OSFP 1.6T 2 x FR4 2 km

# Datasheet

| | |
|---|---|
| **Issue** | **Draft 0.1** |
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# Contents

# 1 Features and Applications

## Features

- OSFP MSA rev5.22 compliant
- OSFP CMIS 5.3 Management Interface compliant
- IEEE 802.3dj compliant
- OIF CEI-224G-VSR-PAM4 compliant
- Digital diagnostic functions
- Hot-pluggable OSFP Type2 formfactor with closed top heat sink
- 2 x CWDM4 lanes MUX/DeMUX design
- Dual duplex LC connector
- Maximum power consumption 25 W
- Single 3.3 V power supply
- Up to 2 km transmission on single mode fibers with FEC
- RoHS 2 compliant

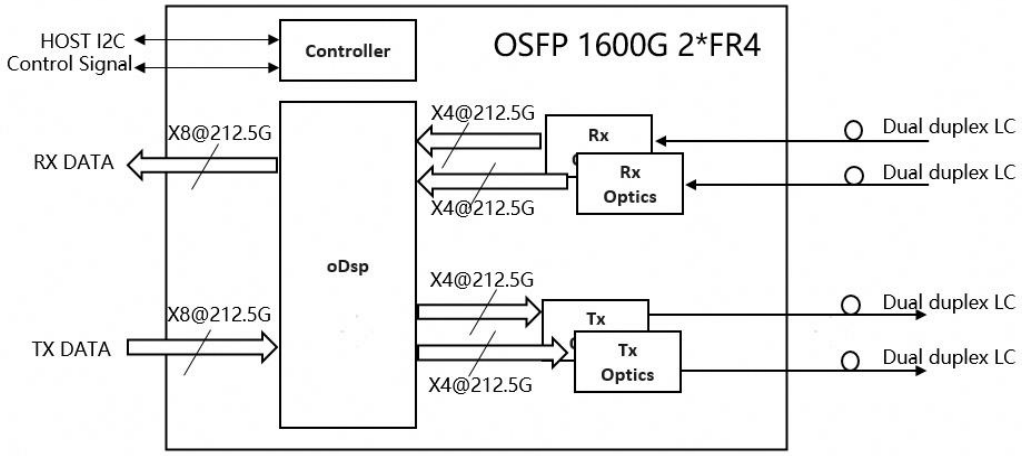
## Applications

- 1600G Ethernet
- Data center network

# 2 Description

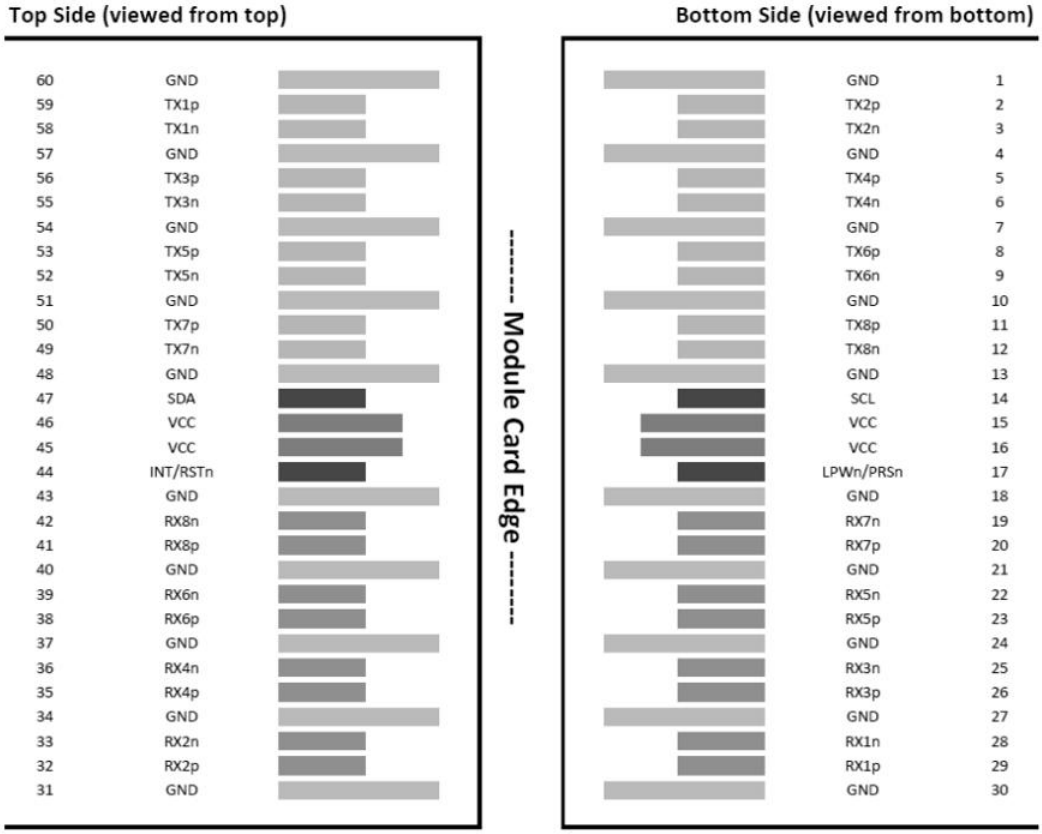
The OSFP 1.6T 2 x FR4 2 km module is a transceiver module designed for use in 1600 Gigabit links on up to 2 km. It is well-suited for applications in data centers and cloud networks. It is compliant with CMIS 5.3. Digital diagnostic functions are available via the I2C interface. This module can convert 8-channel 212.5 Gbps electrical data to 8-channel 212.5 Gbps optical signals, and transmits them into two channels for 800 Gbps optical transmission. Similarly, it optically transmits a 1600 Gbps input into 8-channel signals, and converts them to 8-channel output electrical data on the receiver side. It has been designed to meet the harshest external operating conditions including temperature, humidity and EMI interference.

**Figure 2-1** Transceiver block diagram



# 3 Pin Description

**Figure 3-1** OSFP MSA compliant connector




| Pin | Logic | Symbol | Description | Plug Sequence | Note |
