

## 400G QSFP-DD Active Optical Cable

### Key Features

- Low latency DSP-free electronics-based CDR
- Multi-data rate up to 56.15 Gb/s per lane
- PAM4 modulation
- HPC grade BER  $\leq 5 \times 10^{-8}$
- Single 3.3 V power supply
- Low power consumption: 7.6 W per cable end with all CDRs enabled
- Up to 100 m length
- QSFP-DD MSA compliant
- CMIS 3.0 compliant
- Commercial operating case temperature range: 0 to 70°C
- Hot pluggable
- RoHS/REACH compliant
- TUV-certified
- LSZH, LSZH/OFNR or OFNP-rated cable



### Applications

- IEEE 802.3cm 400GBASE SR8
- Datacenter: servers, switches, storages and NIC adapters
- Proprietary HPC interconnections

## 1. Absolute Maximum Ratings

| Parameters          | Symbol       | Min. | Typ. | Max. | Unit | Note    |
|---------------------|--------------|------|------|------|------|---------|
| Supply Voltage      | $V_{IN}$     | 0    | -    | 4.0  | V    |         |
| Input Swing         | $V_{IN-MAX}$ |      |      | 1500 | mVpp |         |
| Storage Temperature | $T_{STG}$    | -40  | -    | 85   | °C   | Ambient |
| Relative Humidity   | RH           | 5    | -    | 85   | %    |         |

## 2. Operating Specifications

| Parameters                 | Symbol   | Min. | Typ. | Max. | Unit | Note |
|----------------------------|----------|------|------|------|------|------|
| Operating Case Temperature | $T_{OP}$ | 0    | -    | 70   | °C   |      |
| Power Supply Voltage       | $V_{CC}$ | 3.15 | 3.30 | 3.47 | V    |      |
| Power Supply Current       | $I_{CC}$ | -    | 2300 | 2500 | mA   | 1    |
| Power Consumption          |          | -    | 7.6  | 8.0  | W    | 1    |

## 3. Electrical Characteristics

| Parameters                       | Symbol       | Min.                | Typ.    | Max.                 | Unit     | Note |
|----------------------------------|--------------|---------------------|---------|----------------------|----------|------|
| Data Rate (Per Channel)          | BR           | -                   | 26.5625 | -                    | GBd      | 2    |
| <b>Transmitter</b>               |              |                     |         |                      |          |      |
| Input Differential Impedance     | $R_{IN}$     | 90                  | 100     | 110                  | $\Omega$ |      |
| Differential Data Input Voltage  | $V_{INP-P}$  | 900                 |         |                      | mV       |      |
| <b>Receiver</b>                  |              |                     |         |                      |          |      |
| Output Differential Impedance    | $R_{OUT}$    | 90                  | 100     | 110                  | $\Omega$ |      |
| Differential Data Output Voltage | $V_{OUTP-P}$ | -                   | 800     | -                    | mV       |      |
| Bit Error Ratio (at 26.5625 GBd) | -            | -                   | -       | $2.4 \times 10^{-4}$ | -        | 3    |
| <b>Digital Logic</b>             |              |                     |         |                      |          |      |
| Input High Voltage               | $V_{IH}$     | $0.7 \times V_{CC}$ |         |                      | V        |      |
| Input Low Voltage                | $V_{IL}$     |                     |         | $0.3 \times V_{CC}$  | V        |      |
| Output High Voltage              | $V_{OH}$     | $V_{CC} - 0.7$      |         |                      | V        |      |
| Output Low Voltage               | $V_{OL}$     |                     |         | 0.6                  | V        |      |

Note:

- Per end, all channel CDRs are enabled.
- Dual data rate of 25.78125 and 28.07618 Gbaud are available upon request.
- Pre-FEC Bit Error Ratio with a PRBS  $2^{31} - 1$  test pattern over a normal operating temperature range.

