User Manual
E Series Data Radio

ER450 Remote Data Radio

EB450 Base Station

EH450 Hot Stand-by Base Station

TRIO

DATACOM

Part A – Preface

Warranty

All equipment supplied by Trio DataCom Pty. Ltd. is warranted against faulty workmanship and parts for a period of twelve (12) months from the date of delivery to the customer. During the warranty period Trio DataCom Pty. Ltd. shall, at its option, repair or replace faulty parts or equipment provided the fault has not been caused by misuse, accident, deliberate damage, abnormal atmosphere, liquid immersion or lightning discharge; or where attempts have been made by unauthorised persons to repair or modify the equipment.

The warranty does not cover modifications to software. All equipment for repair under warranty must be returned freight paid to Trio DataCom Pty. Ltd. or to such other place as Trio DataCom Pty. Ltd. shall nominate. Following repair or replacement the equipment shall be returned to the customer freight forward. If it is not possible due to the nature of the equipment for it to be returned to Trio DataCom Pty. Ltd., then such expenses as may be incurred by Trio DataCom Pty. Ltd. in servicing the equipment in situ shall be chargeable to the customer.

When equipment for repair does not qualify for repair or replacement under warranty, repairs shall be performed at the prevailing costs for parts and labour. Under no circumstances shall Trio DataCom Pty. Ltd.'s liability extend beyond the above nor shall Trio DataCom Pty. Ltd., its principals, servants or agents be liable for the consequential damages caused by the failure or malfunction of any equipment.

Important Notice

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This manual covers the operation of the E Series of Digital Data Radios. Specifications described are typical only and are subject to normal manufacturing and service tolerances.

Trio DataCom Pty Ltd reserves the right to modify the equipment, its specification or this manual without prior notice, in the interest of improving performance, reliability or servicing. At the time of publication all data is correct for the operation of the equipment at the voltage and/or temperature referred to. Performance data indicates typical values related to the particular product.

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⚠ Warning :- RF Exposure

The radio equipment described in this user manual emits low level radio frequency energy. The concentrated energy may pose a health hazard depending on the type of antenna used. In the case of a non-directional antenna do not allow people to come within 0.5 metres of the antenna when the transmitter is operating. In the case of a directional antenna do not allow people to come within 6 metres of the antenna when the transmitter is operating.

Related Products

ER450 Remote Data Radio
EB450 Base/Repeater Station
EH450 Hot Stand-by Base Station

Other Related Documentation and Products

Quick Start Guide
TVIEW+ Management Suite
Digital Orderwire Voice Module (EDOVM)
Stream Router/Multiplexer (95MSR)

Revision History

Issue 1	July 2002	Intitial Release
Issue 2	August 2002	Added EH450 Quick Start Section and Specifications Section
Issue 3	November 2002	Major Edits to TVIEW and minor edits to quick start sections.

Contents

Part B – E Series Overview

Definition of E Series Data Radio

The E Series is a range of wireless modems designed for the transmission of data communications for SCADA, telemetry, and any other information and control applications that utilise ASCII messaging techniques. The E Series uses advanced "digital" modulation and signal processing techniques to achieve exceptionally high data throughput efficiency using traditional licensed narrow band radio channels.

The products are available in many frequency band and regulatory formats to suit spectrum bandplans in various continental regions. The range is designed for both fixed point to point (PTP), and multiple address (MAS) or point to multipoint (PMP) systems.

E Series Product Range

The E Series range consists of the basic *half duplex* "Remote" radio modem, an extended feature *full duplex* Remote radio modem, and ruggedised *Base Station* variants, including an optional *Hot Standby controller* to control two base station units in a redundant configuration.

Frequency band variants are indicated by the band prefix and model numbering. (See Model Number Codes)

ER450 Remote Radio

EB450   Base / Repeater Station

EH450 Hot Standby Base Station

E Series – Features and Benefits

Common Features and Benefits of the E Series Data Radio

- Up to 19200bps over-air data rates using programmable DSP based advanced modulation schemes
- Designed to various International regulatory requirements including FCC, ETSI and ACA
- Superior receiver sensitivity
- Fast data turnaround time <10mS
- Flash upgrade-able firmware – insurance against obsolescence
- Multi-function bi-colour Tx/Rx data LEDS showing Port activity (breakout box style), as well as LEDs indicating Tx, Rx, RF Signal, Data Synchronisation and DC Power status of the radio
- Rugged N type antenna connectors on all equipment
- High temperature transmitter foldback protection
- Two independent configurable data ports and separate system port
- Higher port speeds to support increased air-rate (up to 76800bps on Port A and 38400bps on Port B)
- Independent system port for interruption free programming and diagnostics (in addition to two (2) user ports)
- 9600bps in 12.5 kHz radio channels with ETSI specifications
- Remote over-the-air configuration of any radio from any location
- Multistream™ simultaneous data streams allows for multiple vendor devices / protocols to be transported on the one radio network
- Flexible data stream routing and steering providing optimum radio channel efficiency – complex data radio systems can be implemented with fewer radio channels
- The ability to duplicate data streams – that is, decode the same off-air data to two separate ports.
- Multi-function radio capable of dropping off one stream to a port and forward on or repeat (store and forward) the same or other data.
- Stand-alone internal store and forward operation – buffered store and forward operation even in the ER remote units
- Unique integrated C/DSMA collision avoidance technology permits simultaneous polling and spontaneous reporting operation in the same system
- Digital receiver frequency tracking for long term data reliability
- Network wide non intrusive diagnostics which runs simultaneously with the application

- Network wide diagnostics interrogation which can be performed from anywhere in the system including any remote site

- Diagnostics will route its way to any remote or base / repeater site regardless of how many base / repeater stations are interconnected

- Full range of advanced features available within Network Management and Remote Diagnostics package – BER testing, trending, channel occupancy, client / server operation, etc.

- On board memory for improving user data latency – increased user interface speeds

- Full CRC error checked data – no erroneous data due to squelch tails or headers

- Radio utilises world standard HDLC as its transportation protocol

- Various flow control and PTT control mechanisms

- Configurable backward compatibility with existing D Series modulation scheme for use within existing networks

- Digital plug in order wire option for commissioning and occasional voice communications without the need to inhibit users application data

Features and Benefits of ER450 Remote Data Radio

- Optional full duplex capable remote – separate Tx and Rx ports for connection to an external duplexer

- New compact and rugged die cast case with inbuilt heatsink

- Low power consumption with various sleep modes

- Rugged N type antenna connectors

- In-line power supply fuses

- Data Port "breakout box" style flow LEDs for easier troubleshooting

Features and Benefits of EB450 Standard Base / Repeater Station

- Competitively priced high performance base

- Incorporates a rugged 5W power amplifier module

- External input for higher stability 10MHz reference – GPS derived

Features and Benefits of EH450 Hot Standby Base / Repeater Station

- Individual and identical base stations with separate control logic changeover panel

- ALL modules are hot swapable without any user downtime

- Flexible antenna options – single, separate Tx & Rx, two Tx and two Rx

- Increased sensitivity with receiver pre-amplifier

- Both on-line and off-line units monitored regardless of active status

- External input for higher stability 10MHz reference – GPS derived

Model Number Codes

D, E & S Series Data Radios - Part Number Matrix = Tyxxx-aabbb-cd

T	y	x	x	-	a	a	b	b	b	-	c	d

Options - Base Stations*

0	= No Options
1	= 450MHz Band Reject [DUPLX450BR]
2	= 450MHz Band Reject (<9MHz split)[DUPLX450BR/5]
3	= 450MHz Band Pass [DUPLX450BP]
4	= 900MHz Band Reject [DUPLX900BR]
5	= 900MHz Band Pass [DUPLX900BP]
6	= 900MHz Band Pass (76MHz split)[DUPLX852/930]

Note: Specify Internally or Externally fitted. Externally fittered duplexes require feeder tails.

Options - Remote Antenna Connector*

0	= No Options (Standard)
N	= N Connector (D Series only)
S	= SMA Connector (SR450 only)

Options*

0	= No Options
D	= Diagnostics - [DIAGS/D, DIAGS/DH, DIAGS/E or DIAGS/EH] (D & E Series Only)
H	= Extended Temp Option [HITEMP]
N	= Remote Fitted into NEMA Enclosure [NEMA 4/R]
F	= Full Duplex Operation [ERFD450] (ER450 only)
X	= Full Duplex Operation [ERFD450 & DIAGS/E] (ER450 only)

RF Channel Data Rate & Bandwidth (Internal Modem)

D Series		E Series		S Series	
A01	= ACA 4800bps in 12.5kHz	A01	= ACA 4800# / 9600bps in 12.5Hz	001	= 12.5kHz (No Modem Fitted)
A02	= ACA 9600bps in 25kHz	A02	= ACA 9600# / 19k2bps in 25kHz	002	= 25kHz (No Modem Fitted)
F01	= FCC 9600bps in 12.5kHz	F01	= FCC 9600# / 9600bps in 12.5kHz	241	= 2400bps in 12.5kHz [24SR]*
		F02	= FCC 19k2bps in 25kHz	242	= 2400bps in 25kHz [24SR]*
		E01	= ETSI 9600bps in 12.5kHz	482	= 4800bps in 25kHz [48SR]*
		E02	= ETSI 19k2bps in 25kHz		

Frequency (200 & 400 MHz range)

39	= 208 to 240MHz (Tx & Rx)
50	= 403 to 417MHz (Tx & Rx)
58	= (Tx) 406 to 421MHz (Rx) 415 to 430MHz
59	= (Tx) 415 to 430MHz (Rx) 406 to 421MHz
56	= 418 to 435MHz (Tx & Rx)
57	= 428 to 443MHz (Tx & Rx)
55	= 436 to 450MHz (Tx & Rx)
51	= 450 to 465MHz (Tx & Rx)
52	= 465 to 480MHz (Tx & Rx)
53	= 480 to 494MHz (Tx & Rx)
54	= 505 to 518MHz (Tx & Rx)
27	= (Tx) 511 to 515MHz (Rx) 501 to 505MHz
48	= 395 to 406MHz (Tx & Rx)

Frequency (900 MHz range) (D & S Series Only)

07	= (Tx) 847 to 857MHz (Rx) 923 to 933MHz (D Series only, 1W Full Duplex)
10	= (Tx) 848 to 858MHz (Rx) 920 to 934MHz
06	= (Tx) 923 to 933MHz (Rx) 847 to 857MHz (D Series only, 1W Full Duplex)
11	= (Tx) 920 to 934MHz (Rx) 848 to 858MHz
12	= 855 to 860MHz (Tx & Rx)
14	= (Tx) 925 to 943MHz (Rx) 906 to 924MHz
15	= (Tx) 904 to 922MHz (Rx) 925 to 943MHz
16	= 924 to 944MHz (Tx & Rx)

Note: Other frequency bands available upon request.

Generic Frequency Band

200	= 208 to 245MHz (D & S Series only)
450	= 400 to 518MHz (E & S Series only)
900	= 800 to 960MHz (D & S Series only)

NOTES:

* Additional charges apply. Must be ordered seperately. Please refer to price list.
 # Provides compatibility with D Series radio
Items in [ ] parenthesis refer to actual Trio part numbers

Unit Type

R	= Remote Station
B	= Base / Repeater Station
S	= Standard Base / Repeater Station (D Series Only)
H	= Hot Standby Base / Repeater (D & E Series Only)

Standards:

ACA - Australian Communications Authority
FCC - Federal Communications Commission
ETSI - European Telcommunication Standards Institute

Model Type

D	= D Series Family
E	= E Series Family
S	= S Series Family

Example:

E	R	4	5	0	-	5	1	A	0	2	-	D	0

The above example specifies: E Series, Remote Radio, generic 450MHz band, with a specific frequency of 450MHz to 465MHz, a 96/19.2kbps modem, with a bandwidth of 25kHz, diagnostics and standard N type connector.

Version: 11/02

Standard Accessories

Part Number	Description

Duplexers

Part Number	Description
DUPLX450BR	Duplexer BAND REJECT 400-520 MHz for use with Base / Repeater / Links. For Tx / Rx frequency splits >9MHz. (Fitted Externally for a Link, Intenally or Externally for Base / Repeater)
DUPLX450BR/5	Duplexer BAND REJECT 400-520 MHz for use with Base / Repeater / Links. For Tx / Rx frequency splits <9MHz. (Fitted Externally for a Link, Intenally or Externally for Base / Repeater)
DUPLX450BP	Duplexer PSEUDO BAND PASS Cavity 400-520 MHz for External use with Base / Repeater / Links.

Notes:

1. *Frequencies must be specified at time of order.*

2. *Interconnecting (Feeder Tail) cables must be ordered separately for Externally fitted Duplexers.*

Antennas

Part Number	Description
ANT450/9A	Antenna Yagi 6 Element 9dBd Aluminium 400-520 MHz c/w mtg clamps
ANT450/9S	Antenna Yagi 6 Element 9dBd S/Steel 400-520 MHz c/w mtg clamps
ANT450/13A	Antenna Yagi15 Element 13dBd Aluminium 400-520 MHz c/w mtg clamps.
ANT450/13S	Antenna Yagi 15 Element 13dBd S/Steel 400-520 MHz c/w mtg clamps.
ANTOMNI/4	Antenna Omni-directional Unity Gain Side Mount Dipole 400-520 MHz c/w galv. clamp
ANT450/D	Antenna Omni-directional Unity Gain Ground Independant Dipole 400-520 MHz c/w 3m cable, mounting bracket & BNC connector
ANT450/6OM	Antenna Omni-directional 6dBd 400-520 MHz c/w mtg clamps
ANT450/9OM	Antenna Omni-directional 9dBd 400-520 MHz c/w mtg clamps

Note:

1. *Frequencies must be specified at time of order.*

Power Supplies

Part Number	Description
PS13V82A	Power Supply 13.8V 2A 240VAC
PS13V810A	Power Supply Switch Mode 240VAC 13.8V 10A for Base Stations – Battery Charge Capability

RF Cables and Accessories

Part Number	Description
NM/NM/TL	Feeder Tail - N Male to N Type Male 50cm fully sweep tested
NM/NM/TLL	Feeder Tail - N Male to N Type Male 1 metre fully sweep tested
RFCAB5M	5.0m RG-58 type Antenna Feeder Cable terminated with N type Male Connectors
RFCAB5M2	5.0m RG-213 type Antenna Feeder Cable terminated with N type Male Connectors
RFCAB10M	10.0m RG-213 type Antenna Feeder Cable terminated with N type Male Connectors
RFCAB20M	20.0m RG-213 type Antenna Feeder Cable terminated with N type Male Connectors
RFCAB20M4	20.0m LDF4-50 type (1/2" foam dialectric) Antenna Feeder Cable terminated with N type Male Connectors
LGHTARRST	Lightning Surge Arrestor In-line N Female to N Female

Multiplexers

Part Number	Description
95MSR/6	Multiplexer/Stream Router – 6 Port with RS-232 I/faces and Manual
95MSR/9	Multiplexer/Stream Router – 9 Port with RS-232 I/faces and Manual

Network Management Diagnostics

Part Number	Description
DIAGS/E	Network Management and Remote Diagnostics Facilities per Radio – E Series
DIAGS/EH	Network Management and Remote Diagnostics Facilities – E Series for EH450

Software

Part Number	Description
TVIEW+	Configuration, Network Management and Remote Diagnostics Software

Other

Part Number	Description
NEMA 4 /R	Stainless Steel Enclosure for Remote Site Equipment.Size 600mm (h) x 600mm (d) x 580mm (w) – Room for Third Party RTU / PLC equip. (Approx. 400(h) x 600(d) x 580mm(w)
HITEMP	Extended Temperature Option for S, D and E Series Radios -30 to +70C
EDOVM	Digital Order Wire Voice Module
ERFD450	ER450…. Conversion to Full Duplex Operation (N Type – Tx Port, SMA - Type Rx Port) *Note: Requires external duplexer*
ERFDTRAY	19" Rack Tray for Mounting of ER450 Full Duplex Radio and External Band Reject Duplexer

Part C – Applications

Generic Connectivity

The E Series has been designed for SCADA and telemetry applications, and any other applications that use an ASCII communications protocol, and which connect physically using the RS232 interface standard (although converters can be used to adapt other interfaces such as RS422/485, RS530/V35, G703 etc).

Any protocol that can be displayed using a PC based terminal program operating via a serial comm port is suitable for transmission by the E Series radio modems.

An ASCII protocol is any that consists of message strings formed from ASCII characters, that being defined as a 10 or 11 bit block including start and stop bits, 7 or 8 data bits and optional parity bit(s). Port set-up dialog that includes the expressions "N,8,1", or E,7,2" or similar indicate an ASCII protocol.

Most of the dominant telemetry industry suppliers utilise proprietary ASCII protocols, and also common "open standard" industry protocols such as DNP3, MODBUS, TCP/IP, and PPP. These are all ASCII. based protocols.

Industries and Applications

The E Series products are widely used in point-to-point and point-to-multipoint (multiple access) applications for remote interconnection of PLC's, RTU's, dataloggers, and other data monitoring and control devices including specialist utility devices (such as powerline ACR's). In addition, other applications such as area wide security and alarm systems, public information systems (traffic flow and public signage systems) and environmental monitoring systems.

Application Detail

SCADA Systems

This is where one or more centralised control sites are used to monitor and control remote field devices over wide areas. Examples include regional utilities monitoring and controlling networks over entire shires or a greater city metropolis'. Industry sectors include energy utilities (gas and electricity distribution), water and sewerage utilities, and catchment and environment groups (rivers, dams, and catchment management authorities).

Telemetry Systems

Dedicated telemetry control systems interconnecting sequential devices where cabling is not practical or distances are considerable.

Examples include ore conveyor or slurry pipeline systems, simple water systems (pump and reservoir interlinking), broadcast industry (linking studio to transmitter) etc.

Information Systems

Public Information systems such as freeway vehicle flow and travel time monitoring, and feedback signage, parking signage systems, meteorological stations etc.

Systems Architecture

Point-to-Point

This simple system architecture provides a virtual connection between the two points, similar to a cable. Dependant of the hardware chosen, it is possible to provide a full duplex connection (i.e. data transfer in both directions simultaneously) if required.

