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 (OM1/OM2/OM3)

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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	℃	
3.3V Power Supply Voltage	Vcc	-0.5		3.6	V	
Data Input Voltage-Single Ended		-0.5		V_{cc}+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	℃	
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
Transceiver Electrical Characteristics						
TRx Power Consumption				1.5	W	
TRx Power Supply Current	Icc			420	mA	
TRx Power-On Initialization Time	T_{pwr_init}			2000	ms	1
Transmitter Electrical Characteristics						
Data Input Differential Peak-to-Peak Voltage Swing	ΔVDI PP			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: X1, X2; Y1, Y2		Specification Value 0.11, 0.31; 95, 350			UI; mV	3
Receiver Electrical Characteristics						
Data Output Differential Peak-to-Peak Voltage Swing	ΔVDO PP	200		900	mVpp	4
Output Transition Time 20% to 80%	t_rise, t_fall	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: X1, X2; Y1, Y2		Specification Value 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 × 10-5 per sample.
4. AC-Coupled with 100Ω differential output impedance.

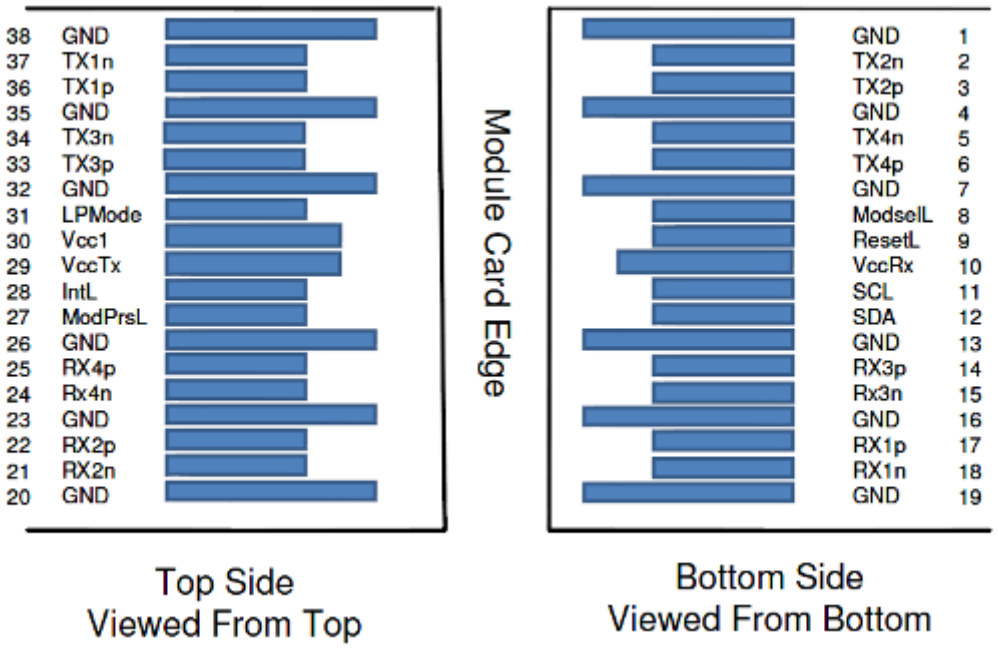
Optical Characteristics

Parameter	Symbol	Min	Typ.	Max	Unit	Note
Transmitter Optical Characteristics						
Center Wavelength	λ	840		860	nm	1
Spectral Width – RMS	Δλ			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: X1, X2, X3; Y1, Y2, Y3		Specification Value 0.23, 0.34, 0.43; 0.27, 0.35, 0.4			UI	2
Receiver Optical Characteristics						
Center wavelength, each lane	λ	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 × 10-5 per sample.
3. Measured with 10.3125-Gbps of PRBS-31 at 10-12 BER.

