ModuleTek

DATA SHEET

MODULETEK: AOC-QSFP-40G-aaa.aaM-G1G1C

40G QSFP Active Optical Cable Transceiver

Overview

AOC-QSFP-40G-aaa.aaM-G1G1C active optical cable transceivers are based on 40G Ethernet IEEE 802.3 standard and complies with SFF-8436 standard, providing fast and reliable interface for 40G Ethernet. It provides four independent transmit and receive channels, each capable of 10Gbps, with a total bandwidth of 40Gbps, making it a high-performance, low-power, short-haul interconnect solution.

Product Features

• Supports 4-channel 10.3125Gbps bi-directional data links

• Compliant with IEEE 802.3

• Compliant with SFF-8436

• Hot-pluggable QSFP footprint

• 850nm VCSEL array laser transmitter

• Built-in digital diagnostic functions

• Up to 400m in length

• Low power consumption (Operating Power <1.5W@Single-end)

• Single power supply 3.3V

• RoHS-6 Compliant

• Operating temperature range (Case Temperature): Commercial Level: 0°C to 70°C

Applications

• 40G Ethernet Data Center Intra-Rack and Inter-Rack links

Ordering Information

Part Number	Produce ID	Description	Color on Clasp
AOC-QSFP-40G-aaa.aaM-G1G1C	M514804	40G QSFP Active Optical Cable, Length 0.5~400 meters	beige

Notes:
1.Product ID is the abbreviated order number of our company's product standard model
2.Model AOC-QSFP-40G-aaa.aaM-G1G1C, where aaa.aaM refers to the length of the AOC cable

For More Information Or To Order The Above Products, Please Contact:

Email: sales@moduletek.com

ModuleTek Web: www.moduletek.com

General Specifications

Parameter	Symbol	Min	Typ	Max	Unit	Remarks
Data Rate (Per Channel)	DR		10.3125		Gbps	
Bit Error Rate	BER			1×10^{-12}		1
Operating Temperature	T_C	0		70	°C	2
Storage Temperature	T_{STO}	-40		85	°C	3
Supply Current	I_{CC}			450	mA	4
Input Voltage	V_{CC}	3.15	3.3	3.46	V	
Maximum Voltage	V_{MAX}	-0.5		3.6	V	
Power (Single-end)	P			1500	mW	
Product Weight			90.6		g/PCS	5
Fiber Optical Cable Weight			5.8		g/M	6

Notes:
1. Measured with data rate at 10.3125Gbps, PRBS 2^{31}-1
2. Case temperature
3. Ambient temperature
4. For electrical power interface
5. The weight of AOC-QSFP-40G-1M-G1G1C
6. The weight of fiber optical cable per unit length

Electrical Characteristics – Transmitter

V_{CC}=3.15V to 3.46V, T_C=0°C to 70°C

Parameter	Symbol	Min	Typ	Max	Unit	Remarks
Input differential impedance	R_{IN}		100		Ω	
Differential Data Input Swing	V_{IN_PP}	180		1200	mV	
Transmitter Disable Voltage	V_D	2		V_{CC}	V	
Transmitter Enable Voltage	V_{EN}	V_{EE}		V_{EE}+0.8	V	

Electrical Characteristics – Receiver

V_{CC}=3.15V to 3.46V, T_C=0°C to 70°C

Parameter	Symbol	Min	Typ	Max	Unit	Remarks
Differential output swing	V_{OUT_PP}	300		850	mV	
Data Output Rise/Fall Time (20%-80%)	t_r/t_f	28			ps	
LOS Assert	V_{LOS_A}	2		V_{CC_HOST}	V	
LOS De-Assert	V_{LOS_D}	V_{EE}		V_{EE}+0.8	V	

Digital Diagnostic Function

AOC-QSFP-40G-aaa.aaM-G1G1C supports the 2-wire serial communication protocol defined in SFF-8436, which provides access to digital diagnostic information through a 2-wire interface. The internal microcontroller unit provides real-time access to module operating parameters such as module temperature, laser bias current, transmit optical power, receive optical power and module supply voltage. The module implements the SFF-8436's alarm function, which alerts the user when specific operating parameters are out of normal range.