## 4. Pin Description

| Pin | Logic       | Name     | Description  | Note |
|-----|-------------|----------|--|------|
| 1   |             | GND      | Ground   | 1    |
| 2   | CML-I       | Tx2n     | Transmitter Inverted Data Input                            |      |
| 3   | CML-I       | Tx2p     | Transmitter Non-Inverted Data Input                        |      |
| 4   |             | GND      | Ground   | 1    |
| 5   | CML-I       | Tx4n     | Transmitter Inverted Data Input                            |      |
| 6   | CML-I       | Tx4p     | Transmitter Non-Inverted Data Input                        |      |
| 7   |             | GND      | Ground   | 1    |
| 8   | LVTTTL-I    | ModSelL  | Module Select  |      |
| 9   | LVTTTL-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   | 1    |
| 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                              |      |
| 25  | CML-O       | Rx4p     | Receiver Non-Inverted Data Output                          |      |
| 26  |             | GND      | Ground   | 1    |
| 27  | LVTTTL-O    | ModPrsL  | Module Present   |      |
| 28  | LVTTTL-O    | IntL     | Interrupt  |      |
| 29  |             | VccTx    | +3.3V Power Supply Transmitter                             | 2    |
| 30  |             | Vcc1     | +3.3V Power Supply   | 2    |
| 31  | LVTTTL-I    | InitMode | Initialization Mode; In legacy QSFP applications, LPM mode |      |
| 32  |             | GND      | Ground   | 1    |
| 33  | CML-I       | Tx3p     | Transmitter Non-Inverted Data Input                        |      |
| 34  | CML-I       | Tx3n     | Transmitter Inverted Data Input                            |      |
| 35  |             | GND      | Ground   | 1    |
| 36  | CML-I       | Tx1p     | Transmitter Non-Inverted Data Input                        |      |
| 37  | CML-I       | Tx1n     | Transmitter Inverted Data Input                            |      |
| 38  |             | GND      | Ground   | 1    |

Note:

- GND is the symbol for signal and supply (power) common for the QSFP-DD module. All are common within the QSFP-DD module and all module voltages are referenced to this potential unless otherwise noted.
- VccRx, VccRx1, Vcc1, Vcc2, VccTx and VccTx1 shall be applied concurrently. The connector pins are each rated for a maximum current of 1000 mA.
- All Vendor Specific, Reserved, No Connect and ePPS pins may be terminated with 50 ohms to ground on the host, and not connected within the Module. Pad 65 (No Connect) is left unconnected within the module.

