



## QSFP28

### EQ2Bxx10X-3LCD10

#### 100Gb/s QSFP28 BIDI LR1 10KM Single Lambda Optical Transceiver

- Hot-pluggable QSFP28 form factor
- Support Ethernet CAUI-4
- Support OTU4
- High Sensitivity PD Receiver
- Operation case temperature C/E/I-Temp
- Single 3.3V power supply
- Aligned with IEEE 802.3bs and 100G Lambda MSA
- Simplex LC receptacles
- I2C management interface
- RoHS-6 compliant
- 4X28G serial Interface(CEI-28G-VSR)



### Applications

- Transmission over 10km
- Ethernet / OTN OTU4

### General Description

The 100G LR1 BIDI Optical Transceiver module is a optical transceiver module designed for single channel O-band over 10km optical transmissions. The module converts 4x25Gb/s(4x28Gb/s) NRZ electrical input data to single channel optical signals for 100Gb/s optical transmission, Reversely, on the receiver side, the module optically converts a 100Gb/s optical input data to 4x25Gb/s (4x28Gb/s) NRZ electrical output data.

The optical interface of the module is a simplex LC and is compliant to the QSFP28 MSA, 100G Lambda MSA. Also it support Dual Rate for 112GBASE-OTU4,It provides an excellent solution for 100G data transmission up to 10km single mode fiber.

## Functional Description

Electrical interface: All signal interfaces are compliant with the QSFP28 MSA specifications. The high speed DATA interface is differential AC-coupled internally and can be directly connected to a 3.3V SERDES IC. Hardware control and status reporting pins include a 2-wire serial interface (SCL and SDA) and five 3.3V LVTTTL hardware signals (ModSelL, ResetL, LPMode, ModPrsL, and IntL). The 2-wire interface pins are 3.3V LVCOMS compatible. Hosts shall use pull-up resistor connected to Vcc\_host on each of the 2-wire interface SCL, SDA, and all low speed status outputs.

ModSelL: The ModSelL is an input pin. When held low by the host, the module responds to 2-wire serial communication commands. The ModSelL allows the use of multiple modules on a single 2-wire interface bus. When the ModSelL is "High", the module shall not respond to or acknowledge any 2-wire interface communication from the host. ModSelL signal input node shall be biased to the "High" state in the module. In order to avoid conflicts, the host system shall not attempt 2-wire interface communications within the ModSelL de-assert time after any modules are deselected. Similarly, the host shall wait at least for the period of the ModSelL assert time before communicating with the newly selected module. The assertion and de-asserting periods of different modules may overlap as long as the above timing requirements are met.

ResetL: The ResetL pin shall be pulled to Vcc in the module. A low level on the ResetL pin for longer than the minimum pulse length ( $t_{Reset\_init}$ ) initiates a complete module reset, returning all user module settings to their default state. Module Reset Assert Time ( $t_{init}$ ) starts on the rising edge after the low level on the ResetL pin is released. During the execution of a reset ( $t_{init}$ ) the host shall disregard all status bits until the module indicates a completion of the reset interrupt. The module indicates this by asserting "low" an IntL signal with the Data\_Not\_Ready bit negated. Note that on power up (including hot insertion) the module should post this completion of reset interrupt without requiring a reset.

LPMode: The LPMode pin shall be pulled up to Vcc in the module. The pin is a hardware control used to put modules into a low power mode when high. By using the LPMode pin and a combination of the Power\_override, and Power\_set software control bits (Address A0h, byte 93 bits 0,1), the host controls how much power a module can dissipate. The allowed QSFP28 powerconsumption is shown in below truth table.

| LPMode<br>PIN<br>State | Power_<br>override bit | Power_<br>set bit | Power Allowed |
|------------------------|------------------------|-------------------|---------------|
| 1                      | 0                      | X                 | 1.5W          |
| 0                      | 0                      | X                 | 4W            |

|   |   |   |      |
|---|---|---|------|
| X | 1 | 1 | 1.5W |
| X | 1 | 0 | 4W   |

ModPrsL: ModPrsL is pulled up to Vcc\_Host on the host board and grounded in the module. The ModPrsL is asserted "Low" when inserted and deasserted "High" when the module is physically absent from the host connector.

