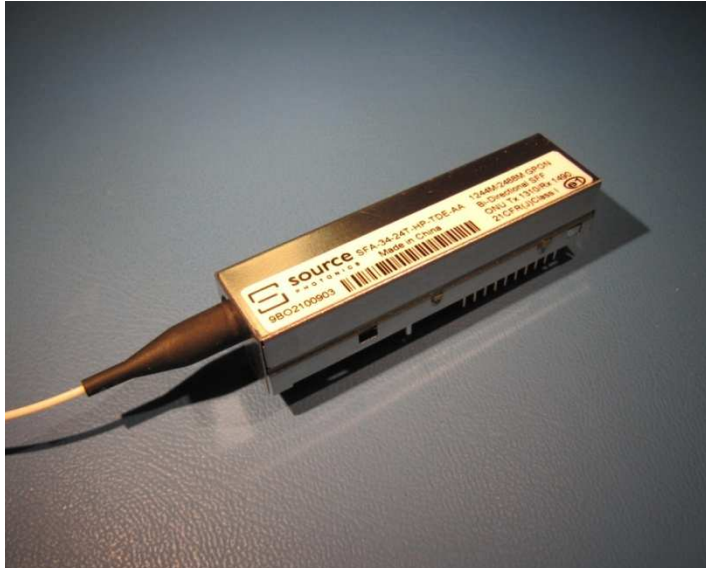


## Integrated Diplexer Transceiver

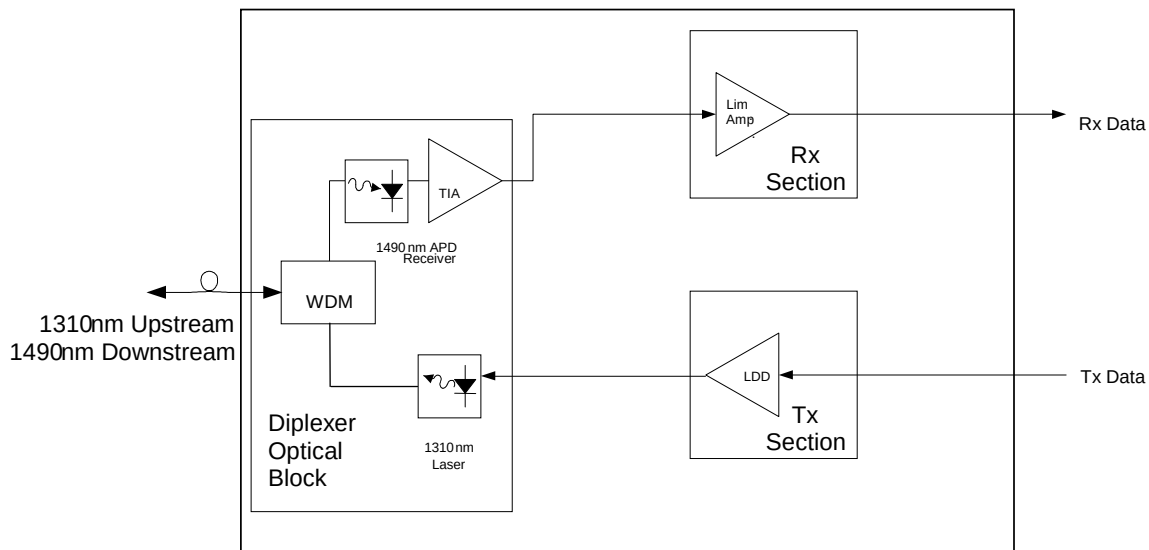


### Features

- Single Fiber, CWDM Integrated Diplexer Transceiver
- 2x5 SFF pinout
- 2x10 SFF pinout supports I<sup>2</sup>C digital diagnostics
- Voice/Data FTTx ONT/ONU Applications
- 1244 Mbps Tx, 2488 Mbps Rx Asymmetric Data Rate
- 5 Wavelength Pairs Available
- Burst Mode Transmission
- TX Burst Mode Detection, TX-SD
- Commercial temperature
- 28 dB link budget; 20 km reach
- Compliant to IEC-60825 Class 1 laser diode
- SC/APC or SC/UPC fiber connector
- RoHS compliant

- **Digital Transmitter:** A CWDM laser diode is employed for upstream transmission at OC-24 (1244Mbps). The optical transmitter includes a back facet photodetector to monitor laser power for APC control.

