APPLICATIONS

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

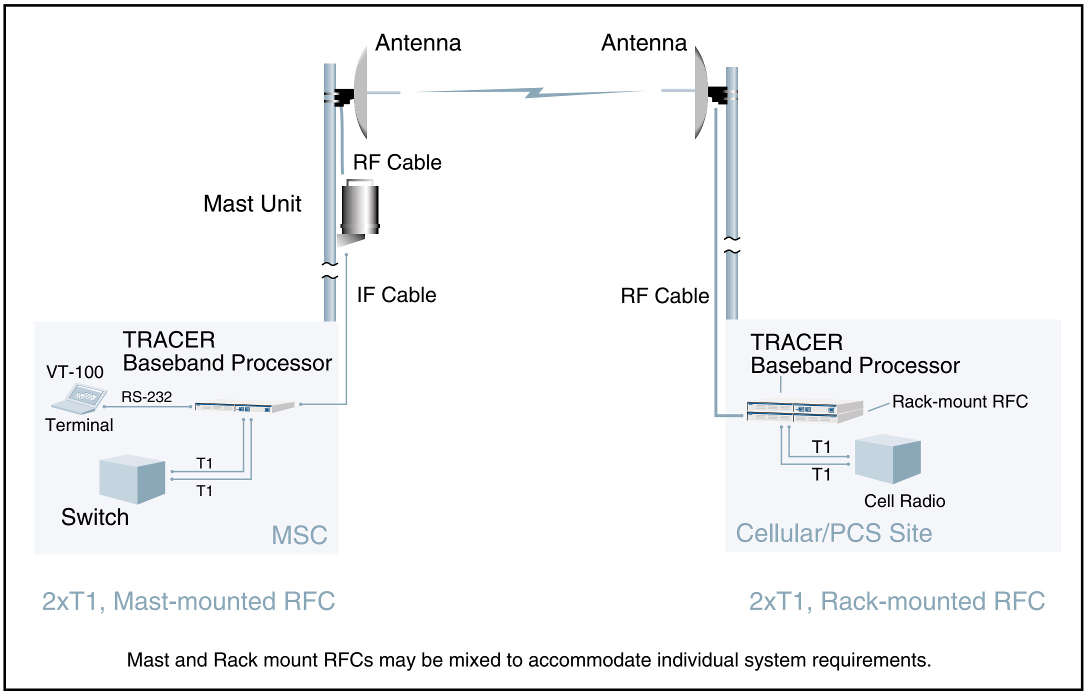

Figure 1-1. Typical Application

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." The FCC rules allow 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

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

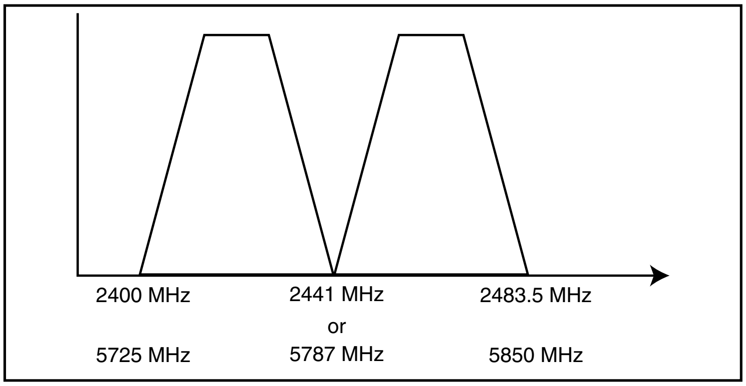

Figure 1-2. Bandwidth Division

The transmitter at one end (TxA) 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 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, 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).

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 (SF). 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 SYSTEM CONFIGURATION

A TRACER 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 (ADTRAN part number 1280003L2) is a 1-U, 19-inch rackmountable unit that 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, VT-100 terminal, alarm contacts, IF signal, DC power (from facility), and power (from AC adapter). The BBP and its rear panel are illustrated in **Figure 1-3 and 1-4**.

