



HydraX SM Silicon Optical Transceiver Module MPO-12/APC OSFP PAM4 400G DR4 1310nm 500m



The module has 4 independent electrical input/output channels operating up to 106.25Gbps per channel.

Each operating on a set of wavelengths on the ITU G.694.2 CWDM at 1310nm

Up to 500m over SMF with KP4 FEC

MPO-12 connector with APC end face

Hot Pluggable

Power consumption < 9W

PIN and TIA array on the receiver side

Safety Certification: TUV/UL/FDA*1

Design Reference

IEEE 802.3ck

IEEE 802.3cu

OSFP MSA

Application

4x100G Ethernet

400G Ethernet

InfiniBand

Working Condition

Operation Temperature

-0°C ~ +70°C (Case)

Storage Temperature

-40°C ~ +85°C (Ambient)

Relative humidity

5% ~ 95%

Compliance

CE Mark

FCC Mark

Safety and EMI

Protection of over
voltage/current

General Description

The Hermesys HydraX™ series OSFP-21400005DR4H5-FT-SI 400G DR4 OSFP transceiver module is designed for use in 400 Gigabit Ethernet links over 500m single mode fiber. The module has 4 independent electrical input/output channels operating up to 106.25Gbps per channel. This transceiver consists of a transmitter/receiver unit, with each operating on a set of wavelengths on the ITU G.694.2 CWDM at 1310nm. The transmitter path of the module incorporates a bi-directional PAM4 re-timer ASIC integrated with EML laser and 4-channel internal driver. On the receiver path, used 4 photodiodes and a 4-channel TIA array, along with the PAM4 re-timer.

Maximum Ratings

Parameter	Symbol	Min	Typ	Max	Unit	Ref.
Supply Voltage	V _{CC}	-0.5	3.3	3.6	V	
Data Input Voltage - Single Ended		-0.5		V _{CC} +0.5	V	
Data Input Voltage - Differential*4				0.8	V	



Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Unit
Power Supply Voltage	V _{CC}	3.135	3.3	3.465	V
Power supply voltage	V _{CC}	3.135	3.3	3.465	V
Power dissipation	PD			9	W
Electrical Signal Rate per Channel (PAM encoded) *7	BRAVE		53.125		Gbd
Optical Signal Rate per Channel (PAM encoded) *8	BRLANE		53.125		Gbd
Power Supply Noise *9	TD			66	mVpp
Receiver Differential Data Output Load		100			Ohm
Fiber Length (9um SMF) *10				500	m

Power Supply specifications, Instantaneous, sustained and steady state current compliant with OSFP MSA Power Classification.

The position of case temperature measurement is shown in Figure 9.

400GAUI-4 operation with Host generated FEC. The transmitter must receive pre-coded FEC signals from the host ASIC.

4x100G DR1 operation with Host generated FEC. The transmitter must receive pre-coded FEC signals from the host ASIC.

Power Supply Noise is defined as the peak-to-peak noise amplitude over the frequency range at the host supply side of the recommended power supply filter with the module and recommended filter in place. Voltage levels including peak-to-peak noise are limited to the recommended operating range of the associated power supply. See Figure 7 for recommended power supply filter.

9um SMF. The maximum link distance is based on an allocation of 3dB of attenuation and 3dB total connection and splice loss. The loss of a single connection shall not exceed 0.5dB.

General Electrical Characteristics

Unless otherwise stated, the following characteristics are defined under recommended operating conditions.

Parameter	Symbol	Min.	Typ	Max.	Unit
Transceiver Power Consumption				9	W
Transceiver Power Supply Current, Total				2870	mA
AC coupling capacitors (Internal)			0.1		uF

For control signal timing including LPWn/PRSn, INT/RSTn, SCL and SDA see Control Interface Section.

Reference Points

Parameter	Description
TP0 to TP5	The channel including the transmitter and receiver differential controlled impedance printed circuit board insertion loss and the cable assembly insertion loss
TP1 to TP4	All cable assembly measurements are made between TP1 and TP4 as illustrated in Figure 1
TP0 to TP2 TP3 to TP5	A mated connector pair has been included in both the transmitter and receiver specifications defined in 802.3ck 162.9.3 and 162.9.4. The recommended maximum insertion loss from TP0 to TP2 or from TP3 to TP5 including the test fixture is provided in 802.3ck 162.9.3.
TP2	Unless specified otherwise, all transmitter measurements defined in 802.3ck 162.9.3 are made at TP2 utilizing the test fixture specified in Annex 162B.
TP3	Unless specified otherwise, all receiver measurements and tests defined in 802.3ck 162.9.4 are made at TP3 utilizing the test fixture specified in Annex 162B.

