TC1630

T1/E1
FIBER OPTIC MODEM
User's Manual

MODEL:_____

S/N:_____

DATE:_____

Notice!

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TC COMMUNICATIONS
FIBER OPTIC CONNECTIVITY

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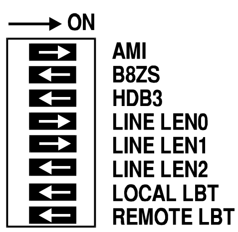
This unit has been setup as following at the factory:

LINE CODE				LINE LENGTH				
AMI	B8ZS	HDB3	T1/E1 (ohm)	1-133	133-266	266-399	399-533	533-655

<u>Only one should be marked</u>



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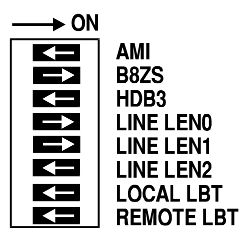

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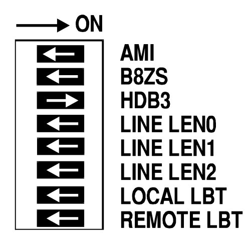

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Description

The TC1630 is a T1/E1 Fiber Optic Modem that offers advanced features such as Jitter Removal and a replaceable Line Interface Module. Because it is based on modern FPGA (Field Programmable Gate Array) technology, it offers extremely low current consumption and higher reliability.

Transparent to the framing format, the TC1630's T1/E1 interface shapes the transmit pulse to support CCITT G.703, or, for connecting DSX-1 cross connects, copper line distances are from 0 to 655 feet. The internal elastic buffer removes jitter from transmit data.

The TC1630 has eight LED indicators to ease installation and troubleshooting--one each for Power, T1/E1 Signal Loss, Bipolar Violations, All Ones warning, Alarm, Optical Synchronization, RMT1-0 (indicates all ZERO'S signal received from the user's equipment), and Remote Loopback. Eight DIP switches, accessible from the panel, are provided to control settings for Line Code, Line Length, Local & Remote Loopback and more. The intelligent Line Code switches help eliminate Line Code and Line Length mismatched settings.

The TC1630 is compatible with all popular types and sizes of optical cable. Fiber optic connectors are ST; FC is optional. Special four-position and two-position feed-thru detachable terminals are provided for connecting the T1/E1 twisted pairs. Input power is 9V to 12V DC or 115/230V AC with an external power cube. Alternate power sources are also available (see Chapter 5 - Specifications).

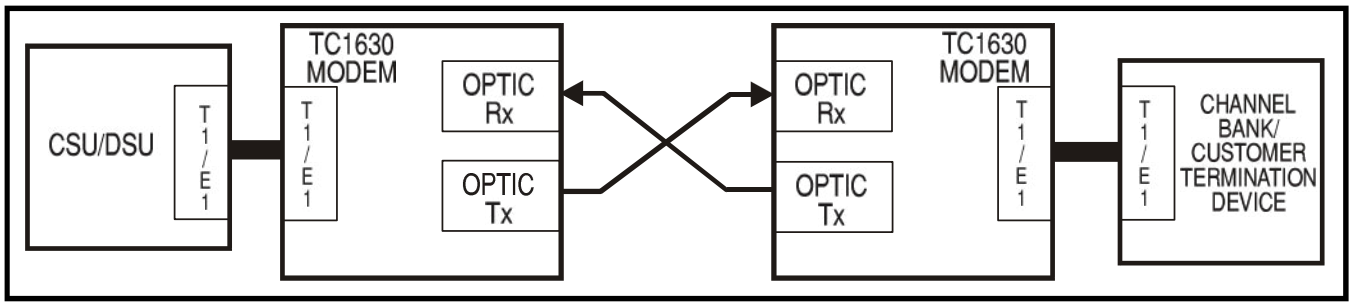


Figure 1. Typical Point-to-Point T1/E1 Application

The TC1630 has multiple status monitoring features. The fiber optic and electrical signals are monitored continually so that, should a cable breakage or other fault condition occur, an alarm will be triggered and the corresponding LEDs will indicate the type and location of the problem. By understanding the function of each LED and DIP switch, the user can ease installation and troubleshooting.

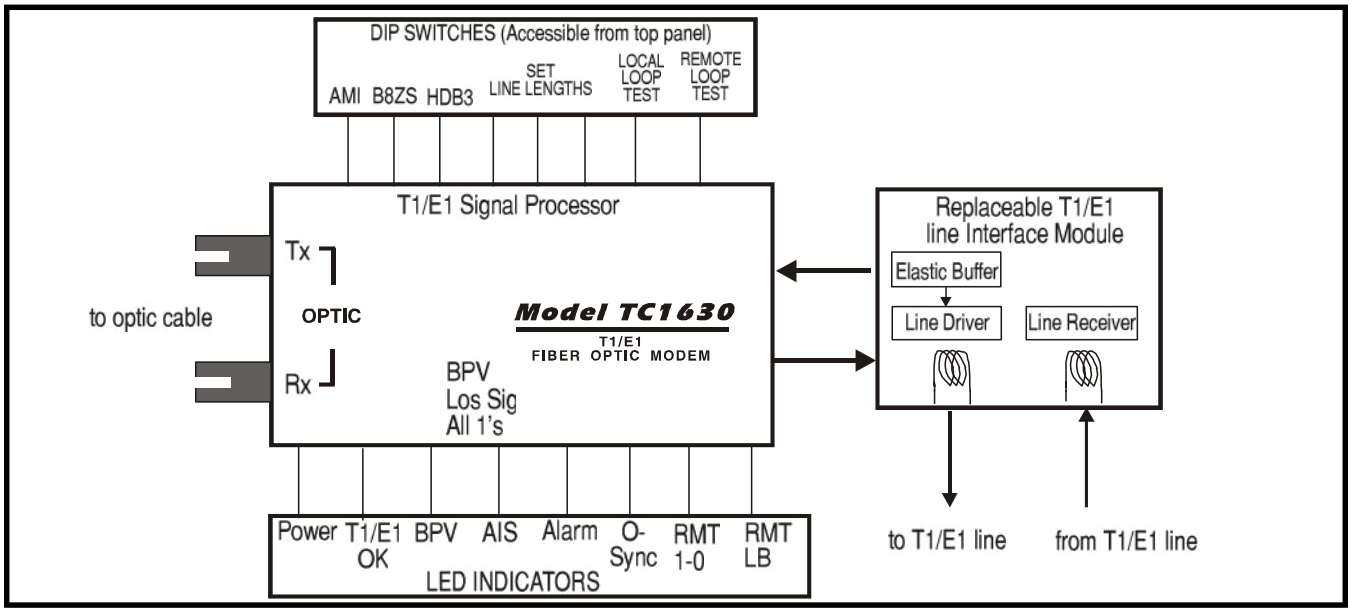
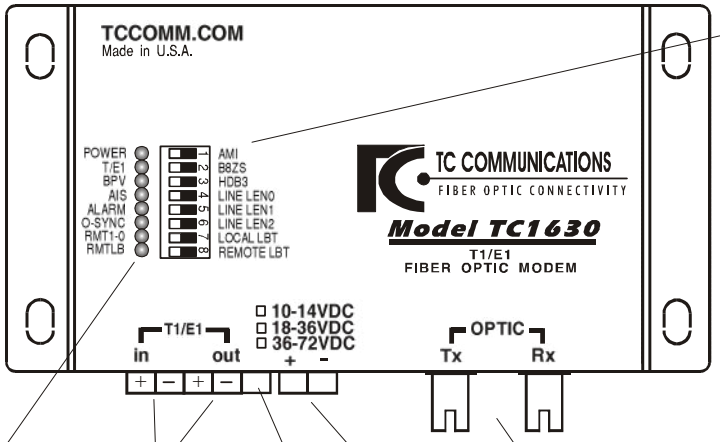


