

# TS-C4-311H-10DC

## 100 Gb/s CFP4 LR4 Transceiver

### PRODUCT FEATURES

- Compliant with 100GBASE-LR4
- Support line rates from 103.125 Gbps to 111.81 Gbps
- Integrated LAN WDM TOSA / ROSA for up to 10 km reach over SMF
- Digital Diagnostics Monitoring Interface
- Duplex LC optical receptacle
- No external reference clock
- Single 3.3 V power supply
- Case operating temperature range: 0°C to 70°C
- Power dissipation < 6W

### APPLICATIONS

- Local Area Network (LAN)
- Data Center
- Ethernet switches and router applications

### STANDARD

- Compliant to IEEE 802.3ba
- Compliant to CFP MSA CFP4 Hardware Specification
- Compliant to CFP MSA Management Interface Specification

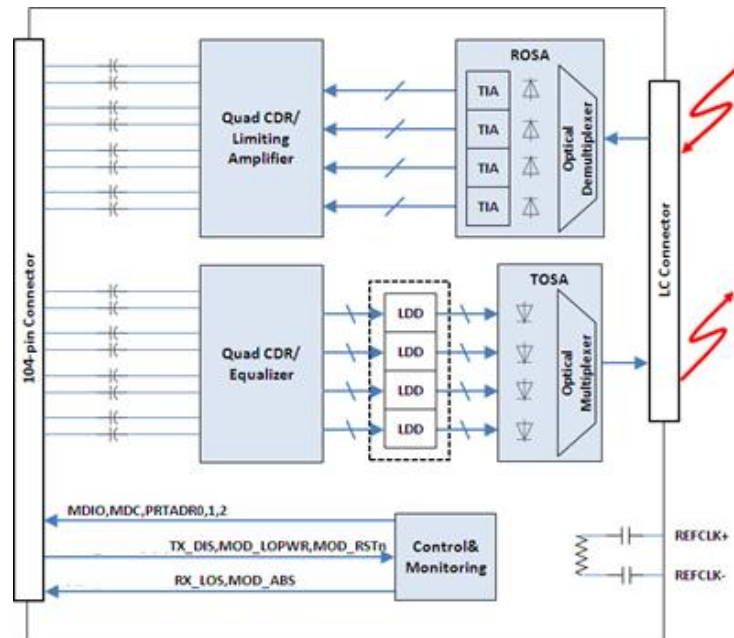
### General Description

100G CFP4 LR4 optical Transceiver integrates receiver and transmitter path on one module. In the transmit side, four lanes of serial data streams are recovered, retimed, and passed to four laser drivers. The laser drivers control four EMLs (Electric-absorption Modulated Lasers) with center wavelength of 1296 nm, 1300nm, 1305nm and 1309 nm. The optical signals are multiplexed to a single –mode fiber through an industry standard LC connector. In the receive side, the four lanes of optical data streams are optically de-multiplexed by the integrated optical de-multiplexer. Each data

stream is recovered by a PIN photo-detector and trans-impedance amplifier, retimed. This module features a hot-pluggable electrical interface, low power consumption and MDIO management interface.

The module provides an aggregated signaling rate from 103.125 Gbps to 111.81 Gbps. It is compliant with IEEE 802.3 ba 100GBASE-LR4 and ITU-T G.959.1, and OIF CEI-28G-VSR. The MDIO management interface complies with IEEE 802.3 Clause 45 standard. The transceiver complies with CFP MSA CFP4 Hardware Specification, CFP MSA Management Interface Specification, and OIF CEI-28G-VSR standards.

A block diagram is shown in Figure 1.



**Figure 1. CFP4 LR4 Optical Transceiver functional block diagram**

### Transmitter

The transmitter path converts four lanes of serial NRZ electrical data from line rate of 25.78 Gbps to 27.95 Gbps to a standard compliant optical signal. Each signal path accepts a 100  $\Omega$  differential 100 mV peak-to-peak to 900 mV peak-to-peak 25 Gbps electrical signal on TDxn and TDxp pins. Inside the module, each differential pair of electric signals is input to a CDR (clock-data recovery) chip. The recovered and retimed signals are then passed to a laser driver which transforms the small swing

voltage to an output modulation that drives a EML laser. The laser drivers control four EMLs with center wavelengths of 1295.56 nm, 1300.05 nm, 1304.58 nm and 1309.14 nm. The optical signals from the four lasers are multiplexed together optically. The combined optical signals are coupled to single-mode optical fiber through an industry standard LC optical connector.

