TC2100

RACK MOUNT/STAND ALONE
MULTI-DROP
(DUAL MASTER Self Healing Ring)
FIBER OPTIC MODEM
User's Manual

MODEL: _____

S/N: _____

DATE: _____

Notice!

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Chapter 1 - Overview

Description

The TC2100 is a multi-drop fiber optic modem designed for dual ring (as known as counter rotating ring) topology with self-healing capability as shown in Figure 1. It can also be configured for single ring topology without self-healing capability. The TC2100 also has “Dual Master mode” ability, which can provide a backup master unit when emergency condition occurs (see page 8 for details). The following description applies only to dual ring configuration.

When connected to a SCADA host controller, the Master unit (TC2100) can broadcast its poll messages to all the remote (Slave) units (also referred to as Slave units). The Remote Terminal Unit (RTU) connected to the TC2100 (Slave) 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 TC2100 can detect ring breakage on either the A-Ring or B-Ring. When a cable breakage occurs, both the upstream TC2100 (Master) and downstream TC2100 (Slave) can detect the breakage and "wrap" around the data accordingly, as shown in Figure 5.

The TC2100’s panel is 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 TC2100 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 TC2100 can provide maximum reliability for crucial SCADA applications.

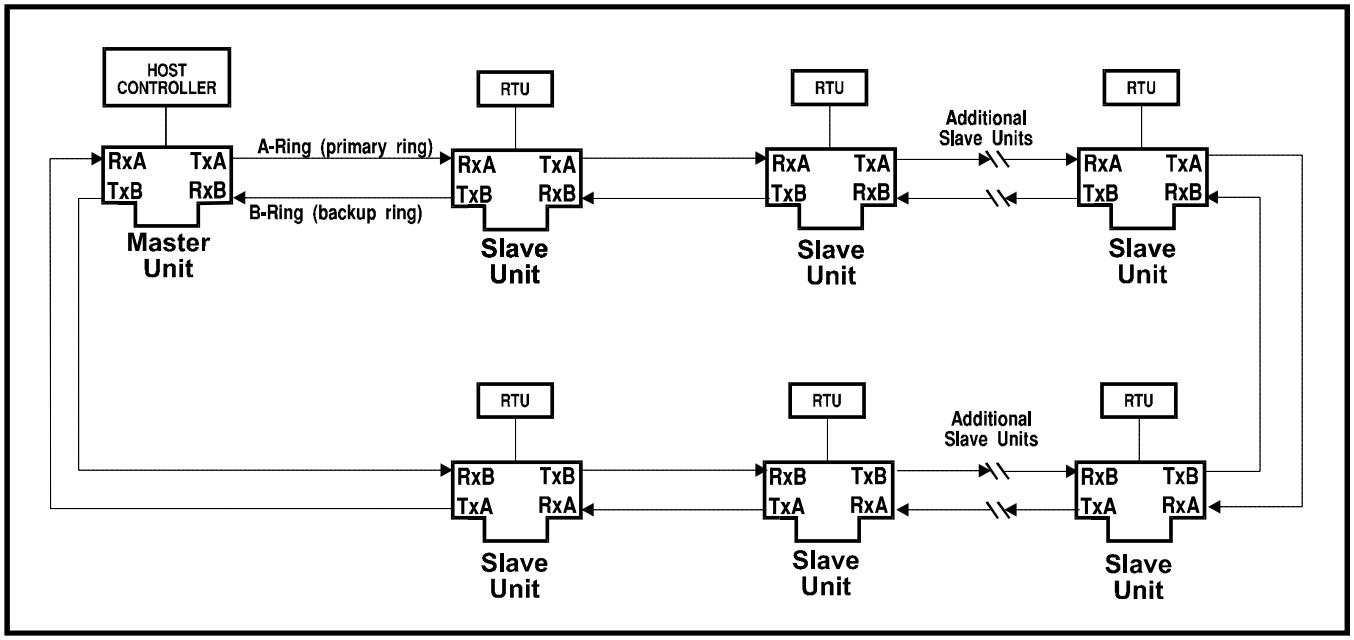


Figure 1. Self-Healing Ring Topology

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 TC2100'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.

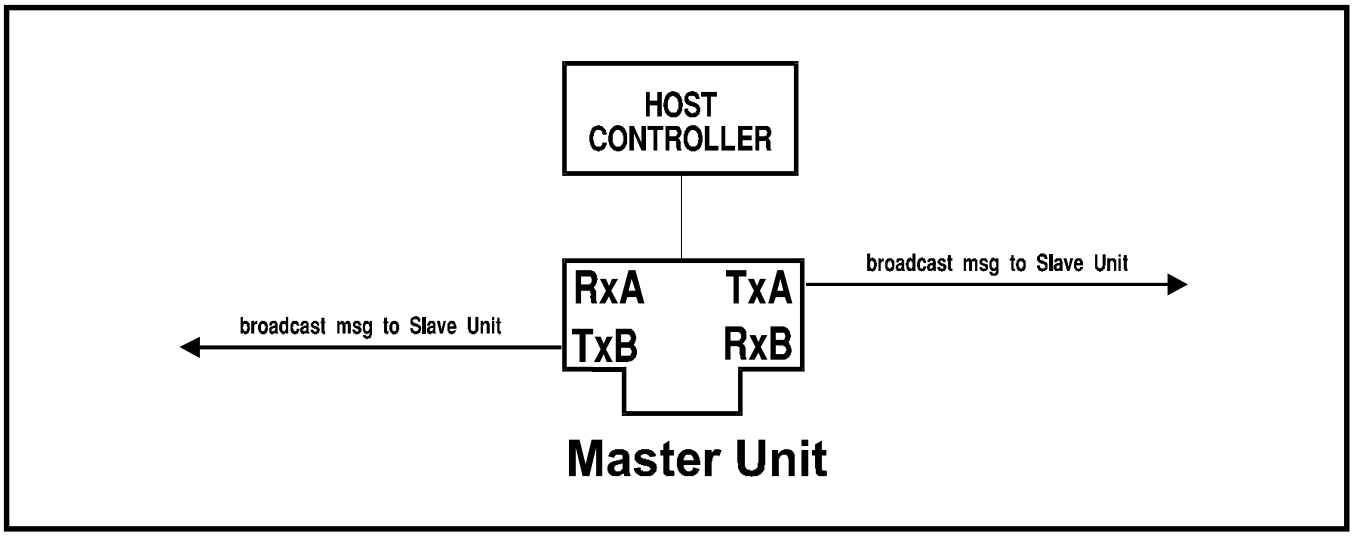


Figure 2. Ring Broadcast Directions

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.

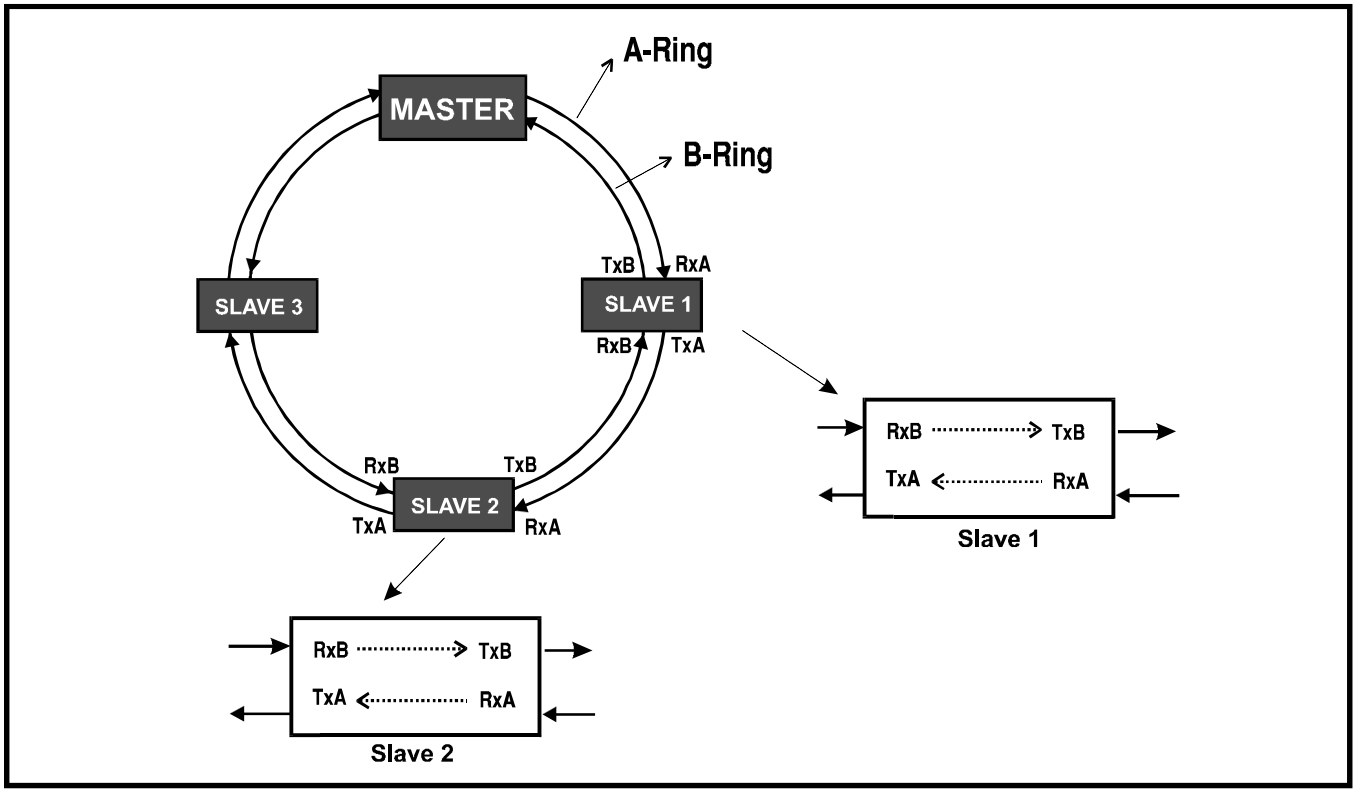


Figure 3. Ring Operation Under Normal Conditions

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.