|---|---|---|---|---|---|
| 1 | - | GND | Ground | 1 | - |
| 2 | CML-I | TX2p | Transmitter Data Non-Inverted | 3 | - |
| 3 | CML-I | TX2n | Transmitter Data Inverted | 3 | - |

| Pin | Logic | Symbol | Description | Plug Sequence | Note |
|---|---|---|---|---|---|
| 4 | - | GND | Ground | 1 | - |
| 5 | CML-I | Tx4p | Transmitter Data Non-Inverted | 3 | - |
| 6 | CML-I | Tx4n | Transmitter Data Inverted | 3 | - |
| 7 | - | GND | Ground | 1 | - |
| 8 | CML-I | TX6p | Transmitter Data Non-Inverted | 3 | - |
| 9 | CML-I | TX6n | Transmitter Data Inverted | 3 | - |
| 10 | - | GND | Ground | 1 | - |
| 11 | CML-I | TX8p | Transmitter Data Non-Inverted | 3 | - |
| 12 | CML-I | TX8n | Transmitter Data Inverted | 3 | - |
| 13 | - | GND | Ground | 1 | - |
| 14 | LVCMOS-I/O | SCL | 2-wire Serial Interface Clock | 3 | Open-Drain with pull-up resistor on Host |
| 15 | - | VCC | +3.3 V Power | 2 | - |
| 16 | - | VCC | +3.3 V Power | 2 | - |
| 17 | Multi-Level | LPWn/PRSn | Low-Power Mode/Module Present | 3 | See pin description for required circuit |
| 18 | - | GND | Ground | 1 | - |
| 19 | CML-O | RX7n | Receiver Data Inverted | 3 | - |
| 20 | CML-O | RX7p | Receiver Data Non-Inverted | 3 | - |
| 21 | - | GND | Ground | 1 | - |
| 22 | CML-O | RX5n | Receiver Data Inverted | 3 | - |
| 23 | CML-O | RX5p | Receiver Data Non-Inverted | 3 | - |
| 24 | - | GND | Ground | 1 | - |
| 25 | CML-O | RX3n | Receiver Data Inverted | 3 | - |
| 26 | CML-O | RX3p | Receiver Data Non-Inverted | 3 | - |
| 27 | - | GND | Ground | 1 | - |

