Professional high-speed optical transceiver

# OPN-S1HD38-40LC2 / OPN-S1HD38-40LC2I

**10.3 Gbps / 40 km /100GHz DWDM Digital Diagnostic LC SFP+ SINGLE-MODE TRANSCEIVER**

## PRODUCT FEATURES

- Up to 10.5 Gb/s Bi-directional Data Links
- Complaint to SFP+ MSA
- Compliant to IEEE 802.3ae 10GBASE-ER/EW
- Maximum Link Length of 40 km
- Temperature-stabilized DWDM EML Transmitter
- 14 dB Power Budget at Least
- 100 GHz ITU Grid, C Band
- SFF-8472 Digital Diagnostic Function
- AC/AC Coupling according to MSA
- Single +3.3 V Power Supply
- RoHS Compliant
- 0 to 70ºC Operating: OPN-S1HD38-40LC2
- -50 to 85ºC Operating: OPN-S1HD38-40LC2I
- Class 1 Laser International Safety Standard IEC-60825Compliant

## APPLICATIONS

- 10GBASE-ER/EW
- OC-192 / STM-64 IR-2
- 40 km 10G Fibre Channel

## PRODUCT DESCRIPTION

The OPN-S1HD38-40LC2I series single mode transceiver is a small form factor pluggable module for bi-directional serial optical data communications such as IEEE 802.3ae 10GBASE-ER/EW. It is with the SFP 20-pin connector toallow hot plug capability. Digital diagnostic functions are available via an $I^2C$. This module is designed for single mode fiber and operates at a nominal wavelength of 100GHz ITU Grid, C Band DWDM wavelength. A guaranteed minimum optical link budget of 14 dB is offered. The transmitter section uses temperature-stabilized DWDM electrical-modulated laser (EML) 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.

## ORDER INFORMATION

| P/No. | Bit Rate (Gb/s) | 10G | Distance (km) | Spacing (GHz) | Wavelength (nm) | Package | Case Temp (ºC) | RoHS Compliant |
|---|---|---|---|---|---|---|---|---|
| OPN-S1HD38-40LC2 | 9.95 – 10.52 | ER / EW | 40 | 100 | DWDM* | SFP+ with DMI | 0 to 70 | Yes |
| OPN-S1HD38-40LC2I | 9.95 – 10.52 | ER / EW | 40 | 100 | DWDM* | SFP+ with DMI | -50 to 85 | Yes |

*: XX: 100GHz ITU Grid wavelength (Please see below)

| Channel # | Product code | Frequency (THz) | Center Wavelength (nm) | Label |
|---|---|---|---|---|
| 19 | OPN-S1HD19-40LC2I | 191.9 | 1562.23 | D19 |
| 20 | OPN-S1HD20-40LC2I | 192.0 | 1561.42 | D20 |
| 21 | OPN-S1HD21-40LC2I | 192.1 | 1560.61 | D21 |
| 22 | OPN-S1HD22-40LC2I | 192.2 | 1559.79 | D22 |
| 23 | OPN-S1HD23-40LC2I | 192.3 | 1558.98 | D23 |
| 24 | OPN-S1HD24-40LC2I | 192.4 | 1558.17 | D24 |
| 25 | OPN-S1HD25-40LC2I | 192.5 | 1557.36 | D25 |
| 26 | OPN-S1HD26-40LC2I | 192.6 | 1556.55 | D26 |
| 27 | OPN-S1HD27-40LC2I | 192.7 | 1555.75 | D27 |
| 28 | OPN-S1HD28-40LC2I | 192.8 | 1554.94 | D28 |
| 29 | OPN-S1HD29-40LC2I | 192.9 | 1554.13 | D29 |
| 30 | OPN-S1HD30-40LC2I | 193.0 | 1553.33 | D30 |
| 31 | OPN-S1HD31-40LC2I | 193.1 | 1552.52 | D31 |
| 32 | OPN-S1HD32-40LC2I | 193.2 | 1551.72 | D32 |

