EasyReach

SPREAD SPECTRUM RADIO

USER MANUAL

Handbook 1H90941

ISSUE 4 November 17, 1999

PLESSEY

Plessey Asia Pacific Pty Limited
ACN 076-409-311

5 Talavera Road
NORTH RYDE NSW 2113
AUSTRALIA

REVISION No.	AUTHORITY	DATE INSERTED	INITIALS
01	ECO E1983	30 Nov 98	RSR
02	ECO E2136	16 July 1999	MI
03	ECO E2209	27 October 1999	MI
04	ECO E2224	17 November 1999	MI

CONTENTS

FIGURES

TABLES

WARNINGS AND CAUTIONS

WARNING

RF RADIATION

RF ENERGY AT MICROWAVE FREQUENCIES IS PRESENT WITH THIS EQUIPMENT. PERSONNEL SHOULD NOT BE EXPOSED TO HIGH RF ENERGIES, AND SHOULD NOT BE IN FRONT OF THE ANTENNA WHEN THE EQUIPMENT IS SWITCHED ON.

ALL ACCESSIBLE RF CONNECTIONS MUST BE TERMINATED WHEN THE RADIO IS POWERED ON.

THE RADIO SHOULD NOT BE POWERED ON WITH ANY OF ITS COVERS REMOVED.

CAUTION

Do not connect the antenna ports of two units directly together. Damage of both units WILL result.

OPERATING WITHIN FCC GUIDLINES

The U.S. Federal Communications Commission (FCC), Section 15.247 excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The equipment should be professionally installed, ensuring that the system is used exclusively for fixed, point-to-point operations and that the FCC radiated emission guidelines are meet.

FUNCTION

General Description

The Plessey ***EasyReach*** is a radio link platform that provides two-way full duplex transport of 2Mbit/s (European) or 1.544Mbit/s (USA) of data between two points. The design provides a reliable and cost effective solution for connecting disparate communications facilities.

The Plessey ***EasyReach*** spread spectrum radio operates in the 2.4 GHz ISM band. It does not require a spectrum management license in most countries.

The unit is constructed as a stand-alone chassis that can be used as a desktop unit, or mounted either to a wall or in a 19-inch rack.

Product range

The EasyReach product range encompasses the following orderable variants:

E1 (2.048 Mbit/s) full duplex transport.

T1 (1.544 Mbit/s) full duplex transport.

DC Power supply.

AC Power supply.

Features

The Plessey ***EasyReach*** has the following features:

- **Multiple link capability:**

  Up to three ***EasyReach*** links can operate from a single mast. With careful site planning, more links can be installed at a single site.

- ***EasyReach* Element Manager:**

  The Element Manager is a software package which allows the user to control and monitor monitor the status of the radio using a PC, and provides the means by which a link may be configured for special requirements.

- **Loopback facilities:**

  Loopback facilities are available to aid system commissioning and for checking the integrity of the equipment connected to the link.

- **DC supply version:**

The DC supply version of ***EasyReach*** can operate from supply voltages of +20 to +60 volts or -20 to -60 volts.

- **AC supply version:**

  The AC supply version of ***EasyReach*** can operate from nominal mains voltages between 110 and 240 volts AC and frequency between 50 and 60 Hertz.

SYSTEM CONFIGURATION

Equipment

The following equipment is supplied as a Plessey ***EasyReach*** radio system:

- Two ***EasyReach*** units each supplied with a mains power cable (for units to be powered from AC) or a DC supply mating connector (for units to be powered from DC).
- User manual.
- Element Manager software package on 3.5-inch floppy disc.
- PC serial interface cable.
- Two antennas, 19 dBi or 22 dBi (supplied optionally).
- Two antenna feeder cables, with N-type terminations (supplied optionally).
- Optional accessories (see page 28).

Additional items required to set up a link are:

- Data cables (BNC terminations for E1 or RJ48C termination for T1).
- Wire pair for antenna alignment measurement.
- Voltmeter for antenna alignment measurement.
- PC for optional configuration and monitoring (minimum of Windows 95).
- Connector sealant for antenna connection.

Configuration

The equipment is set up on installation as shown in Figure 1.

The use of a PC is not required unless configuration change or monitoring facilities are required.

Figure 1 EasyReach Equipment Setup (E1 Version)

