

TC8612

8 Channel DIO Over T1/E1 Multiplexer

User Manual
MNL-86120-01-01



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Record of Revisions

Revision	Date	Description of Changes
1.0	3/10/14	Initial Release of TC8612.
1.1	08/27/2020	New version update

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Guide to Alert Symbols

These alert symbols are used in Caution, Warning, and Danger notes.





Symbol	Meaning
	Pinching or crushing hazard
	Electrical hazard.
	Equipment alert: be careful of damage from static electricity
	General alert: used for all other hazardous conditions (referring to people, not equipment).

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1.1 General Information

This manual is intended to describe the features and functionality in addition to aiding in the planning, configuring, commissioning and maintaining of the TC8612 Digital I/O (DIO) over T1/E1 multiplexer.

1.2 Product Description

The Model TC8612 8-Channel DIO over T1/E1 multiplexer is economical, simple to install and comes standard with built-in power redundancy.

Diagnostics include DIP switches for Local & Remote Loopback and other application configuration switches. Each unit also provides multiple LEDs for Alarm, Power, Vcc, T1/E1 Status, and RLY & DET status LEDs for each channel.

Optional “Dry Contact Status Hold”*. When this feature is enabled, the dry contact will retain the last “Open” or “Close” status if the T1/E1 link is broken.

A built-in sync mechanism verifies both device and T1/E1 link operation. No other test equipment is required for link and device verification.

The TC8612 is compatible with standard 100Ω T1 for copper line lengths up to 6000ft and up to 2.5km for 75Ω / 120Ω E1 (copper line length is the distance between the TC8612 and the T1/E1 cross-connect). The T1/E1 uses a RJ48F connector and the dry contact channels use RJ11 connectors.

An optional BNC adapter cable is available for 75 Ohm E1. Standard power is 12VDC or optional 24VDC, -48VDC, 125VDC, or 115/230VAC with an external power cube. A high temperature version (-20°C to 70°C) and extreme temperature version (-40°C to 80°C) are available for harsh environments.