Figure 2. TC1630 Functional Diagram

LEDs, DIP Switches and Connectors



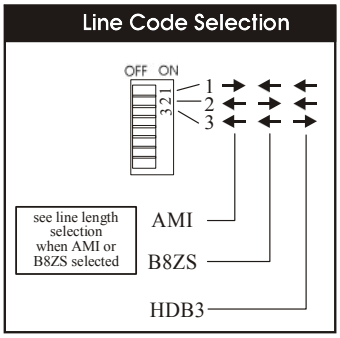
T1/E1 Signal Connectors

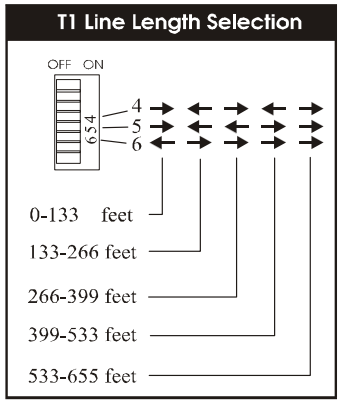
Not used

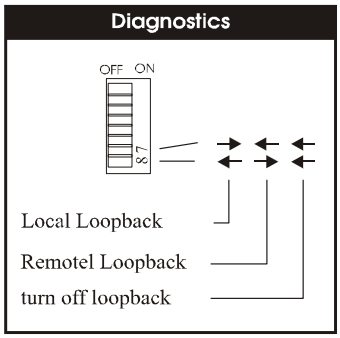
Optic Transmitter & Receiver

Power Connector

DIP Switch Settings







LED Indicators

POWER: Unit has adequate power supply

T1/E1 OK: Indicates a valid T1/E1 signal

BPV: Bipolar Violation

AIS: When flashingn, idicates "All Ones" signal from user's equipment

ALARM: Conditions include; T1/E1 signal lost, All ones received (LED flashes dim), Bipolar violation, Line code setup violation, & Line length setup mismatches line code

O-SYNC: Optic signal above minimum threshold sensitivity level

RMT1-0: This LED flashes under two conditions;
a) Indicates "All zeros" received from user's equipment
b) Indicates that the remote unit is in RMTLB mode

RMTLB: Remote loopback

***Note*: The T1/E1 signal is bipolar, independent of the polarity.**

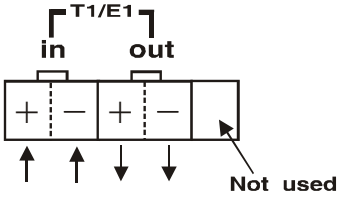
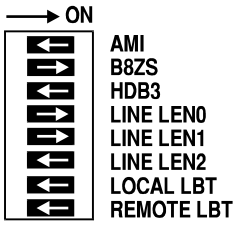


Figure 3. TC1630's Top Panel

DIP Switch Functions

Slide switch to the Right position to activate the function.



AMI/B8ZS/HDB3: These switches select the Line Code (see Figure 3).

LEN0/LEN1/LEN2: These switches define the DSX-1 cross connect distance. There are 5 partitions to choose from. In a T1 application, this is the length of twisted pair cable connecting the TC1630 to the user's equipment, which may be a CSU or DSU. The cable lengths can be from 0 to 655 feet (see Figure 3). The five partition arrangements meet CB-19 requirements when using ABAM cable.

LOCAL LBT: This switch initiates the Local Loopback function. The T1/E1 signal is received and decoded, then looped back to the T1/E1 "out" terminals for diagnostic testing.

REMOTE LBT: This switch initiates the Remote Loopback function. The composite optic signal is received from optic "Rx" and decoded, then looped back to optic "Tx."

Fiber Optic Specifications

Transmission Distances (typical)

The TC1630 is compatible with all popular sizes and types of fiber. Transmission distances up to 3km* are typical over Multimode fiber at 850nm and 4km* at 1310nm. Distances to 24km* are typical over Single Mode fiber at 1310nm.

Launch Power & Sensitivity

Transmitter:	**LED/ELED; typical Launch Power -**	**-18dBm* (850nm/1310nm MM, @62.5/125μm)** **-18dBm* (1310nm Single Mode, @9/125μm)**
Receiver:	**PIN Diode; typical Sensitivity -**	**-36dBm* (850nm/1310nm MM, @62.5/125μm)** **-36dBm* (1310nm Single Mode, @9/125μm)**

Launch power, sensitivity and distance are listed for reference only. These numbers may vary. The factory default launch power is -18dBm.

Chapter 2 - Installation

Unpacking the Unit

Before unpacking any equipment, inspect all shipping containers for evidence of external damage caused during transportation. The equipment should also be inspected for damage after it is removed from the container(s). Claims concerning shipping damage should be made directly to the pertinent shipping agencies. Any discrepancies should be reported immediately to the Customer Service Department at TC Communications, Inc.

Equipment Location

The TC1630 should be located in an area that provides adequate light, work space, and ventilation. Avoid locating it next to any equipment that may produce electrical interference or strong magnetic fields, such as elevator shafts or heavy duty power supplies. As with any electronic equipment, keep the unit from excessive moisture, heat, vibration, and freezing temperatures.

Power Supply

The TC1630 is powered by an external DC power adapter rated 9V to 12V DC @250mA.

T1/E1 Connection

Two pairs of terminal blocks are provided to connect the T1/E1 wire pairs. When facing the front panel, the left pair is for the T1/E1 signal going into (transmit) the TC1630 while the right pair is for the received signal.

Installation Procedure

The TC1630 is designed for quick and easy installation. To install the unit, you must first configure the modem for your specific application by setting the Line Code and Line Length. Once this is completed, you can connect the optical, T1/E1 signal source and power.

Installation Procedure:

1. Select the Line Code (SW1, 2, 3).

2. For T1, select the Line Length (SW4, 5, 6).

3. Connect the T1/E1 signal source.

4. Connect the optic cables. Verify the correct optic cable connections are made.

5. Connect the power.

After installation is complete, it is an excellent idea to verify the optical cable loss. This reading will both verify the integrity of the circuit and provide a benchmark for future troubleshooting efforts (see Chapter 3 - Troubleshooting).

TC1630's Configuration

1. Select the application's Line Code (SW1, 2 or 3). Slide the appropriate switch to the Right position.

   AMI: set SW1 to the Right position.
   B8ZS: set SW2 to the Right position.
   HDB3: set SW3 to the Right position.

   Only one of the above switches should be selected, as any two switches in the Right position will cause the "Alarm" LED to flash.

