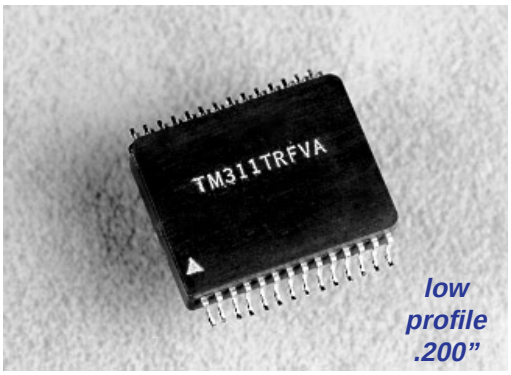
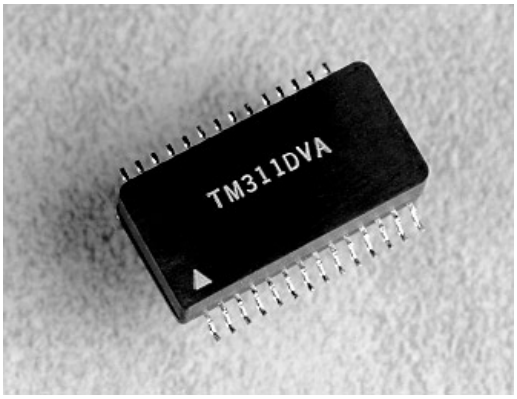
# Copperhead™ Series CMI Transceiver line interface modules

## for SONET/SDH applications (E4/STM-1 and STM-1)

***Compact, one package transceiver line interface modules for interfacing to the most widely used CMI chip sets for E4/STM-1 and STM-1 applications***




**Model TM311TRFVA for AMCC S3015/S3016 or S3031B chip sets. Contains loss-of-signal (LOS) detection circuit.**




**Model TM311DVA
for AMCC S3005/S3006 chip sets**

### Features

- Convenient, one package solution replaces several components on pc boards
- Enhanced distance capabilities; excellent signal integrity
- ECL logic interface — directly compatible, completely inter-operable
- Maximum operating distance exceeds 200 meters on 75 ohm RG-6/u and RG-11/u coaxial cable
- Industrial temperature range -40°C to +85°C
- Two models:
  - TM311DVA is compatible with AMCC S3005/S3006 and similar chip sets
  - TM311TRFVA is equipped with G.775 compliant loss-of-signal (LOS) detection circuitry, and is compatible with AMCC S3015/S3016 or S3031B and similar chip sets
- Exceptional return loss ( ≥ -15dB)
- Low transmit/receive jitter
- Small footprint for surface mounting
- Low power dissipation; 475 mW typical
- Complies with ANSI, Bellcore, and ITU-T/G.703 specifications

### Applications

- STM-1 or E4-based transmission systems
- STM-1 or E4 modules
- STM-1 or E4 test equipment
- Compatible with AMCC (S3005/S3006 or S3015/S3016) and other leading STM-1 or E4 chip sets

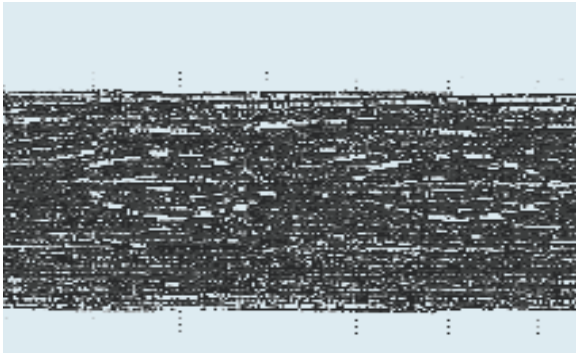
Copperhead™ CMI transceiver line interface modules offer a convenient, one package, high performance solution for the complex chip interfacing requirements of CMI applications. The compact packages include transformer coupling for both $T_X$ and $R_X$ functions, an equalizer, a differential amplifier, and buffering for ECL level input and output.

Designed to be inter-operable with existing ECL fibre transceiver drivers, the transceivers meet SONET/ITU-T requirements for coded mark inversion (CMI) data transmission over copper.

The transceivers function equally well in both 311.04 Mb/s SONET STM-1 CMI and 278.528 Mb/s SONET E4 CMI applications, delivering fibre speed data transmission and reception over more than 200 meters of 75 ohm RG-6/u or RG-11/u coaxial cable.

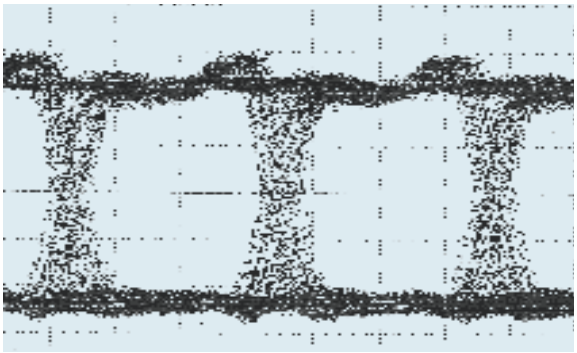
Both Copperhead™ CMI transceiver line interface modules are supplied as surface mount gull wing packages.