| Pin | Logic | Symbol | Description | Plug Sequence | Note |
|---|---|---|---|---|---|
| 28 | CML-O | RX1n | Receiver Data Inverted | 3 | - |
| 29 | CML-O | RX1p | Receiver Data Non-Inverted | 3 | - |
| 30 | - | GND | Ground | 1 | - |
| 31 | - | GND | Ground | 1 | - |
| 32 | CML-O | RX2p | Receiver Data Non-Inverted | 3 | - |
| 33 | CML-O | RX2n | Receiver Data Inverted | 3 | - |
| 34 | - | GND | Ground | 1 | - |
| 35 | CML-O | RX4p | Receiver Data Non-Inverted | 3 | - |
| 36 | CML-O | RX4n | Receiver Data Inverted | 3 | - |
| 37 | - | GND | Ground | 1 | - |
| 38 | CML-O | RX6p | Receiver Data Non-Inverted | 3 | - |
| 39 | CML-O | RX6n | Receiver Data Inverted | 3 | - |
| 40 | - | GND | Ground | 1 | - |
| 41 | CML-O | RX8p | Receiver Data Non-Inverted | 3 | - |
| 42 | CML-O | RX8n | Receiver Data Inverted | 3 | - |
| 43 | - | GND | Ground | 1 | - |
| 44 | Multi-Level | INT/RSTn | Module Interrupt/Module Reset | 3 | See pin description for required circuit |
| 45 | - | VCC | +3.3 V Power | 2 | - |
| 46 | - | VCC | +3.3 V Power | 2 | - |
| 47 | LVCMOS-I/O | SDA | 2-wire Serial Interface Data | 3 | Open-Drain with pull-up resistor on Host |
| 48 | - | GND | Ground | 1 | - |
| 49 | CML-I | TX7n | Transmitter Data Inverted | 3 | - |
| 50 | CML-I | TX7p | Transmitter Data Non-Inverted | 3 | - |
| 51 | - | GND | Ground | 1 | - |

| Pin | Logic | Symbol | Description | Plug Sequence | Note |
|---|---|---|---|---|---|
| 52 | CML-I | TX5n | Transmitter Data Inverted | 3 | - |
| 53 | CML-I | TX5p | Transmitter Data Non-Inverted | 3 | - |
| 54 | - | GND | Ground | 1 | - |
| 55 | CML-I | TX3n | Transmitter Data Inverted | 3 | - |
| 56 | CML-I | TX3p | Transmitter Data Non-Inverted | 3 | - |
| 57 | - | GND | Ground | 1 | - |
| 58 | CML-I | TX1n | Transmitter Data Inverted | 3 | - |
| 59 | CML-I | TX1p | Transmitter Data Non-Inverted | 3 | - |
| 60 | - | GND | Ground | 1 | - |

# 4 Absolute Maximum Ratings

It has to be noted that the operation in excess of any individual absolute maximum ratings might cause permanent damage to this module.

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Unit |
|---|---|---|---|---|---|---|
| Maximum supply voltage | Vcc | –0.3 | 3.3 | 3.6 | V | - |
| Storage temperature | Ts | –40 | - | 85 | °C | - |
| Relative humidity | RH | 0 | - | 85 | % | - |

# 5 Operating Environments

Electrical and optical characteristics below are defined under this operating environment, unless otherwise specified.

