



TRACER[®] 2 x E1 User's Manual

RADIO FREQUENCY INTERFACE STATEMENT

This equipment has been tested and found to comply with the limits for an intentional radiator, pursuant to Part 15, Subpart C of the FCC Rules. This equipment generates, uses, and can radiate radio frequency energy. If not installed and used in accordance with the instructions, it may cause interference to radio communications.

The limits are designed to provide reasonable protection against such interference in a residential situation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment on and off, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna of the affected radio or television.
- Increase the separation between the equipment and the affected receiver.
- Connect the equipment and the affected receiver to power outlets on separate circuits.
- Consult the dealer or an experienced radio/TV technician for help.

WARNING

Changes or modifications not expressly approved by ADTRAN could void the user's authority to operate the equipment.

SHIELDED CABLES

A shielded-type power cord is required in order to meet FCC emission limits and also to prevent interference with nearby radio and television reception when using the AC voltage adapter. It is essential that only the ADTRAN-provided power cord be used.

FCC OUTPUT POWER RESTRICTIONS

The FCC does not require licensing to implement this device. However, the FCC has established restrictions regarding maximum output power and the adjustments required when employing directional gain antennae. (Refer to "Setting the Transmitter Power" in Section 2 of this manual). These restrictions are detailed in FCC Part 15.247 (b)(1), (b)(3)(i), and (3)(iii). It is the responsibility of the individuals designing and implementing the radio system to assure compliance with these and any other pertinent FCC Rules and Regulations. This device must be professionally installed.

EXPOSURE TO RADIO FREQUENCY FIELDS

The TRACER is designed in three versions with the following power options:

2.4 GHz @ 100 mW

2.4 GHz @ 1 W

5.8 GHz @ 100 mW

These levels of RF energy are below the Maximum Permissible Exposure (MPE) levels specified in FCC OET 65:97-01. The installation of high gain antenna equipment in the system configuration may create the opportunity for exposure to levels higher than recommended for the general population at a distance less than 15 feet (4.6 meters) from the center of the antenna. The following precautions must be taken during installation of this equipment:

Radio Frequency Interference Statement

- The installed antenna must not be located in a manner that allows exposure of the general population to the direct beam path of the antenna at a distance less than 15 feet (4.6 meters). Installation on towers, masts, or rooftops not accessible to the general population is recommended; or
- Mount the antenna in a manner that prevents any personnel from entering the area within 15 feet (4.6 meters) from the front of the antenna.
- It is recommended that the installer place radio frequency hazard warnings signs on the barrier that prevents access to the antenna.
- Prior to installing the antenna to the RFC output, make sure the power is adjusted to the settings specified in section 2 of this manual.
- During antenna installation, be sure that power to the TRACER equipment is turned *off* in order to prevent any energy presence on the coaxial connector.
- During installation and alignment of the antenna, do not stand in front of the antenna assembly.
- During installation and alignment of the antenna, do not handle or touch the front of the antenna.

These simple precautions must be taken to prevent general population and installation personnel from exposure to RF energy in excess of specified MPE levels.

	Page
Section 1. Tracer Description	
Introduction	1
Applications	1
Spread Spectrum	1
Direct Sequence	2
Coding	2
Channel Selection	2
Forward Error Correction	2
E1 Interfaces	3
Tracer System Configuration	3
Baseband Processor or BBP	3
VT100 RS-232 Interface	4
Alarm Contacts	5
IF Signal	5
Power	5
Controls and Indicators	5
Non-volatile Memory	7
Built-In Tests	8
Radio Frequency Converter or RFC	8
Antenna Selection	10
Section 2. Installation	
Unpack, Inspect	11
Rackmounted RFC Configuration	11
Mastmounted RFC Configuration	11
Installation	11
Location and Mounting	11
Power Requirements	11
Grounding	12

Table of Contents

E1 Interfaces	13
Link Planning	14
Antenna Feedline Loss	15
Antenna Gain	15
Path Loss	16
Path Availability	16
Setting the Transmitter Power	17
2.4 GHz, 1 Watt Transmitter Option	17
Setting the RFC Frequency Plan on Non 1 Watt 2.4 GHz Models	18
Setting the RFC Frequency Plan on 5.8 GHz Models	20
Directions for Changing the Frequency Plan on the Rackmount RFC	20
Directions for Changing the Frequency Plan on the Mastmount RFC	20
Connecting the BBP and the RFC	21
Applying Power	21
Automatic BBP Frequency Plan	21
Spreading Code	21
Co-Locating Multiple Systems	22
Antenna Alignment	22
RF Low	22
Remote BERT	23
Alarm Contacts	23
Section 3. Operation	
VT100 User Interface	25
RS-232 Interface	25
Cable Connections	25
Password	25
Main Menu Selections	26
System Status Screen	26

Main Menu Screen.....	27
E1 Status / Configuration / Loopback Screen	28
Link Performance History	29
E1A Statistics Page.....	30
E1B Statistics Page.....	30
Section 4. Troubleshooting	
General	31
Problem Descriptions and Recommended Actions	31
Troubleshooting Using the Front Panel Indicators	31
“Link Down” Light is Lit	31
CV/CRC Light On E1A or E1B is Lit – when CRC is enabled	32
“LBK-A” or “LBK-B” is Lit	33
“LOS/OOF Light on E1A or E1B is Lit	33
ALM is Lit	34
No “Power” Light	34
“Test” Light is Lit or Blinking	35
“TST” Light is Lit after Pressing “Remote Test” Button	35
“Fail” Light is Lit after Pressing “Remote Test” Button	36
“RF Low” Light is On	36
Troubleshooting Using the VT100 User Interface	37
LOS Alarm	37
CV Alarm	37
OOF Alarm	38
CRC Alarm	38
RMT Alarm	38
UA1 Alarm	39
Code Sync Status	40

Table of Contents

Carrier Sync Status or E1 Mux Sync Status	41
RFC Link Up Status	42
ES Values in E1A or E1B Performance History Menu	42
SES Values in E1A or E1B Performance History Menu	43
Section 5. Specifications	
Transmitter	45
Receiver	45
Frequency Plans	45
Spread Spectrum Data Pump	45
Interface Specifications	45
User Interface	45
VT100 Terminal Interface	46
Mechanical & Environmental	46
Power	46
Section 6. Warranty, Ordering and Return Information	
Warranty	47
Sales	47
Repairs and Returns	47
Technical Support	47
Glossary	
Acronyms Used in This Manual	49
Appendix A.	
Cable Connections	A-1
Terminal Connection (DB-25)	A-1
Personal Computer Connection (DB-9)	A-1
Modem Connection (DB-25)	A-1

Illustrations

Figure 1-1.	Typical Application	1
Figure 1-2.	Bandwidth Division	2
Figure 1-3.	BBP	3
Figure 1-4.	BBP Rear Panel	3
Figure 1-5.	BBP Block Diagram	4
Figure 1-6.	BBP Front Panel (with door closed)	6
Figure 1-7.	BBP Front Panel (with door open)	6
Figure 1-8.	RFC Function Block Diagram	8
Figure 1-9.	RFC Module	8
Figure 1-10.	Front and Rear of Rackmount RFC Housing	9
Figure 1-11.	Mastmount RFC Housing	10
Figure 2-1.	E1 Loopback Locations	14
Figure 2-2.	2.4 GHz Diplexer	18
Figure 2-3.	5.8 GHz Diplexer	20
Figure 3-1.	System Status Screen	26
Figure 3-2.	Main Menu Screen	27
Figure 3-3.	System Configuration Menu Screen	27
Figure 3-4.	E1A Status Screen	28
Figure 3-5.	E1B Status Screen	28
Figure 3-6.	Link Performance History Screen	29
Figure 3-7.	E1A Statistics Screen	30
Figure 3-8.	E1B Statistics Screen	30

Table of Contents

SECTION 1 TRACER DESCRIPTION

INTRODUCTION

The Dual E1 version of TRACER provides two, individual E1 transports via a 2.4 GHz or 5.8 GHz, direct sequence, spread spectrum microwave link. The transmitter output power is 20 dBm maximum while the receiver sensitivity is -89 dBm @ 2.4 GHz and -87 dBm @ 5.8 GHz. System performance is determined, in part, by the engineering of the microwave link. Each TRACER radio is comprised of two components – the baseband processor and the radio frequency converter (RFC). The E1 interfaces (G.703, G.704 compliant) are provided on the back of the baseband processor, which is mountable in a 515 mm rack. The radio frequency converter is rackmountable adjacent to the baseband processor or mastmountable in a weatherproof enclosure, located up to 110 meters apart, using RG-8 style coax. A single coaxial cable connects the baseband processor (via a Type N connector) to the RFC and another coaxial cable connects the RFC to the antenna (via a Type N connector).

Applications

Any application that would typically use metallic E1 as a transport can use the TRACER instead. **Figure 1-1** illustrates a typical application.

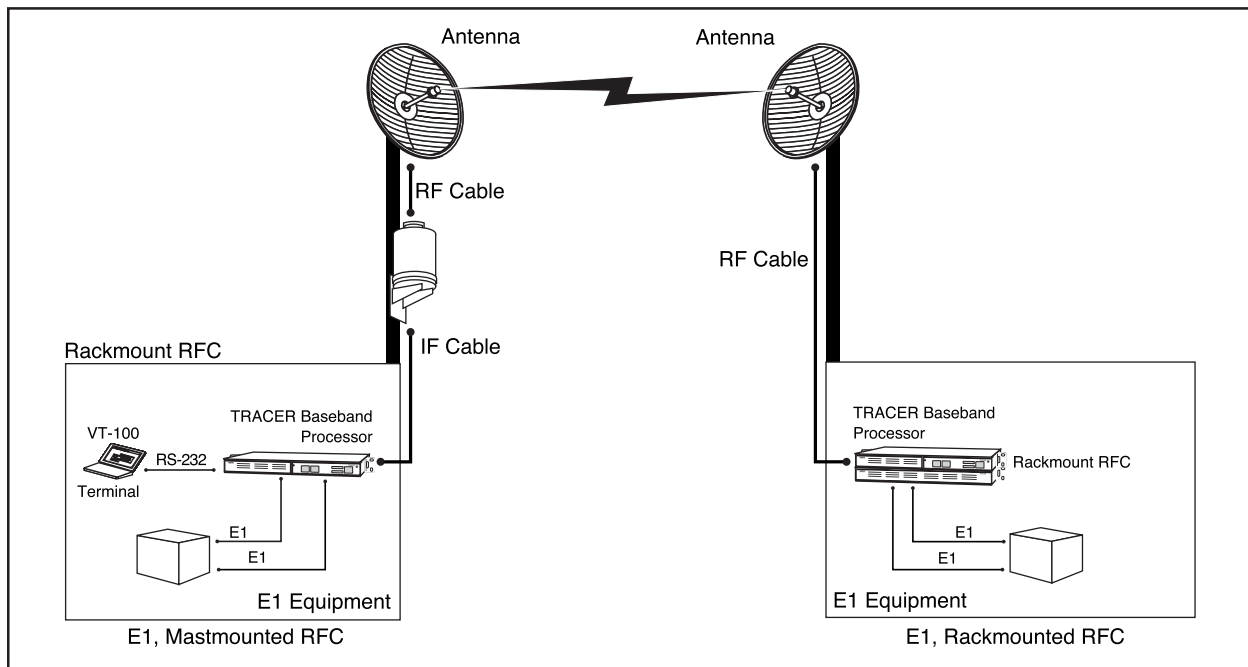


Figure 1-1. Typical Application

In addition to telephony applications, TRACER can be used in data communications such as inter-networking, video conferencing, and telemetry.

Spread Spectrum

Spread spectrum is a form of communication in which the bandwidth of a message signal is intentionally increased or "spread." There are two methods of spreading -- frequency hopping and direct sequence. TRACER employs direct sequence spread spectrum.

Section 1 TRACER Description

Direct Sequence

A direct sequence transmitter spreads the signal by mixing the data with the output of a pseudorandom number generator which changes state at a rate higher than the data rate. This rate is called the “chipping” rate. The TRACER chipping rate is twelve times the data rate.

Coding

Many different pseudorandom sequences exist. The sequences are called pseudorandom because, although they appear noise-like, they are determinant and repeat after a specific number of chips. The longer a code is, the better correlation characteristics it possesses. These traits allow multiple spread spectrum systems to operate in the presence of one another with minimal interference if they are operating with different sequences. The TRACER allows the selection of one of ten different 120-bit long sequences.

Channel Selection

The FCC has allocated 83.5 MHz of spectrum in the 2.4 GHz band and 125 MHz in the 5.8 GHz band in which TRACER operates. A TRACER system fully uses the available bandwidth – transmitting in one half and receiving in the other. **Figure 1-2** illustrates the bandwidth division.

