TC2400 & TC2401

RACK MOUNT/STAND ALONE
HI-SPEED MULTI-DROP (RING)
FIBER OPTIC MODEM

User's Manual

MODEL: ____________________

S/N: ____________________

DATE: ____________________

Notice!

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Chapter 1 - Overview

Description

The TC2400R/S and TC2401R/S are high speed multi-drop fiber optic modems designed for a ring topology with a self-healing capability as shown in Figure 1. When connected to a SCADA host controller, the Master unit (TC2400) can broadcast its poll messages to all the remote (TC2401) units (also referred to as Slave units). The Remote Terminal Unit (RTU) connected to the TC2401 will respond only to the poll with that RTU's own specified ID (or address), which is embedded in the poll message. The communication between the Master and Slave is transparent to protocol and data rate; transmission can be full duplex provided only one RTU responds at a time.

The dual ring consists of an "A-Ring" and a "B-Ring." The A-Ring is the primary fiber optic ring and the B-Ring is the backup fiber optic ring. Each Slave unit can detect any one of four possible cable breakage conditions, referred to as "fault conditions," as shown in Figure 4. The TC2400/2401 can detect ring breakage on either the A-Ring or B-Ring. When a cable breakage occurs, both the upstream TC2401 and downstream TC2401 can detect the breakage and "wrap" around the data accordingly, as shown in Figure 5.

The TC2400 and TC2401's panels are equipped with multiple LED indicators and DIP switches. The LEDs indicate data wrap or fault conditions such as "A2B" (or Loop A to B), "B2A" (or Loop B to A), or optic signal loss. The DIP switches can activate the "Local Loopback" function or generate a pulsed electrical signal to simulate a broadcast signal from the SCADA host. These features can be very useful during installation or when troubleshooting the system. A dry contact relay alarm can be utilized to provided alarm status to the local RTU. In the event that self-healing occurs, the local RTU can relay the alarm condition back to the SCADA host controller, enabling the operator to easily determine and locate the problem site(s).

The electrical interface for the TC2400/2401 can be RS-232, RS-422, or RS-485 (2 or 4 wire). Typical applications include SCADA, process control, traffic control, and energy management. Due to the Self-Healing capability, the TC2400/2401 can provide maximum reliability for crucial SCADA applications.

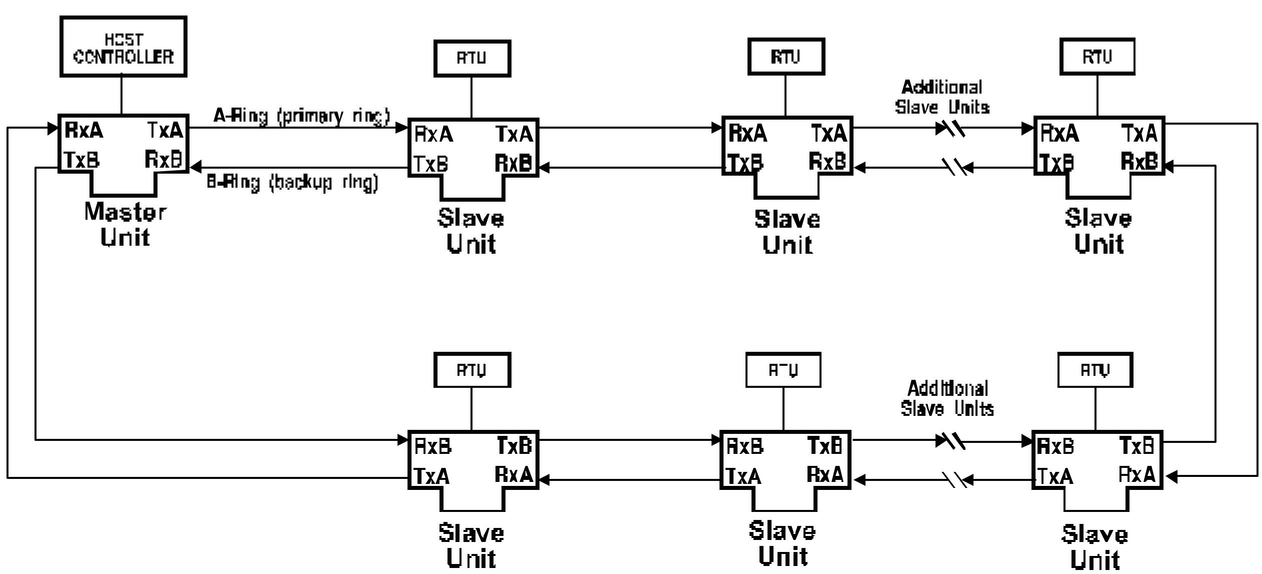


Figure 1. Self-Healing Ring Topology

Operation of Self-Healing Ring

In a poll-response environment, the host controller broadcasts poll messages to every RTU. Because the poll message is embedded with a specific RTU's ID (or address), only the RTU with the correct ID responds to the Master's polling. The TC2400's function is to convert the electrical signal from the Host controller to a fiber optic signal and transmit that signal in both ring directions, as shown in Figure 2.

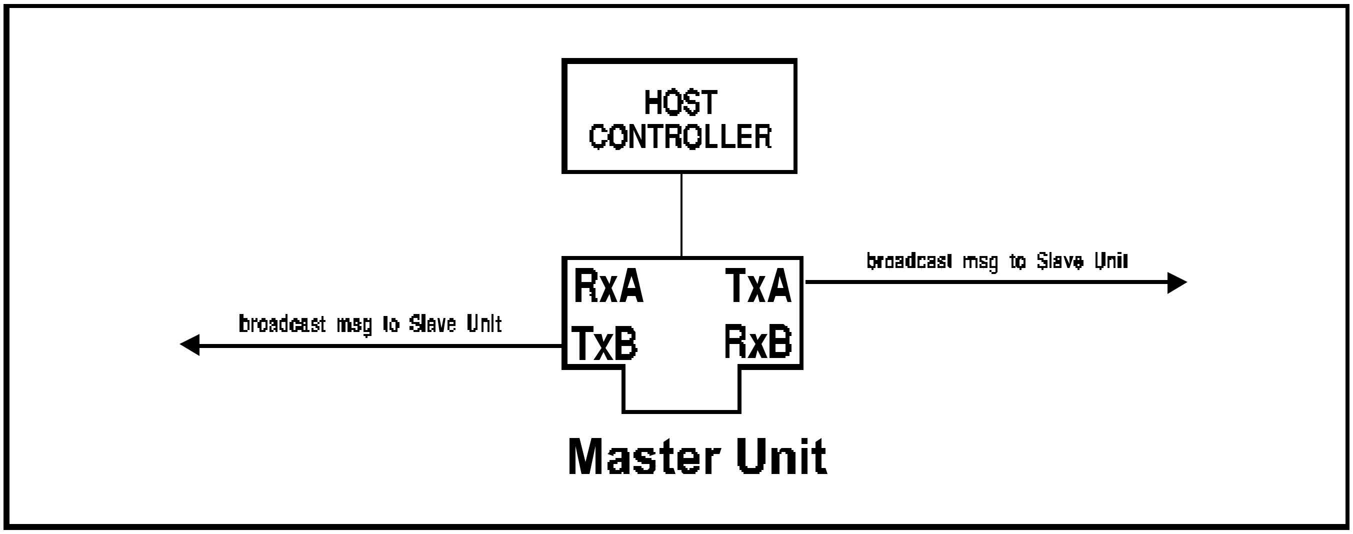


Figure 2. Ring Broadcast Directions

The first Slave unit in the ring intercepts the Master's broadcast message and forwards it to the downstream Slave unit. Each subsequent Slave forwards the broadcast message until it reaches the last Slave in the ring. The RTU with the correct ID then sends a response message. Each Slave then forwards the response message through the ring until it eventually reaches the Master unit.

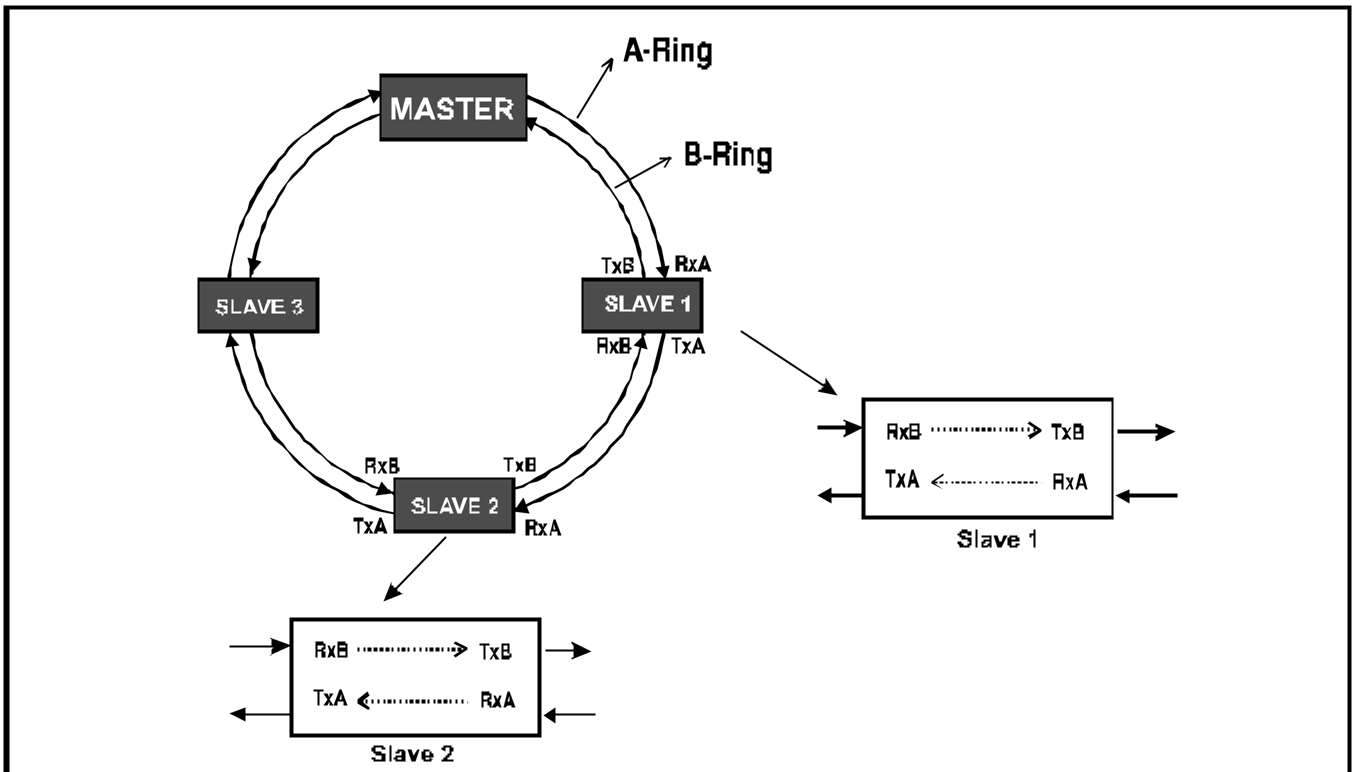


Figure 3. Ring Operation Under Normal Conditions

When an optic fault condition occurs, as shown in Figure 4, the self-healing function will detect the fault and reroute the data, as shown in Figure 5.

