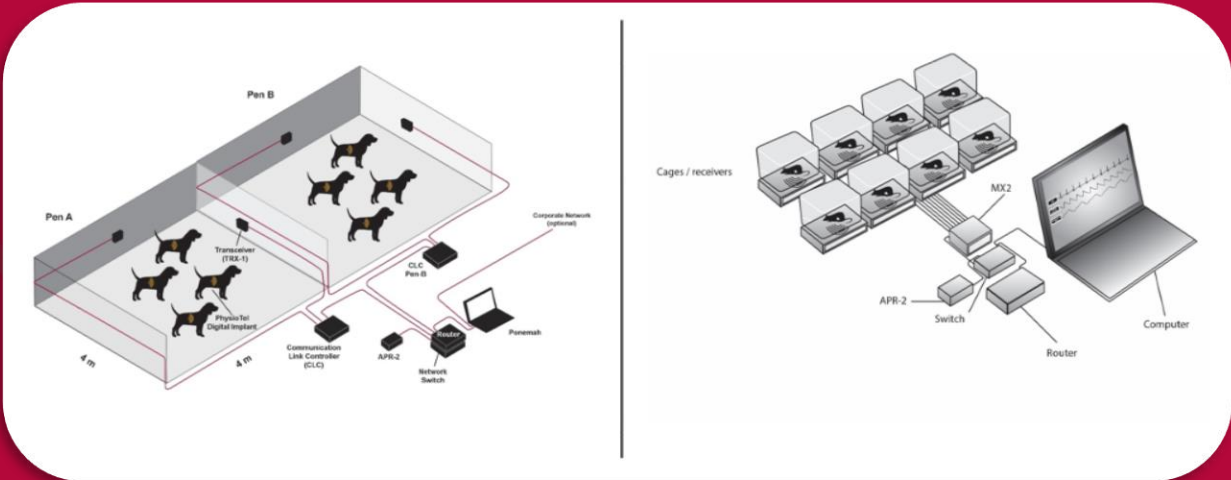


DSI Ponemah™

Implantable Telemetry System Manual



OVERVIEW

This manual highlights how DSI's Implantable Telemetry, Telemetry hardware, and Ponemah software interact as a system. This document will provide an overview of the PhysioTel, PhysioTel HD, and PhysioTel Digital implants and provide detailed instructions on how to set-up their associated hardware. It also includes detailed procedures of how to use the Ponemah software to acquire, analyze, and manage the physiologic data to get more from the data obtained using your DSI implants.

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Table of Contents

Welcome	7
PhysioTel HD and PhysioTel Legacy Telemetry Platform Manual	8
System Overview	8
About the Implants.....	10
PhysioTel Hybrid Digital (HD)	10
PhysioTel Legacy	12
PhysioTel 4ET Device.....	13
Implant Components.....	18
Understanding Activity Measurements	21
Understanding Specifications.....	23
Animal Implantation Recommendations	23
Device Warranty.....	23
Pressure Specifications.....	23
Battery Life	24
Instructions for Implant Operation	24
PhysioTel Digital Telemetry Platform Manual	26
System Overview	26
About the Implants.....	27
PhysioTel Digital Features	27
Nomenclature	27
Implant Components.....	28
Understanding Activity Measurements	34
Broadcasting Frequencies	34
Instructions for Implant Operation	36
Implant Operation Modes.....	36
Implant Activation	36
Implant Deactivation	37
Implantable Telemetry Hardware Manual	41
Telemetry Hardware Connections.....	41
PhysioTel and PhysioTel HD Platform Hardware.....	42
Receiver Overview	42

RPC-1	42
RPC-2	43
RPC-3	44
RSC-1	45
RMC-1.....	46
DRA Functionality	48
Matrix 2.0 (MX2)	48
Signal Interface.....	50
PhysioTel Digital Platform Hardware	52
Transceiver (TRX).....	52
Communication Link Controller (CLC)	53
Universal System Hardware	55
Ambient Pressure Reference (APR-2)	55
Networking Hardware	55
Ponemah Software Manual	56
Software Overview	56
Understanding Experiments.....	56
Creating a New Experiment	57
Acquisition Interface Configuration	61
Edit APR Configuration	62
Edit PhysioTel /HD (MX2) Configuration	62
Edit PhysioTel Digital (CLC) Configuration.....	77
Subject Setup.....	92
Edit Subject Setup	92
Subject Details.....	94
Channel Details	97
Graph Setup.....	99
Graph Setup Dialog	99
Autoconfigure Graphs	100
Manual Configuration	101
Graph Types	101
Graph Concepts.....	103
Graph Menus and Toolbar	104
Data Acquisition	107
Sampling Control — Starting Data Acquisition.....	107
Data Acquisition Dialog	115

Logging Rate	117
Marking Events.....	118
Review During Acquisition	119
Remote Notification – Email Alerts	120
Parameter Viewer	123
Opening Parameter Viewer.....	123
Loading Data	123
Parameter Viewer Dialog Overview	125
Using Generated Graphs	135
Data Export.....	135
Data Review.....	137
Loading Data into Review.....	137
Using Review	139
Data Parser.....	149
Data Reduction.....	153
Variability Analysis	157
Data Insights.....	167
Saving Analysis Sessions.....	186
Data Export.....	188
Subject Sheets	189
Pivot Compatible Sheets	190
Analysis Modules.....	191
Analysis Attribute Dialogs	191
RAW, BARO, TEMP, and ACT	194
Blood Pressure (BP).....	200
Blood Pressure Respiration (BPR)	212
Left Ventricular Pressure (LVP)	218
Electrocardiogram (ECG).....	228
ECG Pattern Recognition Option (ECG PRO)	245
Electromyogram (EMG).....	255
Electroencephalogram (EEG)	260
Glucose (GLU).....	265
Pulmonary Air Flow (PAF).....	282
Pulmonary Volume (PVO)	291
Add-on Modules.....	304
Video	304
Remote Connection	319

EDF Export.....	324
Appendices.....	326
Implant Appendix.....	326
Exchange Program.....	326
Implant Zero Pressure Offset	327
Implant Maintenance After First Implantation	333
PhysioTel Digital Hexadecimal Conversion	335
Hardware Appendix.....	336
PhysioTel and PhysioTel HD Caging and Shielding Recommendations.....	336
Transceiver Placement Recommendations	339
Ambient Pressure Reference (APR-2)	342
Ethernet to Serial Converter (E2S-1)	344
Nova Statstrip® Xpress™ Glucometer	346
Software Appendix.....	347
Installation and Maintenance	347
Ponemah Menus	350
Experiment Settings Dialog Description	357
Remote Notification – Email Alerts	358
Data Insights.....	361
PhysioTel Digital Diagnostics.....	370
MX2 Diagnostics.....	389
APR Diagnostics.....	395
Network Time Protocol (NTP) & Process Utilities Application	396
Files Types	398
Printing.....	400
ASCII Output.....	402
Application Configuration	403
Tutorials	406
Glucose Calibration Process	406
Overview	406
Graph Setup	406
Performing a Multi-point Glucose Calibration	409
Performing a Single-point Glucose Calibration	413
Data Insights.....	415
Finding Second Degree AV Block.....	415

Finding Unique Cyle Morphologies using Template Tags	417
Returning Products to DSI.....	423
Contacting Technical Support.....	424
DSI Support Center.....	424
Contact Details	424
DSI Technical Support—North America	424
DSI Technical Support—Europe	424
DSI Technical Support—All Other Countries	424

WELCOME

Congratulations on joining the community of users worldwide who rely on DSI's products to perform preclinical physiologic research. Thank you for your interest in DSI products. We are committed to providing you with quality products and services.

This manual will help you get to know your telemetry system, as well as your Ponemah acquisition and analysis software platform. The structure of the manual was designed to sequentially guide you through using your DSI system from signal to summary.

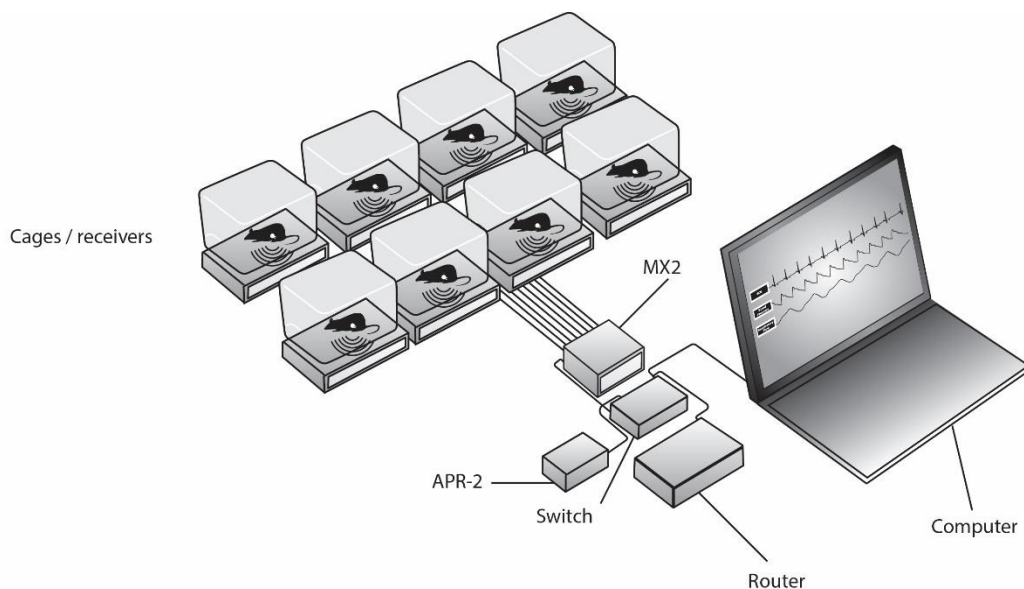
WHAT YOU WILL BE LEARNING

1. Understand your telemetry platform.
 - a. PhysioTel and PhysioTel HD
or
 - b. PhysioTel Digital
2. How to setup your telemetry system hardware.
3. How to use the Ponemah software to:
 - a. Create an Experiment.
 - b. Acquire data.
 - c. Visualize, Review and Analyze data.
 - d. Export your Results.

SYSTEM OVERVIEW

DSI’s PhysioTel™ implants are designed for monitoring and collecting data from conscious, freely moving laboratory animals—providing stress-free data collection while eliminating percutaneous infections.

PhysioTel implants are offered in different sizes to support a variety of research models ranging from mice and rats to dogs and non-human primates. The shape of DSI implants are also designed to accommodate various surgical placements, including subcutaneous and intraperitoneal placement. A small animal system diagram is shown below to help illustrate this (See the Transceiver Placement Recommendations for large animal system diagrams).



PhysioTel implants come in three different sizes:

- **Extra-small:** extra-small implants are designed for use in cages that measure 33 x 33 x 14 cm. Species commonly monitored with extra-small implants include mice, hamsters, gerbils, and juvenile rats.
- **Small:** small implants are designed for use in cages that measure 42 x 42 x 18 cm. Species commonly monitored with small implants include rats, guinea pigs, rabbits, ferrets, and marmosets.
- **Large:** PhysioTel D70 implants are designed for use in cages that measure 1 m3, however, multiple RMC-1 receivers can be used to ensure signal detection in a larger cage. Species commonly monitored with large implants include, but are not limited to, non-human primates, dogs, rabbits, and swine.

Note: See the PhysioTel and PhysioTel HD Caging and Shielding Recommendations section or contact Technical Support for more system setup options

Specialized surgical expertise is required as these devices are implanted much like a pacemaker is for clinical applications. The implant body is placed subcutaneously or intra-peritoneal (IP) and the biopotential leads and catheters are then routed to the source of the physiologic signal. Although surgery, once mastered, can be simple and quick, many surgeons have found that survival surgery requires strict attention to detail as infection or animal discomfort can impact study results. DSI provides various surgical manuals with recommended methods (proven over 30+ years of experience) on how to implant the device depending on the physiologic parameters of interest. Further hands-on training by DSI's trained surgical staff is also recommended as it has been found to be the most helpful for DSI customers.

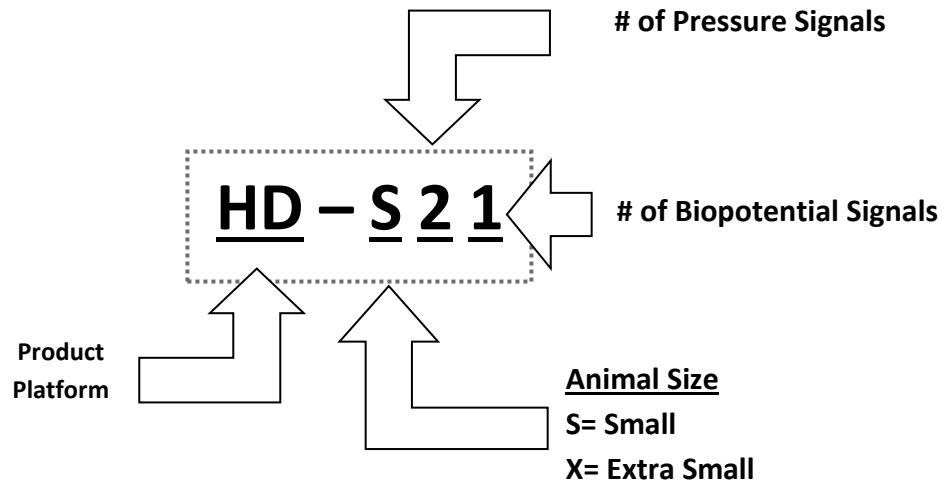
DSI's experienced surgical services team is available to answer any questions by phone or email. In person, hands-on surgical training is available onsite or at DSI headquarters with group rates available. Training at headquarters often includes a tour of manufacturing, as well as some time with DSI's technical support for specialized hands on software training and the opportunity to meet with other DSI employees. DSI also offers high quality pre-implanted animals for any surgical technique we recommend and can accommodate small quantities or recommend a larger pre-implanted animal vendor.

ABOUT THE IMPLANTS

PHYSIOTEL HYBRID DIGITAL (HD)

NOMENCLATURE

HD stands for “Hybrid Digital” and is used to distinguish the platform from other DSI products. See the diagram below for instructions on how to de-code a model name for this platform of devices.



Model	Animal Model	Dual Frequency*	Glucose	Pressure Signals	Biopotential Signals	Temperature	Activity
HD-S21	Rat or similar	-	-	● 2x	●	●	●
HD-S11	Rat or similar	●	-	●	●	●	●
HD-S20	Rat or similar	-	-	● 2x	-	●	●
HD-S10	Rat of similar	-	-	●	-	●	●
HD-S1	Rat or similar	●	-	●	-	●	●
HD-S02	Rat of similar	-	-	-	● 2x	●	●
HD-X11	Mouse	-	-	●	●	●	●
HD-X10	Mouse	-	-	●	-	●	●
HD-XG	Rat or similar, Mouse	-	●	-	-	●	●
HD-X02	Mouse	-	-	-	● 2x	●	●

***DUAL FREQUENCY**

Some PhysioTel HD models are available in multiple frequencies. These models will have an additional indication associated with their model name; e.g. HD-S11-F0 or HD-S11-F2

- **F0:** Frequency indicator for standard 455 kHz implants.
- **F2:** Frequency indicator for 18 MHz implants.

Note: To use these implants to social house animals, the RPC-3 will be needed. **F0** implants can also be used on RPC-1 and RSC-1 receiver models. Please see the **Receiver Overview** section of this manual for more information.

PHYSIOTEL HD FEATURES

The HD platform digitally transmits the Animal ID, implant ON time and battery voltage with the physiologic signals. During system setup, the HD implant will also transmit the stored factory calibration data to remove human error from manual entry of these values.

ANIMAL ID

The digital Animal ID (or serial number) feature enables an implant to be specifically linked to the receiver when it is configured in the software. This feature removes human error of placing the wrong animal in the wrong cage after dosing or behavioral testing, as the software will expect to see data from a specific animal be collected from a specific receiver. The software will notify you that an incorrect implant is detected, and data will not be collected, as it is from the incorrect animal.

Ambient electromagnetic interference (EMI) generated by large power sources and other equipment (even other telemetry equipment) can impact signal quality. With this feature, the impact is minimized because the hardware is intelligent enough to know from where the implant signal is coming. If noise is detected, the signal will not be collected, this ensures clean data is collected and data corrupt with noise has less impact on data reporting. Shielding from potential noise sources is important to understand for telemetry studies. See the PhysioTel and PhysioTel HD Caging and Shielding Recommendations section to learn more.

FACTORY CALIBRATIONS

When setting up the software, the factory calibrations will auto populate when the device is turned on (using magnet). The implant sends out these calibration values every time it is turned on. This may mean there is a slight delay in obtaining physiologic data when the device is initially turned on, as the system is verifying the device's identity. This means that the calibration values on the label do not need to be tracked as closely, as they are stored digitally in the device itself. However, researchers should keep the sterile tray the device comes in if they wish to participate in the DSI Exchange Program as it is used to return product back to DSI. See the DSI Exchange Program or www.datasci.com to learn more.

BATTERY ON TIME

At any point in time, researchers can now see how much battery life has been used throughout the duration of the study. Battery ON time is separate from the battery voltage as the ON time is a digital feature calculated from an internal clock which is temperature dependent and only records ON time correctly at body temperature. The ON time usage is updated every 16 hours of continuous use. The software will display ON time in increments of 0.7 Days ON. Battery life specifications are stated as warranted battery life which means duration of continuous ON time. When the implant is turned OFF, it is not using battery life and therefore the implant ON time will not be tracking battery life either.

Note: the accuracy of the ON Time counter at body temperature (37°C) is within 1.5 days.

BATTERY VOLTAGE

When an HD implant reaches 1.5 V, the battery voltage feature will alarm in the software, meaning the implant has reached its end of life. Once this limit is achieved, the implant should be returned to DSI for exchange. It is not recommended to re-implant the device in subsequent subjects or reuse in additional studies once this limit has been reached.

DUAL FREQUENCY

Specific HD implant models are available in two frequencies: **F0** and **F2**. This permits researchers to simultaneously collect data from pair-housed animals as the data from each animal is transmitted using unique frequencies. Dual frequencies also permit the collection of data from subjects whose home cages are spaced more closely together, reducing the chance for crosstalk when using a higher density cage rack setup.

PHYSIOTEL LEGACY

NOMENCLATURE

An implant model number, for example TA11ETA-F40 and TL11M2-C50-PXT, means the following:

- First character indicates device type: TA11ETA-F40 and TL11M2-C50-PXT.
 - **T** = Transmitter
- Second character indicates device series: TA11ETA-F40 and TL11M2-C50-PXT.
 - **A** = Single Channel
 - **L** = Multi Channel
- Third and fourth characters indicate **Design** type: TA**11**ETA-F40 and TL**11**M2-C50-PXT.
- For Multi-Channel Transmitters, the next two characters indicate how many channels are available: TL11**M2**-C50-PXT.
 - **M2** = 2 channels
 - **M3** = 3 channels
 - **M4** = 4 channels
- Data types monitored by the device are indicated by a block of two to four alphabetic characters. This is the most important information required for configuration: TA11**ETA**-F40 and TL11M2-C50-**PXT**.
 - **E** = +/- 2.5mV biopotential input
Note: The biopotential channels in the F20-EET, F40-EET, TM-S1 and TM-S2 transmitters have +/- 1.25mV biopotential inputs.
 - **X** = +/- 5mV biopotential input
 - **C** = +/- 10mV biopotential input
 - **P** = Pressure
 - **T** = Temperature
 - **A** = Physical activity
- The remaining block of alpha numeric characters indicate the transmitter's package type/shape and relative transmitting distance. This information is important for ordering the correct transmitter for each species. TA11ETA-**F40** and TL11M2-**C50**-PXT.
 - **F** = Flat
 - **C** = Cylinder

- **D** = Disk
- **10** = Small
- **20** = Small
- **40** = Medium length
- **50** = Long length
- **70** = Large

PHYSIOTEL LEGACY FEATURES

- PhysioTel PA series implants measure pressure (P) and activity (A) in mice, small animals and large animals.
- PhysioTel TA series implants measure temperature (T) and activity (A) in mice, small animals and large animals.
- PhysioTel EA, CA, ETA and CTA series implants measure biopotentials (E, C) such as ECG, EEG and EMG as well as temperature (T) and activity (A) in mice, small animals and large animals.
- PhysioTel Multiplus series transmitters measure combinations of pressure (P), biopotentials (E, X, C), respiratory impedance (R), temperature (T) and activity (A) in large animals.

PHYSIOTEL 4ET DEVICE

The 4ET is a PhysioTel device primarily designed to enhance studies of the Central Nervous System (CNS). The 4ET device allows the measurement of four biopotential channels, temperature, and general locomotor activity in rats and other similarly sized animals. Each biopotential channel is a differential channel that can be used to record signals such as electroencephalogram (EEG), electromyogram (EMG), electrocardiogram (ECG), and electrooculogram (EOG). This device can also monitor two animals that are housed together (pair-housed) through the use of two independent transmission frequencies. Additionally, the two frequencies may allow single-housed animals to be placed closer together without the concern of cross-talk. These features should bring more data and increased flexibility for study design than the standard DSI devices.

The 4ET device is a dual-module device. The complete device consists of two modules that are electrically and physically connected with an IS-1 lead. The biopotential leads and temperature sensor are included in the component that is termed the sensing module. The battery and data transmission circuitry are housed in the telemetry module. The device is designed to allow the option of replacing the telemetry module in-vivo to extend the battery life without interfering with the sensing module and lead placement. This in turn also extends the usable life of the animal model. The receiver that is compatible with this device is the RPC-2.

Unlike other DSI devices, neither the sensing module nor telemetry module can be exchanged. However, the sensing module was designed to be resterilized and reused in multiple animals with a new telemetry module replacement. A lead coupler kit for repairing or extending the biopotential leads is also available to facilitate sensing module reuse.

NOMENCLATURE

The complete 4ET device (sensing module + telemetry module) is available in two models depending on the transmission frequency: 4ET-S1 and 4ET-S2. The model name is defined by the following:

- The first alpha-numeric value is indicative of the device type: 4ET-S1
4E = Four biopotential channels
T = Temperature channel
- The next alpha-numeric value represents size and frequency of device as determined by the telemetry module: 4ET-S1:
S1 = Small animal, frequency 1
S2 = Small animal, frequency 2

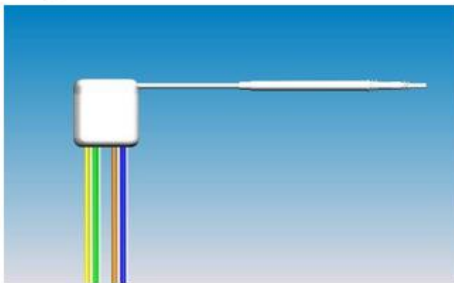
Telemetry module replacements can be purchased individually. There are two model names: TM-S1 and TM-S2. These model names are defined by the following:

- TM = Telemetry module (without sensing module)
S1 = Small animal, frequency 1
S2 = Small animal, frequency 2

4ET DEVICE

The 4ET device is a dual module device consisting of a sensing module and telemetry module. The sensing module and telemetry modules are shipped disconnected in individual pouches to guarantee complete sterility.

Sensing Module



Sensing module (SM)

- Senses biopotential channels and temperature
- Color-coded biopotential leads to indicate channel number and polarity
- IS-1 lead permanently attached for connection to telemetry module
- Designed to be implanted intraperitoneally or subcutaneously
- Universal to either telemetry module frequency

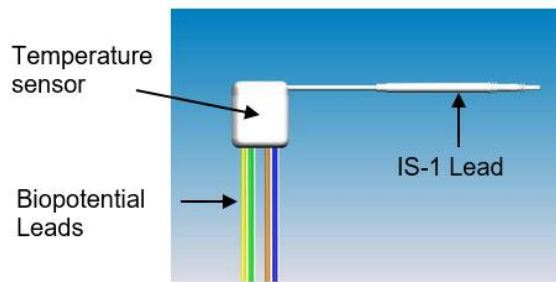
Telemetry Module



Telemetry module (TM)

- Contains battery and transmission electronics
- Frequency designation (2 models)
- Magnetic on/off switch
- One set screw for securing IS-1 lead
- Replaceable
- Designed to be implanted subcutaneously for minimally invasive replacement

SENSING MODULE



The sensing module is universal and can be used with either telemetry module frequency. It does not function without a telemetry module connected. The sensing module receives power from the telemetry module via the IS-1 lead to sense the biopotential signals and temperature data. The outer pouch of the sensing module package contains a peel-away label with its calibration values. These calibration values are unique to each sensing module and are entered into the software. Please document these values and the serial number.

Each of the four biopotential channels are differential channels and have two leads, a positive and a negative lead. These biopotential leads can be used to monitor any combination of EEG, EMG, ECG, or EOG signals. A channel indicator card will be provided sterile with each sensing module as a guide during surgery.

CH1 Blue	CH2 Orange	CH3 Green	CH4 Yellow
-------------	---------------	--------------	---------------

Positive Lead: Solid color

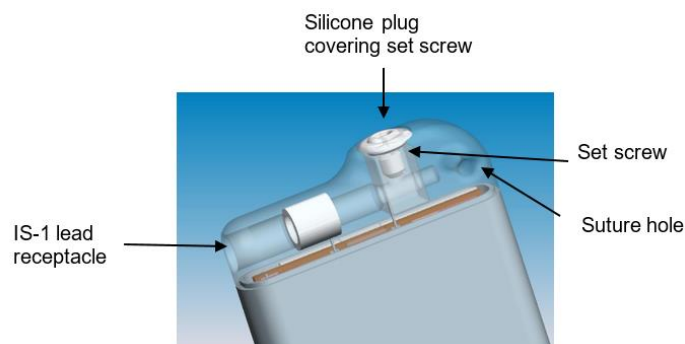
Negative Lead: Solid color with white stripe

To ensure the most reliable and highest quality data, consider the following when selecting which channel number to use to monitor the various types of biopotential signals.

- Channels 1 and 3 are shared channels, meaning that another parameter is transmitted along with the biopotential data on the same channel. Try to use these channels to monitor biopotential signals unlikely to have baseline wander, such as EEG or EMG.
- Channel 1 is also internally tied to the common reference. For optimal performance, Channel 1 should be used to monitor the signal expected to have the lowest amplitude.

The sensing module can be resterilized and reused until an implant duration of one year is reached.

TELEMETRY MODULE



The telemetry module receives the physiologic data from the sensing module via the IS-1 lead and transmits them telemetrically to the RPC-2 receiver. This transmission occurs using one of two independent frequencies to allow

two devices to simultaneously send data to the same RPC-2 receiver. These transmission frequencies are designated by the model name as described in the previous section. The model name appears on the peel-away label located on the outer pouch. It is important to document this information in addition to the serial number. The telemetry module does not require any calibration data.

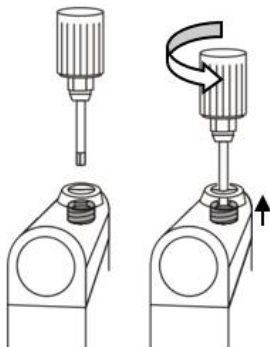
The telemetry module contains a magnetic switch to turn it on and off. When the device is ON, an audible tone can be heard with the 4ET radio. The telemetry module can be turned ON without being attached to a sensing module. This is called 'free-run' mode. The tone heard in free-run mode is slightly higher than the tone in normal mode. Free-run mode is used to ensure the telemetry module is OFF prior to storage so the battery is not unknowingly depleted. When the telemetry module is connected to the sensing module and the set screw is tightened, it transmits in 'normal' mode and the RPC-2 receiver can detect the signal.

The telemetry module was designed to be replaced after battery depletion using an existing sensing module. This can be accomplished in-vivo through a minor surgical procedure to extend the useful life of the sensing module and prolong the use of the animal. Telemetry module replacement can also help promote the reuse of the sensing module in multiple animals. Although the sensing module may be resterilized and reused, it is not recommended that the telemetry module be resterilized and reused.

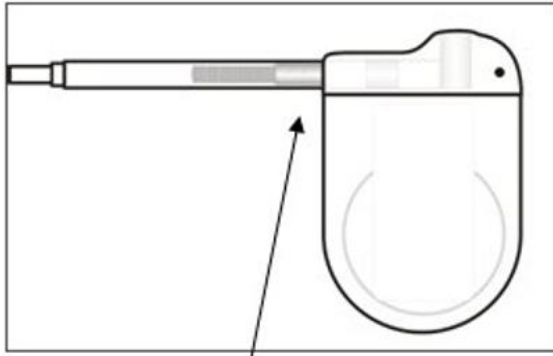
CONNECTING THE SENSING AND TELEMETRY MODULES

Connecting the sensing module to the telemetry module is a critical step to ensure proper functionality and long-term performance. Please follow these steps closely to correctly connect the modules at the appropriate time during the surgical procedure. Do not grasp the IS-1 lead with any sharp instruments.

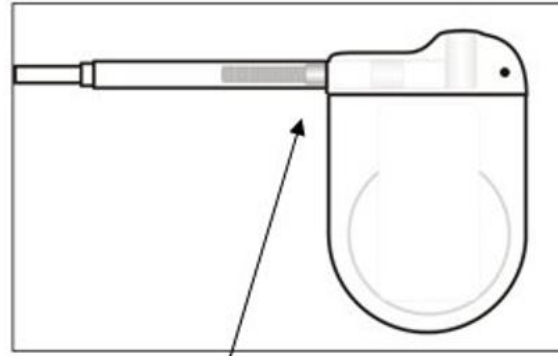
1. **The set screw in the telemetry module will be engaged upon receipt which will prevent the IS-1 lead from being fully inserted.** Before connecting the two modules, carefully insert the torque wrench through the slit in the silicone plug covering the set screw. Rotate the torque wrench counter-clockwise 1 full rotation and leave the torque wrench in the set screw until after the lead is inserted.



2. Insert the IS-1 lead into the telemetry module. Verify that the lead is fully inserted by observing that approximately 1.5 mm of solid metal on the IS-1 lead is extending out of the telemetry module. There should be no more than 2 mm of solid metal on the IS-1 lead extending out of the telemetry module.

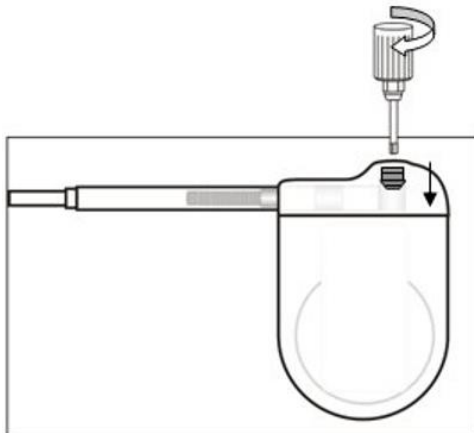


Lead **not** inserted far enough. Excess solid metal is visible.



Proper insertion.
Only 1.5 mm of solid metal is visible.

3. Rotate the torque wrench clock-wise to tighten the set screw until three clicks are heard. This secures the set screw to the IS-1 lead and completes the electrical connection. Remove the torque wrench from the set screw. Gently pull on the IS-1 lead to verify it is secure.



4. Use a 4ET radio and magnet to turn the device ON. Swipe the magnet over the telemetry module and confirm functionality by hearing a tone. If the biopotential leads are not implanted, it is likely this tone will significantly vary in pitch and sound “noisy”. Once the leads are implanted, it will be a solid tone.
Note: Connecting the modules can cause the telemetry module to turn on without using the magnet. Use the 4ET radio to verify the device is in the desired on or off mode.
5. If possible, use Ponemah with an RPC-2 receiver to view the signals.
6. After confirming functionality, place a small amount of silicone adhesive (Nusil Med1511) over the existing silicone plug covering the set screw. Visually inspect that any holes in the existing plug are filled with the adhesive. **Failure to complete this step may cause the device to stop working while implanted and will void the device warranty!**
7. Allow the silicone adhesive to set for a few minutes and become tack-free before placing the device in the animal.

FREQUENCY DESIGNATION

The frequency of the 4ET device is designated in the telemetry module. The device model name and telemetry module model name include the frequency designation with the actual frequency values shown in the following table:

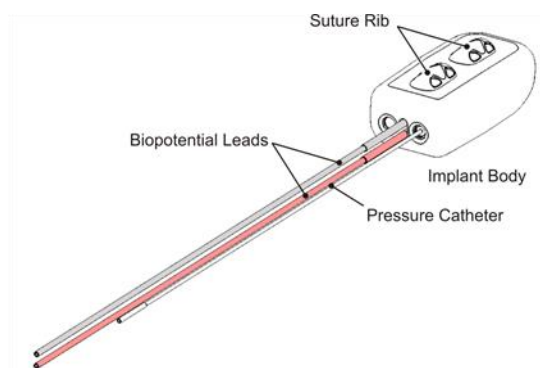
Device model name	Telemetry module model name	Frequency
4ET-S1	TM-S1	8MHz
4ET-S2	TM-S2	18MHz

The 4ET Radio provided in the starter kit can be used to hear an audible tone from the device at the corresponding frequency value.

PAIR-HOUSING CONSIDERATIONS

If 4ET animals will be pair-housed, they must be implanted with devices of two separate frequencies. This is accomplished by implanting one animal with a 4ET-S1 device and implanting the other animal with a 4ET-S2 device. The transmission frequency is designated in the telemetry module. It is not possible to monitor two animals implanted with the same 4ET model in the same cage. DSI recommends waiting approximately 2 weeks after surgery or when the animals are fully recovered before pairing them. Consult with your internal animal care and use committee for additional recommendations for pairing animals.

IMPLANT COMPONENTS



Drawing of HD-S11 small animal implant

IMPLANT BODY

The biocompatible housing consists of the following major components:

- **Pressure sensor** (Pressure implants models only): solid-state pressure sensor which receives pressure fluctuations from the fluid-filled catheter and sends the signals to the electronics module.
- **Electronics module**: translates the pressure fluctuations, glucose fluctuations, and biopotential signal into digitized signals and transmits them to a receiver. Temperature data is sent digitally. The reusable electronics module also contains a magnetically activated switch that allows the device to be switched on or off.
- **Battery**: provides power to the electronics module. Battery ON time and voltage parameters are sent digitally during sampling.
- **Suture rib** (*optional*): allows the surgeon to suture the device securely in place at the implant site.
- **Temperature sensor**.

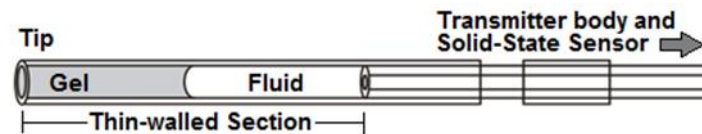
SUTURE RIB

On most implants the suture rib is optional and therefore it is important to understand when it is necessary. The suture rib is recommended for IP placement of the device and should be secured to the abdominal wall to restrict movement. Subcutaneous placement of the device does not require a suture rib, as the connective tissue will hold the implant in position. Please see the specific surgical manual for the model implant being used for additional information.

PRESSURE CATHETER

The pressure catheter is made of high-performance polyurethane tubing that extends out of the device body and contains:

- **Non-compressible fluid:** relays pressure fluctuations to the sensor in the device body.
- **Thin-walled section:** tip of the catheter farthest from the device body that senses the dynamic portion of the pressure wave. It is designed to be completely inserted into the vessel or space where the desired pressure can be sensed. It contains biocompatible gel at the very tip, which prevents the non-compressible fluid from leaving the catheter and blood from clotting in the catheter tip.
- **Tip cover:** removable section of silicone tubing that protects the catheter tip until it is inserted into the desired vessel.



Detailed diagram of catheter components with the tip cover removed

Some catheter components are optional. For example, the ligation aid is offered for catheter placement in the left ventricle, right ventricle, or bladder. It has a groove between the end of the thin-walled section and an additional thin band of tubing. This feature can be best described with the image below. It is intended to provide a secure location to suture which aides in the anchoring of the catheter to the surrounding tissue. This feature is only available on the HD and PhysioTel Digital platforms.

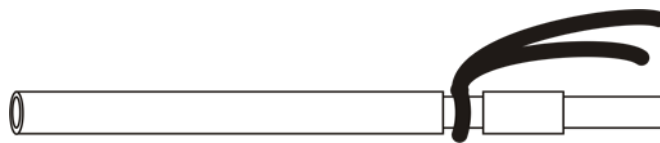


Diagram highlighting the ligation aid option

Many catheter lengths are available. Please contact your DSI Account Manager to learn which catheter length best suits your application.

BIOPOTENTIAL LEADS

Two leads (clear and pink) extend out of the device body and are made of:

- Silicone tubing which provides insulation from external electrical activity
- Helix of medical grade stainless steel wire which senses the desired biopotential voltage changes

The leads are designed to be cut to a length suitable for the biopotential signal to be monitored. The clear lead is used to collect the negative signal of the biopotential and the red lead is used to collect the positive signal. The biopotential signal monitored could be an ECG, EEG, EOG, EMG, etc. Examine the biopotential specifications listed in Appendix B to learn more about the product specifications including measurement sensitivity and range. This is especially important for special applications.

The small animal sized implants come with tip covers (as shown below) to prevent the end of the steel helix from irritating the surrounding tissue. Mouse sized implants do not come with these, as the leads are too small. See the surgical guide to learn more about how to make tip covers from the existing lead material, for lead placement guidance and other recommendations when using biopotential leads.



Photo of leads with tip covers placed appropriately

GLUCOSE SENSOR AND REFERENCE

The HD-XG continuous glucose telemetry implant is intended for use in rodents in a broad array of research applications. The device provides continuous measurements of glucose, temperature and activity as frequently as every second for 28 days or longer.

The HD-XG has silicone tubing that extends out of the device body and contains:

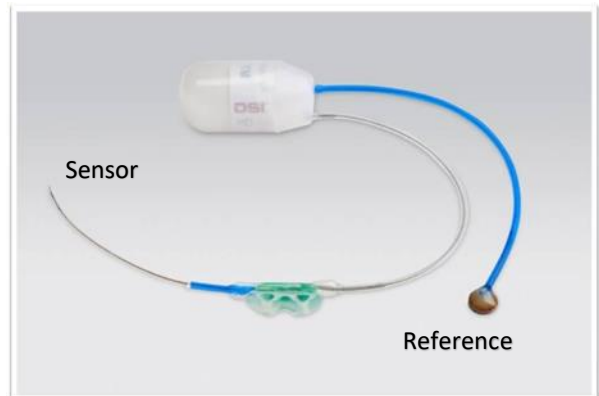
- **Blood glucose sensor:** relays blood glucose fluctuations to the sensor in the device body. The actual glucose sensing portion of the sensor is located at the distal 1 mm of the sensor.
- **Reference electrode:** acts as an electrical reference for the current being measured by the glucose sensor.

Mouse



Reference is not visible, as it is built into the implant body.

Rat



There are several known limitations relating to use of the device. The base of knowledge will continue to grow as researchers use the HD-XG in new and novel applications. The following are a few of the known limitations at the time of release in spring 2014:

- The HD-XG device incorporates an electrochemical sensor. The enzyme on the sensor has a finite stability. The sensor reaction and interaction with surrounding cells and tissue will occur whether the device is turned on or off. Turning the device off will not prolong the effective monitoring life of the sensor and may necessitate recalibration after turning the device back on. We therefore strongly recommend turning the device on at the time of surgery and leaving it on for the duration of the study. We additionally recommend recording the data from the time of surgery to observe the animal recovery and sensor stabilization over several days of recovery.
- Turning the device on immediately after implantation and leaving it on is recommended. Turning the device off for any significant duration can damage the sensor resulting in decreased sensor life and/or require recalibration.
- Sensor longevity is dependent on the level of hyperglycemia. For animals that have sustained glucose levels lower than 750 mg/dL one should expect consistent performance out to 28 days. For animals that approach and exceed sustained levels of 750 mg/dL or higher, the sensors may drift notably prior to 28 days sufficient to result in unusable signals. For normal, healthy animals with glucose levels consistently below 200 mg/dL, the glucose sensors may last 6-8 weeks or longer.
- Significant tissue and fibrin growth over the sensor may impact the dynamic response of the sensor and the sensor readout. In most cases this can be corrected by collecting periodic reference values twice per week for calibration throughout the 28 days following surgery. In severe cases an additional 2-point calibration may be warranted.
- Typical recovery time following surgery is 7 days. The rats should not be used for official study purposes within the first 7 days following surgery. However, an initial 2-point calibration may be performed (and is recommended) 4-7 days following surgery.

UNDERSTANDING ACTIVITY MEASUREMENTS

When using PhysioTel Legacy and PhysioTel HD implants, activity counts are not directly generated by the implant, but instead are generated by the Matrix 2.0 (MX2). As the Subject moves about in its cage, the telemetry signal transmitted to the receiver antennas varies in strength. The signal strength may vary due to orientation of the animal relative to the receiver, or due to the distance of the animal from the receiver antennas. When the signal strength changes by a certain amount, the MX2 generates an activity count. The number of counts generated is dependent on both distance and speed of movement.

EXAMPLE OF HOW ACTIVITY IS DERIVED

The following example illustrates how the MX2 generates activity counts. Using the Ponemah software, configure a transmitter and enable the A_TA2 Activity parameter. Start continuous sampling. Set the y-axis of the Primary Graph pane associated with Signal Strength to 0-60. The limits to the range of Signal Strength is approximately 17-51. There are no units associated with Signal Strength.

Turn on a transmitter with a magnet and place the transmitter directly on a receiver. Now slowly pull the transmitter from the receiver until the transmitter goes out of range. An updated activity count will appear every 60 seconds, or the duration to which the Logging Rate is defined. Ponemah will report a value of 6 counts/min for a single activity count within the Logging Period. If the transmitter is moved slowly from directly on the receiver until it goes out of range during the Logging Period, the MX2 will record 8-10 activity counts and Ponemah will report 48-60 counts/min.

It may be prudent to experiment with movement of the transmitter to get a general idea of how many activity counts to expect under various conditions.

The actual number generated depends on the following factors:

- Transmitter model.
- Speed with which the transmitter moves.
- Any outside interference such as a nearby transmitter or power source.
- Slight variation from receiver to receiver.

ACTIVITY AS A PARAMETER

The Ponemah software Activity Analysis module contains two Derived Parameters for Activity.

- Total Activity (A_TA) reports the integral of the Activity signal over a 60 second duration. When sampling the Activity channel using the default sampling rate of 1Hz the A_TA will equal the sum of the Activity values over the 60 seconds. This results in values with units of counts/minute.
- Total Activity 2 (A_TA2) reports the integral of the Activity signal over the defined Logging Rate, normalized to a minute. When sampling the Activity channel using the default sampling rate of 1Hz the A_TA2 will equal the sum of the Activity values over the Logging Rate. This results in values with units of counts/minute.

Since Ponemah reports derived data based on the Logging Rate, Total Activity 2 is the recommended parameter for use with Activity.

MULTIPLE RECEIVERS WITH THE DISTRIBUTED RECEIVER ARRAY (DRA) FUNCTION

The software has the capability of utilizing up to 8 receivers to extend the coverage area of a cage. When using multiple receivers with an individual animal, the MX2 monitors the signal strength from each receiver. It determines which receiver is detecting the strongest telemetry signal and designates it as the active receiver for that sampling period. The active receiver is then the only receiver that reports the telemetry signal during the sampling period. The MX2 will automatically switch between designated active receivers with no loss of data. The DRA function may be enabled within the *Implant Details* of the *Edit MX2 Configuration* dialog by associating multiple receivers with an implant (see the *Edit PhysioTel /HD (MX2) Configuration* for more information).

VARIABILITY BETWEEN RECEIVERS

Many factors can have subtle effects on the activity level of an individual receiver. These include the tuning of the individual receiver, the ambient radio frequency noise level of the environment, and the transmitter model used. It is common to see a difference of 10-20% in the activity counts generated by two receivers under similar conditions. Therefore, DSI recommends viewing activity as a qualitative measure.

UNDERSTANDING SPECIFICATIONS

Please see the DSI website (www.datasci.com) for implant specification values for the implant of interest. Listed below is additional information regarding certain implant specifications that DSI sees as being the most valuable for researchers to understand. Please contact Technical Support (Support@datasci.com) with any questions.

ANIMAL IMPLANTATION RECOMMENDATIONS

The **minimum animal size** is listed because it is the smallest animal DSI's surgical team feels this product can be implanted in without complications. Smaller animals can be used, but concerns about growth of the animal and surgical complications increase as smaller animals are used. Please contact DSI's surgical service team if the study requires implantation in smaller animals than DSI recommends, as there may be some things we can suggest to ensure success.

The **maximum cage size** is listed due to the standard recommended DSI configuration setup for the intended animal model. If a different animal model and/or caging configuration is required, DSI offers some additional hardware options to make the system more flexible. View the receiver portion of this user manual and the shielding requirements section to better understand caging restrictions before contacting Technical Support.

DEVICE WARRANTY

DSI's goal is to achieve high standards of product reliability and performance and our Limited Warranty Policy is unparalleled in the wireless monitoring industry – this reflects DSI's confidence and over 30 years of experience as well as our increasing investments in product design and testing.

The *in vivo* environment presents significant product reliability challenges, especially for electronic devices used for chronic applications. Included in our warranty policy is a three-part program covering our implanted devices with separate warranty durations for (i) battery life, (ii) implant life, and (iii) maximum warranty period. For complete details on device warranty information and description please see the DSI website Warranty page (<http://datasci.com/policies/product-warranty>).

PRESSURE SPECIFICATIONS

Understanding the pressure specifications is key to understanding the accuracy of the data over a long period of implantation. Please see the DSI website for an overview of each implants pressure specifications:

<https://www.datasci.com/products/implantable-telemetry/specification-overview>

DSI's catheters are filled with a patented non-compressible fluid which is biocompatible and designed for long term chronic use. Any catheter will have issues with **patency** over time, but some handle it better than others. Because of the material selected and after many years of experience, DSI has optimized the technology that ensures the catheter will stay patent over the warranted implantation duration and over the calibrated temperature range.

As a rule of thumb: the shorter the DSI catheter the better the **frequency response**. The required frequency response of the pressure signal depends on the physiologic signal of interest. For most applications, DSI catheters have more than enough frequency response for the basic physiologic signals being measured in the most common animal models.

If more information is required or questions arise about this parameter, please contact technical support for assistance. Please be equipped with what physiologic signal is being monitored, what analysis is required and if possible, the highest frequency component of the signal that is used in this analysis. This only applies if a signal is being analyzed in a new way or if the device is being used in an untested animal model. Again, for basic pressure measurements such as heart rate, blood pressure, and pulse pressure the frequency response will be adequate for the recommended animal models.

The sensor used in this device is a solid-state sensor which is protected within the device housing. This sensor has been characterized for long term use and its **pressure drift** over time is very low. As with any sensor, the calibration can vary depending on temperature, humidity, and voltage and may not be consistent over time. Sensors drift over time due to a variety of factors. DSI's sensors are solid-state and are protected within the device body. Because of this, the HD platform has proven to have the lowest pressure drift specifications of all DSI small animal telemetry devices. This ensures the calibration accuracy of the device is consistent over time and little to no adjustment needs to be made to the data over the duration of implantation.



It is recommended to take a pressure offset prior to implanting the device. Entering this offset in the software will automatically adjust for the initial pressure drift. Please see the Implant Zero Pressure Offset section of this manual for instructions on how to perform this action.

BATTERY LIFE

DSI is known for its technical ability to optimize **battery life** with the smallest devices on the market today. DSI devices have guaranteed battery life specifications which means that if the product fails prematurely DSI will replace the device under full warranty. Because of this, customers can have confidence that DSI treats the listed warranted battery life as the absolute minimum requirement. No maximum battery life is listed so the added battery voltage feature and On Time counter are much more useful for researchers to use to better plan the study protocols.

Calibrations are dependent on battery voltage and therefore the calibration data may be compromised if used past the warranted battery life. Each battery is different which is why the minimum life is all that is specified. Use past warranted life is at the discretion of the researcher as eventually the battery will degrade and the impact to the study calibrations or actual end of life may vary.

Batteries naturally degrade over time, regardless of if they are standard or rechargeable. The batteries in this product will not last forever. Leaving them unused on a shelf is considered in the **shelf life** specification. It is not recommended to use old implants as batteries discharge over time whether they are used or not. The battery life specification will then be invalid. It would be prudent to send them back to DSI if they have gone past the shelf-life as the battery life and product calibrations will be compromised. Because DSI's devices are magnetically activated, be sure to consider keeping the battery far away from any strong magnetic fields during storage. See Implant Maintenance After First Implantation for more storage tips.

INSTRUCTIONS FOR IMPLANT OPERATION

PhysioTel HD implants are activated with a magnet, like other DSI implants. An AM radio tuned to the low end of the AM band may be used for implant activation verification when using implants that transmit at the standard 455 kHz frequency. Alternatively, DSI's Signal Detector may also be used. The Signal Detector allows for activation

verification of implants transmitting at 455 kHz, 8 MHz (e.g. 4ET-S1) and 18 MHz (e.g. 4ET-S2 and HD-S11-F2) frequencies.

HD implants are equipped with two operational modes: ON and OFF. Implants are shipped in the OFF mode. The battery in the implant is not activated. When switched to ON, the implants begin to sense and transmit data. The switch to change between these two modes is in the interior of each device and is therefore not visible. The switch is magnetically activated and will switch between modes when exposed to a strong magnetic field.

To switch operational modes using a radio:

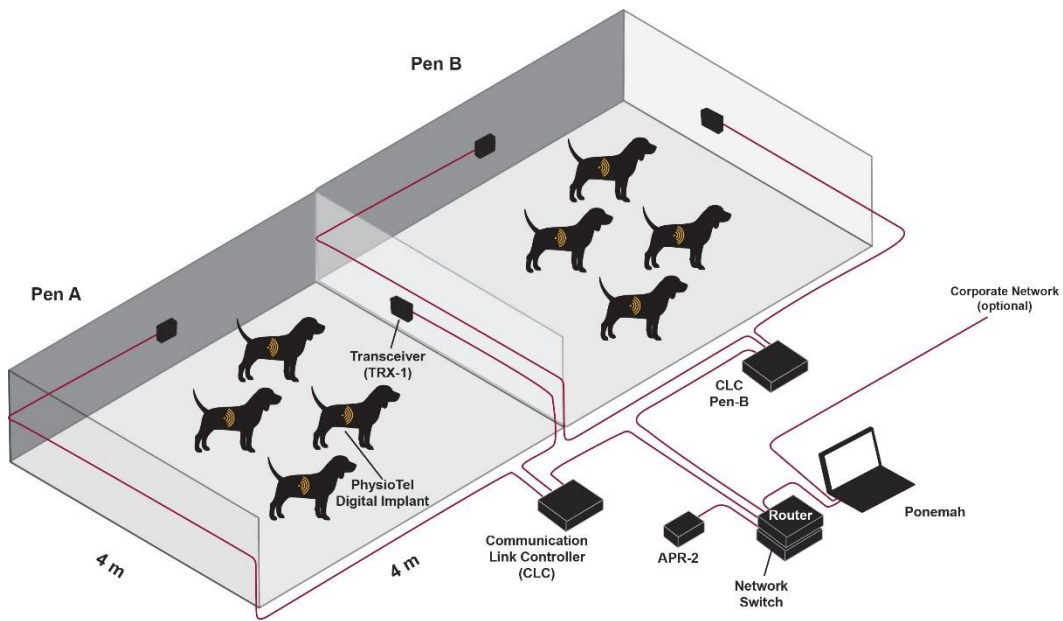
- Power on an AM radio and tune it to 550 kHz (the low end of the AM band).
- Bring the radio close to the device.
- Momentarily bring a strong magnet within approximately one inch of the device implant, holding it near for two to five seconds.
- The order of modes using a radio is:
 - Off (No tone on the radio)
 - On (Tone on the radio)

To switch operational modes using the Signal Detector:

- Turn the Power switch until you feel a click. This indicates it is ON.
- Hold the Signal Detector within 6 inches of the implant.
- Momentarily bring a strong magnet within approximately one inch of the implant, holding it near for two to five seconds.
- The order of modes using a radio is:
 - Off (No tone or lights displayed)
 - On (The corresponding light will illuminate above the frequency it has detected. If the volume is turned high enough, a distinct sound will be heard as well)

SYSTEM OVERVIEW

The PhysioTel™ Digital telemetry platform is comprised of four main components; the data acquisition computer, Communication Link Controllers (CLC), transceivers (TRX), and implants. The CLC and the implants actively communicate with one another, with the TRX being the transmitting and receiving link between them. Using the hardware configuration interface within the data acquisition software, the user assigns a set of implants to a CLC; up to six implants can be assigned to one CLC (five in China), and up to four CLC's per system (three in Europe and China and two in Japan). Each CLC operates on a separate communication frequency. Please see **the Broadcasting Frequencies** section of this manual for further details.



ABOUT THE IMPLANTS

PHYSIOTEL DIGITAL FEATURES

At the heart of the PhysioTel Digital platform is the implant; a digital device that allows for: social housing, improved GLP traceability, real time battery tracking, faster setup time with auto configuration of reliable manufacturing calibrations, and remote power management.

Implants are available in two different series: L series and M series.

- L series– Designed for chronic physiologic monitoring research, the L series is available in two configurations offering various combinations of physiologic parameters available. L series implants are often used in Safety Pharmacology studies to address core battery requirements in cardiovascular (CV) and respiratory applications. Core CV measurements include systemic pressure and ECG and includes LV pressure as a secondary measurement. For respiratory studies the second pressure channel is used to monitor intra-pleural pressure to provide a measure of respiration rate.

There are 4 models available; the L21, L11, L03, and L04. Like other DSI implants the L series devices are part of DSI Exchange.

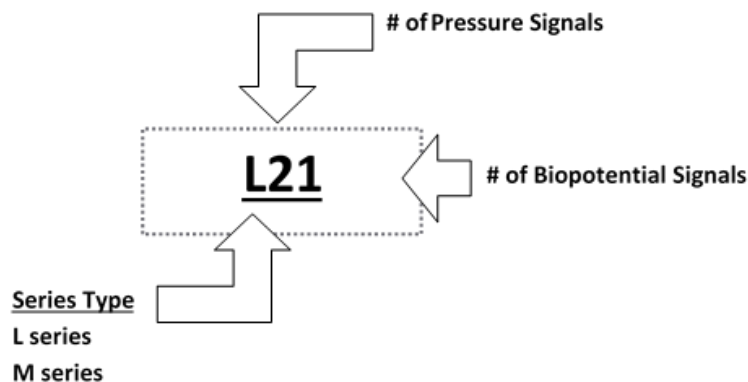
- M series – One-time use implants that are ideal for shorter duration studies. The smaller size of M series allows the PhysioTel Digital technology to be expanded in to a broader range and size of species. Primary applications for M series are toxicology and biological defense studies

There are four models available; the M11, M10, M01, and the M00. M series implants have been designed for one-time use and are not part of DSI Exchange.

It is important to note that all PhysioTel Digital devices also provide Temperature and Activity measurements, via three-axis accelerometer.

NOMENCLATURE

See the diagram below for instructions on how to de-code a model name for this platform of devices.

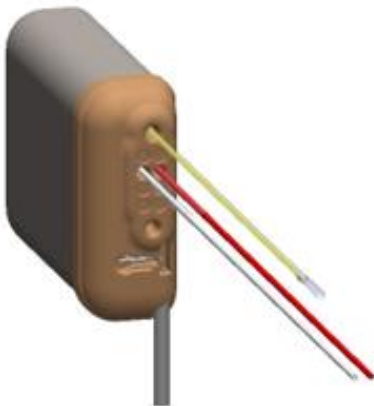


The follow table lists the available PhysioTel Digital implants and the available input channels from each model.

Model	Special	Pressure 1	Pressure 2	Biopotential	Temperature	Activity
L11	-	●	-	●	●	●
L21	-	●	●	●	●	●
L11R	Impedance	●	-	●	●	●
L03	-	-	-	● x3	●	●
L04	-	-	-	● x4	●	●
M00	-	-	-	-	●	●
M01	-	-	-	●	●	●
M10	-	●	-	-	●	●
M11	-	●	-	●	●	●
M0G	Glucose	-	-	-	●	●
M1G	Glucose	●	-	-	●	●

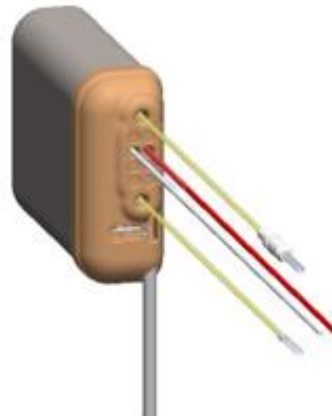
IMPLANT COMPONENTS

The following illustrates the various implant components of the PhysioTel Digital L series implants.



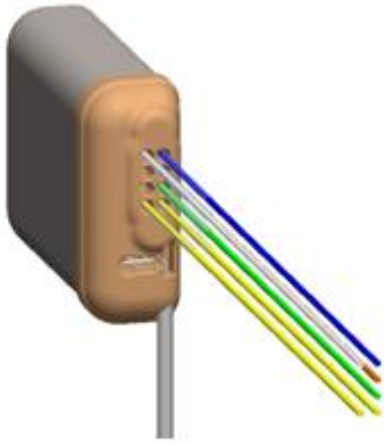
L11

One pressure channel; Biopotential pair (red – positive, clear – negative)



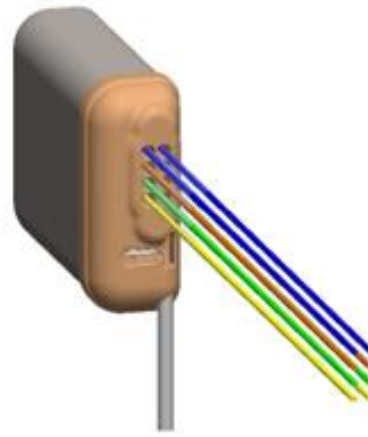
L21

Two pressure channel; Biopotential pair (red – positive, clear – negative)



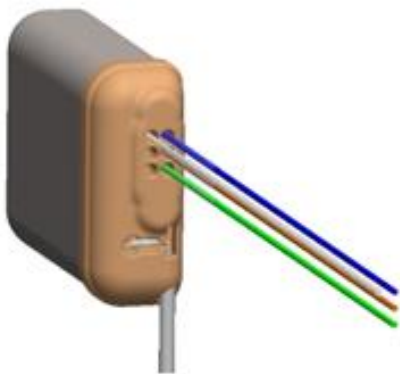
Common Reference L04

Channels 1-3: three positive (blue, orange, green) biopotential leads to one negative reference (clear);
 Channel 4: biopotential positive and negative pair (yellow)



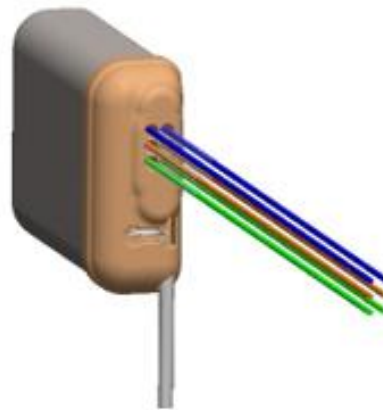
Biopotential Pair L04

Channels 1-4: biopotential positive and negative pairs (blue, orange, green, yellow)



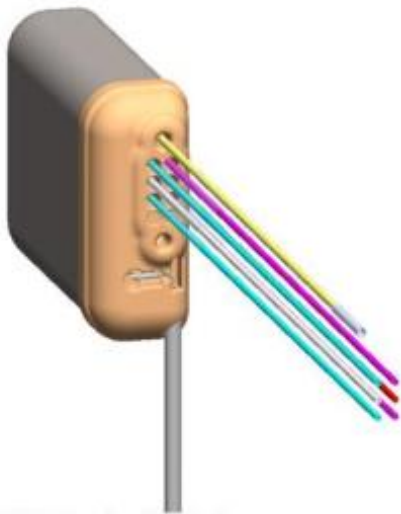
Common Reference L03

Channels 1-3: three positive (blue, orange, green) biopotential leads to one negative reference (clear)

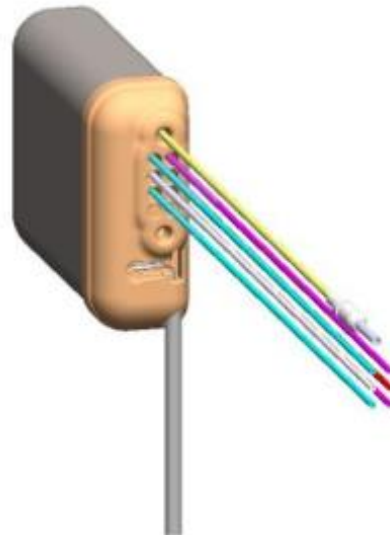


Biopotential Pair L03

Channels 1-3: biopotential positive and negative pairs (blue, orange, green)

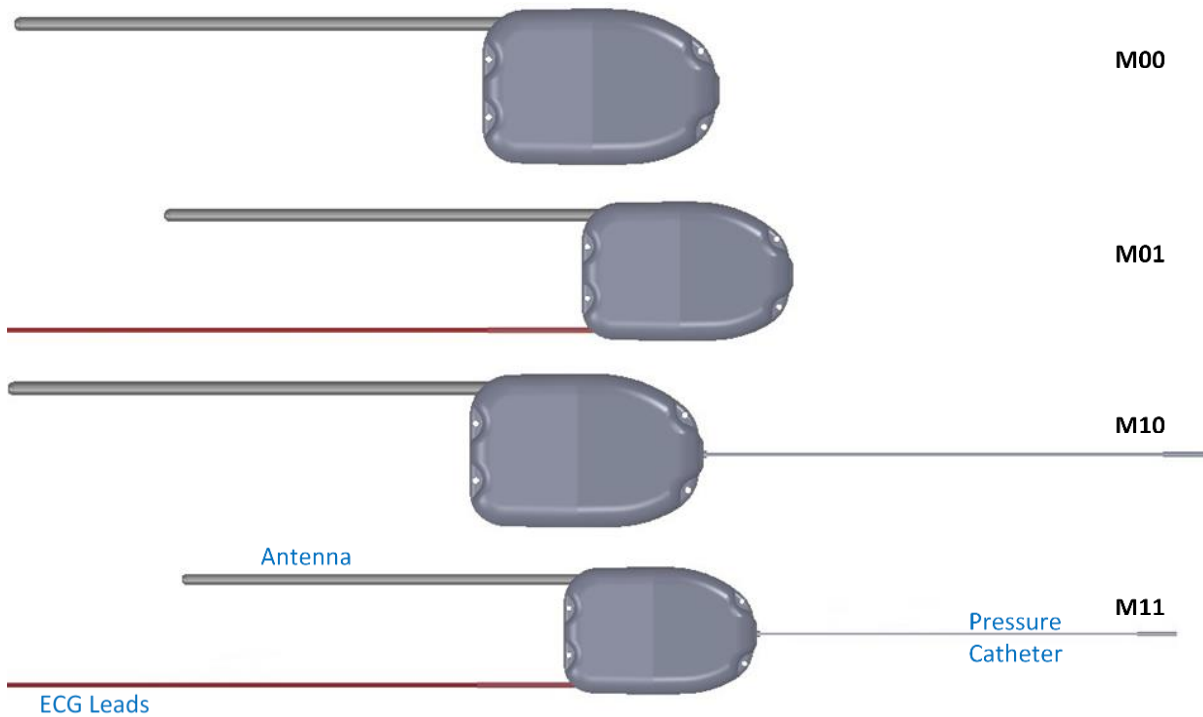


L11R Standard Catheter
 One pressure channel: Biopotential pair (red – positive, clear – negative); Two Respiratory pairs (violet pair, turquoise pair) Clear can be configured with a regular lead.



L11R LV Catheter
 One LV pressure channel: Biopotential pair (red – positive, clear – negative); Two Respiratory pairs (violet pair, turquoise pair) Clear can be configured with a regular lead.

The following illustrates the various implant components of the PhysioTel Digital M series implants.



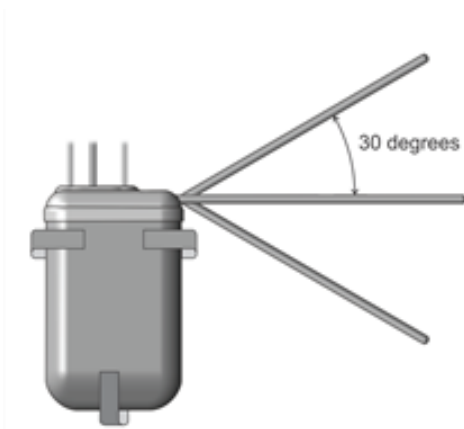
IMPLANT BODY

The implant consists of the following major components:

- **Housing:** L series implants contain a titanium housing. M series implants contain a biocompatible housing.
- **Pressure sensor** (Pressure implants models only): solid-state pressure sensor which receives pressure fluctuations from the fluid-filled catheter and sends the signals to the electronics module.
- **Electronics module:** translates the pressure fluctuations, biopotential signal, temperature, and 3-axis accelerometer signals into digitized signals and transmits them to a transceiver. It also interprets signals received from the laboratory software and contains a magnetically activated switch that allows the implant to be switched on or off. Note: M series implants are not eligible for DSI Exchange.
- **Battery:** provides power to the electronics module. Battery ON time and voltage parameters are sent digitally during sampling.
- **Suture aids:** L series contains straps located on 3 sides of the implant, allowing the surgeon to suture the implant securely in place at the implant site. M series contains four holes on the short sides of the implant allow the surgeon to suture the implant securely in place at the implant site. Straps are also available on the long sides of the implant as an alternative method to secure.
- **Temperature sensor.**
- **3-axis accelerometer.**

ANTENNA

- Extends 7cm out of the implant:
- Necessary for signal transmission
- For optimum transmission, the L series antenna should be placed relatively perpendicular to the implant (within approximately 30 degrees).



- Should NOT be cut prior to implantation but can be cut at explanation ONLY if sending back in for exchange

PRESSURE CATHETER(S)

Polyurethane tubing that extends (25, 35 or 40 cm) out of the implant and contains:

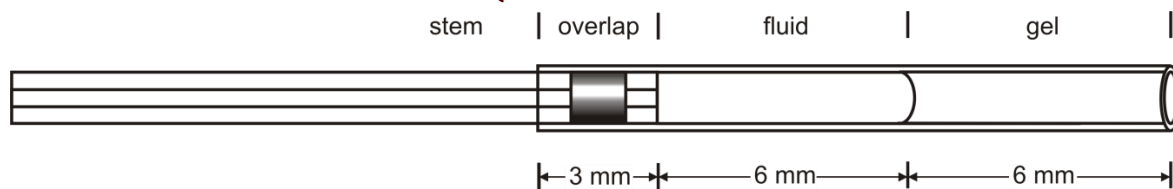
- Non-compressible fluid: relays absolute pressure to the sensor in the implant.
- Thin-walled section: tip of the catheter farthest from the implant that senses the dynamic portion of the pressure wave. It is designed to be completely inserted into the vessel or space where the desired

pressure can be sensed. It contains biocompatible gel at the very tip, which prevents the non-compressible fluid from leaving the catheter and blood from clotting in the catheter tip (see Figure 5).

- Tip cover: removable section of silicone tubing that protects the catheter tip until it is actually inserted into the desired location. Must be removed prior to catheter insertion.
- Systemic blood pressure catheter: containing a radio-opaque ring encircling the distal end of the systemic blood pressure catheter (This is the channel 2 catheter) (see Figure 3).
- Left ventricular pressure catheter (L series only): containing a plastic suture collar near the tip, with only the thin-walled section protruding beyond. The white suture collar will be inserted until the suture groove is flush with the heart wall (This is the channel 1 catheter). If this catheter is not required, the implant may be ordered with a second catheter without the suture collar.

It is important to be familiar with the catheter and its features. See the figures below for a detailed diagram of each catheter.

PRESSURE CATHETER WITH RADIO-OPAQUE MARKER

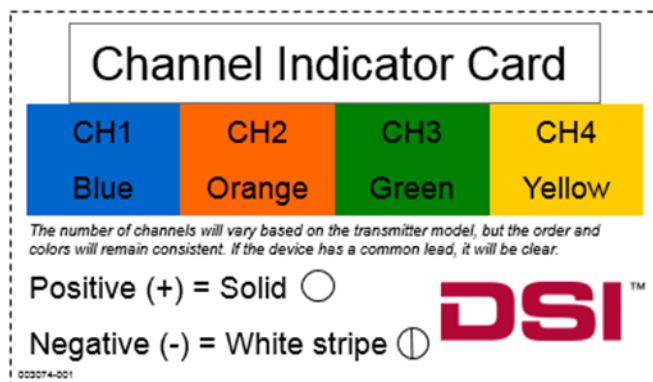


LEFT VENTRICULAR CATHETER TIP WITH COLLAR



BIOPOTENTIAL LEADS

Silicone jacketed helices of medical grade alloy wire extending out of the implant. The leads are designed to be cut to a length suitable for the biopotential signal to be monitored. L11, L21, M01, and M11 implants with only one biopotential channel available have red positive leads and clear negative leads. Multiple biopotential channel implants, such as the L03 and L04, utilize an alternative color scheme outlined the key listed immediately below.



SOLID TIP LEAD

The solid tip lead is designed to be introduced into the right jugular vein and fed into the cranial vena cava to provide the negative electrode for ECG signals. This implant location provides greater amplitude with reduced movement artifact vs. electrodes placed intramuscularly. It has a clear polyurethane insulation jacket and is NOT meant to be cut (unless you require traditional lead placement).



GLUCOSE SENSOR AND REFERENCE ELECTRODE

Silicone tubing that extends 15, 35, 40, 60 or 80 cm out of the device body and contains:

- Blood glucose sensor: relays blood glucose fluctuations to the sensor in the device body.
- Lead: provides connection between the connector board and implant housing.
- Connector board: provides connection between the lead and glucose sensor.
- Glucose sensor: an enzymatic sensor utilizing glucose oxidase.

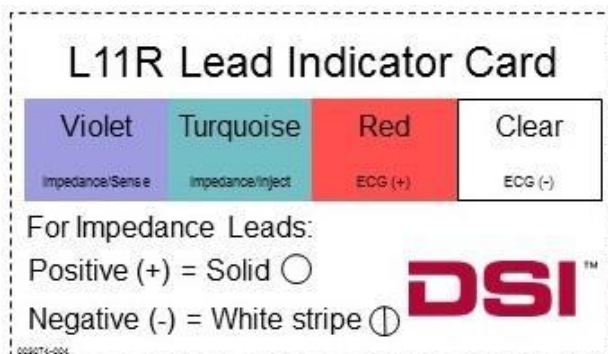
The reference electrode is silicone tubing extending 5 cm out of the device body and is only present on Glucose implants. The reference electrode acts as an electrical reference for the current being measured by the glucose sensor.

RESPIRATORY IMPEDANCE LEADS

Four leads that extend out of the device body. The leads are designed to be cut to a length suitable for the respiratory impedance signal to be monitored. The leads are violet (purple) and turquoise (light blue) in color. The turquoise leads are the injecting leads meaning they send a small current across the thoracic cavity. The violet leads are the sensing leads. They sense the impedance across the thoracic cavity. The positive leads are a solid colored lead and the negative leads have a white stripe. In addition, each lead has a black silicone line every 4 cm. These lines are indicative of where to cut the lead to obtain the proper surface area contact between the tissue and electrode.

- Silicone tubing: provides insulation from external electrical activity.
- Helix of medical grade alloy wire extending out of the implant that sends and receives the impedance signal.

The L11R utilizes the color scheme outlined in the key listed immediately below:



UNDERSTANDING ACTIVITY MEASUREMENTS

PhysioTel Digital implants contain a three-axis accelerometer used by the Ponemah software to report activity measurements. The three-axis accelerometer provides acceleration data along the x-, y-, and z-axes, relative to the orientation of the implant. Acceleration for the x, y and z axes is reported as a value from an analog-to-digital converter. A range of at least -7Gs to +7Gs is provided, with a corresponding output from approximately 0 to 4095. A value near 2047 will be displayed when zero acceleration for a given axis is sensed-- when in a steady, neutral alignment (orthogonal) to earth's gravitational field. The displayed sampling rate for the x, y and z axis acceleration data is 10Hz.

Along with the values from each axis of the accelerometer, Ponemah will also report an Activity value calculated from the accelerometer axes in Jerks. The accelerometer Jerk calculation is as follows:

$$\text{JerkValue}_i = C * \sqrt{(X_{i+1} - X_i)^2 + (Y_{i+1} - Y_i)^2 + (Z_{i+1} - Z_i)^2}$$

Where C is a constant based on the delta time for the accelerometer sampling rate.

$$C = \text{Sampling Rate} * 3.5347$$

The default Sampling Rate for Activity channels is 1 Hz.

It is recommended to use Total Activity 2 (A_TA2) reports the integral of the Activity signal over the defined Logging Rate, normalized to a minute. When sampling the Activity channel using the default sampling rate of 1Hz the A_TA2 will equal the sum of the Activity values over the Logging Rate reported in units of Jerks/minute.

BROADCASTING FREQUENCIES

The PhysioTel Digital system consists of CLCs, TRXs, and implants. The CLC and the implants actively communicate with one another, with the TRX being the transmitting and receiving link between them. The proprietary communication protocols use several different radio frequencies to communicate with the implants. All individual CLCs and implants are assigned to a unique frequency. Upon power up, the CLC will not have a frequency. It will become the frequency of the first TRX that is plugged into it. New TRXs and implants that have not been previously configured will be detectable using the default frequency (**B1**) assigned during manufacturing.

The frequencies are designated by four alpha-numeric characters F#1 – X#2 (F#1 = region, X = frequency, #2 = group). The following table outlines the currently available Frequencies and Groups by Region:

North America	Europe	Japan	China
F1-A1	F2-A1	F3-A1	F4-A1
F1-B1	F2-B1	F3-B1	F4-B1
F1-C1	F2-C1		F4-C1
F1-D1			
F1-A2	F2-A2	F3-A2	F4-A2
F1-B2	F2-B2		F4-B2
F1-C2			
F1-D2			

The frequency designations (above) are grouped into Primary or Secondary frequencies. **Group 1 (A1, B1, C1, D1)** is the Primary frequency and **Group 2 (A2, B2, C2, D2)** is the Secondary frequency.

Configuring the frequencies used by each CLC and implant is discussed in detail in the Edit PhysioTel Digital (CLC) Configuration section of this manual. At high level, each CLC must be defined to a unique operating frequency. Implants will change from their initial frequency to the frequency of their assigned CLC during the configuration process. TRXs are used to manage the bi-directional communication between the CLC to which they are connected and the implants within the environment.

When setting up a system:

- Up to four CLC's may be used per system (three in Europe and China, two in Japan).
- Each CLC in the system must be assigned a unique communication frequency.

For example:

- CLC #1 – A1
- CLC #2 – B1
- CLC #3 – C1
- CLC #4 – D1
- CLC frequencies must be unique and should be from the same frequency Group.

For example:

- A1, B1, C1, D1 (Primary Frequencies)
- A2, B2, C2, D2 (Secondary Frequencies)

The number of implants that can be assigned to one CLC will depend on the combination of CLC and Implant firmware version:

CLC Firmware Version [#]	Implant Firmware Version	# implants per CLC
0.1.28	1.62816	6[^]
0.1.28	Any firmware prior to 1.62816	4
Any firmware prior to 0.1.28*	1.62816	4

[#]CLC Firmware v1.30 is required for user with L03 and L04 implants modes.

^{*}CLC Firmware v0.1.28 is required for use with Ponemah v6.33 and later.

[^] The maximum number of implants per CLC for China is 5, which is also the default setting in the CLC Diagnostic Settings page. Note, if using L03 or L04 implants, the maximum number of implants per CLC for China is 4.

The CLC will default to using the 4 implant settings regardless of firmware combination. To enable 6 implant support, ensure all implant and CLC firmware is compatible and update the MaxImplantCount setting to 6 in the CLC Diagnostics webpage | CLC Settings link. No reboot is required. It will default back to 4 after a firmware upgrade, like most settings.

INSTRUCTIONS FOR IMPLANT OPERATION

IMPLANT OPERATION MODES

Off Mode:	Power Off. The Implant requires a magnet swipe and configuration through the software to activate the device.
Standby Mode:	Low power, listening for commands from the data acquisition system.
Active Mode:	Full power, ON, collecting and transmitting data.

IMPLANT ACTIVATION

Implants are activated by bringing a strong magnet within proximity (1-2 inches) of the implant for 5 seconds or less. Once activated, the implant will switch to Standby Mode and listen for acknowledgment from a CLC on the same frequency.

POWER ON DETECTOR (POD)

The Power On Detector (POD) is a handheld device which can be used to determine if a PhysioTel Digital implant has been successfully turned on by the magnet swipe. When an implant is first turned on, it emits a short transmission burst, or chirp. The POD listens for the chirp, and when heard, emits a short beep and blink its LED. This indicates that the magnet swipe was successful and the implant is on.

The POD will only indicate if a magnet swipe was successful and the implant turned on. It cannot be used to determine if an implant is already turned on.

POD COMPATIBILITY

Implants manufactured after 4/23/2014 with firmware version 1.38049 or later will work with the POD. The firmware version can be obtained through the PhysioTel Digital Diagnostics page. Please contact DSI technical support for assistance in determining the implant firmware version.

All implants sent through DSI Exchange will automatically be updated to the latest firmware version.

BATTERIES

The POD is shipped without batteries installed. It requires two AA batteries and is shipped with a box of four AA batteries. Before first use, open the battery compartment and install two AA batteries in the indicated “+” and “-” polarity. The POD is shipped with EN91 Energizer alkaline AA batteries, but will accept any standard AA 1.5V alkaline battery. It is very important to turn the POD OFF when not in actual use to maximize the life of the batteries.

ACTIVATION INSTRUCTIONS

To activate the PhysioTel Digital implant into Standby Mode:

1. Turn ON the POD by pressing its black Power button on the front panel to turn the POD on. The POD will emit a short beep and its LED will blink indicating it has been turned ON.
2. Bring the POD within 3-5 meters of the implant that will be turned ON.
3. Use the magnet to turn on an implant by bringing it within 1-2 inches of the implant.

- The POD will emit a beep for 2 seconds and blink its LED to indicate a successful magnet swipe.

If it was not successful do the following:

- Ensure the implant manufacturing date and firmware version are compatible with the POD. See POD Compatibility.
 - Ensure the POD is not located next to any potential noise sources (Monitors, PCs, outlets, etc.)
 - Wait 10 seconds, then try to magnet ON the implant again.
- Configure the implant to the desired CLC. Please see the Edit PhysioTel Digital (CLC) Configuration section of this manual for instructions on how to perform this action.
 - Once the implant is configured and joined to a CLC, it will remain in Standby Mode until automatically Activated via Start Acquisition.

Note: If the implant cannot establish communication with a CLC within 10 minutes, the device will automatically shut off to conserve battery life. Repeat the magnet swipe to switch to Standby Mode.

- Once the Acquisition is terminated, the implant will automatically revert to Standby Mode. The implant will remain in Standby Mode as long as it stays within range of a CLC.

IMPLANT DEACTIVATION

There are several scenarios in which the implant will return to the OFF Mode.

MANUAL SHUT OFF – MAGNET

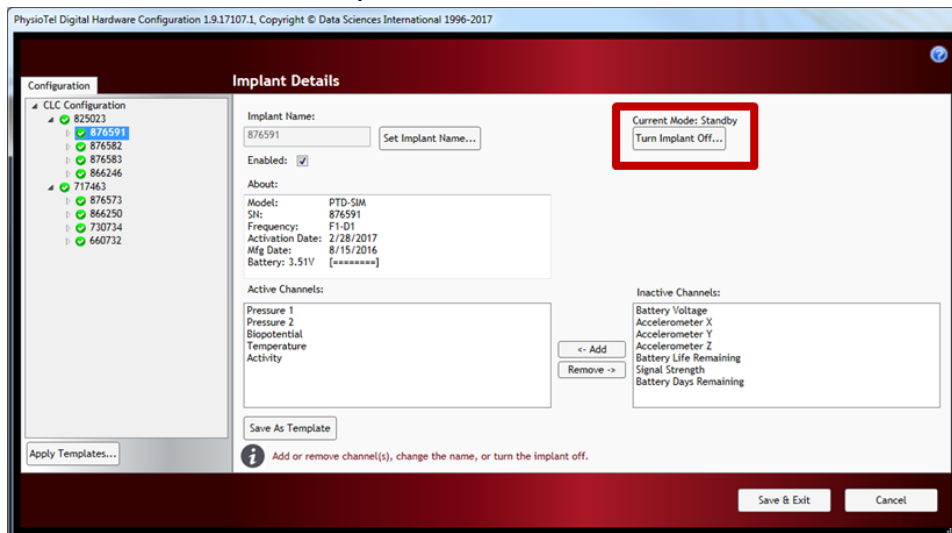
The implant may be turned off manually with a magnet swipe. Bring a strong magnet within proximity (1-2 inches) of the implant for 5 seconds or less.

MANUAL SHUT OFF – SOFTWARE

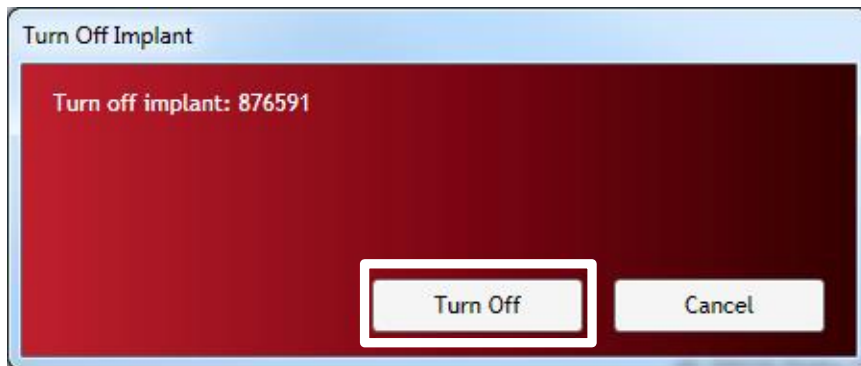
The implant may be turned off remotely using the **PhysioTel Digital (CLC) Configuration** dialog within the Ponemah software.

To remotely switch off an individual implant using the software:

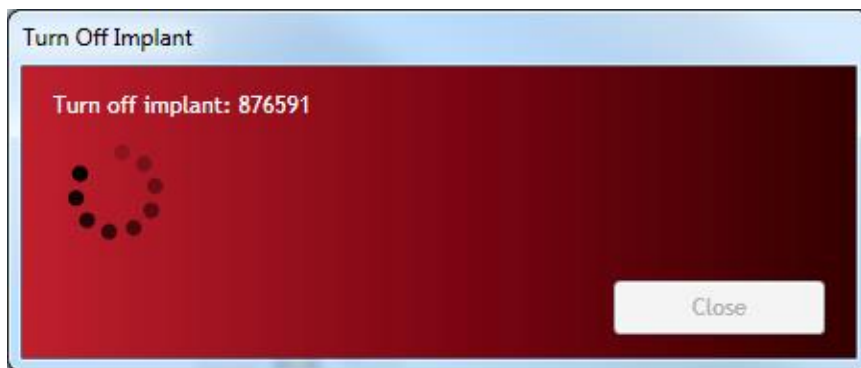
- Select the implant by clicking the line item in the Configuration column on the left of the screen.
- Click the button labeled **Turn Implant Off**.



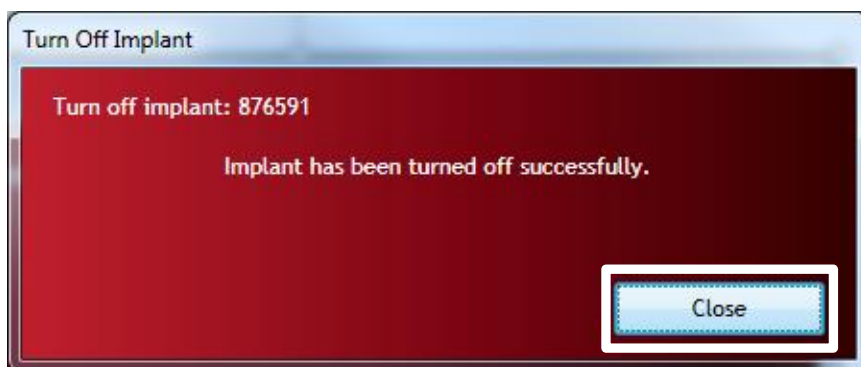
3. Confirm your intentions by clicking the button labeled **Turn Off**.



4. The progress dial will indicate the status of the operation. The completed process will be indicated by the statement "**Implant has been turned off successfully.**"



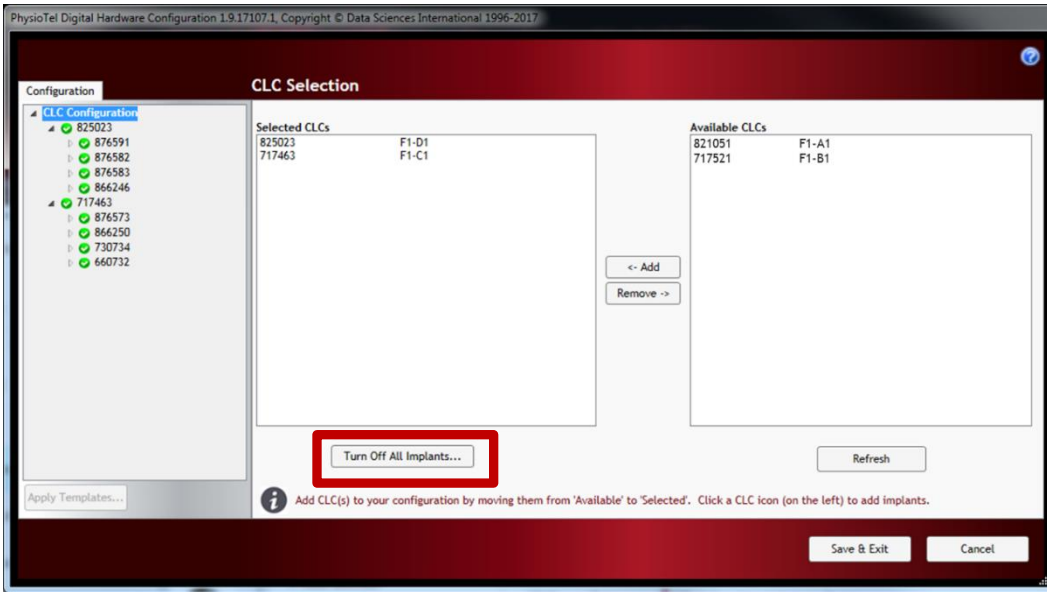
5. Click the **Close** button to return to the **Implant Details** view.



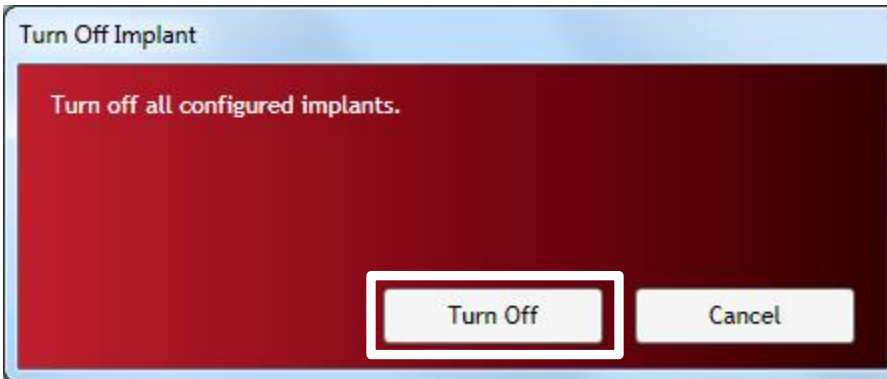
WARNING: Once you turn OFF an implant, it may only be returned to the ON state (Standby Mode) by physically passing a strong magnet close to the implant device for a few seconds.

To remotely switch off ALL implants within the configuration at one time:

1. Select the CLC Configuration line item in the Configuration column on the left of the screen.
2. Click the button labeled **Turn Off All Implants**.



3. Click **Turn Off**.



4. The progress dial will indicate the status of the operation. The completed process will be indicated by the statement **“Implants have been turned off successfully.”**



5. Click the **Close** button.



WARNING: Once you turn OFF an implant, it may only be returned to the ON state (Standby Mode) by physically passing a strong magnet close to the implant device for a few seconds.

AUTO SHUT OFF – 10 MINUTES

When an implant is switched from OFF to ON (Standby Mode), it will attempt to communicate with a CLC. If it cannot establish a link with a CLC on its assigned frequency within 10 minutes, the implant will turn itself OFF to preserve battery life.

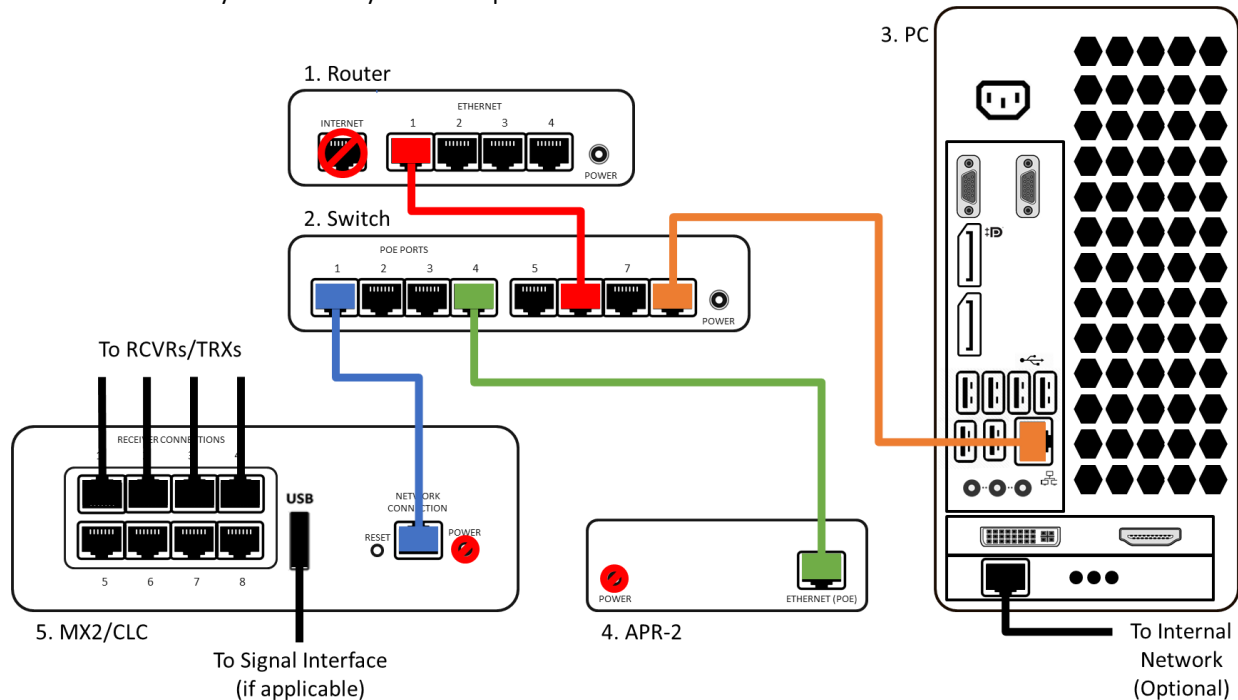
AUTO SHUT OFF – 60 MINUTES (DEFAULT VALUE)

If a configured implant loses contact with its CLC, i.e. moves out of range of the TRXs; the implant will attempt to re-connect with the CLC for a period of 60 minutes (default) after which it will turn itself OFF.

TELEMETRY HARDWARE CONNECTIONS

The Ponemah Data Acquisition system automates the collection of physiologic data via wireless telemetry.

Note: Please do not power any devices until directed in the appropriate step. As a courtesy, DSI has included the colored cables referenced in the figure below with the system. However, any color standard Cat5e or Cat6 Ethernet cables may be used in system set-up.



To connect your hardware:

1. Connect the red Ethernet cable from the output of the router (1) to a non- PoE port on the switch (2).
2. Connect the orange Ethernet cable from the PC (3) to a non-PoE port on the switch (2).
3. Connect the yellow Ethernet cable from the J1-Ethernet jack on the APR-2 (4) to a PoE port on the switch (2).
4. Power up the Router (1). This may take up to two minutes. See router user documentation to learn how to tell when it is fully powered up.
5. After the Router has fully booted, power up the switch (2). This may take up to two minutes.
6. After the switch is powered up, connect the blue Ethernet cable from the network connection jack of the Matrix 2.0 (MX2) (5) or the Communication Link Controller (CLC) (5) to one of the PoE ports on the switch (2).
7. The MX2/CLC (5) should power up in about 1.5 minutes, but can take up to 5 minutes. The front panel LEDs indicate when the MX2/CLC is ready.
8. Connect the individual RPC/RSC/RMC/TRX cables to the receiver (RCVR/TRX) connections on the back of the MX2/CLC (5).
 - If using PhysioTel Digital, connect TRXs in sequential order starting at jack 1. This will optimize communication with the Digital Implants for the best experience.

Note: If a PoE switch is not available, the individual components will need their own individual power supplies. If the router and switch are not powered up first, the MX2/CLC will boot up without an IP address, resulting in flashing Error LED. Once the router and switch complete their boot up process, the MX2/CLC will obtain the address and the Error light will stop blinking.

RECEIVER OVERVIEW

Multiple receiver options exist and selection depends on the implant model and the caging setup. Listed below are the receivers that support this implant’s transmission frequency (455 kHz or 18MHz). Check the implant’s transmission range listed as the cage requirement in the product specifications (Appendix B). If space is an issue, if a non-standard cage is being used, or if there is a lot of signal drop out, skip to the shielding section in this document to learn more.

DSI receiver options for PhysioTel Legacy and HD implants are listed below to assist researchers in determining the appropriate receiver for specific study needs. Information about maximum receiver range, DRA capability, antenna capability, application and frequency is detailed for each receiver. DSI does offer repair servicing for receivers when they are not working properly. Contact your sales representative to learn more.

Receiver	Maximum Signal Range*	DRA Capability	Antenna Capability	Frequency	Dimensions	Application
RPC-1	Sufficient coverage for up to 16 in (41 cm)	●	Single Internal	455kHz	12.9 x 8.9 x 1.3 in. (328 x 227 x 33 mm)	Typically used for monitoring rats, mice, and other animals housed in plastic cages that can be placed on top of the receiver.
RPC-2		●	Dual Internal	8MHz & 18MHz	12.9 x 8.9 x 1.3 in. (328 x 227 x 33 mm)	Paired housing use cases with PhysioTel 4ET implant.
RPC-3		●	Dual Internal	455kHz & 18MHz	12.9 x 8.9 x 1.3 in. (328 x 227 x 33 mm)	Multiple implants in the same animal or paired housing use cases
RSC-1		●	Single Internal or Auxiliary External	455kHz	5.25 x 3.3 x 1.2 in. (132 x 84 x 30 mm)	Supplementary for larger cage sizes or for unique cage configurations
RMC-1	Sufficient coverage up to 1 meter (39 in)	●	Single Internal	455kHz	12.5 x 10 x 1.5 in. (317x253x38mm)	Typically used for monitoring primates, dogs, rabbits, ferrets and other animals housed in metal cages.

**Range is highly dependent on telemetry model. The miniature implant size typically has a 20cm range, the small animal implant size typically has a 25cm range, and the large animal implant size typically has a 1.5m range.*

The receivers are powered by the connection with the MX2. When connected, the Ponemah software will detect the model and serial number and configure the software appropriately for all DSI hardware.

RPC-1

The Receiver Plastic Cage (RPC-1) is used to collect data from any 455 kHz associated PhysioTel implant. The RPC-1 can pick up the signal from the implant or from a neighboring cage so it is important to put enough distance between them so the signals do not interfere. Some PhysioTel 455 kHz implants can be reach up to 40-45cm away

from the receiver because of the dual axis antenna located inside the RPC-1 housing. Please see the PhysioTel and PhysioTel HD Caging and Shielding Recommendations section to learn more about cage requirements.

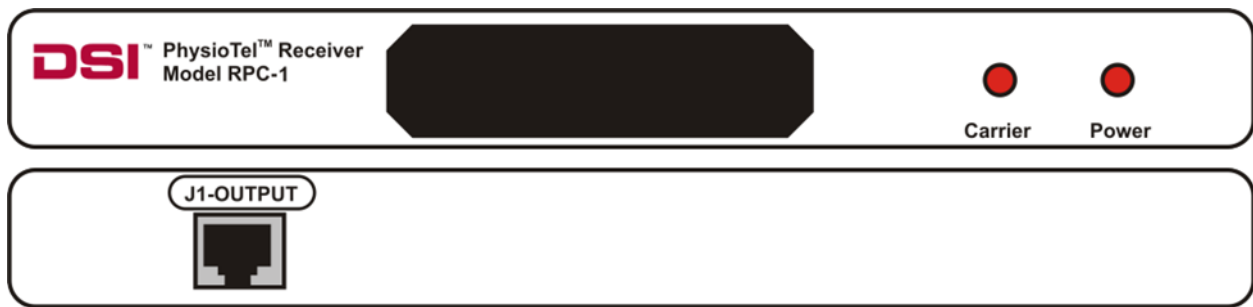


Illustration of the front (top) and back (bottom) panels of the RPC-1.

INDICATOR LIGHTS

- The **Power** light indicates that the receiver is connected to the MX2 and powered appropriately. The light is either on or off.
- The **Carrier** light indicates when the receiver can detect an implant signal. The light is either on or off, so depending on the quality of the signal users may observe what appears to be blinking if the quality of the signal is poor.

JACKS

- Plug the “J” output jack into the MX2 to establish a power and data connection.

RPC-2

The RPC-2 Receiver was designed specifically for use with the 4ET transmitter. It accommodates the new transmission frequencies of the 4ET and can simultaneously receive data from up to two pair-housed animals implanted with the device. Like DSI’s standard rodent receiver (RPC-1) it is typically placed underneath the subject’s cage to receive the data transmission from the implanted transmitter(s). There are 2 power lights and 2 carrier lights to represent the 2 transmission frequencies of the 4ET. It is the same size as the RPC-1 receiver and can only be used with 4ET transmitter models.

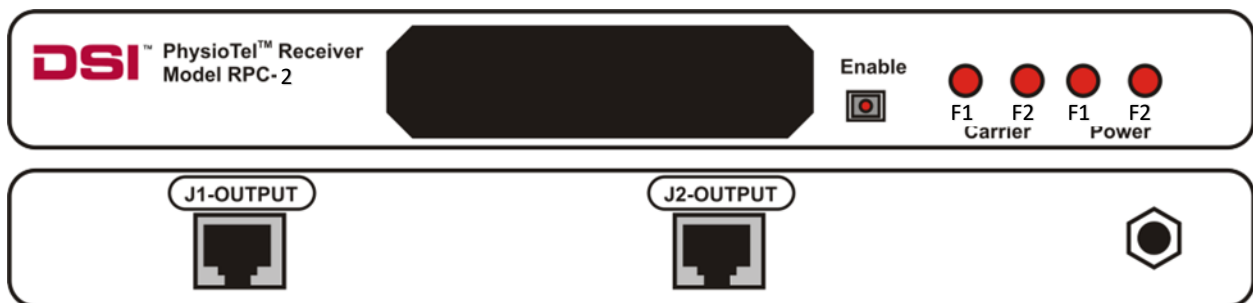


Illustration of the front (top) and back (bottom) panels of the RPC-2.

INDICATOR LIGHTS

The front panel of the RPC-2 has two power lights and two carrier lights each designated with either ‘F1’ or ‘F2’. F1 corresponds to frequency 1 as received from a 4ET-S1 transmitter. F2 corresponds to frequency 2 as received from a 4ET-S2 transmitter.

- The **Power** light indicates that the receiver is connected to the MX2 and powered appropriately. The light is either on or off.
- The **Carrier** light indicates when the receiver can detect an implant signal. The light is either on or off, so depending on the quality of the signal users may observe what appears to be blinking if the quality of the signal is poor.
- The **Enable** button on the front of the RPC-2 allows the user to turn off the receiver. Power will still be provided to the receiver; it just severs the connection between the receiver and the MX2. This is useful in situations when using a PhysioTel implant that is not of the HD platform. This feature prevents the receiver from detecting information when an animal or cage is removed from a rack. Because the receiver is so sensitive, sometimes it will pick up data from other sources that look physiologic in cases where it is not watching for an encrypted signal like the HD implants use. The signal is “enabled” when the button is pressed in and the LED light is on. To “disable” or disconnect from the MX2 press the button again and it should pop out with the LED light turned off. The carrier lights will both turn off as well indicating that the signal cannot be read by the acquisition system.

JACKS

- The RPC-2 has two “J” output jacks, one for each antenna, required to plug into the MX2 for power and data connection.
- J1-Output is used for 4ET-S1 (8 MHz) implants.
- J2-Output is used for 4ET-S2 (18 MHz) implants.
- Grounding jack and cable

The back panel of the RPC-2 receiver contains a circular grounding jack. This jack is used to ground the RPC-2 receiver to a metal shelf or other conductive surface. A grounding cable is provided with each RPC-2 receiver. One end of the cable has a ‘banana’ plug to be inserted into this jack and the other end contains a clip for attachment to a metal surface, such as the cage rack. Please see Section 9 for more information on grounding the RPC-2 receiver. The grounding clips should not be attached to any non-metal surface.

RPC-3

The RPC-3 was designed for DSI’s Dual Frequency solutions. This includes the HD-S11-F2 implant, used for pair housing Subjects, and the F50-W-F2, used for Sympathetic Nerve Activity (SNA) monitoring. Both implant models operate using 18 MHz transmission frequency to allow use in conjunction with a 455 kHz PhysioTel implant. The RPC-3 can be used with HD products and the 4ET. It contains two antennas and is used to collect signals from 2 animals simultaneously which are pair-housed or from two implants in one animal. One of the signals must be from an 18 MHz implant and the other from a 455 kHz implant. This is important if the system will use 18 MHz frequencies in the future such as the 4ET, F50-W-F2, or the HD-S11-F2.

Like DSI’s standard rodent receiver (RPC-1) it is typically placed underneath the subject’s cage to receive the data transmission from the implanted transmitter(s). The RPC-3 can still pick up the signal from a neighboring implant so it is important to put enough distance between them so the signals do not interfere.

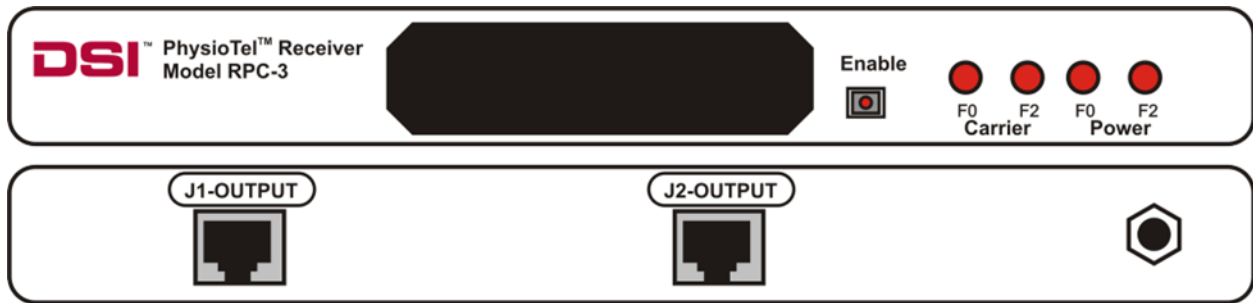


Illustration of the front (top) and back (bottom) panels of the RPC-3.

INDICATOR LIGHTS

The front panel of the RPC-3 has two power lights and two carrier lights each designated with either 'F0' or 'F2'. F0 corresponds to frequency 0 as received from a standard 455 kHz implant. F2 corresponds to frequency 2 as received from an 18 MHz implant.

- The **Power** light indicates that the receiver is connected to the MX2 and powered appropriately. The light is either on or off.
- The **Carrier** light indicates when the receiver can detect an implant signal. The light is either on or off, so depending on the quality of the signal users may observe what appears to be blinking if the quality of the signal is poor.
- The **Enable** button on the front of the RPC-3 allows the user to turn off the receiver. Power will still be provided to the receiver; it just severs the connection between the receiver and the MX2. This is useful in situations when using a PhysioTel implant that is not of the HD platform. This feature prevents the receiver from detecting information when an animal or cage is removed from a rack. Because the receiver is so sensitive, sometimes it will pick up data from other sources that look physiologic in cases where it is not watching for an encrypted signal like the HD implants use. The signal is "enabled" when the button is pressed in and the LED light is on. To "disable" or disconnect from the MX2 press the button again and it should pop out with the LED light turned off. The carrier lights will both turn off as well indicating that the signal cannot be read by the acquisition system.

JACKS

- The RPC-3 has two "J" output jacks, one for each antenna, required to plug into the MX2 for power and data connection.
- J1-Output is used for Standard (8 MHz) implants.
- J2-Output is used for 18 MHz implants.

RSC-1

The Receiver Special Cage (RSC-1) contains the same antenna as the RPC-1 but has a much smaller profile. The RSC-1 is used in special situations where the RPC-1 is too large or will not fit close enough to the animal. Applications that are considered special situations could be adding a running wheel to the existing cage setup, using a metabolic cage or a large maze. The RSC-1 can be used to supplement an existing system. This device also has been used in larger caging setups with the DRA function (explained in the software manuals and briefly described below). The RSC-1 also has the function to attach any external antenna. Speak to DSI technical support if to learn more about this option for a specific use case. Some researchers may have interest in developing their

own custom antenna. An engineering based manual is available by request to instruct users on how to interface their design to the RSC-1.



Photo of RSC-1 as viewed from the front (left) and back (right).

INDICATOR LIGHTS

- **Power**
The power light indicates that the receiver is connected to the MX2 and powered appropriately. The light is either on or off.
- **Carrier**
The carrier light indicates when the receiver can detect an implant signal. The light is either on or off, so depending on the quality of the signal users may observe what appears to be blinking if the quality of the signal is poor.
- **Signal**
The signal light is available on the RSC-1 only. It has a more gradual transition from off to on which is designed to indicate when the implant enters the reception range and the strength of the signal. This is useful in tuning remote antennas for custom antenna work.

JACKS

- Plug the “J” output jacks into the MX2 to establish a power and data connection.
- The “AUX” is used in DSI manufacturing to test the product.
- The “ANT” is where customers can plug in a custom antenna made by DSI or by their own engineers.

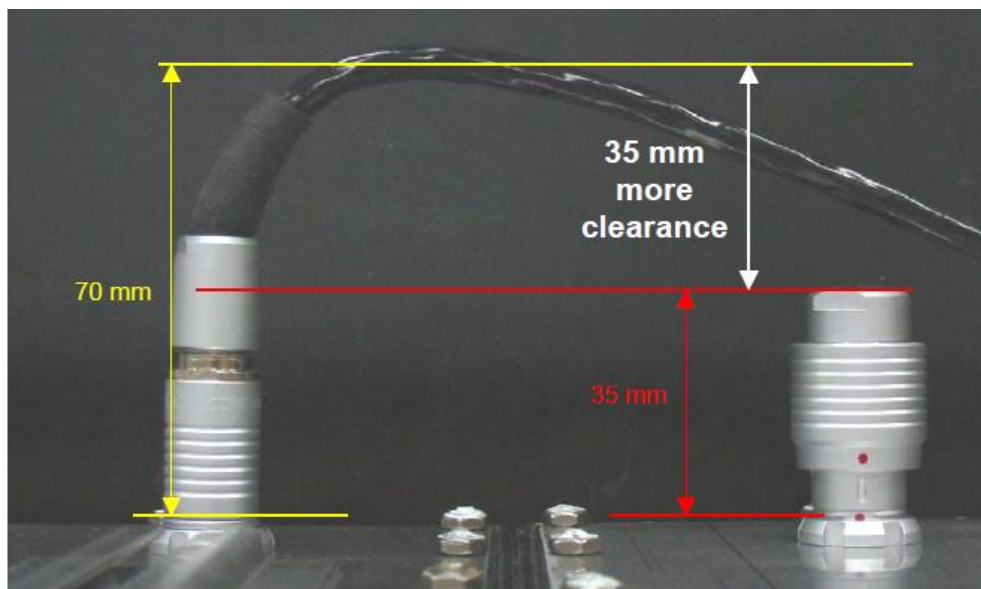
RMC-1

The Receiver Metal Cage (RMC-1) is most often used for monitoring rabbits, ferrets, primates, dogs, and other animals housed in metal cages when using DSI’s D70 PhysioTel implants. The RMC-1 is housed in stainless steel and polycarbonate with a gasket seal and water-resistant connector, making it possible to spray down the cages with the receiver in place. The RMC-1 receiver provides reliable reception of data transmitted via telemetry and has two receiving antennae oriented at right angles to minimize dropouts due to directionality of the transmission pattern.

Note: If monitoring primates (or another animal that can reach through the cage and grasp objects), DSI recommends placing a short piece of PVC pipe over the cable where it exits the transceiver housing to protect it from the animal.



DSI offers a right-angle connector for the RMC-1, which reduces the space needed to accommodate the cable exiting the rear of the RMC-1 receiver. This offers the flexibility of placing cages closer to walls or adjacent cages.



INDICATOR LIGHTS

- Indicator lights are not available on the RMC-1.

JACKS

- Plug the output jack on the back of the RMC-1 into the MX2 to establish a power and data connection.

DRA FUNCTIONALITY

If a cage is being used that is larger than a single RPC-1, the receivers can be arranged in a Distributed Receiver Array (DRA) mode to cover a larger area. The DRA feature allows groups of receivers to be used with a single animal to expand the coverage area and improve signal quality. A single data stream is passed back to the data acquisition computer based on instantaneous switching to the receiver that has the strongest signal strength. The DRA function requires that all receivers within a group are the same receiver model. Please refer to the Edit PhysioTel /HD (MX2) Configuration section of this manual for more information on configuring a DRA setup.

Note: DRA functionality is only available for PhysioTel Legacy and PhysioTel HD implants. PhysioTel Digital does not require the user to define receivers for this type of functionality since the platform accounts for this automatically with its hardware. See the **PhysioTel Digital Platform Hardware** section for information.

MATRIX 2.0 (MX2)

The Matrix 2.0 (MX2) manages communication between PhysioTel Legacy and PhysioTel HD telemetry implants and the acquisition computer. The MX2 can connect up to 8 receivers and can transmit data from 8 implants simultaneously.

The MX2 is only compatible with the RPCs, RMC, and RSC models of receivers.

Three tasks performed by the MX2:

1. It multiplexes the signals obtained by the receivers and sends this signal stream to the computer via Ethernet connectivity.
2. It powers the connected receivers.
3. It detects changes in signal strength that indicate animal movement.

Dimensions 7.3 x 4.5 x 2.5 in.
 (185 x 114 x 64 mm)

FRONT PANEL

On the front of the MX2, indicators are used to provide a quick overview of its operational status. These indicators are pictured and described below.



Illustration of the of the MX2 front panel.

Indicator	Color	Status
ERROR	RED	Seen during the boot process. Will blink if the MX2 does not receive an IP address from the Network. Reboot the MX2 or check your Network configuration.
STATUS	AMBER	Illuminated during the boot sequence
POWER	GREEN	Power ON

BACK PANEL

The back of the MX2 has 8 available input jacks. These jacks are used to connect DSI's receivers. Each MX2 has a unique serial ID number assigned at the factory that the data acquisition software recognizes when verifying the hardware configuration.

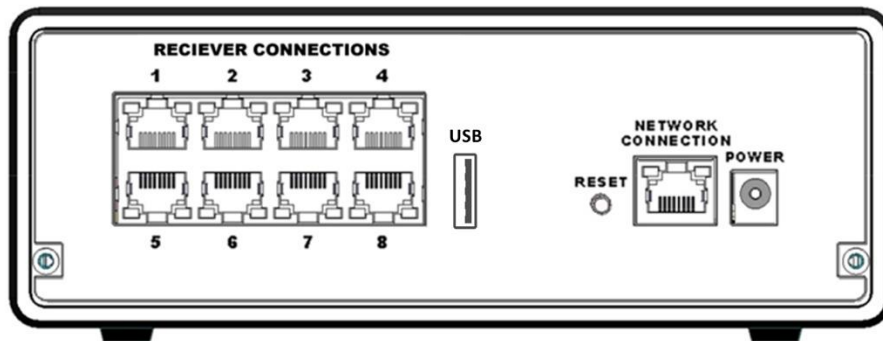


Illustration of the MX2 back panel.

RECEIVER CONNECTION INDICATORS

All connections (RJ45 jacks) on the back panel of the MX2 are equipped with indicator lights.

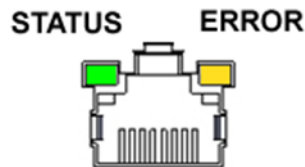


Illustration of the of the MX2 Receiver connection.

Indicator	Color	Location	Mode	Description
Status	Green	Left of Jack	ON	Valid receiver connected
			OFF	No connection
Error	AMBER	Right of Jack	ON	Invalid device connected
			OFF	No connection

USB PORT

The USB 3.0 port permits the MX2 connection with the DSI Signal Interface, via Type A to Type B cable, for analog and digital signal inputs to the system.

RESET SWITCH

The reset switch allows the user to manually reboot the MX2. The reset can also be used to assign a new IP address to the MX2 if the MX2 is currently set to a static IP address. The Reset switch is a recessed button on the back panel of the MX2 found next to the Network jack.

Function	Directions
Reboot	Press and release within 5 seconds
Requests a new IP address, if using a dynamic IP address, and reboots	Press and hold 5 – 15 seconds

SIGNAL INTERFACE

The DSI Signal Interface permits users to acquire and time synchronize signals from third-party products with implantable telemetry data. The Signal Interface is only compatible with the MX2.

Dimensions 7.3 x 5.8 x 1.8 in.
(185 x 147 x 45 mm)

FRONT PANEL

On the front of the Signal Interface, indicators are used to provide a quick overview of its operational status. These indicators are pictured and described below.

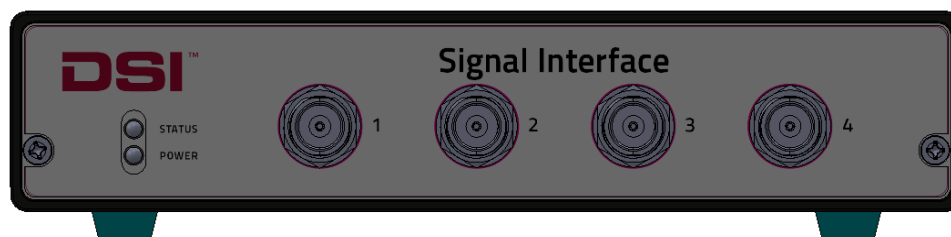


Illustration of the Signal Interface front panel.

Indicator	Color	Status
STATUS	AMBER	Blinks at 1Hz when not acquiring. Blinks rapidly when acquiring.
POWER	GREEN	Power ON

ANALOG CHANNEL INPUT SPECIFICATIONS

The following provides specifications of the analog inputs:

Connector Type	BNC
# Channels	4, Single-ended
Type of Coupling	DC
Resolution	12 Bit
Max Sample Rate	1000 Hz per channel User selectable rates in software: 1, 10, 50, 100, 500, 1000, 2000, 4000 Hz <i>Note: Rates above 1000Hz use repeat sample interpolation.</i>
Input Voltage Range	±5V
Max Input (without damage)	±20V
Input Impedance	100kΩ per input
Analog Bandwidth	200Hz

Accuracy	10mV offset, 20mV full scale
Noise	10mV peak-to-peak (<0.2 full scale)
Synchronization with telemetry signals on same MX2	±10mS

Note: When no input is attached to the Signal Interface analog channels, a default voltage reading of 1.4V will be seen on the channel.

REAR PANEL

The rear panel contains the USB and Digital Inputs.

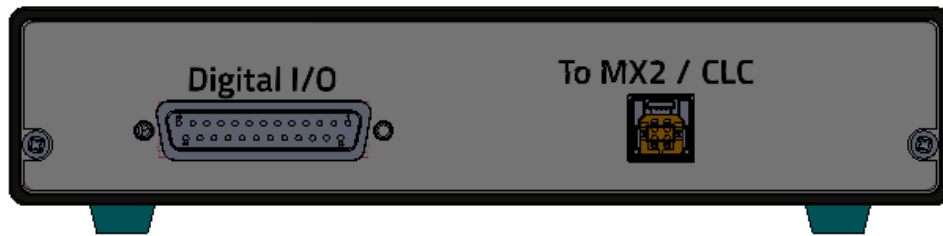


Illustration of the Signal Interface rear panel.

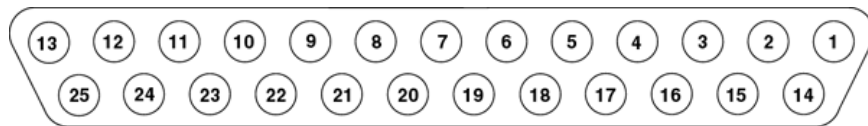
USB PORT

USB 3.0 (Type A to Type B) cable required. The USB port permits the DSI Signal Interface to connect with the MX2 for analog and digital signal inputs to the system.

DIGITAL CHANNEL INPUT SPECIFICATIONS

The following provides specifications of the analog inputs:

Connector Type	1, 25-pin D-connector
# Channels	8
TTL Compatibility	0-5V, +5V high
Sample Rate	100Hz fixed <i>Note:</i> May vary up to 20Hz depending on the number of inputs/telemetry sources.
Pinout	Pins 1-8 correspond to Digital Channels 1-8. Pins 14-25 are ground.



TRANSCEIVER (TRX)

The TRX is a radio-telemetry transceiver. The TRX receives and transmits Radio-Frequency (RF) signals from the implants and sends them, via cable, to the Communication Link Controller. It is most often used for monitoring rabbits, ferrets, primates, dogs, and other animals housed in metal cages when using DSI's PhysioTel Digital implants. The TRX is housed in stainless steel and polycarbonate with a gasket seal and water-resistant connector, making it possible to spray down the cages with the receiver in place.



DSI offers a right-angle connector for the TRX -1, which reduces the space needed to accommodate the cable exiting the rear of the transceiver. This offers the flexibility of placing cages closer to walls or adjacent cages.

Note: If monitoring primates (or another animal that can reach through the cage and grasp objects), DSI recommends placing a short piece of PVC pipe over the cable where it exits the transceiver housing to protect it from the animal.

Dimensions 12.5 x 10 x 1.5 in.
(317x253x38mm)

INDICATOR LIGHTS

- Indicator lights are not available on the TRX-1.

JACKS

- Plug the output jack on the back of the TRX into the CLC to establish a power and data connection.

COMMUNICATION LINK CONTROLLER (CLC)

The Communication Link Controller (CLC) manages communication between the PhysioTel Digital telemetry implants and the acquisition computer. Up to 6 implants can be configured to a CLC (5 in China). See the **Broadcasting Frequencies** section of this manual for more information.

The CLC is only compatible with the PhysioTel Digital transceivers (TRX).

Three tasks are performed by the CLC:

1. It allocates radio frequencies to the implants.
2. It tells the implants when to send their data and sends the data along to the acquisition software.
3. It powers the connected receivers.

Dimensions 7.3 x 4.5 x 2.5 in.
(185 x 114 x 64 mm)

FRONT PANEL

The front panel of the CLC contains three status indicator lights. In normal operational mode, only the green power indicator light is illuminated.

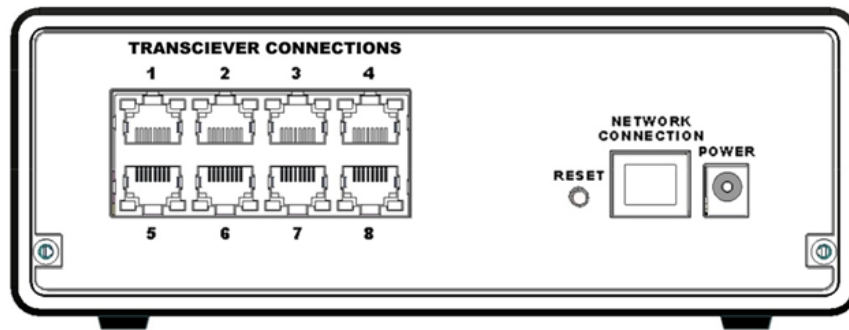


Illustration of the CLC front panel.

Indicator light	Pattern	Status
RED	Constant ON - ERROR	ERROR (usually caused by Power-On self-test error) – repeat the power on procedure
	Blinks Once Per Second	CLC Powered up without receiving an IP Address (when using dynamic IP address) – Verify Router connection, and repeat power on procedure
AMBER	Blinks for ten seconds then turns off	INTERFERENCE detected.
GREEN	Power ON	Power ON

BACK PANEL

The back of the CLC has 8 available input jacks. These jacks are used to connect DSI's transceivers (TRX). Although 8 inputs are available, the CLC can only collect data from 6 implants (5 in China). Additional TRXs can be added to the system to optimize telemetry coverage. Each CLC has a unique serial ID number assigned at the factory that the data acquisition software recognizes when verifying the hardware configuration.



TRANSCEIVER (TRX) CONNECTION INDICATORS

All connections (RJ45 jacks) on the back panel of the MX2 are equipped with indicator lights.

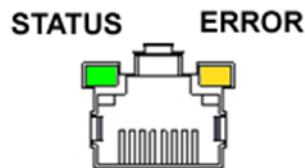


Illustration of the of the CLC Transceiver connection.

Indicator	Color	Location	Pattern	Description
Status	Green	Left of Jack	Blinks ~twice per second	Normal communication and implants are actively transmitting data to the CLC
			Blinks once per second	Normal communication, no data received from the implants
Error	AMBER	Right of Jack	Constant On	Loss of communication with the TRX
			Single Blink	TRX Error

RESET SWITCH

The reset switch allows the user to manually reboot the CLC. The reset can also be used to assign a new IP address to the CLC if the CLC is currently set to a static IP address. The reset switch is a recessed button on the back panel of the CLC found next to the Network jack.

Directions	Function
Press and release within 5 seconds	Reboot
Press and hold 5 – 15 seconds	Requests a new IP address, reboot, and restore default CLC settings to factory values.

AMBIENT PRESSURE REFERENCE (APR-2)

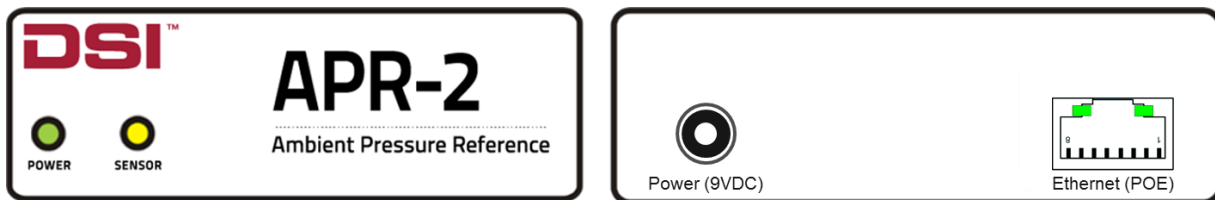
The Ambient Pressure Reference Monitor (APR-2) is a special type of barometer that measures atmospheric pressure to provide dynamic corrections via a digital signal to the computer. An APR-2 is required when measuring pressure via pressure transmitters to compensate for the absolute (relative to a vacuum) measurements taken by the transmitters. All local environmental pressure fluctuations and changes in ambient barometric pressure are automatically corrected against measurements obtained by the acquisition system. Thus, the APR-2 is a necessary component of each DSI telemetry system where accurate pressure measurements are required.

Note: Specifications for the APR-2 can be found in the Ambient Pressure Reference (APR-2) Hardware Appendix.

The front panel contains two indicator lights. The function of these is described below:

- **Sensor** Lights when the pressure sensor is operating normally. This will light shortly after power is applied to the APR-2. If it does not light, contact DSI Technical Services for assistance.
- **Power** Lights when power is applied to the APR-2. The APR-2 does not have an on/off switch.

The back panel contains a single Ethernet jack which is used to connect the APR-2 to a Power over Ethernet (PoE) jack of the network switch. This jack used to obtain power and communicate to the rest of the system. Should you not have a PoE capable switch, a power port is available for use with an external power supply.



Front panel of APR-2 (left), rear panel (right)

THE APR-2 REQUIRES ROUTINE CALIBRATION TO ENSURE THE ACCURACY OF THE DATA.

Other pressure monitoring hardware systems may come with the ambient pressure reference built into the acquisition hardware. DSI values accuracy and knows that all sensing equipment will drift over time. Calibrating the system is much more difficult when it is built into the hardware and DSI prefers it in its own smaller box for ease of calibration frequency and minimal system downtime. To learn more about maintaining the APR-2's accuracy, please see the Ambient Pressure Reference (APR-2 section within the **Hardware Appendix**.

NETWORKING HARDWARE

DSI recommends using a dedicated network for the Ponemah v6.x system to assure uninterrupted data collection. Many configurations are possible; the simplest would be to use a router and a network switch to connect all PCs, MX2s/CLCs, and the APR-2. In this configuration, the router will automatically provide network IP addresses so that manual settings will not be required for the computers, MX2s/CLCs, or APR-2. A configuration such as this may also be connected to the corporate network via a router to router connection. This can be arranged through your institutional IT group.

Here are some typical examples:

- Router

- Cisco RV130 – 4-port Gigabit security router.
- Switch
 - GS116PP-100NAS – 16-port Gigabit, unmanaged switch with 16-port Power over Ethernet plus (PoE+).

PONEMAH SOFTWARE MANUAL

SOFTWARE OVERVIEW

Ponemah is a complete physiologic data acquisition and analysis software platform used by researchers to confidently collect, accurately analyze, and quickly summarize study data. Ponemah is designed for use with all DSI implantable telemetry to provide optimal compatibility wherever your research takes you.

This manual is designed to help you start using Ponemah to collect, analyze, and report data. The manual layout is in the recommended sequence of events used to start and complete each Experiment.

You will be guided through the following procedures:

1. Experiment Configuration
 - a. Acquisition Interface Configuration
 - b. Subject Setup
 - c. Graph Setup
2. Data Acquisition
 - a. Continuous Sampling
 - b. Scheduled Sampling
3. Data Review
 - a. Data Navigation
 - b. Reanalyzing Data
4. Data Export

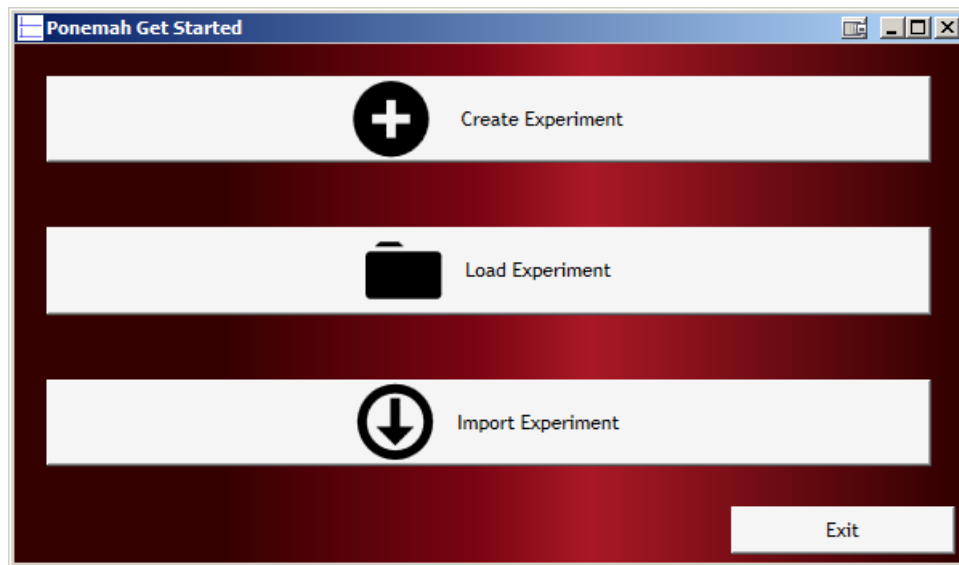
Note: Installation and Maintenance information can be found in the Software Appendix section.

UNDERSTANDING EXPERIMENTS

Think of an experiment within Ponemah as a container of all the information associated with your telemetry study. The experiment will retain all information regarding your hardware and implant setup, subject information, sampling definitions, and experimental settings (such as graph setup). In addition, it provides the software with context for what you are doing within Ponemah. With this capability, you can automatically name and associate data files collected during acquisition and load data into Ponemah Review without having to search for specific files. You can also export data into Microsoft® Excel, based on criteria you define across the entire experiment; this could be days or weeks.

CREATING A NEW EXPERIMENT

If this is the first time opening Ponemah, you will be prompted with the **Ponemah Get Started** dialog.



The **Ponemah Get Started** dialog offers three options:

- **Create Experiment**—Creates a new experiment folder in the default data directory.
- **Load Experiment**—Loads an existing experiment (perhaps from a different data folder).
- **Import Experiment**—Creates a new experiment by importing data files from previous versions of Ponemah or Dataquest ART.

After the first Experiment is created, Ponemah will automatically open the last loaded Experiment. These three options can then be accessed by selecting one of the following options from the menu in the main Ponemah window:

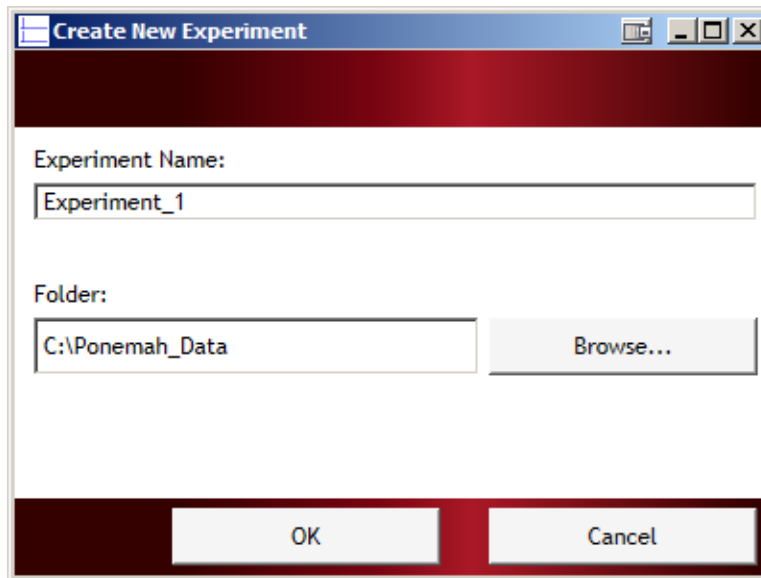
- **Experiment | Create...**
- **Experiment | Open...**
- **Experiment | Import...**

These options are described in the sections that follow.

CREATING A NEW EXPERIMENT

The Create New Experiment dialog can be accessed from the Ponemah Get Started window, or from the main Ponemah menu by selecting **Experiment | Create...**

Note: It is advisable to organize all active Experiments in the directory **C:\Ponemah_Data**. This is the default directory that Ponemah uses to store and retrieve data.



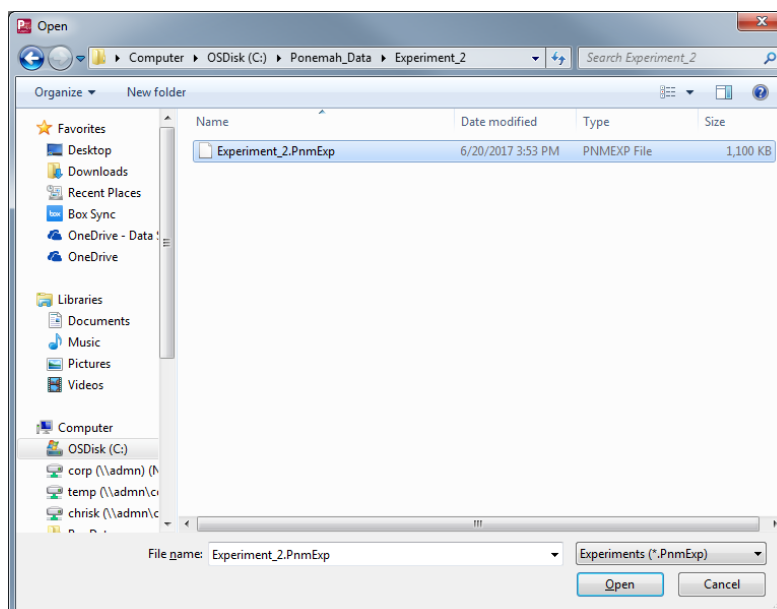
To create a new experiment:

1. Accept the new **Experiment Name** or create a new name.
Note: The Create New Experiment dialog will prompt you to accept a new sequential experiment name in the format "**Experiment n**" (where *n* represents a positive integer).
2. Click **OK** to continue.

LOADING A PREVIOUSLY CREATED EXPERIMENT

The **Load Experiment** option allows you to access previously created Experiments.

Accessing the **Load Experiment** option opens the **Browse For Folder** dialog, this option can be accessed from the **Ponemah Get Started** window, or from the main Ponemah menu by selecting **Experiment | Open...**



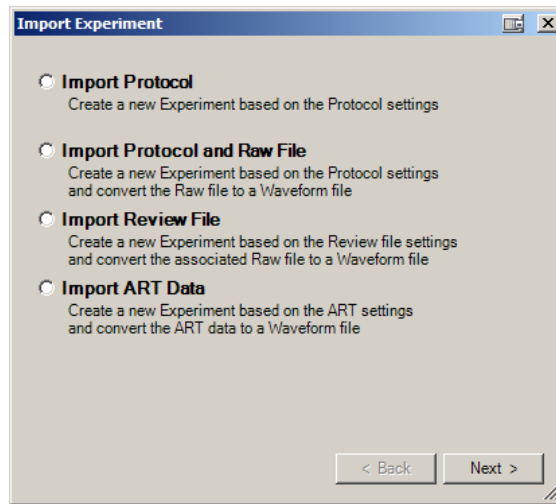
To load a previously created experiment:

1. Navigate to and select the Experiment file (.PnmExp).
2. Click **Open** to continue.

IMPORT FILES TO CREATE AN EXPERIMENT

The Import Experiment option allow the user to create new Experiments from data files that were collected and or generated using previous versions of Ponemah or Dataquest ART.

The **Import Experiment** dialog can be accessed from the **Ponemah Get Started** window, or from the main Ponemah menu by selecting **Experiment | Import...** .




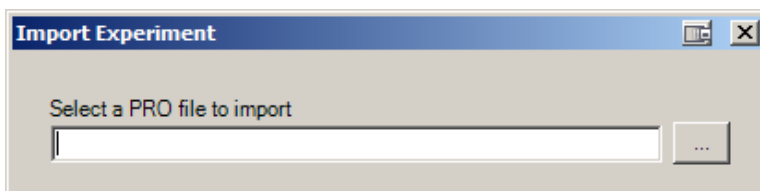
Select the desired option and click **Next** to continue.

Note: These options are described in more detail in the following sections.

IMPORT PROTOCOL

Allows the user to create a new Experiment based upon previously used Protocol settings.


1. From the **Import Experiment** dialogue click on the browse button () to select a **Protocol File (*.PRO)**, this opens the **Select PRO to Import** window. Select a file and Click **Open**.



2. The file name and path will appear in the text box, Click **Next**.
3. Confirmation information may be supplied in an **Import Settings** message. Click **Import**.
4. This opens the **Create New Experiment** dialog.

IMPORT PROTOCOL AND RAW FILE


Allows the user to create a new Experiment based upon previously used Review file settings and converts the Ponemah RAW file to a Waveform file.

1. From the **Import Experiment** dialogue click on the browse button () to select a **Protocol File (*.PRO)**, this opens the **Select PRO to Import** window. Select a file and Click **Open**.
2. The file name and path will appear in the text box, Click **Next**.
3. A second dialog will prompt the user to select a RAW file (***.RAW**), this opens the **Select RAW to Import** window. Select a file and Click **Open**.
4. The file name and path will appear in the text box.
5. There is a checkbox for **Treat negative rail as dropouts ***, this is enabled by default. Click **Next**.
6. Confirmation information may be supplied in an **Import Settings** message. Click **Import**.
7. This opens the **Create New Experiment** dialog.

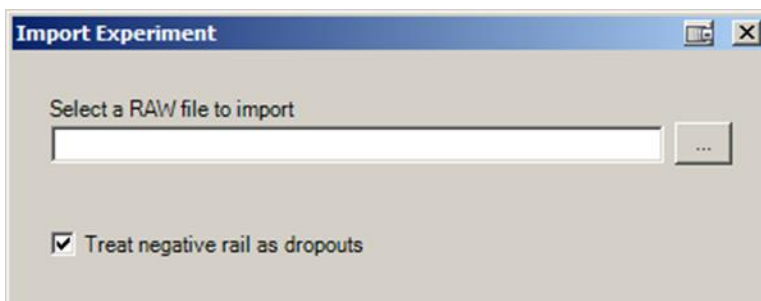
**Note:* negative rails are caused by invalid data due to varying reasons being sent to the application. These values are converted to a dropout value so it can be ignored by the analysis modules and not used in any calculations.

IMPORT REVIEW FILE

Allows the user to create a new Experiment based the Review file settings and converts the associated RAW file to a Waveform file.


1. From the **Import Experiment** dialogue click on the browse button () to select a **Review File (*.RVW)**, this opens the **Select RVW to Import** window. Select a file and Click **Open**.
2. The file name and path will appear in the text box, Click **Next**.
3. There is a checkbox for **Treat negative rail as dropouts ***, this is enabled by default. Click **Next**.
4. Select a “**marks section**” from the list and Click **Next**. Selecting a marks section will load its marks information into the current and reference sections and update the graphics and derived data accordingly.
5. Confirmation information may be supplied in an **Import Settings** message. Click **Import**.
6. This opens the **Create New Experiment** dialog.

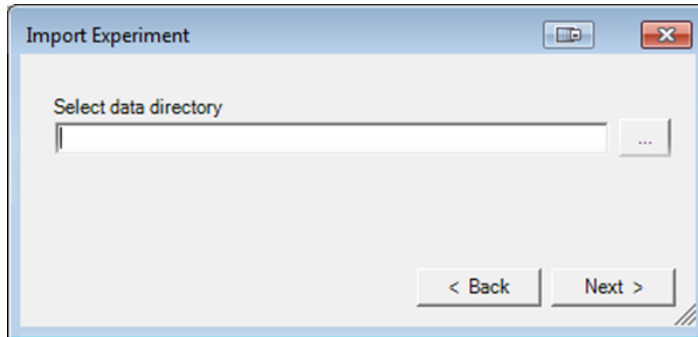
**Note:* negative rails are caused by invalid data due to varying reasons being sent to the application. These values are converted to a dropout value so it can be ignored by the analysis modules and not used in any calculations.



IMPORT ART DATA

Allows the user to create a new Experiment based upon settings used in Dataquest ART and converts the ART data to a Waveform file.

1. From the **Import Experiment** dialogue click on the browse button () to select a **Data Directory**. This opens the **Browse for Folder** window. Select a folder and Click **OK**.



2. The file name and path will appear in the text box, click **Next**.
3. Select the Subjects to import by clicking on the check box(s).
4. Confirmation information may be supplied in an **Import Settings** message. Click **Import**. This opens the **Create New Experiment** dialog.

ACQUISITION INTERFACE CONFIGURATION

The **Acquisition Interface Configuration** section provides guidance on how to configure your telemetry implants and hardware within the Ponemah, as well as detailed information on each **Acquisition Interface**.

Use the following **Acquisition Interfaces** to:

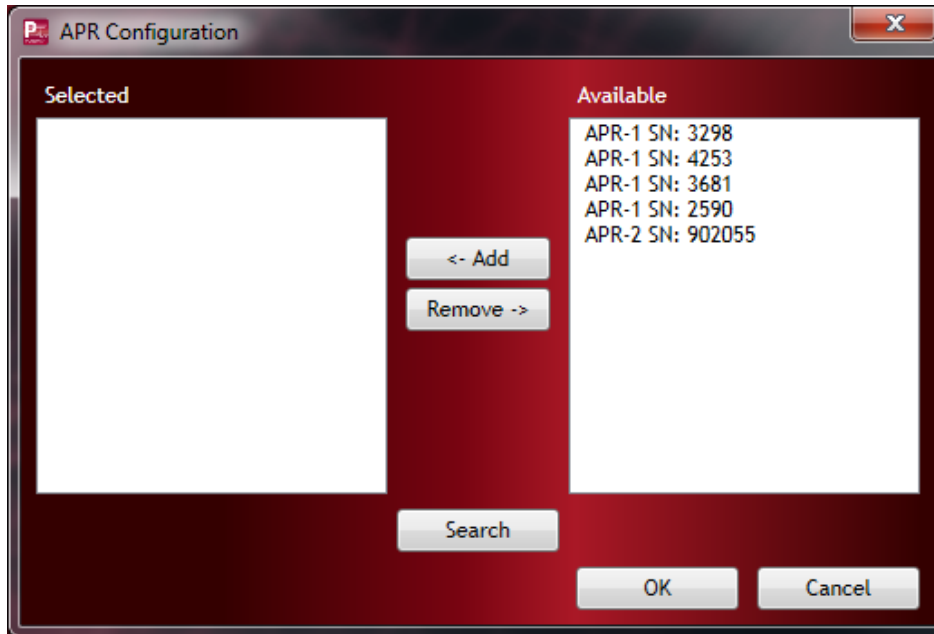
- **APR** Used to add an Ambient Pressure Reference to your experiment. This is only needed if your implant has a Pressure channel.
- **PhysioTel Digital** Used to configure hardware and implants when using DSI's Large Animal PhysioTel Digital implantable telemetry platform.
- **MX2** Used to configure hardware and implants when using DSI's PhysioTel HD and PhysioTel implantable telemetry platform.

EDIT APR CONFIGURATION

For implants that include a pressure channel, the Ambient Pressure Reference (APR-2) will need to be selected. It is recommended to configure the APR-2 prior to configuring the rest of your telemetry hardware.

To add an APR-2 to your Experiment:

1. Select the **Hardware** menu and choose **Edit APR Configuration...**



2. Add the APR associated with your system from the **Available** column to the **Selected** column by clicking-and-dragging the appropriate APR from the **Available** column to the **Selected**.
3. Select **OK**.

Notes:

- Both the APR-1 and APR-2 are compatible with the telemetry system. Their model will be called out (as illustrated above), along with their serial number for easy identification.
- Select the **Search** button should hardware changes occur while this dialog is up to reflect the changes.

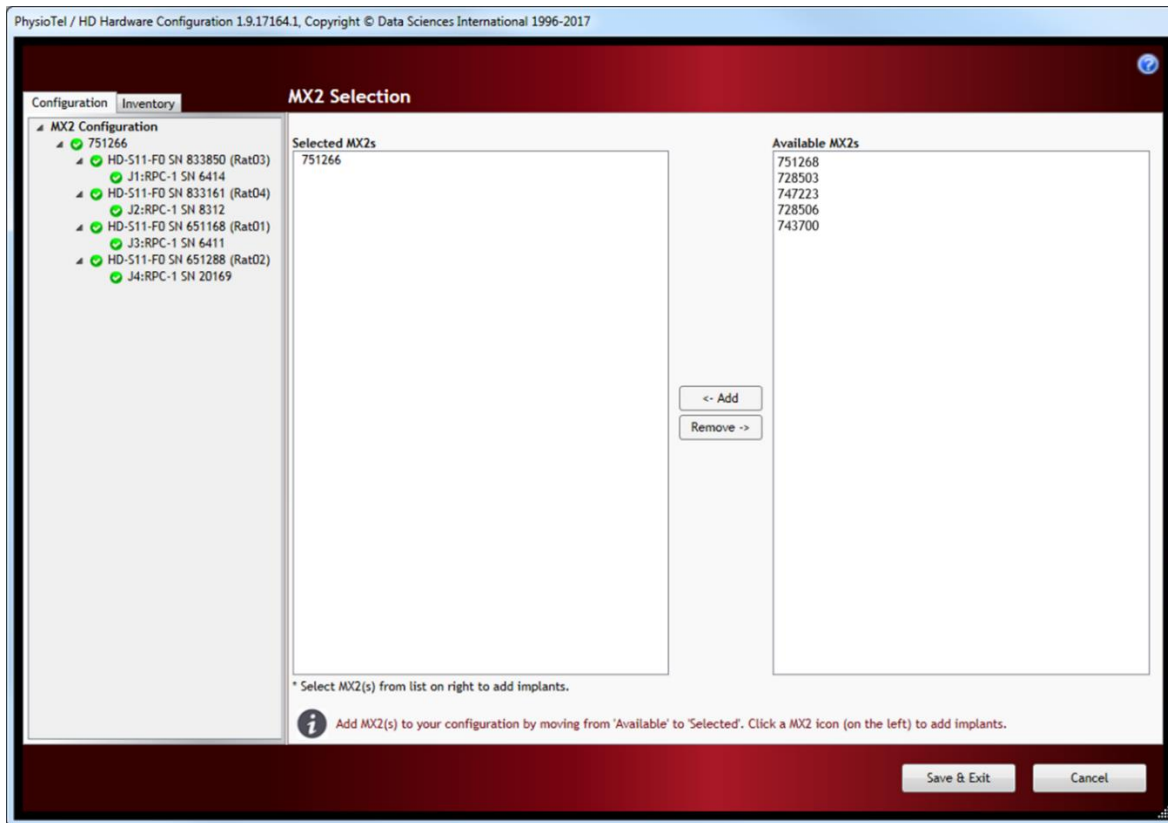
EDIT PHYSIOTEL /HD (MX2) CONFIGURATION

The PhysioTel /HD (MX2) Configuration process allows you to add PhysioTel and PhysioTel HD implants to the Experiment and associate them with the appropriate telemetry receiver (e.g. RPC-1) for data collection.

The PhysioTel /HD (MX2) Configuration process is composed of four major steps:

- Select MX2s to be configured in the Experiment
- Add implants to the individual MX2s
- Configure the implants accordingly for signal types and sample rates
- Associate receivers with specific implants

To edit the PhysioTel /HD (MX2) Configuration dialog select the **Hardware menu | Edit PhysioTel /HD (MX2) Configuration...** to open the MX2 Hardware Configuration dialog.

