

LMS-3 ARRM System Installation Guide

Revision 5 April 2002

LMS-3 ARRM System Installation Guide



Warning

This equipment is NOT approved for use in areas where hazardous gases may be present.



Warning

This equipment is only approved for use on cables subject to IEC664 Installation (Over-voltage) Category 3 or below at the Outposts and Category 2 at the LMS.



Warning

This equipment automatically applies high voltages to the cable sheath as part of its normal operation, appropriate working practices are required for anybody likely to come into contact with this.



Warning

The LMS, Outposts and LTUs contain surge protection devices that will discharge high currents to the grounds under some conditions, appropriate precautions are required.



Warning

The Outposts and LTUs can fail and pass large currents to ground resulting in hazardous voltages on the ground connections, suitable precautions are required.



This instrument, or family of instruments, will not be permanently damaged by reasonable electrostatic discharge. However, in extreme cases temporary malfunction may occur. If this happens, switch off, wait and switch on again.

Radiodetection makes every effort to ensure that information about locating equipment and its use is correct. Radiodetection accepts no responsibility for damage or problems caused through use of the equipment. Priority must be given to local and national safety requirements. Radiodetection products are under continuous development and are subject to change without notice.

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired

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1 SYSTEM OVERVIEW

1.1 INTRODUCTION

The Radiodetection Automated Remote Resistance Monitoring (ARRM) System automatically monitors the condition of underground cables, by measuring the cable-sheath resistance to ground, at each isolated cable-sheath section. It can be used with most types of cable having a conductive sheath and outer insulation. Other optional sensors are available for environmental monitoring, e.g. humidity, water ingress etc.

The ARRM System (refer to Figure 1) comprises the following:

- (a) A PC-based Central Monitoring Station.
- (b) One or more LMS-3 ARRM Transmitters (normally located within a regenerator building).
- (c) A number of 'Outposts' connected to the cable-sheath (usually at splices).
- (d) Line Termination Units (LTU).

The Outposts can be buried, or mounted within a manhole.

The cable sheath ground connection is made at the end of lines using LTUs.

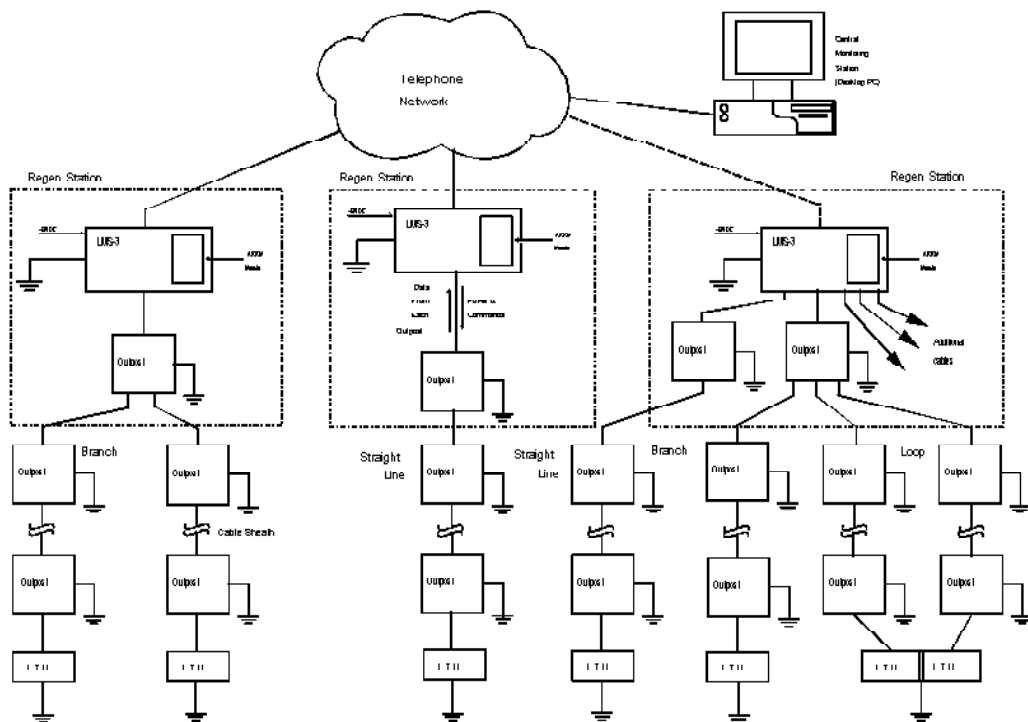


Figure 1. ARRM System

Periodically, at times programmed by the user, the LMS-3 will command each Outpost to measure the resistance to ground of its local cable-sheath section. Each Outpost in turn then transmits the information, via the cable-sheath (and ground return), back to the LMS-3. The Outposts also derive their power from the LMS-3 via the cable-sheath (and ground return).

The LMS-3 checks the data received from each Outpost and generates alerts if the operational limits are exceeded. The LMS-3 also stores the data until it is uploaded to the Central Monitoring Station, where it can be further processed.

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Optional sensors at each cable splice enclosure can measure humidity and the presence of liquid water detected.

The Central Monitoring Station analyses the data received from the LMS-3, and displays graphically how the cable-sheath resistance to ground changes with time.

The LMS-3 can be controlled locally, with a hand-held touch-sensitive display module, remotely over the Public Switch Telephone Network (PSTN) with Dual-Tone Multi-Frequency (DTMF) signals, with a remote PC, or a local laptop PC.

Cable sections between outposts are typically between 2km and 10 km in length. Any longer and faults will not be resolved to a reasonable length for fault finding and the capacitance to ground limit between outposts may be reached (this will also depend on the number of line filters installed). Much shorter generally has little advantage, but they can be as close as you like – to get more than 3 outputs two (or more) outposts are used with a section of Zero length between one of the outputs on the first and the input to the second.

When establishing the number of outposts to use, the work involved in maintaining the ARRM system must be weighed up against the improvements in maintaining the cable system, e.g. does adding thirty outposts (adds about one outpost failure per year) save more time finding faults than it takes to repair the outpost? (This is not a simple equation since it might include improved cable down time etc!)

In addition to ARRM, the LMS-3 enables advanced cable location and identification techniques to be used on the cable route.

During the period that the ARRM system is interrogating the Outposts, the normal LMS-3 locate and FF signals are disabled. At all other times the LMS-3 locate and FF functions operate normally.

1.2 ARRM MAIN FEATURES

By monitoring cables automatically, the Radiodetection ARRM system provides many advantages over traditional monitoring methods:

- (a) Automates a function that may only seldom, if ever, be performed.
- (b) Eliminates the time-consuming task of routinely visiting numerous cable section measuring points.
- (c) Provides Early Warning
The system can be configured to generate an alert if the resistance to ground of any cable-sheath section or other sensors falls outside a user-configured value.
- (d) Improves Network Reliability
Damage to a cable's outer insulation can be identified quickly, and repaired before internal degradation and loss of service occurs.
- (e) The LMS-3 can be controlled and monitored locally, or via the PSTN with DTMF signals or remote PC.
- (f) Frequent Monitoring
The cable-sheath resistance to ground can be monitored as frequently as once per hour, if required, and so provides an early warning of cable-sheath problems. Repair work can be scheduled to fit in with other maintenance tasks.
- (g) Eliminates the possibility of human error associated with measuring and recording the resistance at each measuring point.
- (h) From the historical data stored for each ARRM Base Station, the Central Monitoring Station can graphically display changes with time of the cable-sheath's resistance to ground and other sensors. This allows trends and patterns to be easily identified.
- (i) The Radiodetection ARRM system uses the cable's outer conductive sheath to supply power to the Outposts, and to transmit and receive data - the ground is used as the return path for power and signalling. Monitoring systems requiring additional conductors are not compatible with fibre optic cables containing only a conductive sheath.
- (j) Line Termination Units (LTUs) terminate Locate signals to ground without affecting the ARRM sheath insulation resistance measurement.

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1.3 OPTIONS

1.3.1 Switch Card

The Switch Card is an LMS-3 option which, when fitted, allows up to 16 external signal relays to be driven (a number of these may be energised simultaneously).

Not currently supported.

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2 PRE-INSTALLATION REQUIREMENTS

2.1 PRE-CONDITIONS

Before considering an LMS-3 ARRM system installation, the network must meet the following pre-conditions:

- (a) It must be possible to ensure the safety of everybody likely to come into contact with the cable. If this is not possible this system should NOT be considered for that installation. *This system applies high voltages to the cable sheath and therefore requires these to be considered.*
- (b) This system is intended for operation on fiber optic cables. It can be applied to copper cables provided :
 - the cable does not contain lines with high voltage supplies
 - a major fault in the cable that applies the ARRM system voltages to internal wires is acceptable
 - any coupling of the frequencies to be applied onto the wires is at acceptable levels
- (c) All measures necessary for safety, operating procedures, access covers, access control, etc. must be in place before commissioning the system can be considered.
- (d) Splices must be accessible for the installation of outposts.
- (e) Connection to the sheath must be possible. The connection method to be defined by the customer.
- (f) Suitable location for the LMS-3 must be available (e.g. Regeneration Station).
- (g) The cable must meet, or be better than the following operational limits:

Maximum number of Outposts:	26
Maximum total cable resistance:	1.8 k Ω
Maximum total capacitance to ground between Outposts:	20 μ F
Minimum total Fault Resistance to ground:	5 k Ω *
Maximum total length:	100 km

- (h) Additionally two grounds are required where maximum ground resistance at each outpost:

Power ground:	<400 Ω
Measurement ground:	<4k Ω

* This parameter affects the maximum number of Outposts that may be installed on a cable and the total distance that may be covered. If this value is exceeded the system may not operate.

- (i) Each Outpost requires the two grounds to be separated by 3 m (10 ft). Where this is not available the measurements may be degraded.
- (j) Outposts can be buried up to 3 m (10 ft) from the surface to improve protection from mechanical and environmental damage.

2.2 RESISTANCE CHECKS

Using a High Voltage Insulation Meter measure the sheath resistance to ground (with all ground connections removed). The total fault resistance to ground of the complete cable must be >5 k Ω .

For cables with a continuous sheath this can be measured in one measurement.

For cables with a discontinuous sheath, the resistance to ground between splices must be measured individually and added up.

Lower resistance measurements indicate that fault finding and rectification of faults must be carried out before continuing (refer to the Fault-Finding User Guide).

Isolate each section (where possible) when fault finding.

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2.3 OUTPOST CONNECTION



Warning

All Outpost connections are terminated in specially sealed crimps with 7mm holes. These crimps must not be removed since they form part of the sealing of the units and help prevent leakage from the cable into the splice.

Determine a suitable method for connecting an Outpost in accordance with Company work practices.

The connection to the cable is installation specific and usually performed by the customer, this connection needs to be adequate for the surge currents expected (lightning etc) and be low resistance.

Suitable conditions for two grounds separated by 3 m (10 ft), are required.



Warning

Outpost ground connections are used for surge discharge and hence can have high transient voltages on them. Suitable precautions are required to control this hazard.



Warning

Unless the ground connection can sustain 5A without rising to dangerous voltage levels it must be considered dangerous at all times. Under failure conditions of the Gas tubes or outpost electronics the ground connections can have sustained high currents passing through them (up to the available output of the LMS and any pickup on the line) inducing high voltages on them.

2.4 MAINTENANCE / OPERATING REQUIREMENTS



Warning

The safety of everybody likely to come into contact with the cable must be considered It is the customers responsibility to ensure that all aspects are considered.



Warning

This system automatically applies high voltages to the cable sheath. These can be periodic, be user requested, the sequences can be interrupted and automatically re-start later – NEVER operate on the cable without suitable precautions.



