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# **ESTxxX-40D(I) Tunable**

## **10Gb/s Tunable DWDM 40km SFP+ Transceiver**

### **PRODUCT FEATURES**

- **Supports 9.95Gb/s to 11.3Gb/s bit rates**
- **Monolithically integrated full C-band tunable transmitter and PIN receiver**
- **50 GHz ITU channel spacing with integrated wavelength locker**
- **Up to 40km on 9/125μm SMF**
- **Hot-pluggable SFP+ footprint**
- **Compliant with SFP+ MSA with LC connector**
- **Metal enclosure, for lower EMI**
- **RoHS-10 compliant and lead-free**
- **Support Digital Diagnostic Monitoring interface**
- **Specifications compliant with SFF-8472 V11.3& SFF-8690 V1.4**
- **Single +3.3V power supply**
- **Temperature Range:**
  - Commercial: 0°C ~70°C**
  - Industrial: -40°C ~85°C**

### **APPLICATIONS**

- **DWDM 10GBASE-ER/EW Ethernet**
- **DWDM SONET OC-192&SDH STM-64**
- **10G Fiber Channel**

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## DESCRIPTIONS

The ETU-Link tunable transceiver is an integrated fiber optic transceiver that provides a high-speed serial link at signaling rates from 9.95 Gb/s to 11.3 Gb/s. The module complies with the 10 Gigabit Enhanced Small Form Factor Pluggable (SFP+) multisource agreement-MSA (SFF-8431) and SFF-8432, SFF-8690, SFF-8472. It complies with the ITU-T G.698.1 standard with 50 GHz channel spacing for SONET/SDH, IEEE DWDM 10GBASE-ER for 40 km reach (Ethernet), and DWDM 10GFC for 40 km reach (Fiber Channel) applications.

The transceiver integrates the receiver and transmitter path on one module. The transceiver contains a C-band-tunable integrated Mach-Zehnder (MZ) laser, enabling data transmission over single-mode fiber through an industry-standard LC connector. On the receiver side, the 10 G/bps data stream is recovered from an PIN/trans-impedance amplifier, and passed to an output driver. This module features a hot-pluggable electrical interface.

ETU transceivers provide a unique enhanced digital diagnostic monitoring interface, which allows real-time access to device operating parameters such as transceiver temperature, laser bias current, transmitted optical power, and received optical power and transceiver supply voltage. It also defines a sophisticated system of alarm and warning flags, which alerts end-users when particular operating parameters are outside of a factory set normal range.

The SFP+ MSA defines a 256-byte memory map in EEPROM that is accessible over a 2-wire serial interface at the 8 bit address 1010000X (A0h). The digital diagnostic monitoring interface makes use of the 8 bit address 1010001X (A2h), so the originally defined serial ID memory map remains unchanged.

## Ordering Information

| Part No.    | Data Rate(optical) | Laser | Fiber Type | Distance | Optical Interface | Temp     | DDMI | Latch Color |
|-------------|--------------------|-------|------------|----------|-------------------|----------|------|-------------|
| ESTxxX-40D  | 10.3125Gbps        | EML   | SMF        | 40km     | LC                | 0~70°C   | Y    | Green       |
| ESTxxX-40DI | 10.3125Gbps        | EML   | SMF        | 40km     | LC                | -40~85°C | Y    | Green       |