Host Computer

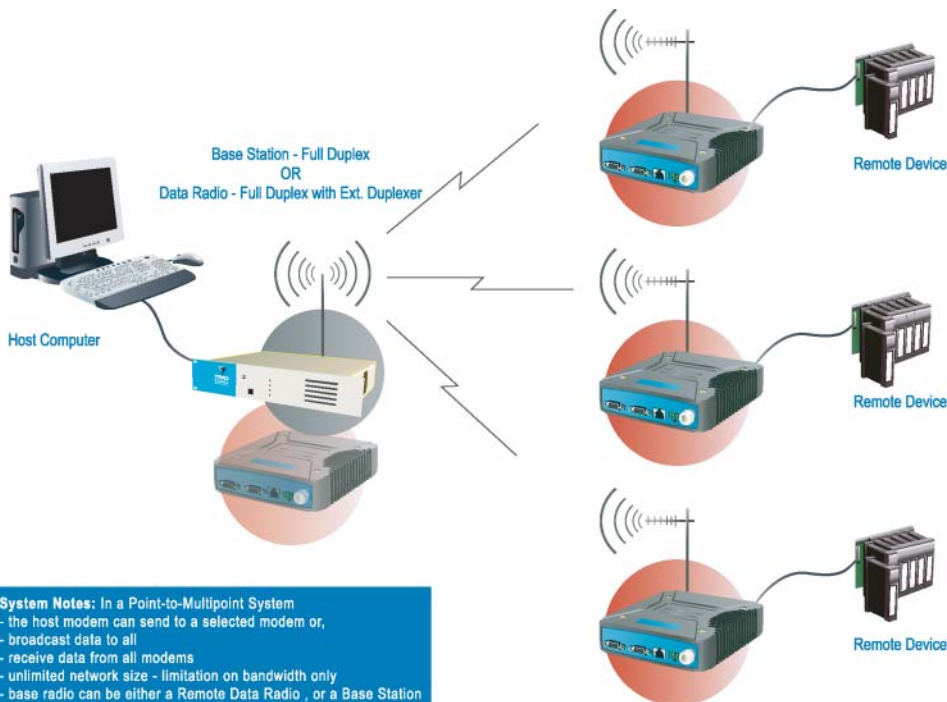Remote Device

Data Radio - Half Duplex
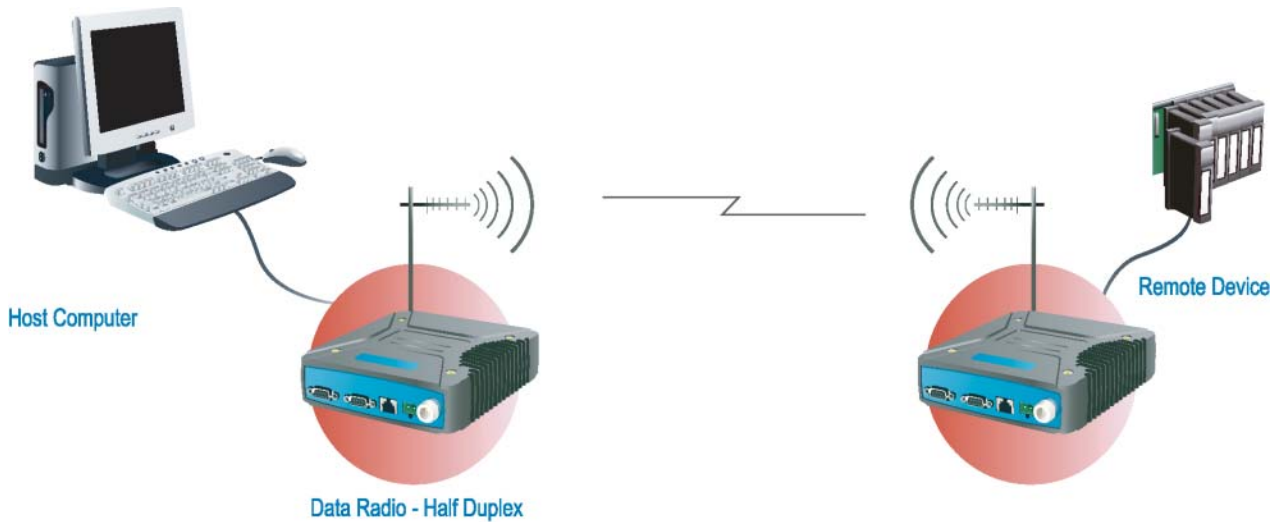
Point-to-Multipoint Systems

In a multiple access radio system, messages can be broadcast from one (master) site to all others, using a half duplex radio system, or from any site to all others, using a simplex radio channel.

Half duplex systems often utilise a full duplex master, to make the system simpler, and to operate faster.

In either case, it will be necessary for the application to support an addressing system, since the master needs to be able to select which remote device it wishes to communicate to. Normally, the radio system is allowed to operate "transparently", allowing the application's protocol to provide the addressing, and thus control the traffic. Where the application layer does not provide the addressing, the E Series can provide it using SID codes™. (See Part F - Operational Features)


Base Station - Full Duplex
OR
Data Radio - Full Duplex with Ext. Duplexer

Host Computer

Remote Device

Remote Device

Remote Device

System Notes: In a Point-to-Multipoint System
- the host modem can send to a selected modem or,
- broadcast data to all
- receive data from all modems
- unlimited network size - limitation on bandwidth only
- base radio can be either a Remote Data Radio , or a Base Station

Digipeater Systems

This configuration is used where all sites are required to communicate via a repeater site. A repeater site is used because it has a position and/or height advantage and thus provides superior or extended RF coverage. The radio modem at the repeater does not have to be physically connected to the application's master

site. Information from the application's master is transmitted to the repeater via radio, and the repeater then relays this information to the other field sites. In this scenario, the repeater is the master from an RF point of view, and the application master is effectively a "remote" from an RF point of view, even though it is controlling the data transfer on the system.
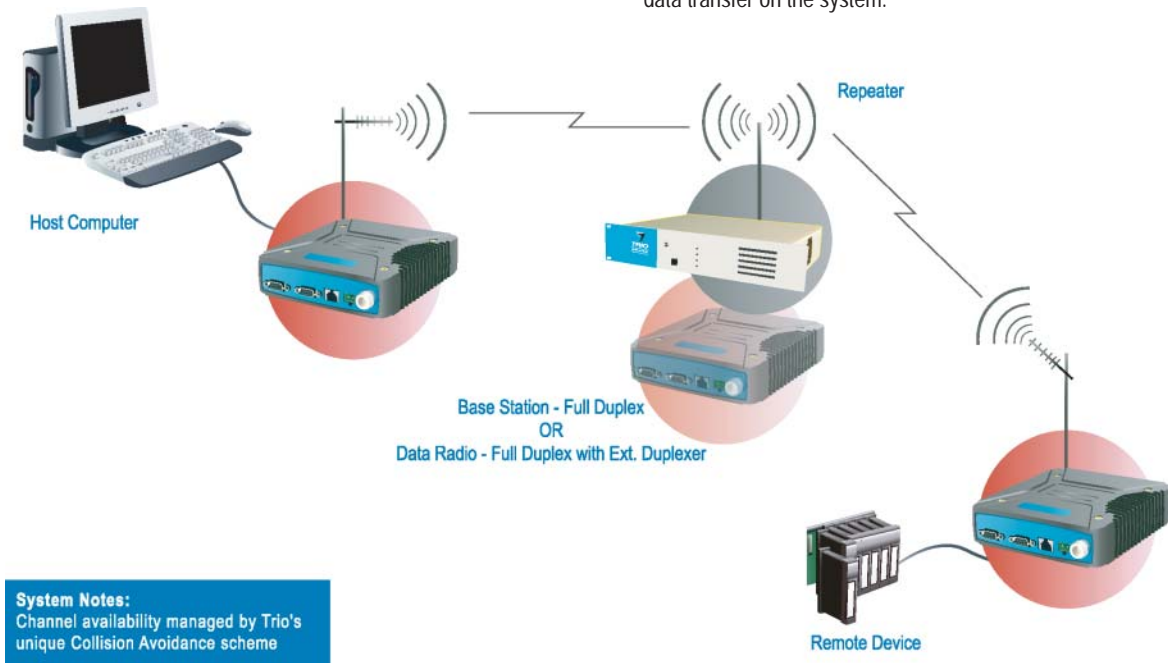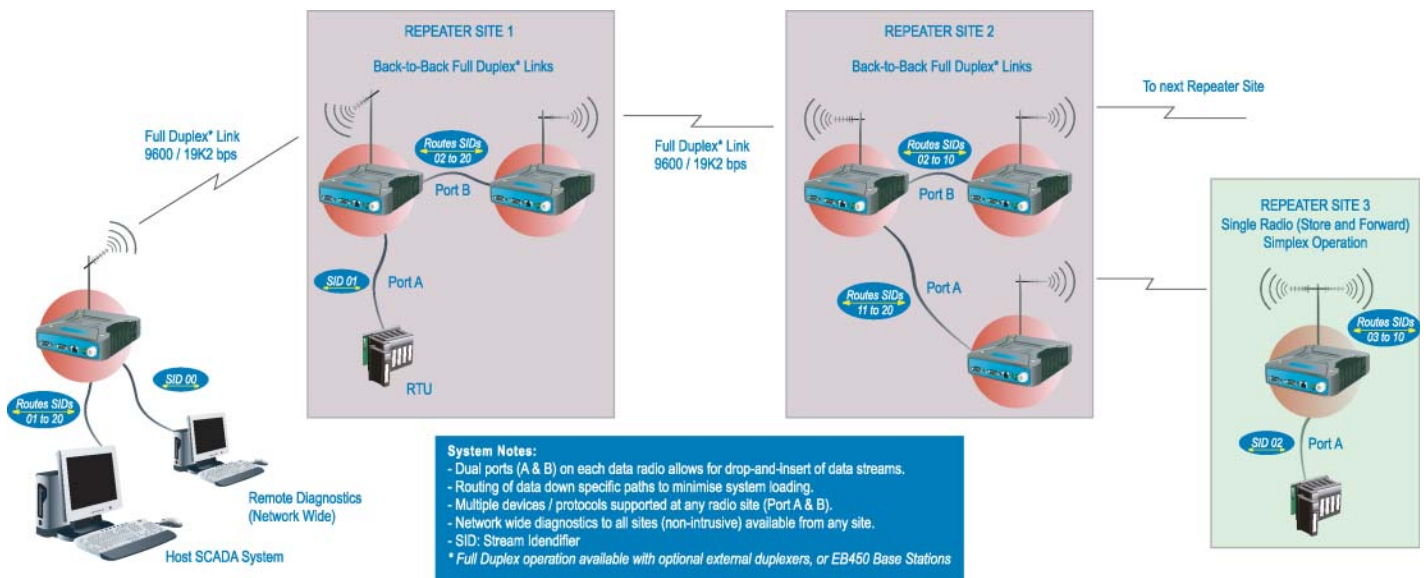

System Notes:
Channel availability managed by Trio's unique Collision Avoidance scheme

Store and Forward Systems

Store and forward is used as a way of extending RF coverage by repeating data messages from one site to another.

This can be done globally using the inbuilt data repeating functions, or selectively using intelligent address based routing features available in some PLC/RTU protocols.

In this case it is necessary for all units on the system to operate in half duplex mode (only key-up when transmitting data), so that each site is free to hear received signals from more than one source.

System Notes:
- Dual ports (A & B) on each data radio allows for drop-and-insert of data streams.
- Routing of data down specific paths to minimise system loading.
- Multiple devices / protocols supported at any radio site (Port A & B).
- Network wide diagnostics to all sites (non-intrusive) available from any site.
- SID: Stream Identifier
* Full Duplex operation available with optional external duplexers, or EB450 Base Stations

Part D – System Planning and Design

Understanding RF Path Requirements

A radio modem needs a minimum amount of received RF signal to operate reliably and provide adequate data throughput.

In most cases, spectrum regulatory authorities will also define or limit the amount of signal that can be transmitted, and the transmitted power will decay with distance and other factors, as it moves away from the transmitting antenna.

It follows, therefore, that for a given transmission level, there will be a finite distance at which a receiver can operate reliably with respect to the transmitter.

Apart from signal loss due to distance, other factors that will decay a signal include obstructions (hills, buildings, foliage), horizon (effectively the bulge between two points on the earth), and (to a minimal extent at UHF frequencies) factors such as fog, heavy rain-bursts, dust storms, etc.

In order to ascertain the available RF coverage from a transmitting station, it will be necessary to consider these factors. This can be done in a number of ways, including

(a)   using basic formulas to calculate the theoretically available signal - allowing only for free space loss due to distance,

(b)   using sophisticated software to build earth terrain models and apply other correction factors such as earth curvature and the effects of obstructions, and

(c)   by actual field strength testing.

It is good design practice to consider the results of at least two of these models to design a radio path.

Examples of Predictive Path Modelling

Clear line of site

Radio path with good signal levels, attenuated only by free space loss.
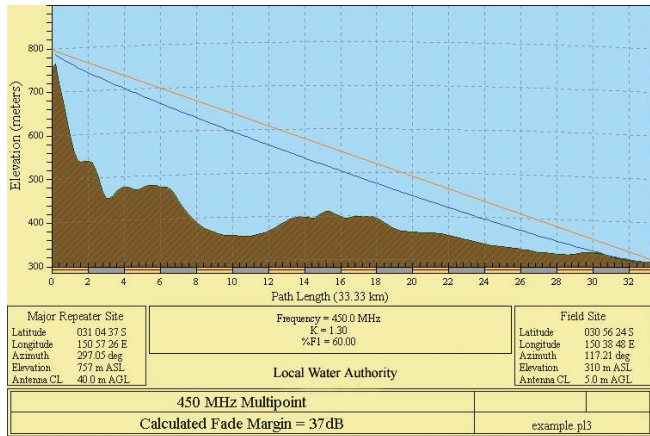
goodpath.pl3	Major Repeater Site	Field Site
Elevation (m)	756.69	309.67
Latitude	031 04 37.49 S	030 56 24.00 S
Longitude	150 57 26.34 E	150 38 48.00 E
Azimuth	297.05	117.21
Antenna Type	ANT450/6OM	ANT450/9AL
Antenna Height (m)	40.00	5.00
Antenna Gain (dBi)	8.15	11.15
Antenna Gain (dBd)	6.00	9.00
TX Line Type	LDF4-50	LDF4-50
TX Line Length (m)	40.00	5.00
TX Line Unit Loss (dB/100 m)	6.79	6.79
TX Line Loss (dB)	2.72	0.34
Connector Loss (dB)	2.00	2.00
Frequency (MHz)	450.00	
Path Length (km)	33.33	
Free Space Loss (dB)	115.99	
Diffraction Loss (dB)	0.00	
Net Path Loss (dB)	103.75	103.75
Radio Type Model	EB450	ER450
TX Power (watts)	5.00	1.00
TX Power (dBW)	6.99	0.00
Effective Radiated Power (watts)	6.71	4.63
Effective Radiated Power (dBW)	8.27	6.66
RX Sensitivity Level (uv)	0.71	1.26
RX Sensitivity Level (dBW)	-140.00	-135.00
RX Signal (uv)	45.93	102.70
RX Signal (dBW)	-103.75	-96.76
RX Field Strength (uv/m)	453.14	545.42
Fade Margin (dB)	36.25	38.24
Raleigh Service Probability (%)	99.976	99.985

Obstructed Radio Path

This path has an obstruction that will seriously degrade the signal arriving at the field site.
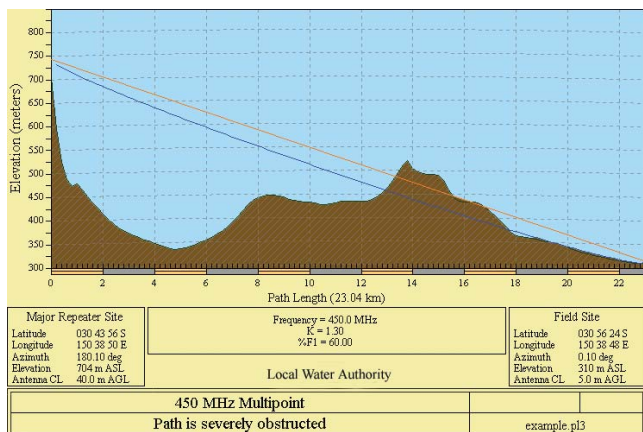
obstpath.pl3	Major Repeater Site	Field Site
Elevation (m)	703.83	309.67
Latitude	030 43 55.92 S	030 56 24.00 S
Longitude	150 38 49.51 E	150 38 48.00 E
Azimuth	180.10	0.10
Antenna Type	ANT450/6OM	ANT450/9AL
Antenna Height (m)	40.00	5.00
Antenna Gain (dBi)	8.15	11.15
Antenna Gain (dBd)	6.00	9.00
TX Line Type	LDF4-50	LDF4-50
TX Line Length (m)	40.00	5.00
TX Line Unit Loss (dB/100 m)	6.79	6.79
TX Line Loss (dB)	2.72	0.34
Connector Loss (dB)	2.00	2.00
Frequency (MHz)	450.00	
Path Length (km)	23.04	
Free Space Loss (dB)	112.78	
Diffraction Loss (dB)	16.71	
Net Path Loss (dB)	117.25	117.25
Radio Type Model	EB450	ER450
TX Power (watts)	5.00	1.00
TX Power (dBW)	6.99	0.00
Effective Radiated Power (watts)	6.71	4.63
Effective Radiated Power (dBW)	8.27	6.66
RX Sensitivity Level (uv)	0.71	1.26
RX Sensitivity Level (dBW)	-140.00	-135.00
RX Signal (uv)	9.70	21.70
RX Signal (dBW)	-117.25	-110.26
RX Field Strength (uv/m)	95.74	115.23
Fade Margin (dB)	22.75	24.74
Raleigh Service Probability (%)	99.470	99.665

Effect of Earth Curvature on Long Paths

This path requires greater mast height to offset the earth curvature experienced at such a distance (73km).
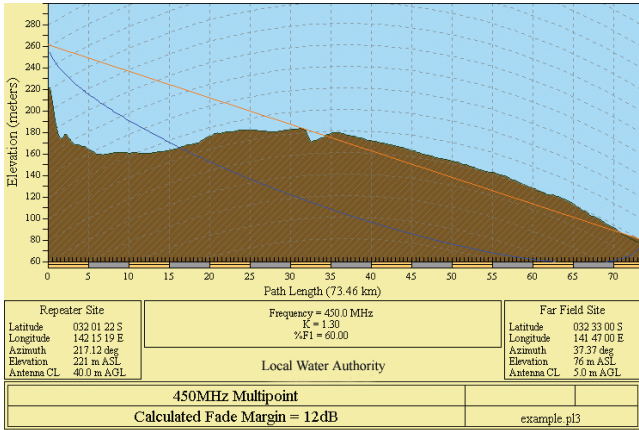
| longpath.pl3	Repeater Site	Far Field Site
Elevation (m)	221.26	75.58
Latitude	032 01 21.63 S	032 33 00.00 S
Longitude	142 15 19.26 E	141 47 00.00 E
Azimuth	217.12	37.37
Antenna Type	ANT450/6OM	ANT450/9AL
Antenna Height (m)	40.00	5.00
Antenna Gain (dBi)	8.15	11.15
Antenna Gain (dBd)	6.00	9.00
TX Line Type	LDF4-50	LDF4-50
TX Line Length (m)	40.00	5.00
	6.79	6.79
TX Line Loss (dB)	2.72	0.34
Connector Loss (dB)	2.00	2.00
Frequency (MHz)	450.00	
Path Length (km)	73.46	
Free Space Loss (dB)	122.85	
Diffraction Loss (dB)	22.94	
Net Path Loss (dB)	133.55	133.55
Radio Type Model	EB450	ER450
TX Power (watts)	5.00	1.00
TX Power (dBW)	6.99	0.00
Effective Radiated Power (watts)	6.72	4.64
Effective Radiated Power (dBW)	8.27	6.66
RX Sensitivity Level (uv)	0.71	1.26
RX Sensitivity Level (dBW)	-140.00	-135.00
RX Signal (uv)	1.49	3.32
RX Signal (dBW)	-133.55	-126.56
RX Field Strength (uv/m)	14.65	17.64
Fade Margin (dB)	6.45	8.44
Raleigh Service Probability (%)	79.735	86.656

Selecting Antennas

There are basically two types of antennas – omni directional, and directional.