### **Receiver**

The receiver takes incoming combined four lanes optical data from line rate of 25.78 Gbps to 27.95 Gbps through an industry standard LC optical connector. The four incoming wavelengths are separated by an optical de-multiplexer into four separated channels. Each output is coupled to a PIN photo-detector. The electrical currents from each PIN photo-detector are converted to a voltage with a high-gain trans-impedance amplifier. The electrical output is recovered and retimed by the CDR chip. The four lanes of reshaped electrical signals are output to RDxp and RDxn pins.

### **Low Speed Signaling**

Low speed signaling is based on low voltage CMOS (LVCMOS) operating at a nominal voltage of 3.3 V for the control and alarm signals, and at a nominal voltage of 1.2 V for MDIO address, clock and data signals. All low speed inputs and outputs are based on the CFP MSA CFP4 Hardware Specification and CFP MSA Management Interface Specification.

MDC/MDIO: Management interface clock and data lines.

PRTADR0, 1, 2: Input pins. MDIO physical port addresses.

GLB\_ALEMn: Output pin. When asserted low indicates that the module has detected an alarm condition in any MDIO alarm register.

TX\_Disable: Input pin. When asserted high or left open the transmitter output is turned off. When Tx\_Disable is asserted low or grounded the module transmitter is operating normally. Pulled up with 4.7 k $\Omega$  to 10 k $\Omega$  resistors to 3.3 V inside the CFP4 module.

MOD\_LOPWR: Input pin. When asserted high or left open the CFP4 module is in low power mode. When asserted low or grounded the module is operating normally. Pulled up with 4.7 k $\Omega$  to 10 k $\Omega$  resistors to 3.3 V inside the CFP4 module.

MOD\_RSTn: Input pin. When asserted low or grounded the module is in Reset mode. When asserted high or left open the CFP4 module is operating normally after an initialization process. Pulled down with 4.7 k $\Omega$  to 10 k $\Omega$  resistors to ground inside the CFP4 module.

Mod\_ABS: Output pin. Asserted high when the CFP4 module is absent and is pulled low when the

CFP4 module is inserted.

RX\_LOS: Output pin. Asserted high when insufficient optical power for reliable signal reception is received.

## Pin Function Definitions

| Top Row |           | Bottom Row |           |
|---------|-----------|------------|-----------|
| PIN#    | Name      | PIN#       | Name      |
| 56      | GND       | 1          | 3.3V_GND  |
| 55      | TX3n      | 2          | 3.3V_GND  |
| 54      | TX3p      | 3          | 3.3V      |
| 53      | GND       | 4          | 3.3V      |
| 52      | TX2n      | 5          | 3.3V      |
| 51      | TX2p      | 6          | 3.3V      |
| 50      | GND       | 7          | 3.3V_GND  |
| 49      | TX1n      | 8          | 3.3V_GND  |
| 48      | TX1p      | 9          | NUC       |
| 47      | GND       | 10         | NUC       |
| 46      | TX0n      | 11         | TX_DIS    |
| 45      | TX0p      | 12         | RX_LOS    |
| 44      | GND       | 13         | GLB_ALRMn |
| 43      | (REFCLKn) | 14         | MOD_LOPWR |
| 42      | (REFCLKp) | 15         | MOD_ABS   |
| 41      | GND       | 16         | MOD_RSTn  |
| 40      | RX3n      | 17         | MDC       |
| 39      | RX3p      | 18         | MDIO      |
| 38      | GND       | 19         | PRTADR0   |
| 37      | RX2n      | 20         | PRTADR1   |
| 36      | RX2p      | 21         | PRTADR2   |
| 35      | GND       | 22         | NUC       |
| 34      | RX1n      | 23         | NUC       |
| 33      | RX1p      | 24         | NUC       |
| 32      | GND       | 25         | GND       |
| 31      | RX0n      | 26         | TX_MCLKn  |
| 30      | RX0p      | 27         | TX_MCLKp  |
| 29      | GND       | 28         | GND       |