**Contact factor for options*



Figure 1-1 TC8612 DIO Over T1/E1 Multiplexer

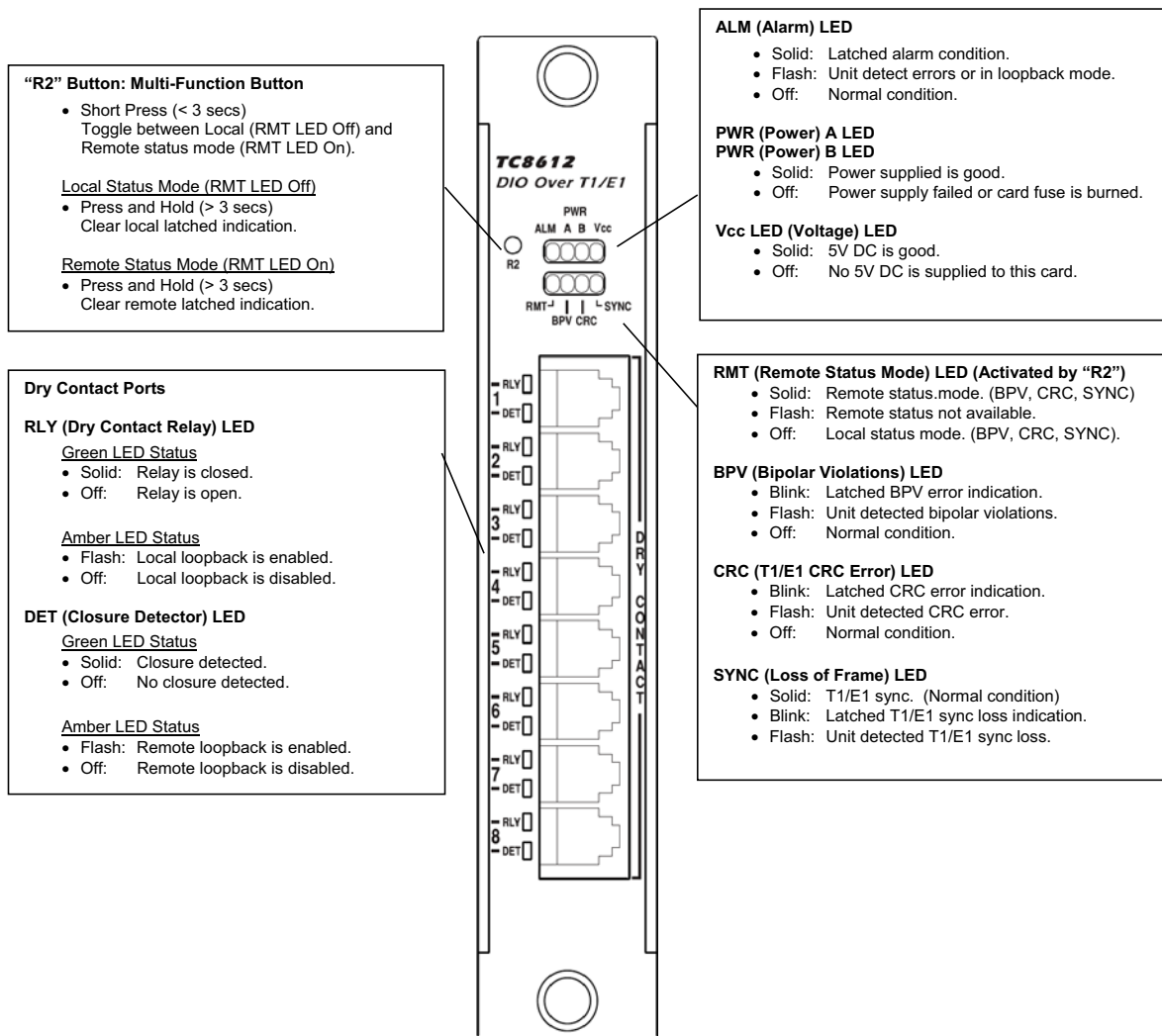


Figure 1-2 TC8612 Front LED Definitions

1.2.1 Features

- 8-channel Dry Contact
- T1 Features:
 - ESF Framing Support (SF Framing, Optional)
 - Supports Line Length up to 3000ft (T1)*
 - 24 timeslots (DS0) 1-24. TC8612 utilizes timeslots 12 and 24
- E1 Features:
 - Supports Line Length up to 2.5km
 - PCM31C Framing Support (PCM30, PCM30C, PCM31 Optional)
 - 32 timeslots 0-31. TC8614 utilizes timeslots 15 and 31
- Very Low Latency - 1.5ms

- Dry contact detectors with Isolated Ground
- LEDs for "DET/RLY" (to monitor each channel's analog and dry contact signal status)
- LEDs for "SYNC", "AMI", "BPV", "LOS", "AIS", "RAI", "CRC" (to monitor each T1/E1 channel status)
- LEDs for "PWR A," "PWR B," "Vcc," & "ALM" (to monitor each unit's power supply and alarm condition status)
- Built-in Power Redundancy
- Diagnostic DIP Switches for Local Loopback, and T1/E1 Loopback Tests.
- Rack Mount or Stand Alone

**Note: For line lengths beyond 655ft additional testing is required.*

1.2.2 Applications

The TC8612 Serial-over-T1/E1 Multiplexer provides an inexpensive method for connecting Async/Sync terminals, printers, and status collecting devices. It is also used in harsh environments where EMI/RFI interference, ground loops and lightning conditions may exist.

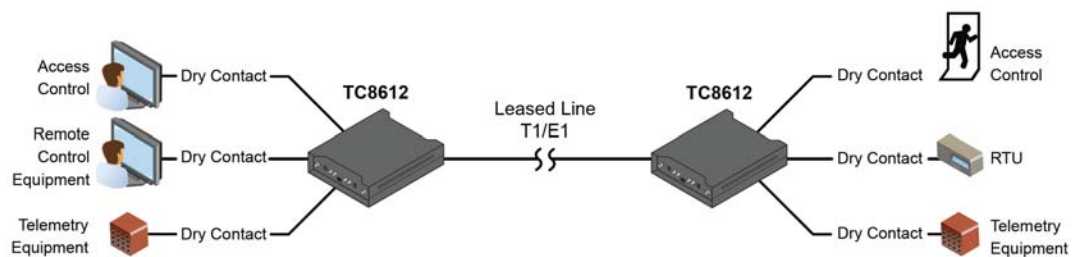


Figure 1-3 Typical Application using the TC8612

1.3 Specifications

Channel Capacity	
Channels	8 Channels of Bi-directional Dry Contact

Electrical	
Dry Contact	RJ11
T1/E1 Connector	RJ48

Dry Contact Interface Specification	
Mode	Normal Open (Standard) Normal Close (Optional)
Latency	1.5ms
Load Voltage (peak AC)	60V
Load Voltage (DC)	60V
Continuous load current	0.55A
Peak load current	1.2A
Max On Resistance	2.5Ω
Output Capacitance	150pF

System	
Bit Error Rate	1 in 10 ⁹ or better
Visual Indicators	PWR A, PWR B, Vcc, ALM, SYNC, AMI, BPV, LOS, AIS, RAI, CRC, RMT DET (1 each Dry Contact Ports 1-8) RLY (1 each Dry Contact Ports 1-8)
Diagnostic Functions	Local Loopback, Remote Loopback, and T1/E1 Loopback

Power Source	
Standard	12VDC @300mA
Optional	24VDC, -48VDC, 125VDC, or 115/230VAC with an external power cube

Temperature	
Operating	-10°C to 50°C
(Optional Hi-Temp Version)	-20°C to 70°C
(Optional Extreme-Temp Version)	-40°C to 80°C
Storage	-40°C to 90°C
Humidity	95% non-condensing

Physical (Standalone Unit)	
Height	(3.53 cm) 1.40"
Width	(18.14 cm) 7.20"
Depth	(24.89 cm) 9.80"
Weight	(907g) 2.0 lbs.

Physical (Rack mount 1U "Pizza Box" with two cards) Height	
Height	(4.45 cm) 1.75"
Width	(48.26 cm) 19"
Depth	(22.86 cm) 9"
Weight	(1.86 Kg) 4.1 lbs.

2.1 General Information

The installation section describes how to:

- Unpack the unit
- Ensure an optimum site location
- Install the power supply and dry contact connection

2.2 Unpacking

Before unpacking any equipment:

- Inspect all shipping containers for evidence of external damage caused during transportation
- Inspect for damage after it is removed from the containers

IMPORTANT



Any 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. at (949) 852-1973.

2.3 Equipment Location

The TC8612 should be located in an area that provides adequate light, work space and ventilation.

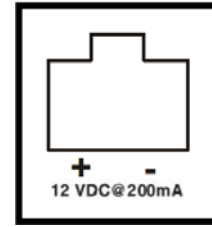
Important

Avoid locating it next to any equipment that may produce electrical interference or strong magnetic fields, such as elevator shafts or heavy duty power supplies.

As with any electronic equipment, keep the unit from excessive moisture, heat, vibration and freezing temperatures.

2.4 Power Supply

The TC8612 can be powered by an external DC power adapter rated 12 VDC @300mA. There are two terminal block connectors labeled "PWR A" and "PWR B" only one is required to power up the unit (single power option units, see note below)*. Since each TC8612 card is equipped with a power redundancy capability, the power LEDs on the front panel will light according to which power jack (A or B) is connected. Both LEDs will light when power redundancy is utilized.