Omni directional antennas are designed to radiate signal in a 360 degrees segment around the antenna. Basic short range antennas such as folded dipoles and ground independent whips are used to radiate the signal in a "ball" shaped pattern. High gain omni antennas such as the "co-linear" compress the sphere of energy into the horizontal plane, providing a relatively flat "disc" shaped pattern which goes further because all of the energy is radiated in the horizontal plane.

Directional antennas are designed to concentrate the signal into "beam" of energy for transmission in a single direction (ie for point-to-point or remote to base applications).

Beamwidths vary according to the antenna type, and so can be selected to suit design requirements. The most common UHF directional antenna is the yagi, which offers useable beam widths of 30-50 degrees. Even higher "gain" is available using parabolic "dish" type antennas such as gridpacks.

Onmi directional
360 degree signal

Directional
Concentrated beam
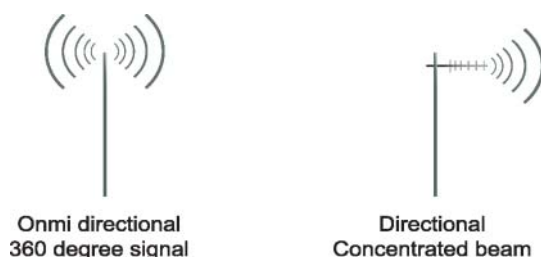
Antenna Gain

By compressing the transmission energy into a disc or beam, the antenna provides more energy (a stronger signal) in that direction, and thus is said to have a performance "gain" over a basic omni antenna. Gain is usually expressed in dBd, which is referenced to a standard folded dipole. Gain can also be expressed in dBi, which is referenced to a theoretical "isotropic" radiator. Either way, if you intend to send and receive signals from a single direction, there is advantage in using a directional antenna - both due to the increased signal in the wanted direction, and the relatively decreased signal in the unwanted direction (i.e. "interference rejection" properties).

Tuning the Antenna

Many antennas are manufactured for use over a wide frequency range. Typical fixed use antennas such as folded dipoles and yagis are generally supplied with the quoted gain available over the entire specified band range, and do not require tuning. Co-linear antennas are normally built to a specific frequency specified when ordering.

With mobile "whip" type antennas, it is sometimes necessary to "tune" the antenna for the best performance on the required frequency. This is usually done by trimming an antenna element whilst measuring VSWR, or simply trimming to a manufacturer supplied chart showing length vs frequency. These antennas would normally be supplied with the tuning information provided.

Antenna Placement

When mounting the antenna, it is necessary to consider the following criteria:

The mounting structure will need to be solid enough to withstand additional loading on the antenna mount due to extreme wind, ice or snow (and in some cases large birds).

For omni directional antennas, it is necessary to consider the effect of the mounting structure (tower mast or building) on the radiation pattern. Close in structures, particularly steel structures, can alter the radiation pattern of the antenna. Where possible, omni antennas should always be mounted on the top of the mast or pole to minimise this effect. If this is not possible, mount the antenna on a horizontal outrigger to get it at least 1-2m away from the structure. When mounting on buildings, a small mast or pole (2-4m) can significantly improve the radiation pattern by providing clearance from the building structure.

For directional antennas, it is generally only necessary to consider the structure in relation to the forward radiation pattern of the antenna, unless the structure is metallic, and of a solid nature. In this case it is also prudent to position the antenna as far away from the structure as is practical. With directional antennas, it is also necessary to ensure that the antenna cannot move in such a way that the directional beamwidth will be affected. For long yagi antennas, it is often necessary to instal a fibreglass strut to stablilise the antenna under windy conditions.

Alignment of Directional Antennas

This is generally performed by altering the alignment of the antenna whilst measuring the received signal strength. If the signal is weak, it may be necessary to pre-align the antenna using a compass, GPS, or visual or map guidance in order to "find" the wanted signal. Yagi antennas have a number of lower gain "lobes" centred around the primary lobe. When aligning for best signal strength, it is important to scan the antenna through at least 90 degrees, to ensure that the centre (strongest) lobe is identified.

When aligning a directional antenna, avoid placing your hands or body in the vicinity of the radiating element or the forward beam pattern, as this will affect the performance of the antenna.

RF Feeders and Protection

The antenna is connected to the radio modem by way of an RF feeder. In choosing the feeder type, one must compromise between the loss caused by the feeder, and the cost, flexibility, and bulk of lower loss feeders. To do this, it is often prudent to perform path analysis first, in order to determine how much "spare" signal can be allowed to be lost in the feeder. The feeder is also a critical part of the lightning protection system.

All elevated antennas may be exposed to induced or direct lightning strikes, and correct grounding of the feeder and mast are an essential part of this process. Gas discharge lightning arresters should also be fitted to any site that stands elevated or alone, particularly in rural areas.

Common Cable Types	Loss per meter @ 450MHz	Loss per 10m @ 450MHz
RG58C/U	0.4426dB	4.4dB
RG213/U	0.1639dB	1.6dB
FSJ1-50 (¼″ superflex)	0.1475dB	1.5dB
LDF4-50 (1/2″ heliax)	0.0525dB	0.52dB
LDF5-50 (7/8″ heliax)	0.0262dB	0.3dB

Data Connectivity

The V24 Standard

The E Series radio modems provide two asynchronous V24 compliant RS232 ports for connection to serial data devices.

There are two types of RS232 interfaces – DTE and DCE.

DTE stands for *data terminal equipment* and is generally applied to any intelligent device that has a need to communicate to another device via RS232. For example: P.C. Comm ports are always DTE, as are most PLC and RTU serial ports.

DCE stands for *data communication equipment* and is generally applied to a device used for sending data over some medium (wires, radio, fibre etc), i.e. any MODEM.

The standard interface between a DTE and DCE device (using the same connector type) is a straight through cable (ie each pin connects to the same numbered corresponding pin at the other end of the cable).

The "V24" definition originally specified the DB25 connector standard, but this has been complicated by the emergence of the DB9 (pseudo) standard for asynch devices, and this connector standard has different pin assignments.

The wiring standard is "unbalanced", and provides for three basic data transfer wires (TXD, RXD, and SG – signal ground).

Hardware Handshaking

Hardware handshake lines are also employed to provide flow control, however (in the telemetry industry) many devices do not always support all (or any) flow control lines.

For this reason, the E Series modems can be configured for full hardware flow control, or no flow control at all (simple 3 wire interface).

Note: that when connecting devices together with differing handshake implementations, it is sometimes necessary to "loop" handshake pins in order to fool the devices handshaking requirements.
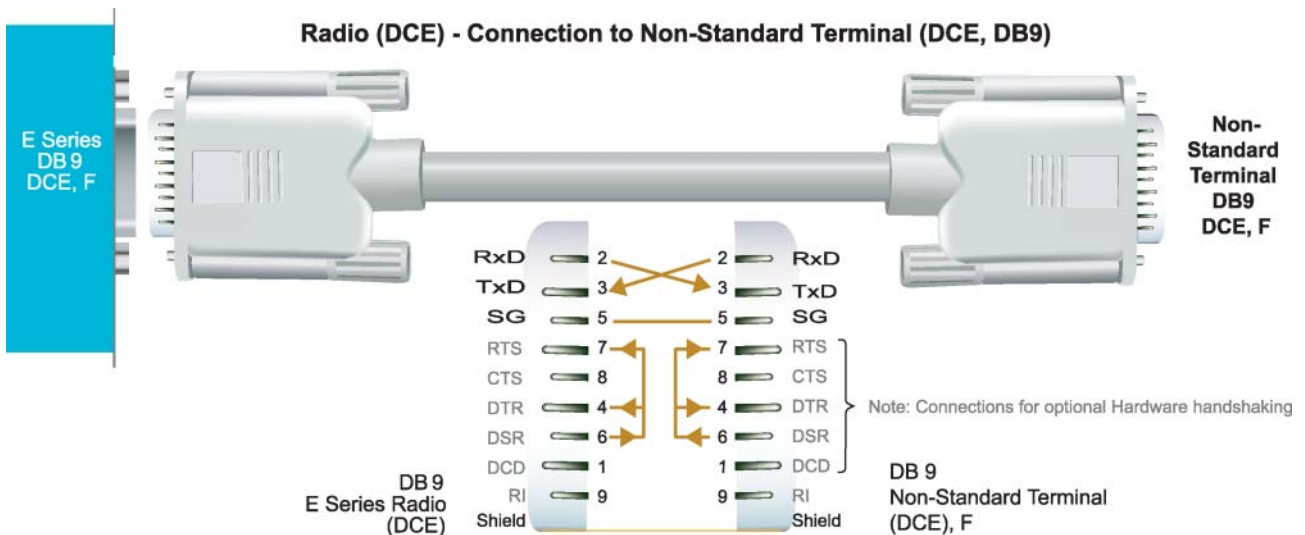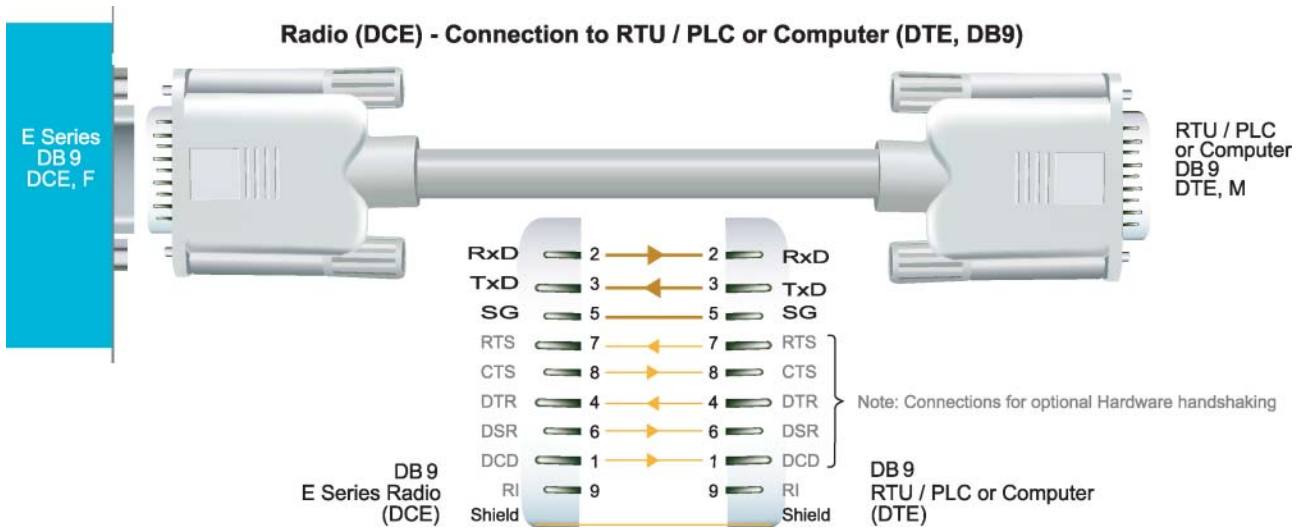
In telemetry applications (particularly where port speeds can be set to the same rate as the radio systems over-air rate) then flow control, and therefore handshaking, is usually NOT required. It follows that any devices that CAN be configured for "no flow control" should be used in this mode to simplify cabling requirements.
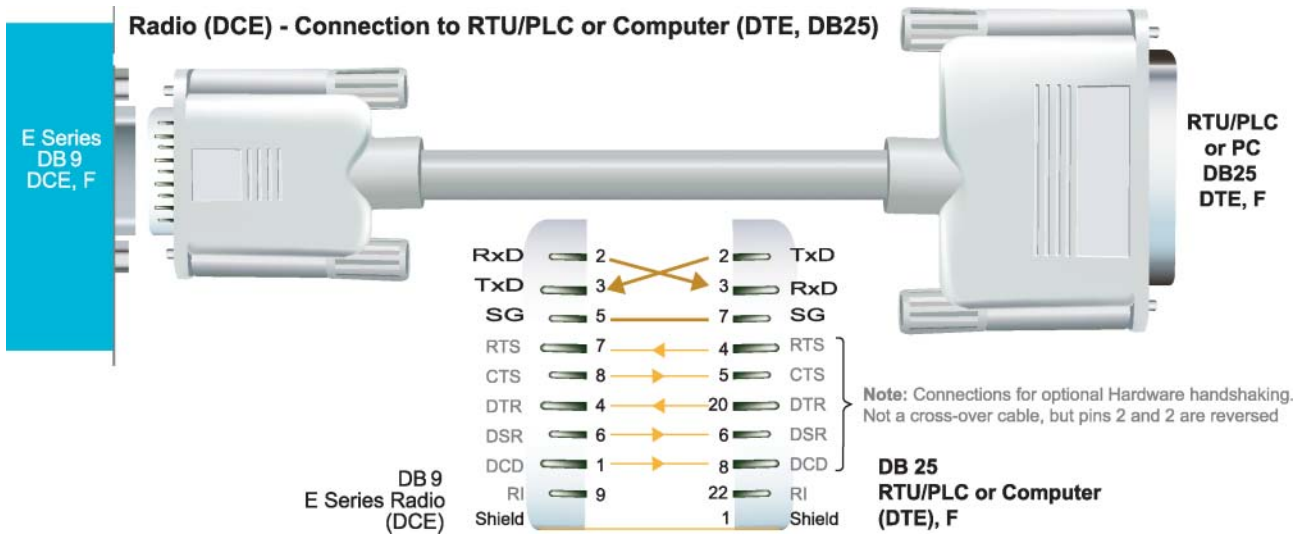
Handshaking lines can generally be looped as follows:

DTE (terminal) – loop RTS to CTS, and DTR to DSR and DCE.

DCE (modem) - loop DSR to DTR and RTS (note-not required for E Series modem when set for **no handshaking**).
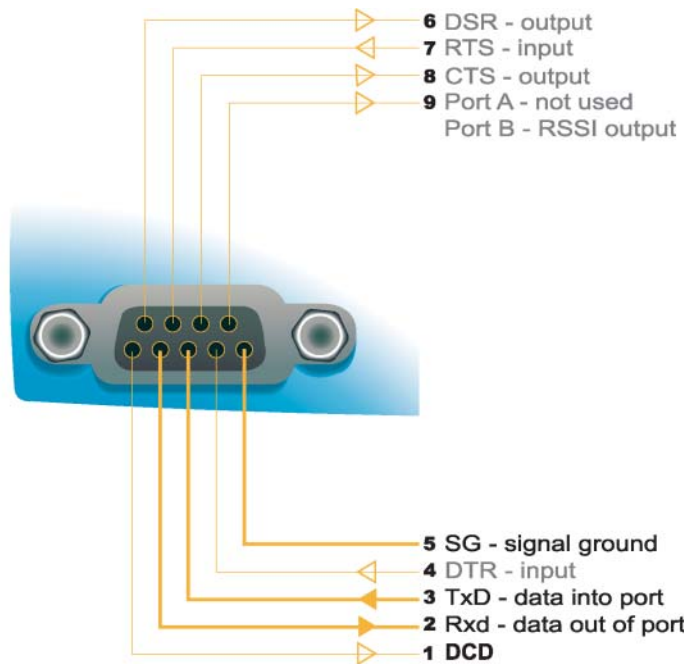
Cable Wiring Diagrams

Radio (DCE) - Connection to RTU / PLC or Computer (DTE, DB9)

E Series
DB 9
DCE, F

RTU / PLC
or Computer
DB 9
DTE, M

RxD	2 → 2	RxD	
TxD	3 ← 3	TxD	
SG	5 — 5	SG	
RTS	7 ← 7	RTS	
CTS	8 → 8	CTS	
DTR	4 ← 4	DTR	Note: Connections for optional Hardware handshaking
DSR	6 → 6	DSR	
DCD	1 → 1	DCD	
RI	9 9	RI	
Shield		Shield	

DB 9
E Series Radio
(DCE)

DB 9
RTU / PLC or Computer
(DTE)

Radio (DCE) - Connection to Non-Standard Terminal (DCE, DB9)

E Series
DB 9
DCE, F

Non-
Standard
Terminal
DB9
DCE, F

RxD	2 ⤬ 2	RxD	
TxD	3 ⤬ 3	TxD	
SG	5 — 5	SG	
RTS	7 ← 7	RTS	
CTS	8 8	CTS	
DTR	4 ← 4	DTR	Note: Connections for optional Hardware handshaking
DSR	6 6	DSR	
DCD	1 1	DCD	
RI	9 9	RI	
Shield		Shield	

DB 9
E Series Radio
(DCE)

DB 9
Non-Standard Terminal
(DCE), F

Cable Wiring Diagrams

Radio (DCE) - Connection to RTU/PLC or Computer (DTE, DB25)

E Series
DB 9
DCE, F

RTU/PLC
or PC
DB25
DTE, F

RxD	2	✕	2	TxD	
TxD	3		3	RxD	
SG	5		7	SG	
RTS	7	◄	4	RTS	
CTS	8	►	5	CTS	
DTR	4	◄	20	DTR	
DSR	6	►	6	DSR	
DCD	1	►	8	DCD	
RI	9		22	RI	
Shield			1	Shield	

DB 9
E Series Radio
(DCE)

Note: Connections for optional Hardware handshaking. Not a cross-over cable, but pins 2 and 2 are reversed

DB 25
RTU/PLC or Computer
(DTE), F

RS232 Connector Pin outs (DCE)
Port A and B, Female DB9

- **6** DSR - output
- **7** RTS - input
- **8** CTS - output
- **9** Port A - not used
  Port B - RSSI output

- **5** SG - signal ground
- **4** DTR - input
- **3** TxD - data into port
- **2** Rxd - data out of port
- **1** DCD

Power Supply and Environmental Considerations

General

When mounting the equipment, consideration should be given to the environmental aspects of the site. The cabinet should be positioned so that it is shaded from hot afternoon sun, or icy cold wind. Whilst the radios are designed for harsh temperature extremes, they will give a longer service life if operated in a more stable temperature environment. In an industrial environment, the radio modems should be isolated from excessive vibration, which can destroy electronic components, joints, and crystals.

The cabinet should provide full protection from moisture, dust, corrosive atmospheres, and other aspects such as ants and small vermin (who's residues can be corrosive or conductive). The radio modem will radiate heat from the in-built heatsink, and the higher the transmitter duty cycle, the more heat will be radiated from the heatsink. Ensure there is sufficient ventilation in the form of passive or forced air circulation to ensure that the radio is able to maintain quoted temperature limits.

Power Supply

The power supply should provide a clean, filtered DC source. The radio modem is designed and calibrated to operate from a 13.8VDC regulated supply, but will operate from 10-15 volts (filtered) DC.