Figure 2 CFP4 optical transceiver pin-out

**Table 1 CFP4 optical transceiver pin descriptions**

| Pin no. | Type      | Description                                                                                                                  |
|---------|-----------|------------------------------------------------------------------------------------------------------------------------------|
| 1       | 3.3V_GND  | 3.3V Module Supply Voltage Return Ground, can be separate or tied together with Signal Ground                                |
| 2       | 3.3V_GND  |                                                                                                                              |
| 3       | 3.3V      | 3.3V Module Supply Voltage                                                                                                   |
| 4       | 3.3V      | 3.3V Module Supply Voltage                                                                                                   |
| 5       | 3.3V      | 3.3V Module Supply Voltage                                                                                                   |
| 6       | 3.3V      | 3.3V Module Supply Voltage                                                                                                   |
| 7       | 3.3V_GND  | 3.3V Module Supply Voltage Return Ground, can be separate or tied together with Signal Ground                                |
| 8       | 3.3V_GND  |                                                                                                                              |
| 9       | NUC       | Module Vendor I/O. Must No Connect at host board                                                                             |
| 10      | NUC       | Module Vendor I/O. Must No Connect at host board                                                                             |
| 11      | TX_DIS    | Transmitter Disable for all lanes, "1" or NC = transmitter disabled, "0" = transmitter enabled                               |
| 12      | RX_LOS    | Receiver Loss of Optical Signal, "1": low optical signal, "0": normal condition                                              |
| 13      | GLB_ALRMn | Global Alarm. "0": alarm condition in any MDIO Alarm register, "1": no alarm condition, Open Drain, Pull Up Resistor on Host |
| 14      | MOD_LOPWR | Module Low Power Mode. "1" or NC: module in low power (safe) mode, "0": power-on enabled                                     |
| 15      | MOD_ABS   | Module Absent. "1" or NC: module absent, "0": module present, Pull Up Resistor on Host                                       |
| 16      | MOD_RSTn  | Module Reset. "0" resets the module, "1" or NC = module enabled, Pull Down Resistor in Module                                |
| 17      | MDC       | Management Data Clock (electrical specs as per 802.3ae and ba)                                                               |
| 18      | MDIO      | Management Data I/O bi-directional data (electrical specs as per 802.3ae and ba)                                             |
| 19      | PRTADR0   | MDIO Physical Port address bit 0                                                                                             |
| 20      | PRTADR1   | MDIO Physical Port address bit 1                                                                                             |
| 21      | PRTADR2   | MDIO Physical Port address bit 2                                                                                             |
| 22      | NUC       | Module Vendor I/O. Must No Connect at host board                                                                             |
| 23      | NUC       | Module Vendor I/O. Must No Connect at host board                                                                             |
| 24      | NUC       | Module Vendor I/O. Must No Connect at host board                                                                             |
| 25      | GND       |                                                                                                                              |
| 26      | TX_MCLKn  | TX Monitor Clock Output (Positive)                                                                                           |
| 27      | TX_MCLKp  | TX Monitor Clock Output (Negative)                                                                                           |
| 28      | GND       |                                                                                                                              |
| 29      | GND       |                                                                                                                              |
| 30      | RX0p      | Lane 0 Receiver Output (Positive)                                                                                            |
| 31      | RX0n      | Lane 0 Receiver Output (Negative)                                                                                            |