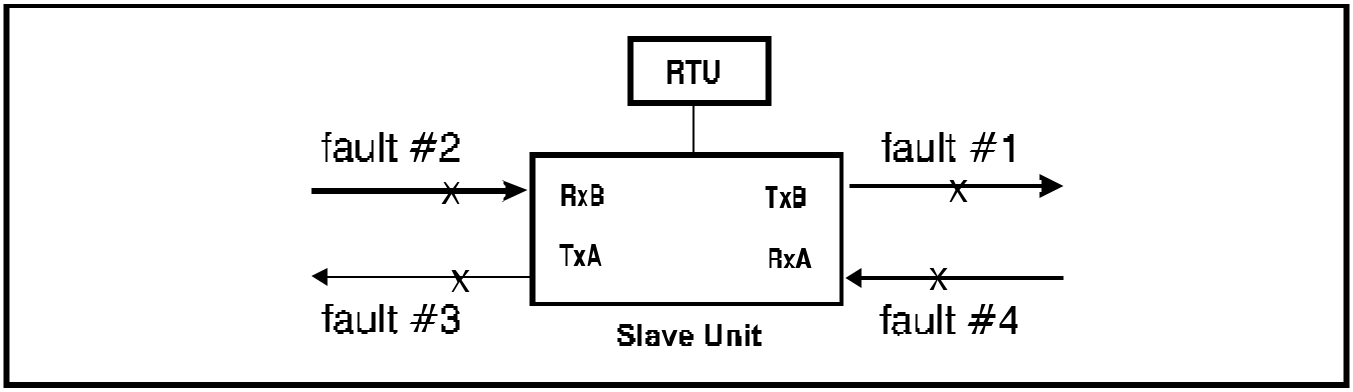


Figure 4. Optic Fault Conditions

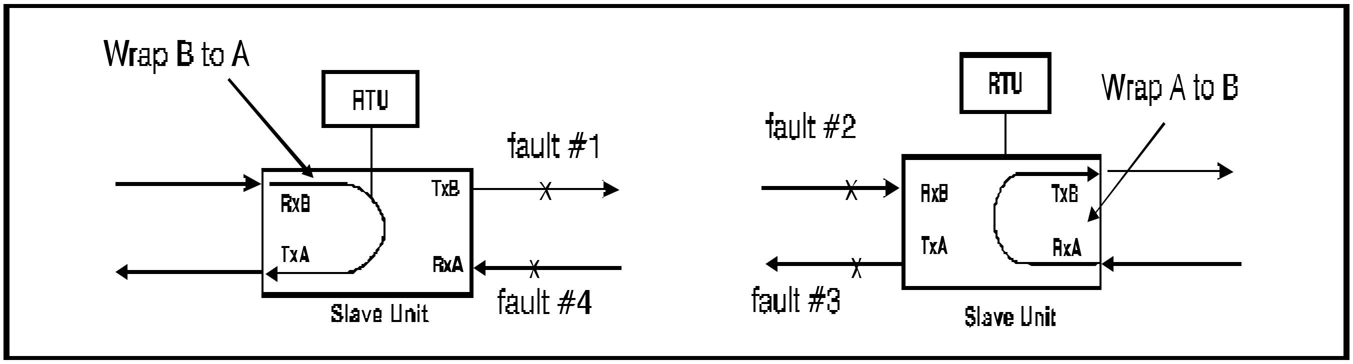


Figure 5. Data Wrap Condition due to Fault #2 or #3

As Figure 6 below illustrates, should a cable breakage occur between Slave 1 and Slave 2, then Slave 1 and 2 will detect the fault and "wrap" the data to avoid the broken cable. Slave 1 will wrap the A-Ring's data path to the B-Ring while Slave 2 wraps the B-Ring's data path to the A-Ring.

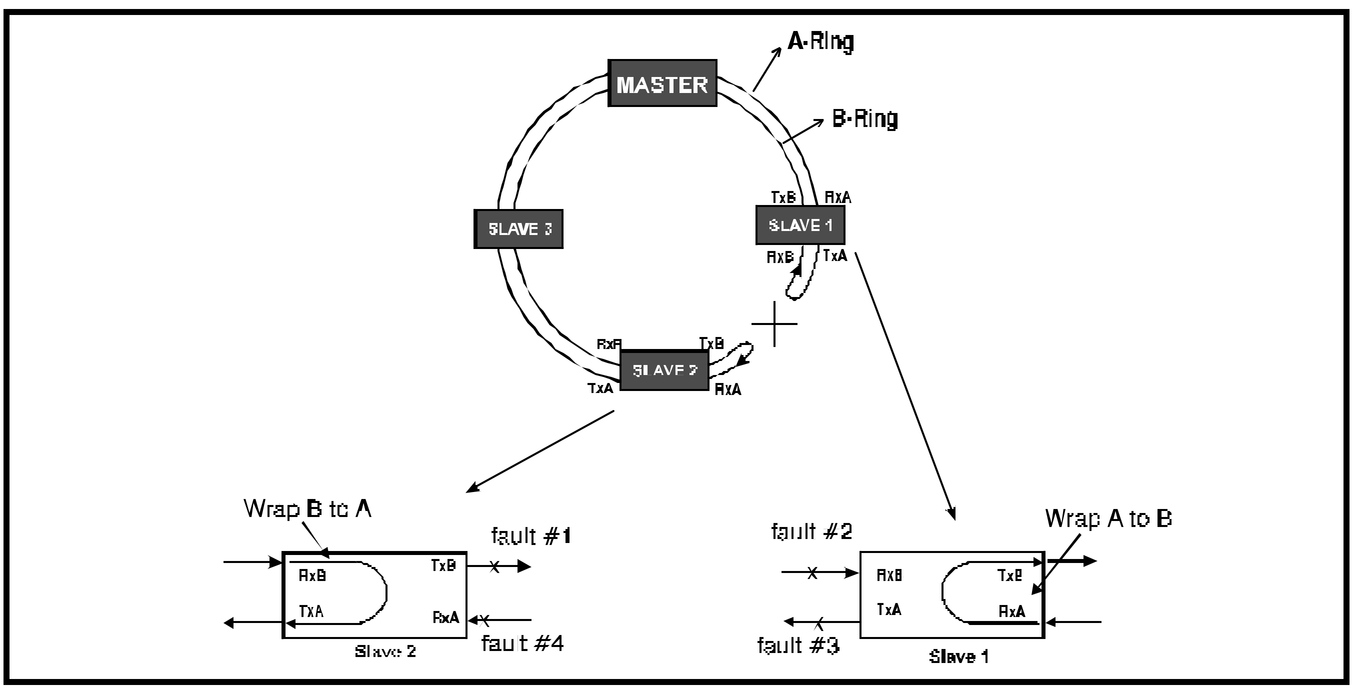


Figure 6. Self-Healing Function resulting from Optic Cable Breakage

Fiber Optic Ring's Integrity Monitors

Since communication between Master and Slave can be self-healed, it is necessary to monitor the ring's integrity and generate an alarm signal once the A-Ring or B-Ring has breakage (See Figure 7). The TC2400 has two loop monitors, one for the A-Ring and one for the B-Ring. The monitoring signal originates from the Master unit and travels along the A-Ring and B-Ring. Each Slave relays the monitoring signal to the next unit. If the monitoring signal is not received by the Master, an alarm at the Master will be triggered. The Alarm relay switch will be activated. In the meantime, the self-healing function is performed automatically by the upstream and downstream Slave units, thereby maintaining the integrity of the link.