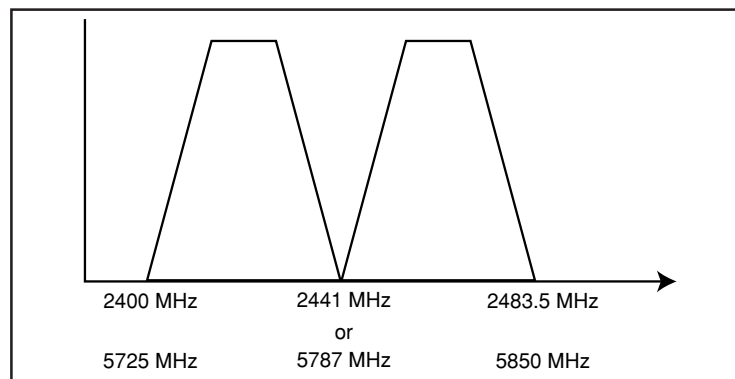


Figure 1-2. Bandwidth Division

The transmitter at one end of a link (TxA) will transmit in the lower half of the spectrum. Consequently, the receiver at the other end will receive in the lower half of the band and transmit in the upper half. Thus, a system will operate in one of two frequency plans -- transmit in the upper and receive in the lower or vice versa. These two plans are called Plan A and Plan B. One end of a path will be on Plan A and the other will be on Plan B. Shipment of a link will consist of an A and a B unless specified otherwise.

Forward Error Correction

With the addition of overhead data, error detection and correction capability can be added to a data stream. Error correction can be accomplished by allowing the receiver to request to retransmit of the erred block once detected. The TRACER, on the other hand, implements forward error correction (FEC) which adds enough overhead data for the receiver to detect and correct errors in the data stream. This capability comes at the cost of bandwidth. The addition of FEC decreases the required signal-to-noise (S/N) ratio by approximately 5.5 dB to achieve a given bit error rate (BER).

Section 1 TRACER Description

E1 Interfaces

The E1 interfaces conform to the ITU G.703 and G.704 electrical and signaling interface recommendations. Two interfacing configurations are allowed - two pair of BNC coaxial connectors or two 15-pin sub-D connectors and RJ48 connectors.

The coaxial connection provides a 75Ω unbalanced connection. The shield of the TX coaxial connection is attached to earth ground. A strap is provided to optionally connect the shield of the RX coaxial connection to ground as described in G.703. The 15 pin sub-D and RJ48 connection provides a 120Ω balanced connection.

TRACER System Configuration

A TRACER system is composed of three major subsystems -- a baseband processor, a radio frequency converter, and an antenna. The following section describes the system components.

Baseband Processor or BBP

The baseband processor or BBP is a 1-U, 515 mm (19-inch) rackmountable unit. This unit provides the system electrical interfaces, user controls and indicators, and performs the spread spectrum processing for the system. The rear panel provides all of the electrical interface points -- E1 interfaces, VT100 compatible terminal, alarm contacts, IF signal, and DC power (from facility or optional AC adapter).

The BBP front and rear panels are illustrated in **Figures 1-3** and **1-4**.

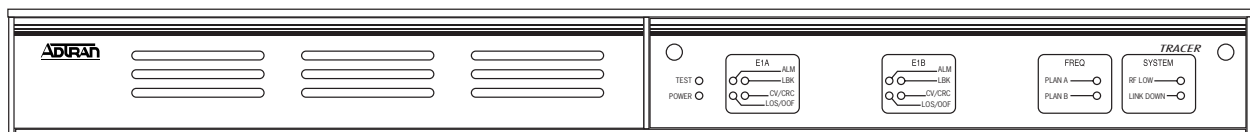


Figure 1-3. BBP

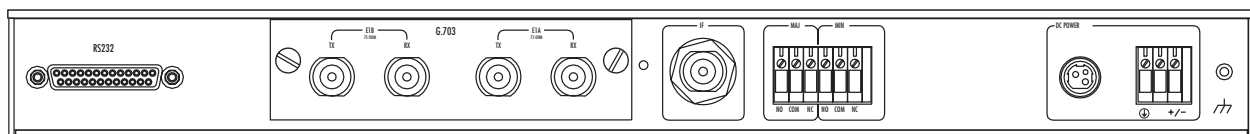


Figure 1-4. BBP Rear Panel (75Ω Option)

Section 1 TRACER Description

A block diagram of the BBP is shown in **Figure 1-5**.

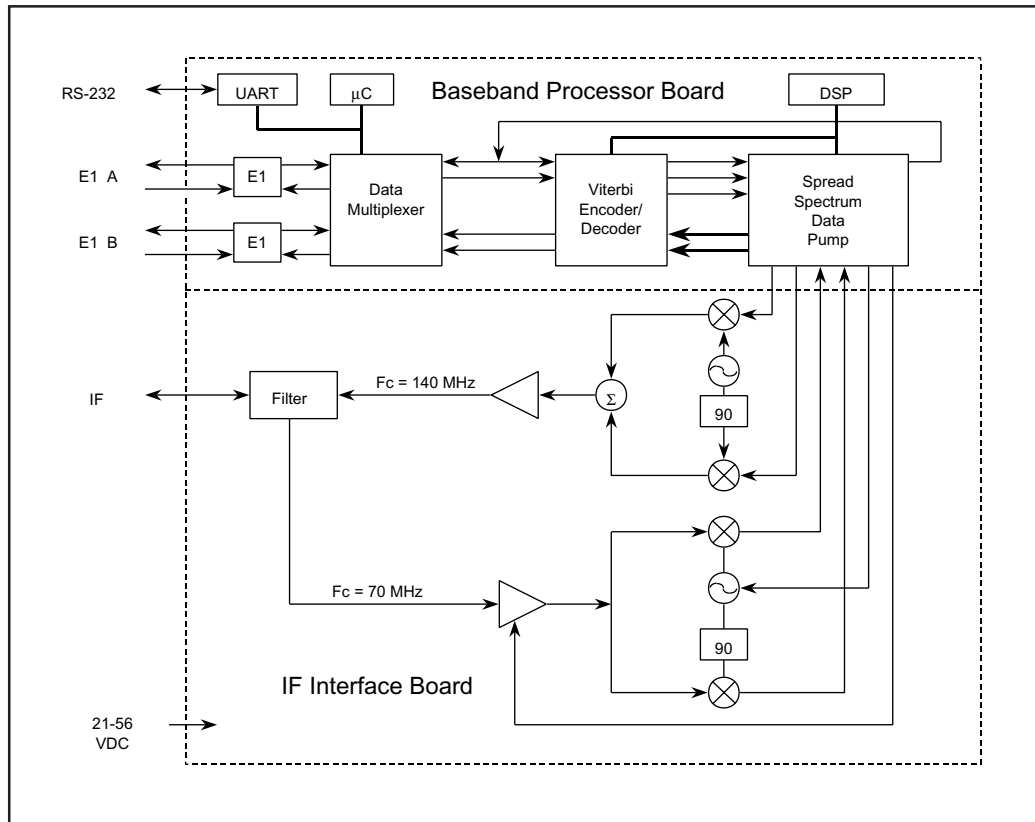


Figure 1-5. BBP Block Diagram

VT100 RS-232 Interface

An RS-232 interface is provided via a 25-pin D connector for attaching a VT100 compatible terminal. The active signals used on this interface are listed below

Signal Name	Pin Number	Source
Transmit Data	2	Terminal/Modem
Receive Data	3	TRACER
Request to Send	4	Terminal/Modem
Clear to Send	5	TRACER
Data Set Ready	6	TRACER
Signal Ground	7	

The management system allows the E1 interfaces to be provisioned. The line code can be selected as AMI or HDB3. The signaling can be selected as channel associated signaling (CAS) or common channel signaling (CCS). Alarm conditions can also be monitored. The management system will report the following alarms on the E1 interfaces:

- Loss of signal
- Code violation
- CRC error
- Framing error
- Remote alarm
- UA1

A seven-day error history of the E1 interfaces and radio link is also provided. Fifteen-minute histories are provided for the most recent 24 hours of operation.

The status of the microwave link can also be monitored from the management system. The transmitter power setting as well as an indication of the received microwave signal level are provided.

Alarm Contacts

Two classes of alarm, MAJOR and MINOR, are provided. A MAJOR alarm is signaled if, for any reason, the microwave path is not operational. A MINOR alarm is signaled when the data path is operating, but impaired. A minor alarm will be activated when an alarm is sensed on the E1 interfaces or when the received RF signal level falls below approximately -80 dBm. Both normally-open and normally-closed contacts are provided for each alarm class. Access is provided by a six-position terminal strip on the back of the baseband processor.

IF Signal

The Type N Connector provides the interface point between the baseband processor and the radio frequency converter (RFC). This connection provides the signal, power, and configuration information to the RFC. A coaxial cable (ADTRAN part number 3125RF027 is provided for connecting the BBP to the RFC for the rackmount model. Cable for connecting the BBP to a mastmount RFC must be provided by the customer after the length of the cable has been determined.

Power

The unit receives power via one of two connectors. Power for the entire system is provided by these interfaces. The 3 pin circular DIN connector is provided to connect an ADTRAN supplied desktop AC adapter providing 48 volts DC. The three-pin terminal block allows the connection of any DC power source providing between 21 and 60 volts DC. The power consumption of the entire system is approximately 30 watts.

Controls and Indicators

The system may be configured via the front panel, which is accessible behind a drop-down panel on the right half of the BBP. The front panel is illustrated in **Figures 1-6** and **1-7**.

Section 1 TRACER Description

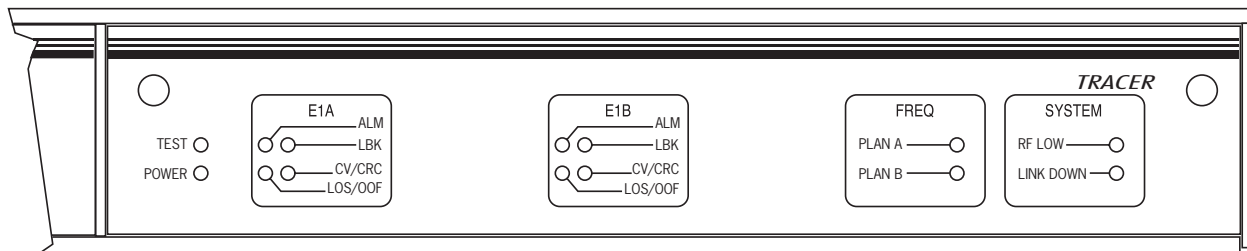


Figure 1-6. BBP Front Panel with Door Closed

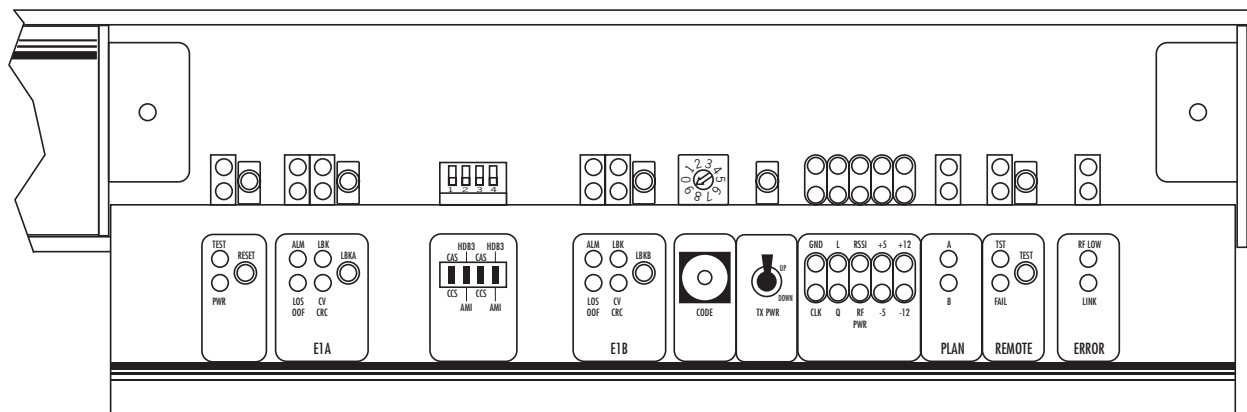


Figure 1-7. BBP Front Panel with Door Open

As a rule, a green LED indicates a normal situation, a red LED indicates an error situation, and a yellow LED indicates a configuration option. LEDs indicating overall system integrity are listed below.

- Self Test Blinking red if the self-test has completed and failed; Solid red if self-test is in progress or did not complete
- Power Green if DC voltage is applied

The LEDs associated with the E1 interfaces are listed below.

