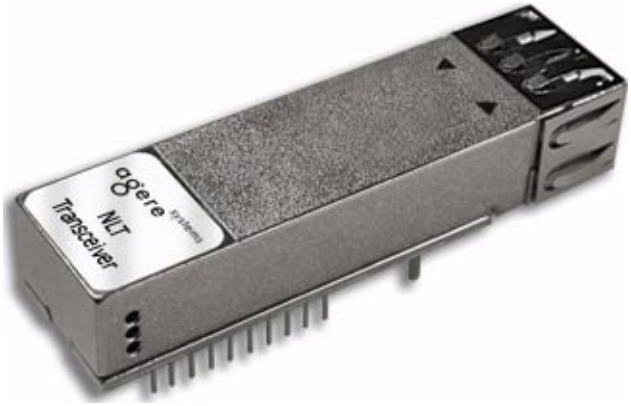
agere systems

Data Sheet
April 2002

# *Netlight*® NLT25-15-RA 2.5 Gbits/s 1310 nm Laser Transceiver with CDR for Intermediate Reach




**Available in a small form-factor, metal package with LC receptacle connector, the NLT25-15-RA transceiver is a high-performance, cost-effective, optical transceiver for SONET/SDH applications.**

## Features

- Multisource agreement compliant SFF package
- LC duplex receptacle
- Metal package for superior EMI performance
- Uncooled 1310 nm laser transmitter with automatic output power control
- Transmitter disable input
- Wide dynamic range receiver with InGaAs PIN photo detector
- Recovered clock outputs
- LVTTL signal detect output
- Low power dissipation
- Single 3.3 V power supply
- ac-coupled LVPECL/CML compatible data inputs and CML compatible data outputs
- Operating temperature range of –40 °C to +85 °C
- Telecom reliability (GR-468-CORE RT)
- Wave solderable and aqueous wash compatible

## Applications

- SONET OC-48 IR-1, SDH S-16.1 applications

## Description

The NLT25-15-RA transceiver is a high-speed, cost-effective optical transceiver that is intended for 2.488 Gbits/s shelf-to-shelf optical interconnect applications, as well as SONET OC-48 IR-1 and SDH S-16.1 applications. The transceiver features the Agere Systems' optics and is packaged in a narrow-width metal housing with an LC-duplex receptacle. The 20-pin package pinout conforms to a multisource transceiver agreement.

The transmitter features the ability to interface to both LVPECL and CML differential logic level data inputs via ac-coupled inputs. The transmitter also features a LVTTL logic level disable input and laser bias and backfacet monitor outputs. The receiver features ac- coupled differential CML logic level data outputs, an LVTTL logic level signal-detect output, and direct access to the PIN-photodetector bias input for photocurrent monitoring purposes.

## Absolute Maximum Ratings

Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. These are absolute stress ratings only. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operations sections of the data sheet. Exposure to absolute maximum ratings for extended periods can adversely affect device reliability.

**Table 1. Absolute Maximum Ratings**

| Parameter | Symbol | Min | Max | Unit |
|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | 0 | 5 | V |
| Operating Case Temperature Range | $T_C$ | –40 | 85 | °C |
| Storage Temperature Range | $T_S$ | –40 | 85 | °C |
| Lead Soldering Temperature/Time | — | — | 256/10 | °C/s |
| Operating Wavelength Range | λ | 1.2 | 1.6 | µm |