**BEFORE**
**(unequalized)**



**(Figure 1) Actual oscilloscope tracing of 311 Mb/s unequalized input to receiver pins 13 and 14 after transmission over 200 meters of RG-6/u coaxial cable.**

**AFTER**
**(equalized for CMI)**



**(Figure 2) Tracing of the same signal after equalization. Receiver output measured at pins 2 and 3.**

## Technical description

Copperhead™ CMI transceiver line interface modules (LIM) take a differential ECL level CMI (coded mark inversion) data signal from the available CMI silicon and convert it to a drive level suitable for transmission over copper cable, and pre-conditioned to meet the G.703 output masks (for binary "ones" and "zeros").

The transceiver LIM matches the impedance of both the ECL circuit and the cable plant, providing a resultant output signal with exceptional return loss. It accomplishes this by utilizing a specially designed wideband pulse transformer, which converts the signal to the appropriate current and voltage levels.

The receiver portion of the transceiver LIM takes the signal from the copper cable, equalizes it using similar impedance matching techniques, and converts the composite signal to ECL level CMI for the mating STM-1 silicon. Signal clarity is much improved over non- interfaced conditions (see figures above).

## Benefits of transformer coupling

The pulse transformers used in our Copperhead™ transceiver LIMs provide high isolation and optimum damping of transients. They also eliminate DC components in the signal and provide common mode signal rejection. The transformer is also used to match the load to the source and provide maximum power transfer, and also to prevent reflections from transmission line effects.

## Product Qualification Test Outline

**I. Subgroup I (all devices - 40 pieces)**
**Electrical tests at 25˚**
- Receiver ($R_X$) tests
  - Jitter (total peak-to-peak)
- Transmit ($T_X$) tests
  - CMI Mask Test (rise time, fall time, and amplitude)
  - Jitter (total peak-to-peak)
- Total power supply current

**II. Subgroup II (4 pieces)**
**External visual inspection**
- Resistance to solvents per MIL-STD-202, Method 215H
  - 1 part isopropyl alcohol, 3 parts mineral spirits
  - Trichloroethane
  - Terpene defluxer with a minimum of 90% d-limonene and 10% surfactant
  - 42 parts water, 1 part propylene glycol monomethyl ether, 1 part monoethanolamine
- Terminal strength per MIL-STD-883, Method 2004.5
  - Lead tension

**III. Subgroup III (4 pieces)**
**Solderability**
- Per MIL-STD-202, Method 208, with a 4-hour steam age

**IV. Subgroup IV (6 pieces)**
**Resistance to soldering heat**
- Hand solder (2 pieces), solder dip temperature of 430 ±5° C for 3 seconds maximum
- Vapor phase reflow (4 pieces) for a period of 60 seconds at a temperature of 215 +5/-0° C

**V. Subgroup V (6 pieces)**
**Thermal shock**
- Per MIL-STD-202, Method 107, Condition A-1, except temperature range shall be -20° C to +125° C, 25 cycles

**Vibration**
- Per MIL-STD-202, Method 204D, Condition D, 20G peak acceleration, 10 Hz to 2 KHz and return to 10 Hz traversed in 6 minutes

**Shock**
- Per MIL-STD-202, Method 213B, Condition J, 30G, 11msec shock, 3 shocks in each direction along mutually perpendicular axes

**VI. Subgroup VI (6 pieces)**
**Life Test**
- Per MIL-STD-202, Method 108, 1000 hours at a temperature of 75° C

**VII. Subgroup VII (8 pieces)**
**Humidity Test**
- Humidity test @ 40° C, and 90% humidity (4 pieces)

**VIII. Subgroup VIII (6 pieces)**
**Electrostatic Discharge, ESD Classification**
- The ESD classification to be derived from ESD testing per IEC801-2, EN50082-1, Criteria B

**NOTE: There shall be 0 (zero) rejects allowable for each of the subgroups.**

## EMC Immunity and Radiated Emissions Tests

- EN 55022: (1993) Radio Disturbance CISPR Class A
- IEC 1000-4-2 ESD Test Method
  Performance Criteria B, Level 2
- IEC 1000-4-3 Radiated Immunity
  Performance Criteria A, Level 3 (10V/m)
- IEC 10004-4 EFT Test Method
  Performance Criteria B, Level 3 (at I/O port)

Criteria A: The system shall continue to operate normally. The EUT shall be deemed to have passed the immunity tests if no bit errors occur when receiving data over the cable. Changes of state, reset condition, unrecoverable jab condition, blocked network, or loss of packets is unacceptable.

