**Product Specification**

# 1000BASE-T COPPER SFP Optical Transceiver

**FCLF-8520/8521-3**

## PRODUCT FEATURES

- Up to 1.25Gb/s bi-directional data links
- Hot-pluggable SFP footprint
- Extended case temperature range -0°C to +85°C
- Fully metallic enclosure for low EMI
- Low power dissipation (1.05W typical)
- Compact RJ-45 connector assembly
- RoHS-6 compliant (lead-free)
- Access to physical layer IC via 2-wire serial bus
- 10/100/1000 BASE-T operation in host systems with SGMII interface

## APPLICATIONS

- 1.25 Gigabit Ethernet over Cat 5 cable

Finisar's FCLF-8520/8521-3 1000BASE-T Copper Small Form Pluggable (SFP) transceivers are based on the SFP Multi Source Agreement (MSA)[1]. They are compatible with the Gigabit Ethernet and 1000BASE-T standards as specified in IEEE Std 802.3[2]. The 1000BASE-T physical layer IC (PHY) can be accessed via I2C, allowing access to all PHY settings and features.

The FCLF-8520-3 uses the SFP's RX_LOS pin for link indication, and 1000BASE-X auto-negotiation should be disabled on the host system. The FCLF-8521-3 is compatible with 1000BASE-X auto-negotiation, but does not have a link indication feature (RX_LOS is internally grounded). See AN-2036 ("Frequently Asked Questions Regarding Finisar's 1000BASE-T SFPs") for a more complete explanation on the differences between the two models and details on applications issues for the products.

The optical transceiver is compliant per the RoHS Directive 2011/65/EU. See Finisar Application Note AN-2038 for more details[5,6].

## PRODUCT SELECTION

| Part Number | Link Indicator on RX_LOS Pin | 1000BASE-X auto-negotiation enabled by default |
|---|---|---|
| FCLF-8520-3 | Yes | No |
| FCLF-8521-3 | No | Yes |

## I. SFP to Host Connector Pin Out

| Pin | Symbol | Name/Description | Note |
|---|---|---|---|
| 1 | $V_{EET}$ | Transmitter ground (common with receiver ground) | 1 |
| 2 | $T_{FAULT}$ | Transmitter Fault. Not supported | |
| 3 | $T_{DIS}$ | Transmitter Disable. PHY disabled on high or open | 2 |
| 4 | MOD_DEF(2) | Module Definition 2. Data line for serial ID | 3 |
| 5 | MOD_DEF(1) | Module Definition 1. Clock line for serial ID | 3 |
| 6 | MOD_DEF(0) | Module Definition 0. Grounded within the module | 3 |
| 7 | Rate Select | No connection required | |
| 8 | LOS | Loss of Signal indication. | 4 |
| 9 | $V_{EER}$ | Receiver ground (common with transmitter ground) | 1 |
| 10 | $V_{EER}$ | Receiver ground (common with transmitter ground) | 1 |
| 11 | $V_{EER}$ | Receiver ground (common with transmitter ground) | 1 |
| 12 | RD- | Receiver Inverted DATA out. AC coupled | |
| 13 | RD+ | Receiver Non-inverted DATA out. AC coupled | |
| 14 | $V_{EER}$ | Receiver ground (common with transmitter ground) | 1 |
| 15 | $V_{CCR}$ | Receiver power supply | |
| 16 | $V_{CCT}$ | Transmitter power supply | |
| 17 | $V_{EET}$ | Transmitter ground (common with receiver ground) | 1 |
| 18 | TD+ | Transmitter Non-Inverted DATA in. AC coupled | |
| 19 | TD- | Transmitter Inverted DATA in. AC coupled | |
| 20 | $V_{EET}$ | Transmitter ground (common with receiver ground) | 1 |

Notes: 1. Circuit ground is connected to chassis ground
2. PHY disabled on $T_{DIS}$ > 2.0V or open, enabled on $T_{DIS}$ < 0.8V
3. Should be pulled up with 4.7k – 10k Ohms on host board to a voltage between 2.0 V and 3.6 V. MOD_DEF(0) pulls line low to indicate module is plugged in.
4. LVTTL compatible with a maximum voltage of 2.5V. Not supported on FCLF-8521-3.