Important

Read and only connect a supply voltage that corresponds to the type plate of your device. Make sure that the contact load capacity of the signal contact is not exceeded.

2.5 Dry Contact Alarm Relay (DCAR)

A terminal block connector at the rear panel provides for the Dry Contact Alarm Relay. This relay can be used in NO (Normal Open) or NC (Normal Close) configuration.

When used in NO (Normal Open) configuration, the relay will close if the unit loses power completely or the Alarm is on. The relay remains open during normal operation.

When used in NC (Normal Close) configuration, the relay will open if the unit loses power completely or the Alarm is on. The relay remains close during normal operation.

2.6 System Start Up

Apply the power by plugging the power plug into a power jack (both PWRA & PWRB for dual power units).

After power is applied, all LEDs (except PWR & VCC LEDs) will flash momentarily and the following LED status should be observed from the front and back panels:

1. The Power "A" and/or "B" and VCC LEDs should be lit.

NOTE

TC8612 cards installed in the 1U rack chassis will not show the PWR A LED in the "On" lit state and will be Off. This is normal and the power to the card will be monitored by the VCC LED being "On" lit.

2. The "AMI" LED on the rear panel will be Lit or Off depending on the setting of the rear panel DIP switch SW4. The LED will be Lit when SW4 is "Off" (Up) position, set for AMI. The LED will be Off when SW4 is "On" (Down) position, set for B8ZS (T1) or HDB3 (E1).
3. The "ALM" and "SYNC" LEDs on the front panel will be flashing indicating that the T1/E1 connection is not established. This is normal when T1/E1 connection has not been established.

2.7 System Configuration

The TC8612 has been pre-tested and switches have been set per factory specifications. The channels can be factory configured (in groups of four) for RS-232, RS-422 and RS-485 interfaces at the time of ordering.