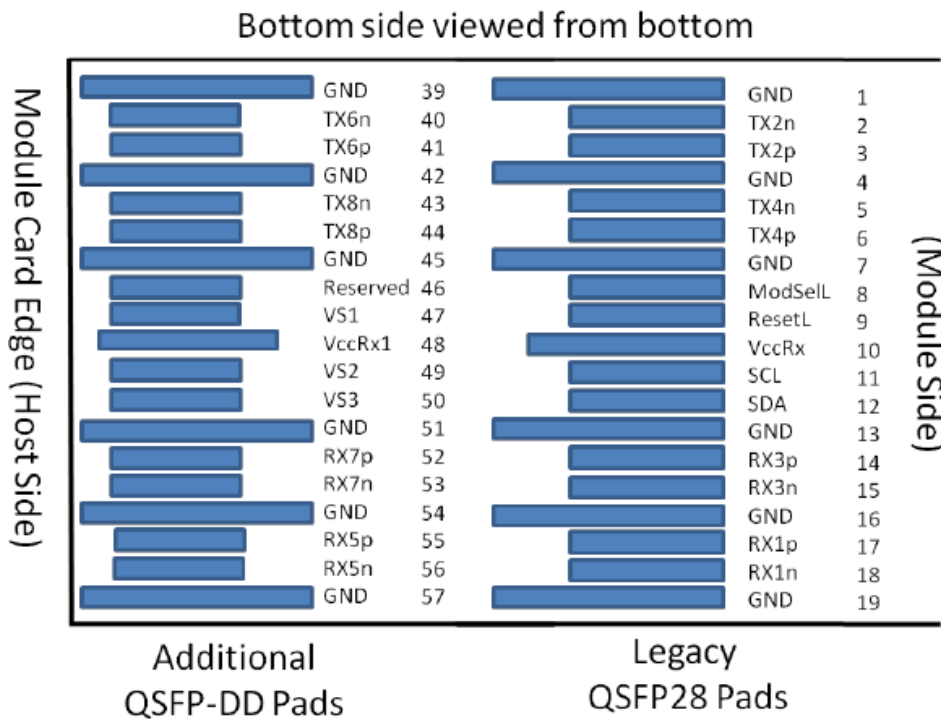
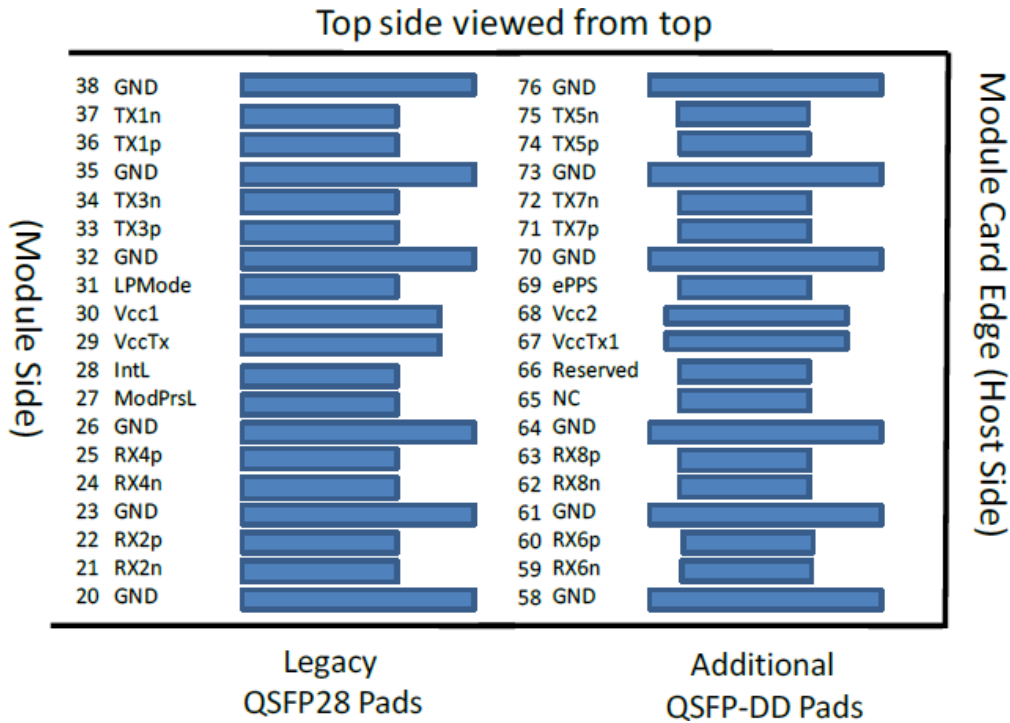
## 4. Pin Description