2. For T1, select the Line Length setting (SW4, 5, 6). Slide the appropriate switches to the Right.

   Depending on the distance between the TC1630 and the T1 cross connect, set the Line Length for the T1 transmit line driver according to the table below. There is no need to set the Line Length for E1 applications; set SW4, 5, and 6 to the Left position.

Legend: 0 = Off 1 = On			LINE CODE			LINE LENGTH			LOCAL & REMOTE LOOPBACK TESTS	
			SW1	SW2	SW3	SW4	SW5	SW6		
AMI	DSX-1 ABAM	0-133 feet	1	0	0	1	1	0	0	0
		133-266 feet	1	0	0	0	0	1	0	0
		266-399 feet	1	0	0	1	0	1	0	0
		399-533 feet	1	0	0	0	1	1	0	0
		533-655 feet	1	0	0	1	1	1	0	0
	CSU NETWORK INTERFACE	0-655 feet	1	0	0	0	1	0	0	0
			1	0	0	1	1	0	0	0
B8ZS	DSX-1 ABAM	0-133 feet	0	1	0	1	1	0	0	0
		133-266 feet	0	1	0	0	0	1	0	0
		266-399 feet	0	1	0	1	0	1	0	0
		399-533 feet	0	1	0	0	1	1	0	0
		533-655 feet	0	1	0	1	1	1	0	0
	CSU NETWORK INTERFACE	0-655 feet	0	1	0	0	1	0	0	0
			0	1	0	1	1	0	0	0
HDB3	PCM-30, G.703	0-655 feet	0	0	1	0	0	0	0	0

Figure 4. TC1630 Configuration Table

3. Connect the T1 or E1 signal.

   T1 signal connection for *100 ohm line:* Connect the incoming T1 signal (from your equipment) to the "in" terminal blocks on the front panel; they are not polarity sensitive. A valid T1 signal will cause the "T1/E1 OK" LED to be solidly lit. Connect the outgoing T1 signal (received from the optical cable) to the "out" terminal blocks.

   E1 signal connection (The E1 interface can be used for either 75 or 120 ohm line):

   ***75 ohm line*:** Connect the incoming signal (from your equipment) to the "in" BNC adapter. Connect the outgoing signal (received from optical cable) to the "out" BNC adapter.

   120 ohm line: If twisted-pairs are used, connect the wires in the same way as the T1's wire. If dual coaxial is used, connect the cores to the "in" terminal blocks for the incoming signal and to the "out" terminal blocks for the outgoing signal (each cable has two cores & a shield).

4. Verify optical connections:

   Make sure the local TC1630's optic "Tx" is connected to the remote TC1630's optic "Rx" (and vice-versa).

5. Connect power to both units.

System Start Up

When power is initially connected, the following conditions should be observed:

1. The "POWER" LED is lit.
2. The "T1/E1 OK" LED is lit, indicating a valid T1/E1 signal input.
3. The "O-SYNC" LED should be lit, indicating a valid received optic signal.
4. The "ALARM" LED should be Off.

Note: If the modem is not functioning properly at this point, please refer to Chapter 3 - Troubleshooting.

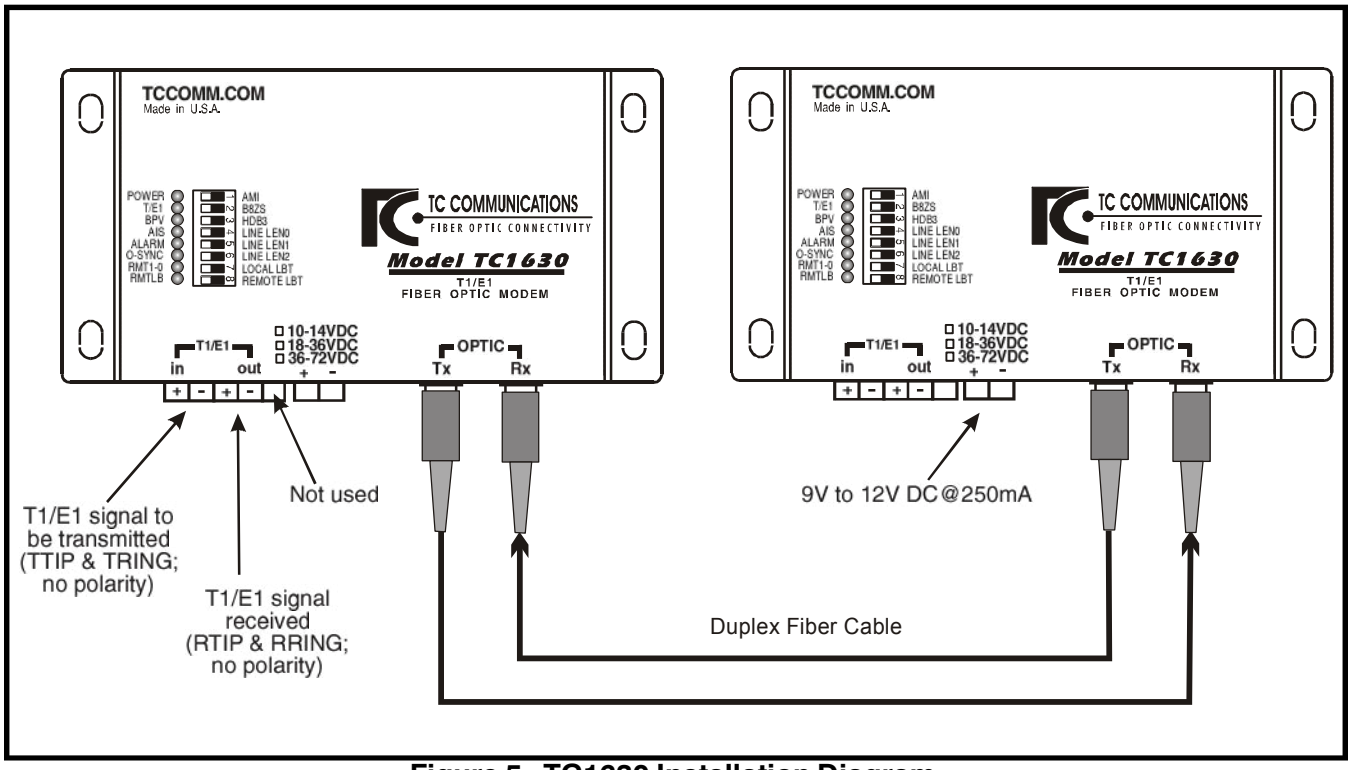


Figure 5. TC1630 Installation Diagram

Chapter 3 - Troubleshooting

General

Alarm conditions occur whenever an optical problem or "fault" condition is detected by the TC1630.

All LEDs are Off

If no LEDs are lit on the unit, check the DC power supply, terminal block connector plug, and/or the power source. If the problem persists, contact the Technical Support Department at TC Communications, Inc.

Alarm LED

When an alarm condition is detected, the Alarm LED will flash. The following fault conditions will cause the alarm to be triggered:

1. An invalid Line Code setting exists.
2. An invalid Line Length setting exists.
3. The Line Length setting does not match the Line Code.
4. The local T1/E1 signal is lost; the "T1/E1 OK" LED will be flashing.
5. The unit receives an invalid transmission (all 1's). This Alarm may appear more dim than others.
6. A broken and/or damaged fiber optic cable.

