MU-X9 Receiver and HH2S-9XL10 Transmitter
Split Bridge–Trolley/Hoist Manual

U113.0.0
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**FCC Statements**

**15.19 – Two Part Warning**

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.

**15.21 – Unauthorized Modification**

NOTICE: The manufacturer is not responsible for any unauthorized modifications to this equipment made by the user. Such modifications could void the user’s authority to operate the equipment.

15.105(b) – Note:

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 or more 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.

**Industry Canada Statement**

This device complies with Canadian RSS-210. The installer of this radio equipment must ensure that the antenna is located or pointed such that it does not emit RF field in excess of Health Canada limits for the general population; consult Safety Code 6, obtainable from Health Canada’s website [www.hc-sc.gc.ca/rpb](http://www.hc-sc.gc.ca/rpb).

Le présent appareil est conforme aux CNR d’Industrie Canada applicables aux appareils radio exempts de l’obtention d’une licence. L’exploitation est autorisée aux deux conditions suivantes : (1) l’appareil ne doit pas produire de brouillage, et (2) l’utilisateur de l’appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d’en compromettre le fonctionnement.

**Industry Canada Statement**

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d’Industrie Canada applicables aux appareils radio exempts de licence. L’exploitation est autorisée aux deux conditions suivantes : (1) l’appareil ne doit pas produire de brouillage, et (2) l’utilisateur de l’appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d’en compromettre le fonctionnement.

**IC Unlicensed Devices EIRP Statements for Removable Antennas**

Part 1: Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

Conformément à la réglementation d’Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d’un type et d’un gain maximal (ou inférieur) approuvé par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l’intention des autres utilisateurs, il faut choisir le type d’antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l’intensité nécessaire à l’établissement d’une communication satisfaisante.

Part 2: This radio transmitter (LOBSRF-305) has been approved by Industry Canada to operate with the antenna type listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Le présent émetteur radio (LOBSRF-305) a été approuvé par Industrie Canada pour fonctionner avec les types d’antenne énumérés ci-dessous et ayant un gain admissible maximal et l’impédance requise pour chaque type d’antenne. Les types d’antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l’exploitation de l’émetteur.
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Cervis Inc. Safety Precautions

✓ Read and follow all instructions.
✓ Failure to abide by Safety Precautions may result in equipment failure, loss of authority to operate the equipment, and personal injury.
✓ Use and maintain proper wiring. Follow equipment manufacturer instructions. Improper, loose, and frayed wiring can cause system failure, equipment damage, and intermittent operation.
✓ Changes or modifications made to equipment not expressly approved by the manufacturer will void the warranty.
✓ Owner/operators of the equipment must abide by all applicable Federal, State, and Local laws concerning installation and operation of the equipment. Failure to comply could result in penalties and could void user authority to operate the equipment.
✓ Make sure that the machinery and surrounding area is clear before operating. Do not activate the remote control system until certain that it is safe to do so.
✓ Turn off the handheld remote and remove power from the receiver before attempting any maintenance. This will prevent accidental operation of the controlled machinery.
✓ Use a damp cloth to keep units clean. Remove mud, concrete, dirt, etc. after use to prevent obstructing or clogging the buttons, levers, wiring, and switches.
✓ Do not allow liquid to enter the handheld or receiver enclosures. Do not use high pressure equipment to clean the handheld remote or receiver.
✓ Disconnect the radio receiver before welding on the machine. Failure to disconnect the base unit may result in destruction of or damage to the receiver.
✓ Operate and store units only within the specified operation and storage temperatures defined in the specifications of this document.
✓ Keep high-energy RF devices away from handheld remotes. Activation of high-power communication radios, for instance, in close proximity to handheld remotes can result in interference and “false” circuit activation.
✓ Do not key 2-way radios while using the handheld remote.
1.0 Warrior MU-X9 RX#1 and RX#2 Receivers

Warrior MU-X9 RX#1 and RX#2 are machine-mounted receivers intended for use on industrial cranes and hoists. Provided here in the 900MHz FCC Part 15 license free radio band, the standard MU-X9 is self-contained and preconfigured for bridge and trolley/hoist control. This split bridge trolley/hoist system is designed such that the designated bridge receiver will provide mainline contactor, warning/start and 3 contact bridge motion control. The second receiver will provide 3 contact trolley and hoist commands as well as will provide its own mainline and warning start relay outputs that can be utilized if desired. Factory mounted 90dB warning buzzers may be provided if purchased with the primary system.

