T400 TRI-C
Total Reach® ISDN Central Office Card
Installation and Maintenance

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1. GENERAL

This practice provides installation and maintenance procedures for the ADTRAN Low Voltage Total Reach® ISDN - Central Office circuit card (TRI-C). **Figure 1** is an illustration of the T400 TRI-C.

Revision History

Issue 3 of this document inserts an additional table (new Table 9) describing cable type and temperature loss data.

Features

Total Reach ISDN-C, part number 1212082L1, features include:

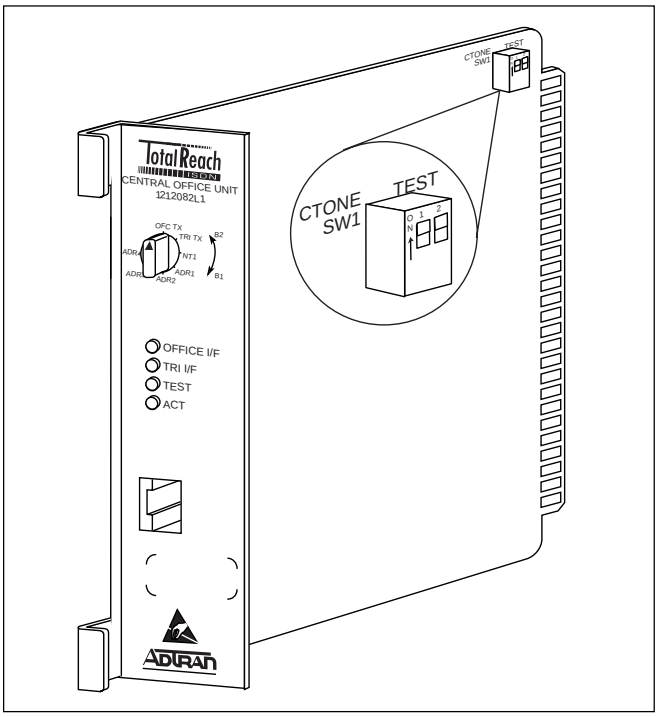

Figure 1. T400 Total Reach ISDN-C

- ISDN 2B1Q U-interface meets all Layer 1 requirements as specified in ANSI T1.601-1992.
- U-interface provides 18 kft nominal range on mixed gauge wire.
- Total Reach (TR) interface provides 30.5 kft nominal range on mixed gauge wire.
- Distinctive LUNT metallic DC test signature as specified in TR-NWT-000397.
- Performance monitoring of the Layer 1 facility as specified in TR-NWT-000397 and TR-TSY-000829.
- Eight hours of performance history as specified by TR-NWT-000829.
- Local test access for DS0 digital test sets.
- Eight ISDN BRA National Standard embedded operations channel *(eoc)* messages responded to, including B1, B2, and 2B+D loopbacks.

- Lightning and power cross protection in compliance with GR-1089-CORE.
- Provides span powering for the Total Reach ISDN-Remote unit.
- Span powering compliant with GR-1089-Core Class A2 powering requirements.

General Description

The Low Voltage TRI-C is a Type 400 mount circuit card that occupies a single slot in the ADTRAN T400 19 inch or 23 inch shelf, or in any standard T400 compatible backplane. The TRI-C can also be deployed in a Western Electric Metallic Facilities Termination (MFT) shelf.

The T400 TRI-C, in conjunction with the TRI-R remote card, provides transmission of Basic Rate ISDN service to the customer premise at distances up to 30.5 kft over a single twisted pair of mixed gauge wire.

Located at the central office, the TRI-C provides both an ANSI T1.601 two-wire ISDN U-interface to an ISDN capable switch, and the Total Reach ISDN (TRI) extended range interface to the DSL. The TRI-C converts the U-interface 2B+D data and Layer 1 *eoc* information to the TRI-interface for transport to the remote TRI-R.

The TRI-C provides -130 VDC maximum to the TRI interface for span powering of the TRI-R. The TRI-R terminates the DSL and restores the 2B+D data and Layer 1 *eoc* information received on the TRI interface to an ANSI T1.601 compatible U-interface for delivery to the customer NT1/TA.

