FICER Technology Co., Ltd.
明虹科技股份有限公司

2F, No.138, Daye Rd., Beitou Dist.,
Taipei City 112030, Taiwan
www.Ficer.com

SKU: 00T0K14

# 100G QSFP28 ZR4 Transceiver
# Hot Pluggable, Duplex LC, LAN-WDM EML, SMF 80km, DDM, I-Temp(40~+80°C)

## Part Number: FQ28-K7-L13-80Di



## Overview

FQ28-K7-L13-80Di is a 4-Channel LWDM 1300nm QSFP28 transceiver for 100GbE applications especially in Telecom, Datacom, Data Center & Storage networks. The transmitter converts 4-Channel 25G electrical input data to four LWDM optical signals and multiplex that into one 100G signal. The receiver de-multiplex the 100G signal reversely and converts that to 4-Channel 25G electrical output data. The techniques bring a compact transceiver module for an aggregate bandwidth of 100Gbps up to SMF 80km optical links in Industrial Temperature range.

## Applications

- 100GBASE-ZR4 Ethernet
- Data Centers Switch Interconnect
- Server and Storage Area Network Interconnect

## Features

- Compatible with IEEE802.3ba 100GBASE-ER4
- Compliant with SFF-8665 QSFP28 MSA
- Compliant with IEEE 802.3bm CAUI-4 Interface
- 4CH LWDM MUX / DEMUX design
- Data Rate up to 25.78125Gbps per Lane
- Built in quad Tx CDR and Rx CDR
- Hot Pluggable QSFP28 footprint
- O-Band LWDM EML transmitter
- SOA + PIN receiver
- Duplex LC connector
- 2-wire interface for management and diagnostic monitor compliant with SFF-8636
- Single 3.3V power supply
- Link distance 80km over SM fiber with FEC
- Link distance 60km over SM fiber without FEC
- Operating Temperature -40~+80°C
- Maximum Power consumption 6.5W
- RoHS compliant



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## Laser Safety

- This is a Class 1 Laser Product complies with 21 CFR 1040.10 and 1040.11 except for conformance with IEC 60825-1 Ed. 3., as described in Laser Notice No. 56, dated May 8, 2019.
- Caution: Use of control or adjustments or performance of procedure other than those specified herein may result in hazardous radiation exposure.

## Absolute Maximum Ratings

| Parameters | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|
| Storage Temperature | $T_{ST}$ | -40 | +85 | °C |
| Relative Humidity | RH | 5 | 85 | % |
| Supply Voltage | $V_{CC}$ | -0.5 | +3.6 | V |

## Recommended Operating Conditions

| Parameters | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Case Operating Temperature | $T_{OP}$ | -40 | - | +80 | °C |
| Supply Voltage | $V_{CC}$ | +3.13 | +3.3 | +3.47 | V |
| Data Rate, per Lane | DR | | 25.78125 | | Gb/s |
| Data Rate Accuracy | ΔDR | -100 | | +100 | ppm |
| Bit Error Rate | BER | | | $5x10^{-5}$ | |
| Supply Current | $I_{CC}$ | | | 1900 | mA |
| Power Consumption | P | | | 6.5 | W |
| Transceiver Power-on Initialization Time | | | | 2000 | ms |
| Control Input Voltage High | $V_{IH}$ | 2.0 | | Vcc | V |
| Control Input Voltage Low | $V_{IL}$ | GND | | 0.8 | V |
| Control Output Voltage High | $V_{OH}$ | 2.0 | | Vcc | V |
| Control Output Voltage Low | $V_{OL}$ | GND | | 0.8 | V |



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## Transmitter Electro-optical Characteristics