## Pin Information

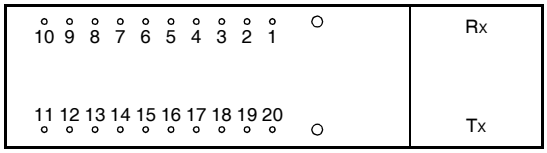



**Figure 1. Top View of the NLT25-15-RA Transceiver, 20-Pin Configuration**

**Table 2. Receiver Pin Descriptions**

| Pin # | Symbol | Functional Description | Logic Family |
|---|---|---|---|
| MS | MS | **Mounting Studs.** The mounting studs are provided for transceiver mechanical attachment to the circuit board. The mounting studs must be connected to the equipment chassis ground. | NA |
| 1 | $V_{PD}$ | **Photodetector Bias Input**. This lead supplies bias for the PIN photodetector diode. | NA |
| 2 | $V_{EER}$ | **Receiver Signal Ground.** | NA |
| 3 | $V_{EER}$ | **Receiver Signal Ground.** | NA |
| 4 | CLK– | **Received Recovered $\overline{\text{Clock}}$ Out.** The rising edge occurs at the rising edge of the received data output. The falling edge occurs in the middle of the received data baud period. | NA |
| 5 | NIC | **Received Recovered Clock Out.** The falling edge occurs at the rising edge of the received data output. The rising edge occurs in the middle of the received data baud period. | NA |
| 6 | $V_{EER}$ | **Receiver Signal Ground.** | NA |
| 7 | $V_{CCR}$ | **Receiver Power Supply.** | NA |
| 8 | SD | **Signal Detect.**<br>Normal operation: logic one output.<br>Fault condition: logic zero output. | LVTTL |
| 9 | RD– | **Received $\overline{\text{Data}}$ Out.** | ac-coupled CML |
| 10 | RD+ | **Received Data Out.** | ac-coupled CML |

## Pin Information (continued)

**Table 3. Transmitter Pin Descriptions** (continued)

| Pin # | Symbol | Functional Description | Logic Family |
|---|---|---|---|
| 11 | VCCT | **Transmitter Power Supply.** | NA |
| 12 | VEET | **Transmitter Signal Ground.** | NA |
| 13 | TDIS | **Transmitter Disable.** | LVTTL |
| 14 | TD+ | **Transmitter Data In.** An internal 50 Ω termination is provided consisting of a 100 Ω resistor between the TD+ and TD– pins. | ac-coupled PECL/CML |
| 15 | TD– | **Transmitter $\overline{\text{Data}}$ In**. See TD+ pin for terminations. | ac-coupled PECL/CML |
| 16 | VEET | **Transmitter Signal Ground.** | NA |
| 17 | BMON(–) | **Laser Diode Bias Current Monitor—Negative End.** Optional feature. If feature is not used, do not connect. The laser bias current is accessible as a dc voltage by measuring the voltage developed across pins 17 and 18. | NA |
| 18 | BMON(+) | **Laser Diode Bias Current Monitor—Positive End**. Optional feature. If feature is not used, do not connect. See pin 17 description. | NA |
| 19 | PMON(–) | **Laser Diode Optical Power Monitor—Negative End.** Optional feature. If feature not used do not connect. The backface diode monitor current is accessible as a voltage proportional to the photocurrent through a 200 Ω resistor between pins 19 and 20. | NA |
| 20 | PMON(+) | **Laser Diode Optical Power Monitor—Positive End.** Optional feature. If feature not used do not connect. See pin 19 description. | NA |

## Electrostatic Discharge

**Caution: This device is susceptible to damage as a result of electrostatic discharge (ESD). Take proper precautions during both handling and testing. Follow *EIA*® Standard *EIA*-625.**

Although protection circuitry is designed into the device, take proper precautions to avoid exposure to ESD.

Agere Systems employs a human-body model (HBM) for ESD susceptibility testing and protection-design evaluation. ESD voltage thresholds are dependent on the critical parameters used to define the model. A standard HBM (resistance = 1.5 kΩ, capacitance = 100 pF) is widely used and, therefore, can be used for comparison purposes. The HBM ESD threshold established for the NLT25-15-RA is ±1000 V.

## Application Information

The NLT receiver section is a highly sensitive fiber-optic receiver. Although the data outputs are digital logic levels (CML), the device should be thought of as an analog component. When laying out system application boards, the NLT transceiver should receive the same type of consideration one would give to a sensitive analog component.

### Printed-Wiring Board Layout Considerations

A fiber-optic receiver employs a very high gain, wide-bandwidth transimpedance amplifier. This amplifier detects and amplifies signals that are only tens of nA in amplitude when the receiver is operating near its sensitivity limit. Any unwanted signal currents that couple into the receiver circuitry cause a decrease in the receiver's sensitivity and can also degrade the performance of the receiver's signal detect (SD) circuit.

## Application Information (continued)

### Printed-Wiring Board Layout Considerations (continued)

To minimize the coupling of unwanted noise into the receiver, careful attention must be given to the printed-wiring board.

At a minimum, a double-sided printed-wiring board (PWB) with a large component-side ground plane beneath the transceiver must be used. In applications that include many other high-speed devices, a multilayer PWB is highly recommended. This permits the placement of power and ground on separate layers, which allows them to be isolated from the signal lines.

