DSI Implantable Telemetry System Manual

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OVERVIEW

This manual highlights how DSI's Implantable Telemetry, Telemetry hardware, and Ponemah software interact as a system. This document will provide an overview of the PhysioTel Legacy, PhysioTel HD, and PhysioTel Digital implants and provide detailed instructions on how to set-up their associated hardware.

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WELCOME

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

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

WHAT YOU WILL BE LEARNING

1. Understand your telemetry platform.
    a. PhysioTel and PhysioTel HD
    or
    b. PhysioTel Digital
2. How to setup your telemetry system hardware.
3. How to configure the Ponemah software to permit data acquisition using your telemetry system.

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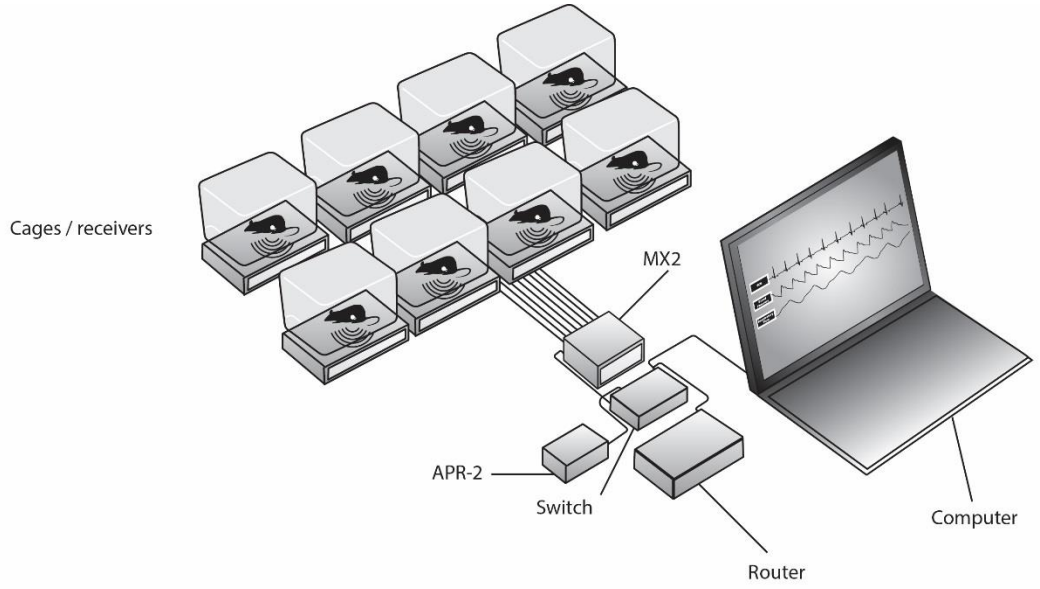
SYSTEM OVERVIEW

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

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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.

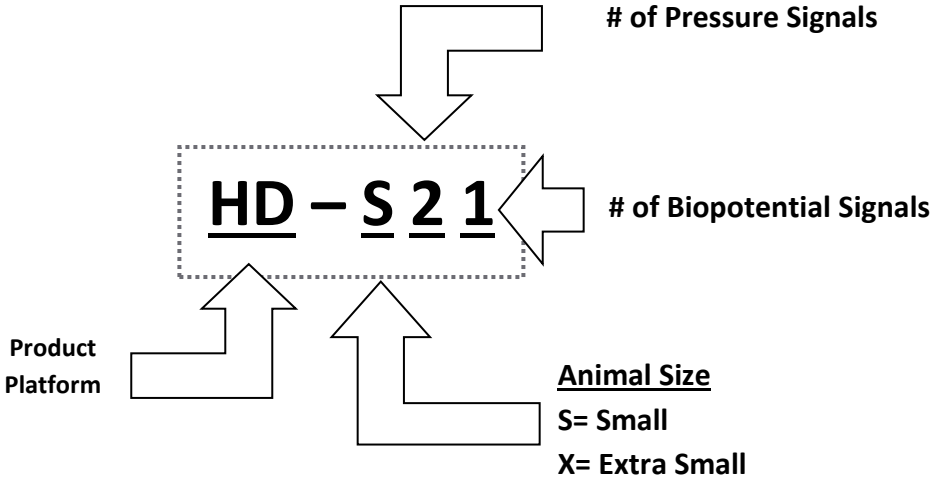
DSI's experienced surgical services team is available to answer any questions by phone or email. In person, hands-on surgical training is available onsite or at DSI headquarters with group rates available. Training at headquarters often includes a tour of manufacturing, as well as some time with DSI's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

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*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.

PHYSIOTEL 4ET DEVICE

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

The 4ET device is a dual-module device. The complete device consists of two modules that are electrically and physically connected with an IS-1 lead. The biopotential leads and temperature sensor are included in the

component that is termed the sensing module. The battery and data transmission circuitry are housed in the telemetry module. The device is designed to allow the option of replacing the telemetry module in-vivo to extend the battery life without interfering with the sensing module and lead placement. This in turn also extends the usable life of the animal model. The receiver that is compatible with this device is the RPC-2.

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

NOMENCLATURE

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

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

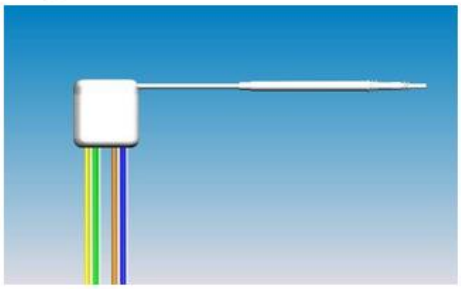
Telemetry module replacements can be purchased individually. There are two model names: TM-S1 and TM-S2. These model names are defined by the following:

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

4ET DEVICE

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

Sensing Module



Telemetry Module

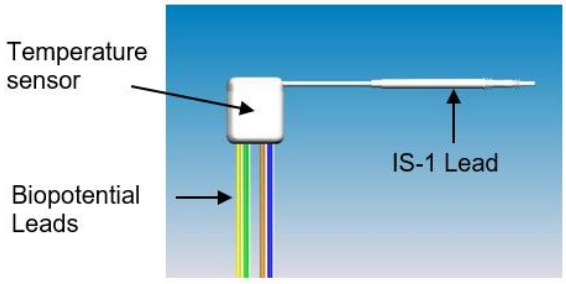
Sensing module (SM)

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

Telemetry module (TM)

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

SENSING MODULE



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

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

CH1 Blue	CH2 Orange	CH3 Green	CH4 Yellow

Positive Lead: Solid color

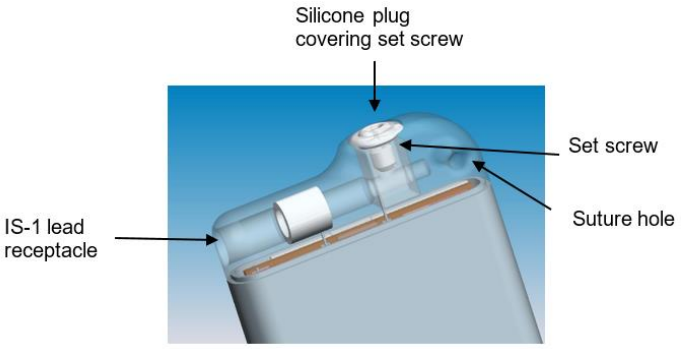
Negative Lead: Solid color with white stripe

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

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

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

TELEMETRY MODULE



The telemetry module receives the physiologic data from the sensing module via the IS-1 lead and transmits them telemetrically to the RPC-2 receiver. This transmission occurs using one of two independent frequencies to allow two devices to simultaneously send data to the same RPC-2 receiver. These transmission frequencies are designated by the model name as described in the previous section. The model name appears on the peel-away label located on the outer pouch. It is important to document this information in addition to the serial number. The telemetry module does not require any calibration data.

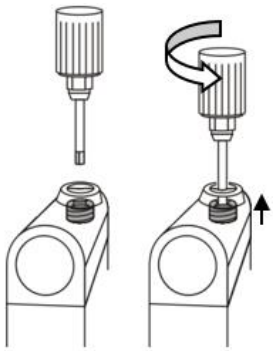
The telemetry module contains a magnetic switch to turn it on and off. When the device is ON, an audible tone can be heard with the 4ET radio. The telemetry module can be turned ON without being attached to a sensing module. This is called 'free-run' mode. The tone heard in free-run mode is slightly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

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

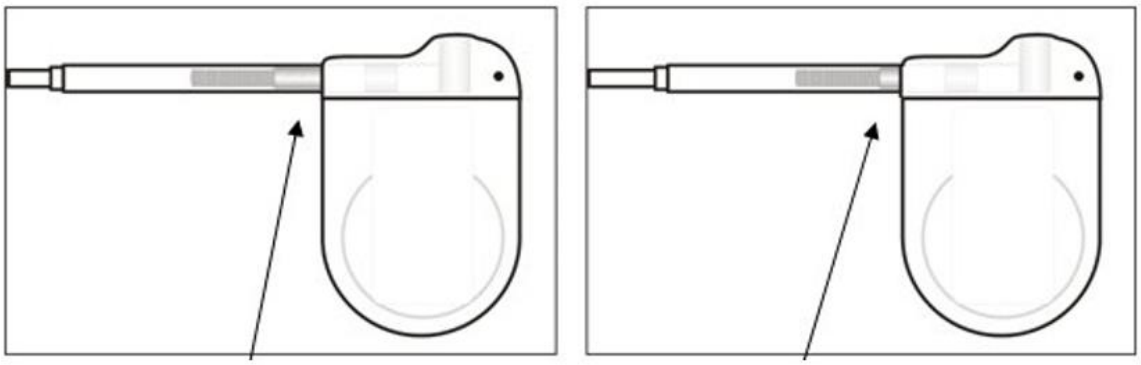
CONNECTING THE SENSING AND TELEMETRY MODULES

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

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



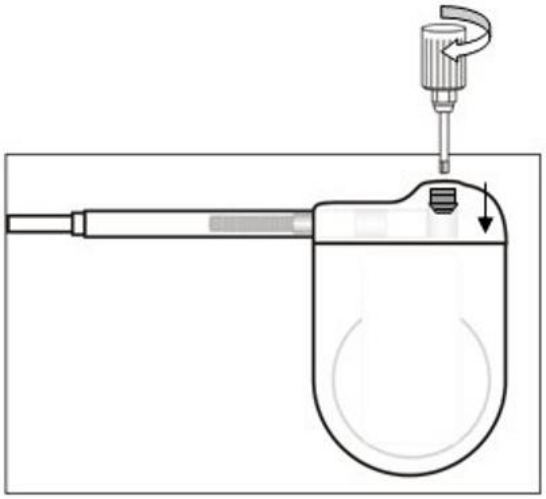
2. Insert the IS-1 lead into the telemetry module. Verify that the lead is fully inserted by observing that approximately 1.5 mm of solid metal on the IS-1 lead is extending out of the telemetry module. There should be no more than 2 mm of solid metal on the IS-1 lead extending out of the telemetry module.



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

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

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



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

FREQUENCY DESIGNATION

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

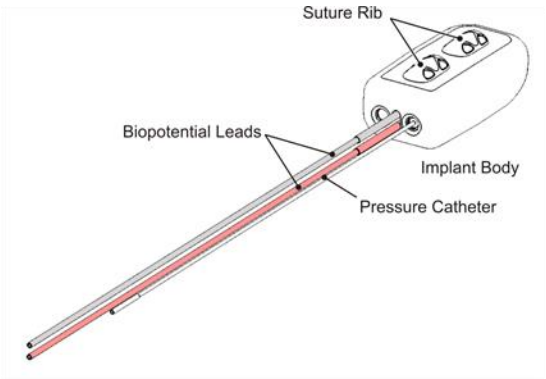
Device model name	Telemetry module model name	Frequency
4ET-S1	TM-S1	8MHz
4ET-S2	TM-S2	18MHz

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

PAIR-HOUSING CONSIDERATIONS

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

IMPLANT COMPONENTS



Drawing of HD-S11 small animal implant

IMPLANT BODY

The biocompatible housing consists of the following major components:

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

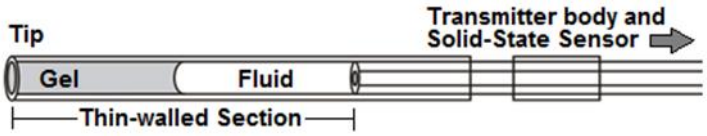
SUTURE RIB

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

PRESSURE CATHETER

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

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



Detailed diagram of catheter components with the tip cover removed

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

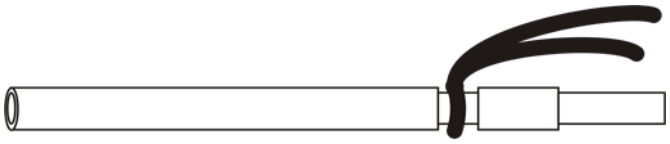


Diagram highlighting the ligation aid option

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

BIOPOTENTIAL LEADS

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

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

The leads are designed to be cut to a length suitable for the biopotential signal to be monitored. The clear lead is used to collect the negative signal of the biopotential and the red lead is used to collect the positive signal. The

biopotential signal monitored could be an ECG, EEG, EOG, EMG, etc. Examine the biopotential specifications listed in Appendix B to learn more about the product specifications including measurement sensitivity and range. This is especially important for special applications.

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

Photo of leads with tip covers placed appropriately

GLUCOSE SENSOR AND REFERENCE

Note: The HD-XG is only supported in Ponemah v6.x. It is not supported in Ponemah v5.x.

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.

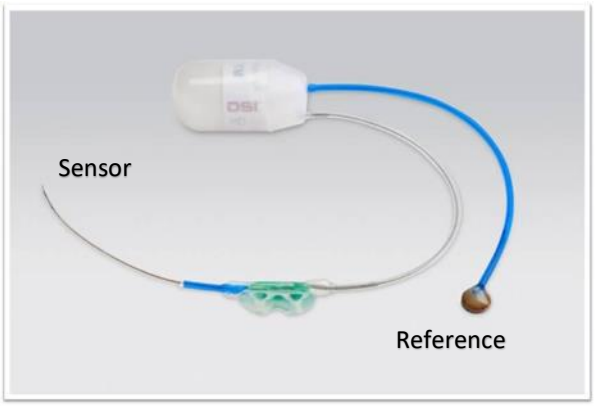
The HD-XG has silicone tubing that extends out of the device body and contains:

- **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 **Error! Reference source not found.** 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:

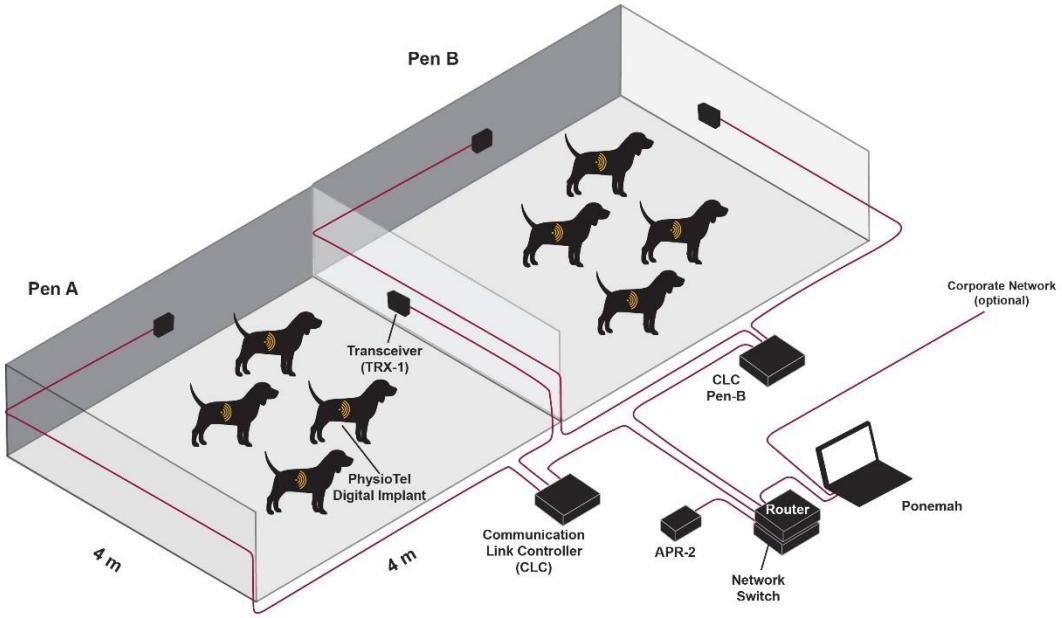
- Power on an AM radio and tune it to 550 kHz (the low end of the AM band).
- Bring the radio close to the device.
- Momentarily bring a strong magnet within approximately one inch of the device implant, holding it near for two to five seconds.
- The order of modes using a radio is:
    - Off (No tone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

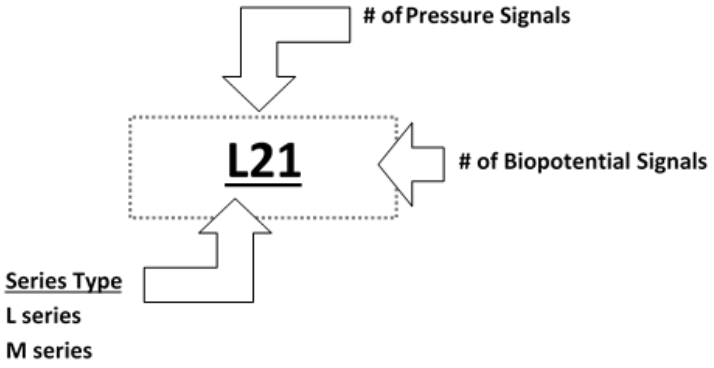
- M series – One-time use implants that are ideal for shorter duration studies. The smaller size of M series allows the PhysioTel Digital technology to be expanded in to a broader range and size of species. Primary applications for M series are toxicology and biological defense studies

  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.



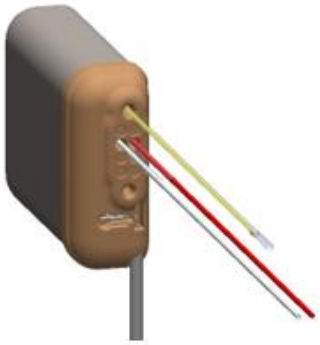
The follow table lists the available PhysioTel Digital implants and the available input channels from each model.

Model	Pressure 1	Pressure 2	Biopotential	Temperature	Activity
L11	●	–	●	●	●
L21	●	●	●	●	●

Model	Pressure 1	Pressure 2	Biopotential	Temperature	Activity
L03	–	–	● x3	●	●
L04	–	–	● x4	●	●
M00	–	–	–	●	●
M01	–	–	●	●	●
M10	●	–	–	●	●
M11	●	–	●	●	●

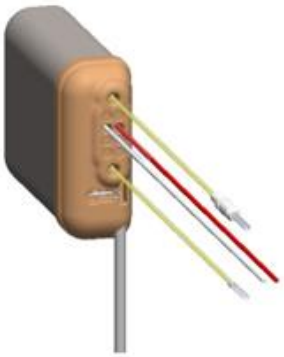
IMPLANT COMPONENTS

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



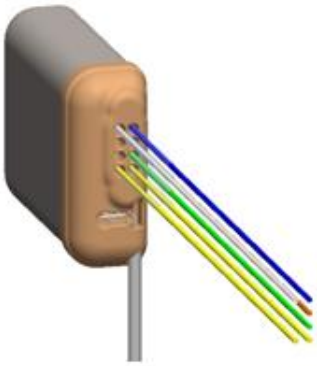
L11

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



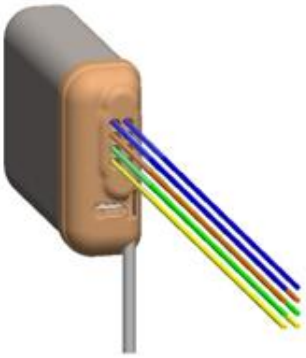
L21

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



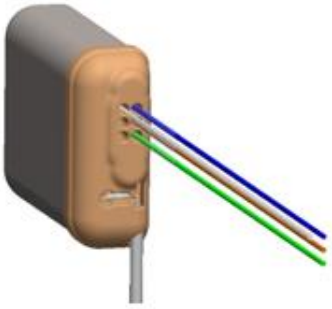
Common Reference L04

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



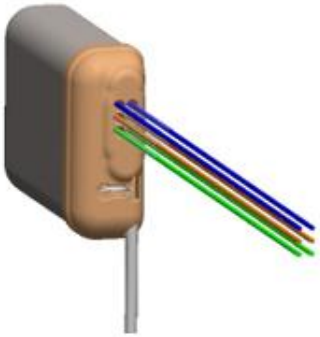
Biopotential Pair L04

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



Common Reference L03

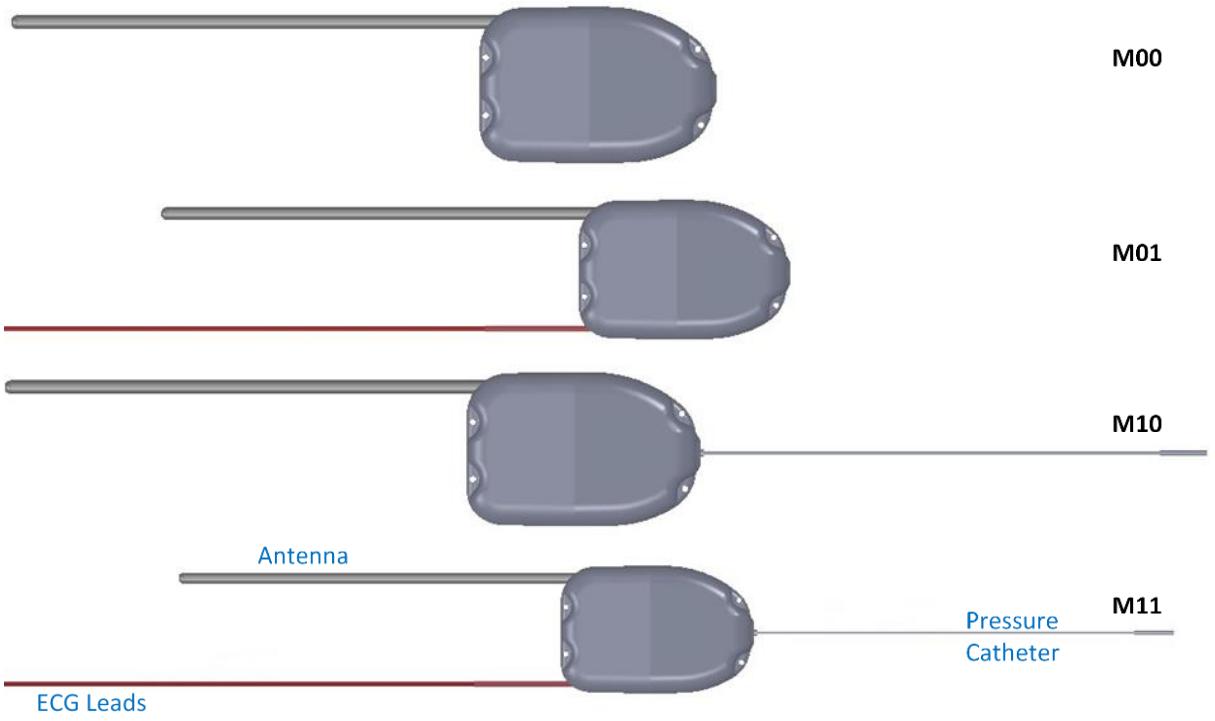
Channels 1-3: three positive (blue orange, green) biopotential leads to one negative reference (clear)



Biopotential Pair L03

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

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



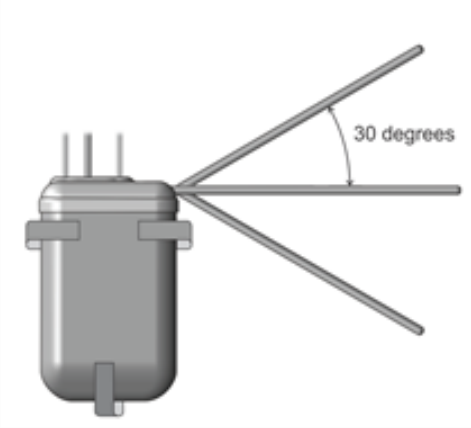
IMPLANT BODY

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)

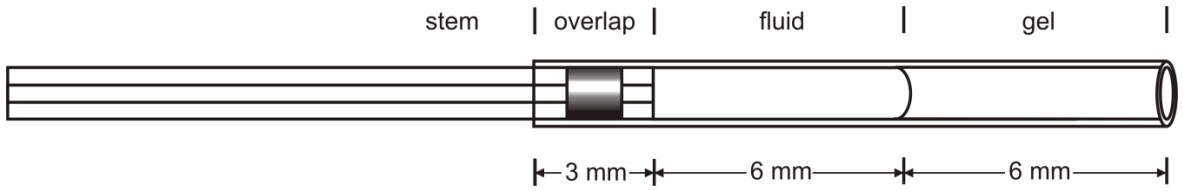
Polyurethane tubing that extends (25, 35 or 40 cm) out of the implant and contains:

- 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.

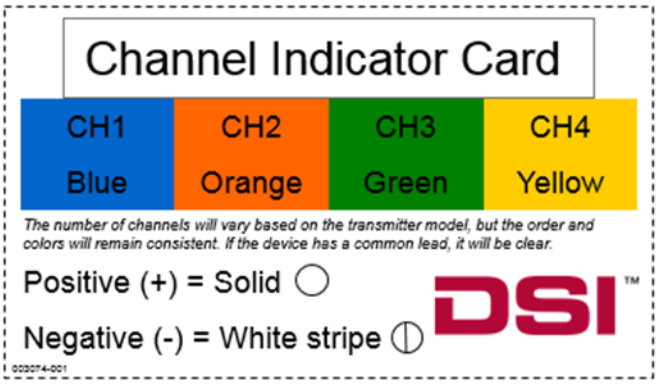
PRESSURE CATHETER WITH RADIO-OPAQUE MARKER



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).

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**

North America	Europe	Japan	China
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 omits a short transmission burst, or chirp. The POD listens for the chirp, and when heard, emits a short beep and blink its LED. This indicates that the magnet swipe was successful and the implant is on.

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

POD COMPATIBILITY

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

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

BATTERIES

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

ACTIVATION INSTRUCTIONS

To activate the PhysioTel Digital implant into Standby Mode:

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

   If it was not successful do the following:
   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

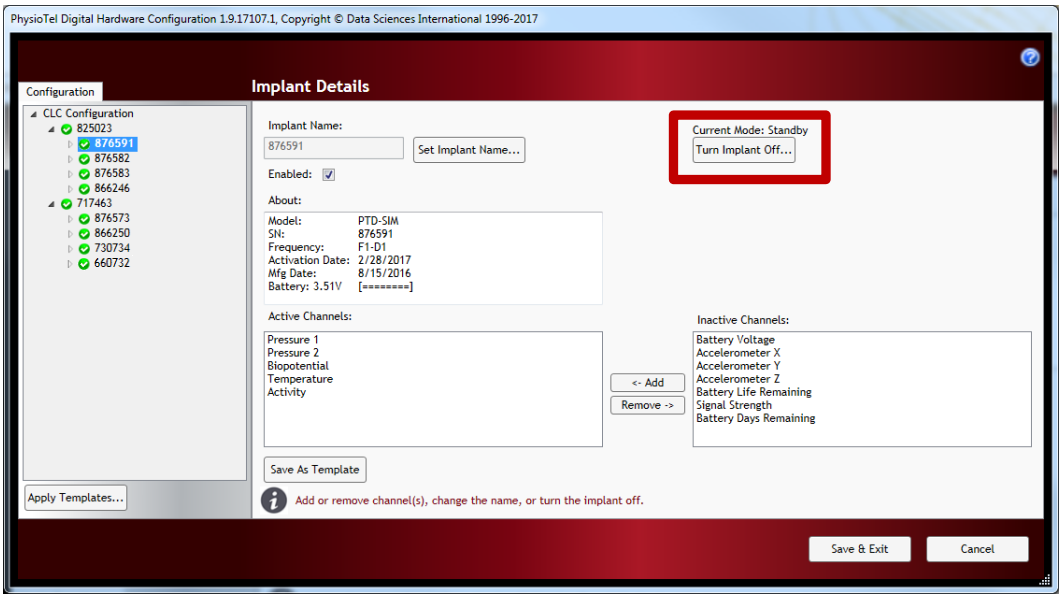
The implant may be turned off manually with a magnet swipe. Bring a strong magnet within proximity (1-2 inches) of the implant for 5 seconds or less.

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:

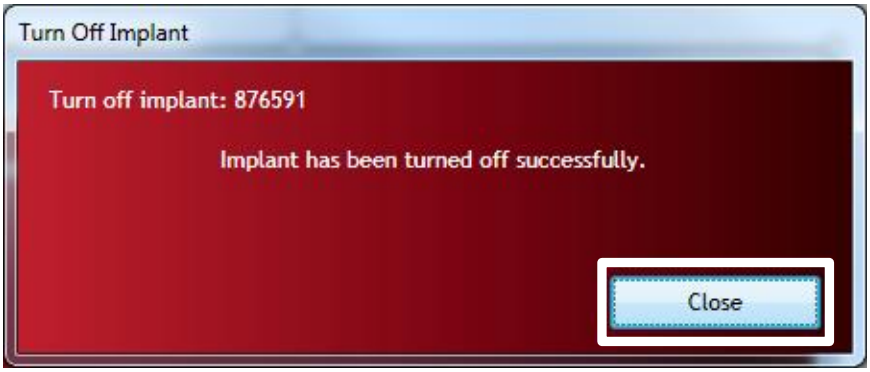
1. Select the implant by clicking the line item in the Configuration column on the left of the screen.
2. Click the button labeled **Turn Implant Off**.



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.