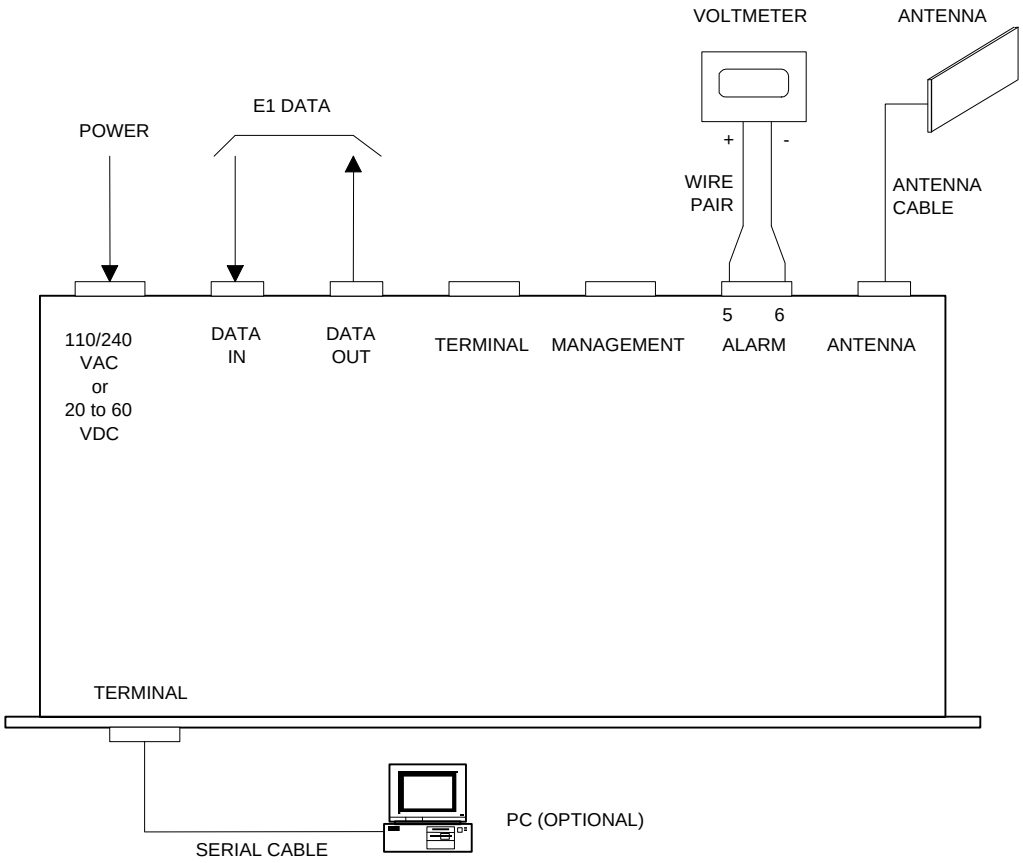
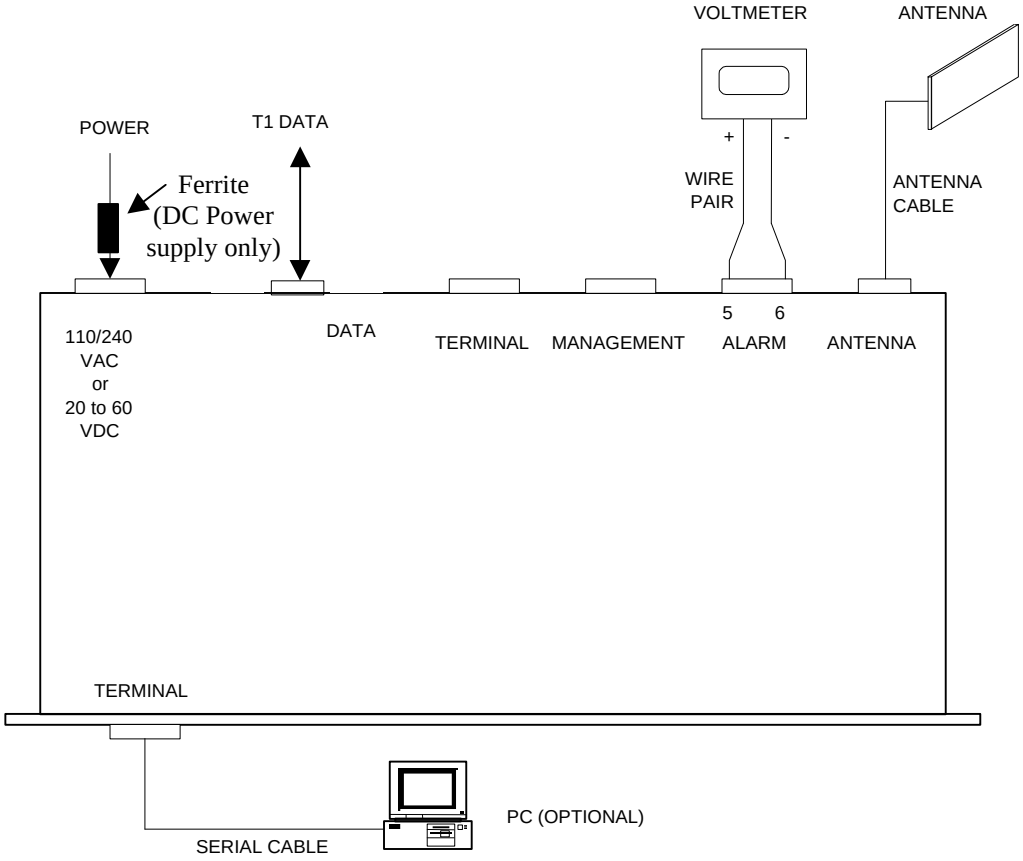


Figure 2 EasyReach Equipment Setup (T1 Version)



Connections

LOCATION	TYPE	FUNCTION
Front panel	**TERMINAL** port	Configuration port for PC (is connected in parallel with the **TERMINAL** port on the rear panel – either one can be used as the configuration port).
Rear panel	**POWER** connector	AC power version (110 to 240 volts AC), 2 ampere slow blow fuse.
		DC power version (20 to 60 volts DC, isolated), 2 ampere slow blow fuse.
	DATA IN connector	E1 data in from user equipment
	DATA OUT connector	E1 data out to user equipment.
	DATA connector	T1 data in from user equipment and out to user equipment.
	TERMINAL port	Configuration port for PC (is connected in parallel with the **TERMINAL** port on the front panel – either one can be used as the configuration port).
	MANAGEMENT port	Network management system port (reserved for future upgrade).
	ALARM port	Provides system alarm status contacts and a signal strength indication.
	ANTENNA	Port for connection to the antenna.

Front Panel Indicators

The names and functions of the front panel status indicators are as follows:

LEGEND	If GREEN	If RED
POWER	Power is on	-
FAIL	The unit has passed self-test	Power or system fail
DATA	Data acquired	Loss of data or line code violations detected at **DATA IN** or **Data** port
RF SIGNAL	Signal strength is above threshold	Signal strength is below threshold

INSTALLATION AND COMMISSIONING

Conformance to Emission Requirements

Users must ensure that the ***EasyReach*** system is deployed, configured and used in a manner such that it conforms to the emission requirements specified by the appropriate regulatory body.

Mounting the *EasyReach* Unit

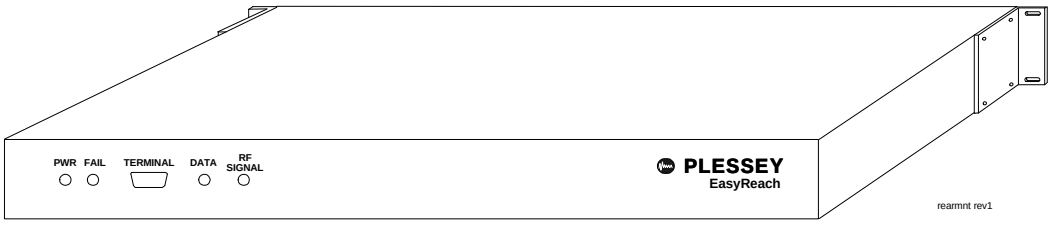
The ***EasyReach*** unit can operate in an environment in which the temperature range does not exceed the limits specified in the environmental specifications.

The unit comes with mounting feet attached, ready for desktop mounting.