Multilayer construction also permits the routing of sensitive signal traces away from high-level, high-speed signal lines. To minimize the possibility of coupling noise into the receiver section, high-level, high-speed signals such as transmitter inputs and clock lines should be routed as far away as possible from the receiver pins.

Noise that couples into the receiver through the power supply pins can also degrade performance. It is recommended that the pi filter, shown in Figure 4, be used for both the transmitter and receiver power supplies.

### Data and Signal Detect Outputs

Due to the high switching speeds of CML outputs, transmission line design must be used to interconnect components. To ensure optimum signal fidelity, both data and clock outputs should be terminated identically. The signal lines connecting the data outputs to the next device should be equal in length and have matched impedances. Controlled-impedance stripline or microstrip construction must be used to preserve the quality of the signal into the next component and to minimize reflections back into the receiver, which could degrade its performance. Excessive ringing due to reflections caused by improperly terminated signal lines makes it difficult for the component receiving these signals to decipher the proper logic levels and can cause transitions to occur where none were intended. Also, by minimizing high-frequency ringing, possible EMI problems can be avoided.

The signal-detect output is positive LVTTL logic. A logic low at this output indicates that the optical signal into the receiver has been interrupted or that the light level has fallen below the minimum signal detect threshold. This output should not be used as an error rate indicator since its switching threshold is determined only by the magnitude of the incoming optical signal.

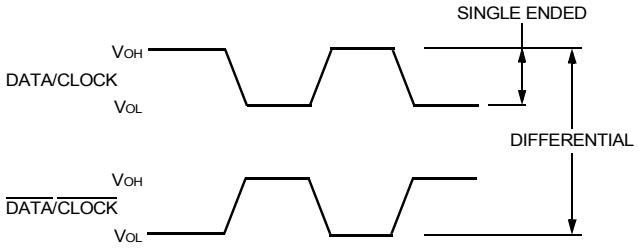



**Figure 2. Data and Clock Output Logic Level Definitions**

### Transceiver Processing

When the process plug is placed in the transceiver's optical port, the transceiver and plug can withstand normal wave soldering and aqueous spray cleaning processes. However, the transceiver is not hermetic, and should not be subjected to immersion in cleaning solvents. The transceiver case should not be exposed to temperatures in excess of 125 °C. The transceiver pins can be wave soldered at 260 °C for up to 10 seconds. The process plug should only be used once. After removing the process plug from the transceiver, it must not be used again as a process plug; however, if it has not been contaminated, it can be reused as a dust cover.

## Transceiver Optical and Electrical Characteristics

**Table 4. Transmitter Optical and Electrical Characteristics** ($T_C$ = –40 °C to +85 °C, $V_{CC}$ = 3.135 V—3.465 V. All parameters must meet the specifications over the entire lifetime.)

| Parameter | Symbol | Min | Max | Unit |
|---|---|---|---|---|
| Average Optical Output Power | $P_O$ | –5 | 0 | dBm |
| Optical Wavelength | $\lambda c$ | 1266 | 1360 | nm |
| Spectral Width | $\Delta\lambda_{-20}$ | — | 1 | nm |
| Side-mode Suppression Ratio | SMSR | 30 | — | dB |
| Dynamic Extinction Ratio | EXT | 8.2 | — | dB |
| Output Optical Eye | Compliant with SONET GR-253-CORE and ITU-T G.957 Eye Mask Requirements | | | |
| Power Supply Current | $I_{CCT}$ | — | 150 | mA |
| Input Data Voltage—Single Ended[1]<br>Input Data Voltage—Differential[1] | $V_{INp-p}$<br>$V_{INp-p}$ | 150<br>300 | 800<br>1600 | mVp-p<br>mVp-p |
| Transmit Disable Voltage[2] | $V_D$ | Vcc – 0.9 | Vcc | V |
| Transmit Enable Voltage[2] | $V_{EN}$ | $V_{EE}$ | $V_{EE}$ + 0.8 | V |
| Laser Bias Voltage | $V_{BIAS}$ | 0.0 | 0.7 | V |
| Laser Backfacet Monitor Voltage | $V_{BF}$ | 0.01 | 0.2 | V |

1. 50 Ω load, measured single ended. Differential operation is necessary for optimum performance. (See Figure 2 for a visual representation.)
2. TTL compatible interface.