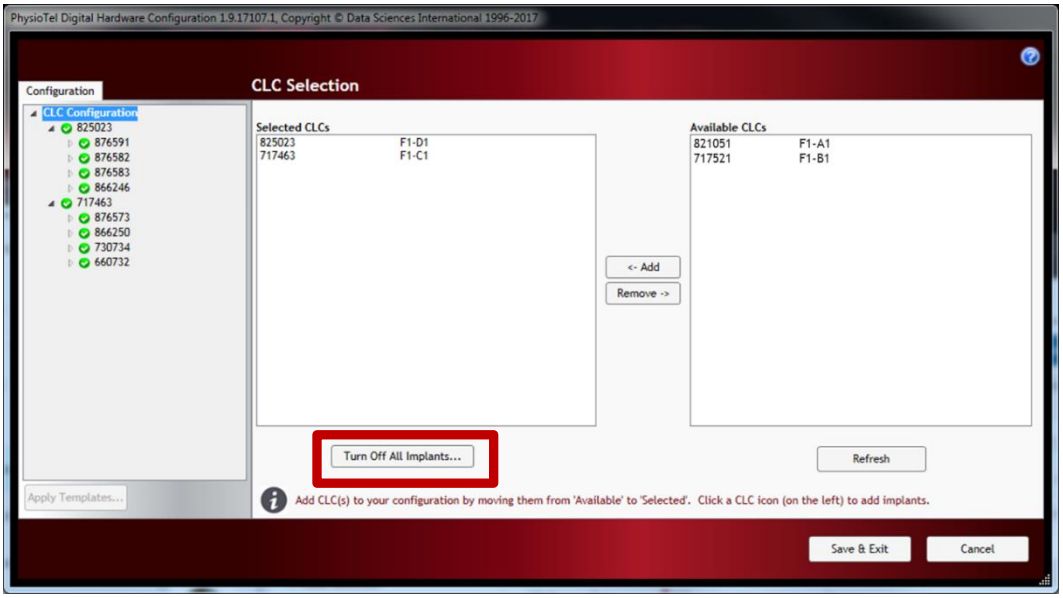


WARNING: Once you turn OFF an implant, it may only be returned to the ON state (Standby Mode) by physically passing a strong magnet close to the implant device for a few seconds.

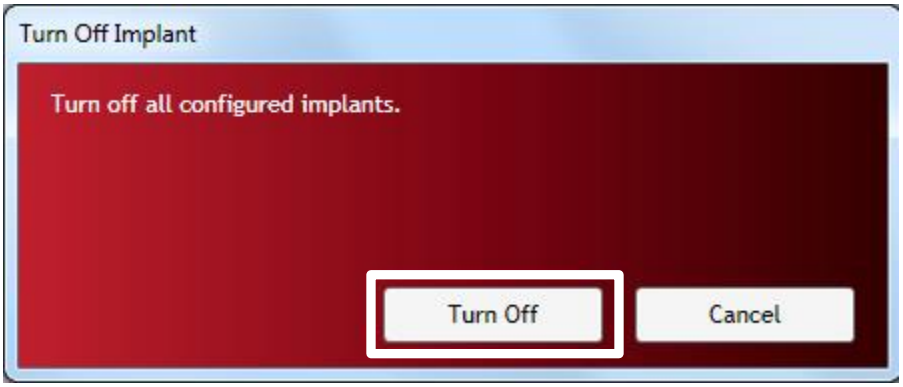
To remotely switch off ALL implants within the configuration at one time:

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.

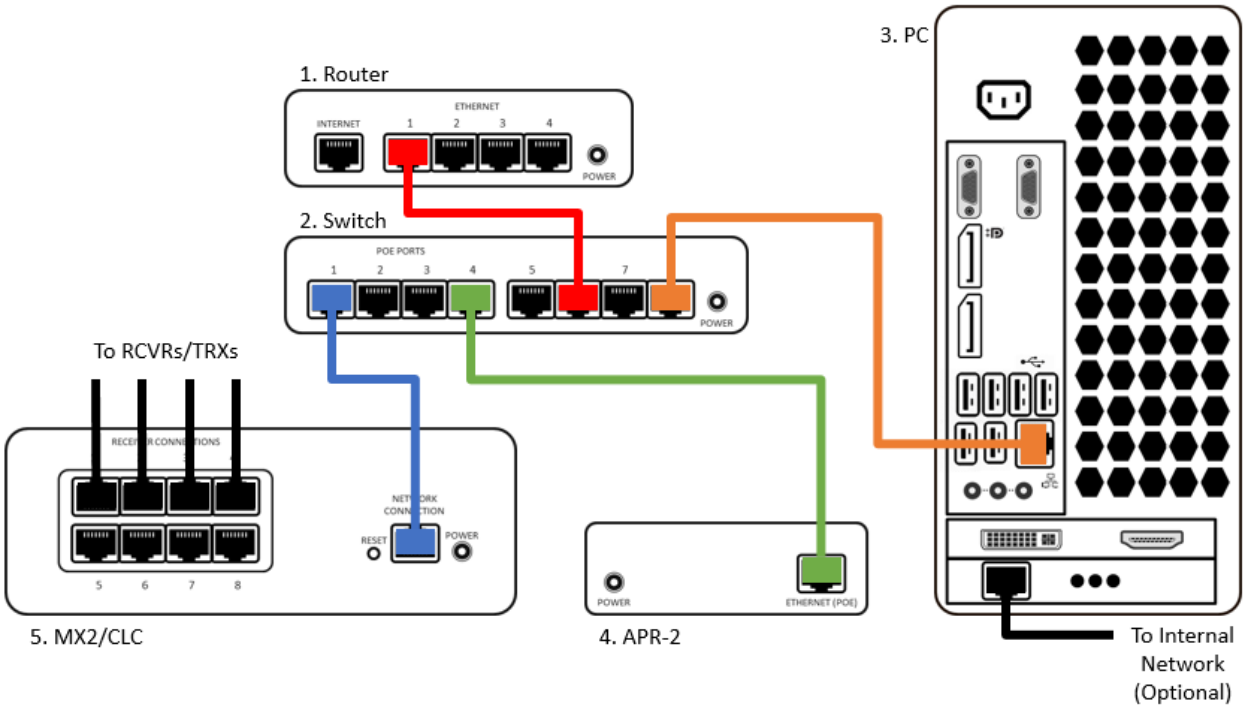
AUTO SHUT OFF – 60 MINUTES (DEFAULT VALUE)

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.

TELEMETRY HARDWARE CONNECTIONS

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

Note: Please do not power any devices until directed in the appropriate step. As a courtesy, DSI has included the colored cables referenced in the figure below with the system. However, any color standard Cat5e or 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 a non- PoE port on the switch (2).
2. Connect the orange Ethernet cable from the PC (3) to a non-PoE port on the switch (2).
3. Connect the yellow Ethernet cable from the J1-Ethernet jack on the APR-2 (4) to a PoE port on the switch (2).
4. Power up the Router (1). This may take up to two minutes. See router user documentation to learn how to tell when it is fully powered up.
5. After the Router has fully booted, power up the switch (2). This may take up to two minutes.
6. After the switch is powered up, connect the blue Ethernet cable from the network connection jack of the Matrix 2.0 (MX2) (5) or the Communication Link Controller (CLC) (5) to one of the PoE ports on the switch (2).
7. The MX2/CLC (5) should power up in about 1.5 minutes, but can take up to 5 minutes. The front panel LEDs indicate when the MX2/CLC is ready.
8. Connect the individual RPC/RSC/RMC/TRX cables to the receiver (RCVR/TRX) connections on the back of the MX2/CLC (5).
    - If using PhysioTel Digital, connect TRXs in sequential order starting at jack 1. This will optimize communication with the Digital Implants for the best experience.

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

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.

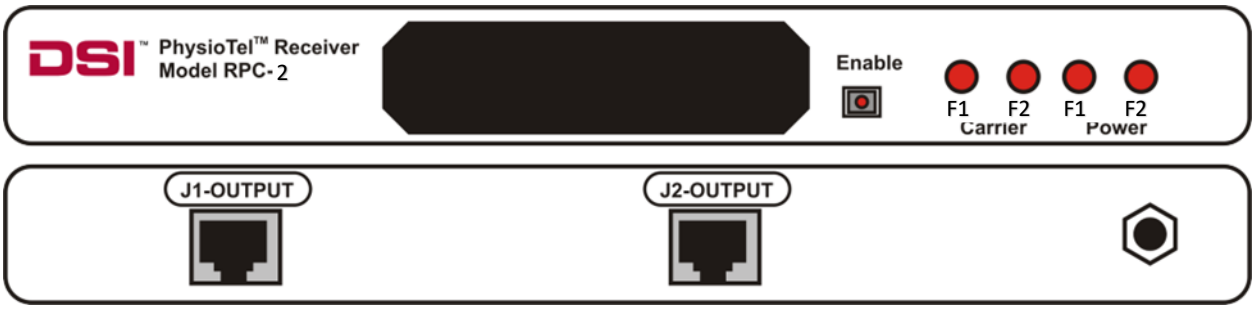


Illustration of the front (top) and back (bottom) panels of the RPC-2.

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.

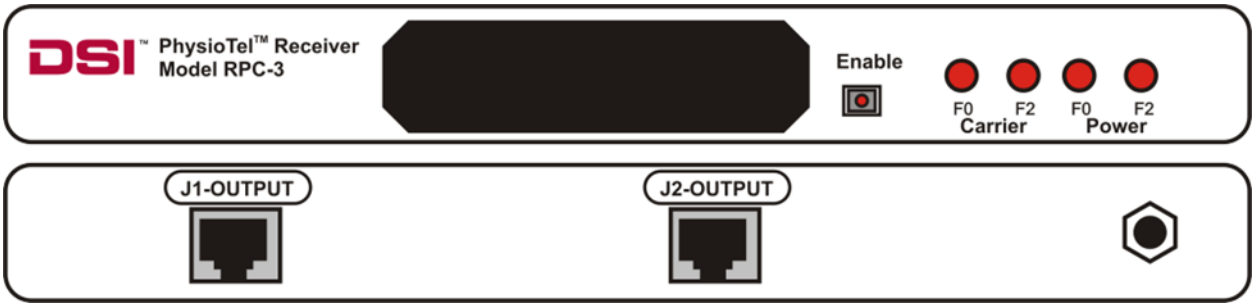


Illustration of the front (top) and back (bottom) panels of the RPC-3.

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

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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

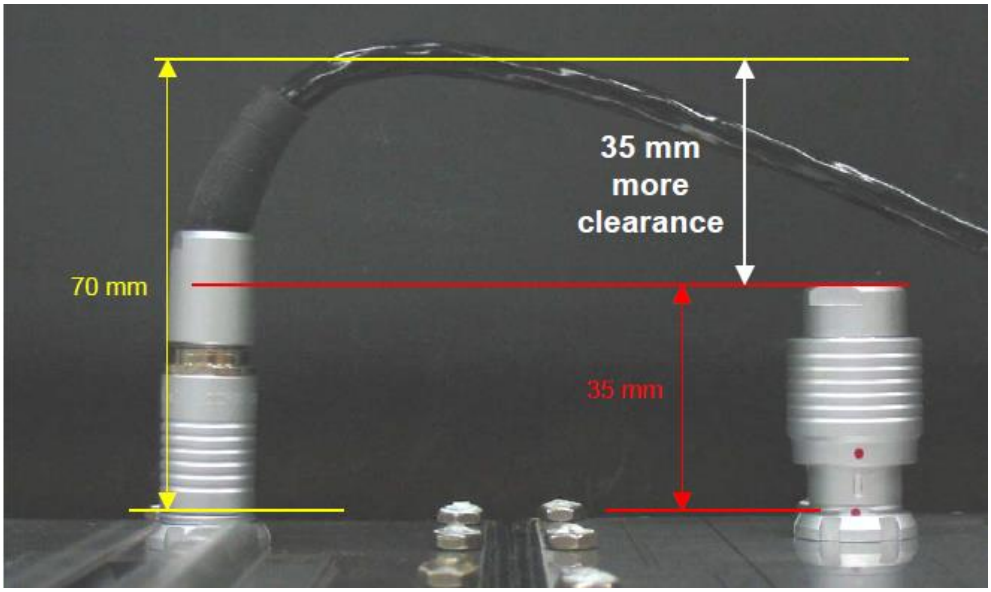
- Plug the "J" output jacks into the MX2 to establish a power and data connection.
- The "AUX" is used in DSI manufacturing to test the product.
- The "ANT" is where customers can plug in a custom antenna made by DSI or by their own engineers.

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.

MX2's basic specifications:

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.

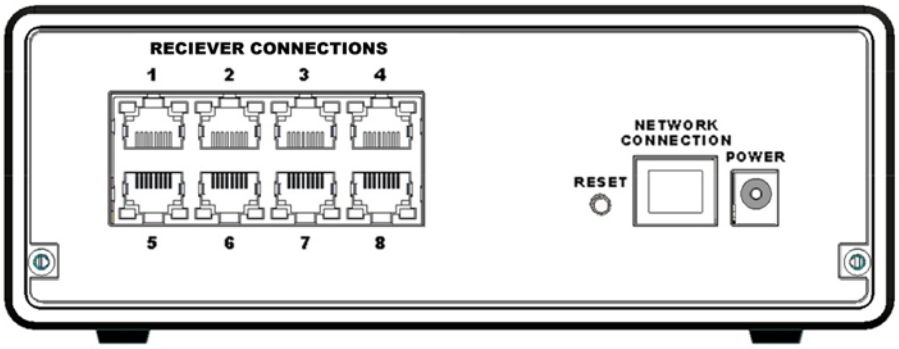


Illustration of the MX2 back panel.

RECEIVER CONNECTION INDICATORS

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

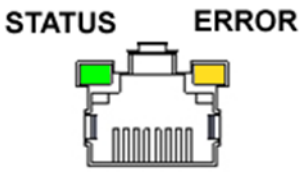


Illustration of the of the MX2 Receiver connection.

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

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

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.

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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.

CLC's basic specifications:

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

FRONT PANEL

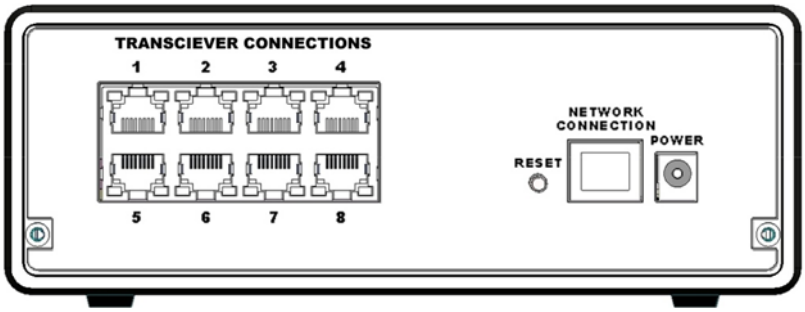
The front panel of the CLC contains three status indicator lights. In normal operational mode, only the green power indicator light is illuminated.

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.

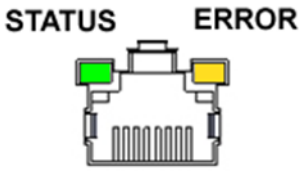


Illustration of the of the CLC Transceiver connection.

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.

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.

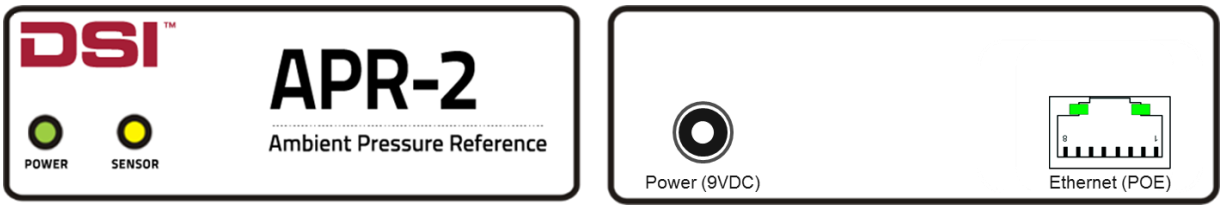
Note: Specifications for the APR-2 can be found in the Ambient Pressure Reference (APR-2) Hardware Appendix.

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)

012527-001 Rev 01

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 in to 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 (Small Business Class)
    - Cisco RV130 – 4-port Gigabit security router.
- Switch (Small Business Class)
    - Netgear FS116PNA – 16-port Gigabit, unmanaged switch with 8-port Power over Ethernet (PoE).

ACQUISITION INTERFACE CONFIGURATION

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

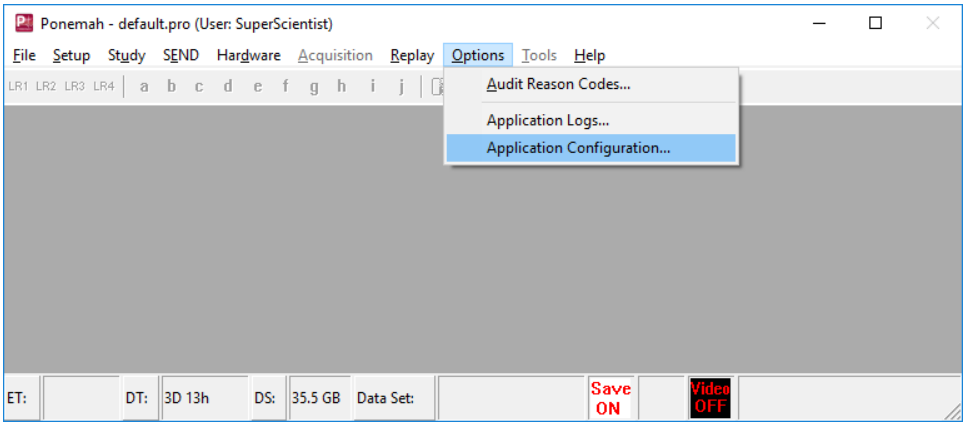
Use the following **Acquisition Interfaces** to:

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

Prior to configuration, the appropriate acquisition interface must be selected.

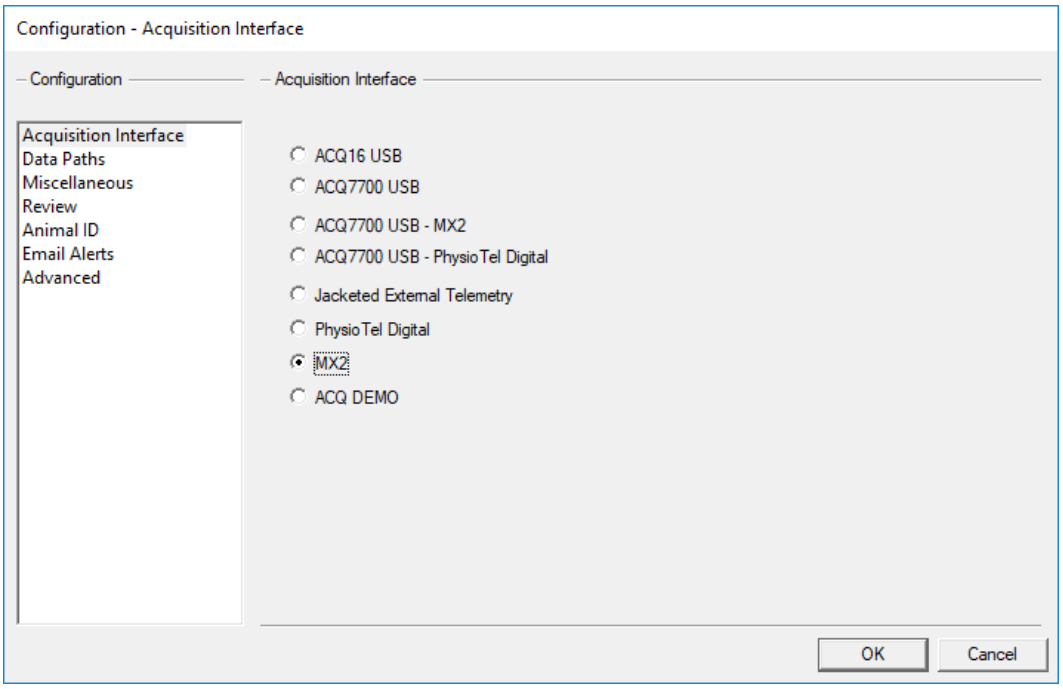
To do this:

1. Click the **Options menu | Application Configuration | Acquisition Interface**.



2. Then select the desired acquisition interface: MX2 for PhysioTel or PhysioTel HD or PhysioTel Digital for Digital Implant L series or M series. In the example below, MX2 is selected.

   Note: Ponemah will need to be restarted if the acquisition interface selection is changed

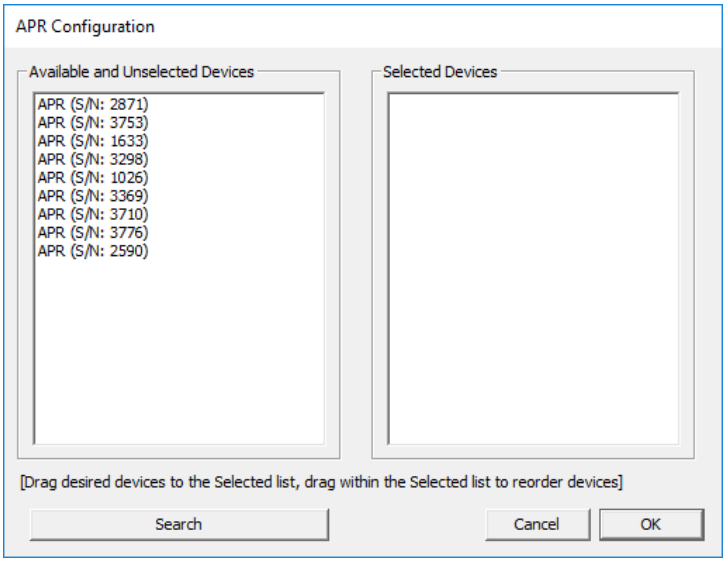


EDIT APR CONFIGURATION

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 **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.
- Select the **Search** button should hardware changes occur while this dialog is up to reflect the changes.

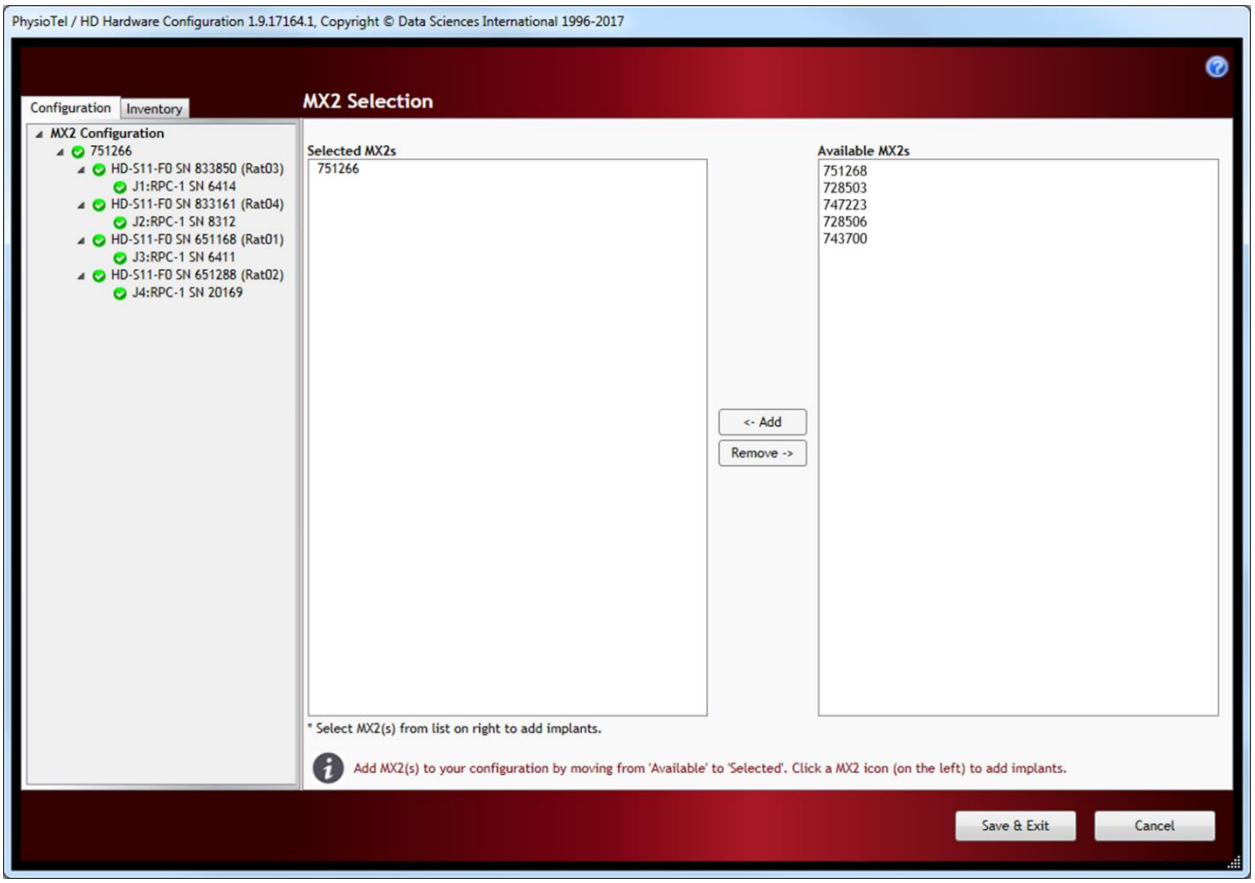
EDIT PHYSIOTEL /HD (MX2) CONFIGURATION

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 Configuration…** to open the MX2 Hardware Configuration dialog.