## Wavelength Selection: C-band $\lambda$ c Wavelength Guide Pin Descriptions

| Channel | Wavelength (nm) | Frequency (THZ) | Channel | Wavelength (nm) | Frequency (THZ) |
|---------|-----------------|-----------------|---------|-----------------|-----------------|
| 1       | 1566.72         | 191.35          | 50      | 1546.92         | 193.8           |
| 2       | 1566.31         | 191.4           | 51      | 1546.52         | 193.85          |
| 3       | 1565.9          | 191.45          | 52      | 1546.12         | 193.9           |
| 4       | 1565.5          | 191.5           | 53      | 1545.72         | 193.95          |
| 5       | 1565.09         | 191.55          | 54      | 1545.32         | 194             |
| 6       | 1564.68         | 191.6           | 55      | 1544.92         | 194.05          |
| 7       | 1564.27         | 191.65          | 56      | 1544.53         | 194.1           |
| 8       | 1563.86         | 191.7           | 57      | 1544.13         | 194.15          |
| 9       | 1563.45         | 191.75          | 58      | 1543.73         | 194.2           |

|    |         |        |    |         |        |
|----|---------|--------|----|---------|--------|
| 10 | 1563.05 | 191.8  | 59 | 1543.33 | 194.25 |
| 11 | 1562.64 | 191.85 | 60 | 1542.94 | 194.3  |
| 12 | 1562.23 | 191.9  | 61 | 1542.54 | 194.35 |
| 13 | 1561.83 | 191.95 | 62 | 1542.14 | 194.4  |
| 14 | 1561.42 | 192    | 63 | 1541.75 | 194.45 |
| 15 | 1561.01 | 192.05 | 64 | 1541.35 | 194.5  |
| 16 | 1560.61 | 192.1  | 65 | 1540.95 | 194.55 |
| 17 | 1560.2  | 192.15 | 66 | 1540.56 | 194.6  |
| 18 | 1559.79 | 192.2  | 67 | 1540.16 | 194.65 |
| 19 | 1559.39 | 192.25 | 68 | 1539.77 | 194.7  |
| 20 | 1558.98 | 192.3  | 69 | 1539.37 | 194.75 |
| 21 | 1558.58 | 192.35 | 70 | 1538.98 | 194.8  |
| 22 | 1558.17 | 192.4  | 71 | 1538.58 | 194.85 |
| 23 | 1557.77 | 192.45 | 72 | 1538.19 | 194.9  |
| 24 | 1557.36 | 192.5  | 73 | 1537.79 | 194.95 |
| 25 | 1556.96 | 192.55 | 74 | 1537.4  | 195    |
| 26 | 1556.55 | 192.6  | 75 | 1537    | 195.05 |
| 27 | 1556.15 | 192.65 | 76 | 1536.61 | 195.1  |
| 28 | 1555.75 | 192.7  | 77 | 1536.22 | 195.15 |
| 29 | 1555.34 | 192.75 | 78 | 1535.82 | 195.2  |
| 30 | 1554.94 | 192.8  | 79 | 1535.43 | 195.25 |
| 31 | 1554.54 | 192.85 | 80 | 1535.04 | 195.3  |
| 32 | 1554.13 | 192.9  | 81 | 1534.64 | 195.35 |
| 33 | 1553.73 | 192.95 | 82 | 1534.25 | 195.4  |
| 34 | 1553.33 | 193    | 83 | 1533.86 | 195.45 |
| 35 | 1552.93 | 193.05 | 84 | 1533.47 | 195.5  |
| 36 | 1552.52 | 193.1  | 85 | 1533.07 | 195.55 |
| 37 | 1552.12 | 193.15 | 86 | 1532.68 | 195.6  |
| 38 | 1551.72 | 193.2  | 87 | 1532.29 | 195.65 |
| 39 | 1551.32 | 193.25 | 88 | 1531.9  | 195.7  |
| 40 | 1550.92 | 193.3  | 89 | 1531.51 | 195.75 |
| 41 | 1550.52 | 193.35 | 90 | 1531.12 | 195.8  |
| 42 | 1550.12 | 193.4  | 91 | 1530.72 | 195.85 |
| 43 | 1549.72 | 193.45 | 92 | 1530.33 | 195.9  |
| 44 | 1549.32 | 193.5  | 93 | 1529.94 | 195.95 |
| 45 | 1548.91 | 193.55 | 94 | 1529.55 | 196.00 |
| 46 | 1548.51 | 193.6  | 95 | 1529.16 | 196.05 |
| 47 | 1548.11 | 193.65 | 96 | 1528.77 | 196.10 |
| 48 | 1547.72 | 193.7  |    |         |        |
| 49 | 1547.32 | 193.75 |    |         |        |

Notes:

1. When a tunable module is plugged in for the first time, it will go to a default channel, ETU default channel is 1566.72nm, compatible with channel range from 1 to 96
2. When the module is power cycled it will automatically go to the last channel selected, or when Tx \_Disable asserted and then re-enabled, the module returns to the last channel selected.

