4200 Alarm Circuit Unit (ACU)

99059

TABLE OF CONTENTS

List of Figures:

1. Introduction

The 4200 Alarm Circuit Unit (ACU) plug-in card for the 4200 Cable Management System provides armor, copper pair or tracewire monitoring to an outside plant cable network along with sensor monitoring of splice enclosure, remote cabinet and building locations. The ACU can monitor up to 78 miles or 125 kilometers of cable armor/copper conductor and 799 sensor devices. The ACU employs Digital Signal Processing (DSP) circuitry that allows for adjustable filtering and for future enhancements to measurement and operation capabilities.

Operating over a metallic conductor, such as a cable armor (fiber optic cable), copper pair or tracewire, the system will detect and warn the user of any damage to the protective cable jacket ensuring an adequate preparation time for repair. Providing proactive protection, the system cathodically protects the damage site, which inhibits corrosion of the metallic conductor, until a repair can be carried out.

1.1 Standard Features

- Alarm thresholds fully adjustable via serial port, modem or telnet connection
- Digitally coded Sensor Units monitor splice enclosures for moisture ingression, remote cabinets/buildings for environmental and equipment failure
- Cathodically protects the metallic conductor to prevent corrosion

1.2 Specifications

Alarm Circuit Unit (ACU)

Input Voltage	-36 to-60	V dc
Output Voltage	-48.0 ± 0.5	V dc
Voltage Resolution	10	mV dc
Voltage Accuracy	± 100	mV dc
Output Current	± 25	mA dc
Current Resolution	± 5.0	µA dc
Current Accuracy	± 10	µA dc
Max. Monitoring Distance	125/78	km/miles
Maximum # of Branch Terminations	20 on STU network, 5 on TSU network	
Max. Induced AC Voltage	16	V rms
Sensor Baud Rates	3, 10, 32	baud

2. Theory of Operation

2.1 Basic monitoring system concepts

When cable infrastructures (which include interconnected splice enclosures, remote cabinet/building equipment) are exposed to the natural elements they can deteriorate, become damaged or stop functioning over time. Unfortunately, this is not the only cause of cable infrastructure damage. Accidental cable dig ups, vandalism and vehicle collisions with aerial installation structures also account for cable damage. One way to minimize the down time and reduce costly emergency repairs is to install a cable monitoring system.

Cable monitoring is accomplished by using some or all of the following:

- Metallic cable shield(s) or armor
- Copper pair conductor
- Tracewire conductor
- Splice enclosure sensors and moisture detection tape
- Termination sensors
- Battery Fail Sensors (remote cabinet/building)
- Multiplexed Remote Sensors (remote cabinet/building)

2.2 Norscan Cable Management Systems

The 4200 ACU card is capable of providing cable, splice enclosure, end to end continuity and remote cabinet/building monitoring when installed in the 4200 CMS chassis. The ACU card will monitor the metallic conductor for faults to ground, end to end connectivity and sensor activation activity to give indication of the condition of the cable network infrastructure. Very specific sensor types (SSU, STU, TSU, BFS and MRS) are placed throughout the cable network to monitor for wet splices, termination point testing, remote cabinet/building battery, fans, heaters and power supplies devices just to name a few. The ACU card deciphers the codes that are transmitted from the activated sensors, which are then relayed to the 4200 CMS cable management and alarm reporting processes.

2.3 ACU Monitoring (Using STU Termination Sensors)

The 4200 ACU card can be configured for monitoring a cable network using a Sequence Termination Sensor (STU). Using STUs allows for a cable network to have up to 20 monitored branches. The cable network system would be composed of lengths of cable joined at splice points that have Splice Sensor Units (SSU) installed and branches that are

terminated by STU sensors. This section will describe how Cable, Line and Sensor alarms are determined once the above-mentioned devices are installed (Figure 1).

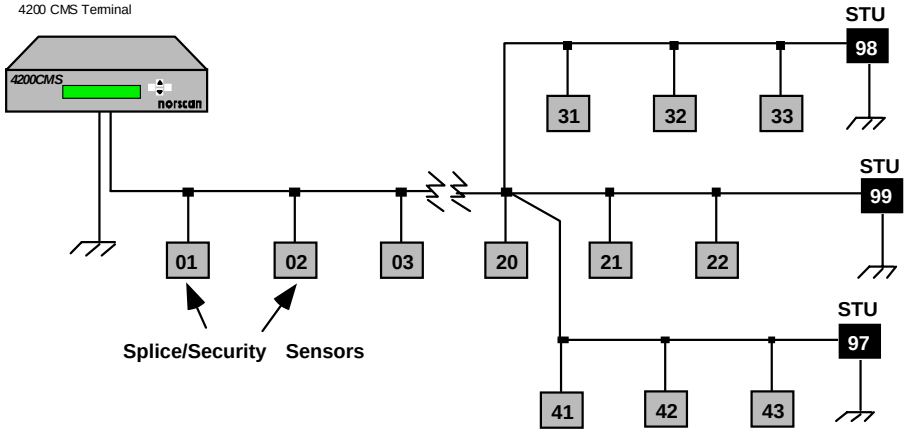


Figure 1: Monitoring with Sequenced Termination Units (STU)

The ACU card in the 4200 CMS is connected to the conductive metallic conductor and applies -48 V dc to the cable network system. The cable metallic conductors are connected together at the splice enclosures. Uniquely addressed Splice Sensor Units (SSUs) are connected in parallel between the metallic conductor (across Tip and Ring in copper pair applications) and ground at each splice enclosures to detect water ingression. The SSUs are electrically invisible until triggered by moisture that enters the enclosure. A STU sensor is a switch that simulates an open circuit resulting in a nominal line current of 0.00 mA in a system with no faults to ground and terminates the cable metallic conductor (Figure 2).

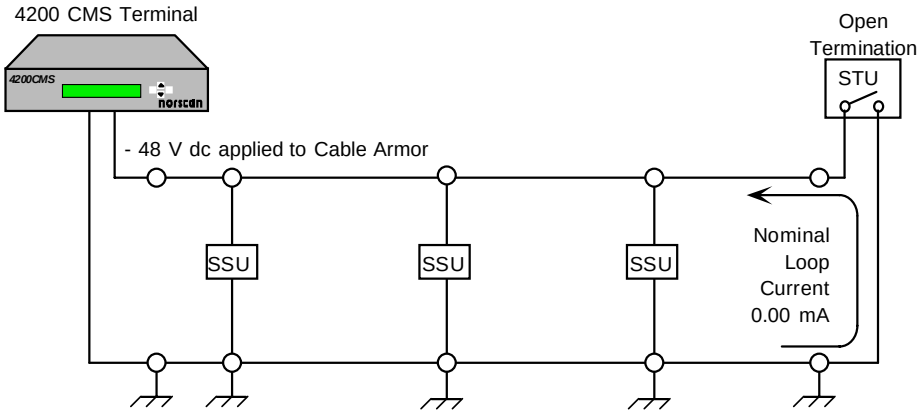


Figure 2: STU Theory of Operation Diagram

When the polyethylene sheath becomes damaged (exposing the metallic conductor) the line current will start to increase depending on the size of the fault. This is referred to as

fault loop current. If the fault loop current exceeds a preset threshold, a **Cable Alarm** condition will appear on the 4200 CMS (Figure 3).

$$R_{fault} = \frac{48V}{I_{faultcurrent}}$$

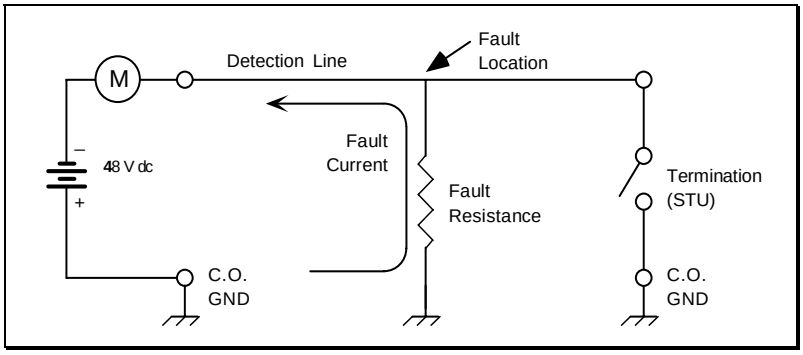


Figure 3: Cable Alarm - STU Network Schematic

When installing a new metallic conductor cable network system or connecting additional branches to existing cable networks using STU sensors, a linear resistance measurement has to be recorded. This measurement is for comparison purposes to determine conductor continuity from the office equipment to each termination. A line initialization test must be performed on each ACU card to determine the nominal line resistance value for each STU sensor that is connected to the ACU card via the cable metallic conductor. This test applies a reverse polarity current to the cable network system, which causes each STU sensor to turn on sequentially (highest to lowest coded STU). Once activated, the highest number coded STU will first transmit its preprogrammed sensor code, which is decoded by the ACU card and then initiate the High Current Line Resistance test. It takes approximately three minutes for each STU sensor to complete the Initialization Test cycle. Once completed the nominal line resistance value is then recorded for each branch in the cable network system on the associated ACU card (Figure 4).