The unit may be either front or rear mounted in a 19-inch rack. The universal mounting brackets can be screwed onto either side of the unit at the front or back. The four mounting feet must be removed from the underside of the unit. Figure 3 shows an example of the brackets located at the front for a front mounted unit, and Figure 4 shows the arrangement for rear mounting of a unit.

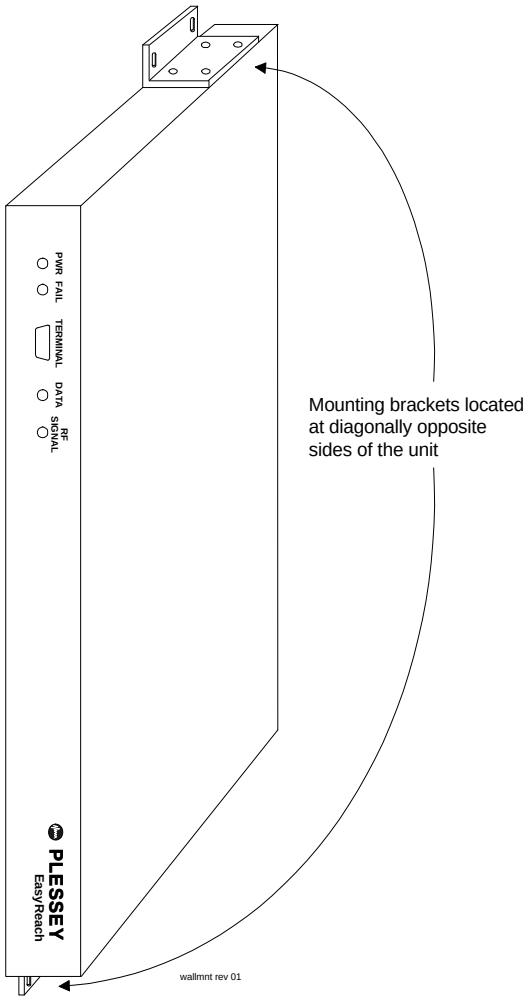
Figure 3 Front Mounting of *EasyReach* Unit

Figure 4 Rear Mounting of *EasyReach* Unit



The unit may be also be wall mounted. Attach the mounting brackets on diagonally opposite sides of the unit, as shown in Figure 5 , and leave the feet attached to buffer the unit from the wall surface.

Figure 5 Wall Mounting of *EasyReach* Unit



Antenna Mounting

The antenna is best suited to be mounted on a pole of diameter between 50 and 100 mm. The pole must be rigidly mounted to prevent any swaying or vibration of the antenna.

It is crucial that the two antennas in the link are mounted with the same polarisation. Different polarisations add approximately 25 dB to the link path loss, thus seriously reducing the link range.

Ensure that no objects are within 20 degrees of the antenna boresight within the immediate vicinity of the antenna.

Position the antennas at both ends of the link as accurately as possible to be pointing to within ±6 degrees of each other in the vertical and horizontal planes (within the antenna's 3 dB beamwidth). Failure to do this will reduce the received signal strength and may prevent the link from initialising.

Antenna Cable Ducting

The cable should be ducted so that it maintains a safe bending radius. If the cable is tied or clamped to fixtures, ensure that the cable sheath is protected from damage and the cable is not crushed. Ensure also that the cable is fixed so that it cannot vibrate under wind loading.

Failure to correctly duct the antenna cable will result in the degradation of system performance.

The cable connection to the antenna should be sealed to prevent moisture from entering the joint, after the antenna alignment (see page 13) has been satisfactorily completed.

Supply Connection

AC Power Version

Connect the unit to mains power using the supplied mains power cable.

DC Power Version

A mating connector is supplied for the connection of DC power.

The DC power option provides isolated positive and negative power terminals and a chassis ground terminal. It is recommended that the ground rail of the supply be connected to the chassis ground.

For example, if a -48V supply is used, the -48V rail will be connected to "-" and the 0V rail will be connected to "+" and also to the chassis ground terminal.

A ferrite is supplied with the T1 version of *EasyReach*, this ferrite should be clipped over the DC power supply cable as close as possible to the DC power connector of the unit.

RF Frequency Variants

EasyReach units come in two different frequency variants, and with complementary transmit/receive frequencies for each variant. The frequencies of the variants are listed in Table 1.

In setting up a radio link consisting of frequency variant 1 units, the unit at one end of the link must be a 1a variant and the unit at the other end of the link must be a 1b variant. Similarly, if frequency variant 2 units are used, one unit must be a 2a variant and the other one a 2b.

Table 1 RF Frequency Variants

VARIANT	TX FREQUENCY	RX FREQUENCY
1a	2412 MHz	2452 MHz
1b	2452 MHz	2412 MHz
2a	2426 MHz	2464 MHz
2b	2464 MHz	2426 MHz

Initial Switch-On

Verify that the radiated emission regulations are not exceeded by either calculation using Equation 1 or using the EasyReach Element Manager. If necessary the output power can be adjusted using the EasyReach Element Manager.

Equation 1 Use to calculate radiated emissions

EIRP = Output Power – Cable Losses + Antenna Gain

Ensure that the equipment is set up according to Figure 1 (see page 4).

It is not necessary to interface a PC to the ***EasyReach*** unit unless the user requires either to monitor the system operation or to re-configure the control and monitoring parameters – see “System Control and Monitoring” below, and “Control and Configuration Using *EasyReach* Element Manager” on page 22.

Ensure that the antennas at both sites are pointing to within ±6 degrees of the other site in both the vertical and horizontal planes.

Switch on the power to the equipment at both ends of the link.

The four front-panel status indicator LEDs should all be green (although they may not be if the antenna alignment is not yet accurate enough).

Perform the antenna alignment procedure detailed on page 13.

Antenna Alignment

WARNING

RF RADIATION

RF ENERGY AT MICROWAVE FREQUENCIES IS PRESENT WITH THIS EQUIPMENT. PERSONNEL SHOULD NOT BE EXPOSED TO HIGH RF ENERGIES, AND SHOULD NOT TO BE IN FRONT OF THE ANTENNA WHEN THE EQUIPMENT IS SWITCHED ON.

The following procedure allows antenna alignment to be performed by one person.