## Transceiver Optical and Electrical Characteristics (continued)

**Table 5. Receiver Optical and Electrical Characteristics** ($T_C$ = –40 °C to +85 °C, $V_{CC}$ = 3.135 V—3.465 V)

| Parameter | Symbol | Min | Max | Unit |
|---|---|---|---|---|
| Average Sensitivity[1] | $P_I$ | — | –18 | dBm |
| Maximum Input Power[1] | $P_{MAX}$ | 0 | — | dBm |
| Power Supply Current | $I_{CCR}$ | — | 200 | mA |
| Output Data /Clock Voltage—Single Ended[2]<br>Output Data/Clock Voltage—Differential[2] | $V_{OUT}$p-p<br>$V_{OUT}$p-p | 300<br>600 | 500<br>1000 | mVp-p<br>mVp-p |
| Clock Duty Cycle | dc | 45 | 55 | % |
| Output Clock Random Jitter | $J_C$ | — | 0.01 | UI |
| Output Clock Random Jitter Peaking | $J_P$ | — | 0.1 | UI |
| Clock/Data Alignment[3] | $T_{CDA}$ | –40 | 40 | ps |
| Jitter Tolerance/Jitter Transfer | *Telcordia Technologies*™ GR-253-Core and ITU-TG.958 Compliant | | | |
| Signal-detect Switching Threshold<br>Assert<br>Deassert | <br>LSTD<br>LSTI | <br>–45<br>–45 | <br>–19.0<br>–18.5 | <br>dBm<br>dBm |
| Signal-detect Hysteresis | HYS | 0.5 | 6 | dB |
| Signal-detect Voltage[4]<br>Low<br>High | <br>$V_{OL}$<br>$V_{OH}$ | <br>0.0<br>2.4 | <br>0.8<br>$V_{CC}$ | <br>V<br>V |
| Signal-detect Response Time | SDRT | — | 100 | µs |
| Reflectance | — | — | –27 | dB |

1. $2^{23} – 1$ PRBS with a BER of $1 \times 10^{-10}$.
2. 50 Ω load, measured single ended. Differential operation is necessary for optimum performance. (See Figure 2 for a visual representation.)
3. See Figure 3.
4. TTL compatible interface.

