

ADIRAN TRACER USER'S MANUAL

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SECTION 1 **TRACER DESCRIPTION**

INTRODUCTION

The Single E1 version of Tracer provides single E1 transport via a 2.4 GHz, direct sequence, spread spectrum microwave link. The transmitter output power is 20 dBm maximum while the receiver sensitivity is -91 dBm or better. 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 interface (G.703, G.704 compliant) is 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. The figure below illustrates a typical application.

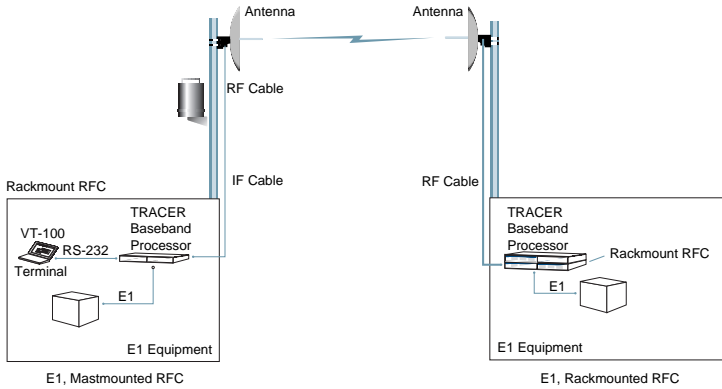


Figure 1-1. Typical Application

The Tracer can be used in any application requiring that data be shared at a high rate of speed. 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.

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

There is 83.5 MHz of spectrum in the 2.4 GHz band in which Tracer operates. A Tracer system fully uses the available bandwidth -- transmitting in one half and receiving in the other. The figure below illustrates the bandwidth division.

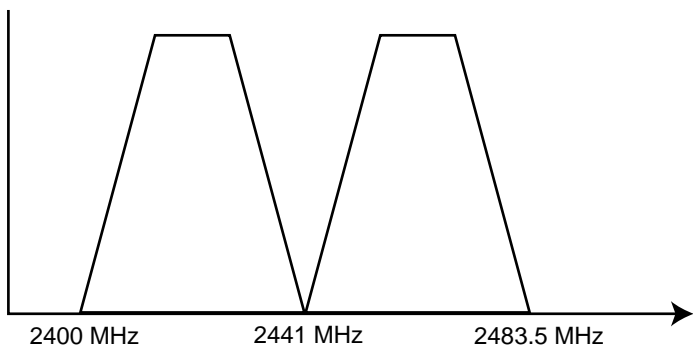


Figure 1-2. Bandwidth Division

The transmitter at one end of a link 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 the re-transmission of an errored 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).

E1 INTERFACE

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

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.

A block diagram of the BBP is shown in the figure below.

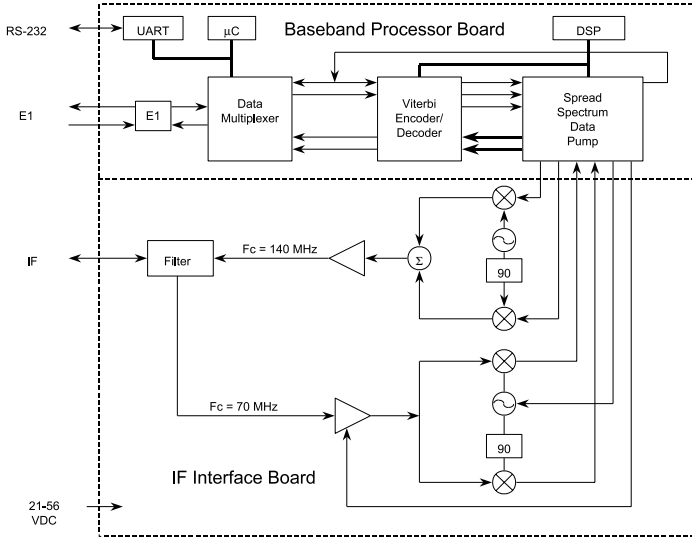


Figure 1-5. BBP Block Diagram

VT-100 RS-232 INTERFACE

An RS-232 interface is provided via a 25-pin D connector for attaching a VT-100 compatible terminal. The active signals used on this interface are listed below

Signal Name	Pin Number	Source
Receive Data	2	Terminal/Modem
Transmit 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 interface 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 interface:

- Loss of signal
- Bipolar violation
- CRC error
- Framing error
- Remote alarm

A seven-day error history of the E1 interface and radio link is also provided. Fifteen-minute histories are provided for the most recent eight 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 interface 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 front 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@A) 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.

AC/DC 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 24 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 the figures below.

