DSI™
An Affiliate of Harvard Bioscience, Inc.

Implantable Telemetry System

USER MANUAL

007678-010 Rev 01

Table of Contents

Compliance Statement

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

ISED RSS-Gen Notice

This device complies with Industry Canada's licence-exempt RSSs. Operation is subject to the following two conditions:

1. This device may not cause interference; and
2. This device must accept any interference, including interference that may cause undesired operation of the device."

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

1. l'appareil ne doit pas produire de brouillage;
2. l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement."

SoHo Implants

FCC/ISED Compliance

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Model **SoHo-X00N**	**Models** **SoHo-X02, SoHo-X01, SoHo-X00**	**Models** **SoHo-S02, SoHo-S01, SoHo-S00**
FCC ID: MHASOHO IC: 5681A-SOHO Japan MIC Certification R 011-230018 CE UK CA	FCC ID: MHASOHOFLA IC: 5681A-SOHOFLA Japan MIC Certification R 011-250044 CMIIT ID: XXXXXXXXXX KCC ID: R-S-ABC-YYYYYY CE UK CA	FCC ID: MHASOHOFLA IC: 5681A-SOHOFLA Japan MIC Certification R 011-250044 CMIIT ID: XXXXXXXXXX KCC ID: R-S-ABC-YYYYYY CE UK CA

SoHub

Model(s): SoHub

FCC/ISED Compliance (statement on the product label)

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Contains FCC ID: XPYBMD345
IC: 8595A-BMD345
Japan MIC Certification

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

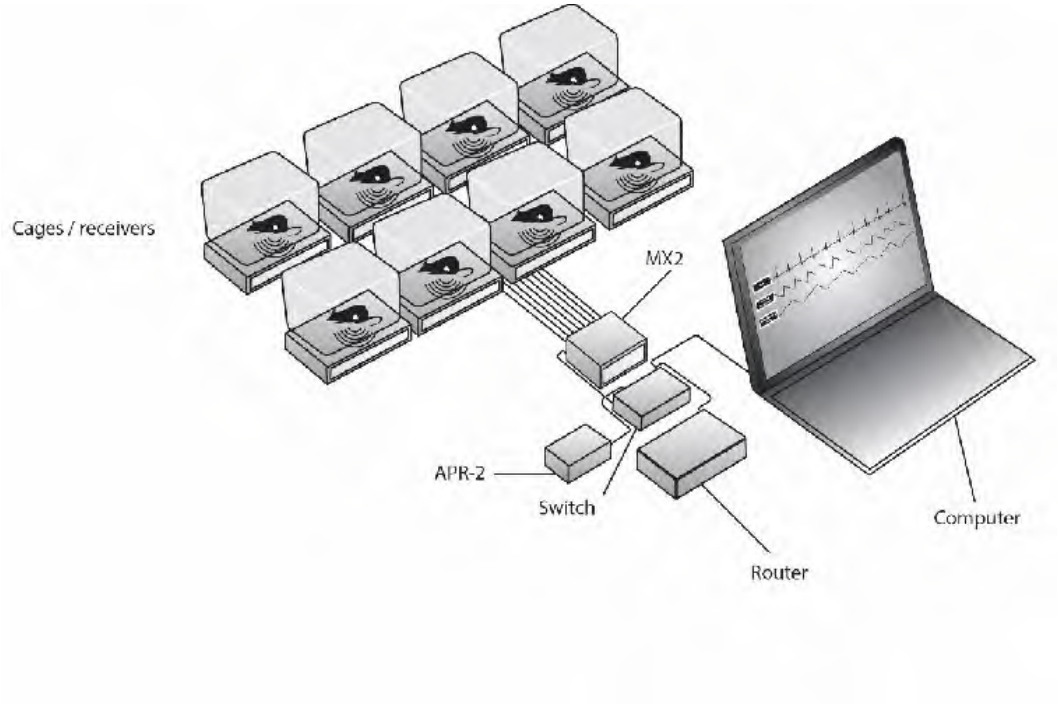
1. Understand your telemetry platform.
    a. **PhysioTel and PhysioTel HD**
    or
    b. **PhysioTel Digital**
    or
    c. **SoHo**
2. How to setup your telemetry system hardware.
3. How to use the Ponemah software to:
    a. Create an Experiment.
    b. Acquire data.
    c. Visualize, Review and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

PhysioTel HD and PhysioTel Legacy Telemetry Platform Manual

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.

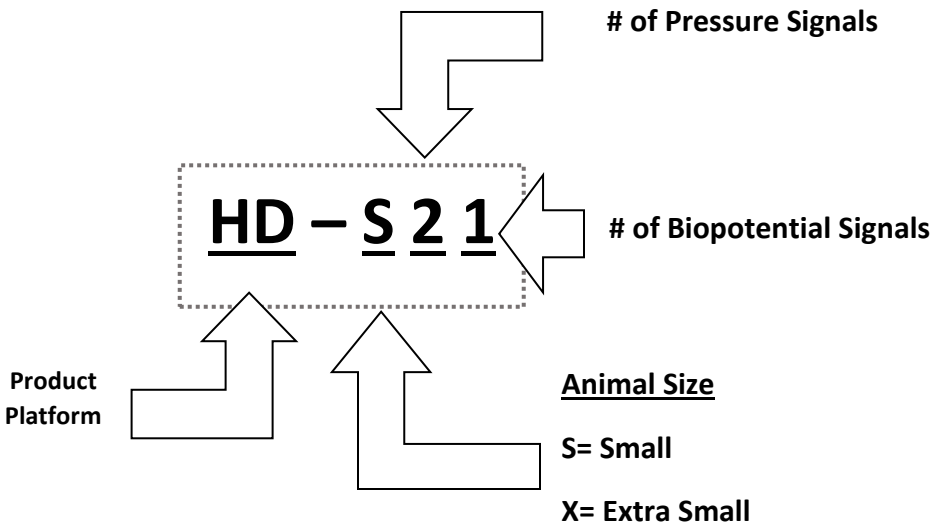
DSI's experienced surgical services team is available to answer any questions by phone or email. In person, hands-on surgical training is available onsite or at DSI headquarters with group rates available. Training at headquarters often includes a tour of manufacturing, as well as some time with DSI's 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 warrantied 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:

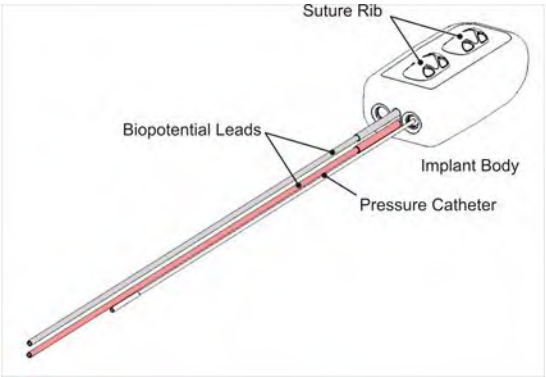
- First character indicates device type: **T**A11ETA-F40 and **T**L11M2-C50-PXT.
  - **T** = Transmitter
- Second character indicates device series: T**A**11ETA-F40 and T**L**11M2-C50-PXT.
  - **A** = Single Channel
  - **L** = Multi Channel
- Third and fourth characters indicate **Design** type: TA**11**ETA-F40 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.

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**.

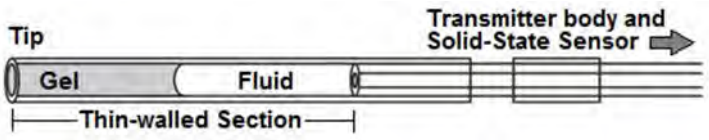
Suture Rib

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.

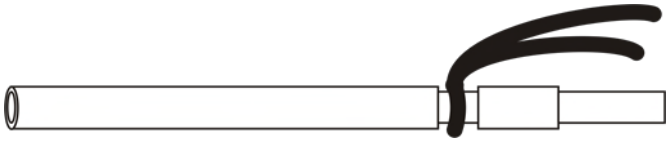


Diagram highlighting the ligation aid option

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.

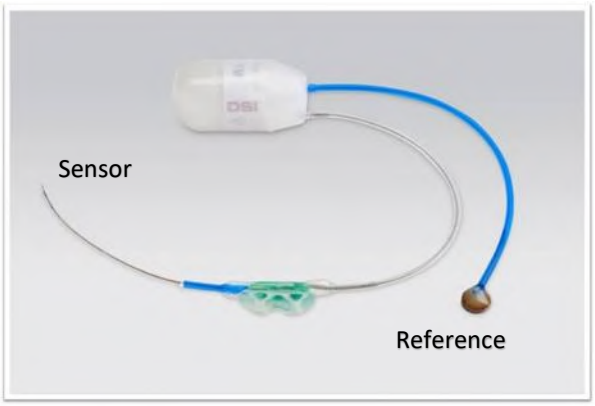
The HD-XG has silicone tubing that extends out of the device body and contains:

- **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.

Battery's 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:

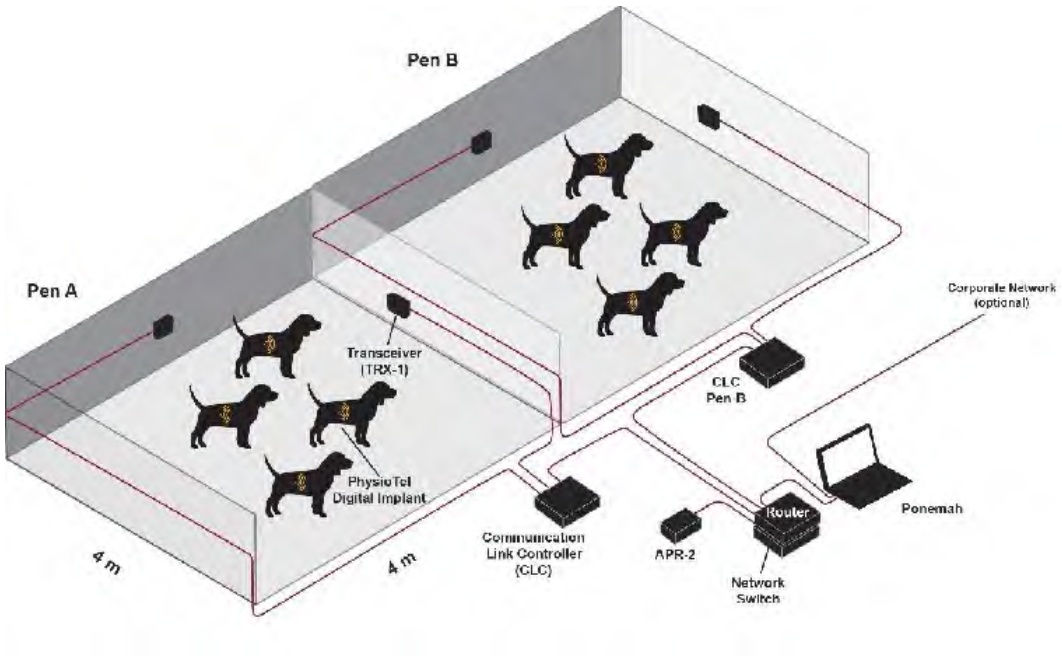
- Power on an AM radio and tune it to 550 kHz (the low end of the AM band).
- Bring the radio close to the device.
- Momentarily bring a strong magnet within approximately one inch of the device implant, holding it near for two to five seconds.
- The order of modes using a radio is:
    - Off (No tone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

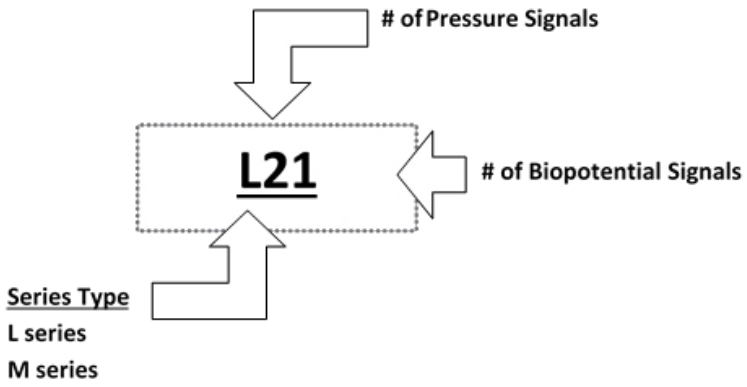
- M series – One-time use implants that are ideal for shorter duration studies. The smaller size of M series allows the PhysioTel Digital technology to be expanded in to a broader range and size of species. Primary applications for M series are toxicology and biological defense studies

  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.

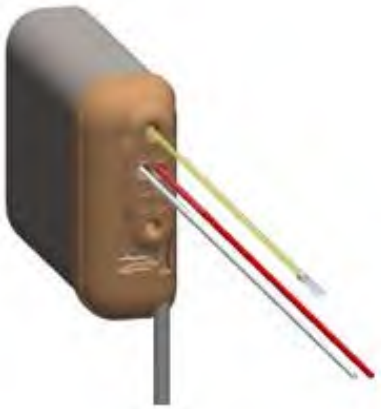


The follow table lists the available PhysioTel Digital implants and the available input channels from each model.

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	●	–	–	●	●

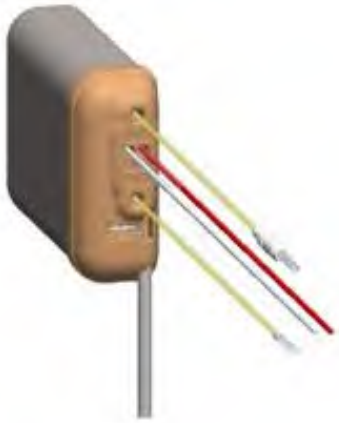
Implant Components

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



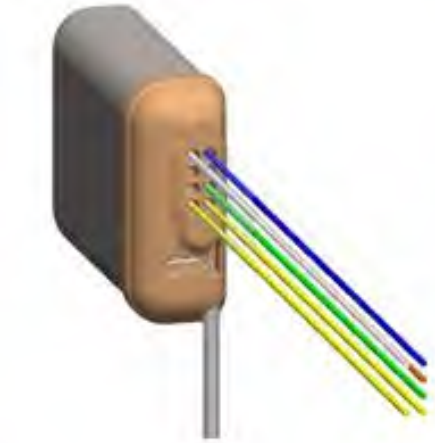
L11

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



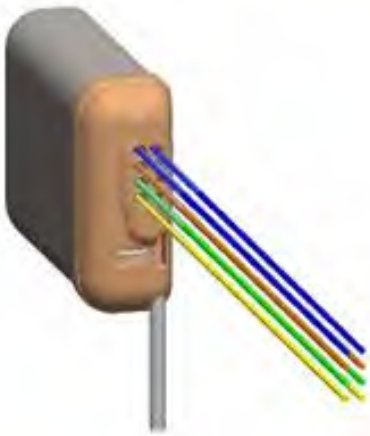
L21

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



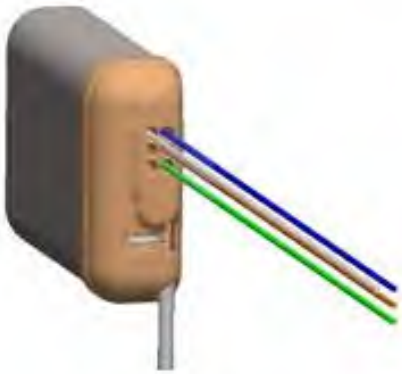
Common Reference L04

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



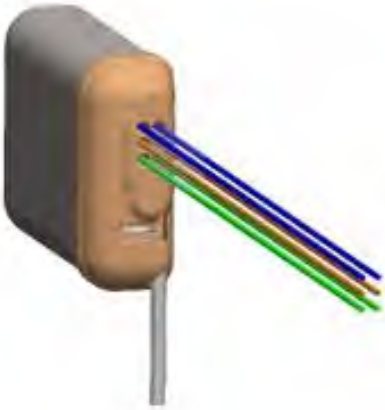
Biopotential Pair L04

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



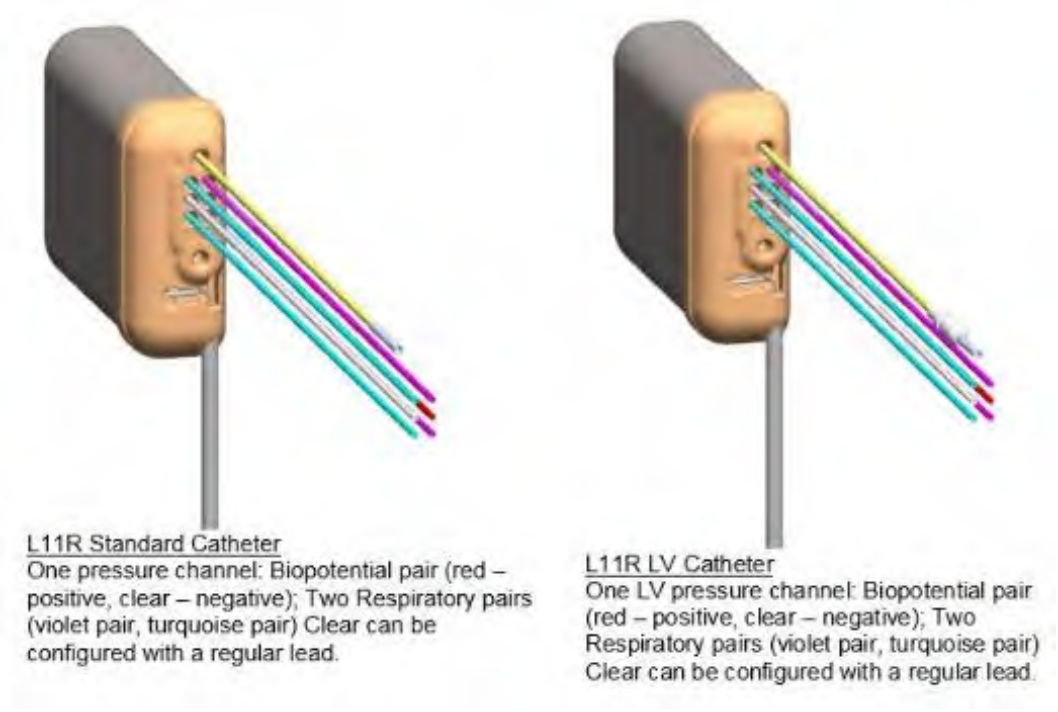
Common Reference L03

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



Biopotential Pair L03

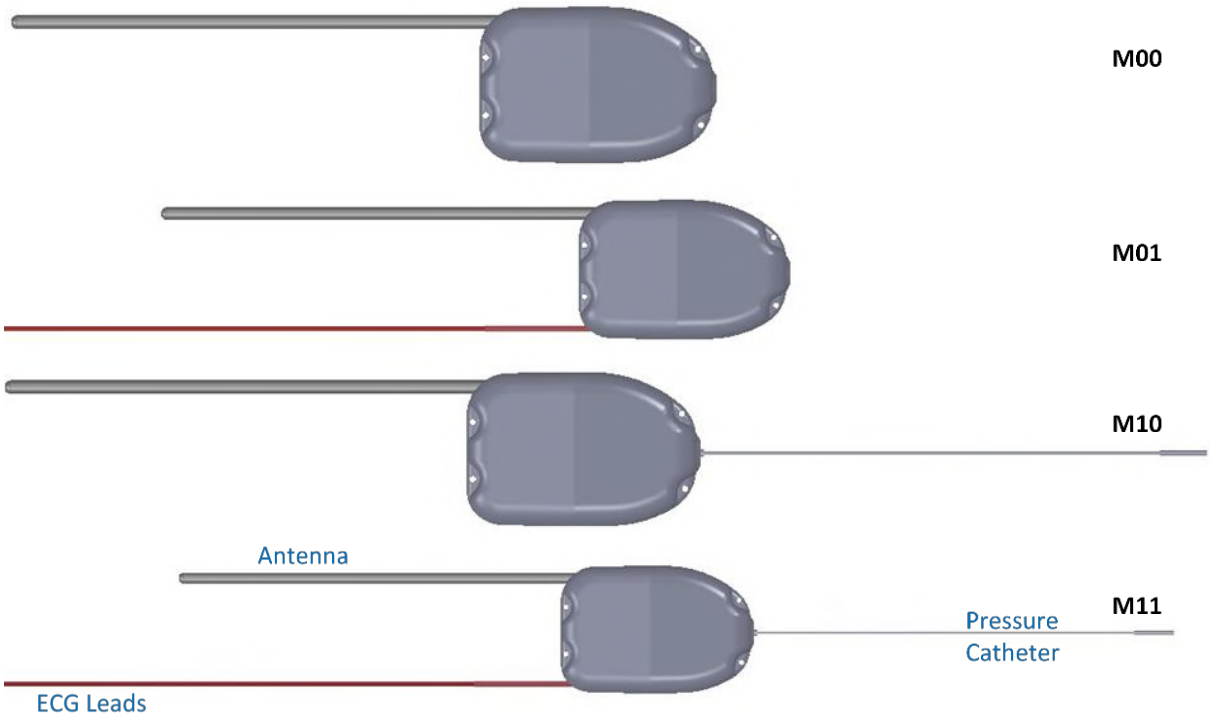
Channels 1-3: biopotential positive and negative pairs (blue, orange, green)



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.



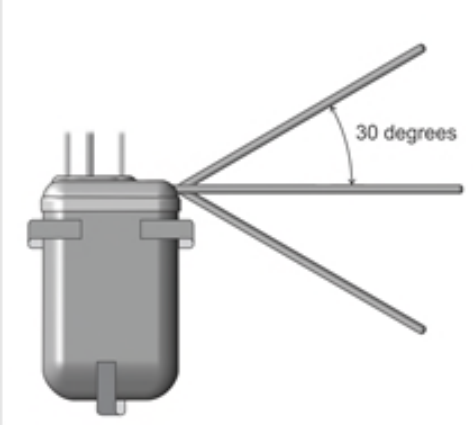
Implant Body

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

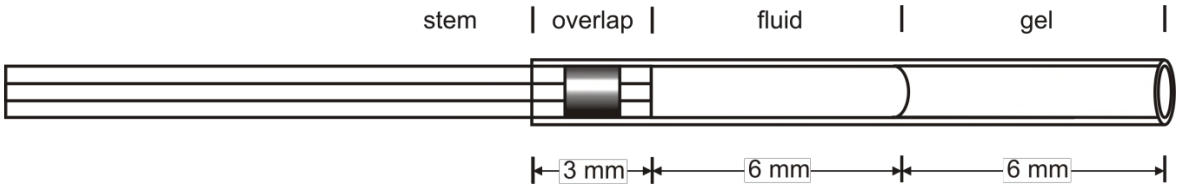
Pressure Catheter(s)

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.

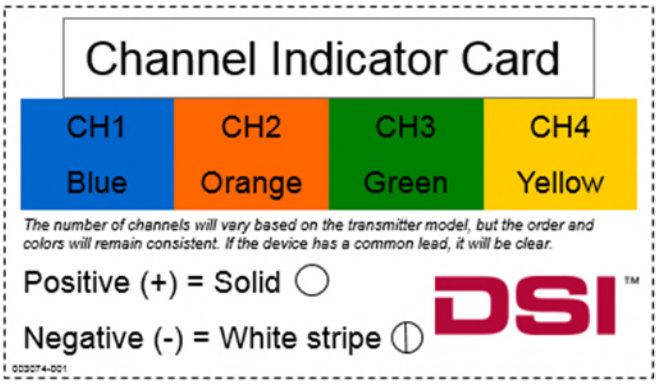
PRESSURE CATHETER WITH RADIO-OPAQUE MARKER



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 place 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.

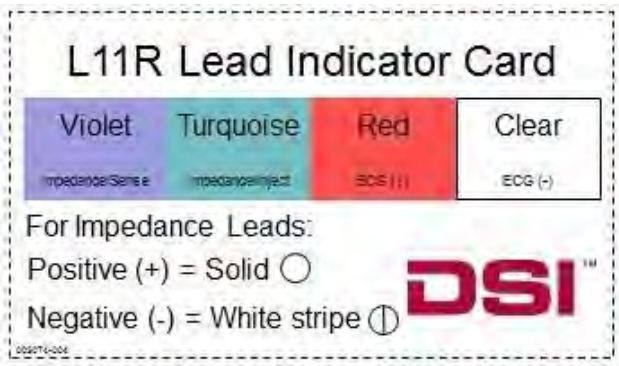
Respiratory Impedance Leads

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 = 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 blinks 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' on/off Power button on the front panel. The screen on the POD will activate and show device information for 5 seconds, then switch to implant scanning mode.
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.
4. The POD will emit a beep for 2 seconds, blink its LED and also vibrate to indicate a successful magnet swipe. Implant information will be displayed on the screen.

   If the power on process was not successful:
   a. Ensure the implant manufacturing date and firmware version are compatible with the POD. See POD Compatibility.
   b. Ensure the POD is not located next to any potential noise sources (Monitors, PCs, outlets, etc.)
   c. Wait 10 seconds, then try to magnet ON the implant again.

5. 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.
   a. 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.
   b. 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.

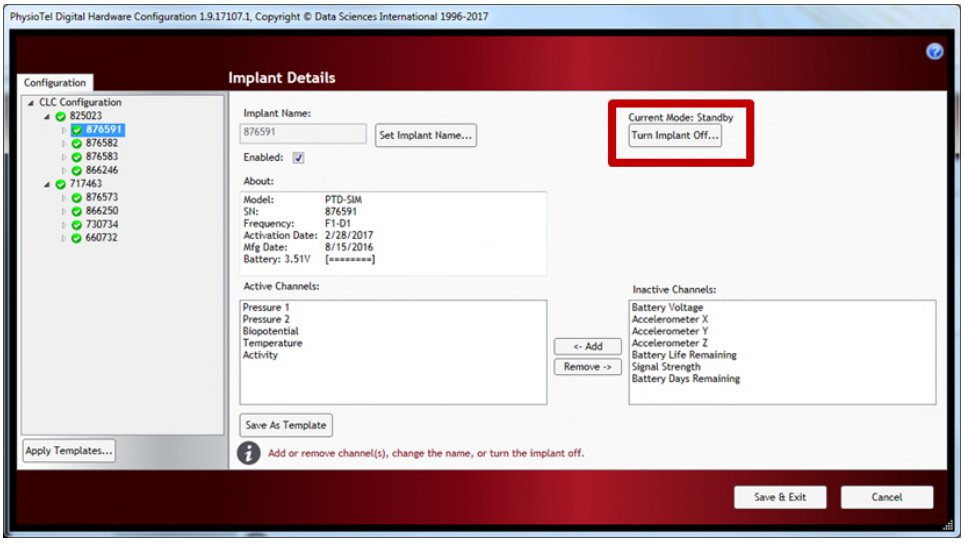
MANUAL SHUT OFF – SOFTWARE

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

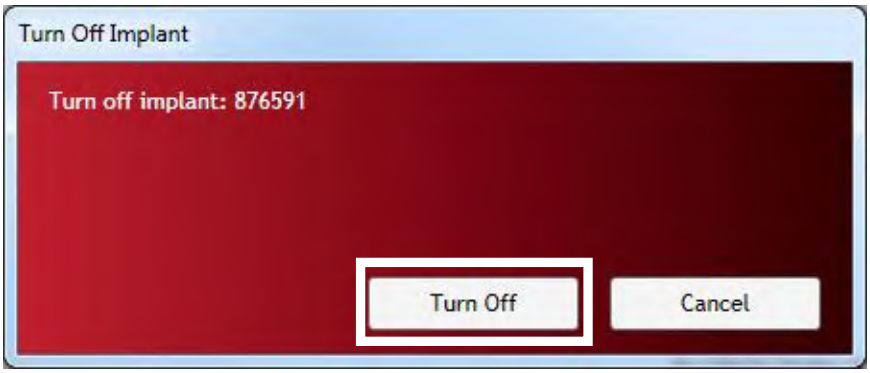
To remotely switch off an individual implant using the software:

1. Select the implant by clicking the line item in the Configuration column on the left of the screen.

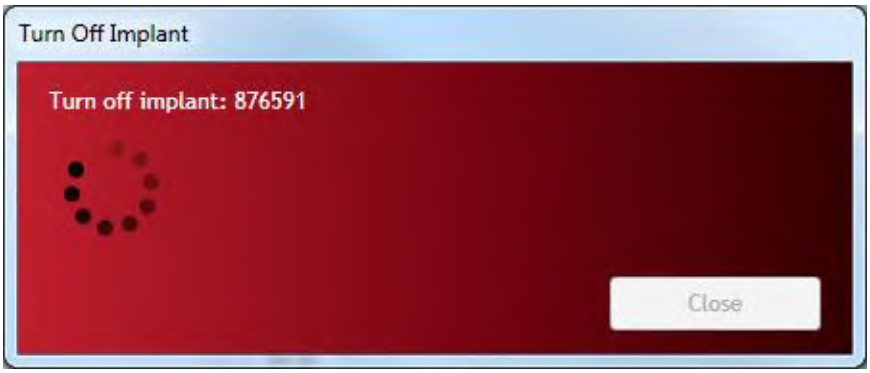
2. Click the button labeled **Turn Implant Off**.



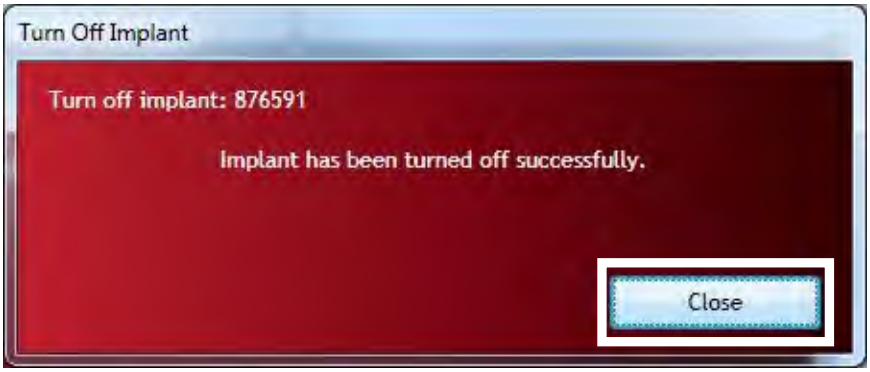
3. Confirm your intentions by clicking the button labeled **Turn Off**.



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**."