Other LEDs

1. If optic "Rx" is not receiving a signal (or receiving a marginal signal which causes invalid data packets to be received) the "O-SYNC" LED will be Off.
2. If no valid T1/E1 signal is present at the terminal blocks (in) then the "T1/E1 OK" LED will be flashing.
3. If bipolar violations occur during T1/E1 signal reception, the "BPV" LED will flash according to the frequency of the violation.

Optic Cable Types

Conventionally, fiber optic cable with yellow-colored insulation is used for Single Mode applications; gray or orange-colored insulated cable is for Multimode use. If Multimode cable is used in a Single Mode application, the test results could be erroneous and confusing.

Calculating the Fiber Optic Loss Budget

The fiber optic link and/or connectors are frequently the source of various problems. Check out the connectors and the integrity of the link first. Ideally, the link should be calibrated for total loss after the installation has been completed. This will accomplish two things: (1) it will verify that the total loss of the link is within the loss budget of the device and (2) it will provide a benchmark for future testing. For example, a system that has been tested as having 6dB total loss when installed and suddenly tests out as having a loss of 10dB probably has a connector or link problem.

To calculate the loss budget:

Multimode 850nm	**:**	**3 dB loss per km on 62.5/125μm cable***
Multimode 1310nm	**:**	**2 dB loss per km on 62.5/125μm cable***
Single Mode 1310nm	**:**	**0.5 dB loss per km on 9/125μm cable***
Single Mode 1550nm	**:**	**0.4 dB loss per km on 9/125μm cable***

These numbers are listed for reference only. We recommend an OTDR reading be used to determine actual link loss.

Cable Connection Verification

Electrical Cables:

1. Make sure all electrical signal connections match the pin assignments (I/O) for the device (check User's Manual if necessary and/or refer to Appendix B of this manual).

2. Verify signal connections by checking the status LEDs on the top panel of the TC1630. If the "T1/E1 OK" LED is flashing, a transmit signal is not being detected from the local device.

3. Verify that the correct Line Code setting (and Line Length setting for T1) has been configured.

4. Conduct a Local Loopback Test to help isolate an electrical interface problem (see Chapter 4 - Bench Tests).

Optic Cables:

If the "O-SYNC" LED on the top panel is flashing or Off, this is an indication that the optic signal is not being correctly received. Usually, unsecured fiber optic connectors or faulty cable are to blame. A good connection is indicated by the "O-SYNC" LED on the top panel being solidly lit. This indicates that the receiving cable is correctly connected to Remote unit's optic "Tx."

General

It is highly recommended to conduct bench tests before actual installation. Bench testing allows the user to become familiar with all the functions and features of the TC1630 in a controlled environment. Knowledge of the TC1630's functions and features will ease installation and troubleshooting efforts later on.

Test Equipment Requirements

End-user equipment required for testing:

1. Model 5575A T1 Micro BERT (Bit Error Rate Tester) Test Set with Terminal Block Connectors.
2. Two optical cable jumpers (patch cords) with appropriate connectors.

Pre-Installation Tests

1. Make sure the appropriate power supply accompanies the TC1630 unit (see page 7).
2. To verify that the unit functions properly, connect power to the unit's power terminal block connector (be sure to observe correct polarity) without connecting any other cables to the unit.
3. On the top panel, the "POWER" LED should be illuminated.
4. The "T1/E1 OK", and the "ALARM" LED's should be flashing.

Local Loopback Bench Test

The purpose of this test is to verify the signal source recognition and the connection between the incoming signal and the TC1630's terminal blocks.

1. Make sure your BERT tester is turned on and configured with the same setup as the TC1630 (and your application).
2. Plug in the terminal blocks from the BERT tester to the TC1630's connectors on the front panel. When the input and output are connected correctly, the "T1/E1 OK" LED on the TC1630 will be lit.
3. Slide SW7 (LOCAL LBT) to the Right position.
4. Make sure the "TERM" or "BRIDGE" LED on the tester is lit, and that the tester is in the "RUN" mode. The tester should indicate an "O-SYNC" signal.
5. If any other LEDs illuminate or flash, make sure that all DIP switches on the TC1630 are in the correct position, then reset the BERT tester. You should not see any bit errors. To verify this, inject an error using the BERT tester to see if it will be recorded by the tester, then verify that no additional errors appear after the user injected error. Return SW7 to the Left position and proceed to the Optical Loopback Test.

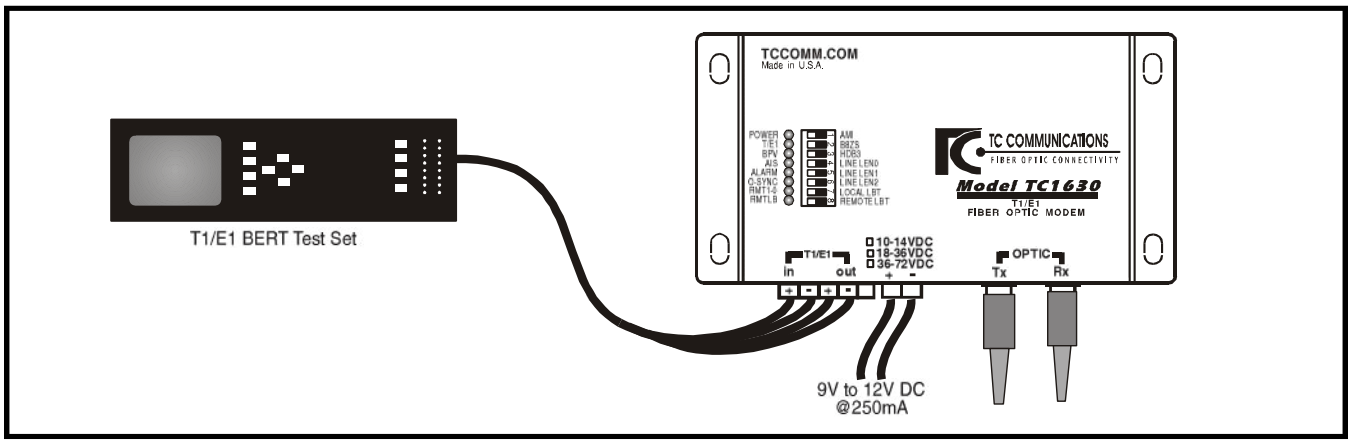


Figure 6. Local Loopback Bench Test Connection Diagram

Optical Loopback Bench Test

At any time you may use a short optic cable to loopback the unit's Optic "Tx" to "Rx." The "O-SYNC" LED on the top panel should light (solid) when a good optic signal is received. This test verifies the optic transmitter's function as well as the receiver's. Upon successful completion of this test, proceed to the Remote Loopback Test.

