

## Specification

Quad Small Form-factor Pluggable

Optical Transceiver Module

40GBASE-ESR4



## Ordering Information

T Q S - Q 1 L H 9 - P C A

| Model Name    | Voltage | Category  | Device type  | Interface | Temperature | Distance                           |
|---------------|---------|-----------|--------------|-----------|-------------|------------------------------------|
| TQS-Q1LH9-PCA | 3.3V    | With DDMI | 850 nm VCSEL | CML/CML   | 0°C~+70°C   | 33m / 82m / 300m<br>( OM1/OM2/OM3) |

## Purpose

This document validates solely for the product of FormERICA OptoElectronics Inc., 40-Gbps QSFP+ Parallel Optical Enhanced Transceiver Module. However, this document is not fully complete yet, therefore, this datasheet only provides basic information and electronic characteristics. This document is for customer's reference only, and it subjects to change without notice.

## Description

FormERICA OptoElectronics Inc. Quad Small Form-factor Pluggable Plus (QSFP+) product is a new high speed pluggable I/O interface products. This interconnecting system offers 4 channels and maximum bandwidth of 40Gbps which are based on the proprietary technique Silicon Optical Bench (SiOB) optical engine. Compared to common 40GBASE-SR4 transceiver only can support cable length up to 100-m via OM3 MMF, this product can extend the cable length up to 300-m via common OM3 MMF by special dispersion suppression technique. This module provides high performance and extra longer cable distance for datacom applications.

## Features

- Compliant with 40GBASE-SR4 per IEEE 802.3ba D3.2 and SFF-8436 QSFP+ MSA Rev. 4.1.
- Operating at 10.3125-Gbps per lane with 64b/66b coded data
- Low power dissipation < 1.5W (Power Level-1)
- Full Digital Diagnostics Monitor Interface
- Hot pluggable electrical interface
- Standard 12/8 lane optical fiber with MPO pluggable optical connector.
- 0 to 70°C case temperature operating range
- 300/400-m Link Length via OM3/OM4 with MPO Optical Connector
- RoHS Compliance and Lead-Free

## Applications

- 40GBASE-SR4 Ethernet links
- Infiniband QDR, DDR and SDR
- 4G/8G/10G Fiber Channel
- SATA/SAS Storage
- HPC Interconnects
- Proprietary Interconnections

### Absolute Maximum Rating

Not necessarily applied together. Exceeding these values may cause permanent damage.  
Functional operation under these conditions is not implied.

| Parameter                          | Symbol | Min  | Typ. | Max                  | Unit | Note |
|------------------------------------|--------|------|------|----------------------|------|------|
| Storage Temperature                | Ts     | -40  |      | 85                   | °C   |      |
| 3.3V Power Supply Voltage          | Vcc    | -0.5 |      | 3.6                  | V    |      |
| Data Input Voltage-Single Ended    |        | -0.5 |      | V <sub>cc</sub> +0.5 | V    |      |
| Relative Humidity                  | RH     | 5    |      | 85                   | %    |      |
| Rx Optical Damage Threshold / Lane | DT     | 3.4  |      |                      | dBm  |      |

### Recommended Operating Conditions

| Parameter                                       | Symbol | Min   | Typ. | Max     | Unit | Note |
|---|--------|-------|------|---------|------|------|
| Case Temperature                                | Tc     | 0     | 40   | 70      | °C   |      |
| 3.3 V Power Supply Voltage                      | Vcc    | 3.135 | 3.3  | 3.465   | V    |      |
| Signal Rate per Channel                         |        | 2.5   |      | 10.3125 | Gbps | 1    |
| Control* Input Voltage High                     | Vih    | 2     |      | Vcc+3   | V    |      |
| Control* Input Voltage Low                      | Vil    | -0.3  |      | 0.8     | V    |      |
| Two Wire Serial (TWS) Interface Clock Rate      |        |       | 100  |         | kHz  |      |
| Power Supply Noise Ripple Susceptibility (PSNR) | PSNR   |       |      | 50      | mVpp | 2    |
| Receiver Differential Data Output Load          |        |       | 100  |         | Ohms |      |
| Fiber Length: 2000 MHz·km 50µm MMF (OM3)        |        | 0.5   |      | 300     | m    | 3    |
| Fiber Length: 4700 MHz·km 50µm MMF (OM4)        |        | 0.5   |      | 400     | m    | 3    |