Warning

The LMS(s) must always be turned off when working on or near the cable without suitable precautions.

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3 CENTRAL MONITORING SYSTEM

3.1 INTRODUCTION

The Central Monitoring System is a standard desktop PC in an office environment. It requires a connection to the telephone network via a modem (either internal or external), connection to a printer and provides the following functions:

- (a) Centralised data capture, data management & viewing.
- (b) Alarm generation, including visual, fax, pager and e-mail.

Fax and e-mail require the NT Mail Client (Outlook or Exchange depending on the version) to be configured. Access to a Modem is required for fax and access to a Mail Server is required for e-mail.

- (c) Report Generation (fault/history reports).
- (d) Network analysis/planning tool providing:
 - (i) User entry of network configuration.
 - (ii) Network map generation and checking.

An IBM PC compatible to run Windows™ NT with the following specification is required:

Hardware

The minimum hardware requirements for the Central Monitor PC are as follows:

Microprocessor	Pentium 133 (P3 500+ recommended)
RAM	64 Mbytes minimum (128 Mbytes recommended)
HDD Capacity	2 drives (2 Gbytes minimum)
Video Adapter	VGA color or better
Monitor	VGA colour or better (19" recommended)
Keyboard	Standard 102 key
Mouse	Standard two-button serial or bus
Floppy Disk Drive	Standard 1.44 Mbytes
Communications	Internal or external V.32 bis modem (2 off)

Recommended Peripherals

2 Comm. ports	allows connection of a second modem
Colour Printer	for printing of graphical results
CD writer	allows an extra method of data backup

Software

In addition to the software supplied by Radiodetection, the Central Monitor PC requires Windows™ NT version 4.0 or later (Service Pack 3 or later).

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3.2 OVERVIEW

The CMS is a collection of software components running on a Windows NT platform.

The main components of the system are detailed in Figure 2.

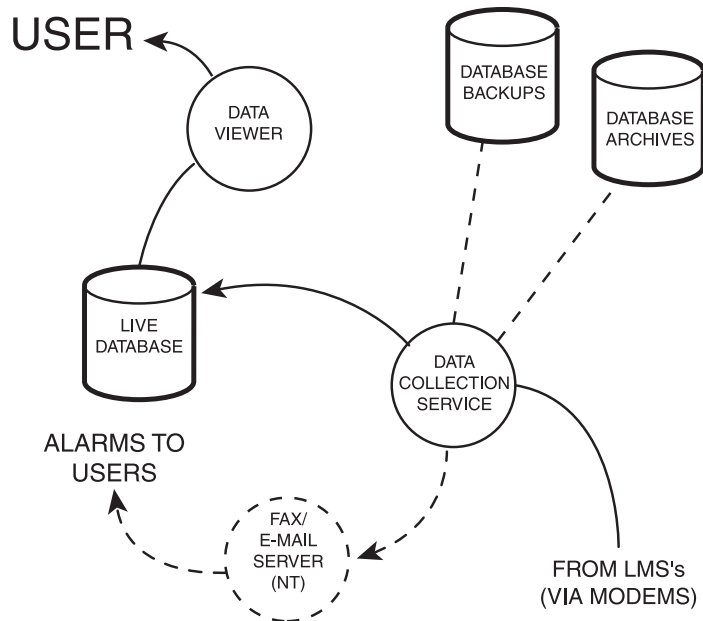


Figure 2. CMS Main Components

The Data Viewer provides the user with access to the information in the database. It presents the information in tabular and graphical formats as required. By default the Data Viewer looks at the live database but a window can be opened onto any database (i.e. an archive or backup).

The Data Collection Service (DCS) maintains the database with information from the LMSs. It is either rung by or rings the LMSs on a regular basis and updates its information. This program runs as a Windows NT service and needs to be set up accordingly.

If alarm conditions are reported it generates Fax/e-mail messages as defined by the set-up (this set-up is specified in the Address Book facility). To generate these it needs access to a Mail Client that supports them, commercial products as required support this. The DCS also maintains the backups and archives of the live database.

Backups

At a specified interval (nominally daily) a new copy of the live database is created in a backup directory (this should be on a different disk or machine). A set number of backups are maintained with old backups being deleted.

Archives

At specified periods (nominally monthly) data older than a certain age (nominally 90 days) is removed from the live database and an archive file is created for it. This is a database file that can be viewed by the Data Viewer. A new database file is created for each archive so with the default periods each archive file contains one months data and the most recent is 90 days old. A backup of Archive files is the responsibility of the operator.

3.3 INSTALLATION

3.3.1 PC Set-up

See instruction manual supplied with the PC.

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3.3.2 NT Set-up

Set up the computer and ensure that Windows NT with Service Pack 3, or later, is installed. See Windows NT documentation for information on this. Install drivers for the printers, modems and networks as necessary.

3.3.3 Remote access

If access to the data is required remotely then access needs to be provided; this can be performed by:

- (a) Adding a network connection with the relevant set-up.
- (b) Reserving modems for dial up networking and configuring accordingly etc.

The set-up of these features is specific to the implementation and managed by the customer.

3.3.4 NT Users

For the set-up of user accounts see the Windows NT manuals. Accounts should be set up as follows:

- (a) The Machine should have an Administrator account to allow maintenance of the system. This account should not be for general use.
- (b) If the DCS is to perform any operation over a network it will need an account with the relevant privileges. If the DCS is to be used locally it can be set-up to use the system account and hence does not need its own. If this account is ever changed after installation of the DCS, the DCS service information needs to be updated and the service needs to be restarted (in Windows 'Control Panel - Services').
- (c) Set up user accounts as required for the operators of the system.

Managing Users: for details see Windows NT user manuals

Select the 'User Config' tab.

This page displays a list of all configured users and three buttons to create, edit or delete users.

To create a new user, click the New User button. This displays the 'Add New User Details' dialogue. Enter the user details here.

Click OK when done to save new user.

Existing users may have their details changed by either double clicking the user in question, or by selecting the user and clicking the Edit button. This displays the 'Edit User Details' dialogue, where the user details can be edited. Click OK when done to save the changes.

Users may be deleted from the database by clicking the Delete button with the unwanted user selected.

3.3.5 Telephone Interface

Connect the modems internally or to spare COM ports and connect the telephone lines.

The modem can be installed using the standard Windows 'Control Panel'. Help on how to do this can be obtained via the 'Help' available from the Windows 'Start Menu'. You should always allow Windows NT to auto-detect the modem. Once installed, the modem properties should be checked.

From 'Control Panel' select 'Modems'.

For each modem, select 'Properties'.

Verify the 'Maximum Speed' is no higher than 38400 bps.

Click the 'Connection' button, then click 'Advanced'

Ensure that 'Use flow Control' is NOT checked.

Ensure that 'Use Error Control' is NOT checked (or not enabled).

Need to ensure that the set-up of the modem (Extra setting field) is as Appendix A:

Press 'OK' to finish the set-up.

Configure 'Dialling Properties' for the exchange (e.g. Dial '9' for an external line, only put this in one place - either here or in the telephone number, not both).

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3.3.6 Software Installation Overview

The Installation of the CMS is achieved by installing the DCS on the NT machine due to run the data collection and then installing the Data Viewer on as many machines as required (must have visibility of the database - directly, over a network or over dial up networking).

The CMS software is installed from a single CD-ROM. The set-up routine allows a choice of 1 of 3 options (DCS only, DCS & Data Viewer, Data Viewer only), depending on what you want to install.

Installation should be initiated by inserting the CD-ROM and running the Setup.exe program in the root directory of the CD-ROM.

Once this is set up, CMS Users will have to be defined for operators who want to make changes to the system set-up. When a change is to be made the software will prompt for a user and password. This provides a mechanism to prevent accidental modification of the system and is independent of the NT/Network security systems.

3.3.7 Data Collection Service (DCS)

Ensure that you are currently logged into the PC with Administrator rights. If you do not have Administrator rights then contact the System Administrator of the site and get them to organise this. You will not be able to install the DCS as a service unless you have Administrator rights.

Install the DCS from the CD-ROM by selecting either the 'DCS Only' option or the 'DCS & Data Viewer' option.

The set-up routine will give on-screen instructions.

As part of the set-up you will be asked where the DCS should create archive and backup files. Ideally these locations should be separate disk or on a remote machine across a network link so that data could be recovered in the event that the PC the DCS is being installed on crashes causing data corruption. You should ensure that the account that is set up for the DCS has full access rights to the locations you enter (check with the site's Network Administrator).

The DCS is an NT service, and thus needs to be explicitly activated through a service installation routine. This is done as part of the overall installation process.

Note that if a previous version of the DCS has already been installed as a service the Set-up routine will stop this service from running and automatically remove it from the NT Service list.

The newly installed DCS will then automatically be added to the NT Service list and will be set up to log on to NT as a System account.

Once set up, the DCS will run whenever the machine is running.

You may need to modify the default set-up of the DCS service in order for the service to run network operations such as archiving and backup. If no network access is required then there is no need to modify the default set-up of the service.

To modify the DCS service:

Set up a suitable user account for the DCS using the NT provided services (you will need suitable privileges to do this), consult your IT support group for this. A typical account name could be "DCS". You will also need to create a password for the DCS account, which does not need changing, or expire automatically. This account will need visibility and write access to the area where the Backups & Archives are wanted.

From Control Panel, start 'Services', select the 'DCS' service and click 'Start-up'.

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Under 'Log on As', select 'This Account' and enter the account created earlier for the DCS (including the password).

Click OK, then Close Services, and Close Control Panel.

Although defaults are provided for all directories and folders, it should be noted which directories are used in the event that changing the default databases at a later date may be required.

Once installation is complete, there are various options that can be configured using 'CMS Config' from 'Control Panel'. Most of the settings are default and need no further action but the modems to be used by the CMS do, however, need to be allocated.

From 'Control Panel' select 'CMS Config'.

In order to make changes to settings you should select the Edit option and then enter a CMS username and password, see below.

Click on the 'CMS - LMS Comms' tab.

The modem(s) installed above should be listed in the 'Modem Configuration' window.

Choose the number of modems to be used by the CMS. The CMS can only utilise a continuous block of modems starting from the first. Enter the number of modems in the 'Use First x Modems' box.

Other items can be verified/modified as required.

Reboot the system for these changes to take effect.

3.3.8 Data Viewer (& Alarm Monitor)

Install the Data Viewer from the CD-ROM by selecting either the "DCS & Data Viewer" or "Data Viewer Only" option.

The Data Viewer needs no further action and will be ready to run.

If the Data Viewer is being run on a remote machine the location of the Live Database will have to be set using the "CMS Config" program placed in the Control Panel.

A monitor program called "Alarm Monitor" is installed whenever the Data Viewer is installed, this program monitors the database and alerts the user if a new alarm condition is detected. A short cut to this program is inserted in the Start-up directory in the Start menu so that it is always running, if this is not required delete the item in the start-up group.

3.4 CONFIGURATION

3.4.1 CMS Users

In order to make changes to the settings (in the CMS Config) or alter the Network set-up on the Data Viewer you will have to enter a username and password.

This is only prompted for when an action is performed that can make a change, so users that do not want to make changes do not need to be defined.

A User (RADIODETECTION password RADIODETECTION) is created automatically for use at installation time; this can be removed if required once others have been created.

3.4.2 Creating and Editing the Network

LMSs can be added to the network as required using "Add New LMS" option in the Edit Menu.

To edit or create the network from an LMS, select the LMS then select the plan view (View Menu or Plan button).

Edit the plan as required

Outposts & LTUs can be added or deleted.

The network can be linked up to represent the system.

LMS, Line, Section & Outpost parameters can be edited from here.

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Committing the changes will update the database; this will create a scheduled event to download the information to the LMS(s) concerned. The event should be processed within a minute.