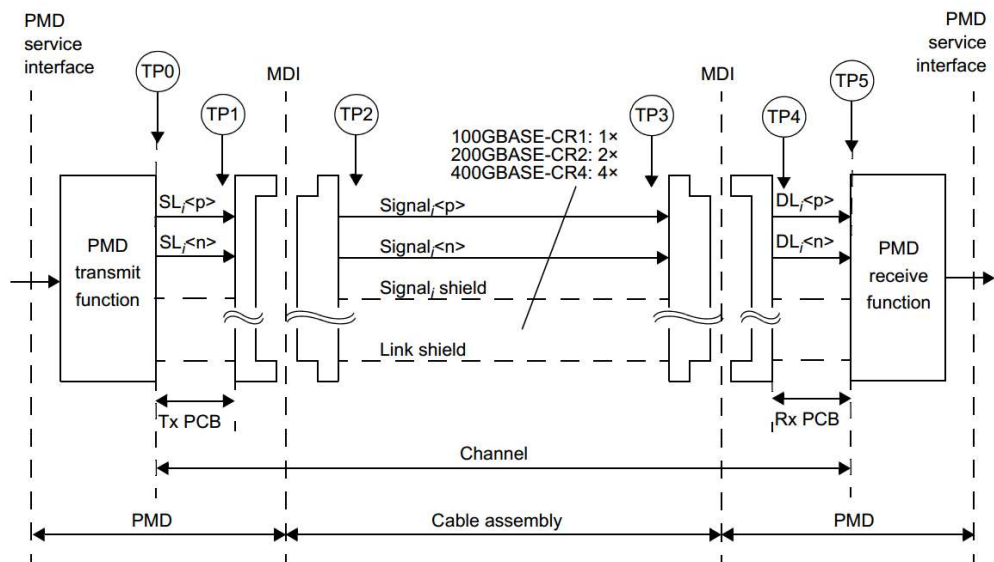
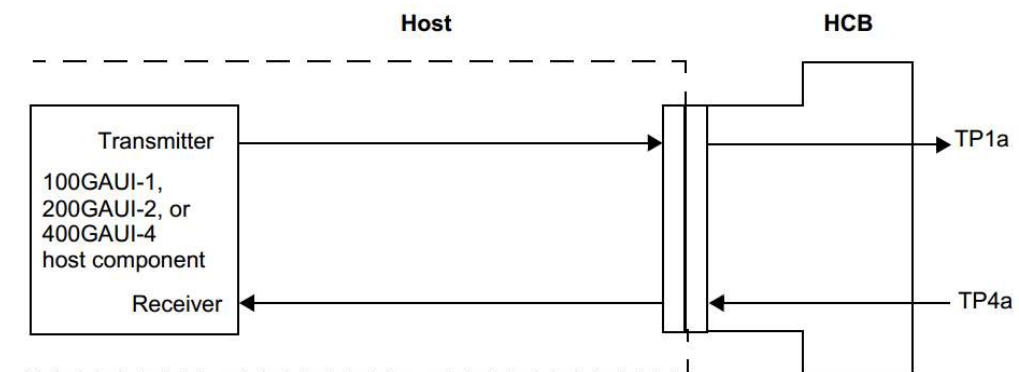
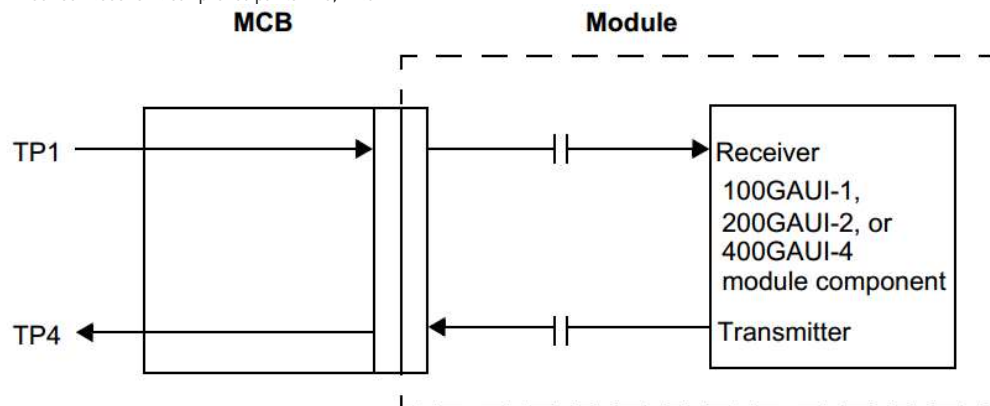