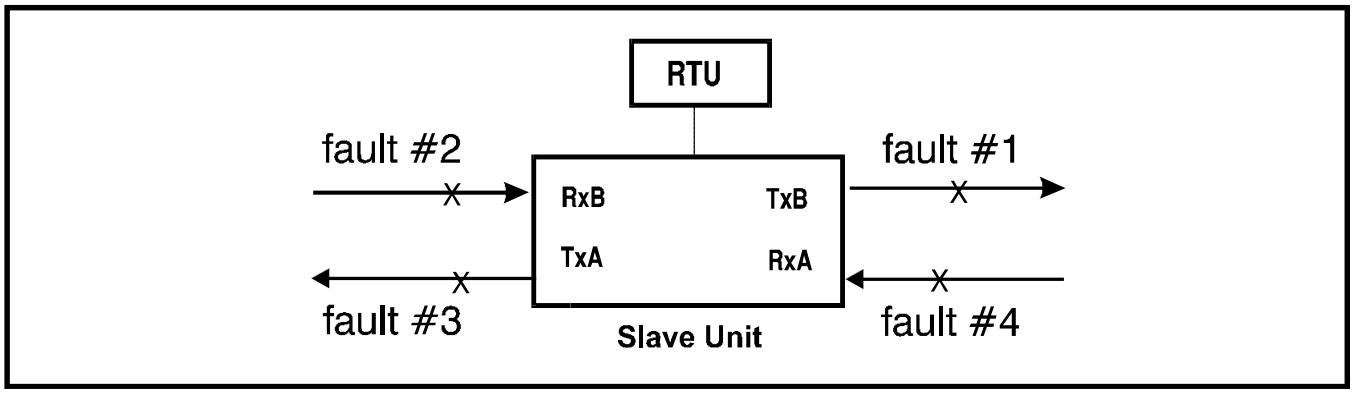


Figure 4. Optic Fault Conditions

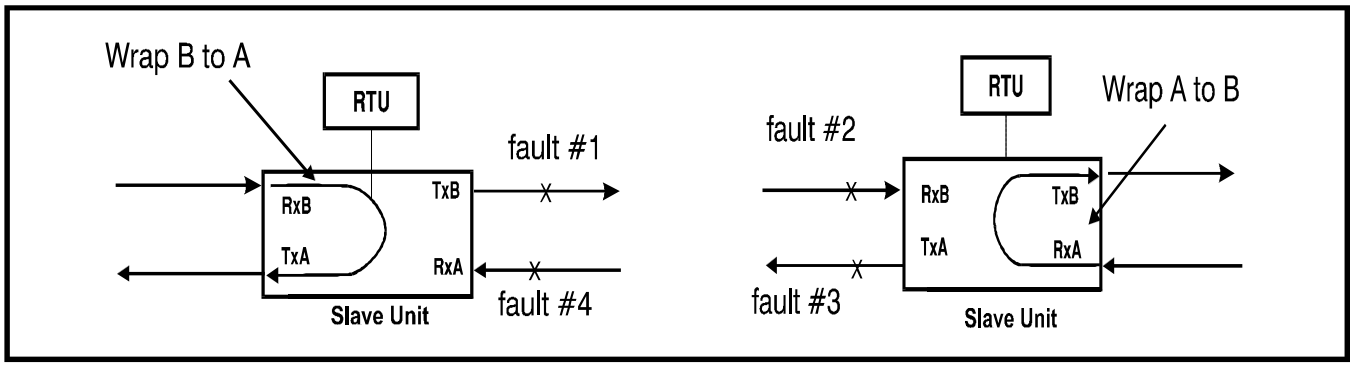


Figure 5. Data Wrap Condition due to Fault #2 or #3

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.

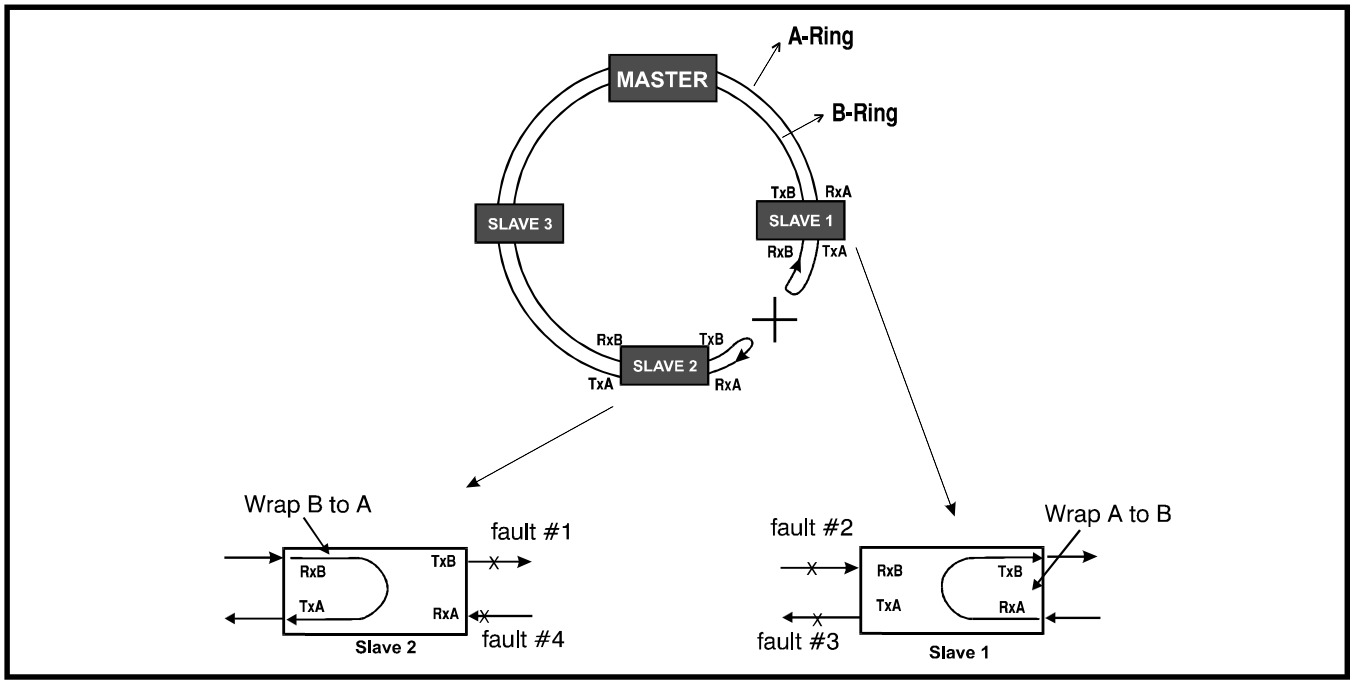


Figure 6. Self-Healing Function resulting from Optic Cable Breakage

Fiber Optic Ring's Integrity Monitors

Since communication between Master and Slave can be automatically 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 TC2100 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. An "Alarm" LED will flash and 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.

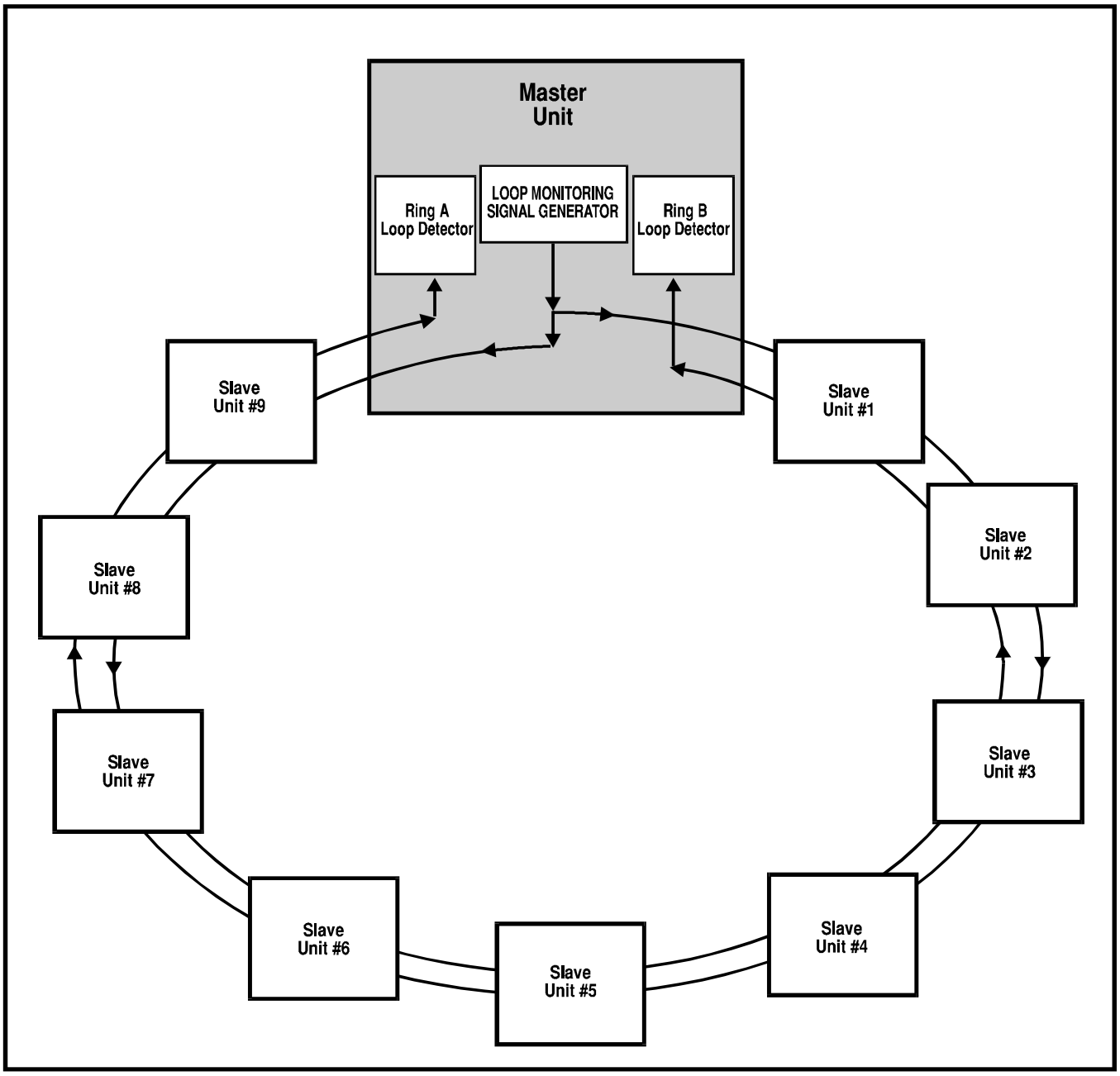


Figure 7. Fiber Optic Ring's Integrity Monitors

Cable Fault Detection between Slaves

The TC2100'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.