![Warrior MU-X9 Receivers and 900MHz External Antennas](image)

**Figure 1. Warrior MU-X9 Receivers and 900MHz External Antennas**

Warrior MU-X9 Receiver Features

- Two Motion, Two Speed Control
- Two Series MLC (Main Line Contactor) Relays
- Dedicated Horn/Light and Start Relays
- Compact Designed to IP65/IP67 Standards
- 900MHz @ 100mW No License Required Operation
- Designed to ICS 8 NEMA Crane Specification
- External Antenna
- Self-Contained, Factory Pre-Configured Terminal Wiring with Single Pigtail Harness
- Fourteen Screw Terminals for Optional Custom User Wiring
2.0 MU-X9 Receiver Mounting

The MU-X9 can be mounted using the molded enclosure mounting flanges that provide the option of using the four pre-drilled 0.20” holes with bolts or screws, or by using the two 0.425” holes with the 0.225” x 1.00” shank-slides. The sturdy enclosure allows the MU to operate worry free in harsh weather conditions and factory environments.

Figure 2. MU-X9 Receiver Mounting Dimensions
3.0 MU-X9 Receiver Wiring

The standard MU-X9 receiver is pre-wired for crane operation. Please refer to the document drawing package included with the system for wiring details for RX#1 and RX#2.

✓ **Note:** Flying leads that are not connected on the jobsite must be insulated at the wire end or the wire must be disconnected from the appropriate terminal.

![Figure 3. MU-X9 Receiver Terminals Standard Wiring](image-url)
4.0 MU-X9 Receiver Relays Schematic

The ten Form A system relays of the MU-X9 are divided into two groups of three relays — K1 through K3, and K4 through K6, and one group of four relays — K7 though K10.

- Group 1 and 2 perform motion functions.
- Group 3 contains the MLC (Main Line Contact) redundant-contact safety circuit, the Start, and the Horn/Light relays.

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**Figure 4. MU-X9 Receiver Relay Schematic**
5.0 MU-X9 Receiver Diagnostic LEDs and Relay Locations

5.1 MU-X9 Internal Diagnostic/Status LEDs (Five)

The MU-9X receiver has five board-mounted system status LEDs that can be used as diagnostics tools to verify operation. Removing the MU-X9 cover allows access to the LEDs. These LEDs as shown in Figure 5 are LED1 Health; LED2 TX; LED3 RX; LED4 Output; and LED5 System 12V. See Table 1.

Table 1. MU-X9 Diagnostic LEDs

<table>
<thead>
<tr>
<th>LED</th>
<th>Name</th>
<th>LED State</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Health</td>
<td>Blinking</td>
<td>Unit OK, normal processor operation</td>
</tr>
<tr>
<td>2</td>
<td>TX (Transmit)</td>
<td>Fast Blinking</td>
<td>Indicates RF Messages sent to handheld</td>
</tr>
<tr>
<td>3</td>
<td>RX (Receive)</td>
<td>Fast Blinking</td>
<td>Indicates RF Messages received from handheld</td>
</tr>
<tr>
<td>4</td>
<td>Output</td>
<td>Steady ON</td>
<td>Indicates any relay is being commanded to close</td>
</tr>
<tr>
<td>5</td>
<td>System 12V</td>
<td>Steady ON</td>
<td>Indicates internal 12V bus OK</td>
</tr>
</tbody>
</table>

5.2 MU-X9 Strobe LED

The Strobe LED is extremely bright. Caution should be used when removing the MU-X9 cover for troubleshooting while the unit is powered. Avoid looking directly at the Strobe. Cervis advises pressing the Strobe Shut Off Switch immediately after removing the cover when the unit is powered. Take care not to engage power circuits when deactivating Strobe.

The Strobe LED (Figure 5, Table 2) illuminates the MU-X9 enclosure when active by flashing at a rate of ¼ second per second. It is active:

- When a Warrior transmitter attempts to Associate (link communications) with the receiver
- When the Mainline relay (MLC) initially activates
- While the Mainline relay is active.

Table 2. MU-X9 Strobe LED

<table>
<thead>
<tr>
<th>LED</th>
<th>Name</th>
<th>LED State</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Strobe</td>
<td>Blinking</td>
<td>Slow blink when mainline relay is closed and &quot;motion&quot; is enabled</td>
</tr>
</tbody>
</table>

5.3 MU-X9 Strobe Stop Switch

The primary use of the Strobe Shut Off Switch (Figure 5) is to turn off the strobe when the MU-X9 cover is removed for troubleshooting. When pressed, the strobe will remain off for an hour. The strobe while off will become active anytime a Warrior transmitter attempts to associate with the receiver.
5.4 Low Battery Mode

When the transmitter battery voltage drops to or below 2.2V (Low Battery Warning Mode), the handheld LED 2 begins flashing and the MU-X9 Horn/Light relay K7 energizes four times per minute to alert the operator that the transmitter batteries need to be replaced with a fresh set. K7 will continue to activate four times per minute until the handheld batteries are replaced.