Digital Diagnostic Threshold Range				
Parameter	High Alarm(HEX)	High Warning(HEX)	Low Warning(HEX)	Low Alarm(HEX)
Temperature(°C)	75.00(4B00h)	70.00(4600h)	0.00(0000h)	-5.00(FB00h)
Voltage(V)	3.63(8DCCh)	3.46(8728h)	3.13(7A44h)	2.97(7404h)
Bias Current(mA)	12.00(1770h)	11.50(1676h)	2.00(03E8h)	1.00(01F4h)
Tx Power(dBm)	3.40(5575h)	2.40(43E2h)	-7.60(06CAh)	-8.60(0565h)
Rx Power(dBm)	3.40(5575h)	2.40(43E2h)	-9.50(0462h)	-10.50(037Ch)

A0h Write Protection

Security Level 1 Password (Factory Value)		
Password Entry ADDr	Size	Vaules(HEX)
A0h, 123h-126h	4	00 00 10 11

AOC-QSFP-40G-aaa.aaM-G1G1C has the function of A0h write-protection, which allows users to enter the security level 1 working state and write the contents of Table 00 and Table 02 of the device address A0h. The method to enter the security level 1 working state is to write the security level 1 password sequentially in the 123h-126h registers of the device address A0h; after entering the security level 1, the user can modify the contents of the 127h Table Selection Register of the device address A0h to write the contents of Table 00 and Table 02. This version module supports users to modify the password of security level 1 by writing a new security level 1 password in the 119h-122h register(Password Change Entry) in the device address A0h; the new security level password ranges from 00000000-7FFFFFFF (hex), and the highest bit of the new security level 1 password must be 0b.

A0h Register Map Low 128 Bytes

Lower Memory Map (A0h)				
IIC ADDr	Size	Name	Description	Initial Vaules(HEX)
0	1	Identifier	QSFP+	0D
1	1	Status	Reserved	00
2	1	Status	Bit7-Bit3=0000: Reserved Bit2=0: Upper memory Paged (at least upper page 03h implemented) Bit1: Digital state of the IntL Interrupt output pin Bit0: Data Not Ready	Variable
3	1	Channel Status LOS Flag	Tx/Rx LOS Flag	Variable
4	1	Channel Status TxFault Flag	TxFAULT Flag	Variable
5	1	Reserved	Reserved	00
6	1	Module Monitor Temperature Alarm/Warning Flag	Temperature Alarm/Warning flag and initialization completion flag bit	Variable
7	1	Module Monitor Vcc Alarm/Warning Flag	Vcc Alarm/Warning Flag	Variable
8	1	Vendor Specific	Vendor Specific information	00

9-10	2	Channel Mon RxPower Alarm/Warning Flag	RxPower Alarm/Warning Flag	Variable
11-12	2	Channel Mon TxBias Alarm/Warning Flag	TxBias Alarm/Warning Flag	Variable
13-18	6	Channel Mon Reserved	Reserved	00 00 00 00 00 00
19-21	3	Vendor Specific	Vendor Specific information	00 00 00
22-23	2	Module Monitor Temperature	Temperature diagnosis, unit is 1/256°C	Variable
24-25	2	Reserved	Reserved	00 00
26-27	2	Module Monitor Voltage	Supply Voltage diagnosis, unit is 100uV	Variable
28-29	2	Reserved	Reserved	00 00
30-33	4	Vendor Specific	Vendor Specific information	00 00 00 00
34-35	2	Channel Mon Rx1 Power	Rx1 average receive power diagnosis, unit of 0.1uW	Variable
36-37	2	Channel Mon Rx2 Power	Rx2 average receive power diagnosis, unit of 0.1uW	Variable
38-39	2	Channel Mon Rx3 Power	Rx3 average receive power diagnosis, unit of 0.1uW	Variable
40-41	2	Channel Mon Rx4 Power	Rx4 average receive power diagnosis, unit of 0.1uW	Variable
42-43	2	Channel Mon Tx1 Bias	Tx1 bias current diagnosis, unit of 2uA	Variable
44-45	2	Channel Mon Tx2 Bias	Tx2 bias current diagnosis, unit of 2uA	Variable
46-47	2	Channel Mon Tx3 Bias	Tx3 bias current diagnosis, unit of 2uA	Variable
48-49	2	Channel Mon Tx4 Bias	Tx4 bias current diagnosis, unit of 2uA	Variable
50-65	16	Reserved	Reserved	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
66-81	16	Vendor Specific	Vendor Specific information	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
82-85	4	Reserved	Reserved	00 00 00 00