Criteria B: The system shall operate normally with no data errors through the loop after the test. During the test, data errors, aborted frames and collisions are acceptable. No change of operating state such as system reset or unrecoverable condition is permitted during or after the test.

## Table 1 Absolute Maximum Ratings

| PARAMETER | SYM | MIN | MAX | UNIT |
|---|---|---|---|---|
| Storage temperature | $T_S$ | -55 | +150 | °C |
| Operating temperature ambient | $T_A$ | -40 | +85 | °C |
| Power supply voltage ( MECL or PECL) | $V_{CC}$ | -6.0 | 6.0 | V |
| Power supply current[1] | $I_C$ | - | 100 | mA |
| Power dissipation (total) | $P_D$ | - | 525 | mW |
| Output current | $I_O$ | - | 100 | mA |
| Data input voltage | $V_I$ | 0 | $V_{CC}$+0.5 | V |
| Differential input voltage | $V_D$ | - | 2.40 | V |
| Component body temperature/time | - | - | 220/60 | °C/s |

Note 1: Excluding external pull-down resistors

***Important: This is a hybrid device and is rated for 220ºC max for 60 seconds. Contact factory for recommended solder reflow profile.***

## Table 2 General Electrical Parameters

| PARAMETER | STM-1 | E4/STM-1 | UNIT |
|---|---|---|---|
| Data rate | 155.52 | 139.264 | Mb/s |
| Clock rate | 311.04 | 278.528 | Mb/s |
| Tolerance | ± 100 | ± 100 | ppm |
| Operating distance RG-6/u or RG-11/u cable | 0 to 200 | 0 to 200 | meters |
| Cable impedance RG-6/u or RG-11/u cable | 75 | 75 | ohms, nominal |

## Table 3 Transmitter Electrical Characteristics $V_{CC}$ = 4.75V to 5.25V

| PARAMETER | | SYM | MIN | TYPICAL | MAX | UNIT |
|---|---|---|---|---|---|---|
| Input data voltage | Low<br>High | $V_{IL}$<br>$V_{IH}$ | $V_{CC}$ -2.000<br>$V_{CC}$ -1.110 | $V_{CC}$ -1.750<br>$V_{CC}$ -0.880 | $V_{CC}$ -1.500<br>$V_{CC}$ -0.670 | V<br>V |
| Input current | Low<br>High | $I_{IL}$<br>$I_{IH}$ | 0.4<br>- | -<br>- | -<br>0.4 | mA<br>mA |
| Data rate | | DR | 139.264 | - | 155.52 | Mb/s |
| Return loss for 139.264 Mb/s (7MHz to 210MHz) | | $S_{11}$ | -15 | - | - | dB |
| Return loss for 155.51 Mb/s (8MHz to 240MHz) | | $S_{11}$ | -15 | - | - | dB |
| Total peak-peak transmit jitter | | $T_{PK-PK}$ | - | 50 | 225 | ps |

Note: Output of transmitter shall meet the mask requirements of G.703 Figures 24 and 25 (155.52 Mb/s) and Figures 19 and 20 (139.264 Mb/s)

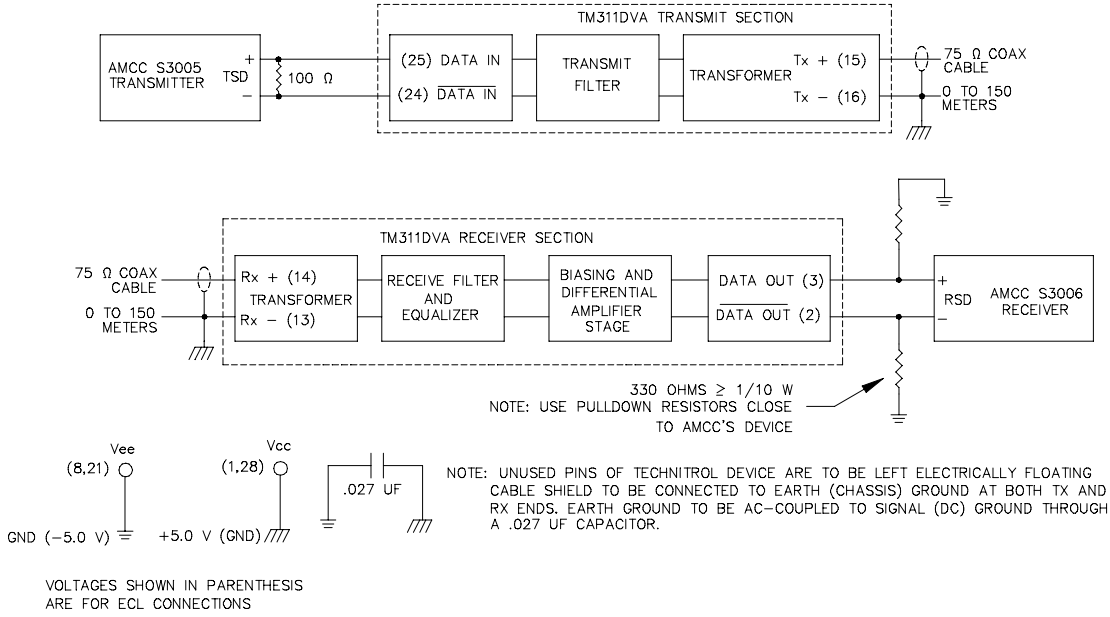
## Table 4 Receiver Electrical Characteristics $V_{CC}$ = 4.75V to 5.25V