- **Digital Receiver:** An APD with TIA is employed for downstream data reception at OC-48 (2488Mbps). A post amplifier is also included for CML output compatibility.



Diplexer Block Diagram

## Absolute Maximum Ratings

Usage of this transceiver shall adhere to the following absolute maximum ratings. Stresses beyond those in Table 1 may cause permanent damage to the unit. These are stress ratings only, and functional operation of the unit at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect unit reliability.

**Table 1 - Absolute Maximum Ratings**

| Parameter                          | Minimum | Maximum    | Unit/Conditions |
|------------------------------------|---------|------------|-----------------|
| Ambient Storage Temperature        | -40     | 85         | °C              |
| Operating Temperature*             | 0       | 70         | °C, C-Temp      |
| Operating Humidity Range           | 10%     | 90%        | non-condensing  |
| ESD Sensitivity (Human Body Model) | -       | 1000       | V               |
| Lead Soldering Temperature         | -       | 260°C      | 10 sec          |
| Vcc_Rx                             | -0.4    | +4.2       | V               |
| Vcc_Tx                             | -0.4    | Vcc_Rx + 1 | V               |

\*Operating temperature minimum is ambient, maximum is module case temperature.

## Module Characteristics

**Table 2 - Module Characteristics**

| Parameter                      | Minimum | Typical | Maximum | Unit/Conditions |
|--------------------------------|---------|---------|---------|-----------------|
| Tx to Rx Crosstalk             | -       | -       | -47     | dB              |
| Total TX and RX Supply Current | -       | -       | 350     | mA              |

## Functional Characteristics

The following tables list the performance specifications for the various functional blocks of the integrated optical transceiver module.

**Table 3 – Digital Transmitter Specifications**

| Parameter                                          | Minimum          | Typical                              | Maximum                                         | Unit  | Notes                                        |
|----------------------------------------------------|------------------|--------------------------------------|-------------------------------------------------|-------|----------------------------------------------|
| Operating Voltage                                  | 3.14             | 3.30                                 | 3.46                                            | V     | V <sub>CC</sub> referenced to GND_Tx         |
| Data Rate                                          | -                | 1244.16                              | -                                               | Mbps  |                                              |
| Average Optical Output Power, P <sub>O</sub> (BOL) | 1.5              | -                                    | 5                                               | dBm   |                                              |
| Average Optical Output Power, P <sub>O</sub> (BOL) | 0.5              | -                                    | 5                                               | dBm   |                                              |
| Output Power at Transmit Off                       | -                | -                                    | -40                                             | dBm   |                                              |
| Extinction Ratio                                   | 10               | -                                    | -                                               | dB    | PRBS 2 <sup>23</sup> -1, NRZ, 50% duty cycle |
| Transmitter Output Eye                             | G.984.2 Figure 3 |                                      |                                                 |       |                                              |
| Optical Rise and Fall Time                         | -                | 250                                  | -                                               | ps    | 20% to 80%                                   |
| Center Wavelength                                  |                  | 1271<br>1291<br>1311<br>1331<br>1351 |                                                 | nm    | C-temp ±6.5nm                                |
| SMSR                                               |                  | 30                                   |                                                 | dB    |                                              |
| Differential Input Voltage, V <sub>in</sub>        | 200              | -                                    | 1600                                            | mVp-p | TXD+/-, DC-coupled                           |
| Common-Mode Input Voltage                          | GND_Tx +<br>1.4  | -                                    | V <sub>CC</sub> - (V <sub>in</sub> /2) -<br>0.1 | V     | DC coupled                                   |
| Tx Burst Enable Time                               | -                | -                                    | 12.86                                           | ns    | 16 bits data @ 1244Mbps                      |
| Tx Burst Disable Time                              | -                | -                                    | 12.86                                           | ns    | 16 bits data @ 1244Mbps                      |
| Jitter Generation                                  | -                | -                                    | 0.2                                             | UI    | 4 kHz to 10 MHz                              |
| TX_DIS Input Low                                   | 0                |                                      | 0.8                                             | V     |                                              |
| TX_DIS Input High                                  | 2.0              |                                      | V <sub>CC_RX</sub>                              | V     |                                              |
| TX_SD timing "D"                                   |                  |                                      | 1000                                            | ns    | See figure 3                                 |
| TX_SD timing "X"                                   |                  |                                      | 350                                             | ns    | See figure 3                                 |