86	1	Control TxDisable	Bit7-Bit4=0000: Reserved Bit3: Bit of Channel4 Laser disable Bit2: Bit of Channel3 Laser disable Bit1: Bit of Channel2 Laser disable Bit0: Bit of Channel1 Laser disable	Variable
87	1	Control Rx Rate Select	This product does not support this function, Initize to 00（hex）	00
88	1	Control Tx Rate Select	This product does not support this function, Initize to 00（hex）	00
89	1	Control Rx4 App Select	This product does not support this function, Initize to 00（hex）	00
90	1	Control Rx3 App Select	This product does not support this function, Initize to 00（hex）	00
91	1	Control Rx2 App Select	This product does not support this function, Initize to 00（hex）	00
92	1	Control Rx1 App Select	This product does not support this function, Initize to 00（hex）	00
93	1	Control Power	This product does not support this function, Initize to 00（hex）	00
94	1	Control Tx4 App Select	This product does not support this function, Initize to 00（hex）	00
95	1	Control Tx3 App Select	TThis product does not support this function, Initize to 00（hex）	00
96	1	Control Tx2 App Select	This product does not support this function, Initize to 00（hex）	00
97	1	Control Tx1 App Select	This product does not support this function, Initize to 00（hex）	00
98-99	2	Reserved	Reserved	00 00
100	1	Mask Tx/Rx LOS	Masking Tx/Rx LOS	Variable
101	1	Mask TxFault	Masking TxFAULT	Variable
102	1	Reserved	Reserved	00
103	1	Mask Temperature Alarm/Warning	Masking Temperature Alarm/Warning	Variable
104	1	Mask Vcc Alarm/Warning	Masking Voltage Alarm/Warning	Variable
105-106	2	Vendor Specific	Vendor Specific information	00 00
107-118	12	Reserved	Reserved	00 00 00 00 00 00 00 00 00 00 00 00
119-122	4	Password Change Entry Area(optional)	Modify security level 1 password entry, power-up default 00000000(hex); readback not supported after writing	00 00 00 00

123-126	4	Password Entry Area (optional)	Security level 1 password entry, power-up default 00000000(hex); readback not supported after writing	00 00 00 00
127	1	Page Select Byte	Table selection, select A0h high 128 byte page	00

A0h Register Map High 128 Bytes

Upper Memory Map Page 00h				
ICC Addr	**Size**	**Name**	**Description**	**Initial Value(HEX)**
128	1	Identifier	QSFP+	0D
129	1	Ext. Identifier	Bit7Bit6=00: Power Class 1 Module (<1.5W) Bit5=0: Reserved Bit4=0: No CLEI code Bit3=0: Tx without CDR function Bit2=0: Rx without CDR function Bit1Bit0=00: Reserved	00
130	1	Connector Type	No separable connector	23
131-138	8	Specification Compliance	40G Base AOC	00 00 00 00 00 00 00 00
139	1	Encoding	Unspecified	00
140	1	Nominal bit rate	Unit is 100Mbps	67
141	1	Extended Rate Select Compliance	No rate selection function	00
142	1	Length (SMF)	SMF transmission distance, unit of 1km	00
143	1	Length (OM3 50 um)	OM3 transmission distance, unit of 2M	00
144	1	Length (OM2 50 um)	OM2 transmission distance, unit of 1M	00
145	1	Length (OM1 62.5 um)	OM1 transmission distance, unit of 1M	00
146	1	Cable Assembly Length (Copper or active cable)	Copper or activer cable length, unit of 1M	00
147	1	Device technology	Bit7-Bit4=0000: 850nm VCSEL Bit3=0: No wavelength control Bit2=0: Uncooled transmitter device Bit1=0: Pin detector Bit0=0: Transmitter not tunable	00