| PARAMETER | | SYM | MIN | TYPICAL | MAX | UNIT |
|---|---|---|---|---|---|---|
| Output data voltage | Low<br>High | $V_{OL}$<br>$V_{OH}$ | $V_{CC}$ -2.000<br>$V_{CC}$ -1.110 | $V_{CC}$ -1.750<br>$V_{CC}$ -0.880 | $V_{CC}$ -1.500<br>$V_{CC}$ -0.670 | V<br>V |
| Data rate | | DR | 139 | - | 155 | Mb/s |
| Output rise and fall time | (20-80%) | $T_R/T_F$ | 0.4 | - | 1.7 | ns |
| Return loss for 139.264 Mb/s (7MHz to 210MHz) | | $S_{11}$ | -15 | -22 | - | dB |
| Return loss for 155.51 Mb/s (8MHz to 240MHz) | | $S_{11}$ | -15 | -22 | - | dB |
| Total peak-peak receive jitter | (100m RG-6/u) | $T_{PK-PK}$ | - | 350 | 900 | ps |

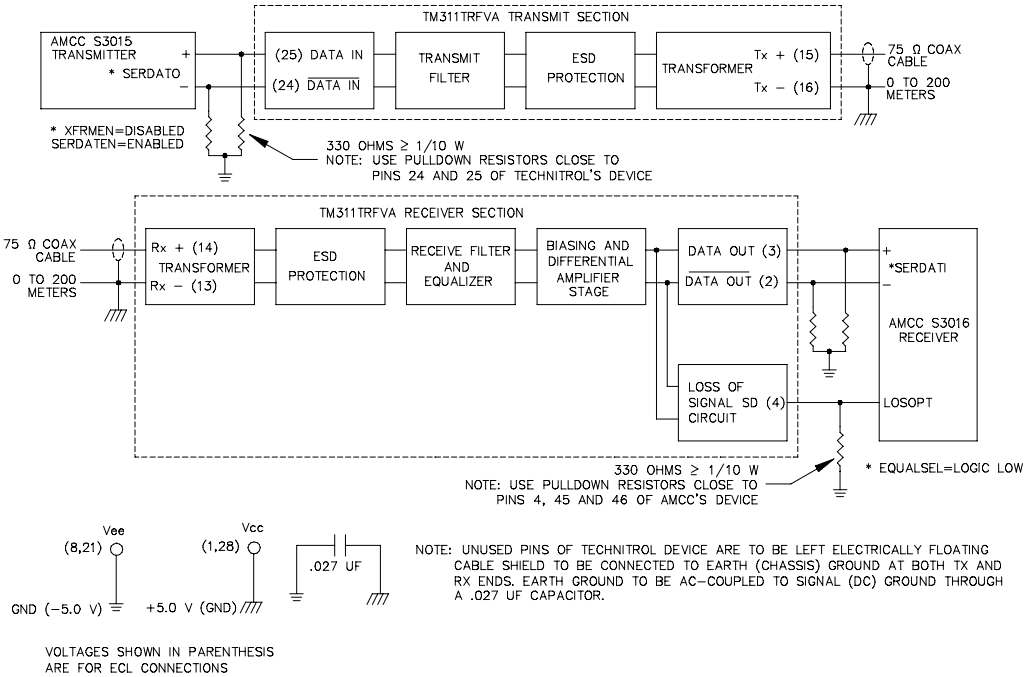
## Table 5 G.775 Loss of Signal (LOS); applicable to TM311TRFVA only

| PARAMETER | | MIN | MAX |
|---|---|---|---|
| 20 dB flat response 1 MHz to 311.04 MHz<br>Signal detect pin #4 shall be asserted | $V_{OH}$ | $V_{CC}$ -1.110V | $V_{CC}$ -0.670V |
| 35 dB flat response 1 MHz to 311.04 MHz<br>Signal detect pin #4 shall be deasserted | $V_{OL}$ | $V_{CC}$ -2.000V | $V_{CC}$ -1.500V |
| Attenuation RG-6/u ~ 4 dB/33 meters (100 ft) @ 300 MHz<br>16 dB ~ 120 meters of RG-6/u (cable loss)<br>±3 dB margin<br>19 dB loss budget | | | |