The T400 TRI-C, part number 1212082L1, is compatible with the following TRI-R units: 1212083L1, 1212083L2, 4212083NID, 4212083LID, 4212083CASE, and all future variants of this product, see **Figure 2**.

NOTE

ADTRAN does not recommend that the Low Power TRI-C be installed on existing circuits terminated with P/N 1210083L1, 1210083L2, 4210083NID, and 4210083LID. No damage will result from inadvertent deployment of the Low Voltage -130 VDC TRI-C with a -190 VDC TRI-R.

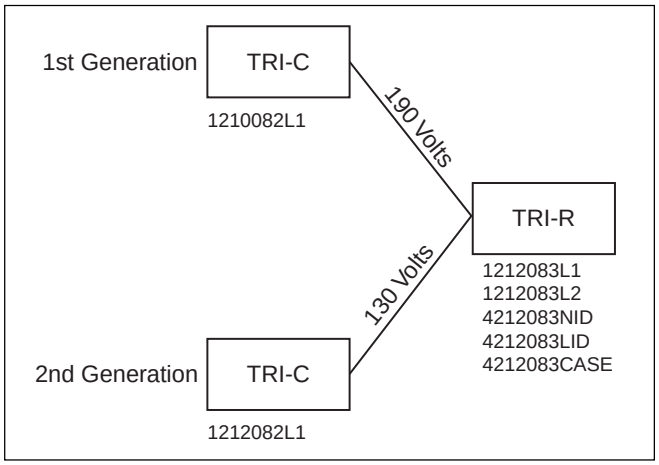

Figure 2. 1st to 2nd Generation Compatibility

The feature set of the Low Voltage T400 TRI-C is compatible with the 1st Generation TRI-Central Office Unit, 1210082L1. with the exception of the lower span-powering voltage. It is not interchangeable on circuits terminated with -190 VDC TRI Remote Units.

The TRI-C makes use of ADTRAN's Simple Coded Pulse Amplitude Modulation (SC PAM) line coding technology to extend the service range of ISDN without the use of current mid-span U-Repeater technology. SC PAM is a full-duplex, multilevel encoding scheme that uses bandwidth reduction and improved adaptive equalization to transparently extend the ISDN Digital Subscriber Line (DSL) well beyond the current serving range of ISDN.

The Total Reach ISDN system extends the DSL serving range up to 52 dB when measured at 20 kHz. This is based on -44.2 dBm of 2B1Q Near End Crosstalk (NEXT) as defined in ANSI T1.601 (typically referred to as 0 dB margin). Refer to Deployment Guidelines for additional information.

2. INSTALLATION

CAUTION!
SUBJECT TO ELECTROSTATIC DAMAGE OR DECREASE IN RELIABILITY.
HANDLING PRECAUTIONS REQUIRED.

After unpacking the unit inspect it for damage. If damage is noted file a claim with the carrier, then contact ADTRAN. See *Warranty and Customer Service.*

Optioning

A two-position DIP switch, SW1, is used for option selection. The card must be withdrawn from the shelf to make option changes. See **Table 1** for a description of option settings.

Table 1. SW1 Option Settings

Switch	Label		Description
SW1-1	CTONE	ON	Enables continuous periodic wake-up tones to the ISDN switch or LULT device. Wake-up tones are repeated at 17 second intervals.
		OFF	Default and normal condition, in that the TRI-C sends one wake-up tone on power-up only.
SW1-2	TEST	ON	Used for factory test only.
		OFF	Default and operational mode.

Connections

The TRI-C is a single T400 mount circuit card that operates from the -48 or -72 VDC provided by the shelf. All signal connections are made through the card edge connector interface to the T400 backplane. The card pin assignments are illustrated in **Figure 3**.