148-163	16	Vendor name	MODULETEK	ASCII Format
164	1	Extended Module	InfinBand application are not supported	00
165-167	3	Vendor OUI	IEEE Company Identifier for the vendor	00 00 00
168-183	16	Vendor PN	Vendor Part Number	ASCII Format
184-185	2	Vendor rev	Vendor Part Revision Number	Defined by vendor
186-187	2	Wavelength	Undefined	00 00
188-189	2	Wavelength tolerance	Undefined	00 00
190	1	Max case temp	Max case temp is 70°C, unit of °C	46
191	1	CC_BASE	The check code of Bytes 128-190	Defined by vendor
192	1	Options	Reserved	00
193	1	Options	Bit7-Bit1=0000000: Reserved Bit0=1: RX output amplitude programming	01
194	1	Options	BIT7-BIT4=0000: Reserved Bit3=1: Rx Squelch Disable implemented Bit2=1: Rx Output Disable capable implemented Bit1=1: Tx Squelch Disable implemented Bit0=1: Tx Squelch implemented	0F
195	1	Options	Bit7=1: Memory Page 02 provided Bit6=1: Memory Page 01 provided Bit5=0: Rate selection funtion not implemented Bit4=1: Tx-DISABLE implemented Bit3=1: Tx-FAULT signal implemented Bit2=1: Tx Squelch implemented to reducing by average optical power Bit1=1: Tx Los of signal implemented Bit0=0: Reserved	DE
196-211	16	Vendor SN	Vendor Part Serial Number	Defined by vendor
212-219	8	Date Code	Date	Defined by vendor
220	1	Diagnostic Monitoring Type	Bit7-Bit4=0000: Reserved Bit3=1: Received Optical Power is the Average Optical Power Bit2-Bit0=000: Reserved	08
221	1	Enhanced Options	No implemented	00
222	1	Reserved	Reserved	00

223	1	CC_EXT	The check code of Byte 192-222	Defined by vendor
224-255	32	Vendor Specific	Vendor Specific information	Defined by vendor

Upper Memory Map Page 02h				
IIC Addr	**Size**	**Name**	**Description**	**Initial Value(HEX)**
128-255	128	User-writable EEPROM	User defined, readable and writeable under security level 1	User-defined

| Upper Memory Map Page 03h				
IIC Addr	**Size**	**Name**	**Description**	**Initial Vlan(HEX)**
128-129	2	Temp High Alarm	Temperature high alarm	See Table Of Threshold Ranges
130-131	2	Temp Low Alarm	Temperature low alarm	See Table Of Threshold Ranges
132-133	2	Temp High Warning	Temperature high warning	See Table Of Threshold Ranges
134-135	2	Temp Low Warning	Temperature low warning	See Table Of Threshold Ranges
136-143	8	Reserved	Reserved	00 00 00 00 00 00 00 00
144-145	2	Vcc High Alarm	Voltage high alarm	See Table Of Threshold Ranges
146-147	2	Vcc Low Alarm	Voltage low alarm	See Table Of Threshold Ranges
148-149	2	Vcc High Warning	Voltage high warning	See Table Of Threshold Ranges
150-151	2	Vcc Low Warning	Voltage low warning	See Table Of Threshold Ranges