## Application example:
## TM311DVA with AMCC S3005/S3006 chip sets

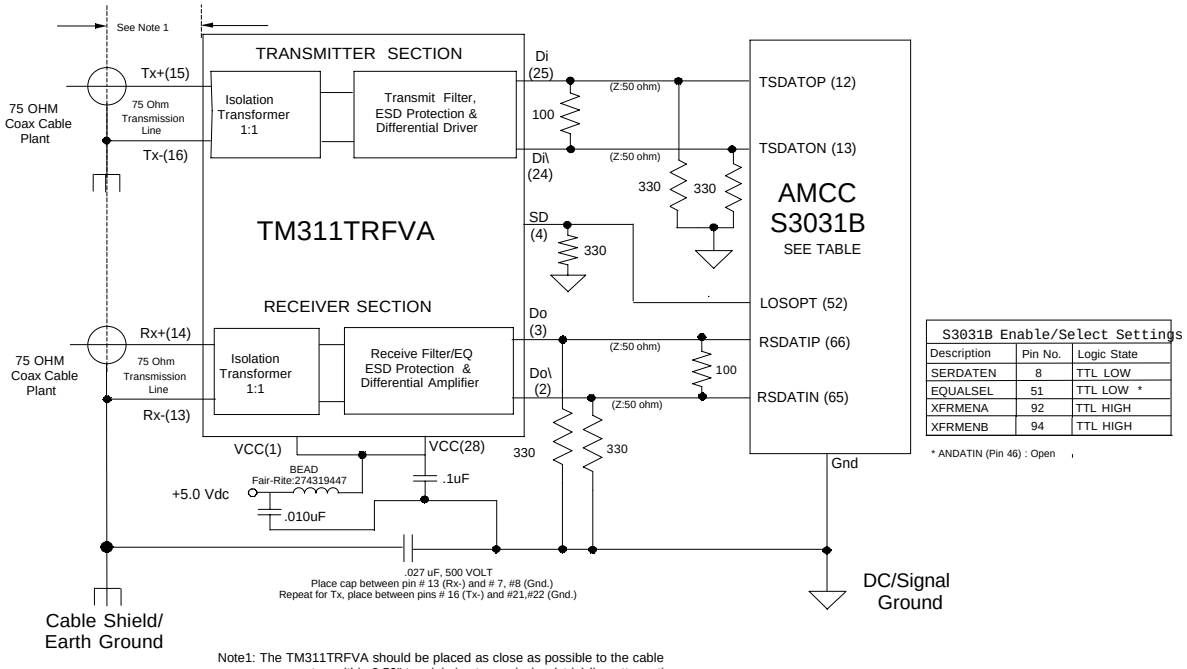



## Application example:
## TM311TRFVA with AMCC S3015/S3016 chip sets



# Application example:
# TM311TRFVA with AMCC S3031B chip

Interface Application Note: For AMCC S3031B and TM311TRFVA




S3031B Enable/Select Settings

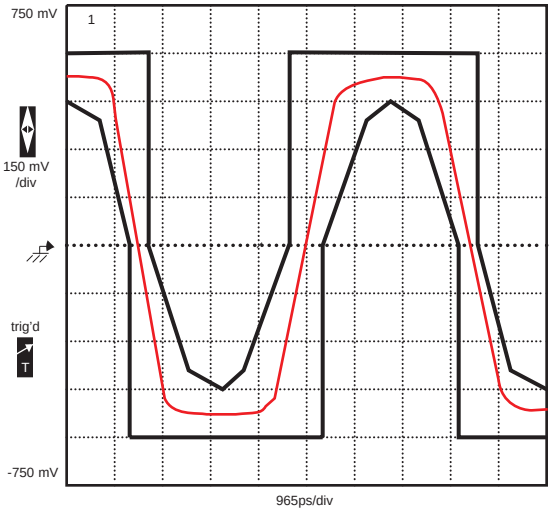
| Description | Pin No. | Logic State |
|---|---|---|
| SERDATEN | 8 | TTL LOW |
| EQUALSEL | 51 | TTL LOW * |
| XFRMENA | 92 | TTL HIGH |
| XFRMENB | 94 | TTL HIGH |

* ANDATIN (Pin 46) : Open

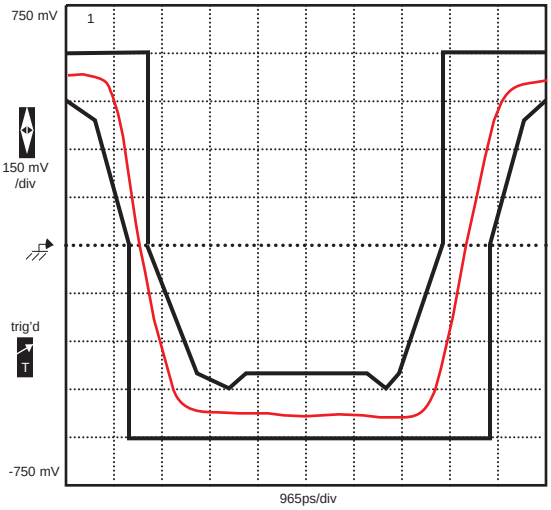
Note1: The TM311TRFVA should be placed as close as possible to the cable connector, within 0.50" to minimize transmission (strip) line attenuation.