**Table 1. SFP to host connector pin assignments and descriptions**

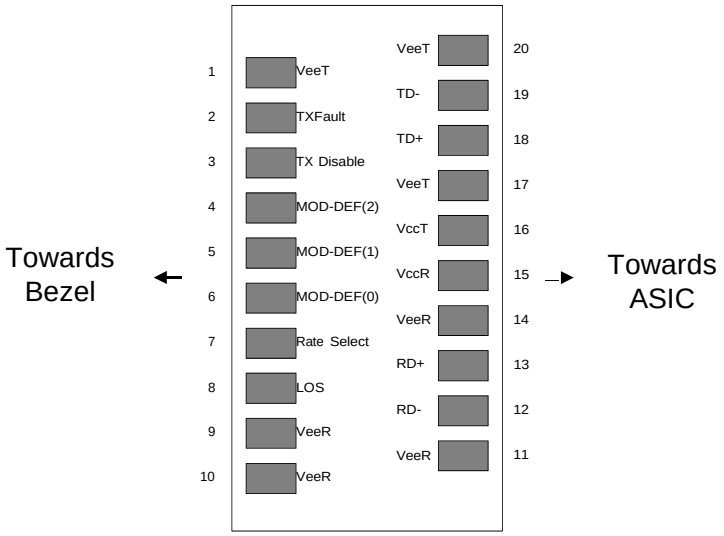



**Figure 1. Diagram of host board connector block pin numbers and names**

## II. +3.3V Volt Electrical Power Interface

The FCLF-8520/8521-3 has an input voltage range of 3.3 V +/- 5%. The 4 V maximum voltage is not allowed for continuous operation.

| **+3.3 Volt Electrical Power Interface** | | | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | **Symbol** | **Min** | **Typ** | **Max** | **Units** | **Notes/Conditions** |
| Supply Current | $I_s$ | | 320 | 375 | mA | 1.2W max power over full range of voltage and temperature. See caution note below |
| Input Voltage | $V_{cc}$ | 3.13 | 3.3 | 3.47 | V | Referenced to GND |
| Maximum Voltage | $V_{max}$ | | | 4 | V | |
| Surge Current | $I_{surge}$ | | | 30 | mA | Hot plug above steady state current. See caution note below |

Caution: Power consumption and surge current are higher than the specified values in the SFP MSA

**Table 2. +3.3 Volt electrical power interface**

## III. Low-Speed Signals

MOD_DEF(1) (SCL) and MOD_DEF(2) (SDA), are open drain CMOS signals (see section VII, "Serial Communication Protocol"). Both MOD_DEF(1) and MOD_DEF(2) must be pulled up to host_Vcc.

| **Low-Speed Signals, Electronic Characteristics** | | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Symbol** | **Min** | **Max** | **Units** | **Notes/Conditions** |
| SFP Output LOW | $V_{OL}$ | 0 | 0.5 | V | 4.7k to 10k pull-up to host_Vcc, measured at host side of connector |
| SFP Output HIGH | $V_{OH}$ | host_Vcc - 0.5 | host_Vcc + 0.3 | V | 4.7k to 10k pull-up to host_Vcc, measured at host side of connector |
| SFP Input LOW | $V_{IL}$ | 0 | 0.8 | V | 4.7k to 10k pull-up to Vcc, measured at SFP side of connector |
| SFP Input HIGH | $V_{IH}$ | 2 | Vcc + 0.3 | V | 4.7k to 10k pull-up to Vcc, measured at SFP side of connector |

**Table 3. Low-speed signals, electronic characteristics**

## IV. High-Speed Electrical Interface

All high-speed signals are AC-coupled internally.

| **High-Speed Electrical Interface, Transmission Line-SFP** | | | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | **Symbol** | **Min** | **Typ** | **Max** | **Units** | **Notes/Conditions** |
| Line Frequency | $f_L$ | | 125 | | MHz | 5-level encoding, per IEEE 802.3 |
| Tx Output Impedance | $Z_{out,TX}$ | | 100 | | Ohm | Differential, for all frequencies between 1MHz and 125MHz |
| Rx Input Impedance | $Z_{in,RX}$ | | 100 | | Ohm | Differential, for all frequencies between 1MHz and 125MHz |