The power supply must be able to supply sufficient current to provide clean filtered DC under the full current conditions of the radio modem (ie when transmitting full RF power). The current requirement is typically 120mA (230mA for EB450) in receive mode, and will vary in transmit mode according to RF output power level (typically 0.5-1.5 amps, 1.3-2.5 amps for EB450).
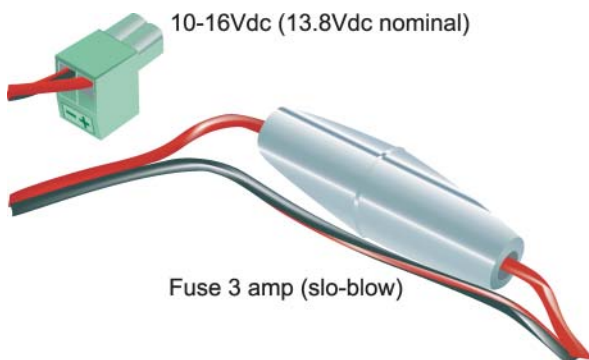
10-16Vdc (13.8Vdc nominal)

Fuse 3 amp (slo-blow)

⚠️ **Caution**: There is **NO** internal replaceable fuse, and therefore the radio modem **MUST** be externally fused with the fuse holder provided (ER450: 3 amp slo-blow fuse, EB450: 5 amp fast-blow fuse).

Solar Applications

In solar or battery-backed installations, a battery management unit should be fitted to cut off power to the radio when battery levels fall below the minimum voltage specification of the radio. In solar applications, a solar regulation unit MUST ALSO be fitted to ensure that the radio (and battery) is protected from excessive voltage under full sun conditions.

When calculating solar and battery capacity requirements, the constant current consumption will be approximately equal to the transmit current multiplied by the duty cycle of the transmitter, plus the receive current multiplied by the (remaining) duty cycle of the receiver.

The Tx/Rx duty cycle will be entirely dependent on the amount of data being transmitted by the radio modem, unless the device has been configured for continuous transmit, in which case the constant current consumption will be equal to the transmit current only (at 100% duty cycle).

Site Earthing

The radio must not be allowed to provide a ground path from chassis to (DB9) signal ground or (-) battery ground. Ensure that the chassis mounting plate, power supply (-) earth, RTU terminal device, and lightning arrester (if fitted), are all securely earthed to a common ground point to which an earth stake is attached. Please pay particular attention to 24VDC PLC systems using DC-DC converters to supply 13.8Vdc.

Physical Dimensions of the Remote Data Radio - ER450

Physical Dimensions of the Base Station - EB450

Physical Dimensions of the Hot Standby Base Station - EH450

Part E – Getting Started

ER450 Quick Start Guide

Introduction

Welcome to the *ER450 Quick Start Guide.* This guide provides step-by-step instructions, with simple explanations to get you up-and-running.
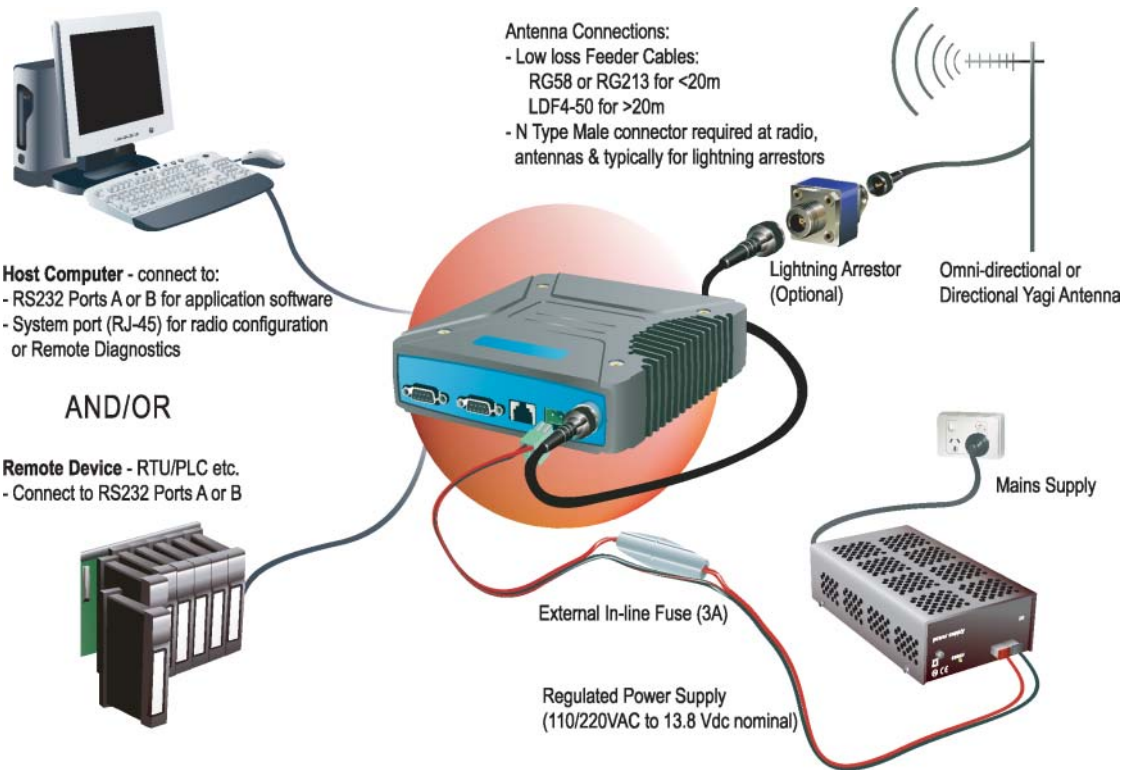
Mounting and Environmental Considerations

The ER450 radio comes complete with a mounting cradle and is attached to a panel or tray by means of screws or bolts, using the hole slots provided.

Note: In high power or high temperature applications, it is desirable to mount the radio with the heatsink uppermost to allow ventalation for the heatsink.

The radio should be mounted in a clean and dry location, protected from water, excessive dust, corrosive fumes, extremes of temperature and direct sunlight. Please allow sufficient passive or active ventilation to allow the radio modem's heatsink to operate efficiently.

Typical Radio Setup

ER450 Connections Layout

User Interface Ports - RS232 DCE
Port A   Port B

DC Power
(13.8Vdc nominal)

System Port
RS232 (RJ45)
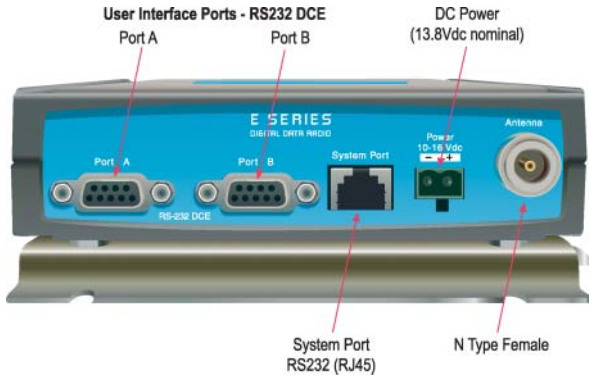
N Type Female

Connecting Antennas and RF Feeders

The RF antenna system should be installed in accordance with the manufacturers notes.

The RF connector used on the E Series radios are N Type female connectors. Always use good quality low loss feeder cable, selected according to the length of the cable run. Ensure all external connections are waterproofed using amalgamating tape.

Preset directional antennas in the required direction using a compass, GPS, or visual alignment and ensure correct polarisation (vertical or horizontal).

Communications Ports

System Port – RJ45

The System Port (available front and rear on EB/EH450) is a multi-function interface used for:

- Programming / Configuration of the radio

- Remote Diagnostics connections

To access these functions use the standard E Series System Cable assembly (RJ45 Cable and RJ45 to DB9 Adaptor).

System Port pinout assignments:

Pin 1   System port data out (RS232)

Pin 2   System port data in (RS232)

Pin 3   Not used

Pin 4   Shutdown

Pin 5   Not used

Pin 6   Not used

Pin 7   Ground

Pin 8   External PTT

Special user pinouts:

- Shutdown (Pin 4) - Active low for power save function

- External PTT (Pin 8) - Provides a manual PTT override facility for enabling the transmitter. For testing this can be activated by connecting PTT (Pin 8) to Gnd (Pin 7).

Computer

RJ45 to DB-9 Adaptor

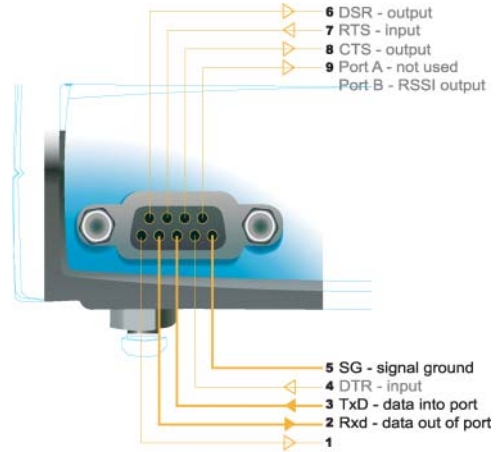System Cable - RJ45
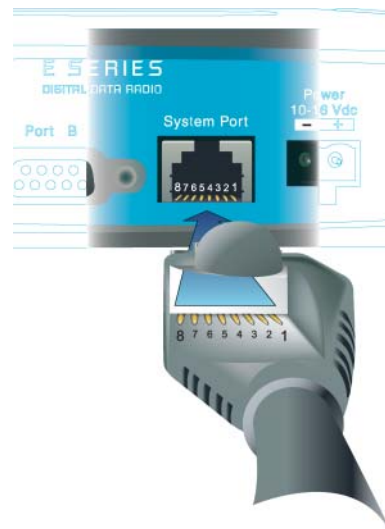
User Interfaces – Ports A & B

Each user port (A & B) is wired as a RS232 DCE, configurable for no handshaking (3-wire) interface, or for hardware or software (X-on/X-off) flow control. In most systems flow control is not required, in which case only 3 wires need to be connected between the radio and the application device.

Typical pins used:

· Pin 2 (RxD) - data output from the radio modem,

· Pin 3 (TxD) - data input to the radio modem,

· Pin 5 (SG) - signal ground.

See Part D – System Planning and Design - Data Connectivity, for further details of other cable configurations.

RS232 Connector Pin outs (DCE)
Port A and B, Female DB9

- **6** DSR - output
- **7** RTS - input
- **8** CTS - output
- **9** Port A - not used
- Port B - RSSI output

- **5** SG - signal ground
- **4** DTR - input
- **3** TxD - data into port
- **2** Rxd - data out of port
- **1**

Radio (DCE) - Connection to RTU / PLC or Computer (DTE, DB9)

E Series DB 9 DCE, F

RTU / PLC or Computer DB 9 DTE, M

E Series Radio (DCE)			RTU / PLC or Computer (DTE)
RxD	2 → 2	RxD	
TxD	3 ← 3	TxD	
SG	5 — 5	SG	
RTS	7 ← 7	RTS	
CTS	8 → 8	CTS	
DTR	4 ← 4	DTR	
DSR	6 → 6	DSR	
DCD	1 → 1	DCD	
RI	9 9	RI	
Shield		Shield	

Note: Connections for optional Hardware handshaking

Activating the Transmitter

In most systems, the transmitter by default is controlled automatically by the radio when it has data to transmit.

In some systems, such as full duplex point-to-point links or full duplex point-to-multipoint base stations, it is desirable to run the transmitter all the time (hot keyed).

Two mechanisms are provided to do this:

· the radio modem can be configured to transmit continuously whenever powered, or

· the radio modem can be configured to transmit whenever an external RTS signal (Pin 7) is applied to one (or either) user ports. (To simulate an external RTS input, loop pins 6 to 7).

To operate in these modes, the radio must be configured via the programming software.

⚠ **Caution**: When the radio is configured to transmit continuously, ensure an RF load is present BEFORE applying power to the unit.

Power Supply Requirements

The E Series radio modem is designed and calibrated to operate from a filtered 13.8Vdc regulated supply, but will operate from a 10-16Vdc (11-16Vdc for EB450 & EH450) range.

The current requirement is typically 120mA (230mA for EB450) in receive mode, and will vary in transmit mode according to RF output power level (typically: ER450 0.5-1.5 amps, EB450 1.3-2.5 amps, EH450 2-3.2 amps).

⚠ **Caution**: There is **NO** internal replaceable fuse, and therefore the radio modem **MUST** be externally fused with the fuse holder provided (ER450: 3 amp slo-blow fuse, EB450: 5 amp fast-blow fuse).
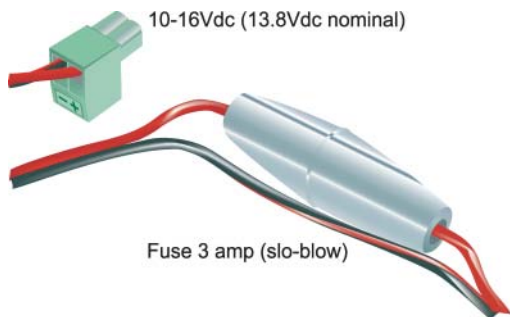
The radio is designed to self protect, and will blow the external fuse if the voltage exceeds 16Vdc, or if reverse polarity is applied.

The radio modem can also be damaged if there is any potential difference between the chassis-ground, RS232 signal ground, power (-) input, or antenna coaxial shield. Before connecting any wiring, ensure all components are earthed to a common ground point (please pay particular attention to 24V PLC power systems where converters are used).

Connect the antenna and RS 232 plugs BEFORE applying power to the unit.

Lastly, before inserting the power plug, please **re-check** that the polarity and voltage on the power plug is correct using a multimeter.

TVIEW+ Management Suite

Radio Configuration

This TVIEW+ Management Suite allows a number of features including: Configuration (Local - serial, or Remote - over-the-air), Remote Diagnostics Facilities and Firmware Upgrades.

The configuration wizard can be used to provide Quick Start generic templates for the types of systems architecture you wish to employ.

Example: Local configuration session –

1   Attach the programming cable from the PC to the System Port of the radio

2   Launch TVIEW+ & Select "Programmer"

3   Select "Read" the radio

4   Change the configuration as required

5   Select "Write" the parameters back to the radio

Refer to Parts I & J – TVIEW+ Management Suite for detailed operation of advanced features.
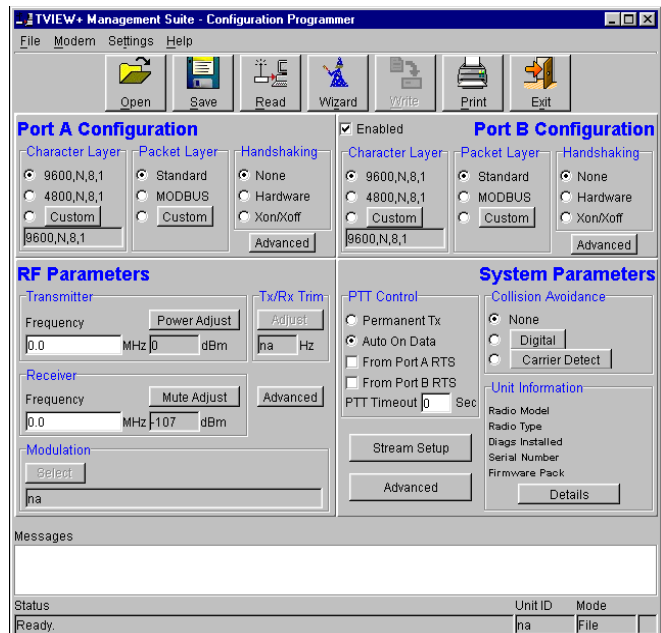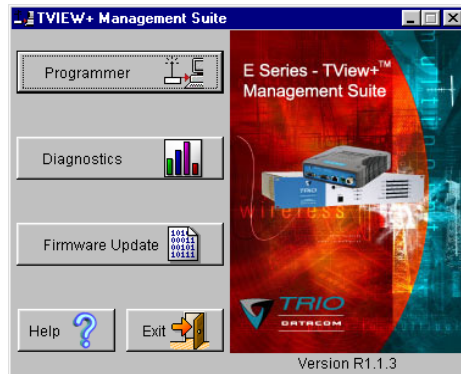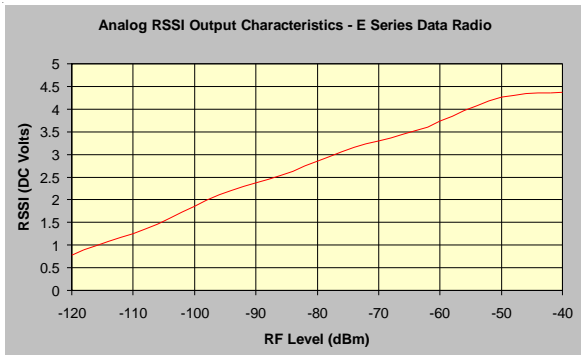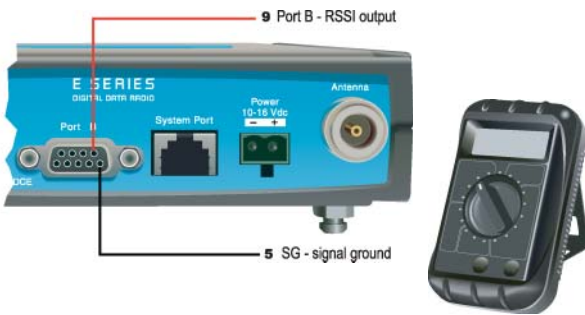
Optimising the Antenna for VSWR and best RX signal

Once the unit is operational, it is important to optimise the antenna tuning.

In the case of a directional antenna, it will be necessary to align the antenna for the best received signal.

This can be done by using the (0-5Vdc) output on Pin 9 of Port B to indicate signal strength (RSSI). This voltage can be converted to dBm using the chart below.

9 Port B - RSSI output

5 SG - signal ground

Analog RSSI Output Characteristics - E Series Data Radio

VSWR testing is achieved by activating the radio's transmitter using:

a) An RTS loop

b) A system port PTT plug

See Part G - Commissioning for further details.

LED Indicators & Test Outputs

Radio is Powered

If all the LEDs are off, no power is reaching the radio modem.

Successful power-up is indicated by the **"PWR"** LED indicating a continuous (healthy) GREEN state. Note that this LED is turned RED when the transmitter is active.
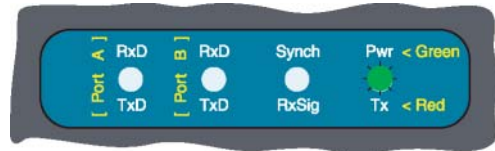
Voltage Error

If the voltage is too high(>16Vdc) or too low(<10Vdc), an error message will be displayed on the staus LED's by illuminating all four LED's RED.

Hardware Error

A hardware error is indicated on any one of the status LED's by illuminating solid RED. In the case of a hardware error, the unit must be returned to the service point for repair. Record the result with the service return information.

