

TLK2500 Serdes EVM Kit Setup and Usage

User's Guide

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Read This First

About This Manual

This manual should be used to determine how to setup and use the TLK2500 evaluation module in order to evaluate the TLK2500 device.

How to Use This Manual

This document contains the following chapters:

- ☐ Chapter 1 — Introduction
- ☐ Chapter 2 — TLK2500 EVM Board Configuration
- ☐ Chapter 3 — PCB Construction and Characteristics
- ☐ Appendix A — Schematics, Board Layouts, and Suggested Optics and Cable Assembly Specifications
- ☐ Appendix B — NetLight™ 1417K4A 1300 nm Laser 2.5 Gbits/s SpeedBlaster™ Transceiver data sheet

Notational Conventions

This document uses the following conventions.

- ☐ Program listings, program examples, and interactive displays are shown in a special typeface similar to a typewriter's. Examples use a **bold version** of the special typeface for emphasis; interactive displays use a **bold version** of the special typeface to distinguish commands that you enter from items that the system displays (such as prompts, command output, error messages, etc.).

Here is a sample program listing:

```
0011 0005 0001      .field    1, 2
0012 0005 0003      .field    3, 4
0013 0005 0006      .field    6, 3
0014 0006           .even
```

Here is an example of a system prompt and a command that you might enter:

```
C:  csr -a /user/ti/simuboard/utilities
```

- In syntax descriptions, the instruction, command, or directive is in a **bold typeface** font and parameters are in an *italic typeface*. Portions of a syntax that are in **bold** should be entered as shown; portions of a syntax that are in *italics* describe the type of information that should be entered. Here is an example of a directive syntax:

.asect *"section name", address*

.asect is the directive. This directive has two parameters, indicated by *section name* and *address*. When you use *.asect*, the first parameter must be an actual section name, enclosed in double quotes; the second parameter must be an address.

- Square brackets (**[** and **]**) identify an optional parameter. If you use an optional parameter, you specify the information within the brackets; you don't enter the brackets themselves. Here's an example of an instruction that has an optional parameter:

LALK *16-bit constant [, shift]*

The LALK instruction has two parameters. The first parameter, *16-bit constant*, is required. The second parameter, *shift*, is optional. As this syntax shows, if you use the optional second parameter, you must precede it with a comma.

Square brackets are also used as part of the pathname specification for VMS pathnames; in this case, the brackets are actually part of the pathname (they are not optional).

- Braces (**{** and **}**) indicate a list. The symbol **|** (read as *or*) separates items within the list. Here's an example of a list:

{ *** | **+* | **-* }

This provides three choices: ***, **+*, or **-*.

Unless the list is enclosed in square brackets, you must choose one item from the list.

- Some directives can have a varying number of parameters. For example, the *.byte* directive can have up to 100 parameters. The syntax for this directive is:

.byte *value₁ [, ... , value_n]*

This syntax shows that *.byte* must have at least one value parameter, but you have the option of supplying additional value parameters, separated by commas.

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Introduction

The Texas Instruments (TI) TLK2500 serdes evaluation module (EVM) board is used to evaluate the TLK2500 device(VQFP) and associated optical interface (NetLight™) for point-to-point data transmission applications.

The board enables the designer to connect 50-Ω parallel buses to both transmitter and receiver connectors. The TLK2500, using high speed PLL technology, serializes, encodes (8b/10b), and transmits data along one differential pair. The receiver part of the device deserializes, decodes and presents data on the parallel bus. The high speed (up to 2.5 Gbps) data lines interface to four 50-Ω controlled-impedance SMA connectors. The designer can either use this copper interface directly or loop back to the laser module section for an optical interface(not provided).

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1.1 Introduction

The board can be used to evaluate device parameters while acting as a guide for high-speed board layout. The evaluation board can be used as daughter boards that are plugged into new or existing designs. Since the TLK2500 operates over a wide range of frequencies, the designer will need to optimize his or her design for the frequency of interest. Additionally, the designer may wish to use buried transmission lines and provide additional noise attenuation and EMI suppression to optimize their end product.

As the frequency of operation increases, the board designer must take special care to ensure that the highest signal integrity is maintained. To achieve this, the board's impedance is controlled to 50 Ω for both the high-speed differential serial and parallel data connections. In addition, impedance mismatches are reduced by designing the component pad size to be as close as possible to the width of the connecting transmission lines. Vias are minimized and, when necessary, placed as close as possible to the device drivers. Since the board contains both serial and parallel transmission lines, care was taken to control both impedance and trace length mismatch (board skew).

Overall, the board layout is designed and optimized to support high-speed operation. Thus, understanding impedance control and transmission line effects are crucial when designing high-speed boards.

Some of the advanced features offered by this board include:

- ☐ PCB (printed-circuit board) is designed for high-speed signal integrity.
- ☐ Flexibility—The PCB can be configured for copper or optical interfaces.
- ☐ SMA and parallel fixtures are easily connected to test equipment.
- ☐ All input/output signals are accessible for rapid prototyping.
- ☐ Analog and digital power planes can be supplied through separate banana jacks for isolation or can be combined using ferrite bridging networks.
- ☐ Series termination resistors provide parallel RD outputs.
- ☐ Onboard capacitors provide ac coupling of high-speed signals.

1.2 TLK2500 EVM Kit Contents

- ☐ TLK2500 EVM board
- ☐ TLK2500 EVM kit documentation (This document)

TLK2500 EVM Board Configuration

The TLK2500 EVM board gives the developer various options for operation, many of which are jumper selectable. Other options can be either soldered into the EVM or connected through input connectors.

The TX and RX parallel connectors, J1–J4 of Figures 8 and 10 in Appendix A, provide a connection for both transmitted and received data. The reference clock is supplied through the SMA connector J8, and jumper J5 must be installed between pins 1 and 2. A direct clock connection can also be made to J5 pins 1 and 3. The high-speed serial data is transmitted through the J13 and J14 SMA connectors. The received recovered clock (RX_CLK) is output through J15 header. Received data connects through SMA connectors J17 and J23 on the RX side of the board. Header J7 provides static signals (normally pulled high) to configure the device for different modes of operation. The J20 header indicates the optical transmitter has detected a signal and J21 allows the operator to disable the optical transceiver.

The power planes are split three ways to provide power for different parts of the board. This prevents coupling of switching noise between the analog and digital sections of the TLK2500 and provides voltage isolation for the laser section. The laser section of the board requires 3.3 volts and is energized through the VCC connector. The VDD and VDDA connectors require 2.5 volts and are joined together by a removable ferrite bead L3 that is installed in the default configuration. Thus, only the VDD connection is necessary to energize the TLK2500 device in the default configuration. In all sections of the board, the ground planes are common and each ground plane is tied together at every component ground connection. For a detailed schematic and layout see *TLK2500EVM Schematic*, *Optical Transceiver Schematic* and *Board Layer Stack-up* in Appendix A.

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The board is normally delivered in a default configuration that requires external clock and data inputs. The TLK2500 is shipped with jumpers for default operation. Table 2–1 shows the default configuration for sending data.

Table 2–1. Default Transceiver Board Configuration as Shipped

| Designator | Function | Condition |
|------------|---------------------------|--|
| J5 | GTX CLK SEL | Jumper installed – Provides a method of supplying a input clock to the board |
| J7 | TESTEN | Jumper installed (Logic 0) Disables the TLK2500 test mode |
| J7 | PRBSEN | Jumper installed (Logic 0) Disables the TLK2500 PRBS internal production test mode |
| J7 | LCKREFN | Jumper not installed (Logical 1) Locks to received clock |
| J7 | ENABLE | Jumper not installed (Logical 1) Enables the device for normal operation |
| J7 | TXER | Jumper installed (Logic 0) Puts the TLK2500 in a state to transmit TX bus data. |
| J7 | LOOPEN | Jumper installed (Logic 0) Disables the TLK2500 internal loop back mode |
| J7 | TXEN | Jumper not installed (Logical 1) Puts the TLK2500 in a state to transmit TX bus data. |
| L3 | VDD– bridge –VDDA | Joins VDD and VDDA power planes |
| C24, C25 | TX ac coupling capacitors | These capacitors (normally installed) are provided to ac couple the transmitted signal. |
| C22, C23 | RX ac coupling capacitors | These capacitors (normally installed) are provided to ac couple the received signal |

Note: For details, see TLK2500 data sheet

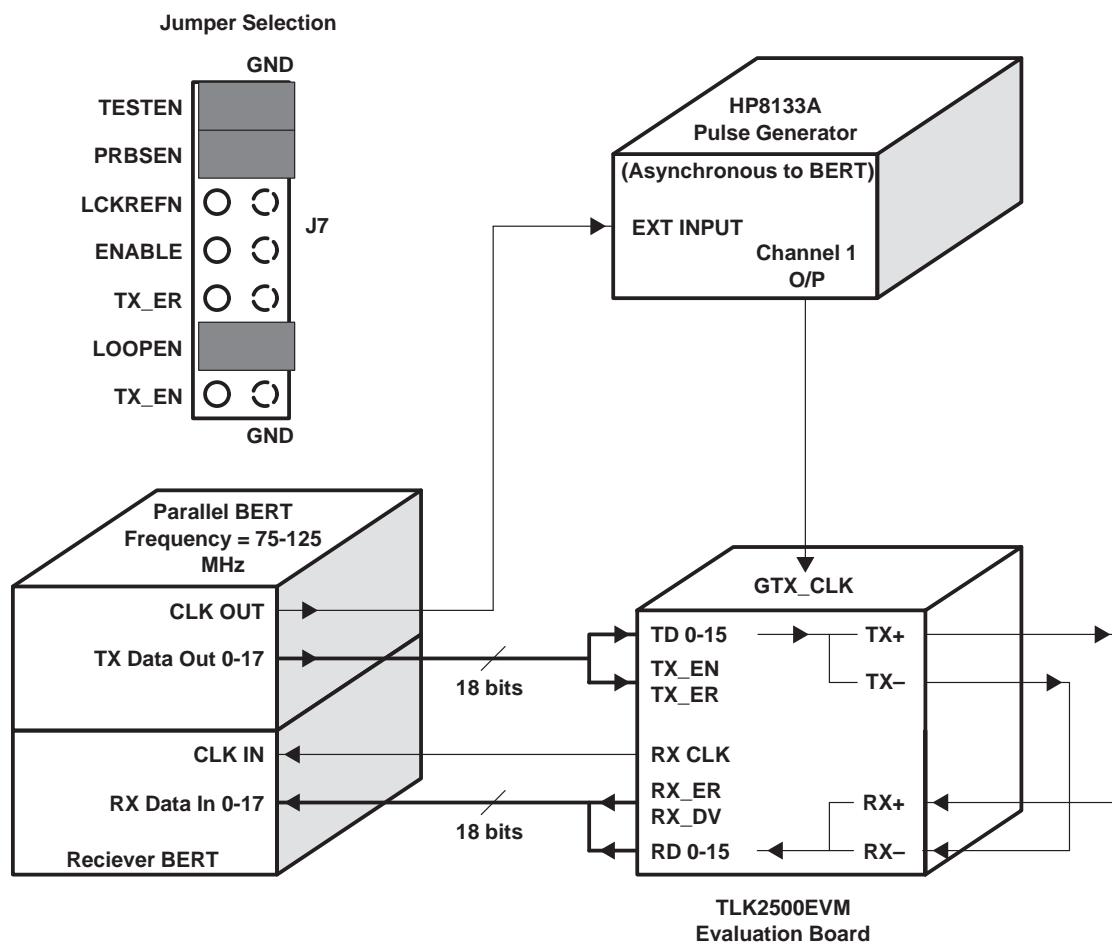
Table 2–2. Configuration Changes Necessary for DC Coupling of the High Speed Signals

| Designator | Function | Condition or Changes Necessary for DC Coupling |
|------------|---------------------------|---|
| C24, C25 | TX ac coupling capacitors | Install zero ohm resistors |
| C22, C23 | TX ac coupling capacitors | Install zero ohm resistors. |
| R34 | RX bias resistor | Install zero ohm resistor. |
| R33 | RX bias resistor | Uninstall resistor (open circuit) |
| R37, R38 | TX termination network | Uninstall resistors (open circuit) – Termination and pullup is achieved at the receiver. Differential swing is increased. |

2.1 Typical Test and Setup Configurations

The following configurations are used to evaluate and test the TLK2500 transceiver. The first configuration is a serial loopback of the high-speed signals shown in Figure 2–1. The serial loopback allows the designer to evaluate most of the functions of both transmitter and receiver sections of the TLK2500 device. To test a system, a parallel bit error rate tester (BERT) generates a predefined parallel bit pattern. The pattern is connected to the transmitter through parallel connectors TD0–TD15. Additionally, two control pins TX_ER and TX_EN are configured by the BERT for valid data transmission (TX_ER low and TX_EN high). The TLK2500 device encodes, serializes, and presents the data on the high-speed serial pair. The serial TX data is then looped back to the receiver side and the device deserializes, decodes and presents the data on the receive side RD0–RD15. The data and indication bits (RX_DV and RX_ER) are received by the BERT and compared against the transmitted pattern and monitored for valid data and errors. If any bit errors are received, a bit error rate is evaluated at the parallel receive BERT.

Figure 2–1. TLK2500 Serial Loop-Back Test Configuration



If a parallel BERT is not available, the designer can take advantage of the built in test mode of the device, see Figure 2–2. If the designer asserts the PRBSEN pin high this results in a pseudo random bit pattern to be transmitted. This pin also puts the receiver in a mode to detect a valid PRBS pattern. A valid pattern is indicated by the PRBSPASS pin indicating high. This test only validates the high-speed serial portion of the device and system interconnects. The PRBS pattern is compatible with most serial BERT test equipment. This function allows the operator to isolate and test the transmitter and receiver independently. A typical configuration is shown in Figure 2–3. The dashed lines represent optional connections that can be made monitoring eye patterns and measuring jitter.