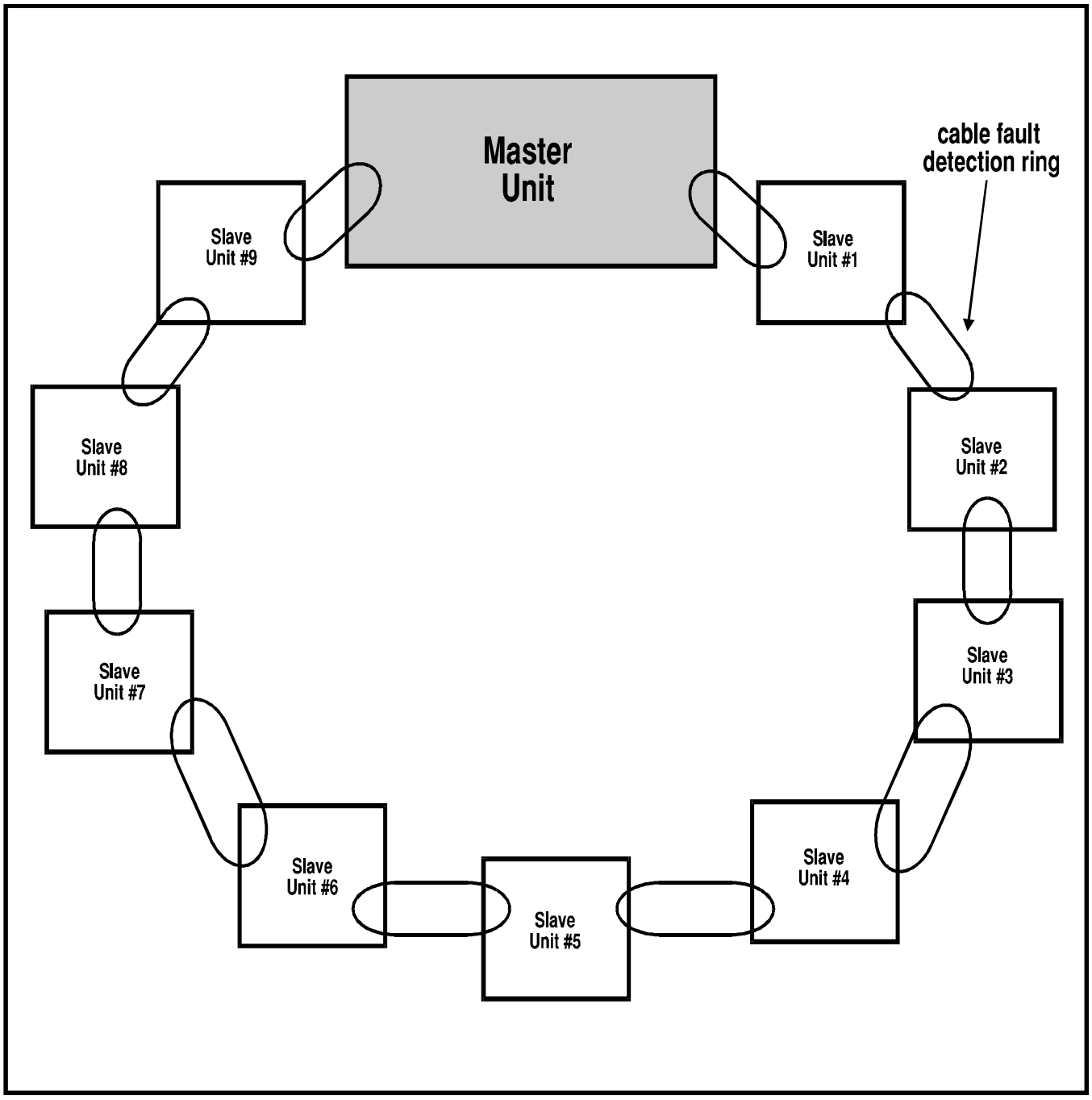


Figure 8. Cable Fault Detection Rings

Dual Master Mode Description

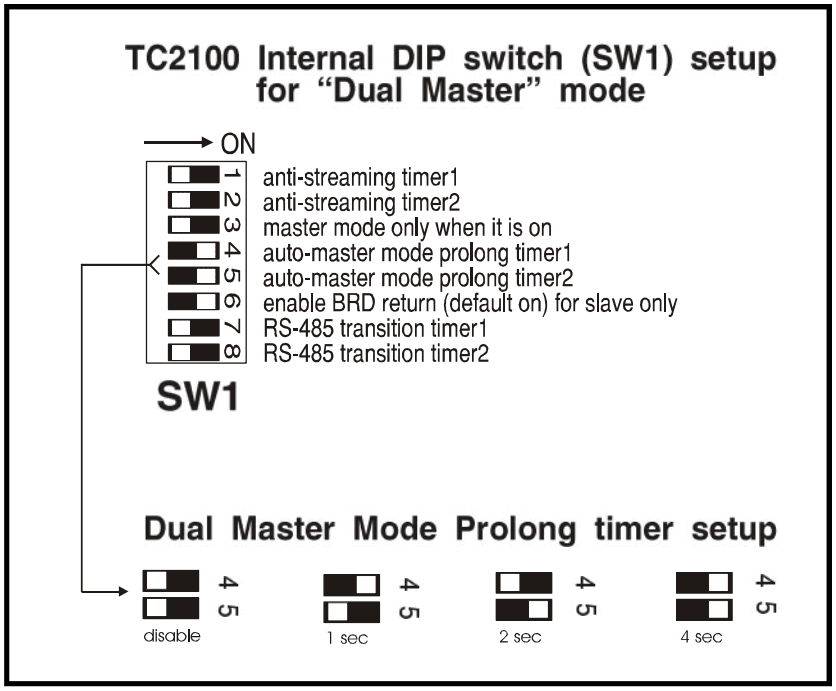
TC2100 has a special feature called "Dual Master." When a unit is enabled as "Dual Master," it can be either a slave unit or a master unit. It is a very useful tool against major cable breakage and unit malfunction (especially if the master unit is the source of the problem), because one of the slave units can be a backup master unit.

The purpose of having one of the slave units in "Dual Master Mode" is to provide a backup master unit when necessary. In most cases, TC2100's standard self-healing ring capability is able to prevent network break down from cable breakage or unit failure. However, there are limitations, such as: 1.) the master unit is the source of the problem. 2.) The master unit is isolated from rest of the network. 3.) Both A-ring and B-ring break in more than one location, which split the network into half. The "Dual Master mode" is designed to prevent these problems from happening.

Warranty Note: *You must contact the Technical Support Department at TC Communications, Inc. for approval before opening any device for internal settings. Otherwise, the warranty will be void.*

Dual Master Mode Setup

To enable TC2100 as "Dual Master" simply move switches 3, 4, 5, and 6 of the "internal DIP switches" (as SW1 on PC board) to the right (on) position. Switches 4 and 5 are designed for "Dual Master Mode Prolong timer setup," they will determine how long the unit will take (1, 2, or 4 second) to change from a master unit to a slave unit.



Operation of Dual Master mode

When a unit is in "Dual Master" mode, it can be either a slave unit or a master unit depending on following conditions:

1.) If TC2100 receives electrical signal from Host Controller, it will become a master unit.

2.) If TC2100 receives electrical signal from local RTU, it will become a slave unit.

3.) If TC2100 doesn't receive any electrical signal, it will become a slave unit.

As shown in Figure 9, "unit 1" is set as a dedicated master unit; "unit 2" and "unit 4" are set as dedicated slave units. "Unit 3" is set as "Dual Master Mode" unit. During normal condition "unit 3" will function as a slave unit, and the network operates like a dual ring topology. If there is cable breakage or malfunction, "unit 3" can become a master unit to prevent network from break down, such as demonstrated in case one and two in following pages.

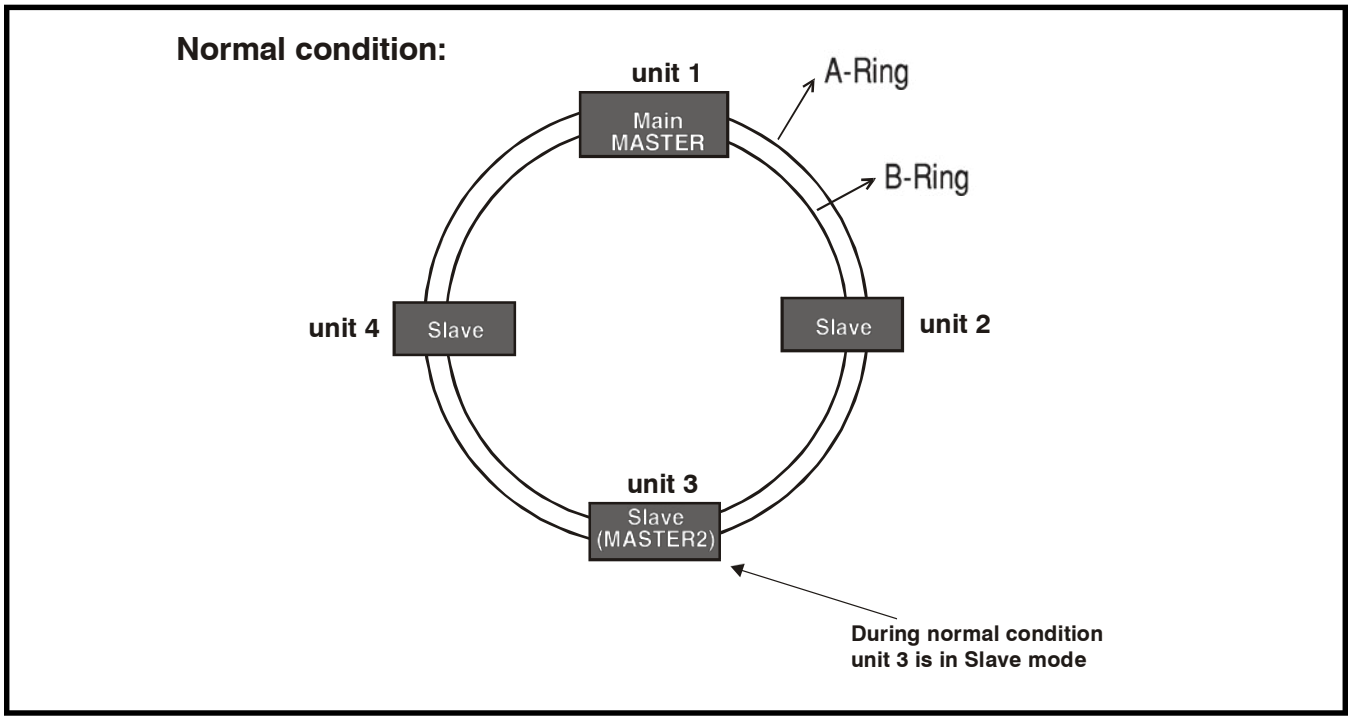


Figure 9. Ring operation under normal condition

In case one, both A-ring and B-ring are broken on both sides of main master unit (see figure 10), which stops "unit 1" from sending any signal to rest of the units. Normally, the network will be down even with self-healing ring feature, but with "unit 3" in "Dual Master Mode" user only needs to connect "unit 3" to Host Controller. The "unit 3" will become a master unit and send signals to rest of the units on the network. In the mean time "unit 2" and "unit 4" will activate self-healing feature, which wraps the data to avoid the broken data link, and the network will function normally again.