#### Note:

1. Lane speed up to 12.5-Gbps is available upon customer requests.
2. Power supply noise is defined as peak-to-peak noise amplitude over 1K to 15 MHz frequency range at host supply side by the recommended power supply filter for module. See Section 10 for the recommended power supply filter.
3. Extended 300-m /400-m via OM3/OM4 MMF is only supported as long as two ends of QSFP+ transceiver module belonging to Extended SR4; otherwise, the link length might only supports to 100-m/150-m via OM3/OM4 MMF according to 40GBase-SR4.

## Electrical Characteristics

| Parameter   | Symbol                                | Min  | Typ. | Max  | Unit   | Note |
|---|---------------------------------------|--|------|------|--------|------|
| <b>Transceiver Electrical Characteristics</b>       |                                       |  |      |      |        |      |
| TRx Power Consumption                               |                                       |  |      | 1.5  | W      |      |
| TRx Power Supply Current                            | I <sub>cc</sub>                       |  |      | 420  | mA     |      |
| TRx Power-On Initialization Time                    | T <sub>pwr_init</sub>                 |  |      | 2000 | ms     | 1    |
| <b>Transmitter Electrical Characteristics</b>       |                                       |  |      |      |        |      |
| Data Input Differential Peak-to-Peak Voltage Swing  | ΔV <sub>DI PP</sub>                   |  |      | 1200 | mVpp   |      |
| Differential Input Return Loss                      |                                       | Per IEEE 802.3ba, Section 86A.4.1.1        |      |      | dB     | 2    |
| Differential to Common Mode Input Return Loss       |                                       | 10   |      |      | dB     | 2    |
| J2 Jitter Tolerance                                 | Jt2                                   | 0.17                                       |      |      | UI     |      |
| J9 Jitter Tolerance                                 | Jt9                                   | 0.29                                       |      |      | UI     |      |
| Eye Mask Coordinates:<br>X1, X2; Y1, Y2             |                                       | Specification Value<br>0.11, 0.31; 95, 350 |      |      | UI; mV | 3    |
| <b>Receiver Electrical Characteristics</b>          |                                       |  |      |      |        |      |
| Data Output Differential Peak-to-Peak Voltage Swing | ΔV <sub>DO PP</sub>                   | 200  |      | 900  | mVpp   | 4    |
| Output Transition Time 20% to 80%                   | t <sub>rise</sub> , t <sub>fall</sub> | 28   |      |      | ps     |      |
| Output Transition Return Loss                       |                                       | Per IEEE 802.3ba, Section 86A.4.2.1        |      |      | dB     | 2    |
| Common Mode Output Return Loss                      |                                       | Per IEEE 802.3ba, Section 86A.4.2.2        |      |      | dB     | 2    |
| Output Total Jitter                                 |                                       |  |      | 62   | Ps     |      |
| J2 Jitter Output                                    |                                       |  |      | 0.42 | UI     |      |
| J9 Jitter Output                                    |                                       |  |      | 0.65 | UI     |      |
| Eye Mask Coordinates:<br>X1, X2; Y1, Y2             |                                       | Specification Value<br>0.29, 0.5; 150, 425 |      |      | UI; mV | 3    |

### Notes:

1. "Initialization Time" is the time from when the supply voltages reach and remain above the minimum "Recommended Operating Conditions" to the time when the module enables TWS access. The module at that point is fully functional.
2. 10M to 11.1 GHz according to IEEE 802.3ba specification.
3. Hit ratio=  $5 \times 10^{-5}$  per sample.
4. AC-Coupled with 100Ω differential output impedance.