2.7.1 Front Panel

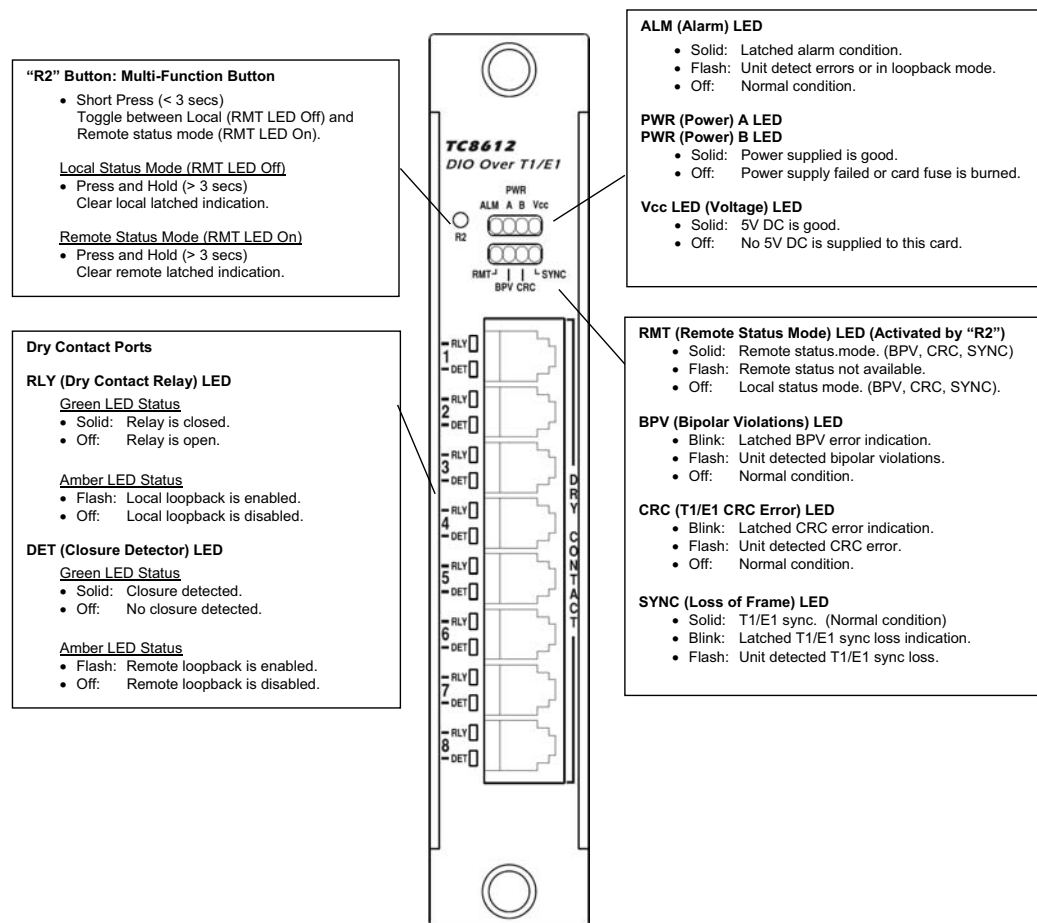


Figure 2-1 TC8612 Front Panel

2.7.2 Rear Panel

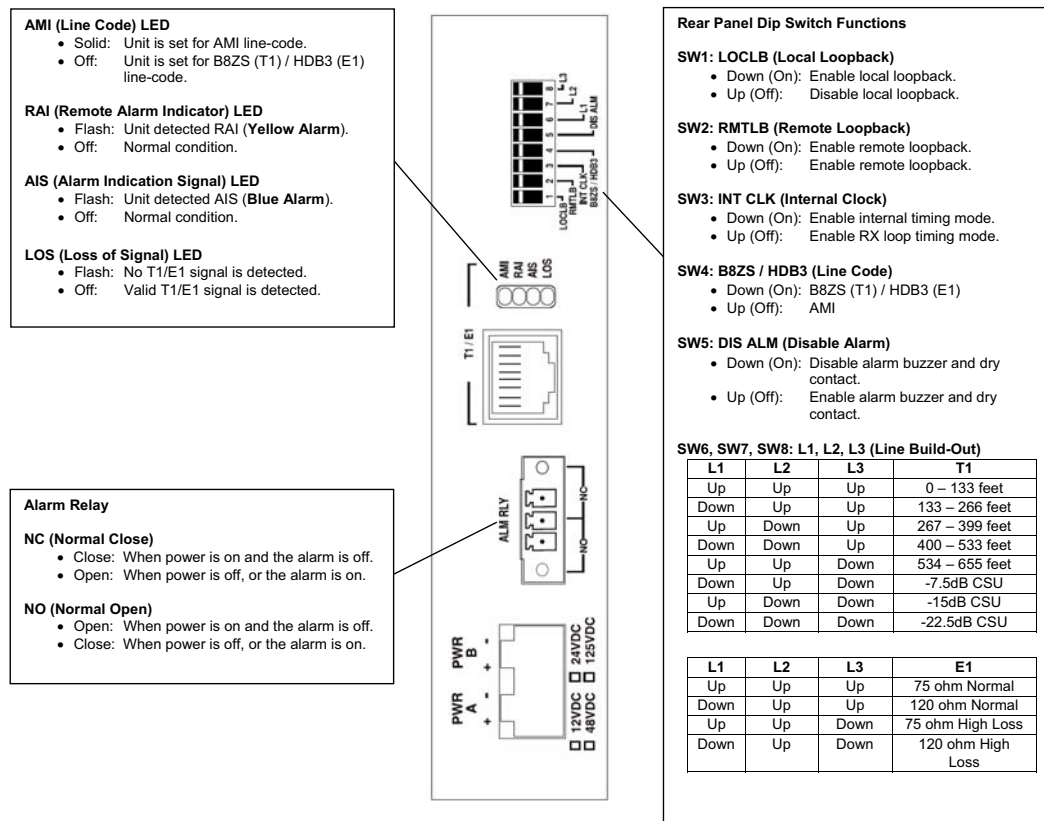
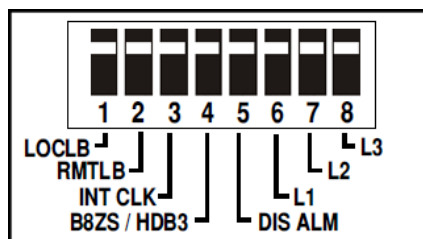


Figure 2-2 TC8612 Rear Panel

2.7.2.1 Rear Panel DIP Switch Functions



The DIP switch functions on the TC8612 are described below. To activate the function, slide the appropriate switch to the On (Down) position.

- **LOCLB:** Local Loopback. This switch (SW1) initiates the Local Loopback function. The dry contact detect status (RX) is looped back to the relay closure pins (TX) for diagnostic testing.
- **RMTLB:** Remote Loopback. This switch (SW2) initiates the Remote Loopback function. Enabling this function on the local unit triggers the remote unit to loopback the received dry contact closure detect status.

- **INT CLK:** Internal Clock. This switch (SW3) is used to setup the internal clock. "On" for internal T1/E1 timing mode. "Off" for Rx loop timing.
- **B8ZS / HDB3:** This switch (SW4) is used to setup the T1/E1 Line Code. "On" for B8ZS (T1) / HDB3 (E1). "Off" for AMI (Both T1/E1).
- **DIS ALM:** This switch (SW5) is used to disable alarm outputs.
- **L1, L2, L3:** These switches (SW6, SW7, & SW8) are used to set the DSX-1 cross-connect distance (copper line build-out) for T1 applications or the impedance for an E1 application.

For example, in a T1/E1 application, this is the length of twisted pair cable connecting the TC8612 to the user's equipment, which may be a CSU or DSU. See Table 2-1 and Table 2-2.

Table 2-1: Copper Line Length Setup Table

T1 Settings			
L1	L2	L3	Application Line Length
Up	Up	Up	DSX-1 (0 to 133 feet) / 0 dB CSU
Down	Up	Up	DSX-1 (133 to 266 feet)
Up	Down	Up	DSX-1 (266 to 400 feet)
Down	Down	Up	DSX-1 (400 to 533 feet)
Up	Up	Down	DSX-1 (533 to 655 feet)
Down	Up	Down	-7.5 dB CSU
Up	Down	Down	-15 dB CSU
Down	Down	Down	-22.5 dB CSU

Table 2-2: E1 Termination Setup Table

E1 Settings			
L1	L2	L3	Application Termination
Up	Up	Up	75 Ohm Normal
Down	Up	Up	120 Ohm Normal
Up	Up	Down	75 Ohm High Loss
Down	Up	Down	120 Ohm High Loss

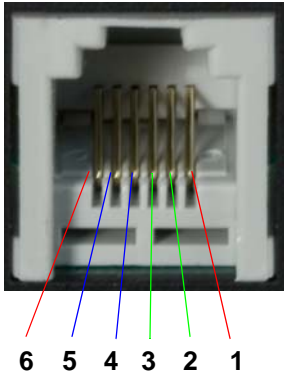
2.7.3 Electrical Signal Interface Connection & Pin Assignments

The RJ-11 connectors are located at the front panel of the TC8612.

2.7.3.1 Dry Contact Ports

For dry contact closure applications, the TC8612 can be used as either the Closure Detector or Relay depending on which pins are used.