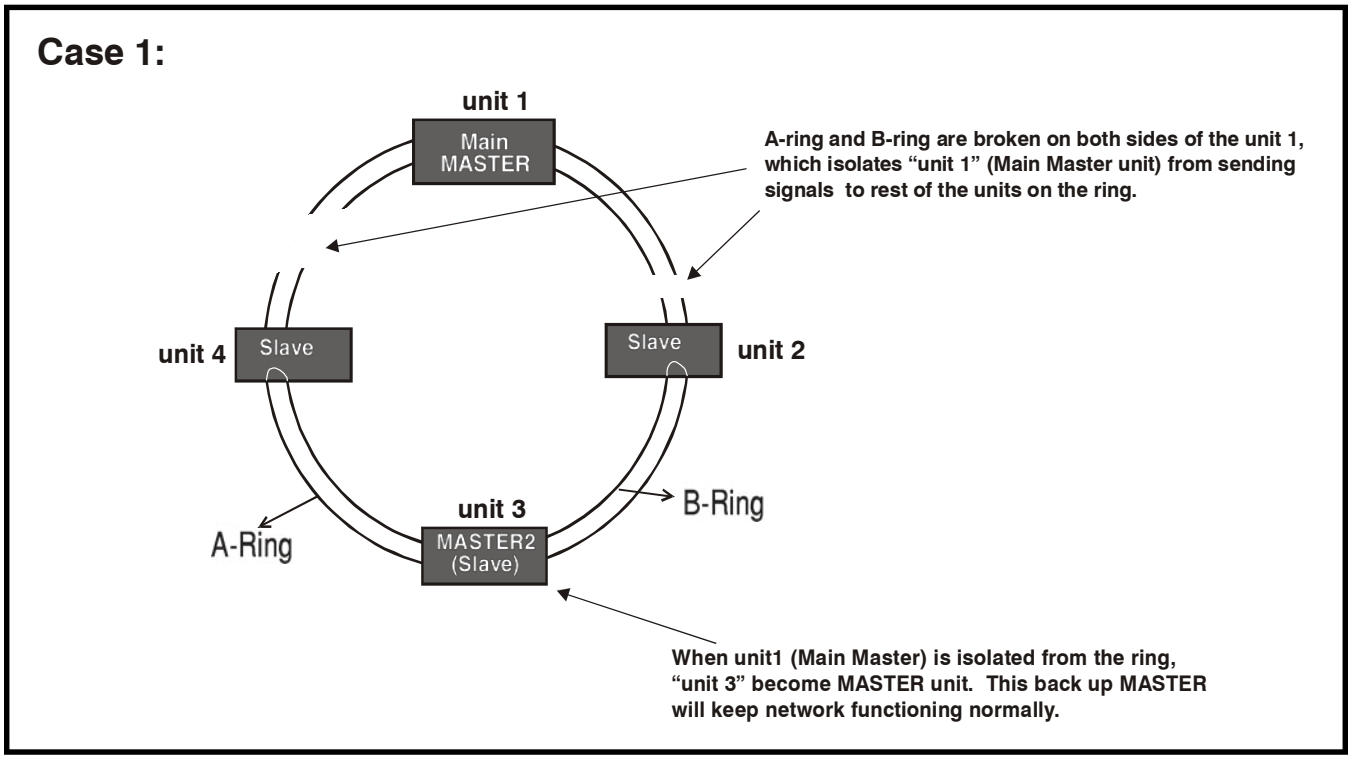


Figure 10 . Unit 1 is isolated from network

In case two, both A-ring and B-ring are broken in different locations, and the rings are cut in half. (See figure 11.) The self-healing ring is able to keep the network between "unit 1" and "unit 2" up, but "unit 3" and "unit 4" will still be down because they are isolated from the cable breakage. The main master unit (unit 1) is only able to transmit data to "unit 2." However, with "unit 3" in "Dual Master Mode," it can be a backup master by connecting to a host controller. This way, "unit 3"will become a master unit, and it can transmit signals to "unit 4." The entire network will then function normally.

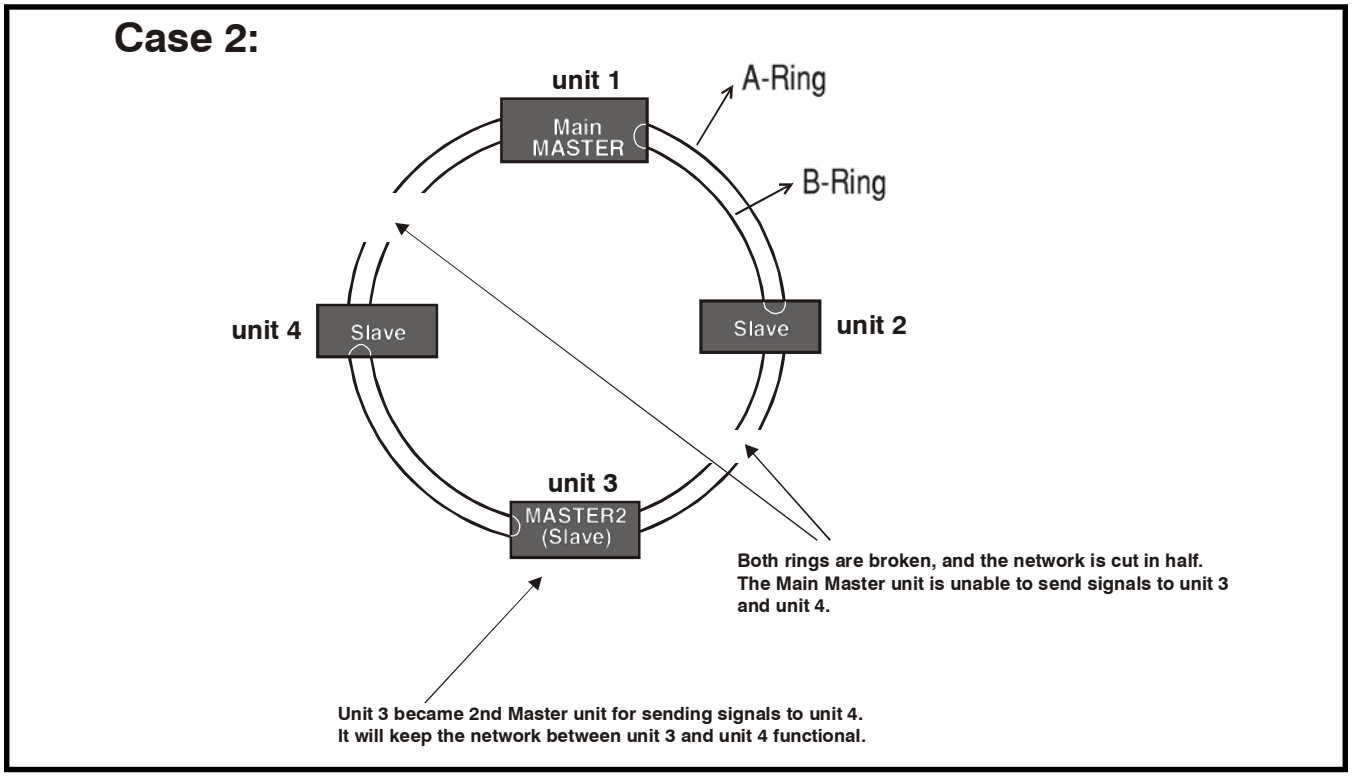


Figure 11. The network is cut in half

LEDs, DIP Switches and Connectors

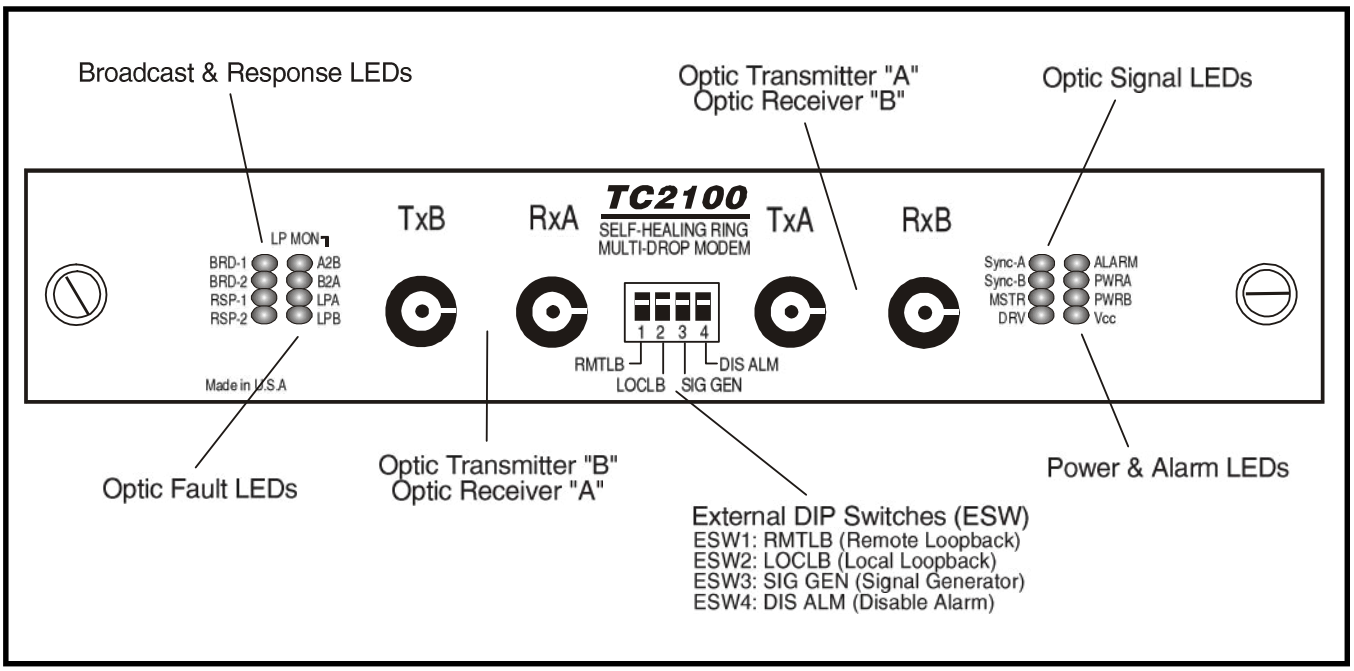
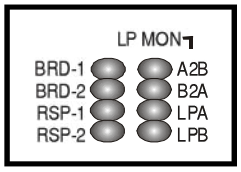


Figure 12. TC2100's Front Panel

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).