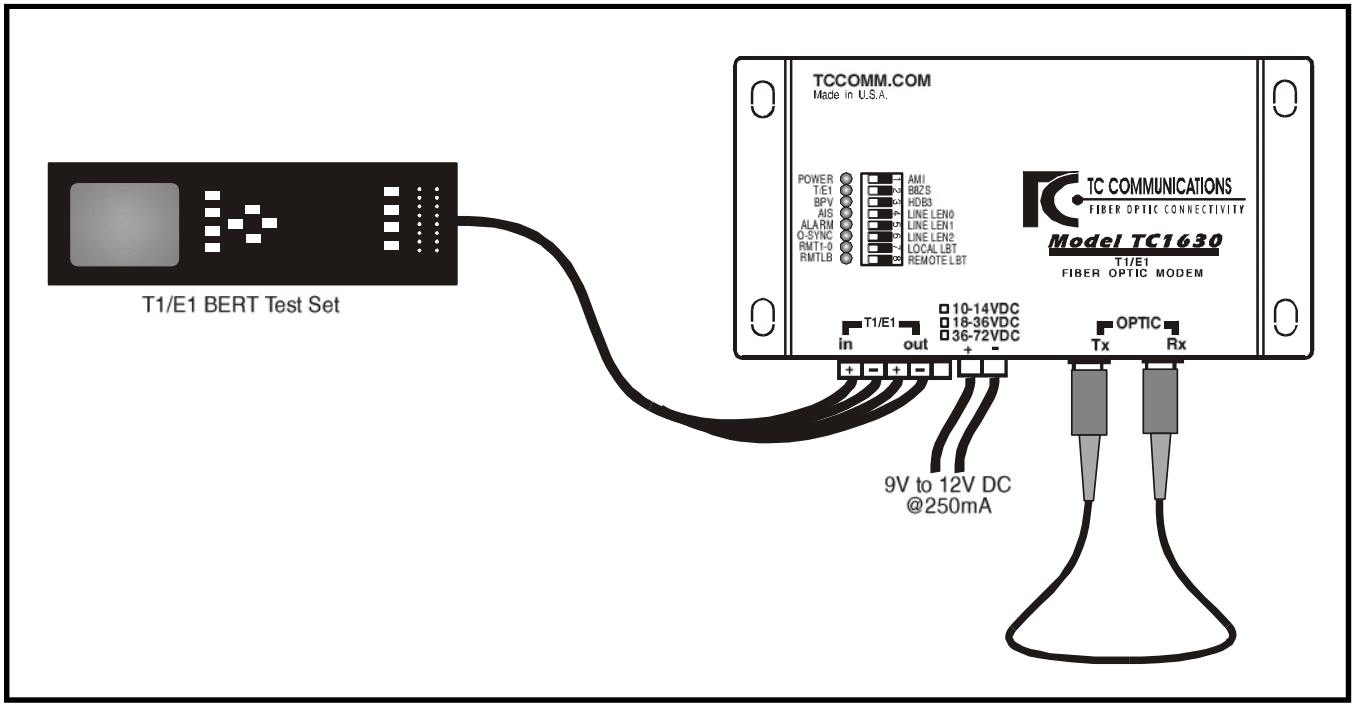


Figure 7. Optical Loopback Bench Test Connection Diagram

Remote Loopback Bench Test

1. Connect a second TC1630 unit. As with the first unit, follow the bench test steps on the previous page. When you have completed the Local Loopback & Optical Loopback tests for the second unit, proceed to the next step.
2. Remove the optical jumper cable from the local unit's "Rx" and connect it to a second unit's optic "Rx." Add a second optical jumper cable to connect the local unit's "Rx" to the second unit's "Tx."
3. Verify that both TC1630 units have the same Line Code and Line Length settings.
4. On the local TC1630, slide SW8 (REMOTE LBT) to the Right position. The "T1/E1 OK", and the "ALARM" LED's should flash on the remote unit. On the local unit, only the ALARM LED should be flashing.
5. Make sure the "TERM" or "BRIDGE" LED on the tester is lit, and that the tester is in the "RUN" mode. The tester should indicate a "O-SYNC" signal.
6. If any other LEDs illuminate or flash on the unit, make sure that all DIP switches on both of the TC1630's are in the correct position, then reset the BERT tester. You should not see any bit errors.
7. At this point, both units tested will have passed all electrical and optical tests and will have been verified that they are functioning properly. When finished, return SW8 to the Left position (normal position).

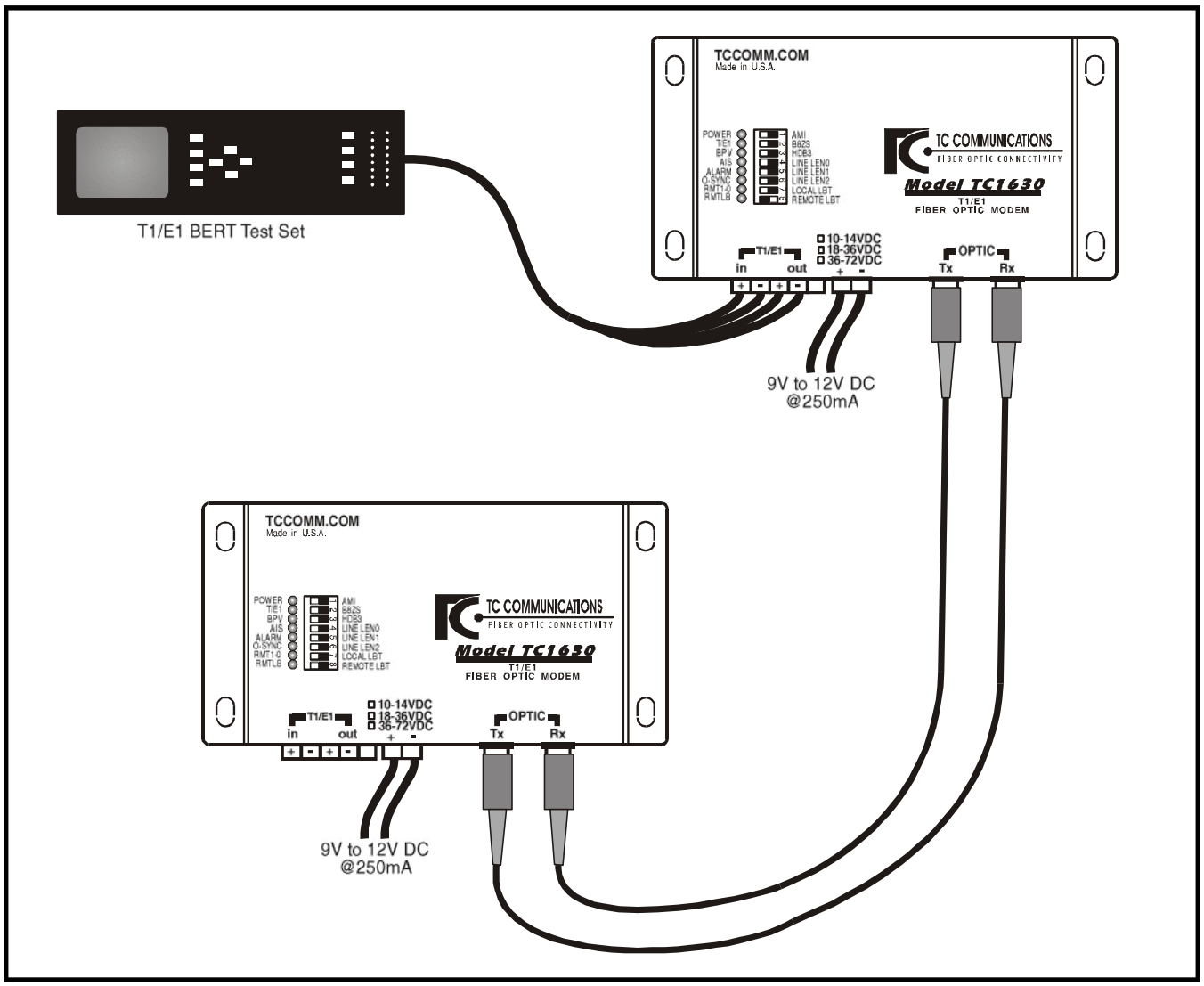


Figure 8. Remote Loopback Bench Test Connection Diagram

Data Rates

T1 (per channel) ..... **1.544 Mbps**
E1 (per channel) ..... **2.048 Mbps**
Line Code ..... **AMI, B8ZS, or HDB3**

