HIGH PERFORMANCE
HIGH RELIABILITY
HIGH SECURITY

Terrain Defender ™
TD-100
Product Guide

FCC Interference Statement (Part 15.105 (b))

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC Part 15 Clause 15.21:

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

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

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1. Introduction

TD-100 is a covert buried line intrusion detection sensor. It utilizes two parallel leaky coaxial cables to create an invisible electromagnetic field that follow the cables around corners and up and down hills. The transmit (TX) cable creates a field that couples into the parallel RX cable. An intruder moving in proximity to the cables disturbs the coupled signal. Measuring the time delay between the onset of the coded pulse transmission and the receipt of the change due to the intruder allows the system to detect and pinpoint the location of the intruder.

TD-100 is unique in its use of Multiple Input and Multiple Output (MIMO) DSP to detect and locate intruders using End to End (E2E) Correlation. To generate an Alarm the intruder must be detected at the same time and same location. The product provides high Probability of Detection (PD) and low Nuisance Alarm Rate and False Alarm Rate (NAR/FAR) detection with unprecedented Fail-Safe features.

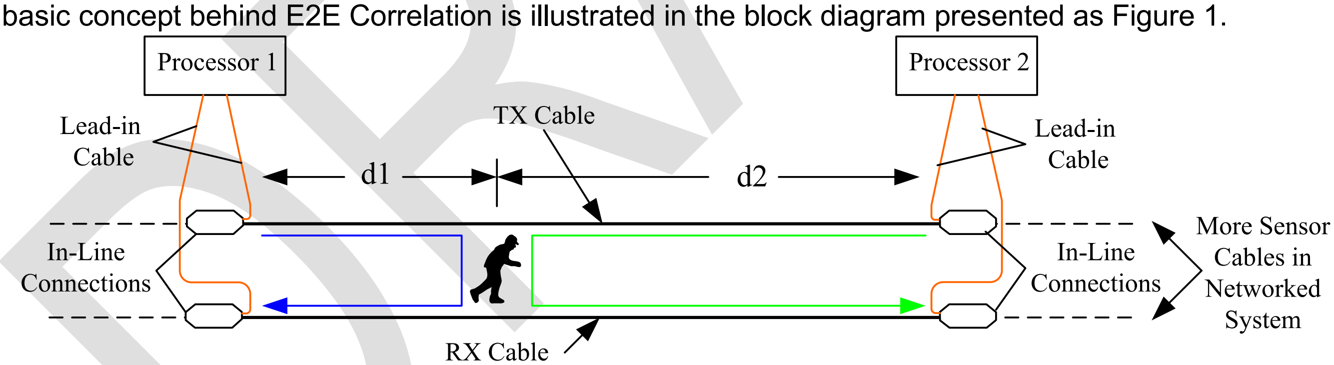
This brief introduction to the technology provides a starting point for those who wish to operate the TD-100. It introduces the product components and the way that they can be interconnected to address various applications.

The information presented herein provides background for the more detailed and subject focused manuals that describe the inner workings of TD-100.

- Installation Manual
- Access Module Manual
- Configuration Tool Manual

Introduction

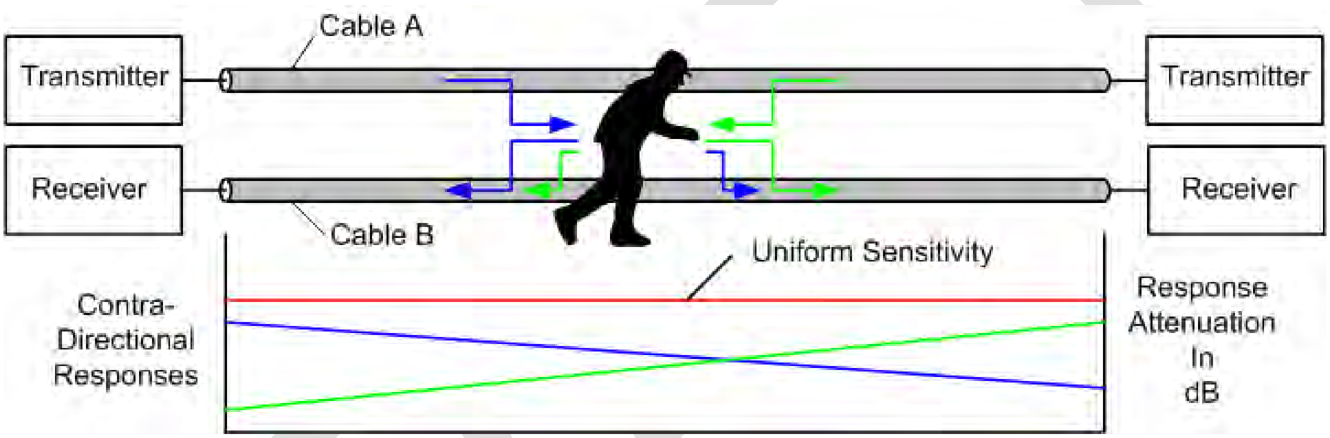
The basic concept behind E2E Correlation is illustrated in the block diagram presented as Figure 1.



Block Diagram
Figure 1

The leaky coaxial sensor cable is a standard coaxial cable with an apertures or a continuous slot in the outer conductor to allow RF energy to couple between the signal travelling inside the cable to a surface wave travelling outside the cable but bound to the cable. There are two transmitters and two receivers in each processor - one TX/RX pair looking left and the second TX/RX pair looking right. The “blue” trace in Figure 1 shows the TX from Processor 1 propagating down the cable to illuminate the intruder. A portion of the energy is reflected back along the RX cable to the receiver. We refer to this “out and back” flow of energy as the contra-directional coupling. The time delay between the onset of the coded pulse and the receipt of the change due to the intruder, determines the location of the intruder. The same process is repeated by Processor 2 from the other end of the cables. E2E Correlation requires that the intruder be detected at the same time and at the same location to be declared as an Alarm.

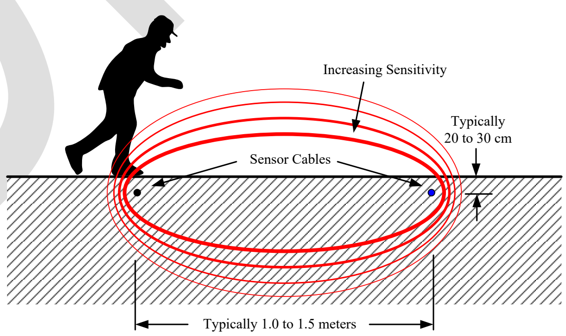
As illustrated in Figure 2 the response measured in dB decays linearly due to cable attenuation.



End to End (E2E) Correlation
Figure 2

In the E2E process we take the complex product of the signal seen from both ends of the cables. The result is the uniform sensitivity shown in red. Other leaky coaxial cable sensors use expensive “graded” cables to compensate for cable attenuation.

The detection zone created around the TX and RX cables is illustrated in Figure 3.



Detection Zone Cross Section
Figure 3

The red ovals depict contours of equal sensitivity. The thresholds are typically set to provide detection of a person up to 1 meter above ground and 0.5 meters on either side of the cable pair.

TD-100 is composed of the following components:

- Processor
  - Optional External Enclosure
  - Optional Relay Board
- Sensor Cable – 400-meter reels
- Demarcation Modules – in-line connections
  - Terminal Blocks
- Access Module (Optional) – interface to Head End
- Configuration Tool – laptop setup of system
- Power Supply – 48VDC Linear w/enclosure

Site Description

Every site is unique. To accommodate all of the different site conditions it is helpful to define a number of features that can be used to describe a particular site and the TD-100 components required to optimize performance at that site.
Most every site that can utilize TD-100 can be described using the following terminology.

1. Single or Multi Processor Site – up to 400 meters of cable between processors
2. Open or Closed Perimeters

On these perimeters there are three possible processor positions:

1. Lead – connected via Ethernet to an Access Module,
2. Middle – a processor in a Multi-Processor site between the Lead and End and
3. End – connected via Ethernet to an Access Module for redundant operation

There are two basic ways that a Processor can detect and locate an intruder:

1. E2E Correlated (Double Ended – a processor on both ends of cables)
2. Single Ended – with cut cable or failed processor or by design

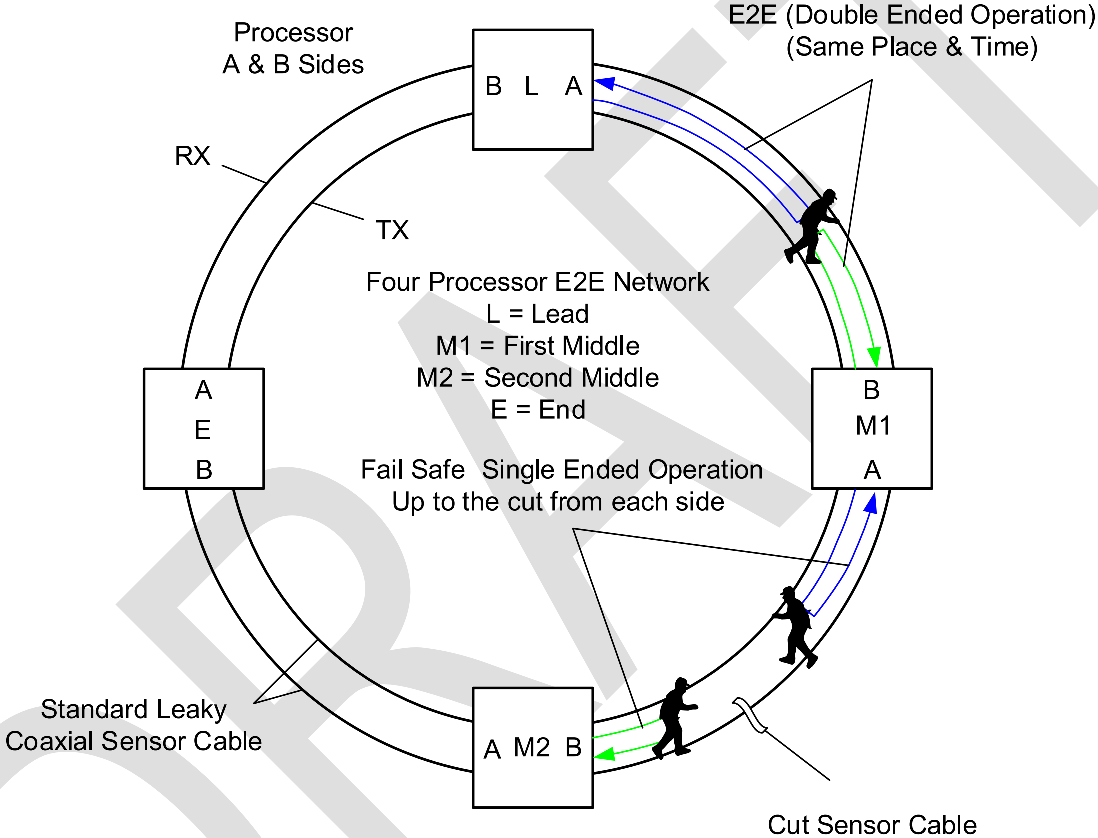
The RF Ports of each Processor are terminated by one of:

1. Sensor Cable with a Processor at other end of cables,
2. Sensor Cable with Resistive Terminations or
3. Resistive Terminations.

There are many possible combinations of these ways to describe a perimeter and the mode of operation when one considers the possible ways to terminate a processor.

The concept of “Open” or “Closed” perimeters describes whether the sensor line encompasses the whole perimeter or only a part of the perimeter. In a “Closed” perimeter, an intruder cannot enter the perimeter without passing over the sensor cables. There are some exceptions such as a perimeter that includes a building as part of the perimeter.

A 4-processor “Closed” perimeter showing E2E and Single Ended Operation is shown in Figure 4.



Four Processor Closed Perimeter
Figure 4

The Processors are usually powered over the sensor cables. DC power can be supplied over the RX or TX cables or over both cables for redundancy. In high security sites it is common to provide DC power to both ends of the TX and RX cables to provide even more redundancy. This includes an open circuit or short circuit cable fault.

E2E Correlation is unique to TD-100. E2E describes a means of processing response information from both ends of the cables in a process referred to as Double Ended operation. To generate and alarm the intruder(s) must be detected by the Processors at the two ends of the cables at the same time and at the same physical location along the length of sensor cables.

An important benefit of E2E Correlation is “Fail Safe” operation. If a cable or Processor should fail the two processors can revert to “Single Ended” operation whereby each processor detects and locates intruders on either side of the cable fault.

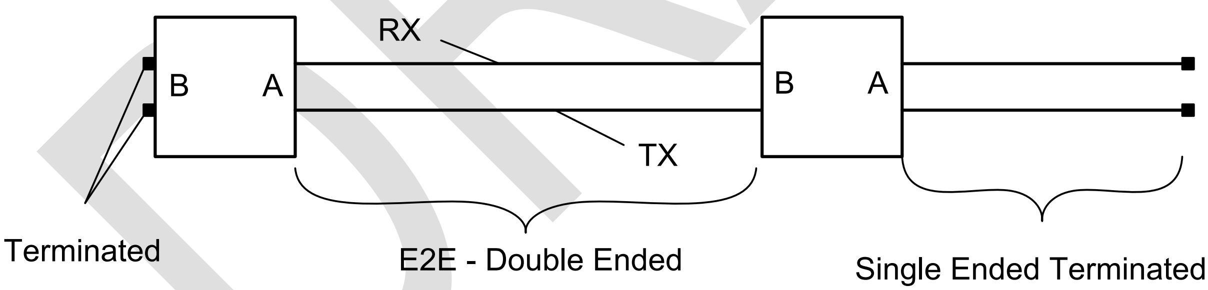
The primary processor on the perimeter is in the “Lead” position. The secondary processor at the end of the perimeter is in the “End” position. All other processors are referred to as Middle processors – numbered from Lead to End. Redundant operation is made possible when there is an Ethernet connection to both the Lead and End processors.

Under normal operation all intruder detection would be performed using E2E Correlation. The response data seen at the Side B of the cables is sent over the cables to Side A where the data are combined using E2E Correlation.

Cables start at Side A of a processor and terminated on Side B of the adjacent processor. Range Bin numbering increases with distance from each processor. The Range Bins for sides A and B bisect to create C-Bins (Correlated Bins). C-Bin numbering is the concatenation of the complementary Side A and B Range Bins. When target location is annunciated in meters or feet it is measured from Side A. Side A distances are positive and Side B distances are negative.

The cut cable in Figure 4 illustrates Fail Safe Mode based on Single Ended Operation. Both Side A and Side B detect and locate intruders up to the cable cut. When a Cable Fault Alarm is annunciated the Operator is given the option of switching to Single Ended Operation for the cables affected.

The different types of processor terminations are illustrated in Figure 5.