To correctly align the antenna(s), perform the following steps:

- Ensure both sites are set up according to Figure 1 (see page 4).
- Switch both units on and set up according to the initialisation procedure detailed on page 11.
- Ensure that the antennas at both sites are pointing to within ±6 degrees of the other site in both the vertical and horizontal planes (within the 3 dB antenna beamwidth).
- Run a pair of wires from the unit to the antenna. Connect the wires to pins 5 and 6 of the alarm port mating connector supplied (see Table 7) and plug the connector into the **ALARM** port at the rear of the unit. Connect a voltmeter to these wires at the antenna end.
- The antenna can now be accurately aligned by slowly panning it to the point where the peak voltage value is obtained on the voltmeter, then slowly tilting it to obtain the highest value possible. Once the maximum signal level is obtained, secure the antenna, waterproof the connections, and disconnect the voltmeter and wire pair.
- Perform the antenna alignment at the other site.
- The **DATA** and **RF SIGNAL** indicator LEDs should both be green at the units at both sites.

System Configuration

System operational parameters can be set using a PC connected to either one of the **TERMINAL** ports. These parameters are preset in the supplied units to factory defaults as detailed in Table 2 below.

Table 2 Default Settings of Operational Parameters

PARAMETER	DEFAULT SETTING
COM port selection	COM 1
Loopback mode for system checking	Disabled
Transmitter power at antenna port	24 dBm
Setting of the digital signal processor (DSP) spreading code	E1 - 11100010010 (Barker code) T1 - 1111100110101
T1 Line Build Out	0 to 110 Feet

If the application requires any variation to any of these parameters, refer to “Control and Configuration Using *EasyReach* Element Manager” on page 22 for detail on how to do this, or to examine what the current parameter settings are.

OPERATION

Once the Plessey ***EasyReach*** link is properly installed and the antennas are aligned, it will initialise and operate on power-up without any special configuration requirements.

It is not necessary to interface a PC to the ***EasyReach*** unit unless the user requires either to monitor the system operation or to re-configure the control and monitoring parameters – see "System Control and Monitoring" below, and "Control and Configuration Using *EasyReach* Element Manager" on page 22.

Normal Startup Procedure

Switch on the power to the equipment at both ends of the link.

The four front-panel status indicator LEDs should all be green; if they are not, refer to the troubleshooting hints on beginning on page 16.

System Control and Monitoring

The ***EasyReach*** Element Manager software allows the user to control and configure various operational and monitoring parameters.

The facilities and usage of the Element Manager are explained on page 22.

TROUBLESHOOTING

If the installation and configuration procedures described in this manual have been followed, the Plessey ***EasyReach*** should work correctly when it is first turned on. If, however, the Plessey ***EasyReach*** does not work as expected, there are three general methods that can be used to determine equipment status and operating conditions:

- If the front-panel status indicators are not showing normal (all green) status, refer to the procedures under “Status Indicators” below. The error table on page 18 gives a summary of how various error conditions can affect the status indicators.

- If the performance is such that the antenna systems are suspect, the two ***EasyReach*** terminal units of a link can be brought together and bench tested with the antennas bypassed. The procedure for this is detailed in “Bench Testing” on page 19.

- If system performance is thought to be below standard, the ***EasyReach*** Element Manager can be used not only to monitor ongoing system performance parameters but also to perform system loopback and other tests. These procedures are detailed in “Control and Configuration Using *EasyReach* Element Manager” on page 22.

In the event of a faulty ***EasyReach***, refer to qualified service personnel or return the ***EasyReach*** for service.

Status Indicators

POWER LED Not Green

If the POWER LED is not green when the **SUPPLY** switch is on, the problem may be one of the following:

- The power supply to the unit has failed or there is a faulty connection.

  Check the connections. Check the unit power supply. For DC versions of ***EasyReach***, it should be between 20 and 60 volts DC. Ensure that the polarisation is correct. For AC versions of ***EasyReach***, it should be between 110 and 250 volts AC.

- The power fuse on the ***EasyReach*** board has blown, caused by:

  Incorrect fuse rating. Check the rating and replace.

  Fault in the ***EasyReach*** power supply.

FAIL LED is Red

This indicates a power or system fail:

- Internal fault with the unit. Return for repair.

DATA LED is Red

The DATA LED is red when:

- The ***EasyReach*** unit cannot detect data on the **DATA** port.
- The ***EasyReach*** unit detects bipolar code violations on the **DATA** port.

Check the **DATA** connection and verify the integrity of the incoming E1 or T1 data.

RF SIGNAL LED is Red

The RF SIGNAL is red when the ***EasyReach*** unit is not receiving an RF signal of sufficient strength from the other end of the link to acquire reliable data.

Firstly, check that the unit at the other end of the link is switched on.

If the RF SIGNAL indicator at the other end of the link is also red or intermittently red, then the problem may be one of the following:

- Incorrect use of ***EasyReach*** frequency variants. Refer to page 11 for details of the available frequency options.
- One of the ***EasyReach*** units has been configured incorrectly. Restart both units, and ensure that both radio units have the same

configuration. Check that the near end transmit and the far end receive spreading codes are the same.

- The antennas may not be aligned correctly; perform the alignment procedure in "Antenna Alignment" on page 13.
- The RF cable at either end is damaged or its connections are not secure.
- The link is operating over too great a distance; consult the technical specifications attached to this manual.
- There are obstacles intruding into the link signal path.

The link may be set up to operate without antennas to ensure integrity of both units; see the procedure in “Bench Testing” on page 19. If both RF SIGNAL indicators are subsequently green, then the problem is most likely one of those mentioned above.

If the **RF SIGNAL** indicator at the other end of the link is green, then the problem may be that one of the ***EasyReach*** units has been configured incorrectly. Check that configurations are the same at both ends of the link, and restart both units:

Error Table

A summary of the various error conditions that may affect the condition of the LED status indicators is shown in Table 3 below.

