

## QSFP-100G-FR-S

### 100GBase-FR QSFP28 Transceiver

Hot Pluggable, +3.3V, MPO, 1310nm, 2km, SMF, Commercial Temperature

#### FEATURES

- Four-channel full-duplex transceiver modules
- Transmission data rate up to 26Gbit/s per channel
- Maximum link length of 2km on Single Mode Fiber (SMF)
- Low power consumption < 3.5W
- Commercial Operating Temperature Range: 0 to 70°C
- 3.3V power supply voltage
- RoHS 6 compliant
- Hot Pluggable QSFP form factor
- MPO connector receptacle
- Built-in digital diagnostic function

#### APPLICATIONS

- IEEE 802.3bm 100GBASE-FR and 40GBASE-FR
- Proprietary High-Speed Interconnections
- Data centre

#### DESCRIPTION

ATGBICS QSFP-100G-FR-S transceiver is a Four-Channel, Pluggable, Parallel, Fibre-Optic QSFP28 transceiver for IEEE 802.3bm, 100GBASE-FR applications, or 40 Gigabit Ethernet and InfiniBand FDR/EDR applications. The QSFP28 full-duplex optical module offers 4 independent transmit and receive channels, each capable of 26Gbps operation for an aggregate data rate of 104Gbps 70m using OM3 Fibre. These modules are designed to operate over multimode fibre systems using 1310nm VCSEL laser array. An optical fibre ribbon cable with an MPO/MTPTM connector can be plugged into the QSFP module receptacle. QSFP28 FR is one kind of parallel transceiver which provides increased port density and total system cost savings.

## ABSOLUTE MAXIMUM RATINGS

| Parameter                          | Symbol          | Min. | Max.                 | Unit |
|------------------------------------|-----------------|------|----------------------|------|
| Storage Temperature                | T <sub>o</sub>  | -40  | 85                   | °C   |
| Relative Humidity (non-condensing) | RH              | 0    | 85                   | %    |
| Operating Case Temperature         | T <sub>o</sub>  | 0    | 70                   | °C   |
| Supply Voltage                     | V <sub>cc</sub> | -0.3 | 3.6                  | V    |
| Input Voltage                      | V <sub>in</sub> | -0.3 | V <sub>cc</sub> +0.3 | V    |

## RECOMMENDED OPERATING ENVIRONMENT AND SUPPLY REQUIREMENTS

| Parameter                    | Symbol          | Min. | Typical  | Max. | Unit |
|------------------------------|-----------------|------|----------|------|------|
| Operating Case Temperature   | T <sub>o</sub>  | 0    |          | 70   | °C   |
| Power Supply Voltage         | V <sub>cc</sub> | 3.13 | 3.3      | 3.47 | V    |
| Power Consumption            |                 | -    |          | 3.5  | W    |
| Data Rate                    | DR              |      | 25.78125 |      | Gbps |
| Data Speed Tolerance         | ΔDR             | -100 |          | +100 | ppm  |
| Link Distance with OM3 Fibre | D               | 0    |          | 70   | m    |

## OPTICAL CHARACTERISTICS

All parameters are specified under the recommended operating conditions with PRBS31 data pattern unless otherwise specified.