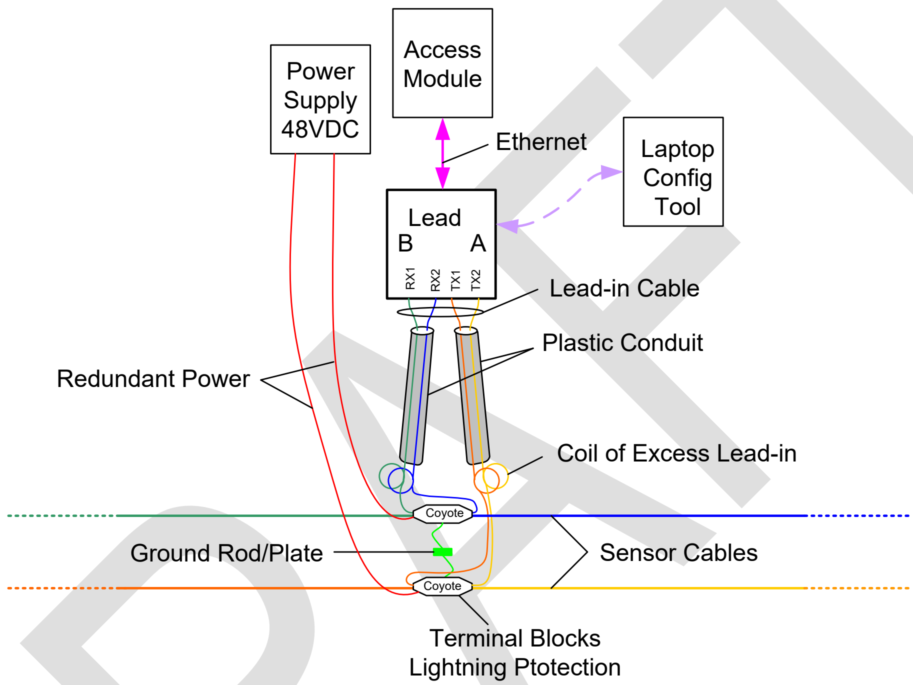


Processor Termination
Figure 5

When only one Side of a processor is being used the other Side should be terminated.

As previously described Single Ended operation allows TD-100 to provide Fail Safe operation. When the cable length required to complete a perimeter is short, less than 100m you may design a site with a length of cable operating in Single Ended Mode. The other leaky coaxial cable sensors on the market today effectively are operating in Single Ended Mode.

The various connections that can be made to a Processor are illustrated in Figure 6.



Connections to a Processor Figure 6

The Processor connects to the sensor cables using factory made lead-in cables. The lead-in cables are 9 meters long with connectors and ferrite beads attached. For a Middle processor, two TX lead-in cables and two RX lead-in cables with the TX and RX cables installed in separate plastic conduit. Power is provided to the Processor from the Demarcation Module over the lead-in cables. Excess lead-in cable is buried in a loop at the end of the conduit.

The Processor can mounted outdoors in a ventilated metal enclosure on the protected side of the perimeter, or inside a customer provided enclosure. This enclosure mounts to a fence post. The cables connecting to the processor enter through the bottom of the vented enclosure via plastic conduit. The plastic conduit is routed to the edge of the detection zone, about ½ meter from the nearest cable. The conduit protects the cables from accidental cutting or crushing.

Each lead-in cable connects to the sensor cable inside a waterproof enclosure. The waterproof enclosures are installed “in-line” with the sensor cables. The connections inside the enclosures are made using a Terminal Block. The Terminal Block uses spring loaded lugs to make the connections.

Lightning protection circuitry is provided at the Terminal Block. The ground connection is made from the Terminal Block through the ground lug integrated into the waterproof enclosure to a ground rod or plate that is installed midway between the sensor cables.

Power is provided to the sensor cables at the Terminal Blocks. For Fail Safe operation 48VDC is supplied independently to the TX and RX cables. Each processor collects its power over the lead-in cables with a diode OR arrangement so that one can withstand either an open or shorted sensor cable. For even more redundancy one can supply power at both the Lead and End processor. In very long perimeters power can be applied at Middle processors as well.

The Lead Processor typically connects to an Access Module via Ethernet cable. For redundant operation, the End Processor can also connect to the same or a separate Access Module.

During installation, connect a Laptop Computer to a processor and run the Configuration Tool software. While this software has some of the same displays as the Access Module it is more focused on setting up a processor.

Conclusion

This Introduction to TD100 provides the background for the reader to be ready to understand and appreciate the detailed information provided in the following manuals:

1. Installation Manual – This describes how one should design and install TD-100 at a specific site. It addressed how to install the cables and other components so as to optimize the sensor performance at that site.
2. Access Module Manual – Most sites having more than a couple of processors will benefit from and Access Module. It provides the interface to the outside world. Often it is via a custom software interface to a Head-End Display and Control system. On other occasions it drives a relay interface. Most importantly it achieves the performance of the equipment and provides maintenance and diagnostic tools addressing all the processors form the Head-End location. The manual steps through all of the pages and tabs showing screen captures and providing a description as to how each feature can be used.
3. Configuration Tool Manual – The Configuration Tool connects directly to a processor. While some of its features are in common with those available using the Access Module the Configuration Tool is even more detailed. The manual walks through the pages and tabs with many screen captures and descriptions of how each feature can be used.

As comprehensive as these manuals are TD-100 is intended to be installed by trained professionals. This is essential if one is to optimize the performance of the system at any site.

This section contains information to help ensure safety and the proper operation of equipment. Please follow these instructions carefully, and keep them accessible, for future reference. When using the **TD-100**, use only attachments and accessories that have been specified by FSI, and refer all servicing to qualified personnel.

2.Safety

As comprehensive as these manuals are TD-100 is intended to be installed by trained professionals. This is essential if one is to optimize the performance of the system at any site. Safety Terms

The following icons may appear throughout this manual:

CAUTION: Identifies conditions or practices that could result in damage to equipment and/or loss or contamination of data.

WARNING: Identifies conditions or practices that could result in non-fatal personal injury.

Electrical Safety

If the **TD-100** is damaged or malfunctions, disconnect power to the APU. Do not use the APU if any of the following conditions exist:

- It is visibly damaged.
- It does not operate as expected.
- It has been subjected to prolonged storage under adverse conditions.
- It has been damaged during shipment.

Do not put the APU into service until qualified service personnel have verified its safety.

Covers and Panels

There are no user-serviceable parts inside the APU. To avoid personal injury, do not remove any of the APU's covers or panels. The product warranty is void if any factory seal is broken. Do not operate the product unless the covers and panels are installed.

Inspection

The **TD-100** APU should be inspected for shipping damage. If any damage is found, notify **Fiber SenSys** and file a claim with the carrier. Save the shipping container for possible inspection by the carrier.

FCC Rules

Note: FCC Part 15 Clause 15.21:

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

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

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the manufacturer, dealer, or an experienced radio/TV technician for help.

As comprehensive as these manuals are TD-100 is intended to be installed by trained professionals. This is essential to optimize the performance of the system at any site.

3.System Planning

Survey the Site

Every site is unique and each with its own challenges. To ensure the best performance of the TD-100 system, this section will help guide you through the process and provide you the tools needed for the best design and solution.

Note: Please contact Fiber SenSys to help you with your TD-100 site design
As comprehensive as these manuals are TD-100 is intended to be installed by trained professionals. This is essential to optimize the performance of the system at any site.

Check List

CAD/PDF Drawings pertaining to PID's

- Show location of:
  - Fences (Type, Height, Distance from sensor cable)
  - Proposed cable path on drawing
  - Gates (Single, Double)
  - Driveways, Walkways
- Soil Type
  - Describe soil type. Example: sandy, dry granular, loam, clay, heavy clay, etc.
    - If more than one soil type, show change
- Concrete
  - Thickness
  - Reinforced Yes/No
- Asphalt
  - Thickness
  - Reinforced Yes/No, Fiber/Metal
- Stone/Crush Rock
  - Thickness
- Water
  - Irrigation Pipes (Metal/Plastic)
  - Drainage Pipes (Metal/Plastic)
  - Shoreline (Lake, River, Stream)
  - Run-Off Ditches
  - Sewer Pipes (Metal/Plastic)
- Electrical
  - Conduit Raceways (Metal/Plastic)

Photographs/Video

- If existing site, provide Pictures and/or Video clip of the area of detection

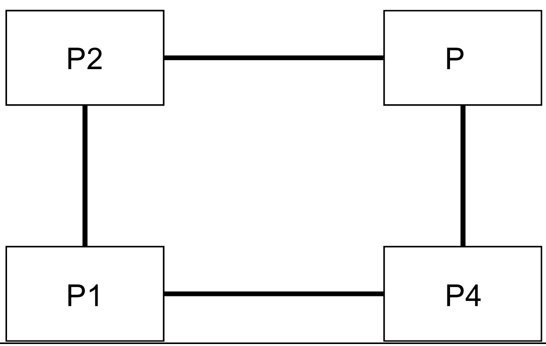
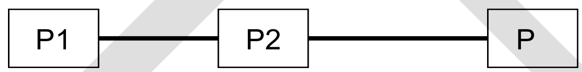
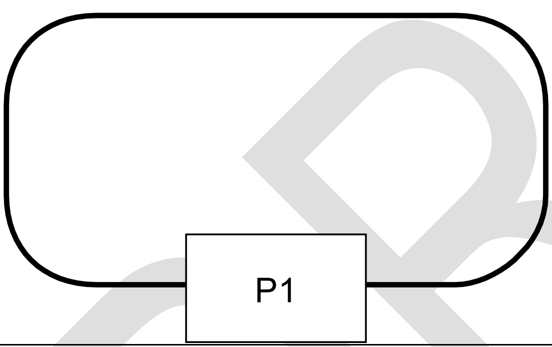
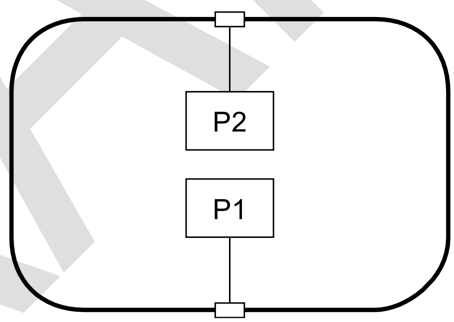
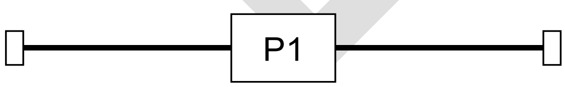
  description of local weather conditions
- Provide address and/or GPS coordinates

Site Desired Security Level

- Is TD-100 being used as part of layered detector?
- Detection flow. Detecting intruders from outside in, or inside out?
- What is the desired primary detection target?

Processor Configuration(s)

A TD100 system can be configured to cover all manner of installations. Some examples are depicted below:

	
Fully Enclosed, Multi-processor	Partially Enclosed, Multi-processor
	
Fully Enclosed, Single Processor	Fully Enclosed, Processors Distant from Sensor Cables
	
Processor w/Terminated Sensor Cables (No E2E)	

4.Installing Sensor Cable

Cable installation overview

System performance starts with the proper installation of the sensor cables.

To install the cables and cable fittings, perform the following steps in order.

- Verify the site plans cable routing and note potential hazard areas from the check list provided earlier like; Underground Water/Electrical Utilities
- Mark the sensor cable route with Marking Chalk, a temporary, fast-drying, water-based spray paint. Chalk can be used to spray paint surfaces such as Pavement, Concrete, Gravel, Soil, and Grass.
- Plow/Dig trenches based on application or cut asphalt/concrete slots if applies.
- Set cables in the trenches or slots, verifying the depth as you go.
    - Keep in mind burial depth required for your application, cable spacing, and distance from potential hazards.
    - Limit grade changes to <30°.
    - Make sweeping gradual turns around corners.
- Install In-Line TD Insensitive Cable Kit (includes: BGC, Lead-in Cable, Terminal Block) Note: Keep TX cables separated from RX cables.
- Verify sensor cables with a continuity tester for shorts and grounds prior to termination.
- Replace soil to cover sensor cables where applicable, restore asphalt trenches, and caulk concrete slots.

Cable Plow/Trenchers

Using a cable plow to install the TD-100 sensor cable is the most efficient and economical method. It helps control burial depth and width. The TD-100 sensor was designed specifically for this method. However, traditional trenching methods can also be used when installing the TD-100 Sensor Cables

There are a few tools from DIY converted sub-soiler, to commercial cable trenchers.

Installation Method using Cable Plow

Planning the Cable Installation

TD-100 Sensors cables must maintain a minimum spacing of **1M/3.3ft**, and maximum of **2M/6.5ft**.

Once spacing has been determined for a site, that spacing must be consistence throughout the system.

Width of sensor cable trenches.

- o Using a Cable Plow Machine, the cutting blade should be twice the width of the outer diameter of the sensor cable. Cable 13cm/.60in Trench 27mm/1.1in
- o Using a Trenching Machine for sites or areas where the cable plow will not work, the trenches width is determined by the width of the cutting teeth. Most are 4 to 6 inches wide, which is more than required.

Soil

Burial depths are dependent on soil type, asphalt, crushed stone, and concrete.

- o Standard soil is the simplest of mediums to install. Maintain 23cm/9in
- o There are various clay soils and knowing which you are working with will help when planning the site civil work and TD-100 components.
  - o When heavy clay medium is present, 15cm/6in is optimal. It may be necessary to add additional processing to maintain the specific PD/NAR requirements. With TD-100 simply add a middle TD-100 processor Kit, in-line anywhere along the detection cable to increase the gain needed to reduce clay soil effects.

Simple Trench

Simple Trench

Asphalt

- When application requires sensor cables to be installed in Asphalt, it is necessary to determine the thickness. Asphalt's properties do not contain the RF signal as soil, and in most cases, it would be like installing the cable on top of the ground. Also consider not placing the sensor cable so deep that the height of the detection field is reduced.
  - If the Asphalt is <10cm/<4in., a 23cm/9in burial depth is acceptable, unless clay is present, then that would need to be factored in. It is always best to work with your Fiber SenSys Representative to determine the best method when installing TD-100 Sensor Cable.
  - Asphalt will require cutting a section out, wide enough that allows for the removal of spent materials and allowing access to the soil below where hand digging or using a trencher to reach the appropriate sensor cable depth.