Table 3 Error Condition/Status Indication Matrix

CONDITION	LED Indicator Status				ALARM Port Relay
	POWER	RF SIGNAL	FAIL	DATA	
Normal	GREEN	GREEN	GREEN	GREEN	Normal
Fuse blown	OFF	OFF	OFF	OFF	ALARM
No +5 volts	RED	OFF	OFF	OFF	ALARM
E1 / T1 internal clock failure	GREEN	GREEN	RED	GREEN	ALARM
Converter clock failure	GREEN	GREEN	RED	GREEN	ALARM
Internal voltage out of limit	GREEN	GREEN	RED	GREEN	ALARM
Transmit VCO unlocked	GREEN	GREEN	RED	GREEN	ALARM
Receive VCO unlocked	GREEN	GREEN	RED	GREEN	ALARM
Transmit power out of limit	GREEN	GREEN	RED	GREEN	ALARM
E1 / T1 line input signal loss	GREEN	GREEN	GREEN	RED	ALARM
E1 / T1 code violation	GREEN	GREEN	GREEN	RED	ALARM
Receive power outside limit	GREEN	RED	GREEN	GREEN	ALARM
Mismatch in spreading codes	GREEN	RED	GREEN	GREEN	ALARM
External interference	GREEN	RED	GREEN	GREEN	ALARM

Bench Testing

To aid system commissioning or to check the integrity of the equipment, the Plessey ***EasyReach*** link may be bench tested by bypassing the antennas, as shown in Figure 6.

Units may only be connected with an attenuator exceeding 50 dB in the path between antenna ports.

CAUTION

Do not connect the antenna ports of two units directly together. Damage of both units will result.

Figure 6 Bench Testing Arrangement (E1 Version)

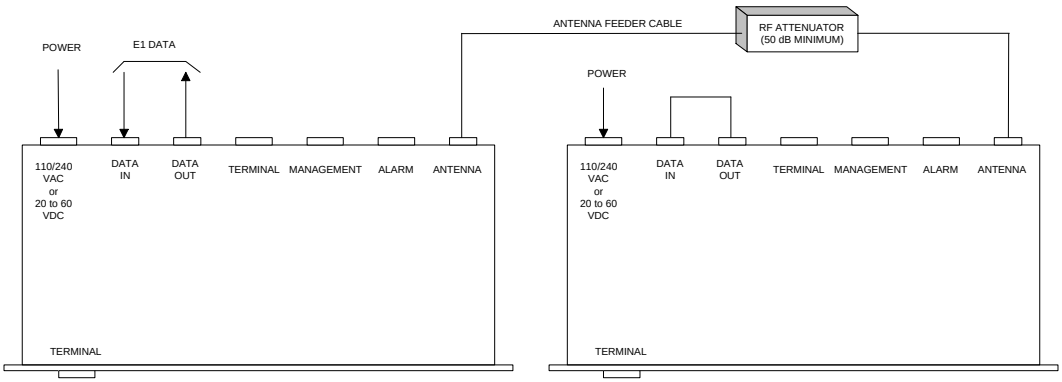
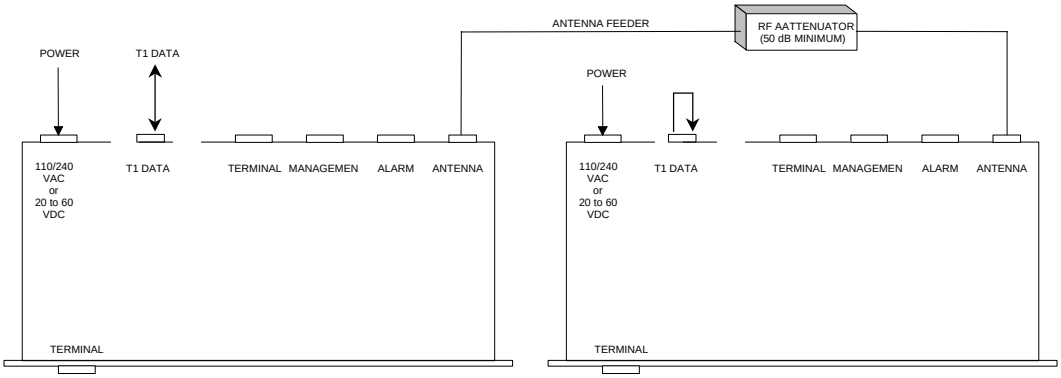


Figure 7 Bench Testing Arrangement (T1 Version)



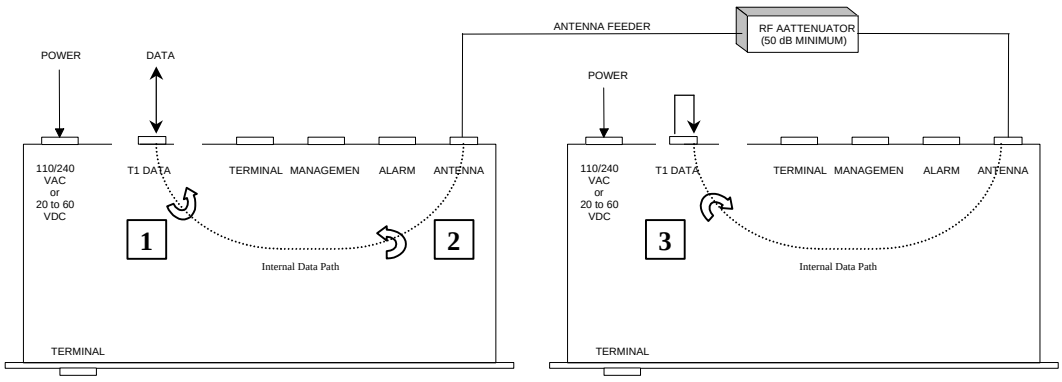
The system may be tested using a single E1 / T1 data stream by looping back the data from the data output to the data input of the E1 / T1 port on one of the units as shown above.

The following procedure provides a method of testing the system at one location using an E1/ T1 data communications anaylser:

- Set up the equipment according to Figure 6 by looping back the data at the data port on one of the units, and connecting an E1 / T1 data communications analyser to the E1 / T1 port of the other unit.
- Switch on the power to the equipment at both ends of the link.
- The four front panel LEDs should be green.
- The E1 / T1 data communications analyser should indicate no errors.

Procedure using internal loopbacks to isolate the fault.

Figure 8 Location of internal loopbacks.



Follow the testing flow shown in Table 1 using the EasyReach Element Manager software to place the radio into loopback at the locations shown in Figure 8.

Table 4 Testing procedure using internal loopbacks.

Loopback	Description	If good	If bad
1	Local E1 / T1	Go to 2	Check near end Connection.
2	Local Modem	Go to 3	Check spreading codes.
3	Far End E1 / T1	Check E1 / T1 far end connection.	Check RF connection.