Figure 2–2. TLK2500 Serial Loop-Back Test Configuration

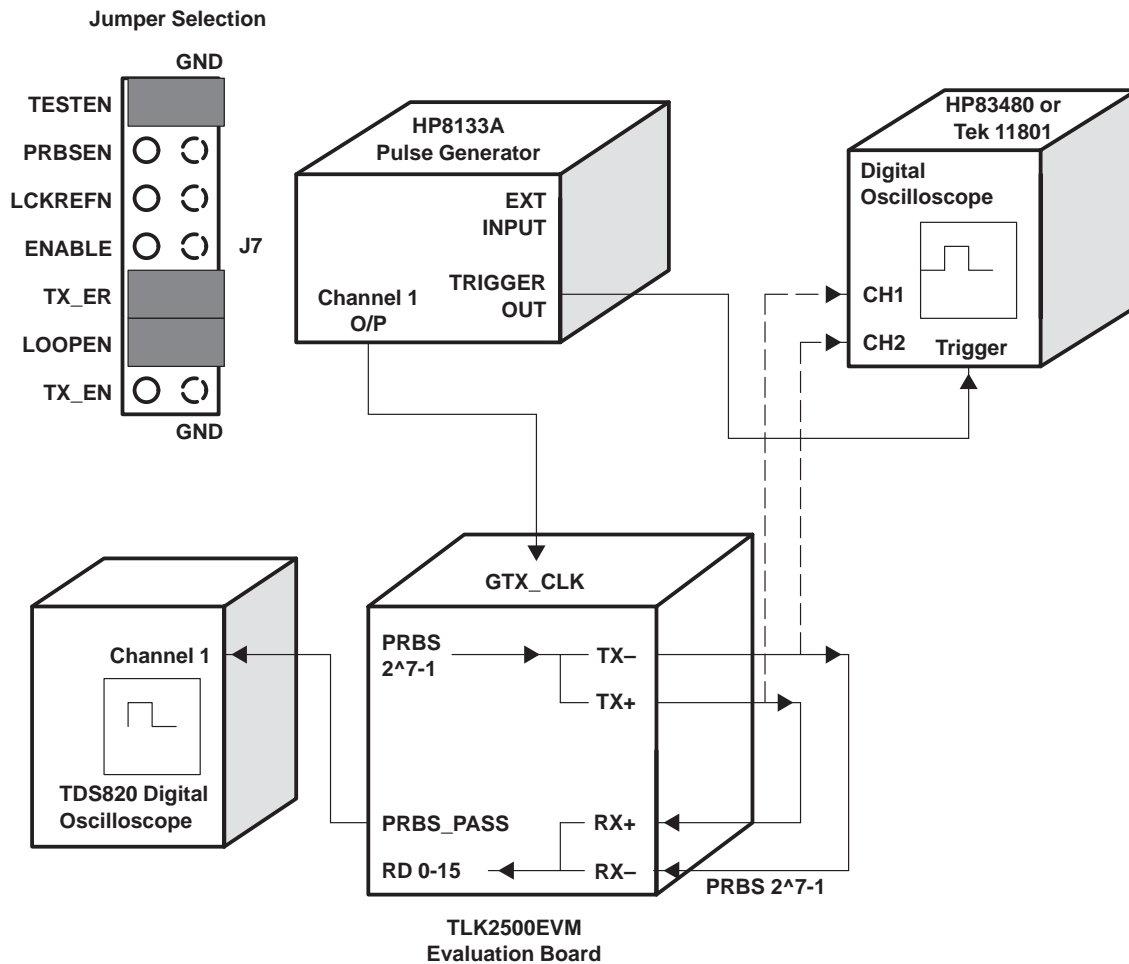
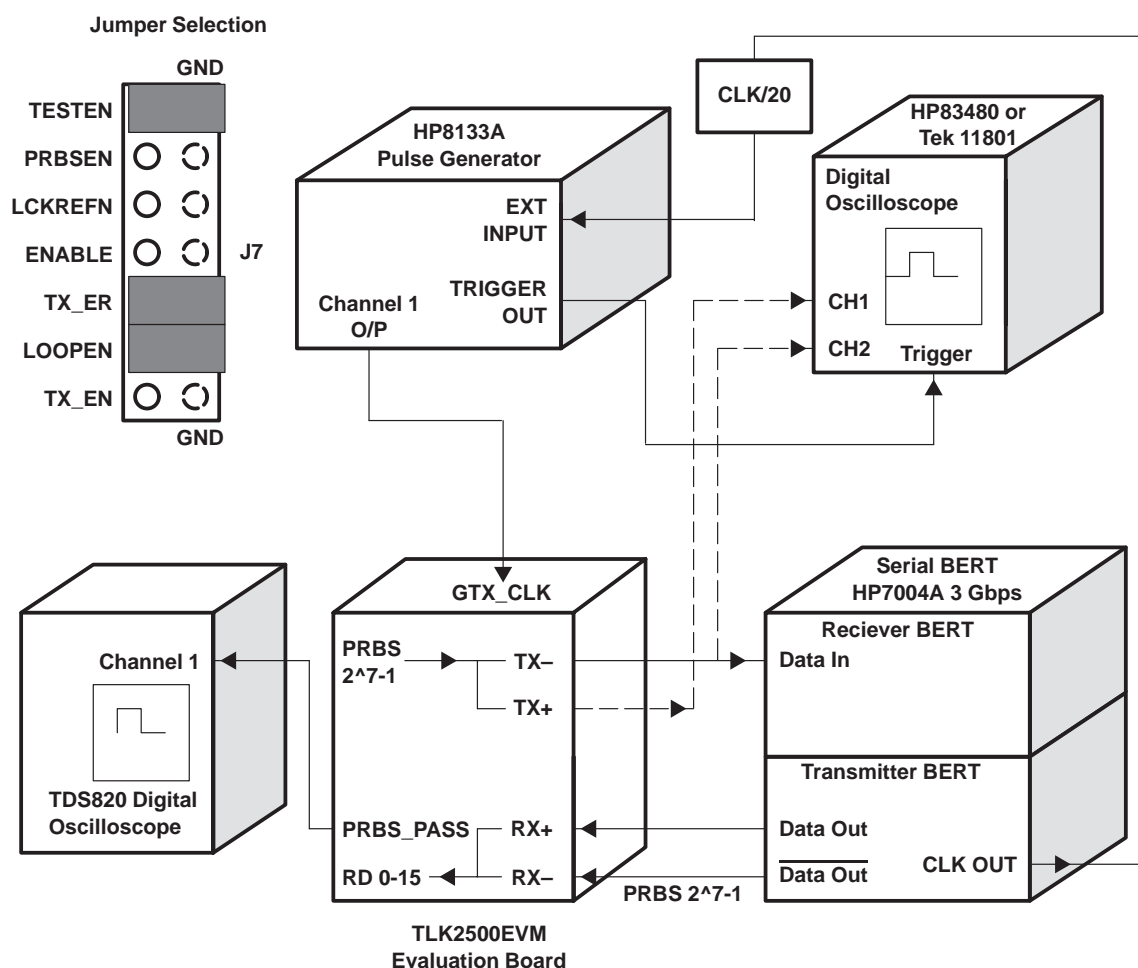
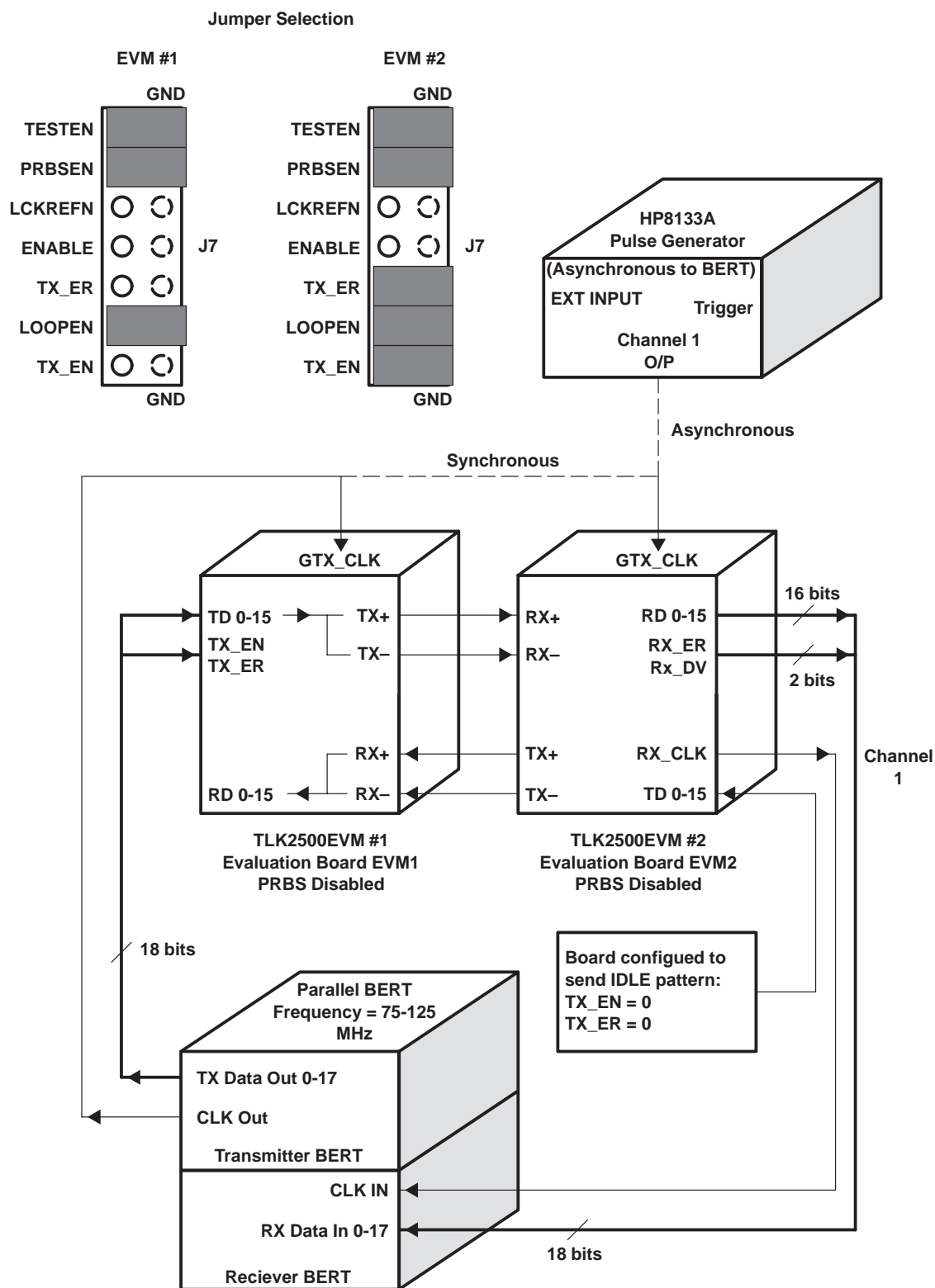


Figure 2–3. TLK2500 Serial PRBS BERT Test Configuration



A board-to-board communication link is a practical method of evaluating the TLK2500 in a system-like environment as shown in Figure 2–4. A Parallel BERT or a logic analyzer can be used to provide and monitor signals to and from the transceiver pairs. The BERT would need to configure the TX_ER and TX_EN signals for data transmission before any data is sent. On the receive side the RX_ER and RX_DV can monitor the device for errors. Both GTX_CLK sources must have the same frequency within 200 PPM for asynchronous operation. Synchronous operation can be achieved by using either the BERT or a synchronized pulse generator to supply both boards with GTX_CLK inputs.

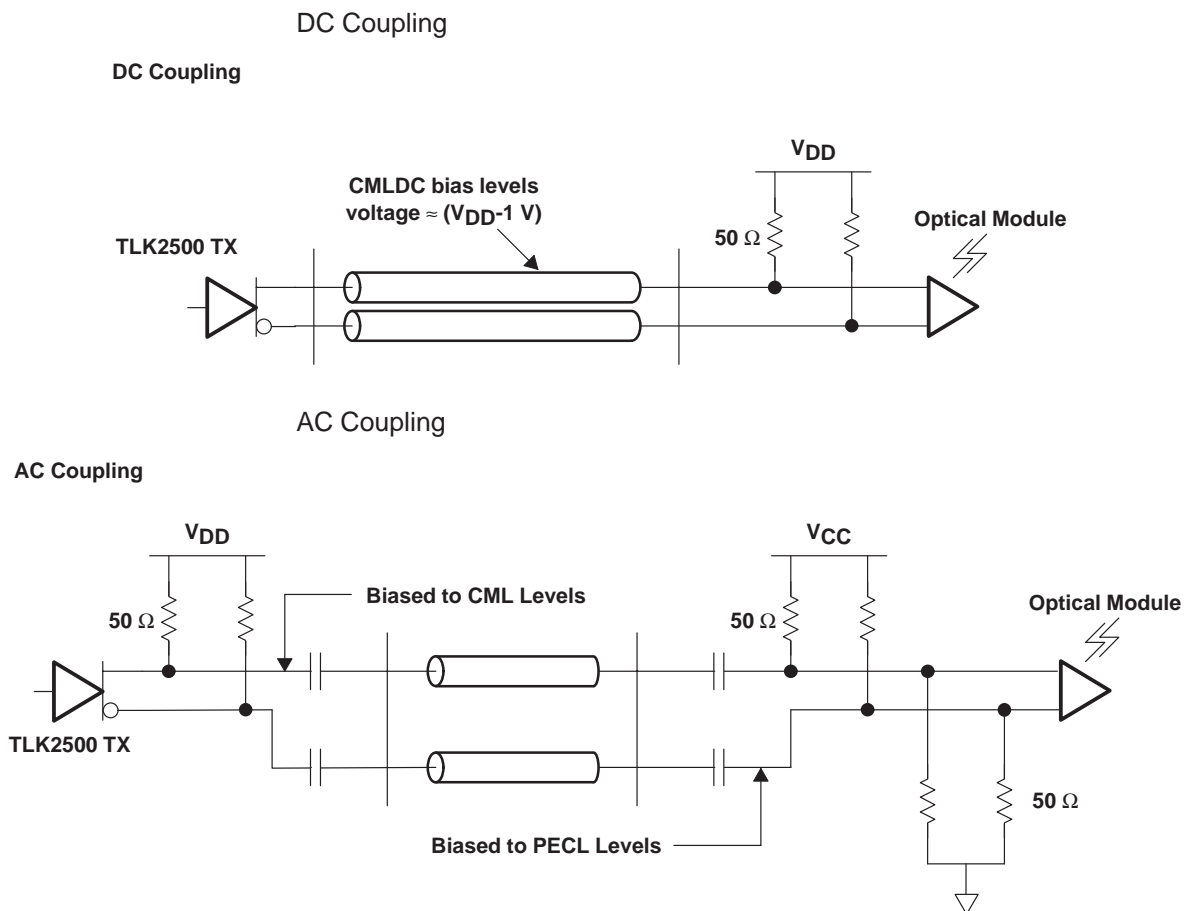
Figure 2–4. TLK2500 Serial PRBS BERT Test Configuration