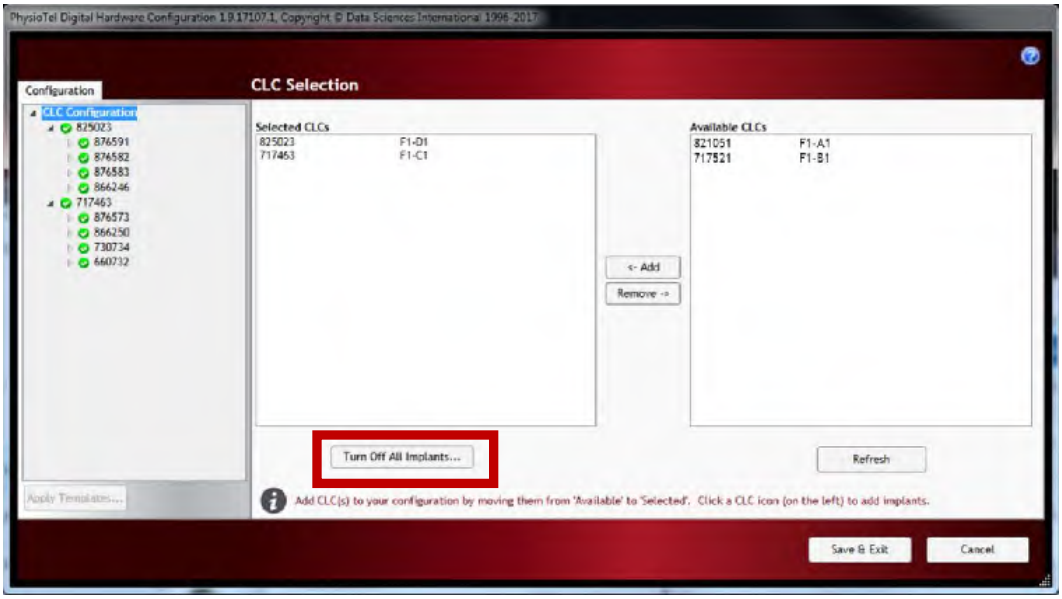
5. Click the **Close** button to return to the **Implant Details** view.



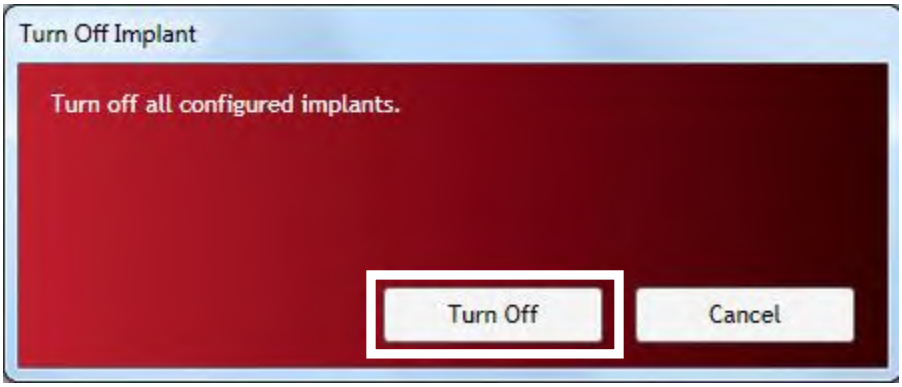
WARNING: Once you turn OFF an implant, it may only be returned to the ON state (Standby Mode) by physically passing a strong magnet close to the implant device for a few seconds.

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

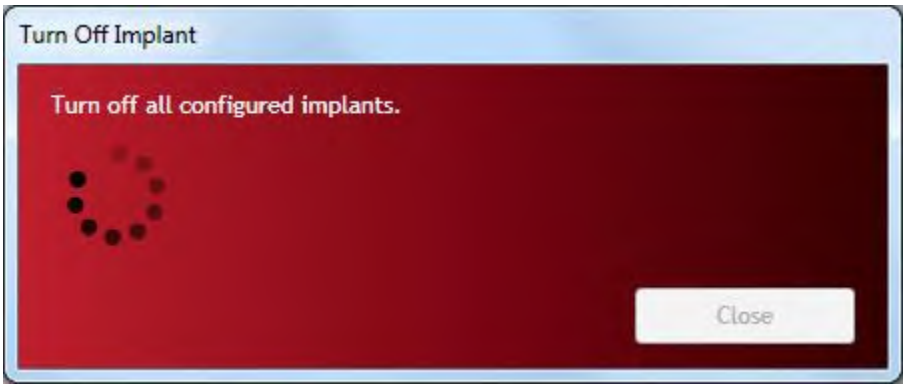
1. Select the CLC Configuration line item in the Configuration column on the left of the screen.
2. Click the button labeled **Turn Off All Implants**.



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)

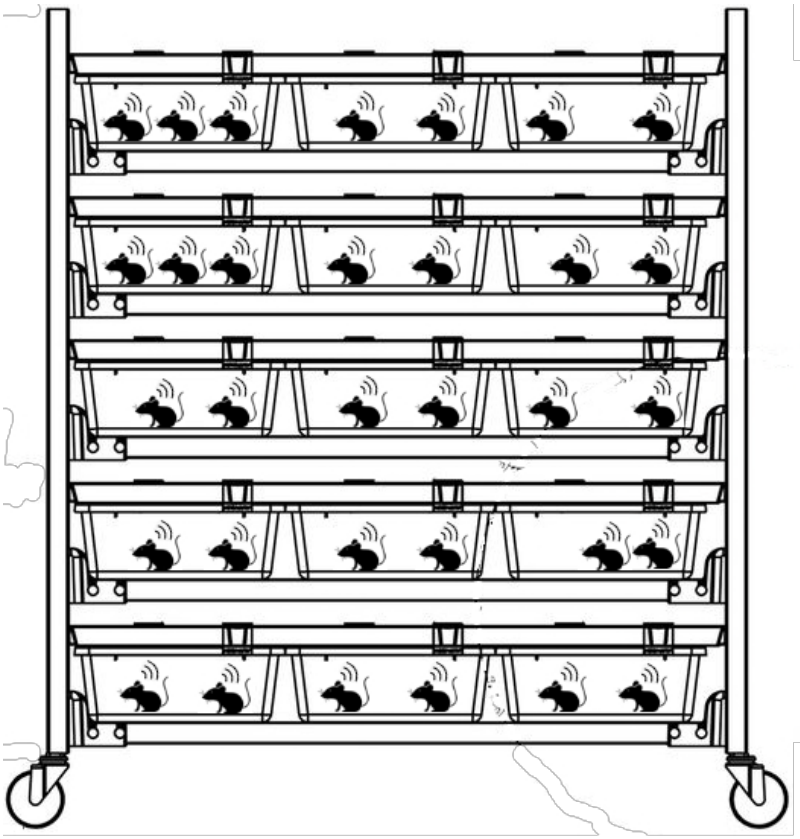
If a configured implant loses contact with its CLC, i.e. moves out of range of the TRXs; the implant will attempt to re-connect with the CLC for a period of 60 minutes (default) after which it will turn itself OFF.

SoHo Telemetry Platform Manual

System Overview

The SoHo™ telemetry platform is designed for monitoring and collecting data from conscious, freely moving laboratory animals in a single, pair or group housed setup—providing stress-free data collection while promoting natural social behaviors. The shape of DSI implants are also designed to accommodate various surgical placements, including subcutaneous and intraperitoneal placement.

The SoHo™ telemetry platform is comprised of three main components: the data acquisition computer, SoHub(s) and implants. The SoHub and the implants actively communicate with one another. Using the hardware configuration interface within the data acquisition software, the user assigns a set of implants to a SoHub; up to sixteen implants can be assigned to one SoHub, and multiple SoHubs can be connected on one system.



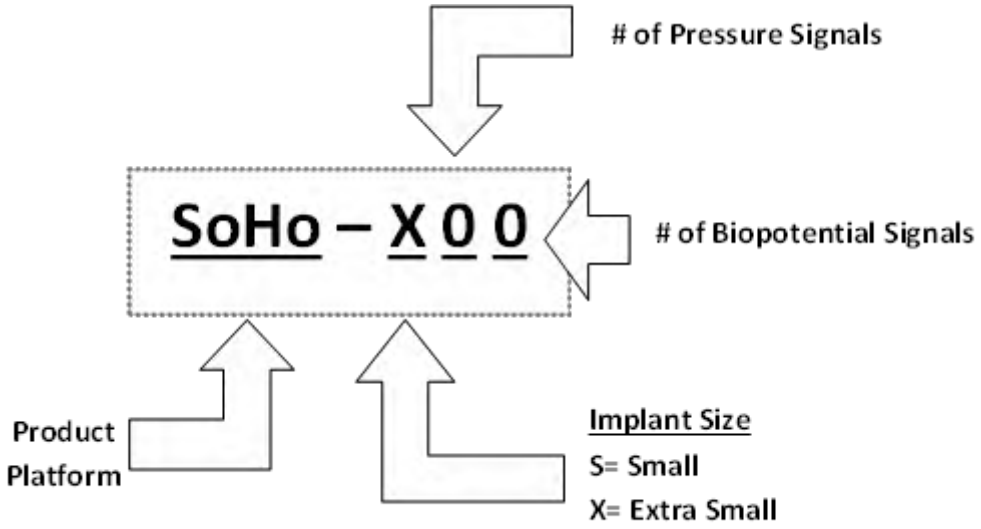
About the Implants

SoHo Features

At the heart of the SoHo™ telemetry 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. It is important to note that all SoHo devices also provide Temperature and Activity measurements via a three-axis accelerometer.

Nomenclature

SoHo™ stands for "Social Housing" 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.



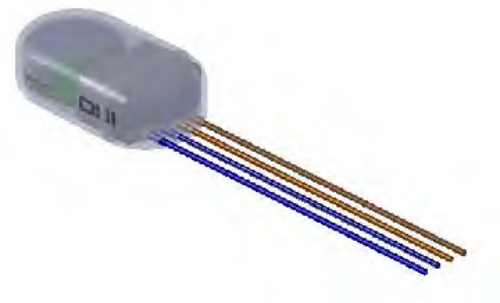
Model	Glucose	Pressure Signals	Biopotential Signals	Temperature	Activity
SoHo-X00	-	-	-	•2x	•
SoHo-X02	-	-	•2x	•2x	•
SoHo-X01	-	-	•	•2x	•
SoHo-S01			•	•2x	•
SoHo-S02			•2x	•2x	•

Implant Components

The following illustrates the various implant components of the SoHo series implants.

X00N – Temperature and Activity

X00 – Temperature and Activity



X02 – Two biopotential differential pairs, Temperature and Activity

X01 – One biopotential differential pair, Temperature and Activity

Implant Body

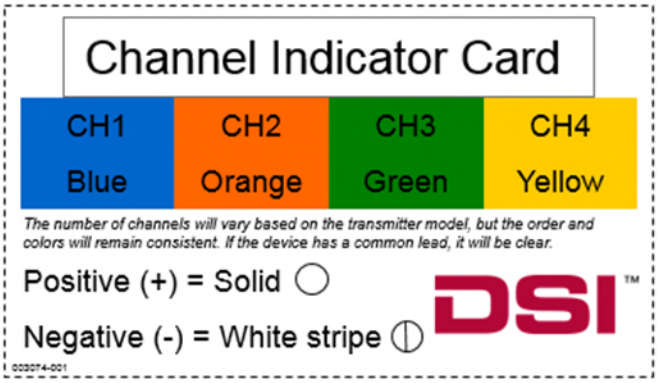
The implant consists of the following major components:

- **Housing:** SoHo implants contain a biocompatible housing.
- **Electronics module**: translates the pressure fluctuations, biopotential signal, temperature, and 3-axis accelerometer signals into digitized signals and transmits them to a SoHub. 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.
- **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 secure the implant in place.
- **Temperature sensor**.
    - **There are two temperature channels**
- **3-axis accelerometer.**

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. The X01 implant with only one biopotential

channel available has red positive leads and clear negative leads. Multiple biopotential channel implants such as the X02 uses an alternative color scheme indicated by the key shown below.



Understanding Activity Measurements

SoHo 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. A range of at least -3Gs to +3Gs is provided. 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 1Hz.

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.

$$C = 353.47$$

The default Sampling Rate for Activity channels is 1 Hz.

It is recommended to use Total Activity 2 (A_TA2) which 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.

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.

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).

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.

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 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 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

Implant Operation Modes

MODE	POWER	Battery Use per week	Description
Off Mode:	0%	NA	The Implant is fully powered off and requires a magnet swipe and configuration through the software to activate the device.
Standby Mode:	33% (X01/X02) 58% (X00)	8% 8%	Low power, listening for commands from the data acquisition system.
Sampling Mode:	100%	25% (X01/X02) 7% (X00)	Full power, ON, collecting and transmitting data.
Sleep Mode:	9%	2%	Very low power, An implant can be placed into sleep mode via the Ponemah software, where it will check for a SoHub every 2 minutes. Waking implant from sleep should take up to 2 minutes, but if an implant misses a communication it can take longer. An implant left in sleep for longer than 48 hours will automatically enter the lower power hibernate mode.
Hibernate Mode:	.1%	.03%	Lowest power setting, An implant can be placed into hibernate mode via the Ponemah software, where it will only communicate and check for the SoHub every 20 mins. Waking implant from hibernate should take up to 20 minutes, but if an implant misses a communication it can take longer.
Snooze Mode:	5%	variable	Implants that are configured using scheduled sampling will enter snooze mode in between the scheduled collection intervals. Implants will wake up 45 seconds prior to the beginning of the next schedule to prepare for sampling.

Snooze and Scheduled Sampling: If scheduled sampling is being used and the scheduled interval is too short, the implant will not enter Snooze Mode but remain in Standby in between intervals. DSI recommends to set an appropriate interval (minimum 6 minutes) and duration to allow snooze mode for optimal battery savings.

An implant cannot be manually awoken from snooze mode and is communicated with once per hour. If a schedule must be aborted, the implant will go back to Standby in one hour or less. If needed, the implant can manually be turned off and back on using a magnet swipe to reset.

Implant Activation and Detection

Magnet Swipe - Implants are activated by bringing a magnet within proximity (1-2 inches) of the implant for 1-2 seconds. Once activated, the implant will listen for a SoHub to pair with. Pairing must be done through the configuration menu of the software.

After a magnet swipe there are multiple options to verify an implant has successfully powered on:

Ponemah Software

Implants can be detected and configured in the SoHub Configuration menu of Ponemah.

Please see the Edit SoHo Configuration section of this manual for instructions on how to perform this action.

a) Once the implant is associated with a SoHub, it will remain in Standby Mode until automatically switched to Active Mode via Start Acquisition AS LONG AS the SoHub remains powered on and in range. (see Note below)

b) Once the Acquisition is ended, the implant will automatically revert back to Standby Mode. The implant will remain in Standby Mode if it stays within range of a SoHub.

Note: If the implant cannot establish communication, or it loses connection with a SoHub for greater than 16 seconds, it will automatically enter sleep mode to preserve battery life. To find an implant that is in sleep mode:

a) Open the Edit SoHub Configuration window and search for implants. Wait at least 2 minutes for the implant to be found.

b) To speed up the process, swipe the implant with a magnet to turn off, WAIT 15 seconds, and then swipe with a magnet again to turn on.

SoHo Power On Detector (SoHo POD)

The SoHo Power On Detector is a handheld device which can be used to determine if a SoHo implant has been successfully turned on by the magnet swipe.

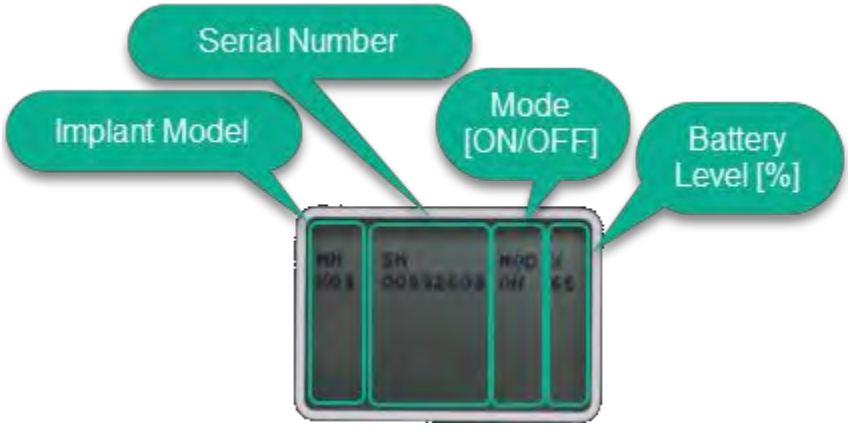
Power On: The SoHo POD has a single On/Off button in the center of the front panel. When the SoHo POD turns on it will display its' SN, Firmware version and battery information for 5 seconds and then switch to scan mode.

Powering On Scan Mode

Scan Mode: When an implant is turned On OR Off, it emits a short transmission called an advertisement. The advertisement is automatically picked up when the SoHo POD is within range (approx. 5 meters). The SoHo POD will display information for one implant per row and can show a maximum of five implants on the screen at one

time. As additional implants are turned on/off, they will appear at the top of the list and the list will shift down, removing implants at the bottom.

An advertisement that is received contains the following information about an implant: **Model, SN, Power Mode Change and Battery Life**.



The SoHo POD will only indicate when an implant turns On or Off. It cannot be used to determine if an implant is already turned on and in standby, sleep or hibernate mode.

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. It is very important to turn the POD OFF when not in use to maximize the life of the batteries.

Signal Detector

Used to detect if an implant is ON or OFF only.

a. Turn the Power switch of the Signal Detector until you feel a click and the red Power Light illuminates.
b. Hold the Signal Detector within ONE INCH of an implant.
c. The sound of static and clicking noises may be heard and the 455kHz or 8MHz light on the SD may illuminate, which will indicate that an implant is ON. If there is no response the implant is OFF.

Changing Implant Mode

SoHo implants can enter different modes for optimal power and battery management. See details in the Edit SoHo Configuration section of this manual on changing power modes.

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 1-2 seconds. NOTE: The implant can take up to 8 seconds to power off after a magnet swipe.

Manual shut off – Software

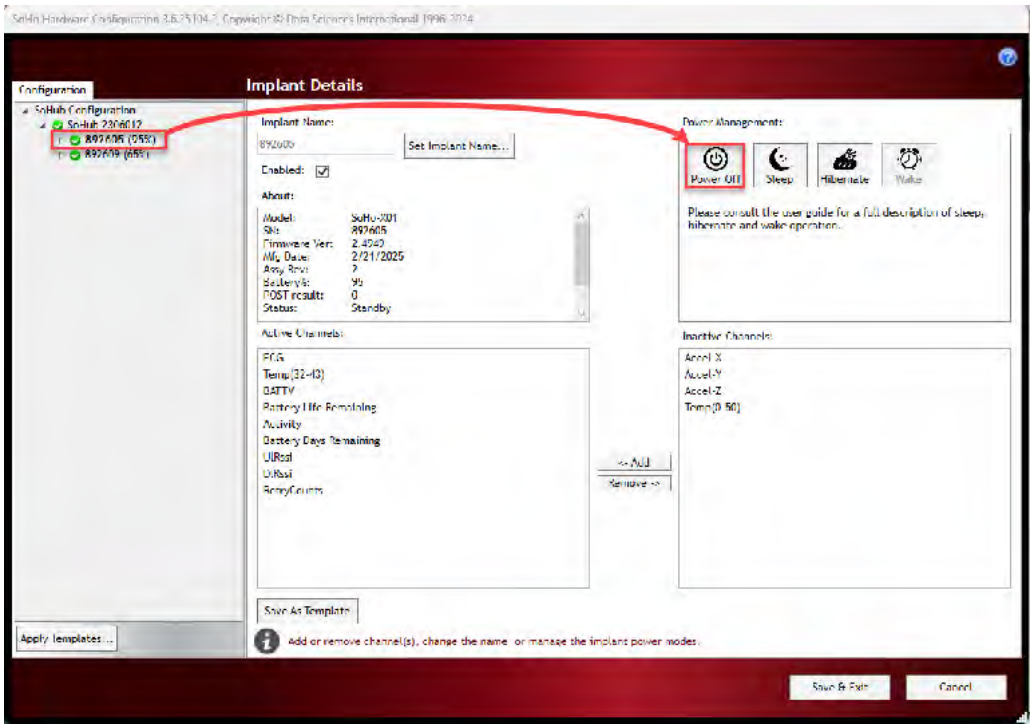
A single implant or multiple implants may be turned off remotely using the **SoHub Configuration** dialog within the Ponemah software.

Warning: The Power Off button will send the command for implant to power off continuously for one minute. If the implant is turned back on with a magnet within the minute after clicking Power Off, it will shut off.

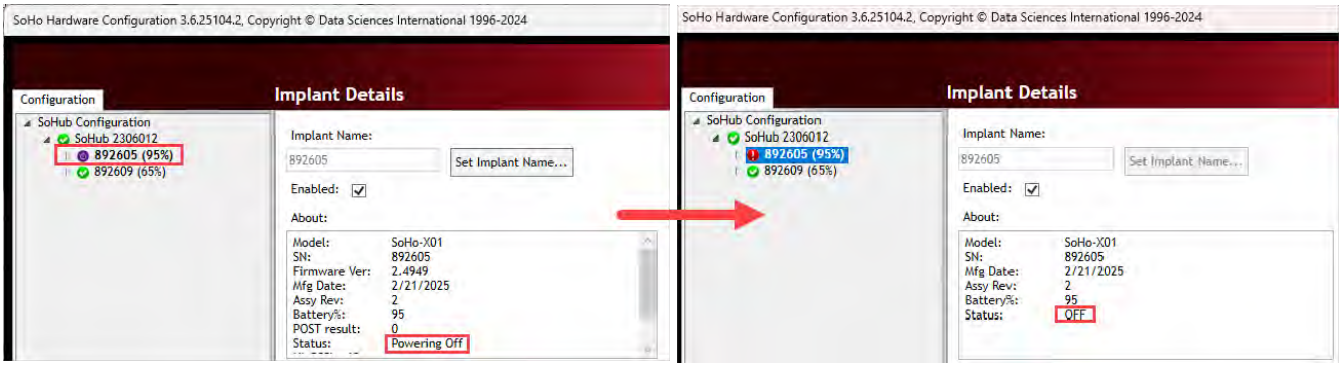
To remotely switch off an individual implant using the software:

Select the implant by clicking the line item in the Configuration column on the left of the screen.

Click the button labeled **Power Off** in the Implant Power Management Window.



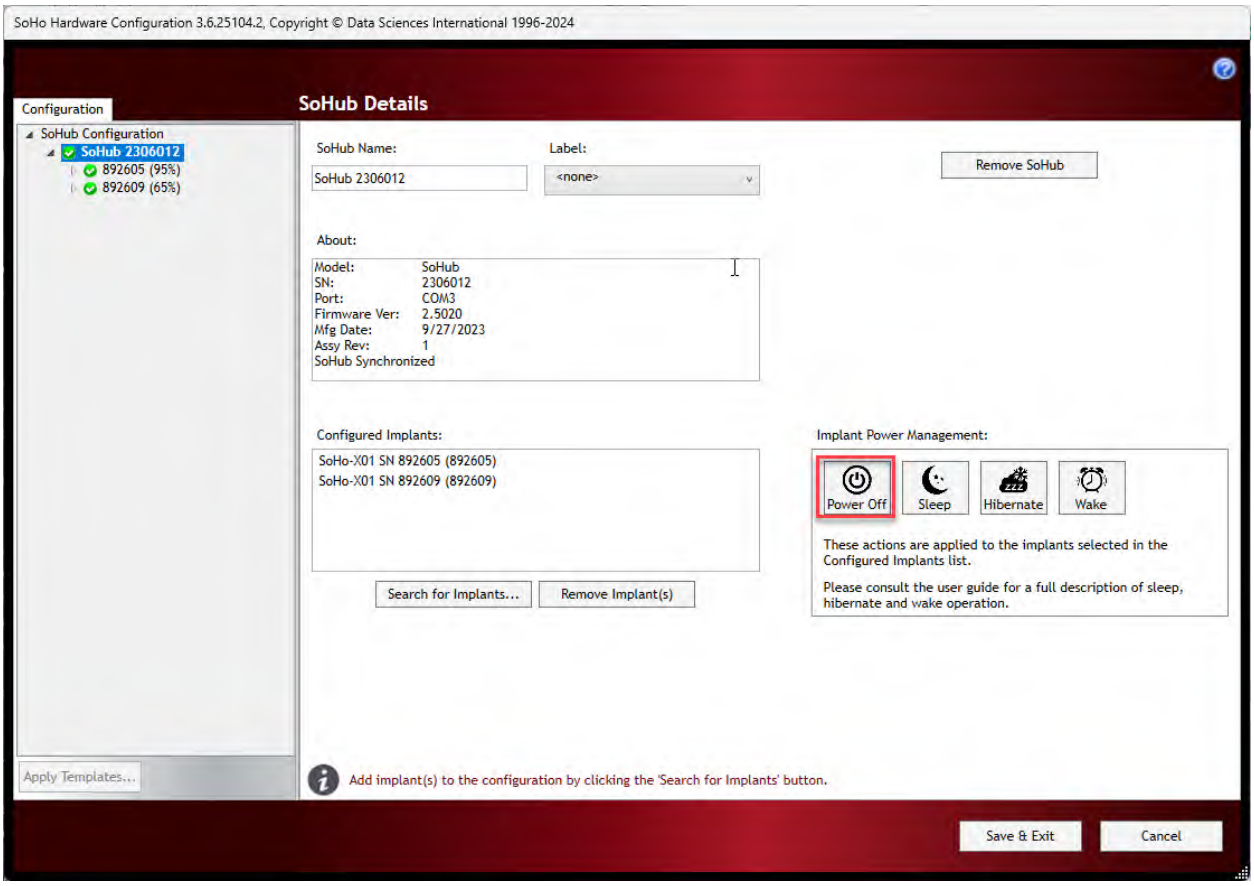
A SoHo Implant can take up to **8 seconds** to fully power off. While in the power down process the indicator will switch to a purple power down icon and the status will show [Powering Off]. When the implant has fully powered down the indicator will switch to red and the status will show [Off]:



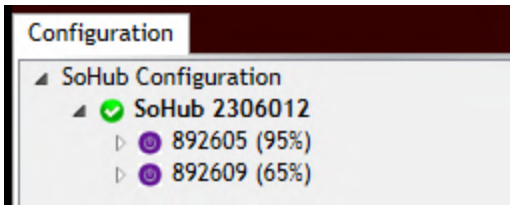
To remotely switch off all the implants on a SoHub:

1. Select a SoHub from the line item in the Configuration column on the left side of the screen.

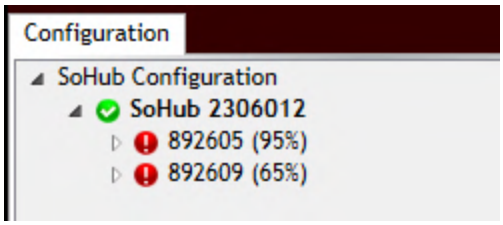
Click the button labeled **Power Off** in the Implant Power Management window.



ALL implants on the selected SoHub will show a purple power down icon during the power down process, which will take up to 8 seconds.



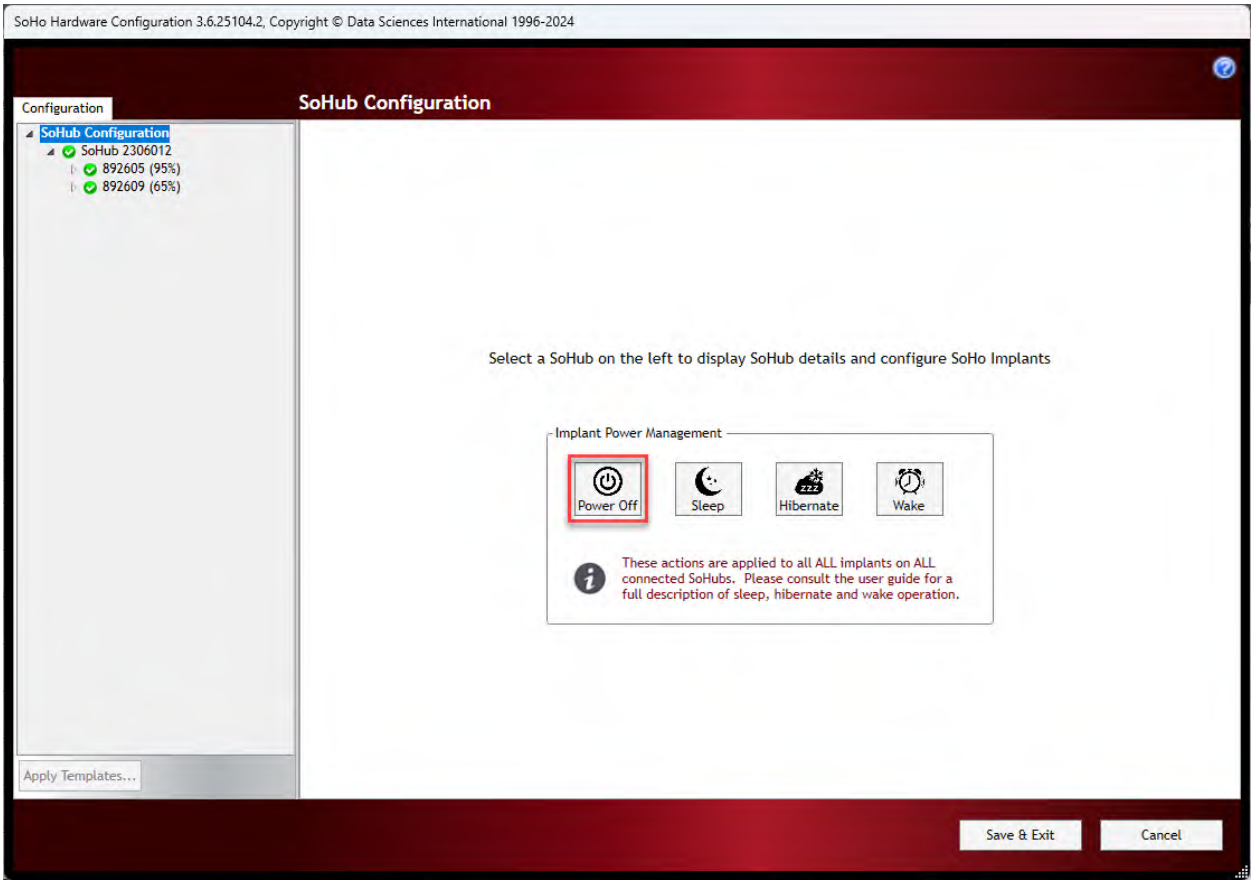
Implants will all turn red after they have powered off.



