



**RoHS compliant**  
**1310nm SFP+ single-Mode Transceiver, With Diagnostic Monitoring**  
**Small Form Pluggable (SFP+), with Diagnostic Monitoring**  
**0.6~10Gbps CPRI/OBSAI**



### Features

- Operating data rate up to 11.3Gbps
- 1310nm DFB-LD Transmitter
- Distance up to 10km
- Single 3.3V Power supply and TTL Logic Interface
- Duplex LC Connector Interface
- Hot Pluggable
- Power Dissipation < 1.0W
- Compliant with MSA SFP+ Specification SFF-8431
- Compliant with IEEE 802.3ae 10GBASE-LR/LW
- Operating Case Temperature
- Industrial: -40°C~+85°C

### Applications

- 10GBASE-LR at 10.31Gbps
- 10GBASE-LW at 9.95Gbps
- OBSAI rates 6.144 Gb/s, 3.072 Gb/s,
- 1.536 Gb/s, 0.768Gb/s
- CPRI rates 10.138Gb/s ,9.830
- Gb/s,7.373Gb/s, 6.144 Gb/s, 4.915
- Gb/s, 2.458 Gb/s, 1.229 Gb/s,
- 0.614Gb/s

### Ordering Information

| PART NUMBER        | INPUT/OUTPUT | SIGNAL DETECT | VOLTAGE | TEMPERATURE    |
|--------------------|--------------|---------------|---------|----------------|
| CL-SFP+_LR_10 CPRI | AC/AC        | TTL           | 3.3V/5V | -40°C to 85 °C |



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**Regulatory  
Compliance\***

| Product Certificate | Certificate Number | Applicable Standard           |
|---------------------|--------------------|-------------------------------|
| TUV                 | R50135086          | EN 60950-1:2006+A11+A1+A12+A2 |
|                     |                    | EN 60825-1:2014               |
|                     |                    | EN 60825-2:2004+A1+A2         |
| UL                  | E317337            | UL 60950-1                    |
|                     |                    | CSA C22.2 No. 60950-1-07      |
| EMC CE              | AE 50285865 0001   | EN 55022:2010                 |
|                     |                    | EN 55024:2010                 |
| FCC                 | WTF14F0514417E     | 47 CFR PART 15 OCT., 2013     |
| FDA                 | /                  | CDRH 1040.10                  |
| ROHS                | /                  | 2011/65/EU                    |

\*The above certificate number updated to June 2014, because some certificate will be updated every year, such as FDA and ROHS. For the latest certification information, please check with Carelink.

**Product Description**

The CL series single mode transceiver is small form factor pluggable module for serial optical data communications such as IEEE 802.3ae 10GBASE-LR/LW. It is with the SFP+ 20-pin connector to allow hot plug capability.

This module is designed for single mode fiber and operates at a nominal wavelength of 1310 nm.

The transmitter section uses a 1310nm multiple quantum well FP laser and is a class 1 laser compliant according to International Safety Standard IEC-60825.

The receiver section uses an integrated InGaAs detector preamplifier (IDP) mounted in an optical header and a limiting post-amplifier IC.

**Absolute Maximum Ratings\*<sub>note2</sub>**

| Parameter           | Symbol          | Min. | Max.            | Unit |
|---------------------|-----------------|------|-----------------|------|
| Storage Temperature | T <sub>s</sub>  | -40  | +85             | °C   |
| Supply Voltage      | V <sub>cc</sub> | -0.5 | 3.6             | V    |
| Input Voltage       | V <sub>in</sub> | -0.5 | V <sub>cc</sub> | V    |
| Output Current      | I <sub>o</sub>  | -    | 50              | mA   |

Note2: Exceeding any one of these values may destroy the device permanently.