Rollback will cancel the changes, leaving the database as it was before the start of the editing session.

3.4.3 Scheduled Events

Scheduled events can be viewed, created, edited and deleted from the Scheduled events page in the Data Viewer.

The available actions include:

(a) DB Backup:

This action saves a copy of the current live database to the backup directory (set in the CMS Config). By default this event is daily, but can be changed to any period required.

(b) DB Archive:

This action moves data older than a configured date to the archive directory (set in the CMS Config). By default this event is monthly on day one of the month, but can be changed to any period required. The age of the data to be removed to an Archive file is set in the CMS Config.

(c) Upload LMS Results

This action can be used if the CMS is required to ring the LMS for the results rather than the LMS to report them after a test.

(d) Online Outpost or Line Reading:

This action dials a specified LMS and requests readings. It is created whenever a test on a section is requested.

(e) Housekeeping:

This action performs any internal DCS housekeeping (currently undefined). A default event of this type is created by the DCS on start-up, when there is no configured housekeeping event already configured.

Scheduled events may be added by clicking right mouse button in this window, entering a username and password, then selecting New Event.

This will result in the 'Enter Scheduled Event Details' dialogue being displayed.

Select the desired Event Code from the combo box. If the chosen event involves reading data from an LMS, the LMS id should also be selected at this point.

Next, select an Event time and cycle. The event may be run daily, weekly, monthly, annually or just once, at the specified time.

The event name is generated automatically when the event code and time are selected, but should then be edited to provide a more meaningful name.

Scheduled events may only have their event times and names changed. Once created, an event may not have its event code changed. The only way to change an event's code is to delete this event and create another one.

To edit an event, right clicking the event in question and selecting the Edit Event menu item.

Adding Readings to Scheduled Events

Select the event to delete, right click the event and select the Delete menu item.

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4 LMS-3 ARRM TRANSMITTER

4.1 INTRODUCTION

The LMS-3 ARRM Transmitter (Figure 3) provides signals for monitoring, locating and fault finding, and communicates with the Outposts (via the cable sheath) and the Central Monitoring Station (via the telephone network).

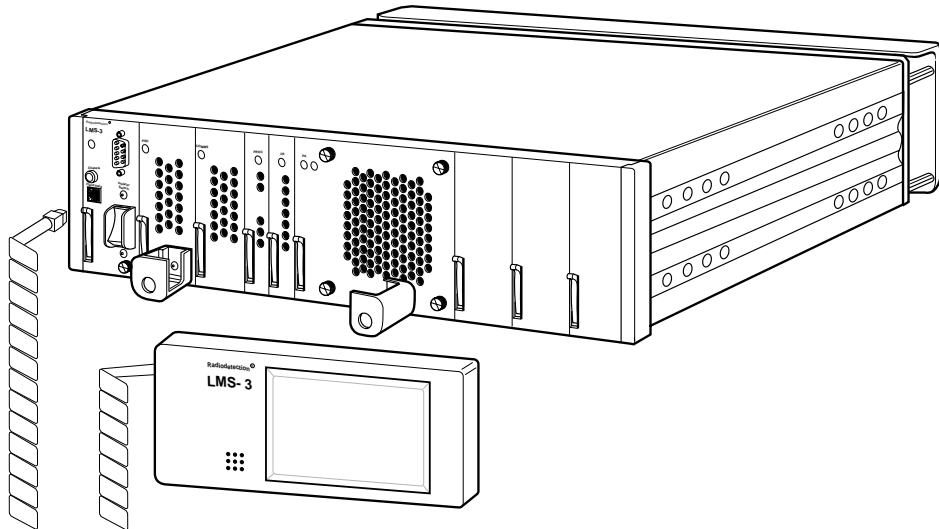


Figure 3. LMS-3 ARRM Main Unit and Hand-held Display Unit

4.2 HARDWARE INSTALLATION

The LMS-3 ARRM Transmitter is designed to be permanently installed in a standard 48.3 cm (19 in.) or 58.4 cm (23 in.) rack within a Regeneration Station.

Read through the whole of this section before starting the installation. Familiarise yourself with the procedure, and ensure you have all the information, equipment and tools you need.



Warning

Always follow relevant work practices when disconnecting any cable sheath from station ground. Remember high voltages may be induced on to the cable sheath.

The LMS-3 is capable of generating high voltages. It is most important to fit heat-shrink sleeving to all LMS signal path connections and to attach 'HIGH VOLTAGE' warning labels where appropriate.

4.2.1 Tools Required

The following tools are required to install an LMS-3 System:

Flat-Blade / Philips Screwdrivers

Pliers / Side Cutters

Crimping Tool

Crescent Wrench

Heat Gun

Voltmeter

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4.2.2 Preparation

Remove the Rear Panel Protection Plate, if fitted, and place it where it will not be damaged, or forgotten. Take care not to lose the screws.

The LMS-3 is supplied with three pairs of steel brackets for rack mounting, and a pair of plastic brackets to support the hand-held display unit. Select and fit these brackets as described below.

4.2.3 Fitting the Steel Mounting Brackets

Select the appropriate pairs of brackets, as described below, for the rack configuration required. The objective is usually to install the LMS-3 so that its front panel is in line with other equipment in the rack.

Flush Mounting

If the LMS-3 is to be mounted so that its front or rear is flush with the rack, unscrew the front or rear side-corners from the LMS-3 chassis. Fit the Flush Mounting brackets (Figure 4) in their place using the screws just removed. If the rack is 58.4 cm (23 in.) wide, fit the 58.4 cm (23 in.) extenders to the Flush Mounting brackets.

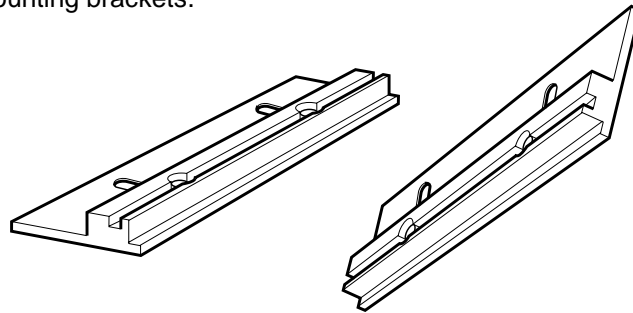


Figure 4. Flush Mounting Brackets

Intermediate Positions

If the LMS-3 is to be mounted so that its front or rear is not flush with the rack, do not remove the side corners from the LMS-3 chassis. Instead fit the Standard Mounting brackets (Figure 5), using the screws supplied, to any of the 8 fixing positions. The brackets can be fitted facing forwards or backwards. If the rack is 58.4 cm (23 in.) wide, fit the 58.4 cm (23 in.) extenders to the Standard Mounting brackets.

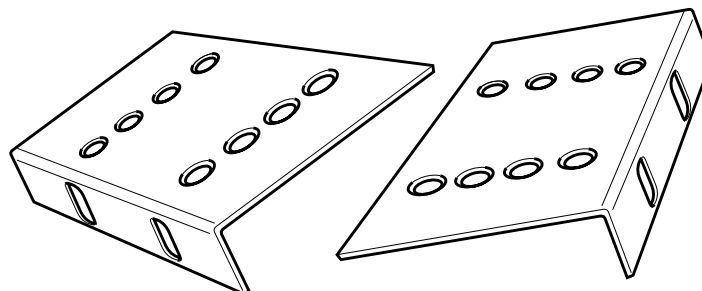


Figure 5. Standard Mounting Brackets

Fitting the 58.4 cm (23 in.) Cabinet Extenders

The extenders (Figure 6) are required only if the LMS-3 is to be installed in a 58.4cm (23 in.) rack. Screw these to the already fitted brackets, using the screws supplied.

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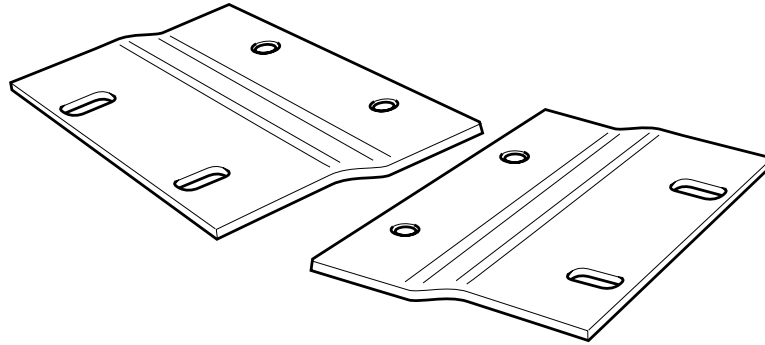


Figure 6. 58.4 cm (23 in.) Cabinet Extenders

4.2.4 Placing the LMS-3 in the Rack

The LMS-3 is designed to be rack-mounted in an air-conditioned Central Office or Repeater environment. It is important that the LMS-3 is positioned so that its ventilation holes are not obstructed.



Warning

The LMS-3 is heavy! Do not attempt to lift the LMS-3 into the rack without help. Always bend your knees, and keep your back straight, when lifting.

Determine where the LMS-3 will be installed, and fit captive nuts to the rack if required. Lift the LMS-3 into position and secure with the four screws and washers supplied.

Note: Do not make any connections to the LMS-3 rear panel at this stage.

Connect the hand-held display unit to the front panel connector, and rest the display in the plastic brackets.

4.2.5 Installing the Transmit-Line Equipment

The term 'Transmit Line', refers to a line which is driven by the LMS-3 Transmitter at this location. A Filter/Protector is normally connected between the cable closure and Ground.

Follow the manufacturers recommended guidelines for installing the cable closure.

Read this section before proceeding with the Transmit-Line installation.



Warning

Always follow relevant work practices when disconnecting any cable sheath from station ground. Remember high voltages may be induced on to the cable sheath.

Proceed as follows:

- (a) If the Transmit-Line already has a Filter/Protector, leave it connected. If there is no Filter/Protector, observe the 'Warning' above and disconnect the Transmit-Line Ground Strap (between the Transmit-Line cable closure and Station Ground).
- (b) Measure the ac voltage between the Transmit-Line Cable Sheath and Ground. If it is greater than 50 Volts, do not proceed until a 'Mains Filter' (Figure 8) has been installed, it should be connected between the cable closure and Station Ground.

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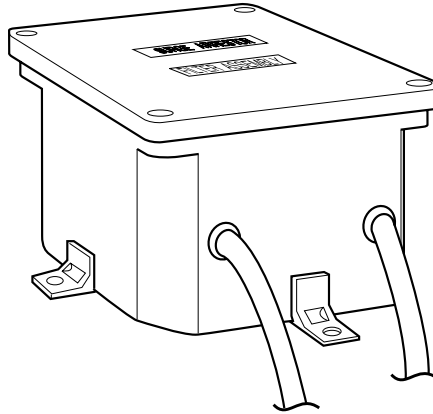


Figure 8. Mains Filter

Mount the Ground Control Unit on a vertical surface close to the Transmit-Line cable closure. Position the unit so that:

- (i) The distance between its lower (Ground) terminals and the Ground Bar is no more than 15.2cm (6 in.).
 - (ii) There is sufficient room to run #6 AWG cable from its upper terminals to the Transmit-Line cable closure, while ensuring the Bend Radius is at least 20.3 cm (8 in).
- (d) Using the Green #6 AWG wire and spade connectors provided, make connections to Station Ground from the ground terminal of the Ground Control Unit (internal).



Caution

Refer to working practices ensuring that the bend radius is not too small.

- (e) With the 3-pin XLR male and AMP relay drive connector at the LMS-3 Transmitter, route the signal/relay drive cable through appropriate cable ducting back to the Ground Control Unit.