Note 2: Pins nos.1 & 28 of TM311TRFVA to be individually AC-coupled to GND with 0.1uF/50V capacitors. Pin nos. 7,8,21,& 22 to be connected to VEE (GND for PECL).

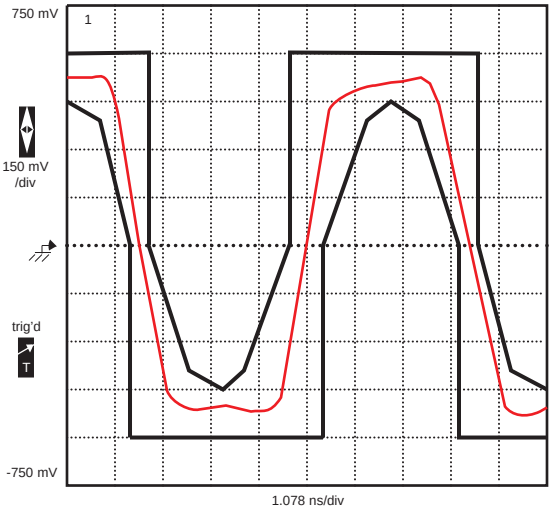
## G.703 Compliant Binary 0 Mask (155.52 Mb/s)



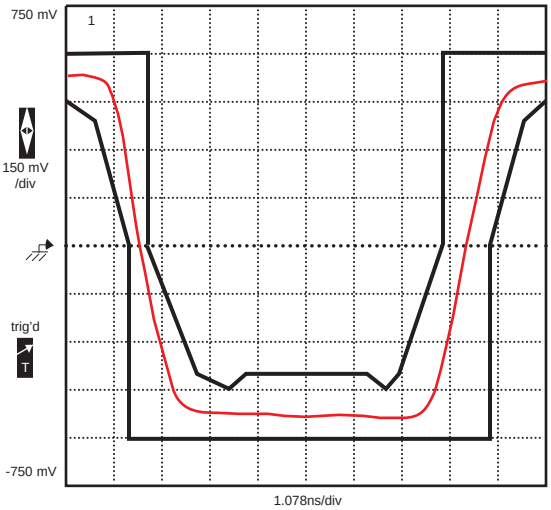

## G.703 Compliant Binary 1 Mask (155.52 Mb/s)




## G.703 Compliant Binary 0 Mask (139.264 Mb/s)




## G.703 Compliant Binary 1 Mask (139.264 Mb/s)



## Transceiver Pinouts

**Pin number(s)**

**1,28** . . . . . The positive supply of the line interface module. Connect to +5.0V for PECL applications, and to Gnd for ECL applications.

**2,3** . . . . . $\overline{D_O}$ , $D_O$: Differential ECL data outputs. These outputs can drive 50 ohm loads connected to $V_{CC}$ –2.0V. Recommend 330 ohms to Gnd.

**TM 311TRFVA (with G.775-compliant LOS)**

**4** . . . . . $S_D$: Single ECL compatible output indicating the state of the electrical input. An ECL HIGH on $S_D$ indicates that the input voltage level is above threshold. Threshold = 20dB flat response 1 to 311.04 MHZ.

**5** . . . . . $\overline{S_D}$: Opposite polarity of Pin #4.

**TM 311DVA (without LOS)**

**4** . . . . . No connect.

**5** . . . . . No connect.

**7,8** . . . . . Gnd ($V_{EE}$): The negative supply of the line interface module. Connect to Gnd for raised ECL (PECL) applications, and to –5.2V for standard ECL applications.

**13,14** . . . . . $R_X$-, $R_X$+ : Transformer coupled differential inputs to receiver section. For coax applications, $R_X$- should be connected to shield of cable/earth Gnd; $R_X$+ should be connected to the center conductor. Earth Gnd should be AC coupled to DC signal Gnd using a 0.027 µF capacitor, 500V.

**15,16** . . . . . $T_X$+ , $T_X$- : Transformer coupled differential outputs to cable. For coax applications, $T_X$- should be connected to shield of cable/earth Gnd; $T_X$+ should be connected to the center conductor. Earth Gnd should be AC coupled to DC signal Gnd using a 0.027 µF capacitor, 500V.