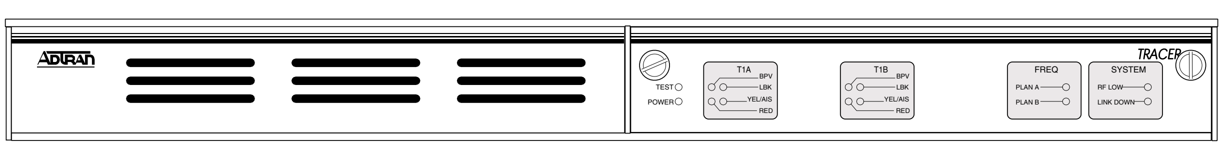

Figure 1-3. BBP

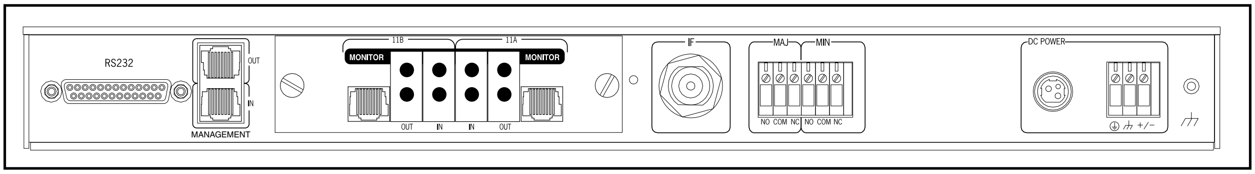

Figure 1-4. BBP Rear Panel

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 interfaces are illustrated in **Figure 1-5**, BBP Block Diagram. The functions of the BBP are partitioned into three printed circuit boards or PCBs, all contained in the same enclosure.

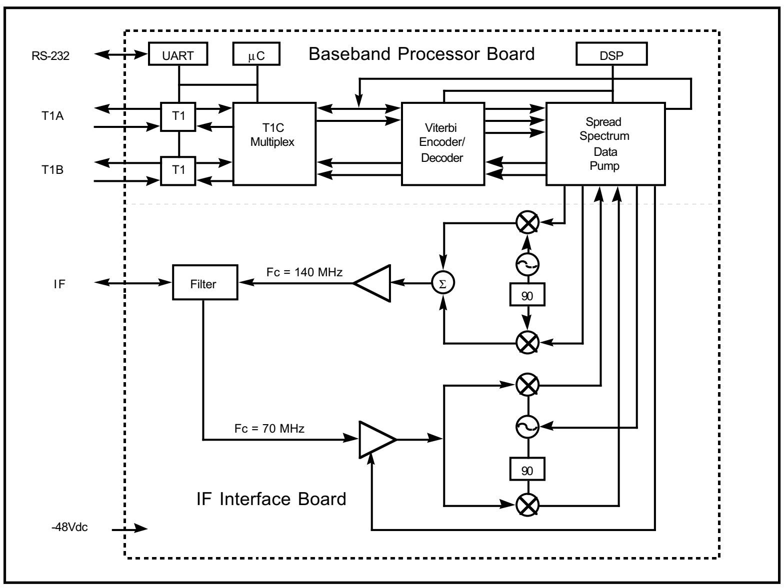

Figure 1-5. BBP Block Diagram

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 either 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 BBP and is labelled “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 (part number 3127004) and is included with the BBP.

VT-100 RS-232 Interface

A serial interface port using RS-232C signal levels is provided for attaching a VT-100-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

Two sets of alarm contacts are provided on the rear of the BBP: major alarm and minor alarm. A major alarm indicates the radio link is not operational. A minor alarm indicates that system performance is degraded or that the T1 interfaces are experiencing errors. 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.

IF Signal

The N-type connector on the rear panel provides the interface point between the BBP and the RFC. This connection provides the data 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 cable has been determined.

Power

The unit receives power via one of two connectors. Power for the entire system is provided by these interfaces. The three-pin circular DIN connector is provided to connect an optional ADTRAN desktop AC adapter (ADTRAN part number 1360DSK24VL1), 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 30 watts.

Controls and Indicators

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

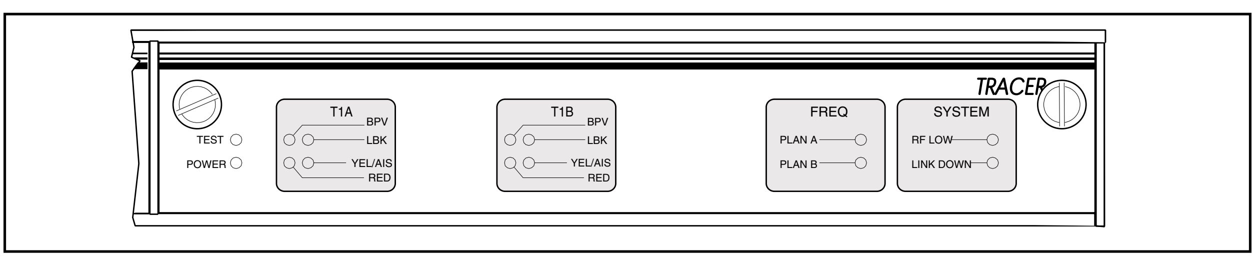

Figure 1-6. BBP Front Panel (with door closed)