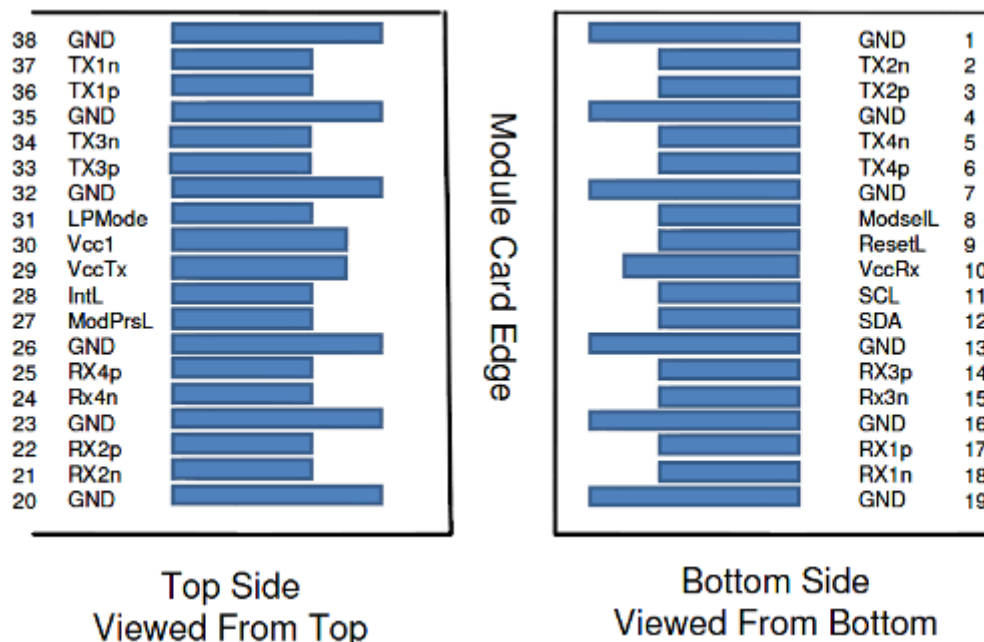
### Optical Characteristics

| Parameter   | Symbol          | Min  | Typ. | Max  | Unit | Note |
|---|-----------------|--|------|------|------|------|
| <b>Transmitter Optical Characteristics</b>          |                 |  |      |      |      |      |
| Center Wavelength                                   | $\lambda$       | 840  |      | 860  | nm   | 1    |
| Spectral Width – RMS                                | $\Delta\lambda$ |  |      | 0.55 | nm   |      |
| Output Optical Power: Average                       | PO AVE          | -7.6   |      | 2.4  | dBm  |      |
| Output Optical Modulation Amplitude, per lane       | OMA             | -2.5   |      |      | dBm  |      |
| Difference in Power between any Two Lanes in OMA    |                 |  |      | 4.0  | dB   |      |
| Transmitter and Dispersion Penalty (TDP,) each Lane |                 |  |      | 3.5  | dB   |      |
| Extinction Ratio                                    | ER              | 3  |      |      | dB   |      |
| Output Optical Power: Disabled                      | PO_OFF          |  |      | -30  | dBm  |      |
| Eye Mask Coordinates:<br>X1, X2, X3; Y1, Y2, Y3     |                 | Specification Value<br>0.23, 0.34, 0.43; 0.27, 0.35, 0.4 |      |      | UI   | 2    |
| <b>Receiver Optical Characteristics</b>             |                 |  |      |      |      |      |
| Center wavelength, each lane                        | $\lambda$       | 840  | 850  | 860  | nm   |      |
| Damage Threshold                                    |                 | 3.4  |      |      | dBm  |      |
| Maximum Average power at receiver input, each lane  |                 |  |      | 2.4  | dBm  |      |
| OMA, each Lane                                      |                 |  |      | 3    | dBm  |      |
| Non-Stressed receiver sensitivity (Avg)             |                 |  |      | -7.5 | dBm  | 3    |
| LOS Assert  |                 | -30  |      |      | dB   |      |
| LOS De-Assert                                       |                 |  |      | -7.5 | dB   |      |
| LOS Hysteresis                                      |                 | 0.5  |      |      | dB   |      |

### Notes:

1. RMS spectral width is measured at 10.3125-Gbps of PRBS-31 signals injected.
2. Hit ratio=  $5 \times 10^{-5}$  per sample.
3. Measured with 10.3125-Gbps of PRBS-31 at 10-12 BER.