QSFP+ Module Pad Assignments and Descriptions



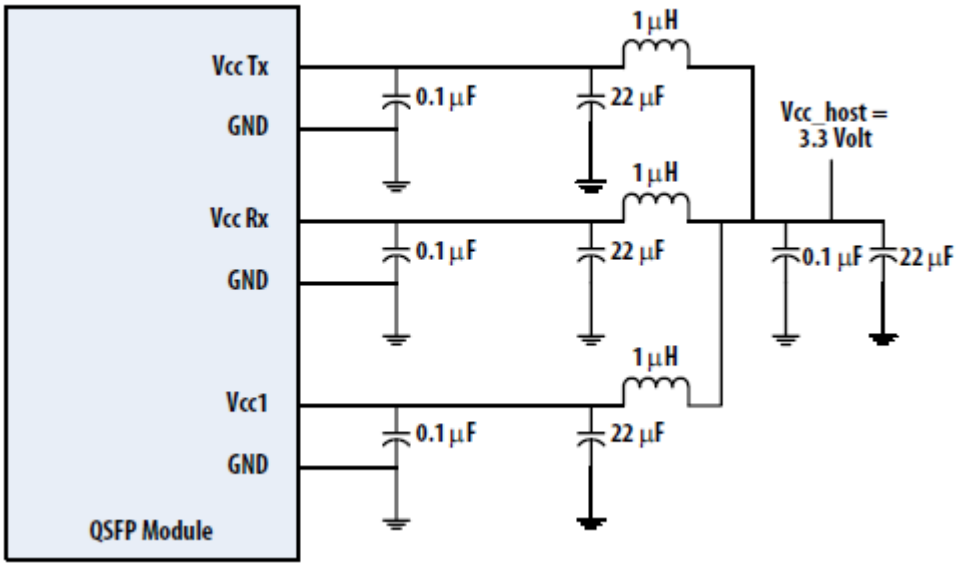
Pin	Logic	Symbol	Description	Plug Sequence	Notes
1		GND	Ground	1	1
2	CML-I	Tx2n	Transmitter Inverted Data Input	3	
3	CML-I	Tx2p	Transmitter Non-Inverted Data Input	3	
4		GND	Ground	1	1
5	CML-I	Tx4n	Transmitter Inverted Data Input	3	
6	CML-I	Tx4p	Transmitter Non-Inverted Data Input	3	
7		GND	Ground	1	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	LVCMOS-I/O	SCL	2-wire serial interface clock	3	
12	LVCMOS-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

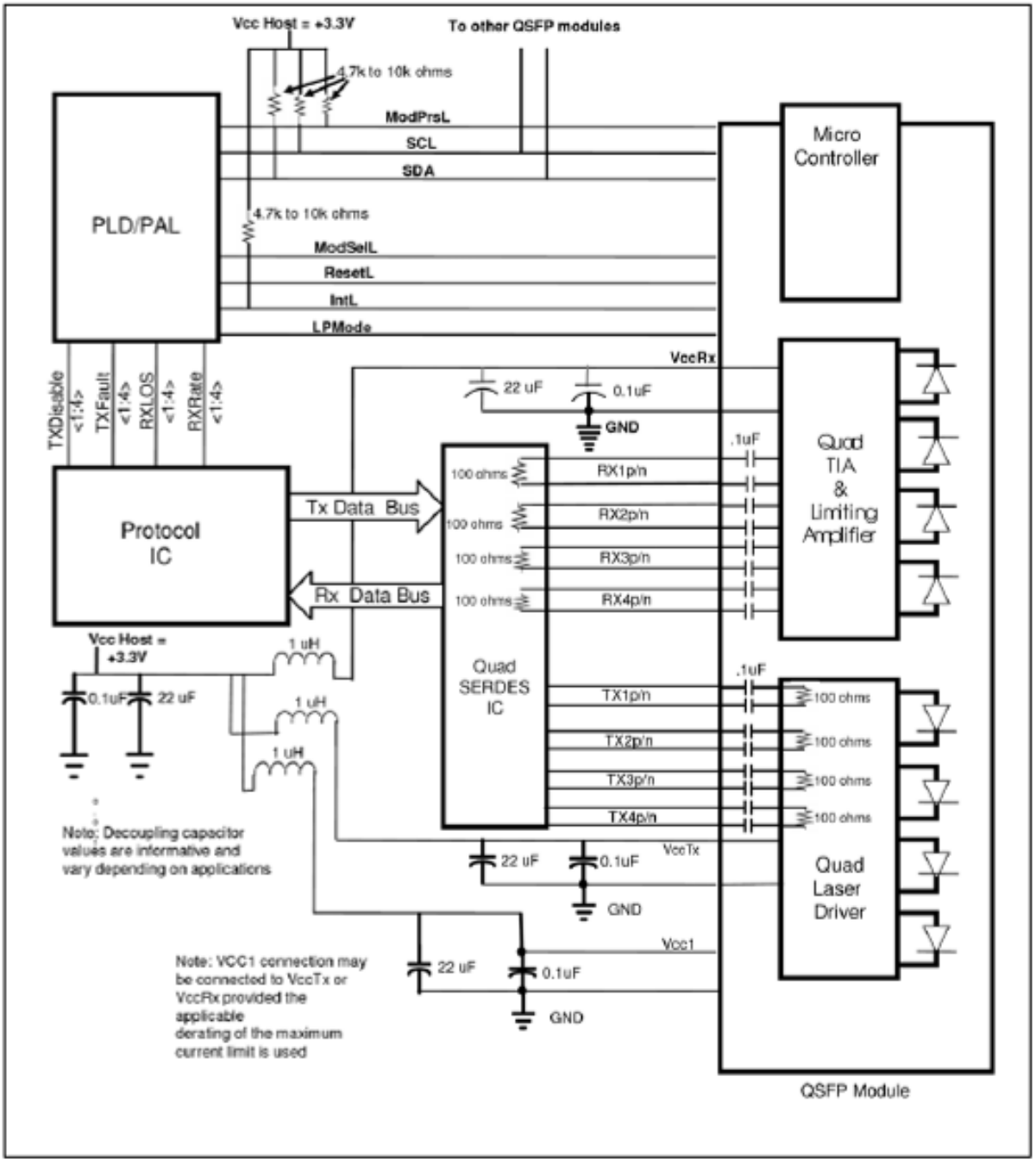
Note:

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.

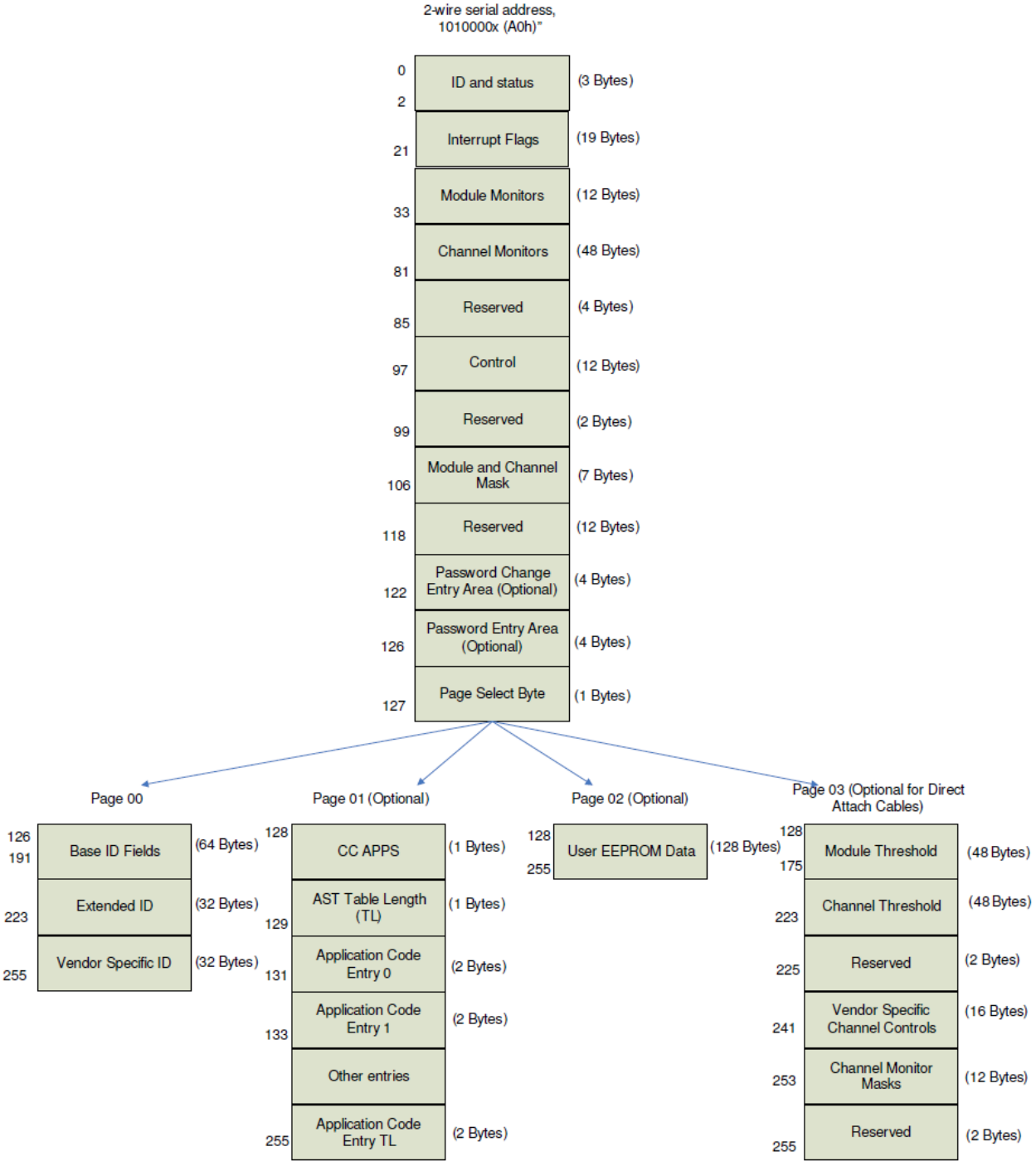
Recommended Host Board Power Supply Circuit