**Caution!**
Transmitter batteries should be replaced as soon as possible after the Low Battery Warning begins. If the transmitter battery voltage drops to 2.0V, the transmitter will shut down and cannot be used until fresh batteries are installed.
6.0 MU-X9 Dual Receiver Theory of Operation

Two MU-X9 receivers — one for Bridge/Mainline and one for Trolley/Hoist — are used to reduce the amount of wiring required to install the Cervis remote control system. The receiver designated for the bridge must be mounted and wired to the bridge control panel; the receiver designated for the trolley/hoist must be mounted and wired to the trolley/hoist panel. Wiring diagrams for your particular system are provided with the system when it is delivered.

- RX#1 is designated for Bridge/Mainline control and must be mounted and wired to the Bridge Control Panel.
- RX#2 is designated for Trolley/Hoist control and must be mounted and wired to the Trolley/Hoist Control Panel.
- Wiring Diagrams are provided with the Document Package that shipped with the Warrior Split Bridge T/H system.

6.1 Terminology

Association
The process of exchanging and storing serial numbers. This allows the transmitter and receiver to work as a system. This is established at the factory but may be required to be done in the field as well.

✓Note 1: Multiple transmitters can be associated to the receivers. First come first serve operation is always active.

Pairing
The process of linking a transmitter (TX) to a receiver (RX). Pairing can only take place if the transmitter(s) and receivers have been associated. Only one TX can be paired to an RX at a time (First come/First Serve).

MLC Relay
Two safety relays in the radio package that are wired in series and are used to energize the customer mainline contactor. The radio MLC is shut off with any communication fault thus killing power to the crane controls.

RX#1 — Bridge/Mainline Receiver
RX#1 MLC is energized when the Horn/Start button pressed.

RX#2 — Trolley/Hoist Receiver
RX#2 MLC is energized when the Horn/Start button pressed, after RX#1 MLC is energized. It will take approximately three to five seconds before RX#2 is powered-up and ready for operation.

6.2 Standby Mode
While in Standby Mode none of the motion control buttons on the transmitter will be functional.

1. Apply power to RX#1. When this is done, the Horn/Light relay of RX#1 momentarily energizes. This alert is meant to let the operator know that association has been enabled for the next two minutes.

2. Turn on the HH2S-9XL10 transmitter by pressing STOP button B1. This wakes the TX and checks to make sure the STOP button is functional.

3. Standby Mode is indicated by LEDs 1, 3, and 4 on solid.
6.3 Run Mode

1. Enter Run Mode by pressing the transmitter Horn/Start button B2. It is during this time that the transmitter and RX#1 establishes an RF link, and the RX#1 MLC is energized. When the RX#1 MLC is energized the Horn/Light relay K7 (Horn/Light) in RX#1 will sound for a ½ second and, if supplied, the Cervis pre-wired buzzer will also sound for ½ second. This alert is to let the operator know that the transmitter is active (turned on) and linked to the receivers, and the system is ready for operation.

2. Power is then applied to RX#2 through the system wiring. When power is first applied to RX#2, its Horn/Light output K7 momentarily energizes and if supplied the Cervis pre-wired buzzer will also sound for a ½ second. RX#2 MLC is then energized.

3. Provided receivers RX#1 and RX#2 are correctly wired, it will take approximately 3 to 5 seconds for both receivers to power-up. During this startup time, there are a series of relay closures that are provided to alert the operator that the system is about to come on-line. During this last alert the Horn/Light K7 relays of RX#1 and RX#2 simultaneously activate to indicate that motion is now enabled.

6.4 HH2S-9XL10, MU-X9 Communications: Associate Handheld Remote Transmitter(s) with Paired Receivers

The system HH2S-9XL10 transmitter(s) and MU-X9 receivers are associated at the factory before the system is shipped. The Associate process is used when necessary to establish a communication link with the MU-X9 receivers. MU-X9 receivers do not need to have the case opened to complete association.

✔️ Note 1: MU-X9 association can only occur during the first 2-minutes following power-up of the unit. If this 2-minute window times out before attempting to associate the transmitter, the attempt will be rejected and the target MU-X9 must be powered-off and then turned on again restarting the two minute window.

✔️ Note 2: A receiver that is actively in use (ON) with another handheld cannot be associated.

✔️ Note 3: There is no association-lock dip switch on an MU-9X.