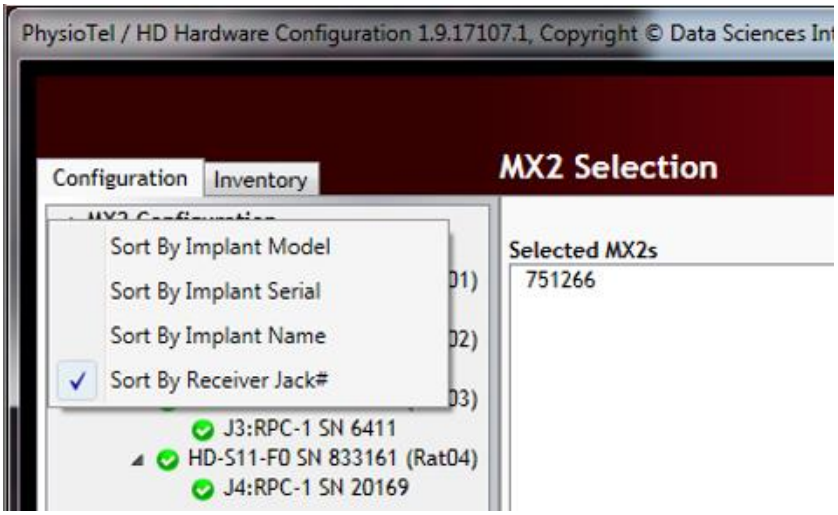


There are two functional areas in the **Configuration** dialog:

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

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

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

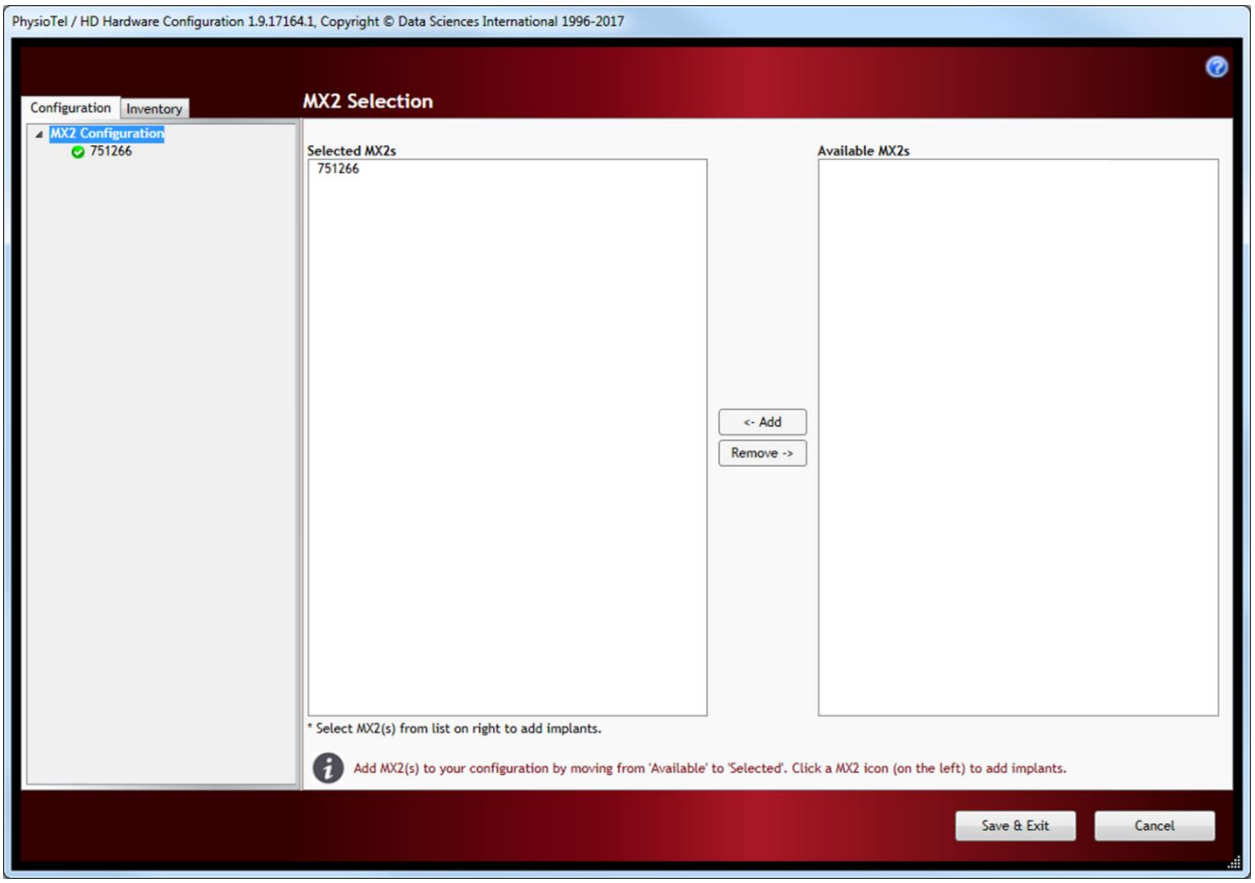


CONFIGURATION

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

To begin your configuration process:

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



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

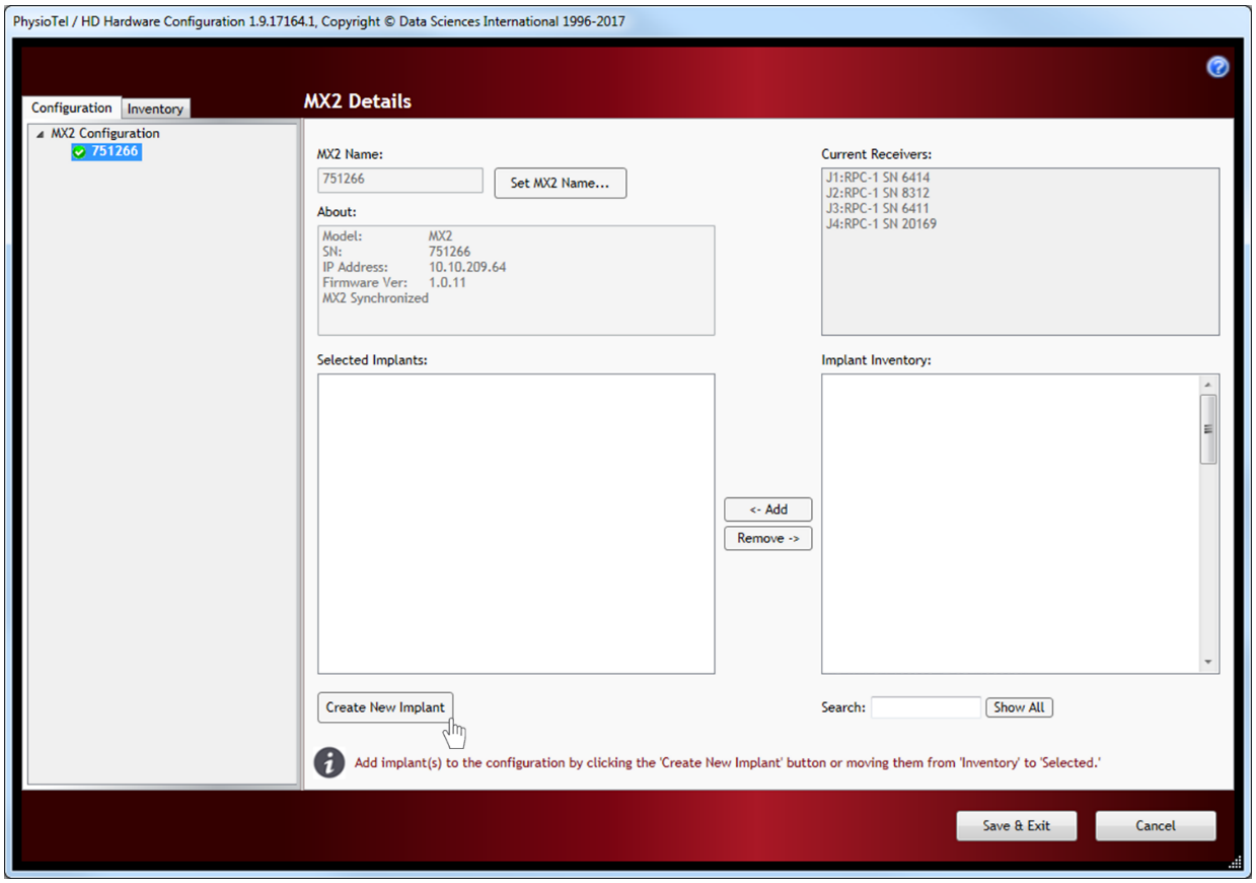
Enabled – a green colored icon with checkmark indicates the MX2 is synchronized and ready; i.e. it is connected and not currently configured in another system's Experiment.

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

Synchronizing – a yellow colored, time icon indicates 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.

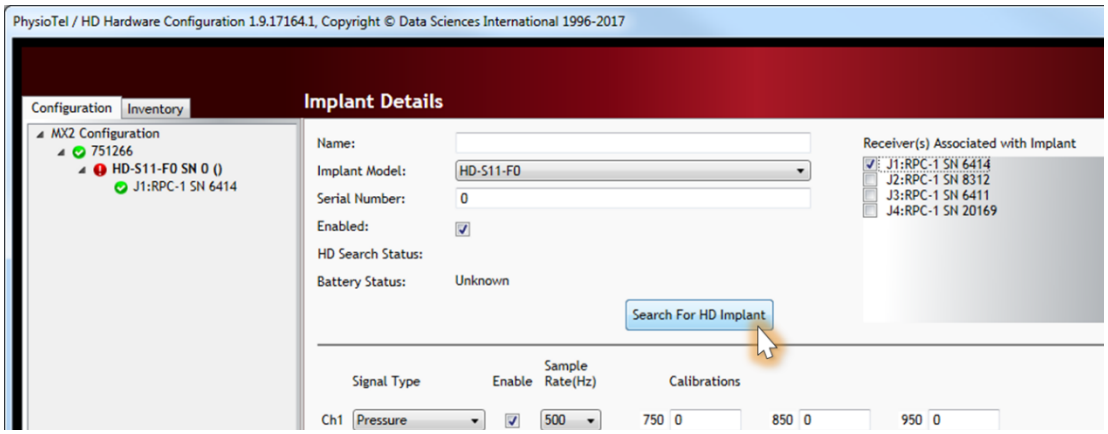


Note: Implants can be added to an MX2 by selecting the **Create New Implant** button or by click-and-dragging pre-configured implants from the **Inventory** list. Please see the Inventory section of the manual to learn more about this feature.

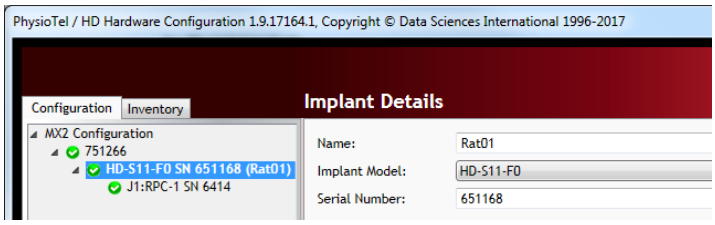
5. **For PhysioTel HD Implants**:
    a. Select the **Implant Model** using the dropdown menu.
    b. Associate a receiver(s) with the implant by checking the receiver checkbox you wish to configure it on. This will enable the **Search for HD Implant** button.

    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.

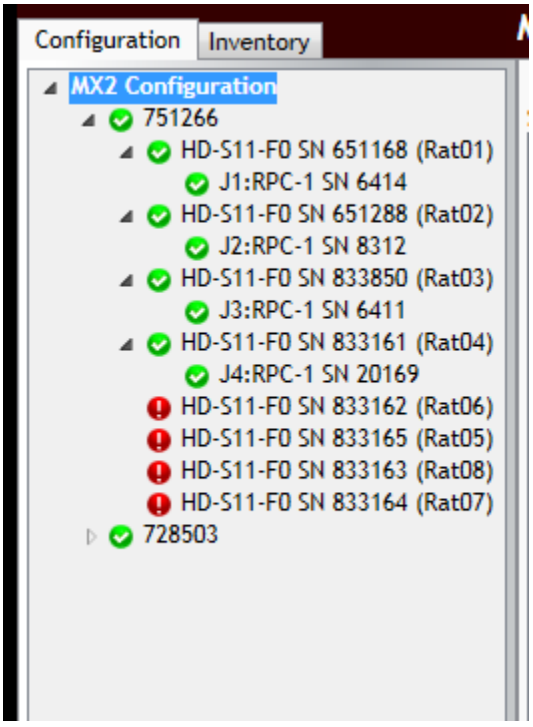
Disabled – a red colored icon with exclamation mark indicates the implant is not currently available (e.g. in configuration but does not have at least one Receiver selected).

- *Typical Signal Type and Sampling Rate values:

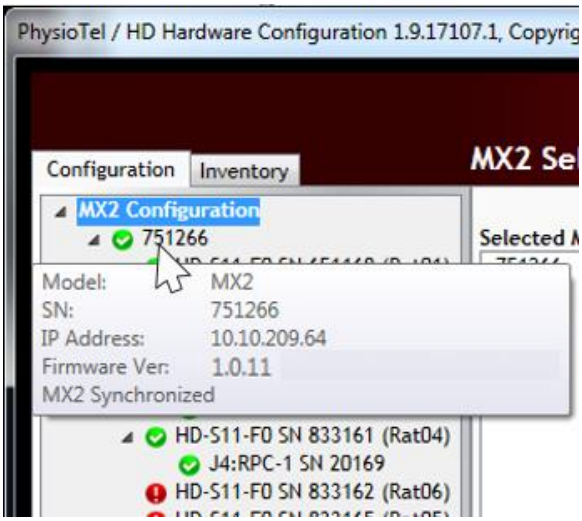
Signal Type	Sampling Rate (Hz)
Blood Pressure (BP)	500
Left Ventricular Pressure (LVP)	500
Electrocardiogram (ECG)	1000
Electroencephalogram (EEG)	1000
Electromyogram (EMG)	1000
Temperature	1
Activity	1
Signal Strength	1

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.



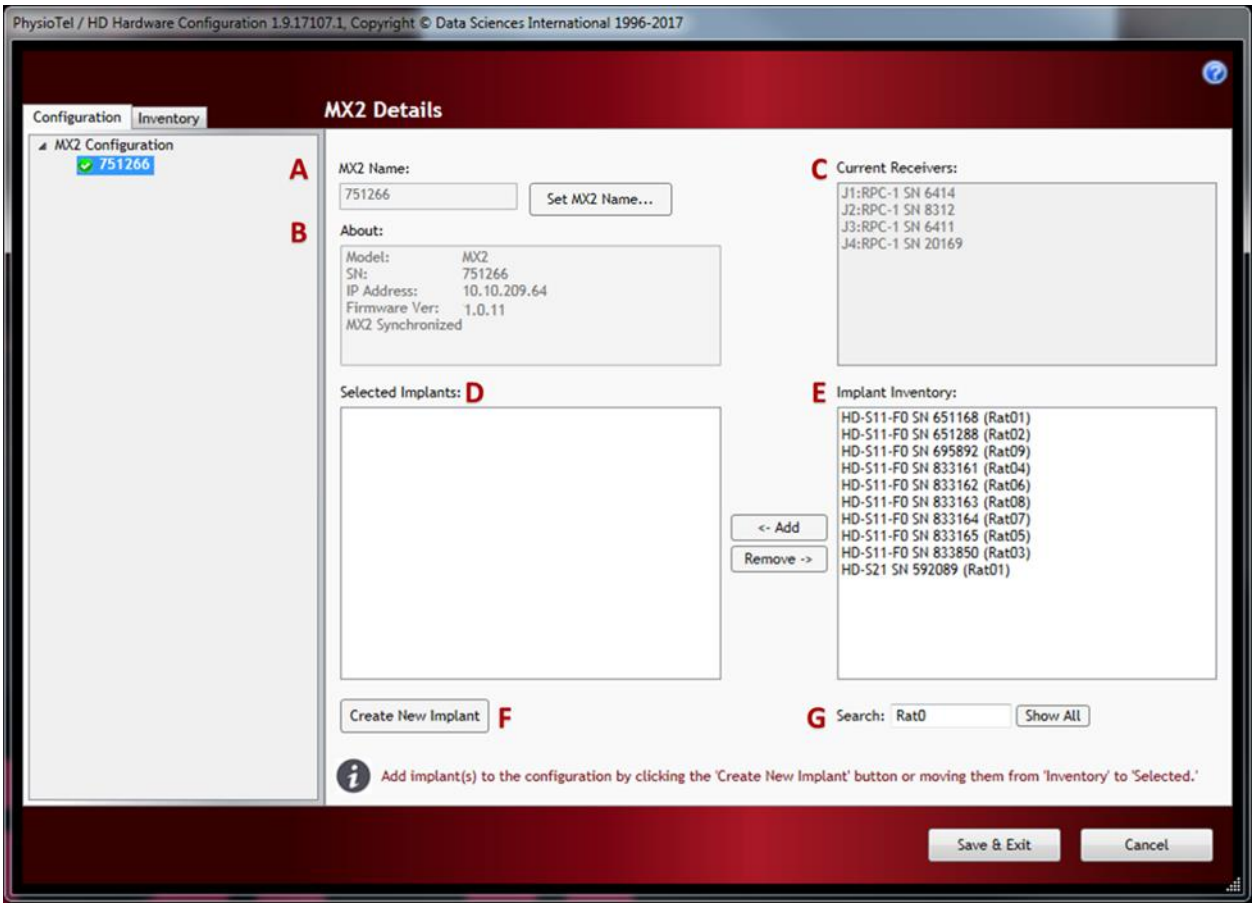
The **MX2 Configuration** is the first line in the List View and displays the **Selected MX2** for the current configuration.

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.

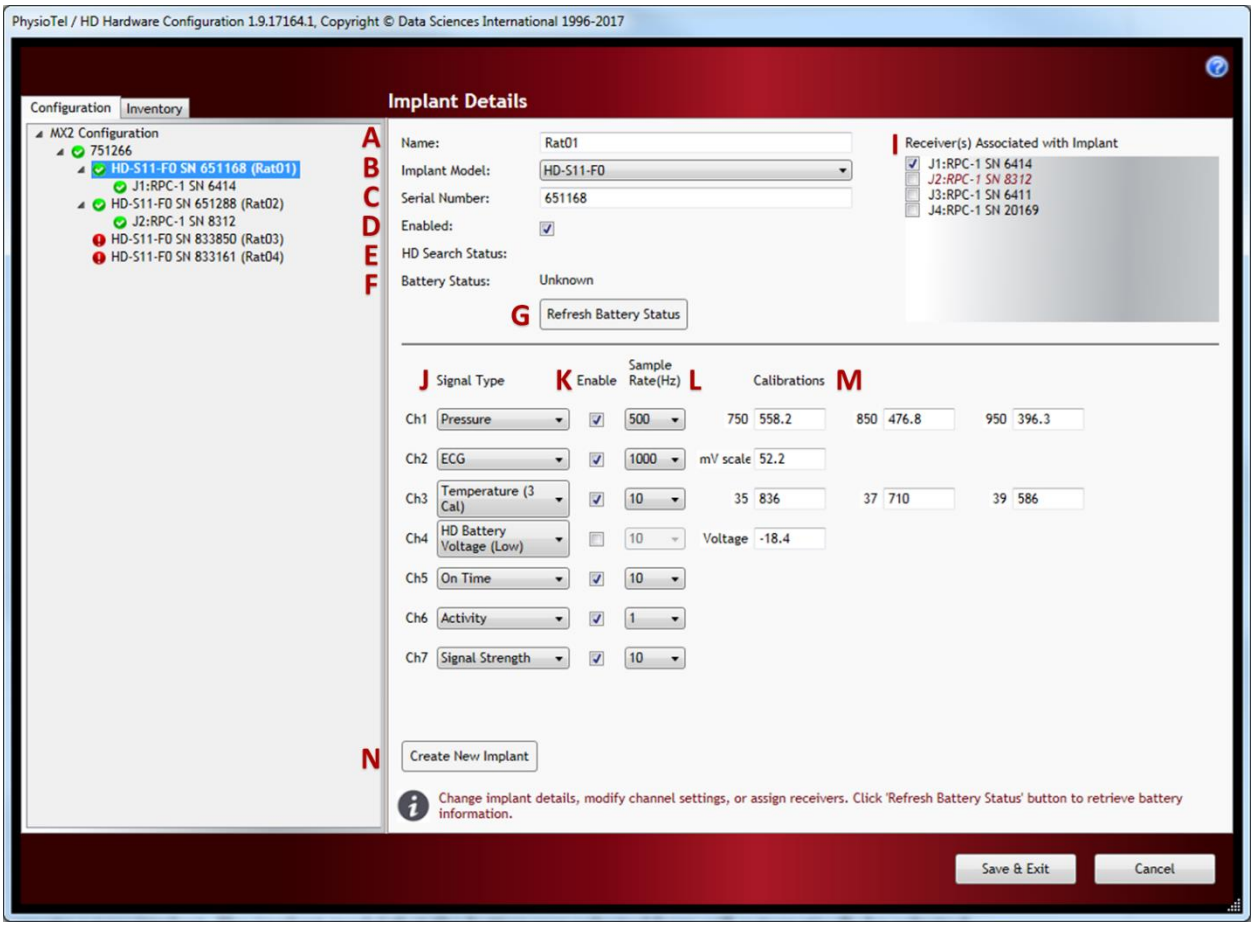


The following features are available in the **MX2 Details** dialog:

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.

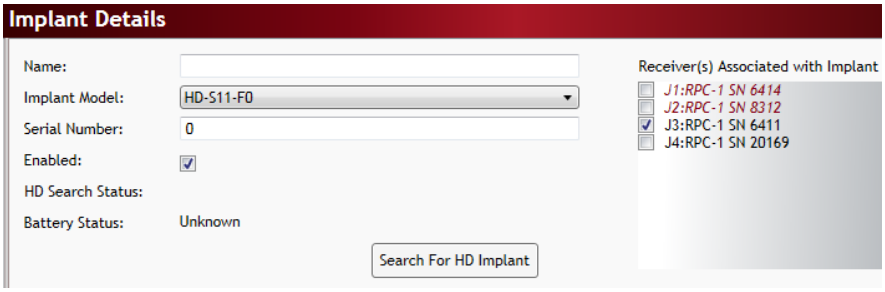
> ⚠ *WARNING: if the implant is not **Enabled**, the implant will still be powered **ON** and in communication with the system, but no data from the implant will be acquired.*

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.

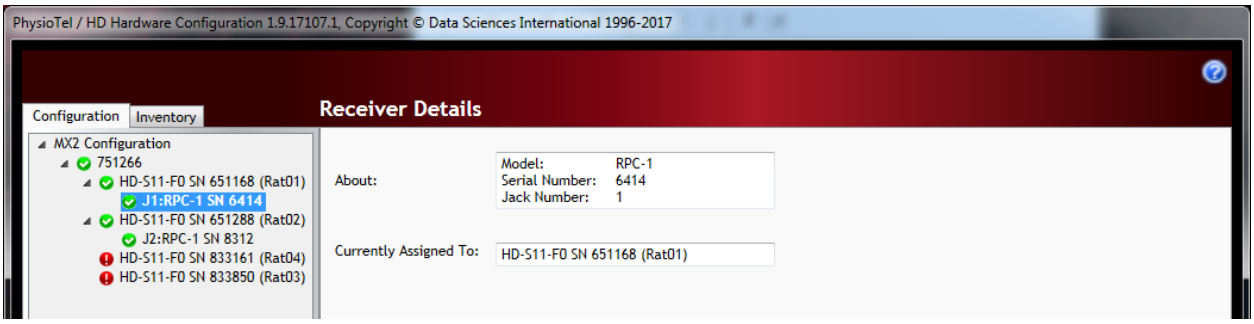
L. **Sampling Rate**: allows the user to define a unique sampling rate to each implant channel.

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.



INVENTORY

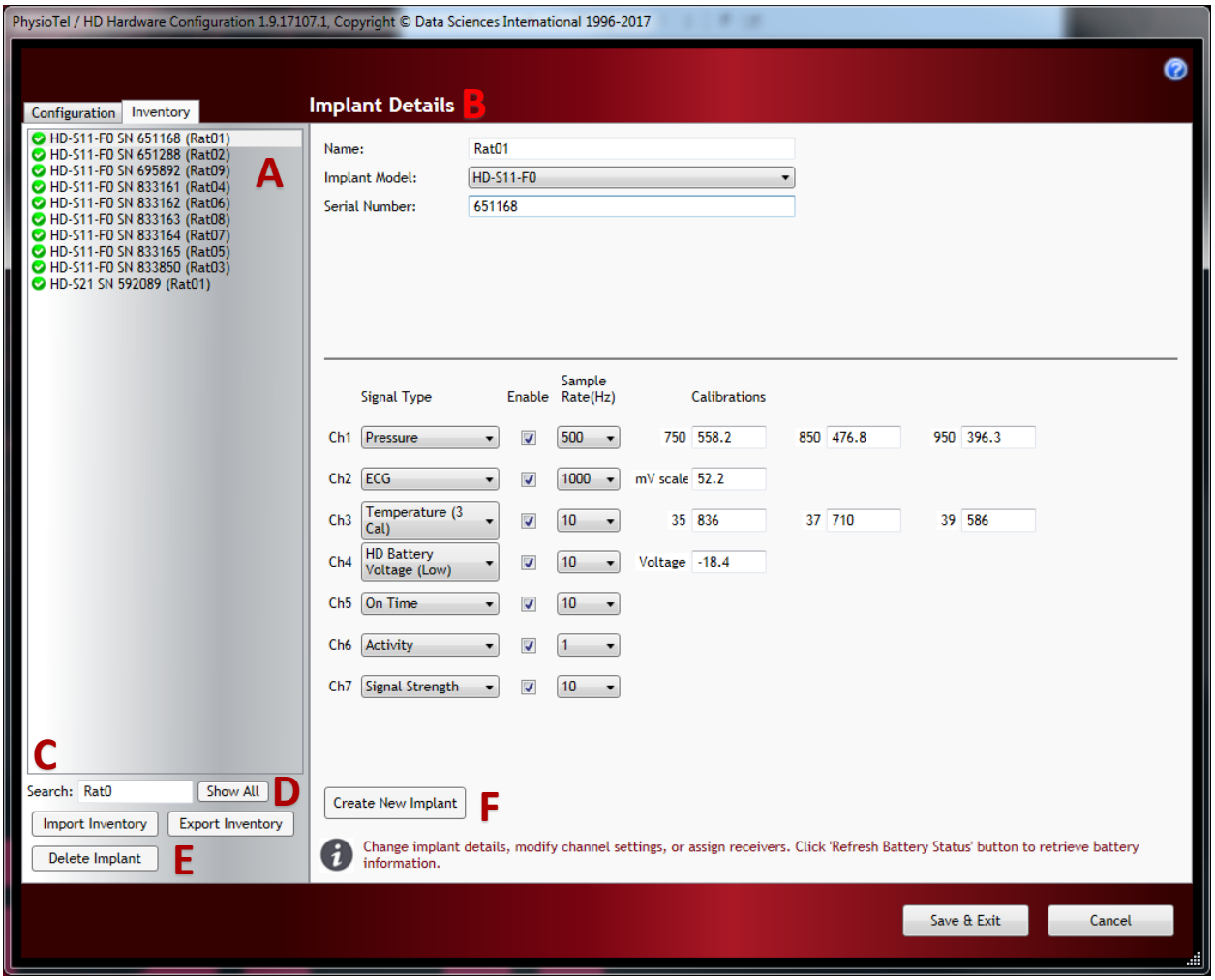
The **Inventory** is a repository for the storage and retrieval of implant details which have been configured in the current Experiment, or previously configured Experiments. The implants contained within the Inventory can be used across Experiments without having to re-configure the implant within each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

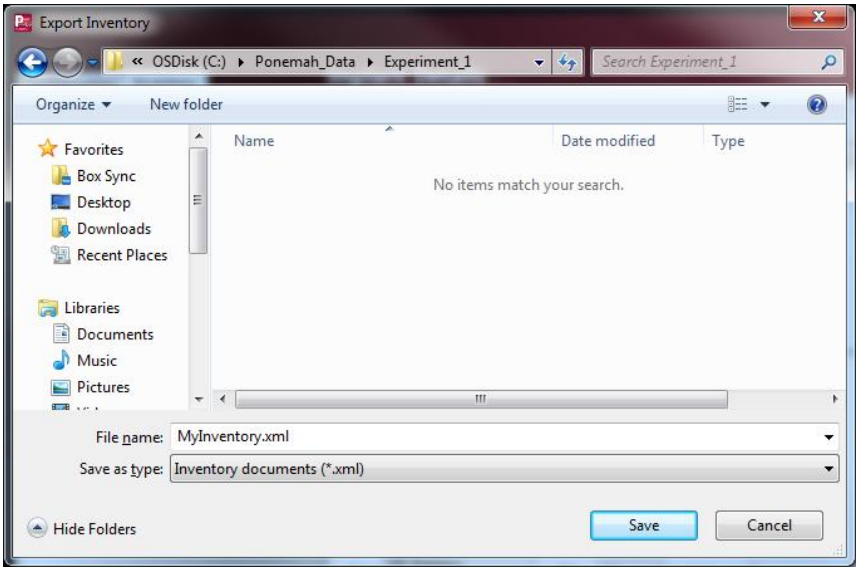
A. **List of Implants**: lists the implants available from the Inventory.
B. **Implant Details**: allows the User to configure individual implants.
C. **Search**: allows the user to query the Inventory to locate specific implants. User can locate implants by model or serial number.
D. **Export/Import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

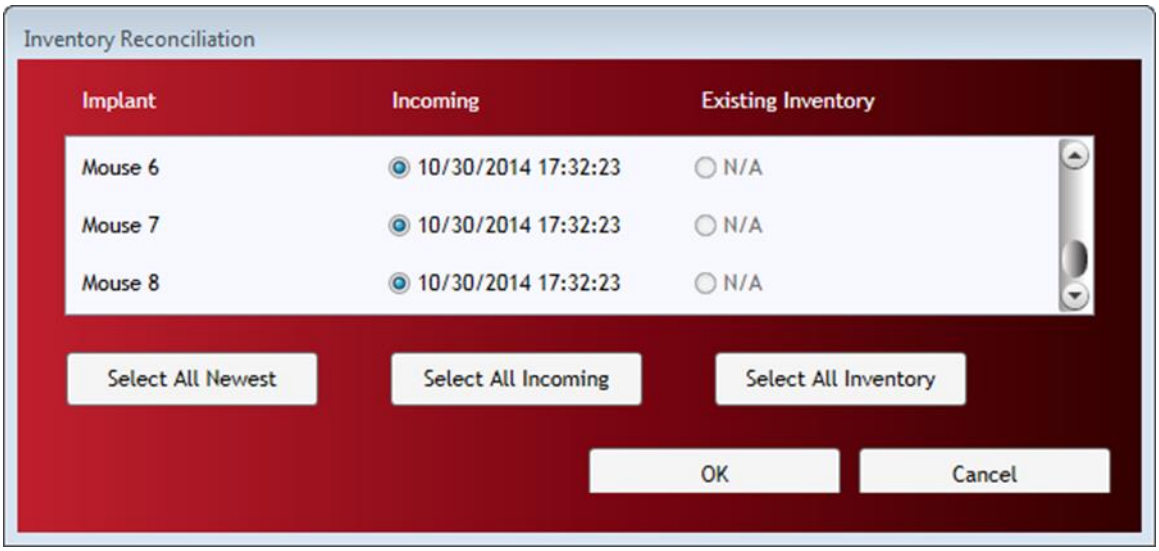


2. The default filename is **MyInventory.xml** but the user may use any filename with an .xml file extension.
3. Click **Save**.