- CV/CRC Red if the incoming E1 stream contains code violations, or a CRC error
- LOS/OOF Red if there is no signal present at the E1 interfaces or if framing synchronization is lost
- Loopback Solid yellow if the E1 interfaces are in local line loopback. Blinking yellow if the E1 interfaces are in link loopback.
- ALM Solid red if a UA1 is detected at the incoming E1, blinking red if a remote alarm signal is found

The functions of the LEDs which relate system configuration information are listed below.

- Frequency Plan A Yellow if frequency plan A is selected
- Frequency Plan B Yellow if frequency plan B is selected
- Remote Test Active Yellow if the remote test is active
- Remote Test Fail Red if the remote test failed

Section 1 TRACER Description

Built-In Tests

The TRACER has several features to aid in site setup and later debugging. These diagnostics include E1 loopbacks and a link test with BERT (Bit Error Rate Test) data. A link test is performed by pressing the test button. The remote unit will then send a pseudorandom data pattern, and the local end will compute a BER. After the conclusion of the test, the remote end will automatically be instructed to terminate the pattern generation. If any bit errors are introduced, the Remote Test Fail LED will illuminate.

Radio Frequency Converter or RFC

The radio frequency converter (RFC) provides the radio frequency (RF) interface between the baseband processor and the antenna. The RFC is partitioned, functionally, into two major components - the transmitter and the receiver. **Figure 1-8** is a block diagram of the RFC. The major connections illustrated are transmit signal, receive signal, and the IF signal connection.

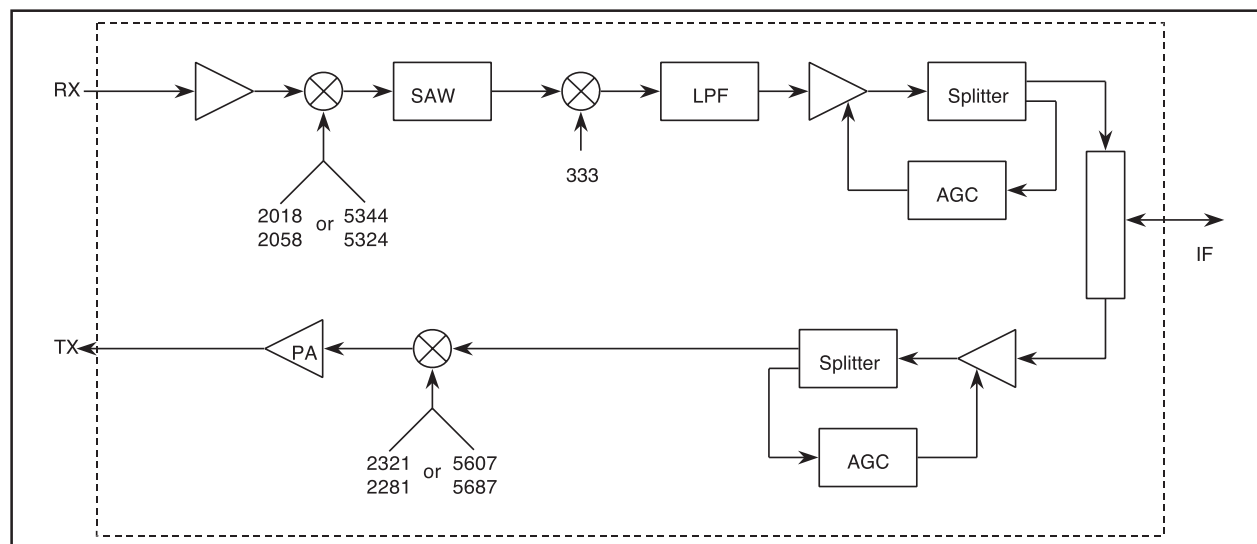


Figure 1-8. RFC Block Diagram

The RFC unit is enclosed in a metal enclosure approximately 26.7cm x 14cm x 2.5cm and is mounted in a 515 mm rackmountable housing or mastmountable, weatherproof enclosure. The RFC is illustrated in **Figure 1-9**.

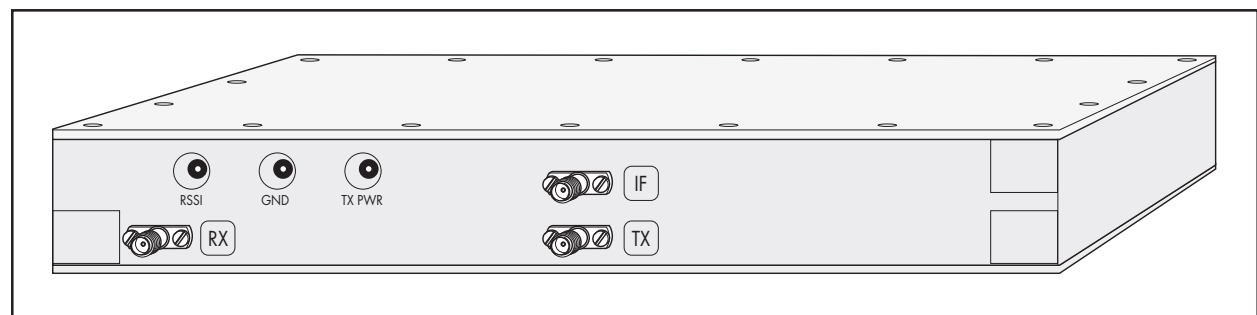


Figure 1-9. RFC Module

Section 1 TRACER Description

Three SMA connectors, located on the RFC module, provide RF and IF connection points. A test point is provided for monitoring the received signal strength indicator (RSSI). The voltage (relative to the GND test point) present on this test point represents the level of the received signal. This signal is used to align the antenna when installing the system and to verify the link is performing as designed.

NOTE

The voltage level present at the RSSI test point represents a relative signal level of receive strength from the far end. No direct correlation can be made between RSSI voltage level and actual receive level in dBm. This test point is provided to assess relative signal level for alignment of antennae.

The only connections that must be made in the field are a coax connection between the baseband processor and the RFC and a coax connection between the RFC and the antenna. These connections require male, type N coax connectors.

The *IF* connector provides the connection between the baseband processor and the rackmounted or mastmounted RFC. An 8" IF cable (ADTRAN P/N 3125RF027) is provided for rackmount systems. The *TO ANTENNA* connection provides the connection between the RFC and the antenna.

CAUTION

When connecting an RF converter (RFC) to a Baseband Processor (BBP), verify that the connector labeled "IF" on the rear panel of the Baseband Processor is connected via coax to the connector labeled "IF" on the RF converter. Connecting the Baseband Processor to the incorrect connector on the RF converter will cause the internal 1 amp 250 V fuse to blow in the Baseband Processor. This fuse is accessed by removing the top of the Baseband Processor, and is located on the left side of the chassis when facing the front panel.

The RFC module is enclosed in either an ETSI-compliant rackmount housing or a weather-tight enclosure suitable for mastmounting near the antenna for enhanced system performance. The RFC mastmount and rackmount housings are illustrated in **Figures 1-10** and **1-11**.

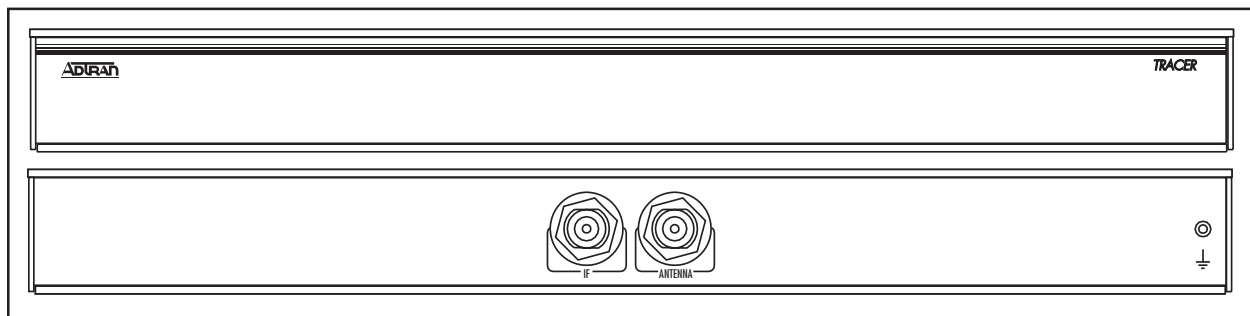


Figure 1-10. Front and Rear of Rackmount RFC Housing

Section 1 TRACER Description

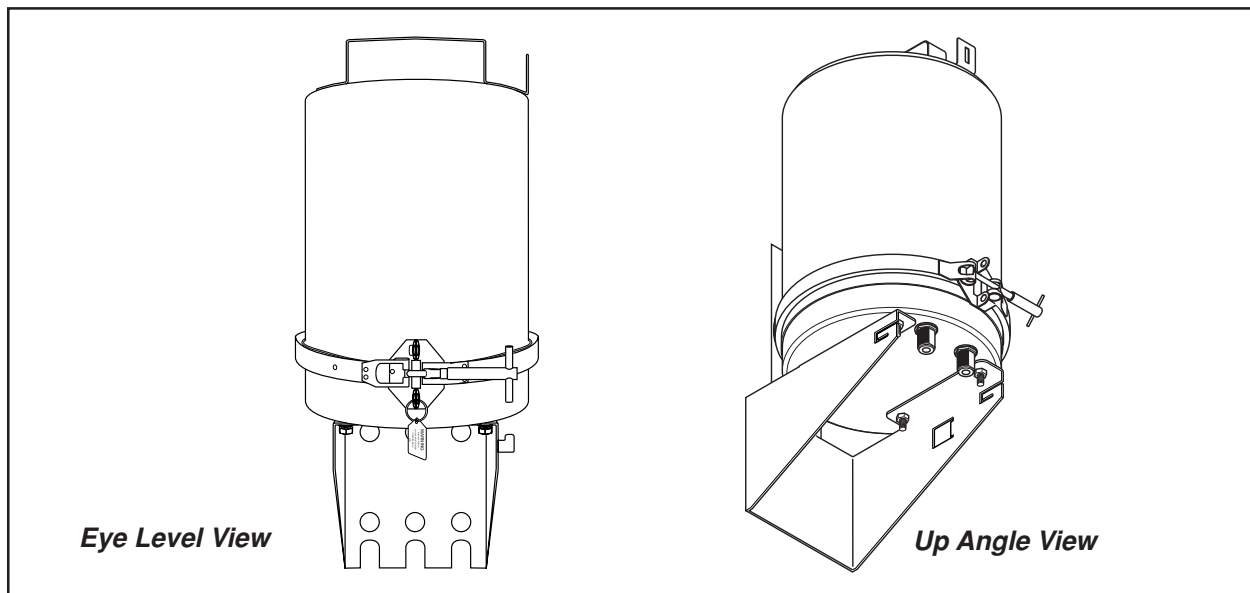


Figure 1-11. Mastmount RFC Housing

Antenna Selection

TRACER is intended to be coupled with an antenna that is directional (thus providing signal gain). There are several reasons for this requirement:

- TRACER operates in point-to-point applications so omnidirectional antennas cannot be used.
- The low power transmitter is intended to be used with a high-gain antenna for long links.
- Directional antennas minimize the interference that a site is susceptible to and also minimize the site's interference to other sites.

The antenna requirements are listed below.

<u>Antenna</u>	<u>100 mW</u>	<u>1 W</u>
Minimum gain	15 dBi	6 dBi
Minimum return loss	15 dB	15 dB
Connector	N-type	N-type
Impedance	50Ω	50Ω

UNPACK, INSPECT

Carefully inspect the TRACER for any shipping damages. If damage is suspected, file a claim immediately with the carrier then contact ADTRAN Customer Service. If possible, keep the original shipping container for use in shipping the TRACER back for repair or for verification of damage during shipment.

Before beginning installation, verify that all of the following components are present.

Rackmounted RFC Configuration:

Provided by ADTRAN

- Baseband Processor (BBP)
- Rackmounted RF Converter (RFC)
- BBP to RFC IF interconnect cable

Provided by customer

- E1 Interface cables
- Antenna feedline cable
- Antenna and mounting hardware
- VT100 terminal and RS-232 interface cable (optional)
- 21 to 60 volt DC power source (available from ADTRAN), either polarity referenced to ground

Mastmounted RFC Configuration:

Provided by ADTRAN

- Baseband Processor
- Mastmounted RF Converter

Provided by customer

- E1 interface cables
- Antenna feedline cable
- Antenna and mounting hardware
- BBP to mastmounted RFC IF interconnect cable
- VT100 terminal and RS-232 interface cable (optional)
- 21 to 60 volt DC power source (available from ADTRAN), either polarity referenced to ground

INSTALLATION

Location and Mounting

Install the TRACER in a location that requires minimal antenna feedline length (the loss in this cable directly affects overall system performance). When used with a rackmount RFC the BBP is designed to be mounted above the RFC. Although no space is needed between the units, certain regulations may require at least 19.05 mm (.75") of space above and below the BBP.