**$V_{CC}$ = 3.13V to 3.47V, $T_{OP}$ = -40 °C to +80 °C**

| Parameters | Symbol | Min. | Typ. | Max. | Unit | Note |
|---|---|---|---|---|---|---|
| Line Rate, per Lane | | | 25.78125 | | Gb/s | |
| Total Average Launch Power | $TP_{AVG}$ | | | +12.5 | dBm | |
| Average Launch Power, per Lane | $P_{AVG}$ | +1 | | +6.5 | dBm | |
| Optical Modulation Amplitude (OMA), per Lane | $P_{OMA}$ | +2 | | +6.5 | dBm | 1 |
| Difference in Launch Power between any two Lanes (OMA) | $P_{TX-DIFF}$ | | | 3 | dB | |
| Transmitter Dispersion Penalty, per Lane | TDP | | | 3 | dB | |
| Launch Power in OMA minus Transmitter and Dispersion Penalty (TDP), per Lane | OMA-TDP | +1.3 | | | dBm | 2 |
| Optical Wavelength, each Lane | $\lambda_{L0}$ | 1294.53 | 1295.56 | 1296.59 | nm | |
| | $\lambda_{L1}$ | 1299.02 | 1300.05 | 1301.09 | nm | |
| | $\lambda_{L2}$ | 1303.54 | 1304.58 | 1305.63 | nm | |
| | $\lambda_{L3}$ | 1308.09 | 1309.14 | 1310.19 | nm | |
| Spectral Width (-20dB) | $\Delta\lambda$ | | | 1 | nm | |
| Side Mode Suppression Ratio | SMSR | 30 | | | dB | |
| Optical Extinction Ratio | ER | 6 | | | dB | |
| Optical Eye Mask { X1, X2, X3, Y1, Y2, Y3 } | | { 0.25, 0.4, 0.45, 0.25, 0.28, 0.4 } | | | | 3 |
| Average Launch Power OFF, per Lane | $P_{OFF}$ | | | -30 | dBm | |
| Relative Intensity Noise (OMA) | RIN | | | -130 | dB/Hz | |
| Optical Return Loss Tolerance | ORLT | | | 20 | dB | |
| Transmitter Reflectance | $R_{TX}$ | | | -12 | dB | |
| Input Differential Impedance | $Z_{IN}$ | 90 | 100 | 110 | Ω | |
| Differential Data Input Voltage | $V_{IN-PP}$ | 180 | | 1000 | mVpp | |

**Note1:** Even if the TDP < 1 dB, the OMA min must exceed the minimum value specified here.

**Note2:** Transmitter wavelength and launch power need to meet the OMA minus TDP specs to guarantee link performance.

**Note3:** Hit ratio $5x10^{-5}$ hits per sample.

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## Receiver Electro-optical Characteristics

**$V_{CC}$ = 3.13V to 3.47V, $T_{OP}$ = -40 °C to +80 °C**

| Parameters | Symbol | Min. | Typ. | Max. | Unit | Note |
|---|---|---|---|---|---|---|
| Line Rate, per Lane | | | 25.78125 | | Gb/s | |
| Damage Threshold, per Lane | $D_{TH}$ | +5.5 | | | dBm | 1 |
| Average Receive Power, per Lane | $P_{RX-AVG}$ | -28 | | -6 | dBm | |
| Receiver Power (OMA), per Lane | $P_{RX-OMA}$ | | | -5 | dBm | |
| Receiver Sensitivity (OMA), per Lane | $SEN_{OMA}$ | | | -27 | dBm | 2 |
| Stressed Receiver Sensitivity (OMA), per Lane | $SRS_{OMA}$ | | | -25 | dBm | 2 |
| Receiver Reflectance | $R_{RX}$ | | | -26 | dB | |
| LOS De-Assert | $LOS_D$ | | | -28 | dBm | |
| LOS Assert | $LOS_A$ | -36 | | | dBm | |
| LOS Hysteresis | $LOS_{HY}$ | 0.5 | | 5 | dB | |
| Receiver Electrical 3dB upper Cutoff Frequency, each Lane | $F_{CUT}$ | | | 31 | GHz | |
| Output Differential Impedance | $Z_{OUT}$ | 90 | 100 | 110 | Ω | |
| Differential Data Output Voltage | $V_{OUT-PP}$ | | | 900 | mVpp | |
| **Conditions of Stress Receiver Sensitivity Test (Note.3)** | | | | | | |
| Vertical Eye Closure Penalty, per Lane | VECP | | 1.5 | | dB | |
| Stressed Eye J2 Jitter, per Lane | J2 | | 0.3 | | UI | |
| Stressed Eye J9 Jitter, per Lane | J9 | | 0.47 | | UI | |