INTERFACING THE EASYREACH

The ***EasyReach*** may be monitored and configured using a PC with the supplied software and interface cable. The unit provides two **TERMINAL** port connections for this purpose:

- 9-way D-type at the front of the unit.
- RJ45 type at the rear of the unit.

CAUTION

The two* TERMINAL *ports are connected internally. Do not connect external devices to both ports at the same time.

Control and Configuration Using *EasyReach* Element Manager

The unit may be monitored and configured using the ***EasyReach*** Element Manager software running under Windows 95 (minimum) on a PC.

The Element Manager allows access to the following parameters and status information:

- COM port selection.
- Current alarm summary.
- Loopback mode for system checking.
- Monitoring of internal power supplies.
- Monitoring of internal clocking.
- Setting of the digital signal processor (DSP).spreading code.
- Setting of transmit output power.

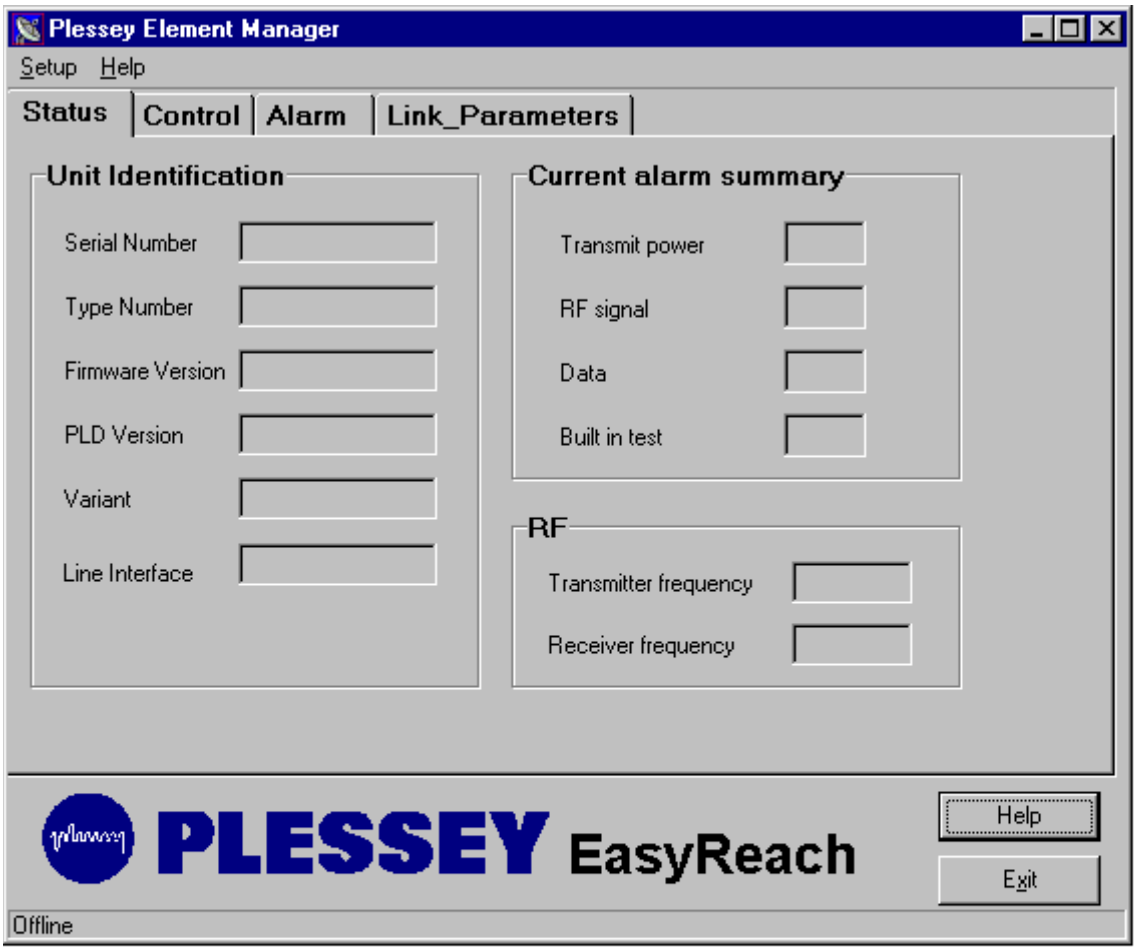
The Element Manager contains a help menu that provides information on all of its functions.

To set up the PC to run the Element Manager, insert the ***EasyReach*** diskette into the a: drive, select Run from the Windows 95 / 98 start menu and type:

Setup.exe

Follow the installation instructions shown on the screen. The appearance of the Element Manager after the installation is complete is shown in Figure 9.

Figure 9 EasyReach Element Manager Startup Window



Interface Cable Configurations

The 9-way D-type interface cable supplied allows access to the front panel **TERMINAL** port, and its pinout is as shown below; pinouts of both ends of the cable are identical.

Table 5 Interface Cable Pinout

Pin	Connection
1	Not connected
2	Transmit
3	Receive
4	Not connected
5	GND
6	Not connected
7	CTS
8	RTS
9	Not connected

If the RJ45 **TERMINAL** port on the rear of the EasyReach unit is to be connected to a PC 9-way D-type port, the interface cable pinout is required to be as below.

Table 6 Rear Panel TERMINAL Port Pinout

Pin	Connection at *EasyReach* End (RJ45)	Connection at PC End (9-way D-type)
1	Not connected	Not connected
2	RTS	Transmit
3	GND	Receive
4	Transmit	Not connected
5	Receive	GND
6	GND	Not connected
7	CTS	CTS
8	Not connected	RTS
9		Not connected

ALARM PORT FUNCTIONS

The ***EasyReach*** provides information on received signal strength and system status from the **ALARM** port connector at the rear of the unit.

The **ALARM** port provides two functions:

- Received signal strength:

  The voltage between pins 5 and 6 give a qualitative indication of the received signal strength. This function is used when aligning the antennas in the link.

- Alarm status:

  This function may be used for external alarm monitoring.

The **ALARM** port allows access to two relays in the unit, one with contacts normally open, the other with contacts normally closed. When the unit is powered and operating correctly, the relays are held in the "ON" state. When an "alarm" occurs or if power to the unit fails, the relays switch to the "OFF" state. An "alarm" is defined in Table 3 (see page 18) and may be configured using the user interface.