### QSFP+ Module Pad Assignments and Descriptions



Top Side  
Viewed From Top

Bottom Side  
Viewed From Bottom

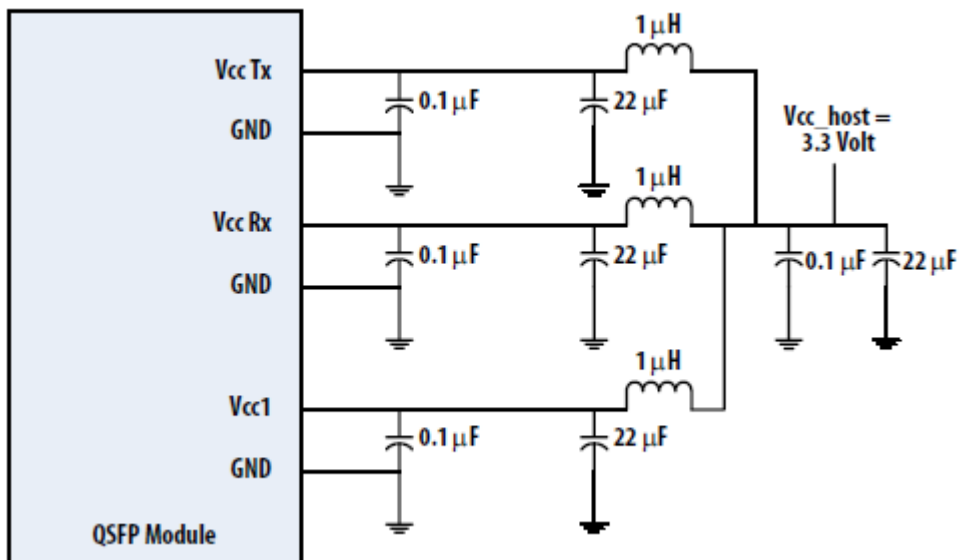
| Pin | Logic       | Symbol  | Description                         | Plug Sequence | Notes |
|-----|-------------|---------|-------------------------------------|---------------|-------|
| 1   |             | GND     | Ground                              | 1             | 1     |
| 2   | CML-I       | Tx2n    | Transmitter Inverted Data Input     | 3             |       |
| 3   | CML-I       | Tx2p    | Transmitter Non-Inverted Data Input | 3             |       |
| 4   |             | GND     | Ground                              | 1             | 1     |
| 5   | CML-I       | Tx4n    | Transmitter Inverted Data Input     | 3             |       |
| 6   | CML-I       | Tx4p    | Transmitter Non-Inverted Data Input | 3             |       |
| 7   |             | GND     | Ground                              | 1             | 1     |
| 8   | LVTTL-I     | ModSelL | Module Select                       | 3             |       |
| 9   | LVTTL-I     | ResetL  | Module Reset                        | 3             |       |
| 10  |             | Vcc Rx  | +3.3V Power Supply Receiver         | 2             | 2     |
| 11  | LVC MOS-I/O | SCL     | 2-wire serial interface clock       | 3             |       |
| 12  | LVC MOS-I/O | SDA     | 2-wire serial interface data        | 3             |       |
| 13  |             | GND     | Ground                              | 1             | 2     |
| 14  | CML-O       | Rx3p    | Receiver Non-Inverted Data Output   | 3             |       |
| 15  | CML-O       | Rx3n    | Receiver Inverted Data Output       | 3             |       |
| 16  |             | GND     | Ground                              | 1             | 1     |
| 17  | CML-O       | Rx1p    | Receiver Non-Inverted Data Output   | 3             |       |
| 18  | CML-O       | Rx1n    | Receiver Inverted Data Output       | 3             |       |