Power Requirements

The TRACER can operate from a supply between 21 and 60 volts DC, with either polarity referenced to ground, and consumes 30 watts. Amperage is determined by dividing the wattage (30) by the input voltage (i.e., 30 watts/48 volts = .625 amps).

Section 2 Installation

Grounding

The following grounding instructions are derived from the Underwriters' Laboratory *UL 1459 Standard for Safety: Telephone Equipment* dated September 20, 1993.

An equipment grounding conductor that is no smaller in size than the ungrounded branch-circuit supply conductors is to be installed as part of the circuit that supplies the product or system. Bare, covered, or insulated grounding conductors are acceptable. Individually covered or insulated equipment grounding conductors shall have a continuous outer finish that is either green, or green with one or more yellow stripes. The equipment grounding conductor is to be connected to ground at the service equipment.

The attachment-plug receptacles in the vicinity of the product or system are all to be of a grounding type, and the equipment grounding conductors serving these receptacles are to be connected to earth ground at the service equipment.

A supplementary equipment grounding conductor shall be installed between the product or system and ground that is in addition to the equipment grounding conductor in the power supply cord.

The supplementary equipment grounding conductor shall not be smaller in size than the ungrounded branch-circuit supply conductors. The supplementary equipment grounding conductor shall be connected to the product at the terminal provided, and shall be connected to ground in a manner that will retain the ground connection when the product is unplugged from the receptacle. The connection to ground of the supplementary equipment grounding conductor shall be in compliance with the rules for terminating bonding jumpers at Part K or Article 250 of the National Electrical Code, ANSI/NFPA 70. Termination of the supplementary equipment grounding conductor is permitted to be made to building steel, to a metal electrical raceway system, or to any grounded item that is permanently and reliably connected to the electrical service equipment ground.

Bare, covered, or insulated grounding conductors are acceptable. A covered or insulated grounding conductor shall have a continuous outer finish that is either green, or green with one or more yellow stripes.

The supplemental equipment grounding terminals are located on the rear of the BBP adjacent to the power connectors and on the rear of the rackmounted RFC. The mastmounted RFC has a ground lug mounted on the installation bracket.

E1 Interfaces

The E1 interface conforms to the ITU G.703 and G.704 electrical and signaling interfaces recommendations. Two interfacing configurations are available:

- 75Ω unbalanced BNC coaxial connectors.
- 120Ω balanced 15 pin / RJ48 connectors with the pinouts shown here.

15 Pin		RJ-48	
<u>Pin</u>	<u>Function</u>	<u>Pin</u>	<u>Function</u>
1	E1 Out ring	1	E1 Out ring
2	Frame ground	2	E1 Out tip
3	E1 In ring	3	N.C.
4	Frame ground	4	E1 In ring
5	N.C.	5	E1 In tip
6	N.C.	6	N.C.
7	N.C.	7	N.C.
8	N.C.	8	N.C.
9	E1 Out tip		
10	N.C.		
11	E1 In tip		
12	N.C.		
13	N.C.		
14	N.C.		
15	N.C.		

The 75Ω unbalanced interface provides two pair of 75Ω BNC connectors. The shield of the OUT coaxial connection is attached to earth ground. A jumper is provided to optionally connect the shield of the INPUT coaxial connection to ground as described in G.703. This jumper is located on the inside of the E1 interface board, between each of the two BNC connectors. The E1 module must be removed to access this option.

The 120Ω balanced interface provides two individual 120Ω 15-pin connectors.

Section 2 Installation

Three loopback functions are provided for diagnostic capability of each E1 interface. The local line loopback (Loop 1 as illustrated in Figure 2-1) loops the incoming E1 signal back out at the E1 framer. The remote link loopback (Loop 3 as illustrated in Figure 2-1) loops the E1 data back to the local end from the remote end. This allows a BERT to be run across the microwave link and back. The local link loopback (Loop 2 as illustrated in Figure 2-1) allows the local unit to loop E1 data back towards the remote end. The available loopback functions are illustrated in **Figure 2-1**.

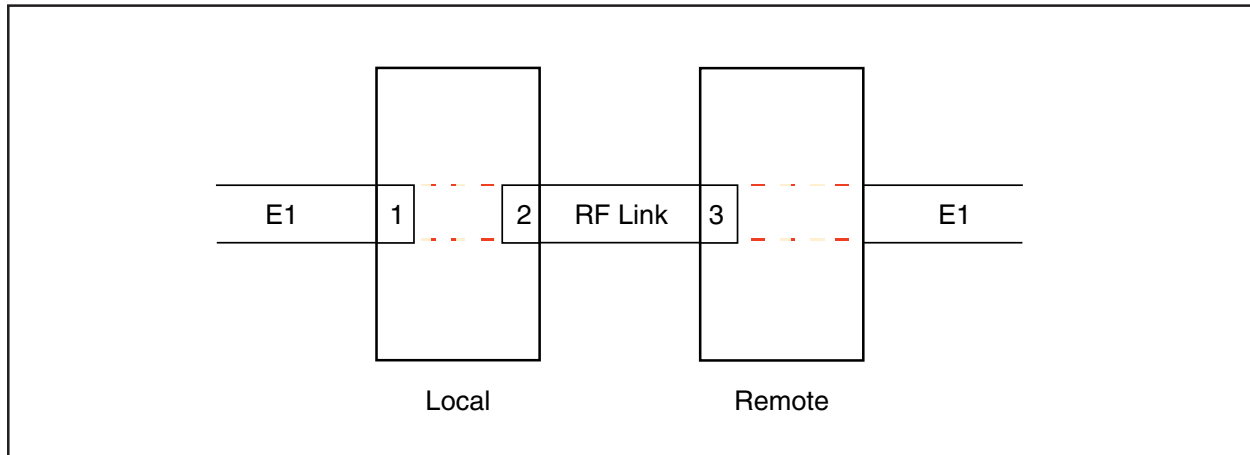


Figure 2-1. E1 Loopback Locations

LINK PLANNING

I M P O R T A N T

The appropriate transmitter power must be calculated as part of the link planning.

The factors that must be taken into account when planning a link are optimal received signal level, transmitter power, antenna feedline loss (each end), antenna gain (each end), free space path loss, and required fade margin.

I M P O R T A N T

The optimal signal level for the receiver is -60 dBm.

Section 2 Installation

Antenna Feedline Loss

Feedline loss is a function of feedline type and length. Feedline loss per 30.48 meters (100 feet) for several types of coax at IF and RF frequencies is detailed in the table below. The IF loss applies to BBP/RFC interconnection, and the RF loss applies to RFC/antenna interconnection. Cable manufacturers' specifications may vary.

Cable	IF Loss/100 feet (in dB)	2.4 GHz RF Loss/100 feet (in dB)	5.7 GHz RF Loss/100 feet (in dB)
RG58	5.7	80	N/A
RG8 (air)	2.7	20	N/A
RG8 (foam)	2	9	N/A
1/4" Coax	1.42	5.91	11.36
3/8" Coax	1.25	5.76	9.65
1/2" Coax	0.81	3.83	6.49
7/8" Coax	0.44	2.2	N/A
1 1/4" Coax	0.33	1.62	N/A
1 5/8" Coax	0.27	1.41	N/A
5.8 GHz Elliptical Waveguide	N/A	N/A	1.23

Antenna Gain

Best performance will result from the use of a parabolic dish antenna. Antenna gain is determined by the size of the dish, with typical figures detailed below. Dish manufacturers will be able to supply gains for other types of antenna.

Dish Diameter (in cm)	2.4 GHz Gain (in dBi)	5.8 GHz Gain (in dBi)
60	21	28.5
120	27	34.2
180	31	37.5
243	33	40.7
304	35	42.5
365	37	44.2

Section 2 Installation

Path Loss

The free space path loss is given by

$$Loss(dB) = 96.6 + 20 \log_{10} f + 20 \log_{10} D * 1.609344$$

where D is distance in kilometers

f is operating frequency in GHz

A tabulation of various path loss is given below.

2.4 GHz		2.4 GHz		5.8 GHz		5.8 GHz	
Link Distance (in miles)	Path Loss (in dB)	Link Distance (in miles)	Path Loss (in dB)	Link Distance (in miles)	Path Loss (in dB)	Link Distance (in miles)	Path Loss (in dB)
1	104	13	126	1	112	13	134
2	110	14	127	2	118	14	135
3	114	15	128	3	121	15	135
4	116	16	128	4	124	16	136
5	118	17	129	5	126	17	136
6	120	18	129	6	127	18	137
7	121	19	129	7	129	19	137
8	122	20	130	8	130	20	138
9	123	21	130	9	131	21	138
10	124	22	131	10	132	22	139
11	125	23	131	11	133	23	139
12	126	24	132	12	133	24	139

Path Availability

The availability of a path can be expressed by:

$$availability = (1 - C \times T \times 2.5 \times 10^{-6} \times f \times (D \times 1.609344)^3 \times 10^{-(F/10)}) \times 100\%$$

where C is the climate factor

T is the terrain factor

f is the frequency in GHz

D is the path length in kilometers

F is the fade margin in dB

Climate factors are given below.

<u>Climate</u>	<u>Climate Factor</u>
Very Dry	$\frac{1}{8}$
Temperate	$\frac{1}{4}$
Humid	$\frac{1}{2}$

Terrain factors are listed below.

<u>Terrain</u>	<u>Terrain Factor</u>
Smooth	4
Average	1
Mountainous	$\frac{1}{4}$

The nominal received signal level is -60 dBm. For help in link planning, use the path loss calculation worksheet below.

-	89 dBm / -87 dBm	Minimum Signal Power for 2.4 GHz / 5.8 GHz
+	_____	Transmitter Feedline Loss
-	_____	Transmitter Antenna Gain
+	_____	Path Loss
-	_____	Receiver Antenna Gain
+	_____	Receiver Feedline Loss
+	_____	Required Fade Margin
=	_____	(dBm) Transmitter Power Setting

SETTING THE TRANSMITTER POWER

The FCC specifies the maximum transmitter power that may be used for antennas of a given gain. FCC rules Part 15, Subpart 247 allow for a maximum power of 1 watt into antennae of a gain less than or equal to 6 dBi. For every 3 dB of gain over 6 dBi, the transmitter must be reduced by 1 dB. The following table lists the maximum transmitter power for given antennae gains. For the 5.8 GHz band, there is no reduction in transmitter output power required for antenna gains greater than 6 dBi.

<u>Antenna Gain</u>	<u>Power</u>
6 dBi	30 dBm (2.4 GHz, 1 watt output option)
12 dBi	28 dBm (2.4 GHz, 1 watt output option)
18 dBi	26 dBm (2.4 GHz, 1 watt output option)
24 dBi	24 dBm (2.4 GHz, 1 watt output option)
30 dBi	22 dBm (2.4 GHz, 1 watt output option)
36 dBi	20 dBm (TRACER, 2.4 GHz, 100 mw output option)

The transmitter power is set by way of a momentary switch on the front panel of the BBP or via the configuration page of the VT100 interface. The RFC must be attached by way of the IF cable during this operation. Attach an RF power meter to the N-type antenna connector on the RFC, and adjust the power by way of the front panel switch or VT100 until the desired transmitter power is obtained. If a mastmount RF converter is used, the transmitter power adjustment should be made before the RFC is installed on the mast.

2.4 GHZ, 1 WATT TRANSMITTER OPTION

The 2.4 GHz TRACER model is offered with a standard +20 dBm power output or optional 1 watt power output option. The 1 watt option provides an add-on amplifier that is installed in the rackmount RFC chassis. This amplifier is connected to the transmit cable of the RFC module and amplifies the +20 dBm output power to a maximum level of +30 dBm (1 watt), factory set to +27 dBm. The output power is proportional to the output level from the RFC module. The level is adjusted via the Baseband Processor front panel or VT100 terminal.

Because the 1 watt amplifier is frequency specific, the frequency plans can not be manually changed by swapping the TX and RX cables in the RFC chassis as described in the following section. If a frequency reversal is required, the rackmount RFCs will have to be relocated to the opposite ends of the microwave path. The 1 watt option is only available for the 2.4 GHz, rackmount RF converter.

Section 2 Installation

SETTING THE RFC FREQUENCY PLAN ON NON 1 WATT 2.4 GHz MODELS

The frequency plan designates on which frequencies the TRACER transmits and receives. Plan A corresponds to a transmitting (Tx) center frequency of 2422 MHz and a receive (Rx) center frequency of 2462 MHz. Plan B corresponds to a Tx center frequency of 2462 MHz and a Rx center frequency of 2422 MHz. Shipment of a link consists of one RFC set to Plan A and the other set to Plan B unless specified otherwise. The RFC plan can, however, be changed in the field if required. This procedure involves reconfiguring the RFC interconnect cables.