Refer to Figure 1 which schematically describes the high speed data inputs/outputs of the optical transceiver module.

For CML  
Tx/Rx Data

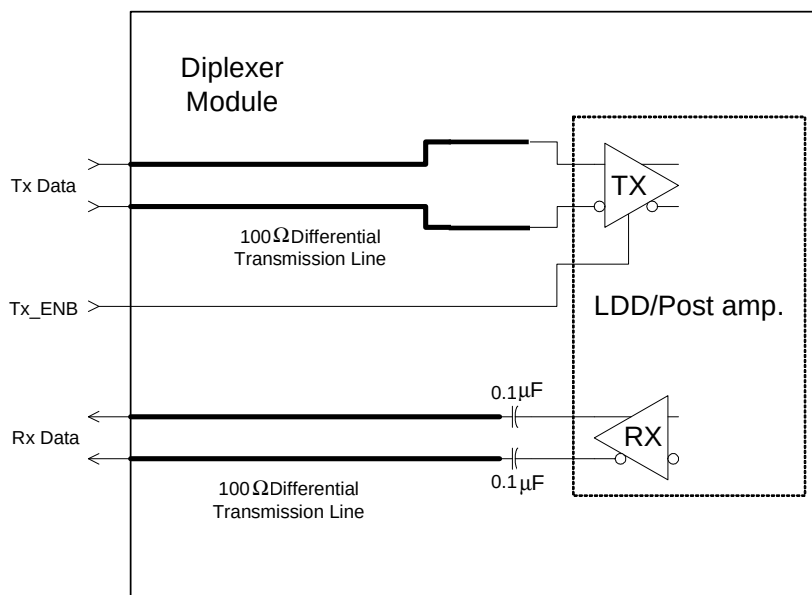


Figure 1 - Schematic representation of the module high speed inputs/outputs

Table 4 – Digital Receiver Specifications

| Parameter                         | Minimum | Typical                              | Maximum | Unit | Notes                                                                                                  |
|-----------------------------------|---------|--------------------------------------|---------|------|--------------------------------------------------------------------------------------------------------|
| Operating Voltage                 | 3.14    | 3.30                                 | 3.46    | V    | V <sub>CC</sub> referenced to GND_RX                                                                   |
| Data Rate                         | -       | 2488.32                              | -       | Mbps |                                                                                                        |
| Operational Wavelength Range      |         | 1451<br>1471<br>1491<br>1511<br>1531 |         | nm   |                                                                                                        |
| Received Optical Power, BOL       | -28.0   | -                                    | -8      | dBm  | PRBS 2 <sup>23</sup> -1, 50% duty cycle                                                                |
| Received Optical Power, EOL       | -27.0   | -                                    | -8      | dBm  | PRBS 2 <sup>23</sup> -1, 50% duty cycle                                                                |
| Data Output Rise and Fall Time    | -       | 160                                  | -       | ps   | 20% to 80%                                                                                             |
| Signal Detect Assertion Level     | -       | -                                    | -31     | dBm  | Transition during increasing light                                                                     |
| Signal Detect De-Assertion Level  | -45     | -                                    | -       | dBm  | Transition during decreasing light                                                                     |
| Signal Detect Hysteresis          | 0.5     | -                                    | 6       | dB   |                                                                                                        |