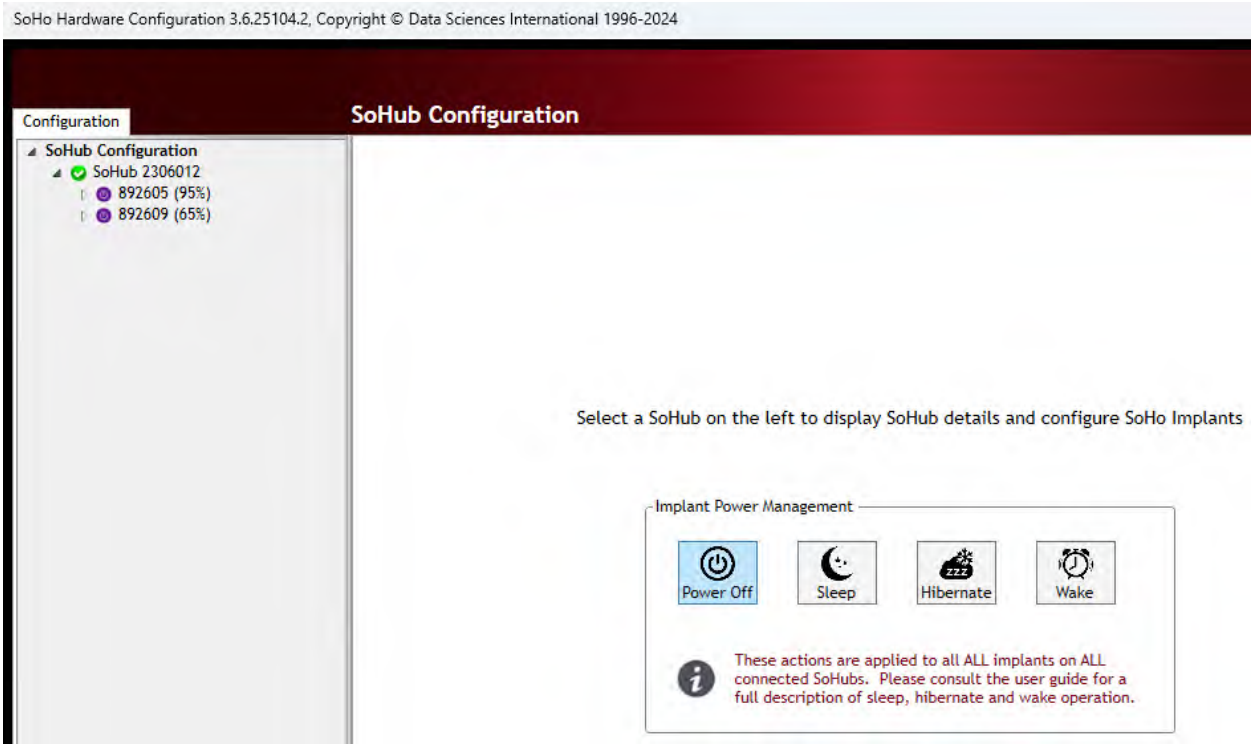
To remotely switch off all the implants in the configuration (All SoHubs):

1. Select **SoHub Configuration** from the line item in the Configuration column on the left side of the screen.

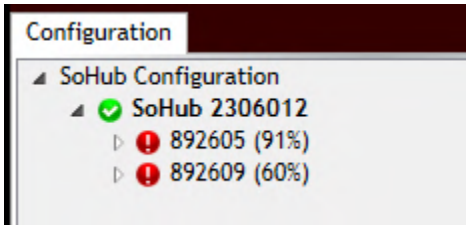
Click the button labeled **Power Off** from Implant Power Management window.



ALL implants in the configuration on ALL SoHubs will turn purple during the power down process which will take up to 8 seconds.



Implants will all turn red after they have powered off.

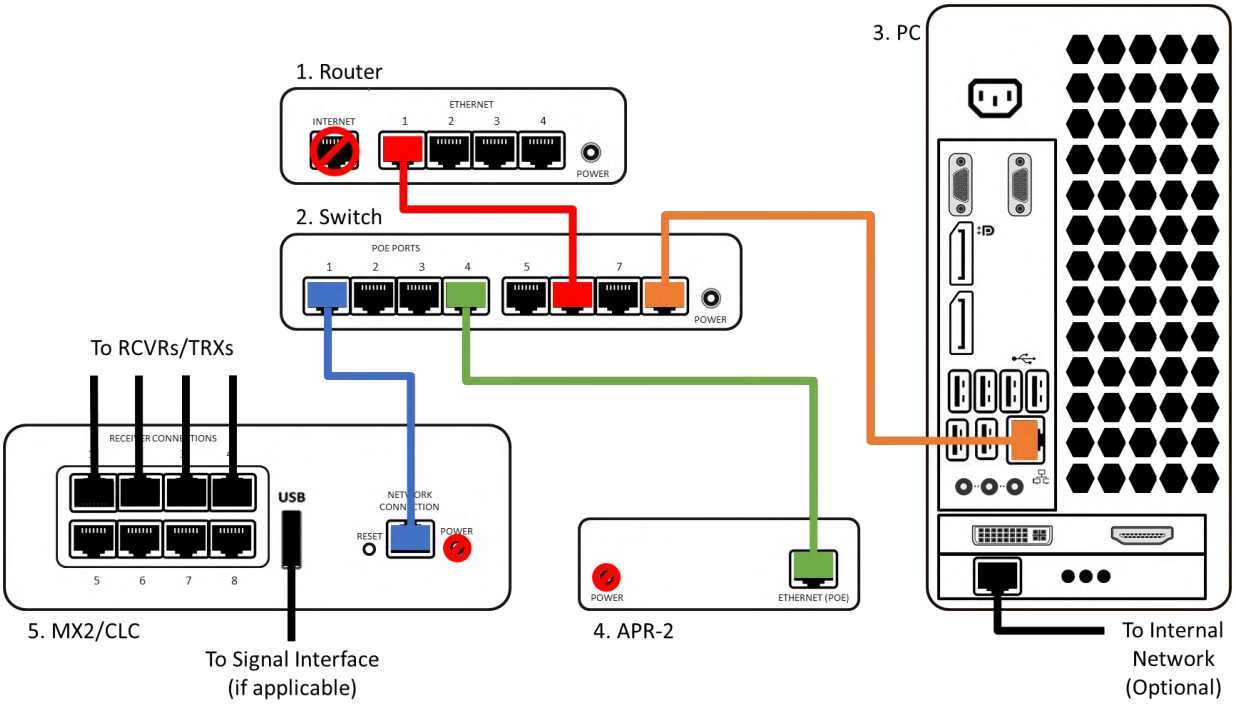


Implantable Telemetry Hardware Manual

Telemetry Hardware Connections (PhysioTel, PhysioTel HD and PhysioTel Digital) (PhysioTel, PhysioTel HD and PhysioTel Digital)

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 Cat6e Ethernet cables may be used in system set-up.



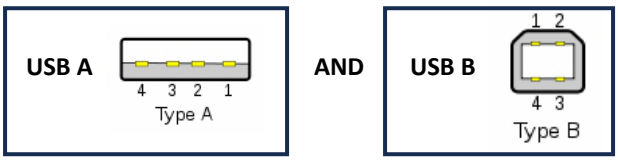
To connect your hardware:

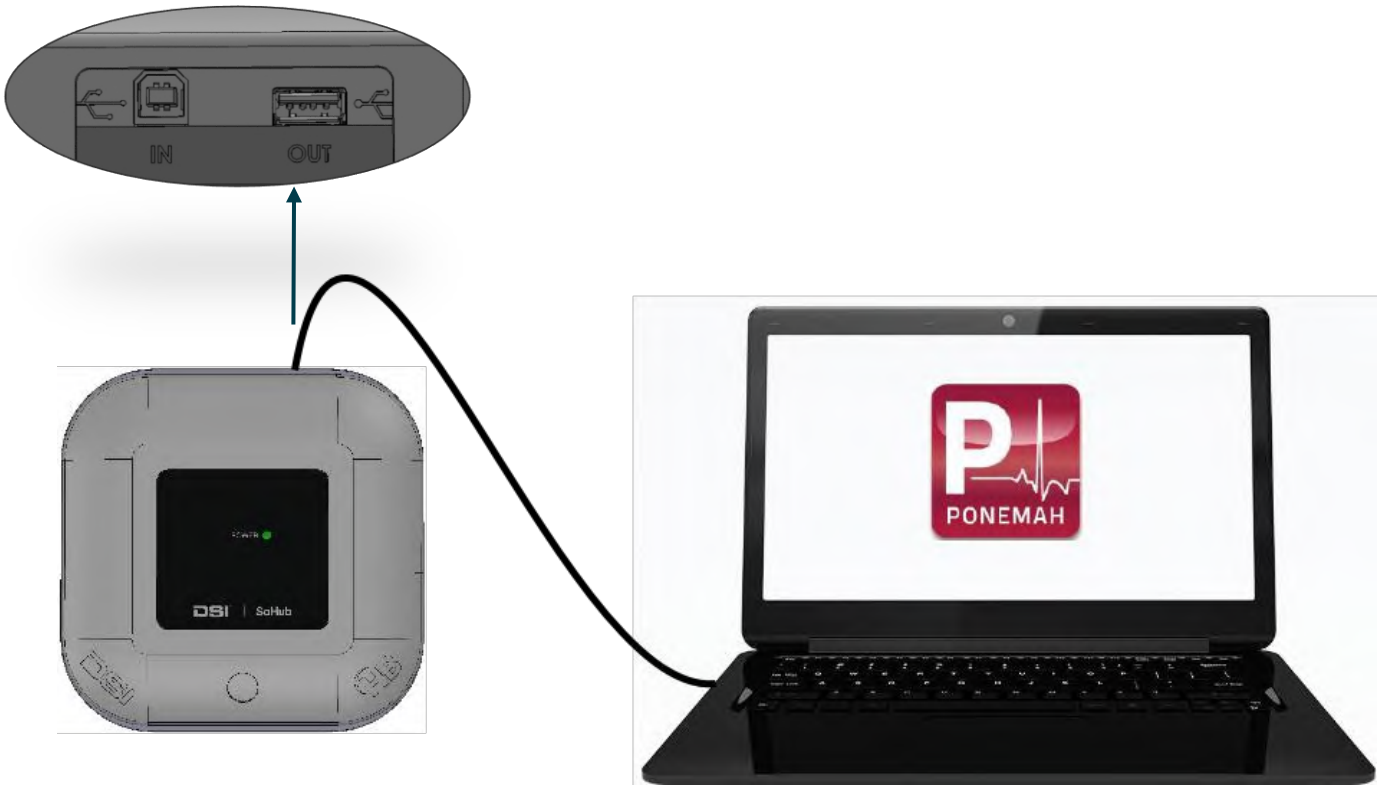
1. Connect the red Ethernet cable from the output of the router (1) to any port (PoE or non-PoE) on the switch (2).
2. Connect the orange Ethernet cable from the PC (3) to any port (PoE or non-PoE) on the switch (2).
3. Connect the yellow Ethernet cable from the J1-Ethernet jack on the APR-2 (4) to a 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.

Telemetry Hardware Connections (SoHo Telemetry)

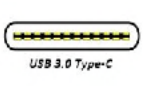
The SoHub connection system uses USB communication to a PC, and the provided SoHub cables have a different USB connection on each end:



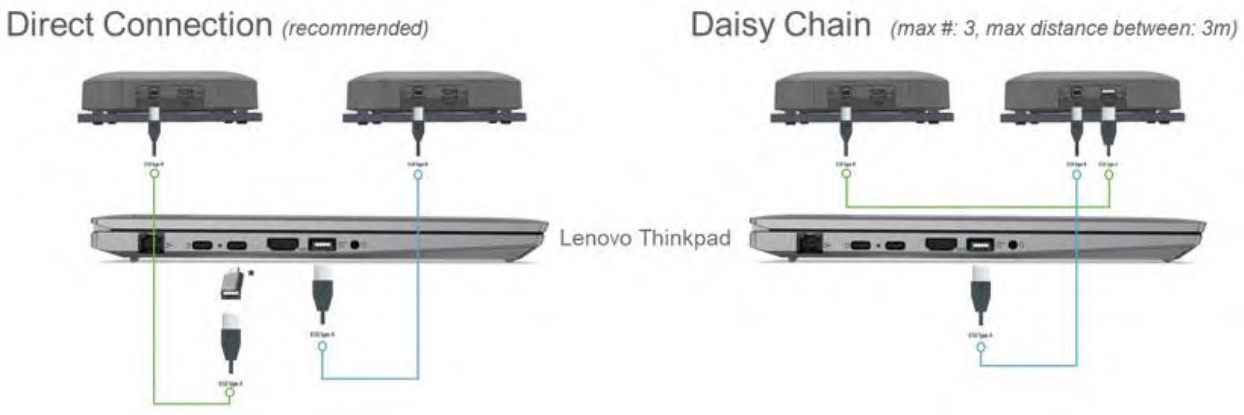


To connect your hardware:

1. Connect the USB Type B end of the provided cable to the IN port on the SoHub.
2. Connect the USB Type A end of the provided cable to an open USB port on the laptop or PC.
   NOTE: If the laptop or PC does not have available USB Type A ports but has smaller ports with rounded ends, this is USB Type C. An adapter is provided for USB Type A to USB Type C.



3. If more than one SoHub is to be used, additional SoHubs can be connected in one of two ways:
   a. Direct to the PC. Each SoHub can be connected to a separate port on laptop or PC. In addition, a USB hub can be used to expand the available USB ports.
   b. Daisy Chain configuration. SoHubs can be connected one after another in a chain.
      i. Connect the USB Type A end of the provided cable to the OUT port on the first SoHub.
      ii. Connect the USB Type B end of the provided cable to the IN port on the second SoHub.



PhysioTel and PhysioTel HD Platform Hardware

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.

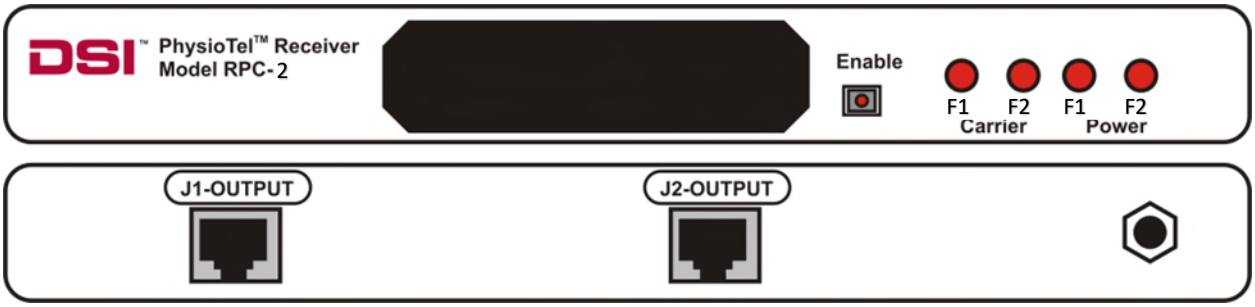


Illustration of the front (top) and back (bottom) panels of the RPC-2.

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.

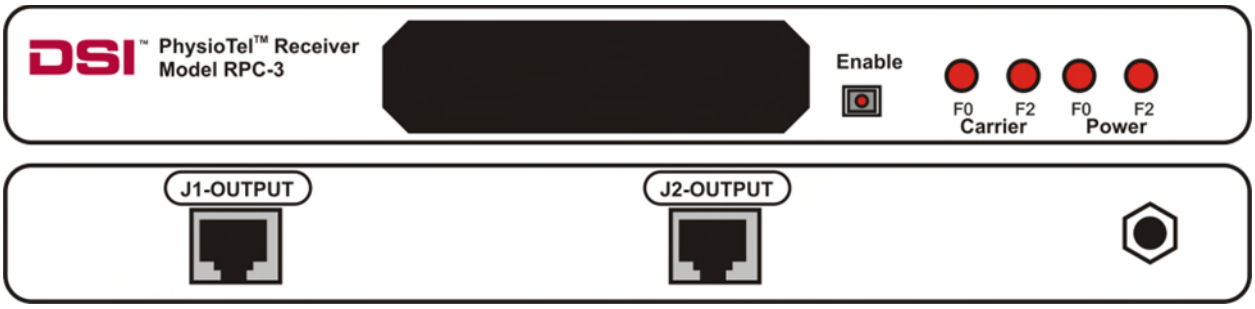


Illustration of the front (top) and back (bottom) panels of the RPC-3.

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

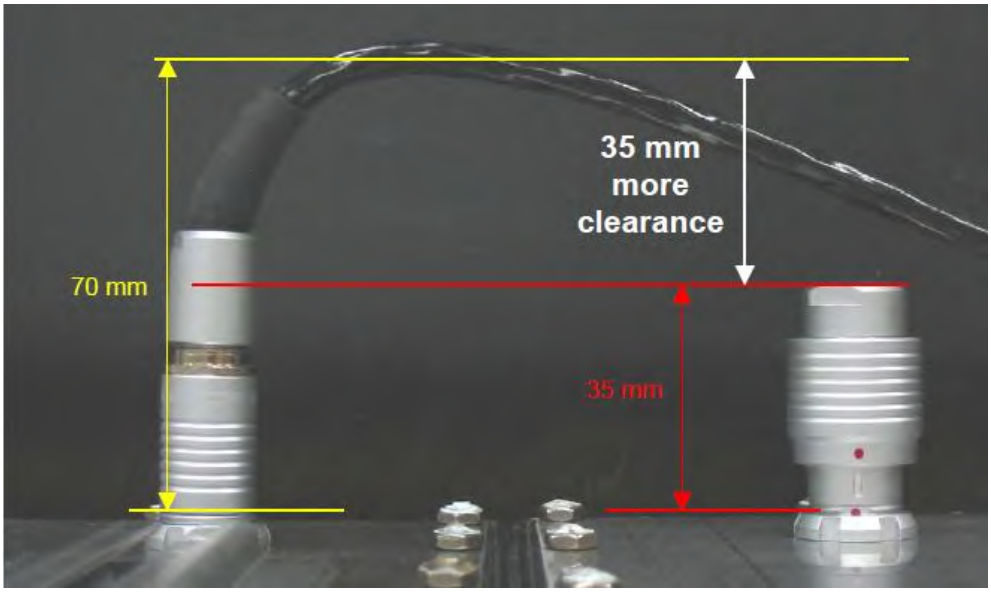
- Plug the "J" output jacks into the MX2 to establish a power and data connection.
- The "AUX" is used in DSI manufacturing to test the product.
- The "ANT" is where customers can plug in a custom antenna made by DSI or by their own engineers.

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 compatibility 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.

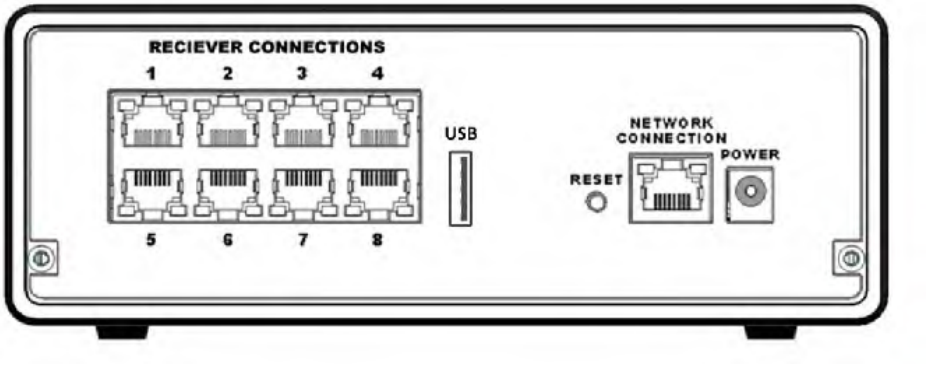


Illustration of the MX2 back panel.

RECEIVER CONNECTION INDICATORS

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

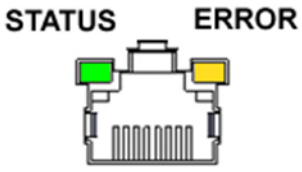


Illustration of the of the MX2 Receiver connection.

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

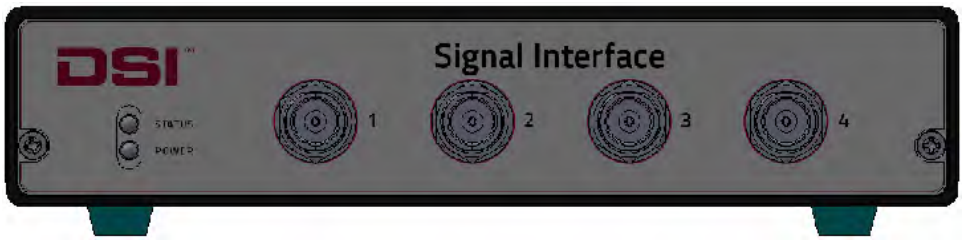


Illustration of the Signal Interface front panel.

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 *Note*: Rates above 1000Hz use repeat sample interpolation.
Input Voltage Range	±5V
Max Input (without damage)	±5.5V
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.

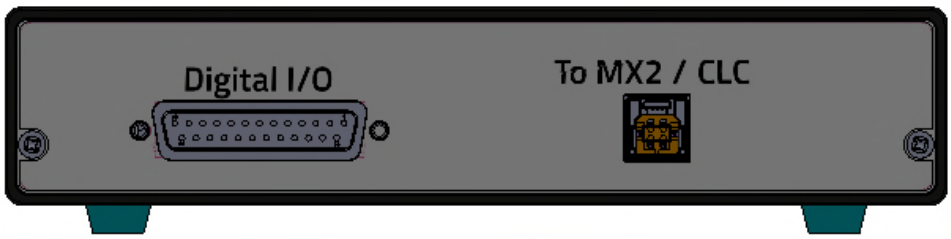


Illustration of the Signal Interface rear panel.

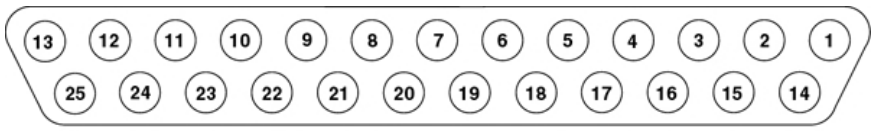
USB PORT

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 *Note*: 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.



PhysioTel Digital Platform Hardware

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 compatibility 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

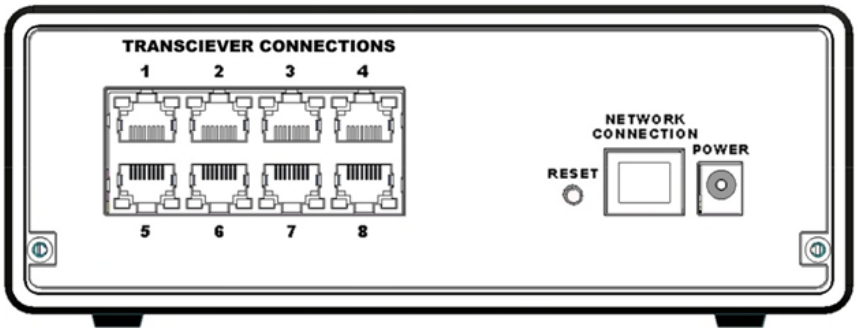
The front panel of the CLC contains three status indicator lights. In normal operational mode, only the green power indicator light is illuminated.

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.

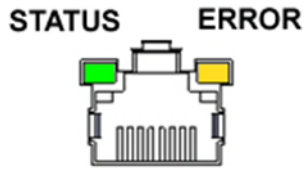


Illustration of the of the CLC Transceiver connection.

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.

SoHo Telemetry Platform Hardware

SoHub Overview

The SoHub acts as a transceiver i.e. it transmits and receives signals from the SoHo implants and it sends the implant data to the telemetry software on the PC. The SoHo system communicates via RF technology. Each SoHub can communicate and manage data collection from up to 16 SoHo implants.

Illustration of SoHub from the top and side.

Dimensions SoHub 6.16 x 5.98 x 1.31 in.
(156 x 152 x 33.2 mm)

	Plate 6.41 x 6.41 x .285 in. (163 x 163 x 7.2 mm)
Weight	281.5g – SoHub 261.4g – Plate

Indicator Lights

- The **Power** light indicates that the SoHub is connected to a USB port and powered appropriately. The light is either on or off.

Jacks

- Plug a USB Type B cable into the IN port on the SoHub to establish a power and data connection.
- Plug a USB Type A cable into the OUT port on the SoHub to connect additional SoHubs in a daisy chain setup.

See SoHo Telemetry Hardware connections section for details.

Universal System Hardware

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.

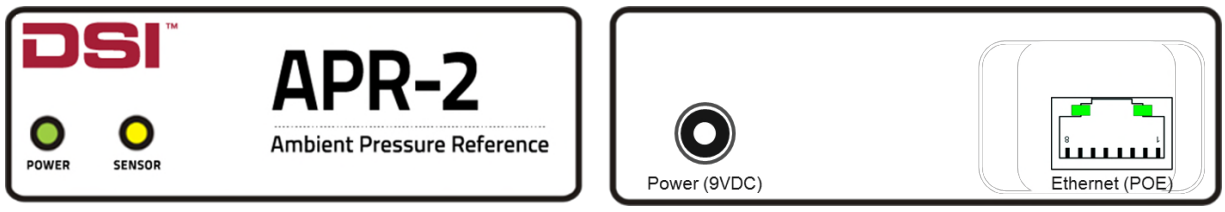
Note: Specifications for the APR-2 can be found in the Ambient Pressure Reference (APR-2) Hardware Appendix.

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
  - Netgear GS116PP-100NAS – 16-port Gigabit, unmanaged switch with 16-port Power over Ethernet plus (PoE+).

SignalSync

The DSI SignalSync permits users to acquire and time synchronize signals from third-party products with implantable telemetry data. The SignalSync can also be used independently from telemetry hardware as a standalone interface.

Dimensions	6.3 x 6.3 x 1.83 in. (160 x 160 x 46.4 mm)
Weight	.74kg

TOP PANEL

The top of the SignalSync contains the BNC connections used for analog inputs to the system. Detailed specifications of the inputs are listed below.

Illustration of the SignalSync top panel.

ANALOG CHANNEL INPUT SPECIFICATIONS

Connector Type	BNC
# Channels	16, Single-ended
Type of Coupling	DC
Resolution	16 Bit
Sample Rate	User selectable rates in software: 1, 10, 50, 100, 500, 1000, 2000, 4000 Hz
Input Voltage Range	±1V, ±2V, ±5V, ±10V, Not Used
Max Input (without damage)	±15V
Input Impedance	>100kΩ per input
Analog Bandwidth	200Hz

Accuracy

Range	Offset error (µV)	Absolute accuracy at Full Scale (µV)
±10 V	915	4075
±5 V	686	2266
±2 V	336	968
±1 V	245	561

Noise	10mV peak-to-peak (<0.2% full scale)
Synchronization with telemetry signals	<1 second

FRONT PANEL

The front panel contains the USB connection as well as indicators that provide a quick overview of the operational status.

Illustration of the SignalSync front panel.

Indicator	Color	Status
Power	GREEN	Constant ON when powered
Activity	GREEN	Blinks during communication, otherwise OFF

USB PORT

USB 2.0 Type A to Type B cable required for connection to an available USB port on PC.

Note: Do NOT connect the SignalSync to the USB output of the SoHub. It may not function correctly.

RIGHT SIDE PANEL

The right panel contains a 25 pin connector which is used for connection of a breakout cable that can be used for digital inputs.

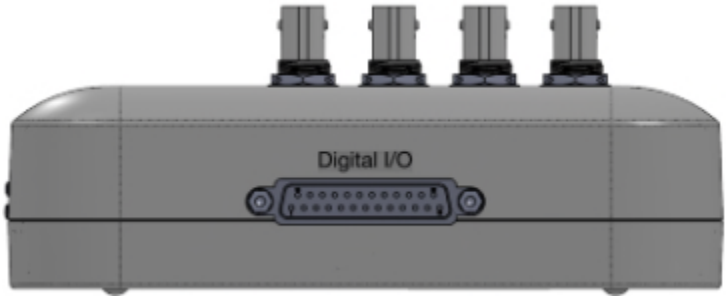
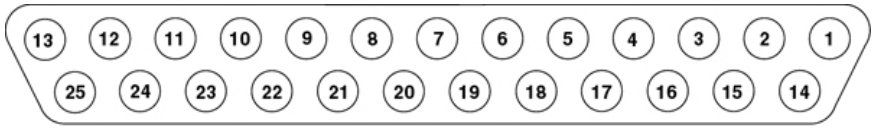


Illustration of the SignalSync right side panel.

DIGITAL CHANNEL INPUT SPECIFICATIONS

Connector Type	1, 25-pin D-connector
# Channels	8
TTL Compatibility	0-5V, Configured as pull up (+5V) for switch closure.
Sample Rate	100Hz fixed
Pinout	Pins 1-8 correspond to Digital Channels 1-8. Pins 9-13 must be left open. Pins 14-25 are ground.



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

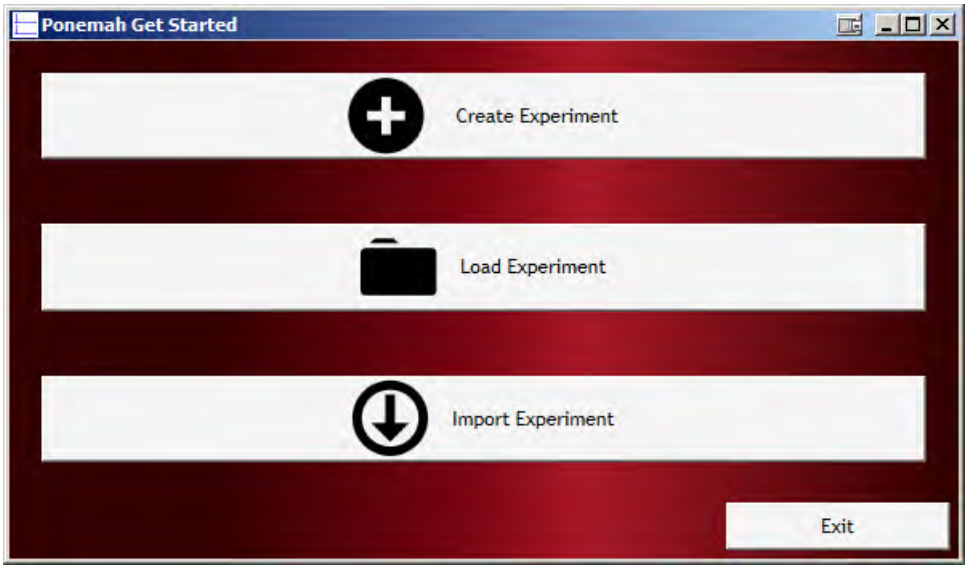
Note: Installation and Maintenance information can be found in the Software Appendix section.