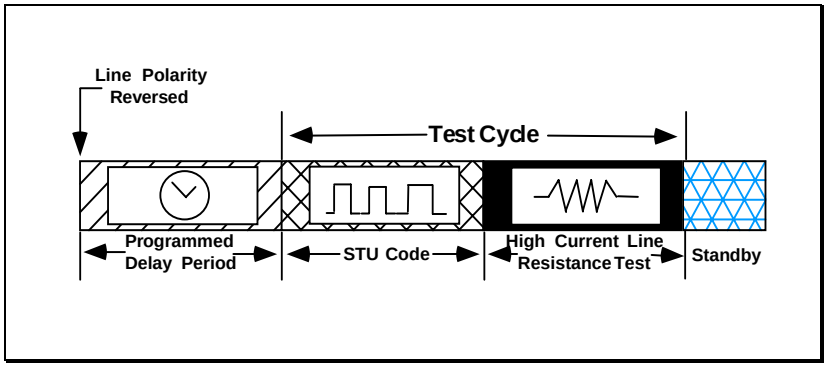


Figure 4: STU Initialization/Status Test Sequence

To check for sensor code decoding and end-to-end line continuity testing, the ACU card can be programmed to run a STU Status resistance test (daily or weekly) on a periodic basis. The test sequence is identical to what is shown on Figure 4. The test verifies that each STU sensor code can be received, thus verifying end-to-end continuity and making it safe to assume that the SSU codes can be decoded. The test also compares the recorded nominal resistance value of the Initialization Test to the measured resistance during a STU Status test. Changes in linear line resistance (metallic conductor continuity from the office equipment to each termination) are typically caused by a loose or corroded series bonds at splice points or by a break in the metallic conductor (detection line) as shown in Figure 5. If the measured line resistance value in the STU Status test exceeds the preset line resistance threshold above the nominal record resistance value, then a **Line Alarm** condition will appear on the 4200 CMS. ***Note: Normal monitoring operation is resumed after the STU Status test is completed.***

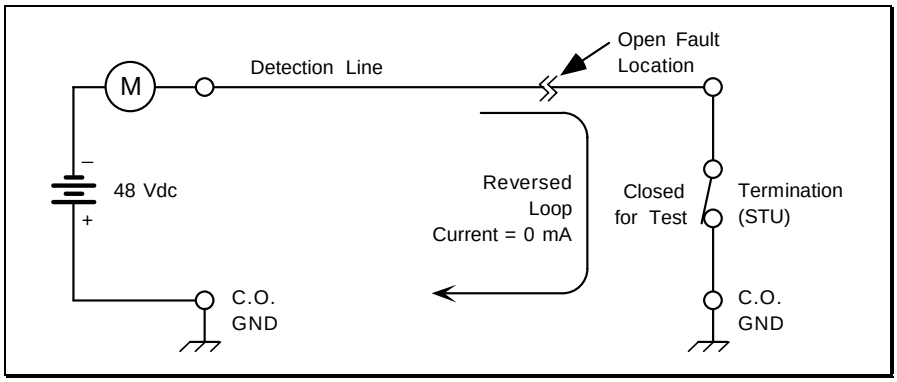


Figure 5: Line Alarm - STU Network Schematic

2.4 ACU Monitoring (Using TSU Termination Sensors)

The 4200 CMS uses an ACU card that can be configured for monitoring a cable network using a Termination Sensor Unit (TSU) and Branch Termination Sensors (BTS). The cable network system would be composed of lengths of cable joined by splices using Splice Sensor Units (SSU) with the main cable line terminated by one TSU sensor. In addition, branch termination is accomplished by the use of up to four Branch Termination Sensors (BTS) in conjunction with a TSU sensor. This section will describe how Cable, Line and Sensor alarms are determined (Figure 6).

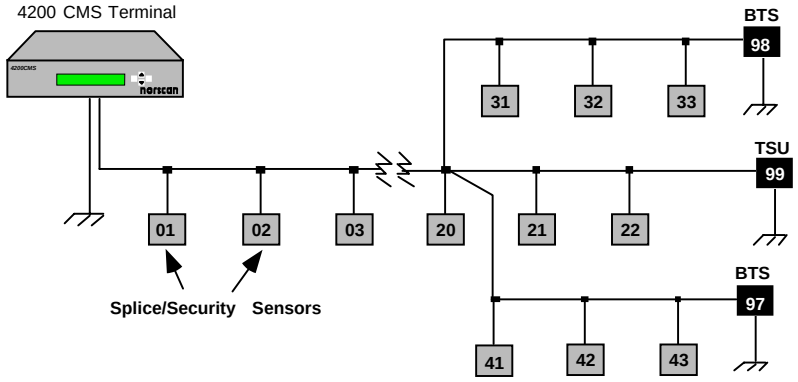


Figure 6: Monitoring with Termination Sensor Units (TSU)

The ACU card in the 4200 CMS is connected to the conductive metallic conductor and applies –48 V dc to the cable armor network system. The cables and metallic conductors are connected together at the splice enclosures. Uniquely addressed Splice Sensor Units (SSUs) are also connected in parallel between the metallic conductor (across Tip and Ring in a copper pair cable network) and ground at the splice enclosure to monitor for ingression of water. The SSUs are electrically invisible until triggered moisture that enters the enclosure. The metallic cable conductor is terminated by a TSU sensor and up to four additional BTS sensors.

The TSU sensor has a built in resistive load of 100kΩ that establishes a controlled current loop for the cable network system. BTS sensors have the same resistive load and must be taken into account when calculating controlled loop current. By applying the following Ohm's law formula we can arrive at the I_{nom} current which would be 0.48 mA for a TSU network with one termination (Figure 7).

$$I_{nom} = \frac{E}{R} = \frac{48V}{100k\Omega} = 0.48mA$$

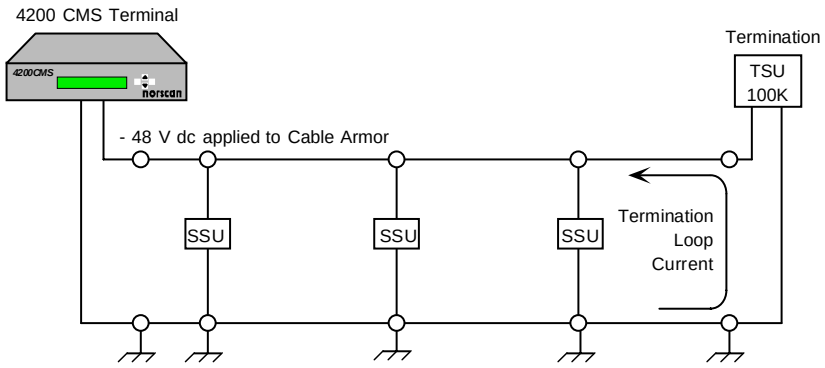


Figure 7: TSU Theory of Operation Diagram

The ACU card in the 4200 CMS applies a -48 V dc to the TSU cable metallic conductor network. In an ideal situation with no faults to ground the loop current (I_{nom}) would be 0.48 mA. When the polyethylene sheath becomes damaged and exposes the metallic conductor, the loop current will start to increase. This is due to the parallel resistive fault and the TSU resistive path along the cable network system. If the cable network system's loop current exceeds a preset limit, a **Cable Alarm** condition will appear on the 4200 CMS (Figure 8).

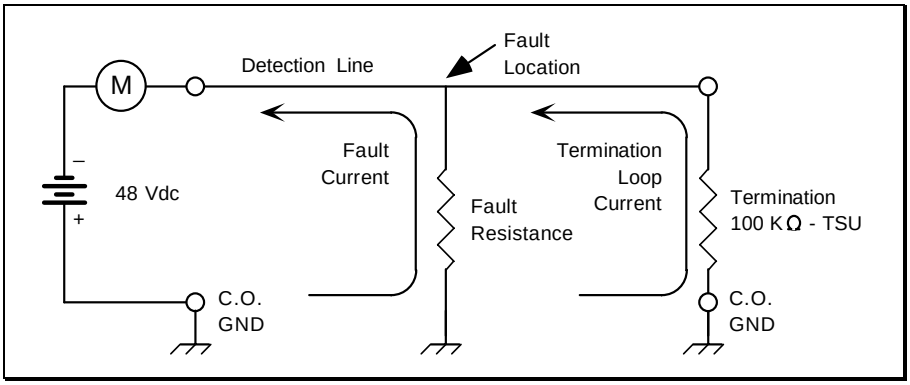


Figure 8: Cable Alarm - TSU Network Schematic

A drop in the loop current would result from an increase in the linear line resistance (metallic conductor continuity from the office equipment to each termination). This is typically caused by a loose or corroded series bonds at splice points or by a break in the metallic conductor (detection line) as shown in Figure 9. The line is considered "open" if the termination loop current drops below a preset threshold. If the cable network's loop current drops below this preset limit, a **Line Alarm** condition will appear on the 4200 CMS.

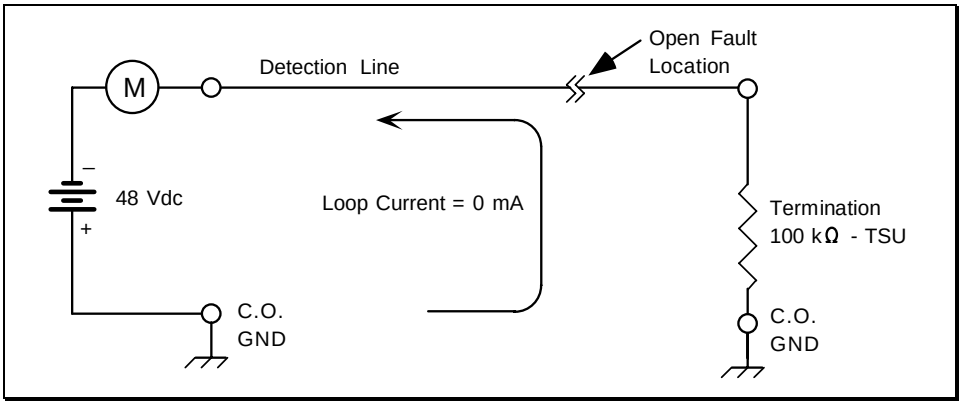


Figure 9: Line Alarm - TSU Network Schematic

2.5 Splice Sensor Unit (SSU) Operation

In a splice enclosure the SSU sensor is connected in parallel, across the metallic conductor and local ground (across Tip and Ring in a copper pair network). The sensors are normally in the **OFF** state and draw no current from the line making the sensor appear electrically invisible and will not interfere with cable location tone equipment. If enough moisture enters the splice enclosure, causing the contract wires within the Moisture Detection Tape (MDT) to create an electrical short at the input leads of the SSU sensor, the sensor will turn **ON**. With current now flowing through the sensor, the SSU transmits a digitally coded address to the 4200 CMS causing a **Cable/SSU alarm**. A triggered sensor causes an increase of 1.5 - 2.5 mA in the detection line current. A **Cable alarm** may be registered simultaneously if the cable alarm fault level threshold is set within this current range (Figure 10).