Note: Do not connect to the LMS-3 at this stage.

Connect the other end of the cable to the GCU (Ground Control Unit) within the box.

IMPORTANT: ATTACH 'HIGH VOLTAGE' WARNING LABELS TO THE CABLE CLOSURES AND GROUND CONTROL UNIT.

4.2.6 Connecting the LMS-3 Transmitter

Read this section before connecting the LMS-3 Transmitter.

4.2.6.1 First Outpost

The first Outpost can be placed either before or after the line selection relays and protection.

If there are only two lines the first Outpost can be installed before the line selection, it therefore appears as the first Outpost on both lines and saves an Outpost.

If more flexibility is required the first Outpost can be placed after the line selection logic, this requires an Outpost per line, but does allow the other outputs of the Outpost to be used for other lines from that point.

Note: When using multiple outputs from an Outpost they are shorted together so 'Locate, Fault Find' etc. flows down all paths.

In either case the installation of the Outpost is the same as described later, except that the Outpost will need mounting in an appropriate location.

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4.2.6.2 General Connections

The LMS-3 Transmitter General Connections are detailed in Figure 9.

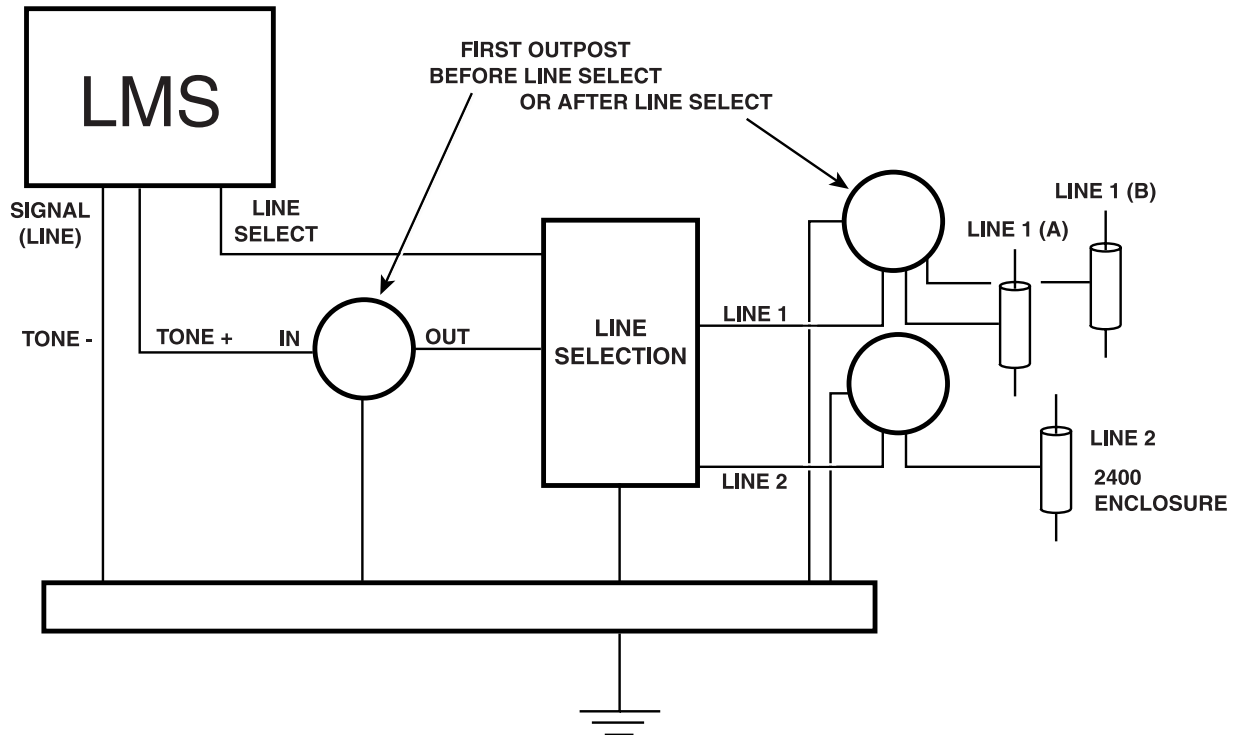


Figure 9. LMS-3 General Connections

4.2.6.3 Line Selection

There are three options for the line selection as follows:

- (a) Discrete relays

Connections for Line Selection using discrete relays are detailed in Figures 10 and 11.

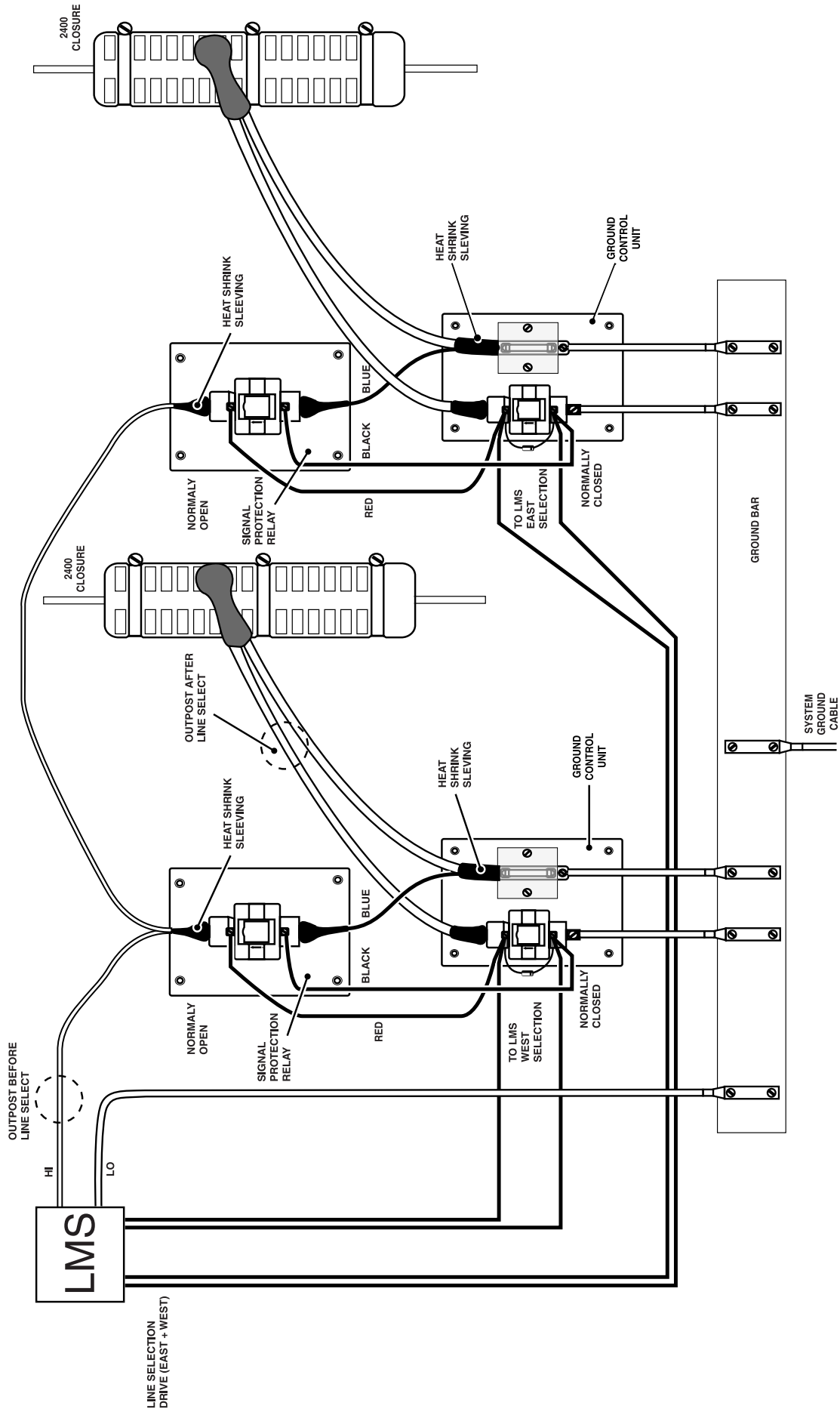


Figure 10. LMS-3 Discrete Relay Connections

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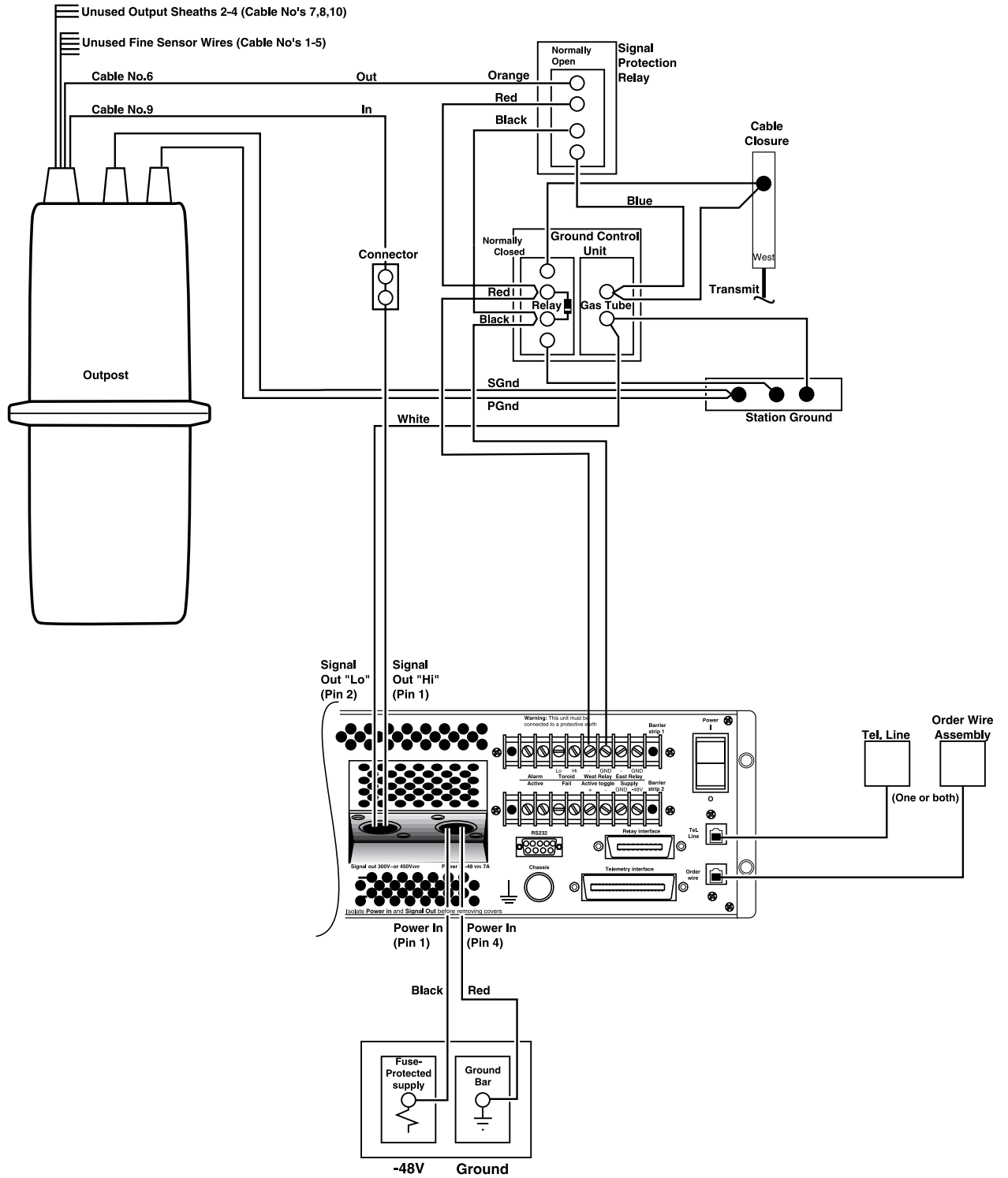


Figure 11. LMS-3 Rear Panel Connections

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(b) Two-way ACT Unit

Connections for Line Selection using a two-way ACT Unit are detailed in Figure 12.