A mating connector for this port is supplied with the equipment for user deployment as required. The port pinout is shown in Table 7 below, and the pin configuration is as shown in Figure 10.

Table 7 ALARM Port Pinout

Pin	Connection
1	Relay normally-open contact (non-error state)
2	Relay common
3	Relay normally-closed contact (non-error state)
4	Ground
5	Received signal strength +
6	Received signal strength -

Figure 10 ALARM Port Pin Configuration (Rear View)

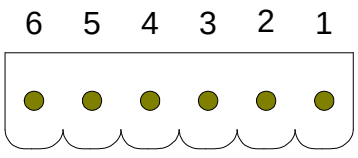


Table 8 DC Power Connector Pinout

Pin	Connection
1	Positive (+)
2	Negative (-)
3	Ground
4	Ground

Figure 11 DC Power Connector Pin Configuration (Rear View)

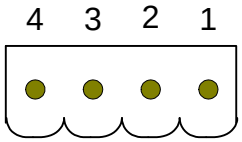
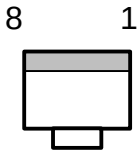


Table 9 T1 Data Connector RJ48C Pinout

Pin	Connection
1	Receive (ring)
2	Receive (tip)
3	Not Used
4	Transmit (ring)
5	Transmit (tip)
6	Not Used
7	Not Used
8	Not Used

Figure 12 T1 Data Connector RJ48C (Rear View)



CO-LOCATION OF EASYREACH LINKS

It is possible to operate up to three ***EasyReach*** links with antennas mounted on the same mast. The antennas must be mounted so they do not interfere with each other. The following measures minimise interference:

- Frequency Diversity.

  The Plessey ***EasyReach*** is factory fitted to operate on one of two channels within the ISM band. Where more than one link is required, one link should be selected to use a different band from the other link(s).

- Space Diversity.

  Interference may be minimised by locating antennas from different links as far as possible from each other. In the case where the antennas are mounted on the same pole or tower, they should be separated as much as possible, particularly if they are not pointing in opposite directions.

- Polarisation Diversity:

  The antennas may be mounted so the antennas from one link are mounted with a different polarisation to the antennas from another link. This is especially important in the case where three links are used, since two links must share the same frequency band.

ACCESSORIES

The accessories available for the Plessey ***EasyReach*** are:

Part Number	Description
1B90949-x	Feed cable (Standard loss, High flexibility) Where x is a 3 digit number indicating length in 10^{th} of a metre. For example the order code for a 10 metre length would be 1B90949-100.
2B90949-x	Feed cable (Low loss, Standard flexibility) Where x is a 3 digit number indicating length in 10^{th} of a metre. For example the order code for a 10 metre length would be 1B90949-100.
3B90949	Antenna, 19dBi
4B90949	Antenna, 22dBi
5B90949	Surge protector
6B90949	N Type adaptor, right angle, M/f
7B90949	N Type adaptor, BH flange, F/F
8B90949	N type adaptor, BH panel, F/F
9B90949	75 / 120 Ohm Balun BNC / Krone
10R90949	Antenna, 21dBi
11R90949	Antenna, 24dBi

Contact Plessey for details of these items, if required.

TECHNICAL SPECIFICATIONS

The technical operational specifications for the ***EasyReach*** system are detailed following.

System (E1 Version)

RF range	2400 … 2483.5 MHz
Link distance, with 22dBi antenna and 20 dB fade margin	> 30 km
Type of operation	Frequency division duplexing
Antenna port	N-type female, 50 ohms
PN code	11 bits
Processing gain	Better than 10 dB
Data rate	2.048 Mbits/s
Data interface	ITU-T G.703, 75 ohms, BNC
Jitter specification	ITU-T G.823
Residual BER	Better than 1E-10
Alarm indicators	Power, system and data fail
External alarm	Relay contact, normally-open

System (T1 Version)

RF range	2400 … 2483.5 MHz
Link distance, with 22dBi antenna and 20 dB fade margin	> 30 km
Type of operation	Frequency division duplexing
Antenna port	N-type female, 50 ohms
PN code	13 bits
Processing gain	Better than 10 dB
Data rate	1.544 Mbits/s
Data interface	RJ48C
Jitter specification	ITU-T G.823
Residual BER	Better than 1E-10
Alarm indicators	Power, system and data fail
External alarm	Relay contact, normally-open

Transmitter

Nominal Power at antenna port	+24 dBm, 10 dB adjustable
Frequency stability	15 PPM maximum
Modulation	QPSK, direct sequence

Receiver

Reference level	-63 dBm/50 ohms
Overload point	-25 dBm
Sensitivity (typical) at antenna port	-88 dBm at BER = 10E-6

Power Supply

DC source	-20 to –60 volts
Optional AC input	110 to 240 volts 50 to 60 Hertz (Auto ranging)

Mechanical

Chassis	19-inch rack-mountable 1 RU height, 440 mm deep Can be freestanding and stackable

Environmental

Operating temperature	5^{O}C to 40^{O}C (41^{O}F to 104^{O}F)

Compliance

Safety	AS 3260
EMC	AS3548 FCC, ETSI

TECHNICAL ASSISTANCE NOTES

Surge Protection for Radio Equipment

General

Devices exist to assist in the protection of radio equipment from surges caused by lightning strikes and nuclear blasts. The level of protection based on the fact that damage thresholds for microwave diodes are in the order of 1.E-8 joules. This note does not address surges in power lines.

Surge Characteristics

Surges in equipment conductors are induced by broad band, high-energy electromagnetic pulses. These pulses are caused by lightning (LEMP) and/or nuclear blasts (NEMP). Most of the energy in lightning pulses is confined within DC to 1 MHz with rise time in the nanoseconds range. Electric field associated with LEMP are in order of 500 kV/m while those from NEMP are about one order of magnitude less. In the normal configurations with an antenna mounted on a mast and connected to the transmitter/receiver via coaxial cable/waveguide, induced voltages (currents) are in *common mode at the entrance point* (around the top of the mast). Potential difference will develop between different conducting paths as the surge is transmitted towards ground equipment due to different (transient) propagation characteristic of the cable/waveguide. For coaxial cables for example, higher inductance of the inner conductor delays and flattens (longer rise time) the pulse relative to the one received from the shield. LNAs located outside right at the antenna are often not affected by large common mode surges. Apart from high potential difference, the resultant high surge currents can also excessively heat, to melting, the various conducting paths on their way escaping to ground.