**21,22** . . . . . Gnd ($V_{EE}$): The negative supply of the line interface module. Connect to Gnd for raised ECL (PECL) applications, and to –5.2V for standard ECL applications.

**23** . . . . . $V_{BB}$ : Is an output pin, which is used for biasing up a threshold reference level, i.e. PECL (3.67V). This pin can only source 1 mA maximum.

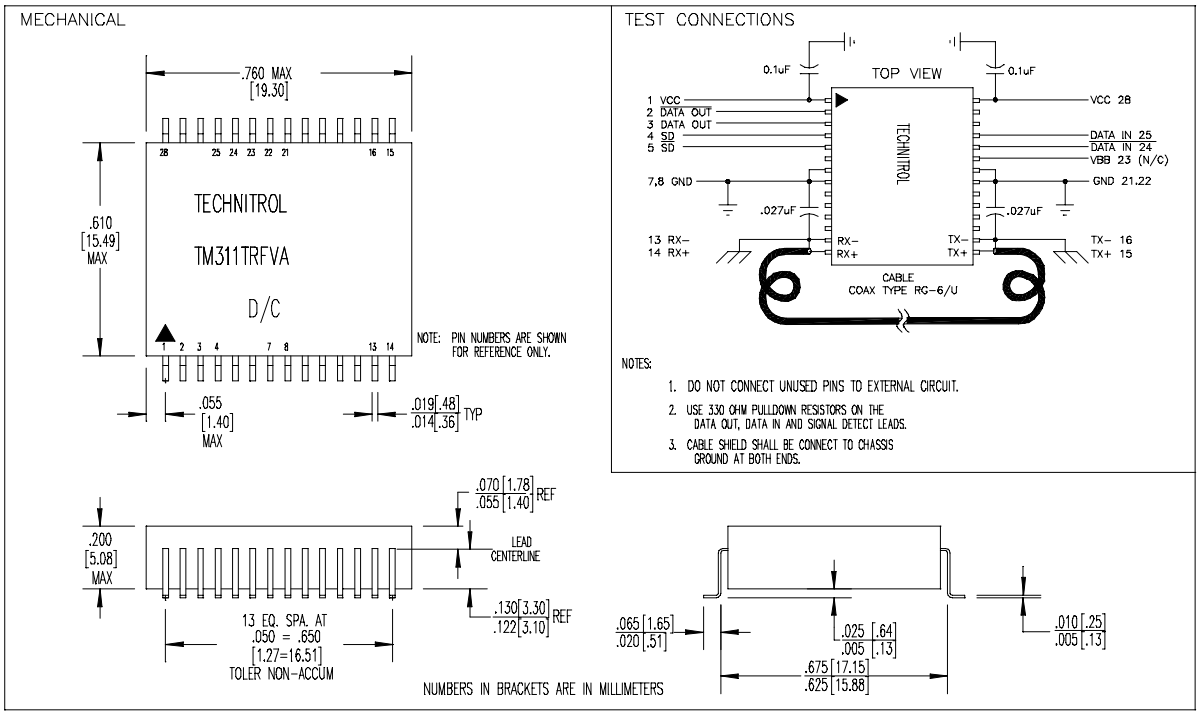
**24,25** . . . . . $\overline{D_I}$, $D_I$ : Differential ECL compatible data inputs to the transmitter side of the module.

**6, 9, 10, 11, 12, 17, 18,19, 20, 26, 27 . . These pins are "no connect;" do not apply Gnd, VCC, or signal lines to these pins.**