**Table 4. High-speed electrical interface, transmission line-SFP**

| **High-Speed Electrical Interface, Host-SFP** | | | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | **Symbol** | **Min** | **Typ** | **Max** | **Units** | **Notes/Conditions** |
| Single ended data input swing | $V_{insing}$ | 250 | | 1200 | mV | Single ended |
| Single ended data output swing | $V_{outsing}$ | 350 | | 800 | mV | Single ended |
| Rise/Fall Time | $T_r$,$T_f$ | | 175 | | psec | 20%-80% |
| Tx Input Impedance | $Z_{in}$ | | 50 | | Ohm | Single ended |
| Rx Output Impedance | $Z_{out}$ | | 50 | | Ohm | Single ended |

**Table 5. High-speed electrical interface, host-SFP**

## V. General Specifications

| General | | | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | **Symbol** | **Min** | **Typ** | **Max** | **Units** | **Notes/Conditions** |
| Data Rate | BR | 10 | | 1,000 | Mb/sec | IEEE 802.3 compatible.<br>See Notes 2 through 4 below |
| Cable Length | L | | | 100 | m | Category 5 UTP. BER $<10^{-12}$ |

**Table 6. General specifications**

**Notes:**
1. Clock tolerance is +/- 50 ppm
2. By default, the FCLF-8520/8521-3 is a full duplex device in preferred master mode
3. Automatic crossover detection is enabled. External crossover cable is not required
4. 10/100/1000 BASE-T operation requires the host system to have an SGMII interface with no clocks, and the module PHY to be configured per Application Note AN-2036. With a SERDES that does not support SGMII, the module will operate at 1000BASE-T only.

## VI. Environmental Specifications

The FCLF-8520/8521-3 has an extended range from 0°C to +85°C case temperature as specified in Table 8.

| Environmental Specifications | | | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | **Symbol** | **Min** | **Typ** | **Max** | **Units** | **Notes/Conditions** |
| Operating Temperature | $T_{op}$ | 0 | | 85 | °C | Case temperature |
| Storage Temperature | $T_{sto}$ | -40 | | 85 | °C | Ambient temperature |

**Table 7. Environmental specifications**

## VII. Serial Communication Protocol

All Finisar SFPs support the 2-wire serial communication protocol outlined in the SFP MSA[1]. These SFPs use an Atmel AT24C01A 128 byte $E^2$PROM with an address of A0h. For details on interfacing with the $E^2$PROM, see the Atmel data sheet titled "AT24C01A/02/04/08/16 2-Wire Serial CMOS $E^2$PROM."[3]