152-159	8	Reserved	Reserved	00 00 00 00 00 00 00 00
160-175	16	Vendor Specific	Vendor Specific information	Defined by vendor
176-177	2	Rx Power High Alarm	RX power high alarm	See Table Of Threshold Ranges
178-179	2	Rx Power Low Alarm	RX power low alarm	See Table Of Threshold Ranges
180-181	2	Rx Power High Warning	RX power high warning	See Table Of Threshold Ranges
182-183	2	Rx Power Low Warning	RX power low warning	See Table Of Threshold Ranges
184-185	2	Tx Bias High Alarm	Bias current high alarm	See Table Of Threshold Ranges
186-187	2	Tx Bias Low Alarm	Bias current low alarm	See Table Of Threshold Ranges
188-189	2	Tx Bias High Warning	Bias current high warning	See Table Of Threshold Ranges
190-191	2	Tx Bias Low Warning	Bias current low warning	See Table Of Threshold Ranges
192-193	2	Tx Power High Alarm	TX power high alarm	See Table Of Threshold Ranges
194-195	2	Tx Power Low Alarm	TX power low alarm	See Table Of Threshold Ranges
196-197	2	Tx Power High Warning	TX power high warning	See Table Of Threshold Ranges

198-199	2	Tx Power Low Warning	TX power low warning	See Table Of Threshold Ranges
200-207	8	Reserved	Reserved	00 00 00 00 00 00 00 00
208-223	16	Vendor Specific	Vendor Specific information	Defined by vendor
224-225	2	Reserved	Reserved	00 00
226-237	12	Vendor Specific	Vendor Specific information	Defined by vendor
238	1	Optional Channel Controls	Bit7-Bit4: Rx1 output amplitude Bit3-Bit0: Rx2 output amplitude	Variable
239	1	Optional Channel Controls	Bit7-Bit4: Rx3 output amplitude Bit3-Bit0: Rx4 output amplitude	Variable
240	1	Optional Channel Controls	Bit7-Bit4: Rx4-Rx1 squelch enable Bit3-Bit0: Tx4-Tx1 squelch enable	00
241	1	Optional Channel Controls	Bit7-Bit4: Rx4-Rx1 output enable Bit3-Bit0: Reserved	00
242-243	2	Channel Monitor Masks	Masking Bit for Rx power Alarm/Warning	Variable
244-245	2	Channel Monitor Masks	Masking Bit for Bias current Alarm/Warning	Variable
246-247	2	Channel Monitor Masks	Masking Bit for Tx power Alarm/Warning	Variable
248-249	2	Channel Monitor Masks	Reserved	00 00
250-253	4	Channel Monitor Masks	Reserved	00 00 00 00
254-255	2	Reserved	Reserved	00 00

Notes：

1.The alarm threshold information can be modified according to the customter's definition, please contact us if you have any modification requirements.

Block-Diagram-of-Transceiver
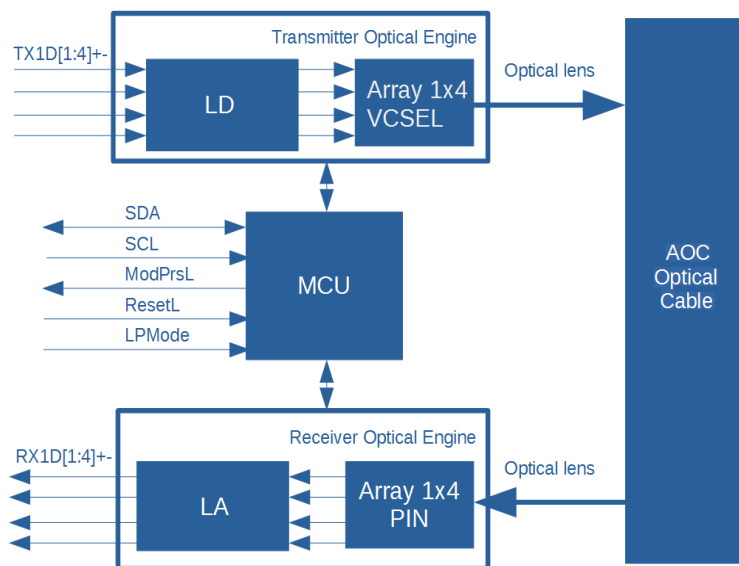
Functions Description

AOC-QSFP-40G-aaa.aaM-G1G1C module is manufactured using advanced COB (Chip on Board) process and consists of a microcontroller, a transmitter-side optical engine and a receiver-side optical engine.