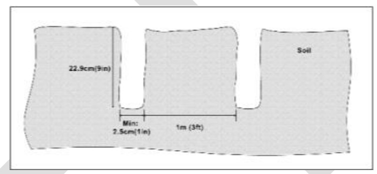
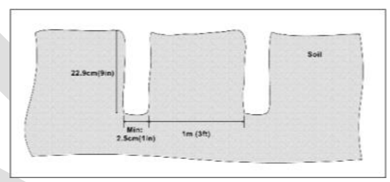
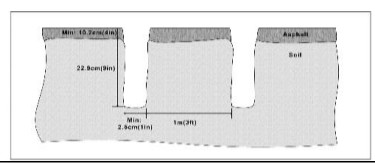
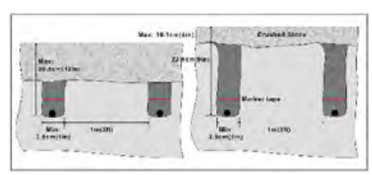
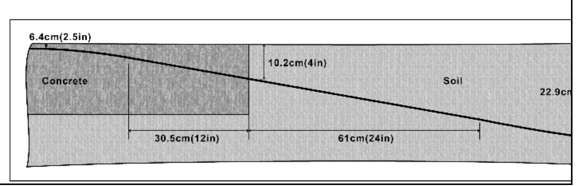
Asphalt Cut Total 23cm/9in depth

Asphalt to Soil transition maintain 23cm/9in depth

Concrete

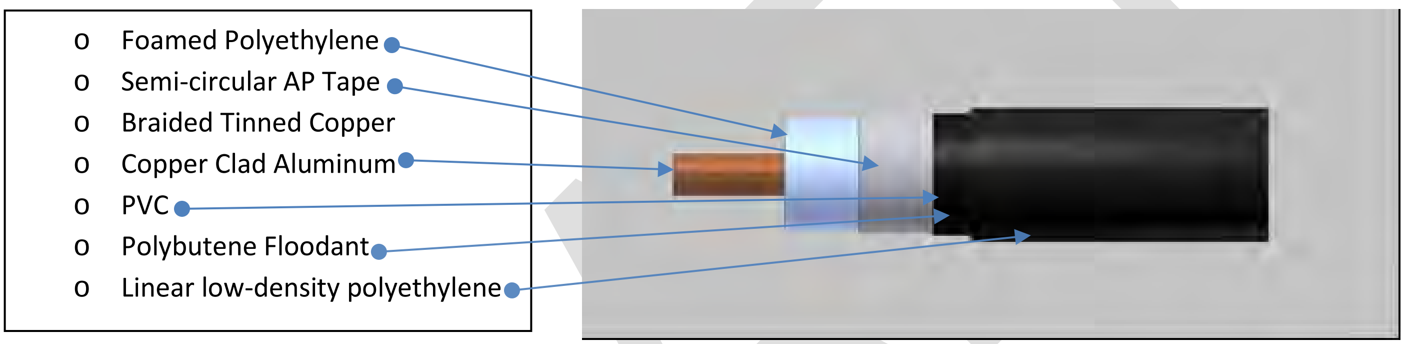
- Concrete installation applications defer from the other methods due to its density.
  - A 6.35cm/2.5in deep, 1.5cm/.600in wide slot will be required for concrete =>10cm/=>4in thick.
  - Before placing the sensor cables into the slots, verify there are no sharp edges, and free from debris. Using a 1m/3ft section of sensor cable is a simple tool to help verify your depth and width are good before handing the spool.
  - Once the sensor cable is set into the slot, a foam backer rod is placed on top of the sensor cable then sealed with a road grade caulking.

Burial Depth Table

Burial Depth in Soil	23cm/9in.	
Burial in Moderate to Heavy clay soil (If needed, adding an additional TD-100 Processor will improve performance in these conditions)	10cm/6in.	
Burial **under** asphalt, or **under** concrete that is < 10cm/4in. thick	10cm to 23cm/6in. to 9in.	
Crushed Stone		
Transition from Concrete to Soil		

5.Shielded Terminal Modules

The TD-100 product uses a uniquely modified coaxial cable sensor element. The cable has two outer jackets separated by a flooding compound designed for direct burial. Beneath the two jackets there is an outer conductor which has two parts; a foil tape which allows for a slotted aperture and a braided conductor that provides a low resistance DC path to accommodate power supplied over the cable. Unlike the competitor's cable, the slot width formed by the foil is constant over the length of the cable. The leaky cable is connected to coaxial lead-in cable which connects to the processor. The connection between the sensor and the lead-in is made inside the Demarcation Enclosure (DME), which is designed for direct burial. The connection is made inside the DME in an RF shielded metal box. This note describes how to install that shielded termination.



There is passive circuitry inside the shielded termination that connects the RF from lead-in cable to the leaky sensor cable, providing lightning suppression and 48VDC power over each sensor cables. In most applications there are two shielded terminations inside a DME to support sensor cables going to the left and right of the processor. (When the processor is at the end of an open perimeter there will only be one shielded termination.)

The processors on the perimeter receive power over the sensor cables. The shielded terminations allow power to pass through the DME from left to right or right to left directly from one pair of sensor cables to the next. The power is supplied in parallel over both the TX and RX sensor cables, providing redundancy. Each processor receives its power over the TX and RX lead-in cables from the DME. This ensures a redundant power connection with only the power going to the processor over the lead-in cables. This ensures that power goes to all processors even if the lead-in cables are cut or a processor should fail. The perimeter power goes from DME to DME redundantly on the TX and RX sensor cable and in a closed perimeter redundantly from both ends of the perimeter. This supports the hallmark redundancy of operation of the TD-100.

The lead-in cables come in a standard 30ft/9m lengths with factory installed Ferrite Beads, and SMA connectors at each end. When there is excess lead-in cable, bury to the outside of detection zone created by the sensor cables. The lead-in cable connects to the SMA connector on the shielded termination inside the DME and to an appropriate SMA connector on the bottom of processor. Custom lead-in cable lengths can be created, just ask your Fiber SenSys representative.

The TD-100 system was design so that the sensor cable could be installed around the entire perimeter and add the DME's/TD-100 processors after where they are needed to meet soil conditions or site infrastructure locations with its In-Line processing design.

Prepare Installation of Demarcation Module to Processor

Dig 2 parallel trenches from the TD-100 Processor to the Demarcation modules. The outdoor TD-100 enclosure has 2 K.O.'s 1.25"/1.50" for PVC pipe on the bottom to feed the TX lead in cable(s) in one and the RX lead in in the other. It is important to keep the TX and RX separated, each in separate conduits.

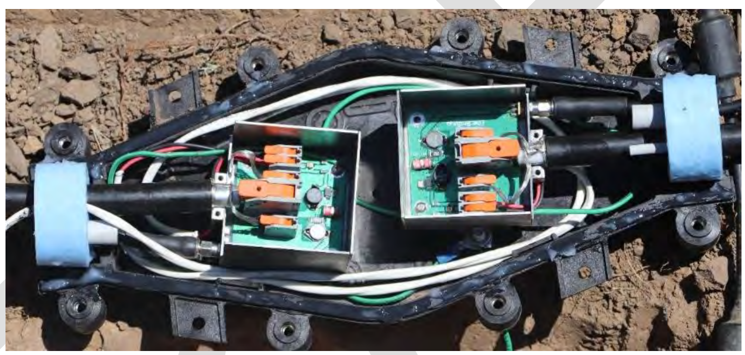
Install Ground Rod in between the DM's

Sensor cables and lead-in cables in place

Demarcation Module locations

In this example the Demarcation Module will have the sensor cables coming from both directions, requiring two terminal blocks for the TX cable and two for the RX cable.

The TX Demarcation Module will have a TX1 connection to one terminal block and TX2 to the other. The same applies to the RX Demarcation Module, respectively.



Preparing the Sensor Cable

The cable is cut using a Coaxial Cable Cutter like that shown.

Coaxial Cable Cutter

Step 1
Rotate the tool around the cable as you apply pressure. This only requires a small amount of pressure to cut through the jackets, the outer conductor, and the heavy copper clad aluminum center conductor. Once the cutters blade contacts the center conductor, simply score the outside of the center conductor. Remove the cutter, grab the sensor cable from both sides of the cut and bend until it breaks in two leaving a clean square cut.

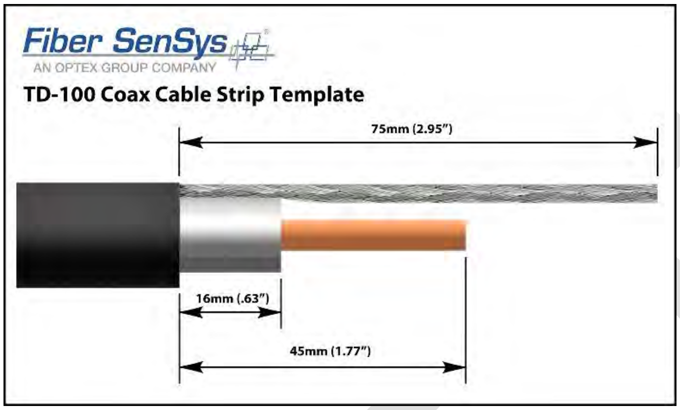
Step 2
Remove one of the two silicon gromet provided from DM package. Notice the 2 larger holes and the 2 smaller holes. Pull sensor cable from one side through one of the two larger holes, and lead-in cable with terminated SMA connector through one of the two smaller holes. Note: the lead-in cable with ferrite beads are positioned closest to DM. Also note that Pull the 18awg 2 conductor through the remaining smaller hole that provides 48VDC to the terminal block.

Step 2a
Pull the cables through grommet, pulling a little extra sensor cable through providing room for the following steps. The sensor cable in a later step will be pull back at the time of the terminal block are placed inside the enclosures.

Step 2b
Remove the second of the two silicon grommets and repeat the process from step **2**. This grommet is used for the other side of the sensor cable

Step 3
Using the Coax Ringer Stripper, Figure 2, cut through the outer polyethylene jacket **75mm/2.95"**, Figure 3, from the end of the cable. Be careful not to cut too deep. It is OK to score the second PVC jacket but DO NOT cut through the second jacket. (If you cut too deep you will cut through the outer conductor and you will have to start again.)

Coax Ringer Stripper



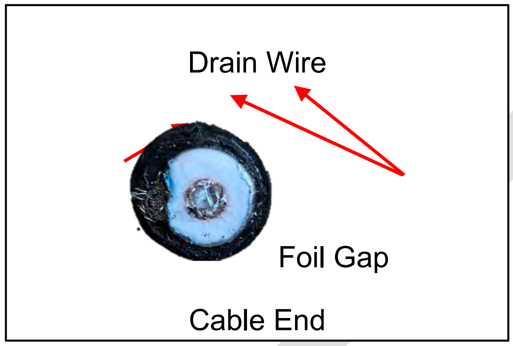
Sensor Cable Template

Step 4
Twist the outer jacket and pull outer polyethylene it off the cable. This will expose the second jacket which will be covered in flooding compound. The flooding compound can be easily removed using a Cable Gel Solvent. The flooding compound is to seal any pin holes in the outer jacket resulting from direct burial. The cable with the outer jacket removed.

Sensor Cable with Outer Jacket Removed

Step 5

Looking at the end of the cable can see where the braid is located on the circumference of the dielectric. You can also locate the gap in the foil, which is generally the opposite site of the drain wire. Using a sharp utility knife make a cut through the second polyethylene jacket, avoiding cutting into the dielectric. From the end of the outer jacket previously removed, to the end of the cable trying to stay within the FOIL GAP.



Step 6
Using a pair of pliers, tear off the second layer of polyethylene jacket where it was scored to expose the slotted foil and drain wire.

Outer Conductor and Braid Exposed

Step 7
Fold back the braid and using the Coax Ringer Stripper cut off 45mm/1.77” of the outer conductor and foamed polyethylene dielectric. Be very careful not to score the center conductor. The foam dielectric can then be pulled off the center conductor. You may find that a pair of pliers and a twisting motion works well. The result is shown.

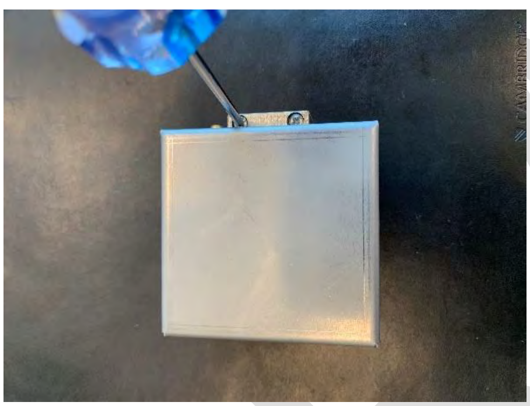
Braid Folded Back and Center Conductor Exposed

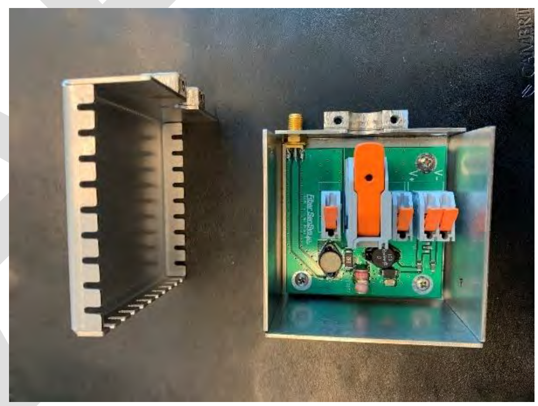
Step 8
Separate the braid into two parts and twist as illustrated in.

Center Conductor Exposed

Step 9

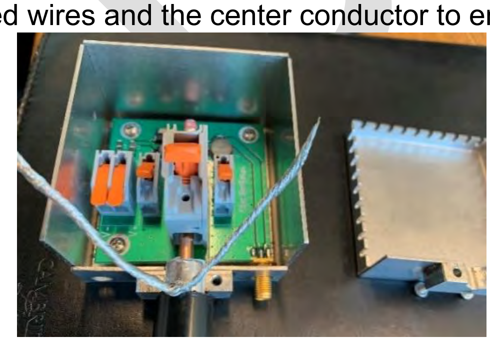
Remove the lid from the shielded termination box by removing the Philips screws on the four corners. Set it aside.

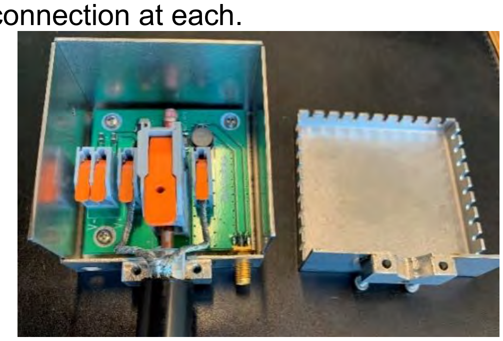




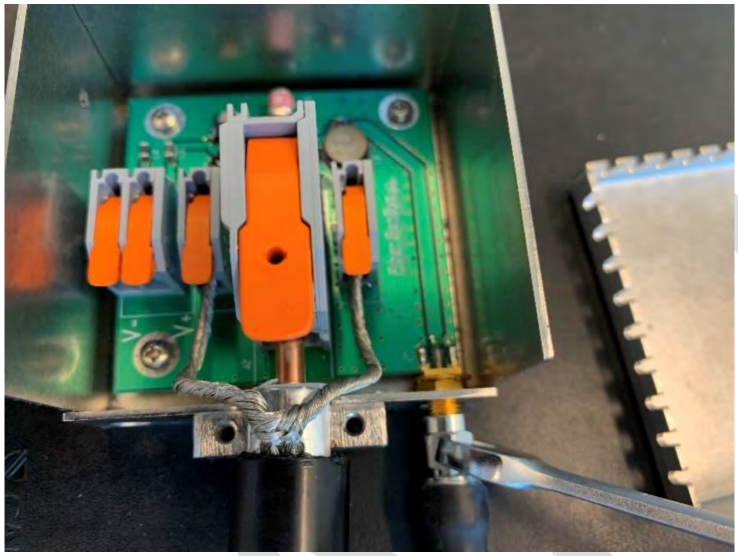
Step 10

Flip up the large orange center connector and the two smaller on each side of center. Place the cable onto the bottom portion of the clamp, while aligning the center conductor into the large connector. Once the center conductor is in place, close the large orange clamp. Arrange that the braid is on the top of the cable. Push the cable and braid until the cable jacket meets the cable clamp. Now with the divided braid already twisted, place one into to the left and one to the right connectors. Make sure that there are no small strands of braid that could contact the center conductor. With all three connectors snapped into place now moderately pull on both braided wires and the center conductor to ensure a solid connection at each.