## Transceiver Optical and Electrical Characteristics (continued)

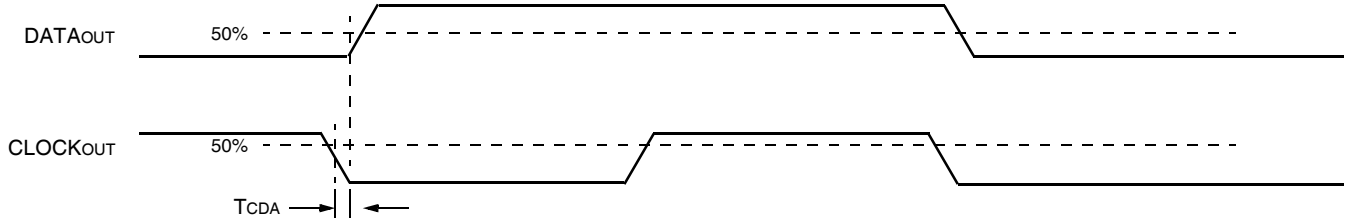



**Figure 3. Clock/Data Alignment**

## Qualification and Reliability

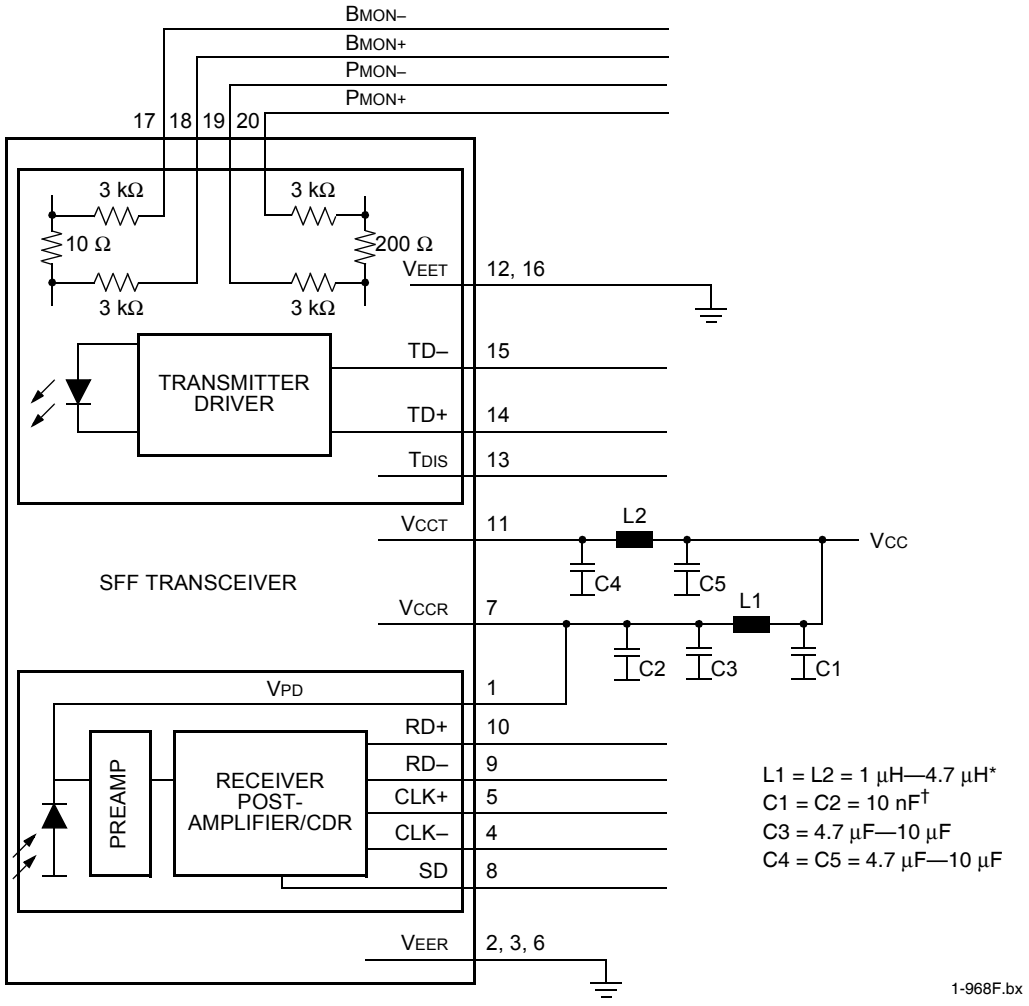
To help ensure high product reliability and customer satisfaction, Agere Systems is committed to an intensive quality program that starts in the design phase and proceeds through the manufacturing process. Optoelectronic modules are qualified to ITU GR-468-CORE remote terminal standards, using sampling techniques consistent with *Telcordia Technologies* requirements.

In addition, Agere Systems design, development, and manufacturing facilities have been certified to be in full compliance with the latest *ISO*®-9001 Quality System Standards.

**Table 6. Regulatory Compliance**

| Feature | Test Method | Performance |
|---|---|---|
| Laser Eye Safety | U.S. 21 CFR (J) 1040.10 and 1040.11; *IEC*® 60825-1 1988, *IEC* 60825-2 1997 | CDRH compliant and Class 1 laser safe. |
| Electrostatic Discharge (ESD) to Electrical Pins | MIL-STD 883C, Method 3015.4 | Class 1 (>1000 V) |
| Electrostatic Discharge (ESD) to Optical Connector | *IEC* 61000-4-2; 1999 | Withstand discharges of 15 kV using an air-discharge probe |
| Electromagnetic Interference (EMI) | FCC Part 15 Subpart J Class B, CISPR 22: 1997; EN 55022: 1998 Class B, VCCI Class I | Compliant with standards. |
| Immunity | *IEC* 61000-4-3-1998 | Less than 1 dB change in receiver sensitivity with field strength of 3 V/m RMS, from 10 MHz to 1 GHz. |
| Component | *UL*® 1950, CSA C22.2 #950, *IEC* 60950: 1999 | — |
| Flammability | *UL* 94 V-0 | — |

## Electrical Schematic

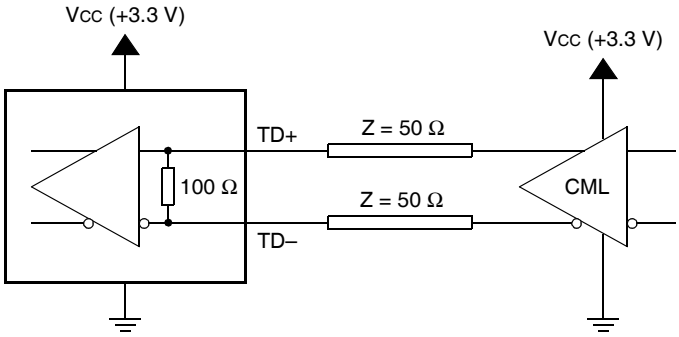



* Ferrite beads can be used as an option.
† For all capacitors, MLC caps are recommended.

