

# OC-3/STM-1 SFP TRANSCEIVERS WITH DIGITAL DIAGNOSTICS

## TRPU03xx1x000E1G



### Product Description

The TRPU03-E1G SFP series of fiber optic transceivers with integrated digital diagnostics monitoring functionality provide a quick and reliable interface for long reach (LR) applications. The diagnostic functions, alarm and warning features as described in the Multi-Source Agreement (MSA) document, SFF-8472 (Rev.11.0), are provided via an I<sup>2</sup>C serial interface.

Available products under this series are compliant with applicable SONET/SDH standards for OC-3/STM-1. All modules satisfy Class 1 Laser Safety requirements in accordance with the U.S. FDA/CDRH and international IEC-60825 standards.

The TRPU03-E1G transceivers connect to standard 20-pad SFP connectors for hot plug capability. This allows the system designer to make configuration changes or maintenance by simply plugging in different types of transceivers without removing the power supply from the host system.

The transceivers have colored bail-type latches, which offer an easy and convenient way to release the modules. The latch is compliant with the SFP MSA.

The transmitter design incorporates a highly reliable 1310nm InGaAsP laser and a driver circuit. The receiver features a transimpedance amplifier IC optimized for high sensitivity and wide dynamic range. The transmitter and receiver DATA interfaces are AC-coupled internally. LVTTTL Transmitter Disable control input and Loss of Signal output interfaces are also provided.

The transceivers operate from a single +3.3V power supply over operating case temperature ranges of -5°C to +70°C (COM), -5°C to +85°C (EXT) or -40°C to +85°C (IND). The housing is made of metal for EMI immunity



### Features

- Compliant with SFP MSA
- Compliant with SONET/SDH OC-3/STM-1(155Mb/s)
- SONET/SDH Reaches(SR-1,IR-1,LR-1)
- Lead Free Design & RoHS Compliant
- Digital Diagnostics through Serial Interface
- Internal Calibration for Digital Diagnostics
- Eye Safe (Class 1 Laser Safety)
- Duplex LC Optical Interface
- Wide Operating Case Temperature Option
- Loss of Signal Output & TX Disable Input
- Hot-pluggable
- Single +3.3V Power Supply

### Absolute Maximum Ratings

| Parameter                               |            | Symbol   | Minimum | Maximum  | Units |
|---|------------|----------|---------|----------|-------|
| Storage Temperature Range               |            | $T_{ST}$ | - 40    | + 85     | °C    |
| Operating Case Temperature <sup>1</sup> | Commercial | $T_{OP}$ | - 5     | + 70     | °C    |
|   | Extended   |          | - 5     | + 85     |       |
|   | Industrial |          | - 40    | + 85     |       |
| Supply Voltage                          |            | $V_{CC}$ | 0       | + 5.0    | V     |
| Input Voltage                           |            | $V_{IN}$ | 0       | $V_{CC}$ | V     |

<sup>1</sup> Measured on top side of SFP module at the front center vent hole of the cage.

**Transmitter Performance Characteristics** (Over Operating Case Temperature.  $V_{CC} = 3.13$  to  $3.47V$ )

All parameters guaranteed only at typical data rate

| Parameter   | Symbol  | Minimum | Typical | Maximum | Units |
|---|---|---------|---------|---------|-------|
| Operating Data Rate   | $B$   | -       | 156     | -       | Mb/s  |
| Average Optical Output Power (coupled into single mode fiber), 50% duty cycle | IR-1  | - 15.0  | -       | - 8.0   | dBm   |
|   | LR-1  | - 5.0   | -       | 0       |       |
| Extinction Ratio  | $ER$  | 8.2     | -       | -       | dB    |
| Center Wavelength   | IR-1  | 1261    | 1310    | 1360    | nm    |
|   | LR-1  | 1270    | 1310    | 1360    |       |
| Spectral Width (RMS)  | $\Delta\lambda_{RMS}$   | -       | -       | 3       | nm    |
| Optical Output Eye  | Compliant with Telcordia GR-253-CORE and ITU-T Recommendation G.957 |         |         |         |       |

**Receiver Performance Characteristics** (Over Operating Case Temperature.  $V_{CC} = 3.13$  to  $3.47V$ )

All parameters guaranteed only at typical data rate

| Parameter  | Symbol                 | Minimum         | Typical | Maximum | Units   |
|--|------------------------|-----------------|---------|---------|---------|
| Operating Data Rate  | $B$                    | -               | 156     | -       | Mb/s    |
| Receiver Sensitivity ( $10^{-10}$ BER) <sup>1</sup>        | IR-1                   | -               | -       | - 28.0  | dBm     |
|  | LR-1                   | -               | -       | - 34.0  |         |
| Maximum Input Optical Power ( $10^{-10}$ BER) <sup>1</sup> | IR-1                   | - 8.0           | -       | -       | dBm     |
|  | LR-1                   | - 10.0          | -       | -       |         |
| LOS Thresholds   | Increasing Light Input | IR-1            | -       | - 28.0  | dBm     |
|  |                        | LR-1            | -       | - 34.0  |         |
|  | Decreasing Light Input | $P_{los-}$      | - 45.0  | -       |         |
| LOS Timing Delay   | Increasing Light Input | $t_{loss\_off}$ | -       | 100     | $\mu s$ |
|  | Decreasing Light Input | $t_{loss\_on}$  | 2.3     | 100     |         |
| LOS Hysteresis   | -                      | 0.5             | -       | -       | dB      |
| Wavelength of Operation                                    | $\lambda$              | 1100            | -       | 1600    | nm      |

<sup>1</sup> Specified in average optical input power and measured with 2<sup>23</sup>-1 PRBS at 51Mb/s & 156Mb/s and 1310nm for IR-1 & LR-1.

**Laser Safety:**

All transceivers are Class 1 Laser products per FDA/CDRH and IEC-60825 standards. They must be operated under specified operating conditions.

**Oplink Communications, LLC.**

This product complies with  
21 CFR 1040.10 and 1040.11  
**Meets Class 1 Laser Safety Requirements**

**Transmitter Electrical Characteristics** (Over Operating Case Temperature.  $V_{CC} = 3.13$  to  $3.47V$ )

| Parameter                                     | Symbol        | Minimum | Typical | Maximum        | Units |
|---|---------------|---------|---------|----------------|-------|
| Input Voltage Swing (TD+ & TD-) <sup>1</sup>  | $V_{PP-DIFF}$ | 0.5     | -       | 2.4            | V     |
| Input HIGH Voltage (TX Disable) <sup>2</sup>  | $V_{IH}$      | 2.0     | -       | $V_{CC}$       | V     |
| Input LOW Voltage (TX Disable) <sup>2</sup>   | $V_{IL}$      | 0       | -       | 0.8            | V     |
| Output HIGH Voltage (TX Disable) <sup>3</sup> | $V_{OH}$      | 2.0     | -       | $V_{CC} + 0.3$ | V     |
| Output LOW Voltage (TX Disable) <sup>3</sup>  | $V_{OL}$      | 0       | -       | 0.8            | V     |

<sup>1</sup>Differential peak-to-peak voltage.<sup>2</sup>There is an internal 4.7 to 10k $\Omega$  pull-up resistor to VccT.<sup>3</sup>Open collector compatible, 4.7 to 10 k $\Omega$  pull-up resistor to Vcc (Host Supply Voltage)**Receiver Electrical Characteristics** (Over Operating Case Temperature.  $V_{CC} = 3.13$  to  $3.47V$ )

| Parameter                                     | Symbol        | Minimum | Typical | Maximum        | Units |
|---|---------------|---------|---------|----------------|-------|
| Output Voltage Swing (RD+ & RD-) <sup>1</sup> | $V_{PP-DIFF}$ | 0.6     | -       | 2.0            | V     |
| Output HIGH Voltage (LOS) <sup>2</sup>        | $V_{OH}$      | 2.0     | -       | $V_{CC} + 0.3$ | V     |
| Output LOW Voltage (LOS) <sup>2</sup>         | $V_{OL}$      | 0       | -       | 0.5            | V     |

<sup>1</sup>Differential peak-to-peak voltage across external 100 $\Omega$  load.<sup>2</sup>Open collector compatible, 4.7 to 10k $\Omega$  pull-up resistor to Vcc (Host Supply Voltage).**Electrical Power Supply Characteristics** (Over Operating Case Temperature.  $V_{CC} = 3.13$  to  $3.47V$ )

| Parameter         | Symbol   | Minimum | Typical | Maximum | Units |
|-------------------|----------|---------|---------|---------|-------|
| Supply Voltage    | $V_{CC}$ | 3.13    | 3.3     | 3.47    | V     |
| Power Dissipation | $PW$     | -       | -       | 1       | W     |

**Module Definition**

| MOD_DEF(0)<br>pin 6 | MOD_DEF(1)<br>pin 5 | MOD_DEF(2)<br>pin 4 | Interpretation by Host            |
|---------------------|---------------------|---------------------|-----------------------------------|
| TTL LOW             | SCL                 | SDA                 | Serial module definition protocol |

**Electrical Pad Layout**

|    |                    |    |               |
|----|--------------------|----|---------------|
| 20 | TX GND             | 1  | TX GND        |
| 19 | TD- (TX DATAIN-)   | 2  | TX Fault      |
| 18 | TD+ (TX DATAIN+)   | 3  | TX Disable    |
| 17 | TX GND             | 4  | MOD_DEF(2)    |
| 16 | VccTX              | 5  | MOD_DEF(1)    |
| 15 | VccRX              | 6  | MOD_DEF(0)    |
| 14 | RX GND             | 7  | NO CONNECTION |
| 13 | RD+ (RX DATA OUT+) | 8  | LOS           |
| 12 | RD- (RX DATA OUT-) | 9  | RX GND        |
| 11 | RX GND             | 10 | RX GND        |

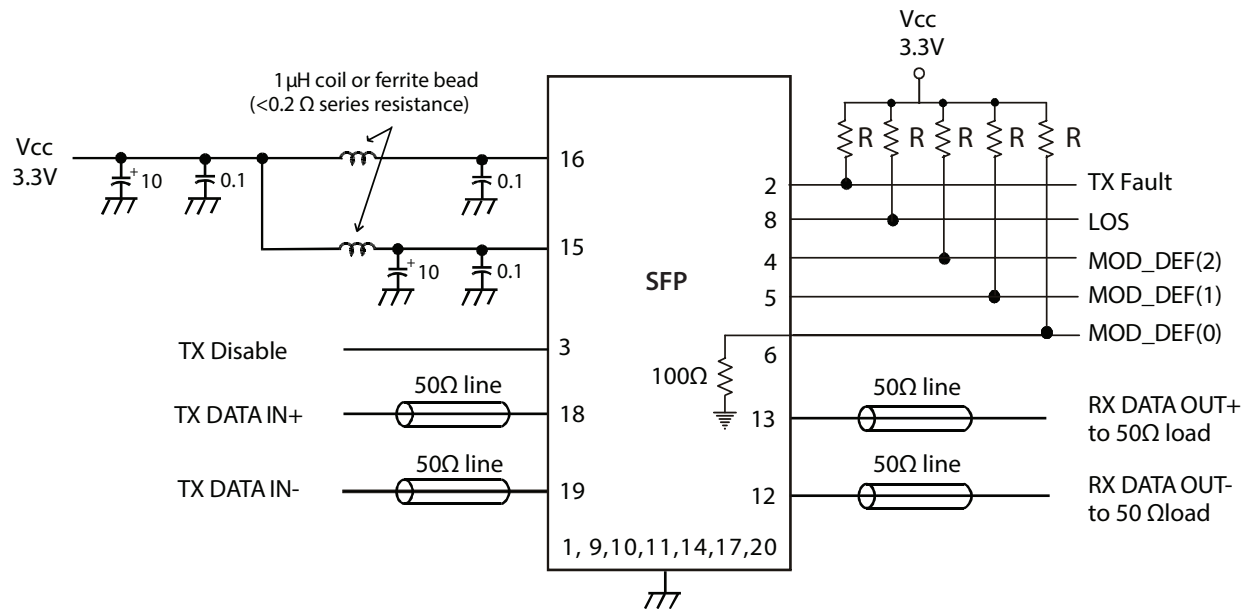
Top of Board

Bottom of Board  
(as viewed thru top of board)**Host Board Connector Pad Layout**

|    |  |    |  |
|----|--|----|--|
| 1  |  | 20 |  |
| 2  |  | 19 |  |
| 3  |  | 18 |  |
| 4  |  | 17 |  |
| 5  |  | 16 |  |
| 6  |  | 15 |  |
| 7  |  | 14 |  |
| 8  |  | 13 |  |
| 9  |  | 12 |  |
| 10 |  | 11 |  |

Toward  
BezelToward  
ASIC

### Example of SFP host board schematic



R: 4.7 to 10kΩ  
CAP Values in μF

### Application Notes

**Electrical interface:** All signal interfaces are compliant with the SFP MSA specification. The high speed DATA interface is differential AC-coupled internally with 0.1μF and can be directly connected to a 3.3V SERDES IC. All low speed control and sense output signals are open collector TTL compatible and should be pulled up with a 4.7-10kΩ resistor on the host board.

**Loss of Signal (LOS):** The Loss of Signal circuit monitors the level of the incoming optical signal and generates a logic HIGH when an insufficient photocurrent is produced.

**TX\_Fault:** The output indicates LOW when the transmitter is operating normally, and HIGH with a laser fault including laser end-of-life. TX Fault is an open collector/drain output and should be pulled up with a 4.7-10kΩ resistor on the host board.

**TX\_Disable:** When the TX Disable pin is at logic HIGH, the transmitter optical output is disabled (less than -45dBm).

**Serial Identification and Monitoring:** The module definition of SFP is indicated by the three module definition pins, MOD\_DEF(0) MOD\_DEF(1) and MOD\_DEF(2). Upon power up, MOD\_DEF(1:2) appear as NC (no connection), and

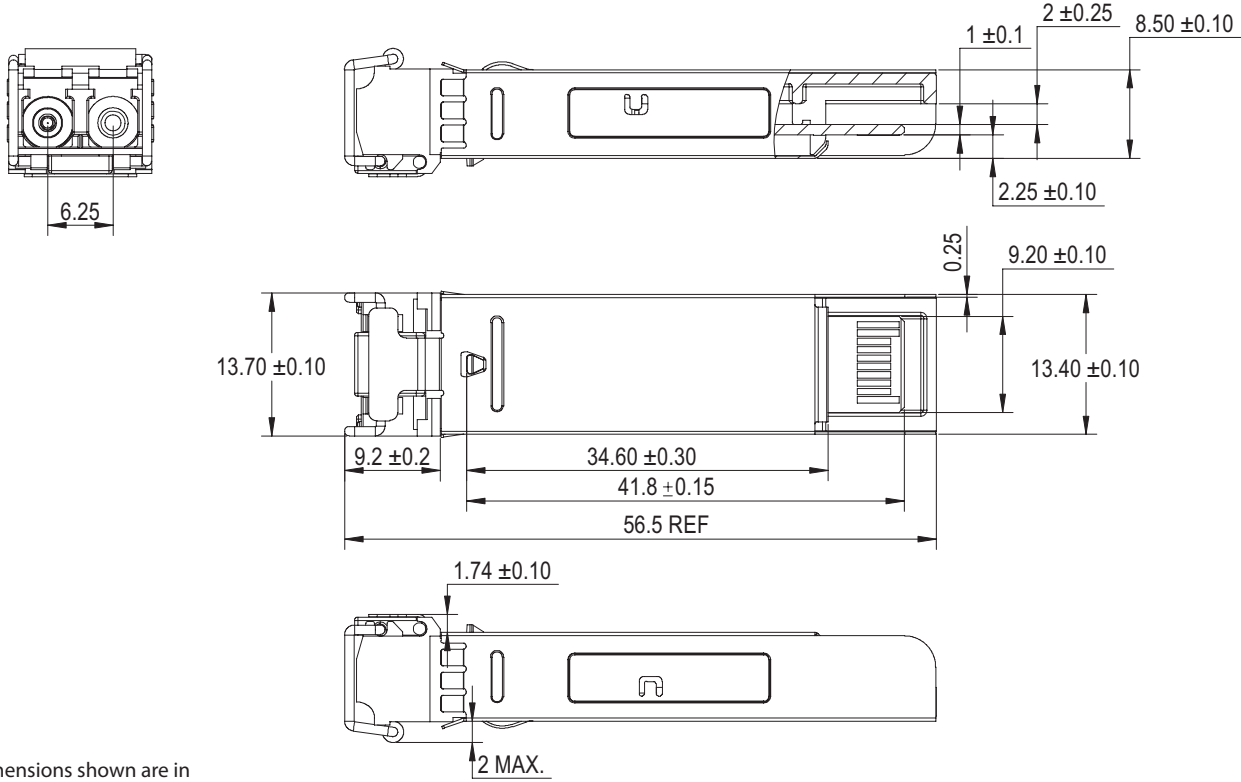
MOD\_DEF(0) is TTL LOW. When the host system detects this condition, it activates the serial protocol (standard two-wire I2C serial interface) and generates the serial clock signal (SCL). The positive edge clocks data into the EEPROM segments of the SFP that are not write protected, and the negative edge clocks data from the SFP.

The serial data signal (SDA) is for serial data transfer. The host uses SDA in conjunction with SCL to mark the start and end of serial protocol activation. The supported monitoring functions are temperature, voltage, bias current, transmitter power, average receiver signal, all alarms and warnings, and software monitoring of TX Fault/LOS. The device is internally calibrated.

The data transfer protocol and the details of the mandatory and vendor specific data structures are defined in the SFP MSA, and SFF-8472, Rev. 11.0.

**Power supply and grounding:** The power supply line should be well-filtered. All 0.1μF power supply bypass capacitors should be as close to the transceiver module as possible.

**Mechanical Package**



All dimensions shown are in [inches] and millimeters. Millimeters are the primary units. Tolerances are in accordance with SFF-8432 Rev.5.

**Ordering Information**

| Part Number                   | Operating Temperature |            | Center Wavelength | Distance <sup>1</sup> | Latch Color |
|-------------------------------|-----------------------|------------|-------------------|-----------------------|-------------|
| TRPU03AI1C000E1G <sup>2</sup> | - 5°C to +70°C        | Commercial | 1310nm            | 15km                  | Yellow      |
| TRPU03EL1C000E1G              | - 5°C to +70°C        | Commercial | 1310nm            | 40km                  | Red         |
| TRPU03AI1I000E1G <sup>2</sup> | - 40°C to +85°C       | Industrial | 1310nm            | 15km                  | Yellow      |
| TRPU03EL1I000E1G              | - 40°C to +85°C       | Industrial | 1310nm            | 40km                  | Red         |
| TRPU03AI1E000E1G <sup>2</sup> | - 5°C to +85°C        | Extended   | 1310nm            | 15km                  | Yellow      |
| TRPU03EL1E000E1G              | - 5°C to +85°C        | Extended   | 1310nm            | 40km                  | Red         |

<sup>1</sup> These are target distances to be used for classifications and not for specifications, per Telcordia GR-253-CORE/ITU-T Recommendation G.957

<sup>2</sup> The TRPU03AI1C000E1G and TRPU03AI1I000E1G can also be used for short reach SR-1/I-1 applications