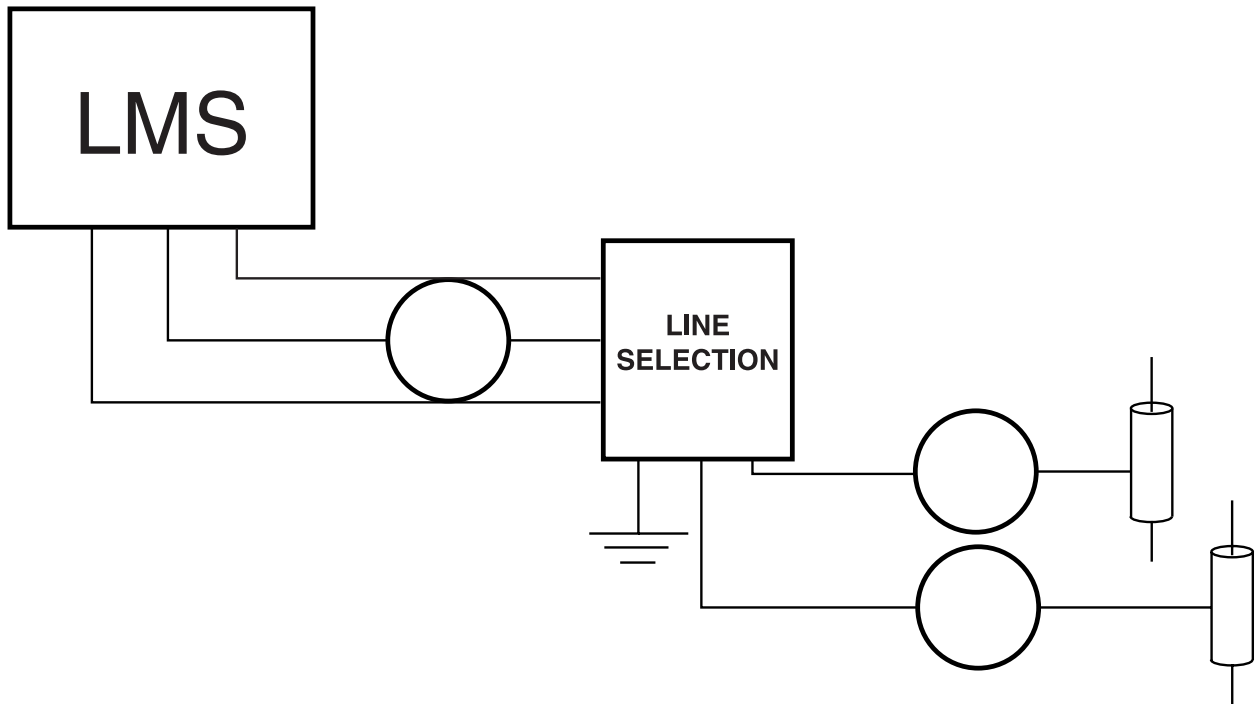


Figure 12. LMS-3 Two-way ACT Unit Connections

Connect the ACT Unit using the supplied Control Cable and separate Signal Cable.

Connect signal 'Lo' to the earth point and 'Hi' to the lower side of J1 and J2.

Remove jumpers J1, J2, J3 and J4.

(c) Radiodetection Line Control Unit

Connections for Line Selection using a Radiodetection Line Control Unit are detailed in Figure 13.

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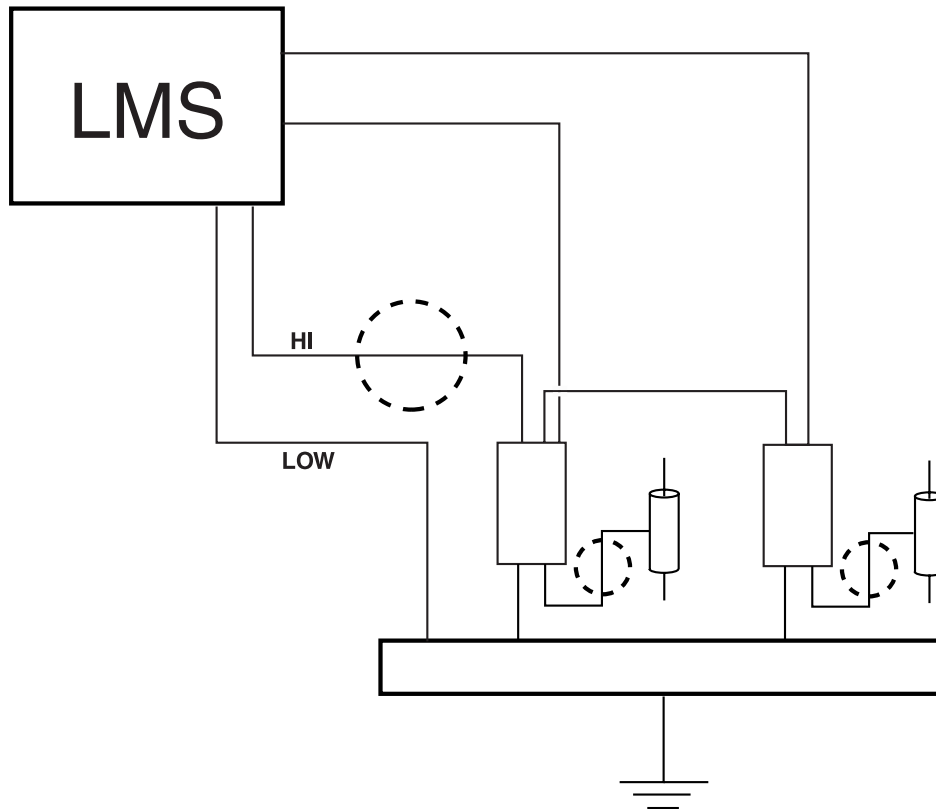


Figure 13. LMS-3 Line Control Unit Connections

Proceed as follows:

- (a) *Note: The LMS-3 Transmitter must be grounded to the rack.*

Cut to length a piece of #6 AWG insulated wire and fit a crimp connector to one end. Secure this to the rack with a screw, having first removed any insulating material (e.g. paint) from around the screw hole. Strip the insulation from the other end of the wire and connect it to the LMS-3 Rear Panel Chassis Ground.

- (b) The LMS-3 supports two types of DTMF control interfaces. The 'Tel. Line' Jack is for connection to a conventional telephone line for remote Direct Dial access. The 'Order Wire' Jack is for connection to Pulsecom, Dantel or Ft Series 6 order wire.

Connect the DTMF/Order Wire cable to either the 'Tel. Line' or the 'Order Wire' Jack as required. Route the cable through appropriate cable trays to the designated interface.

Telephone Interface

The wires provided are for standard US applications.

The following is a general guide to installation in other countries.

US modems are connected internally to pins 3 and 4 (the innermost pair) of the RJ11 connector.

UK modems are connected internally to pins 2 and 5 of the RJ11 connector.

Generally modems do not care about the polarity of the connection.

Determine the country of origin of the modem.

Determine which pins on the telephone socket are connected to the telephone wires and modify or make a lead to connect these together.

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- (c) With the 4-pin XLR female connector at the LMS-3 Transmitter, route the #16 AWG Red/Black Power Lead through appropriate cable ducting to the Power Bay.

Note: Do not connect to the LMS-3 at this stage.

In some cases it may be necessary to modify the supplied Power Cable to comply with existing requirements. At the Power Bay, remove the fuse.



Warning

The polarity of the Power connection is Critical.

When working on Live power, proper methods and procedures MUST BE FOLLOWED.

The Black wire of the Power Cable should be cut to length, terminated with a crimp terminal, and connected to the designated -48V terminal. The Red wire should be cut to length, terminated with a crimp terminal, and connected to Station Ground.

The -48 Volt d.c. supply to the LMS-3 must be fused at 10 Amps.

- (d) Return to the LMS-3, check that the rear mounted Power Switch is OFF, and connect the 'Power In' connector.
- (e) Connect the 'Signal Out' connector.
- (f) Fit the Rear Panel Protection Plate.
- (g) Check that the Front Panel Circuit Breaker is switched on, and then switch on the rear mounted Power Switch. The LMS-3 should always be switched on and off at the rear mounted Power Switch - not at the Circuit Breaker.

The unit will perform a self-test, lasting approximately 45 seconds. During the self-test some of the module LED's will be Red, and the PROC module LED will flash Red/Green. When the self-test is complete all module LED's should be Green, except the right-hand LED on the PA module, which should be off.

The Hardware Installation is now complete. Continue with paragraph 4.3 to set-up the Software Configuration using the INSTALL function.

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4.3 SOFTWARE INSTALLATION

This section describes how to use the LMS-3 'INSTALL' function to set-up its Software configuration. The information here is relevant to initial installation and subsequent modification (or re-installation).

If the LMS-3 has not previously been installed, or its configuration has been wiped, it will force you to use the INSTALL function after power-up. If at any time it is necessary to re-install the LMS-3, the INSTALL function can be accessed from the Utilities Menu.

The LMS-3 makes various line measurements during the INSTALL procedure, so all hardware must already be connected.

4.3.1 Preparation

Before Proceeding with the INSTALL function you will require the following information:

<u>INFORMATION</u>	<u>EXAMPLE</u>
(a) Your User ID: A numeric identification - up to 6 digits	1234
(b) Station number: A numeric station number - up to six digits	001030
(c) The Station Name: An alphanumeric name - up to 32 characters English station name and state	XING CHANG
(d) Which lines the LMS-3 will drive: East, West, or East and West	
(e) Whether or not the LMS-3 is required to monitor the Current received on a line driven by a remote LMS-3	NO
(f) Whether or not output levels in excess of 50 Volts or in excess of 100 Volts are authorised	YES
(g) Whether or not A.C.ID (Absolute Current Identification) is required	NO
(h) The Phone Number of the telephone line connected to the LMS-3 - (10 digits)	
(i) The LSMS phone number that the LMS-3 should automatically call - including any PBX access code	NIL
(j) The Serial Number of the LMS-3 - (5 digits)	10467
(k) The 'P' Number (Point Of Interest) of the LMS-3 Station - (7 digits)	P001234
(l) The Span Reference of each Span the LMS-3 will drive - (6 digits)	S00407

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4.3.2 Using the Install Function

The INSTALL function is controlled from the Display module by pressing touch-sensitive areas on the screen. Throughout this User Guide the term 'key' is used to refer to these touch-sensitive areas.

When a key is pressed, the display module generates a confirmation 'beep' sound. To indicate that a key's function is currently selected, the key is shown dark (inverse video).

If the display back-light is off, simply touch the screen anywhere to bring it back to life.

4.3.2.1 Ensure that all physical installation has been completed, and that all front panel LED's are showing green - the right-hand LED on the Power Amplifier (PA) module should be off.

4.3.2.2 If the LMS-3 has not previously been installed, or the configuration has been wiped, the display will show 'Unit is not installed'.

Press the INSTALL key to start the installation.

Have the information listed in 4.3.1 ready to input at the relevant times.

If you accessed the INSTALL function from the Utilities Menu, the Installation procedure continues at paragraph 4.3.6.

4.3.2.3 Using the displayed keypad key in your User ID (up to 6 digits).

Press the ENTER key.

Note: This screen is not displayed if you accessed the Install function from the Utilities Menu - go to paragraph 4.3.6.