IntL: IntL is an output pin. When IntL is "Low", it indicates a possible module operational fault or a status critical to the host system. The host identifies the source of the interrupt using the 2wire serial interface. The IntL pin is an open collector output and shall be pulled to host supply voltage on the host board. The INTL pin is deasserted "High" after completion of reset, when byte 2 bit 0 (Data Not Ready) is read with a value of '0' and the flag field is read (see SFF-8636).

## Schematic Diagram

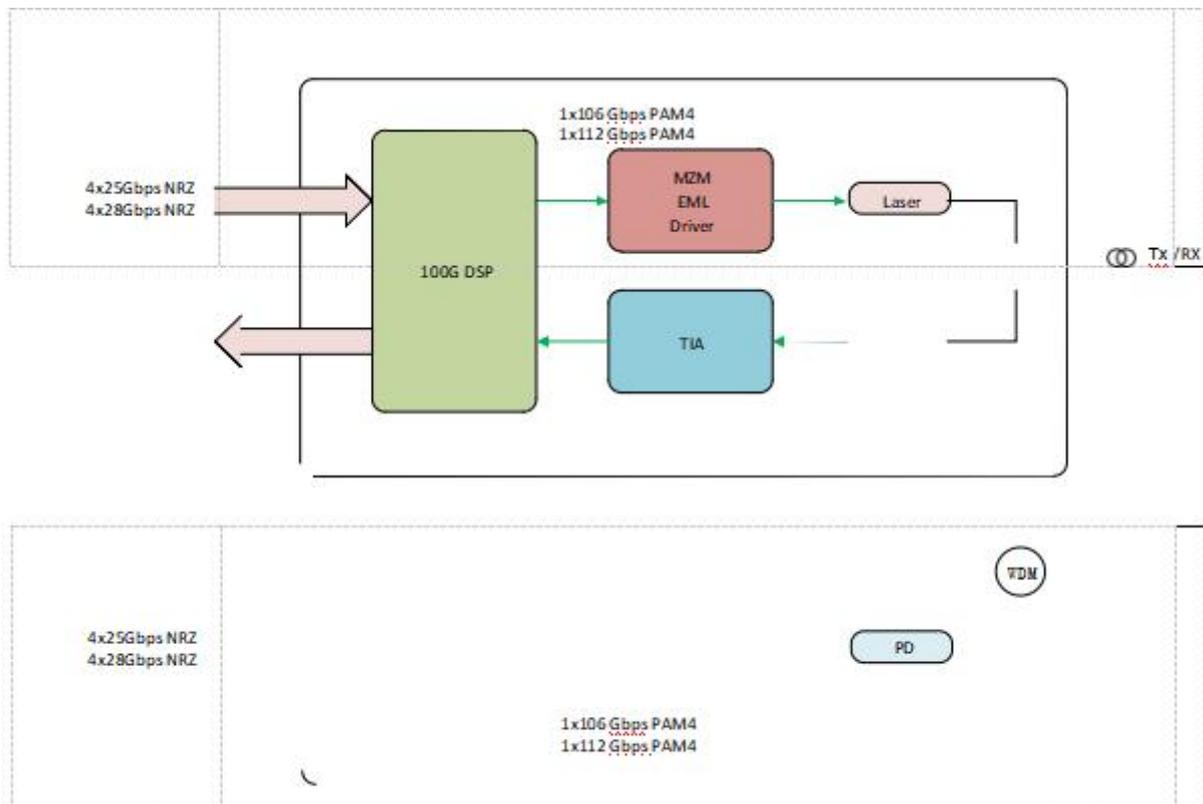


Figure 1. Block Diagram

## Module Connector Pad Layout

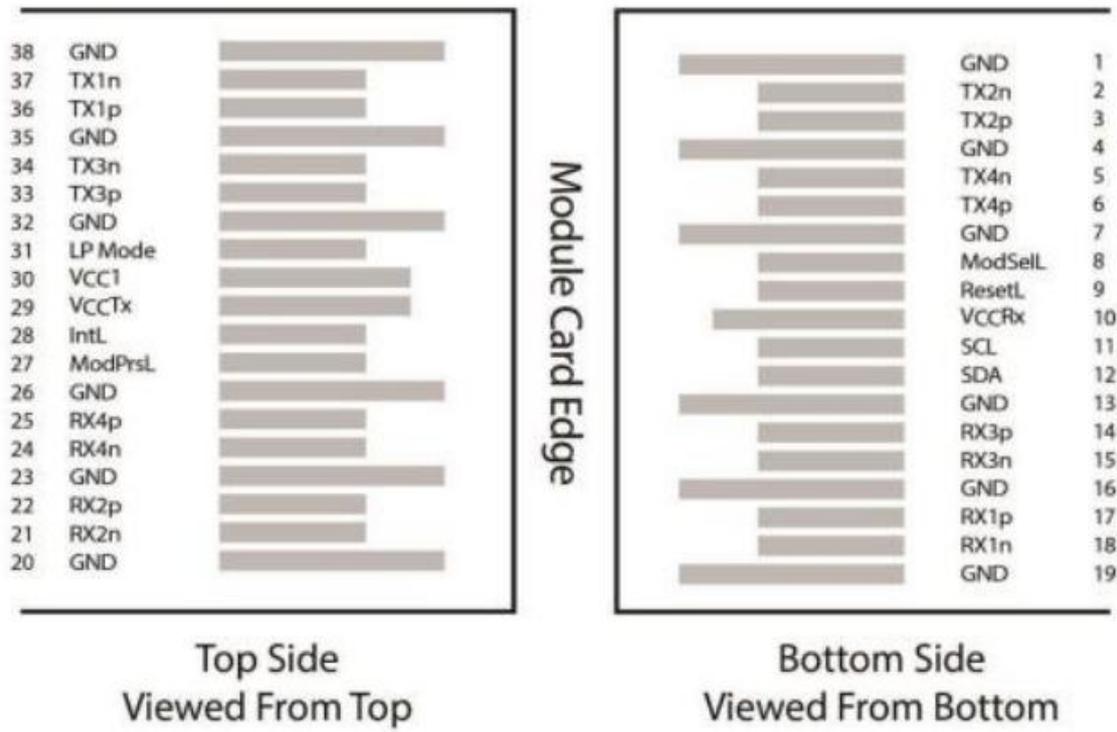


Figure 2. QSFP28 Connector Pad layout

## Module Connector Pad Definition

| PIN | Logic  | Symbol  | Name/Description                    | Notes |
|-----|--------|---------|-------------------------------------|-------|
| 1   | GND    | GND     | Ground                              | 1     |
| 2   | CML    | Tx2n    | Transmitter Inverted Data Input     | 2     |
| 3   | CML    | Tx2p    | Transmitter Non-Inverted Data Input | 3     |
| 4   | GND    | GND     | Ground                              | 4     |
| 5   | CML    | Tx4n    | Transmitter Inverted Data Input     | 5     |
| 6   | CML    | Tx4p    | Transmitter Non-Inverted Data Input | 6     |
| 7   | GND    | GND     | Ground                              | 7     |
| 8   | LVTTL  | ModSelL | Module Select                       | 8     |
| 9   | LVTTL  | ResetL  | Module Reset                        | 9     |
| 10  | VCC    | VCC_Rx  | +3.3V Receiver Power Supply         | 10    |
| 11  | LVCMOS | SCL     | 2-wire Serial Interface Clock       | 11    |
| 12  | LVCMOS | SDA     | 2-wire Serial Interface Data        | 12    |
| 13  | GND    | GND     | Ground                              | 13    |