Optical

Transmitter ..... **LED/ELED**
Receiver ..... **PIN Diode**
Wavelength ..... **850nm/1310nm Multimode**
..... **1310nm Single Mode**
Fiber Optic Connectors ..... **ST* (FC optional)**
Loss Budget ..... **15dB** Multimode 850nm/1310nm @62.5/125μm**
..... **20dB** Single Mode 1310nm @9/125μm**

Electrical

Interface **T1/E1**
T1 Connector (100 ohm) ..... **Terminal Block**
E1 Connector (120 ohm) ..... **Terminal Block**
E1 Connector (75 ohm) ..... **Terminal Block with BNC Adapter**

System

Bit Error Rate ..... **1 in 10^{10} or better**

Visual Indicators

LED ..... **POWER, SYNC, BPV, LOS SIG, ALARM**

Power Source

Standard ..... **9V to 12V DC @250mA (typical)**
Optional ..... **24V DC @80mA (typical)**
Optional ..... **48V DC @40mA (typical)**
Optional ..... **115V or 230V AC with external power cube**

Temperature

Operating ..... **-10°C to 50°C**
Storage ..... **-40°C to 90°C**
Humidity ..... **95% non-condensing**

Physical

Height ..... **(2.80 cm) 1.125"**
Width ..... **(12.75 cm) 5.0"**
Depth ..... **(7.50 cm) 3.0"**
Weight ..... **(180 gm) 5.1 oz**

ST is a trademark of AT&T

The E1 interface impedance on the TC1630 is user configurable by changing the jumpers on the interface module. Please follow the instructions below to set the E1 impedance appropriately.

Setting the E1 Interface Impedance

1. Unscrew the 4 cover panel screws and remove the unit's housing.
2. Locate the interface module at board location P1 (the board plugs vertically into the main board's socket).
3. For 75 ohm impedance, the jumpers on the interface module should be set as follows:

   JP2------- removed

   JP1,3,4,5,6------- installed

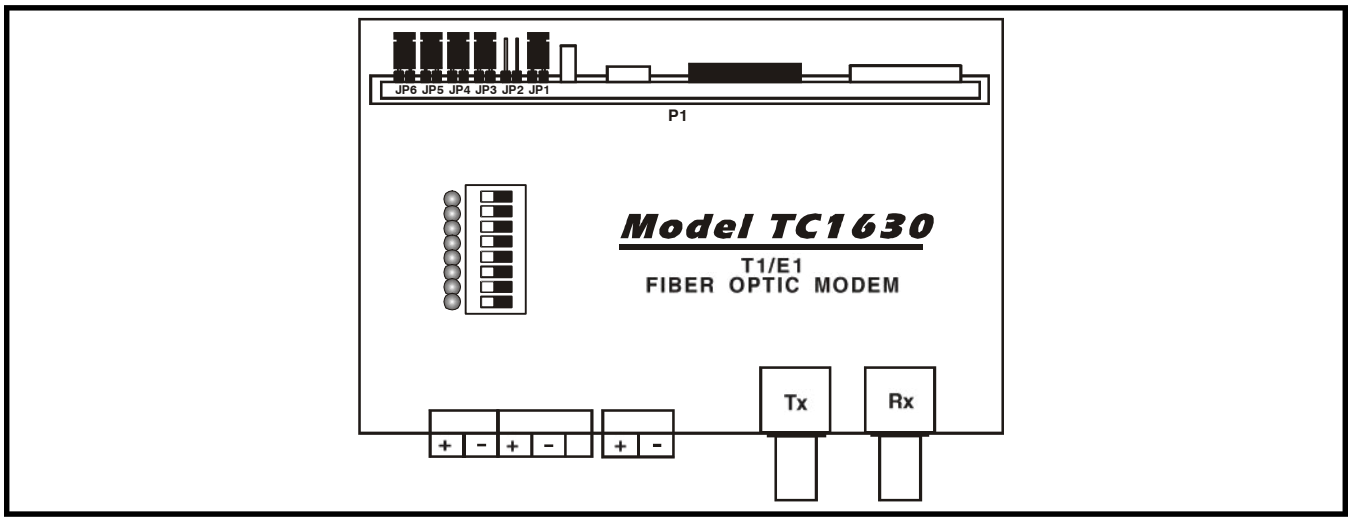


Figure 9. TC1630's E1 (75 ohm) Interface Module Configuration

4. For 120 ohm impedance, the jumpers on the interface module should be set as follows:

   JP1------- installed

   JP2,3,4,5,6------- removed

5. Replace the unit's cover and secure it with the 4 screws.

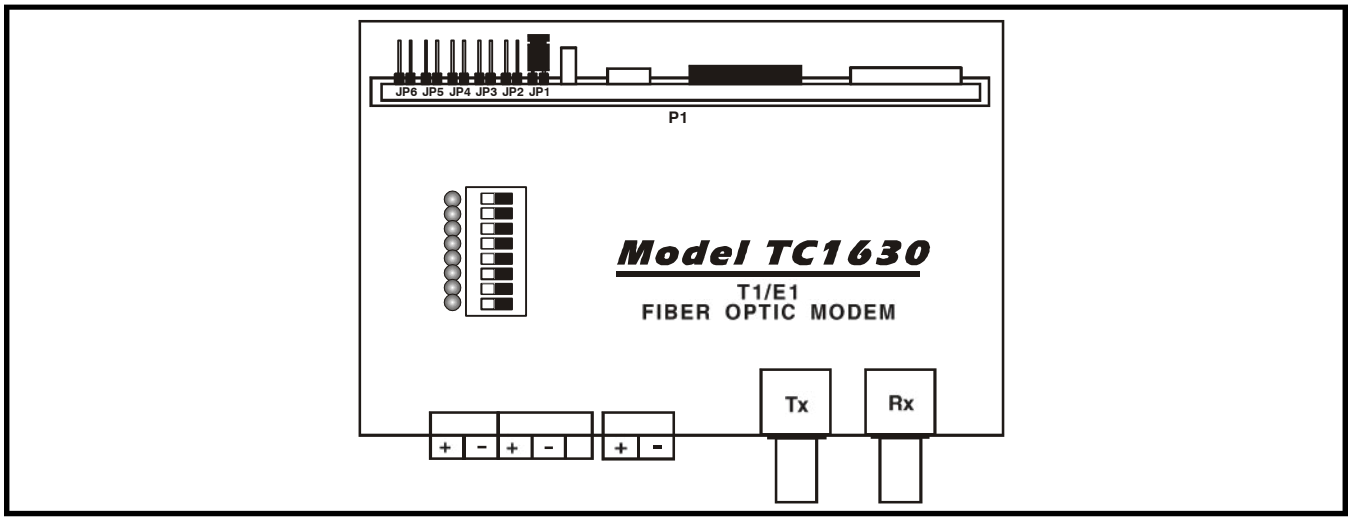
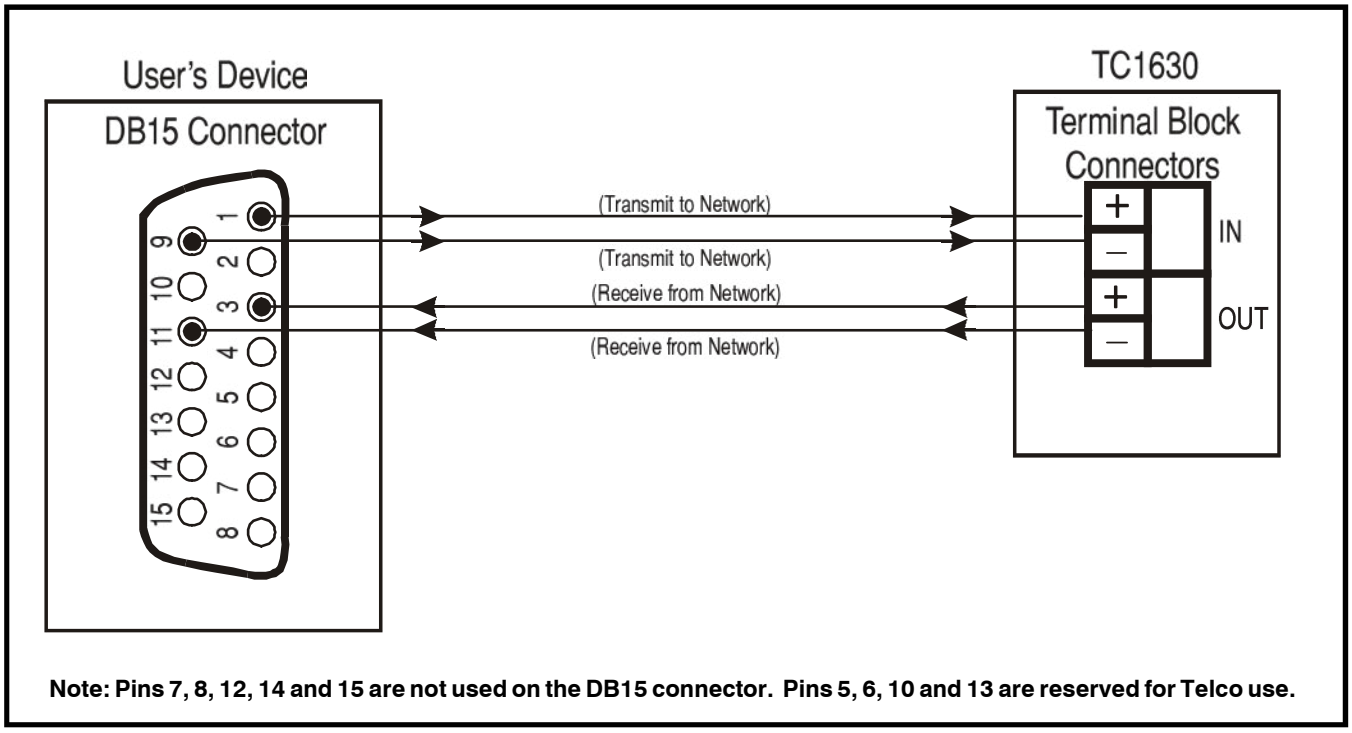


Figure 10. TC1630's E1 (120 ohm) Interface Module Configuration

Electrical Signal Cable Connection

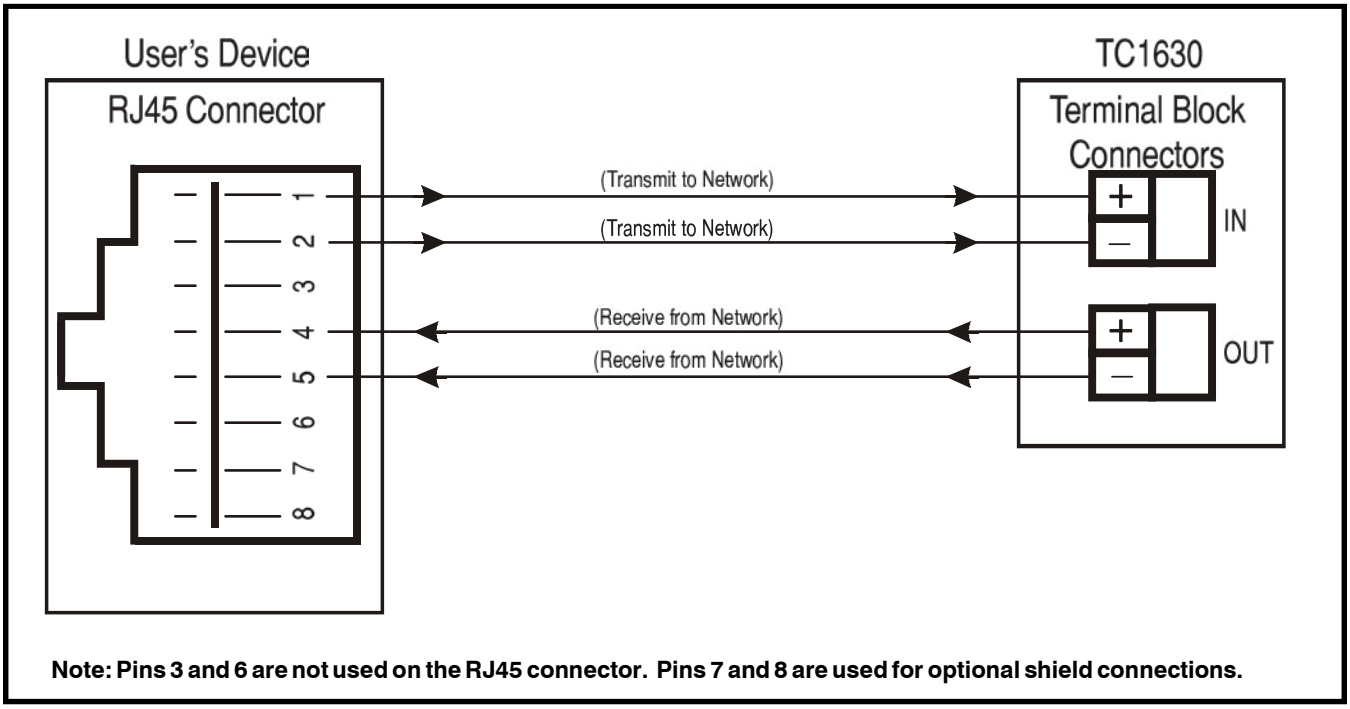
The user's device may have a DB15 or RJ45 connector. The following connection diagrams illustrate the signal flow direction and pin assignments typically used with these connectors.