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## Recommended Operating Conditions

| Parameter                  | Symbol      | Min. | Typical | Max. | Unit |
|----------------------------|-------------|------|---------|------|------|
| Operating Case Temperature | $T_c$       |      |         |      | °C   |
|                            | CLi         | -40  |         | +85  |      |
| Power Supply Voltage       | $V_{cc}$    | 3.15 | 3.3     | 3.45 | V    |
| Power Supply Current       | $I_{cc}$    |      |         | 300  | mA   |
| Surge Current              | $I_{surge}$ |      |         | +30  | mA   |
| Baud Rate                  |             | 0.6  |         | 11.3 | Gbps |

## Performance Specifications – Electrical

| Parameter                              | Symbol     | Min. | Typ. | Max          | Unit | Notes                                |
|--|------------|------|------|--------------|------|--------------------------------------|
| <b>Transmitter</b>                     |            |      |      |              |      |                                      |
| CML Inputs(Differential)               | $V_{in}$   | 150  |      | 1200         | mVpp | AC coupled inputs                    |
| Input AC Common Mode Voltage           |            | 0    |      | 25           | mV   | RMS                                  |
| Input Impedance (Differential)         | $Z_{in}$   | 85   | 100  | 115          | ohm  | $R_{in} > 100 \text{ kohms}$<br>@ DC |
| Differential Input S-parameter         | $S_{DD11}$ | -    | -    | -10          | dB   |                                      |
| Differential to Common Mode Conversion | $S_{CD11}$ | -    | -    | -10          | dB   |                                      |
| Tx_DISABLE Input Voltage – High        |            | 2    |      | 3.45         | V    |                                      |
| Tx_DISABLE Input Voltage – Low         |            | 0    |      | 0.8          | V    |                                      |
| Tx_FAULT Output Voltage – High         |            | 2    |      | $V_{cc}+0.3$ | V    | $I_o = 400\mu A$ ; Host $V_{cc}$     |
| Tx_FAULT Output Voltage – Low          |            | 0    |      | 0.5          | V    | $I_o = -4.0mA$                       |
| <b>Receiver</b>                        |            |      |      |              |      |                                      |
| CML Outputs (Differential)             | $V_{out}$  | 350  |      | 700          | mVpp | AC coupled outputs                   |



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|                                 |                  |     |     |                      |     |  |
|---------------------------------|------------------|-----|-----|----------------------|-----|--|
| Output AC Common Mode Voltage   |                  | 0   |     | 15                   | mV  | RMS  |
| Output Impedance (Differential) | Zout             | 90  | 100 | 110                  | ohm |  |
| Differential Output S-parameter | S <sub>D22</sub> | -   | -   | -10                  | dB  |  |
| Rx_LOS Output Voltage – High    |                  | 2   |     | V <sub>cc</sub> +0.3 | V   | I <sub>o</sub> = 400μA; Host V <sub>cc</sub> |
| Rx_LOS Output Voltage – Low     |                  | 0   |     | 0.8                  | V   | I <sub>o</sub> = -4.0mA                      |
| MOD_DEF ( 0:2 )                 | VoH              | 2.5 |     |                      | V   | With Serial ID                               |
|                                 | VoL              | 0   |     | 0.5                  | V   |  |

