

**Professional high-speed optical transceiver**

**OPN-SG159-D32LC2 / OPN-SG159-D32LC2I**

**3.3V / CWDM / 1.25 Gbps Digital Diagnostic SFP LC SINGLE-MODE TRANSCEIVER**

**PRODUCT FEATURES**

- Hot-Pluggable SFP Footprint LC Optical Transceiver
- Small Form-Factor Pluggable (SFP) MSA compatible
  - Compliant with IEEE 802.3z Gigabit Ethernet
  - Compliant with Fibre Channel 1X SM-LC-L FC-PI
    - SFF-8472 Digital Diagnostic Function
- 18 Wavelength ( $\lambda$ ): 1270 nm to 1610 nm CWDM DFBLD Transmitter
  - APD High Sensitivity Receiver
  - 32 dB Power Budget at Least
  - AC/AC Coupling according to MSA
    - Single +3.3 V Power Supply
    - RoHS Compliant
  - 0 to 70°C Operation: OPN-SG159-D32LC2
  - -50 to 85°C Operation: OPN-SG159-D32LC2I
- Class 1 Laser International Safety Standard IEC-60825Compliant

**APPLICATIONS**

- Gigabit Ethernet Switches and Routers
- Fibre Channel Switch Infrastructure
  - XDSL Applications
  - Metro Edge Switching

**PRODUCT DESCRIPTION**

The OPN-SG159-D32LC2 series single mode transceivers are small form factor pluggable module for bi-directional serial optical data communications such as Gigabit Ethernet and Fibre Channel 1x SM-LC-L FC-PI. It is with the SFP20-pin connector to allow hot plug capability. Digitaldiagnostic functions are available via an I<sup>2</sup>C. This module is designed for single mode fiber and operates at a nominal wavelength of CWDM wavelength. There are eighteen center wavelengths available from 1270 nm to 1610 nm, with each step 20 nm. A guaranteed minimum optical linkbudget of 32 dB is offered

The transmitter section uses a multiple quantum well CWDM DFB laser and is a class 1 laser compliant according to International Safety Standard IEC-60825. The receiver section uses an integrated InGaAs Avalanche photodetector preamplifier mounted in an optical header and a limiting post-amplifier IC.

**ORDER INFORMATION**

| P/No.             | Bit Rate (Gb/s) | 1000 BASE | Power Budget (dB) | Wavelength (nm) | Package         | Temp. (°C) | TX Power (dBm) | RX Sens. (dBm) | RoHS Compliant |
|-------------------|-----------------|-----------|-------------------|-----------------|-----------------|------------|----------------|----------------|----------------|
| OPN-SG159-D32LC2  | 1.25            |           | > 32              | CWDM*           | LC SFP with DMI | 0 to 70    | 5 to 0         | -32            | Yes            |
| OPN-SG159-D32LC2I | 1.25            |           | > 32              | CWDM*           | LC SFP with DMI | -50 to 85  | 5 to 0         | -32            | Yes            |

CWDM\* Wavelength (0 to 70°C)

| Central Wavelength | Min. (nm) | Typ. (nm) | Max. (nm) | Clasp Color Code | Central Wavelength | Min. (nm) | Typ. (nm) | Max. (nm) | Clasp Color Code |
|--------------------|-----------|-----------|-----------|------------------|--------------------|-----------|-----------|-----------|------------------|
| 127                | 1264.5    | 1270      | 1277.5    | Light Purple     | 145                | 1444.5    | 1450      | 1457.5    | Yellow Orange    |
| 129                | 1284.5    | 1290      | 1297.5    | Sky Blue         | 147                | 1464.5    | 1470      | 1477.5    | Gray             |
| 131                | 1304.5    | 1310      | 1317.5    | Yellow Green     | 149                | 1484.5    | 1490      | 1497.5    | Violet           |
| 133                | 1324.5    | 1330      | 1337.5    | Yellow Ocher     | 151                | 1504.5    | 1510      | 1517.5    | Blue             |
| 135                | 1344.5    | 1350      | 1357.5    | Pink             | 153                | 1524.5    | 1530      | 1537.5    | Green            |
| 137                | 1364.5    | 1370      | 1377.5    | Beige            | 155                | 1544.5    | 1550      | 1557.5    | Yellow           |
| 139                | 1384.5    | 1390      | 1397.5    | White            | 157                | 1564.5    | 1570      | 1577.5    | Orange           |
| 141                | 1404.5    | 1410      | 1417.5    | Silver           | 159                | 1584.5    | 1590      | 1597.5    | Red              |
| 143                | 1424.5    | 1430      | 1437.5    | Black            | 161                | 1604.5    | 1610      | 1617.5    | Brown            |

CWDM\*: 18 Wavelengths from 1270 nm to 1610 nm, each step 20 nm.