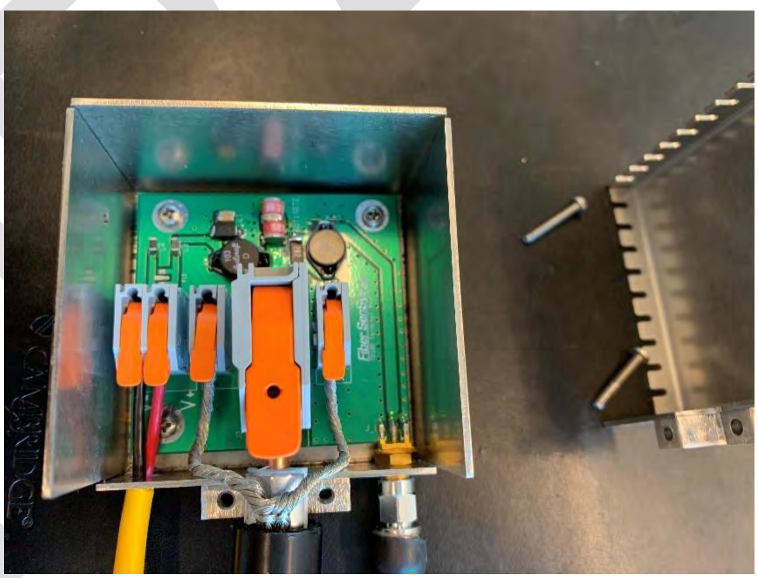


Step 11
Connect lead-In to SMA female onto the board with fingers. These have fine threads so care should be taken when beginning to screw connector on so not to cross thread. Once the connector is finger tight, use the 5/16" wrench, turn until the connector is just snug. Once snug tighten approximately ¼ turn.



Lead-in Cable Connection

Step 12
Connect 48VDC to Terminal Block. Left connector is -VDC, Right +VDC.



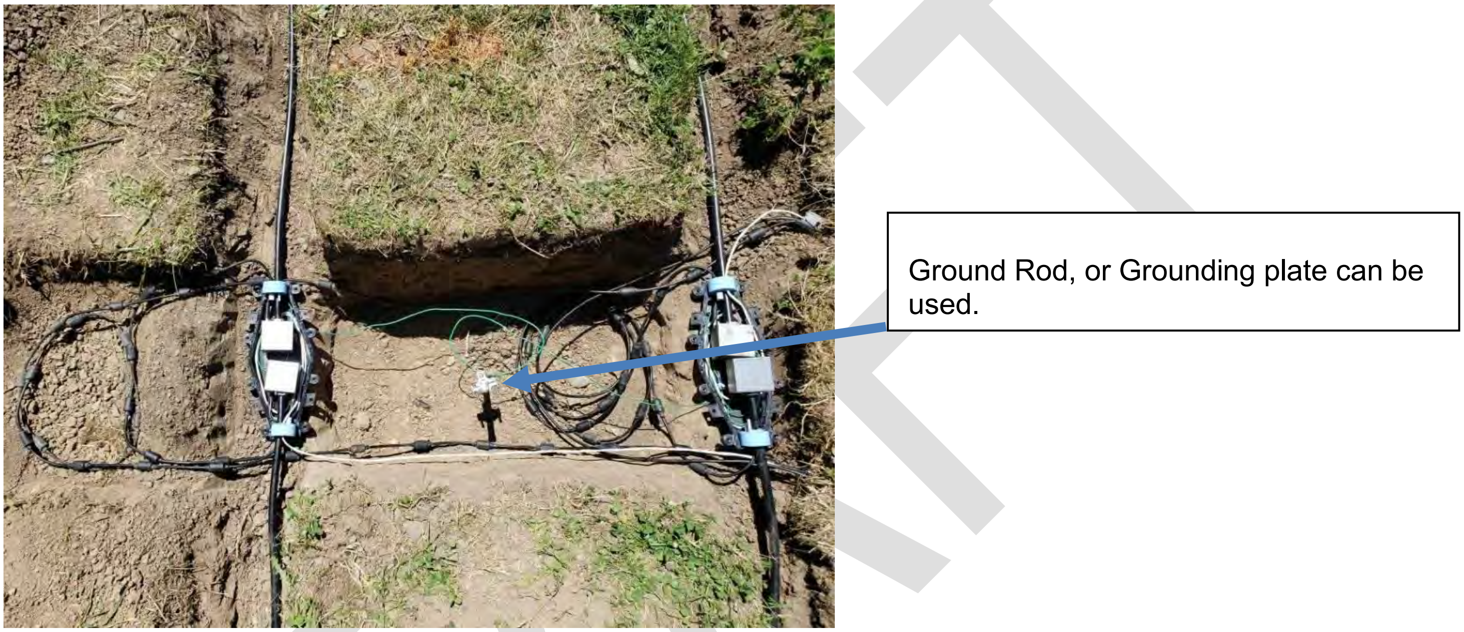
Connect Power

Step 14
Check to make sure that there are no strands of braid wire shorting to the center conductor. Check that the connectors are firmly in place. Ensure the braid wire is on top of the sensor cable.
The terminal block lid has an indent centered on the clamp to accommodate for the braid wire. Carefully place the terminal cover onto the lower enclosure making sure to align the clamp screws. Begin alternating between tightening screws until they are both tight and that there is no gap between the lid and base. The enclosure provides RF shielding of the connection between the cable Lead-In to and from processors and sensor cable.

Step 15
Repeat this process for the other half of the sensor cable (if applies) and repeat from step 1 for the adjacent sensor cable.

6.Grounding

Connect the ground lug on the back of the enclosure to the ground lug on the other shielded enclosure and to the ground lug passing through the bottom of the DME. The ground lugs on the outside of the DME are connected to a ground rod or ground plate buried below the DMEs. In the event of lightning this provides a direct path to ground. Further lightning suppression is provided at the processor.



Glossary of Technical Terms

There are several technical terms that are often used to describe TD-100. These include the following:

SDR – Software Defined Radio. TD-100 is based upon the LimeSDR. The actual SDR integrated circuit includes all the components necessary to provide two transmitters and two receivers that are controlled by software. The SDR integrated circuit is part of the LimeSDR circuit board.

FPGA – Field Programmable Gate Array – An integrated circuit that includes millions of digital logic gates that can be programmed to perform specific functions. The LimeSDR has a Cyclone FPGA which is used to perform the correlator function.

BPSK – Binary Phase Shift Keying – The phase of the RF signal is inverted based on a binary sequence of +1s and -1s. All the RF transmissions are encoded using BPSK including the transmission used to detect intruders and to send messages from one processor to the next over the sensor cables.

PN Coded Pulse – While it is convenient to think of the transmission as a single short burst of RF that propagates down the TX cable and back on the RX cable it is in fact 131,071 bursts that are modulated using BPSK. The sequence of +1/-1s are generated as a Pseudo Noise (*PN*) using a logic shift register. It is called PN because it has all the statistical properties of noise (as though one flipped a coin 131,071 times keeping track of the heads and trails)

Carrier Frequency – The RF frequency about which the transmission is modulated, TD-100 carrier frequency is 31.2 MHz. It is controlled by the LimeSDR.

Transmission Spectrum – When the carrier frequency is modulated by the *PN* code it requires band width. TD-100 produces a sin(x)/x shaped spectrum about the carrier frequency with the first nulls at 31.2 +/-5 MHz.

Chip – The burst of RF that represents a +1 or -1 in the transmission is called a chip. In TD-100 a chip is 200 nanoseconds long – approximately 6 cycles of the carrier frequency

Contra-Directional and Co-Directional Coupling – This refers to the propagation direction of the received signal relative to the direction of the transmitted signal. Contra-Directional coupling provides location information. Co-Directional coupling is used to send messages to the neighboring processor

Correlator – The mixing of the received signal with a replica of the transmitted signal delayed in time. There is a time delayed signal for every Range Bin.

Range Bin – Each tap of the correlator output is referred to as a Range Bin. Each Range Bin corresponds to approximately 12 meters of sensor cable.

C-Bin – Correlated Bin – A C-Bin is the combination of a Range Bin as seen from Side A with is complementary C-Bin from Side B. Each C-Bin corresponds to approximately 6 meters of sensor cable

Complementary Range Bins – two Range Bins that form a C-Bin corresponding to the same location along the sensor cables as seen from Side A and Side B

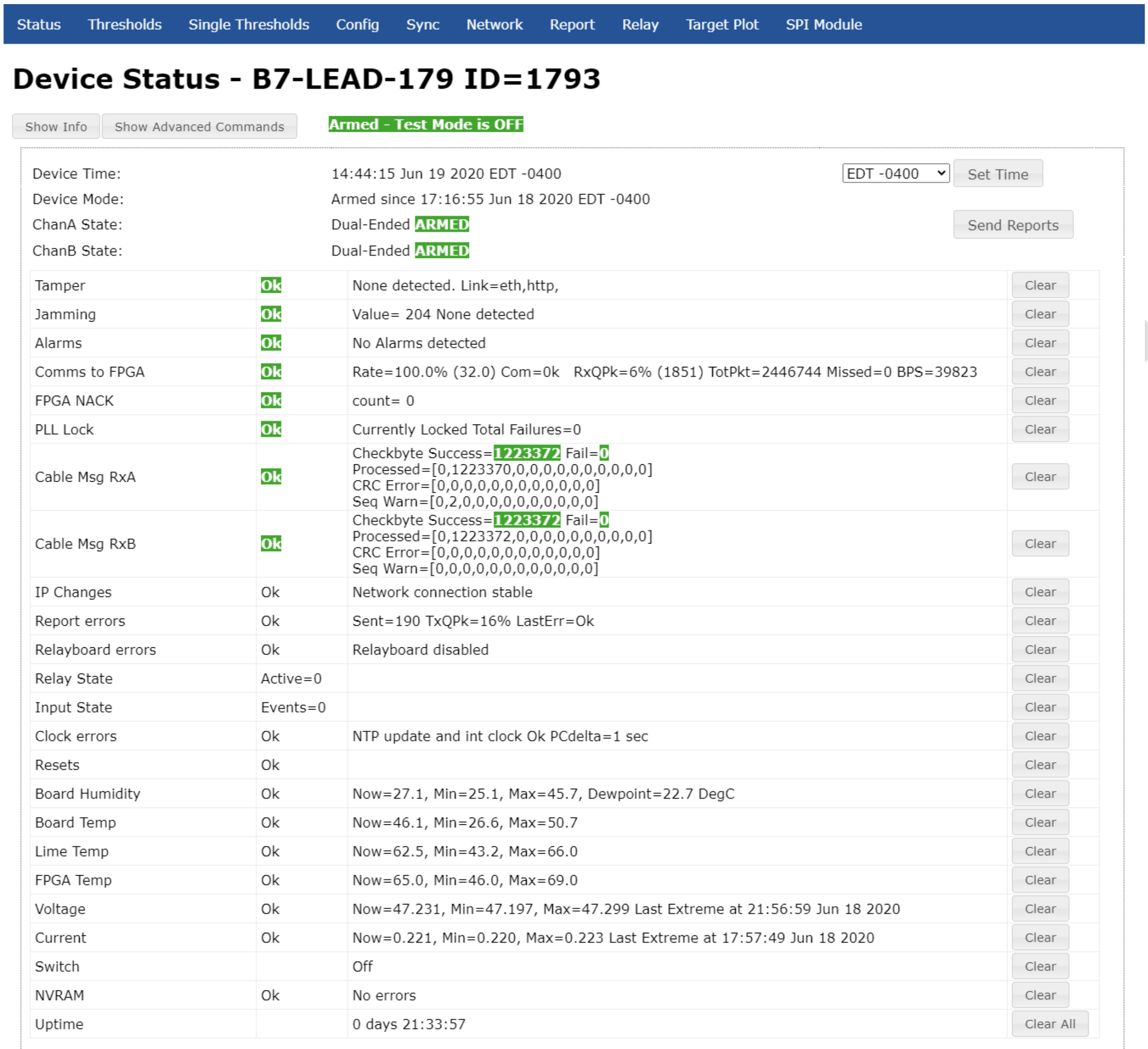
Bisecting Range Bins – If one thinks of Range Bins as a tape measure from the start of Side A at one end of the cables and the start of Side B at the other end of the cables they are described as bisecting when the Range Bin form Side B starts and ends midway between the Range Bins from Side A.

Single Ended – Processing the response to the *PN* coded pulse sent along the TX cable as seen by the receiver on the parallel RX cable. This is based on Contra-Directional coupling.

Double Ended – Processing the responses from processors on both ends of the cables using E2E Correlation

Status Page

The Status page contains an organized, comprehensive summary of processor health.


Status | Thresholds | Single Thresholds | Config | Sync | Network | Report | Relay | Target Plot | SPI Module

Device Status - B7-LEAD-179 ID=1793

Show Info | Show Advanced Commands | Armed - Test Mode is OFF

Device Time:	14:44:15 Jun 19 2020 EDT -0400	EDT -0400 / Set Time
Device Mode:	Armed since 17:16:55 Jun 18 2020 EDT -0400	
ChanA State:	Dual-Ended ARMED	Send Reports
ChanB State:	Dual-Ended ARMED	

Tamper	Ok	None detected. Link=eth,http,	Clear
Jamming	Ok	Value= 204 None detected	Clear
Alarms	Ok	No Alarms detected	Clear
Comms to FPGA	Ok	Rate=100.0% (32.0) Com=0k RxQPk=6% (1851) TotPkt=2446744 Missed=0 BPS=39823	Clear
FPGA NACK	Ok	count= 0	Clear
PLL Lock	Ok	Currently Locked Total Failures=0	Clear
Cable Msg RxA	Ok	Checkbyte Success=1223372 Fail=0 Processed=[0,1223370,0,0,0,0,0,0,0,0,0,0] CRC Error=[0,0,0,0,0,0,0,0,0,0,0,0] Seq Warn=[0,2,0,0,0,0,0,0,0,0,0,0]	Clear
Cable Msg RxB	Ok	Checkbyte Success=1223372 Fail=0 Processed=[0,1223372,0,0,0,0,0,0,0,0,0,0] CRC Error=[0,0,0,0,0,0,0,0,0,0,0,0] Seq Warn=[0,0,0,0,0,0,0,0,0,0,0,0]	Clear
IP Changes	Ok	Network connection stable	Clear
Report errors	Ok	Sent=190 TxQPk=16% LastErr=Ok	Clear
Relayboard errors	Ok	Relayboard disabled	Clear
Relay State	Active=0		Clear
Input State	Events=0		Clear
Clock errors	Ok	NTP update and int clock Ok PCdelta=1 sec	Clear
Resets	Ok		Clear
Board Humidity	Ok	Now=27.1, Min=25.1, Max=45.7, Dewpoint=22.7 DegC	Clear
Board Temp	Ok	Now=46.1, Min=26.6, Max=50.7	Clear
Lime Temp	Ok	Now=62.5, Min=43.2, Max=66.0	Clear
FPGA Temp	Ok	Now=65.0, Min=46.0, Max=69.0	Clear
Voltage	Ok	Now=47.231, Min=47.197, Max=47.299 Last Extreme at 21:56:59 Jun 18 2020	Clear
Current	Ok	Now=0.221, Min=0.220, Max=0.223 Last Extreme at 17:57:49 Jun 18 2020	Clear
Switch		Off	Clear
NVRAM	Ok	No errors	Clear
Uptime		0 days 21:33:57	Clear All

Each row's errors and counters can be cleared individually by clicking the Clear button. All rows can be cleared simultaneously by clicking the Clear All button.