## Performance Specifications – Optical

| Parameter                                     | Symbol             | Min. | Typical | Max.  | Unit    |
|---|--------------------|------|---------|-------|---------|
| 9μm Core Diameter SMF                         |                    |      | 2       |       | Km      |
| Data Rate                                     |                    | 0.6  |         | 11.3  | Gbps    |
| <b>Transmitter</b>                            |                    |      |         |       |         |
| Centre Wavelength                             | λ <sub>c</sub>     | 1270 | 1310    | 1355  | nm      |
| Spectral Width (RMS)                          | Δλ                 |      |         | 3     | nm      |
| Average Output Power*note3                    | P <sub>out</sub>   | -6   |         | -1    | dBm     |
| Extinction Ratio                              | ER                 | 3.5  |         |       | dB      |
| Average Power of OFF Transmitter              | P <sub>off</sub>   |      |         | -30   | dBm     |
| Transmitter Dispersion Penalty                | TDP                |      |         | 3.2   | dB      |
| TX Disable Assert Time                        | t <sub>off</sub>   | -    | -       | 10    | us      |
| TX_DISABLE Negate Time                        | t <sub>on</sub>    | -    | -       | 1     | ms      |
| TX_BISABLE time to start reset                | t <sub>reset</sub> | 10   | -       | -     | us      |
| Time to initialize, include reset of TX_FAULT | t <sub>init</sub>  | -    | -       | 300   | ms      |
| TX_FAULT from fault to assertion              | t <sub>fault</sub> | -    | -       | 100   | us      |
| Total Jitter                                  | TJ                 | -    | -       | 0.28  | UI(p-p) |
| Data Dependant Jitter                         | DDJ                | -    | -       | 0.1   | UI(p-p) |
| Uncorrelated Jitter                           | UJ                 | -    | -       | 0.023 | RMS     |
| <b>Receiver</b>                               |                    |      |         |       |         |
| Centre Wavelength                             | λ                  | 1260 |         | 1565  | nm      |
| Sensitivity*note4                             | P <sub>min</sub>   |      |         | -14.4 | dBm     |
| Receiver Overload                             | P <sub>max</sub>   | 0.5  |         |       | dBm     |
| Optical Return Loss                           | ORL                |      |         | -12   | dB      |
| LOS De-Assert                                 | LOS <sub>D</sub>   |      |         | -16   | dBm     |



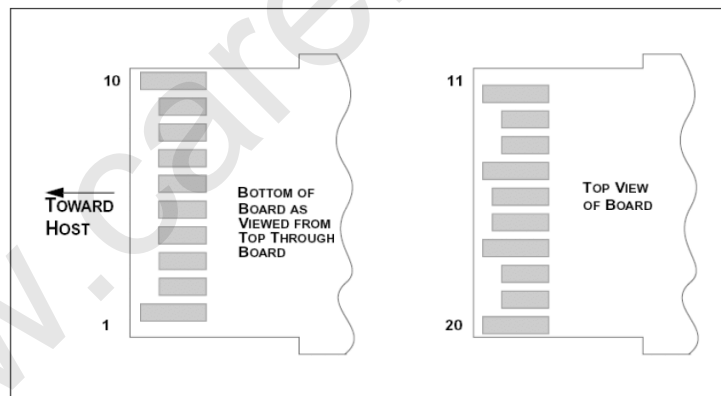
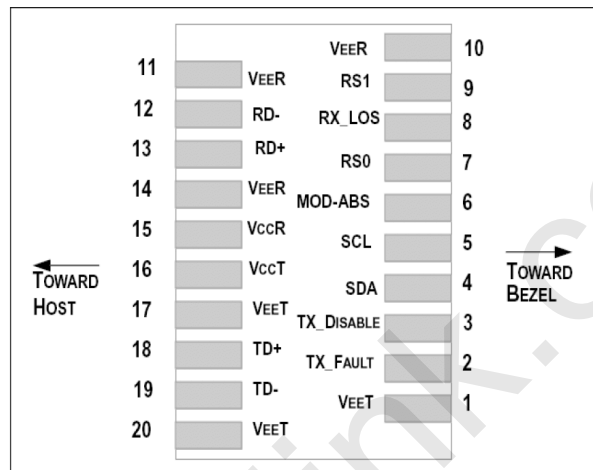
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|            |                  |     |  |  |     |
|------------|------------------|-----|--|--|-----|
| LOS Assert | LOS <sub>A</sub> | -28 |  |  | dBm |
|------------|------------------|-----|--|--|-----|

Note3: Output is coupled into a 9/125um SMF.

Note4: Minimum average optical power measured at the BER less than 1E-12, back to back. The measure pattern is PRBS 2<sup>31</sup>-1.