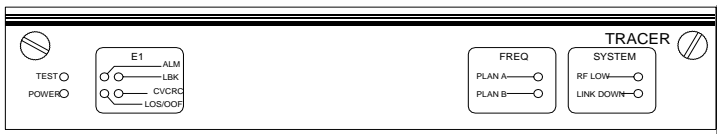


Figure 1-6. BBP Front Panel with Door Closed

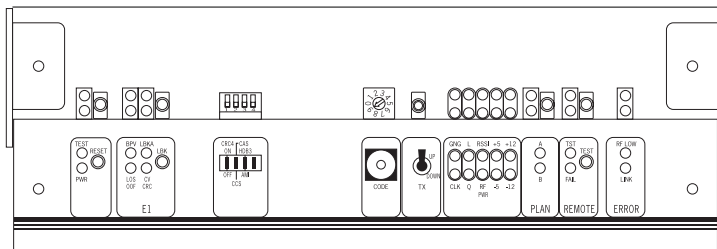


Figure 1-7. BBP Front Panel with Door Open

As a rule, a green LED indicates a good 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 interface 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 interface or if framing synchronization is lost
Loopback	Solid yellow if the E1 interface is in local line loopback. Blinking yellow if the E1 interface is in link loopback.
ALM	Solid red if an AIS 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

The LEDs that indicate error conditions in the spread spectrum data pump and RFC are listed below. All of these LEDs are visible through the front panel. Any one of these LEDs indicates and error condition that precludes system operation.

Link Down	Red if the RF link is not operational E1 interface will transmit AIS on the affected E1 to indicate an error
RF Low	Red if the received RF carrier level is below -80 dBm.

The controls available from the control panel are listed below.

Name	Function
Reset	Reset the system
LBK	Toggles E1 between normal and local line loopback modes
CRC4 ON	Affects the E1 Performance Monitoring characteristics. ES (errored second) is one or more CRC4 errors or Loss of Frame. SES (severely errored second) is more than one Loss of Frame, one or more Loss of Receive Signal or more than 805 CRC4 errors.
CRC4 OFF	Affects the E1 Performance Monitoring characteristics. ES (errored second) is one or more BPV (bipolar violations) for an AMI configured circuit or one or more Code Errors for an HBD3 configured circuit. SES (severely errored second) is Loss of Signal or Frame, 805 or more BPV (bipolar violations) or Code Errors.
CAS	Selects Channel Associated Signalling
CCS	Selects Common Channel Signalling
HDB3	Selects HDB3 Line Coding
AMI	Selects AMI Line Coding
Remote Test	Initiate a remote test across the RF link

The monitor points provided on the front panel of the system are described below.

EYE I	Demodulated received baseband output
EYE Q	Demodulated received baseband output
EYE CLK	Recovered clock for observing EYE pattern
RSSI	DC voltage indicating strength of the received signal at the antenna
+5	System 5 volts
-5	System -5 volts
+12	System +12 volts
-12	System -12 volts
RF PWR	DC voltage supplying RF power
GND	System ground

NON-VOLATILE MEMORY

The Tracer system contains non-volatile memory to retain certain configuration settings. These settings include:

- Frequency plan
- Chipping code (if set from VT-100)
- Password
- Password enabling
- Site name
- E1 line coding (if set from VT-100)
- E1 framing (if set from VT-100)

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.

The major connections illustrated are transmit signal, receive signal, and the IF signal connection.

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 below.

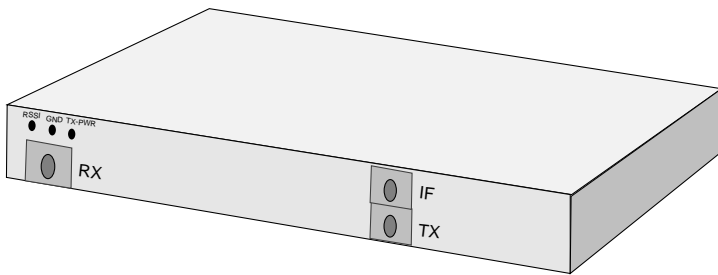


Figure 1-8. RFC Module

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. Another test point is provided to monitor the transmitter output power during system configuration. 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 part # 3125RF027@A] is provided for rackmount systems). The *TO ANTENNA* connection provides the connection between the RFC and the antenna.

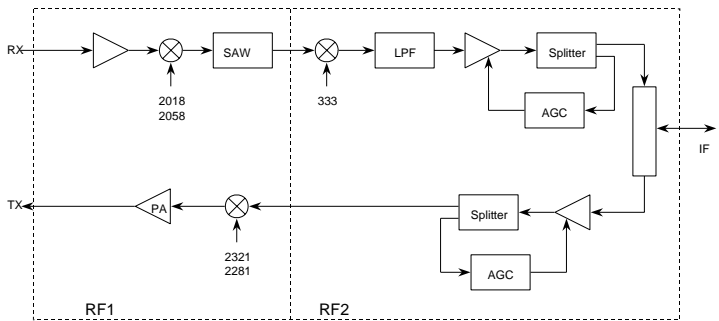


Figure 1-9. RFC Block Diagram

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 below.