Device Time: Time can be automatically fetched from TD100 Access Module, or from the PC that is browsing the Status Page. To set the processor's time from the PC, select the time zone from the pull-down menu and click "Set Time".

Send Reports: This button will instruct the processor to generate and send all reports to the Access Module.

Device Mode: Displays the last state of the processor and the time when it changed.

ChanA State, ChanB State: Displays the status of each channel of the processor.

Tamper: The colored indicator reports the present status of the tamper switch. The adjacent text shows what physical connections are active on the processor.

eth	A computer is connected via Ethernet
http	A computer is using the web interface
uart	A computer is actively using the UART DEBUG port
tcp1	A computer is actively using the TCP1 DEBUG port

Jamming: Displays the present signal level of the jam detector as well as the cumulative count of occurrences where the detector signal exceeds the threshold. The detector's threshold is set on the Config page. The jam counter runs 16 times a second. The count is latched until a user clears the counter.

Alarms: Displays a count of occurrences where an alarm was declared at any point in the cable. The count is latched until a user clears the counter.

Comms to FPGA: Displays detailed information about the UART connection between the mainboard and the LimeSDR. The display will also count UART hardware failures such as framing.

FPGA Nack: Displays a count of occurrences where the mainboard sent incorrect UART messages to the LimeSDR.

PLL lock: Displays the count of occurrences where the LimeSDR detects a loss of lock to the sync signal. A timestamp of the last occurrence will be displayed.

Cable Msg RxA, Cable Msg RxB: Displays the status of messaging over the sensor cable for that channel. Cable messages are 4800 bytes with checksum. Each processor uses a dedicated subsection set by Processor Position on the Config page. These subsection messages also contain a checksum.

Checkbyte Success	Count of occurrences where entire cable message passes checksum
Fail	Count of occurrences where entire cable message fails checksum
Processed	Count of occurrences where processor subsection message is processed OK
CRC Error	Count of occurrences where processor subsection message fails checksum

Seq Warn	Count of occurrences where processor misses subsection message

IP Changes: Displays a count where the processor's IP address has changed. Can be used to detect ethernet cabling faults when using DCHP.

Report Errors: If Reporting to Access Module is enabled, this field displays the count of reports sent, the peak usage of the report queue, and cause of the latest error. If no errors have occurred since the row was cleared, LastErr will state "OK".

Relayboard Errors: If a relay board is installed in the processor, this row will show any errors with the RS485 comms to it.

Relay State: Displays whether any relay is presently activated. Non-latching.

Input State: Displays whether an input channel's voltage is out of the range configured on the Relay page.

Clock Errors: Displays any time difference between the internal clock of the processor and the PC connected to it.

Resets: Shows separate cumulative counts of brownouts, power outs, hard resets and soft resets.

Board Humidity: Shows present, minimum, and maximum relative humidity since last clearing. Show present dewpoint.

Board Temp: Shows present, minimum, and maximum temperature of the processor enclosure.

Lime Temp: Shows present, minimum, and maximum temperature of the LimeSDR.

FPGA Temp: Shows present, minimum, and maximum temperature of the FPGA.

Voltage: Shows present, minimum, and maximum temperature of the voltage measured at the processor power connector. When a new minimum or maximum is measured, the time of discovery will be displayed.

Current: Shows present, minimum, and maximum temperature of the current measured at the processor power connector. When a new minimum or maximum is measured, the time of discovery will be displayed.

Switch: Shows whether the TEST button on the main board is pressed.

NVRAM: Displays any errors when NVRAM is accessed.

Uptime: Displays the cumulative time since last power up.

<u>Show Info & Show Advanced Sections</u>

Clicking on the Show Info button will expand the Info section above the main status table. Clicking the Show Advanced button exposes extra controls below the ChanB State display.

ID: Displays the processor ID, Site ID and Position ID set in the Config page.

Hostname: Displays the hostname set on the Network page.

MAC: Displays the MAC address of the processor's Ethernet controller.

Model: Displays the processor model set in the Config page.

SW Version: Displays the firmware's version.

TCP Stack Version: Displays the firmware's TCP stack version.

Build Date: Displays the firmware build date.

LimeSuite Version: Displays the LimeSDR's driver version.

FPGA Version: Displays the FPGA's firmware version.

Reboot: Reboots processor without confirmation.

Bootloader: Reboots processor into Bootloader mode.

Toggle FPGA LED: Toggles the red LED of LED1 on LimeSDR.

Test Alarm: Sends a short test alarm to the Access Module at the location specified in the text input box.

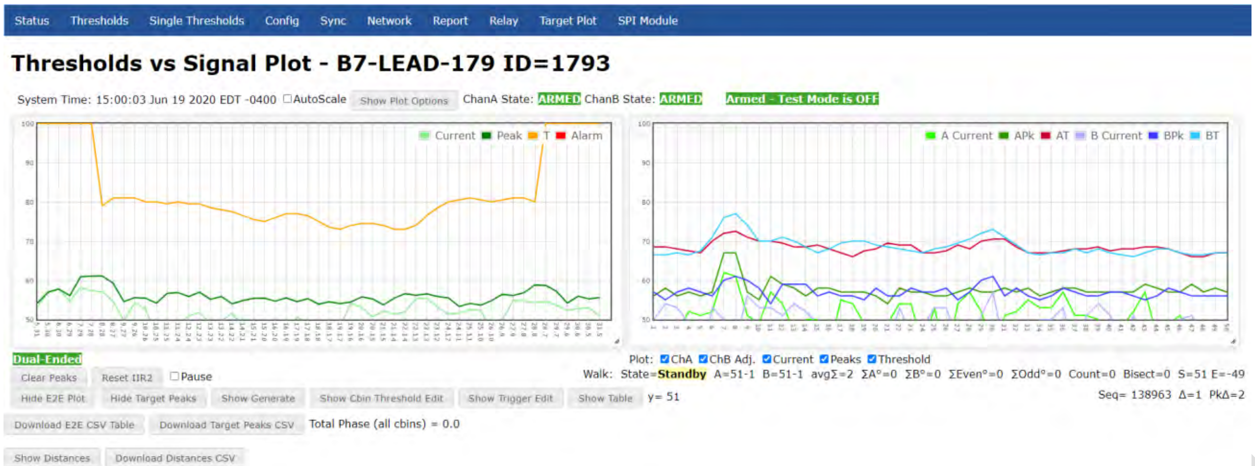
Test Tamper: Sends a short tamper alarm to the Access Module.

TestDataOn: Swaps sensor cable data for test signal data.

TestDataOff: Restores data source back to sensor cable.

Upload new webpages

Thresholds Page



The thresholds page contains controls to:

- Set the alarm thresholds,
- Set the alarm triggering criteria,
- Determine the interleaving of single-ended bins for dual-ended detection,
- Determine the transmitter gain setting to stay under FCC limits.

This page is only used for channel A dual-ended cable layout. If ChanA State is not staying ARMED, then there is a problem with communications between the two processors which must be corrected.

Plotting settings are above the charts. Autoscale sets the vertical scale to encompass the smallest and largest values in the plots. Clicking on Show Plot Options exposes more plotting controls above the charts:

The Bars, Lines and Lines+steps buttons change the style of each series in both charts.

When Autoscale is deselected, Bottom Y dB sets the minimum value of the vertical scale. The maximum vertical scale value is offset from the minimum value by the amount specified in Y Range dB.

Clear peaks resets the peak traces of both charts.

Reset IIR2 will reset the target filters.

Hide E2E plot will remove the left chart from view and expand the right chart horizontally to fill the space.

Hide Target peaks will remove the right chart from view and expand the left chart horizontally to fill the space.

The Pause checkbox will stop updates to the plots. Changes in settings while paused will still be communicated to the processor.

Show Generate will expose the controls and instructions for profiling the cable.

Generate Thresholds

The purpose of the following steps is to identify the start and end of the cable as well as to adjust the signal timing and thresholds to achieve the best SNR performance.

1. Click on [Clear Peaks] and wait at least 10 seconds to capture the noise floor.
2. Click on [Generate From Noise] to set a threshold about 10 dB above the noise floor. Adjust the level if needed using the controls in step 7.
3. Click on [Save Generated Dual for Walk] to set the thresholds for the walk and click on [Clear Generated] to clear the curve from the plot.
4. Set blanking seconds to 0 (it is already 0 so no action required).
5. Click on [Begin Walk] to restart the process for calculating the start, end and bisect settings.
6. Perform a walk along the entire length of cable.
7. Click on [Generate From Ref Walk] to generate a new threshold curve 10 dB below the peaks for the reference walk.
8. Optionally, adjust all generated thresholds up or down using the buttons below and shift the curve left or right using the ← and → buttons. Only the generated thresholds for the plotted channel(s) will be modified.
   Adjust all generated Thresholds by [+0.5db] [+1db] [+5db] [-0.5db] [-1db] [-5db] [←] [→]
9. Click on [Apply Walk Range] to set the start and end bins and bisecting adjustment for dual-ended signal processing on channel A.
10. Click on [Save Generated Dual for E2E] to save for dual-ended signal processing on channel A.
11. Click on [Generate Single A and Badj Thresholds] to generate Single A thresholds from the current Cbin thresholds.
12. Click on [Save Single A and Badj Thresholds] to save the generated thresholds for Single A and Badj. Note: Subsequent adjustment of Single A thresholds is done on the Single Thresholds page of this processor and on the adjacent processor for Badj.
13. Click on [Clear Generated] to clean up the plot since the curve is no longer needed.
14. Restore blanking sections to the setting required for the site. Typically 5 seconds.
15. Finally, adjust the saved Cbin thresholds under the Threshold Edit section or using adjustment controls in the table.

After Begin Walk is clicked, the real-time results of the profiling are shown below the Target Peaks chart.

Walk: State=**Standby** A=51-1 B=51-1 avgΣ=2 ΣA°=0 ΣB°=0 ΣEven°=0 ΣOdd°=0 Count=0 Bisect=0 S=51 E=-49

The recommended gain setting is displayed next to the Download CSV buttons.

Show Cbin Threshold Edit exposes the controls for lowering or raising the entire set of C-bin thresholds.

Adjust All Cbin Thresholds

Adjust Thresholds for all Cbins by [+0.5db] [+1db] [+5db] [-0.5db] [-1db] [-5db] [Flatten Outer Bins]

Show Trigger Edit exposes the controls for setting the dual-ended alarm triggering parameters.

Adjust Trigger Parameters

Trigger parmeters affect how alarms are detected and reported

Compression	8	The number of samples to compress before reporting the alarm to the headend. With a sample rate of 16, a value of 8 is 1/2 second which is a good compromise between compression and alarm report delay. Default is 8
Max Mps	25	The maximum speed in meters per second for tracking. When faster than this speed, targets are treated as individual targets and may be filtered out by their short duration. Default is 25.
Phase	90	The max degrees that one sample can deviate from the last in terms of conjugate phase to be considered a possible target. Default is 90
Blanking Sec.	0	The number of seconds to wait before allowing another alarm on a bin - set to 0 to disable. Default is 5.
Alarm Window %	40	The percentage of the alarm window that must be in alarm for an alarm to be declared. Lower the value to allow shorter events and increase to filter out short duration events. Default is 80 for a window of 24.
Alarm Window Len	12	The number of samples over which the alarm window % is measured. Combined with the window percentage, it defines how many actual samples are required for a trigger. Note that the window size with window percentage can impact the delay in reporting an alarm. Default is 24 for a percentage of 80.
Hysteresis	0	The number of samples in a window for which there must be no alarm to constitute the end of an alarm. Set to 0 to disable. Default is 0 and currently it is not editable.
Display Latch	2	The number of seconds for which to display an alarm on this page. The value resets to 2 when the page is loaded.

Show Table exposes a table containing the data in the E2E plot, as well as controls for editing individual C-bin thresholds.

CBin	Min	Max	Alarm count	Event Phase	Total alarms	Total Phase	Dist m	Peak	Threshold	Adjust Up	Adjust Down	Deselect
5.31	43.02	49.93						57.62	100	+0.5dB +1dB +5dB	-0.5dB -1dB -5dB	☐
5.30	47.71	51.66						58.46	100	+0.5dB +1dB +5dB	-0.5dB -1dB -5dB	☐
6.30	47.46	55.03						57.74	100	+0.5dB +1dB +5dB	-0.5dB -1dB -5dB	☐
6.29	50.87	55.35						58.25	100	+0.5dB +1dB +5dB	-0.5dB -1dB -5dB	☐
7.29	54.18	55.3						60.89	100	+0.5dB +1dB +5dB	-0.5dB -1dB -5dB	☐
7.28	49.2	52.38						61.47	100	+0.5dB +1dB +5dB	-0.5dB -1dB -5dB	☐
8.28	44.11	50.69						61.1	79	+0.5dB +1dB +5dB	-0.5dB -1dB -5dB	☐
8.27	47.01	49.58						59.24	81	+0.5dB +1dB +5dB	-0.5dB -1dB -5dB	☐
9.27	40.4	51.21						56.98	81	+0.5dB +1dB +5dB	-0.5dB -1dB -5dB	☐
9.26	37.43	47.81						58.44	81	+0.5dB +1dB +5dB	-0.5dB -1dB -5dB	☐
10.26	37.22	48.17						57.32	80	+0.5dB +1dB +5dB	-0.5dB -1dB -5dB	☐
10.25	39.8	45.12						57.2	80	+0.5dB +1dB +5dB	-0.5dB -1dB -5dB	☐

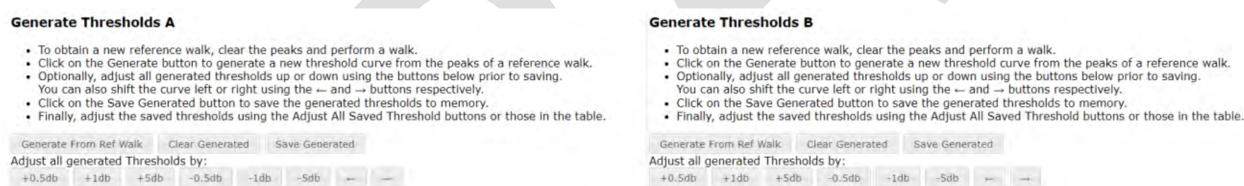
C-bin thresholds can be edited in groups by clicking the check box next to each part of the group, then clicking on any of the adjust buttons of the group.