2.2 Optical Interfacing and Configuration

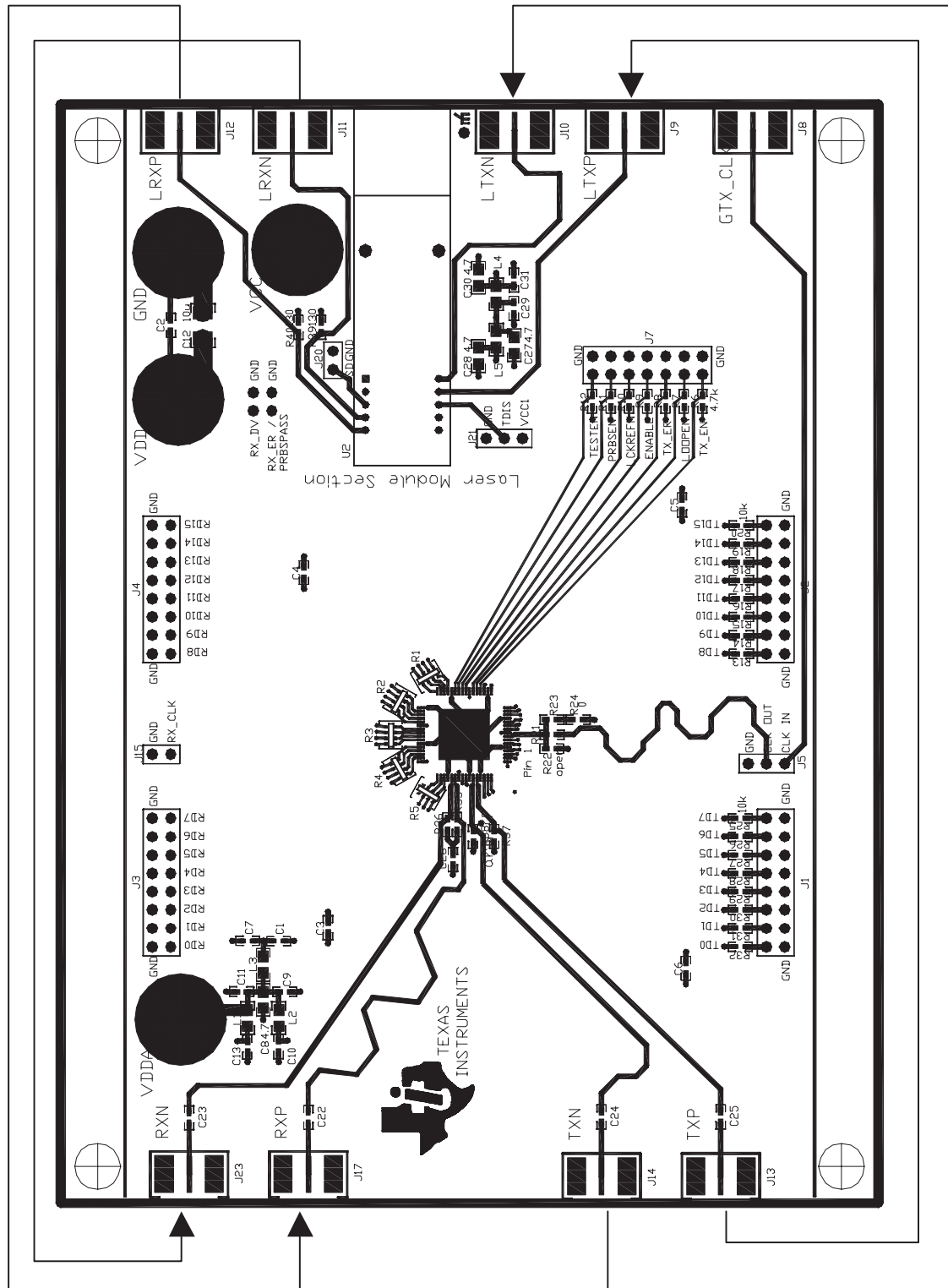
An interface between the TLK2500EVM and an optical transceiver can be achieved in many ways depending on the design of the optics module and its associated interface circuitry. Direct connection is achieved only if the optical interface supports the current mode logic levels of the TLK2500 device ($V_{DD} - 1$ V). If the optics module does not support or can not be biased to the CML levels then ac coupling must be used. Both ac and dc coupling schemes are shown in Figure 2–5. The *Laser Module Section* of the EVM is configured as an ac-coupled optics module. The board is shipped with an ac-coupled output and all that is required is external loopback cabling.

Figure 2–5. Optical Interface Configuration



The *Laser Module Section* is isolated from the rest of the board and requires external loopback as shown in Figure 2–6. This makes for a versatile system where the laser can be connected independently to other EVM systems.

Figure 2–6. TLK2500EVM to Laser Module Configuration



PCB Construction and Characteristics

The PCB characteristics are calculated and based on the layer construction and trace width of the board. This should be useful in determining the proper interface to the EVM and establishing system timing.

Table 3–1. TLK2500 EVM TTL Bus PCB Transmission Line Characteristics

| Device Pin No./Des. | Connector Pin Label | Trace Width (inches) | Length (inches) | Capacitance (pF) | Inductance (nH) | Impedance (Ω) | Line Delay (ps) |
|---------------------|---------------------|----------------------|-----------------|------------------|-----------------|------------------------|-----------------|
| 62 – TXD0 | TD0 | 0.0118 | 1.887 | 5.2 | 14.1 | 51.9 | 272.1 |
| 63 – TXD1 | TD1 | 0.0118 | 1.884 | 5.2 | 14.1 | 51.9 | 271.7 |
| 64 – TXD2 | TD2 | 0.0118 | 1.904 | 5.3 | 14.3 | 51.9 | 274.7 |
| 2 – TXD3 | TD3 | 0.0118 | 1.898 | 5.3 | 14.2 | 51.9 | 273.7 |
| 3 – TXD4 | TD4 | 0.0118 | 1.903 | 5.3 | 14.2 | 51.9 | 274.4 |
| 4 – TXD5 | TD5 | 0.0118 | 1.899 | 5.3 | 14.2 | 51.9 | 273.8 |
| 6 – TXD6 | TD6 | 0.0118 | 1.901 | 5.3 | 14.2 | 51.9 | 274.1 |
| 7 – TXD7 | TD7 | 0.0118 | 1.906 | 5.3 | 14.3 | 51.9 | 274.8 |
| 10 – TXD8 | TD8 | 0.0118 | 1.860 | 5.2 | 13.9 | 51.9 | 268.2 |
| 11 – TXD9 | TD9 | 0.0118 | 1.908 | 5.3 | 14.3 | 51.9 | 275.1 |
| 12 – TXD10 | TD10 | 0.0118 | 1.884 | 5.2 | 14.1 | 51.9 | 271.7 |
| 14 – TXD11 | TD11 | 0.0118 | 1.912 | 5.3 | 14.3 | 51.9 | 275.7 |
| 15 – TXD12 | TD12 | 0.0118 | 1.903 | 5.3 | 14.2 | 51.9 | 274.4 |
| 16 – TXD13 | TD13 | 0.0118 | 1.910 | 5.3 | 14.3 | 51.9 | 275.4 |
| 17 – TXD14 | TD14 | 0.0118 | 1.911 | 5.3 | 14.3 | 51.9 | 275.6 |
| 19 – TXD15 | TD15 | 0.0118 | 1.901 | 5.3 | 14.2 | 51.9 | 274.1 |
| 51 – RXD0 | RD0 | 0.0118 | 1.814 | 5.0 | 13.6 | 51.9 | 26.6 |
| 50 – RXD1 | RD1 | 0.0118 | 1.804 | 5.0 | 13.5 | 51.9 | 260.3 |
| 49 – RXD2 | RD2 | 0.0118 | 1.802 | 5.0 | 13.5 | 51.9 | 259.9 |
| 47 – RXD3 | RD3 | 0.0118 | 1.862 | 5.2 | 13.9 | 51.9 | 268.5 |
| 46 – RXD4 | RD4 | 0.0118 | 1.866 | 5.2 | 14.0 | 51.9 | 269.1 |
| 45 – RXD5 | RD5 | 0.0118 | 1.876 | 5.2 | 14.0 | 51.9 | 270.5 |
| 44 – RXD6 | RD6 | 0.0118 | 1.880 | 5.2 | 14.1 | 51.9 | 271.1 |
| 42 – RXD7 | RD7 | 0.0118 | 1.865 | 5.2 | 14.0 | 51.9 | 268.9 |
| 40 – RXD8 | RD8 | 0.0118 | 1.860 | 5.2 | 13.9 | 51.9 | 268.2 |
| 39 – RXD9 | RD9 | 0.0118 | 1.860 | 5.2 | 13.9 | 51.9 | 268.2 |
| 37 – RXD10 | RD10 | 0.0118 | 1.863 | 5.2 | 13.9 | 51.9 | 268.6 |
| 36 – RXD11 | RD11 | 0.0118 | 1.872 | 5.2 | 14.0 | 51.9 | 269.9 |
| 35 – RXD12 | RD12 | 0.0118 | 1.816 | 5.0 | 13.6 | 51.9 | 261.9 |
| 34 – RXD13 | RD13 | 0.0118 | 1.855 | 5.2 | 13.9 | 51.9 | 267.5 |
| 32 – RXD14 | RD14 | 0.0118 | 1.809 | 5.0 | 13.9 | 51.9 | 260.9 |
| 31 – RXD15 | RD15 | 0.0118 | 1.821 | 5.1 | 13.6 | 51.9 | 262.9 |

Note: All values presented in this table are theoretical calculated values and may not reflect actual measured parameters.

Table 3–2. TLK2500 Differential Pair PCB Transmission Line Characteristics

| Device Pin No. | Connector Pin No. | Trace Width (inches) | Length (inches) | Impedance (Ω) | Line Delay (ps) |
|----------------|-------------------|----------------------|-----------------|------------------------|-----------------|
| 60 – DOUUTXP | TXP | 0.025 | 2.390 | 51.2 | 347.5 |
| 59 – DOUUTXN | TXP | 0.025 | 2.363 | 51.2 | 343.6 |
| 54 – DINRXP | RXP | 0.025 | 2.889 | 51.2 | 420.1 |
| 53 – DINRXN | RXN | 0.025 | 2.883 | 51.2 | 419.2 |

Note: All values presented in this table are theoretical calculated values and may not reflect actual measured parameters.

Figure 3–1. TLK2500 EVM Layer Construction

| | | |
|---------|--------|--------------------|
| Layer 1 | | Top 50 Ω |
| Layer 2 | 14 Mil | GND1 |
| Layer 3 | 5 Mil | V _{DD1} |
| Layer 4 | 21 Mil | V _{DD2} |
| Layer 5 | 05 Mil | GND2 |
| Layer 6 | 07 Mil | Solder 50 Ω |

Notes:

- 1) All cores consist of 1 oz. Cu.
- 2) Trace width
 - A) 25 mils (for 50 Ω Layer 1)
 - B) 11.8 mils (for 50 Ω Layer 6)
- 3) Overall board thickness is 62 mils \pm 5 mil
- 4) Copper and solder mask adds approximately 10 mils to the overall board thickness.
- 5) Impedance is 50 Ω \pm 5%
- 6) Material is G-Tek. Dielectric constant = 3.9
- 7) For overall thickness: add 1.2 to 1.4 mils for each metal layer in the stack-up.

Schematics, Board Layouts, and Suggested Optics and Cable Assembly Specifications

This appendix contains schematics and corresponding bill of materials for the TLK2500EVM transceiver board along with board layouts. Specifications for the NetLight™ 1417K4A 1300 nm laser assembly are also included.