   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

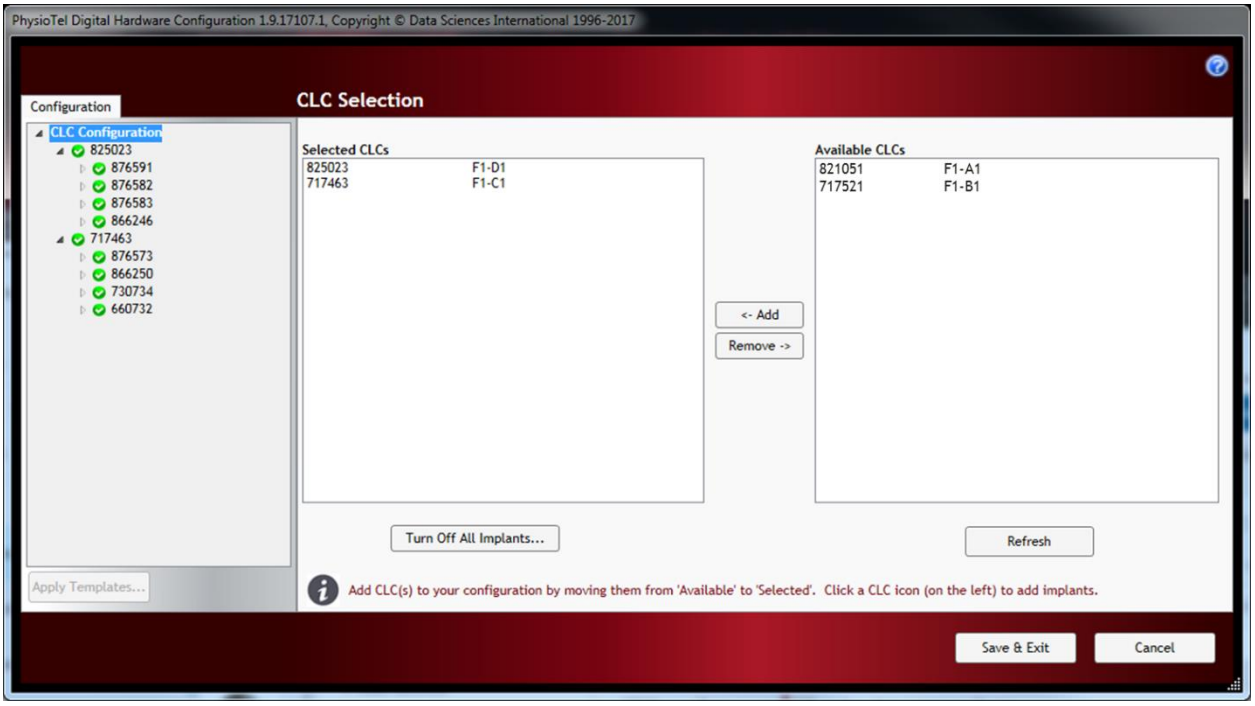
The PhysioTel Digital system automates the collection of physiologic data from freely moving research animals via wireless telemetry. The system consists of a sophisticated acquisition and analysis software platform and a family of advanced, state of the art implantable telemetry transmitters. The communications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



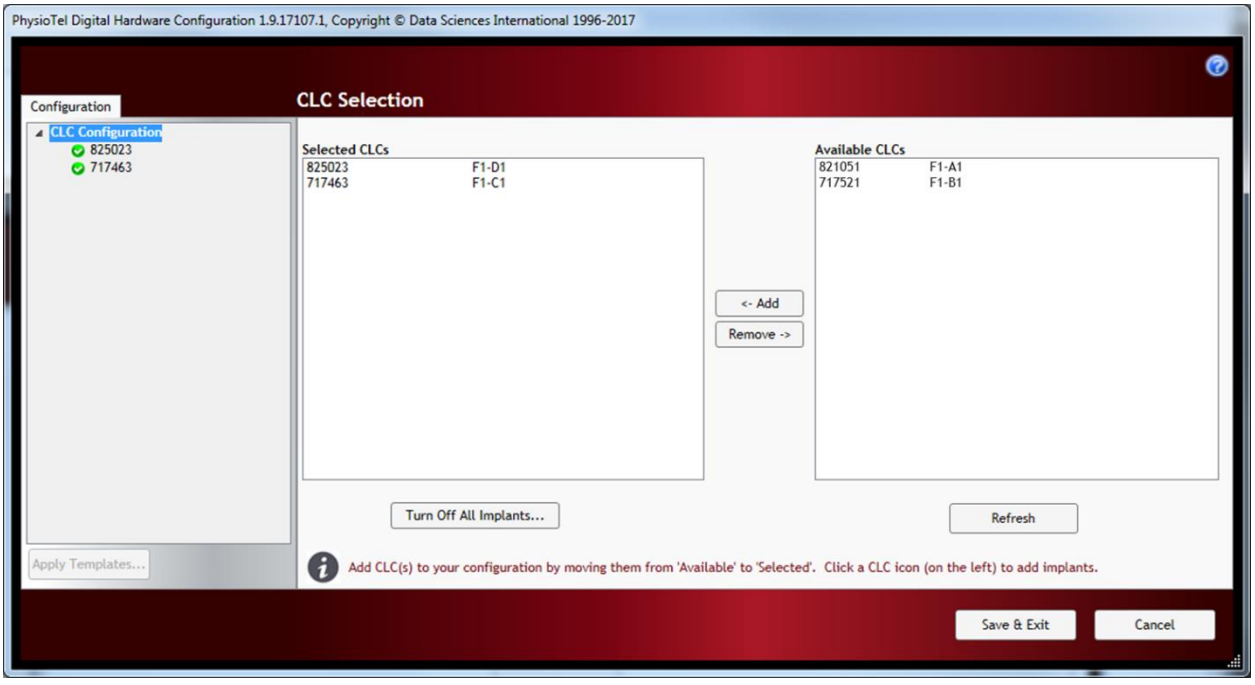
CONFIGURATION

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.

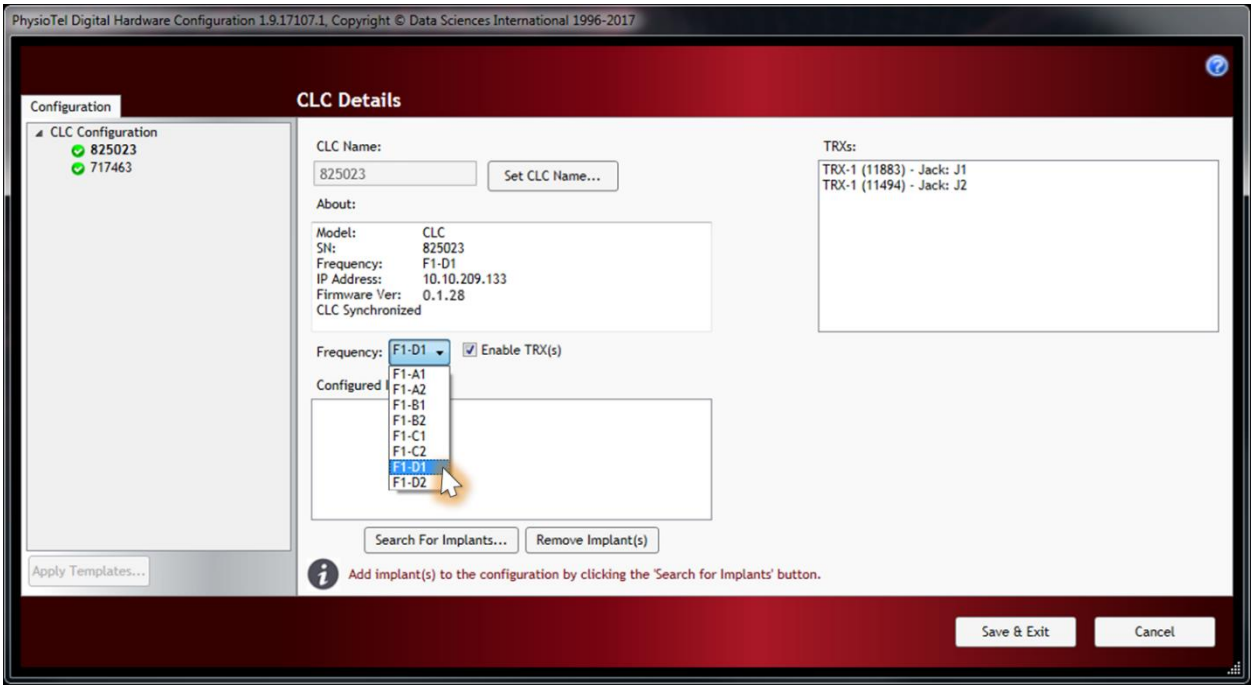
Disabled – a red colored icon with exclamation mark indicates the CLC is not currently available (e.g. in configuration but not connected to the network) or is currently configured in an Experiment on another system.

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.

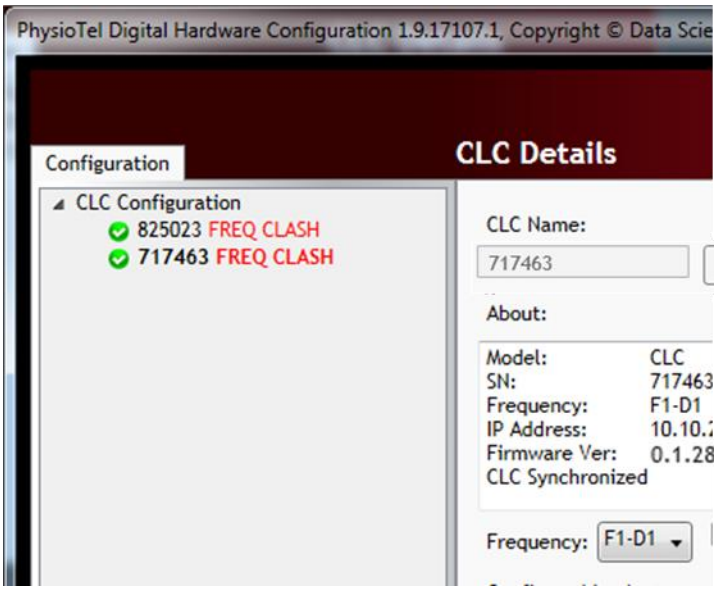
Unknown – a yellow colored icon with question mark indicated the CLC is connected but does not have any TRXs connected.

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).

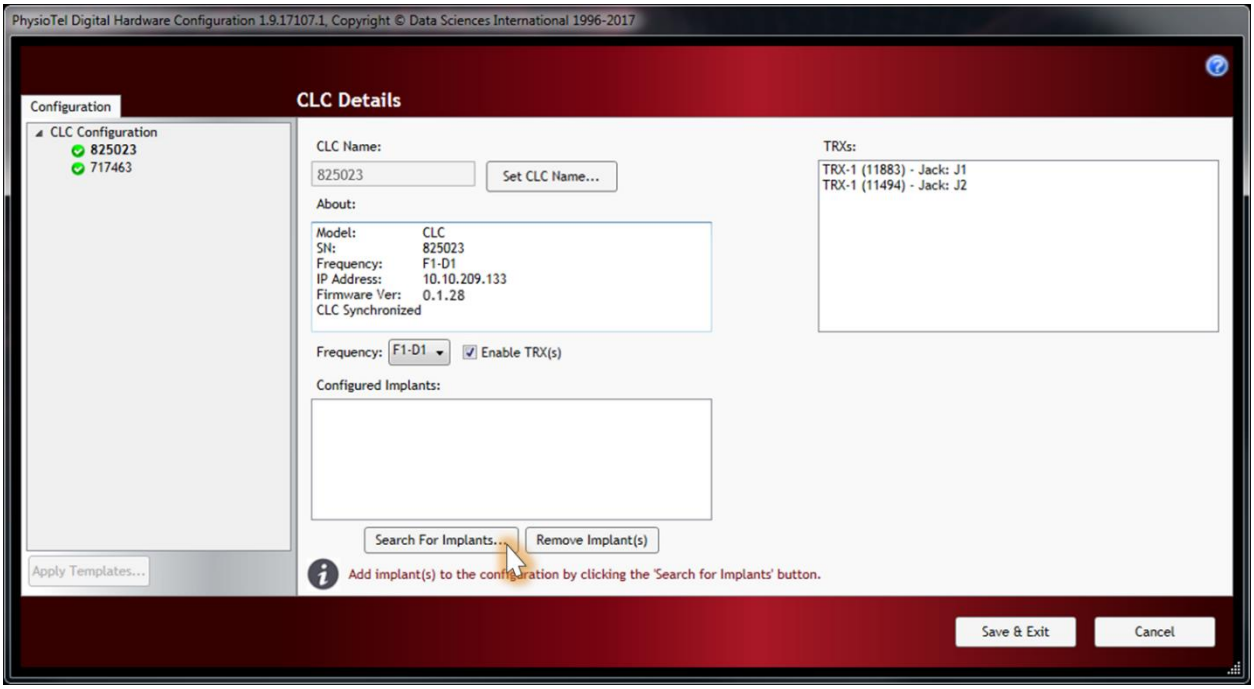


5. Repeat Steps 3 and 4 for any additional CLCs within your configuration. Ensure each is assigned a unique frequency. If you choose a frequency previously defined to another CLC, a **FREQ CLASH** notification will be placed next to the CLCs with conflicting frequencies.



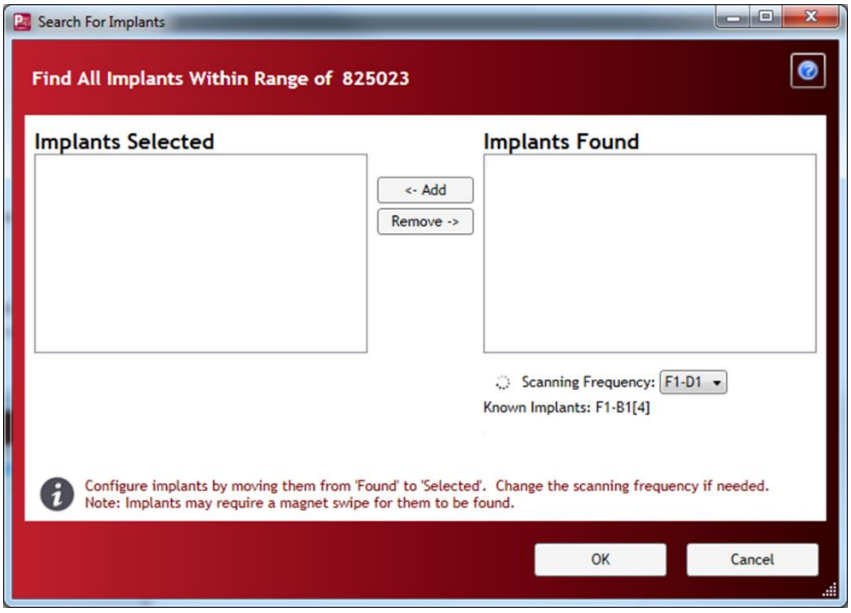
Note: FREQ CLASH will also be displayed should the frequency of a configured CLC be the same as the frequency of another CLC on the network (Available CLCs column within the CLC Configuration line of the List View). If these CLCs are spaced appropriately, they should not interfere with each other.

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



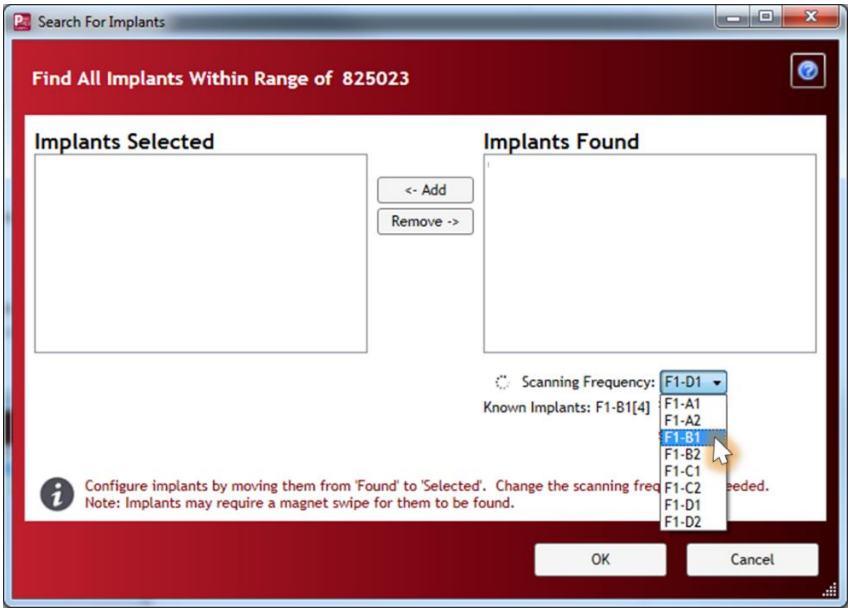
The *Search for Implants* dialog will display and automatically begin searching for implants across all supported frequencies if they are powered ON and within transmitter range. Any implants in Standby

Mode and on the CLC's current frequency will be displayed in the **Implants Found** column.

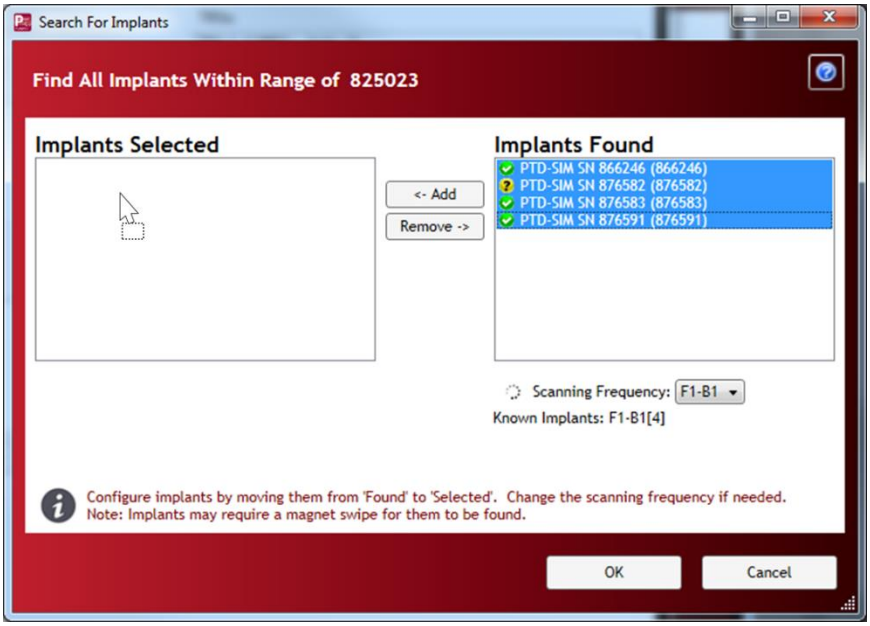


*Note: The **Known Implants** line will provide guidance on which frequencies the CLCs are seeing implants on, as well as the number of implants in brackets on that frequency. New implants that have not been previously configured will be detectable using the default frequency (**B1**).*

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.



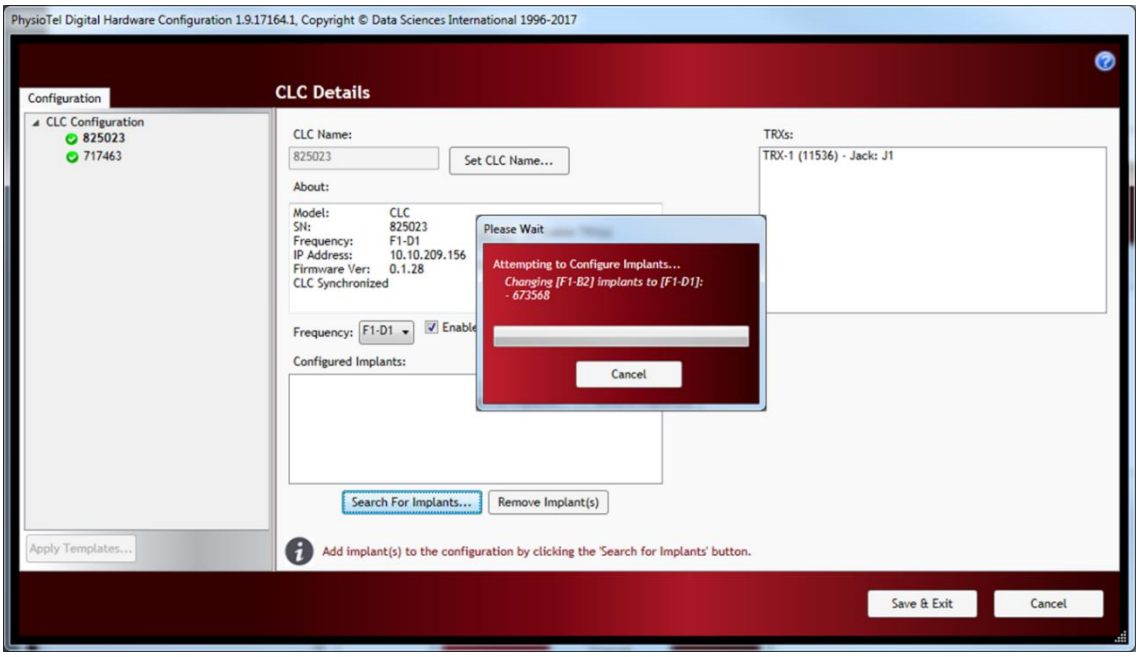
*Note: Implants only need to be listed in the **Implants Found** column to be added to the **Implants Selected** column. Their icon color and indication have no bearing on this action.*

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

Connected – 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.

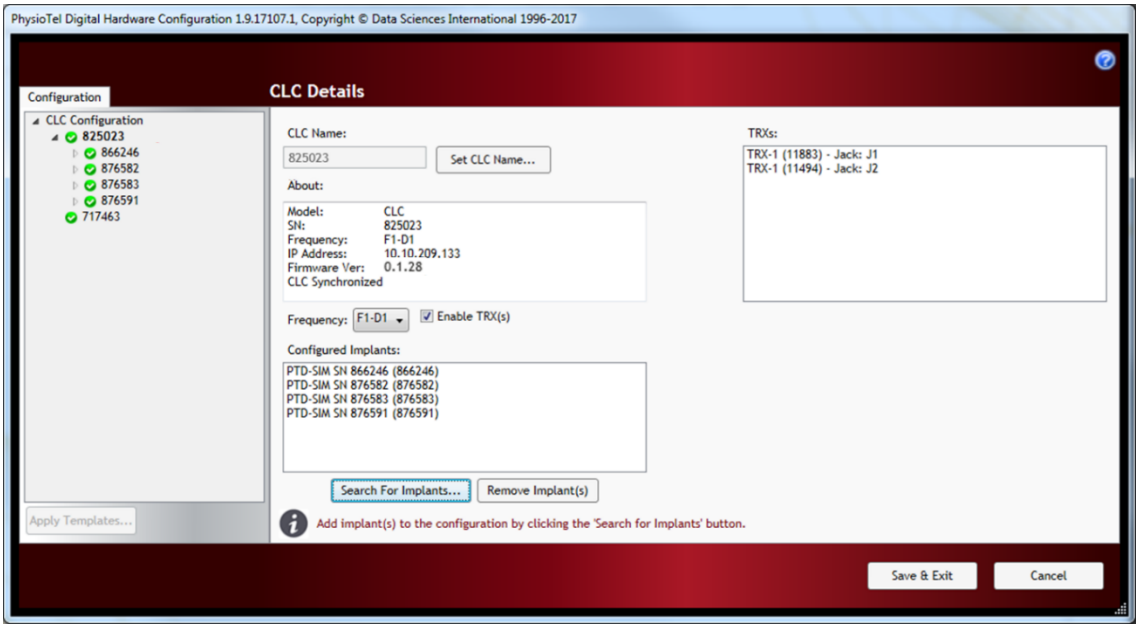
9. Click **OK**.
Again, no need to wait for icons to turn green. A message will be displayed requesting you to wait for the implants to be configured to their new frequencies.



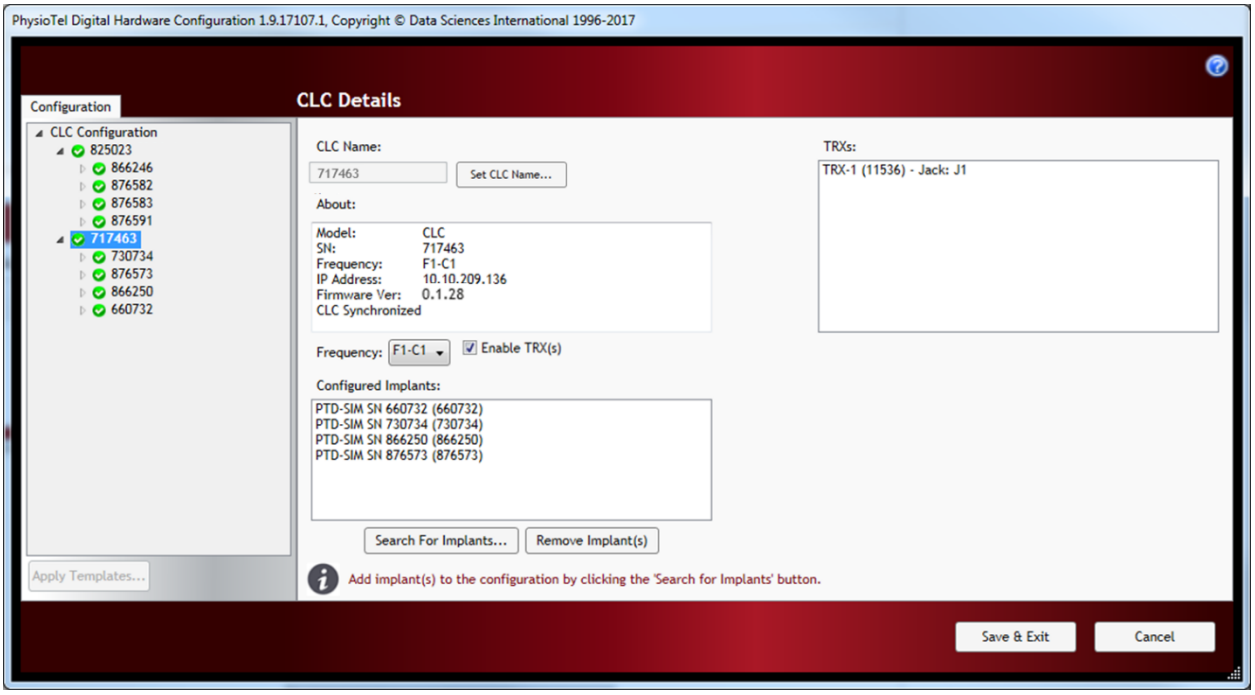
WARNING: Do not unplug any connected hardware during the programming process.

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*.



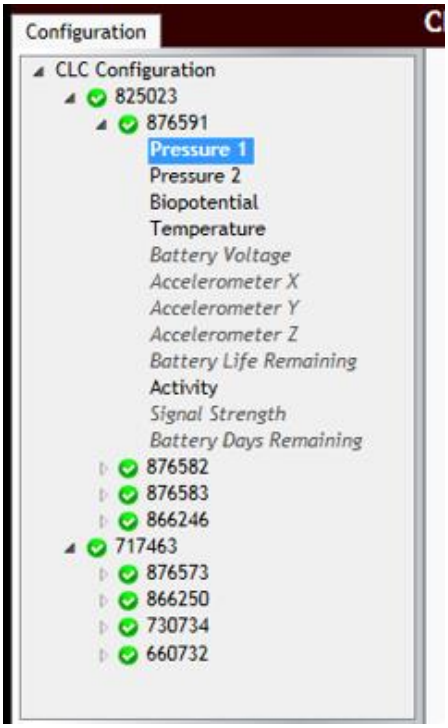
11. Repeat steps 6-10 for any additional CLCs/implants.



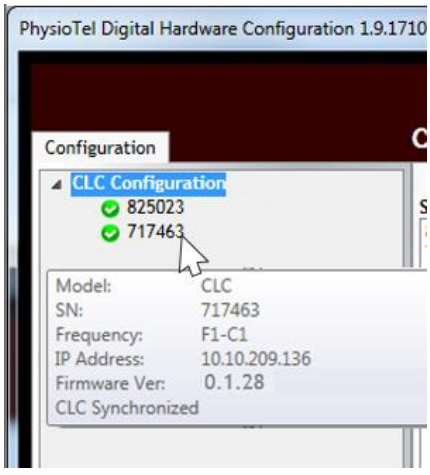
12. Once complete, click the **Save & Exit** button.

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.



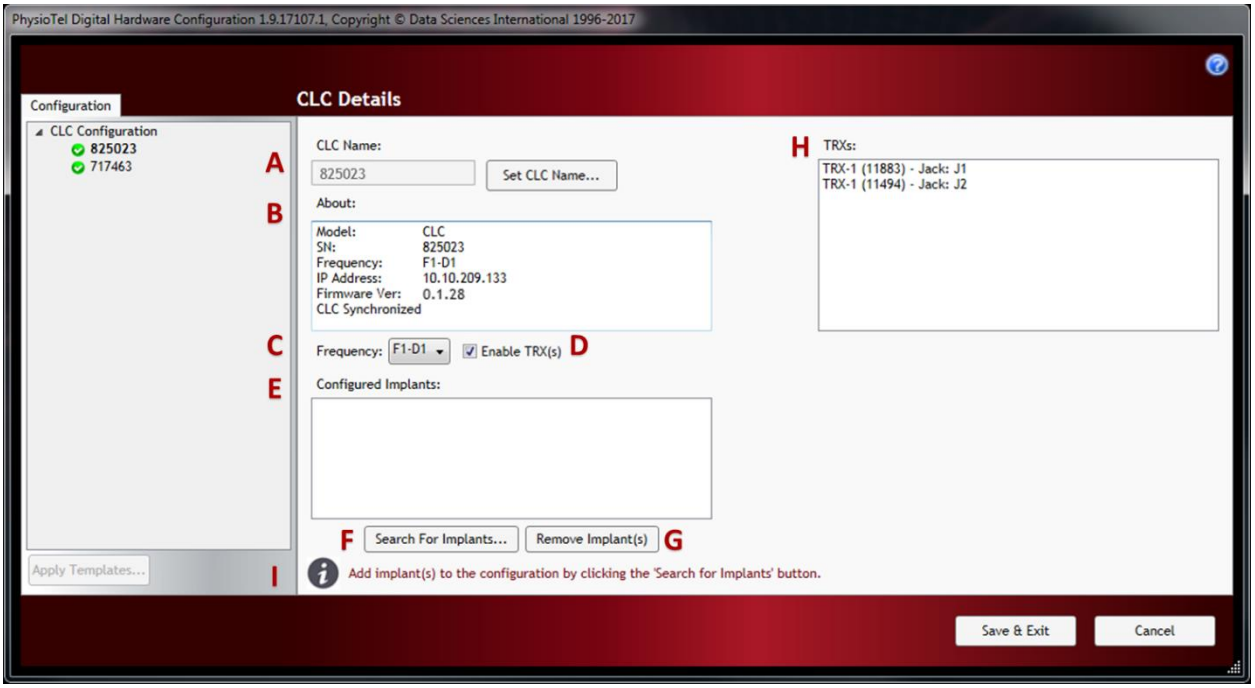
The **CLC Configuration** is the first line in the List View and displays the **Selected CLC** for the current configuration.