| Parameter                                                                     | Symbol                             | Min  | Typical | Max   | Unit | Notes |
|-------------------------------------------------------------------------------|------------------------------------|------|---------|-------|------|-------|
| TRANSMITTER                                                                   |                                    |      |         |       |      |       |
| Centre Wavelength                                                             | $\lambda_C$                        | 1300 | 1310    | 1320  | nm   | 1     |
| RMS Spectral Width                                                            | $\lambda_{rms}$                    | -    |         | 0.65  | nm   | 1     |
| Average Launch Power, each lane                                               | PAVG                               | -7   | -2.5    | 0     | dBm  |       |
| Optical Modulation Amplitude (OMA)                                            | POMA                               | -5   | -2.5    | 0     | dBm  | 1     |
| Difference in Launch Power between any two lanes                              | Ptx,diff                           |      |         | 4.0   | dB   |       |
| Launch Power in OMA minus Transmitter and Dispersion Penalty (TDP), each Lane | OMA-TDP                            |      |         | 3.5   | dB   | 1     |
| Extinction Ratio                                                              | ER                                 | 3.5  |         |       | dB   |       |
| Transmitter Eye Mask Margin                                                   | EMM                                | 10   |         |       | %    | 2     |
| Average Launch Power OFF Transmitter, each Lane                               | Poff                               |      |         | -30   | dBm  |       |
| Transmitter Eye Mask Definition<br>{X1, X2, X3, Y1, Y2, Y3}                   | {0.3, 0.38, 0.45, 0.35, 0.41, 0.5} |      |         |       |      |       |
| RECEIVER                                                                      |                                    |      |         |       |      |       |
| Centre Wavelength                                                             | $\lambda_C$                        | 1300 | 1310    | 1320  | nm   |       |
| Damage Threshold                                                              | THd                                | +3   |         |       | dBm  |       |
| Overload, each lane                                                           | OVL                                | +2.4 |         |       | dBm  |       |
| Receiver Sensitivity in OMA, each Lane                                        | SEN                                |      |         | -10.3 | dBm  |       |
| Signal Loss Assert Threshold                                                  | LOSA                               | -30  |         |       | dBm  |       |
| Signal Loss Deassert Threshold                                                | LOSD                               |      |         | -9    | dBm  |       |
| LOS Hysteresis                                                                | LOSH                               | 0.5  |         | 6     | dB   |       |
| Optical Return Loss                                                           | ORL                                |      |         | -12   | dBm  |       |

Notes:

1. Transmitter wavelength, RMS spectral width and power need to meet the OMA minus TDP specs to guarantee link performance.
2. The eye diagram is tested with 1000 waveform.

## ELECTRICAL SPECIFICATIONS

| Parameter                             | Symbol           | Min                  | Typical | Max             | Unit  |
|---------------------------------------|------------------|----------------------|---------|-----------------|-------|
| Differential Input Impedance          | Zin              | 90                   | 100     | 110             | Ohm   |
| Differential Output Impedance         | Zout             | 90                   | 100     | 110             | Ohm   |
| Differential Input Voltage Amplitude  | $\Delta V_{in}$  | 300                  |         | 1100            | mVp-p |
| Differential Output Voltage Amplitude | $\Delta V_{out}$ | 500                  |         | 800             | mVp-p |
| Bit Error Rate                        | BR               |                      |         | E-12            |       |
| Input Logic Level High                | V <sub>IH</sub>  | 2.0                  |         | V <sub>CC</sub> | V     |
| Input Logic Level Low                 | V <sub>IL</sub>  | 0                    |         | 0.8             | V     |
| Output Logic Level High               | V <sub>OH</sub>  | V <sub>CC</sub> -0.5 |         | V <sub>CC</sub> | V     |
| Output Logic Level Low                | V <sub>OL</sub>  | 0                    |         | 0.4             | V     |