A-2

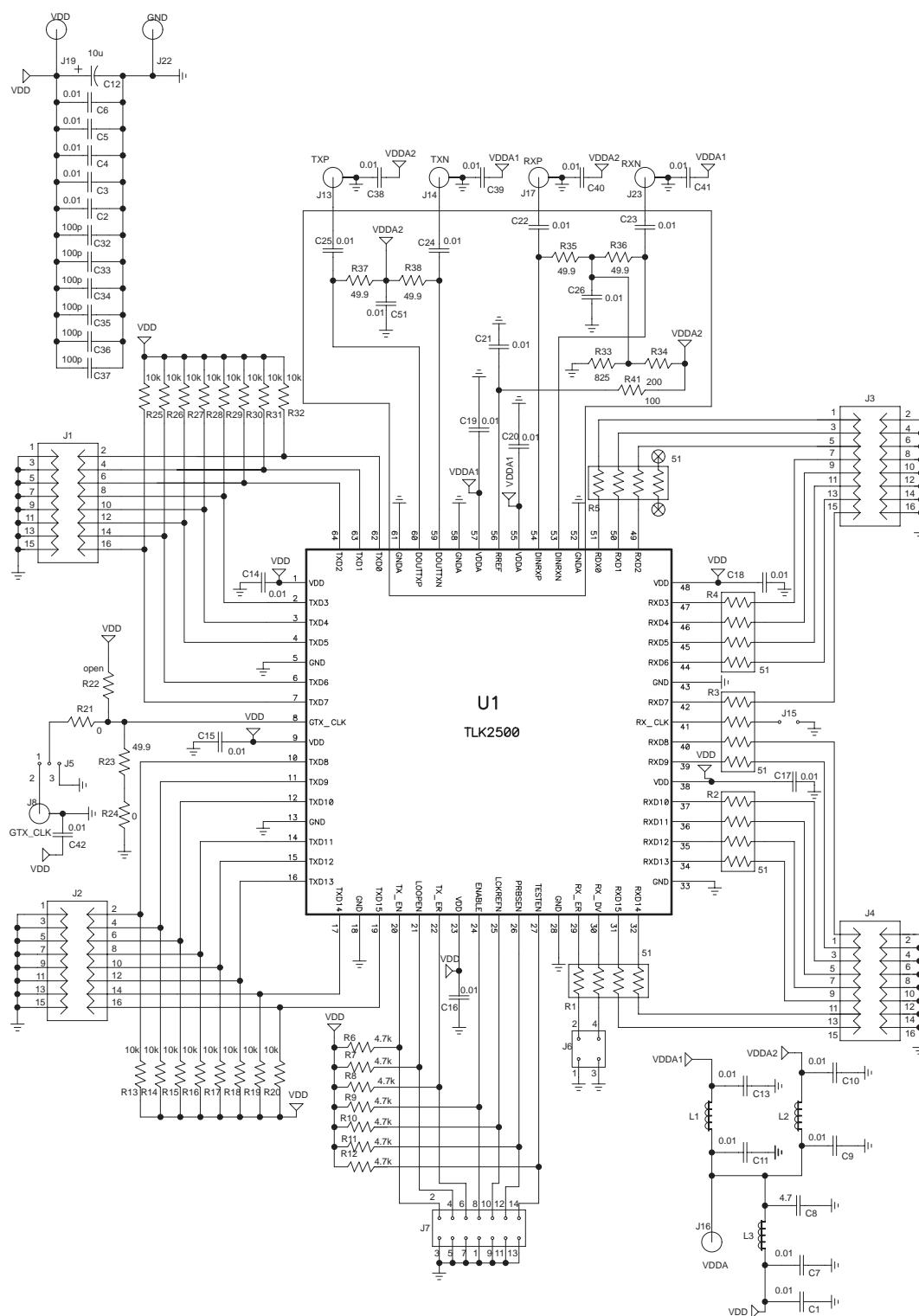


Figure A–2. Optical Transceiver Schematic

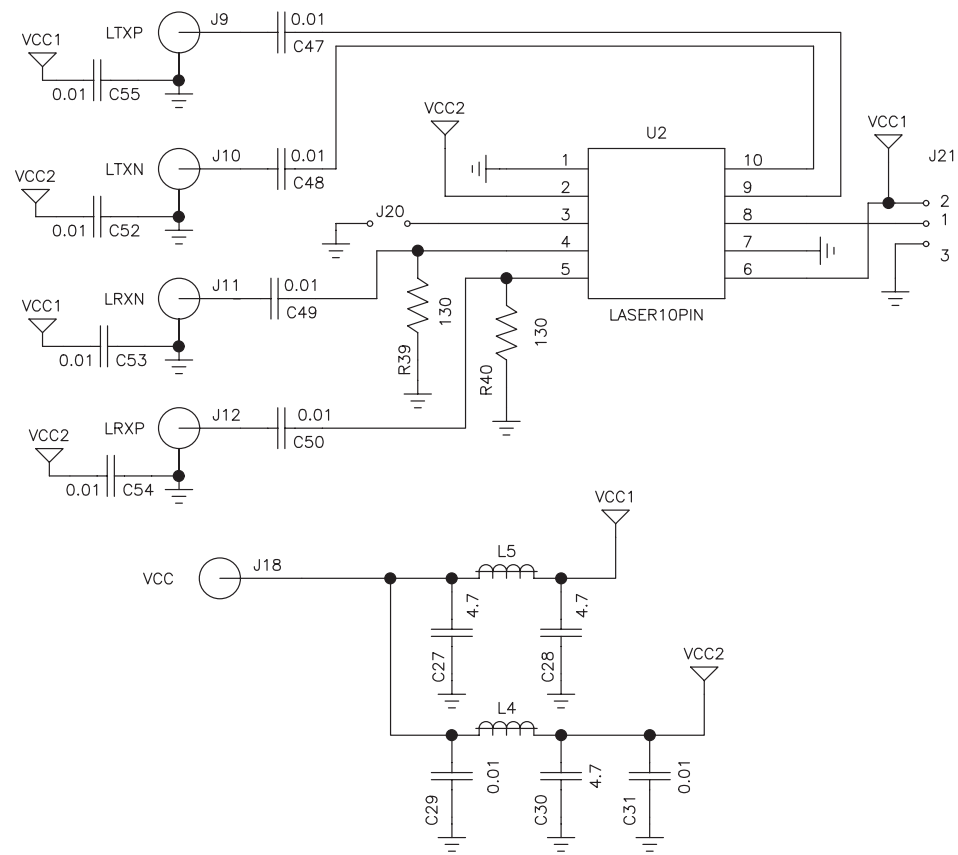


Table A–1. TLK2500 EVM Transceiver Bill of Materials

| Item | Qty | Mfg / Dist. | Mfg Part No. | Ref Des | Description | Value or Function |
|------|-----|-------------|------------------|--|---------------------------|----------------------------|
| 1 | 1 | Digi-Key | S2011-02-ND | J6 | 2x2 HEADER | 0.1 x 0.1 CENTERS |
| 2 | 1 | Digi-Key | S2011-07-ND | J7 | 2x7 HEADER | 0.1 x 0.1 CENTERS |
| 3 | 4 | Digi-Key | ECS-T1DX475R | J1, J2, J3, J4 | 2x8 HEADER | 0.1 x 0.1 CENTERS |
| 4 | 1 | Digi-Key | S1111-03-ND | J5 | 3 PIN JUMPER | 0.1 CENTERS |
| 5 | 4 | Newark | 39N867 | J16,J18,J19, J22 | Banana Jack | 100 V, 5%, 0.1 μ F |
| 6 | 40 | Digi-Key | PCC1784CT-ND | C1–C7, C9–C11, C13–C26, C29, C31, C38–C51 | CAPACITOR, SMT603 | 25 V, 5%, 0.01 μ F |
| 7 | 4 | Digi-Key | PCC1842CT-ND | C8,C27, C28,C30 | CAPACITOR, SMT0603 | 25 V, 5%, 4.7 μ F |
| 8 | 1 | Digi-Key | PCC1894CT-ND | C12 | CAPACITOR, SMT0805 | 25 V, 5%, 10 μ F |
| 9 | 3 | Digi-Key | 240-1018-1ND | L1 – L3 | FERRITE BEAD 805 500ma | 600 Ω |
| 10 | 2 | Digi-Key | S1111-02-ND | J15, J20 | JUMPER | HEADER, 1x2, 0.1 CENTER |
| 11 | 1 | LUCENT | 1417K4A LAS | U2 | Laser Transceiver | 2.5 Gbps |
| 12 | 2 | Digi-Key | TSW-110-07-G-D | R21, R24 | RESISTOR, SMT, 0402 | 0 Ω |
| 13 | 7 | ANY | P4.75KLTC-ND | R6–R12 | RESISTOR, SMT, 0402 | 4.7 k Ω |
| 14 | 16 | Digi-Key | P10.0KLTC-ND | R15–R20, R25–R32 | RESISTOR, SMT, 0402 | 10 k Ω |
| 15 | 5 | Digi-Key | P49.9LCT-ND | R23, R35, R36, R37, R38 | RESISTOR, SMT, 0402 | 49.9 Ω |
| 16 | 2 | Digi-Key | P130LTC-ND | R39, R40 | RESISTOR, SMT, 0402 | 130 Ω |
| 17 | 2 | Digi-Key | P200LTC-ND | R34, R41 | RESISTOR, SMT, 0402 | 200 Ω |
| 18 | 1 | Digi-Key | P825LTC-ND | R33 | RESISTOR, SMT, 0402 | 825 Ω |
| 19 | 1 | N/A | N/A | R22 | RESISTOR, SMT, 0402 | OPEN |
| 20 | 5 | | MNR14 E0AB J 510 | R1, R2, R3, R4, R5 | Resistor R-PAC(4) | 51 Ω |
| 21 | 9 | Newark | 142-0711-821 | | SMA END-LAUNCH | 422 Ω |
| 22 | 4 | Newark | 92N4922 | STANDOFF | Standoff 0.5' 4-40 thread | |
| 23 | 4 | Newark | 30F082 | | Machine Screw 4-40 x 3/8' | |
| 24 | 1 | TI | TLK2500 | U1 | TI TLK2500 DUT | 64 PIN VQFP |
| 25 | 6 | Digi-Key | PCC101ACVCT-ND | C32–C37 | CAPACITOR, SMT 0603 | 25 V, 20%, 100 pF |