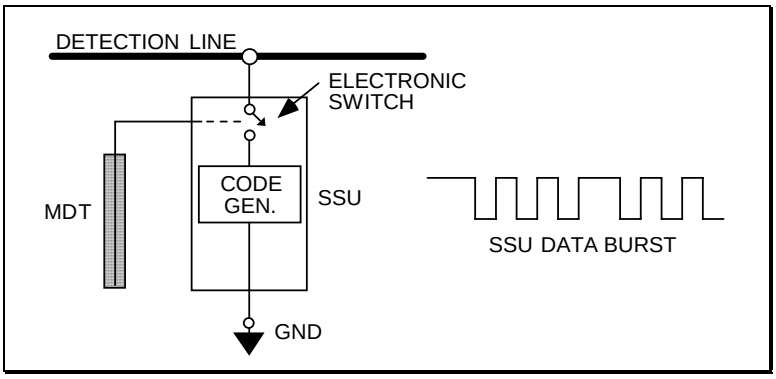


Figure 10: Basic SSU Operation

The communication for each Line has to be set correctly on the ACU card to match the type of sensors that are installed throughout the cable network. Currently there are four different sensor communication settings which are Standard, SISU, TSU or IRIS. Standard is used for legacy SSU, BFS and STU termination monitoring, SISU is used for MRS monitoring along with SSU, BFS and STU sensors that have product model number accompanied with a '-S' designation. Both TSU and IRIS sensor communication is very specific to those types of sensor usage and is set accordingly. When installing sensors in a already populated outside plant cable network, make sure that the new sensors match the pre-existing sensor line communication scheme.

2.6 Battery Fail Sensor (BFS) Operation

The Battery Fail Sensor (BFS) is designed to monitor a battery backup system at a Central Office or remote equipment locations using the 4200 ACU card. The BFS is connected to the monitored cable plant as is any other sensing element (Splice Sensor Unit (SSU), Sequenced Termination Unit (STU), etc).

Battery cells under constant charging will deteriorate over time. As the cells begin to deteriorate they draw more current from the charging source and will begin to heat up. When the cell overcharges the battery will begin to vent oxygen and hydrogen gases. These **gases can become extremely explosive** if they are allowed to accumulate in an enclosed area. This series of events can be avoided if early detection of the battery half-string voltage variation or over-charging occurs. The BFS is designed to alarm when there is a change in battery cell voltage. The alarm is received by the CMS, and then forwarded to a NOC or maintenance center for immediate attention.

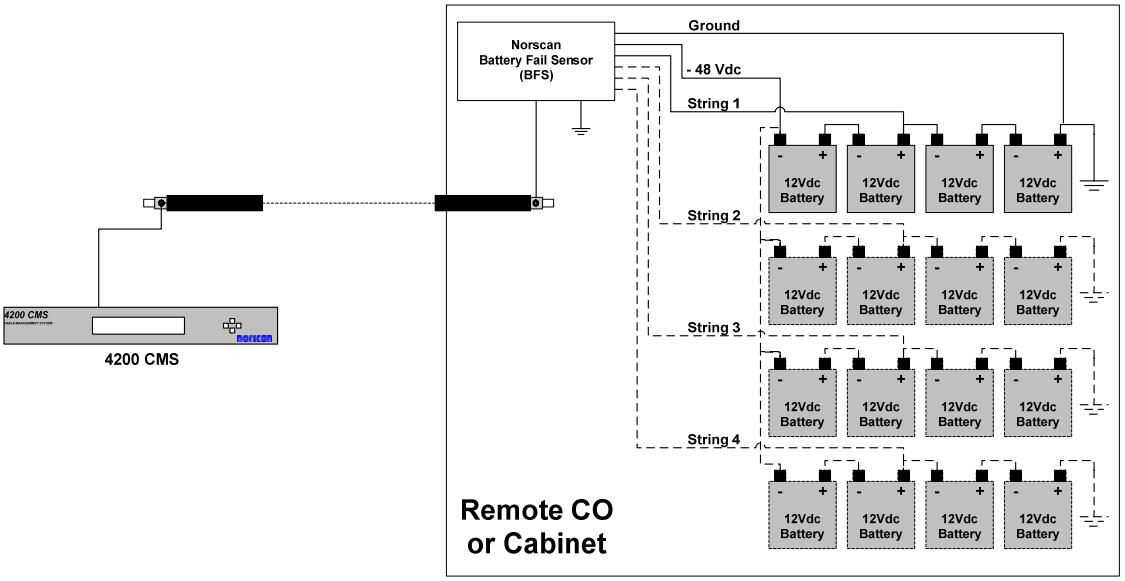


Figure 11: BFS Installation Diagram

The sensor portion of the BFS is powered from the line monitoring voltage provided from the 4200 ACU card. This ensures monitoring and alarm functionality in the event of a complete loss of battery power at the remote site. The sensing circuit is powered from the monitored battery string. The indicator LED on the BFS turns green when the mid-point voltage of the monitored battery string is within specification. It will turn red when the battery mid-point voltage goes outside the user selected threshold.

The BFS can monitor up to four -48Vdc battery strings using a midpoint (-24Vdc) and a full string (-48Vdc) measurement. It uses the midpoint to effectively treat the battery string as two separate -24Vdc half-strings.

Should one -24Vdc half-string vary from the other by more than the user selected threshold (0.5-1.75V) or the total battery string fails, the BFS will trigger an alarm. After a 60 second delay, the indicator LED will turn red and the BFS will transmit its user programmed code to the central office unit (4200 CMS) for processing and reporting to a NOC or maintenance center.

NOTE: The power light may turn off if either half-string voltage drops below -19Vdc. The BFS, however, will recognize this as a battery failure and still transmit its code to the CMS for processing.

The BFS will continue to transmit its code until the line is reset or the string differential returns to within the failure threshold for more than 60 seconds (automatic). The alarm indication on the 4200 ACU card will remain until the line is reset (requires user acknowledgement and intervention).

2.7 Multiplexed Remote Sensor (MRS) Operation

The Multiplexed Remote Sensor (MRS) is designed to provide security and equipment monitoring to remote cabinet/building locations. A typical installation would be in a DSLAM or E-Cabinet, other locations could be Environmental Vaults or Fiber Optic Repeater Huts. The MRS is used in conjunction with 4200 ACU card and operates as all the other Norscan sensors do when activated. Each MRS that is installed in a cable network is configured with a Base Code (i.e. 1, 17, 33 etc) which represents 16 input connections along with an associated STU code (used for end to end testing).

The MRS can monitors up to 16 normally open contact closure inputs. These inputs may monitor such conditions as:

- Security – Access doors
- Commercial AC supply
- Rectifiers – Major & Minor
- DSL – Major & Minor
- Environmental Temperature – Major & Minor
- Back-up Battery – Operation & Condition
- Moisture – Humidity and/or pit water level

Once a specific MRS input is activated, the input code is received by the 4200 ACU card which activates the alarm process on the 4200 CMS unit. Information regarding the location of the MRS and which input was activated is relayed in the Alarm Report via email, SMS, SNMP or modem communication.

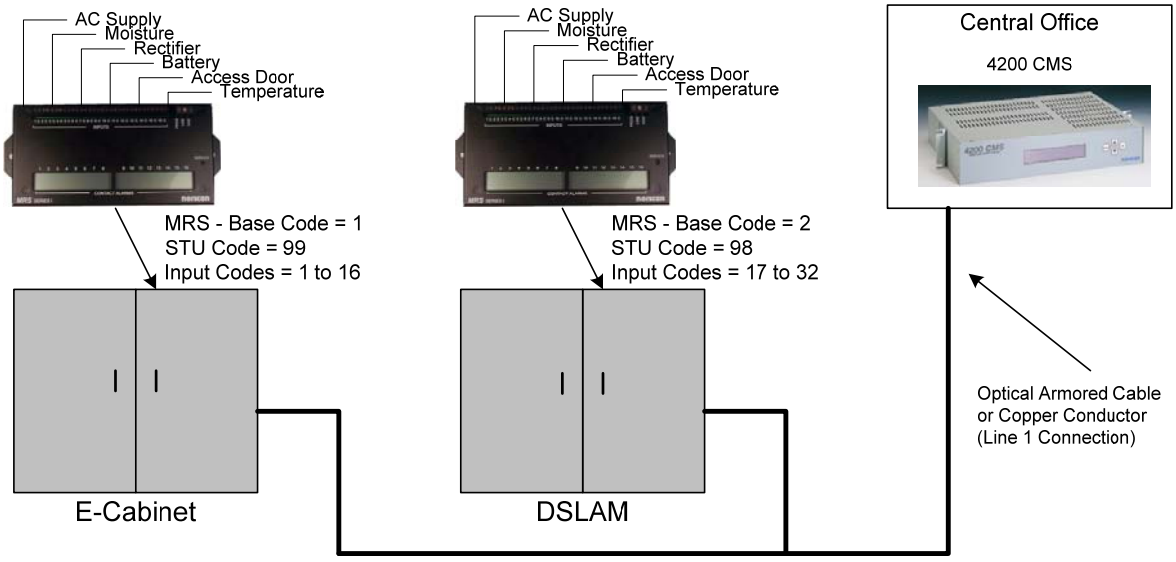


Figure 12: MRS Install Diagram

The status of each MRS connected to the 4200 ACU card and its designated Line (1, 2, 3 or 4) can be tested to verify the operation of each unit. When a status test (end to end code check) is executed, each MRS will be polled and its STU code is expected to be received. If a MRS does not respond with its STU code, a Line Alarm will be forwarded to the alarm monitoring center.

3. Installation

The following instructions will explain the installation of a 4200 Cable Management System that is used in conjunction with a 4200 ACU card for metallic cable conductor and sensor monitoring.

A typical monitored cable network is illustrated in Figure 13 with the 4200 CMS unit located in the originating central office. In operation, the metallic conductor (armored cable, copper pair or tracewire) becomes a sensing element which can give indication of damage to the protective outer jacket (creating a resistive fault to ground), once detected, will cause cable alarms. To prevent corrosion at any damaged site, the system inherently applies a protective cathodic current to the metallic conductor.

Addressable sensors are strategically placed throughout the cable network to monitor for specific occurrences. Splice Sensor Unit (SSU) and Moisture Detection Tape (MTD) are placed in every splice enclosure to monitor for wet splices. The Sequence Termination Units are place at the end of each line/branch and monitor the metallic conductor to ensure that end to end connectivity is maintained along with end of line sensor decode testing. Remote cabinet/building monitoring is achieved by placing Battery Fail and Multiplexed Remote Sensors at those locations to indicate the environmental or equipment operation status.