| Pin | Logic   | Symbol  | Description                         | Plug Sequence | Notes |
|-----|---------|---------|-------------------------------------|---------------|-------|
| 19  |         | GND     | Ground                              | 1             | 1     |
| 20  |         | GND     | Ground                              | 1             | 1     |
| 21  | CML-O   | Rx2n    | Receiver Inverted Data Output       | 3             |       |
| 22  | CML-O   | Rx2p    | Receiver Non-Inverted Data Output   | 3             |       |
| 23  |         | GND     | Ground                              | 1             | 1     |
| 24  | CML-O   | Rx4n    | Receiver Inverted Data Output       | 3             |       |
| 25  | CML-O   | Rx4p    | Receiver Non-Inverted Data Output   | 3             |       |
| 26  |         | GND     | Ground                              | 1             | 1     |
| 27  | LVTTL-O | ModPrsL | Module Present                      | 3             |       |
| 28  | LVTTL-O | IntL    | Interrupt                           | 3             |       |
| 29  |         | Vcc Tx  | +3.3V Power supply transmitter      | 2             | 2     |
| 30  |         | Vcc1    | +3.3V Power supply                  | 2             | 2     |
| 31  | LVTTL-I | LPMode  | Low Power Mode                      | 3             |       |
| 32  |         | GND     | Ground                              | 1             | 1     |
| 33  | CML-I   | Tx3p    | Transmitter Non-Inverted Data Input | 3             |       |
| 34  | CML-I   | Tx3n    | Transmitter Inverted Data Input     | 3             |       |
| 35  |         | GND     | Ground                              | 1             | 1     |
| 36  | CML-I   | Tx1p    | Transmitter Non-Inverted Data Input | 3             |       |
| 37  | CML-I   | Tx1n    | Transmitter Inverted Data Input     | 3             |       |
| 38  |         | GND     | Ground                              | 1             | 1     |

**Note:**

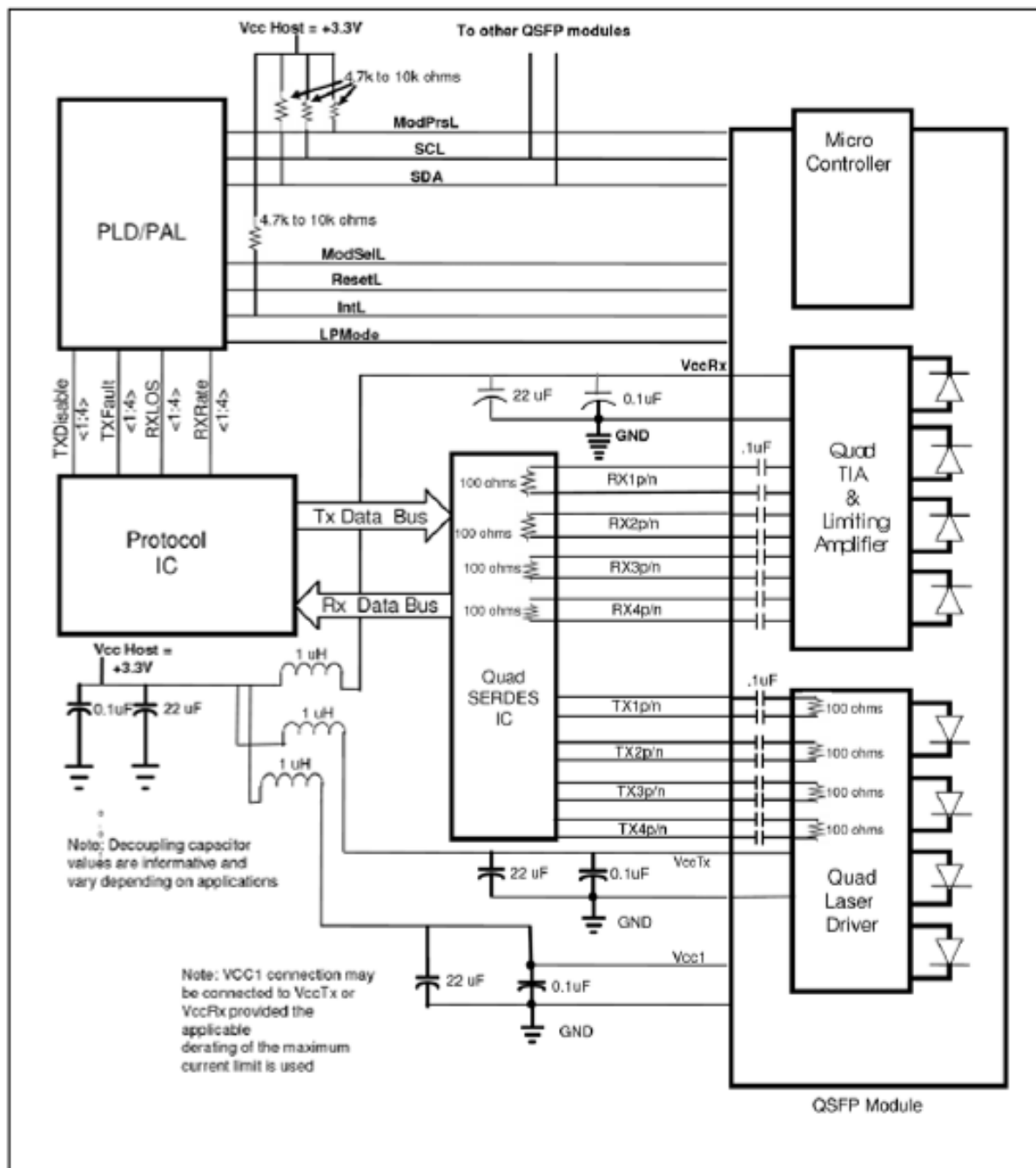
1. GND is the symbol for signal and supply (power) common for the QSFP+ module. All are common within the QSFP+ module and all module voltages are referenced to this potential unless otherwise noted. Connect these directly to the host board signal-common ground plane.
2. Vcc Rx, Vcc1 and Vcc Tx are the receiver and transmitter power supplies and shall be applied concurrently. Requirements defined for the host side of the Host Edge Card Connector are listed in Table . Recommended host board power supply filtering is shown in next page. Vcc Rx Vcc1 and Vcc Tx may be internally connected within the QSFP+ module in any combination. The connector pins are each rated for a maximum current of 500 mA.