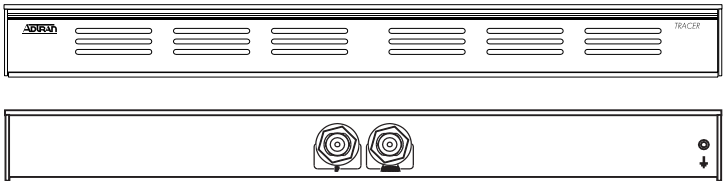


Figure 1-10. Front and Rear of Rackmount RFC Housing

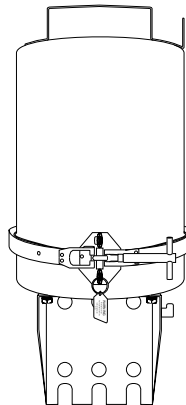


Figure 1-11. Mastmount RFC Housing

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 minimizes the site's interference to other sites.

The antenna requirements are listed below.

- Minimum gain 15 dBi
- Minimum return loss .. 15 dB
- Connector N-type
- Impedance 50 Ω

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
- Rackmounted RFC
- BBP to RFC IF interconnect cable

Provided by customer --

- Antenna feedline cable
- Antenna and mounting hardware
- VT-100 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 RFC

SECTION 2

Provided by customer --

- E1 interface cables
- Antenna feedline cable
- Antenna and mounting hardware
- BBP to mastmounted RFC IF interconnect cable
- VT-100 terminal and RS-232 interface cable (optional)
- 21 to 56 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). The BBP is designed to be mounted in a rack, 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 56 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., $30 \text{ watts} / 48 \text{ volts} = .625 \text{ amps}$),

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 undergrounded 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.

SECTION 2

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 INTERFACE

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

- A 75 Ω unbalanced BNC coaxial connector.
- A 120 Ω balanced 15 pin connector / RJ 48 with the pinouts shown below.

15 Pin		RJ-48	
Pin	Function	Pin	Function
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 BNC configuration interface provides a 75Ω unbalanced connection. 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 the two BNC connectors. The E1 module must be removed to access this option.

The 15-pin / RJ-48 configuration interface provides a 120Ω balanced connection.

Three loopback functions are provided for diagnostic capability. The local line loopback loops the incoming E1 signal back out at the E1 framer. The remote link loopback 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 allows the local unit to loop E1 data back towards the remote end. The available loopback functions are illustrated below.

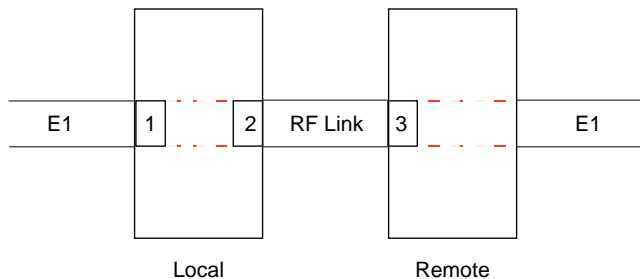


Figure 2-1. E1 Loopback Locations

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.

ANTENNA FEEDLINE LOSS

Feedline loss is a function of feedline type and length. Feedline loss per 30.48 meters 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/30.48 m (in dB)	RF Loss/30.48 m (in dB)
RG58	5.7	80
RG8 (air)	2.7	20
RG8 (foam)	2	9
1/4" Waveguide	1.42	5.91
3/8" Waveguide	1.25	5.76
1/2" Waveguide	0.81	3.83
7/8" Waveguide	0.44	2.2
1 1/4" Waveguide	0.33	1.62
1 5/8" Waveguide	0.27	1.41

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)	Gain (in dBi)
60	21
120	27
180	31
243	33
304	35
365	37

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.

Link Distance (in km)	Path Loss (in dB)	Link Distance (in km)	Path Loss (in dB)
1	108	13	131
2	115	14	131
3	118	15	132
4	121	16	133
5	122	17	133
6	124	18	134
7	125	19	134
8	127	20	135
9	128	21	135
10	128	22	135
11	129	23	136
12	130	24	136

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.

Climate	Climate Factor
Very Dry	$\frac{1}{8}$
Temperate	$\frac{1}{4}$
Humid	$\frac{1}{2}$

Terrain factors are listed below

Terrain	Terrain Factor
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.

- 91 dBm Minimum Signal Power
- + _____ Transmitter Feedline Loss
- _____ Transmitter Antenna Gain
- + _____ Path Loss
- _____ Receiver Antenna Gain
- + _____ Receiver Feedline Loss
- + _____ Required Fade Margin
- = _____ (dBm) Transmitter Power Setting

SECTION 2

SETTING THE TRANSMITTER POWER

The transmitter power is set by way of a two-position, momentary toggle switch on the front panel of the BBP or via the configuration page of the VT-100 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 potentiometer or VT-100 until the desired transmitter power is obtained. For convenience, the transmitter power adjustment should be made before the RFC is installed on the mast.