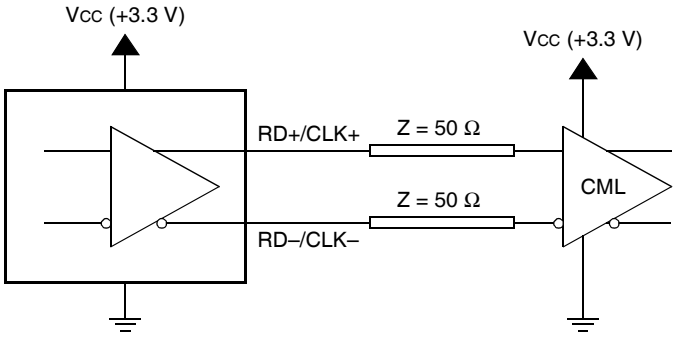
**Figure 4. Power Supply Filtering for the Small Form Factor Transceiver**

## Application Schematics

### Electrical Data Interface—Current Mode Logic (CML)




(A) TRANSMITTER INTERFACE—dc COUPLED—(CML)



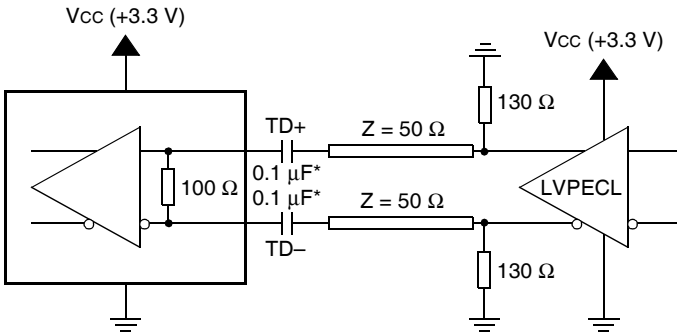

(B) RECEIVER INTERFACE—dc COUPLED—(CML)

1-1033F.e

**Figure 5. 3.3 V Transceiver Interface with 3.3 V ICs and CML**

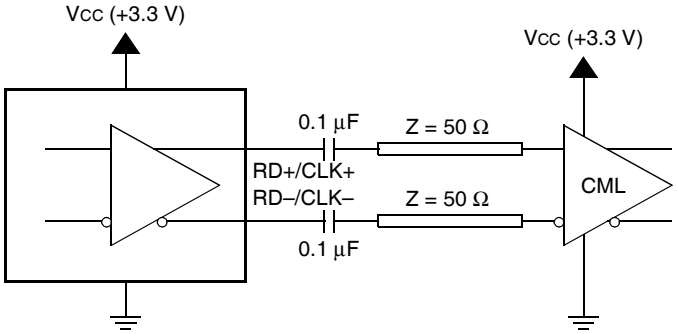
## Application Schematics (continued)

### Alternate Electrical Data Interface Options




* Optional ac-coupling capacitors; use ceramic X7R or equivalent.

(A) TRANSMITTER INTERFACE—ac OR dc COUPLED—(LVPECL)




(B) RECEIVER INTERFACE—ac COUPLED—(CML)