✔️ Note 4: Associate procedure is standard in that it uses the same buttons to enter modes and to select receivers (RXs). Two RX selections are required with this procedure.

Caution! Two MU-X9 receivers — RX1 and RX2 — must be associated when attempting to establish communication links. If an attempt is made to associate only one RX, the association attempt will be rejected.

The MU-X9 must be powered-on prior to attempting to use the handheld to Associate.

1. Start the association process by entering Maintenance Mode. Wake the HH2S-9XL10 handheld remote by pressing B1 (STOP) - within the first second, press buttons 9 + 10 simultaneously. Next, enter Association Mode by pressing buttons 3 + 4 simultaneously for 5-seconds. The transmitter will nominate all available receivers as candidates for association. Two of those RXs will be stored in HH2S-9XL10 transmitter memory SLOTS A and B, but each RX must be assigned accordingly. The first RX selected is for the Bridge/Mainline control (RX1). The second RX selected will be for the Trolley/Hoist control (RX2).
2. Once the first receiver is selected (RX1) and confirmed (using B9/B10), the operator must press the horn/start (B2) to start the search for the second receiver (RX2). After horn/start has been pressed and MLC1 is energized, power is supplied to RX2.

3. The same process of Step 1 is used to select RX2: use B9 (next) to search for the correct RX, then use B10 to select it. The strobe light on the RX flashes and the K7 (H/L) relay will pulse during the RX selection period to alert the operator as to which RX is being considered for association.

4. Once RX2 has been selected, press B2 (horn/start) to launch into normal system operation.

**Associate Synopsis**

- Apply power to RX1 to unlock the 2-minute association period.
- Enter Maintenance Mode. This is indicated by scrolling LED’s (B>A>BAT>RAD).
- Find RX1 using B9 (next) to move from one RX to another. The Strobe LED flashing and K7 pulsing indicates a nominated RX.
- Press B10 (select) to finalize selection of RX1.
- Press B2 (horn/start) to start the search for RX2.
- Find RX2 using B9 (next) to move from one RX to another. The Strobe LED flashing and K7 pulsing indicates nominated RX.
- Once RX2 has been selected (B10 pressed), it is indicated by LED’s 3 and 4 flashing (A & B flashing). All pushbuttons are disabled.
- Press B2 (Horn/Start) to launch into normal system operation.
- RX1 and RX2 must have been properly associated for Split RX system to operate.

*Figure 6. Association Buttons*
7.0 MU-X9 Receiver Antenna

The MU-X9 comes with a 900MHz external antenna (BB3-03A) that attaches to the receiver using the external unit connector. Antenna extensions are available in 3, 10 and 25 foot lengths.

**Caution!**

Ensure that the metal ends of an extension cable DO NOT contact or become grounded to any other metal surface. Chassis noise can be conducted to the antenna ground causing RF interference and may result in poor range/communication performance.

Available Extension Cables:
- 25’ J5-13
- 10’ J5-02
- 3’ J5-07

Figure 7. MU-X9 900MHz External Antenna and Optional Extension Cables
8.0 MU-X9 Safety Circuit

Figure 8 illustrates a high-level view of the system safety architecture. This architecture is based around redundant enable signals that are generated by separate hardware circuits. The microprocessor generates an enable signal to K09 when all conditions are met and the user activates the start sequence. The watchdog circuit generates an independent enable signal to K10 as long as the microprocessor generates the proper signaling to the watchdog. Additionally, these two independent enable signals are ANDed together to enable an internal +V bus that provides coil power to all relays. The system is not capable of any relay closures until both watchdog and microprocessor enables are asserted. The loss of either signal immediately causes the MLC path to open and all output relays to de-energize.

If there is a software fault in the microprocessor, the watchdog will not assert its enable output, which will cause K10 to open. Additionally, this will disable the internal +V bus resulting in all relay outputs returning to their non-active state regardless of what the microprocessor is commanding.

If there is a fault in the watchdog circuit that causes its output to never assert (set to active state), the unit will be safe as the MLC (Main Line Contact) path cannot close because K10 will be open and the internal +V bus will be disabled. If the fault causes the watchdog circuit to never de-assert (set to the inactive state—perhaps the contacts on K10 weld closed), the system is still safe because the microprocessor has independent control of K9 that can break the MLC path and internal +V bus.

This architecture has been devised such that any one fault will not cause loss of control of the MLC path.