LED Legend   < Green
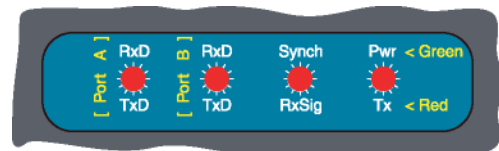
Received Signal Indicator

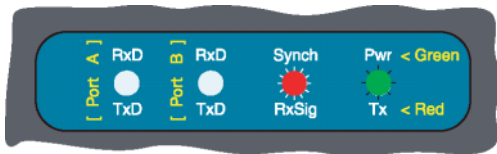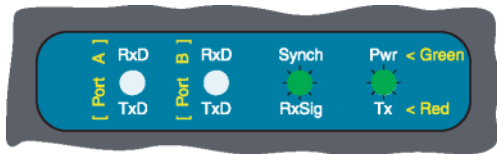The **"RX/SYNC"** LED is used to indicate the state of the receiver.

If the LED is off, no signal is being received.

A RED indication shows that an RF carrier is being received, but no data stream can be decoded. This will briefly happen at the very start of every valid received transmission or may indicate the presence of interference, or another user on the channel.

A continuous GREEN indication shows that the modem is locked and synchronised to the incoming signal, and has excellent Bit Error Rate (BER). Any losses of synchronisation (BER errors) are shown as a visible RED flicker of the LED.

Note: This might only be apparent on a PTMP slave when only receiving.

Data Flow "breakout" LEDs

There are also two LEDs to indicate data flow into and out of the two user ports.

Input data to be transmitted is shown as a RED flash, and received data to be output to the port is shown as a GREEN flash.

If data is alternately flowing in and out quickly, then the indicator appears orange.

LED Legend

Verifying Operational Health

It is possible to verify the operation of the radio modem using the indicators provided by the unit. The state of the transmitter and receiver, and data flow can be interpreted by the indicator LEDs (see below).

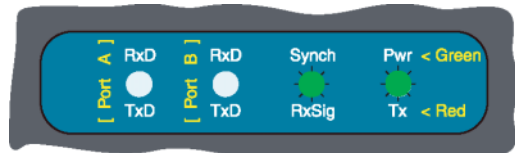*Note: Port A and Port B's RxD and TxD will be Active on Data Flow*
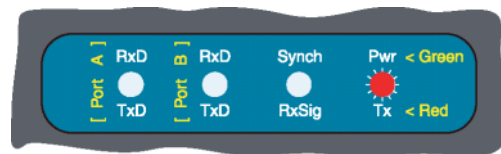
Full Duplex – PTP Master or Slave
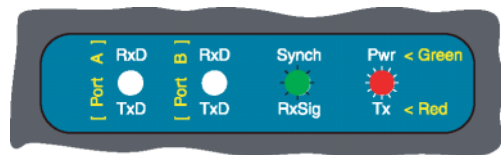
Full Duplex – PTMP Master Tx
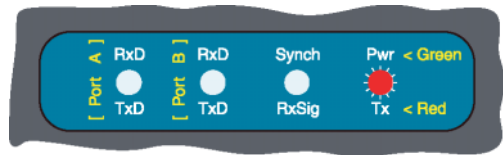
Half Duplex – PTMP Slave Rx

Half Duplex – Master or Slave (Tx)

Half Duplex – Master or Slave (Rx)

EB450 Quick Start Guide

Introduction

Welcome to the *Quick Start Guide for the EB450 Base / Repeater Data Radio.* This guide provides step-by-step instructions, with simple explanations to get you up-and-running.

Mounting and Environmental Considerations

The EB450 Base Station is housed in a 2RU 19″ rack enclosure. The 4 mounting holes on the front panel should be used to secure the unit to the rack.

The radio should be mounted in a clean and dry location, protected from water, excessive dust, corrosive fumes, extremes of temperature and direct sunlight. Please allow sufficient passive or active ventilation to allow the radio modem's heatsink to operate efficiently.

All permanent connections are made at the rear of the unit. This includes: Power, Antenna, Communications Ports, Digital I/O and System Port. The front panel has an additional System Port connection point for easy access.
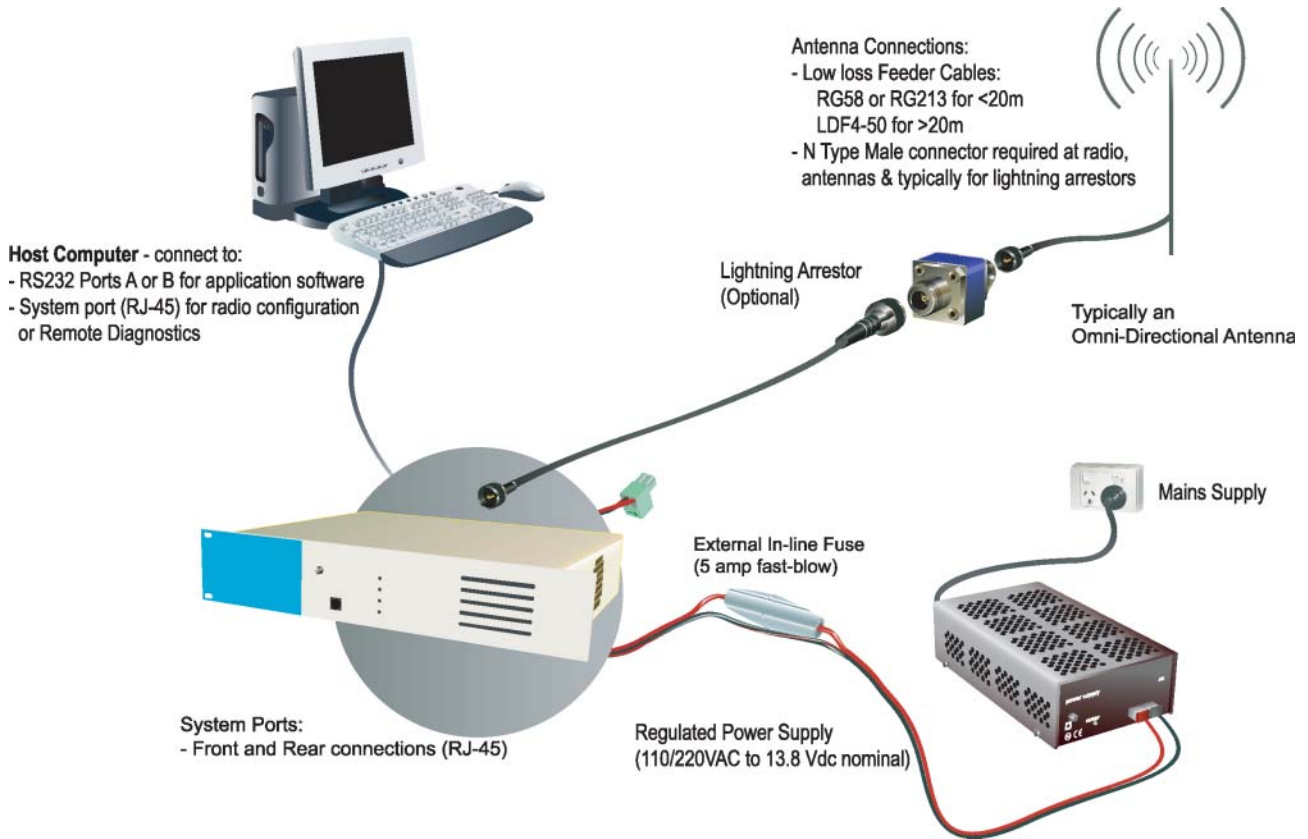
Full Duplex Considerations

The EB450 is designed for continuous full duplex transmission. An automatic thermostatically controlled fan will operate whenever the internal temperature exceeds 50 degrees Celsius.

External Duplexer Considerations

The EB450 is normally supplied with seperate Tx and Rx ports for connection to an external duplexing system.

Depending on the frequency band of operation and the Tx/Rx frequency split, internal band reject duplexers are available.

Typical Radio Setup

Host Computer - connect to:
- RS232 Ports A or B for application software
- System port (RJ-45) for radio configuration
  or Remote Diagnostics

Antenna Connections:
- Low loss Feeder Cables:
  RG58 or RG213 for <20m
  LDF4-50 for >20m
- N Type Male connector required at radio,
  antennas & typically for lightning arrestors

Lightning Arrestor
(Optional)

Typically an
Omni-Directional Antenna

Mains Supply

External In-line Fuse
(5 amp fast-blow)

System Ports:
- Front and Rear connections (RJ-45)

Regulated Power Supply
(110/220VAC to 13.8 Vdc nominal)

Connecting Antennas and RF Feeders

See ER450 Quick Start Guide

Communications Ports

See ER450 Quick Start Guide Section

Power Supply and Protection

See ER450 Quick Start Guide Section

TVIEW+ Management Suite - Radio Configuration

See ER450 Quick Start Guide Section

Optimising the Antenna for VSWR and best RX signal

See ER450 Quick Start Guide Section

LED Indicators & Test outputs

Radio is Powered

If all the LEDs are off, no power is reaching the radio modem.

Successful power-up is indicated by the **"PWR"** LED indicating a continuous (healthy) GREEN state. Note that this LED is turned RED when the transmitter is active.

STATUS

DC Power ● Tx

Synch ● Rx Sig

[Port A] RxD ● TxD

[Port B] RxD ● TxD

^ Green   ^ Red

LED Legend   < Green
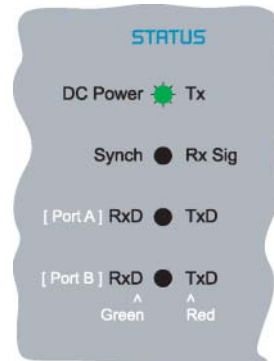
Voltage Error

If the voltage is too high(>16Vdc) or too low(<10Vdc), an error message will be displayed on the status LED's by illuminating all four (4) LED's RED.

Hardware Error

A hardware error is indicated on any one of the status LED's bu illuminating solid RED. In the case of a hardware error, the unit must be returned to the service point for repair. Record the result with the service return information.

Received Signal Indicator

The "RX/SYNC" LED indicates the state of the receiver.

If the LED is off, no signal is being received.

A RED indication shows that an RF carrier is being received, but no data stream can be decoded. This will briefly happen at the very start of every valid received transmission or may indicate the presence of interference, or another user on the channel.

A continuous GREEN indication shows that the modem is locked and synchronised to the incoming signal, and has excellent Bit Error Rate (BER). Any losses of synchronisation (BER errors) are shown as a visible RED flicker of the LED.
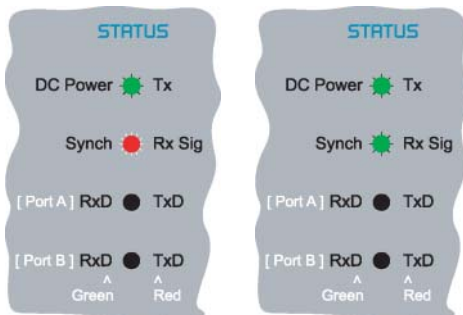
Note: This might only be apparent on a PTMP slave when only receiving.

Data Flow "breakout" LEDs

There are also two LEDs to indicate data flow into and out of the two user ports.

Input data to be transmitted is shown as a RED flash, and received data to be output to the port is shown as a GREEN flash.

If data is aternately flowing in and out quickly, then the indicator appears orange.

Bar Graph Indicators

The bar graph indicators on the front panel provide variable information regarding the performance of the Base Station. To enable / disable the bar graph display depress the Display ON / OFF button. The display will turn off automatically after 5 minutes.

DC Supply:

Indicates the supply input voltage at the exciter module. Typically 13.8Vdc.

Indication: <10Vdc no LED's on, 10-10.9Vdc LED's RED, 11-15.6Vdc All LED's GREEN, >=15.7Vdc last LED RED.

Tx Power:

Indicates forward RF power output as measured at the TX antenna port. Typically +37dBm.

Indication: <20dBm no LED's on, 20-40.6dBm (11.5W) LED's GREEN, >=40.7dBm last LED RED.

Tx Drive:

Indicates exciter drive level. Typically +20dBm.

Indication: <10dBm no LED's on, 10.0-25.9dBm LED's GREEN, >=26.0dBm last LED RED.

Rx Sig:

Indicates receive signal strength. Typically -85 to -65dBm.

Indication: <-120dBm no LED's on, -120 to -110.1dBm LED's RED, >=-110dBm LED's GREEN.

RxFreq. Offset:

Indicates offset of receiver AFC - useful in determining frequency drift. Typically 0kHz.

Indication: Single GREEN LED to indicate current value, <-3.6kHz or >+3.6kHz LED is RED. No signal, all LED's OFF. Note: 5 second peak hold circuitry.
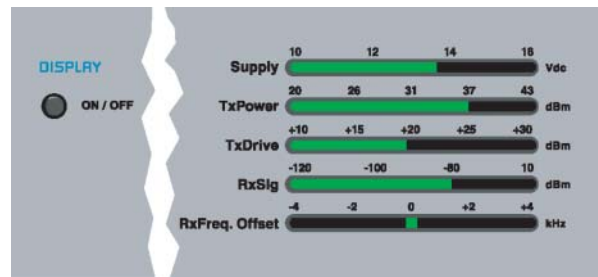
Test Mode

The Bar Graph indicators have a Test Mode, which cycles all LED's for correct operation (before returning to their normal operation). To activate this mode, simply depress the ON / OFF button while applying power to the unit.

EH450 Quick Start Guide

Introduction

Welcome to the *Quick Start Guide for the EH450 Hot Standby Base / Repeater Station*. This section provides additional step-by-step instructions to install, commission and operate the EH450 Hot Standby Base Station. This document should be read in conjunction with the EB450 Base Station Quick Start Guide.

The EH450 is a fully redundant, hot standby digital data radio base / repeater station providing automatic changeover facilities.

The EH450 is designed as a modular solution, comprising 2 identical EB450 base station units (standard) linked to a central, fail-safe monitoring and change-over controller (Hot Standby Controller). Either base station may be taken out for maintenance without the need for any system down time. The automatic change-over is triggered by out of tolerance (alarm) conditions based on either RF and/or user data throughput paramaters.

Features and Benefits

- Individual and identical base stations with separate control logic changeover panel

- Modules are hot swapable without user downtime

- Flexible antenna options – single, separate Tx & Rx, two Tx and two Rx

- Increased sensitivity with receiver pre-amplifier

- Both on-line and off-line units monitored regardless of active status

- External input for higher stability 10MHz reference – GPS derived

- Also refer to the common Features and Benefits list of the E Series Data Radio

Base / Repeater Unit

Hot Standby Controller Unit

Base / Repeater Unit

NOTE: RF connectors not used or ETSI version

Rear View

Operational Description

The Hot Standby Controller (HSC) unit is a 1RU rack mounted module that interfaces to two physically separate base stations (each 2RU rack mounted modules) via a number of RF and data cables.

Both base stations are operating simultaneously and both units are constantly receiving signals, however only data from one base station, the "online" base station is directed to the user equipment. The online base station is the only base station transmitting at any time. The Hot Standby Controller has the following functions:

- Diplex the transmit and receive paths (Assuming internal duplexer fitted), TX Only.

- Amplify and split the incoming signal two ways so both base stations receive at once.

- Monitor status reports from both base stations to identify faults and swap over the online base station if required.

- Switch the antenna via internal coaxial relay duplexer to the online base station transmitter and inhibit the offline base station from transmitting.

- Switch the User A and B data ports through to the online base station.

An optocoupler based switch in the base station controller directs data to and from ports A and B on the rear panel directly to ports A and B on the on-line base station without any involvement from the Hot Standby controller microcontrollers (apart from selecting the on-line base). This provides protection of the system from failure of the microcontroller.

As well as ports A and B, each base has a system port. The system port of each base station is interfaced to the microcontroller on the Hot Standby controller. This allows the microcontroller in charge of selecting the base station to receive diagnostic messages from each base station to decide their health.

The base station has it's own system port on the rear panel and this is interfaced to the Hot Standby Contruller Module. The HSC will route diagnostics at the rear panel system port to and from the system ports of the base stations.

Mounting and Environmental Considerations

The EH450 Hot Standby Base Station is housed as a 5RU 19" rack mounted set, encompassing 2 x 2RU Base Station units and 1 x 1RU Hot Standby Controller unit. The mounting holes on the front panels should be used to secure the units to the rack.

The unit should be mounted in a clean and dry location, protected from water, excessive dust, corrosive fumes, extremes of temperature and direct sunlight. Please allow sufficient passive or active ventilation to allow the radio modem's heatsink to operate efficiently.

All permanent connections are made at the rear of the unit. This includes: Power, Antenna, Communications Ports, Digital I/O and System Port. The front panel has an additional System Port connection point for easy access.

The Base Station front panel system ports must not be used while in this config.

Communications Ports

The A & B Data Ports and System Ports of each Base Station connect directly to the Hot Standby Controller units corresponding ports with the cables provided. Ensure all clamping screws on the Data Port cables are firmly secured and the System Port cables are clipped in correctly. See figure below for further details.

Note: Only the front or rear User System Port can be used at any one time on the HSC.

Note: RF Connectors not used for ETSI version

The Hot Standby Controller units A & B Data Ports connect directly to you application device and the System Port connects directly to your local PC. See ER450 Quick Start Guide Section for further details.
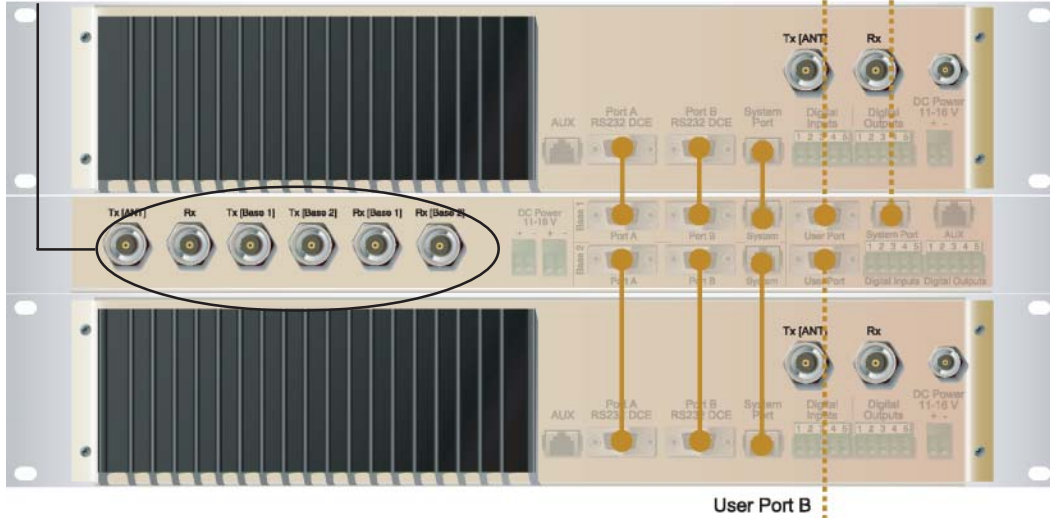
Power Supply and Protection

The EH450 has facilities for dual power supplies to provide for a redundant system. A separate power supply should be used for each of the Base Station units. The Hot Standby Controller unit has connections for dual power supplies and it is recommended that the power supplies from each of the Base Stations also be used to power the Hot Standby Controller unit. See Figure below for further details.

