# Multi-rate OC-12/STM-4 SFP Transceivers with Digital Diagnostics

## TRPA12M SM




### Product Description

The TRPA12M SFP series of multi-rate fiber optic transceivers with integrated digital diagnostics monitoring functionality provide a quick and reliable interface for OC-12 short reach (SR), intermediate reach (IR) and long reach (LR) applications. The diagnostic functions, alarm and warning features as described in the Multi-Source Agreement (MSA) document, SFF-8472 (Rev. 9.3), are provided via an $I^2C$ serial interface.

Available products under this series are compliant with SONET/SDH standards for OC-12/STM-4 applications and are capable of operating down to 155Mb/s data rate. The SR-1 and IR-1 versions are compliant with OC-12/STM-4 and OC-3/STM-1 interface standards. All modules satisfy Class I Laser Safety requirements in accordance with the U.S. and international standards as described in the FDA/CDRH and IEC-60825 documents, respectively.

The TRPA12M multi-rate 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 shutting down the power supply of 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 or 1550nm InGaAsP laser and an integrated 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. LVTTL Transmitter Disable control input and Loss of Signal output interfaces are also provided.

The transceivers operate from a single +3.3V power supply over two operating case temperature ranges of -5°C to +70°C and -40°C to +85°C.

### Features

- ☑ Compliant with SONET/SDH OC-12/STM-4 (622Mb/s)
- ☑ Compatible with SONET/SDH OC-3/STM-1 (155Mb/s)
- ☑ Compatible with SFP MSA
- ☑ SONET/SDH Reaches (SR-1, IR-1, LR-1 & LR-2)
- ☑ Digital Diagnostics through Serial Interface
- ☑ Internal Calibration for Digital Diagnostics
- ☑ Eye Safe (Class I Laser Safety)
- ☑ Duplex LC Optical Interface
- ☑ -40°C to +85°C Operating Temperature Option
- ☑ Excellent EMI & ESD Protection
- ☑ Hot-pluggable
- ☑ TX Fault & Loss of Signal Outputs
- ☑ TX Disable Input
- ☑ Single +3.3V Power Supply

### Absolute Maximum Ratings

| Parameter | | Symbol | Minimum | Maximum | Units |
|---|---|---|---|---|---|
| Storage Temperature | | $T_{st}$ | - 40 | + 85 | °C |
| Operating Case Temperature [1] | "B" option | $T_{op}$ | - 5 | + 70 | °C |
| | "A" option | | - 40 | + 85 | |
| Supply Voltage | | $V_{cc}$ | 0 | + 5.0 | V |
| Input Voltage | | $V_{in}$ | 0 | + 5.0 | V |

[1] 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)

| Parameter | | Symbol | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|---|---|
| Operating Data Rate | | $B$ | 125 | - | 622 | Mb/s |
| Average Optical Output Power (coupled into single mode fiber), 50% duty cycle | SR-1 & IR-1 | $P_O$ | - 15.0 | - 11.0 | - 8.0 | dBm |
| | LR-1 & LR-2 | | - 3.0 | - 1.0 | + 2.0 | |
| Transmitter OFF Output Power | | $P_{OFF}$ | - | - | - 45.0 | dBm |
| Extinction Ratio | SR-1 & IR-1 | $P_{hi}/P_{lo}$ | 8.2 | - | - | dB |
| | LR-1 & LR-2 | | 10 | - | - | |
| Center Wavelength [1] | SR-1 | $\lambda_C$ | 1261 | 1310 | 1360 | nm |
| | IR-1 | | 1274 | 1310 | 1356 | |
| | | | 1293 | 1310 | 1334 | |
| | LR-1 | | 1280 | 1310 | 1335 | |
| | LR-2 | | 1480 | 1550 | 1580 | |
| Spectral Width (RMS) [1] | SR-1 | $\Delta\lambda_{RMS}$ | - | - | 4.0 | nm |
| | IR-1 | | - | - | 2.5 or 4.0 | |
| Spectral Width (-20dB) | LR-1 & LR-2 | $\Delta\lambda_{20}$ | - | - | 1.0 | nm |
| Side Mode Suppression Ratio | LR-1 & LR-2 | $SMSR$ | 30 | - | - | dB |
| Optical Output Eye | Compliant with Telcordia GR-253-CORE and ITU-T Recommendation G.957 | | | | | |

[1] For IR version, the center wavelength is either 1274nm ≤ λc ≤ 1356nm for $\Delta\lambda_{RMS}$ ≤ 2.5nm
or 1293nm ≤ λc ≤ 1334nm for $\Delta\lambda_{RMS}$ ≤ 4.0nm