The use of a T400/MFT adapter provides the mechanical and electrical interfaces required for proper operation of the TRI-C in the MFT mounting. The T400/MFT adapters are available in either a custom-wired or an unwired model and can be obtained from multiple suppliers. The unwired version requires wire-wrapping to interconnect the T400 56-pin connector to the MFT 40-pin connector. **Table 2** defines the TRI-C pinout for both T400 and HR12 Shelves. **Table 3** shows the recommended MFT interconnect wiring option for a T400 TRI-C. **Table 4** shows the pin assignments for the Westel 9407-00 NCTE/MFT Adapter.

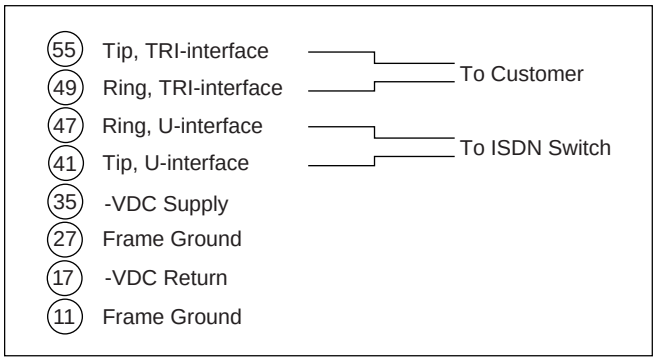

Figure 3. T400 TRI-C Pin Assignments

WARNING

-130 VDC may be present on the TRI-C tip and ring.

Using Figure 3 and the T400 shelf documentation, connect the U-interface and the TRI-interface to the appropriate cross-connect. These connections are not sensitive to Tip/Ring reversal.

WARNING

Frame ground must be connected to provide lightning and power cross protection for the TRI-C.

To install the T400 TRI-C, grasp the unit by the faceplate and insert it into a shelf slot. Push the T400 TRI-C into the backplane connector until firmly seated. After the TRI-C is installed or powered on, faceplate LEDs will initially blink and then stabilize with the OFFICE I/F and TRI I/F LEDs ON. **Table 5** describes the four front panel status LEDs.

Following powerup, the TRI-C provides -130 VDC maximum span power to the TRI-R and sends one wake-up tone toward the ISDN switch or LULT interface, SW1-1 OFF. Once synchronization is achieved over the U-interface, the OFFICE I/F LED will go Off. The receipt of Near End Block Errors (NEBEs) on the U-interface will be indicated by a once per second flash on the OFFICE I/F LED.

If the TRI-R has been installed, training will begin on the TRI-interface. Upon synchronization of the TRI-interface, the TRI I/F LED will go Off. The receipt of NEBEs on the TRI-interface will be indicated by a once per second flash on the TRI I/F LED.

The OFFICE I/F and TRI I/F LEDs may flash briefly upon synchronization at either interface, but should then go out. When synchronization to each interface is achieved, the associated LED provides an indication of the error performance on that interface. If either LED continues to flash intermittently, this indicates a possible error condition on the associated interface which should be checked before concluding circuit turn-up.

Once all connections are made and synchronization is complete, the TRI-C indicates activation using the

Table 2. TRI-C Pinout on Different Shelves

Slot Number	23" T400 Shelf (1150092L1)		23" and 19" T400 (1150024L1 & 1150028L1)		HR12 Shelf	
	Switch Side U-Interface (Pins 47/41)	Field Side TRI-Interface (Pins 49/55)	Switch Side U-Interface (Pins 47/41)	Field Side TRI-Interface (Pins 49/55)	Switch Side U-Interface (Pins 47/41)	Field Side TRI-Interface (Pins 49/55)
1	P1-1/26	P3-1/26	P1-1/26	P2-1/26	P2-14/39	P1-14/39
2	P1-2/27	P3-2/27	P1-3/28	P2-5/30	P2-15/40	P1-15/40
3	P1-3/28	P3-3/28	P1-5/30	P2-9/34	P2-16/41	P1-16/41
4	P1-4/29	P3-4/29	P1-7/32	P2-13/38	P2-17/42	P1-17/42
5	P1-5/30	P3-5/30	P1-9/34	P2-17/42	P2-18/43	P1-18/43
6	P1-6/31	P3-6/31	P1-11/36	P2-21/46	P2-19/44	P1-19/44
7	P1-7/32	P3-7/32	P1-13/38	P3-1/26	P2-20/45	P1-20/45
8	P1-8/33	P3-8/33	P1-15/40	P3-5/30	P2-21/46	P1-21/46
9	P1-9/34	P3-9/34	P1-17/42	P3-9/34	P2-22/47	P1-22/47
10	P1-10/35	P3-10/35	P1-19/44	P3-13/38	P2-23/48	P1-23/48
11	P1-11/36	P3-11/36	P1-21/46	P3-17/42	P2-24/49	P1-24/49
12	P1-12/37	P3-12/37	P1-23/48	P3-21/46	P2-25/50	P1-25/50
13	P1-13/38	P3-13/38	N/A	N/A	N/A	N/A
14	P1-14/39	P3-14/39	N/A	N/A	N/A	N/A