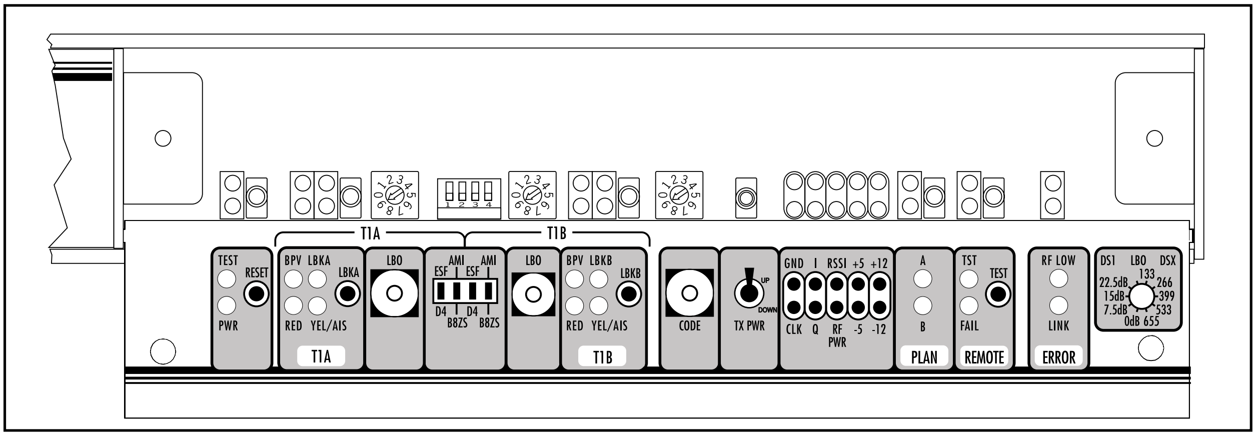

Figure 1-7. BBP Front Panel (with door open)

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 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
RED	Red if there is no signal present at the T1 interface
LPBK............................	Yellow if the T1 interface is in loopback
YEL/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 is too low
Link Down	Radio path is down

The front panel controls are listed below.

Reset	Reset the system
LBKA	Toggles the T1-A between no loopback and line loopback
LBO	Selects TI line buildout. Template on right edge of faceplate designates switch setting.
LBKB	Toggles the T1-B between no loopback and line loopback

Tx PWR........................UP increments radio transmit power up.
DOWN increments radio transmit power down.
VT100 terminal will indicate Tx Power setting.

Remote Test ....Initiate a remote test across the RF link

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)

Built-In Tests

The TRACER has several features to aid in site 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. 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.

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
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 ....Voltage supplying RF power
GND ....System ground

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 in **Figure 1-8** are transmit signal, receive signal, and the IF signal connection.

The RFC unit is enclosed in a metal enclosure approximately 9.5 inches x 5.5 inches x 1 inch and is mounted in a 1-U, 19-inch rackmountable housing or mastmountable, weatherproof enclosure.

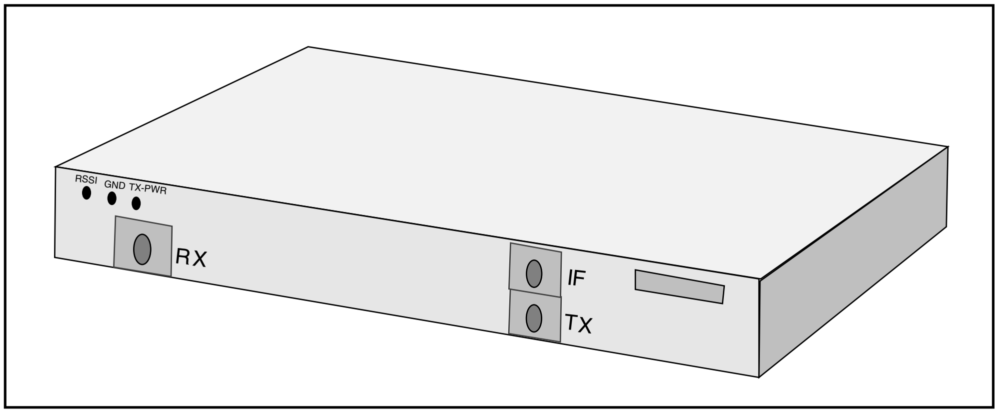

Figure 1-8. RFC Module

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-inch IF cable [ADTRAN part # 3125RF027@A] is provided for rackmount systems). The *TO ANTENNA* connection provides the connection between the RFC and the antenna. A block diagram of the RFC functions is show in **Figure 1-9**.