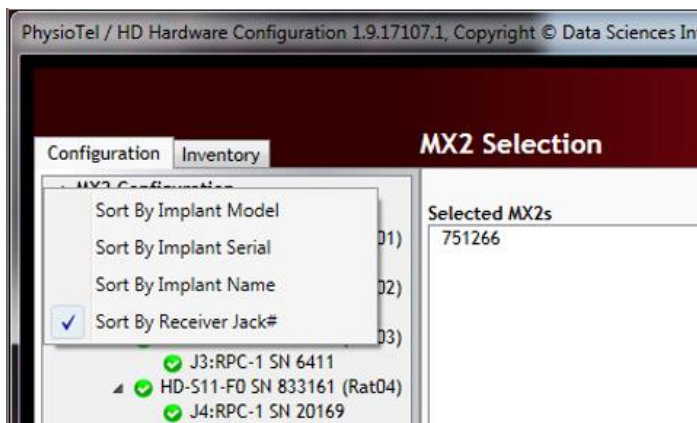


There are two functional areas in the **Configuration** dialog:

- The “**List**” view on the left is a container which tracks the growing hardware configuration. As MX2s, implants, and receivers are added to the configuration, the individual items will be automatically arranged in a tree structure to represent their relationships.
- The “**Details**” view on the right provides the customizable options available for the hardware items when selected from the List dialog.

Note: The **List View** may be sorted based on your preferences by right-clicking anywhere in the **List**. The following options are available to sort by:

- Implant Model
- Implant Serial Number
- Implant Name
- Receiver Jack # (default)

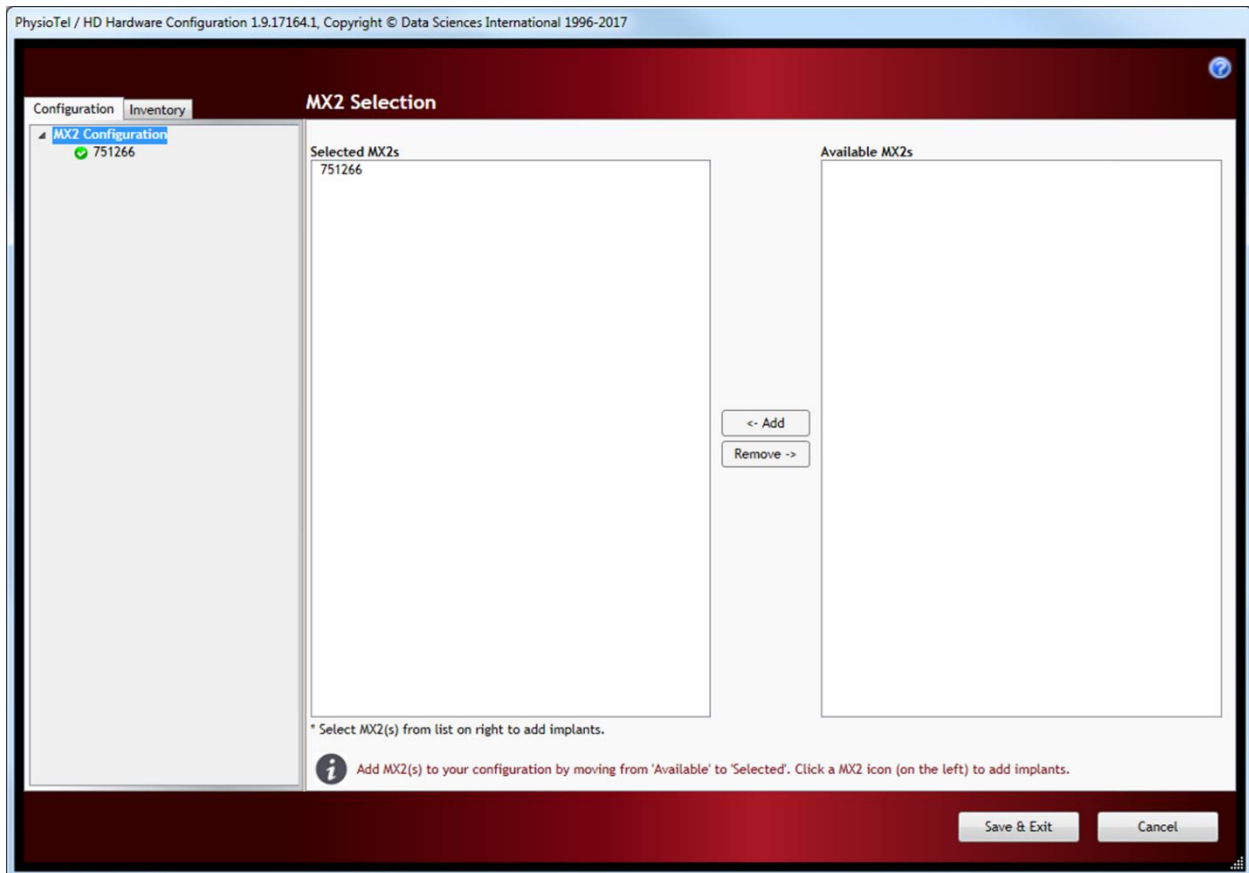


CONFIGURATION




The **PhysioTel /HD (MX2) Configuration** allows you to add PhysioTel and PhysioTel HD implants to the system and associate them with the appropriate receiver for data collection.

To begin your configuration process:

1. Select **MX2 Configuration** from the **Configuration** tab's **List View**.
2. The **MX2 Selection** view will display a list of MX2s which are **Available** on the network. The **Selected** column lists the user selected MX2s for configuration in the current Experiment. Click-and-drag the MX2(s) from the **Available** column to the **Selected** column.

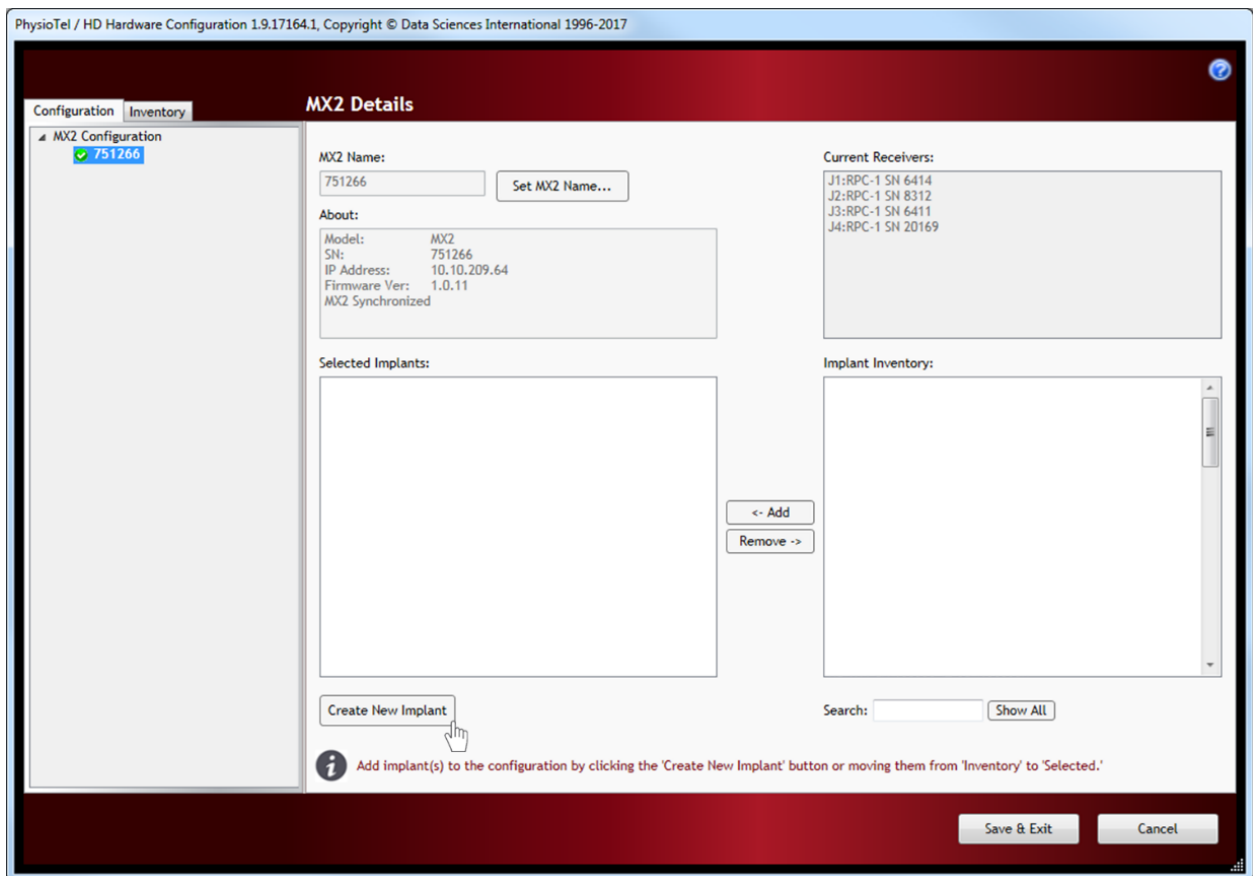


Once a MX2 is listed in the **Selected** column, it will also be added to the **MX2 Configuration** tree in the **Configuration** tab on the far left. It will also be accompanied by a colored icon next to its name:

-  Enabled – a green colored icon with checkmark indicates the MX2 is synchronized and ready; i.e. it is connected and not currently configured in another system's Experiment.
-  Disabled – a red colored icon with exclamation mark indicates the MX2 is not currently available (e.g. in configuration but not connected to the network) or is currently configured in an Experiment on another system.
-  Synchronizing – a yellow colored, time icon indicates the MX2 is attempting to synchronize to the computer time or does not currently have any receivers physically connected.

Note: An individual MX2 can only be configured by one Ponemah system at a time. The MX2 will be visible on the network but, if it remains part of a configured Experiment, it will not be available to any other system on the network. To free up a configured MX2, the Experiment which holds its configuration must be closed.

3. Select an **MX2** from the **Configuration** tree on the left of the dialog to display the *MX2 Details* view and begin adding implants to the configuration.
4. Select the **Create New Implant** button to display the *Implant Details* view.



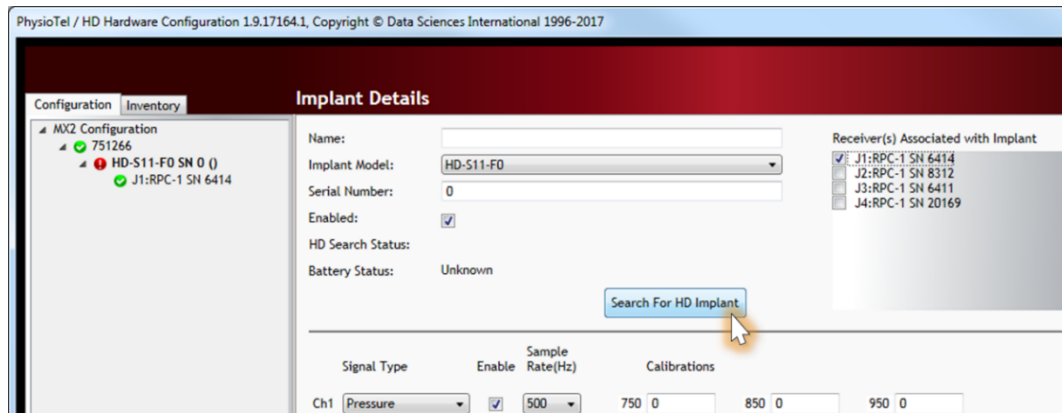
Note: Implants can be added to an MX2 by selecting the **Create New Implant** button or by click-and-dragging pre-configured implants from the **Inventory** list. Please see the Inventory section of the manual to learn more about this feature.

5. For PhysioTel HD Implants:

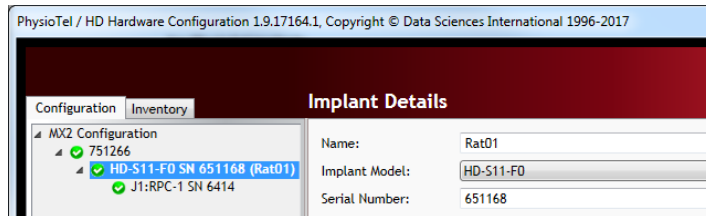
- a. Select the **Implant Model** using the dropdown menu.
- b. Associate a receiver(s) with the implant by checking the receiver checkbox you wish to configure it on. This will enable the **Search for HD Implant** button.

Note: multiple receivers may be associated with the implant.

- c. Select the **Search for HD Implant** button and then activate the HD implant with the magnet. The serial number and calibration values will automatically download from the HD implant to the software.



- d. Enter the **Implant Name**.



For PhysioTel Implants

- Enter the **Implant Name** and select the **Implant Model** using the dropdown menu.
- Enter the **Implant Serial Number**.
- Enter the **Calibration Values** located on the back of the implant packaging to correspond with the appropriate channels.
- Associate a receiver(s) with the implant(s) at any time throughout/after the creation process by checking the appropriate receiver checkbox.

Note: multiple receivers may be associated with the implant.

- Use the dropdowns to assign the appropriate **Channel Type** and **Sampling Rate** for each channel. These will default to typical values based on the Implant Model selected. *See Notes for typical values.
- Once all implants have been configured select **Save & Exit**.

Notes:

- The signal type should be updated to appropriately represent the signal you are acquiring as it is used by the system to automatically assign the analysis module used to calculate physiologic values from the signal.
- The sampling rate should be set high enough to capture all significant changes in the signal, but low enough to avoid excessive over-sampling. The following is a list of recommended sample rates for the standard telemetry signal types.
- Implant icon definitions:



Enabled – a green colored icon with checkmark indicates the implant has a Name, Serial Number, Calibrations Values, and at least one Receiver selected.



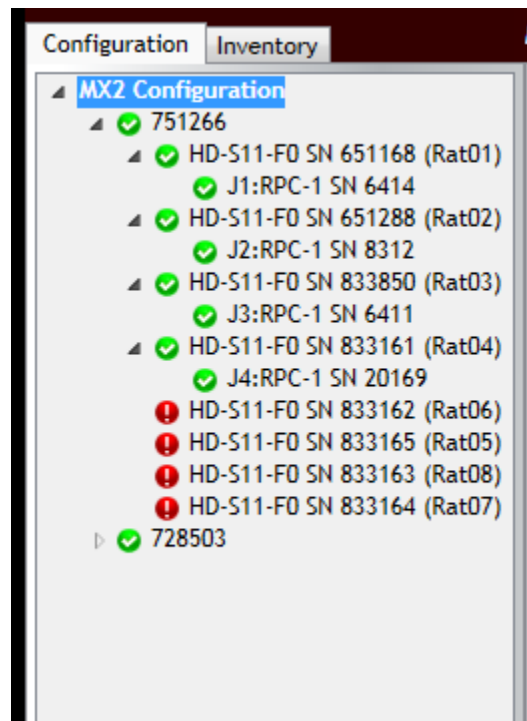
Disabled – a red colored icon with exclamation mark indicates the implant is not currently available (e.g. in configuration but does not have at least one Receiver selected).

- *Typical Signal Type and Sampling Rate values:

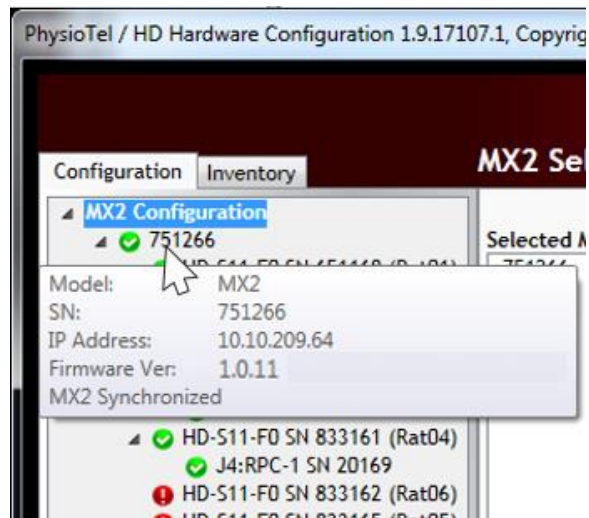
Signal Type	Sampling Rate (Hz)
Blood Pressure (BP)	500
Left Ventricular Pressure (LVP)	500
Electrocardiogram (ECG)	1000
Electroencephalogram (EEG)	1000
Electromyogram (EMG)	1000
Temperature	1
Activity	1
Signal Strength	1

PHYSIOTEL CONFIGURATION DETAILS

Multiple layers of information are contained in the *PhysioTel/HD Hardware Configuration* dialog, each accessed using the List View on the left side. The **MX2 Configuration** column lists the entire setup in an expandable tree structure. The MX2s are listed with their assigned implants listed underneath.



Note: The tree structure can be expanded and contracted by clicking on the arrows immediate to the left of the individual line items. Hover the mouse cursor over any line item in the Configuration box to activate an information pop-up with that device's key status condition. The example below is the hover information for an MX2.



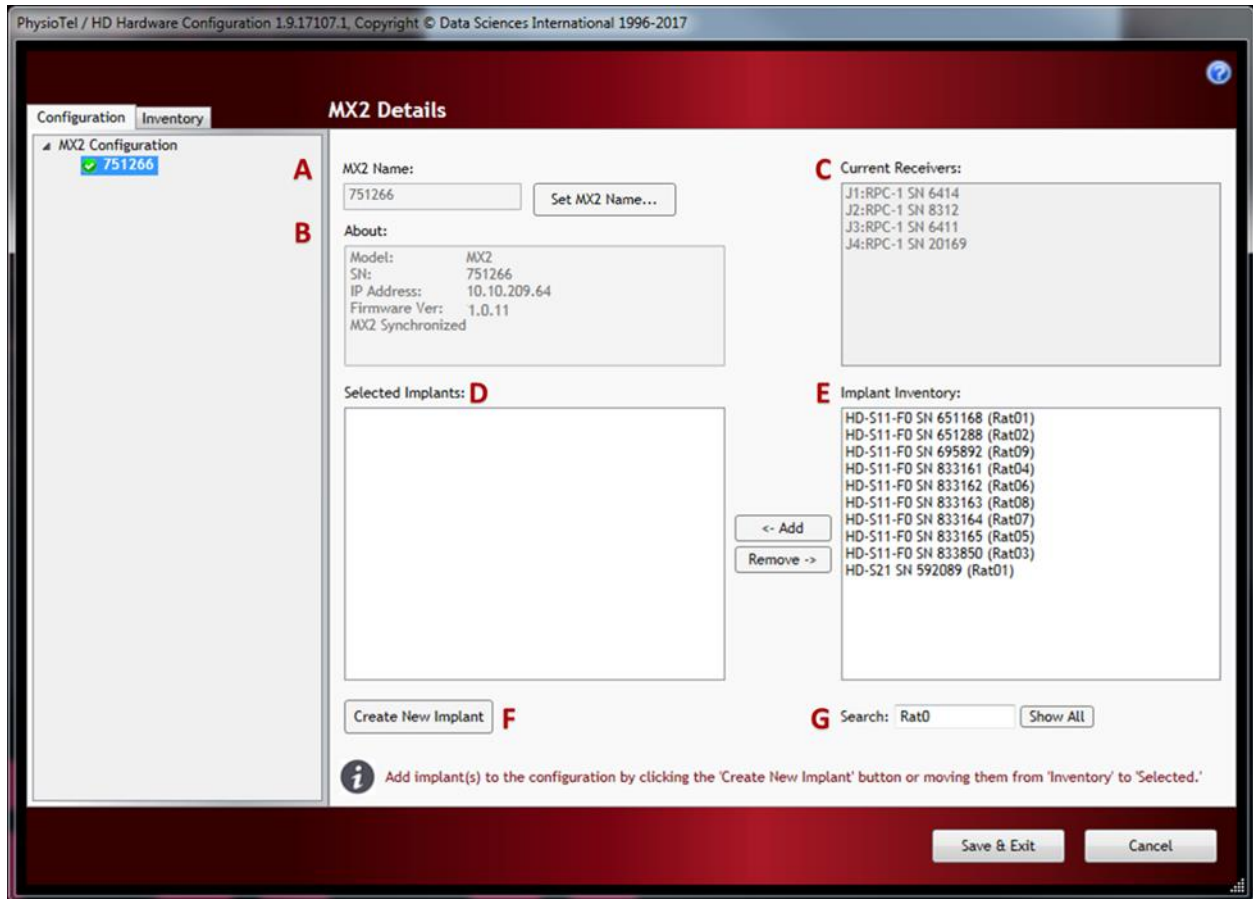
The **MX2 Configuration** is the first line in the List View and displays the **Selected MX2** for the current configuration.

The List View can also be used to access the following information:

- MX2 Details
- Implant Details
- Receiver Details

MX2 DETAILS

The **MX2 Details** dialog provides detailed information on the associated MX2. The following displays the MX2 Details page and defines each component of the dialog.

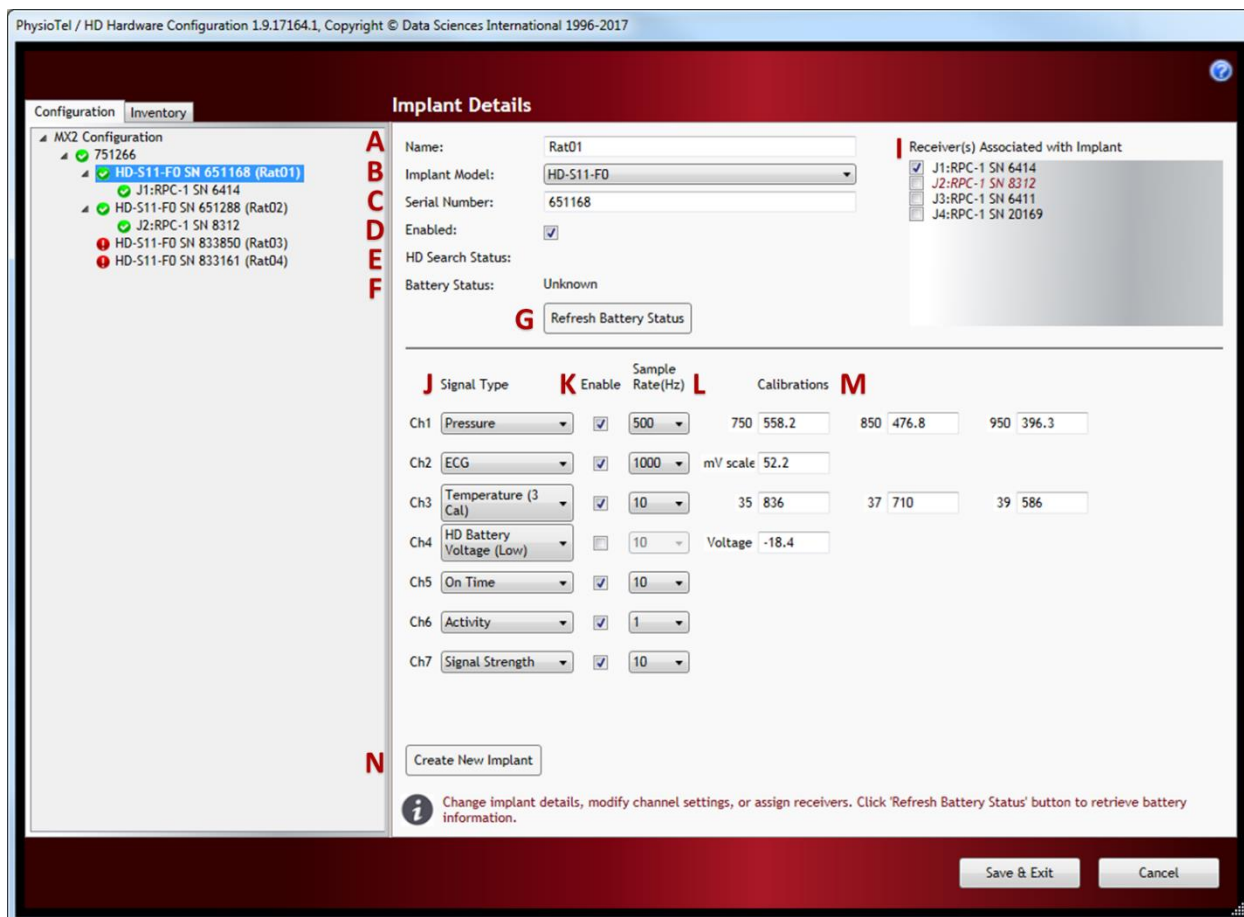


The following features are available in the **MX2 Details** dialog:

- A. **MX2 Name:** Select the **Set MX2 Name...** button to create or change the name of the MX2. This name is saved on the MX2 and will be the name seen when searching the network for available MX2s to add to the configuration with the *MX2 Configuration* view.
- B. **About:** lists information pertinent to the MX2.
- C. **Current Receivers:** list of the receivers that are connected to the MX2 sorted by jack number.
- D. **Active Implants:** lists the implants that are configured to the MX2.
- E. **Implant Inventory:** list of implants currently configured in the Inventory.
- F. **Create New Implant:** clicking the button will create a blank implant and open a new *Implant Details* dialog.
- G. **Search:** search function for the Implant Inventory. This will work on the implant model, serial number, or implant name

IMPLANT DETAILS

The **Implant Details** dialog is an interactive dialog that helps users configure the Implants and manage the associated hardware used to acquire data. An example of the dialog is provided below.



The following features are available from the **Implant Details** dialog:

- A. **Name**: allows the user to associate an **Animal ID** with the implant. This will be used to automatically generate the Subject Name upon selecting **Save & Exit** from the **MX2 Configuration** dialog.
- B. **Implant Model**: list of available implant models that can be added to the system.
- C. **Serial Number**: location to enter the implant serial number found on the implant and implant packaging. For HD implants, this field will be greyed out as the serial number is transmitted to the system with the calibration values upon HD configuration.
- D. **Enabled**: This check box will toggle the implant between '**Enabled**' and '**Disabled**' modes. The Enabled mode allows the software system to record, store, and analyze data from the implant.



WARNING: if the implant is not **Enabled**, the implant will still be powered **ON** and in communication with the system, but no data from the implant will be acquired.

- E. **HD Search Status**: When the **Search for HD Implant** button is selected, the status of the search is indicated here.
- F. **Battery Status**: Displays the current On Days of PhysioTel HD implants.

- G. **Refresh Battery Status:** Allows the user to refresh the Battery Status information to obtain the latest values.
- H. **Search for HD Implant (pictured below):** This button is activated when a PhysioTel HD Implant model is selected from the dropdown box and a Receiver is selected. Selecting this button will put the software into a search mode, waiting for the HD implant to be turned **ON** via a magnet. Once **ON**, the implant will send a burst of information, including its **serial number** and **calibration values**. These will be displayed in the appropriate fields once received by the system.

Implant Details

Name:

Implant Model:

Serial Number:

Enabled:

HD Search Status:

Battery Status: Unknown

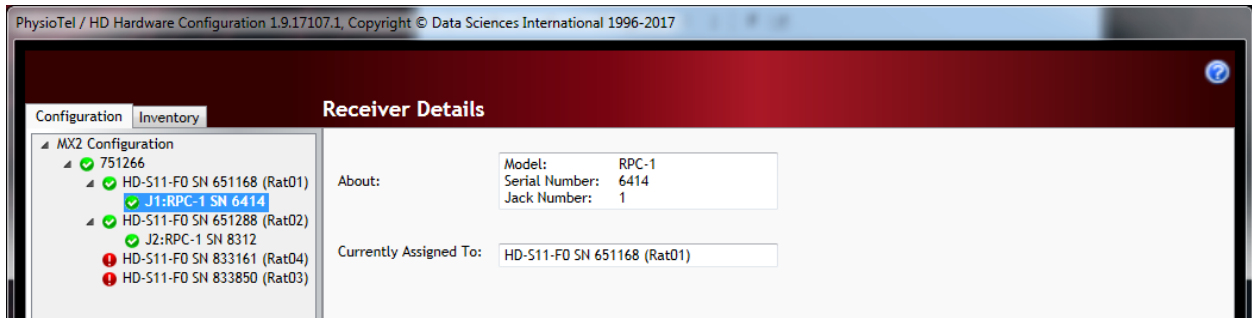
Receiver(s) Associated with Implant

- J1:RPC-1 SN 6414
- J2:RPC-1 SN 8312
- J3:RPC-1 SN 6411
- J4:RPC-1 SN 20169

- I. **Receiver(s) Associated with Implant:** allows the user to associate a receiver with an implant. More than 1 receiver may be associated with an implant to extended the telemetry coverage range across a larger area; e.g. larger than standard mouse cage or animal runs. Hovering over the receivers in this list will provide details on the receiver and with which subject it is associated. Receivers that are displayed in *red italicized* font are those that are currently assigned to an implant.
- J. **Signal Type:** allows the user to define which signal type should be used for the particular implant channel. These will default to the most common signal types based on the implant model selected; e.g. **HD-S10** pressure channel will default to the **Pressure** signal type. This is important because the signal type defined here is used to automatically define the **Analysis Module** assigned to the channel when automatically creating **Subjects**.
- K. **Enabled (associated with channel):** This check box will toggle the **Input** channel between 'Enabled' and 'Disabled' modes. The **Enabled** mode allows the software system to record, store, and analyze data from the **Input** channel.
- L. **Sampling Rate:** allows the user to define a unique sampling rate to each implant channel.
- M. **Calibrations:** allows the user to enter the implant calibration values located on the back of the implant packaging. For HD implants, these will automatically be generated when selecting **Search for HD Implant** button (not displayed in this example).
- N. **Create New Implant:** selecting this button will generate a blank **Implant Details** page to allow the user to create a new implant. The implant model that the button was selected from will automatically be selected within the **Implant Model** dropdown for optimal efficiencies in implant configuration.

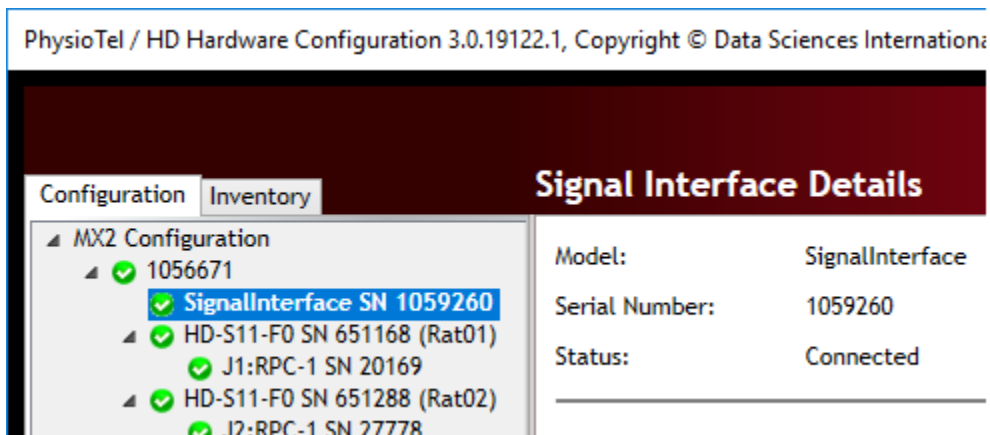
RECEIVER DETAILS

The **Receiver Details** dialog provides information on the Receiver, including its Serial Number, MX2 jack location, and the Subject to which it is currently assigned. No user actions take place from the Receiver Details dialog.



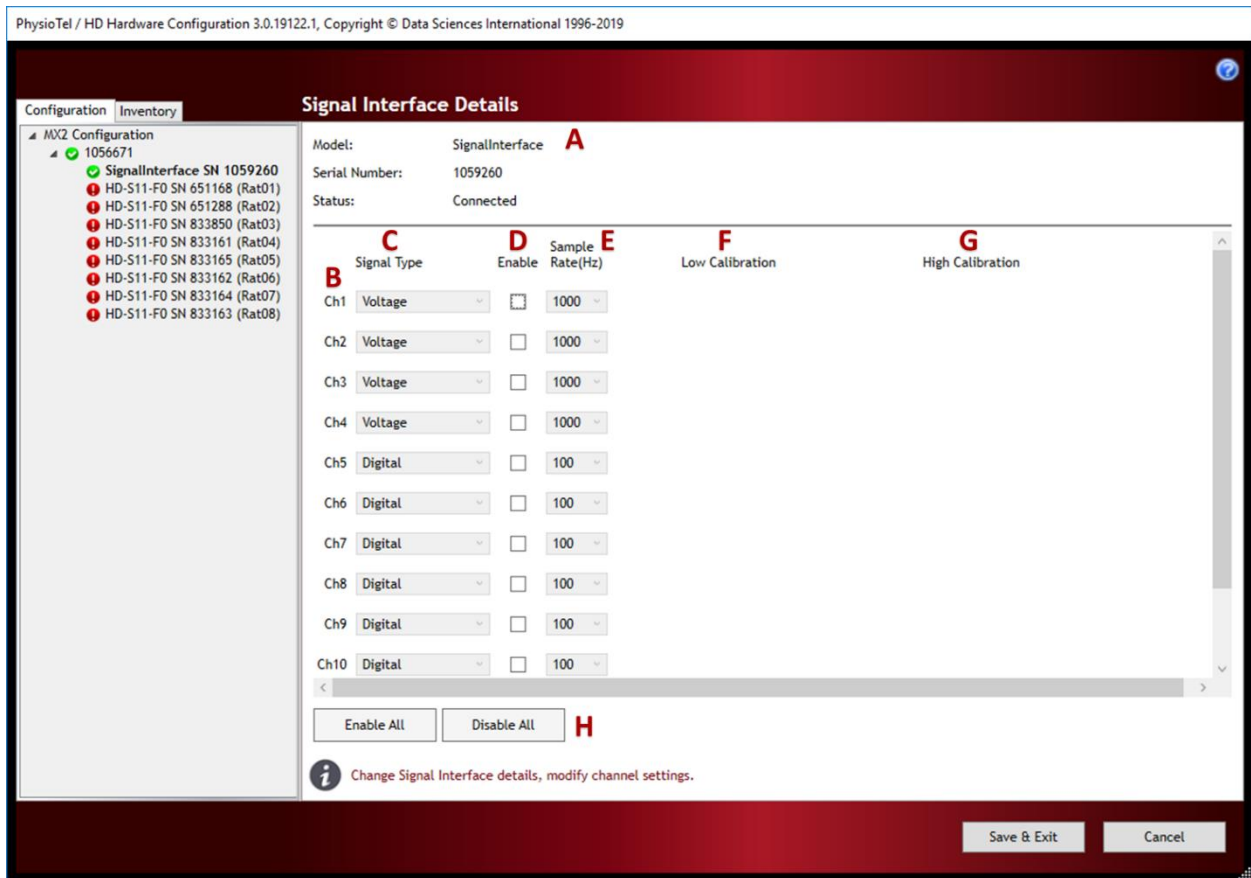
SIGNAL INTERFACE CONFIGURATION

When using a Signal Interface to collect external 3rd party signals, it will be listed in the tree view immediately below the MX2 to which it is connected. Please see **Signal Interface** for details on the device.



SIGNAL INTERFACE DETAILS

The **Signal Interface Details** is an interactive dialog helping users configure and calibrate the 4 analog and 8 digital channels.



The following features are available from the **Signal Interface Details** dialog:

- A. **Signal Interface:** displays the model, serial number, and current status of the Signal Interface.
- B. **Channel Labels:** lists the available Signal Interface channels. Channels 1-4 within the dialog are associated with the analog channels 1-4 on the front panel of the Signal Interface. Channels 5-12 in the dialog are associated with the digital channels available via the 25-pin D connector on the back panel of the Signal Interface.
- C. **Signal Type:** allows the user to define which signal type should be used for the particular Signal Interface channel. The signal type defined here is used to automatically define the **Analysis Module** assigned to the channel when automatically creating **Subjects**. This defaults to Voltage, which is used to collect an uncalibrated signal. Changing this to another Signal Type, i.e. Pressure, will display fields for Low and High Calibration.
- D. **Enabled:** This check box will toggle the Signal Interface Channel between 'Enabled' and 'Disabled' modes. The Enabled mode allows the software system to record, store, and analyze data from the channel.
- E. **Sampling Rate:** allows the user to define a unique sampling rate to each implant channel.
- F. **Low Calibration:** permits low end calibration of the channel.
- G. **High Calibration:** permits high end calibration of the channel.

Note: The Signal Interface supports a 2-point calibration if an input calibration signal (voltage) is available. These fields become available when the Signal Type is changed from voltage to another type.

- H. **Enable All/Disable All:** these buttons toggle the checkboxes of all 12 channels to Enabled or Disabled.

CALIBRATING THE SIGNAL INTERFACE ANALOG CHANNELS

An input calibration signal (voltage) may be applied to the Signal Interface analog channels to perform a 2-point calibration.

To calibrate a channel:

1. Enable the Signal Interface Channel; i.e. Ch1.
2. Select the appropriate Signal Type; i.e Pressure.
3. Enter the Low and High values in actual physical units; i.e. Low value = 0, High Value = 100.

Signal Type	Enable	Sample Rate(Hz)	Low Calibration		High Calibration			
Ch1 Pressure	<input checked="" type="checkbox"/>	1000	0	0	Measure	100	0	Measure
Ch2 Voltage	<input type="checkbox"/>	1000						

4. Apply the calibration signal (voltage) to associate with the **LOW** value, then click the Measure button associated with the **LOW Calibration**. The systems will sample from the Signal Interface channel for 5 seconds and then populate the **LOW Calibration** field with the average voltage over that 5 seconds.
5. Apply the calibration signal (voltage) to associate with the **HIGH** value, then click the Measure button associated with the **HIGH Calibration**. The systems will sample from the Signal Interface channel for 5 seconds and then populate the **HIGH Calibration** field with the average voltage over that 5 seconds.
6. Repeat for any additional Signal Interface channels required.

INVENTORY

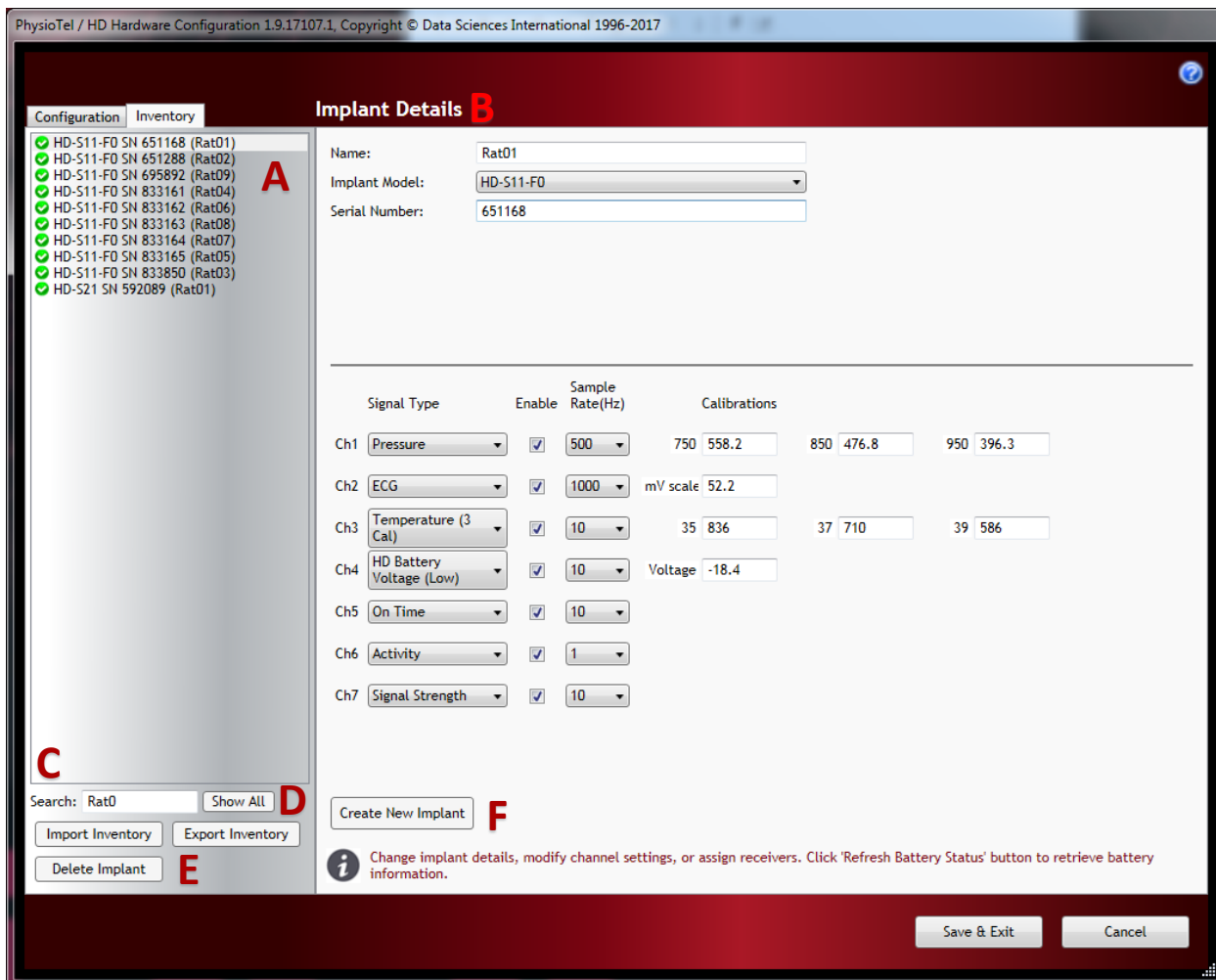
The **Inventory** is a repository for the storage and retrieval of implant details which have been configured in the current Experiment, or previously configured Experiments. The implants contained within the Inventory can be used across Experiments without having to re-configure the implant within each new Experiment it is to be used. The Inventory is available to all Experiments started from the PC.

Users can export their Implant Inventory and import them on different acquisition PC's. This allows the User to add implants previously configured on one PC to another for use in new experiments without having to re-enter calibration values.

The Inventory of available implants can be viewed in two locations within the **PhysioTel /HD Hardware Configuration** dialog:

- The **Implant Inventory**: dialog box within the **MX2 Details** page.
- The **Inventory** tab on the left side of the **Configuration** dialog.

The Inventory is managed through the **Inventory** tab located on the on the left side of the **MX2 Configuration** dialog.



Inventory tab includes:

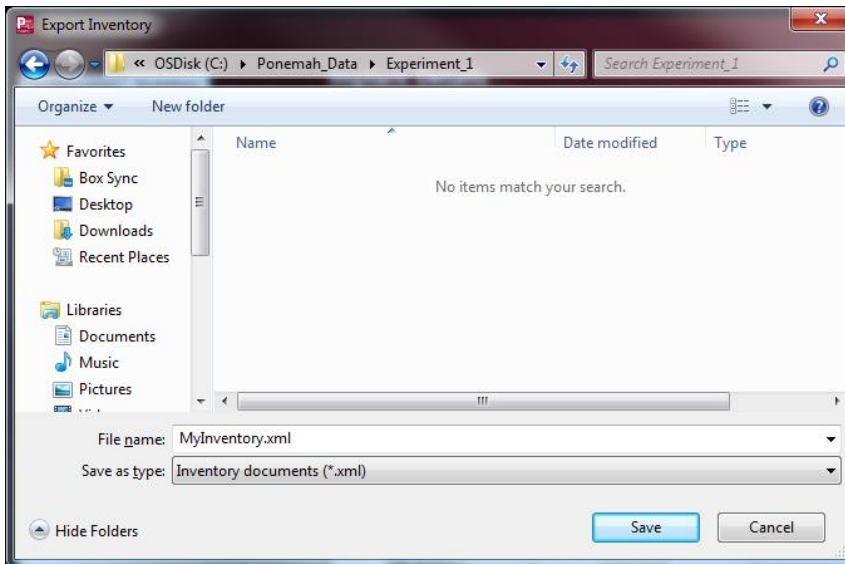
- A. **List of Implants:** lists the implants available from the Inventory.
- B. **Implant Details:** allows the User to configure individual implants.
- C. **Search:** allows the user to query the Inventory to locate specific implants. User can locate implants by model or serial number.
- D. **Export/Import Inventory:** saves and retrieves inventory information in *.xml file format.
- E. **Delete Implant:** removes implants from the Inventory.
- F. **Create New Implant:** adds a new implant to the Inventory.

EXPORT/IMPORT INVENTORY INSTRUCTIONS

Users can import and export their Implant Inventory from one Experiment to another or from one PC to another. This allows the User to add implants previously configured on one PC to another for use in new experiments without having to re-enter calibration values.

Exporting configured Implants:

1. From the **Inventory** tab in the **MX2 Configuration** dialog, click the **Export Inventory** button. This opens the **Export Inventory** dialog.

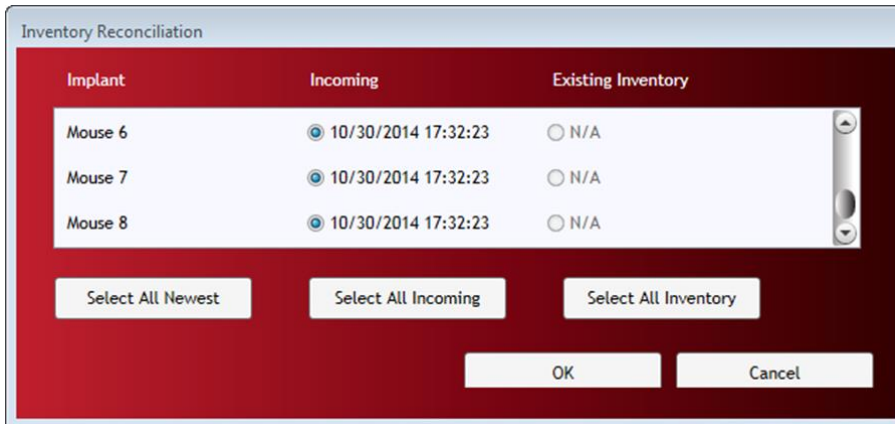


2. The default filename is **MyInventory.xml** but the user may use any filename with an .xml file extension.
3. Click **Save**.

Note: Export Inventory will export all implants listed in the Inventory tab, regardless of which implant names are selected.

Importing configured Implants:

1. From the **Inventory** tab in the **PhysioTel / HD Hardware Configuration** dialog, click the **Import Inventory** button. This opens the **Import Inventory** dialog.
2. Locate the saved inventory file (*.xml) you wish to import and click **Open**. This opens the **Inventory Reconciliation** dialog.



3. This dialog will provide information on the incoming implants and check if any implants with the same model and serial number already exist in the Inventory the import is taking place. Manually select the implant configurations you wish to import by selecting the appropriate radio buttons associated with each Implant or use the buttons to auto-select.

The option to **Select All Newest** will select all implants that did not pre-exist as well as overwrite duplicate implants with the data from the import if their last modified date (listed in the dialog) is more recent than

the implant already in the inventory. If it is less recent, it will not import the duplicate implant information over the pre-existing implant.

The **Select All Incoming** button will select all implants for import and will overwrite any duplicate pre-existing implant models/serial numbers upon selecting **OK**.

4. Select **OK** to import. The selected implant names will be added to the list in the Inventory tab.

DELETE IMPLANTS FROM INVENTORY

To remove configured implants from the **Inventory**:

1. From the **Inventory** tab in the **PhysioTel / HD Hardware Configuration** dialog, select the implant names you wish to delete from the **Inventory**. Multiple implant names may be selected.
2. Select **Delete Implant**. This will prompt a confirmation **Delete Implant from Inventory** dialog.
3. Select **Yes** if appropriate. A separate **Delete Implant from Inventory** dialog will appear for each implant selected for deletion.



WARNING: This option permanently removes the implant information from the system. The **Delete Implant** option will only remove the implant configuration from the Inventory. Any data collected with the implant will remain unaltered in the data folders until the files are moved or deleted.

CREATE IMPLANTS WITHIN INVENTORY

New Implants may be configured within the Inventory to conveniently configure PhysioTel implants once received from DSI. This may be useful to save time once the user has their Experimental Protocol defined and are ready to start an experiment, as implants can then be quickly pulled from the inventory and associated to the appropriate MX2s at this time. Please see the **Configuration** section within **Edit PhysioTel / HD Hardware Configuration** on how to quickly add implants from the **Inventory** to an MX2.

EDIT PHYSIOTEL DIGITAL (CLC) CONFIGURATION

The PhysioTel Digital system automates the collection of physiologic data from freely moving research animals via wireless telemetry. The system consists of a sophisticated acquisition and analysis software platform and a family of advanced, state of the art implantable telemetry transmitters. The communications link between these two components consists of wired and wireless components collectively referred to as the PhysioTel Digital Hardware.

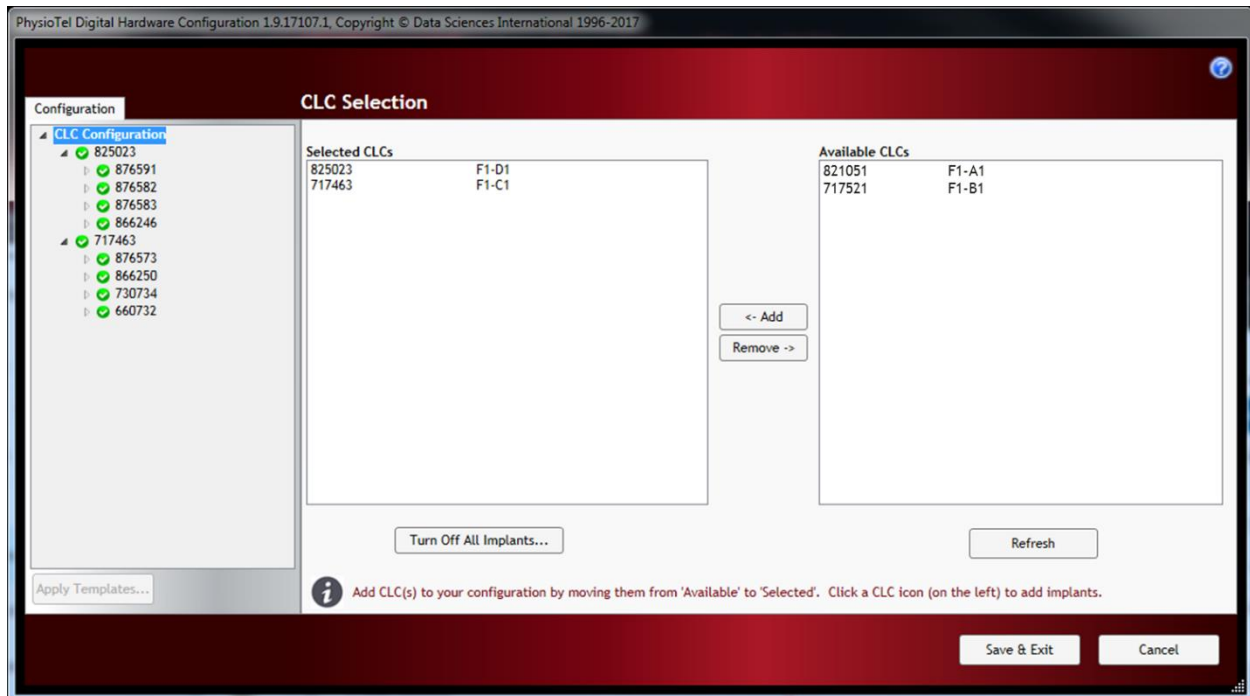
The **PhysioTel Digital Configuration** allows you to add PhysioTel Digital implants to the system and associate them with the appropriate CLC for data collection.

To edit the PhysioTel Digital (CLC) Configuration dialog select **Hardware | Edit PhysioTel Digital (CLC) Configuration...**

There are two functional areas in the **PhysioTel Digital Configuration** dialog:

- The “**List**” view on the left is a container which tracks the growing hardware configuration. As CLCs, implants, and transceivers are added to the configuration, the individual items will be automatically arranged in a tree structure to represent their relationships.

- The “**Details**” view on the right provides the customizable options available for the hardware items when selected from the List dialog.



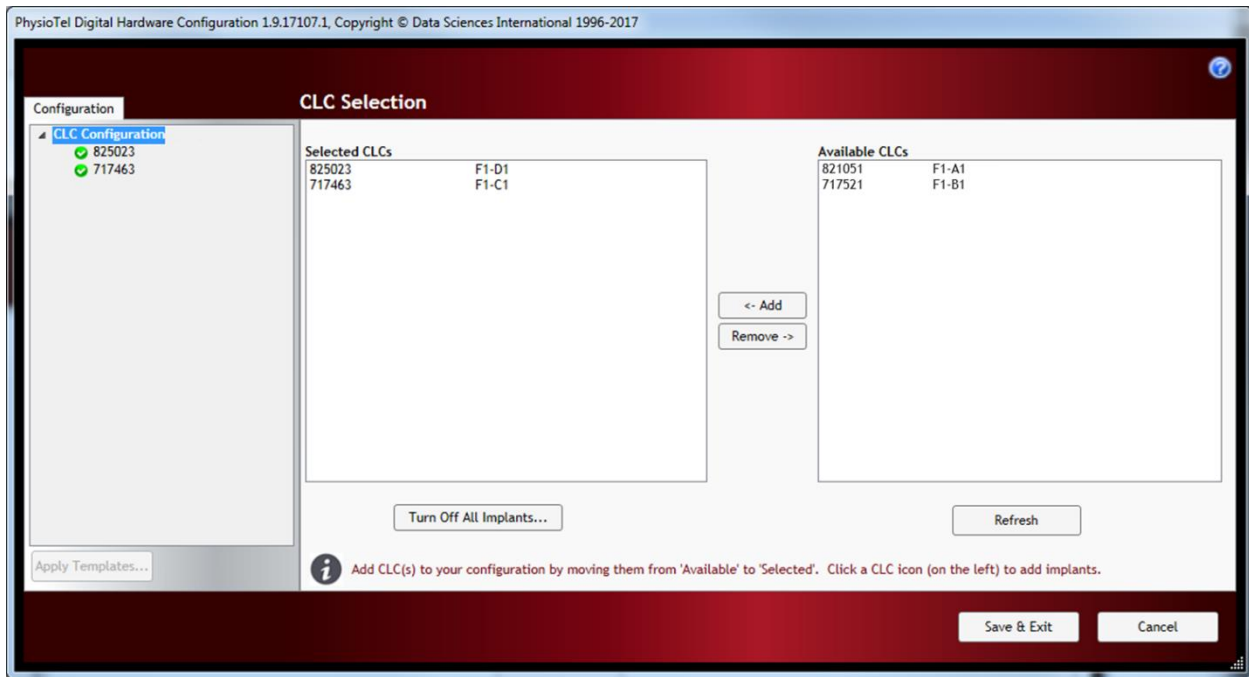
CONFIGURATION

The **PhysioTel Digital Configuration** allows you to add PhysioTel Digital implants to the system and associate them with the appropriate CLC for data collection.





To begin your configuration process:

1. Activate the implants to be added to this configuration per the procedure described in Implant Activation Section of this manual.
2. Select **CLC Configuration** line from the **Configuration** tab’s **List View**.
3. The **CLC Selection** view will display a list of CLCs which are **Available** on the network. The **Selected** column lists the CLC(s) the user has selected for configuration in the current Experiment. Click-and-drag the CLC(s) from the **Available** column to the **Selected** column.

Note: The frequency group designations associated with the CLCs in the Available CLCs list only updates upon the initial population of the column; therefore, changes made to those CLCs from other configurations (acquisition workstations) will not dynamically update the list to display their new frequencies. Select the **Refresh** button to update the list with the latest Available CLC frequencies.

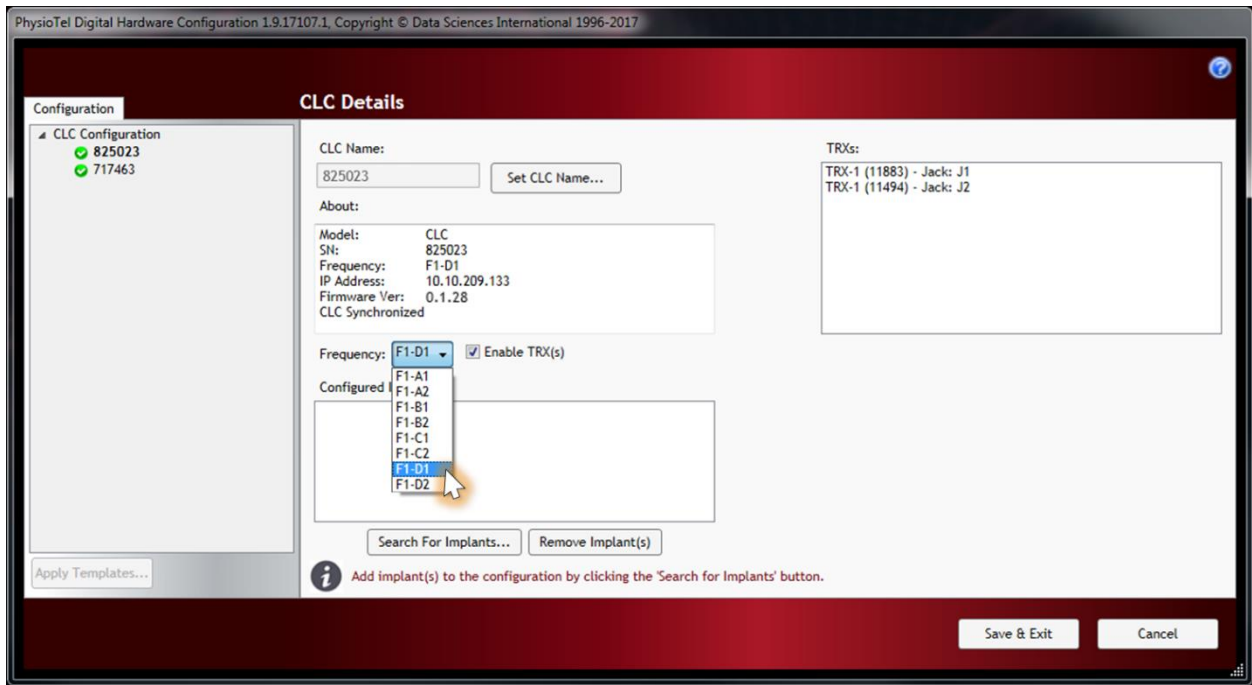


Once a CLC is listed in the **Selected** column, it will also be added to the **CLC Configuration** in the Configuration tab on the far left. It will also be accompanied by a colored light next to name:

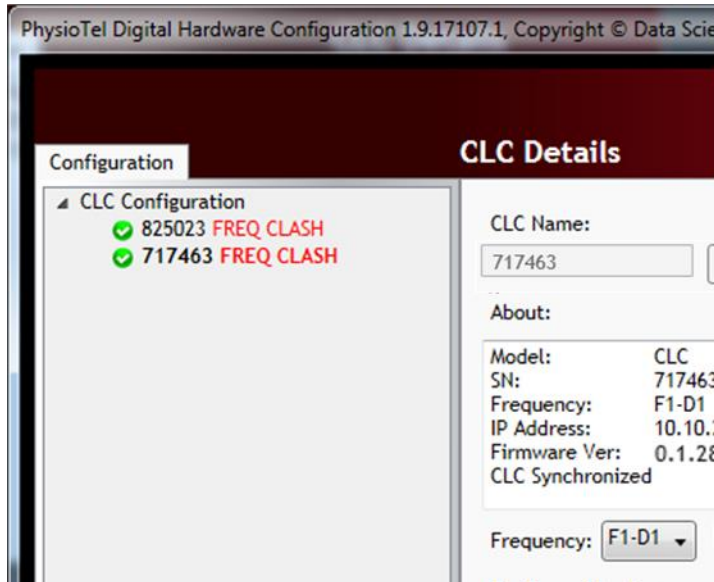
-  Enabled – a green colored icon with checkmark indicates the CLC is synchronized and ready; i.e. it is connected and not currently configured in another system's Experiment.
-  Disabled – a red colored icon with exclamation mark indicates the CLC is not currently available (e.g. in configuration but not connected to the network) or is currently configured in an Experiment on another system.
-  Synchronizing – a yellow colored, time icon indicates the CLC is attempting to synchronize to the computer time or does not currently have any TRXs physically connected.
-  Unknown – a yellow colored icon with question mark indicated the CLC is connected, but does not have any TRXs connected.

Note: An individual CLC can only be configured by one Ponemah system at a time. The CLC will be visible on the network but, if it remains part of a configured Experiment, it will not be available to any other system on the network. To free up a configured CLC, the Experiment which holds its configuration must be closed.

4. Select the first CLC in the List View to display its Details page. Use the **Frequency** dropdown to define it to a unique frequency (e.g. F1-D1).

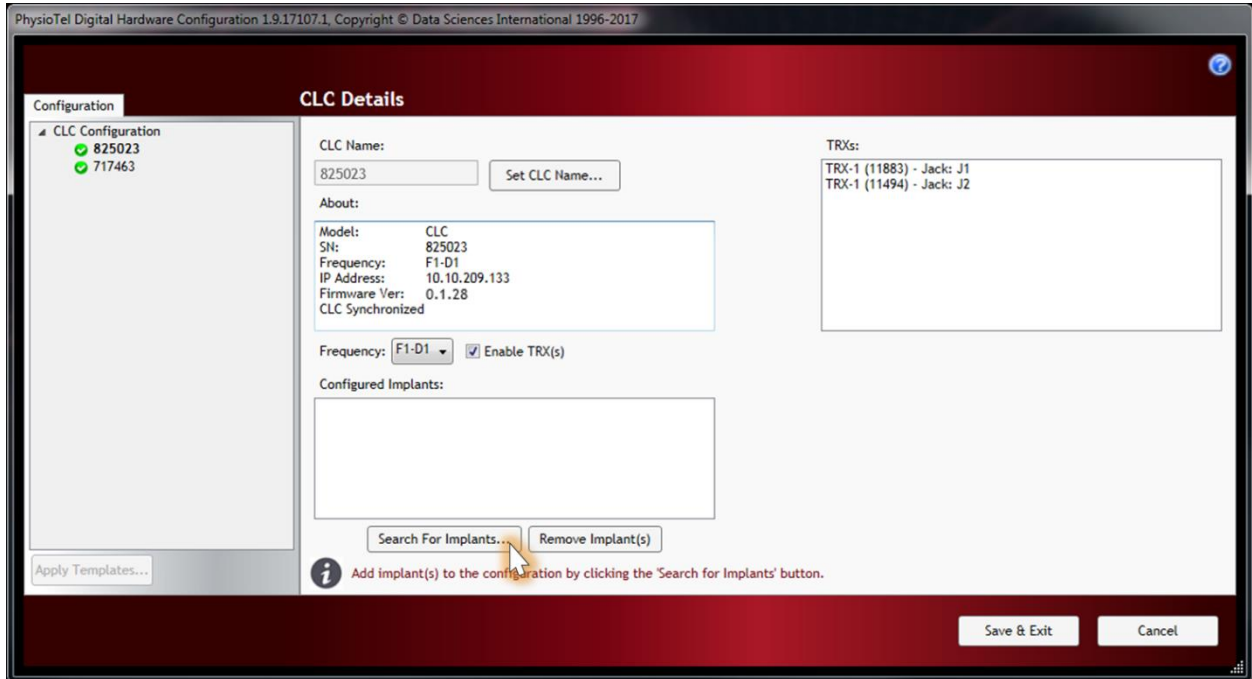


- Repeat Steps 3 and 4 for any additional CLCs within your configuration. Ensure each is assigned a unique frequency. If you choose a frequency previously defined to another CLC, a **FREQ CLASH** notification will be placed next to the CLCs with conflicting frequencies.

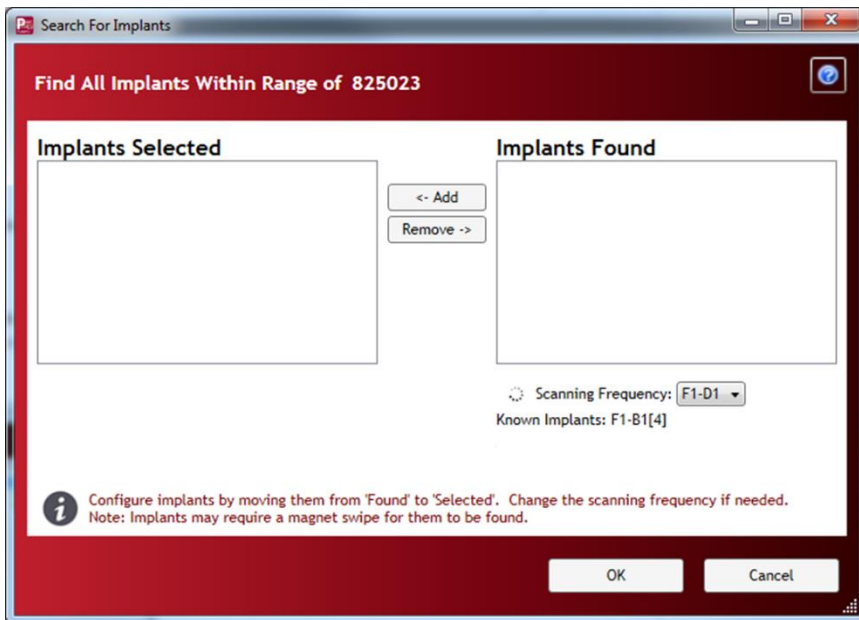


Note: FREQ CLASH will also be displayed should the frequency of a configured CLC be the same as the frequency of another CLC on the network (Available CLCs column within the CLC Configuration line of the List View). If these CLCs are spaced appropriately, they should not interfere with each other.

6. Select the first CLC from the List View and select the **Search for Implants...** button.

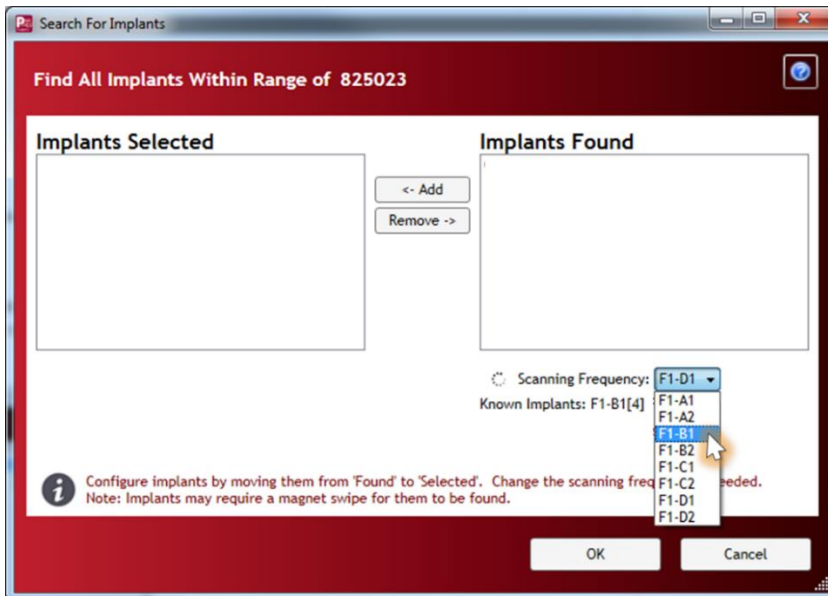


The *Search for Implants* dialog will display and automatically begin searching for implants across all supported frequencies if they are powered ON and within transmitter range. Any implants in Standby Mode and on the CLC's current frequency will be displayed in the **Implants Found** column.

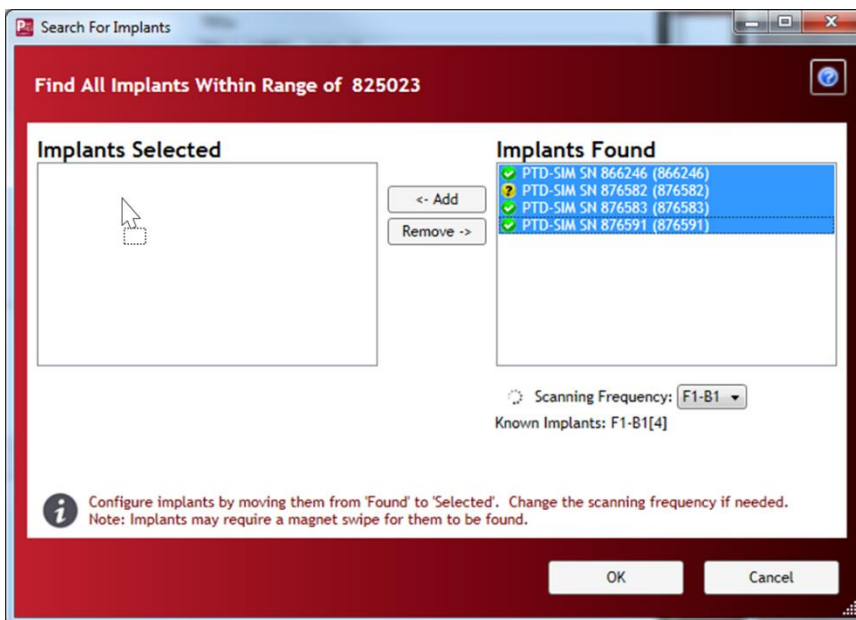


*Note: The **Known Implants** line will provide guidance on which frequencies the CLCs are seeing implants on, as well as the number of implants in brackets on that frequency. New implants that have not been previously configured will be detectable using the default frequency (B1).*

- If implants are not listed in the **Implants Found** column, or the implants listed are not the desired implants to configure to this CLC, select the Scanning Frequency dropdown to select a new frequency to scan (e.g. F1-B1).





- Drag-and-drop the desired implants from the **Implants Found** column to the **Implants Selected** column to assign the implant to this CLC. Implants may be multiselectable.



*Note: Implants only need to be listed in the **Implants Found** column to be added to the **Implants Selected** column. Their icon color and indication have no bearing on this action.*

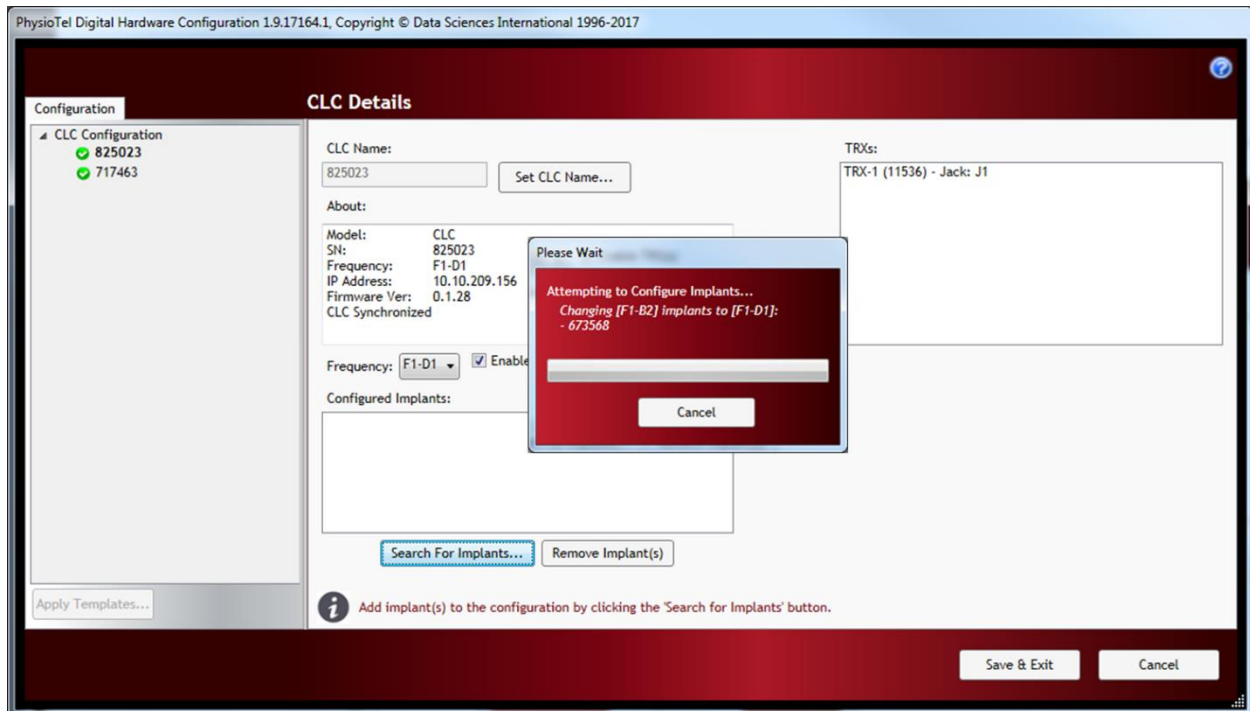


Synchronizing – a yellow colored icon with question mark indicates the CLC has received a request from the implant to connect.

-  Enabled – a green colored icon with checkmark indicates the implant has successfully connected to the CLC.
-  OFF/Out of Range – The implant is in the configuration, but is either in OFF mode or the CLC has never received any communication from it.

9. Click **OK**.

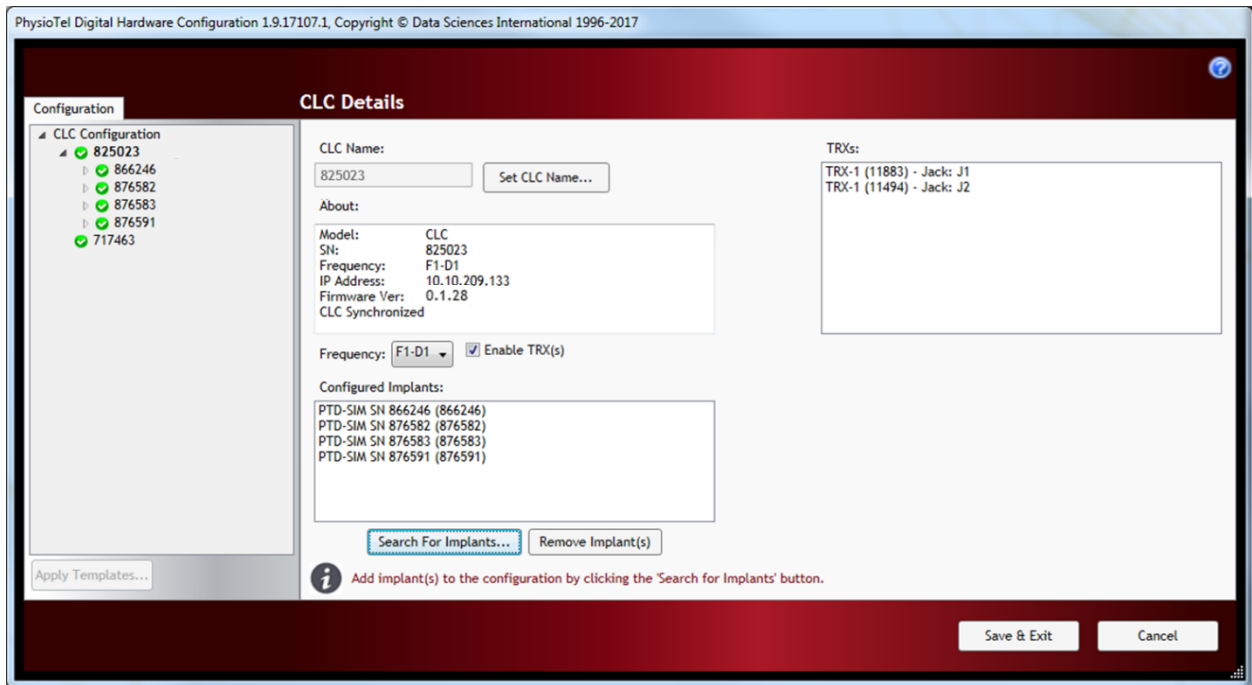
Again, no need to wait for icons to turn green. A message will be displayed requesting you to wait for the implants to be configured to their new frequencies.



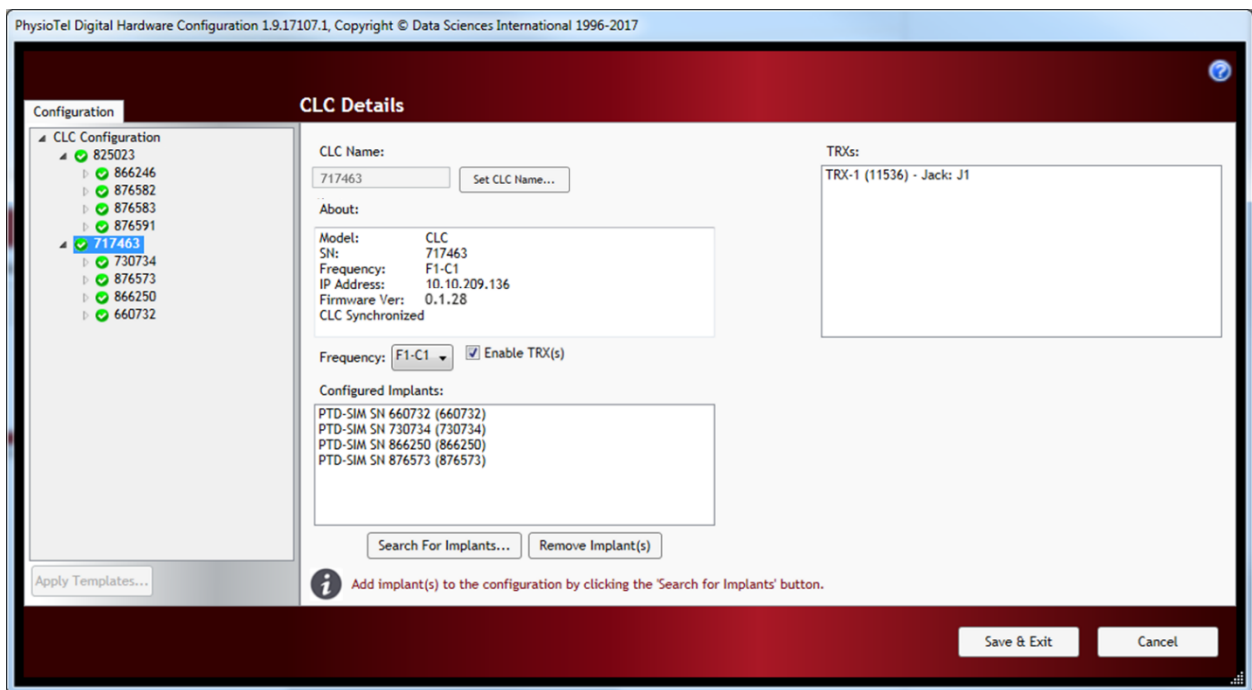
WARNING: Do not unplug any connected hardware during the programming process.

Note: The Frequency in the CLC Details page will display the last Frequency selected in the Search for Implants dialog (e.g. F1-B1). Once the implants change to their new frequency (e.g. F1-D1), the CLC Details Frequency will reflect its originally selected Frequency (F1-D1)

10. The **CLC Configuration** List View will update with the implants, along with the *Configured Implants* list within the *CLC Details*.



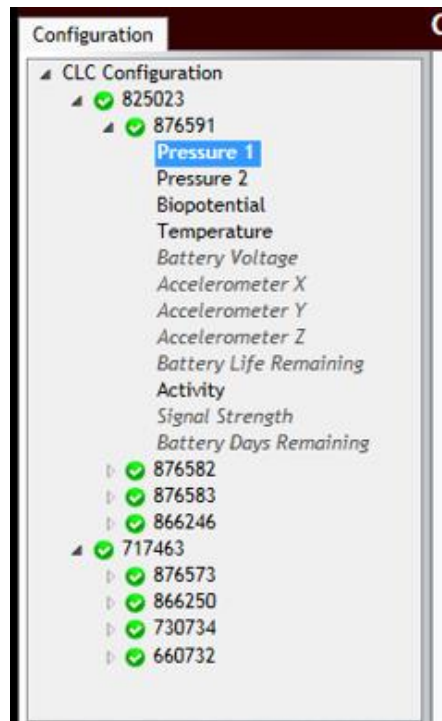
11. Repeat steps 6-10 for any additional CLCs/implants.



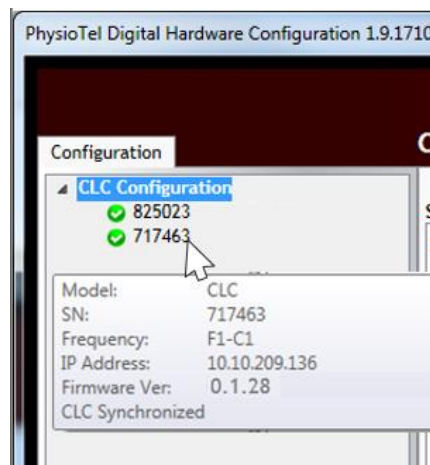
12. Once complete, click the **Save & Exit** button.

PHYSIOTEL DIGITAL CONFIGURATION DETAILS

Multiple layers of information are contained in the *PhysioTel Digital Hardware Configuration* dialog, each accessed using the List View on the left side. The **CLC Configuration** column lists the entire setup in an expandable tree structure. The CLCs are listed with their assigned implants nested underneath.



Note: The tree structure can be expanded and contracted by clicking on the arrows immediately to the left of the individual line items. Hover the mouse cursor over any line item in the Configuration box to activate an information pop-up with that device's key status condition. The example below is the hover information for a CLC.

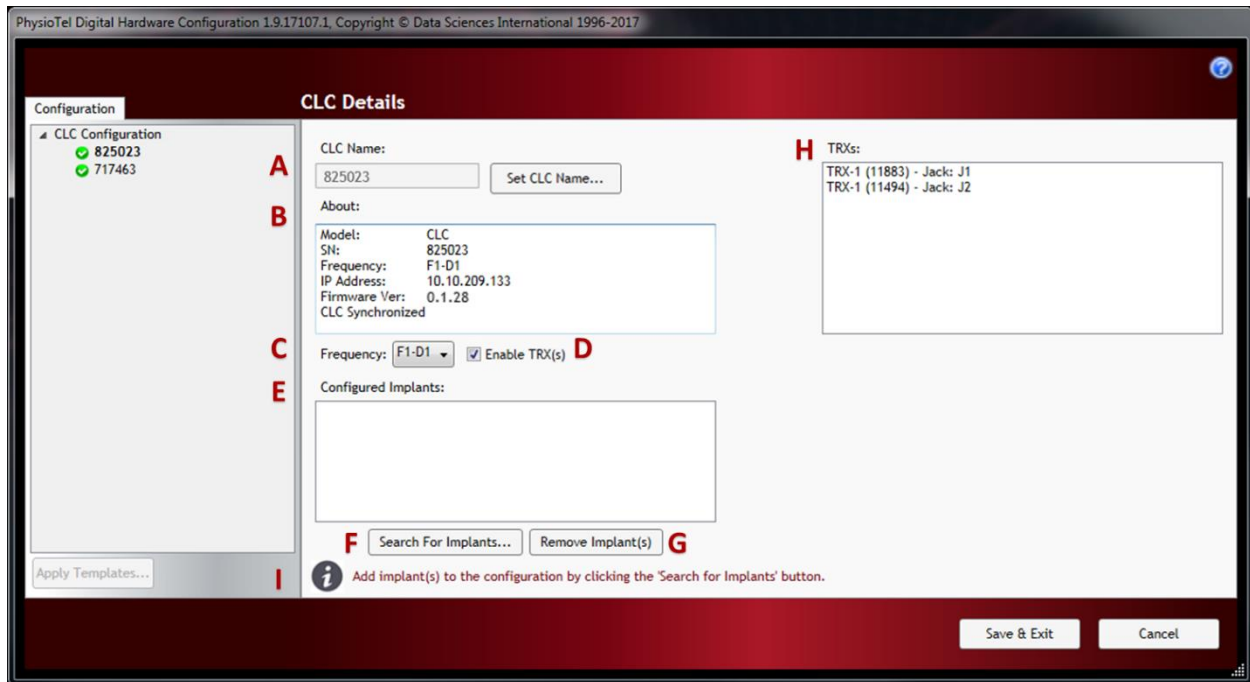


The **CLC Configuration** is the first line in the List View and displays the **Selected CLC** for the current configuration.

The List View can also be used to access the following information: CLC Details, Implant Details, and Channel Details

CLC Details

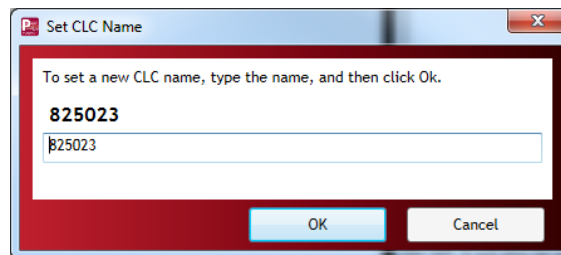
The **CLC Details** view can be accessed by left-clicking on any of the CLC line items in the **List View**.



CLC Details include:

A. CLC Name:

Select the **Set CLC Name...** button to create or change the name of the CLC. This name is saved on the CLC and will be the name seen when searching the network for available CLCs to add to the configuration with the **PhysioTel Digital Configuration**.



B. About:

Important information including CLC model and serial numbers, current frequency, IP Address, and Firmware. This same information is available by hovering the mouse cursor over the line item in the List View.

C. Frequency

Dropdown box used to select the frequency of the CLC.

D. Enable TRX(s)

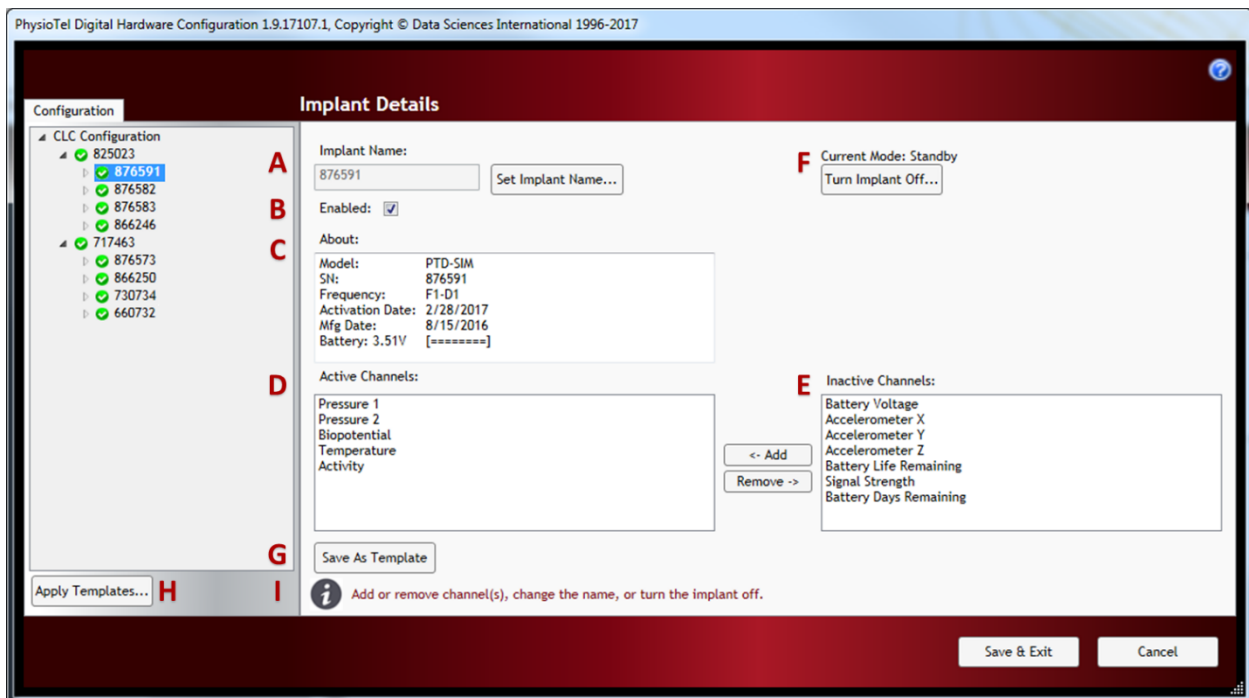
Checkbox used to enable (checked) and disable (unchecked) the CLC broadcast frequency. Disabling the TRXs may be useful in preventing the CLC from

interfering with the implant configuration process of another CLC in the configuration or on the network.

- E. Configured Implants** Lists the implants currently configured to this CLC.
- F. Search for Implants...** Allows the user to search for implants that are powered ON and in range for assignment to the CLC within this configuration.
- G. Remove Implants** Allows the user to select the implants from the *Configured Implants* list and remove them from the configuration.
- H. TRXs:** List of TRXs and serial numbers assigned to that CLC and the “Jack” number on the back panel of the CLC the TRX is plugged into.
- I. Information** Provides the user with instructions on actions to perform on that Details page.

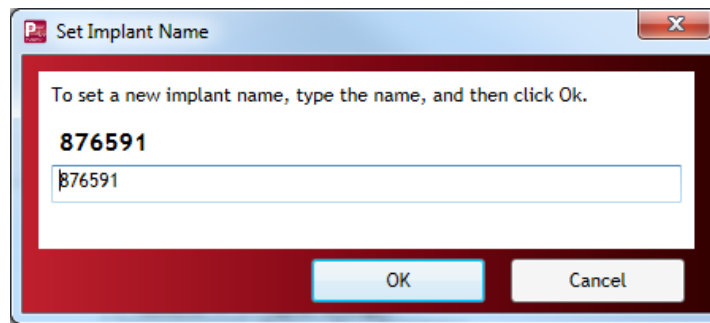
Implant Details


The **Implant Details** can be accessed by left-clicking on any of the implant names in the **List View**. The Implant Details view contains implant information, as well as some important interactive features.



Implant Details contains the following information:


- A. Implant Name:** User may rename the implant by selecting the **Set Implant Name...** button. In the displayed dialog, enter the desired name in the text field and select **OK**.



Upon selecting OK, a  will display next to the existing implant name while the CLC communicates the name to the Implant. Once the implant is programmed with the name, the dialog will close.

The name specified here is also used by Ponemah as the Subject Name when automatically creating the Subject upon clicking Save & Exit within this dialog.

- B. Enabled:** This check box will toggle the implant between 'Enabled' and 'Disabled' modes. The Enabled mode allows the software system to record, store, and analyze data from the implant.

 **WARNING:** if the implant is not **Enabled**, the implant will still be powered ON and in communication with the system, but no data from the implant will be acquired.

- C. About:** Important information including model and serial numbers, activation and manufacture dates, as well as a battery level indicator. This same information is available by hovering the mouse cursor over the line item in the List View.

Activation date is a date stored in the implant. It is written the first time that implant is configured by a Ponemah system.

- D. Active Channels**
E. Inactive Channels
- These columns allow the user to select which data collection channels are activated in the implant. **Active Implant Channels** collect physiologic data and transmit the data through the acquisition system to be stored in the data acquisition computer. **Inactive Channels** do not collect physiologic data as those channels are disabled.

Note: In addition to avoiding the collection of unnecessary data, the in-activation of certain data channels has the potential to preserve battery resources.

F. Current Mode:

This displays the current implant operation mode. The **Turn Implant Off** button allows the user to remotely switch the implant to the **OFF** mode.

See the PhysioTel Digital Implant Deactivation section of this manual for the process.



WARNING: *Once in the implant is in OFF mode, it cannot be remotely returned to the ON mode. The implant can only be turned ON by physically passing a strong magnet close to the device for a few seconds. See the Implant Activation section of the manual for the process.*

G. Save As Template:

H. Apply Templates...

This allows the user to identically configure a group of implants with the same channel arrangement. Once the channel configuration is set for one of the implants, the user can save the implant configuration as a Template and apply that configuration template to all similar implants in the current configuration.

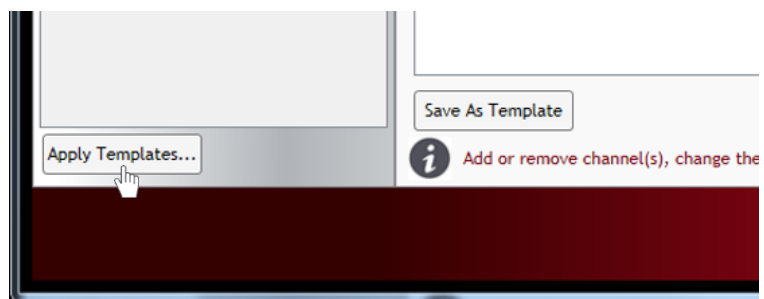
To create a Model Template:

1. Select an implant from the **CLC Configuration** column on the left side of the screen.
2. Use the Active Channels dialog to configure the implant in the manner you wish to save as a Template.
3. Click the **Save As Template** button.
4. You will be offered a confirmation message “**Are you sure you want to replace the template ...?**”
5. Click **Yes** to confirm.

Note: Only one Model Template can be saved per implant model type.

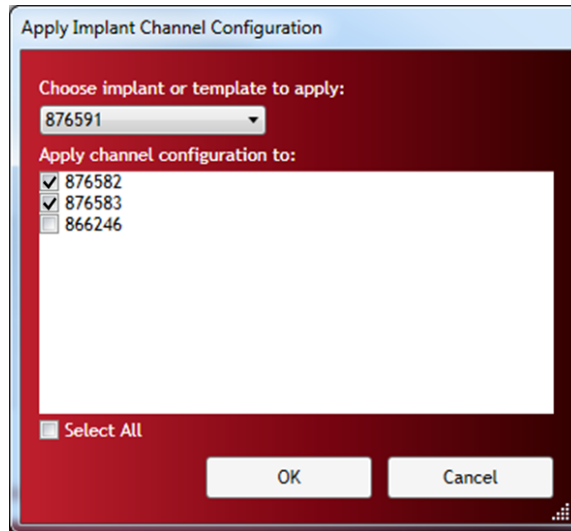
To apply a saved Model Template to other implants in the CLC Configuration List View:

1. Click the **Apply Templates...** button in the lower left corner of the window to open the **Apply Implant Channel Configuration** screen.

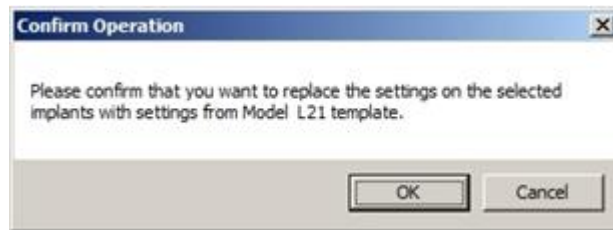


2. Use the drop-down menu under **Choose implant or template to apply:** to select the saved template you wish to apply to the other implants. It is also possible to copy the channel configurations from one implant to another provided they are the same model type.

- In the **Apply channel configuration to:** dialog box, select the individual implants to which the template should be applied. Select the implants using the check boxes next to the implant label. The **Select All** check box can be used to select/deselect all implants in the dialog box.



- The **Select All** check box can be used to select/deselect all implants in the dialog box.
- Click **OK** to apply the saved template configuration.



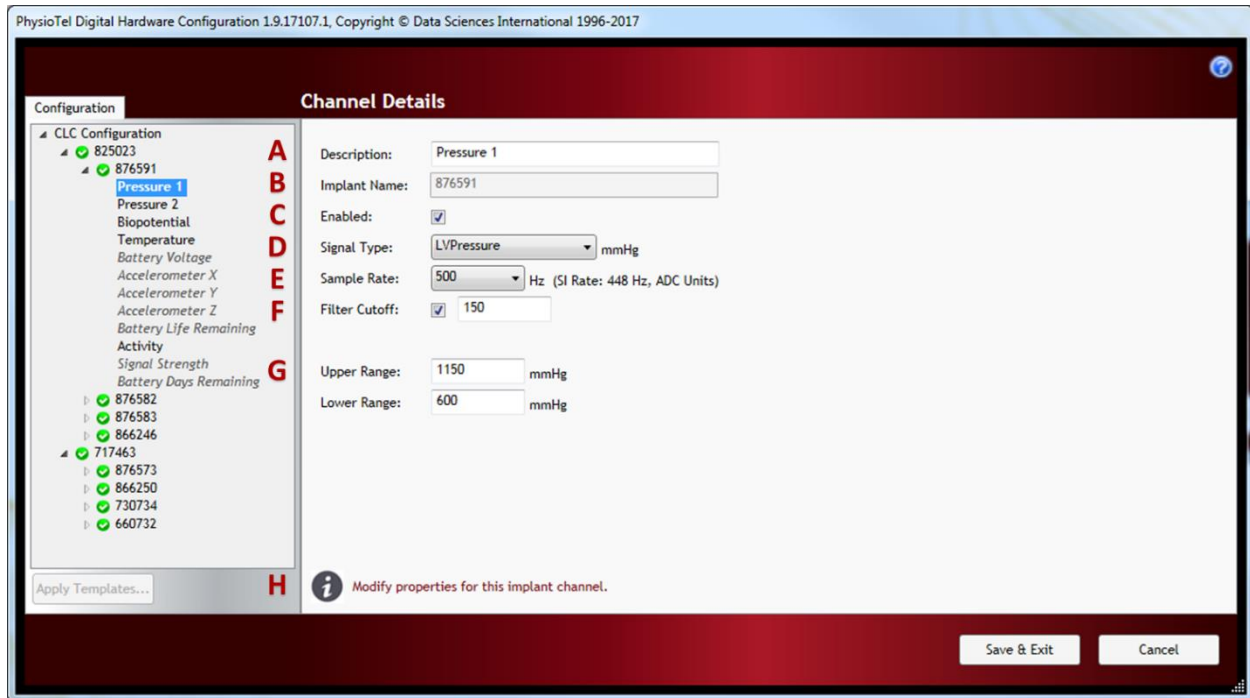
- A **Confirm Operation** dialog is offered as a precaution, click **OK** to accept.

I. Information

Provides the user with instructions on actions to perform on that Details page.

Channel Details

Implant **Channel Details** are accessed by selecting a **Channel** associated with an implant from the **CLC Configuration** List View. Click on the arrow icon to the left of implant name within the List View display the implant Channels. The current “active” channels are listed in **bold** text in the List View once the tree structure is fully expanded. The inactive channels are listed in *italic* text.



Channel Details contain the following information:

- A. Description** Allows the user to change the name of the channel. Unlike the CLC and Implant name, the Channel name is not saved to the device and will revert to its default name in new configurations.
- B. Implant Name** Displays the implant name.
- C. Enabled** This check box will toggle the **Input** channel between ‘**Enabled**’ and ‘**Disabled**’ modes. The **Enabled** mode allows the software system to record, store, and analyze data from the **Input** channel.
- D. Signal Type** Allows the user to define which signal type should be used for the particular implant channel. These will default to the most common signal types based on the implant model selected; e.g. **L21** Channel 1 pressure channel will default to the **LVPressure** signal type. This is important because the signal type defined here is used to automatically define the **Analysis Module** assigned to the channel when Ponemah automatically creating Subjects upon **Save & Exit** from this dialog.

E. Sample Rate	Allows the user to define a unique sampling rate to each implant channel.
F. Filter Cutoff	Filter cutoff defines the frequency in Hz at which the finite impulse response (FIR) low-pass digital filter attenuates the waveform by 3 decibels (dB). Contact DSI Technical Support prior to changing these values.
G. Upper/Lower Range	Used to determine the range of values that can be represented in a stored waveform. Data values outside this range will be marked as bad when they are saved.
H. Information	Provides the user with instructions on actions to perform on that Details page.

SUBJECT SETUP

Ponemah represents the research animals used for data acquisition as **Subjects**. Ponemah will only acquire from **Input Sources** (e.g. implants, APR-2) if they are defined to a Subject, as the Subject is used to group Input Sources together as a single entity for acquisition start. Subjects are also used to group waveform and derived data from the associated Input Sources throughout the Ponemah application.

EDIT SUBJECT SETUP

The Subject Setup dialog can be entered in the following ways:

- Select the **Setup** menu and choose **Subject Setup**.
- Double-click a **Subject** from the **Sampling Control** dialog.

Note: Double-clicking a Subject from the Sampling Control dialog will open the Subject Setup dialog with the Subject that was double-clicked selected.


There are two functional areas in the **Subject Setup** dialog:

- The “**List**” view on the left lists the **Subjects** and their associated **Input Source Channels**.
- The “**Details**” view on the right provides the customizable options available for the Subjects/Channels highlighted in the List view.

CREATING SUBJECTS


Subjects will be automatically created upon clicking **Save & Exit** from the **PhysioTel / HD or PhysioTel Digital Hardware Configuration** dialogs. Subjects will be named with the **Name** defined while configuring the implant in the Hardware Configuration and will have that specific implant automatically associated with it as its **Input Source**.

To manually create **Subjects**:

1. Navigate to the **Subject Setup** dialog
2. Select the  button at the top of the dialog.
3. Enter a **Subject Name**.
4. Repeat for additional Subjects.

Note: Subjects that are created prior to configuring implants to the Experiment can automatically associate implants once configured by using the identical **Subject Name** for the **Implant Name**.


DELETING SUBJECTS

Subjects can be removed from the Experiment by selecting the Subject from the Subject list and selecting the  button.

Note: Subjects cannot be deleted from an Experiment once data has been acquired from it.

REPLACING SUBJECTS/REUSING IMPLANTS

If an implant is to be reused by a new subject within the same experiment, it is recommended to use the following process:

1. Select the  button at the top of the dialog to create the new Subject.
2. Enter a Subject Name.
3. Select the Subject to which the desired implant for reuse is currently assigned.
4. Drag-and-drop the desired implant to the newly created Subject.

The new subject will now be displayed in the *Sampling Control* dialog, data acquired will be acquired to its own .PnmWav file, and the Subject's data will be available for Review.

SUBJECT DETAILS

Details about the subject are automatically defined based on the **Signal Types** defined during implant creation. Settings such as Subject Name, Gender, Species, Analysis Attributes, Label, Units, and Trigger can be edited based on your preference.

Note: It is important to choose the **Species** that most closely represents the heart rate of the species you are using. **Rat** is the default **Species** setting selection.

The following displays the Subject Details page and defines its various settings:

Subject Setup

Subject Details

Add Delete Save Print

Rat01

- Pressure
- ECG
- Temp
- BattVolt
- OnTime
- Activity
- SignalStr
- Bpr
- APR
 - Pressure
 - Raw

Rat02
 Rat03
 Rat04
 Rat05
 Rat06
 Rat07
 Rat08

Subject Name: **A**

Gender: Male Female N/A **B**

Species: **C**

Camera: **D**

HD-S11-F0 (651168) **E**

F Analysis	H Label	I Units	J Trigger
BP <input type="checkbox"/>	Pressure	mmHg	<input checked="" type="radio"/>
ECG <input type="checkbox"/>	ECG	mV	<input type="radio"/>
TEMP <input type="checkbox"/>	Temp	Celsius	<input type="radio"/>
RAW <input type="checkbox"/>	BattVolt	V	<input type="radio"/>
RAW <input type="checkbox"/>	OnTime	Days	<input type="radio"/>
ACT <input type="checkbox"/>	Activity	Counts	<input type="radio"/>
RAW <input type="checkbox"/>	SignalStr	%	<input type="radio"/>
Soft Channels			
BPR <input type="checkbox"/>	Bpr	mmHg	<input type="radio"/>
BARO <input type="checkbox"/>	APR	mmHg	<input type="radio"/>
Signal Interface (1059260) Ch 1			
<input type="checkbox"/> BP <input type="checkbox"/>	Pressure	mmHg	<input type="radio"/>
Signal Interface (1059260) Ch 2			
<input type="checkbox"/> RAW <input type="checkbox"/>	Raw	RAW	<input type="radio"/>

K
 L

- A. Subject Name:** User defined field to add or edit the Subject Name. This field is automatically populated with the Implant Name defined in the Acquisition Interface Configuration dialogs upon selecting Save & Edit.

Note: If this name is changed within the Subject Details page, it will not update the Implant name in the Acquisition Interface Configuration dialogs. This will not impact your Experiment.

- B. Gender:** User defined Subject gender designation. Default is N/A.
- C. Species:** Define the species being used within the Experiment. Options include: Mouse, Rat, Dog, and Non-human Primate species. The system will automatically select the species based on the species most commonly used with the defined implant model but may be updated manually.

This selection impacts the default value recommendations within the Analysis Modules.

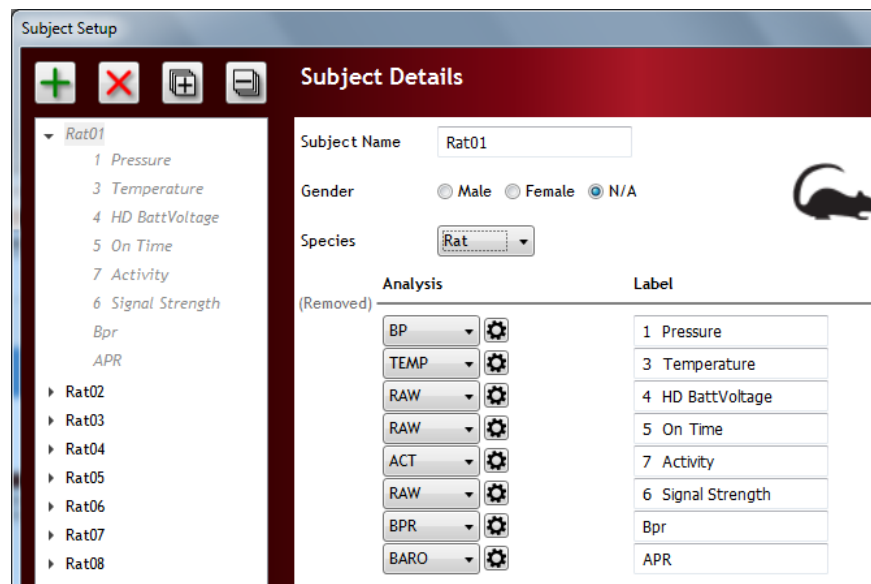
Note: If the species model to be used in the Experiment is not listed here, it is recommended to set the species to the animal model that is nearest in heart rate with the model being used.

- D. Camera** The Camera dropdown will list any configured video camera, if licensed for video acquisition. Use the dropdown to assign a configured camera to a Subject.
- E. Input Source** The device (implant, APR-2) model and serial number are listed to group Channels into an easily recognizable organization. The APR-2 will only be listed if it has been configured through the **Hardware menu** and if the implant configured to the Subject contains a pressure channel.

Soft Channels refer to any channel that is not directly acquired from the device, but instead is calculated from one of the implant channels. In the example above, the Blood Pressure Respiration (BPR) is a Respiratory signal calculated from the Blood Pressure channel.


Signal Interface channels will also be listed as available input source channels for the Subject. To assign a Signal Interface channel to the Subject, simply enable the checkbox corresponding to the desired channel from the *Subject Details* dialog or the Subject tree view on the left of the dialog. Alternatively, use the **Signal Interface Setup** button (L) to more quickly assign channels to multiple Subjects.

Note: If the data is imported from Dataquest A.R.T. or Ponemah (v5.20 or earlier) or if the **Input Source** is removed after data has been collected, the Channels will be displayed but the location will communicate that the **Source** is no longer available by displaying *Removed*.



- F. **Analysis:** Allows the user to choose the appropriate analysis module that will be used to analyze the data during Acquisition and Review.

Note: It is strongly recommended to use the default **Analysis** selected based on the **Signal Type** defined during implant configuration. However, if the **Signal Type** was not updated appropriately, the analysis module can be modified. For example, if collecting Left Ventricular Pressure (LVP) and the **Signal Type** was set to Pressure (BP), the **BP** analysis module will be defined in the **Subject Details**. This should be updated to the **LVP** analysis module to analyze the data appropriately. The analysis module can be modified after an acquisition has been performed should the incorrect module be used; however, all analysis results for this **Channel** will be purged from the Experiment and will require reanalysis using the correct module.

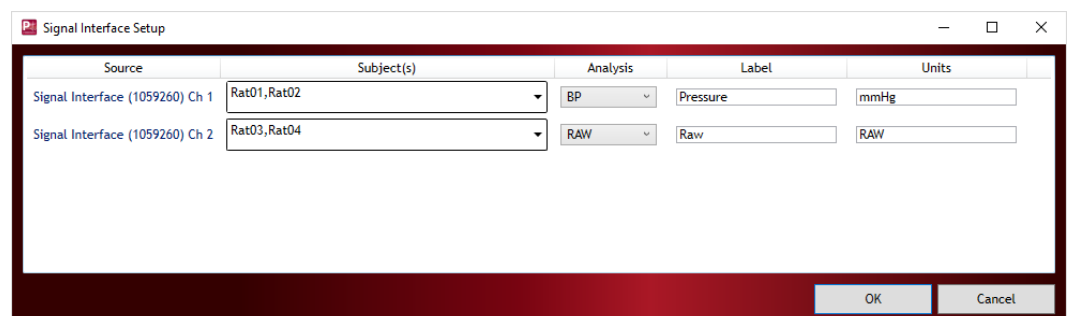
- G.  Opens the **Analysis Attribute** dialogs for the associated analysis module.
- H. **Label:** Lists the Input Source Channel Signal Type for the graph labels.
- I. **Units:** Lists the input signal units label for the graph labels.
- J. **Trigger:** Allows the user to designate a Channel per Subject to serve as the trigger to report derived data to the **Derived Parameter** spreadsheet during Acquisition and Review. The **Trigger Channel** is only used when the **Logging Rate** is defined to Epoch (Cycle) mode. See the **Data Acquisition | Logging Rate** section of this manual for more information.
- K. **Apply to Similar Subjects:** Allows the User to custom configure one of the Subjects in the list and apply those same custom settings to all Subjects with the same Implant model. This includes the following **Subject Details** settings: **Gender, Species, Analysis Module, Analysis Attributes, Labels, Units, and Trigger Channel**. It also includes the following **Channel Details** settings: **Parameter, Digital Display, and Alarm** selections.

Once a Subject is configured with the desired Subject and Channel Details settings that you wish to apply to all Subjects with the same Implant model:

1. Highlight the configured Subject by clicking on the **Subject Name** in the **Subject list**.
2. Click the **Apply to Similar Subjects** button and the custom setting will be applied to all Subjects with the same Implant type.

- L. **Signal Interface Setup** Opens a dialog allowing the User to quickly assign Signal Interface channel(s) to multiple subjects. Channels may be assigned to one, multiple, or all Subjects using the Subject(s) dropdown.

The dialog also permits redefining the Analysis module, Label, and Units associated with the Signal Interface channel(s).



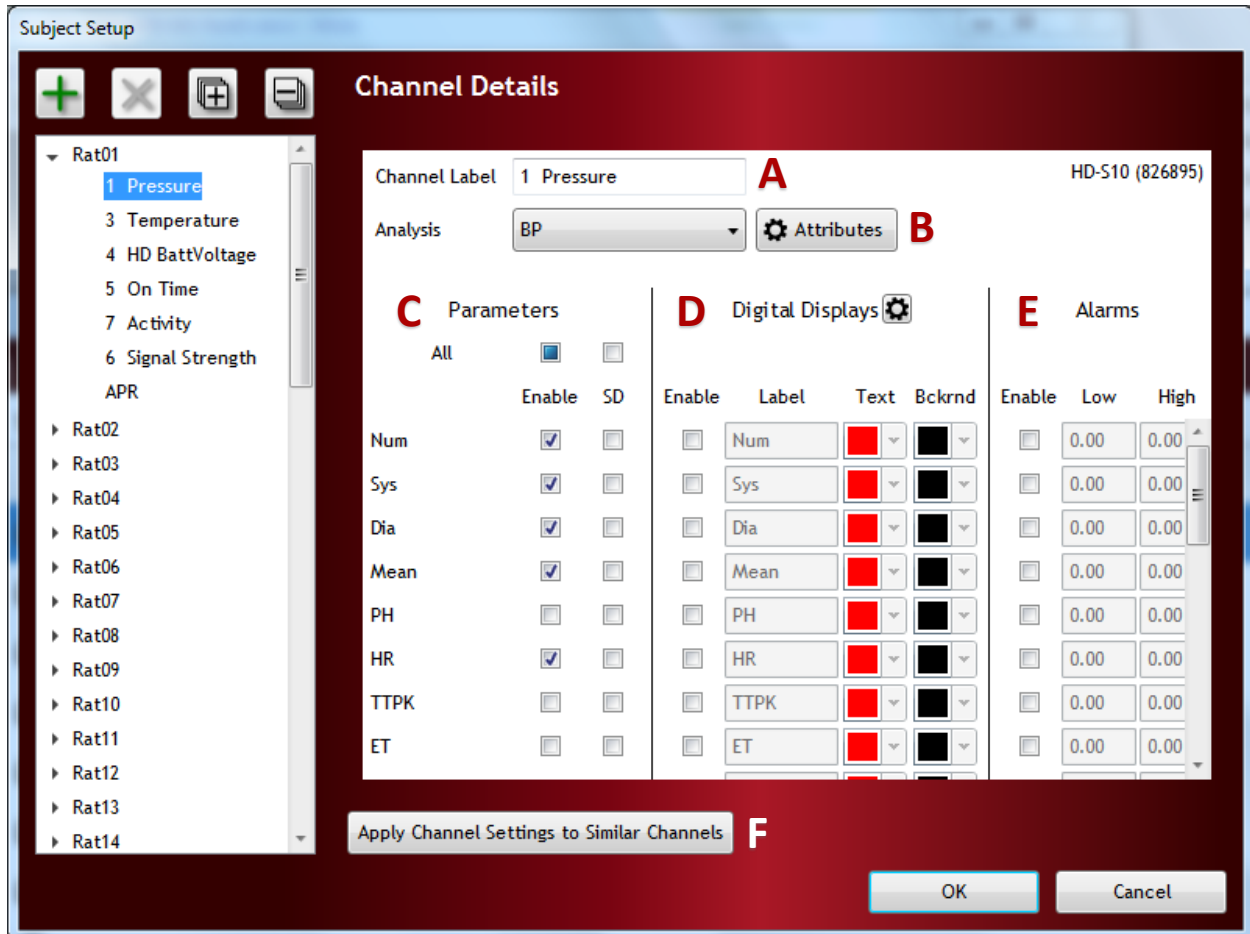
CHANNEL DETAILS

Left-clicking the **Channel** associated with the Subject from the Subject list will display the **Channel Details**.

The Channel Details page will allow you to enable/disable the following:

- Analysis Attributes
- Derived Parameters
- Digital Displays
- Alarm Conditions


The following displays the Channel Details page and defines its various settings:



- A. Analysis:** Allows the user to select the appropriate analysis module for the Channel.
- B. Attributes:** Allows the user to configure the variables that control how the analysis will be performed for the specific channel. Each analysis module has its own set of attributes. See the appropriate analysis module section for more information regarding attributes.
- C. Parameters:** Parameters are derivations made from the waveform data by the analysis module. By default, the most common parameters will be enabled (checked) based on the analysis module selected. Simply enable or disable the parameters you are most interested in.

Parameters are reported for a specified logging period during Acquisition and Review. The logging period is defined in the **Logging Rate** dialog (See **Logging Rate** section). If using a **time-based Logging Rate**, the Derived Parameters are reported to the List Views as averaged **Log Line. Standard Deviations** of the data contained within the **Logged Line** of data can also be enabled. See the appropriate analysis module section for more information regarding specific derived parameter and averaging information.

Note: Derived parameters can be enabled/disabled during post-acquisition data review.

D. Digital Displays: Allows the User to define up to 33 digital display windows that will display selected derived parameters during Acquisition in large, easy-to-see windows. Timer or Clock information can also be displayed using the  button.

E. Alarms: Allows the user to define alarm conditions per derived parameter. Conditions are defined using low and high alarm limits. When the derived data goes above or below the defined alarm limits, an alarm will be triggered.

A triggered alarm will result in updating the **Alarm list view** to displays the Subject, Channel, Parameter, low and high alarm levels, and current value of the parameter. If the Digital Display is set up with a Parameter that has met the alarm conditions, it will notify the user by inverting its text and background colors.

See the Remote Notification section to learn how alarms can be configured to notify you when an alarm occurs via email or text message.

F. Apply Channel Settings to Similar Channels Allows the User to custom configure one of the Subjects' Channels in the list and apply those same custom settings to all Channels defined to the same **Analysis Module**. This includes the following **Channel Detail** settings: **Parameter**, **Digital Display**, and **Alarm** selections.

Once a Channel is configured with the desired **Channel Details** settings that you wish to apply to all Channels with the same **Analysis Module**:

1. Highlight the configured Channel by clicking on the **Channel Name** in the **Subject list**.
2. Click the **Apply Channel Settings to Similar Channels** button and the custom setting will be applied to all Channels with the same **Analysis Module**.

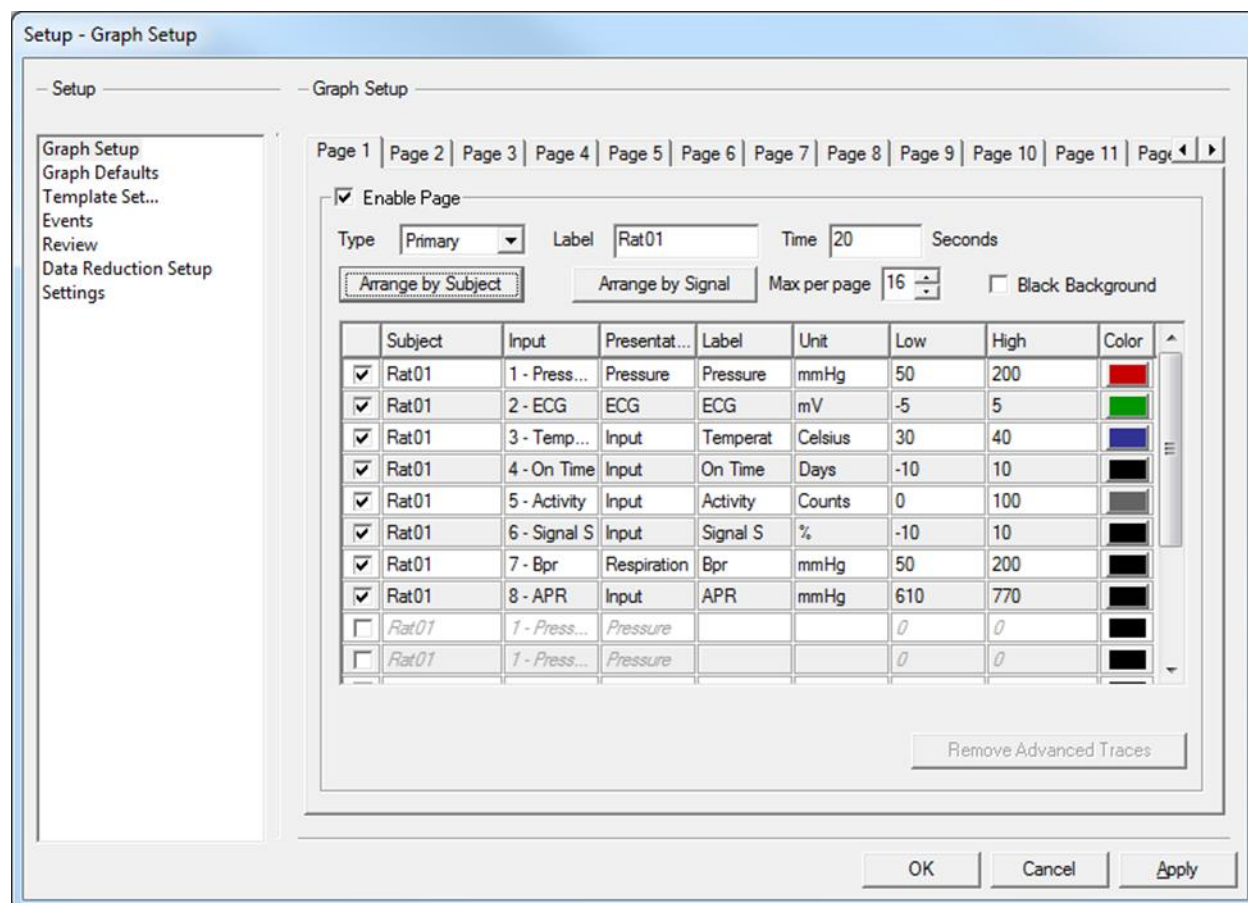
GRAPH SETUP

The **Graph Setup** allows the user to create customized graph windows that are displayed during Acquisition and Review. Up to sixteen graph windows may be created. Depending on the display selected, the graph windows will display raw input signals (Primary and Page View graphs) or derived parameters (Trend, XY-Loop, and Scatter graphs). The graph configurations can be changed any time during the Experiment Setup, Acquisition, and Review.

The **Graph Setup** is accessed from the Ponemah main menu: **Setup | Experiment Setup...** When the **Setup** dialog appears, select **Graph Setup** from the list on the left.

GRAPH SETUP DIALOG

There are 16 page tabs available across the top of the Graph Setup dialog. These graph pages can be customized according to the information the User wishes to see during an Acquisition or Review.



Enable Page:

Checkbox that toggles the display on and off for each individual graph.

Type:

This drop-down menu allows the User to select the display of the graph. The available choices are: Primary, Trend, XY-Loops, Scatter, Page View or Template. See *Graph Types* section for more information.

Label:

An edit field allows the User to define a name (up to 11 characters) for the graph page. The label will be placed in the title bar of the graph window.

Time: An edit field allows the User to define the time for the X-axis. The time will be defined in units of *seconds* for Primary graphs and units of *minutes* for Trend graphs (depending upon what was selected for Type).

Black Background: Check this box to choose a black colored background for the display window.

Max per page Allows the User to define the max number of channels the **Arrange by** buttons will configure to help viewing the Signals on the Graph Page. E.g. If the Max per page is defined to 16 and the Arrange by Signal is selected for 16 Subjects with ECG signals, all 16 ECG signals will be configured to one Graph Page. This will be difficult to view and provide little use. Update the max per page to ≤ 8 for a more meaningful viewing of signals.

AUTOCONFIGURE GRAPHS

Once Subjects are defined within the Experiment, Ponemah can automatically set up graphs to display the signals being collected for each Subject.

Two options are available to automatically set up graphs:

Arrange by Subject: Selecting this button will enable **Primary Graph** pages and configure one Subject per page, up to 16 Subjects. If more than 16 Subjects exist, the **Primary Graph** will be configured to display two Subjects per page. Graph titles, labels, units, and high/low axis values will also be configured based on the Subject settings.

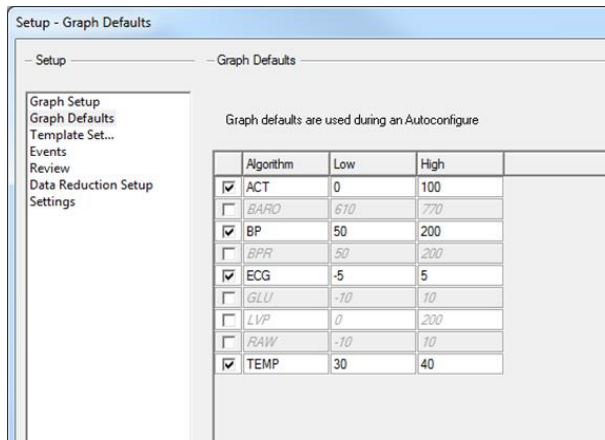
Graph titles will be populated with **Subject Names**, while Labels will be populated with Channel Label.

Arrange by Signal: Selecting this button will enable **Primary Graph** pages and configure each page to a specific Channel Signal, up to 16 Channels per page; e.g. the ECG Channels from all Subjects will be assigned to the same graph page. Graph titles, labels, units, and high/low axis values will also be configured based on the Channel settings.

Graph titles will be populated with **Channel Name**, while Labels will be populated with **Subject Names**.

When using the **Arrange by** buttons, Ponemah will configure the graphs pages to display all available input signals for each Subject at a predefined y-axis range specific for each signal type, by default. Using the **Graph Defaults** menu, you may customize these buttons to display only the signals you are interested in and define the y-axis range for each signal type based on what makes sense for your experiment.

In the example below, only the input signals associated with the enabled (checked) algorithm type will be displayed when one of the Arrange by buttons is selected. Also, the High and Low y-axis values defined here will be used as the new default values.



To automatically configure your graphs:

1. Select **Experiment Setup...** from the **Setup** menu.
2. Select **Graph Defaults**.
3. Disable any algorithms associated with input signals you wish not to be configured within the graphs.
4. Define y-axis range by entering the desired Low and High values.
5. Select **Graph Setup**.
6. Select the desired **Arrange by** button.
7. When prompted, choose **Yes**.

Note: You may set up additional graphs to display trends of derived data through the **Graph Setup** dialog by enabling a graph page, choosing the **Trend** graph type, and using the drop-down menus to choose Subject, Channel, and Parameter.

MANUAL CONFIGURATION

For unique graph setups or when choosing to use graph types other than **Primary** users may manual configure graphs using the dropdown and text entry boxes associated with each **Enabled** channel. Standard Windows multi-select options are available to make manual graph setup more efficient. To multi-select channels:

- Left-click-and-drag the mouse over the desired, consecutive channels.
- Press and hold <Shift> + Left-click over the desired, consecutive channels.
- Press and hold <Ctrl> + Left-click the desired, non-consecutive channels.

GRAPH TYPES

The following defines the different Graph Types that are available:

Primary:

A **Primary** graph displays the raw (physical) format of the signal over a specified period of time. The **Primary** graph is similar to an oscillographic recorder output in that it displays the waveform signal over a specified period of time. Sixteen traces can be set up per graph page and are displayed in unique **Display Panes**. Each **Display Pane** has its own scaling information

Notes on Primary graphs:

- **Real Time (RT:)** – This field is located in the lower left corner of the graph gage just below the Delta Time. The **Real Time** field displays the calendar date and the precise

time of day the data was collected. The **Real Time** display is synced with the PC clock. The default format of the date field is mm/dd/yyyy. The default format of the time field is hh:mm:ss:ms.

- **Delta Time (DT):** – This field is only available within **Review** and is located in the lower left corner of the graph page. It displays the time interval between the current position of the cursor and point at which the **Delta Time** was reset. To reset **Delta Time**, first position the cursor by performing a left-click at the desired reference point. Next, perform a right-click to bring up the right mouse menu and select **Reset Delta Time**.
- **Label Area** – Each Channel that is displayed in a graph page has an associated label area to the left of its display pane that contains the Channels' label and scaling information.

Note: Right-click the **Label Area** to display **Copy and Paste** options for the data displayed in the graph page.

- **ID Text** - This field lies to the right of the **Delta Time** field and is used to provide additional information about **Marks, Events, and Bad Data Marks**. Hovering the mouse cursor over one of these objects will display a descriptive text string in this field.

Note: If the mouse is not hovering over one of the areas described above, this field will be blank.

Trend:	A Trend graph displays derived data (such as heart rate, mean blood pressure, or dP/dtMAX) from the output of the analyzed input signals over time; it is similar to a dose response curve. Sixteen trends can be graphed with up to four derived parameters for each trend.
XY-Loop:	An XY-Loop graph allows one analog signal to be plotted against another analog signal. For example, to display pressure volume loops, the user would set up the graph to plot pressure versus volume.
Scatter:	A Scatter Graph allows two derived parameters to be plotted against each other. At the point of intersection, a "+" is drawn to indicate where the values for the two derived parameters intersect. The Scatter graph will only refresh after the user causes the graph to redraw, which occurs when sized or minimized and then restored. When the Scatter plot is refreshed, the last 2000 data points will be re-drawn.
Page View:	This allows the user to view the same channel of continuous data on multiple panes within a single graph page. The operation of the graph page is the same as a Primary graph page. The number of panes configured is set up when selecting the page view graph page in the Graph Setup . Below is a screen capture of a page view graph page. The number of panes that can be configured are from 1 to 16.
Template (Review Only)	The purpose of the Template graph is to aid ECG analysis using the ECG Pattern Recognition Option (ECG PRO). It allows users define templates from a small number of representative cycles and use these templates to compare like regions of the ECG signals within the data set to update the marks on matched cycles. Template analysis is a Review only feature, and uses template enabled analysis modules.

For more information on **Template Analysis**, see the **ECG PRO** section of this manual.

REVIEW CURSOR

A **Cursor** is available in each graph page and is represented by a vertical black line that spans all **Display Panes** in the graph page. A **Cursor** may be positioned by left clicking with the mouse in a **Display Pane**. The **Cursor** may also be positioned by using the left/right arrow keys. Use of the arrow keys will result in the **Cursor** moving by one sample or one pixel, whichever is greater. Time information at the **Cursor** location is displayed in the **RT** (Real Time) field in the bottom left corner of the graph page. Sample information at the **Cursor** is displayed in the bottom left corner of each **Display Pane**. The min/max values of the points represented by the screen pixel will be reported at the **Cursor**. If the X Axis scale is set to display one sample per pixel, the min and max values will be equal since only one sample is being represented by that pixel.

DISPLAY PANE

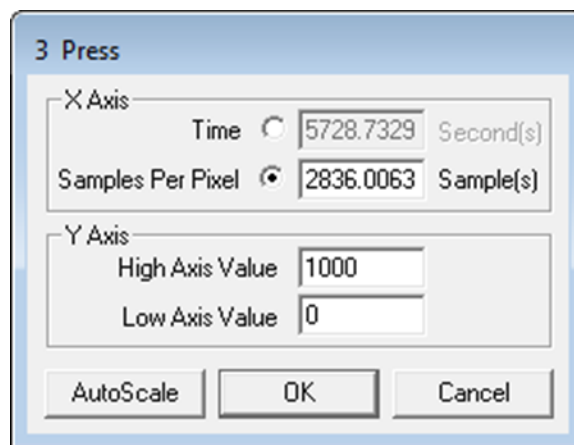
Each channel that is displayed in a graph page has an associated Display Pane that contains the graphical representation of the selected presentation. The Display Pane can be selected by left-clicking anywhere within the pane; only one Display Pane can be selected at a time. When selected, a border is drawn around the text in the **Label Area** for the selected **Display Pane**. Keyboard input and search functions are applied to the selected display pane. A display pane is selected by clicking in the display pane or in its label area. Alternatively, the selected display pane may be changed by using the up/down arrow keys.

COPY

Graphical data may be copied for use in reports. Individual **Display Panes** may be copied or an entire graph page may be copied. To copy a waveform image, right click in the label area of the display pane/graph page to be copied. Select **Copy Entire Graph Page Image** to copy the graph page. Select **Copy Selected Channel Image** to copy the selected **Display Pane**.

SCALING

Double-clicking on a particular signal’s display pane will display a **Scaling** dialog that permits the user to scale the graph.



- **X axis**
 - The X axis scaling is defined for the entire graph page and permits the user to switch between **Time** and **Samples per Pixel** modes.
 - When in **Time** mode, the time that corresponds to the graph page width is specified.

- When in **Samples per Pixel** mode, the user specifies the number of samples that should be displayed per pixel, and this relationship is maintained if the size of the graph page is modified.
- **Y axis**
 - The Y axis scaling is defined only for the signal within the graph pane the **Scaling** dialog was launched from.
 - The user can scale the Y axis manually or choose the **AutoScale** option. Clicking on the **AutoScale** button will set the **High Axis Value** and **Low Axis Value** of the Y axis edit fields to the upper and lower limits of the signal currently displayed in the display pane.

Note:

- Use the **View Entire Dataset** toolbar icon to obtain an overview of the entire acquisition period. This ultimately scales the X Axis to display the entire dataset. It is recommended to toggle **OFF** the **Validation Mark** using the graph toolbar to more clearly view the data at this scale. The **Bad Data Mark** and **Data Break Marks** may also need to be toggled off using their respective toolbar icon toggles.
- Left-click and drag the across the **Display Pane** to zoom in. If the start point of the left-click has marks clustered together, use the **Snap Zoom** icon, as this allows the left-click and drag zoom in feature to ignore the marks.
- Various icons can be used to scale the graphical data. Please see the **Graph Menus** and **Toolbar** section for compress, expand, zoom in, and zoom out icons.

DATA BREAKS

Data Breaks are only seen during a Review session and are green, vertical, dotted lines that represent time intervals where the saving of raw data has been turned off during Acquisition. Users may see **Data Breaks** for the following reasons:













- **Scheduled** sampling is being used – See the **Scheduled Sampling** section for more information.
- Multiple acquisition sessions have been loaded into Review. For example, the user acquires for eight hours during the day, stops Acquisition overnight, and then restarts acquisition for 8 hours the next day. This will result in a time gap between the two collection periods. If data is loaded into Review that overlaps this idle period, a **Data Break** will be present.
- The user has added **Parser Segments** during a previous **Review** session and has now loaded data into Review by **Parser Segment**. See the **Data Parser** and **Loading Data into Review** sections for more information.

















Note: The display of **Data Breaks** may be toggled off using its toolbar icon to more easily see the waveform morphology.



GRAPH MENUS AND TOOLBAR

The following displays and defines the graph page Toolbar for Primary, Trend, and Page View graphs. The example screenshot is from a Primary Graph within Review (not all icons described in the table are displayed).



Toolbar Icon	Menu Selection	Mode Available	Description
	File | Print	Acquisition, Review	Prints the current graph page based on the current Review Print Setup. See the Printing section.
 Not pictured in example above.		Acquisition	The Freeze Toggle icon allows the window contents to be frozen or unfrozen. Freezing the graph does not impact the collection of data, only how it is displayed in the graph. Upon unfreezing the graph, the signals will speed ahead to real-time data.
	File | ASCII Output	Review	This option brings up a dialog for the user to create ASCII Output based on the options selected.
	Edit | Expand	Acquisition, Review	Expands the time span (X axis).
	Edit | Compress	Acquisition, Review	Compresses the time span (X axis).
 Not pictured in example above.		Acquisition	Scales the Y axis to display the minimum and maximum Y values of all signals displayed in the graph. Each Channel area is scaled separately to accommodate the signal it is displaying.
	Edit | View Entire Data Set	Review	Scales the X axis to display all available data from the Channels within the graph page that have been loaded into the Review session. This selection is useful to obtain an overview of the entire acquisition period by observing the signal envelope and to zero in on regions of interest by using the Zoom feature. It is recommended that validation marks be turned off when using this feature to permit viewing of the signal envelope
	Edit | Snap Zoom In	Review	Use to expand the X axis to display the selected region. Selecting this icon will change the mouse cursor to crosshairs and permit the user to drag the mouse over an area of interest to zoom in to the selection. When this is used on an XY-Loop or Scatter graph, it changes both the X and Y scaling.
	Edit | Snap Zoom Out	Review	Use to compress the X axis to display the current X axis range in the area selected. Selecting this icon will change the mouse cursor to crosshairs and permit the user to zoom out by dragging the mouse over an area of interest which will result in the data currently displayed in the graph page to be compressed to fit in the selected region. When this is used on an XY-Loop or Scatter graph, it changes both the X and Y scaling.
	Edit | Undo Graph Time Change	Review	Removes the last graph time change, reverting to the previous state. This feature will not be available if Enable Difference Calculations is disabled in the Setup | Application Configuration | Review dialog.
	Edit | Sync with Derived Data	Review	Syncs derived and data reduction list views with the current cursor position.
	Edit | Change - Search Right	Review	Searches for the next change marker in the selected channel. This feature will not be available if Enable Difference Calculations is disabled in the Review dialog. This is accessed

Toolbar Icon	Menu Selection	Mode Available	Description
			through the Application Configuration dialog from the Tools pull down menu.
	Edit | Change - Search Left	Review	Searches for the previous change marker in the selected channel. This feature will not be available if Enable Difference Calculations is disabled in the Setup | Application Configuration | Review dialog.
	Edit | Note - Search Right	Review	Searches for next Note in the selected channel.
	Edit | Note - Search Left	Review	Searches for previous Note in the selected channel.
	Edit | Event - Search Right	Review	Searches for next Event in the selected channel.
	Edit | Event - Search Left	Review	Searches for previous Event in the selected channel.
	Edit | Parser Segment - Search Right	Review	Searches for the next Parser Segment .
	Edit | Parser Segment - Search Left	Review	Searches for the previous Parser Segment .
	Edit | Time - Search	Review	Searches for a specific time in the selected channel.
	Edit | Unmatched - Search Right	Review	Searches for the next unmatched cycle (Template Analysis feature).
	Edit | Unmatched - Search Left	Review	Searches for the previous unmatched cycle (Template Analysis feature).
	Edit | Bad Data Mark - Search Right	Review	Searches for the next Bad Data Mark .
	Edit | Bad Data Mark - Search Left	Review	Searches for the previous Bad Data Mark .
	Options | Toggle Validation Marks	Acquisition, Review	Toggles the Validation Marks for all channels in the graph page. Note: during Acquisition, this is only accessible from the main Ponemah dialog and is not located within the graph page dialogs.
	Options | Draw Mark Differences	Review	Toggles the Mark Differences on the graph page. This feature will not be available if Enable Difference Calculations is disabled in the Setup | Application Configuration | Review dialog.
	Options | Draw Parser Segment Watermarks	Review	Toggles the display of Parser Segment Watermarks on the graph page ON/OFF .
	Options | Toggle Data Break Marks	Review	Toggles the display of Data Break Marks ON/OFF . See the Graph Concepts section of this manual for more information on Data Breaks .

Toolbar Icon	Menu Selection	Mode Available	Description
 Not pictured in example above.	Options | Calibration Dialog	Acquisition, Review	Launches Glucose Calibration dialog for the entry and augmentation of Glucose Calibration values. <i>Note:</i> Only visible in Toolbar when glucose input signals are being displayed by the graph page.
 Not pictured in example above.	Options | Draw Calibration Marks	Acquisition, Review	Toggles the display of Glucose calibration Reference Values ON/OFF . <i>Note:</i> Only visible in Toolbar when glucose input signals are being displayed by the graph page.

DATA ACQUISITION

SAMPLING CONTROL — STARTING DATA ACQUISITION

The **Sampling Control** dialog permits the user to manage the Ponemah Data Acquisition.

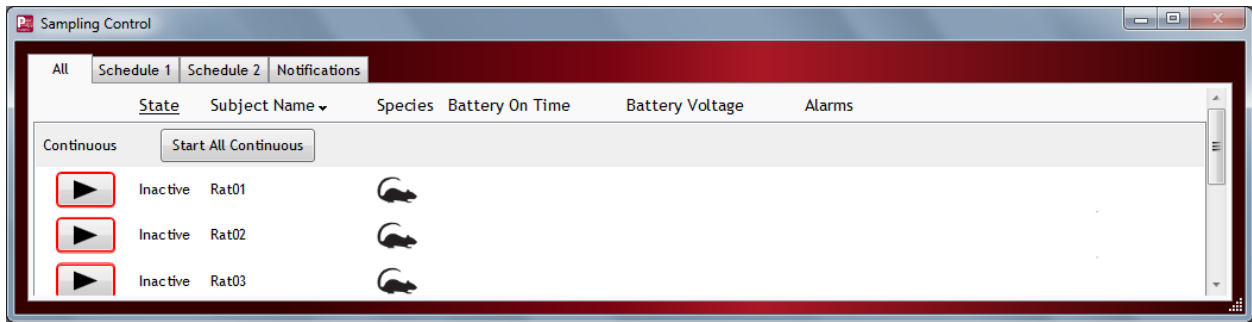
If this is a new Experiment or hardware has not previously been configured, the **Sampling Control** dialog will display the following message *“Please configure Sources from the Hardware menu.”*

The **Sampling Control** dialog contains all subjects that have been configured for the Experiment. This is the interface that controls which Subjects get sampled, in which order, and how often. Sampling tabs are used to manage each sampling method and provide visual feedback on the state of the data acquisition.

When Ponemah is opened, it will load the last Experiment used and automatically populate the **Sampling Control** dialog with the previously configured Subject list.

There are four tabs across the top of the window:

- **Continuous** Toggles Continuous sampling **ON** and **OFF** for any combination of the Subjects in the **Sampling Control** list.
- **Schedule 1** Allows subjects to be grouped for intermittent, sequential sampling.
- **Schedule 2** Allows the user to run a second, separate schedule. This schedule may be run simultaneously with **Schedule 1** or with Subjects sampling continuously.
- **Notifications** List all hardware events associated with the Experiment. For fatal hardware events, such as hardware disconnects or reboots, the tab will include a **Warning** icon as displayed.



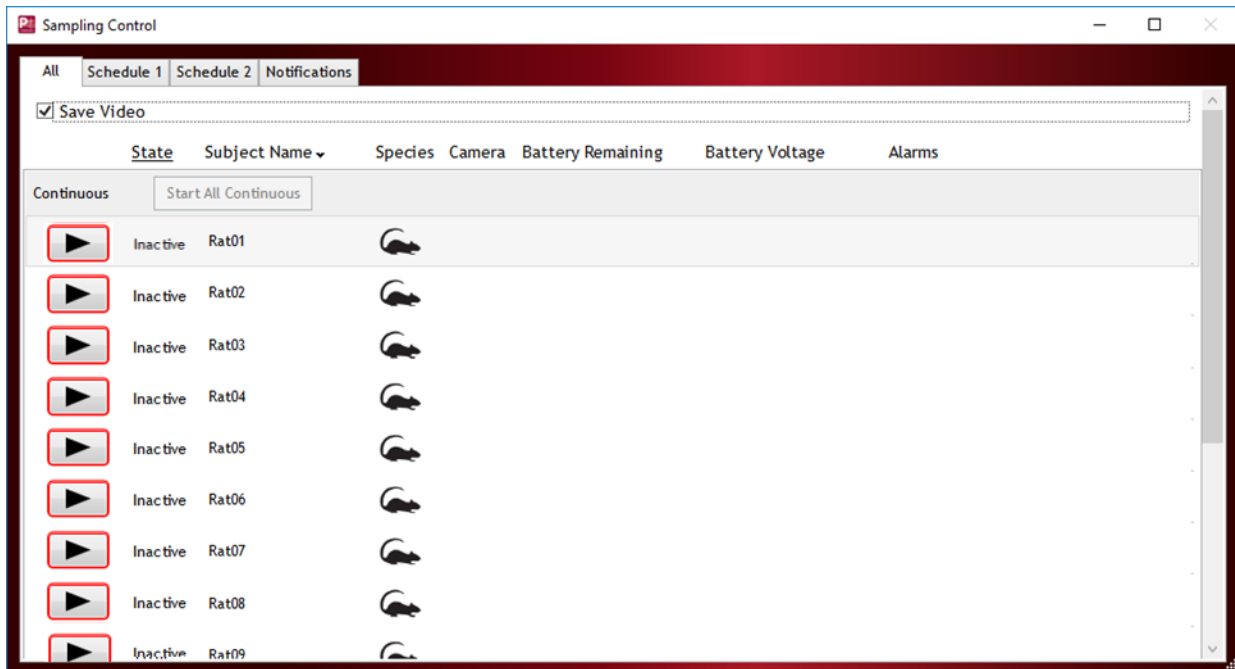
Notes:

- By default, new Subjects are automatically added to the **Continuous** sampling tab.
- The Sampling Control allows you to acquire using the Continuous Sampling method in conjunction with two (2) disparate Scheduled Sampling sequences.
- The number of Subjects you may acquire from simultaneously is determined by the Subject number defined by your software license; this number is shared across all Continuous and Scheduled tabs.

Note: The maximum number of subjects that can be sampled from simultaneously is 32, assuming the software license is at its maximum.

CONTINUOUS SAMPLING

Continuous sampling allows you to sample one or more implants for an extended period of time and without breaks in the data. Continuous sampling is manually started, and continues uninterrupted for minutes, hours, or days, until you stop the process.




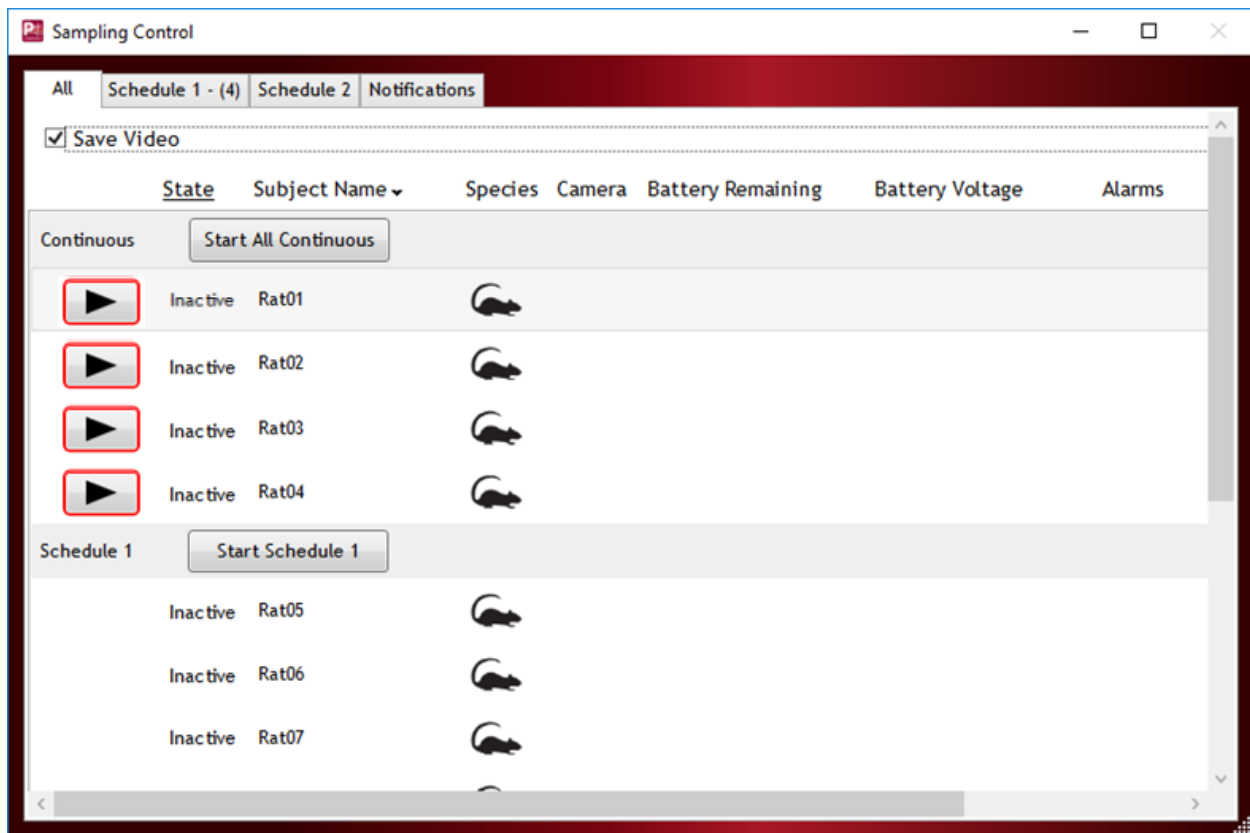
The **Continuous** tab is laid out in columns:

- **Sampling:** Displays the sampling state using graphical icons.
- **State:** Displays the sampling state using text (line items in the list may be sorted by clicking on this column heading).
- **Subject Name:** Lists the Subject Name along with a pictograph of the species (line items in the list may be sorted by clicking on this column heading).
- **Species** Displays the Subject Icon associated with the Species selection within Subject Setup.
- **Camera** Displays associated camera if configured and assigned to subject.
- **Battery Remain:** Displays the Battery Days Remaining of PhysioTel HD and PhysioTel Digital implants while actively acquiring data.