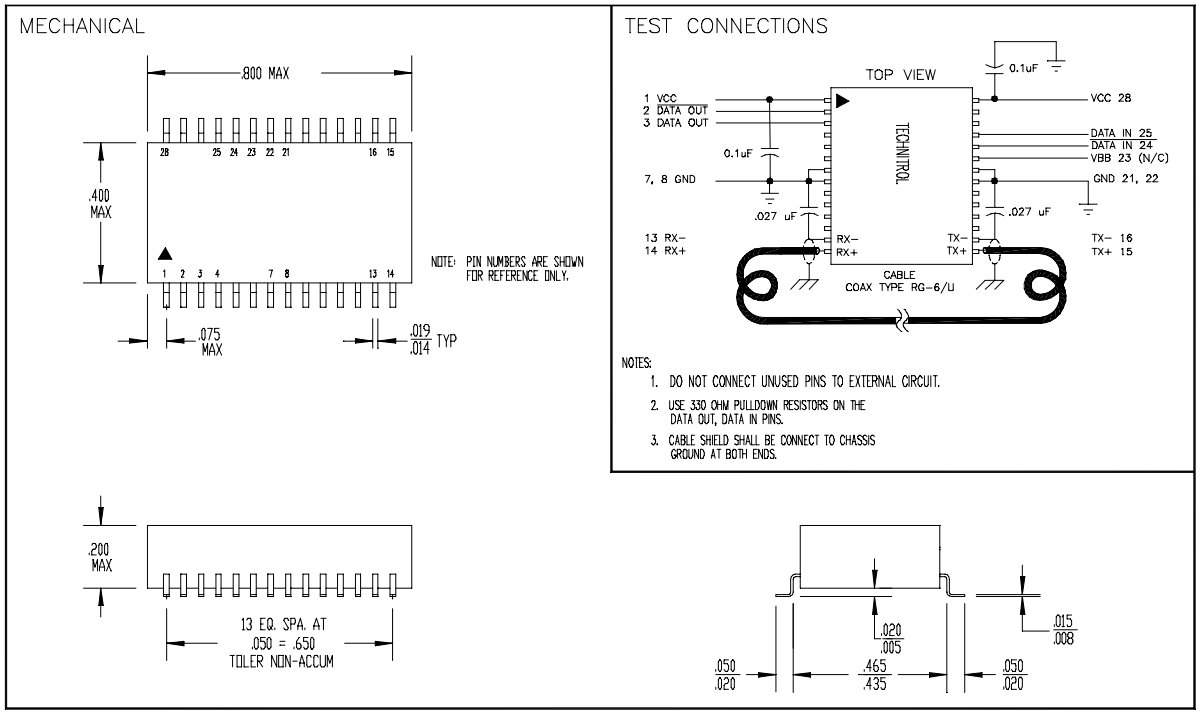
## Board Layout Considerations

- 0.1 µF capacitors should be ceramic and placed as close to the VCC pins (1 & 28) of the transceiver as possible.
- Differential lines should be of equal length.
- Data out and signal detect output lines should be as short as possible and isolated from noisy sources.
- Controlled impedance traces from pins 14 (RX+) and 15 ($T_X$+) of the transceiver to the BNCs must be used in order to control return loss.
- A DC signal ground plane should occupy the complete area directly beneath the transceiver from pins 1-12 and 17-28.
- The earth ground plane should occupy the complete area directly beneath pins 13-14 and 15-16.
- There should be a separation of 0.050" between earth and DC ground.
- The earth ground should be AC coupled to DC ground with a 0.027 µF capacitor on both sides of the tranceiver ($T_X$ side and $R_X$ side).

## Dimensions and transceiver connections: TM311TRFVA




## Dimensions and transceiver connections: TM311DVA



## Ordering Information

**Available Part Numbers:**

**TM 311 TR F V A**

- A - All 28 pins provided for mounting
- V - Impedance matched for video and mini coax (75 ohm)
- F - Surface mount, gull wing flat package: .610"W x .760"L x .200"H
- TR - G.775 LOS (loss of signal) circuit and transmitter and receiver circuits
- 311 - 311.04 Mb/s SONET STM-1 CMI; also for SONET E4 CMI 278.528 Mb/s
- TM - Line interface module; compact surface-mount package

**TM 311 D V A**

- A - All 28 pins provided for mounting
- V - Impedance matched for video and mini coax (75 ohm)
- C - Impedance matched for 50 ohm coax
- D - Surface mount, gull wing DIP package: .400"W x .800"L x .200"H
- 311 - 311.04 Mb/s SONET STM-1 CMI; also for SONET E4 CMI 278.528 Mb/s
- TM - Line interface module; compact surface-mount package

## Related Products

| Series | Features |
|---|---|
| TM133 Series | 132.8125 Mbaud version 1/8 speed Fibre Channel/ATM |
| TM266 Series | 265.625 Mbaud version 1/4 Speed Fibre Channel |
| TM531 Series | 531.25 Mbaud version 1/2 Speed Fibre Channel |
| TM622 Series | 622.08 Mbaud version SONET OC-12, STM-4 |
| TM1062 Series | 1.0625 Gbaud version; short haul and long haul models |
| TM1250 Series | 1.250 Gbaud version (Ethernet); short haul and long haul models |
| T-330SCT | 330 Mbaud "HOT LINK"; 265.625 Mbaud version 1/4 speed Fibre Channel Transformer |
| T-1062SCT | 1.0625 Gbaud version full speed Fibre Channel Transformer |

# WARRANTY

**Pulse Specialty Components warrants for a period of 90 days from the date of shipment, that under normal use and service, its products will be free from defects in workmanship and material. Pulse Specialty Components' sole responsibility under this warranty is, at its option, to repair or replace, without charge, any defective product or part, or to credit buyer for the purchase price of such defective product, provided:**

**1) Buyer promptly notifies Pulse Specialty Components in writing within the warranty period, and**

**2) The defective product or part is returned to Pulse Specialty Components with transportation charges prepaid by Buyer, and**

**3) Pulse Specialty Components examination of such product shall disclose to its satisfaction that said defect exists and has not been caused by misuse, neglect, improper installation, repair or alteration, or accident.**

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