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Note |
|---|---|---|---|---|---|---|
| Supply voltage | Vcc | 3.135 | 3.3 | 3.465 | V | - |
| Case temperature | T | 0 | - | 70 | °C | - |
| Data rate accuracy | - | –50 | - | 50 | ppm | - |
| Link distance | - | 0.5 | - | 2000 | m | See Note 1 |

NOTE

1. G.652 single-mode optical fiber.

# 6 Electrical Characteristics

| Parameter | | Min. | Typ. | Max. | Unit | Note |
|---|---|---|---|---|---|---|
| Power consumption | | - | - | 25 | W | - |
| Supply current | | - | - | 7.576 | A | - |
| **Host-to-Module electrical specifications (module input)** | | | | | | |
| Single-Ended voltage tolerance | | –0.4 | - | 1.4 | V | - |
| DC common-mode voltage tolerance | | 0.15 | - | 1.05 | V | - |
| Peak-to-peak AC common-mode voltage tolerance | Low-frequency, VCMLF | - | - | 32 | mV | - |
| | Full-band, VCMFB | - | - | 85 | mV | - |
| Differential-mode to common-mode return loss, RLcd | | Equation (179–20) | - | - | dB | See Note 2 |
| Effective return loss (ERL) | | 8.5 | - | - | dB | - |
| Amplitude tolerance | | 0.5 | - | - | V | See Note 1 |
| Interference tolerance | | - | - | Table 176D–9 | - | See Note 2 |
| Jitter tolerance | | - | - | Table 176D–10 | - | See Note 2 |
| **Module-to-Host electrical specifications at TP4 (module output)** | | | | | | |
| Differential pk-to-pk voltage | Output disabled | - | - | 30 | mV | - |
| | Output enabled | - | - | 1000 | mV | - |
| DC common-mode voltage tolerance | | 0.15 | - | 1.05 | V | - |
| AC common mode peak-to-peak voltage (Vcm) | Low-Frequency, VCMLF | - | - | 15 | mV | - |
| | Full-Band, VCMFB | - | - | 60 | mV | - |

| Parameter | | Min. | Typ. | Max. | Unit | Note |
|---|---|---|---|---|---|---|
| Effective return loss, ERL (min) | | 8.5 | - | - | dB | - |
| Common-mode to common-mode return loss, RLcc | | Equation (179–12) | - | - | dB | See Note 2 |
| Common-mode to differential-mode return loss, RLdc | | Equation (179–13) | - | - | dB | See Note 2 |
| Transmitter steady-state voltage, Vf | | 0.4 | - | 0.5 | V | - |
| Linear fit pulse peak ratio, Rpeak | | 0.456 | - | - | - | - |
| Level separation mismatch ratio RLM | | 0.95 | - | - | - | - |
| Transmitter output waveform | absolute value of step size for all taps | 0.005 | - | - | - | - |
| | absolute value of step size for alltaps | - | - | 0.025 | - | - |
| | value at minimum state for c(–3) | - | - | –0.06 | - | - |
| | value at maximum state for c(–2) | 0.12 | - | - | - | - |
| | value at minimum state for c(–1) | - | - | –0.34 | - | - |
| | value at minimum state for c(0) | - | - | 0.5 | - | - |
| | value at minimum state for c(1) | - | - | –0.2 | - | - |
| Signal-to-noise-and-distortion ratio, SNDR | | Table 179–9 | - | - | dB | See Note 2 |
| Signal-to-residual-intersymbol-interference ratio, SNRISI | | 28 | - | - | dB | - |
| Output jitter | JRMS | - | - | 0.023 | UI | - |
| | EOJ03 | - | - | 0.025 | UI | - |
| | J4u03 | - | - | 0.118 | UI | - |

**NOTE**

1. Specified as the steady-state voltage (as defined in 176D.8.4) measured at the test transmitter's output.
2. See IEEE 802.3dj.