|    |        |         |  |    |
|----|--------|---------|--|----|
| 14 | CML    | Rx3p    | Receiver Non-Inverted Data Output          | 14 |
| 15 | CML    | Rx3n    | Receiver Inverted Data Output              | 15 |
| 16 | GND    | GND     | Ground                                     | 16 |
| 17 | CML    | Rx1p    | Receiver Non-Inverted Data Output          | 17 |
| 18 | CML    | Rx1n    | Receiver Inverted Data Output              | 18 |
| 19 | GND    | GND     | Ground                                     | 19 |
| 20 | GND    | GND     | Ground                                     | 20 |
| 21 | CML    | Rx2n    | Receiver Inverted Data Output              | 21 |
| 22 | CML    | Rx2p    | Receiver Non-Inverted Data Output          | 22 |
| 23 | GND    | GND     | Ground                                     | 23 |
| 24 | CML    | Rx4n    | Receiver Inverted Data Output              | 24 |
| 25 | CML    | Rx4p    | Receiver Non-Inverted Data Output          | 25 |
| 26 | GND    | GND     | Ground                                     | 26 |
| 27 | LVTTTL | ModPrsL | Module Present, grounded inside the module | 27 |
| 28 | LVTTTL | IntL    | Interrupt                                  | 28 |
| 29 | VCC    | VCC_Tx  | +3.3V Transmitter Power Supply             | 29 |
| 30 | VCC    | VCC1    | +3.3V Power Supply                         | 30 |
| 31 | LVTTTL | LPMMode | Low Power Mode, active high                | 31 |
| 32 | GND    | GND     | Ground                                     | 32 |
| 33 | CML    | Tx3p    | Transmitter Non-Inverted Data Input        | 33 |
| 34 | CML    | Tx3n    | Transmitter Inverted Data Input            | 34 |
| 35 | GND    | GND     | Ground                                     | 35 |
| 36 | CML    | Tx1p    | Transmitter Non-Inverted Data Input        | 36 |
| 37 | CML    | Tx1n    | Transmitter Inverted Data Input            | 37 |
| 38 | GND    | GND     | Ground                                     | 38 |

## Absolute Maximum Ratings

| Parameter                            | Symbol | Min | Max | Units | Notes |
|--------------------------------------|--------|-----|-----|-------|-------|
| Maximum Supply Voltage               | VCC    | 0   | 3.6 | V     |       |
| Storage Temperature                  | TS     | -40 | 85  | °C    |       |
| Relative Humidity (non-condensation) | RH     | 0   | 85  | %     |       |
| Damage Threshold                     | THd    | 5.8 |     | dBm   |       |

## Recommended Operating Conditions

| Parameter         | Symbol | Min   | Typical | Max                        | Units | Notes |
|-------------------|--------|-------|---------|----------------------------|-------|-------|
| Supply Voltage    | Vcc    | 3.135 | 3.3     | 3.465                      | V     |       |
| Supply Current    | Icc    |       |         | 1.21                       | A     |       |
| Power Consumption |        |       |         | 4(C-Temp)<br>4.5(E/I Temp) | W     |       |
| Case Temperature  | C-Temp | 0     |         | 70                         | °C    |       |
|                   | E-Tem  | -5    |         | 85                         |       |       |
|                   | I-Temp | -40   |         | 85                         |       |       |
| Link Distance     | D      |       |         | 10                         | km    |       |

## Electrical Characteristics

The following electrical characteristics are defined over the Recommended Operating Environment unless otherwise specified.

| Parameter   | Symbol | Min            | Typical | Max             | Units |
|---|--------|----------------|---------|-----------------|-------|
| <b>Transmitter (each Lane)</b>                          |        |                |         |                 |       |
| Signaling rate  | Rate   | 25.78 (CAUI-4) |         |                 | Gbps  |
|   |        | 27.95 (OTU4)   |         |                 |       |
| Differential Input Impedance                            | Zd     | -              | 100     | -               | Ω     |
| Differential Input Voltage per lane                     | -      | -              | -       | 900             | mV    |
| Input impedance mismatch                                | -      | -              | -       | 10              | %     |
| Input High Voltage                                      | VIH    | 2              | -       | Vcc+0.3         | V     |
| Input LOW Voltage                                       | VIL    | -0.3           | -       | 0.8             | V     |
| <b>Receiver (each Lane)</b>                             |        |                |         |                 |       |
| Signaling rate  | Rate   | 25.78 (CAUI-4) |         |                 | Gbps  |
|   |        | 27.95 (OTU4)   |         |                 |       |
| Common mode voltage                                     | Vcm    | -350           | -       | 2850            | mV    |
| Common Mode Noise, rms                                  | -      | -              | -       | 17.5            | mV    |
| Differential Termination Resistance Mismatch (at 1 MHz) | -      | -              | -       | 10              | %     |
| Differential Return Loss (SDD22)                        | -      | -              | -       | Per CEI-28G-VSR | dB    |

|  |      |      |   |                     |    |
|--|------|------|---|---------------------|----|
| Common Mode to<br>Differential conversion a<br>nd Differential to<br>Common Mode<br>Conversion (SDC22,SCD22) | -    | -    | - | Per CEI-<br>28G-VSR | dB |
| Common Mode Return<br>Loss (SCC22) -<br>from 250 MHz to 30 GHz   | -    | -    | - | -2                  | -  |
| Transition Time: 20/80%  | -    | 9.5  | - | -                   | ps |
| Vertical Eye Closure   | VEC  | -    | - | 6.5                 | dB |
| Eye width at 10-<br>15robability   | EW15 | 0.57 | - | -                   | UI |
| Eye height at 10- 15<br>probability  | EH15 | 228  | - | -                   | mV |