By default, the dry contact Relay will open when T1/E1 link is not in sync.
(Optional factory setting: Dry contact Relay will retain the last good state when T1/E1 link is not in sync.)

RJ-11 Dry Contact Relay Pin Assignment		RJ-11 Jack
Pin	Connection	
1	N/A	
2	Relay	
3	Relay	
4	Detector	
5	Detector GND	
6	N/A	

- The Closure Detector side has a dry contact closure detector.
- The Receiver side has a dry contact Relay.

The Close or Open status is controlled by a relay switch inside the card. It reflects the remote detector's status. The virtual pin connections allow the TC8612 to be used as either a closure detector or a dry contact relay. (See [Dry Contact Closure Detector](#), on page 2-7)

- The RJ-11's pins 4 and 5 are closed at the closure detector side, the status is reflected at the remote relay side of the RJ-11's pins 2 and 3.
- The Relay switch is rated 1.5A DC maximum switching current with a maximum voltage of 60 VDC. (See [Specifications](#), on page 1-5.)

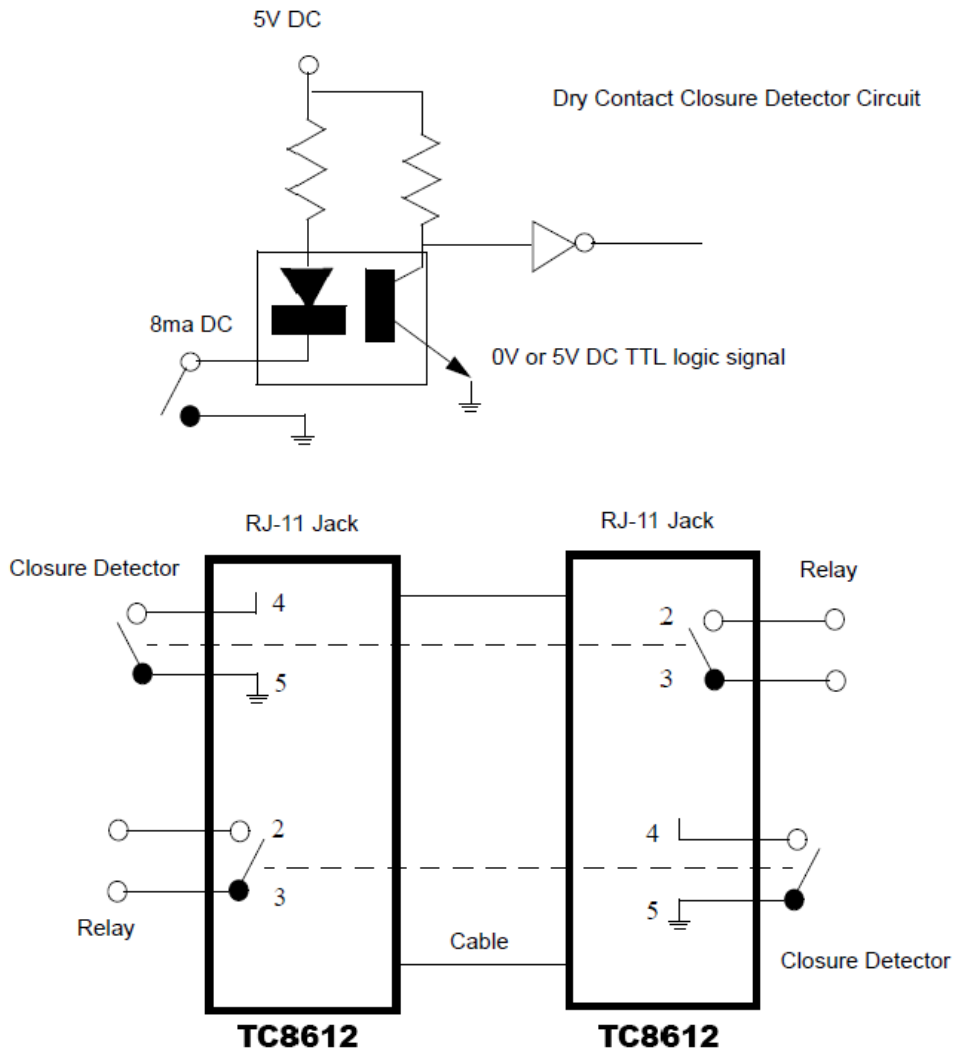


Figure 2-3 Dry Contact Closure Detector

3.1 Introduction

The TC8612 is designed for quick and easy installation. First, configure the unit for your specific application by setting the Line Code, and Line Length DIP switches. Once configured, you can connect the Dry Contact, T1/E1 signal source and power.

3.2 Setup

1. Select the appropriate Line Code for your application with the front panel dip switch SW4. “On” (Down) for B8ZS(T1) or HDB3(E1) and “Off” (Up) for AMI .
2. For T1 applications, set the Copper Line Length with the front panel SW6, SW7, & SW8. Generally, it will be factory set to "0-133 feet."
3. For E1 applications, set the proper impedance for your application with the front panel SW6, SW7, & SW8.
4. Set the appropriate T1/E1 timing mode with rear panel DIP switch SW3. There should be one and only one clock source throughout the entire T1/E1 network.

If two TC8612 units are connected back to back, one unit should set to “Internal” timing mode, and the other unit should set to “RX Loop” timing mode. “On” (Down) for internal timing mode. "Off" (Up) for Rx loop timing mode.