Download E2E CSV Table and Download Target Peaks CSV will export the values of all traces in the respective charts to CSV format.

Single Thresholds Page

The Single Thresholds page is used to configure the alarm thresholds and alarm triggering settings for any channel whose layout is single-ended.

This page is similar to the Dual-Ended Thresholds page with the exception of Show Generate interface. Controls for both channels are displayed simultaneously. Clicking on Show Generate will expose the threshold generation interface.



Much like profiling for dual-ended detection, the peaks should be cleared before doing the walk.

When the walk is finished, clicking the Generate from Walk button will generate a set of thresholds below the peak as a magenta trace. The entire set can be adjusted up or down before saving.

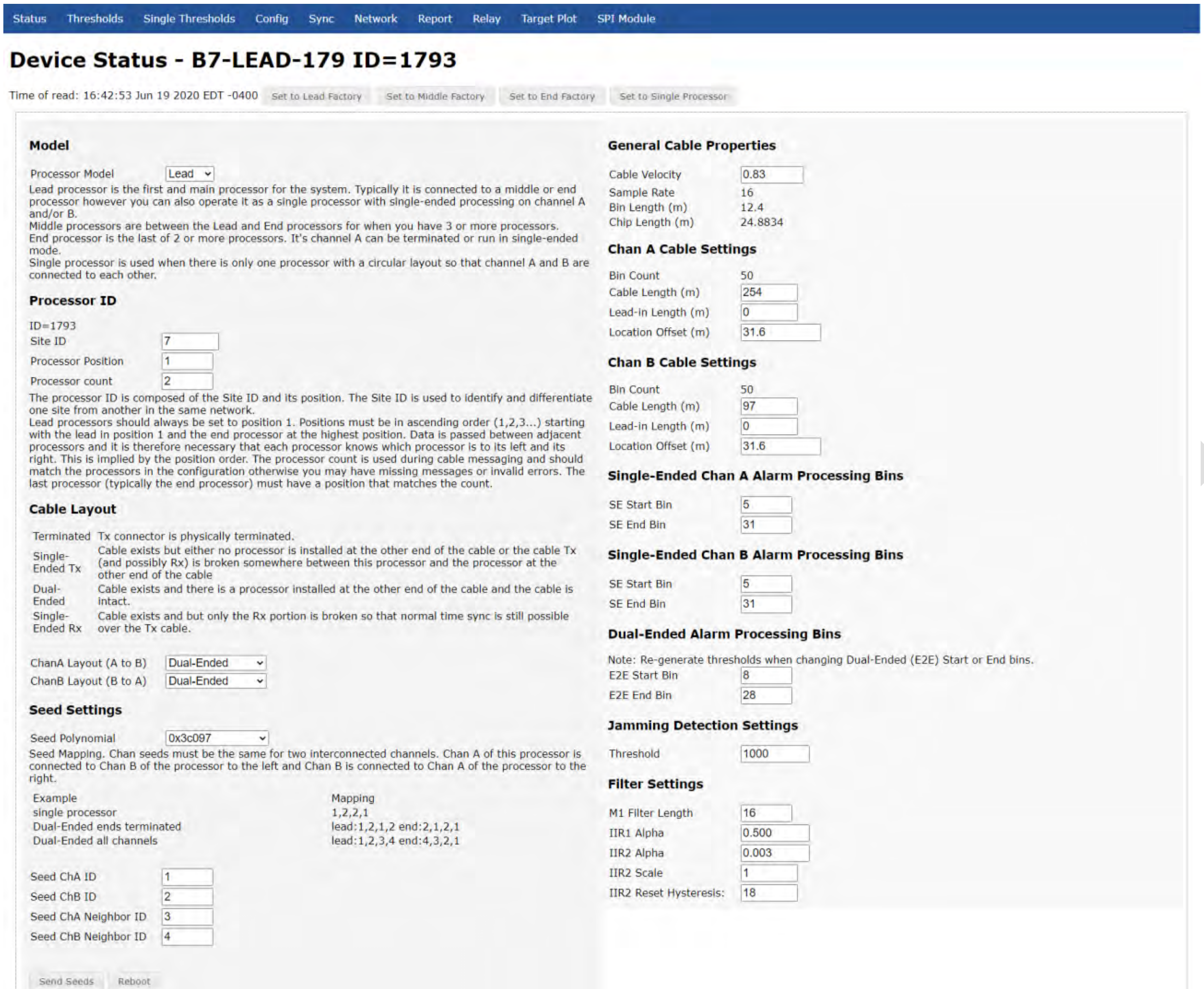
Individual thresholds can be edited by clicking the Show Table button.

Bin	Min	Max	Alarm count	Event Phase	Total alarms	Total Phase	Dist m	Peak	Threshold	Adjust Up	Adjust Down	Deselect
3	44.65	52.67						58.63	66.5	+0.5dB +1dB +5dB	-0.5dB -1dB -5dB	☐
4	46.64	52						61.5	66.5	+0.5dB +1dB +5dB	-0.5dB -1dB -5dB	☐
5	43.53	51.12						59.38	68	+0.5dB +1dB +5dB	-0.5dB -1dB -5dB	☐
6	51.01	54.07						61.65	74.5	+0.5dB +1dB +5dB	-0.5dB -1dB -5dB	☐

Bin	Min	Max	Alarm count	Event Phase	Total alarms	Total Phase	Dist m	Peak	Threshold	Adjust Up	Adjust Down	Deselect
3	40.3	52.91						58.86	70	+0.5dB +1dB +5dB	-0.5dB -1dB -5dB	☐
4	53.49	56.59						58.34	70	+0.5dB +1dB +5dB	-0.5dB -1dB -5dB	☐
5	41.72	47.67						59.24	70	+0.5dB +1dB +5dB	-0.5dB -1dB -5dB	☐
6	49.89	53.38						60.35	70	+0.5dB +1dB +5dB	-0.5dB -1dB -5dB	☐

Thresholds can be edited in groups by clicking the check box next to each part of the group, then clicking on the adjust buttons.

Config Page



Set Factory Buttons

Sets all fields to defaults while assigning a processor model depending on which of the four buttons is pressed.

Model

The Processor Model determines many automatic processor behaviors including whether a processor communicates to an external system over Ethernet. There are four types of processor: “Lead, Middle, End, and Single. A multi-processor system must have at least one Lead and one End, while a single-processor system must be set to Single.

These, in combination with Cable Layout settings, will determine how the processor starts up, and selects automatic processes related to synchronization and messaging over the sensor cable.

Processor ID

These settings are used by the processor's messaging systems to ensure correct routing between processors and the Access Module. Site ID is used to identify a group of processors on perimeters that share the same IP network. A Processor Position number is assigned to each processor by the installer and must adhere to the following:

- Each processor must have a unique Position value
- Lead processors must have a Processor Position of 1
- Each subsequent Middle Processor must be assigned incremental position numbers.
- End processors must have the same Processor Position value as the Processor count.

These settings are used to assign a processor a unique ID. The ID is calculated by the following formula:

ID = Site ID * 256 + Processor Position

Cable Layout

The Processor Model and the Cable Layout determine what each processor does on startup, what automatic processes are enabled during run time. Detection mode is also controlled here. Selecting a layout that is different than what is actually installed may prevent proper startup and run time behavior.

Seed Settings

The Seed Polynomial and Seed ID determine the pattern that the processor uses for broadcast and reception on a channel. It is advised that each channel on every processor on a perimeter use the same Seed Polynomial but a separate Seed ID.

Seed ChA Neighbor ID and Seed ChB Neighbor ID select the seed that is used to decode transmissions coming from a neighboring processor connected to that channel.

For example, if a Lead processor's Seed ChA ID is 5, then the partner processor at the other end of the cable should have its Seed ChB Neighbor ID set to 5. If the partner processor has a Seed ChB ID of 9, then the Lead processor's Seed ChA Neighbor ID must be 9.

General Cable Properties

The Cable Velocity control is used in the calculation of location for a target. If the location reported at the beginning of the sensor cable is correct, but the reported location at the far end of the cable differs greatly from the measured length, then the velocity can be adjusted to fine-tune the location calculation. An increase in this setting will increase the reported length of the cable while a decrease will decrease the reported length.

Chan A and Chan B Cable Settings

Cable Length (m) is not used for target location reporting.

Lead-in Length (m) is used by the processor to automatically exclude bins from the beginning of the correlator.

Location Offset (m) sets the amount of distance to subtract from the target's reported location.

Single-Ended Chan A and Chan B Alarm Processing Bins

SE Start Bin and SE End Bin set the specific area of the cable to detect on.

Dual-Ended Alarm Processing Bins

E2E Start Bin and E2E End Bin select which bins to interleave for Dual-Ended mode. They are determined by profiling the cable.

Jamming Detection Settings

The threshold is determined by observing the jamming signal level on the Target Plot page.

Filter Settings

These settings determine the range of speeds of targets to detect.

M1 Filter Length sets upper limit of target speeds to detect.

IIR1 Alpha fine tunes the upper end of the speed range, while IIR2 Alpha fine tunes the lower end.

IIR2 Reset Hysteresis controls the amount of time a target needs to be below threshold before triggering a filter reset.

Sync Page

The Sync page shows a detailed view of the inner workings of a processor.

Charts 1 through 4 show the clutter for Co A, Co B, Contra A, and Contra B. Vertical units are linear signal. Horizontal units are bin number.

Charts 5 and 7 show the RSSI during the Co time slot. Mainly used to troubleshoot time sync. Vertical units are linear signal. Horizontal units are time at 1/16 second.

Charts 6 and 8 show the angle of the peak co-bin. Used to troubleshoot sensor cable messaging. Vertical and horizontal units are linear signal.

Clicking on the + button next to the charts exposes the Plot settings of the four bar charts.

Autoscale checkbox only applies to the four bar charts.

When Autoscale is deselected, the Y Scale control sets the upper end of the vertical scale according to the following table:

Y Scale Value	Upper Scale	Y Scale Value	Upper Scale
0	1000	10	2M
1	2000	11	5M
2	5000	12	10M
3	10000	13	20M
4	20000	14	50M
5	50000	15	100M
6	100000	16	200M
7	200000	17	500M
8	500000	18	1000M
9	1M		

The Pause Updates checkbox will halt the updating of all charts. Changes in settings will be communicated to the processor but the effects will not be seen.

The Contra correlator pulldown menu selects which filter output to display on charts 3 and 4. Values in the M1 set will contain clutter and target, while the IIR2 set will only contain clutter.

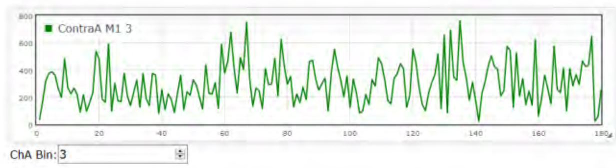
When the mouse pointer is over a chart, the text display between the Contra pulldown menu and the Show MPlots button shows scaled vertical and horizontal values of a chart at the tip of the mouse pointer.

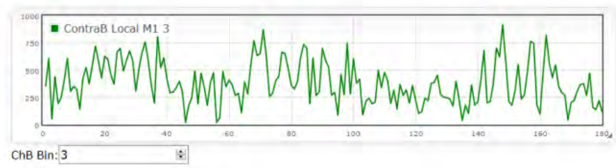
When the mouse pointer is over the correlator charts (1 through 4), a horizonal red line will be drawn across the chart through the tip of the pointer. The display will show the signal level for the line, followed by the bin number at the tip of the pointer.

When the pointer is over charts 5 and 7, only the signal value will be displayed.

When the pointer is over charts 6 and 8, the display will show the vertical and horizontal signal levels.

Clicking Show MPlots replaces charts 5 through 8 with two time plots:





These plots show the output of the M1 or IIR2 Filters of the bin selected in ChA Bin or ChB Bin.

ChA Fbin: Displays the estimated fractional bin value of the Co-A peak.

Download M1 Contra: Saves the signal levels of all 50 bins of charts 3 and 4, as well as the 50 bins of contra signal received from the partner processor. (If there is no partner, this data will be invalid.)
Source: Selects whether to display channel B contra data from the current processor, or the partner processor. (If present and communicating properly.)

Below charts 5 and 7 are the power controls for each channel's transmitter. Clicking the indicator text next to Tx toggles the main power to the chip's amplifier while clicking the indicator text next to Power toggles the muting of the amplifier.

These controls affect dual-ended installations. When a transmitter's main power is turned off, the partner processor will see a large increase in clutter due to a change in impedance match. Using muting does not result in as large of a change.

The State display shows the current state of that channel's startup routine for diagnostic purposes.

Rx Check and Fail shows the count of consecutive pass and fails of the sensor cable messages received for that channel. Rx Check counter resets every time a failure occurs.

The PLL display shows whether the processor is locked to the 10 MHz sync signal.

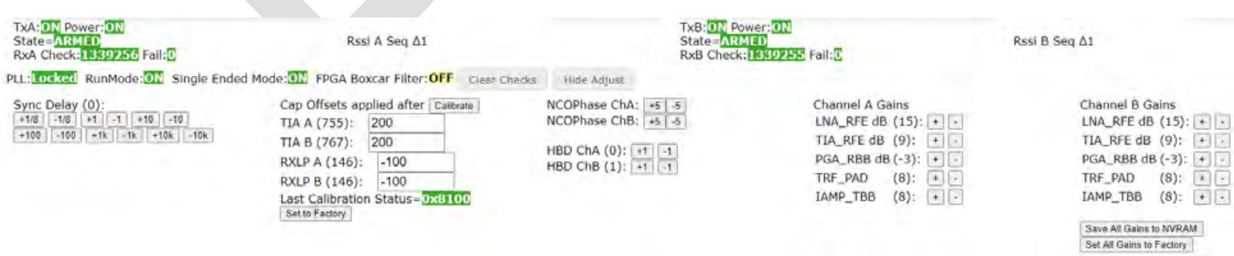
RunMode shows whether the processor has RunMode set.

Single Ended Mode controls whether the Contra correlator acquires 25 whole bins or 50 half bins of response.

FPGA Boxcar Filter controls whether the contra correlator data is averaged in the FPGA.

Clear Checks: Resets the Rx Check and Fail counters for both channels.

Show Adjust: Exposes the controls for manually adjusting time sync, RX filter settings, RX phase offset, RX sample delay, as well as TX and RX gain controls.



Sync Delay buttons are used to manually advance or decrease timing between when the Lead processor starts a process cycle and when the Middle or End processor does.

Cap offsets are used to fine tune the RX filter response after calibration. The value is added to the existing setting after calibration. The calibrated setting plus the offset is displayed in brackets. This is used to optimize the receive filter response. Clicking Set to Factory will reset the values to 200, 200, -100, -100.

NCO Phase controls the amount of phase in degrees to rotate the channel's receiver data. The phase will automatically wrap around at 0 or 360 degrees.