Recommended Interface Circuit



Memory Map


2-wire serial address, 1010000x (A0h)"
0
ID and status
(3 Bytes)
2
Interrupt Flags
(19 Bytes)
21
Module Monitors
(12 Bytes)
33
Channel Monitors
(48 Bytes)
81
Reserved
(4 Bytes)
85
Control
(12 Bytes)
97
Reserved
(2 Bytes)
99
Module and Channel Mask
(7 Bytes)
106
Reserved
(12 Bytes)
118
Password Change Entry Area (Optional)
(4 Bytes)
122
Password Entry Area (Optional)
(4 Bytes)
126
Page Select Byte
(1 Bytes)
127
Page 00
126
Base ID Fields
(64 Bytes)
191
Extended ID
(32 Bytes)
223
Vendor Specific ID
(32 Bytes)
255
Page 01 (Optional)
128
CC APPS
(1 Bytes)
AST Table Length (TL)
(1 Bytes)
129
Application Code Entry 0
(2 Bytes)
131
Application Code Entry 1
(2 Bytes)
133
Other entries
Application Code Entry TL
(2 Bytes)
255
Page 02 (Optional)
128
User EEPROM Data
(128 Bytes)
255
Page 03 (Optional for Direct Attach Cables)
128
Module Threshold
(48 Bytes)
175
Channel Threshold
(48 Bytes)
223
Reserved
(2 Bytes)
225
Vendor Specific Channel Controls
(16 Bytes)
241
Channel Monitor Masks
(12 Bytes)
253
Reserved
(2 Bytes)
255

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Address	Description	Hex	Real Value
128	Identifier	0D	QSFP+
129	Ext. Identifier	00	Power Class 1 Module; No CLEI code present in Page 02h; No CDR in TX and RX
130	Connector	0C	MPO
131	Specification 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	64B66B
140	BR, nominal	64	10.3Gbps
141	Extended rate select 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 control; Uncooled transmitter device; Pin detector; Transmitter not tunable
148-163	Vendor name	46,4F,52,4D,45,52,49,43, 41,4F,45,20,20,20,20,20	FORMERICAOE
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, 39,2D,50,43,41,20,20,20	TQS-Q1LH9-PCA
184-185	Vendor rev	20, 20	
186-187	Wave length or Copper cable Attenuation	42, 68	850nm
188-189	Wavelength tolerance	07, D0	±10nm
190	Max case temp.	46	70℃
191	CC_BASE		Check sum of byte 128 ~ 190
192-195	Options	00, 00, 00, 12	Tx Disable and Tx Loss of Signal are implemented
196-211	Vendor SN		
212-219	Date Code		
220	Diagnostic Monitoring Type	08	Average Power
221	Enhanced Options	00	
222	Reserved	00	
223	CC_EXT		Check sum of byte 192 ~ 222
224-255	Vendor Specific		

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Address	Description	Hex	Real Value
128-129	Temp high alarm	50,00	80℃
130-131	Temp low alarm	FB,00	-5℃
132-133	Temp high warning	4B,00	75℃
134-135	Temp low warning	00,00	0℃
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