For rackmounted systems, do the following to reconfigure the RFC interconnect:

1. Remove the six screws which retain the RFC cover and remove the cover.
2. The RF unit may be identified by following the connection from the port labelled “IF” on the rear of the RFC. This connection terminates at the RF unit. The diplexer may be identified by following the connection from the “Antenna” port on the rear of the RFC. This connection terminates at the diplexer, illustrated in **Figure 2-2**.

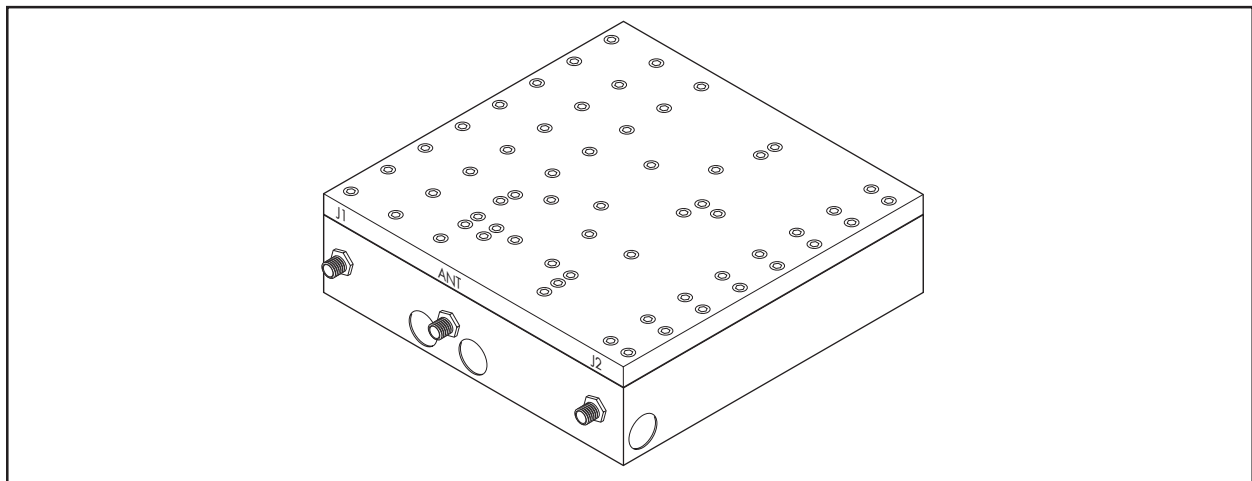


Figure 2-2. 2.4 GHz Diplexer

3. Unscrew the cable assemblies from the ports labelled “Tx” and “Rx” on the RFC, and the ports labelled “J1” and “J2” on the diplexer, depending on the frequency Plan (Plan A or Plan B).
4. Unscrew the cable assembly from the port labelled “ANT” on the diplexer.
5. Remove the four screws from the bottom of the RFC that hold the diplexer in place.
6. Turn the diplexer over revealing the opposite frequency plan (from Plan A to Plan B, or vice versa).
7. Realign the diplexer with the screw holes and replace the four screws that attach it to the bottom of the RFC.
8. Reattach the loose cable assembly (from step 4) to the port labelled “Antenna” on the diplexer. Minimum bend radius on cables is 3/4 inches (2 cm). Exercise care in handling and forming bends in these cables.

9. Reattach the cable assemblies from the ports labelled “Tx” and “Rx” on the RFC and the ports labelled “J1” and “J2” on the diplexer. Cable connections should be aligned to each other as follows.

Plan A

RF converter Tx connected to
Diplexer Port J1

RF converter Rx connected to
Diplexer Port J2

Plan B

RF converter Tx connected to
Diplexer Port J2

RF converter Rx connected to
Diplexer Port J1

10. Replace and secure the RFC cover.

For mastmounted systems, do the following to reconfigure the RFC interconnect:

1. Remove the lid of the mast RFC.
2. Disconnect the three cables attached to the diplexer. The diplexer may be identified by following the antenna connector to the middle connector of the diplexer. Leave the cables in the same positions.
3. Remove the two screws securing the diplexer and rotate the diplexer to reveal the opposite frequency plan label.
4. Reinstall the two screws and reattach the cables in the same positions – Minimum bend radius on cables is 3/4 inches (2 cm). Exercise care in handling and forming bends in these cables.
5. Reinstall the lid of the mast RFC.

Section 2 Installation

SETTING THE RFC FREQUENCY PLAN ON 5.8 GHz MODELS

The 5.8 GHz RFC operates on Plan A, Tx = 5747 MHz center frequency, Rx = 5827 MHz center frequency or Plan B, Tx = 5827 MHz center frequency, Rx = 5747 MHz center frequency. See **Figure 2-3** for an illustration of the 5.8 GHz diplexer.

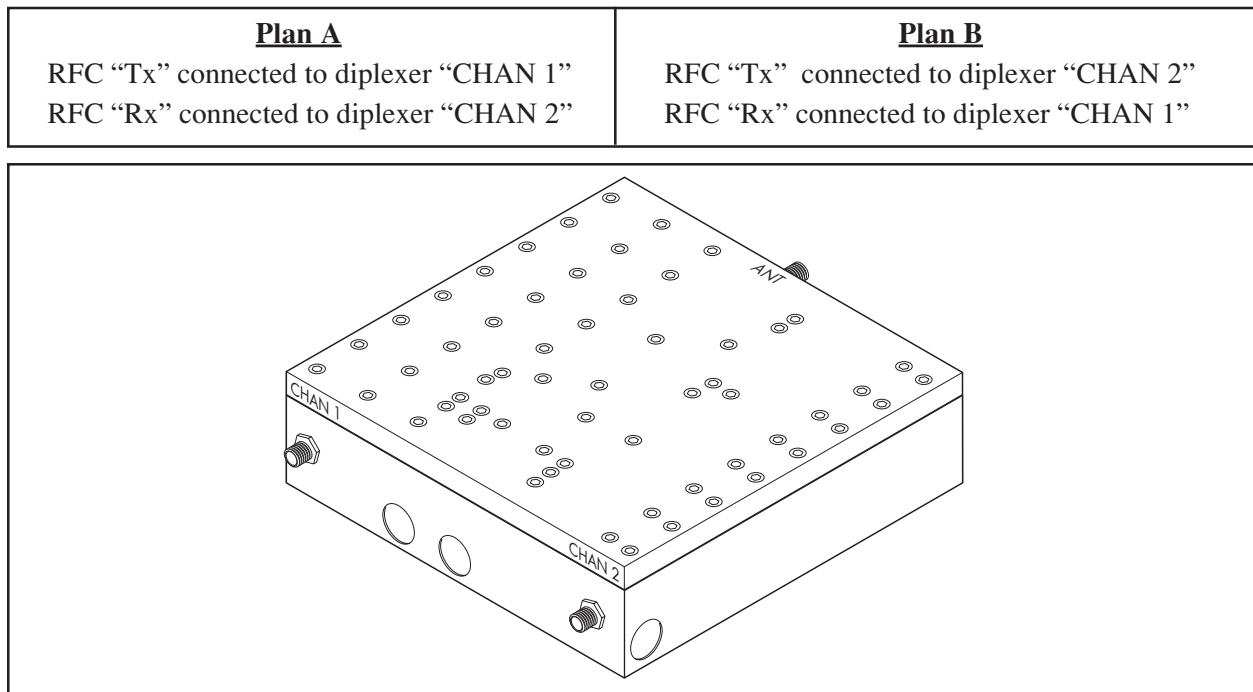


Figure 2-3. 5.8 GHz Diplexer

Directions for Changing the Frequency Plan on the Rackmount RFC

1. Remove RFC top cover by removing six screws.
2. Disconnect the cables at the “Tx” and “Rx” RFC module ports. Swap and reconnect these two cables to the RFC module ports. Minimum bend radius on these cables is 3/4 inch (2 cm). Use care in handling and forming bends in these cables.
3. Reinstall the RFC top cover with the six screws previously removed.

Directions for Changing the Frequency Plan on the Mastmount RFC

1. Remove the lid of the Mast RFC.
2. Disconnect the two cables at both ends; at the diplexer and RFC module.
3. Swap and reconnect these cables. Minimum bend radius on these cables is 3/4 inch. Use care in handling and forming bends in these cables.
4. Reinstall the lid of the Mast RFC.

CONNECTING THE BBP AND THE RFC

The BBP and the RFC are connected by an IF cable, either supplied by ADTRAN (for rackmount assembly) or by the customer (for mastmount assembly). This single connection provides everything the RFC requires. The cable assembly attaches to the ports labeled “IF” on the BBP and the RFC.

CAUTION

When connecting an RF converter (RFC) to a Baseband Processor (BBP), verify that the connector labeled “IF” on the rear panel of the Baseband Processor is connected via coax to the connector labeled “IF” on the rear panel of the RF converter. Connecting the Baseband Processor to the incorrect connector on the RF converter will cause the internal 1 amp 250 V fuse to blow in the Baseband Processor. The fuse is accessed by removing the top of the Baseband Processor, and is located on the left side of the chassis when facing the front panel.

APPLYING POWER

If the ADTRAN-supplied tabletop power source is used, simply plug it into the circular receptacle located in the “DC Power” area on the rear of the BBP. If a source of 21 to 60 volts DC (30 watts), either polarity referenced to ground is available, it may be attached to the terminal block located on the rear of the BBP. Ground (or common) should be applied to the terminal with the ground symbol (Terminal 1) and positive or negative voltage should be applied to the “+/-” terminal (Terminal 3). When a positive voltage reference power supply is used (+24V for example), connect the ground (or “-”) cable from the power supply to the ground terminal (Terminal 1) and the “+” cable from the power supply to the “+/-” terminal (Terminal 3). When a negative reference power supply is used (-48V for example), connect the ground cable from the power supply to the ground terminal (Terminal 1) and the “-” cable from the power supply to the “+/-” terminal (Terminal 3).

CAUTION

Power sources must not be attached to both the circular connector and the terminal blocks at the same time or damage will occur.

AUTOMATIC BBP FREQUENCY PLAN

Upon the initial application of power, the BBP will default to the factory-preset Frequency Plan, or to the Frequency Plan determined by the cable configuration of the RFC. The LED will indicate which frequency plan is active. On subsequent reboots, such as after a loss of power, the BBP will default to the most recently-used Plan setting.

SPREADING CODE

The spreading code for each end must be the same. The choice of operating code is selectable by the operator or the installer. TRACER is shipped in a matched (default) configuration.

WARNING

Spreading code to be set through the VT100 interface from the other end of the link. If the new spreading code is unknown, step the local end of the link through all other spreading codes until the link is reestablished.

Section 2 Installation

CO-LOCATING MULTIPLE SYSTEMS

When multiple transmitters are to be co-located (installed in the same equipment room or on the same tower), it is advised to set all systems as follows:

1. If more than one system in the same frequency band is transmitting from the same location, set the antenna polarity of one system *horizontal* and the other system(s) *vertical*. (The antennas should be marked as to which mounting position is vertical or horizontal.) This will provide approximately 30 dB of isolation between the different antennas.
2. If more than one TRACER system is installed, set the co-located transmitters to the same frequency plan (example: Plan A or Plan B) and set each to a different spreading code. This keeps the transmitters on the additional system(s) from interfering with the co-located receiver(s).
3. If the systems are from different manufacturers, set the transmit frequencies as close as possible with different spreading codes. Other manufacturers may not use the exact frequency plans as the TRACER system, but keeping the frequencies close will reduce the probability of the transmitter(s) interfering with the co-located receiver(s).

ANTENNA ALIGNMENT

After the transmitter power for each end has been adjusted and the BBP and RFC have been installed and connected, the antenna should be connected to the RFC via the feedline. Verify that both antennas are arranged on the same polarity: vertical or horizontal. The antennas should be aimed toward one another as precisely as possible and the received signal strength indicator (RSSI) voltage measured. The RSSI voltage is a function of the signal strength at the receiver and is used to measure the received signal strength. RSSI varies approximately from 0 to >4 volts, with 0 volts corresponding to a weaker received signal and 4 volts or better corresponding to a stronger received signal.

NOTE

The voltage level present at the RSSI test point represents a relative signal level of receive strength from the far end. No direct correlation can be made between RSSI voltage level and actual receive level in dBm. This test point is provided to assess relative signal level for alignment of antenna.

RF LOW

The “RF Low” LED indicates that the received signal is within 10dB of the minimum received signal strength (RSL < approximately -80 dBm). If this indicator is on, the link performance may be marginal. The antennas should be peaked in azimuth and elevation until the desired signal level is achieved. RSSI may be monitored on either the RF unit or the front of the BBP. If the received signal is too strong and RSSI reaches a maximum such that the peak cannot be discerned, then the transmitter on the far end should be turned down.