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

| Parameter | | Symbol | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|---|---|
| Operating Data Rate | | $B$ | 125 | - | 622 | Mb/s |
| Receiver Sensitivity ($10^{-10}$ BER) [1] | | $P_{min}$ | - 28.0 | - 31.0 | - | dBm |
| Maximum Input Optical Power ($10^{-10}$ BER) [1] | | $P_{max}$ | - 7.0 | - 3.0 | - | dBm |
| LOS Thresholds [1] | Increasing Light Input | $P_{los+}$ | - | - | - 28.0 | dBm |
| | Decreasing Light Input | $P_{los-}$ | - 45.0 | - | - | |
| LOS Timing Delay | Increasing Light Input | $t_loss_off$ | - | - | 100 | µs |
| | Decreasing Light Input | $t_loss_on$ | 2.3 | - | 100 | |
| LOS Hysteresis | | - | 0.5 | 1.5 | - | dB |
| Wavelength of Operation | | $\lambda$ | 1100 | - | 1600 | nm |
| Receiver Reflectance (LR-2) | | - | - | - | - 27.0 | dB |

[1] Specified in average optical input power and measured at 155Mb/s & 622Mb/s and 1310nm wavelength (1550nm for LR-2) with $2^{23}$-1 PRBS, and at 125Mb/s with $2^7$-1 PRBS.

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

**Oplink Communications, Inc.**
DATE OF MANUFACTURE:

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

## Transmitter Electrical Interface (Over Operating Case Temperature, $V_{CC}$ = 3.13 to 3.47V)

| Parameter | Symbol | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|---|
| Input Voltage Swing (TD+ & TD-) [1] | $V_{PP-DIF}$ | 0.25 | - | 2.4 | V |
| Input HIGH Voltage (TX Disable) [2] | $V_{IH}$ | 2.0 | - | $V_{CC}$ | V |
| Input LOW Voltage (TX Disable) [2] | $V_{IL}$ | 0 | - | 0.8 | V |
| Output HIGH Voltage (TX Fault) [3] | $V_{OH}$ | 2.0 | - | $V_{CC}$ + 0.3 | V |
| Output LOW Voltage (TX Fault) [3] | $V_{OL}$ | 0 | - | 0.8 | V |

[1] Differential peak-to-peak voltage.
[2] There is an internal 4.7 to 10kΩ pull-up resistor to *VccT*.
[3] Open collector compatible, 4.7 to 10kΩ pull-up resistor to *Vcc* (Host Supply Voltage).

## Receiver Electrical Interface (Over Operating Case Temperature, $V_{CC}$ = 3.13 to 3.47V)

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

[1] Differential peak-to-peak voltage across external 100Ω load.
[2] Open collector compatible, 4.7 to 10kΩ pull-up resistor to *Vcc* (Host Supply Voltage).

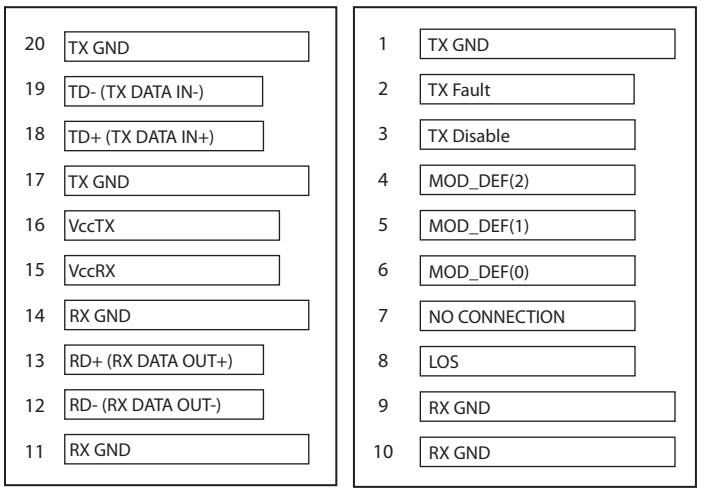
## Electrical Power Supply Characteristics (Over Operating Case Temperature, $V_{CC}$ = 3.13 to 3.47V)

| Parameter | Symbol | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | 3.13 | 3.3 | 3.47 | V |
| Supply Current | $I_{CC}$ | - | 210 | 275 | mA |