## Absolute Maximum Ratings

| Parameter                            | Symbol          | Min. | Typical | Max. | Unit | Notes |
|--------------------------------------|-----------------|------|---------|------|------|-------|
| Storage Temperature                  | T <sub>s</sub>  | -40  |         | 85   | °C   |       |
| Power Supply Voltage                 | V <sub>CC</sub> | -0.5 |         | 3.6  | V    |       |
| Relative Humidity (non-condensation) | RH              | 5    |         | 95   | %    |       |
| Damage Threshold                     | TH <sub>d</sub> | 0    |         |      | dBm  |       |

## Recommended Operating Conditions

| Parameter                  | Symbol          | Min.  | Typical | Max.            | Unit | Notes      |
|----------------------------|-----------------|-------|---------|-----------------|------|------------|
| Case Operating Temperature | Top             | 0     | -       | 70              | °C   | Commercial |
|                            |                 | -40   |         | 85              |      | Industrial |
| Power Supply Voltage       | V <sub>CC</sub> | 3.135 | 3.3     | 3.465           | V    |            |
| Data Rate                  |                 |       | 10.3125 |                 | Gb/s |            |
| Control Input Voltage High |                 | 2     |         | V <sub>CC</sub> | V    |            |
| Control Input Voltage Low  |                 | 0     |         | 0.8             | V    |            |
| Link Distance (SMF)        | D               |       |         | 40              | km   | 9/125um    |

## Electrical Characteristics

| Parameter                                    | Symbol | Min. | Typical | Max. | Unit | Notes      |
|----------------------------------------------|--------|------|---------|------|------|------------|
| Power Consumption                            | p      |      |         | 1.8  | W    | Commercial |
|                                              |        |      |         | 2.3  |      | Industrial |
| Supply Current                               | Icc    |      |         | 545  | mA   | Commercial |
|                                              |        |      |         | 700  |      | Industrial |
| Transmitter (Module Input)                   |        |      |         |      |      |            |
| Single-ended Input Voltage Tolerance         | Vcc    | -0.3 |         | 4.0  | V    |            |
| AC Common Mode Input Voltage Tolerance (RMS) |        | 15   |         |      | mV   |            |
| Differential Input Voltage Swing             | Vin,pp | 240  |         | 910  | mVpp |            |
| Differential Input Impedance                 | Zin    | 90   | 100     | 110  | Ohm  | 1          |
| Transmit Disable Assert Time                 |        |      |         | 10   | us   |            |

|                                   |         |         |     |          |      |   |
|-----------------------------------|---------|---------|-----|----------|------|---|
| Transmit Disable Voltage          | Vdis    | Vcc-1.3 |     | Vcc      | V    |   |
| Transmit Enable Voltage           | Ven     | Vee     |     | Vee +0.8 | V    | 2 |
| <b>Receiver (Module Output)</b>   |         |         |     |          |      |   |
| Differential Output Voltage Swing | Vout,pp | 350     |     | 800      | mVpp |   |
| Differential Output Impedance     | Zout    | 90      | 100 | 110      | Ohm  | 3 |
| Data output rise/fall time        | Tr/Tf   | 30      |     |          | ps   | 4 |
| LOS Assert Voltage                | VlosH   | Vcc-1.3 |     | Vcc      | V    | 5 |
| LOS De-assert Voltage             | VlosL   | Vee     |     | Vee +0.8 | V    | 5 |
| Power Supply Rejection            | PSR     | 100     |     |          | mVpp | 6 |