SETTING THE RFC FREQUENCY PLAN

The frequency plan designates on which frequencies the Tracer transmits and receives. Plan A corresponds to a transmitting (Tx) frequency of 2421 MHz and a receive (Rx) frequency of 2462 MHz. Plan B corresponds to a Tx frequency of 2462 MHz and a Rx frequency of 2421 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 configuring the RFC interconnect cables.

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

1. Remove the four 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 the figure below.

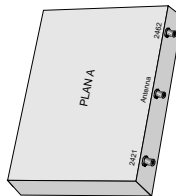


Figure 2-2. Diplexer

3. Unscrew the cable assemblies from the ports labelled “Tx” and “Rx” on the RFC, and the ports labelled “2421” and “2462” (or “J1” and “J2” on some models) on the diplexer, depending on the frequency Plan (Plan A or Plan B).
4. Unscrew the cable assembly from the port labelled “Antenna” 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.
9. Reattach the cable assemblies from the ports labelled “Tx” and “Rx” on the RFC, and the ports labelled “2421” and “2462” (or “J1” and “J2” on some models) on the diplexer. Cable connections should be aligned to each other as follows.

Plan A

Tx = 2421

Rx = 2462

Plan B

Tx = 2462

Rx = 2421

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.
5. Reinstall the lid of the mast RFC.

SECTION 2

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.

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. The positive lead should be attached to the “+” side of the block and the negative lead should be attached to the “-” side of the block.

C A U T I O N

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.

CO-LOCATING MULTIPLE 2.4 GHz SYSTEMS

When multiple 2.4 GHz 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 2.4 GHz system 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, Tx=2421; or Plan B, Tx=2462) 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).

This equipment is authorized under CFR 47 Part 15.247. With this authorization by the FCC, this equipment shall not be co-located with a similar transmitter that transmits identical information.

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. 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 corresponding to a stronger received signal.

SECTION 2

RF Low

The “RF Low” LED indicates that the received signal is within 10dB of the minimum received signal strength (-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

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.

VT-100 USER INTERFACE

The Tracer may be accessed with a VT-100 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 ESC key will present the System Status 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 VT-100 terminal, personal computer, or modem. The RS-232 port is configured as a DCE with the following pin assignments:

Signal Name	Pin Number	Direction
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 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 SELECTIONS

SYSTEM STATUS PAGE

This page displays the status of major system components. This is a status screen only; no configurations can be performed. More detailed information can be obtained by way of the Main Menu.

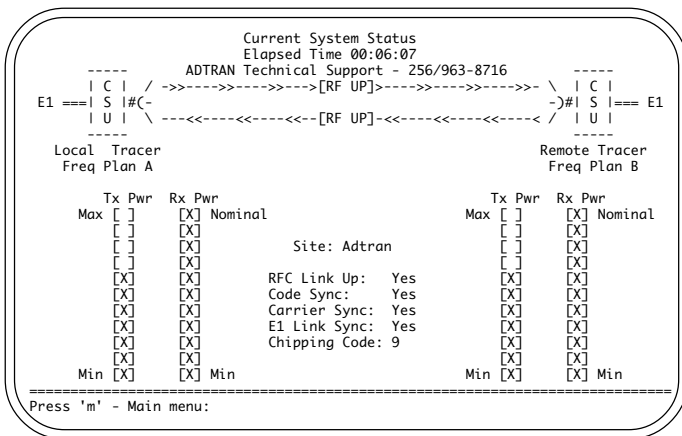


Figure 3-1. Current System Status Page

The upper portion of the screen indicates how long the system has been running since the last reset operation. The “E1” label will be highlighted if any error conditions exist on that E1 interface.

The status of the radio link is indicated as Up or Down. The left portion of the screen reports the status of the local system (the system to which the terminal is attached); the right portion reports the status of the remote system. The approximate transmitter and receiver signal levels are shown via the “fuel gauges.” If the link is down and remote end data is unavailable, the fuel gauges will show “-” instead of “x.” The RFC Link, Code Sync, Carrier Sync, and E1 Link status will all report “yes” if the link is operational. Chipping code indicates the code to which the system is set. At any point in the VT-100 menu structure, press the Escape key to return to this screen.

MAIN MENU PAGE

Pressing “M” on any screen will take the user to the Main Menu, from which the subsequent screens can be accessed.