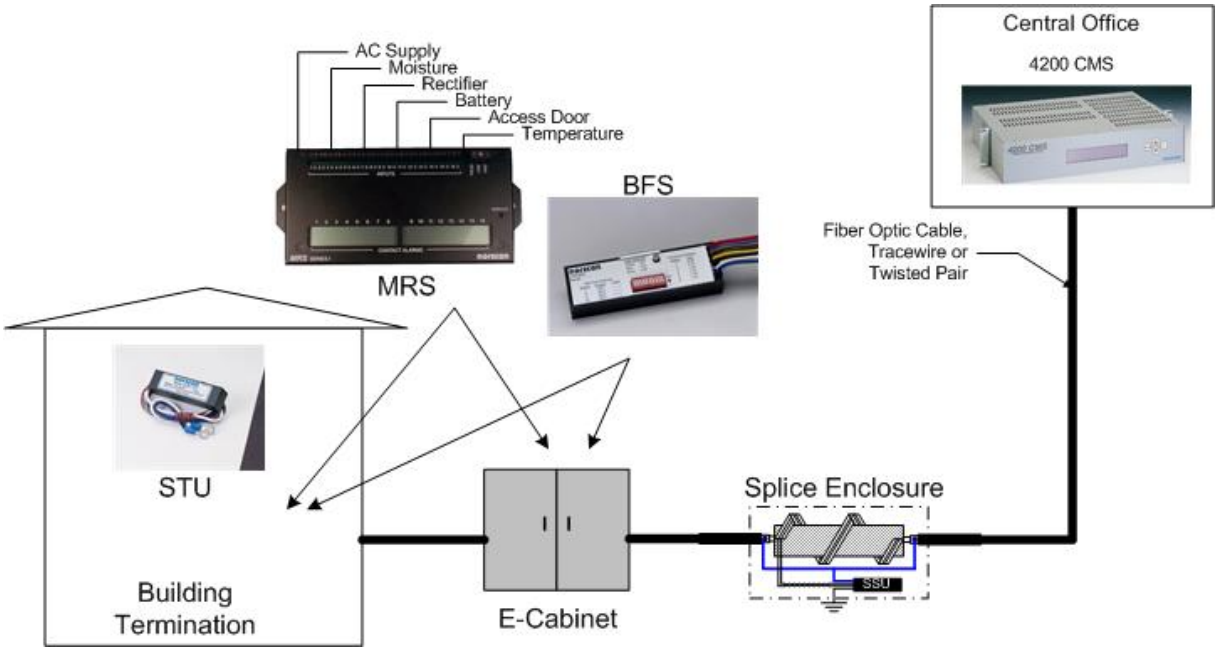


Figure 13: Typical Cable/Sensor Monitoring Installation

3.1 Alarm Circuit Unit (ACU) card

The Alarm Circuit Unit card provides constant monitoring of the metallic conductor (detection line) for sensor activation signals, end to end continuity, and faults to ground damage.

Each ACU card can monitor up to 78 miles or 125 kilometers of continuous metallic cable conductor or any combination of cables whose combined length is 78 miles or 125 kilometers.

The ACU card can be configured to operate in one of four different line monitoring modes which are related to the type of communication schemes that the sensors are using to transmit sensor codes. The four types of communication schemes that are available are Standard, SISU, TSU or IRIS. The sensor communication requirement is identified by the model number printed on the sensor label. Model numbers that are **not** identified with a '-S' are Standard communication, with a '-S' are SISU, TSU model number uses TSU communication and IRIS model numbers use IRIS. MRS sensors can only use SISU communication because of the possibility of multiple alarm activations at the same time.

Each Alarm Circuit Unit card can monitor up to 799 sensor cable monitoring devices. Security products such as the BFS, IRIS or MRS sensors have limits to the number of these types of sensors that can be installed on an outside plant line, contact Norscan for more details.

In an ACU/STU network this would include up to 20 STUs and the remaining would be Splice Sensor Units (SSU).

In an ACU/TSU network this would include 1 TSU, up to 4 Branch Termination Sensors (BTS) or Branch Circuit Terminations (BCT), and the remaining number can be Splice Sensor Units (SSU).

3.2 Installation at the Central Office

The Alarm Circuit Unit card (ACU) card can be installed in slots 3, 4, 5 or 6 of the 4200 CMS chassis. Note: A Maximum of four ACU cards can be installed in one 4200 CMS chassis. Ensure that the 4200 CMS unit is powered off before installing or removing any of the cards from the chassis.

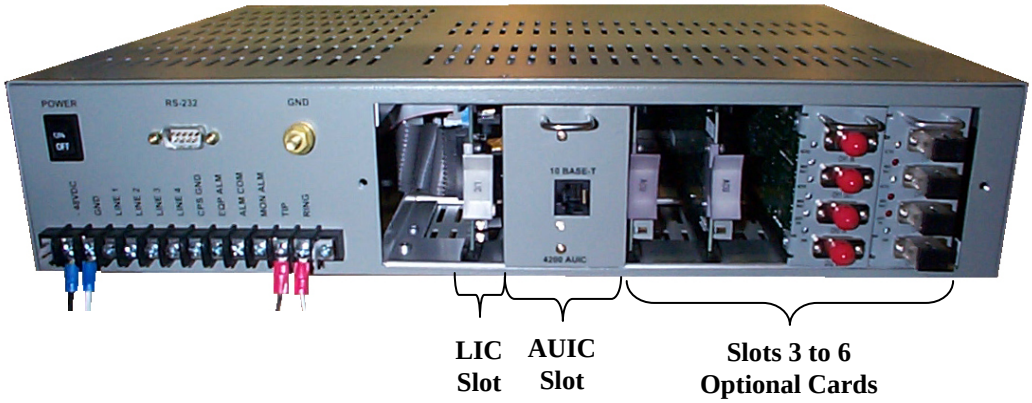


Figure 14: 4200 CMS Slot Designation

Figure 14 above illustrates the exposed plug-in slot designation when the back panel is removed. Slots 1 and 2 are reserved for the LIC and AUIC cards that are keyed to only allow these two cards to fit into the first two slots respectively. Slots 3 to 6 can accommodate up to 4 optional plug-in cards that are available for this system. As mentioned earlier up to 4 ACU cards can be installed in the 4200 CMS chassis to accommodate four outside plant lines for cable armor monitoring.

3.3 Connecting to Terminal Block (North American version)

Connect all wires carefully to the terminal block according to your cable system network. A description of each connection is explained in Table A.

POSITION	FUNCTION	DESCRIPTION
TB1-1	-48 Vdc	Central office battery voltage connection to -48 Vdc supply. Use a minimum 16 American Wire Gauge (AWG) wire. ***Must be fused at 5 amps.***
TB1-2	GND	Earth or Station ground connection. Use a minimum 16 American Wire Gauge (AWG) wire. ***Note: Not to be confused with CPS Anode GND.***
TB1-3	LINE 1	Input connection line for ACU metallic conductor monitoring or MTM tone access line. Use a minimum 24 AWG wire. ***Warning: Must be connected to a Transmitter Protection Assembly unit at the cable vault area. Shock Hazard Warning (Page 22).***
TB1-4	LINE 2	Input connection line for ACU metallic conductor monitoring or MTM tone access line. Use a minimum 24 AWG wire. ***Warning: Must be connected to a Transmitter Protection Assembly unit at the cable vault area. Shock Hazard Warning (Page 22).***
TB1-5	LINE 3 or CPS1	Input connection line for ACU, CPS metallic conductor monitoring or MTM tone access line. Use a minimum 24 AWG wire. ***Warning: Must be connected to a Transmitter Protection Assembly unit at the cable vault area. Shock Hazard Warning (Page 22).***
TB1-6	LINE 4 or CPS2	Input connection line for ACU, CPS metallic conductor monitoring or MTM tone access line. Use a minimum 24 AWG wire. ***Warning: Must be connected to a Transmitter Protection Assembly unit at the cable vault area. Shock Hazard Warning (Page 22).***
TB1-7	CPS ANODE GND	Cathodic protection sacrificial Anode Ground connection. Use a minimum 10 AWG wire to connect Anode Ground to this terminal. ***Note: Not to be confused with GND.***
TB1-8	EQUIPMENT ALARM	Output connection for an external supervisory alarm system. Use a minimum 24 AWG wire. (Relay switch is normally in OPEN state)
TB1-9	ALARM COMMON	Common connection for an external supervisory alarm system. Use a minimum 24 AWG wire.
TB1-10	MONITORING ALARM	Output connection for an external supervisory alarm system. Use a minimum 24 AWG wire. (Relay switch is normally in OPEN state)
TB1-11	PHONE TIP	Input connection phone tip line for using modem communication. Use a minimum 24 AWG wire.
TB1-12	PHONE RING	Input connection phone ring line for using modem communication. Use a minimum 24 AWG wire.

Table A: TB1-Terminal Block Connections (North American version)

3.4 Connecting to Terminal Block (UK and European version)

Connect all wires carefully to the terminal block according to your cable system network. A description of each connection is explained in Table B.

POSITION	FUNCTION	DESCRIPTION
TB1-1	-48 Vdc	Central office battery voltage connection to -48 Vdc supply. Use a minimum 16 American Wire Gauge (AWG) wire. ***Must be fused at 5 amps.***
TB1-2	GND	Earth or Station ground connection. Use a minimum 16 American Wire Gauge (AWG) wire. ***Note: Not to be confused with CPS Anode GND.***
TB1-3	LINE 1	Input connection line for ACU metallic conductor monitoring or MTM tone access line. Use a minimum 16 AWG shielded twisted pair wire (typical length 10 meters). ***Warning: Must be connected to a LPU and IVF at the cable vault. LPU not required with MTM.***
TB1-4	LINE 2	Input connection line for ACU metallic conductor monitoring or MTM tone access line. Use a minimum 16 AWG shielded twisted pair wire (typical length 10 meters). ***Warning: Must be connected to a LPU and IVF at the cable vault. LPU not required with MTM.***
TB1-5	LINE 3 or CPS1	Input connection line for ACU/CPS metallic conductor monitoring or MTM tone access line. Use a minimum 16 AWG shielded twisted pair wire (typical length 10 meters). ***Warning: Must be connected to a LPU and IVF at the cable vault. LPU not required with MTM.***
TB1-6	LINE 4 or CPS2	Input connection line for ACU/CPS metallic conductor monitoring or MTM tone access line. Use a minimum 16 AWG shielded twisted pair wire (typical length 10 meters). ***Warning: Must be connected to a LPU and IVF at the cable vault. LPU not required with MTM.***
TB1-7	CPS ANODE GND	Cathodic protection sacrificial Anode Ground connection. Use a minimum 10 AWG wire to connect Anode Ground to this terminal. ***Note: Not to be confused with GND.***
TB1-8	EQUIPMENT ALARM	Output connection for an external supervisory alarm system. Use a minimum 24 AWG wire. (Relay switch is normally in OPEN state)
TB1-9	ALARM COMMON	Common connection for an external supervisory alarm system. Use a minimum 24 AWG wire.
TB1-10	MONITORING ALARM	Output connection for an external supervisory alarm system. Use a minimum 24 AWG wire. (Relay switch is normally in OPEN state)
TB1-11	PHONE TIP	Input connection phone tip line for using modem communication. Use a minimum 24 AWG shielded twisted pair wire (typical length 1.5 meters).
TB1-12	PHONE RING	Input connection phone ring line for using modem communication. Use a minimum 24 AWG shielded twisted pair wire (typical length 1.5 meters).