HBD controls the delay between a channel's transmission and reception by 1/ 2 nd of a chip (or 6.25 ns). Hard limit at 0 and 4.

Channel Gains:

Controls the attenuation of each of the amplifiers for both transmit and receive. Only TRF_PAD needs to be adjusted for FCC and sensitivity purposes. The present setting is displayed in brackets. Clicking + will increase attenuation. When setting is 0 to 10, the transmit power changes by 1 dB. When the setting is 11 or greater, the power changes by 2 dB.

Settings are not saved automatically. Clicking Save All Gains to NVRAM will store them.

Clicking Set All Gains to Factory will set the gains to 15, 9, -3, 8, and 8 for both channels. Settings are not saved automatically.

The Auto Update checkbox controls whether the website will overwrite your settings with the setting that the processor confirms it has set. The page is designed to avoid requiring the user to manually submit updated settings to the processor while ensuring that the values displayed are the actual ones the processor is using. The website checks whether the user has made any changes within a time interval before sending the setting to the processor and overwriting the web interface with the value that the processor confirms.

If the Auto Update checkbox is cleared, the user does not have confirmation of what setting the processor is actually using.

Autostart pulldown menu sets the startup and runtime behavior of a processor.

Disabled	Processor pauses after the calibration step.
Start	Processor runs after calibration. Does not perform further startup steps.
Start and Sync	Processor runs and performs all startup steps.
Start and Sync Paused	Processor runs but stops where it is at in the startup routine.

Bisect pulldown menu controls how the processor determines and applies the bisect offset. Presently the bisect offset is determined during cable profiling and is not expected to change.

No Bisect	Does not apply an offset to ChA Timeslot Seq Contra Corr.
Manual Bisect	Applies the offset to ChA Timeslot Seq Contra Corr specified by Manual Bisect Offset control.
Run Once at Start	Tries to calculate bisect offset based on the bin number of the co-directional peaks for each processor.
Run Periodically	Recalculates bisect offset and applies it periodically.

Manual Bisect Offset: This value sets the additional eights to add to the ChA Timeslot Seq Contra Corr to fine tune the dual-ended interleaving. Value is determined during cable profiling. Can be negative.

Run Bisect: Clicking this button will perform the bisect action chosen from the Bisect pulldown menu.

Re-load Lime: Clicking this button will reset the FPGA, re-load the LimeSDR configuration, recalibrate the LimeSDR RF and restart the Autostart process.

Reboot: Reboots the processor without confirmation.

RestartLGR: Resets the TD100 portion of the FPGA.

ResetLogicReg: Resets the digital portion of the LMS7002M.

Force Arm: Forces the processor to armed state.

Set 80 MHz sampling rate: Sets the sample rate of the LMS7002M to 80 MHz. The rest of the processing chain is unaffected.

Set Default sampling rate: Sets the sample rate of the LMS7002M to 160 MHz. The rest of the processing chain is unaffected.

Runtime FPGA Settings

RF Switch Control

Xor msg/lfsr: When Yes, the processor will encode the sensor cable message with the same sequence that is used for detection.
Msg-pos_offset: This controls the amount of time after the detection broadcast is finished before the receiver is connected to the TX cable. Units are 50 nanoseconds.
Det-pos_offset: The controls the amount of time after the cable message broadcast is finished before the receiver is switched back to the RX cable. Units are 50 nanoseconds.
Quad Phase: When enabled, the phase of the transmitter and receiver will be rotated 90 degrees every broadcast.

RF ChA and ChB Switch

Enable: When Yes, the receiver RF switch will be driven according to the rest of the settings.

Auto-manual: When Auto, the receiver RF switch will automatically drive the switch based on the Start @pn, Msg-pos_offset and Det-pos_offset settings. When Manual, the receiver RF switch is set to the position selected in Position pulldown menu.

Start @pn: When Yes, the Msg-pos_offset counter will start when the detection broadcast starts. When No, the counter will start when the message broadcast starts.

Position: Selects which cable to connect the receiver to. Detection is the RX cable, Message is the TX cable. This setting is ignored if Auto-manual is set to Auto.

DC Offset Sub ChA and ChB

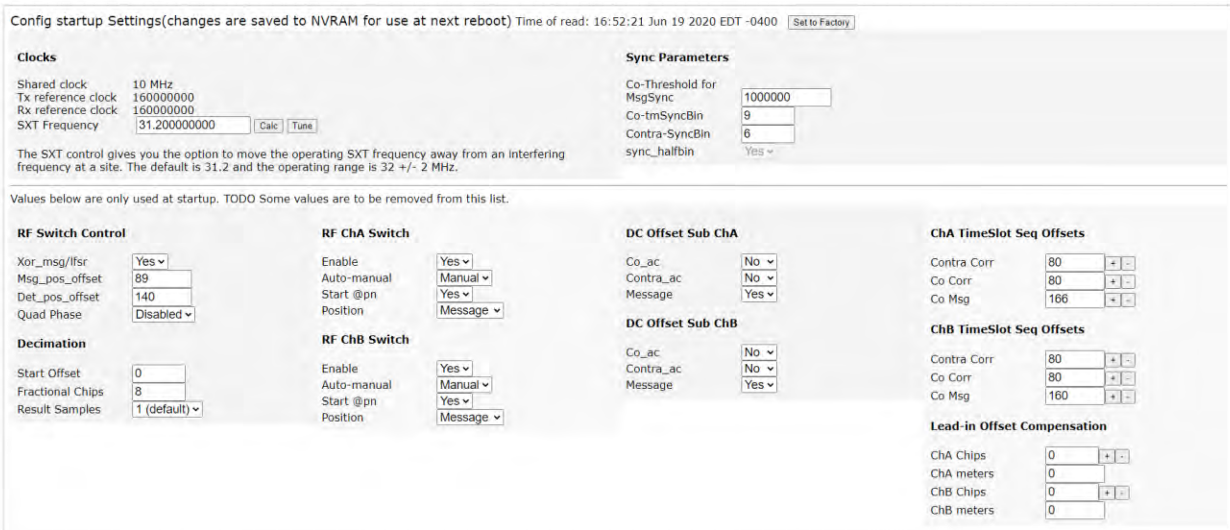
The DC offset of a receiver is determined by averaging the detection portion of the received signal. This offset is stored, and can be subtracted off the next received signal of the correlators and/or the cable message by selecting Yes or No from their pulldown menus.

ChA and ChB Timeslot Seq Offsets

Contra Corr sets the time delay from when the channel’s transmitter begins broadcasting and when the same channel’s correlator begins. Units are 50 nanoseconds.
Co Corr sets the time delay from when the channel’s transmitter begins broadcasting and when the opposite channel’s correlator begins. Units are 50 nanoseconds.
Co Msg sets the time delay from when the opposite channel’s correlator ends and when the message decoder starts. Units are 50 nanoseconds.

Config Startup Settings

Clicking on the Show Config Startup Settings button will expose the settings that are stored in NVRAM. The top portion’s controls are used during run time.



Clicking on Set to Factory resets the bottom portion to factory defaults.

SXT Frequency: Sets the carrier frequency used by the processor. Units are MHz. If interference from another installation is suspected, changing the frequency by a few Hz may resolve the problem.

Co-Threshold for MsgSync: Sets the threshold of the message decoder's low signal indicator.

Co-tmSyncBin: Sets the bin number of the Co-B correlator to synchronize the processor to.

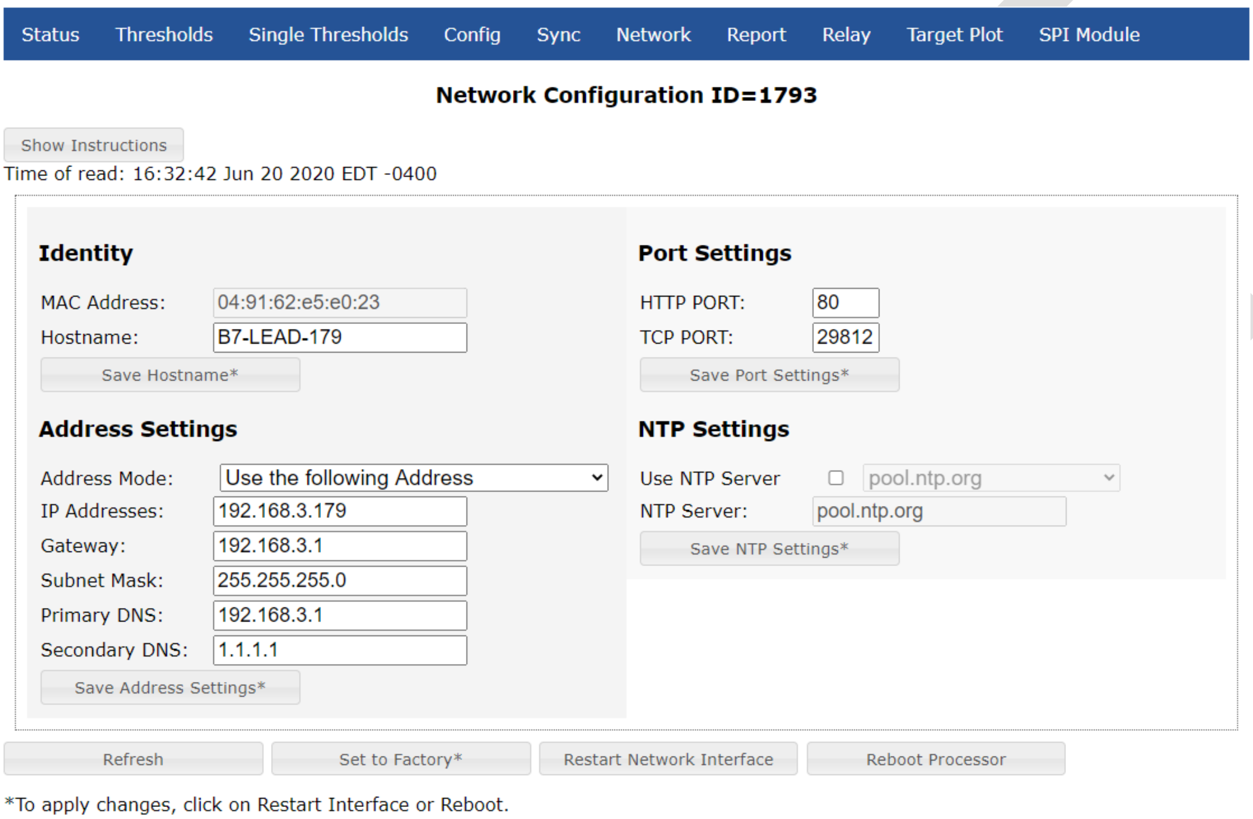
Contra-SyncBin: Sets the bin number of the Contra correlators during self-cal.

The remainder of this set of controls are a mirror of the Runtime settings. These settings are only applied during startup.

Network Configuration

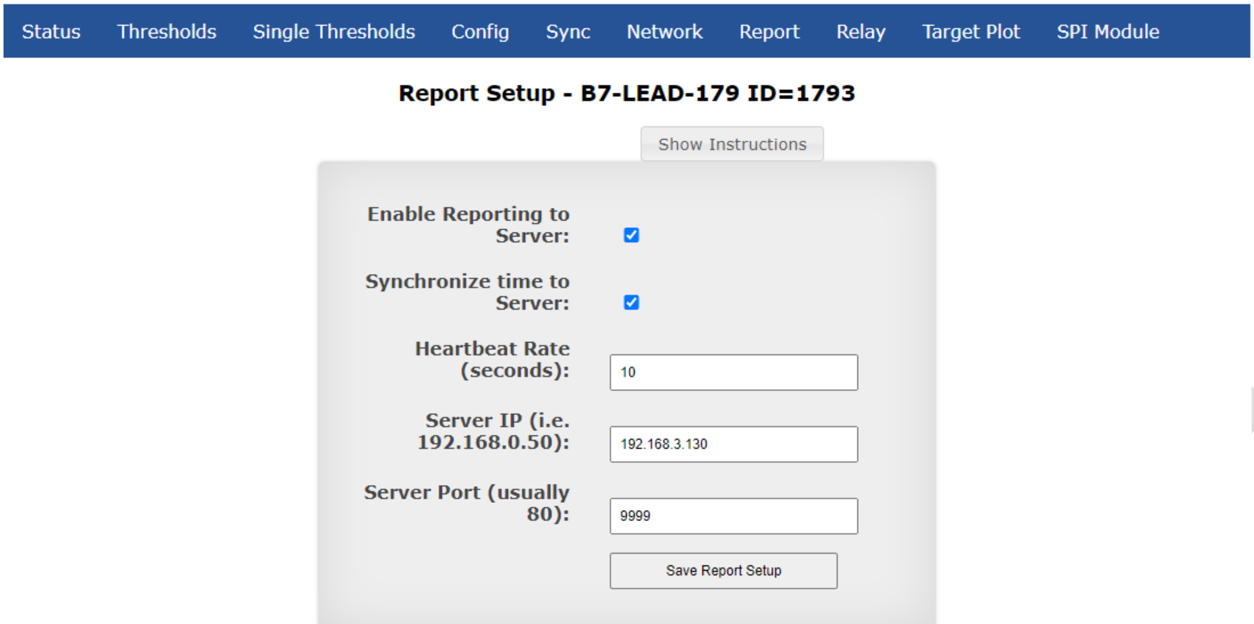
The Network Configuration page provides a familiar interface to set the Hostname, IP address, server ports, as well as internet time server settings.

Clicking on Show Instructions provides a detailed description of each control.



Report Setup

The Report Setup page allows the user to set up communication to the TD100 Access Module.



Enable Reporting to Server: Select whether or not to send reports to the Access Module. If reporting is enabled, the Status page will display any errors related to report uploads.

Synchronize time to Server: Specifies whether the processor will get its system time from the Access Module. This system time is shared amongst all processors via sensor cable messaging.