Note: PhysioTel HD Battery ON Time counts the number of days the implant is in ON mode. The values in this field, then represents the warranted battery life with the Battery Days ON time subtracted. PhysioTel Digital reports Day Remaining by default. See the **Battery ON** time section of the **PhysioTel HD Features** section and the **PhysioTel Digital Features** section.

- **Battery Voltage:** Displays the **Battery Voltage** of PhysioTel HD and PhysioTel Digital implants while actively acquiring data. See the **Battery Voltage** section of the **PhysioTel HD Features** section.
- **Alarms:** The user may set low and high alarm thresholds on parameters such as HR and when that parameter goes over that threshold, the value will be displayed in the alarm column in line with the subject that has the alarm.

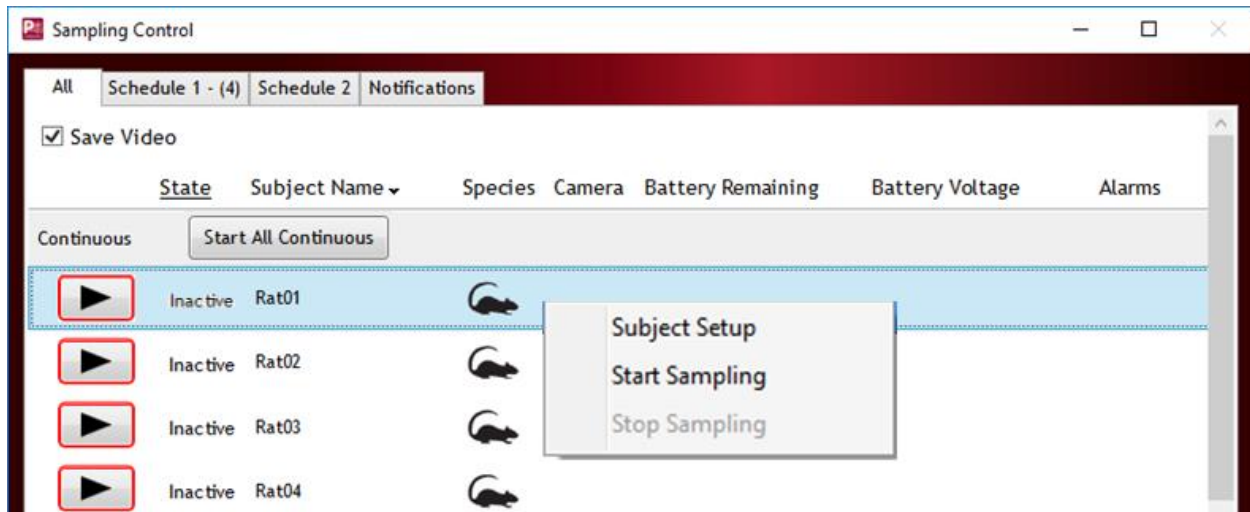
Note: The **Sampling Method** is indicated on the far-left side of the *Sampling Control* dialog and is used to indicate which **Sampling Method** – *Continuous*, *Schedule 1*, or *Schedule 2* – the Subject is assigned. If a Subject is assigned to a Schedule, a **Remove from Schedule** button  is available to quickly reassign the Subject to *Continuous Sampling* without first having to navigate to its *Schedule* tab.



STARTING/STOPPING A CONTINUOUS SAMPLING OF A GROUP OF SUBJECTS

To start/stop **Continuous** sampling using right-mouse-click option:




1. Start All Subjects for Continuous Sampling:
 - a. Select the **Start All Continuous** button from the *Sampling Control* dialog.
 - b. Alternatively, select the **Actions menu | Start Sampling | Continuous – All Subjects**.
2. To start a group of Subjects for Continuous Sampling:
 - a. Multi-select the subjects you wish to start sampling from using **<Shift> + left-mouse-click** or **<CTRL> + left-mouse-click** (used if Subjects are non-sequential).
 - b. Right-click and choose **Start Sampling**.



3. Stop sampling using any of the menu options below:
 - a. **Actions | Stop Sampling | All**
 - b. **Actions | Stop Sampling | Continuous – Selected Subjects**
 - c. **Actions | Stop | Stop Acquisition**
 - d. **Right-mouse-click** Subject and Choose **Stop Sampling**.

STARTING/STOPPING CONTINUOUS SAMPLING OF INDIVIDUAL SUBJECTS

Continuous sampling can be controlled individually per subject using the interactive buttons in the **Sampling** column of the **Sampling Control** dialog. The sampling control buttons change in appearance according to the **State** of the acquisition process. Left-Click on the button to elicit the action.

Sampling	State	Action
	Inactive	Click to Start Sampling
	Waiting	None
	Sampling	Click to Stop Sampling

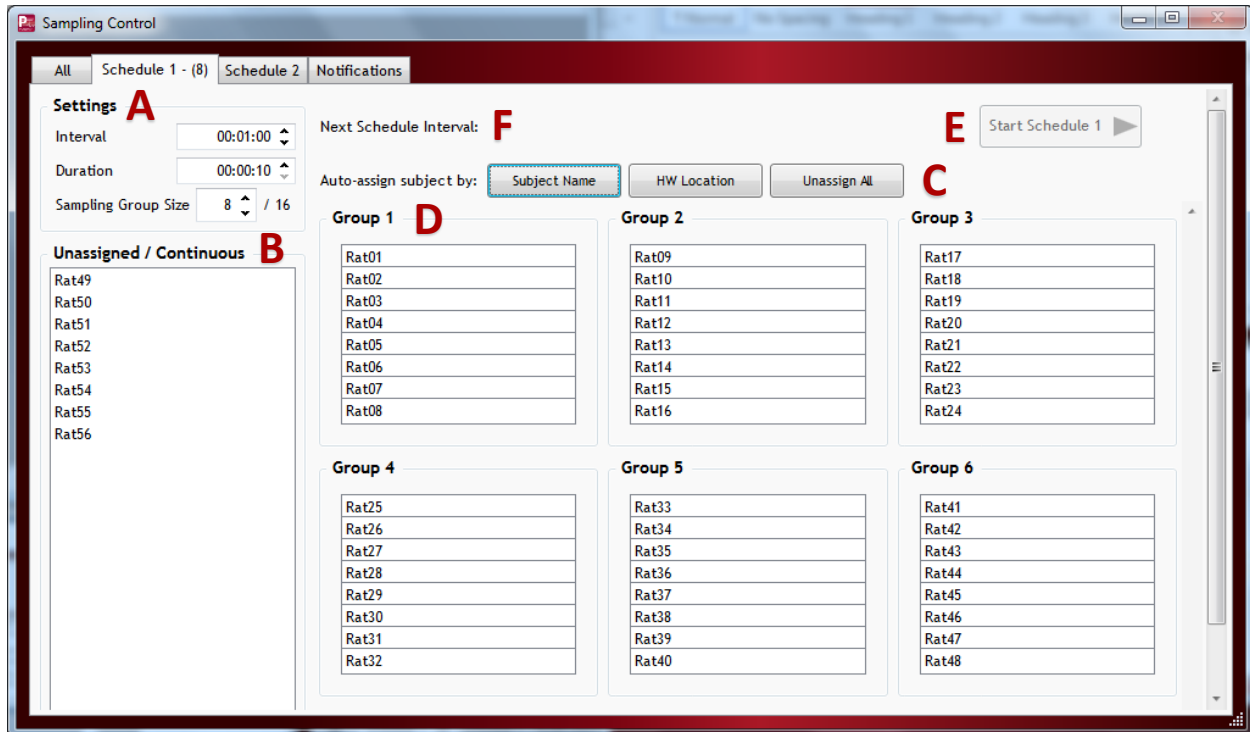
Note: Starting and stopping Continuous Sampling for a single subject will not impact the sampling of other subjects within the experiment. Use the **Play/Pause** buttons in the column on the left to control the sampling of each Subject individually.

SCHEDULED SAMPLING

Scheduled sampling allows you to sample many implants sequentially, and at intervals you may define in the two **Scheduled** tabs. This allows you to cycle Subjects through the number of available resources defined by your software license to maximize the number of Subjects that can be sampled. The *Sampling Control* dialog organizes Subject sampling according to **Groups**. The user can select how the subjects are grouped and in which order they are sampled.

Scheduled sampling is controlled through the two **Schedule** tabs found in the **Sampling Control** dialog. The **Schedule 2** tab allows the flexibility to run two separate schedules simultaneously.

The following displays the Schedule tab and defines its functional areas.



A. Settings

The Settings section of the Schedule tab contains user defined adjustments that automatically open and close sampling groups depending upon the length of the sampling period (**Duration**) and the frequency of sampling episodes ().

- **Interval**
- **Duration**
- **Sampling Group Size**

The time repetition (hh:mm:ss) over which all **Sampling Groups** are sampled.

The time (hh:mm:ss) for which waveform data is acquired from the **Sampling Group**.

Defines the number of Subjects that will be sampled together during the Schedule. This setting is configured as a fraction. The numerator is the user-selected number of Subjects per sampling Group. The denominator is the number of “sources” available as specified in the software license. As the **Sampling Groups** size is changed, the blank lines in the group lists increase or decrease.

B. Unassigned / Continuous

List of configured subjects that are available for assignment to a **Sampling Group**.

C. Auto-assign Subject by:

Automated grouping features.

- **Subject Name**
- **HW Location**


Assigns Subjects to groups based on **Subject Name**. Automatically populates the sampling **Group** with individual Subjects according to the **Subject Name**. Fill all slots in Group1, fill all slots in Group 2, etc.

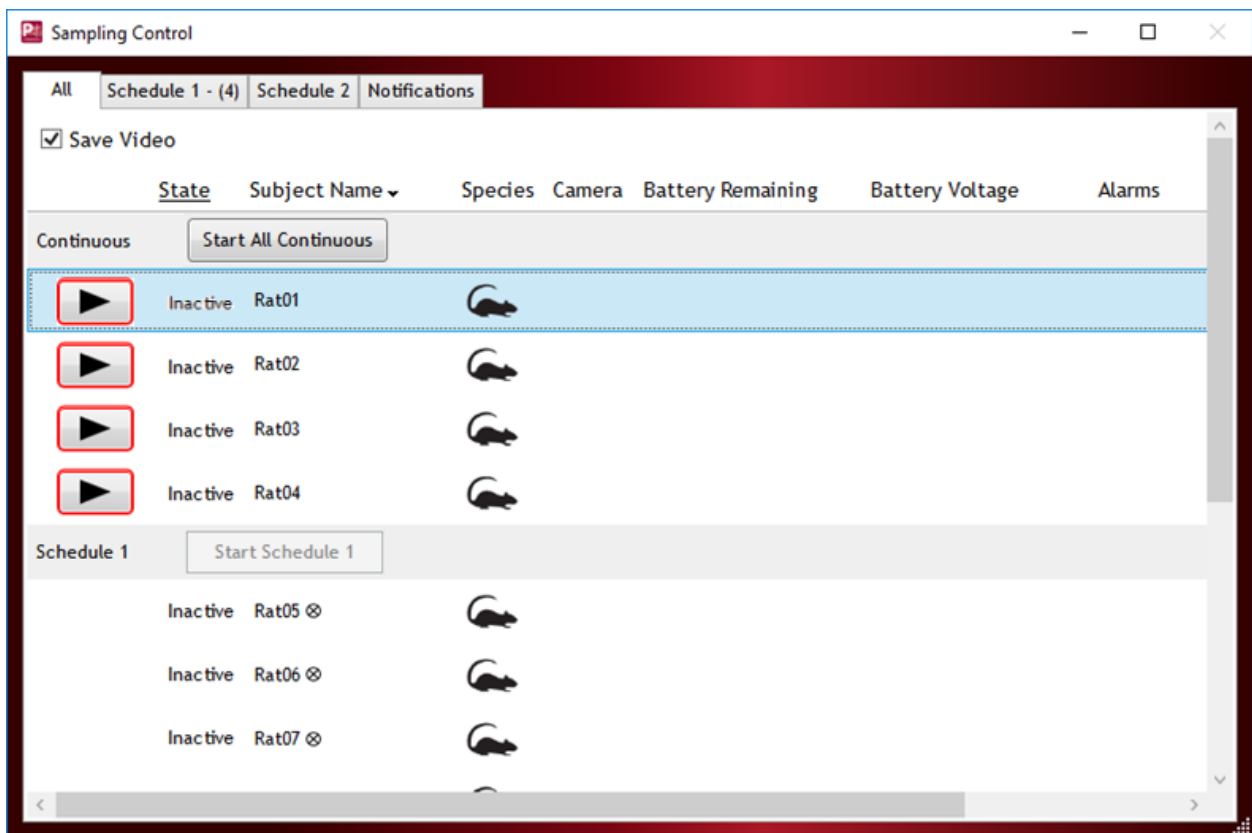
Automatically populates the sampling **Group** with individual Subjects according to the MX2 configuration and the receiver association. Fill all slots in Group1, fill all slots in Group 2, etc.

- **Unassign All** Empties the **Groups** and returns the all Subjects to the Unassigned / Continuous list box. A confirmation dialog will be presented. This only operates on with the selected **Schedule** tab.
- D. Groups** A group of Subjects that will be sampled together during the **Schedule**. New **Groups** will be added and removed according to the **Settings** selected by the user.
- E. Start/Stop Schedule** Initiates/terminates **Scheduled** sampling for that tab.
- F. Next Schedule Interval** Displays the start time of the next **Scheduled** acquisition interval.

ADDING SUBJECTS TO SCHEDULED SAMPLING GROUPS

- **Auto-assign** – This automates the grouping of subjects as described in Section C. of the table immediately above.
- **Drag-and-Drop** – Manually click on individual Subjects, “drag” them to a group, and release the mouse button to “drop” into its group.

Once the Subjects are configured for **Scheduled** sampling they are designated as such in the Continuous tab in the *Sampling Control* dialog. The **State** is listed as **Inactive** and the **Sampling Method** is listed by the **Schedule** tab it is assigned to. It also is listed with a **Remove from Schedule** button  as show below.



STARTING/STOPPING A SCHEDULED SAMPLING GROUP

To start a sampling Schedule:

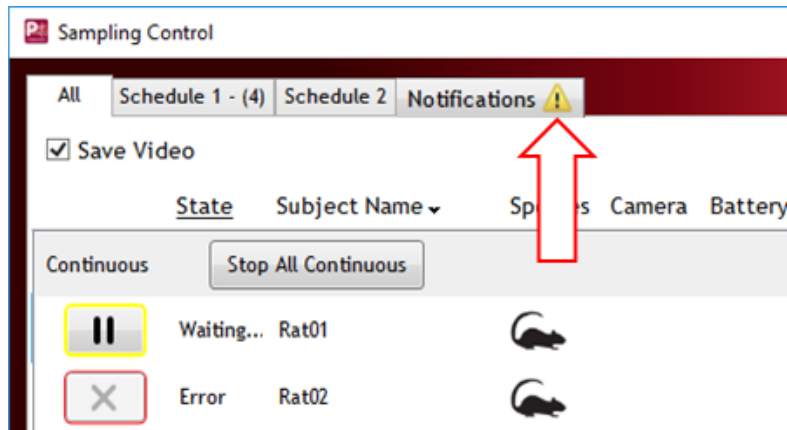
- Select the **Start Schedule** button on the particular **Schedule** tab desired.
- Select the **Actions menu | Start Sampling | Schedule 1** (or **Schedule 2**).

- Select the **Start Schedule** button on the **Continuous** tab for the desired **Schedule**.

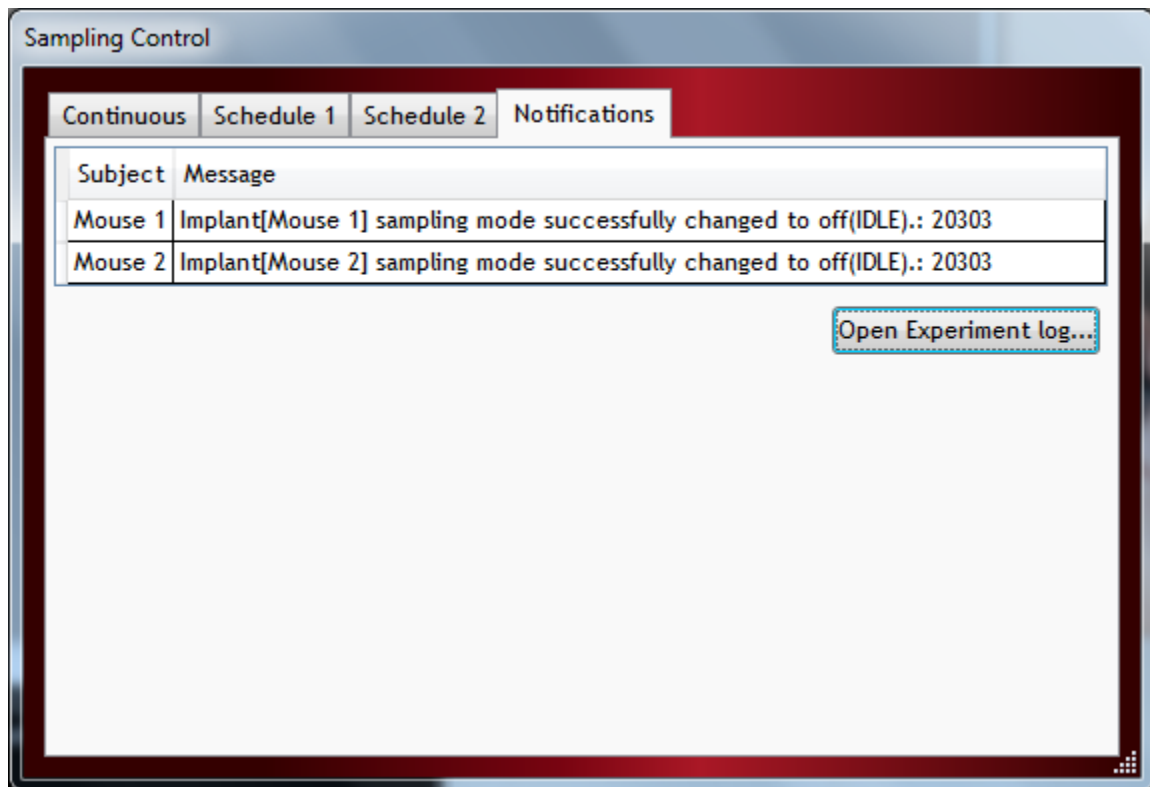
Upon starting the *Schedule Sampling*, the **Start Sampling** buttons will update to **Stop Sampling** buttons. To stop the *Schedule Sampling*, simply select one of the **Stop Sampling** buttons or select the **Actions menu | Stop Sampling | Schedule 1** (or **Schedule 2**).

NOTIFICATION TAB

The **Notifications** tab will list all hardware events associated with the Experiment. For fatal hardware events, such as hardware disconnects or reboots, the tab will include a **Warning** icon as displayed below:



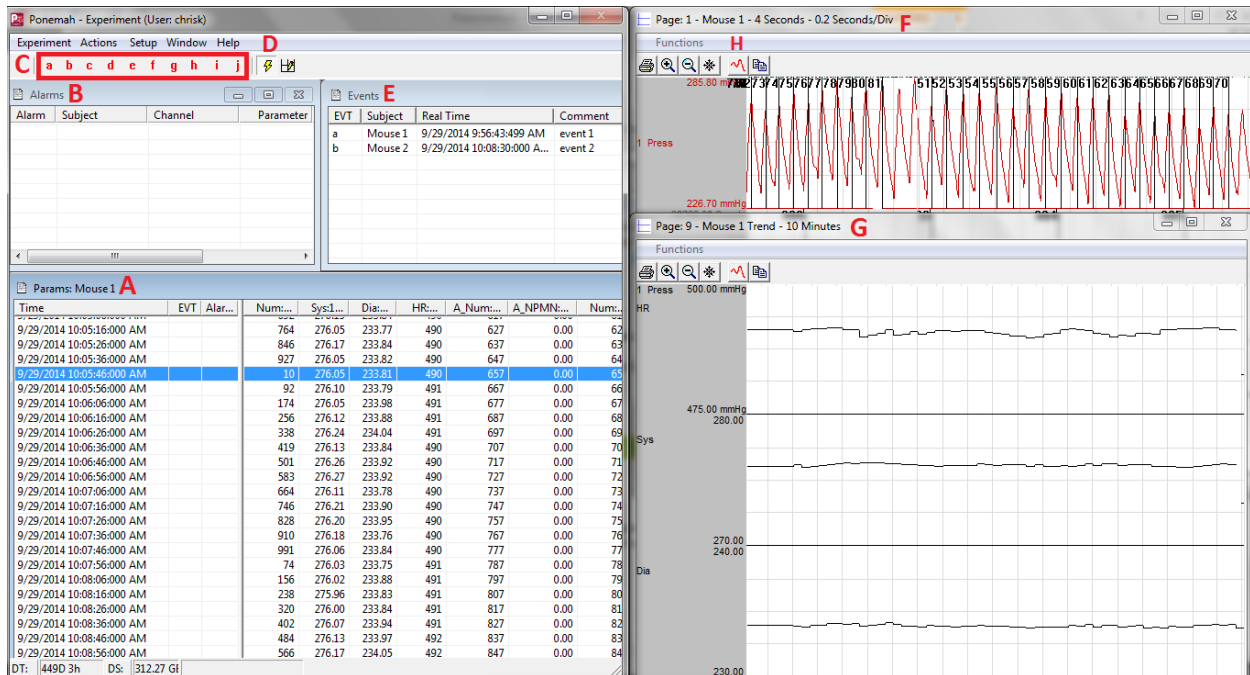
To see the notifications and clear the **Warning** icon, click the **Notification** tab. Users can see the historical notifications by selecting the **Open Experiment log...** button.



DATA ACQUISITION DIALOG

Once the Experiment is configured through the **MX2 Configuration** and **Subjects** are configured through the **Sampling Control**, the data acquisition functions are activated upon clicking **Start Sampling**. Once an acquisition session is initiated Ponemah automatically opens and displays all graph pages that are configured in the **Graph Setup** dialog.

The functions and views of Data Acquisition dialog are called out and are described in detail below:



A. Derived Parameter List View:

Organizes and displays **Derived** (calculated) **Parameter** data (such as heart rate, mean blood pressure, etc.) from the real-time data analysis. **Derived Parameters** are logged to the **List View** based on user-defined settings defined within the **Logging Rate** dialog. The data on each line is from the data contained within the **Logging Period** – the rate specified in the **Logging Rate** dialog.

By default, one **Derived Parameter List View** will be available for each **Subject** being sampled. This is ideal when each **Subject** has a large number of **Channels** and associated **Derived Parameters** available and/or enable. For example, if an HD-S21 is being used, each **Subject** will have an LVP, BP, ECG, Temperature and Activity **Channels** available, each with their own set of **Derived Parameters** that can be calculate.

Time	EVT	Alar...	Num...	Sys3...	Dia...	HR...	Num...	NPMN...	Num...	RR-I...	HR...	P-H...
11/18/2014 3:05:00:000 PM			295	138.12	100.66	387	0	0.00	295	165	363	0.07
11/18/2014 3:06:00:000 PM			682	138.33	100.88	387	0	0.00	682	155	387	0.07
11/18/2014 3:07:00:000 PM			71	138.34	100.90	387	0	0.00	70	155	387	0.07
11/18/2014 3:08:00:000 PM			458	138.35	100.91	387	0	0.00	457	155	387	0.07
11/18/2014 3:09:00:000 PM			845	138.36	100.90	387	0	0.00	845	155	387	0.07
11/18/2014 3:10:00:000 PM			234	138.42	100.95	387	0	0.00	233	155	387	0.07
11/18/2014 3:11:00:000 PM			621	138.34	100.88	387	0	0.00	620	155	387	0.07
11/18/2014 3:12:00:000 PM			9	138.33	100.87	387	0	0.00	8	155	387	0.07
11/18/2014 3:13:00:000 PM			396	138.33	100.87	387	0	0.00	396	155	387	0.07
11/18/2014 3:14:00:000 PM			783	138.31	100.86	387	0	0.00	783	155	387	0.07
11/18/2014 3:15:00:000 PM			172	138.29	100.84	387	0	0.00	171	155	387	0.07

Alternatively, the **Derived Parameter List View** may be organized in an **Aggregate** mode. In **Aggregate** mode, one **Derived Parameter List View** will be available

during Acquisition that displays the **Derived Parameters** from all Subjects' **Input Channels** that are being sampled. This is ideal when each Subject has a small number of **Channels** and associated **Derived Parameters**. For example, if an HD-XG is being used, each Subject will only have Glucose, Temperature, and Activity Channels available. In this case, the user may choose to only display three **Derived Parameters** per Subject – Average Glucose, Average Temperature, and Average Activity – for the **Logging Period**. Users can change the **Derived Parameter List View** to Aggregate mode by selecting **Setup | Experiment Setup | Settings** and check the check box associated with **Aggregate Parameter Window**.

Note: Once data has been acquired, the **Derived Parameter List View** organization cannot be augmented. The organization used for Acquisition will also be used during Review.

B. Alarms List View:

Enumerates any alarm conditions met during the acquisition, based on user-defined settings defined within **Subject Setup | Channel Details**.

The following provides more detail on the **Alarms List View**:

Alarm	Subject	Channel	Parameter	Low	High	Condition
1	Rat1	1	Mean	80.00	120.00	124
2	Rat1	2	HR	50.00	100.00	

- **Alarm** is the number of the alarm.
- **Subject** is the subject name that is assigned to the alarm.
- **Channel** is the sampling channel
- **Parameter** is the derived parameter that is assigned to the alarm.
- **Low** is the low alarm value.
- **High** is the high alarm value.
- **Condition** is the condition of the alarm. If the field is blank, then no alarm condition exists for that parameter. If a value is in the field, that value is the alarm value.

C. Events Toolbar:

Buttons labeled “a” through “j” are used to enter an **Event**. These are defined within the **Setup | Experiment Setup** dialog, and can be executed by selecting the appropriate Subject(s) within the **Sampling Control** dialog and selecting the appropriate event.

The following provides more detail on the **Alarms List View**:

EVT	Subject	Real Time	Comment
a	A- DOG123	10:57:57	Inject Drug
b	A- DOG123	10:58:15	Start Occul.
c	A- DOG123	10:58:19	End Occul.

- **EVT** is an identification mark. It is a letter between a through j if the User gave the Event a predefined name, or it contains an x (for external). External refers to a hand-entered Event through the Events dialog.
- **Subject** references the Subject Name assigned to the signal. (See Subject Details).
- **Real Time** is the actual time the Event happened.
- **Comment** is the name the User gave the Event in the Groups and Events configuration.

D. Validation Mark Toolbar button	Toggles the display of Validation Marks on the Primary graph page ON/OFF. Validation Marks are tick marks placed on the Primary graph page by the Analysis Modules to indicate key points of interest on the waveform. These are used to visually verify that the analysis is triggering properly. See the Validation Marks section.
<i>Note:</i> Toggle Validation Marks ON/OFF using the <F10> keyboard key.	
E. Events List View	Enumerates executed Events by Subject for the acquisition period.
F. Primary Graph	Displays the signal's waveform data in raw (physical) format over a specified period of time.
G. Trend Graph	Displays the derived parameter data located in the Derived List View as a graph.
H. Auto Scale Toolbar button	Auto scales all axes on the graph page. To auto scale a single channel's axis, double-click that channel and click auto scale.

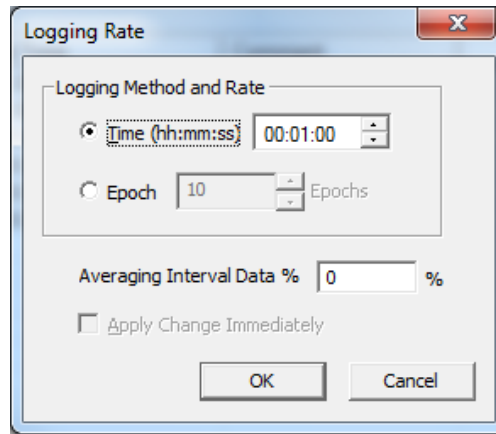
LOGGING RATE

The **Logging Rate** defines how often derived data is logged to the **Derived Parameter List View** or plotted to graphs that use derived parameter data (See Graph Types). The **Logging Rate** dialog allows the user to change the rate at which the derived parameters are logged to the **Derived Parameter List View** and graphs that display the derived parameters (**Trend** and **Scatter**) as the data is being acquired or while in Review. The **Logging Rate** can be augmented at any time during Acquisition or Review.

Note: The rows of data listed in the **Derived Parameter List View** are referred to as **Log Lines**.

To open the **Logging Rate** dialog, select one of the options below:

- From the **Actions menu | Logging Rate...**
- Pressing the <F8> key from the keyboard
- Left-clicking the **LR** button on the Acquisition toolbar



The following define the settings available within the **Logging Rate** dialog:

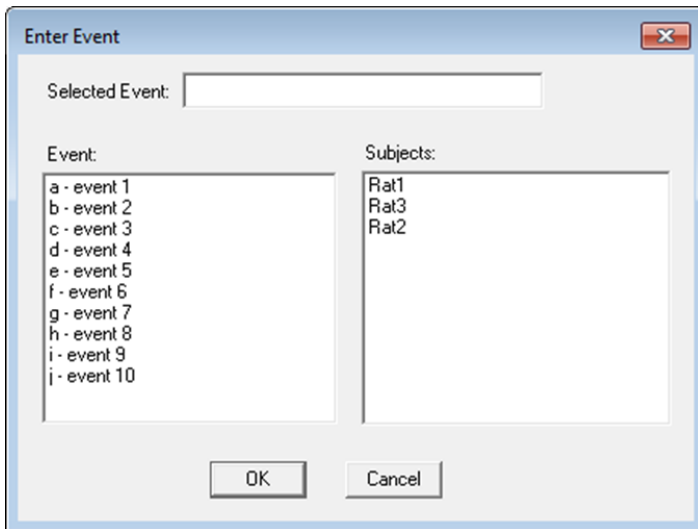
Logging Method and Rate	Determines how often data is plotted on the graphs and logged into the files.
Time (hh:mm:ss)	Sets the Logging Rate to a specified time interval.
Epoch	Sets the Logging Rate to cycles (beats, breaths, contractions, etc.).
Averaging Interval Data %	The Logging Interval will be rejected and will not be reported if the % of available data within a Logging Interval is less than the Averaging Interval Data % value.
Apply Changes Immediately	Causes the system to begin using the new logging rate immediately and not to wait for the current logging period to finish. The line of data associated with this logging period will be based on fewer values averaged in the logged line of data. If this is not used the system will finish the last logged line of data before using the new logging rate. For example, if the last logging rate was 30 seconds, but only 20 seconds has elapsed, choosing OK without checking this causes the system to wait 10 seconds, log the full 30 seconds of data to the Derived Parameter List View , then begin using the new logging rate.
OK	Applies the Logging Rate setting changes – see Apply Changes Immediately section.
Cancel	Closes the Logging Rate dialog without applying any changes.

MARKING EVENTS

The User may predefine a set of **Events** (a - j). During Acquisition, the user can execute one of the predefined Events. The executed Event will be marked in the **Primary** graph and in the **Derived Parameter and Event List Views** during the Acquisition for availability within Review.

To mark an Event:

1. Select **Actions | Events...** or press <F9> key form the keyboard.



2. Select the **Event** you wish to mark from the **Events** column.
3. Select the **Subjects** you wish to apply the **Event** to from the **Subjects** column.
4. Select **OK**.

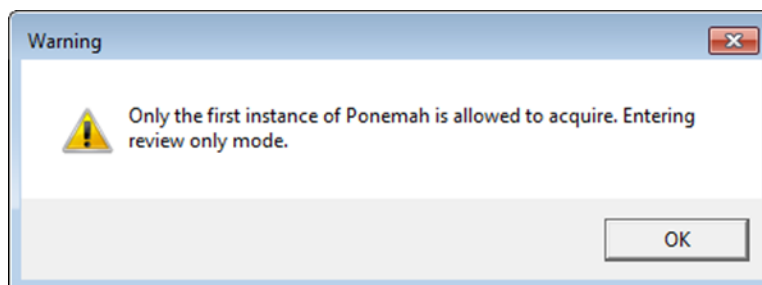
Note: The user has the option to display **Events** as a string. This will display the complete Event message on the graph screen. To display Events as a string, see Settings Configuration section.

REVIEW DURING ACQUISITION

Review mode can be accessed from the main Ponemah window: **Actions | Start Review....** However, this option is not available during an active data Acquisition. To enter Review mode during data Acquisition, a second instance of Ponemah can be activated from the **Windows Start Menu** or by **double-clicking** the **Ponemah icon**.

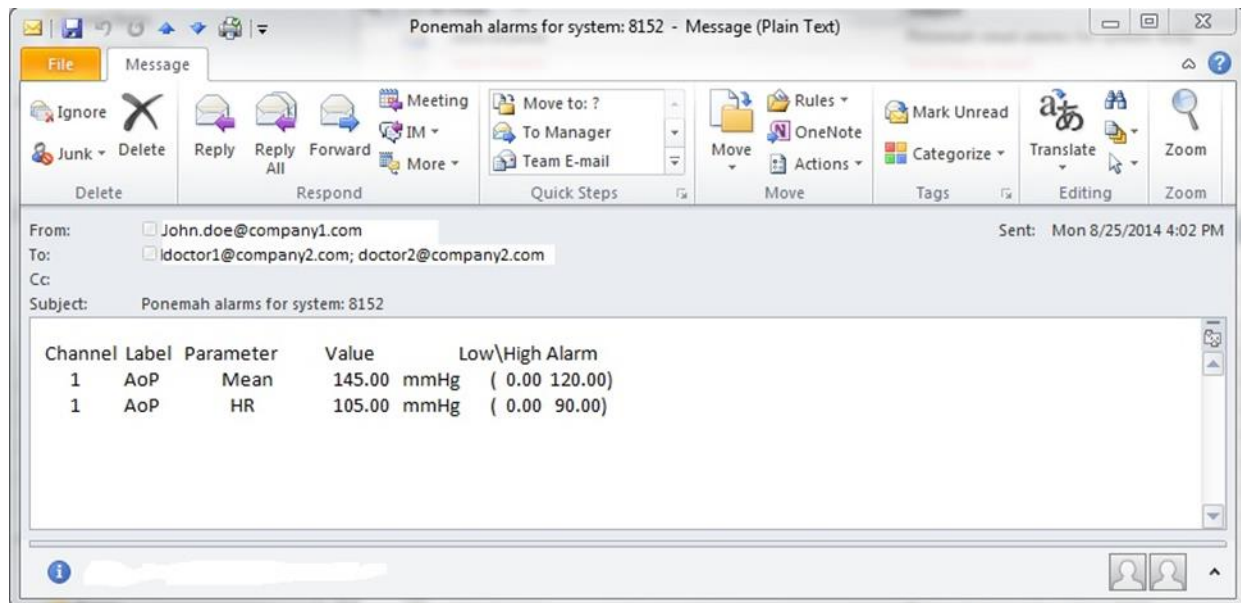
This will initiate a **Review Only Mode** and provide access to data from previous Experiments, as well as the currently acquiring Experiment.

Note: If reviewing data from the currently acquiring **Experiment**, all data will be available up to the point of selecting **Start Review**. To gain access to data collected after this point, close and re-start Review. Additionally, at least 5 minutes of data is required to **Start Review** during the Acquisition; Ponemah will display a notification if less than 5 minutes have been acquired.



REMOTE NOTIFICATION – EMAIL ALERTS

The Ponemah application supports the sending of an informational **Remote Notification** using **Email Alerts** for two types of conditions by using Simple Mail Transfer Protocol (SMTP).



One type of the email alert is for parameters that go into an alarm condition during acquisition. The alarm thresholds can be set by the user for any **Derived Parameter** and are updated for every **Logging Period**. The user may set a time, in minutes, that set the frequency of the alerts.

This will help prevent sending many email alerts for an alarm if the logging period is set for a short duration but the user would only want to be notified of the alarm condition every 30 minutes. With the delay of sending emails this helps prevent a non-physiological event from sending multiple alarms with a short duration logging period.

The second type of email alert is for an application failure and fatal hardware events. The application failure would be for Data Buffer Overflows. Data Buffer Overflows occur when an application uses many of the resources of the system and starves the Ponemah application from processing incoming data, such as when a virus checker starts scanning. The processing of this data gets too far behind and causes the failure which then sends out an email alert allowing the issue to be addressed. Fatal hardware events include hardware disconnects and reboots.

As email alerts are sent out, these actions are also logged in the **Ponemah Application log**.

Note: To send emails as text messages, please see the **Remote Notification – Email Alerts** appendix.

EMAIL ALERT CONFIGURATION

To setup the Email Alert notifications, the first step is to setup the Email server that will be used to allow sending the emails, the recipient addresses to which the alerts will be sent and setting up the desired alarm conditions to trigger the alerts.

To access the Email Alert settings, choose **Setup | Application Configuration | Email Alerts**.

Note: If are using an account that requires a password change, be sure to update the password used in this configuration.

Configuration - Email Alerts

Configuration | Email Alerts

Experiment Path
Miscellaneous
Email Alerts
Advanced
Review

Mail server (SMTP): smtp.servemame.com

Port (default 25 or 587): 587 Encryption: Auto

From E-mail Address: testuser@servemame.com

User Name:

Password:

Alarm Alerts

Enabled Delay between notifications (mins): 10 Test Alarm Email

Email Alarms To: testuser@servemame.com

Acquisition Failures

Enabled Delay between notifications (mins): 10 Test Failure Email

Email Failures To: testuser@servemame.com

OK Cancel

Depending on the email server that will be used to send the email alerts, the configuration can be accomplished by setting the appropriate fields to match the server configuration. In certain cases, such as for Exchange Server, specific configuration settings may be needed to allow access. If you are unsure of settings, please contact your IT systems administrator. See Appendix 1 for typical Exchange Server configuration.

- **Email Server:** This field should have the name of the email server that will be used for sending the emails. In the above example mail.company1.com would be email server that would be authenticated against with the provided logon credentials to send the email.
- **Port:** This is the SMTP host port that is used and defaults are listed below. If the email server uses a different port, that specific port number should be entered in this field.
 - Exchange Server: 25
 - Microsoft Live: 587
 - Gmail: 587
- **Encryption:** allows the connection to use an encrypted connection.
 - **None:** No SSL or TLS encryption should be used.
 - **Auto (default):** Allow the mail service to decide which SSL or TLS options to use. If the server does not support SSL or TLS, then the connection will continue without any encryption.
 - **SslOnConnect:** The connection should use SSL or TLS encryption immediately.
 - **StartTls:** Elevates the connection to use TLS encryption immediately after reading the greeting and capabilities of the server. If the server does not support the STARTTLS extension, then the connection will fail and a not supported exception will be displayed.

- **StartTlsWhenAvailable:** Elevates the connection to use TLS encryption immediately after reading the greeting and capabilities of the server, but only if the server supports the STARTTLS extension.
- **Logon Name and Password:** These fields contain the email address and password of the user that will authenticate the email communication connection.

Note: this email address will be the one used in the **From** field of the sent email.

ALARM ALERTS

The user can choose to have the alarms generated from out of limit derived parameters to send a detailed email of the alarm condition. This only works when the application has alarms defined in the protocol.

- **Enabled:** This allows the user to enable or disable the sending the email alerts when using alarms.
- **Delay between notifications (min):** The system may set a time-delay, in minutes, between consecutive alerts triggering an email notification to be sent out. For example, if the time-delay is set to 1 minute and Ponemah is logging data every 10 seconds, then when a parameter is in an alarmed condition for 3 consecutive logging periods, 30 seconds, Ponemah will only send out one email notification instead of three notifications.
- **Email Alarms To:** This field contains the recipients email addresses that will receive the alarm email alert. Multiple names can be entered separated by a comma or semicolon.
- **Test Alarm Email:** Click this button to test the configured mail server and send a test email to the recipients listed. The email subject will be Test Email along with the body of the email containing Ponemah workstation serial number.
 - This will save the current configuration even if Cancel is used to exit Application Configuration.
 - For failures see **Remote Notification – Email Alerts Appendix**.

Note: Invalid email addresses will be ignored and no warning is posted.

APPLICATION FAILURES

The user can choose to have an email notification sent to them for alarms generated from certain application failures.

- **Enabled:** This allows the user to enable or disable the sending the email failures.
- **Email Failure To:** This field contains the recipients email addresses that will receive the failure email alert. Multiple names can be entered separated by a comma or semicolon.
- **Test Failure Email:** Click this button to test the configured mail server and send a test email to the recipients listed. The email subject will be Test Email along with the body of the email containing Ponemah workstation serial number.
 - This will save the current configuration even if cancel is used to exit Application Configuration.
 - For failures see **Remote Notification – Email Alerts Appendix**

Note: Invalid email addresses will be ignored, and no warning is posted.

PARAMETER VIEWER

Ponemah Parameter Viewer is a powerful, flexible visualization tool that permits users to quickly view Derived Parameter data over an entire Experiment; this may be hours, days, weeks, or months of data.

Use Parameter Viewer to:

- Observe long-term trends in derived data or view historic data during acquisition.
E.g. did core body temperature rise or fall over the 30-day collection period.
- Quickly locate outliers to perform targeted data analysis within Ponemah Review.
E.g. non-physiologic measurements for blood pressure parameters are observed between 10:00 AM and 1:00 PM on day two of collection, enter Ponemah Review to assess the waveform data within this time range and reanalyze if necessary.
- Perform averages of averages to determine the perfect level of depth at which to report.
E.g. overlay 1 minute, 1 hour, 4 hour, and 12 hour averages of Pulse Pressure data to determine which provides the most insightful visualization.
- Compare changes in Derived Parameters caused by a dose response.
E.g. align the heart rate based on an event to see intra-subject effect based on dose level or to see the heart rate response across all subject for low dose.

OPENING PARAMETER VIEWER

To access Parameter Viewer from within an Experiment, select the **Actions menu | Open Parameter Viewer**.

Parameter Viewer may be used during Acquisition or Review, also available through the **Actions menu**. It may also be run outside of Ponemah (without having to open Ponemah) by selecting **Ponemah Parameter Viewer** from the Windows Start Menu.

Multiple instances of Parameter Viewer may be opened at once for flexibility in viewing preferences. Simply select **Actions menu | Open Parameter Viewer** additional times to launch additional instances. Similarly, launching **Ponemah Parameter View** from the Windows Start menu multiple times will launch additional instances. Ponemah does not enforce a limit to the number of instances that may be opened, performance will be dependent on the specifications of the computer being used.

Note: If running Parameter Viewer without the main Ponemah application being open, the USB security key is still required to be plugged into the computer.

LOADING DATA

When opened, Parameter Viewer will load the current Experiment opened in Ponemah. If running a standalone instance of Parameter Viewer, it will load the last Experiment opened by the main Ponemah application.

Once launched, Parameter Viewer will have access to all data available up to the point of opening. If not actively acquiring data, this means all data is accessible. However, if Parameter Viewer is opened during an Acquisition, it will load all data up to the last line of data as logged within the Ponemah Derived List Views.

Data will be loaded based on the logging rate used to calculate and save the Derived Parameter data. By default, the logging rate is 60 seconds. To learn more about logging rates, please see the **Logging Rate** section of this manual.

To dynamically load data as it is being acquired, check the **Dynamic Load** checkbox under the **Options** menu. This will sync the Experiment every 15 seconds.

Users may also refresh the data within Parameter Viewer to reflect updated results should changes be made while in Review by selecting **File | Sync Experiment** from the *Parameter Viewer* dialog.

Note: Different sections of data may have different logging rates depending upon when they were changed; e.g. If the original 24 hour Acquisition used the default logging rate of 60 seconds, but an 8 hour section of data was opened in Review and reanalyzed using a 10 second logging rate, then Parameter Viewer will display 1 point every 10 seconds for that 8 hour section, while displaying 1 point every 60 seconds for the other 16 hours of data.

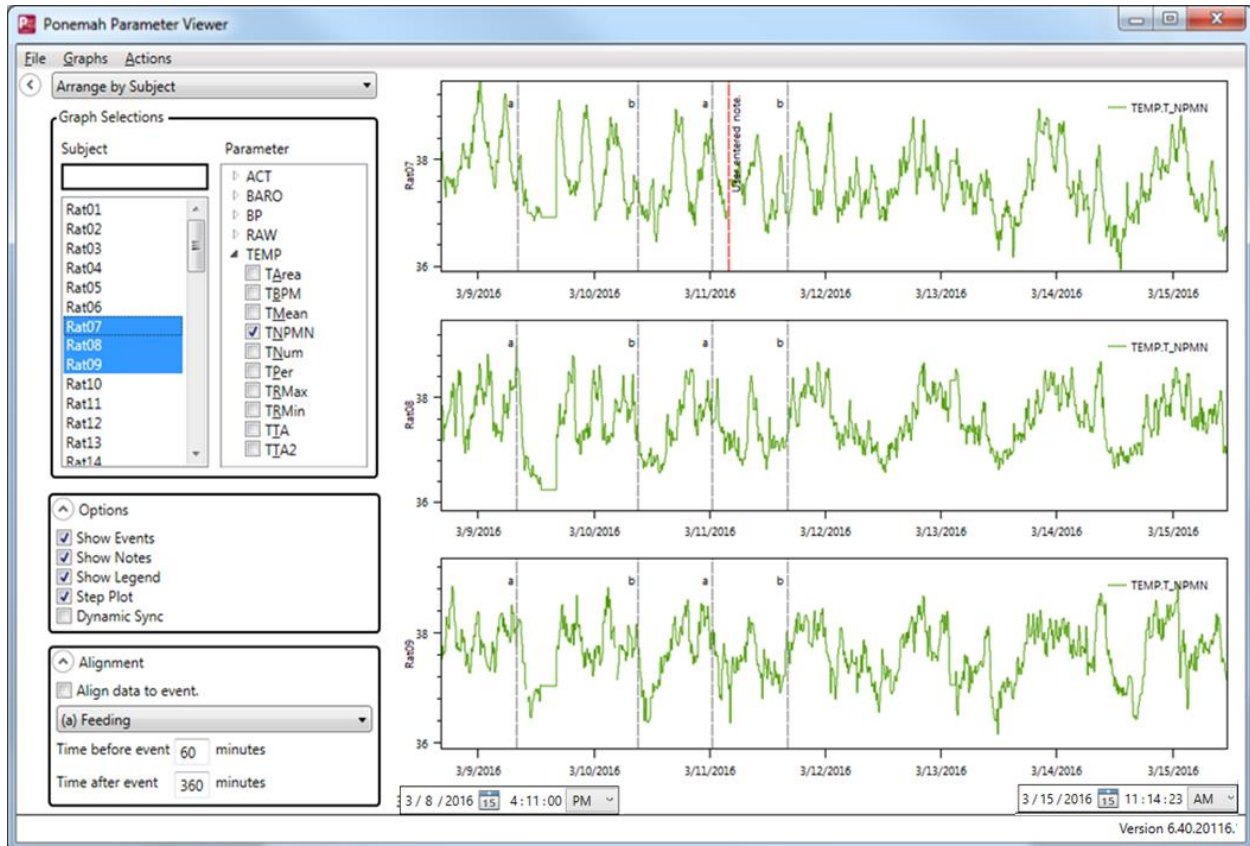
To load data from a different Experiment:

- Select the **File menu | Open Experiment**.
- Navigate to the folder containing Experiment of Interest.
- Select the Ponemah Experiment File (**.PnmExp**)
- Select **Open**.

The 5 most recent Experiments loaded into Parameter Viewer will also be listed under the file menu to quickly switch between Experiments.

Note: Different instances of Parameter Viewer may display data from the same Experiment or from different Experiments.

PARAMETER VIEWER DIALOG OVERVIEW



The Parameter Viewer dialog is split into two sections: **Setup** is on the left and the **Graph** section is on the right.

SETUP

The **Setup** section allows the user to configure which data is to appear in the **Graph** pane and how the data should be displayed. Once settings are configured, the Setup may be collapsed to display the Graphs using the collapse

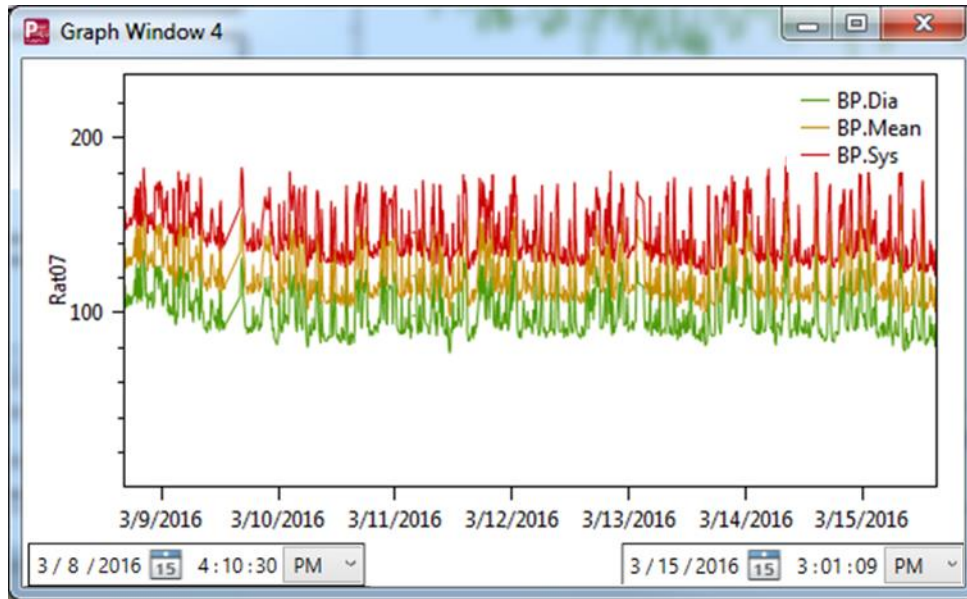
icon. 

ARRANGE BY

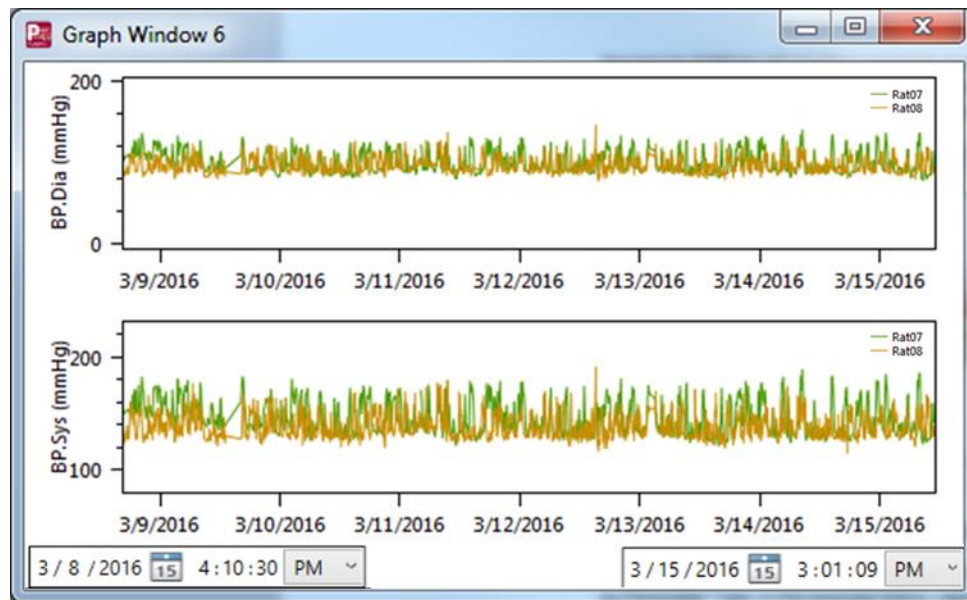
The **Arrange by** dropdown menu permits the user to arrange graphs by Subject, Parameter Type, or Parameter.

Arrange by Subject will result in a separate graph being created per Subject. All parameter selections will be displayed together for that Subject.

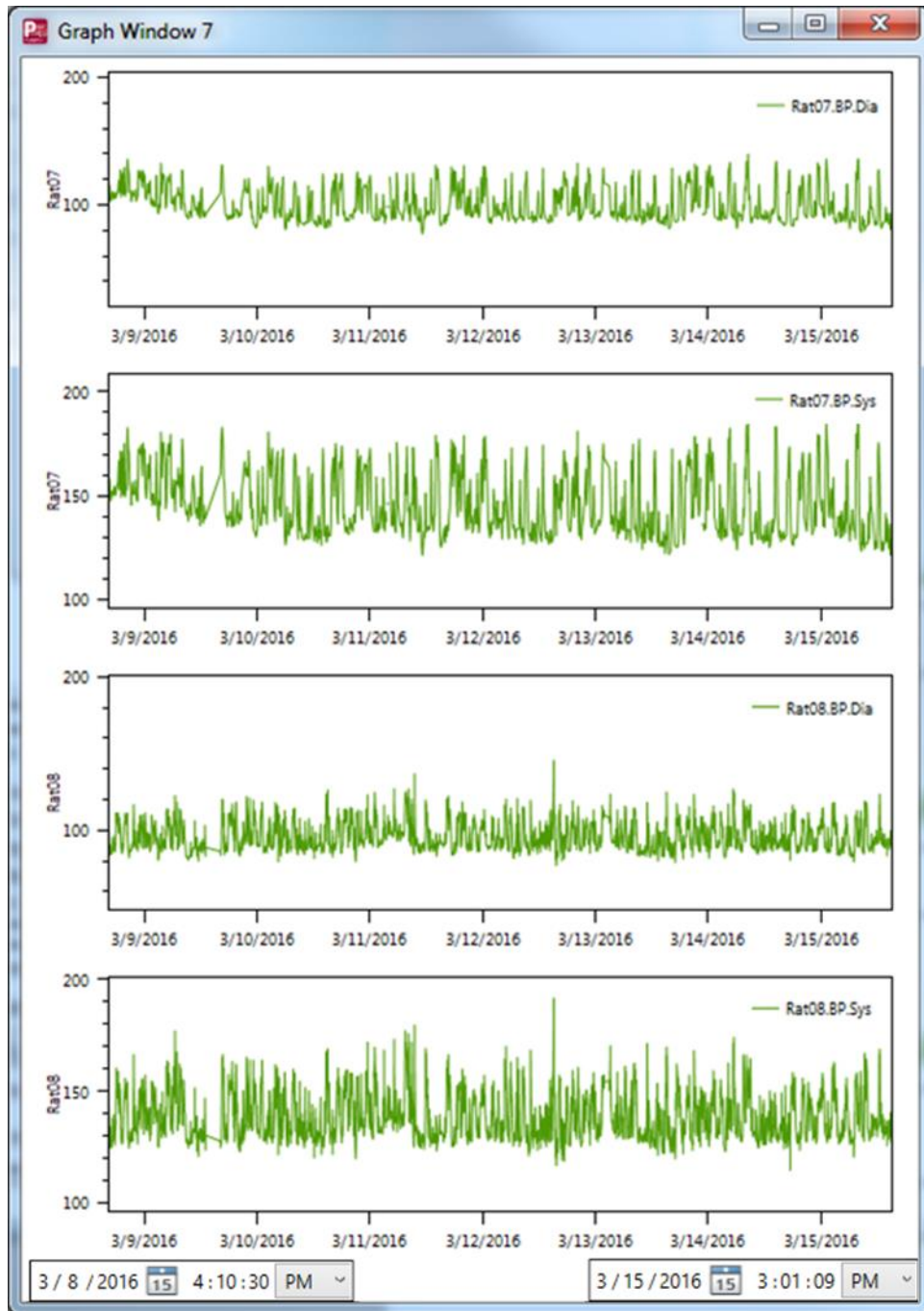
In the example below, 7 days of Systolic, Mean, and Diastolic blood pressure data is displayed for Subject Rat07.



Arrange by Parameter Type permits the user to graph multiple Subjects on a single graph by Parameter Type. In the example below, separate Diastolic and Systolic pressure graphs are displayed containing data from Subject Rat07 and Rat08.



Arrange by Parameter will create a separate graph per Subject and Parameter. In the example below, separate Diastolic and Systolic pressure graphs for Subject Rat07 and Rat08.



GRAPH SELECTIONS

The **Graph Selection** allows the user to select which Subjects and Parameters should be displayed within the Graph pane. The **Subject** list includes all Subjects with available Derived Parameter data that may be selected for display within the graph. A single left-click of a **Subject Name** will select that Subject to be included in any graphs created. The text box at the top of the list permits users to filter the Subject list for a more efficient method of locating a Subject without scrolling through the list. Multiple Subjects may be selected.

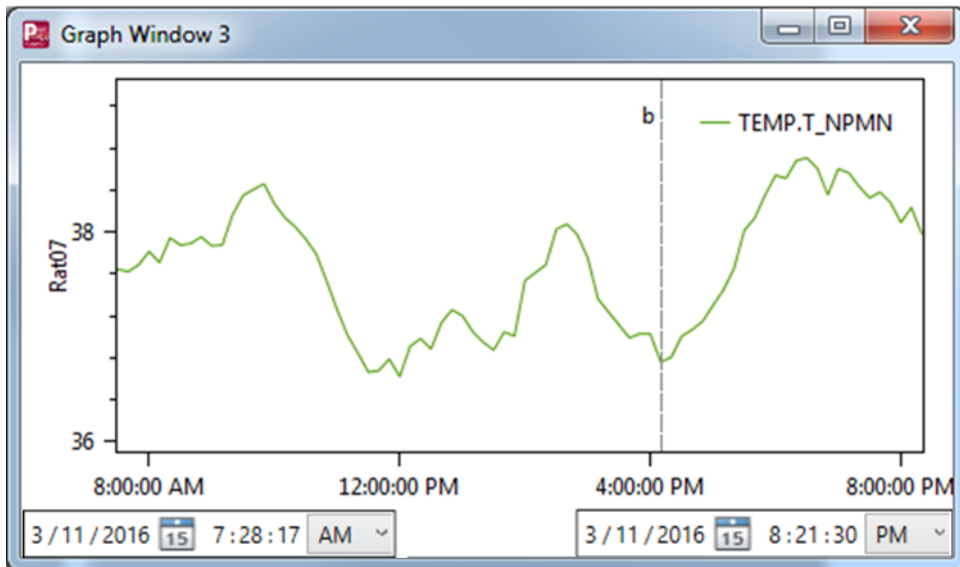
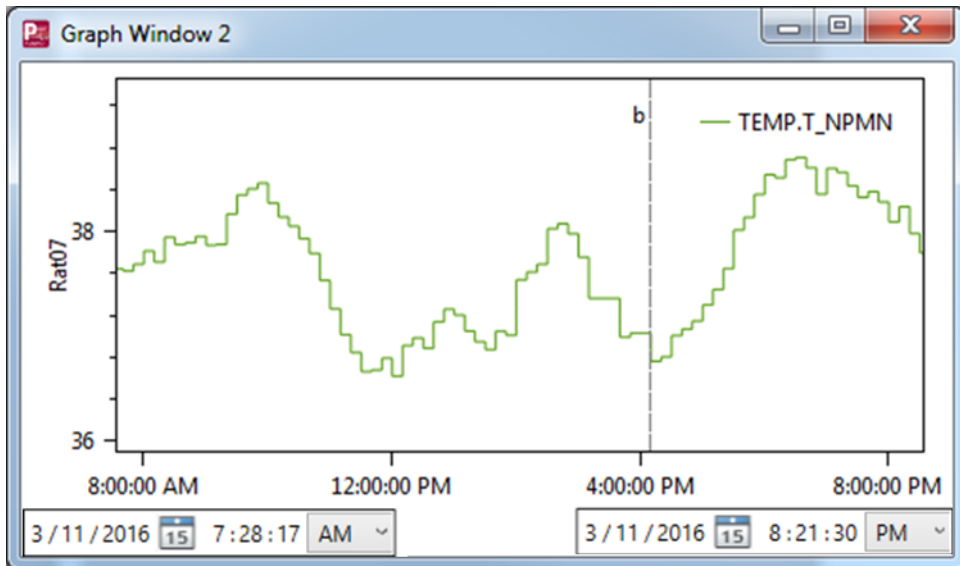
The **Parameter** list displays all Derived Parameters available for graphing, organized by Analysis Module used within the Experiment. Expand the Analysis Module and select the checkbox associated with the Derived Parameter desired to be graphed. Multiple Parameters may be selected.

The example used at the beginning of this manual section has the non-pulsatile mean of the Temperature channel for Subjects Rat07, Rat08, and Rat08 selected.

OPTIONS

The **Options** section allows the user control of the following graphical features:

- **Show Events** Displays user entered **Event Markers** associated with Subjects within the graph pane. Events will be represented by one of the **a – j** Event characters. Hovering the mouse cursor over the displayed Event in the graph pane will display its associated user-define text as entered within the **Experiment Setup | Events** dialog (see the **Data Acquisition | Marking Events** section for details). The example used at the beginning of this manual section includes events **a** and **b** across all Subjects graphed.
- **Show Notes** Displays any **Freeform Notes** entered during Review that is associated with the selected Subject Parameter data. Notes are displayed as vertical, dashed red lines with associated text. Should the text extend past the visible graph pane, hovering the mouse cursor over the Note will display the full text. The example used at the beginning of this manual section includes a Freeform Note associated with Subject Rat07.
- **Show Legend** Toggles the graph legend ON (checked) and OFF (unchecked).
- **Step Plot** Toggles between a Step Plot (checked) and a Line Plot (smoothed). The example below displays the non-pulsatile mean of Subject Rat07's Temperature data over an 8-hour period using a Step Plot (*top*) and a Line Plot (*bottom*).

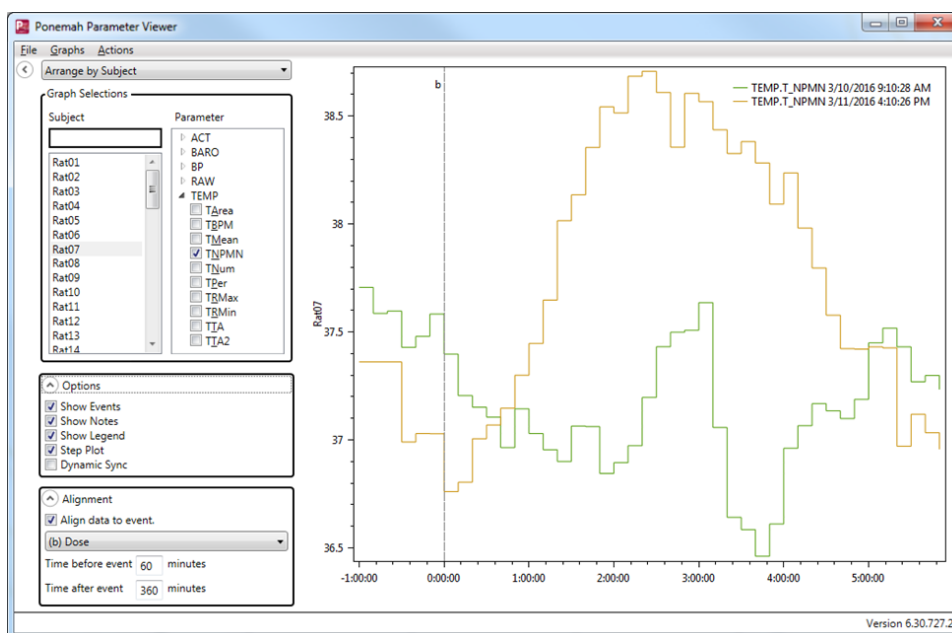


- **Dynamic Sync** When actively acquiring data with Parameter Viewer opened, checking this Option will update the Derived Parameter data within Parameter Viewer every 15 seconds, automatically.

ALIGNMENT

Permits the user to align the data to an Event. Check the associated checkbox to enable data alignment. Select the Event to which the data should align using the dropdown menu. Specify a time (in minutes) to display within the graph pane before and after the event.

In the example below, the graph has been configured to aligned Subject Rat07's data to the Dose Event b and to display data from 60 minutes (1 hour) prior to the Event to 360 minutes (6 hours) after the Event. Notice, two data series are graphed as only two b Events existed in the data set.



Note: Changing the Arrange by dropdown to Arrange by Parameter Type and selecting multiple Subject Names from the Subject list will allow multiple Subjects' data to align to an Event, if the Event is present within the selected Subjects.

GRAPHS

The Graph displays the generated graphs based on the selections made in the Setup section. Up to 16 graph panes may be displayed within the Graph section at one time.

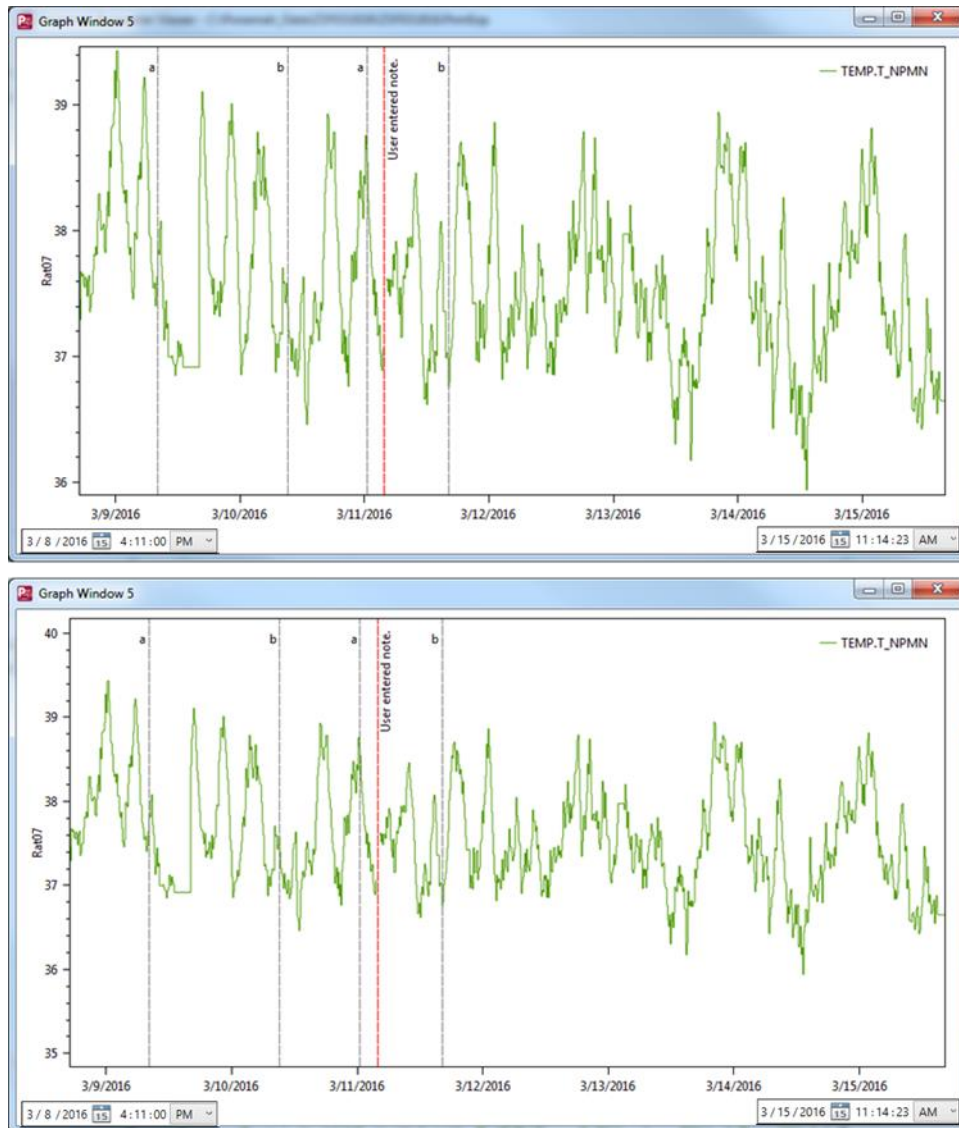
SCALING/ZOOM

The Graph Pane autoscales the y-axis range based on the match results being displayed. The x-axis range defaults to the display the entire duration of the Experiment.

To change the scale of the x- or y-axis, hover the mouse over the desired axis and use **<Ctrl> + Mouse Wheel** to change its scale. Scrolling down will zoom out, expanding the axis ranges and compressing the data to effectively displaying more points within the associated Graph Pane. Scrolling up will zoom in, compressing the axis range and expanding the data to display fewer points. Select **<Shift> + <F9>** to autoscale the y-axis of the selected graph or **<Ctrl> + <F9>** to autoscale the y-axis of all graphs within the Graph Pane section.

Mouse cursor position on the axis dictates how the axis scaling will change. The position of the mouse cursor acts as an anchor at the position, expanding out or compressing to that position. In the example below, the autoscale

was used for the top graph. However, to display a scale from 35 to 40 °C as in the bottom graph, the mouse cursor was first placed at the bottom of the y-axis and the Mouse Wheel was scrolled down until 40 came into view, then the Mouse Wheel was placed at the top of the y-axis and scrolled up down to bring 35 into view.

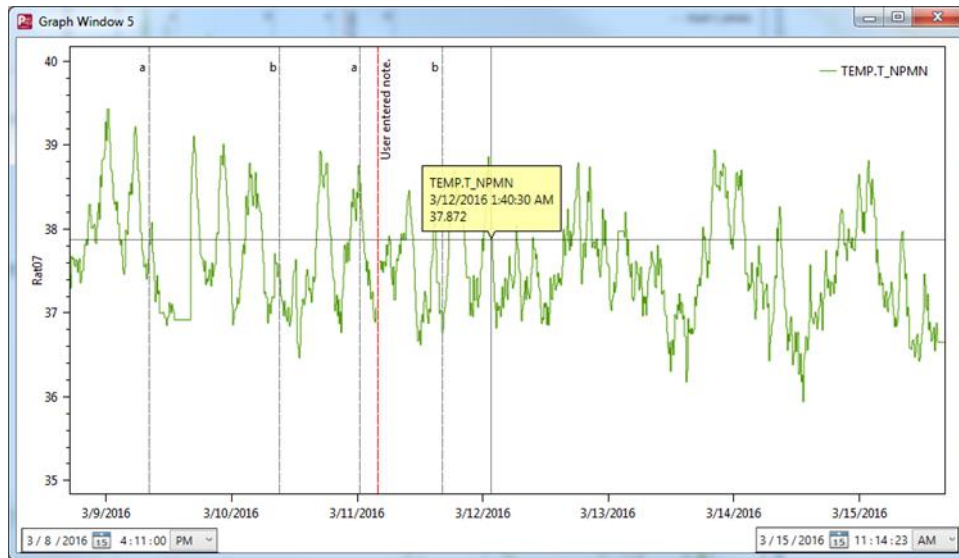


Note: Window size will affect the axis resolution.

Alternatively, **left-click-and-drag** may also be used to zoom in on graph, providing more control of exactly which data points will be displayed by the zoom. While zoomed into the data, the **Mouse Wheel** may be used to navigate forward (toward the end of the data series) and backwards (toward the beginning of the data series) within the data.

Right-click the x-axis to undo a zoom. Each right-click will expand the axis until the entire data series is displayed in the graph pane.

Hovering the mouse cursor on a point within the Graph Pane will display the series the point belongs to, the time of the point, and the point value.



The user may also position the x-axis based on a user defined time. Simply click into the date/time fields and make the appropriate changes based on the desired times to display.

ACTIONS

The **Actions** menu permits the user to perform **Averaging** and **Clipping** functions on the data series. Once an **Action** is created for one Subject, it is available for any Subject selected.

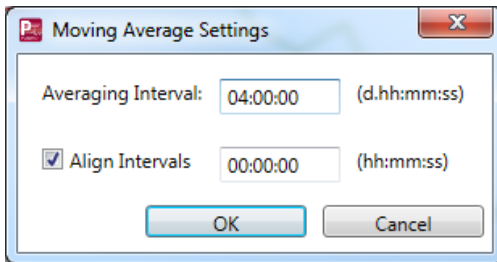
AVERAGE

The **Average Action** averages data from frequent intervals to longer intervals for ease of analysis or practical usage. In some cases, this function may make trends in the data easier to discern with less data outside of reasonable limits (averaging out any outliers). A typical use of the Average Action is to average data collected over a certain period to show circadian patterns in the data.

To apply an Average Action:

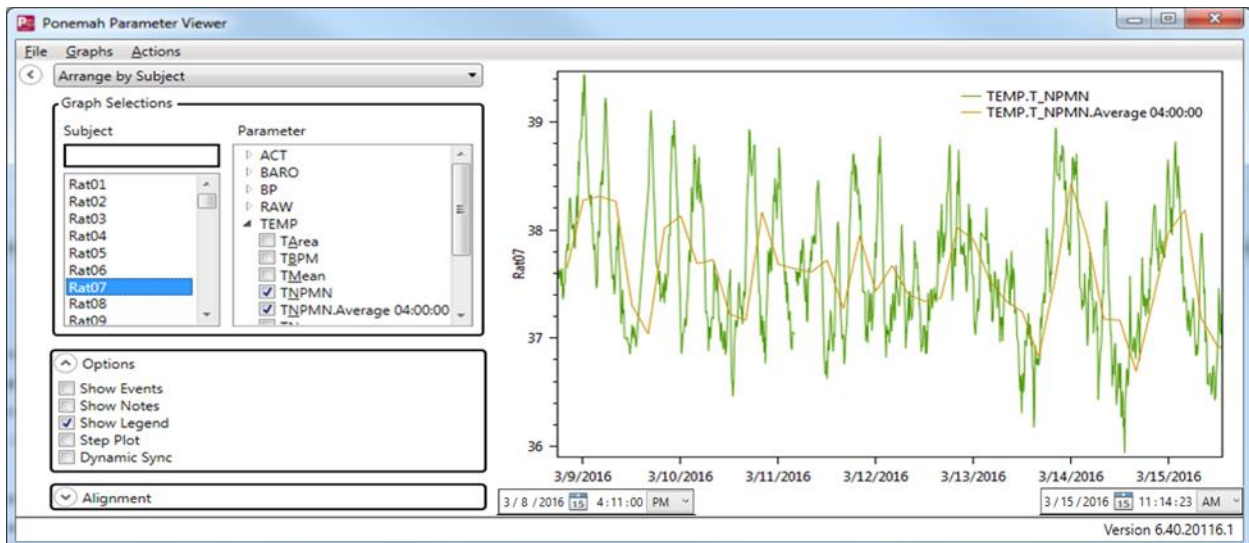
1. Select a **Subject Name** from the *Subject* list.
2. Check the checkbox associated with the desired **Derived Parameter(s)** within the *Parameter* list on which the *Action* will apply.

3. Select **Actions menu | Average...** or right-click and select **Average...**
The *Moving Average Settings* dialog will display.



4. Enter the desired **Averaging Interval**.
This is the interval over which the data points that make up the data series will be averaged. The resultant averaged point will be placed at the end of the Averaging Interval specified. For instance, if the original data series was logged with a 60 second logging rate and started at 08:00:00 AM and was then averaged with an Averaging interval of 04:00:00 (hh.mm.ss), then the first point of the resultant averaged series will be placed at 12:00:00 PM.
5. (Optional) Check the **Align Intervals** checkbox and enter the desired alignment interval.
Enabling Align Interval will align the averaging interval such that the result averaged points fall on the specified time. The alignment time is based on a 24 hour clock; i.e. 00:00:00 (hh:mm:ss) is 12:00:00 AM. If the Align Intervals is disabled, averaging will start at the beginning of the available data.
6. Select **OK**.
This will generate a new Derived Parameter selection within the Parameter list, just beneath the Parameter from which it was generated. The new Parameter will append the Action name (e.g. Average) to the end of the Parameter name, along with the Averaging Interval used (e.g. TNPMN.Average 04:00:00).

The example below shows the Average Action applied to the non-pulsatile mean of Subject Rat07's Temperature channel as outlined in the procedure described above.



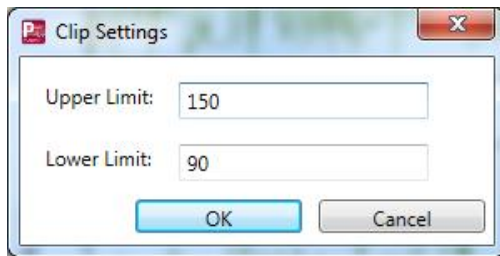
CLIP

The **Clip Action** eliminates data points outside of a user defined range. A typical use of the Clip Action is to exclude outliers or data known to be bad or erroneous (non-physiological).

All values above the specified upper limit will be considered outside the data range and will be removed from the graph. The lower clipping limit does the same for values below this limit. The system will not recognize any data values outside the clipping limits if the Clip Action is performed prior to the Average Action.

To apply a Clip Action:

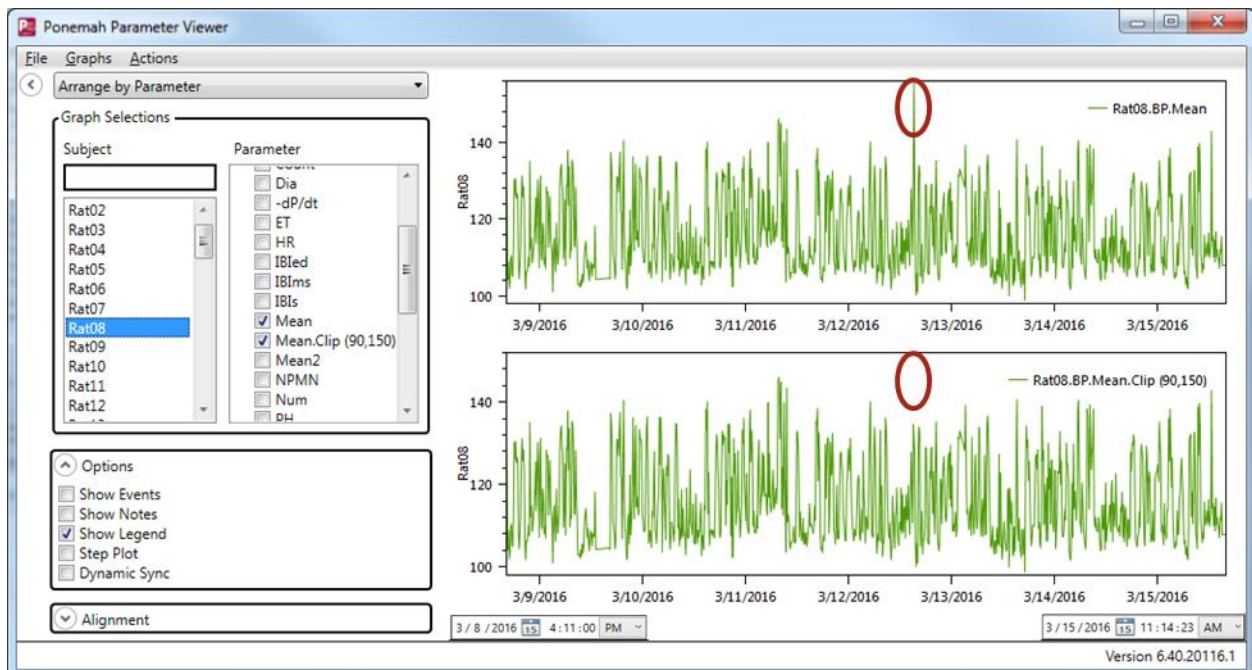
1. Select a **Subject Name** from the *Subject* list.
2. Check the checkbox associated with the desired **Derived Parameter(s)** within the *Parameter* list on which the *Action* will apply.
3. Select **Actions menu | Clip...** or right-click and select **Clip...**
The *Clip Settings* dialog will display.



4. Enter an **Upper Limit** and a **Lower Limit**.
5. Select **OK**.

This will generate a new Derived Parameter selection within the Parameter list, just beneath the Parameter from which it was generated. The new Parameter will append the Action name (e.g. Clip) to the end of the Parameter name, along with the Lower and Upper Limits used (e.g. TNPMN.Clip (90,150)).

The example below shows the Clip Action applied to the Mean Pressure of Subject Rat08's Blood Pressure channel as outlined in the procedure described above. Notice, the circled point was removed from the Clipped series graph display.



USING GENERATED GRAPHS

Once the Graph is configured for the Subject or set of Subjects to display the Parameter data as desired, the graph may be opened in a **New Graph Window** to preserve the setup. This is useful if additional Graphs need to be generated, but require to be **Arranged by** different settings to illustrate a particular occurrence or trend in the data. New Graph Windows will only display the graphical data within the **Graph** section of Parameter Viewer at the time the New Graph Window was generated; the **Setup** section of Parameter Viewer is not accessible. New Graph Windows are ideal when screen shots of Graphs are needed for inclusion in presentations or publications. New Graph Windows are not preserved upon exiting Parameter Viewer.

Zoom/Scaling functions the same within the New Graph Windows as it does in the main Parameter Viewer dialog.

To create a New Graph Window:

1. Make the appropriate selections within the Setup section of Parameter Viewer to display the data as desired.
2. Select the **Graph menu | New Graph Window**.
This will create the New Graph Window with the identical setup as displayed in Parameter Viewer. Graph Windows will be numbered. Selecting the Graph menu | Graph Windows will display a list of the New Graph Windows generated since the Parameter Viewer was opened.
3. Repeat steps 1-2 for any additional views desired.

To capture the New Graph Window for inclusion in a presentation or publication, select the desired Graph Window to include, strike **<Alt> + <Print Screen>**, and then paste into desired third-party tool (e.g. Microsoft PowerPoint).

DATA EXPORT

Once the Parameter Viewer graphs are setup in the desired configurations, users may export the derived data that compose these graphs. This is important should the use of third-party programs be desired for further data manipulation or visualization.

Only data visible within the *Parameter Viewer* dialog will be exported, meaning the user may zoom into a desired area of the data to export only that specific section of data. To export all data in the experiment for the derived data selections, the user must zoom out to display the entire trend graph.

Two export options are available from the Parameter Viewer **File** menu:

- **Export** This export option will export derived parameter data filtered by the selected parameters from the selected subjects within the Graph Selection section of Parameter Viewer. A separate .csv file will be generated for each subject. Additional .csv files will be generated for Events and Notes associated with each subject.

.csv File Naming Convention:

- "<Experiment name>_<Subject name>_Parameters_<yyyymm>_<hhmmss>.csv"
- "<Experiment name>_<Subject name>_Events_<yyyymm>_<hhmmss>.csv"

- "<Experiment name>_<Subject name>_Notes_<yyyymm>_<hhmmss>.csv"

If the Parameter Viewer Alignment feature **IS NOT** used, the .csv files will contain the following columns

- Time column yyyy/mm/dd hh:mm:ss.mmm
- Column per parameter <algorithm abbreviation>.<parameter abbreviation>

If the Parameter Viewer Alignment feature **IS** used, the .csv files will contain the following columns:

- Time column yyyy/mm/dd hh:mm:ss.mmm
- Time from Event hh:mm:ss.mmm
- Column per parameter <algorithm abbreviation>.<parameter abbreviation>

Note: If trying to export Clipped or Averaged data together with standard parameter selections, an **Inconsistent number of rows** error will be displayed and the .csv files will not be generated. To export these data together, please use the **Export to Pivot Format** option described below.

- **Export to Pivot Format**

This export option will export derived parameter data filtered by the selected parameters from the selected subjects within the Graph Selection section of Parameter Viewer to a single .csv file.

.csv File Naming Convention:

- "<Experiment name>_<yyyymm>_<hhmmss>.csv"

If the Parameter Viewer Alignment feature **IS NOT** used, the .csv files will contain the following columns

- Subject Subject name
- Parameter Name <algorithm abbreviation>.<parameter abbreviation>.<averaging if any>
- Date and Time yyyy/mm/dd hh:mm:ss.mmm
- Parameter Value

If the Parameter Viewer Alignment feature **IS** used, the .csv files will contain the following columns:

- Subject Subject name
- Parameter Name <algorithm abbreviation>.<parameter abbreviation>.<averaging if any>
- Date and Time yyyy/mm/dd hh:mm:ss.mmm (parameter date and time)
- Event Date and Time yyyy/mm/dd hh:mm:ss

- Time from Event hh:mm:ss.mmm
- Parameter Value

DATA REVIEW

Ponemah Data Review is a powerful, flexible post-processing tool that permits the user to tailor data visualization, analysis and reporting on any acquired data contained within the Experiment.

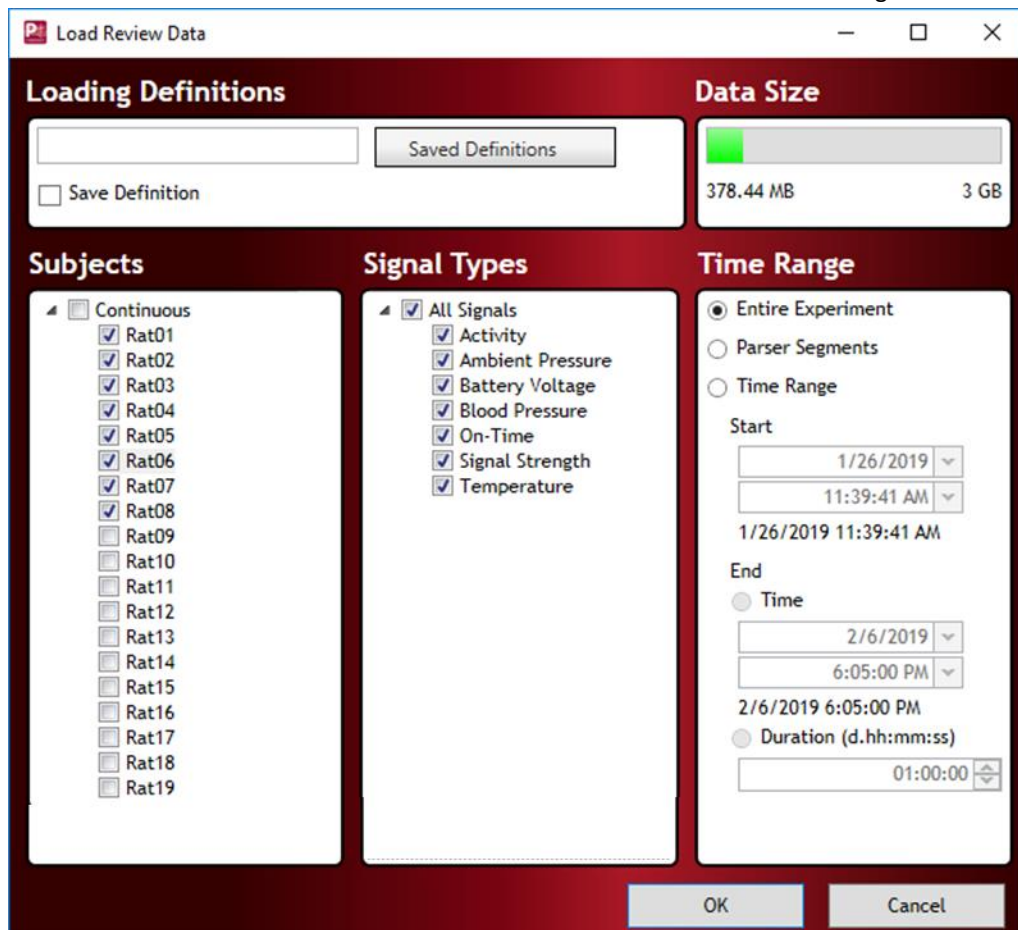
Use Review to:

- View results graphically using a combination of graphic display windows and numerically using the Derived Parameter and Data Reduction List Views.
- Refine results for greater accuracy should the default analysis module settings not be suitable for your subjects' signal morphologies.

LOADING DATA INTO REVIEW

Ponemah provides a simple data loading tool to allow you to choose specific data sections to load into **Review**. To load data into **Review**

1. Select **Start Review** from the **Actions** menu to launch the **Load Review Data** dialog.



2. Select Subject(s) from the **Subjects** column using the associated checkboxes. Select the checkbox associated with the Continuous option to **Select/Deselect All**.

Note: Subjects are arranged by the *Sampling Method* they are assigned to upon entering the **Load Review Data** dialog. In the example above, all subjects were assigned to **Continuous** sampling and are therefore listed under a **Continuous** sampling group. If subjects are defined to **Schedule 1** or **Schedule 2**, they will be listed under their respective Sampling Method.

3. Select the desired Signals from the **Signal Types** column to be loaded into *Ponemah Review* using the associated checkboxes.



Important: Selecting a Blood Pressure of Left Ventricular Pressure channel will automatically select the Ambient Pressure channel. The Ambient Pressure must be loaded when loading Blood Pressure or Left Ventricular Pressure to appropriately display and calculated derived data as expected.

4. Select the data range for the selected data from the **Time Range** column. Options include:
 - a. **Entire Data** This will load all data available for the selected **Subjects** and **Signals**.
 - b. **Parser Segments** If **Parser Segments** were added during a previous **Review** session, you may also choose to load only data contained within the **Parser Segments** by selecting the **Filter** radio button for **Parser Segments**.
 - c. **Time Range** This permits specific time ranges to easily be loaded into *Ponemah Review*. Enter the specific **Start Time** after which the data is desired to be loaded. Next, enter the specific **End Time** or a time **Duration** (e.g. load 1 hour of data from Start Time of 12:00 PM January 26, 2019).
5. Select **OK** to load the selected data into **Review**.

DEFINITIONS

Definition allow the user to save the selected **Load Review Data** settings to more easily load this same section of data in a future Review session without having to remember the exact selections.

- **Definitions** are saved when a name is entered into the associated text box and the Save Definition checkbox is selected.
- To load a previous saved **Definition**, select the Saved **Definitions** button and select the desired Definition. Once selected, the *Load Review Data* dialog will populate with the previously configured Subject, Signal, and Time Range settings.

DATA SIZE

The **Data Size** bar will update based on the selection within the *Load Review Data* dialog to provide the User with an indication of how much data is being loaded into *Ponemah Review*. Ponemah will currently permit up to 3 GB of data to be loaded into Ponemah Review.

Please contact DSI Technical Support for assistance, should the User need to load more than 3 GB of data at a time into *Ponemah Review*.

DATA NAVIGATION

Many methods are available to navigate, search, and work with the graphical data.

SCROLL BAR

Each graph page includes a horizontal scroll bar that provides a representation of the data currently being viewed, relative to the entire data set. The scroll bar may be used to view different portions of the data. Clicking on the left/right arrow moves the data by a tenth of the Axis time. Clicking on the scroll bar to the left/right of the bar moves the data by a page. The bar may be dragged to move through the data as well.

AUTOSCALE

AutoScaling the Channel signals configured within the graph pages is a quick, easy way to correct the y-axis value of the **Display Pane** to get a full-scale view of the signal. **Primary** and **Trend Graph** pages treat each **Display Pane** disparately for the user to scale each based on the amplitude of its signal. Users can **AutoScale** a signal **Display Pane** by double-clicking within the **Display Pane** and selecting the **AutoScale** button.

To **AutoScale** all **Display Panes** configured within the **Primary** and **Trend Graph** page, use the hotkey <Ctrl>+<F9> or by select the **Edit menu | AutoScale – All Panes**.

PAGE UP AND PAGE DOWN

The **Page Up** and **Page Down** keys page through the data. **Page Up** moves forward in time and **Page Down** moves back in time.

SEARCH FUNCTIONS

Search capabilities have been provided to search for the next/previous Mark, Change Marker, Note, Event, unmatched cycle (Template), bad data mark, and for searching by Time. These search functions are directed towards the selected display pane in a graph page.

Searching for Change Markers, Notes, Events, Time, unmatched cycles, and bad data marks have corresponding tool bar/menu items. Searching for the next mark is achieved using the Tab key, previous mark, by using the Shift-Tab key.

Note: If the Shift key is pressed when selecting search for events, a dialog with available events will be displayed, permitting selection of a specific event.

LIST VIEWS

Various **List Views** are available within Review to display **Derived Parameter** data, **Data Reduction** data, and **Events**. **List Views** may be sorted by clicking on the column header that is desired for sorting. A second click will invert the sorting order. To return the values to their original order, click on the Time column.

Note: Convenient examine outliers by sorting Log Lines of data or Events and synchronizing them with the graphical data.

SYNC

The graphical and derived data can be synchronized with each other as follows:

- Synchronizing the Derived Data with the Graphical Data
Position the Review **Cursor** at the point of interest and ensure that a display pane belonging to the channel to be synchronized is selected. Select the **Synchronize with Derived Data** tool bar button/menu item. The **Derived Parameter** and **Data Reduction List Views** will be adjusted to bring the associated data into view.
- Synchronizing the Graphical Data with the Derived Data
To view the graphical data that was used in the calculation of derived data or data reduction information, double-click on the **Log Line**. All graph pages that contain data associated with the double-clicked channel will be adjusted to bring the associated data into view.

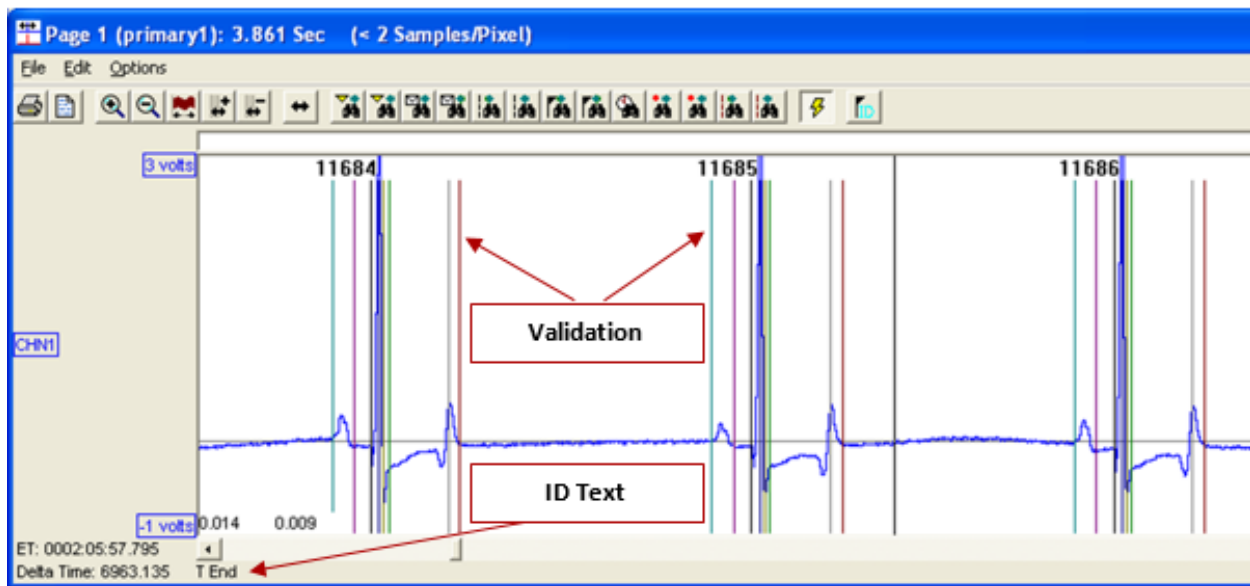
When a **Derived Parameter List View** is clicked on, affected **Primary** graph pages' X axes (time) will scroll the data range associated with the **Log Line** of data into view and will scale the Y axes to display the waveforms appropriately. **Trend** graphs will not scale their axes but will scroll data into view as follows: If the time range associated with the **Log Line** fits on the trend graph page, it will be centered on the graph page. If not, the start of the time range will be set to the left edge of the graph page. **Scatter** graphs will also not scale, however the data point that is associated with the synchronized data line will be selected.

When data in a **Data Reduction List View** is clicked on, associated **Primary** and **Trend** graph pages' X axes (time) will scroll the relevant data range into view. The time range used is the time associated with the **Data Reduction** interval/control interval that is clicked on.

The user may also drag and drop multiple **Log Lines** of data from the **Derived Parameter** and **Data Reduction List Views** to the graph pages. This allows the user to easily select specific data from the **List Views** and to view in the graph pages. For example, if using an **Epoch** based **Logging Rate** of one (every marked Cycle is logged to the **Derived Parameter List View**) and three **Log Lines** of data are dragged and dropped onto the **Primary** graph page, those three cycles will be the only ones displayed.

VALIDATION MARKS

Validation Marks are tick marks placed on the **Primary** graph page by the analysis modules to indicate key points of interest on the waveform. Validation Marks are represented by different color, solid vertical lines. Hovering over the **Validation Mark** with the mouse cursor will indicate what the line depicts in the **ID Text** area (displayed in the lower left corner after Delta Time).



The positioning of the **Validation Marks** are used to calculate the **Derived Parameters** from the waveform data and logged to the **Derived Parameter** and **Data Reduction List Views**. These are also used to visually verify that the analysis is triggering properly during Acquisition and Review. The **Validation Marks** placed during real-time analysis can be viewed and augmented during a Review session.

Validation Marks are stored in the **Marks** database when a **Marks Section** is saved.

Display of **Validation Marks** in a graph page is controlled by the **Toggle Validation Marks** toolbar button (⚡). The display of **Validation Marks** can also be controlled on a mark-by-mark basis through the **Analysis Attributes** dialog (see **Analysis Modules | Analysis Attributes Dialog** section). In other words, if the **End of T** mark of an ECG signal is not needed because the user is only interested in Heart Rate, this **Mark** can be turned off and no longer displayed. Positioning the mouse cursor over a mark will identify the mark in the **ID Text** field at the bottom left of the graph page.

Note: Each analysis module identifies one of the marks in a cycle as the **Logging Mark**. This mark is used to record the time at which the cycle occurred within the **Derived Parameter List View** when in **Epoch** mode. See the analysis module section of interest to learn which mark is the cycle's **Logging Mark**.

MOVING MARKS

Validation Marks can be moved when the mouse cursor is positioned over a Mark such that the mouse cursor changes from a pointer to a double-sided (East-West) arrow. A **Mark** can be moved by clicking the left mouse button and dragging it to a new location. On repositioning the **Mark**, the associated derived output will be recalculated to display the updated calculation in the **Derived Parameter** and **Data Reduction List Views**.

Right-clicking on a moved mark will present an **Undo Move** menu option. Selecting **Undo Move** will return the mark to its original location and will remove the change marker. Alternatively, the mark could be repositioned manually. If any other marks interfere with the return of the moved mark, **Undo Move** will not be present in the right click menu.

Notes:

- Marks cannot be moved past adjacent marks, **Bad Data Marks**, or **Data Breaks**.
- Calculated Marks, whose positions are calculated from the location of other marks (such as **Percent Recovery**) Marks cannot be moved.
- Instead of moving **Marks** manually, the user may instruct Review to reanalyze a portion or all of the waveform data. See **Reanalyzing Data** for more information.

DELETING/INSERTING A MARK

Deletion/insertion options exist from the **Display Pane's** right-click menu.

To delete a mark:

1. Position the mouse cursor over the no longer desired **Mark**.
2. Right-click to display the right-click menu.
3. Select the appropriate **Delete** option.

Note:

- To delete all **Marks** associated with a cycle, position the mouse cursor over the **Logging Mark**.
- Some analysis modules permit deletion/insertion of certain marks while some analysis modules only permit insertion/deletion of cycles. Please refer to the analysis module section for more information.
- Change Markers can be displayed to provide a visual representation of any change to Mark location. Change Markers are **OFF** by default, but can be turned **ON** in the **Setup | Application Configuration | Advanced Settings** dialog.
 - When a mark or cycle is inserted the new mark(s) is/are tagged with a green **Change Marker**.
 - When a mark or cycle is deleted, the deleted mark(s) are drawn with red dashed lines and are tagged with red **Change Marker(s)** lines.
 - When a mark or cycle is changed/moved, the original Mark location is tagged with a yellow dashed line and are tagged with yellow **Change Marker(s)**.

EVENTS

All **Events** created in Acquisition are available during a Review session. Events can be seen within the Events List View and are also displayed at the appropriated time points within the **Primary** and **Trend** graph pages.

Note: The **Events List View** can be sorted by clicking on the column headers. All information within the list view will be sorted based on the column selected and the direction of the arrow in the column header.

Placing the mouse cursor over an event will display its text string in the **ID Text** field in the lower left corner of the graph page. **Events** can be added and deleted while in Review.

To add an Event:

1. Right-click on a **Primary** or **Trend** graph at the point where the **Event** should be inserted.
2. Select **Add Event** from the right-click menu.

To delete an Event:

1. Position the cursor over the **Event** to be removed.
2. Right-click and select **Delete Event** from the right-click menu.

Note:

- **Events** can also be moved by clicking on them and dragging them to a new location.

- If Data Reduction is triggered off an event that is added, deleted, or moved, the Data Reduction output will be updated.
- Double-clicked on an Event from the **Events List View** to synchronize the data within the graph pages and list views associated with the selected **Event**.

BAD DATA MARKS

Bad Data Marks enable the user to eliminate sections of noisy or erroneous data from calculations. Bad Data Marks are represented by two dashed burgundy colored lines, a **Start Bad Data Mark** and an **End Bad Data Mark**.



***IMPORTANT:** Introducing Bad Data Marks will not remove the enclosed waveform data. Only the marks associated with the enclosed cycles will be removed to ensure that the data is not used to calculate derived parameters.*

ADDING BAD DATA MARKS

Bad Data Marks can be inserted in two ways:

1. Automatically by the analysis modules if the Noise tab is enabled and its user-defined criteria are achieved. See the appropriate analysis module Noise tab section for more information on available configuration settings.
2. Manually from the right-click menu.

Note: **Bad Data Marks** may be introduced anywhere in the data as long as they do not span over an existing **Bad Data Mark** or **Data Break**, or are placed within a bad data region. If **Bad Data Marks** are inserted/moved within a cycle, the cycle's marks will be deleted. If **Bad Data Marks** are inserted/moved between two cycles, their cycle marks will not be deleted.

DELETING BAD DATA MARKS

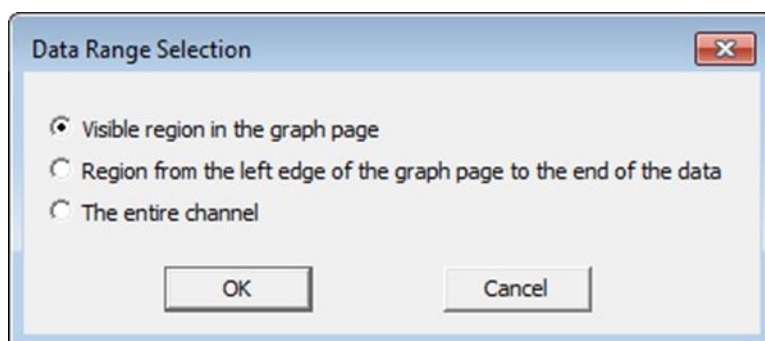
To delete **Bad Data Marks**:

1. Right-click on a **Bad Data Mark**.
2. Select **Delete Bad Data Marks – Single**.
This will delete the current **Bad Data Marks**.

OR

Delete Bad Data Marks - Range.

This will display the **Data Range Selection** dialog. Select the radio button associated with the desired option and click **OK**.



- a. **Visible region on the graph page** – all **Bad Data Marks** from the current graph page view will be deleted.
- b. **Region from the left edge of the graph page to the end of the data** – all **Bad Data Marks** from the currently visible left edge of the graph page to the end of the data loaded into the Review session will be deleted.
- c. **The entire channel** – all **Bad Data Marks** within the data loaded into the Review session for the entire channel will be deleted.

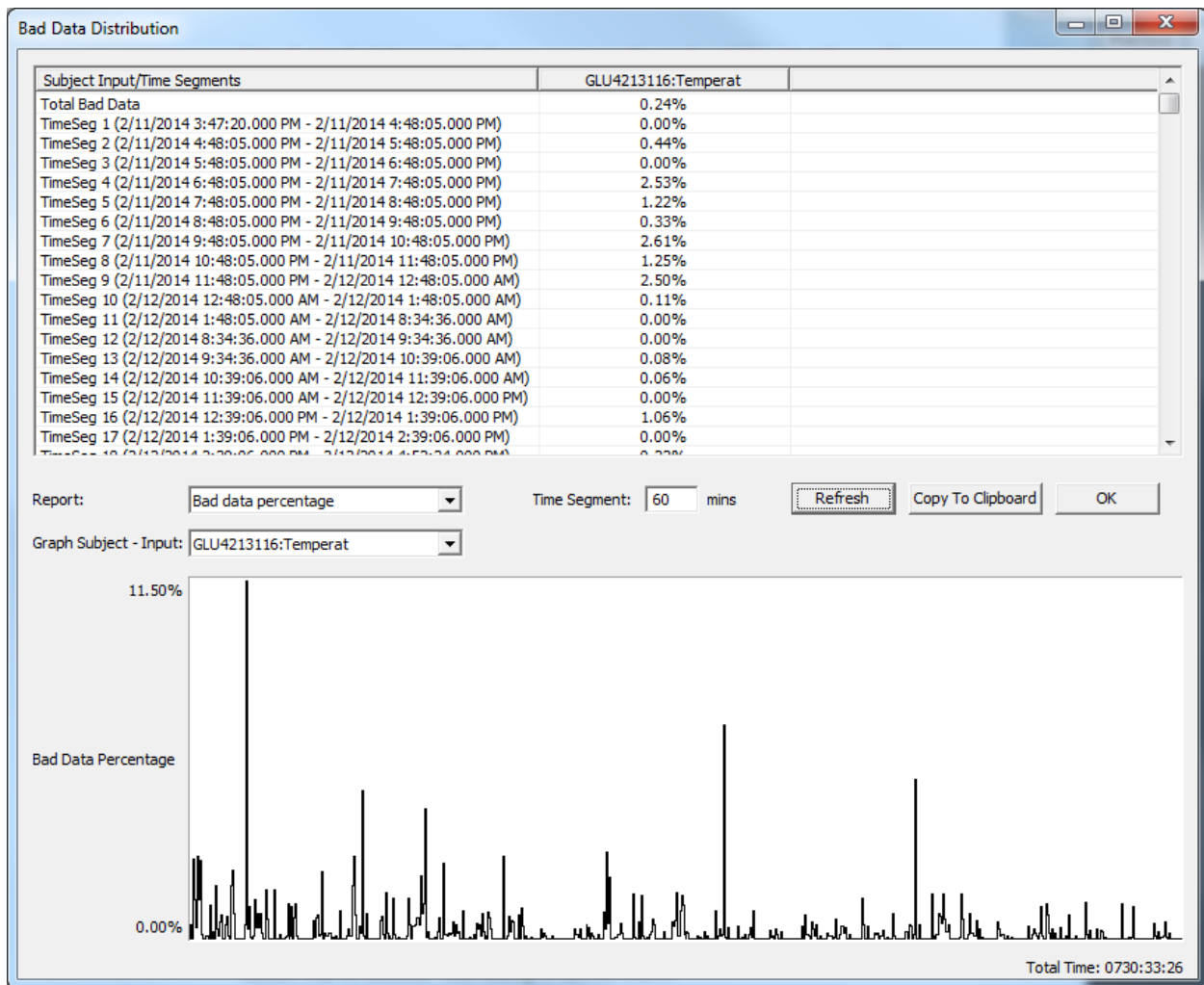
A toolbar is provided to toggle **Bad Data Marks** ON/OFF. By default, the button is enabled to show all **Bad Data Marks** in the graph. When disabled, the visible marks will disappear, however all data within the marks will remain excluded from derived parameter calculations.

Note: When Bad Data Marks are toggled OFF, the only available right-click options will be **Add Bad Data Mark** and **Delete Bad Data Marks - Range**. Adding **Bad Data Marks** here will remain invisible until the option has been enabled again.

BAD DATA MARK PERCENTAGE

Bad Data Mark Percentage provides the ability to view the percentage and distribution of data removed by **Bad Data Marks**. This allows the user to determine if too much data has been excluded from analysis. Additionally, this feature allows the user to report on the number of “Good” cycles.

Available channels are listed along with a Channel/Time Segments column defaulting to 1 minute segments. The channels display the percentage of Total Bad Data for the study (first line in the spreadsheet) as well as percentages for each segment. A graphical representation of the bad data distribution is provided in the bottom half of the window.

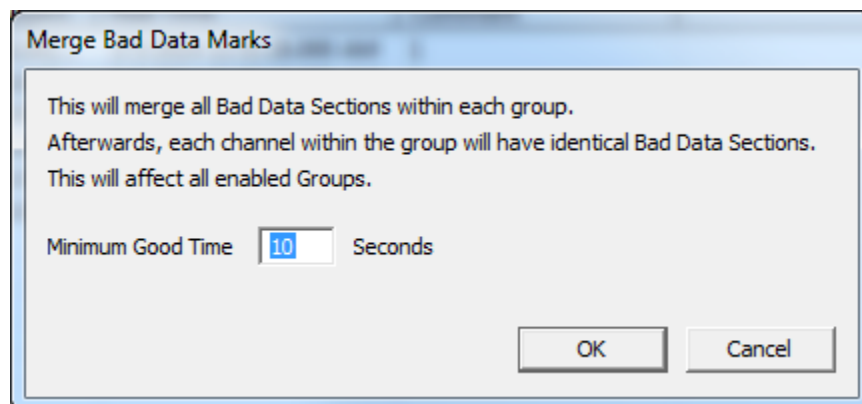


The following defines the options available from this dialog:

- Report** This field allows the user to select **Bad Data Percentage** or **Number of Good Cycles** in a Segment. Choosing of one of these selections will automatically update the data columns with the appropriate information.
- Time Segments** **Time Segment** determines how the data is averaged and displayed. The default value is 1 and the units are in minutes. The maximum value that can be entered is 9999.
- Refresh** After changing the value in the **Time Segment** field, the **Refresh** button must be selected to update the data.
- Copy to Clipboard** This feature allows the calculated data to be copied and placed into another format such as Microsoft Excel or Word.
- OK** This button closes the dialog.
- Graph Subject Input** This feature allows the user to switch between inputs. Only one channel may be displayed at a time.

MERGE BAD DATA MARKS

Merge Bad Data Marks is a Review only option. Selecting **Actions | Merge Bad Data** will instruct Review to merge all **Bad Data Mark** sections within a **Subject**, such that all **Subject Input** channels will have identical **Bad Data Mark** sections. If new **Bad Data Marks** are placed within any **Input** channel after the button has been pressed, these will not be applied across all **Input** channels within the **Subject**. The button should be pressed again to merge any newly added **Bad Data Marks** across the associated **Subject Input** channels. The **Minimum Good Time** defines the upper limit of the time interval between **Bad Data Marks** to determine if the **Bad Data Marks** sections should be marked as a single section or marked separately as distinct sections. The default time is 10 seconds. This will affect how data is reported by **Subject** in the **Derived Parameter** and **Data Reduction List Views** and the corresponding data output.

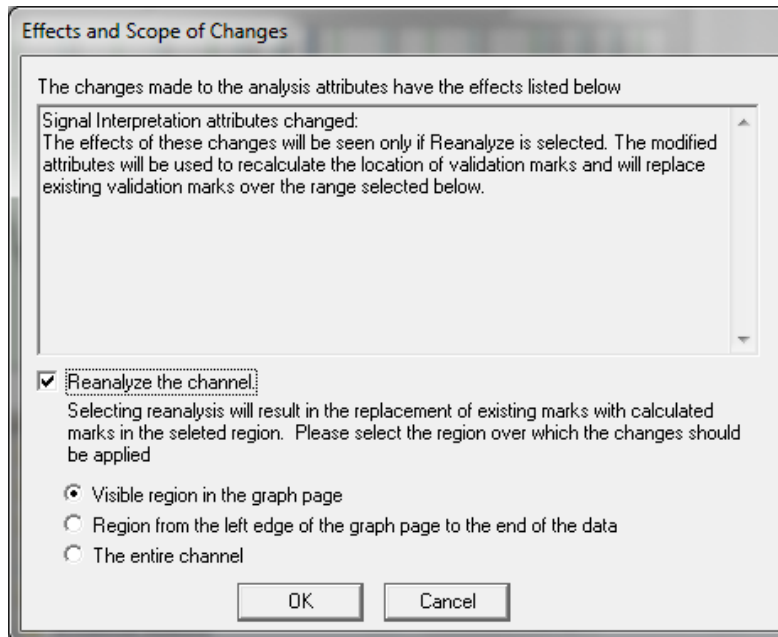


FREEFORM NOTES

Freeform Notes are supported in Review and may be placed anywhere in a **Display Pane**. **Notes** are added and deleted using the right-click menu. The text associated with a **Note** may be viewed by hovering the mouse cursor over the **Note**. Drawing of **Notes** for a **Display Pane** may be suppressed by selecting **Display Options** from the right-click menu and disabling the check box. **Notes** can be applied to one or all channels by selecting or deselecting the **Apply to all changed channels** checkbox at the bottom of the **Notes** dialog box.

REANALYZING DATA

Ponemah Review easily allows results to be refined for greater accuracy should the default analysis module settings not be suitable for your subjects' signal morphologies. Instead of moving **Validation Marks** manually, reanalyze using the automated analysis modules by updating their settings and choosing to reanalyze the channel.



To reanalyze a channel:

1. Right-click on the channel of interest from its **Primary Graph Display Pane**.
2. Select **Analyze [Attributes]** from the right click menu. The analysis attributes dialog will be displayed with the current data in the waveform window.
3. Adjust the attributes as necessary to ensure the analysis is triggering correctly
4. Select **OK** to launch the **Effects and Scope of Changes** dialog.
This dialog outlines the effects of the modifications to the attributes and allows you to select the range over which the reanalysis should be performed. See the **Analysis Attributes Dialog** section to learn about **Attribute Types** and how they impact data analysis.
5. Select the **Reanalyze the channel** check box and select the desired reanalysis range.
Ponemah allows you to reanalyze the entire channel, the data visible in the graph, or the data from the left edge of the visible region from the primary graph forward to the end of the loaded data set.
6. Select **OK** to begin the reanalysis.
Changes to marks positions will be displayed and derived data will be recalculated.

Note: The **Marks** tab within the **Attributes** dialog can be altered to enable/disable the visible **Validation Marks** without having to reanalyze the entire channel. Simply enable/disable the **Validation Marks** of choice, select **OK**, and then, without checking the **Reanalyze the channel** check box, select **OK**.

To learn about **Attribute Types** and which **Types** trigger a reanalysis or a redraw of the signal, please see the **Analysis Modules | Analysis Attributes Dialog | Attribute Types** section of this manual.

HOTKEYS

Certain hotkeys have been made available within Review to help facilitate quicker execution of certain functions from the keyboard and/or mouse without having to click additional icons or access menu options. Please note that they hotkeys are currently available only within Ponemah Review and cannot yet be augmented by the user.

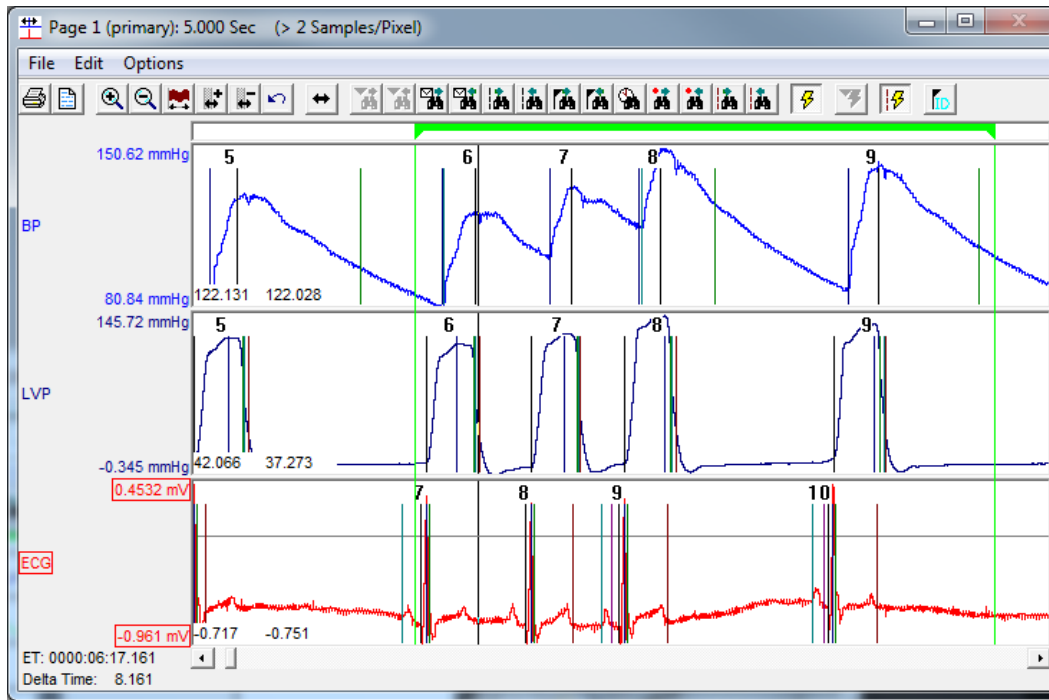
Key Combination	Description of Action
Zoom/Graphical Navigation	
<Alt>+<s>	Synchronize Primary , Trend , and Scatter graphs with associated spreadsheet
<+> (on keypad)	Expand graph
<-> (on keypad)	Compress graph
<Ctrl>+<+> (on keypad)	Expand graph by factor
<Ctrl>+<-> (on keypad)	Compress graph by factor
<Shift>+Mouse wheel	Expand/Compress
<Ctrl>+Mouse wheel	Expand/Compress graph by a factor
Mouse Wheel	Scroll graph page left/right
Page Up	Scrolls waveform window to the left (increase in time) by screen time
Page Down	Scrolls waveform window to the right (decrease in time) by screen time
<Shift>+<F9>	Auto scale waveform in a window
<Ctrl>+<F9>	Auto scale all pans within graph page
<Ctrl>+<1> - <Ctrl>+<5>	Change time scale to predefined entries defined within Advanced settings of Setup | Application Configuration : Review.Graph.Times <i>n</i>
<Ctrl>+<6> - <Ctrl>+<9>	Scale all Y axis to one of the 4 defined entries (see above)
<Shift>+<6> - <Shift>+<9>	Scale one Y axis to one of the 4 defined entries (see above): Review.Graphs.High.Scale <i>n</i> Review.Graphs.Low.Scale <i>n</i>
<Ctrl>+<z>	Undo zoom on waveform (only one level)
<↑>	Move up one trace area – activate trace area
<↓>	Move cursor down one trace area – activate trace area
<←>	Move cursor left
<→>	Move cursor right
<Ctrl>+<←>	Move cursor the left by a factor
<Ctrl>+<→>	Move cursor the right by a factor
<Shift>+<F6>	Moves to the previous Parser Segment
<Shift>+<F7>	Moves to the next Parser Segment
Add Events	
<Shift>+<a> - <Shift>+<j>	Add Event to currently selected Group
<Shift>+<Ctrl>+<a> - <Shift>+<Ctrl>+<j>	Add Event to all Groups
 on Event	Delete selected Event
Mark Placement/Positioning	
<Tab>	Move to next validation mark
<Shift>+<Tab>	Move to previous validation mark
<Shift>+<X>	Add Bad Data Mark
<Shift>+<F2>	Move to next Bad Data Mark
<Shift>+<F3>	Move to previous Bad Data Mark
<Shift>+<F4>	Find next change (only if Change Markers are enabled)
<Shift>+<F5>	Find previous change (only if Change Markers are enabled)

<Ctrl>+ <←> or <→> on Validation Mark or Bad Data Mark	Move selected mark left of right
<Alt>+<v>	Executes reanalysis for the visual region of the selected channel within a Primary graph.
 on Validation Mark	Delete selected mark <i>Note:</i> If on main Cycle mark (e.g. R-mark) deletes complete cycle
 on Bad Data Mark	Delete selected Bad Data Mark
<Alt>+<r>	Deletes all Bad Data Marks within the selected channel and automatically executes a reanalysis of the channel
<Alt>+	Adds Bad Data Marks across the visible region of data within Primary and Trend graphs for the <i>currently selected channel</i>
<Alt>+<z>	Adds Bad Data Marks across the visible region of data within Primary and Trend graphs for <i>all groups and their associated channels</i>
ECGPRO	
<Ctrl>+<N>	Add New Template Cycle and analyze
<Shift>+<U>	Delete Unmatched Cycles on a Channel (user will be prompt for confirmation)
Data Insights	
Mouse Wheel	Scroll waveform window left/right
<Ctrl> + Mouse wheel	Expand/Compress graph by a factor Scroll Wheel up – zoom in (expand time span) Scroll Wheel down – zoom out (compress time span)
Left-click-and-drag	Zoom in to selected area
<Enter> or Double left-click	Sync to Match Result within Primary graph, Trend graph, Scatter Graph and Logged Line of Derived List View.
<Ctrl> + <r>	Reject selected Match Result(s)
<Ctrl> + 	Add Bad Data Marks around selected Match Result(s)
<Ctrl> + <d>	Delete cycle validation marks from selected Match Result(s)

DATA PARSER

The Data Parser is a tool designed to permit the selection of sections of data at specific time points of interest. Data Parser functionality is only available from within a Review session.

Parser Segments are represented in the Parser Bar located at the top of the Primary and Trend graph pages. The Parser Bar may be displayed/hidden by selecting **Display Parser Bar in Graphs** from the Data Parser menu. The default selection is visible.



Parser Segments may be defined using any of the three methods described below:

- Automatically based on user-defined rules.
- Graphically via the **Primary** or **Trend** graph.
- Manually by typing in start and end times for each segment

ADDING PARSER SEGMENTS USING THE PARSER RULE SETUP

Here's how to do this.

1. Open the Data Parser dialog by selecting **Open Data Parser Dialog** from the **Data Parser** menu.
2. Select the **Parser Rule Setup** tab.
3. Click on the **New** button.
4. Enter a unique name into the **Rule Name** text box to identify the rule.
5. Set the **Starting Criteria**. The options are as follows.
 - a. **Real Time**
Enter the starting time needed for the parser section.
 - b. **Prior to Event** (Note that an existing event is needed for this function to work)
Select the Event and Subject that the event is associated with and enter the amount of time prior to the event that will be used.
 - c. **Following Event** (An existing event is needed)
Select the Event and Subject that the event is associated with and enter the amount of time after the event that will be used as the starting point.
 - d. **Time Span**
Enter the desired time duration of the Data Parser starting from the Starting Time and ending once the duration has been achieved.

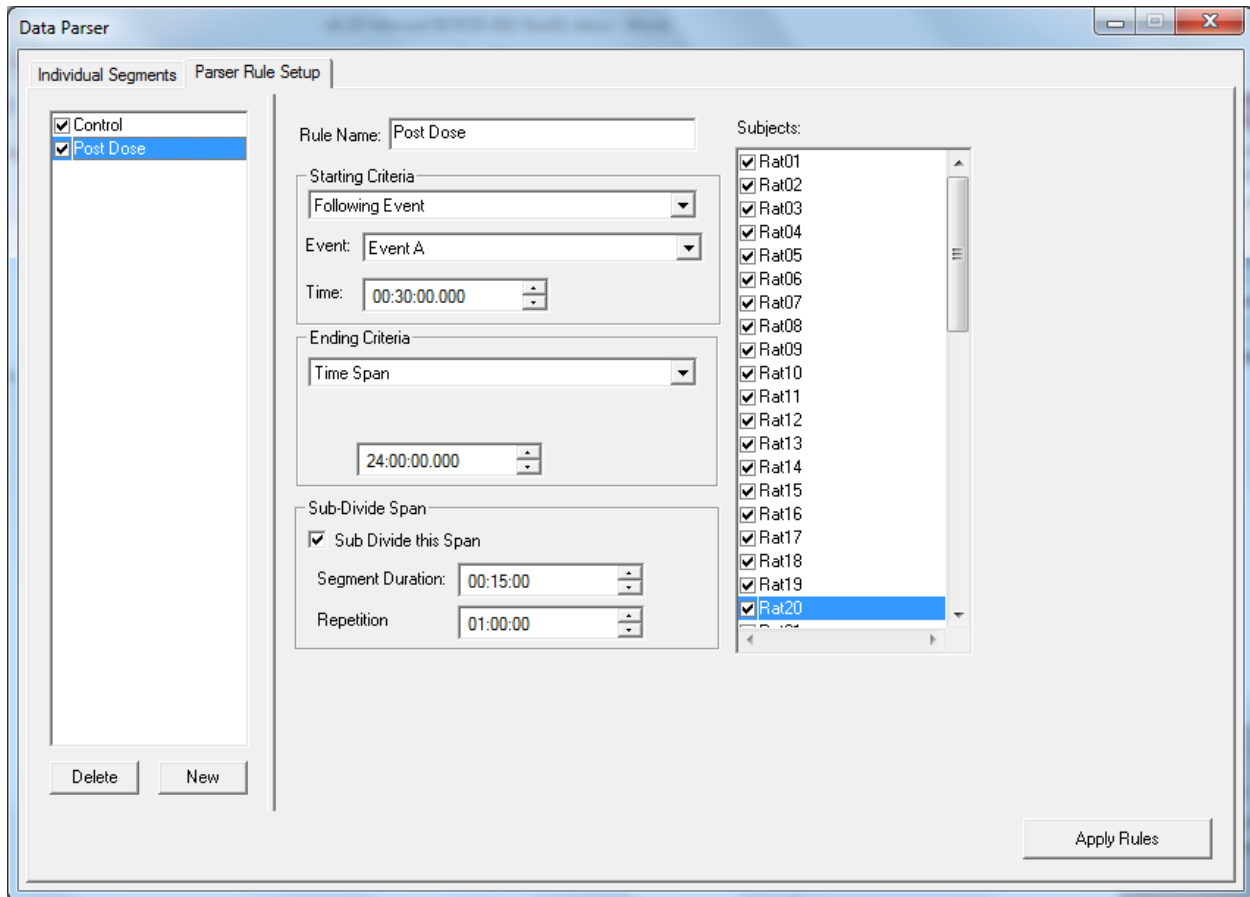
6. Set the **End Criteria**.

The end criteria are the same as the starting criteria except for one addition, setting the **Time Span**, which is the length of time from the start point of the **Parser Segment** to the end point of the **Parser Segment**.

7. Set the **Sub-Divide Span** (Optional)

This allows the user to configure multiple, iterative **Parser Segments**. The time over which **Parser Segments** will be configured is based on the start and end criteria and each segment will be configured for the length of time set up in the **Segment Duration** for every **Repetition Interval** set. For example, if a rule is set up like the one below, 24 Data Parser Segments will be configured, each with a duration of 15 minutes.

8. Add additional Rules as necessary based on desired goal.

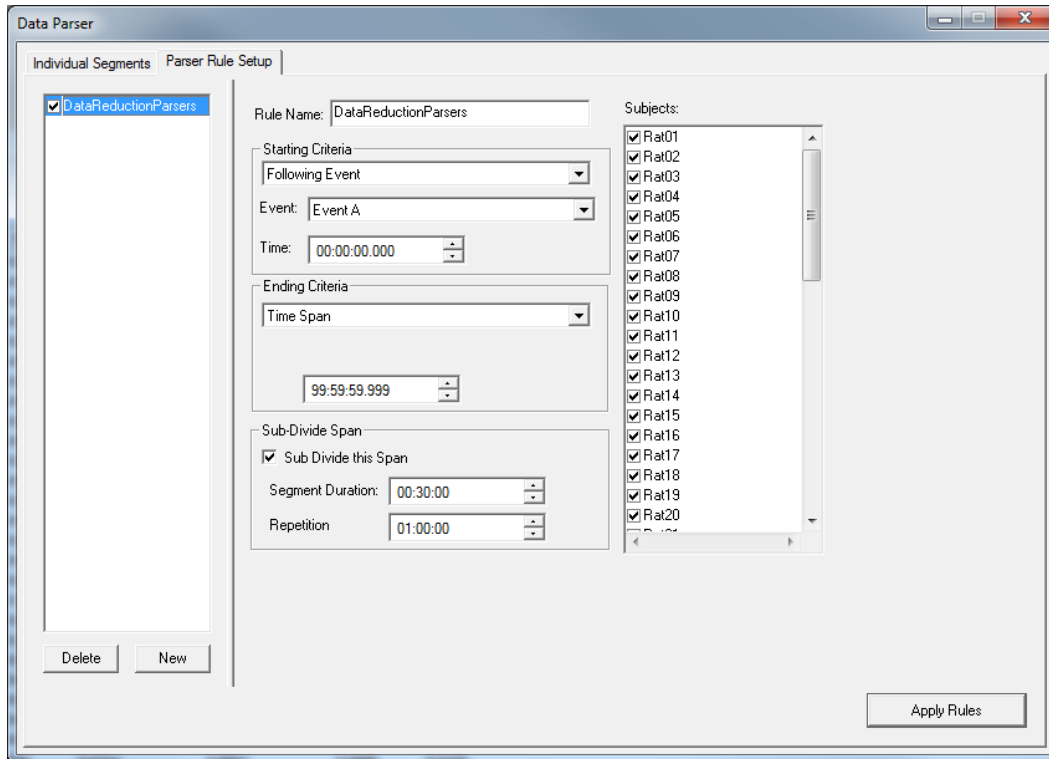


Notes:

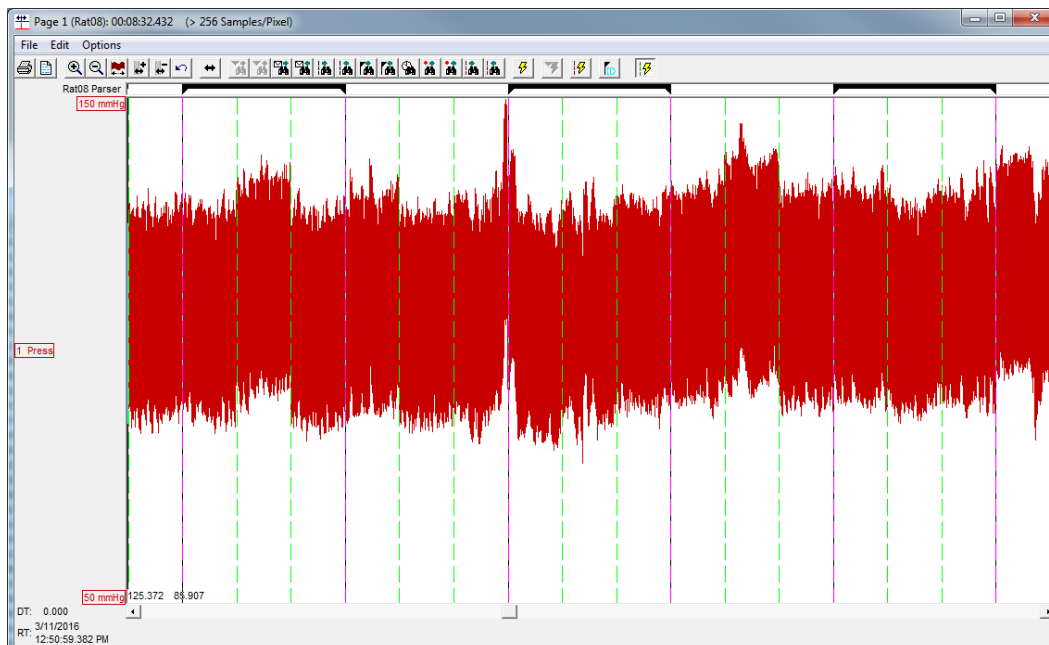
- When using the same **Event** letter to specify the start and end criteria, two separate events must be entered. Data Parser will not use a single event to trigger both start and end. If a fixed time is desired from the start, **Time Span** should be used.
- Once segments have been created, they are no longer directly associated with the underlying rules. Thus, in the case of rules based on **Events**, any subsequent changes to Events will not affect the Parser Segments unless the underlying rules are reapplied. The rules and the Parser Segments may be modified independently. The Parser Segments may be modified graphically on time based graph pages.

- Data Parser Segments may span across **Data Breaks**. Data Parser is based on real-time and Parser Segments will span accordingly. For example, if using Scheduled Sampling to sample 30 seconds every 10 minutes and have configured your Parser Rules to include a repetition of 30 mins every 60 minutes, then the Parser Segment will span three Scheduled Sampling Segments. This scenario is depicted below.

Data Parser Setup:



Resultant Data Parser Segments visible on Graph page:



ADDING PARSER SEGMENTS USING INDIVIDUAL SEGMENTS

The following outlines the process to add Parser Segments using Individual Segments:

1. Open the *Data Parser* dialog by selecting **Open Data Parser Dialog** from the **Data Parser** menu.
2. Select the **Individual Segments** tab.
3. Select the appropriate group desired to parse.
4. Select the **Insert** button.

ADDING PARSER SEGMENTS FROM THE GRAPH PAGE

To add Parser Segment directly from the **Primary** or **Trend** graph page:

1. Right-click on the **Parser Bar**.
2. Select **New Parser Segment**.
3. Adjust the position and the size of the **Parser Segment** as described in that section.

ALTERING THE SIZE AND LOCATION OF THE PARSER SEGMENT

Parser Segments can be augmented directly from the graph.

To compress/expand the **Parser Segment** size:

1. Hover over the left boundary of the **Parser Segment**. The mouse turns into a left-right arrow.
2. Left-click and drag the side to the desired location.
3. Repeat for the right-hand boundary.

To move the entire **Parser Segment** to a new location:

1. Left-click on the top boundary of the **Parser Segment**
2. Drag to the desired location.
4. Repeat the above steps for multiple segments.

Parser Segments can also be augmented using the **Data Parser** Dialog:

1. From the main Ponemah window, select **Data Parser | Segments...**
2. Adjust the **Start** and **End** times to the times needed.
3. Select hours, minutes, seconds, or milliseconds, and either type a new number in or use the up/down arrow buttons to change the times.

DATA REDUCTION

The Data Reduction function allows the system to be configured to reduce the amount of derived parameter data into user-defined summary intervals.

For example, if you require an averaged value at 1-, 5-, 10-, and 30-minute post-dose, **Data Reduction** can be configured to produce this output. Data Reduction can be configured for all Subjects in the Experiment and begins when triggered by a **Time-0 (T0) Event**. The data will be broken down into Control and Dosing periods, based on this **Event**, as defined by the user during **Data Reduction Setup**. This provides a time-aligned output based on the

T0 Event that can then be used to determine Group means and standard deviations, as well as in statistical packages in a more advanced statistic calculations.

The **Data Reduction** output will be displayed in the **Data Reduction List View** located in the main Ponemah window during an Acquisition or Review session. A separate **List View** will be available for each **Subject** and will contain all Parameters listed in the **Derived Parameter List View** for the **Subject**. If in **Aggregate** mode, the **Data Reduction List Views** will not aggregate the **Derived Parameter** data from all subjects into one **List View**. See the Subject **Channel Details** section to learn how to control which parameters are reported on within these two **List Views**. See the **Data Acquisition Dialog** section's **Derived Parameter List View** description for more information on Aggregate mode.

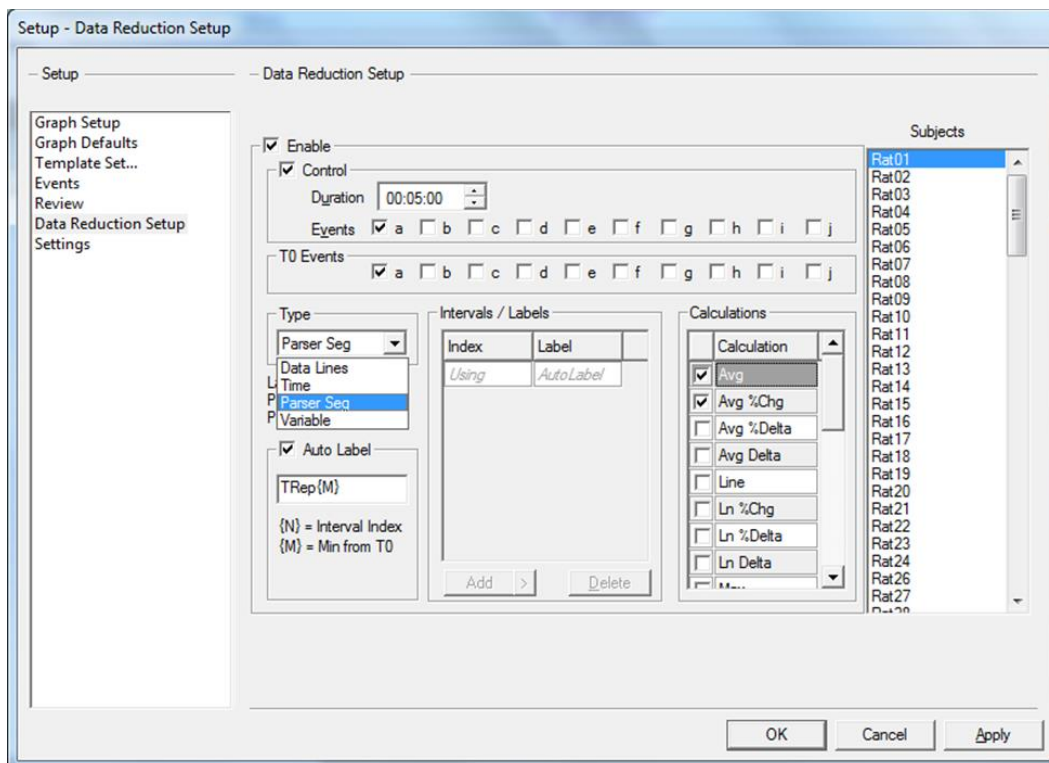
Note: Data Reduction can be setup to report summary averages and standard deviations based on time intervals, the number of **Logged Lines** in the **Derived Parameter List View**, or **Data Parsers**. Configuring Data Reduction to use Data Parser Segments can be an extremely useful method to tightly control which data is chosen for the summary intervals.

DATA REDUCTION SETUP

The **Data Reduction Setup** dialog is used to configure how the summary intervals will be executed and to which Subjects the Data Reduction will apply.

To configure **Data Reduction**:

1. Select **Setup | Experiment Setup | Data Reduction Setup**.



2. Select the Subject(s) to which the **Data Reduction** will be applied from the **Subjects** list on the right of the dialog.
3. Enable **Data Reduction** for the selected Subjects by checking the **Enabled** check box.
4. (Optional) Enable the **Control** period by checking the associated check box.

The **Control** period permits the user to define a pre-dose period to which to compare all other **Data Reduction** intervals for **%Change**, **%Delta**, and **Delta** calculations.

- a. Define the time **Duration** over which logged data is averaged for the **Control** period.
The **Control** duration works relative to the **Event(s)** that are selected in **Control | Events**. For example, a **Control Duration** of 5 minutes (00:05:00) will report the average and standard deviation of the **Derived Parameters** for the data range beginning 5 minutes prior to the **Event** and ending at the **Event**.

Note: If **Data Parser** is selected as the **Data Reduction Type**, the **Duration** will be ignored and the first available **Data Parser** will be used for the **Control**.

- b. Select the **Event** to be used to trigger the Control period calculation.
The **Control** Duration is defined relative to the location of the Event placement in the data. For example, a **Control Duration** of 5 minutes (00:05:00) will report the average and standard deviation of the **Derived Parameters** for the data range beginning 5 minutes prior to the **Event** and ending at the **Event**
5. Select the **T0 Event** that will be used to trigger the commencement of the post-dose **Data Reduction** intervals. Which **Events** used for **Control** and **T0 Events** will depend on the experimental protocol and how the **Data Reduction** is desired to be controlled.
6. Select the **Data Reduction Type** to define the method used.
 - a. **Data Lines**
This allows you to define the number of **Log Lines** data from the **Derived Parameters List Views** that will be repeated after the activation of an **Event (T0)**. If the **Logging Rate** is set to 10 seconds and the desired interval to report on is 60 seconds, then set the **Data Lines** to 6.
 - b. **Time**
This allows you to define a time interval over which you would like the summary data to be reported to the **Data Reduction List View**. This interval will be repeated after the activation of an **Event (T0)**. For example, defining **Time** to 60 minutes will result in reporting summary data to the **Data Reduction List View** every 60 minutes from the **T0 Event**.
 - c. **Variable Intervals**
This allows you to insert a list of times in the system that will start after the activation of the **T0 Event**. The maximum number of variable intervals that can be entered is 100.
 - d. **Parser Segments**
This allows you to summarize data based on defined **Parser Segments**.

Note: If **Parser Segment** is defined as the **Data Reduction Type** and is triggered during an Acquisition, Data Reduction will be running in Time mode, as Data Parser is a Review Only tool. Once the data is loaded into Review, the **Data Reduction** will update to use the **Parser Segments**.

CALCULATIONS

When a summary interval has reached its user-defined duration, calculations are reported to the **Data Reduction List View**, along with the Start Time, End Time and **Duration** of the interval in elapsed time. The calculations are enabled by checking the associated check box within the **Calculations** column of the dialog. The following defines the calculations available from **Data Reduction**.

Note: If a calculation requires a **Control** period to be enabled and the **Control** is not enabled, then the calculation will be grayed.

Calculation	Description
Line	The Log Line of data from the Derived Parameter List View at the specific time interval being logged within the Data Reduction List View .
Ln Delta*	Difference between current Log Line of data and the Control Log Line from the Data Reduction List View . (Current - Control)
Ln %Chg*	Log Line/Control * 100
Ln %Delta*	(Log Line - Control)/Control *100
Avg	Average of the Parameter data within the Data Reduction interval.
Avg Delta*	Difference between the Average Log Line and the Control (Average - Control)
Avg %Chg*	Average/Control * 100
Avg %Delta*	(Average - Control)/Control *100
SDev Samp	The Standard Deviation of the data between the last Monitoring Time and the current.
SDev Est	The Standard Deviation estimate of the entire population of data between the last Monitoring Time and the current.
Max	The Maximum parameter value of the data within the Data Reduction interval.
Max Delta*	Difference between Maximum parameter value and the Control (Max - Control)
Max %Chg*	Maximum/Control * 100
Max %Delta*	(Maximum - Control)/Control *100
MaxT	The time at which the Maximum parameter value of the data occurred within the Data Reduction interval.
Min	The Minimum parameter value of the data within the Data Reduction interval.
Min Delta*	Difference between Minimum parameter value and the Control (Minimum - Control)
Min %Chg*	Minimum/Control * 100
Min %Delta*	(Minimum - Control)/Control *100
MinT	The time at which the Minimum parameter value of the data occurred within the Data Reduction interval.
Median	The Median parameter value of the data logged within the Data Reduction interval is reported. If an odd number of data lines are being summarized, the median is calculated by sorting the parameter data values in order and reporting the middle value. If an even number of data lines is being summarized, the median is calculated by sorting the data to be summarized in order and reporting the average of the two middle values.

*Indicates a calculation which cannot be used when **Control** is disabled.

VARIABILITY ANALYSIS

INTRODUCTION

Variability Analysis permits Heart Rate Variability (HRV) analysis via ECG and Blood Pressure waveform data. Variability Analysis functionality is only available from within a Review session.

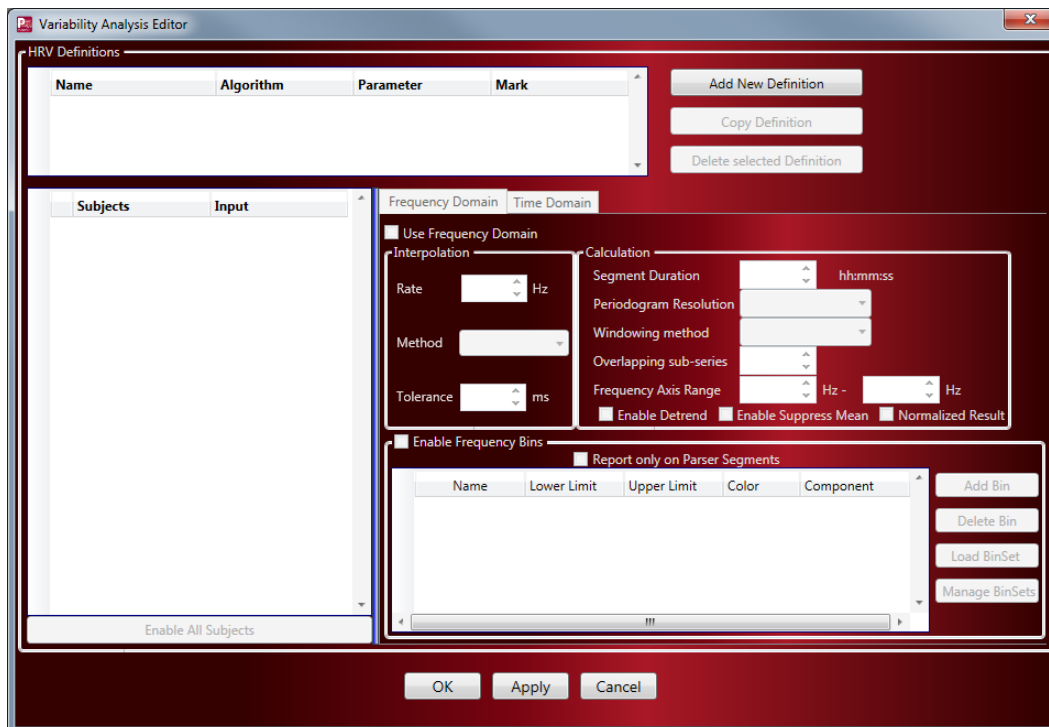
HRV provides a representation of the balance between sympathetic and parasympathetic branches of the autonomic nervous system. High HRV is an indication of healthy autonomic and cardiovascular response, while low HRV indicates that sympathetic and parasympathetic nervous systems are not properly coordinating to provide an appropriate heart rate response. There are several factors that can affect HRV (both positively and negatively) including: reflexes, respiration, renin-angiotensin system, physical or mental stress, exercise, cardiovascular and non-cardiovascular disease states, age and drugs.

SETUP

To use Variability Analysis, at least one channel needs to be set to ECG, BP or LVP for the analysis option.