TC2100 OPTIC FAULT LEDs

A2B: When lit, indicates a data wrap condition exists and the unit is routing "RxA" data to "TxB." (not lit for single ring configuration)

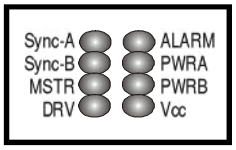
B2A: When lit, indicates a data wrap condition exists and the unit is routing "RxB" data to "TxA." (not lit for single ring configuration)

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



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

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

MSTR: Indicates the unit is set as Master unit (or in master mode for dual master unit), when lit; when Off, it indicates the unit is set to Slave mode.

DRV: Indicates the unit is in "drive" mode (when lit); when Off, it indicates the unit is in "receive" mode.

POWER & ALARM LEDs

ALARM: When lit, the dry contact relay will be activated and the audio buzzer will sound. This LED indicates one or more of the following fault conditions has occurred:

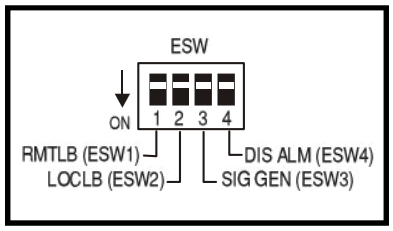
1. The unit lost an optic "Tx" or "Rx" signal.
2. The unit received an invalid packet.
3. The Anti-streaming timer has expired (slave only).
4. The unit is in a diagnostic (testing) mode.

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: Indicates a +5V DC operating voltage is being derived from the power supply (when lit).

External DIP Switch Functions (See Figure 12)



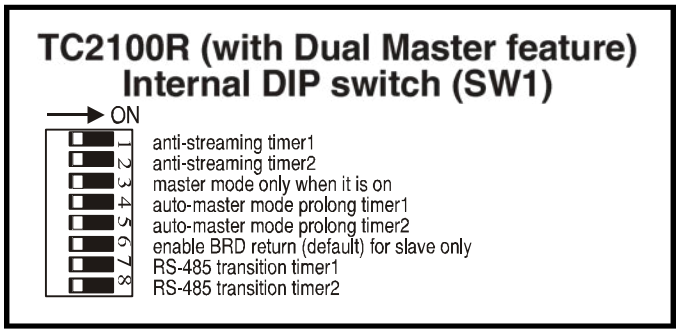
ESW1: **RMTLB** (Remote Loopback). Loops back the received signal from a remote location (for diagnostic testing).

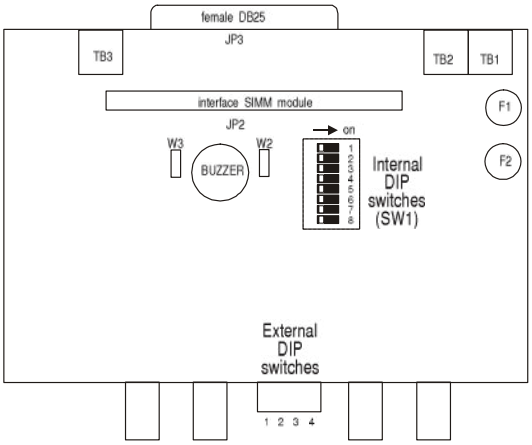
ESW2: **LOCLB** (Local Loopback). Loops back the received signal from the local DB25 connector (for diagnostic testing).

ESW3: **SIG GEN** (Signal Generator). Generates a pulse signal that emulates a broadcast msg (for diagnostic testing).

ESW4: **DIS ALM** (Disable Alarm). When this switch is in the down (On) position, the audio alarm buzzer and dry contact relay are disabled.

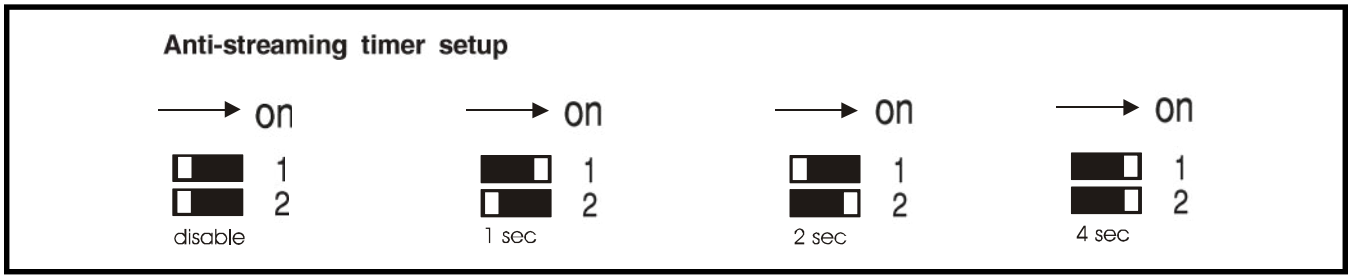
Internal DIP Switch (SW1) Functions





Anti-Streaming Timer

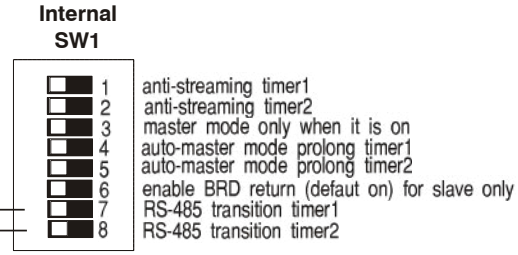
The TC2100 (slave) has a built-in Anti-Streaming Timer that prevents a defective RTU or PLC from bringing down the entire network. The electrical channels (TxD & RTS) from the RTU(s) are monitored individually; they are based on data (not control) signals. When the Anti-Streaming Timer is exceeded (after either 1,2 or 4 seconds of continuous transmission depending on customer's request), 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 both switch 1 and switch 2 of Slave's internal DIP switches(SW1) to the left (Off) position.



Setting Up RS-485 Transition Time

RS-485 interface requires high impedance at the output when it is in idle condition. Transition time is defined as the interval between last data bit sent and the output turns into high impedance. For different BAUD rate the interval will be changed accordingly.

There are two DIP switches of SW1 are designated for this purpose. Please refer to the transition time table to setup your RS-485 interface.



Baud	SW7	SW8
RS-422	Off	Off
4800	On	Off
9600	Off	On
19.2K & up	On	On

RS-485 Transition Time Table

Note: *Refer to the Warranty Note on page 8 for warranty purposes before opening any unit(s) for internal settings.*

Electrical Specifications

The electrical signal interface for the TC2100 can be RS-232, RS-422, or RS-485 (2 or 4-wire) DCE (unless factory configured as DTE). The data rate is Asynchronous DC (with control) up to 38.4Kbps (or two Async channels without control). Data flow is controlled by XON/XOFF and RTS/CTS. The electrical connector is DB25 Female.

Pin Assignments

The electrical signal interface is connected to the host or RTU via a DB25 female connector at the rear panel of the TC2100. The RS-232 (DTE & DCE) and RS-422/485 DB25 pin assignments are as illustrated in the diagrams that follow.

For units with an RS-232 interface, two separate channels are provided for handshaking signals or connection of an additional device (this additional channel is not present on Multi-Master units). Pins 2 & 4 are inputs while pins 3 & 5 are outputs.

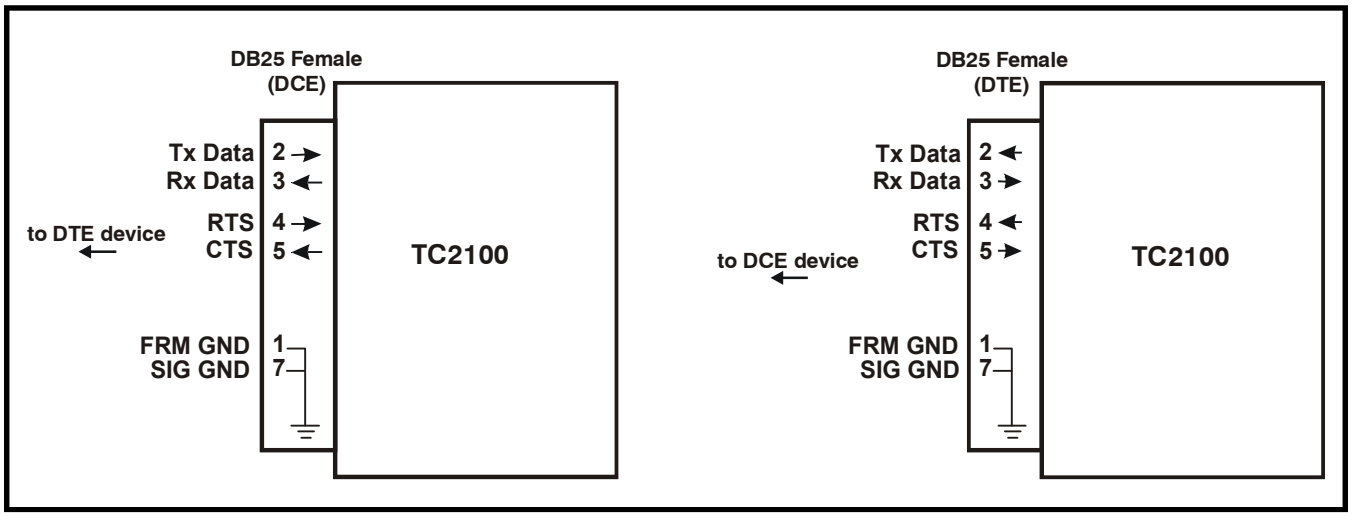


Figure 13. RS-232 Pin Assignments

For 2-wire RS-485 interfaces, pins 3(-) & 16(+) are input/outputs.