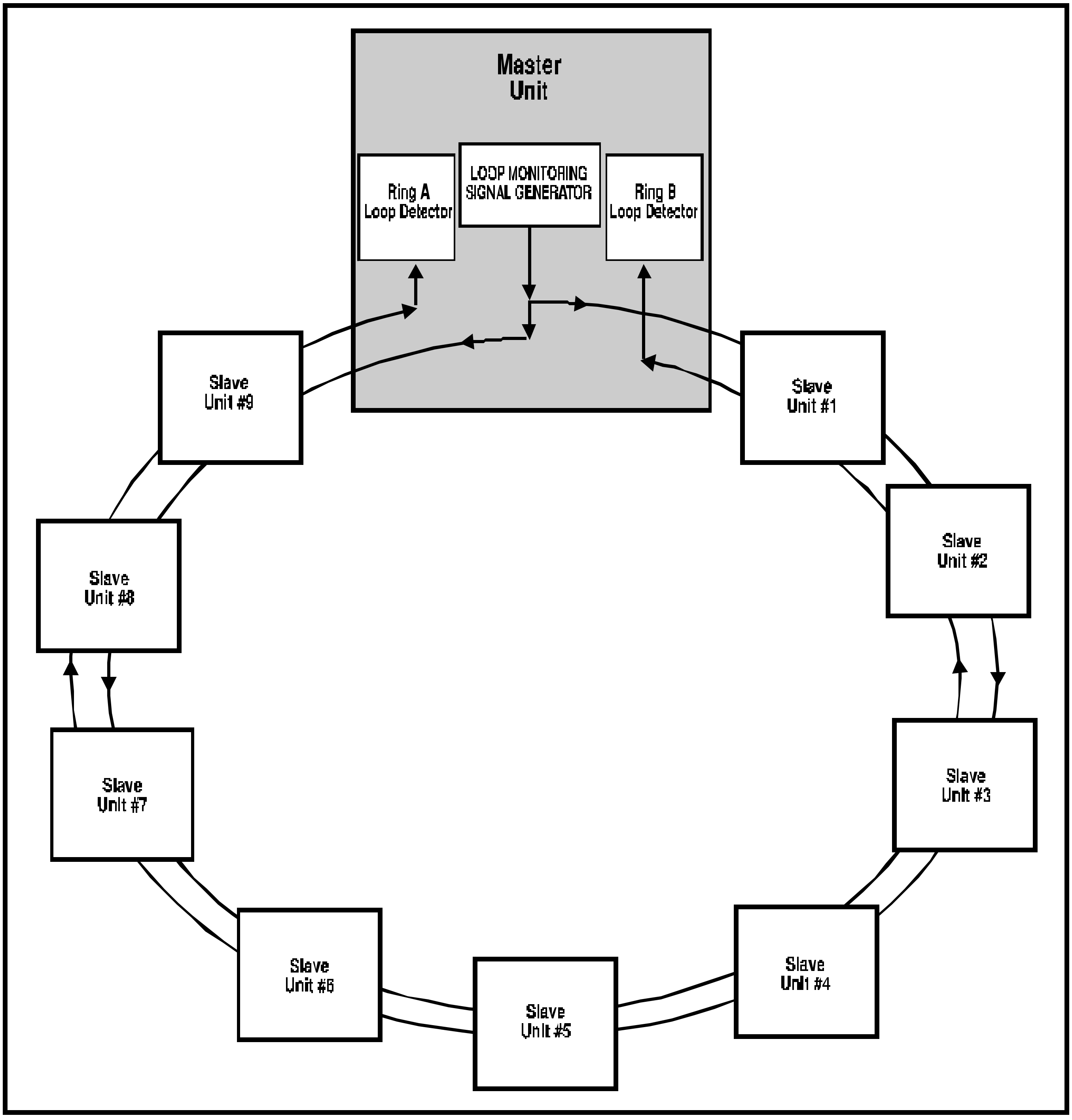


Figure 7. Fiber Optic Ring's Integrity Monitors

Cable Fault Detection between Slaves

The TC2400/2401's link monitor consists of cable fault detection rings that are implemented between Slaves and between the Slave and Master units. This monitor can detect cable breakage between any of the units, as illustrated in Figure 8.

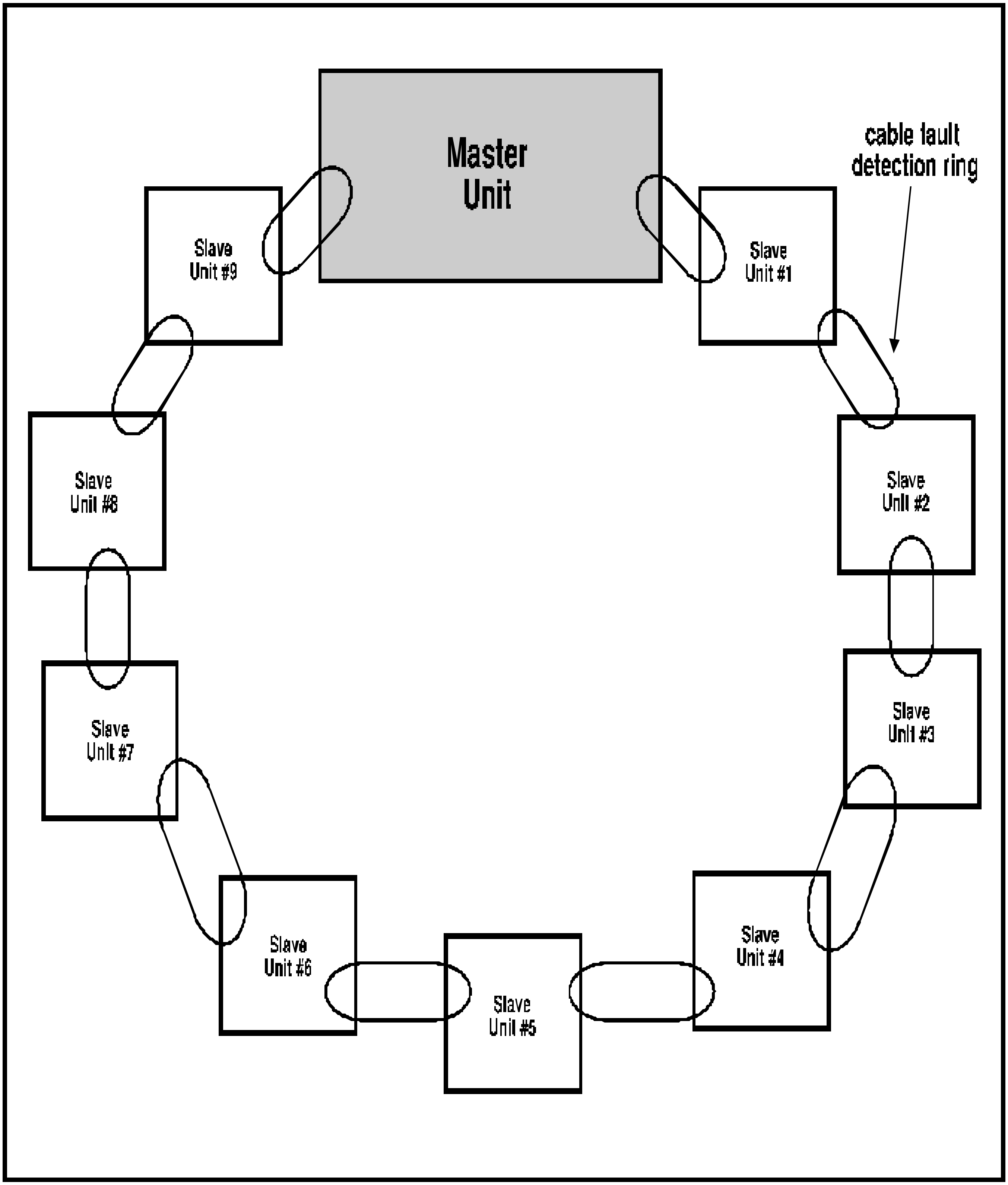


Figure 8. Cable Fault Detection Rings

LEDs, DIP Switches and Connectors

The TC2400 (Master) and TC2401 (Slave) have the similar front panels with two exceptions: the Optic Fault LEDs on the TC2401 (Slave) can indicate a data wrap condition, while the Optic Fault LEDs on the TC2400 (Master) can indicate an invalid data transmission.

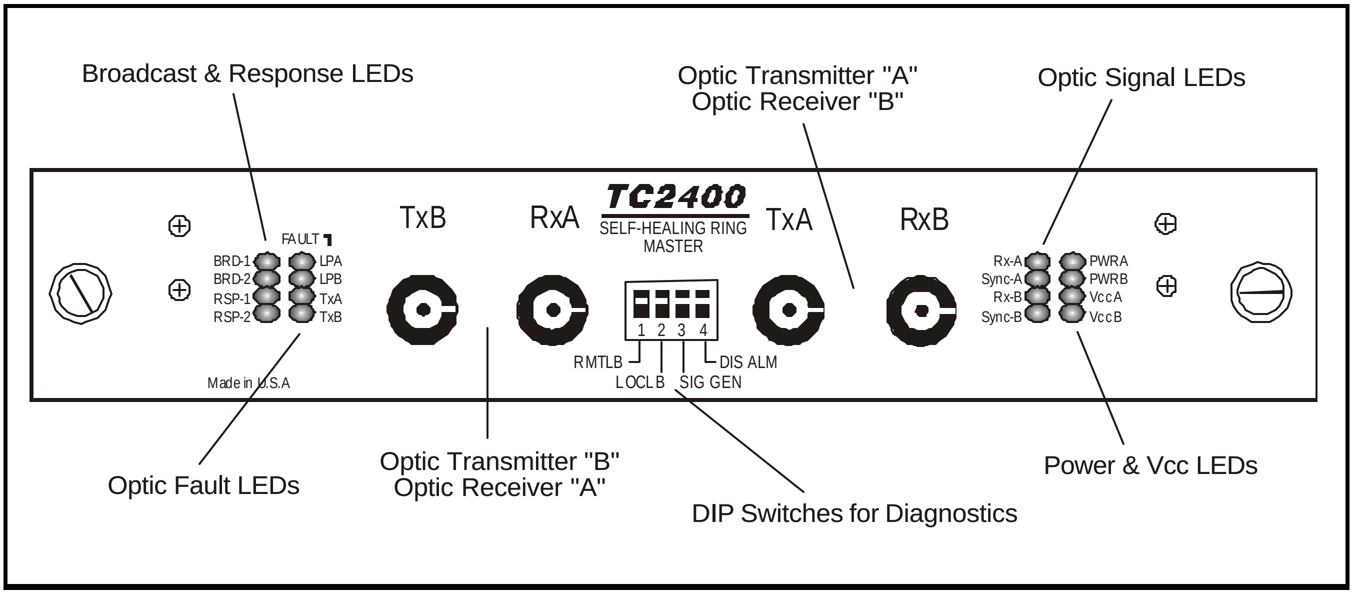


Figure 9. TC2400's Front Panel

LED Functions

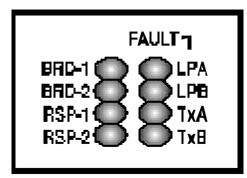
BROADCAST & RESPONSE LEDs

BRD-1: Indicates a broadcast msg from the local device on Channel 1 (when lit).

BRD-2: Indicates a broadcast msg from the local device on Channel 2 (when lit).

RSP-1: Indicates a response msg from a remote device on Channel 1 (when lit).

RSP-2: Indicates a response msg from a remote device on Channel 2 (when lit).



TC2400 (Master) OPTIC FAULT LEDs

LPA: When lit, indicates the A-Ring loop monitor signal is received; flashes when the A-Ring is degraded or broken.

LPB: When lit, indicates the B-Ring loop monitor signal is received; flashes when the B-Ring is degraded or broken.

TxA: When lit, indicates the optic signal transmitted from "TxA" is valid; flashes when the signal is invalid.

TxB: When lit, indicates the optic signal transmitted from "TxB" is valid; flashes when the signal is invalid.

TC2401 (Slave) OPTIC FAULT LEDs

A2B: When lit, indicates a data wrap condition exists and the unit is routing "RxA" data to "TxB."