At this point the radio link should be operational. Proper operation can be determined by the status of the “LINK DOWN” LED. If this LED is *on*, the link is *not* operational. If this LED is not on, the link is operating. Certain types of interference can cause one end of a path to operate and the other end to fail. In some instances, this may be corrected by swapping the frequency plan at each end, thus avoiding the interference if it is stronger at one end than the other. Changing the spreading code at each end may also allow interference to be mitigated.

REMOTE BERT

The TRACER includes a Bit Error Rate Tester (BERT) to verify that the installed system is operating correctly. When the “Remote Test” button is pushed on the local BBP, the remote end will send a BERT pattern for approximately ten seconds. The “Remote TST” indicator will turn yellow and remain on for the duration of the test. If no bit errors are detected, the “Remote TST” indicator will turn off. If any bit errors are detected, the “Remote Fail” indicator will turn red. This test should be run after the radio link has been aligned. If the test fails, refer to Section 4, “Troubleshooting,” for guidance.

ALARM CONTACTS

Two classes of alarm, MAJOR and MINOR, are provided. A MAJOR alarm is signaled when the microwave path is not operational. A MINOR alarm is activated when any of the following conditions are detected at one of the E1 interfaces:

- Loss of Signal
- Code Violation
- CRC error
- Framing Error
- Remote Error
- UA1

Both normally-open and normally-closed contacts are provided for each alarm class. Access is provided by a six-position terminal strip on the baseband processor.

Section 2 Installation

VT100 USER INTERFACE

The TRACER may be accessed with a VT100 compatible terminal set to 9600 bits per second, 8 data bits, and no parity, connected to the RS-232 port on the back of the unit. Once a terminal is connected, pressing the “Ctrl” and “L” keys will redraw the current screen. If password access has been enabled, then press “Enter” or “Return” in order to see the “Enter Password:” message. TRACER is shipped with password protection disabled.

RS-232 INTERFACE

The TRACER has an RS-232 interface for system management via an attached VT100 terminal, personal computer, or modem. The RS-232 port is configured as a DCE with the following pin assignments:

Signal	Pin	
<u>Name</u>	<u>Number</u>	<u>Direction</u>
TXD	2	To TRACER
RXD	3	From TRACER
RTS	4	To TRACER
CTS	5	From TRACER
DSR	6	From TRACER
Ground	7	

CABLE CONNECTIONS

The cable connections required for various configurations are detailed in Appendix A of this manual.

PASSWORD

TRACER provides optional password protection of the terminal interface. If enabled, a password prompt is presented at power-up, reboot, or after thirty minutes of inactivity on the terminal. The default configuration is “No password.” Password protection is enabled via the configuration menu. The password is also set via the configuration menu.

If the password is forgotten, physical access to TRACER is required to access the terminal interface. The password may be bypassed by holding in the LPBK A button while the system is rebooted. This will bring up the terminal interface and allow the password to be changed or disabled via the configuration screen.

CAUTION

This procedure is service-affecting.

Main Menu Screen

Pressing “M” on any screen will take the user to the Main Menu (see **Figure 3-2**), from which the subsequent screens can be accessed.

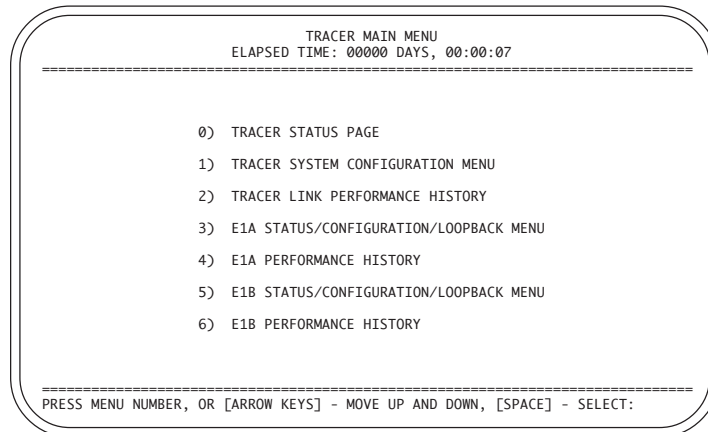


Figure 3-2. Main Menu Screen

To make changes to any of the items in the System Configuration Menu (**Figure 3-3**), use the keyboard Arrow keys to highlight desired option and make change.

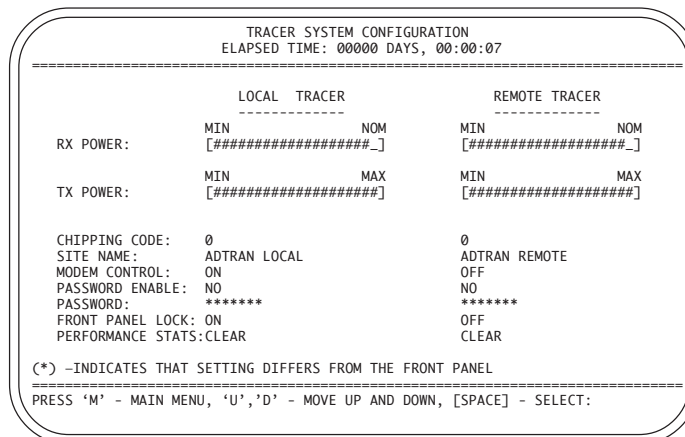


Figure 3-3. System Configuration Menu Screen

Set Tx Power allows the transmitter power to be adjusted.

Set Chipping Code allows the chipping code to be selected. Each end of the link must be configured for the same chipping code.

Site ID allows a string of up to 32 characters to be entered as a site identifier.

Enable/Disable Password allows password protection to be enabled or disabled. The default setting is Disabled.

Change Password allows the password to be set.

Performance Stats resets all the error counters.

Section 3 Operation

E1 Status / Configuration / Loopback

The status of the two E1 interfaces is displayed on this screen. Information such as alarm status, signaling, line coding, and CRC4 Detection framing type are shown. From this screen the E1 can be configured for a particular application by using the keyboard cursor keys to highlight the desired option and perform the change. A local or remote loopback may be activated or deactivated from this screen. The E1A Status Screen is illustrated in **Figure 3-4**, and the E1B Status Screen is illustrated in **Figure 3-5**.

```

E1A STATUS/CONFIGURATION/LOOPBACK

RX ==>|----|>----->----->-----{ RF }----->----->----->|+ |==> TX
| | LOCAL { / \ / \ / \ / \ } REMOTE | | |
TX <==|----|<-----<-----<-----{ UP }-----<-----<-----<|+ |X== RX

LOCAL TRACER          REMOTE TRACER
-----
E1 INTERFACE ALARMS: UA1 RMT LOS      UA1   LOS
                    OOF CV  CRC

E1 INTERFACE TYPE:   120 OHM          75 OHM

ALARM REPORTING:    ENABLED            DISABLED
CRC4 DETECTION:     ENABLED            ENABLED
SIGNALING:          CAS                 CAS
LINE CODE:          HDB3                HDB3

LOOP/NORMAL STATE:  NORMAL             NORMAL

(*) -INDICATES THAT SETTING DIFFERS FROM THE FRONT PANEL
=====
PRESS 'M' - MAIN MENU, 'U','D' - MOVE UP AND DOWN, [SPACE] - SELECT:

```

Figure 3-4. E1A Status Screen

```

E1B STATUS/CONFIGURATION/LOOPBACK

RX ==>|----|>----->----->-----{ RF }----->----->----->|+ |==> TX
| | LOCAL { / \ / \ / \ / \ } REMOTE | | |
TX <==|----|<-----<-----<-----{ UP }-----<-----<-----<|+ |X== RX

LOCAL TRACER          REMOTE TRACER
-----
E1 INTERFACE ALARMS: UA1 RMT LOS      UA1   LOS
                    OOF CV  CRC

E1 INTERFACE TYPE:   120 OHM          75 OHM

ALARM REPORTING:    ENABLED            DISABLED
CRC4 DETECTION:     ENABLED            ENABLED
SIGNALING:          CAS                 CAS
LINE CODE:          HDB3                HDB3

LOOP/NORMAL STATE:  NORMAL             NORMAL

(*) -INDICATES THAT SETTING DIFFERS FROM THE FRONT PANEL
=====
PRESS 'M' - MAIN MENU, 'U','D' - MOVE UP AND DOWN, [SPACE] - SELECT:

```

Figure 3-5. E1B Status Screen

Link Performance History

The screen in **Figure 3-6** presents detailed error statistics for the RF link. The data is presented as RFC (Radio Frequency Converter) and LNK (RF Link) representing seconds out of service for each. RFC represents the communications channel between the BBP and RFC via the IF interconnect cable. LNK represents errored seconds received on the wireless link and is generally an indication of path or interference problems. Error History for the most recent 24 hours is recorded in 15-minute increments, and 24-hour totals are recorded for the most recent 7 days. To view the next eight hours (32 15-minute intervals) of performance history, press “N”. To view the previous eight hours, press “P”. This information is available for both ends of the link.

LINK PERFORMANCE HISTORY										
24 HOUR REGISTERS				15 MINUTE REGISTERS						
--RFC--	--LNK--	--RFC--	--LNK--	<-->	--RFC--	--LNK--	--RFC--	--LNK--	--RFC--	--LNK--
00000	00000	00000	00000		000	000	000	000		
-1: -----	-----	-----	-----	- 1: ---	---	---	---	---	-17: ---	---
-2: -----	-----	-----	-----	- 2: ---	---	---	---	---	-18: ---	---
-3: -----	-----	-----	-----	- 3: ---	---	---	---	---	-19: ---	---
-4: -----	-----	-----	-----	- 4: ---	---	---	---	---	-20: ---	---
-5: -----	-----	-----	-----	- 5: ---	---	---	---	---	-21: ---	---
-6: -----	-----	-----	-----	- 6: ---	---	---	---	---	-22: ---	---
-7: -----	-----	-----	-----	- 7: ---	---	---	---	---	-23: ---	---
	LOCAL		REMOTE	- 8: ---	---	---	---	---	-24: ---	---
				- 9: ---	---	---	---	---	-25: ---	---
				-10: ---	---	---	---	---	-26: ---	---
				-11: ---	---	---	---	---	-27: ---	---
				-12: ---	---	---	---	---	-28: ---	---
				-13: ---	---	---	---	---	-29: ---	---
				-14: ---	---	---	---	---	-30: ---	---
				-15: ---	---	---	---	---	-31: ---	---
				-16: ---	---	---	---	---	-32: ---	---
					LOCAL		REMOTE		LOCAL	REMOTE

=====

PRESS 'M' - MAIN MENU, 'P' - PREVIOUS PAGE, 'N' - NEXT PAGE:

Figure 3-6. Link Performance History Screen

Section 3 Operation

E1A Statistics Page

The screen in **Figure 3-7** presents detailed error statistics for E1A. The data is presented as Errored Seconds and Severely Errored Seconds. Error History for the most recent 24 hours is recorded in 15-minute increments, and 24-hour totals are recorded for the most recent 7 days. To view the next eight hours (32 15-minute intervals) of performance history, press “N”. To view the previous eight hours, press “P”. This information is available for both ends of the link.

E1A PERFORMANCE HISTORY																			
24 HOUR REGISTERS				15 MINUTE REGISTERS															
---	ES	---	SES	---	ES	---	SES	---	ES	---	SES	---	ES	---	SES	---	ES	---	SES
00000	00000	00000	00000	<-->	000	000	000	000	---	---	---	---	---	---	---	---	---	---	---
-1:	-----	-----	-----		- 1:	---	---	---		-17:	---	---	---						
-2:	-----	-----	-----		- 2:	---	---	---		-18:	---	---	---						
-3:	-----	-----	-----		- 3:	---	---	---		-19:	---	---	---						
-4:	-----	-----	-----		- 4:	---	---	---		-20:	---	---	---						
-5:	-----	-----	-----		- 5:	---	---	---		-21:	---	---	---						
-6:	-----	-----	-----		- 6:	---	---	---		-22:	---	---	---						
-7:	-----	-----	-----		- 7:	---	---	---		-23:	---	---	---						
	LOCAL		REMOTE		- 8:	---	---	---		-24:	---	---	---						
					- 9:	---	---	---		-25:	---	---	---						
					-10:	---	---	---		-26:	---	---	---						
					-11:	---	---	---		-27:	---	---	---						
					-12:	---	---	---		-28:	---	---	---						
					-13:	---	---	---		-29:	---	---	---						
					-14:	---	---	---		-30:	---	---	---						
					-15:	---	---	---		-31:	---	---	---						
					-16:	---	---	---		-32:	---	---	---						
						LOCAL		REMOTE			LOCAL		REMOTE						

PRESS 'M' - MAIN MENU, 'P' - PREVIOUS PAGE, 'N' - NEXT PAGE:

Figure 3-7. E1A Statistics Screen

E1B Statistics Page

The screen in **Figure 3-8** presents detailed error statistics for E1B. The data is presented as Errored Seconds and Severely Errored Seconds. Error History for the most recent 24 hours is recorded in 15-minute increments, and 24-hour totals are recorded for the most recent 7 days. To view the next eight hours (32 15-minute intervals) of performance history, press “N”. To view the previous eight hours, press “P”. This information is available for both ends of the link.