Figure A-4. GND Layers 2 and 5

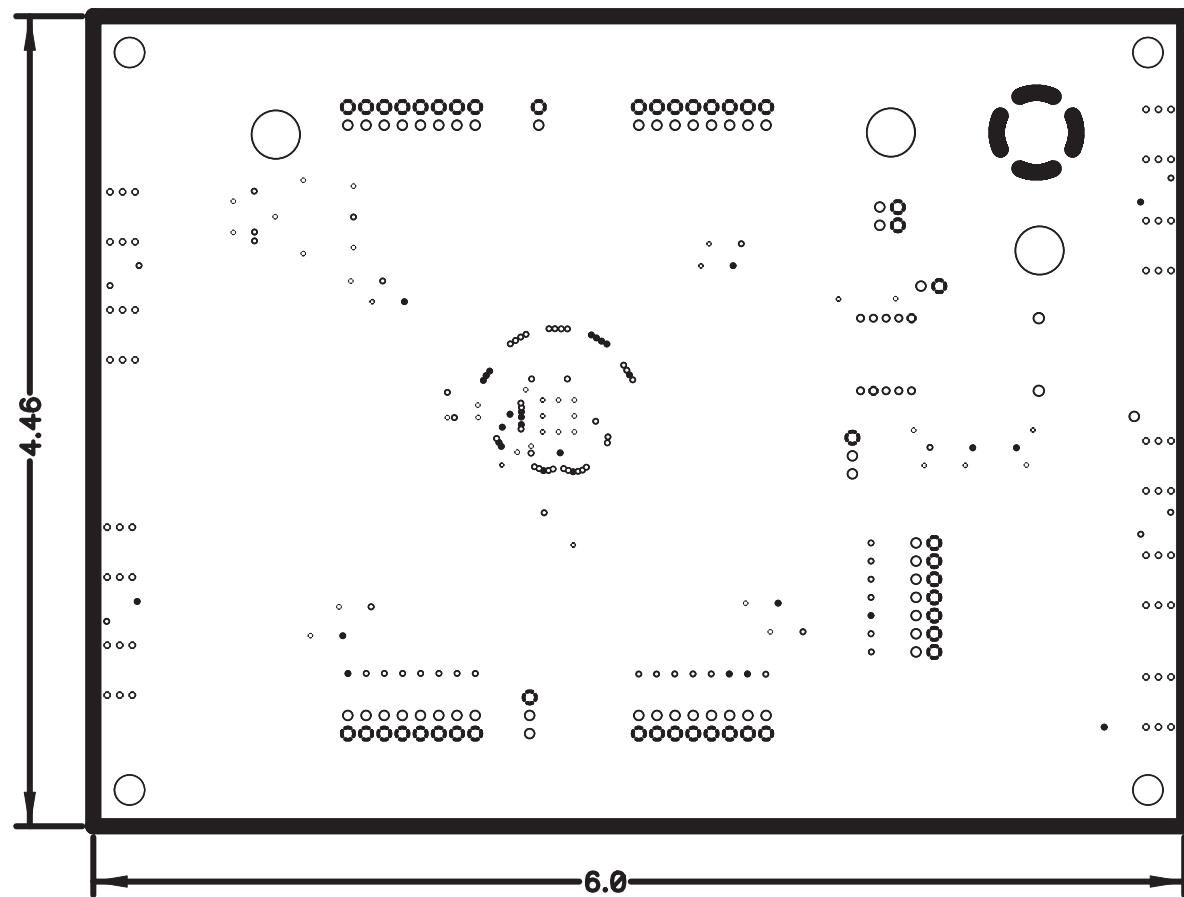


Figure A-5. Power Plane 1

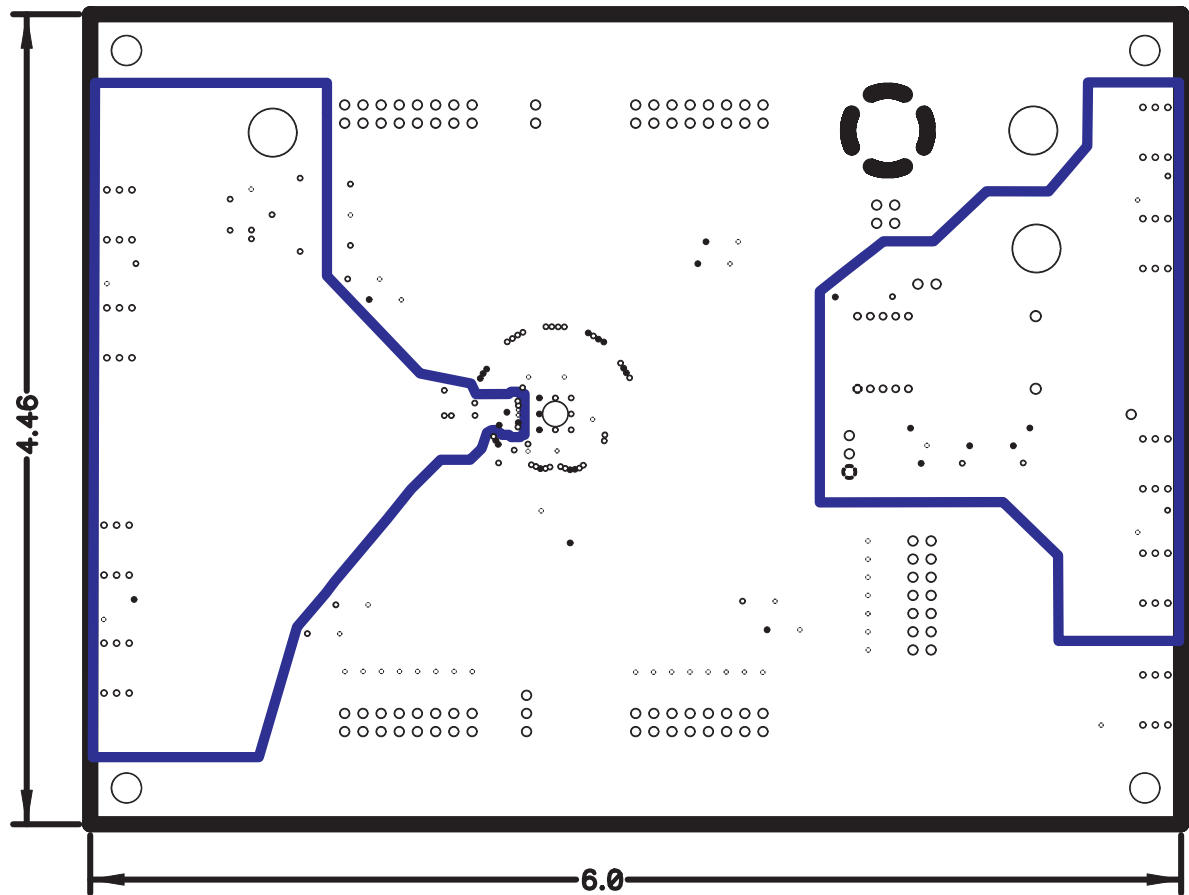


Figure A-7. Bottom Layer 7

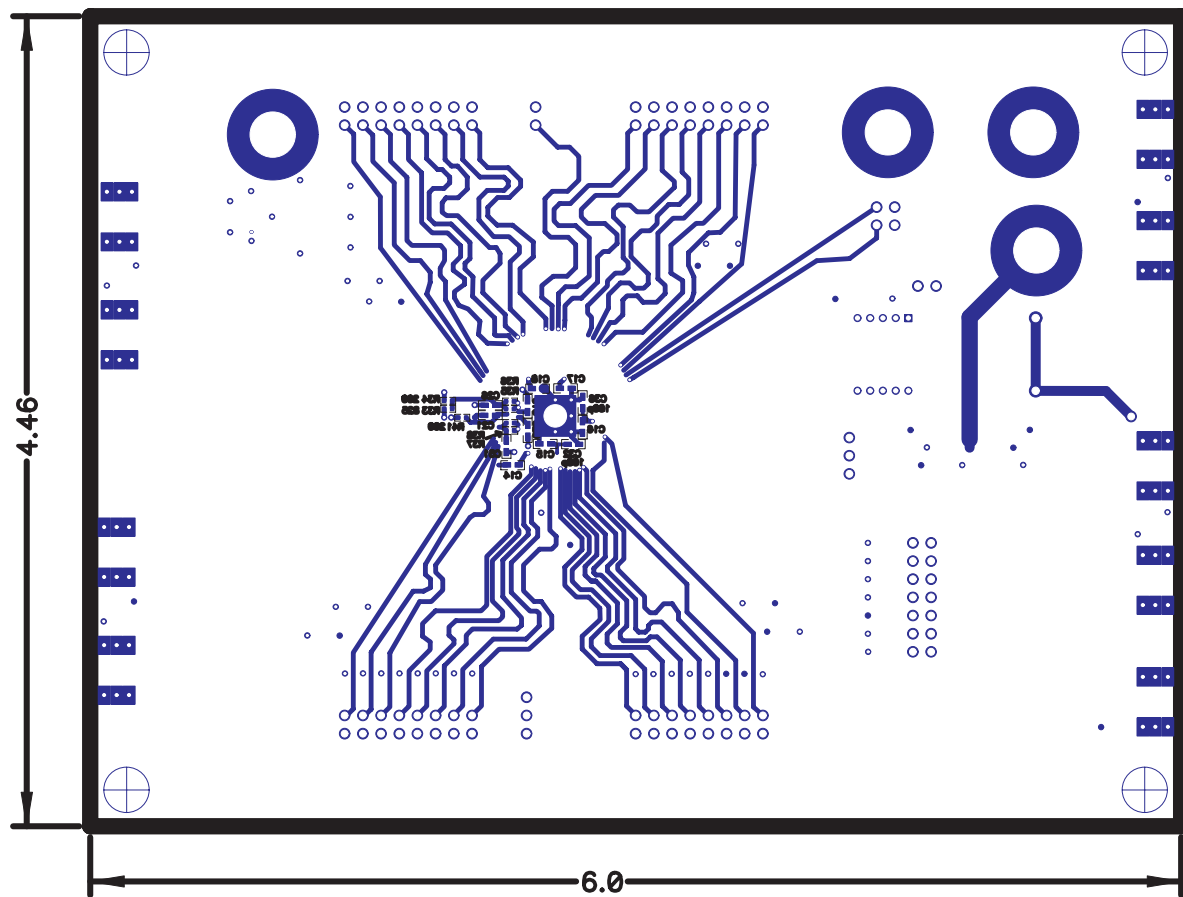


Figure A-8. Top Layer 1

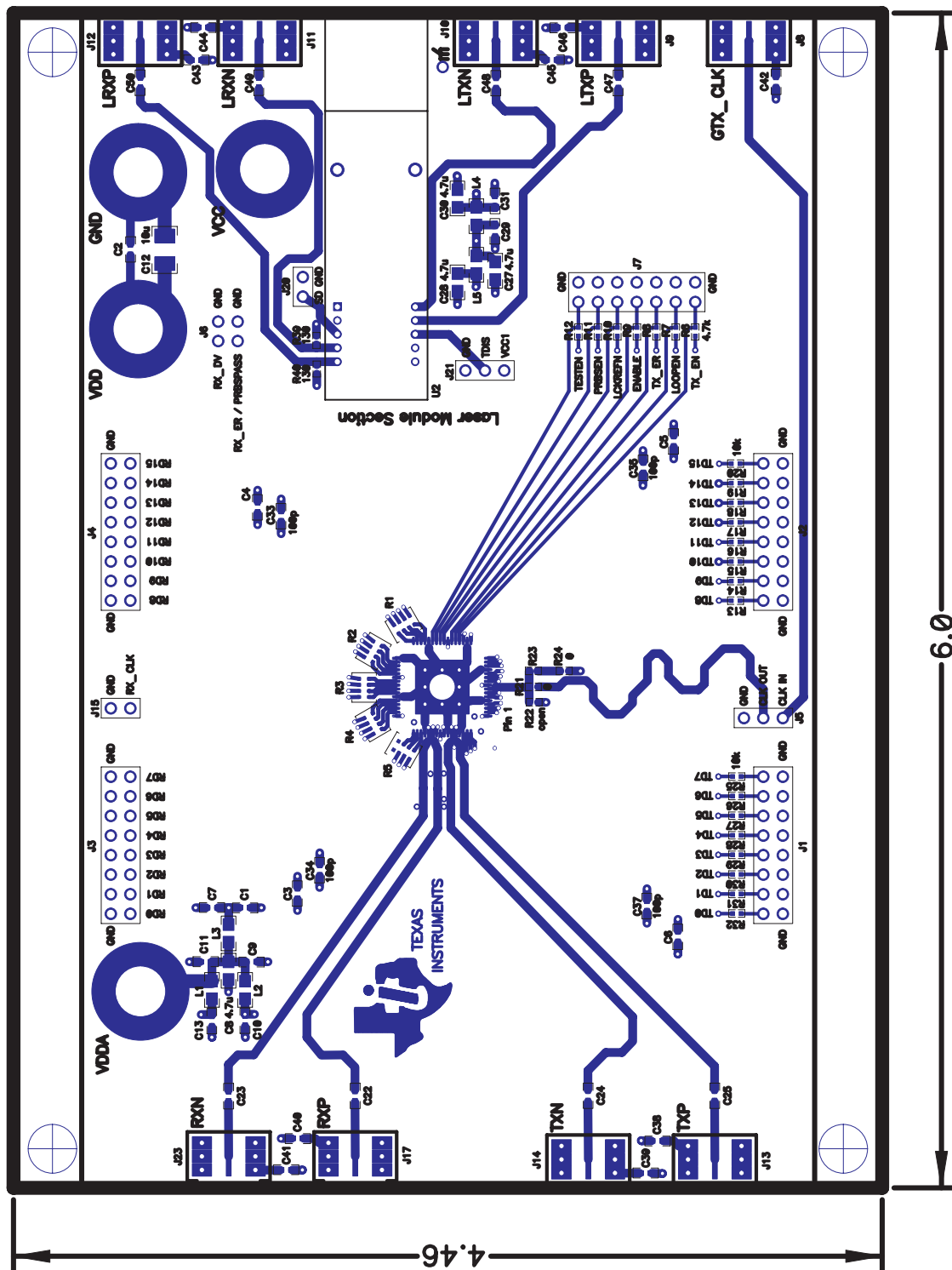


Figure A-9. Detail of Top Layer 1

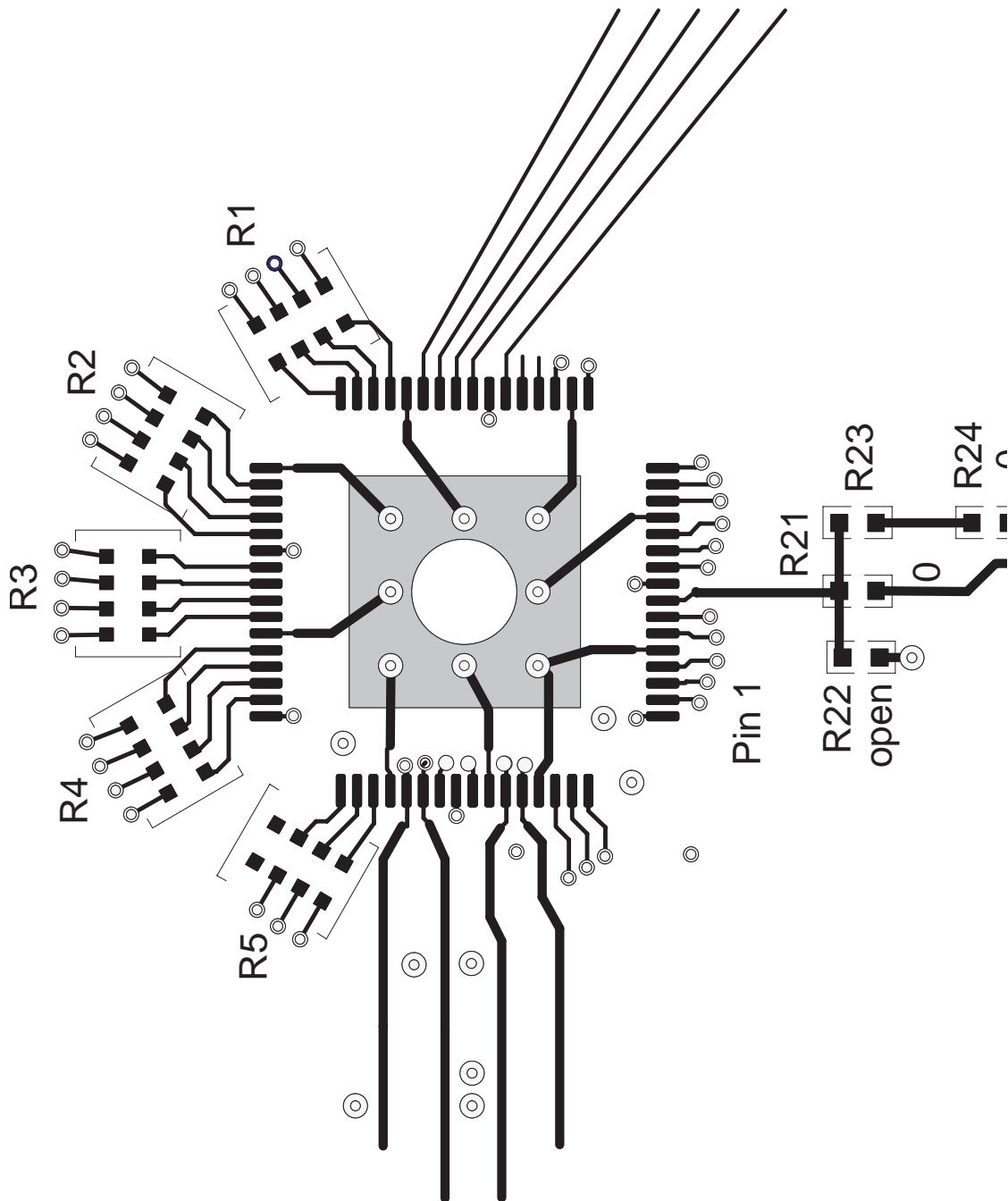


Figure A-10. GND Layers 2 and 5

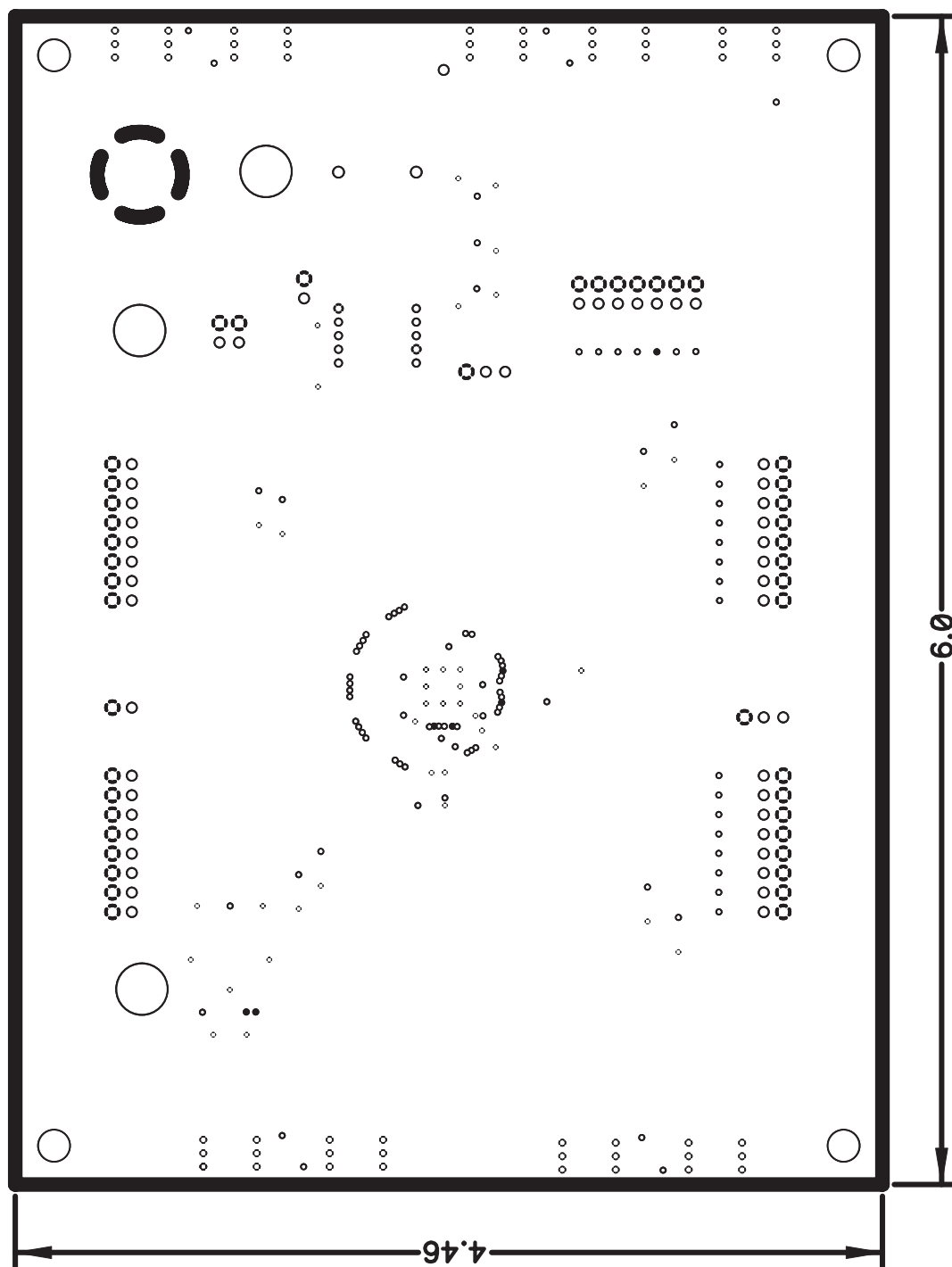
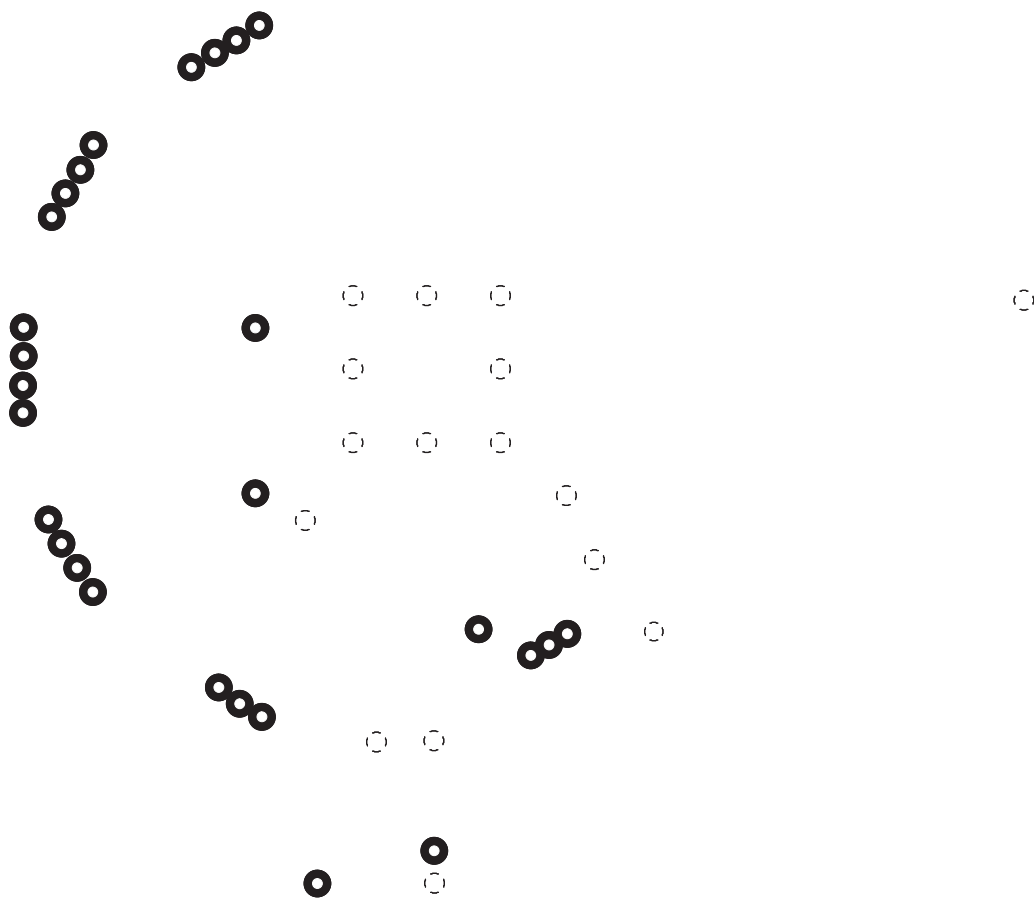