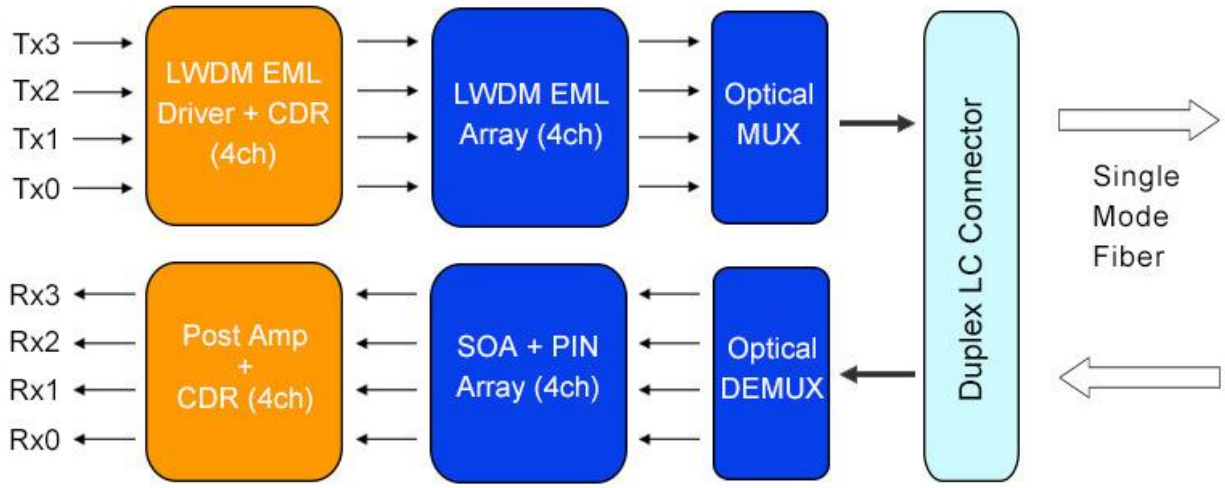
**Note1:** The receiver shall be able to tolerate, without damage, continuous exposure to a modulated optical input signal having this power level on one lane. The receiver does not have to operate correctly at this input power.