E1B PERFORMANCE HISTORY																			
24 HOUR REGISTERS				15 MINUTE REGISTERS															
---	ES	---	SES	---	ES	---	SES	---	ES	---	SES	---	ES	---	SES	---	ES	---	SES
00000	00000	00000	00000	<-->	000	000	000	000	---	---	---	---	---	---	---	---	---	---	---
-1:	-----	-----	-----		- 1:	---	---	---		-17:	---	---	---						
-2:	-----	-----	-----		- 2:	---	---	---		-18:	---	---	---						
-3:	-----	-----	-----		- 3:	---	---	---		-19:	---	---	---						
-4:	-----	-----	-----		- 4:	---	---	---		-20:	---	---	---						
-5:	-----	-----	-----		- 5:	---	---	---		-21:	---	---	---						
-6:	-----	-----	-----		- 6:	---	---	---		-22:	---	---	---						
-7:	-----	-----	-----		- 7:	---	---	---		-23:	---	---	---						
	LOCAL		REMOTE		- 8:	---	---	---		-24:	---	---	---						
					- 9:	---	---	---		-25:	---	---	---						
					-10:	---	---	---		-26:	---	---	---						
					-11:	---	---	---		-27:	---	---	---						
					-12:	---	---	---		-28:	---	---	---						
					-13:	---	---	---		-29:	---	---	---						
					-14:	---	---	---		-30:	---	---	---						
					-15:	---	---	---		-31:	---	---	---						
					-16:	---	---	---		-32:	---	---	---						
						LOCAL		REMOTE			LOCAL		REMOTE						

PRESS 'M' - MAIN MENU, 'P' - PREVIOUS PAGE, 'N' - NEXT PAGE:

Figure 3-8. E1B Statistics Screen

GENERAL

If you experience a problem with the TRACER system, check to ensure that all connectors, coaxial cables, antennas, and E1s are all properly connected; and that the system configuration ensures proper transmit and receive levels for the RF equipment. Then, if the problem persists, follow the actions recommended in this section. For further assistance, call ADTRAN Technical Support at (011) 256-963-8716.

NOTE

Each TRACER is completely system-tested and all specifications verified prior to shipment. Most problems on a new link tend to have installation-related solutions.

PROBLEM DESCRIPTIONS AND RECOMMENDED ACTIONS

Each problem described below is followed by a list of Possible Causes, each of which is followed by a number (or numbers) corresponding to a Recommended Action (or Actions).

IMPORTANT

If problems persist after you have followed the Recommended Actions, contact ADTRAN Technical Support at (011) 256-963-8716.

Troubleshooting Using the Front Panel Indicators

Link Down Light is Lit

This alarm will activate when the RF link is not operational.

Possible Cause	Recommended Action (see list below)
• The RF link is down.	1-10
• The RX power is below the specified receiver sensitivity.	1-4,7-10
• The far-end transmitter is off, or is transmitting low power	1-4,7-10
• The RF path is not aligned.	1,2,10
• Water is in the antenna feedhorn or connectors.	1,4
• Both units are set to the same frequency plan.	5,10
• Both units are not set to the same P/N code.	6
• The 1 amp 250 V fuse in the BBP is blown.	8
• The connection between the BBP and the RFC is faulty.	1,7-10
• The connection between the RFC and the antenna is faulty.	1,7-10
• The BBP or RFC is faulty.	10

Section 4 Troubleshooting

I M P O R T A N T

If problems persist after you have followed the Recommended Actions, contact ADTRAN Technical Support at (011) 256-963-8716.

Recommended Actions:

1. Check the RX power using the VT100 user interface or RSSI voltage.
2. Check the far-end transmitter for operation and proper transmit power.
3. Check the RF path using a spectrum analyzer or RSSI voltages for proper alignment. Have path professionally re-aligned and check system path engineering.
4. Check the antenna feedhorn and all outdoor connections for water.
5. Change the frequency of one radio through the VT100 user interface or front panel button.
6. Set both units to the same P/N code.
7. Check all connections between the BBP, the RFC, and the antenna.
8. Check the fuse on the IF board. This fuse is accessed by removing the top of the baseband processor, and is located on the left side of the chassis when facing the front panel. If this fuse is open, verify that the coax connections are correctly installed and check the BBP to RFC coaxial cable for a short.
9. Check the IF and RF cables for shorts.
10. Check the connections inside the mastmount or rackmount RFC.
11. Replace the RFC.

CV/CRC Light on E1A or E1B is Lit – when CRC is enabled

The CV indicator will activate when the incoming E1 stream presents Code Violations or a CRC4 error.

Possible Cause	Recommended Action (see list below)
<ul style="list-style-type: none"> • The incoming E1 contains CVs or CRC errors • The line codes between E1 equipment and the TRACER are incompatible • The incoming E1 lines have CRC4 error checking turned off 	<p>1</p> <p>2</p> <p>3</p>

Recommended Actions:

1. Check the incoming E1 signal for CVs and CRCs using an E1 test set.
2. Correct the line code on the TRACER or E1 equipment.
3. Turn off CRC4 detection on TRACER.

IMPORTANT

If problems persist after you have followed the Recommended Actions, contact ADTRAN Technical Support at (011) 256-963-8716.

“LBK-A” or “LBK-B” is Lit

This indicator will activate when a software or front panel command E1 loopback has been established.

Possible Cause	Recommended Action (see list below)
• A loopback has been commanded from the VT100 user interface.	1,2
• The “LBK-A” or “LBK-B” button has been pressed.	1,2

Recommended Actions:

1. Through the VT100 user interface, deactivate the loopback in the Loopback Menu.
2. Press the “LBK-A” or “LBK-B” button to deactivate the loopback.

LOS/OOF Light on E1A or E1B

The LOS/OOF indicator will flash when an out of frame error has occurred.

This indicator will remain on (solid) if a loss of signal has occurred on the E1.

Possible Cause	Recommended Action (see list below)
• TRACER is receiving no E1 signal	1,2, 3, 4, 5
• The connection at the E1 input or E1 equipment is faulty	6
• A compatibility or set up problem exists between TRACER and the E1 equipment.....	7

Recommended Action

1. Reset the E1 equipment and verify operation.
2. Verify the presence of an E1 signal using an E1 test set.
3. Check the far-end equipment for alarms or an UA1 condition.
4. Check the E1 connections at the far-end equipment.
5. Reset the far-end equipment.
6. Verify that all cables and connectors are properly wired.
7. Check CCS/CAS settings of all equipment to assure compatibility.

Section 4 Troubleshooting

I M P O R T A N T

If problems persist after you have followed the Recommended Actions, contact ADTRAN Technical Support at (011) 256-963-8716.

ALM is Lit

When the ALM light is on (solid), it indicates reception of an UA1 signal at the E1 interface. If the “ALM” is blinking, it indicates an RRA alarm has been received.

Possible Cause	Recommended Action (see list below)
<ul style="list-style-type: none"> • TRACER has received an unframed all 1s signal from the E1 input..... 1 • TRACER has received a Received Remote Alarm (RRA) signal from the E1 input 1 	<p>Recommended Action</p> <ol style="list-style-type: none"> 1. Check E1 equipment for error conditions.

No “Power” Light

Possible Cause	Recommended Action (see list below)
<ul style="list-style-type: none"> • DC voltage is not applied 1,2,4 • The polarity of the power connection is reversed 2 • The AC transformer is not functioning properly 3,4 • The AC transformer is not connected to the DC jack on the BBP, or not connected to AC outlet 3,4 	

Recommended Actions:

1. Verify that the DC voltage is between 21-60 VDC (\pm).
2. Verify that negative voltage is applied to the negative terminal, and positive voltage applied to the positive terminal.
3. Verify that the “Power” light is lit on the AC transformer.
4. Verify that the AC transformer is connected to an AC power cord on the transformer and connected to the DC jack on the BBP. Verify that the AC power cord is connected to an AC outlet. Verify that the AC outlet has proper AC voltage present.

Section 4 Troubleshooting

IMPORTANT

If problems persist after you have followed the Recommended Actions, contact ADTRAN Technical Support at (011) 256-963-8716.

“Test” Light is Lit or Blinking

The test alarm will remain on (solid) during power-up, indicating a self-test is in progress. The light will flash or remain on (solid) if the self-test fails.

Possible Cause	Recommended Action (see list below)
• One-flash interval indicates a RAM test failure.	1
• Two-flash interval indicates an internal mux failure.	1
• Three-flash interval indicates the E1-A framer failed.	1
• Four-flash interval indicates the E1-B framer failed.	1
• Five-flash interval indicates a DSP failure.	1
• On (solid) indicates a faulty internal component.	1

Recommended Actions:

1. Replace the BBP.

“TST” Light is Lit After Pressing “Remote Test” Button

The Remote Test light will activate during a remote test in progress. The Remote Test performs a 10-second bit error rate test (BERT) over the RF link to the far-end.

Possible Cause	Recommended Action (see list below)
• A Remote Test has been activated from the front panel “Remote Test” button or the VT100 user interface.	1

Recommended Actions:

1. Allow the remote test to complete. If the Remote Test Fail light does not activate, the remote test passed. If the Remote Test Fail light activates, see section on FAIL light is lit after pressing Remote Test button.

Section 4 Troubleshooting

I M P O R T A N T

If problems persist after you have followed the Recommended Actions, contact ADTRAN Technical Support at (011) 256-963-8716.

“Fail” Light is Lit After Pressing “Remote Test” Button

The Remote Fail light will activate after a Remote Test has failed.

Possible Cause	Recommended Action (see list below)
<ul style="list-style-type: none"> • The 10-second BERT has failed over the RF link to the far-end. 1 • The RX power may be below the specified receiver sensitivity 1 	

Recommended Actions:

1. Verify that the “RF Low” light is off.

“RF Low” Light is On

This alarm will activate if the RX power is below approximately -80 dBm.

Possible Cause	Recommended Action (see list below)
<ul style="list-style-type: none"> • The RX power is below approximately -80 dBm..... 1-5,7,8 • The far-end transmitter is off, or is transmitting low power. 2-5,7,8 • The RF path is not aligned. 3,8 • Water is in the antenna feedhorn or connectors. 4,8 	

Recommended Actions:

1. Check the far-end transmitter for operation and proper transmit power.
2. Check the RF path using a spectrum analyzer or RSSI voltages for proper alignment. Have path professionally re-aligned and check system path engineering.
3. Check the antenna feedhorn and all outdoor connections for water.
4. Check all connections between the BBP, the RFC, and the antenna.
5. Check the IF and RF cables for shorts.
6. Check the connections inside the mastmount or rackmount RFC.
7. Replace the RFC.

IMPORTANT

If problems persist after you have followed the Recommended Actions, contact ADTRAN Technical Support at (011) 256-963-8716.

Troubleshooting Using the VT100 User Interface

This section provides information for troubleshooting the Alarm Menu on the VT100 user interface. The conditions present in the Alarm Menu are software indications and should match the front panel LED indications.

LOS Alarm

The LOS alarm is indicated on the E1A or E1B Status/Configuration/Loopback page. This alarm is the same as an LOS alarm on the front panel.

Possible Cause	Recommended Action (see list below)
• No E1 signal or a degraded E1 signal is present at the E1 input.	1,2
• The connection at the E1 input or E1 equipment is faulty.	2

Recommended Actions:

1. Verify the presence of an E1 signal at the E1 monitor jack using an E1 test set.
2. Verify that all cables and connectors are correctly wired.

CV Alarm

The CV alarm is indicated on the E1A or E1B Status/Configuration/Loopback page.

Possible Cause	Recommended Action (see list below)
• The incoming E1 contains CVs or errors.	1
• The line codes between the E1 equipment and the TRACER are incompatible.	2

Recommended Actions:

1. Check the incoming E1 signal for CVs using an E1 test set.
2. Correct the line code on the TRACER or E1 equipment.

Section 4 Troubleshooting

I M P O R T A N T

If problems persist after you have followed the Recommended Actions, contact ADTRAN Technical Support at (011) 256-963-8716.

OOF Alarm

The OOF alarm is indicated on the E1A or E1B Status/Configuration/Loopback page.

Possible Cause	Recommended Action (see list below)
<ul style="list-style-type: none"> • The E1 signal has lost framing sync 1 • The line codes between the E1 equipment and the TRACER are incompatible. 2 	

Recommended Actions:

1. Verify the presence of an E1 signal at the E1 monitor jack using an E1 test set.
2. Verify that all cables and connectors are correctly wired.