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:

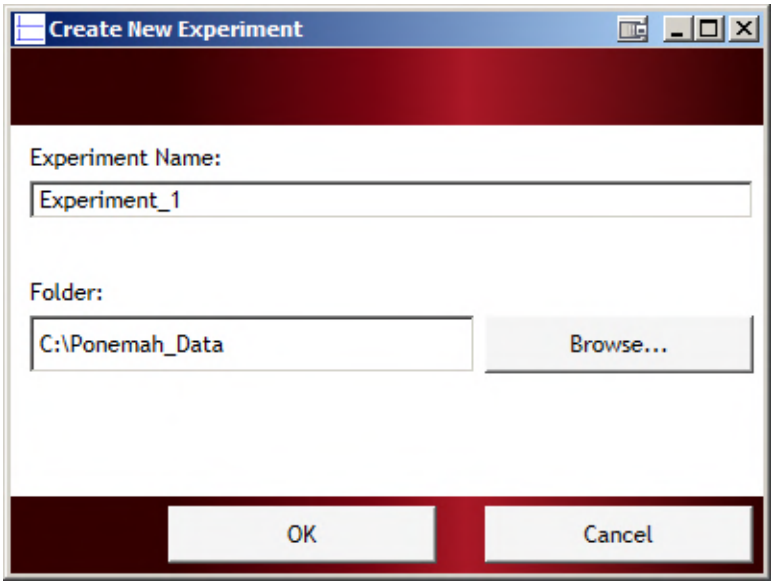
- **Experiment | Create…**
- **Experiment | Open…**
- **Experiment | Import…**

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:

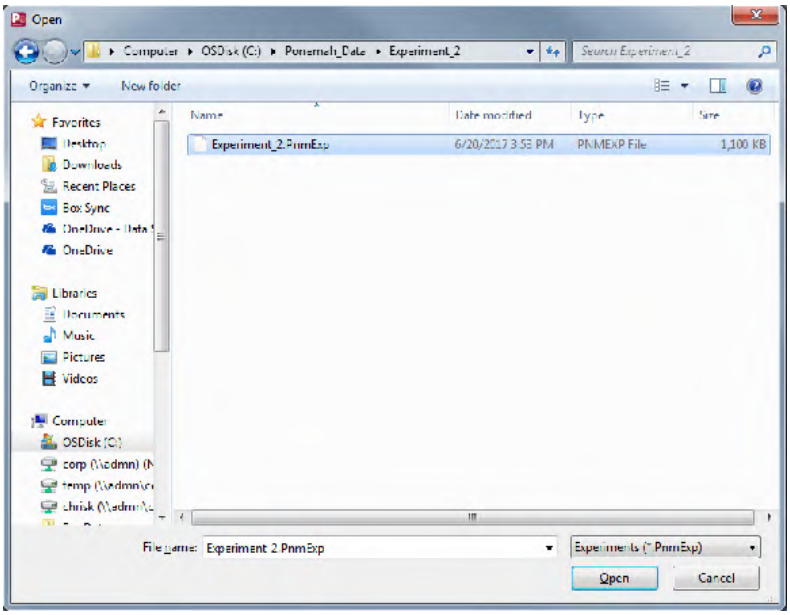
1. Accept the new **Experiment Name** or create a new name.
   Note: The Create New Experiment dialog will prompt you to accept a new sequential experiment name in the format "**Experiment n**" (where *n* represents a positive integer).

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…** .



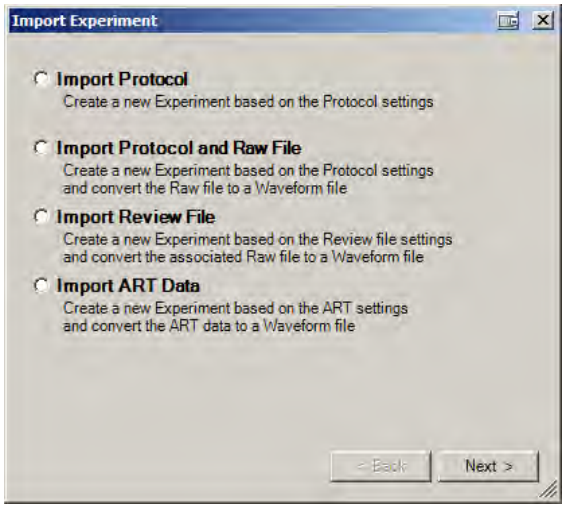
To load a previously created experiment:

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.

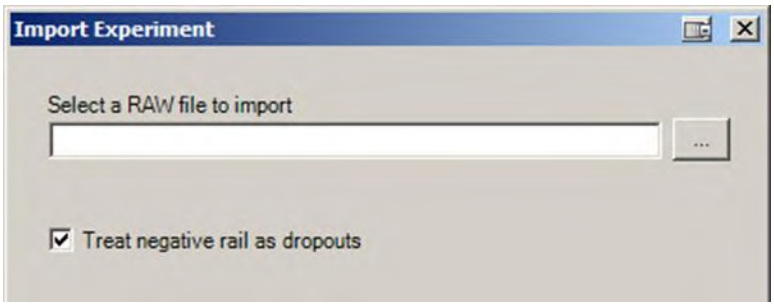
IMPORT REVIEW FILE

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.

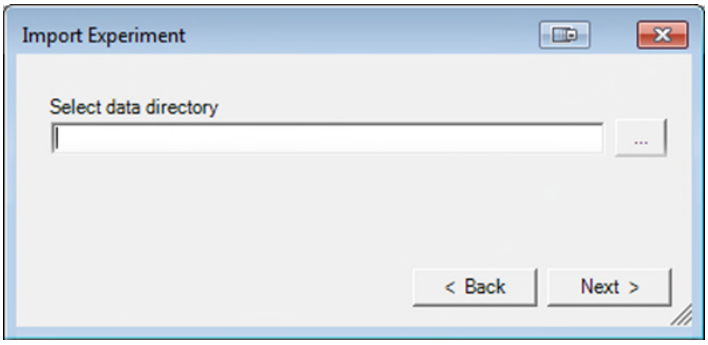
**Note*: negative rails are caused by invalid data due to varying reasons being sent to the application. These values are converted to a dropout value so it can be ignored by the analysis modules and not used in any calculations.



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

See the DSI Implantable Telemetry System Manual for interface setup

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.

- **SoHo**
  Used to configure hardware and implants when using DSI's SoHo implantable telemetry platform.

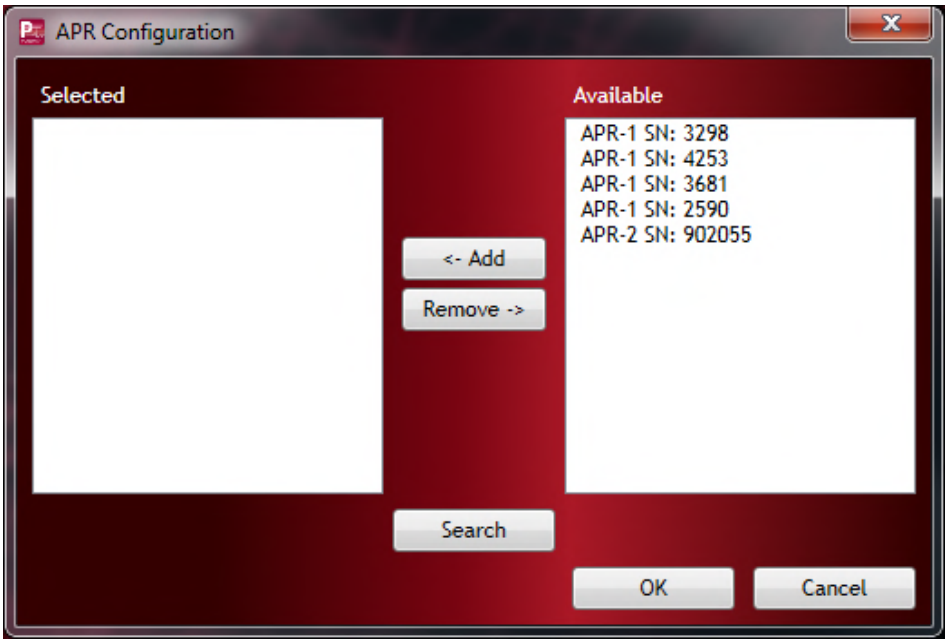
- **SignalSync**
  Configure the SignalSync analog and digital inputs.

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.

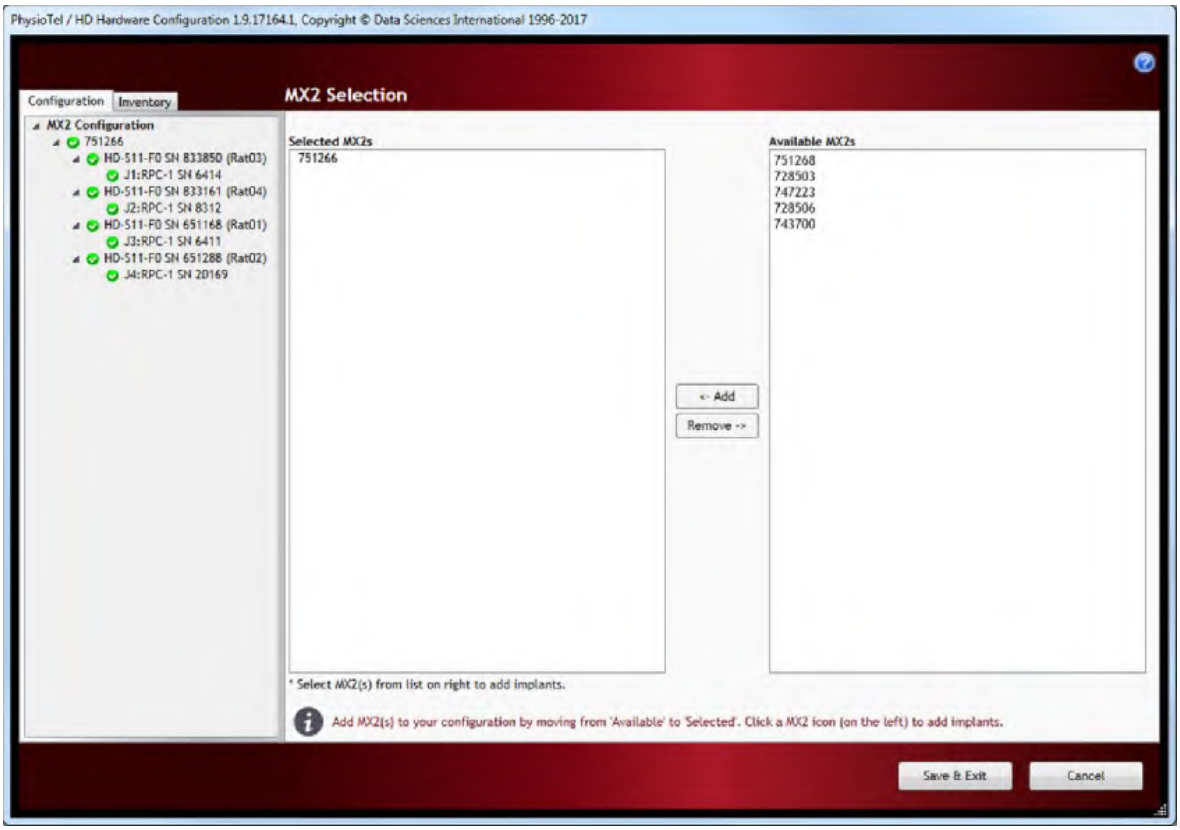
Edit PhysioTel /HD (MX2) Configuration

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…**

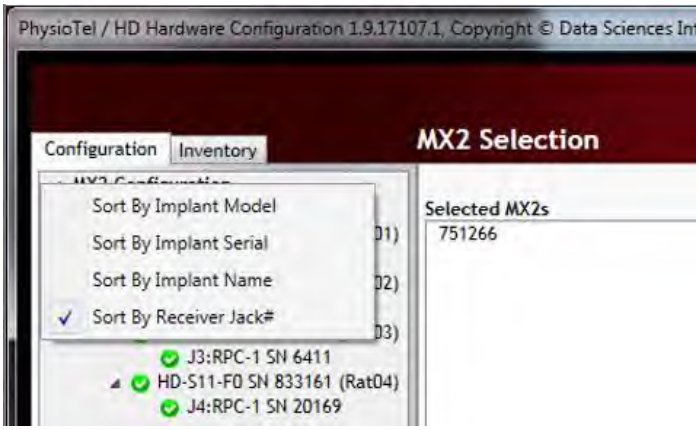


There are two functional areas in the **Configuration** dialog:

- 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)

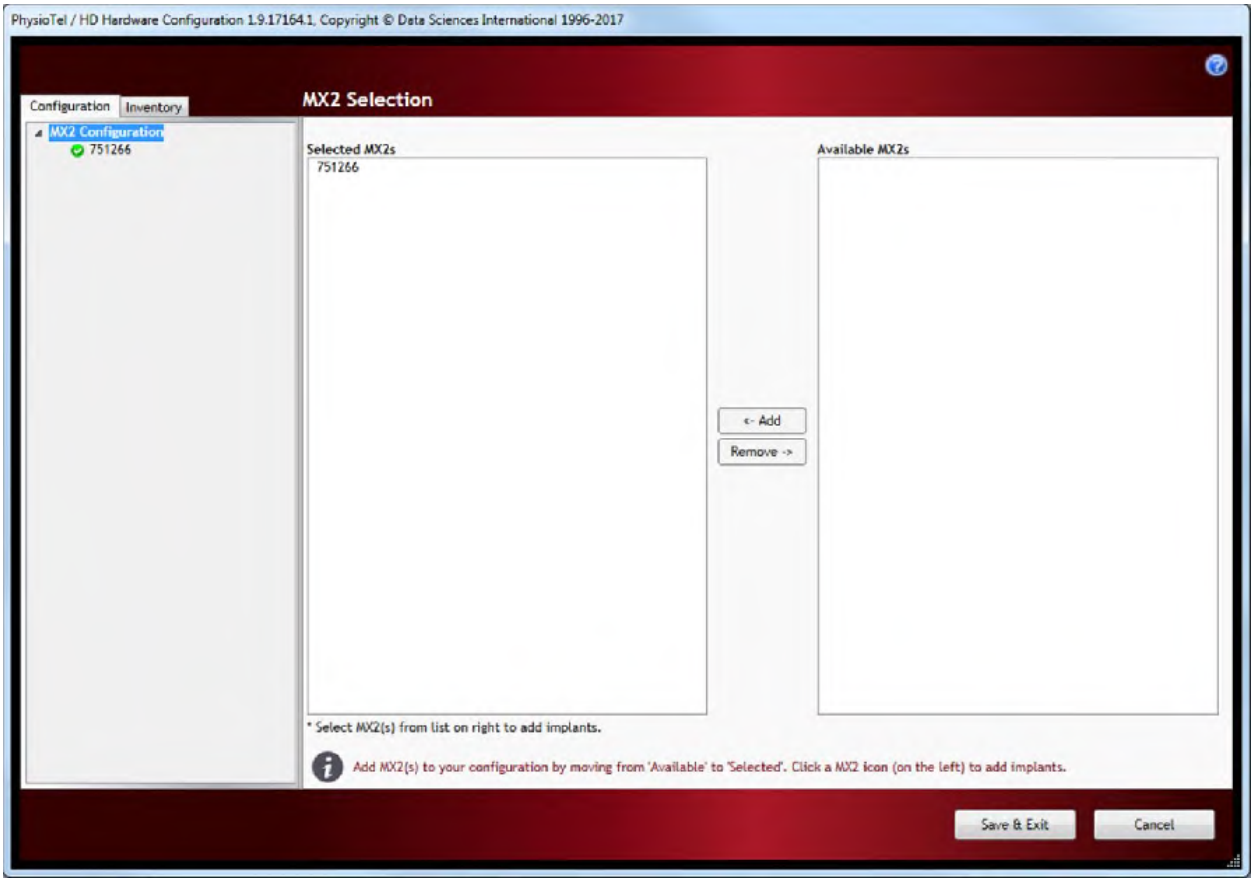


Configuration

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.

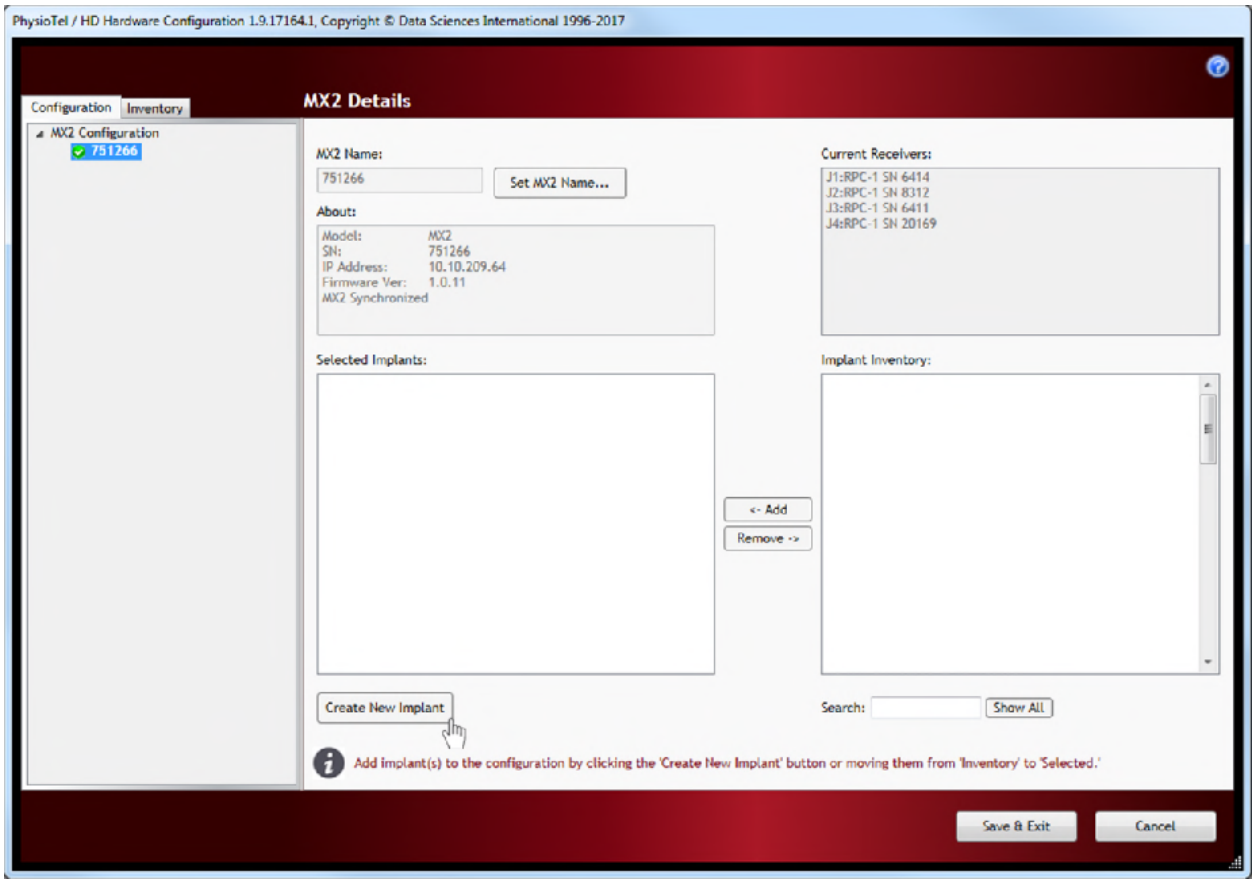
Disabled – a red colored icon with exclamation mark indicates the MX2 is not currently available (e.g. in configuration but not connected to the network) or is currently configured in an Experiment on another system.

Synchronizing – a yellow colored, time icon indicates thes 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.

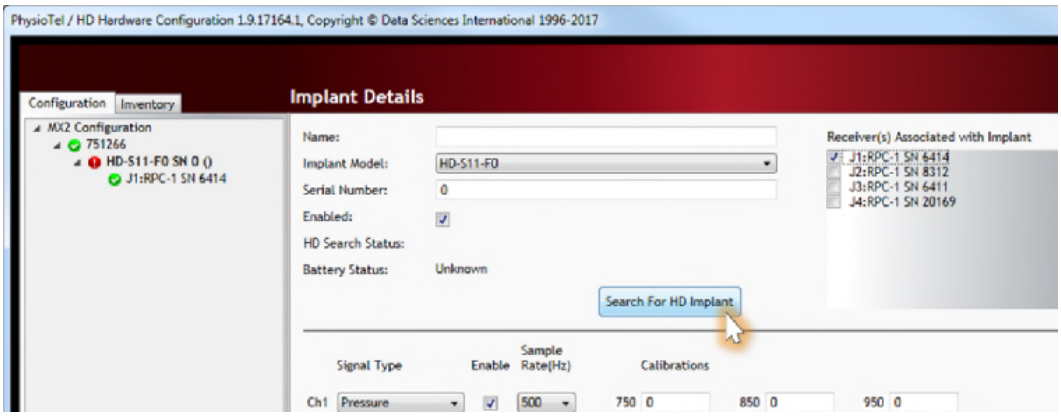


Note: Implants can be added to an MX2 by selecting the **Create New Implant** button or by click-and-dragging pre-configured implants from the **Inventory** list. Please see the Inventory section of the manual to learn more about this feature.

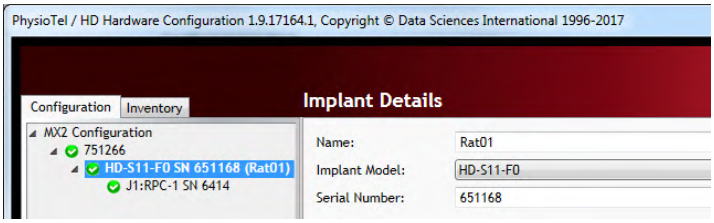
5. **For PhysioTel HD Implants**:
    a. Select the **Implant Model** using the dropdown menu.
    b. Associate a receiver(s) with the implant by checking the receiver checkbox you wish to configure it on. This will enable the **Search for HD Implant** button.

        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

a. Enter the **Implant Name** and select the **Implant Model** using the dropdown menu.
b. Enter the **Implant Serial Number**.
c. Enter the **Calibration Values** located on the back of the implant packaging to correspond with the appropriate channels.
d. 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.

6. 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.
7. 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.

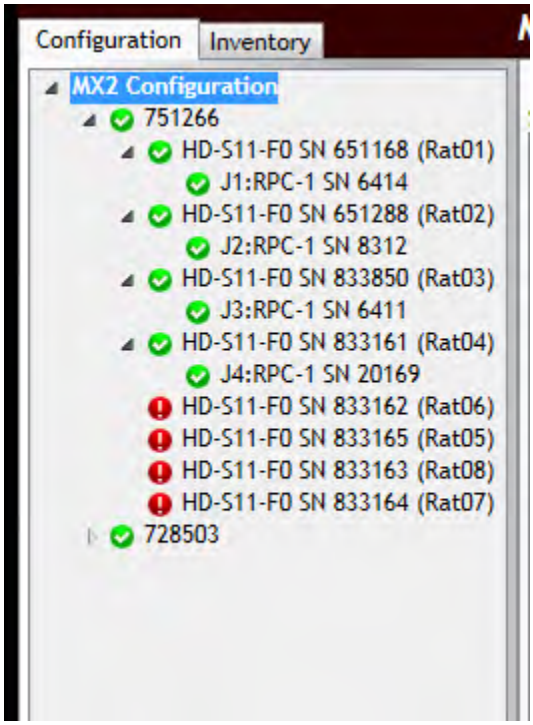
Disabled – a red colored icon with exclamation mark indicates the implant is not currently available (e.g. in configuration but does not have at least one Receiver selected).

- *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.

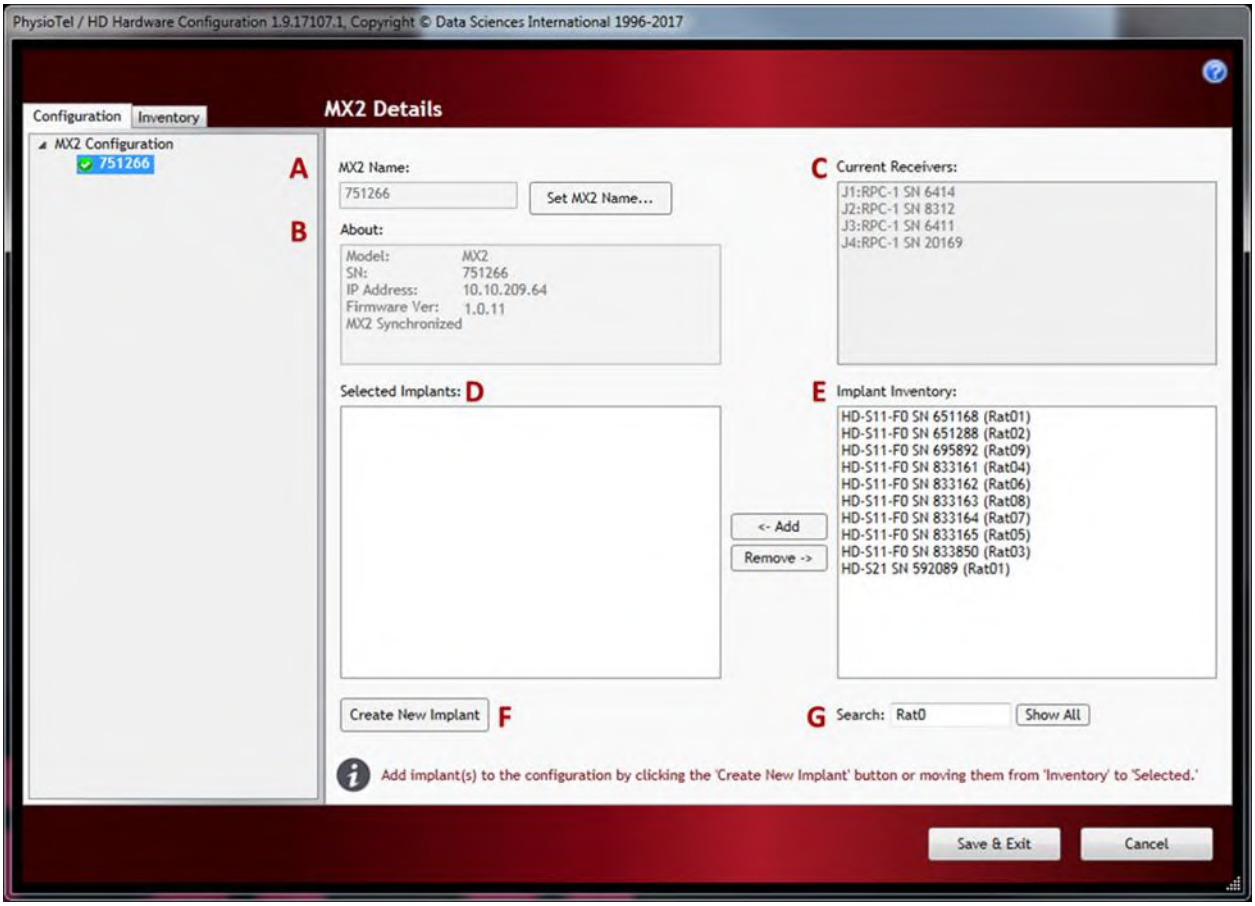
The **MX2 Configuration** is the first line in the List View and displays the **Selected MX2** for the current configuration.

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.

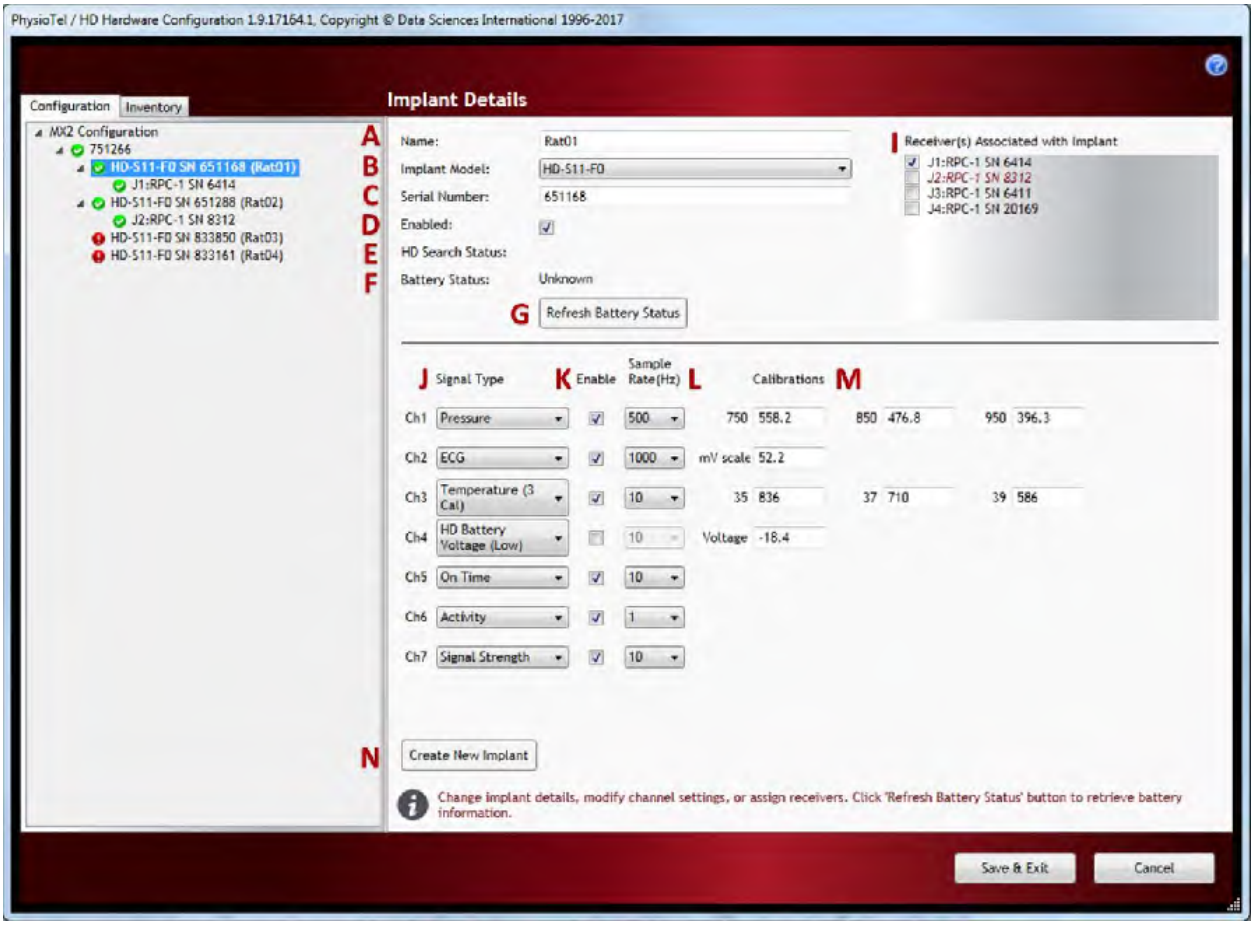


The following features are available in the **MX2 Details** dialog:

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.

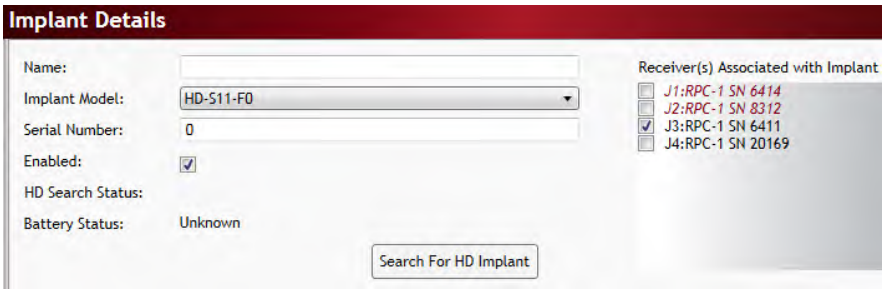
> ⚠ *WARNING: if the implant is not **Enabled**, the implant will still be powered **ON** and in communication with the system, but no data from the implant will be acquired.*

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 Batter 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.