## SFP+ Transceiver Electrical Pad Layout





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## Pin Function Definitions

| Pin Num. | Name       | FUNCTION                     | Plug Seq. | Notes                                   |
|----------|------------|------------------------------|-----------|---|
| 1        | VeeT       | Transmitter Ground           | 1         | Note 5                                  |
| 2        | TX Fault   | Transmitter Fault Indication | 3         | Note 1                                  |
| 3        | TX Disable | Transmitter Disable          | 3         | Note 2, Module disables on high or open |
| 4        | SDA        | Module Definition 2          | 3         | 2-wire Serial Interface Data Line.      |
| 5        | SCL        | Module Definition 1          | 3         | 2-wire Serial Interface Clock.          |
| 6        | MOD-ABS    | Module Definition 0          | 3         | Note 3                                  |
| 7        | RS0        | RX Rate Select (LVTTTL).     | 3         | No Function Implement                   |
| 8        | LOS        | Loss of Signal               | 3         | Note 4                                  |
| 9        | RS1        | TX Rate Select (LVTTTL).     | 1         | No Function Implement                   |
| 10       | VeeR       | Receiver Ground              | 1         | Note 5                                  |
| 11       | VeeR       | Receiver Ground              | 1         | Note 5                                  |
| 12       | RD-        | Inv. Received Data Out       | 3         | Note 6                                  |
| 13       | RD+        | Received Data Out            | 3         | Note 7                                  |
| 14       | VeeR       | Receiver Ground              | 1         | Note 5                                  |
| 15       | VccR       | Receiver Power               | 2         | 3.3V $\pm$ 5%, Note 7                   |
| 16       | VccT       | Transmitter Power            | 2         | 3.3V $\pm$ 5%, Note 7                   |
| 17       | VeeT       | Transmitter Ground           | 1         | Note 5                                  |
| 18       | TD+        | Transmit Data In             | 3         | Note 8                                  |
| 19       | TD-        | Inv. Transmit Data In        | 3         | Note 8                                  |
| 20       | VeeT       | Transmitter Ground           | 1         | Note 5                                  |

### Notes:

1) TX Fault is an open collector/drain output, which should be pulled up with a 4.7K – 10K $\Omega$  resistor on the host board. Pull up voltage between 2.0V and VccT/R+0.3V. When high, output indicates a laser fault of some kind. Low indicates normal operation. In the low state, the output will be pulled to < 0.8V.

2) TX disable is an input that is used to shut down the transmitter optical output. It is pulled up within the module with a 4.7K – 10 K $\Omega$  resistor. Its states are:

Low (0 – 0.8V): Transmitter on

(>0.8, < 2.0V): Undefined

High (2.0 – 3.465V): Transmitter Disabled

Open: Transmitter Disabled



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- 3) Module Absent, connected to VeeT or VeeR in the module.
- 4) LOS (Loss of Signal) is an open collector/drain output, which should be pulled up with a 4.7K – 10K $\Omega$  resistor. Pull up voltage between 2.0V and VccT/R+0.3V. When high, this output indicates the received optical power is below the worst-case receiver sensitivity (as defined by the standard in use). Low indicates normal operation. In the low state, the output will be pulled to < 0.8V.
- 5) The module signal ground contacts, VeeR and VeeT, should be isolated from the module case.
- 6) RD-/+ : These are the differential receiver outputs. They are AC coupled 100 $\Omega$  differential lines which should be terminated with 100 $\Omega$  (differential) at the user SERDES. The AC coupling is done inside the module and is thus not required on the host board.
- 7) VccR and VccT are the receiver and transmitter power supplies. They are defined as 3.3V  $\pm$ 5% at the SFP+ connector pin. Maximum supply current is 300mA. Inductors with DC resistance of less than 1 ohm should be used in order to maintain the required voltage at the SFP+ input pin with 3.3V supply voltage. When the recommended supply-filtering network is used, hot plugging of the SFP+ transceiver module will result in an inrush current of no more than 30mA greater than the steady state value. VccR and VccT may be internally connected within the SFP+ transceiver module.
- 8) TD-/+ : These are the differential transmitter inputs. They are AC-coupled, differential lines with 100 $\Omega$  differential termination inside the module. The AC coupling is done inside the module and is thus not required on the host board.