CRC Alarm

The CRC alarm is indicated on the E1A or E1B Status/Configuration/Loopback page.

Possible Cause	Recommended Action (see list below)
<ul style="list-style-type: none"> • The incoming E1 signal is not configured for CRC4 error checking 1 	

Recommended Actions:

1. Turn off CRC4 detection in the E1A or E1B Status/Configuration/Loopback Menu.

RMT Alarm

This alarm is indicated on the E1A or E1B Status/Configuration/Loopback page.

Possible Cause	Recommended Action (see list below)
<ul style="list-style-type: none"> • The far-end equipment is in an LOS condition and transmitting a RMT alarm 1,2,3 	

I M P O R T A N T

If problems persist after you have followed the Recommended Actions, contact ADTRAN Technical Support at (011) 256-963-8716.

Recommended Actions:

1. Check the far-end equipment for alarms or a LOS condition.
2. Check the E1 connections at the far-end equipment.
3. Reset the far-end equipment.

UA1 Alarm

This alarm is indicated on the E1A or E1B Status/Configuration/Loopback page.

Possible Cause**Recommended Action
(see list below)**

- The E1 equipment is sending unframed all 1's **1,2**

Recommended Actions:

1. Reset the upstream equipment and verify normal operation.
2. Verify the presence of an E1 signal at the E1 monitor jack using an E1 test set.

Section 4 Troubleshooting

I M P O R T A N T

If problems persist after you have followed the Recommended Actions, contact ADTRAN Technical Support at (011) 256-963-8716.

Code Sync Status

The Code Sync Status will indicate NO on the TRACER System Status page when the link is down or not operational. The Code Sync Status will indicate NO when data synchronization has not been achieved between each end of the RF link.

Possible Cause	Recommended Action (see list below)
• The RF link is down	1-10
• The RX power is below the specified receiver sensitivity	1-4,7-10
• The far-end transmitter is off, or is transmitting low power	1-4,7-10
• The RF path is not aligned	1,3,10
• Water is in the antenna feedhorn or connectors	1,4
• Both units are set to the same frequency	5,10
• Both units are not set to the same P/N code	6
• The connection between the BBP and the RFC is faulty	1,7-10
• The connection between the RFC and the antenna is faulty	1,7-10
• The BBP or RFC is faulty	10

Recommended Actions:

1. Check the RX power using the VT100 user interface or RSSI voltage.
2. Check the far-end transmitter for operation and proper transmit power.
3. Check the RF path using a spectrum analyzer or RSSI voltages for proper alignment. Have path professionally re-aligned and check system path engineering.
4. Check the antenna feedhorn and all outdoor connections for water.
5. Change the frequency of one radio through the VT100 user interface or front panel button.
6. Set both units to the same P/N code.
7. Check all connections between the BBP, the RFC, and the antenna.
8. Check the IF and RF cables for shorts.
9. Check connections inside the mastmount or rackmount RFC.
10. Replace the RFC.

I M P O R T A N T

If problems persist after you have followed the Recommended Actions, contact ADTRAN Technical Support at (011) 256-963-8716.

Carrier Sync Status or E1 Mux Sync Status

The Carrier Sync status will indicate NO on the TRACER System Status page when frequency synchronization has not been achieved between each end of the the RF Link. The E1 Mux Sync Status will indicate NO on the TRACER System Status page when synchronization between the E1 mux on each radio has not been achieved.

Possible Cause	Recommended Action (see list below)
• The RF link is down.	1-10
• The RX power is below the specified receiver sensitivity.	1-4,7-10
• The far-end transmitter is off, or is transmitting low power.	1-4,7-10
• The RF path is not aligned.	1,3,10
• Water is in the antenna feedhorn or connectors.	1,4
• Both units are set to the same frequency.	5,10
• Both units are not set to the same P/N code.	6
• The connection between the BBP and the RFC is faulty.	1,7-10
• The connection between the RFC and the antenna is faulty.	1,7-10
• The BBP or RFC is faulty.	10

Recommended Actions:

1. Check the RX power using the VT100 user interface or RSSI voltage.
2. Check the far-end transmitter for operation and proper transmit power.
3. Check the RF path using a spectrum analyzer or RSSI voltages for proper alignment. Have path professionally re-aligned and check system path engineering.
4. Check the antenna feedhorn and all outdoor connections for water.
5. Change the frequency of one radio through the VT100 user interface or front panel button.
6. Set both units to the same P/N code.
7. Check all connections between the BBP, the RFC, and the antenna.
8. Check the IF and RF cables for shorts.
9. Check connections inside the mastmount or rackmount RFC.
10. Replace the RFC.

Section 4 Troubleshooting

RFC Link Up Status

The RF Link Up Status will indicate NO on the TRACER System Status page when communication between the BBP and RFC has failed.

Possible Cause	Recommended Action (see list below)
• Failure of the IF cable.	1
• Fuse blown in BBP.	2
• Loose cable connections in the RFC.	3
• Failure of the BBP.	4
• Failure of the RFC.	5

Recommended Actions:

1. Check the IF cable for shorts or loose connections.
2. Check for blown fuse in the BBP. This fuse is accessed by removing the top of the Baseband Processor, and is located on the left side of the chassis when facing the front panel. If this fuse is open, verify that the coax connections are correctly installed and check the BBP to RFC coaxial cable for a short.
3. Check all connections in the RFC.
4. Replace the BBP.
5. Replace the RFC.

ES Values in E1A or E1B Performance History Menu

This value indicates the number of Errored Seconds in the E1 data stream.

Possible Cause

- When CRC is enabled, an errored second is listed when more than 1 CRC error occurs within that second.
- When CRC is disabled, an errored second is listed when more than 1 CV error occurs within that second.

Recommended Actions:

1. Check the E1 signal with a BERT test set to determine origin of error.

SES Values in E1A or E1B Performance History Menu

This value indicates the number of Severely Errored Seconds in the E1 data stream.

Possible Cause

- When CRC is enabled, a severely errored second is listed when more than 805 CRCs occur within that second.
- When CRC is disabled, an errored second is listed when more than 850 CVs occur within that second.

Recommended Actions:

1. Check the E1 signal with a BERT test set to determine origin of error.

Section 4 Troubleshooting

This section lists the specifications for the TRACER system.

Transmitter

Output Power	
100 mW Transmitter	+20 dBm, maximum
1 W Transmitter	+30 dBm, maximum (Factory preset to +27 dBm)
Frequency Range	5725 to 5850 MHz or 2400 to 2483.5 MHz
Channel Bandwidth	62 MHz (5.8 GHz) or 40 MHz (2.4 GHz), (two channels)
IF	140 MHz

Receiver

Receive Level, range	-30 to -89 dBm @ 2.4 GHz, (-30 to -87 dBm @ 5.8 GHz)
Receive Level, maximum	-30 dBm
Receive Level, nominal	-60 dBm
IF	70 MHz

Frequency Plan

Plan A 2.4 GHz	Tx 2.421 GHz, Rx 2.462 GHz
Plan B 2.4 GHz	Tx 2.462 GHz, Rx 2.421 GHz
Plan A 5.7 GHz	Tx 5.747 GHz, Rx 5.827 GHz
Plan B 5.7 GHz	Tx 5.827 GHz, Rx 5.747 GHz

Spread Spectrum Data Pump

Modulation	QPSK
Spreading Method	Direct sequence
Code Length	120 bits
Processing Gain	>12 dB
Number of Codes	10
Chipping Rate	12 times

Interface Specifications

Capacity	2 x E1
Connection	RJ-48C, bantam
Line Code	AMI, HDB3
Framing	CAS, CCS
Alarms	LOS, OOF, CV, CRC, RMT, UA1
Loopbacks	Local and remote, per E1 channel

User Interface

Front Panel	Alarm LEDs, Configuration Switches, Monitor Jacks
Diagnostics	E1 Loopback, Remote Test with built-in BERT

Section 5 Specifications

Test Points	RSSI, QPSK Constellation
VT100 Terminal	Menu-Driven User Interface, Control of the Remote End, Password Protected (Optional), Event History

VT100 Terminal Interface

Data Rate	9600 bps
Data Bits	8
Parity	None
Stop Bits	1
Terminal Emulation.....	VT100

Mechanical & Environmental

Baseband Processor

Operating Temperature	-25°C to 65°C
Size	42.4 cm x 4.4 cm x 29.2 cm
Humidity	95%, Non-condensing
Weight	6 lbs (2.7 kg)

Rack RFC

Operating Temperature	-40°C to 65°C
Size	42.4 cm x 4.4 cm x 29.2 cm
Humidity	95%, Non-condensing
Weight	6 lbs (4.8 kg).

Mast Unit

Operating Temperature	-40°C to 65°C
Size	52.5 cm high x 22.5 cm diameter
Humidity	100%
Weight	18 lbs (8.1 kg).

Power

Input Voltage	21 to 60 volts DC, either polarity referenced to ground
Power Consumption	30 watts
Connector	3 pin DIN (AC adapter), 3 pin screw clamp terminal block (DC)

SECTION 6 **WARRANTY, ORDERING AND RETURN**

WARRANTY

ADTRAN will replace or repair this product within five years from the date of shipment if it does not meet its published specifications or fails due to defects in materials and workmanship.

For detailed warranty, repair, and return information, refer to the ADTRAN Equipment Warranty, Repair, and Return Policy and Procedure (P/N 60000116-10) located on the ADTRAN web site at <http://www.adtran.com>.

SALES

For TRACER sales information, contact ADTRAN Sales at:

(888) 3ADTRAN

or

(011) (256-963-7768)

for International calls

<http://www.adtranwireless.com/>

REPAIRS AND RETURNS

Return Material Authorization (RMA) is required prior to returning equipment to ADTRAN.

For RMA information, contact ADTRAN at:

(800) 726-8663

or

**ADTRAN, Inc.
Customer Service Department
P.O. Box 140000 / 901 Explorer Boulevard
Huntsville, Alabama 35814**

TECHNICAL SUPPORT

Standard support hours are 7 a.m. to 7 p.m. CST, Monday through Friday. Emergency technical support is available 24 hours a day, seven days a week.

For technical support at any time, contact ADTRAN at:

(800) 726-8663

or

(011) (256-963-8716)

for International calls

Section 6 Warranty, Ordering and Return Information

ACRONYMS USED IN THIS MANUAL

AMI	Alternate Mark Inversion
BER	Bit Error Rate
BBP	Baseband Processor
CRC	Cyclic Redundancy Check
DCE	Data Communications Equipment
DTE	Data Terminal Equipment
ESF	Extended superframe
FCC	Federal Communications Commission
FEC	Forward Error Correction
IF	Intermediate Frequency
ISM	Industrial, Scientific, and Medical
LBK	Loopback
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RFC	Radio Frequency Converter
RSSI	Received Signal Strength Indicator
Rx	Receive
SF	Superframe
Tx	Transmit
HDB3	High Density Bipolar 3
CV	Coding Violation
CCS	Clear Channel Signalling
CAS	Channel associated Signalling
RMT	Remote Alarm
UA1	Unframed all 1s
RRA	Received Remote Alarm

APPENDIX A CABLE CONNECTIONS

The cable connections required for various configurations are detailed below.

Terminal Connection (DB-25)

<u>Tracer (DCE)</u>			<u>Terminal (DTE)</u>	
Number	Name		Number	Name
2	TXD	↔	2	TXD
3	RXD	↔	3	RXD
4	RTS	↔	4	RTS
5	CTS	↔	5	CTS
6	DSR	↔	6	DSR
7	Ground	↔	7	Ground

Personal Computer Connection (DB-9)

<u>Tracer (DCE)</u>			<u>Computer (DTE)</u>	
Number	Name		Number	Name
2	TXD	↔	3	TXD
3	RXD	↔	2	RXD
4	RTS	↔	7	RTS
5	CTS	↔	8	CTS
6	DSR	↔	6	DSR
7	Ground	↔	5	Ground

Modem Connection (DB-25)

<u>Tracer (DCE)</u>			<u>Modem (DCE)</u>	
Number	Name		Number	Name
2	TXD	↔	3	RXD
3	RXD	↔	2	TXD
4	RTS	↔	5	CTS
5	CTS	↔	4	RTS
6	DSR	↔	20	DTR
7	Ground	↔	7	Ground

Appendix A Cable Connections

Free Manuals Download Website

<http://myh66.com>

<http://usermanuals.us>

<http://www.somanuals.com>

<http://www.4manuals.cc>

<http://www.manual-lib.com>

<http://www.404manual.com>

<http://www.luxmanual.com>

<http://aubethermostatmanual.com>

Golf course search by state

<http://golfingnear.com>

Email search by domain

<http://emailbydomain.com>

Auto manuals search

<http://auto.somanuals.com>

TV manuals search

<http://tv.somanuals.com>