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.

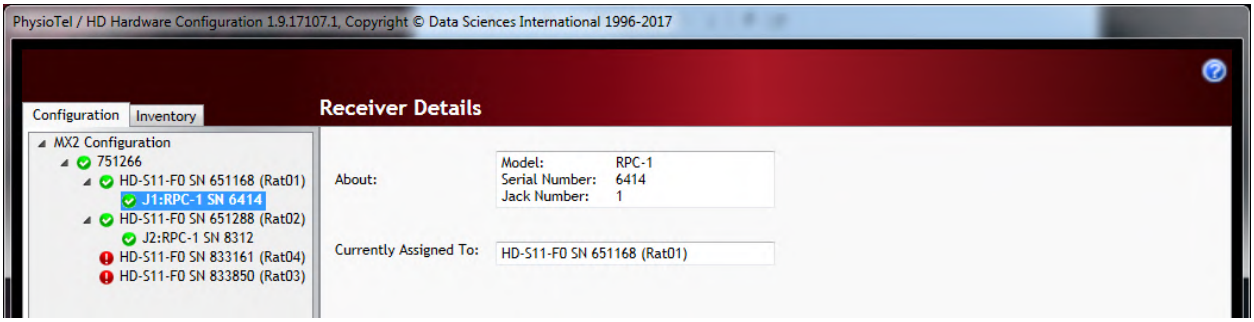
L. **Sampling Rate**: allows the user to define a unique sampling rate to each implant channel.

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.

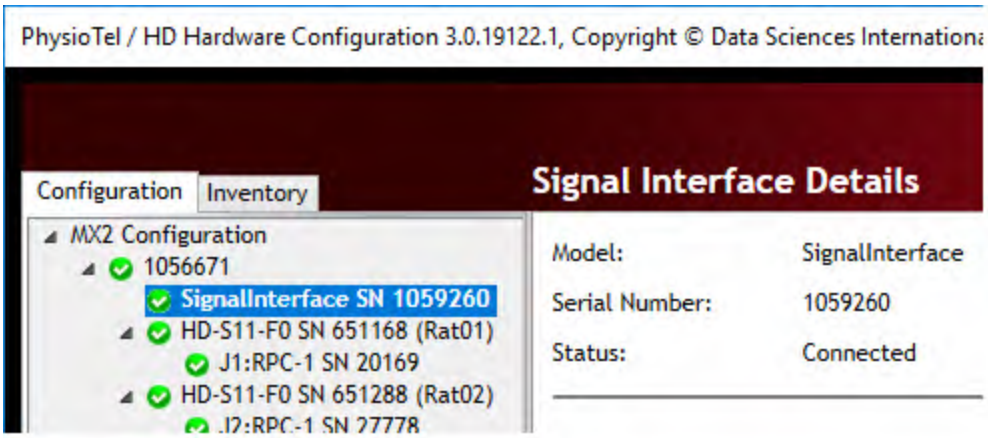
RECEIVER DETAILS

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.



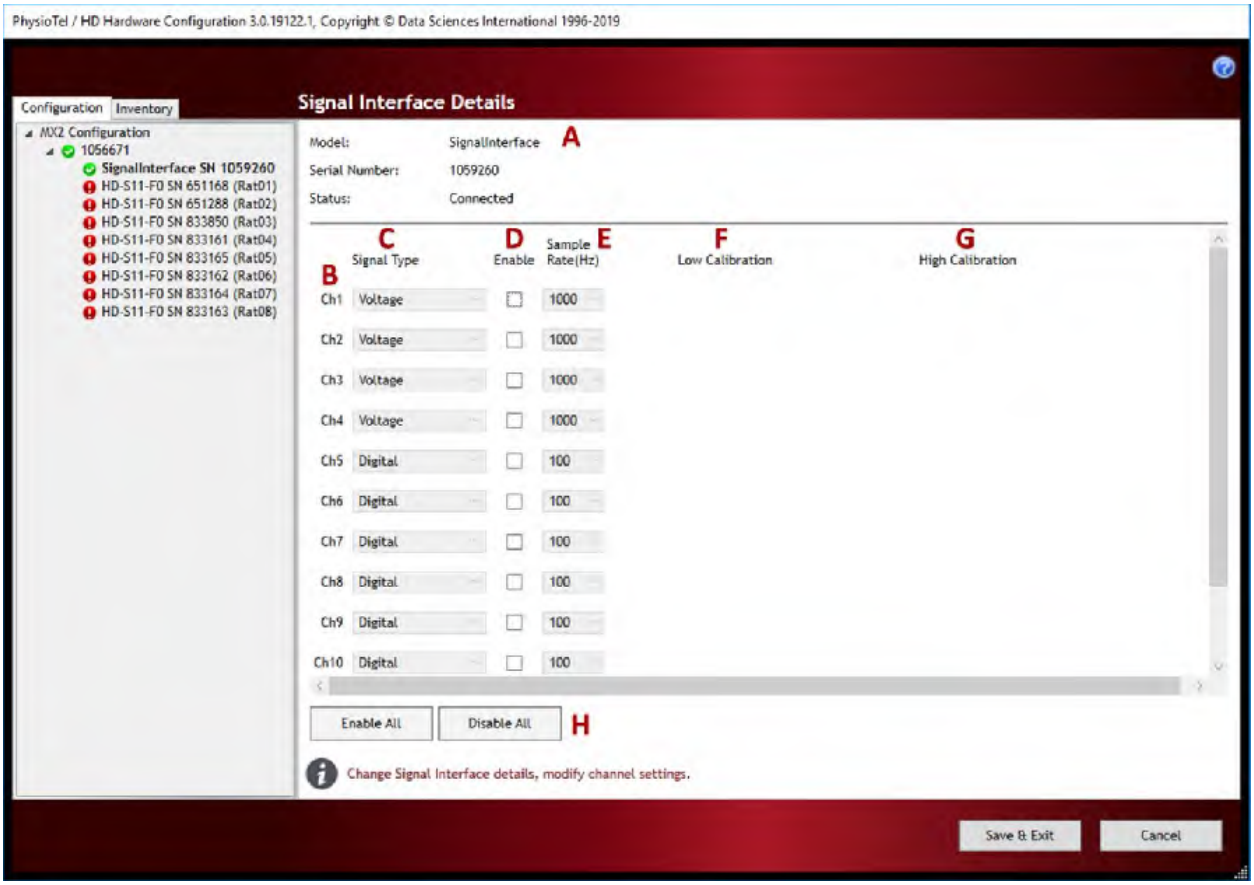
Signal Interface Configuration

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.

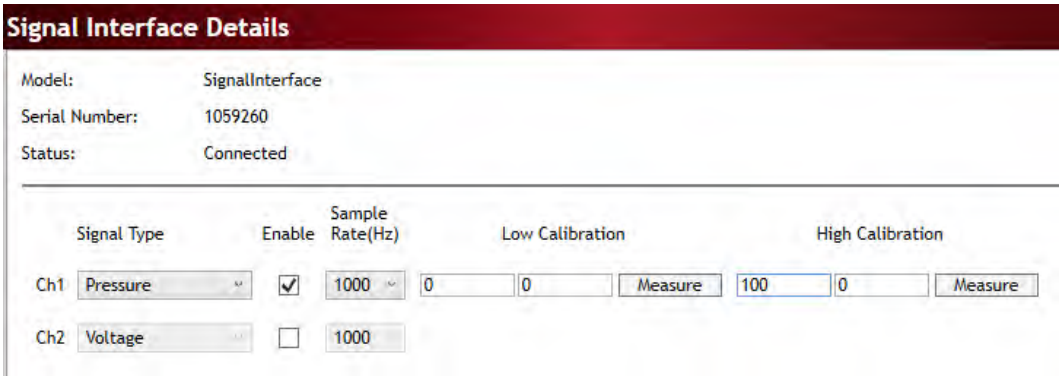
H. **Enable All/Disable All:** these buttons toggle the checkboxes of all 12 channels to Enabled or Disabled.

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.



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

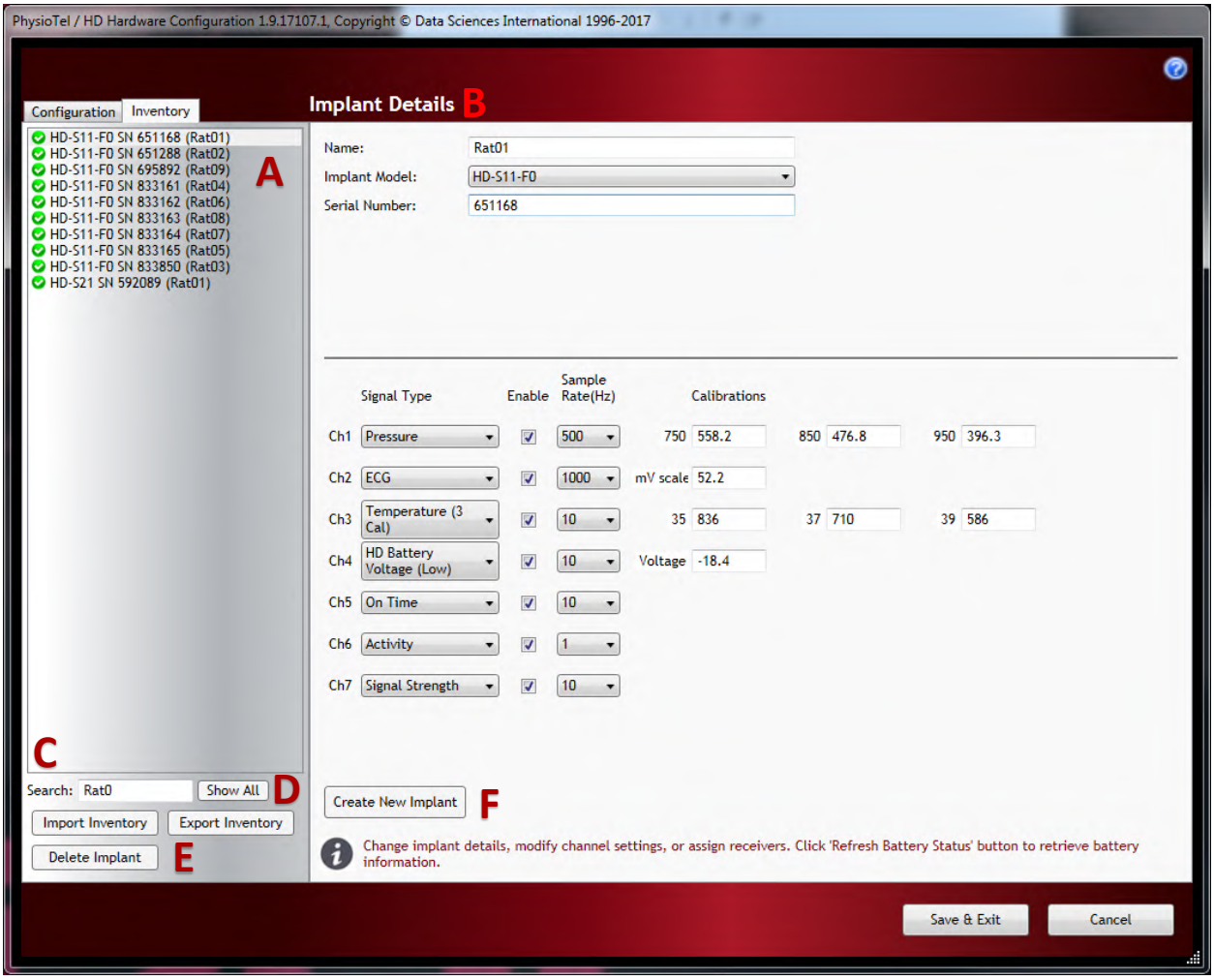
The **Inventory** is a repository for the storage and retrieval of implant details which have been configured in the current Experiment, or previously configured Experiments. The implants contained within the Inventory can be used across Experiments without having to re-configure the implant within each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

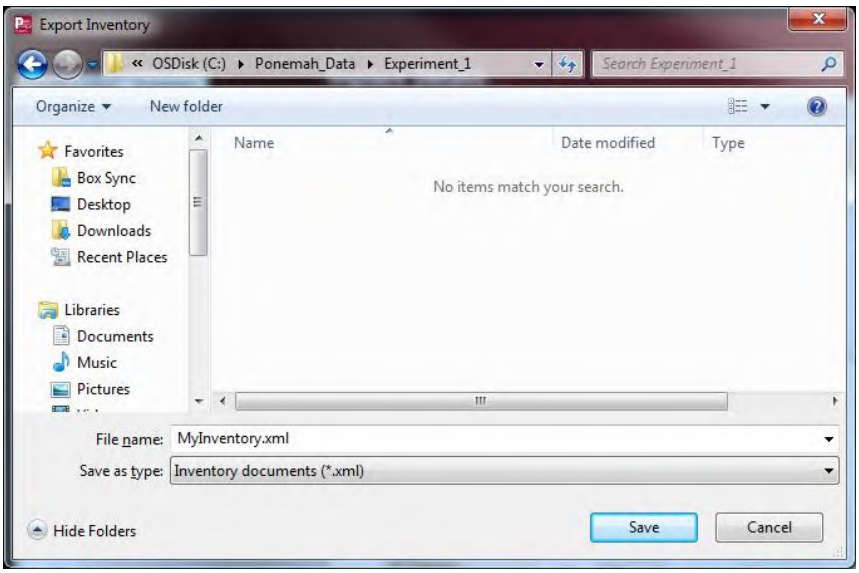
A. **List of Implants**: lists the implants available from the Inventory.
B. **Implant Details**: allows the User to configure individual implants.
C. **Search**: allows the user to query the Inventory to locate specific implants. User can locate implants by model or serial number.
D. **Export/Import 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.

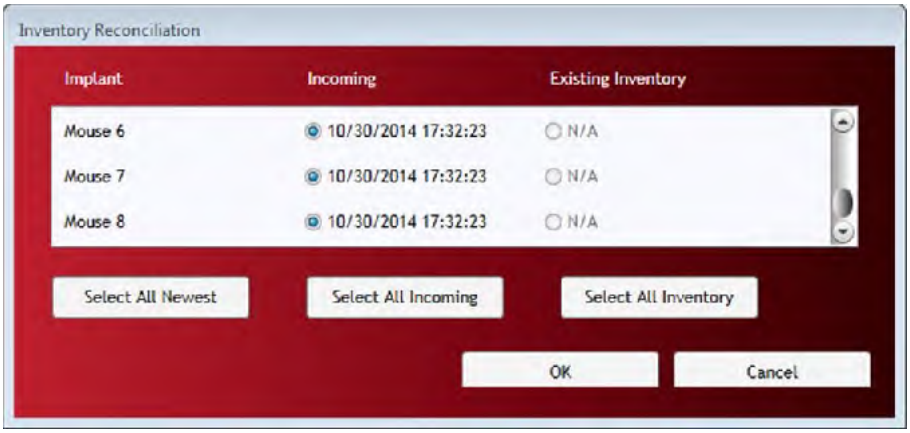


2. The default filename is **MyInventory.xml** but the user may use any filename with an .xml file extension.
3. Click **Save**.

   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

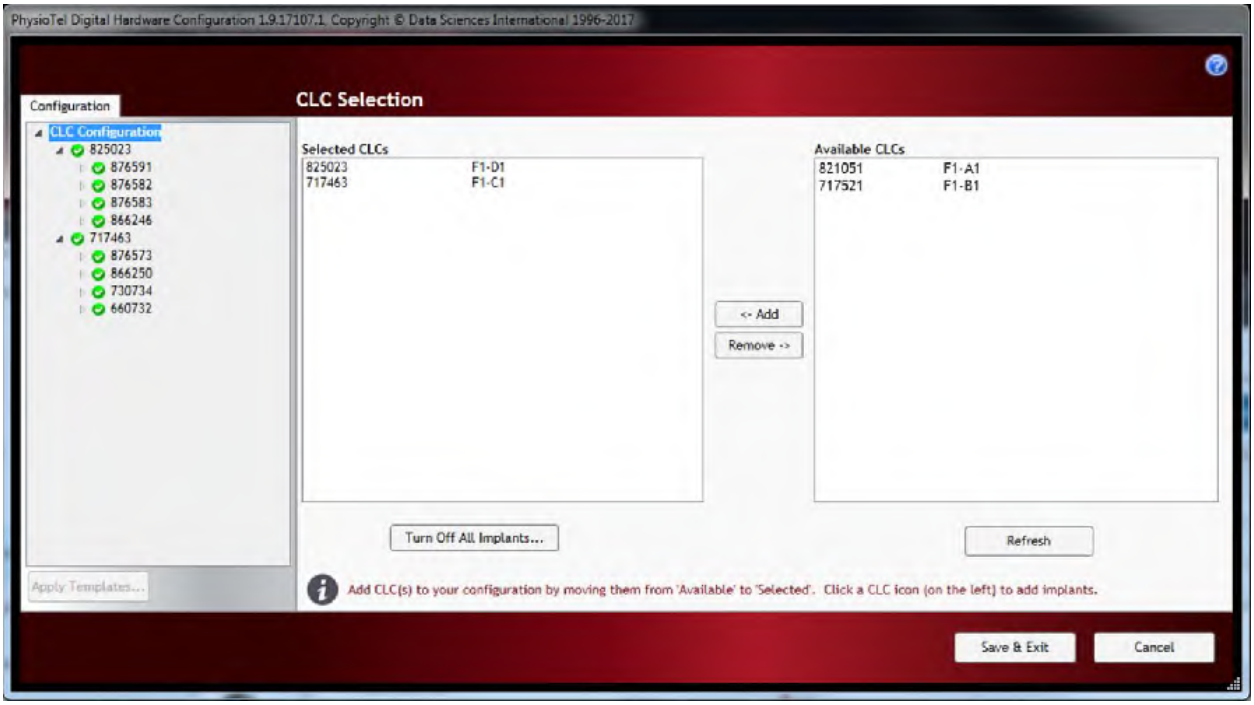
The PhysioTel Digital system automates the collection of physiologic data from freely moving research animals via wireless telemetry. The system consists of a sophisticated acquisition and analysis software platform and a family of advanced, state of the art implantable telemetry transmitters. The communications 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.



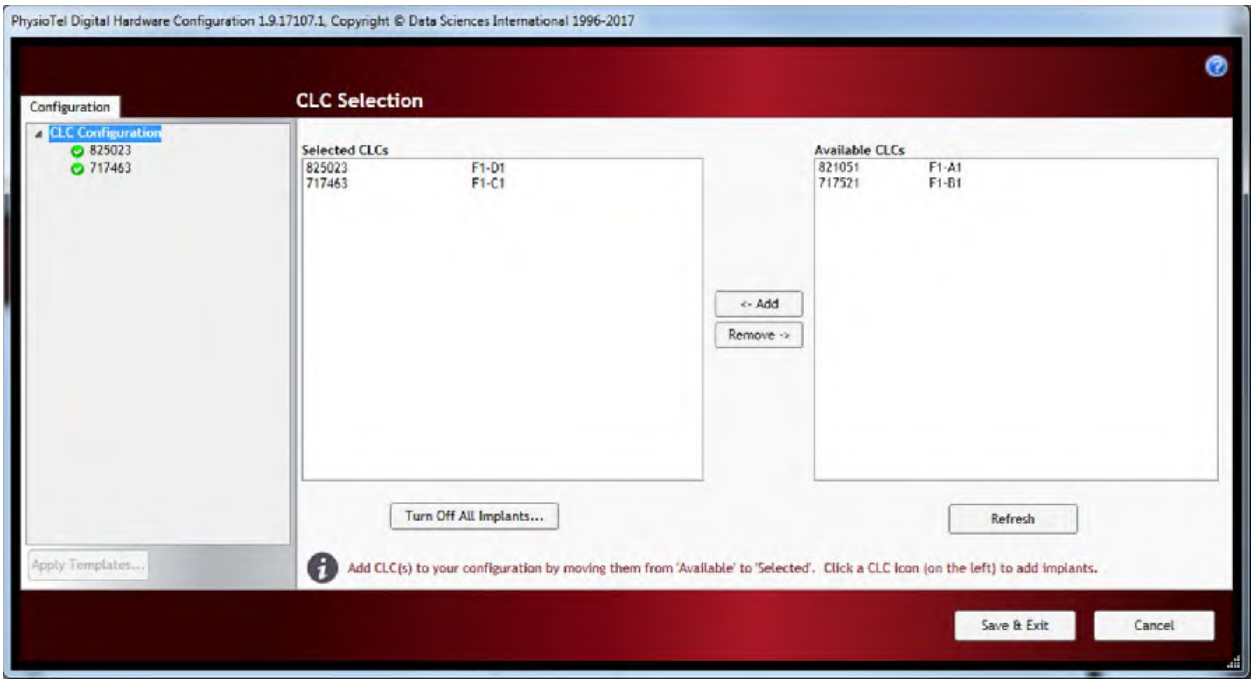
Configuration

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.

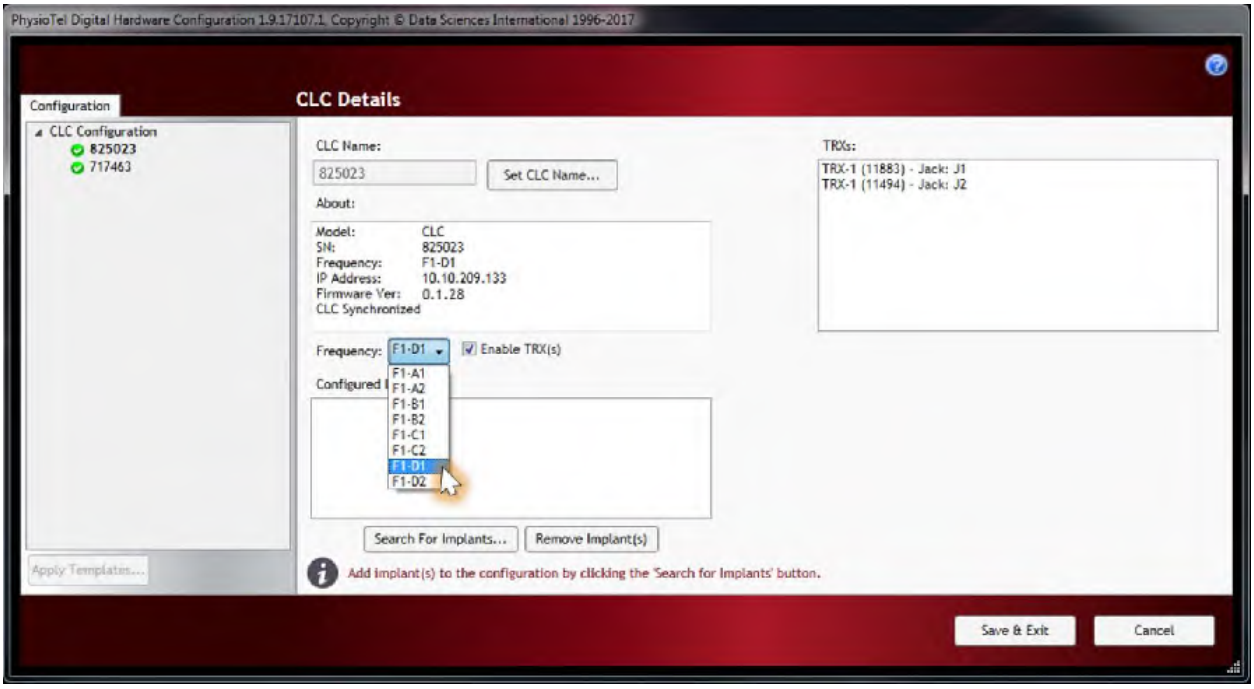
Disabled – a red colored icon with exclamation mark indicates the CLC is not currently available (e.g. in configuration but not connected to the network) or is currently configured in an Experiment on another system.

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.

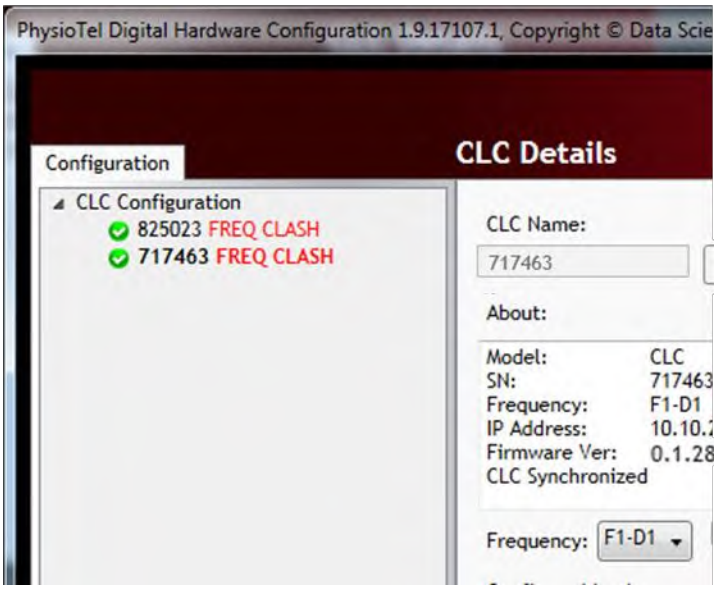
Unknown – a yellow colored icon with question mark indicated the CLC is connected, but does not have any TRXs connected.

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).

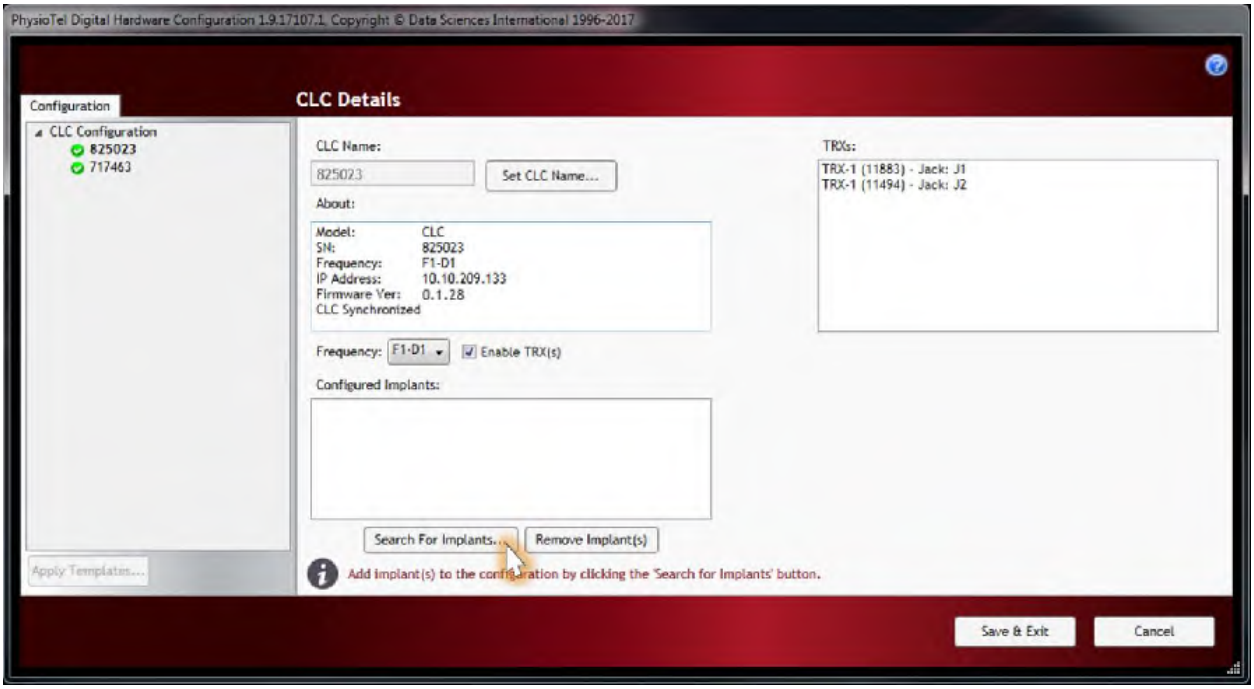


5. Repeat Steps 3 and 4 for any additional CLCs within your configuration. Ensure each is assigned a unique frequency. If you choose a frequency previously defined to another CLC, a **FREQ CLASH** notification will be placed next to the CLCs with conflicting frequencies.

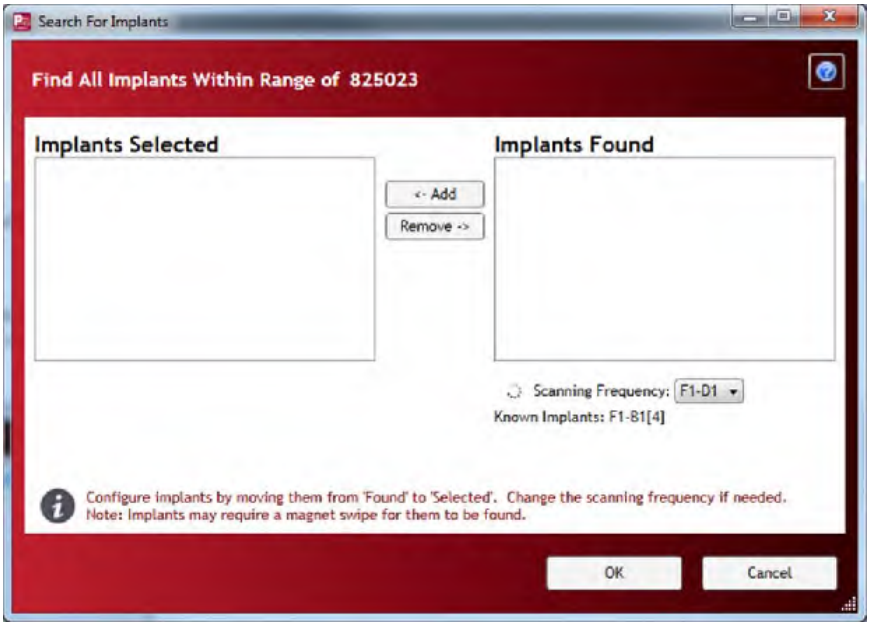


Note: FREQ CLASH will also be displayed should the frequency of a configured CLC be the same as the frequency of another CLC on the network (Available CLCs column within the CLC Configuration line of the List View). If these CLCs are spaced appropriately, they should not interfere with each other.