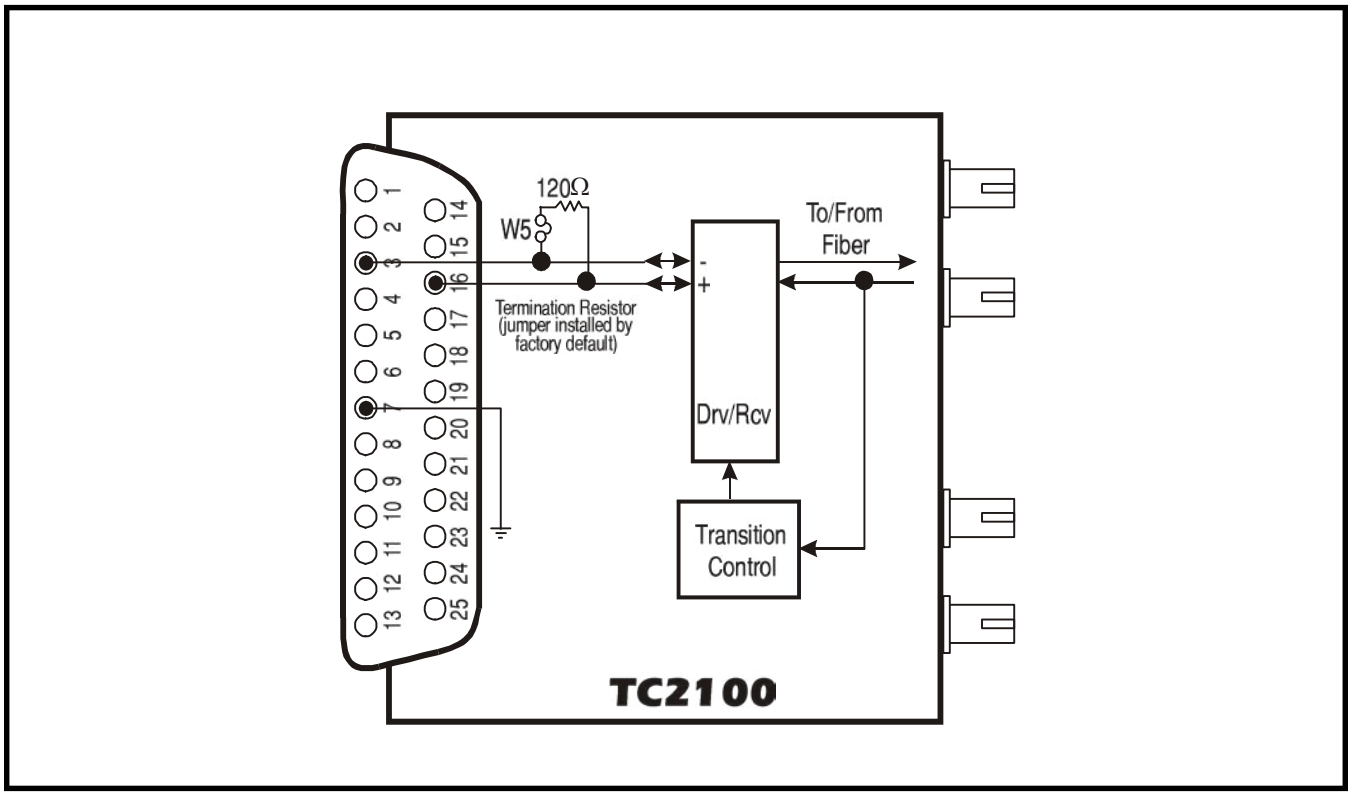


Figure 14. 2-wire RS-485 Connection/Logic Diagram

For RS-422 and RS-485 4-wire interfaces, pins 2(-) & 14(+) are inputs while pins 3(-) & 16(+) are outputs.

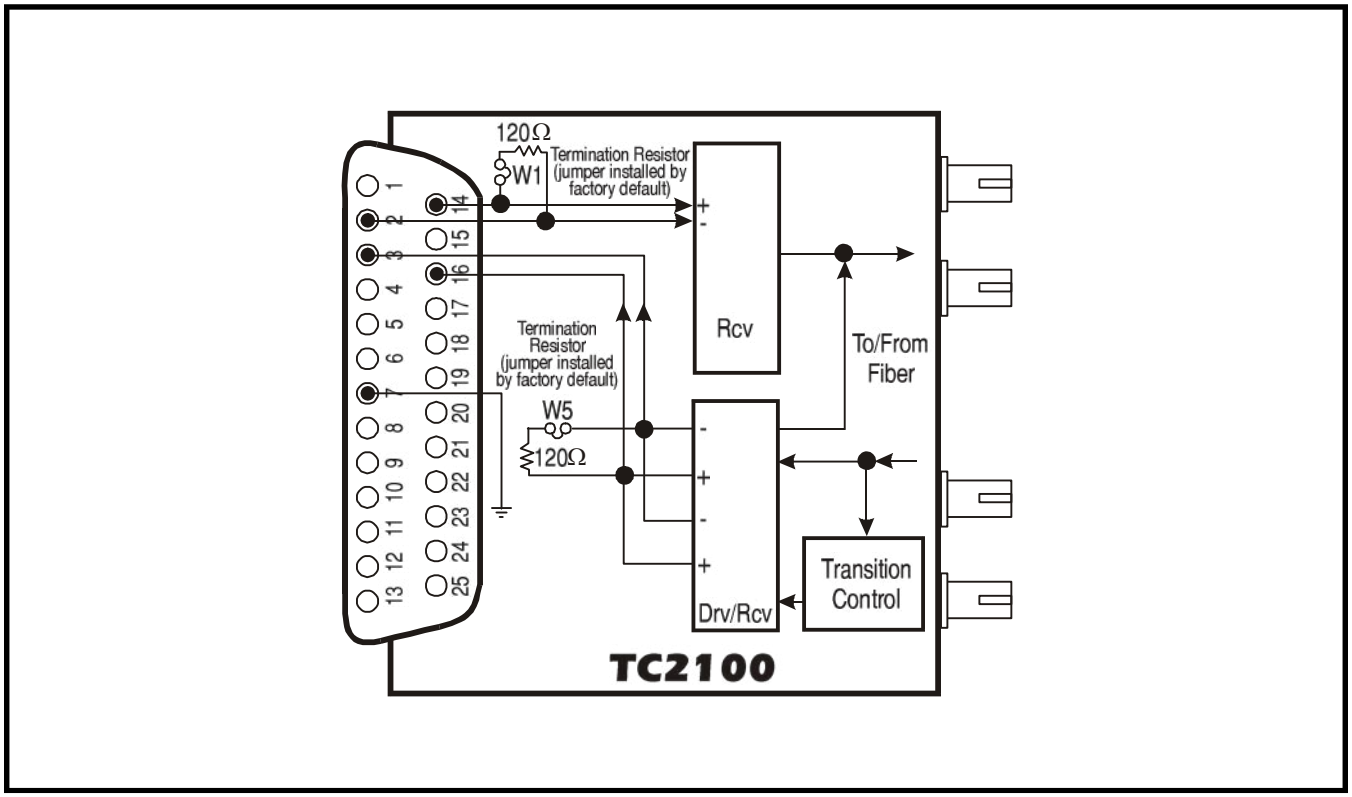


Figure 15. 4-wire RS-422/RS-485 Connection/Logic Diagram

Fiber Optic Specifications

Transmission Distances (typical)

The TC2100 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 35km* are typical over Single Mode fiber at 1310nm. Contact factory for longer distance requirements (Laser version).

Launch Power & Sensitivity

Transmitter:	LED/LD; typical Launch Power:	-19dBm* (850nm Multimode, @62.5/125μm) -19dBm* (1310nm Multimode, @62.5/125μm) -16dBm* (1310nm Single Mode, @9/125μm)
Receiver:	PIN Diode; typical Sensitivity:	-34dBm* (850nm Multimode, @62.5/125μm) -34dBm* (1310nm Multimode, @62.5/125μm) -36dBm* (1310nm Single Mode, @9/125μm)

**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 TC2100 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 TC2100. 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 TC2100 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. Connect the Host's RS-232, RS-422 or RS-485 signal (see pages 14 & 15 for pin assignments) to the TC2100 (Master) unit's DB25 connector.

B. Connect power to the Master unit. Run an Local Electrical Loopbacktest and Optic Loopback Test (see pages 20 & 21).

C. Connect the RTU's RS-232, RS-422 or RS-485 signal to the TC2100 (Slave) unit's DB25 connector.

D. Connect power to the Slave unit. Run an Local Loopback, Optic Loopback and Remote Loopback Test (see pages 20, 21 & 22).

E. Connect additional Slave units into the ring. Run an Optic Loopback, Local Loopback and Remote Loopback Test for each additional Slave unit installed.

F. Verify system integrity:

At Master unit: check “BRD1,” “BRD2,” "LPA," "LPB," "Sync-A," "Sync-B," "PWR," “MSTR,” and "Vcc" LED indicators.

At each Slave unit: check "BRD1," "BRD2," "LPA," "LPB," "Sync-A," "Sync-B" “PWR,” “DRV,” and “Vcc” 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 TC2100. Under normal operation, all LEDs should be "On" (either solid or blinking), with the exception of the "ALARM" LED.

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.

Alarm LED

When there is an alarm condition, the Alarm LED should be on solidly and at least one additional LED will flash. The following fault conditions will cause the Alarm to be triggered:

1. Optic signal lost from "RxA" or "RxB." "Sync-A" or "Sync-B" LED will be flashing.
2. Optic signal is marginal, which causes invalid data packets to be received. The "Sync-A" or "Sync-B" LED will also be "Off."
3. Optic overdrive can cause the "Sync-A" or "Sync-B" LED to turn "Off," although optic "A" or "B" still receives a valid signal.
4. One (or more) of the external DIP switches is in the "On" position.
5. The Anti-Streaming function has been activated.
6. On the Master unit, the "A-Ring" or "B-Ring" is incomplete.
7. On the Slave units, a data wrap condition exists. The "A2B" or "B2A" LED is flashing, indicating the wrap condition, and the "LPA" or "LPB" LED will also be blinking.