### Recommended Host Board Power Supply Circuit

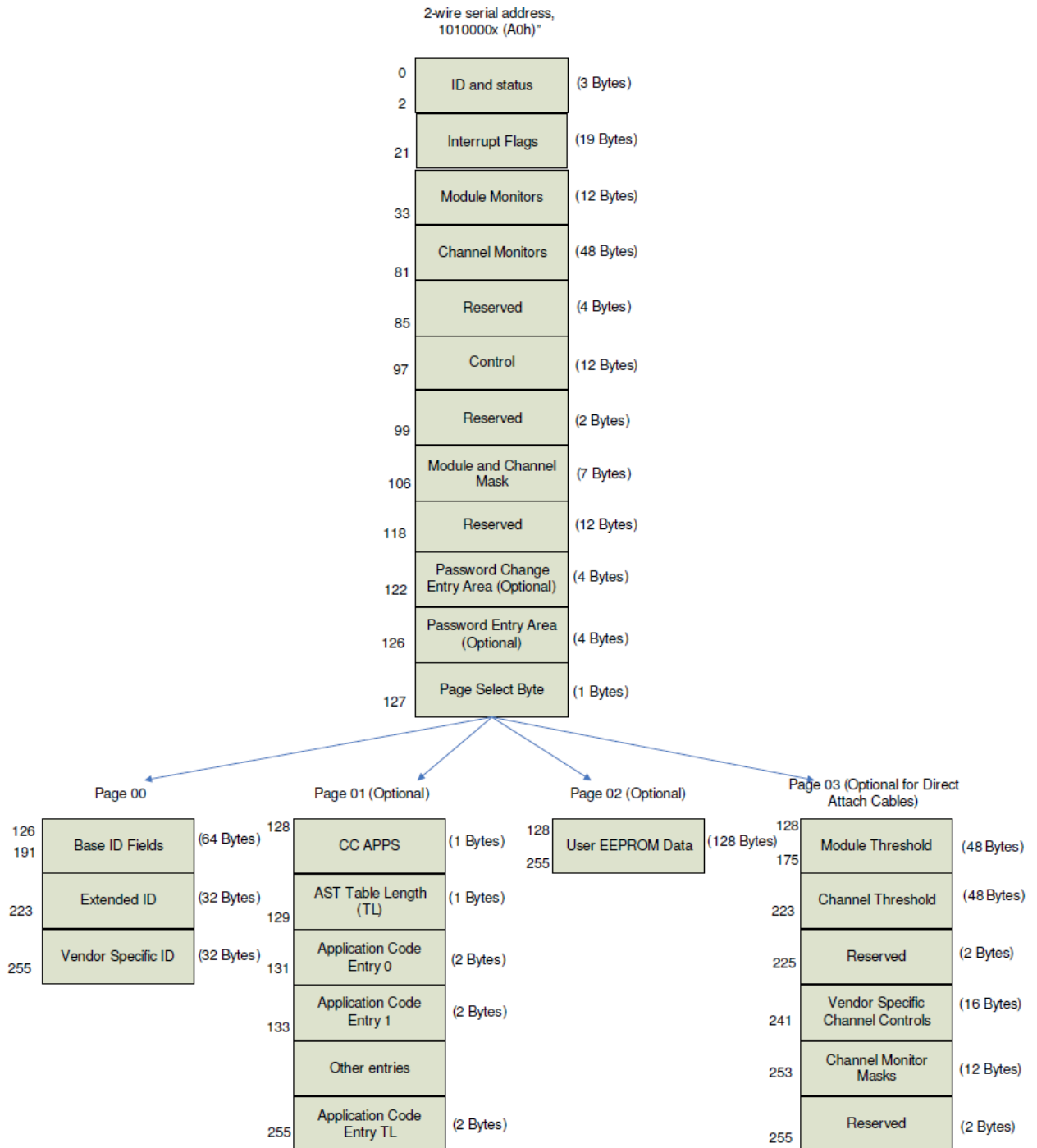




Recommended Interface Circuit



## Memory Map

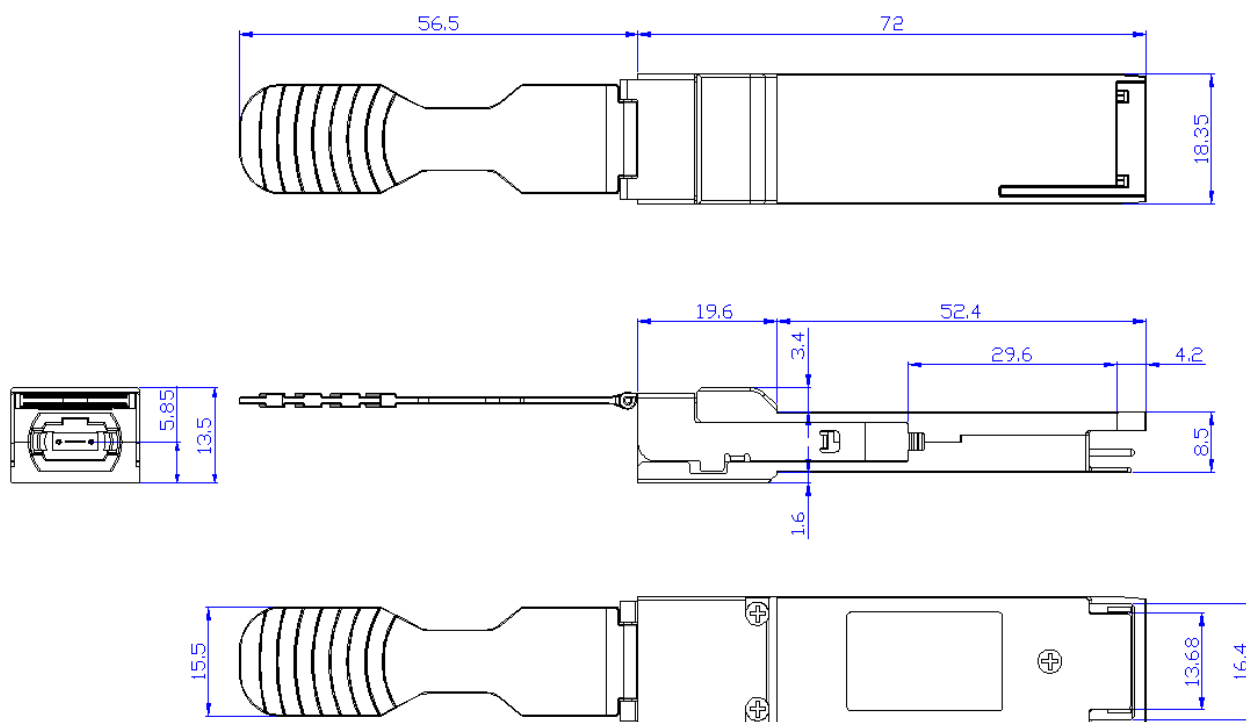


| Address | Description                                   | Hex   | Real Value  |
|---------|---|---|---|
| 128     | Identifier                                    | 0D  | QSFP+   |
| 129     | Ext. Identifier                               | 00  | Power Class 1 Module;<br>No CLEI code present in Page 02h;<br>No CDR in TX and RX                               |
| 130     | Connector                                     | 0C  | MPO   |
| 131     | Specification<br>Compliance                   | 04  | 40GBASE-SR4   |
| 132     |   | 00  | Not compliant   |
| 133     |   | 00  | Not compliant   |
| 134     |   | 00  | Not compliant   |
| 135     |   | 40  | Short distance (S)  |
| 136     |   | 40  | Shortwave Laser w/o OFC (SN)  |
| 137     |   | 06  | Multi-Mode 50m (M5), 50um (OM3)   |
| 138     |   | 00  | Not compliant   |
| 139     |   | Encoding  | 05  |
| 140     | BR, nominal                                   | 64  | 10.3Gbps  |
| 141     | Extended rate select<br>Compliance            | 00  | Not compliant   |
| 142     | Length(SMF)                                   | 00  | Not compliant   |
| 143     | Length(OM3 50 um)                             | 96  | 300M  |
| 144     | Length(OM2 50 um)                             | 52  | 82M   |
| 145     | Length(OM1 62.5 um)                           | 00  | Not compliant   |