## Optical Characteristics

| Parameter   | Symbol    | Min                      | Typical | Max   | Units |
|---|-----------|--------------------------|---------|-------|-------|
| <b>Transmitter (each Lane)</b>  |           |                          |         |       |       |
| Data Rate (each Lane)   |           | 53.125 ± 100 ppm(CAUI-4) |         |       | GBd   |
|   |           | 56.25 ± 100 ppm(OTU4)    |         |       |       |
| Modulation Format   |           | PAM4                     |         |       |       |
| Wavelength  | UP-LINK   | 1271+/-6.5               |         |       | nm    |
|   | DOWN-LINK | 1331+/-6.5               |         |       |       |
| Side-mode Suppression<br>ratio  | SMSR      | 30                       |         |       | dB    |
| Average launch power <sup>1</sup>   | PAVG      | - 1.9                    |         | 4.8   | dBm   |
| Outer Optical Modulation<br>Amplitude (OMA <sub>outer</sub> )<br>TECQ<1.4dB<br>TECQ>1.4dB | POMA      | 1.1<br>0.3+TECQ          |         | 5     | dBm   |
| Transmitter and<br>Dispersion penalty <sup>2</sup>  | TDECQ     |                          |         | 3.4   | dB    |
| TECQ  | TECQ      |                          |         | 3.4   | dB    |
| TDECQ-TECQ  (max)   |           |                          |         | 2.5   | dB    |
| Extinction Ratio  |           | 3.5                      |         |       | dB    |
| Optical Return Loss<br>Tolerance  |           |                          |         | 15.6  | dB    |
| Transmitter Reflectance <sup>3</sup>  | RL        |                          |         | -26   | dB    |
| Average Launch Power OFF Transmitter  | Poff      |                          |         | - 15  | dBm   |
| RIN <sub>15.6</sub> OMA   | RIN       |                          |         | - 136 | dB/Hz |
| <b>Receiver (each Lane)</b>   |           |                          |         |       |       |

|   |           |                          |  |                     |     |
|---|-----------|--------------------------|--|---------------------|-----|
| Data Rate (each Lane)   | Rate      | 53.125 ± 100 ppm(CAUI-4) |  |                     | GBd |
|   |           | 56.25 ± 100 ppm(OUT4)    |  |                     |     |
| Modulation Format   |           | PAM4                     |  |                     |     |
| Lane Wavelength   | UP-LINK   | 1331+/-6.5               |  |                     | nm  |
|   | DOWN-LINK | 1271+/-6.5               |  |                     |     |
| Damage Threshold <sup>4</sup>   |           | 5.8                      |  |                     | dBm |
| Average receive power <sup>5</sup>                                      |           | -8.2                     |  | 4.8                 | dBm |
| Receive Power(OMAouter)   |           |                          |  | 5                   | dBm |
| Receiver Reflectance  |           |                          |  | -26                 | dB  |
| Receiver sensitivity(OMAouter)  |           |                          |  | Max(-6.1, TECQ-7.5) | dBm |
| Stressed receiver sensitivity (OMAouter), each laned (max) <sup>6</sup> | SRS       |                          |  | -4.1                | dBm |
| Receiver Reflectance  |           |                          |  | -26                 | dB  |
| LOS Assert  | LOSA      | -20                      |  | -14                 | dBm |
| LOS De-assert   | LOSD      |                          |  | -11                 | dBm |
| LOS Hysteresis  | LOSH      | 0.5                      |  |                     | dB  |
| <b>Conditions of Stress Receiver Sensitivity Test</b>                   |           |                          |  |                     |     |
| Stressed eye closure for PAM4 lane under test (SECQ),                   |           |                          |  | 3.4                 | dB  |

Notes:

1. Average launch power (min) is informative and not the principal indicator of signal strength. A transmitter with launch power below this value cannot be compliant; however, a value above this does not ensure compliance.
2. TDECQ test based on 10km fiber.
3. Transmitter Reflectance is defined looking into the transmitter.
4. The receiver shall be able to tolerate, without damage, continuous exposure to a modulated optical input signal having this power level on one lane.
5. Average receive power (min) is informative and not the principal indicator of signal strength. A received power below this value cannot be compliant; however, a value above this does not ensure compliance.
6. Measured with conformance test signal at TP3 for the BER specified in IEEE Std 802.3.