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 become familiar with all the functions and features of the TC2100 in a controlled environment. Knowledge of the TC2100's functions and features will ease installation and troubleshooting efforts later on.

Bench Test with Built-In Signal Generator

The TC2100 has a built-in signal generator. It can simulate a broadcast message from a SCADA host when th unit is in “master mode.” However, when the unit is in “slave mode,” the built-in signal generator will simulate an RTU's response message instead. 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 16. At the Master unit, turn "On" the "SIG-GEN" by sliding ESW3 downward. The "BRD-1" and "BRD-2" LEDs on the TC2100 (Master) should start blinking. The "BRD-1" and "BRD-2" LEDs on the TC2100s (Slaves) should also blink, indicating receipt of the Master's broadcast signal.
2. At any Slave, turn "On" the "SIG-GEN" by sliding ESW3 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 TC2100 to simulate a cable breakage. The "BRD-1" & "BRD-2" and "RSP-1" & "RSP-2" LEDs on the TC2100 (Master) and TC2100 (Slave) 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 11 & 12 for the LED functions of the TC2100.

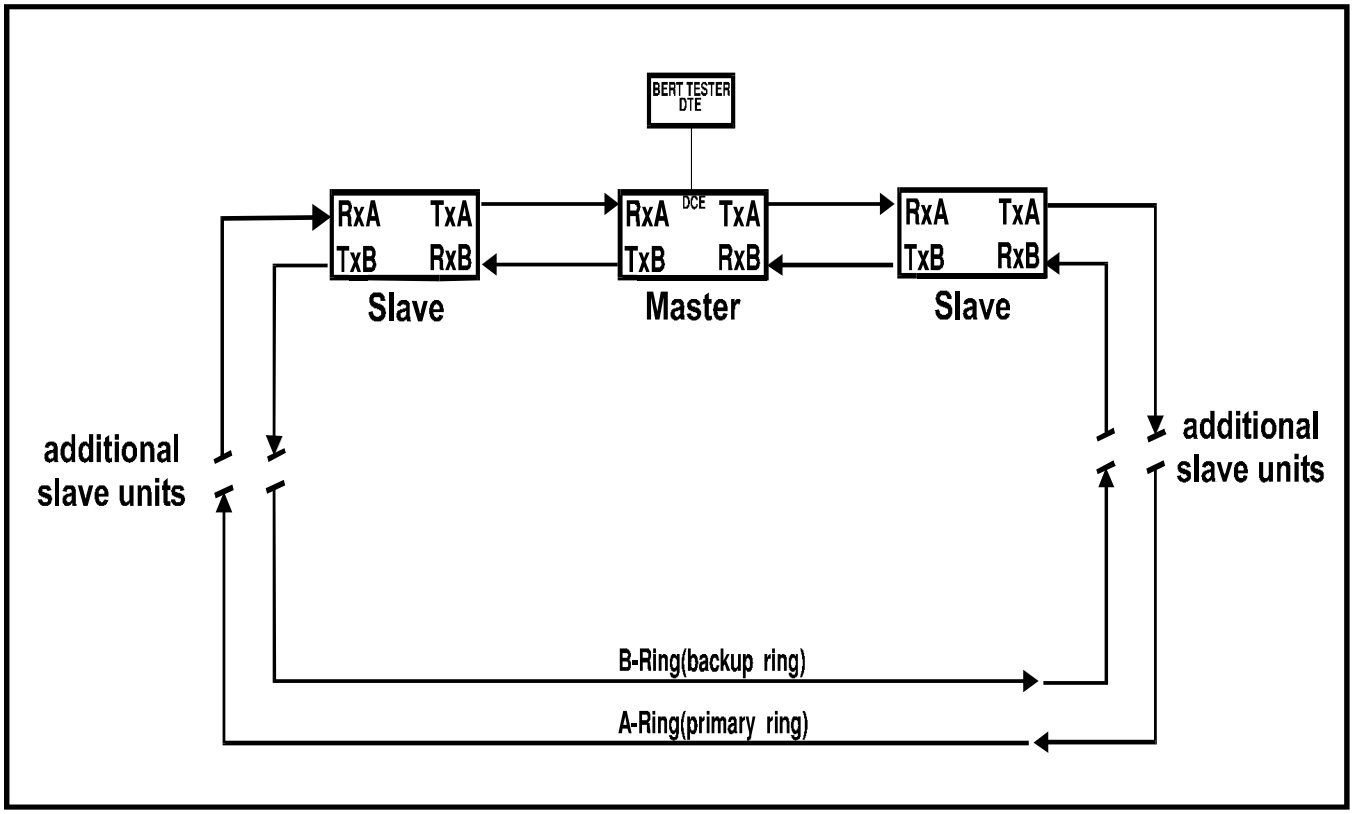


Figure 16. Bench Test Connection Diagram

Local Electrical Loopback Bench Test *(not applicable for RS-485)*

Purpose: To verify the DB25's 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.

Procedure: Set up the bench test as shown in Figure 17. Set ESW2 (front panel) to the down (On) position and the Alarm LED should start flashing. Set the BERT tester up as a DTE device *(set the tester up as a DCE device if the TC2100 was factory configured as a DTE)*. 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.

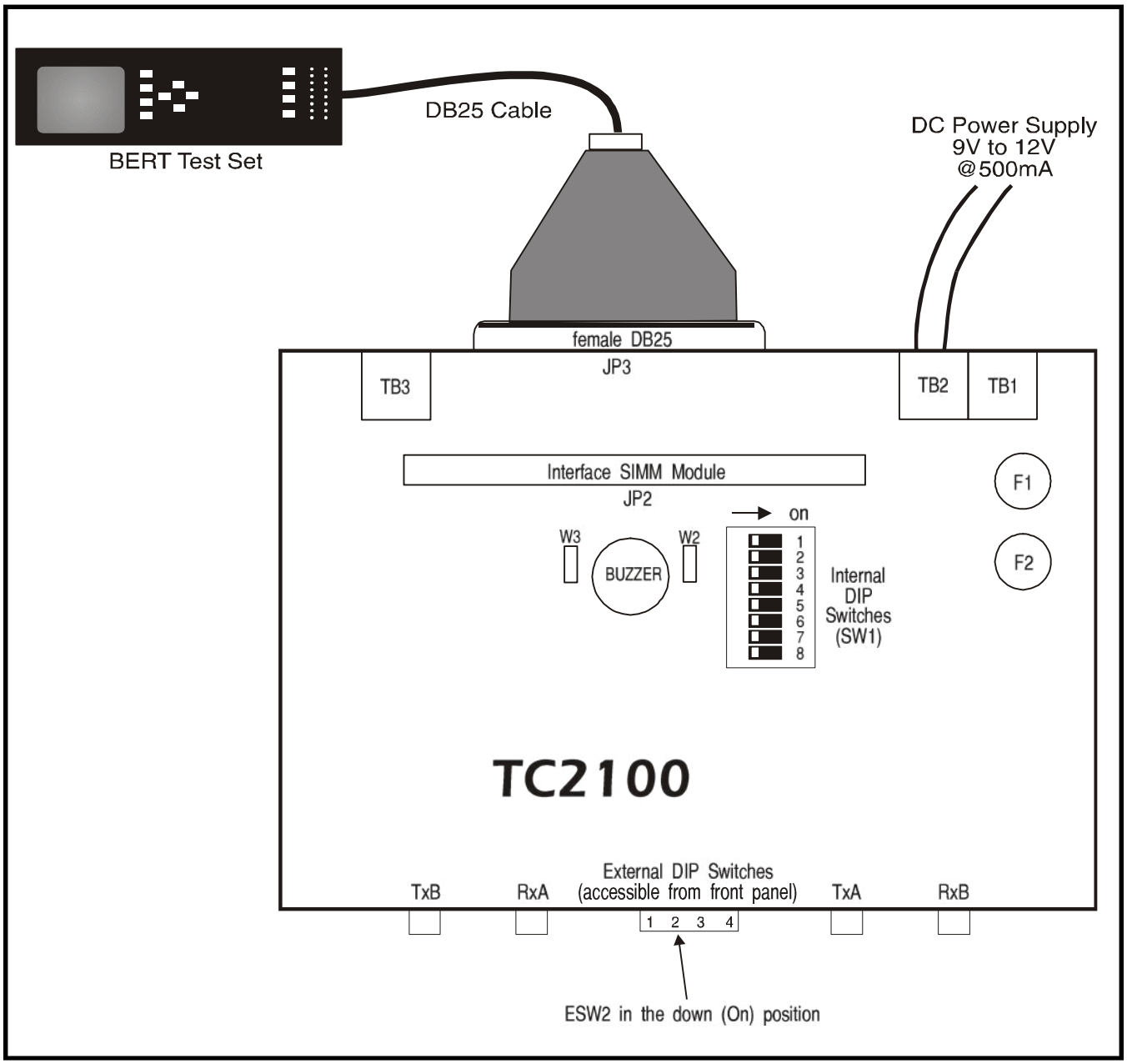


Figure 17. Local Electrical Loopback Bench Test Connection Diagram

Optic Loopback Bench Test (for master only) *(not applicable for RS-485)*

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.

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

Procedure: Set up the bench test as shown in Figure 18. Remove power, alarm, and DB25 connectors from the rear of the TC2100. Unscrew the two flathead screws on the TC2100's front panel. Gently slide the unit out of the housing. Set the switch 3 of the internal DIP switch (SW1) to the right (On) position and all others to the left position. Connect an optic patch cord from "TxA" to "RxA." Connect a BERT tester to the DB25 connector. Set the tester up as a DTE device *(set the tester up as a DCE device if the TC2100 was factory configured as a DTE)*. 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."