Table 3. Recommended MFT Interconnect

T400/56-pin TRI-C	MFT 40-pin
Tip Field Side	55 ↔ 14 Tip side A
Ring Field Side	49 ↔ 13 Ring side A
Tip Switch Side	41 ↔ 17 Tip1 side B
Ring Switch Side	47 ↔ 19 Ring1 side B
-48 supply	35 ↔ 11 -48 V
-48 return	17 ↔ 18 ground
Frame ground	11 ↔ 1 chassis ground
Frame ground	27

Table 4. Westel 9407-00 Pin Assignment

T400/56-pin TRI-C	MFT 40-pin
Tip Field Side	55 ↔ 17 Tip1 side A
Ring Field Side	49 ↔ 19 Ring1 side A
Tip Switch Side	41 ↔ 14 Tip side B
Ring Switch Side	47 ↔ 13 Ring side B
-48 supply	35 ↔ 11 -48 V
-48 return	17 ↔ 18 ground
Frame ground	11
Frame ground	27

ACT LED. The ACT LED will light after successful exchange of the activation bit between the customer's terminal equipment and the ISDN Switch. The ACT LED will flash if the activation bit is received on the TRI-interface (when the NT1 or the customer's terminal equipment is providing the activation bit), but is not received from the ISDN Switch.

During normal operation, the ACT LED will be ON, and all other LEDs will be OFF. See Table 5 for additional LED information.

Deployment Guidelines

The Total Reach ISDN system is designed to provide range extension on single, twisted-pair, non-loaded loops that exceed the typical ISDN deployment range. The general guidelines require that the loop have an insertion loss of less than 52 dB at 20 kHz, or less than 61 dB at 40 kHz with 135 ohms driving and terminating impedances. See **Table 6** for loop loss conversion for different wire gauges.

The recommended TRI-interface deployment guidelines for Total Reach ISDN are listed in **Table 7**. Adherence to these guidelines will allow general deployment of Total Reach ISDN without further qualification. If any of the stated guidelines are exceeded additional circuit testing will be required to ensure loop loss and noise levels are not exceeded.

CAUTION

Remove load coils from the circuit pairs being deployed. Loading coils are designed to pass frequencies in the lower bandwidth range. Higher bandwidth ranges such as ISDN will not operate properly if loading coils are not removed from the pair.

Specific cable loss constant values and DC loop resistance for various wire gauges are provided in **Table 8**. Loop loss constants (in db/kft) are provided for 20 and 40 kHz and can be used to determine the Estimated Measured Loss (EML) for any local loop. Examples of maximum loop lengths are provided for each wire gauge and are based on 70°F PIC cable with –44.2 dBm ANSI NEXT. Additional temperature loss data for different wire gauges and cable material is shown in **Table 9**.

These constants were derived using *Bell Lab Transmission System for Communications, 1982*, and the method for determining the insertion loss with 135 ohms driving and termination impedances. The total length of multi-gauge cable must yield a loop loss less than or equal to 52 dB @ 20 kHz or 61 dB @ 40 kHz.