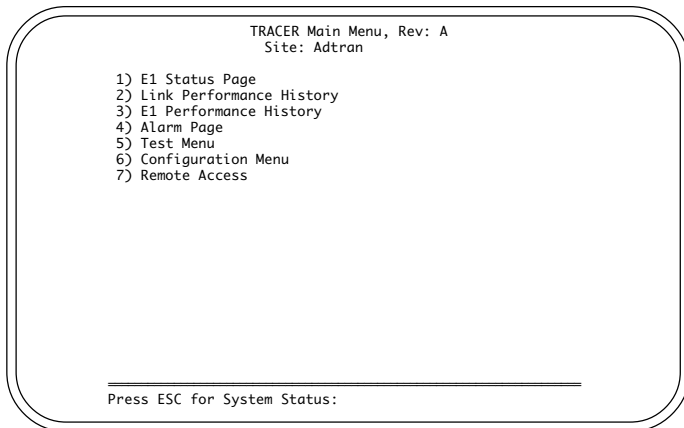


Figure 3-2. Main Menu Page

E1 STATUS PAGE

The status of the E1 interface is displayed on this screen. This is a status screen only.

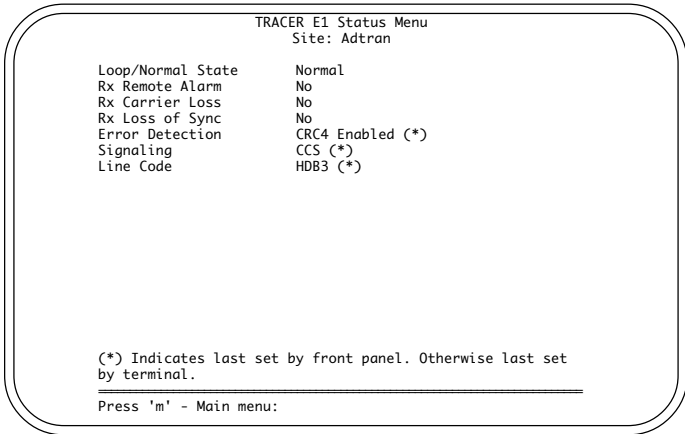


Figure 3-3. E1 Status Page

LINK PERFORMANCE HISTORY

This screen presents detailed error statistics for the RF link. The data is presented as RFCL (Radio Frequency Converter Link) and LINK (RF Link) representing seconds out of service for each. The RFCL represents the communications channel between the BBP and RFC via the IF interconnect cable. The counts for the most recent 24 hours are recorded in 15-minute increments. Twenty-four-hour totals are recorded for the most recent days.

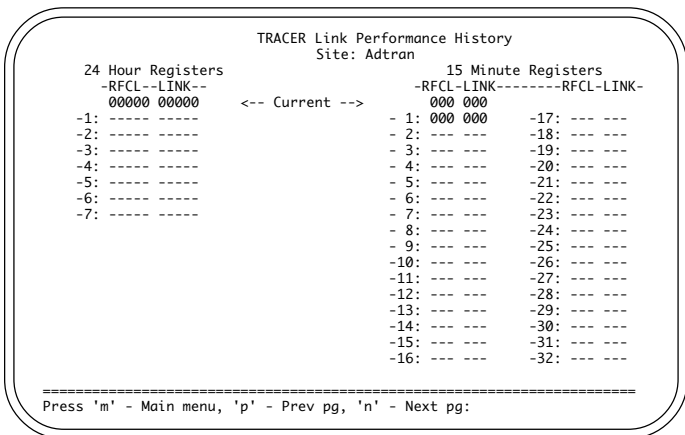


Figure 3-4. Link Performance History Page

E1 PERFORMANCE HISTORY PAGE

This screen presents detailed error statistics for E1. The data is presented as Errored Seconds and Severely Errored Seconds. The counts for the most recent 24 hours are recorded in 15-minute increments. Twenty-four-hour totals are recorded for the most recent days.

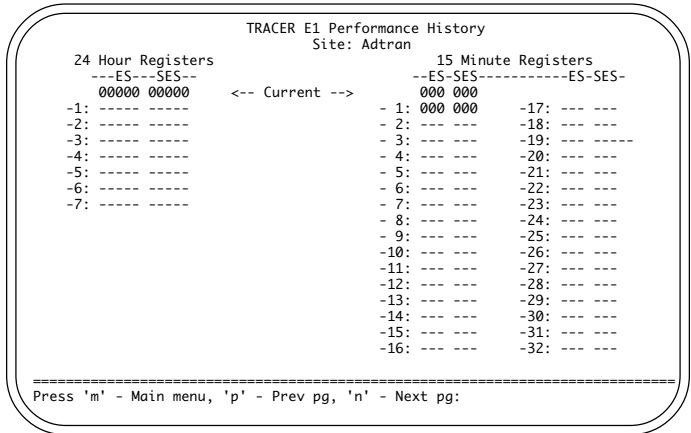


Figure 3-5. E1 Performance History Page

ALARM PAGE

This screen presents alarm information for the system. The E1 alarm is described in the chapter entitled “Troubleshooting.” If any of the E1 alarms are active, a minor alarm will be indicated at the alarm contacts. The RF link alarm will be activated when communication between the BBP and the RFC has failed. Code Sync, Carrier Sync, and Link Sync alarms indicate that various portions of the spread spectrum data pump are not operating. Any of these alarms will cause a major alarm to be activated at the alarm contacts. An RX Remote Alarm is an indication alarm from the receive portion of the circuit to indicate that a failure has occurred in the receive direction. RX Carrier Loss and RX Loss of Sync indicate the E1 has lost sync.