**Note2:** Measured with conformance test signal at receiver input for BER= $5x10^{-5}$.

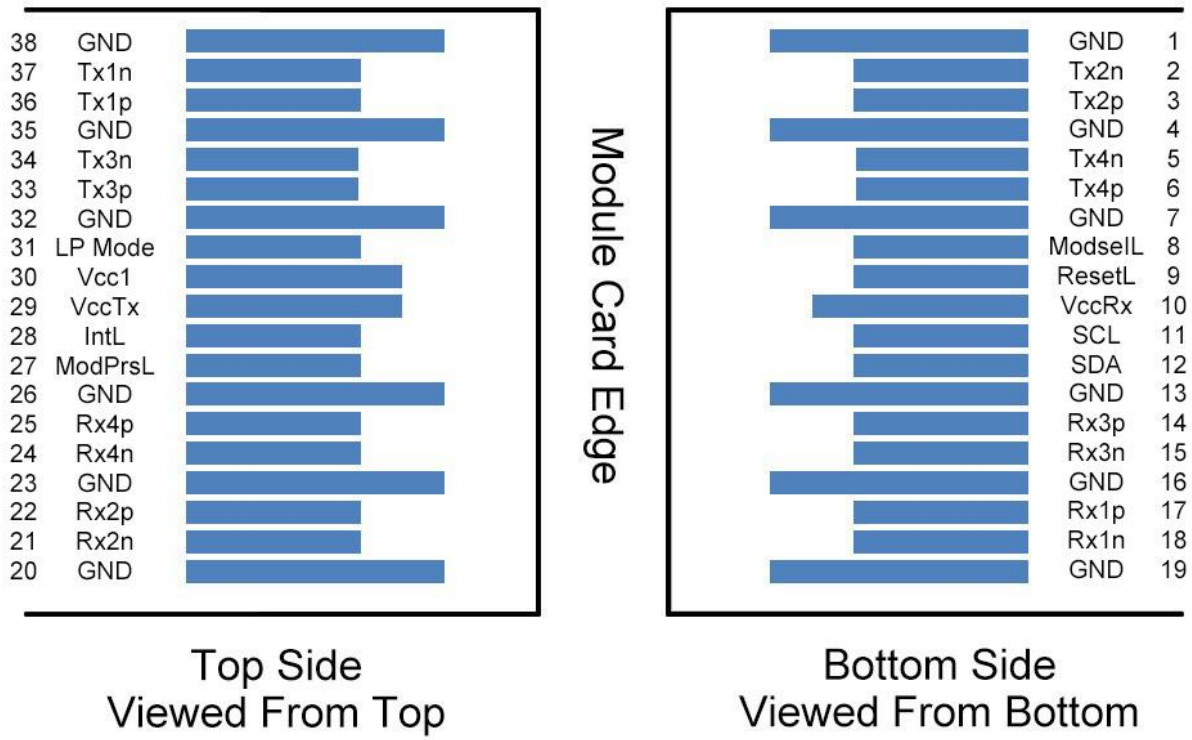
**Note3:** Vertical eye closure penalty and stressed eye jitter are test conditions for measuring stressed receiver sensitivity. They are not characteristics of the receiver.

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## Transceiver Block Diagram




## Pin Assignment




Top Side
Viewed From Top

Bottom Side
Viewed From Bottom

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## Pin Description

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



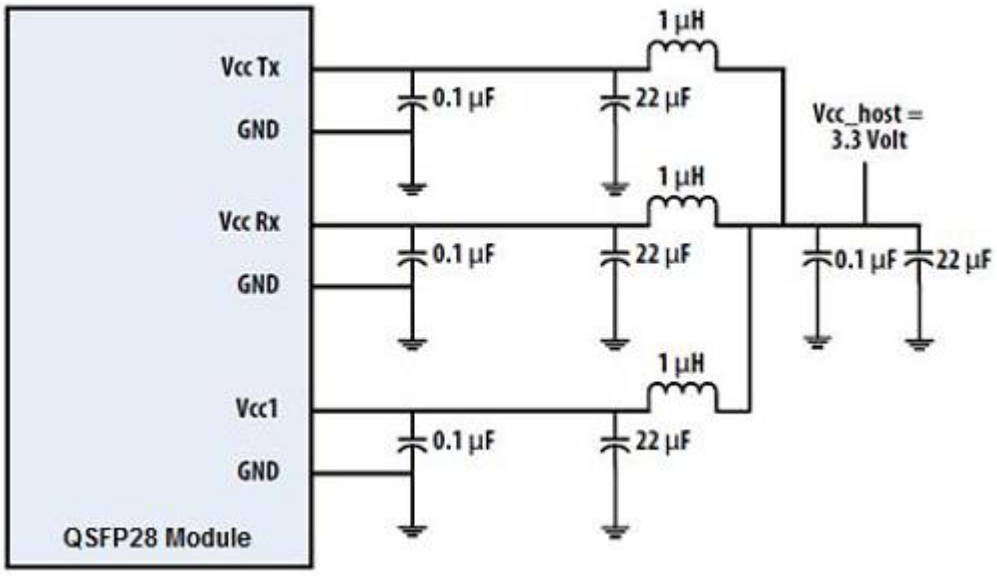
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| | | | |
|---|---|---|---|
| 33 | CML-I | Tx3p | Transmitter Non-Inverted Data Input |
| 34 | CML-I | Tx3n | Transmitter Inverted Data Input |
| 35 | | GND | Module Ground |
| 36 | CML-I | Tx1p | Transmitter Non-Inverted Data Input |
| 37 | CML-I | Tx1n | Transmitter Inverted Data Input |
| 38 | | GND | Module Ground |

**Note1:** GND is the symbol for signal and supply (power) common for QSFP28 modules. All are common within the QSFP28 module and all module voltages are referenced to this potential unless otherwise noted. Connect these directly to the host board signal common ground lane.