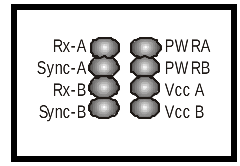
B2A: When lit, indicates a data wrap condition exists and the unit is routing "RxB" data to "TxA."

LPA: When lit, indicates the A-Ring loop monitor signal is received; flashes when the A-Ring is degraded or broken.

LPB: When lit, indicates the B-Ring loop monitor signal is received; flashes when the B-Ring is degraded or broken.

LED Functions (cont.)

OPTIC SIGNAL LEDs



Rx-A: When lit, indicates the optic signal received at "RxA" is above the sensitivity threshold. It does not necessarily mean a valid signal is received.

Sync-A: Indicates a valid data packet is received at "RxA" (when lit); flashes if data packet is invalid.

Rx-B: When lit, indicates the optic signal received at "RxB" is above the sensitivity threshold. It does not necessarily mean a valid signal is received.

Sync-B: Indicates a valid data packet is received at "RxB" (when lit); flashes if data packet is invalid.

POWER & Vcc LEDs

PWRA: Indicates a +12V DC power supply is connected to the power jack "A" input on the rear panel (when lit).

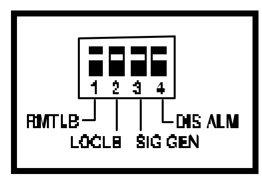
PWRB: Indicates a +12V DC power supply is connected to the power jack "B" input on the rear panel (when lit).

Vcc A: Indicates a +5V DC operating voltage is being derived from the power supply that connected to power jack “A”(when lit).

Vcc B: Indicates a +5V DC operating voltage is being derived from the power supply that connected to power jack “B”(when lit).

External DIP Switch Functions

SW1: **RMTLB** (Remote Loopback). Loops back the received signal from a remote location (for diagnostic testing).



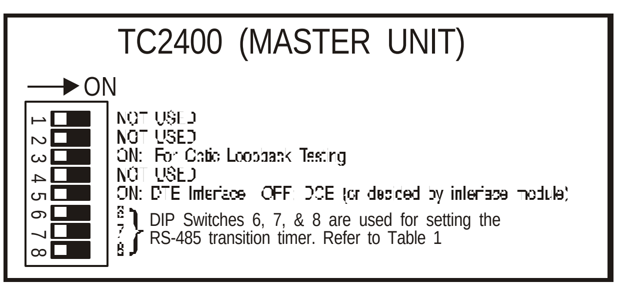
SW2: **LOCLB** (Local Loopback). Loops back the received signal from the local RJ11 connector (for diagnostic testing).

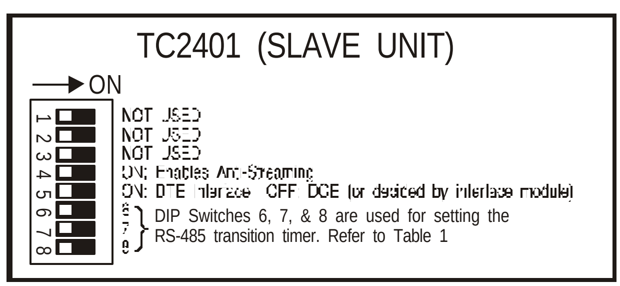
SW3: **SIG GEN** (Signal Generator). Generates a pulse signal that emulates a broadcast msg (for diagnostic testing).

SW4: **DIS ALM** (Disable Alarm). When this switch is in the down (On) position, the audio alarm buzzer and dry contact relay are disabled.

Internal SW2 DIP Switch Functions

The Internal DIP Switches are located on the TC2400/2401’s PCB at board location SW2 (see Chapter 5). The DIP Switch functions for the Master and Slave units are as illustrated below.





Anti-Streaming Timer

The TC2401 (Slave unit) has a built-in Anti-Streaming Timer that prevents a defective RTU or PLC from bringing down the entire network. The electrical channels (TxD & RTS) from the RTU(s) are monitored individually; they are based on data (not control) signals. When the Anti-Streaming Timer is exceeded (after about 4 seconds of continuous transmission), an alarm is triggered and the RTU's defective electrical channel is automatically disconnected, preventing the unit from jabbering continually. The timer will automatically reset once the jabbering subsides. The Anti-Streaming Timer can be disabled by sliding the Slave's internal DIP switch SW5 to the right (Off) position.

Electrical Specifications

The electrical signal interface for the TC2400/TC2401 can be RS-232 or RS-422/485 (DCE only). Data rates up to 120 Kbps are supported for RS-232 Asynchronous DC (no handshake), or two Async channels without control. Data rates up to 1 Mbps are supported for RS-422/485 Asynchronous DC (on "AUX1" port only). The "AUX2" port (secondary channel) supports data rates up to 256 Kbps for the RS-422/485 interface. Data flow is controlled by XON/XOFF and RTS/CTS. The electrical connectors are RJ11 Female. Two RJ11 ports ("AUX3" & "AUX4") are not used.

Electrical Signal Interface Connections & Pin Assignments

The electrical signal interface is connected to the host or RTU via an RJ11 female connector at the rear panel of the TC2400/2401. The RJ11 DCE pin assignments are as illustrated in Figures 10, 11 & 12.

For RS-232 interfaces, pin 5 is the input (TxD) pin while pin 4 is the output (RxD) pin.

RS-232 Asynchronous

For RS-232 interfaces, pin 5 is the input (TxD) pin while pin 4 is the output (RxD) pin.

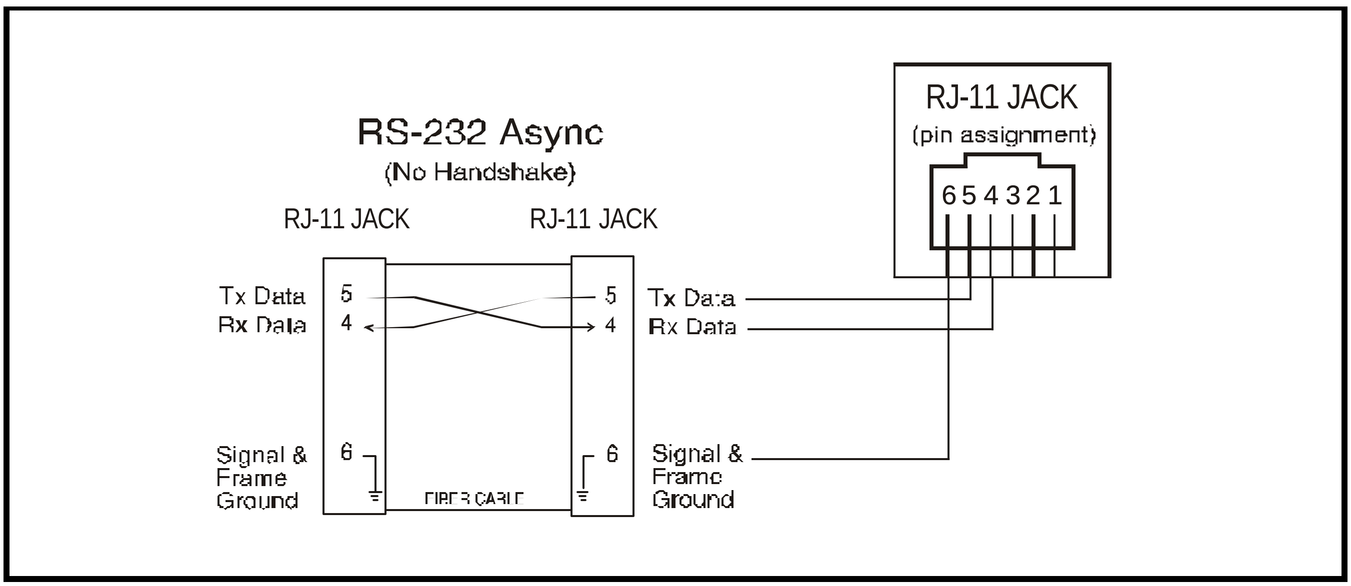


Figure 10. RS-232 Pin Assignments & Virtual Connection

Four Wire RS-422/RS-485 Asynchronous

For RS-422 & RS-485 interfaces, pins 2 and 5 are balanced input pins. Pin 2 is the positive input (TxD+) while pin 5 is negative (TxD-).

Pins 3 and 4 are balanced output pins. Pin 3 is the positive output (RxD+) while pin 4 is negative (RxD-). Either pin 6 or pin 1 can be Signal Ground.

Only RS-422/RS-485 Async communications can be used with the TC2400 due to the limited number of pins on the RJ-11 connector.

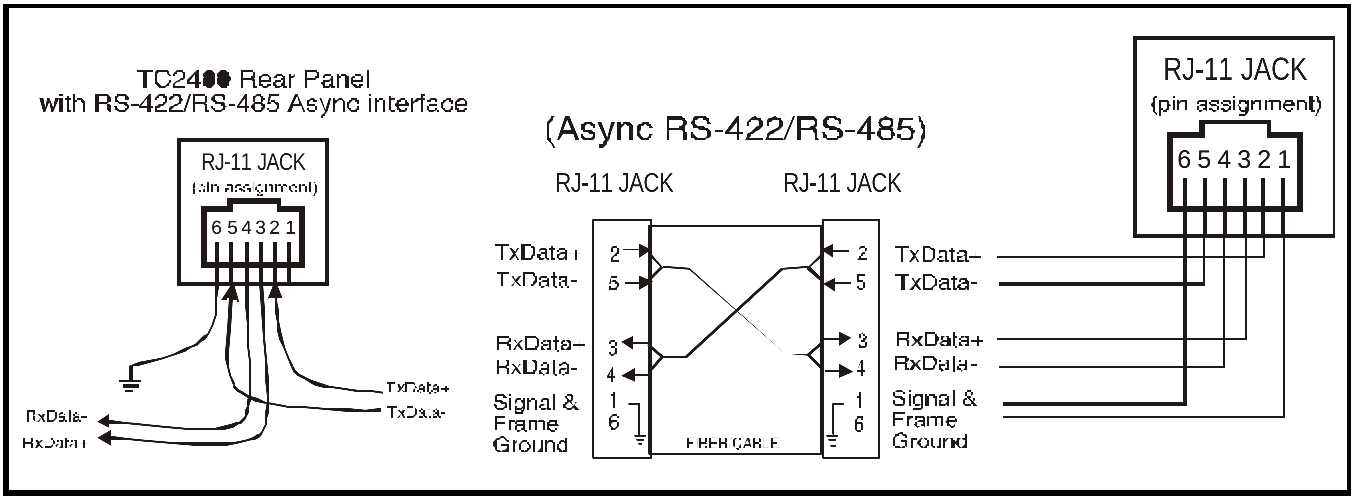


Figure 11. RS-422/485 Async Pin Assignments & Virtual Connection Diagrams

Two wire (Half Duplex) RS-485 Asynchronous

For two wire RS-485, use pins 3 and 4.