The DEL key can be used to delete characters one at a time.

Pressing the 'Abort' key will abort the installation.

4.3.2.4 You will be asked to enter time date information during the install procedure. At the appropriate time proceed as follows.

Set the Time Zone (Table 1), Date and Time by pressing the arrow keys above and below each item. Select or de-select 'Daylight Saving' as required.

STANDARD CODE	DAYLIGHT SAVING CODE	TIME ZONE
AST	ADT	Atlantic Standard / Daylight-Saving Time
EST	EDT	Eastern Standard / Daylight-Saving Time
CST	CDT	Central Standard / Daylight-Saving Time
MST	MDT	Mountain Standard / Daylight-Saving Time
PST	PDT	Pacific Standard / Daylight-Saving Time
KST	KDT	Alaska Standard / Daylight-Saving Time
HST	HDT	Hawaii Standard / Daylight-Saving Time
GMT	BST	Greenwich Mean Time / British Summer Time

Table 1. Standard Time Zones

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Note: If it is necessary to change the Time Zone and/or Daylight Saving, do so before setting the time.

Press the ENTER key to proceed.

Pressing the 'Abort' key will abort the installation.

Note: It is necessary to manually adjust 'Daylight Saving' at the appropriate dates (i.e. twice per year).

When Daylight Saving is switched Off, the Time Zone codes are displayed as AST, EST, CST etc.

When Daylight Saving is switched On, the Time Zone codes become ADT, EDT, CDT etc.

Note: GMT/BST is the exception.

4.3.2.5 Having completed the 'Install function' the display will return to the Standby mode.

The LMS is now fully installed.

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5 SWITCH CARD

5.1 INTRODUCTION

The Switch Card is an LMS-3 option which, when fitted, allows up to 16 external signal relays to be driven (a number of these may be energised simultaneously).

Connection to the Switch Card is via a multi-way socket on the rear panel of the LMS-3.

Not Currently Supported.

5.2 INSTALLATION

Switch off the LMS-3 using the Power Switch on the Rear Panel.

Release the securing latch on the far right blanking plate and remove it from the LMS-3 Front Panel. Insert the Switch Card in slot 11 (the left-hand slot of the two which are visible) and latch into position.

Remove the Expansion Panel on the left-hand side of the LMS-3 Rear Panel. Connect the Switch Card Connection Module to the slot 11 pins on the rear of the LMS-3 backplane. Fit the panel mounted connector of the Connection Module to the LMS-3 Expansion Panel aperture.

Connect the LMS-3 Signal Out socket and the Connection Module socket to the ACT Switch Box.

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6 OUTPOST

6.1 INTRODUCTION

The Outposts perform the following functions under control of LMS-3:

- (a) Receive power and data.
- (b) Isolate sections of cable.
- (c) Measure local line parameters including:
 - (i) Resistance between sheath and ground.
 - (ii) Water and humidity in splice.
- (d) Verify the integrity of internal circuitry and external ground connections.
- (e) Transmit data to LMS-3.

The Outpost incorporates surge protection.

The Outposts are generally installed at each splice points along the cable route, typically two to ten kilometres apart dependant on user requirements and line parameters. They may be direct buried or installed in a manhole.

The Outposts have one input and two outputs, which allow connection in branched 'tree' or long networks. Two ground connections provide power ground and measurement ground (via two ground rods).

Any through connection between the cable-sheath sections must be removed. All connections must be sealed.

Typical Outpost connections are detailed in Figure 14.

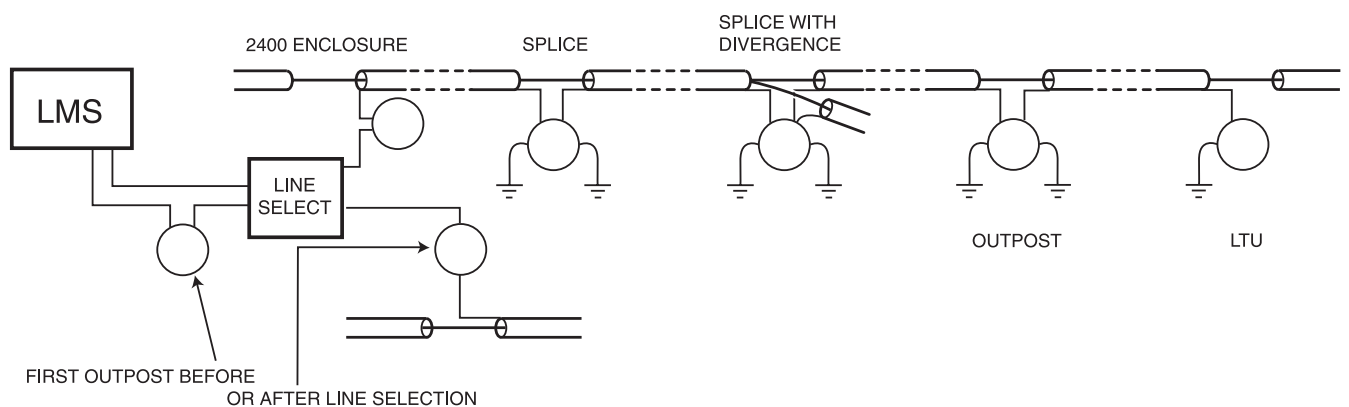


Figure 14. Typical Outpost Connections

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6.2 INSTALLATION

6.2.1 Burial Depth

The recommended Outpost burial depth is down to 3 m (10 ft). The Outpost must have adequate protection from mechanical and environmental damage, and generally the burial depth will be the same as the fibre optic cable.

6.2.2 Equipment Required

Cable locator and portable transmitter

Ground connections

If using the optional ground connection kit (suitable with good ground conditions)

1.2 m (3.9 ft) ground rod (2 off)

Ground rod cable clamp (2 off) & adapter plate

If other ground connection arrangement, the following tools are recommended depending on the installation:

Earth Resistance Meter

Outpost

Set of metric spanners

Excavation equipment

Relevant materials to:

Seal the outpost cable into the Cable Splice

Connect the outpost wires to the Cable sheath (installation specific).

6.2.3 Access

Obtain access to the splice.

6.2.4 Cable Identification

The Outpost cable arrangement and input/output cable identification is detailed below.

The cables are part of the top assembly and if the base is replaced it is the version of the remaining top unit that is important.

SIGNAL	CABLE IDENTIFICATION	
	Outposts Mk 2 & 3 LTU Mk 2	Outposts MK 4 & later LTU Mk 3 & later
Surge Block	V2 Build	V1 Build
Input	9	Black
Output 1	6	Black with Yellow Stripe
Output 2	10	Black with Blue Stripe (not used)
Output 3	7	Black with White Stripe

Table 2. Outpost Cable Arrangement

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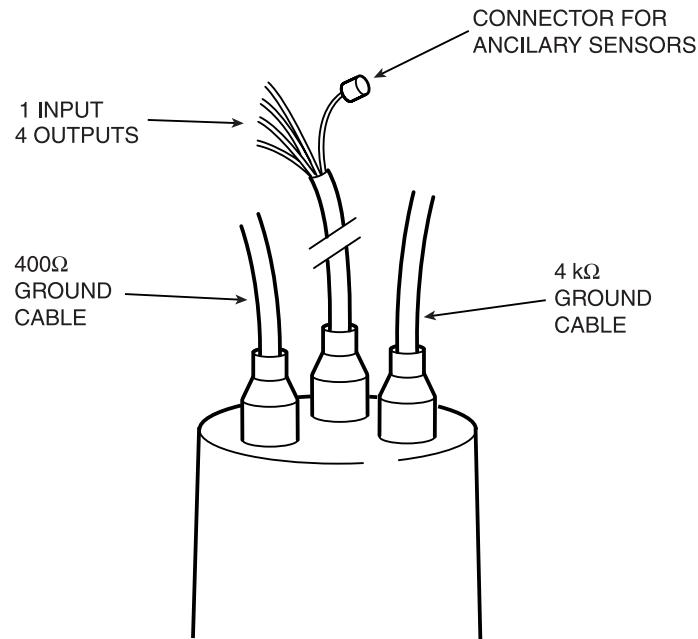


Figure 15. Mk 2 & 3 Outpost and Mk 2 LTU cable arrangement

For MK 4 Outposts and Mk 3 LTUs onwards, the arrangement is as above, but: 3 Output cables rather than 4 (cables now colour coded)

Power & Measurement Grounds now identified by colour coding

Power Ground	-	Green / Yellow
Measurement Ground	-	Black

6.2.5 Ground Connections

Note: A three or four terminal Earth Resistance Meter must be used to measure the resistance of the ground connections. Follow the instructions supplied with the meter. A standard DVM or moving coil meter will give incorrect results.

Note: Using a Radiodetection Locator ensure that it is safe to dig and sink Ground Rods at the intended positions.

Two ground connections are required meeting the resistance and separation requirements outlined above.

If using the optional ground connection kit:

Sink the rods supplied separated by at least 3 m (10 ft).

Attach a ground rod cable clamp to each rod.

Using the adapters supplied, attach the Power earth cable to the clamp on the 400Ω rod and the Measurement connection to the clamp on the 4 kΩ rod then tighten the clamps.

Provide strain relief to the cable ends by securely mounting the cables close to the rods.

If using another ground connection method follow instructions for that method.

If the Outpost is being installed into a location with existing ground connections available (typically the case for the first outpost in the regen) and providing another 2 (independent) ground connections is impractical the following needs to be considered.

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The outpost only operates correctly with less than 4 V r.m.s. (6 V peak/d.c.) between the Power and Measurement Ground connections (this includes any voltage generated from its operating current of 15mA)

If an available ground connection is being considered for the Power ground, and that ground connection has other equipment actively using it, i.e. passing current into it, check the voltage generated. If it is too high, obtain an independent Power and Measurement ground, or connect both the Power and Measurement grounds to it.

The Power and Measurement grounds can be connected to the same point, but

- The Megger results may have an error if any dc is present (from other equipment) - Outposts ignore mains frequency signals.
- The Megger results may have an error if the ground resistance is more than a few ohms (typically building grounds are fractions of an Ohm).
- The checks on the ground resistance do not operate. They will detect problems between the outpost and the connection point.



Caution

DO NOT remove the cable end crimps as they are sealed to prevent moisture ingress, unless the installation is in a dry environment.

6.2.6 Outpost Connection

Outposts are normally installed from the LMS-3 outwards, using the predetermined numbering on the Network Map.

Refer to the LMS-3 installation section for connection of an Outpost at the LMS-3.

When replacing an Outpost the new unit must be programmed with the same identification number as the unit being removed, refer to section 6.2.9 for programming instructions.

Connect the input sheath to the sheath from the LMS-3. Connect the output sheaths to the ongoing cable sheaths (normally only one used). Unused output sheaths must be insulated. There should be no other connections between the input and output sheaths.

Ensure that the induced mains voltage on the cable is less than 50 V and, if not, fit mains filters as required.



Caution

DO NOT remove the cable end crimps as they are sealed to prevent moisture ingress. Any unconnected crimps should be suitably insulated to prevent shorting.

6.2.7 Warning labels

The Outposts operate with hazardous voltages on the cable sheath and under surge and failure conditions discharge high currents to the ground connections resulting in hazardous voltages on these.

Hazard warning labels must be attached to the all points of access to the cable sheath and the Outpost. Labels are supplied for:

- The splice
- The outpost
- Both Ground connections
- The LMS-3 and Line selection equipment.

If access is possible then additional warnings are required.

Maintenance procedures must account for the hazards.