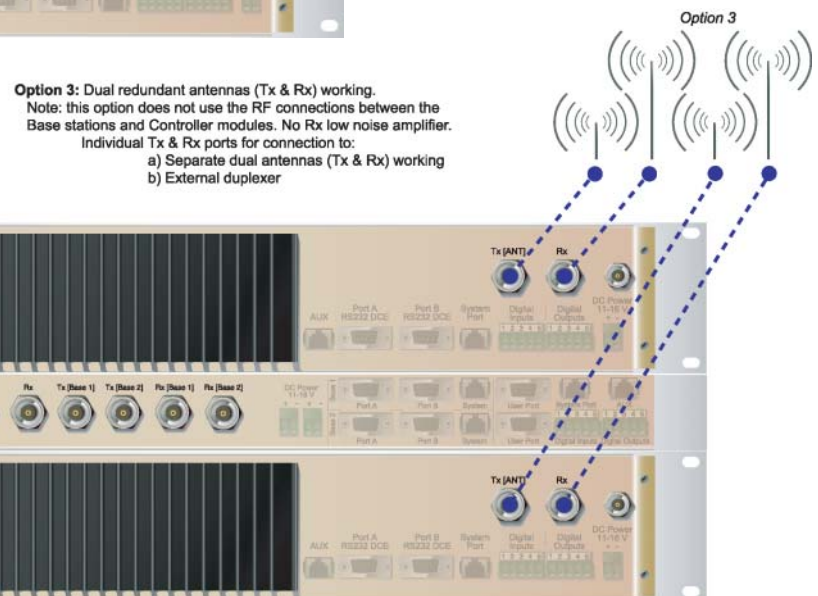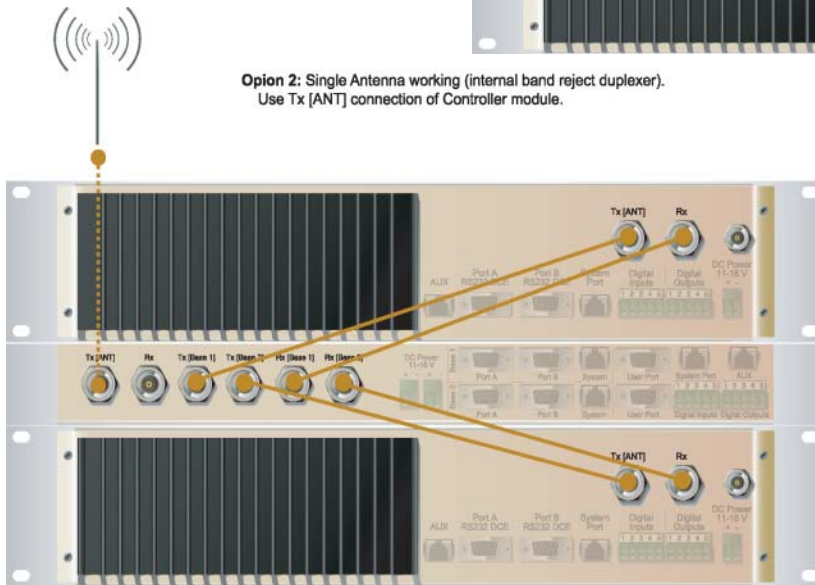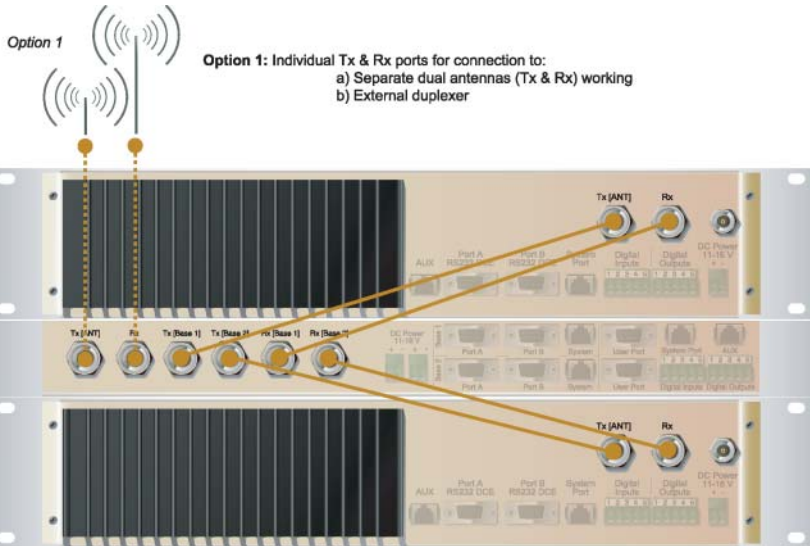See ER450 Quick Start Guide Section for detailed wiring information.

Note: RF Connectors not used for ETSI version
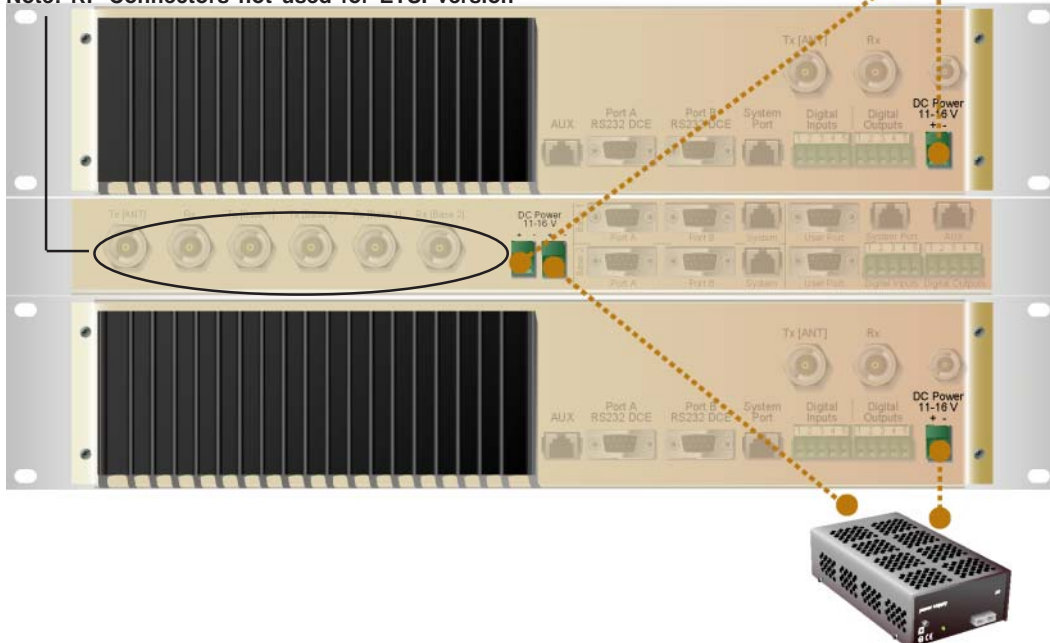
Connecting Antennas and RF Feeders

There are 3 primary antenna connection options. All connectors used are standard N Type sockets. See figures below for further details.

See ER450 Quick Start Guide for detailed wiring information.

Option 1

Option 1: Individual Tx & Rx ports for connection to:
a) Separate dual antennas (Tx & Rx) working
b) External duplexer

Opion 2: Single Antenna working (internal band reject duplexer).
Use Tx [ANT] connection of Controller module.

Option 3

Option 3: Dual redundant antennas (Tx & Rx) working.
Note: this option does not use the RF connections between the Base stations and Controller modules. No Rx low noise amplifier.
Individual Tx & Rx ports for connection to:
a) Separate dual antennas (Tx & Rx) working
b) External duplexer

Front Panel Operation

Switches

Select Switch

The 3 position switch (1 / Auto / 2) on the front panel provides the following functionality:

· Position 1: base station 1 is forced into operation

· Position Auto: changeover hardware will select the online base station

· Position 2: base station 2 is forced into operation

The select switch is also used to identify the target base station for configuration programming.

Adjacent to the select switch are two LEDs: These LEDs indicate the current active base station.

Select LED's

• Green - Auto Mode

• Red - Remote Force

• Amber - Local Force

2 Green Firmware Download

2 Amber Test Mode

2 Red Fatal Error - refer user manual

Reset Switch

This is a momentary close switch which when depressed will reset all LED alarm indications.

System Port

There are two system port connection points, one on the rear panel and one on the front panel. Both have the same functionality and can be used for local diagnostics, firmware front panel downloads and hot standby controller testing. To access the system port use the diagnostic/programming cable supplied.

Note: Wnen connection is made to front panel system rear system port is disabled.

Alarm Status LEDs

There are 10 alarm LEDs on the fron panel, five for base 1 and five for base 2. These LEDs provide a general indication of base station status. More detailed base station status information is available by using the diagnostic utility software.

The indicated alarms for each base station are:

Freq.	=>	Frequency Error
RxSig	=>	Receive Signal (RF) Error
Data	=>	Receive Data Error
TxPower	=>	Transmit Power (RF) Error
Supply	=>	DC Voltage Error

The status of each alarm is represented as follows:

Green	=>	No Error
Red	=>	Current (active) Error condition
Amber	=>	Recovered Error condition

Any active or recovered error LEDs will turn to green after the reset alarms switch has been pushed or remotely reset.

Part F - Operational Features

Multistream functionality (SID codes)

The E Series sends data messages in packets. A feature of the E Series is that an address can be embedded in each packet. This address is called the stream identifier code (SID).

By configuring a user serial port for a specific SID code, it is possible to steer messages to similarly configured ports between radio modems. In effect, it is possible to use the multiple serial ports available on the E Series, to enable multiple protocols to share the same RF channel. The SID codes also facilitate the use of other features such as TView diagnostics. Unique selective routing, repeating, and data splitting functions available in the radio modems configuration allow data steering and bandwidth management in complex systems.

See Part I - TView+ Management Suite - Programmer and Part J - TView Remote Diagnostics and Network Controller for details.

Collision Avoidance (digital and RFCD based)

Where multiple "un synchronised" protocols co-exist on a common "multiple access" radio channel, there is always a possibility that both "hosts" may poll different "remote" devices at the same time. If both devices attempt to answer back to the single master radio at the same time, it follows that a collision could occur on the radio channel.

To facilitate the operation of multiple protocol operation on the radio channel, a transparent collision management system has been implemented : See Part I - TView+ Management Suite - Programmer for details.

Digital Collision Avoidance System

If the "multiple access master" has been configured for full duplex operation, it is possible to use the inbuilt collision avoidance signaling system.

Once the master radio receives a valid incoming data stream from a remote, a flag within the "outbound" data stream is used to alert all other remote devices that the channel has become busy. Remote devices wishing to send data will buffer the message until the channel status flag indicates that the channel is clear. A pseudo-random timing value is added to the retry facility to ensure that waiting remotes do not retry at the same time.

RF Carrier Detect RSSI based Collision Avoidance

In half duplex systems, the receiver's RF carrier detect is used to inhibit the transmitter whilst a signal is being received.

Digipeater Operation

A feature of the E Series radio modems is the ability to internally repeat data packets to provide stand alone repeater facilities without the need for external intelligence.

This is done by programming "SID Codes" to "Repeat" a stream or range of streams. Wizard templates can be used to simplify setup of this and other features.

See Part I - TVIEW+ Management Suite for details.

TVIEW+ Diagnostics

The E Series has an inbuilt remote configuration and diagnostics utility.

This facility allows transparent remote access to the key configuration and operating parameters of the radio.

See Part J - TView Remote Diagnostics and Network Controller for details.

Part G – Commissioning

Check DC power connector for correct voltage (10-16VDC) and polarity, BEFORE plugging in the power connector.

Power-up

Upon power up, the radio will self test and shortly after the green power LED will be displayed.

Failure of the power LED to light indicates no power, or failure of the fuse due to incorrect polarity or over-voltage.

Other failure such as fatal internal errors will initiate error modes indicated by a flashing sequence of all LEDS red, followed by one or more green LED's to indicate the nature of the failure (see Part E – Getting Started: LED Indicators and Test Outputs).

LED Indicators

Will depend on the system architecture. If the device is a remote site receiving a base station with a constant carrier, then the RXSIG/SYNC LED should be green to indicate healthy reception of the wanted signal.

If the site has been configured as a constantly transmitting base station, then the PWR/TX LED should show red.

In other types of systems, TX and RX bursts would be indicated by the RX or TX LED's as above.

Data flow to and from the user ports is indicated by the TXD/RXD LEDs for each port.

(See Part E – Getting Started: LED Indicators and Test Outputs.)

Data Transfer Indications

Bi-colour LEDs are provided to indicate RS232 data being transmitted and received on each data port. A RED flash indicates a byte (or bytes) of incoming data from the serial line which will be transmitted to air, and a green flash indicates a byte of data received "off air" being released onto the serial line.

If data is being sent to the radio modem and the Data LED does not flash RED, this may indicate a wiring or configuration problem. Check that the TX and RX data lines are correctly wired (see Part E – Getting Started: LED Indicators and Test Outputs).

Also check that character set and parity settings (i.e. N,8,1 etc) are set identically at the terminal and the radio modem. Note that some incorrect settings of the character set parameter can still produce transmittable data, even though the data will not be understood by the application.
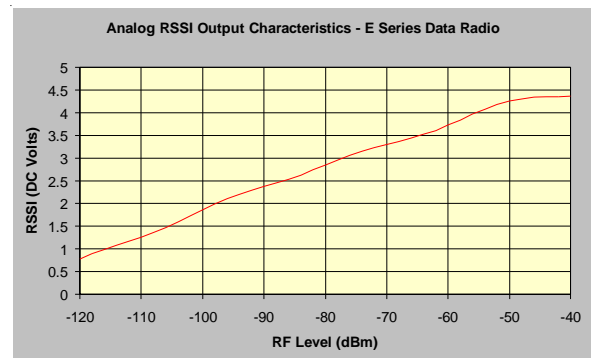
Antenna Alignment and RSSI Testing

Once the RXSIG LED is lit, it is possible to confirm RX signal strength and align a directional antenna by monitoring the RSSI output.

This DC voltage appears at Pin 9 of Port B.

A ground reference can be obtained from chassis ground or Pin 5 of Port A or B.

The chart below shows Pin 9 voltage as it relates to signal strength.

Link Establishment and BER Testing

Once communications has been established, it is possible to confirm the packet error rate performance of the radio path, and thus estimate the BER figure.

There are a number of tools provided to do this. The easiest is to use the "indicative packet error test" provided within the TVIEW+ Diagnostics under "statistical performance tools". Alternatively, it is possible to use hyper terminal, or other packet test instruments or PC programs to run end to end or perform "loopback" testing.

Please note that when using a "loopback plug" some understanding of the packetising process is necessary, since each "test message' must be carried in a single packet for meaningful results to be obtained.

Note also that in PTMP systems, allowance must be made for collision potential if other data is being exchanged on the system.

VSWR Testing

VSWR testing is achieved using specialized VSWR testing equipment, or a "Thruline" power meter that measures forward and reverse power.

VSWR is the ratio between forward and reflected transmitter power, and indicates the health and tuning of the antenna and feeder system.

VSWR should be better than 3 to 1, or expressed as a power ratio, <6dB or no more than 25%. To activate the radios transmiter for VSWR testing, use:

a)   An RTS loop

b)   A system port PTT plug

Part H – Maintenance

Routine Maintenance Considerations

The E Series hardware itself does not require routine maintenance. However all radio products contain crystal frequency references, and the stability of these crystals changes with time. The effect of this is that the product will slowly drift off frequency, and eventually it will require re-calibration. E Series radios are designed with high quality, low drift specification references, to ensure a long maintenance free lifespan. The length of this lifespan will depend on the severity of temperature extremes in the operating environment, but is normally 3–5 years. Extended frequency drift can be detected using TVIEW+ Diagnostics "Freq error" parameter.

Generally, recalibration is achieved by replacing the radio in the field with a spare, and returning the radio to a service centre for re-calibration and specification testing at moderate cost.

Routine maintenance should be performed on external equipment subject to greater environmental stresses including antennas, RF feeder cables, backup batteries and cooling fans (if required). This maintenance should include testing of site commissioning figures such as received signal strength, VSWR, P/S voltage etc.

SECTION 2

Part I – TVIEW+ Management Suite - Programmer

Part J – TVIEW Remote Diagnostics and Network Controller

Part K – Appendices

Part L - Support Options

Part I – TVIEW+ Management Suite - Programmer

Introduction

This manual covers the installation and operation of the E Series TVIEW+ Management Suite which incorporates 3 utilities:

- Programmer for configuration of the radio RF parameters, system parameters and data ports

- Diagnostics* for real-time monitoring and logging of radio performance parameters

- Firmware Update for loading new firmware releases into the radio data modem

All utilities can be run on any IBM compatible computer running Windows 95® and above. This section describes use of the programmer and firmware Update utilities in detail. Users should refer to the separate Diagnostics section for information about this utility.

The programmer is used to set configuration parameters within the ER450 data radio modem and EB450 base station. The utility permits configuration of modems connected directly to the PC as well as over the air to a remote unit. Configuration parameters can be saved to a disk file for later retrieval, or used for clone programming of other modems.

All configuration parameters are held in non-volatile memory (NVRAM) on the Data Radio Modem. Configuration is fully programmable via the Systems Port using the programming adaptor and cable supplied. Disassembly of the unit is not required for any reason other than for servicing.

The diagnostics utility permits monitoring and logging of radio performance parameters for both E Series* as well as D Series* data radio modems and base stations. It supports homogeneous systems of radios as well as mixed systems of both E and D series radios.

The firmware update utility permits field upgrade of the firmware in an ER450 data radio modem, EB450 base station and EH450 hot standby unit connected directly to the PC. A special serial adaptor cable is required to be connected to Port B to load firmware into the unit.

Requires the optional DIAGS Network Management and Remote Diagnostic Facility to be installed - per radio.

Installation

Unit Connection

Programmer and Diagnostics Utilities

The unit is connected to the PC using the supplied DB9-RJ45 adaptor cable (part no. TVIEW+ Cable) for local configuration changes or diagnostic monitoring. The cable should be connected to the RJ45 System Port of the unit and a valid PC serial port (eg; COM 1) DB9 connector.

(See Part E - Getting Started: Communications Ports)

Firmware Update Utility

The unit to be updated with firmware connects to the PC using the DB9-DB9 adaptor (part no. DRPROG). The cable should be connected to the DB9 Port B connector on the unit and a valid PC serial port (See Appendix C for details) DB9 connector.

Software

Please take a moment to read this important information before you install the software.

The installation of this Software Suite is a 2 step process.

Step 1 completes the typical installation of the TVIEW+ Management Suite and will install the Programming Software together with the E Series Documentation.

Step 2 installs the Diagnostic Software and is optional. This step is only required if your radios have Remote Diagnostics enabled.

STEP 1: Installation - TVIEW+ Management Suite

Note: If a previous version of the TVIEW+ Management Suite has been installed on your PC, you must uninstall it via Control Panel "Add/Remove Programs".

- Close down all other programs currently running.

- Place the CD-ROM in the drive on the PC.

- Using Windows Explorer locate the files on the CD-ROM.