| Differential Output Voltage       | 300     | -                                    | 1200    | mV   | CML output, ac coupled (0.1μF)                                                                         |
| Signal Detect Output HIGH Voltage | 2.4     | -                                    | -       | V    | LVTTL with internal 4.7kΩ pull up resistor. Asserts HIGH when input data amplitude is above threshold. |
| Signal Detect Output LOW Voltage  | -       | -                                    | 0.6     | V    | LVTTL. De-asserts LOW when input data amplitude is below threshold .                                   |
| RSSI Range                        | -28     | -                                    | -8      | dBm  | 2x10 only                                                                                              |
| RSSI Accuracy                     | -3      | -                                    | +3      | dB   | 2x10 only                                                                                              |

**Table 5 - Microcontroller Specifications**

| Parameter               | Minimum | Typical | Maximum | Unit | Notes                                                                                                                          |
|-------------------------|---------|---------|---------|------|--------------------------------------------------------------------------------------------------------------------------------|
| Operating Voltage       | 3.14    | 3.30    | 3.46    | V    |                                                                                                                                |
| SDA <sup>a</sup>        | -       | -       | -       | -    | LVTTTL, open collector serial data line from the I <sup>2</sup> C bus to the on board Microcontroller. 100kbps max. data rate. |
| SCL <sup>b</sup>        | -       | -       | -       | -    | LVTTTL, open collector serial clock line from the I <sup>2</sup> C bus to the on board Microcontroller.                        |
| Reset hold <sup>c</sup> | 30      | -       | -       | ms   | LVTTTL input, internal 50kΩ pull-up. Active Low                                                                                |

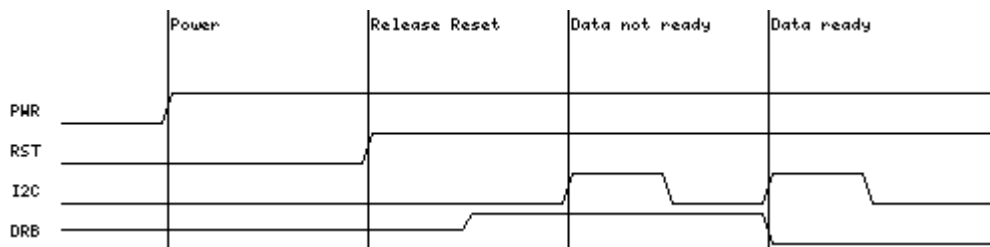
<sup>a</sup> I<sup>2</sup>C SDA and SCL must be open collector or open drain connections.

<sup>b</sup> Clock stretching, as per paragraph 13.2 of the I<sup>2</sup>C Bus Standard, must be implemented to operate correctly.

<sup>c</sup> Please see Table 6 and the timing diagram in Figure 2 below for the recommended system start-up sequence.

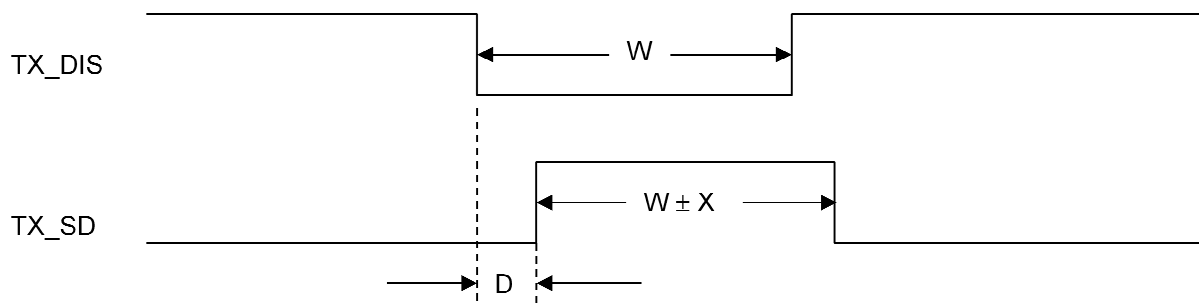
**Table 6 – Suggested Start-up Sequence**