Either pin 6 or pin 1 can be Signal Ground.

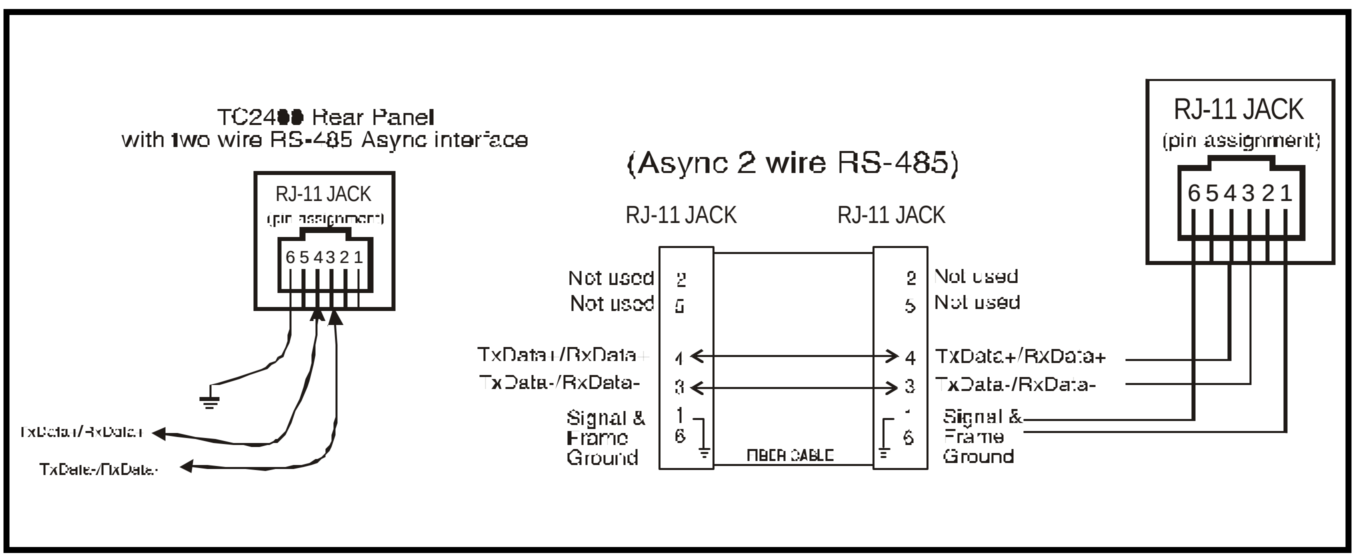


Figure 12. Two Wire RS-485 Async Pin Assignments & Virtual Connection Diagrams

RS-485 Transition Timer Setup

The Internal SW2 DIP Switches are located on the TC2400/2401's PCB at board location SW2 (see Chapter 5). The SW2 DIP Switches #6, 7, and 8 functions are to set up the transistion time for the RS-485.

Table 1 provides setup information for configuring the SW2 Internal DIP switches for an RS-485 application. To use the table, determine the baud rate of your application and set SW6, SW7, & SW8 accordingly. For example, if you know the async data baud rate of your application is 32Khz, then set SW1_6 to the Right (On); SW1_7 to the Right (On); and SW8 to the left (Off).

		SW2_6	SW2-7	SW2_8
RS-422	4Khz	Off	Off	Off
RS-485	8Khz	On	Off	Off
	16Khz	Off	On	Off
	32Khz	On	On	Off
	65Khz	Off	Off	On
	125Khz	On	Off	On
	250Khz	Off	On	On
	500Khz	On	On	On

SW2

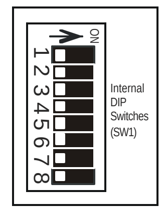


Table 1. Settings for the RS-485 Transition Time (Internal SW2)

RJ11-to-DB25 Female (Async DCE) Conversion Cables

The user's device may have a DB25 male connector. The following illustrations depict the RS-232 & RS-422/485 wiring diagrams for constructing an RJ11-to-DB25 adapter cable for such applications.

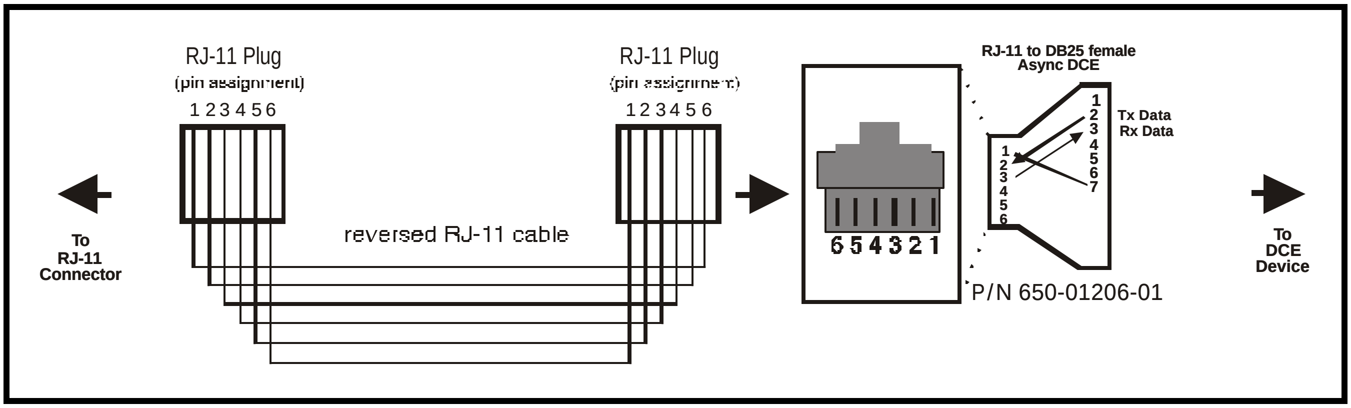


Figure 13. RS-232 (ASYNC DCE) DB25 Conversion Cable

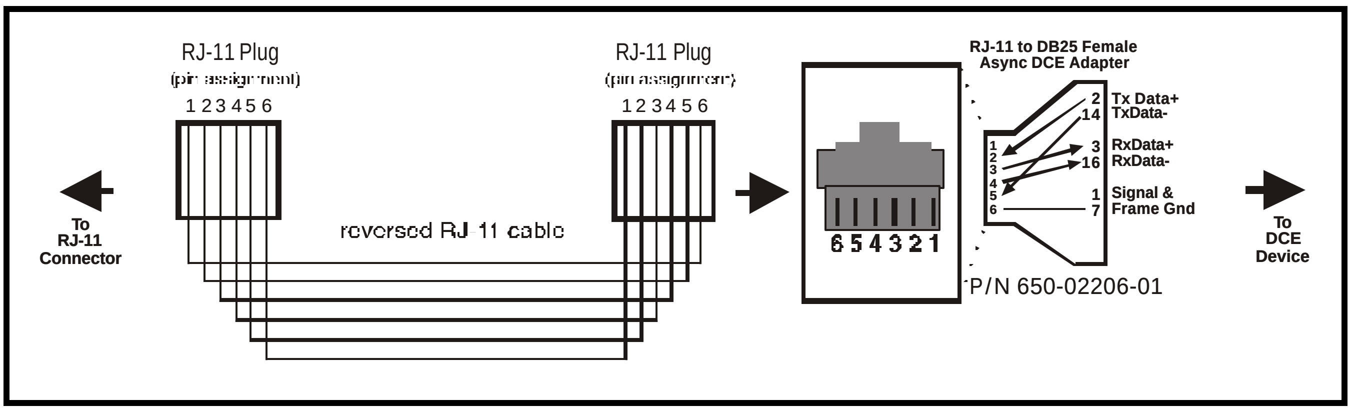


Figure 14. RS-422/485 (ASYNC DCE) DB25 Conversion Cable

Optical Specifications

The TC2400/TC2401 will work with all popular sizes and types of fiber optic cable.

Transmission Distances

Transmission distances of up to 4km* are typical over Multimode fiber at 850nm and 8km* at 1310nm. Distances of up to 35km* are typical over Single Mode fiber at 1310nm. Should an application require greater distances than those listed, contact the factory for information on the TC2400/TC2401 Laser version.

Launch Power & Sensitivity

Transmitter:	**LED/ELED; typical Launch Power:**	**-19dBm* (850/1310nm Multimode, @62.5/125µm)**
	LASER:	**-16dBm* (1310/1550nm Single Mode, @9/125µm)**
Receiver:	**PIN Diode; typical Sensitivity:**	**-34dBm* (850/1310nm Multimode, @62.5/125µm)**
	LASER:	**-36dBm* (1310/1550nm Single Mode, @9/125µm)**
Loss Budget:	**850/1310nm Multimode, @62.5/125µm:**	**15dB**
	1310/1550nm Single Mode, @9/125µm:	**20dB**

Launch power, sensitivity and distance are listed for reference only. These numbers may vary.

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 TC2400 and TC2401 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, heavy duty power supplies, etc. As with any electronic equipment, keep the unit from excessive moisture, heat, vibration, and freezing temperatures.

Dry Contact Alarm Relay

A terminal block connector at the rear panel provides for the Dry Contact Alarm Relay. Normally in the OPEN position, any alarm condition will force the switch to a CLOSED position. This relay can be used in conjunction with an external device (such as an RTU) to signal an alarm condition to the Host.

Power Supply

Typically, a 9V to 12V DC @500mA power supply is adequate for the TC2400/2401. The power plug is a terminal block connector with positive & negative polarity indicated on the rear panel of the unit. Alternate power sources are available as an option (see Chapter 6 - Specifications).

Installation Procedure Summary

The TC2400/2401 is designed for quick and easy installation. Before installing, however, make sure all DIP switches on the front panel are in the up (Off) position and double-check the polarity at the DC power's terminal block connector.