Notes:

1. Connected directly to TX data input pins. AC coupled thereafter.
2. Or open circuit.
3. Input 100 ohms differential termination.
4. These are unfiltered 20-80% values.
5. Loss of Signal is LVTTL. Logic 0 indicates normal operation; logic 1 indicates no signal detected.
6. Receiver sensitivity is compliant with power supply sinusoidal modulation of 20 Hz to 1.5 MHz up to specified value applied through the recommended power supply filtering network.

## Optical and Characteristics

| Parameter                            | Symbol             | Min.                       | Typical | Max.  | Unit | Notes |
|--------------------------------------|--------------------|----------------------------|---------|-------|------|-------|
| Transmitter                          |                    |                            |         |       |      |       |
| Center Wavelength                    | $\lambda_{c\_BOL}$ | z-1.5                      | z       | Z+1.5 | GHz  |       |
| Center Wavelength                    | $\lambda_{c\_EOL}$ | z-2.5                      | z       | Z+2.5 | GHz  |       |
| Center Wavelength Spacing            |                    |                            | 50      |       | GHz  |       |
| Side Mode Suppression Ratio          | SMSR               | 35                         |         |       | dB   |       |
| Average Optical Power                | P <sub>AVG</sub>   | -1                         |         | 4     | dBm  | 1     |
| Optical Extinction Ratio             | ER                 | 8.2                        |         |       | dB   |       |
| Transmitter and Dispersion Penalty   | TDP                |                            |         | 3     | dB   |       |
| Transmitter off Output power         | P <sub>off</sub>   |                            |         | -30   | dBm  |       |
| Transmitter Eye Mask                 |                    | Compliant with IEEE802.3ae |         |       |      |       |
| Receiver                             |                    |                            |         |       |      |       |
| Center Wavelength                    | $\lambda_c$        | 1270                       |         | 1610  | nm   |       |
| Receiver Sensitivity( Average power) | Sen.               |                            |         | -16   | dBm  | 2     |
| Input Saturation Power (overload)    | P <sub>sat</sub>   | -1                         |         |       | dBm  |       |
| LOS Assert                           | LOSA               | -30                        |         |       | dB   |       |
| LOS De-assert                        | LOSD               |                            |         | -16   | dBm  |       |
| LOS Hysteresis                       | LOSH               | 0.5                        |         |       | dBm  |       |

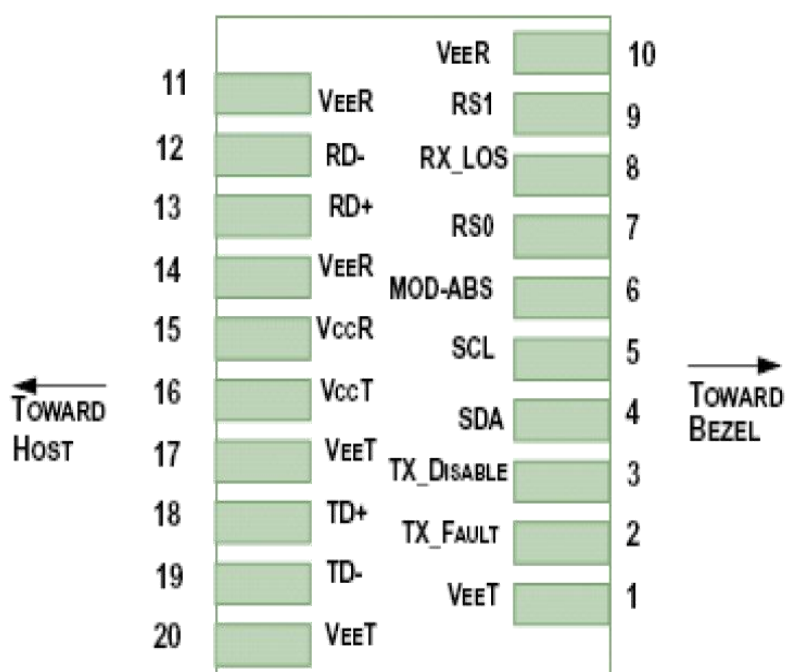
Notes:

1. Class 1 Laser Safety per FDA/CDRH and IEC-825-1 regulations.
2. Measured with Light source 1529.16~1568.36nm, ER=6.0dB; BER =<10<sup>-12</sup> @10.3125Gbps, PRBS=2<sup>31</sup>-1 NRZ.

## Digital Diagnostics

| Parameter                             | Symbol   | Min. | Max | Unit | Notes                |
|---------------------------------------|----------|------|-----|------|----------------------|
| Temperature monitor absolute error    | DMI_Temp | -3   | 3   | degC | Over operating temp  |
| Supply voltage monitor absolute error | DMI_VCC  | -0.1 | 0.1 | V    | Full operating range |
| RX power monitor absolute error       | DMI_RX   | -3   | 3   | dB   |                      |
| Bias current monitor                  | DMI_bias | -10% | 10% | mA   |                      |
| TX power monitor absolute error       | DMI_TX   | -3   | 3   | dB   |                      |

## Pin Diagram



## Pin Definitions

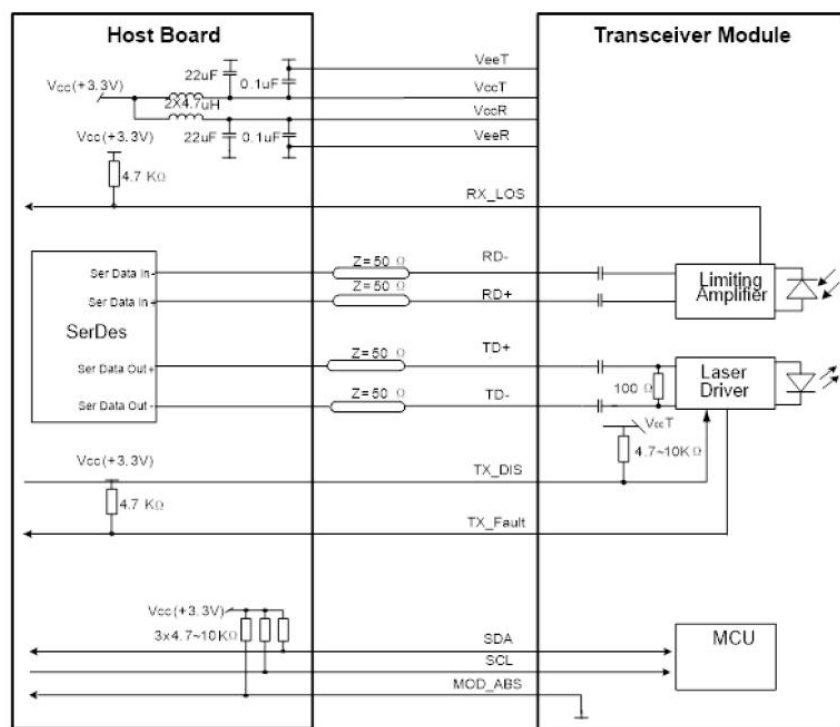
| PIN # | Name               | Function                                                       | Notes |
|-------|--------------------|----------------------------------------------------------------|-------|
| 1     | V <sub>EET</sub>   | Transmitter Ground (Common with Receiver Ground)               | 1     |
| 2     | T <sub>FAULT</sub> | Transmitter Fault.                                             | 2     |
| 3     | T <sub>DIS</sub>   | Transmitter Disable. Laser output disabled on high or open.    | 3     |
| 4     | SDA                | 2-wire Serial Interface Data Line                              | 4     |
| 5     | SCL                | 2-wire Serial Interface Clock Line                             | 4     |
| 6     | MOD_ABS            | Module Absent. Grounded within the module                      | 4     |
| 7     | RS0                | Rate Select 0                                                  | 5     |
| 8     | LOS                | Loss of Signal indication. Logic 0 indicates normal operation. | 6     |
| 9     | RS1                | No connection required                                         |       |

|    |           |                                                  |   |
|----|-----------|--------------------------------------------------|---|
| 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 |