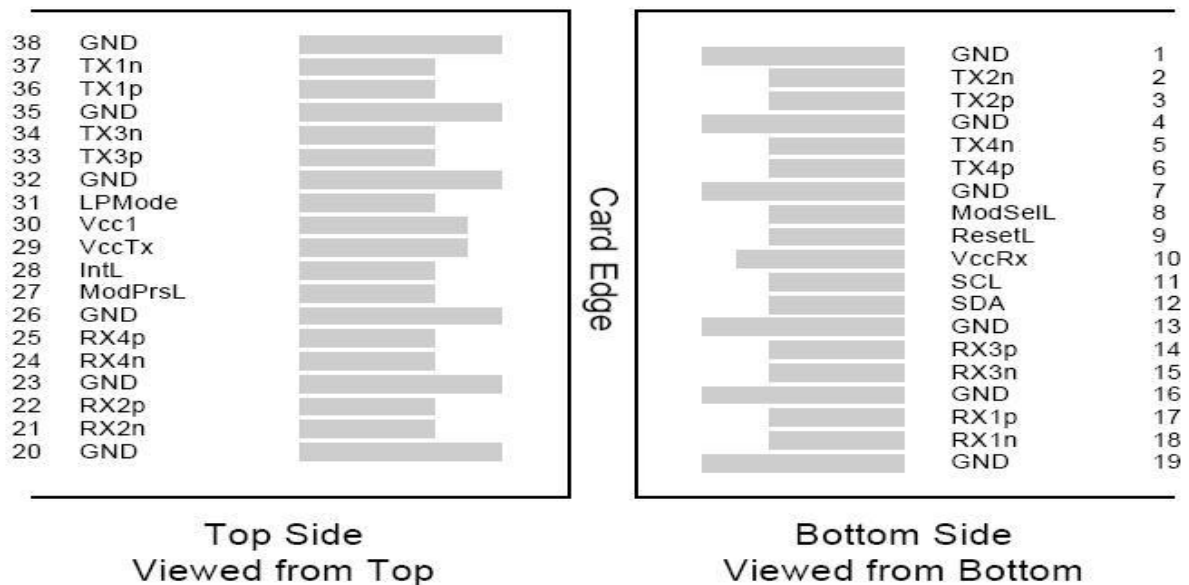
## PIN ASSIGNMENT

| PIN | Logic       | Symbol  | Name/Description                     | Note |
|-----|-------------|---------|--------------------------------------|------|
| 1   |             | GND     | Ground                               | 1    |
| 2   | CML-I       | Tx2n    | Transmitter Inverted Data Input      |      |
| 3   | CML-I       | Tx2p    | Transmitter Non-Inverted Data output |      |
| 4   |             | GND     | Ground                               | 1    |
| 5   | CML-I       | Tx4n    | Transmitter Inverted Data Input      |      |
| 6   | CML-I       | Tx4p    | Transmitter Non-Inverted Data output |      |
| 7   |             | GND     | Ground                               | 1    |
| 8   | LVTLL-I     | ModSelL | Module Select                        |      |
| 9   | LVTLL-I     | ResetL  | Module Reset                         |      |
| 10  |             | VccRx   | +3.3V Power Supply Receiver          | 2    |
| 11  | LVC MOS-I/O | SCL     | 2-Wire Serial Interface Clock        |      |
| 12  | LVC MOS-I/O | SDA     | 2-Wire Serial Interface Data         |      |
| 13  |             | GND     | Ground                               |      |
| 14  | CML-O       | Rx3p    | Receiver Non-Inverted Data Output    |      |
| 15  | CML-O       | Rx3n    | Receiver Inverted Data Output        |      |
| 16  |             | GND     | Ground                               | 1    |
| 17  | CML-O       | Rx1p    | Receiver Non-Inverted Data Output    |      |
| 18  | CML-O       | Rx1n    | Receiver Inverted Data Output        |      |
| 19  |             | GND     | Ground                               | 1    |
| 20  |             | GND     | Ground                               | 1    |
| 21  | CML-O       | Rx2n    | Receiver Inverted Data Output        |      |
| 22  | CML-O       | Rx2p    | Receiver Non-Inverted Data Output    |      |
| 23  |             | GND     | Ground                               | 1    |
| 24  | CML-O       | Rx4n    | Receiver Inverted Data Output        | 1    |
| 25  | CML-O       | Rx4p    | Receiver Non-Inverted Data Output    |      |
| 26  |             | GND     | Ground                               | 1    |
| 27  | LVTTL-O     | ModPrsL | Module Present                       |      |
| 28  | LVTTL-O     | IntL    | Interrupt                            |      |
| 29  |             | VccTx   | +3.3 V Power Supply transmitter      | 2    |
| 30  |             | Vcc1    | +3.3 V Power Supply                  | 2    |
| 31  | LVTTL-I     | LPMODE  | Low Power Mode                       |      |
| 32  |             | GND     | Ground                               | 1    |
| 33  | CML-I       | Tx3p    | Transmitter Non-Inverted Data Input  |      |
| 34  | CML-I       | Tx3n    | Transmitter Inverted Data Output     |      |

| PIN | Logic | Symbol | Name/Description                    | Note |
|-----|-------|--------|-------------------------------------|------|
| 35  |       | GND    | Ground                              | 1    |
| 36  | CML-I | Tx1p   | Transmitter Non-Inverted Data Input |      |
| 37  | CML-I | Tx1n   | Transmitter Inverted Data Output    |      |
| 38  |       | GND    | Ground                              | 1    |

Notes:

1. Module circuit ground is isolated from module chassis ground within the module. GND is the symbol for signal and supply (power) common for QSFP modules.
2. The connector pins are each rated for a maximum current of 500mA.