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| Absolute Maximum Ratings   |        |          |          |       |                                       |
|----------------------------|--------|----------|----------|-------|---------------------------------------|
| Parameter                  | Symbol | Min      | Max      | Units | Notes                                 |
| Storage Temperature        | Tstg   | -50      | 85       | °C    |                                       |
| Operating Case Temperature | Topr   | 0<br>-50 | 70<br>85 | °C    | OPN-SG159-D32LC2<br>OPN-SG159-D32LC2I |
| Power Supply Voltage       | Vcc    | -0.5     | 3.6      | V     |                                       |

| Recommended Operating Conditions |                        |          |      |            |                                                 |
|----------------------------------|------------------------|----------|------|------------|-------------------------------------------------|
| Parameter                        | Symbol                 | Min      | Typ  | Max        | Units / Notes                                   |
| Power Supply Voltage             | Vcc                    | 3.13     | 3.3  | 3.47       | V                                               |
| Operating Case Temperature       | Topr                   | 0<br>-50 |      | 70<br>85   | °C / OPN-SG159-D32LC2<br>°C / OPN-SG159-D32LC2I |
| Power Supply Current             | I <sub>CC(TX+RX)</sub> |          | 200  | 300<br>600 | mA / OPN-SG159-D32LC2<br>mA / OPN-SG159-D32LC2I |
| Data Rate                        |                        | 100      | 1250 |            | Mb/s                                            |

| Transmitter Specifications (0°C < Topr < 70°C, 3.13V < Vcc < 3.47V) |                                   |                      |                |                      |       |                    |
|---------------------------------------------------------------------|-----------------------------------|----------------------|----------------|----------------------|-------|--------------------|
| Parameter                                                           | Symbol                            | Min                  | Typ            | Max                  | Units | Notes              |
| <b>Optical</b>                                                      |                                   |                      |                |                      |       |                    |
| Optical Transmit Power                                              | P <sub>o</sub>                    | 0                    | ---            | 5                    | dBm   | 1                  |
| Output Center Wavelength                                            | λ                                 | λ <sub>c</sub> - 5.5 | λ <sub>c</sub> | λ <sub>c</sub> + 7.5 | nm    | 2                  |
| Output Spectrum Width                                               | Δλ                                | ---                  | ---            | 1                    | nm    | -20 dB Width       |
| Side Mode Suppression Ratio                                         | SMSR                              | 30                   |                |                      | dB    |                    |
| Extinction Ratio                                                    | E <sub>R</sub>                    | 9                    | ---            | ---                  | dB    |                    |
| Optical Rise Time                                                   | t <sub>r</sub>                    |                      |                | 260                  | ps    | 20 % to 80% Values |
| Optical Fall Time                                                   | t <sub>f</sub>                    |                      |                | 260                  | ps    | 20 % to 80% Values |
| Relative Intensity Noise                                            | RIN                               |                      |                | -120                 | dB/Hz |                    |
| <b>Electrical</b>                                                   |                                   |                      |                |                      |       |                    |
| Data Input Current – Low                                            | I <sub>IL</sub>                   | -350                 |                |                      | μA    |                    |
| Data Input Current – High                                           | I <sub>IH</sub>                   |                      |                | 350                  | μA    |                    |
| Differential Input Voltage                                          | V <sub>IH</sub> - V <sub>IL</sub> | 0.5                  |                | 2.4                  | V     | Peak-to-Peak       |
| TX Disable Input Voltage – Low                                      | T <sub>DIS, L</sub>               | 0                    |                | 0.5                  | V     | 3                  |
| TX Disable Input Voltage – High                                     | T <sub>DIS, H</sub>               | 2.0                  |                | Vcc                  | V     | 3                  |
| TX Disable Assert Time                                              | T <sub>ASSERT</sub>               |                      |                | 10                   | μs    |                    |
| TX Disable Deassert Time                                            | T <sub>DEASSERT</sub>             |                      |                | 1                    | ms    |                    |
| TX Fault Output Voltage -- Low                                      | T <sub>FaultL</sub>               | 0                    |                | 0.5                  | V     | 4                  |
| TX Fault Output Voltage -- High                                     | T <sub>FaultH</sub>               | 2.0                  |                | Vcc+0.3              | V     | 4                  |

1. Output power is power coupled into a 9/125 μm single mode fiber.
2. ITU-T G.694.2 CWDM wavelength from 1270 nm to 1610 nm, each step 20 nm.
3. There is an internal 4.7K to 10K ohm pull-up resistor to VccTX.
4. Open collector compatible, 4.7K to 10K ohm pull-up to Vcc (Host Supply Voltage).