# 7 Optical Characteristics

| Parameter | | Min. | Typ. | Max. | Unit | Note |
|---|---|---|---|---|---|---|
| **Transmitter** | | | | | | |
| Data rate, each Lane | | 106.25 ± 50 ppm | | | GBd | - |
| Modulation format | | PAM4 | | | - | - |
| Line wavelengths | | 1264.5 | - | 1277.5 | nm | - |
| | | 1284.5 | - | 1297.5 | nm | - |
| | | 1304.5 | - | 1317.5 | nm | - |
| | | 1324.5 | - | 1337.5 | nm | - |
| Side-mode suppression ratio (SMSR), each lane | | 30 | - | - | dB | - |
| Total average launch power | | - | - | 10.9 | dBm | - |
| Average launch power, each lane | | –2.2 | - | 4.9 | dBm | - |
| Optical modulation amplitude (OMA), each lane | | - | - | 4.8 | dBm | - |
| Outer optical modulation amplitude (OMAouter) each lane | For max(TECQ, TDECQ) < 0.9 dB | -0.8 | - | - | dBm | - |
| | For 0.9 dB < max(TECQ, TDECQ) < 3.4 dB | –0.1 + max(TECQ, TDECQ) | - | - | dBm | - |
| Difference in launch power between any two lanes (OMAouter) | | - | - | 4 | dB | - |
| Transmitter and dispersion eye closure for PAM4 (TDECQ), each lane | | - | - | 3.4 | dB | - |

| Parameter | | Min. | Typ. | Max. | Unit | Note |
|---|---|---|---|---|---|---|
| Transmitter eye closure for PAM4 (TECQ), each lane | | - | - | 3.4 | dB | - |
| \|TDECQ – TECQ\|, each lane | | - | - | 2.5 | dB | - |
| Transmitter functional symbol error histogram, each lane | | - | - | See Table 180–17 | - | See Note 3 |
| Transmitter overshoot and undershoot, each lane | | - | - | 22 | % | - |
| Transmitter power excursion, each lane | | - | - | 2.9 | dBm | - |
| Extinction ratio, each lane | | 3.5 | - | - | dB | - |
| Transmitter transition time, each lane | | - | - | 8 | ps | - |
| Average launch power of OFF transmitter, each lane | | - | - | –16 | dBm | - |
| RINxxOMA, each lane | | - | - | –139 | dB/Hz | - |
| Optical return loss tolerance, each lane | | - | - | 17.1 | dB | - |
| Transmitter reflectance, each lane | | - | - | –26 | dB | - |
| **Receiver** | | | | | | |
| Data rate, each lane | | 106.25 ± 50 ppm | | | GBd | - |
| Modulation format | | PAM4 | | | - | - |
| Line wavelengths | | 1264.5 | - | 1277.5 | nm | - |
| | | 1284.5 | - | 1297.5 | nm | - |
| | | 1304.5 | - | 1317.5 | nm | - |
| | | 1324.5 | - | 1337.5 | nm | - |
| Damage threshold, each lane | | 5.9 | - | - | dBm | - |
| Average receiver power, each lane | | –6.2 | - | 4.9 | dBm | - |
| Receiver power, each lane (OMA) | | - | - | 4.8 | dBm | - |
| Receiver sensitivity (OMAouter), each lane | For TECQ < 0.9 dB | - | - | –3.7 | dBm | See Note 1 |
| | For 0.9 dB < TECQ < SECQ | - | - | –4.6 + TECQ | dBm | See Note 1 |
| Stressed receiver sensitivity | | - | - | –1.2 | dBm | See Note 2 |

| Parameter | Min. | Typ. | Max. | Unit | Note |
|---|---|---|---|---|---|
| (OMAouter), each lane | | | | | |
| **Conditions of stressed receiver sensitivity** | | | | | |
| Stressed eye closure for PAM4 (SECQ), lane under test | - | 3.4 | - | dB | - |
| OMAouter of each aggressor lane | - | 0.8 | - | dBm | - |

NOTE

1. Measured with conformance test signal (from Rx overload point to Rx sensitivity point) for Pre-FEC Bit Error Ratio < 1E–6, Post-FEC Bit Error Ratio = 0 and FEC symbol error distribution below 7.
2. Measured with conformance test signal for Pre-FEC Bit Error Ratio < 2.4E-4.
3. See IEEE 802.3dj.