| Pin | Logic   | Name     | Description                                       | Note |
|-----|---------|----------|---|------|
| 39  |         | GND      | Ground  | 1    |
| 40  | CML-I   | Tx6n     | Transmitter Inverted Data Input                   |      |
| 41  | CML-I   | Tx6p     | Transmitter Non-Inverted Data Input               |      |
| 42  |         | GND      | Ground  | 1    |
| 43  | CML-I   | Tx8n     | Transmitter Inverted Data Input                   |      |
| 44  | CML-I   | Tx8p     | Transmitter Non-Inverted Data Input               |      |
| 45  |         | GND      | Ground  | 1    |
| 46  |         | Reserved | For future use                                    | 3    |
| 47  |         | VS1      | Module Vendor Specific 1                          | 3    |
| 48  |         | VccRx1   | 3.3V Power supply                                 | 2    |
| 49  |         | VS2      | Module Vendor Specific 2                          | 3    |
| 50  |         | VS3      | Module Vendor Specific 3                          | 3    |
| 51  |         | GND      | Ground  | 1    |
| 52  | CML-O   | Rx7p     | Receiver Non-Inverted Data Output                 |      |
| 53  | CML-O   | Rx7n     | Receiver Inverted Data Output                     |      |
| 54  |         | GND      | Ground  | 1    |
| 55  | CML-O   | Rx5p     | Receiver Non-Inverted Data Output                 |      |
| 56  | CML-O   | Rx5n     | Receiver Inverted Data Output                     |      |
| 57  |         | GND      | Ground  | 1    |
| 58  |         | GND      | Ground  | 1    |
| 59  | CML-O   | Rx6n     | Receiver Inverted Data Output                     |      |
| 60  | CML-O   | Rx6p     | Receiver Non-Inverted Data Output                 |      |
| 61  |         | GND      | Ground  | 1    |
| 62  | CML-O   | Rx8n     | Receiver Inverted Data Output                     |      |
| 63  | CML-O   | Rx8p     | Receiver Non-Inverted Data Output                 |      |
| 64  |         | GND      | Ground  | 1    |
| 65  |         | NC       | No Connect  | 3    |
| 66  |         | Reserved | For future use                                    | 3    |
| 67  |         | VccTx1   | 3.3V Power Supply                                 | 2    |
| 68  |         | Vcc2     | 3.3V Power Supply                                 | 2    |
| 69  | LVTTL-I | ePPS     | Precision Time Protocol (PTP) refence clock input | 3    |
| 70  |         | GND      | Ground  | 1    |
| 71  | CML-I   | Tx7p     | Transmitter Non-Inverted Data Input               |      |
| 72  | CML-I   | Tx7n     | Transmitter Inverted Data Input                   |      |
| 73  |         | GND      | Ground  | 1    |
| 74  | CML-I   | Tx5p     | Transmitter Non-Inverted Data Input               |      |
| 75  | CML-I   | Tx5n     | Transmitter Inverted Data Input                   |      |
| 76  |         | GND      | Ground  | 1    |