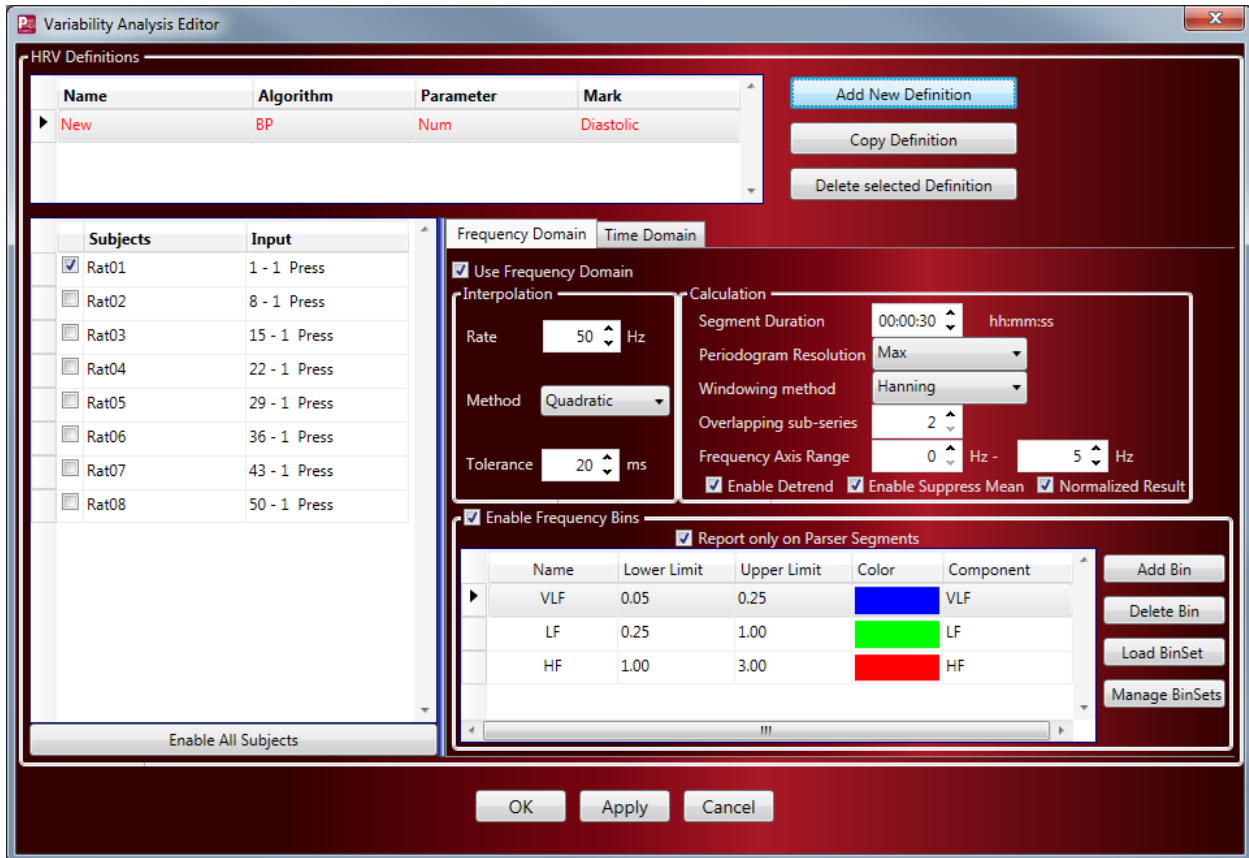
To configure:

1. Start a *Review Session* by selecting **Actions | Start Review**
2. Select the desired Subjects, Channels, and Time Range
(see the **Loading Data into Review** section of the manual for details.)
3. Select **Setup | Variability Analysis...**



- Select the **Add New Definition** button.

A new *HRV Definition* will be added for configuration. *HRV Definitions*, allow you the user to configure multiple analyses based on different setting selections for additional analysis results reporting or to compare results.



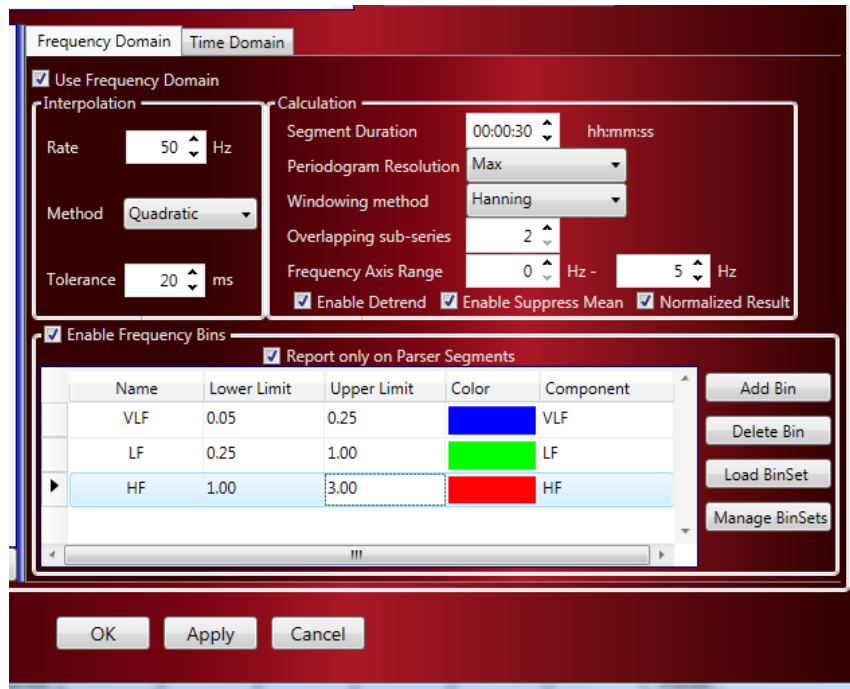
- From the **HRV Definitions** settings box, enter a unique **Definition Name**, select the **Algorithm**, **Parameter**, and **Mark** to use.

- Algorithm** Defines the analysis module this definition will use for the HRV analysis. If deriving HRV from ECG, choose ECG as the Algorithm. If deriving HRV from blood pressure, choose BP as the Algorithm.
- Parameter** Defines the parameter used for the variability analysis. **RR-I** is typically used for ECG, while **IBImS** is typically used for Blood Pressure.
- Mark** Used as the time stamp for reporting parameter data. Typically, the **R-wave** is used for ECG, while **Diastolic** is typical used for Blood Pressure.

- Select the **Subjects** to analyze with the defined HRV settings using the checkboxes associated with the Subject IDs listed.
- Select the dropdown menu under the **Input** column to choose the channel to analyze. The **Input** dropdown menu will only list channels associated with the **Algorithm** selected; e.g. if BP is selected as the

Algorithm, only BP channels will be listed. This is important if the implant being used has multiple ECG or BP channels to ensure the intended channel is the one being analyzed.

8. If interested in HRV Analysis using the *Frequency Domain*, enable the checkbox associated with **Use Frequency Domain**.



- a. Define the *Interpolation* settings. This will equally space the selected data series to accurately calculate the Periodogram.
 - **Rate** Defines the numerical frequency value used for the interpolation interval.
 - **Method** Defines the interpolation method. Options include Linear, Quadratic and Cubic.
 - **Tolerance** Allows the user to permit interpolation over data gaps to prevent aborting analysis of the segment when Bad Data Marks are encountered. Default is 20 milliseconds. Time entry format: ss.mmm.

- b. Define the *Calculation* settings used to calculate a high resolution Periodogram of the selected data. The Periodogram splits the data into multiple overlapping windows (smaller data sets or sub-series) and performs a mathematical operation called a Fast Fourier Transform (FFT) on each sub-series.
 - **Segment Duration** Time interval used for Variability Analysis calculations. The segment duration is different from the Logging Rate used in other areas of Ponemah.
 - **Periodogram Resolution** Defines the number of points used to calculate the Periodogram.

- **Windowing Method** The mathematics behind the FFT assumes that the input waveform repeats cyclically. This is not the case with most waveforms, so to avoid sharp discontinuities that would cause additional frequency components in the result, a windowing method is used. Windowing is used to taper the sub-series endpoints to better approximate a truly periodic signal. By tapering the window smoothly to zero at each end, the height of the side lobes resulting from a rectangular window can be diminished; this is achieved at the expense of a wider main lobe (coarser response at the true center frequency). Choose a windowing method to define how the time domain signal will be truncated. Options include:

 - **Rectangle** - This windowing method does not modify the data signal and produces the sharpest spectral peaks, but produces the worst side lobes due to 'border artifact'.
 - **Hanning** - Similar to a bell curve, this windowing method provides greater weighting for points in the center of the window. This is a good general-purpose window; however, it does remove most of the signal. If unsure about which window would be best, try this one first. In comparison with the rectangular window, it reduces border artifact by virtue of its smaller first side lobe amplitude. However, non-rectangular windowing affects the average power of a signal because some of the time samples are attenuated when multiplied by the window.
 - **Hamming** - Similar to the Hanning window, this windowing method provides another way to taper endpoints of the sub-series and preserves more of the original signal than a Hanning window, but at the price of unpleasant side lobes. The Hamming window has slightly more attenuation in the first side lobe than the Hanning window, but the subsequent side lobes trail off more slowly than with the Hanning window.

- **Overlapping Subseries** Used to subdivide the data segment into smaller segments that are windowed individually to provide the desired frequency resolution. Values can be between 2 and 50.

- **Frequency Axis Range** Range of the x-axis to display the Periodogram data.

- **Detrend** Removal of any baseline wander in the data.

- **Suppress Mean** Removes the baseline offset so that all data averages to 0. Enabling this option helps to ensure precise statistical measures.

- **Normalized Result** Normalizes the Periodogram result so that the maximum y-axis value is equal to 1.

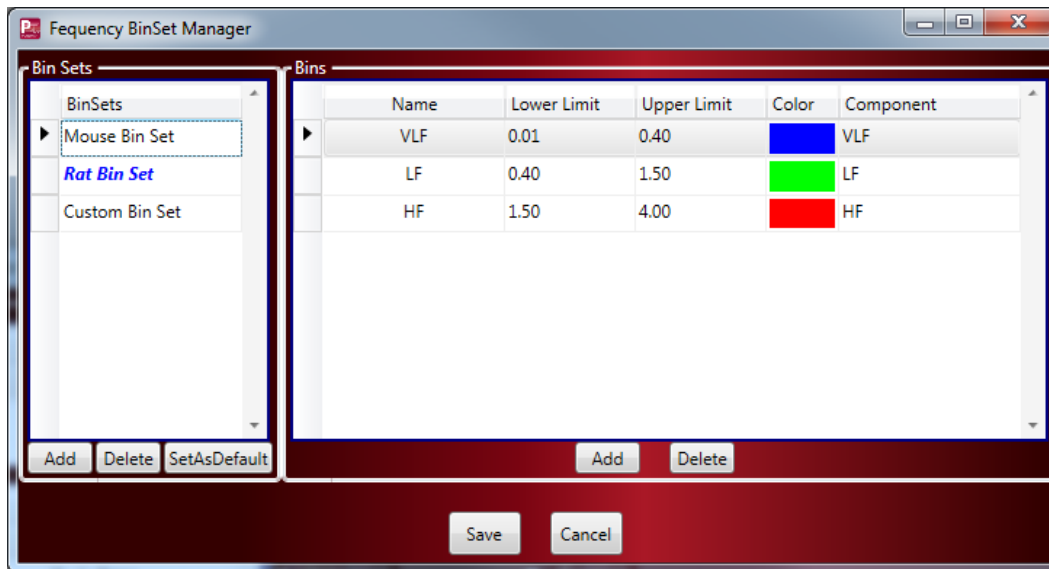
- c. **Enable Frequency Bins** to create a Periodogram. The power contained within each of the bins is determined and used for further analysis. The default values provided in the list are examples and may be adjusted.

Enable **Report only on Parser Segments** to only report HRV Frequency analysis results from waveform data contained within defined **Parser Segments**. This is important as it allows the use to have equally spaced segments of data that should be signal noise free to ensure the Periodogram are accurate. Noise within the waveform segment select will lead to unexpected results.

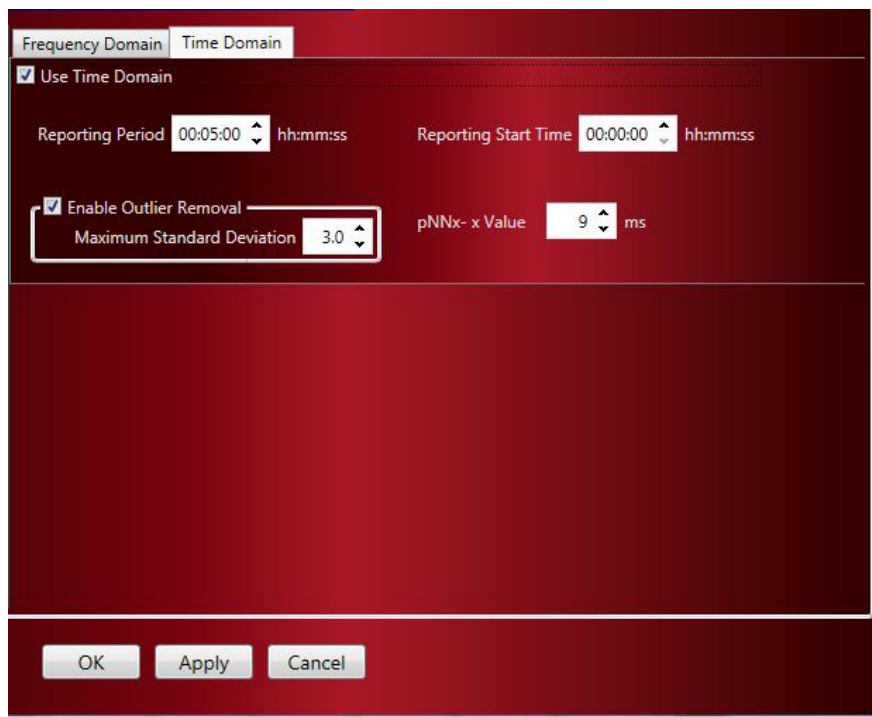
To setup the Frequency Bins, define the following items:

- **Name** Name assigned to the frequency bin. Default values are shown, but can be changed by clicking within the box that contains the name.
- **Lower Limit** Numerical frequency value used for the Lower Limit for the specific frequency bin. The Lower Limit must be less than the Upper Limit. The value can be changed by clicking within the box that contains the Lower Limit value.
- **Upper Limit** Numerical frequency value used for the Upper Limit for the specific frequency bin. The Upper Limit must be greater than the Lower Limit. The value can be changed by clicking within the box that contains the Upper Limit value.
- **Color** Color used on graph pages for the specific frequency bin. The color can be changed by clicking on the color box.
- **Component** The Variability Analysis calculates parameters specific for HRV. For the calculations to perform correctly, the specific frequency components must be identified. Options are ULF, VLF, LF, HF and Unspecified. The Unspecified option is the only frequency option that can be used more than once. For the named frequency components, the Upper Limit of VLF must be less than the Lower Limit for LF and the Upper Limit for LF must be less than the Lower Limit of HF.
- **Add Bin** Used to add additional frequency bins.
- **Delete Bin** Used to delete additional frequency bins.
- **Load BinSet** Selecting the **Load BinSets** button will display the available, predefined frequency bin sets. Mouse and Rat bin sets are available as defaults. However, any user-defined bin set will be listed if they exist. Selecting the bin set will load it into the *Variability Analysis Editor* dialog for use with the currently displayed HRV Definition analysis.
- **Manage BinSets** Choosing **Manage Bin Sets ...** will display the **Manage Frequency Bins** dialog. This displays the bin sets available for use and allows the user to create customer bin sets for easy selection. The default bin set used for calculations can be customized by

selecting the desired bin set to load by default and then selecting the **SetAsDefault** button. The default bin set is identified by bold, blue font.



9. If interested in HRV Analysis using the *Time Domain*, select the Time Domain tab and enable the checkbox associated with **Use Time Domain**.



Configure the following Time Domain settings:

- **Reporting Period** Defines the rate at which data is reported to the **Variability Analysis Derived List Views**.
- **Report Start Time** This defines the time offset at which to start reporting **Time Domain HRV Results** to the **Derived List View**. For example, if the experiment data is loaded at 7:00 AM but you want the analysis to start at 10:00 AM, then enter a **Report Start Time** of 03:00:00 to indicate a 3 hour offset.
- **pNNx – x Value** The time, in milliseconds, used to calculate the number of valid adjacent NN values not separated by data breaks or bad data marks that differ by more than this value. The number of counts based on this setting are reported as the Derived Parameter NNx.

Note: Default values by species are:

- Mouse 6 milliseconds
- Rat 9 milliseconds
- Monkey 25 milliseconds
- Dog 50 milliseconds

- **Outlier Removal** Enable the checkbox for **Enable Outlier Removal** and define the **Maximum Standard Deviation** above which values will be removed.

Note: **Outlier Removal** is disabled by default.

DERIVED PARAMETERS

Derived Parameters from the *Variability Analysis* operations is made available as separate **Variability Analysis List View** in the main Ponemah window. Disparate *List Views* will be displayed for **Frequency Domain** and **Time Domain Variability Analysis**. Each *List View* will be titled with the domain type of the Derived Parameters it contains within. The *List Views* contain separate tabs per **Subject** and per **HRV Definition**. The example *List View* below displays the Frequency Domain Derived Parameters for Rat01 – Rat08 when two separate HRV Definitions have been applied (HRV BP and HRV ECG). A similar List View contains the Time Domain Derived Parameters.

Note: For **Frequency Domain** Analysis, the **Derived Parameters** will only be available if binned analysis was setup during creation of the Variability Analysis, as described in **Step 8c** above.

Variability Analysis: Frequency Domain - Rat01.HRV BP										
Rat01 - HRV BP	Rat02 - HRV BP	Rat03 - HRV BP	Rat04 - HRV BP	Rat05 - HRV BP	Rat06 - HRV BP	Rat07 - HRV BP	Rat08 - HRV BP	Rat01 - HRV ECG	Rat02 - HRV ECG	Rat03 - HRV ECG
Start Time	End Time	VLF	LF	HF	TP	Normalized LF	Normalized HF	LF/HF	*Status	
3/8/2016 4:10:00 PM	3/8/2016 4:10:30 PM	0.0779	0.0166	0.1047	0.1992	0.1366	0.8634	0.1582		
3/8/2016 4:20:00 PM	3/8/2016 4:20:30 PM	0.0706	0.0200	0.1338	0.2244	0.1299	0.8701	0.1493		
3/8/2016 4:30:00 PM	3/8/2016 4:30:30 PM	0.0509	0.0423	0.3791	0.4723	0.1003	0.8997	0.1115		
3/8/2016 4:40:00 PM	3/8/2016 4:40:30 PM	0.0118	0.0564	0.4871	0.5554	0.1038	0.8962	0.1158		
3/8/2016 4:50:00 PM	3/8/2016 4:50:30 PM	0.0684	0.0903	0.4131	0.5718	0.1794	0.8206	0.2186		
3/8/2016 5:00:00 PM	3/8/2016 5:00:30 PM	0.0180	0.0318	0.2814	0.3313	0.1016	0.8984	0.1131		
3/8/2016 5:20:00 PM	3/8/2016 5:20:30 PM	0.0476	0.0415	0.2339	0.3229	0.1508	0.8492	0.1776		
3/8/2016 5:40:00 PM	3/8/2016 5:40:30 PM	0.0561	0.0941	0.4816	0.6318	0.1635	0.8365	0.1954		

The **Derived Parameter** data for **Variability Analysis** will be saved when **Save Derived Data** or **Save Mark Section** is executed, as described in the **Saving Analysis Sessions** section of this manual. Once saved, the **Derived Parameters** will be available via Excel as separate tabs.

Frequency Domain Derived Parameters

The following details the available **Derived Parameters** from the Frequency Domain Variability Analysis.

Name	Definition
VLF	The Very Low Frequency (VLF) as defined in the Variability Analysis Frequency Domain Frequency Bins over the user-defined Segment Duration.
LF	The Low Frequency (LF) as defined in the Variability Analysis Frequency Domain Frequency Bins over the user-defined Segment Duration.
HF	The High Frequency (HF) as defined in the Variability Analysis Frequency Domain Frequency Bins over the user-defined Segment Duration.
TP	The Total Power (TP) over the user-defined Segment Duration.
Normalized LF	The normalized Low Frequency (LF) as defined in the Variability Analysis Frequency Domain Frequency Bins over the user-defined Segment Duration. This removes the VLF component.
Normalized HF	The normalized High Frequency (HF) as defined in the Variability Analysis Frequency Domain Frequency Bins over the user-defined Segment Duration. This removes the VLF component.
LF/HF	The power ratio of Low Frequency content divided by High Frequency content over the user-defined Segment Duration.
Status	Provides an indication to the user should an issue be encountered with the analysis over the user-defined Segment Duration. See Variability Analysis | Trouble Shooting section for more information.

Time Domain Derived Parameters

The following details the available **Derived Parameters** from the Time Domain Variability Analysis.

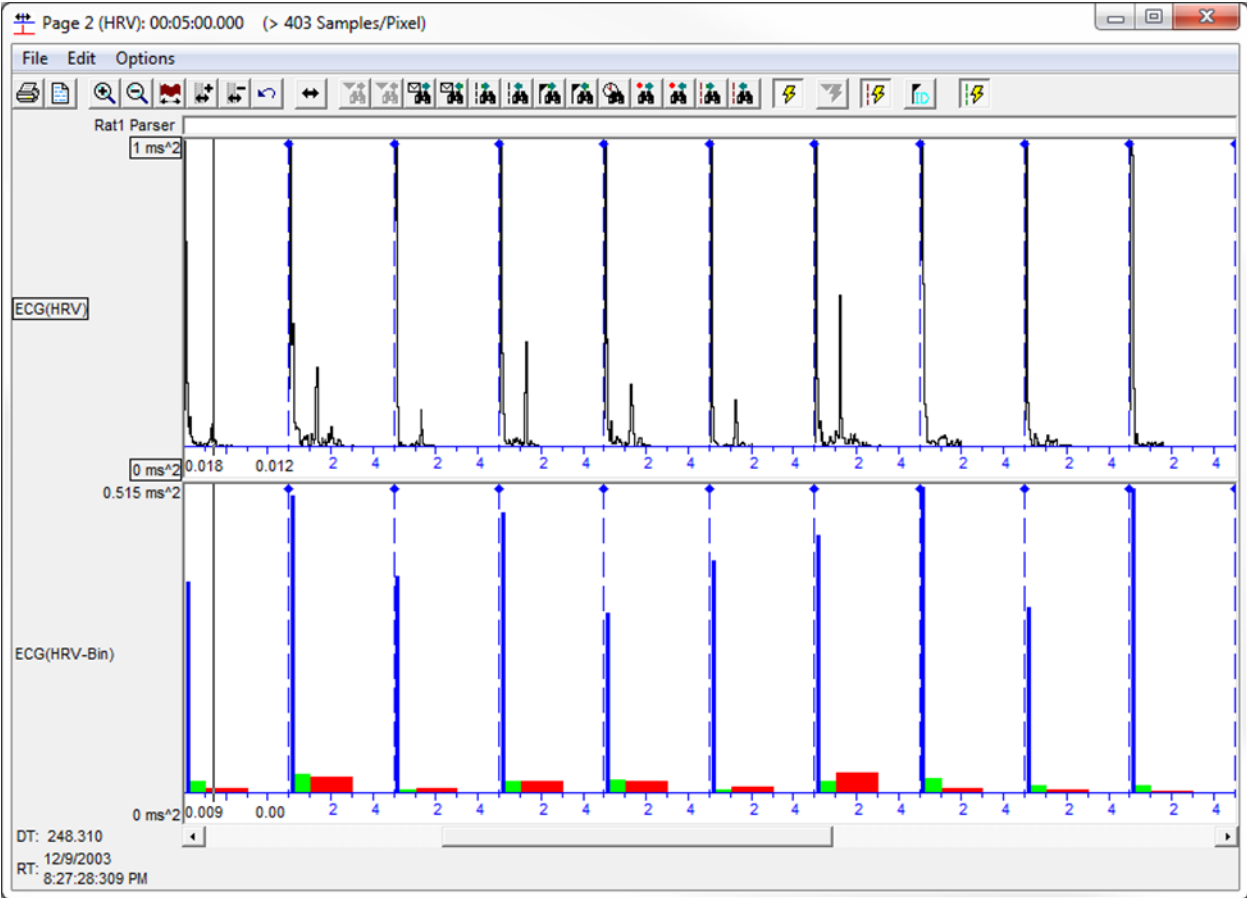
Name	Definition
NNInterval	The average of all Normal-Normal (NN) intervals in milliseconds over the user-defined Time Domain Reporting Period.
SDNN	The standard deviation of the averaged Normal-Normal (NN) intervals in milliseconds over the user-defined Time Domain Reporting Period.
RMSSD	The root mean square of successive differences in milliseconds. $\sqrt{\frac{1}{N} \sum (NN_n - NN_{(n-1)})^2}$ <p>Where N is the number of valid adjacent NN values that are not separated by data breaks or bad data marks.</p>
NNx	The number of valid adjacent NN values that are not separated by data breaks or bad data marks that differ by more than x milliseconds. X is defined in the Time Domain pNNx – x Value setting.

pNNx	The proportion of valid adjacent NN values that are not separated by data breaks or bad data marks that differ by more than x milliseconds (NNx) divided by the total number of Normal-Normal intervals (Cycles).
Cycles	The number of available NN values.
Status	Provides an indication to the user should an issue be encountered with the analysis over the user-defined Segment Duration. See Variability Analysis | Trouble Shooting section for more information.

GRAPH PAGE SETUP

Results from Variability Analysis can be shown graphically via **Primary** and **Trend** Graph pages.

High resolution Periodogram and binned Periodogram can be viewed in a **Primary** graph, by selecting the dedicated items in the **Presentation** column. Since Variability Analysis is a Review Only feature, these Presentation graphs are only available while in a Review session. The Presentation dropdown box will list the Variability Analysis Name, which will display the Periodogram, and the Variability Analysis Name – bins, which will display the binned data as shown below:



Note: All derived variability analysis data (e.g. LF/HF) can be viewed in **Trend** graphs.

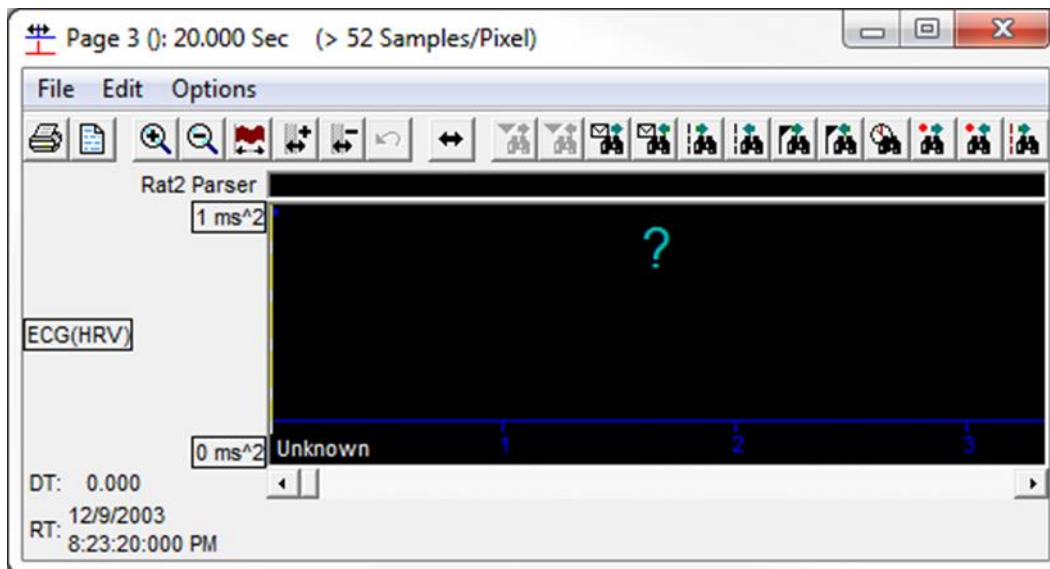
TROUBLESHOOTING

In order for the Variability Analysis to work correctly it is important to include the analysis attributes for the ECG or blood pressure raw signal. If this is not done, then the Derived Parameter data and graph pages will not display the variability analysis data.

Ponemah will provide visual feedback regarding any potential error

s related to Variability Analysis. The screenshots below provide an example for when no valid data points are available for the Variability Analysis. The error condition can also be verified by right-clicking the mouse in the axis for the Periodogram or binned data. This is shown in the last screen capture.

Start Time	End Time	NNInterval	SDNN	RMSSD	NNx	pNNx	Cycles	*Status
3/8/2016 4:05:00 PM	3/8/2016 4:10:00 PM	x	x	x	x	x	x	PNM4604: No valid data points.
3/8/2016 4:15:00 PM	3/8/2016 4:20:00 PM	x	x	x	x	x	x	PNM4604: No valid data points.
3/8/2016 4:25:00 PM	3/8/2016 4:30:00 PM	x	x	x	x	x	x	PNM4604: No valid data points.
3/8/2016 4:35:00 PM	3/8/2016 4:40:00 PM	x	x	x	x	x	x	PNM4604: No valid data points.
3/8/2016 4:45:00 PM	3/8/2016 4:50:00 PM	x	x	x	x	x	x	PNM4604: No valid data points.
3/8/2016 4:55:00 PM	3/8/2016 5:00:00 PM	x	x	x	x	x	x	PNM4604: No valid data points.
3/8/2016 5:05:00 PM	3/8/2016 5:10:00 PM	x	x	x	x	x	x	PNM4604: No valid data points.



DATA INSIGHTS

Data Insights allows researchers to assess the quality of their data analysis and target problem areas for additional cleaning and analysis without having to manually over read the dataset. Data Insights reveals these problem areas by applying user-defined search rules to the dataset and displaying cycles that match the search criteria. Match results are displayed in graphical and tabular formats to provide researchers a multi-faceted view of each search result and how the results are distributed throughout their dataset. This provides researchers the necessary information to better understand their data and make an informed decision on whether or not to exclude certain sections of data due to signal artifact or data dropout without investing a significant amount of time.

In addition to searches for data validation and analysis, researchers may create Data Insights searches to locate, present, and report on any data pattern or anomaly within the dataset, e.g., cardiac arrhythmias. The use of Data Insights permits the user to move beyond snapshots of data for efficient coverage of large volumes of data.

Using Data Insights searches, researchers can optimize their data review and analysis process to achieve consistent, reproducible results for reporting purposes.

DATA INSIGHTS DIALOG OVERVIEW

Data Insights is accessed from the **Experiment** menu when in Review. All active channels loaded into Review will be available for use within Data Insights.

Channel/Search Association

Channel	Group	Algorithm	Search	Match
3:ECG	Group A	ECG	ar_ Junctional	4418
3:ECG	Group A	ECG	ar_ PAC	876
3:ECG	Group A	ECG	ar_ Sinus Pause	854
3:ECG	Group A	ECG	ar_ V Bigeminy	2596
3:ECG	Group A	ECG	ar_ V Couplet	3534
3:ECG	Group A	ECG	ar_ V Ectopic	71773
3:ECG	Group A	ECG	ar_ V Ectopic Single	13327
3:ECG	Group A	ECG	ar_ V Series	4004
3:ECG	Group A	ECG	ar_ V Trigeminy	969

Search Definitions

Search	Match
ar_ PR Change	854
ar_ Sinus Pause	854
ar_ V Bigeminy	2596
ar_ V Couplet	3534
ar_ V Couplet Serk	3534
ar_ V Ectopic	71773
ar_ V Ectopic Singl	13327
ar_ V Series	4004
ar_ V Trigeminy	969

Results Wave View

Results Derived View

1:LogTime	2:Duration	3:CycleNum	4:Series(ar_V Ectopic Single, 2)	5:Value(Numcyc-1)
0003:39:42.779	0:00:04.350	2663		2663
0000:40:21.358	0:00:04.428	2700		2699
0002:50:09.440	0:00:03.874	12299		12298
0002:57:27.180	0:00:04.562	12931		12930
0003:04:05.336	0:00:03.046	13439		13438
0003:08:17.670	0:00:02.836	13864		13863
0003:08:23.302	0:00:03.308	13874		13873
0003:08:27.524	0:00:05.072	13881		13880
0003:09:09.930	0:00:07.654	13947		13946
0003:10:14.296	0:00:03.870	14066		14065

Results Distribution View

Bin Length: 60 minutes, Data Percentage: 25 %

SEARCH SECTION

The **Search** section of the dialog provides a means to define search criteria and associated desired searches to channels to populate the **Results** section. The Search section is split into three grids:

- **Channel/Search Association and Match Results**
(left grid)

The Channel/Search Association grid includes the physical channel, Subject name, analysis module assigned to that channel and all searches that have been applied to that channel. In the above example, the ar_V Bigeminy search has been applied to channel 3.

- **Search and Match grid**
(middle grid)

This section of the dialog displays the names associated with the defined Searches and the total number of occurrences matching that rule or search criteria. If the same rule is applied across multiple channels, the Match field will list the total number of matches across all associated channels. A list of predefined Searches is present by default and available for use.

The list of default Searches follow the following naming convention:

- an_ Searches used to aid in data analysis. Currently used to help construct high value ECG PRO Template Libraries.
- ar_ Searches used to aid in arrhythmia detection.
- dv_ Searches used to aid in data validation by quickly exposing outliers and potentially mismarked data that may require focused attention.

To learn more about the default Searches, please see the **Data Insights** section of the **Software Appendix**.

- **Search Definition**
(right grid)

This section displays the Search Definition for a given Search. Click on any Search under the **Search** header and the search criteria used to define the search will be displayed within this grid. Searches are composed of one or more Search Clauses that may be combined using Boolean operators (AND, OR). One or more Search Definitions may be associated with each acquired signal.

See **Customizing Search Definitions** to learn more about Search Definitions.

RESULTS SECTION

The **Results** section of the dialog contains graphical and numerical information based on the results from the searches that have been performed. This section is also divided into three sections:

- **Results Wave View**
(top)

Displays the waveform data that matches the search criteria assigned to that channel. Dashed green lines indicate the cycles that match the search criteria for a contiguous time segment. The number of segments displayed in the graphical view corresponds to the number of matches found.

- **Results Derived View**
(middle)

Displays numeric data for each clause within the search, as well as the Log Time associated with the match. The example below illustrates how each clause of the Search Definition Clauses is associated with its own column in the Derived View.

1:LogTime	2:CycleNum	3:%Decrease(RR-Icyc-1, RR-Icyc0)	4:%Change(RR-Icyc-1, RR-Icyc1)	5:Value(Numcyc-2)
0005:48:43.812	30438	51.1236	2.247191	30436
0002:16:03.926	12228	-9.54128	9.174312	12226
0003:58:33.942	20862	41.29213	11.51685	20860
0021:52:47.866	10166	18.69159	18.2243	10164
0021:52:48.784	10168	18.57708	16.20553	10166
0020:54:25.344	4766	17.63441	8.387096	4764
0006:55:11.506	36036	17.50663	16.97613	36034

%Decrease(RR-Icyc-1, RR-Icyc0)	>	10
AND %Change(RR-Icyc-1, RR-Icyc1)	<	20
AND Value(Numcyc-2)	>	0

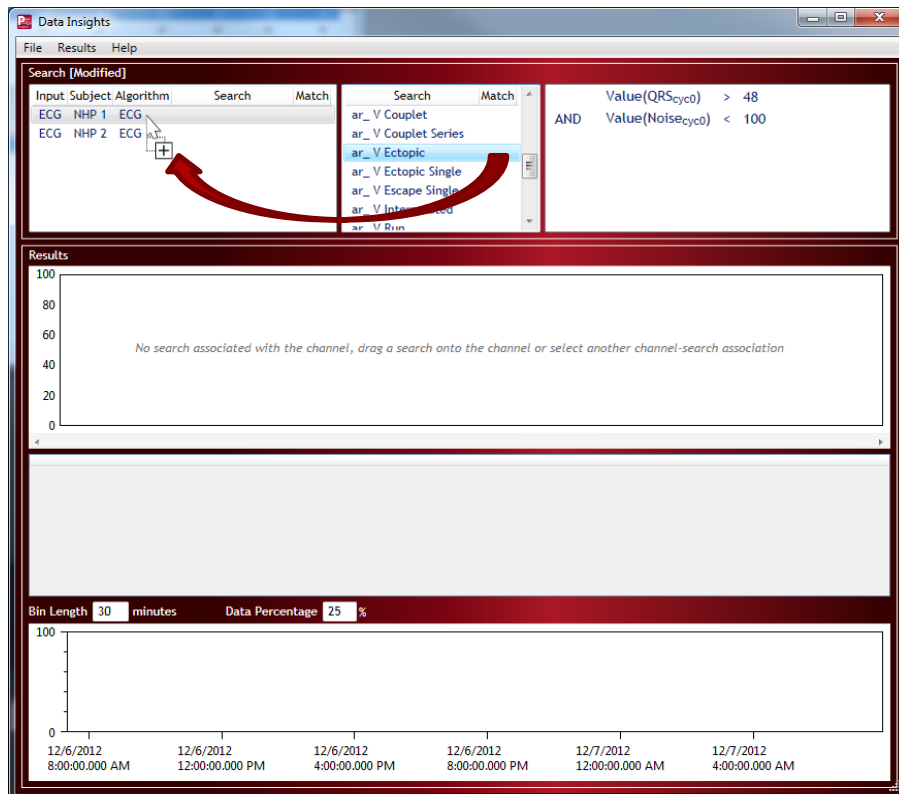
- **Results Distribution View**
(bottom)

Displays a histogram graph of the match results binned into user defined time segments to visualize the result distribution across the period of data loaded into Ponemah Review.

EXECUTING SEARCHES

To apply a **Search** to a channel, click-and-drag a Search from the **Search and Match** grid to the channel of interest. Selection of multiple Searches is also supported to apply two or more at the same time by multi-selecting the Searches of interest. Drag-and-dropping the search to a single channel will apply that search only to that channel, while dropping it on the grid header will apply that search to all channels loaded into Review to which that search is applicable.

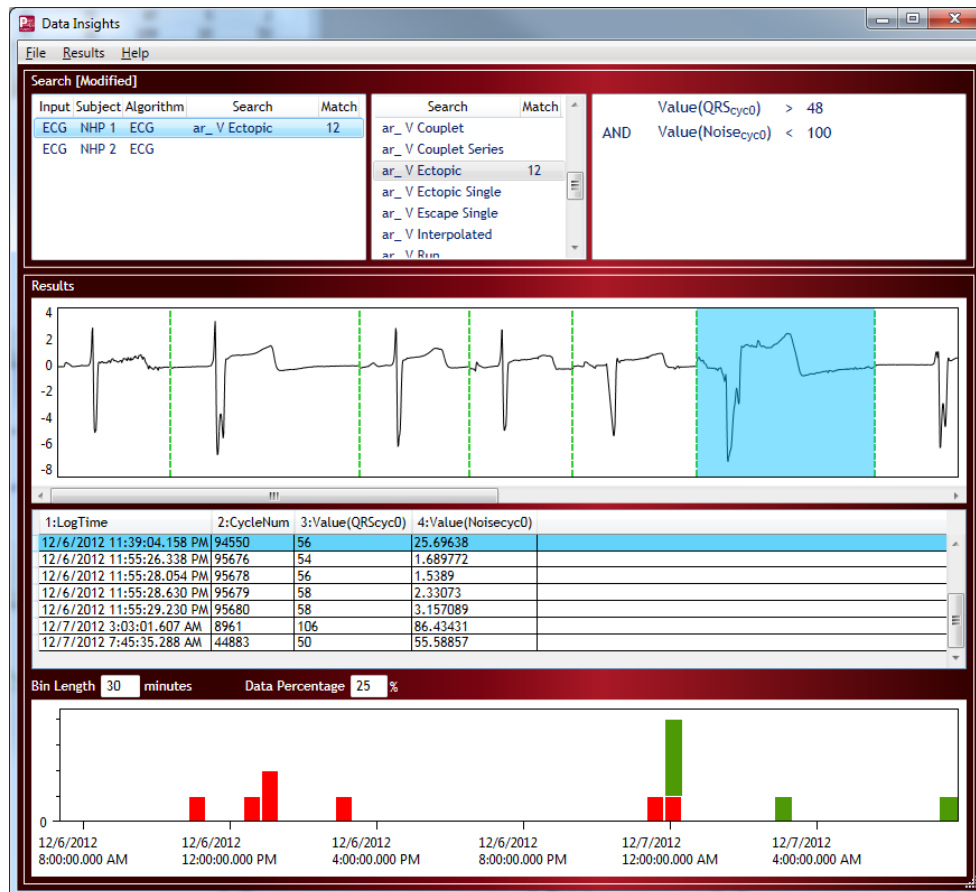
Note: Searches are specific to a channel and specie type. For example, Searches constructed using ECG parameter information cannot be applied to pressure channels. Searches should be created specific to both specie and signal type. Searches that do not match the signal type will not be allowed to be drag-and-dropped on that channel.



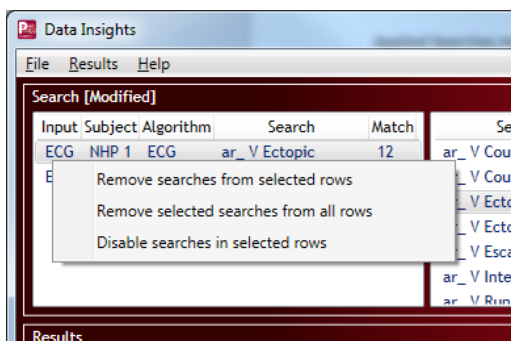
Once associated with a channel, the Search name will appear under the **Search** column next to the channel information. Analysis will automatically be performed, populating the number of occurrences matching the search criteria under the **Match** column and the **Results** section.



Warning: The Data Insights match results reflects the current state of the cycle marks and, therefore, dynamically updates if the cycle marks are changed; e.g. reanalyzing data with the analysis module or manually moving marks may change the match results.



Applied Searches may be disassociated from a channel by right-clicking the mouse on any of the Channel/Searches pairs. This will display a pop-up menu to permit the Search to be removed or disabled across one or multiple channels.



NAVIGATING RESULTS

Data is displayed in the **Results** section by clicking on a specific Channel/Search. Only one signal may be viewed at a time. Data is scaled in user units.

NAVIGATING THE WAVE VIEW

The following may be used to move forward (toward the end of the data) and backward (toward the beginning of the data) through the results in the Wave View

- **Scroll Bar** The scroll bar below the Wave View is used to move through the data by using the mouse to drag the scroll bar left and right.
- **Mouse Wheel** The mouse wheel may also be used to scroll through the match results. With the cursor hovering within the Wave View, scrolling the mouse wheel up will move forward in the data, while scrolling down will move backwards in the data.
- **Arrow Keys** The Right Arrow key moves forward in the data, while the Left Arrow key moves backwards. Progression will be one result at a time.
- **Page Up/Page Down** The Page Up key moves forward in the data, while the Page Down key moves backwards in the data. Progression will be one result page at a time.

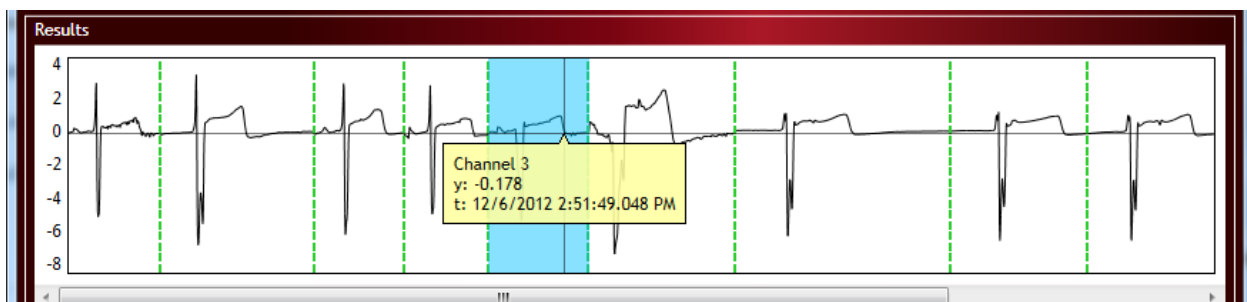
SCALING/ZOOM

The Wave View autoscales the y-axis range based on the match results being displayed.

Use **<Ctrl> + Mouse Wheel** to change the x-axis range. Scrolling down will zoom out, compressing the data and effectively displaying more results within the Wave View. Scrolling up will zoom in, expanding the data to display fewer results. Alternatively, **left-click-and-drag** may also be used to zoom in on results, providing more control of exactly which Results will be displayed by the zoom.

Note: Zooming out may not be performed via a click-and-drag function. Use the **<Ctrl> + Mouse Wheel** to zoom out as described above.

Additionally, pressing **<Ctrl> + Left-click** on a point in the Wave View will display its corresponding x- and y-axis values at that point.



PROCESSING RESULTS

The following features assist in the processing of large sets of results and the identification of appropriate thresholds for use in search definitions.

SORTING RESULTS BY SEARCH INPUT

By default, the search results are ordered chronologically. However, the search results may be sorted by any of the columns in the Results Derived View by clicking on the column header. Sorting updates the order of results in both the Results Derived View and the Results Wave View. Clicking the **LogTime** column header will bring the results back to their sort default by time.

RESULT ACTIONS

The following are a list of actions that can be taken on each result and their associated hot keys and definitions:

- **Reject**
<Ctrl> + <R>
Removes the match result(s) from the Wave View, Derived View, and Distribution View and reduces the number of matches listed in the **Match** columns of the associated searches. Rejecting a match result does not affect the derived data outside of the Data Insights dialog, it simply removes it as a match.
- **Add Bad Data Marks**
<Ctrl> +
Adds Bad Data Marks around the currently selected match result(s) within the Ponemah Review graph pages. This feature functions the same as using Bad Data Marks in Review (outside of using Data Insights). This will result in the match result being removed from the Search Results, as well as the cycle being removed from the data reported to the Derived Parameter and Data Reduction List Views.
- **Delete Cycles**
<Ctrl> + <D>
Removes the validation marks from match result cycle without adding Bad Data Marks. This will result in the match result being removed from the Search Results, as well as the cycle being removed from the data reported to the Derived Parameter and Data Reduction List Views.

Multiple results may be selected and either rejected as not belonging to the set of results or marked as bad data to prevent further analysis on the data samples. The number of results that may be selected at once is limited to less than 5000 results. A notification will popup if this limit is exceeded.

Note: These Result Actions may be executed from the Results Wave and Results Derived Views.

SYNCHRONIZING RESULTS

A single mouse left-click on a result in the Wave View will highlight the result and synchronize it with its associated numerical Result in the Derived View. Similarly, if a numeric result is selected from the Derived View, Data Insights will select and synchronize to the result in the Wave View.

A double left-click on the result from either the Wave View or the Derived View will also synchronize with the Parameter and Data Reduction List Views within the main Ponemah dialog, as well as with all other configured graph pages.

To aid in locating the exact match being synchronized to within the Ponemah Primary Graph page for additional observation, a background color may be applied to the match results. This is also helpful when over-reading data to determine if regions have already been identified by an applied Search within Data Insights.

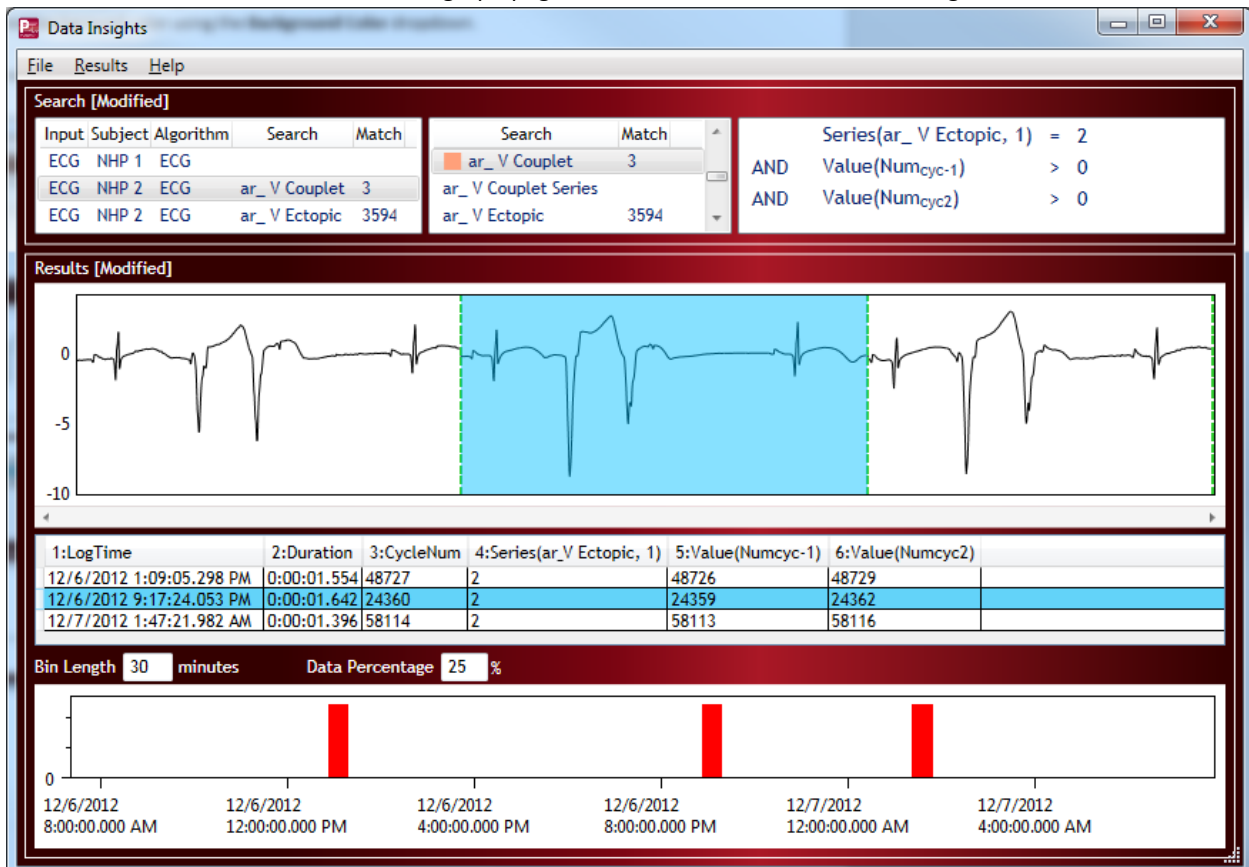
To add a background color for a particular Search:

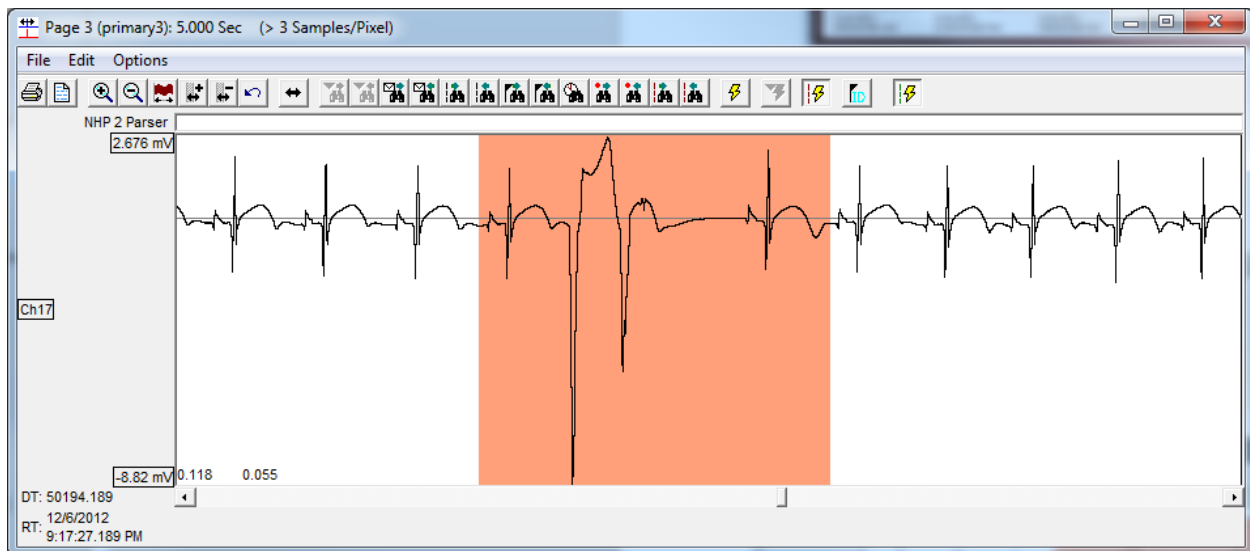
1. Locate the Search of interest within the **Search and Match Grid** (center grid in the top section).
2. Double-click the Search name.
3. Check the checkbox for **Display Background Color**.
4. Select the desired background color using the **Background Color** dropdown.
5. Click **OK**.
6. Double-click a match result to synchronize with the **Primary Graph**.

If the user decides the result within a colored region should not be included as a match, it may be rejected by right-clicking the mouse on the colored waveform segment in the Primary Graph and select **Reject Selected Search Result**. Match Results will be removed from Search Results and added to the Reject Results. Rejecting a result does not affect the derived data outside of the Data Insights dialog. In addition, **Add Bad Data Marks** and **Delete Cycles** can be used from the Primary Graph page to remove mismarked data from the Derived Parameter and Data Reduction List Views and subsequently the Data Insights Search Results. To view data that has been removed using the **Reject** function, select **Results** from the pull-down menu from the top of the Data Insights dialog and select **Rejected Results**.

Note:

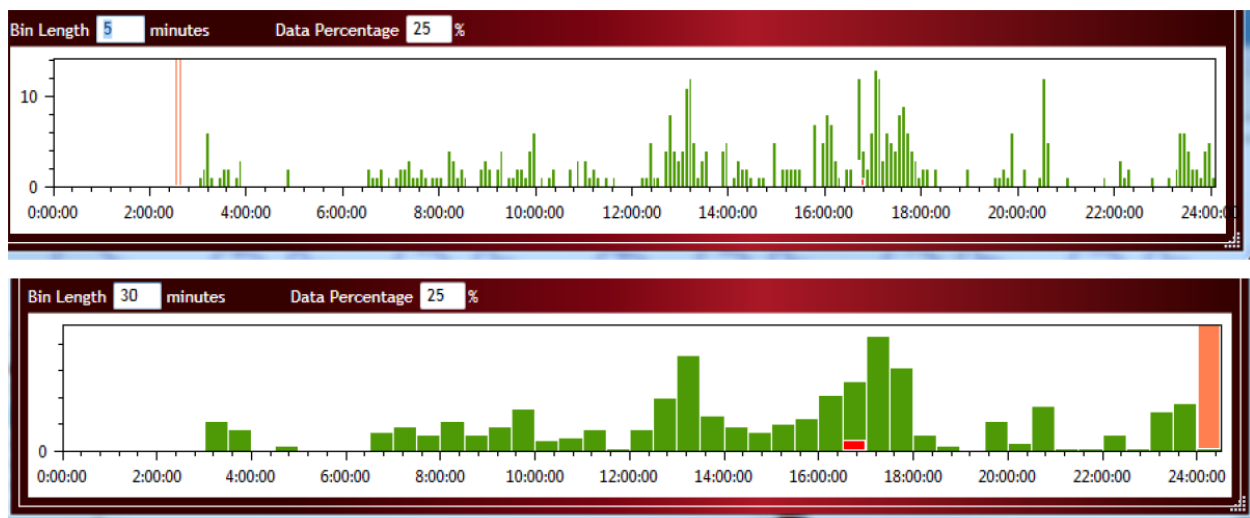
- The Search column within the **Search and Match Grid** will display the selected color associated with the search.
- Background colors will also be displayed in **Page View Graphs**.
- Should a region be matched by multiple applied Searches with associated background colors, these colors will stack within the graph pages to allow the user to see both background colors.



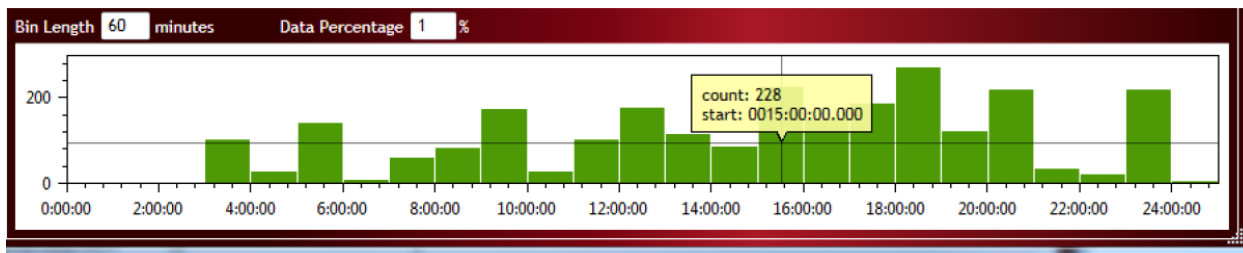


RESULTS DISTRIBUTION VIEW

Match results are also displayed in a histogram. The width of each histogram bar corresponds to a user defined **Bin Length** (time in minutes), which only impacts the visualization of the data. To modify the Bin Length, simply type in the desired length, in minutes, and the graphical component will update automatically. In the examples below, the **Bin Lengths** have been set to 5 minute and 30 minute intervals for comparison.

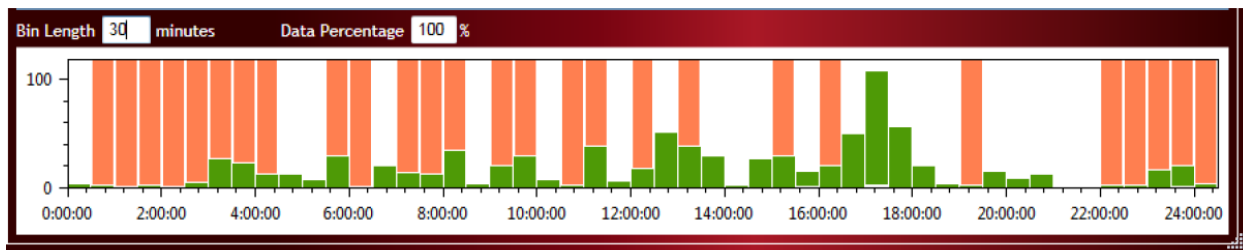


The height of each green histogram bar corresponds to the number of matches in the bin. Left-click the mouse and hold for information on the search results for a given bin. In the example below, 228 matches were found for the search. The start time for each bin is also provided.



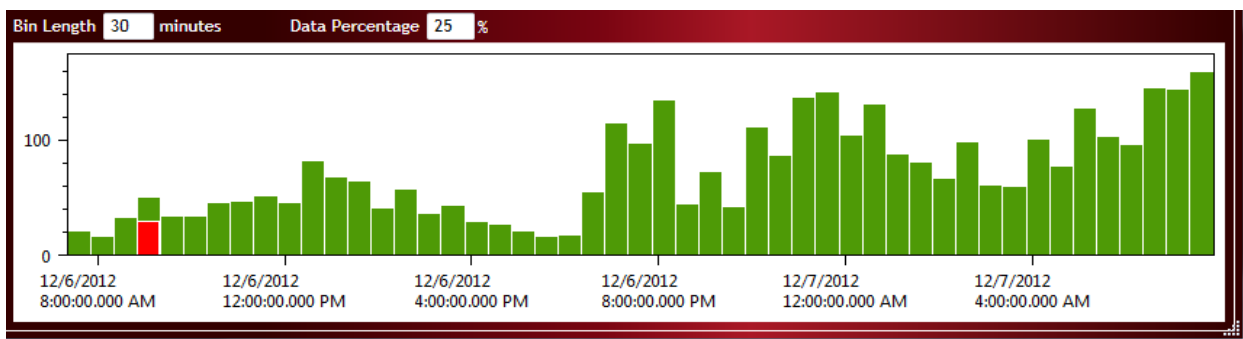
If the usable data in a bin drops below the value specified in the **Data Percentage** field, the background of the bin will change to a coral color. This alerts the user to regions that have a break in acquired data or have lost a significant amount of data to noise. In the example below, the Data Percentage was changed to 100% to illustrate the color change.

Note: The last column in the histogram will likely always contain a coral color bin, as the end of the data set typically does not align with the Bin Length. This is based on when the acquisition was stopped.



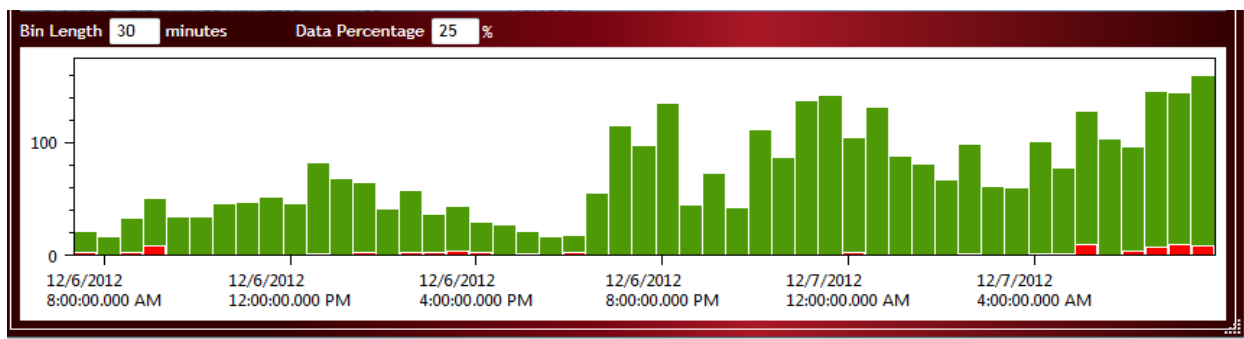
The red regions within the green bins indicate the location and number of matches currently displayed in the *Results Wave View*. If red segments are not visible, it is likely that too few match results are visible within the *Results Wave View* as compared to the total number of matches present within each bin, making the red match indicator very thin and difficult to see. To see the match indicator, reduce the size of your bins or zoom out within the *Results Wave View* to bring more matches into the viewing area.

The red segment updates automatically based on your location in the *Results Wave View*. Using one of the scrolling functions to move forward or backward through the match results also move the location of the red segment to the green bin location where the match was found.



If sorting is performed within the Results Derived View, the red segments may appear across multiple bins since data is no longer sorted chronologically. This provides an easy way to see if the results with the highest or lowest

match values are spread throughout the dataset or are localized to a particular area. To restore chronological order, simply click on the **LogTime** column header.

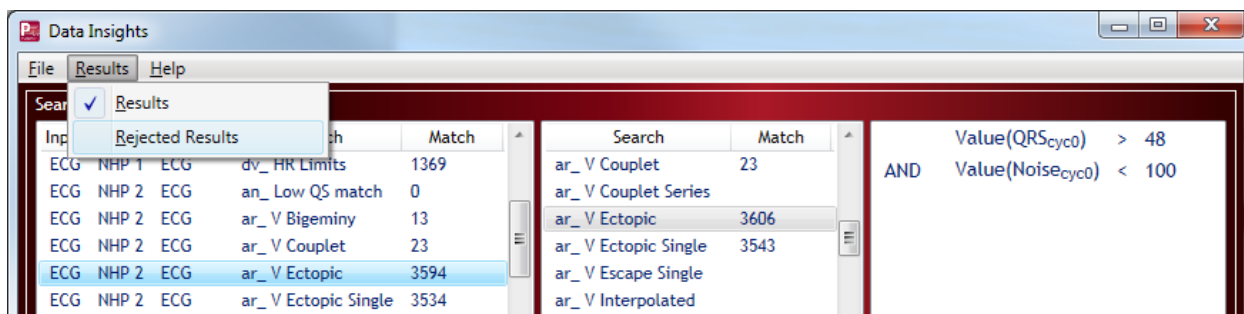


Note: Right-click the Results Distribution View to enable or disable the **Time Axis**.

RECOVERING REJECT RESULTS

Each Search will track the match results, as well as any match results that has been **Rejected**. The Results dropdown menu allows the use to toggle between displaying **Results** and **Reject Results**. When Reject Results is selected, each Channel/Search pair Match Count will update with the number of rejected match results. The Results Wave View, Derived View, and Distribution View will also update to display the rejected results for the active (selected) Channel/Search pair.

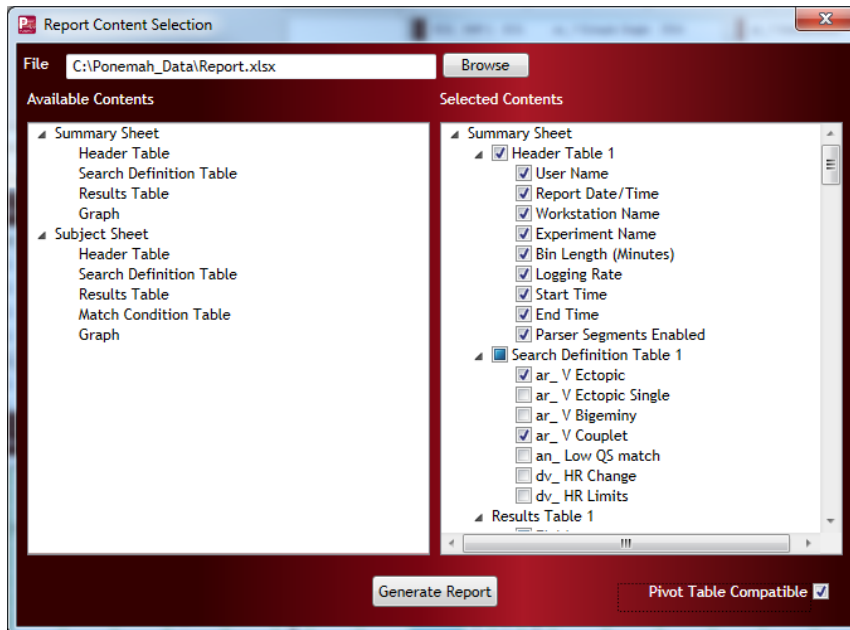
Rejecting a Rejected Match Result, ultimately moves the match result back to the Results view and effectively recovers that match result from being rejected.



Note: Adding or removing search clauses will result in all rejected data to be removed. Changing values in the clauses will not affect those results that have been rejected.

REPORTING RESULTS

The **File** menu provides access to the Data Insights report functionality. Selecting **Report** will open the **Report Content Selection** dialog. This dialog allows customization of the report output including file information, search criteria, graphical information, and table information.



A report name and file location can be inputted and a report generated in Microsoft® Excel format. To enable specific output, ensure that the feature is checked. Uncheck to remove the information from the report output.

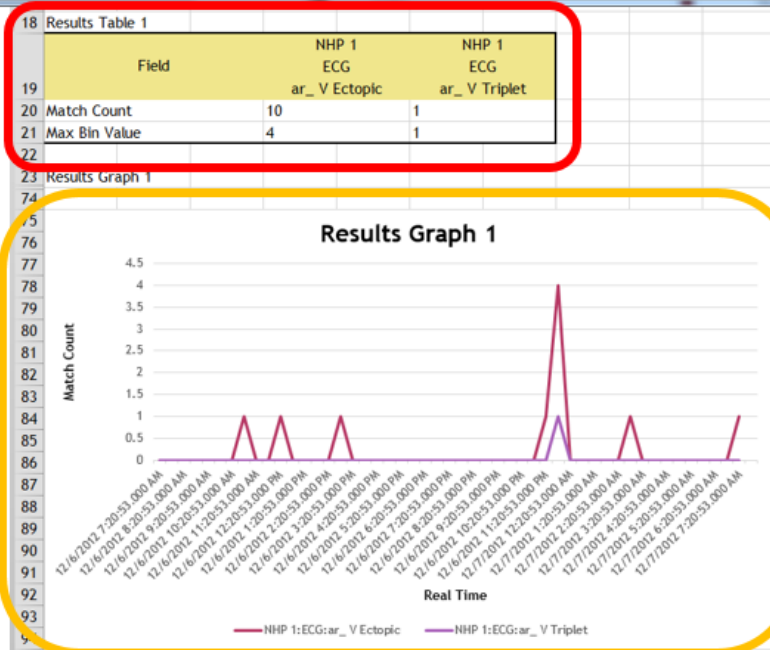
All information displayed within the Data Insights dialog is available as a selection within the Report. Reports are generated in the form of a Microsoft Excel Workbook and consists of one Summary sheet and a Subject sheet for each subject included in the report.

PRINTING RESULTS

Data Insights Match Results may also be printed to a PDF or an external printer. To do this, please see the **Printing** section of this manual in the Software Appendix.

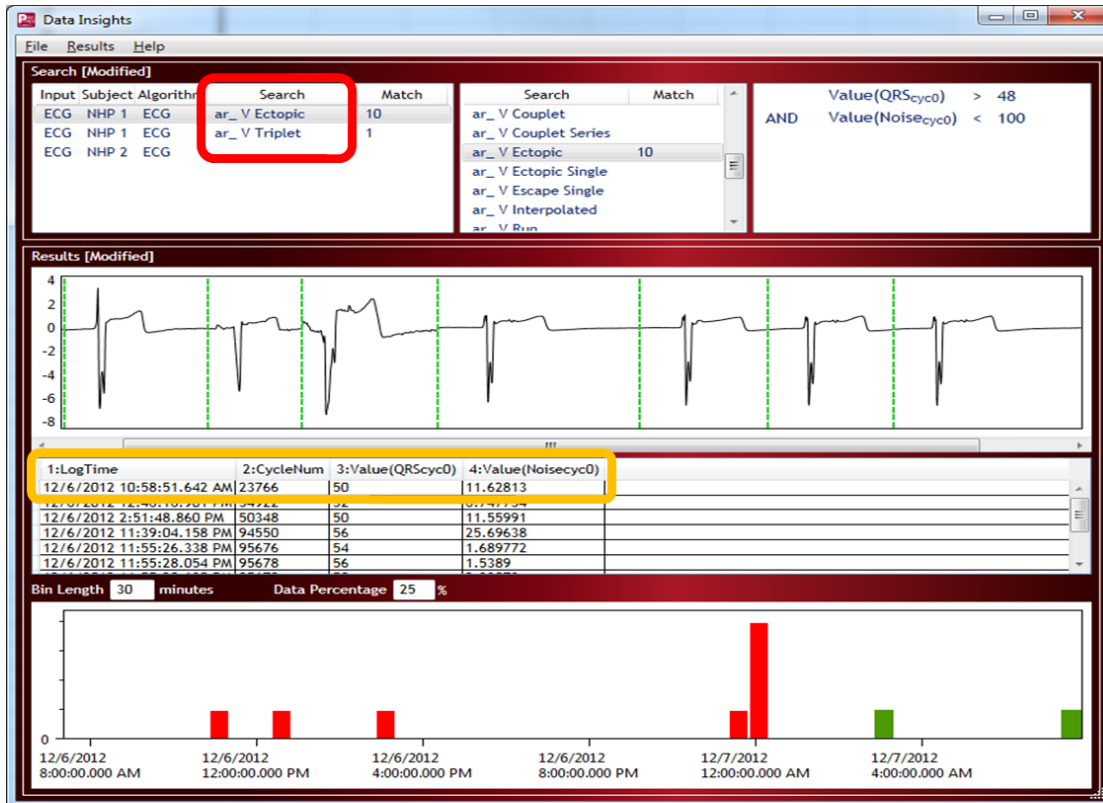
SUMMARY SHEET

The Summary Sheet Results Table contains the high-level match information as displayed in the Data Insights Channel/Search Pairs area for all subject that have searches associated. In the example below, only 1 subject group is being used, resulting in only the search results from this 1 subject being displayed. The Summary Sheet may also contain a Results Graph, which represents the Results Distribution View



SUBJECT SHEET

The Subject sheet contain the same information as the Summary sheet broken out by subject. The Subject sheet also contains a **Match Conditions Table**. The Match Conditions table contains all Channel/Searches pairs. In the example below, the V Ectopic and V Triplet searchers are listed, along with their associated Results Derived View values.

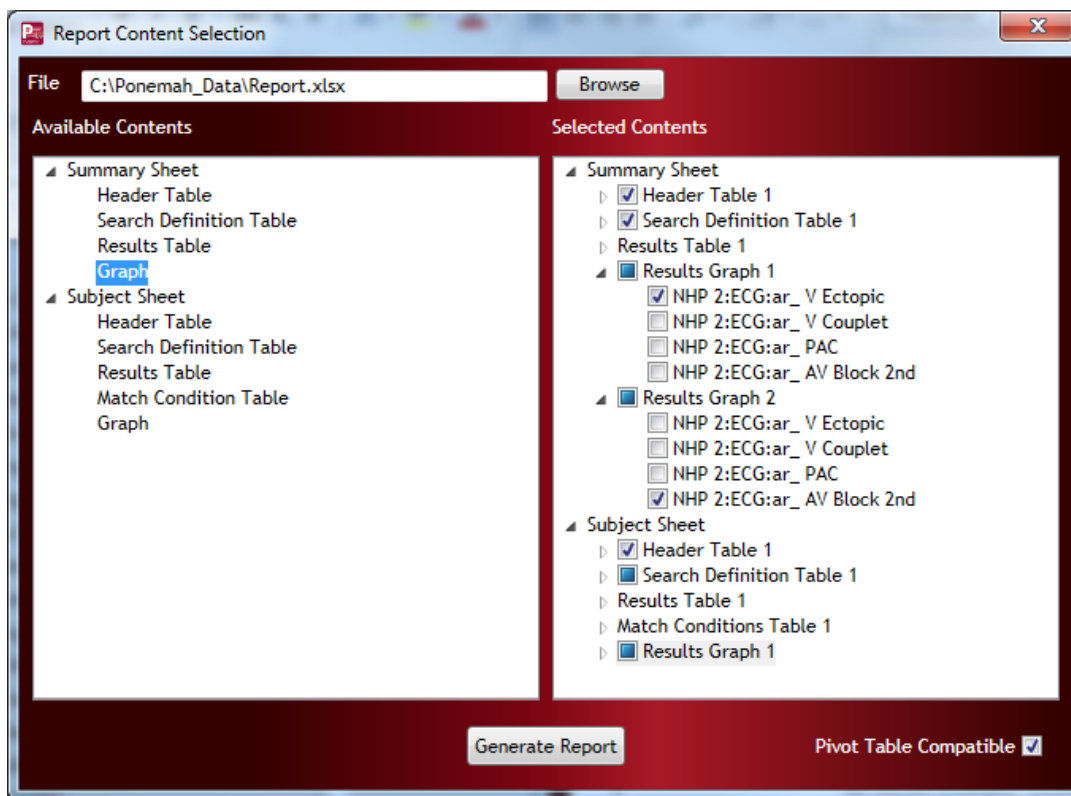


Match ID	Channel	Search	Condition	LogTime	Log Duration	Value
75	ECG	ar_V Ectopic	Value(ECG:QRScyc0)	12/6/2012 10:58:51.642 AM	406	50
76	ECG	ar_V Ectopic	Value(ECG:NoiseCyc0)	12/6/2012 10:58:51.642 AM	406	11.628
77	ECG	ar_V Ectopic	Value(ECG:QRScyc0)	12/6/2012 12:46:16.901 PM	673	52
78	ECG	ar_V Ectopic	Value(ECG:NoiseCyc0)	12/6/2012 12:46:16.901 PM	673	6.748
79	ECG	ar_V Ectopic	Value(ECG:QRScyc0)	12/6/2012 2:51:48.860 PM	439	50
80	ECG	ar_V Ectopic	Value(ECG:NoiseCyc0)	12/6/2012 2:51:48.860 PM	439	11.56
81	ECG	ar_V Ectopic	Value(ECG:QRScyc0)	12/6/2012 11:39:04.158 PM	635	56
82	ECG	ar_V Ectopic	Value(ECG:NoiseCyc0)	12/6/2012 11:39:04.158 PM	635	25.696
83	ECG	ar_V Ectopic	Value(ECG:QRScyc0)	12/6/2012 11:55:26.338 PM	940	54
84	ECG	ar_V Ectopic	Value(ECG:NoiseCyc0)	12/6/2012 11:55:26.338 PM	940	1.69
85	ECG	ar_V Ectopic	Value(ECG:QRScyc0)	12/6/2012 11:55:28.054 PM	597	56
86	ECG	ar_V Ectopic	Value(ECG:NoiseCyc0)	12/6/2012 11:55:28.054 PM	597	1.539
87	ECG	ar_V Ectopic	Value(ECG:QRScyc0)	12/6/2012 11:55:28.630 PM	590	58
88	ECG	ar_V Ectopic	Value(ECG:NoiseCyc0)	12/6/2012 11:55:28.630 PM	590	2.331
89	ECG	ar_V Ectopic	Value(ECG:QRScyc0)	12/6/2012 11:55:29.230 PM	872	58
90	ECG	ar_V Ectopic	Value(ECG:NoiseCyc0)	12/6/2012 11:55:29.230 PM	872	3.157
91	ECG	ar_V Ectopic	Value(ECG:QRScyc0)	12/7/2012 3:03:01.607 AM	257	106
92	ECG	ar_V Ectopic	Value(ECG:NoiseCyc0)	12/7/2012 3:03:01.607 AM	257	86.434
93	ECG	ar_V Ectopic	Value(ECG:QRScyc0)	12/7/2012 7:45:35.288 AM	239	50
94	ECG	ar_V Ectopic	Value(ECG:NoiseCyc0)	12/7/2012 7:45:35.288 AM	239	55.589
95	ECG	ar_V Triplet	Series(ar_V Ectopic, 1)	12/6/2012 11:55:28.054 PM	2064	3

CUSTOMIZING REPORTS

Additional content may be added by right-clicking a content section from the *Available Contents* column and choosing **Add**. This provides a method to generate specific tables and graphs based on the desired reporting

needs. For instance, instead of graphing all arrhythmia types on a single summary graph, the user may configure a specific graph to display only Ventricular Ectopics from all subjects and another graph to display the occurrences of AV Blocks across all subjects. This is done by adding a second Summary Graph content section and making the appropriate selections, as illustrated below as selected in the Summary Sheet's Result Graph 1 and Results Graph 2.



Checking the **Pivot Table Compatible** checkbox will output the data with minimal formatting to permit Excel Pivot Tables to be created from the Results Tables. This is useful when additional analysis is desired or if importing into third-party programs is desired.

Please see the **Software Appendix | Data Insights** section for a description of each of the Content sections.

CUSTOMIZING SEARCH DEFINITIONS

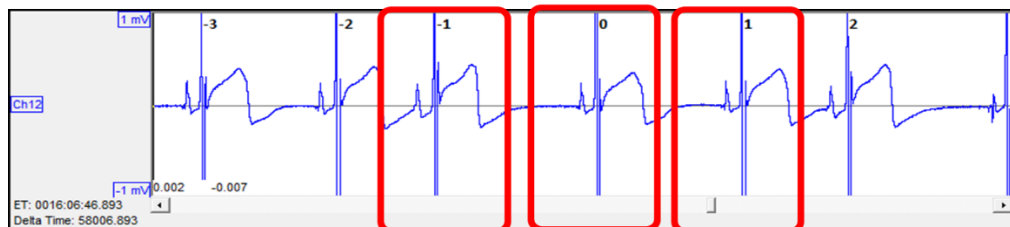
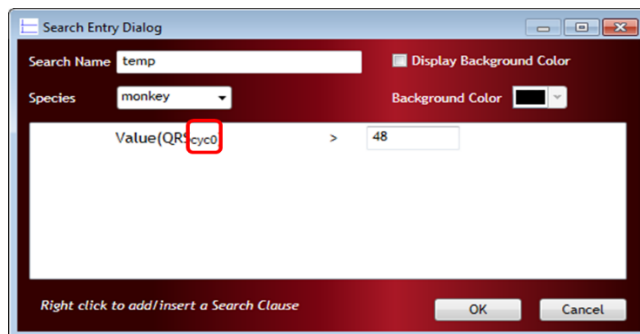
A list of predefined Searches is present and available for use by default in *the Search and Match Grid*. Existing Search Definitions may be modified or new Search Definitions may be created by the user. Before modifying or creating new Search Definitions, it is important to understand how Searches are composed.

UNDERSTANDING SEARCH DEFINITIONS

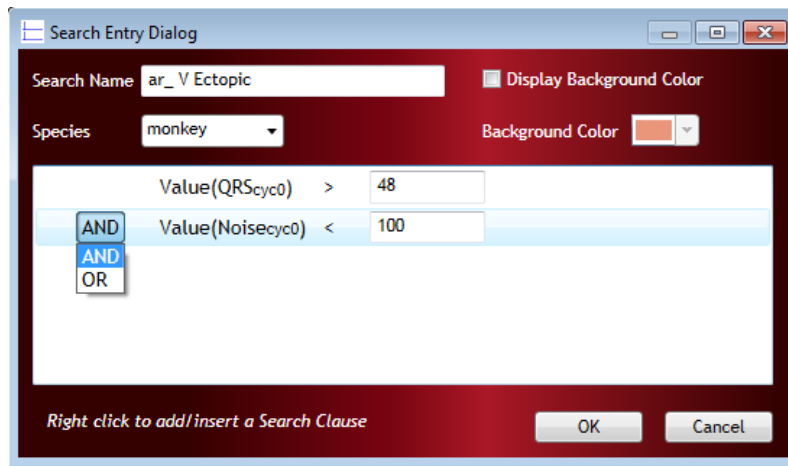
Searches are composed of one or more **Search Clauses** that may be combined using Boolean operators (AND, OR). Each Search Clause is a Boolean expression composed of the following:

- **Function** The functions (Value, %Increase, % Change, etc.) determine how inputs are used when evaluating the Boolean expression that forms a Search Clause.

- **Input** The inputs include amplitude and timing data calculated by Ponemah (RR interval, Heart Rate, LVEDP, etc.), pattern matching results, and time of day information. When selecting an input, the Analysis Algorithm (ECG, BP, LVP, etc.) must be selected first, then choose the desired input.
- **Range** Specifies whether cycle information, averaged data, or standard deviation will be used for purposes of determining the type of change desired. The clause will look at changes from the reference cycle to a surrounding cycle. If averaged data or standard deviation is used, the data from the Derived Parameter List Views will be used at the active logging rate defined.
- **Offset** The Offset is used to specify the location of the cycle relative to the cycle of interest. An Offset of 0 denotes the current cycle of interest. An offset of -1 denotes the cycle just prior to the current cycle. The permitted range is +/- 10.

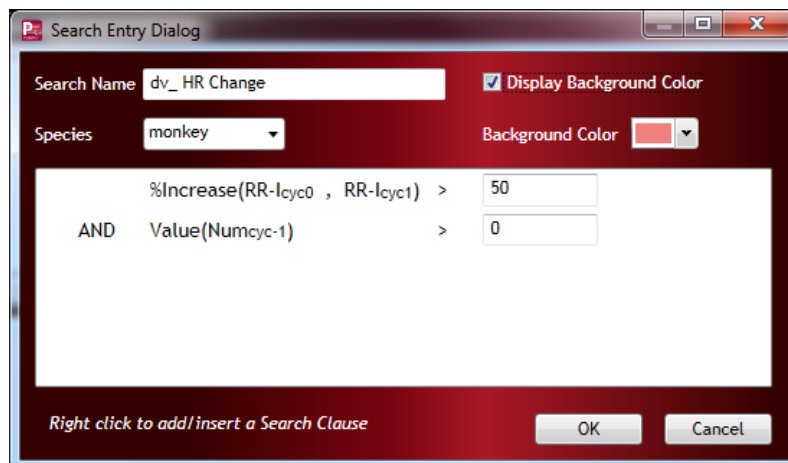


- **Operator** Operators include greater than (>), less than (<), greater than and equal to (>=), less than and equal to (<=), equal to (=), not equal to (!=). However, those offered change with the Function being used.
- **Value** The value is also dependent on the Function and is used as a threshold for the Function to determine a match. Values are in user units; i.e. if the signal is calibrated in mmHg, then amplitude values will also be in mmHg.
- **Boolean Operators** Boolean AND or OR operators are used to combine clauses. When AND is used to combine clauses, each condition must be satisfied to be considered a match. When OR is used, either condition may be satisfied to be considered a match.



Note: Clauses may be grouped to create more elaborate searches.

In the example below, a set of conditions is defined to locate Heart Rate changes using the RR Interval. To be a valid match in this example, a percent increase of greater than 50% in the RR Interval from the current cycle (RR-_{I_{cy0}}) to the following cycle (RR-_{I_{cy1}}) must occur, as well as the Cycle Number from the previous cycle (RR-_{I_{cy-1}}) must be greater than a value of 0.



In this example the components of the search are as follows:

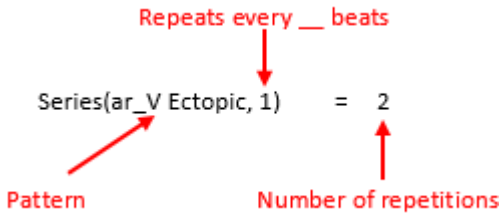
- Function: Percent Increase
- Input: RR-1 (from ECG)
- Range and Offset: Cycle-based from the previous cycle to the current cycle
- Operator: Greater than (>)
- Value: 50%

Note: Data Insights will only display the cycles directly called out within the search in the Results Wave View. In the example below, it was desired to also see the previous ECG cycle. Therefore, a condition that is always true was added to ensure the inclusion of that particular cycle; i.e. Ponemah numbers waveform cycles starting at cycle 1, consequently all cycle numbers are greater than 0.

FUNCTIONS

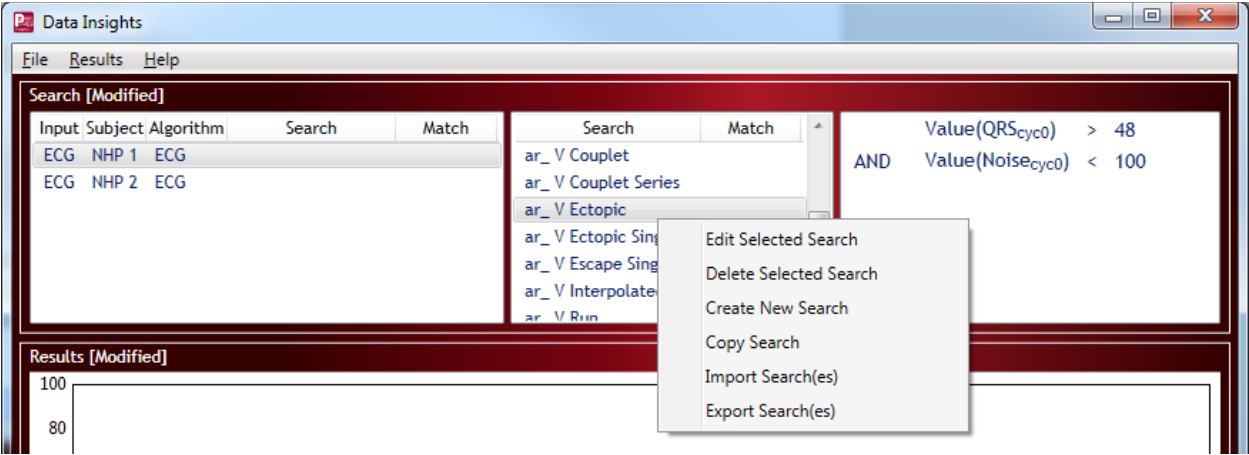
The basic functions and their definitions are listed below.

Function	Definition	Example
Value	Represents a given value for a parameter.	Identifies all cycles where the Systolic value is greater than 170 mmHg. Value(SyScyc0) > 170
Increase, Decrease, Change	Represents an increase, decrease, or change in value from parameter 1 to parameter 2.	Identifies all cycles that show an increase in the RR interval of more than 300 milliseconds from the previous cycle (cyc -1) to the current (cyc0). Functions that are similar to Increase() are Decrease() and Change(). Increase(RR-I _{cyc-1} , RR-I _{cyc0}) > 300
%Increase, %Decrease, %Change	Represents a percent increase, decrease, or change in value from parameter 1 to parameter 2.	Identifies all cycles that show a decrease in the RR interval of more than 30% from the previous cycle (cyc -1) to the current (cyc0). Functions that are similar to %Decrease() are %Increase() and %Change(). %Decrease(RR-I _{cyc-1} , RR-I _{cyc0}) > 30
Template	Used in conjunction with ECG PRO, Template searches can be performed to pull specific ECG complexes/morphologies that match a tagged Template Cycle into the Data Insights dialog for review. See the Tutorials | Data Insights | Finding Morphology Changes using Template Tags for an example.	Identifies all cycles that match templates tagged with a Ventricular Ectopic tag. Template(ECG _{cyc0}) = Ventricular Ectopic
Search	Permits users to utilize existing Searches as part of the criteria used within the Search Definition. <i>Note:</i> The search used within the Search-based search must also be applied to the channel. If not, the Search-based search will not be able to be applied to the channel.	Identifies all cycles that do not match a PAC search. A Search() function would typically be used in conjunction with other clauses. Search(_{cyc0}) != ar_PAC

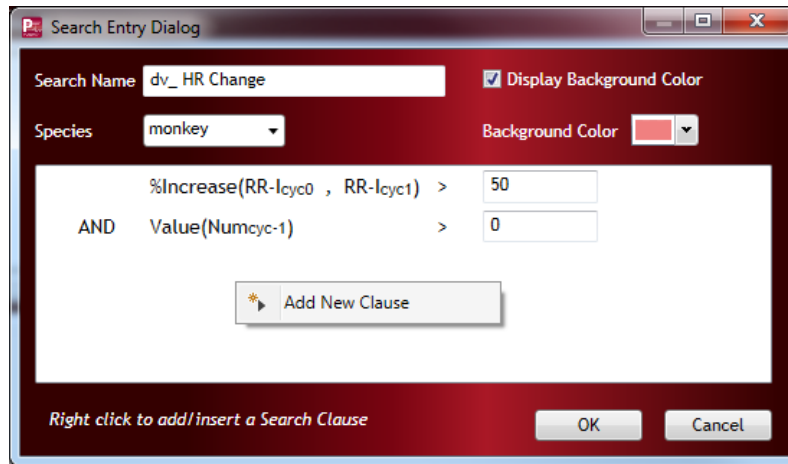
<p>Series</p>	<p>Used to define sequences or patterns within the data utilizing an existing search.</p> <p><i>Note:</i> The search used within the Series search must also be applied to the channel. If not, the Series search will not be able to be applied to the channel.</p>	<p>Identifies multiple occurrences of a pattern. In this example, all instances where exactly two consecutive cycles match an <i>ar_V Ectopic</i> search are identified.</p> 
<p>Real Time</p>	<p>Used to find cycles within a specific time range; such as before and after dosing, during light and dark cycles, or during any other period of interest.</p>	<p>Identifies all cycles that fall between 8:00 AM and 8:00 PM within each 24 hour cycle, such a search would typically be used in conjunction with other clauses.</p> <pre> RealTime() > 08:00:00 AND RealTime() < 20:00:00 </pre>

EDITING SEARCHES

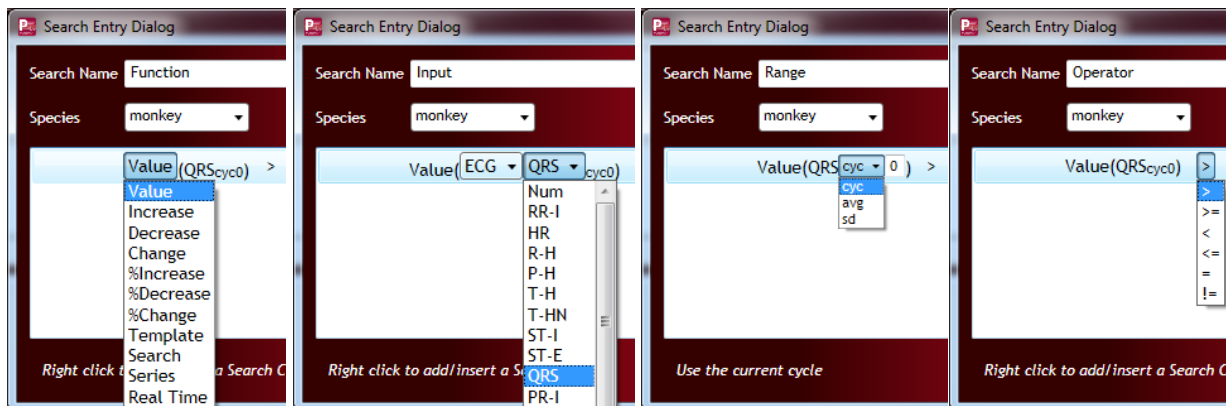
Existing Search Definitions may be modified or new Search Definitions may be created by the user. Right-click the *Search and Match Grid* to access the Search modification menu.



Select **Edit Selected Search** or **Create New Search** to launch the *Search Entry* dialog. This dialog is also accessible by double-clicking a Search. The *Search Entry* dialog displays the criteria used to define the Search. Additional **Search Clauses** may be added by right-clicking within the white box and selecting **Add New Clause**.

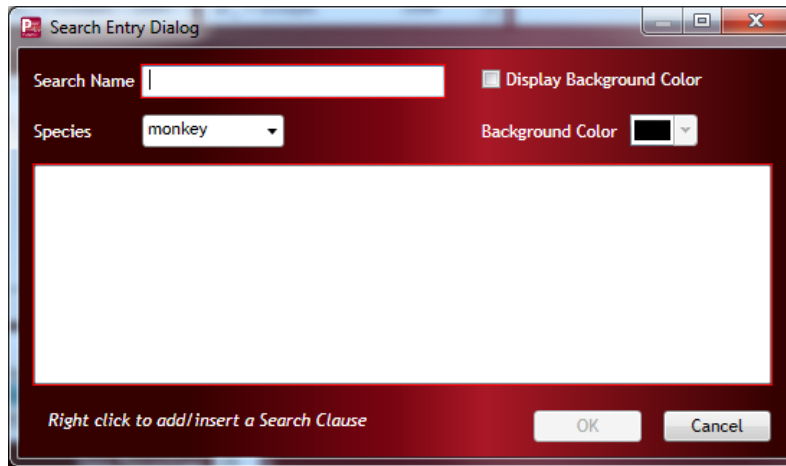


Selecting the **Function**, **Input**, **Range** or **Operator** will display a dropdown menu to permit selection of the desired method, while **Offset** and **Value** are text fields for direct user entry.



CREATING/DELETING/COPYING SEARCHES

Right-click the **Search and Match Grid** and select **Create New Search**. The user will be presented with an empty *Search Entry* dialog. Any edit field that expects an input to be provided will be outlined in red. Below, the **Search Name** and field to enter search clauses are both highlighted along the border of the edit field in red. A **Search Name** and a complete search clause is needed to save the search. The **OK** button will not be available until all edit boxes expecting information have been updated completely.



The **Delete Selected Search** allows you to remove the selected search from the list. Once removed, the search will no longer appear in the **Search and Match Grid** and be available for use. In addition, if the Search was associated to any channel or group of channels, that search will be removed from analysis and all data associated with that search will be removed.

The **Copy Search** function copies the currently highlighted Search in the list. Once copied, the duplicate Search will be visible below the copied Search and be denoted by “_Copy” appended to the end of the Search name. This permits the utilization of previously constructed Searches without needing to start from an empty Search.

EXPORTING/IMPORTING SEARCHES

The **Export Search(es)** function allows users to export customized searches for deployment across all workstations. This is intended to help improve consistency in data analysis and cleanup to ensure results are consistent and repeatable. Exported custom Searches are saved to an .xml file in the Ponemah directory or the directory where the program is installed, by default. Alternatively, Searches may be saved to a location of the users’ choice, such as external USB drives or network locations. Exported Searches can then be imported to other systems using the **Import Search(es)** function.

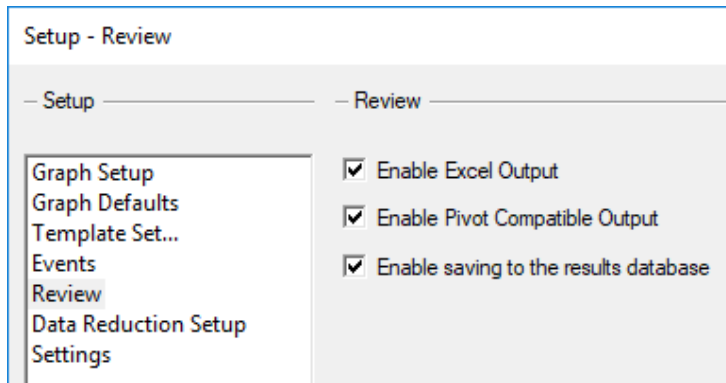
Both the Export and Import functions are available from the **Search and Match Grid** right-click menu.

Note: When importing searches that reference other searches, the referenced searches must also be present in the.xml file that is being imported. If the referenced search is not contained in the xml file, the search or searches using the missing reference will not be loaded. Additionally, none of the searches in the .xml file being imported should be present in the current Search list. Remove any duplicates before importing. In some cases, it may be advisable to remove all searches prior to importing a new list.

SAVING ANALYSIS SESSIONS

The three saving options are located in the **Experiment** Menu and are defined as follows:

- **Save Experiment** – This saves any configuration changes that occur, such as graph pages, analysis attributes.
- **Save Derived Data** – This saves the **Derived Parameters** and **Data Reduction** values from the data currently loaded in Review to an Excel file only. The type of data output when this option is selected is controlled by the options located in **Setup | Experiment Setup | Review**.



Save Options:

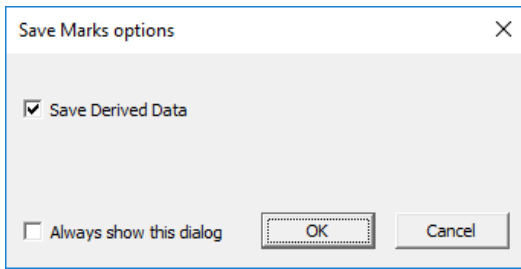
- Enable Excel Output** If enabled, generates an Excel file with Derived Parameter and Data Reduction data from the currently loaded data section. If disabled, the Excel file will not be generated.
- Enable Pivot Compatible Output** If enabled, the Excel file will contain two pivot table compatible tabs, one for Derived Parameter and one for Data Reduction data. If disabled, the Excel file will not contain the two pivot tabs generated. Note, if Excel Output is disabled, the Pivot Output will automatically disable.
- Enable Saving to the Results Database** If enabled, the calculated Derived Parameter and Data Reduction data will update the Results Database, replacing the previous values with the current data from the loaded section. If disabled, the Results database will not be updated with the newly calculated data from the current Review Session.



IMPORTANT. The data exported outside of Review (**Experiment | Export Data**) and/or displayed in **Parameter Viewer** are based on the data within the Results Database. If analysis is updated within Review and saved with this check box unchecked, the new results will not be reflected in subsequent exports or be viewable in Parameter Viewer.

- Save Marks Section** – This saves the **Marks** positions in the **Marks** database so they can be loaded in subsequent Review sessions. Saving a **Mark Section** will only save the **Marks** associated with the data loaded into the Review session from which the **Save Marks Section** action is executed. By default, this will also create a new Excel file with the **Derived Parameter** and **Data Reduction** outputs from the currently loaded data. This output is also based on the selections from Setup | Experiment Setup | Review dialog, as outlined above.

Holding the <CTRL> key when selecting **Save Mark Section** will display the following dialog:

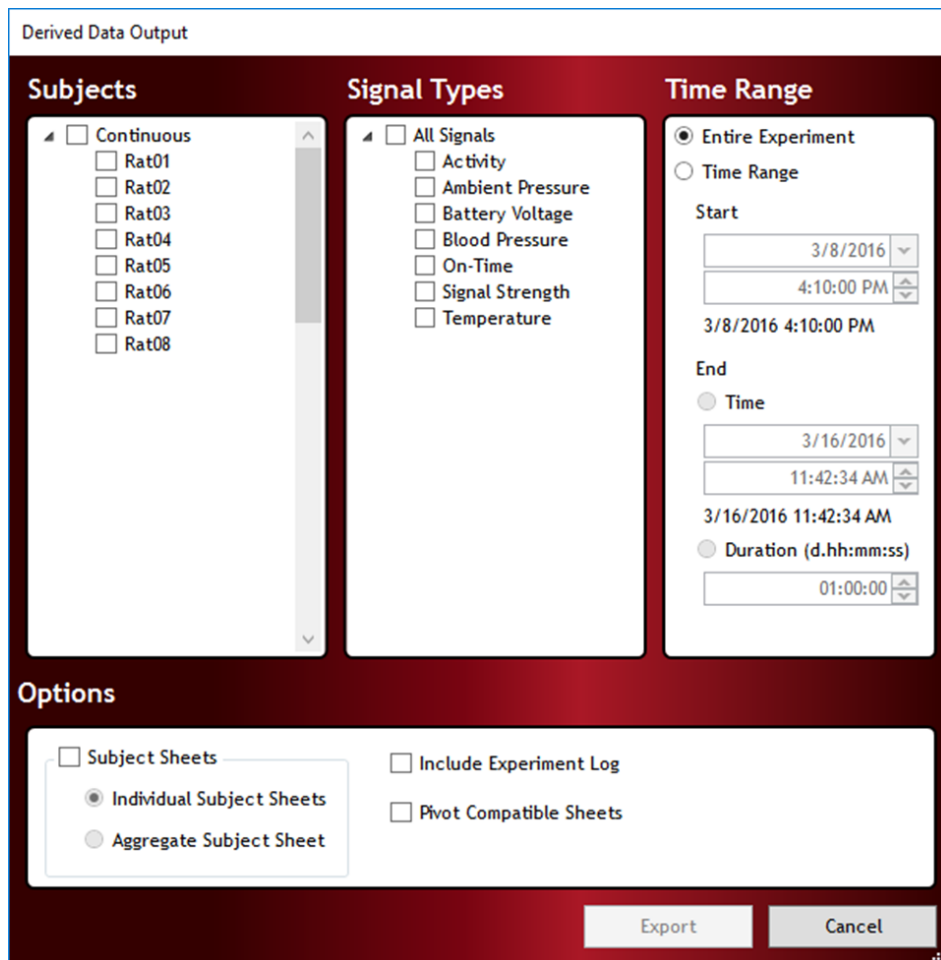


Unchecking the **Save Derived Data** checkbox will only save the Marks positions and will not output derived data to Excel. This is beneficial, as it drastically improves the time required to save the Marks Section.

DATA EXPORT

Ponemah's Derived Data Export allows you to efficiently export derived data from multiple Subjects and across multiple acquisition days without requiring the raw waveform data to be loaded into Review. Exporting data using this method will generate an Excel file in the Experiment folder containing the Derived Parameter data based on the user-defined setting.

1. Choose **Export Data...** from the **Experiment** menu to launch the **Derived Data Output** dialog.



2. Select the Subjects whose data is desired to be exported using their associated checkboxes.
3. Select the Signal Types desired from which to export derived parameter data.
4. Select to export data across the **Entire Experiment** or across a specific user-defined **Time Range**.
5. Optional selections:
 - a. **Include Experiment Log** – this will include a separate tab with the log information listed in the **Experiment menu | Experiment Log...** dialog as part of the export.
 - b. **Subject Sheets** – this permits the user to include Derived Parameter and Data Reduction calculations in an easy-to-read formatted data table. This can be unchecked to reduce the size and improve the performance of Excel, should Pivot Compatible Sheets be the performed output method.
 - i. **Individual Subject Sheets** – when this is selected, a separate Excel sheet will be created for the **Derived Parameter** and **Data Reduction** data per Subject.
 - ii. **Aggregate Subject Sheets** – when this is selected, the **Derived Parameter** and **Data Reduction** data from all Subjects will be listed in a single Excel sheets.
 - c. **Pivot Compatible Sheets** – when checked, this will generate a Normalization Table for the **Derived Parameter** and **Data Reduction** data. Normalization tables may be used to create Excel Pivot Tables for an efficient method of obtaining summarized data tables and graphs.
6. Select **Export**.

Note: Export may occur from the main Acquisition instance of Ponemah, as well as a Review while Acquiring instance should Derived data need to be obtain without stopping the acquisition.

SUBJECT SHEETS

Individual Subject Sheets are created during an acquisition session, as well as in Review upon Saving a Marked Section. Each Subject will have a Subject sheet and Parameter sheet. The *Subject* sheet will list the Subject Name, Species, and Gender. The *Parameter* sheet will list all user-defined Derived Parameters for each Input Channel configured to that Subject in an easy to read format. An example of a Subject’s Parameter sheet is below.

Rat01												
1 Pressure											3 Temperature	
StartDate	StartTime	EndDate	EndTime	TimeZone	ElapsedTime	Event	Num	Sys	Dia	Mean	HR	T_NPMN
3/8/2016	3:10:00.000 PM	3/8/2016	3:10:30.000 PM	(Central Standard Time)	0000:00:30.000		134	136.609436	90.52502441	112.4187164	272.1690369	37.34703445
3/8/2016	3:20:00.000 PM	3/8/2016	3:20:30.000 PM	(Central Standard Time)	0000:10:30.000		147	146.9205627	102.797287	123.993927	297.1908264	37.28772736
3/8/2016	3:30:00.000 PM	3/8/2016	3:30:30.000 PM	(Central Standard Time)	0000:20:30.000		123	128.6481781	86.18132782	106.0572968	249.6588593	37.04970169
3/8/2016	3:40:00.000 PM	3/8/2016	3:40:30.000 PM	(Central Standard Time)	0000:30:30.000		148	149.3728943	103.9626389	126.8388748	299.2671204	37.24596786
3/8/2016	3:50:00.000 PM	3/8/2016	3:50:30.000 PM	(Central Standard Time)	0000:40:30.000		155	149.4419556	103.0318985	126.476181	313.0293274	37.52760696
3/8/2016	4:00:00.000 PM	3/8/2016	4:00:30.000 PM	(Central Standard Time)	0000:50:30.000		147	156.2026062	108.5932541	132.3897095	297.433136	37.68206787
3/8/2016	4:10:00.000 PM	3/8/2016	4:10:30.000 PM	(Central Standard Time)	0001:00:30.000		153	157.8722992	115.2322922	136.7112274	383.8836975	37.46191025
3/8/2016	4:20:00.000 PM	3/8/2016	4:20:30.000 PM	(Central Standard Time)	0001:10:30.000		155	149.0792847	102.8190994	125.3578186	314.1574707	37.60414886
3/8/2016	4:30:00.000 PM	3/8/2016	4:30:30.000 PM	(Central Standard Time)	0001:20:30.000		152	145.160965	97.25898743	119.97229	267.9667053	37.76757431
3/8/2016	4:40:00.000 PM	3/8/2016	4:40:30.000 PM	(Central Standard Time)	0001:30:30.000		140	140.2393341	98.5561676	118.5805817	283.8473206	36.92850494
3/8/2016	4:50:00.000 PM	3/8/2016	4:50:30.000 PM	(Central Standard Time)	0001:40:30.000		145	131.912735	91.58348846	110.6707993	294.4784546	36.96973419
3/8/2016	5:00:00.000 PM	3/8/2016	5:00:30.000 PM	(Central Standard Time)	0001:50:30.000		146	140.5414124	94.36432648	116.316864	296.3414001	37.53689575
3/8/2016	5:10:00.000 PM	3/8/2016	5:10:30.000 PM	(Central Standard Time)	0002:00:30.000		132	139.5060425	93.97766876	115.2552948	268.8834534	37.7036972
3/8/2016	5:20:00.000 PM	3/8/2016	5:20:30.000 PM	(Central Standard Time)	0002:10:30.000		132	145.160965	97.25898743	119.97229	267.9667053	37.76757431
3/8/2016	5:30:00.000 PM	3/8/2016	5:30:30.000 PM	(Eastern Standard Time)	0002:20:30.000		147	146.9765778	100.356575	123.2407837	296.5872498	37.67933273
3/8/2016	5:40:00.000 PM	3/8/2016	5:40:30.000 PM	(Eastern Standard Time)	0002:30:30.000		152	143.0802002	98.85190582	119.5695267	299.27005	37.83528519
3/8/2016	5:50:00.000 PM	3/8/2016	5:50:30.000 PM	(Eastern Standard Time)	0002:40:30.000		163	153.3775787	108.6781387	129.9898662	330.6123962	37.80846786
3/8/2016	6:00:00.000 PM	3/8/2016	6:00:30.000 PM	(Eastern Standard Time)	0002:50:30.000		180	153.6975098	109.7119904	131.6583862	365.3560791	37.96051025

Note: If using the **Experiment | Export Data** dialog with the **Aggregate Subject Sheet** selected, only one *Subject* sheet will be available contain the Subject Name, Species, and Gender of all Subjects selected for the export. Similarly, only one *Parameter* sheet will be available containing the **Derived Parameter** data from all Subjects selected for the export in the same format as the example displayed above.

PIVOT COMPATIBLE SHEETS

Pivot Compatible Sheets allow users to create Normalization tables by exporting formatted Derived Parameter and Data Reduction data tables used to create Excel Pivot Tables, providing an efficient method of generating summarized data tables and graphs. Normalization tables are used to simplify and eliminate data consolidation errors from the data summarization process. They are also useful for importing data into 3rd party software for further data processing and reporting, e.g. LIMS, SAS, and R. Normalization table will also aid in converting data into SEND format.

Normalization tables are created during an acquisition session, as well as in Review upon Saving a Marked Section. These tables consolidate data from all subjects into a single tabular format per data type. They are the first two sheets within the Excel output file. Additionally, these table may be created to include data from the entire Experiment through the **Experiment menu | Export Data...** feature by enabling the **Pivot Compatible Sheets** checkbox.

The two tables are:

- **Derivations** This table is created from the Derived List View within Ponemah and contains all derived parameter data averaged at the user-specified logging rate.
- **DataReduction** This table is created from the data reduction tables and contains all derived data configured within the user-define **Data Reduction** setup menu.

	A	B	C	D	E	F	G	H
1	Subject	Gender	RealDate	RealTime	Event	Alarm	ParameterName	ParamValue
2	Rat01		3/8/2016	3:10:30.000 PM			Num:1 Pressure	134
3	Rat01		3/8/2016	3:10:30.000 PM			Sys:1 Pressure	136.609436
4	Rat01		3/8/2016	3:10:30.000 PM			Dia:1 Pressure	90.52502441
5	Rat01		3/8/2016	3:10:30.000 PM			Mean:1 Pressure	112.4187164
6	Rat01		3/8/2016	3:10:30.000 PM			HR:1 Pressure	272.1690369
7	Rat01		3/8/2016	3:10:30.000 PM			T_NPMN:3 Temperature	37.34703445
8	Rat01		3/8/2016	3:10:30.000 PM			NPMN:4 HD BattVoltage	1.59576714
9	Rat01		3/8/2016	3:10:30.000 PM			NPMN:5 On Time	0.015501232
10	Rat01		3/8/2016	3:10:30.000 PM			A_NPMN:7 Activity	0.000992079
11	Rat01		3/8/2016	3:10:30.000 PM			NPMN:6 Signal Strength	28.69282532
12	Rat01		3/8/2016	3:10:30.000 PM			B_NPMN:APR	748.6924438
13	Rat01		3/8/2016	3:20:30.000 PM			Num:1 Pressure	147
14	Rat01		3/8/2016	3:20:30.000 PM			Sys:1 Pressure	146.9205627
15	Rat01		3/8/2016	3:20:30.000 PM			Dia:1 Pressure	102.797287
16	Rat01		3/8/2016	3:20:30.000 PM			Mean:1 Pressure	123.993927
17	Rat01		3/8/2016	3:20:30.000 PM			HR:1 Pressure	297.1908264

ANALYSIS MODULES

This section provides detailed information on all available analysis modules for the Ponemah.


The Analysis Attributes dialog covers common functionality between all analysis modules. The common functionality is not discussed within the individual analysis sections unless there is a change from the standard operation.

ANALYSIS ATTRIBUTE DIALOGS

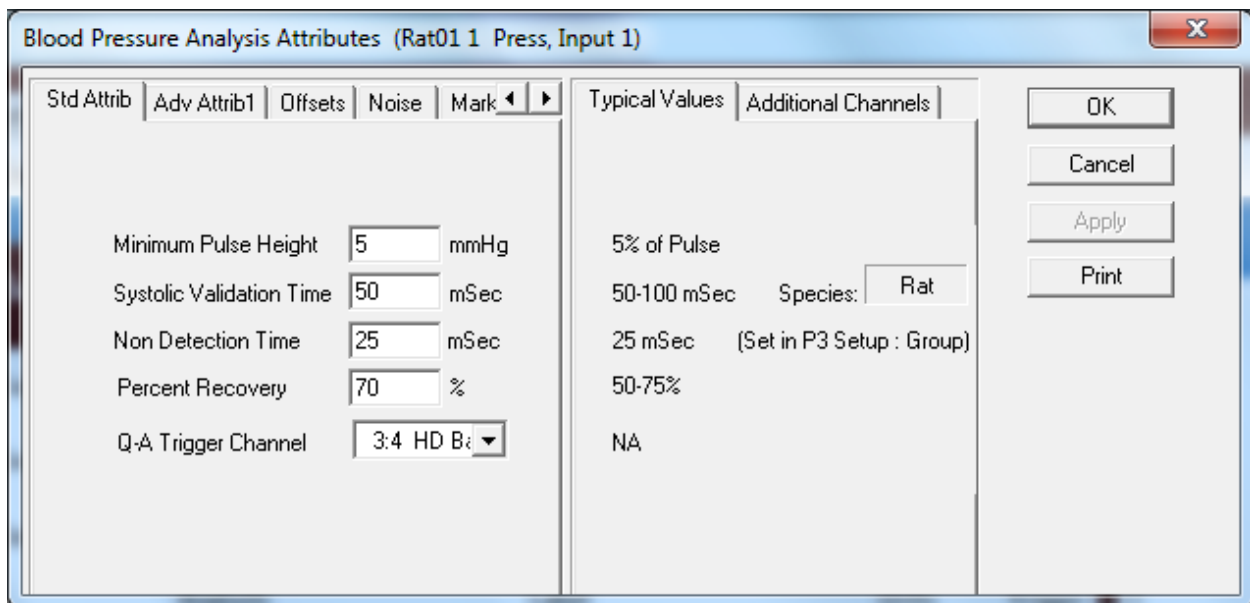
All analysis modules have a common setup dialog with specific attributes for the type of analysis being set up.

ACCESSING THE ATTRIBUTES DIALOG

To access the analysis attributes:

1. During Experiment Setup and Acquisition
 - Select Setup | Subject Setup
 - Choose the  icon associated with the desired analysis module.
2. During Review
 - From the **Primary** graph page, select the **Display Pane** associated with the channel whose analysis attributes are desired to be viewed/updated.
 - Right-click and select **Analyze [Attributes]**.

Displayed below is a typical **Blood Pressure Attributes** dialog.



The **Attributes** dialog is organized as a tabbed dialog and will always have the following selections:

- **Std Attrib** are the standard attributes that are the most common attributes that would need to be changed during acquisition for the specific analysis module.
- **Adv Attrib1** are advanced attributes that normally do not need to be changed during the acquisition. The attributes in this tab require greater knowledge and understanding of how these attributes affect the analysis module.

- **Offset** is where a pressure adjustment can be made based on either a measured offset before implantation and / or if an APR is not being used, the actual barometric pressure and be entered. This tab is only available in the Blood Pressure and left Ventricular Pressure modules.
- **Noise** is where additional Noise Detection and Dropout Detection can be enabled. and
- **Marks** allow the turning on and off individual validation marks and the cycle count. This helps un-clutter the validation marks on the signal if certain validation marks are not needed. The marks are turned on and off by the on-line menu Functions - Validate F10.
- **Notes** allow a user to select a predefined note or enter a free form text note for the attribute change.
- **Precision** allows the user to specify how the derived parameters are going to be reported.
- **Typical Values** displays recommended values for a particular set of criteria. This tab will be updated according to which tab on the left has been selected. The values are for reference only, and the values in this tab have no effect on the analysis.
- **Additional Channels** will display all Inputs that have the same type of analysis that the attributes can be applied to. Select all channels that would need the attributes assigned to them and select Apply or OK to apply the attributes.

Note: Changes are not applied to attributes that require the selection of a dependent channel for calculating data when using the Additional Channels feature. This is done to ensure that the sample rates don't vary between both channels to ensure proper calculation of parameter data. Examples would be Blood Pressure's Q-A Trigger Channel or Upstream Channel.

ATTRIBUTE TYPES

Analysis attributes deal with several distinct features such as, interpretation of the input signal, filtering, identifying associated channels, etc. The effects, on Review, of changing different types of attributes differs, with some changes only affecting the region to which they are applied and some affecting the entire signal or all marks sections. When changes are made to analysis attributes, the effects of these changes may be previewed in the **Effects and Scope of Changes** dialog, prior to putting the changes in effect.

Signal Interpretation Attributes These are attributes that are used by the analysis to aid in the identification of cycles and in the placement of marks that are dictated by signal morphology. Such attributes are used during Acquisition to determine the placement of marks. Thereafter Review uses the marks positions rather than the attribute settings for its calculations. A user can request the analysis to reanalyze data using the displayed attributes. This requires the user to select the **Reanalyze** check box and specify the range over which the analysis should be performed, as described above.

All other attributes take effect on selecting **OK** from the **Effects and Scope of Changes** dialog, whether or not the **Reanalyze** check box is checked.

If a **Signal Interpretation Attribute** is changed, the following text will be displayed in the Effects and Scope of Changes dialog:

*Signal Interpretation attributes changed:
The effects of these changes will be seen only if Reanalyze is selected. The modified attributes will be used to recalculate the location of validation marks and will replace existing validation marks over the range selected below.*

Signal Conditioning Attributes

These are used to precondition the input signal prior to analysis. This may be low/high pass filtering, conversion from a volume signal to a flow signal, subtraction of atmospheric pressure, inverting a signal, etc. During Acquisition, changes to these attributes affect future processing of the input signal. During Review, the current setting is applied to the entire loaded dataset.

The user will be notified that changes to these attributes may result in the invalidation of existing marks due to changes in the input signal. Calculated marks will be recalculated following such a change. The **Derived Parameters** will automatically be recalculated.

If a **Signal Conditioning Attribute** is changed, the following text will be displayed in the **Effects and Scope of Changes** dialog:

Signal Conditioning attributes changed:

These changes affect all data in this channel and may result in the modification of the primary signal. If these changes are accepted, previously generated marks may be rendered invalid for this channel. Marks may be recalculated by reanalyzing the entire channel.

Calculation Attributes

These are attributes that are used to provide numeric input that is used in the calculation of some marks positions and some derived parameters. Examples include Percent Recoveries, etc. During Acquisition, changes to these attributes affect future calculations only. During Review, the current settings are applied to the entire loaded dataset.

Changes to such attributes will result in recalculation of all Derived Parameters and marks that depend on the attribute.

If a **Calculation Attribute** is changed, the following text will be displayed in the **Effects and Scope of Changes** dialog:

Calculation attributes changed:

These changes will be applied to the entire channel and will result in the recalculation of marks and derived parameters that are dependent on Calculation attributes.

Precision Attributes

These are attributes that are set in the precision tab. Changes to **Precision Attributes** will result in a reformatting of the channels values displayed in the **Derived Parameter List View(s)**.

If a **Precision Attribute** is changed, the following text will be displayed in the **Effects and Scope of Changes** dialog:

Precision information changed:

The affected derived parameters will be updated.

Redraw Attributes

These are attributes that if changed require a redraw of the graph pages. Examples of such attributes include filters, marks, cycle numbers, etc.

If a **Redraw Attribute** is changed, the following text will be displayed in the **Effects and Scope of Changes** dialog:

Redraw required:

These changes require a redraw of this channel.

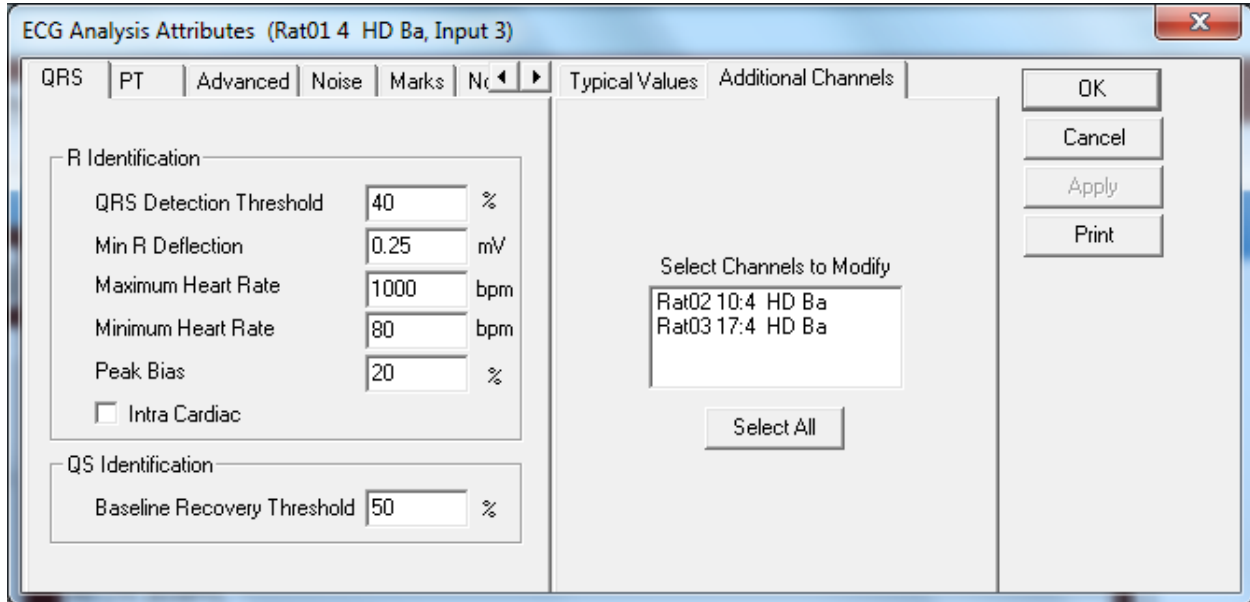
EXECUTING DATA ANALYSIS

See the **Reanalyzing Data** section within **Data Review | Using Review**.

ADDITIONAL CHANNELS TAB

This displays all channels that are using the same type of analysis module.

Select all channels that will use the same attribute settings as this channel. Then select the **OK** or **Apply** button. This automatically sets the attributes in the selected channels.



Additional Channels

RAW, BARO, TEMP, AND ACT

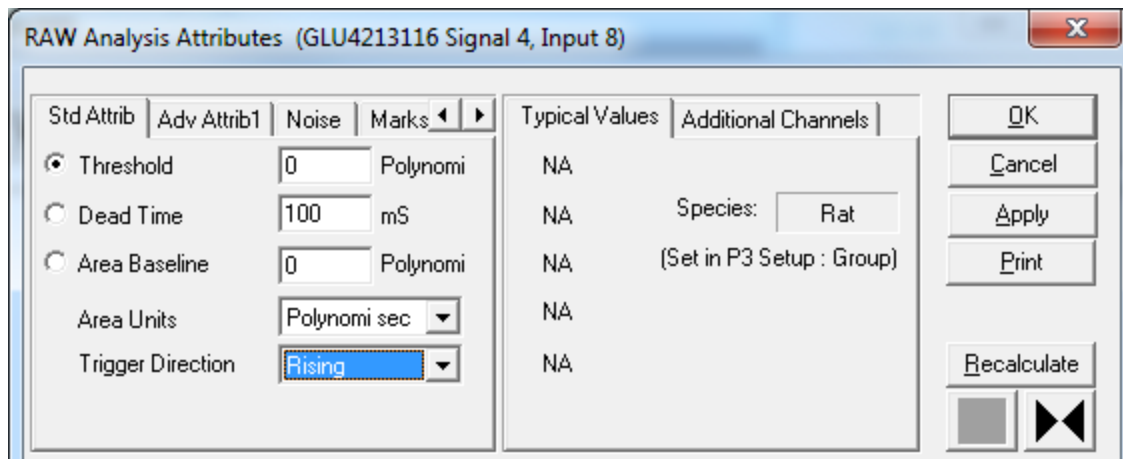
The **RAW** Electrical Mean analysis module is designed to record and measure any signal that does not have a specific signal analysis (e.g. EEG). Three additional modules are available and are identical in function to the RAW analysis. These modules include Barometric (**BARO**), Temperature (**TEMP**) and Activity (**ACT**). The primary reason for distinct names is to ease setup. This allows the user to easily identify a specific RAW channel based on function. Otherwise, the modules are identical except where noted.

ATTRIBUTES DIALOG

The **RAW Analysis** attributes dialog allows you to modify the signal analysis for different types of signals and signal conditions. If an analysis change in the **Attributes** dialog is performed mid-cycle, then the attribute change will not take effect until the following cycle.

STANDARD ATTRIBUTES TAB

The **Standard** attributes allow setting the most common attributes that would need to be changed during Acquisition or Review.



RAW Electrical Mean Standard Attributes Tab

Threshold Specifies the threshold that the incoming signal must cross before the analysis will trigger and track the maximum and minimum value from the previous threshold level. The signal must go above and below this level before the derived parameters **Rmax**, **Rmin**, **Period**, **BPM**, and **Area** are updated.

The **Threshold** level does not function if the **Trigger Direction** is disabled.

Dead Time This is the amount of time that the analysis does not look for a threshold once the analysis module has been triggered. The **Dead Time** does not function if the **Trigger Direction** is disabled.

Area Baseline This is the reference line in which area is calculated to. The **Area Baseline** does not function if the **Trigger Direction** is disabled.

Area Units This is the reference line in which area is calculated to. The **Area Baseline** does not function if the **Trigger Direction** is disabled.

- **msec** – for units * milliseconds
- **sec** – for units * seconds
- **min** – for units * minutes
- **hr** – for units * hours

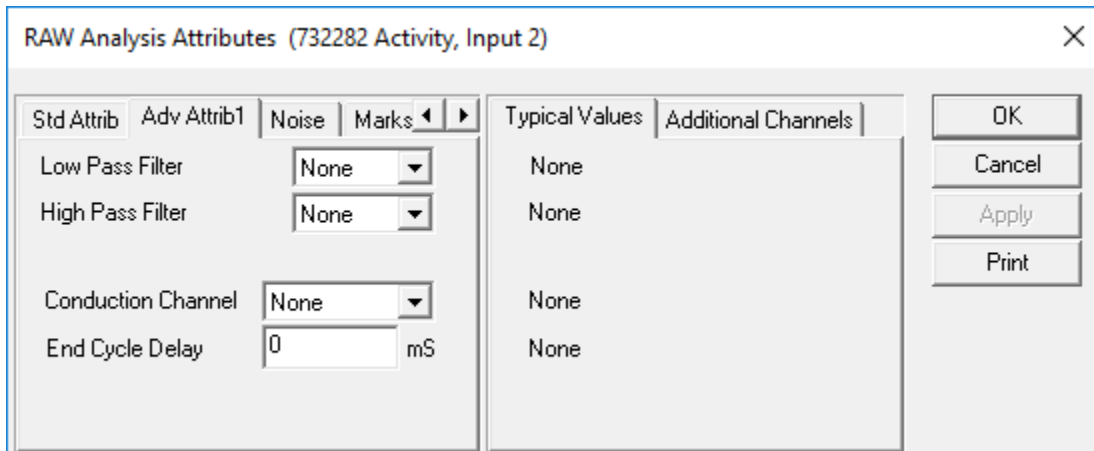
Trigger Direction Specifies the direction of the slope for which the analysis will track **Rmax**, **Rmin**, **Period**, and **BPM**. If **Trigger Direction** is disabled, these derived parameters will contain 0, which is invalid data. The **Mean Derived Parameter** will produce a mean for the entire **Logging Period**.

Valid choices are:

- **Disable** disables the **Trigger Direction**. A RAW cycle will be generated every second, permitting all derived parameters to be reported.
- **Rising** specifies that the slope must be going in the positive direction when the **Threshold** level is met.
- **Falling** specifies that the slope must be going in the negative direction when the **Threshold** level is met.

ADVANCED ATTRIBUTES

The **Advanced** attributes allow selection of attributes which are not commonly changed during Acquisition or Review.

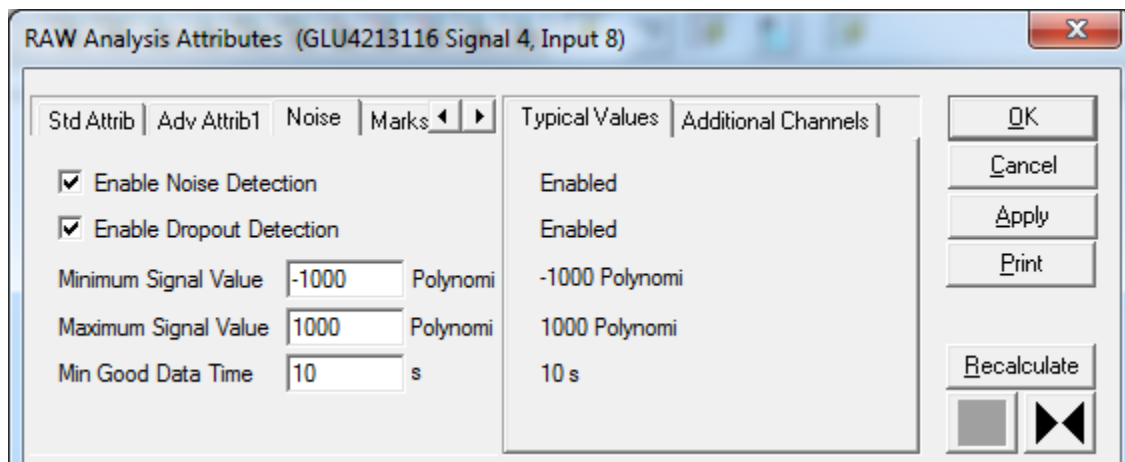


RAW Electrical Mean Advanced Attributes 1 Tab

Low Pass Filter	Selection of Low Pass filter in hertz.
High Pass Filter	Selection of High Pass filter in hertz.
Conduction Channel	Lists all available RAW channels for selection to calculate the Conduction Time (CT) derived parameter.
End Cycle Delay	Specifies duration after the Trigger Channel report to spreadsheet event occurs to wait in order to capture the cycle mark of the Conduction Channel when calculating Conduction Time. This is useful when the Trigger Channel's cycle occurs prior to the Conduction Channel's cycle.

NOISE TAB

The **Noise Tab** contains attributes that are used to identify noisy data. On identifying "noisy" data, as defined by the user, **Bad Data Marks** will be placed to span the noisy sections.



RAW Electrical Mean Noise Tab

- Enable Noise Detection** Enables the **Noise Detection** attributes for the automatic placement of **Bad Data Marks**.

- Enable Dropout Detection** If **Dropout Detection** is enabled, any negative dropout data encountered when analyzing data shall be bracketed **by Bad Data Marks** such that the dropout data falls within the **Bad Data Start** and **End** marks. The dropout check shall be performed on unfiltered samples.

- Minimum Signal Value** User defined threshold for determining the minimum value for acceptable data. Data that falls below this threshold will be considered noise and bracketed by **Bad Data Marks**.

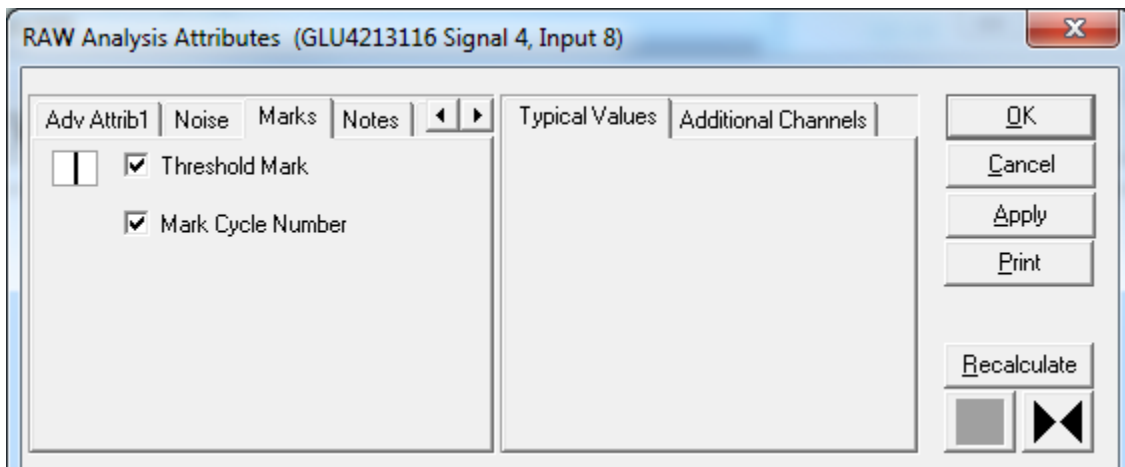
- Maximum Signal Value** User defined threshold for determining the maximum value for acceptable data. Data that exceeds this threshold will be considered noise and bracketed by **Bad Data Marks**.

- Minimum Good Data Time** Provides the user the ability to mark data as bad between two **Bad Data Mark** regions. If the time between the regions is less than the value specified. If the time is less than what is specified, the **Bad Data Mark** region will appear as one contiguous segment.

MARKS (VALIDATION) TAB

The **Marks** dialog allows turning on and off the validation marks for threshold and the cycle numbers that are placed on the signal during processing. This also allows the turning off and on of the cycle number that is placed on a graph page.

Displayed below is the **Raw Electrical Mean Marks** tab:



RAW Electrical Mean Marks Tab

The validation marks and their meanings are listed below:

Color		Meaning
Black		Threshold Mark
		Mark Cycle Numbers

TYPICAL VALUES

The typical values cannot be specified here since they are specific to the application and this is a general analysis module.

DERIVED PARAMETERS

Derived Parameters are selected within the **Channel Details** of the **Subject Setup** dialog. The **Derived Parameters** selected in this dialog will be calculated, and the results will be placed in the Derived Parameter List View(s). The following details the available **Derived Parameters** from the Blood Pressure module and the averaging method used within Review.

Name	Definition	Review Averaging Method
Num	Num is the number assigned to the cycle when using a Threshold . When running in a logging mode other than 1 epoch, the last cycle number will be reported.	Recent
Mean	Mean is the sum of all the samples that occurred for a cycle divided by the number of those samples.	Mean
Rmax	The maximum value that occurred within a cycle.	Mean
Rmin	The minimum value that occurred within a cycle.	Mean
Per (Period)	The Period is the amount of time (in milliseconds) between Validation Marks .	Mean
BPM	Beats per minute is computed in cycles per minute and is the reciprocal of the time interval for the cycle multiplied by 60. $BPM = (1/\text{period}) * 60$	Harmonic Mean
Area	Area is calculated over a cycle between the signal and the Area Baseline . The Area is reported in the selected Area Units .	Mean
TA	Total Activity parameter reports the integral of the input signal over a 60 second duration.	Mean
NPMN	Non-Pulsatile Mean integrates the input samples over the entire Logging Period .	Mean
TA2	Total Activity 2 parameter reports the integral of the input signal over the Logging Period .	Mean
Count	Count reports the number of cycles within a logging interval or data reduction interval.	Sum
CT	Conduction Time measures the time difference between logging marks in two RAW channels, in milliseconds.	Mean
SampSD	Standard Deviation of Samples reports the standard deviation of the samples in the current logging interval, calculated as Excel's STDEVP	Standard Deviation

PRESENTATION SIGNALS

Below is a list of presentation signals that are available for the **RAW** analysis module:

Signal	Description
Input	This is the input signal (after applying any software filters).
Derivative	This will display the derivative of the signal.
Activity	This is the instantaneous value of the TA parameter.

DATA REVIEW

This is a list of the Data Review related features of the **RAW** analysis module. The analysis specific portion of Data Review centers on the marks that the User is permitted to display, insert, and delete and how the user is permitted to move them.

Displaying Marks and Cycle Numbers	The marks and cycle numbers displayed in a Review Primary graph page Display Pane are controlled through the Marks Tab in the Analysis Attributes dialog. The Analysis Attributes dialog is accessed through the right click menu – Analyze [Attributes] .
Mark Operations	The Threshold mark is the only mark supported by RAW , BARO , TEMP , and ACT and defines a RAW cycle.
Inserting Marks	A Threshold mark may be inserted by right clicking at the point of insertion in the Primary Graph Display Pane of the Channel of interest. The pop-up menu that is displayed will provide the option to insert a RAW cycle.
Insert RAW Cycle	Inserts a RAW cycle. When a RAW cycle is inserted, it is assigned a sequential cycle number and subsequent cycle numbers are incremented.
Deleting Marks	Marks are deleted by positioning the mouse cursor on the mark to be deleted and bringing up the right click menu.
Moving Marks	Moving the Threshold mark follows the standard rules used in Data Review.
Calculations	The calculations of Derived Parameters are identical to those performed during Acquisition.
Logging Mark	The Logging Mark for a RAW cycle is the Threshold Mark . The time at the logging mark is the time used to report a cycle's derived data. If a RAW cycle's logging mark falls within a logging interval, the RAW cycle's data will be included in the logging interval.
End of Cycle	The start of a RAW cycle is at the point after the previous Threshold mark. The end of a RAW cycle occurs one nano second after the Threshold mark.

ATTRIBUTE TYPES IN REVIEW

The following table describes the effects of changing RAW attributes in Review. Please refer to the **Analysis Attributes | Attribute Types** section for details on the effects of each attribute type.

Attribute	Effect On Review
Threshold	Signal Interpretation
Dead Time	Signal Interpretation
Area Baseline	Calculation
Area Units	Calculation
Trigger Direction	Signal Interpretation
High Pass Filter	Signal Conditioning, Calculation, Redraw
Low Pass Filter	Signal Conditioning, Calculation, Redraw
Marks and cycle Numbers	Redraw
Precision	Precision

TROUBLESHOOTING

Use the following table to assist in troubleshooting the analysis:

Issue	Solution
Rmax, Rmin, Period, BPM, and/or Area not responding (all zeroes or incorrect values).	The Threshold Level is not properly set. The input signal must go above and below the Threshold Level to report the Rmax, Rmin, Period, and BPM values.
"x" in Derived Parameter List View window instead of a number	The Derived Parameter value is too large for the field. An "x" was placed here, so that a truncated number would not be displayed.

BLOOD PRESSURE (BP)

The **Blood Pressure** analysis module can analyze any pressure from the circulatory system and can derive, on a beat-to-beat basis, values for the cardiac cycle.

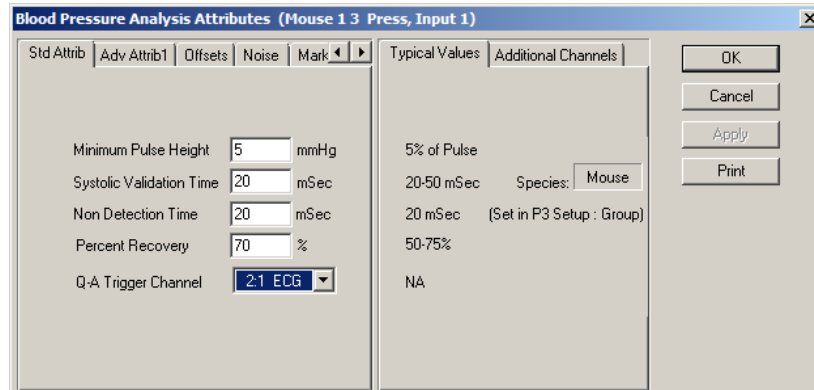
Note: Even though the Blood Pressure Analysis Module can be used on a Left Ventricular Pressure, it is highly recommended that the Left Ventricular Pressure Analysis Module be used when analyzing left ventricular pressure from the heart. This will assure that the pressure is analyzed correctly due to the different waveform morphology.

ATTRIBUTES DIALOG

The **Blood Pressure Analysis Attributes** dialog allows you to modify the signal analysis for different types of blood pressure signals and signal conditions. If an analysis change in the **Attributes** dialog is performed mid-cycle, then the attribute change will not take effect until the following cycle.

STANDARD ATTRIBUTES TAB

The **Standard** attributes allow setting the most common attributes that would need to be changed during Acquisition or Review.

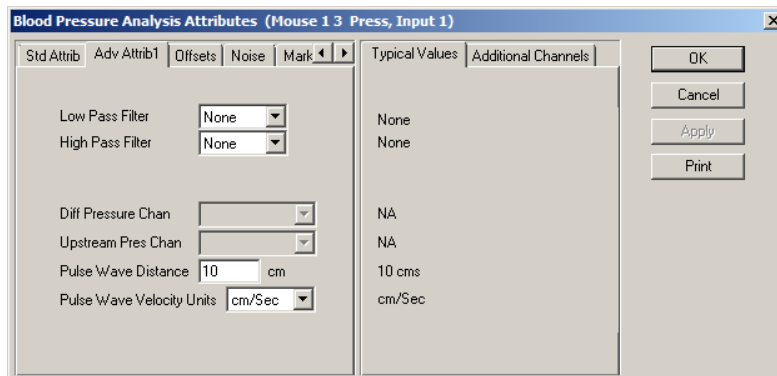


Blood Pressure Standard Attributes Tab

- | | |
|---------------------------------|---|
| Minimum Pulse Height | Sets the minimum developed pressure that must be achieved before the analysis will detect and validate a cardiac cycle. The Minimum Pulse Height is useful for preventing the analysis from triggering on artifacts. |
| Systolic Validation Time | Specifies the period, in milliseconds, a valid peak must be held before the cardiac cycle is terminated.
This value helps the system determine the correct systolic pressure. |
| Non Detection Time | Specifies the period, in milliseconds, of dead time that the analysis does not look for a pulse pressure. This is used to move the peak analysis past the dicrotic notch. |
| Percent Recovery | Defines a Percent Recovery Point from the developed pulse pressure. The %REC derived parameter reports the amount of time it takes to reach this pressure. |
| Q-A Trigger Channel | Permits the selection of an ECG channel for the calculation of the Q-A Interval. If no ECG channels are set up, this control is disabled. ECG channels must be set up prior to using this attribute. |

ADVANCED ATTRIBUTES TAB

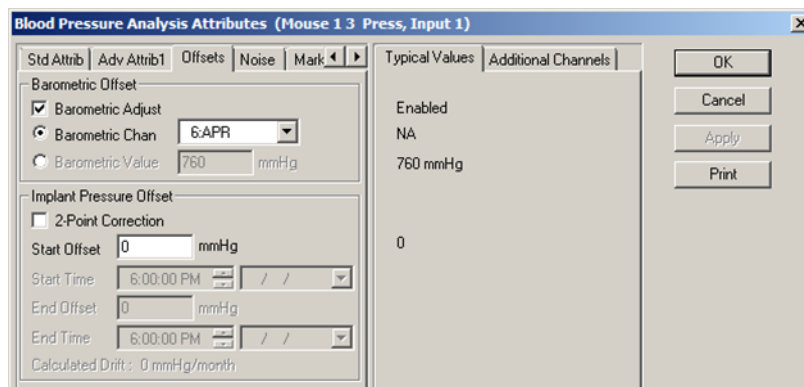
The **Advanced** attributes allow selection of attributes which are not commonly changed during Acquisition or Review.



Blood Pressure Advanced Attribute Tab

- Low Pass Filter** Selection of Low Pass filter in hertz.
- High Pass Filter** Selection of High Pass filter in hertz.
- BP Epoch Channel** When the **Respiration from Blood Pressure** option has been installed, the Blood Pressure channel can update the logging buffer when in beat mode either by the cardiac cycle (checkbox enabled) or by respiratory cycle (checkbox disabled).
- Diff Pressure Chan** This list box allows the selection of a channel that can be used to subtract another channel from the input. The only effect that this has is for display. To display the difference, the **Presentation** field in a **Primary** graph must be set to **Diff**.
- Upstream Pres Chan** Sets the upstream pressure channel for calculating Pulse Wave Velocity. This drop down list will display all BP channels within a single group that are sampled at the same sampling rate.
- Pulse Wave Distance** User defined distance (in cm) used in the calculation of Pulse Wave Velocity. The default setting is 10cm.
- Pulse Wave Velocity Units** The units for the Pulse Wave Velocity (PWV) derived parameter are user selectable and can be specified as cm/Sec or m/Sec.

OFFSET TAB



Offsets Tab

The Offsets tab allows the designation of barometric channels, barometric values and implant offset values to be used for compensating pressures from the BP analysis.

Barometric Adjust	This check box enables the correction for barometric pressure. This is used for certain telemetry systems that do not compensate for barometric pressure internally. The correction factor is applied by using a RAW channel as the input. The pressure offset is in kilopascals.
Barometric Chan	This list box will display the available RAW inputs that could be used for the offset adjustment and is only used when the Barometric Adjust check box is enabled.
Barometric Value	User defined value that can be used to account for pressure offset when not continuously monitoring barometric pressure using the APR.
2-Point Correction	When checked, permits the user to define an offset value at the date and time prior to implant and another offset value at the date and time once explanted to apply a linear pressure drift correction if desired.
Start Offset	Allows the entry of an implant offset that will be used to adjust the pressure output of the BP analysis. This may be manually typed in by the user or physically measured by selecting the Measure button. Performing an acquisition will allow the user to Measure the pressure offset from the implant. This feature is disabled in Review mode.

NOISE TAB

The **Noise Tab** contains attributes that are used to identify noisy data. On identifying “noisy” data, as defined by the user, **Bad Data Marks** will be placed to span the noisy sections.

Attribute	Value	Typical Value
Enable Noise Detection	<input checked="" type="checkbox"/>	Enabled
Enable Dropout Detection	<input checked="" type="checkbox"/>	Enabled
Minimum Signal Value	-50 mmHg	-50 mmHg
Maximum Signal Value	500 mmHg	500 mmHg
Minimum Heart Rate	200 bpm	200 bpm
Maximum Heart Rate	1000 bpm	1000 bpm
Min Good Data Time	10 s	10 s

Noise Tab

Enable Noise Detection Enables the **Noise Detection** attributes for the automatic placement of **Bad Data Marks**.

Enable Dropout Detection If **Dropout Detection** is enabled, any negative dropout data encountered when analyzing data shall be bracketed **by Bad Data Marks** such that the dropout

data falls within the **Bad Data Start** and **End** marks. The dropout check shall be performed on unfiltered samples.

- Minimum Signal Value** User defined threshold for determining the **minimum value** for acceptable data. Data that falls below this threshold will be considered noise and bracketed by **Bad Data Marks**.

- Maximum Signal Value** User defined threshold for determining the **maximum value** for acceptable data. Data that exceeds this threshold will be considered noise and bracketed by **Bad Data Marks**.