## Module Definition

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

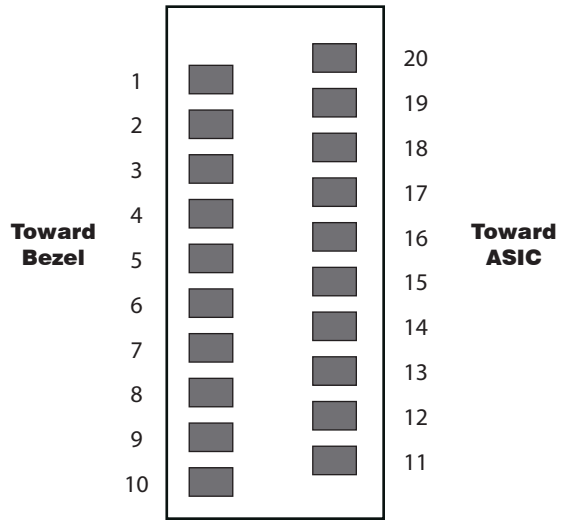
### Electrical Pad Layout



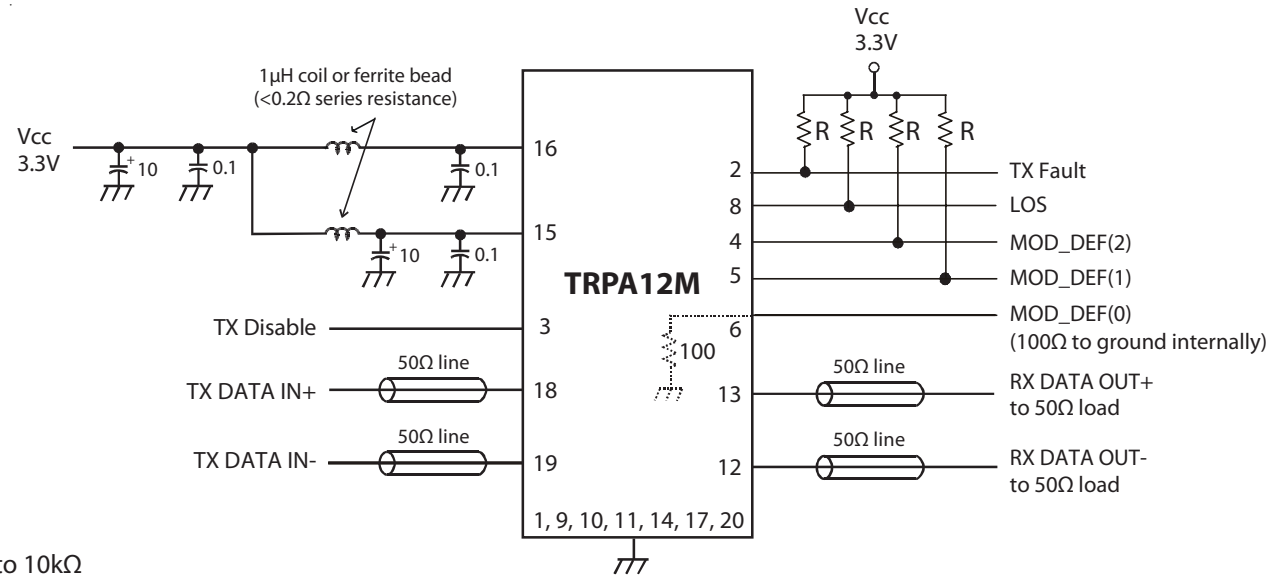

Top of Board

Bottom of Board
(as viewed thru top of board)

### Host Board Connector Pad Layout



**Example of SFP host board schematic**




## 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 Fault is non-latching (automatically deasserts when fault goes away).

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

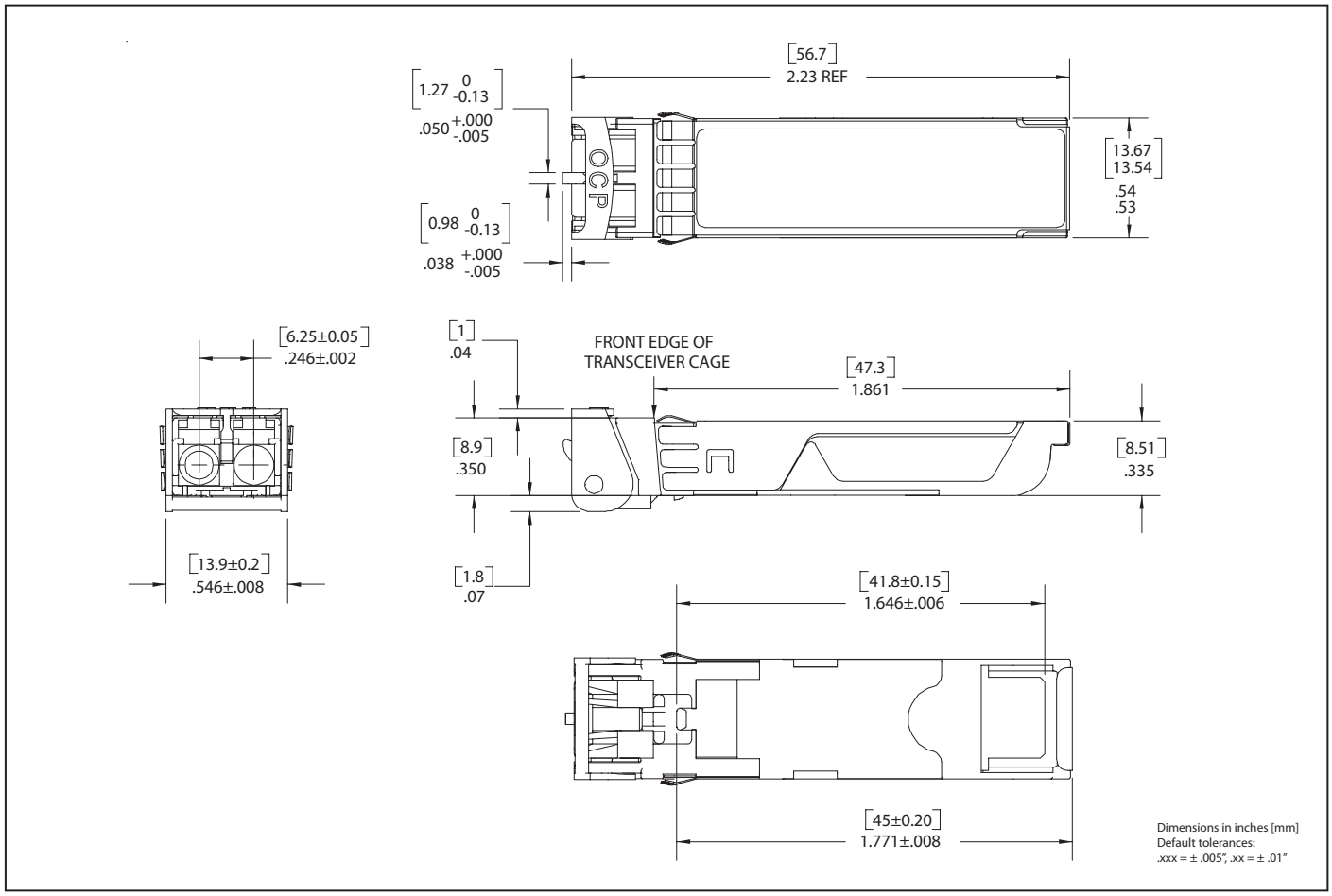
**Serial Identification and Monitoring:** The module definition of SFP is indicated by the three module definition pins, MOD_DEF(0), MOD_DEF(1) and MOD_DEF(2). Upon power up, MOD_DEF(1:2) appear as NC (no connection), and MOD_DEF(0) is TTL LOW. When the host system detects this condition, it activates the serial protocol (standard two-wire $I^2C$ 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. 9.3.

**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.

## Package Outline




## Ordering Information

| Model Name | Operation Temperature | Latch Color | Nominal Wavelength | SONET/SDH Standad | Reach [1] |
|---|---|---|---|---|---|
| TRPA12S1ABAM | - 5°C to +70°C | Gray | 1310nm | SR-1/I-4 | 12/2km |
| TRPA12I1ABYM | - 5°C to +70°C | Yellow | 1310nm | IR-1/S-4.1 | 21/15km |
| TRPA12L1GBRM | - 5°C to +70°C | Red | 1310nm | LR-1/L-4.1 | 42/40km |
| TRPA12L2GBWM | - 5°C to +70°C | White | 1550nm | LR-2/L-4.2 | 85/80km |
| TRPA12S1AAAM | 40°C to +85°C | Gray | 1310nm | SR-1/I-4 | 12/2km |
| TRPA12I1AAYM | 40°C to +85°C | Yellow | 1310nm | IR-1/S-4.1 | 21/15km |
| TRPA12L1GARM | 40°C to +85°C | Red | 1310nm | LR-1/L-4.1 | 42/40km |
| TRPA12L2GCWM | 40°C to +85°C | White | 1550nm | LR-2/L-4.2 | 85/80km |

[1] These are target distances to be used for classification and not for specification, per Telcordia GR-253-CORE/ITU-T Recommendation G.957.

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