| Step | Action                                                                                                                                                                                                     |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Power up the host system, with the RESET pin pulled to ground via a ≤4.7kΩ resistor.                                                                                                                       |
| 2    | Drive the RESET pin LOW.                                                                                                                                                                                   |
| 3    | Ensure power to the unit is on.                                                                                                                                                                            |
| 4    | Drive the RESET pin HIGH to release the unit to become operational.                                                                                                                                        |
| 5    | Read byte A2.6E several times. There will be a NACK until the processor is booted, followed by a 01 (DATA READY BAR) until the A2D data is ready, followed by 00 (assuming TXDIS and TXFAIL are inactive). |
| 6    | The unit is now ready for normal operation.                                                                                                                                                                |



**Figure 2 - Recommended transceiver module start-up sequence**

**Fig 3 TX\_SD Timing Diagram**



## 2x5 Pin Definitions

Refer to Table 7 for a description of the function of each I/O pin.

| Pin Number | Label  | Definition                                                                                               |
|------------|--------|----------------------------------------------------------------------------------------------------------|
| 1          | GND_RX | Digital Rx Ground                                                                                        |
| 2          | Vcc_RX | Digital Rx Vcc                                                                                           |
| 3          | SD     | Signal Detect output, pull up internally. Asserts high when input optical power level is above threshold |
| 4          | RxD-   | RX data bar output, CML. 50Ω terminated to Vcc and AC coupled to module output (0.1μF)                   |
| 5          | RxD+   | RX data output, CML. 50Ω terminated to Vcc and AC coupled to module output (0.1μF)                       |
| 6          | Vcc_TX | Digital Tx Vcc                                                                                           |
| 7          | GND_TX | Digital Tx Ground                                                                                        |
| 8          | TX_DIS | Tx Disable, LVTTTL Input (1=TX OFF, 0=TX ON)                                                             |
| 9          | TxD+   | Tx data input, CML. Internally DC coupled. 100Ω differential termination.                                |
| 10         | TxD-   | Tx data bar input, CML. Internally DC coupled. 100Ω differential termination.                            |

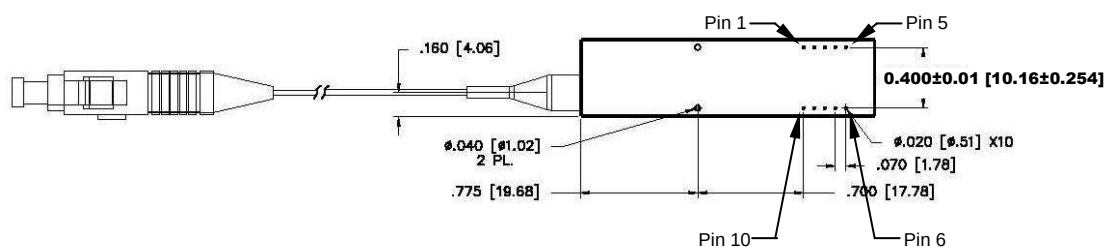
## 2x10 Pin Definitions

Refer to Table 8 for a description of the function of each I/O pin.