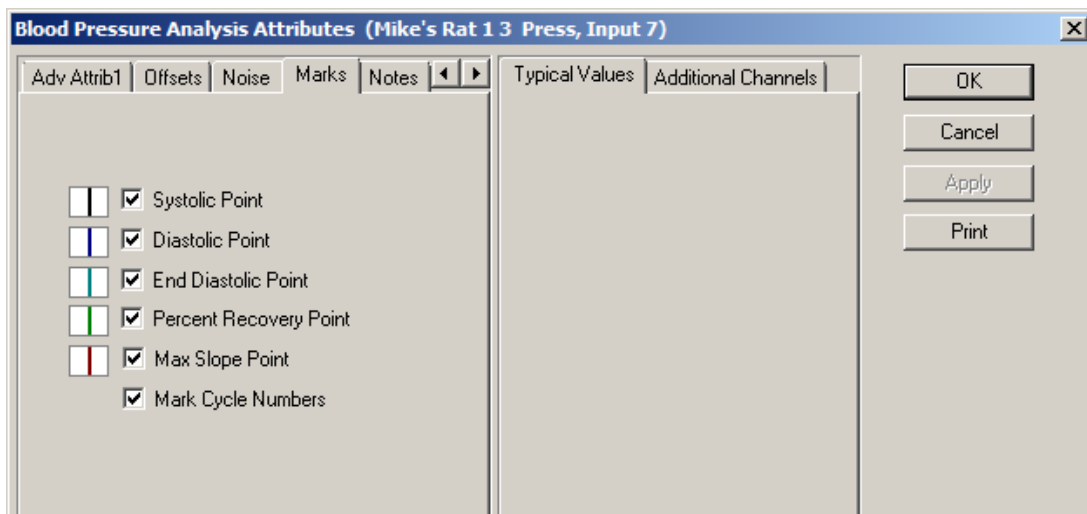
- Minimum Heart Rate** User defined threshold for determining the **minimum HR** for acceptable data. Data that falls below this threshold will be considered noise and bracketed by **Bad Data Marks**.

- Maximum Heart Rate** User defined threshold for determining the **maximum HR** for acceptable data. Data that exceeds this threshold will be considered noise and bracketed by **Bad Data Marks**.

- Minimum Good Data Time** Provides the user the ability to mark data as bad between two **Bad Data Mark** regions. If the time between the regions is less than the value specified. If the time is less than what is specified, the **Bad Data Mark** region will appear as one contiguous segment.

MARKS (VALIDATION) TAB

The **Blood Pressure** analysis displays validation tick marks for each cardiac cycle. Each cardiac cycle should have only one set of validation marks. These marks verify that the system is analyzing the blood pressure signal correctly. If there is more than one set of validation marks per cardiac cycle, correct the problem by changing the analysis attributes.



The validation marks and their meanings are listed below:

Color		Meaning
Black		Systolic Point
Blue		Diastolic Point

Cyan		End Diastolic Point
Green		Percent Recovery Point
Red		Max Slope Point
		Mark Cycle Numbers

TYPICAL VALUES

The table contains typical values for different heart rates. Use these values as guidelines for a first-time setup. Under different situations, values above or below the typical values may need to be used.

Heart Rate	Attribute	Setting	Units
40-600 (All)	Minimum Pulse Height	5% of Pulse	mmHg
	Percent Recovery	50-75	%
	Q-A Trigger Channel	NA	NA
40-200 (Dog and Monkey)	Systolic Validation Time	100-150	mSec
	Non-Detection Time	50	mSec
200-400 (Rat)	Systolic Validation Time	50-100	mSec
	Non-Detection Time	25	mSec
400-600 (Mouse)	Systolic Validation Time	20-50	mSec
	Non-Detection Time	20	mSec

DERIVED PARAMETERS

Derived Parameters are selected within the **Channel Details** of the **Subject Setup** dialog. The **Derived Parameters** selected in this dialog will be calculated, and the results will be placed in the Derived Parameter List View(s). The following details the available **Derived Parameters** from the Blood Pressure module and the averaging method used within Review.

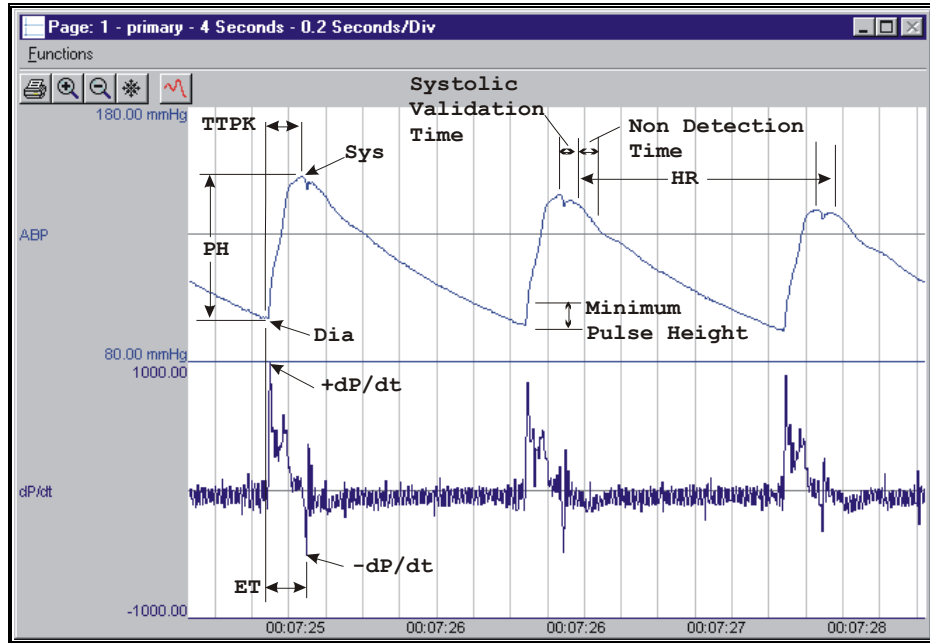
Name	Definition	Review Averaging Method
Num	The number of the cardiac cycle. This number will appear on a primary graph page when validation marks are turned on and the cycle numbers are enabled. When running in a logging mode other than 1 epoch, the last cycle number will be reported.	Recent
Sys	The systolic pressure is the maximum pressure that occurs during the cardiac cycle.	Mean
Dia	The diastolic pressure is the minimum pressure that occurs during the cardiac cycle.	Mean
Mean	The mean blood pressure is calculated by averaging the data from the current diastolic mark to one sample prior to the following diastolic mark. $\frac{1}{n} \sum_{i=1}^n d_i$, where d is the value of the signal, i=1 is at the current diastolic mark and n=number of points to the subsequent diastolic mark.	Mean
PH	The pulse height is the difference between the systolic pressure and the diastolic pressure for a cardiac cycle.	Mean

HR	The heart rate is computed in beats-per-minute. It is calculated by taking the reciprocal of the time interval for the cardiac cycle multiplied by 60. Note: When running in a logging rate other than 1 epoch, sum the cycles in seconds in the logging period, divide by the number of cycles, take the reciprocal, and multiply the value by 60.	Harmonic Mean
TTPK	Time to peak is the time from the rise of the systolic pressure to the peak pressure. The value is reported in milliseconds.	Mean
ET	Ejection time is the time from the rise of the systolic pressure to the point of -dP/dt. The time value is reported in milliseconds.	Mean
+dP/dt	+dP/dt is the maximum positive value of the first derivative of the pressure that occurs during the cardiac cycle.	Mean
-dP/dt	-dP/dt is the maximum negative value of the first derivative of the pressure that occurs during a cardiac cycle.	Mean
%REC	The %REC is the amount of time it takes the pressure to recover from the rise of the systolic pressure to the Percent Recovery point. The time is in milliseconds.	Mean
NPMN	The NPMN is the non-pulsatile mean pressure reported for a logging period. This parameter is reported even if no pulse pressure exists.	Analysis
Q-A	The Q-A Interval is the time in milliseconds from the start of the Q-wave, in the ECG trigger channel, to the start of the systolic pressure rise.	Mean
RNum	Now available only in the BPR module. The analysis will report 0's if selected during acquisition and X's when in Review.	Not available. Must be configured as a separate BPR channel to utilize Review.
RInt	Now available only in the BPR module. The analysis will report 0's if selected during acquisition and X's when in Review.	Not available. Must be configured as a separate BPR channel to utilize Review.
RBpm	Now available only in the BPR module. The analysis will report 0's if selected during acquisition and X's when in Review.	Not available. Must be configured as a separate BPR channel to utilize Review.
Mean2	An alternate representation for Mean calculated as $(\text{Systolic} + 2 * \text{Diastolic})/3$.	Mean
PTT	Pulse Transit Time (PTT) is the time between the prior systolic time of the upstream channel and the systolic time of the selected channel. This time is reported in ms.	Mean
PWV	Pulse Wave Velocity (PWV) is the velocity calculated by using the Pulse Wave Distance (PWD) and Pulse Transit Time (PTT). PWV is calculated as: Pulse Wave Velocity = Pulse Wave Distance / Pulse Transit Time.	Mean

Count	This parameter will provide a total of the number of marked cycles within the defined logging period. This is different from the Num parameter which will simply list the last cycle within the logging period.	Sum
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ONLINE SCREENS AND FUNCTIONS

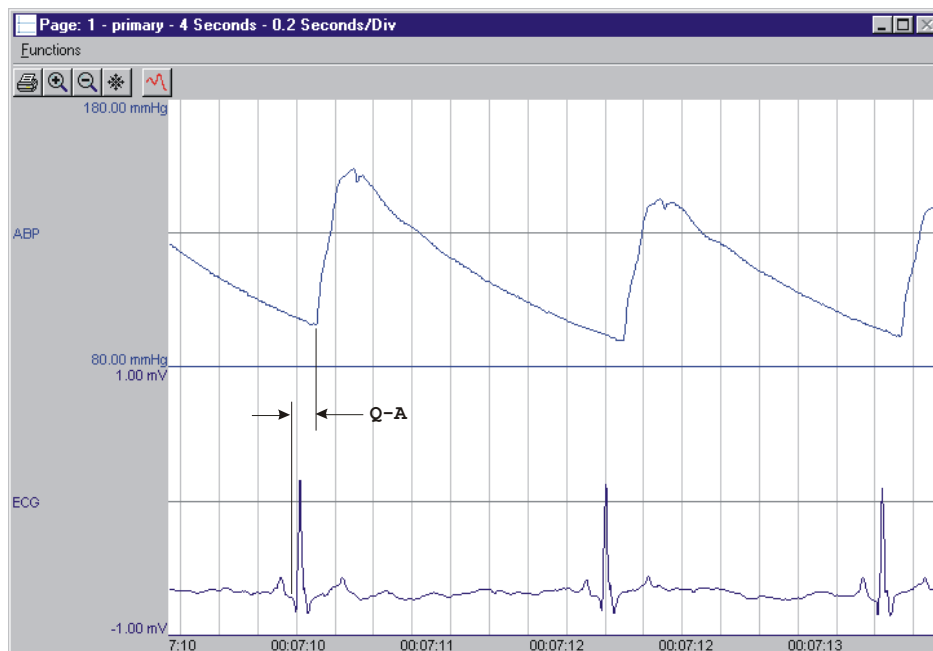
The following is an example of a **Primary** graph displaying an aorta blood pressure signal along with its differential.



Blood Pressure Key Marks

In the above figure, the **Blood Pressure** is displayed with validation tick marks and their meanings. The validation marks identify the **Systolic Pressure**, **Diastolic Pressure**, and the **%Recovery** point.

The image below defines the measurement of Q-A Interval.



Blood Pressure Q-A Interval Mark

PRESENTATION SIGNALS

Below is a list of presentation signals that are available for the BP Analysis Module:

Signal	Description
Pressure	This is the original pressure signal after applying any software filters.
Derivative	This will display the derivative of the pressure signal.
Mean	This will display the mean pressure updated at every cardiac cycle.
Heart Rate	This will display the heart rate updated at every cardiac cycle.
Difference	This will display the difference between this input signal, and an input signal selected in the Advanced Attributes tab (other available pressure signals). The analysis module will subtract the current blood pressure signal from the signal selected from the list box and make the resulting signal available to be graphed.

DATA REVIEW

This is a list of the Data Review related features of the Blood Pressure Analysis Module. The analysis specific portion of Data Review centers on the marks that the user is permitted to display, insert, and delete and how the User is permitted to move them.

Displaying Marks and Cycle Numbers

The marks and cycle numbers displayed in a Review **Primary** graph page **Display Pane** are controlled through the **Marks** Tab in the **Analysis Attributes** dialog. The

Analysis Attributes dialog is accessed through the right click menu – **Analyze [Attributes]**.

Mark Operations	Blood Pressure marks are divided into two types, marks that always exist when a valid cycle is found (Diastolic , End Diastolic , and Systolic) and marks that may or may not exist, depending on the signal morphology (Percent Recovery).
Inserting Marks	Marks may be inserted by right clicking at the point of insertion in the Primary Graph Display Pane of the Channel of interest. The pop-up menu that is displayed will provide the option to insert marks as appropriate. The list of marks available for insertion will depend on the marks adjacent to the point of insertion; signal morphology is not considered.
Insert BP Cycle	Inserts an entire Blood Pressure cycle , Diastolic , End Diastolic , Systolic , and Percent Recovery , if applicable. This set of marks may be inserted between a Percent Recovery Mark and a Diastolic Mark . If a Percent Recovery Mark is not present, the cycle may be inserted between a Systolic Mark and a Diastolic Mark . When a Blood Pressure cycle is inserted, it is assigned a sequential cycle number and subsequent cycle numbers are incremented.
Deleting Marks	Marks are deleted by positioning the mouse cursor on the mark to be deleted and bringing up the right click menu. A Blood Pressure cycle's marks cannot be deleted individually. They are linked to the Systolic Mark . To delete these marks, the entire cycle must be deleted; the cursor is positioned on the Systolic Mark and the right mouse button is clicked to delete the marks. One of the selections in the pop-up menu will permit deletion of all the marks in the cycle.
Moving Marks	Moving of the Diastolic and End Diastolic and Systolic Marks follow the standard rules used in Data Review. There are special considerations when dealing with the Percent Recovery Mark . The Percent Recovery Mark is a calculated mark; its position is dependent on the systolic and diastolic levels and cannot be adjusted by the user. If the user changes the position of either the Diastolic or Systolic Marks , the Percent Recovery Mark will be recalculated.
Calculations	<p>The calculations of derived parameters are identical to those performed during acquisition, with the exception of +dP/dt and -dP/dt. For non-pulsatile parameters, the start point is the point after the previous log time. The end point is the point at which the line is logged.</p> <p>The -dP/dt parameter is obtained from the data between the peak and the end of the peak detection time.</p> <p>In Review, +dP/dt is obtained from the data between the end diastolic point and the systolic point.</p>
Logging Mark	The Logging Mark for a Blood Pressure cycle is the Systolic Mark . The time at the Logging Mark is the time used to report a cycle's derived data.
End of Cycle	The end of a Blood Pressure cycle occurs one sample prior to the next cycle's diastolic mark. When BP and ECG data are brought into Review, the ECG channel should be used as the epoch channel to ensure that related cycles are kept together.

ATTRIBUTE TYPES IN REVIEW

The following table describes the effects of changing BP attributes in Review. Please refer to the **Analysis Attributes Dialog | Attribute Types** section for the meanings of the effects of each attribute type described.

Attribute	Effect On Review
Minimum Pulse Height	Signal Interpretation
Systolic Validation Time	Signal Interpretation
Non Detection Time	Signal Interpretation
Percent Recovery	Calculation, Redraw
QA Trigger Channel	Calculation
High Pass Filter	Signal Conditioning, Calculation, Redraw
Low Pass Filter	Signal Conditioning, Calculation, Redraw
Barometric Adjust	Signal Conditioning, Calculation, Redraw
Barometric Channel	Signal Conditioning, Calculation, Redraw
Diff Pressure Chan	Signal Conditioning, Calculation, Redraw
BP Epoch Channel	None
Marks and cycle numbers	Redraw
Precision	Precision
Pulse Wave Distance	Calculation
Upstream Pressure Channel	Calculation
Pulse Wave Velocity units	Calculation
Enable Noise Detection	Signal Interpretation
Minimum Signal Value	Signal Interpretation
Maximum Signal Value	Signal Interpretation
Maximum Heart Rate	Signal Interpretation
Minimum Heart Rate	Signal Interpretation
Minimum Good Data Time	Signal Interpretation

TROUBLESHOOTING

Use the following table to assist in troubleshooting the analysis:

Issue	Solution
Heart Rate is doubled	The analysis is triggering on the dicrotic notch. This can be rectified by lengthening the Systolic Validation Time and Non-Detection Time values. Refer to the chart of Typical Values for a specific heart rate range.
Heart Rate is halved	The analysis is pausing too long for the specified heart rate. The problem can be rectified by shortening the Systolic Validation Time and Non-Detection Time values. Refer to the chart of Typical Values for a specific heart rate.
All Derived Parameters are reporting zero	The Minimum Pulse Height may be set too high for the specified signal. Lower the Minimum Pulse Height .
Heart Rate is out of range (very high)	The analysis may be triggering on noise. The two solutions for this are: <ol style="list-style-type: none"> 1. Increase the Minimum Pulse Height to a value of 10% of pulse pressure. 2. Increase the Low Pass Filter (in the Adv Attrib tab) to remove the noise or artifact. Select a lower value in the list box.
"x" in Derived Parameter List View	The Derived Parameter value is too large for the field. An "x" was placed here, so that a truncated number would not be displayed.

window instead of a number	
Cannot find the analysis module in the Subject Setup | Subject Details dialog	The analysis module is likely not enabled in the Ponemah License. Check License options via Help | View License .
Analysis does not trigger (No marks)	Reduce the sample rate to 250-1000Hz (Sample Rate within the Acquisition Interface dialog).
0 or "x" reported for PWV	No upstream pressure channel available for the selected channel. Cycles that have 0 Pulse Transit Time (PTT) reported.
Pulse Transit Time (PTT) and Pulse Wave Velocity (PWV) report "x" in review	No cycles exist between the downstream cycle's systolic mark and a segment start or a bad data mark end.

BLOOD PRESSURE RESPIRATION (BPR)

The **Blood Pressure Respiration (BPR)** analysis can analyze any pressure from the circulatory system and derive, on a beat-to-beat basis, respiration values from the cardiac cycle. For the BPR analysis to function properly, a BP channel needs to be configured and the BPR channel must be associated with the acquired BP channel.

ATTRIBUTES DIALOG

The **Blood Pressure Respiration Analysis Attributes** dialog allows you to modify the signal analysis for different types of blood pressure signals and signal conditions. If an analysis change in the **Attributes** dialog is performed mid-cycle, then the attribute change will not take effect until the following cycle.

STANDARD ATTRIBUTES

The **Standard** attributes allow setting the most common attributes that would need to be changed during Acquisition or Review.

Blood Pressure Respiration Analysis Attributes (Rat01 Bpr, Input 8)

Std Attrib | Adv Attrib1 | Noise | Marks ◀ ▶

Minimum Pulse Height 0.5 mmHg

Pressure Drop 0.25 mmHg

Respiration Smoothing 0 ms

BP Channel 1:Pressure

Sample Rate 50 Hz

Typical Values: 0.50 mmHg, 0.25 mmHg, 0 ms, NA

Additional Channels: Species: Rat (Set in P3 Setup : Group)

OK, Cancel, Apply, Print

Blood Pressure Respiration Standard Attributes Tab

Minimum Pulse Height

Sets the minimum developed pressure that must be achieved before the analysis will detect and validate a cycle. The **Minimum Pulse Height** is useful for preventing the analysis from triggering on small variations in the signal.

Pressure Drop

This setting is used to set the minimum level by which the signal must fall, relative to its recent maximum, for the analysis to identify a cycle. This setting is useful in eliminating false triggering on small variations in the signal.

Respiration Smoothing

This sets the duration over which data derived from the blood pressure signal is smoothed to yield the respiration signal. This should be set to approximately $\frac{1}{4}$ of a respiration cycle. If this parameter is set too small, the respiration signal will appear jagged. If it is set too large, the respiration signal will appear washed out, and the pulse height of individual cycles will become smaller.

BP Channel

This associates the proper BP channel from which the BPR channel is derived. These two channels must be configured in the same Subject. If no BP channel is associated with the BPR channel, the analysis will not trigger.

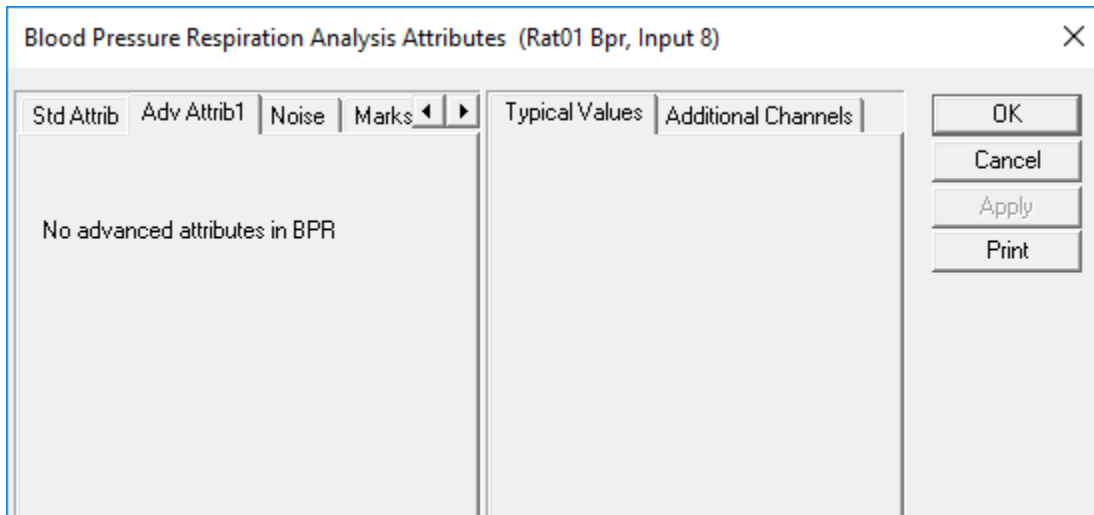
Note: The BP channel must be sampled at, or faster than the BPR sample rate.

Sampling Rate

Rate at which the Blood Pressure Respiration is derived from the Blood Pressure channel and collected during the Acquisition.

ADVANCED ATTRIBUTES

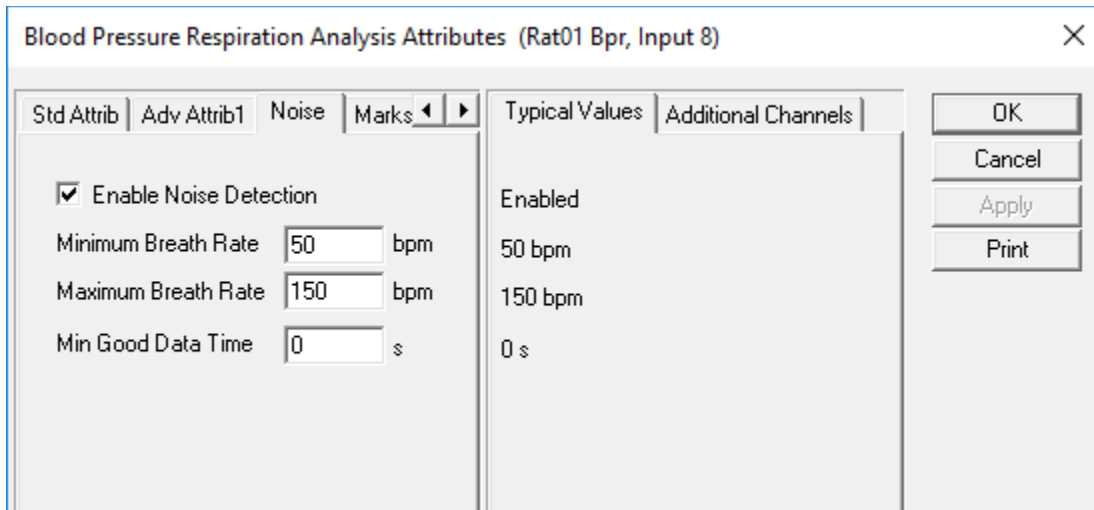
The BPR Analysis modules does not have **Advanced** attributes.



Blood Pressure Respiration Advanced Attributes Tab.

NOISE TAB

The **Noise Tab** contains attributes that are used to identify noisy data. On identifying “noisy” data, as defined by the user, **Bad Data Marks** will be placed to span the noisy sections.



Blood Pressure Respiration Noise Tab

- Enable Noise Detection** Enables the **Noise Detection** attributes for the automatic placement of **Bad Data Marks**.

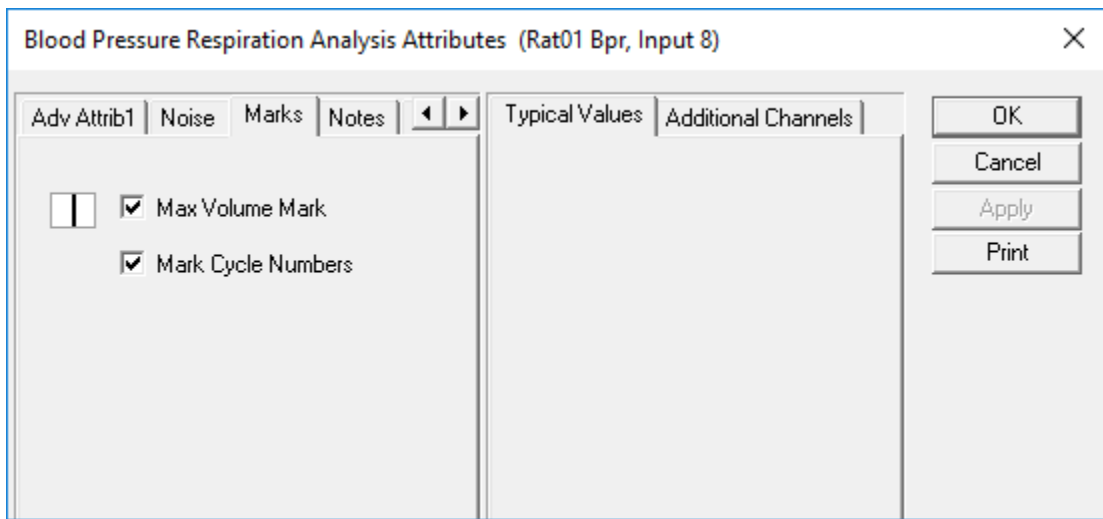
- Minimum Breath Rate** User defined threshold for determining the **minimum breath rate** for acceptable data. Data that falls below this threshold will be considered noise and bracketed by **Bad Data Marks**.

- Maximum Breath Rate** User defined threshold for determining the **maximum breath rate** for acceptable data. Data that exceeds this threshold will be considered noise and bracketed by **Bad Data Marks**.

- Minimum Good Data Time** Provides the user the ability to mark data as bad between two **Bad Data Mark** regions. If the time between the regions is less than the value specified. If the time is less than what is specified, the **Bad Data Mark** region will appear as one contiguous segment.

MARKS (VALIDATION) TAB

The **Blood Pressure Respiration** analysis displays validation tick marks for each cardiac cycle. Each cardiac cycle should have only one set of validation marks. These marks verify that the system is analyzing the blood pressure signal correctly. If there is more than one set of validation marks per cardiac cycle, correct the problem by changing the analysis attributes.



Blood Pressure Respirations Marks Tab

The validation marks and their meanings are listed below:

Color		Meaning
Black		Max Volume Mark
		Mark Cycle Numbers

TYPICAL VALUES

The table contains typical values for different heart rates. Use these values as guidelines for a first-time setup. Under different situations, values above or below the typical values should be used.

Species	Attribute	Setting	Units
(All) Dog, Monkey, Rat, Mouse	Minimum Pulse Height	5% of Pulse	mmHg
	Pressure Drop	5% of Pulse	mmHg
	Respiration Smoothing	2000	mSec
	BN Channel	NA	NA

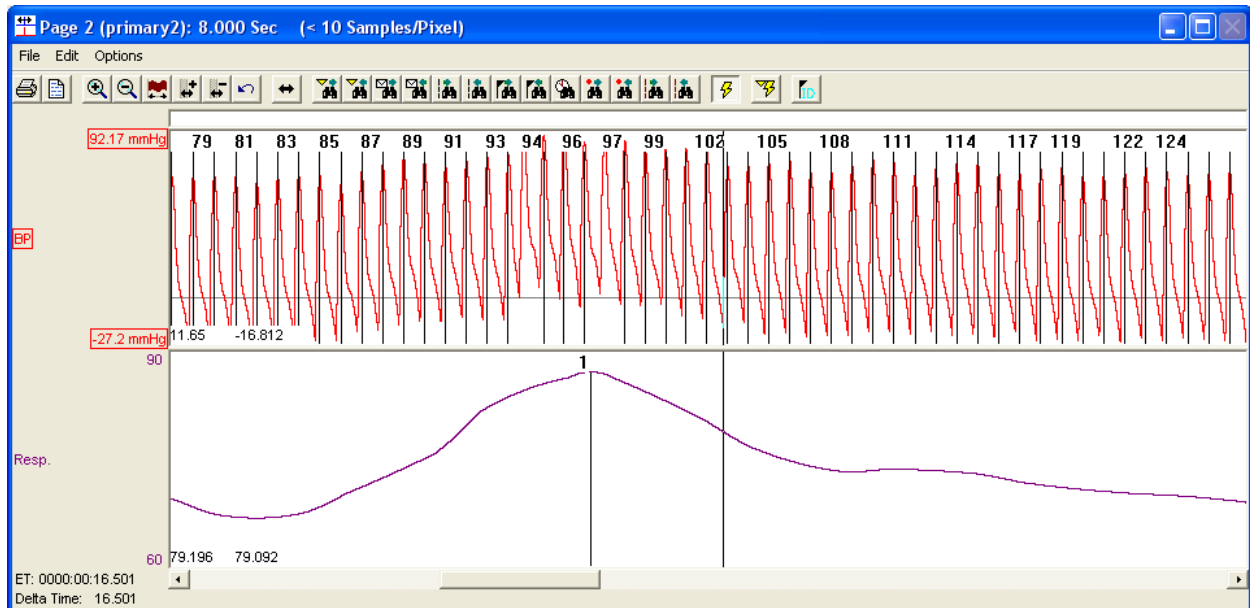
DERIVED PARAMETERS

Derived Parameters are selected within the **Channel Details** of the **Subject Setup** dialog. The **Derived Parameters** selected in this dialog will be calculated, and the results will be placed in the Derived Parameter List View(s). The following details the available **Derived Parameters** from the Blood Pressure module and the averaging method used within Review.

Name	Definition	Review Averaging Method
RNum	The number of the respiration cycle. This number will appear on a primary graph page when validation marks are turned on and the cycle numbers are enabled. When running in a logging mode other than 1 epoch, the last cycle number will be reported.	Recent
RInt	The time, in milliseconds, over which a full respiration waveform is detected.	Mean
RBpm	Respiration rate in breaths per minute.	Harmonic Mean

ONLINE SCREENS AND FUNCTIONS

The following is an example of a **Primary** graph displaying an aorta blood pressure signal along with its differential.



Blood Pressure Respiration Key Marks

In the above figure, the **Blood Pressure Respiration** signal is displayed with validation tick marks and their meanings. The validation mark identifies the Max Volume Mark point.

PRESENTATION SIGNALS

Below is a list of presentation signals that are available for the BP Analysis Module:

Signal	Description
Respiration	This will display the calculated respiration signal.

DATA REVIEW

This is a list of the Data Review related features of the Blood Pressure Analysis Module. The analysis specific portion of Data Review centers on the marks that the user is permitted to display, insert, and delete and how the User is permitted to move them.

Displaying Marks and Cycle Numbers	The marks and cycle numbers displayed in a Review Primary graph page Display Pane are controlled through the Marks Tab in the Analysis Attributes dialog. The Analysis Attributes dialog is accessed through the right click menu – Analyze [Attributes] .
Mark Operations	Marks are divided into two types, marks that always exist when a valid cycle is found (Diastolic , End Diastolic , and Systolic) and marks that may or may not exist, depending on the signal morphology (Percent Recovery). BPR has only a single mark (Max Volume Mark) that exists when a valid cycle is found.
Inserting Marks	Marks may be inserted by right clicking at the point of insertion in the Primary Graph Display Pane of the Channel of interest. The pop-up menu that is displayed will provide the option to insert marks as appropriate. The list of marks available for insertion will depend on the marks adjacent to the point of insertion; signal morphology is not considered.
Insert BPR Cycle	Inserts an entire Blood Pressure Respiration cycle with the associated Max Volume Mark . This mark may be inserted at any point along the waveform. When a Blood Pressure Respiration cycle is inserted, it is assigned a sequential cycle number and subsequent cycle numbers are incremented.
Deleting Marks	Marks are deleted by positioning the mouse cursor on the mark to be deleted and bringing up the right click menu. When deleting these marks, the entire cycle will be deleted; the cursor is positioned on the Max Volume Mark and the right mouse button is clicked to delete the mark.
Moving Marks	Moving the Max Volume Marks follow the standard rules used in Data Review. A Max Volume Mark cannot be dragged past another Max Volume Mark.
Calculations	The calculations of derived parameters are identical to those performed during acquisition, with the exception of RBpm as it uses a Harmonic Mean. For non-pulsatile parameters, the start point is the point after the previous log time. The end point is the point at which the line is logged.

Logging Mark	The Logging Mark for a Blood Pressure Respiration cycle is the Max Volume Mark . The time at the Logging Mark is the time used to report a cycle's derived data.
End of Cycle	The end of a Blood Pressure Respiration cycle occurs one sample prior to the next cycle's Max Volume Mark .

ATTRIBUTE TYPES

The following table describes the effects of changing BPR attributes in Review. Please refer to the **Analysis Attributes Dialog | Attribute Types** section for the meanings of the effects of each attribute type described.

Attribute	Effect On Review
Minimum Pulse Height	Signal Conditioning, Calculation, Signal Interpretation, and Redraw
Pressure Drop	Signal Conditioning, Calculation, Signal Interpretation, and Redraw
Respiration Smoothing	Signal Conditioning, Calculation, and Redraw
BP Channel	Signal Conditioning, Calculation, Signal Interpretation, and Redraw
Marks and Cycles	Signal Conditioning, Calculation, and Redraw
Precision	Signal Conditioning, Calculation, Redraw, and Precision
Reanalyze only – No attribute change	Signal Conditioning, Calculation, and Redraw

TROUBLESHOOTING

Use the following table to assist in troubleshooting the analysis. This includes issues that may exist in the BP analysis module which may affect the BPR module:

Issue	Solution
Heart Rate is doubled	The analysis is triggering on the dicrotic notch. This can be rectified by lengthening the Systolic Validation Time and Non-Detection Time values. Refer to the chart of Typical Values for a specific heart rate range.
Heart Rate is halved	The analysis is pausing too long for the specified heart rate. The problem can be rectified by shortening the Systolic Validation Time and Non-Detection Time values. Refer to the chart of Typical Values for a specific heart rate.
All Derived Parameters are reporting zero	The Minimum Pulse Height may be set too high for the specified signal. Lower the Minimum Pulse Height .
Heart Rate is out of range (very high)	The analysis may be triggering on noise. The two solutions for this are: <ol style="list-style-type: none"> 1. Increase the Minimum Pulse Height to a value of 10% of pulse pressure. 2. Increase the Low Pass Filter (in the Adv Attrib tab) to remove the noise or artifact. Select a lower value in the list box.

"x" in Derived Parameter List View window instead of a number	The Derived Parameter value is too large for the field. An "x" was placed here, so that a truncated number would not be displayed.
Cannot find the analysis module in the Subject Setup | Subject Details dialog	The analysis module is likely not enabled in the Ponemah License. Check License options via Help | View License .
Analysis does not trigger (No marks)	Reduce the sample rate to 250-1000Hz (Sample Rate within the Acquisition Interface dialog).

LEFT VENTRICULAR PRESSURE (LVP)

The **Left Ventricular Pressure** analysis module analyzes the left ventricular pressure from the heart. The analysis calculates the common parameters that are associated with left ventricular pressure on a beat-to-beat basis.

ATTRIBUTES DIALOG

The **Left Ventricular Pressure Analysis Attributes** dialog allows you to modify the signal analysis for different types of left ventricular pressure signals and signal conditions. If an analysis change in the **Attributes** dialog is performed mid-cycle, then the attribute change will not take effect until the following cycle.

STANDARD ATTRIBUTES TAB

The **Standard** attributes allow setting the most common attributes that would need to be changed during Acquisition or Review.

Std Attrib	Adv Attrib1	Offsets	Noise	Mark	Typical Values	Additional Channels
Minimum Pulse Height	5	mmHg			5% of Pulse	
% Pressure Drop	20	%			25% of Pulse	
dP/dt A	40	mmHg			40mmHg	Species: Rat
dP/dt B	50	mmHg			50mmHg	(Set in P3 Setup : Group)
dP/dt C	60	mmHg			60mmHg	
dP/dt D	70	mmHg			70mmHg	
Relaxation Time 1	60	%			60%	
Relaxation Time 2	70	%			70%	
Tau Duration	40	mSec			40mSec	
Tau Method	Pressure				Pressure	
ECG Channel	3:1 ECG				NA	

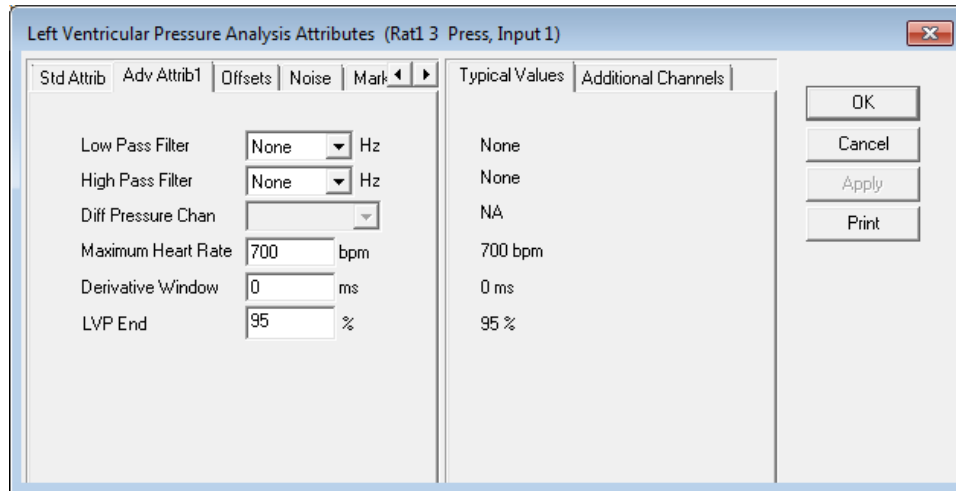
Standard Attributes tab

The standard attributes allow setting the most common attributes that would need to be changed during Acquisition or Review.

Minimum Pulse Height	Sets the minimum developed pressure that the signal must achieve before the analysis will detect and validate a cardiac cycle. The Minimum Pulse Height prevents the analysis from triggering on artifacts.
% Pressure Drop	Defines how far the Systolic pressure must drop before the cardiac cycle will terminate. The pressure used in determining the percentage is the difference from the Systolic pressure to the Minimum pressure.
dP/dt (A, B, C, and D)	Defines four pressure levels that the dP/dt will be reported from during the systolic period.
Relaxation Time 1, 2	Defines levels in the derivative signal at which relaxation times will be reported. A relaxation period begins when -dP/dtMAX occurs, and ends when the derivative signal reads zero. For example, if Relaxation Time is set to 60%, then the system will report how long it took (in milliseconds) for the derivative to rise by 60% of -dP/dtMAX.
Tau Duration	<p>Defines the duration over which Tau is to be calculated, starting at -dP/dtMAX. Tau Duration is measured in milliseconds. Three methods are used for calculating Tau: Pressure, dP/dt, and DevPressure.</p> <p>Pressure: Tau is calculated as the negative inverse of the slope of the regression line of the natural logarithm of Left Ventricular Pressure versus time.</p> <p>dP/dt: Tau is calculated as the negative inverse of the slope of the regression line of the natural logarithm of -dP/dt versus time.</p> <p>DevPressure: Tau is calculated as the negative inverse of the slope of the regression line of the natural log of left ventricular pressure - the previous end diastolic level versus time.</p>
Tau Method	Defines which two values are used in the calculation of Tau . Use different methods for different conditions. Each method passes the data into the formula that calculates the linear line equation using the least square method. The three available methods are: Pressure, dP/dt, and DevPressure.
ECG Channel	Permits the selection of an ECG channel for the calculation of the Q-A Interval. If no ECG channels are set up, this control is inactivated. ECG channels must be set up prior to using this attribute.

ADVANCED ATTRIBUTES TAB

The Advanced attributes allow selection of attributes which are not commonly changed during Acquisition or Review.

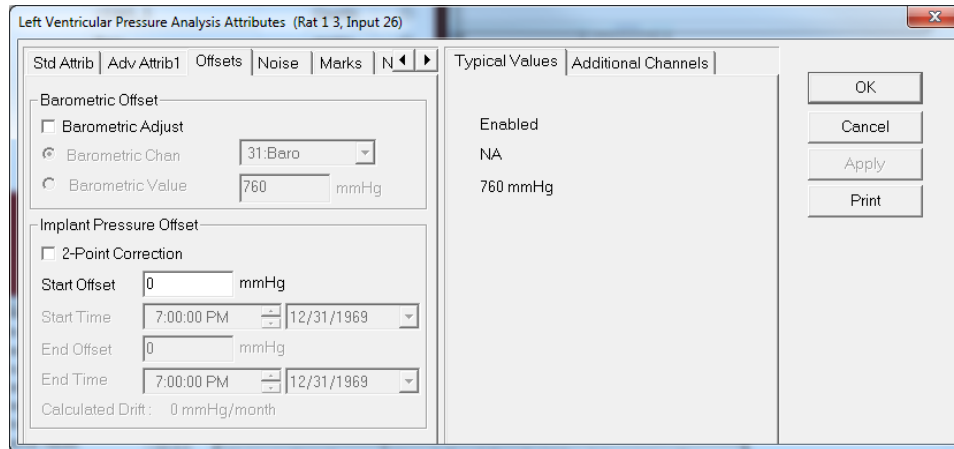


Advanced Attributes tab

- Low Pass Filter** Selection of Low Pass filter in hertz.
- High Pass Filter** Selection of High Pass filter in hertz.
- Diff Pressure Chan** This list box allows the selection of a channel that can be used to subtract another channel from the input. The only effect that this has is for display. To display the difference, the **Presentation** field in a **Primary** graph must be set to **Diff**.
- Maximum Heart Rate** This attribute is used to assist the analysis in the rejection of noise, to ensure that large rapid signal fluctuations due to noise are not marked as cardiac cycles. Maximum Heart Rate should be set higher than the highest expected heart rate.
- Derivative Window** The Derivative Window defines the range of samples over which the LVP's derivative signal is calculated. This window acts as a smoothing function for the derivative by calculating across a larger range. Using a value of 0ms will provide the derivative between two consecutive points, whereas entering a larger value may provide the derivative across non-consecutive points.
Ex: If sampling at 1000 Hz, the time between consecutive points is 1ms. By choosing a Derivative Window of 2ms, the derivative will be calculated across every other point.
- LVP End** The LVP End attribute controls the placement of the LVP End Mark. The mark is placed at the point where the derivative signal rises by "LVP End" % of $-dP/dt_{MAX}$.

OFFSET TAB

The Offsets tab allows the designation of barometric channels, barometric values and implant offset values to be used for compensating pressures from the LVP analysis.

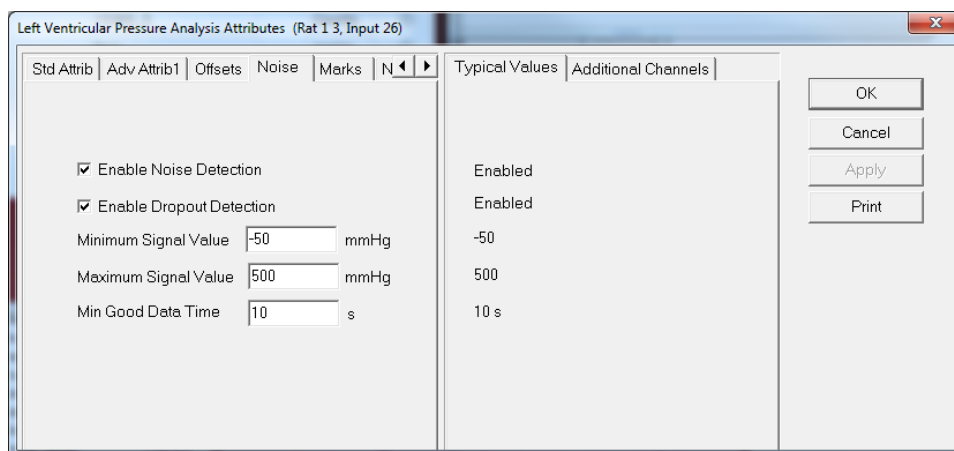


Offsets tab

Barometric Adjust	This check box enables the correction for barometric pressure. This is used for certain telemetry systems that do not compensate for barometric pressure internally. The correction factor is applied by using a RAW channel as the input. The pressure offset is in kilopascals.
Barometric Chan	This list box will display the available RAW inputs that could be used for the offset adjustment and is only used when the Barometric Adjust check box is enabled.
Barometric Value	User defined value that can be used to account for pressure offset when not continuously monitoring barometric pressure using the APR.
2-Point Correction	This check box allows for the correction of transmitter drift over a user defined period of time.
Start Offset	Allows the entry of an implant offset that will be used to adjust the pressure output of the analysis. This value is manually typed in by the user and can be used independently as a constant, static value over time or used in conjunction with the 2-Point Correction attributes.
Start Time	Start time and date that the 2-point correction for drift will be applied.
End Offset	Allows the entry of an end implant offset that will be used to adjust the pressure output of the analysis over a user specified range of time. 2-Point Pressure Offset is calculated as $(\text{End Offset} - \text{Start Offset}) / ((\text{End Date/Time} - \text{Start Date/Time}).\text{months})$
End Time	End time and date that the 2-point correction for drift will be applied.

NOISE TAB

The **Noise Tab** contains attributes that are used to identify noisy data. On identifying “noisy” data, as defined by the user, **Bad Data Marks** will be placed to span the noisy sections.



Noise tab

Enable Noise Detection Enables the **Noise Detection** attributes for the automatic placement of **Bad Data Marks**.

Enable Dropout Detection If **Dropout Detection** is enabled, any negative dropout data encountered when analyzing data shall be bracketed by **Bad Data Marks** such that the dropout data falls within the **Bad Data Start** and **End** marks. The dropout check shall be performed on unfiltered samples.

Minimum Signal Value User defined threshold for determining the minimum value for acceptable data. Data that falls below this threshold will be considered noise and bracketed by **Bad Data Marks**.

Maximum Signal Value User defined threshold for determining the maximum value for acceptable data. Data that exceeds this threshold will be considered noise and bracketed by **Bad Data Marks**.








Minimum Good Data Time Provides the user the ability to mark data as bad between two **Bad Data Mark** regions. If the time between the regions is less than the value specified. If the time is less than what is specified, the **Bad Data Mark** region will appear as one contiguous segment.

MARKS (VALIDATION) TAB

The **Left Ventricular Pressure** analysis displays validation tick marks for each cardiac cycle. Each cardiac cycle should have only one set of validation marks. These marks verify that the system is analyzing the left ventricular

pressure signal correctly. If there is more than one set of validation marks per cardiac cycle, correct the problem by changing the analysis attributes.

The validation marks and their meanings are listed below:

Color		Meaning
Black		End Diastolic Point
Magenta		+dP/dt
Blue		Systolic Point
Green		-dP/dt
Cyan		% Recovery 1
Red		% Recovery 2
Yellow		LVP End
		Mark Cycle Numbers

TYPICAL VALUES

Use these values as guidelines for a first time setup. Under different situations, values above or below the typical values will have to be used.

Attribute	Setting	Units
Minimum Pulse Height	5% of Pulse	mmHg
% Pressure Drop	25% of Pulse	%
dP/dt A	40	mmHg
dP/dt B	50	mmHg
dP/dt C	60	mmHg
dP/dt D	70	mmHg
Relaxation Time 1	60	%
Relaxation Time 2	70	%
Tau Duration	40	mSec
Tau Method	Pressure	NA
QA Trigger Channel	NA	NA

DERIVED PARAMETERS

Derived Parameters are selected within the **Channel Details** of the **Subject Setup** dialog. The derived parameters selected in this dialog box will be calculated, and the results will be placed in the **Derived Parameter List View(s)**. The following details the available **Derived Parameters** from the Left Ventricular Pressure module and the averaging method used within Review.

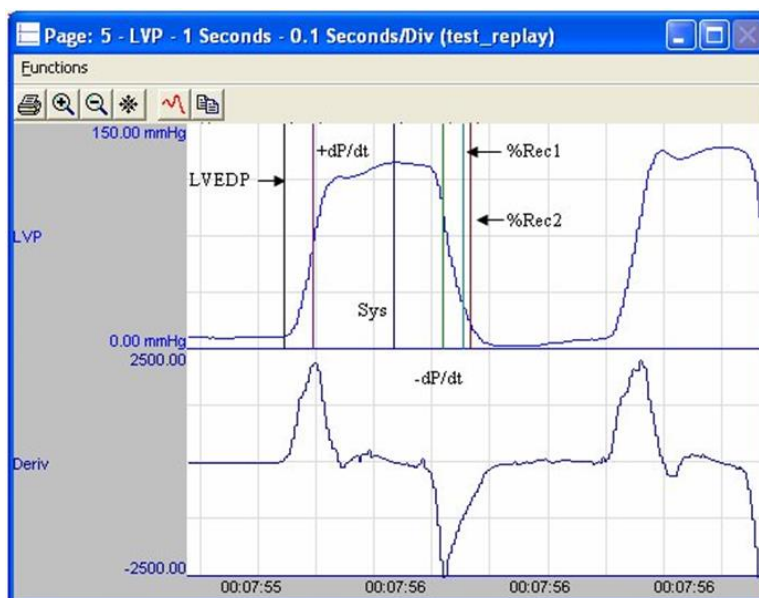
Name	Definition	Averaging Method in Review
Num	The number of the cardiac cycle. This number will appear on a primary graph page when validation marks are turned on and the cycle numbers are enabled. When running in a logging mode other than 1 epoch, the last cycle number will be reported.	Recent
Sys	The systolic pressure is the maximum pressure that occurs during the cardiac cycle.	Mean

LVEDP	The left ventricular end diastolic pressure is the pressure at the last zero crossing of the differentiated pressure during the rise to the systolic period.	Mean
Min	The minimum pressure during the cardiac cycle. Not defined over a specific cycle. Min is calculated over the period of time that the logging period takes place.	Mean
TTI	Tension-Time Index is the area under the left ventricular pressure during the ejection phase of the contraction. This is the integration between the LVEDP point and $-dP/dt_{MAX}$.	Mean
DP	Developed pressure is the difference between the systolic pressure and the left ventricular end diastolic pressure (SYS-LVEDP).	Mean
HR	The heart rate is computed in beats-per-minute. It is calculated by taking the reciprocal of the time interval for the cardiac cycle multiplied by 60. Note: When running in a logging rate other than 1 epoch, sum the cycles in seconds in the logging period, divide by the number of cycles, take the reciprocal, and multiply the value by 60.	Harmonic Mean
+dP/dt	+dP/dt is the maximum positive value of the first derivative of the pressure that occurs during the cardiac cycle.	Mean
-dP/dt	-dP/dt is the maximum negative value of the first derivative of the pressure that occurs during the cardiac cycle.	Mean
CI	Contractility index is +dP/dt divided by the pressure at that point.	Mean
RT1, RT2	The Relaxation Time is the time period from -dP/dt to the time specified by the Relaxation Time attribute. The time is reported in milliseconds.	Mean
dP (A, B, C, and D)	These parameters report the value of dP/dt at the pressure levels specified in dP/dt A, dP/dt B, dP/dt C, and dP/dt D (in the attributes window). These values will not be reported accurately if these pressure values are set too close to the Pressure Threshold Value (Minimum Pulse Height). The dP/dt (A, B, C, and D) pressure settings in the attribute dialog under the Std Attributes tab should at least be set to a value 20 units above that of the Minimum Pulse Height value.	Mean
NPMN	The non-pulsatile mean pressure reported for a logging period. This parameter is still reported even if no pulse pressure exists.	Mean
Q-A	The Q-A Interval is the time in milliseconds from the start of the Q-wave, in the ECG trigger channel, to the start of the systolic pressure rise (LVEDP)	Mean
IVT	The time in milliseconds from the start of the systolic pressure rise (LVEDP) to the maximum slope of the systolic pressure rise (+dP/dt)	Mean
TTI-T	LVEDP to -dP/dt. The time is in milliseconds.	Mean
Tau	Tau is the time constant isovolumic left ventricular pressure decay. It is reported in milliseconds, and can be defined as described in the Attributes window section.	Analysis
Period	The duration of the current cycle time, in milliseconds.	Mean
EMw	Time difference between the end of Systole and the end of ventricular relaxation and is calculated as QLVPend Interval - QT Interval	Mean

Count	This parameter will provide a total of the number of marked cycles within the defined logging period. This is different from the Num parameter which will simply list the last cycle within the logging period.	Sum
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ONLINE SCREENS AND FUNCTIONS

Below is a **Primary** graph displaying a typical left ventricular pressure signal with its digitally generated differential. The **Validation Marks** also are displayed on the waveform.



Labeled LVP waveform

PRESENTATION SIGNALS

Below is a list of presentation signals that are available for the LVP Analysis Module:

Signal	Description
Pressure	This is the original pressure signal after applying any software filters.
Derivative	This will display the derivative of the pressure signal.
Heart Rate	This will display the heart rate updated at every cardiac cycle.
Difference	This will display the difference between this input signal, and an input signal selected in the Advanced Attributes tab (other available pressure signals). The analysis module will subtract the current pressure signal from the signal selected from the list box and make the resulting signal available to be graphed.

DATA REVIEW

This is a list of the Data Review related features of the Left Ventricular Pressure Analysis Module. The analysis specific portion of Data Review centers on the marks that the user is permitted to display, insert, and delete and how the user is permitted to move them.

Displaying Marks and Cycle Numbers	The marks and cycle numbers displayed in a Review window channel are controlled through the Marks Tab in the attribute dialog accessed via the Analyze selection in the Right click menu.
Mark Operations	Left Ventricular Pressure marks are divided into two types, marks that always exist when a valid cycle is found (End Diastolic, Systolic, Max Slope, Min Slope) and marks that may or may not exist, depending on the signal morphology (Recovery 1, Recovery 2).
Inserting Marks	Marks are inserted by right clicking at the point of insertion in the Review window. The pop-up menu that is displayed will provide the option to insert marks as appropriate. The list of marks available for insertion will depend on the marks adjacent to the point of insertion; signal morphology is not considered.
Insert LVP Cycle	Inserts an entire Left Ventricular Pressure cycle: End Diastolic, Systolic, Max Slope, Min Slope, LVP End, and Recoveries, if applicable. This set of marks may be inserted between the second Recovery Mark and an End Diastolic Mark. If a Recovery Mark is not present, the cycle may be inserted between a Min Slope Mark and an End Diastolic Mark. When a Left Ventricular Pressure cycle is inserted, it is assigned a sequential cycle number and subsequent cycle numbers are incremented.
Deleting Marks	Marks are deleted by positioning the mouse cursor on the mark to be deleted and bringing up the right click menu. A Left Ventricular Pressure cycle's marks cannot be deleted individually. They are linked to the Systolic Mark. To delete these marks, the entire cycle must be deleted; the cursor is positioned on the Systolic Mark and the right mouse button is clicked to delete the marks. One of the selections in the pop-up menu will permit deletion of all the marks in the cycle.
Moving Marks	Moving of the End Diastolic, Systolic, Max Slope, Min Slope, and LVP End marks follow the standard rules used in Data Review. The Recovery marks are calculated marks; their positions are dependent on the Min Slope value and cannot be adjusted by the user. If the user changes the position of the Min Slope Mark, the Recovery marks will be recalculated. The Min Slope Mark may be moved past the Recovery marks.
Calculations	<p>The calculations of derived parameters are identical to those performed during acquisition, with the exception of Min. For non-pulsatile parameters, the start point is the point after the previous log time. The end point is the point at which the line is logged.</p> <p>In Review the Min parameter is calculated between the Min Slope mark and the following cycle's LVEDP mark.</p>
Logging Mark	The logging mark for a Left Ventricular Pressure cycle is the Systolic Mark. The time at the logging mark is the time used to report a cycle's

derived data. If an LVP cycle's logging mark falls within a logging interval, the LVP cycle's data will be included in the logging interval.

End of Cycle

The end of an LVP cycle occurs one nanosecond prior to the next cycles LVEDP mark. For the last cycle in a data segment, the logging time +1 nanosecond is used.

When LVP and ECG data are brought into Review, the ECG channel should be used as the epoch channel to ensure that related cycles are kept together.

ATTRIBUTES IN REVIEW

The following table describes the effects of changing LVP attributes in Review. Please refer to the **Analysis Attributes Dialog | Attribute Types** section for the meanings of the effects of each attribute type described.

Attribute	Effect On Review
Minimum Pulse Height	Signal Interpretation
% Pressure Drop	Signal Interpretation
Relaxation Time 1	Calculation, Redraw
Relaxation Time 2	Calculation, Redraw
dP/dt A	Calculation
dP/dt B	Calculation
dP/dt C	Calculation
dP/dt D	Calculation
QA Trigger Channel	Calculation
Tau Duration	Calculation
Tau Method	Calculation
High Pass Filter	Signal Conditioning, Calculation, Redraw
Low Pass Filter	Signal Conditioning, Calculation, Redraw
Diff Pressure Chan	Signal Conditioning, Calculation, Redraw
Maximum Heart Rate	Signal Interpretation
Derivative Window	Signal Conditioning, Calculation, Redraw
LVP End	Signal Interpretation
Barometric Adjust	Signal Conditioning, Calculation, Redraw
Barometric Channel	Signal Conditioning, Calculation, Redraw
Barometric Value	Signal Conditioning, Calculation, Redraw
2-Point Correction	Signal Conditioning, Calculation, Redraw
Start Offset	Signal Conditioning, Calculation, Redraw
Start Time	Signal Conditioning, Calculation, Redraw
End Offset	Signal Conditioning, Calculation, Redraw
End Time	Signal Conditioning, Calculation, Redraw
Marks and cycle numbers	Redraw
Precision	Precision

TROUBLESHOOTING

Use the following table to assist in troubleshooting the analysis:

Problem	Solution
Heart Rate is doubled	The analysis is triggering on an artifact. Increase the Minimum Pulse Height and/or the % Pressure Drop. Refer to the chart of Typical Analysis Attribute Settings for typical values.
All Derived Parameters are reporting zero	The Minimum Pulse Height may be set too high for the specified signal. Lower the Minimum Pulse Height.
Heart Rate is out of range (very high)	The analysis may be triggering on noise. The two solutions for this are: Increase the Minimum Pulse Height to a value of 10% of pulse pressure. Increase the Low Pass Filter (in the Adv Attrib1 tab) to eliminate noise on the signal. Select a lower value in the list box.
Tau is negative or very large	The method being used to calculate Tau influences the values that are reported. When the Pressure vs. Time method is used, this field may report values that do not exist. This occurs when the pressure goes to zero, because the natural log of zero is undefined and the system will return an infinite value for this reading. If this occurs, use another method for Tau.
"x" in Derived Parameter List View window instead of a number	The derived number is too large for the field. An "x" was placed here, so that a truncated number would not be displayed.
Cannot find the analysis module in the Input Setup dialog	The analysis module is likely not enabled in the Ponemah License. Check License options via Help | View License .
Algorithm does not trigger (No marks)	Reduce the sample rate to 250Hz, or increase the Low Pass Filter in the Adv Attrib1 tab. Select a lower value in the list box.

ELECTROCARDIOGRAM (ECG)

The **Electrocardiogram** analysis module analyzes ECG complexes. The analysis calculates **Derived Parameters** from the input signal on a beat-to-beat basis.

COMPATIBILITY

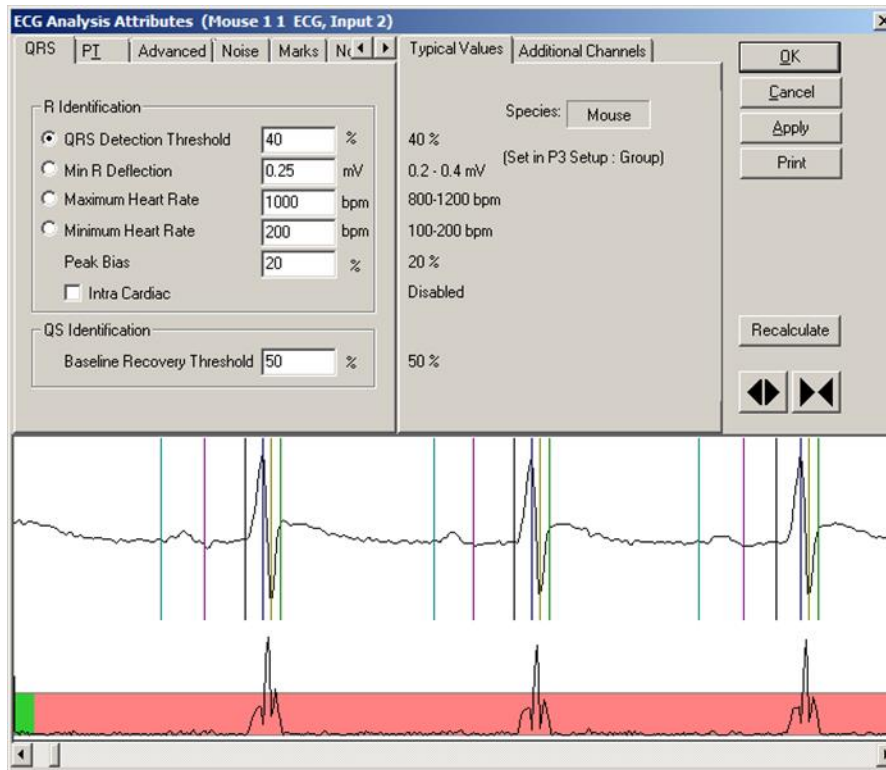
- Cross-channel calculations for QA-Interval and Electromechanical window (EMw) are only available in Review.

SEGMENT BASED ANALYSIS

- The ECG signal is divided into discrete QRS Segments for the purpose of analysis. The use of segments when analyzing an ECG signal permits establishing a context for QRS identification based on adjacent data. Use of segments also ensures uniformity between results displayed in the Attribute Dialog box and results in the primary graph page
- QRS Segment boundaries may be observed in the attribute dialog box when graphically modifying the QRS Detection Threshold Attribute.
- Noise spikes in the ECG signal may affect the identification of cycles within the affected segment, but adjacent segments will not be affected.

ATTRIBUTES DIALOG

The **ECG Analysis Attributes** dialog allows you to modify the signal analysis for different types of ECG signals and signal conditions. If an analysis change in the **Attributes** dialog is performed mid-cycle, then the attribute change will not take effect until the following cycle.



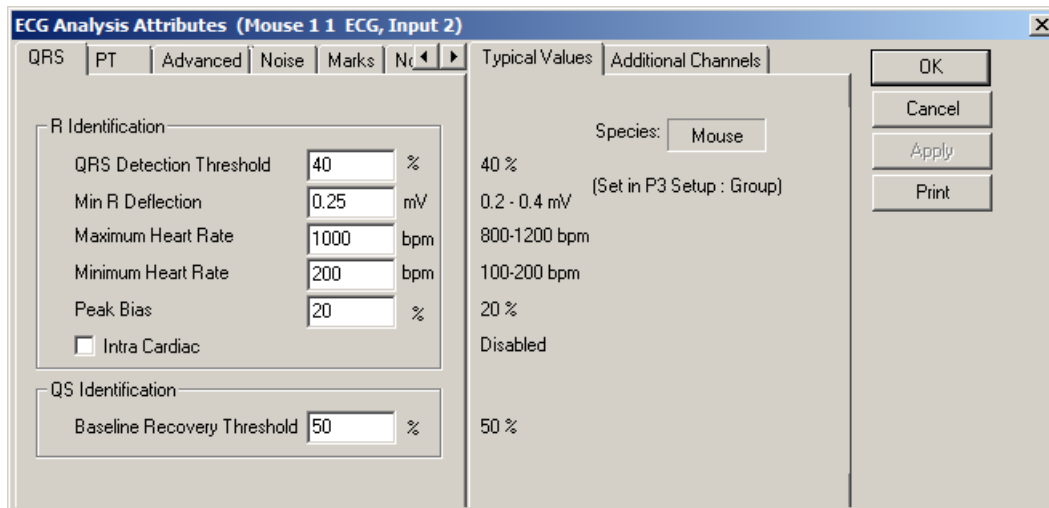
Attributes Dialog Window. The first complex is displayed in gray, the second complex is displayed in black.

WAVEFORM WINDOW

- The Waveform Window contains a portion of the ECG signal with validation marks visible to indicate the analysis module is triggering properly. This window is only present during an active Acquisition or Review session and is not present during Experiment configuration while in Configuration mode.
- If the data point located at the left edge of the Waveform Window coincides with a QRS Segment boundary, the time point at the left edge of the signal will match the time point at the left edge of the Primary graph page from which the ECG Analysis Attribute dialog was invoked.
- If this data does not coincide with a QRS or Data Segment boundary, additional data will be pulled into the Waveform Window prior to the time associated with the left edge of the Primary graph page to complete the partial QRS segment and provide the full context for analysis of that segment. This additional data is displayed in gray to distinguish it from the visible portion of the waveform as seen in the Primary graph page which is displayed in black. This section may be seen by scrolling the Waveform Window to the left.

QRS ATTRIBUTES TAB

The QRS attributes allow setting the most common attributes used to detect the QRS complex.



QRS Attributes Tab

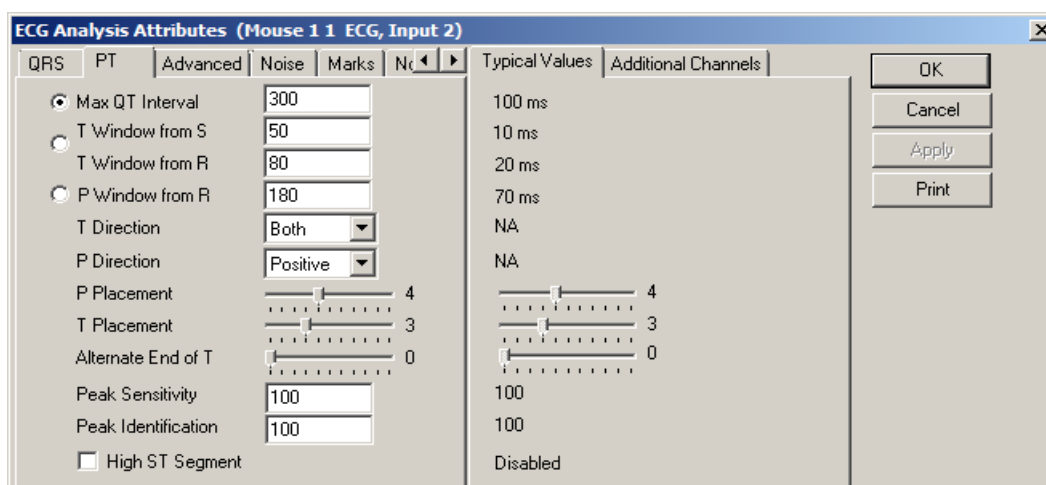
<p>QRS Detection Threshold</p>	<ul style="list-style-type: none"> A. The QRS detection threshold is used to calculate the threshold for identifying potential Rs from the rectified derivative signal B. The % entered is applied to the largest derivative peak in a QRS segment that results in potential Rs that satisfy Minimum Heart rate criteria. C. A high minimum heart rate may result in the analysis unnecessarily searching for potential Rs D. Decreasing the minimum heart rate attribute to cover the longest anticipated RR will prevent unexpected lowering E. Attribute Dialog <ul style="list-style-type: none"> ○ Two signals are displayed, the ECG signal and the rectified derivative of the smoothed ECG. ○ The derivative peak used to calculate the height of the pink region is marked in green. There will be one green cycle per QRS segment ○ When adjusting the pink region, the attribute is set relative to the height of the green derivative peak ○ The goal is to place the top of the pink box such that it only intersects valid derivative peaks. F. Tip: Setting the QRS Detection Threshold <ul style="list-style-type: none"> ○ Too Low – analysis will be inefficient, investigating more derivative peaks than necessary. It is likely that some erroneous peaks will be identified ○ Too High – Some QRSs will be missed especially in the case of higher heart rate data (i.e. HR > Min HR)
<p>Min R Deflection</p>	<ul style="list-style-type: none"> • The QRS amplitude change in the smoothed ECG* must exceed this value for the complex to be recognized. This is based on max/min signal value, and does not depend on the iso-electric level • Attribute Dialog <ul style="list-style-type: none"> ○ The displayed signal is the smoothed ECG signal ○ The pink adjustment boxes will be anchored to the lowest point for positive complexes and vice versa

	<ul style="list-style-type: none"> ○ This attribute should be set above the noise level but lower than the smallest anticipated QRS ● Tip: Setting the Min R Deflection <ul style="list-style-type: none"> ○ Too Low – The analysis may mark noise ○ Too high – The analysis may miss valid Rs <p>* The QRS Smoothing Filter attribute is used to decrease the influence of noise when searching for ECG complexes. The resultant smoothed signal is used internally for QRS identification, not for reporting of derived data.</p>
Maximum Heart Rate	<p>The Maximum Heart Rate attribute should be set higher than the maximum expected heart rate. The analysis will disregard Rs that result in a heart rate higher than the Max Heart Rate attribute.</p> <ul style="list-style-type: none"> ● The value for Maximum Heart Rate must be greater than value entered for the Minimum Heart Rate ● Attribute Dialog <ul style="list-style-type: none"> ○ The displayed signal is the ECG signal ○ The pink region represents the time interval corresponding to the max heart rate ● Tip: Setting the Maximum Heart Rate <ul style="list-style-type: none"> ○ Too Low – QRSs will be missed ○ Too high – Noisy cycles have a greater chance of getting marked.
Minimum Heart Rate	<p>This attribute is used by the analysis to determine when it should search for missing QRS complexes. The Minimum Heart Rate attribute does not represent a hard cutoff like the Maximum Heart Rate attribute and there may be situations where it should be set higher than the lowest heart rate.</p> <ul style="list-style-type: none"> ● The Minimum Heart Rate attribute should be set close to the lowest anticipated heart rate. ● Tip: Setting the Minimum Heart Rate <ul style="list-style-type: none"> ○ Too Low – Rs may be missed in noisy areas ○ Too high – Analysis efficiency will decrease due to unnecessary searches for QRS.
Peak Bias	<p>The Peak Bias is used to influence the marking positive or negative Rs. A positive Peak Bias favors positive Rs, a negative Peak Bias favors negative Rs.</p>
Intra Cardiac	<p>This checkbox is used to enable processing of ECG signals which exhibit rapid changes in the P wave such that the derivative of the P wave exceeds the QRS derivative. Enabling this check box prevents the analysis from marking the P wave as the R wave.</p> <p>When enabled, potential QRSs that are followed by potential QRSs within the interval specified by the P window from R attribute, will not be marked as a QRS, instead the following QRS will be marked.</p> <p><i>WARNING:</i> If the Intra Cardiac setting is enabled, it is important to correctly set the P Window from R setting. If the P Window from R is set too large or too</p>

	<p>small, the analysis may mis-trigger. For example, if the P Window from R is too small, the analysis may mark some of the P waves as R waves. If the P Window from R is too large, the P wave may be marked where the T wave of the previous cycle is located.</p>
Baseline Recovery Threshold	<p>When a disturbance is seen on the leading or lagging edge of the R wave, the analysis may mark the Q or S wave at the point of the disturbance. This attribute may be used to prevent the analysis from looking for the Q or S wave until after the disturbance.</p> <p>The number in the edit field represents the percentage of the leading edge of the R wave by which the signal must return (from the R peak) before the analysis will look for the Q or S wave.</p> <ul style="list-style-type: none"> • If this value is set to 0 (default), the analysis will start looking for the Q or S wave from the level of the R peak. • If this value is set to 70, the signal will have to recover by 70% of the R height before the analysis starts looking for the Q or S wave.

PT ATTRIBUTES TAB

This tab contains attributes that affect affecting the detection of the P & T waves.



PT Attributes Tab

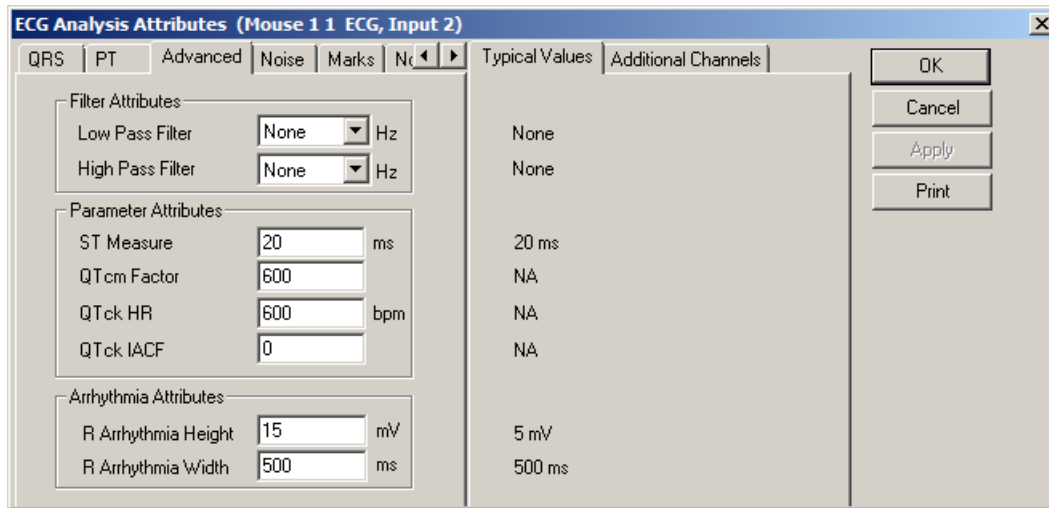
Max QT Interval	<p>After the analysis has determined the location of the end of the T wave, it will accept it as a valid end of T provided the QT interval (measured from the beginning of the Q wave to the end of the T wave) does not exceed the Max QT Interval.</p>
T Window from S \ T Window from R	<p>These two parameters define the region in which the analysis will look for an end of T. The analysis will scan the portion of the signal to the right of the T Window from S and to the left of the T window from R. T Window from S uses S end.</p>
P Window from R	<p>Defines the region where the analysis will look for the beginning of the P wave.</p>

T Direction	<p>This attribute directs the analysis to look for a T wave that is either “exclusively”:</p> <ul style="list-style-type: none"> • Positive • Negative • Both (either positive, negative, or bi-directional). <p>In most cases a setting of Both should work, and the analysis will determine the nature of the T wave. Positive and Negative settings may be used to help the analysis along when dealing with troublesome data.</p>
P Direction	<p>This attribute directs the analysis to look for a P wave that is either “exclusively”:</p> <ul style="list-style-type: none"> • Positive • Negative • Both (either positive, negative, or bi-directional). <p>In most cases a setting of Both should work, and the analysis will determine the nature of the P wave. Positive and Negative settings may be used to help the analysis along when dealing with troublesome data.</p>
P Placement	<p>This attribute permits the user to shift the P mark towards the peak or away from the peak of the P wave.</p> <p>A lower value (slider towards the left) moves the P mark away from the peak. The effect of this attribute is more pronounced on P waves that exhibit a gradual rise from the baseline.</p>
T Placement	<p>This attribute permits the user to shift the T mark towards the peak or away from the peak of the T wave.</p> <p>A lower value (slider towards the left) moves the T mark away from the peak. The effect of this attribute is more pronounced on T waves that exhibit a gradual return to the baseline.</p>
Alternate End of T	<p>The alternate end of T attribute permits the algorithm to search beyond the first potential end of T for another end of T further in the complex.</p> <ul style="list-style-type: none"> • A lower value (slider towards the left) causes the analysis to select the first end of T that it finds. • A higher value (slider towards the right), utilizes a more aggressive search for an alternate end of T. <p>This attribute is useful when dealing with complexes in which the T wave, after the peak, does not return to the baseline smoothly, but shows a second peak.</p>
Peak Sensitivity	<p>Peak Sensitivity controls the elimination of small peaks when identifying T and P peaks. This parameter should be used in conjunction with Peak Identification.</p> <p>When dealing with extremely small P or T waves, the analysis may not identify the end of T or beginning of P, in such cases, the Peak Sensitivity attribute may help in correctly validating the signal.</p> <p>The default sensitivity level is 100:</p> <ul style="list-style-type: none"> • Reducing this attribute permits greater sensitivity with 0 being maximum sensitivity • Adjust this parameter in steps of 25.
Peak Identification	<p>Peak Identification controls the thresholds used to identify potential T and P peaks. If small peaks are not identified, Peak Sensitivity should be lowered. If</p>

	the problem persists after Peak Sensitivity is lowered to 0, Peak Identification should be lowered as well.
High ST Segment	<p>This attribute may be used in the case of a signal in which the T wave runs into the QRS complex resulting in a high ST segment. This attribute should be enabled only if the analysis is incorrectly marking the T wave.</p> <p>The default sensitivity level is 100:</p> <ul style="list-style-type: none"> Reducing this attribute permits greater sensitivity with 0 being maximum sensitivity Adjust this parameter in steps of 25.

ADVANCED ATTRIBUTES TAB

The Advanced tab allows the selection of attributes that would less likely need to be changed during Acquisition or Review.

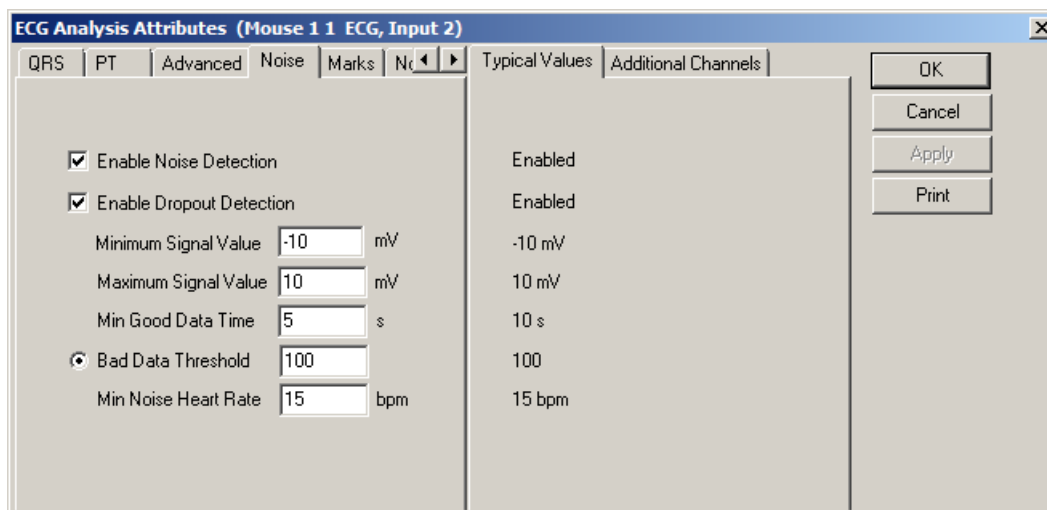


Advanced Tab

Filter Attributes	<p>Low Pass Filter: Selection of Low Pass filter in hertz.</p> <p>High Pass Filter: Selection of High pass filter in hertz.</p> <ol style="list-style-type: none"> Click on the drop-down button to access the filter choices Select a value for the filter Click Apply
Parameter Attributes	<p>ST Measure: The number of milliseconds after the end of the S wave, at which the ST elevation is measured. The default value is 10.</p> <p>QT cm Factor: Matsunaga correction factor. This sets the RR value in ms. used in the correction factor. This default value is based on a HR of 100 beats per minute.</p> <p>QTck HR: King correction factor for HR. Used in the calculation of QTck.</p> <p>QTck IACF: Individual animal correction factor (King) used in calculating QTck.</p>
Arrhythmia Attributes	<p>R Arrhythmia Height: If the peak of the R wave, measured from the Iso-electric level, exceeds this value, this beat will be marked invalid.</p> <p>R Arrhythmia Width: If the width of the signal from the beginning of the Q wave to the beginning of the S wave exceeds the R Arrhythmia Width, the associated beat will be marked invalid.</p>

NOISE TAB

The **Noise Tab** contains attributes that are used to identify noisy data. On identifying “noisy” data, as defined by the user, **Bad Data Marks** will be placed to span the noisy sections.

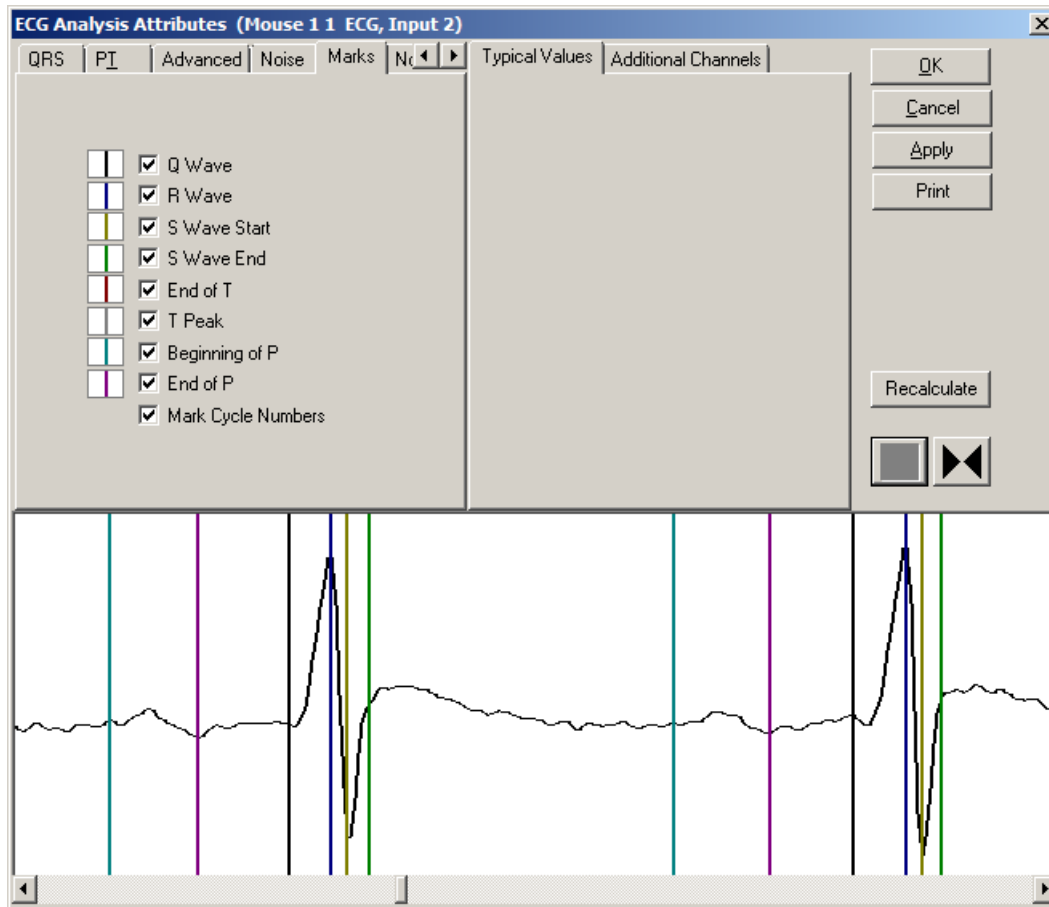


Noise tab

- | | |
|---------------------------------|--|
| Enable Noise Detection | Enables the Noise Detection attributes for the automatic placement of Bad Data Marks . |
| Enable Dropout Detection | Enabling this function places Bad Data Marks around data that is defined as dropout. |
| Minimum Signal Value | User defined threshold for determining the minimum value for acceptable data. Data that falls below this threshold will be considered noise and bracketed by Bad Data Marks . |
| Maximum Signal Value | User defined threshold for determining the maximum value for acceptable data. Data that exceeds this threshold will be considered noise and bracketed by Bad Data Marks . |
| Min Good Data Time | Provides the user the ability to mark data as bad between two Bad Data Mark regions. If the time between the regions is less than the value specified. If the time is less than what is specified, the Bad Data Mark region will appear as one contiguous segment. |
| Bad Data Threshold | This edit box specifies a noise level. When the level set in this box is exceeded, the data will be interpreted as noise and Bad Data Marks will be inserted to remove the section of data from analysis. |
| Min Noise Heart Rate | Heart rates detected by the analysis that fall below the level specified will be treated as noise and Bad Data Marks will be inserted to remove the data from analysis. |


MARKS (VALIDATION) TAB

The **ECG** analysis displays validation tick marks for each cardiac cycle. Each cardiac cycle should have only one set of validation marks. These marks verify that the system is analyzing the left ventricular pressure signal correctly. If there is more than one set of validation marks per cardiac cycle, correct the problem by changing the analysis attributes.



Marks tab

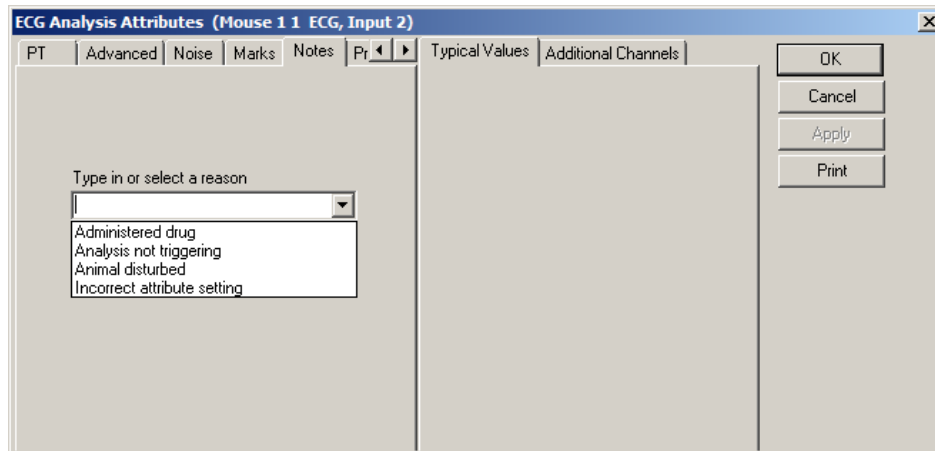
The validation marks and their meanings are listed below:

Color		Meaning
Black		Q Wave
Blue		R Wave
Yellow		S Wave Start
Green		S Wave End
Red		End of T
Gray		T Peak
Cyan		Beginning of P
Magenta		End of P
		Mark Cycle Numbers

NOTES TAB

The Notes tab allows the user to enter a note for the change that has occurred.

The user can either select one of the predefined reasons or enter a text message. This entry is then inserted into the experimental log file along with the user who made the change and the time that the note was entered.



Notes tab

PRECISION TAB

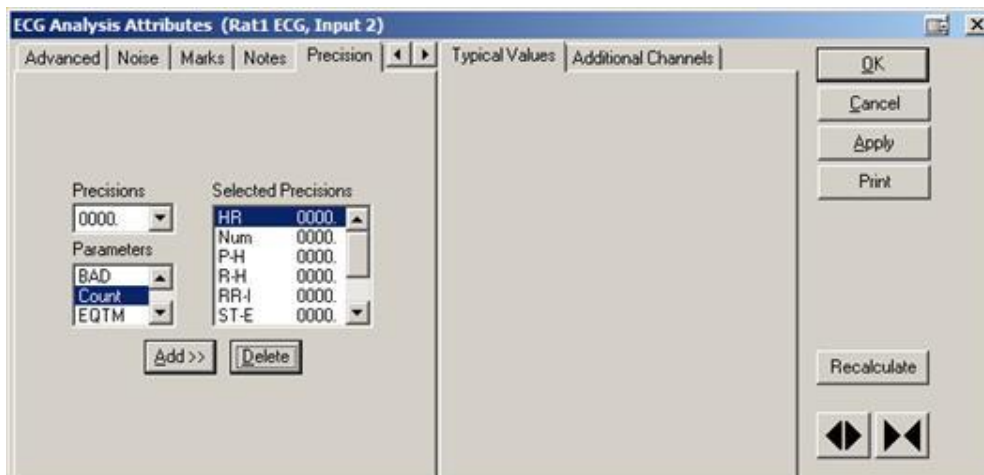
The Precision tab allows the user to define the precision at which each derived parameters will be reported.

Add items to the list of Selected Precisions:

1. Select the parameter from the Parameters list
2. Select the precision from the dropdown list for that particular parameter
3. Click the Add button to have that parameter added to the list of Selected Precisions

Delete items from the list of Selected Precisions:

1. Select a line item from the **Selected Precisions** list
2. Click **Delete**



Precision Tab

TYPICAL VALUES

The table contains typical values for different heart rates based on species selection in the PONEMAH Setup Group Tab. Selection of a species will automatically update these values in the attributes dialog. When using a species other than those listed, choose a species designation based on similar HR. Use these values as guidelines for a first time setup. Under different situations, values above or below the typical values will have to be used.

Attributes tab	Typical Value-Dog HR=40-200	Typical Value-Monkey HR=120-180	Typical Value-Rat HR=300-480	Typical Value-Mouse HR=400-600
QRS tab				
QRS Detection Threshold	40%	40%	40%	40%
Min R Deflection	0.2-0.4 mV	0.2-0.4 mV	0.2-0.4 mV	0.2-0.4 mV
Maximum Heart Rate	200-400 bpm	200-400 bpm	800-1200 bpm	800-1200 bpm
Minimum Heart Rate	10-30 bpm	30-100 bpm	50-150 bpm	100-200 bpm
Peak Bias	20%	20%	20%	20%
Baseline Recovery Threshold	50%	50%	50%	50%
PT tab				
Max QT Interval	300mSec	300mSec	150mSec	100mSec
T Window from S	50mSec	50mSec	25mSec	10mSec
P Window from R	180mSec	180mSec	100mSec	70mSec
Advanced tab				
ST Measure	20mSec	20mSec	20mSec	20mSec

DERIVED PARAMETERS

Derived Parameters are selected within the **Channel Details** of the **Subject Setup** dialog. The derived parameters selected in this dialog box will be calculated, and the results will be placed in the **Derived Parameter List View(s)**. The following details the available **Derived Parameters** from the ECG module and the averaging method used within Review.

Name	Definition	Averaging in Review
Num	The number of the cardiac cycle. This number will appear on a primary graph page when validation marks are turned on and the cycle numbers are enabled. When running in a logging mode other than 1 epoch, the last cycle number will be reported. The cycle number may be used to correlate a line of derived data to the graphical display of numbered ECG cycles.	Recent
RR-I	Time interval in milliseconds from one R wave to the next R wave.	Mean
HR	The heart rate is computed in beats-per-minute and is the reciprocal of the RR-I for the cardiac cycle multiplied by 60. Note: When running in a logging rate other than 1 epoch, sum the cycles in seconds in the logging period, divide by the number of cycles, take the reciprocal, and multiply the value by 60.	Harmonic Mean
R-H	Height of the R wave from the Iso-electric level, in millivolts.	Mean

P-H	Height of the P wave from the Iso-electric level, in millivolts.	Mean
T-H	Highest point between the end of the S wave and the end of the T wave relative to the Iso-electric point.	Mean
T-HN	Lowest point between the end of the S wave and the end of the T wave relative to the Iso-electric point.	Mean
ST-I	Time interval in milliseconds from the S wave to end of the following T wave.	Mean
ST-E	The ST elevation, measured "ST Measure" milliseconds after the S wave, from the Iso-electric level.	Mean
QRS	Time interval of the QRS complex, from the Q wave to the S wave, measured in milliseconds.	Mean
PR-I	PR interval measured from the start of the P wave to the beginning of the Q wave, in milliseconds.	Mean
QT-I	QT interval measured from the Q wave to the end of the following T wave, in milliseconds	Mean
QAT	Q Alpha T is the time interval from the Q wave to the peak of the following T wave in milliseconds.	Mean
QTcb	The corrected QT interval, using Bazett's method. Computed as the QT interval divided by the square root of the RR-I in seconds. The corrected QT is reported in milliseconds. When running in a multiple epoch logging rate, or second logging rate, the averaged value will be calculated off of the averaged RR-I value	Analysis
QTcf	The corrected QT interval, using Fridericia's method. Computed as the QT interval divided by the cube root of the RR-I in seconds. The corrected QT is reported in milliseconds. When running in a multiple epoch logging rate, or second logging rate, the averaged value will be calculated off of the averaged RR-I value.	Analysis
QTcv	The corrected QT interval, using Van de Water's method. Computed as: $QT\ Interval - 0.087 (RR\ Interval - 1)$ Where the RR Interval and the QT Interval are in seconds. The resultant corrected QT is reported in milliseconds. When running in a multiple epoch logging rate, or second logging rate, the averaged value will be calculated off of the averaged RR-I value.	Analysis
EQTS	Extended QT in a single lead. The longest QT interval in any of the recorded leads in a single group.	Mean
EQTSc	The channel from which the longest QT Interval was obtained, in the current group. This is the channel from which the EQTS parameter was reported. Note: When running in a logging mode other than 1 epoch, the averaged value will be reported as the channel that was reported most in the logging period. A 'tie' of two or more channels will report the lowest numbered channel.	Max Times

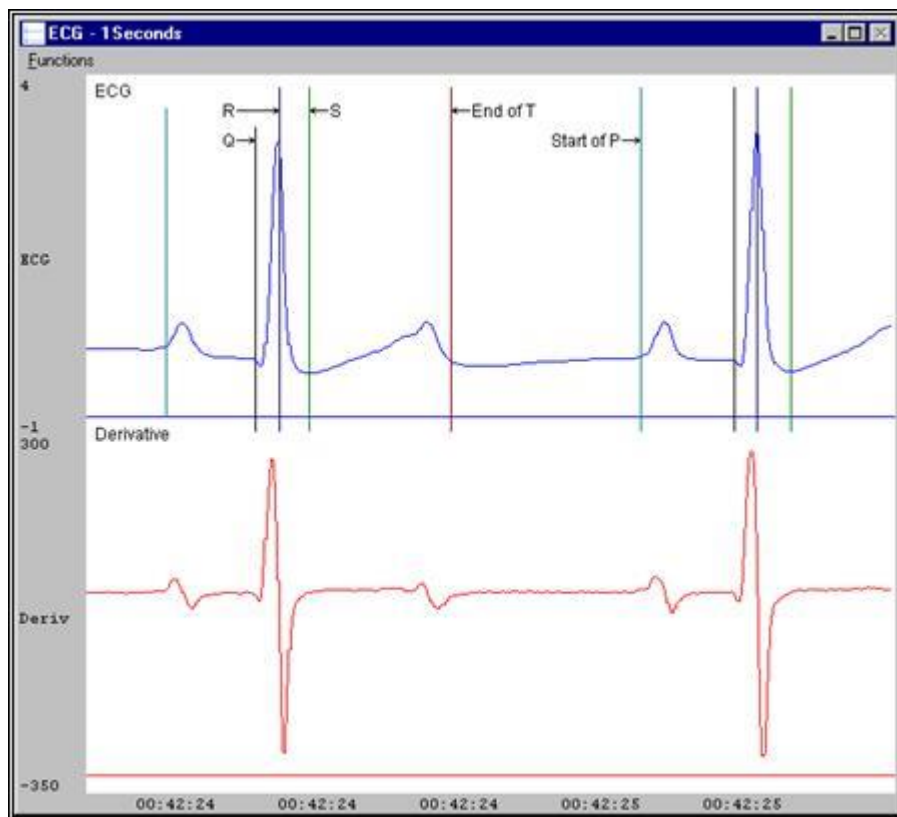
EQTM	Extended QT for multileads. The QT Interval measured from the first occurrence of the Q wave to the last occurrence of the T wave across all recorded leads in a single group.	Mean
EQTMcs	The channel from which the first Q was found, in the current group. This is the Q used to report the EQTM parameter. Note: When running in a logging mode other than 1 epoch, the averaged value will be reported as the channel that was reported most in the logging period. A 'tie' of two or more channels will report the lowest numbered channel.	Max Times
EQTMce	The channel from which the last T was found, in the current group. This is the T used to report the EQTM parameter. Note: When running in a logging mode other than 1 epoch, the averaged value will be reported as the channel that was reported most in the logging period. A 'tie' of two or more channels will report the lowest numbered channel.	Max Times
QTD	QT Dispersion, which is the longest QT interval measured in any recorded lead minus the shortest QT measure in any recorded lead in a single group.	Mean
QTMc	The channel from which the shortest QT interval was found, in the current group. Note: When running in a logging mode other than 1 epoch, the averaged value will be reported as the channel that was reported most in the logging period. A 'tie' of two or more channels will report the lowest numbered channel.	Max Times
QR-I	QR interval measured from the Q wave to the following R wave, in milliseconds	Mean
QRSA	QR amplitude in the lowest point on the Q wave to the peak of the R wave. This is calculated as R wave value minus the lowest point between the Q and R marks.	Mean
MxdV	Maximum derivative of the R wave.	Mean
T-A	Area of the T wave from the Iso-electric level calculated from the S end mark to the point prior to the T end mark.	Mean
Pct	The number of valid P waves encountered in the logging period. Note: When running in a logging mode other than 1 epoch, the averaged value will be the number of counts over the logging period.	Sum
Tct	The number of valid T waves encountered in the logging period. Note: When running in a logging mode other than 1 epoch, the averaged value will be the number of counts over the logging period.	Sum
QTct	QT count, the number of channels in a group from which the EQTS, EQTM, and QTD parameters are calculated. Note: When running in a logging mode other than 1 epoch, the averaged value will be the smallest number obtained from the lines of data that are used.	Min
BAD	The number of arrhythmic beats detected during a specified logging period. This counter does not count missing T waves as BAD. Note: When running in a logging mode other than 1 epoch, the averaged value will be the number of counts over the logging period.	Sum
GW	The Good Wave counter counts the total number of complete complexes detected during the logging period. A complex is considered to be complete when the Q, P,	Sum

	and T waves are detected. Note: When running in a logging mode other than 1 epoch, the averaged value will be the number of counts over the logging period.	
TW	The total number of good and bad complexes that were detected during a logging period. The sum of the BAD and GW does not necessarily equal the TW, since the system can analyze a complex even if there are no end of T waves detected. Note: When running in a logging mode other than 1 epoch, the averaged value will be the number of counts over the logging period.	Sum
QATN	Reports the time, in milliseconds, between the Q wave and the lowest point between the end of S and the end of T wave.	Mean
PWdth (Pwidth)	Reports the time, in milliseconds, between the start and end of the P wave.	Mean
Tpe-l	This parameter reports the time in milliseconds between the peak of the T wave and the end of the T wave. The peak of the T is identified as the greatest deflection from the Iso-electric level between the end of S and the End of T and is marked with the T peak mark.	Mean
T-P	his parameter reports the time in milliseconds between the peak of the T wave and the end of the T wave. The peak of the T is identified as the greatest deflection from the Iso-electric level between the end of S and the End of T and is marked with the T peak mark.	Mean
Match	Used specifically with Template Analysis. Reports the percentage of cycles that match a template in a given logging period	Mean
Pmatch	Used specifically with Template Analysis. Reports the average degree of match for the P Region for cycles within the logging interval.	Mean
Qmatch	Used specifically with Template Analysis. Reports the average degree of match for the Q Region for cycles within the logging interval.	Mean
Smatch	Used specifically with Template Analysis. Reports the average degree of match for the S Region for cycles within the logging interval.	Mean
Tmatch	Used specifically with Template Analysis. Reports the average degree of match for the T Region for cycles within the logging interval.	Mean
Noise	This parameter reports an approximation of the noise level in the ECG cycle. The value reported is the RMS value of the derivative between the 2 R marks after excluding the following regions: <ul style="list-style-type: none"> • 10% of the signal following the start R mark • 10% of the signal prior to the end R mark • 10% of the signal around the 2 largest derivative peaks <p>If a derivative greater than 3 times the largest QRS derivative is encountered, T and P regions will not be removed.</p>	Mean
QT cm	The corrected QT interval, using Matsunaga's method. Computed as $QT_{cm} = \log(QT_{cm} \text{ Factor}) * QT / \log(RR)$ (where RR is expressed in mSec).	Analysis
Qtck	The corrected QT interval using King's method. Computed as $QT + \text{Beta} * (HR - "QTck \text{ HR}").$	Analysis

Count	This parameter will provide a total of the number of marked cycles within the defined logging period. This is different from the Num parameter which will simply list the last cycle within the logging period.	Sum
-------	---	-----

ONLINE SCREENS AND FUNCTIONS

The following is an example of a **Primary** graph displaying an ECG signal and its derivative.



ECG Key Marks

In the above figure, the Electrocardiogram signal is displayed along with its validation tick marks. The validation marks identify Q, R, End of S, End of T, and Beginning of P.

PRESENTATION SIGNALS

Below is a list of presentation signals that are available for the ECG Analysis Module:

Signal	Description
ECG	This is the original ECG waveform after applying any software filters and spike removal algorithms (if spike detection is enabled)
Derivative	This will display the derivative of the ECG signal.

DATA REVIEW

The analysis specific portion of Data Review centers around the marks that the User is permitted to display, insert, and delete and how the User is permitted to move them.

Displaying Marks and Cycle Numbers	The marks and cycle numbers displayed in a Review Graph Page Display Pane are controlled through the Marks Tab in the Analysis Attributes dialog. The Analysis Attributes dialog is accessed through the right click menu – Analyze.
Mark Operations	ECG marks are divided into two types, marks that always exist when a valid cycle is found (Q, R, Sstart, Send) and marks that may or may not exist, depending on the signal quality and morphology (Pstart, Pend, Tend, and Tpeak). The R mark may exist by itself (Arrhythmic R mark) to indicate a bad cycle.
Inserting Marks	Marks are inserted by right clicking at the point of insertion in the Review window. The popup menu that is displayed will provide the option to insert marks as appropriate. The list of marks available for insertion will depend on the marks adjacent to the point of insertion, signal morphology is not considered.
Insert QRS	Inserts QRSsSe. This set of marks may be inserted at any location except between a Ps, Pe, and anywhere within a set of QRSsSe marks. When a QRS is inserted, it is assigned a sequential cycle number and subsequent cycle numbers are incremented.
Insert Arrhythmic R	An Arrhythmic R may be inserted between two ECG cycles, but not within a cycle. An ECG cycle is composed of PsPeQRSsSeTe. The PsPe and Te marks may not be present. The first and last marks present in a cycle represent the limits prior to and after which the Arrhythmic R may be inserted.
Insert T End	This selection will be available if an insert is attempted to the right of an S End mark and a T End is not present for the current cycle. Tp is added along with Te.
Insert S End	This selection will be available if an insert is attempted to the right of an S Start mark and an S End mark is not present for the current cycle. The only location where an S Start is present without an S End, may be at the end of the review file depending on how much of the next cycle is available.
Insert Pse	This selection will be available if an insert is attempted at the start of a cycle and P marks are not present for the cycle.
Deleting Marks	Marks are deleted by positioning the mouse cursor on the mark to be deleted and bringing up the right click menu. Ps, Pe, Tp and Te may be deleted in this fashion. Q, Ss, and Se marks cannot be deleted individually. They are linked to an R wave. To delete these marks, the entire cycle must be deleted; the cursor is positioned on the R wave and the right mouse button is clicked to delete the marks. One of the selections in the popup menu will permit deletion of all the marks in the cycle, including any Ps, Pe, Tp, and Te marks associated with the R wave. Deleting either of the P wave marks will delete both P wave marks. Deleting T end will delete the T peak mark as well.

Moving Marks

Moving Ps, Pe, Q, R, Ss, Se, Tp and Te marks follow the standard rules used in Data Review. One exception is the interaction between the T marks and the subsequent cycles P marks. The T marks can be moved past the P and vice versa.

ATTRIBUTE TYPES IN REVIEW

The following table describes the effects of changing ECG attributes in Review. Please refer to the **Analysis Attributes Dialog | Attribute Types** section for the meanings of the effects of each attribute type described.

Attribute	Effect on Review
QRS Detection Threshold	Signal Interpretation
Min R Deflection	Signal Interpretation
Maximum Heart Rate	Signal Interpretation
Minimum Heart Rate	Signal Interpretation
Peak Bias	Signal Interpretation
Baseline Recovery Threshold	Signal Interpretation
QRS Smoothing Filter	Signal Interpretation
QRS Segment Length	Signal Interpretation
QRS Width	Signal Interpretation
QRS Baseline Deriv Threshold	Signal Interpretation
Peak Baseline Window	Signal Interpretation
Peak Width Similarity	Signal Interpretation
Valid Peak Threshold	Signal Interpretation
Alternate Peak Threshold	Signal Interpretation
Wide Q Wave	Signal Interpretation
Intracardiac	Signal Interpretation
R Width Max	Signal Interpretation
R Width Min	Signal Interpretation
Average HR	Calculation
R Arrhythmia Height	Signal Interpretation
R Arrhythmia Width	Signal Interpretation
Max QT Interval	Signal Interpretation
T Window from S	Signal Interpretation
T Window from R	Signal Interpretation
P Window from R	Signal Interpretation
P Placement	Signal Interpretation
T Placement	Signal Interpretation
Alternate End of T	Signal Interpretation
Peak Sensitivity	Signal Interpretation
Peak Identification	Signal Interpretation
T Direction	Signal Interpretation
P Direction	Signal Interpretation
High ST Segment	Signal Interpretation
ST Measure	Calculation
QTcm Factor	Calculation
QTck HR	Calculation
QTck IACF	Calculation
Low Pass	Signal Conditioning, Calculation, Redraw
High Pass	Signal Conditioning, Calculation, Redraw

TROUBLESHOOTING

Use the following table to assist in troubleshooting the analysis:

Problem	Solution
A complex is incorrectly marked as an arrhythmia	Verify R Arrhythmia Width is wide enough to accommodate the QRS complex. Ensure that R Arrhythmia Height setting is large enough to accommodate the R wave.
Start of P wave not marked	Ensure that P Window from R extends beyond the P wave.
End of T wave not marked correctly	Ensure that the T Window from S and the T Window from R correctly define the region in which the end of T is expected. Ensure that Max QT Interval extends beyond the T wave.
Algorithm does not trigger (No marks)	Reduce the sample rate to 250-1000Hz.
The R waves are marked with a single mark, and nothing else is marked	Is Max R Deflection too low? Is R Arrhythmia Width too small?
T mark is not displayed	Ensure that the Max QT Interval extends beyond the end of the T wave. The T window from R should encompass the P wave. The T window from S should end prior to the start of the T wave and be close to the Iso electric level.
T mark is not displayed even though the T windows are set correctly	Check T Direction .
P mark is not displayed	Verify that the P window from R extends beyond the beginning of the P wave. If the P mark does not appear, check the P Direction attribute.
Cannot find the analysis module in the Input Setup dialog	The analysis module is likely not enabled in the Ponemah License. Check License options via Help | View License .

ECG PATTERN RECOGNITION OPTION (ECG PRO)

The purpose of **ECG PRO Analysis** is post-acquisition pattern recognition option (PRO) analysis.

It allow users to modify attribute analysis mark placements based on user-defined ECG cycle mark placement.

Template analysis uses these templates to compare like regions of ECG signals within the data set and updates the marks on matched cycles. ECG PRO analysis is a **Review** only feature.

Briefly, the process for analyzing using ECG PRO analysis is:

- User selects ECG cycles for inclusion in the **Template Library**.
- User defines the **Match Criteria**.
- PRO Analysis evaluates the match.

- **Marks** and **Derived Parameters** are updated.

TEMPLATE LIBRARY SETUP

ECG PRO Analysis is Review only feature; therefore, **Template Setup** can only be done while in Review.

To setup ECG PRO Analysis:

1. Select **Setup | Experiment Setup**.
2. Select the **Template Setup** configuration and select a **Template Library**.

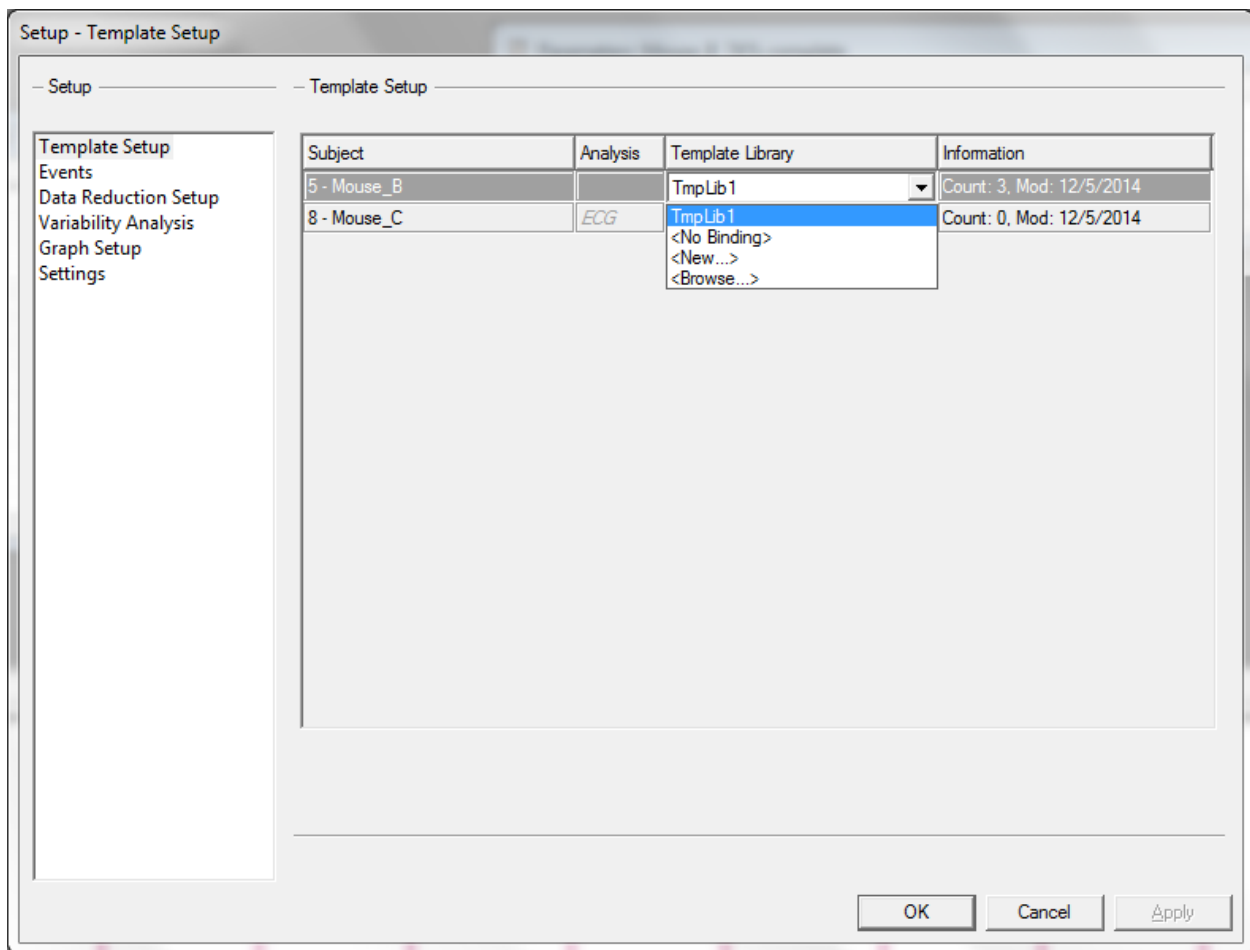
Template Library is a file in which **Templates** are stored. Template Libraries may contain Templates from different waveform files.

Templates are ECG cycles with accurately placed **Marks** that will be used as the representative ECG cycles for patten recognition analysis.

3. Select **<New...>** from the dropdown to create a new **Template Library**.

The user has a few options from the dropdown:

- a. **<No Binding>** disassociates any previous configured **Template Library** from the Subject.
- b. **<Browse...>** - associates an existing **Template Library** that was configured during a previous Review session.



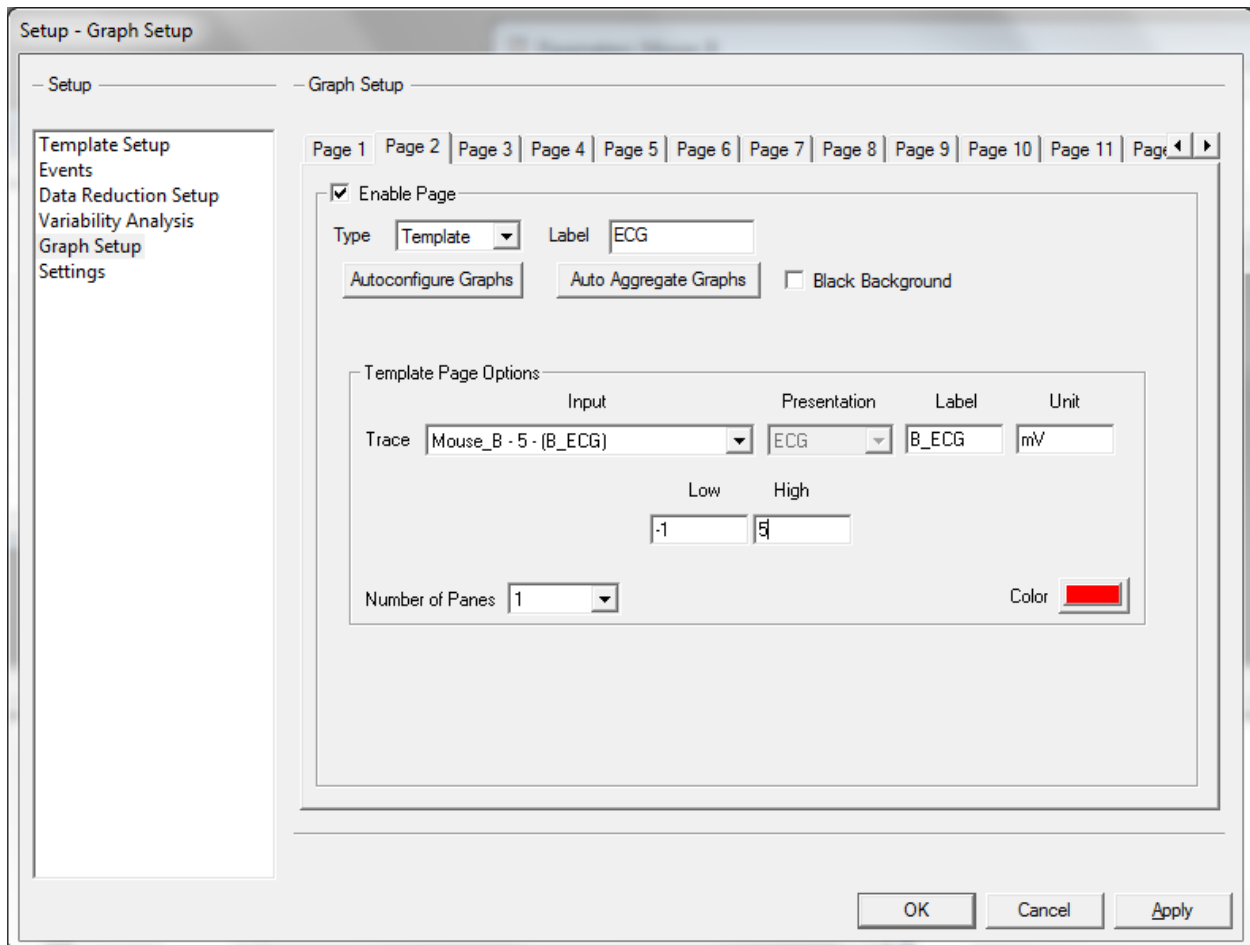
Note: The sample rate used to collect the data in the **Template Library** must match the sample rate of the data being analyzed by that library.

GRAPH PAGE SETUP

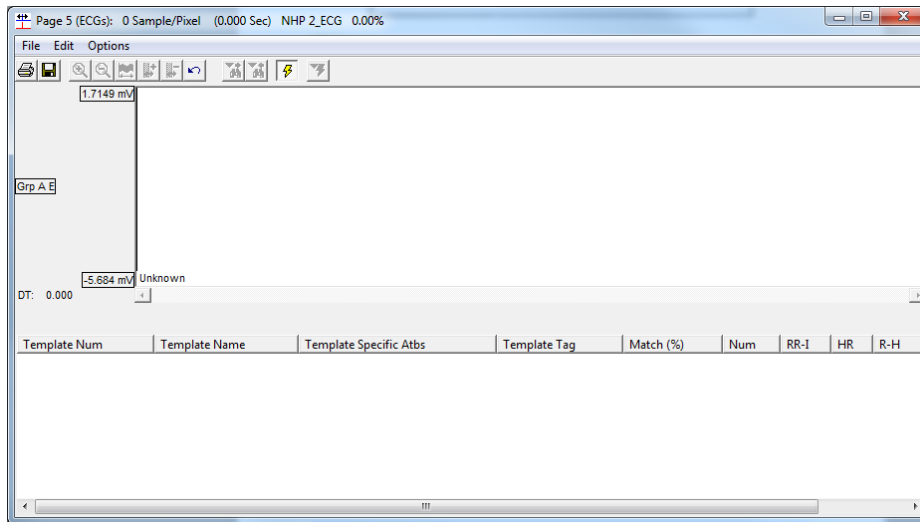
A **Template** graph is used to aggregate **Template** cycles defined by the user. Within this **Template** graph, the user can update cycle **Marks** and view match criteria.

To configure a **Template** graph:

1. Select **Setup | Experiment Setup**.
2. Select the **Graph Setup** configuration.
3. Select a page to use as a **Template** graph page.
4. Check the **Enable Page** check box.
5. Select **Template** for the **Type**.
6. **Input** should reflect the users Subject/Channel selection.
7. Type the appropriate information in the **Label**, **Unit**, **Low** and **High** text boxes.
Note: The user can also select a **Black Background** and trace **Color**.
8. Select the **OK** button.



A graph page similar to the one below will appear. When starting from scratch, the **Template** graph will be empty. The next step is to add **Templates** to the **Template Library**.



ADDING TEMPLATES TO THE TEMPLATE LIBRARY

Any ECG cycle with accurately placed **Validation Marks** can be used as a **Template**. To learn more about Validation Marks and how to alter their positions, please see the **Validation Marks** section within the **Data Review | Using Review** portion of this manual.

IMPORTANT - R marks must be identified for cycles prior to analyzing with ECG PRO. This requires that either the **R marks** be preserved from Acquisition or the attribute based analysis must be executed prior to performing ECG PRO analysis. The other marks (**P, Q, S** and **T**) need not be present in order to perform ECG PRO analysis.

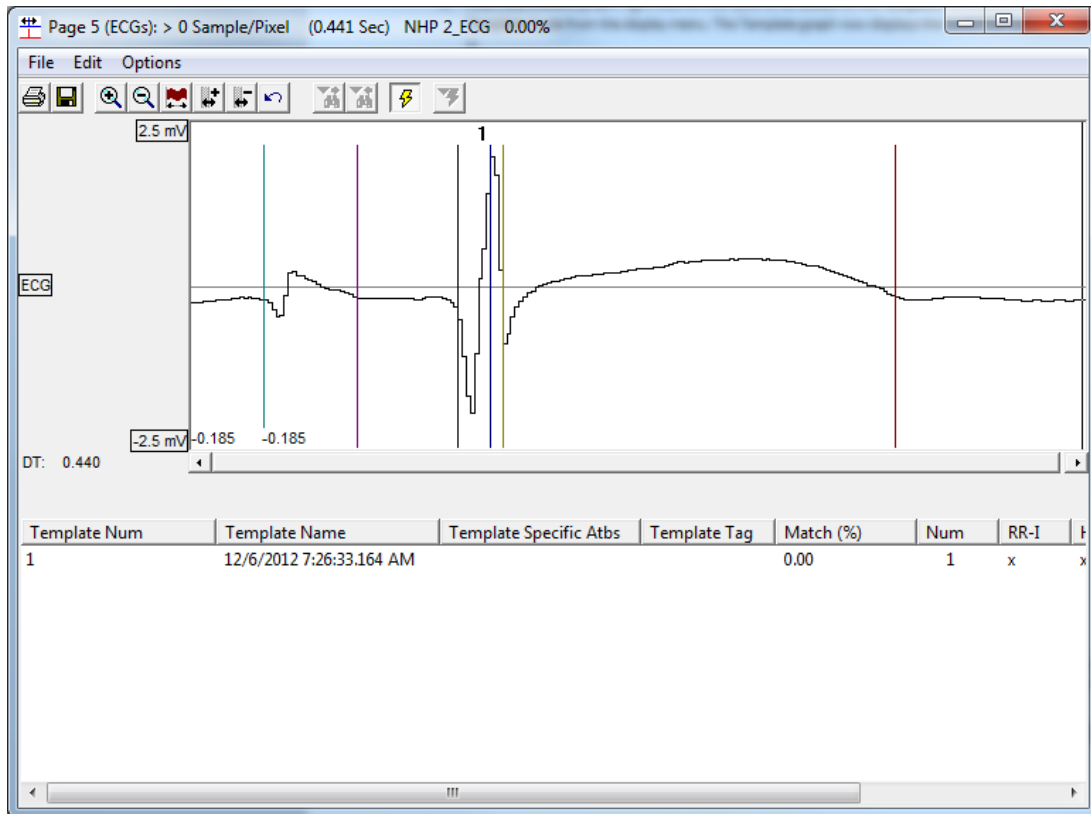
To add **Templates** to the **Template Library**:

1. Locate an ECG cycle from the **Primary** graph.
2. If necessary, adjust the **Validation Marks** to accurately reflect the appropriate positions of the **ECG Marks** of interest.

Note: **ECG Marks** may be moved within the **Template** graph page.

3. From the **Primary** graph, right-click on the cycle to be added to the **Template Library** and select **Add Template Cycle** from the display menu. The Template graph now displays the cycle that was just added to it.

Note: An **Autoscale** may need to be performed for both the X and Y axes to see the full Cycle.



The list view displays the following:

Template Number The **Cycle Number** displayed in the waveform area.

Template Name Defaults to the time associated with the **Template** cycle.

Template Specific Attribute Indicates whether **Template Specific Attributes** are enabled for the **Template** cycle. Template Specific Attributes permit specific attributes to be used for the Template cycle, overriding the global attribute settings used when Template Analysis is executed.

The current use case for enabling these is to mark Isolated P waves when searching for Second Degree Atrioventricular (AV) Block using **Data Insights**.

For more information, see **Data Insights | Finding Second Degree AV Block using Template Specific Attributes** within the **Tutorial** section of this manual.

Template Tag Indicates the applied Template Tag(s) associated with the Template cycle.

Once a Template Tag is associated with a Template cycle, the Tag is also associated with any cycles within the waveform that are matched to the Template cycle. This is useful to identify unique waveform morphologies. Data Insights may then be used to search, visualize, and report on these cycles.

For more information, see **Data Insights | Finding Unique Cycle Morphologies using Template Tags** within the **Tutorial** section of this manual.

Match % Indicates the percent match of the **Template** within the matched cycles. The **Match %** will always add up to 100%.

Derived Parameters Derived parameters for the Template cycle.

Dialog Match % After the analysis is complete a percentage will appear in the **Template** graph page after the title (in the title bar). This indicates the percentage of cycles that the **Template Library** matched within the data set.

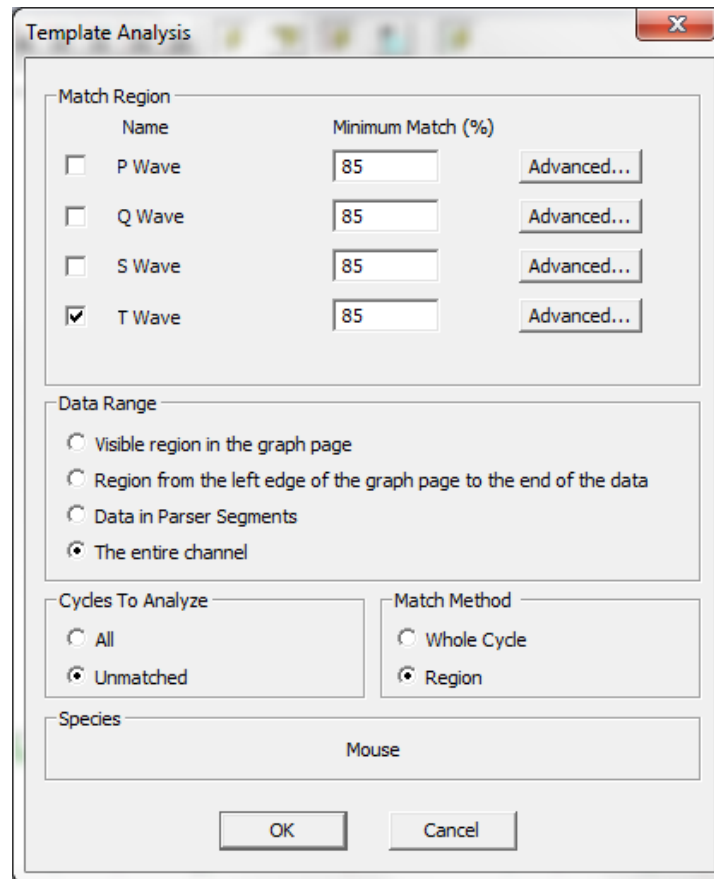
The next step is to analyze the data using the **Template** that was added.

ANALYZING WITH THE TEMPLATE LIBRARY

The following section outlines the process to execute ECG PRO analysis and describes the various dialogs.

To analyze using the current **Template Library**:

1. Right-click the **Display Pane** associated with the Subject's Channel you wish you analyze from the **Primary** graph and select **Analyze [Entire Library]**. This will launch the **Template Analysis** dialog shown below.



2. Select the desired **Template Match Region** to which all other ECG cycles will be compared.
In this example, the T Wave is selected as the **Match Region** for analysis with a **Minimum Match** of 85%. This means that if the T Region does not match with at least 85% confidence, the cycle will not be marked as matched.

If needed, change the advanced settings for the desired Match Region. See the **Advanced Setup** section below.

Note: Multiple **Match Regions** may be selected depending on the desired output from the analysis (the **Derived Parameters** of interest).

3. Select a **Data Range** on which to perform the analysis.

The **Data Range** allows you to reanalyze the data visible in the graph, the data from the left edge of the visible region from the primary graph forward to the end of the loaded data set, the data within the **Parser Segments**, or the entire channel.

Note: When on the first analysis pass using ECG PRO, the entire channel is typically used. However, there may be value to setting up regular **Parser Segments** when working with large (24 hour or more) data sets. This can be used to focus on a representative subset of the data while setting up the **Template Library**. When the **Template Library** is complete the entire data set can be analyzed using the **Template Library**. This can speed up the Analysis process significantly. See the **Data Parser** section of this manual to learn how to set up rule based **Parser Segments**.

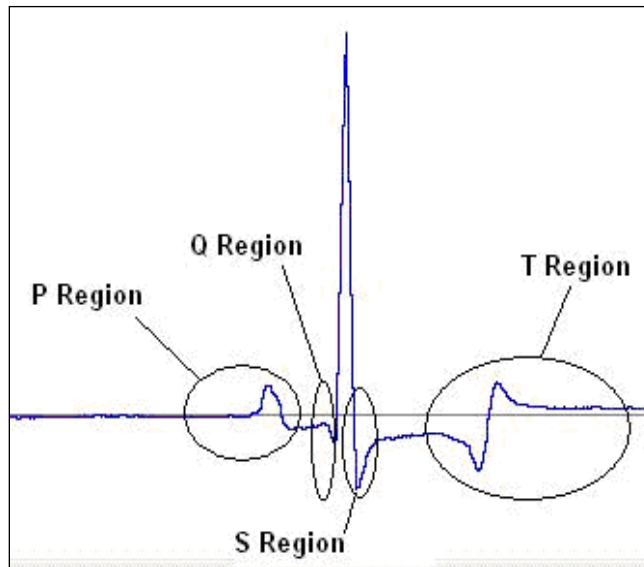
4. Select the type of **Cycles to Analyze**

- a. **All** will compare the Template Library to All cycles with a valid R mark.
- b. **Unmatched** will skip previously matched cycles and compare the **Template Library** to only the unmatched cycles. This is useful when adding additional **Templates** to the **Template Library** for greater match coverage, as the processing time is quicker.

5. Select the desired **Match Method**.

When multiple **Match Regions** are selected and **Whole Cycle** is chosen, the **Template** that, on average, matches the cycle best will be used to place the marks. When **Region** is used, the best match for each **Match Region** will be used to place the marks, possibly from different **Templates**.

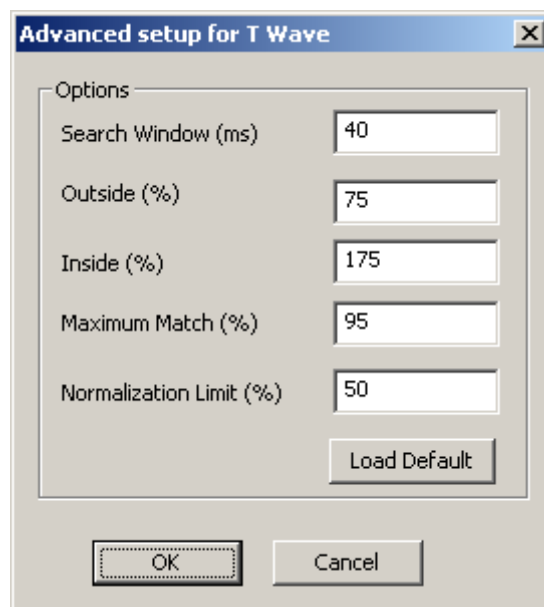
For the different match regions please refer to the image below:



6. Select **OK** to execute the analysis.
7. Add additional **Template Cycles** to the **Template Library** and re-run the **Template** analysis until your desired **Dialog Match %** is achieved.
8. **Template Libraries** are saved through **Templates | Save** when the Review Session is closed.

ADVANCED SETUP

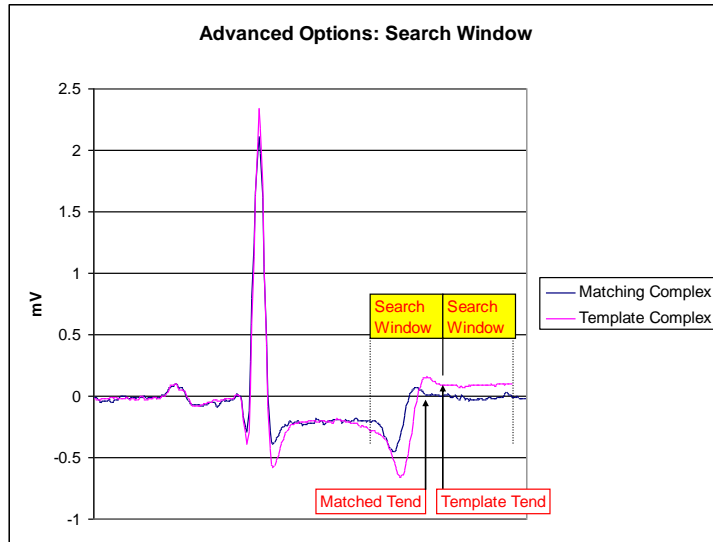
From the **Template Analysis** dialog select the **Advanced** button for a specific **Match Region**. The dialog is shown below. It is unlikely that users will need to modify the **Advanced** settings.



The available options are:

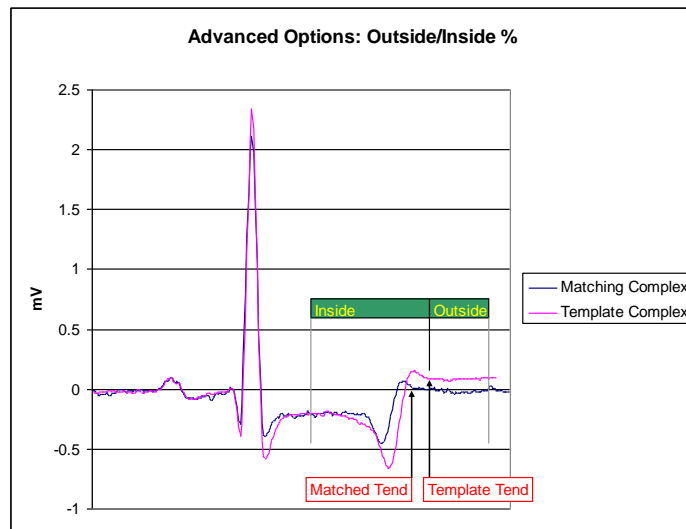
Search Window

Template analysis will search for the best match for a Match Region, being P, Q, S, or T over the range of data specified by the Search Window. Each region has a specific mark that the search window is centered around. The example below displays the search window for Tend. The 40 millisecond window, displayed in yellow below, is applied to the Trend data from the template to locate a match within the unmatched data that is being analyzed. Below are graphical representations of a template and data that is being analyzed.



Inside and Outside %

Specifies the range of template data for the selected region used in the comparison. Once a candidate complex has been located, the template analysis will search the specified percentage on each side of the mark. In the case below the Outside % follows the mark and the Inside % precedes the mark. Displayed below is the range for the Trend windows.



Further explanation of Inside and Outside percentages:

The Inside and Outside percentages relate to how much data around a mark is used for matching purposes. The specifics for each mark follow:

P Wave

The percentages relate to the region between the **P Start** and **P End**.

When matching against the **P Start mark**, an inside % of 80% and outside % of 35% corresponds to:

- **Inside time** = 80% of the time between P start and P end
- **Outside time** = 35% of the time between P start and P end
- **Inside time is to the right** of the P start mark
- **Outside time to the left** of the P start mark

When matching against the **P End** mark, an inside % of 80% and outside % of 35% corresponds to:

- **Inside time** = 80% of the time between P start and P end
- **Outside time** = 35% of the time between P start and P end
- **Inside time is to the left** of the P end mark
- **Outside time to the right** of the P end mark

Q Wave

The percentages relate to the region between the **Q mark** and the **R mark**.

An inside % of 120% and outside % of 30% corresponds to:

- **Inside time** = 120% of the time between Q and R
- **Outside time** = 30% of the time between Q and R
- **Inside time is to the right** of the Q mark (this will extend past the R mark)
- **Outside time to the left** of the Q mark

Similarly for the **S** and **T** marks, where:

For the **S** mark, the region is between the **S end and the R** mark

For **T** marks, the region is between the **T peak and T end** marks

- **Maximum Match (%)** - Once a template matches the data at or above the maximum match, no further match attempts are made for the cycle.
- **Normalization Limit (%)** - is used to control how much of a change in amplitude between a template and data will still be regarded as a match. If a user is interested in amplitude changes this parameter should be kept small.

The **Load Default** button will add the species specific default values.

BATCH TEMPLATE ANALYSIS

Batch Template Analysis (analysis across multiple channels at once) may be performed by selecting this option via the **Actions** menu located in the main Ponemah window. This is typically used after **the Template Libraries** have been configured for each Subjects' ECG Channels.

Batch Template Analysis can be applied to the entire data set or across the defined **Parser Segments** of the data set. From **Actions** within a Review session, select **Batch Template Analysis**. Once started, **Batch Template Analysis** will analyze all valid channels without requiring any user interaction, and is capable of being started immediately after the Review file has been loaded. Prior to starting a **Template Batch Analysis**, the user has the option of using each individual channel's **Match Range** settings or overriding all settings with global **Match Range** settings. The **Data Range**, **Cycles to Analyze** and **Match Method** will be selectable and applied globally to each

channel, these settings will not use the settings saved within each channel. The **Settings Override** option, along with the global settings themselves, will be saved within Review.

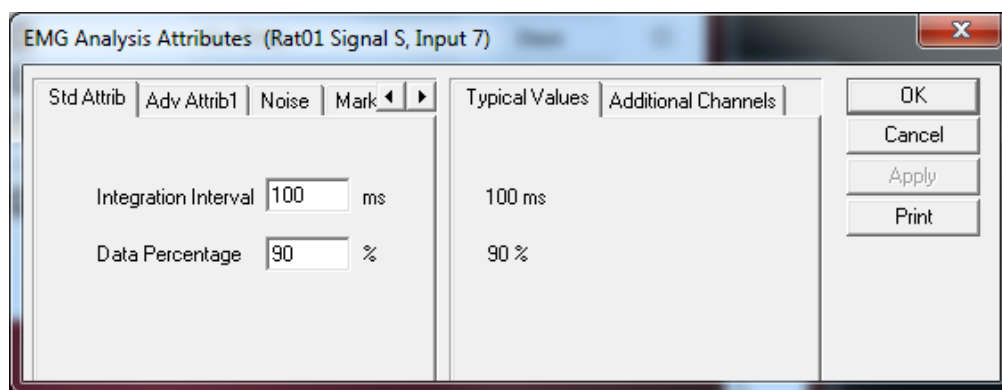
ELECTROMYOGRAM (EMG)

The Electromyogram Analysis Module analyzes electromyogram signals. The analysis calculates derived parameters from the input signal over a user specified logging period.

ATTRIBUTE WINDOW

The **EMG Analysis** attributes dialog allows you to modify the signal analysis for different types of EMG signals and signal conditions. If an analysis change in the **Attributes** dialog is performed mid-cycle, then the attribute change will not take effect until the following cycle.

STANDARD ATTRIBUTES TAB



EMG Standard Attribute Tab

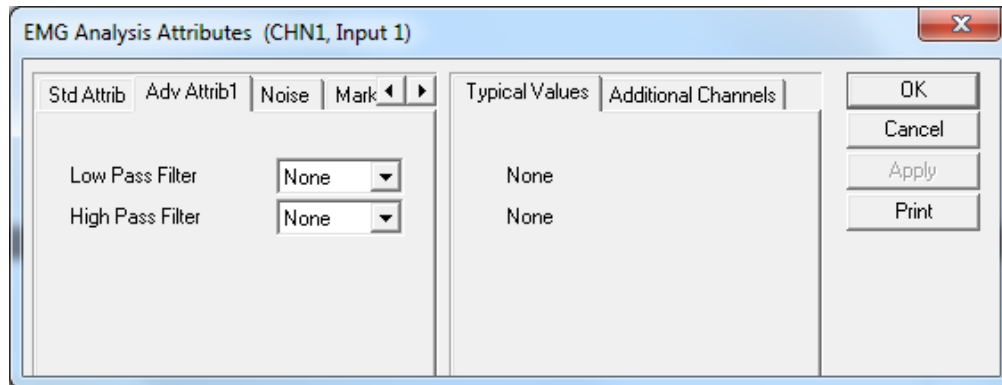
Integration Interval

The period over which the EMG signal is integrated before resetting. The result of the previous integration is displayed over this period.

Data Percentage

ADVANCED ATTRIBUTES TAB

The **Advanced** attributes allow selection of attributes which are not commonly changed during Acquisition or Review.



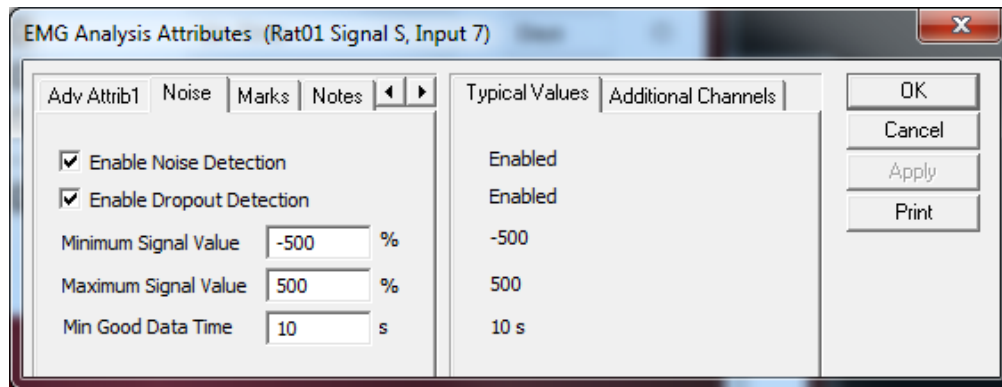
EMG Advanced Attribute Tab

Low Pass Filter Selection of Low Pass filter in hertz.

High Pass Filter Selection of High Pass filter in hertz.

NOISE TAB

The **Noise Tab** contains attributes that are used to identify noisy data. On identifying “noisy” data, as defined by the user, **Bad Data Marks** will be placed to span the noisy sections.



EMG Noise Tab

Enable Noise Detection Enables the **Noise Detection** attributes for the automatic placement of **Bad Data Marks**.



Enable Dropout Detection If **Dropout Detection** is enabled, any negative dropout data encountered when analyzing data shall be bracketed **by Bad Data Marks** such that the dropout data falls within the **Bad Data Start** and **End** marks. The dropout check shall be performed on unfiltered samples.

- Minimum Signal Value** User defined threshold for determining the **minimum value** for acceptable data. Data that falls below this threshold will be considered noise and bracketed by **Bad Data Marks**.
- Maximum Signal Value** User defined threshold for determining the **maximum value** for acceptable data. Data that exceeds this threshold will be considered noise and bracketed by **Bad Data Marks**.
- Minimum Good Data Time** Provides the user the ability to mark data as bad between two **Bad Data Mark** regions. If the time between the regions is less than the value specified. If the time is less than what is specified, the **Bad Data Mark** region will appear as one contiguous segment.

MARKS (VALIDATION) TAB

The **EMG** analysis displays a validation tick mark at the end of each Integration Interval. This mark is used to denote the logging mark of the cycle (interval) as well as used to determine the cycle number.

The validation marks and their meanings are listed below:

Color		Meaning
Black		Integration Interval
		Mark Cycle Numbers

TYPICAL VALUES

Use this value as a guideline for a first-time setup. Under different situations, a value above or below the typical value should be used.

Attribute	Setting	Units
Integration Interval	100	ms

DERIVED PARAMETERS

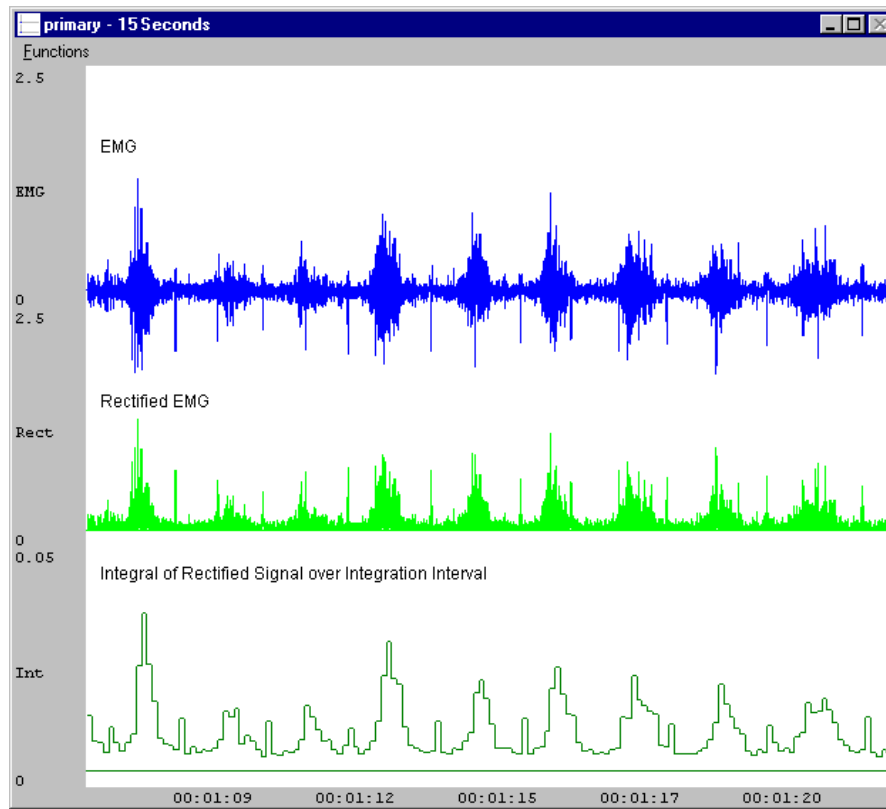
Derived Parameters are selected within the **Channel Details** of the **Subject Setup** dialog. The **Derived Parameters** selected in this dialog will be calculated, and the results will be placed in the Derived Parameter List View(s). The following details the available **Derived Parameters** from the Electromyogram module and the averaging method used within Review.

Name	Definition	Review Averaging Method
Num	The number of the cardiac cycle. This number will appear on a primary graph page when validation marks are turned on and the cycle numbers are enabled. When running in a logging mode other than 1 epoch, the last cycle number will be reported.	Recent
INT	The integral of the rectified signal over the integration interval.	Mean

PEAK	The maximum interval over the logging period.	Max
INT2	The integral of rectified input signal over the logging rate.	Mean

ONLINE SCREENS AND FUNCTIONS

The following is an example of a Primary graph displaying an EMG signal.



EMG, Rectified EMG and EMG Integration

In the above figure, the Electromyogram signal is displayed along with the rectified signal and its integral over the **Integration Interval**.

PRESENTATION SIGNALS

Below is a list of presentation signals that are available for the EMG Analysis Module:

Signal	Description
EMG	This is the original EMG input signal after applying any software filters.
Rectified	This will display the rectified EMG signal.
Integral	This will display the integral of the rectified signal over the integration Interval.

DATA REVIEW

This is a list of the Data Review related features of the EMG Analysis Module. The analysis specific portion of Data Review centers on the marks that the user is permitted to display, insert, and delete and how the User is permitted to move them.

Displaying Marks and Cycle Numbers	The marks and cycle numbers displayed in a Review Primary graph page Display Pane are controlled through the Marks Tab in the Analysis Attributes dialog. The Analysis Attributes dialog is accessed through the right click menu – Analyze [Attributes] .
Mark Operations	EMG only supports the Integration Interval mark.
Inserting Marks	Marks may be inserted by right clicking at the point of insertion in the Primary Graph Display Pane of the Channel of interest. The pop-up menu that is displayed will provide the option to insert marks as appropriate. The list of marks available for insertion will depend on the marks adjacent to the point of insertion; signal morphology is not considered.
Insert EMG Cycle	Inserting EMG cycles is not permitted as the mark placement is based on the time specified for the Integration Interval.
Deleting Marks	Deleting EMG cycles is not permitted.
Moving Marks	Moving EMG cycles is not permitted.
Calculations	The calculations of derived parameters are identical to those performed during acquisition.
Logging Mark	The Logging Mark for an EMG cycle is the Integration Interval . The time at the Logging Mark is the time used to report a cycle's derived data.
End of Cycle	The end of an EMG cycle occurs one sample prior to the next cycle's Integration Interval mark.

ATTRIBUTES IN REVIEW

The following table describes the effects of changing EMG attributes in Review. Please refer to the **Analysis Attributes Dialog | Attribute Types** section for the meanings of the effects of each attribute type described.

Attribute	Effect On Review
Integration Interval	Signal Interpretation
High Pass Filter	Signal Conditioning, Calculation, Redraw
Low Pass Filter	Signal Conditioning, Calculation, Redraw
Marks and cycle numbers	Redraw
Precision	Precision
Enable Noise Detection	Signal Interpretation
Minimum Signal Value	Signal Interpretation
Maximum Signal Value	Signal Interpretation
Maximum Heart Rate	Signal Interpretation
Minimum Good Data Time	Signal Interpretation

TROUBLESHOOTING

There is no troubleshooting for this analysis module.

