TRACER II 4203
User 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.

W A R N I N G

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 antennas. (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

Radio Frequency Interference Statement

These levels of RF energy in 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 16.5 feet (5 meters) from the center of the antenna. **The following precautions must be taken during installation of this equipment**:

- 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 16.5 feet (5 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 16.5 feet (5 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.

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INTRODUCTION

The TRACER 4103 provides T1 transport by way of a spread spectrum microwave link for distances up to 30 miles or more depending on path engineering. System performance is determined, in part, by the engineering of the microwave link. Each end of a TRACER 4103 link is composed of one unit – the baseband processor (BBP) and the radio frequency converter (RFC). Two DS1/DSX-1 (T1) interfaces are provided on the rear of the TRACER 4103, which can be mounted in a 19-inch rack. The DS1/DSX-1 interface provides connections up to 6000 feet from T1 equipment. A single coaxial cable connects the TRACER 4103 to the antenna.

ISM BAND SPREAD SPECTRUM

The Federal Communications Commission (FCC) has established several portions of the radio frequency (RF) spectrum for use in Industrial, Scientific, and Medical (ISM) applications. Part 15.247 of the FCC rules describes the requirements of systems that operate in these bands. The three bands set aside, 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz, are designated for use by spread spectrum transmitters, either frequency hopping or direct sequence. The TRACER 4103 operates in the 2400 to 2483.5 MHz or 5725-5850 MHz band using direct sequence spread spectrum (DSSS) transmission.

APPLICATIONS

Any application that would typically use metallic T1 as a transport can use the TRACER 4103 instead. **Figure 1-1** illustrates a typical application.

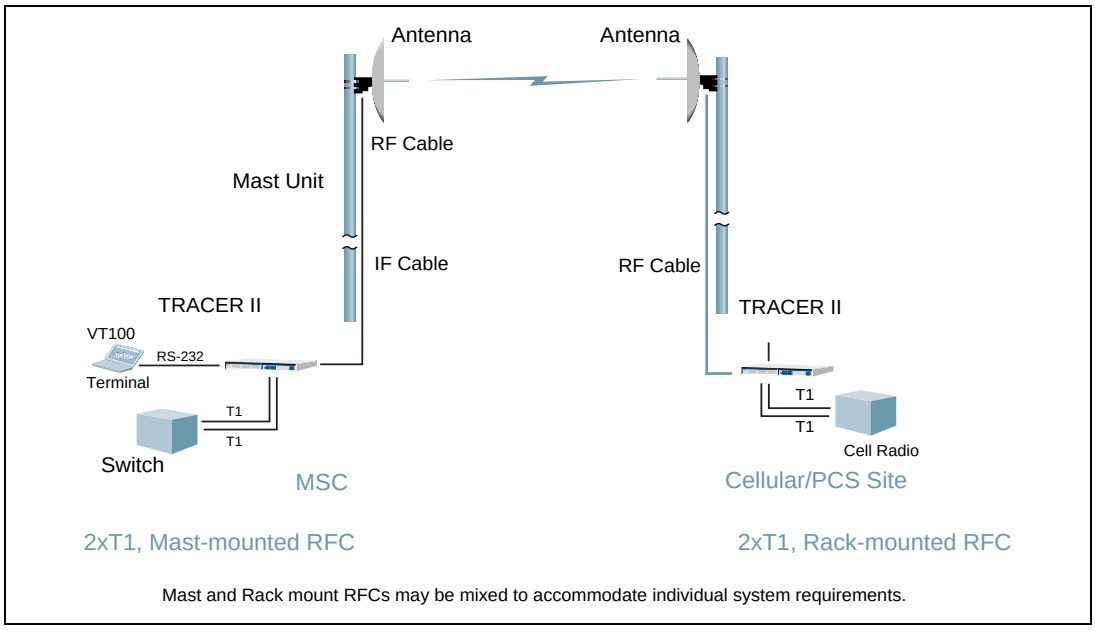

Figure 1-1. Typical Application

The TRACER 4103 can be used in any application requiring that data be shared at a high rate of speed. In addition to telephony applications, TRACER 4103 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”. The FCC rules allow two methods of spreading – frequency hopping and direct sequence. TRACER 4103 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 4103 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 4103 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 4103 operates. A TRACER 4103 system divides the band into two portions - transmitting in one and receiving in the other. **Figure 1-2** illustrates the bandwidth division.

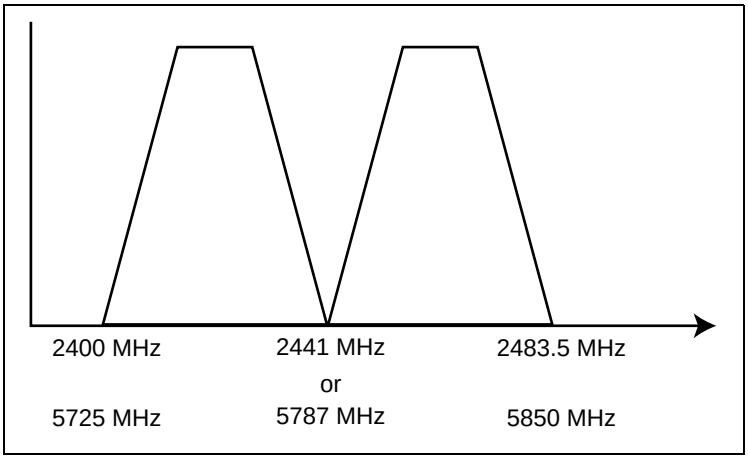

Figure 1-2. Bandwidth Division

The transmitter at one end of a link will transmit in the lower portion of the spectrum. Consequently the receiver at the other end will receive in the lower portion of the band and transmit in the upper portion. 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 otherwise specified.

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 4103, 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. 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).

T1 Operation

Framing

The data in a T1 stream is delimited by framing bits. The pattern of the framing bits follows one of two formats – extended superframe (ESF) or superframe (D4). The T1 interface must be prepared for the format that will be used.

Line Code

A mark in the data stream is coded as a pulse on the T1 line. A space is coded as "no activity" on the T1 line. As a form of error detection, subsequent marks in the data stream are coded as pulses of alternating polarity, either positive going or negative going. This type of line coding is called alternate mark inversion (AMI).

For the T1 receiver to operate correctly, a minimum number of "1s" must exist on the T1 facility. If the data cannot be guaranteed to meet this requirement, then another line coding format is used. In the bipolar 8 zero substitution (B8ZS) scheme, a string of eight "0s" is replaced by a special sequence of eight bits that contains a bipolar violation. The receiver, upon recognizing this sequence, reinserts the eight "0s" and the data is recovered intact.

DS1/DSX-1 Interface

When connecting the interface to the public switched network, an ADTRAN-provided cross-over cable (part number 3125M011@A) is required to meet FCC part 68 and IC CS03 requirements. This cable is required to cross-over the Tx and Rx pairs to meet the connecting arrangement of a network interface device. This cable is included with the BBP and is labelled "T1 Crossover."

Line Buildout or LBO

The DS1/DSX-1 interface provides two different types of line buildouts (LBOs), respectively. When set for DS1, LBOs for 0 dB, -7.5 dB, -15 dB, and -22 dB are available. The DS1 interface can operate on line lengths up to 6,000 feet. When set for DSX-1 interface, LBOs for 0-133 feet, 266-399 feet, 399-533 feet, and 533-655 feet are available.

TRACER 4103 SYSTEM CONFIGURATION

A TRACER 4103 system is composed of three major subsystems – a baseband processor, a radio frequency convertor, and an antenna. The following section describes the system components.

Baseband Processor or BBP

The BBP 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 – DS1/DSX-1 interface, DS1/DSX-1 monitor, VT100 terminal, alarm contacts, DC power (from facility), and power (from AC adapter).

DS1/DSX-1 Interface

Two DS1/DSX-1 interfaces, labelled "T1A" and "T1B," are provided for connecting to the T1 equipment. Two types of physical interfaces are provided – RJ-48C and bantam jacks.

The functions of the BBP are contained in one printed circuit board or (PCB), all contained in the same enclosure.

The DS1/DSX-1 interfaces provided for each channel are the same. The upper bantam connectors, labeled "Monitor," provide isolated monitor points for testing. The lower bantam jacks provide signal insertion points. The insertion of a bantam jack disconnects the RJ-48C connector from the circuit. The DS1/DSX-1 interface can operate on line lengths up to 6000 feet.

When connecting the T1 interface to the public switched network, an ADTRAN-provided cross-over cable (part number 3125M011@A) is required to meet FCC part 68 and IC CS03 requirements. This cable is included with the TRACER 4103 and is labeled "T1 Crossover." This cable is required to cross-over the TX and RX pairs to meet the connecting arrangement of a network interface device.

For connections to other CPE-type equipment, such as an ADTRAN TSU-100, a straight-through T1 cable is provided by ADTRAN (P/N 3127004) and is included with the TRACER 4103.

VT100 RS-232 Interface

A serial interface port using RS-232C signal levels is provided for attaching a VT100-compatible terminal. The connection is made via a DB-25 connector on the rear panel. The data rate is configured for 9600 bps, 8 data bits, no parity, and 1 stop bit.

A 7-day error history of the T1 interfaces and radio link is also provided. Fifteen-minute histories are provided for the most recent 24 hours of operation.

Alarm Contacts

One alarm contact, the major alarm, is provided on the rear of the BBP. A major alarm indicates the radio link is not operational. Normally-open and Normally-closed contacts are provided for both alarm types. Under normal operating conditions there is no continuity between the Normally-open and Common contacts, and, under an alarm condition, continuity between those contacts exists. The Normally-closed and Common contacts normally have continuity, while under alarm conditions, these contacts are open.

Power

Power for the entire system is provided by these interfaces. The three-pin circular DIN connector is provided to connect an optional ADTRAN desktop AC adapter (ADTRAN P/N 1360DSK24VL1),

providing 24 volts DC. The three-pin terminal block that allows the connection of any DC power source providing between 21 and 60 volts DC. The power consumption of the entire system is 30 watts.

Controls and Indicators

The system may be configured via the VT100 interface, which is accessible behind a drop-down panel on the right half of the TRACER 4103. The front panel is illustrated in **Figure 1-3** and **Figure 1-4**.

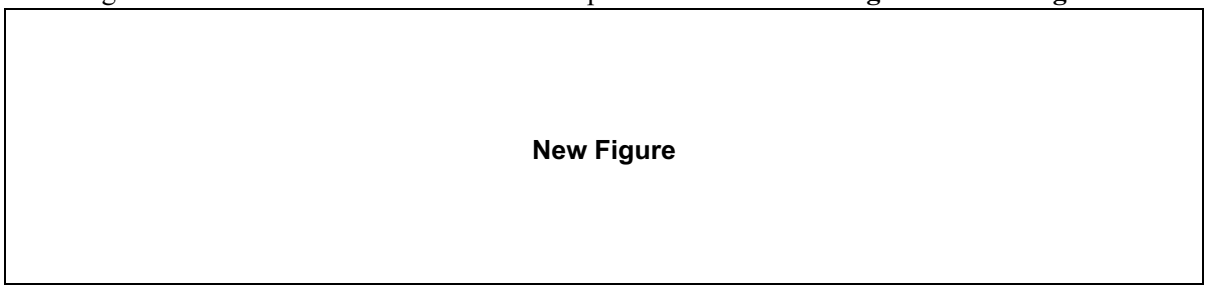

Figure 1-3. BBP Front Panel (with door closed)

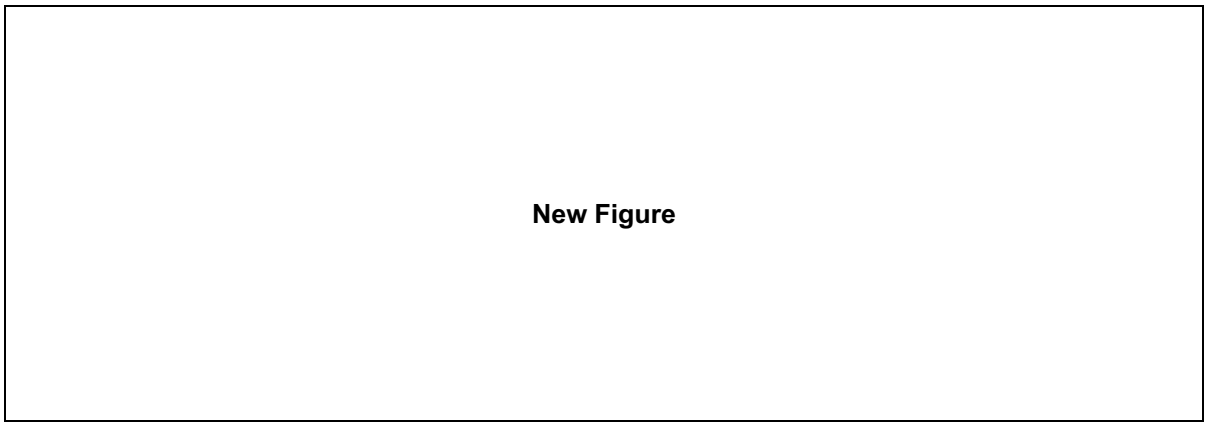

Figure 1-4. BBP Front Panel (with door open)

Options are set from the terminal interface. 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.

Test	*Red* indicates that the self-test has completed and failed
PWR	*Green* indicates that DC voltage is applied

The LEDs associated with the DS1/DSX-1 interfaces are listed below. There are two sections of identical indicators – one for each DS1/DSX-1 interface.

BPV	*Red* if the incoming T1 stream contains bipolar violations
LOS	*Red* if there is no signal present at the T1 interface
LBKA/LBKB	*Yellow* if the T1 interface is in loopback

AIS	Flashes to indicate a T1 Yellow Alarm; remains *On* (solid) to indicate an AIS alarm (when the DS1/DSX-1 is receiving a Blue code)

The LEDs indicating error conditions are listed below.

RF Low	*Red* indicates the received RF carrier level within approximately 10 dB of the minimum receive level
RF Down	Radio path is down

The front panel controls are listed below.

LBKA	Toggles the T1-A between no loopback and line loopback
LBKB	Toggles the T1-B between no loopback and line loopback
Tx PWR	Right arrow increments radio transmit power up Left arrow decrements radio transmit power down VT100 terminal will indicate Tx Power setting

Non-volatile Memory

The TRACER 4103 system contains non-volatile memory to retain certain configuration settings. These settings include:

Frequency plan
Chipping code
Password
Password enabling
Site name
T1 line coding
T1 framing
Signalling framing

Built-In Tests

The TRACER 4103 has several T1 loopbacks to aid in site setup and later debugging.

The monitor points provided on the front panel of the system are listed on the next page.

I	Demodulated received baseband output
Q	Demodulated received baseband output
RSSI	DC voltage indicating strength of the received signal at the antenna
GND	System ground

TX PWR	DC voltage indicating strength of transmitted signal of the baseband XXXX level

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.

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 TRACER 4103 and the antenna. These connections require male, type N coax connectors.

The *TO ANTENNA* connection provides the connection between the TRACER 4103 and the antenna.

Antenna

TRACER 4103 is intended to be coupled with an antenna that is directional and provides signal gain. There are several reasons for this requirement:

- TRACER 4103 operates in point-to-point applications; therefore, an omnidirectional antenna is not needed.
- The FCC provides no recourse in this band in the event of nearby interference, so a directional antenna reduces the likelihood of interference in the antenna pattern.
- The low power transmitter is intended to be used with a high-gain antenna for long links.

The antenna requirements are listed below.

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

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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 antennas. (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 4103 is designed in three versions with the following power options:

2.4 GHz @ 100 mW
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 16.5 feet (5 meters) from the center of the antenna. **The following precautions must be taken during installation of this equipment:**

- 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 16.5 feet (5 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 16.5 feet (5 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 4103 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.

UNPACK, INSPECT

Carefully inspect the TRACER 4103 for any damage. If damage is suspected, file a claim with the carrier, then contact ADTRAN Customer Service. If possible, keep the original shipping container for use in shipping the TRACER 4103 back for repair or for verification of damage during shipment.

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

Configuration

Provided by ADTRAN
- TRACER 4103 unit
- DS1/DSX-1 interface cable (RJ-48 to RJ-48)

Provided by customer
- 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

INSTALLATION

Location and Mounting

Install the TRACER 4103 in a location that requires minimal antenna feedline length (the loss in this cable directly affects overall system performance). The TRACER 4103 is designed to be mounted in a rack.

Power Requirements

The TRACER 4103 can operate from a supply between 21 and 60 volts DC, with either polarity referenced to ground, and consumes 15 watts. Current required (in amps) is determined by dividing the power consumed (in watts) by the applied voltage (in volts). As an example, TRACER 4103 would draw approximately 15 watts/48 volts = .3145 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.

The supplemental equipment grounding terminals are located on the rear panel of the TRACER 4103 adjacent to the power connectors.

DS1/DSX-1 Interface

The rear panel of the TRACER 4103 has two sets of jacks labeled T1A and T1B which provide the same functionality. The pin assignments for the eight-position modular jack are listed below.

Pin	Name	Function
1	R	Send data (ring)
2	T	Send data (tip)
3		Not Used
4	R1	Receive data (ring)
5	T1	Receive data (tip)
6		Not Used
7		Not Used
8		Not Used

Bantam jack connections are provided for test equipment access. Data is received on the jack labeled "IN" and is transmitted on the jack labeled "OUT." Bantam jacks are provided for both inserting and monitoring the interfaces. When a plug is placed in the insert jack, the connection between the modular jack and the interface circuitry is broken. The monitor jacks provide access to monitor the transmitted and received signals without interference.

When connecting the T1 interface to the public switched network, an ADTRAN-provided crossover cable (P/N 3125M011@A) is required to meet FCC part 68 and IC CS03 requirements. This cable is required to cross-over the Tx and Rx pairs to meet the connecting arrangement of a network interface device. This cable, labeled "T1 Crossover," is included with the TRACER 4103.

For connections to other CPE-type equipment, such as an ADTRAN TSU, a straight-through T1 cable (ADTRAN P/N 3127004) is included with the TRACER 4103.

Each DS1/DSX-1 interface must be configured for line code and framing via the VT100 terminal. The choices for line code are AMI and B8ZS. The options for framing are D4 and ESF. Each channel can be configured independently of the other and should be configured to match the attached T1 equipment.

The line buildout (LBO) must be set for each DS1/DSX-1 interface. The LBO setting allows each DS1/DSX-1 interface transmitter to drive the interface with the correct signal strength and equalization based on the line attenuation between TRACER 4103 and the attached equipment. The LBO is independently set for each interface via rotary switches on the front panel. Two sets of configurations are provided – DSX-1 for short-haul interface (less than 655 feet) and DS1 for long-haul interfaces (greater than 655 feet). The settings are detailed below.

Interface Type	LBO	Switch Setting
DSX-1	0-133 feet	2, 3
DSX-1	133-266 feet	4
DSX-1	266-399 feet	5

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 -60dBm.

Antenna Feedline Loss

Feedline loss is a function of feedline type and length. Feedline loss per 100 feet for several types of coax at RF frequencies is detailed in the table below. The RF loss applies to TRACER 4103/antenna interconnection. Antenna manufacturers' specifications may vary.

Cable	2.4 GHz RF Loss/100 ft (in dB)	5.7 GHz RF Loss/100 ft (in dB)
RG58	80	N/A
RG8 (air)	20	N/A
RG8 (foam)	9	N/A
1/4” Coax	5.91	11.36
3/8” Coax	5.76	9.65
1/2” Coax	3.83	6.49
7/8” Coax	2.2	N/A
1 1/4” Coax	1.62	N/A
1 5/8” Coax	1.41	N/A
5.8 GHz Elliptical Waveguide	N/A	N/A

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.

IF Loss/100 ft (in dB)	2.4 GHz RF Loss/100 ft (in dB)	5.7 GHz RF Loss/100 ft (in dB)
2	21	28.5
4	27	34.2
6	31	37.5
8	33	40.7
10	35	42.5
12	37	44.2

Path Loss

The free space path loss is given by

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

where D is distance in miles

f is operating frequency in GHz

A tabulation of various path loss is given below.

Link Distance (in miles)	2.4 GHz Path Loss (in dB)	Link Distance (in miles)	2.4 GHz Path Loss (in dB)	Link Distance (in miles)	5.8 GHz Path Loss (in dB)	Link Distance (in miles)	5.8 GHz 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:

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

where C is the climate factor
T is the terrain factor
f is the frequency in GHz
D is the path length in miles
F is the fade margin in dB

Climate factors are given below.

Climate	Climate Factor
Very Dry	1/8
Temperate	1/4
Humid	1/2

Terrain factors are listed below.

Terrain	Terrain Factor
Smooth	4
Average	1
Mountainous	1/4

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

-91 dBm (-90 dBm for 5.8 GHz)	Minimum Signal Power
+	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 antennae 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 antennae gains greater than 6 dBi.

Antenna Gain	Power
6 dBi	30 dBm (TRACER 4103 & 2.4 GHz 1 watt output option)
12 dBi	28 dBm (TRACER 4103 & 2.4 GHz 1 watt output option)
18 dBi	26 dBm (TRACER 4103 & 2.4 GHz 1 watt output option)
24 dBi	24 dBm (TRACER 4103 & 2.4 GHz 1 watt output option)
30 dBi	22 dBm (TRACER 4103 & 2.4 GHz 1 watt output option)
36 dBi	20 dBm (TRACER 4103 standard output option)

The transmitter power is set via a/b rocker switch via the configuration page of the interface VT100. Attach an RFC power meter to the N-type antenna connector on the rear panel on the TRACER 4103, and adjust the power by the VT100 until the desired transmitter power is obtained.

APPLYING POWER

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 TRACER 4103. 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. The LED will indicate which frequency plan is active.

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. Through the VT100 terminal, TRACER 4103 is shipped in a matched (default) configuration.

W A R N I N G

It is possible for the spreading code to be changed remotely through the VT100 interface from the other end of the link. When this is performed, communications will be lost to the far end. The spreading code will chine to code “0” and communications will be lost as soon as this change is made. If this happens, set the Spreading Code on the local unit to code “0”. The units should regain communications as soon as the correct code is selected.

CO-LOCATING MULTIPLE SYSTEMS

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 TRACER 4103 has been installed and connected, the antenna should be connected to the TRACER 4103 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 5 volts, with 0 volts corresponding to a weaker received signal and 5 volts corresponding to a stronger received signal.

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 the front of the TRACER 4103. 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 “RF 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.

ALARM CONTACTS

One alarm contact, the major alarm, is provided on the rear of the TRACER 4103. A major alarm indicates the radio link is not operational. A See **Table 2-1** for a summary of major and minor alarms. Under normal operating conditions there is no continuity between the Normally-open and Common contacts and under an alarm condition continuity between those contacts exists. The Normally-closed and Common contacts normally have continuity, while under alarm conditions, these contacts are open.

Table 2-1. Discreet Alarm Summary

Alarm Type	Interface	Description
Major	RF	T1 Mux Sync Fail (Link Error)
Minor	RF	RF Low
Minor	T1A	Yellow Alarm
Minor	T1A	Bipolar Violations
Minor	T1A	Received AIS (Blue Alarm)
Minor	T1A	Carrier Loss
Minor	T1A	Sync Loss
Minor	T1A	Data Loss
Minor	T1B	Yellow Alarm
Minor	T1B	Bipolar Violations
Minor	T1B	Received AIS (Blue Alarm)
Minor	T1B	Carrier Loss
Minor	T1B	Sync Loss
Minor	T1B	Data Loss

VT100 USER INTERFACE

The TRACER 4103 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 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 4103 is shipped with password protection disabled.

RS-232 INTERFACE

The TRACER 4103 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 Name	Pin Number	Direction
TXD	2	To TRACER 4103
RXD	3	From TRACER 4103
RTS	4	To TRACER 4103
CTS	5	From TRACER 4103
DSR	6	From TRACER 4103
Ground	7	
DCD	8	To TRACER 4103
DTR	20	To TRACER 4103

MODEM CONNECTION

Modem controls, discussed in the Configuration Menu page of this section, will enable or disable modem control. When this option is enabled from a standard terminal connection, all RS-232 communications will cease until a modem is attached with a Null-Modem adapter between the TRACER 4103 and data modem. The data modem will need to be configured for AUTO ANSWER and 9600 BPS. When the user connects via modem to the TRACER 4103 unit, communications via the RS-232 port will resume. If a user accidentally enables modem control from a terminal and disrupts the RS-232 communication, pressing [CTRL Z] three times, will temporarily disable the modem control option. This will allow the user to access the system configuration page to disable modem control.

When modem control is enabled, the RS-232 port is inactive until DTR and DCD are active. This prohibits data being sent to the modem or received from the modem while idle. The required Null-Modem adapter may be obtained at any computer hardware supplier. A straight-through serial cable should be used between the adapter and the modem or TRACER 4103 unit. To ensure that the far-end modem disconnects when desired, modem control system of the CONFIGURATION PAGE will disconnect the modem. The modem must be configured to drop the connection on loss of DTR in order to disconnect.

Table 3-1. Alarm, Status, and Command Overview

Item	Description
Frequency Plan	A = 2422 MHz TX, 2462 MHz RX or 5747 Tx, 5827 Rx B = 2462 MHz TX, 2422 MHz Rx or 5827 Tx, 5747 Rx
10 Second BERT Test	Remote end sends BERT pattern for 10 seconds
Local T1A Line Loopback	Loops local T1A interface towards local CPE
Local T1B Line Loopback	Loops local T1B interface toward local CPE
Local T1A Line Loopback	Loops local T1A interface towards remote CPE over the RF link
Local T1B Line Loopback	Loops local T1B interface toward remote CPE over the RF link
RFC Link Fail	Active if the command link between the baseband processor and the RF converter is down
Code Sync Fail	Active if the link fails to achieve code sync
Carrier Sync Fail	Active if the link fails to avchieve carrier sync
T1 Mux Sync Fail (Link Error)	Active if the T1C Mux fails to achieve sync
Remote RF Down	Active if the remote TRACER 4103 unit is not receiving data
RF Low	Active if receive power is below – 80 dBm
Remote Test Fail	Active if the 10 second BERT has failed over the RF link to the far end
T1A BPV	Active when the T1A incoming data stream presents bipolar violations
T1A LOS	Active when ther is no signal present at the T1A interface
T1A AIS	Active when the T1A DS1/DSX-1 is recieiving a blue code (all one)
T1A LBKA	Active when the T1A is transmitting a blue alarm code (all ones)
T1B BPV	Active when the T1B incoming data stream presents bipolar violations
T1B LOS	Active when ther is no signal present at the T1B interface
T1B Yellow Alarm	Active when the far end T1B equipment is in red alarm
T1B AIS	Active when the T1A DS1/DSX-1 is recieiving a blue code (all one)
T1B LBKB	Active when the T1B DS1/DSX-1 is transmitting a blue code (all ones)

Table 3-2. Discreet Alarm Summary

Alarm Type	Interface	Description
Major	RF	T1 Mux Sync Fail (Link Error)
Minor	RF	RF Low
Major alarm contacts are provided on the rear of the TRACER 4103. A major alarm indicates the radio link is not operational.		

RF DOWN SYSTEM STATUS

If there is an error condition on the RF link, the [RF UP] labels on the link map will be replaced by [RF DOWN] or [?????] labels. During a RF error condition, it is not possible to receive status information from the remote site. However, when the RF link is intact, error conditions on any of the T1 interfaces

are reported by the “T1A” and / or “T1B” labels becoming highlighted in reverse video. If the error is on the local TRACER 4103, the T1 status menu can be accessed for complete alarm information. If the error is on the remote unit, remote access can be utilized (via another menu option) to check the status of the T1 interfaces at the remote end. The System Status Screen is shown in **Figure 3-1**.

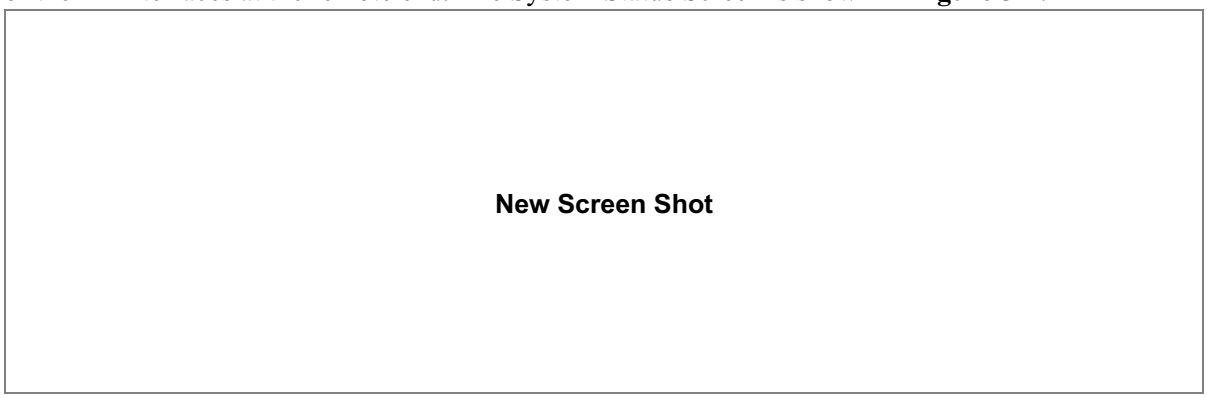

Figure 3-1. System Status Screen

CABLE CONNECTIONS

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

PASSWORD

TRACER 4103 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 “Disabled.” Password protection is enabled via the system configuration menu. The password is also set via the system configuration menu.

If the password is forgotten, physical access to TRACER 4103 is required to access the terminal interface. The password may be bypassed by holding in the LBK 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.

C A U T I O N

This procedure is service-affecting.

MAIN MENU SELECTIONS

System Status Screen

The Screen in **Figure 3-2** displays the status of major system components. 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.

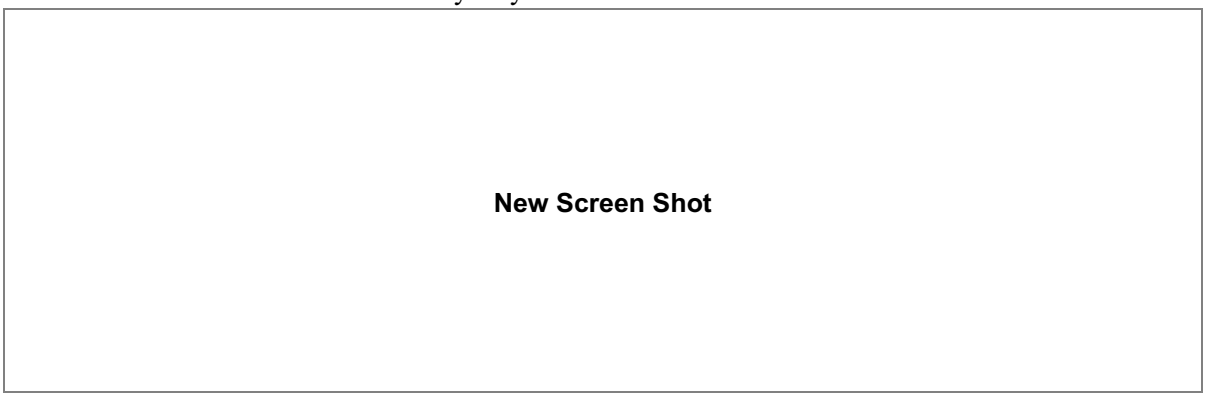

Figure 3-2. System Status Screen

The upper portion of the screen indicates how long the system has been running since the last reset operation. The “T1A” and “T1B” labels will be highlighted if any error conditions exist on that T1 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 remote side fuel gauges will be replaced with a “Data Not Available” message. The Code Sync, Carrier Sync, and T1 Mux Sync will all be “yes” for an operational link. Chipping code indicates the code to which the system is set. At any point in the VT100 menu structure, pressing the 0 (zero) key will bring the operator back to this screen.

Main Menu Screen

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

Figure 3-3. Main Menu Screen

System Configuration Screen

The system configuration is displayed on this screen. The T1 receive level cannot be configured. Information such as T1 transmit levels, chipping code, site name, modem control, password, and performance stats can be configured. Selections are made by highlighting the option with the up or down arrow keys and then pressing Enter. The option is changed by using the left or right arrow keys and the pressing Enter.

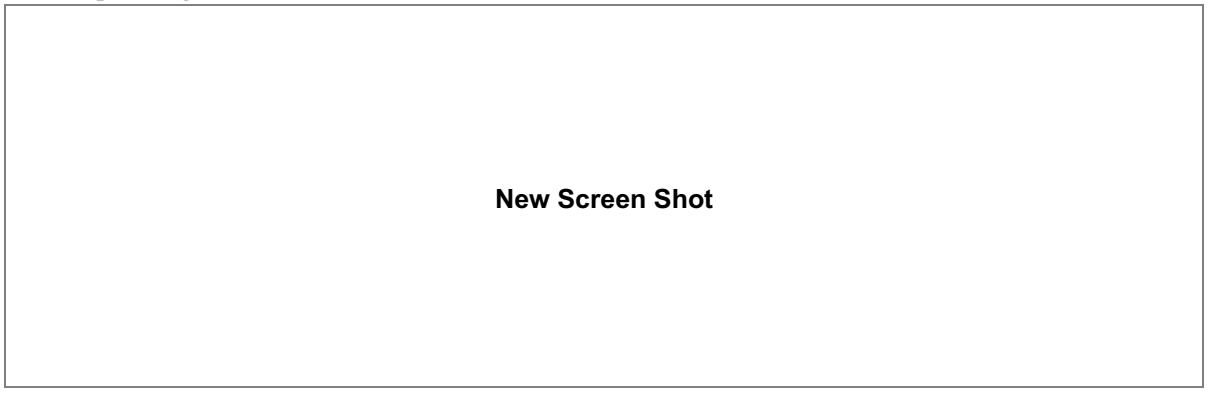

Figure 3-4. T1 Status Screen

W A R N I N G

It is possible for the spreading code to be changed remotely through the VT100 interface from the other end of the link. When this is performed, communications will be lost to the far end. The spreading code will change to code "0" and communications will be lost as soon as this change is made. If this happens, set the Spreading Code on the local unit to code "0." The units should regain communications as soon as the correct code is selected.

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.

Reset All Statistics resets all the error counters.

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

Change Password allows the password to be set.

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

Enable T1 disables Alarm and LEDs related to T1-B, but will pass T1 data.

Disable/Enable Modem Control enables modem control leads on RS 232 port. See Modem Connection under Operation Section.

Disable Modem lowers the DSR signal, which becomes DTR after passing through the null modem adapter. When modem is configured to disconnect on loss of DTR, the connection will drop.

Link Performance History Screen

This screen in **Figure 3-5** 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 counts for the most recent 24 hours are recorded in 15-minute increments. Twenty-four-hour totals are recorded for the most recent days.

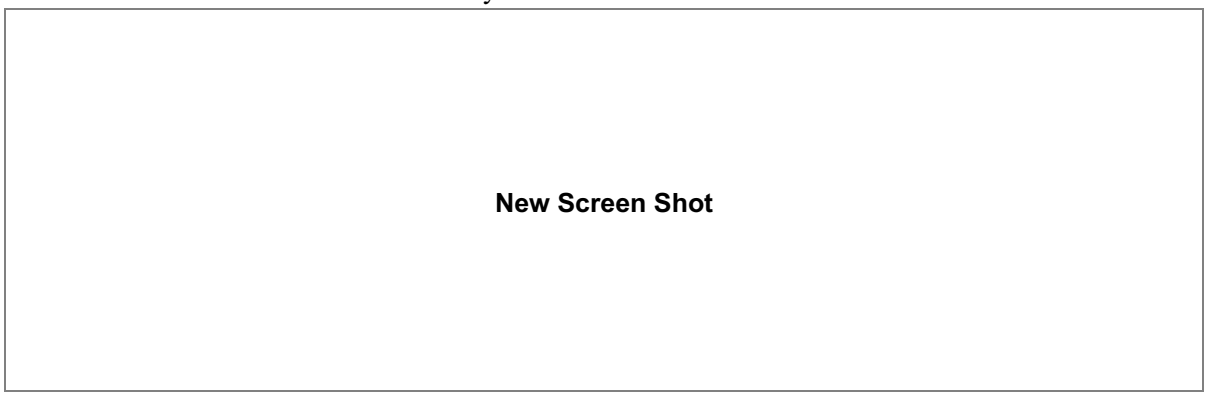

Figure 3-5. Link Performance History Screen

T1A Performance History

This screen in **Figure 3-6** presents detailed error statistics for T1A. 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.

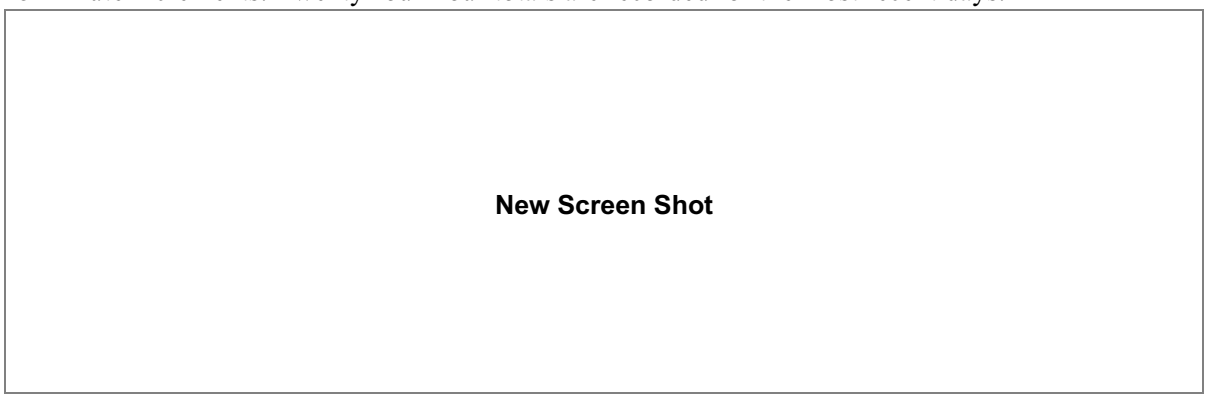

Figure 3-6. T1A Performance History

T1B Performance History

This screen in **Figure 3-7** presents detailed error statistics for T1B. 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.

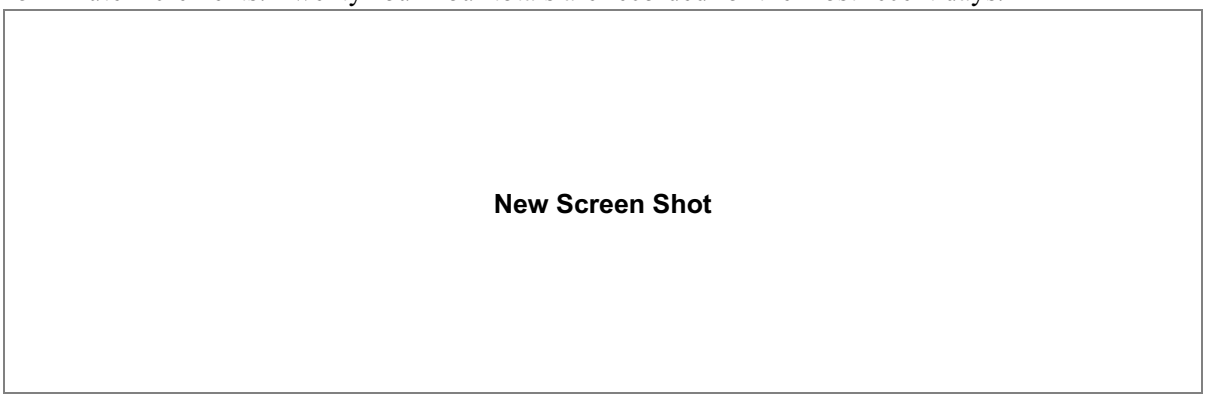

Figure 3-7. T1B Performance History

T1A and T1B Status/Configuration/Loopback Page

This screen reports remote and local T1 interface alarms and allows all T1A or T1B configurations to be performed.

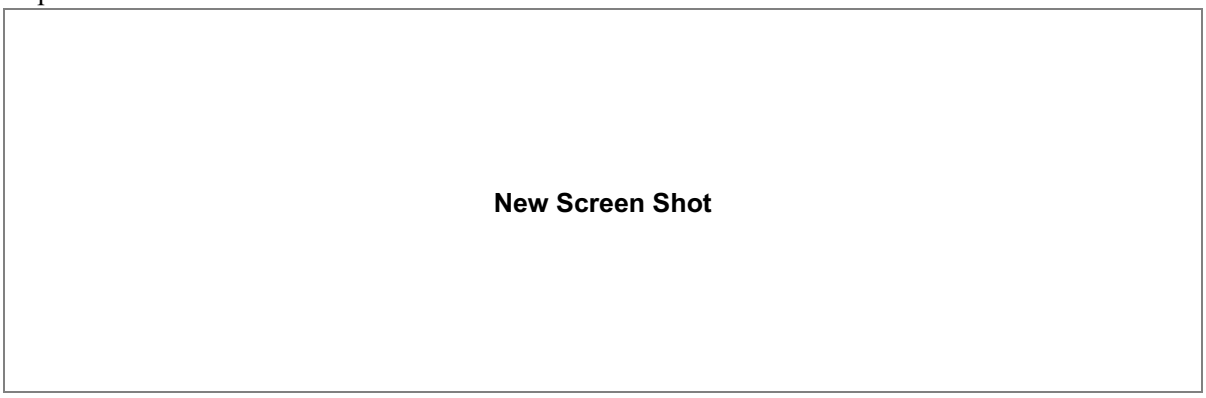

Figure 3-8. T1A Status/Configuration/Loopback Page

The menu selections are described below.

T1A and **T1B Framing** allow each T1 to be configured for SF or ESF framing.

T1A and **T1B Line Code** allow each T1 to be configured for AMI or B8ZS.

T1A and **T1B Line Buildout** allow each T1 to be configured for the appropriate line buildout, based on the distance to the T1 equipment.

Local Line (T1-A/T1-B) loops the appropriate local T1 interface towards the local customer equipment.

Local Link (T1-A/T1-B) loops the appropriate local T1 interface towards the remote customer equipment, over the RF Link.

Remote Line (T1-A/T1-B) loops the appropriate remote T1 interface toward the remote customer equipment.

Remote Link (T1-A/T1-B) loops the appropriate remote T1 interface towards the local customer equipment, over the RF link.

Figure 3-9 shows these loopback locations.

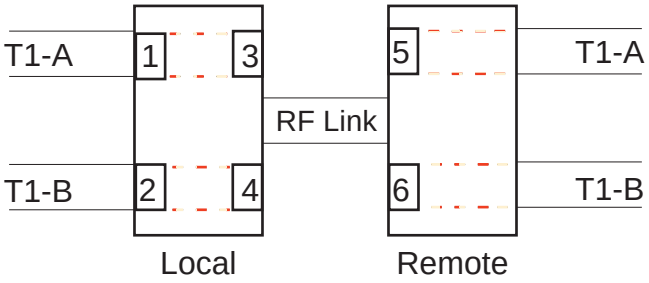

Figure 3-9. T1 Loopback Locations

Table 3-3 describes the T1 interface alarms.

Table 3-3. T1 Interface Alarms

BPV	This alarm will activate when the incoming T1 stream presents bipolar violations (BPUs).
AIS	This alarm will activate when the DS1/DSX-1 input receives a “blue code” (a string of 2316 1s with no more than one zero.
YEL	This alarm will activate when a YEL signal is received on the T1.
RED	This alarm will activate when there is no signal present on the T1 interface.
LOS	This alarm (loss of signal) will activate when there is no signal present at the T1 interface.

I M P O R T A N T

If problems persist after you have followed the Recommended Actions, contact ADTRAN Technical Support at (800)726-8663.

Power LED is not Lit

If the power LED is not lit, it is an indicator that the baseband processor is not receiving adequate DC power.