Figure A-11. Detail of GND Layers 2 and 5



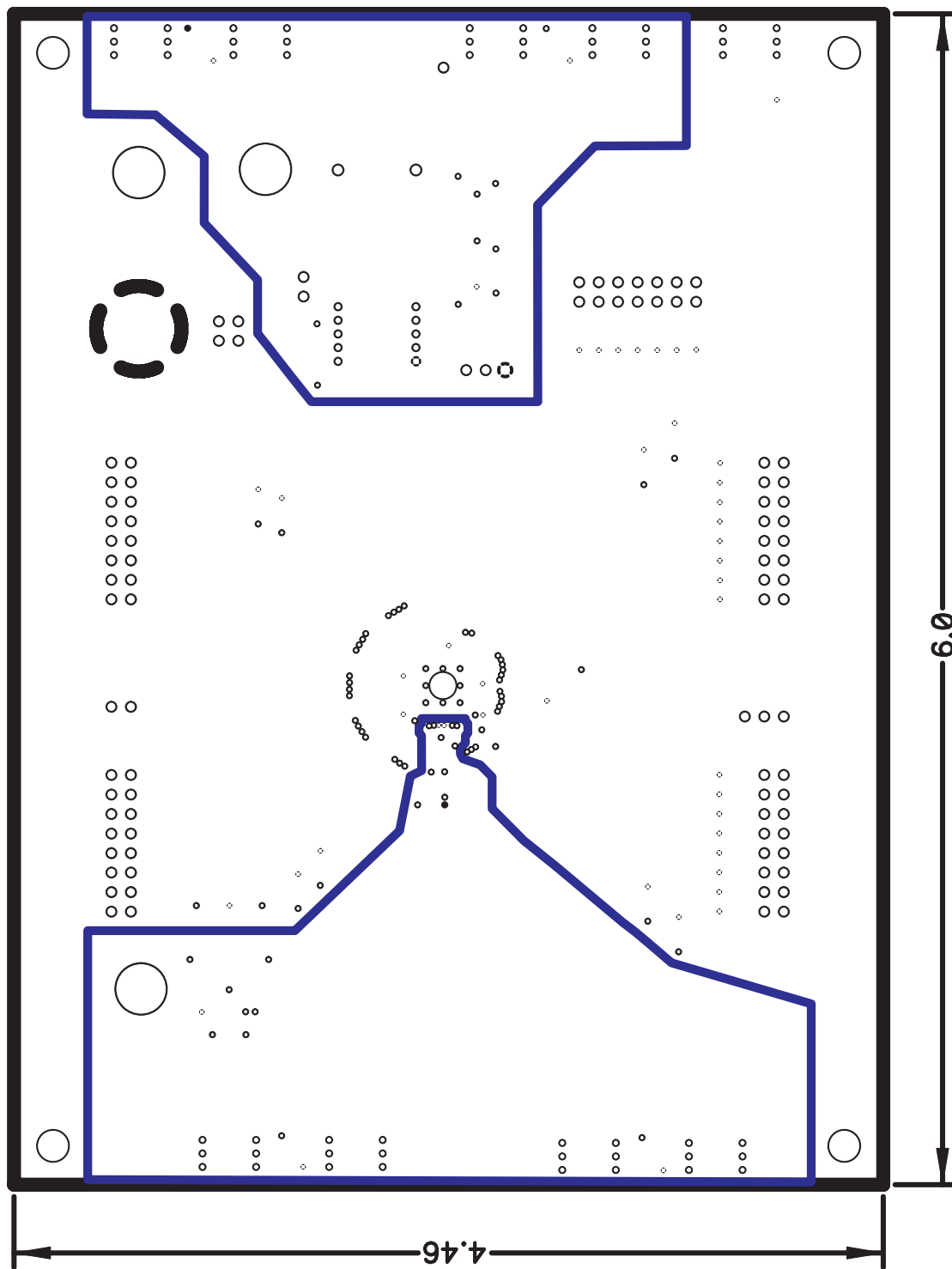


Figure A-13. Detail of Power Plane 1

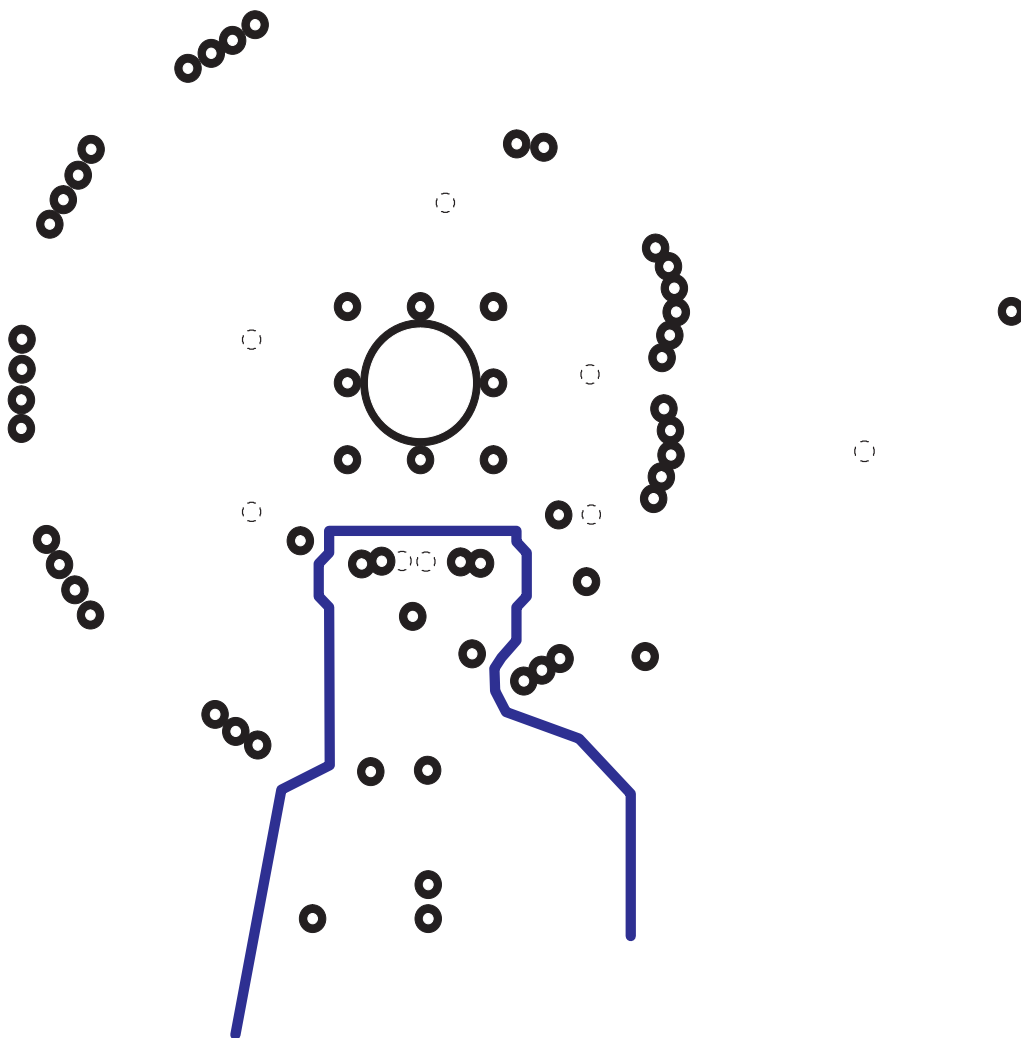


Figure A-14. Bottom Layer 6

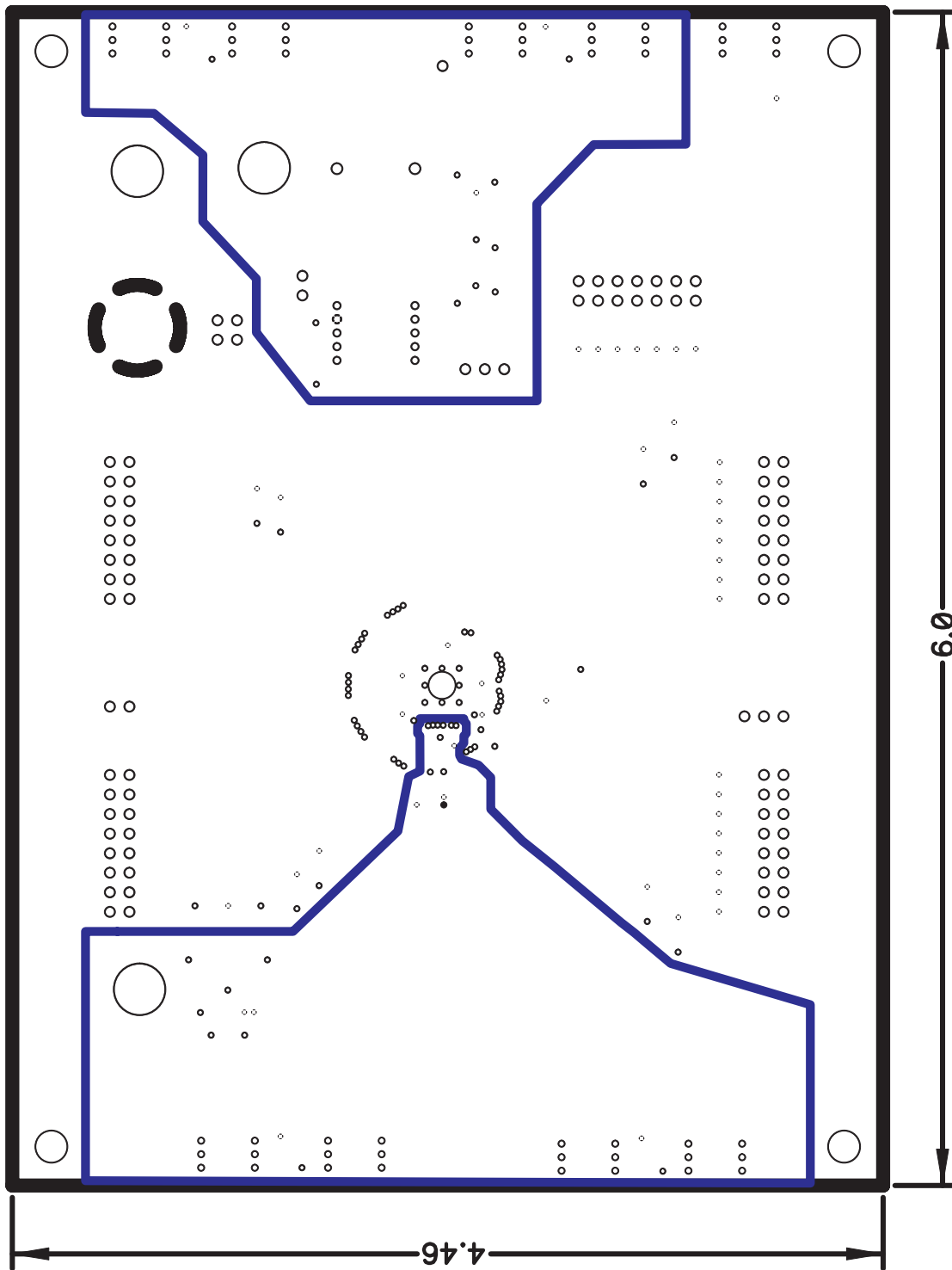


Figure A-15. Detail of Bottom Layer 6

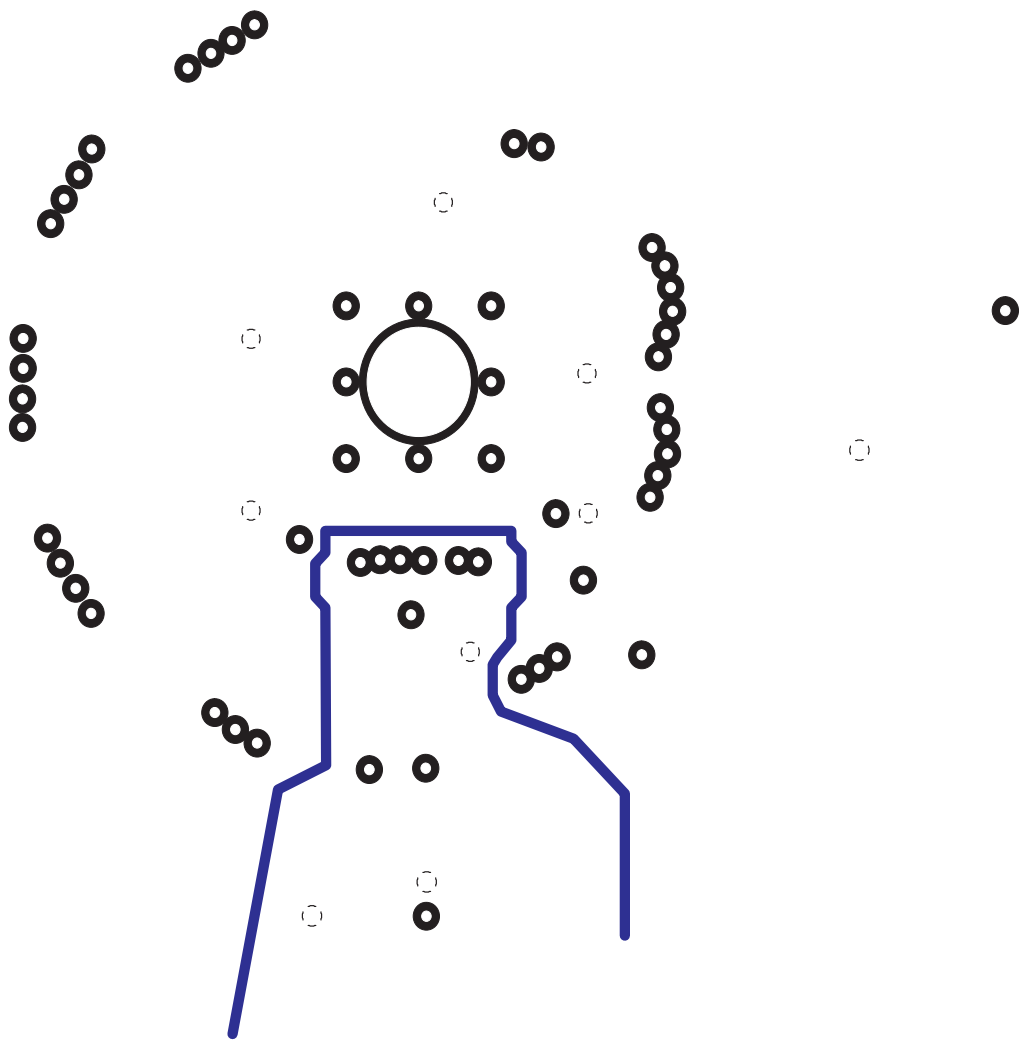


Figure A-16. Bottom Layer 6

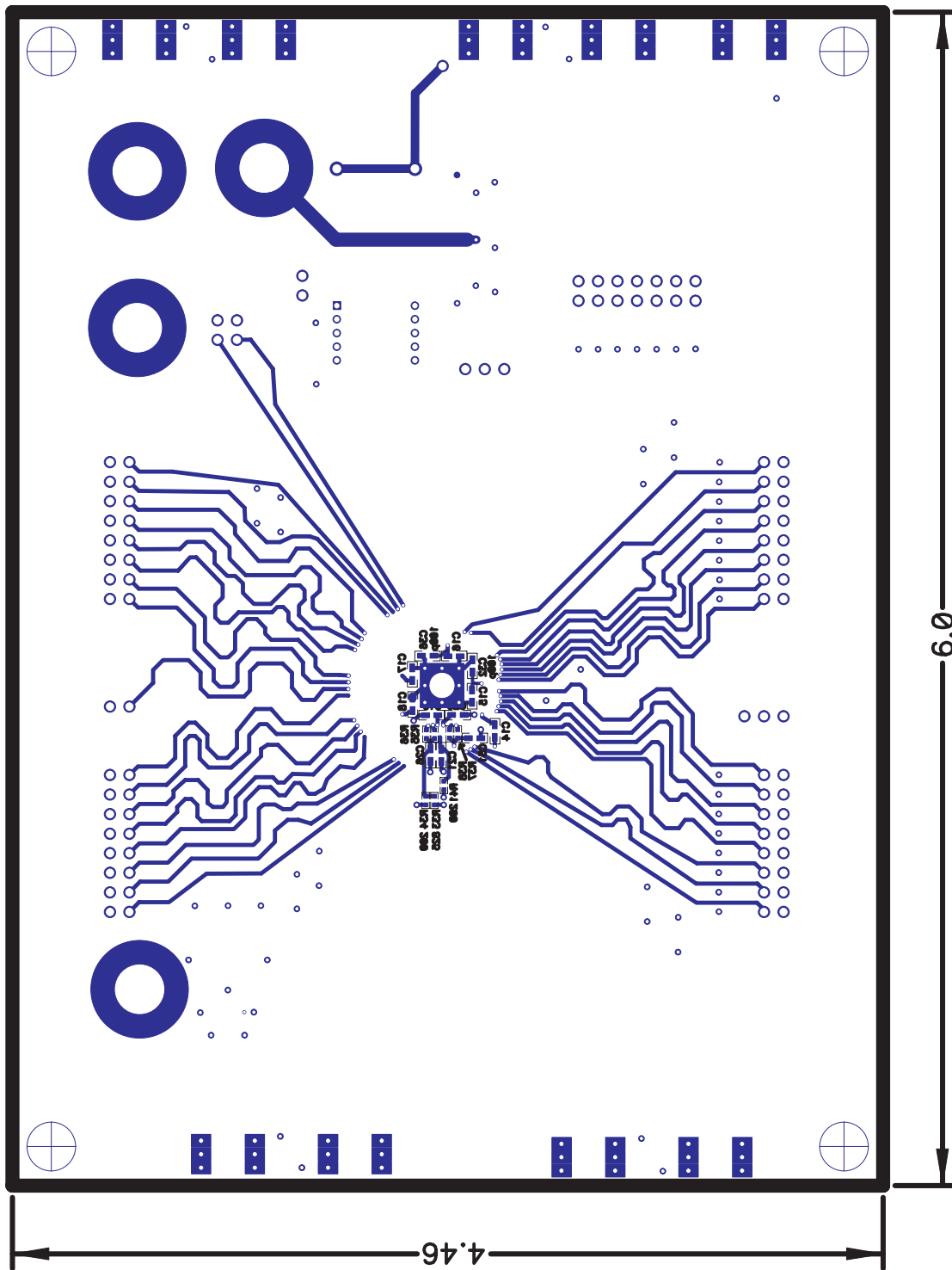
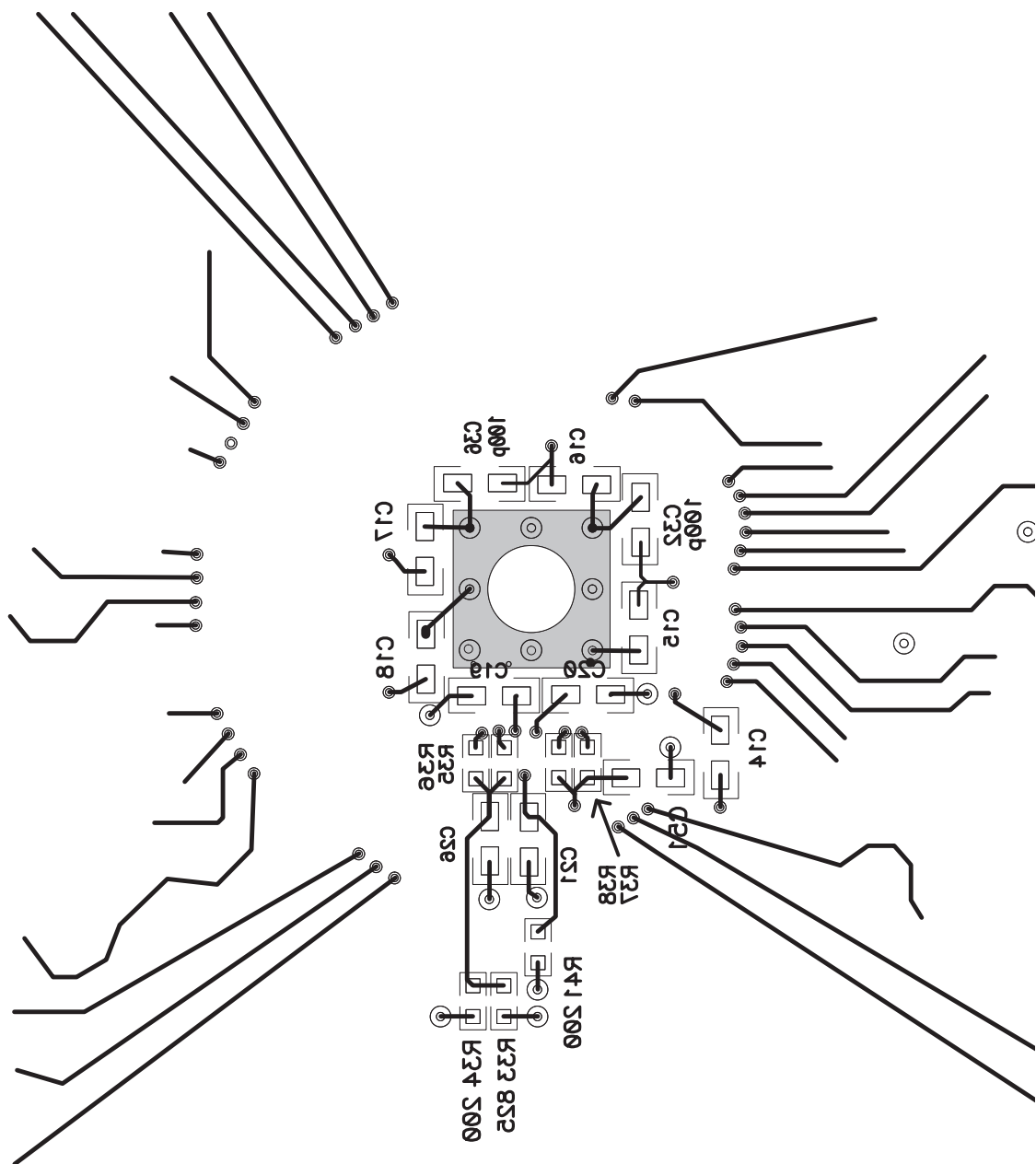


Figure A-17. Detail of Bottom Layer 6





NetLight™ 1417K4A 1300 nm Laser 2.5 Gbits/s SpeedBlaster™ Transceiver

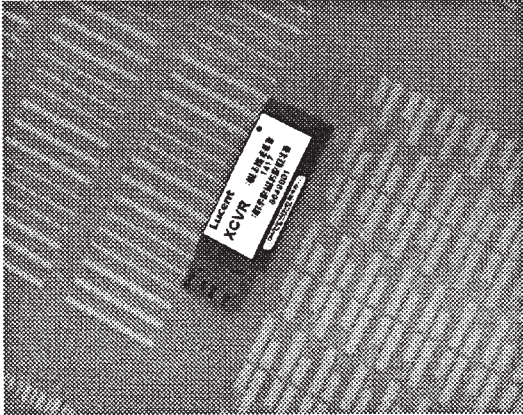
The document shown in this appendix is an advanced information data sheet from Lucent Technologies Inc.

| Topic | Page |
|--|-------------|
| NetLight 1417K4A 1300 nm Laser 2.5 Gbits/s Speedmaster Transceiver Data Sheet | B-2 |



Advanced Data Sheet
December 1999

NetLight™ 1417K4A 1300 nm 2.5 Gb/s Laser Transceiver



Available in a small form factor, RJ-45 size, plastic package, the 1417K4A Transceiver is a high-performance, cost-effective, optical transceiver for SONET/SDH applications.

- LVPECL/CML compatible data inputs and CML compatible data outputs
- Operating temperature range of 0 °C to 70 °C
- Lucent Reliability and Qualification Program for built in quality and reliability

DESCRIPTION

The 1417K4A 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 SR OC-48 and SDH I-16 applications. The transceiver features the Lucent optics and is packaged in a narrow-width plastic housing with an LC duplex receptacle. This receptacle fits into an RJ-45 form factor outline. The 10-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. The transmitter also features a TTL logic level disable input. The receiver features differential CML logic level data outputs and a TTL logic level Signal Detect output.

FEATURES

- SONET SR OC-48, SDH I-16 applications
- High Speed Optical Data Interface for Shelf to Shelf Interconnect
- Small Form Factor, RJ-45 size, 10-pin package
- LC duplex receptacle
- Uncooled 1300 nm laser transmitter with automatic output power control
- Transmitter disable input
- Wide dynamic range receiver with InGaAs PIN photodetector
- TTL Signal Detect output
- Low power dissipation
- Single +3.3 V power supply

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.

| PARAMETER | SYMBOL | MIN | MAX | UNIT |
|--|-----------|-----|--------|---------------|
| Supply Voltage | V_{CC} | 0 | 5 | V |
| Operating Temperature Range ¹ | T_A | 0 | 70 | °C |
| Storage Temperature Range | T_S | -40 | 85 | °C |
| Lead Soldering Temperature/Time | — | — | 250/10 | °C/s |
| Operating Wavelength Range | λ | 1.1 | 1.6 | μm |

1. Under conditions of 2 m/s forced airflow.

Pin Information

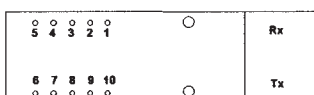


Figure 1. 1417K4A transceiver, 10-Pin Configuration, Top View

Table 1. Transceiver Pin Descriptions

| Receiver | | | |
|-------------|------------|---|---------------|
| Pin Number | Symbol | FUNCTIONAL DESCRIPTION | LOGIC FAMILY |
| MS | MS | Mounting Studs The mounting studs are provided for transceiver mechanical attachment to the circuit board. They may also provide an optional connection of the transceiver to the equipment chassis ground. | NA |
| 1 | V_{ee_r} | Receiver Signal Ground | NA |
| 2 | V_{cc_r} | Receiver Power Supply | NA |
| 3 | SD | Signal Detect Normal Operation: Logic one output Fault Condition: Logic zero output | LVTTL |
| 4 | RD- | Received Data Out Bar | CML |
| 5 | RD+ | Received Data Out | CML |
| Transmitter | | | |
| 6 | V_{cc_t} | Transmitter Power Supply | NA |
| 7 | V_{ee_t} | Transmitter Signal Ground | NA |
| 8 | Tdis | Transmitter Disable | LVTTL |