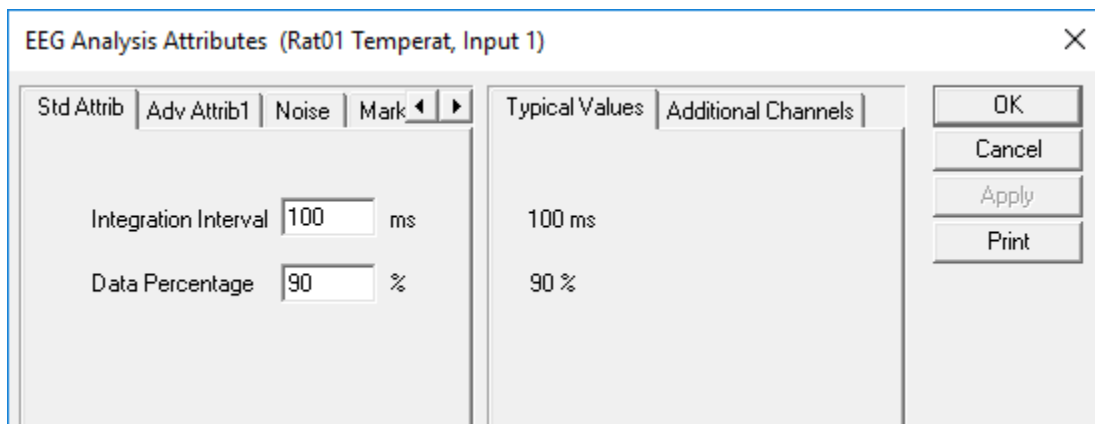
ELECTROENCEPHALOGRAM (EEG)

The Electroencephalogram Analysis Module analyzes electrical activity signals from the brain. The analysis calculates derived parameters from the input signal over a user specified logging period.

ATTRIBUTE WINDOW

The **EEG Analysis** attributes dialog allows you to modify the signal analysis for different types of EEG signals and signal conditions. If an analysis change in the **Attributes** dialog is performed mid-cycle, then the attribute change will not take effect until the following cycle.

STANDARD ATTRIBUTES TAB



EEG Standard Attribute Tab

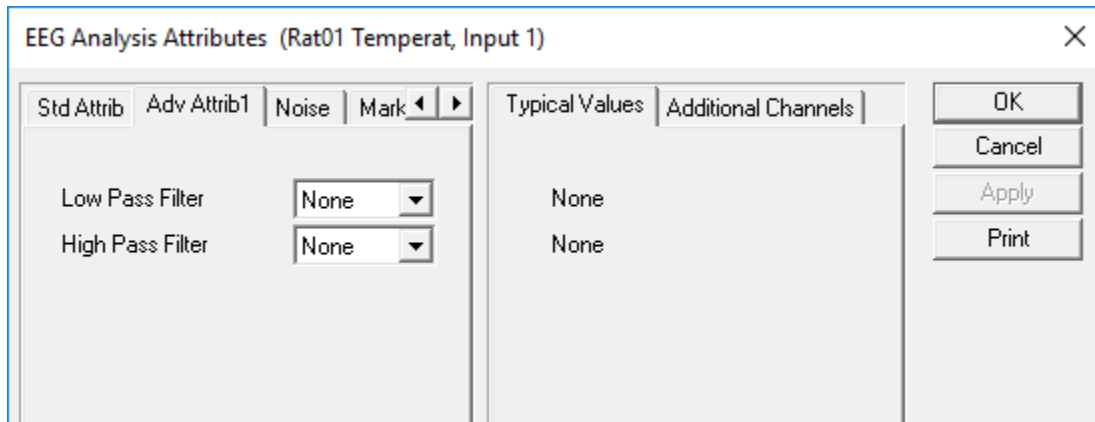
Integration Interval

The period over which the EEG signal is integrated before resetting. The result of the previous integration is displayed over this period.

Data Percentage

ADVANCED ATTRIBUTES TAB

The **Advanced** attributes allow selection of attributes which are not commonly changed during Acquisition or Review.



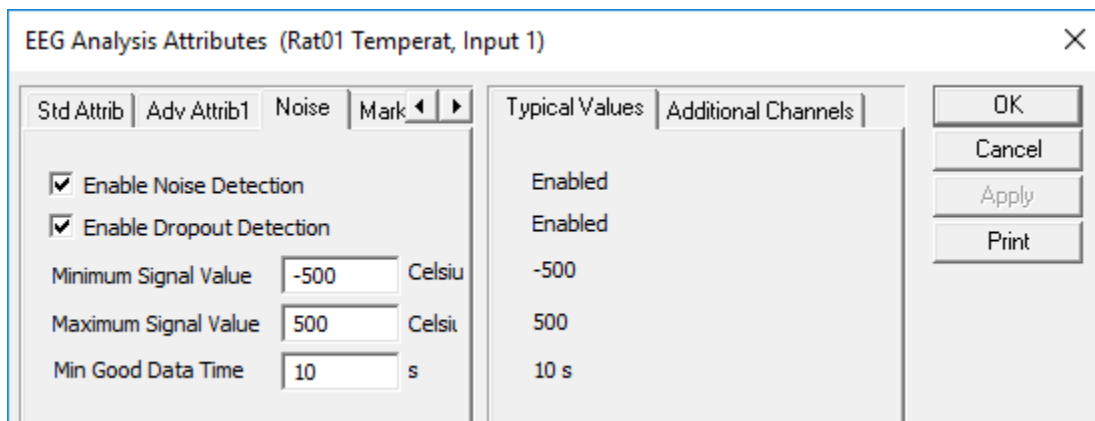
EEG Advanced Attribute Tab

Low Pass Filter Selection of Low Pass filter in hertz.

High Pass Filter Selection of High Pass filter in hertz.

NOISE TAB

The **Noise Tab** contains attributes that are used to identify noisy data. On identifying “noisy” data, as defined by the user, **Bad Data Marks** will be placed to span the noisy sections.



EEG Noise Tab

Enable Noise Detection Enables the **Noise Detection** attributes for the automatic placement of **Bad Data Marks**.



Enable Dropout Detection If **Dropout Detection** is enabled, any negative dropout data encountered when analyzing data shall be bracketed **by Bad Data Marks** such that the dropout data falls within the **Bad Data Start** and **End** marks. The dropout check shall be performed on unfiltered samples.

- Minimum Signal Value** User defined threshold for determining the **minimum value** for acceptable data. Data that falls below this threshold will be considered noise and bracketed by **Bad Data Marks**.
- Maximum Signal Value** User defined threshold for determining the **maximum value** for acceptable data. Data that exceeds this threshold will be considered noise and bracketed by **Bad Data Marks**.
- Minimum Good Data Time** Provides the user the ability to mark data as bad between two **Bad Data Mark** regions. If the time between the regions is less than the value specified. If the time is less than what is specified, the **Bad Data Mark** region will appear as one contiguous segment.

MARKS (VALIDATION) TAB

The **EEG** analysis displays a validation tick mark at the end of each Integration Interval. This mark is used to denote the logging mark of the cycle (interval) as well as used to determine the cycle number.

The validation marks and their meanings are listed below:

Color		Meaning
Black		Integration Interval
		Mark Cycle Numbers

TYPICAL VALUES

Use this value as a guideline for a first-time setup. Under different situations, a value above or below the typical value should be used.

Attribute	Setting	Units
Integration Interval	100	ms

DERIVED PARAMETERS

Derived Parameters are selected within the **Channel Details** of the **Subject Setup** dialog. The **Derived Parameters** selected in this dialog will be calculated, and the results will be placed in the Derived Parameter List View(s). The following details the available **Derived Parameters** from the Electromyogram module and the averaging method used within Review.

Name	Definition	Review Averaging Method
Num	The number of the cardiac cycle. This number will appear on a primary graph page when validation marks are turned on and the cycle numbers are enabled. When running in a logging mode other than 1 epoch, the last cycle number will be reported.	Recent
INT	The integral of the rectified input signal over the integration interval.	Mean

PEAK	The maximum interval over the logging period.	Max
INT2	The integral of rectified input signal over the logging rate.	Mean

PRESENTATION SIGNALS

Below is a list of presentation signals that are available for the EEG Analysis Module:

Signal	Description
EEG	This is the original EEG input signal after applying any software filters.
Rectified	This will display the rectified EEG signal.
Integral	This will display the integral of the rectified signal over the integration Interval.

DATA REVIEW

This is a list of the Data Review related features of the EEG Analysis Module. The analysis specific portion of Data Review centers on the marks that the user is permitted to display, insert, and delete and how the User is permitted to move them.

Displaying Marks and Cycle Numbers	The marks and cycle numbers displayed in a Review Primary graph page Display Pane are controlled through the Marks Tab in the Analysis Attributes dialog. The Analysis Attributes dialog is accessed through the right click menu – Analyze [Attributes] .
Mark Operations	EEG only supports the Integration Interval mark.
Inserting Marks	Marks may be inserted by right clicking at the point of insertion in the Primary Graph Display Pane of the Channel of interest. The pop-up menu that is displayed will provide the option to insert marks as appropriate. The list of marks available for insertion will depend on the marks adjacent to the point of insertion; signal morphology is not considered.
Insert EEG Cycle	Inserting EEG cycles is not permitted as the mark placement is based on the time specified for the Integration Interval.
Deleting Marks	Deleting EEG cycles is not permitted.
Moving Marks	Moving EEG cycles is not permitted.
Calculations	The calculations of derived parameters are identical to those performed during acquisition.
Logging Mark	The Logging Mark for an EEG cycle is the Integration Interval . The time at the Logging Mark is the time used to report a cycle's derived data.
End of Cycle	The end of an EEG cycle occurs one sample prior to the next cycle's Integration Interval mark.

ATTRIBUTES IN REVIEW

The following table describes the effects of changing EEG attributes in Review. Please refer to the **Analysis Attributes Dialog | Attribute Types** section for the meanings of the effects of each attribute type described.

Attribute	Effect On Review
Integration Interval	Signal Interpretation
High Pass Filter	Signal Conditioning, Calculation, Redraw
Low Pass Filter	Signal Conditioning, Calculation, Redraw
Marks and cycle numbers	Redraw
Precision	Precision
Enable Noise Detection	Signal Interpretation
Minimum Signal Value	Signal Interpretation
Maximum Signal Value	Signal Interpretation
Maximum Heart Rate	Signal Interpretation
Minimum Good Data Time	Signal Interpretation

TROUBLESHOOTING

There is no troubleshooting for this analysis module.

GLUCOSE (GLU)

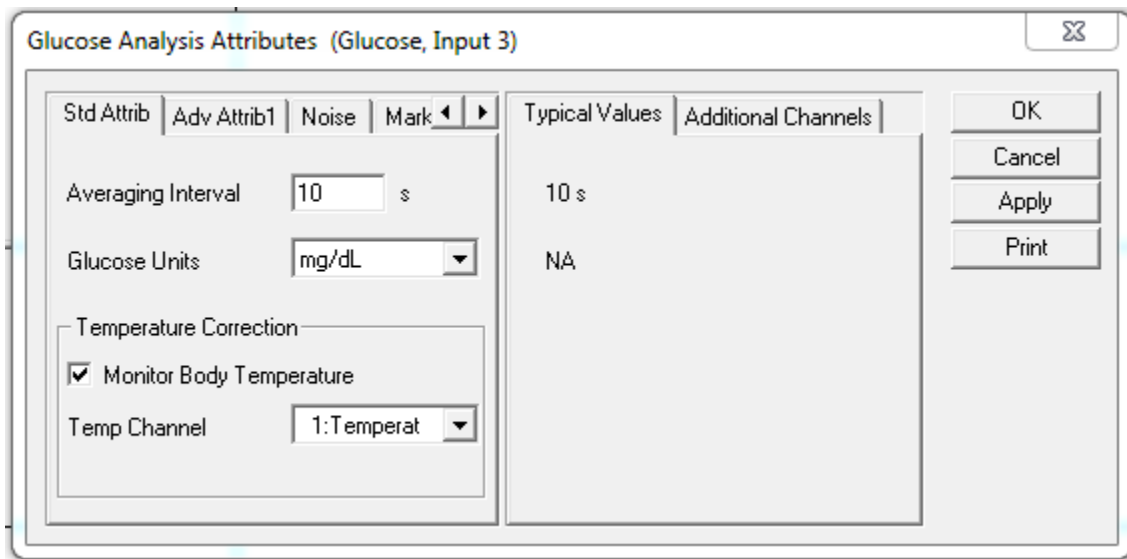
The **Glucose** analysis module analyzes the blood glucose signal obtained from the HD-XG implant. The analysis calculates the common parameters that are associated with glucose after the signal has been calibrated.

ATTRIBUTES WINDOW

The **Glucose Analysis Attributes** dialog allows you to modify the signal analysis for different types of glucose signals and signal conditions. If an analysis change in the **Attributes** dialog is performed **Averaging Interval**, then the attribute change will not take effect until the following cycle.

STANDARD ATTRIBUTES

The **Standard** attributes allow setting the most common attributes that would need to be changed during Acquisition or Review.



Glucose Standard Attributes Tab

Averaging Interval

Interval at which glucose “cycles” will be reported by the analysis module. This represents the finest granularity at which data are reported. Data may be further averaged depending on the **Logging Rate** or **Data Reduction** settings.

A **Mark** will be placed every **Averaging Interval**, referenced from the start of the acquisition i.e. elapsed time 0.

Glucose Units

Allows the user to select either **mg/dL** or **mmol/L**. This selection is used to set the **Units** for other attributes and to update the “**Min Calibration Range**”

value and units within the **Glucose Calibrations | Calibration Settings** dialog.

Monitor Body Temperature

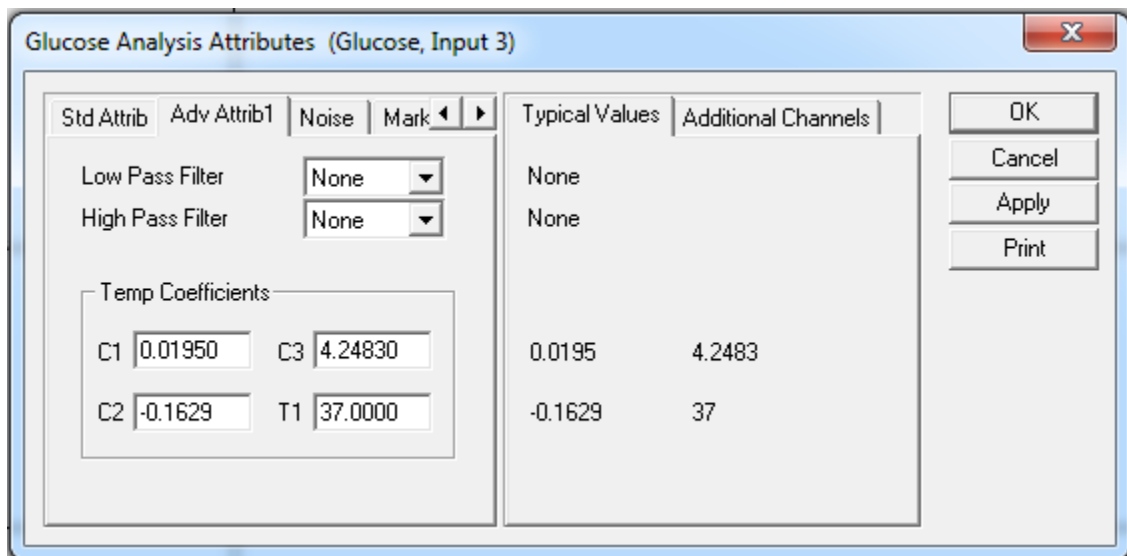
Checking this box will enable the selection of the **Temp Channel**.

Temperature Channel

The channel from which temperature values are retrieved for calculating corrected nA. This will default to the temperature channel from the HD-XG device associated with the Subject.

ADVANCED ATTRIBUTES TAB

The **Advanced** attributes allow selection of attributes which are not commonly changed during Acquisition or Review.



Glucose Advanced Attribute Tab

Low Pass Filter

Selection of Low Pass filter in hertz.

High Pass Filter

Selection of High Pass filter in hertz.

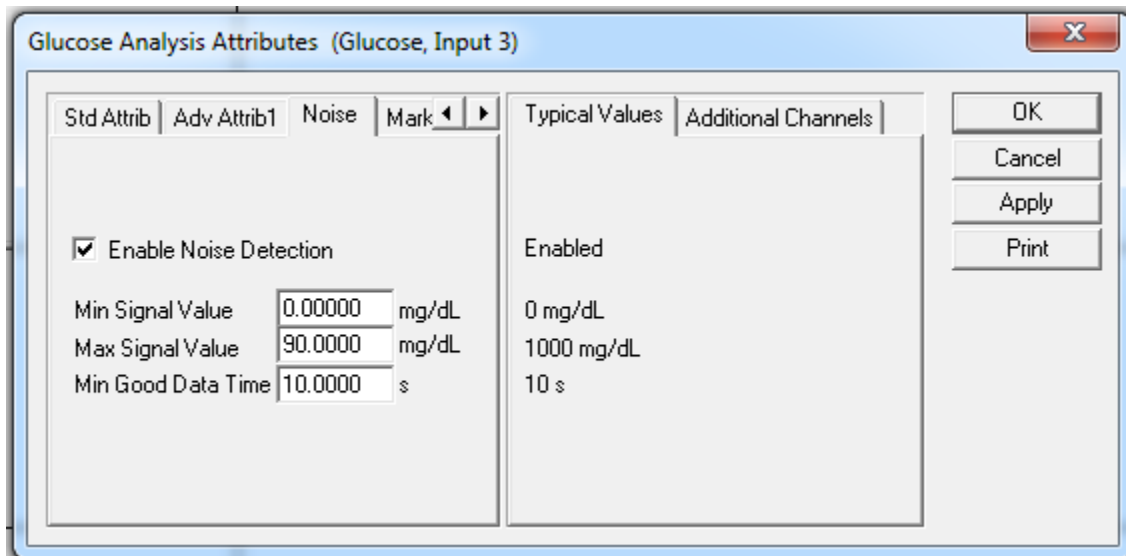
Temp Coefficients

Coefficients used to apply temperature correction to the input nA signal. Four coefficients are required.

DSI recommends not changing these values.

NOISE TAB

The **Noise Tab** contains attributes that are used to identify noisy data. On identifying “noisy” data, as defined by the user, **Bad Data Marks** will be placed to span the noisy sections.



Glucose Noise Tab

Enable Noise Detection Enables the **Noise Detection** attributes for the automatic placement of **Bad Data Marks**. Enabling this function will also place **Bad Data Marks** around data that is defined as **Dropout**.

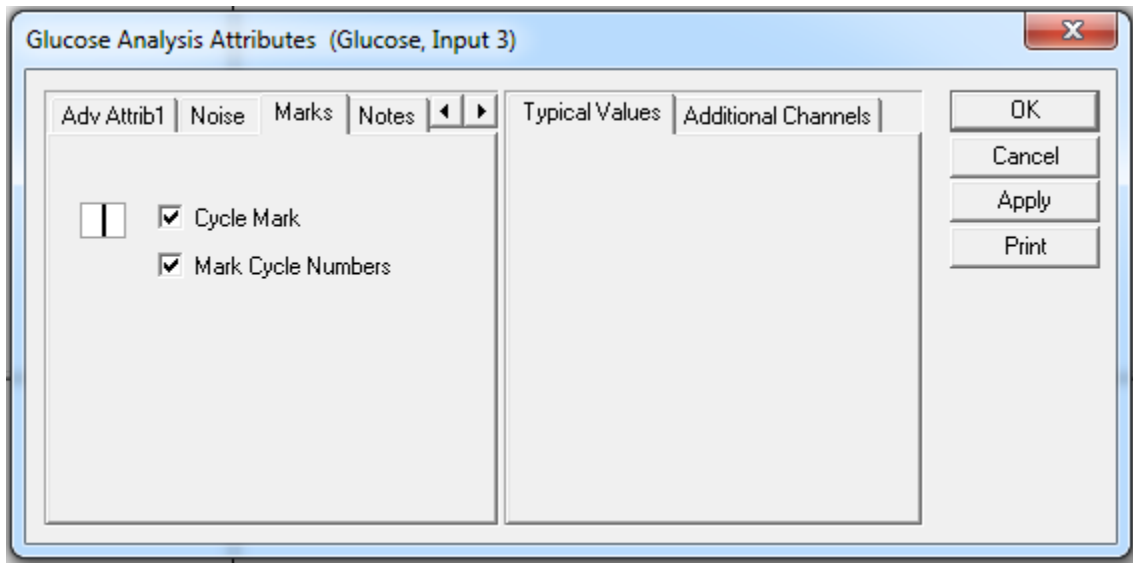
Minimum Signal Value User defined threshold for determining the minimum value for acceptable data. Data that falls below this threshold will be considered noise and bracketed by **Bad Data Marks**.

Maximum Signal Value User defined threshold for determining the maximum value for acceptable data. Data that exceeds this threshold will be considered noise and bracketed by **Bad Data Marks**.

Min Good Data Time If multiple **Bad Data Marks** exist in the file and are separated by less than the time specified in the window, the analysis will combine the sections to create one contiguous **Bad Data Mark** section.


MARKS (VALIDATION) TAB

The **Glucose** analysis displays validation tick marks for each cardiac cycle. Each cardiac cycle should have only one set of validation marks. These marks verify that the system is analyzing the glucose signal correctly.



Glucose Marks Tab

The validation marks and their meanings are listed below:

Color		Meaning
Black		Cycle Mark

TYPICAL VALUES

Use these values as guidelines for a first time setup. Under different situations, values above or below the typical values will have to be used.

Attribute	Setting	Units
Averaging Interval	10	s
Glucose Units	mg/dL or mmol/L	N/A
Monitor Body Temperature	Enabled	N/A
Temperature Channel	Enabled	Input channel associated with same Subject
Low Pass Filter	None	Hz
High Pass Filter	None	Hz
Temp Coefficients	C1=0.0195 C2=-0.1629 C3=4.2483 T1=37	N/A

DERIVED PARAMETERS

Derived Parameters are selected within the **Channel Details** of the **Subject Setup** dialog. The derived parameters selected in this dialog box will be calculated, and the results will be placed in the **Derived Parameter List View(s)**. The following details the available **Derived Parameters** from the ECG module and the averaging method used within Review.

Name	Definition	Review Averaging Method
Num	The number of the averaging interval since start of Acquisition. This number will appear on a primary graph page when validation marks are turned on and the cycle numbers are enabled. When running in a logging mode other than 1 epoch, the last cycle number will be reported.	Recent
nAavg	Average of nA samples within the averaging interval. All samples within a cycle are included in the calculation, with the following exceptions: <ul style="list-style-type: none"> • Railed samples • Samples within bad data marks 	Mean
nAmax	Maximum of nA samples within the averaging interval. All samples within a cycle are included in the calculation, with the following exceptions: <ul style="list-style-type: none"> • Railed samples • Samples within bad data marks 	Mean
nAmin	Minimum of nA samples within the averaging interval. All samples within a cycle are included in the calculation, with the following exceptions: <ul style="list-style-type: none"> • Railed samples • Samples within bad data marks 	Mean
Gavg	Average of calibrated Glucose signal samples within the averaging interval. All samples within a cycle are included in the calculation, with the following exceptions: <ul style="list-style-type: none"> • Railed samples • Samples within bad data marks 	Mean
Gmax	Maximum of calibrated Glucose signal samples within the averaging interval. All samples within a cycle are included in the calculation, with the following exceptions: <ul style="list-style-type: none"> • Railed samples • Samples within bad data marks 	Mean
Gmin	Minimum of calibrated Glucose signal samples within the averaging interval.	Mean

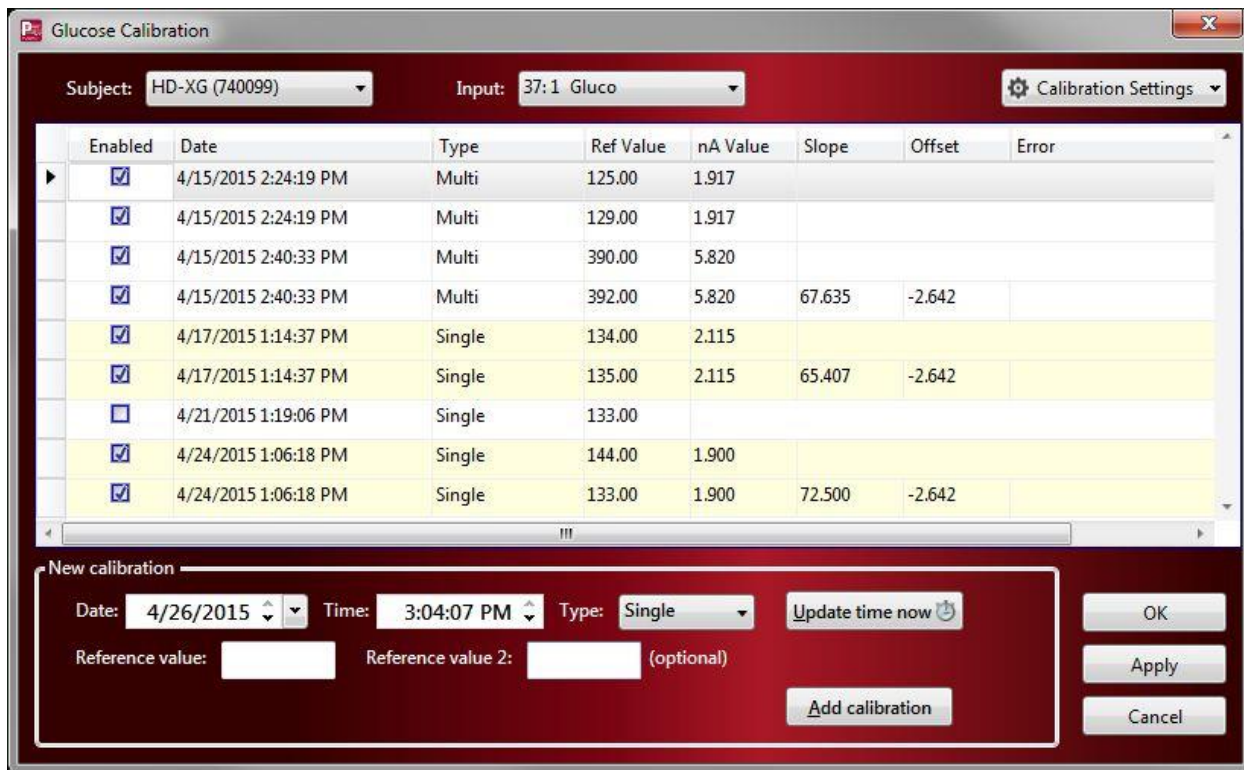
	All samples within a cycle are included in the calculation, with the following exceptions: <ul style="list-style-type: none"> • Railed samples • Samples within bad data marks 	
Samp	The number of samples used in reporting nAxxx and Gxxx derived parameters.	Minimum
Ref-Ds	The averaged Reference values of all disabled calibration points during the logging interval.	Mean
Ref-En	The averaged Reference values of all enabled calibration points during the logging interval.	Mean
Slope	The averaged interpolated Slope during the logging period.	Mean
Offset	The averaged interpolated Offset during the logging period.	Mean

CALIBRATION – IN VIVO

It is necessary to perform an initial multi-point calibration and to collect periodic calibration points at least twice per week throughout the duration of a glucose study. Calibration data is collected using blood samples from the tail or other appropriate sampling point with analysis performed by the StatStrip Xpress glucose meter or an equivalent analytical method. Calibration reference points should always be collected while the Ponemah Acquisition program is actively collecting data, and ideally, while the Subject is on or within range of the telemetry receiver (typically within about 25 cm of the receiver).

Ponemah Acquisition provides a dialog to facilitate entry of the calibration values that will later be used during Review. This can be accessed from the **Toolbar** menu by clicking on the **Glucose Calibration** icon. This provides several important features to facilitate the process:

- Automated or manual entry of date/time stamps associated with each sample point
- Entry of individual or duplicate samples for each time point
- Designation of calibration as single-point or multi-point calibration (this can be changed later)
- Ability to add multiple calibration values without dismissing the dialog
- Ability to switch between available subjects without dismissing the dialog



Each subject will have its own list of Glucose calibration reference values. If the dialog provided in Ponemah doesn't meet your particular needs, it is also possible to add these calibration reference values to an Excel file and import them during a Review session.

CALIBRATION FREQUENCY RECOMMENDATION

The glucose sensor is affected over the implant duration by the presence of fibrin, tissue, and glucose levels. For optimal performance, the HD-XG must be calibrated using reference measurements over the course of a study:

- Initial multi-point calibration
- Twice weekly single-point calibration
- End-of-study multi-point calibration

Raw telemetry data is recorded in nanoamperes (nA) and calibration reference values are recorded in milligrams per deciliter (mg/dL) or millimoles per liter (mmol/L). The calibration algorithm converts the telemetry (nA) data to values that are equivalent to the appropriate mg/dL or mmol/L values.

SELECTING A CALIBRATION REFERENCE

Several calibration reference options exist, including glucose analyzers, reagents and diagnostics equipment, and glucometers with test strips. DSI recommends the Nova StatStrip Xpress meter and test strips, as it provides comparable results to other laboratory analytics with the advantage and convenience of requiring smaller blood samples (1.2 μ L) and providing immediate results. The StatStrip Xpress provides measurement and correction for hematocrit and other common interferences, as well as a higher level of accuracy than most alternative hand-held glucometers. See the DSI website www.datasci.com/glucose for more information on the StatStrip Xpress.

MULTI-POINT CALIBRATION

A multi-point calibration establishes a linear relationship between the sensor output and blood glucose levels. DSI typically recommend using two points (baseline and slightly post-peak) for calibration purposes, but can support multiple points over the course of the challenge, such as an Oral Glucose Tolerance Test (OGTT). The blood glucose levels should differ by at least 200 mg/dL (11 mmol/L) to minimize calibration error caused by inaccuracies of the glucose reference. DSI recommends using an OGTT for multi-point calibration; however, an Intraperitoneal Glucose Tolerance Test (IPGTT) may also be used.

DSI recommends that at least two people are involved in the calibration process. One person is responsible for recording the calibration values on the Ponemah system and providing direction on the appropriate sample times. The second person handles the subjects, collects the samples, and reports the measurements. Additional personnel can be leveraged to streamline the process and increase throughput.

In a normal rat, the baseline blood glucose level might be approximately 100 mg/dL (5.5 mmol/L); while the peak value after an OGTT might be at least 300 mg/dL (16.7 mmol/L). Peak glucose values will typically occur 12-16 minutes post-dose during an OGTT in a healthy animal. DSI recommends taking a reading 5 to 10 minutes after this peak for an OGTT or 3 to 5 minutes after this peak for an IPGTT. If telemetry data cannot be viewed in real-time, such as when the computer is not physically located in the procedure room, please characterize the animal prior to collecting calibration values to estimate an appropriate post-dose time for the appropriate post peak blood glucose sample.

To learn how to perform a multi-point calibration, please see the **Glucose Calibration Process** section within the **Tutorials** section.

SINGLE-POINT CALIBRATION

Single-point calibrations help account for non-physiologic changes in the baseline glucose value over time. Examples of non-physiologic changes include sensor drift due to enzyme instability or fibrin and tissue growth on the sensor. Single-point calibrations should be performed at least twice per week at the same time of day, and during a time period when the animal's blood glucose is relatively stable.

To learn how to perform a single-point calibration, please see the **Glucose Calibration Process** section within the **Tutorials** section.

BEST PRACTICES

LEAVE TELEMETRY DEVICE ON DURING THE ENTIRE STUDY

Leave the HD-XG implant in **ON** mode throughout the entire study to improve glucose sensor stability. Turning the device **ON** after extended time in **OFF** mode will result in a positive spike and it will take 1-5 hours for the glucose values to return to normal. If an implant is turned **OFF** mid-study, a single-point calibration should be performed at least 5 hours after turning **ON**. If there is a notable change in the baseline from the previous on time, it is advisable to perform a new multi-point calibration.

TAKE DUPLICATE SAMPLES FOR EACH REFERENCE VALUE

- Duplicate samples should be used to minimize error and establish the most reliable calibration of the implantable glucose sensor. If duplicate samples vary by >10%, one or more additional samples are recommended to establish a more accurate reference value.
- Take duplicate glucose samples from a single point in time by drawing blood from the animal and testing the blood glucose level twice (e.g. using two different test strips). Enter the two reference values in the **Glucose Calibration** dialog in the **Reference value** and **Reference value 2** text fields, the software will average them.

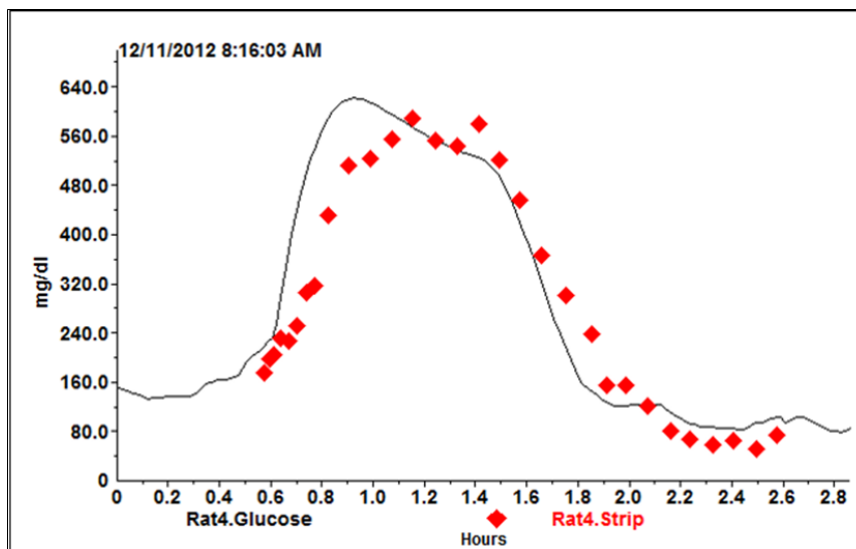
MINIMIZE STRESS, ANESTHESIA ARTIFACTS

- Taking blood samples too frequently from animals that are stressed (due to restraint) can cause significant bias and variability in reference samples.
- Taking samples from anesthetized animals is discouraged as isoflurane has been demonstrated to impact the glucose sensor reading in some cases, particularly at later points in the study period.

CONSIDERATIONS & ALTERNATIVES

In order to optimize implant calibration, there are several factors to consider.

- **Potential lag time between the glucose values** taken by the implanted sensor and the calibration reference. In a normal, healthy rat the peak glucose value is typically observed 4-7 minutes post dose for an intraperitoneal glucose tolerance test (IPGTT) and 12-16 minutes post dose for an OGTT. These durations will vary based on the glucose dose, whether or not the animal was fasted, and the animal strain. A blood sample taken from the tip of a rat's tail may have a 2-5 minute (or more) delayed response to the glucose dose due to stress artifact and the hemodynamics of the tail. Figure 23 below demonstrates the glucose measurement lag between the descending abdominal aorta and tail. The tail sample has a peak glucose value that occurs later than the peak value detected by the sensor in the descending aorta, which could result in errors during the calibration process. By sampling a few minutes after the peak is observed in the telemetry signal, the stable periods for the implant and reference signal can be more closely aligned and the theoretical calibration error can be reduced. This has a similar effect to shifting the tail samples backwards in time to better align with the telemetry signal. Data illustrated below is an example of the blood glucose measurement lag in the tail (Rat4.Strip) vs. descending aorta (Rat4.Glucose). This lag is variable and can last as little as a few seconds or greater than 10 minutes depending on animal stress, tail blood hemodynamics.



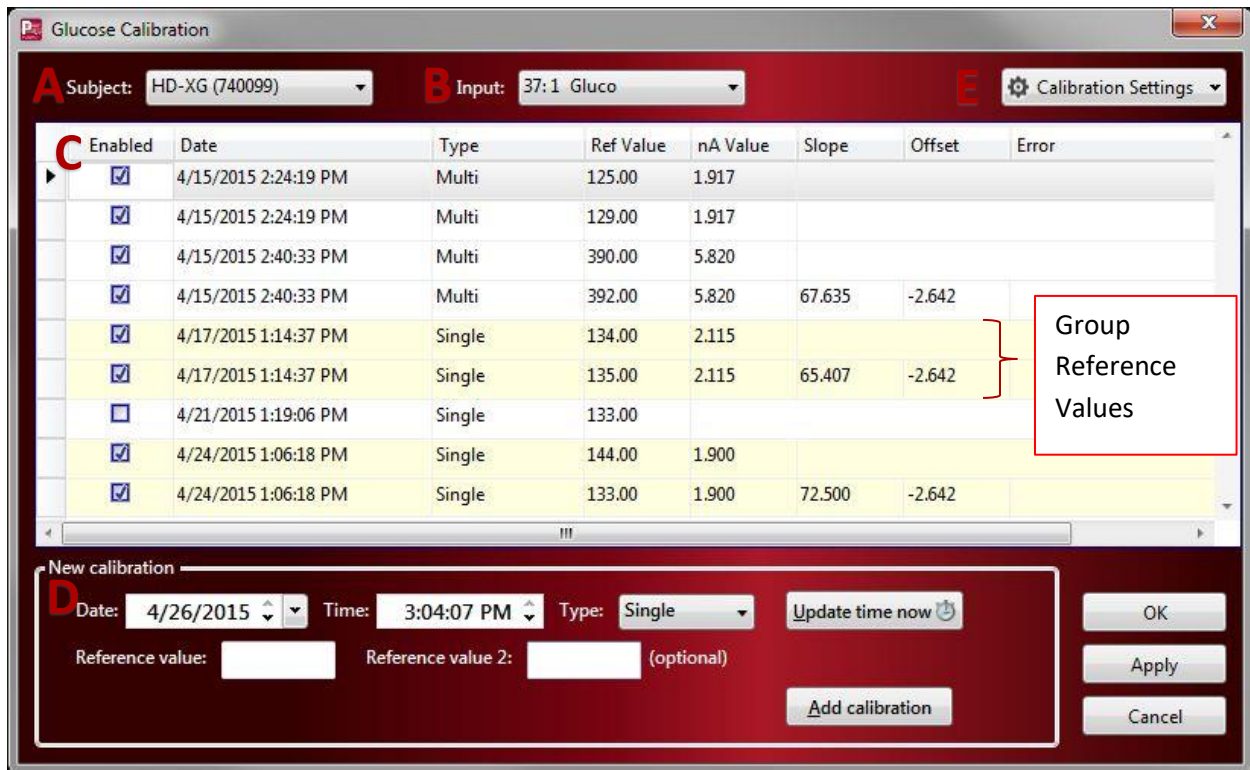
- **The method used to increase glucose levels to record baseline and peak values.** Several methods can be used to increase blood glucose levels if an increase of at least 200 mg/dL (11 mmol/L) needs to be achieved. Oral or IP glucose tolerance tests can be used and the method chosen depends on your study needs. IPGTTs typically result in faster and higher glucose peaks, which can expedite the calibration process and aid in achieving the desired glucose difference of 200 mg/dL (11 mmol/L), however, glucose is metabolized more quickly and the peak glucose value lasts for a shorter period of time. OGTTs require a large bolus of glucose to achieve the target 200 mg/dL (11 mmol/L) difference. However, peak glucose

levels typically remain stable for a longer period of time, resulting in an easier and more accurate calibration process.

When using Type 1 or Type 2 diabetic animals, an IP insulin tolerance test can be substituted for the glucose tolerance test.

GLUCOSE CALIBRATION DIALOG

The **Glucose Calibration** dialog is used during Acquisition and Review to enter **Glucose Calibration Reference** values obtained by your Glucose Reference during Multi- and Single-point calibrations. The following describes dialog in detail. For instructions on how to use while performing a Multi- or Single-point calibration, please see the **Glucose Calibration Process Tutorial**.



The following describes the components of the dialog:

- A. Subject** Dropdown box used to select the **Subject** whose calibrations information is desired to be displayed. Ensure the correct Subject is chosen before entering calibration values.
- B. Input** Dropdown box used to designate which implant **Input** channel is displayed within the dialog. Since the HD-XG only has one glucose input channel, it will automatically be displayed and cannot be changed.
- C. Calibration List View** This is an interactive **List View**, displaying information on all calibration values recorded for the selected **Subject** and **Input**.

Note: Visual cues (row highlights) are provided to indicate when **Calibration Reference** values are used together to calculate the calibration **Slope** and **Offset**. Information on when these are grouped together is provided in the **Slope/Offset** section below.

Each column is explained below:

- **Enabled** Allows the user to enable (**checked**) or disabled (**unchecked**) calibration values without losing the record. This permits the researcher to view the Glucose signal with certain calibration values disabled in order to improve the quality of the resultant signal.
- **Date** Displays the **Date** and **Time** the Glucose Reference value was taken, as recorded when entering the calibration value. If necessary, this may be updated directly in the List View by left-clicking the associated **Date/Time** text.
- **Type** Displays the **Type** of calibration to which the associated Glucose Reference value was defined; e.g. **Multi-** or **Single-point**.
- **Ref Value** Displays the recorded **Reference Value** measured by the **Glucose Reference** during the **Multi-** or **Single-point** calibration process. This can be augmented directly in the List View by left-clicking the **Ref Value** text.
- **nA Value** Displays the corresponding averaged nano Ampere (nA) value recorded by the implant at the time the **Ref Value** was recorded.
- **Slope/Offset** The **Slope** and **Offset** values are calculated by Ponemah based on the recorded calibration information and are used to generate the **Glucose** signal from the **nA** signal. These cannot be modified directly, as they are calculations.

Only the last entry in a set of **Multi-point** calibrations will report a **Slope** and **Offset**. Each set of **Single-points** will report a **Slope** and **Offset**. A set of **Single-points** meaning those recorded with the same date/time point; e.g. Reference value and Reference value 2.

In the case of a set of **Multi-point**, the **Slope** and **Offset** are obtained calculating a regression line through the **Reference** (y axis) and **nA** (x axis) values. All consecutive **Multi-points** within one hour of the last **Multi-point** will be grouped as part of the same challenge, yielding a single **Slope** and **Offset** value. The resultant **Slope** and **Offset** values will be applied from the start of the **Multi-point** sequence.

In the case of each **Single-point** calibration, the **Offset** remains unchanged from the previous time point and the **Slope** is adjusted by **Calibration Damping %** of the difference between the previous **Slope** and the **Slope** that would yield a 100% correction.

- **Error** This will list any validation errors associated with the record. These must be corrected prior to closing the **Glucose Calibration** dialog.

- D. New Calibration** Permits the user to add additional **Glucose Calibration Reference** values to the selected **Subject**. The user can enter the **Date** and **Time** at the time of the blood draw or simply select Update Time now to automatically update these fields with the current computer time. The user would also choose the calibration **Type** from the dropdown box and then enter the blood glucose **Reference values** measured by the **Glucose Reference**. Once all information is entered, select the **Add Calibration** button to add the reference information to the **Calibration List View**.
- E. Calibration Settings** Provides access to advanced calibration settings. These settings are **Subject** specific; i.e. changes made are only applied to the currently selected **Subject**.



The following describes the settings listed within this dialog

- **Min Cal Range** Used to ensure the **Reference values** entered for a **Multi-point** calibration span at least the specified range to be valid. In this example, the **Multi-point** calibration **Reference values** must span at least 50 mg/dL to be a valid **Multi-point** calibration.
- **Calibration Interval** Used to define the range of data averaged when retrieving the **nA value** that corresponds to the recorded glucose **Reference value** reading.
- **Calibration Damping** Used to adjust the aggressiveness of the linear scaling during the calibration process.
 - Can be set to a value of **0-50%**, defaults to **20%**.
 - Is only applied to the **Single-point** calibration values and does not affect **Multi-point** calibration.
 - If the **Damping Factor** is set to **0%** the interpolation will be undamped and scale factor will be adjusted to compensate completely for each enabled single-point calibration value. The resulting calibrated telemetry data will pass directly through the single-point calibration value (or the average value of duplicate calibration samples).
 - If the **Damping Factor** is set to **20%** the applied scale factor will compensate for all but 20% of the difference between the previously used scale factor and the scale factor calculated for this point if 0% damping were used. The resulting calibrated telemetry data will not pass directly through the single-point calibration value unless 0% damping is used.
 - If the **Damping Factor** is set to **50%** the applied scale factor will compensate for all but 50% of the difference between the previously used scale factor and the scale factor calculated for

this point if 0% damping were used. The resulting calibrated telemetry data will not pass directly through the single-point calibration value unless 0% damping is used.

- Use of a **damping factor** greater than zero will minimize the amount that the glucose signal “bounces” between **Single-point** calibrations based on potential error in the **Calibration Reference** values. It may also under correct for a signal which is drifting due to loss of sensitivity.
- **Use Initial Slope and Offset** Used during the calibration process to define a slope and offset to use until such time as reference values are available. The use of the initial slope and offset are not typically required, as the Ponemah calibration algorithms apply the first multipoint calibration both forward and backward in time.

Below are some examples of when using this feature may prove beneficial:

- User desires to have estimates of blood glucose levels reported during acquisition and prior to a multipoint calibration.
- User suspects the validity of a multipoint calibration and deems not to use it in the calibration process. (reference values lost, reference values suspect, timing of reference measurements concerning, ...)
- A valid multipoint calibration is not available (was not performed)
- Animal applied to another experiment and data directory changed.
 - In this case even if a valid multipoint calibration were previously performed, the data from that portion of the study is in a different directory and would not be available for calibration purposes. As such, one would obtain the slope and offset by performing a calibration in the other experiment and then could apply that slope and offset in this new experiment using the initial slope and offset feature.

Note that in the examples above it is up to the user to define the slope and offset based upon their expert opinion and/or available data.

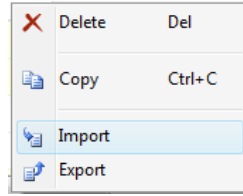
IMPORT/EXPORT CALIBRATION DATA

IMPORT

Calibration data can be recorded using Excel during the blood draw and glucose reference measurement periods and imported into the Glucose Calibration dialog at a later time. To import Glucose Calibration Reference values:

1. Start a Review session by selecting **Actions | Start Review**
2. Select the **Glucose Calibration** toolbar icon for a **Primary** graph page.
3. Select the **Subject** to which the calibration values will be imported.
4. Right-click the **List View** within the **Glucose Calibration** dialog.

5. Select **Import**.



6. Select the file to import.
 - a. **.csv files**: allows the user to import calibration values from Excel, when saved as a CSV.
 - b. **.glu files**: allows the user to import calibration data previously entered using Dataquest A.R.T.

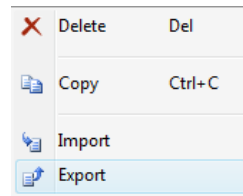
Note: **.csv files** should be in the following format to properly import **Glucose Calibration Reference values**.

	A	B	C	D
1	#DateTime	RefValue	CalType	Enabled
2	2/17/2014 9:42	101	1	1
3	2/17/2014 9:42	95	1	1
4	2/17/2014 9:52	180	1	1
5	2/17/2014 9:52	222	1	1
6	2/24/2014 8:21	95	0	1

EXPORT

Calibration data can be exported from the Calibration dialog to a .csv file, permitting the user to view these in Excel. To export Glucose Calibration Reference values:

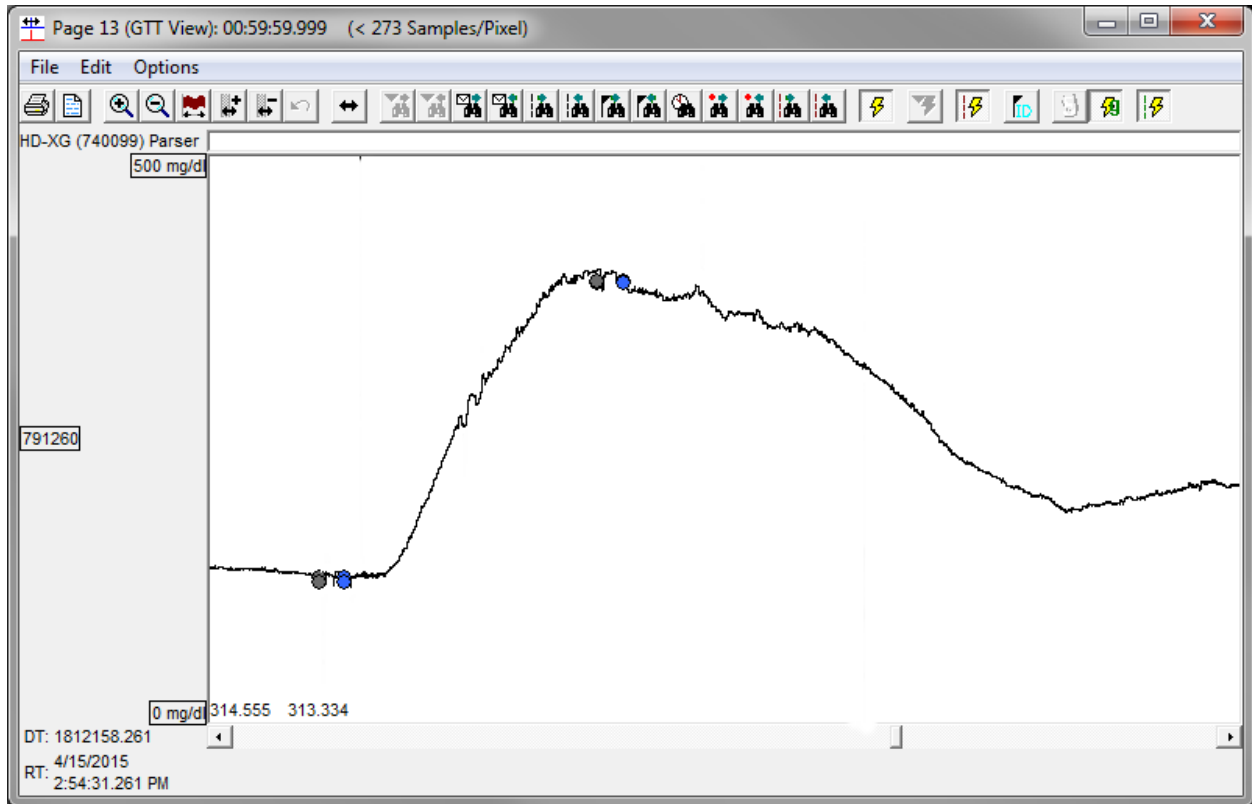
1. Within a Review session, select the **Glucose Calibration** toolbar icon for a **Primary** graph page.
2. Right-click the **List View** within the **Glucose Calibration** dialog.
3. Select **Export**.



4. Enter a **File name** and browse to the folder location desired to save the file.
5. Select **Save**.

ONLINE SCREENS AND FUNCTIONS

The following is an example of a **Primary** graph displaying a Glucose signal during a **Glucose Tolerance Test (GTT)**.



The **Validation Mark** for Glucose is the **Cycle** mark, is currently not displayed to provide a full view of the signal. The circular, colored marks displayed on the waveform are **Calibration Reference Points**. These points were entered in the **Glucose Calibration** dialog and correspond to glucose measurements taken manually using a **Glucose Reference**; e.g. glucometer.


The mark color indicators are described below:

Reference Mark Color	State
Blue	Enabled Single-point Reference Value
Cyan	Enabled Multi-point Reference Value
Gray	Disabled Reference Value
Red	Error with recorded Reference Value

Hovering over these marks will provide information on the reference value, as shown below:



Note: **Calibration Reference Value** marks can be toggled **ON/OFF** using the **Glucose Reference Value Toggle**

toolbar icon. 

PRESENTATION SIGNALS

Below is a list of presentation signals that are available for the Glucose Analysis Module:

Signal	Description
nA_uc	This will display the nA input signal without temperature correction applied.
nA	This will display the nA input signal with temperature correction applied.
Glucose	This will display the nA input signal converted to glucose readings using slope(s) and offset(s) from the Glucose Calibration dialog. The resultant units will depend on the units of the reference values entered during calibration.

DATA REVIEW

The analysis specific portion of Data Review centers around the marks that the User is permitted to display, insert, and delete and how the User is permitted to move them.

Displaying Marks and Cycle Numbers The marks and cycle numbers displayed in a Review **Primary** graph page **Display Pane** are controlled through the **Marks** Tab in the **Analysis Attributes** dialog. The **Analysis Attributes** dialog is accessed through the right click menu – **Analyze [Attributes]**.

Mark Operations The **Cycle** mark is the only mark supported by Glucose and defines a glucose cycle.

Inserting Marks	A Cycle mark may be inserted by right clicking at the point of insertion in the Primary graph's Display Pane of the Channel of interest. The pop-up menu that is displayed will provide the option to insert a Cycle mark.
Insert Glucose Cycle	Inserts a Glucose "cycle". When a Glucose cycle is inserted, it is assigned a sequential cycle number and subsequent cycle numbers are incremented.
Deleting Marks	Marks are deleted by positioning the mouse cursor on the mark to be deleted and bringing up the right click menu.
Moving Marks	Moving the Cycle mark is permitted between the previous Cycle mark/ Data Break/Bad Data Mark and the following Cycle mark/ Data Break/Bad Data Mark
Calculations	The calculations of Derived Parameters are identical to those performed during Acquisition.
Logging Mark	The Logging Mark for a Glucose "cycle" is the Cycle Mark . The time at the logging mark is the time used to report a "cycle's" derived data. If a Glucose "cycle's" logging mark falls within a logging interval, the Glucose "cycle's" data will be included in the Logging interval.
End of Cycle	The start of a Glucose "cycle" is at the Cycle mark. The end of a "cycle" depends on what follows its Logging Mark : <ul style="list-style-type: none"> • If the Logging Mark is not followed by a data break or another Logging Mark within 600s, the "cycle" will end at the last sample within 600s of the Logging Mark. • If the logging mark is followed by a Data Break with no intervening logging marks, the "cycle" will end on the sample that coincides with the Data Break. • If the Logging Mark is followed by a Logging Mark with no intervening Data Breaks, the "cycle" will end on the sample that precedes the Logging Mark.

ATTRIBUTE TYPES IN REVIEW

The following table describes the effects of changing Glucose attributes in Review. Please refer to the **Analysis Attributes Dialog | Attribute Types** section for the meanings of the effects of each attribute type described.

Attribute	Effect on Review
Averaging Interval	Signal Interpretation
Glucose Units	None
Monitor Body Temperature	None
Temperature Channel	Signal Conditioning
Low Pass Filter	Signal Conditioning
High Pass Filter	Signal Conditioning
Temp Coefficients	Signal Conditioning
Enable Noise Detection	Signal Interpretation
Minimum Signal Value	Signal Interpretation
Maximum Signal Value	Signal Interpretation
Min Good Data Time	Signal Interpretation

PULMONARY AIR FLOW (PAF)

The **Pulmonary Air Flow** analyzes pulmonary airflow signals obtained from a plethysmograph box, a pneumotachograph, or via respiratory inductive plethysmography (RIP). It also calculates values for the respiratory cycle on a breath-to-breath basis.

ATTRIBUTES DIALOG

The **Pulmonary Air Flow Analysis Attributes** dialog allows you to modify the signal analysis for different types of air flow signals and signal conditions. If an analysis change in the **Attributes** dialog is performed mid-cycle, then the attribute change will not take effect until the following cycle.

STANDARD ATTRIBUTES TAB

The **Standard** attributes allow setting the most common attributes that would need to be changed during Acquisition or Review.

The screenshot shows a dialog box titled "Pulmonary Air Flow Analysis Attributes (Dog01 Flow, Input 433)". It has several tabs: "Std Attrib", "Adv Attrib1", "RIP", "Noise", "Typical Values", and "Additional Channels". The "Std Attrib" tab is active. It contains the following settings:

Attribute	Value	Units
Minimum Flow	2.58	ml/s
Primary Signal	Flow	
Input Flow Units	ml/s	
Secondary Channel	None	
Percent Relaxation	70	%
Abdomen Channel	None	

On the right side of the dialog, there are buttons for "OK", "Cancel", "Apply", and "Print". Below the "Typical Values" tab, the following values are displayed:

Value	Species
2.58 ml/sec	Dog
Flow	
ml/Sec	(Set in P3 Setup : Group)
NA	
70%	
NA	

Pulmonary Air Flow Standard Attributes Tab

Minimum Flow

Sets the minimum flow that the analysis must achieve before the analysis will detect and validate a pulmonary cycle. The Minimum Flow stops the analysis from triggering on artifacts such as cardiac noise.

Primary Signal

Sets the system for either a Flow input signal or a Volume input signal or RIP input signals. If Volume is selected as the primary signal, you can display the digitally derived flow signal on a primary graphic page by selecting Flow as the Presentation in the Primary Graph Page Setup window. If Flow is selected as the primary signal, you can display the digitally derived volume signal on the primary graph page by selecting Volume as the Presentation in the Primary Graph Page Setup window.

Input Flow Units

Input Flow Units is active when Flow is selected as the Primary Signal. Input Flow Units specifies the units of flow being measured so that the system calculates the volume correctly.

Calculated Flow Units is active when Volume or Vol-RIPChest is selected as the Primary Signal. Calculated Flow Units specifies the volume units used so that the system calculates the flow values correctly.

mL/Sec (milliliters per second)

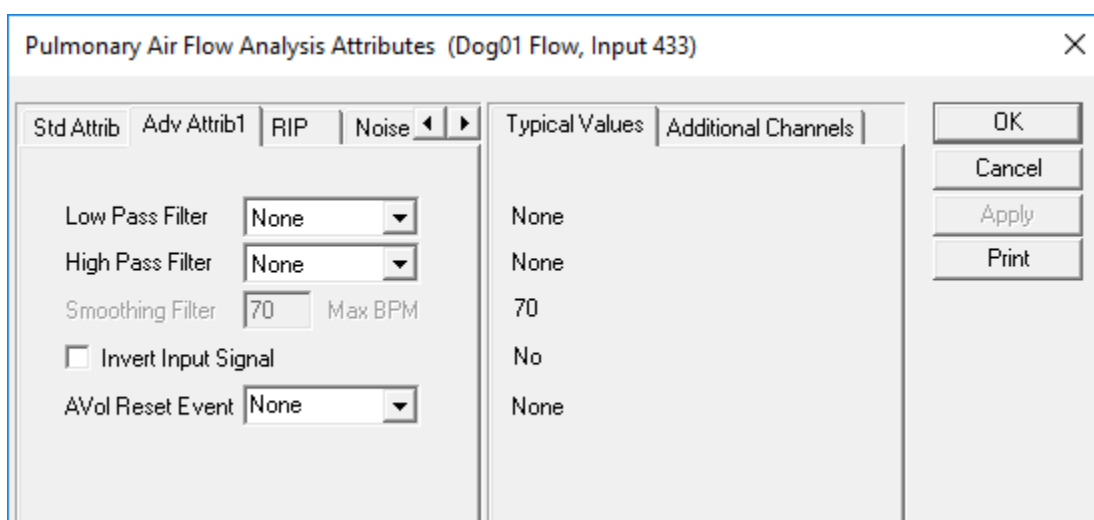
mL/Min (milliliters per minute)

L/Sec (liters per second)
L/Min (liters per minute)

Secondary Channel	Not Applicable.
Percent Relaxation	Used to draw the percent relaxation mark and to calculate Penh and RT. The Percent Relaxation Mark is drawn when the volume signal drops from its maximum value by the specified percentage.
Abdomen Channel	Not Applicable.

ADVANCED ATTRIBUTES TAB

The **Advanced** attributes allow selection of attributes which are not commonly changed during Acquisition or Review.



Pulmonary Air Flow Advanced Attribute Tab

Low Pass Filter	Selection of Low Pass filter in hertz.
High Pass Filter	Selection of High Pass filter in hertz.
Smoothing Filter	Defines a smoothing function by specifying the maximum breaths per minute that will not experience signal loss due to the filter. This filter is only applied when the Primary Signal is a volume signal, either Volume or Vol-RIP-chest. If Flow is selected as the Primary Signal, this attribute will be disabled, and a smoothing filter will not be applied. Setting the Smoothing Filter to a high value (e.g. 999) will effectively disable this filter.
Invert Input Signal	This check box should be enabled if the respiration signal is acquired such that inspiration is negative. The PAF Analysis Module requires that inspiration is positive. Selecting the check box will reverse the polarity of the acquired signal.

AVol Reset Event

Used to determine the start point for the Accumulated Volume derived parameter (AVol). The selection of an event, “a” through “J”, will determine the start point for the calculation of AVol. If “None” is selected, the AVol derived parameter will report zero (acquisition and replay) or “x” (Review).

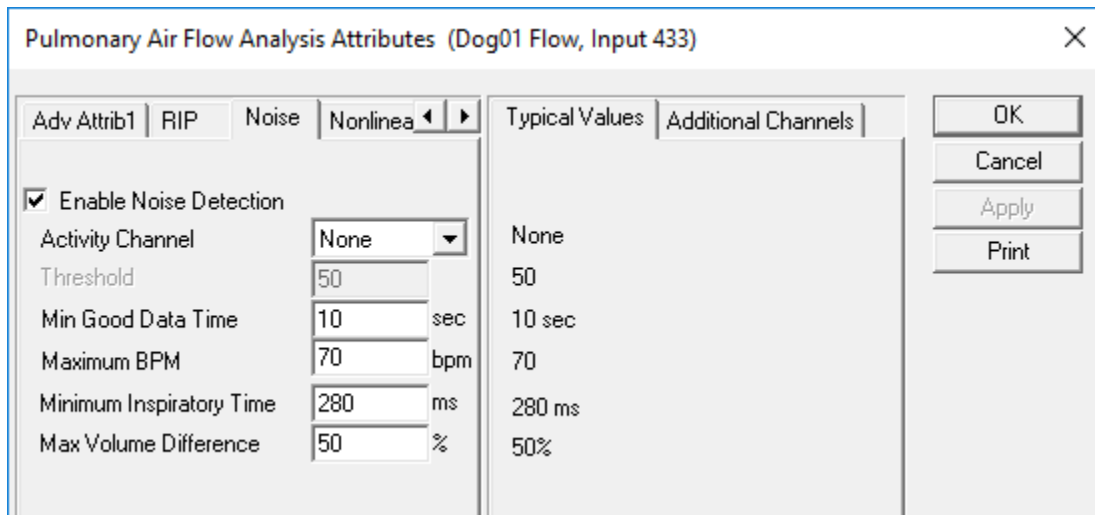
The start of an acquisition, a break in the data, or subsequent entries of the event to trigger the start point for the AVol calculation will result in the derived parameter being reset.

RESPIRATORY INDUCTIVE IMPEDANCE (RIP) TAB

This tab is used with DSI Jacketed External Telemetry (JET) for calibration of its RIP module. This is not applicable for Ponemah v6.x, as it is not compatible with DSI JET.

NOISE TAB

The **Noise Tab** contains attributes that are used to identify noisy data. On identifying “noisy” data, as defined by the user, **Bad Data Marks** will be placed to span the noisy sections.



Noise Tab

Enable Noise Detection Enables the **Noise Detection** attributes for the automatic placement of **Bad Data Marks**.

Activity Channel Not applicable.

Threshold Not applicable.

Minimum Good Data Time Provides the user the ability to mark data as bad between two **Bad Data Mark** regions. If the time between the regions is less than the value specified. If the time is less than what is specified, the **Bad Data Mark** region will appear as one contiguous segment. This is a Review only feature.

Maximum Breaths per minute (BPM) User defined threshold for determining the **maximum BPM** for acceptable data. Data that exceeds this threshold will be considered noise and bracketed by **Bad Data Marks** for removal from analysis.

Minimum Inspiratory Time This sets the minimum allowable value for **Minimum Inspiratory Time**.

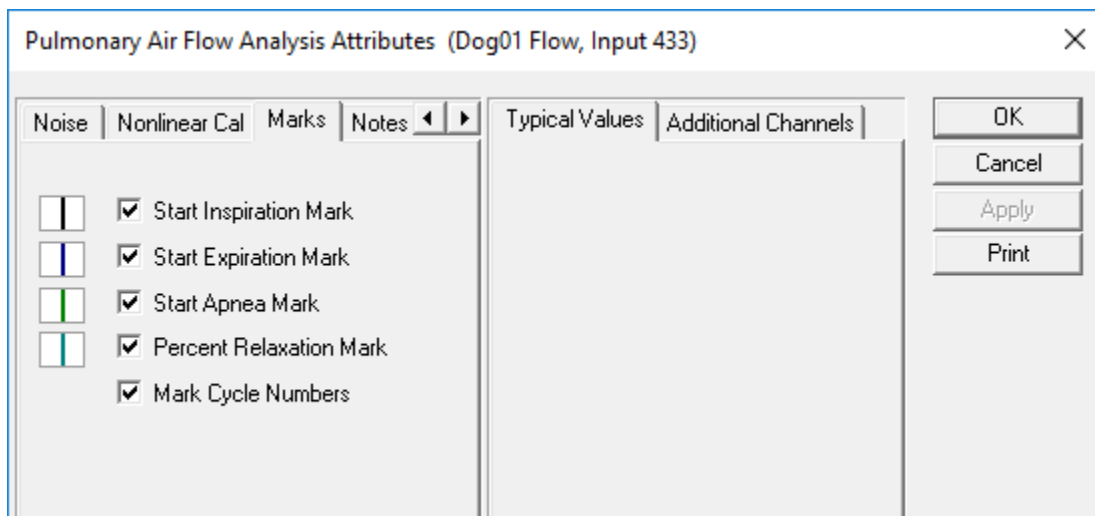
Maximum Volume Difference The difference between inspiration and expiration volumes greater than this percentage will be considered noise and bracketed by **Bad Data Marks**.

NONLINEAR CALIBRATION TAB

This tab is not applicable for Ponemah v6.x.





MARKS (VALIDATION) TAB

The **Pulmonary Air Flow** analysis displays validation tick marks for each respiratory cycle. Each respiratory cycle should have only one set of validation marks. These marks verify that the system is analyzing the PAF signal correctly. If there is more than one set of validation marks per respiratory cycle, correct the problem by changing the analysis attributes.



Marks Tab

The validation marks and their meanings are listed below:

Color		Meaning
Black		Start of Inspiration
Blue		Start of Expiration
Green		Start of Apnea
Cyan		Percent Relaxation
		Mark Cycle Numbers

TYPICAL VALUES

The table contains typical values for different heart rates. Use these values as guidelines for a first-time setup. Under different situations, values above or below the typical values may need to be used.

Attribute	Setting	Units
Minimum Flow	Dog 2.58	mL/Sec
	Monkey 0.65	
	Rat 0.18	

	Mouse 0.02	
Primary Signal	Flow	NA
Input Flow Units	User Defined	
Percent Relaxation	70	%

DERIVED PARAMETERS

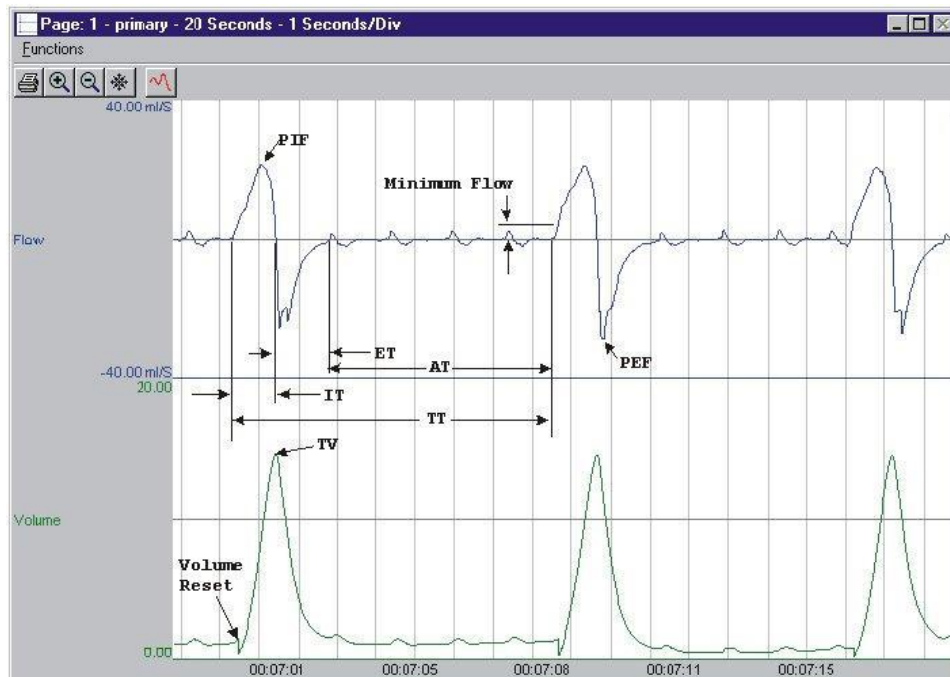
Derived Parameters are selected within the **Channel Details** of the **Subject Setup** dialog. The **Derived Parameters** selected in this dialog will be calculated, and the results will be placed in the Derived Parameter List View(s). The following details the available **Derived Parameters** from the Pulmonary Air Flow module and the averaging method used within Review.

Name	Definition	Review Averaging Method
Num	The number of the respiratory cycle. This number will appear on a primary graph page when validation marks are turned on and the cycle numbers are enabled. When running in a logging mode other than 1 epoch, the last cycle number will be reported.	Recent
PIF	Peak Inspiratory Flow is the maximum inspiratory flow that occurs during a valid breath.	Mean
PEF	Peak Expiratory Flow is the maximum expiratory flow that occurs during a valid breath.	Mean
TV	The Tidal Volume is the total volume of air that was inspired during a breath and is always reported in milliliters.	Mean
MV	The Minute Volume is the product of the tidal volume and the number of breaths-per-minute. The equation is: $MV = TV * BPM$. Note: When running in a logging mode other than 1 epoch, the averaged value will be calculated off of the averaged TV and averaged BPM values.	Mean
BPM	The number of breaths-per-minute is calculated on a breath-to-breath basis. It is computed as the reciprocal of the total time for a respiratory cycle * 60. Note: When running in a logging rate other than 1 epoch, sum the cycles in seconds in the logging period, divide by the number of cycles, take the reciprocal, and multiply the value by 60.	Harmonic Mean
IT	The Inspiratory Time is calculated from the first zero crossing of the flow in the inspiratory direction to the zero crossing of the flow in the expiratory direction. The time value is reported in milliseconds.	Mean
ET	The Expiratory Time is calculated from the zero crossing of the flow in the expiratory direction until flow reaches zero again. The time value is reported in milliseconds.	Mean
TT	The Total Time is the time period, in milliseconds, from one valid breath to the next valid breath.	Mean
AT	The Apnea Time is computed as follows: $AT = TT - (IT + ET)$	Mean
CaRaw	Not Applicable	
Phase	Not Applicable	
dT	Not Applicable	
Penh	Enhanced Pause. Calculated as:	Mean

	$((ET+AT)/RT-1) * (PEF/PIF)$ Formula from Noninvasive Measurement of Airway Responsiveness in Allergic Mice Using Barometric Plethysmography Hamelmann et al.	
RT	Relaxation Time. This is the time from the start of expiration to the point where the volume signal drops by the Percent Relaxation value from its maximum value for the cycle.	Mean
TVe	This is the difference between the volume at the start expiration mark and the volume at the point prior to the next cycles start inspiration mark. It is always reported in milliliters.	Mean
IF50	IF50 reports the inspiratory flow value at the point where the volume signal rises to 50% of the tidal volume.	Mean
EF50	EF50 reports the expiratory flow value at the point where the volume signal drops to 50% of the tidal volume.	Mean
AVol	Accumulated Volume is the summed total of the Tidal Volume (TV) from a reset point forward and is reported in milliliters. Reset points include the start of data collection, break in the data or the selection of the event associated with the AVol Reset Event attribute.	Recent

ONLINE SCREENS AND FUNCTIONS

The following is an example of a **Primary** graph displaying a typical Pulmonary Air Flow signal along with its digitally integrated volume signal. Key derived parameters are also indicated.



Pulmonary Air Flow Key Parameters

PRESENTATION SIGNALS

Below is a list of presentation signals that are available for the PAF Analysis Module:

Signal	Description
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Flow	When Primary Signal = Flow, this will be the original flow signal. When Primary Signal = Volume, this will display the differential of the signal, and it is generated as a two-point differential.
Volume	When Primary Signal = Flow, this will display the integration of the flow signal over the entire breath and reset at the start of the next valid breath. When Primary Signal = Volume, this will display the original volume signal.
CaRaw	Not Applicable
Phase	Not Applicable

DATA REVIEW

This is a list of the Data Review related features of the Pulmonary Air Flow Analysis Module. The analysis specific portion of Data Review centers on the marks that the user is permitted to display, insert, and delete and how the User is permitted to move them.

- Displaying Marks and Cycle Numbers** The marks and cycle numbers displayed in a Review **Primary** graph page **Display Pane** are controlled through the **Marks** Tab in the **Analysis Attributes** dialog. The **Analysis Attributes** dialog is accessed through the right click menu – **Analyze [Attributes]**.
- Mark Operations** PAF marks are divided into two types, marks that always exist when a valid cycle is found (**Start Inspiration** and **Start Expiration**) and marks that may or may not exist, depending on the signal morphology (**Percent Recovery** and **Start Apnea**).
- Inserting Marks** **Marks** may be inserted by right clicking at the point of insertion in the **Primary Graph Display Pane** of the Channel of interest. The pop-up menu that is displayed will provide the option to insert marks as appropriate. The list of marks available for insertion will depend on the marks adjacent to the point of insertion; signal morphology is not considered.
- Insert PAF Cycle** Inserts an entire **PAF cycle**, **Start Inspiration**, **Start Expiration**, and **Percent Relaxation**, if applicable. **Start Apnea** is not inserted; if Apnea exists this must be inserted manually. This set of marks may be inserted between a **Start Inspiration** mark and the last mark of the preceding cycle. Cycles may also be inserted prior to the first cycle and after the last cycle. When a PAF cycle is inserted, it is assigned a sequential cycle number and subsequent cycle numbers are incremented.
- Insert Start Apnea** Inserts a **Start Apnea** mark. This mark may be inserted prior to a **Start Inspiration** mark or after the last cycle, as long as the preceding mark is not a **Start Apnea** mark.
- Deleting Marks** **Marks** are deleted by positioning the mouse cursor on the mark to be deleted and bringing up the right click menu. Only the **Start Apnea** mark may be deleted in this fashion. The rest of the marks cannot be deleted individually. An entire cycle may be deleted. A cycle is deleted by positioning the cursor on the **Start Inspiration** mark, bringing up the right mouse menu, and selecting **Delete Cycle**.
- Moving Marks** Moving of the **Start Inspiration**, **Start Expiration** and **Start Apnea** marks follow the standard rules used in Data Review. There are special considerations when dealing with the **Percent Relaxation** mark. The **Percent Relaxation** mark is a calculated mark; its position is dependent on the Tidal Volume and cannot be adjusted by the

user. If the user changes the position of the **Start Inspiration**, **Start Expiration**, or **Start Apnea** marks, the **Percent Relaxation** mark will be recalculated. When the **Percent Relaxation** mark is moved the derived parameter RT may change and will not be marked as a grayed cell unless a reanalyze is performed. This is also the case when the Secondary Channel is changed for the derived parameters CaRaw, Phase, and dT.

Calculations

The calculations of derived parameters are identical to those performed during acquisition and replay. Review reports the volume at the start of expiration as the Tidal Volume. Replay reports the maximum volume over the entire cycle. In most cases the values reported from Review and Replay are identical.

When a Review file is opened, the trace data may not be identical to the acquired data. The difference arises because of the scaling involved in the storage and reconstitution of the data. The difference for a point, on average, is less than 0.05%.

One of the consequences of this difference is seen with Calculated Marks. If, after opening a Review file, Review is prompted to recalculate a Calculated Mark, the mark may move with no change to the marks on which it depends. This is because the original placement of the Calculated Mark was based on the Replay data values whereas, recalculation uses the data values present in Review.

Logging Mark

The **Logging Mark** for a **PAF cycle** is the **Start Inspiration Mark**. The time at the **Logging Mark** is the time used to report a cycle's derived data.

End of Cycle

The end of a **PAF cycle** occurs one sample prior to the next cycle's **Start Inspiration** mark. When a PAF channel is the epoch channel, all review channels that display their cycle's logging mark prior to the end of the epoch channel's cycle will be included in the derived output.

ATTRIBUTE TYPES IN REVIEW

The following table describes the effects of changing PAF attributes in Review. Please refer to the **Analysis Attributes Dialog | Attribute Types** section for the meanings of the effects of each attribute type described.

Attribute	Effect On Review
Minimum Flow	Signal Interpretation
Primary Signal	Signal Conditioning, Calculation, Redraw
Input Flow Units and Calculated Flow Units	Signal Conditioning, Calculation, Redraw
Secondary Channel	Calculation
Percent Relaxation	Calculation, Redraw
High Pass Filter	Signal Conditioning, Calculation, Redraw
Low Pass Filter	Signal Conditioning, Calculation, Redraw
Smoothing Filter	Signal Conditioning, Calculation, Redraw
Maximum BPM	Signal Interpretation
Minimum Inspiratory Time	Signal Interpretation
Invert Input Signal	Signal Conditioning, Calculation, Redraw
Max Volume Difference	Signal Interpretation
AVol Reset Event	Calculation
Marks and Cycle Numbers	Redraw
Precision	Precision

TROUBLESHOOTING

Use the following table to assist in troubleshooting the analysis:

Issue	Solution
Breaths-per-Minute is doubled, halved, etc.	This usually occurs when the analysis triggers on noise or artifacts. It can be corrected by changing the Minimum Flow to a higher or lower value to eliminate rates higher or lower than normal. If the signal has a lot of baseline noise, change the Low Pass Filter (in the Adv Attrib1 tab) to a higher value to remove the noise. Select a lower value in the list box.
All Derived Parameters are reporting zero	The Minimum Flow may be set too high for the specified signal. Lower the Minimum Flow value.
Tidal Volume incorrect	<ol style="list-style-type: none"> 1. This can be caused by the flow signal drifting above or below the zero line. Enable a High Pass Filter at 3Hz (in the Adv Attrib1 tab) if the flow signal is drifting. 2. The wrong Input Flow Units are being used. Since the volume is derived mathematically, the system must know the real units of flow being measured. 3. If the Tidal Volume is low, there could be a problem with the experimental setup. If the animal is in a plethysmograph, verify that there are no air leaks. This also pertains to any other setup. There can be no air leaks.
"x" in Derived Parameter List View window instead of a number	The Derived Parameter value is too large for the field. An "x" was placed here, so that a truncated number would not be displayed.
Cannot find the analysis module in the Subject Setup | Subject Details dialog	The analysis module is likely not enabled in the Ponemah License. Check License options via Help | View License .

PULMONARY VOLUME (PVO)

The **Pulmonary Volume** analyzes pulmonary volume signals obtained from a respiratory impedance implant. It also calculates values for the respiratory cycle using volume-based attributes on a breath-to-breath basis.

ATTRIBUTES DIALOG

The **Pulmonary Volume Analysis Attributes** dialog allows you to modify the signal analysis for different types of volume signals and signal conditions. If an analysis change in the **Attributes** dialog is performed mid-cycle, then the attribute change will not take effect until the following cycle.

STANDARD ATTRIBUTES TAB

The **Standard** attributes allow setting the most common attributes that would need to be changed during Acquisition or Review.

The screenshot shows a dialog box titled "Pulmonary Volume Analysis Attributes (asdfas Impedanc, Input 433)". It has a close button (X) in the top right corner. The dialog is divided into several sections: "Std Attrib", "Adv Attrib1", "Noise", "Imped:", "Typical Values", and "Additional Channels". The "Std Attrib" section contains the following attributes and values:

Attribute	Value	Unit	Typical Value
Minimum Volume	10	ml	10.00 ml
Apnea Volume	10	% of TVe	10% of TVe
Apnea Max Flow	20	% of PEF	20% of PEF
Max Volume Diff	50	%	50%
Max IT+ET	30	seconds	30 sec
Calculated Flow Units	ml/Sec		ml/Sec
Percent Relaxation	70	%	70%

The "Additional Channels" section includes a "Species:" dropdown menu set to "Dog" and a note "(Set in P3 Setup : Group)". On the right side of the dialog, there are buttons for "OK", "Cancel", "Apply", and "Print".

Pulmonary Volume Standard Attributes Tab

Minimum Volume

Sets the minimum volume the analysis must achieve before the analysis will detect and validate a pulmonary cycle. The **Minimum Volume** stops the analysis from triggering on artifacts such as cardiac noise.

Apnea Volume

Sets the maximum volume as a percent of Tidal Volume Expired that could be included within the Apnea Time. If the volume exceeds this value the time prior to this will not be marked as an apnea. This feature is used in combination with **Apnea Max Flow** to determine periods of apnea.

Apnea Max Flow

Sets the maximum flow as a percent of Peak Expiratory Flow that could be included within the **Apnea Time**. If the flow exceeds this value the time prior to this may not be marked as an apnea. This feature is used in combination with **Apnea Volume** to determine periods of apnea.

Max IT + ET

Sets the maximum inspiratory time plus expiratory time for a breath to be considered valid. The total breath time (IT+ET+AT) is used.

Calculated Flow Units

Calculated Flow Units specifies the volume units used for the system to correctly calculate flow values.

mL/Sec (milliliters per second)

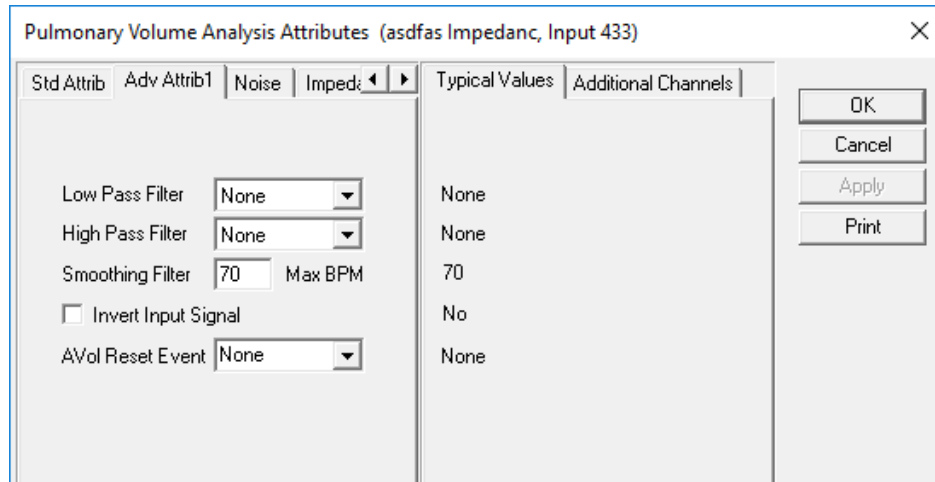
Percent Relaxation

mL/Min (milliliters per minute)
L/Sec (liters per second)
L/Min (liters per minute)

Used to draw the percent relaxation mark and to calculate Penh and RT. The Percent Relaxation Mark is drawn when the volume signal drops from its maximum value by the specified percentage.

ADVANCED ATTRIBUTES TAB

The **Advanced** attributes allow selection of attributes which are not commonly changed during Acquisition or Review.



Pulmonary Volume Advanced Attribute Tab

- Low Pass Filter** Selection of Low Pass filter in hertz.
- High Pass Filter** Selection of High Pass filter in hertz.
- Smoothing Filter** Defines a smoothing function by specifying the maximum breaths per minute that will not experience signal loss due to the filter. This filter is only applied when the Primary Signal is a volume signal, either Volume or Vol-RIP-chest. If Flow is selected as the Primary Signal, this attribute will be disabled, and a smoothing filter will not be applied.
- Setting the Smoothing Filter to a high value (e.g. 999) will effectively disable this filter.
- Invert Input Signal** This check box should be enabled if the respiration signal is acquired such that inspiration is negative. The PVO Analysis Module requires that inspiration is positive. Selecting the check box will reverse the polarity of the acquired signal.
- AVol Reset Event** Used to determine the start point for the Accumulated Volume derived parameter (AVol). The selection of an event, “a” through “J”, will determine the start point for the calculation of AVol. If “None” is selected, the AVol derived parameter will report zero (acquisition and replay) or “x” (Review).

The start of an acquisition, a break in the data, or subsequent entries of the event to trigger the start point for the AVol calculation will result in the derived parameter being reset.

NOISE TAB

The **Noise Tab** contains attributes that are used to identify noisy data. On identifying “noisy” data, as defined by the user, **Bad Data Marks** will be placed to span the noisy sections.

Attribute	Value	Unit	Typical Value
Enable Noise Detection	<input checked="" type="checkbox"/>		Enabled
Enable Rail Detection	<input checked="" type="checkbox"/>		Enabled
Minimum Signal Value	-500	mV	-500 mV
Maximum Signal Value	500	mV	500 mV
Min Good Data Time	10	s	10 s
Activity Channel	None		None
Threshold	50		50
Maximum BPM	70	bpm	70
Minimum Inspiratory	280	ms	280 ms
Volume Fluctuation	50		50
Flow Fluctuation	1000		1000
Max Tidal Volume	600	ml	600 ml

Noise Tab

- Enable Noise Detection** Enables the **Noise Detection** attributes for the automatic placement of **Bad Data Marks**.
- Enable Rail Detection** If **Rail Detection** is enabled, any negative telemetry dropout data encountered when analyzing data shall be bracketed by **Bad Data Marks** such that the dropout data falls within the **Bad Data Start** and **End** marks. The dropout check shall be performed on unfiltered samples.
- Minimum Signal Value** User defined threshold for determining the **minimum value** for acceptable data. Data that falls below this threshold will be considered noise and bracketed by **Bad Data Marks**.
- Maximum Signal Value** User defined threshold for determining the **maximum value** for acceptable data. Data that exceeds this threshold will be considered noise and bracketed by **Bad Data Marks**.
- Minimum Good Data Time** Provides the user the ability to mark data as bad between two **Bad Data Mark** regions. If the time between the regions is less than the value specified. If the time is less than what is specified, the **Bad Data Mark** region will appear as one contiguous segment. This is a Review only feature.
- Activity Channel** Allows user to identify which channel is to be used as the Activity channel.
- Threshold** User defined threshold the signal from the defined **Activity Channel** must exceed to be interpreted as noise. If exceeded **Bad Data Marks** will be inserted to remove the section of data from analysis.

Maximum Breaths per minute (BPM) User defined threshold for determining the **maximum BPM** for acceptable data. Data that exceeds this threshold will be considered noise and bracketed by **Bad Data Marks** for removal from analysis.

Minimum Inspiratory Time This sets the minimum allowable value for **Minimum Inspiratory Time**.

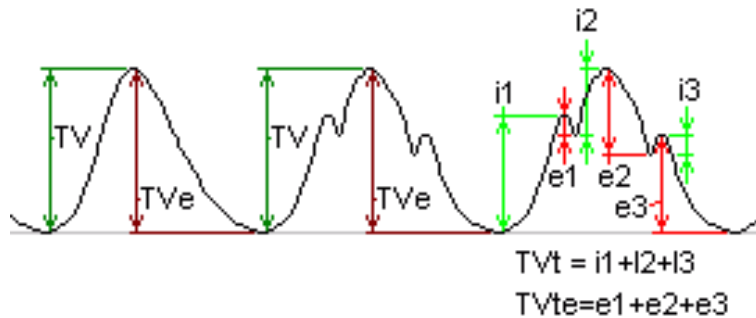
Volume Fluctuation Volume fluctuation compares all of the inspiratory and expiratory volumes within a breath (TVt and TVte) to the Tidal volume inspired and expired (TV and TVe).

If the volume fluctuation exceeds this setting it will be treated as noise and Bad Data Marks will be inserted to remove the data from analysis.

The volume fluctuation is calculated as:

$$= 100 \left(\frac{TVt + TVte}{TV + TVe} - 1 \right)$$

The below graphic shows a cycle with no volume fluctuation and then two cycles with volume fluctuation. For clarity the marks have been placed on different cycles; however, this fluctuation is calculated within a single breath cycle.



Flow Fluctuation Flow fluctuation compares all the inspiratory and expiratory flows in a manner similar to volume fluctuation.

If the flow fluctuation exceeds this setting it will be treated as noise and Bad Data Marks will be inserted to remove the data from analysis.

The flow fluctuation is calculated as:

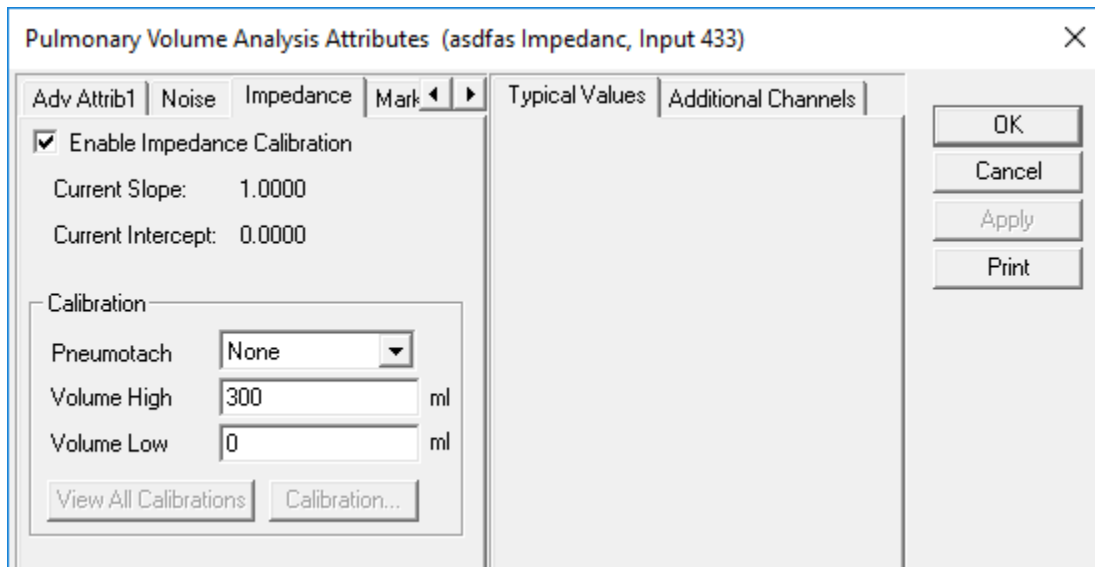
$$= 100 \left(\frac{CumulativeFlow}{2PIF + 2PEF} - 1 \right)$$

where CumulativeFlow is the sum of the range of flows covered by all continuously increasing or decreasing flows in cycle.

Max Tidal Volume Sets the maximum allowed tidal volume. Cycles with volumes greater than this will be treated as noise and Bad Data Marks will be inserted to remove the data from analysis.

IMPEDANCE TAB

The **Impedance Tab** permits users to calibrate the respiratory impedance channel of the implant against a direct measurement from a pneumotach or a Fixed Volume.

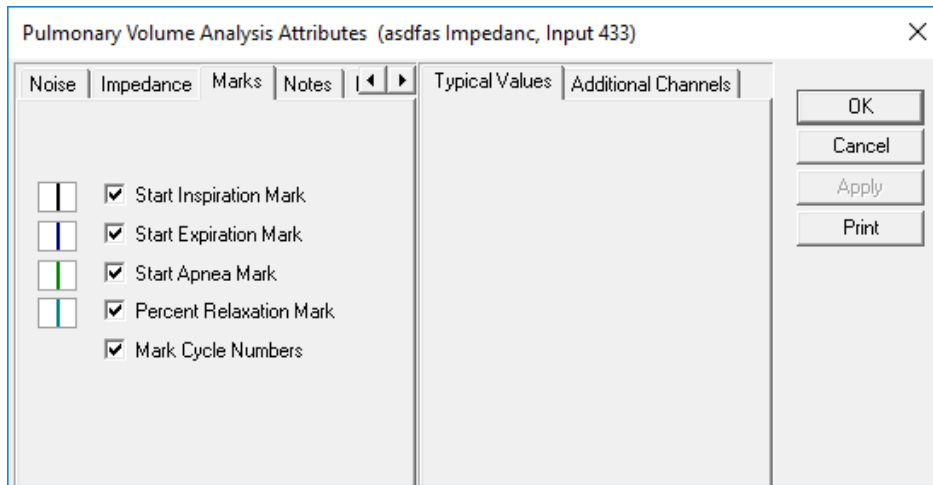


Impedance Tab

Enable Impedance Calibration	Enables the Impedance Calibration attributes to be edited and used by the software.
Current Slope	Displays the current slope value from the impedance calibration.
Current Intercept	Displays the current intercept from the impedance calibration.
Pneumotach	Permits selection of the pneumotach channel. Download list will display all channels with PAF analysis module defined.
Volume High	The high volume used for impedance calibration when a pneumotach channel is not used.
Volume Low	The low volume used for impedance calibration when a pneumotach channel is not used.





MARKS (VALIDATION) TAB

The **Pulmonary Volume** analysis displays validation tick marks for each respiratory cycle. Each respiratory cycle should have only one set of validation marks. These marks verify that the system is analyzing the PVO signal correctly. If there is more than one set of validation marks per respiratory cycle, correct the problem by changing the analysis attributes.



Marks Tab

The validation marks and their meanings are listed below:

Color		Meaning
Black		Start of Inspiration
Blue		Start of Expiration
Green		Start of Apnea
Cyan		Percent Relaxation
		Mark Cycle Numbers

TYPICAL VALUES

The table contains typical values for different heart rates. Use these values as guidelines for a first-time setup. Under different situations, values above or below the typical values may need to be used.

Attribute	Setting		Units
Minimum Volume	Dog	20.0	mL
	Monkey	5.0	
Minimum Volume	Dog	2.0	Ohms
	Monkey	1.0	
Apnea Volume	Dog	10	%
	Monkey	10	
Apnea Max Flow	Dog	20	%
	Monkey	20	
Max Volume Difference	Dog	50	%
	Monkey	50	
Max IT + ET	Dog	60	Sec
	Monkey	30	
Calculated Flow Units	mL/Sec		mL/Sec
Percent Relaxation	70		%
Smoothing Filter*	Dog	30-50	Max BPM
	Monkey	40-60	

* A value below the actual breaths per minute is not recommended. Additionally, the user should take caution to set a value which does not significantly alter the amplitude or width of the volume waveform.

DERIVED PARAMETERS

Derived Parameters are selected within the **Channel Details** of the **Subject Setup** dialog. The **Derived Parameters** selected in this dialog will be calculated, and the results will be placed in the Derived Parameter List View(s). The following details the available **Derived Parameters** from the Pulmonary Volume module and the averaging method used within Review.

Name	Definition	Review Averaging Method
Num	The number of the respiratory cycle. This number will appear on a primary graph page when validation marks are turned on and the cycle numbers are enabled. When running in a logging mode other than 1 epoch, the last cycle number will be reported.	Recent
PIF	Peak Inspiratory Flow is the maximum inspiratory flow that occurs during a valid breath.	Mean
PEF	Peak Expiratory Flow is the maximum expiratory flow that occurs during a valid breath.	Mean
TV	The Tidal Volume is the total volume of air that was inspired during a breath and is always reported in milliliters.	Mean
MV	The Minute Volume is the product of the tidal volume and the number of breaths-per-minute. The equation is: $MV = TV * BPM$. Note: When running in a logging mode other than 1 epoch, the averaged value will be calculated off of the averaged TV and averaged BPM values.	Mean
BPM	The number of breaths-per-minute is calculated on a breath-to-breath basis. It is computed as the reciprocal of the total time for a respiratory cycle * 60. Note: When running in a logging rate other than 1 epoch, sum the cycles in seconds in the logging period, divide by the number of cycles, take the reciprocal, and multiply the value by 60.	Harmonic Mean
IT	The Inspiratory Time is calculated from the first zero crossing of the flow in the inspiratory direction to the zero crossing of the flow in the expiratory direction. The time value is reported in milliseconds.	Mean
ET	The Expiratory Time is calculated from the zero crossing of the flow in the expiratory direction until flow reaches zero again. The time value is reported in milliseconds.	Mean
TT	The Total Time is the time period, in milliseconds, from one valid breath to the next valid breath.	Mean
AT	The Apnea Time is computed as follows: $AT = TT - (IT + ET)$	Mean
Penh	Enhanced Pause. Calculated as: $((ET+AT)/RT-1) * (PEF/PIF)$ Formula from Noninvasive Measurement of Airway Responsiveness in Allergic Mice Using Barometric Plethysmography Hamelmann et al.	Mean
RT	Relaxation Time. This is the time from the start of expiration to the point where the volume signal drops by the Percent Relaxation value from its maximum value for the cycle.	Mean
TVe	This is the difference between the volume at the start expiration mark and the volume at the point prior to the next cycles start inspiration mark. It is always reported in milliliters.	Mean
IF50	IF50 reports the inspiratory flow value at the point where the volume signal rises to 50% of the tidal volume.	Mean
EF50	EF50 reports the expiratory flow value at the point where the volume signal drops to 50% of the tidal volume.	Mean

AVol	Accumulated Volume is the summed total of the Tidal Volume (TV) from a reset point forward and is reported in milliliters. Reset points include the start of data collection, break in the data or the selection of the event associated with the AVol Reset Event attribute.	Recent
VolBa	The Volume Baseline is the volume at start of inspiration. It is reported in the same units as the volume waveform.	Mean
VFluc	Volume fluctuation compares all the inspiratory and expiratory volumes within a breath (TVt and TVte) to the Tidal volume inspired and expired (TV and TVe). The difference is reported as a percent change.	Mean
FFluc	Flow fluctuation compares all the inspiratory and expiratory flows in a manner similar to volume fluctuation.	Mean
TVm	The median tidal volume (TV) – available for trending.	Median
MVm	The median minute volume (TV) – available for trending.	Median
TVt	The Tidal Volume Throughout is the total volume of air that was inspired at any time during a breath and is always reported in milliliters. This is the sum of all positive changes in volume from start of inspiration to start of expiration.	Mean
TVte	The Tidal Volume Expired Throughout is the total volume of air that was expired at any time during a breath and is always reported in milliliters. This is the sum of all negative changes in volume from start of inspiration to start of expiration.	Mean
PZr	If a pneumotach is available and defined within the calibration dialog this derived data point will output the ratio of pneumotach volume divided by volume signal (calibrated if enabled) for the logging period.	Mean

CALIBRATION

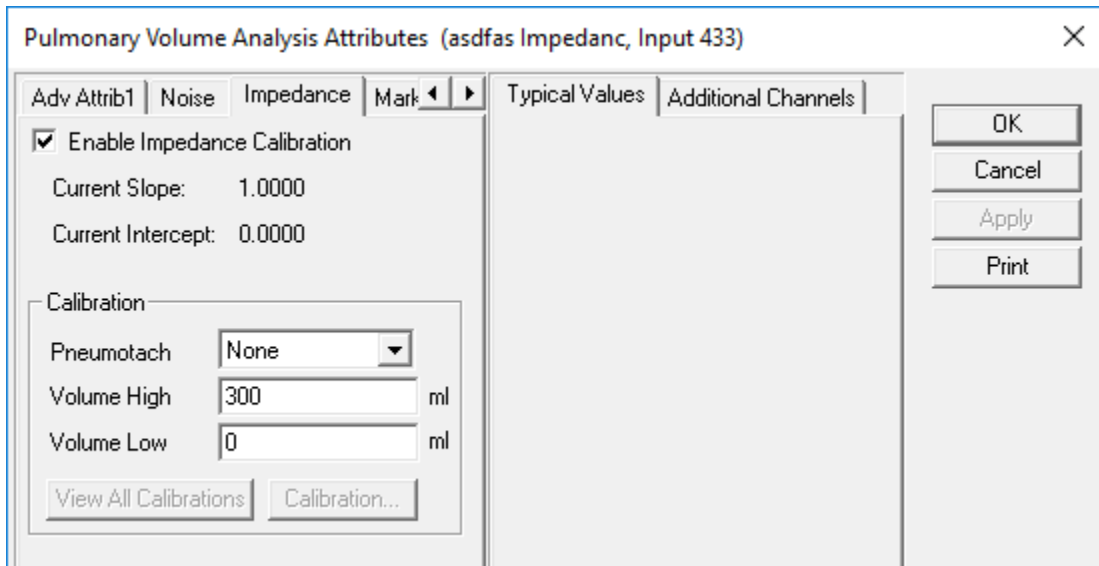
The respiratory impedance signal when uncalibrated reports volumetric changes as impedance (in ohms). In order to transform from impedance into units of volume a calibration is required. The respiratory impedance volume signal may be calibrated versus a pneumotach or versus fixed volume values entered manually.

If calibrating versus a pneumotach, the user is required to have previously set up and calibrated the pneumotach within the software in such a way that it may be used in a synchronized manner with the D70-PCTR or L11R implants; i.e. using a pneumotach interface to the MX2 Signal Interface.

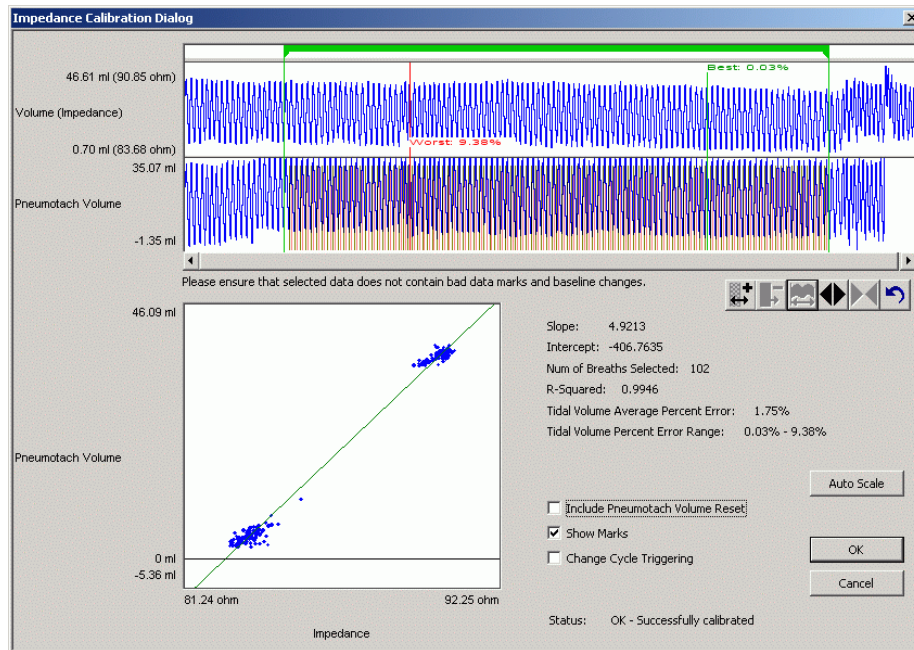
Once the user has the hardware configured correctly and attached to the animal the user must collect data from the pneumotach and the D70-PCTR or L11R. The data will preferably be very clean and with the animal in a posture representative of the posture which the animal will be in during a normal data collection. Data may be collected for as long or short as desired; however, during the calibration process only 5 consecutive minutes may be used. It is strongly recommended to only calibrate during periods when the impedance signal baseline is consistent and bad data marks are not present.

Following data collection:

1. Start Review.
2. Find the start of that “calibration period” and have it within a Primary graph window.
3. Right-click on the impedance waveform and select **Analyze [Attributes]**.
4. Select the **Impedance tab**.



5. Enable the **Impedance Calibration**
6. If calibrating against Pneumotach
 - a. Define the **Pneumotach** channel.
Note: The Fixed Volume entry is disabled when using the Pneumotach option.
 - b. Select the **Calibration** button.



- c. Place Calibration Segment Bar(s).
 The green bar located near the top of the dialog is the Calibration Segment Bar. The Calibration Segment Bar allows the user to select which breaths to calibrate versus the pneumotach signal. The bar can be shortened or elongated using the computer mouse. Multiple segments can be added to maximize the number of typical breaths used in the calibration. Additional segments are added by right-clicking in the Calibration Segment Bar portion of the dialog.

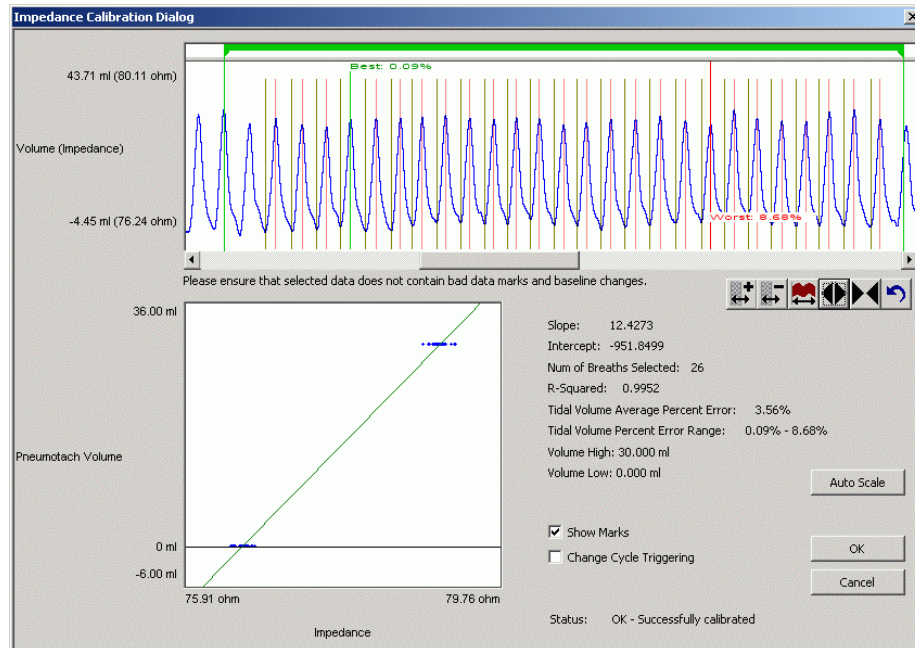
Note: The Impedance Calibration Dialog will display up to a five-minute segment of data starting at the left edge of the viewable section of data from the Primary graph page.

7. If calibrating **WITHOUT** Pneumotach
 - a. Enter in **High Volume** and **Low Volume**.

Typical values:

Species	High Volume (mL)	Impedance (ohms)	Slope
Dog	~150-300	~8-10	~15-45
Primate	~10-30	~3-5	~4-15

- b. Select **Calibrate** button.



- c. Place Calibration Segment Bar(s).
The green bar located near the top of the dialog is the Calibration Segment Bar. The Calibration Segment Bar allows the user to select which breaths to calibrate versus the pneumotach signal. The bar can be shorted or elongated using the computer mouse. Multiple segments can be added to maximize the number of typical breaths used in the calibration. Additional segments are added by right-clicking in the Calibration Segment Bar portion of the dialog.

Note: The Impedance Calibration Dialog will display up to a five-minute segment of data starting at the left edge of the viewable section of data from the Primary graph page.

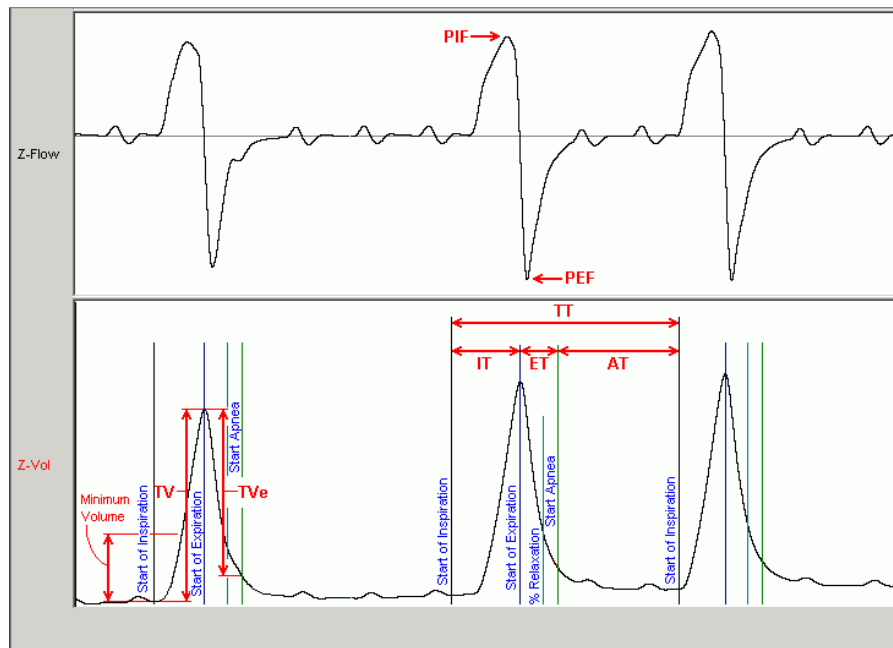
8. After placing the Calibration Segment Bar(s) the following will automatically calculated and displayed in the dialog:
 - a. Slope and Intercept
 - b. Number of Breaths Selected (determined by the placement of the Calibration Segment Bar(s))
 - c. Number of Breaths Used in the calibration
 - d. R² value
 - e. Average Percent Error $[(V_{total} - V_{Pneumo})/V_{Pneumo}]$ of the breaths used in the calibration
 - f. Percent Error Range

- Click **OK** once the calibration is acceptable.

The slope and intercept values will automatically populate the Impedance Calibration dialog. The user may then reanalyze the data set. Scaling of graphs, minimum flows, etc will need to be adjusted to obtain an appropriate analysis.

ONLINE SCREENS AND FUNCTIONS

The following is an example of a **Primary** graph displaying a typical Pulmonary Flow and Volume signal. Key derived parameters are indicated, along with the validation marks: **Start of Inspiration**, **Start of Expiration**, **Percent Relaxation**, and **Start of Apnea**.



Pulmonary Volume Key Parameters and Marks

PRESENTATION SIGNALS

Below is a list of presentation signals that are available for the PAF Analysis Module:

Signal	Description
Flow	This will display the differential of the signal, and it is generated as a two-point differential.
Volume	This will display the original volume signal (in ohms if uncalibrated, if mL if calibrated).
Input	This will display the original volume signal (in ohms) regardless of calibration.

DATA REVIEW

This is a list of the Data Review related features of the Pulmonary Volume Analysis Module. The analysis specific portion of Data Review centers on the marks that the user is permitted to display, insert, and delete and how the User is permitted to move them.

Displaying Marks and Cycle Numbers	The marks and cycle numbers displayed in a Review Primary graph page Display Pane are controlled through the Marks Tab in the Analysis Attributes dialog. The Analysis Attributes dialog is accessed through the right click menu – Analyze [Attributes] .
Mark Operations	PVO marks are divided into two types, marks that always exist when a valid cycle is found (Start Inspiration and Start Expiration) and marks that may or may not exist, depending on the signal morphology (Percent Recovery and Start Apnea).
Inserting Marks	Marks may be inserted by right clicking at the point of insertion in the Primary Graph Display Pane of the Channel of interest. The pop-up menu that is displayed will provide the option to insert marks as appropriate. The list of marks available for insertion will depend on the marks adjacent to the point of insertion; signal morphology is not considered.
Insert PVO Cycle	Inserts an entire PVO cycle , Start Inspiration , Start Expiration , and Percent Relaxation , if applicable. Start Apnea is not inserted; if Apnea exists this must be inserted manually. This set of marks may be inserted between a Start Inspiration mark and the last mark of the preceding cycle. Cycles may also be inserted prior to the first cycle and after the last cycle. When a PVO cycle is inserted, it is assigned a sequential cycle number and subsequent cycle numbers are incremented.
Insert Apnea Mark	Inserts a Start Apnea mark. This mark may be inserted prior to a Start Inspiration mark or after the last cycle, as long as the preceding mark is not a Start Apnea mark. In many cases, a start apnea mark will already exist and be overlapped by the subsequent cycle's start of inspiration mark. Movement of these marks may be necessary to differentiate and place them as needed.
Deleting Marks	Marks are deleted by positioning the mouse cursor on the mark to be deleted and bringing up the right click menu. Only the Start Apnea mark may be deleted in this fashion. The rest of the marks cannot be deleted individually. An entire cycle may be deleted. A cycle is deleted by positioning the cursor on the Start Inspiration mark, bringing up the right mouse menu and selecting Delete Cycle .
Moving Marks	Moving of the Start Inspiration , Start Expiration and Start Apnea marks follow the standard rules used in Data Review. There are special considerations when dealing with the Percent Relaxation mark. The Percent Relaxation mark is a calculated mark; its position is dependent on the Tidal Volume and cannot be adjusted by the user. If the user changes the position of the Start Inspiration , Start Expiration , or Start Apnea marks, the Percent Relaxation mark will be recalculated. When the Percent Relaxation mark is moved the derived parameter RT may change and will not be marked as a grayed cell unless a reanalyze is performed
Calculations	The calculations of derived parameters are identical to those performed during acquisition and replay. Review reports the volume at the start of expiration as the Tidal Volume. Replay reports the maximum volume over the entire cycle. In most cases the values reported from Review and Replay are identical.

When a Review file is opened, the trace data may not be identical to the acquired data. The difference arises because of the scaling involved in the storage and reconstitution of the data. The difference for a point, on average, is less than 0.05%.

One of the consequences of this difference is seen with Calculated Marks. If, after opening a Review file, Review is prompted to recalculate a Calculated Mark, the mark may move with no change to the marks on which it depends. This is because the original placement of the Calculated Mark was based on the Replay data values whereas, recalculation uses the data values present in Review.

Logging Mark

The **Logging Mark** for a **PVO cycle** is the **Start Inspiration Mark**. The time at the **Logging Mark** is the time used to report a cycle's derived data.

End of Cycle

The end of a **PVO cycle** occurs one sample prior to the next cycle's **Start Inspiration** mark. When a PVO channel is the epoch channel, all review channels that display their cycle's logging mark prior to the end of the epoch channel's cycle will be included in the derived output.

ATTRIBUTE TYPES IN REVIEW

The following table describes the effects of changing PVO attributes in Review. Please refer to the **Analysis Attributes Dialog | Attribute Types** section for the meanings of the effects of each attribute type described.

Attribute	Effect On Review
Minimum Flow	Signal Interpretation
Apnea Volume	Signal Conditioning, Calculation, Redraw
Apnea Max Flow	Signal Conditioning, Calculation, Redraw
Max Volume Difference	Calculation
Max IT + ET	
Calculated Flow Units	
Percent Relaxation	Calculation, Redraw
High Pass Filter	Signal Conditioning, Calculation, Redraw
Low Pass Filter	Signal Conditioning, Calculation, Redraw
Smoothing Filter	Signal Conditioning, Calculation, Redraw
Invert Input Signal	Signal Conditioning, Calculation, Redraw
AVol Reset Event	Calculation
Threshold (Activity)	
Min Good Data Time	
Maximum BPM	Signal Interpretation
Minimum Inspiratory Time	Signal Interpretation
Volume Fluctuation	
Flow Fluctuation	
Max Tidal Volume	
Slope	
Intercept	
Pneumotach	
Volume High	
Volume Low	
Marks and Cycle Numbers	Redraw
Precision	Precision

TROUBLESHOOTING

Use the following table to assist in troubleshooting the analysis:

Issue	Solution
Breaths-per-Minute is doubled, halved, etc.	This usually occurs when the analysis triggers on noise or artifacts. It can be corrected by changing the Minimum Volume to a higher or lower value to eliminate rates higher or lower than normal. If the signal has a lot of baseline noise, change the Low Pass Filter (in the Adv Attrib1 tab) to a higher value to remove the noise. Select a lower value in the list box.
All Derived Parameters are reporting zero	The Minimum Volume may be set too high for the specified signal. Lower the Minimum Volume value.
Tidal Volume incorrect	Verify the impedance calibration is correct. Ensure the Calculated Flow Units are correct. Adjust noise settings.
“x” in Derived Parameter List View window instead of a number	The Derived Parameter value is too large for the field. An “x” was placed here, so that a truncated number would not be displayed.
Cannot find the analysis module in the Subject Setup | Subject Details dialog	The analysis module is likely not enabled in the Ponemah License. Check License options via Help | View License .

ADD-ON MODULES

This section provides detailed information on add-on modules available within Ponemah. If a Ponemah add-on module was purchased, please ensure the license file lists the add-on, as this indicates it is enabled.

VIDEO

DSI has partnered with Noldus Information Technology, the leading solution provider for human and animal behavioral research for 25 years, to offer scientists a better video experience. By integrating the Noldus Media Recorder and DSI’s Ponemah Physiology Platform, scientists now have an easy method for synchronizing physiologic data with video data.

The Noldus Media Recorder enables synchronous video recordings from **up to eight** different video sources. When integrated with Ponemah, you can command the Media Recorder to save and sync video data with the physiologic data recorded from DSI hardware and manage all your data with one application. This combined solution provides greater insights into the physiologic data to better understand your results.

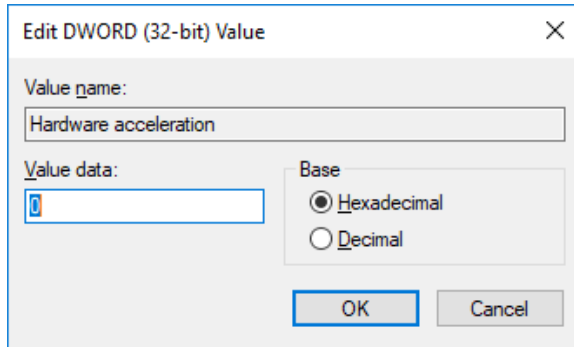
Note: Synchronization of video data with physiologic signals will be within +/- 1 second.

INSTALLATION

In addition to the Ponemah installation, users are required to install the Noldus Media Recorder software and necessary cameras drivers. For information on installing these items, please refer to the Noldus Media Recorder Reference Manual.

Once installed, launch Noldus Media Recorder. The following registry entry should then be updated:
\\HKEY_CURRENT_USER\\Software\\MainConcept\\MainConcept AVC/H.264 Video Decoder\\MediaRecorder.exe

- Double-click **Hardware Acceleration**
- Change the **Value data** to **0**
- Click **OK**.



- Close the Registry.

GIGE CAMERA SETUP

GigE cameras are high-performance industrial cameras. They can have a higher frame rate and resolution than the other supported cameras. The images are sent unprocessed to the computer using a standard network cable (UTP). Noldus Media Recorder is compatible with certain Basler GigE Cameras.

For GigE camera setup and support, please see the **Noldus Media Recorder Reference Manual**.

Note:

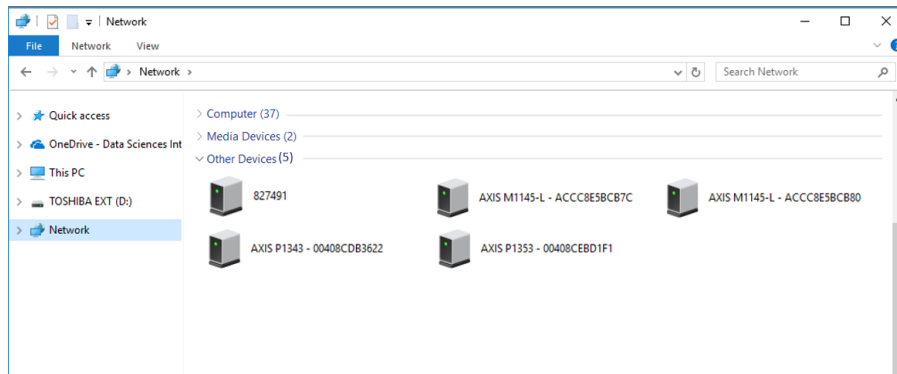
- File size of a 24 hours recording is very large (at least 12 Gb).
- When using multiple GigE cameras, it takes a while before they become visible in Media Recorder. GigE cameras take time to initialize.

IP CAMERA SETUP

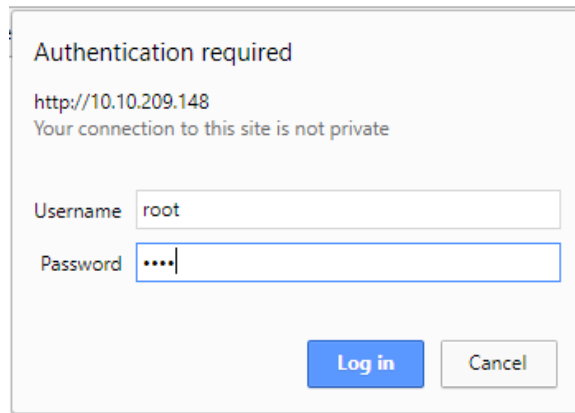
IP cameras are connected directly to a network. IP cameras are especially useful to film remote locations and receive the video files through an ethernet network on your computer. Noldus Media Recorder is compatible with Axis IP Cameras. In order to configure Axis IP Cameras in Noldus Media Recorder a few camera settings are required to be updated.

To Configure:

1. Access the camera's webpage:
 - a. Open Windows Explorer.
 - b. Select the Network folder.



- c. Double-click the camera to launch its webpage.
- d. When prompted for Authentication, enter the following:
 - i. Username: root
 - ii. Password: root

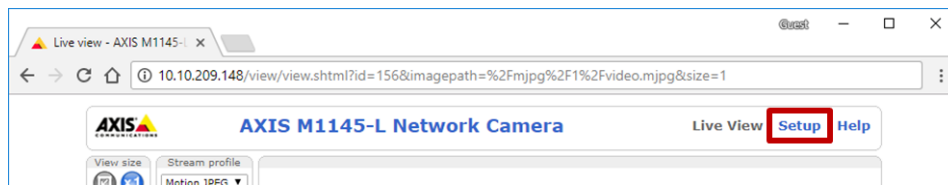


- e. Note the IP Address of the camera, as it will be needed later when configuring the cameras in Noldus Media Recorder.

2. Add an ONVIF Admin User:

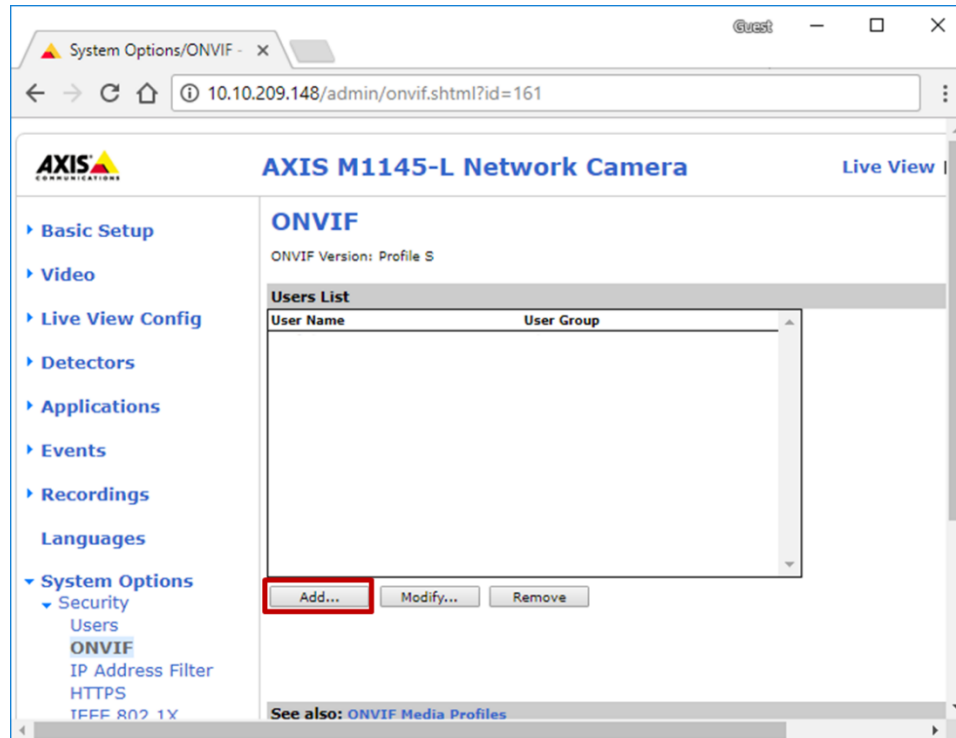
ONVIF is a communication standard for network devices. ONVIF Profile S applies video and audio streaming and PTZ control. Most IP cameras nowadays support ONVIF Profile S. For cameras that do so, pan, tilt, and zoom control can be done with Media Recorder and audio from the camera can be recorded. For cameras that do not support ONVIF, pan, tilt, and zoom control must be done with a browser and audio must be recorded with a microphone connected to the sound card of the computer.

- a. Select the **Setup** link in the upper right side of the webpage.

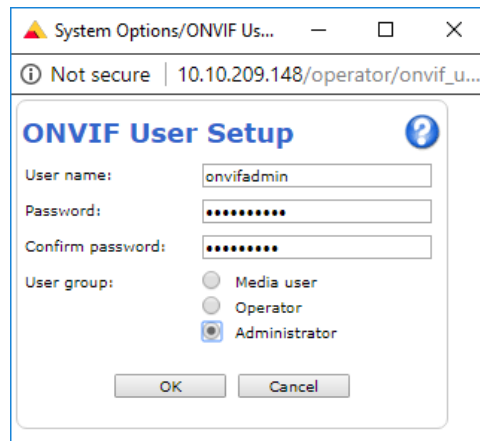


- b. From the menu options on the left side of the webpage, select **System Options | ONVIF**.

- c. Click the **Add...** button associated with the *User List*.



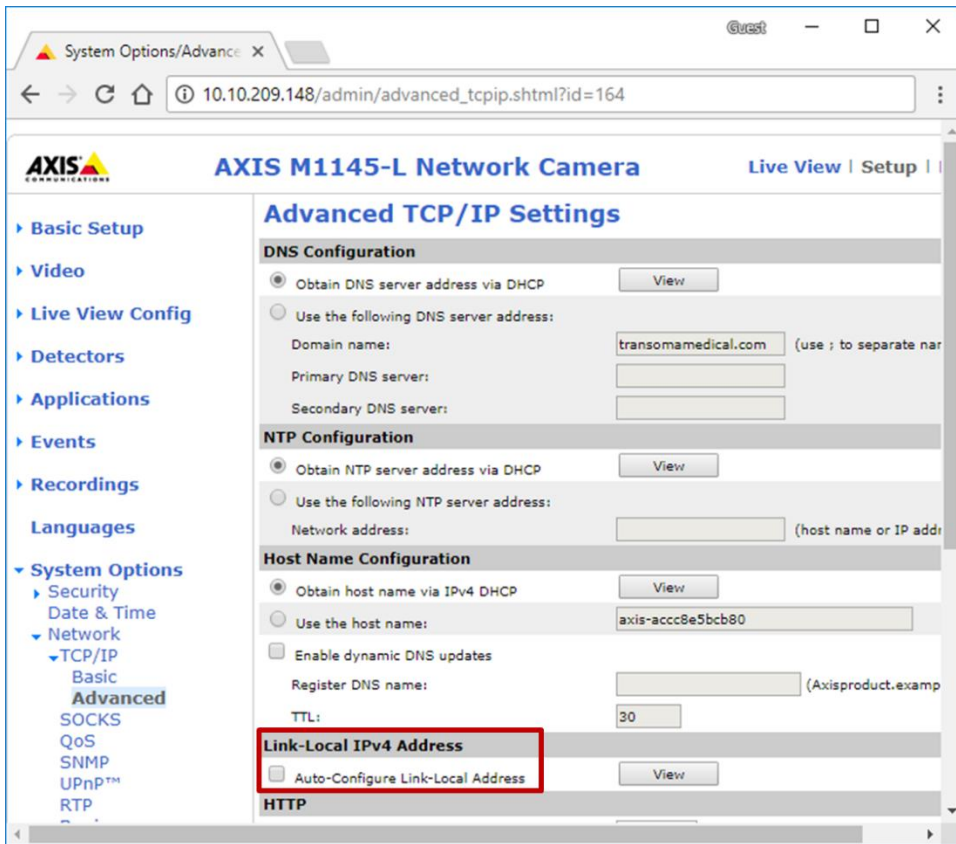
- d. When prompted, enter the following:
- Username: onvifadmin
 - Password: onvifadmin
 - User Group: Administrator



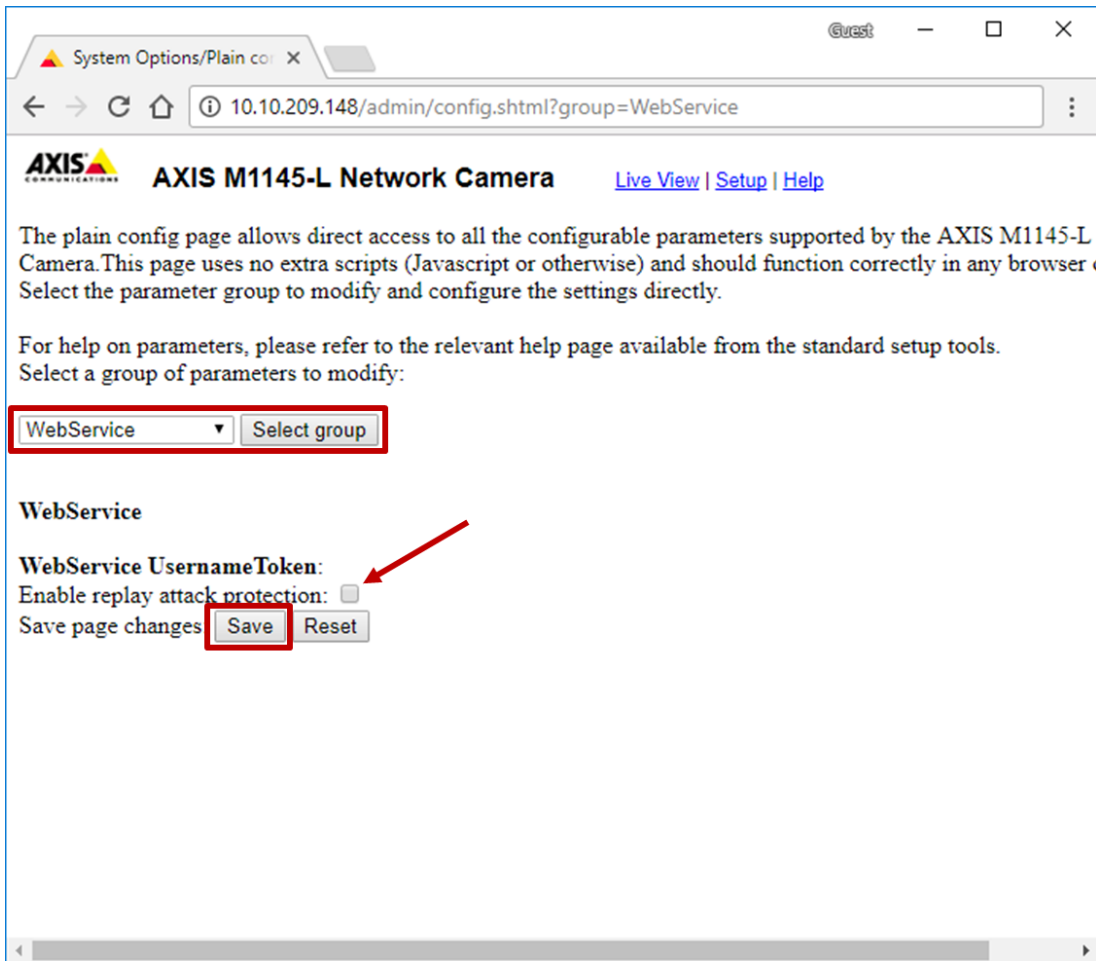
- e. Click **OK**.

3. Update TCP/IP Settings:

- Still within the **System Options**, select **Network | TCP/IP | Advanced**.
- Locate the *Link-Local IPv4 Address* heading.
- Uncheck Auto-Configure Link-Local Address**.



4. Update Webservice Settings:
 - a. Still within the **System Options**, select **Advanced | Plain Config | Advanced**.
 - b. Select **Webservice** from the dropdown menu, then click **Select Group**.
 - c. **Uncheck** the *Enable replay attach protection* setting.
 - d. Click **Save**.



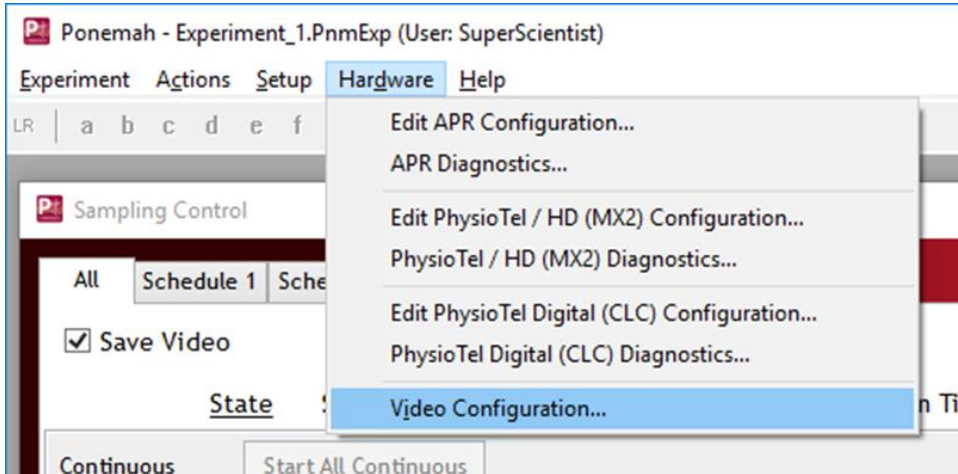
5. Repeat steps 1-4 above for any additional Axis IP Cameras.

CONFIGURING CAMERAS IN MEDIA RECORDER

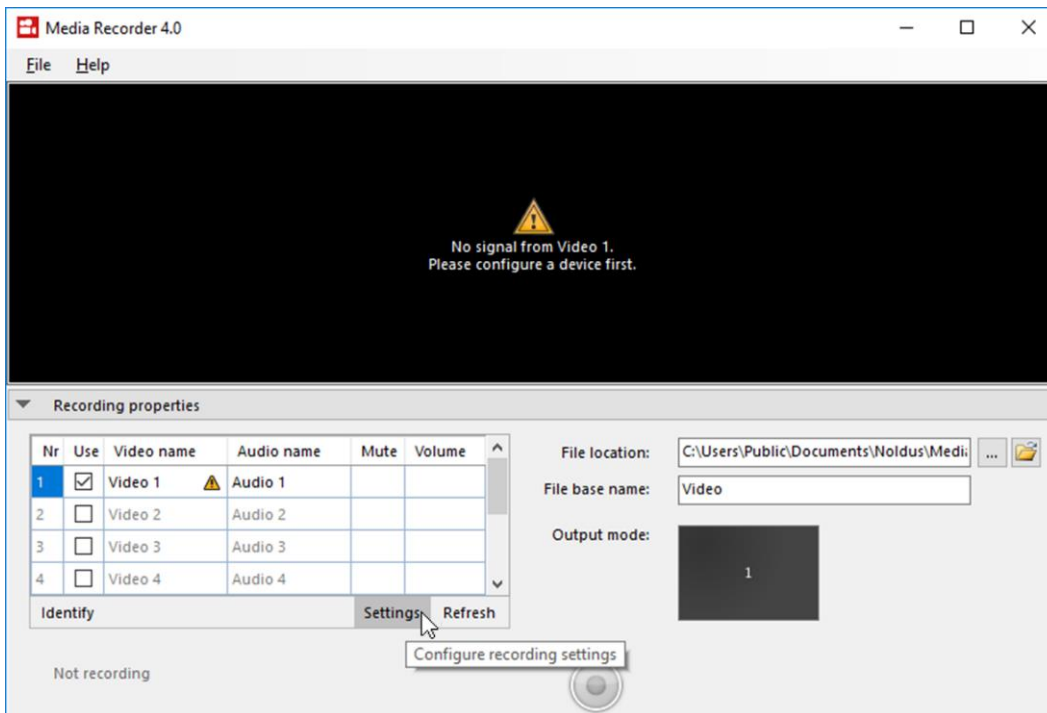
To configure cameras within Noldus Media Recorder:

1. Launch Ponemah.
2. Open the appropriate Experiment.

3. Select the **Hardware menu | Video Configuration** to launch Noldus Media Recorder.

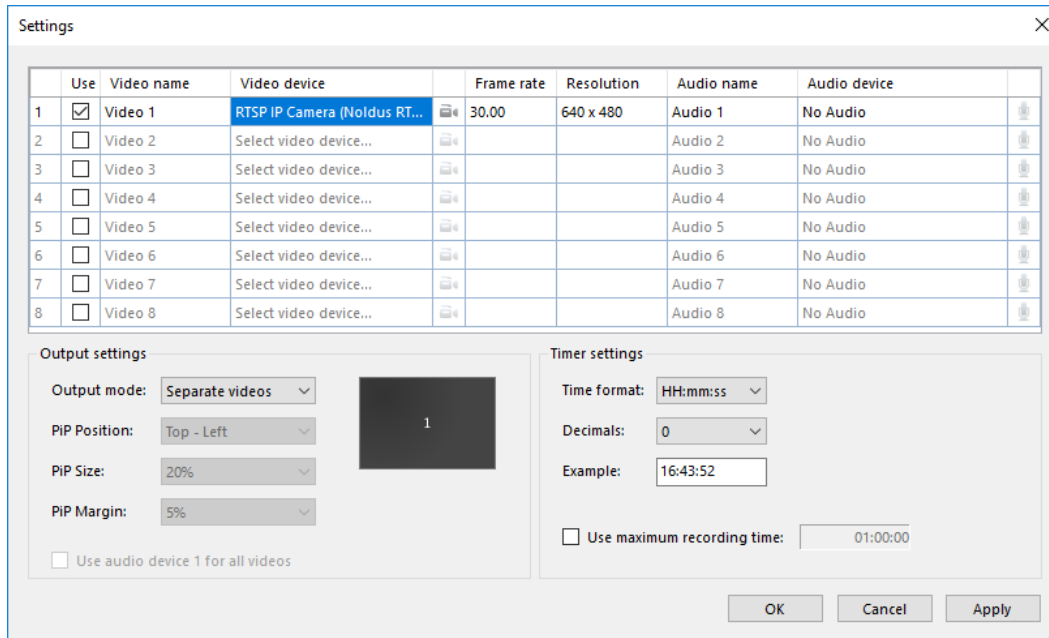



4. Click the **Settings** button or choose the **File menu | Settings**.

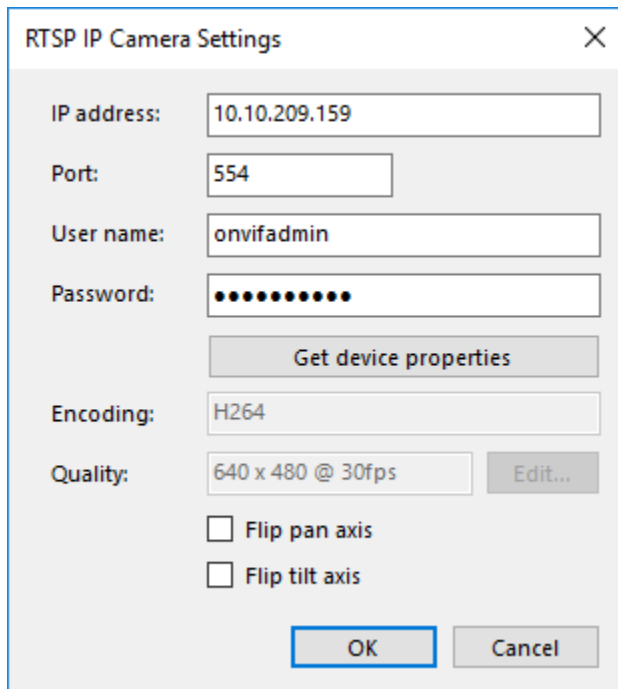


5. (Optional) Update the name of video camera.
The name specified here will be displayed within Ponemah during the camera assignment process.

- Select **RTSP IP Cameras** from the dropdown list under *Video Device*.



- Click the **Camera Icon**  to access the advanced settings.
- Complete the Camera Settings dialog with the camera's IP Address obtained from **IP Camera Setup** section (step 1) and ONVIF username and password from (step 2.d.), then click **Get device properties**.



- Click **OK**.
- Select the desired **Frame Rate** and **Resolution**.
The available options will depend on the camera model. By default, the optimal combination of frame

rate and resolution for the camera is selected. If you increase the frame rate, the maximum resolution available goes down and vice versa. If you select an impossible combination of frame rate and resolution and format, Media Recorder gives a warning.

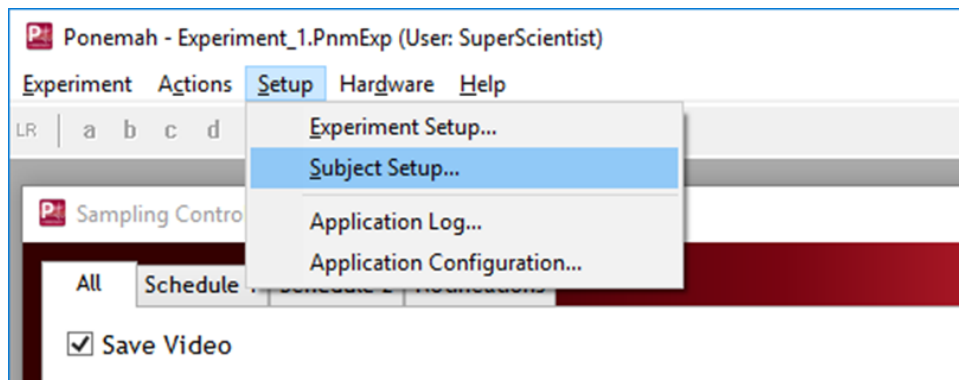
11. Add subsequent cameras by enabling the checkbox under the *Use* header.
12. Repeat steps 5-10 for additional cameras.
13. Click **OK** to close the *Medial Recorder Settings* dialog.
14. Once camera setup is complete, choose File | Exit to close Noldus Medial Recorder and return to Ponemah to associate the cameras to the desired subjects.

Note: Please keep the default settings for Output Settings, Timer Settings, File Location, and File Base Name.

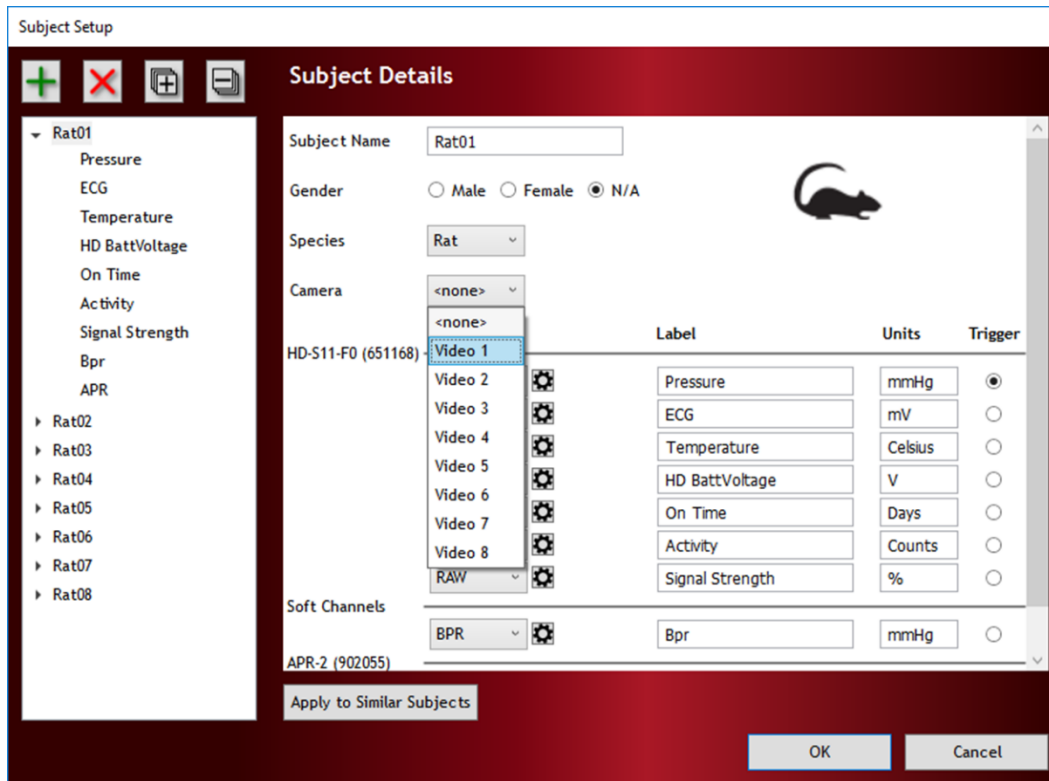
ASSOCIATING CAMERAS TO PONEMAH SUBJECTS

To assign cameras to the appropriate subject for synchronized physiologic data and video data acquisitions:

1. Select the Ponemah **Setup menu | Subject Setup**.



2. Select a Subject from the tree view on the left to associate the camera.
3. Select the **Camera** dropdown menu in the *Subject Details* section and select the desired camera to pair with the Subject.