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

- CLC Details
- Implant Details
- Channel Details

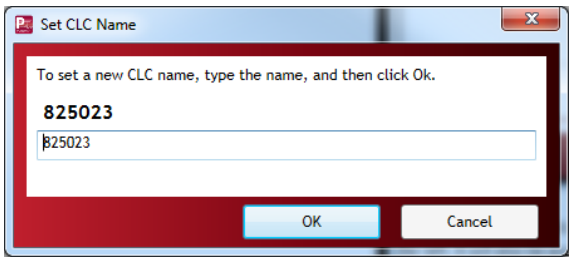
CLC Details

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



CLC Details include:

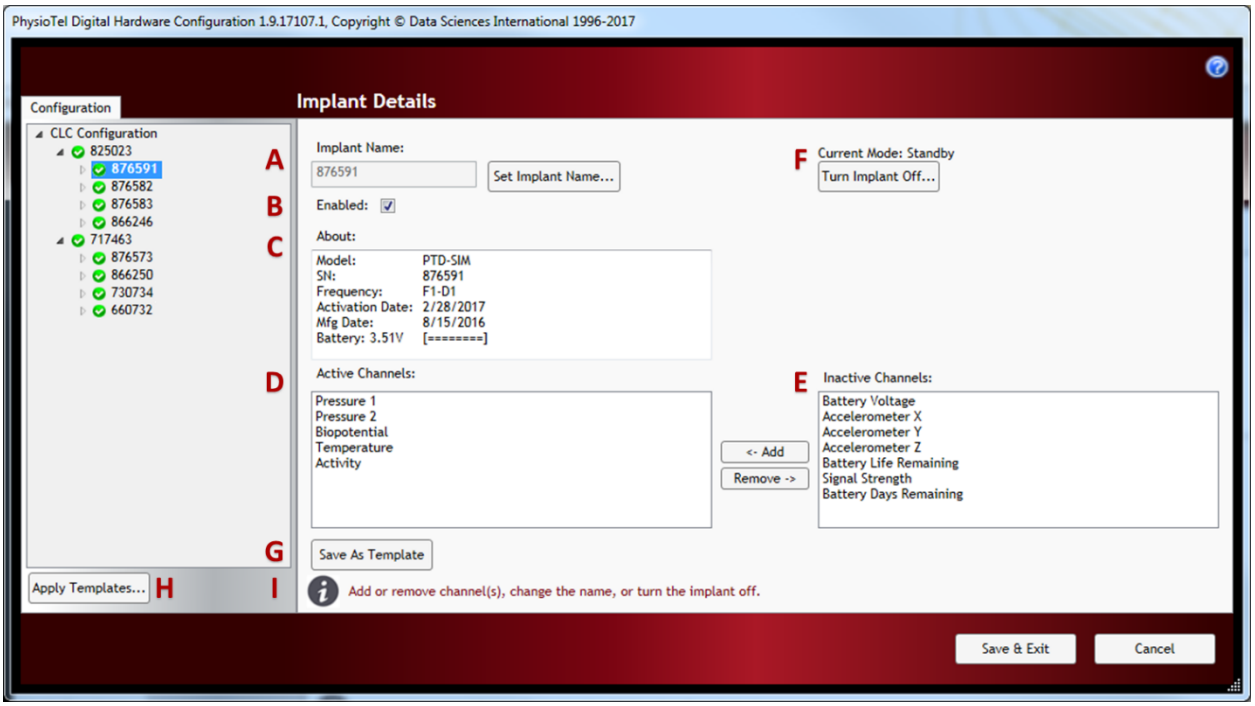
A. CLC Name: Select the **Set CLC Name…** button to create or change the name of the CLC. This name is saved on the CLC and will be the name seen when searching the network for available CLCs to add to the configuration with the **PhysioTel Digital Configuration**.



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.

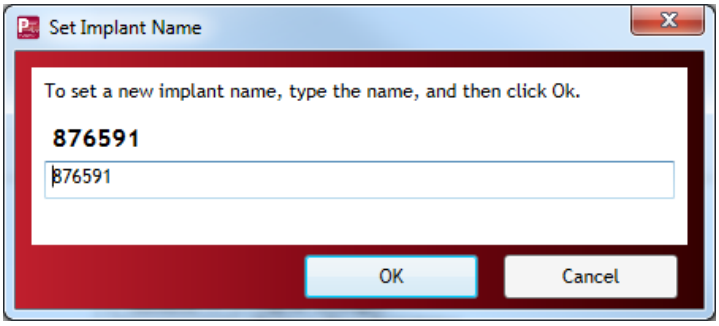
Implant Details

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.

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:

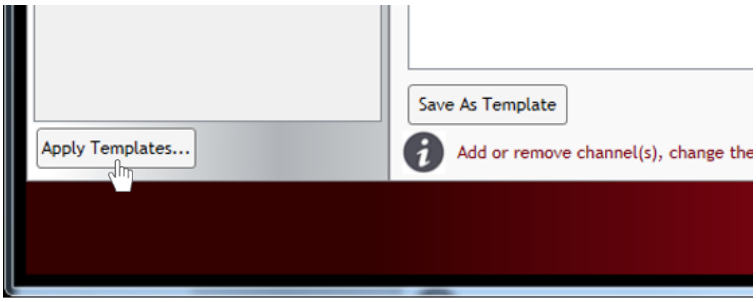
1. Select an implant from the **CLC Configuration** column on the left side of the screen.

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.

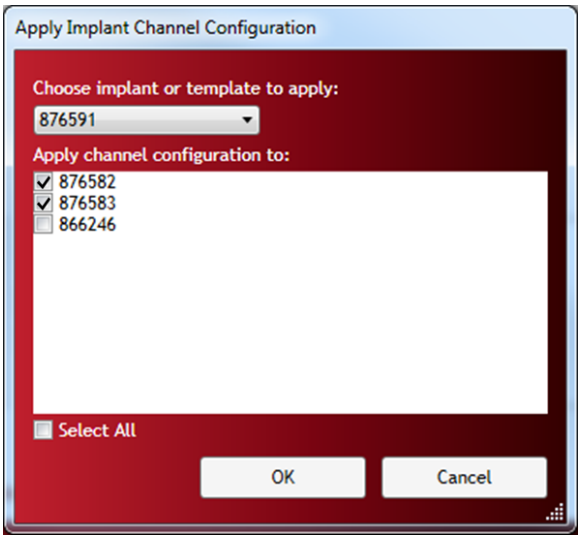
   Note: Only one Model Template can be saved per implant model type.

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.



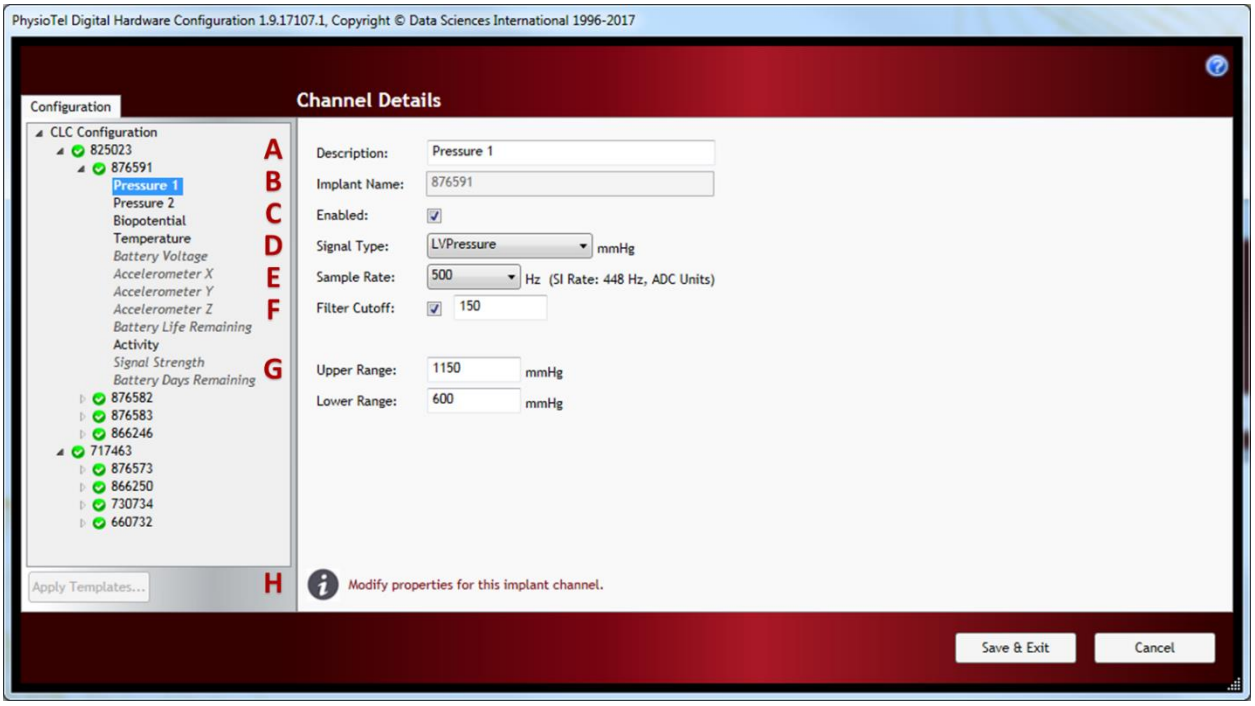
4. The **Select All** check box can be used to select/deselect all implants in the dialog box.
5. Click **OK** to apply the saved template configuration.

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.

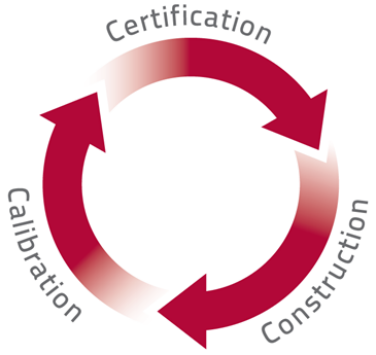
APPENDICES

This appendix provides information about DSI's implant exchange program, tells you how to manage a zero-pressure offset, and describes how to maintain an implant after it has been first implanted.

IMPLANT APPENDIX

EXCHANGE PROGRAM

The DSI Exchange program allows you to exchange your used telemetry implants for replacement implants at a fraction of the original purchase price. In addition, we ensure that each implant provided as part of DSI Exchange program will meet or exceed your design expectations for guaranteed performance and quality. By participating in the DSI Exchange program, the overall costs of your study should be considerably reduced. The three key elements to this program are construction, calibration, and certification.



CONSTRUCTION

All implants are hand assembled by DSI's highly skilled technicians, and before being shipped to you, each implant is rigorously inspected to ensure that all components meet the highest quality standards.

In addition, we take the following steps to ensure that you receive a biocompatible device that is guaranteed to perform to specifications *in vivo*.

- A new battery is installed, which guarantees the implant will function throughout the warranty period.
- All implants are sterilized and placed in a biocompatible housing before being shipped to you.
- Biopotential leads and catheters are provided to ensure signal fidelity.

CALIBRATION

Here's what we do to ensure that all our implants are properly calibrated.

1. Mechanical and electrical testing of all components to guarantee optimal functionality.
2. Full calibration of each physiologic signal, followed by testing to ensure accuracy specifications are met or exceeded, when used as intended. Signals include: temperature, pressure, biopotential, and respiratory impedance.

3. Each implant includes a calibrations label on the sterile package to document that the device has been calibrated for accuracy.

CERTIFICATION

Every implant shipped from DSI has the same warranty policy, and is guaranteed to operate in exactly the same every time. Implants that are received through the exchange program are like a new product. Exchanged implants are purchased for a fraction of the cost of new devices, which reduces ongoing study costs while maintaining data quality and accuracy.

IMPLANT MAINTENANCE AFTER FIRST IMPLANTATION

EXPLANTATION

For complete information on products and techniques approved for use with DSI implants, visit www.datasci.com or contact Technical Support (Support@datasci.com). When explanting DSI implants that are implanted intra-peritoneally or subcutaneously, consider the following.

- First carefully detach the implant body.
- Be careful not to drop the implant.
- *Never* cut a catheter, if the intention is to re-use the implant.
    - If cutting the catheter is necessary, use only a new scalpel blade to cut the catheter at a 45-degree angle away from the device body and approximately 3 cm from the implant body.
    - Do not use any instrument other than a scalpel blade to cut the catheter. Cutting the catheter with a pair of scissors or any other instrument could cause damage to the pressure sensor and *void the warranty*.
    - *If the catheter must be cut, the implant cannot be reused in another animal model*. Please send the device back to DSI for participation in the Exchange Program and the standard Exchange discount on a new device will apply.
- Leads can be cut as there are lead coupler kits available for purchase to extend the length of the leads. Lead coupler kits may make the leads less flexible over time so try to save as much length as possible during explantation.
- Clean and sterilize the implant with an approved enzyme detergent and sterilant before returning the implant to DSI or re-using in another animal.
- If the animal should die unexpectedly and the implant cannot be explanted immediately, the animal can be placed in a refrigerator until the explant can take place. The refrigerator will not damage the device, however; storage in a refrigerator will allow for an easier retrieval. Clots may be more difficult to remove from the catheter so it is recommended to heat the catheter to body temperature in a warm water bath to prevent the sensor from being blown. Never cut the tip of the catheter.

ON-SITE CLEANING AND RE-STERILIZATION

All new and exchanged implants shipped to an investigator are sterile and ready for implantation. In studies where implants are implanted for short periods at a time, significant battery life may remain at the end of the study allowing reuse of the implant. DSI has published specifications on the minimum guaranteed hours of battery life. Record the amount of time the device is on to track use and to calculate the battery life left. The PhysioTel HD platform allows this tracking to be much easier as the battery voltage and approximate on time is transmitted from the implant when it is in the ON mode.

DSI has developed detailed procedures for cleaning and sterilizing telemetry implants. These procedures will increase the number of times you can use each implant before returning it to DSI via the Exchange Program, helping to reduce overall costs per study. Sterilization procedures are available online at www.datasci.com.

SHELF-LIFE AND STORAGE

The following sections tell you what to do when you receive a new implant, and how to store it.

- New Implants Direct from Manufacturing
  Here's what to do when you receive a new implant from DSI.
  - Carefully examine all implants when they arrive at your facility.
  - Remove the sterile packages containing the implants from the shipping boxes. All implants are sterile upon arrival.
  - Save the shipping boxes to use, when returning used implants for the Exchange Program.
  - Inspect each implant's sterile packaging for signs of damage. If the package remains undamaged, this sterility is warranted according to the information on the package label.
  - Confirm that each implant is turned off before storing.
    - Using the AM radio on the low frequency setting, turn each implant on and off by scanning a magnet across the implant to ensure that none of the implants were damaged during shipping.
    - Although each unit is checked just before shipping, the implant may have been exposed to stray magnetic fields during shipment. This can cause the unit to be turned on unintentionally.
    - Implants in the OFF mode may lose up to 10% of the battery life within 12 months after the manufacture date.

- Storage of Sterilized Implants
  Occasionally there may be a delay between the implant removal from the animal and the beginning of the next study. Proper storage of the on-site sterilized implant is necessary to ensure that the unit will perform normally during the next study.
  - Using the AM radio on the low frequency setting, check each implant to ensure that it is properly turned off.
  - Thoroughly clean and sterilize each implant according to DSI's On-Site Re-sterilization procedure at www.datasci.com/resources/technical-notes.

- If the original implant sterile package was saved, place the implant into the plastic packaging. This will help to identify the implant and the calibration values associated with it. Do not store implants in saline or other liquid!
- Sterilization before storage is necessary to prevent the spread of bacteria during handling.
- Each implant will require sterilization again at the time of use, because there is no effective way of maintaining sterility after the sterile package has been opened.

- Storage Location Requirements
  The implants should be stored in a cool (between 10 and 25 degrees Celsius), dry area away from exposure to static discharge and magnetic fields. *Never* expose them to temperatures above 60 degrees Celsius, as this will void all warranties. It is also important to store them in an area where they will not be accidentally dropped or have items placed on top of them, as the catheter could be crushed and the sensor blown. Battery life is *not* significantly increased by storing your implant in a refrigerator. By following the proper storage procedures, the implants should perform just as well as the day they were shipped.

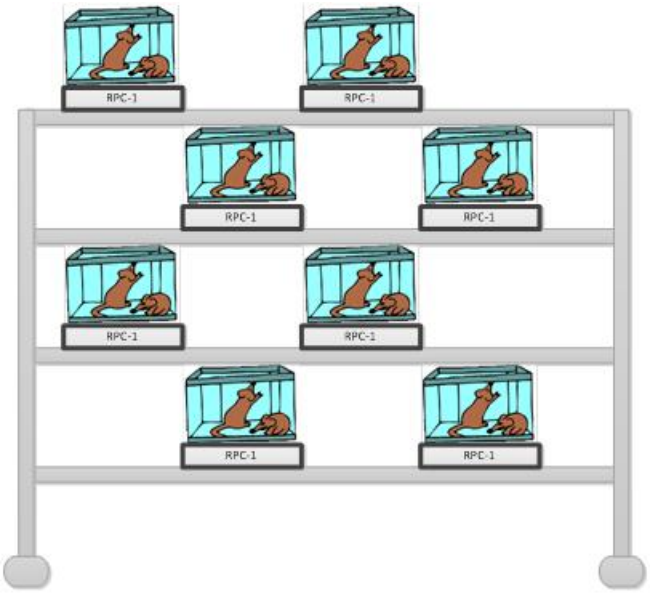
PHYSIOTEL DIGITAL HEXADECIMAL CONVERSION

Hexadecimal is base 16. Base 16 is where the 'numbers' you can use are zero through to the letter F (0123456789ABCDEF). i.e. the decimal value for '1' is represented in hexadecimal as '1' but the hexadecimal value of '15' (decimal) is shown as 'F' (hexadecimal) and the value of '17' (decimal) is '11' in Hexadecimal.

Decimal	Hex	Decimal	Hex	Decimal	Hex
1	1	11	B	30	1E
2	2	12	C	40	28
3	3	13	D	50	32
4	4	14	E	60	3C
5	5	15	F	70	46
6	6	16	10	80	50
7	7	17	11	90	5A
8	8	18	12	100	64
9	9	19	13	500	1F4
10	A	20	14	1000	3E8

PHYSIOTEL AND PHYSIOTEL HD CAGING AND SHIELDING RECOMMENDATIONS

DSI has experience using the typical shoe box sized cages but more and more customers are finding that lab space is difficult to come by. Many different configurations are possible depending on the animal model and space available. As a rule of thumb, always leave at a minimum the distance of one RPC-1 (~12 inches or 31cm) between cages. The best case situation would be placing each cage two receiver widths (18 inches or 45 cm) away from each other. Excluding pair housing studies, below is an example of the minimum recommended small animal configuration without any shielding:



As shown above, stagger the cages on a shelf to conserve the most space with this single frequency device. This illustration represents one implanted animal in each cage paired with another animal that is not implanted. With the HD-S11-F2 device, it is possible to pair two implanted animals with different frequency implants in the same cage and gather data simultaneously. The RPC-3 receiver is mandatory for pair housing studies and requires the same amount of distance between cages as that of the RSC-1 (~12 inches or 31cm).

SHIELDING RECOMMENDATIONS

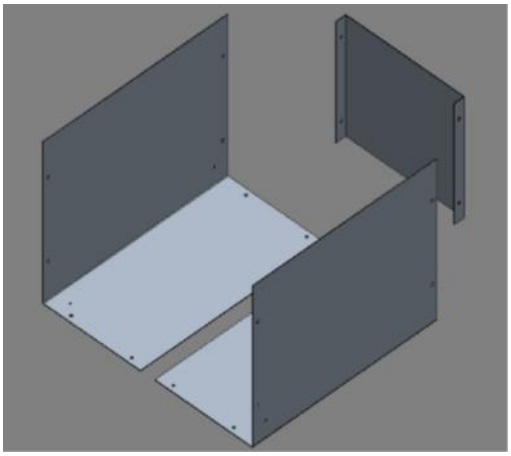
If the receivers need to be closer together and data loss is prevalent (>5%) implement electromagnetic shielding. Shielding comes in many forms from sheet metal and chicken wire to high tech clear specifically designed metal mesh. Locate the source of the noise and enclose that with shielding if possible. For example, the MX2 or another implant can be a source of noise if it is placed too close to the receivers. If problems arise or if you require a list of

acceptable shielding options, technical support is equipped to help determine the best shielding method either remotely or onsite if necessary.

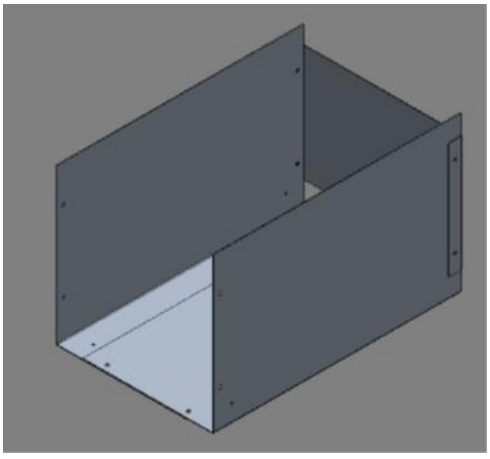
There are a number of ways to shield cages to prevent electromagnetic noise interference in the data. Shielding can be used around individual animal cages and/or MX2s. If possible, additional shielding should be used when configuring the animal room. Shielding is highly recommended when non-metal shelves are used. The shielding material should consist of conductive metal such as copper, stain-less steel, or aluminum. As shown below, shielding allows cages to be placed closer together.

Note: The shields can be constructed in such a manner that the following four configurations can be achieved (length x width x height):

- 18 x 12 x 10 inches
- 18 x 12 x 12 inches
- 18 x 18 x 10 inches
- 18 x 18 x 12 inches



Shield components



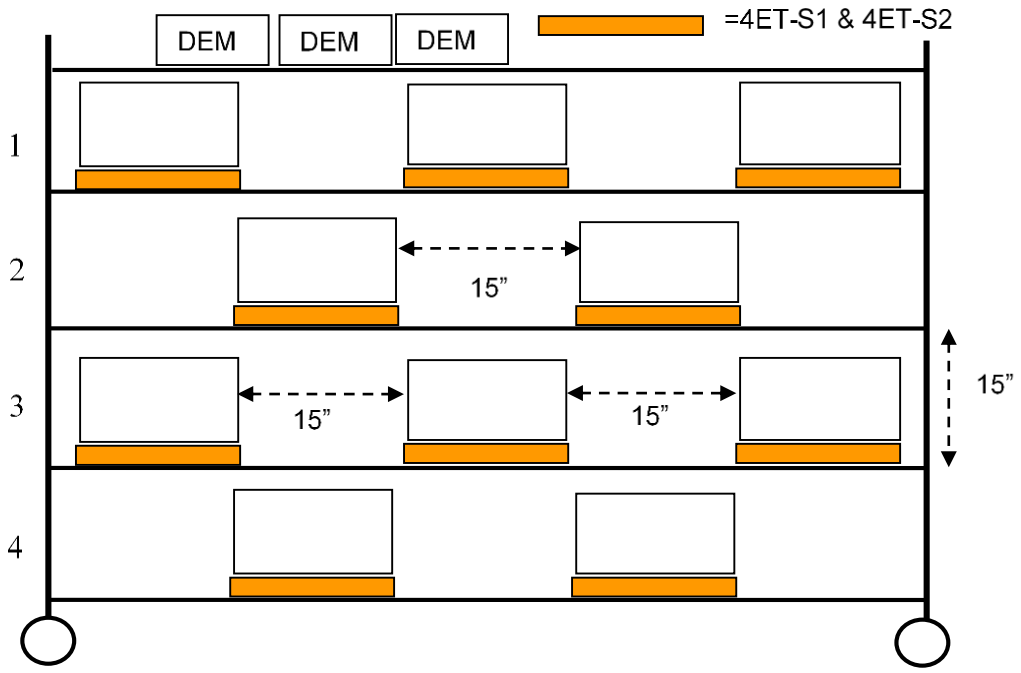
Shield assembled

4ET WITH RPC-2

There may be slight differences in the transmission characteristics of the 4ET device compared with standard DSI devices. In certain laboratory environments, ambient noise levels may be higher at the 4ET frequencies and could impact the data quality. DSI recommends using one of the following configurations when setting up your animal room. Care should be taken to ensure high-quality data is received before initiating a study. Each room environment is unique and may require additional modifications to achieve acceptable noise levels. These modifications are discussed in the next section. It is highly recommended that metal shelving be used to act as a barrier to the vertical signal transmission and to provide a conductive surface if grounding is necessary. Additional shielding between cages is also recommended as described in the Shielding section below.

PAIR-HOUSED NO SHIELDING

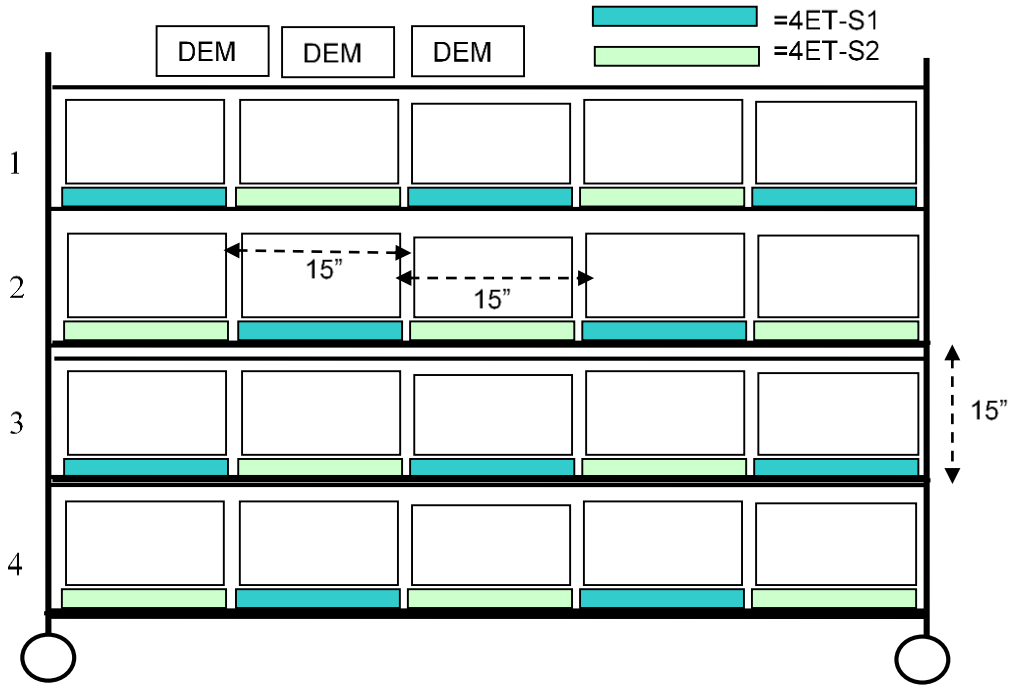
When animals are pair-housed, both of the 4ET transmission frequencies are present in the cage. Adjacent cages containing the same frequencies must be adequately separated to prevent cross-talk. DSI recommends separating adjacent cages a minimum of 15” horizontally from the adjacent sides of the cages and 15” vertically from cage bottom to cage bottom as shown below. Staggering of the cages between each vertical shelf is also recommended.



Cage setup: pair-housed no shielding

SINGLE-HOUSED NO SHIELDING

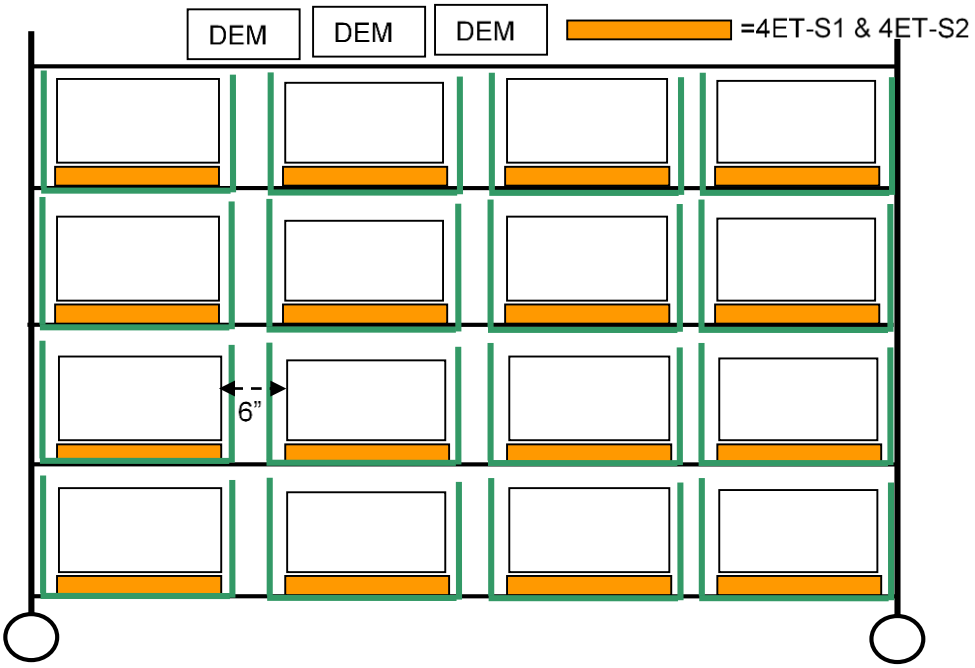
As described above, cages with the same frequency must be horizontally and vertically spaced a minimum of 15”. However, with single-housed animals, the transmission frequency can be alternated and cages can be placed directly next to each other if different frequencies are used. This configuration allows more animals per cage rack than standard DSI devices.



Cage setup: single-housed no shielding

SHIELDING

The 4ET device transmits the signal on different frequencies compared to existing DSI PhysioTel™ devices. The use of additional shielding between vertically and horizontally placed cages reduces the device transmission range and potential for cross-talk. It also reduces the amount of ambient noise that is acquired by the RPC-2 receiver.



Cage setup: Shielded cages single or pair housed

TRANSCEIVER PLACEMENT RECOMMENDATIONS

This appendix is intended to provide recommendations for placing Transceivers (TRX) in animal cages to minimize any signal drop-out with PhysioTel Digital implants. In general, a single TRX can cover 3-5 meters; however, null points may exist. To be safe, DSI recommends one TRX for every 3 meters, and at least 2 for every CLC. When more than one TRX is used, DSI suggests placing them at right angles to one another to help protect against null points which are small areas of poor signal reception.

It is important to note that there are many different cage and room set-ups and the examples shown below are DSI's suggestions based on customer testing and assessment of the PTD product.