| 146     | Length(Copper)                                | 00  | Not compliant   |
| 147     | Device tech                                   | 00  | 850nm VCSEL; No wavelength<br>control; Uncooled transmitter<br>device; Pin detector; Transmitter<br>not tunable |
| 148-163 | Vendor name                                   | 46,4F,52,4D,45,52,49,43,<br>41,4F,45,20,20,20,20,20 | FORMERICA OE  |
| 164     | Extended Module                               | 07  | QDR, DDR, SDR   |
| 165-167 | Vendor OUI                                    | 00, 00, 00  |   |
| 168-183 | Vendor PN                                     | 54,51,53,2D,51,31,4C,48,<br>39,2D,50,43,41,20,20,20 | TQS-Q1LH9-PCA   |
| 184-185 | Vendor rev                                    | 20, 20  |   |
| 186-187 | Wave length or<br>Copper cable<br>Attenuation | 42, 68  | 850nm   |
| 188-189 | Wavelength tolerance                          | 07, D0  | ±10nm   |
| 190     | Max case temp.                                | 46  | 70°C  |
| 191     | CC_BASE                                       |   | Check sum of byte 128 ~ 190   |
| 192-195 | Options                                       | 00, 00, 00, 12                                      | Tx Disable and Tx Loss of Signal<br>are implemented   |
| 196-211 | Vendor SN                                     |   |   |
| 212-219 | Date Code                                     |   |   |
| 220     | Diagnostic Monitoring<br>Type                 | 08  | Average Power   |
| 221     | Enhanced Options                              | 00  |   |