## MODSELL PIN

The ModSelL is an input pin. When held low by the host, the module responds to 2-wire serial communication commands. The ModSelL allows the use of multiple QSFP modules on a single 2-wire interface bus. When the ModSelL is “High”, the module will not respond to any 2-wire interface communication from the host. ModSelL has an internal pull-up in the module.

## RESETL PIN

Reset. LPMode\_Reset has an internal pull-up in the module. A low level on the ResetL pin for longer than the minimum pulse length ( $t_{\text{Reset\_init}}$ ) initiates a complete module reset, returning all user module settings to their default state. Module Reset Assert Time ( $t_{\text{init}}$ ) starts on the rising edge after the low level on the ResetL pin is released. During the execution of a reset ( $t_{\text{init}}$ ) the host shall disregard all status bits until the module indicates a completion of the reset interrupt. The module indicates this by posting an IntL signal with the Data\_Not\_Ready bit negated. Note that on power up (including hot insertion) the module will post this completion of reset interrupt without requiring a reset.

## LP MODE PIN

ATGBICS QSFP28 FR operate in the low power mode (less than 1.5 W power consumption) This pin active high will decrease power consumption to less than 1W.

## MODPRSL PIN

ModPrsL is pulled up to Vcc on the host board and grounded in the module. The ModPrsL is asserted “Low” when the module is inserted and deasserted “High” when the module is physically absent from the host connector.

## INTL PIN

IntL is an output pin. When “Low”, it indicates a possible module operational fault or a status critical to the host system. The host identifies the source of the interrupt by using the 2-wire serial interface. The IntL pin is an open collector output and must be pulled up to Vcc on the host board.

## POWER SUPPLY FILTERING

The host board should use the power supply filtering shown in Figure 1

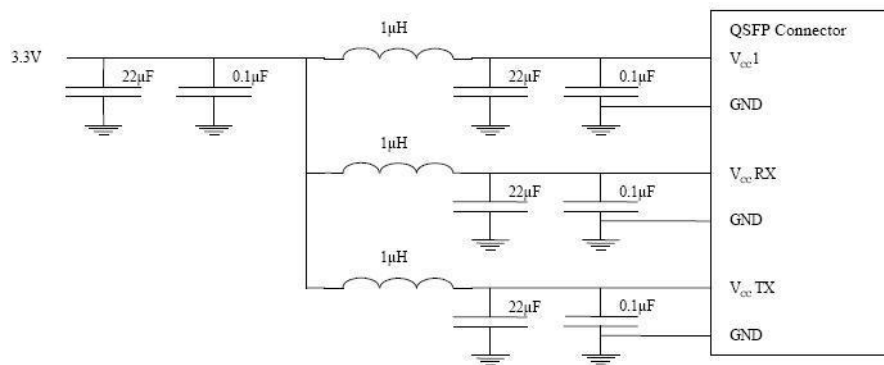
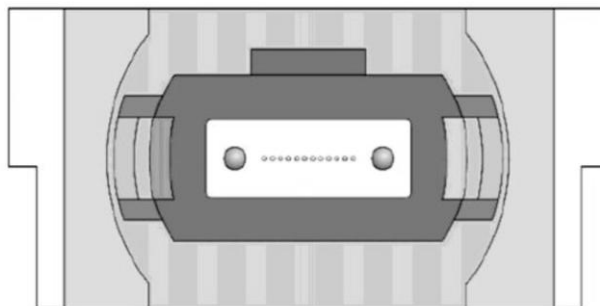


Figure1. Host Board Power Supply Filtering

## OPTICAL INTERFACE LANES & ASSIGNMENT

The optical interface port is a male MPO connector. The four fibre positions on the left as shown in Figure 2, with the key up, are used for the optical transmit signals (Channel 1 through 4). The fibre positions on the right are used for the optical receive signals (Channel 4 through 1). The central four fibres are physically present.