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

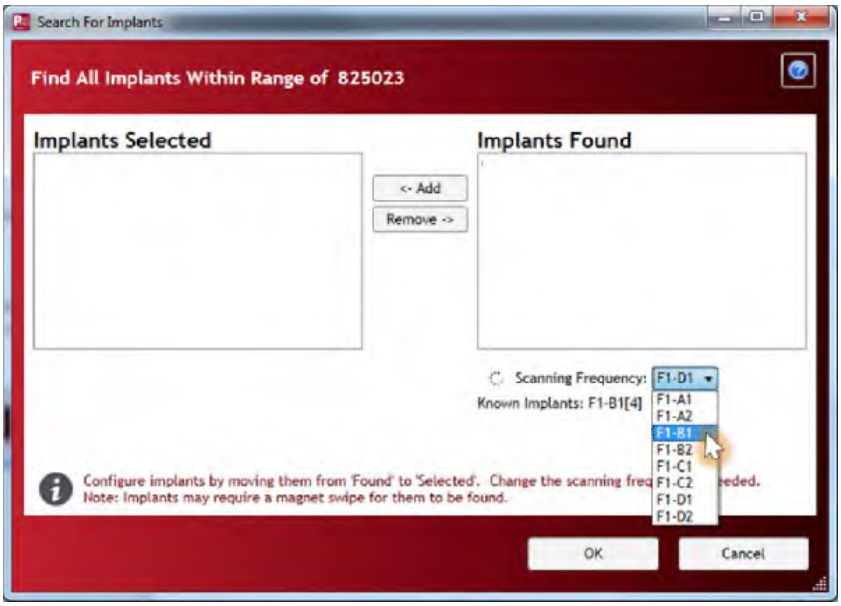


The *Search for Implants* dialog will display and automatically begin searching for implants across all supported frequencies if they are powered ON and within transmitter range. Any implants in Standby Mode and on the CLC's current frequency will be displayed in the **Implants Found** column.

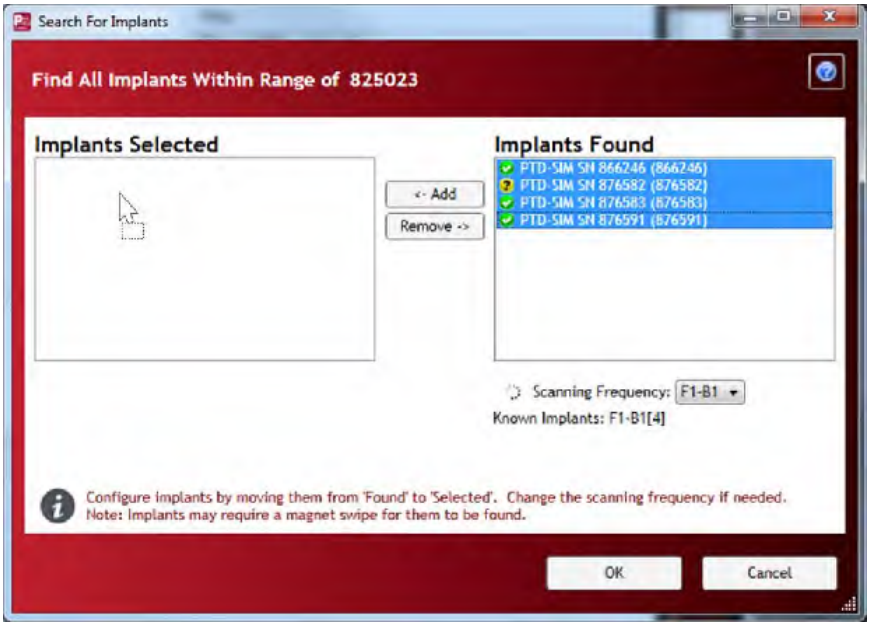


*Note: The **Known Implants** line will provide guidance on which frequencies the CLCs are seeing implants on, as well as the number of implants in brackets on that frequency. New implants that have not been previously configured will be detectable using the default frequency (**B1**).*

7. 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).



8. 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 multiselected.



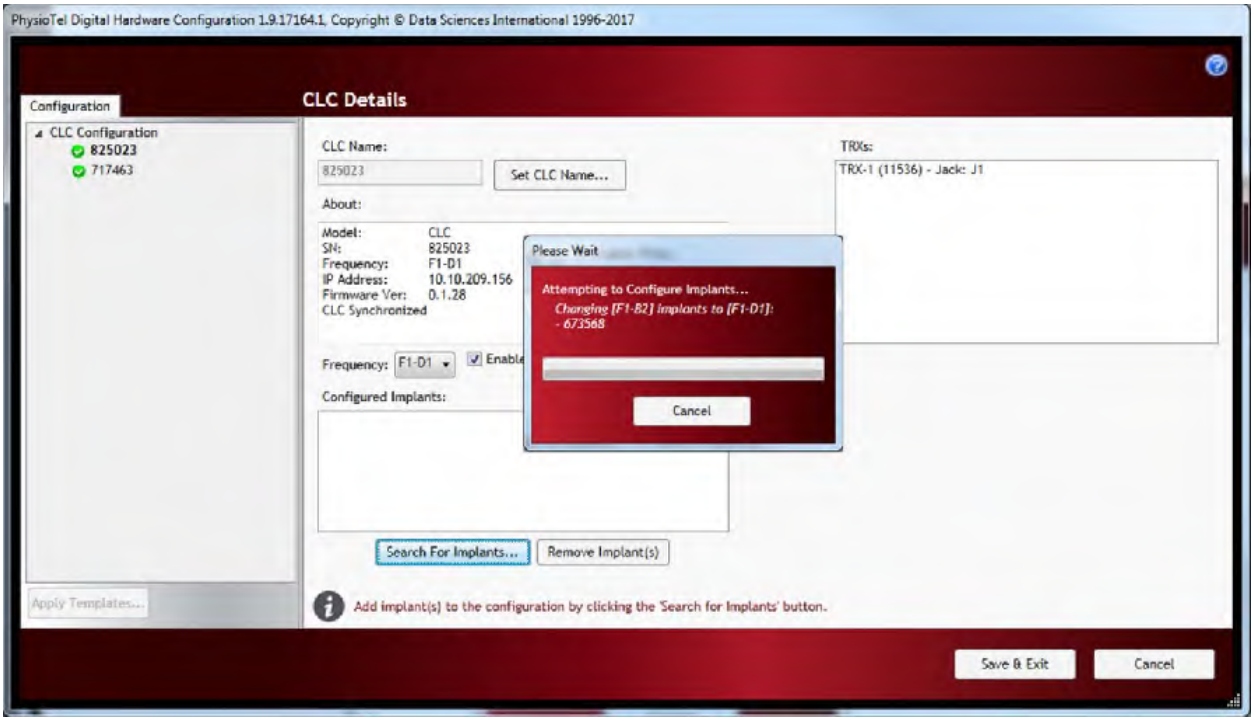
*Note: Implants only need to be listed in the **Implants Found** column to be added to the **Implants Selected** column. Their icon color and indication have no bearing on this action.*

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.

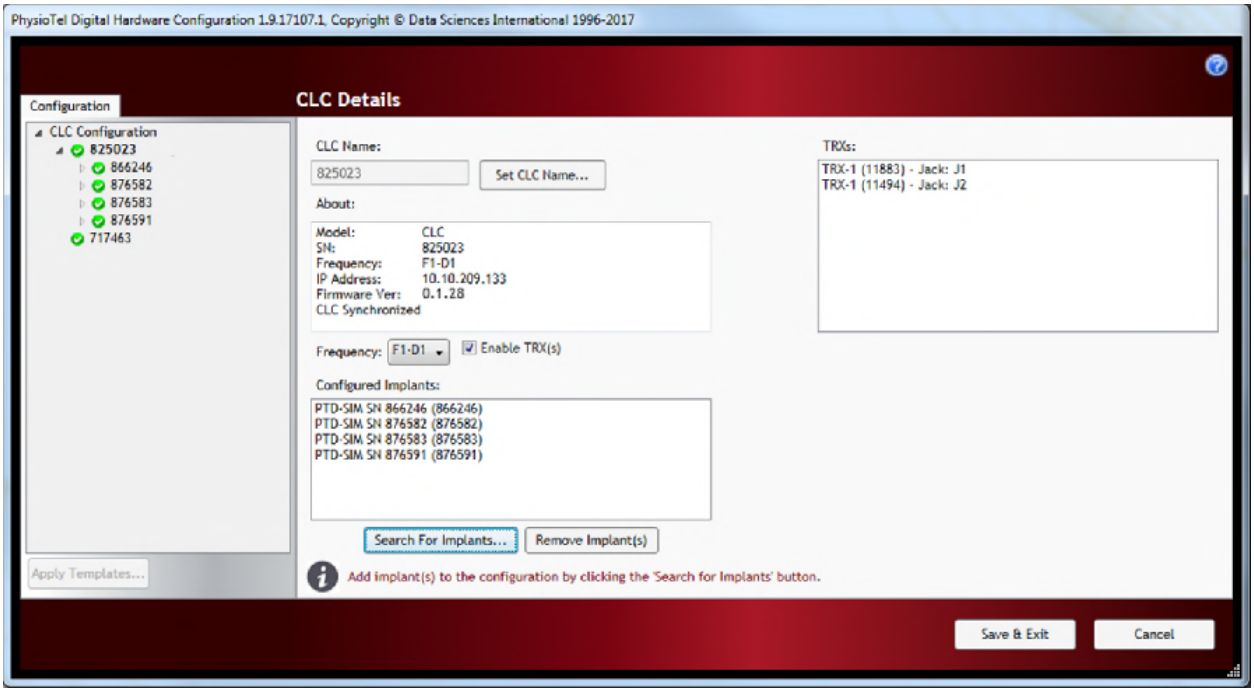
9. Click **OK**.
   Again, no need to wait for icons to turn green. A message will be displayed requesting you to wait for the implants to be configured to their new frequencies.



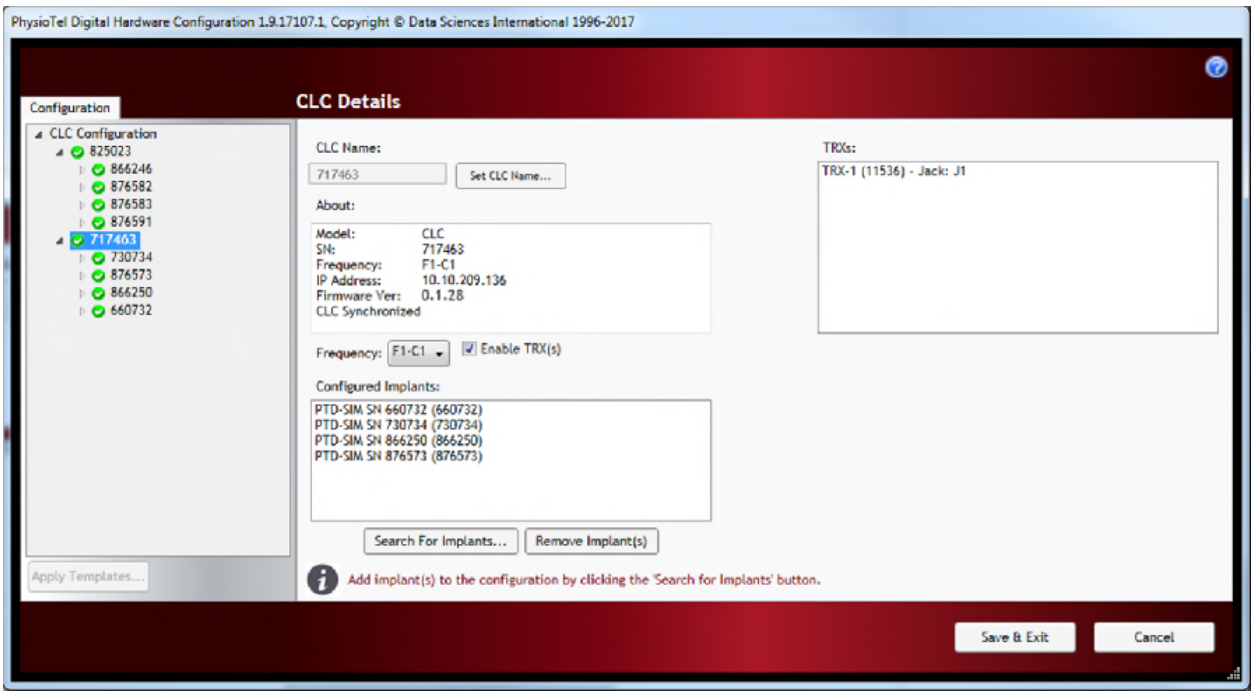
WARNING: Do not unplug any connected hardware during the programming process.

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.

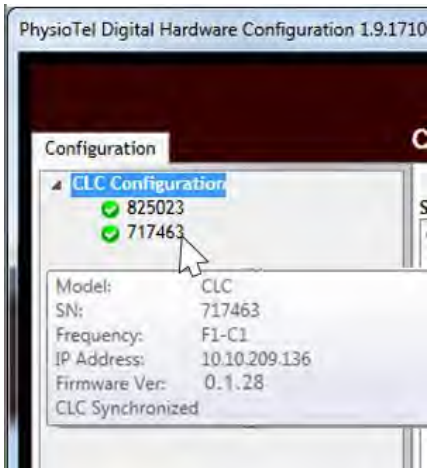


12. Once complete, click the **Save & Exit** button.

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.

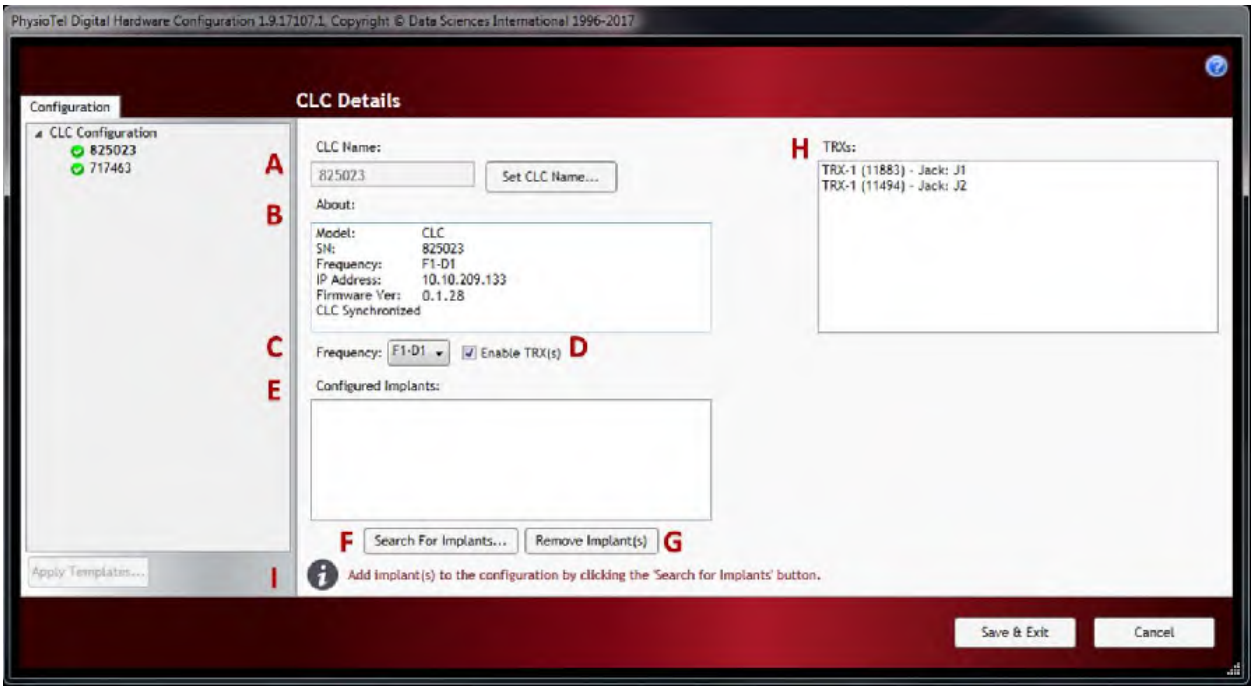


The **CLC Configuration** is the first line in the List View and displays the **Selected CLC** for the current configuration.

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

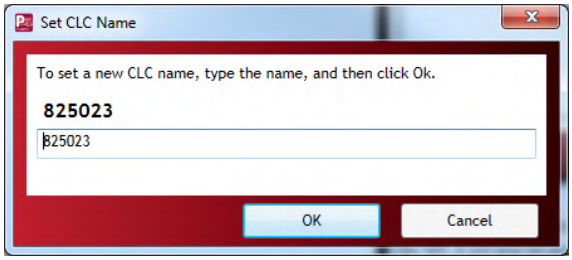
CLC Details

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**.

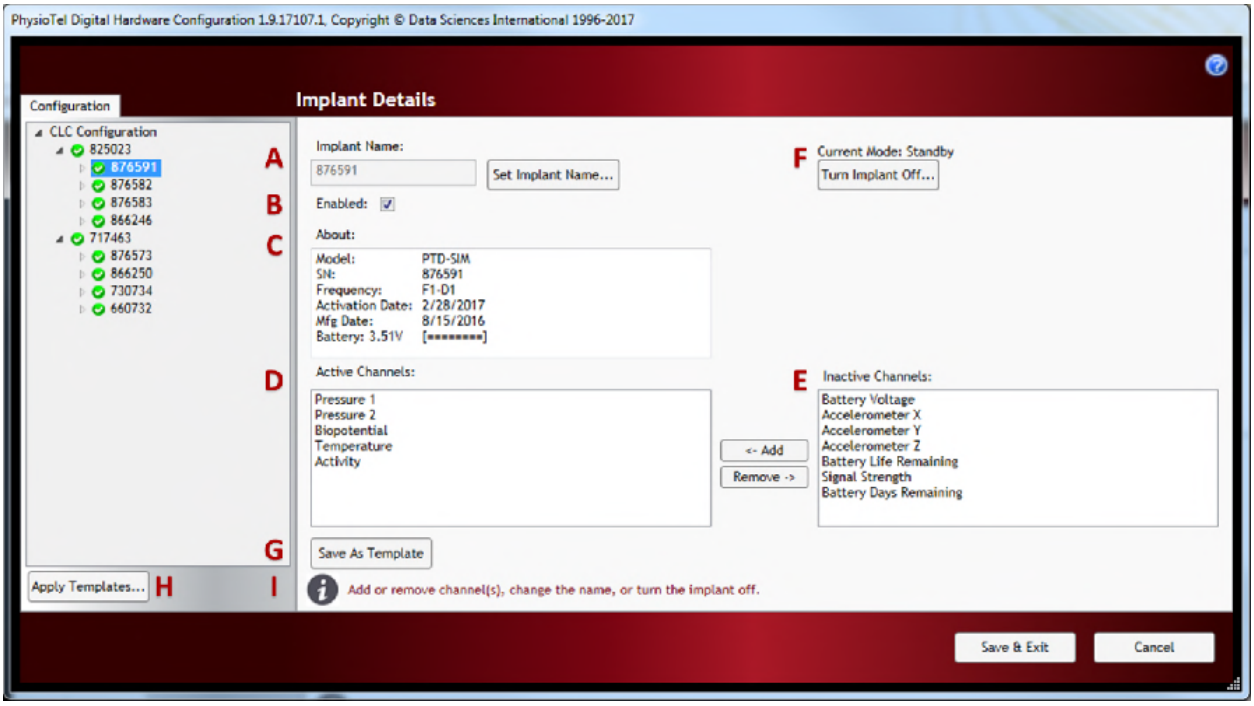


B. About: Important information including CLC model and serial numbers, current frequency, IP Address, and Firmware.

		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.

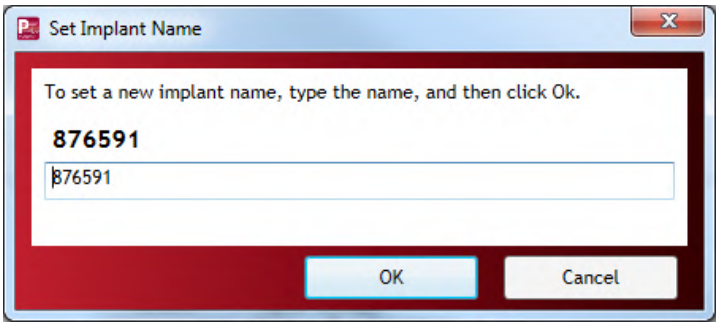
Implant Details

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.

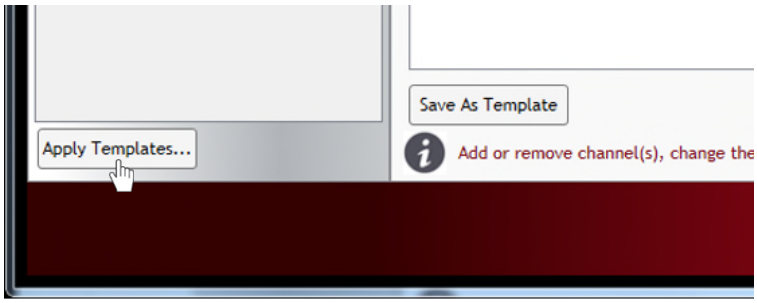
To create a Model Template:

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.

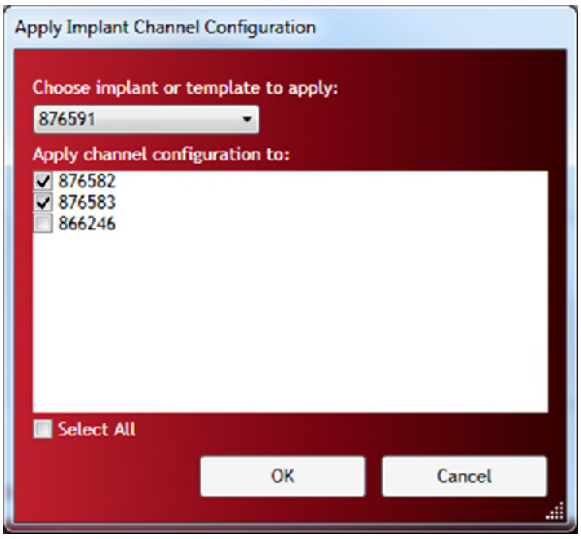
Note: Only one Model Template can be saved per implant model type.

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.
3. 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.



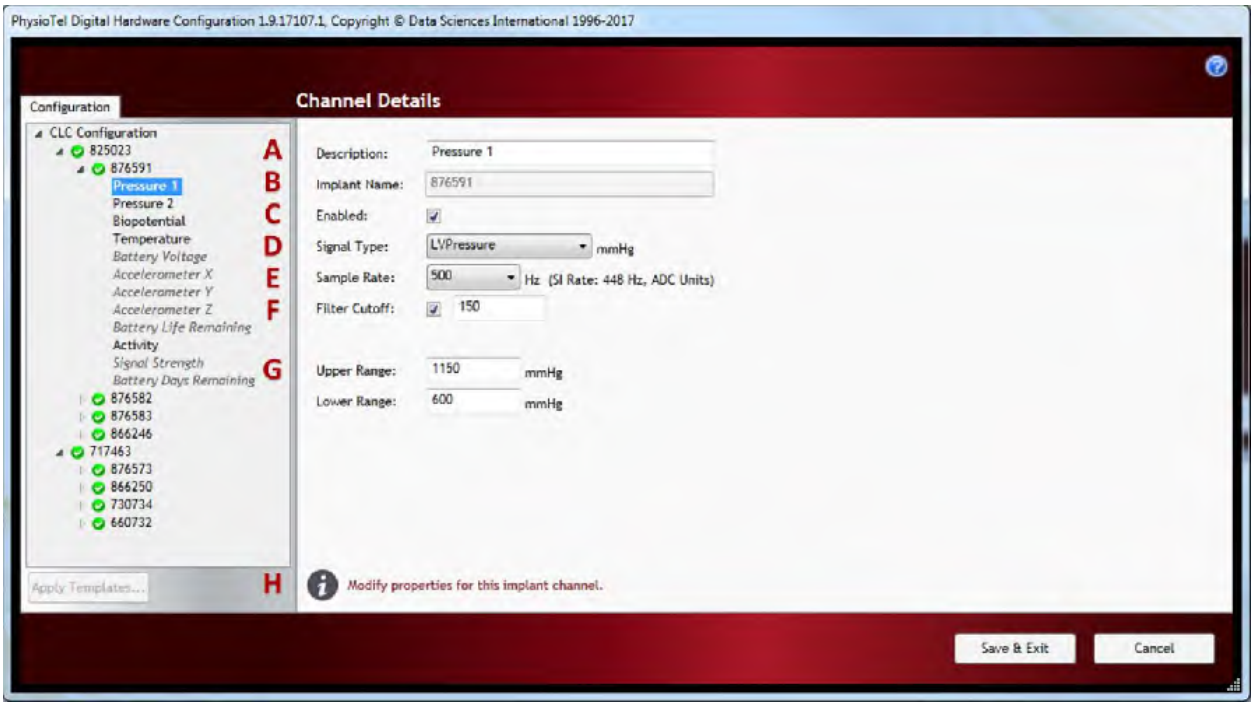
4. The **Select All** check box can be used to select/deselect all implants in the dialog box.
5. Click **OK** to apply the saved template configuration.

6. 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.

Edit SoHo Configuration

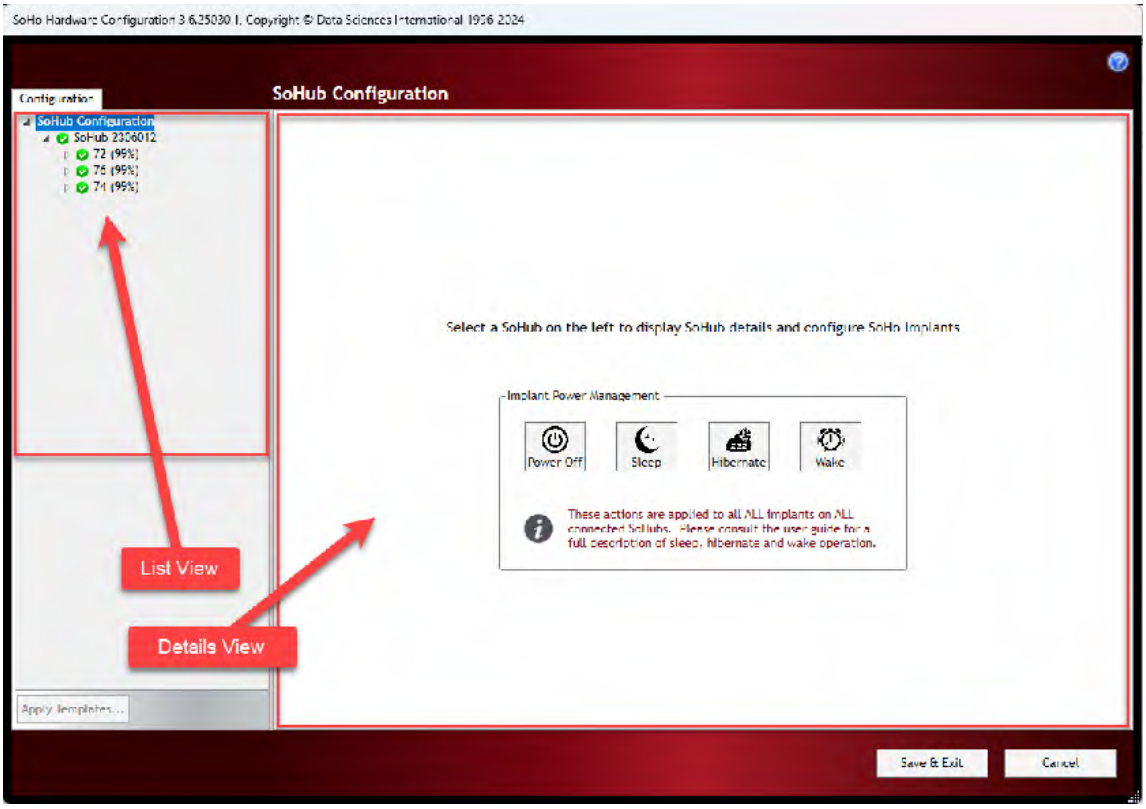
The SoHo telemetry platform automates the collection of physiological data from freely moving research animals via wireless telemetry. The system consists of a sophisticated acquisition and analysis software platform and a family of advanced, state-of-the-art implantable telemetry transmitters.

The SoHo Configuration allows a user to add SoHo implants to the system, associate implants with the appropriate SoHub for data collection and change implant mode (turn off, sleep, hibernate, wake up).

The SoHo Configuration dialog is launched from the **Hardware** menu.

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

- The "**List**" view on the left is a container which tracks the growing hardware configuration. When the dialog is opened all currently connected SoHubs will be displayed. As implants are added 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.



SoHub Configuration

The **SoHub Configuration** is the first line in the List View. When selected it will indicate in the Details Section to the right to select a SoHub for implant configuration, and it also introduces the **Implant Power Management** box which allows implants to be set to different power states to optimize and save battery life.

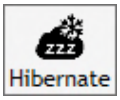
Implant Power Management

Note: The Implant Power Management is available at different levels and will affect either ALL IMPLANTS (SoHub Configuration level), ONLY IMPLANTS on a given SoHub (Sohub level) or just an individual implant (implant level).

Sends a command for implants to power off. See Implant Deactivation for details.

Warning: The Power Off button will send the command for implant to power off continuously for one minute. If the implant is turned back on with a magnet within the minute after clicking Power Off, it will shut off.

Sends implants to Sleep Mode. Implants can be taken out of Sleep Mode using the Wake function. See Implant Operation Modes for details.



Sends implants to Hibernate Mode. Implants can be taken out of Hibernate Mode using the Wake Function. See Implant Operation Modes for details.

Begins the process to Wake implants from either Sleep or Hibernate Mode. The time to wake can vary. See Implant Operation Modes for details.

Configuring Implants

The **SoHo Configuration** allows you to add SoHo implants to the system and associate them with the appropriate SoHub for data collection.