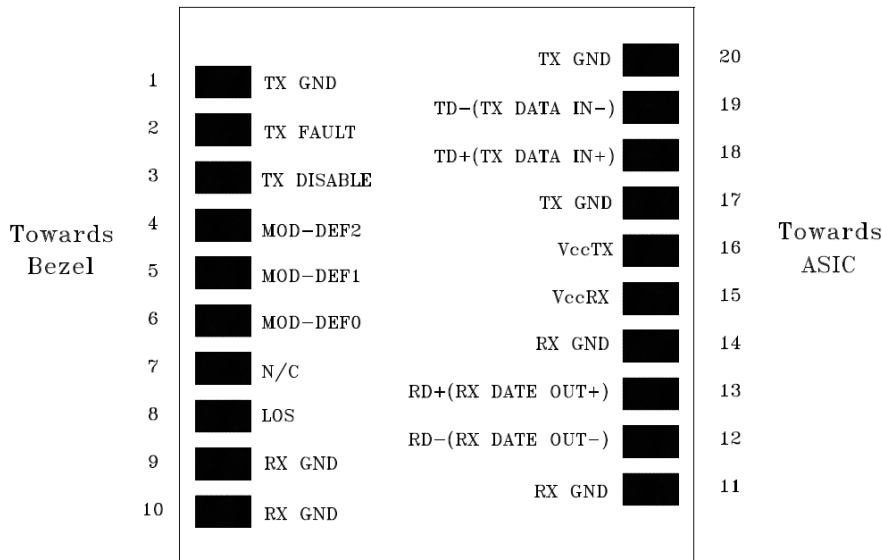
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| Receiver Specifications (0°C < Topr < 70°C, 3.13V < Vcc < 3.47V) |                                   |      |     |         |       |                         |
|------------------------------------------------------------------|-----------------------------------|------|-----|---------|-------|-------------------------|
| Parameter                                                        | Symbol                            | Min  | Typ | Max     | Units | Notes                   |
| <b>Optical</b>                                                   |                                   |      |     |         |       |                         |
| Sensitivity                                                      | Sens                              |      |     | -32     | dBm   | 4                       |
| Maximum Input Power                                              | Pin                               | -9   |     |         | dBm   | 4                       |
| Signal Detect -- Asserted                                        | Pa                                | ---  |     | -32     | dBm   | Transition: low to high |
| Signal Detect -- Deasserted                                      | Pd                                | -45  | --- | ---     | dBm   | Transition: high to low |
| Signal detect -- Hysteresis                                      |                                   | 1.0  | --- |         | dB    |                         |
| Wavelength of Operation                                          |                                   | 1100 | --- | 1620    | nm    |                         |
| <b>Electrical</b>                                                |                                   |      |     |         |       |                         |
| Differential Output Voltage                                      | V <sub>OH</sub> - V <sub>OL</sub> | 0.6  |     | 2.0     | V     |                         |
| Output LOS Voltage -- Low                                        | V <sub>OL</sub>                   | 0    |     | 0.5     | V     | 5                       |
| Output LOS Voltage -- High                                       | V <sub>OH</sub>                   | 2.0  |     | Vcc+0.3 | V     | 5                       |