Transmit Channels: 1 2 3 4  
Unused positions: x x x x  
Receive Channels: 4 3 2 1

Figure 2. Optical Receptacle and Channel Orientation

## DIAGNOSTIC MONITORING INTERFACE

Digital diagnostics monitoring function is available on all ATGBICS QSFP28 FR. A 2-wire serial interface provides user to contact with module. The structure of the memory is shown in Figure 3. The memory space is arranged into a lower, single page, address space of 128 bytes and multiple upper address space pages. This structure permits timely access to addresses in the lower page, such as Interrupt Flags and Monitors. Less time critical time entries, such as serial ID information and threshold settings, are available with the Page Select function. The interface address used is A0xh and is mainly used for time critical data like interrupt handling to enable a one-time-read for all data related to an interrupt situation. After an interrupt, IntL, has been asserted, the host can read out the flag field to determine the affected channel and type of flag.

| Parameter                                      | Symbol    | Min. | Max | Unit | Notes                |
|------------------------------------------------|-----------|------|-----|------|----------------------|
| <b>Temperature Monitor Absolute Error</b>      | DMI_Temp  | -3   | +3  | °C   | Over operating temp  |
| <b>Supply Voltage Monitor Absolute Error</b>   | DMI_VCC   | -0.1 | 0.1 | V    | Full operating range |
| <b>Channel RX Power Monitor Absolute Error</b> | DMI_RX    | -3   | 3   | dB   | Per channel          |
| <b>Channel Bias Current Monitor</b>            | DMI_Ibias | -10% | 10% | mA   | Per channel          |

Figure 3

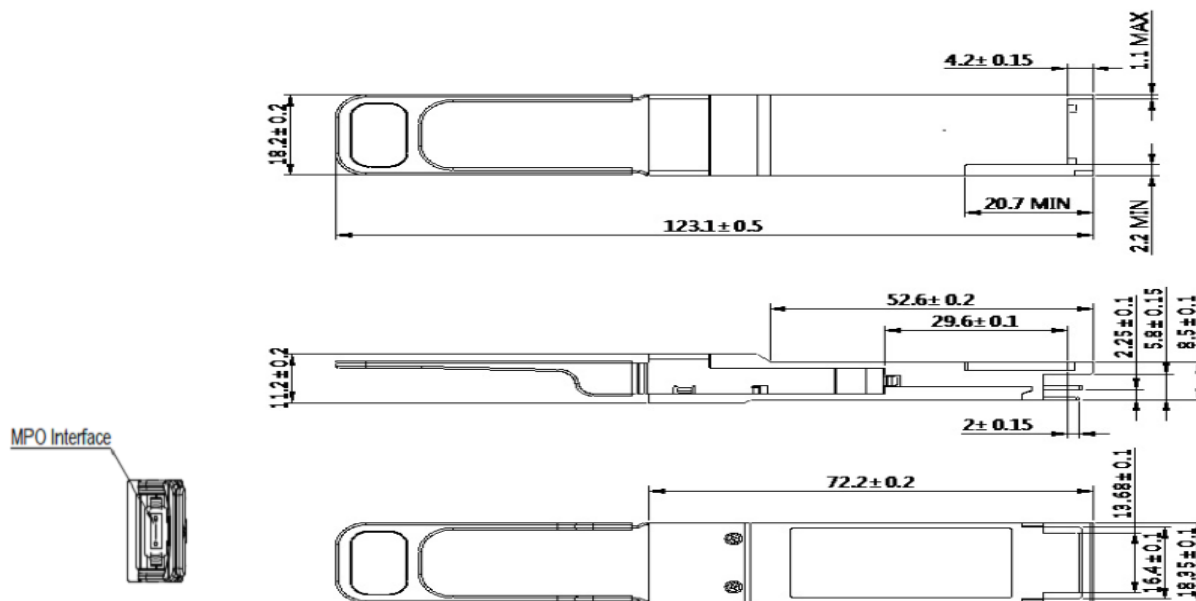
## EEPROM SERIAL ID MEMORY CONTENTS

Serial ID: Data Fields (Page 00)