- In Windows Explorer double click on the file called TVIEW+_(Version#)_install.exe

- After the installer starts follow directions.

STEP 2: Installation - TView Diagnostic Software (Optional)

Note: If a previous version of the "TView WinDiags" software has been installed on your PC, you must uninstall it via Control Panel "Add/Remove Programs".

- Close down all other programs currently running.

- Place the CD-ROM in the drive on the PC.

- Using Windows Explorer open the "Diagnostics" directory on the CR-ROM.

- Double click on the file called setup.exe

- After the installer starts follow directions.

Other:

The current E Series Manuals are supplied and installed as part of the TVIEW+ Management Suite installation in Adobe Acrobat format.

Adobe Acrobat Reader is provided on the CD-ROM for installation if required.

TVIEW+ Front Panel

When started the TVIEW+ front panel appears. The larger buttons permit each of the three utilities to be started. The diagnostics button may be greyed out if this utility has not been installed or found in the correct file directory. Access to local help and an exit facility are provided by the remaining 2 buttons.
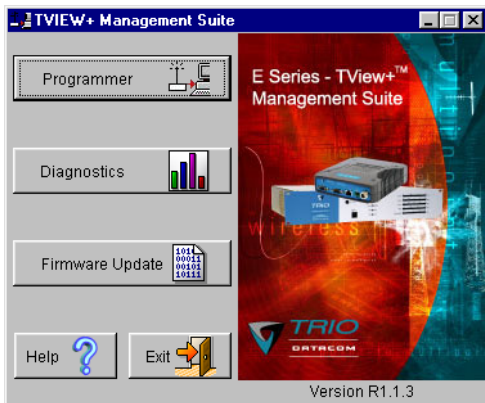
Programmer

Main Window

When first started the programmer is in file mode as indicated by the mode field at the bottom right of the panel shown below. In this mode it is possible to open a previously saved configuration file, or configure various programming options and save the configuration to a file.

Note: Modulation type is not available in this mode.

To commence programming a unit (radio remote or base station) a session must first be established by using the "READ" function. This function reads the current configuration from the unit and displays it in the main window. The "mode" displays changes to local or remote depending on the type of session selected at the read function. Several options in the main window may be blanked out until a session has been established with a unit.

Note: Changing any item on the menu will in general not take effect until data is written back to the unit using the "WRITE" function.

The procedure to follow for normal programming of unit is:

- Read unit

- Configure parameters (or Open a previously saved configuration file)

- Write unit

Several modems of the same radio type can be programmed with the same configuration using the clone facility described in Clone Mode. It is important to note that when using this facility the cloned radio should be of the same type to ensure it does not operate outside its capability.
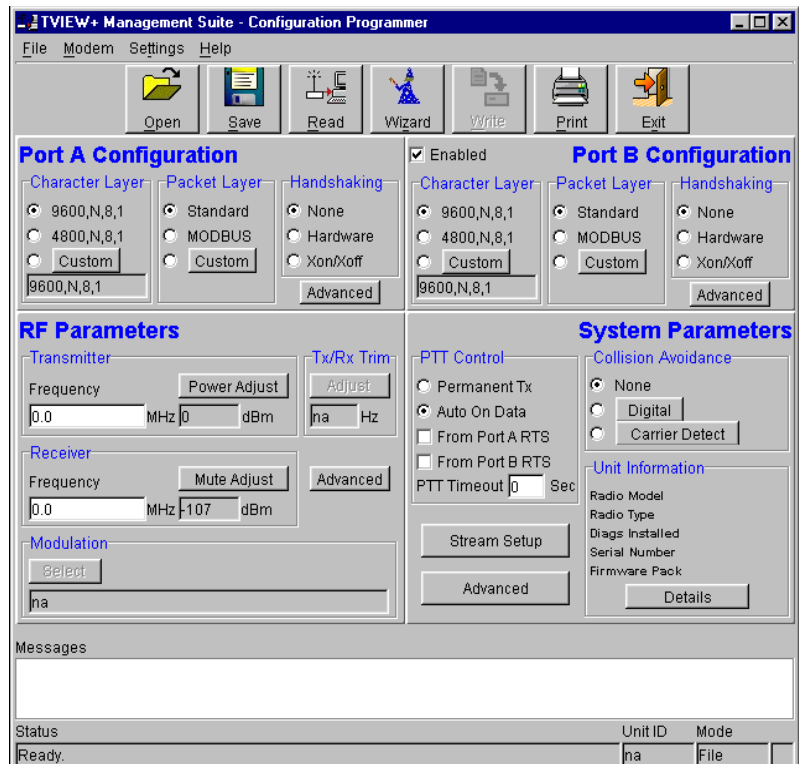
Pull Down Menus and Toolbar Buttons

The items on the pull-down menus can be selected either directly with a mouse or using the ALT key in combination with a HOT KEY (eg ALT-F to select the file menu). Several of the functions within each menu are also available on the toolbar (click once to select).
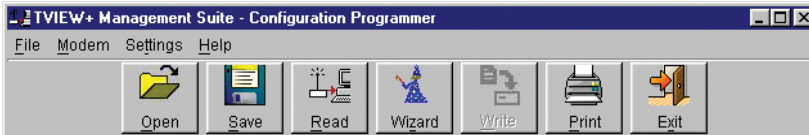
File Menu

The file menu allows the user to load (open) or save configuration data as well as to quit the program. The files are saved with an ".cfg" file extension

Open (also available on the toolbar)

This function is used to load an existing configuration file that can be used to directly program the radio or to use as a starting point to edit configuration parameters. Note that a session must be established with the unit by initially reading the configuration parameters from the unit prior to being written to a unit.

If in file mode the modulation type will not be displayed. If in local/remote mode and a file that was saved from local/remote mode is opened, then modulation type will be imported and used, but only if it is valid for the connected hardware. If not then the units read modulation type will be used.
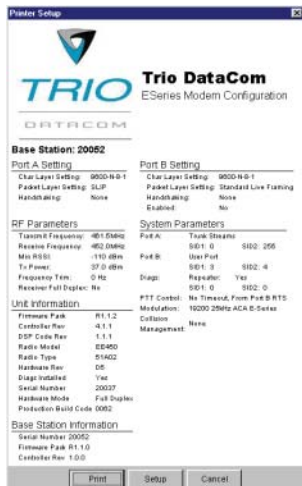
Save (also available on the toolbar)

This function is used to save the current configuration parameters to a file for future recall.

If in "file mode" only basic RF, Port and System parameters are saved and re called. If in local/remote mode then modulation type is saved and re called.

Print (also available on the toolbar)

This function prints out the configuration data to the default printer in a standard format. There are no options for this item.

This should be used if a complete record is required for site/unit configuration. Firmware/Modulation/Diags/Hardware type are all printed.

Exit (also available on the toolbar)

This function terminates the program. The user is requested to confirm this selection before exiting the application.

Modem Menu

This radio menu allows configuration data to be read from and written to the unit (remote radio or base station) using the selected PC serial port connection (see Settings menu). The action of reading the configuration establishes a session with the unit. Communications is maintained with the unit to ensure that the session remains open. If the session has been lost due to data transmission errors or disconnection of the programming cable it will need to be re-established to ensure any updated configuration is written successfully to the unit.

Read (also available on the toolbar)

This function establishes a session with the unit, reads configuration data from the unit and displays it in the programmer main window. When selected a dialogue window appears prompting the user to choose whether the unit to read is local (connected directly to the serial port or remote (connected over the air to the unit connected to serial port). Unit no. (serial no.) musty be entered and the stream SID code is "on" (default =0)). After configuration data is read from the unit it is available for editing and writing back to the unit or saving to a file. The progress of data transfer to or from the unit is indicated by a message window as well as a rotating indicator in the bottom right hand corner of the main window.
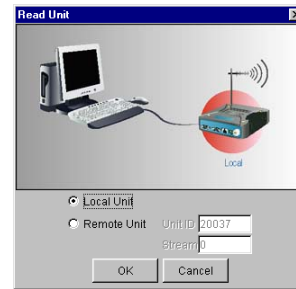
Write (also available on the toolbar)

This function writes configuration data displayed in the main window to the unit and reboots the unit. When selected a dialogue window appears prompting the user to confirm whether to proceed. A progress indicator in the bottom right hand corner of the main window is displayed while data is being read. This selection is only available if a session has been previously established and maintained with the unit.

This dialog provides a facility for reversing any remote configuration changes and reverting to the previous configuration.

Select "No" to send a command to the unit to accept the new configuration changes and to close the session. Select "Yes" to send a command to the unit to cancel the new configuration changes and to close the session.

The configuration settings will revert to their previous values if the data communications circuit with the unit has been interrupted after the new changes have been made, but before they have been verified, as just described, then the unit will automatically discard the new changes. A "Timeout Error" message will appear in the event of such an interruption and the programmer will revert back to file mode.

After configuration data has been written the session with the unit is closed and the programmer goes back to file mode

NOTE: In general any change made on the programmer screen must be written to the unit using this function before it becomes permanently stored. Changes to Power Adjust, Mute Adjust and Tx/Rx Trim however do take immediate effect to permit a tuning capability prior to being permanent stored.

Cancel Session (also available on the toolbar)

This function closes the session with unit and puts the programmer back into file mode. All configuration changes are discarded including changes to Power Adjust, Mute Adjust and Tx/Rx Trim.

Wizard (also available on toolbar)

This function permits the user to select standard configurations after the configuration from a unit has been read or a file opened. The user is prompted via a series of dialogue windows to select the desired configuration that can then be written to the unit (remote radio or base station).
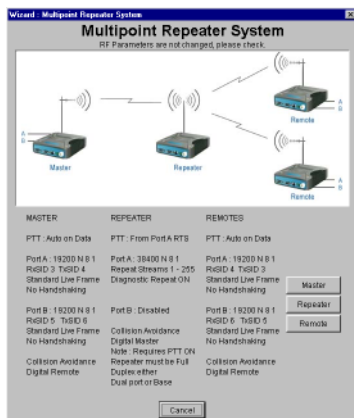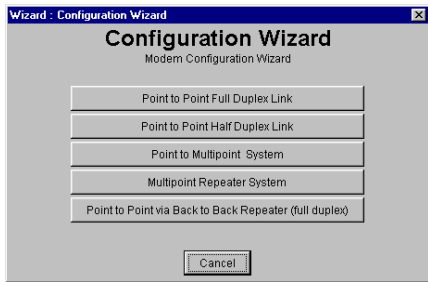
Clone Mode

This function permits writing of the same configuration data to several units. This feature is normally used for configuring data radio modems connected locally. The procedure is:

- Read the configuration from the first unit

- Configure the parameters (or Open a previously saved configuration file)

- Select Clone Mode (Modem menu)

- Write the configuration to the first unit

- The changes will take effect when repowered

- Connect the next unit

- Write the next unit which establishes a session and recognises the unit serial number and type, and then configures the unit

- Repower the unit for changes to take effect

- Repeat the last 3 steps for the remaining units.

Settings

This menu permits selection of the PC serial port (COM1 to COM4) to be used for communications with the unit. COM1 is the default selection and if a different port is to be used it must be set before establishing a session by reading the configuration from a unit. Whilst a session is established with a unit this menu can not be accessed.

Help

This menu permits selection of help information using the Contents key. Warnings regarding use of the programmer software using the Warnings key and version detail using the About key.

Port A and Port B Configuration

Data from these two user ports is multiplexed for transmission over the air. Each port can be configured separately for the Character layer (Data speed, number of data bits, number of stop bits, parity), Packet layer and Handshaking (flow control). Port B must be enabled if required by setting the check box at the top of its configuration section.

if Port B is off, the 16K memory is split equally between Port A Rx/Tx buffers (ie: 8K & 8 K). If Port B is on, then the 16K is split equally across Port A & B Rx/Tx buffers (ie: 4K, 4K, 4K & 4K).

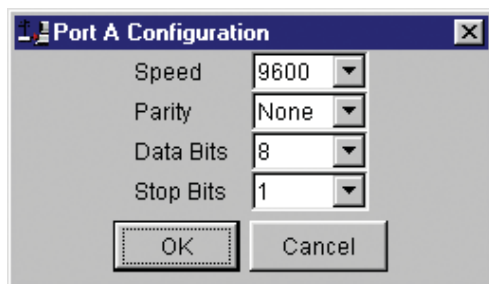The following description is common to both ports.
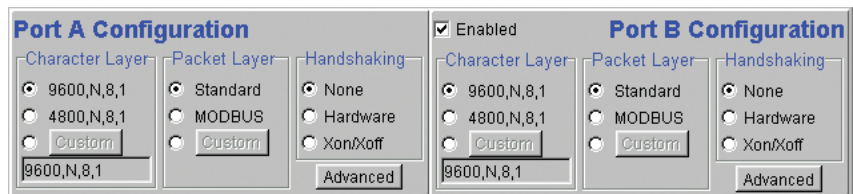
Character Layer

There are two standard formats and a custom format that can be selected by checking the appropriate control button to the left of the description. The standard formats are:

- 9600,N,8,1 (data speed = 9600 bps, no parity, 8 data bits, 1 stop bit)

- 4800,N,8,1 (data speed = 4800 bps, no parity, 8 data bits, 1 stop bit)

A non-standard format can be selected via the Custom button that displays a dialogue box to permit selection of data speed, parity, number of data bits and stop bits. Once selected the OK button should be used to complete the selection. The custom selection is also displayed in the main window below the Custom button.

Packet Layer

There are two standard configurations and a custom configuration which can be selected by checking the appropriate control button to the left of the description. There are essentially two basic modes of operation for the packet assembler and disassembler (PAD). The first is where the PAD operates in a standard mode with data received at the port being immediately sent over the radio channel. The second is a store and forward or delayed mode where whole data packets are received from the port before being sent over the radio channel. In both cases data is sent over the radio channel in variable length frames and delineation of these frames is dependent on the configuration selected as well as the characteristics of the data stream received at the data port.

The packet layer configuration options which can be selected are:

Standard (live framing)

With standard live framing data received from the host by the modem is immediately placed into a frame and transferred onto the radio channel. This avoids placing "store and forward" delays in the data transmission.

If a stream of characters is received by the modem, then several characters at a time may be placed into the same frame. The number of characters in the frame depends mainly on the respective baud rates of the user port and the primary channel baud rate of the modem, as well as the level of overheads experienced on the radio channel and the user data stream.

For example a constant stream of 300 baud user data placed onto a 9600 baud channel will result in 1 character per frame being transmitted. If the user baud rate was lifted to 9600,N,8,1 with a continuous data stream, then the frame size would settle to about 16 characters plus 32 overhead bits. If collision avoidance is enabled as master the average frame size will increase to 32 characters plus overhead bits.

The number of data bits associated with the user data stream will also have an effect on the average size of a frame. For instance the number of stop bits, and number of data bits per character.

The system designer must choose the best compromise of all the above items to ensure the most efficient method of data transmission.

Note: The first character is always packetized and sent by itself regardless of all the above variables.
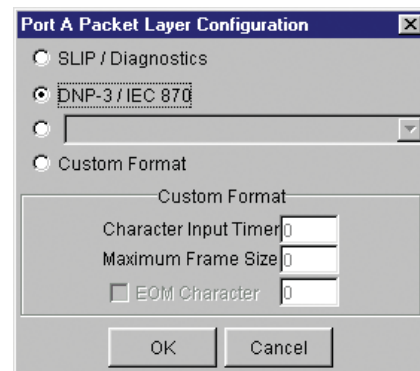
Modbus

This selection configures the PAD driver with options automatically set to implement the MODBUS protocol. eg: 5 mSec timer.

Custom

Other configurations of the PAD driver can be selected via the Custom button which displays a dialogue box to permit selection of several configuration options as follows:

SLIP / DIAGNOSTICS

SLIP is a well known protocol for transferring binary data packets over a data link. Each data packet is delineated by <FEND> characters, and a substitution mechanism exists that allows these characters to be included in the data packet. Appendix B describes the SLIP protocol which is used extensively in UNIX(tm) based systems, and is closely associated with TCP/IP networks.

The diagnostics controller package uses the SLIP protocol to communicate between base station and remote modems.

DNP-3 / IEC870

This selection configures the PAD driver to implement the DNP-3 Protocol and IEC870 Protocol.

Pull Down Menu Selection

The PAD driver can be configured for a number of vendor specific protocols by selecting the desired option.

Custom Format

This selection permits PAD driver to be configured in a variety of ways and requires a greater understanding of the system design.

For the modem to successfully transmit its packets (or frames) of data over the radio channel, it must be told on what basis to delineate data packets received at the data port. Once the end of a data packet has been received at the port the data frame is closed and transmission over the radio channel commences. Delineation of data packets can be configured to occur via any combination of:

- A predefined minimum time delay between packets received at the port. Typically the time delay would reflect the absence of a couple of characters in the data stream at the specified user port baud rate.

- Limiting the maximum number of characters which can be put in the data frame sent over the radio channel.

- Receipt of a selected end of message (EOM) character at the port. An ASCII carriage return (character 13) is often used for this purpose.

As each data frame to be transmitted over the radio channel has overhead data consisting of checksums and SID codes. The system designer must determine the best compromise between the ratio of overhead versus user data which depends on packet size and user data packet transmission latency.

The fields which can be configured are:

- Character Input timer: Set the input timer value in ms or enter zero to disable. Range 0 - 255.

- Maximum Frame Size: Set the maximum number of characters or enter zero to disable. Range 0 - 4095.

- EOM Character: Select the check box to the left of the description to enable and enter the EOM character as a decimal value. Range 0 - 255.

Handshaking

If the standard PAD is selected (i.e. any settings apart from SLIP/Diagnostics), then flow control can be either hardware handshaking, XON/XOFF protocol or none.

The XON/XOFF flow control is not possible when using either the SLIP/Diagnostics protocol.

The Handshaking section of the screen allows the selection of either of the handshaking methods as well as allowing handshaking to be disabled.

Details of the two handshaking methods are given below.

Hardware

The modem acts as Data Communications Equipment (DCE) and supplies to the host controller the following interface signals:

Data Set Ready	(DSR)
Data Carrier Detect	(DCD)
Clear To Send	(CTS)
Receive Data Output	(RXD)

The host controller must act as Data Terminal Equipment (DTE) and supplies to the modem the following interface signals :

Data Terminal Ready	(DTR)
Request To Send	(RTS)
Transmit Data Input	(TXD)

- DCD

   DCD has several modes of operation. It is set to TRUE when data is being transferred from the modem to the host - RXD line active. The signal is asserted approximately 500ms before the start bit of the first character in the data stream and remains for approximately 1 character after the last bit in the data stream. The other modes of operation are dependent on the advanced settings.

- DSR

   DSR is permanently set to TRUE.

- CTS

   The CTS is a signal from the modem to the host informing the host that the modem is able to accept incoming data on the TXD line. It responds to the actions of the RTS line similar to the operation of a "standard" line modem.

   The CTS is FALSE if the RTS line is FALSE. Once the RTS line is set to TRUE (signalling that the host wants to send some data to the modem on the TXD line), then the CTS will be set TRUE within 1ms, *if* the modem is capable of accepting more data.