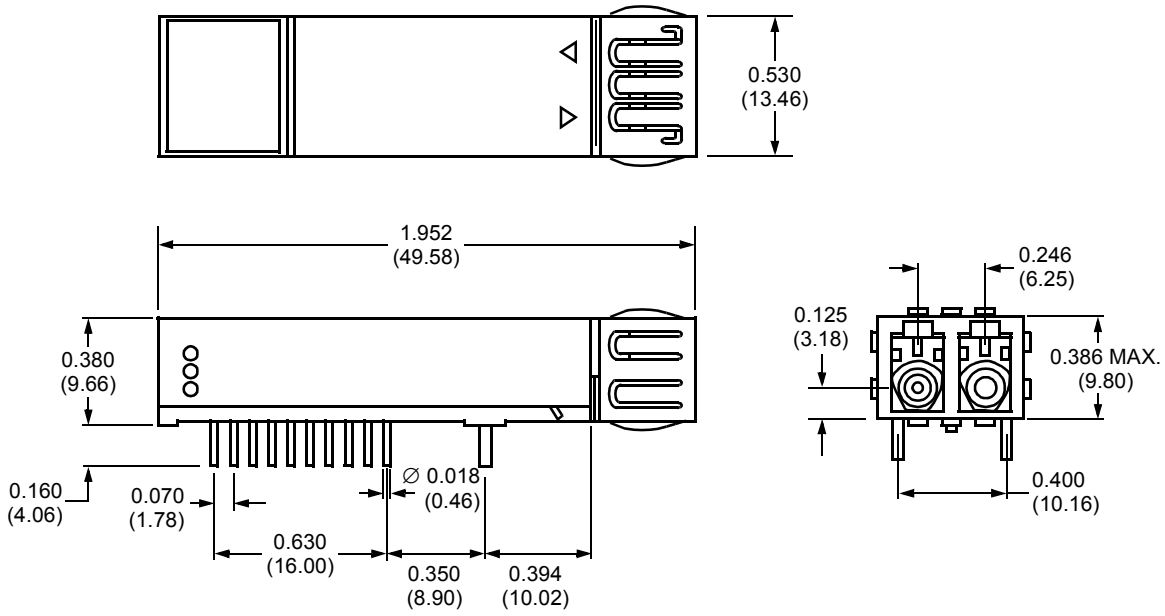
1-1033F.e

**Figure 6. 3.3 V Transceiver Interface with 3.3 V ICs**

## Outline Diagrams

### Package Outline

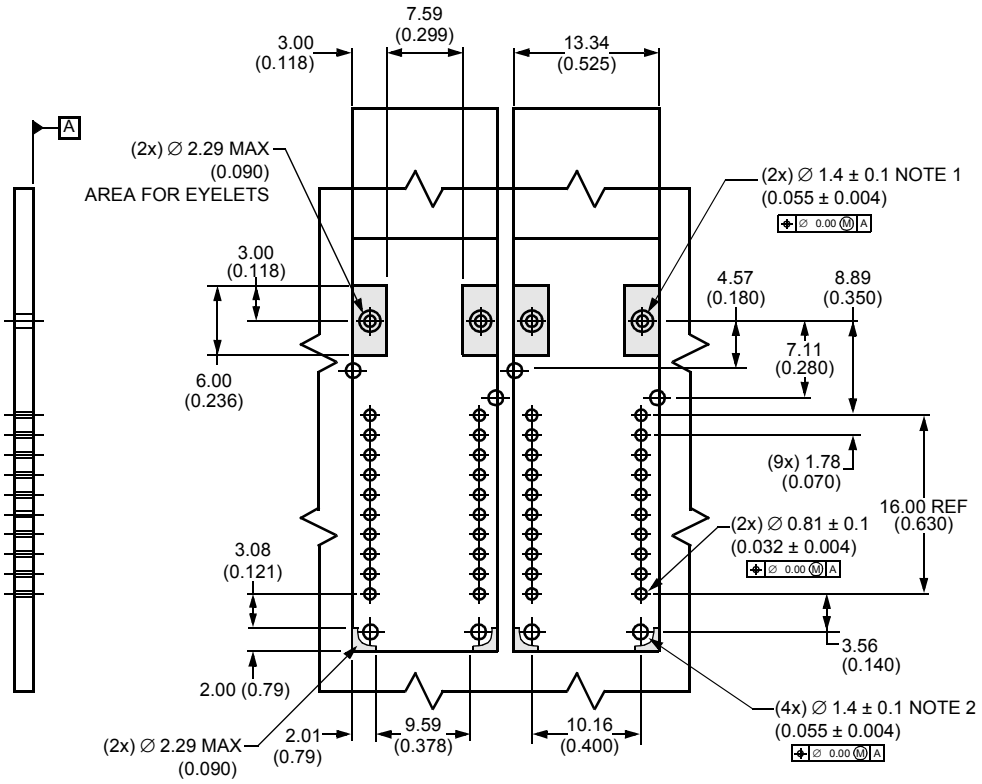
Dimensions are in inches and (millimeters).