Please contact DSI Technical Support (support@datasci.com) for assistance and recommendations in setting up your specific animal room.

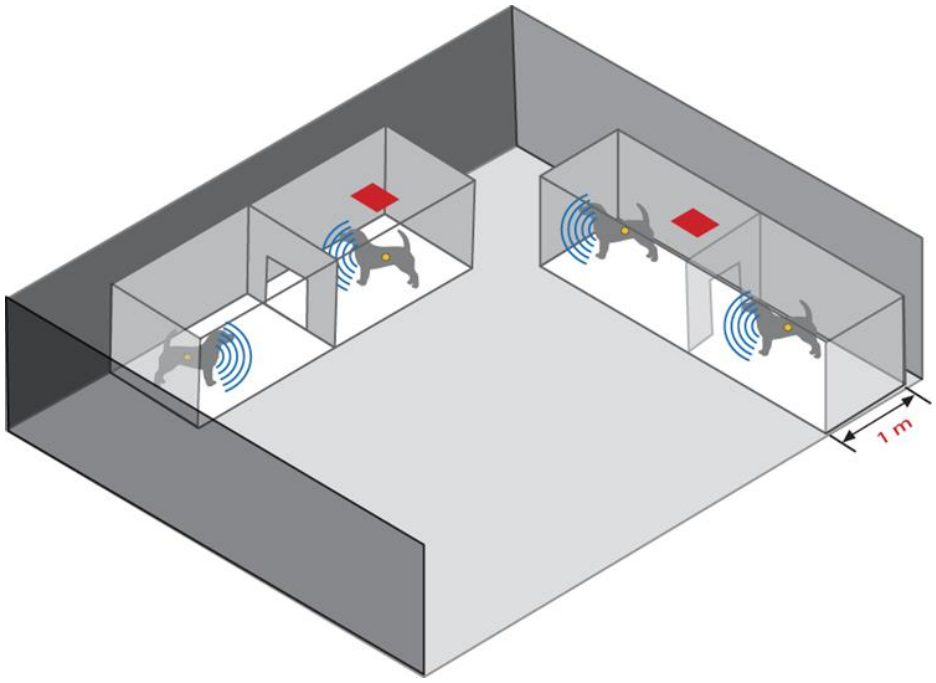
There are several factors that affect the transmission range of the implant.

- Monitoring environment
- Placement of the implant antenna
- Size of the animal

Regulatory Note: China: Tested to MIIT[2005]423 for short range devices' technical characteristics and test methods (Report No. C170417Z08, C170417Z09, C170417Z10).

DOG CAGE EXAMPLE 1

The diagram below illustrates the cage setup with Group Housing and two TRXs. Cage Dimensions are 1 Meter x 1 Meter x 1 Meter. The red square indicates a TRX.



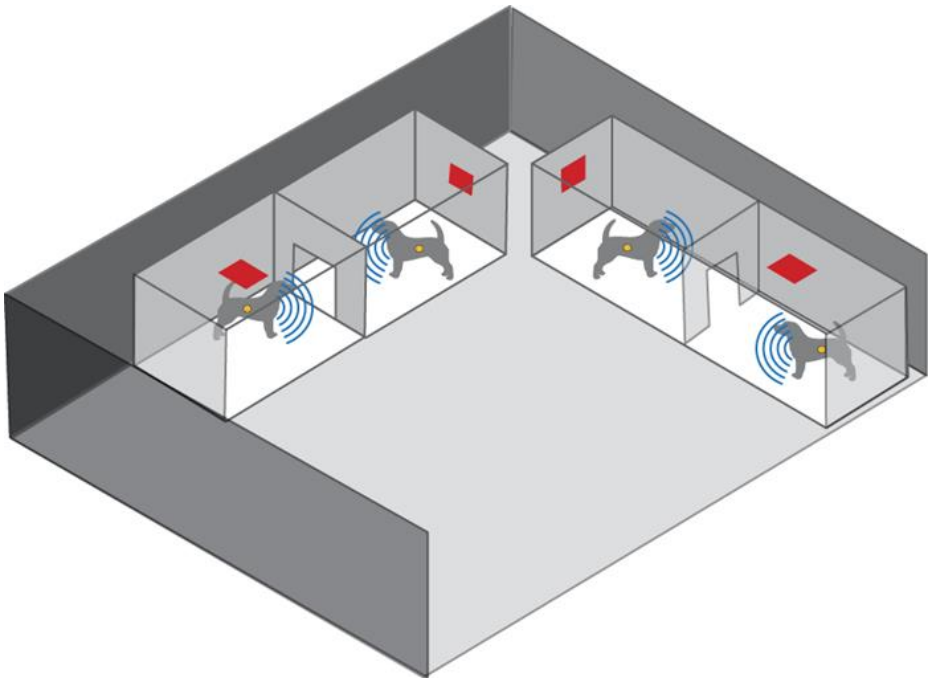
The set-up shown above includes one (1) TRX to cover the two cages on either side of the room. In this scenario the door between the cages is open and animals are able to freely move between cages.

If the door between the cages is closed, an additional TRX may be needed to provide supplemental coverage. DSI suggests testing this scenario to ensure that no drop-out occurs. If drop-out does occur, a second TRX should be used.

The following example illustrates a more ideal setup using four TRXs for increased coverage

DOG CAGE EXAMPLE 2

The diagram below illustrates the cage setup with Group Housing and four TRXs. Cage Dimensions are 1 Meter x 1 Meter x 1 Meter. The red square indicates a TRX.



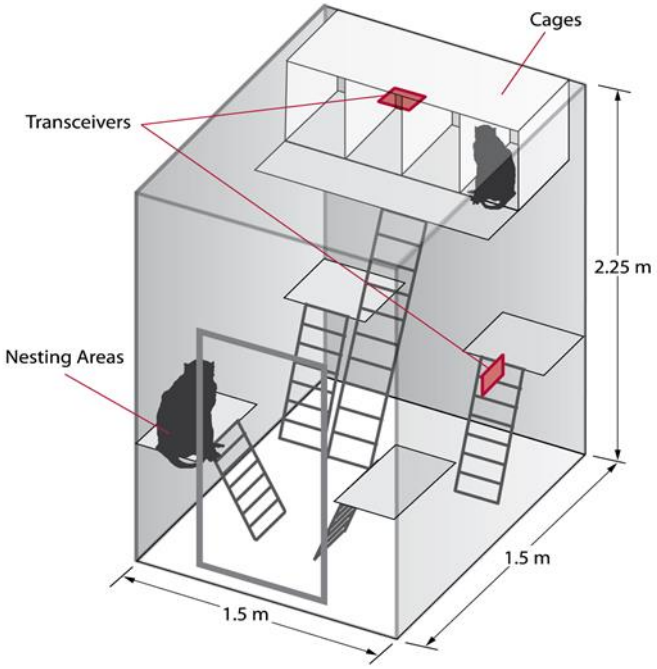
The set-up shown above includes two (2) TRXs to cover the two cages on either side of the room. In this scenario the door between the cages is open and animals are able to freely move between cages.

The TRXs are placed at right angles to one another to provide better coverage of the telemetry signal (having TRXs on different 'planes' helps avoid null areas and reduce the possibility of signal drop-out).

The set-up shown above would work either for the pair-housed or single-housed recordings without modification.

PRIMATE CAGE EXAMPLE

The diagram below illustrates a primate cage setup with Group Housing and two TRXs.



The set-up shown above includes two (2) TRXs to cover the larger communal primate cage. In the example above, this type of cage can co-house up to four primates at the same time.

Placing the TRXs at right angles to one another will provide better coverage.

AMBIENT PRESSURE REFERENCE (APR-2)

MAINTAINING PRESSURE ACCURACY

Maintaining accuracy of the APR-2 is a critical element of pressure measurements throughout the Dataquest system. A 1-mmHg error in the measurement of barometric pressure at the APR-2 will result in a 1-mmHg error in pressure measurements recorded by your system. The same level of error will appear on all pressure measurements obtained with the system using the APR-2. Therefore, if absolute accuracy of pressure measurements is important in your research, it is essential that you take the steps necessary to keep the APR-2 accurate.

Extensive qualification testing and calibration prior to shipment assures that under normal use the APR-2 will not drift as a result of temperature changes or shock from shipment. Therefore, the most important part of assuring accuracy is to determine if the APR-2 has drifted over time. The following are three suggestions on how this can be accomplished.

- Comparison with the Weather Service or other barometer
  Compare your APR-2 with the weather, radio or TV station, or another reliable barometer reading at regular

intervals (e.g. every 3 months) and when you first receive your APR-2. Perform these comparisons when the weather is relatively calm and avoid comparisons during thunderstorms or when strong weather fronts are moving through your area. To obtain the APR-2 measurement, initiate acquisition from a Subject with a pressure (BP or LVP) input channel. Ambient pressure values will be listed in the Derived List View as NPMN, within the main Ponemah window.

Keep a record of the comparison measurements you have taken. Keep in mind that it is important to obtain a local reading at the same elevation above sea level as your telemetry system. The APR-2 measures the absolute pressure of the room it is placed in, and does not correct for elevation differences. For further information, contact DSI for the Technical Note 'A Consideration When Comparing DSI's Ambient Pressure Monitor Readings to Other Barometers and the Weather Service.' Any noted difference over time should be constant. If you find that the difference is increasing, then it is likely that the APR-2 has drifted. Contact DSI Technical Services to discuss further action. You can also perform this procedure by comparing the APR-2 with a highly accurate barometer (one with an accuracy of better than 1 mmHg) at your facility or by purchasing a second APR-2.

- Checking the offset of pressure transmitters
  If you are checking the offset of several DSI transmitters that have a manufacture date within the last month, they will provide a good indication of whether your APR-2 has drifted. Check the offset of these transmitters using the procedure outlined in the Implant Appendix | **Error! Reference source not found.** section of this manual. If you find that all transmitters have an offset that is excessively and consistently biased in one direction (above or below zero mmHg), this may indicate that the APR-2 has drifted. Contact DSI Technical Services to discuss whether you should take further action.

- Recalibration by DSI
  DSI recommends that investigators working under GLP conditions send their APR-2 back to DSI for recalibration every year. For those not working under GLP conditions, DSI recommends recalibration every 3-5 years. The drift specification indicates that, barring failure of the device, it will drift less than 1.0 mmHg per year. Therefore, if you return it for recalibration every year, accuracy will likely remain within +/- 1 mmHg. Contact DSI Technical Services for information regarding recalibration of your APR-2.

Note: If using the APR-1 with the E2S-1, the same recommendations apply.

APR-2 SPECIFICATIONS

Barometric pressure range	0-1000 mmHg (torr)
Initial accuracy	+/- 1 mmHg
Stability over time	Better than 1.0 mmHg / year at 20ºC to 30ºC.
Physical dimensions	12.5 x 10.5 x 4 cm
Weight	570 g
Data output connector	RJ45 (8 pin non-keyed)
Power connector	9VDC
Voltage requirement	9VDC or 12V POE (IEEE 802.3af compliant)

Current	60 mA
Standard cable length	1 meter
Maximum cable length	10 meters
Operating temperature range	0º to 45º C
Operating humidity	<70% R.H. non-condensing
Storage temperature	-20º to 65º C
Storage humidity	<85% R.H. non-condensing

APR-1 SPECIFICATIONS

Barometric pressure range	650-800 mmHg (torr)
Initial accuracy	+/- 1 mmHg
Stability over time	Better than 1.0 mmHg / year at 20ºC to 30ºC.
Physical dimensions	14 x 10.5 x 4 cm
Weight	510 g
Data output connector	RJ45 (8 pin non-keyed)
Voltage requirement	6.25 to 12.0 VDC
Current	60 mA
Standard cable length	1 meter
Maximum cable length	10 meters
Operating temperature range	0º to 50º C
Operating humidity	<70% R.H. non-condensing
Storage temperature	-20º to 65º C
Storage humidity	<85% R.H. non-condensing

ETHERNET TO SERIAL CONVERTER (E2S-1)

The E2S-1 is only necessary when using an APR-1 with the PhysioTel Implantable Telemetry system. If using the APR-2, the E2S-1 is not required.

The E2S-1 passes data from the APR-1 to the Ponemah system while operating in a network environment. It does not modify the data received from the APR-1.

The E2S-1 uses DHCP by default as a means of being assigned a dynamic IP address. Should the E2S-1 not be discoverable within your network an alternate network configuration may be required (e.g. static IP address). Such configurations are possible but should not be modified unless absolutely necessary. To modify the network configuration please see the **Hardware Appendix: Ethernet to Serial Converter (E2S-1)**. If not set up for static IP addresses, the E2S-1 requires a DHCP server to be active on the network to which it is connected. If you are running the system across your corporate network this service is likely already present. If you are using a dedicated network separate from your corporate network the simplest method of providing this service is through the use of a router with this capability built in (e.g. Cisco Small Business Router RV130). Alternately you could install a DCHP

server onto one of the PCs on your dedicated network. An Open Source DHCP server is available from SourceForge at http://sourceforge.net/projects/dhcp-dns-server/.

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

- **Ready**
  Constantly lit when the power is on and the E2S-1 is functioning normally. Blinking when the E2S-1 has been located by a software command. Off when the E2S-1 is not powered or a power error exists, the IP Address cannot be found, or there is an IP Address conflict.

- **Power**
  Constantly lit when power is available to the E2S-1 via a network cable that supplies Power over Ethernet (PoE) to J2 or when the external power source is used appropriately. The E2S-1 does not have an on/off switch

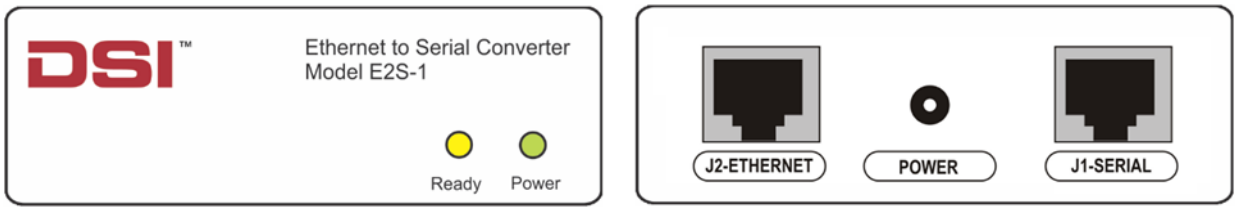
The back panel contains three unique connections:

- J1-Serial
  Plug the cable from the APR-1 into this jack. It provides a path for the barometric pressure signal to pass to the E2S-1 and also for the power from the E2S-1 to the APR-1.

  WARNING: Do Not mistake the "J2 Ethernet" port with "J1 Serial" port. Incorrectly plugging the wrong Ethernet cable into the wrong port may cause serious damage to your network devices. DSI will not replace or repair product or reimburse customers for devices that become damaged due to incorrect installation, nor is DSI liable for any loss of business resulting in the incorrect installation of this product.

- J2-Ethernet
  Plug the cable from the Ethernet network into this jack. It provides a path for the barometric pressure signal to pass to the Ponemah Computer System from the E2S-1 and also for the power from a PoE capable network (if available) to pass into the E2S-1.

- Power
  Plug the cable from the power supply into this jack to power the E2S-1. This is optional if a PoE capable network is used.



Front panel of E2S-1 (left), rear panel (right)

SPECIFICATIONS

Physical dimensions	14 x 10.5 x 4 cm
Weight	<500 g (<18 ounces)
J1 Serial connector	RJ45 (8 pin non-keyed)
J2 Ethernet connector	RJ45 (8 pin non-keyed)
Power connector	9VDC
Voltage requirement	9VDC or 12V POE (IEEE 802.3af compliant)
Standard cable length	1 meter
Maximum cable length	10 meters
Operating temperature range	0º to 50º C
Operating humidity	<70% R.H. non-condensing
Storage temperature	-20º to 65º C
Storage humidity	<85% R.H. non-condensing

TROUBLESHOOTING

- Power Indicator on Front Panel Does Not Light
  If using a PoE capable network verify that the Ethernet cable between the network switch and the E2S-1 is plugged in securely at both the E2S-1 and network jack/switch. If this does not resolve the issue try a different cable, try a different network switch, or use the provided power supply.

  If using a non-PoE capable network verify that the power supply is plugged into a functional outlet and securely plugged into the E2S-1. If this does not resolve the issue try a different outlet and/or power supply.

- Ready Indicator on Front Panel Does Not Light
  Power may not be available. Assure the power indicator light is constantly lit. If not, correct per the above troubleshooting.

  If power is available, then the E2S-1 cannot connect to the network and/or an IP Address conflict exists. Reboot the E2S-1 to obtain a new dynamically assigned IP Address.

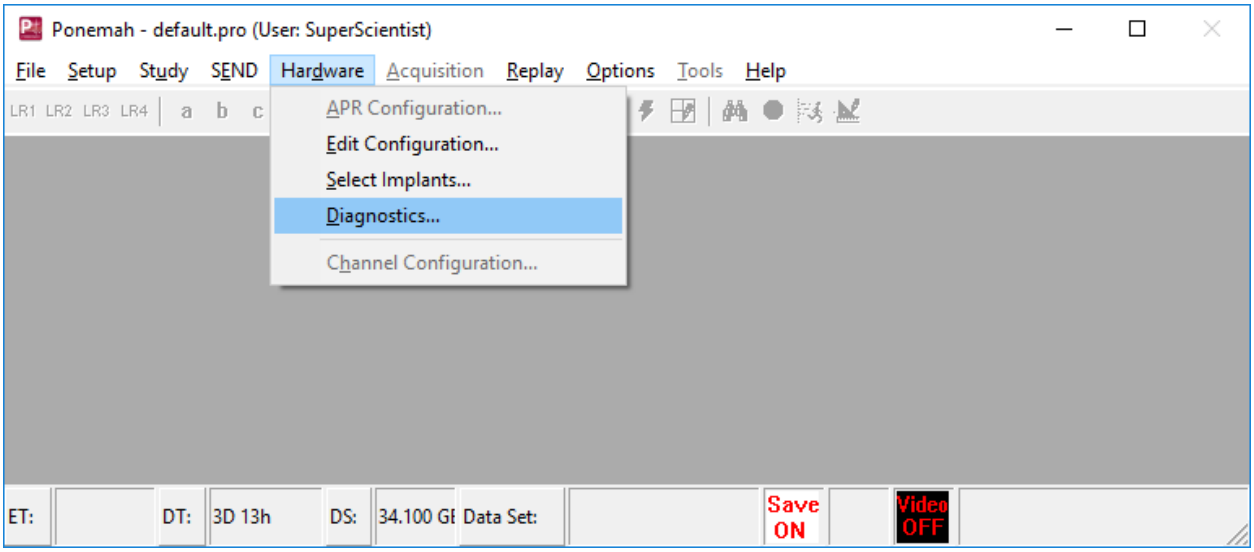
  If you are unable to solve your problem contact DSI Technical Services.

SOFTWARE APPENDIX

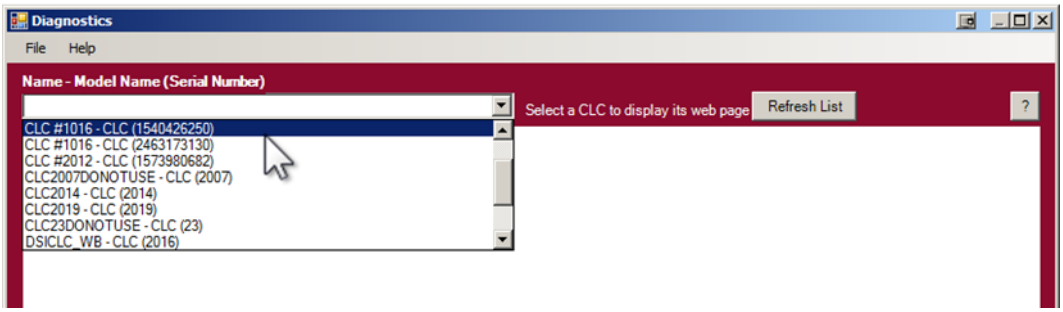
PHYSIOTEL DIGITAL DIAGNOSTICS

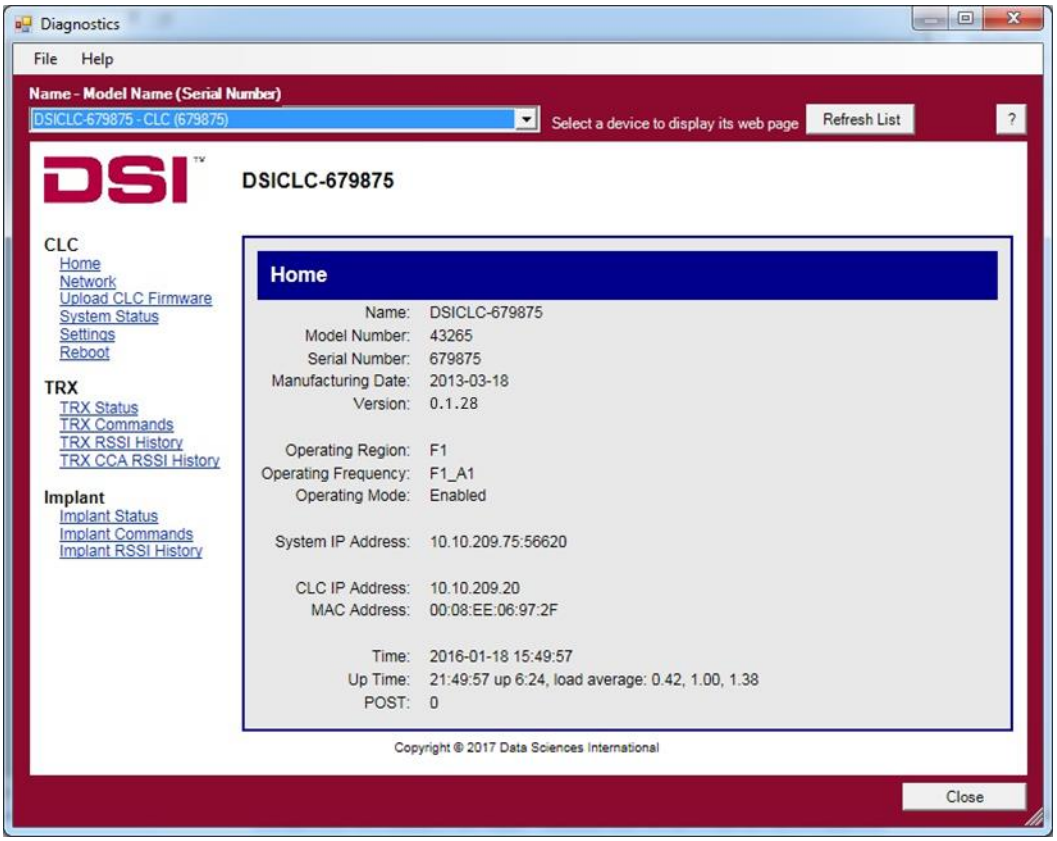
The Diagnostics user interface is a browser based webpage that allows the user to check the status of the PhysioTel Digital hardware components, update firmware, and perform diagnostic tests to optimize the performance of the system components.

The Diagnostic user interface is accessed from the Ponemah Hardware menu.



To select a specific CLC click on the drop-down menu located in the top left corner of the diagnostics window. All of the configured CLCs that are connected to the system will appear in this list.



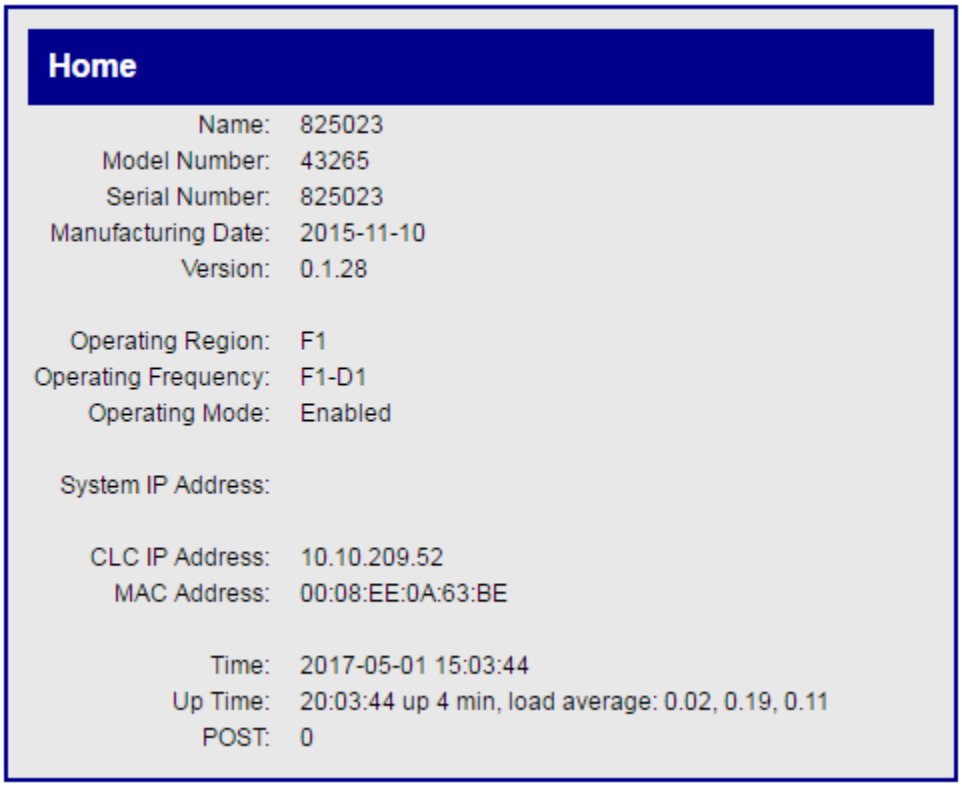


CLC Options

The CLC section of the Diagnostics webpage options are describe below.

Home

The Home page lists general information about the select CLC.



Name Displays the user defined name assigned to the CLC.

Model Number Displays a numeric value representing the CLC model.

Serial Number Displays the CLC serial number.

Manufacturing Date Displays the date the CLC was manufactured at DSI. Format is YYYY-MM-DD.

Version Displays the firmware version the CLC is currently running.

Operating Region Displays the current Operating Region of the CLC.

Frequency	Region
F1	US
F2	Europe
F3	Japan
F4	China

Operating Frequency Displays the currently assigned Operating Frequency, based on TRX connection.

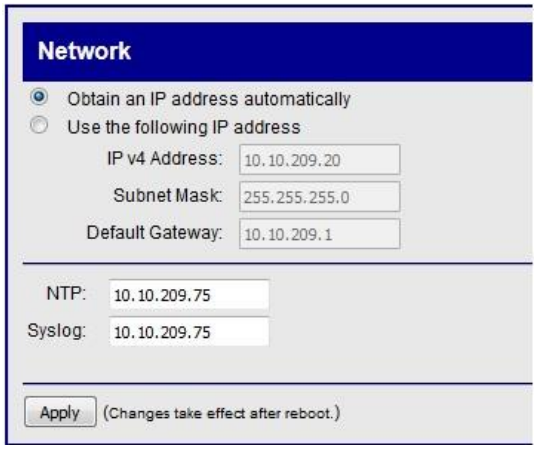
Note: the Operating Frequency will read “Unknown” if CLC is powered up without a TRX connected.

Operating Mode Enabled: Normal operational mode.

	Disabled: The CLC sends and receives no RF data. Assessment: The CLC monitors the RF field and collects RSSI data from attached TRXs.
System IP Address	IP address of the data acquisition computer.
CLC IP Address	IP address of this particular CLC.
MAC Address	Unique identifier for the CLC network interface.
Time	Current Date & Time (Format = YYYY-MM-DD HR:MN:SC).
Up Time	Status information since last reboot
POST	Power On Self-Test (0 = Passed, OK …)

Network

The Network section allows the user to define how IP addresses are assigned to the CLC.



- **Obtain an IP address automatically**

  This is the normal operating mode for the CLC. With this option selected the CLC is queried and the values that it reports back are displayed in the appropriate text boxes:
  - IP v4 Address:
  - Subnet Mask:
  - Default Gateway:

  Note: A new IP address can be generated by performing an "extended" reset: push and hold the reset button on the back of the CLC for 5-15 seconds.

- **Use the following IP address**

  If the user wishes to manually assign a specific IP address to the CLC, click this radio button and type a new IP address in the text box.

If you wish to perform this operation, follow this procedure:

1. Click the radio button for Use the following IP address
2. Enter the desired values in the text boxes labeled:
    - IP v4 Address:
    - Subnet Mask:
    - Default Gateway:
3. Click Apply.

Note: A reboot of the system will have to be performed in order for the new IP Address to activate.

⚠ *Caution*: In the event that the user-assigned IP address is not accessible, this diagnostics tool will lose contact with the CLC. To generate a new IP address, the user will have to perform an "extended" reset: push and hold the reset button on the back of the CLC for 5-15 seconds.

- **NTP**

The CLC keeps synchronization with the PC using Network Time Protocol (NTP). By default Ponemah will set the NTP IP address to be the IP address of the PC. If it is desired, the NTP IP address can be set manually.

- **Syslog**

This is an IP address that can be set by DSI personal for on-site troubleshooting. It is not needed for normal operation.

Upload CLC Firmware

This page allows the user to update the CLC firmware. From time to time it may be advantageous to upgrade the internal read-only program instructions through a firmware upgrade. This often results in improved performance.