## Interacing The Transceiver

Host can determine the characteristic and status of the transceiver through a 2-wire common management interface. The interface also provides host a mechanism to control the operation of a module. SFF-8636 describes the interface details such as memory map and communication protocol used to transfer information between host and a module.

The common memory map is arranged into a single lower page address space (A0h) of 128 bytes and multiple upper address pages. This structure permits timely access to addresses in the lower page such as interrupt flags

and monitors. Less time critical entries such as serial ID information and threshold settings are available with the page select function.

## Lower Memory Overview

| Address | Size | Subject Area              | Description  |
|---------|------|---------------------------|--|
| 0-3     | 4    | ID and Status Area        | Module ID from SFF-8024 list, version number, Type and status  |
|         |      |                           | Flat mem indication, CLEI present indicator, Maximum TWI speed, Current state of Module, Current state of the Interrupt signal |
| 4-7     | 4    | Lane Flag Summary         | Flag summary of all lane flags on pages 10h-1Fh  |
| 8- 13   | 6    | Module-Level Flags        | All flags that are not lane or data path specific  |
| 14-25   | 12   | Module-Level Monitors     | Monitors that are not lane or data path specific   |
| 26-30   | 5    | Module Global Controls    | Controls applicable to the module as a whole   |
| 31-36   | 6    | Module-Level Flag Masks   | Masking bits for the Module-Level flags  |
| 37-38   | 2    | CDB Status Area           | Status of most recent CDB command  |
| 39-40   | 2    | Module Firmware Version   | Module Firmware Version.   |
| 41-63   | 23   | Reserved Area             | Reserved for future standardization  |
| 64-82   | 19   | Custom Area               | Vendor or module type specific use   |
| 83-84   | 2    | Inactive Firmware Version | Version Number of Inactive Firmware. Values of 00h indicates module supports only a single image.                              |
| 85- 117 | 33   | Application Advertising   | Combinations of host and media interfaces that are supported by module data path(s)  |
| 118-125 | 8    | Password Entry and Change |  |
| 126     | 1    | Bank Select Byte          | Bank address of currently visible Page   |
| 127     | 1    | Page Select Byte          | Page address of currently visible Page   |

## Digital Diagnostic Functions

The following digital diagnostic characteristics are defined over the normal operating conditions unless otherwise specified.

| Parameter                             | Symbol    | Min  | Max | Units | Notes                            |
|---------------------------------------|-----------|------|-----|-------|----------------------------------|
| Temperature monitor absolute error    | DMI_Temp  | -3   | 3   | degC  | Over operating temperature range |
| Supply voltage monitor absolute error | DMI_VCC   | -0.1 | 0.1 | V     | Over full operating range        |
| Channel RX power monitor              | DMI_RX_Ch | -3   | 3   | dB    | 1                                |

|  |              |       |     |    |   |
|--|--------------|-------|-----|----|---|
| absolute error                             |              |       |     |    |   |
| Channel Bias current monitor               | DMI_Ibias_Ch | - 10% | 10% | mA |   |
| Channel TX power monitor<br>absolute error | DMI_TX_Ch    | -3    | 3   | dB | 1 |

## Notes:

Due to measurement accuracy of different single mode fibers, there could be an additional +/-1 dB fluctuation, or a +/- 3 dB total accuracy.