   The CTS line will be set to FALSE if the transmit buffer in the modem exceeds 4075 bytes, or the number of queued frames exceeds 29 to ensure that no overflow condition can occur.

- RTS

  The RTS line is used for two reasons. The first is to assert the CTS line in response to RTS. The RTS line can also be used to key up the transmitter stage of the modem.

- DTR

  The DTR line is used for flow control of data being sent from the modem to the host controller. When the host is able to accept data it sets this line to TRUE, and if data is available within the modem, it will be sent to the host. If the host cannot accept any more data, then it sets the DTR to FALSE, and the modem will stop all transmissions to the host.

- **Xon/Xoff**

  If the flow control mechanism is XON/XOFF then the modem uses the standard ASCII control codes of DC1 {^Q=11(Hex)=17(Dec)} for XON and DC3 {^S=13(Hex)=19(Dec)} for XOFF. The DTR input line is totally ignored.

  NOTE: There is no substitution mechanism employed in the XON/XOFF protocol, so care must be taken when transferring binary data to ensure that invalid flow control characters are not generated.

Advanced

This button provides access to the advanced features of the port configuration. When selected a dialogue box appears which permits selection of the source for the port DCD output signal.
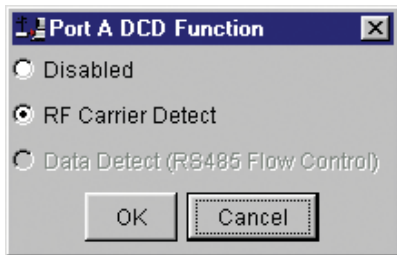
Disabled

This selection disables the DCD output on the port. This selection is not permissible if hardware based flow control has been selected.

RF Carrier Detect

This selection causes DCD to be asserted at the onset of a received RF signal being detected. This will generally occur several milliseconds before data is transmitted from the port.

Data Detect (RS485 Flow Control)

This selection causes DCD to be asserted when data is about to be transmitted from the port. This option is not available if handshaking is set to "None" or "Xon/Xoff".

RF Parameters

This section of the main window permits adjustment of transmitter and receiver, radio channel modulation scheme, frequency trim and advanced features.
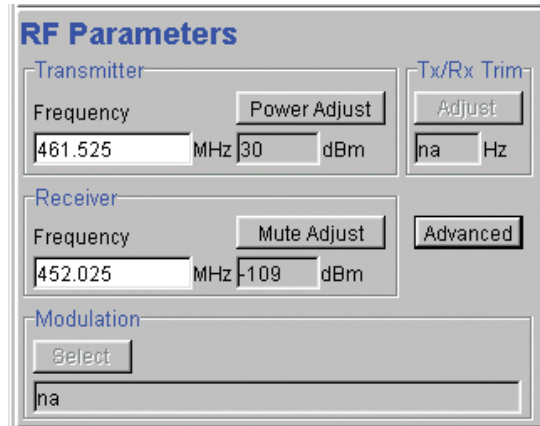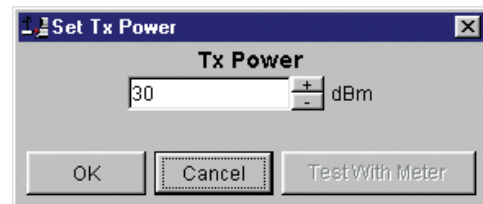

Transmitter

The transmitter can be configured for transmit frequency and power level.

Frequency

The required transmit frequency in MHz can be entered in the display field. The programmer checks that the selected frequency is in the range for the particular model of radio and provides warnings if not.

Power Adjust

The currently selected transmit power is displayed below the button in dBm. The power level can be adjusted by selecting this button which displays a dialogue box. The up/down keys, or a typed in value, can be used to select the required power level in dBm steps. There are two methods for setting the power.

- Using Factory Calibration

  To use the factory calibration of the radio the desired power is set immediately using the OK button in the dialogue box. This method permits the transmit power to be set without energising the transmitter. Note that although the transmit power has been adjusted it must be written to NVRAM using the modem "Write" function to ensure it is retained after a power on reset.

- Using a Power Meter

  To overcome manufacturing variations in the power setting a more accurate setting of power can be achieved by the selecting the "Test With Meter" button in the dialogue box. This displays another dialogue box warning the user that the transmitter is about to be energised and that the power meter used should be able to handle at least 10 Watts from the modem.

  Selecting OK in this warning dialogue box will energise the transmitter which will also be indicated by the red transmit LED on the unit. The power is adjusted using the up/down keys until the required power level is obtained. Selecting OK will retain the power setting and turn the transmitter off. Note that although the transmit power has been adjusted it must be written to NVRAM using the modem "Write" function to ensure it is retained after the modem is rebooted.

  Selecting "stop test" will stop and leave you in power adjust box. "Cancel" will stop test and take you back to the main window.
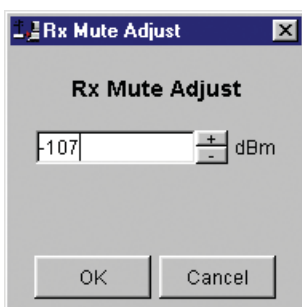
Receiver

The receiver can be configured for receive frequency and mute level.

Frequency

The required receive frequency in MHz can be entered in the display field. The programmer checks that the selected frequency is in the range for the particular model of radio and provides warnings if not.

Mute Adjust

The currently selected mute level is displayed in the main window below the button in dBm. The mute level can be adjusted by selecting this button which displays a dialogue box. The up/down keys, or a typed in value, can be used to select the required mute level in dBm steps. Whilst a session is in progress with a unit the mute level adjustment is live. Selecting OK will retain the mute level setting. Note that although the mute level has been adjusted it must be written to NVRAM using the modem "Write" function to ensure it is retained after the modem is rebooted.

Whilst the modem is capable of receiving extremely weak radio signals, and successfully extracting the data content from the waveforms the mute level should be set to assist the modem in filtering out unwanted signals. Unwanted signals can be the result of background noise or interference. The mute level should be set at a level above these unwanted signals and at a level low enough to detect the wanted signal. Detection of a received signal above the mute level is indicated by the "RxSig" LED on the unit.

Setting of a correct mute level at a base station is critical if collision avoidance is operational in a point to multipoint system. In this situation detection of "noise" instead of a valid transmission from the remote modems will effectively "lock out" all of the remote units from accessing and using the channel.

Due to normal manufacturing variations the actual mute level may vary by several dBm to that selected. If a more accurate adjustment is required an unmodulated signal of the correct frequency and desired threshold level can be applied to the radio modem's antenna connector.

Modulation

The radio modem utilises a DSP to control the modulation of transmit signals and de-modulation of received signals. This provides greater flexibility in the ability of the radio modem to support new modulation schemes whilst maintaining compatibility with existing modulation schemes.

The currently selected modulation scheme is displayed in the main window below the select button. The modulation scheme can be adjusted by selecting this button which displays a dialogue box. The desired modulation scheme can then be selected from the pull-down menu in the dialogue box and retained using the OK button.

In the case of 12.5kHz channel radio modems the presently supported
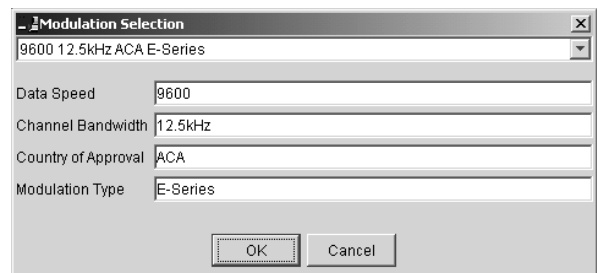

modulation schemes include:

- 9600 12.5kHz ACA E Series. This is a new 9600bps modulation scheme available in E Series products which supports a significantly reduced delay between detection of a valid RF carrier signal and demodulation of user data.

- 4800 12.5kHz ACA D Series. This is a current 4800bps modulation scheme used in the D Series products to provide backward compatibility.

In the case of 25kHz channel radio modems the presently supported modulation schemes include:

- 19200 25kHz ACA E Series. This is a new 19200bps modulation scheme available in E-Series products which supports a significantly reduced delay between detection of a valid RF carrier signal and demodulation of user data.

- 9600 25kHz ACA D Series. This is a current 9600bps modulation scheme used in the D Series products to provide backward compatibility.

Tx/Rx (Frequency) Trim

The currently selected frequency trim, which is common to both transmitter and receiver, is displayed in the main window below the button in Hz. The frequency trim can be adjusted live by selecting this button which displays a dialogue box. The up/down keys can be used to select the required frequency offset in steps pre-determined by the radio modem. Selecting OK will retain the frequency trim setting. Note that although the frequency trim has been adjusted it must be written to NVRAM using the modem "Write" function to ensure it is retained after the modem is rebooted.
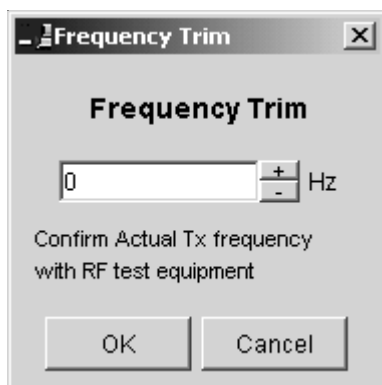
This facility permits correction for drifts in the frequency reference caused by component ageing. For example, a standard crystal may vary in fundamental frequency operation over 1 year by one part per million. An adjustment range of ± 10ppm, displayed in Hz, has been allowed for and if this is insufficient the unit should be returned to the dealer/factory for re-calibration.

Advanced

This button permits setting of advanced features. When selected a dialogue box appears which permits configuration of the type of received data clock alignment method.
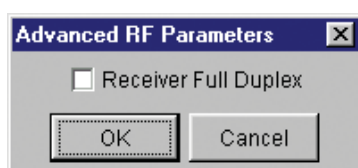
In the case of full duplex units the receiver is always active and is not interrupted by transmissions from the unit as would be the case for half duplex units. In this situation it is not necessary, or desirable in the case of a base station, for the recovered data clock alignment to be remembered between bursts of received signals. In this situation the "Receiver Full Duplex" check box to the left should be selected.

NOTE: For half duplex units the "Receiver Full Duplex" check box should not be set.

System Parameters

This section of the main window configures the PTT control, collision avoidance, stream setup for routing of data, advanced features and provides unit information.

PTT (Press To Talk) Control

RF transmission can be configured to occur permanently, automatically on data received at Port A or Port B, or RTS being asserted on Port A or Port B. A PTT timeout facility can be configured to limit the period for which the transmitter is enabled. Each option is selected by setting the control to the left of the description on the main window. When PTT is active the "Tx" LED on the unit is illuminated and RF power is being fed to the antenna.

Permanent Tx

This will cause the transmitter to be permanently enabled (keyed) and displays another dialogue box warning the user that the transmitter will be energised immediately after the configuration is written to the unit. Selecting OK confirms this setting. The other PTT selections are disabled when this option is selected.

NOTE: This option is only available for half duplex units when being programmed locally.

Auto On Data

This will cause the transmitter to be enabled (keyed) automatically on data received at Port A or Port B and included in a complete frame for transmission over the radio channel. The maximum period for which the transmitter will be enabled is limited by the PTT timeout setting.

From Port A RTS

This will cause the transmitter to be enabled (keyed) on Port A RTS being asserted. The maximum period for which the transmitter will be enabled is limited by the PTT timeout setting. Applications which rely on establishing a link ahead of data being transferred require this method of activation.

From Port B RTS

This will cause the transmitter to be enabled (keyed) on Port B RTS being asserted. The maximum period for which the transmitter will be enabled is limited by the PTT timeout setting. Applications which rely on establishing a link ahead of data being transferred require this method of activation.

PTT Timeout

The PTT timeout facility is used to disable the transmitter if it exceeds the designated time. The timeout value can range from 1 to 255 seconds and the facility is disabled by setting a zero value.

The timeout value chosen for this should be set according to system requirements which may include:

• Prevention of a remote unit remaining keyed up and locking out all other remote units in a point to multipoint system.

• Limiting the period a remote unit remains keyed up to prevent battery drain in a low power application.

NOTE: If a PTT timeout occurs before completion of a data transmission data will be lost.

Stream Setup

This button brings up a dialogue box to permit editing of Stream IDentifier (SID) codes which are used by the modem as the addressing mechanism for data stream routing. A SID code can be placed at the start of each data frame as it is sent over the radio channel. The receiving modems use this code to determine how to route the data message. The modem supports simultaneous operation of both Port "A" and Port "B" over the one radio link, along with the inclusion of a diagnostics data stream.

Each port is independant and fully supports one of four options which can be chosen as described below. Note that the port B parameters are greyed out when port B is not enabled.

The following diagram illustrates the structure of the stream routing function for each data port.

Stream Router
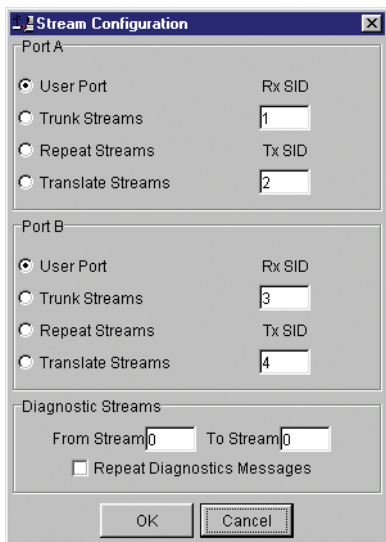
User Port

This option is selected by clicking on the User Port button and filling in the RXSID and TXSID fields to the right.

In the User Port mode (Referred to in the previous programmer as MUX/DEMUX mode) all SID code operations are performed transparently to the user. Data placed into a user port which has been assigned a specified SID code, will only be received by a modem at the other end of the radio link that has a user port assigned with the same SID code.

In this way, Port "A" and Port "B" can be assigned different SID codes, thereby separating the data streams.

Two SID codes values are available for each user port RXSID and TXSID. The RXSID codes apply to the data being received by the modem, and the TXSID codes apply to the data being transmitted by the modem. This allows for different transmit and receive codes if required, but generally they would be both the same.

A situation where Tx and Rx SID codes may be different is in a repeater configuration. In this type of application all data messages sent to the repeater will be "repeated". Thus by having different Tx and Rx codes a control unit will not "hear" its own transmission and remotes will not hear the reply from any other remote.

If the diagnostics facility is installed in the modem, then it too has a pair SID codes. The diagnostics data simply uses a different data stream or streams to the user data, but is processed internally by the modem. If access to the diagnostics facility is required, similar to when the diagnostics utility is used with the modem, then the data port concerned and the diagnostics stream, must have the same SID codes assigned to them. Alternatively the System port can be used, which is 19.2K, Slip.

(Previously TXSID was referred to as SIDA2 or SIDB2 and RXSID was referred to as SIDA1 or SIDB1 for ports A and B respectively).

Trunk Streams

In the Trunk Streams mode, data that is inputted into the modem for transmission must have a SID code appended to the start of the data packet by the user. The modem does not do it as in the User Port mode of operation. When a data packet is received by the modem, it is passed through a SID code filter which is bounded by a lower and upper limit of SID codes. The SID code is *not stripped off* from the user data.

For instance the lower bound is 03 and the upper bound is 07. If a message is received with a SID code of 02 appended it would not be passed to the user. If a message is received with a SID code of 04 then it is passed to the user, with 04 at the start of the frame.

The SID codes can range from 0 to 255, and physically consist of the byte value of the code i.e. a code of 156 is equivalent to "10011100" binary.
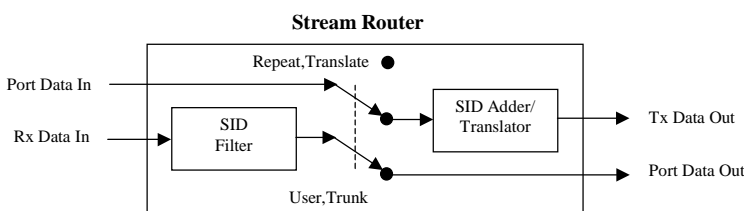
To select the Trunk Streams option click on the Trunk Streams button of the port to be used and fill in the fields to the right. The "From" field is for the lower SID code limit and the "To" field for the upper SID code limit.

NOTE: When using Trunk Streams an unambiguous packet delineation scheme (eg. SLIP) should be used so that the SID code in the user data can be decoded correctly.

Repeat Streams

The modem is capable of operating in a repeater mode. Each user port can be configured as a separate repeater. The associated user ports are effectively disconnected from the "outside world" when in repeater mode. Data received from the radio channel is passed directly to the transmitter, and placed back onto the radio channel.

The repeater must receive a complete frame of data before it is retransmitted. In some systems this store and forward delay may be significant, and careful selection of maximum frame sizes configured at the source unit must be considered to minimise the delay.

To enable the mode for the port click the Repeat Streams button and select the range of SID codes on frames to be repeated.

Translate Streams

This is essentially a hybrid of the User Port and Repeat Streams functions available on a port. Whereas the latter repeats a range of streams, this function instead translates one stream to another, by demultiplexing one stream (defined by Rx SID), and re-transmitting it with a new stream address (defined by Tx SID).

NOTE: Data is not presented to the user ports.

Diagnostics Processor

The Diagnostics Processor uses several streams defined by the range of SID codes. The diagnostics commands received on each stream are sent back over the same stream. The Diagnostics Processor is an option which must be enabled before this section of the menu will become active.

Diagnostics Repeat

This option can be toggled on and off simply by clicking the button.

Some applications will require that the master unit in a point to multipoint system to repeat diagnostics frames only (i.e. the master modem is *not* set up as a repeater).

This will be the case when the system diagnostics controller is connected to a remote unit in the system, and it polls the system population from this point. The master unit must retransmit any diagnostic frames that are not addressed to itself onto the remainder of the population.

Advanced

This button permits setting of advanced system parameter features. This presently includes enabling the diagnostics facility within the unit. Once enabled the diagnostics utility can be used to monitor the performance of the unit.
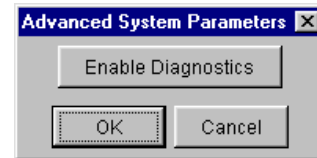
The Enable Diagnostics button should be selected and the 8 character diagnostics key code entered prior to selecting OK. If the key code is accepted or has been previously entered the Enable Diagnostics button will be greyed out. Contact your supplier for Key Code purchase.

Collision Avoidance

In a point to multipoint system the master unit (usually a base station) can transmit at any time and the remotes will all receive the broadcast signal. However, if more than one remote unit transmits at a time, then a collision will occur during the multiple transmissions, resulting in a loss of data from one or more units.

Two collision avoidance mechanisms have been included in the modem. The standard (Digital) method utilises a signalling channel which is embedded in overhead data transmitted over the radio channel. The second method utilises detection of a carrier signal to postpone transmission of data. Both methods require configuration of several options for successful operation.

The desired option for collision avoidance is selected by checking the control button to the left of the description on the main window.

None

When selected this turns off all collision avoidance mechanisms. This should only be used in point to point applications.

Digital

This is the standard method of collision avoidance and utilises a channel busy indication bit in the signalling channel transmitted to all remotes for control. When selected a dialogue box appears and several options must be configured: