Technical Specifications

The following pages contain the technical specifications for the Rackmount TRACER with 1 Watt option as provided by ADTRAN, Inc. Included in the specifications is an RF block diagram. ADTRAN, Inc. respectfully requests that this information be withheld from public inspection.

Revision	Date	ECO#	Comments

Tracer - Rack Configuration With 1 Watt Option

PRODUCT SPECIFICATION

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Introduction

Overview

The Tracer provides dual T1 transport via a spread spectrum microwave link for distances over 20 miles. System performance is determined, in part, by the engineering of the microwave link. Each end of a Tracer link is comprised of two units - the baseband processor and the radio frequency converter (RFC). The DS-1 (T1) interfaces are provided on the rear of the baseband processor, which is mounted in a nineteen inch rack. The DS-1 interface provides connections up to 6000 feet from T1 equipment. The radio frequency converter can be rack-mounted adjacent to the baseband processor or, for higher system performance, can be mounted in a weather-tight enclosure adjacent to the antenna. A single coaxial cable connects the baseband processor to the RFC and another coaxial cable connects the RFC 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 are 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz and are designated for use only by spread spectrum transmitters, either frequency hopping or direct sequence. The Tracer operates in the 2400 - 2483.5 MHz band using direct sequence spread spectrum transmission.

Applications

Any application which would typically use metallic T1 as a transport can use Tracer instead. Figure 1 illustrates a typical application.

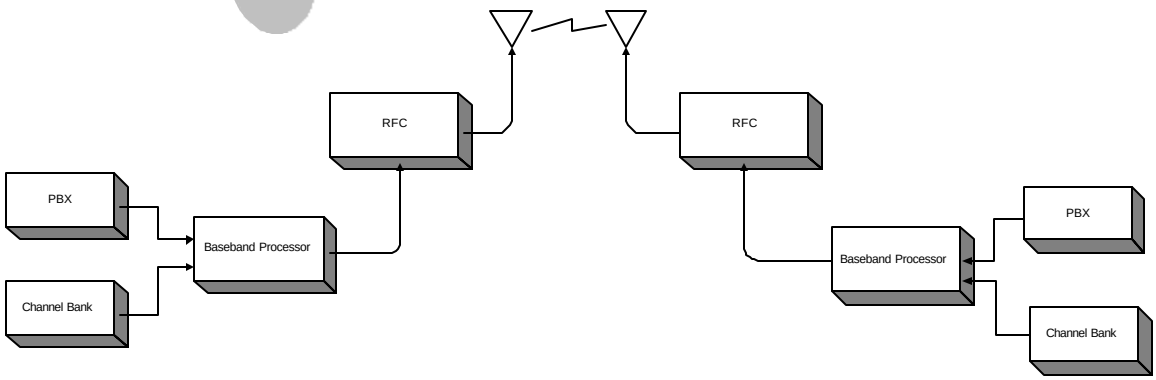


Figure 1

In addition to telephony applications, uses in data communications, such as internetworking, video conferencing, and telemetry are possible. In short, any requirement for sharing data at a high rate is an application in which Tracer can be put to use.

Spread Spectrum

Spread spectrum is a form of communication in which the bandwidth of a message signal is *intentionally* increased, or spread. The FCC allows two methods of spreading - frequency hopping and direct sequence.

Frequency Hopping

A frequency hopping transmitter shifts the carrier frequency in discrete increments as dictated by a code sequence. The FCC mandates the minimum number of channels which may be used and the maximum amount of time, on average, that the transmitter may dwell on a given frequency.

Direct Sequence

A direct sequence transmitter spreads the signal by performing some operation, such as an exclusive -OR, with the message signal and another signal, typically a pseudo-random sequence, which changes at a higher rate than the message signal. The rate at which the pseudo-random sequence changes is called the chipping rate. The Tracer uses direct sequence with a chipping rate that is twelve times the data rate.

Coding

Many different pseudo-random sequences exist. The sequences are called pseudo-random because, although they appear random, they are determinant and repeat after a specific number of chips. The longer a code is, the better correlation characteristics it possesses, *e.g.* cross-correlation between different sequences is low, auto-correlation of non-aligned like sequences is low, but auto-correlation of aligned sequences if high. Tracer allows the selection of one of eight different one-hundred and twenty bit long sequences.

Channel Selection

The FCC has allocated 83.5 MHz of spectrum in the band in which the Tracer operates. A Tracer system fully utilizes the available bandwidth - transmitting in one half and receiving the other. Figure 2 illustrates the bandwidth division.

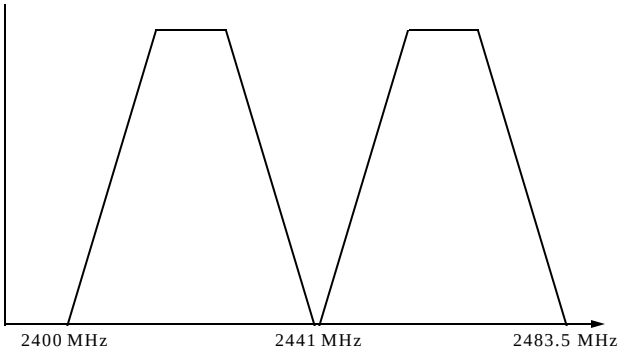


Figure 2

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 frequency plan A and frequency plan B. One end of a path will be on frequency plan A and the other will be on frequency plan B. Each RFC must be configured for a given channel plan by using a specific cabling scheme. Additionally, the RFC must be informed for which plan it is configured to allow the frequency synthesizers to be correctly programmed. This is accomplished via the front panel or the terminal interface.

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 retransmission of an errored block, once detected. The Tracer implements forward error correction (FEC), on the other hand, which adds enough overhead data for the receiver to detect and correct errors in the data stream. This capability comes at the cost of additional bandwidth. The addition of FEC decreases the required S/N by approximately 5.5 dB for a given bit error rate (BER).

Functional Specification

Tracer *System Configuration*

A Tracer system is comprised of three major subsystems - baseband processor, radio frequency converter (RFC), and antenna. This section describes the major system components.

Baseband Processor

The baseband processor is a 1-U, nineteen inch rack-mountable unit. This unit provides the system electrical interfaces, user controls and indicators, and performs the spread spectrum processing for the system. The rear panel provides all of the electrical interface points - DS-1 interface, DS-1 monitor, VT-100 compatible terminal, alarm contacts, IF signal, DC (from facility), and DC power (from AC adapter). A block diagram of the baseband processor is shown in Figure 3.

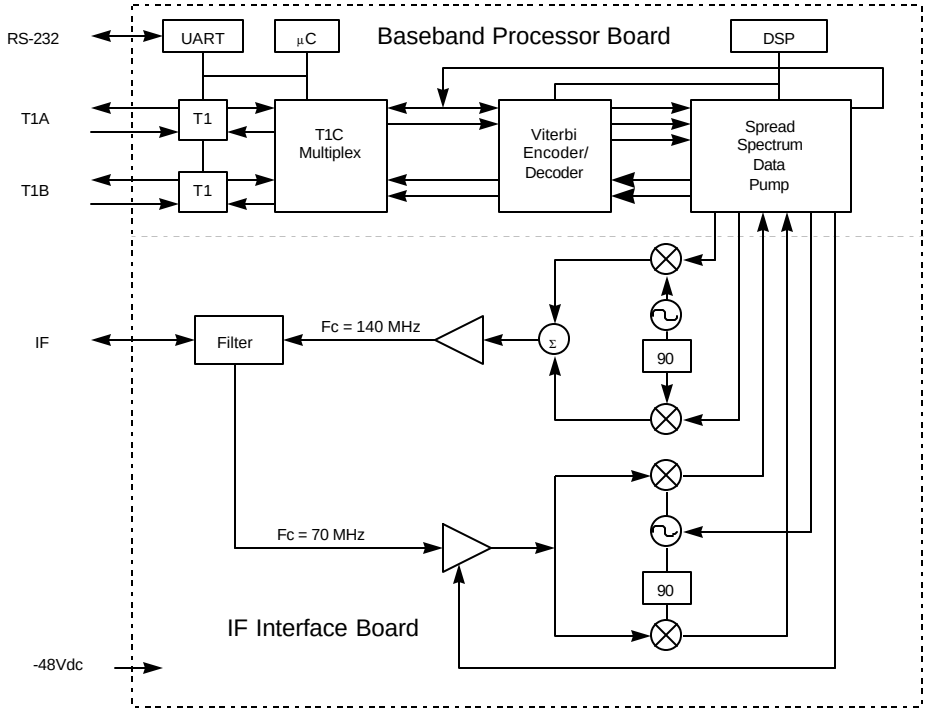


Figure 3

This diagram illustrates the RS-232, DS-1, power, and IF interfaces. The functions of the baseband processor are partitioned into three printed circuit boards, all contained in the same enclosure.

DS-1 Interface

Two DS-1 interfaces, designated T1A and T1B, are provided for connecting to the T1 equipment. Two types of physical interfaces are provided - RJ-48C and bantam jacks. The DS-1 interfaces 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.

T1 Alarms

The following definitions of T1 alarms apply to Tracer.

red alarm: A red alarm is caused by a locally detected facility failure.

yellow alarm: An alarm received at the transmit end of the circuit to indicate that a failure has occurred in the receive direction.

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 red alarm has occurred upstream in the circuit. This is also called a blue alarm.

When 192 consecutive zeroes are detected at the T1 interface the *RED* LED will light. The remote Tracer will transmit an AIS on the effected T1 to indicate a blue alarm.

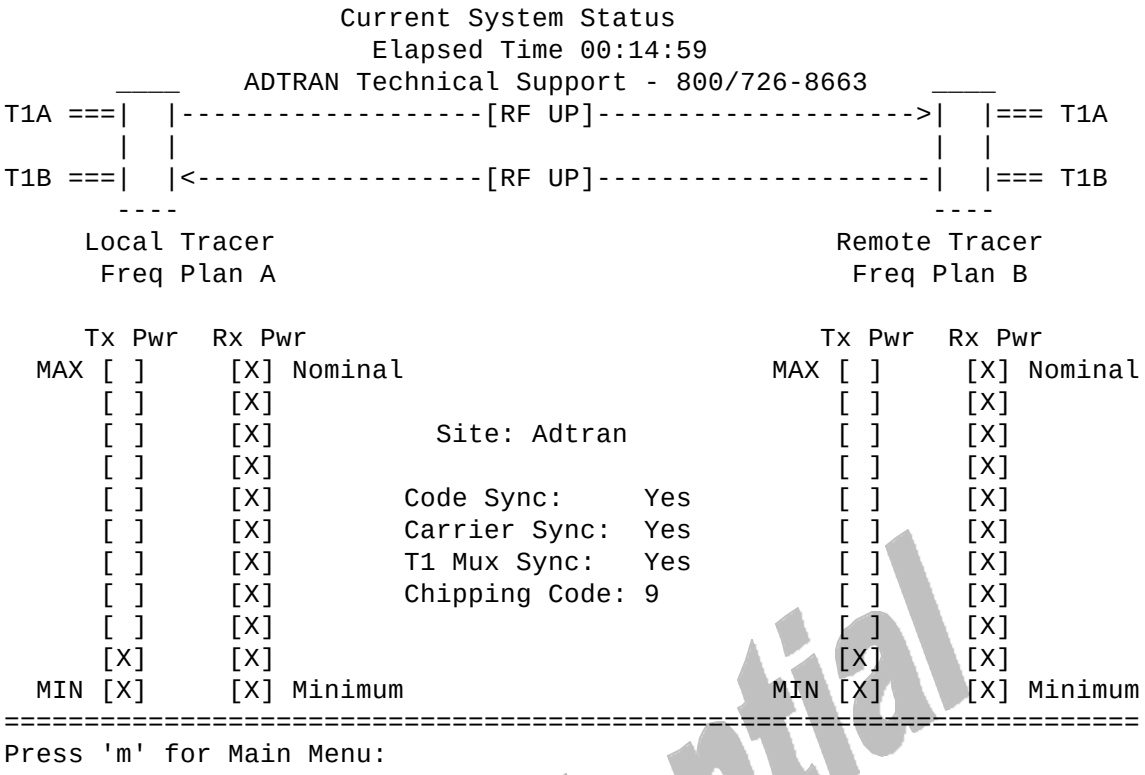
When the RF link is down a BLUE alarm will be transmitted on all T1s. No T1 alarm LEDs will be lit in this situation, but the *LINK DOWN* LED will illuminate.

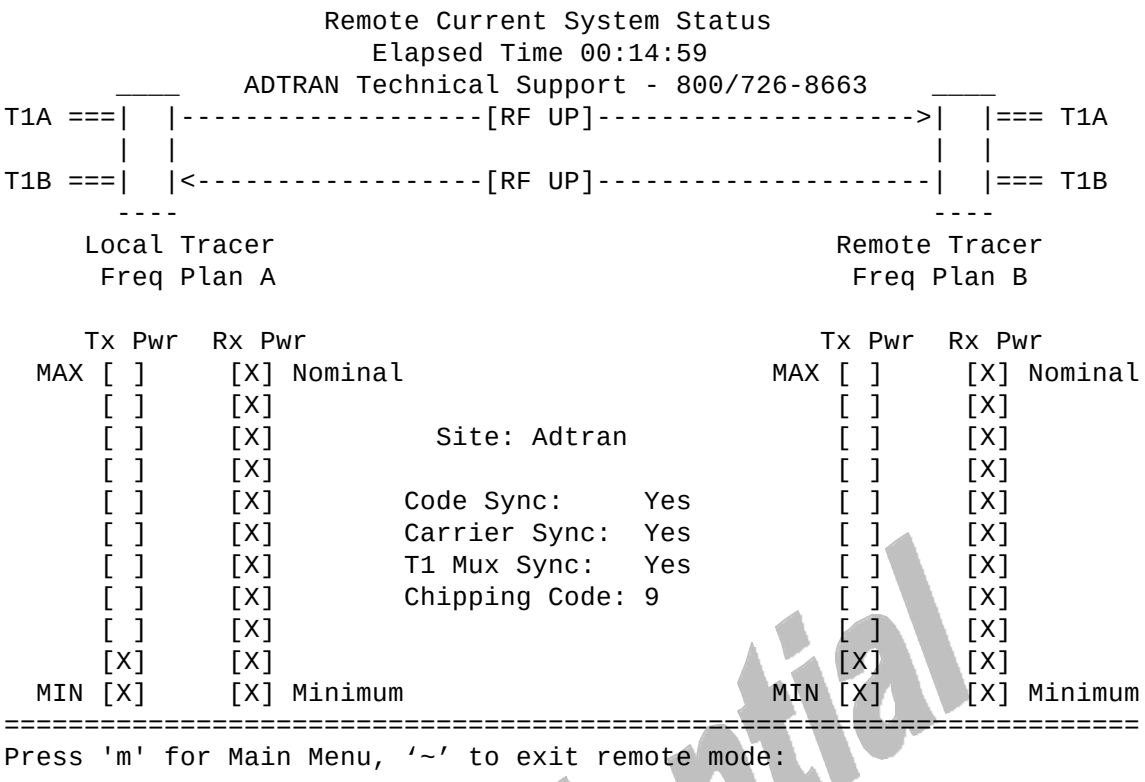
When a T1 interface receives a YELLOW alarm the *AIS/YEL* LED will blink. The Tracer at the remote end will pass the yellow alarm though on the effected T1.

When a T1 interface receives an AIS the *AIS/YEL* LED will light continuously. The remote T1 will transmit the AIS signal.

VT-100 Interface

A RS-232 interface is provided via a 25-pin D connector for attaching a VT-100 compatible terminal. The following pages illustrate the menu screens.





```
                Tracer Main Menu, Rev: C
                  Site: Adtran

 1) T1 Status Page
 2) T1A Performance History
 3) T1B Performance History
 4) Alarm Page
 5) Test Menu
 6) Configuration Menu
 7) Remote Access

================================================================
Press ESC for System Status:
```

```
                    Tracer T1 Status Menu
               Site: Adtran

                         T1A                       T1B

Loop/Normal State        Normal                    Normal
Received Signl Lvl       +2dB to -7.5dB            Less than -22.5dB
RX LOS (Red) Alarm       No                        Yes
RX AIS (Blue) Alarm      No                        No
RX Yellow Alarm          No                        No
TX AIS (Blue) Alarm      No                        No
Framing                  ESF (*)                   ESF (*)
Line Code                B8ZS (*)                  B8ZS (*)
Line Build Out           DSX 133 to 266 feet(*)    DSX 133 to 266 feet(*)

(*) Indicates last set by front panel. Otherwise last set by terminal.
================================================================================
Press 'm' for Main Menu:
```

```
                    Tracer T1A Performance History
                  Site: Adtran
     24 Hour Registers                          15 Minute Registers
       ---ES---SES--                           --ES-SES-----------ES-SES-
        00000 00000     <-- Current -->          000 000
    -1: ----- -----                         -1: 000 000     -17: --- ---
    -2: ----- -----                         -2: --- ---     -18: --- ---
    -3: ----- -----                         -3: --- ---     -19: --- ---
    -4: ----- -----                         -4: --- ---     -20: --- ---
    -5: ----- -----                         -5: --- ---     -21: --- ---
    -6: ----- -----                         -6: --- ---     -22: --- ---
    -7: ----- -----                         -7: --- ---     -23: --- ---
                                            -8: --- ---     -24: --- ---
                                            -9: --- ---     -25: --- ---
                                           -10: --- ---     -26: --- ---
                                           -11: --- ---     -27: --- ---
                                           -12: --- ---     -28: --- ---
                                           -13: --- ---     -29: --- ---
                                           -14: --- ---     -30: --- ---
                                           -15: --- ---     -31: --- ---
                                           -16: --- ---     -32: --- ---

================================================================================
Press 'm' for Main Menu:
```

```
                    Tracer Alarm Page
                 Site: Adtran

Code Sync Alarm         Off
Carrier Sync Alarm      Off
T1 Mux Sync Alarm       Off

                        T1A                         T1B

RX LOS (Red) Alarm      Off                         Off
RX AIS (Blue) Alarm     Off                         Off
RX Yellow Alarm         Off                         Off
RX BPV Alarm            Off                         Off
TX AIS (Blue) Alarm     Off                         Off

================================================================
Press 'm' for Main Menu:
```

```
                    Tracer Test Menu
                 Site: Adtran

 1) Local T1A Line Loopback
 2) Local T1B Line Loopback
 3) Local T1A Link Loopback
 4) Local T1B Link Loopback
 5) Remote T1A Link Loopback
 6) Remote T1B Link Loopback

================================================================
Press 'm' for Main Menu:
```

```
                    Tracer Configuration Menu
                  Site: Adtran

 1) T1A Framing
 2) T1A Line Code
 3) T1A Line Build Out
 4) T1B Framing
 5) T1B Line Code
 6) T1B Line Build Out
 7) Set Chipping Code
 8) Set TX Power
 9) Set Freq Plan
10) Reset all statistics
11) Enable/Disable Password
12) Change Password
13) Change Site ID
14) Enable/Disable T1B




================================================================
Press 'm' for Main Menu:
```

The active signals used on this interface are listed in Table 1.

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	-

Table 1

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 T1 interfaces:

- Blue alarm
- Bipolar violation
- Red alarm
- Yellow alarm

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

IF Signal

The N-type connector provides the interface point between the baseband processor and the radio frequency converter (RFC), whether rack or mast mounted. This connection provides the signal, power, and configuration information to the RFC. The cable for connecting the baseband processor to a rack-mounted RFC is provided. Because the length and characteristics of the feedline for a mast-mounted RFC are application-dependent the user must provide this cable.

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 3 pin terminal block allows the connection of any DC power source providing between 21 and 56 volts DC. The power consumption of the entire system is 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 baseband processor.

Options that are set from the front panel can be overridden via 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 in Table 2.

Self Test	Solid red if the self-test has did not complete. Blinking red if one portion failed.
Power	Green if DC voltage is applied

Table 2

Table 3 describes the LEDs associated with the DS-1 interfaces. There are two sections of identical indicators - one for each DS-1 interface.

BPV	Red if the incoming T1 stream contains bipolar violations
RED	Red if there is no signal present at the T1 interface (Red Alarm)
Loopback	Solid yellow if the T1 interface is in line loopback. Blinking yellow if the T1 interface is in link loopback.
YEL/AIS	Blinking yellow if yellow alarm is present at the incoming T1 interface Solid yellow if AIS (blue alarm) is present at the incoming T1 interface

Table 3

Table 4 lists the functions of the LEDs which relate system configuration information.

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

Table 4

Table 5 lists the LEDs that indicate error conditions in the spread spectrum data pump and RFC. All of these LEDs are visible through the front panel. Any one of these LEDs indicates and error condition that precludes system operation.

Link	Red if the link is not operational
RF Low	Red if the received RF carrier level is below ~-80 dBm.

Table 5

Table 6 lists the controls available from the front panel.

Name	Function
Reset	Reset the system
Channel A loop	Toggles between normal and line loopback modes
Channel B loop	Toggles between normal and line loopback modes
Remote Test	Initiate a remote test across the RF link

Table 6

Table 7 describes the monitor points provided on the front panel of the system.

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

Table 7

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
- T1 line coding (if set from VT-100)
- T1 framing (if set from VT-100)
- enable/disable state of T1B

Built-In Tests

The Tracer has the capability to perform several tests to aid in sight setup and later debugging. These diagnostics include T1 loopbacks and a link test with BERT (Bit Error Rate Test) data. A link test is performed by pressing the test button on the front panel. The remote will then send a pseudo-random 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.

Radio Frequency Converter

The radio frequency converter (RFC) provides the radio frequency (RF) interface between the baseband processor and the antenna. The RFC is partitioned,

functionally, into two major components - the transmitter and the receiver.

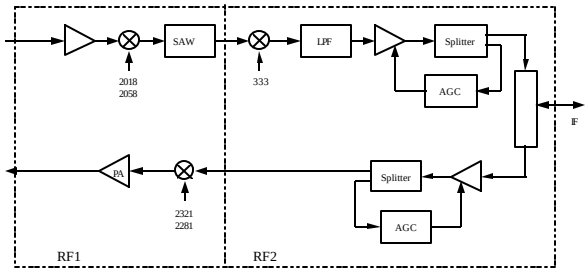


Figure 7

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

The RFC unit is enclosed in a metal enclosure approximately 10.5” x 5.5” x 1” and may be mounted in a nineteen inch rack housing or in a weather-tight enclosure suitable for mast mounting near the antenna. The RFC is illustrated in Figure 8.

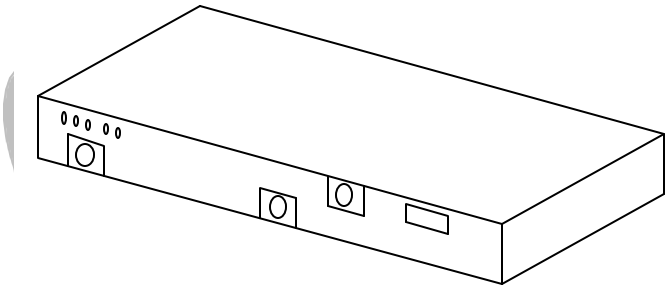


Figure 8

Three SMA connectors provide RF and IF connection points. Two test points are 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. A third test point is provided to monitor the transmitter output power during system configuration. The transmitter power may be adjusted at the RFC. This is a factory adjustment and should not be adjusted in the field. 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. The *IF* connector provides the connection between the baseband processor and the rack-mounted RFC. The *TO ANTENNA* connection provides the connection between the RFC and the antenna.

Antenna

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

- Tracer operates in point-to-point applications so omnidirectional antennas are not needed.
- The FCC provides no recourse in this band in the event of an interfering signal so a highly directional antenna reduces the likelihood of such a signal being 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 in Table 8.

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

Table 8

Detail Specification

This section lists the specifications for the Tracer system.

RF Transmitter

Output Power	+27 dBm factory setting, +30 dBm maximum
Frequency Range	2400 - 2483.5 MHz
Channel Bandwidth	40 MHz (Two Channels)

RF Receiver

Receive Level	-30 to -91 dBm (10^{-6} BER minimum)
Receive Level	0 dBm (no damage)
Receive Level	-60 dBm (nominal)
AGC Range	65 dB

Spread Spectrum Data Pump

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

T1 Interface Specification

Interface Rate	2x1.544 Mbps
Connection	RJ-48C, bantam
Line Code	AMI, B8ZS
Framing	ESF, D4
Alarms	red, yellow, blue
Loopbacks	local line, remote link, local link

User Interface

Panel	Alarm LEDs, Configuration Switches, Monitor Jacks
Diagnostics	T1 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

ASCII Terminal Interface

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

Mechanical & Environmental

Baseband Processor

Operating Temperature	0◦C to 50◦C
Size	19” x 1.75” x 11.5”
Humidity	95%, Non-condensing
Weight	6 lb.

Rack RFC

Operating Temperature	0◦C to 50◦C
Size	19” x 1.75” x 11.5”
Humidity	95%, Non-condensing
Weight	6 lb.

Power

Input Voltage	21 to 56 volts DC 100 to 220 volts AC, 50 or 60 Hz (with optional tabletop AC adapter)
Power Consumption	30 watts
Connector	3 pin DIN (AC adapter) 3 pin screw clamp terminal block (DC)

Compliance

FCC	Part 15