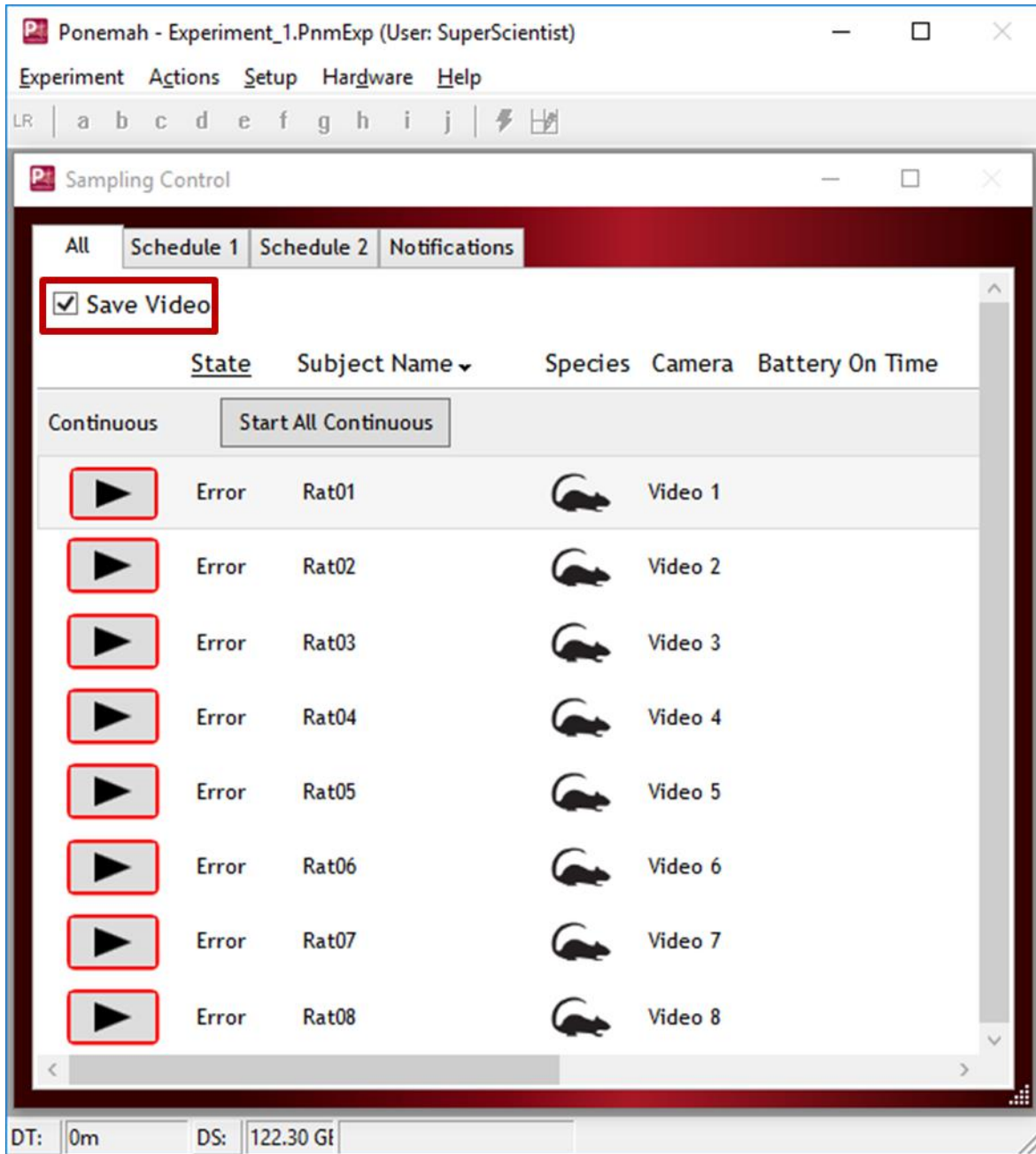


4. Repeat for any addition subjects.
5. Select **OK**.

Note: Cameras may be associated with multiple Subjects.

ACQUIRING SYNCHRONIZED VIDEO DATA

To acquire synchronized video and save video to disc with the physiologic data, **ensure the Save Video checkbox is checked.**



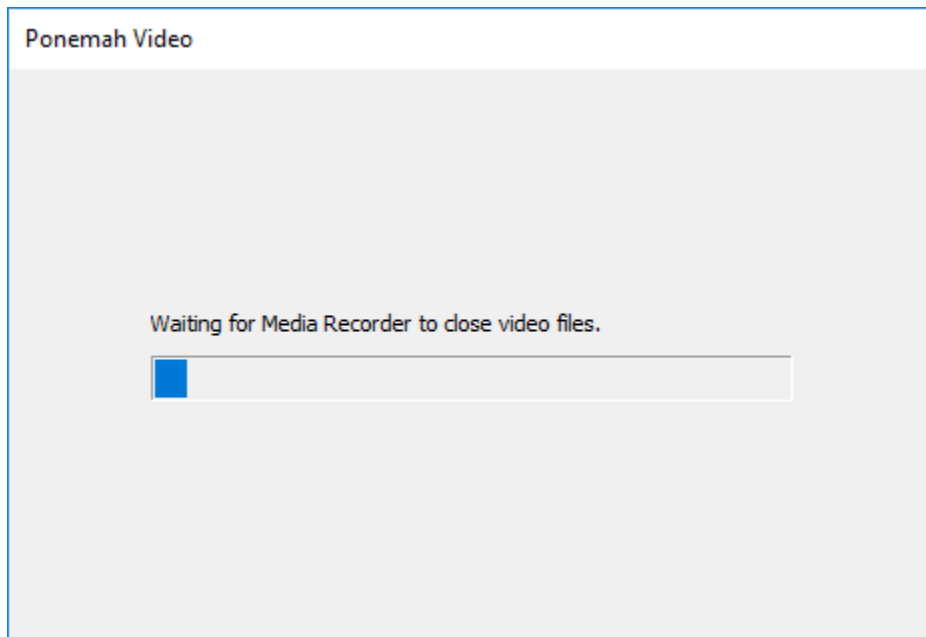
Once **Start All Continuous** is selected, Ponemah will update for acquisition, automatically launch Noldus Media Recorder, and commence video acquisition. Please note, Ponemah will control the start/stop of video recording via Media Recorder.

Scheduled Sampling does not support video acquisition. Video recording is only supported with Continuous Sampling.

UNDERSTANDING VIDEO FILE GENERATION

When acquiring video data, each subject will have its own set of video files. This includes an .XML file containing pertinent meta data about the video file Ponemah requires for Subject association and video playback in Ponemah Review and the actual video data files.

New video data files are created at the start of each acquisition session. When stopping acquisition, Ponemah will wait (up to one minute) for the Media Recorder to close the video files. The user will be presented with the following progress dialog during the file closing process:



FILE INCREMENTATION

During acquisition, the video data file will increment every 24 hours **OR** every 500 MBs, whichever is achieved first. This 500 MB file size threshold is user configurable from the **Application Configuration**; however, the 24-hour threshold cannot be altered.

Once either the 24-hour or 500 MB threshold is achieved, video acquisition will automatically stop for up to 1 minute to close the current video file and then automatically restart collection with a new file. The physiologic data will continue collecting during this period, uninterrupted. A pop-up indicator does not exist for when this occurs, but the Noldus Media Player **Record** button will change, the settings will no longer be greyed out, and Media Recorder will say "*Not recording*" in the lower corner of its dialog during this time. Incrementing the video data files in this fashion is done to keep the video file sizes manageable and the synchronization with physiologic data within the +/-1 second specification.

FILE LOCATIONS

During acquisition, video files are actively saved to the following directory:
C:\Users\Public\Documents\Noldus\Media Recorder\Video Files\

Once acquisition is stopped or the file incrementation threshold discussed above is met, the video files will be closed and automatically transferred to the appropriate Ponemah Experiment folder. Files will also be renamed at

this time based on Ponemah’s file naming structure. Please see the **Experiment Files** section of this manual for descriptions of the video file types.

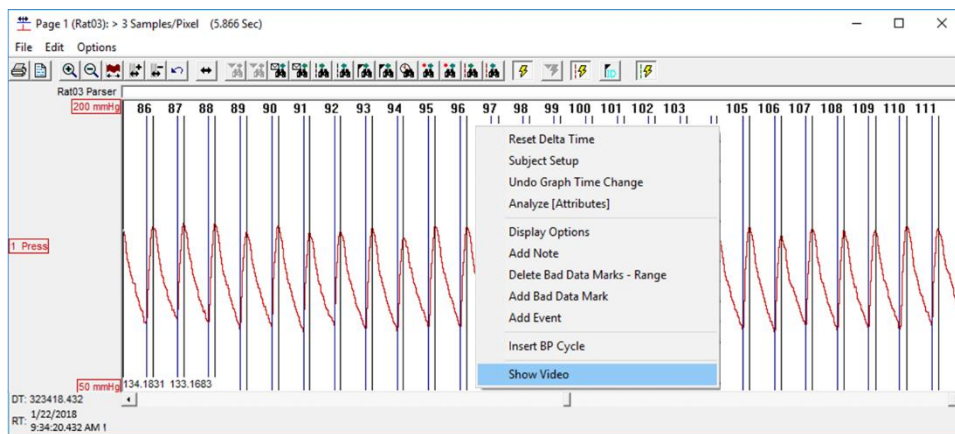
VIDEO PLAYBACK WITHIN PONEMAH REVIEW

Video Data can be reviewed within Ponemah Review. To do this, start a review session as described in the Loading Data into Review section of this manual. Should any video data be associated with the data loaded into Review, it will automatically be available.

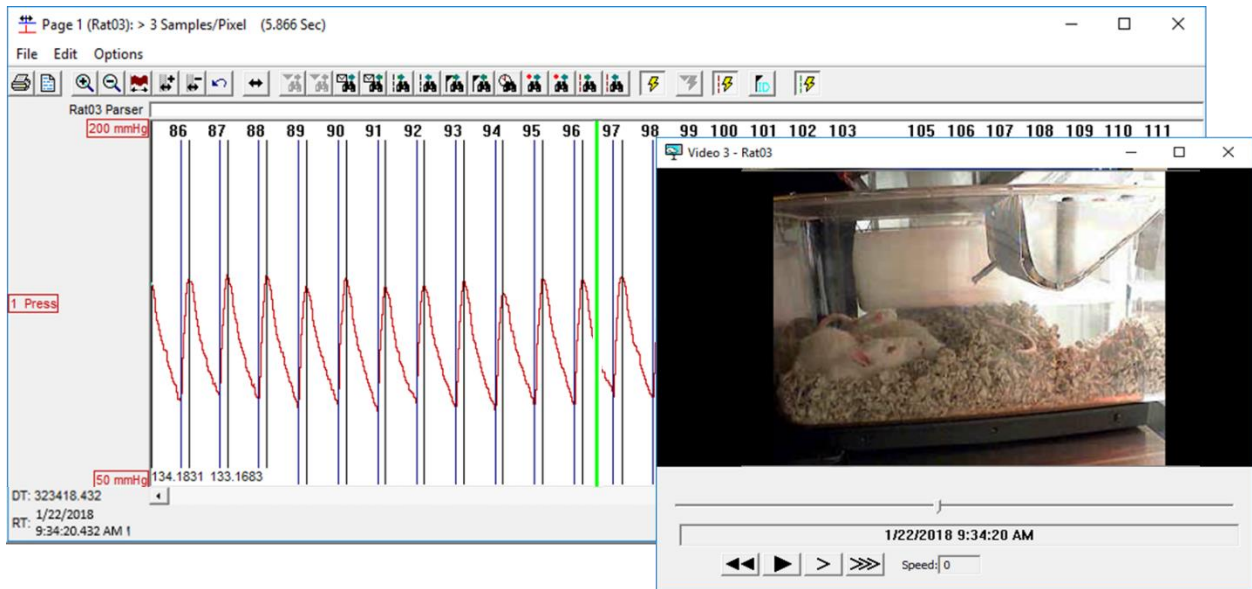
The Noldus Media Recorder software MUST be installed on the Analysis computer for playback to occur within Ponemah Review. The Analysis computer does NOT require a separate Noldus Media Recorder license nor does the Noldus security dongle need to be used.

To launch the Video Player:

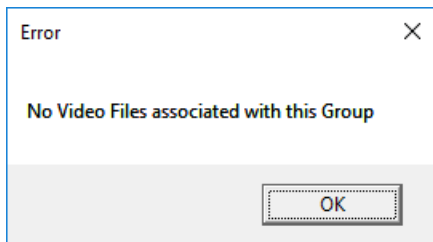
1. Navigate to a Primary or Trend Graph Page.
2. Right-click a graph pane and select **Show Video** from the menu to launch the player.



Once the Video Player is launched, a solid, vertical green line will appear on the graph page to indicate the location of the current frame in relation to the physiologic data. Should this green cursor reach the edge of the graph during video playback, the graph will automatically advance to the next page of data.

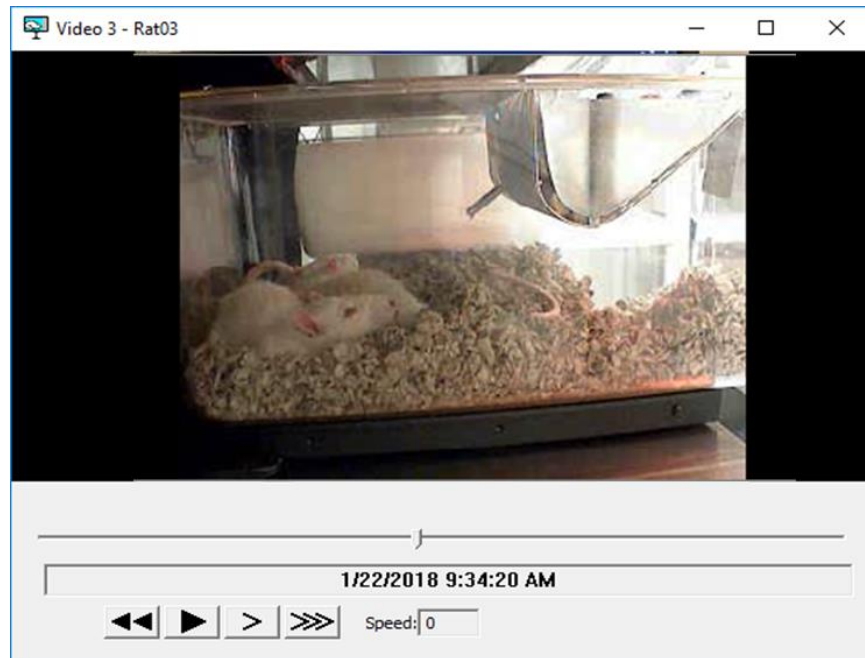


Note: if video files are not found for the Subject, the following message will be displayed:



VIDEO PLAYER CONTROLS

The Video Player offers several control features to navigate through the video file, as outlines below.



1/22/2018 9:34:20 AM

The Video Player will display the date and time of the currently displayed image. This date and time corresponds to the solid, vertical green line associated with the physiologic data on the graph page.



Scroll bar for the video data. Scrolling through with this cursor will also advance the physiologic data graphs to keep synchronized with the image displayed in the Video Player.



Rewind button. Used to step through the video file in reverse, two seconds at a time.



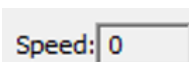
Play button. Used to step through images at the frame rate acquired; i.e. real-time playback. When video is playing back, this button turns into a Pause button.



Reduce playback speed by half.
Min: 0.125



Increase playback speed by double.
Max: 2



Playback speed indicator.

Please note, to step forward through the video file frame-by-frame, use the keyboard right arrow key <=>. Reversing through the file with the left arrow <<=> will step back in 0.1 second increments.

REMOTE CONNECTION

Ponemah Remote Connection allows an external application either on the same workstation or on a remote workstation to connect to a Ponemah acquisition system and receive parameter data at certain user defined intervals. This is done to create a feedback control mechanism.

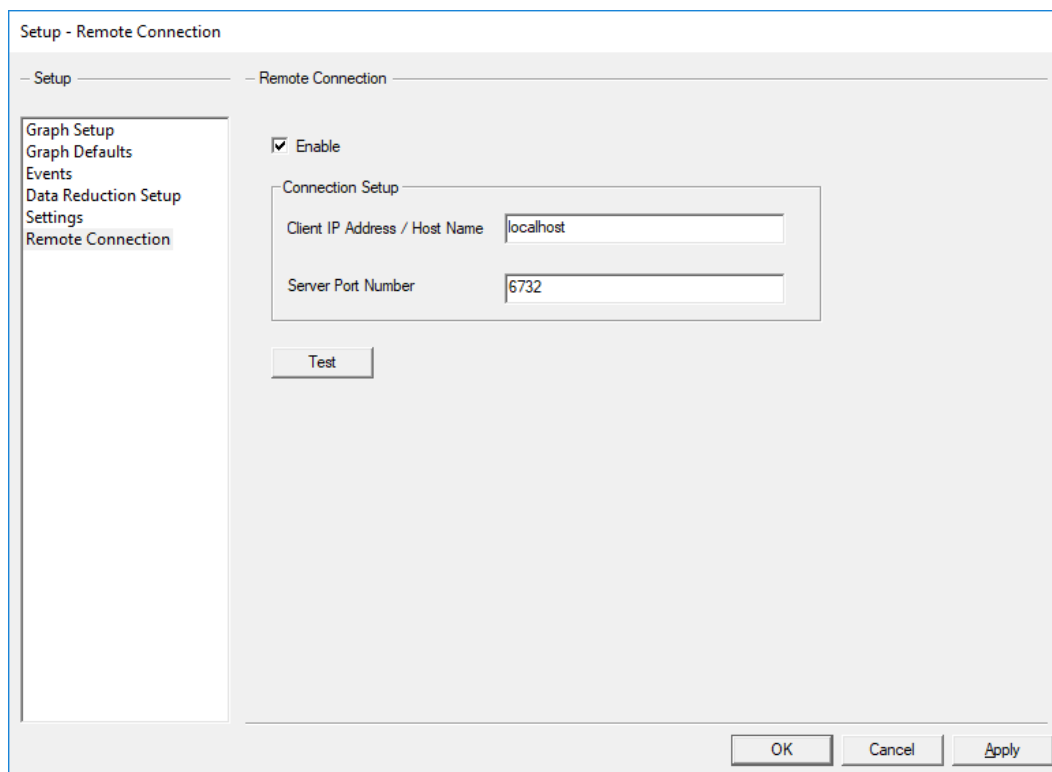
CONFIGURING THE PONEMAH ACQUISITION WORKSTATION

For Remote Connection to send parameter data, Ponemah must be configured appropriately.

Note: when using Remote Connection, do not use ',' or ';' in the Implant Name or Subject Name fields.

To configure Ponemah Remote Connection:

1. Select the Ponemah **Setup menu | Experiment Setup**.
2. Select Remote Connection.



3. Check the Enable checkbox and enter the appropriate TCP/IP communication settings.

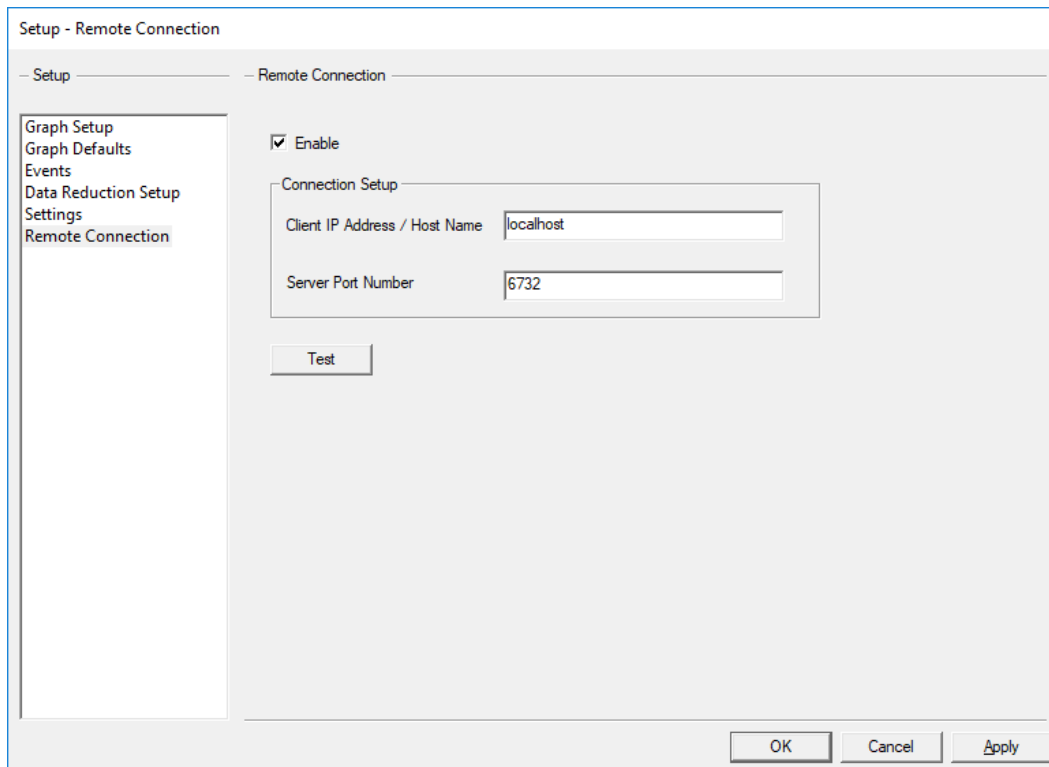
TESTING REMOTE CONNECTION

To test Remote Connection and verify Ponemah is logging data through the port, it is recommended to use the open source tool, PuTTY. PuTTY is a simple application that connects to the TPC/IP port to verify operation. PuTTY is available at: <http://www.putty.org/> Select the Windows 64 bit version.

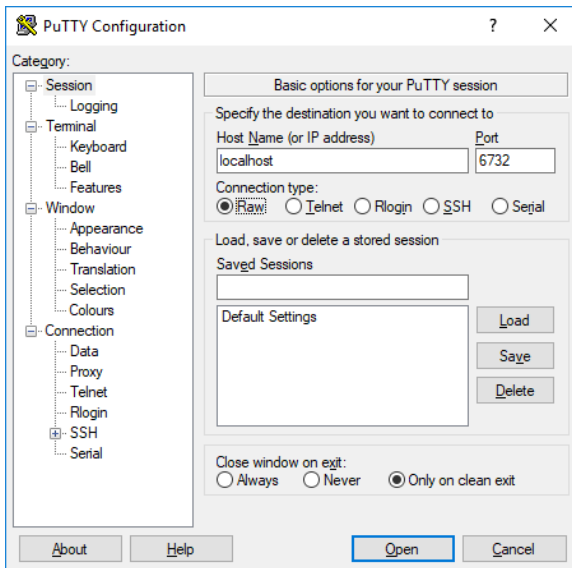
Once PuTTY has been downloaded, run the application on either the same local workstation Ponemah is running on or on the remote workstation the external application will use for the connection. It is important to make sure both workstations can be seen on the network and the appropriate firewall ports are open.

To test the connection:

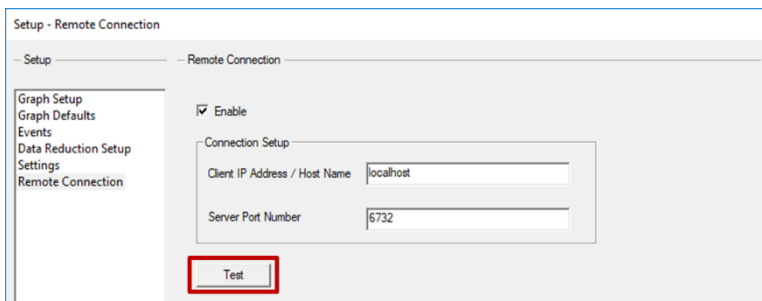
1. Ensure Ponemah and PuTTY are running.
2. Within **Ponemah**, select the Ponemah **Setup menu | Experiment Setup**.
3. Select **Remote Connection**.
 - a. Enter the computer name of the Client PC.
This is the PC name the external application is running on. If it is the external application is running on the same PC as Ponemah, enter **localhost**.
 - b. Enter the desired TCP/IP port to be used for the communication.



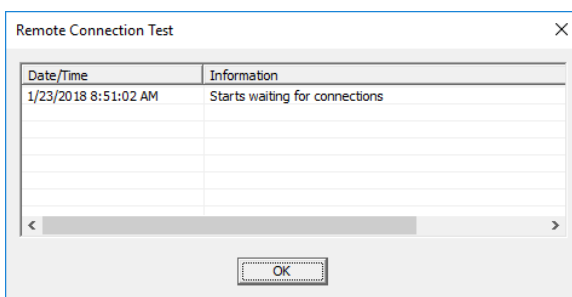
4. Within **PuTTY**, enter the following:
 - a. The PC name of the computer running Ponemah.
 - b. The desired TCP/IP port number to be used for communication.
 - c. Select the **Raw Connection type**.



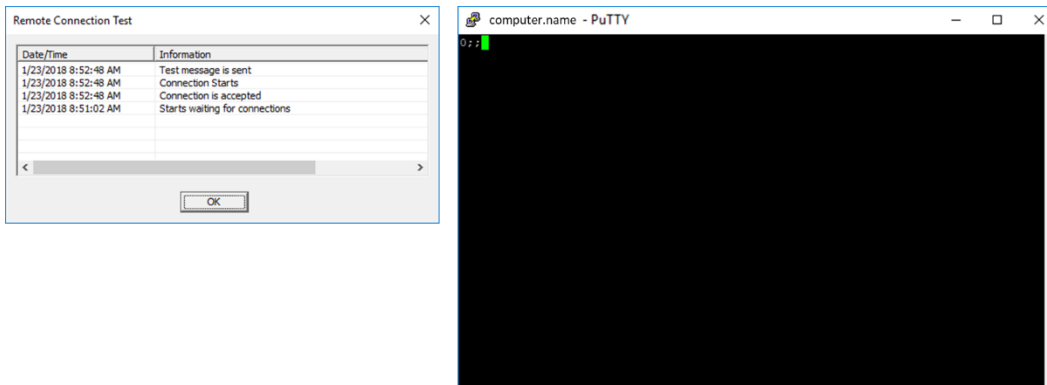
- Once both applications are configured, click the **Test** button from the Ponemah Remote Connection settings dialog.



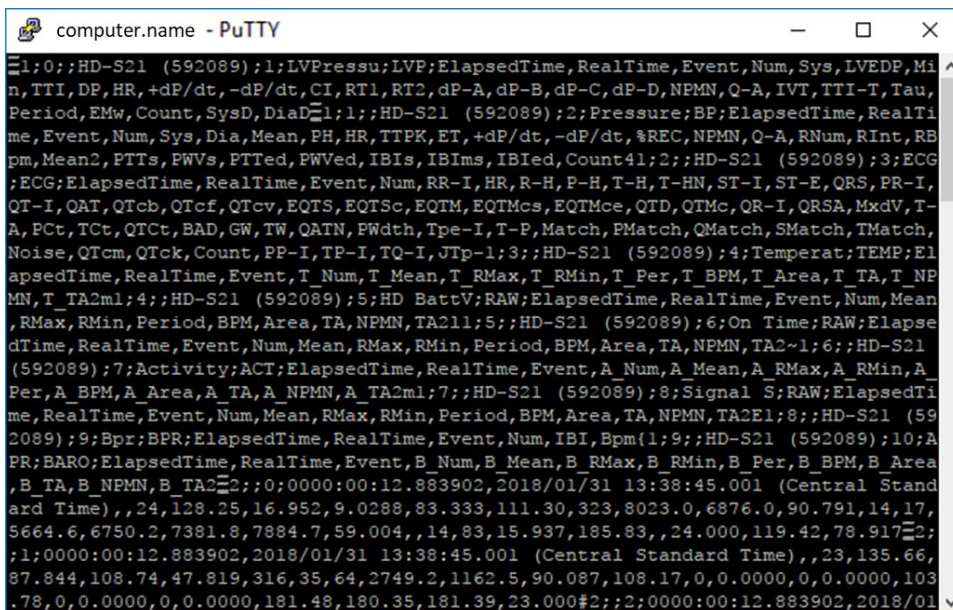
- A window will appear waiting for a connection to the port to occur.



- In PuTTY, select **Open**.
When the Putty response window opens, it will display a response from Ponemah and the Ponemah test window will display the connection status as displayed below.



8. Once a connection has been established, the user can now verify that logged lines of Derived Parameter data from Ponemah can be sent through the connection. Click **OK** to close the *Experiment Setup* dialog.
9. Start an acquisition. (See **Sampling Control — Starting Data Acquisition**)
10. Restart PuTTY and select the connection parameters used in Step 4. and select **Open**.
11. After a logged line of Derived Parameter data is generated by Ponemah, the PuTTY status window will display the information for that logged line of data from the network connection as displayed below.



DATA OUTPUT FORMAT

The format of the data output of logged Ponemah Derived Parameter data is outlined below. Please note, all Ponemah Derived Data is output through the connection, not just the selected parameters from the *Channel Details* page of *Subject Setup*.

Each record will start with a 2 byte unsigned integer in big endian order indicating the length of the whole message in bytes after this counter. The max length for each message is 1024.

DERIVED PARAMETER METADATA (HEADER)

The header data will be in the following format:

[Message length]1; [Instance ID];[Referenced data instance ID];[Subject Name];[Channel Number];[Channel Label];[Channel Analysis];[Elapsed Time, Real Time, Event, Param 1 Name, Param 2 Name...]

Note: Referenced data instance ID will be blank for metadata.

Example:

```
Ξ1;0;;HD-S21 (592089);1;LVPressu;LVP;ElapsedTime,RealTime,Event,Num,Sys,LVEDP,Min,TTI,DP,HR,+dP/dt,-  
dP/dt,Ci,RT1,RT2,dP-A,dP-B,dP-C,dP-D,NPMN,Q-A,IVT,TTI-T,Tau,Period,EMw,Count,SysD,DiaDΞ(186)1;1;;HD-S21  
(592089);2;Pressure;BP;ElapsedTime,RealTime,Event,Num,Sys,Dia,Mean,PH,HR,TTPK,ET,+dP/dt,-dP/dt,%REC,NPMN,Q-  
A,RNum,RInt,RBpm,Mean2,PTTs,PWVs,PTTed,PWVed,IBIs,IBImS,IBIed,Count
```

[2 byte binary data for message length][this is Meta Data for derived parameters];[Data Instance ID is 0];[Reference data instance is not specified];[Subject is 1];[Channel is 1];[Channel Label is LVPressu];[Channel Analysis is LVP];[Parameter sequence: : SubjectID is the first data coming, ElapsedTime is the second, then RealTime, Num, Sys, etc][2 byte binary data for message length][this is Meta Data for derived parameters];[Data Instance ID is 1];[Reference data instance is not specified];[Subject is 1];[Channel is 2];[Channel Label is Pressure];[Channel Analysis is BP];[Parameter sequence: SubjectID is the first data coming, ElapsedTime is the second, then RealTime, Num, Sys, etc]

DERIVED PARAMETER DATA

The Derived Parameter data will be in the following format:

[Message length]2;[Instance ID];[Referenced data instance ID];[Elapsed Time, Real Time, Event text, Param 1 value, Param 2 value, etc]

Note: Instance ID will be blank for derived parameter data.

Example:

```
Ξ2;;0;0006:14:52.000,1/23/2018,15:45:40.001 (Central Standard Time),(a) event 1,212.00,116.89,5.66,-  
2.71,87.59,111.23,307.07,8000.16,6837.67,110.79,14.35,17.32,6749.91,7399.18,7818.33,7748.86,47.11,13.88,87.  
59,6.84,195.40,212.00,116.13,79.31Ξ2;;1;0006:14:52.000,1/23/2018,15:45:40.001 (Central Standard Time),(a)  
event  
1,192.00,125.46,78.00,98.74,47.46,304.24,37.06,65.06,2640.87,1139.93,92.98,98.69,0.00,0.00,0.00,0.00,93.82,0.0  
0,0.00,0.00,0.00,197.22,197.25,197.25,51.00
```

[2 byte binary data for message length][this is a derived data];[Instance ID is not specified];[It references the data with instance ID 0];[animal ID is HD-S21 (592089), according to Meta Data Instance ID 0 ElapsedTime is 0000:00:03.542, RealTime is 1/23/2018 15:45:40.001 Central Standard Time, event a was marked with description “event 1”, Num value is 212, Sys value is 116.89,etc.][2 byte binary data for message length][this is a derived data];[Instance ID is not specified];[It references the data with instance ID 1]; [animal ID is HD-S21 (592089), according to Meta Data Instance ID 1 ElapsedTime is 0000:00:03.542, RealTime is 1/23/2018 15:45:40.001 Central Standard Time, event a was marked with description “event 1”, Num value is 192, Sys value is 125.46,etc.]

INSERTING EVENTS IN PONEMAH

To insert events from the external application, send the message with format outlined below to Ponemah via the connection:

[Message length in 2 byte binary Big endian]3;[Instance ID];[Referenced data instance ID];[Subject];[Event Name]

Example:

[Message length]3;;;Event1

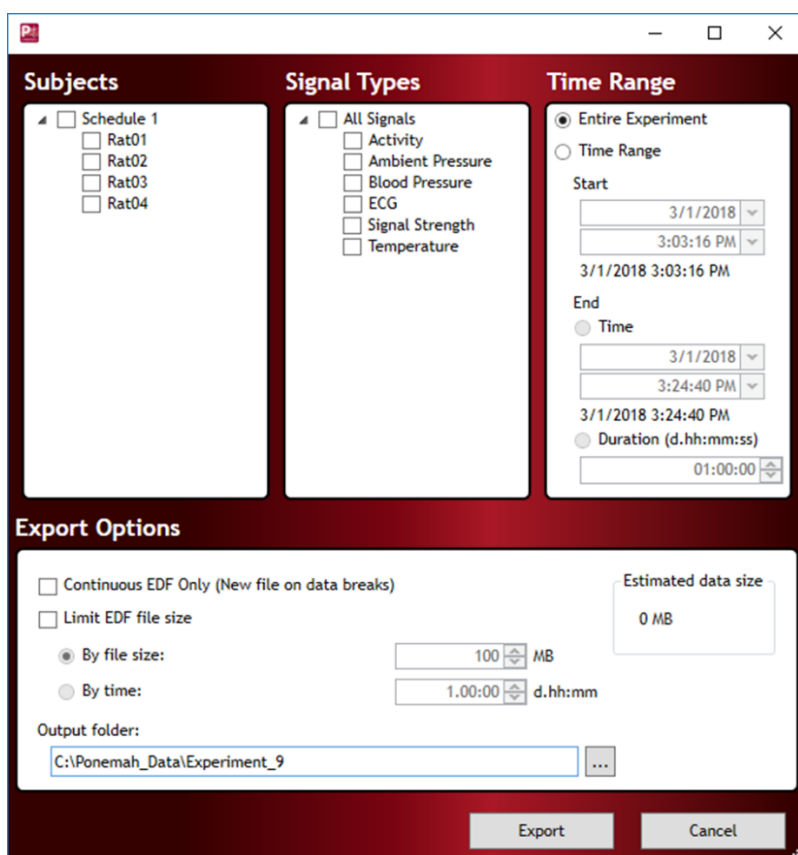
The event will be placed for all Subjects.

EDF EXPORT

Ponemah European Data Format (EDF) Export permits users to export waveform data to EDF format for further processing of data in third party analysis software. More information about EDF format may be found at the following website: <https://www.edfplus.info/>

To export waveform data to EDF format:

1. Select **Experiment menu | Export to EDF**.



2. Select the **Subjects**, **Signal Types**, and **Time Range** desired to export.
Note: Ponemah Presentation Signals (e.g. Derivative Presentation) cannot be exported.
3. (Optional) Select **Continuous EDF Only** option.
This should be used if the third party EDF reader cannot handle time breaks in the data as this will create

a new EDF file for each data section between Data Break marks. See **Graph Concepts** to learn more about Data Breaks. Otherwise, new files will be generated based on the selected file size limiter.

4. (Optional) Select to **Limit the EDF file size** by **Size** or **Time** (duration).
 - a. Check the associated checkbox to enable the EDF file size limiter.
 - b. Use the radio button to select the limiter type.
 - c. Enter the size or time threshold required to be achieved to increment the data into a new EDF file.
5. Select an **Output folder** the EDF files will be save to upon Export.
DSI recommends creating a new folder every time EDF files are exported to ensure previous exports are not overwritten.
6. Select **Export**.

EDF Output Files:

- EDF files will be generated by subject and will be named with the subject name. All channels selected for the subject will be contained in the subject EDF file. Example output without a file limiter:
 - Rat01.0001.edf
 - Rat02.0001.edf
 - Rat03.0001.edf
 - Rat04.0001.edf
- Should a file limiter be enabled, Ponemah will automatically increment the file name:
 - Rat01.0001.edf
 - Rat01.0002.edf
 - Rat01.0003.edf
 - Ect.

APPENDICES

This appendix provides information about DSI's implant exchange program, tells you how to manage a zero-pressure offset, and describes how to maintain an implant after it has been first implanted.

IMPLANT APPENDIX

EXCHANGE PROGRAM

The DSI Exchange program allows you to exchange your used telemetry implants for replacement implants at a fraction of the original purchase price. In addition, we ensure that each implant provided as part of DSI Exchange program will meet or exceed your design expectations for guaranteed performance and quality. By participating in the DSI Exchange program, the overall costs of your study should be considerably reduced. The three key elements to this program are construction, calibration, and certification.



CONSTRUCTION

All implants are hand assembled by DSI's highly skilled technicians, and before being shipped to you, each implant is rigorously inspected to ensure that all components meet the highest quality standards.

In addition, we take the following steps to ensure that you receive a biocompatible device that is guaranteed to perform to specifications *in vivo*.

- A new battery is installed, which guarantees the implant will function throughout the warranty period.
- All implants are sterilized and placed in a biocompatible housing before being shipped to you.
- Biopotential leads and catheters are provided to ensure signal fidelity.

CALIBRATION

Here's what we do to ensure that all our implants are properly calibrated.

1. Mechanical and electrical testing of all components to guarantee optimal functionality.
2. Full calibration of each physiologic signal, followed by testing to ensure accuracy specifications are met or exceeded, when used as intended. Signals include: temperature, pressure, biopotential, and respiratory impedance.
3. Each implant includes a calibrations label on the sterile package to document that the device has been calibrated for accuracy.

CERTIFICATION

Every implant shipped from DSI has the same warranty policy, and is guaranteed to operate in exactly the same every time. Implants that are received through the exchange program are like a new product. Exchanged implants are purchased for a fraction of the cost of new devices, which reduces ongoing study costs while maintaining data quality and accuracy.

IMPLANT ZERO PRESSURE OFFSET

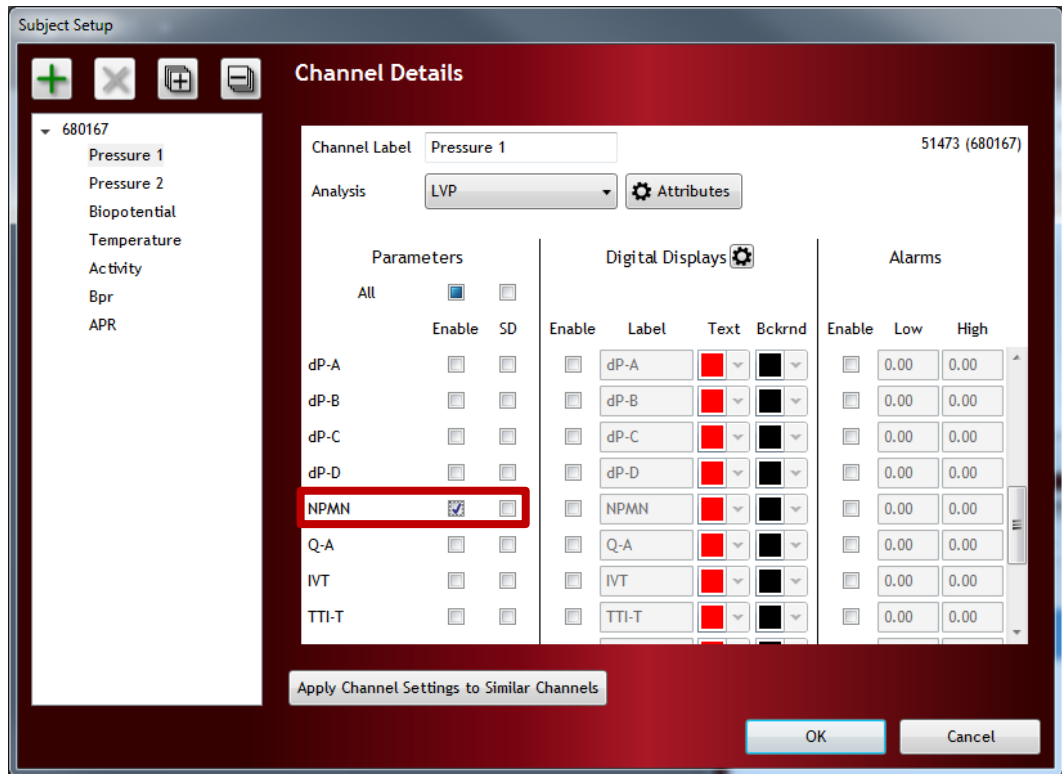
All DSI implants are carefully calibrated and tested before being shipped to the researcher. However, we strongly recommend that all pressure devices be checked again before surgery and after explant. By checking the zero offset before implantation and after explantation, you can be confident that the data being collected are true and accurate. The following procedure will allow you to verify that the implant is functioning normally prior to surgical placement in an animal.

Notes:

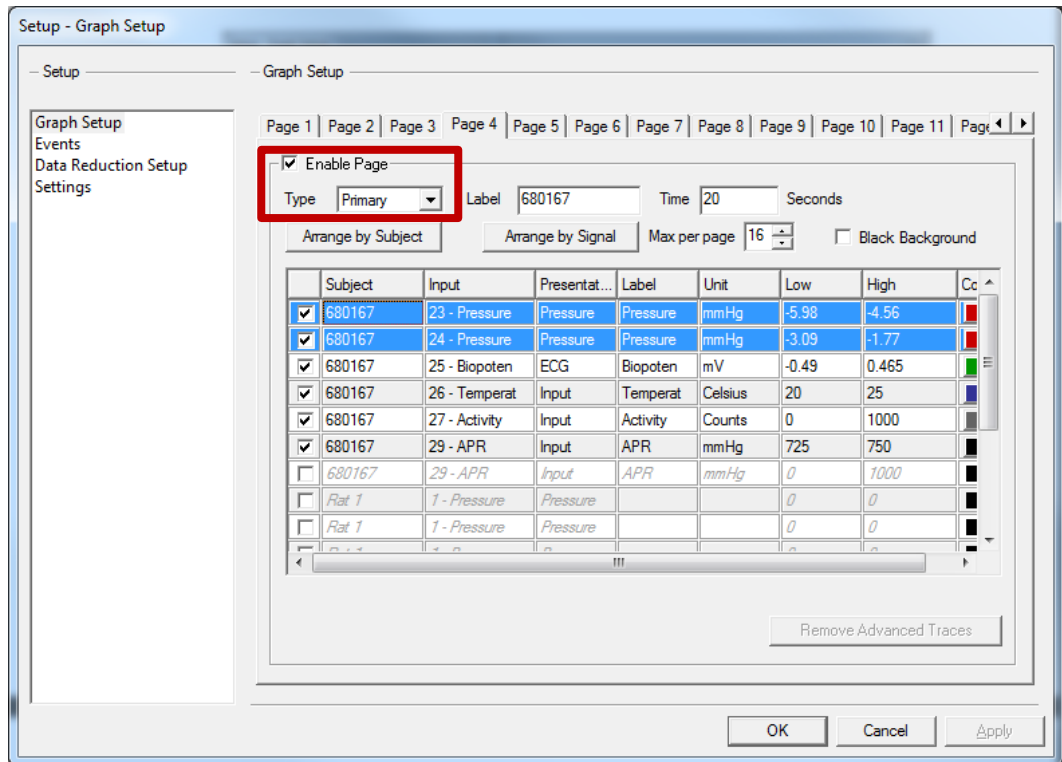
- Please see the Implant Specifications page of the DSI webpage to determine the initial pressure accuracy for your implants.
- It is important that ambient pressure reference (APR-2) is connected and configured prior to checking the zero offset. (See Hardware Configuration).
- It is very important that the catheter tip(s) be level with the implant body. If the catheters are above or below the level of the implant body, the measured values will be affected by hydrostatic pressure and will not be accurate. Checking the implant while still in its sterile package will help to ensure the catheter is in proper position for the zero offset check.
- Do not immerse the implant into liquid or place in a sealed container during this test as it will also cause “head pressure.”

CHECKING ACCURACY BEFORE IMPLANTATION

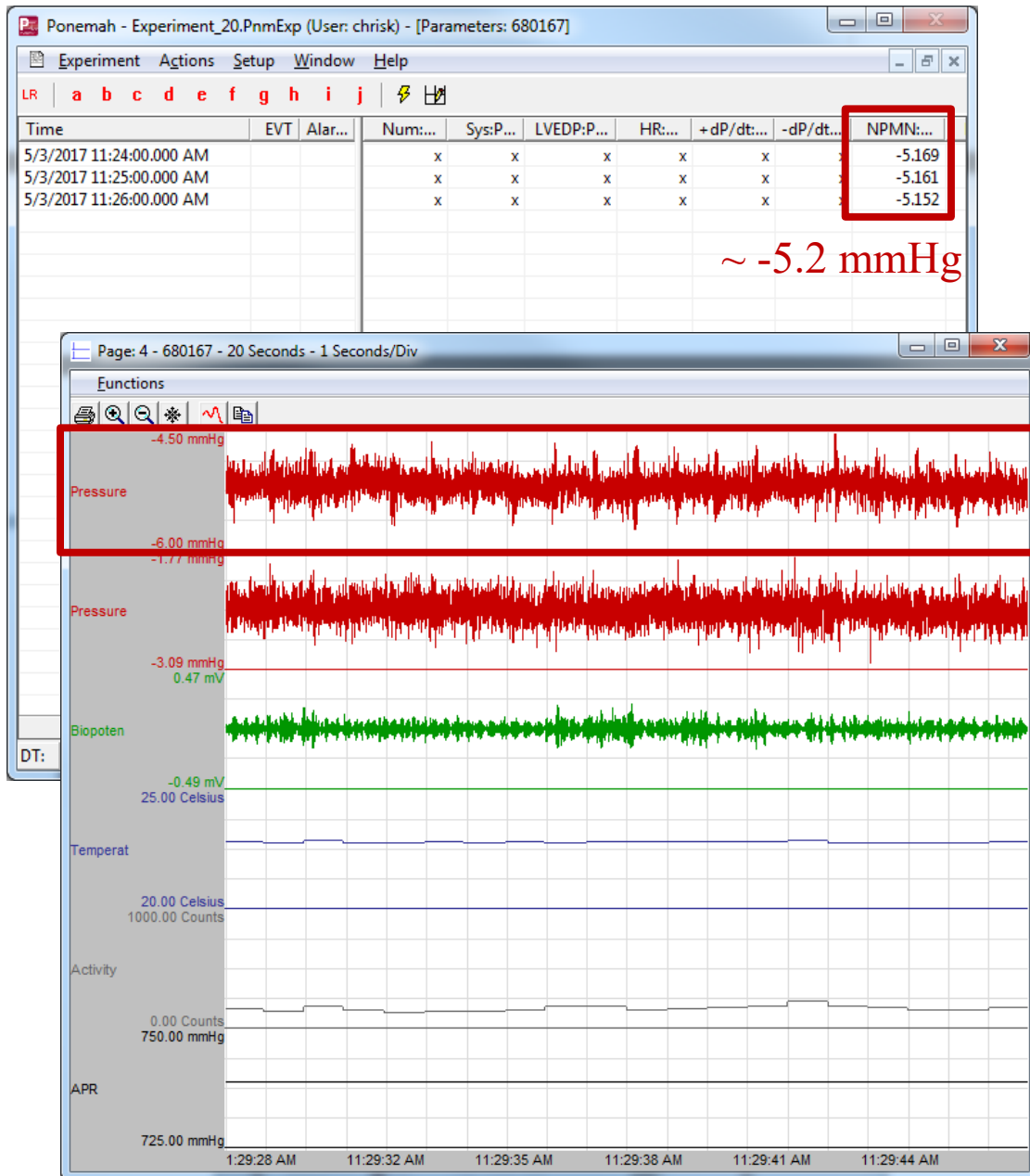
1. Activate the devices and ensure each implant is setup and assigned to a CLC (PhysioTel Digital) or MX2 (PhysioTel and PhysioTel HD).
 - a. For PhysioTel Digital, please see the *Edit PhysioTel Digital (CLC) Configuration* section of the Ponemah User Manual.
 - b. For PhysioTel and PhysioTel HD, please see the *Edit PhysioTel/HD (MX2) Configuration* section of the Ponemah User Manual.
2. In Ponemah, setup the Experiment as described in the **Creating a New Experiment** section of the Ponemah User Manual.
 - a. For the Blood Pressure (BP) and/or Left Ventricular Pressure (LVP) channels, add the Non-Pulsatile Mean (NPMN) derived parameter within the **Subject Setup** dialog's **Channel Details**.




- b. Setup a **Primary** graph page for the LVP and/or BP Input Channel from the **Experiment Setup** dialog.

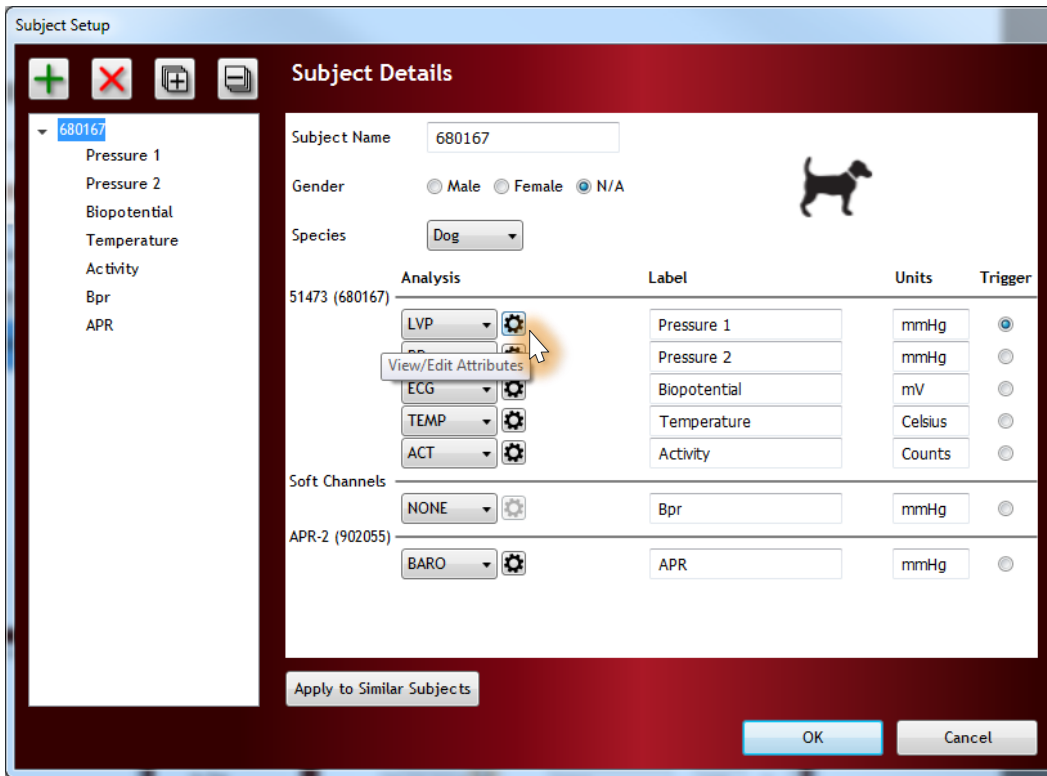


3. Start an acquisition. After a few minutes of collection, assess the NPMN values for the BP and/or LVP channel(s). This is your offset. You may use the Primary Graph(s) to view the real-time recording of the pressure signal to verify it is stable.

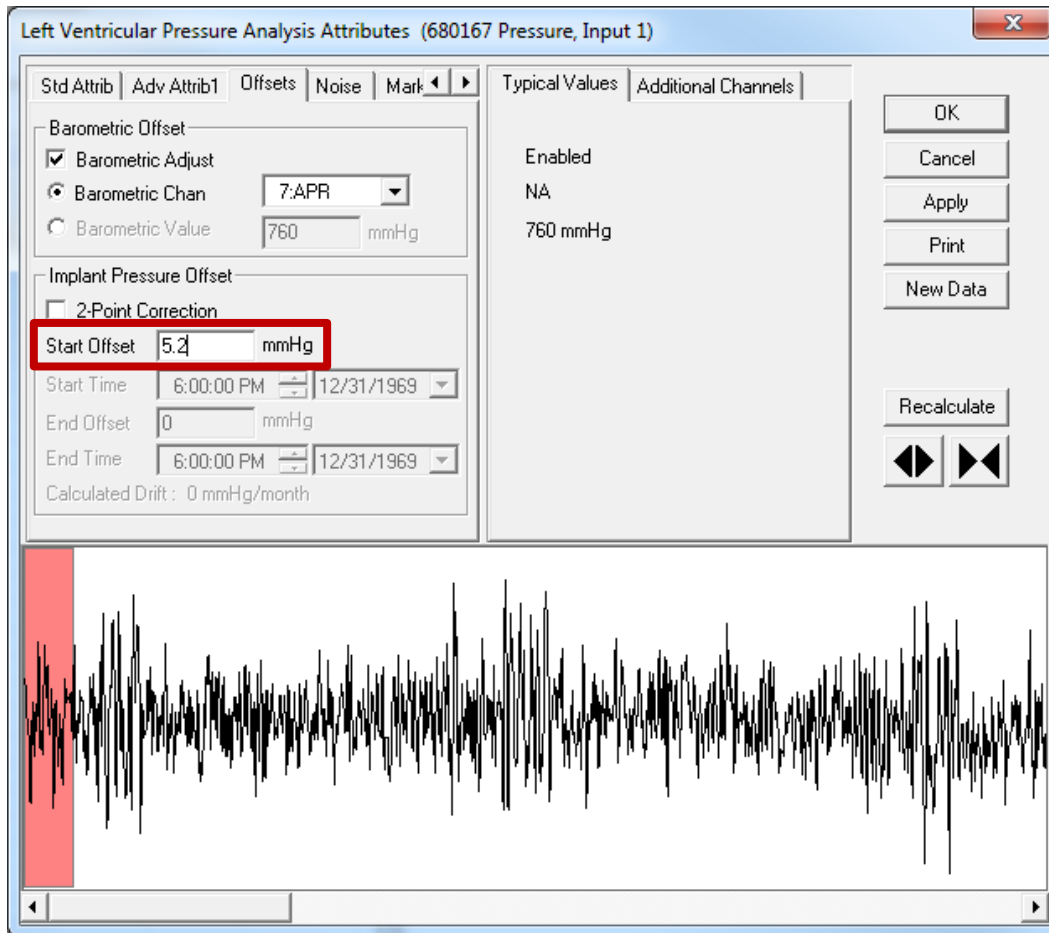


HOW TO ENTER AN OFFSET

1. While running the offset acquisition, navigate to the **Sampling Control All** tab. Double-click on the Subject whose offset you will be entering. Select the  icon associated with the **Blood Pressure Input Channel** and/or **LVP Input Channel** to bring up the **Analysis Attributes** dialog.

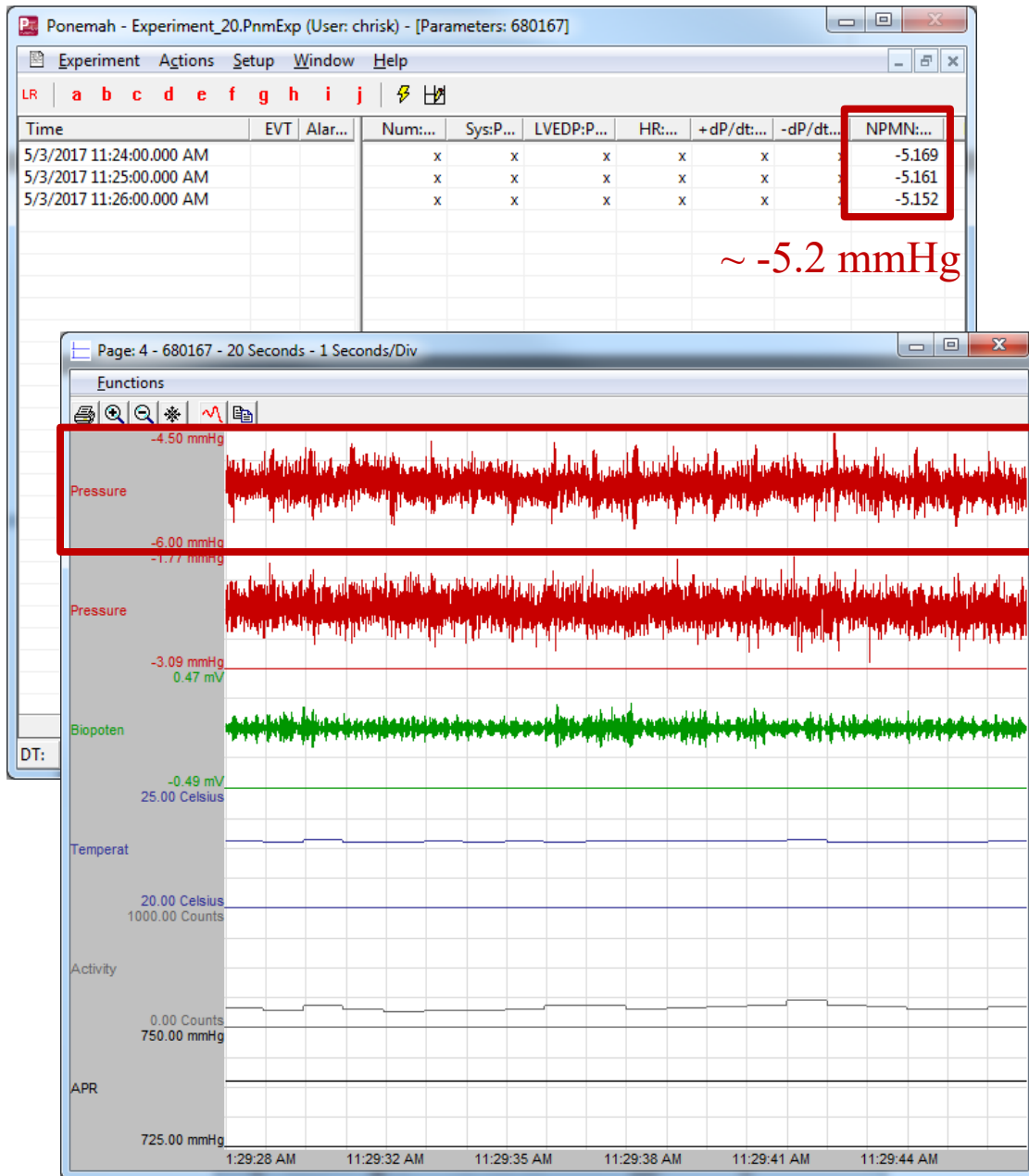


2. Select the **Offsets** tab. At the bottom, located the Offset text box. Enter the value obtained from the NPMN parameter (Step 3 above).



Note: For the LVP (above) and the BP (not pictured) analysis modules, a negative offset will be corrected by entering a positive value into the Start Offset text box. Example: If the signal is -5.2 mmHg below baseline; enter 5.2 in the text box. A positive offset, therefore, will be corrected by entering a negative value into the Start Offset text box. Example: If the signal is +3.1 mmHg below baseline; enter -3.1 in the text box.

3. Check the **NPMN** values after entering the offset to ensure the new value are approximately 0 mmHg. Notice, the signal on the Primary Graph will also reflect the update (may need to auto scale the channel).



- Repeat steps 1-3 from the How to Enter an Offset section for any additional pressure channels.

Note: The 2-point correction checkbox permits the definition of an offset value at the date and time prior to implant and another offset value at the date and time once explanted to apply a linear pressure drift correction over the duration, if desired

Please contact DSI Technical Support with any questions regarding when and how to take a zero pressure offset.

IMPLANT MAINTENANCE AFTER FIRST IMPLANTATION

EXPLANTATION

For complete information on products and techniques approved for use with DSI implants, visit www.datasci.com or contact Technical Support (Support@datasci.com). When explanting DSI implants that are implanted intra-peritoneally or subcutaneously, consider the following.

- First carefully detach the implant body.
- Be careful not to drop the implant.
- *Never* cut a catheter, if the intention is to re-use the implant.
 - If cutting the catheter is necessary, use only a new scalpel blade to cut the catheter at a 45-degree angle away from the device body and approximately 3 cm from the implant body.
 - Do not use any instrument other than a scalpel blade to cut the catheter. Cutting the catheter with a pair of scissors or any other instrument could cause damage to the pressure sensor and *void the warranty*.
 - *If the catheter must be cut, the implant cannot be reused in another animal model*. Please send the device back to DSI for participation in the Exchange Program and the standard Exchange discount on a new device will apply.
- Leads can be cut as there are lead coupler kits available for purchase to extend the length of the leads. Lead coupler kits may make the leads less flexible over time so try to save as much length as possible during explantation.
- Clean and sterilize the implant with an approved enzyme detergent and sterilant before returning the implant to DSI or re-using in another animal.
- If the animal should die unexpectedly and the implant cannot be explanted immediately, the animal can be placed in a refrigerator until the explant can take place. The refrigerator will not damage the device, however; storage in a refrigerator will allow for an easier retrieval. Clots may be more difficult to remove from the catheter so it is recommended to heat the catheter to body temperature in a warm water bath to prevent the sensor from being blown. *Never* cut the tip of the catheter.

ON-SITE CLEANING AND RE-STERILIZATION

All new and exchanged implants shipped to an investigator are sterile and ready for implantation. In studies where implants are implanted for short periods at a time, significant battery life may remain at the end of the study allowing reuse of the implant. DSI has published specifications on the minimum guaranteed hours of battery life. Record the amount of time the device is on to track use and to calculate the battery life left. The PhysioTel HD platform allows this tracking to be much easier as the battery voltage and approximate on time is transmitted from the implant when it is in the ON mode.

DSI has developed detailed procedures for cleaning and sterilizing telemetry implants. These procedures will increase the number of times you can use each implant before returning it to DSI via the Exchange Program, helping to reduce overall costs per study. Sterilization procedures are available online at www.datasci.com.

SHELF-LIFE AND STORAGE

The following sections tell you what to do when you receive a new implant, and how to store it.

- New Implants Direct from Manufacturing

Here's what to do when you receive a new implant from DSI.

- Carefully examine all implants when they arrive at your facility.
- Remove the sterile packages containing the implants from the shipping boxes. All implants are sterile upon arrival.
- Save the shipping boxes to use, when returning used implants for the Exchange Program.
- Inspect each implant's sterile packaging for signs of damage. If the package remains undamaged, this sterility is warranted according to the information on the package label.
- Confirm that each implant is turned off before storing.
 - Using the AM radio on the low frequency setting, turn each implant on and off by scanning a magnet across the implant to ensure that none of the implants were damaged during shipping.
 - Although each unit is checked just before shipping, the implant may have been exposed to stray magnetic fields during shipment. This can cause the unit to be turned on unintentionally.
 - Implants in the OFF mode may lose up to 10% of the battery life within 12 months after the manufacture date.

- Storage of Sterilized Implants

Occasionally there may be a delay between the implant removal from the animal and the beginning of the next study. Proper storage of the on-site sterilized implant is necessary to ensure that the unit will perform normally during the next study.

- Using the AM radio on the low frequency setting, check each implant to ensure that it is properly turned off.
- Thoroughly clean and sterilize each implant according to DSI's On-Site Re-sterilization procedure at www.datasci.com/resources/technical-notes.
- If the original implant sterile package was saved, place the implant into the plastic packaging. This will help to identify the implant and the calibration values associated with it. Do not store implants in saline or other liquid!
- Sterilization before storage is necessary to prevent the spread of bacteria during handling.
- Each implant will require sterilization again at the time of use, because there is no effective way of maintaining sterility after the sterile package has been opened.

- Storage Location Requirements

The implants should be stored in a cool (between 10 and 25 degrees Celsius), dry area away from exposure to static discharge and magnetic fields. *Never* expose them to temperatures above 60 degrees Celsius, as this will void all warranties. It is also important to store them in an area where they will not be accidentally dropped or have items placed on top of them, as the catheter could be crushed and the sensor blown. Battery life is *not* significantly increased by storing your implant in a refrigerator. By following the proper storage procedures, the implants should perform just as well as the day they were shipped.

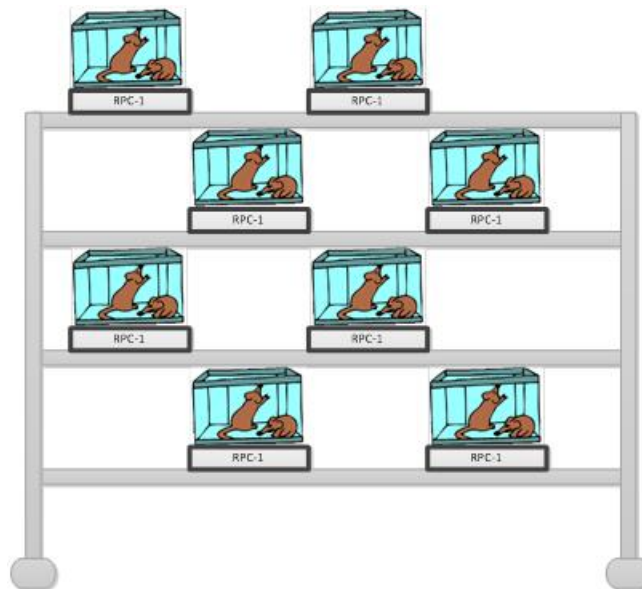
PHYSIOTEL DIGITAL HEXADECIMAL CONVERSION

Hexadecimal is base 16. Base 16 is where the 'numbers' you can use are zero through to the letter F (0123456789ABCDEF). i.e. the decimal value for '1' is represented in hexadecimal as '1' but the hexadecimal value of '15' (decimal) is shown as 'F' (hexadecimal) and the value of '17' (decimal) is '11' in Hexadecimal.

Decimal	Hex	Decimal	Hex	Decimal	Hex
1	1	11	B	30	1E
2	2	12	C	40	28
3	3	13	D	50	32
4	4	14	E	60	3C
5	5	15	F	70	46
6	6	16	10	80	50
7	7	17	11	90	5A
8	8	18	12	100	64
9	9	19	13	500	1F4
10	A	20	14	1000	3E8

PHYSIOTEL AND PHYSIOTEL HD CAGING AND SHIELDING RECOMMENDATIONS

DSI has experience using the typical shoe box sized cages but more and more customers are finding that lab space is difficult to come by. Many different configurations are possible depending on the animal model and space available. As a rule of thumb, always leave at a minimum the distance of one RPC-1 (~12 inches or 31cm) between cages. The best case situation would be placing each cage two receiver widths (18 inches or 45 cm) away from each other. Excluding pair housing studies, below is an example of the minimum recommended small animal configuration without any shielding:



As shown above, stagger the cages on a shelf to conserve the most space with this single frequency device. This illustration represents one implanted animal in each cage paired with another animal that is not implanted. With the HD-S11-F2 device, it is possible to pair two implanted animals with different frequency implants in the same cage and gather data simultaneously. The RPC-3 receiver is mandatory for pair housing studies and requires the same amount of distance between cages as that of the RSC-1 (~12 inches or 31cm).

SHIELDING RECOMMENDATIONS

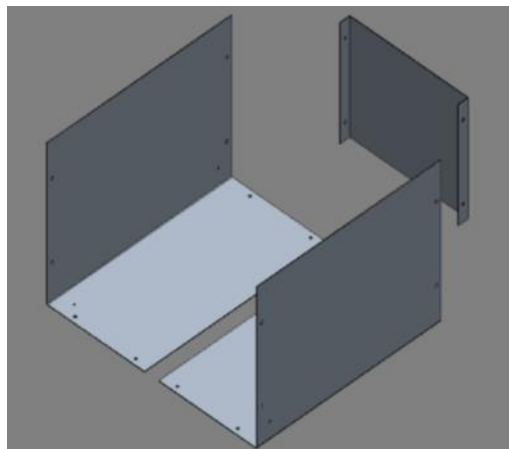
If the receivers need to be closer together and data loss is prevalent (>5%) implement electromagnetic shielding. Shielding comes in many forms from sheet metal and chicken wire to high tech clear specifically designed metal mesh. Locate the source of the noise and enclose that with shielding if possible. For example, the MX2 or another implant can be a source of noise if it is placed too close to the receivers. If problems arise or if you require a list of acceptable shielding options, technical support is equipped to help determine the best shielding method either remotely or onsite if necessary.

There are a number of ways to shield cages to prevent electromagnetic noise interference in the data. Shielding can be used around individual animal cages and/or MX2s. If possible, additional shielding should be used when

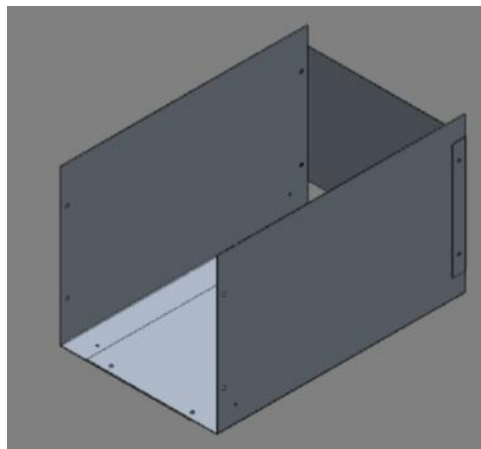
configuring the animal room. Shielding is highly recommended when non-metal shelves are used. The shielding material should consist of conductive metal such as copper, stain-less steel, or aluminum. As shown below, shielding allows cages to be placed closer together.

Note: The shields can be constructed in such a manner that the following four configurations can be achieved (length x width x height):

- 18 x 12 x 10 inches
- 18 x 12 x 12 inches
- 18 x 18 x 10 inches
- 18 x 18 x 12 inches



Shield components



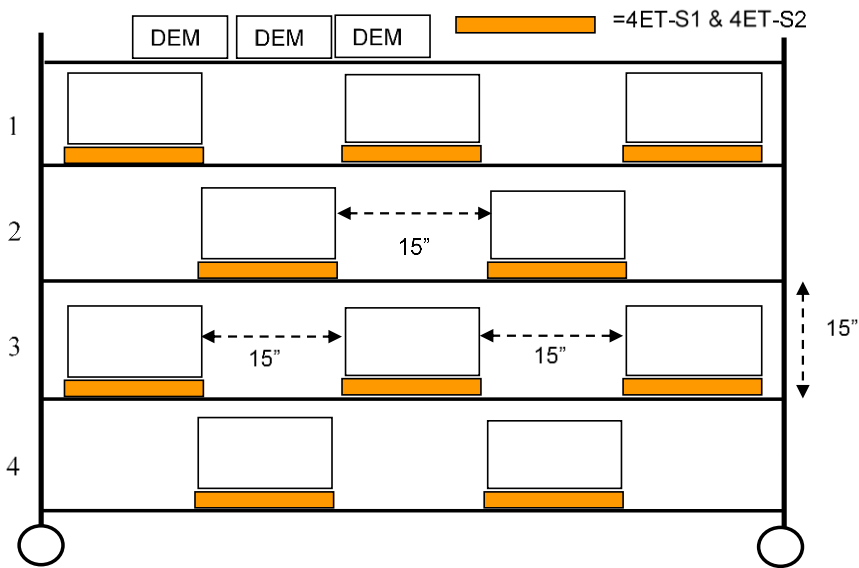
Shield assembled

4ET WITH RPC-2

There may be slight differences in the transmission characteristics of the 4ET device compared with standard DSI devices. In certain laboratory environments, ambient noise levels may be higher at the 4ET frequencies and could impact the data quality. DSI recommends using one of the following configurations when setting up your animal room. Care should be taken to ensure high-quality data is received before initiating a study. Each room environment is unique and may require additional modifications to achieve acceptable noise levels. These modifications are discussed in the next section. It is highly recommended that metal shelving be used to act as a barrier to the vertical signal transmission and to provide a conductive surface if grounding is necessary. Additional shielding between cages is also recommended as described in the Shielding section below.

PAIR-HOUSED NO SHIELDING

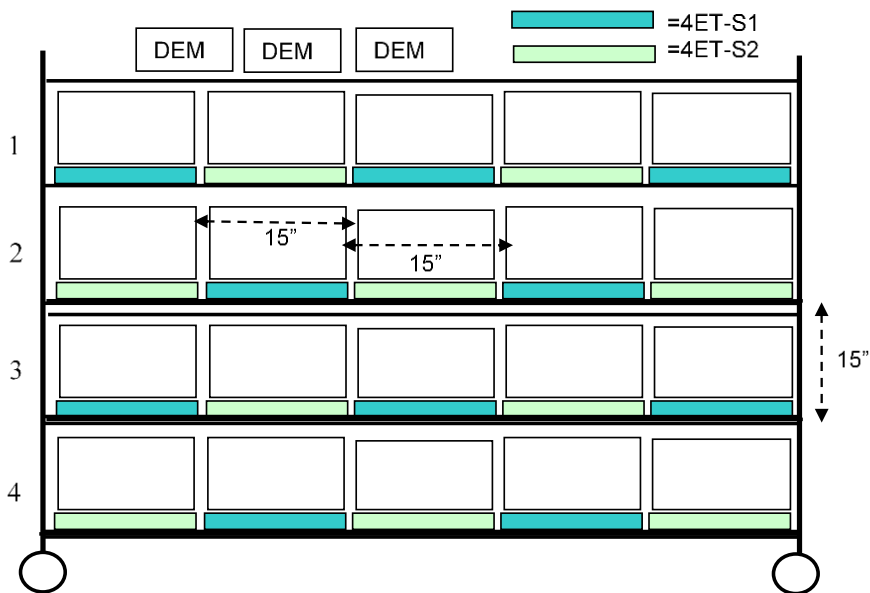
When animals are pair-housed, both of the 4ET transmission frequencies are present in the cage. Adjacent cages containing the same frequencies must be adequately separated to prevent cross-talk. DSI recommends separating adjacent cages a minimum of 15" horizontally from the adjacent sides of the cages and 15" vertically from cage bottom to cage bottom as shown below. Staggering of the cages between each vertical shelf is also recommended.



Cage setup: pair-housed no shielding

SINGLE-HOUSED NO SHIELDING

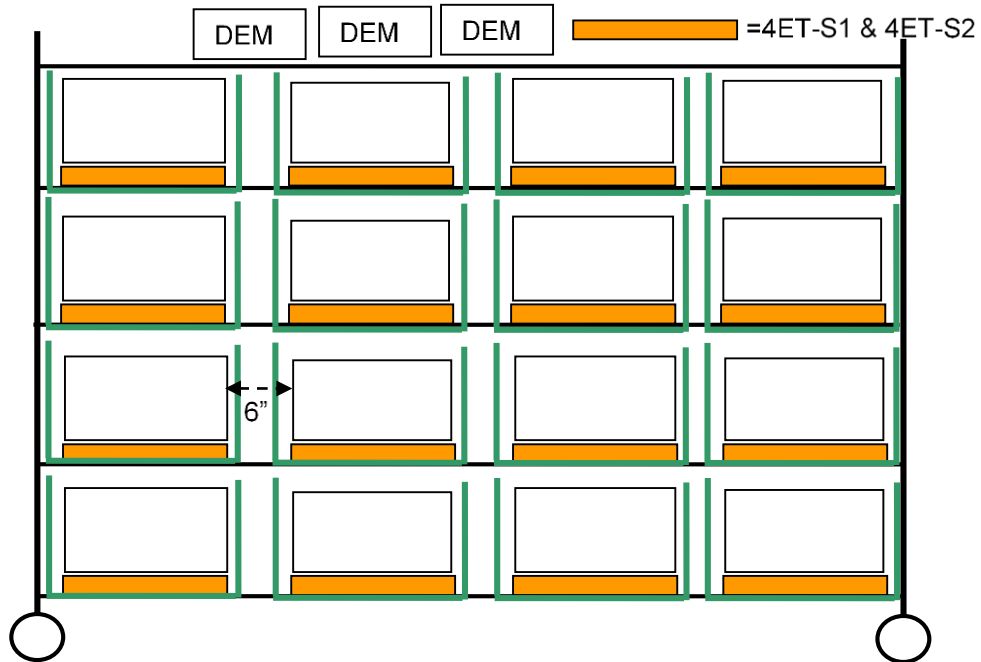
As described above, cages with the same frequency must be horizontally and vertically spaced a minimum of 15". However, with single-housed animals, the transmission frequency can be alternated and cages can be placed directly next to each other if different frequencies are used. This configuration allows more animals per cage rack than standard DSI devices.



Cage setup: single-housed no shielding

SHIELDING

The 4ET device transmits the signal on different frequencies compared to existing DSI PhysioTel™ devices. The use of additional shielding between vertically and horizontally placed cages reduces the device transmission range and potential for cross-talk. It also reduces the amount of ambient noise that is acquired by the RPC-2 receiver.



Cage setup: Shielded cages single or pair housed

TRANSCIVER PLACEMENT RECOMMENDATIONS

This appendix is intended to provide recommendations for placing Transceivers (TRX) in animal cages to minimize any signal drop-out with PhysioTel Digital implants. In general, a single TRX can cover 3-5 meters; however, null points may exist. To be safe, DSI recommends one TRX for every 3 meters, and at least 2 for every CLC. When more than one TRX is used, DSI suggests placing them at right angles to one another to help protect against null points which are small areas of poor signal reception.

It is important to note that there are many different cage and room set-ups and the examples shown below are DSI's suggestions based on customer testing and assessment of the PTD product.

Please contact DSI Technical Support (support@datasci.com) for assistance and recommendations in setting up your specific animal room.

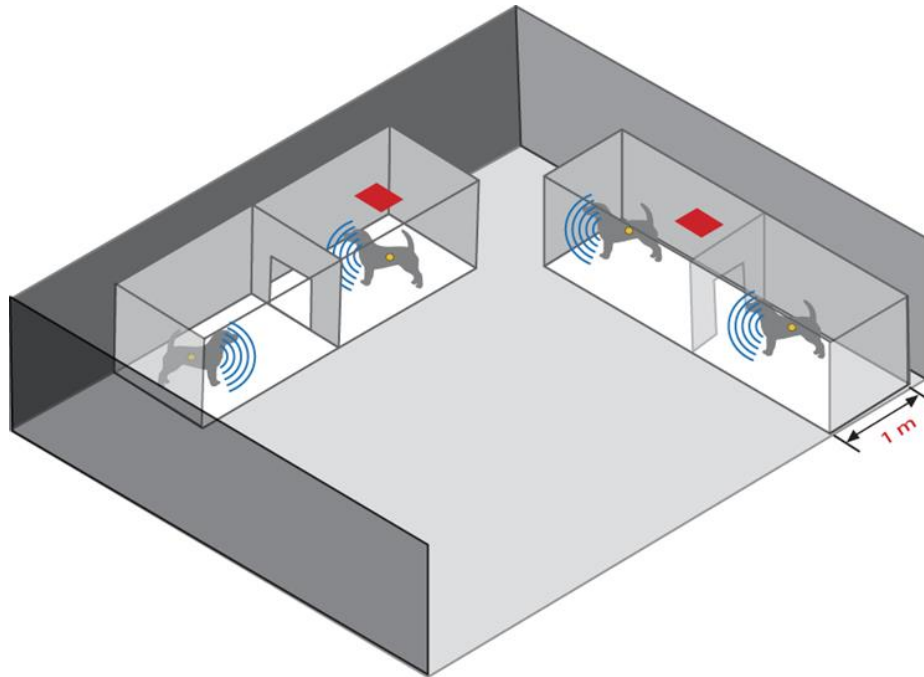
There are several factors that affect the transmission range of the implant.

- Monitoring environment
- Placement of the implant antenna
- Size of the animal

Regulatory Note: China: Tested to MIIT[2005]423 for short range devices' technical characteristics and test methods (Report No. C170417Z08, C170417Z09, C170417Z10).

DOG CAGE EXAMPLE 1

The diagram below illustrates the cage setup with Group Housing and two TRXs. Cage Dimensions are 1 Meter x 1 Meter. The red square indicates a TRX.



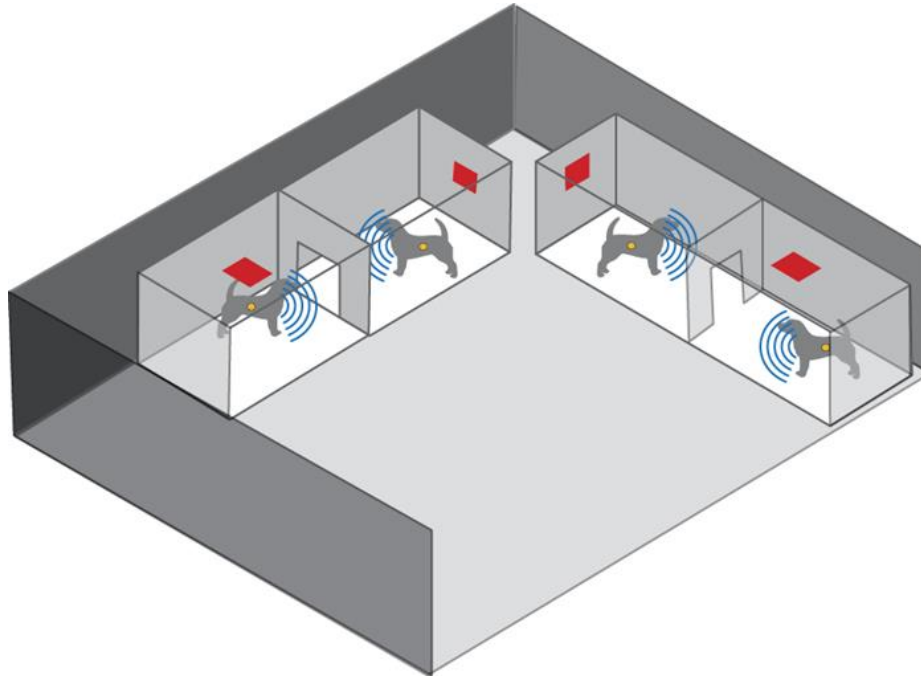
The set-up shown above includes one (1) TRX to cover the two cages on either side of the room. In this scenario the door between the cages is open and animals are able to freely move between cages.

If the door between the cages is closed, an additional TRX may be needed to provide supplemental coverage. DSI suggests testing this scenario to ensure that no drop-out occurs. If drop-out does occur, a second TRX should be used.

The following example illustrates a more ideal setup using four TRXs for increased coverage

DOG CAGE EXAMPLE 2

The diagram below illustrates the cage setup with Group Housing and four TRXs. Cage Dimensions are 1 Meter x 1 Meter x 1 Meter. The red square indicates a TRX.



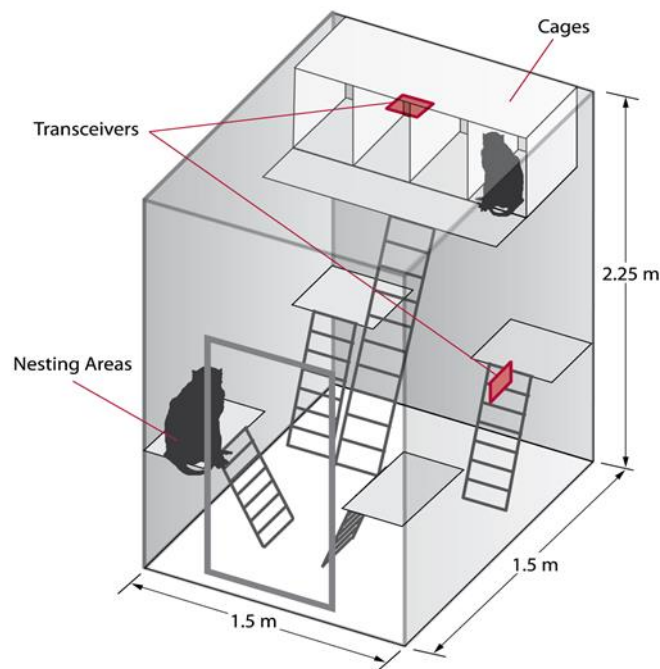
The set-up shown above includes two (2) TRXs to cover the two cages on either side of the room. In this scenario the door between the cages is open and animals are able to freely move between cages.

The TRXs are placed at right angles to one another to provide better coverage of the telemetry signal (having TRXs on different 'planes' helps avoid null areas and reduce the possibility of signal drop-out).

The set-up shown above would work either for the pair-housed or single-housed recordings without modification.

PRIMATE CAGE EXAMPLE

The diagram below illustrates a primate cage setup with Group Housing and two TRXs.



The set-up shown above includes two (2) TRXs to cover the larger communal primate cage. In the example above, this type of cage can co-house up to four primates at the same time.

Placing the TRXs at right angles to one another will provide better coverage.

AMBIENT PRESSURE REFERENCE (APR-2)

MAINTAINING PRESSURE ACCURACY

Maintaining accuracy of the APR-2 is a critical element of pressure measurements throughout the Dataquest system. A 1-mmHg error in the measurement of barometric pressure at the APR-2 will result in a 1-mmHg error in pressure measurements recorded by your system. The same level of error will appear on all pressure measurements obtained with the system using the APR-2. Therefore, if absolute accuracy of pressure measurements is important in your research, it is essential that you take the steps necessary to keep the APR-2 accurate.

Extensive qualification testing and calibration prior to shipment assures that under normal use the APR-2 will not drift as a result of temperature changes or shock from shipment. Therefore, the most important part of assuring accuracy is to determine if the APR-2 has drifted over time. The following are three suggestions on how this can be accomplished.

- Comparison with the Weather Service or other barometer
Compare your APR-2 with the weather, radio or TV station, or another reliable barometer reading at regular

intervals (e.g. every 3 months) and when you first receive your APR-2. Perform these comparisons when the weather is relatively calm and avoid comparisons during thunderstorms or when strong weather fronts are moving through your area. To obtain the APR-2 measurement, initiate acquisition from a Subject with a pressure (BP or LVP) input channel. Ambient pressure values will be listed in the Derived List View as NPMN, within the main Ponemah window.

Keep a record of the comparison measurements you have taken. Keep in mind that it is important to obtain a local reading at the same elevation above sea level as your telemetry system. The APR-2 measures the absolute pressure of the room it is placed in, and does not correct for elevation differences. For further information, contact DSI for the Technical Note ‘A Consideration When Comparing DSI’s Ambient Pressure Monitor Readings to Other Barometers and the Weather Service.’ Any noted difference over time should be constant. If you find that the difference is increasing, then it is likely that the APR-2 has drifted. Contact DSI Technical Services to discuss further action. You can also perform this procedure by comparing the APR-2 with a highly accurate barometer (one with an accuracy of better than 1 mmHg) at your facility or by purchasing a second APR-2.

- **Checking the offset of pressure transmitters**
If you are checking the offset of several DSI transmitters that have a manufacture date within the last month, they will provide a good indication of whether your APR-2 has drifted. Check the offset of these transmitters using the procedure outlined in the Implant Appendix | Implant Zero Pressure Offset section of this manual. If you find that all transmitters have an offset that is excessively and consistently biased in one direction (above or below zero mmHg), this may indicate that the APR-2 has drifted. Contact DSI Technical Services to discuss whether you should take further action.
- **Recalibration by DSI**
DSI recommends that investigators working under GLP conditions send their APR-2 back to DSI for recalibration every year. For those not working under GLP conditions, DSI recommends recalibration every 3-5 years. The drift specification indicates that, barring failure of the device, it will drift less than 1.0 mmHg per year. Therefore, if you return it for recalibration every year, accuracy will likely remain within +/- 1 mmHg. Contact DSI Technical Services for information regarding recalibration of your APR-2.

Note: If using the APR-1 with the E2S-1, the same recommendations apply.

APR-2 SPECIFICATIONS

Barometric pressure range	0-1000 mmHg (torr)
Initial accuracy	+/- 1 mmHg
Stability over time	Better than 1.0 mmHg / year at 20°C to 30°C.
Physical dimensions	12.5 x 10.5 x 4 cm
Weight	570 g
Data output connector	RJ45 (8 pin non-keyed)
Power connector	9VDC
Power Input	9VDC or 12W POE (IEEE 802.3af compliant)
Current	60 mA
Standard cable length	1 meter
Maximum cable length	10 meters

Operating temperature range	0° to 45° C
Operating humidity	<70% R.H. non-condensing
Storage temperature	-20° to 65° C
Storage humidity	<85% R.H. non-condensing

APR-1 SPECIFICATIONS

Barometric pressure range	650-800 mmHg (torr)
Initial accuracy	+/- 1 mmHg
Stability over time	Better than 1.0 mmHg / year at 20°C to 30°C.
Physical dimensions	14 x 10.5 x 4 cm
Weight	510 g
Data output connector	RJ45 (8 pin non-keyed)
Voltage requirement	6.25 to 12.0 VDC
Current	60 mA
Standard cable length	1 meter
Maximum cable length	10 meters
Operating temperature range	0° to 50° C
Operating humidity	<70% R.H. non-condensing
Storage temperature	-20° to 65° C
Storage humidity	<85% R.H. non-condensing

ETHERNET TO SERIAL CONVERTER (E2S-1)

The E2S-1 is only necessary when using an APR-1 with the PhysioTel Implantable Telemetry system. If using the APR-2, the E2S-1 is not required.

The E2S-1 passes data from the APR-1 to the Ponemah system while operating in a network environment. It does not modify the data received from the APR-1.

The E2S-1 uses DHCP by default as a means of being assigned a dynamic IP address. Should the E2S-1 not be discoverable within your network an alternate network configuration may be required (e.g. static IP address). Such configurations are possible but should not be modified unless absolutely necessary. To modify the network configuration please see the **Hardware Appendix: Ethernet to Serial Converter (E2S-1)**. If not set up for static IP addresses, the E2S-1 requires a DHCP server to be active on the network to which it is connected. If you are running the system across your corporate network this service is likely already present. If you are using a dedicated network separate from your corporate network the simplest method of providing this service is through the use of a router with this capability built in (e.g. Cisco Small Business Router RV130). Alternately you could install a DHCP server onto one of the PCs on your dedicated network. An Open Source DHCP server is available from SourceForge at <http://sourceforge.net/projects/dhcp-dns-server/>.

The front panel contains two indicator lights. The function of these is described below:

- **Ready**
Constantly lit when the power is on and the E2S-1 is functioning normally. Blinking when the E2S-1 has been located by a software command. Off when the E2S-1 is not powered or a power error exists,

the IP Address cannot be found, or there is an IP Address conflict.

- **Power**

Constantly lit when power is available to the E2S-1 via a network cable that supplies Power over Ethernet (PoE) to J2 or when the external power source is used appropriately. The E2S-1 does not have an on/off switch

The back panel contains three unique connections:

- **J1-Serial**

Plug the cable from the APR-1 into this jack. It provides a path for the barometric pressure signal to pass to the E2S-1 and also for the power from the E2S-1 to the APR-1.

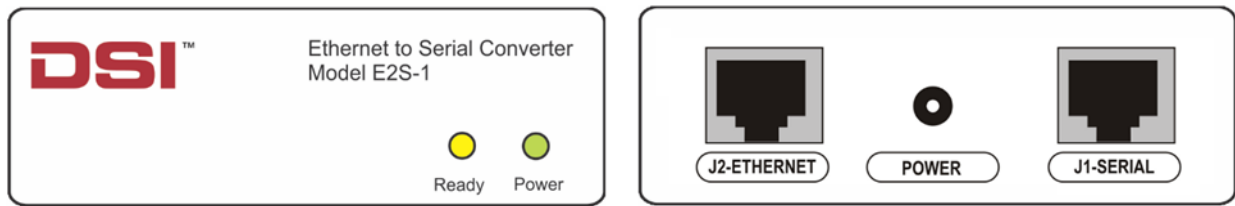
WARNING: Do Not mistake the “J2 Ethernet” port with “J1 Serial” port. Incorrectly plugging the wrong Ethernet cable into the wrong port may cause serious damage to your network devices. DSI will not replace or repair product or reimburse customers for devices that become damaged due to incorrect installation, nor is DSI liable for any loss of business resulting in the incorrect installation of this product.

- **J2-Ethernet**

Plug the cable from the Ethernet network into this jack. It provides a path for the barometric pressure signal to pass to the Ponemah Computer System from the E2S-1 and also for the power from a PoE capable network (if available) to pass into the E2S-1.

- **Power**

Plug the cable from the power supply into this jack to power the E2S-1. This is optional if a PoE capable network is used.



Front panel of E2S-1 (left), rear panel (right)

SPECIFICATIONS

Physical dimensions	14 x 10.5 x 4 cm
Weight	<500 g (<18 ounces)
J1 Serial connector	RJ45 (8 pin non-keyed)
J2 Ethernet connector	RJ45 (8 pin non-keyed)
Power connector	9VDC
Voltage requirement	9VDC or 12V POE (IEEE 802.3af compliant)
Standard cable length	1 meter
Maximum cable length	10 meters
Operating temperature range	0° to 50° C

Operating humidity	<70% R.H. non-condensing
Storage temperature	-20° to 65° C
Storage humidity	<85% R.H. non-condensing

TROUBLESHOOTING

- Power Indicator on Front Panel Does Not Light

If using a PoE capable network verify that the Ethernet cable between the network switch and the E2S-1 is plugged in securely at both the E2S-1 and network jack/switch. If this does not resolve the issue try a different cable, try a different network switch, or use the provided power supply.

If using a non-PoE capable network verify that the power supply is plugged into a functional outlet and securely plugged into the E2S-1. If this does not resolve the issue try a different outlet and/or power supply.

- Ready Indicator on Front Panel Does Not Light

Power may not be available. Assure the power indicator light is constantly lit. If not, correct per the above troubleshooting.

If power is available, then the E2S-1 cannot connect to the network and/or an IP Address conflict exists. Reboot the E2S-1 to obtain a new dynamically assigned IP Address.

If you are unable to solve your problem contact DSI Technical Services.

NOVA STATSTRIP® XPRESS™ GLUCOMETER

The Nova StatStrip Xpress is a hand-held glucometer and test strip system that measures blood glucose levels in laboratory animals. Simply insert a test strip in the Xpress meter, apply 1.2 µL of blood to end of strip, and the glucose value is reported (in mg/dL or mmol/L, depending on the meter model) in just 6 seconds. The measurement range of 10-900 mg/dL (1-50 mmol/L) enables glucose monitoring for various challenge studies.

The StatStrip Xpress meter is one of the most accurate hand-held meters available today. It provides measurement accuracy rivaling that of clinical blood chemistry analyzers. It does this by measuring and correcting for hematocrit and other common interferents such as ascorbic acid, uric acid, acetaminophen, and others.

The hand-held glucometer is used to provide periodic blood glucose levels which are used to calibrate the telemetry readings from the HD-XG implant. Accuracy of these measurements is critically important to the accuracy of the implant data. StatStrip Xpress is the preferred choice for calibrating implantable glucose telemetry.



INSTALLATION AND MAINTENANCE

This section introduces you to the Ponemah software and covers the following topics.

- The minimum system requirements needed to support your Ponemah system.
- How to install your Ponemah software.
- How to license your Ponemah system.

SYSTEM REQUIREMENTS

- The minimum system requirements are as follows.
- Microsoft® Windows® 10 (64 bit)
- Microsoft Office 2007 or later
- 4GB RAM
- 250GB SATA
- Intel® Core™ i7 or Xeon processor
- Microsoft .NET Framework v4.5*
- Sentinel Protection Driver v7.5.0*
- USB Interface for Software Security Key
- 1 Ethernet Network Interface Card+

Notes:

*Provided during the Ponemah installation.

+Minimum of 1 Ethernet Network Interface Card is required for telemetry hardware connection. It is recommended to have 2 Ethernet Network Interface Cards to allow for a dedicated telemetry hardware network and connection to corporate/university networks.

INSTALLATION AND MAINTENANCE

Installation must occur from a Windows® Administrator account.

1. Run the Ponemah Installer by inserting the Ponemah installation CD into the computer's DVD drive.
2. The Installer should auto-run and the Ponemah install screen will appear.
3. Select the Ponemah link to install and follow the onscreen instructions.

Note: If you are updating from a prior Ponemah version, you may retain access to the previous version by installing the new version into a unique Installation Destination folder when prompted.

4. Select Exit once the installation has completed.

Note: DSI recommends uninstalling the currently installed version of Ponemah using Add/Remove Programs and deleting the original Ponemah installation folder prior to upgrading to the latest Ponemah version.

LOADING A LICENSE FILE

To load a Ponemah License file:

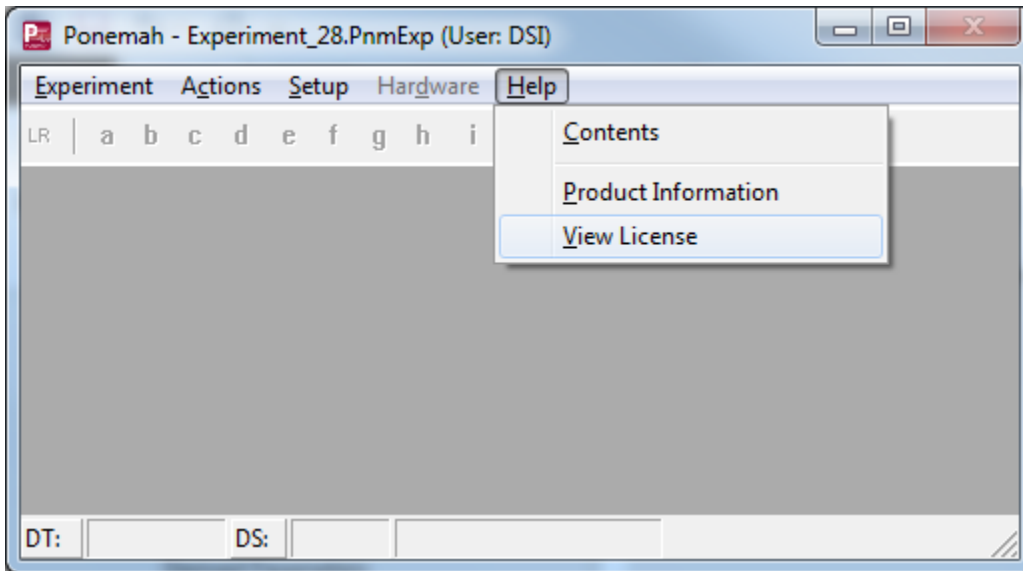
1. Place the Ponemah License File disc in the computer's DVD drive.
2. Browse to the disc using Windows Explorer.
3. Copy both files on the disk, and paste them into the following directory: **C:\Ponemah**.
4. Insert the Ponemah USB Security Key into a free USB port on the computer.
5. Launch Ponemah by clicking on the icon in the Windows Start menu. Ponemah will need to be started for the first time from a Windows Administrator account in order to complete the database installation process.
6. Select the License File (.lic) and click **Open**.

Note: If this is a subscription license, the Expiration Date will be listed within the View License File dialog accessible by selecting the **Help menu | View License**. A warning message will be displayed when 30 days or less is remaining on the license.

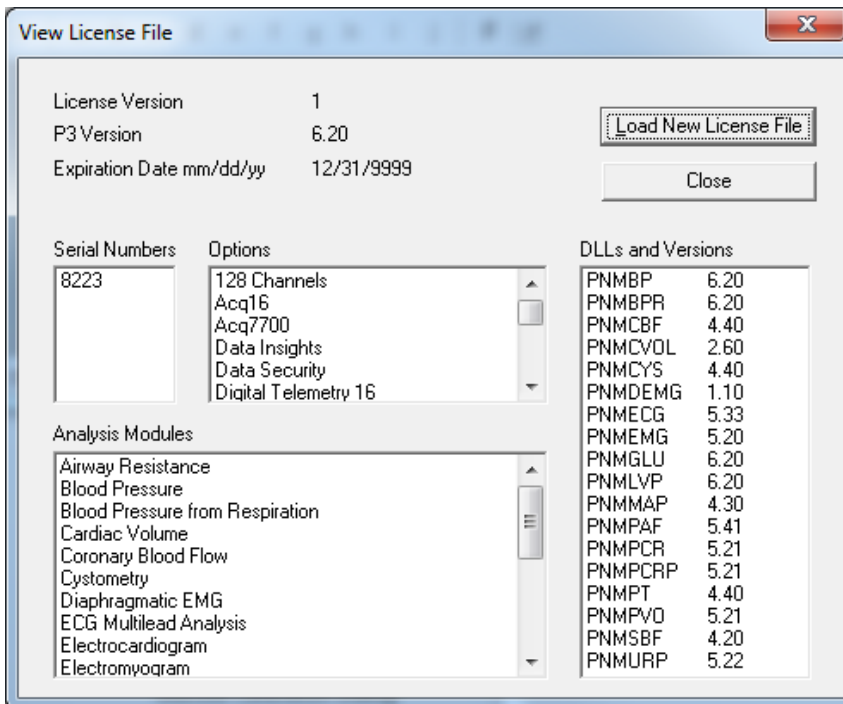
UPDATING A LICENSE FILE

To update a Ponemah License file:

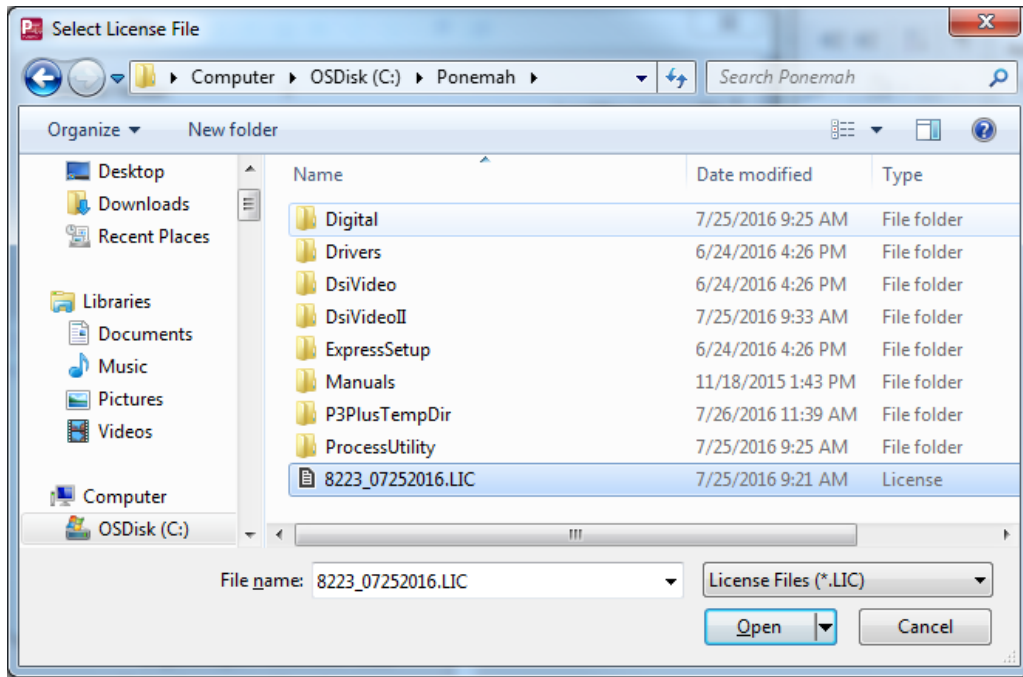
1. Launch Ponemah.
2. Select the **Help menu | View License**.



3. Select Load New License File.



4. Navigate to the license file and select the .LIC file and then click **Open**.



5. The new license will load. Click **Close** within *View License File* dialog.
6. Restart Ponemah.

PONEMAH MENUS

The following outlines the menu structure of Ponemah and provides descriptions of the various menu options.

Note: The menu options are called out if they are required to be located and selected to perform the various procedures described throughout this manual.

CONFIGURATION MENUS

EXPERIMENT

- | | |
|--------------------------|---|
| Create... | Opens the Create New Experiment dialog. |
| Open... | Opens a Browse For Folder selector to allow the user to select a previously created Experiment for further data Acquisition or Review. |
| Import... | Opens the Import Experiment wizard, allowing the user to create a new Experiment using data imported from Dataquest A.R.T. or Ponemah ≤v5.20. |
| Experiment Log... | Opens the Log Viewer dialog to allow the user to see time-sequenced hardware and application related events and errors. |
| Save | Saves any changes to the current Experiment Settings . |
| Save as... | Opens the Save Experiment dialog to allow the user to create a new Experiment using the Experiment Settings from the currently loaded Experiment. |

Export Data...	Opens the Derived Data Output dialog to allow the user to choose which Subjects' Derived Output is desired to be exported to Excel.
Load Recent ►	Lists the recently loaded Experiments to quickly load a recent Experiment.
Review Print Setup	Provides access to signals printing settings to control which data is printed, chart speed, and what information is provided with the printout; e.g. display Validation Marks .
Printer Setup...	Loads Printer Information and Settings dialog.
Exit	Exits the program.

Note: Manual sections exist for each of the options above. See the appropriate sections of the manual for more information of the desired menu item

ACTIONS

Start Sampling | Continuous – All Subjects	Start Continuous Sampling for all Subjects defined to Continuous Sampling within the Sampling Control dialog.
Start Sampling | Continuous – Selected Subjects	Start Continuous Sampling for the highlighted Subjects within the Sampling Control dialog.
Start Sampling | Schedule – 1	Start sampling using Scheduled 1 .
Start Sampling | Schedule – 2	Start sampling using Scheduled 2 .
Start Review	Opens the Load Review Data dialog.
Open Parameter Viewer	Launches the Parameter View feature to view derived data across the entire experiment duration. This is accessible during Acquisition, Review, or when in Idle mode (Ponemah is open but not actively acquiring or in Review).

Note: Manual sections exist for each of the options above. See the appropriate sections of the manual for more information of the desired menu item

SETUP

Experiment Setup...	Opens the master Setup dialog where the user can configure Events, Data Reduction, Variability Analysis, Graphs, and other Experiment Settings .
Subject Setup...	Opens the Subject Setup dialog where the user can change Subject and Channel settings; such as enable additional Derived Parameters .
Application Log...	Opens the Application Log dialog.
Application Configuration...	Opens the Application Configuration dialog where the user can access advanced Ponemah system settings.

Note: Manual sections exist for each of the options above. See the appropriate sections of the manual for more information of the desired menu item.

HARDWARE

Edit APR Configuration...	Opens the APR Configuration dialog.
APR Diagnostics...	Not Available.
Edit MX2 Configuration...	Opens MX2 Hardware Configuration dialog to configure system hardware and add/remove PhysioTel and PhysioTel HD implants from the Experiment.
MX2 Diagnostics...	Opens MX2 Diagnostics web browser.
Edit PhysioTel Digital Telemetry Configuration	Opens PhysioTel Digital Telemetry Hardware Configuration dialog to configure system hardware and add/remove PhysioTel Digital implants from the Experiment.
PhysioTel Digital Telemetry Diagnostics	Opens PhysioTel Digital Telemetry Diagnostics web browser.

Note: Manual sections exist for each of the options above. See the appropriate sections of the manual for more information of the desired menu item.

HELP

Contents	Opens Ponemah online Help (Users' Manual).
Product Information	Opens the Ponemah Version Information dialog that provides the user with information on the installed Ponemah system.

The following describes the information found in each tab:

- **General Tab**
 - **License Version** - Revision level of the software license.
 - **Permitted Ponemah Version** - The Ponemah version permitted by the license file.
 - **Expiration Date** - The expiration date of the license file (the time-frame permitted to upgrade to a new version).
 - **Available Hardware Channels** - Displays the number of channels currently connected.
 - **Permitted Channels** - Displays the total number of channels that the license file allows.
 - **Windows Version** - Displays the currently loaded version of the Windows operating system.
 - **Current User** - The currently logged on windows user.
- **P3 Options Tab**
 - This tab lists all currently enabled options in the system's license file.
- **Analysis Modules Tab**
 - This tab lists all currently loaded analysis modules in the runtime directory.
- **Application Modules Tab**
 - This tab lists all the .DLLs and .EXEs in the runtime directory.
- **System Modules Tab**
 - This tab lists certain drivers, ActiveX controls, and operating system version numbers.

Print Button

This button allows the user to print a hardcopy of the information displayed in the Product Information dialog.

Email Button

This button allows the user to email a report of the information displayed in the Product Information dialog to DSI Technical Support. It should be noted that certain attachments are part of the email report. The attachments contain specific information about the configuration of the system. None of the attachments contain any collected data.

Software License Button

Displays the **DSI Software License Agreement** as a PDF.

- View License** This dialog displays the currently loaded options. It also allows the loading of a new license file.
- **License Version** - Revision level of the software license.
 - **P3 Version** - The Ponemah version permitted by the license file.
 - **Expiration Date mm/dd/yy** - The expiration date of the license file. For perpetual licenses, this is the time-frame the user is permitted to upgrade to a new version if under Software Enhancement Agreement. For subscription licenses, this is the expiration date of the subscription.
 - **Serial Numbers** - The software license file number installed on the system.
 - **Options** - The Ponemah options that are enabled in the license file.
 - **Analysis Modules** - Lists the Analysis Modules that are installed on the system. Note: In order to use the installed Analysis Modules, the Analysis Modules must be enabled in the license file.
 - **DLLs and Versions** - Lists the .DLL (Analysis Modules) installed on the system and the permitted version level allowed to be installed.

ACQUISITION MENUS

EXPERIMENT

- Experiment Log...** Opens the **Log Viewer** dialog to allow the user to see time-sequenced hardware and application related events and errors.
- Review Print Setup** Launches the **Review Print Setup** dialog, permitting changes to the settings used when printing data from Review using an external printer. See the **Printing** section of this manual located in the **Software Appendix** for more information.
- Printer Setup** Launches the **Printer Setup** dialog, which permits the user to configure an external printer to the system.

ACTIONS

- Start Sampling | Continuous – Selected Subjects** Start **Continuous** Sampling for the highlighted **Subjects** within the **Sampling Control** dialog.
- Start Sampling | Schedule – 1** Start sampling using **Scheduled Sampling 1**.
- Start Sampling | Schedule – 2** Start sampling using **Scheduled Sampling 2**.
- Stop Sampling | All** Stops sampling for all active **Subjects** acquiring on **Continuous**, **Schedule 1**, and **Schedule 2** Acquisition.
- Stop Sampling | Continuous – Selected Subjects** Stops **Continuous** Sampling for the highlighted **Subjects** within the **Sampling Control** dialog.

Stop Sampling | Schedule – 1	Stops Scheduled 1 sampling.
Stop Sampling | Schedule – 2	Stops Scheduled 2 sampling.
Logging Rate...	Launches the Logging Rate dialog to permit users to change the way the Derived Parameter data is logged to the Derived Parameter List View . See the Data Acquisition | Logging Rate section of this manual.
Events...	Launches the Events dialog to apply an Event to one or more Subjects during acquisition. See the Marking Events section for more information on how to add Events.
Validate	Toggles ON/OFF the display of Validation Marks on Primary graphs.
Toggle Logging Mark	Toggles ON/OFF the display of the Logging Rate Marks on Primary graphs. These vertical lines represent the start and end of the Logging Period .
Copy Selection	Permits the user to Copy a row or multiple rows of data from the Derived Parameter and Data Reduction List Views to then Paste into another application; e.g. Excel.
Open Parameter Viewer	Launches the Parameter View feature to view derived data across the entire experiment duration. This is accessible during Acquisition, Review, or when in Idle mode (Ponemah is open but not actively acquiring or in Review).

Note: Manual sections exist for each of the options above. See the appropriate sections of the manual for more information of the desired menu item

SETUP

Experiment Setup...	Opens the master Setup dialog where the user can configure Events, Data Reduction, Variability Analysis, Graphs, and other Experiment Settings .
Subject Setup...	Opens the Subject Setup dialog where the user can change Subject and Channel settings; such as enable additional Derived Parameters .
Application Configuration...	Opens the Application Configuration dialog where the user can access advanced Ponemah system settings.

Note: Manual sections exist for each of the options above. See the appropriate sections of the manual for more information of the desired menu item

WINDOWS

Standard Windows menu that permits the user to arrange Ponemah windows in various views. Also permits the selection of specific windows from those listed.

HELP

Provides the same information as in Experiment Configuration. Please see the **Configuration Menus** section above for more information.

EXPERIMENT

Experiment Log...	Opens the Log Viewer dialog to allow the user to see time-sequenced hardware and application related events and errors.
Save Experiment	This saves any configuration changes that occur, such as graph pages, analysis attributes.
Save Derived Data	This save the Derived Parameters and Data Reduction values from the data currently loaded in Review to an Excel (or Access) file only.
Save Mark Sections	This updates the Marks database and saves the Marks so they can be loaded in subsequent Review sessions. Saving a Mark Section will only save the Marks associated with the data loaded into the Review session from which the Save Marks Section action is executed. This will also create a new Excel (or Access) file with the Derived Parameter and Data Reduction outputs from the currently loaded data.
Data Insights	Launches the Data Insights dialog permitting users to find, classify, and report on data patterns and anomalies. See the Data Insights section of the manual for more information.
Review Print Setup	Launches the Review Print Setup dialog, permitting changes to the settings used when printing data from Review using an external printer. See the Printing section of this manual located in the Software Appendix for more information.

ACTIONS MENU

Merge Bad Data Marks	Provides access to the Bad Data Mark Merge button, which will merge all Bad Data Marks sections within a Subject , such that all Subject Input channels will have identical Bad Data Mark sections. See the Bad Data Marks section of this manual for more information on Merge Bad Data Marks .
BDM Percentage	Launches the Bad Data Mark Percentage dialog that provides the ability to view the percentage and distribution of data removed by Bad Data Marks . See the Bad Data Marks section of this manual for more information on BDM Percentage .
Logging Rate	Launches the Logging Rate dialog to permit users to change the way the Derived Parameter data is logged to the Derived Parameter List View . See the Data Acquisition | Logging Rate section of this manual.
ASCII Output	Launches the ASCII Output dialog to permit creating ASCII files from the graphically displayed data. See the ASCII Output section of this manual located in the Software Appendix for more information.
Copy Selection	Permits the user to Copy a row or multiple rows of data from the Derived Parameter and Data Reduction List Views to then Paste into another application; e.g. Excel.

Batch Template Analysis	This permits the user to perform ECG PRO , Template-based, analysis across all Input channels with a valid library binding. Please see the ECG PRO section of this manual for more information.
Close Review	Selecting this will close the current Review section.
Open Parameter Viewer	Launches the Parameter View feature to view derived data across the entire experiment duration. This is accessible during Acquisition, Review, or when in Idle mode (Ponemah is open but not actively acquiring or in Review).

Note: Manual sections exist for each of the options above. See the appropriate sections of the manual for more information of the desired menu item

SETUP

Experiment Setup...	Opens the master Setup dialog where the user can configure Events, Data Reduction, Variability Analysis, Graphs, and other Experiment Settings .
Subject Setup...	Opens the Subject Setup dialog where the user can change Subject and Channel settings; such as enable additional Derived Parameters .
Variability Analysis...	Opens the Variability Analysis Editor dialog permitting users to configure Frequency and Time Domain Heart Rate Variability (HRV). See the Variability Analysis section of the Ponemah Software | Data Review section of this manual.
Manage Frequency Bins	Permits the user to manage the frequency bin sets used within the Variability Analysis dialog if using Frequency Bins for Frequency Domain HRV.
Application Configuration...	Opens the Application Configuration dialog where the user can access advanced Ponemah system settings.

Note: Manual sections exist for each of the options above. See the appropriate sections of the manual for more information of the desired menu item

GRAPHS

Graph Setup...	Opens the master Setup dialog directly to the Graph Setup area to provide quicker access to Graph Settings .
Enabled Graph Page List	Lists all enabled graph pages and permits the user to enable/disable previously configured graphs without having to enter the Experiment Settings | Graph Setting dialog. Since graphs can be closed using the red 'X' associated with the graph window, this permits a quick, easy way to re-enable the page.

Note: Manual sections exist for each of the options above. See the appropriate sections of the manual for more information of the desired menu item

DATA PARSER

- Rules...** Launches the **Data Parser** dialog directly to the **Parser Rules** setup dialog. Please see the **Data Parser** section of this manual for more information.
- Segments...** Launches the **Data Parser** dialog directly to the **Individual Segments** setup dialog. This provides a list of all defined Parser Segments in the loaded data set. Please see the **Data Parser** section of this manual for more information.
- Save Parsed Derived Data** Outputs an Excel file containing the **Derived Parameter** and **Data Reduction** data for only the sections of data contained within the **Parser Segments**.
- Show Parser Bar in Graphs** Toggles **ON/OFF** the display of the **Data Parser** bar (white row) located at the top of each **Primary** and **Trend** graph.

Note: Manual sections exist for each of the options above. See the appropriate sections of the manual for more information of the desired menu item

WINDOWS

Standard Windows menu that permits the user to arrange Ponemah windows in various views. Also permits the selection of specific windows from those listed.

HELP

Provides the same information as in the Experiment Configuration Menus. Please see the **Configuration Menus** section above for more information.

EXPERIMENT SETTINGS DIALOG DESCRIPTION

The **Settings** configuration allows the setup default **Experiment Settings** that are saved with the Experiment and are applied during Acquisition and Review.

ACQUISITION/REVIEW DEFAULTS

This section allows the defaults **Logging Method and Rate** to be defined for when an Acquisition or Review session is begun. This will define how often data will be logged into the **List Views** and on **Trend** and **Scatter** graphs.

Please see the **Logging Rate** dialog section to learn more about these settings and how to change the **Logging Rate** during Acquisition or Review.

DATA SEPARATOR

This section allows the user to select a type of data separator, and therefore, customize how data is displayed in the derivation files. Note: The Data Separator has no effect on ODBC data.

GLOBAL SETTINGS

This sections allows the user to change the default method used to display data and other inputs in the Experiment.

- Logging Rate Marker** This check box allows a dashed line to be drawn on the **Primary** graph during data Acquisition indicating the start/end of a line of data is logged to the **Derived Parameter List View**. This will aid in validating which cycles are in a particular **Logging Period**. This is available only if **Logging Method** is set to **Time** mode.

Events Displayed as String	This check box allows the system to display the complete Event message on the graph page. If the check box is not checked, the system displays a character (a-j) that represent the Event on the graph page.
Validation Marks on at Start	This check box allows the system to place Validation Marks on the Primary graph page as soon as Acquisition starts.
Ignore zeros in Data Reduction	This check box allows Data Reduction to ignore zeros when running calculations. If this check box is enabled and Data Reduction is attempting to reduce all zeros, the result will be a zero. Control related calculations (Delta, %Delta, and %Chg) will report zeros if the reduced data are all zeros.
Aggregated Parameter Window	Organizes the Derived Parameter List View in an Aggregate mode. In Aggregate mode, one Derived Parameter List View will be available during Acquisition that displays the Derived Parameters from all Subjects' Input Channels that are being sampled.
Min Good Time	This provides the user the ability to define the default time frame used to mark data as bad between two Bad Data Mark regions. If the time between the regions is less than the value specified. If the time is less than what is specified, the Bad Data Mark region will appear as one contiguous segment.

REMOTE NOTIFICATION – EMAIL ALERTS

TYPICAL EXCHANGE SERVER CONFIGURATION

The following is a list of items to check in Exchange Server in order to use the Email Alert feature in Ponemah.

- **E-Mail Server**
The value entered in 'Email Server' is typically the same URL used to access email from a web browser. When you connect to email from a browser, please note if the URL starts with HTTP or HTTPS. If you see HTTPS you will need to check the box 'Enable SSL', this will ensure the proper authentication is used.
- **Port**
Port 25, is the most common port used for email.
- **Logon name**
Can be entered one of two ways, Domain\Username or emailaddress@domain.com
e.g. Company1\Doctor or doctor@company1.com
- **Password**
This is the network password for the account you entered in the 'Logon name' field. **Be sure to update this password when you change your network password**, as your alerts will stop working and can result in locking that network account from accessing any other network resources (files, folders, email, intranet, etc.).
- If you are unable to successfully send a Test Alarm email, please contact your IT Administrator to confirm your settings, and that this machine is allowed to relay messages.

EMAIL TO TEXT

To send the email notification as a text message, add the message recipients' 10 digit mobile phone number followed by their cell phone carrier's domain to the **Email Alarms/Failures To** field.

- AT&T – phonenumber@txt.att.net
- Verizon – phonenumber@vtext.com
- T-Mobile – phonenumber@tmomail.net
- Sprint PCS – phonenumber@messaging.sprintpcs.com
- Virgin Mobile – phonenumber@vmobl.com
- US Cellular – phonenumber@email.uscc.net
- Nextel – phonenumber@messaging.nextel.com
- Boost – phonenumber@myboostmobile.com
- Alltel – phonenumber@message.alltel.com
- Metro PCS – phonenumber@mymetropcs.com
- SunCom – phonenumber@tms.suncom.com

Please contact your specific carrier if not listed. It is recommended to send a Test Email to the phone to confirm messages will be received prior to starting a study.

TROUBLESHOOTING

EMAIL SERVER NAME NOT FOUND

This occurs when the email server that is being used to cannot be located in the network. Possible causes are:

- Server name is not valid.
- No network connection to the server.
- Route to the server cannot be found.



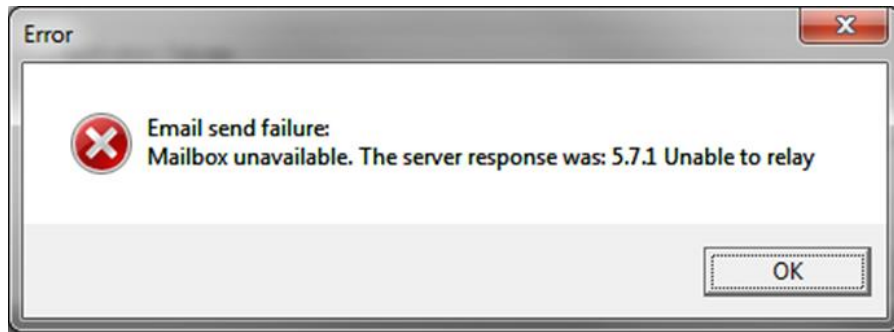
Recommendation:

- Ensure you have a network connection.
- Confirm the Email Server with your IT Administrator.

EMAIL SEND FAILURE

This type of error may occur for the following reasons:

- Bad or invalid email address entered into the **Email To** field(s).
- The outgoing Email server is not allowing an email message to be relayed to another server.

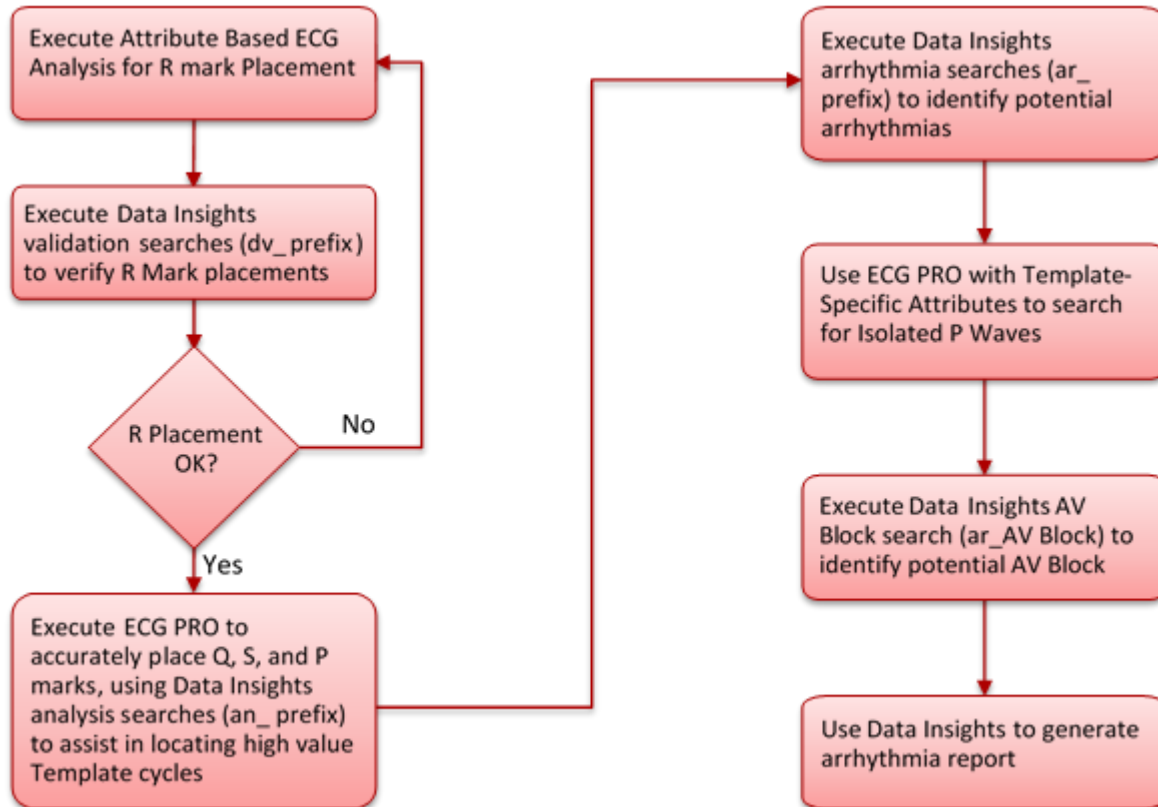


Recommendation:

- Ensure all email addresses entered in the **Email To** field(s) are accurate.
- Confirm that you have the correct value entered for **Email Server** in the **Configuration - Email Alerts** dialog.
- Check with your local IT Administrator to ensure the computer configured to send alerts is allowed to relay emails and that the **Email Server** being entered is correct.

PROCESS FLOW DIAGRAM

The following outlines the recommend process for users performing ECG analysis and arrhythmia detection with Data Insights.



DEFAULT SEARCH DEFINITION BY SPECIES

Predefined Searches are provided with the installation of Data Insights. The searches can be used immediately for purposes of data validation, arrhythmia detection and other purposes. The following searches are defined below:

ANALYSIS SEARCHES

Analysis Searches are used to aid in data analysis process. Currently these are used to help construct high value ECG PRO Template Libraries.

- an_Low P match** (Low P Match - requires ECG PRO):
 Searches for high value P templates by displaying the distribution of P waves with low match percentages. While building a Template Library it is good to use the default Minimum Match % of 85%, this helps keep matched results well marked. Using the Low P Match Search to look for new templates to add ensures the use of low noise cycles that are significantly different from existing templates, i.e. cycles with a match of 84.9% will not be used.

Select a match result from a region of the waveform with many match results for inclusion as a new template cycle.

Species	Definition
Dog	Value(PMatch _{cyc0}) < 70
Monkey	AND Value(Noise _{cyc0}) < 30
Rat	AND Value(NUM _{cyc-1}) > 0
Mouse	

- **an_Low QS match** (Low QS Match - requires ECG PRO):

Searches for high value QS templates by displaying the distribution of Q and S waves with low match percentages. While building a Template Library it is good to use the default Minimum Match % of 85%, this helps keep matched results well marked. Using the Low QS Match Search to look for new templates to add ensures the use of low noise cycles that are significantly different from existing templates, i.e. cycles with a match of 84.9% will not be used.

Select a match result from a region of the waveform with many match results for inclusion as a new template cycle.

Species	Definition
Dog	(Value(QMatch _{cyc0}) < 70
Monkey	OR Value(SMatch _{cyc0}) < 70)
Rat	AND Value(Noise _{cyc0}) < 30
Mouse	

- **an_Unmatched** (Unmatched Cycles - requires ECG PRO):

Searches for unmatched cycles with low noise to display the distribution of unmatched cycles.

Select a match result from a region of the waveform with many match results for inclusion as a new template cycle.

Species	Definition
Dog	Value(Match _{cyc0}) < 100
Monkey	
Rat	
Mouse	

- **an_Unmatched Clean** (Clean Unmatched Cycles - requires ECG PRO):

Searches for unmatched cycles with low noise to display the distribution of clean unmatched cycles.

Select a match result from a region of the waveform with many match results for inclusion as a new template cycle.

Species	Definition
Dog	Value(Match _{cyc0}) < 100
Monkey	AND Value(Noise _{cyc0}) < 20
Rat	
Mouse	

- an_Low T Match** (Low T Match - requires ECG PRO):
 Searches for high value T templates by displaying the distribution of T waves with low match percentages. While building a Template Library it is good to use the default Minimum Match % of 85%, this helps keep matched results well marked. Using the Low T Match Search to look for new templates to add ensures the use of low noise cycles that are significantly different from existing templates, i.e. cycles with a match of 84.9% will not be used.


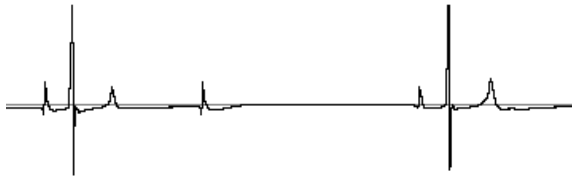
Select a match result from a region of the waveform with many match results for inclusion as a new template cycle.

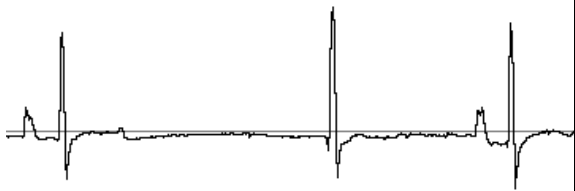
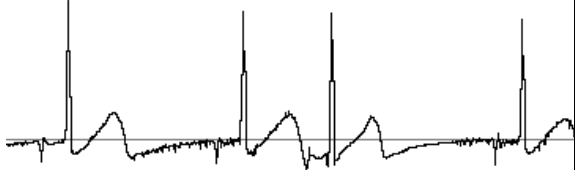
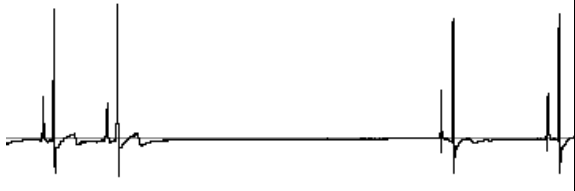
Species	Definition
Dog	Value(TMatch _{cyc0}) < 70
Monkey	AND Value(Noise _{cyc0}) < 30
Rat	AND Value(NUM _{cyc-1}) > 0
Mouse	

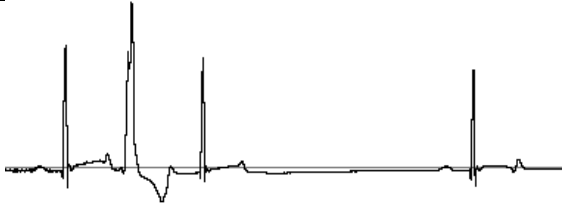
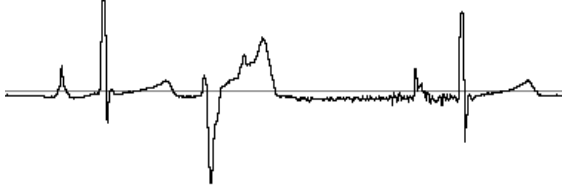
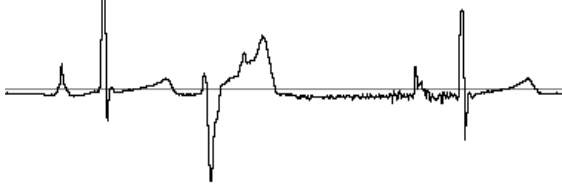
ARRHYTHMIA SEARCHES

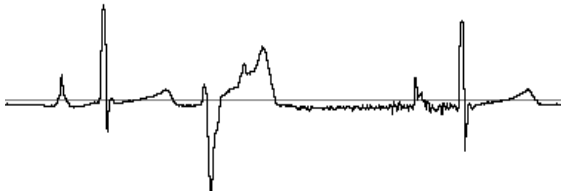
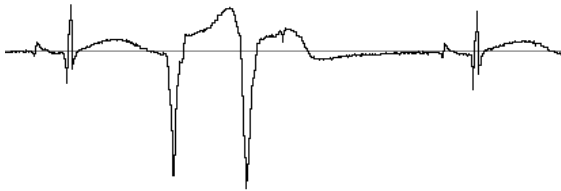
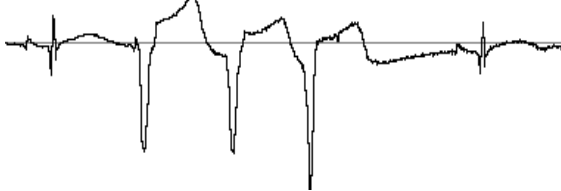
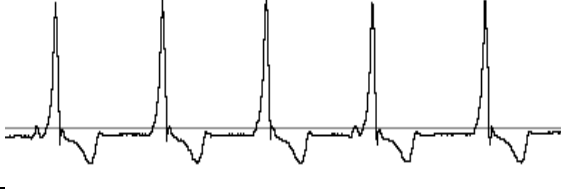
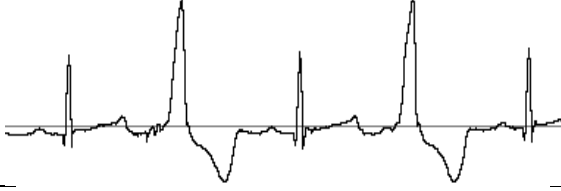
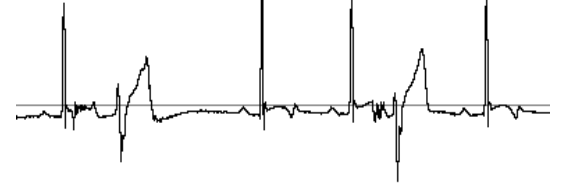
Arrhythmia Searches are used to aid in arrhythmia detection.

Note: If the Species is not specifically called out within the Search Definition, the set of search clauses and the values within are the same for Dog, Monkey, Rat, and Mouse.

Search Definition	Example Waveform Morphology
<p>First-degree AV block (ar_AV Block 1st): Identifies cycles that have a long PR interval that is shorter than the PR interval for a potential isolated P wave</p> <p>Dog Value(PR-I_{cyc0}) > 130 AND Value(PR-I_{cyc0}) < 250 AND Value(NUM_{cyc-1}) > 0 AND Value(Noise_{cyc0}) < 30</p> <p>Monkey Value(PR-I_{cyc0}) > 100 AND Value(PR-I_{cyc0}) < 200 AND Value(NUM_{cyc-1}) > 0 AND Value(Noise_{cyc0}) < 30</p> <p>Rat Not Supported</p> <p>Mouse Not Supported</p>	
<p>Second-degree AV block (ar_AV Block 2nd): Identifies cycles that have a significantly elongated PR intervals. This search is used after marking isolated P waves using ECG PRO's Template Specific Attributes – See the <i>Data Insights | Finding Second Degree AV Block using Template Specific Attributes</i> section of the <i>Tutorials</i>.</p> <p>Dog Value(PR-I_{cyc0}) > 250 AND Value(NUM_{cyc-1}) > 0</p>	

	AND	Value(Noise _{cyc0})	<	30	
Monkey		Value(PR-I _{cyc0})	>	200	
	AND	Value(NUM _{cyc-1})	>	0	
	AND	Value(Noise _{cyc0})	<	30	
Rat		Value(PR-I _{cyc0})	>	100	
	AND	Value(NUM _{cyc-1})	>	0	
	AND	Value(Noise _{cyc0})	<	30	
Mouse		Value(PR-I _{cyc0})	>	250	
	AND	Value(NUM _{cyc-1})	>	0	
	AND	Value(Noise _{cyc0})	<	30	
Junctional Complex (ar_Junctional): Identifies cycles that do not have a P or have a P with a short PR interval and are not Ventricular Ectopics					
(	Value(PCT _{cyc0})	=	0	
OR	%Decrease(PR-I _{avg0} , PR-I _{cyc0})	>	35)	
AND	Search(_{cyc0})	!=	ar_V Ectopic		
Premature Atrial Complexes (ar_PAC): Identifies cycles that show a decrease in RR interval relative to the previous cycle, while showing little change in RR interval between the previous and following cycles.					
	%Decrease(RR-I _{cyc-1} , RR-I _{cyc0})	>	30		
AND	%Change(RR-I _{cyc-1} , RR-I _{cyc1})	<	25		
AND	Value(Num _{cyc-2})	>	0		
AND	Value(Noise _{cyc0})	<	100		
Sinus Pause (ar_Sinus Pause): Identifies cycles with a long RR interval or a marked increase in RR relative to the previous cycle.					
Dog	(	Value(RR-I _{cyc0})	>	3000
	OR	%Increase(RR-I _{cyc-1} , RR-I _{cyc0})	>	200)	
	AND	Value(Num _{cyc-2})	>	0	
Monkey	(	Value(RR-I _{cyc0})	>	2000
	OR	%Increase(RR-I _{cyc-1} , RR-I _{cyc0})	>	200)	
	AND	Value(Num _{cyc-2})	>	0	
Rat	(	Value(RR-I _{cyc0})	>	500
	OR	%Increase(RR-I _{cyc-1} , RR-I _{cyc0})	>	200)	
	AND	Value(Num _{cyc-2})	>	0	
Mouse	(	Value(RR-I _{cyc0})	>	400
	OR	%Increase(RR-I _{cyc-1} , RR-I _{cyc0})	>	200)	
	AND	Value(Num _{cyc-2})	>	0	

<p>Ventricular Interpolated (ar_Interpolated): Identifies when a ventricular beat is inserted within normal sinus beats.</p> <pre> %Decrease(RR-I_{cyc-1}, RR-I_{cyc0}) > 40 AND %Change(RR-I_{cyc0}, RR-I_{cyc1}) < 35 AND %Decrease(RR-I_{cyc2}, RR-I_{cyc1}) > 40 AND Search(_{cyc0}) = ar_V Ectopic Single AND Value(Num_{cyc-2}) > 0 </pre>	
<p>Ventricular Ectopic (ar_V Ectopic): Identifies cycles with a widened QRS.</p> <pre> Dog Value(QRS_{cyc0}) > 54 AND Value(Noise_{cyc0}) < 100 Monkey Value(QRS_{cyc0}) > 48 AND Value(Noise_{cyc0}) < 100 Rat Value(QRS_{cyc0}) > 30 AND Value(Noise_{cyc0}) < 100 Mouse Value(QRS_{cyc0}) > 20 AND Value(Noise_{cyc0}) < 100 </pre>	
<p>Ventricular Ectopic Single (ar_V Ectopic Single): Identifies isolated Ventricular Ectopics bracketed by two sinus (non-ventricular) beats.</p> <pre> Search(_{cyc-1}) != ar_V Ectopic AND Search(_{cyc0}) = ar_V Ectopic AND Search(_{cyc1}) != ar_V Ectopic </pre>	
<p>Ventricular Escape Complex (ar_V Escape Single): Identifies single Escape beats bracketed by two sinus (non-ventricular) beats.</p> <pre> %Increase(RR-I_{cyc-1}, RR-I_{cyc0}) > 40 AND Search(_{cyc0}) = ar_V Ectopic Single AND Value(Num_{cyc-2}) > 0 </pre>	<p>Example not currently available.</p>

<p>Premature Ventricular Complex (ar_PVC Single): Identifies single Premature Ventricular Ectopics bracketed by two sinus (non-ventricular) beats.</p> <p>$\%Decrease(RR-I_{cyc-1}, RR-I_{cyc0}) > 0$</p> <p>AND $Search(cyc0) = ar_V\ Ectopic\ Single$</p> <p>AND $Value(Num_{cyc-2}) > 0$</p>	
<p>Couplet (ar_Couplet): Identifies two contiguous Ventricular Ectopic beats that are bracketed by two sinus (non-ventricular) beats.</p> <p>$Series(ar_V\ Ectopic, 1) = 2$</p>	
<p>Triplet (ar_V Triplet): Identifies three contiguous Ventricular Ectopic beats that are bracketed by two sinus (non-ventricular) beats.</p> <p>$Series(ar_V\ Ectopic, 1) = 3$</p>	
<p>Run (ar_V Run): Identifies greater than three contiguous Ventricular Ectopic beats that are bracketed by two sinus (non-ventricular) beats.</p> <p>$Series(ar_V\ Ectopic, 1) > 3$</p>	
<p>Bigeminy (ar_V Bigeminy): Identifies a repeating pattern of two or more Ventricular beats that are separated by one sinus (non-ventricular) beat.</p> <p>$Series(ar_V\ Ectopic\ Single, 2) >= 2$</p>	
<p>Trigeminy (ar_V Trigeminy): Identifies a repeating pattern of two or more Ventricular beats that are separated by two sinus (non-ventricular) beats.</p> <p>$Series(ar_V\ Ectopic\ Single, 3) >= 2$</p>	

DATA VALIDATION SEARCHES

Data Validation Searches are used to aid in the data validation process by quickly exposing outliers and potentially mismarked data that may require focused attention.

- dv_HR Limits (Heart Rate Limits):**
 Searches for cycles that are at HR extremes to help complete the attribute based analysis process to improve the accuracy of R mark placement. The matches may be valid beats, missed beats or incorrectly marked beats, however there is a greater likelihood of mismarked beats.

Sort the HR column within the **Results Derived View** and step through the extremes until the remaining matches are well mark cycles. Displaying the validation marks in the **Results Wave View** may be helpful. Place Bad Data Marks, Delete Cycles, or reanalyze particular data sections as needed to correct the mismarked data.

Species	Search Definition
Dog	(Value(HR _{cyc0}) > 200
	OR Value(HR _{cyc0}) < 35)
	AND Value(Num _{cyc-1}) > 0
Monkey	(Value(HR _{cyc0}) > 200
	OR Value(HR _{cyc0}) < 50)
	AND Value(Num _{cyc-1}) > 0
Rat	(Value(HR _{cyc0}) > 500
	OR Value(HR _{cyc0}) < 250)
	AND Value(Num _{cyc-1}) > 0
Mouse	(Value(HR _{cyc0}) > 550
	OR Value(HR _{cyc0}) < 300)
	AND Value(Num _{cyc-1}) > 0

- dv_HR Change (Heart Rate Change):**
 Searches for a marked increase in RR-I between the current and the following cycle to help complete the attribute based analysis process to improve the accuracy of R mark placement. The matches may be valid beats, missed beats or incorrectly marked beats, however there is a greater likelihood of mismarked beats.

Sort the RR-I column within the **Results Derived View** and step through the extremes until the remaining matches are well mark cycles. Displaying the validation marks in the **Results Wave View** may be helpful. Place Bad Data Marks, Delete Cycles, or reanalyze particular data sections as needed to correct the mismarked data.

Species	Search Definition
Dog	%Increase(RR-I _{cyc-1} , RR-I _{cyc0}) > 50
Monkey	AND Value(Num _{cyc-1}) > 0
Rat	
Mouse	

- dv_Missed Beats (Missed Beats):**
 Searches for skipped beats to help complete the attribute based analysis process to improve the accuracy of R mark placement.

Sort the RR-I column within the **Results Derived View** and step through the extremes until the remaining matches are well mark cycles. Displaying the validation marks in the **Results Wave View** may be helpful. Place Bad Data Marks, Delete Cycles, or reanalyze particular data sections as needed to correct the mismarked data.

Species	Search Definition
Dog	%Increase(RR-I _{cyc-1} , RR-I _{cyc0}) > 90
	AND %Change(RR-I _{cyc-1} , RR-I _{cyc0}) < 10
	AND Value(HR _{cyc0}) > 140
	AND Value(Noise _{cyc0}) < 100
Monkey	%Increase(RR-I _{cyc-1} , RR-I _{cyc0}) > 90
	AND %Change(RR-I _{cyc-1} , RR-I _{cyc0}) < 10
	AND Value(HR _{cyc0}) > 150
	AND Value(Noise _{cyc0}) < 100
Rat	%Increase(RR-I _{cyc-1} , RR-I _{cyc0}) > 90
	AND %Change(RR-I _{cyc-1} , RR-I _{cyc0}) < 10
	AND Value(HR _{cyc0}) > 400
	AND Value(Noise _{cyc0}) < 100
Mouse	%Increase(RR-I _{cyc-1} , RR-I _{cyc0}) > 90
	AND %Change(RR-I _{cyc-1} , RR-I _{cyc0}) < 10
	AND Value(HR _{cyc0}) > 475
	AND Value(Noise _{cyc0}) < 100

HINTS AND TROUBLESHOOTING

GENERAL CONFIGURATION

- **OK** button is not available for selection after making changes to edit fields. Ensure that all information within boxes outlined in red have been filled in. If information is absent for any field outlined in red, the OK button will not be available.
- Use of the Average function (**avg**) is based on the current averaging interval defined in the Logging Rate field. This is the same logging rate applied to the derived output (DRx) files.
- Derived data is displayed under the **Results** section within the Data Insights dialog. The number of columns and the information provided in each column will differ based on the search criteria (Search, Series, Template, Real Time, etc.) used. Some examples are below.
- Search: Utilizes existing searches within its search clause and provides Cycle Number as the output.
- Series: Utilizes existing searches within its search clause and provides Cycle Number and the number of cycles found for that data segment or **Series** query.
- **Match Condition Table** displays the specific searches used and the conditions for the searches. In addition this table logs the time the match was found, the duration, and the value for each match. If a number of searches are utilized, this could result in a very large number of entries into the report. An informational message may be posted informing the user that information will be truncated. You can remove the number of items selected for the report to address this. This information is typically reported when doing Series based searches because it provides content of the runs as opposed to only the number of runs encountered.

SEARCH CONFIGURATION

- It is important to note that Searches are specific to a channel and specie type. For example, searches constructed using ECG parameter information cannot be applied to pressure channels. Searches should be created specific to both specie and signal type. Searches that do not match the signal type will not be allowed to be dragged and dropped on that channel.
- When importing searches, referenced searches must also be present in the.xml file that is being imported. If the referenced search is not contained in the xml file, the search or searches using the missing reference will not be loaded. Additionally, none of the searches in the .xml file being imported should be present in the current Search list. Remove any duplicates before importing. In some cases it may be advisable to remove all searches prior to importing a new list.
- To delete searches, select all that apply. This can be done one at a time or can be done using the Control or Shift keys and selecting multiple Searches at once. Right click the mouse and select **Delete Selected Searches**.
- Selection of Species within the **Search Entry Dialog** is dependent upon the data loaded into Review. If data is loaded that has been specified as dog, selection of a different species cannot be performed. Data with the desired species must be loaded into Review in order to create the species specific search. Additionally, Searches identified as a one species cannot be applied to data from a different species.
- A Series search depends on an embedded search with one or more of its clauses. If the embedded clauses are not applied to a channel, or channels, the Series search will not be able to be dragged and applied to a channel.