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| Channel # | Product code | Frequency (THz) | Center Wavelength (nm) | Label |
|---|---|---|---|---|
| 33 | OPN-S1HD33-40LC2I | 193.3 | 1550.92 | D33 |
| 34 | OPN-S1HD34-40LC2I | 193.4 | 1550.12 | D34 |
| 35 | OPN-S1HD35-40LC2I | 193.5 | 1549.32 | D35 |
| 36 | OPN-S1HD36-40LC2I | 193.6 | 1548.51 | D36 |
| 37 | OPN-S1HD37-40LC2I | 193.7 | 1547.72 | D37 |
| 38 | OPN-S1HD38-40LC2I | 193.8 | 1546.92 | D38 |
| 39 | OPN-S1HD39-40LC2I | 193.9 | 1546.12 | D39 |
| 40 | OPN-S1HD40-40LC2I | 194.0 | 1545.32 | D40 |
| 41 | OPN-S1HD41-40LC2I | 194.1 | 1544.53 | D41 |
| 42 | OPN-S1HD42-40LC2I | 194.2 | 1543.73 | D42 |
| 43 | OPN-S1HD43-40LC2I | 194.3 | 1542.94 | D43 |
| 44 | OPN-S1HD44-40LC2I | 194.4 | 1542.14 | D44 |
| 45 | OPN-S1HD45-40LC2I | 194.5 | 1541.35 | D45 |
| 46 | OPN-S1HD46-40LC2I | 194.6 | 1540.56 | D46 |
| 47 | OPN-S1HD47-40LC2I | 194.7 | 1539.77 | D47 |
| 48 | OPN-S1HD48-40LC2I | 194.8 | 1538.98 | D48 |
| 49 | OPN-S1HD49-40LC2I | 194.9 | 1538.19 | D49 |
| 50 | OPN-S1HD50-40LC2I | 195.0 | 1537.40 | D50 |
| 51 | OPN-S1HD51-40LC2I | 195.1 | 1536.61 | D51 |
| 52 | OPN-S1HD52-40LC2I | 195.2 | 1535.82 | D52 |
| 53 | OPN-S1HD53-40LC2I | 195.3 | 1535.04 | D53 |
| 54 | OPN-S1HD54-40LC2I | 195.4 | 1534.25 | D54 |
| 55 | OPN-S1HD55-40LC2I | 195.5 | 1533.47 | D55 |
| 56 | OPN-S1HD56-40LC2I | 195.6 | 1532.68 | D56 |
| 57 | OPN-S1HD57-40LC2I | 195.7 | 1531.90 | D57 |
| 58 | OPN-S1HD58-40LC2I | 195.8 | 1531.12 | D58 |
| 59 | OPN-S1HD59-40LC2I | 195.9 | 1530.33 | D59 |
| 60 | OPN-S1HD60-40LC2I | 196.0 | 1529.55 | D60 |
| 61 | OPN-S1HD61-40LC2I | 196.1 | 1528.77 | D61 |

**Absolute Maximum Ratings**

| Parameter | Symbol | Min | Max | Units | Notes |
|---|---|---|---|---|---|
| Storage Temperature | Tstg | -50 | 85 | °C | |
| Relative Humidity | RH | 5 | 85 | % | Non-condensing |
| Operating Case Temperature | Topr | 0 | 70 | °C | OPN-S1HD38-40LC2 |
| | | -50 | 85 | | OPN-S1HD38-40LC2I |
| Power Supply Voltage | Vcc | -0.5 | 3.6 | V | |
| Receiver Input Optical Power | Mip | | 3 | dBm | Average power |