Table B: TB1-Terminal Block Connections (UK & European version)

3.5 Installation at Cable Vault or Cable Entry Location

It is recommended that a Transmitter Protection Assembly (includes two Induced Voltage Filters (IVF) and two TI355 Gas Tubes) be installed at the Cable Vault or Building Entry Location. The use of these devices prevent the potential for stray voltage surges or induced AC voltages from causing serious harm to personnel, equipment and the cable itself. ***Note: This applies to all 4200 CMS systems that are using ACU, CPC cards and MTM modules.***

The Transmitter Protection Assembly is mounted to the wall surface in close proximity to the cable vault area. Connect the metallic conductor from the outside plant to the appropriate connection terminals (East/North, West/South) as they are labeled on the front cover of the assembly. Using a feeder cable (usually 22 gauge, 4 wire, twisted pair shielded cable), connect the 4200 CMS line 1, 2, 3 or 4 to the L1 or L2 terminal block (one line per terminal block, Line 1 to L1, Line 2 to L2) in the Transmitter Protection Assembly. When using twisted pair wire, make sure that one wire of the pair is to L1 or L2 and the other wire of the pair is to GND of the terminal block. Ground the entire Transmitter Protection Assembly by connecting the Ground/Earth terminal to Building Ground (Figure 15).

Warning!

Potential for electrical shock exists when handling cables while the Alarm Circuit Unit (ACU) card is activated or the Multi Tone Module (MTM) is transmitting tone frequencies. Make sure that the ACU card is set to OFF and that the MTM is not transmitting tone on the cable that is being handling at that particular time. Always take DC and AC measurements using a Norscan 1303 System Test Set or a Multi-meter to determine what AC or DC voltages are present before handling the cable. *Note*: Induced AC and transient voltages can also be present on the cable armor. Temporarily hard ground the cable armor before handling the cable in the central office, outside plant splice or remote termination location. Once the work is completed, remove the hard ground connection to the cable armor. Remove the cable armor connection first and then the local ground connection.

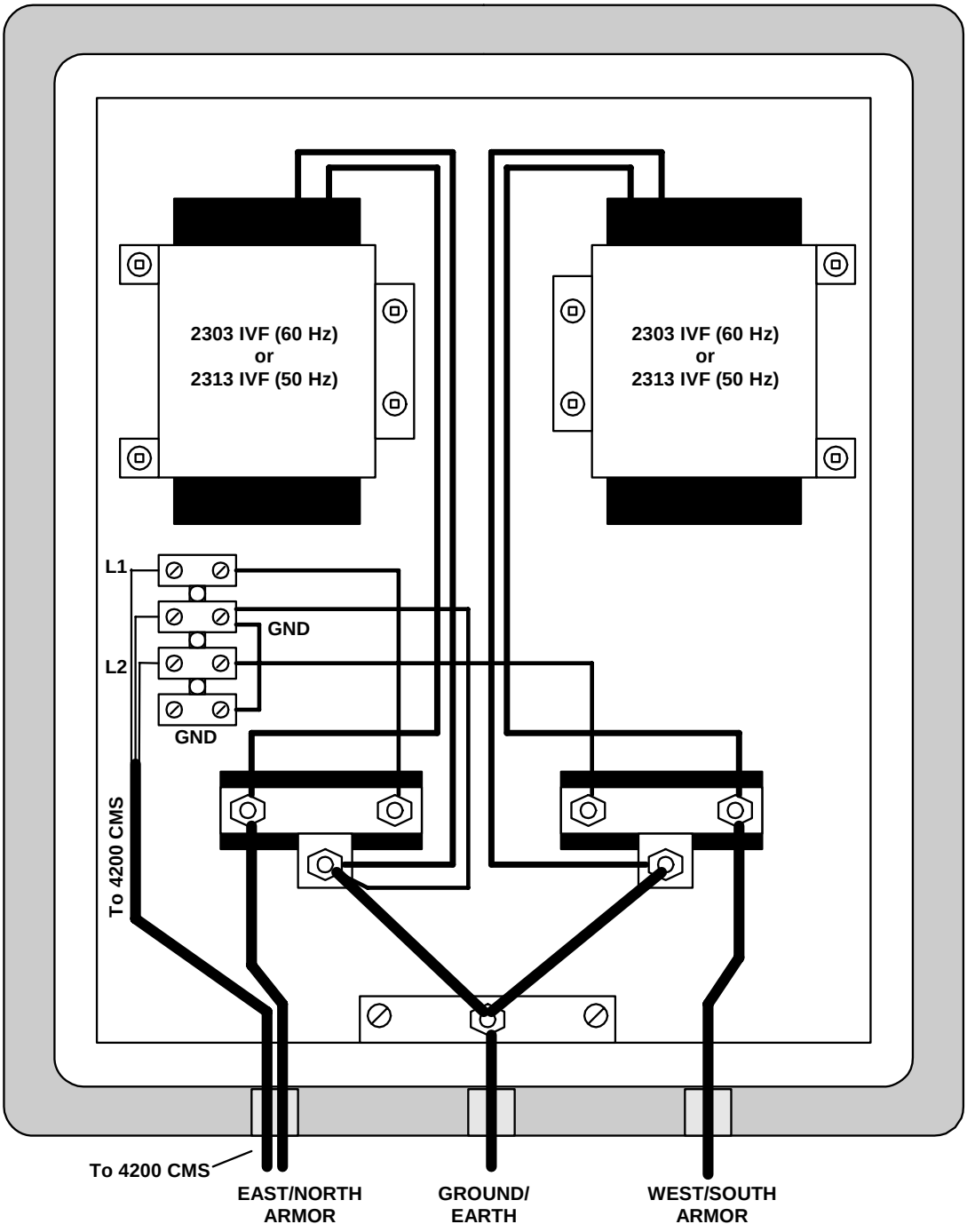


Figure 15: Transmitter Protection Assembly at Cable Vault (Building Entry)

3.6 Installation at Splice Enclosure

The following diagram illustrates the proper way of connecting the cable conductors for monitoring, along with the connection of both the SSU and MDT (Figure 16).

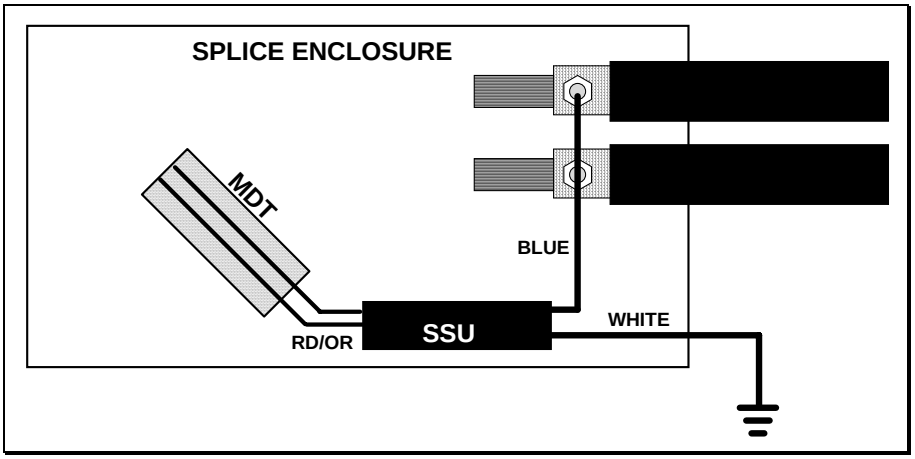


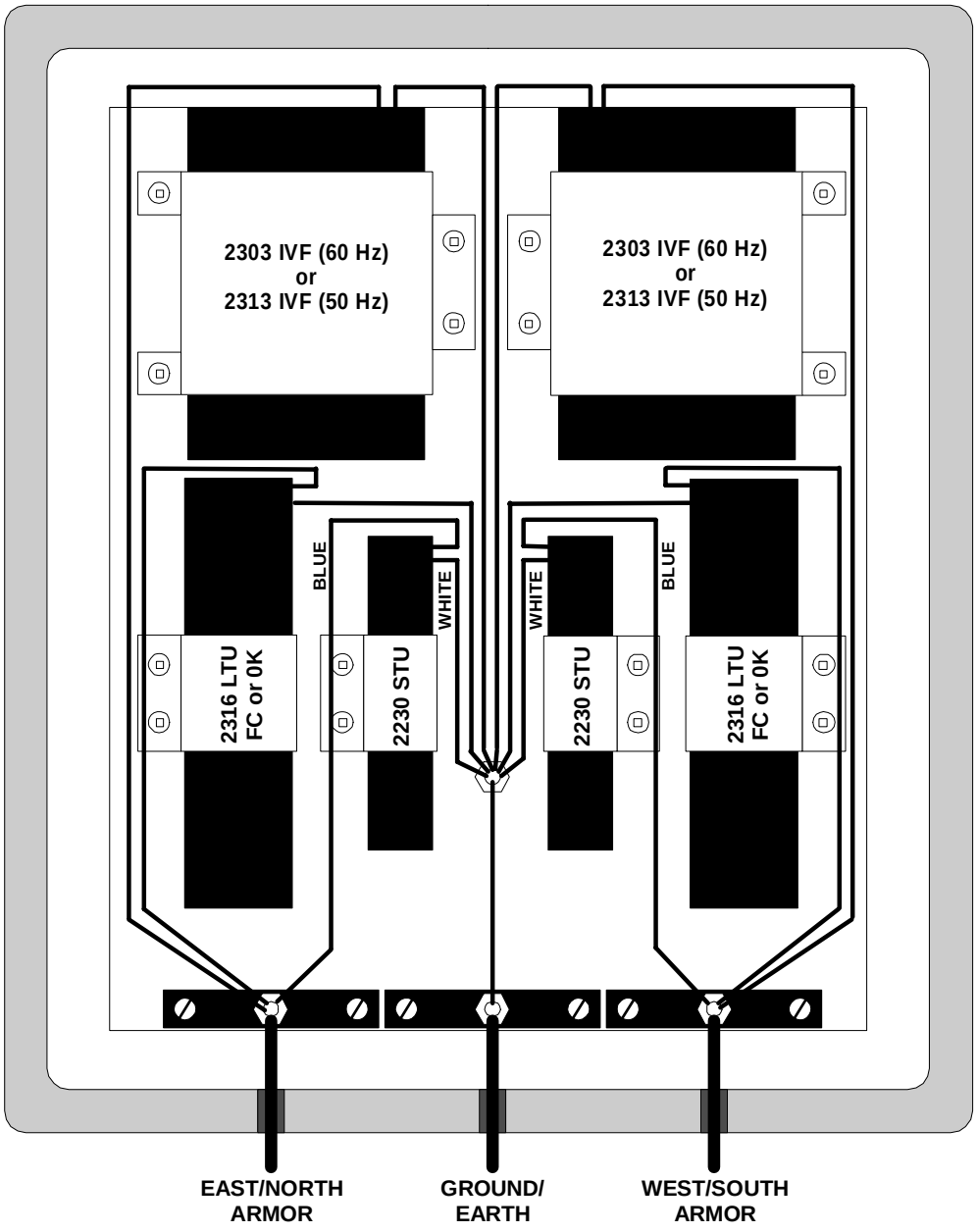
Figure 16: Installation at Splice Enclosure