Installation Procedure:

A. Install the Master unit first. Run an Optic Loopback Test (see page 18).

B. Install one Slave unit. Run a Remote Loopback Test (see page 19).

C. Connect the RS-232 or RS-422/485 signal to the Master unit (See pages 10, 11 & 12).

D. Install additional Slave units. Run Local and Remote Loopback tests.

E. Verify system integrity:

At Master unit: check "RxA," "RxB," "Sync-A," "Sync-B," "LPA" and "LPB" LED indicators.

At each Slave unit: check "RxA," "RxB," "Sync-A," "Sync-B," "A2B," and "B2A" LED indicators.

Verify and record the optical cable loss for each link in the system after installation is complete. This reading will both verify the integrity of the circuit and provide a bench mark for future troubleshooting efforts (see Chapter 3 - Troubleshooting).

Chapter 3 - Troubleshooting

General

Alarm conditions occur whenever an optical problem or "fault" is detected by the TC2400/2401. Under normal operation, all LEDs should be "On" (solid or blinking).

All LEDs are "Off"

If no LEDs are lit on the unit, check the DC power supply, terminal block connector plug, and/or power source.

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 Loss on the Fiber

The fiber optic link and/or the connectors are frequently the source of communication problems. If problems are present, check the optic 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 of signal loss when installed should not suddenly test out as having a loss of 10dB. If this were the case, however, the fiber link or connector would probably be the source of the problem.

These are the reference values we use to calculate the loss on the fiber:

Multimode 850nm	**:**	**3 dB loss per km on 62.5/125 µm cable***
Multimode 1300nm	**:**	**2 dB loss per km on 62.5/125 µm cable***
Single Mode 1300nm	**:**	**0.5 dB loss per km on 9/125 µm cable***
Single Mode 1550nm	**:**	**0.25 dB loss per km on 9/125 µm cable***

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

Chapter 4 - Bench Tests

General

It is highly recommended to conduct these bench tests before actual installation. Bench testing will allow the user to get familiar with all the functions and features of the TC2400/2401 in a controlled environment. Knowledge of the TC2400/2401's functions and features will ease installation and troubleshooting efforts later on.

Bench Test with Built-In Signal Generator

The TC2400 (Master) has a built-in signal generator to simulate a broadcast message from a SCADA host, while the TC2401 (Slave) has a built-in signal generator to simulate an RTU's response message. The built-in signal generator is a pulse signal indicated by a blinking LED. The flash rate is intentionally reduced for easy visual confirmation.

1. Set up the bench test as shown in Figure 15. At the Master unit, turn "On" the "SIG-GEN" by sliding SW3 downward. The "BRD-1" and "BRD-2" LEDs on the TC2400 (Master) should start blinking. The "BRD-1" and "BRD-2" LEDs on the TC2401s (Slaves) should also blink, indicating receipt of the Master's broadcast signal.

2. At any Slave, turn "On" the "SIG-GEN" by sliding SW3 downward. The "RSP-1" and "RSP-2" LEDs on the Slave should start blinking. Verify that the Master's "RSP-1" and "RSP-2" LEDs are also blinking, indicating receipt of the Slave's simulated response.

3. Disconnect the fiber cable from "RxA" or "RxB" on the TC2400 to simulate a cable breakage. The "BRD-1" & "BRD-2" and "RSP-1" & "RSP-2" LEDs on the TC2400 and TC2401 should continue blinking, indicating communication was not disrupted due to the optic cable breakage. Reconnect the fiber cable & repeat this step for each link between the Slaves and Master unit.

4. Observe any other flashing LEDs on each unit. Refer to pages 8 & 9 for the LED functions of the TC2400 and TC2401.

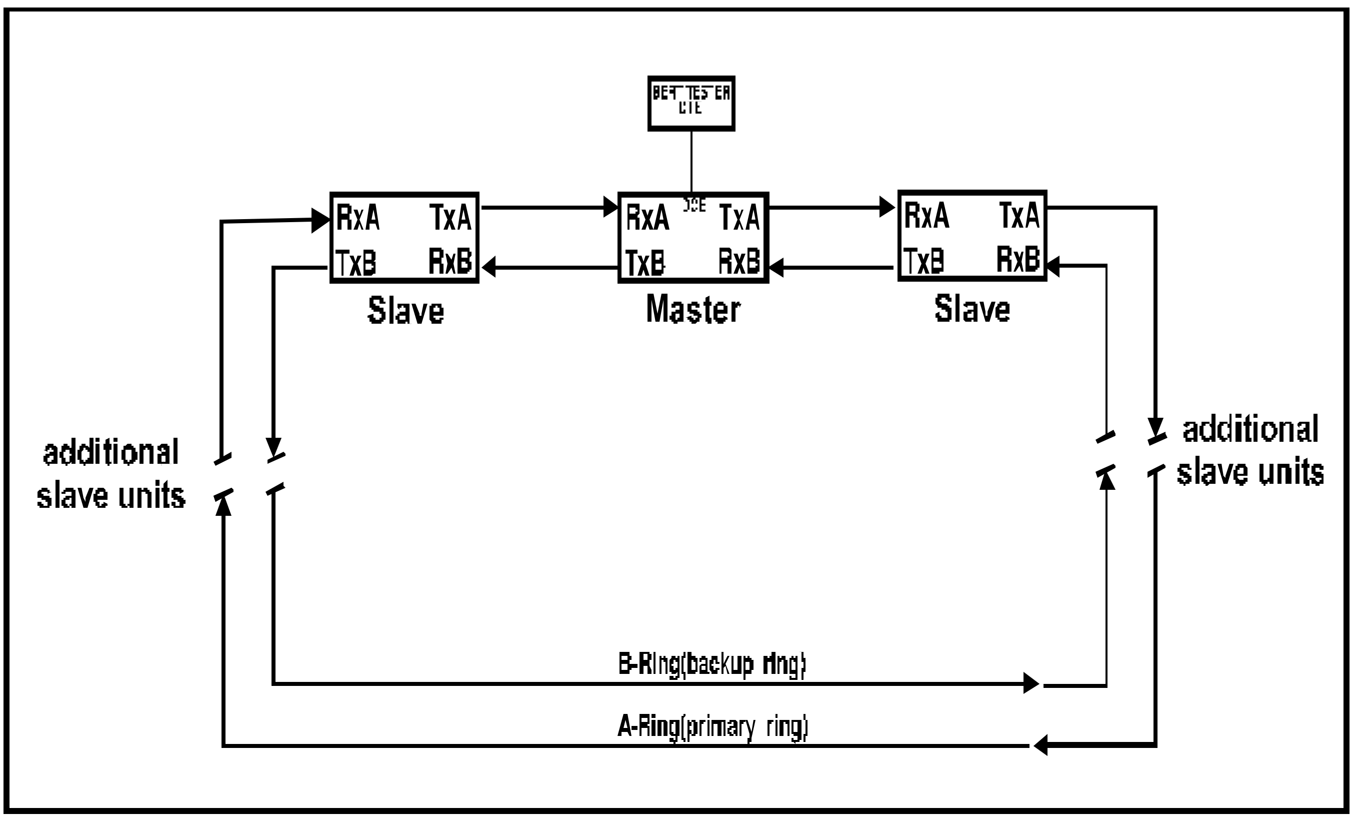


Figure 15. Bench Test Connection Diagram

Local Electrical Loopback Bench Test

Purpose: To verify the electrical cable connections, the electrical interface driver, and the receiver's Integrated Circuitry.

Equipment Requirements: One (1) Bit Error Rate Test (BERT) Set with an appropriate interface module and connectors.

Procedure: Set up the bench test as shown in Figure 16. Set SW2 to the down (On) position. Set the BERT tester up as a DTE device. The "BRD-1" & "BRD-2" and "RSP-1" & "RSP-2" LEDs should be dimly lit, showing the status of the looped signal. The Bert tester should indicate a "SYNC" signal. This test can be performed on each unit individually throughout the system.

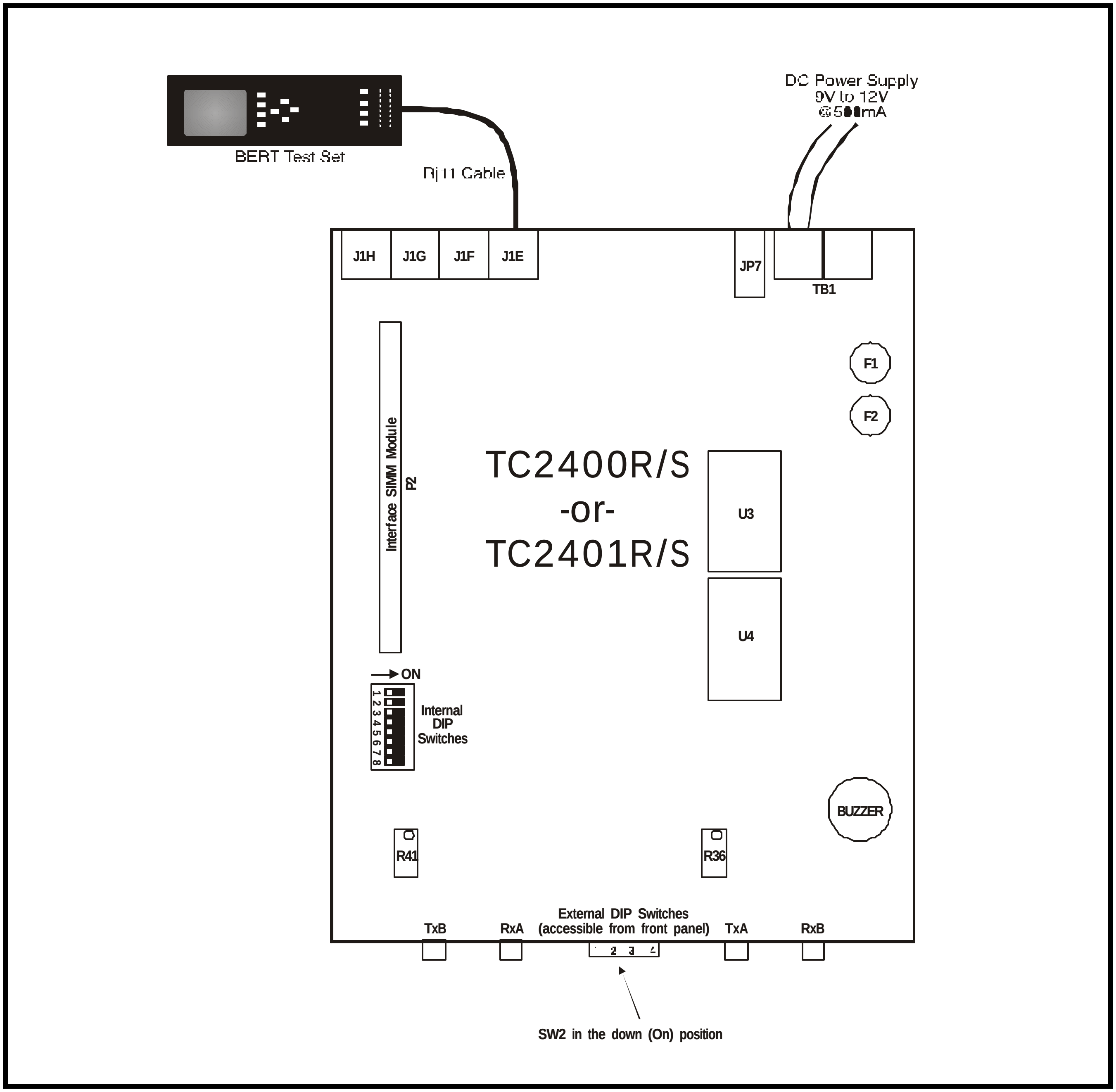


Figure 16. Local Electrical Loopback Bench Test Connection Diagram

Optic Loopback Bench Test (for TC2400 only)

Purpose: To test the broadcast and receive capabilities of the Master unit without a Slave unit attached.