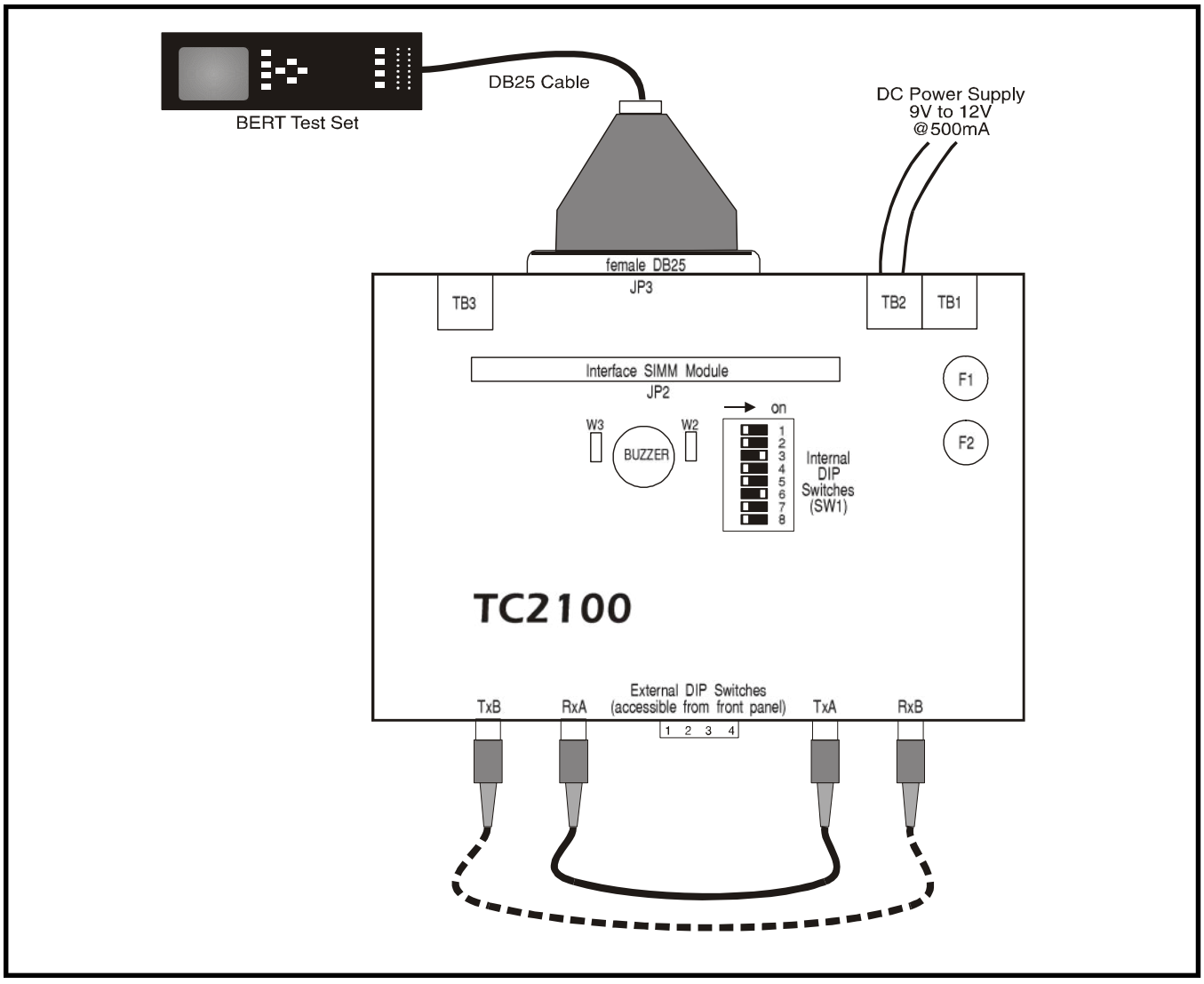


Figure 18. Optic Loopback Bench Test Connection Diagram

Remote Loopback Bench Test *(not applicable for RS-485)*

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.

At least one (1) small copper jumper wire (optional).

Procedure: Set up the bench test as shown in Figure 19. Using a small jumper wire, short pin 2 to pin 3 (for an RS-232 interface) at Slave 1's DB25 connector (or switch ESW1 "RMTLB" to the down position). Set the tester up as a DTE device *(set the tester up as a DCE device if the TC2100 was factory configured as a DTE)*. 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.

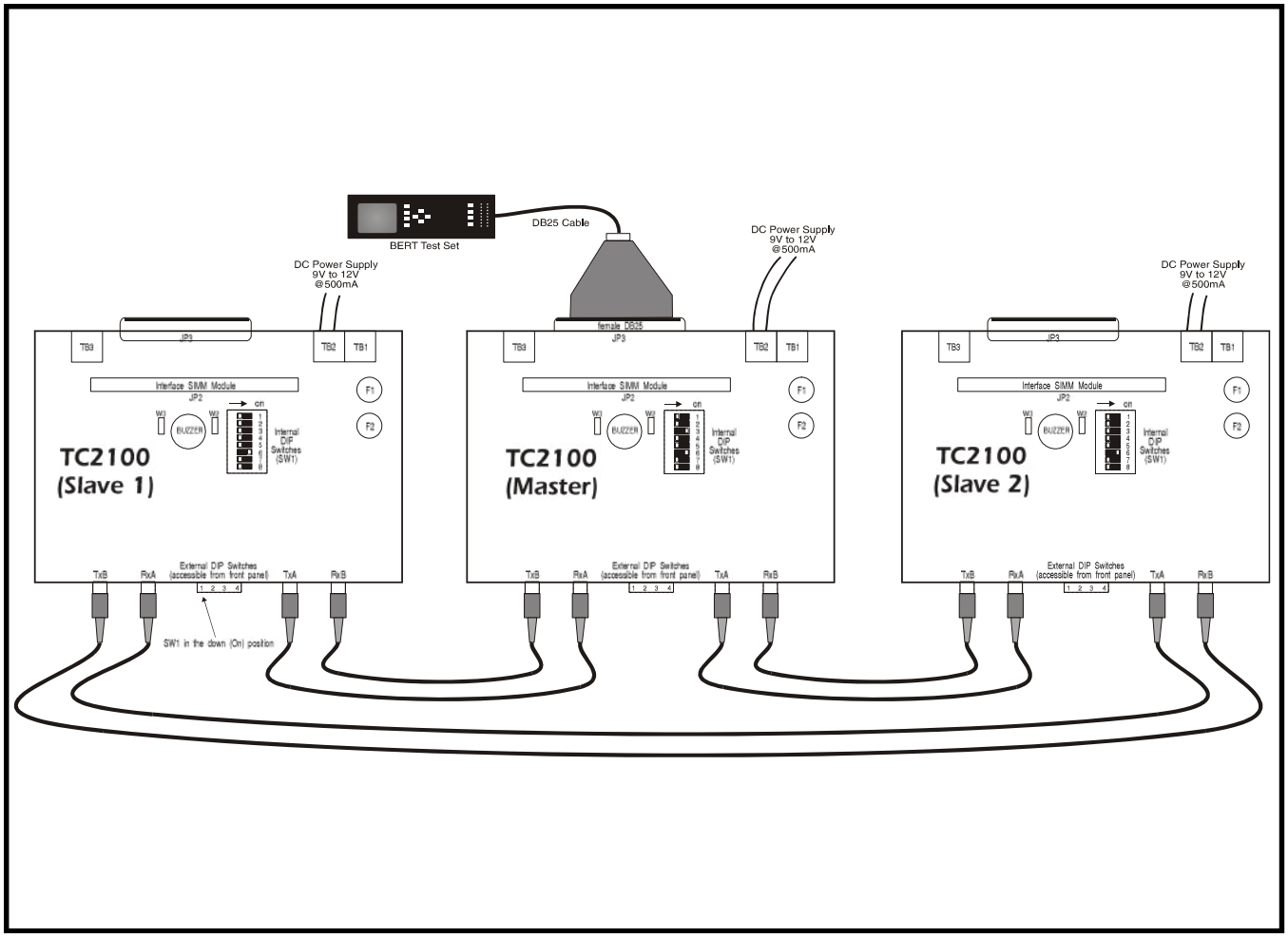


Figure 19. Remote Loopback Bench Test Connection Diagram

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 DB25's connector pins 2 & 4 (for an RS-232 interace) 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 DB25's connector pins 3 & 5 (for an RS-232 interface) 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 TC2100 (Master), by sliding the SIG GEN (ESW3) DIP switch to the down (On) position, a pulse signal will be generated to simulate an incoming signal on the DB25's connector pins. 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.*

For the TC2100 (Slave), by sliding the SIG GEN (ESW3) DIP switch to the down (On) position, a pulse signal will be generated to simulate an incoming signal on the DB25's connector pins just like TC2100 (master). However, this pulse signal is a simulated response signal from the RTU, which will travel through the fiber to Master 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 Master location.

6. What is the "Sync-A" LED ?

Ans: *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.*

7. Where is the best location for "Dual Master" unit?

Ans: Anywhere. It all depends on customer's application and equipments.

Chapter 6 - Specifications

Data Rates

Async with control (or two Data Channels) ..... up to 38.4 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 ..... DB25 Female
Interface ..... DCE (or factory configured DTE) RS-232, RS-422, or RS-485 (2 or 4-wire)

System

Bit Error Rate ..... 1 in 10^9 or better
Visual Indicators ..... BRD-1, BRD-2, RSP-1, RSP-2, LPA, LPB, TxA (TC2100 only),
..... TxB (TC2100 only), A2B (TC2101 only), B2A (TC2101 only),
..... RxA, Sync-A, RxB, Sync-B, PWRA, PWRB, Vcc, ALARM.
Dry Contact Alarm ..... 36V DC, 1A

Power Source

Standard ..... 12VDC@300mA
..... (Optional) -24VDC, -48VDC, 125VDC, or115/230VAC with external power cube

Temperature

Operating ..... -10°C to 50°C
..... High-Temp Version (optional) -20°C to 70°C
..... Extreme-Temp Version (optional) -40°C to 80°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).

Limitation of Liability

In no event shall the total liablility of TC Communications, Inc. to purchaser and/or end user for all damages including but not limited to compensatory, consequential and punitive damages, exceed the total amount paid to TC Communications, Inc. by purchaser for the goods from which the claim arose, in no event shall TC Communications, Inc. be responsible for indirect and consequential damages.

Continue on next page.

Limitation of Liability (Cont.)

In no event shall liability attached to TC Communications, Inc. unless notice in writing is given to TC Communications, Inc. within ten days of the occurrence of the event giving rise to such claim.

TC Communications, Inc. shall not be responsible for delays or non-deliveries directly or indirectly resulting from or contributed to by foreign or domestic embargoes, seizure, fire, flood, explosion, strike, act of God, vandalism, insurrection, riot, war, or the adoption or enactment of any law, ordinances, regulation, or ruling or order or any other cause beyond the control of TC Communications, Inc.

TC Communications, Inc. shall not be responsible for loss or damage in transit and any claims for such loss or damage shall be filed by the purchaser with the carrier.