The RFC module is enclosed in either a 19-inch EIA rackmount housing, or a weather-tight enclosure suitable for mastmounting near the antenna for enhanced system performance. The RFC mastmount and rackmount housings are illustrated in **Figures 1-10 and 1-11**.

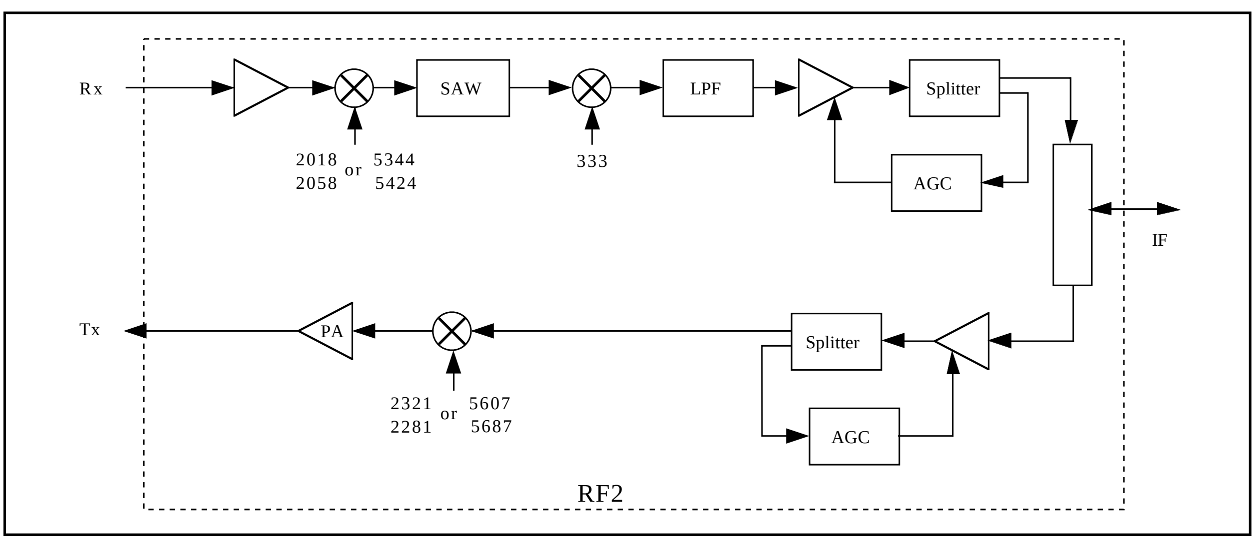

Figure 1-9. RFC Function Block Diagram

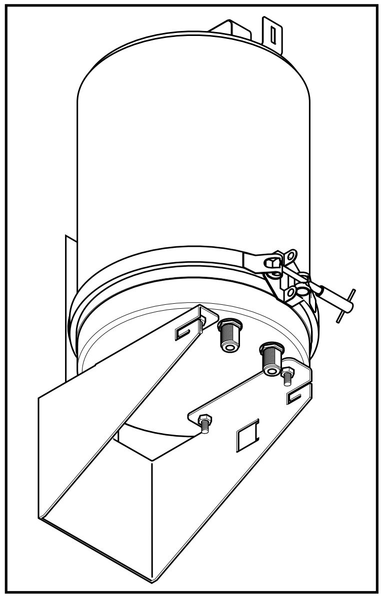

Figure 1-10. Mastmount RFC Housing

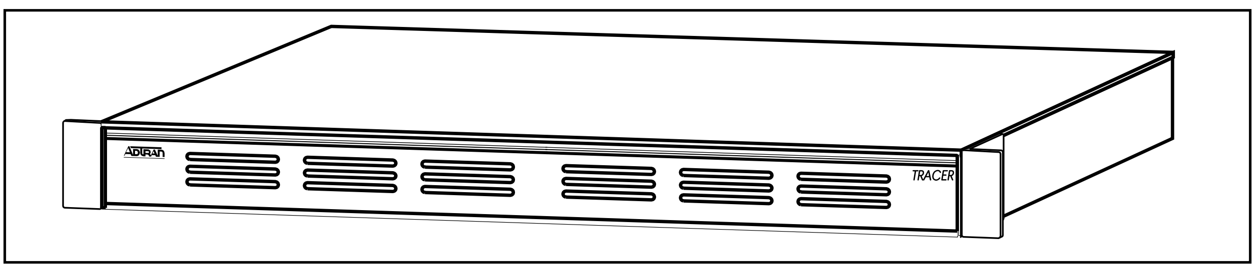

Figure 1-11. Rackmount RFC Housing

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; therefore, an omnidirectional antenna is not needed.
- The FCC provides no recourse in this band in the event of nearby interference, so a highly 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