The microcontroller communicates with the host computer via a 2-wire serial communication interface and provides module control, status reporting, and monitoring (DOM) functions in accordance with the SFF-8436 standard.

The transmitter-side optical engine consists of a 4-channel laser driver circuit (LD) and a 4-channel VCSEL laser array. The high-speed differential electrical signals output from the host computer are amplified by the laser driver, which drives the VCSEL lasers to generate optical signals, which are coupled into the optical fiber through an optical lens.

The optical engine at the receiving end includes a 4-channel photodiode (PIN), a 4-channel signal amplifier (TIA/LA). The optical signal in the optical fiber is coupled to the receiving photodiode (PIN) through an optical lens to be converted into a light-generated current, which is augmented by the amplifier and output to the host computer as a high-speed differential signal. The microcontroller reads the signal strength (modulation amplitude) received by the photodiode and reports a loss of the received signal if it is below a set threshold.

Both the transmitter and receiver have the squelch function. When the transmitter has a signal input, the waveform displayed by the oscilloscope of the transmitter light access is an eye diagram shape, and the waveform displayed by the oscilloscope of the transmitter light access when there is no signal input is a straight line, and the actual measured optical power is lower than the normal value of optical power, but not zero；When the incident light at the receiving end has a signal input, access to the oscilloscope shows that the waveform of the output electrical signal is an eye diagram shape, and when there is no signal input, access to the oscilloscope shows that the waveform of the output electrical signal is a straight line.

Optical Cable Details

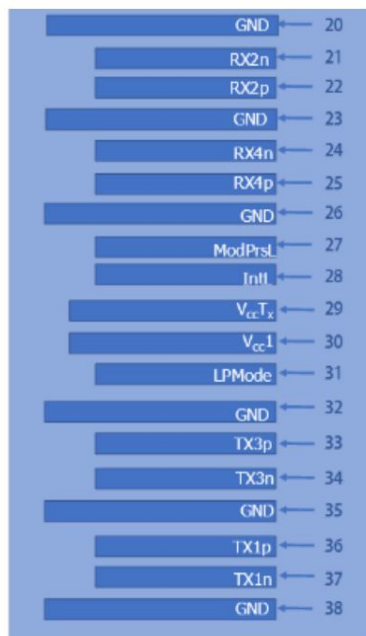| Parameter	Min	Typ	Max	Unit	Remarks
Jacket Material		LSZH			
Jacket Color		Aqua Green			We can provide according to the needs of customers
Flammability Rating		OFN			We can provide according to the needs of customers
Outer Diameter	2.8	3.0	3.2	mm	
Tensile Load(Short Term)			200	N	
Tensile Load(Long Term)			100	N	
Crush Resistance	10			N/mm	IEC 60794-1-21
Impact Resistance	0.5			N.m	IEC 60794-1-21
Flexing	300			Cycles	IEC 60794-1-21
Twist Bend					IEC 60794-1-21
Cable to QSFP+ Plug Connection			90	N	
Bend Radius(Short Term)	25			mm	
Bend Radius(Long Term)	30			mm	