5. Make sure to verify the Dry Contact as well as the T1/E1 pin connections. Then make the actual connections to and from the TC8612s.
6. At the front panel, apply the dry contact signals by plugging in the RJ11 connector plugs one at a time. By opening and closing the TC8612 dry contact closure detector pins, verify that the corresponding channel's "DET" LED turns on to indicate the signal is being received. If the "DET" LED do not turn on for a particular channel, it usually indicates incorrect connections at the RJ11 input port (double-check your connections and verify them with the connection diagrams in the Electrical Signal Interface section).
7. After the T1/E1 connection is established, the front panel "ALM" LED should be off and the "SYNC" LED should be lit solidly.
8. If the front panel "ALM" LED is solidly lit, press and hold the "R2" (“Reset Too”) button for 3 seconds until the "ALM", "BPV", "CRC", and "SYNC" LEDs are flashing. The alarm will reset after the "R2" button is released.

4.1 Introduction

It is highly recommended to conduct bench tests before actual installation. Bench testing allows the user to become familiar with all the functions and features of the TC8612 in a controlled environment. Knowledge of these functions and features will ease installation and troubleshooting efforts later on.

4.2 Latched Alarm

The front panel "ALM", "BPV", "CRC" and "SYNC" LEDs can display both current and latched error conditions.

For example, if the "ALM" LED is on, and "SYNC" LED blinks twice, it indicates that there are two "T1/E1 sync loss" after the last alarm reset.

To reset the alarm, press and hold the "R2" ("Reset Too") button for 3 seconds until the "ALM", "BPV", "CRC", and "SYNC" LEDs are flashing. The alarm will reset after the "R2" button is released.

See the table below for latched alarm definitions,

LED	Normal	Current Error	Latched Error	Note
ALM	Off	Flashing Continuously	On	
BPV	Off	Flashing Continuously	Blink	The number of blinks indicates the number of times the error condition happens. (Max. 3 Blinks)
CRC	Off	Flashing Continuously	Blink	The number of blinks indicates the number of times the error condition happens. (Max. 3 Blinks)
SYNC	On	Flashing Continuously	Blink	The number of blinks indicates the number of times the error condition happens. (Max. 3 Blinks)

4.3 Remote Unit Status Monitoring and Remote Unit Alarm Reset

TC8612 is capable of monitoring the remote unit status and resetting the remote unit alarm condition.

Short press (less than 3 seconds) the "R2" button will toggle between local and remote status display.

"RMT" LED Off: Display Local Status

"RMT" LED On: Display Remote Status

To monitor remote unit status:

1. Check if T1/E1 connection is synched ("SYNC" LED is solidly lit).
2. Short press (< 3 secs) the "R2" button and the "RMT" LED should be lit to indicate it is displaying remote unit status.
3. When "RMT" LED is lit, "ALM", "BPV", "CRC", and "SYNC" LEDs will be displaying remote unit status.
4. The "RMT" LED will turn off automatically after 20 seconds and switch back to local status display.

To reset remote unit alarm condition:

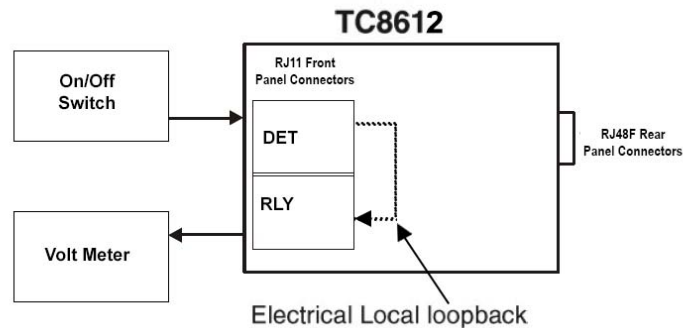
1. Check if T1/E1 connection is synched ("SYNC" LED is solidly lit).
2. Short press (< 3 secs) the "R2" button and the "RMT" LED should be lit to indicate it is displaying remote unit status.
3. Press and hold the "R2" button for 3 seconds until the "ALM", "BPV", "CRC", and "SYNC" LEDs are flashing. The remote unit alarm will reset after the "R2" button is released.
4. The "RMT" LED will turn off automatically after 20 seconds and switch back to local status display.

4.4 Local Loopback Test

With the front panel SW1 (LOCLB) in the On (Down) position and a valid dry contact electrical signal present at the RJ-45, the incoming dry contact detector signal on pin 1 & 2 of Port 1 will be looped back to pin 1 & 2 of Port 3. The loopback is formed inside the TC8612 after the input signal is converted to the TTL level. The purpose of this test is to verify the input and output wiring connections, signal input receiver and signal output driver.

1. The "DET," and "RLY" LEDs on the front panel will flash for that particular channel being tested and the "ALM" alarm LED will flash to indicate that the unit is in diagnostic (local loopback) mode.
2. The "SYNC" and "LOS" LEDs will be blinking since there is no T1/E1 link established for this test.
3. Check that the volt meter is indicating connection integrity.
4. Upon successful completion of this test, please return dip switch SW2 (LOCLB) to the Up (Off) position and proceed to the Remote Loopback Test.