Equipment Requirements: One (1) Bit Error Rate Test (BERT) Set with an appropriate interface module and connectors.

One (1) optical jumper cable (patch cord) with appropriate connectors.

Procedure: Set up the bench test as shown in Figure 17. Remove power, alarm, and RJ11 connectors from the rear of the TC2400. Unscrew the two flathead screws on the TC2400's front panel. Gently slide the unit out of the housing. Set the internal DIP switch SW3 to the left (On) position and all others to the right position. Connect an optic patch cord from "TxA" to "RxA." Connect a BERT tester to the RJ11 “AUX1” port on the TC2400. Set the tester up as a DTE device. The BERT tester should indicate a "SYNC" signal.

Remove the patch cord from "TxA" and "RxA." The "SYNC" light on the tester should turn "Off." Repeat the steps above with an optic patch cord from "TxB" to "RxB."

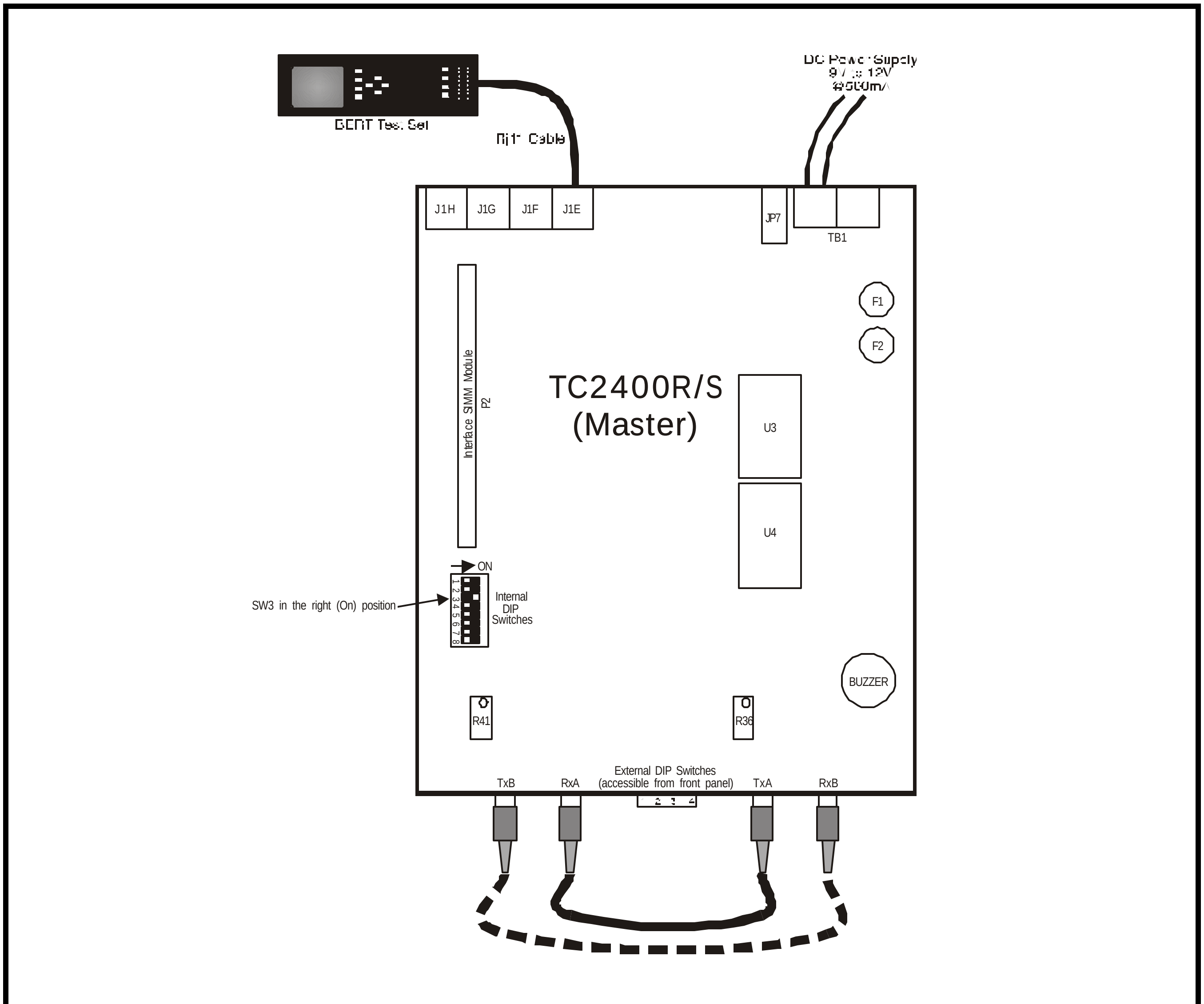


Figure 17. Optic Loopback Bench Test Connection Diagram

Remote Loopback Bench Test

Purpose: To test the Slave unit's optic functions and LED indicators. This procedure also enables the operator to become familiar with the self-healing function. When installing new Slave units in a network, a remote loopback test should be performed between each individual Slave and the Master unit. This will verify the integrity of the system.

Equipment Requirements: One (1) Bit Error Rate Test (BERT) Set with an appropriate interface module.

At least six (6) optical jumper cables with appropriate connectors.

Procedure: Set up the bench test as shown in Figure 18. Switch SW1 (“RMTLB”) to the down position at Slave 1. Set the tester up as a DTE device. The BERT tester (connected to the Master) should indicate a "SYNC" signal.

Verify the self-healing function by disconnecting the fiber at optic "TxA" on Slave 1, creating an optic fault condition. The BERT tester's "SYNC" light may turn "Off" momentarily, then turn "On", indicating the fault was detected and the transmission was rerouted to the alternate ring. Verify the LEDs and reconnect the fiber. Repeat this step for optics "RxA," "TxB," and "RxB" on each of the remaining units to be tested.

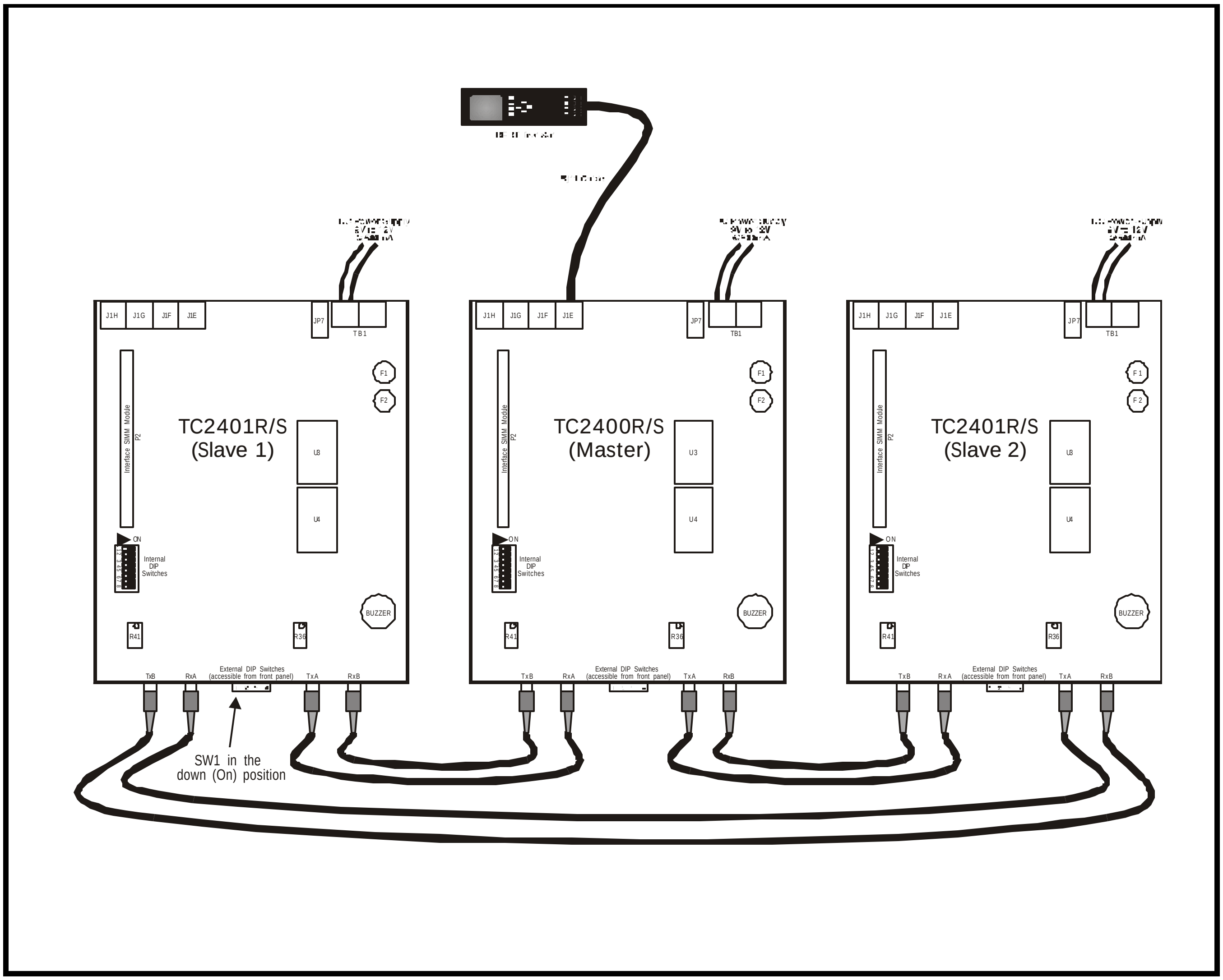


Figure 18. Remote Loopback Bench Test Connection Diagram

Commonly Asked Questions

1. How do I begin to install a counter-rotating ring configuration ?

Ans: *Begin with the A-Ring on the Master unit, then expand with Slaves one at a time in a clockwise direction. Every time a Slave is added, check the ring's integrity. The Master's "LPA" and "LPB" LEDs are designed for this purpose. Always finish the A-Ring connections first and then connect the B-Ring in the same fashion, only counterclockwise. Keep in mind that the "TxA" optic always connects to the downstream unit's "RxA" receptacle in the A-Ring, and "TxB" always connects to "RxB" in the opposite direction on the B-Ring.*