For EML, multiply each section's loop length in kilofeet by the appropriate cable loss constant in Table 8 to determine the insertion loss of each section. To determine the insertion loss for each bridged tap in the feeder, multiply the length of the bridged tap by 1.32 dB (2.09 for 40 kHz). The maximum loss of each bridged tap is 4.2 dB, (4.7 dB for 40 kHz) regardless of length. Assume 250 feet for Central Office wiring. For total insertion loss for the loop, add each section's insertion loss, the loss due to bridged taps, and loss of Central Office wiring.

Some Loop Deployment Programs provide automatic loop insertion loss predictions based on 40 kHz for ISDN 2B1Q. Table 6 provides a conversion estimate in dB between insertion loss at 40 kHz for 2B1Q ISDN and the recommended 20 kHz for Total Reach ISDN. To use, determine the dB loss at 40 kHz using current methods and the largest component cable size (24 or 22 AWG). If the 22 and 24 AWG components are approximately the same, use the values associated with 22 AWG. This table should only be used to provide a rough estimate of the insertion loss at 20 kHz. A more accurate estimate can be obtained by determining the exact cable makeup of a loop and using the cable loss constants in Table 8.

The U-Interface follows local deployment guidelines for standard ISDN, as specified in ANSI T1.601 and shown in **Table 10**.

Table 5. Faceplate LEDs

Indicator	Color	Description
OFFICE I/F	Red	**ON** solid indicates a loss of signal from or synchronization with the 2B1Q BRI interface. **Flashing** once per second indicates receipt of a Near End Block Error (NEBE) from the 2B1Q BRI interface.
TRI I/F	Red	**ON** solid indicates a loss of signal from or synchronization with the TRI-R unit. **Flashing** once per second indicates the receipt of a NEBE from the TRI-R unit.
TEST	Yellow	Indicates the TRI-C unit is in either a local or network-commanded test; 1 **flash** per second for B1 loopback, 2 **flashes** per second for a B2 loopback, and **solid** for 2B+D loopback.
ACT	Green	**ON** solid indicates that the terminal equipment has exchanged ACT bits with the ISDN switch. **Flashing** once per second indicates that the ACT bit is being sent only from the terminal equipment.

Table 6. 20 vs 40 kHz Loop Loss Conversion

20 kHz (dB)	40 kHz w/majority 22 AWG (dB)	40 kHz w/majority 24 AWG (dB)
1	1	1
5	6	6
10	12	12
15	18	18
20	23	24
25	29	30
30	35	36
31	36	38
32	37	39
33	39	40
34	40	41
35	41	42
36	42	44
37	43	45
38	44	46
39	46	47
40	47	48
41	48	50
42	49	51
43	50	52
44	51	53
45	53	55
46	54	56
47	55	57
48	56	58
49	57	59
50	58	61
51	60	62
52	61	63

Table 7. TRI-Interface Deployment Guidelines

Description	Value
Maximum Loop Loss @ -44.2 dBm ANSI NEXT	52 dB @ 20 kHz or 61 dB @ 40 kHz
Maximum DC resistance	2000 Ω
Maximum single bridge tap	2 kft
Maximum total bridged taps	6 kft
Maximum number bridged taps	3

Table 8. Cable Loss Constants (PIC @ 70ºF)

Cable Guage (mm)	Maximum Loop Length*	Loss @ 20 kHz per kft	Loss @ 40 kHz per kft	Ohms per kft
26/0.40	24 kft	2.159 dB	2.721 dB	83
24/0.51	33 kft	1.586 dB	1.921 dB	52
22/0.61	46 kft	1.134 dB	1.325 dB	32
19/0.91	80 kft	0.655 dB	0.770 dB	16
Bridged Tap	6 kft	1.32 dB	2.09 dB	N/A
*Based on – 44.2 dBm ANSI NEXT				

3. TESTING

The TRI-C responds to *eoc* loopbacks, including B1, B2, and 2B+D. Local test access is provided by the TRI-C faceplate when remote testing is not available, or during trouble isolation or equipment malfunction.