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6.2.8 Opening an Outpost or LTU

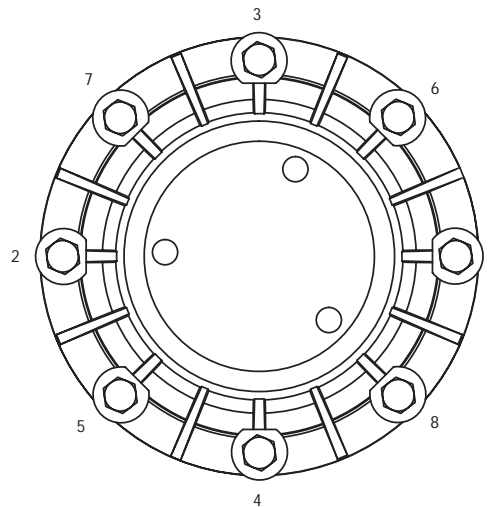
If an Outpost or LTU has to be opened undo the ring and bolts and separate the connections.



Caution

Sheath and Ground connections are accessible so always ensure that appropriate precautions are taken.

To reassemble, ensure all surfaces are clean, cover the o-ring with grease provided, insert the new Silica Gel pack provided reconnect the connectors and bolt together. Tighten bolts in the sequence and to the torque specified.



Torque to
2.8 .. 3.0 n-m
2.0 .. 2.2 lb-ft

6.2.9 Setup of Outpost or LTU

Outpost and Active LTU can be configured at any point prior to commissioning the line.

Open the unit as above. Connect the Outpost setup unit to the Outpost or Active LTU select the 'Setup' option on the Setup unit and turn on.

Set the ID (address) as required for that location. Note Active LTU's are pre-configured as 50 so do not normally need to be changed.

For Outposts set the sheath default to either 'Closed' (input connected to Output) or 'Open' (Input NOT connected to Output) on power down as required.

Turn off and disconnect the setup unit and re-assemble as above.

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6.3 TESTING

6.3.1 Overview

The Outpost can be tested using the CMS or directly from the LMS-3.

Testing from the LMS allows multiple tests to be performed with the line active, testing from the CMS tests either a specific section and outpost or the entire line, powering the line down afterwards, so to test two or more outposts takes longer.

The LMS must be turned off while people are working on the line. It must only be turned on for testing when confirmation that it is safe to do so has been received from anybody working on the line.

6.3.2 Testing from the CMS

Select the section or outpost or Line required and request a test, wait for the results to be reported as specified in the operation manual.

6.3.3 Testing from the LMS-3

There are two methods of testing Outposts from the LMS. If LMS is aware of the plan (i.e it has been downloaded from the CMS) select the "Test Plan" option on the ARRM UTILS menu, navigate to the desired Outpost or section and press Test.

Otherwise you have to use the 'Config Test' option on the ARRM UTILS menu and manually enter the Outposts required.

The results will be displayed as they arrive along with information about missed messages etc.

Exit the menu when testing is complete.

Ensure that the LMS-3 is left in Standby mode (unless it has gone into a scheduled ARRM cycle); if in doubt switch it off and on again.

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7 LINE TERMINATION UNIT

7.1 INTRODUCTION

The Line Termination Unit (LTU) provides a path to ground for the LMS-3 Locate signals without affecting the ARRM sheath insulation resistance measurement. LTUs are normally installed at the end of a branch.

There are two types of LTUs available:

Passive LTUs These provide a locate path to ground but cannot provide a D.C path so cannot be used with ACID

Active LTUs These provide a permanent Locate path to ground and can switch in a D.C. path to allow operation with ACID.

LTUs use the same top section as Outposts allowing them to be changed at a later date, if required.

7.2 INSTALLATION

The installation is as for the Outposts except that the Output wires are unused, and the Measurement ground is unused in the Passive version. The ends of the unused lines must be terminated properly and protected from water ingress.

7.3 TESTING

Using a Radiodetection Locator, test that the LTU is operating by verifying the presence of the LMS-3 Locate signal.

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8 ARRM SYSTEM TESTING

8.1 RESISTANCE TEST

To evaluate the resistance measurement facility, follow the instructions below:

- (a) From data gathered in a previous ARRM test, select a section of cable that has a 'Megger' reading greater than $25\text{M}\Omega$ km.
- (b) Connect a $1\text{M}\Omega$ resistor between the 'OUT' terminal of the Outpost and ground. This can be achieved by using the pedestal connections and a ground stake (if available).
- (c) At the CMS request a test of that section or at the LMS-3 use the installation PC to interrogate a single Outpost.
- (d) Check the results. Note that the value of the resistance reported by the ARRM system will be equal to resistance divided by the cable length in km. The value of the cable length can be found on the network map. The resolution of the measurement is $1\text{ k}\Omega$ and the accuracy at $1\text{M}\Omega$ is $\pm 5\%$.
- (e) Re-instate the original setup parameters.

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9 TYPICAL SYSTEM COMPONENTS

This section is included to provide a shopping list of parts and equipment required to build an ARRM system and highlights issues to be considered.

9.1 PRE CONDITIONS



Can all personnel (public, system operators, maintenance, etc.) be protected from the high voltages that the system is capable of generating? Systems must only be installed in areas where this is possible and all precautions must be in place before the system is commissioned.

The Customers own staff manuals, procedures and work practices will need to be updated, to ensure safe operation. Training may be required.

Additional access control, security, locks, enclosures, etc. may be required to protect both the general public and the customers own staff.

Line conditions

Is the proposed setup within the capability of the system? See the pre-conditions section in this manual (section 2.1).

9.2 CMS

The CMS comprises a desktop PC, usually one per system; this should be a fairly powerful computer to be able to run the data collection and viewing software. A detailed specification for the requirements of this PC can be found in the introduction section of this manual (section 3.1).

General requirements

- 2 HDD are recommended but good backup strategy can be used instead if necessary.
- CD Drive required (to load NT and the CMS SW), consider a CD writer to aid backup.
- Windows NT 4 (service pack 3 or later) required.
- Telephone line(s) must be available.
- Modems (internal or external): One or more is required (in general it is best to have the same type of modem at both the CMS and LMS-3).
- The modem setup (strings) for type and country needs to be established (refer to Appendix A of this manual for guidance on existing modem setups).
- Backup Software - need to backup archives if required.
- Network - for backup and remote Data Viewer
- Radiodetection do not support any networks
- If the customer is prepared to support the network, the Data Viewer(s) can be remote.

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9.3 LMS-3

Phone lines

- A Phone line is required at the LMS for communication with CMS and contact of LMS.

LMS-3 Power supply

A -48 V (fused) supply usually available at station/re-gen.

Location of LMS-3 equipment

Controlled access to the area is required to prevent unauthorised operation of LMS-3 and to act as a safety measure to protect personnel from high voltages.

Line selection

The line selection units provide the primary surge (lightning) protection and the line selection.

These units are placed close to the point the line enters the building and a good ground connection.

Cabling (with connectors) between the LMS-3 and these units is required.

One of four options is available:

1. 2-way ACT Unit & cables.
2. 16-way ACT Unit & cables.
3. Discrete Relay & Protection Kit (AT&T), includes some cables.
4. Radiodetection Relay Box (1 per line)

Grounding

LMS-3 (Safety):

The chassis must be grounded to the same point as that of adjacent equipment with a good ground, so that surge discharges do not present a safety hazard.

Protection unit ground:

This provides the primary surge protection for the line and the ground must be able to handle this safely.

The actual ground connections are installation specific and assumed to be available so are not supplied as standard.

9.4 OUTPOSTS

Outpost mounting

Suitable mounting arrangements need to be considered and provided for the unit; this can vary from nothing (for outposts directly buried or on a shelf alongside the splice) to mounting brackets for some installations.

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Connection to the line

Access to the sheath:

This can require sealed entry to the splice. No sealing materials are supplied as standard because of the variety of enclosures available. Therefore this method needs to be established and materials obtained prior to installation.

Method of connecting to the sheath:

The Outpost Sheath connections are terminated in a 7mm-diameter terminal; a method of attaching this to the sheath is required, probably involving an adapter of some type. Care needs to be taken to ensure that the connection can handle the expected surge currents.

Generally the customer will do this, due to the sensitivity of the cable.

Ground connections

Access to the ground:

Two independent ground connections are required. If not:

- Ground resistance tests will not work.
- There will be undefined Megger errors (especially if grounds not good).
- There is an optional kit for this with the outpost that can be used where reasonable ground connections can be made with the use of ground stakes. Other methods are required for other circumstances, for instance:
- Where the ground resistance is high, earth frames may be required for one or both connections. Under these conditions two independent connections are especially important.
- Where direct access to the ground is difficult, or connections to the existing ground connections are required, connectors, cables, etc will be required.
- Note the safety implications of doing this (high surge currents can produce large voltages even with low resistance).
- Protection of personal (public, maintenance staff, etc.) should be considered. In particular the ground connections should be considered dangerous.

9.5 LTU'S

When using the ARRM LTU the installation is as an Outpost except that only one ground connection is used for the Passive version of the LTU and the output cables are not connected. The measurement ground is not required.

When using the RD Line Control Unit for Line termination see appropriate instructions.

9.6 OUTPOST SET-UP UNIT

One of these will be required per installation team. A PC (laptop) is required to be available to operate with this.

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10 TROUBLE SHOOTING

This section describes how to investigate, and hopefully solve, some of the more basic problems you may encounter with the LMS-3 system. See also Alarm Messages Section.

10.1 SAFETY



This equipment automatically applies high voltages to the cable sheath as part of its normal operation, appropriate working practices are required for anybody likely to come into contact with it. Always follow relevant work practices when performing any tests, maintenance or repair work that could lead to contact with the LMS-3, the cable sheath, Outposts, LTUs and its connections including the ground, as Voltages up to 300 V a.c. or 450 V d.c. may be present.

Always switch off the LMS-3 at the rear-mounted power switch before removing any modules from the front panel. *It is not sufficient to switch off the front panel circuit breaker.*

Always disconnect 'signal out' and 'power in' before removing the output protection circuit panel, or the expansion panel. Remember high voltages may be induced onto the cable sheath. Refit the panels before reconnecting 'signal out' and 'power in'.

Do not work on the LMS-3 or its connections to the line, if it is known that there is an imminent risk of lightning strikes anywhere along the cable routes.

Always observe and follow anti-static precautions when removing, handling or inserting LMS-3 modules.

10.2 BASIC TROUBLESHOOTING

Always take a logical approach to problem solving. Difficulties may arise because the LMS-3 is not configured correctly, or the wrong transmission mode has been selected. Before calling for support, check below to see if the problem you are experiencing is listed.

10.2.1 LMS-3 Dead - No LED's Illuminated

- Check that the rear-mounted Power Switch is ON.
- Check that the front mounted Circuit Breaker is switched ON.
- **Do not attempt to override the Circuit Breaker if it trips.**
- Check that there is power available at the 'Power In' connector. If not, check the external fuse for this circuit.

10.2.2 Front Panel Circuit Breaker Trips

- **Do not attempt to override the circuit breaker if it trips.**
- This is normal if any of the modules are missing.
- Always switch off at the rear panel power switch before removing modules.
- If the Circuit Breaker trips at any other time, there is a fault in the LMS-3.

10.2.3 An LED (Status Indicator) Glows Red or Flashes

When the system is functioning correctly, all the status LED's should be On continuously and illuminated Green, except for the right-hand LED on the PA (Power Amplifier) module, which is Off when the LMS-3 is in Standby mode.

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Table 1 below, describes the indication status of the module LED's and their meaning.