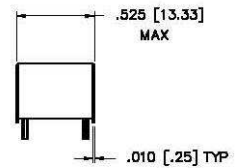
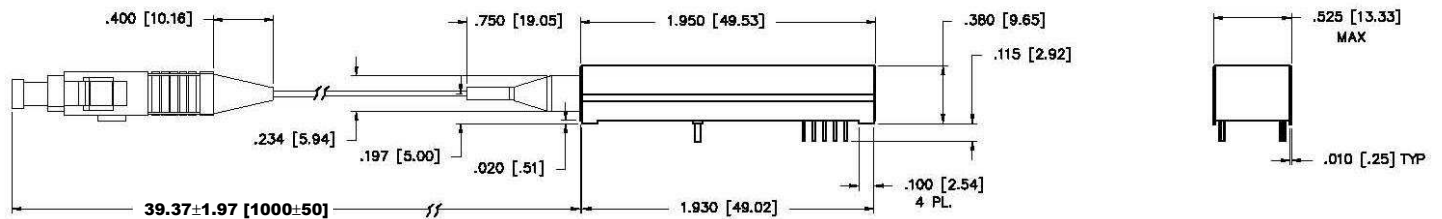
**Table 8 - Module Pin Definitions**

| Pin Number | Label    | Definition                                                                                                                |
|------------|----------|---------------------------------------------------------------------------------------------------------------------------|
| 1          | NC       | No User Connection                                                                                                        |
| 2          | GND_RX   | Digital Rx ground                                                                                                         |
| 3          | GND_RX   | Digital Rx ground                                                                                                         |
| 4          | NC       | Reserved, No User Connection                                                                                              |
| 5          | NC       | Reserved, No User Connection                                                                                              |
| 6          | GND_RX   | Digital Rx Ground                                                                                                         |
| 7          | Vcc_RX   | Digital Rx Vcc                                                                                                            |
| 8          | SD       | Signal Detect output, pull up internally (4.7k $\Omega$ ). Asserts high when input optical power level is above threshold |
| 9          | RxD-     | RX data bar output, CML. 50 $\Omega$ terminated to Vcc and AC coupled to module output (0.1 $\mu$ F)                      |
| 10         | RxD+     | RX data output, CML. 50 $\Omega$ terminated to Vcc and AC coupled to module output (0.1 $\mu$ F)                          |
| 11         | Vcc_TX   | Digital Tx Vcc                                                                                                            |
| 12         | GND_TX   | Digital Tx Ground                                                                                                         |
| 13         | TX_DIS   | Tx Disable, LVTTTL Input (1=TX OFF, 0=TX ON), internal 47k $\Omega$ pull-up.                                              |
| 14         | TxD+     | Tx data input, CML. Internally DC coupled. 100 $\Omega$ differential termination.                                         |
| 15         | TxD-     | Tx data bar input, CML. Internally DC coupled. 100 $\Omega$ differential termination.                                     |
| 16         | GND_TX   | Digital Tx Ground                                                                                                         |
| 17         | SCL      | I2C Clock input                                                                                                           |
| 18         | SDA      | I2C Data input/output                                                                                                     |
| 19         | TX_Fault | TX Fault Alarm, LVTTTL, TX Fault state=High, TX Normal state=Low.                                                         |
| 20         | TX_SD    | TX Signal Detect, TX Active state=High. See TX_SD diagram.                                                                |

## SFF 2x5 Package Diagram



Bottom View





Technical drawing of the connector assembly showing dimensions and tolerances. The drawing includes a side view of the connector on the left and a top view of the rectangular component on the right. Key dimensions and tolerances are labeled:

- Overall length:  $.160$  [4.06]
- Pin diameter:  $\phi .040$  [ $\phi 1.02$ ]
- Pin spacing (center-to-center):  $.775$  [19.68]
- Pin diameter (for Pin 10 and Pin 11):  $\phi .018$  [ $\phi .46$ ] X 20
- Pin 10 position:  $.070$  [1.78]
- Pin 11 position:  $.630$  [16.00]
- Pin 20 position:  $.350$  [8.89]
- Overall width:  $.400 \pm 0.01$  [10.16  $\pm$  0.254]



Technical drawing of the 1000 Series 1/2" probe, showing dimensions in inches and millimeters. The drawing includes a side view and a detail view of the probe tip.