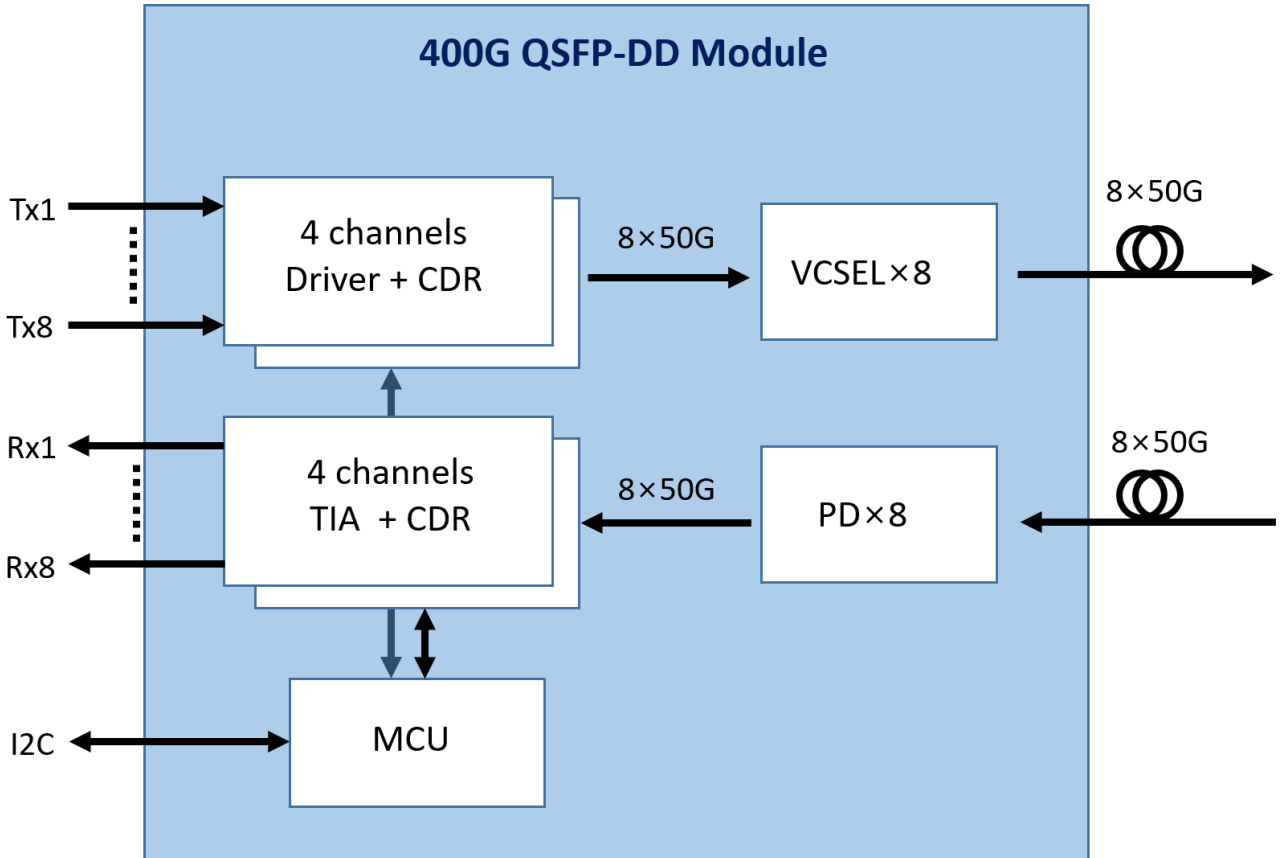
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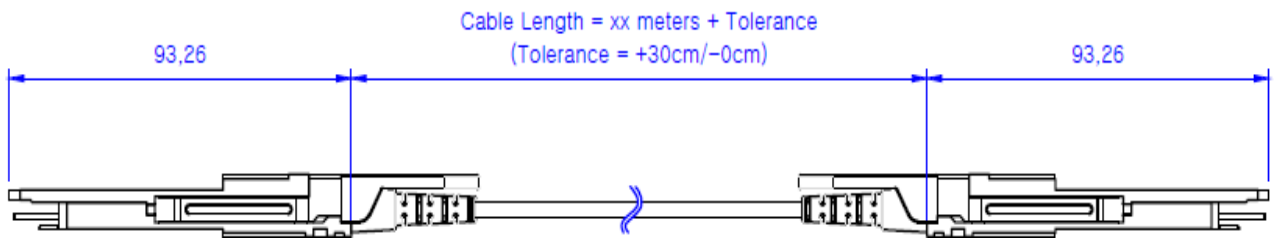
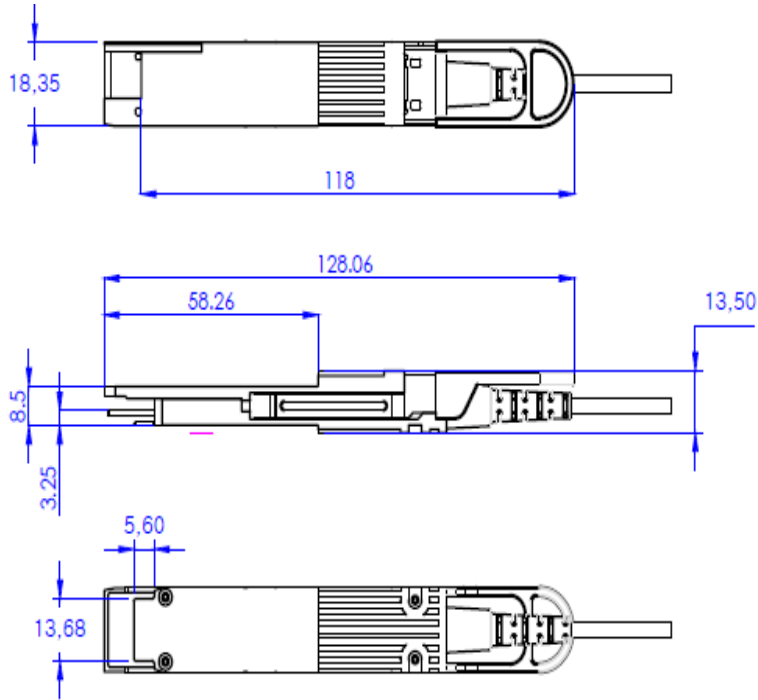
## 4. Pin Description