| 9 | TD+ | Transmitter Data In An internal 50 ohm termination is provided consisting of a 100 ohm resistor between the TD+ and TD- pins. | LVPECL or CML |
| 10 | TD- | Transmitter Data In Bar See TD+ pin for terminations. | LVPECL or CML |

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.

Lucent 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 k Ω , capacitance = 100 pF) is widely used and, therefore, can be used for comparison purposes. The HBM ESD threshold established for the 1417K4A is ± 1000 V.

Application Information

The 1417 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 1417 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. 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 multi-layer 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 3, 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 outputs (RD+/RD-) 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 LVTTTL 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.

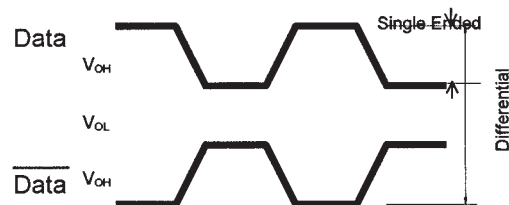


Figure 2. Data Input/Output Logic Level Definitions

Application Information (continued)

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 250 °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 2. Transmitter Optical and Electrical Characteristics ($T_A = 0^\circ\text{C}$ to $+70^\circ\text{C}$, $V_{CC} = 3.135\text{ V} - 3.465\text{ V}$)

| PARAMETER | SYMBOL | MIN | MAX | UNIT |
|--|-----------------------|--------------|----------|--------|
| Average Optical Output Power (EOL) | P_O | -10.0 | -3 | dBm |
| Optical Wavelength | λ_c | 1266 | 1360 | nm |
| Spectral Width | $\Delta\lambda_{RMS}$ | — | 4 | nm |
| Dynamic Extinction Ratio | EXT | 8.2 | — | dB |
| Rise/Fall Time (20%-80%) | T_r/T_f | — | 130 | ps |
| Power Supply Current | I_{CCT} | — | 150 | mA |
| Input Data Voltage – Single Ended ¹ | $V_{IN\text{ p-p}}$ | 150 | 800 | mV p-p |
| Input Data Voltage – Differential ¹ | $V_{IN\text{ p-p}}$ | 300 | 1600 | mV p-p |
| Transmit Disable Voltage ² | V_D | $V_{CC}-0.9$ | V_{CC} | V |
| Transmit Enable Voltage ² | V_{EN} | Vee | Vee+0.8 | V |

Table 3. Receiver Optical and Electrical Characteristics ($T_A = 0^\circ\text{C}$ to $+70^\circ\text{C}$, $V_{CC} = 3.135\text{ V} - 3.465\text{ V}$)

| PARAMETER | SYMBOL | MIN | MAX | UNIT |
|--|---------------------|-----|----------|---------------|
| Average Sensitivity ³ | | | | |
| 800 mV (CML) Differential Input to Transmitter | P_I | — | -18 | dBm |
| 1600 mV (LVPECL) Differential Input to Transmitter | P_I | — | -16 | dBm |
| Maximum Input Power ³ | P_{MAX} | -3 | — | dBm |
| Power Supply Current | I_{CCR} | — | 150 | mA |
| Output Data Voltage – Single Ended ¹ | $V_{IN\text{ p-p}}$ | 300 | 500 | mV p-p |
| Output Data Voltage – Differential ¹ | $V_{IN\text{ p-p}}$ | 600 | 1000 | mV p-p |
| Signal Detect Switching Threshold | | | | |
| Assert | LSTD | -45 | -19 | dBm |
| Deassert | LSTI | — | -18.5 | dBm |
| Signal Detect Hysteresis | HYS | 0.5 | 6 | dB |
| Signal Detect Voltage ² | | | | |
| Low | V_{OL} | 0.0 | 0.8 | V |
| High | V_{OH} | 2.4 | V_{CC} | V |
| Signal Detect Response Time | SDRT | | 100 | μs |

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

Qualification and Reliability

To help ensure high product reliability and customer satisfaction, Lucent is committed to an intensive quality program that starts in the design phase and proceeds through the manufacturing process. Optoelectronic modules are qualified to Lucent internal standards as well as other appropriate industry standards using MIL-STD-883 test methods and procedures, and using sampling techniques consistent with Bellcore requirements. The 1417 Transceiver will be subjected to a set of qualification tests.