## EEPROM

The serial interface uses the 2-wire serial CMOS EEPROM protocol defined for the ATMEL AT24C02/04 family of components. When the serial protocol is activated, the host generates the serial clock signal (SCL). The positive edge clocks data into those segments of the EEPROM that are not written protected within the SFP+ transceiver. The negative edge clocks data from the SFP+ transceiver. The serial data signal (SDA) is bi-directional for serial data transfer. The host uses SDA in conjunction with SCL to mark the start and end of serial protocol activation. The memories are organized as a series of 8-bit data words that can be addressed individually or sequentially.

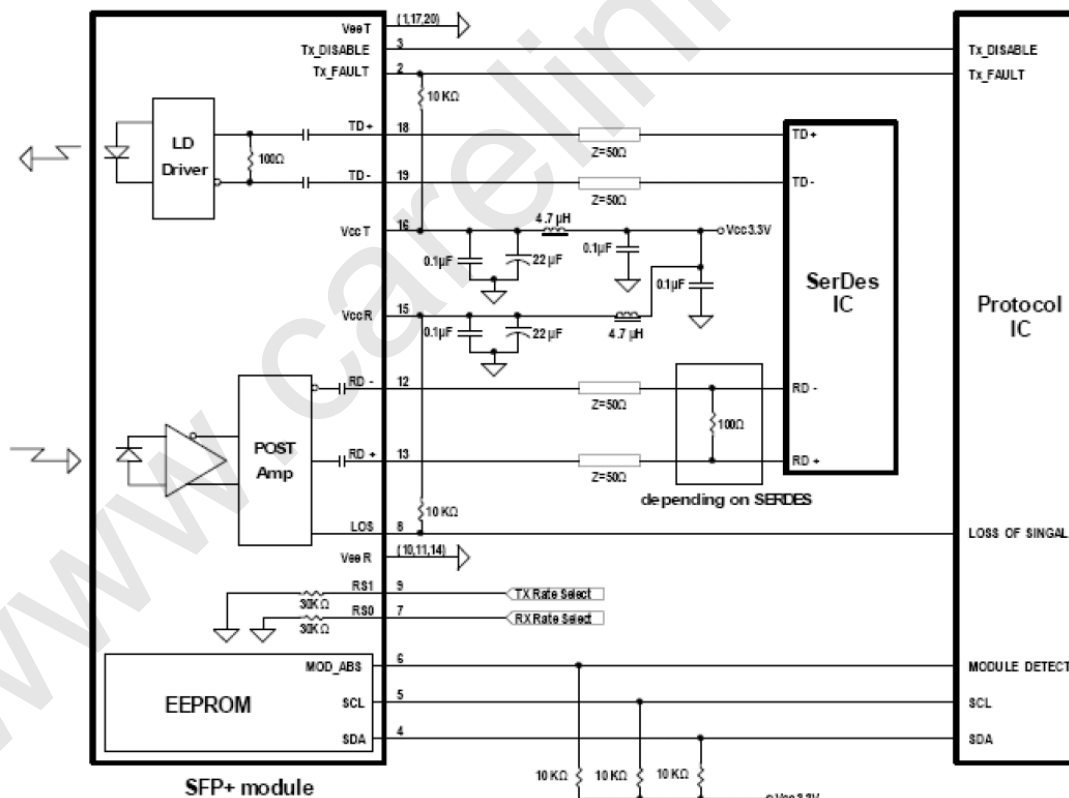
The Module provides diagnostic information about the present operating conditions. The transceiver generates this diagnostic data by digitization of internal analog signals. Calibration and alarm/warning threshold data is written during device manufacture. Received power monitoring, transmitted power monitoring, bias current monitoring, supply voltage monitoring and temperature monitoring all are implemented. If the module is defined as external calibrated, the diagnostic data are raw A/D values and must be converted to real world units using calibration constants stored in EEPROM locations 56 – 95 at wire serial bus address A2h. The digital diagnostic memory map specific data field define as following .For detail EEPROM information, please refer to the related document of SFF 8472 Rev 10.2