*Except the K07 H/L relay because it is necessary to operate the H/L when the MLC is open.
## 9.0 Warrior MU-X9 Receiver Specifications

**Table 3. MU-X9 Receiver Specifications**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power</strong></td>
<td></td>
</tr>
<tr>
<td>Vin</td>
<td>7 to 36 VDC</td>
</tr>
<tr>
<td></td>
<td>110 to 220 VAC @ 50-60 Hz</td>
</tr>
<tr>
<td></td>
<td>10 to 28 VAC @ 50-60 Hz</td>
</tr>
<tr>
<td>Operating Power</td>
<td>2.4W</td>
</tr>
<tr>
<td><strong>Environment</strong></td>
<td></td>
</tr>
<tr>
<td>Operating Temp</td>
<td>-13°F to 158°F (-25°C to 70°C)</td>
</tr>
<tr>
<td>Storage Temp</td>
<td>-40°F to 185°F (-40°C to 85°C)</td>
</tr>
<tr>
<td>Humidity</td>
<td>0–95% non-condensing</td>
</tr>
<tr>
<td><strong>Radio</strong></td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td>906–924 MHz @ 100mW</td>
</tr>
<tr>
<td>License</td>
<td>None required, license free</td>
</tr>
<tr>
<td>Modulation</td>
<td>DSSS</td>
</tr>
<tr>
<td>Antenna</td>
<td>External (RP-TNC)</td>
</tr>
<tr>
<td><strong>Enclosure</strong></td>
<td></td>
</tr>
<tr>
<td>Dimensions</td>
<td>Inches: 4.5” x 2.44” x 5.75”</td>
</tr>
<tr>
<td></td>
<td>mm: 114.3 x 61.89 x 146.05</td>
</tr>
<tr>
<td>Weight</td>
<td>1.5 lbs.</td>
</tr>
<tr>
<td>Durability</td>
<td>NEMA 4, 4X, 6, 6P</td>
</tr>
<tr>
<td></td>
<td>IP65/67</td>
</tr>
<tr>
<td><strong>Indicators</strong></td>
<td></td>
</tr>
<tr>
<td>Power</td>
<td>120V - ON when OK</td>
</tr>
<tr>
<td>Diagnostic</td>
<td>Health - Slow blink when processor OK</td>
</tr>
<tr>
<td></td>
<td>TX - Blinking when transmitting</td>
</tr>
<tr>
<td></td>
<td>RX - Blinking when receiving</td>
</tr>
<tr>
<td>Association</td>
<td>Strobe LED - Used during association or MCL closed</td>
</tr>
<tr>
<td><strong>Outputs</strong></td>
<td></td>
</tr>
<tr>
<td>Function</td>
<td>6-Form A Relays</td>
</tr>
<tr>
<td>System</td>
<td>4-Form A Relays (Two in series for MLC)</td>
</tr>
<tr>
<td>Contact Rating</td>
<td>5A Max. @ 250VAC</td>
</tr>
<tr>
<td><strong>Main Line Contactor</strong></td>
<td>Comprised of two System Form A Relays arranged in series</td>
</tr>
<tr>
<td>(MLC)</td>
<td></td>
</tr>
</tbody>
</table>
Appendix A: Exposure to Radio Frequency Energy

Warrior handheld remote units and receivers contain radio transceivers. When active, a handheld remote sends out radio frequency (RF) energy through its internal antenna. The Warrior handheld remote complies with limits set by the FCC for operating distance from human tissue.

Appendix B: RF Exposure Considerations

The radio module may be used in a variety of host application that fall into two general categories: mobile or portable. Mobile applications are any operating locations that are not on a human body. Portable applications are those where the transmitting equipment is located on the hand, arm, or other part of the human body. In mobile application the host application is typically fixed to mobile equipment, with either an internal or external antenna. In portable applications the equipment is typically held in the hand of an operator or affixed to either a belt of harness on the torso.

Equipment containing the radio module has been evaluated for FR exposure hazards by two approaches: Maximum Permissible Exposure (MPE) for “mobile” applications and SAR for portable applications. Mobile applications are any operating locations that are not on a human body.

The required separation distances are measured from the actual location of the radiated part of the antenna. An antenna may be inside the host application, affixed to the enclosure of the host application or at the end of an optional extension coaxial cable.

Mobile Applications

Equipment must be located in a location at least 20cm away from areas likely to be occupied by an unaware person.

Handheld Applications

All operators of the handheld equipment with any type of antenna require training in the proper operation of the equipment and such training must include RF exposure safety instructions. Once training is completed they are considered to be aware persons.

If the portable operating pose in on the hand or arm it is required that a 5mm separation between the radiating part of the antenna and nearby human tissue.

Required Training

All installers and operators of host applications that include an SRF310 FT module must be trained to use proper RF safety precautions.