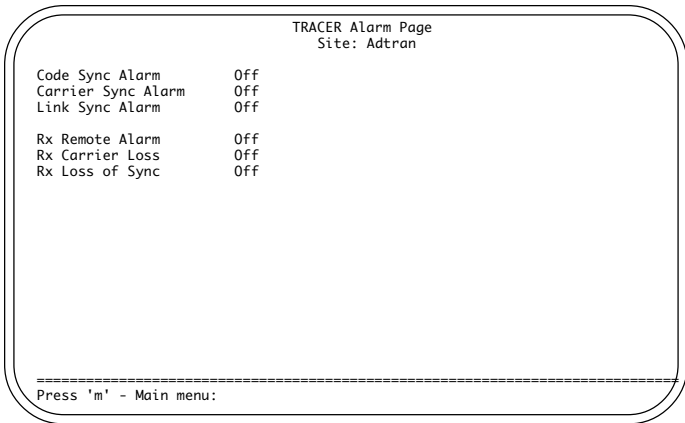


Figure 3-6. Alarm Page

TEST MENU

This screen allows each E1 to be put into loopback mode.

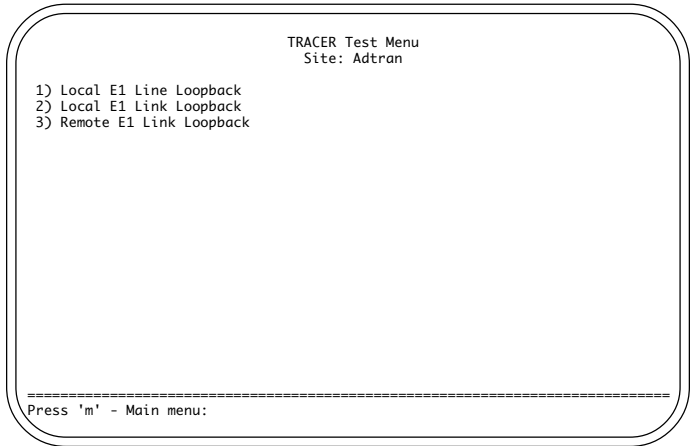


Figure 3-7. Test Menu

Each menu selection is described below:

1. Loops the local E1 interface towards the local customer equipment.
2. Loops the local E1 interface towards the remote customer equipment, over the RF link.
3. Loops the remote E1 interface towards the local customer equipment, over the RF link.

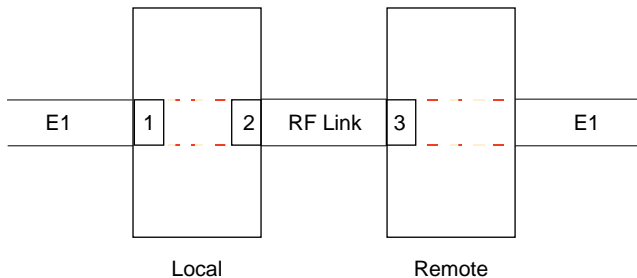


Figure 3-8. E1 Loopback Locations

This screen allows all system configurations to be performed.

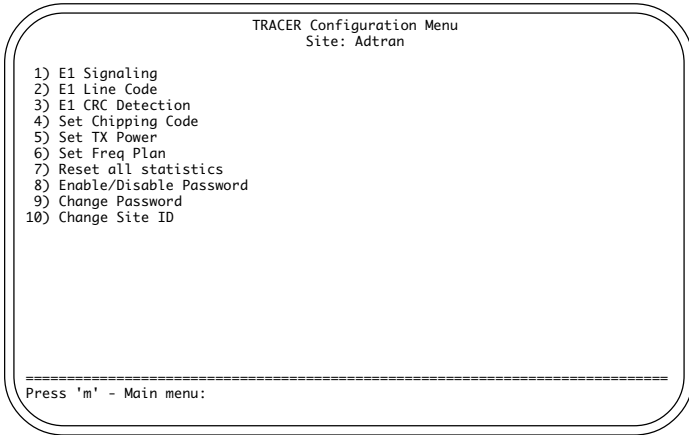


Figure 3-9. Configuration Menu

The menu selections are described below.

E1 Framing allows each E1 to be configured for CAS or CS framing.

E1 Line Code allows each E1 to be configured for AMI or HDB3.

E1 CRC Detection enables or disables CRC4 detection.

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

Set Tx Power allows the transmitter power to be adjusted.

Set Freq Plan manually allows the frequency plan to be set to A or B. One end of a link must be set to A and the other set to B. This function is automatically set when the BBP is attached to the corresponding RFC.