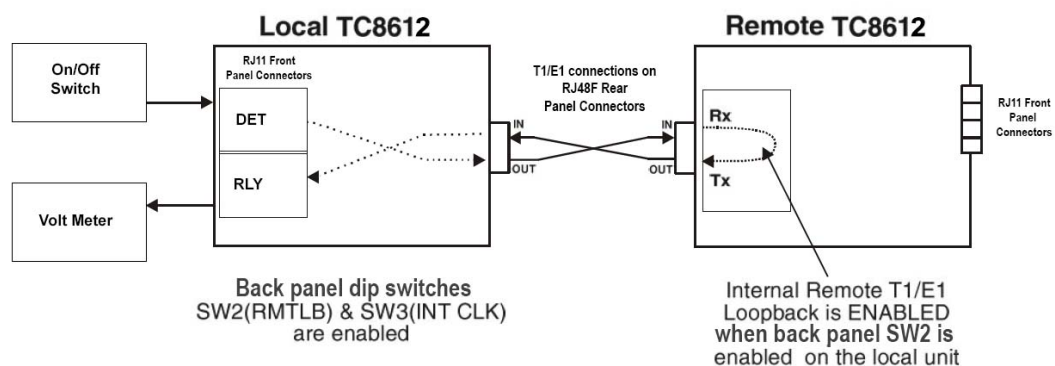
Local Loopback Test



4.5 Remote Loopback Test

1. When you have completed the Local Loopback test for both units, proceed to the next step. Connect the local and remote TC8612 units as shown on the diagram below.
2. Connect the T1/E1 connections as shown on the diagram below. Be sure to make the correct pin connections, refer to page 2-6 for pin assignments.
3. Verify that both TC8612 units have the same Line Code and Line Length settings and that the local unit is set to internal timing mode with dip switch SW3 to the Down (On) position.
4. On the local TC8612, slide dip switch SW2 (Remote Loopback) to the Down (On) position. Observe that the "ALM" alarm LED will flash indicating that the unit is in diagnostic (remote loopback) mode. The "PWR A and/or PWR B" and "VCC" LEDs will be solidly lit. The "SYNC" LED will be solidly lit and both "DET" and "RLY" LEDs will blink indicating the dry contact signal from the user's device is received and looped back through out the link as shown on the diagram below. The "LOS" LED will be Off.
5. On the remote TC8612, observe that the "ALM" alarm LED will flash indicating that the unit is in diagnostic (remote loopback) mode. The "PWR A and/or PWR B," "VCC," and "SYNC" LEDs will be solidly lit. Only the "RLY" LED will blink, the "DET" and "LOS" LEDs will be Off.
6. Check that the volt meter is indicating connection integrity.
7. If any other LEDs illuminate or flash on the units, make sure that all DIP switches on both of the TC8612's are in the correct position.
8. At this point, both units tested will have passed all electrical tests and will have been verified that they are functioning properly. When done, return SW2 and SW3 on the local unit to the Off (Up) position.

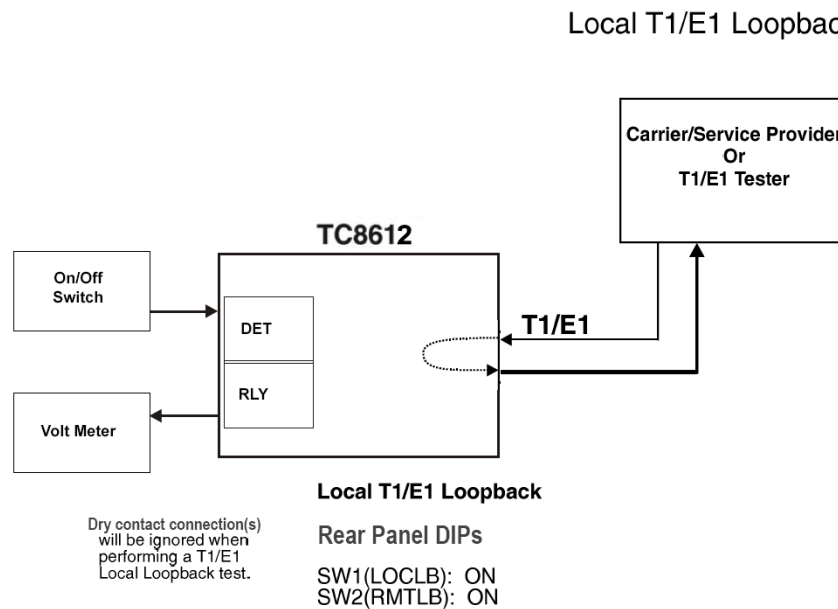
Remote Loopback Test



4.6 T1/E1 Local Loopback Test

A T1/E1 Local loopback is used to test T1/E1 wiring and T1/E1 transceiver functionality. It can be enabled by pushing both rear panel DIP switches SW1 & SW2 to the “On” (Down) position. The diagram below shows the T1/E1 signal flow and related loopback path.

1. The “ALM” LED should be flashing indicating the unit is in T1/E1 Loopback mode.
2. The “LOS” LED should be off indicating that a valid T1/E1 signal is being received. If the “LOS” LED is flashing it means that the TC8612 is not receiving a valid T1/E1 or the T1/E1 cable is in question.
3. The T1/E1 signal should be looped back to the Carrier/Service Provider or T1/E1 tester. Please make sure a valid T1/E1 signal is being received.
4. Upon successful completion of this test, please return dip switches SW1(LOCLB) and SW2(RMTLB) to the “Off”(Up) position for normal operation of the TC8612 unit(s).



5.1 General

Alarm conditions occur whenever a power or sync "fault" condition is detected by the TC8612. Under normal operation, PWR, Vcc, and SYNC LEDs should be lit.

5.2 All LEDs are OFF

If no LEDs are lit on the unit, check the DC power supply, connector plug, and/or the power source. If the problem persists, contact the Technical Support Department at TC Communications, Inc. @ (949) 852-1973.

5.3 Alarm LED

The ALARM LED will flash when the unit has any loopbacks enabled. It will be solid when alarm conditions are present such as T1/E1 loss of frame (no SYNC) or T1/E1 loss of signal (LOS).