Local test access is available using the faceplate eight-position rotary switch and the RJ-45 jack for DS0 digital test set access. The SW2 rotary switch options are listed in **Table 11**.

The RJ-45 jack provides access for the DS0 digital test, and uses a standard wiring pin assignment as shown in **Table 12**. A DS0 test set is required to perform all of the local tests the TRI-C provides. The rotation direction of the switch determines which Bearer channel is to be tested.

CAUTION

When not in test mode, the RJ-45 should be disconnected. This step will prevent the unintentional activation of a test.

Clockwise (CW) rotation selects channel B1 channel, counterclockwise (CCW) selects B2.

Local technicians may test in both the upstream toward the ISDN switch or downstream toward customer's NT1, including loopback for up to four downstream addresses and the customer's NT1. The DS0 logic access allows for standard DS0 logic test sets such as the TPI 108/109 RT II or the FIREBERD 4000/6000. TTC has an available adapter cable, P/N CB-31611, for use with the FIREBERD test sets. TPI offers a 108/109 model with a built-in RJ-45 jack that will connect to the TRI-C using a straight-through 8-conductor RJ-45 cable.

Loopback Testing (ADR1-ADR4 & NT1)

Loopback testing in the network-to-customer direction can be initiated from either the ISDN switch or the faceplate. Loopbacks initiated from the faceplate are non-intrusive to the other B channels and to the D channel. To initiate a loopback, perform the following:

1. Connect the DS0 test set configured for Near Logic to the TRI-C RJ-45 jack.
2. Rotate the rotary switch CW or CCW for B1 or B2 respectively, stopping on the desired address. The TEST LED will turn On yellow when the loopback is established to the selected address. If the selected address does not respond, the TEST LED will remain Off.
3. Observe the bit error counter on the test set to determine error count.
4. Change the rotary switch to another address or Bearer channel to test additional network addresses. It is not necessary to exit the test mode to select a new address.
5. Upon completion of all tests remove the RJ-45 plug and return the address knob to the unused position.

Point-to-Point Test (OFC TX, TRI TX)

A point-to-point (straightaway) test can be performed to either the U-interface (OFC TX) or the TRI-interface (TRI TX). Ensure the local and remote test sets are configured for the same test pattern. To initiate a point-to-point test, perform the following:

1. Connect the DS0 test set configured for Near Logic to the TRI-C RJ-45 jack.
2. Rotate the eight-position rotary switch CW or CCW for B1 or B2 selection respectively, stopping on either OFC TX or TRI TX. The TEST LED will flash once per second for B1 and twice per second for B2.
3. Upon synchronization of the test pattern to the remote test set, observe the test set's bit error counter to determine the error count.
4. Upon completion of all tests remove the RJ-45 plug and return the address knob to the unused position.

Table 9. dB Loss Over Temperature @ 20 kHz

Plastic Cable	dB Loss per kft	Paper Cable	dB Loss per kft
19 Gauge PIC (0º F) 19 Gauge PIC (70º F) 19 Gauge PIC (120º F)	0.568 0.655 0.719	19 Gauge PULP (0º F) 19 Gauge PULP (70º F) 19 Gauge PULP (120º F)	0.611 0.705 0.768
22 Gauge PIC (0º F) 22 Gauge PIC (70º F) 22 Gauge PIC (120º F)	1.006 1.134 1.238	22 Gauge PULP (0º F) 22 Gauge PULP (70º F) 22 Gauge PULP (120º F)	1.054 1.195 1.290
24 Gauge PIC (0º F) 24 Gauge PIC (70º F) 24 Gauge PIC (120º F)	1.429 1.586 1.721	24 Gauge PULP (0º F) 24 Gauge PULP (70º F) 24 Gauge PULP (120º F)	1.475 1.653 1.771
26 Gauge PIC (0º F) 26 Gauge PIC (70º F) 26 Gauge PIC (120º F)	1.961 2.159 2.323	26 Gauge PULP (0º F) 26 Gauge PULP (70º F) 26 Gauge PULP (120º F)	1.955 2.170 2.313