In addition, Lucent Technologies Microelectronics Group Optoelectronics Unit design, development, and manufacturing facilities have been certified to be in full compliance with the latest ISO-9001 Quality System Standards.

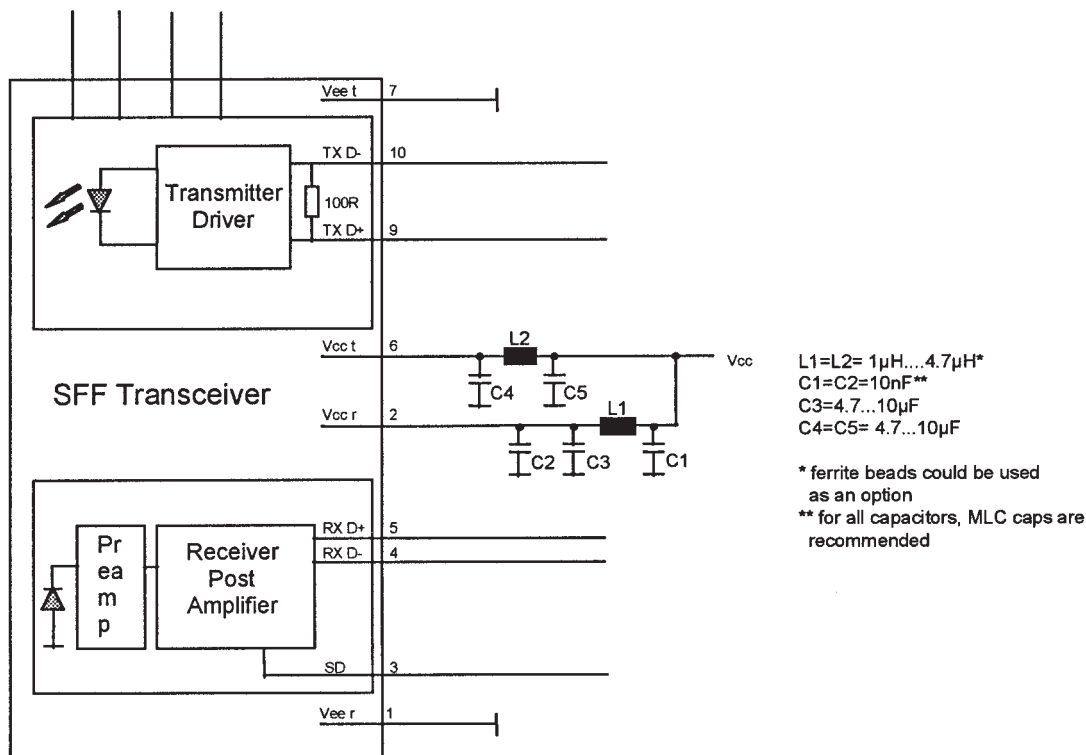
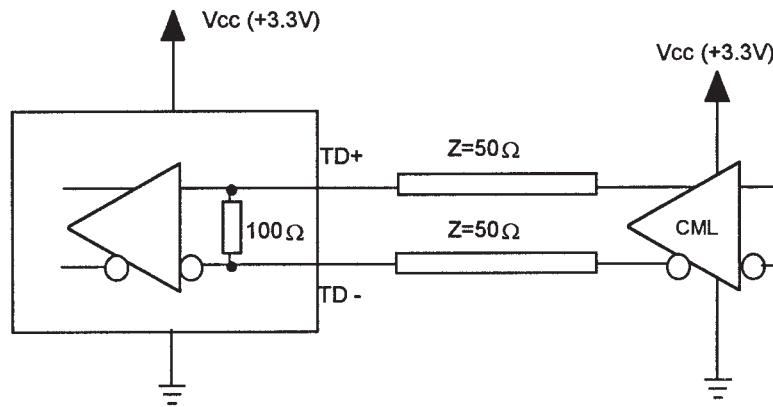
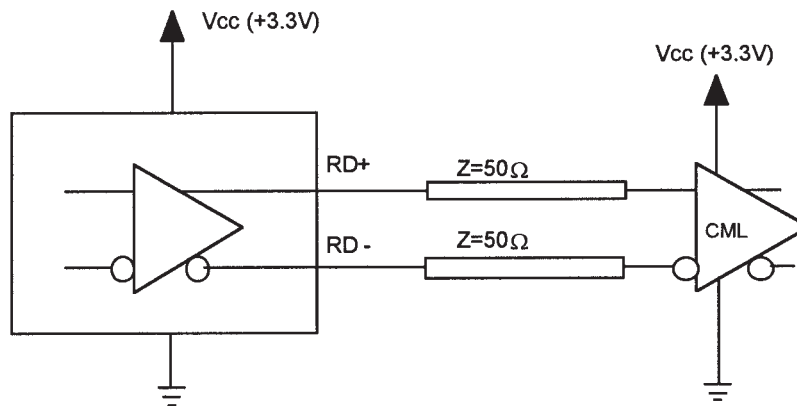


Figure 3: Power Supply Filtering of SFF transceiver

Electrical Data Interface - Current Mode Logic(CML)



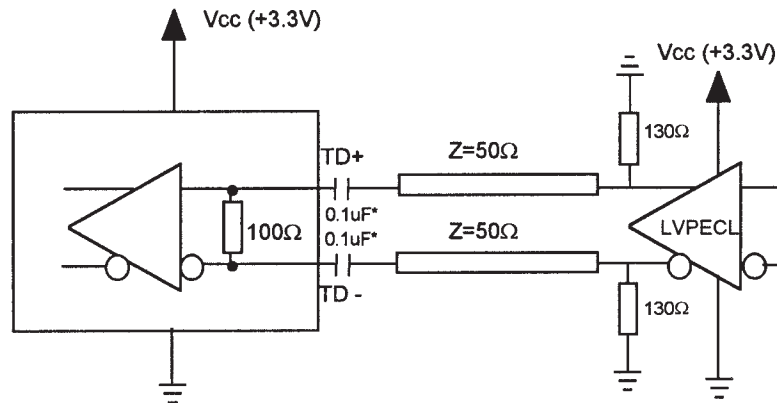
(a) Transmitter Interface – DC Coupled - (CML)



(b) Receiver Interface - DC Coupled - (CML)

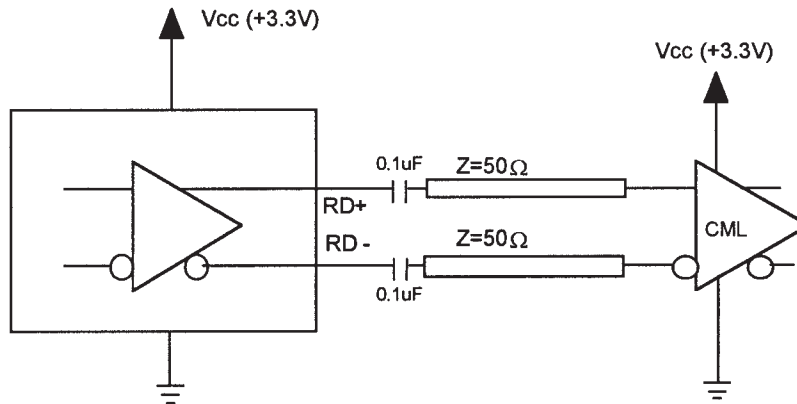
Figure 4: 3.3V Transceiver Interface with 3.3V IC's and CML

Alternate Electrical Data Interface Options



* Optional AC Coupling Capacitors - use ceramic X7R or equivalent

(a) Transmitter Interface – AC or DC Coupled - (LVPECL)

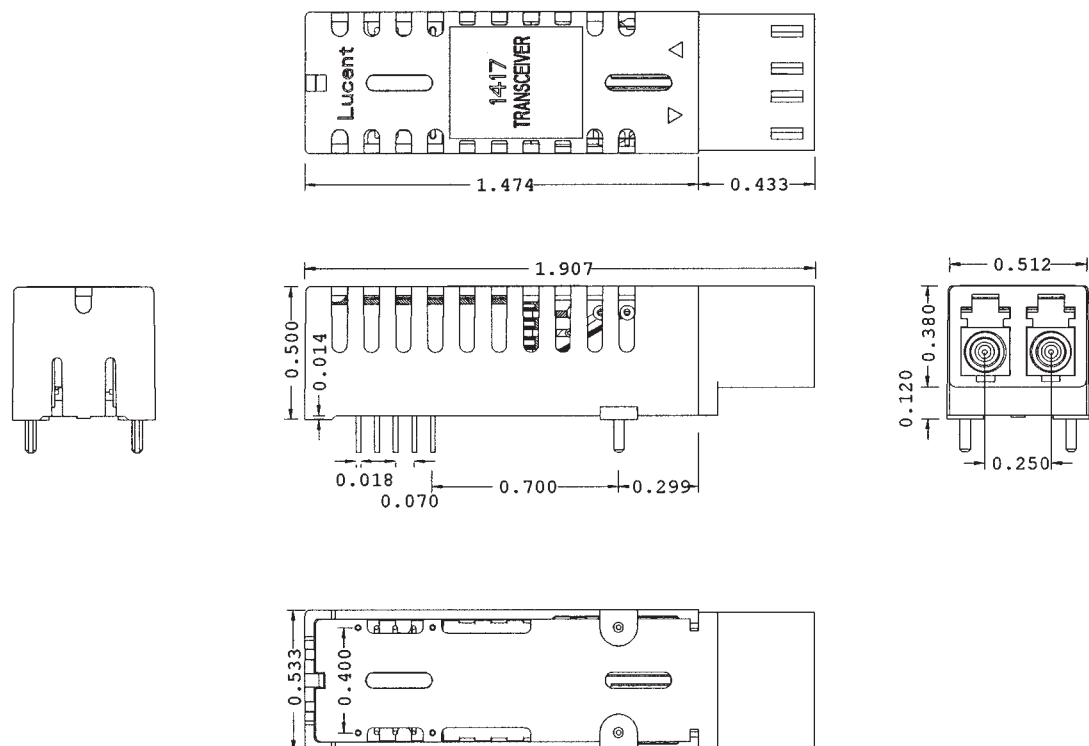


(b) Receiver Interface AC Coupled - (CML)

Figure 5: 3.3V Transceiver Interface with 3.3V IC's

Outline Drawing

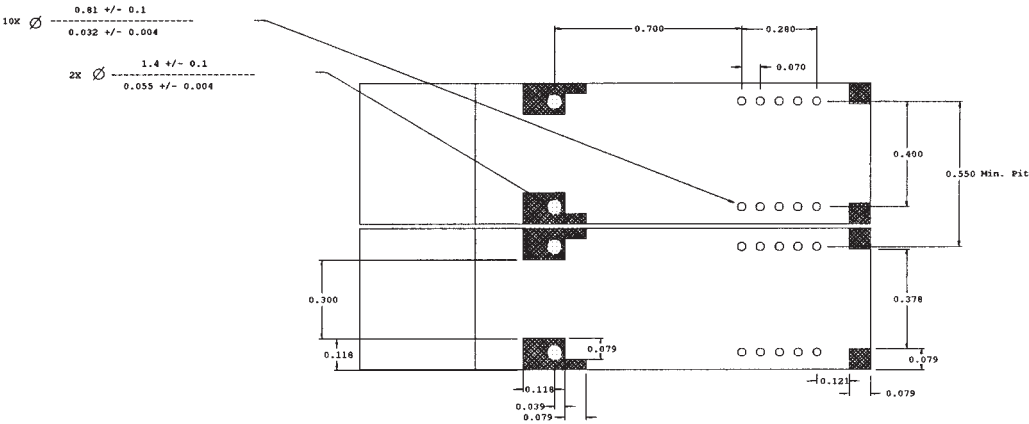
Dimensions in inches.



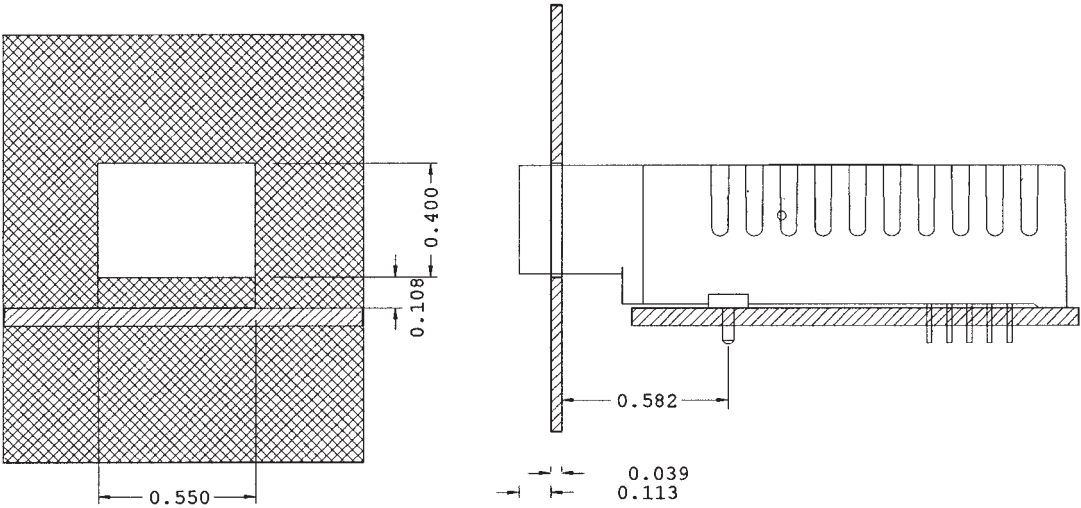
DRAFT

- 8 -

Printed Wiring Board Layout
Dimensions in inches.



Recommended Panel Opening



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 825-1:1993. The transceiver has been certified with the FDA under accession number 8720009.

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 = 1.3 μm

Maximum power = 1.58 mW

Product is not shipped with power supply.

NOTICE

Unterminated optical receptacles may emit laser radiation.

Do not view with optical instruments.

Ordering Information

Table 4. Ordering Information

| Description | Device Code | Comcode |
|---|--------------------|----------------|
| 2 x 5 Singlemode SFF LC receptacle transceiver for 2.488 Gbits/s applications | 1417K4A | 108416694 |

Advanced Data Sheet
December 1999

**NetLight™ 1417K4A 1300 nm
2.5 Gb/s Laser Transceiver**

NOTES:

For additional information, contact your Microelectronics Group Account Manager or the following:

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1-800-372-2447, FAX 610-712-4106 (In CANADA: 1-800-553-2448, FAX 610-712-4106), e-mail docmaster@micro.lucent.com

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