2. How do I know if the optic ring is closed or if the fiber cables are cross-connected somewhere in the ring ?

Ans: *The "LPA" and/or "LPB" LEDs on the Master unit will flash if the associated ring is not closed. If the "RxA" cable is mixed up with the "RxB" cable, the A-Ring and B-Ring are considered "open" and the appropriate LEDs will flash.*

3. What direction is the optic signal traveling in ?

Ans: *The optic signal traveling clockwise is designated as the "A-Ring," which means the fiber connections from one unit's optic "TxA" to the next unit's "RxA," until the ring is complete. Always install the A-Ring first and verify it's integrity before starting the B-Ring.*

The fiber optic signal traveling counterclockwise is designated as the "B-Ring," which means the fiber connections from one unit's optic "TxB" to the next unit's "RxB," until the ring is complete.

4. What do the front panel's "BRD" & "RSP" LEDs mean ?

Ans: *The "BRD-1" & "BRD-2" stand for Broadcast Data. They are the signals from the SCADA Host (connected to the Master) to be transmitted (or broadcasted) to the Slaves. The "BRD-1" & "BRD-2" LEDs on the Master unit reflect the incoming signal status of the RJ11's connector pins 2 & 5 from the SCADA host. On the Slave units, the "BRD-1" & "BRD-2" are the received broadcast signals originating from the SCADA host.*

The "RSP-1" & "RSP-2" stand for Response Data. On the Slave unit, they are the response signals from the local RTU to be transmitted to the Master. The "RSP-1" & "RSP-2" LEDs on the Slave unit reflect the outgoing signal status of the RJ11's connector pins 3 & 4 from the local RTU. On the Master, the "RSP-1" & "RSP-2" are the received response signals originating from the RTU.

5. What is the built-in signal generator and how is it used ?

Ans: *For the TC2400 (Master), by sliding the SIG GEN (SW3) DIP switch to the down (On) position, a pulse signal will be generated to simulate an incoming signal on the RJ11's connector pins 2 & 5. In effect, this pulse signal is a simulated broadcast signal from the SCADA host, which will travel through the fiber to each Slave in the ring. This function is very useful for troubleshooting and verifying network integrity. The slow pulse rate of these LEDs can be easily confirmed at any Slave location.*

6. What is the difference between the front panel's "RxA" and "Sync-A" LEDs ?

Ans: *"RxA" indicates the receiving optical signal strength. When the "RxA" optic signal is above the sensitivity threshold (typically from -33dBm to -36dBm) the "RxA" LED turns "On" (solid). A marginal or fault condition causes it to flash. In some cases, the "RxA" optic signal is above the sensitivity threshold but is of poor quality. This will result in an invalid data packet.*

The possible fault conditions could be one of the following:

A. *Received optic signal's power is marginal (at the borderline of the sensitivity threshold).*

B. *Receiver is being overdriven (optic signal strength is too strong).*

C. *Multimode cable is used on a signal mode unit and causes the receiver to be overdriven.*

D. *Optic cable is cross-connected with another vendor's product and the TC2400/TC2401 can not recognize the data packet being transmitted.*

The "Sync-A" LED turns "On" (solid) once synchronization has been established and remains "On" (solid) so long as sync is maintained. This LED should only flash when the optic signal has been disrupted. The same applies to the "RxB" and "Sync-B" LEDs for the B-Ring.

Chapter 5 - Component Placement

The TC2400 (Master) and TC2401 (Slave) have similar PC Boards.

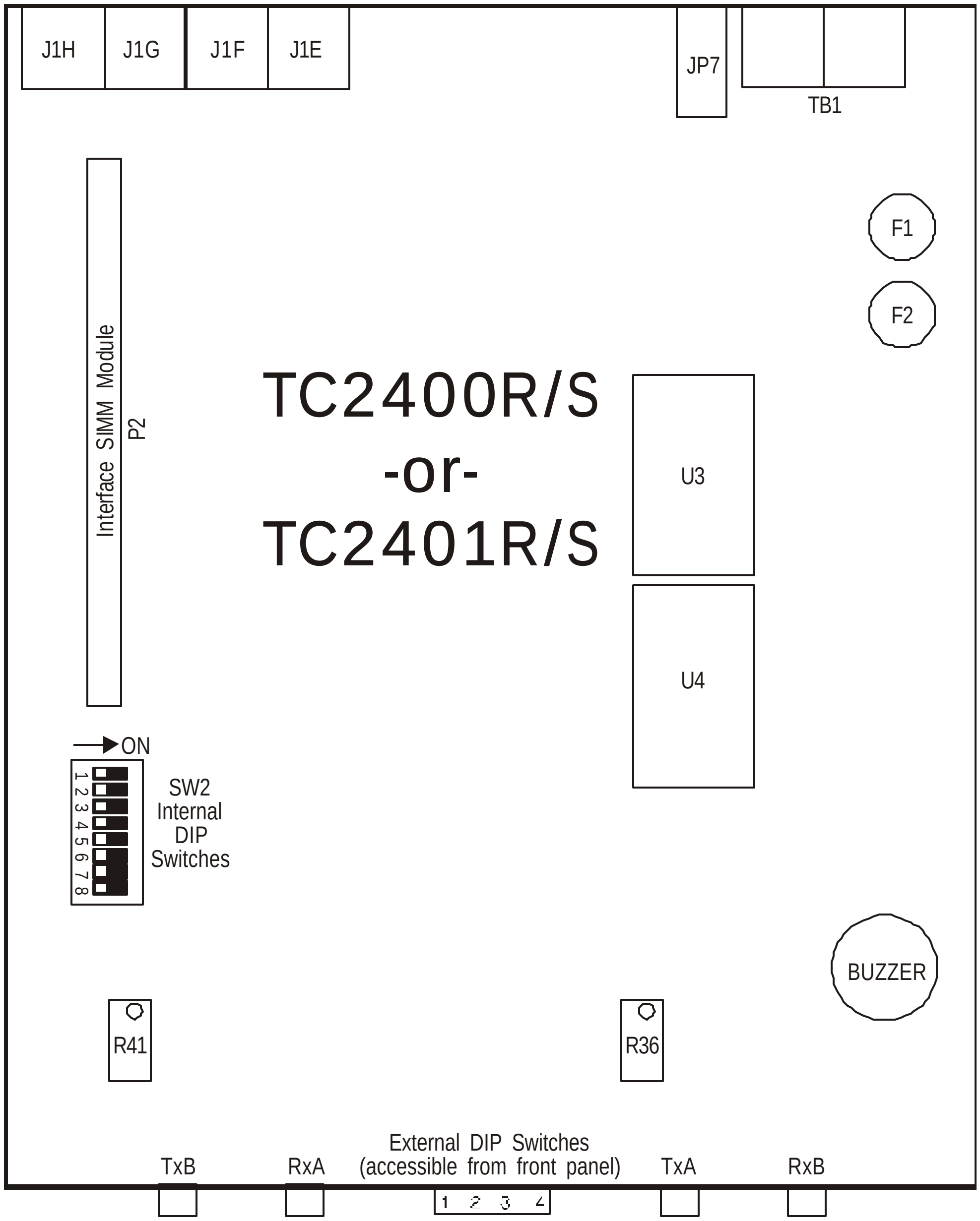


Figure 19. Component Locations on the TC2400/2401's PCB

Chapter 6 - Specifications

Data Rates

RS-232 Async .... **120 Kbps**
RS-422/485 "AUX1" Port .... **1 Mbps**
RS-422/485 "AUX2" Port .... **256 Kbps**

Optical

Transmitter .... **LED/ELED/LASER****
Receiver .... **PIN Diode**
Wavelength .... **850nm/1300nm Multimode**
.... **1300nm Single Mode**
Fiber Optic connectors .... **ST* (optional FC)**
Loss Budget .... **15dB Multimode 850nm/1300nm @62.5/125µm**
.... **20dB Single Mode 1300nm @9/125µm**

Electrical

Connector .... **RJ11 Female**
Interface .... **DCE RS-232** ***(or factory configured as DTE)***

System

Bit Error Rate .... **1 in 10^9 or better**
Visual Indicators .... **BRD-1, BRD-2, RSP-1, RSP-2, LPA, LPB, TxA (TC2400 only),**
.... **TxB (TC2400 only), A2B (TC2401 only), B2A (TC2401 only),**
.... **RxA, Sync-A, RxB, Sync-B, PWRA, PWRB, Vcc, ALARM.**
Dry Contact Alarm .... **36V DC, 1A**

Power Source

Standard .... **12VDC@500mA**
Optional .... **-24VDC@250mA**
Optional .... **-48VDC@125mA**
Optional .... **115/230VAC with external power cube**

Temperature

Operating .... **-10°C to 50°C**
High-Temp Version (optional) .... **-20°C to 70°C**
Storage .... **-40°C to 90°C**
Humidity .... **95% non-condensing**

Physical

Width .... **(18.2 cm) 7.2"**
Height .... **(3.5 cm) 1.4"**
Depth .... **(16.5 cm) 6.50"**
Weight .... **(534 gm) 1.2 lbs**

**ST is a trademark of AT&T*
***Contact factory for Laser version*

Appendix A

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).