Note: The polarity of the T1/E1 signal is bipolar, independent of the polarity. Polarity is shown for reference only.



Note: Pins 7, 8, 12, 14 and 15 are not used on the DB15 connector. Pins 5, 6, 10 and 13 are reserved for Telco use.

Figure 11. DB15 Connection Diagram



Note: Pins 3 and 6 are not used on the RJ45 connector. Pins 7 and 8 are used for optional shield connections.

Figure 12. RJ45 Connection Diagram

Launch Power Adjustment

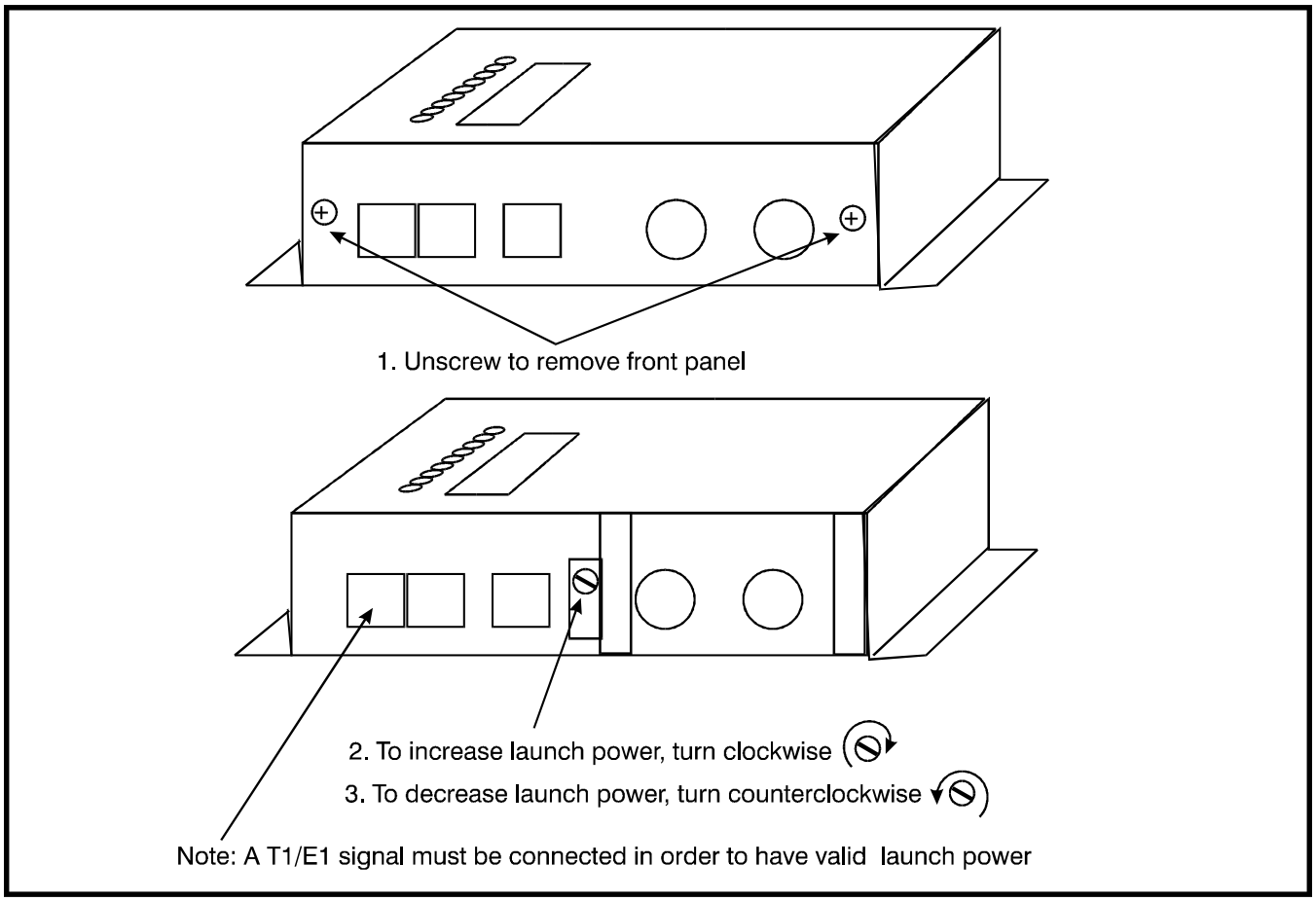


Figure 13. TC1630 Launch Power Adjustment Diagram

Return Policy

To return a product, you must first obtain a Return Material Authorization number from the Customer Service Department. If the product's warranty has expired, you will need to provide a purchase order to authorize the repair. When returning a product for a suspected failure, please provide a description of the problem and any results of diagnostic tests that have been conducted.

Warranty

Damages by lightning or power surges are not covered under this warranty.

All products manufactured by TC Communications, Inc. come with a five year (beginning 1-1-02) warranty. TC Communications, Inc. warrants to the Buyer that all goods sold will perform in accordance with the applicable data sheets, drawings or written specifications. It also warrants that, at the time of sale, the goods will be free from defects in material or workmanship. This warranty shall apply for a period of five years from the date of shipment, unless goods have been subject to misuse, neglect, altered or destroyed serial number labels, accidents (damages caused in whole or in part to accident, lightning, power surge, floods, fires, earthquakes, natural disasters, or Acts of God.), improper installation or maintenance, or alteration or repair by anyone other than Seller or its authorized representative.

Buyer should notify TC Communications, Inc. promptly in writing of any claim based upon warranty, and TC Communications, Inc., at its option, may first inspect such goods at the premises of the Buyer, or may give written authorization to Buyer to return the goods to TC Communications, Inc., transportation charges prepaid, for examination by TC Communications, Inc. Buyer shall bear the risk of loss until all goods authorized to be returned are delivered to TC Communications, Inc. TC Communications, Inc. shall not be liable for any inspection, packing or labor costs in connection with the return of goods.

In the event that TC Communications, Inc. breaches its obligation of warranty, the sole and exclusive remedy of the Buyer is limited to replacement, repair or credit of the purchase price, at TC Communications, Inc.'s option.

To return a product, you must first obtain a Return Material Authorization (RMA) number and RMA form from the Customer Service Department. If the product's warranty has expired, you will need to provide a purchase order to authorize the repair. When returning a product for a suspected failure, please fill out RMA form provided with a description of the problem(s) and any results of diagnostic tests that have been conducted. The shipping expense to TC Communications should be prepaid. The product should be properly packaged and insured. After the product is repaired, TC Communications will ship the product back to the shipper at TC's cost to U.S. domestic destinations. (Foreign customers are responsible for all shipping costs, duties and taxes [both ways]. We will reject any packages with airway bill indicating TC communications is responsible for Duties and Taxes. To avoid Customs Duties and Taxes, please include proper documents indicating the product(s) are returned for repair/retest).