## Outline Diagrams (continued)

### Printed-Wiring Board Layout

Dimensions are in inches and (millimeters).

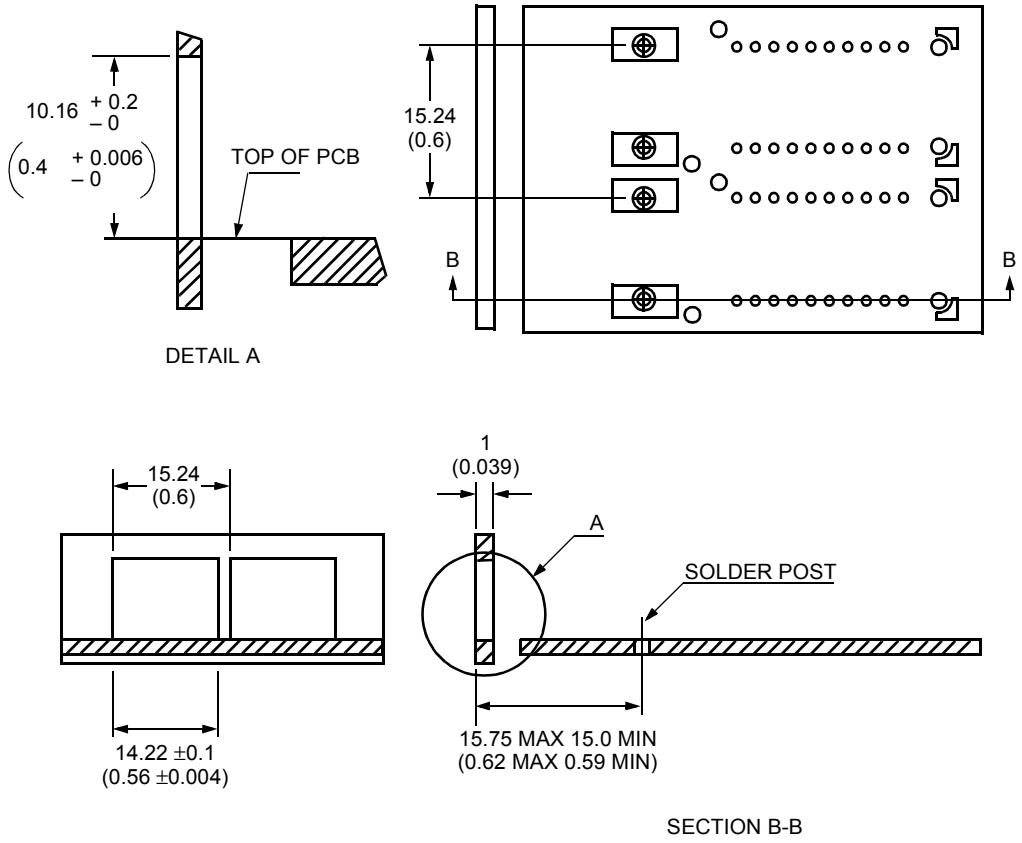



Notes:
1. Holes for mounting studs must be tied to chassis ground.
2. Holes for housing leads must be tied to signal ground.

1-1271(F)

## Recommended Panel Opening

Dimensions in millimeters and (inches).



# Laser Safety Information

## Class I Laser Product

All versions of the transceiver are Class I laser products per CDRH, 21 CFR 1040 Laser Safety requirements. All versions are Class I laser products per *IEC* 60825-1:1993.

**CAUTION: Use of controls, adjustments, and procedures other than those specified herein may result in hazardous laser radiation exposure.**

This product complies with 21 CFR 1040.10 and 1040.11.

Wavelength = 1310 nm

Maximum power = 1.58 mW

Product is not shipped with power supply.

**NOTICE**

**Unterminated optical connectors may emit laser radiation.**

**Do not view with optical instruments.**

# Ordering Information

**Table 7. Ordering Information**

| Description | Device Code | Comcode |
|---|---|---|
| 2 x 10 Singlemode SFF LC receptacle transceiver with clock recovery for 2.488 Gbits/s intermediate reach applications | NLT25-15-RA | 700010602 |



For additional information, contact your Agere Systems Account Manager or the following:
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April 2002
DS02-163METR