3.7 Installation at a Termination

It is recommended that a Termination Protection Assembly (includes two Induced Voltage Filters (IVF), two Line Termination Units (LTU) and two STU, TSU or BTS terminations) be installed at the Cable Vault or Building Entry Location. The STU, TSU and BTS terminations are used to terminate the cable monitoring system. The LTUs are used to provide a return ground path for a tone generated signal for the MTM module which is used in cable locate exercises. The LTU not required for cable and splices monitoring. The STU, TSU and BTS devices have gas tubes embedded in their circuitry, so along with the IVF units, prevent the potential for stray voltage surges or induced AC voltages from causing serious harm to personnel, equipment, and the cable itself.

The Termination Protection Assembly is mounted to the wall surface in close proximity to the cable vault area. Connect the cable conductor from the outside plant to the appropriate connection terminals (East/North, West/South) as they are labeled on the front cover of the assembly. Ground the entire Transmitter Protection Assembly by connecting the Ground/Earth terminal to Building Ground (Figure 17). ***Note: Remember to program the termination sensors out of circuit and reconnect accordingly once programming is complete.***

Model 51300 - TERMINATION PROTECTION ASSEMBLY



Label P/N 50130

Figure 17: Termination Protection Assembly at Building Entry

The following diagram illustrates the proper way of connecting a Termination Sensor (STU, TSU, & BTS) in a splice enclosure (Figure 18).

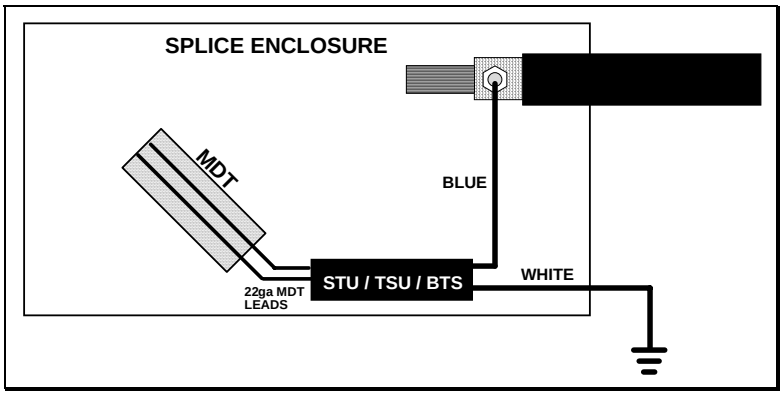


Figure 18: Termination Installation in Splice Enclosure

3.8 Battery Fail Sensor Installation:

Once the BFS sensor is securely mounted within the remote cabinet or building location, connect the BFS leads to the cable network and batteries as illustrated by the chart below.

BFS	CONNECTION
Red	Monitored Battery –48 Vdc
Purple	Monitored Battery Mid-Point 4 (-24 Vdc)
Grey	Monitored Battery Mid-Point 3 (-24 Vdc)
Brown	Monitored Battery Mid-Point 2 (-24 Vdc)
Yellow	Monitored Battery Mid-Point 1 (-24 Vdc)
Black	Monitored Battery Ground
Blue	CMS Monitored Line
White	CMS Ground

3.9 Multiplexed Remote Sensor Installation:

Once the MRS sensor is securely mounted within the remote cabinet or building location, connect the MRS leads to the cable network as illustrated by the picture below.
Terminals 1C to 16C are input connections, Line is cable network connection and GND is ground.

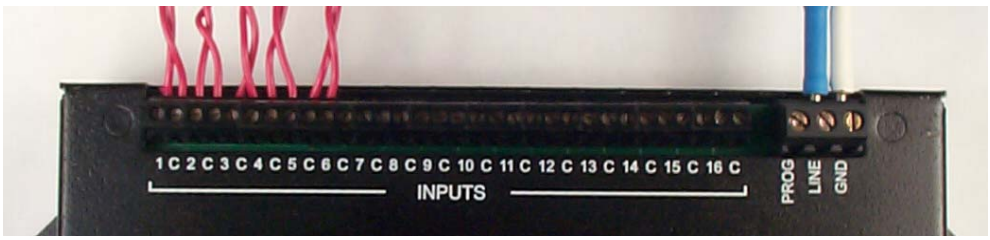


Figure 19: MRS Connections

4. Configuring the Alarm Circuit Unit card

This section will explain the configuration of a 4200 ACU with an AUIC.

Connect to the 4200 CMS via serial, modem or Telnet connection and login using the administrator or diagnostic access. For connection and login details see the ***4200 Cable Management System (CMS) with AUIC*** user manual.

4.1 Line Selection and Configuration

The Main Menu allows the user to configure up to four outside plant lines that correspond to the number of ACU cards that are installed in the 4200 CMS chassis. Each line must have an individual ACU card associated with it to perform cable monitoring. Lines 1, 2, 3, and 4 are designated for cable monitoring and are associated with the TB1 terminal block connection on the back of the 4200 CMS chassis.

To configure a Line for cable monitoring, select the line you want to configure by positioning the arrow beside Line 1, 2, 3 or 4 (Figure 20) and press **enter**.

```
                          Main Menu
->Line 1. <no description> - no cards connected
  Line 2. <no description> - no cards connected
  Line 3. <no description> - no cards connected
  Line 4. <no description> - no cards connected

  System Configuration
  Comms Configuration
  Date/Time Configuration
  Tone Frequency Configuration
  Alarm Target Configuration
  Diagnostics

  Quit
```

Figure 20:4200 CMS Main Menu

4.2 Outside Plant (OSP) Line Configuration

The Main Menu (Figure 20) shows each outside plant (OSP) line connected to the TB1 connector on the rear of the 4200 CMS and each fiber connected to an Optical Alarm Unit (OAU). Lines one through four are the OSP lines and lines five through twelve are used for optical monitoring. A user programmed line description identifies each line. The message “no cards connected” will appear on an OSP line if there are no services associated with that line.

To configure an OSP line, highlight the desired line number (1 – 4) on the 4200 CMS Main Menu and press **enter**. The Line Control Menu will be displayed (Figure 21).

```
                    Line Control Menu
Line 1: <no description>
Tone    :OFF

  Activate Tone (577Hz)
  Activate tone safety lock
->Configure Line..
  Back
```

Figure 21: Line Control Menu for OSP Line

Select the **Configure line** option to open the Configure Line Menu (Figure 22).

```
                Configure Line Menu
  Select tone frequency (577Hz)
  Change tone auto-shutoff period (10 hours)
->Add a service…
  Remove a service…
  Change line description
  Back
```

Figure 22: Configure Line Menu

The Configure Line Menu allows configuration of services that are available on the current line. The tone locating service is always available on the line if the MTM module is install into the 4200 CMS chassis; any additional services must be added to the line in order to be used.

Add a service: Select this option to add a service to the current line. The Add Service Menu will appear (Figure 23). This menu will list all the services that are available for the selected line. Select **Armor monitoring** (metallic conductor ~ armored cable, copper pair or tracewire) for the line and press **enter** (Administrator or Diagnostic login only).

```
                Add Services Menu
->Armor monitoring
  Back
```

Figure 23: Add Services Menu

Remove a service: Select this option to remove a service from the current line. The Remove Service Menu will appear listing the services currently on the line. Select a service to remove and press **enter** (Administrator or Diagnostic login only).

Change line description: This option allows the user to change the line description for the current line (Administrator or Diagnostic login only). The line description is used to identify the line in any alarm reports and on-screen menus.

4.3 ACU ~ Monitoring Configuration

The armor (metallic conductor ~ armored cable, copper pair or tracewire) monitoring service must be added to activate armor monitoring. To set up the monitoring select an OSP line and add the armor monitoring service as described in section 4.2 Outside Plant (OSP) Line Configuration.

The Configure Line Menu (Figure 24) will now have an option for configuring armor monitoring (Administrator or Diagnostic login only).

```
                Configure Line Menu
->Configure armor monitoring…
  Configure tone locating…
  Add a service…
  Remove a service…
  Change line description…
  Back
```

Figure 24: Configure Line Menu with armor monitoring

Select the **Configure Armor Monitoring** and press **enter**. The armor configuration menu will appear (Figure 25).

```
                Armor Configuration
->Set Line type                 <Standard>
  Toggle alarm reporting        <ON>
  Set alarm delay               <5 min>
  Sensor baud                   <03 baud/normal>
  Set line alarm threshold      <400 R>
  Set cable alarm threshold     <1 mA>

  Clear STU data
  Initialize STUs
  Set lowest STU code           <Unset>
  Setup automatic STU tests     <Off>
  Configure sensors…
  Back
```

Figure 25: Armor configuration

To configure armor monitoring, review the following armor configuration settings and press **enter** to change an option.