**Note2:** VccRx, Vcc1 and VccTx are the receiver and transmitter power suppliers and shall be applied concurrently. Recommended host board power supply filtering is shown below. Vcc Rx, Vcc1 and Vcc Tx may be internally connected within the QSFP28 transceiver module in any combination. The connector pins are each rated for a maximum current of 1000mA.

## Recommended Power Supply Filter



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## Digital Diagnostic Functions

As defined by the QSFP28 MSA, Ficer's QSFP28 transceivers provide digital diagnostic functions via a 2-wire serial interface, which allows real-time access to the following operating parameters:

- Transceiver temperature
- Laser bias current (4-Channel)
- Transmitted optical power (4-Channel)
- Received optical power (4-Channel)
- Transceiver supply voltage

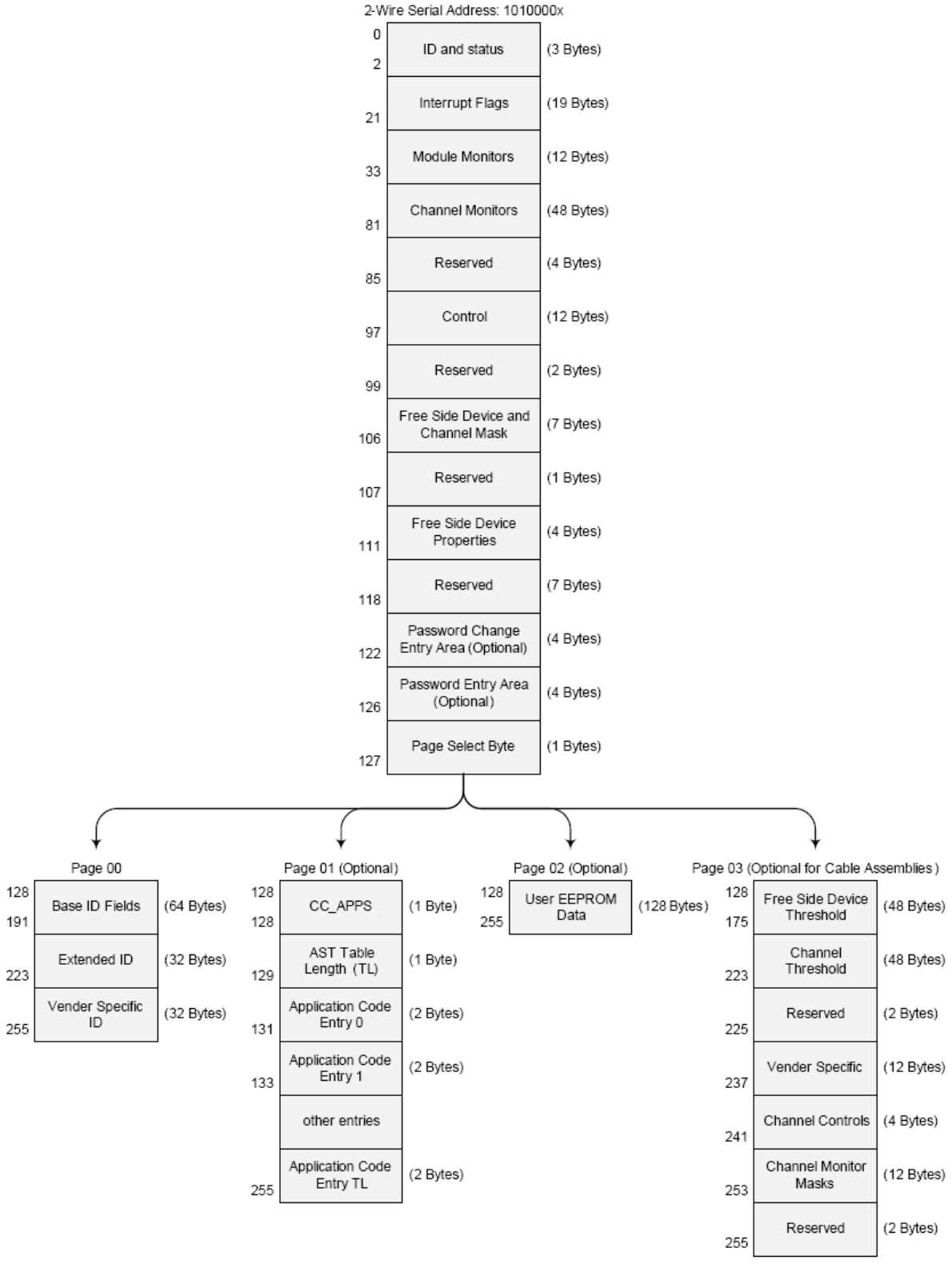
It also provides a sophisticated system of alarm and warning flags, which may be used to alert end-users when particular operating parameters are outside of a factory-set normal range.