# 8 EEPROM Definitions

Refer to CMIS 5.3 used for OSFP.

# 9 Digital Diagnostic Monitoring Functions

Digital diagnostic management interface (DDMI) is realized by I2C interface in compliance with CMIS 5.3. Diagnostic management functions are realized, and the data addresses are listed in the form below.

| Performance Item | Related Bytes | Monitor Error | Note |
|---|---|---|---|
| Module temperature | CMIS 5.3 | ≤ ±3°C | Note 1, 2 |
| Module voltage | CMIS 5.3 | ≤ ±3% | Note 2 |
| Transmitter optical power | CMIS 5.3 | ≤ ±2 dB | Note 2 |
| Bias current | CMIS 5.3 | ≤ ±10% | Note 2 |
| Receiver optical power | CMIS 5.3 | ≤ ±2 dB | Note 2 |

NOTE

1. Actual temperature test point is fixed on module case around laser.
2. Full operating temperature range.

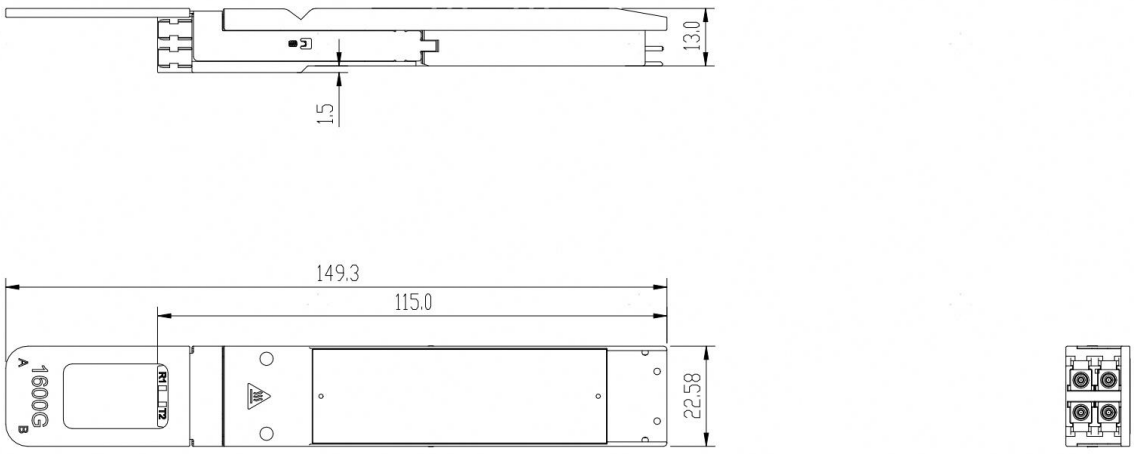
# 10 Alarm and Warning Thresholds

The OSFP 1.6T 2 x FR4 2 km module supports alarms function, indicating the values of the preceding basic performance are lower or higher than the thresholds.

| Performance Item | Alarm Threshold Bytes (Page02h Memory) | Unit | Low Threshold | High Threshold |
|---|---|---|---|---|
| Temperature warning | 132 to 135 | °C | 0 | 70 |
| Voltage warning | 140 to 143 | V | 3.135 | 3.465 |
| Tx power warning | 180 to 183 | dBm | –2.2 | 4.9 |
| Rx power warning | 196 to 199 | dBm | –6.2 | 4.9 |
| Temperature alarm | 128 to 131 | °C | –5 | 75 |
| Voltage alarm | 136 to 139 | V | 2.97 | 3.63 |
| Tx power alarm | 176 to 179 | dBm | –4.2 | 5.9 |
| Rx power alarm | 192 to 195 | dBm | –8.2 | 5.9 |