## Mechanical Dimensions

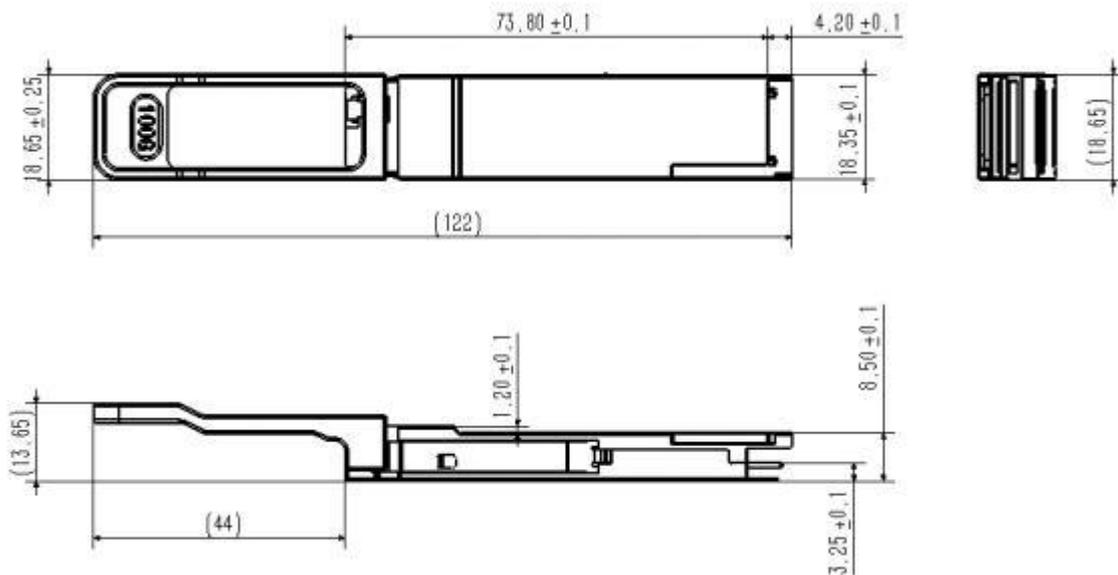


Figure 5. Mechanical Schematic

## ESD

This transceiver is specified as ESD threshold 1kV for high speed data pins and 2kV for all other electrical input pins, tested per MIL-STD-883, Method 3015.4 /JESD22-A114-A (HBM). However, normal ESD precautions are still required during the handling of this module. This transceiver is shipped in ESD protective packaging. It should be removed from the packaging and handled only in an ESD protected environment.

## Laser Safety

This is a Class 1 Laser Product according to EN/IEC 60825-1:2014. This product Complies with 21 CFR 1040.10 and 1040.11 except for conformance with IEC 60825-1 Ed. 3., as described in Laser Notice No. 56, dated May 8, 2019. Caution: Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

## Compatibility Test

In order to ensure the product compatibility, our products will be tested on the switch before shipment. Our modules can be compatible with many mainstream brand switches, such as Cisco, Juniper, Extreme, Brocade, IBM, H3C, HP, Huawei, D-Link, Mikrotik, ZTE, TP-Link...

Our test equipment: VOLKTEK MEN-4110, HP 2530-8G, CRS226-24G-25+RM, Catalyst 2960G Series, Catalyst 3850 XS 10G SFP+, Catalyst 3750-E Series, HUAWEI S5700 Series, H3C S3100V2 Series, Juniper-EX4200, etc.



**Cisco Catalyst 3850**



**HUAWEI S5700**



**H3C S3100V2**



**HP J9264AR**



**Juniper EX 4200**



**Alcatel 6850E-U24X**



**Mikrotik CR5226-24G-25+RM**



**Cisco Catalyst 2960G**



**Volktek MEN-4110**

## Product Production Process

# Quality Assurance

Continuous introduction of new equipment, produced by strict standards, strict quality inspection, to guarantee the high quality standard of each product.



**Standardized  
Production Line**



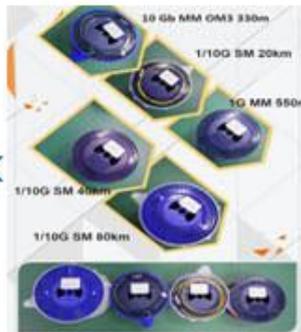
**Professional  
Welding**



**Assembling**



**Aging Testing**



**Distance Testing**



**Cleaning end face**



**Product Initial Test**



**Switch Testing**



**Product Final Test**

## Packaging

ETU-Link provides two kinds of packaging, 10pcs/Tray and individual package.



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Address and phone number also have been listed at [www.etulinktechnology.com](http://www.etulinktechnology.com)

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