| 222     | Reserved                                      | 00  |   |
| 223     | CC_EXT  |   | Check sum of byte 192 ~ 222   |
| 224-255 | Vendor Specific                               |   |   |

| Address | Description           | Hex   | Real Value |
|---------|-----------------------|-------|------------|
| 128-129 | Temp high alarm       | 50,00 | 80°C       |
| 130-131 | Temp low alarm        | FB,00 | -5°C       |
| 132-133 | Temp high warning     | 4B,00 | 75°C       |
| 134-135 | Temp low warning      | 00,00 | 0°C        |
| 144-145 | Vcc high alarm        | 8C,A0 | 3.6V       |
| 146-147 | Vcc low alarm         | 75,30 | 3.0V       |
| 148-149 | Vcc high warning      | 88,B8 | 3.5V       |
| 150-151 | Vcc low warning       | 79,18 | 3.1V       |
| 176-177 | Rx power high alarm   | 61,A8 | 4.0dBm     |
| 178-179 | Rx power low alarm    | 08,FC | -6.4dBm    |
| 180-181 | Rx power high warning | 55,28 | 3.4dBm     |
| 182-183 | Rx power low warning  | 0B,40 | -5.4dBm    |
| 184-185 | Tx bias high alarm    | 30,D4 | 25mA       |
| 186-187 | Tx bias low alarm     | 03,E8 | 2mA        |
| 188-189 | Tx bias high warning  | 2C,EC | 23mA       |
| 190-191 | Tx bias low warning   | 07,D0 | 4mA        |

### Mechanical Design Diagram

Unit: mm



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- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
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- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

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