Dimensions (inches [millimeters]):

- Overall length: 39.37 ± 1.97 [1000 ± 50]
- Tip diameter: .400 [10.18]
- Tip length: .750 [19.05]
- Tip diameter: .234 [5.94]
- Tip length: .197 [5.00]
- Tip diameter: .020 [.51]
- Tip length: .100 [2.54] 4 PL
- Tip diameter: .380 [9.65]
- Tip length: .115 [2.92]
- Tip diameter: .525 [13.33] MAX
- Tip length: .010 [.25] TYP

## Ordering Information

**Table 9 - Ordering Information**

|           | Connector      |          | TX & RX Wavelength<br>(nm) |                 | Temperature Range                         | Digital Diagnostic        | Design<br>Revision | Customer<br>Specific |
|-----------|----------------|----------|----------------------------|-----------------|-------------------------------------------|---------------------------|--------------------|----------------------|
| <b>SF</b> | <b>x</b>       | <b>-</b> | <b>xx</b>                  | <b>-24T-HP-</b> | <b>C</b>                                  | <b>x</b>                  | <b>E</b>           | <b>-xx</b>           |
|           | <b>A</b> = APC |          | <b>AJ</b> = 1271 & 1451    |                 | <b>C</b> = Commercial Temp<br>(0 to 70°C) | <b>N</b> = Non-Diagnostic |                    |                      |
|           | <b>U</b> = UPC |          | <b>BK</b> = 1291 & 1471    |                 |                                           | <b>D</b> = Diagnostic     |                    |                      |
|           |                |          | <b>CL</b> = 1311 & 1491    |                 |                                           |                           |                    |                      |
|           |                |          | <b>DM</b> = 1331 & 1511    |                 |                                           |                           |                    |                      |
|           |                |          | <b>EN</b> = 1351 & 1531    |                 |                                           |                           |                    |                      |

Example: **SFA-CL-24T-HP-CDE** = Transceiver with APC connector, TX=1311nm, RX=1491nm, Commercial Temp, Diagnostic.

**Table 10 - Device Handling/ESD Protection**

|                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                        |
|----------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The devices are static sensitive and may easily be damaged if care is not taken during handling. The following handling practices are recommended. |                                                                                                                                                                                                                                                                                                                                        |
| 1                                                                                                                                                  | Devices should be handled on benches with conductive and grounding surfaces.                                                                                                                                                                                                                                                           |
| 2                                                                                                                                                  | All personnel, test equipment and tools shall be grounded.                                                                                                                                                                                                                                                                             |
| 3                                                                                                                                                  | Do not handle the devices by their leads.                                                                                                                                                                                                                                                                                              |
| 4                                                                                                                                                  | Store devices in protective foam or carriers.                                                                                                                                                                                                                                                                                          |
| 5                                                                                                                                                  | Avoid the use of non-conductive plastics, rubber, or silk in the area where the devices are handled                                                                                                                                                                                                                                    |
| 6                                                                                                                                                  | All modules shall be packaged in materials that are anti-static to protect against adverse electrical environments.                                                                                                                                                                                                                    |
| 7                                                                                                                                                  | Avoid applications of any voltage higher than maximum rated voltages to this part. For proper operation, any VIN or VOUT should be constrained to the range $GND \leq (VIN \text{ or } VOUT) \leq VCC$ . Unused inputs must always be tied to an appropriate logic voltage (e.g. either GND or VCC). Unused outputs must be left open. |

## Warnings

**Handling Precautions:** This device is susceptible to damage as a result of electrostatic discharge (ESD). A static free environment is highly recommended. Follow guidelines according to proper ESD procedures.

**Laser Safety:** Radiation emitted by laser devices can be dangerous to human eyes. Avoid eye exposure to direct or indirect radiation.

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