Appendix A 19" Rack Mount Card Cage

A.1 Features

- 1U height (1.75")
- Universal Power Supply Accepts 90V to 264V AC and 47 to 63 Hz AC
- Standard Power Supply is 12VDC, Optional 24VDC, -48VDC, 125VDC, or AC Power Supply Available
- Over Load & Short Circuit Protection

A.2 Description

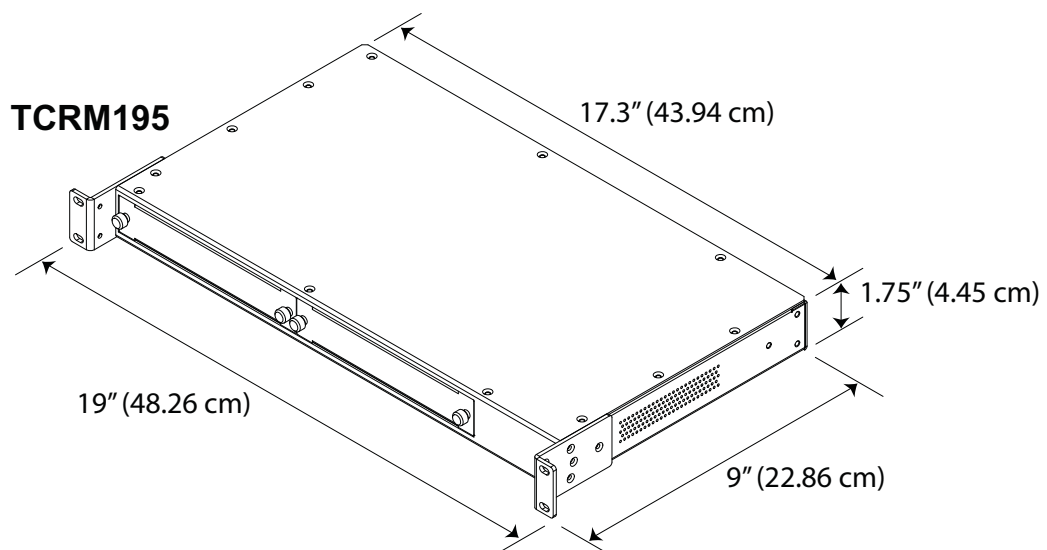
The TCRM195 "Pizza Box" Rack Mount Card Cages hold up to 2 single multiplexer type cards.

It operates with one power supply. The AC power supply automatically adjusts for 90V to 264V AC input and 47 to 63 Hz operation. The DC power supply accepts 24VDC, -48VDC, or 125VDC input (Optional).

The rack assemblies are 19" wide by 1.75" high. The TCRM195 is 9" deep.

A.3 Chassis Ground

The Stand alone and Rack mount chassis provide a connection point for chassis ground with a dedicated chassis ground screw and lock washer. The chassis ground screw is located on the rear side of the chassis. This chassis ground connection point is available in case chassis ground is taken into design consideration by the end user.



Appendix B R2 Button & LED Functions

B.1 R2 (“Reset Too”) Button Description

The recent enhancements implemented on the TC8612 (DIO over T1/E1) will make troubleshooting a much easier process. The alarm LEDs - BPV, CRC, and SYNC - can now latch abnormal conditions until they are reset by the user. These functions are realized in part by the newly added "R2" ("Reset Too") push button.



The "R2" push button is for displaying remote unit LED status and to reset local or remote error and alarm LEDs.

B.1.1 R2 (“Reset Too”) Push Button Functions

R2 push button:

1. To reset the local unit's alarm LEDs, hold down the R2 button for at least 3 seconds until you see the alarm LEDs flash in sequence.
2. To display the remote unit's alarm LEDs on the local unit, briefly press the R2 button on the local unit. The local unit's RMT LED will subsequently turn on and whatever alarm LEDs are being displayed on the remote unit will now be displayed on the local unit's alarm LEDs.
3. To reset the remote unit's alarm LEDs from the local unit, while the RMT LED is lit on the local unit, hold down the local unit's R2 button for at least 3 seconds until you see the alarm LEDs flash in sequence.

Automatic return to local alarm LED status:

Upon briefly pressing the R2 button on a local unit, the local unit will remain in remote alarm LED status (RMT LED is on) for 20 seconds, after which the local unit will automatically revert back to local alarm LED status.

B.2 LED Functions

RMT: displays the remote unit's LED status on the local unit

BPV: displays bi-polar violation(s) for the ingress T1/E1 signal

CRC: displays error(s) in data integrity (only for T1 ESF frame and E1 built-in CRC)

SYNC: displays frame locking for T1 (ESF framing) or E1 (PCM31C framing)

The alarm LEDs - BPV, CRC and SYNC - all have a latching functionality to indicate the number of occurrences for each error. These LEDs will continuously flash at regular intervals until reset by the user. The behavior is noted here:

- When an LED blinks once, it indicates a single error has occurred once. When an LED blinks twice, it indicates the error has occurred twice. When the LED blinks 3 times, it indicates the error has occurred 3 or more times.

B.3 CSU Loop Operation

When the ISP transmits the CSU Loop Up Code towards the unit, the unit will recognize the code and loop back the entire T1/E1 signal back towards the ISP.

Once the Loop Up condition is established, the unit alarm will be flashing and the ISP may perform BER testing and other tests on the looped link.

To cancel the loop, the ISP must transmit the CSU Loop Down Code towards the unit. Alternatively, disconnecting the T1/E1 cable will also cancel the loop.

C.1 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.

C.1.1 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).

C.1.2 Limitation of Liability

1. In no event shall the total liability of T C 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 T C Communications, Inc. by purchaser for the goods from which the claim arose, in no event shall T C COMMUNICATIONS, INC. be responsible for indirect and consequential damages.
2. In no event shall liability attached to T C COMMUNICATIONS, INC. unless notice in writing is given to T C COMMUNICATIONS, INC. within ten days of the occurrence of the event giving rise to such claim.
3. T C 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 T C COMMUNICATIONS, INC.
4. T C 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.