| Address | Size (Bytes) | Name                                   | Description of Base ID Field                                                                                                                                                           | Optical Module |
|---------|--------------|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| 128     | 1            | Identifier                             | Identifier Type of serial Module                                                                                                                                                       | R              |
| 129     | 1            | Ext. Identifier                        | Extended Identifier of Serial Module                                                                                                                                                   | R              |
| 130     | 1            | Connector                              | Code for connector type                                                                                                                                                                | R              |
| 131-138 | 8            | Specification compliance               | Code for electronic compatibility or optical compatibility                                                                                                                             | R              |
| 139     | 1            | Encoding                               | Code for serial encoding algorithm                                                                                                                                                     | R              |
| 140     | 1            | BR, nominal                            | Nominal bit rate, units of 100 Mbits/s                                                                                                                                                 | R              |
| 141     | 1            | Extended rate select                   | Tags for extended rate select compliance                                                                                                                                               | R              |
| 142     | 1            | Length (SMF)                           | Link length supported for SMF Fibre in km (note 1)                                                                                                                                     | R              |
| 143     | 1            | Length (OM3 50um)                      | Link length supported for EBW 50/125 um Fibre (OM3), units of 2m (note 1)                                                                                                              | R              |
| 144     | 1            | Length (OM2 50um)                      | Link length supported for 50/125 um Fibre (OM2), units of 1m (note 1)                                                                                                                  | R              |
| 145     | 1            | Length (OM1 62.5um)                    | Link length supported for 62.5/125 um Fibre (OM1), units of 1m (note 1)                                                                                                                | R              |
| 146     | 1            | Length (Copper)                        | Link length of copper or active cable, units of 1 m (note 1) Link length supported for 50/125 um Fibre (OM4), units of 2 m) when Byte 147 declares 1310nm VCSEL as defined in Table 37 | R              |
| 147     | 1            | Device tech                            | Device technology                                                                                                                                                                      | R              |
| 148-163 | 16           | Vendor name                            | QSFP28 vendor name: ATGBICS                                                                                                                                                            | R              |
| 164     | 1            | Extended Module                        | Extended Module codes for InfiniBand                                                                                                                                                   | R              |
| 165-167 | 3            | Vendor OUI                             | QSFP28 vendor IEEE company ID                                                                                                                                                          | R              |
| 168-183 | 16           | Vendor PN                              | Part Number: QSFP-100G-FR-S                                                                                                                                                            | R              |
| 184-185 | 2            | Vendor rev                             | Revision level for part number provided by vendor (ASCII)                                                                                                                              | R              |
| 186-187 | 2            | Wavelength or Copper cable Attenuation | Nominal laser wavelength (wavelength=value/20 in nm) or copper cable attenuation in dB at 2.5GHz (Adrs 186) and 5.0GHz (Adrs 187)                                                      | R              |
| 188-189 | 2            | Wavelength tolerance                   | Guaranteed range of laser wavelength (+/- value) from nominal wavelength. (wavelength Tol.=value/200 in nm)                                                                            | R              |

| Address                          | Size (Bytes) | Name                       | Description of Base ID Field                                                                            | Optical Module |
|----------------------------------|--------------|----------------------------|---------------------------------------------------------------------------------------------------------|----------------|
| 191                              | 1            | CC_BASE                    | Check code for base ID fields (addresses 128-190)                                                       | R              |
| 192-195                          | 4            | Options                    | Rate Select, TX Disable, TX Fault, LOS, Warning indicators for: Temperature, VCC, RX power, TX Bias     | R              |
| 196-211                          | 16           | Vendor SN                  | Serial number provided by vendor (ASCII)                                                                | R              |
| 212-219                          | 8            | Date Code                  | Vendor's manufacturing date code                                                                        | R              |
| 220                              | 1            | Diagnostic Monitoring Type | Indicates which types of diagnostic monitoring are implemented (if any) in the Module. Bit 1,0 Reserved | R              |
| 221                              | 1            | Enhanced Options           | Indicates which optional enhanced features are implemented in the Module.                               | R              |
| 191                              | 1            | CC_BASE                    | Check code for base ID fields (addresses 128-190)                                                       | R              |
| 222                              | 1            | Reserved                   |                                                                                                         |                |
| 223                              | 1            | CC_EXT                     | Check code for the Extended ID Fields (addresses 192-222)                                               | R<br>R         |
| <b>VENDOR SPECIFIC ID FIELDS</b> |              |                            |                                                                                                         |                |
| 224-255                          | 32           | Vendor Specific EEPROM     |                                                                                                         |                |

## MECHANICAL DIMENSIONS (UNIT: mm)



## ESD

This transceiver is specified as ESD threshold 1kV for high-speed data pins and 2kV for all others electrical input pins, tested per MIL-STD-883, Method 3015.4 /JESD22-A114-A (HBM). However, normal ESD precautions are still required during the handling of this module. This transceiver is shipped in ESD protective packaging. It should be removed from the packaging and handled only in an ESD protected environment.

## LASER SAFETY

This is a Class 1 Laser Product according to IEC 60825-1:2007. This product complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated (June 24, 2007)