The operating and diagnostics information is monitored and reported by a Digital Diagnostics Controller (DDC) inside the transceiver, which is accessed through the 2-wire serial interface. When the serial protocol is activated, the serial clock signal (SCL pin) is generated by the host. The positive edge clocks data into the QSFP28 transceiver into those segments of its memory map that are not write-protected. The negative edge clocks data from the QSFP28 transceiver. The serial data signal (SDA pin) is bi-directional for serial data transfer. The host uses SDA in conjunction with SCL to mark the start and end of serial protocol activation. The memories are organized as a series of 8-bit data words that can be addressed individually or sequentially. The 2-wire serial interface provides sequential or random access to the 8 bit parameters, addressed from 000h to the maximum address of the memory.

For more detailed information including memory map definitions, please see the QSFP28 MSA Specification.

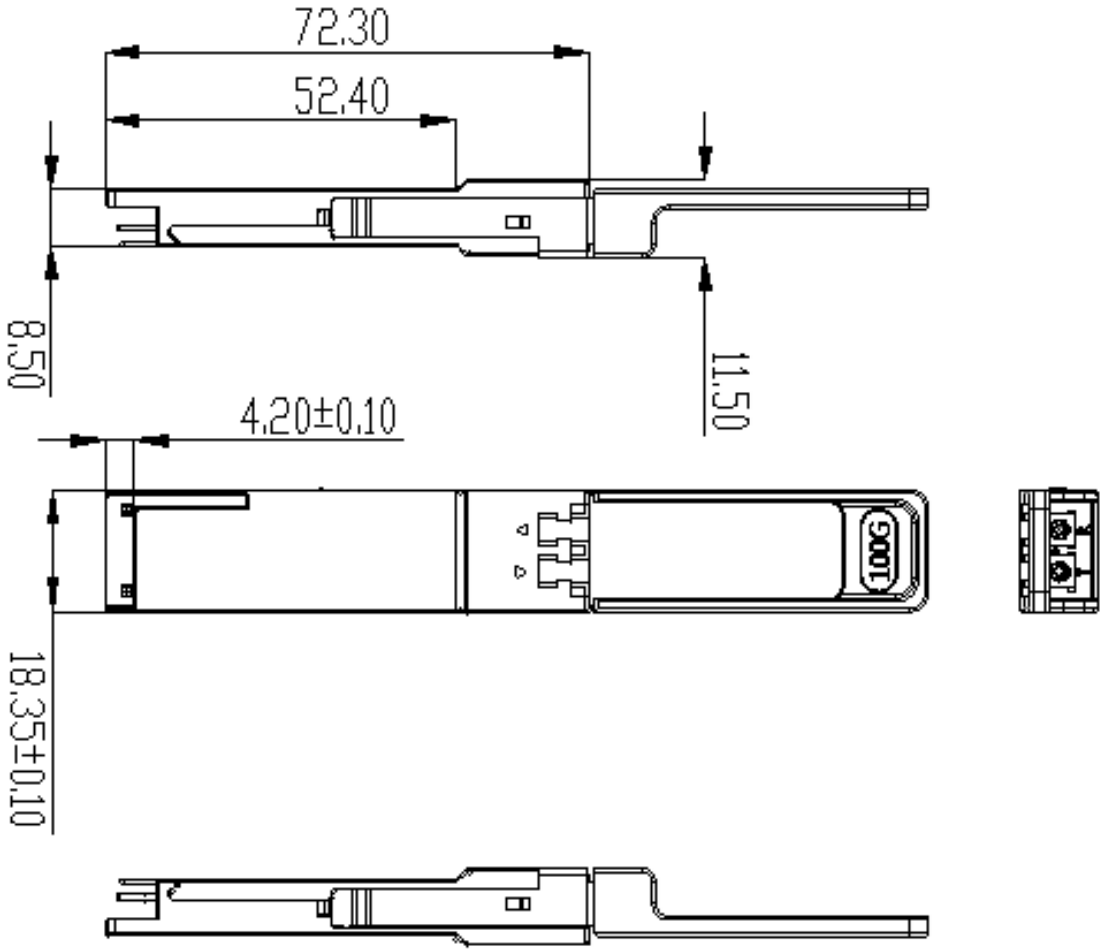
### Digital Diagnostic Memory Map

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2-Wire Serial Address: 1010000x
0
2
ID and status
(3 Bytes)
21
Interrupt Flags
(19 Bytes)
33
Module Monitors
(12 Bytes)
81
Channel Monitors
(48 Bytes)
85
Reserved
(4 Bytes)
97
Control
(12 Bytes)
99
Reserved
(2 Bytes)
106
Free Side Device and Channel Mask
(7 Bytes)
107
Reserved
(1 Bytes)
111