LED	INDICATION	MEANING
Front Panel Connector	Red	The Circuit Breaker has tripped
	Green	Normal
PSU module	Red	One or more of the PSU Outputs has failed
	Green	Normal
COMMS module	Red	A fault has been detected on the COMMS module
	Green	Normal
PROC module	Red	Fatal Error. ROM checksum error, or the RAM test failed
	Red / Green flashing	System Initialising
	Green	System Ready - Normal operation
I/O module	Red	A fault has been detected on the I/O module
	Green	Normal
PA module Left-hand LED	Red	A fault has been detected on the PA module
	Green	Normal
PA module Right-hand LED	Off	LMS-3 in Standby mode
	Green	LMS-3 in Active mode
S/C module	Red	A fault has been detected on the S/C module
	Green	Normal

Table 3. Status LED Indications

10.2.4 Hand Held Display is Blank

- The display backlight switches off automatically after 3 minutes of inactivity. Touching the screen anywhere should bring it back to life.
- Check that the display is plugged in correctly to the Front Panel Connector module via the black curly cable and RJ11 connector.

10.2.5 Unable to Access the LMS-3 Remotely from a Telephone

- Check you are using the correct telephone number and LMS-3 Station identification number (Post number).
- You will not be able to access the LMS-3 remotely if it is currently being controlled from the hand held display unit, or a laptop/PC (via the Front Panel RS232 port) or any software being downloaded. It will report 'LMS not available' over the phone.
- Check the Telephone Line connection at the rear of the LMS-3.

10.2.6 Unable to Access the LMS-3 from the Front Panel RS232 Port

- Check that you are using the correct cable. The Front Panel RS232 port is electrically a DTE. This means that a 'Null Modem', or 'Crossover', cable is necessary if you are connecting directly to a laptop/PC.
- Check that your laptop/PC port is set up as: 19200 bps, 8 Data bits, No Parity, 2 Stop bits.
- Check that the laptop/PC is set for VT100 emulation (or is a VT100 terminal).
- You will not be able to access the LMS-3 from the Front Panel RS232 port if it is currently being controlled from the hand held display unit, remotely by telephone (DTMF), remotely by modem, or by telemetry. The message e.g. 'Hand held already has control' will be displayed on your laptop/PC.

10.2.7 No Tone on the Cable

- Check to see if LED on PA module is green.
- Check that the LMS-3 is switched to Active mode.
- Check that the output is switched to the correct line.
- Check that the correct User Option is loaded and has not been modified.
- Check the rear panel connections.
- Check that the Isolator Protector Relay is energized.

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10.2.8 No A.C.ID signal on the Cable (if option fitted)

- Check that the LMS-3 is switched to either CD or LF modes, with A.C.ID enabled.
- Check that the LMS-3 is switched to Active mode.
- Check that the output is switched to the correct line - East or West.
- From the Operating Mode Menu screen, check A.C.ID status.
- Check that A.C.ID was installed.
- Check that the correct User Option is loaded, and has not been modified.

10.3 SUPPORT CONTACT

If problem still persists call your local Radiodetection Office

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11 MAINTENANCE AND SPARES

This section describes LMS-3 maintenance tasks that can be carried out on site. As the LMS-3 is of modular construction, maintenance and repair is limited to module replacement only. There are no consumable components.

11.1 GENERAL PRECAUTIONS

Always switch off the LMS-3 at the rear panel before removing or replacing modules.

The LMS-3 contains components that are susceptible to damage from electrostatic discharge. Always observe electrostatic precautions before handling any system module - use a wrist strap plugged into the front panel Chassis Ground connector.

11.2 SPARES

Only Radiodetection supplied replacement kits should be used

11.3 CLEANING

It should not normally be necessary to clean the LMS-3, as it will be installed in a clean environment. If the unit does require cleaning, it should be done WITH THE POWER SWITCHED OFF, using a lint free cloth. Take great care to ensure that moisture does not get into the unit or its connectors. Do not use chemicals.

Great care should be taken when cleaning the touch-sensitive screen of the hand held display unit. Avoid cleaning it unnecessarily.

11.4 RETURN PROCEDURE

Should it be necessary to return the LMS-3, or one of its modules, contact the local Radiodetection office or equipment supplier.

Pack the item well and enclose details of the location from where the part was removed, including time, date, serial number and the nature of the problem. In the case of the LMS-3 modules, extra care should be taken when handling and packing to prevent any possible further damages resulting from electrostatic discharge. Observe correct handling procedures and follow electrostatic precaution guidelines before removing or handling any system module - use a wrist strap plugged into the front panel chassis ground connector. Recommended packaging for LMS-3 modules is static dissipative bags conforming to BS EN 100015-1.

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12 SPECIFICATIONS

12.1 LMS-3

This section describes the specifications of the LMS-3 transmitter only.

Housing

Standard 3U chassis, 48.3 cm (19 in.):

Width	-	45 cm (17.7 in.)
Height	-	13.3 cm (5.25 in.)
Depth	-	30 cm (11.8 in.), chassis only
Plus Rear Protector	-	5 cm (2.0 in)
Plus Display brackets	-	4.3 cm (1.7 in.)

Mounting Brackets

Compatible with 48.3 cm (19 in.) and 58.4 cm (23 in.) cabinets

10 fixing positions

Weight, including display	-	10.3 kg (22.7 lb.)
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Electrical Input

-40 V to -60 V d.c. nominal -48 V d.c.

Incorporates reverse polarity protection

Circuit Breaker trip current	-	10 Amps
Fuse Rating	-	5 Amp fast blow when the standard Power Output module is fitted.

Signal Output

Output Power	-	50 Watts
Output Voltage	-	limited to ± 300 V r.m.s. d.c.
Output Current	-	limited to 1A r.m.s. + 600 mA of A.C.ID current (if A.C.ID enabled).

Tracing and Locate Tones:

CD	-	Market dependant
LF	-	Market dependant
8K	-	8.192 kHz
A.C.ID	-	Market/customer dependant
FF	-	4 Hz + 8 Hz + selectable locate (market/customer dependant).

Screening

RFI Emissions meet the following specifications:

FCC Part 15: 1989 Limit B

EN55022: 1987 Limit B

EN50081-1

Vfg 243/1991

EMC Immunity meets the following specifications:

EN55101-2: 1990

EN55101-3: 1990

EN55101-4: 1990

Environmental

Operating Temperature	-	0°C to 40°C (32°F to 104°F)
Storage Temperature	-	-20°C to 70°C (-4°F to 158°F)
Operating Humidity	-	20% to 55% (non-condensing)
Shock and Vibration	-	to BS2011 part 2.1

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Protection

All outputs are isolated from the chassis.

Signal outputs withstand:

Common Mode	-	160 V d.c. with respect to Ground
Differential	-	160 V d.c. or 90 V a.c. at 50Hz/60Hz
Surge Clamp Voltage	-	200 V d.c.
Max Operational Level	-	100 V d.c. + r.m.s. total for common mode and differential signals
Max Impulse Discharge Current	-	5 kA (CCITT 8/20 waveform)

Telemetry Interface

Control Relays	-	Accepts Form A & C type
Response time	-	500 ms
Alarm Relays	-	Isolated
Contact Resistance	-	less than 10Ω

Telephone/Order Wire Interface

Not supported for LMS-3 ARRM

Internal Modem

CCITT V.32 bis, V.32 and V.22 bis (14400 bps, 9600 bps, 2400 bps)

Hand Held Display

Graphical LCD display
Backlit with touch sensitive screen
Connection by coiled cable and RJ11 connector

RS232C Ports

Asynchronous only		
Speed	-	Fixed at 19.2 k bps 8 Data bits, 2 Stop bits, No Parity
Flow Control	-	None
Connector Type	-	Standard 9-way D-type sockets

12.2 OUTPOST

Electrical Input

Supplied from LMS-3 using cable sheath and ground return (-30 to -100 V d.c.)

Screening

RFI Emissions meet the following specifications:

FCC Part 15: 1989 Limit B
EN55022: 1987 Limit B
EN50081-1
Vfg 243/1991

EMC Immunity meets the following specifications:

EN55101-2: 1990
EN55101-3: 1990
EN55101-4: 1990

Environmental

Operating Temperature	-	-20° C to 70° C -40° C to 70° C (with extended temperature range option).
Storage Temperature	-	-40° C to 70° C
Operating Humidity	-	N/A
Max burial depth	-	3m
Shock and Vibration	-	to BS2011 part 2.1
IEC 60529 Rating	-	IP68 at 10 metres

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Protection

Class 2	
Max operational level	- 50 V rms. Mains pickup
Max Impulse Discharge Current on signal input & outputs	
Single impulse:	
20 kA (CCITT 8/20 waveform)	
500A (8/20 waveform)	- 1000 surges
100A (8/20 waveform)	- 5000 surges
10A (8/20 waveform)	- Unlimited surges
500A (10/1000 waveform)	- 1000 surges

Internal setup/diagnostic port

Asynchronous only	
Speed	- Fixed at 4.8k bps 8 Data bits, 1 Stop bits, No Parity
Flow Control	- None
Connector to setup equipment	

Ground connections

2 separate connections required with protection to account for the surge currents.

12.3 ACT 4457-200 ISOLATOR/PROTECTOR RELAY SYSTEM

This section describes the specifications of the ACT Isolator/Protector Relay Systems

This system consists of an ACT 445-200-700 surge protector and an ACT 445-18B-040 cable harness. The system connects to the LMS-3 via the cable harness. This unit switches the 16 directional tone outputs of the LMS-3, while providing surge protection to the transmitters and each of the 16 cables.

If a failure from a transient surge or a.c. power cross occurs, the surge protector shorts to hard ground providing maximum safety to equipment and personnel.

This unit should be placed as close to the site's cable entrance point and as close as possible to the master ground bus bar.

The unit provides:

- Switching of up to 16 direction outputs
- A fail safe short
- Heavy duty protection
- Easy installation and use
- LED's indicating operation

Electrical

Voltage Application	- 150 V a.c. 200 V d.c. (max.)
Clamp Voltage (@1mA d.c.)	- 240 V \pm 20 V d.c.
Peak Current	- 50000 Amps per line
Response Time	- 1.5 nanoseconds
Capacitance	- 8000 pF

Physical

Width	- 35.6 cm (14 in.)
Height	- 40.6 cm (16 in.)
Depth	- 15.3 cm (6 in.)
Construction	- Painted steel enclosure

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12.4 ACT 4454-XXX ISOLATOR/PROTECTOR RELAY SYSTEM

This system consists of an ACT 445-XXX-50-relay system and an ACT 445-S12X-040 cable harness. The system connects to the LMS-3 via the cable harness. This unit switches the 2 directional tone outputs of the LMS-3, while providing surge protection to the transmitter and the 2 connected cables.

If a failure from a transient surge or a.c. power cross occurs, the surge protector shorts to hard ground providing maximum safety to equipment and personnel.

This unit should be placed as close to the site's cable entrance point and as close as possible to the master ground bus.

The unit provides:

- Switching of up to 2 direction outputs
- A fail safe short
- Heavy duty protection
- Easy installation and use
- Directional operation indicators

Electrical for LMS-3 Standard Power Output

Voltage Application	-	150 V a.c. 200 V d.c. (max.)
Clamp Voltage (@1mA d.c.)	-	240 V \pm 20 V dc
Peak Current	-	50000 Amps per line
Response Time	-	1.5 nanoseconds
Capacitance	-	8000 pF

Electrical for LMS-3 High Power Output

Voltage Application	-	320 V a.c. 420 V d.c. (max.)
Clamp Voltage (@1mA d.c.)	-	500 V \pm 50 V dc
Peak Current	-	50000 Amps per line
Response Time	-	1.5 nanoseconds
Capacitance	-	8000 pF

Physical

Width	-	25.4 cm (10 in.)
Height	-	20.3 cm (8 in.)
Depth	-	15.3 cm (6 in.)
Construction	-	Painted steel enclosure

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90/UG029EN05