Recommended Actions:

1. Verify that the power source is delivering between and 21- 60 VDC.
2. Check the polarity of the power connection by verifying that the positive voltage is applied to the terminal labeled "+" and the negative voltage is applied to the terminal labeled "-."

Test LED is Blinking

The test alarm will remain *On (solid)* during power-up indicating a self-test is in progress. If the test LED is *Blinking* or remains *On (solid)*, this indicates that TRACER 4103 unit has failed a self test. This is an internal failure, and ADTRAN technical support should be contacted.

Red Alarm (LOS)

A Red Alarm is generated at the TRACER 4103 T1 interface when that interface cannot find the T1 framing information. This error may be due to a degraded signal or no signal, or it may be caused by improper framing.

Recommended Actions:

1. Verify that the T1 cable is connected to the T1 interface on TRACER 4103 unit.
2. If the RJ-45 connection is used, verify that the connector is wired correctly. If the bantam jacks are used, verify that they are inserted into the correct sockets.
3. Verify the connections at the opposite end of the T1 cable.
4. Verify that the framing mode (ESF or D4) is on the same is on the same setting for both the TRACER 4103 unit and the connected equipment.

Blue Alarm (AIS)

A Blue Alarm (also called AIS, keep alive, and all-ones), when indicated at TRACER 4103, is generated by the attached equipment. The root cause must be determined at the attached equipment. A typical cause of a blue alarm is a lack of input to a CSU.

I M P O R T A N T

If problems persist after you have followed the Recommended Actions, contact ADTRAN Technical Support at (800)726-8663.

Yellow Alarm

A Yellow Alarm, when indicated at TRACER 4103, is generated by the attached equipment. When the attached equipment's T1 interface is in Red Alarm, a Yellow Alarm will be generated at the TRACER 4103 unit.

Recommended Action:

1. Follow the troubleshooting steps for Red Alarm, but do so at the attached equipment BPV Alarm

BPV

This alarm will activate when the incoming T1 stream presents Bipolar Violations (BPV). BPVs indicate an improper configuration or a faulty cable plant.

Recommended Actions:

1. Verify the TRACER 4103 Unit and the attached equipment are configured for the same line coding (AMI or B8ZS).
2. Verify that the Line Buildout (LBO) of the attached equipment is correct.
3. Inspect the cable plant for split pairs. A split pair is a condition in which the T1 interface is incorrectly wired into the cable plant. Each interface direction, transmit and receive, is carried on two signals - tip and ring. Normally, tip and ring for the transmit signal comprise the two wires for a single twisted pair in the bundle. It is not uncommon for one connection from the transmit interface and one connection from the receive interface to comprise another twisted pair. This condition is referred to as a split pair, and it can cause signal degradation.

Link Error LED is Lit, or the RF Link is Down

Recommended Actions:

1. Check the BBP to RFC coaxial cable connection.
2. Check the RFC to antenna coaxial cable connection.
3. Measure the RSSI voltage. If the signal is good ($\geq$ 2.0 Vdc at BBP RSSI Test Point), go to step 8.
4. Verify one plan A and one Plan B.
5. Check the fuse on the IF board. If this fuse is open, check the BBP to RFC coaxial cable for a short.
6. Verify the antenna polarity at both ends of the RF signal transmit and receive path.
7. Verify that the RF signal path is clear.
8. Verify same PN code on both ends of the RF signal path.
9. Possible interference, check or change both ends.

I M P O R T A N T

If problems persist after you have followed the Recommended Actions, contact ADTRAN Technical Support at (800)726-8663.

RF Low LED is Lit

This indicates that the received signal is within approximately 10 dB of the minimum operable signal. This condition is typically indicative of a path problem.

1. Verify the far-end transmitter power setting is the value that the link planning budget allows.
2. Check all coaxial cable connectors for solid connections. Check for water and lightning arrestors around any of the connectors.
3. Verify the RF signal path by verifying the antenna alignment.
4. Check integrity of the cable plant.

This section lists the specifications for the TRACER 4103 system.

Transmitter

Output Power ..... +20 dBm, max, for 1 watt 2.4 GHz, factory setting is +27 dBm
Frequency Range ..... 5747 to 5827 MHz
Channel Bandwidth ..... 40 MHz (2.4 GHz) (two channels) or 62 MHz (5.8 GHz)
I/F ..... 280 MHz

Receiver

Receive Level, range ..... -30 to -91 dBm (-90 dBm, 5.8 GHz) (10-6 BER minimum)
Receive Level, maximum ..... -30 dBm
Receive Level, nominal ..... -60 dBm
IF ..... 140 MHz

Frequency Plan

Plan A 5.8 GHz ..... Tx 5.747 GHz, Rx 5.827 GHz
Plan B 5.8 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 T1
Connection ..... RJ-48C, bantam
Line Code ..... AMI, B8ZS
Framing ..... D4, ESF
Alarms ..... AIS, Red, Yellow, BPVs
Loopbacks ..... Local line, local link, normal link

User Interface

Front Panel ..... Alarm LEDs, Monitor Jacks
Diagnostics ..... T1 Loopback
Test Points ..... RSSI, QPSK Constellation, TX PWR
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

TRACER 4103
Operating Temperature ..... -25°C to 65°C
Size ..... 19" x 1.75" x 10.5"
Humidity ..... 95%, Non-condensing
Weight ..... 6 lbs.

Power

Input Voltage ..... 21 to 60 volts DC, either polarity referenced to ground
Power Consumption ..... 15 watts
Connector ..... 2 pin terminal block (DC)

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 located on the ADTRAN web site at http://www.adtran.com.

SALES

For TRACER 4103 sales information, contact Adtran Sales at:

(888) 3ADTRAN or http://www.adtran.com/wireless

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

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 35814-4000

When returning faulty equipment, please include the RMA number on the shipping label.

ACRONYMS USED IN THIS MANUAL

AMI	Alternate Mark Inversion
B8ZS	Bipolar 8 zero substitution
BER	Bit error rate
BBP	Baseband Processor
CRC	Cyclic Redundancy Check
DCE	Data Communications Equipment
DTE	Data Terminal Equipment
ESF	Extended superframe
FCC	Federal Communicaitons 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

Glossary

The cable connections required for various configurations are detailed below.

Terminal Connection (DB25)

TRACER 4103 (DCE)			Terminal (DTE)	
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)

TRACER 4103 (DCE)			Computer (DTE)	
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)

TRACER 4103 (DCE)			Modem (DCE)	
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