- **Set line type**: It is important to match the communication of the sensors installed in the outside plant to the proper communication setting on the ACU card to insure proper decoding of the sensors when activated Figure 26. When this option is selected, a warning will appear stating that changing the Line type (sensor communication scheme) will reset all settings to default (press enter on <OK> or tab to <Cancel> and press enter). If <OK> was selected from the warning screen, the **Select line type** menu will appear. Select the type that matches the type of

sensors that are installed in the outside plant; **Standard** (SSU/STU sensors labeled 1107B or 1107C SSU, 2230B or 2230C STU), **SISU** (SSU/STU sensors labeled 1107B-S or 1107C-S SSU, 2230B-S or 2230C-S STU, 1160 MRS), **TSU** (TSU sensors labeled 2207B or 2207C) and **IRIS** (when using the infrared motion sensor). ***Default is Standard***.

Sensor Model Type	**Set Line Type to:**
1107B or 1107C (SSU)	Standard
2230B or 2230C (STU)	Standard
1107B-S, 1107C-S (SSU)	SISU
2230B-S, 2230C-S (STU),	SISU
1160 MRS	SISU
2207B or 2207C (TSU)	TSU
1151 IRIS	IRIS

Figure 26: Sensor and Set Line Type chart

If this ACU card will be used for security products, chose either the MRS or IRIS according to the product installed. If the IRIS security product is installed you will be prompted to enter the total number of IRIS sensors that are installed on the line. ***Note: There are limitations to the number security sensors that can be installed on each ACU card, contact Norscan for more details.***

- **Toggle alarm reporting**: Activate or deactivate the armor alarm reports. Default is ON.

- **Set alarm delay**: Set the delay between an alarm occurring and the delivery of the alarm report. Default is 5 min.

- **Set baud rate**: This option will display the Select a Baud Rate Menu (Figure 27). Select the baud rate of the monitored sensors and the characteristics of the OSP line being monitored and press **enter**. Default is 03 baud/normal.

```
   Select a Baud Rate
->03 baud/normal
  10 baud/normal
  32 baud/normal
  03-10 baud/normal
  03 baud/high cap
```

Figure 27: Select a Baud Rate Menu

- **Set line alarm threshold**: Set the maximum difference between the nominal line resistance and the last tested value before a line alarm will occur. Default is 400Ω.

- **Set cable alarm threshold**: Set the maximum difference between the nominal line current and the present current before a cable alarm will occur. Default is 1.0mA.

Next, complete the following steps to configure and initialize the STUs.

Note: The Initialization process has to be performed on new installations or if any new branches are added to an existing cable network system. Initializing an STU cable network should only be done when the monitored line has no faults or relatively low fault current (below 1.0mA) on the ACU card.

- **Clear STU data**: Select this option to clear all the termination data for the current line.

- **Set lowest STU code**: Enter the lowest numbered STU code that is installed on the current line and press **enter**. Testing will begin with STU code x99 and decrease by one for each subsequent test until the lowest STU code has been tested. For example, on a line with three terminations the STU codes will be 99, 98, and 97 so the lowest STU code will be 97.

- **Initialize STUs**: This option will execute a STU test and record the nominal resistance of the current line. The line will not be initialized if the lowest STU code has not been entered. The recorded nominal resistance will be compared to the resistance measured during a termination test to check the end-to-end continuity of the OSP line.

- **Setup automatic STU tests**: Select this option to program the frequency of the automatic termination tests. If daily or weekly is selected the user will be prompted for an hour and a day to run the test. Default is off. The termination test will check the end-to-end continuity by measuring the line resistance of the OSP line and perform a sensor decode operation. If either of the tests fails a line alarm will occur.

- **Configure sensor**: This option allows the user to enter a description for a specific sensor code (for more detailed instructions see Appendix – A of this manual). When this option is selected, a menu will appear showing all the previously entered sensor descriptions for this Line and an option for adding a sensor description. To add a sensor description, select **Add Sensor** and press **enter**. Type the sensor code and description and press **enter** on OK to accept the changes.

5. ACU Monitoring/Operation Overview

This section describes the operational functions of the ACU card and how cable armor (and/or copper pair or tracewire) monitoring is achieved when installed in a 4200 CMS chassis with an AUIC (Advanced User Interface Card).

5.1 Monitoring Operation

To view or control the monitoring functions, ensure the monitoring service has been added to the desired line (see section 4.2 Outside Plant (OSP) Line Configuration) then select the OSP line from the main menu and press **enter**. The Line control menu will appear (Figure 28).

```
                    Line Control Menu
Line 1: <no description>
Sensor   :Standard no alarms
Armor    :ON –0.00mA >150kR no alarms
Tone     :OFF

->Deactivate armor monitoring
  Reset alarms
  Perform termination test
  View test results
  Activate tone (577Hz)
  Activate tone safety lock
  Configure line…
  Back
```

Figure 28: Line Control Menu for OSP Line

The first four lines of the Line Control Menu show the current status of the OSP line.

- **Line x**: Indicates which OSP line is being displayed and the corresponding user line description. Where x is the current line number (1,2,3 or 4 on the TB1 connector on the rear panel of the 4200 CMS).

- **Sensor**: This indicates the sensor communication scheme (Standard, SISU, TSU or IRIS) of the OSP line and any line or sensor alarms that are currently triggered. If a sensor is in an alarm state the sensor code is shown. If the termination test has failed a ***line alarm*** is indicated and the termination code if any is shown. All reporting of the sensor or line alarms are processed through the AUIC card, refer to the 4200 CMS with AUIC manual for alarm reporting setup instructions.

- **Armor**: Shows the fault current and resistance between armor/copper conductor and ground on the selected OSP line. When the resistance between the armor/copper conductor and ground is greater than 150kΩ the display will show >150kR. If the fault current exceeds the preset cable alarm threshold a cable

alarm will occur and is indicated by **cable alarm**. All reporting of the cable alarms are processed through the AUIC card, refer to the 4200 CMS with AUIC manual for alarm reporting setup instructions.

- **Tone**: Shows the status of the locating tone on the current line.

The Line control menu items are used to control the armor monitoring functions.

- **Deactivate armor monitoring**: This option is used to toggle the –48 Vdc monitoring voltage that is applied to the armor/copper conductor. Use this option to disable the monitoring without losing saved termination data.

- **Reset alarms**: This option will reset all alarms on the current OSP line. Any faults or sensor codes still active on the OSP line will re-alarm after the alarm delay has passed.

- **Perform termination test**: When this option is selected, a termination test will be executed on the current OSP line. The termination test will check the end-to-end continuity and termination sensor decoding of the OSP line. With a STU termination, this test will also measure the line resistance and compare it to the initial value recorded when the STU initialization was completed.

- **View test results**: Use this option to view the results of the termination test. Test results will only be shown if the line has been properly initialized. For STU terminations, select the branch to be displayed and press **enter** (Figure 29), a table will appear that shows the initialized line resistance and the line resistance of the last termination test (Figure 30). **Note: The MRS unit has a built in STU sensor which is used for termination testing (end to end code check). The STU code that is assigned to the MRS is dependent on the Base Code programmed into the MRS sensor (see Table 4).**

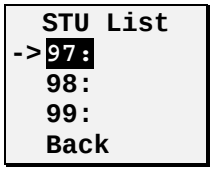


Figure 29: STU List

```
                    View Sensor Data
Line 1: <no description>
STU 99:  Termination description

            |  Current  |  Voltage  | Resistance | Code  |
            |-----------+-----------+------------+------|
  Nominal   |  7.41 mA  |  35.3 V   |   1.44 kR  |  99   |
  Last Test |  7.41 mA  |  35.3 V   |   1.44 kR  |  99   |
           +-----------+-----------+------------+------+

Status
  Resistance Threshold:  400
  Test result:           Normal

                          <Back>
```

Figure 30: STU Test Results Table

The test result field will display one of the following test results:

Normal: Termination test passed line is OK.

Alarm: The termination test failed.

If the termination test failed, one or both of the following alarms will be displayed:

Missed Code: The 4200 did not receive the STU code.

High Resistance: The line resistance has increased by more than the resistance threshold.

6. Appendix A – Sensor Configuration

The 4200 AUIC card contains a database that allows for the configuration of a variety of sensors that are installed within the outside plant cable network. Specific details regarding sensor type (SSU, STU, BFS, IRIS or MRS), code, description and location can be stored within the database. ***Note: The AUIC 'Plus" version of firmware will allow for more descriptive Alarm Reports. The AUIC standard version will only report very basic information regarding the alarm occurrence (i.e. gives sensor code number with no Description or Location information).***

TYPE	FUNCTION	DESCRIPTION
SSU Splice Sensor Unit	Water Ingression	Mainly installed in below grade splice enclosures and monitors for water ingression into the splice enclosure within an armored cable or copper conductor network.
STU Sequence Termination Unit	End to End line testing and water ingression	Mainly installed in a building termination point for armored cable or copper conductors and is used to test end to end continuity and sensor communication. Can be installed in a below grade line terminating splice enclosure when monitoring for water ingression is required.
MRS Multiplexed Remote Sensor	Remote cabinet monitoring and end to end testing	Installed in remote cabinets or building locations. Has 16 normally open alarm contact points for various alarm switch devices. Is equipped with termination point sensor code testing as used in the STU termination test.
BFS Battery Fail Sensor	Remote cabinet battery fail monitoring	Installed in remote cabinets or building locations for battery fail monitoring.
TSU Termination Sensor Unit	Termination testing and water ingression	Mainly installed in a building termination point for armored cable or copper conductors and is used to test for end to end continuity and sensor communication. Can be installed in a below grade line terminating splice enclosure when monitoring for water ingression is required.
IRIS Infrared Intrusion Sensor	Intruder detection	Installed in remote buildings or man-hole infrastructures to detect physical entry of normally secured areas.