To begin your configuration process:

1. Select an available **SoHub** from the **Configuration** tab's **List View**.

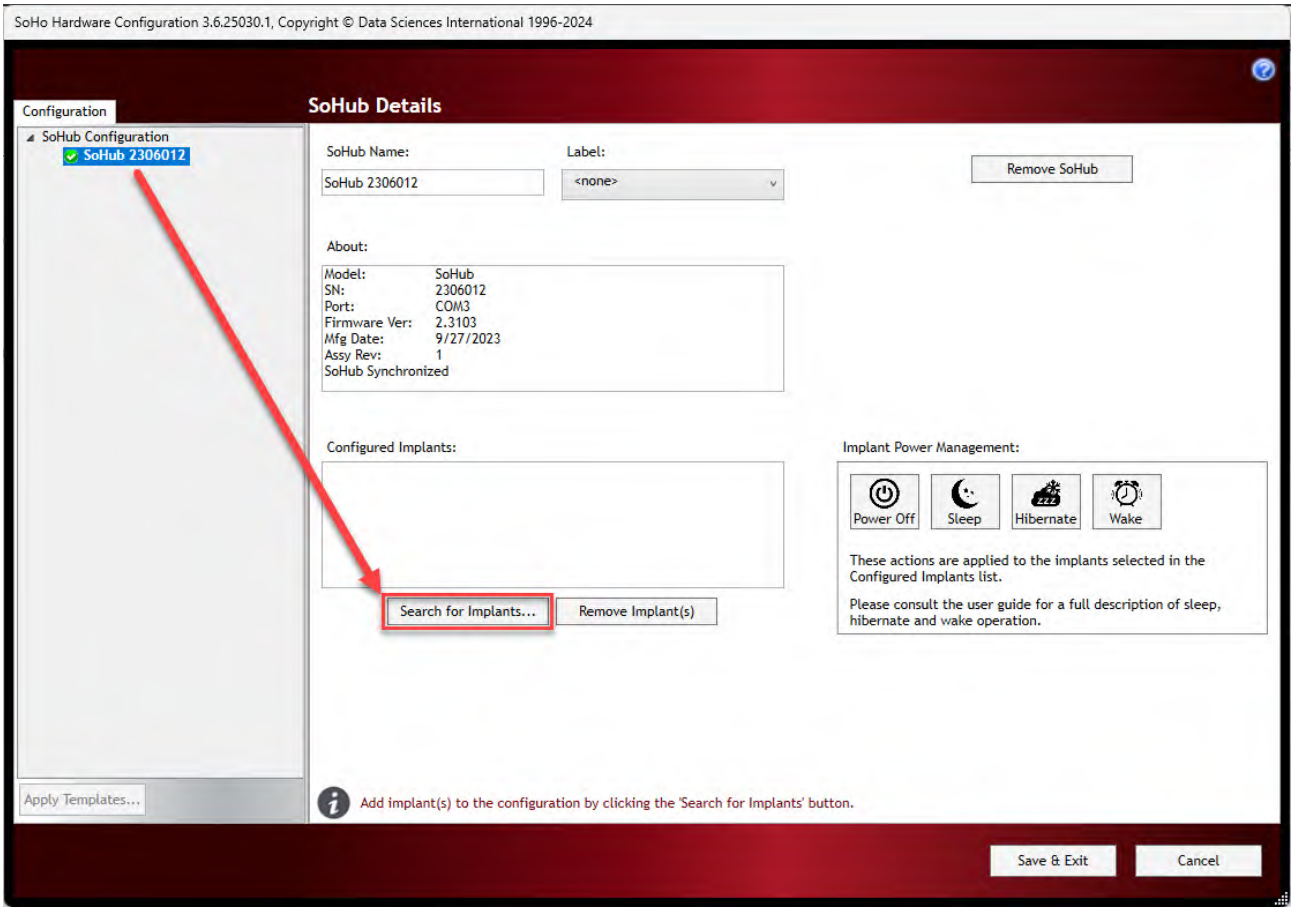
Each SoHub will have a circular icon indicating current status:

Connected – a green colored icon with checkmark indicates the SoHub is synchronized and ready.

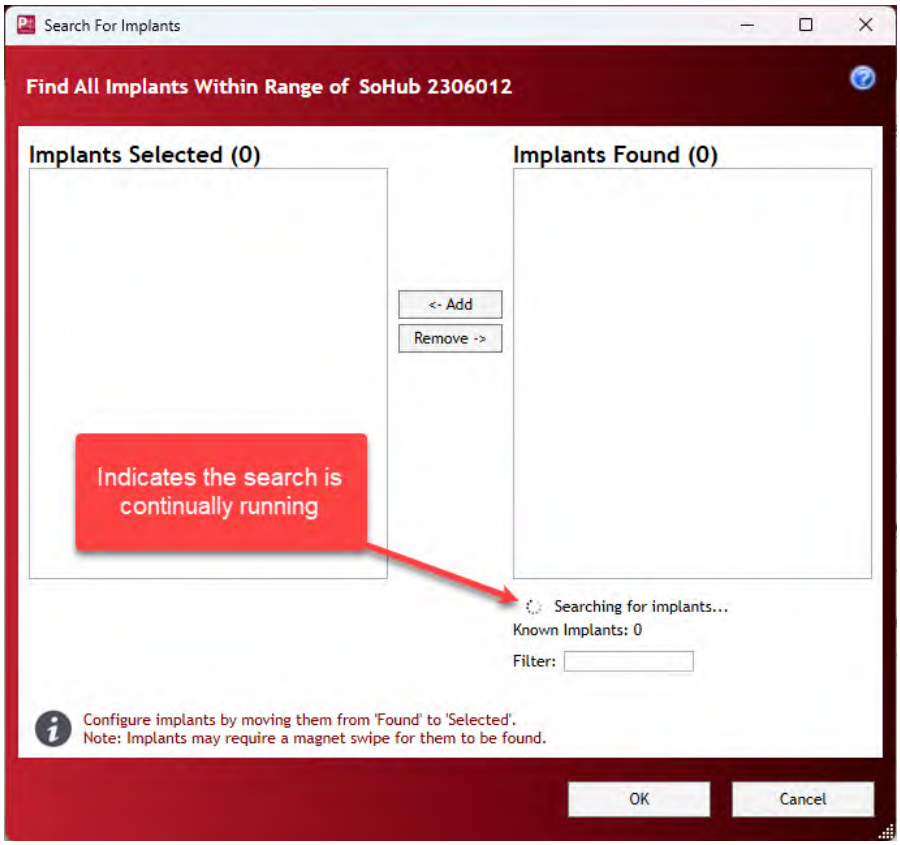
Not Connected – a red colored icon with exclamation mark indicates the SoHub was previously detected but is not currently available. It may have been unplugged.

Synchronizing – a yellow colored, time icon indicates the SoHub is attempting to synchronize to the computer. This is rare and may require a re-connect of the SoHub.

2. Select the **Search for Implants…** button



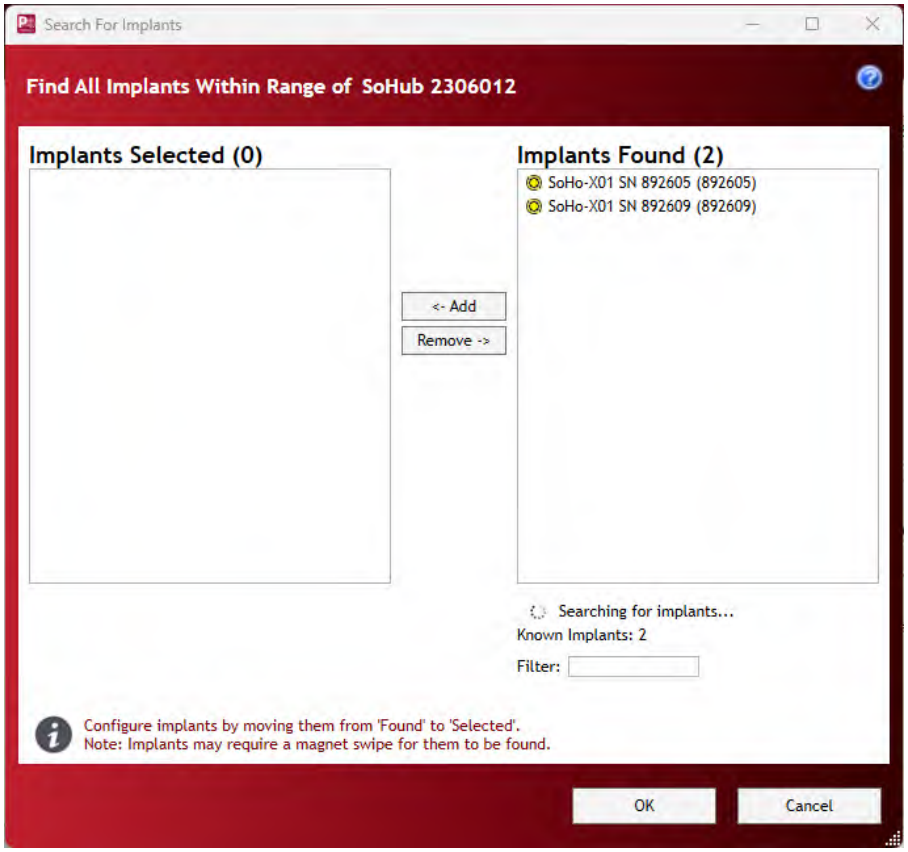
The *Search for Implants* dialog will open and automatically begin searching for implants that are powered ON and within range. The dialog displays the count of implants that are selected, found, and the total number of known implants.



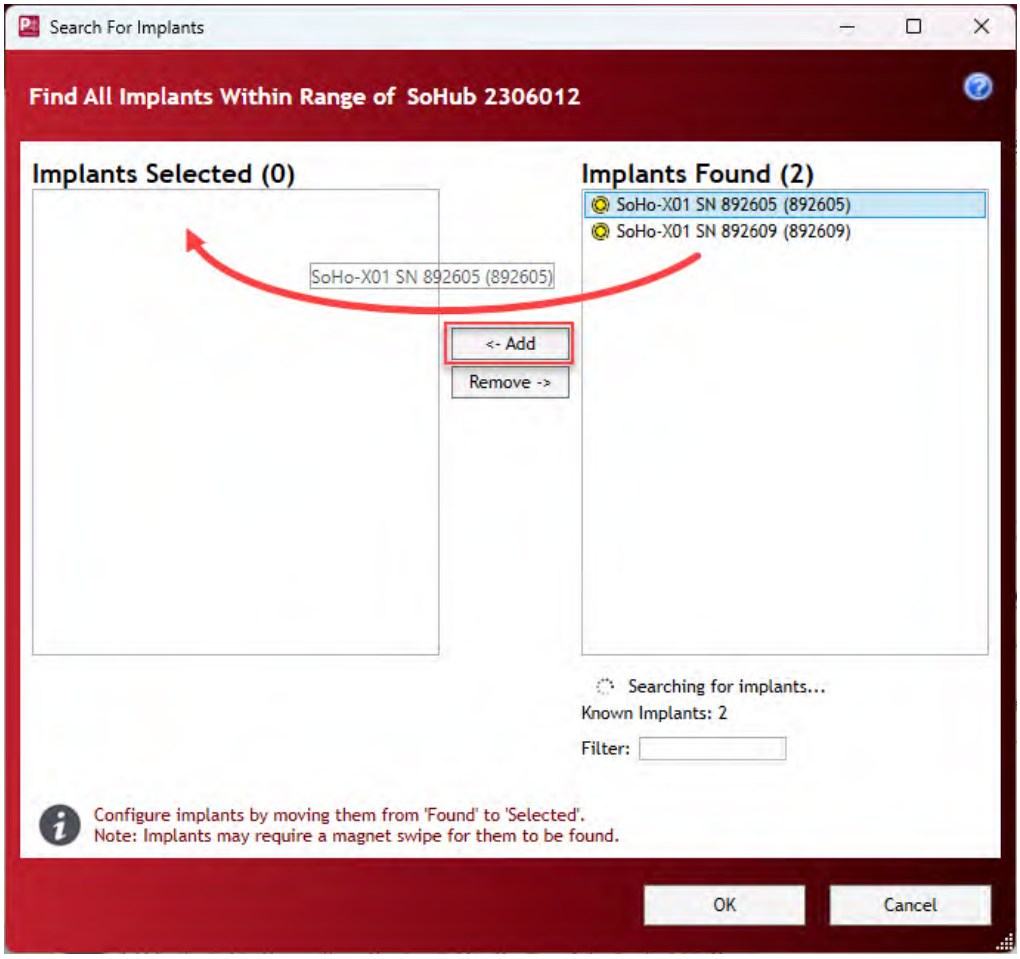
Known Implants: Lists the number of SoHo implants that have been found during this configuration session.

Filter: Implants Found can be filtered by any combination of model or SN

3. Activate the implants to be added to this configuration per the procedure described in Implant Activation of the SoHo Telemetry Platform Section.
4. Implants that are detected by the SoHub will be displayed in the **Implants Found** column.

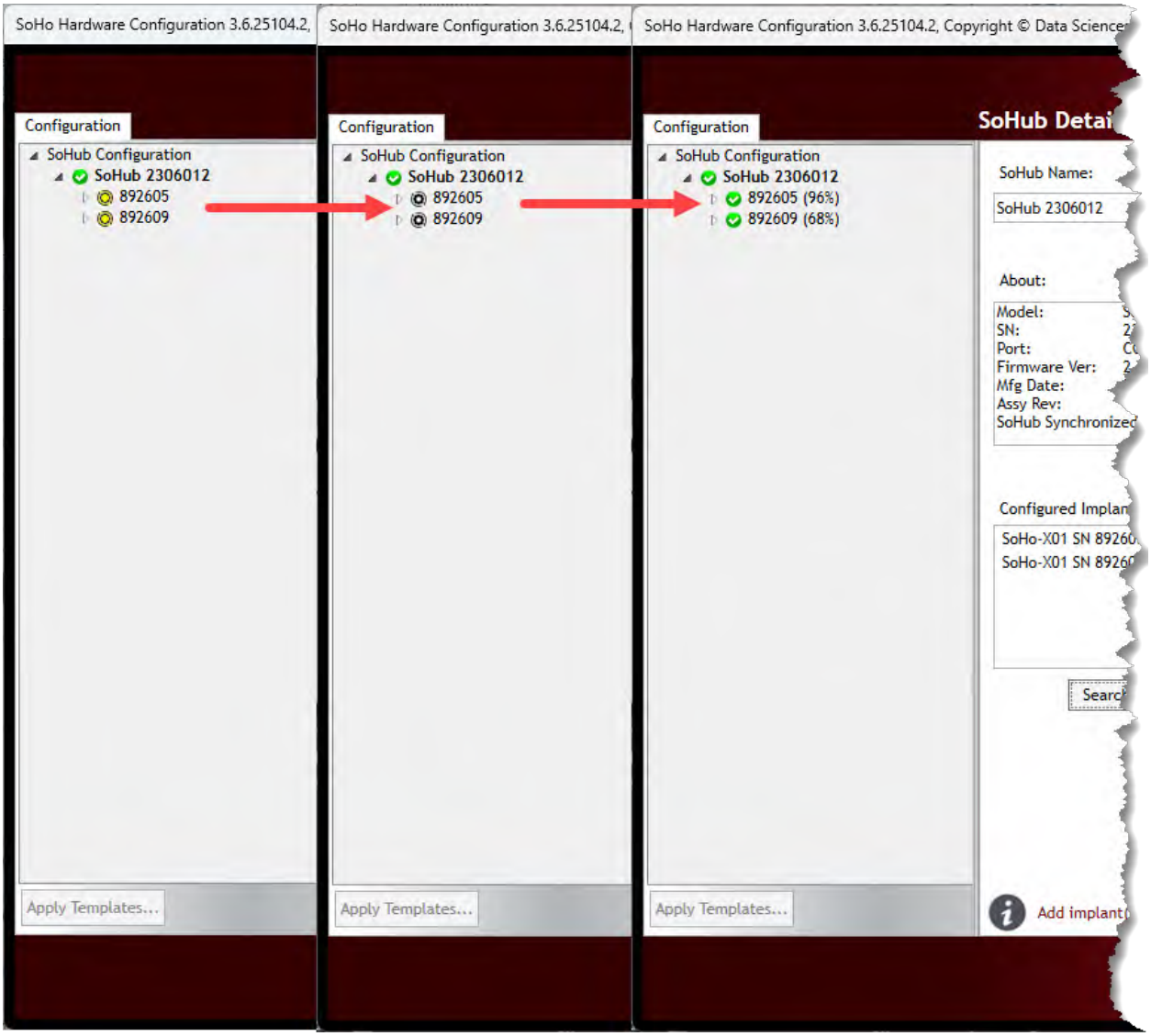


5. Drag-and-drop the desired implants individually from the **Implants Found** column to the **Implants Selected** column to assign the implant to this SoHub. Implants may be multiselected and added all at once using the **Add** button.

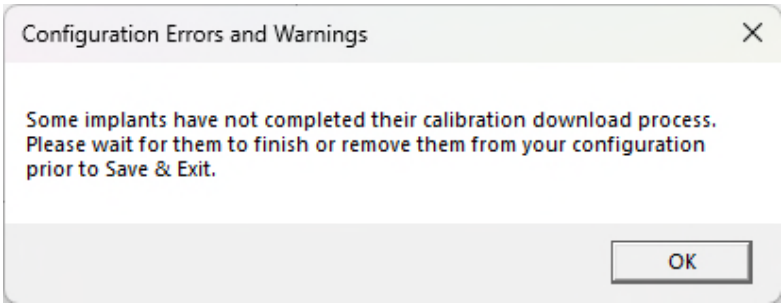


6. Click OK after the desired SoHo implants have been added to the **Implants Selected** column (up to 16). The **Search For Implants** window will close and implants will be displayed with the associated SoHub in the **List View**.

   Implant calibrations are stored on the implants and must be transmitted to the Ponemah software. When implants are initially added, the implant status icon will indicate the calibration download process. Implants that are in queue and pending download will display a yellow gear icon. When implants are actively downloading calibrations the icon will change to a white gear icon, and when the process is completed the icon will turn green. The process can take up to two minutes for all implants.



The implant calibration download process MUST be completed before clicking Save and Exit. If calibration download is not complete, a warning will be displayed to prevent the user from closing the window.



Implants can have the following status:

Searching for Implant – a yellow colored icon with question mark indicates the SoHub was previously communicating with the implant but it has lost connection and is waiting to re-connect.

Pending Download of Calibration Data – a black and yellow gear icon with circling arrows. The implant is in queue and waiting to re-connect. Once connected the state will change to Downloading Calibration Data.

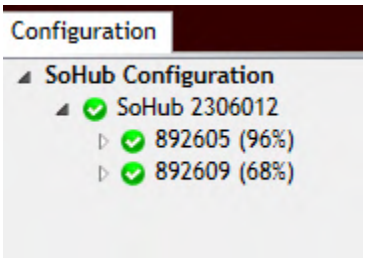
Downloading Calibration Data – a black and white gear icon with circling arrows. When a new implant is added, the pre-configured channel calibration data that is stored on the implant is uploaded to the system.

Standby – a green colored icon with checkmark indicates the implant is currently connected to the SoHub.

Powering Off – A purple colored power-button icon indicates the implant is currently powering off. This status is temporary for up to 8 seconds as an implant fully powers off.

OFF – A red colored icon indicates the implant is in the configuration but is in OFF mode.

Multiple layers of information are contained in the *SoHo Hardware Configuration* dialog, each accessed using the List View on the left side. The **SoHub Configuration** column lists the entire setup in an expandable tree structure. The SoHubs are listed with their assigned implants nested underneath. The number displayed next to the implant in the List View is the remaining battery percentage.



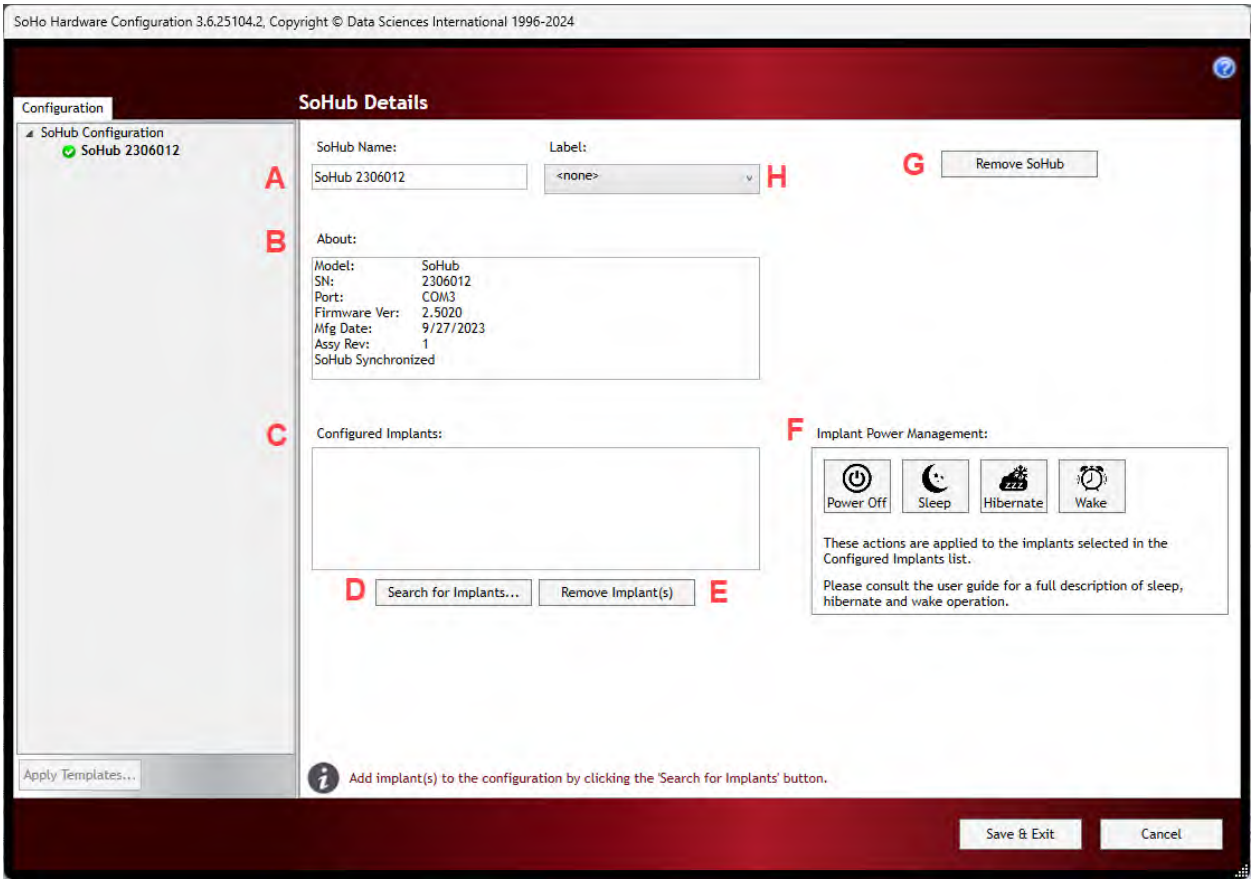
Note: The tree structure can be expanded and contracted by clicking on the arrows immediately to the left of the individual line items. Hover the mouse cursor over any line item in the Configuration box to activate an information pop-up with that device's key status condition.

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

- SoHub Details
- Implant Details
- Channel Details

SOHUB DETAILS

The **SoHub Details** view can be accessed by left-clicking on any of the SoHubs in the **List View**.

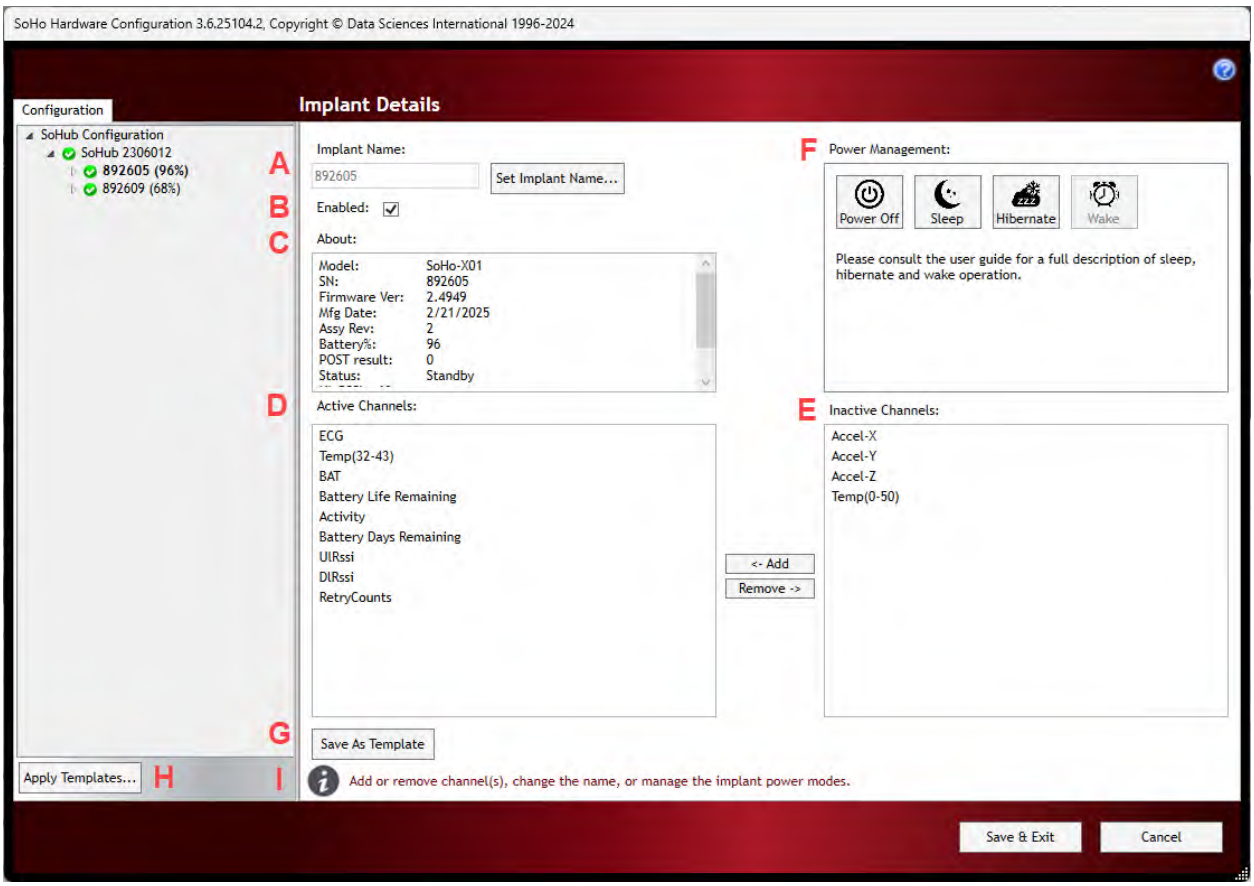


SoHub Details include:

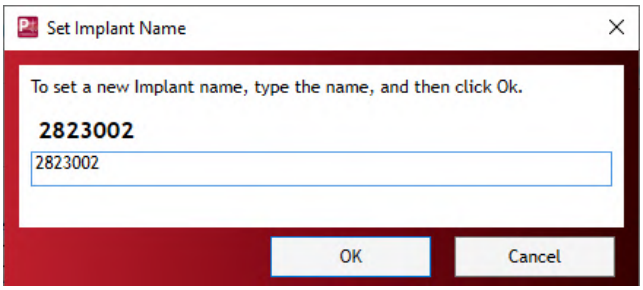
A. SoHub Name:	Click in the SoHub Name box to change the name of the SoHub. This name is saved in the current protocol but not on the SoHub itself.
B. About:	Shows important information including SoHub model, serial number, COM port and Firmware. This same information is available by hovering the mouse cursor over the line item in the List View.
C. Configured Implants:	Lists the current implants paired with the SoHub
D. Search for Implants…	Allows the user to search for implants that are powered ON and in range.
E. Remove Implant(s)	Allows the user to select the implants from the *Configured Implants* list and remove them from the configuration.
F. Implant Power Management	Allows changing of the implant power state for any number of implants on the SoHub to preserve battery life. See the Implant Power Management section for details.
G. Remove SoHub	Removes the selected SoHub from the configuration. A new configuration will need to be started to add the SoHub back.
H. Label:	Allows selection of one of six number labels, which correspond to the circular numbered stickers that are provided in the SoHub packaging.

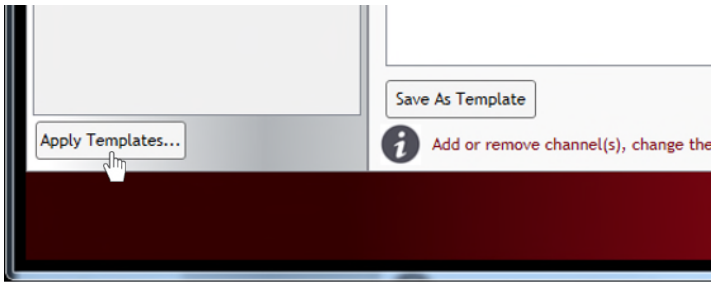
IMPLANT DETAILS

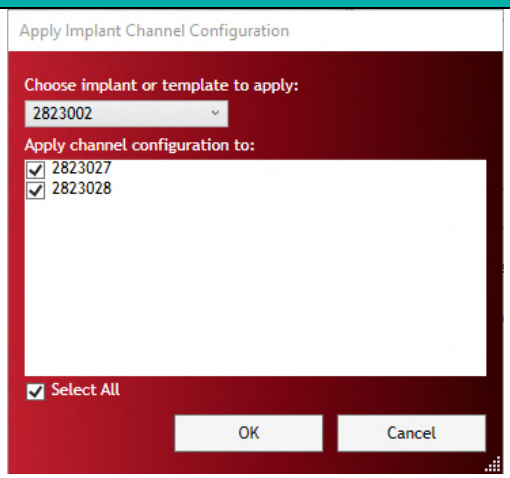
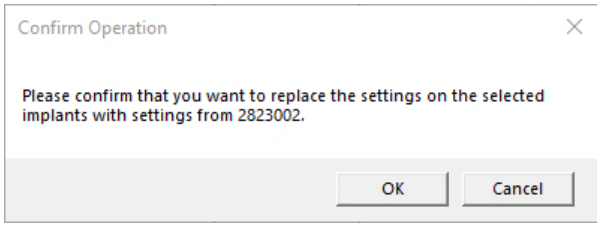
The **Implant Details** can be accessed by left-clicking on any of the implant names in the **List View**. The Implant Details view contains implant information, as well as some important interactive features.