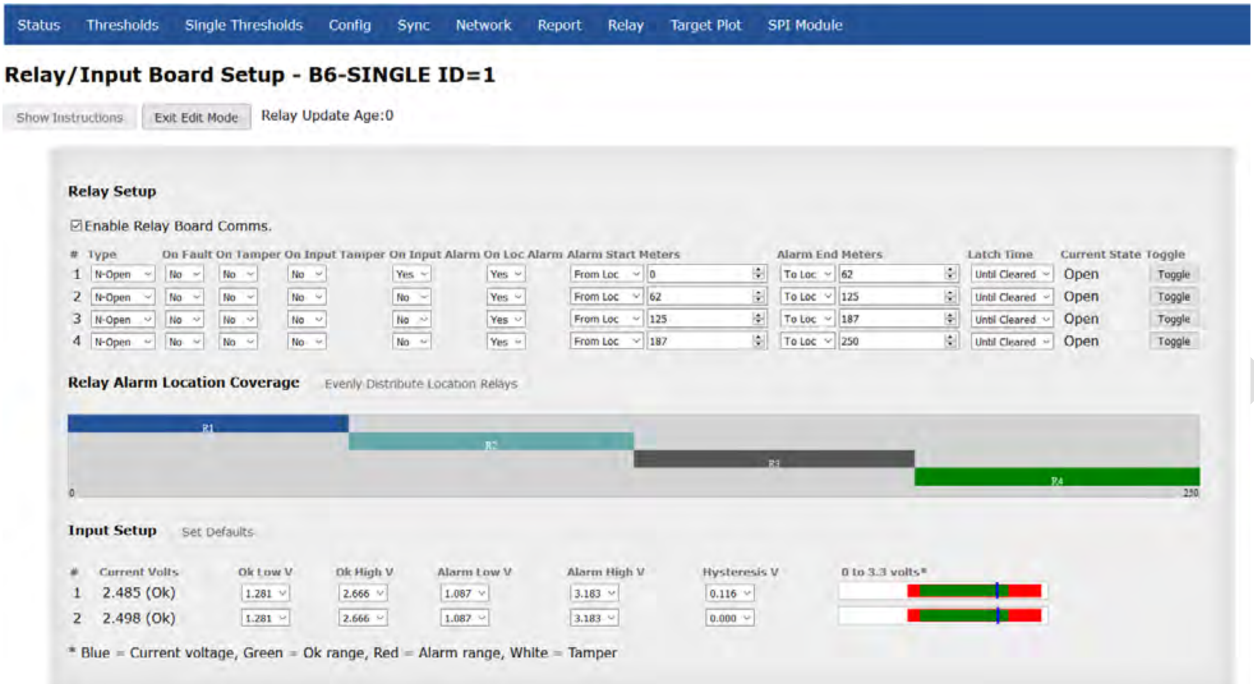
Heartbeat Rate (seconds): Specifies the time interval of status reporting.

Server IP: Sets the Access Module's IP address.

Server Port: Sets the Access Module's port.

Relay Page

The Relay page sets up the behavior of an installed TD100 relay board. The presence of relay boards as well as the number of inputs and outputs are detected upon startup.



Control is permitted by clicking on the Enter Edit Mode button.

Relay Setup

Type: Specifies whether the normally open or normally closed contacts are connected.

On Fault: Relay activates when any error on Status page is declared.

On Tamper: Relay activates when the tamper switch is open.

On Input Tamper: Relay activates when input voltage is outside of OK and Alarm regions.

On Input Alarm: Relay activates when input voltage is outside of Alarm range.

On Loc Alarm: Relay activates then an alarm’s location is in the range specified.

Alarm Start Meters: Sets the beginning of the relay’s location coverage. Selecting From Start will use 0 meters. Selecting From Loc will expose the Meters control.

Alarm End Meters: Set the end of the relay’s location coverage. Selecting to End will set the value to the length specified on the Config page. Selecting To Loc will expose the Meters control.

Latch Time: Controls how long the relay remains activated after all trigger conditions are gone.

Current State: Indicates whether the relay is activated.

Toggle: Allows the user to change a relay's activation status. The control is overridden when a trigger condition is met.

Evenly Distribute Location Relays: Clicking this button will automatically distribute location coverage amongst all relays that have On Loc Alarm set to yes, in ascending order. Location range is specified on Config page, Chan A Cable Settings, Cable Length (m).

Input Setup

Enable Relay Board Comms checkbox must be cleared to allow edits for this section.

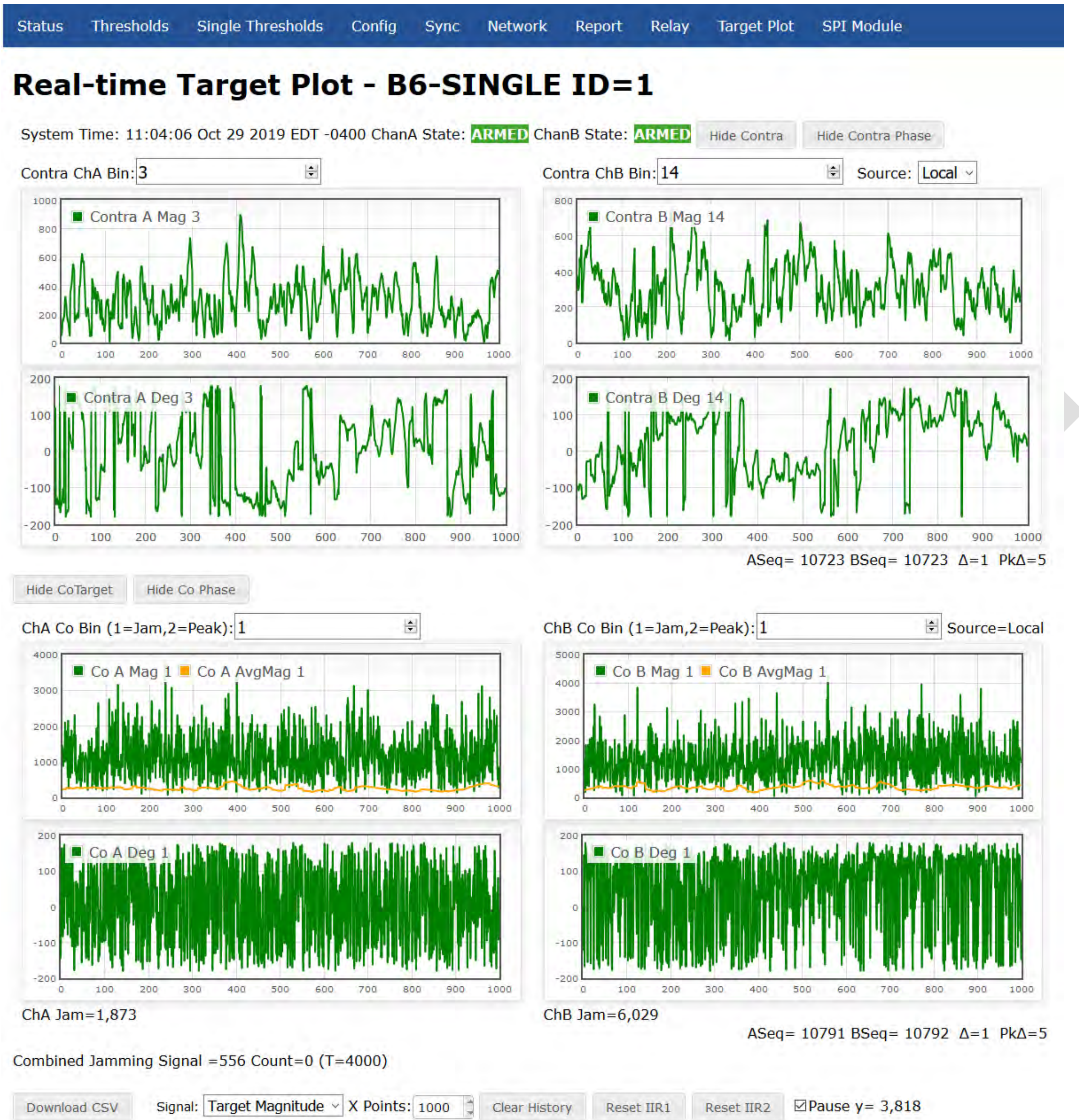
Current Volts: Shows the voltage sensed on the input. The status, or cause of alarm is displayed in brackets. The inputs are regulated to 2.5 V when terminals are floating or open.

Ok Low V and Ok High V sets the region where the input voltage is expected. Input Tampers and Input Alarms will not be declared when voltage is in this range.

Alarm Low V and Alarm High V sets the range where an Input Alarm will be declared. If Ok Low V is lower than Alarm Low V, or Ok High V is higher than Alarm High V, Input Alarm will not be declared.

Hysteresis V sets the amount that the input voltage must change by to be considered for activating relays.

Target Plot Page



The Target Plot page allows a user to see the single-ended target for contra- and co-directional responses, as well as the signal of the jamming detection.

As with the Sync page, the user can also hover their mouse pointer over any chart and have the scaled value displayed. This display is next to the Pause checkbox.

Hide Contra: Hides all four contra-directional charts.

Hide Contra Phase: Hides only the bottom two charts of the Contra section.

Contra ChA and ChB Bin: This selects which bin single-ended bin to continue plotting data from. Plots are not cleared when bins are switched.

Source: Lets the user select which data source the ChB plots are plotting from. When Local is selected, the data source is the processor's channel B. When Adj. is selected, the data source is the partner processor's channel B.

Hide CoTarget: Hides all four co-directional charts.

Hide CoPhase: Hides only the bottom two charts of the Co section.

ChA and ChB Co Bin: Selects between jamming detector data or peak Co-directional bin's data. The yellow trace of the jamming detector data is the jamming signal used.

ChA and ChB Jam: Displays the current level of the signal used by the jamming detector.

ASeq and BSeq: Displays the sequence number of the last received data packet.

Δ: Displays the difference between the sequence number of the present package of data and of the previously received one.

PkΔ: Displays the highest Δ delta value since the last time the Clear History button was clicked.

Download CSV: Clicking this button will download the data from all plots into a CSV file. Limit of 5000 most recent points.

Signal: Selects whether the data is displayed as magnitude and phase, or I/Q and phase. If Target IQ is selected, the jamming signal is not plotted or saved to CSV.

X Points: Selects number of points to display for all charts. Limit of 5000.

Clear History: Clears all data from memory and charts.

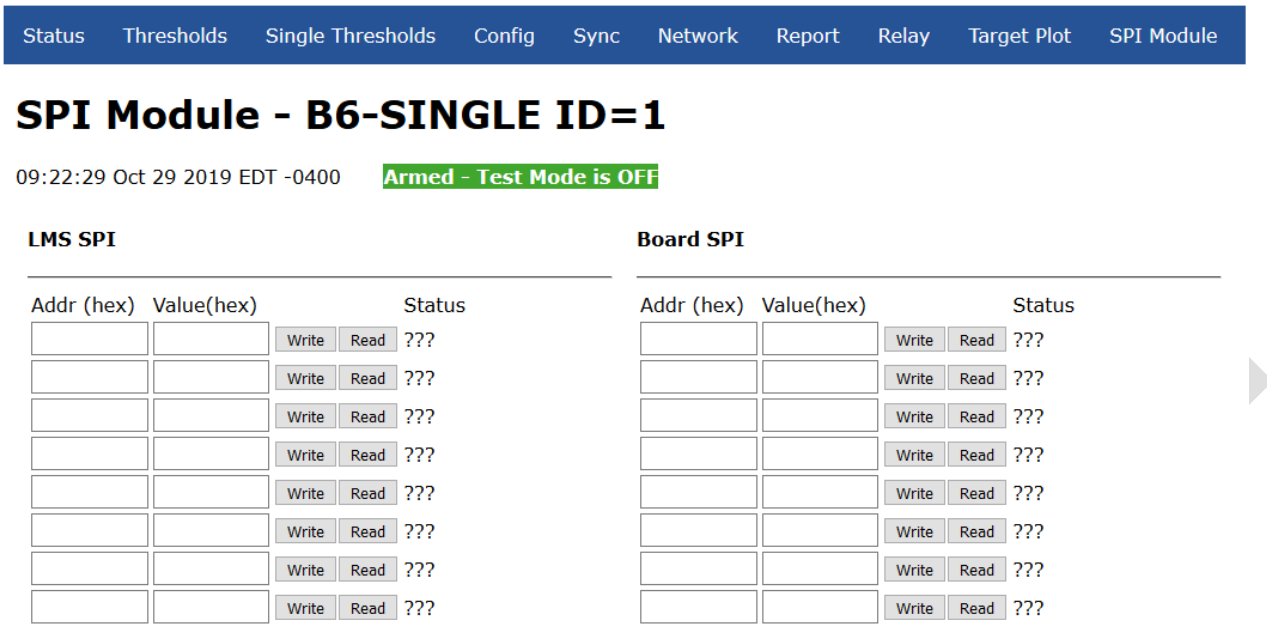
Reset IIR1: Resets the upper corner filter.

Reset IIR2: Resets the clutter filter.

Pause: When this box is checked, the plotting of data is paused.

SPI Module Page

The SPI Module page allows a user to read and write from LMS7002M and FPGA registers, turn DC-DC converters on and off, and select the 10 MHz clock routing.

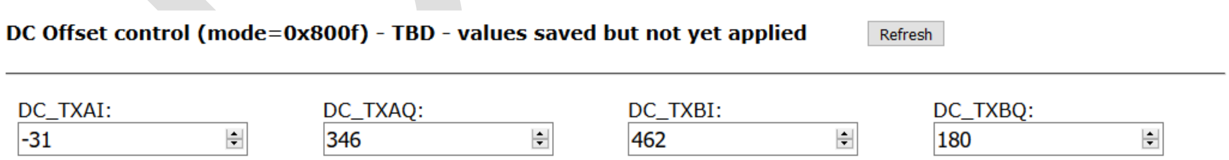


SPI Section

Write and Read actions are only performed on the row where the buttons are clicked. Having 8 rows provides scratch space to reduce typing/reading operations.

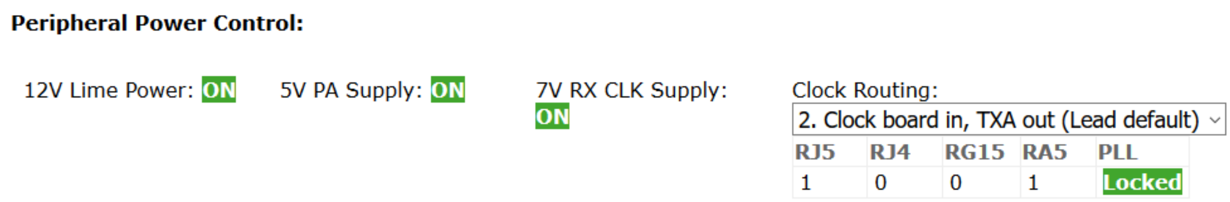
Addr: Accepts 8-bit hex address. “0x” prefix accepted but not necessary. Case insensitive.
Value: Displays or accepts 16-bit hex values.
Write: Writes the value to address of LMS7002M. If Value is blank, will write all zeroes.
Read: Reads the value from the address specified and overwrites contents of Value box.
Status: Displays 0 if the operation completes successfully.
There is no interface to write to TD100 registers.

TX DC Offset Section



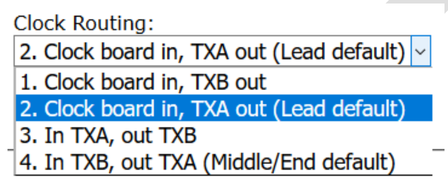
Provides a display of the analog TX DC offset corrector values for both channels.

Peripheral Power Control Section



This section allows a user to toggle any of the DC-DC converters on and off by clicking on the status indicator.

Clock Routing: This pulldown menu selects the clock source and clock destination. The choices are below:



Advanced Seed Control Section

These controls allow a user to set all 4 seeds and polynomial of a processor to the same values. Does not overwrite Config page settings.

FPGA Registers Section

Allows a user to read the TD100 portion of the FPGA registers by clicking on the Read FPGA Registers button.

For troubleshooting assistance, contact **Fiber SenSys** Technical Support Service: telephone, 1-503-726-4455; email, **support@fibersensys.com**; or go to the **Fiber SenSys** website, **www.fibersensys.com**