Reset All Statistics resets all Performance History counters and timers.

Enable/Disable Password enables or disables the Password feature.

Change Password allow the user to change the password.

Change Site ID allows a unique text identifier for each radio, displayed at the top of each page.

SECTION 4 **TROUBLESHOOTING**

GENERAL

If you experience a problem with the Tracer system, check to ensure that all connectors, coaxial cables, antennas and T1s 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 (256) 963-8716.

N O T E

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, but in some cases, the equipment may be at fault.

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 (800) 726-8663.

TROUBLESHOOTING USING THE FRONT PANEL INDICATORS

“LINK ERROR” LIGHT IS LIT, OR LINK IS DOWN

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 -91 dbm threshold.	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.	5,10
• Both units are not set to the same PN 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 VT-100 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 VT-100 user interface or front panel button.
6. Set both units to the same PN code.
7. Check all connections between the BBP, the RFC, and the antenna.
8. Check the IF and RF cables for shorts.
9. Check the connections inside the mast-mount or rack-mount RFC.
10. Replace the RFC.

“LBK” IS LIT

This alarm will activate when a software or manual T1 loopback has been established.

RECOMMENDED ACTION

POSSIBLE CAUSE

(SEE LIST BELOW)

- A loopback has been commanded from the VT-100 user interface. 1,2
- The “LBK” button has been pressed. 1,2

RECOMMENDED ACTIONS:

1. Through the VT-100 user interface, deactivate the loopback in the Loopback Menu.
2. Press the “LBK” button to deactivate the loopback.

No “POWER” LIGHT

RECOMMENDED ACTION

POSSIBLE CAUSE

(SEE LIST BELOW)

- 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 21-56 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.

“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 the T1-C mux failed internal test.	1
• Three-flash interval indicates the E1 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 or the RFC.

“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 VT-100 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.

“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)
• The 10-second BERT has failed over the RF link to the far-end.	1
• The RX power may be below or near the -91 dbm threshold.	1

RECOMMENDED ACTIONS:

1. Check the RX power level using the VT-100 user interface or the RSSI DC voltage test points. Verify the RX power is between -55 & -91 dbm.

“RF Low” LIGHT IS ON

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

POSSIBLE CAUSE	RECOMMENDED ACTION (SEE LIST BELOW)
• The RX power is below -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. Verify the RX power is between -55 & -91 dBm using the VT-100 user interface or RSSI DC voltage test points.
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. Check all connections between the BBP, the RFC, and the antenna.
6. Check the IF and RF cables for shorts.
7. Check the connections inside the mast-mount or rack-mount RFC.
8. Replace the RFC.

TROUBLESHOOTING USING THE VT-100 USER INTERFACE

This section provides information for troubleshooting the Alarm Menu on the VT-100 user interface. The conditions present in the Alarm Menu are software indications and should match the front panel LED indications.

RF LINK ALARM OR CODE SYNC ALARM

The RF Link Alarm will activate when the link is down or not operational.

The Code Sync Alarm will activate when data synchronization has not been achieved between the RF link.

POSSIBLE CAUSE	RECOMMENDED ACTION (SEE LIST BELOW)
• The RF link is down.	1-10
• The RX power is below the -91 dbm threshold.	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 PN 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 VT-100 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 VT-100 user interface or front panel button.
6. Set both units to the same PN 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 mast-mount or rack-mount RFC.
10. Replace the RFC.

CARRIER SYNC ALARM OR T1 MUX FRAMER ALARM

The Carrier Sync alarm will activate when frequency synchronization has not been achieved between the RF link.

The T1 Mux Framers alarm will activate when synchronization between the T1 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 -91 dbm threshold.	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 PN 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 VT-100 user interface or RSSI voltage (refer to RSSI voltage chart)
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 VT-100 user interface or front panel button.
6. Set both units to the same PN 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 mast-mount or rack-mount RFC.
10. Replace the RFC.

E1 ALARMS

The following definitions of E1 alarms apply to Tracer.

Local Alarm is caused by a locally detected facility failure.

Remote Alarm is an alarm received at the receive portion of the circuit to indicate that a failure has occurred in the receive direction.

ALM indicates one of two main problems. First, if a solid red line it indicates a local failure with the E1 signal (Usually the incoming E1 line on the back of the Tracer). A blinking light on the ALM indicates there is a problem on a remote E1 (A machine sending an E1 to the Tracer is connected to has a local failure). When a unit has a local failure it sends out a signal on the E1 lines going out from it saying there is a failure.

- When 192 consecutive zeroes are detected at the E1 interface the ALM LED will light. The remote Tracer will transmit an AIS on the effected E1 to indicate an error.
- When an E1 interface receives a Remote Alarm the ALM LED will blink. The Tracer at the remote end will pass the Remote Alarm though on the effected E1.
- When an E1 interface receives an AIS the ALM LED will light continuously. The remote E1 will transmit the AIS signal.