**Recommended Operating Conditions**

| Parameter | Symbol | Min | Typ | Max | Units / Notes |
|---|---|---|---|---|---|
| Power Supply Voltage | Vcc | 3.135 | 3.3 | 3.465 | V |
| Operating Case Temperature | Topr | 0 | | 70 | °C / OPN-S1HD38-40LC2 |
| | | -50 | | 85 | °C / OPN-S1HD38-40LC2I |
| Relative Humidity | RH | 5 | 85 | % | Non-condensing |
| Power Supply Current | $I_{CC\,(TX+RX)}$ | | 320 | 500 | mA/OPN-S1HD38-40LC2 |
| | | | 320 | 650 | mA/OPN-S1HD38-40LC2I |
| Data Rate | | | 9.95 / 10.3 | 10.5 | Gb/s |

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| Transmitter Optical Specifications (0ºC < Topr < 70ºC, 3.13V < Vcc < 3.47V) | | | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | **Symbol** | **Min** | **Typ** | **Max** | **Units** | **Notes** |
| Average Launch Power | Po, AVG | -2 | | 2 | dBm | 1 |
| Optical Modulation Amplitude | Po, OMA | -1.7 | | | | 1 |
| Extinction Ratio | ER | 8.2 | | | dB | |
| Center Wavelength Spacing | | | 100 | | GHz | 2 |
| Transmitter Center Wavelength -- over life time | λc | X-100 | X | X+100 | pm | 3 |
| Output Spectrum Width | Δλ | --- | | 1 | nm | -20 dB width |
| Side Mode Suppression Ratio | SMSR | 30 | | | dB | |
| Transmitter and Dispersion Penalty @800 ps/nm @10.3Gb/s | TDP | | | 2 | dB | |
| Relative Intensity Noise | RIN | | | -128 | dB/Hz | |
| Average Launch Power of OFF Transmitter | | | | -30 | dBm | |

1. Output power is power coupled into a 9/125 μm single-mode fiber.
2. Corresponds to approximately 0.8 nm.
3. X = specified ITU Grid wavelength.

| Receiver Optical Specifications (0ºC < Topr < 70ºC, 3.13V < Vcc < 3.47V) | | | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | **Symbol** | **Min** | **Typ** | **Max** | **Units** | **Notes** |
| Sensitivity | | | | -16 | dBm | 4 |
| Stressed Receiver Sensitivity, OMA | | | | -11.3 | | |
| Receiver Overload | $P_{MAX}$ | -1 | --- | | dBm | |
| LOS -- Deasserted | $LOS_D$ | --- | --- | -16 | dBm | Transition: low to high |
| LOS -- Asserted | $LOS_A$ | -28 | --- | --- | dBm | Transition: high to low |
| Wavelength of Operation | λc | 1480 | | 1580 | nm | |
| Optical Return Loss | ORL | | | -27 | dB | |

4. Measured with worst ER; BER < $10^{-12}$ and PRBS $2^{31}$-1. Equivalent to -14.3 dBm OMA at ER=8.2 dB.

| Electrical Characteristics | | | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | **Symbol** | **Min** | **Typ** | **Max** | **Units** | **Notes** |
| **High-Speed Signal (CML) Interface Specification** | | | | | | |
| Input Data Rate | | | 9.95 / 10.3 | 10.5 | Gb/s | |
| Differential Input Impedance | Rin | | 100 | | Ω | |
| Differential Data Input Amplitude | | 120 | | 820 | mVpp | Internally AC coupled |
| Output Data Rate | | | 9.95 / 10.3 | 10.5 | Gb/s | |
| Differential Output Impedance | Rout | | 100 | | Ω | |
| Differential Data Output Amplitude | | 350 | 600 | 850 | mVpp | Internally AC coupled |
| **Low-Speed Signal (LVTTL) Interface Specification** | | | | | | |
| Input High Voltage | | 2.0 | | Vcc+0.3 | V | |
| Input Low Voltage | | GND | | 0.8 | V | |
| Output High Voltage | | 2.4 | | Vcc | V | |
| Output Low Voltage | | GND | | 0.5 | V | |