|    |              |                                             |
|----|--------------|---------------------------------------------|
| 32 | GND          |                                             |
| 33 | RX1p         | Lane 1 Receiver Output (Positive)           |
| 34 | RX1n         | Lane 1 Receiver Output (Negative)           |
| 35 | GND          |                                             |
| 36 | RX2p         | Lane 2 Receiver Output (Positive)           |
| 37 | RX2n         | Lane 2 Receiver Output (Negative)           |
| 38 | GND          |                                             |
| 39 | RX3p         | Lane 3 Receiver Output (Positive)           |
| 40 | RX3n         | Lane 3 Receiver Output (Negative)           |
| 41 | GND          |                                             |
| 42 | REFCLKp(NUC) | Reference Clock Input (Positive) (Optional) |
| 43 | REFCLKn(NUC) | Reference Clock Input (Negative) (Optional) |
| 44 | GND          |                                             |
| 45 | TX0p         | Lane 0 Transmitter Input (Positive)         |
| 46 | TX0n         | Lane 0 Transmitter Input (Negative)         |
| 47 | GND          |                                             |
| 48 | TX1p         | Lane 1 Transmitter Input (Positive)         |
| 49 | TX1n         | Lane 1 Transmitter Input (Negative)         |
| 50 | GND          |                                             |
| 51 | TX2p         | Lane 2 Transmitter Input (Positive)         |
| 52 | TX2n         | Lane 2 Transmitter Input (Negative)         |
| 53 | GND          |                                             |
| 54 | TX3p         | Lane 3 Transmitter Input (Positive)         |
| 55 | TX3n         | Lane 3 Transmitter Input (Negative)         |
| 56 | GND          |                                             |

## Absolute Maximum Ratings

| Parameter                                      | Symbol | Min.    | Typ. | Max.    | Unit | Note |
|------------------------------------------------|--------|---------|------|---------|------|------|
| Storage Temperature                            | Ts     | -40     | -    | 85      | °C   |      |
| Relative Humidity                              | RH     | 5       | -    | 95      | %    |      |
| Power Supply Voltage                           | VCC    | -0.3    | -    | 4       | V    |      |
| Signal Input Voltage                           |        | Vcc-0.3 | -    | Vcc+0.3 | V    |      |
| Receive Input Optical Power (Damage threshold) | Pdmg   |         |      | 5.0     | dBm  |      |

## Low Speed Electrical Characteristics

| Parameter                                         | Symbol          | Min                  | Typ. | Max                  | Unit | Notes                    |
|---------------------------------------------------|-----------------|----------------------|------|----------------------|------|--------------------------|
| Supply currents and voltages                      |                 |                      |      |                      |      |                          |
| Voltage                                           | V <sub>CC</sub> | 3.2                  | 3.3  | 3.4                  | V    | With Respect to GND      |
| Supply current                                    | I <sub>CC</sub> |                      |      | 1.8                  | A    |                          |
| Power dissipation                                 | P <sub>WR</sub> |                      |      | 6.0                  | W    |                          |
| Power dissipation (low power mode)                | P <sub>LP</sub> |                      |      | 1.0                  | W    |                          |
| Low speed control and sense signals, 3.3 V LVCMOS |                 |                      |      |                      |      |                          |
| Outputs low voltage                               | V <sub>OL</sub> | -0.3                 |      | 0.2                  | V    | I <sub>OH</sub> =100 μA  |
| Output high voltage                               | V <sub>OH</sub> | V <sub>CC</sub> -0.2 |      | V <sub>CC</sub> +0.3 | V    | I <sub>OH</sub> =-100 μA |
| Input low voltage                                 | V <sub>IL</sub> | -0.3                 |      | 0.8                  | V    |                          |
| Input high voltage                                | V <sub>IH</sub> | 2                    |      | V <sub>CC</sub> +0.3 | V    |                          |
| Input leakage current                             | I <sub>IN</sub> | -10                  |      | 10                   | μA   |                          |
| Low speed control and sense signals, 1.2 V LVCMOS |                 |                      |      |                      |      |                          |
| Outputs low voltage                               | V <sub>OL</sub> | -0.3                 |      | 0.2                  | V    |                          |
| Output high voltage                               | V <sub>OH</sub> | 1.0                  |      | 1.5                  | V    |                          |
| Output low current                                | I <sub>OL</sub> | 4                    |      |                      | mA   |                          |
| Output high current                               | I <sub>OH</sub> |                      |      | -4                   | mA   |                          |
| Input low voltage                                 | V <sub>IL</sub> | -0.3                 |      | 0.36                 | V    |                          |
| Input high voltage                                | V <sub>IH</sub> | 0.84                 |      | 1.5                  | V    |                          |
| Input leakage current                             | I <sub>IN</sub> | -100                 |      | 100                  | μA   |                          |
| Input capacitance                                 | C               |                      |      | 10                   | pF   |                          |
| MDC clock rate                                    |                 | 0.1                  |      | 4                    | MHz  |                          |