Table 10. U-Interface Deployment Guidelines

Description	Value
Maximum Loop Loss @ -38.2 dBm ANSI NEXT	42 dB @ 40 kHz
Maximum DC resistance	1300 Ω
Maximum single bridge tap	2 kft
Maximum total bridged taps	6 kft
Maximum number bridged taps	3
Maximum noise	-57 dBm (135 Ω termination, 50 kb filter)

Table 11. SW2 Address Switch Options

Display	Interpretation
ADR1	Provides for local loopback of the TRI-C.
ADR2	Sends loopback to the next downstream unit, the TRI-R.
ADR3	Sends loopback to a third downstream unit.
ADR4	Sends loopback to a fourth downstream unit.
NT1	Sends loopback to the customer's NT1.
OFC TX	Transmits DS0 logic input toward the ISDN switch.
TRI TX	Transmits DS0 logic input toward the Total Reach interface.

Table 12. RJ-45 Pin Assignments

Pin #	Label	Description
Pin 1 Pin 2	TX-Ring TX-Tip	DS0 logic input to the TRI-C from the test set.
Pin 3 Pin 4	8 kHz 8 kHz Not	Byte clock output of the TRI-C to the DS0 logic test set.
Pin 5 Pin 6	64 kHz 64 kHz Not	Bit clock output of the TRI-C to the DS0 logic test set.
Pin 7 Pin 8	RX-Tip RX-Ring	DS0 logic output of the TRI-C to the DS0 logic test set.

4. MAINTENANCE

The TRI-C does not require routine maintenance for normal operation.

ADTRAN does not recommend that repairs be performed in the field. Repair services are obtained by returning the defective unit to ADTRAN Customer And Product Service (CAPS).

5. SPECIFICATIONS

Specifications for the TRI-C are listed in **Table 13**.

6. WARRANTY AND CUSTOMER SERVICE

ADTRAN will replace or repair this product within 10 years from the date of shipment if it does not meet its published specifications or fails while in service (see: *ADTRAN Carrier Network Equipment Warranty, Repair, and Return Policy and Procedure:* document 60000087-10A).

Contact CAPS prior to returning equipment to ADTRAN.

For service, CAPS requests, or further information, contact one of the following numbers:

ADTRAN Technical Support

(800) 726-8663
Standard hours: Monday-Friday, 7 a.m.-7 p.m. CST
Emergency hours: 7 days/week, 24 hours/day

ADTRAN Sales

(800) 827-0807

ADTRAN Repair/CAPS

(256) 963-8722

Repair and Return Address

ADTRAN, Inc.
CAPS Department
901 Explorer Boulevard
Huntsville, Alabama 35806-2807

Table 13. TRI-C Specifications

2 Wire (Network) Loop Interface	
Line:	2-Wire
Operating Mode:	Full-duplex
Data Rate:	160 kbps total; 144 kbps available to customer
Signal Format:	2B1Q
Transmit Power (rms):	13 dBm to 14 dBm nominal
Tx/Rx Source Impedance:	135 Ω AC Impedance 120 kΩ DC Signature
Receiver Sensitivity:	46 dB @ 40 kHz with -44.2 dBm ANSI (NEXT)
Total Reach ISDN Interface	
Line:	2-Wire
Operating Mode:	Full-duplex
Signal Format:	SC PAM
Transmit Power (rms):	13 dBm nominal
Tx/Rx Source Impedance:	135 Ω nominal
Receiver Sensitivity:	52 dB @ 20 kHz with -44.2 dBm of ANSI NEXT
Output Power:	-130 VDC nominal 2 W nominal
Mechanical	
Size:	1 3/8" high x 5 5/8" wide x 6" deep
Weight:	13 oz
Mounting:	Type 400 compatible
Input Power:	-48 or -72 VDC input 4.5 Watts maximum
Environmental	
Temprature:	Operating: 0 to 50° C (32 to 122° F) Storage: -40 to 85° C (-40 to 185° F)
Relative Humidity:	Up to 95%, noncondensing