ANALYSIS

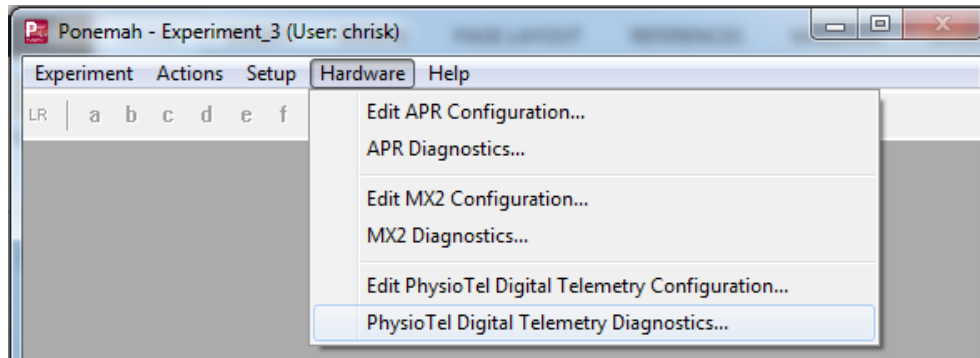
- Templates created in previous versions are not backwards compatible. Contact Technical Support if specific version information is needed. Error messages will be posted stating the adding the Template Library has failed.
- Performing searches looking for increases and decreases greater than a specified value can yield negative results. If only positive results are desired, construct a search clause designating the specific range desired, for example, greater than 0.
- Performing a Search using NUM (cycle number) ensure that the correct channel (algorithm) has been selected. If the incorrect algorithm has not been selected, the Search cannot be applied to the channel. Also, if using NUM as a comparison within a clause, ensure that all clauses using NUM are from the same algorithm. It is possible to apply a Search where NUM has been constructed from different algorithms. However, Match results will equal zero.
- Adding **Bad Data Marks** (BDM) may appear to slow down analysis. Adding BDM at the beginning of the file will update quickly and allow continued analysis or changes within Data Insights. However, adding BDM at the end of the file while parameters are updating will result in the system appearing to slow down. This is due to the fact that BDM placed at the end of the file will wait for the parameters to update before applying the BDM. Removing data in chronological order typically does not show this behavior.
- This may often be seen when sorting on the derived parameters and removing data using BDM. Since the data is no longer in chronological order, removal of data is dependent upon completion of all calculations. Two segments next to each other may be from the opposite ends of the file. Removal of one segment may be performed quickly if it is at the beginning of the dataset. However, removal of the next segment may need to wait for calculations to be completed before applying the BDM updates.
- Adding or removing search clauses will result in all rejected data to be removed. Changing values in the clauses will not affect those results that have been rejected.

- It is useful to include a Noise Clause in searches. This permits the exclusion of noisy data from match results. By default the Noise threshold in the Noise clause should be set high to prevent exclusion and lowered as necessary.

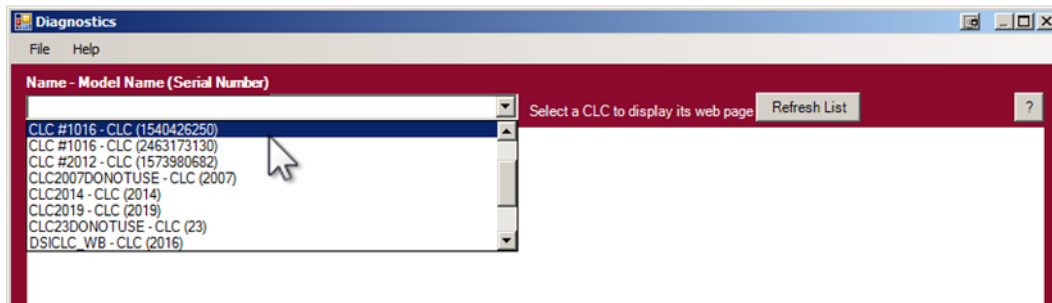
PHYSIOTEL DIGITAL DIAGNOSTICS

The Diagnostics user interface is a browser based webpage that allows the user to check the status of the PhysioTel Digital hardware components, update firmware, and perform diagnostic tests to optimize the performance of the system components.

The Diagnostic user interface is accessed from the Ponemah Hardware menu.



To select a specific CLC click on the drop-down menu located in the top left corner of the diagnostics window. All of the configured CLCs that are connected to the system will appear in this list.



Diagnostics
 File Help
 Name - Model Name (Serial Number)
 DSICLC-679875 - CLC (679875) Select a device to display its web page Refresh List ?

DSI™ DSICLC-679875

CLC
[Home](#)
[Network](#)
[Upload CLC Firmware](#)
[System Status](#)
[Settings](#)
[Reboot](#)

TRX
[TRX Status](#)
[TRX Commands](#)
[TRX RSSI History](#)
[TRX CCA RSSI History](#)

Implant
[Implant Status](#)
[Implant Commands](#)
[Implant RSSI History](#)

Home

Name: DSICLC-679875
 Model Number: 43265
 Serial Number: 679875
 Manufacturing Date: 2013-03-18
 Version: 0.1.28

Operating Region: F1
 Operating Frequency: F1_A1
 Operating Mode: Enabled

System IP Address: 10.10.209.75:56620
 CLC IP Address: 10.10.209.20
 MAC Address: 00:08:EE:06:97:2F

Time: 2016-01-18 15:49:57
 Up Time: 21:49:57 up 6:24, load average: 0.42, 1.00, 1.38
 POST: 0

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Close

CLC Options

The CLC section of the Diagnostics webpage options are describe below.

Home

The Home page lists general information about the select CLC.

Home

Name: 825023
Model Number: 43265
Serial Number: 825023
Manufacturing Date: 2015-11-10
Version: 0.1.28

Operating Region: F1
Operating Frequency: F1-D1
Operating Mode: Enabled

System IP Address:

CLC IP Address: 10.10.209.52
MAC Address: 00:08:EE:0A:63:BE

Time: 2017-05-01 15:03:44
Up Time: 20:03:44 up 4 min, load average: 0.02, 0.19, 0.11
POST: 0

- Name** Displays the user defined name assigned to the CLC.
- Model Number** Displays a numeric value representing the CLC model.
- Serial Number** Displays the CLC serial number.
- Manufacturing Date** Displays the date the CLC was manufactured at DSI. Format is YYYY-MM-DD.
- Version** Displays the firmware version the CLC is currently running.
- Operating Region** Displays the current Operating Region of the CLC.

Frequency	Region
F1	US
F2	Europe
F3	Japan
F4	China

- Operating Frequency** Displays the currently assigned Operating Frequency, based on TRX connection.

Note: the Operating Frequency will read “Unknown” if CLC is powered up without a TRX connected.

Operating Mode	Enabled: Normal operational mode. Disabled: The CLC sends and receives no RF data. Assessment: The CLC monitors the RF field and collects RSSI data from attached TRXs.
System IP Address	IP address of the data acquisition computer.
CLC IP Address	IP address of this particular CLC.
MAC Address	Unique identifier for the CLC network interface.
Time	Current Date & Time (Format = YYYY-MM-DD HR:MN:SC).
Up Time	Status information since last reboot
POST	Power On Self-Test (0 = Passed, OK ...)

Network

The Network section allows the user to define how IP addresses are assigned to the CLC.

Network

Obtain an IP address automatically

Use the following IP address

IP v4 Address: 10.10.209.20

Subnet Mask: 255.255.255.0

Default Gateway: 10.10.209.1

NTP: 10.10.209.75

Syslog: 10.10.209.75

Apply (Changes take effect after reboot.)

- **Obtain an IP address automatically**

This is the normal operating mode for the CLC. With this option selected the CLC is queried and the values that it reports back are displayed in the appropriate text boxes:

- IP v4 Address:
- Subnet Mask:
- Default Gateway:

Note: A new IP address can be generated by performing an “extended” reset: push and hold the reset button on the back of the CLC for 5-15 seconds.

- **Use the following IP address**

If the user wishes to manually assign a specific IP address to the CLC, click this radio button and type a

new IP address in the text box.

If you wish to perform this operation, follow this procedure:

1. Click the radio button for Use the following IP address
2. Enter the desired values in the text boxes labeled:
 - o IP v4 Address:
 - o Subnet Mask:
 - o Default Gateway:
3. Click Apply.

Note: A reboot of the system will have to be performed in order for the new IP Address to activate.



Caution: In the event that the user-assigned IP address is not accessible, this diagnostics tool will lose contact with the CLC. To generate a new IP address, the user will have to perform an “extended” reset: push and hold the reset button on the back of the CLC for 5-15 seconds.

- **NTP**

The CLC keeps synchronization with the PC using Network Time Protocol (NTP). By default Ponemah will set the NTP IP address to be the IP address of the PC. If it is desired, the NTP IP address can be set manually.

- **Syslog**

This is an IP address that can be set by DSI personal for on-site troubleshooting. It is not needed for normal operation.

Upload CLC Firmware

This page allows the user to update the CLC firmware. From time to time it may be advantageous to upgrade the internal read-only program instructions through a firmware upgrade. This often results in improved performance.



To update or change the firmware version in the CLC, follow this procedure:

1. Click on the Browse button and use the file upload window to locate the firmware file.
2. Navigate to the specific filename and click Open
3. Message 1: Uploaded, Validating
4. Message 2: Validated. Upgrade will be applied during reboot.

Note: A reboot of the system will have to be performed in order for the update to activate.

System Status

The System Status is a continuously updating “log” file of the CLC’s communication activity. It can be used to monitor communication issues in the event of discontinuities.

System Status

Actions

NTP Status

remote	refid	st	t	when	poll	reach	delay	offset	jitter
*10.10.209.69	LOCAL(0)	7	u	1	64	37	0.902	0.142	0.807

Active Processes and Memory Usage:

Mem: 20356K used, 73868K free, 0K shrd, 1932K buff, 11068K cached
CPU: 38% usr 61% sys 0% nic 0% idle 0% io 0% irq 0% sirq

Disk Usage

Filesystem	Size	Used	Available	Use%	Mounted on
/dev/root	505.8M	41.9M	438.1M	9%	/
tmpfs	4.0M	52.0K	3.9M	1%	/var/volatile
none	1.0M	80.0K	944.0K	8%	/dev

System Log:

```
May 1 19:58:34 DSICLC daemon.crit c1c_arm[1372]: [TB ] 2017-05-01 19:58
May 1 19:58:34 DSICLC daemon.info c1c_arm[1372]: [MAIN ] 2017-05-01 19:58
May 1 19:58:34 DSICLC daemon.info c1c_arm[1372]: [MAIN ] 2017-05-01 19:58
May 1 19:58:34 DSICLC daemon.info c1c_arm[1372]: [MAIN ] 2017-05-01 19:58
May 1 19:58:34 DSICLC daemon.info c1c_arm[1372]: [MAIN ] 2017-05-01 19:58
May 1 19:58:34 DSICLC daemon.info c1c_arm[1372]: [MAIN ] 2017-05-01 19:58
May 1 19:58:34 DSICLC daemon.crit c1c_arm[1372]: [TB ] 2017-05-01 19:58
May 1 19:58:34 DSICLC daemon.crit c1c_arm[1372]: [TB ] 2017-05-01 19:58
May 1 19:58:34 DSICLC daemon.crit c1c_arm[1372]: [TB ] 2017-05-01 19:58
May 1 19:58:34 DSICLC daemon.info c1c_arm[1372]: [MAIN ] 2017-05-01 19:58
May 1 19:58:34 DSICLC daemon.info c1c_arm[1372]: [MAIN ] 2017-05-01 19:58
May 1 19:58:34 DSICLC daemon.info c1c_arm[1372]: [MAIN ] 2017-05-01 19:58
May 1 19:58:34 DSICLC daemon.info c1c_arm[1372]: [MAIN ] 2017-05-01 19:58
May 1 19:58:34 DSICLC daemon.info c1c_arm[1372]: [MAIN ] 2017-05-01 19:58
May 1 19:58:34 DSICLC daemon.info c1c_arm[1372]: [MAIN ] 2017-05-01 19:58
```

Contents:

- Get All Logs – downloads the CLC log file.
- NTP Status – Reports the last time the CLC received an update from the NTP Server
- Active Processes and Memory Usage
- System Log

Settings

The Settings page allows the user to set the RF Mode, Clear Channel Assessment, Enable Multiple Beacons, set the Maximum Implant Count per CLCs, and Enable Logging.

Settings	
Setting	Value
RFMode	Enabled ▼
ClearChannelAssessmentEnable	<input type="checkbox"/>
MultipleBeaconsEnable	<input checked="" type="checkbox"/>
MaxImplantCount	4
EnableLogging	<input checked="" type="checkbox"/>

Save Reset Defaults

RF Mode

- **Enabled** – Normal operating mode
- **Disabled** – Halts communication between the TRXs and the implants
- **Assessment** – Allows the user to sample individual frequencies to assess the level of background RF interference. The Assessment mode is used for the TRX RSSI History function

Clear Channel Assessment

- For European and Japan customers this function is enabled by default and cannot be changed.
- For North American customers this function is not enabled by default, but can be with no effect on performance. This will allow the user the ability to detect if there are competing RF devices that have the potential of interfering with the Digital system. Reference the TRX CCA RSSI History section below for more detail.
- For customers in China, Clear Channel Assessment is not enabled by default and is not needed.

Multiple Beacons

- Multiple Beacons was an enhancement made to the system to maximize the number of attempts in communicating with the PhysioTel Digital implants. It is enabled by default.

Max Implant Count

- Defines the maximum number of Implants that may be assigned to a CLC. Default is 4. With certain combinations of Implant and CLC firmware, the maximum may be set to 6.
- The default maximum implant count for China is 5, which is also the maximum number of implants that may be assigned to CLCs in China.
- See the PhysioTel Digital Telemetry Platform Broadcasting Frequencies section of this manual for more details on supported frequencies.

REBOOT

This function allows the user to perform a complete reboot of the CLC. A Reboot of the system is required to:

- Activate a firmware upgrade
- Change the IP settings
- To reboot the CLC left click the Reboot button

Note: the Reboot process may take several minutes to complete. There are no progress indicators that appear on this page, However there are indicator lights on the back of the CLC box itself.



TRX OPTIONS

The TRX is the three letter designation for a Transceiver: the component in the system that receives Radio-Frequency (RF) signals and converts it into digital form that is sent, via cable, to the Communication Link Controller.

TRX STATUS

The TRX Status screen is a non-interactive snapshot of the current status of the TRXs that are connected to the CLC. Each CLC is capable of interfacing with eight TRXs. This arrangement follows the layout on the rear panel of the CLC unit. The following is the TRX Status screen indicating that two TRX units are connected and enabled.

TRX Status			
TRX 1 Enabled: <input checked="" type="checkbox"/> CONNECTED Model Number: 39169 Serial Number: 20012 Manufacture Date: 2011-07-23 Assembly Revision: 2 Loader Revision: 1.11648 Firmware Revision: 1.15924 Error Status: 0 Last Error: 0 POST: 0	TRX 2 Enabled: <input checked="" type="checkbox"/> CONNECTED Model Number: 39169 Serial Number: 251100004 Manufacture Date: 2011-11-22 Assembly Revision: 3 Loader Revision: 1.11648 Firmware Revision: 1.15924 Error Status: 0 Last Error: 0 POST: 0	TRX 3 Enabled: <input type="checkbox"/> NOT CONNECTED	TRX 4 Enabled: <input type="checkbox"/> NOT CONNECTED
TRX 5 Enabled: <input type="checkbox"/> NOT CONNECTED	TRX 6 Enabled: <input type="checkbox"/> NOT CONNECTED	TRX 7 Enabled: <input type="checkbox"/> NOT CONNECTED	TRX 8 Enabled: <input type="checkbox"/> NOT CONNECTED

The line items are as follows:

TRX (#): Number 1-8.

Enabled: A check mark in the box indicates that the TRX is connected and available to communicate with the implants

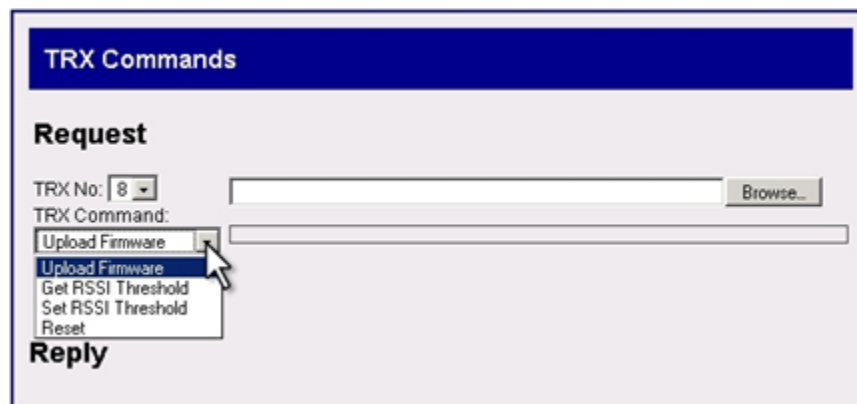
Connected: Indicates whether the TRX is physically CONNECTED or NOT CONNECTED to the CLC

Model Number:	Displays a numeric value representing the TRX model.
Serial number:	Displays the TRX serial number.
Manufacture Date:	Displays the date the CLC was manufactured at DSI. Format is YYYY-MM-DD.
Assembly Revision:	Displays the current Assembly revision.
Loader Revision:	Displays the current Loader revision.
Firmware Revision:	Displays the firmware version the TRX is currently running.
Error Status:	Indicates that at least one error has occurred.
Last error:	Displays the most recent error encountered.
POST:	Power On Self-Test (0 =Passed, OK)

TRX COMMAND

This dialog screen allows the user to perform two functions that affect the performance of the TRX. The user can upload a different version of the on-board read-only software (firmware). Additionally the user can adjust the telemetry receiver thresholds to optimize RF communications.

There are four commands available in this window.



UPLOAD FIRMWARE

To update or change the firmware version in the TRX, follow these steps:

1. Select the **TRX No:** drop-down menu and select the **TRX number** you wish to communicate with.
2. Select the **TRX Command:** drop-down menu and select **Upload Firmware**.
3. Select **Browse...** button and use the file upload window to locate the firmware file.
4. Navigate to the specific filename and click **Open**
5. Message 1: Uploaded.
6. Message 2: Validating

7. Message 3: Updating TRX Firmware...
8. Message 4: Command Completed

GET RSSI THRESHOLD

RSSI stands for Received Signal Strength Indicator. It is a quantitative measure of the strength of the RF signal that the TRX is receiving from the implants. The Get RSSI Threshold command retrieves the current threshold value from the TRX. The default value = 12.

1. Select **Get RSSI Threshold** from the **TRX Command:** drop-down menu.
2. Select **Send**.
3. A successful operation is indicated by a blue colored Command Completed banner at the top of the screen and a text string below the word Reply at the bottom of the screen.
4. The reported text value **OK "xx"** is the Hexadecimal value of the **RSSI Threshold**.



SET RSSI THRESHOLD

The Set RSSI Threshold command allows the user to adjust the lower limit of signal strength that the TRX will accept as viable information from the implants. The default value = 12.

Note: Anytime the TRX is unplugged, or the CLC is rebooted, or the CLC goes through the Configuration Wizard, the RSSI threshold value will revert back to the hexadecimal default value of 0x12.

1. Select **Set RSSI Threshold** from the **TRX Command:** drop-down menu.
2. Select the **TRX #** from the **TRX No:** drop-down menu.
3. Enter a **hexadecimal** value in the small text box above the **Send** button.
4. Select the **Send** button.
5. A successful operation is indicated by a blue colored Command Completed banner at the top of the screen and a text string **"OK"** below the word Reply at the bottom of the screen.



RESET

The Reset function returns the TRX settings to the factory default values.

1. Select **Reset** from the **TRX Command**: drop-down menu.
2. Select the **TRX #** from the **TRX No**: drop-down menu.
3. Change the value in the dialog box below the letters TRX from “ff” to “02”.
4. Click the **Send** button.
5. A successful operation is indicated by a blue colored Command Completed banner at the top of the screen and a text string “OK” below the word Reply at the bottom of the screen.

RFMODE (NOT PICTURED ABOVE)

The RFMode command is only available to EU users. It can be used to change the transmission power of the TRX. By default the TRX leaves the DSI factory with the maximum allowable transmission power. In some cases, that power is too much and it should be decrease to improve RF performance where multiple PhysioTel Digital systems are located in close proximity. The power can be changed from any value of 00 to 08, with the default value of 08. The default value in the United States, Japan, and China is 00.

1. Select **RFMode** from the **TRX Command**: drop-down menu.
2. Select the **TRX #** from the **TRX No**: drop-down menu.
3. Enter a **hexadecimal** value in the small text box above the **Send** button.
4. Select the **Send** button.
5. A successful operation is indicated by a blue colored Command Completed banner at the top of the screen and a text string “OK” below the word Reply at the bottom of the screen.

TRX RSSI HISTORY

This option allows the user to sample how well the TRXs are receiving RF signals from the implants, or as a tool to detect the amount of RF noise that may be present near the PTD system. In an actively running system (**Enabled**) these graphs continually update according to a user prescribed auto refresh rate.

There will be one RSSI graph displayed for each of the enabled TRXs connected to the CLC. The TRXs will display the received signals from all of the implants it is communicating with.

Follow this procedure to utilize the **TRX RSSI History** option:

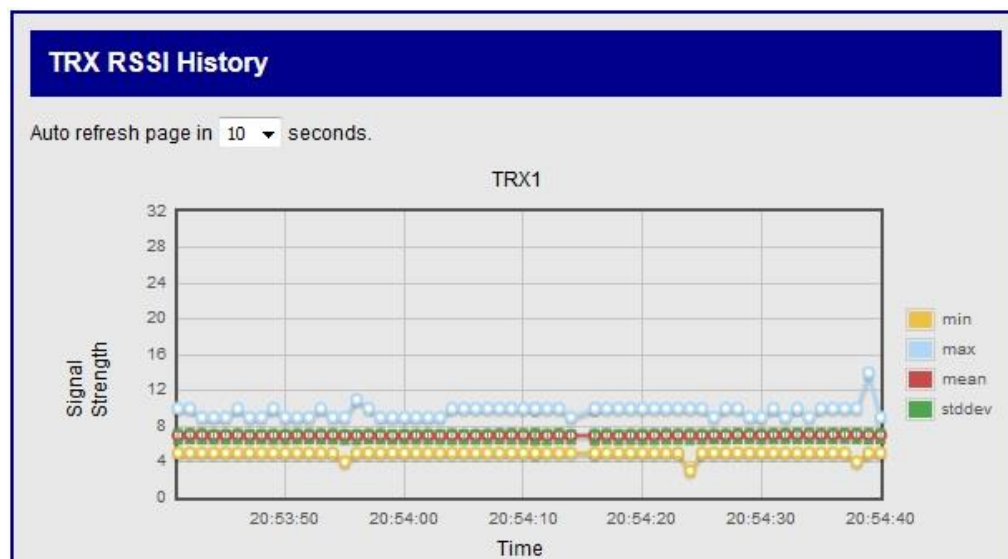
1. Click on the Settings link under the **CLC Options** heading.
2. In the dropdown box to the right of the words **RF Mode**, select the word “**Assessment**” and click the **Save** button below.
3. Using the mouse cursor, click on the link marked **TRX RSSI History**.

- This will open the RSSI graph screen.

Warning! When you are finished with the TRX RSSI History function you MUST return the CLC to the "Enabled" mode!

- Select the **Settings** link under the **CLC Options** heading.
- Return to the dropdown box and select "**Enabled**", and click on the **Save** button below.
- Verify the **CLC status** by **Home** link under the under the **CLC options** heading.
- The **Operating Mode**: line item in the center of the screen should read **Enabled**, if it does not, refresh the internet page, or repeat steps 6-7 above.

The following is a graphical representation of the ability of the TRX to detect RF noise. To set the auto refresh rate of the graph click on the drop-down menu at the top of the screen and select a new value.



TRX CCA RSSI HISTORY

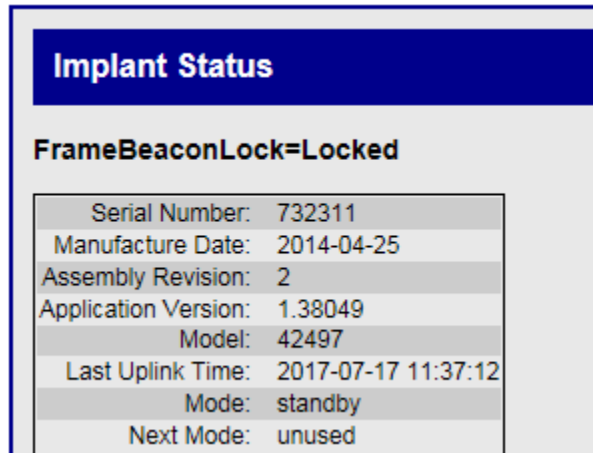
CCA is an acronym for Clear Channel Assessment. According to certain RF regulation environments, it is necessary to invoke a "listen before you talk" policy. The Clear Channel Assessment operation determines whether the wireless medium is busy or idle. The CLC can then make a decision on whether to attempt communication.

The CLC will display the RSSI value of what the TRX is receiving. If the TRX picks up a significant signal from a competing device the CLC delays the transmission of a command to the implant. If the interfering signal persists, communication with the implants may be disrupted.

- The CLC will try to avoid talking in a noisy RF environment.
- The CLC will display an RSSI value of what the TRX is picking up in the Listening window.
- In Europe and Japan the "Listen Before Talk" function is enabled by default.
- In the United States the "Listen Before Talk" function is disabled by default.
- There will be one plot for each of the TRXs assigned to the CLC.
- To set the auto refresh rate of the graph click on the drop-down menu at the top of the screen and select a new value.

IMPLANT STATUS

Implant Status is a non-interactive table which reports the operational status of all implants communicating with a CLC.



The screenshot shows a web interface titled "Implant Status" with a sub-header "FrameBeaconLock=Locked". Below this is a table with the following data:

Serial Number:	732311
Manufacture Date:	2014-04-25
Assembly Revision:	2
Application Version:	1.38049
Model:	42497
Last Uplink Time:	2017-07-17 11:37:12
Mode:	standby
Next Mode:	unused

Frame Beacon Lock is a new feature that will prevent implants from being “stolen” by a configured system. Once a CLC with firmware v0.1.28 is configured, the Accept List of that CLC will become “Locked” and that is indicated on the Implant Status page. If an implant with firmware v1.62816 or later hears a beacon from a locked CLC (that isn’t its intended CLC) it will disregard that beacon/CLC, and continue to listen for its intended beacon/CLC.

Previous versions of the CLC would allow implants that were not configured onto its Accept List if the implant heard the beacon and attempted to join (assuming there was room on the list). If the Accept List was already full, the implant would continuously attempt to become a part of that Accept List until it either a.) it timed out and eventually turned off, or b.) started to hear its intended beacon again. With the new version of the implant firmware, the implant will attempt to hear its intended beacon right away.

A table will be displayed for each implant with the following content:

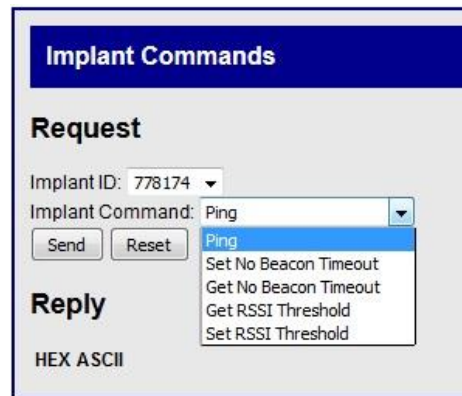
Serial Number	Displays the serial number of the implant.
Manufacture Date	Displays the date the implant was manufactured at DSI. Format is YYYY-MM-DD.
Assembly Revision	Displays the assembly revision.
Application Version	Displays the application version.
Model	Displays the implant model.
Last Uplink Time	The latest time that the CLC received an uplink from the implant.
Mode	Displays the current mode of the implant:

- Standby – On, but not actively transmitting data.
- Active – On and actively transmitting data.
- Unused – Configured but either out of range or off.

Next Mode Will only update when using scheduled sampling in Ponemah.

IMPLANT COMMANDS

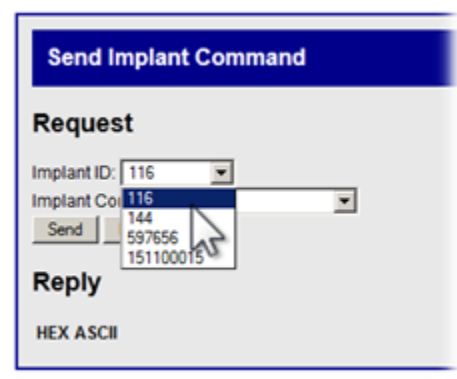
There are three commands with which the user can communicate with individual implants. They are **Ping**, **Get/Set RSSI Threshold**, **Get/No Beacon Timeout**.



- The **Ping** command allows the user to select an individual implant and request a confirmation message that the implant is operating within range.
- The **Get RSSI Threshold** command retrieves the current threshold value from the implant.
- The **Set RSSI Threshold** command allows the user to adjust the lower limit of signal strength that the implant will accept as viable information from any of the TRXs.

PING COMMAND

The **Ping** command allows the user to send a request to an individual implant to reply with a confirmation message that the implant is operating within range.



To **Ping** the implant:

1. Click on the drop-down menu labeled Implant ID:
2. Select a device by left clicking on an implant serial number.
3. Click on the drop-down menu labeled Implant Command.

4. Left click the Ping command
5. Click the Send button

If the Ping dialog is successful:

- A blue colored banner with the word **OK!** will appear at the top of the screen.
- The implant will report back with a Hexadecimal value which is displayed in the Reply table at the bottom of the screen.



If the Ping dialog is unsuccessful:

The Ping will be automatically repeated several times.

- A red colored banner with the word **ERROR** will appear at the top of the screen.
- The more common error codes are listed at the end of this section.
- The implant will not report with a Hex value at the bottom of the screen.

Note: It may take several seconds for an unsuccessful Ping command to generate an error message.



GET RSSI THRESHOLD

The Get RSSI Threshold command retrieves the current threshold value from the implant. Get RSSI Threshold reads the signal strength value that allows the implant to hear commands from the CLC/TRX.



To Get RSSI Threshold:

1. Click on the drop-down menu labeled **Implant ID**:
2. Select a device by left clicking on an implant serial number.
3. Click on the drop-down menu labeled **Implant Command**.
4. Left click the **Get RSSI Threshold** command.
5. Click the **Send** button
6. A successful operation is indicated by a blue colored **OK** banner at the top of the screen.
7. A Hexadecimal value will also be reported in a table below the word **Reply**.
8. If the command cannot be successfully completed an error code may be displayed. Refer to the common error codes below.

SET RSSI THRESHOLD

RSSI stands for Received Signal Strength Indicator. It is a quantitative measure of the strength of the RF signal that the implant is receiving from the TRXs. The Set RSSI Threshold command allows the user to adjust the lower limit of signal strength that the implant will accept as viable information from the CLC/TRX.

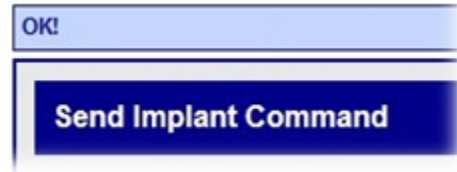
1. Click on the drop-down menu labeled **Implant ID**:
2. Select a device by left clicking on an implant serial number.
3. Click on the drop-down menu labeled **Implant Command**.
4. Left click the **Set RSSI Threshold** command.
5. A small text-entry box will appear below the **Implant Command**: line.
6. Allowable values for **RSSI Threshold** are between 12 and 28 (values must be entered in Hexadecimal format).

Decimal	Hexadecimal
12	0C
28	1C

- Adjusting the **RSSI Threshold** value will affect the implant performance in the following manner.

RSSI value	Sensitivity	Range	Susceptibility to RF Noise
Increase	Decrease	Decrease	Decrease
Decrease	Increase	Increase	Increase

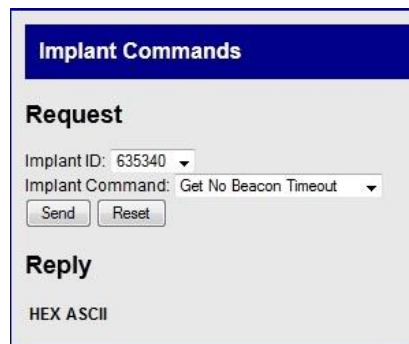
- Enter a new value for the **RSSI Threshold** and click the **Send** button (values must be entered in Hexadecimal format).
- A blue colored banner with the word **OK!** will appear at the top of the screen.



- Repeat the **Get RSSI Threshold** procedure for verification.
- If the command cannot be successfully completed an error code may be displayed. Refer to the common error codes below.
- The RSSI Threshold value will revert to the default value anytime the implant turns off, or if it is assigned a new frequency.

GET NO BEACON TIMEOUT

The Get No Beacon Timeout command retrieves the amount of time that the implant can be out of RF range of the TRXs before it turns off. The returned value is in hexadecimal format and corresponds to minutes. The default value is set in the factory by DSI at a value of 60 minutes



To Get No Beacon Timeout:

- Click on the drop-down menu labeled **Implant ID**:
- Select a device by left clicking on an implant serial number.
- Click on the drop-down menu labeled **Implant Command**.
- Left click the **Get No Beacon Timeout** command.
- Click the **Send** button
- A successful operation is indicated by a blue colored **OK** banner at the top of the screen.
- A Hexadecimal value will also be reported in a table below the word **Reply**.

- If the command cannot be successfully completed an error code may be displayed. Refer to the common error codes below.

SET NO BEACON TIMEOUT

The Set No Beacon Timeout command sets the amount of time that the implant can be out of RF range of the TRXs before it turns off. The table below outlines some common values that could be entered with the hexadecimal conversion.

Minutes	Hexadecimal
60	3C
120	78
180	B4
240	F0
480	FF
Infinite (Doesn't Turn Off)	00

Implant Commands

Request

Implant ID: 635340

Implant Command: Set No Beacon Timeout

78

Send Reset

Reply

HEX ASCII

To Set No Beacon Timeout:

- Click on the drop-down menu labeled **Implant ID**:
- Select a device by left clicking on an implant serial number.
- Click on the drop-down menu labeled **Implant Command**.
- Left click the **Set No Beacon Timeout** command.
- Click the **Send** button
- A successful operation is indicated by a blue colored **OK** banner at the top of the screen.
- A Hexadecimal value will also be reported in a table below the word **Reply**.
- If the command cannot be successfully completed an error code may be displayed. Refer to the common error codes below.

COMMON ERROR CODES

The implant commands in this section are capable of generating an error code if the command cannot be successfully executed. Below is a list of the more common error codes.

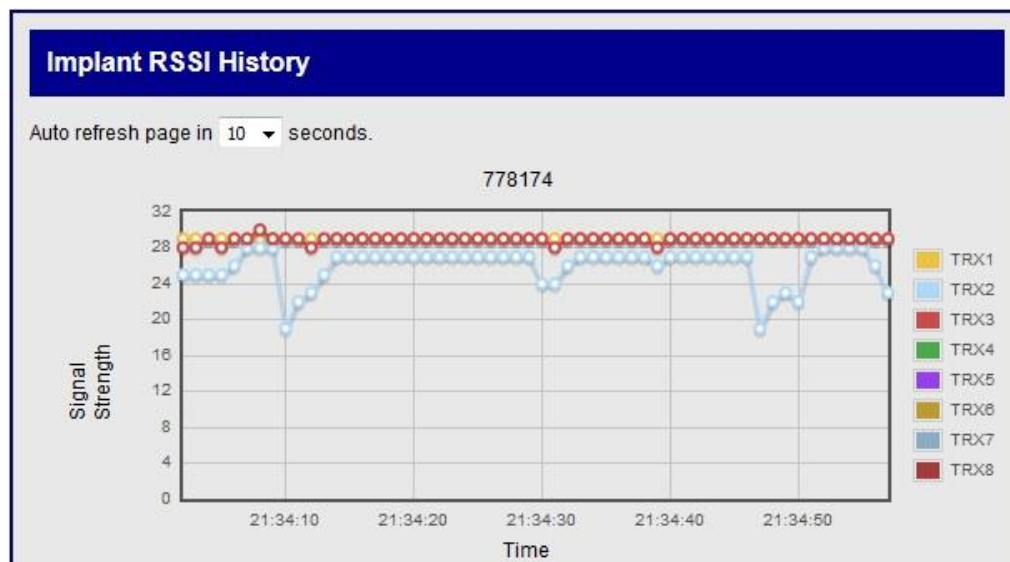
Error code	Description	Solution
900	Unknown Error	
901	Implant Not Found	Make sure implant in range
902	Timeout	Make sure implant in range

903	Send Fail	Make sure implant in range, in standby mode, Ponemah is not trying to send a lot of commands to the implant
905	Implant in Active Mode	Make sure the implant is in standby mode
906	Queue Full	Make sure implant is in range, Ponemah is not trying to send a lot of commands to the implant

IMPLANT RSSI HISTORY

Similar to the TRX RSSI History, the Implant RSSI History generates graphs in which the received signal strength from each of the TRXs is plotted for each implant. These graphs allow the user to track how well the implants are being received by each of the TRXs. In an actively running system these graphs continually update according to a user prescribed auto refresh rate.

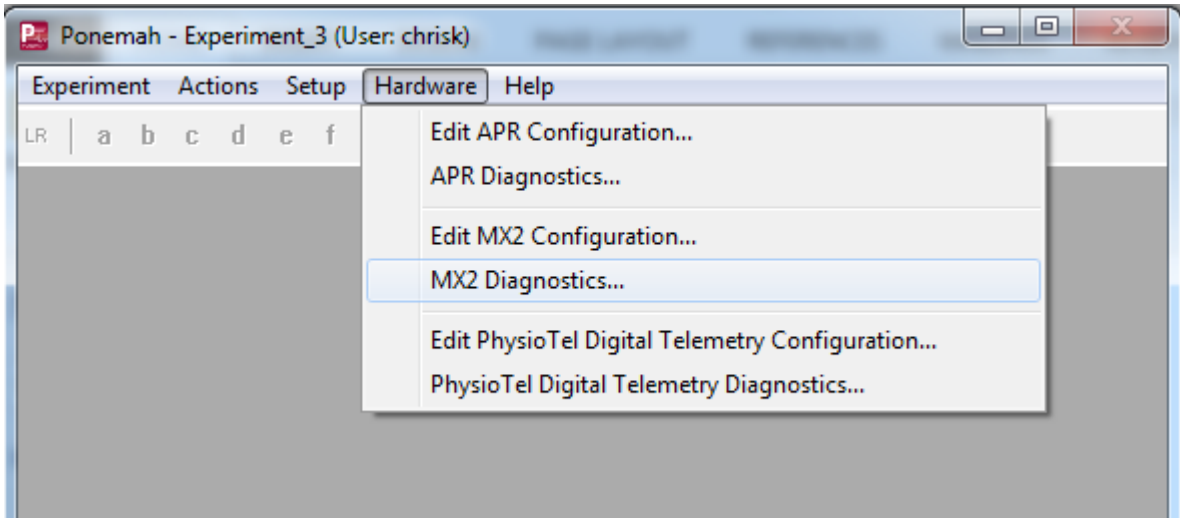
- There will be one RSSI graph for each of the recognized implants in the system.
- Each TRX will report the received signal strength from each of the implants it is communicating with. The RSSI graph will display one data set for each of the implants.
- To Set the Auto refresh rate of the graph, click on the drop-down menu at the top of the screen and select a new value.



MX2 DIAGNOSTICS

The **MX2 Diagnostics** user interface is a browser based webpage that allows the user to check the status of the MX2, Check network connections, update firmware, and perform diagnostic tests to optimize the performance of the system components.

Selecting **MX2 Diagnostics...** from the Hardware menu will open the **MX2 Diagnostics** web browser.



To select a specific MX2 click on the drop-down menu located in the top left corner of the diagnostics window. All of the configured MX2s that are connected to the system will appear in this list.

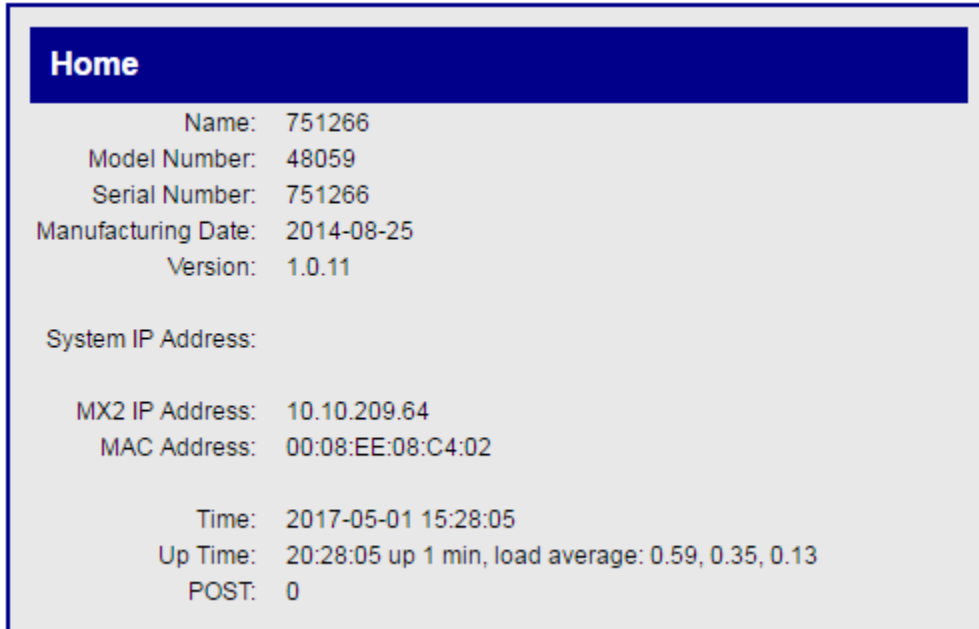


MX2 Options

The MX2 section of the Diagnostics webpage options are describe below.

HOME

The **Home** section lists the general information pertinent to the selected MX2.



The screenshot shows a web interface with a dark blue header containing the word "Home" in white. Below the header, the following information is displayed in a light gray box with a dark blue border:

```
Name: 751266
Model Number: 48059
Serial Number: 751266
Manufacturing Date: 2014-08-25
Version: 1.0.11

System IP Address:

MX2 IP Address: 10.10.209.64
MAC Address: 00:08:EE:08:C4:02

Time: 2017-05-01 15:28:05
Up Time: 20:28:05 up 1 min, load average: 0.59, 0.35, 0.13
POST: 0
```

The information listed on the Home page is as follows:

Name:	Displays the user defined name assigned to the MX2.
Model Number:	Displays the MX2 model number.
Serial Number:	Displays the MX2 serial number.
Manufacturing Date:	Displays the date the MX2 was manufactured at DSI. Format is YYYY-MM-DD.
Version:	Displays the firmware version the MX2 is currently running.
System IP Address:	Displays the IP address of the acquisition computer.
MX2 IP Address	Displays the IP address of the MX2.
MAC Address	Displays the unique identifier for the MX2 network interface
Time:	Current Date & Time (Format = YYYY-MM-DD HR:MN:SC)
Up Time:	Status information since last reboot.
POST:	Power On Self-Test (0 = Passed, OK ...)

NETWORK

The **Network** page allows the User to adjust the network communication settings.

Network

Obtain an IP address automatically

Use the following IP address

IP v4 Address: 10.10.209.64

Subnet Mask: 255.255.255.0

Default Gateway: 10.10.209.1

NTP: 10.10.209.69

Syslog: 0.0.0.0

Apply (IP address changes take effect after reboot.)

- **Obtain an IP address automatically**

This is the normal operating mode for the MX2. With this option selected the MX2 is queried and the values that it reports back are displayed in the appropriate text boxes:

- IP v4 Address:
- Subnet Mask:
- Default Gateway:

Note: A new IP address can be generated by performing an “extended” reset: push and hold the reset button on the back of the MX2 for 5-15 seconds.

- **Use the following IP address**

If the user wishes to manually assign a specific IP address to the MX2, click this radio button and type a new IP address in the text box.

If you wish to perform this operation, follow this procedure:

4. Click the radio button for Use the following IP address
5. Enter the desired values in the text boxes labeled:
 - IP v4 Address:
 - Subnet Mask:
 - Default Gateway:
6. Click Apply.

Note: A reboot of the system will have to be performed in order for the new IP Address to activate.



Caution: If the user-assigned IP address is not accessible, this diagnostics tool will lose contact with the MX2. To generate a new IP address, the user must perform an “extended” reset: push and hold the reset button on the back of the MX2 for 5-15 seconds.

- **NTP**

The MX2 keeps synchronization with the PC using Network Time Protocol (NTP). By default, Ponemah will set the NTP IP address to be the IP address of the PC. If it is desired, the NTP IP address can be set manually.

- **Syslog**

This is an IP address that can be set by DSI personal for on-site troubleshooting. It is not needed for normal operation.

UPLOAD MX2 FIRMWARE

This page allows the user to update the MX2 firmware. From time to time it may be advantageous to upgrade the internal read-only program instructions through a firmware upgrade. This often results in improved performance.

The screenshot shows a web interface for uploading MX2 firmware. At the top, there is a dark blue banner with the text "Upload MX2 Firmware" in white. Below this banner, there is a light gray area containing a file upload field with a "Browse..." button to its right.

To update or change the firmware version in the MX2, follow this procedure:

1. Click on the **Browse** button and use the file upload window to locate the firmware file.
2. Navigate to the specific filename and click **Open**
3. Message 1: Uploaded, Validating
4. Message 2: Validated. Upgrade will be applied during reboot.

Note: A reboot of the system will have to be performed in order for the update to activate.

SYSTEM STATUS

The System Status is a continuously updating “log” file of the MX2’s communication activity. It can be used to monitor communication issues in the event of discontinuities.

System Status

NTP Status

remote	refid	st	t	when	poll	reach	delay	offset	jitter
*10.10.209.93	LOCAL(0)	7	u	111	256	377	0.790	-8.787	3.952

Active Processes and Memory Usage:

Mem: 37928K used, 56296K free, 0K shrd, 1344K buff, 26732K cached
CPU: 28% usr 71% sys 0% nic 0% idle 0% io 0% irq 0% sirq
Log: ...

Disk Usage

Filesystem	Size	Used	Available	Use%	Mounted on
/dev/root	505.8M	38.9M	441.2M	8%	/
tmpfs	4.0M	52.0K	3.9M	1%	/var/volatile
none	1.0M	80.0K	944.0K	8%	/dev
/dev/mmcblk0p5	505.8M	432.0K	479.6M	0%	/media/data
/dev/mmcblk0p6	2.2G	801.5M	1.3G	38%	/media/scratch
tmpfs	4.0M	0	4.0M	0%	/dev/shm
tmpfs	1.0M	0	1.0M	0%	/media/ram
tmpfs	4.0M	48.0K	4.0M	1%	/srv/www/dyn

System Log:

```
Nov 7 21:57:55 DSIEDEM daemon.info eDEM_arm[1369]: [DSPMP] ***** DSP_MESSAGE_WATCHDOG
Nov 7 21:57:55 DSIEDEM daemon.info eDEM_arm[1369]: [FPGA] Processing Status=0x0100
Nov 7 21:57:56 DSIEDEM daemon.info eDEM_arm[1369]: [DSPMP] ***** DSP_MESSAGE_WATCHDOG
Nov 7 21:57:56 DSIEDEM daemon.info eDEM_arm[1369]: [FPGA] Processing Status=0x0100
Nov 7 21:57:57 DSIEDEM daemon.info eDEM_arm[1369]: [DSPMP] ***** DSP_MESSAGE_WATCHDOG
Nov 7 21:57:57 DSIEDEM daemon.info eDEM_arm[1369]: [NetRx] Got DACSS CMD: 0x0004
Nov 7 21:57:57 DSIEDEM daemon.info eDEM_arm[1369]: [NetRx] DACSS gave us a ping.
Nov 7 21:57:57 DSIEDEM local0.notice eDEM_dsp[1359]: still alive.
Nov 7 21:57:57 DSIEDEM daemon.info eDEM_arm[1369]: [FPGA] Processing Status=0x0100
```

Contents:

- NTP Status – Reports the last time the MX2 received an update from the NTP Server
- Active Processes and Memory Usage
- Disk Usage
- System Log

REBOOT

This function allows the user to perform a complete reboot of the MX2. A Reboot of the system is required to:

- Activate a firmware upgrade.
- Change the IP settings.
- To reboot the MX2 left click the Reboot button

Note: the Reboot process may take several minutes to complete. There are no progress indicators that appear on this page, However there are indicator lights on the back of the MX2 box itself



RECEIVER OPTIONS

RECEIVER STATUS

The Receiver Status screen is a non-interactive snapshot of the current status of the receivers that are connected to the MX2. Each MX2 is capable of interfacing with eight receivers. This arrangement follows the layout on the rear panel of the MX2 unit.

Receiver Status		
Receiver 1	Receiver 2	Receiver 3
CONNECTED	CONNECTED	CONNECTED
Model Number: 36865	Model Number: 36865	Model Number: 36865
Serial Number: 8765	Serial Number: 8312	Serial Number: 8765
Manufacture Date: 2002-09-09	Manufacture Date: 2002-05-06	Manufacture Date: 2002-09-09
Assembly Revision: 00M0	Assembly Revision: 00M0	Assembly Revision: 00M0
Chassis Serial: 0	Chassis Serial: 0	Chassis Serial: 0
PCB Revision: 00B0	PCB Revision: 00B0	PCB Revision: 00B0
PLD Revision: 00B0	PLD Revision: 00B0	PLD Revision: 00B0
Receiver 5	Receiver 6	Receiver 7
CONNECTED	CONNECTED	CONNECTED
Model Number: 36865	Model Number: 36865	Model Number: 36865
Serial Number: 27779	Serial Number: 20200	Serial Number: 27779
Manufacture Date: 2013-10-21	Manufacture Date: 2008-07-14	Manufacture Date: 2013-10-21
Assembly Revision: 0075	Assembly Revision: 75	Assembly Revision: 0075
Chassis Serial: 0	Chassis Serial: 0	Chassis Serial: 0
PCB Revision: 0050	PCB Revision: 50	PCB Revision: 0050
PLD Revision: 0035	PLD Revision: 25	PLD Revision: 0035

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The line items are as follows:

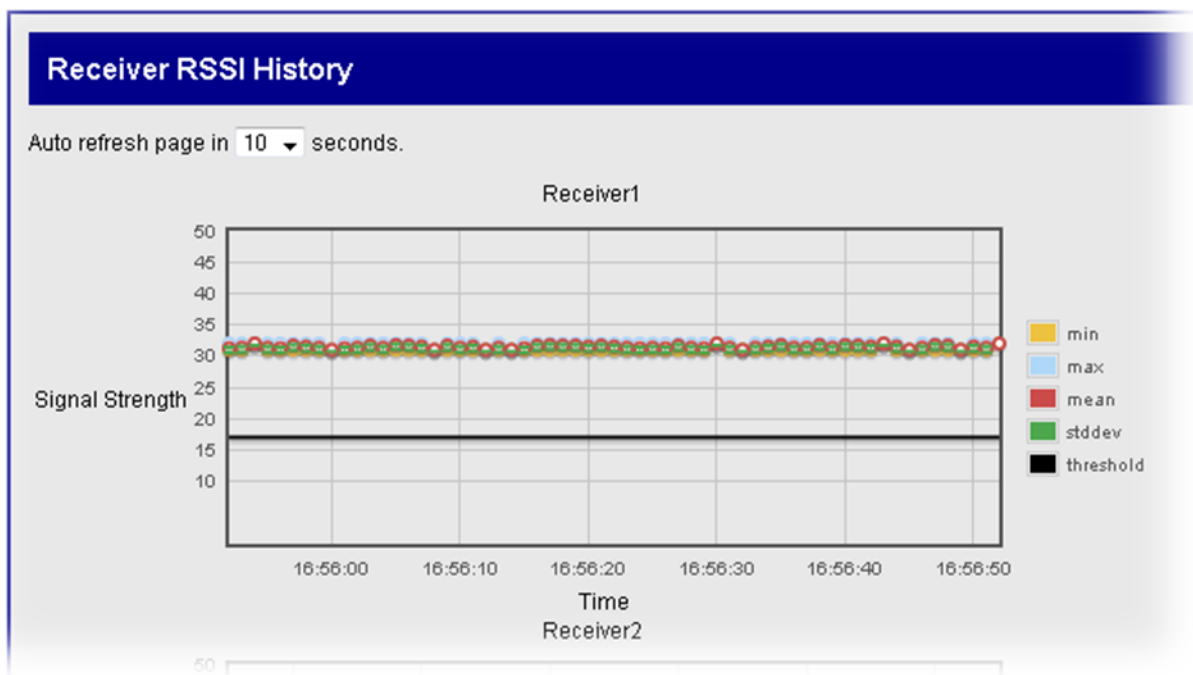
- Receiver (#):** Number 1-8.
- CONNECTED:** Indicates whether the receiver is physically CONNECTED or NOT CONNECTED to the MX2.
- Model Number:** Displays the Receiver model number.
- Serial number:** Displays the Receiver serial number.
- Manufacture Date:** Displays the date the Receiver was manufactured at DSI. Format is YYYY-MM-DD.

- Assembly Revision:** Displays the Assembly revision.
- Chassis Serial:** Not implemented.
- PCB Revision:** Displays the Printed Circuit Board revision.
- PLD Revision:** Displays the Programmable Logic Device revision.

RECEIVER RSSI HISTORY

This option allows the user to view how well the receivers are receiving RF signals from the implants. In an actively running system these graphs continually update according to a user prescribed auto refresh rate.

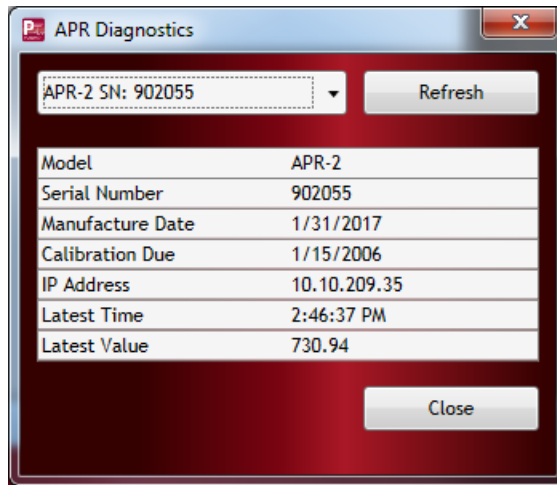
There will be one RSSI graph displayed for each of the receivers connected to the MX2.



APR DIAGNOSTICS

The **APR Diagnostics** user interface allows the user to obtain relevant information regarding the APR. To view the information, select the desired APR from the dropdown.

The following is an example of the diagnostic information from an APR-2:



Note: The Latest Time and Latest Value provide the real-time display of the current ambient pressure detected by the APR. This will update at 1 Hz.

NETWORK TIME PROTOCOL (NTP) & PROCESS UTILITIES APPLICATION

When connected to a CLC or MX2, Ponemah uses a **Network Time Protocol** as a time source instead of **Windows Time** for the sampling of data.

During the installation of Ponemah the needed Network Time Protocol software is installed as a service that will start up and run automatically when Windows is booted. The specifics of the service are:

- **Service Name:** NTP
- **Display Name:** Network Time Protocol Daemon
- **Startup Type:** Automatic

The installation will also turn off Windows Time by setting the startup type to disable. This is needed so there is only a single time source in the system to accurately collect data.

The installation will also add an entry in the Windows Firewall to allow the NTP service to communicate with the connected CLC/MX2 hardware devices. The specifics of the Windows Firewall settings are:

- **Type:** Inbound Rule
- **Name:** NTP UDP Datagram
- **Protocol type:** UDP
- **Local port:** 123
- **Profile:** Domain, Private and Public

MESSAGES

During the startup of Ponemah, the application will check that certain services are in the correct state in order for the application to collect data correctly.

If Windows Time is started and NTP is not, the application will try to change this to Windows Time disabled and NTP enabled. If those states cannot be achieved a message will be posted to notify the user of the issue.

TROUBLESHOOTING NTP

During the startup the application if the needed service states cannot be set an error message will be displayed for the user.

If the user starts an acquisition and the system displays all of the signals with a flat line this can also point to a problem with the NTP time source.

Typically the user can verify that there is an issue by going to the Diagnostic Web page and viewing the Home Page Time. If this time is in the range of 1/30/2012 the hardware device is not synchronized to the NTP time. Try rebooting the hardware device by power cycling the device.

If that does not work exit the application and run a system check by running the Ponemah Process Utilities application which is available in the Ponemah folder under All Applications.

PONEMAH PROCESS UTILITIES APPLICATION

To aid in troubleshooting the user can run the application to view the needed system settings in order to have a valid configuration.

The **Ponemah Process Utilities** application will display the current state of the system settings and the user can select **Verify Required** to see if any of the system setting are not correct and then take appropriate action.

A typical display of a system is shown below.

The screenshot shows the 'Ponemah Process Utilities' application window. It is divided into two main sections: 'Firewall Settings' and 'Process Settings'.

Firewall Settings: The status is 'Windows Firewall NOT Enabled (Port information may not be valid)'. The current profile type is 'Standard'. A table lists the following ports and protocols:

Port	Protocol	Description	Status
123	UDP	NTP UDP Datagram	Enabled
4800	UDP	E2S (APR-1) Converter	Enabled
2867	TCP	Network Discovery (UPnP-In)	Enabled
1900	UDP	Network Discovery (SSDP-In)	Enabled

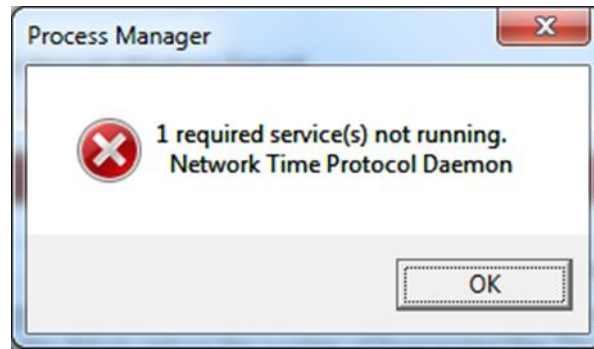
Buttons for 'Enable Ports' and 'Verify Required' are visible. Below the table, it states: 'This application (Ponemah Process Utilities) is NOT allowed to communicate through Windows Firewall' and 'Ponemah (C:\Ponemah\ppp3.EXE) is NOT allowed to communicate through Windows Firewall'.

Process Settings: A table lists the following processes:

Process	Type	Description	Target State	Status
Windows Defender	Windows Scheduled Task	Detects antispyware applications.	Suspended	Enabled
Windows Disk Defragmenter	Windows Scheduled Task	Moves files on the disk to reduce the number of fragmented files.	Suspended	Disabled
Windows Time Synchronization	Windows Scheduled Task	Synchronizes the computer date and time with network servers.	Suspended	Disabled
DSI Clock	Windows Service	Regulates the PC clock with the High Performance Timer.	Suspended	Service DsiClock was not found on computer .:
DSI Time Sync	Windows Service	Synchronizes the PC with ACQ7700.	Suspended	Running
Network Time Protocol Daemon	Windows Service	Synchronizes network devices.	Running	Stopped
Windows Time	Windows Service	Maintains date and time synchronization with network servers.	Suspended	Stopped
Windows Update	Windows Service	Keeps Windows software updated.	Suspended	Running

Buttons for 'Verify Required', 'Disable All', 'Restore All', and 'Refresh' are visible. A note at the bottom states: 'Administrator privileges are required to disable processes. [All task states will be restored on exit]'.

After selecting **Verify Required** in the above condition, the application responded with:



At this time the user can try to change certain settings to resolve the issue. This can be accomplished by contacting the IT group that supports the computer.

For more information, contact DSI Technical Support by seeing the Getting Technical Support section of this manual.

FILES TYPES

This section describes the folders and files types created by Ponemah during Installation and Acquisition.

MAIN DATA FOLDER

The default installation of Ponemah creates a folder that all data will be collected in. The default location and name of this folder is on the root drive with a name of **Ponemah_Data**.

The user has the ability to change both the location of the folder and the name of the folder after the application is started.

EXPERIMENT FOLDER

When a user creates a new Experiment, a new folder is created in the data folder that will contain all of the needed files for that Experiment and each file created in this folder will have the base name of the Experiment in the filename.

Ponemah will default the new Experiment name to **Experiment_nnn** where **nnn** is a numeric value of that particular Experiment name. The user can choose to change this name before the Experiment is created.

EXPERIMENT FILES

Once an Experiment has been created and an acquisition is started, Ponemah will create a set of files with a specific filename structure. Depending on the contents of the file, the extension of that file will designate its usage.

Each file created for the Experiment will have as the first part of the filename the Experiment name itself. For example, with an Experiment name of **RatCardioStudy**, then all of the Experiment files will be in the form of **RatCardioStudy_SubjectName_infromation.filespecific_extension**.

FILENAME EXTENSION MEANINGS

The following table list the definitions for the files that are created.

Extension	Description
.PnmExp	This is a SQLite database that contains all the needed information for the Experiment setup. This replaced Ponemah's protocol file (.PRO).
.PnmExpLog	This is a SQLite database that contains the complete Experimental log. The log contains all information that defines the Experiment such as analysis settings, subject setup and hardware configuration. The log also contains any hardware errors that are generated during the acquisition of data that can impact data.
.PnmMarks	This is a SQLite database that is generated per subject and contains all of the analysis validation marks, event and user notes, bad data marks for each input. The database can be updated with new marks during a Review session over the range of data that is loaded.
.PnmWav	This is a binary file that contains all of the signal data for a particular subject. There can be multiple files generated for a subject. A new file is generated every time the subject starts a new sampling collection or when it reaches a predefined size that is user settable in the application or when a predefined time is reached that is user settable in the application.
.PnmResults	This is a SQLite database that is generated per subject and contains all of the parameter values, data reduction values and variability results. The database can be updated with new values during a Review session over the range of data that is loaded.
.mrs	This is a settings file containing the setup information defined within the Noldus Media Recorder dialog; i.e. camera name, frame rate, resolution, etc.
.mp4	This is the video data file. The name is in the following format: [Camera Name].[yyyymmddhhmmss]
.XML	This is an XML file containing the meta data necessary to associate the video file with the appropriate subject, experiment, and other pertinent information Ponemah requires for video playback. An .XML will exist for every .mp4 file and its file name will be the same as the .mp4.

For Waveform files and Results files, there will also be a file created per subject. If an Experiment has four subjects then the four initial waveform files will be created and four result files would be created.

The waveform files will also have a date and time component associated with the filename.

For the results:

- **RatCardioStudy_Rat1.PnmResults** where Rat1 is the Subject designation
- **RatCardioStudy_Rat1.**

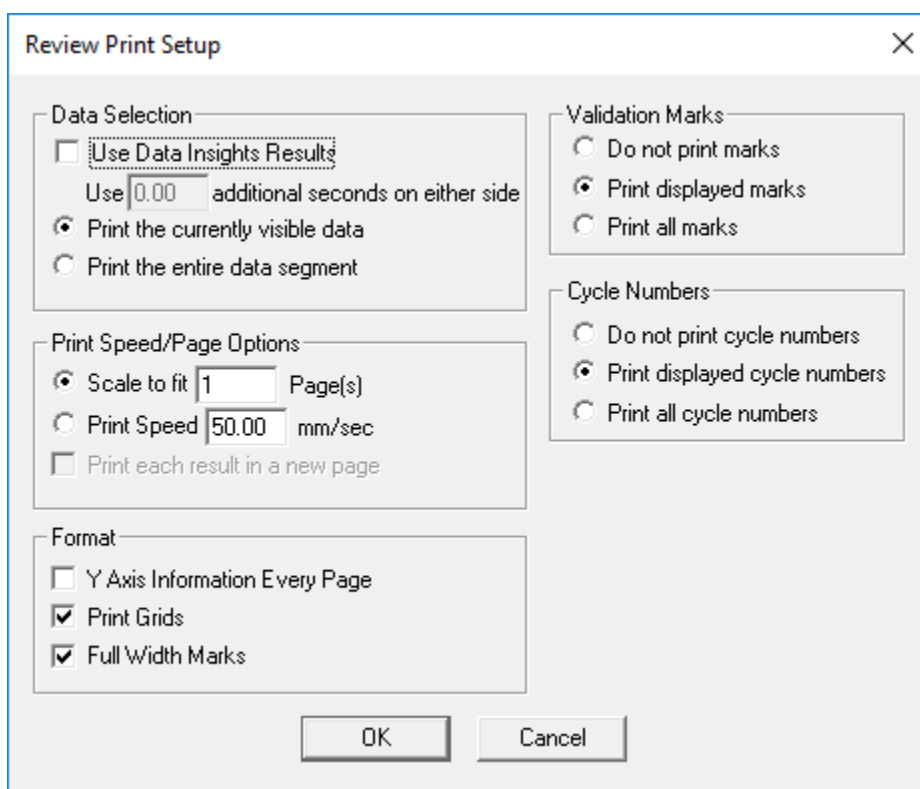
Many of the files are generated as SQLite files and can be viewed with simple SQLite browser. This browser is included on the release CD and is installed along with the application and is accessible in the Ponemah runtime folder in the Utils folder. Below is the browser that is released with Ponemah 6.10.

Ponemah\Utils\SQLiteBrowser.exe

Note: Depending on the version of the SQLite browser, the images in this document may be different than what is shown when running the browser.

PRINTING

Data can be printed on any external printer that has been previously set up. From the main Ponemah menu, select **Review Print Setup** from the **Setup** menu to obtain the **Review Print Setup** dialog. Once configured, select **File | Print** from the *Primary Graph* page.



The following defines the different options within the dialog:

Data Selection This group is used to select the data that will be printed. It permits the selection of either the data as seen in the Review graph page window or the entire data segment.

The default is **Print the currently visible data**.

Check the **Use Data Insights Results** checkbox to print only the Data Insights Match Results contained within the *Primary Graph*. The user **MUST** enable the background color for the

searches desired for printing. To enable background colors, please see the Data Insights **Processing Results** section of this manual.

The time entry box permits users to enter the number of seconds of additional data to be included in the print prior to and following each search result.

When Use Data Insights Results is checked, the Data Selection options will update to the following:

- Print results from the currently visible data, which will print any highlighted (colored background) match results from the data currently displayed in the *Primary Graph*.
- Print results from the entire data segment, which will print any highlighted (colored background) match results from the entire data channel loaded into Ponemah Review.

Notes: The user may specify to **Print each result in a new page** by checking the associated checkbox in the *Print Speed/Page Options* section.

Print Speed Selection

This group is used to adjust the X-axis scale on the printout. The selected data may either be printed on a specified number of pages by regulating the print speed or by setting the print speed and letting the printout span the necessary amount of pages required to print the data.

The defaults for this group are **50 mm/sec** for **Print Speed** and **1 Page(s)** for **Scale to fit**.

Format

This group contains the formatting options for printing Review data.

Y axis scaling information and labels are always printed on the first page. If **Y Axis Information Every Page** is selected, the Y axis information will be displayed on each page of a multiple page printout. The default is disabled.

When **Print Grids** is enabled, grids are printed on the printout. The default is enabled.

When **Full Width Marks** is enabled, validation marks are represented as vertical lines spanning across the channel area. When the **Full Width Marks** check box is disabled, the validation marks are represented as short lines at the bottom of the channel area. The default is enabled.

Validation Marks

This group controls the three options for printing validation marks. Printing **Validation Marks** may be suppressed by enabling **Do not print marks**. **Validation Marks** may be printed as seen in the Review window by enabling **Print displayed marks**. All **Validation Marks** may be printed by enabling **Print all marks**.

The default is **Print displayed marks**.

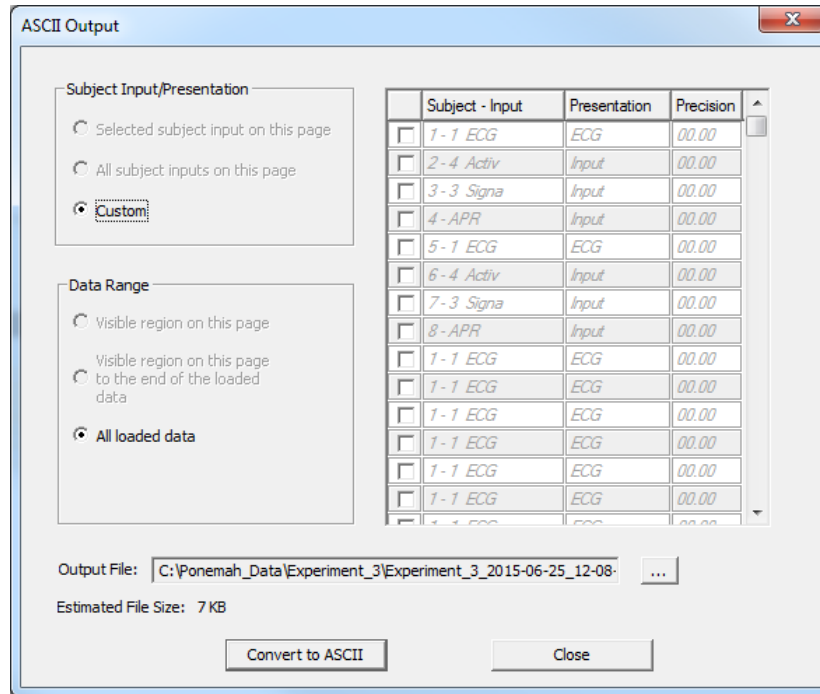
Cycle Numbers

This group controls the options for printing cycle numbers. Printing cycle numbers may be suppressed by enabling **Do not print cycle numbers**, cycle numbers may be printed, as seen in the Review window, by enabling **Print displayed cycle numbers**, or all cycle numbers may be printed by enabling **Print all cycle numbers**.

The default is **Print displayed cycle numbers**.

ASCII OUTPUT

Review has the capability of converting the graphically displayed information into an ASCII file. Each graph page has a button (hovering over the buttons will show tool tips) that allows access to the **ASCII Output** dialog. The dialog can also be accessed from the **Primary** graph **File** menu and Ponemah **Actions** menu. Shown below is an example of the **ASCII Output** dialog.



The following defines the different options within the dialog:

Subject Input /Presentation

The **Subject Input/Presentation** allows the user to select which channels and presentations will be converted. The **Selected display channel** in this page will only convert the highlighted channel from the graph page. The **All display channels** in this page will convert every channel that is listed in the graph page. The **Custom** option will enable the grid on the right of the dialog. This will allow the user to configure any Subject Input and/or Presentation even if it is not configured on a graph.

Data Range

The **Data Range** allows the selection of the specific section of data that will be converted. The **Visible range in this page** will only convert the data that is visible in the page. The **Visible range in this page till the end of the data** will convert the data from the beginning of the graph page all the way to the end of the data. The **All loaded data** option will convert all of the data loaded into the current Review session.

Output File

The **Output File** allows the user to specify the location where the file will be generated. The button to the right can be used to change the name and directory of the output file.

Listed below the **Output File** is an estimation of the file size of the ASCII file that will be generated based on the currently selected options.

Convert to ASCII

The **Convert to ASCII** button will convert the data based on the settings selected. The dialog will not close once a conversion is done. This allows the user to run multiple conversions without having to reopen the dialog. Clicking on the **Close** button will close the dialog.

Note: The **ASCII Output** dialog will change based on the location from where it is opened. If the dialog is opened from a graph page, all available options will be enabled. If the dialog is opened from the main Ponemah window, the only available selection within the **Channel/Presentation** section will be **Custom**. Also, only **All data and Parser Segments** will be available within the **Data Range** section. The **Parser Segments** option will only be available if data parser segments exist in the Review file.

APPLICATION CONFIGURATION

The **Application Configuration** allows the user to define the various settings for an **Experiment**. To access the Application Configuration, select **Setup | Application Configuration...** to display the **Configuration** dialog. Select a category from those listed in the column on the left-hand side of the dialog.

EXPERIMENT PATH

This allows the user to define the default location to which the Experiment Folder will be saved.

Configuration - Experiment Path

— Configuration — Experiment Path

Experiment Path
Miscellaneous
Email Alerts
Advanced
Review

Experiment Path:
C:\Ponemah_Data\

Experiment Defaults

Waveform Size Limit: 100 MB
 Waveform Time Limit: 24 Hours

Video Defaults

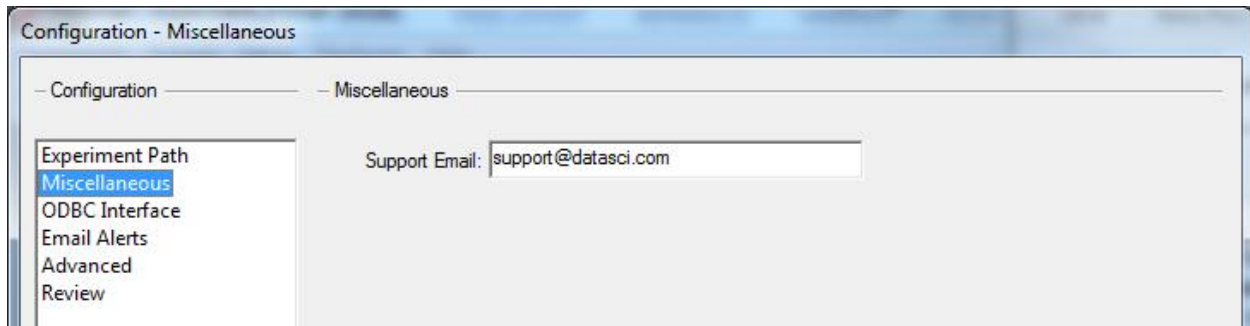
Video File Size Limit: 500 MB

OK Cancel

The **Experiment Defaults** and **Video Defaults** sections allow users to choose the limiting factor to determine the maximum file size for the Experiment. A new iterative data file will be created at which ever limit is reached first.

MISCELLANEOUS

The Miscellaneous configuration allows the default **DSI Technical Support** email account to be modified. This is the default account that system information will be mailed to when sending information from Ponemah such as **Product Information**.

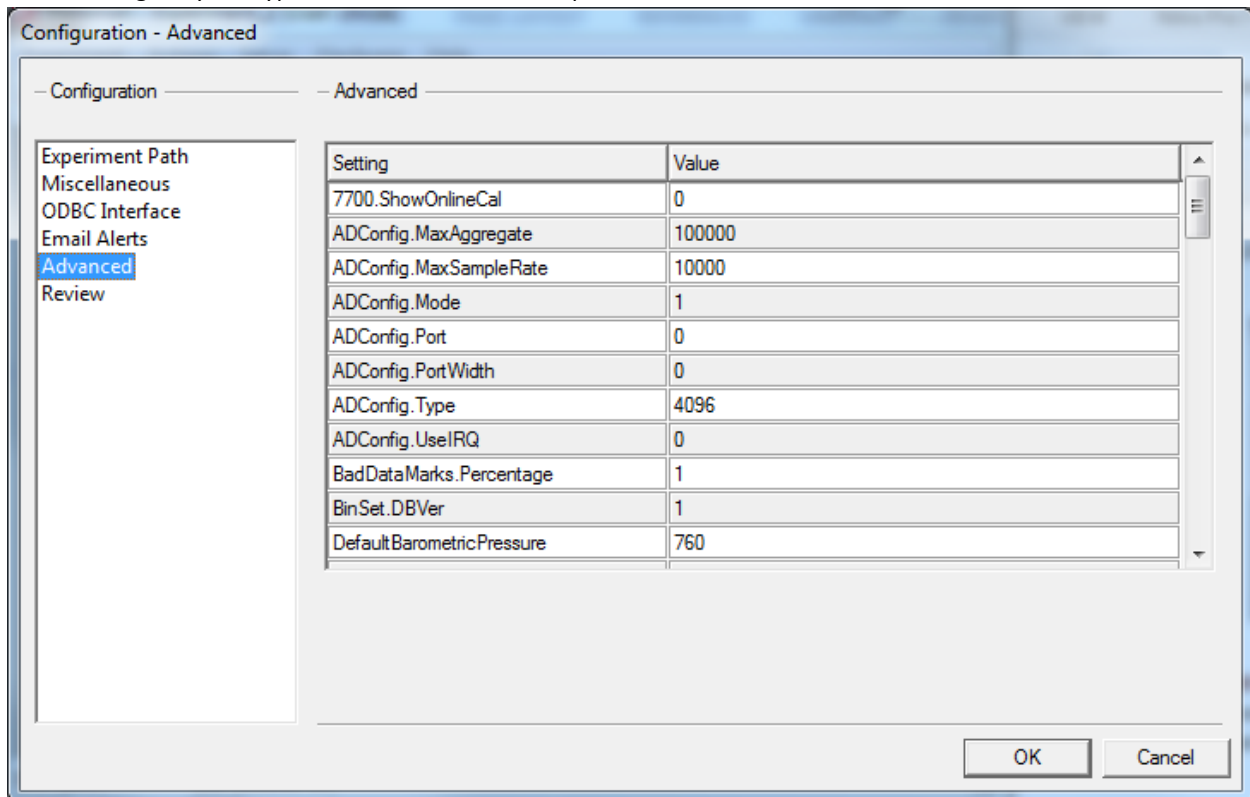


EMAIL ALERTS

See the *Remote Notifications – Email Alerts* section for information on what this feature provides and how it can be configured. Please note that the use of this feature is controlled by the **License File**.

ADVANCED

The **Advanced** configuration shows a list of the other tabs using an advanced configuration. These options should not be changed by the typical user with several exceptions.



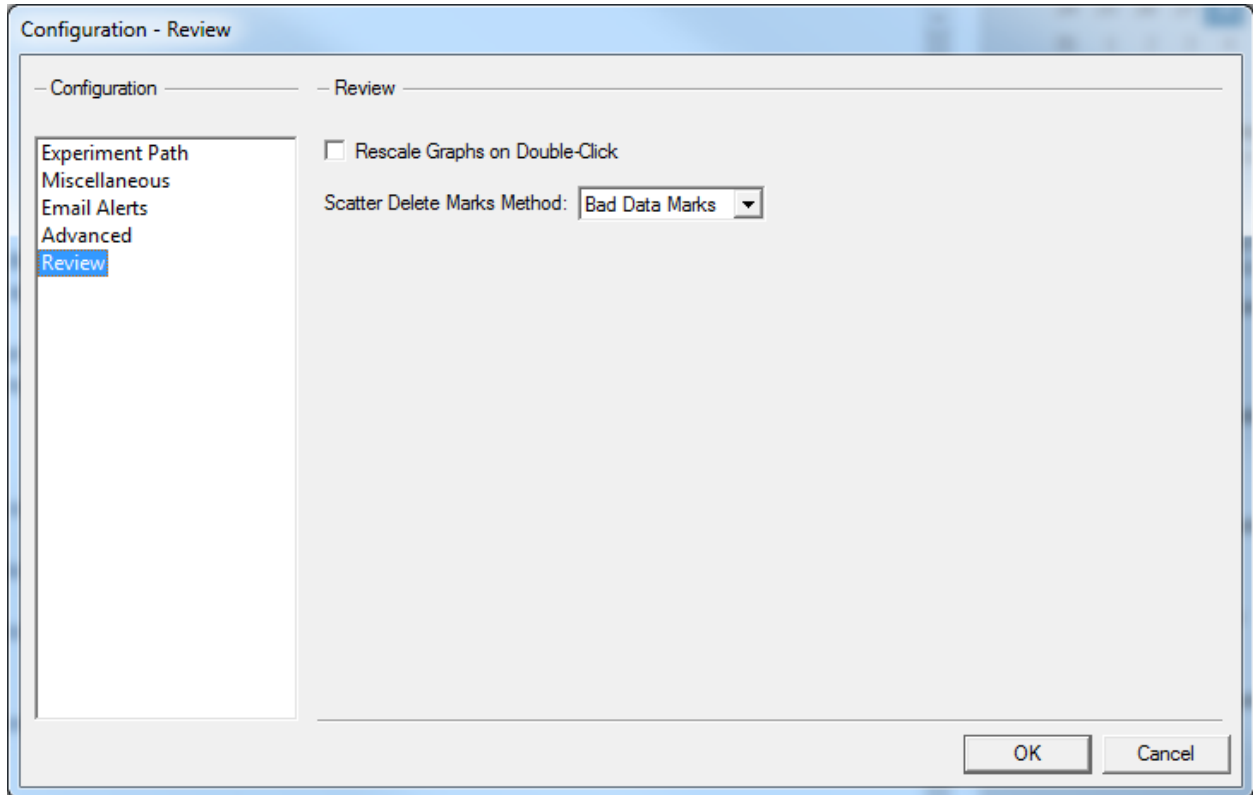
The **SystemMonitor.Processes.Level** allows the user to monitor system processes during acquisition. This feature helps to determine what processes are running during acquisition when issues occur such as buffer overflow errors. The default setting of 1 for the process logger will log processes that are running when an overflow occurs and place this information in the Application Log. The information will be logged in five second intervals for the previous two minutes prior to the overflow. If the setting is changed to 2, the system shall log any processes whose CPU usage exceeds a certain threshold as well as the information obtained with a setting of 1 and place this

information in a separate file with the file information, <dataset name>_ProcessLog.txt. A setting of 0 will not log any information.

BadDataMarks.Percentages will output the percentage of Bad Data Marks across channels in Review. The default setting is 1 which enables this feature. The setting is disabled when changed to 0. When enabled, a new menu item under Experiment called **BDM Percentage** will display a dialog with **Bad Data Mark** information. This information can be copied to clipboard and pasted into other documents.

REVIEW

The Review configuration allows the setup of various review based options.



Below is a basic description of the options.

- **Rescale Graphs on Double-Click** check box allows the user to enable or disable rescaling of the graphical data when double-clicking on the Derived list views or the Data Reduction list views in Review mode.
- The Scatter **Delete Marks Method** drop down list box has the options **Bad Data Marks** and **Delete Cycles**. The **Bad Data Marks** option inserts **Bad Data Marks** in the locations that were **lassoed** and the **Delete Cycles** option deletes the validation marks from the cycles that were **lassoed**.

TUTORIALS

The following sections provides examples of how to use certain Ponemah features to achieve an example goal.

GLUCOSE CALIBRATION PROCESS

OVERVIEW

It is necessary to perform an initial multi-point calibration and to collect periodic calibration points at least once, preferably twice, per week throughout the duration of a glucose study. Calibration data is collected using blood samples from the tail or other appropriate sampling point with analysis performed by the StatStrip Xpress glucose meter or an equivalent analytical method. Calibration reference points should always be collected while the Ponemah Acquisition program is actively collecting data, and ideally, while the Subject is on or within range of the telemetry receiver (typically within about 25 cm of the receiver).

PURPOSE

The purpose of this tutorial is to step you through some of Ponemah's basic glucose analysis functions to familiarize yourself with DSI's HD-XG glucose calibration process.

This tutorial assumes you have:

- Created an Experiment.
- Configured PhysioTel HD hardware.
- Added the HD-XG implants to your hardware configuration.
- Created Subjects.

WHAT YOU WILL BE LEARNING

The following processes will be outlined in the order they are recommended to be performed:

1. Graph setup
2. Verify you are getting a signal from the implant.
3. Enter glucose calibration data into the Ponemah software system.
4. View your glucose tolerance test (GTT) results, graphs, and calibrations for a multi-point calibration
5. Maintain the accuracy of your glucose signal using single-point calibrations

When you've finished the tutorial and complete your initial glucose calibration, you will be able to do the following:

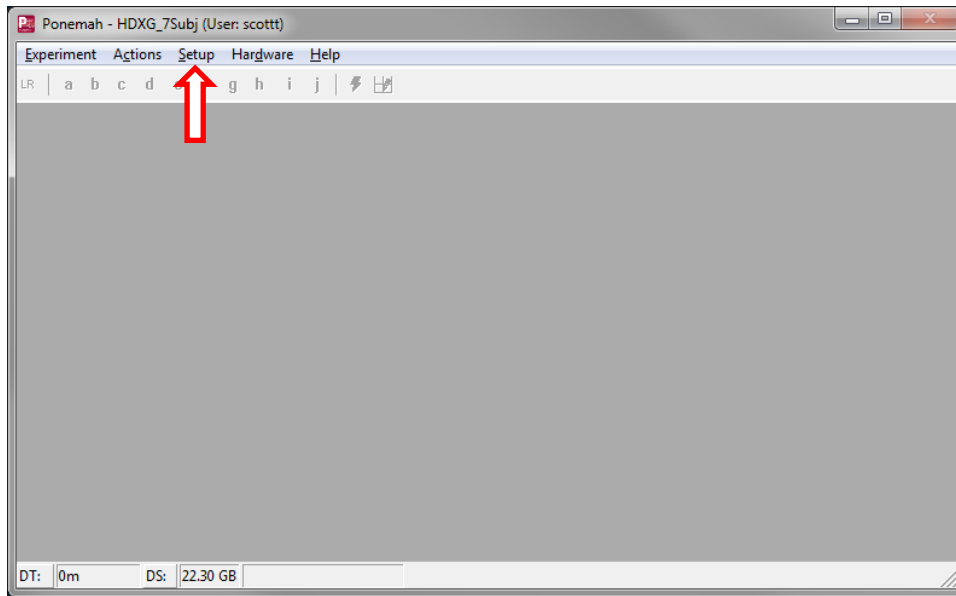
- Run your own GTTs.
- Start collecting data from multiple Subjects.
- View your test subjects' dose response curves.

GRAPH SETUP

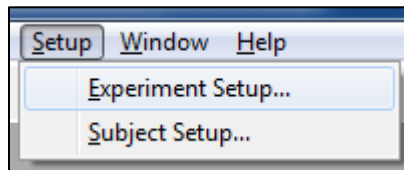
Let's begin by setting up the graph pages to ensure we can view the HD-XG signal over a span of at least 1 hour. This will provide enough data to view the OGTT.

To do this, configure a graph page and start an Acquisition.

1. From the Ponemah main window, select the **Setup** menu.

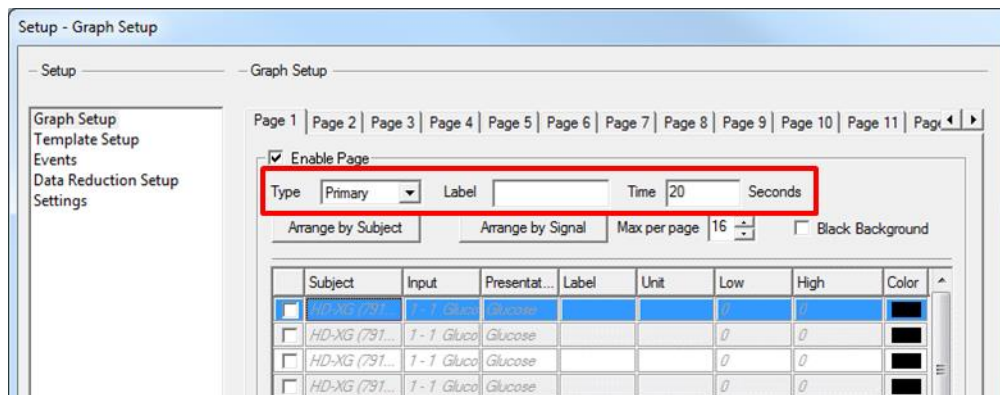


2. Select **Experiment Setup...** from the dropdown menu.



3. Select **Graph Setup**.
4. Click **Arrange by Subjects** to create a separate **Primary** graph for each **Subject** within the **Experiment** to display the raw waveform signal from the implant.

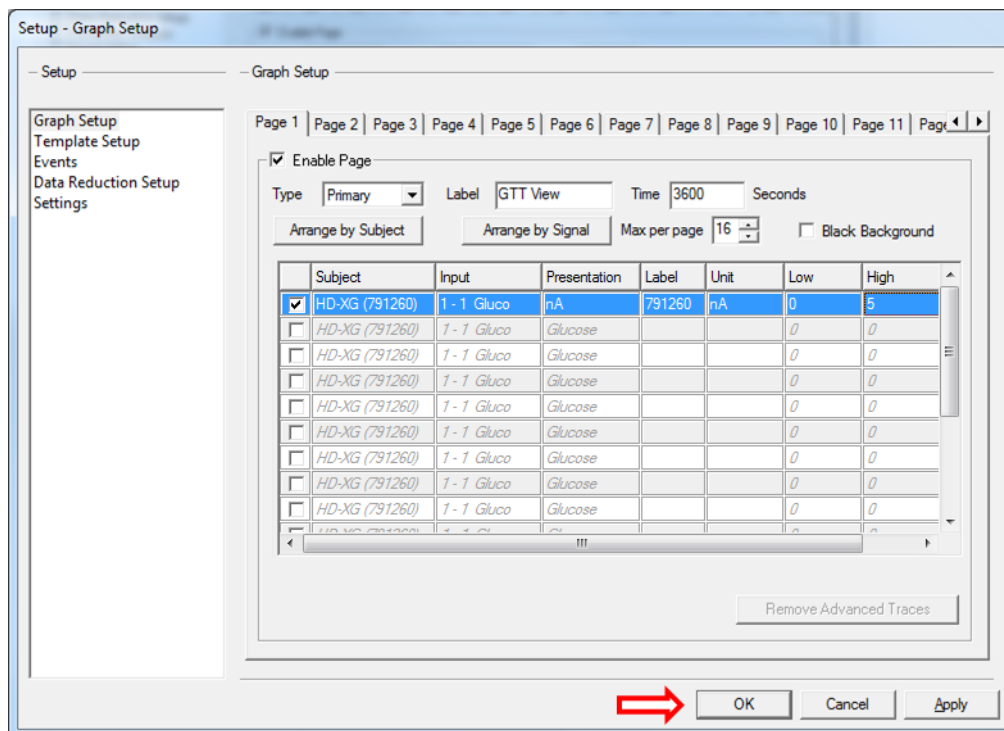
Note: If using more than 16 Subjects, each graph page with contain multiple Subjects; e.g. 2 Subjects per page for and Experiment configured with 32 Subjects.



5. Click the appropriate **Page** tab associated with the name of your **Subject**.
6. Locate the **Time** entry box and enter in the length you expect your OGTT to last in **seconds**. For example, if your OGTT will last one hour, enter a time interval of 3,600 seconds (1 hours x 60 minutes x 60 seconds).
7. Update the graph page setup's **Presentation** signal dropdown menu to ensure the page displays Subject's **nA Presentation** signal.
8. Ensure the **Low** and **High** units are set to **0** and **5**, respectively; update if necessary.

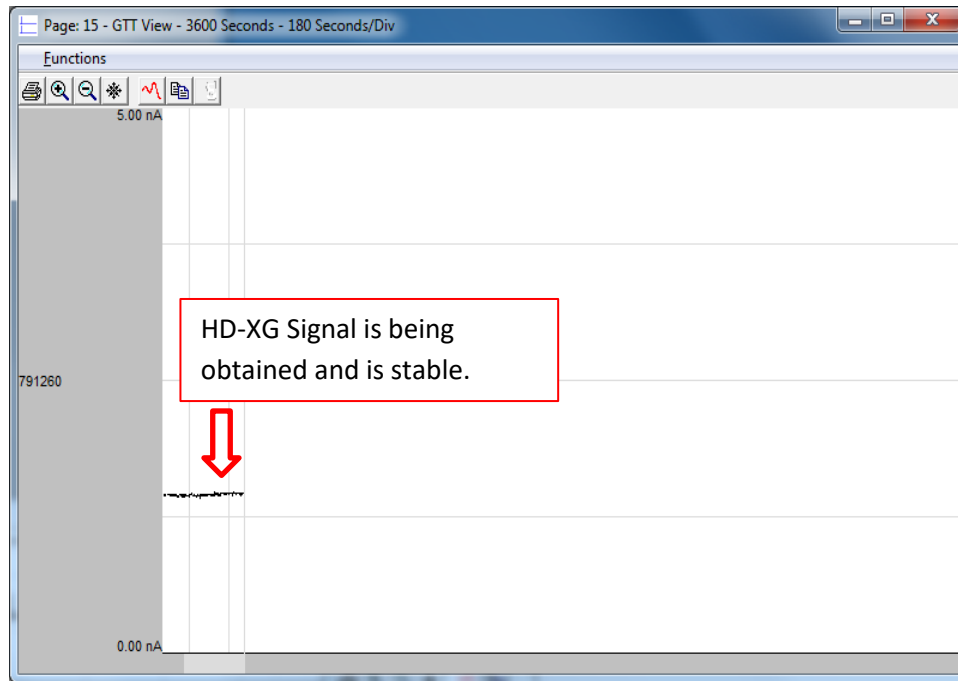
Note: As a general rule, these starting values (0–5 nA) provide a good amplitude range for most glucose studies. If your subjects are very hyperglycemic, you may need a larger **High** value.

9. Select **OK** to close the **Experiment Setup** dialog.



10. Start Acquisition for the Subject(s) of interest by selecting **Actions | Start Sampling | Continuous - Selected** from the **main Ponemah** dialog.

11. Ponemah will display the graphs you just created. After a few minutes you will start to see data appear. After approximately five minutes the implant-signal graph should look something like this:



NEXT STEP

Now that you know you are receiving a good, stable signal, the next step in the process is to perform the initial glucose calibration for each Subject.

PERFORMING A MULTI-POINT GLUCOSE CALIBRATION

In this section, the initial glucose calibration procedure is described. For the first calibration of your HD-XG implant, a Multi-point calibration is required. DSI recommends using an Oral Glucose Tolerance Test (OGTT) for a successful Multi-point calibration; however, an Intraperitoneal Glucose Tolerance Test (IPGTT) may also be used. The following describes performing an OGTT on a group of subjects and *simultaneously* entering the blood-glucose values obtained from the glucose reference into the Ponemah software. DSI recommends that at least two people are involved in the calibration process.

PERSON 1 OVERVIEW

Manages the subjects, collects the samples, and reports the measurements.

- Take a pre-dose (fasted) blood glucose reading and inform Person 2 of the values and time of blood draw.
- Administers the glucose challenge dose orally or intraperitoneally.
- Wait until Person 2 informs them it is time for a second reading.
- Take a post-peak blood glucose reading and inform person 2 of the values and time of blood draw.
- Wait for additional times to draw blood, if applicable and inform Person 2 of the values and time of the blood draw.

PERSON 2 OVERVIEW

Manages recording the calibration reference values within Ponemah and provides direction on the appropriate sample times. Person 2's responsibilities are explored in more detail in the following section, but at a high level consist of the following:

- Enters the calibration references values obtained from the glucose reference device into the dialog for the appropriate time.
- Monitors the implant signal to identify the peak of the OGTT response curve.
- Informs person 1 to take another blood sample 3-5 minutes following peak
- Enters the second set of calibration references values obtained from the glucose reference device.
- Calls out additional blood-draw times, if applicable.

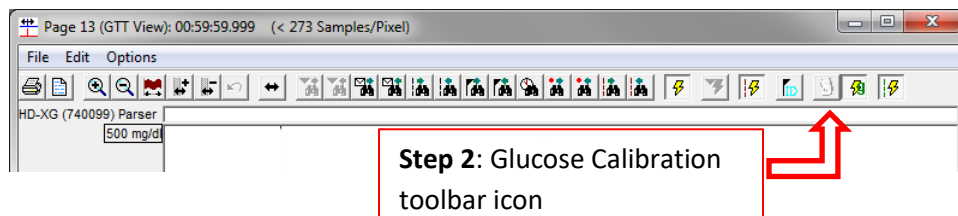
ENTERING BLOOD GLUCOSE READINGS INTO PONEMAH DURING OGTT

Person 2 will enter the blood glucose readings obtained by the glucose reference device into Ponemah and Calibration Reference Values. Doing this will convert the nA signal obtained by the HD-XG into meaningful physiologic values. The software will then calculate and graphically display each Subjects' OGTT-response curves in the user defined units (mg/dL or mmol/L).

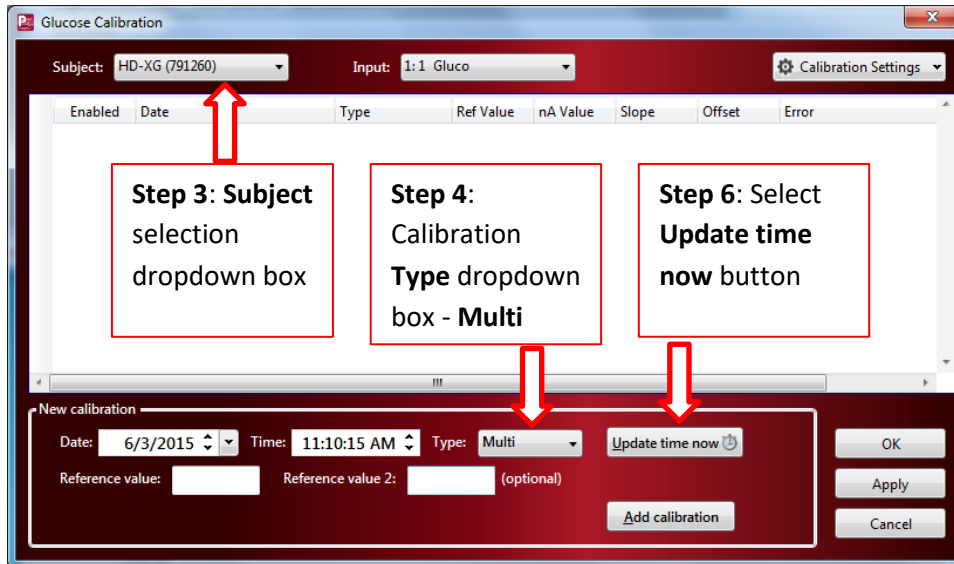
Note: The preferred method for creating calibration data files is to directly enter the calibration data into the Ponemah software interface. Calibration files can also be created offline by entering the values in a spreadsheet using a prescribed format compatible Ponemah program. See the **Import/Export Calibration Data** located within the **Glucose Analysis Module** section of this manual.

To begin Person 2 will:

1. Start the acquisition for the Subjects that will be given the OGTT.
2. Verify that a stable glucose signal is being obtained from the Subjects.
3. From the **Primary** graph page of **Subject 1**, select the **Glucose Calibration toolbar icon** to display its dialog.



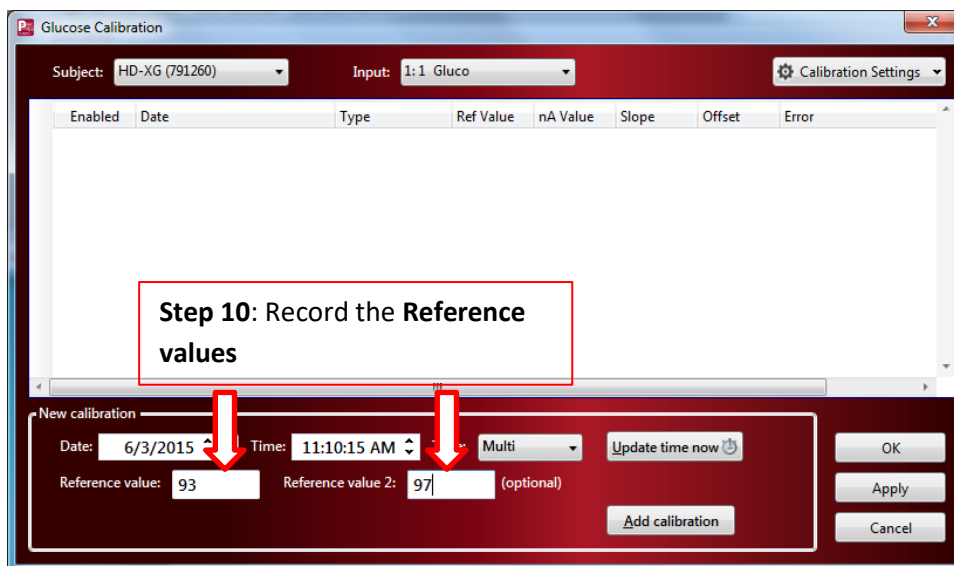
- Using the **Subject** dropdown box, select the **Subject** whose blood sample will be taken first.



- Using the **Type** dropdown box, select the glucose reference **Type** as **Multi**.
- Instruct **Person 1** to draw a blood sample and inform you when it has been taken.
- When informed, select the **Update time now** button. This will put the correct **Date** and **Time** in the associated fields for exactly when the sample was taken.
- Obtain 2 blood glucose readings measured by the glucose reference device from **Person 1**.

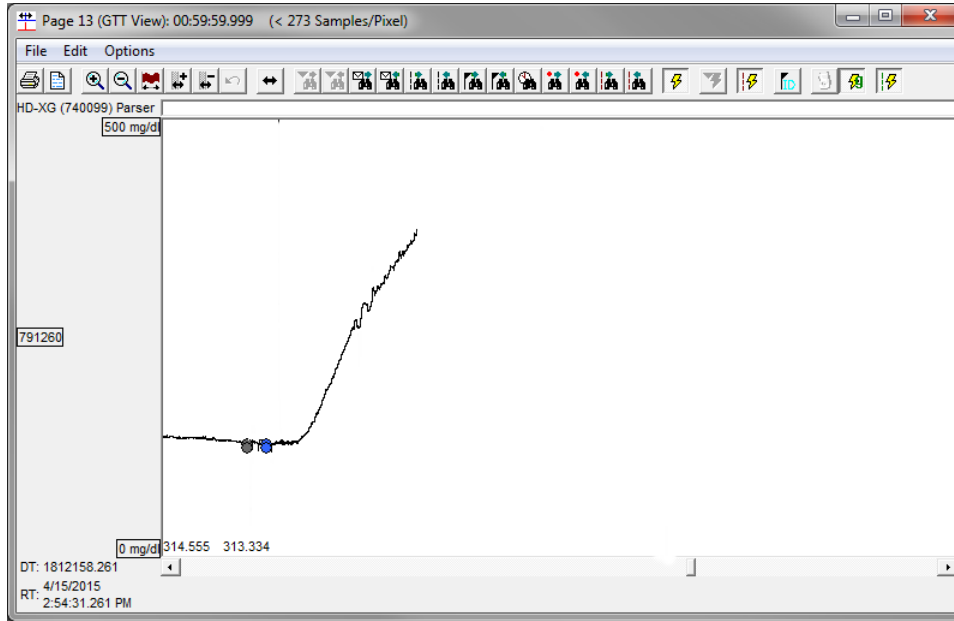
Note: Use of duplicate samples is highly recommended at each calibration time point. If duplicate samples differ by more than 10%, a third sample is recommended. Use only the two closest samples as your **Reference Values**.

- Record the reference values into the **Glucose Calibration** dialog's **Reference value** and **Reference value 2** fields.

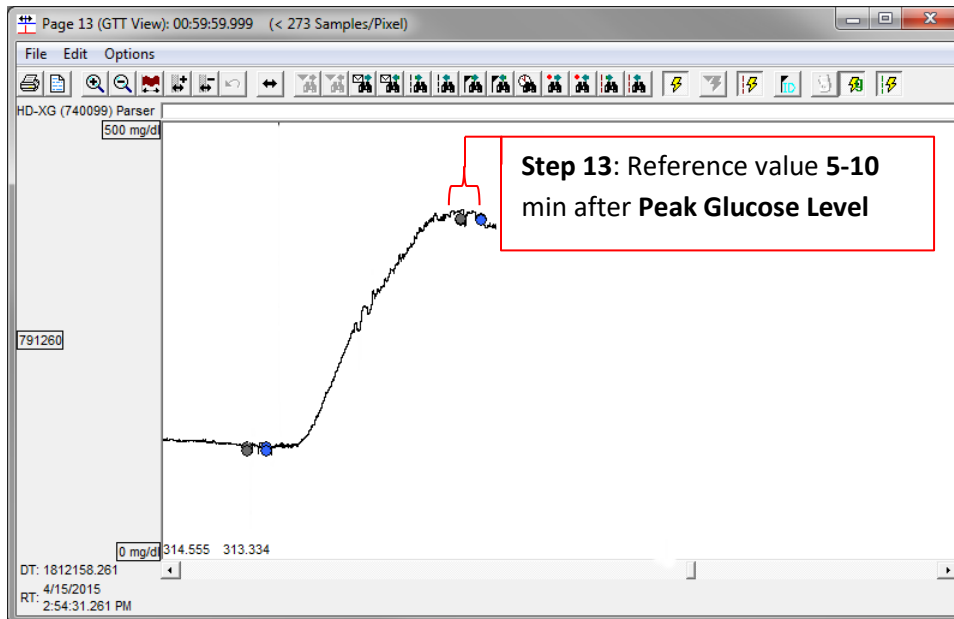


- Select the next **Subject** using the **Subject** dropdown box.
- Repeat steps 6-9 for each subsequent **Subject**.

The Primary graphs should look similar to the following:



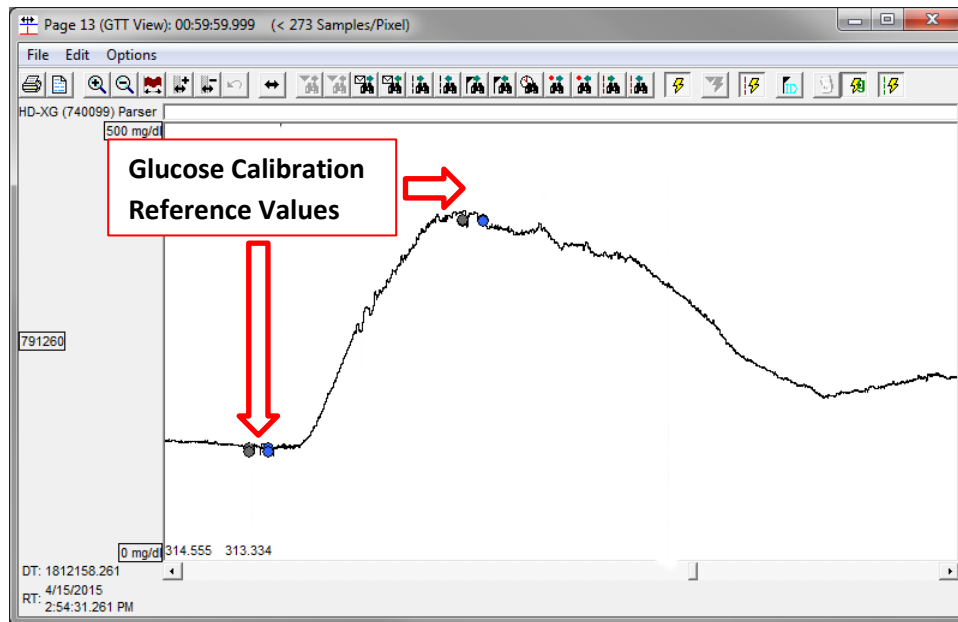
12. Instruct **Person 1** to dose the Subject. For normal, healthy rodents, administering 3-6 g dextrose/kg will increase the blood glucose level by at least 200 mg/dL (11 mmol/L).
13. Once all OGTT have been administered, monitor the **Subjects' Primary** graphs for the **Peak Glucose Level**. **Peak Glucose Levels** will typically occur **12-16 minutes post-dose** during an OGTT in a healthy rodent.
14. Approximately 3-5 minutes after the glucose level peaks or begins to plateau, instruct **Person 1** to draw blood samples again. The Primary graphs should look like the following:



15. Repeat steps 6-9 for each subsequent **Subject**, ensuring you are allowing for the 3 to 5 minute time delay from **Peak Glucose Level** prior to taking the blood glucose readings

This completes the **Multi-point** glucose calibration procedure. The following displays the resultant **Primary** graph of a **Subject** that has completed an OGTT, along with its associated **Multi-point calibration** reference values. To learn

more about Glucose Calibration, please see the **Best Practices** and **Considerations & Alternatives** sections of this manual.

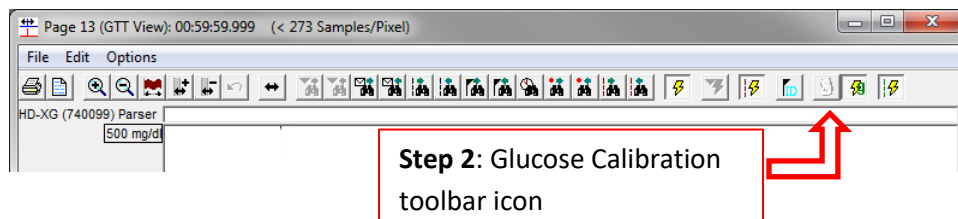


PERFORMING A SINGLE-POINT GLUCOSE CALIBRATION

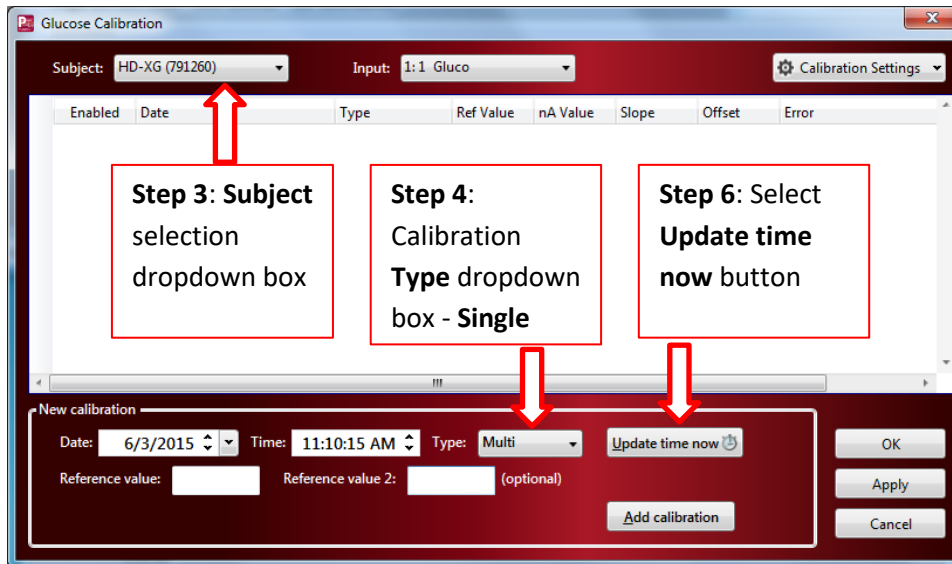
After the initial **Multi-point** calibration process, DSI recommends performing **Single-point** calibrations at least twice per week at the same time of day and during a time period when the Subject's blood glucose is relatively stable.

To perform a **Single-point** calibration while acquiring data:

1. Verify that a stable glucose signal is being obtained from the Subjects.
2. From the **Primary** graph page of **Subject 1**, select the **Glucose Calibration toolbar icon** to display its dialog.



3. Using the **Subject** dropdown box, select the **Subject** whose blood sample will be taken first.



4. Using the **Type** dropdown box, select the glucose reference **Type** as **Single**.
5. Instruct **Person 1** to draw a blood sample and inform you when it has been taken.
6. When informed, select the **Update time now** button. This will put the correct **Date** and **Time** in the associated fields for exactly when the sample was taken.
7. Repeat these step for each subsequent **Subject**.

FINDING SECOND DEGREE AV BLOCK

BACKGROUND

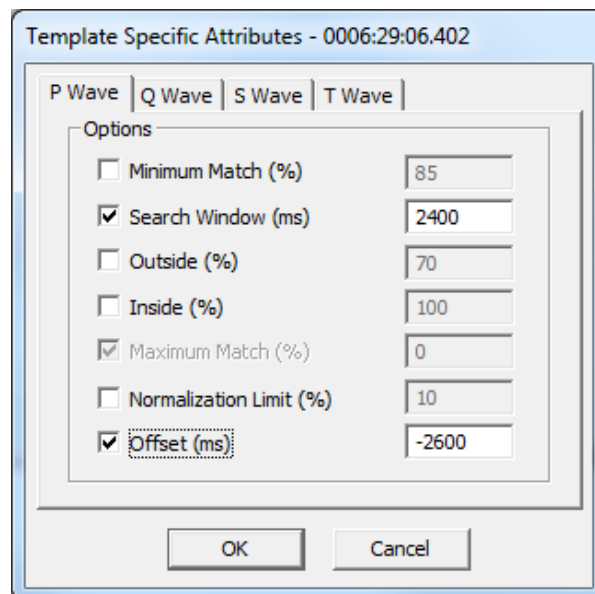
To locate and mark instances of Second Degree AV Block (isolated P waves), a new concept has been introduced in ECG PRO called Template Specific Attributes. Ponemah uses these attributes to mark an isolated P wave by shifting the marks from valid P wave to the isolated P wave. Data Insights can then be used to search for instances of abnormally large PR intervals to find isolated P waves.

This approach is needed as Ponemah will currently only mark one P wave per ECG cycle. When an isolated P is present in the signal, Ponemah is required to choose which P to mark. When using the attribute-based ECG analysis or ECG PRO analysis with standard settings, Ponemah will mark the P wave associated with QRS complex. Isolated P wave will be passed over since they are not directly associated with a valid ECG cycle.

UNDERSTANDING TEMPLATE SPECIFIC ATTRIBUTES

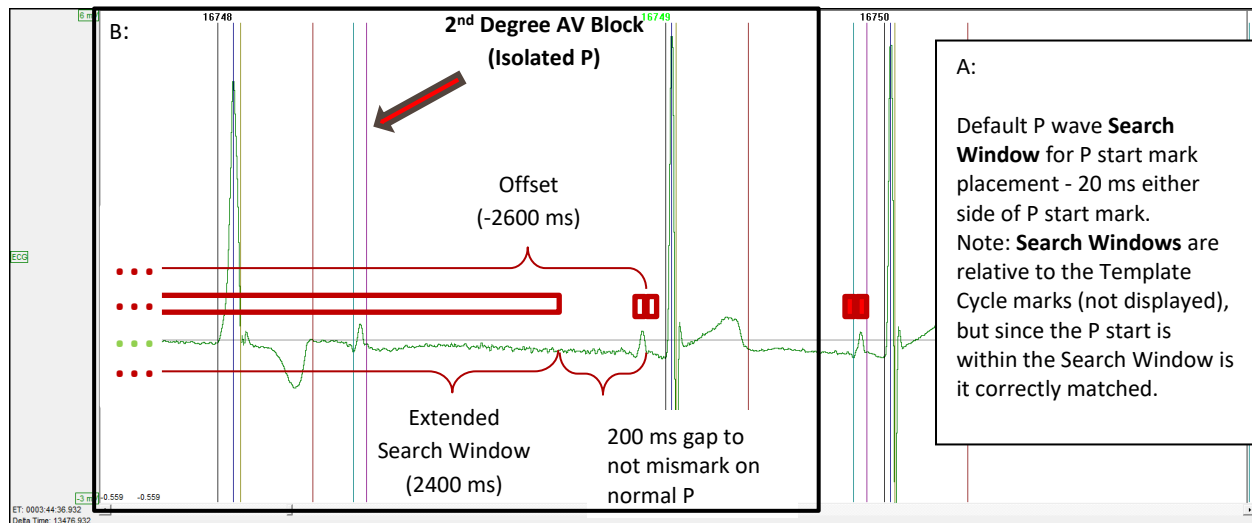
When locating instances of Second Degree AV Block (isolated P waves), normal P waves will need to be temporarily ignored. The P marks are instead placed on one of the isolated P waves without affecting the mark placement of surrounding cycles' Q, R, S, and T waves. This is achieved using Template Specific Attributes to shift and extend the P match Search Region past the normal P wave to an area where the isolated P wave is expected to exist.

To do this, the P wave **Search Window** and **Offset** attributes within the **Template Specific Attributes dialog** need to be enabled. These are defaulted to appropriate durations for an initial search for isolated Ps, but may be augmented based on your data, if necessary.



Note: The **Search Window** and **Offset** attributes are species specific. Values displayed in the example screenshot (right) are for **Dog** and **Monkey**.

To better understand how Template Specific Attributes work, it is important to understand how the **Search Window** and **Offset** Template attributes work under normal conditions. The **Search Window** is the time range over which Template Analysis searches for the best match and is centered on the mark trying to be matched; e.g. P Start mark. The **Offset** attribute then shifts the **Search Window** center point by the time in milliseconds (ms) entered in the associated text field. The images below illustrates the typical ECG PRO Search Window case (A) and how these attributes are applied when updated for isolated P wave searches (B) visually.



In B, the **Search Window** extends past the data being displayed on the graph. The R wave of the previous cycle acts as a hard cutoff for the **Search Window**. This algorithm has additional logic built in to prevent ECG PRO from marking the T wave of the previous cycle as the isolated P wave.

Note: Template Specific Attributes are available for all Search Regions, however the current use case is for isolated P waves.

PROCESS

ECG PRO's Template Specific Attributes provide the user a mechanism to override the global/general ECG PRO Match attributes (Match % and Advanced Setup) for one or more of the Templates within the Template Library, while keeping the global/general Match attributes for the remaining Templates.

The process to find instances of Second Degree AV Block (isolated P waves) is:

1. Run ECG Attribute based analysis with ECG analysis module
2. Use ECG PRO to accurately mark the ECG cycles' Q and S waves
(Optional: Required to identify Ventricular and Junctional beats)
3. Use ECG PRO to accurately mark the ECG cycles' P wave
4. Save Marks Section
(Saving at this time will save the derived data and mark placement prior to shifting the P marks to the isolated P waves for a more accurate representation of the interval-base analysis. See Derived Output Impact section below for more details.)
5. Choose one or more of the Template Cycles used for P wave mark placement for use with Template Specific Attributes.

- a. Template Cycles with the largest match percentage should be used.
 - b. Enable the **Search Window** and **Offset** attributes. DSI recommends starting with the default values.
6. Execute ECG PRO, enabling only the P wave Match Region.
 7. Use Data Insights to find and report on instances of AV Block.

DATA OUTPUT IMPACT

Using ECG PRO Template Specific Attributes may impact your Derived Output. This is due to the shifting of the P wave marks from the ECG cycles associated P wave to the isolated P wave, as this will result in an abnormally large PR interval being calculated for that cycle. This will be averaged into the Log Line averages reported to the Derived Parameter and Data Reduction List Views (spreadsheets).

If only a few isolated P waves exist, then the large PR intervals will not have much of an effect on the derived parameters (based on species and logging rate). However, if a large number of these exist in the data set or are clustered together, the reported PR interval in the Derived Data and Data Reduction List Views will be misrepresented. It is recommended to Save a Mark Section prior to using ECG PRO to search and report on Second Degree AV Block. Once your Second Degree AV Block search is complete, the Template Specific Attributes can be disabled and P wave Match Template analysis can be re-run to return to a state where the normal P waves are marked and reported appropriately.

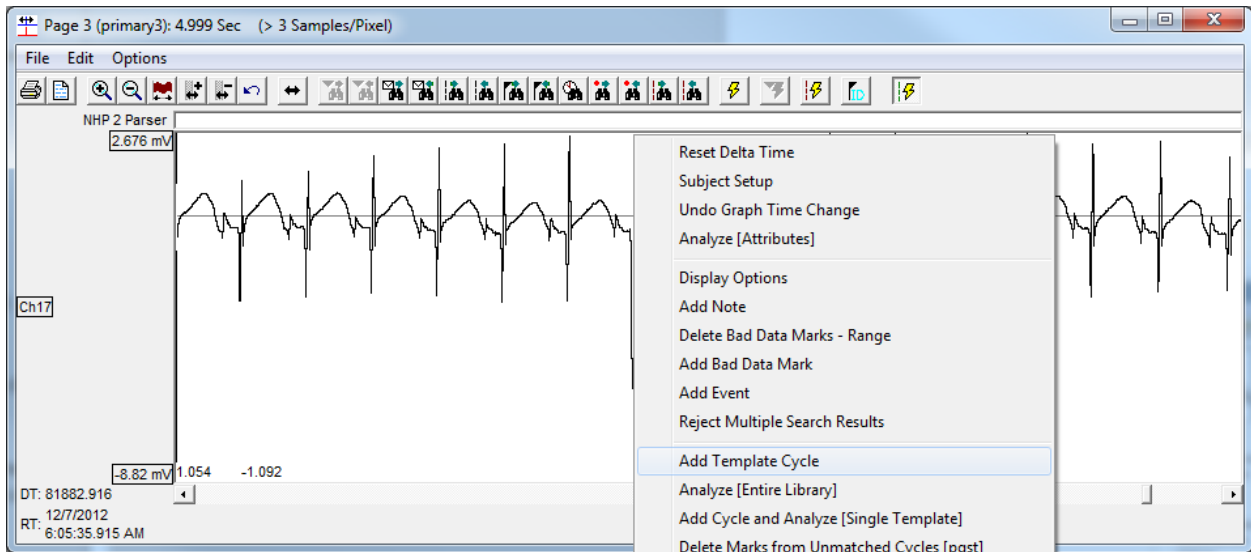
If you should have any questions, please contact DSI Technical Support.

FINDING UNIQUE CYCLE MORPHOLOGIES USING TEMPLATE TAGS

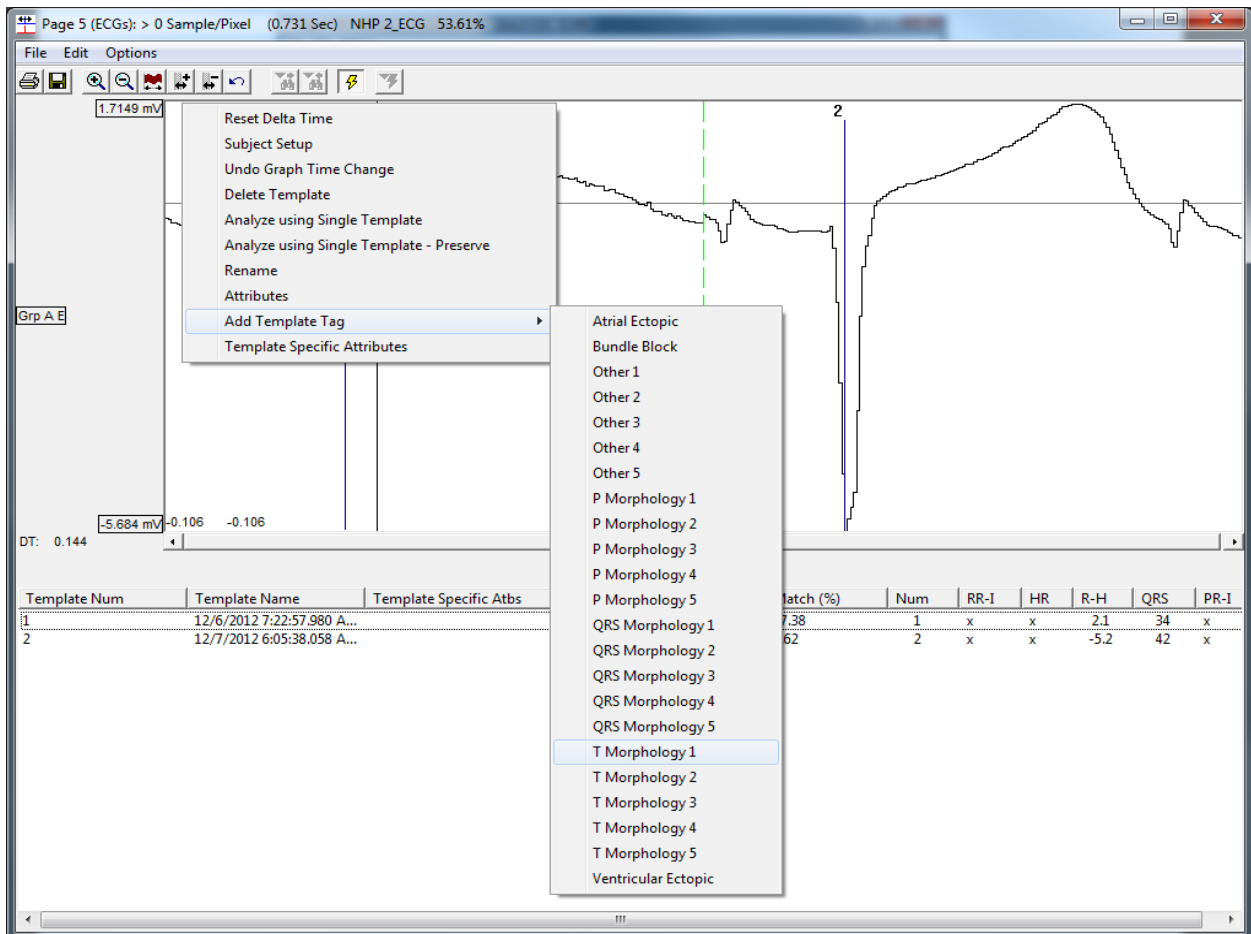
ECG PRO allows **Tags** to be applied to Template cycles when saved to the Template library. Tags allow identification of specific cycle morphologies. By associating Tags to specific cycles, Data Insights can be used to quantify these Tagged cycles. This is useful in instances where count or other derived parameters are desired that are not included in the analysis module's derived parameter list. Tags can also be used to exclude certain morphologies from analysis. By Tagging unwanted morphologies, Searches can be constructed to eliminate these cycles from analysis. Once the desired results have been obtained, use the Report feature to obtain an output file.

To add Template Tags and create a Data Insights Search to locate Tagged cycles:

1. Select a cycle of interest from the **Primary Graph** page and add this to the **Template Graph** page by right-clicking the cycle and selecting **Add Template Cycle**.

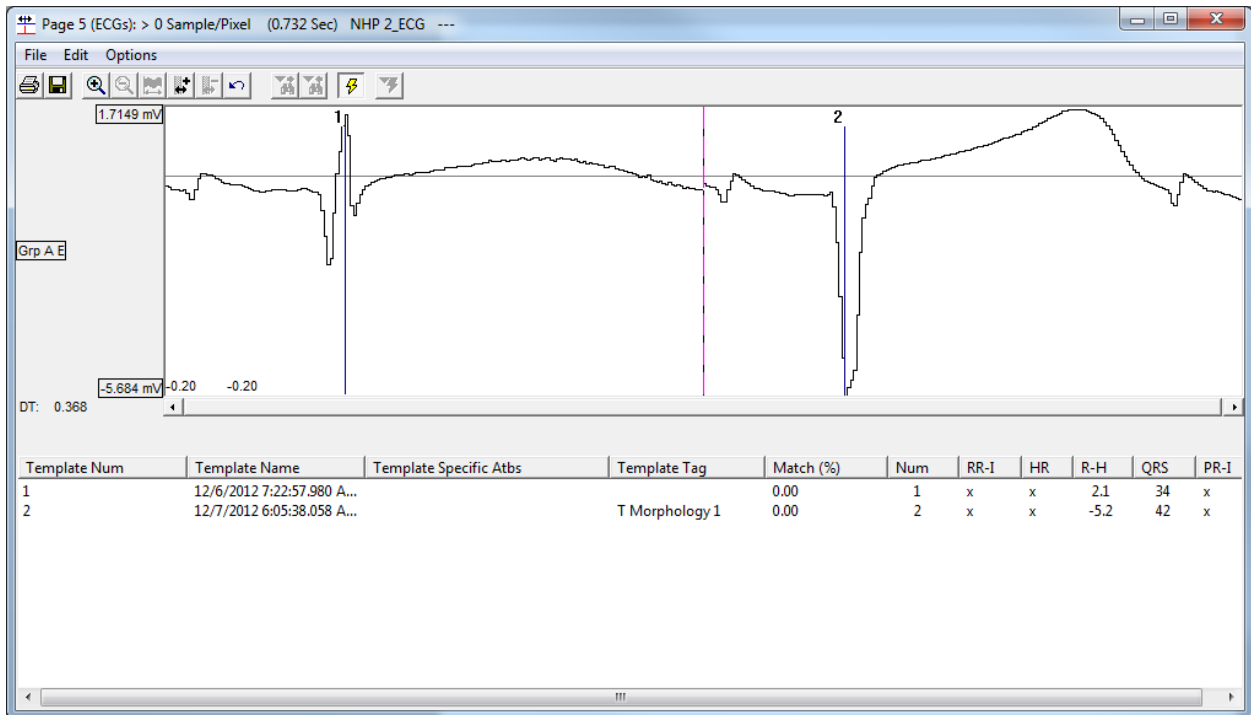


2. Within the **Template Graph** page, right-click and select **Add Template Tag**. Select one of the predefined Tags to mark the cycle and associated Matches, for example T Morphology 1.

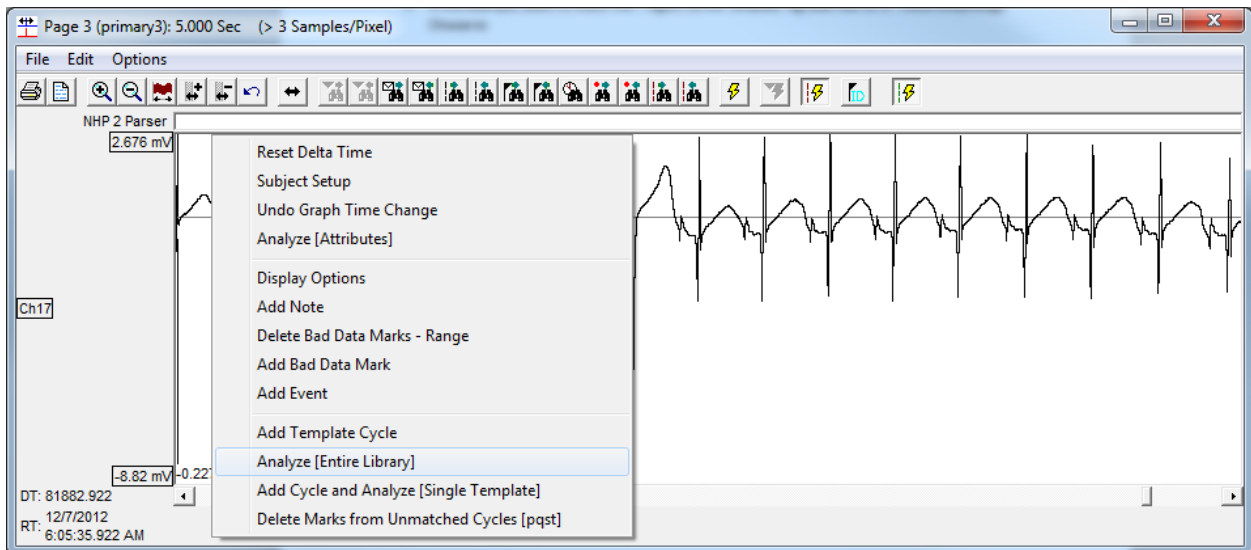


The Tag will be listed under the Template Tag column with its associated Template cycle row within the Template Graph List View.

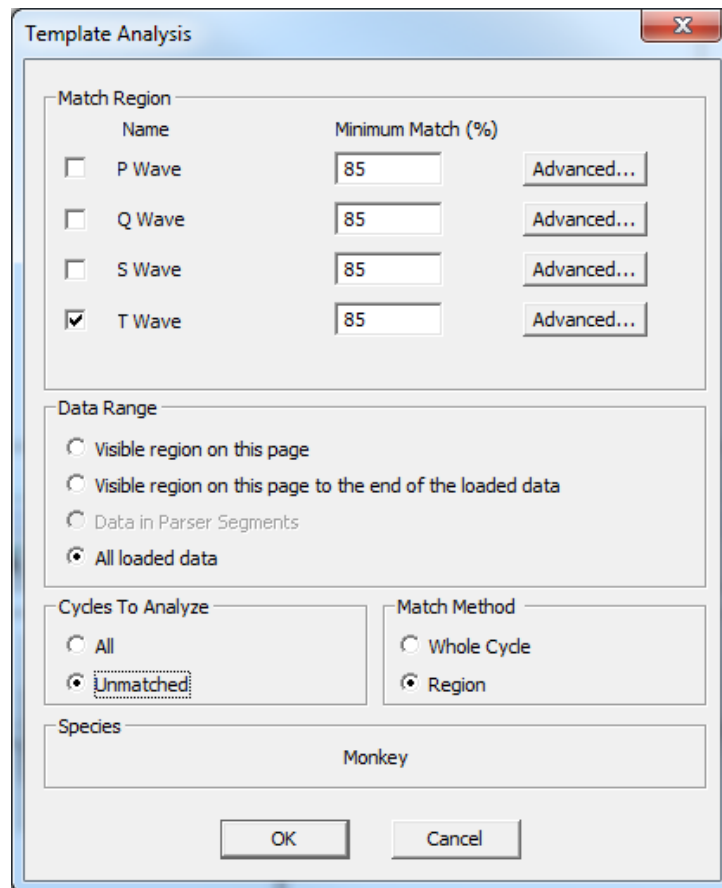
Note: Multiple Tags may be associated with a single Template cycle.



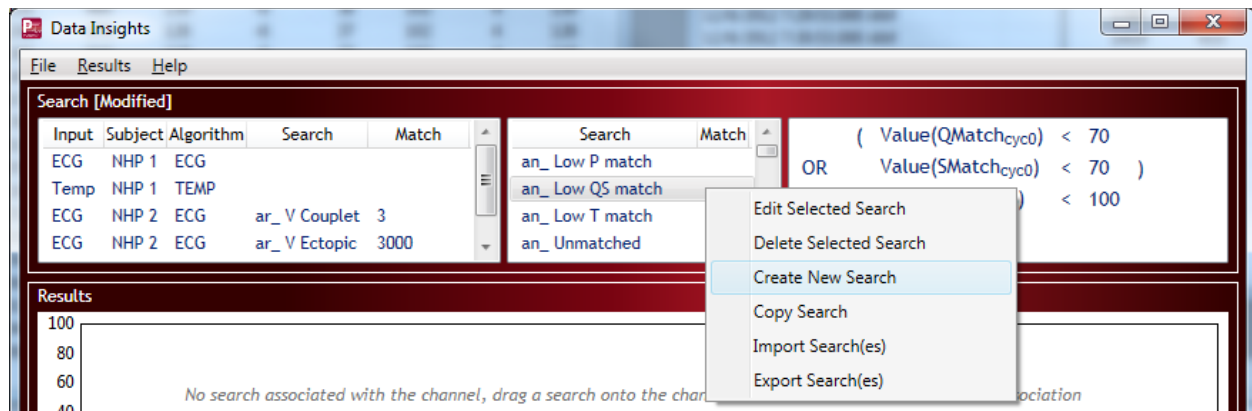
- Execute the **Template Analysis** from the **Primary Graph** page by right-clicking the ECG signal and selecting **Analyze [Entire Library]**.



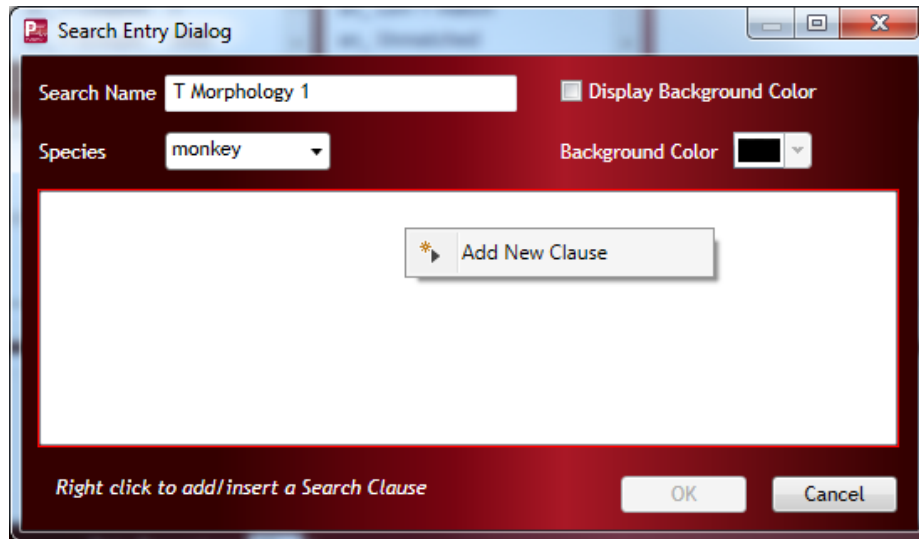
- In this example, select **T Wave** as the *Match Region*, as the Template Tag used was for a T wave Morphology. Use the default 85% *Minimum Match (%)*. Choose **All loaded data** as the *Data Range*, select **Unmatched** for *Cycles to Analyze*, and **Region** for *Match Method*. Then, click **OK**.



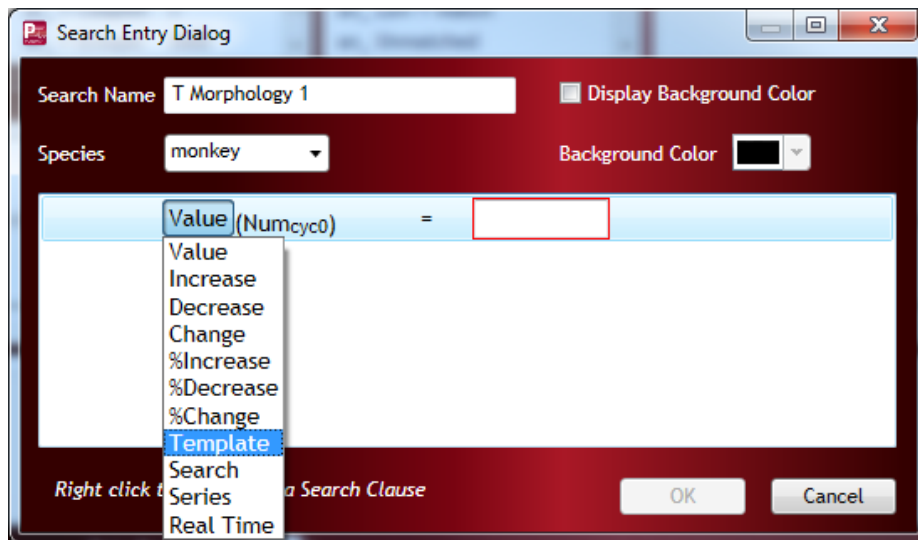
5. Repeat Steps 1-4 for all cycle types of interest.
6. Launch **Data Insights** from the **Experiment** menu.
7. Right-click the **Search and Match Grid** and choose **Create New Search**.



8. Within the *Search Entry* dialog, enter a unique **Search Name**.
9. Right-click within the large white area and select **Add New Clause**.

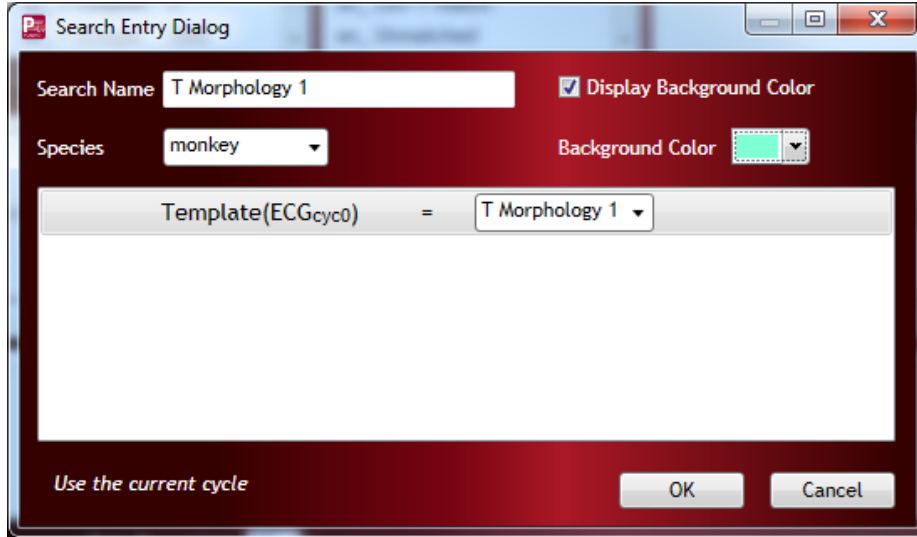


10. Left-click the Value function and select Template.

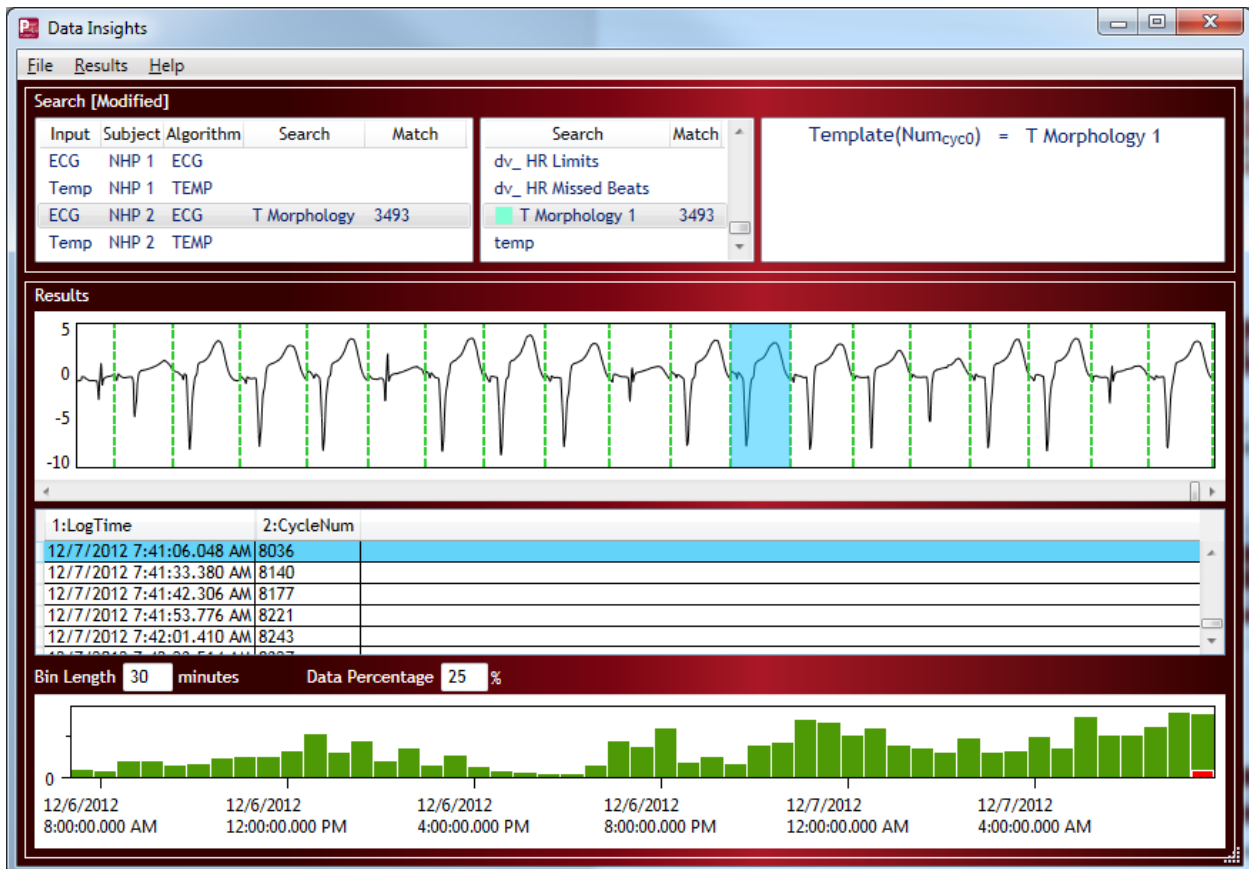


11. Select the Input dropdown and choose the appropriate Template Tag used; e.g. T Morphology 1.
Optional: Check the **Display Background Color** and choose a light shaded **Background Color** to more easily identify match results from the **Primary Graph** page.

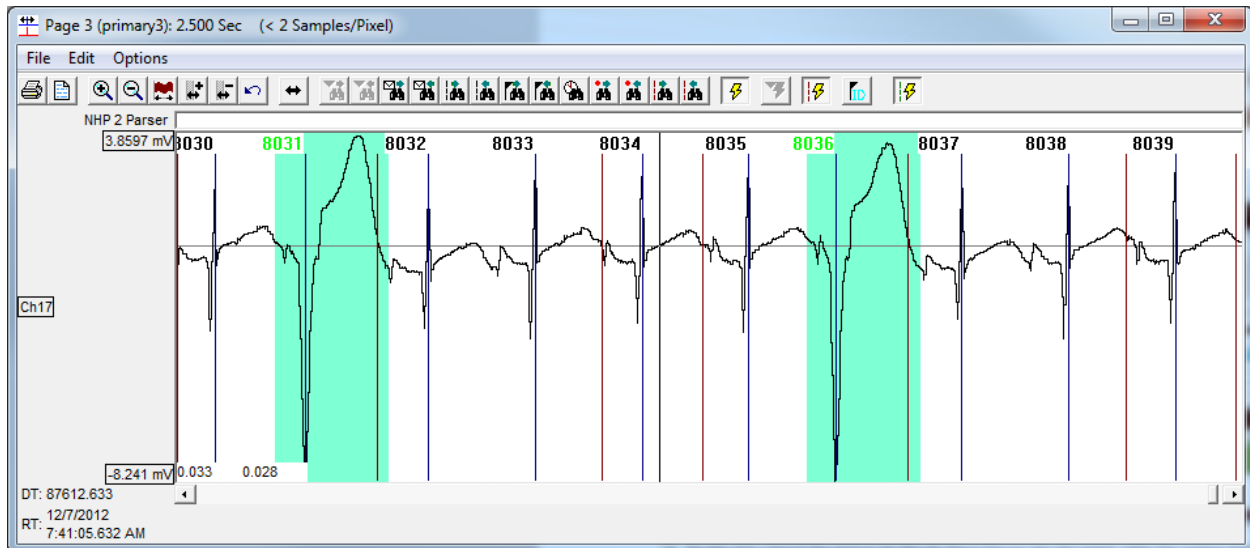
12. Click **OK**.



13. Drag-and-drop the new Search onto the appropriate channel within the **Channel/Search Pair Grid** to execute the Search.



14. Double-click a Search Result from the Results Wave View to view the match within the context of the waveform amongst adjacent beats.



15. Use the Data Insight dialog to review match results. Reject matches if necessary; e.g. the morphology of the cycle is not a close enough match based on desire.
16. Once match results have been reviewed, generate a **Report** via the **File** menu.

RETURNING PRODUCTS TO DSI

If you need to return a product to DSI, here's what you need to do.

A detailed updated procedure for properly returning telemetry products to DSI for failure analysis is provided on our website at www.datasci.com. The following additional considerations should be made:

- To be covered under the manufacturer's warranty, the implants must be returned for exchange within the warranty period (listed in the implant specifications).
- Ensure that the implants are well packed, preferably in their original packaging and boxes.
- Return the implants via a traceable shipping method to prevent losses in transit.

Contact DSI Technical Services with any concerns or comments regarding the performance of the devices upon receipt and after the first use.

Two forms are available that can be requested from customer service (CustomerService@datasci.com) or technical support (Support@datasci.com):

- 001465-001: DSI Exchange Form USA
- 001549-001: DSI Exchange Form Europe
- 004540-001: DSI Exchange Form International
- Product Investigation Form (PIF)—printed email sent from Customer Service.

CONTACTING TECHNICAL SUPPORT

DSI™ is available to help you with your questions and concerns. Should you hit a road block or need some additional training, please feel free to contact us. We are happy to help!

DSI SUPPORT CENTER

DSI provides easy access to the following self-help tools when they are need most:

Please visit support.datasci.com to access the following resources:

- Quick start guides and videos
- User Manuals
- Technical Notes
- Troubleshooting guides
- The latest software and firmware downloads



CONTACT DETAILS

DSI TECHNICAL SUPPORT—NORTH AMERICA

Email: Support@datasci.com

Toll-free in U.S. and Canada

Phone: 1-800-262-9687

Monday through Friday: 8 AM to 5 PM CST
(except Holidays)

DSI TECHNICAL SUPPORT—EUROPE

Email: Europe-support@datasci.com

Phone: +44 1359 259400

Monday through Friday: 8 AM to 5 PM CET

DSI TECHNICAL SUPPORT—ALL OTHER COUNTRIES

Phone: +1-651-481-7400