## High Speed Electrical Specifications

| Parameter                              | Symbol | Min  | Max  | Unit | Notes  |
|----------------------------------------|--------|------|------|------|--------|
| Transmitter electrical input from host |        |      |      |      |        |
| Differential voltage pk-pk             |        |      | 900  | mV   |        |
| Common mode noise (rms)                |        |      | 17.5 | mV   |        |
| Differential termination mismatch      |        |      | 10   | %    |        |
| Transition time                        |        | 10   |      | ps   | 20/80% |
| Common mode voltage                    |        | -0.3 | 2.8  | V    |        |
| Receiver electrical output to host     |        |      |      |      |        |
| Differential voltage pk-pk             |        |      | 900  | mV   |        |
| Common mode noise (rms)                |        |      | 17.5 | mV   |        |
| Differential termination mismatch      |        |      | 10   | %    |        |
| Transition time                        |        | 9.5  |      | ps   | 20/80% |



## MDIO Management Interface

The CFP4 Optical Transceiver incorporates MDIO management interface which is used for serial ID, digital diagnostics, and certain control and status report functions. The CFP4 transceiver supports MDIO pages 8000h NVR 1 Based ID registers, 8080h NVR 2 Extended ID registers, 8100h NVR 3 network lane specific registers , 8180h NVR 4 registers ,and pages A000h module VR 1 registers(module level control and DDM registers), A200h network lane VR 1 registers, A280h network lane VR 2 registers,A400h host lane VR1 specific registers. Details of the protocol and interface are explicitly described in CFP MSA Management Interface Specification. Please refer to the specifications for design reference.

## Optical Transmitter Characteristics

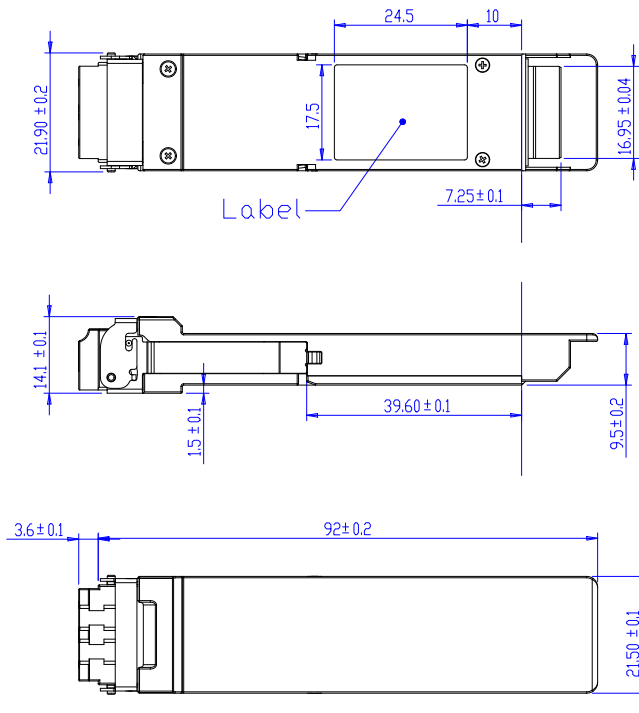
| Parameter                                              | Symbol                | Min                                | Typ.     | Max     | Unit  | Notes            |
|--------------------------------------------------------|-----------------------|------------------------------------|----------|---------|-------|------------------|
| Signaling rate, each lane                              |                       |                                    | 25.78125 |         | Gbps  |                  |
| Lane wavelength (range)                                |                       | 1294.53                            | 1295.56  | 1296.59 | nm    |                  |
|                                                        |                       | 1299.02                            | 1300.05  | 1301.09 | nm    |                  |
|                                                        |                       | 1303.54                            | 1304.58  | 1305.63 | nm    |                  |
|                                                        |                       | 1308.09                            | 1309.14  | 1310.19 | nm    |                  |
| Rate tolerance                                         |                       | -100                               |          | 100     | ppm   | From normal rate |
| Side-mode suppression ratio                            | SMSR                  | 30                                 |          |         | dB    |                  |
| Total launch power                                     |                       |                                    |          | 10.5    | dBm   |                  |
| Average launch power, each lane                        | Pavg                  | -4.3                               |          | 4.5     | dBm   |                  |
| Extinction Ratio                                       | ER                    | 4                                  |          |         | dB    |                  |
| Optical modulation amplitude, each lane (OMA)          | OMA                   | -1.3                               |          | 4.5     | dBm   |                  |
| Difference in launch power between any two lanes (OMA) |                       |                                    |          | 5       | dB    |                  |
| Transmitter and Dispersion Penalty, each lane          | TDP                   |                                    |          | 2.2     | dB    |                  |
| Average launch power of OFF transmitter, each lane     |                       |                                    |          | -30     | dBm   |                  |
| Relative Intensity Noise                               | RIN <sub>20</sub> OMA |                                    |          | -130    | dB/Hz |                  |
| Transmitter reflectance                                |                       |                                    |          | -12     | dB    |                  |
| Transmitter eye mask {X1, X2, X3, Y1, Y2, Y3}          |                       | {0.25, 0.4, 0.45, 0.25, 0.28, 0.4} |          |         |       |                  |