4. Measured at 2<sup>7</sup>-1 PRBS at BER 1E-12.

5. Open collector compatible, 4.7K to 10K ohm pull-up to Vcc (Host Supply Voltage).

**CONNECTION DIAGRAM**



| PIN | Signal Name | Description                                             | PIN | Signal Name  | Description                 |
|-----|-------------|---------------------------------------------------------|-----|--------------|-----------------------------|
| 1   | TX GND      | Transmitter Ground                                      | 11  | RX GND       | Receiver Ground             |
| 2   | TX Fault    | Transmitter Fault Indication                            | 12  | RX DATA OUT- | Inverse Receiver Data Out   |
| 3   | TX Disable  | Transmitter Disable (Module disables on high or open)   | 13  | RX DATA OUT+ | Receiver Data Out           |
| 4   | MOD-DFE2    | Modulation Definition 2 – Two wires serial ID Interface | 14  | RX GND       | Receiver Ground             |
| 5   | MOD-DEF1    | Modulation Definition 1 – Two wires serial ID Interface | 15  | Vcc RX       | Receiver Power – 3.3V±5%    |
| 6   | MOD-DEF0    | Modulation Definition 0 – Ground in Module              | 16  | Vcc TX       | Transmitter Power – 3.3V±5% |
| 7   | N/C         | Not Connected                                           | 17  | TX GND       | Transmitter Ground          |
| 8   | LOS         | Loss of Signal                                          | 18  | TX DATA IN+  | Transmitter Data In         |
| 9   | RX GND      | Receiver Ground                                         | 19  | TX DATA IN-  | Inverse Transmitter Data In |
| 10  | RX GND      | Receiver Ground                                         | 20  | TX GND       | Transmitter Ground          |

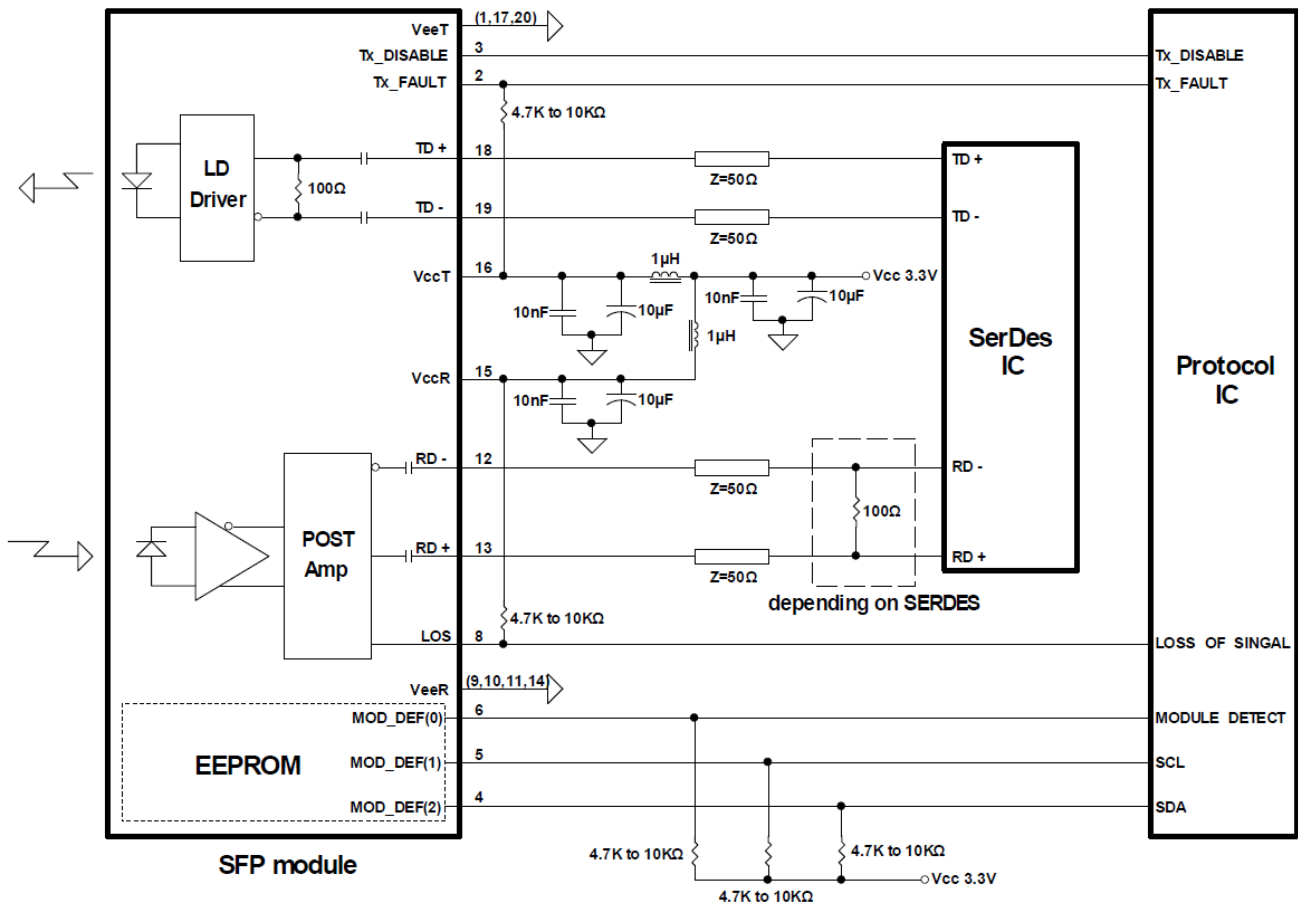
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### Module Definition