Dimensions
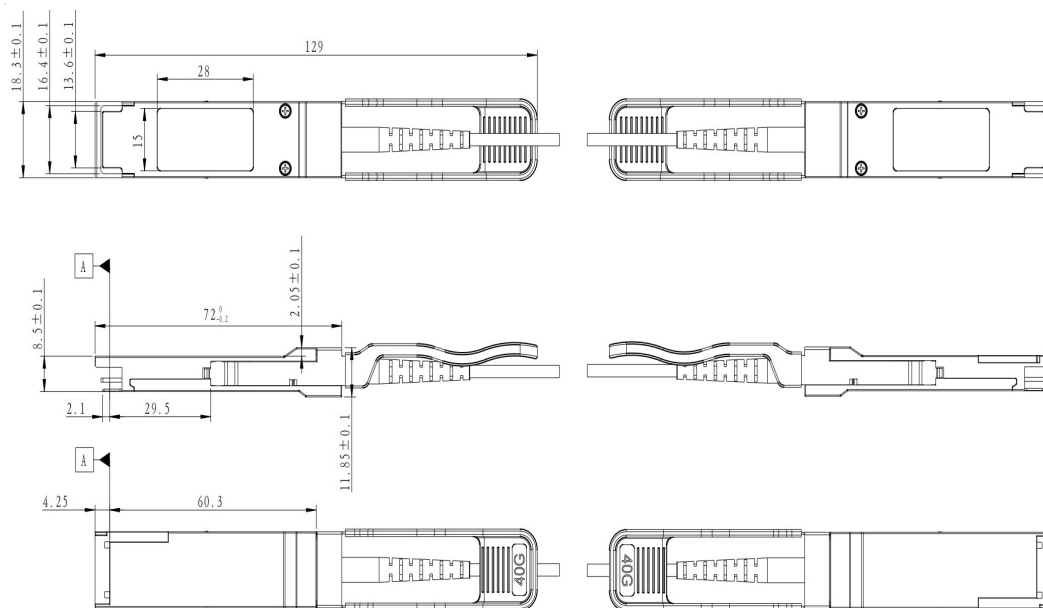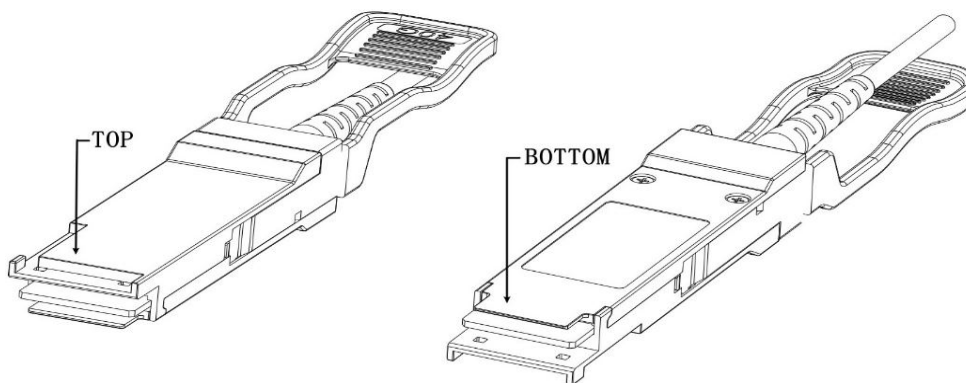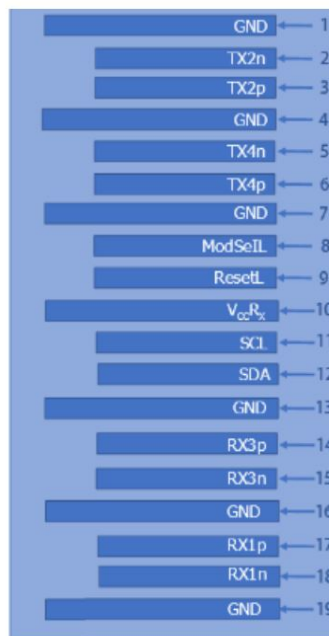

ALL DIMENSIONS ARE ±0.2mm UNLESS OTHERWISE SPECIFIED
UNIT: mm

Electrical Pad Layout

Top View Of Board	Bottom View Of Board

Top View Of Board

GND	← 20
RX2n	← 21
RX2p	← 22
GND	← 23
RX4n	← 24
RX4p	← 25
GND	← 26
ModPrsL	← 27
IntL	← 28
$V_{cc}T_x$	← 29
$V_{cc}1$	← 30
LPMode	← 31
GND	← 32
TX3p	← 33
TX3n	← 34
GND	← 35
TX1p	← 36
TX1n	← 37
GND	← 38