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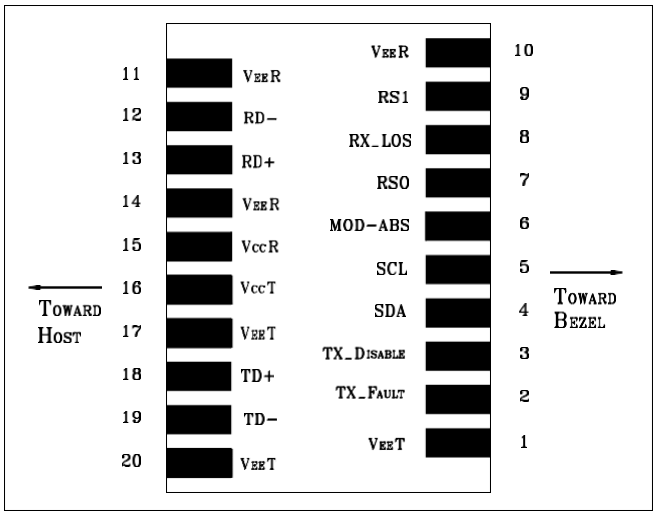
## CONNECTION DIAGRAM




| PIN | Signal Name | Description | PIN | Signal Name | Description |
|---|---|---|---|---|---|
| 1 | $V_{EE}T$ | Transmitter Signal Ground | 11 | $V_{EE}R$ | Receiver Signal Ground |
| 2 | TX_Fault | Transmitter Fault Indication. Logic "1" Output = Laser Fault. Logic "0" Output = Normal Operation | 12 | RD- | Inverse Receiver Data Out |
| 3 | TX_Disable | Logic "1" Input (or no connection) = Laser off, Logic "0" = Laser on. | 13 | RD+ | Receiver Data Out |
| 4 | SDA | Modulation Definition 2 – Two wires serial ID Interface | 14 | $V_{EE}R$ | Receiver Signal Ground |
| 5 | SCL | Modulation Definition 1 – Two wires serial ID Interface | 15 | $V_{CC}R$ | Receiver Power – 3.3V±5% |
| 6 | MOD-ABS | Modulation Definition 0 – Ground in Module | 16 | $V_{CC}T$ | Transmitter Power – 3.3V±5% |
| 7 | RS0 | RX Rate Select (LVTTL). This pin has an internal 30k pulldown to ground. A signal on this pin will not affect module performance. | 17 | $V_{EE}T$ | Transmitter Signal Ground |
| 8 | RX_LOS | Loss of Signal Out (OC). | 18 | TD+ | Transmitter Data In |
| 9 | RS1 | TX Rate Select (LVTTL). This pin has an internal 30k pulldown to ground. A signal on this pin will not affect module performance. | 19 | TD- | Inverse Transmitter Data In |
| 10 | $V_{EE}R$ | Receiver Signal Ground | 20 | $V_{EE}T$ | Transmitter Signal Ground |

## MODULE DEFINITION

| Module Definition | PIN 4 | PIN 5 | PIN 6 | Interpretation by Host |
|---|---|---|---|---|
| 4 | SDA | SCL | MOD-ABS | Serial module definition protocol |