# 11 Mechanical Specifications

**Figure 11-1** The OSFP 1.6T 2 x FR4 2 km module mechanical dimensions (Type 2 OSFP module, closed top)



# 12 Regulatory Compliance

| Feature | Category | Standard | Performance |
|---|---|---|---|
| Safety | NRTL | UL 62368-1<br>CAN/CSA C22.2 No. 62368-1<br>IEC 60825-1:2014<br>IEC 60825-2 | NRTL recognized component for US and CAN |
| | TUV | EN 62368-1<br>EN 60825-1:2014+A11:2021<br>EN 60825-2 | TUV certificate |
| | FDA | U.S. 21 CFR 1040.10 & 1040.11, Notice 56 | FDA/CDRH certified with accession number according to Laser Notice 56 |
| Electromagnetic Compatibility | Radiated emissions | EN 55032<br>CISPR 32<br>ICES-003<br>VCCI-CISPR 32<br>AS/NZS CISPR 32 | Class B digital device with a minimum –6 dB margin to the limit when tested with a metal enclosure. Final margin may vary depending on system application, good system EMI design practice, ie: suitable metal enclosure and well-bonding, is required to achieve Class B margins at the system level. Tested frequency range: 30 MHz to 40 GHz or 5th harmonic (5 times the highest frequency), whichever is less. |
| | ESD | EN 55035 | Withstands discharges of ±8 kV contact, ±15 kV |

| Feature | Category | Standard | Performance |
|---|---|---|---|
| | | CISPR 35 | air. |
| | Radiated immunity | EN 55035<br>CISPR 35 | Field strength of 10 V/m from 80 MHz to 6 GHz. |
| Restriction of Hazardous Substances | RoHS | EN IEC 63000:2018 & BS EN IEC 63000:2018 | CE certificate |

**China RoHS hazardous substance table**

产品满足中国 RoHS 的要求：

| 部件名称<br>Part Descriptions | 有害物质<br>Hazardous Substances | | | | | |
|---|---|---|---|---|---|---|
| | 镉<br>Cd | 铅<br>Pb | 汞<br>Hg | 六价铬<br>Cr (VI) | 多溴联苯<br>PBB | 多溴二苯醚<br>PBDE |
| 印制电路板组件<br>PCBA | ○ | × | ○ | ○ | ○ | ○ |
| 金属部件<br>Metal Part | ○ | × | ○ | ○ | ○ | ○ |
| 聚合物部件<br>Polymeric Part | ○ | ○ | ○ | ○ | ○ | ○ |

备注：本表格依据 SJ/T 11364 的规定编制。

Remark: The table is prepared in accordance with SJ/T 11364.

○: 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下。

It means that the content of the restricted substances in all materials of part is less than the limit defined in GB/T 26572 and other similar directives in other countries.

×: 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求。

It means that the content of the restricted substances in at least one homogenous material of part is not less than the limit defined in GB/T 26572 and other similar directives in other countries.

上表中的“×”表示这些部件适用一项或多项欧盟 RoHS 豁免。

The "×" in the above table indicates that one or more EU RoHS exemptions are applied in these parts.

# 13 ESD Design

Normal ESD precautions are required during the handling of this module. This transceiver is shipped in ESD protective packaging. It should be removed from the packaging and otherwise handled in an ESD protected environment utilizing standard grounded benches, floor mats, and wrist straps.

| Parameter | Threshold Value | Note |
|---|---|---|
| ESD of high-speed pins | 1 kV | Human body model |
| ESD of low-speed pins | 2 kV | Human body model |
| Air discharge during operation | 15 kV | - |
| Direct contact discharges to the case | 8 kV | - |

# 14 Safety Specification Design

**⚠ CAUTION**

Do not look into fiber end faces without eye protection using an optical meter (such as magnifier and microscope) within 100 mm, unless you ensure that the laser output is disabled. When operating an optical meter, observe the operation requirements.

CAUTION–Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

Attention–L'utilisation des commandes ou réglages ou l'exécution des procédures autres que celles spécifiées dans les présentes exigences peuvent être la cause d'une exposition à un rayonnement dangereux.

# 15 Ordering Information

| Number | Description |
|---|---|
| 1 | OSFP 1.6T 2 x FR4 2 km |