Bottom View Of Board

GND	← 1
TX2n	← 2
TX2p	← 3
GND	← 4
TX4n	← 5
TX4p	← 6
GND	← 7
ModSeIL	← 8
ResetL	← 9
$V_{cc}R_x$	← 10
SCL	← 11
SDA	← 12
GND	← 13
RX3p	← 14
RX3n	← 15
GND	← 16
RX1p	← 17
RX1n	← 18
GND	← 19

TOP

BOTTOM

Pin Assignment

PIN #	Symbol	Description	Remarks
1	GND	Ground	5
2	Tx2n	Transmitter Inverted Data Input, LAN2	
3	Tx2p	Transmitter Non-Inverted Data Input, LAN2	
4	GND	Ground	5
5	Tx4n	Transmitter Inverted Data Input, LAN4	
6	Tx4p	Transmitter Non-Inverted Data Input, LAN4	
7	GND	Ground	5
8	ModSelL	Module select pin, the module responds to two-wire serial communication when low level	1
9	ResetL	Module Reset	2
10	$V_{cc}R_X$	+3.3V Power Supply Receiver	
11	SCL	2-wire serial interface clock	
12	SDA	2-wire serial interface data	
13	GND	Ground	5
14	Rx3p	Receiver Non-Inverted Data Output, LAN3	
15	Rx3n	Receiver Inverted Data Output, LAN3	
16	GND	Ground	5
17	Rx1p	Receiver Non-Inverted Data Output, LAN1	
18	Rx1n	Receiver Inverted Data Output, LAN1	
19	GND	Ground	5
20	GND	Ground	5
21	Rx2n	Receiver Inverted Data Output, LAN2	
22	Rx2p	Receiver Non-Inverted Data Output, LAN2	
23	GND	Ground	5
24	Rx4n	Receiver Inverted Data Output, LAN4	
25	Rx4p	Receiver Non-Inverted Data Output, LAN4	
26	GND	Ground	5
27	ModPrsL	Module insertion indication pin, grounded inside the module	
28	IntL	Interrupt	4
29	$V_{cc}T_X$	+3.3V Power Supply transmitter	
30	V_{cc1}	+3.3V Power Supply	
31	LPMode	Low power mode, pull-up to Vcc inside the module	3
32	GND	Ground	5

33	Tx3p	Transmitter Non-Inverted Data Input, LAN3	
34	Tx3n	Transmitter Inverted Data Input, LAN3	
35	GND	Ground	5
36	Tx1p	Transmitter Non-Inverted Data Input, LAN1	
37	Tx1n	Transmitter Inverted Data Input, LAN1	
38	GND	Ground	5

Notes:

1. ModSelL is the input pin. The module responds to 2-wire serial communication commands when it is held low by the host. ModSelL allows multiple QSFP modules to be used on a single 2-wire interface bus. If ModSelL is High, the module will not respond to any 2-wire interface communication from the host. ModSelL has internal pull-up resistors in the module.

2. The module restart pin, when the low level on the ResetL pin lasts longer than the minimum pulse length, resets the module and restores all user modules to their default state. When performing reset device, the host should ignore all status bits. Until the module reset interrupt is completed, please note that during hot plugging, the module will issue this information to complete the reset interrupt without resetting.

3. This pin is active high, indicats that the module is operating in low-power mode, this signal has no effect on the function of the product.

4. IntL is the output pin, which is the open collector output and must be pulled up to Vcc on the motherboard. When it is low, it indicates that the module may malfunction. The host uses a 2-wire serial interface to read internal status.

5.Circuit ground is internally isolated from chassis ground.

References

1. IEEE Std 802.3^{TM} 2022.

2. SFF-8436 Specification for QSFP+ 4X 10 Gb/s Pluggable Transceiver Rev 4.9 August 31, 2018.