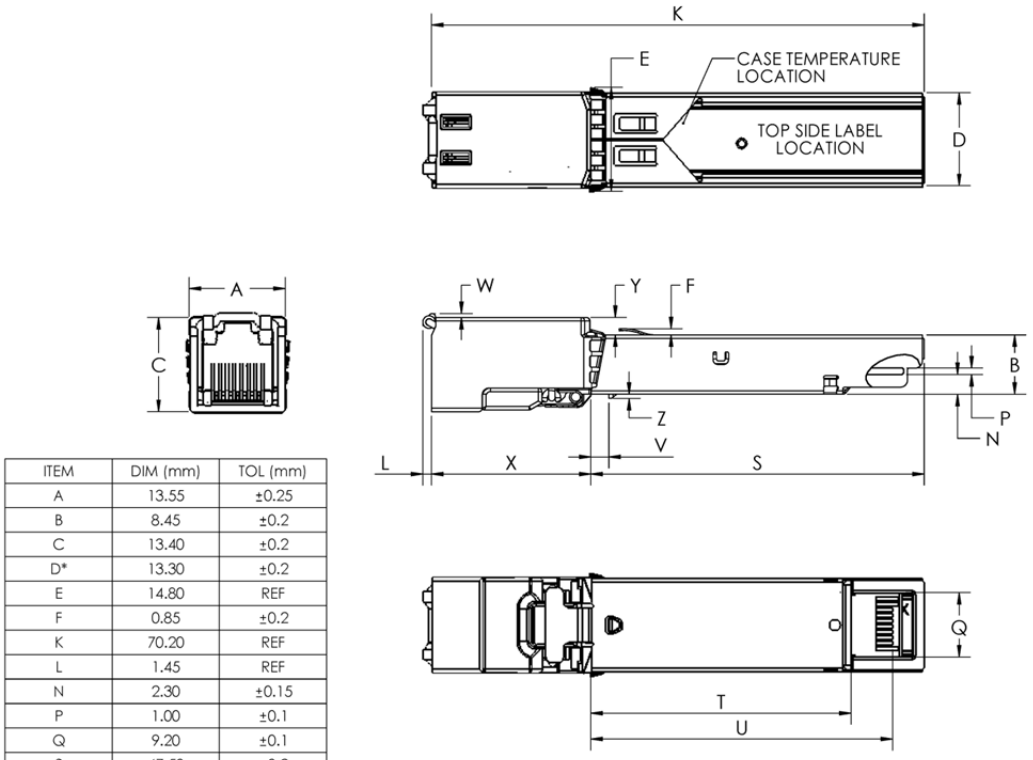
The 1000BASE-T physical layer IC can also be accessed via the 2-wire serial bus at address ACh. For details interfacing with the PHY IC, see Marvell data sheet titled "Alaska Ultra 88E1111 Integrated Gigabit Ethernet Transceiver"[4] (Marvell document number MV-S100649-00).

| Serial Bus Timing Requirements | | | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | **Symbol** | **Min** | **Typ** | **Max** | **Units** | **Notes/Conditions** |
| $I^2C$ Clock Rate | | 0 | | 100,000 | Hz | |

**Table 8. Serial bus timing requirements**

## VIII. Mechanical Specifications

The host-side of the FCLF-8520/8521-3 conforms to the mechanical specifications outlined in the SFP MSA[1]. The front portion of the SFP (part extending beyond the face plate of the host) is larger to accommodate the RJ-45 connector. See Figure 2 below for details.




| ITEM | DIM (mm) | TOL (mm) |
|---|---|---|
| A | 13.55 | ±0.25 |
| B | 8.45 | ±0.2 |
| C | 13.40 | ±0.2 |
| D* | 13.30 | ±0.2 |
| E | 14.80 | REF |
| F | 0.85 | ±0.2 |
| K | 70.20 | REF |
| L | 1.45 | REF |
| N | 2.30 | ±0.15 |
| P | 1.00 | ±0.1 |
| Q | 9.20 | ±0.1 |
| S | 47.50 | ±0.2 |
| T | 37.15 | ±0.3 |
| U | 43.00 | ±0.2 |
| V | 2.55 | ±0.2 |
| W | 0.65 | REF |
| X | 22.70 | ±0.3 |
| Y | 2.50 | ±0.2 |
| Z | 0.55 | +0.20/-0.15 |

*SIDE LABEL ADDS ~0.07 (OPTIONAL)

**Figure 2. FCLF-8520/8521-3 mechanical dimensions**

## IX. References


1. Small Form Factor Pluggable (SFP) Transceiver Multi-Source Agreement (MSA), September 2000. Documentation is currently available at Finisar upon request.

2. IEEE Std 802.3, 2002 Edition. IEEE Standards Department, 2002.

3. "AT24C01A/02/04/08/16 2-Wire Serial CMOS $E^2$PROM", Atmel Corporation. www.Atmel.com

4. "Alaska Ultra 88E1111 Integrated 10/100/1000 Gigabit Ethernet Transceiver", Marvell Corporation. www.marvell.com

5. Directive 2011/65/EU of the European Council Parliament and of the Council, "on the restriction of the use of certain hazardous substances in electrical and electronic equipment".

6. "Application Note AN-2038: Finisar Implementation of RoHS Compliant Transceivers"


## X. For More Information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