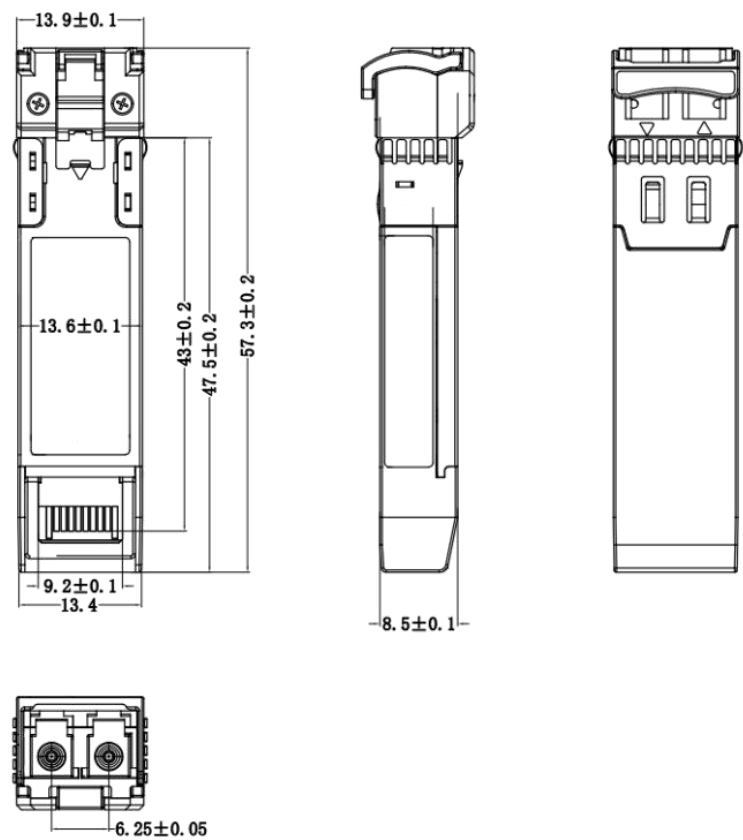
#### Notes:

1. Circuit ground is internally isolated from chassis ground.
2. TFAULT is an open collector/drain output, which should be pulled up with a 4.7k $\Omega$ -10 k $\Omega$  resistor on the host board if intended for use. Pull up voltage should be between 2.0V to  $V_{CC} + 0.3V$ . A high output indicates a transmitter fault caused by either the TX bias current or the TX output power exceeding the preset alarm thresholds. A low output indicates normal operation. In the low state, the output is pulled to <0.8V.
3. Laser output disabled on TDIS >2.0V or open, enabled on TDIS <0.8V.
4. Should be pulled up with 4.7k $\Omega$ -10k $\Omega$  on host board to a voltage between 2.0V and 3.6V. MOD\_ABS pulls line low to indicate module is plugged in.
5. Internally pulled down per SFF-8431 Rev 4.1.
6. LOS is open collector output. It should be pulled up with 4.7k $\Omega$ -10k $\Omega$  on host board to a voltage between 2.0V and 3.6V. Logic 0 indicates normal operation; logic 1 indicates loss of signal.

## Recommended Interface Circuit



# Mechanical Diagram



# Revision History

| Version No. | Date               | Description           |
|-------------|--------------------|-----------------------|
| 1.0         | July 26, 2023      | Preliminary datasheet |
| 2.0         | September 27, 2024 | Format change         |