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

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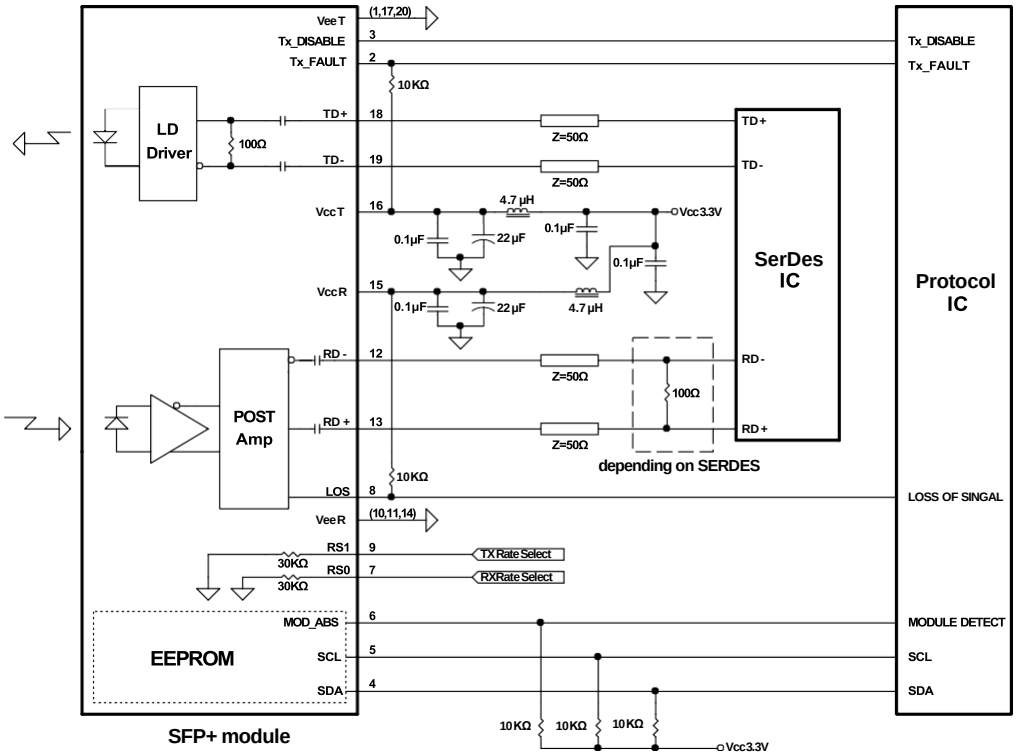
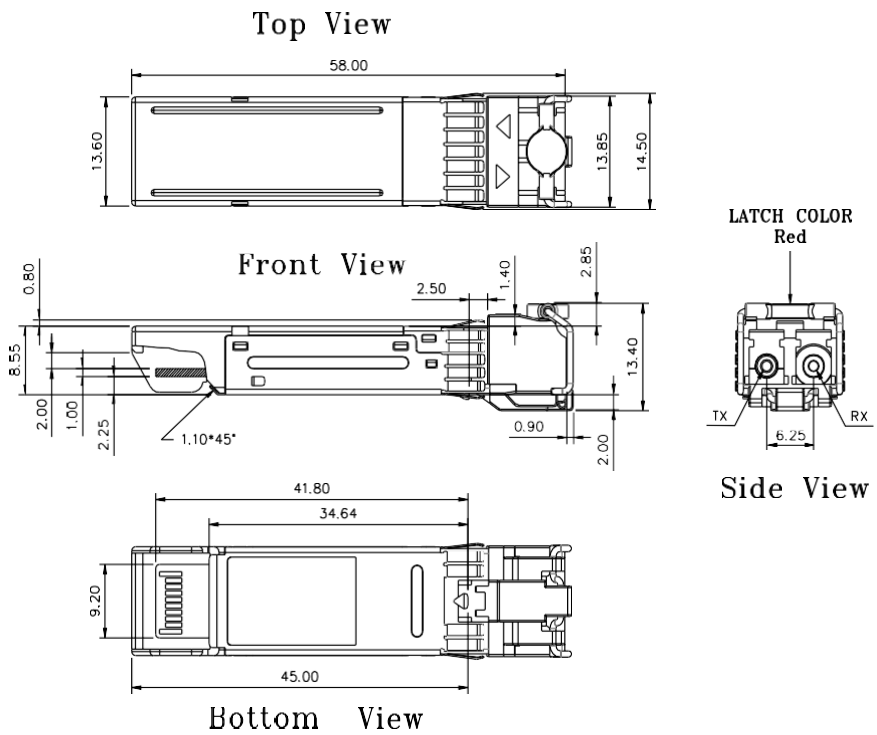
## RECOMMENDED CIRCUIT SCHEMATIC




## PACKAGE DIAGRAM

**Units in mm**




**Note:** Specifications subject to change without notice.