## 5. Block Diagram



## 6. Mechanical Specifications



## 7. Active Optical Cable

| Parameters          | Value   | Unit | Note                  |
|---------------------|---|------|-----------------------|
| Cable Diameter      | <ul style="list-style-type: none"> <li>LSZH, LSZH/OFNR: <math>\varnothing 3.5 \pm 0.15</math></li> <li>OFNP: <math>\varnothing 3.5 \pm 0.20</math></li> </ul> | mm   |                       |
| Minimum Bend Radius | 35  | mm   | Without tension       |
|                     | 70  | mm   | Under Maximum tension |
| Length Tolerance    | +300 / -0   | mm   |                       |
| Cable Jacket        | LSZH, LSZH/OFNR or OFNP-rated, Aqua   |      |                       |

## 8. Ordering Information

| Part Number   | Description  | Note |
|---------------|--|------|
| MD400HXXyyyZZ | AOC, QSFP-DD, HPC-grade, yyy m, three digit number yyy for length in meter |      |
| MD400EXXyyyZZ | AOC, QSFP-DD, Ethernet, yyy m, three digit number yyy for length in meter  |      |

Note:

- Length (yyy)
  - The maximum cable length is 70 m with OM3 or 100 m with OM4.
  - The first digit A, B or C of the three-digit number denotes 0.25 m, 0.50 m and 0.75 m, respectively.
  - The first digit A, B or C of the three-digit number can be used for the cable length no greater than 10 m.
- Cable jacket type (XX): GA (LSZH), GB (LSZH/OFNR), GC (OFNP)
- Customer ID (ZZ): To be assigned upon request.

## Examples

| Part Number            | Description                                      |
|------------------------|--|
| MD400HGAB <u>00</u> ZZ | AOC, QSFP-DD, HPC-grade, LSZH, <u>0.5</u> m      |
| MD400EGBA <u>09</u> ZZ | AOC, QSFP-DD, Ethernet, LSZH/OFNR, <u>9.25</u> m |
| MD400EGCC <u>01</u> ZZ | AOC, QSFP-DD, Ethernet, OFNP, <u>1.75</u> m      |



## 9. Revision History

| Version | Date          | Description   |
|---------|---------------|---|
| 1.0     | Jan. 4, 2021  | Initial release   |
| 1.01    | Feb. 18, 2021 | Added dual rate feature in Sec. 3   |
| 1.02    | Mar. 12, 2021 | Added TUV-certified in key features<br>Added a note on minimum bend radius in Sec. 7<br>Added detailed ordering information in Sec. 8 |
| 1.03    | Jun. 15, 2021 | Modified differential data input/output voltage values in Sec. 3  |
| 1.10    | Oct. 19, 2021 | Added detailed input/output differential impedance values in Sec. 3<br>Added a detailed minimum bend radius value in Sec. 7           |