Table 3: Sensor Description and Function

To initiate the sensor configuration process, arrow down to Configure line from the Line Control Menu.

```
                    Line Control Menu
Line 1: <City Center – North Cable>
Sensor   :Standard no alarms
Armor    :ON –0.00mA >150kR no alarms
Tone     :OFF

  Deactivate armor monitoring
  Reset alarms
  Perform termination test
  View test results
  Activate tone (577Hz)
  Activate tone safety lock
->Configure line…
  Back
```

Figure 31: Line Control Menu

Select Configure armor monitoring from the Configure Line Menu.

```
              Configure Line Menu
->Configure armor monitoring…
  Configure tone locating…
  Add a service…
  Remove a service…
  Change line description…
  Back
```

Figure 32: Configure Line Menu

Select Configure sensors from the Armor Configuration menu Figure 33.

```
              Armor Configuration
  Set Line type               <Standard>
  Toggle alarm reporting      <ON>
  Set alarm delay             <5 min>
  Sensor baud                 <03 baud/normal>
  Set line alarm threshold    <400 R>
  Set cable alarm threshold   <1 mA>

  Clear STU data
  Initialize STUs
  Set lowest STU code         <Unset>
  Setup automatic STU tests   <Off>
->Configure sensors…
  Back
```

Figure 33: Armor Configuration Menu

The next screen prompt is to add a sensor to the database, press enter to proceed.

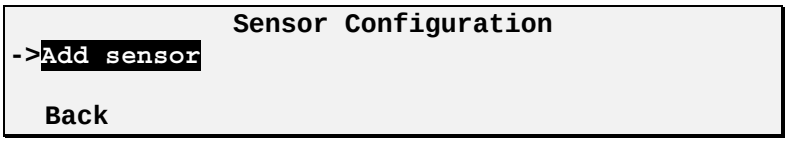


Figure 34: Sensor Configuration Menu

The Select Sensor Type menu will appear. Arrow down to the sensor type you would like to configure and press enter when done.

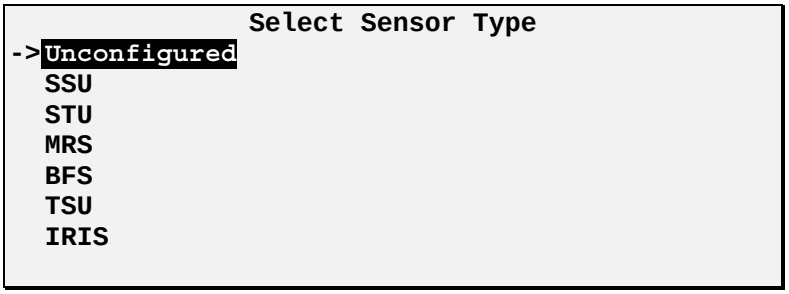


Figure 35: Select Sensor Type Menu

For **SSU, STU, BFS, TSU** and **IRIS** sensors, the configuration process is the same. You will be prompted to enter a sensor code number. Enter the sensor code that correlates with the number of the sensor that was install in the outside plant. Press enter when done and once more on <OK> or tab to <Cancel> and press enter. **Note: Limited to a 3 digit code.**

Figure 36: Sensor Code Menu

The next screen allows for the programming of specific identification of the sensor code that was just entered. If there are no changes to be made to the Sensor Type or Sensor Code press the <Tab> key to move to the Description and Location entries. Enter in the appropriate information in for the Description and Location of the sensor, press enter on <OK> when done or tab to <Cancel> the sensor update process. Repeat the Add Sensor as required until all sensors are programmed into the database.

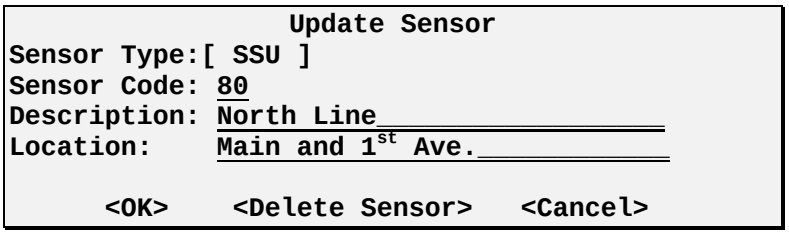


Figure 37: Sensor Update Screen

Once all the sensors have been configured into the database the Sensor Configuration screen will list the sensors that are currently in the database. If required, modifications can be done to any of the sensors by simply highlighting the sensor using the arrow key and pressing enter.

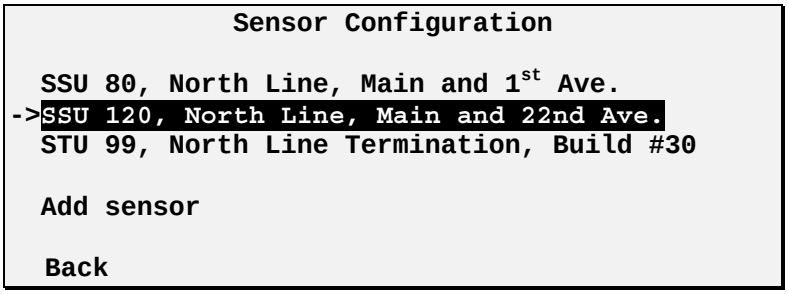


Figure 38: Sensor Configuration Screen

MRS Configuration:

To configure the database when using **MRS** units within the outside cable plant network, certain rules are followed in order for the database to work properly. As indicated by the table below, each MRS unit has a Base Code which represents a block of 16 sensor code inputs along with a termination Status Code. Base code '001' represents 1 to 16 sensor code inputs with a termination Status Code of 99, base code '017' represents 17 to 32 sensor code inputs with a termination Status Code 98 and so on.

		Sensor Codes		
Defender Number	Base Code	min	max	Status Code
1	001	001	016	99
2	017	017	032	98
3	033	033	048	97
4	049	049	064	96
5	065	065	080	95
6	081	081	096	94
7	097	097	112	93
8	113	113	128	92
9	129	129	144	91
10	145	145	160	90
11	161	161	176	89
12	177	177	192	88
13	193	193	208	87
14	209	209	224	86
15	225	225	240	85
16	241	241	256	84
17	257	257	272	83
18	273	273	288	82
19	289	289	304	81
20	305	305	320	80
21	321	321	336	79
22	337	337	352	78
23	353	353	368	77
24	369	369	384	76
25	385	385	400	75
26	401	401	416	74
27	417	417	432	73
28	433	433	448	72
29	449	449	464	71
30	465	465	480	70

Table 4: MRS Base Code and Cross Reference

Select Configure sensors from the Armor Configuration menu Figure 33. The next screen prompt is to add a sensor to the database, make sure that 'Add sensor' is highlighted and press enter to proceed.

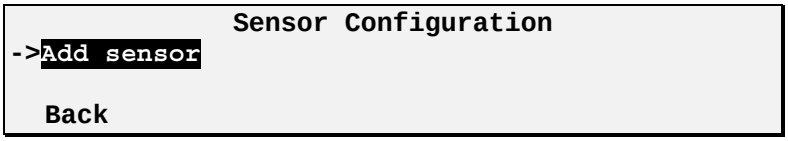


Figure 39: Sensor Configuration menu

The Select Sensor Type menu will appear. Arrow down to the MRS sensor type and press enter when done.

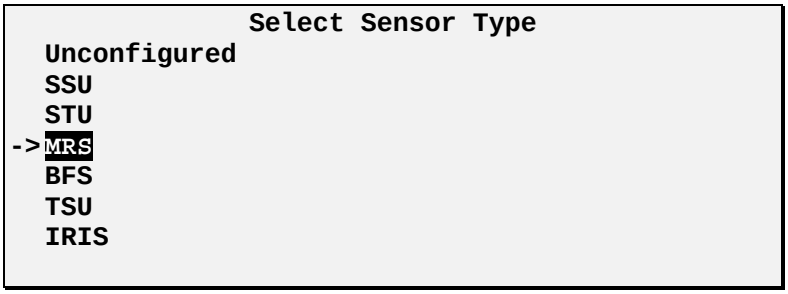


Figure 40: Select Sensor Type

You will be prompted to enter the MRS Base Code number (see Table 4: MRS Base Code and Cross Reference). Valid MRS Base Codes are 1, 17, 33…. 129, 225 and so on. Press enter when done and once more on <OK> to save the value, or tab to <Cancel> and press enter. **Note: Limited to a 3 digit code.**

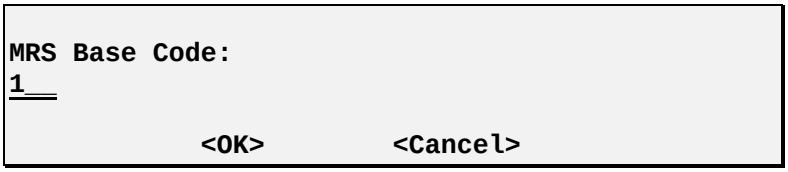


Figure 41: Armor configuration

The next screen allows for programming in specific identification of the MRS Base Code sensor that was just entered. If there are no changes to be made to the Sensor Type or Base Code press the <Tab> key to move to the Description and Location entries. Enter in the appropriate MRS **Description** and **Location**, press enter on <OK> to save values or tab to <Cancel> the sensor update process. Repeat the add sensor as required until all sensors are programmed into the database.

```
                Update Sensor
Sensor Type:[ MRS ]
Base Code: 001
Description: Inputs 1 to 16_____________________
Location:    Remote Cabinet – Main St._________

     <OK>    <Delete Sensor>    <Cancel>
```

Figure 42: Update Sensor - MRS

Once the MRS unit base codes are configured into the database, the 16 sensor code inputs can now be entered. Access to the MRS database is done through the Sensor Configuration menu. From this menu select the MRS base code unit that you want to configure and then press the **right arrow key** on your keyboard to expand the MRS base unit entry field (to minimize once expanded, press the left arrow key).

```
              Sensor Configuration

->+MRS1,Inputs 1 to 16,Remote Cabinet – Main St
  +MRS2,Inputs 17 to 33,Remote Cabinet – 1st St.
  Add sensor

  Back
```

Figure 43: Sensor Configuration - MRS

Type in specific details for each sensor inputs, leave the Input blank if sensor input is not being used. When complete, arrow down to Back to return to the main Armor Configuration menu.

```
              Sensor Configuration

  -MRS1,Inputs 1 to 16,Remote Cabinet – Main St
      MRS, Input 1, Cabinet Door
      MRS, Input 2, Power Supply
      MRS, Input 3, Temperature (High)
      MRS, Input 4, Temperature (Low)
    ->MRS, Input 5,
      MRS, Input 6,
      MRS, Input 7,
      MRS, Input 8,
      MRS, Input 9,
      MRS, Input 10,
      MRS, Input 11,
      MRS, Input 12,
      MRS, Input 13,
      MRS, Input 14,
      MRS, Input 15,
      MRS, Input 16,
    Add sensor

  Back
```

Figure 44: Senor Configuration – MRS Inputs

If you need further assistance please contact

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