CV/CRC is a light that will blink when there is a Code Violation (CV -- related to Bipolar Violations usually) or a CRC4 error on the incoming E1. E1's can have a crc error checking signal mixed in the signalling bits. First thing they should do if this comes on, however, is to be sure that the E1's connected to the Tracer really do have the CRC4 signalling bits turned on. If there is any question about this then CRC4 checking on the dip switches should be turned off, which will simply ignore any CRC bits.

LOS is a Loss Of Signal, meaning the Tracer is receiving no E1 signal on the E1 RX port. **OOF** means Out Of Frame error, meaning we have lost framing synch.

When the RF link is down an AIS will be transmitted on the E1. No E1 alarm LEDs will be lit in this situation, but the LINK DOWN LED will illuminate.

Alarm Indication Signal (AIS) An unframed all ones signal that replaces the normal traffic signal when a maintenance alarm indication has been activated. Its purpose is to notify facilities at the receive end of a circuit that a local alarm has occurred upstream in the circuit.

SECTION 5 SPECIFICATIONS

This section lists the specifications for the Tracer system.

RF TRANSMITTER

Output Power +20 dBm, maximum
Frequency Range 2400 -2483.5 MHz
Channel Bandwidth 40 MHz (Two Channels)

RF RECEIVER

Receive Level Range -30 to -91 dBm (10^{-6} BER minimum)
Receive Level (nominal) ... -60 dBm

FREQUENCY PLAN

Plan A TX=2.422 GHz, RX=2.462 GHz
Plan B..... TX=2.462 GHz, RX=2.422 GHz

SPREAD SPECTRUM DATA PUMP

Modulation DQPSK
Spreading Method Direct Sequence
Code Length 120 bits
Processing Gain >12 dB
Number of Codes 10
Chipping Rate 12

E1 INTERFACE SPECIFICATION

Electrical	G.703
Framing	G.704 CRC-4, CAS, CCS
Jitter	G.823
Line Code	AMI, HDB3
Data Rate	2.048 Mbps
Mechanical	75 Ω unbalanced -- BNC 120 Ω balanced -- DB 15 / RJ-48
Alarms	loss of signal, code violation, CRC error, framing error, remote alarm
Loopbacks	local line, remote link, local link

USER INTERFACE

Panel	Alarm LEDs, Configuration Switches, Monitor Jacks
Diagnostics	E1 Loopback, Remote Test with built in BERT
Test Points	RSSI, System Voltages, QPSK Constellation
Alarms	Major normally open Major normally closed Minor normally open Minor normally closed
ASCII Terminal	Menu-Driven User Interface, Control of the Remote End, Password Protected (Optional), Event History

RS-232 TERMINAL INTERFACE

Data Rate	9600 bps
Data Bits	8
Parity	None
Stop Bits	1
Terminal Emulation	VT-100

MECHANICAL & ENVIRONMENTAL**Baseband Processor**

Operating Temperature -25°C to +65°C

Size 42.4cm x 4.4cm x 29.2cm

Humidity 95%, Non-condensing

Weight 2.7 kg

Rack RFC

Operating Temperature -40°C to +65°C

Size 42.4cm x 4.4cm x 29.2cm

Humidity 95%, Non-condensing

Weight 4.8 kg

Mast RFC

Operating Temperature -40°C to +65°C

Size 22.5 cm diameter x 52.5 cm

Humidity 100%

Weight 8.1 kg

POWER

Input Voltage 21 to 60 volts DC

100 to 220 volts AC, 50 or 60 Hz (with optional AC adapter)

Power Consumption ... 30 watts

Connector 3 pin DIN (AC adapter)

3 pin screw clamp terminal block (DC)

GLOSSARY

ACRONYMS USED IN THIS MANUAL

AMI	Alternate Mark Inversion
BER	Bit error rate
BBP	Baseband Processor
CAS	Channel associated signaling
CCS	Common channel signaling
CRC	Cyclic Redundancy Check
DCE	Data Communications Equipment
DTE	Data Terminal Equipment
FAS	Frame Alignment Signal
FCC	Federal Communications Commission
FEC	Forward error correction
HDB3	High-density bipolar of order 3
IF	Intermediate Frequency
ISM	Industrial, Scientific, and Medical
LBK	Loopback
QPSK	Quadrature Phase Shift Keying
RF	Radio frequency
RFC	Radio frequency converter
RFCL	Radio frequency converter link (IF cable)
RSSI	Received signal strength indicator
Rx	Receive
Tx	Transmit

APPENDIX A **CABLE CONNECTIONS**

The cable connections required for various configurations are detailed below.

TERMINAL CONNECTION (DB25)

<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 (DB9)

<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 (DB25)

<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

E1 NETWORK INTERFACE

15 Pin		RJ48	
Pin	Function	Pin	Function
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.		