Free Side Device Properties
(4 Bytes)
118
Reserved
(7 Bytes)
122
Password Change Entry Area (Optional)
(4 Bytes)
126
Password Entry Area (Optional)
(4 Bytes)
127
Page Select Byte
(1 Bytes)
Page 00
128
191
Base ID Fields
(64 Bytes)
223
Extended ID
(32 Bytes)
255
Vender Specific ID
(32 Bytes)
Page 01 (Optional)
128
128
CC_APPS
(1 Byte)
129
AST Table Length (TL)
(1 Byte)
131
Application Code Entry 0
(2 Bytes)
133
Application Code Entry 1
(2 Bytes)
other entries
255
Application Code Entry TL
(2 Bytes)
Page 02 (Optional)
128
255
User EEPROM Data
(128 Bytes)
Page 03 (Optional for Cable Assemblies)
128
175
Free Side Device Threshold
(48 Bytes)
223
Channel Threshold
(48 Bytes)
225
Reserved
(2 Bytes)
237
Vender Specific
(12 Bytes)
241
Channel Controls
(4 Bytes)
253
Channel Monitor Masks
(12 Bytes)
255
Reserved
(2 Bytes)

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## Mechanical Dimensions




**(All Dimensions are ±0.20mm Unless Otherwise Specified, Unit: mm)**

## Ordering Information

| Part No. | Tx | Rx | Link | DDM | Temp. |
|---|---|---|---|---|---|
| FQ28-K7-L13-80Di | 1295.56 nm<br>1300.05 nm<br>1304.58 nm<br>1309.14 nm | 1295.56 nm<br>1300.05 nm<br>1304.58 nm<br>1309.14 nm | SMF 80km<br>(with FEC)<br>SMF 60km<br>(without FEC) | Yes | -40~+85°C |

**Note:** Distances are indicative only. To calculate a more precise link budget based on specific conditions in your application, please refer to the optical characteristics