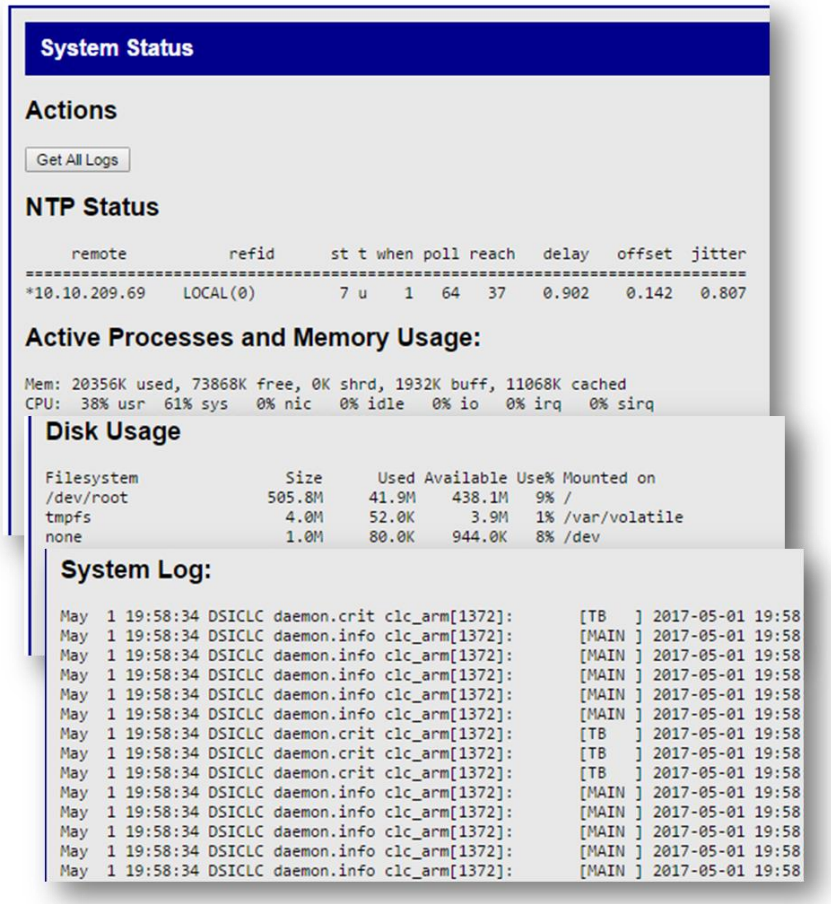
To update or change the firmware version in the CLC, follow this procedure:

1. Click on the Browse button and use the file upload window to locate the firmware file.
2. Navigate to the specific filename and click Open
3. Message 1: Uploaded, Validating
4. Message 2: Validated. Upgrade will be applied during reboot.

Note: A reboot of the system will have to be performed in order for the update to activate.

System Status

The System Status is a continuously updating "log" file of the CLC's communication activity. It can be used to monitor communication issues in the event of discontinuities.

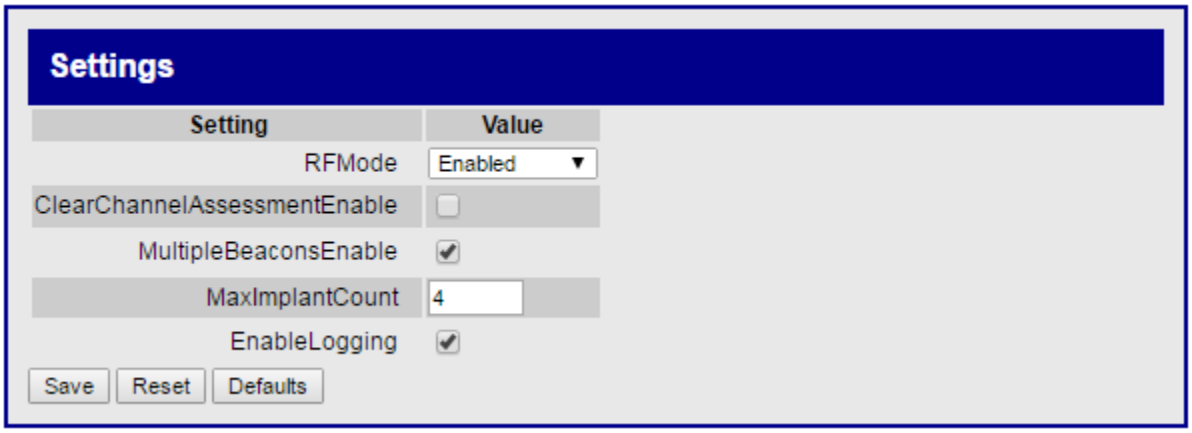


Contents:

- Get All Logs – downloads the CLC log file.
- NTP Status – Reports the last time the CLC received an update from the NTP Server
- Active Processes and Memory Usage
- System Log

Settings

The Settings page allows the user to set the RF Mode, Clear Channel Assessment, Enable Multiple Beacons, set the Maximum Implant Count per CLCs, and Enable Logging.



RF Mode

- **Enabled** – Normal operating mode
- **Disabled** – Halts communication between the TRXs and the implants
- **Assessment** – Allows the user to sample individual frequencies to assess the level of background RF interference. The Assessment mode is used for the TRX RSSI History function

Clear Channel Assessment

- For European and Japan customers this function is enabled by default and cannot be changed.
- For North American customers this function is not enabled by default, but can be with no effect on performance. This will allow the user the ability to detect if there are competing RF devices that have the potential of interfering with the Digital system. Reference the TRX CCA RSSI History section below for more detail.
- For customers in China, Clear Channel Assessment is not enabled by default and is not needed.

Multiple Beacons

- Multiple Beacons was an enhancement made to the system to maximize the number of attempts in communicating with the PhysioTel Digital implants. It is enabled by default.

Max Implant Count

- Defines the maximum number of Implants that may be assigned to a CLC. Default is 4. With certain combinations of Implant and CLC firmware, the maximum may be set to 6.
- The default maximum implant count for China is 5, which is also the maximum number of implants that may be assigned to CLCs in China.
- See the PhysioTel Digital Telemetry Platform Broadcasting Frequencies section of this manual for more details on supported frequencies.

REBOOT

This function allows the user to perform a complete reboot of the CLC. A Reboot of the system is required to:

- Activate a firmware upgrade
- Change the IP settings
- To reboot the CLC left click the Reboot button

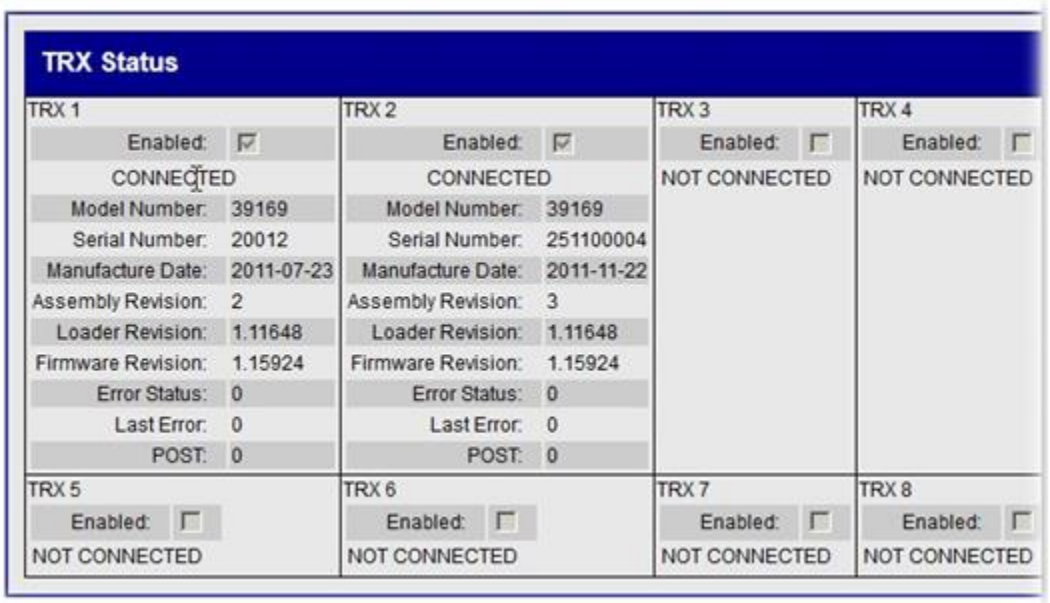
Note: the Reboot process may take several minutes to complete. There are no progress indicators that appear on this page, However there are indicator lights on the back of the CLC box itself.

TRX OPTIONS

The TRX is the three letter designation for a Transceiver: the component in the system that receives Radio-Frequency (RF) signals and converts it into digital form that is sent, via cable, to the Communication Link Controller.

TRX STATUS

The TRX Status screen is a non-interactive snapshot of the current status of the TRXs that are connected to the CLC. Each CLC is capable of interfacing with eight TRXs. This arrangement follows the layout on the rear panel of the CLC unit. The following is the TRX Status screen indicating that two TRX units are connected and enabled.



The line items are as follows:

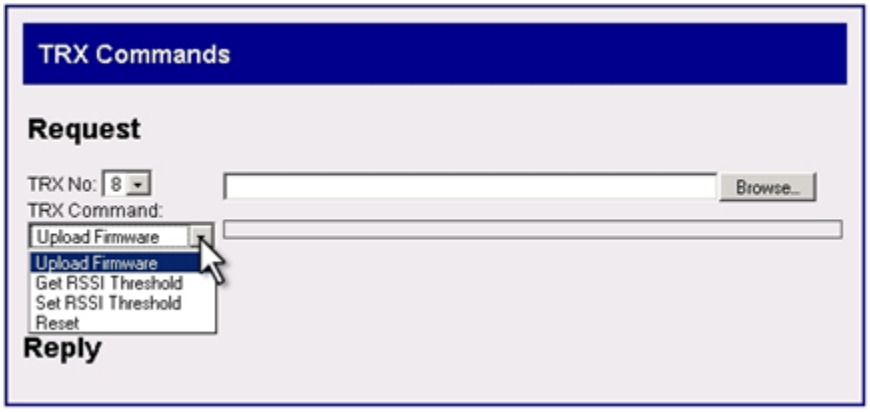
TRX (#):	Number 1-8.
Enabled:	A check mark in the box indicates that the TRX is connected and available to communicate with the implants
Connected:	Indicates whether the TRX is physically CONNECTED or NOT CONNECTED to the CLC
Model Number:	Displays a numeric value representing the TRX model.
Serial number:	Displays the TRX serial number.
Manufacture Date:	Displays the date the CLC was manufactured at DSI. Format is YYYY-MM-DD.
Assembly Revision:	Displays the current Assembly revision.
Loader Revision:	Displays the current Loader revision.
Firmware Revision:	Displays the firmware version the TRX is currently running.

Error Status:	Indicates that at least one error has occurred.
Last error:	Displays the most recent error encountered.
POST:	Power On Self-Test (0 =Passed, OK)

TRX COMMAND

This dialog screen allows the user to perform two functions that affect the performance of the TRX. The user can upload a different version of the on-board read-only software (firmware). Additionally the user can adjust the telemetry receiver thresholds to optimize RF communications.

There are four commands available in this window.



UPLOAD FIRMWARE

To update or change the firmware version in the TRX, follow these steps:

1. Select the **TRX No**: drop-down menu and select the **TRX number** you wish to communicate with.
2. Select the **TRX Command**: drop-down menu and select **Upload Firmware**.
3. Select **Browse…** button and use the file upload window to locate the firmware file.
4. Navigate to the specific filename and click **Open**
5. Message 1: Uploaded.
6. Message 2: Validating
7. Message 3: Updating TRX Firmware...
8. Message 4: Command Completed

GET RSSI THRESHOLD

RSSI stands for Received Signal Strength Indicator. It is a quantitative measure of the strength of the RF signal that the TRX is receiving from the implants. The Get RSSI Threshold command retrieves the current threshold value from the TRX. The default value = 12.

1. Select **Get RSSI Threshold** from the **TRX Command:** drop-down menu.
2. Select **Send**.
3. A successful operation is indicated by a blue colored Command Completed banner at the top of the screen and a text string below the word Reply at the bottom of the screen.
4. The reported text value **OK "xx"** is the Hexadecimal value of the **RSSI Threshold**.

SET RSSI THRESHOLD

The Set RSSI Threshold command allows the user to adjust the lower limit of signal strength that the TRX will accept as viable information from the implants. The default value = 12.

Note: Anytime the TRX is unplugged, or the CLC is rebooted, or the CLC goes through the Configuration Wizard, the RSSI threshold value will revert back to the hexadecimal default value of 0x12.

1. Select **Set RSSI Threshold** from the **TRX Command**: drop-down menu.
2. Select the **TRX #** from the **TRX No**: drop-down menu.
3. Enter a **hexadecimal** value in the small text box above the **Send** button.
4. Select the **Send** button.
5. A successful operation is indicated by a blue colored Command Completed banner at the top of the screen and a text string "**OK**" below the word Reply at the bottom of the screen.

RESET

The Reset function returns the TRX settings to the factory default values.

1. Select **Reset** from the **TRX Command**: drop-down menu.
2. Select the **TRX #** from the **TRX No**: drop-down menu.
3. Change the value in the dialog box below the letters TRX from **"ff"** to **"02".**
4. Click the **Send** button.
5. A successful operation is indicated by a blue colored Command Completed banner at the top of the screen and a text string **"OK"** below the word Reply at the bottom of the screen.

RFMODE (NOT PICTURED ABOVE)

The RFMode command is only available to EU users. It can be used to change the transmission power of the TRX. By default the TRX leaves the DSI factory with the maximum allowable transmission power. In some cases, that power is too much and it should be decrease to improve RF performance where multiple PhysioTel Digital systems are located in close proximity. The power can be changed from any value of 00 to 08, with the default value of 08. The default value in the United States, Japan, and China is 00.

1. Select **RFMode** from the **TRX Command**: drop-down menu.
2. Select the **TRX #** from the **TRX No**: drop-down menu.
3. Enter a **hexadecimal** value in the small text box above the **Send** button.
4. Select the **Send** button.
5. A successful operation is indicated by a blue colored Command Completed banner at the top of the screen and a text string "**OK**" below the word Reply at the bottom of the screen.

TRX RSSI HISTORY

This option allows the user to sample how well the TRXs are receiving RF signals from the implants, or as a tool to detect the amount of RF noise that may be present near the PTD system. In an actively running system (**Enabled**) these graphs continually update according to a user prescribed auto refresh rate.
There will be one RSSI graph displayed for each of the enabled TRXs connected to the CLC. The TRXs will display the received signals from all of the implants it is communicating with.

Follow this procedure to utilize the **TRX RSSI History** option:

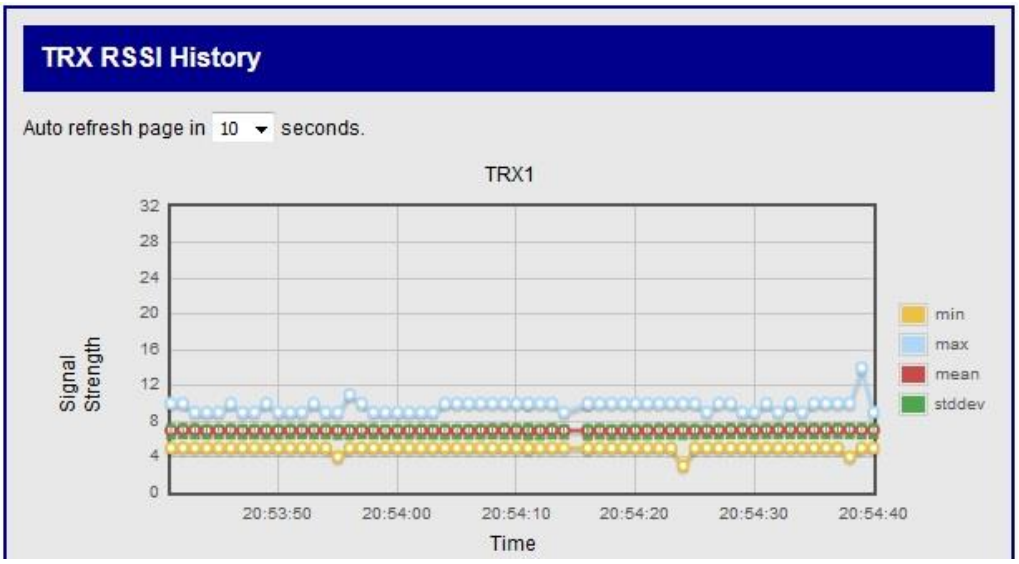
1. Click on the Settings link under the **CLC Options** heading.
2. In the dropdown box to the right of the words **RF Mode**, select the word "**Assessment** "and click the **Save** button below.
3. Using the mouse cursor, click on the link marked **TRX RSSI History**.
4. This will open the RSSI graph screen.

   Warning! When you are finished with the TRX RSSI History function you MUST return the CLC to the "Enabled" mode!

5. Select the **Settings** link under the **CLC Options** heading.
6. Return to the dropdown box and select "**Enabled**", and click on the **Save** button below.
7. Verify the **CLC status** by **Home** link under the under the **CLC options** heading.

8. The **Operating Mode**: line item in the center of the screen should read **Enabled**, if it does not, refresh the internet page, or repeat steps 6-7 above.

The following is a graphical representation of the ability of the TRX to detect RF noise. To set the auto refresh rate of the graph click on the drop-down menu at the top of the screen and select a new value.



TRX CCA RSSI HISTORY

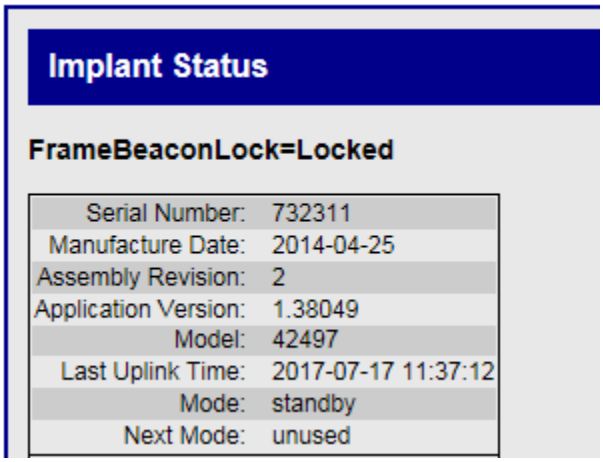
CCA is an acronym for Clear Channel Assessment. According to certain RF regulation environments, it is necessary to invoke a "listen before you talk" policy. The Clear Channel Assessment operation determines whether the wireless medium is busy or idle. The CLC can then make a decision on whether to attempt communication.

The CLC will display the RSSI value of what the TRX is receiving. If the TRX picks up a significant signal from a competing device the CLC delays the transmission of a command to the implant. If the interfering signal persists, communication with the implants may be disrupted.

- The CLC will try to avoid talking in a noisy RF environment.
- The CLC will display an RSSI value of what the TRX is picking up in the Listening window.
- In Europe and Japan the "Listen Before Talk" function is enabled by default.
- In the United States the "Listen Before Talk" function is disabled by default.
- There will be one plot for each of the TRXs assigned to the CLC.
- To set the auto refresh rate of the graph click on the drop-down menu at the top of the screen and select a new value.

IMPLANT STATUS

Implant Status is a non-interactive table which reports the operational status of all implants communicating with a CLC.



Frame Beacon Lock is a new feature that will prevent implants from being "stolen" by a configured system. Once a CLC with firmware v0.1.28 is configured, the Accept List of that CLC will become "Locked" and that is indicated on the Implant Status page. If an implant with firmware v1.62816 or later hears a beacon from a locked CLC (that isn't its intended CLC) it will disregard that beacon/CLC, and continue to listen for its intended beacon/CLC.

Previous versions of the CLC would allow implants that were not configured onto its Accept List if the implant heard the beacon and attempted to join (assuming there was room on the list). If the Accept List was already full, the implant would continuously attempt to become a part of that Accept List until it either a.) it timed out and eventually turned off, or b.) started to hear its intended beacon again. With the new version of the implant firmware, the implant will attempt to hears its intended beacon right away.

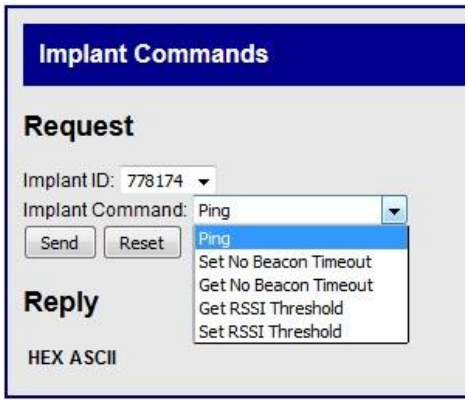
A table will be displayed for each implant with the following content:

Serial Number	Displays the serial number of the implant.
Manufacture Date	Displays the date the implant was manufactured at DSI. Format is YYYY-MM-DD.
Assembly Revision	Displays the assembly revision.
Application Version	Displays the application version.
Model	Displays the implant model.

Last Uplink Time	The latest time that the CLC received an uplink from the implant.
Mode	Displays the current mode of the implant: • Standby – On, but not actively transmitting data. • Active – On and actively transmitting data. • Unused – Configured but either out or range or off.
Next Mode	Will only update when using scheduled sampling in Ponemah.

IMPLANT COMMANDS

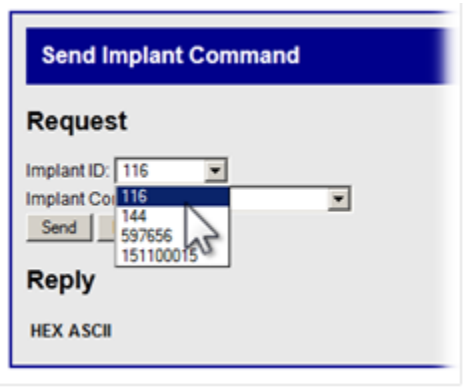
There are three commands with which the user can communicate with individual implants. They are **Ping**, **Get/Set RSSI Threshold**, **Get/No Beacon Timeout**.



- The **Ping** command allows the user to select an individual implant and request a confirmation message that the implant is operating within range.
- The **Get RSSI Threshold** command retrieves the current threshold value from the implant.
- The **Set RSSI Threshold** command allows the user to adjust the lower limit of signal strength that the implant will accept as viable information from any of the TRXs.

PING COMMAND

The **Ping** command allows the user to send a request to an individual implant to reply with a confirmation message that the implant is operating within range.

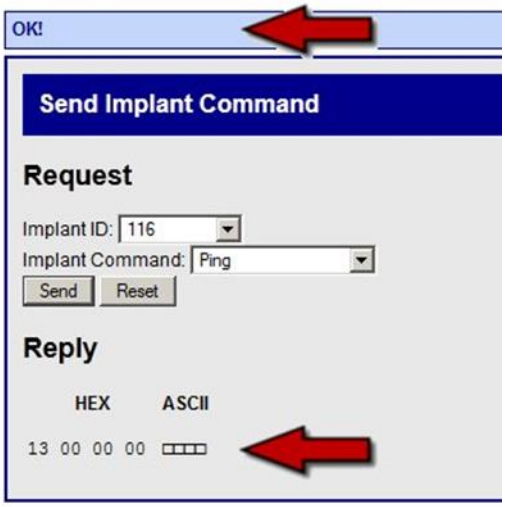


To **Ping** the implant:

1. Click on the drop-down menu labeled Implant ID:
2. Select a device by left clicking on an implant serial number.
3. Click on the drop-down menu labeled Implant Command.
4. Left click the Ping command
5. Click the Send button

If the Ping dialog is successful:

- A blue colored banner with the word **OK!** will appear at the top of the screen.
- The implant will report back with a Hexadecimal value which is displayed in the Reply table at the bottom of the screen.



If the Ping dialog is unsuccessful:
The Ping will be automatically repeated several times.

- A red colored banner with the word ERROR will appear at the top of the screen.
- The more common error codes are listed at the end of this section.
- The implant will not report with a Hex value at the bottom of the screen.

Note: It may take several seconds for an unsuccessful Ping command to generate an error message.

GET RSSI THRESHOLD

The Get RSSI Threshold command retrieves the current threshold value from the implant. Get RSSI Threshold reads the signal strength value that allows the implant to hear commands from the CLC/TRX.

To **Get RSSI Threshold**:

1. Click on the drop-down menu labeled **Implant ID**:
2. Select a device by left clicking on an implant serial number.
3. Click on the drop-down menu labeled **Implant Command**.
4. Left click the **Get RSSI Threshold** command.
5. Click the **Send** button
6. A successful operation is indicated by a blue colored **OK** banner at the top of the screen.
7. A Hexadecimal value will also be reported in a table below the word **Reply**.

8. If the command cannot be successfully completed an error code may be displayed. Refer to the common error codes below.

SET RSSI THRESHOLD

RSSI stands for Received Signal Strength Indicator. It is a quantitative measure of the strength of the RF signal that the implant is receiving from the TRXs. The Set RSSI Threshold command allows the user to adjust the lower limit of signal strength that the implant will accept as viable information from the CLC/TRX.

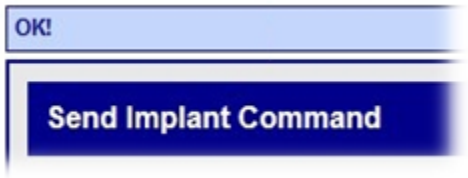
1. Click on the drop-down menu labeled **Implant ID**:
2. Select a device by left clicking on an implant serial number.
3. Click on the drop-down menu labeled **Implant Command**.
4. Left click the **Set RSSI Threshold** command.
5. A small text-entry box will appear below the **Implant Command**: line.
6. Allowable values for **RSSI Threshold** are between 12 and 28 (values must be entered in Hexadecimal format).

Decimal	Hexadecimal
12	0C
28	1C

7. Adjusting the **RSSI Threshold** value will affect the implant performance in the following manner.

RSSI value	Sensitivity	Range	Susceptibility to RF Noise
Increase	Decrease	Decrease	Decrease
Decrease	Increase	Increase	Increase

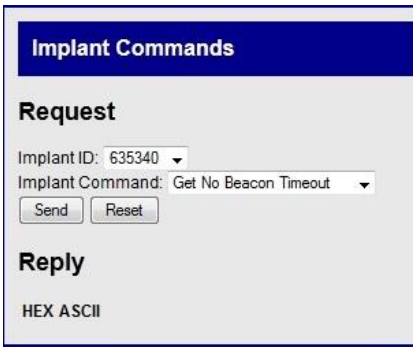
8. Enter a new value for the **RSSI Threshold** and click the **Send** button (values must be entered in Hexadecimal format).
9. A blue colored banner with the word **OK!** will appear at the top of the screen.



10. Repeat the **Get RSSI Threshold** procedure for verification.
11. If the command cannot be successfully completed an error code may be displayed. Refer to the common error codes below.
12. The RSSI Threshold value will revert to the default value anytime the implant turns off, or if it is assigned a new frequency.

GET NO BEACON TIMEOUT

The Get No Beacon Timeout command retrieves the amount of time that the implant can be out of RF range of the TRXs before it turns off. The returned value is in hexadecimal format and corresponds to minutes. The default value is set in the factory by DSI at a value of 60 minutes



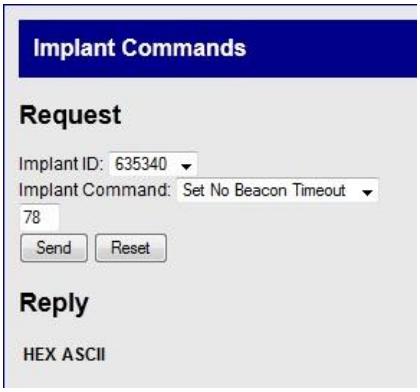
To **Get No Beacon Timeout**:

1. Click on the drop-down menu labeled **Implant ID**:
2. Select a device by left clicking on an implant serial number.
3. Click on the drop-down menu labeled **Implant Command**.
4. Left click the **Get No Beacon Timeout** command.
5. Click the **Send** button
6. A successful operation is indicated by a blue colored **OK** banner at the top of the screen.
7. A Hexadecimal value will also be reported in a table below the word **Reply**.
8. If the command cannot be successfully completed an error code may be displayed. Refer to the common error codes below.

SET NO BEACON TIMEOUT

The Set No Beacon Timeout command sets the amount of time that the implant can be out of RF range of the TRXs before it turns off. The table below outlines some common values that could be entered with the hexadecimal conversion.

Minutes	Hexadecimal
60	3C
120	78
180	B4
240	F0
480	FF
Infinite (Doesn't Turn Off)	00



To **Set No Beacon Timeout**:

1. Click on the drop-down menu labeled **Implant ID**:
2. Select a device by left clicking on an implant serial number.
3. Click on the drop-down menu labeled **Implant Command**.
4. Left click the **Set No Beacon Timeout** command.
5. Click the **Send** button
6. A successful operation is indicated by a blue colored **OK** banner at the top of the screen.
7. A Hexadecimal value will also be reported in a table below the word **Reply**.
8. If the command cannot be successfully completed an error code may be displayed. Refer to the common error codes below.

COMMON ERROR CODES

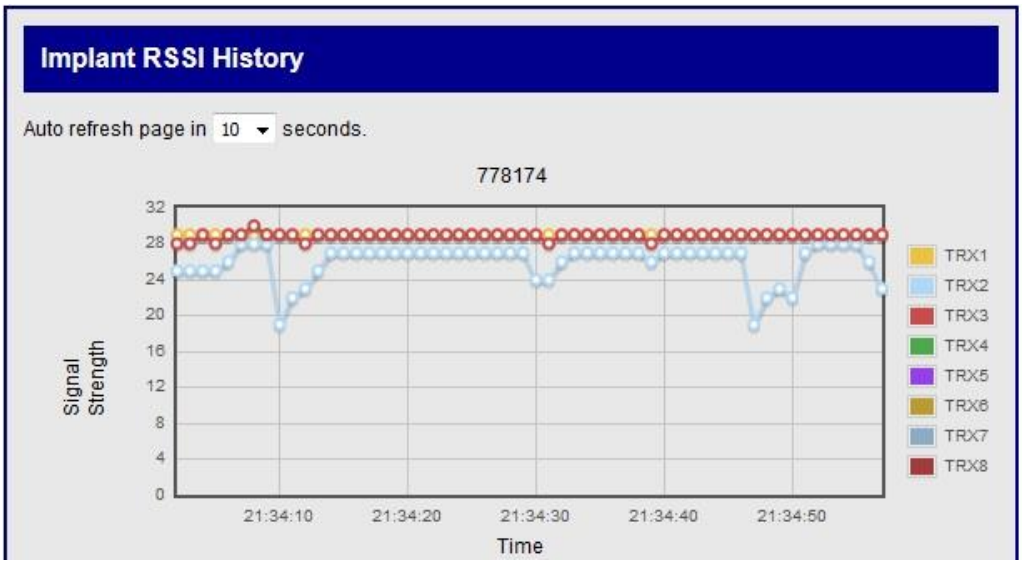
The implant commands in this section are capable of generating an error code if the command cannot be successfully executed. Below is a list of the more common error codes.