Methods of Surge Protection

The causes for surges thus can not be controlled or eliminated. The effects of surges, however, are minimised by good (low inductance) earth paths where surge currents are passed harmlessly down to good earth. The paths may be one or all combinations of the following:

1. the earth paths that are connected to signal line but are open circuit at the operating frequency; or,

2. the improved existing or dedicated conduction earth path; or,

3. the paths that are short-circuited to good ground at the surge voltage.

Each of these three methods is briefly explained below.

Grounded Antennas

Often the antennas are grounded. A most simple example is the folded dipole. Only at the intended frequencies are the paths separated by the characteristic impedance. Away from the radiating elements, the path of least resistance to good earth, will be the one taken lightning surge current. Often this path is discovered after the event, where melted-down metal or burned material is found after a thunderstorm. Deliberate grounding outside the operating frequency band can also be designed into the circuit. The simplest method of doing this is the shorted quarter-wave stubs. The technique is economically suitable when the operating frequency band is well separated from the effective spectrum of the surge pulses. Grounded antennas provide good surge protection and are often not sufficient by itself.

Dedicated Conduction Paths

Away from the radiating elements, surge currents are diverted away from circuit units to the antenna frame by copper earth straps placed at strategic locations. This is a low-cost solution and together with grounded antenna design (as described above) is normally sufficient to protect the antenna system from lightning. Lightning rods providing protection cones can also be used to induce surges to take a particular path down to ground via the antenna frame/tower. The use of heavy-gauge ground wire running up the mast was found not to be cost effective, as the wire needs to be large and fitted at least 0.5 m away from the mast, and often the difference in conductivity between copper and galvanised steel is lost in the difference in inductances due to smaller surface area of the ground wire. Attention also has to be provided for the galvanic voltage.

Dedicated Surge Protection Cells

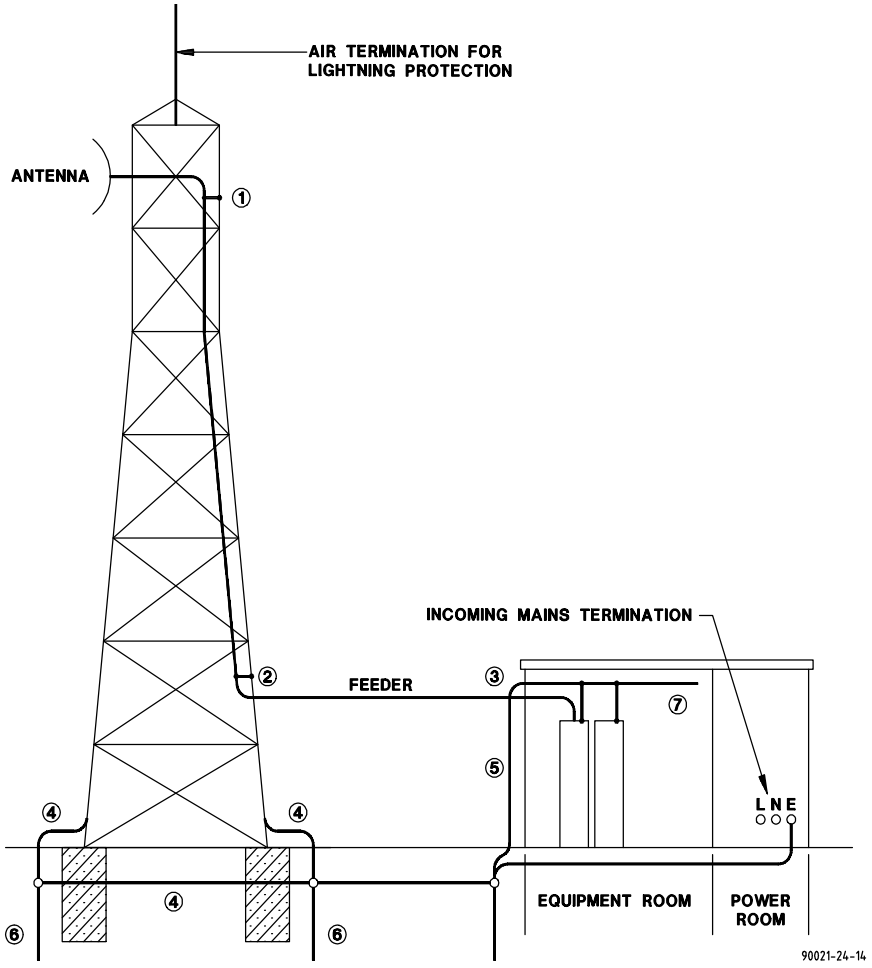
Surge protection cells can be inserted in transmission path between antenna and ground equipment. Cells are generally of two types. One type of cell is designed dedicated to a particular frequency band using ‘1/4-wave’ stub techniques of various sophistication to provide sharpness in the passband. The other type makes use of the voltage discrimination of some non-linear diodes or gas tubes. At voltage higher than a predetermined level, the device shorts the central conductor to its shield, preferably at a point where the shield itself is well grounded.

Standard Earthing Practices

Optimum system performance can ONLY be achieved if correct earthing practices have been adopted. Although it may seem obvious, this is an area that is often neglected or compromised. It is essential that the incoming supply, the 19-inch rack, the antenna feeder, the mast, and all interconnecting bulkheads be **ALL solidly grounded**. If these points are neglected, the user may experience sub-standard performance or interference problems.

The recommended earthing points are depicted in Figure 13.

Figure 13 Standard Earthing Practices at a Communication Site



① Grounding Kit at top end of feeder.

② Grounding Kit at point where feeder leaves antenna.

③ Grounding Kit at point where feeder enters building.

④ Earth Bonds – 30 × 5 mm (minimum) copper or galvanised steel strip.

⑤ Down Conductor – 20 × 3 mm copper strip, or 35 mm^2 stranded conductor.

⑥ Earth Electrode – 12 mm diameter hard drawn copper, or 10 mm diameter copper clad steel rod.

⑦ Internal Station Earth – 20 × 1.5 mm copper strip, or 35 mm^2 stranded conductor.