## Optical Receiver Characteristics

| Parameter                                                                                                                                                                                                                                                       | Symbol | Min   | Typ.     | Max  | Unit | Notes            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-------|----------|------|------|------------------|
| Signaling rate, each lane                                                                                                                                                                                                                                       |        |       | 25.78125 |      | Gbps |                  |
| Rate tolerance                                                                                                                                                                                                                                                  |        | -100  |          | 100  | ppm  | From normal rate |
| Average receive power, each lane                                                                                                                                                                                                                                | Pavg   | -10.6 |          | 4.5  | dBm  |                  |
| Receive max power, each lane (OMA)                                                                                                                                                                                                                              |        |       |          | 4.5  | dBm  |                  |
| Difference in launch power between any two lanes (OMA)                                                                                                                                                                                                          |        |       |          | 5.5  | dB   |                  |
| Receiver Sensitivity (OMA), each lane                                                                                                                                                                                                                           | Rsen   |       |          | -8.6 | dBm  | 1                |
| Stressed Receiver Sensitivity (OMA), each lane                                                                                                                                                                                                                  | SRS    |       |          | -6.8 | dBm  |                  |
| Stressed receiver sensitivity test conditions                                                                                                                                                                                                                   |        |       |          |      |      |                  |
| Vertical eye closure penalty, each lane                                                                                                                                                                                                                         | VECP   |       | 1.8      |      | dB   |                  |
| Stressed sys J2 jitter, each lane                                                                                                                                                                                                                               | J2     |       | 0.3      |      | UI   | 2                |
| Stressed sys J9 jitter, each lane                                                                                                                                                                                                                               | J9     |       | 0.47     |      | UI   | 2                |
| Receiver reflectance                                                                                                                                                                                                                                            |        |       |          | -26  | dB   |                  |
| LOS Assert                                                                                                                                                                                                                                                      | LOSA   | -30   |          |      | dBm  |                  |
| LOS De-assert                                                                                                                                                                                                                                                   | LOSD   |       |          | -12  | dBm  |                  |
| LOS Hysteresis                                                                                                                                                                                                                                                  |        | 0.5   |          | 4    | dB   |                  |
| 1. Receiver sensitivity (OMA), each lane, is informative.<br>2. Vertical eye closure penalty, stressed eye J2 Jitter, and stressed eye J9 Jitter are test conditions for measuring stressed receiver sensitivity. They are not characteristics of the receiver. |        |       |          |      |      |                  |

## Outline Dimensions



Units in mm