Error code	Description	Solution
900	Unknown Error	
901	Implant Not Found	Make sure implant in range
902	Timeout	Make sure implant in range
903	Send Fail	Make sure implant in range, in standby mode, Ponemah is not trying to send a lot of commands to the implant
905	Implant in Active Mode	Make sure the implant is in standby mode
906	Queue Full	Make sure implant is in range, Ponemah is not trying to send a lot of commands to the implant

IMPLANT RSSI HISTORY

Similar to the TRX RSSI History, the Implant RSSI History generates graphs in which the received signal strength from each of the TRXs is plotted for each implant. These graphs allow the user to track how well the implants are being received by each of the TRXs. In an actively running system these graphs continually update according to a user prescribed auto refresh rate.

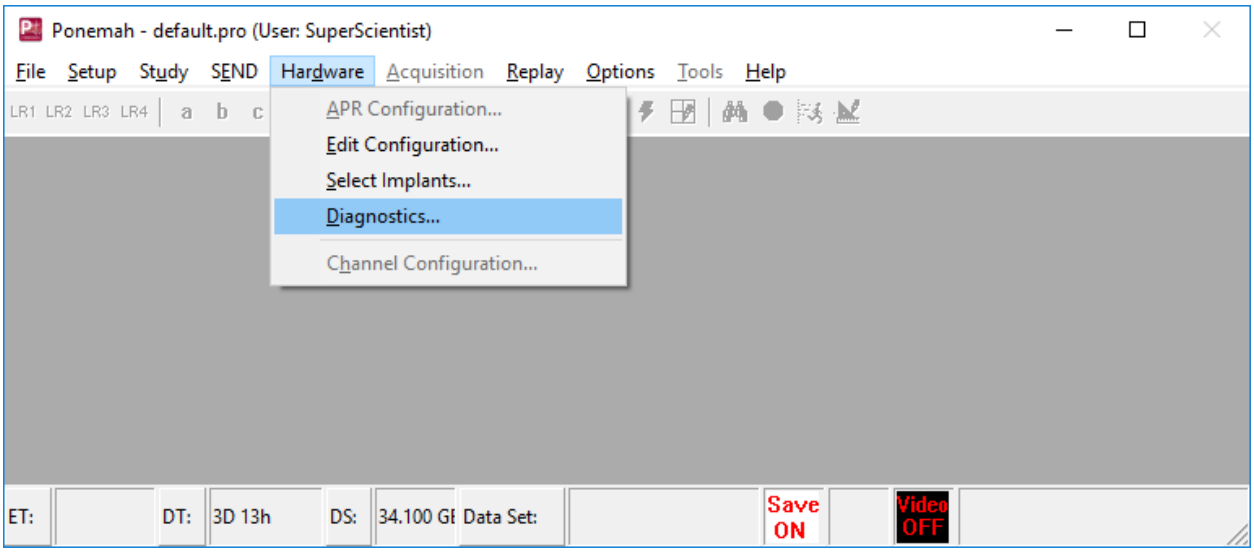
- There will be one RSSI graph for each of the recognized implants in the system.
- Each TRX will report the received signal strength from each of the implants it is communicating with. The RSSI graph will display one data set for each of the implants.
- To Set the Auto refresh rate of the graph, click on the drop-down menu at the top of the screen and select a new value.



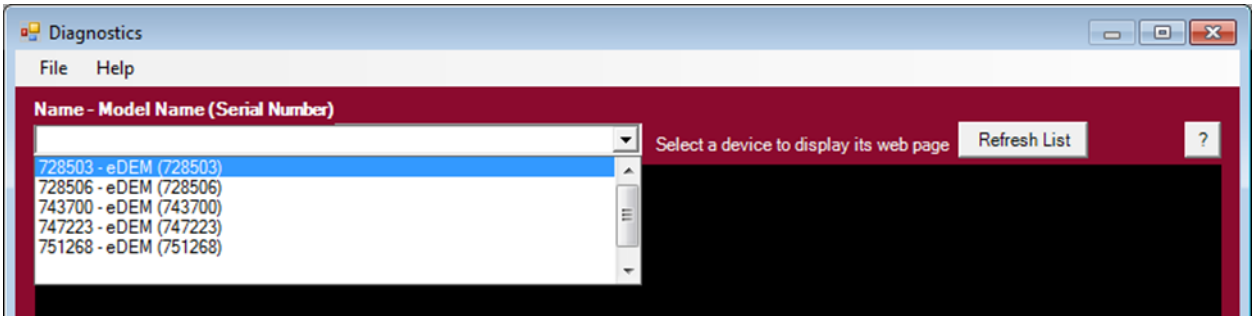
MX2 DIAGNOSTICS

The **MX2 Diagnostics** user interface is a browser based webpage that allows the user to check the status of the MX2, Check network connections, update firmware, and perform diagnostic tests to optimize the performance of the system components.

Selecting **Diagnostics…** from the Hardware menu will open the **MX2 Diagnostics** web browser.



To select a specific MX2 click on the drop-down menu located in the top left corner of the diagnostics window. All of the configured MX2s that are connected to the system will appear in this list.

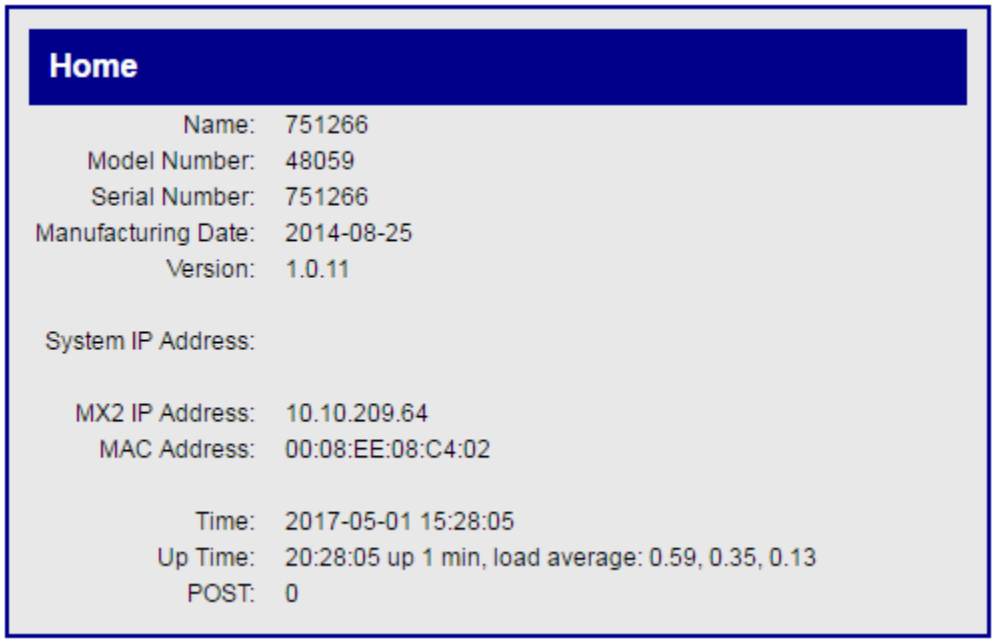


MX2 Options

The MX2 section of the Diagnostics webpage options are describe below.

HOME

The **Home** section lists the general information pertinent to the selected MX2.



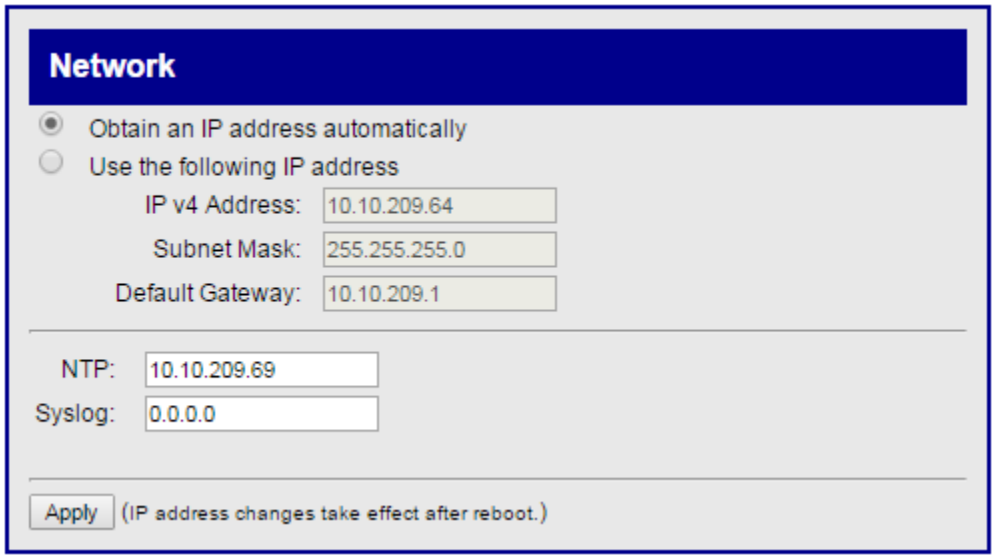
The information listed on the Home page is as follows:

Name:	Displays the user defined name assigned to the MX2.
Model Number:	Displays the MX2 model number.
Serial Number:	Displays the MX2 serial number.
Manufacturing Date:	Displays the date the MX2 was manufactured at DSI. Format is YYYY-MM-DD.
Version:	Displays the firmware version the MX2 is currently running.
System IP Address:	Displays the IP address of the acquisition computer.
MX2 IP Address	Displays the IP address of the MX2.
MAC Address	Displays the unique identifier for the MX2 network interface
Time:	Current Date & Time (Format = YYYY-MM-DD HR:MN:SC)
Up Time:	Status information since last reboot.

POST: Power On Self-Test (0 = Passed, OK …)

NETWORK

The **Network** page allows the User to adjust the network communication settings.



- **Obtain an IP address automatically**

  This is the normal operating mode for the MX2. With this option selected the MX2 is queried and the values that it reports back are displayed in the appropriate text boxes:
  - IP v4 Address:
  - Subnet Mask:
  - Default Gateway:

  Note: A new IP address can be generated by performing an "extended" reset: push and hold the reset button on the back of the MX2 for 5-15 seconds.

- **Use the following IP address**

  If the user wishes to manually assign a specific IP address to the MX2, click this radio button and type a new IP address in the text box.

If you wish to perform this operation, follow this procedure:

4. Click the radio button for Use the following IP address
5. Enter the desired values in the text boxes labeled:
    - IP v4 Address:
    - Subnet Mask:
    - Default Gateway:
6. Click Apply.

Note: A reboot of the system will have to be performed in order for the new IP Address to activate.

> ⚠ *Caution*: If the user-assigned IP address is not accessible, this diagnostics tool will lose contact with the MX2. To generate a new IP address, the user must perform an "extended" reset: push and hold the reset button on the back of the MX2 for 5-15 seconds.

- **NTP**

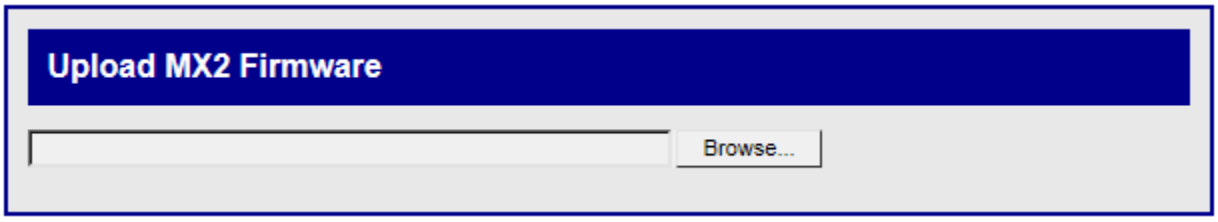
  The MX2 keeps synchronization with the PC using Network Time Protocol (NTP). By default, Ponemah will set the NTP IP address to be the IP address of the PC. If it is desired, the NTP IP address can be set manually.

- **Syslog**

  This is an IP address that can be set by DSI personal for on-site troubleshooting. It is not needed for normal operation.

UPLOAD MX2 FIRMWARE

This page allows the user to update the MX2 firmware. From time to time it may be advantageous to upgrade the internal read-only program instructions through a firmware upgrade. This often results in improved performance.



To update or change the firmware version in the MX2, follow this procedure:

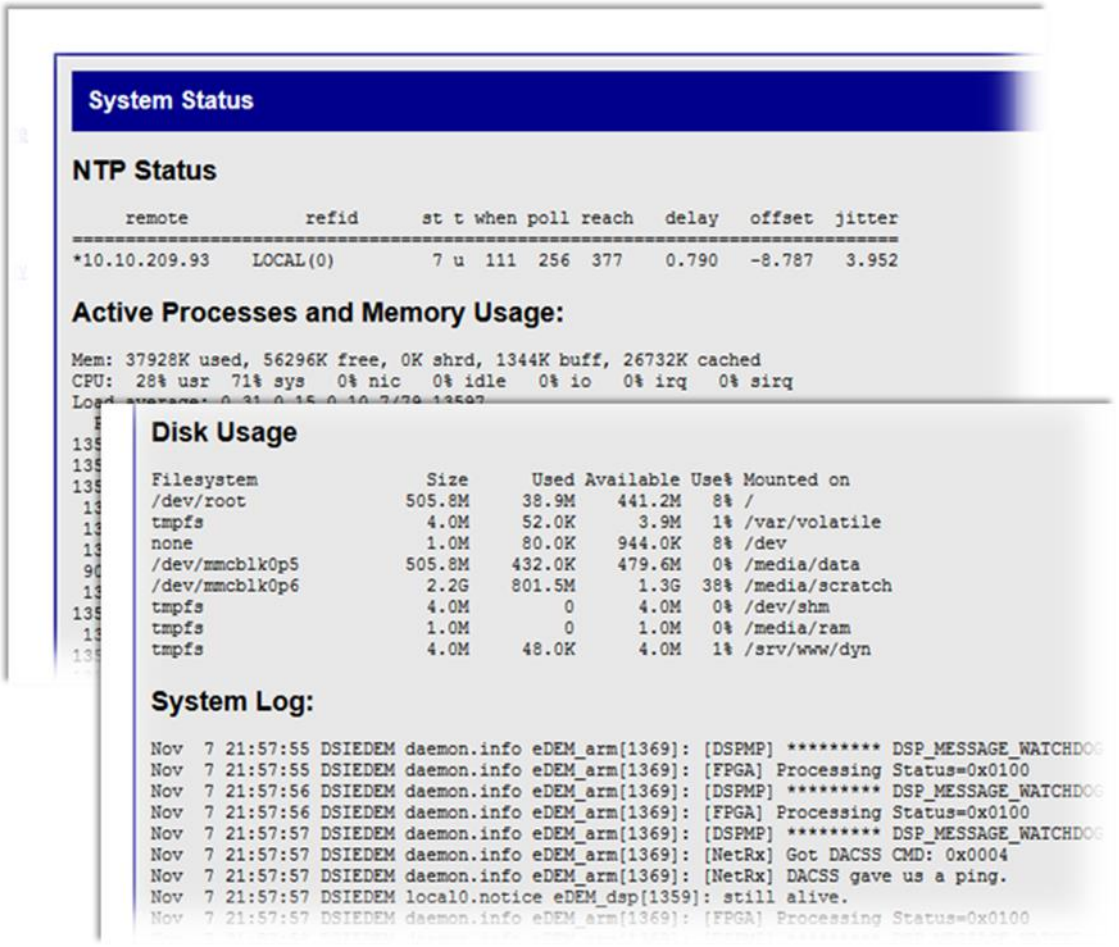
1. Click on the **Browse** button and use the file upload window to locate the firmware file.
2. Navigate to the specific filename and click **Open**

3. Message 1: Uploaded, Validating
4. Message 2: Validated. Upgrade will be applied during reboot.

Note: A reboot of the system will have to be performed in order for the update to activate.

SYSTEM STATUS

The System Status is a continuously updating "log" file of the MX2's communication activity. It can be used to monitor communication issues in the event of discontinuities.



Contents:

- NTP Status – Reports the last time the MX2 received an update from the NTP Server
- Active Processes and Memory Usage
- Disk Usage

- System Log

REBOOT

This function allows the user to perform a complete reboot of the MX2. A Reboot of the system is required to:

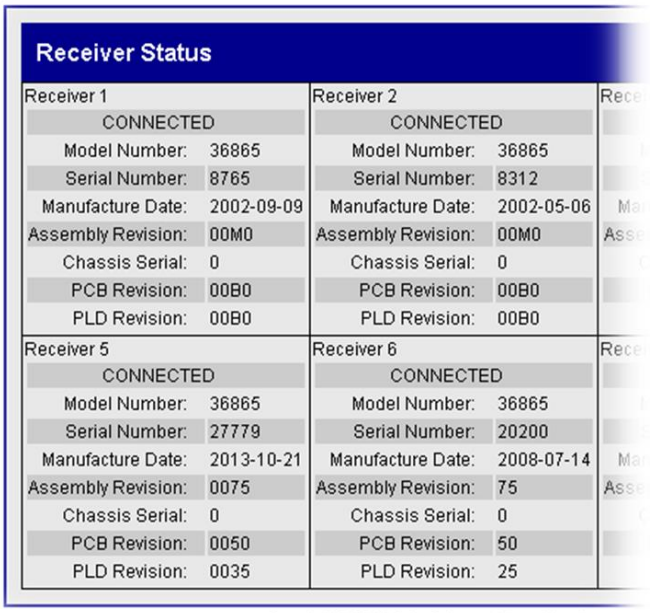
- Activate a firmware upgrade.
- Change the IP settings.
- To reboot the MX2 left click the Reboot button

Note: the Reboot process may take several minutes to complete. There are no progress indicators that appear on this page, However there are indicator lights on the back of the MX2 box itself

RECEIVER OPTIONS

RECEIVER STATUS

The Receiver Status screen is a non-interactive snapshot of the current status of the receivers that are connected to the MX2. Each MX2 is capable of interfacing with eight receivers. This arrangement follows the layout on the rear panel of the MX2 unit.



The line items are as follows:

Receiver (#): Number 1-8.

CONNECTED: Indicates whether the receiver is physically CONNECTED or NOT CONNECTED to the MX2.

Model Number: Displays the Receiver model number.

Serial number: Displays the Receiver serial number.

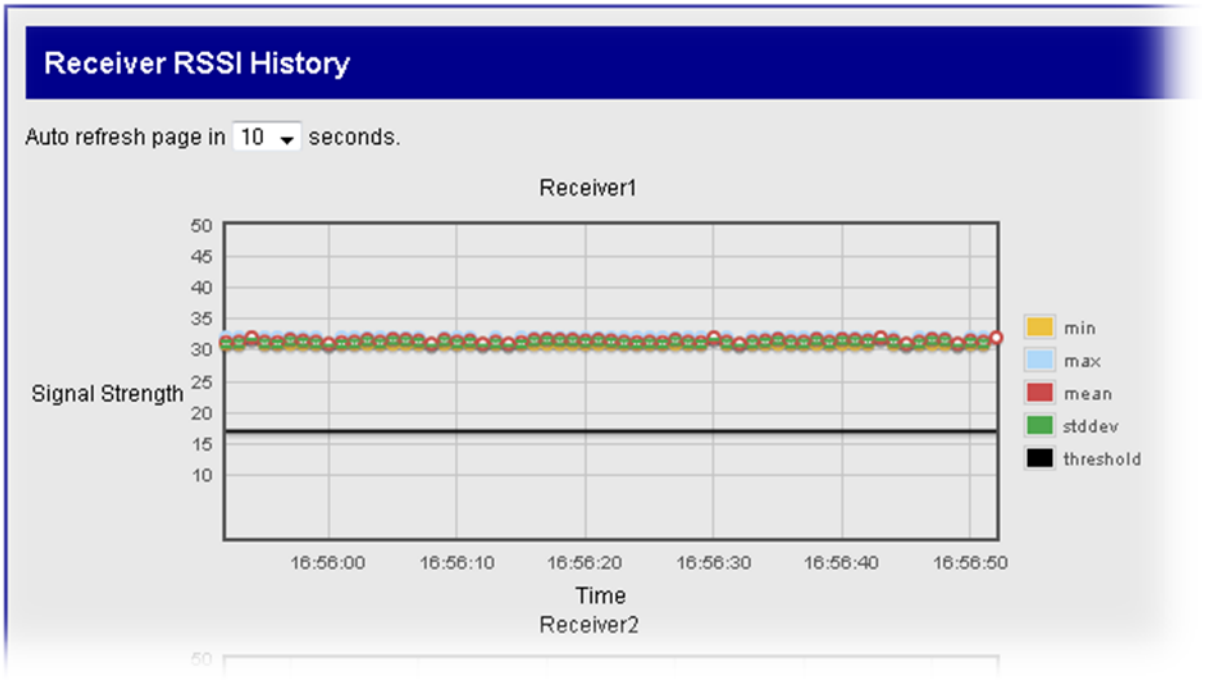
Manufacture Date: Displays the date the Receiver was manufactured at DSI. Format is YYYY-MM-DD.

Assembly Revision: Displays the Assembly revision.
Chassis Serial: Not implemented.
PCB Revision: Displays the Printed Circuit Board revision.
PLD Revision: Displays the Programmable Logic Device revision.

RECEIVER RSSI HISTORY

This option allows the user to view how well the receivers are receiving RF signals from the implants. In an actively running system these graphs continually update according to a user prescribed auto refresh rate.

There will be one RSSI graph displayed for each of the receivers connected to the MX2.



NETWORK TIME PROTOCOL (NTP) & PROCESS UTILITIES APPLICATION

When connected to a CLC or MX2, Ponemah uses a **Network Time Protocol** as a time source instead of **Windows Time** for the sampling of data.

During the installation of Ponemah the needed Network Time Protocol software is installed as a service that will start up and run automatically when Windows is booted. The specifics of the service are:

- **Service Name**: NTP
- **Display Name**: Network Time Protocol Daemon
- **Startup Type**: Automatic

The installation will also turn off Windows Time by setting the startup type to disable. This is needed so there is only a single time source in the system to accurately collect data.

The installation will also add an entry in the Windows Firewall to allow the NTP service to communicate with the connected CLC/MX2 hardware devices. The specifics of the Windows Firewall settings are:

- **Type**: Inbound Rule
- **Name**: NTP UDP Datagram
- **Protocol type**: UDP
- **Local port**: 123
- **Profile**: Domain, Private and Public

MESSAGES

During the startup of Ponemah, the application will check that certain services are in the correct state in order for the application to collect data correctly.

If Windows Time is started and NTP is not, the application will try to change this to Windows Time disabled and NTP enabled. If those states cannot be achieve a message will be posted notify the user of the issue.

TROUBLESHOOTING NTP

During the startup the application if the needed service states cannot be set an error message will be displayed for the user.

If the user starts an acquisition and the system displays all of the signals with a flat line this can also point to a problem with the NTP time source.

Typically the user can verify that there is an issue by going to the Diagnostic Web page and viewing the Home Page Time. If this time is in the range of 1/30/2012 the hardware device is not synchronized to the NTP time. Try rebooting the hardware device by power cycling the device.

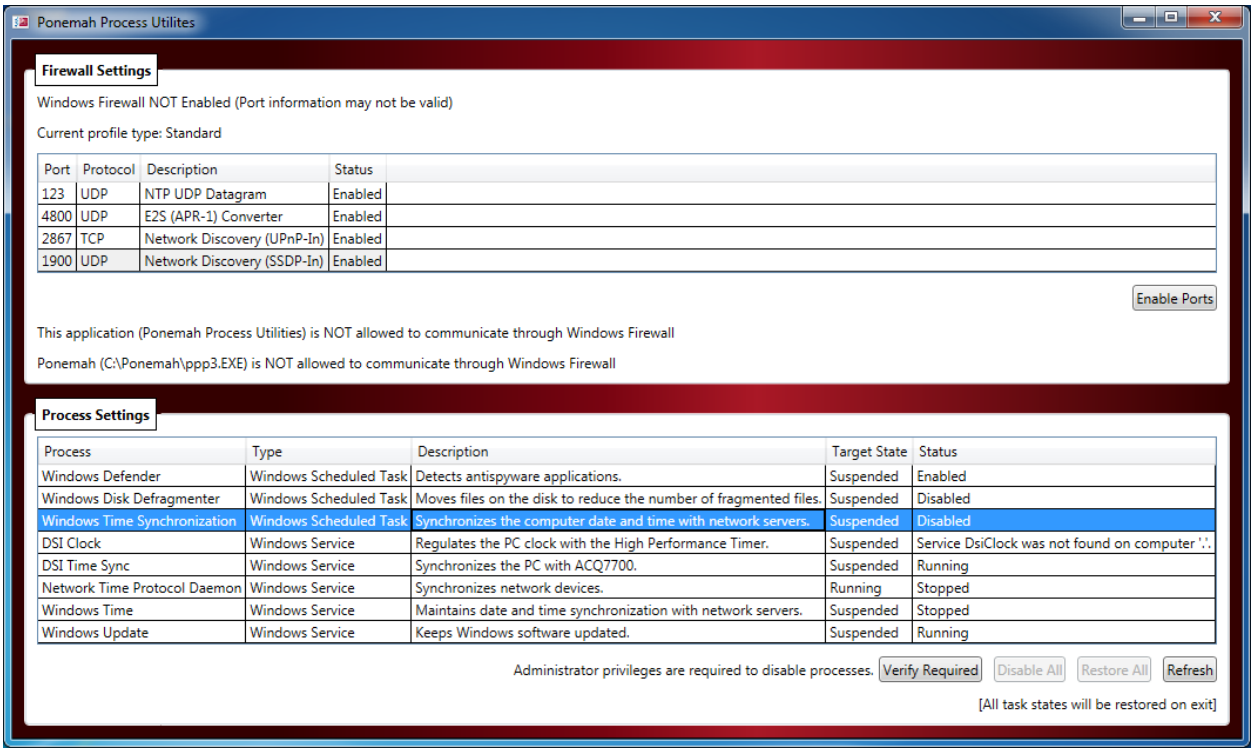
If that does not work exit the application and run a system check by running the Ponemah Process Utilities application which is available in the Ponemah folder under All Applications.

PONEMAH PROCESS UTILITIES APPLICATION

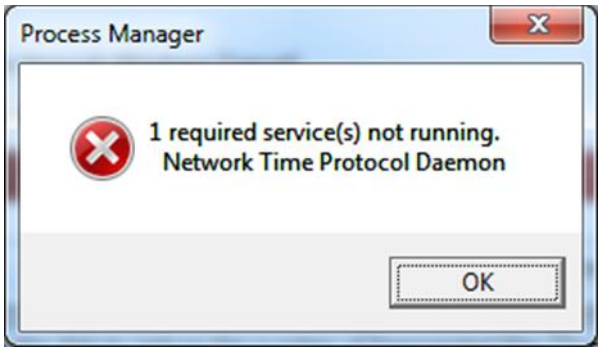
To aid in troubleshooting the user can run the application to view the needed system settings in order to have a valid configuration.

The **Ponemah Process Utilities** application will display the current state of the system settings and the user can select **Verify Required** to see if any of the system setting are not correct and then take appropriate action.

A typical display of a system is shown below.



After selecting **Verify Required** in the above condition, the application responded with:



At this time the user can try to change certain settings to resolve the issue. This can be accomplished by contacting the IT group that supports the computer.

For more information, contact DSI Technical Support by seeing the Getting Technical Support section of this manual.

RETURNING PRODUCTS TO DSI

If you need to return a product to DSI, here's what you need to do.

A detailed updated procedure for properly returning telemetry products to DSI for failure analysis is provided on our website at www.datasci.com. The following additional considerations should be made:

- To be covered under the manufacturer's warranty, the implants must be returned for exchange within the warranty period (listed in the implant specifications).
- Ensure that the implants are well packed, preferably in their original packaging and boxes.
- Return the implants via a traceable shipping method to prevent losses in transit.

Contact DSI Technical Services with any concerns or comments regarding the performance of the devices upon receipt and after the first use.

Two forms are available that can be requested from customer service (CustomerService@datasci.com) or technical support (Support@datasci.com):

- 001465-001: DSI Exchange Form USA
- 001549-001: DSI Exchange Form Europe
- 004540-001: DSI Exchange Form International
- Product Investigation Form (PIF)—printed email sent from Customer Service.

CONTACTING TECHNICAL SUPPORT

DSI™ is available to help you with your questions and concerns. Should you hit a road block or need some additional training, please feel free to contact us. We are happy to help!

DSI SUPPORT CENTER

DSI provides easy access to the following self-help tools when they are need most:

Please visit support.datasci.com to access the following resources:

- Quick start guides and videos
- User Manuals
- Technical Notes
- Troubleshooting guides
- The latest software and firmware downloads

CONTACT DETAILS

DSI TECHNICAL SUPPORT—NORTH AMERICA

Email: Support@datasci.com
Toll-free in U.S. and Canada
Phone: 1-800-262-9687
Monday through Friday: 8 AM to 5 PM CST
(except Holidays)

DSI TECHNICAL SUPPORT—EUROPE

Email: Europe-support@datasci.com
Phone: +44 1359 259400
Monday through Friday: 8 AM to 5 PM CET

DSI TECHNICAL SUPPORT—ALL OTHER COUNTRIES

Phone: +1-651-481-7400