Implant Details contains the following information:

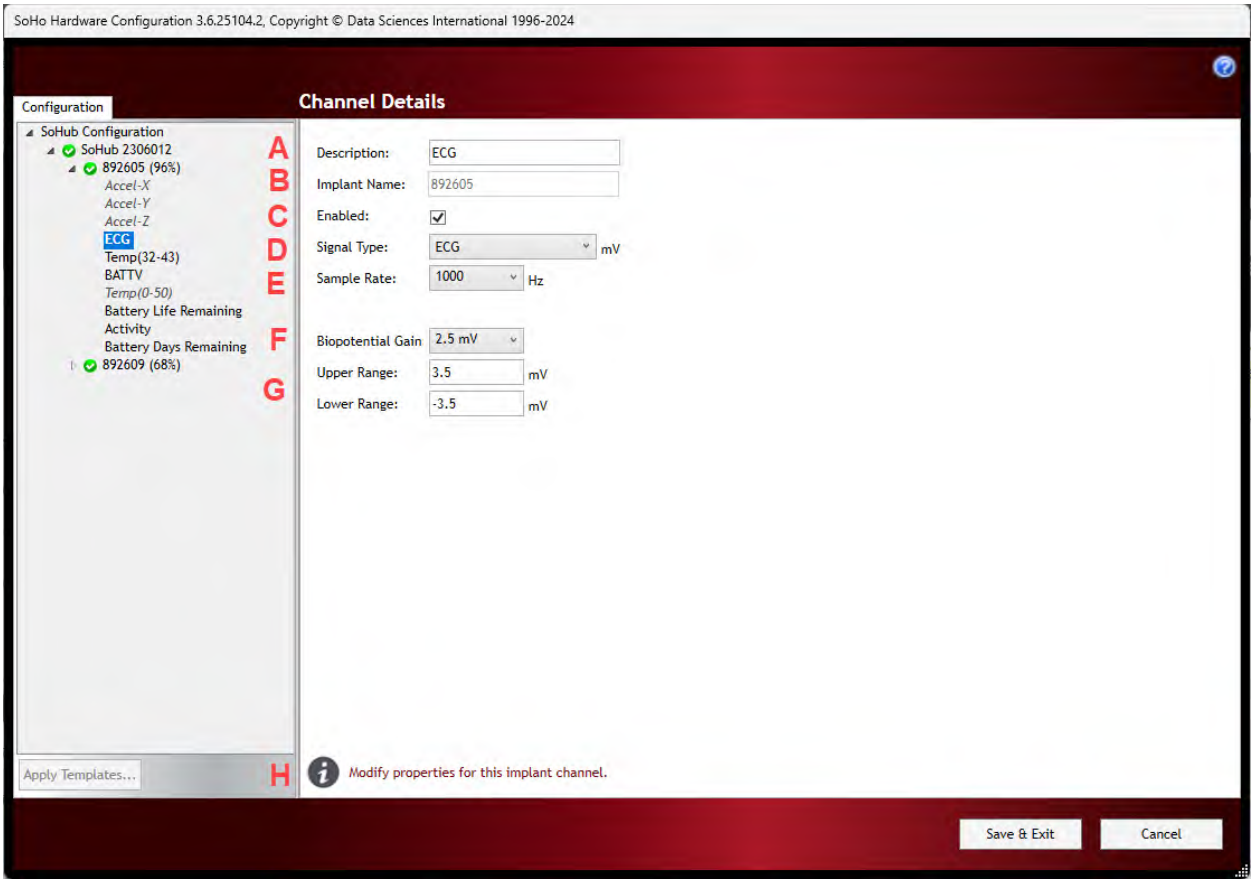
A. Implant Name:	User may rename the implant by selecting the **Set Implant Name…** button. In the displayed dialog, enter the desired name in the text field and select **OK**.  The name specified here is used by Ponemah as the Subject Name when automatically creating the Subject upon clicking Save & Exit within this dialog. If multiple implants are given the same name, they will be associated with the same subject automatically upon exiting the configuration.
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**, but it has not been turned off or put into sleep mode, the implant will still be powered ON and in standby mode which will use battery life.*
C. About:	Important information about the implant including model, serial number, firmware version, Manufacture Date, Assembly Revision, Battery percentage, POST result, implant status, Uplink (UL) RSSI, Downlink (DL) RSSI and Retries.. This same information is available by hovering the mouse cursor over the line item in the List View. *NOTE:* The RSSI values indicate signal strength. A more negative number indicates lower (worse) strength, while a less negative number (closer to zero) is a higher (better) strength. A value greater than -90 is preferred to prevent data loss. *NOTE:* The POST result of zero indicates no errors were detected when the implant powered up. See the POST result table in the Appendix for details.
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 and diagnostic data and transmit the data through the acquisition system to be stored in the data acquisition computer. **Inactive Channels** do not collect data as those channels are disabled.
F. Power Management:	Allows changing of the implant power state for the selected implant to preserve battery life. See the Implant Power Management section for details.

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 **SoHub Configuration** column on the left side of the screen. 2. Use the Active and Inactive 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 SoHub 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. 3. 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.

	 4. The **Select All** check box can be used to select/deselect all implants in the dialog box. 5. Click **OK** to apply the saved template configuration.  6. 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 **SoHub 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. 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 the channel is associated with.
C. Enabled	This check box will toggle the **Input** channel between '**Enabled'** and '**Disabled'** modes. A disabled channel will not have data for that channel saved.
D. Signal Type	Allows the user to define which signal type should be used for the channel. These will default to the most common signal types based on the implant model selected. This is important because the signal type defined here is used to automatically define the **Analysis Module** assigned to the channel.

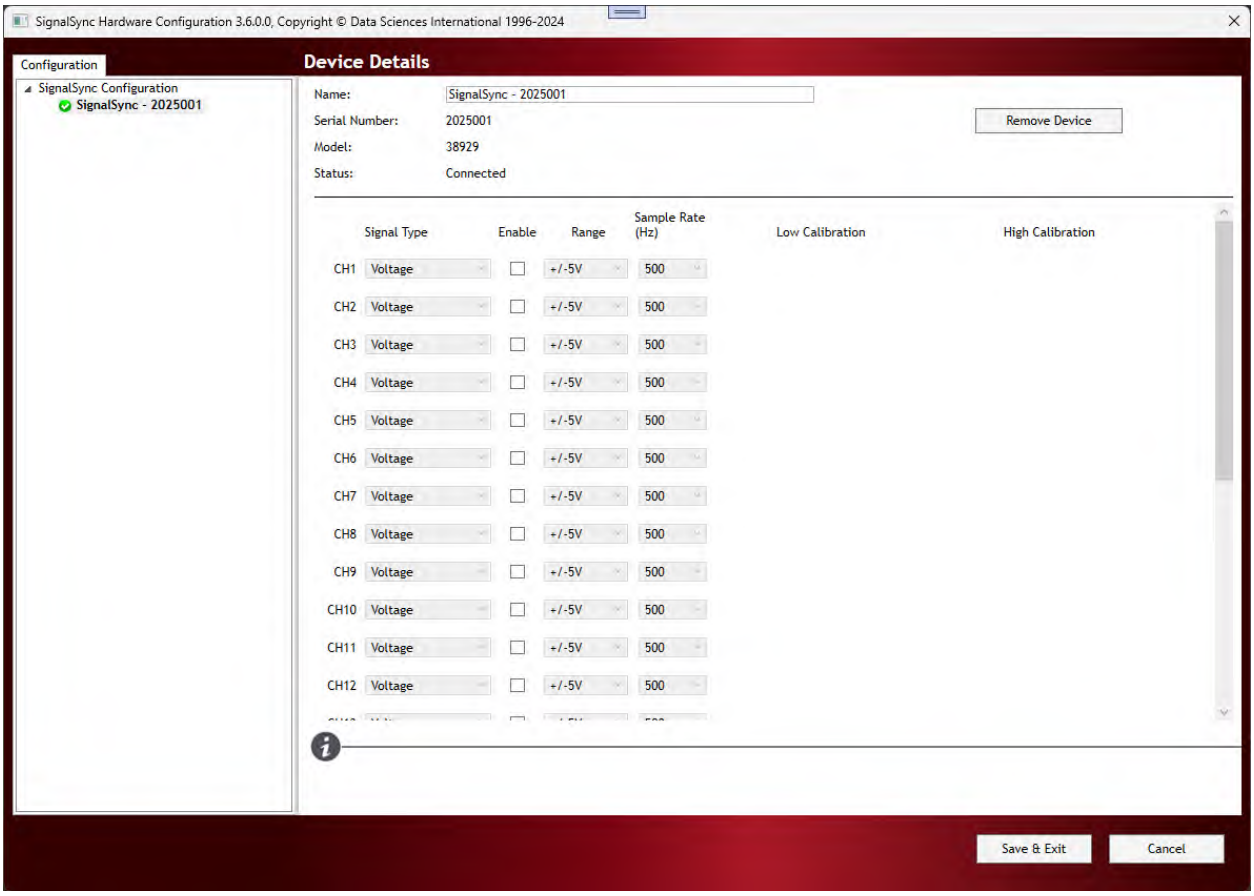
E. Sample Rate	Allows the user to define a unique sampling rate to each implant channel. Available sample rates are shown in the dropdown menu.
F. Biopotential Gain	Only displayed for biopotential channels. A default gain value and Upper/Lower range is automatically set for the Signal Type chosen (ECG, EEG, EMG, etc.) and it can be modified if needed. ⚠ *WARNING: If the recorded signal amplitude is outside of the upper or lower range the signal will be clipped.*
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.

Temperature Channels: SoHo implants have two temperature channels. A more precise temperature channel labeled 'Temp(32-43)' is the standard which is functional between temperatures of 30 to 43 degrees C. A secondary temperature channel labeled 'Temp (0-50)' is functional for temperatures of 0 to 50 degrees C. The secondary channel can be enabled if desired, or for expanded temperature measure needs such as hibernation studies.

Edit SignalSync Configuration

The SignalSync Configuration process allows the user to enable and calibrate (if needed) analog inputs and enable digital inputs. The channels can be assigned to existing subjects and collected with telemetry or standalone.

To edit the SignalSync Configuration dialog select **Hardware | Edit SignalSync Configuration…**



The following features are available from the **SignalSync** dialog:

A. **Device Information**: displays the device name, serial number, model and current status of the SignalSync.
B. **Channel Label Column**: lists the available Signal Interface channels. Channels **1-16** are associated with the analog channels on the top panel of the Signal Interface. Channels **Din-1 to Din-8** in the dialog are associated with the digital channels available via the 25-pin D connector on the right side panel of the SignalSync.
C. **Signal Type:** allows the user to define which signal type should be used for a particular channel. The signal type selected is used to automatically define the **Analysis Module** assigned to the channel. The default type is Voltage, which is used to collect an uncalibrated signal. Changing this to another Signal Type will display fields for Low and High Calibration.
D. **Enable**: This check box will **Enable** or **Disable** a channel. The Enabled mode allows the software system to record, store, and analyze data from the channel.
E. **Range**: Allows selection of a voltage input range.
F. **Sample Rate**: allows the user to define a unique sampling rate for each implant channel.
G. **Low Calibration:** permits low end calibration of the channel.
H. **High Calibration:** permits high end calibration of the channel.

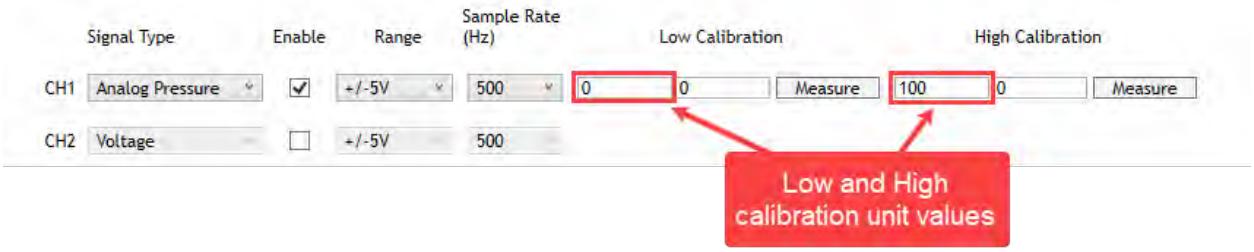
The SignalSync supports a 2-point calibration if an input calibration signal (voltage) is available. These fields become available when the Signal Type is changed from voltage to another type.

CALIBRATING THE SIGNALSYNC ANALOG CHANNELS

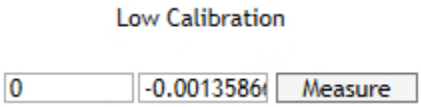
An input calibration signal (voltage) may be applied to the SignalSync analog channels to perform a 2-point calibration.

To calibrate a channel:

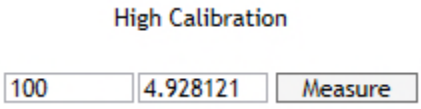
1. Enable the SignalSync Channel.
2. Select the appropriate Signal Type.
3. Enter the Low and High values in physical units. The example shows a low value of 0 and high value of 100, which could be for a pressure calibration in mmHg. Units are not defined in this setup but in the Subject Setup menu.



4. Apply the calibration signal (voltage) to associate with the **LOW** value, then click the Measure button associated with the **LOW Calibration**. The system will sample from the SignalSync channel for 5 seconds and then populate the **LOW Calibration** field with the average voltage.



5. Apply the calibration signal (voltage) to associate with the **HIGH** value, then click the Measure button associated with the **HIGH Calibration**. The system will sample from the SignalSync channel for 5 seconds and then populate the **HIGH Calibration** field with the average voltage.



6. Repeat for any additional SignalSync channels required.

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, one per implant, upon clicking **Save & Exit** from the **PhysioTel / HD or PhysioTel Digital or SoHo 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.

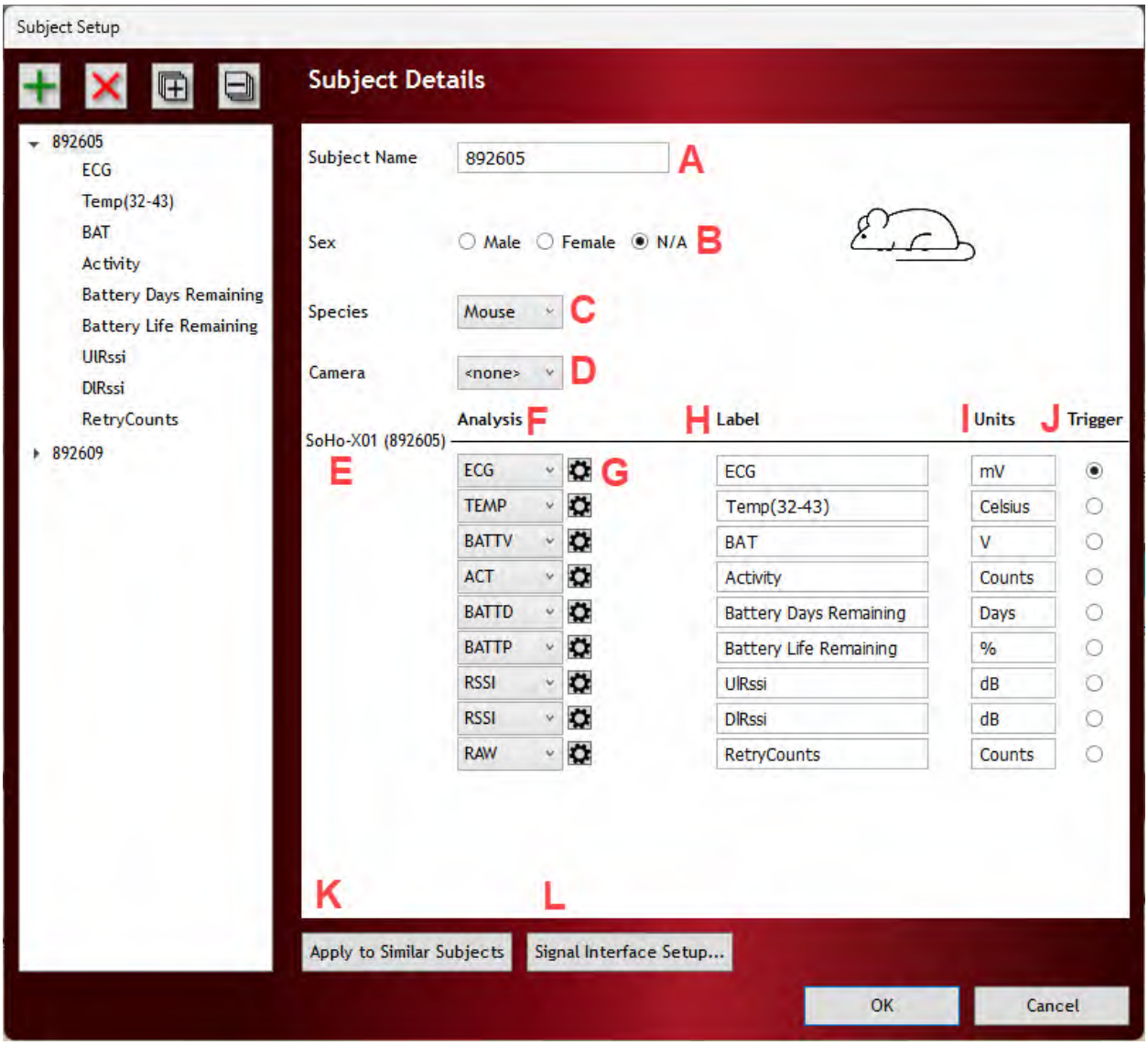
The new subject will now be displayed in the *Sampling Control* dialog, data acquired will be acquired to its own .PnmWav file, and the Subject's data will be available for Review.

Subject Details

Details about the subject are automatically defined based on the **Signal Types** defined during implant creation. Settings such as Subject Name, Sex, 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:



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 & Exit when implants are first added. Subject name must be edited manually afterward.

Note: If subject name is changed within the Subject Details page, it will not update the Implant name in the Acquisition Interface Configuration dialogs.

Warning: DO NOT change the subject name after acquisition has been run. Subject data file names contain the subject name and there will be a mismatch of file names when a new data file is created.

B. Sex:

User defined Subject sex designation. Default is N/A.

C. Species:

Define the species being used within the Experiment. Options include: Dog, Ferret, Guinea Pig, Hamster, Minipig, Monkey, Mouse, Rabbit, Rat, Sheep, Swine species. The system will automatically select the species based on the species most 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.

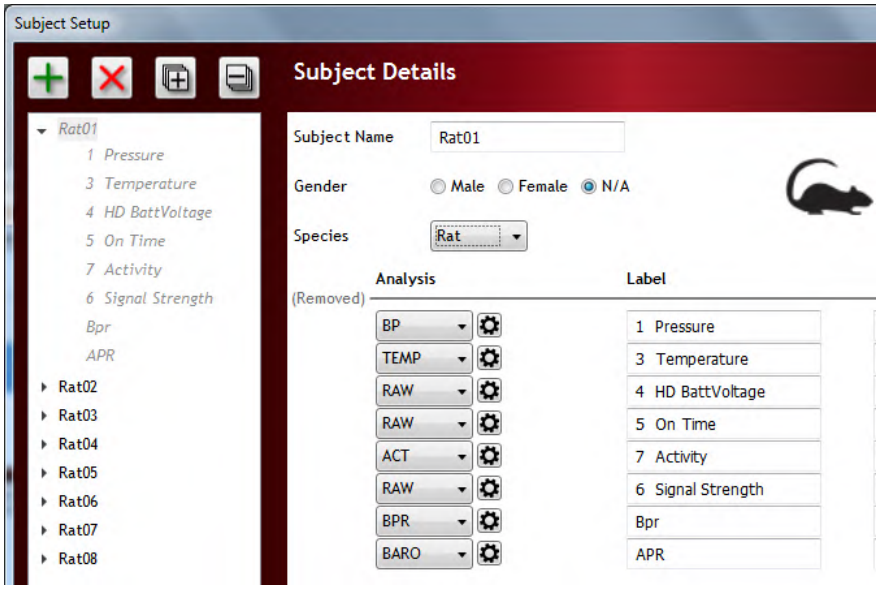
E. Input Source

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: **Sex, Species**, **Analysis Module**, **Analysis Attributes**, **Labels**, **Units**, and **Trigger Channel**. It also includes the following **Channel Details** settings: **Parameter**, **Digital Display**, and **Alarm** selections.

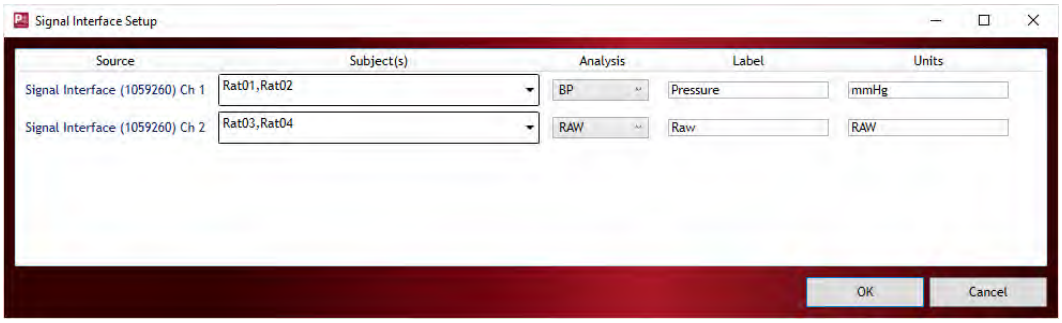
Once a Subject is configured with the desired Subject and Channel Details settings that you wish to apply to all Subjects with the same Implant model:

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).



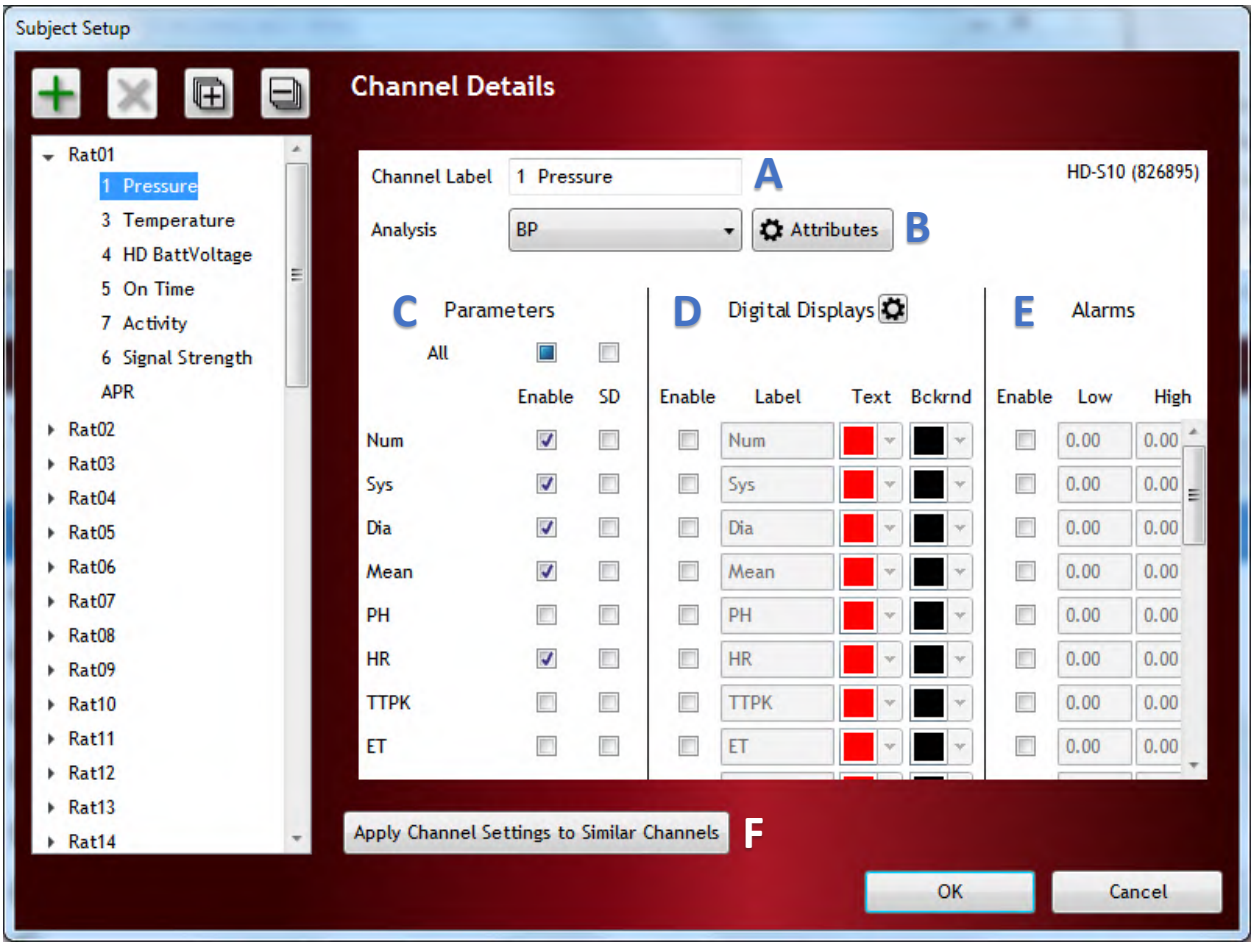
Channel Details

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**.

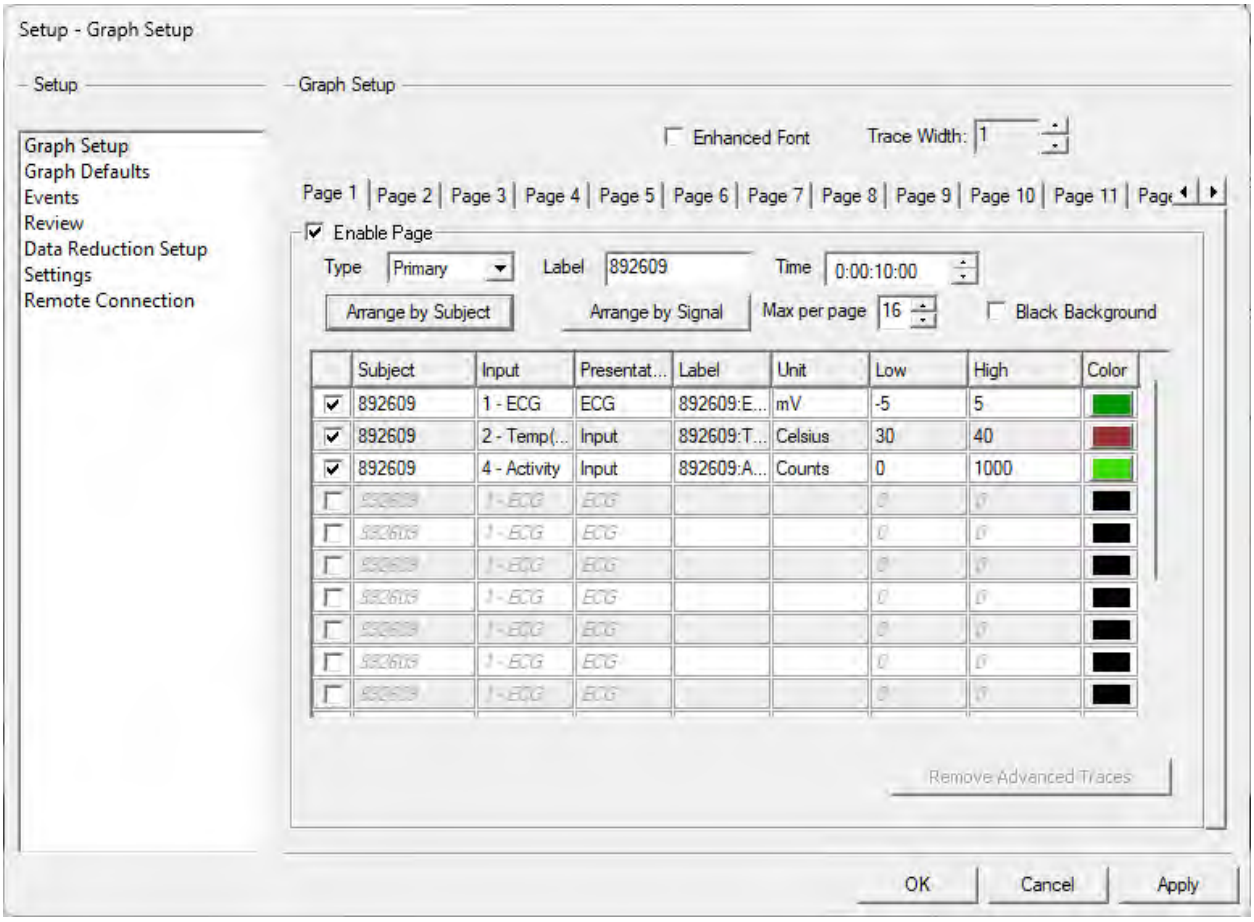
Graph Setup

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 a format of dd:hh:mm:ss for Primary and Trend graphs.
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.
Enhanced Font	Increases the Font size of the graph page units and scale.
Trace Width	Increases the line width of the plotted signal. A value of 1 to 5 can be used.

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.

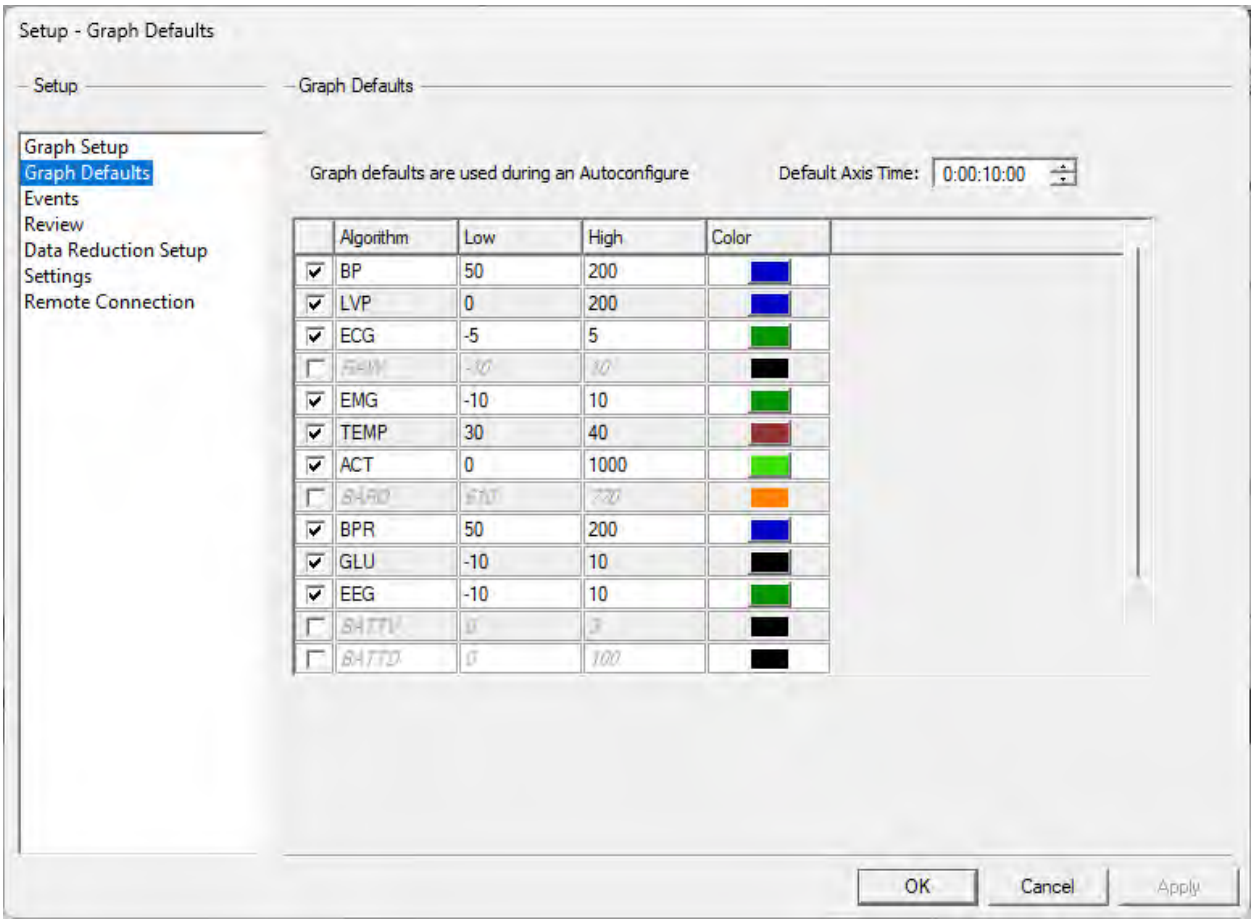
Arrange by Signal:

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 and default color for each signal type based on what makes sense for your experiment. The default axis time can also be set.

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 as well as color 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.

Graph Concepts

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.