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| 2 wire address 1010000X (A0h)           | 2 wire address 1010001X (A2h)             |
|---|---|
| 0                                       | 0   |
| Serial ID Defined by SFP MSA (96 bytes) | Alarm and Warning Thresholds (56 bytes)   |
| 95                                      | 55  |
| Vendor Specific (32 bytes)              | Cal Constants (40 bytes)                  |
| 127                                     | 95  |
| Reserved (128 bytes)                    | Real Time Diagnostic Interface (24 bytes) |
| 255                                     | 119                                       |
|   | 127                                       |
|   | User Writable EEPROM (120 bytes)          |
|   | 247                                       |
|   | Vendor Specific (8 bytes)                 |
|   | 255                                       |

**Recommend Circuit Schematic**

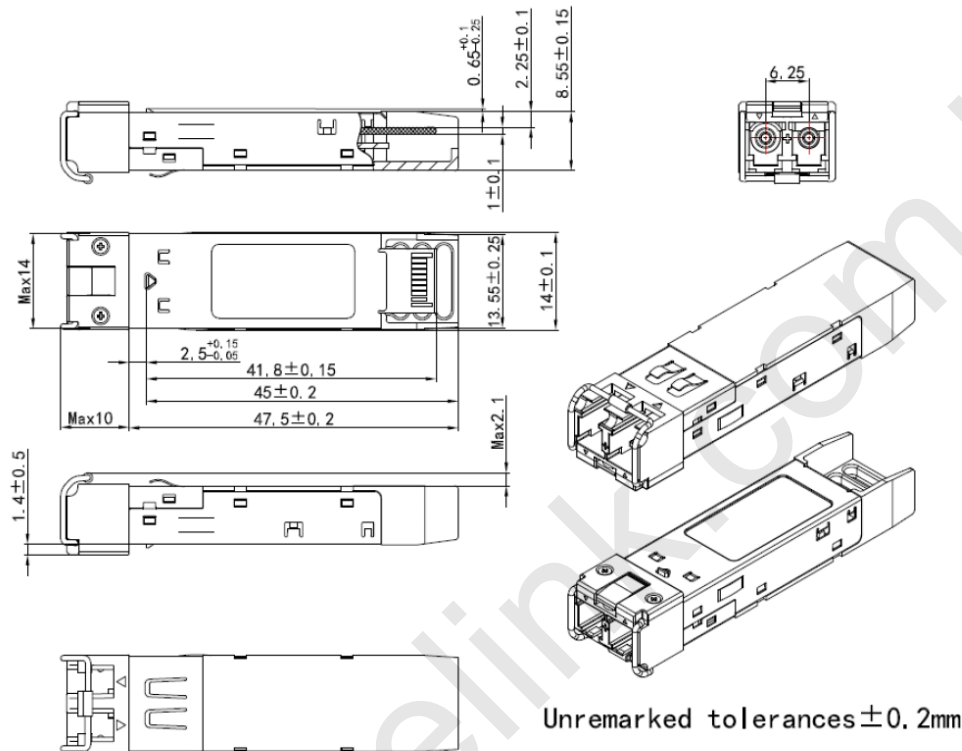






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## Mechanical Specifications



\*This 2D drawing only for reference, please check with Carelink before ordering.

## Eye Safety

This single-mode transceiver is a Class 1 laser product. It complies with IEC-60825 and FDA 21 CFR 1040.10 and 1040.11. The transceiver must be operated within the specified temperature and voltage limits. The optical ports of the module shall be terminated with an optical connector or with a dust plug.

## Notice:

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