| Module Definition | MOD-DEF2<br>PIN 4 | MOD-DEF1<br>PIN 5 | MOD-DEF0<br>PIN 6 | Interpretation by Host            |
|-------------------|-------------------|-------------------|-------------------|-----------------------------------|
| 4                 | SDA               | SCL               | LV-TTL Low        | Serial module definition protocol |

Module Definition 4 specifies a serial definition protocol. For this definition, upon power up, MOD-DEF(1:2) appear as no connector (NC) and MOD-DEF(0) is TTL LOW. When the host system detects this condition, it activates the serial protocol. The protocol uses the 2-wire serial CMOS E<sup>2</sup>PROM protocol of the ATMEL AT24C01A/02/04 family of components.

### RECOMMENDED CIRCUIT SCHEMATIC

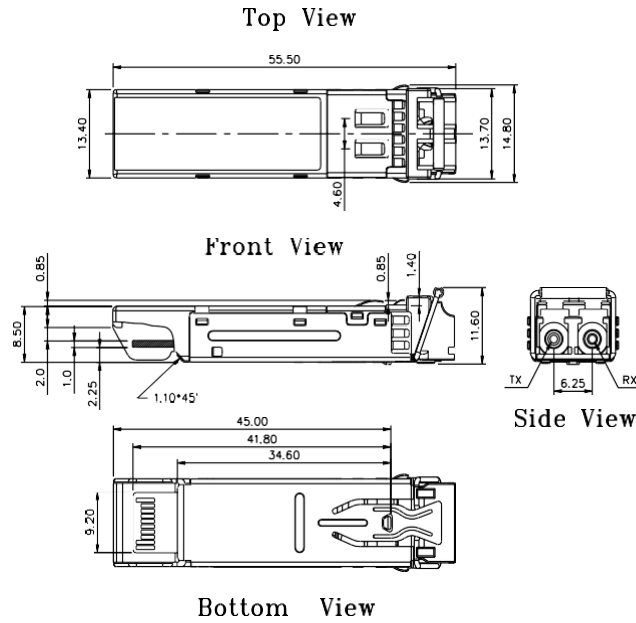


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### PACKAGE DIAGRAM

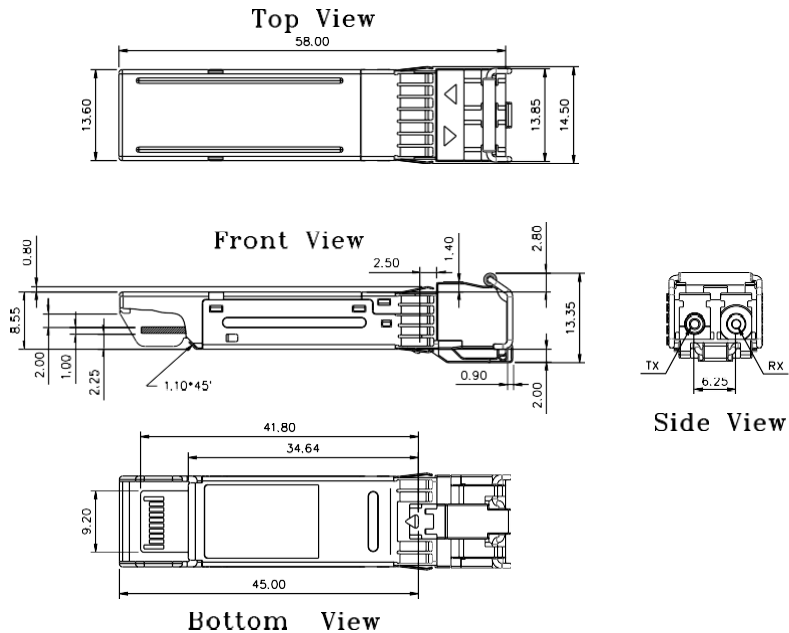
Units in mm

1)



**OPN-SG159-D32LC2**

2)



**OPN-SG159-D32LC2I**

Note: Specifications subject to change without notice.