Figure 1: IEEE 802.3ck 100GBASE-CR1, 200GBASE-CR2 or 400GBASE-CR4 link



IEEE 802.3ck 400GAUI-4 compliance points TP1a, TP4a



IEEE 802.3ck 400GAUI-4 compliance points TP1, TP4



High Speed Electrical Input Characteristics

The following characteristics are defined over the Recommended Operating Conditions unless otherwise noted.

Parameter	Test Point	Min.	Typical	Max.	Unit	Conditions
Signaling Rate, Per Lane(PAM4 encoded)	TP1		53.125		GBd	+/- 100 ppm
Differential peak-peak Input Voltage Tolerance	TP1a	750			mV	
AC common-mode RMS voltage tolerance	TP1a	25			mV	
Differential-mode to common-mode return loss	TP1	Equation(120G-2)			dB	802.3ck
Effective return loss, ERL	TP1	8.5			dB	
Differential termination mismatch	TP1			10	%	
Module stressed input tolerance	TP1a		See120G.3.4.3			802.3ck
Single-ended voltage tolerance range	TP1a	-0.4		3.3	V	
DC common-mode voltage tolerance range	TP1	-350		2850	mV	
Module stressed input tolerance test :						
Pattern generator transition time			9		PS	
Applied peak-peak sinusoidal jitter			Table162-16			802.3ck
Eye height			10		mV	
Vertical eye closure, VEC		12		12.5	dB	
Crosstalk differential peak-to-peak voltage			845		mV	
Crosstalk transition time			8.5		PS	

High Speed Electrical Output Characteristics

The following characteristics are defined over the Recommended Operating Conditions unless otherwise noted.

Parameter	Test Point	Min.	Typical	Max.	Unit
Signaling Rate, Per Lane (range)	TP4		53.125*12 ± 100 ppm		GBd
AC common-mode output voltage	TP4			25	mV
Differential peak-to-peak input voltage Short mode Long mode	TP4			600 845	mV
Eye height	TP4	15			mV
Vertical eye closure	TP4			12	dB
Effective return loss	TP4	8.5			dB
Common-mode to differential-mode return loss	TP4	Equation(120G-1)			dB
Differential termination mismatch	TP4			10	%
Transition time	TP4	8.5			Ps
DC common-mode voltage tolerance	TP4	-0.35		2.85	V

The signaling rate range is derived from the PMD receiver input.



High Speed Optical Transmitter Characteristics

The following characteristics are defined over the Recommended Operating Conditions unless otherwise noted.

Optical Characteristics @TP2 Test Point

Parameter	Symbol	Min.	Typical	Max.	Unit
Signaling speed per lane			53.125± 100ppm		GBd
Modulation format			PAM4		
Center wavelength	λ	1304.5	1311	1317.5	nm
Side-mode Suppression Ratio	SMSR	30			dB
Extinction ratio	ER	3.5		12	dB
Average launch power*13		-2.9		4	dBm
OMAouter per lane		-0.8		4.2	dBm
Launch Power in OMAouter-TDECQ		-2.2			dBm
TDECQ (PAM4)				3.4	dB
RIN21.4 OMA				-136	dB/Hz
Average launch power of OFF transmitter				-15	dBm
Optical return loss tolerance				21.4	dB
Transmitter Reflectance				-26	dB

Average launch power, each lane (min) is informative and not the principal indicator of signal strength. A transmitter with launch power below this value cannot be compliant; however, a value above this does not ensure compliance.

High Speed Optical Receiver Characteristics

The following characteristics are defined over the Recommended Operating Conditions unless otherwise noted.

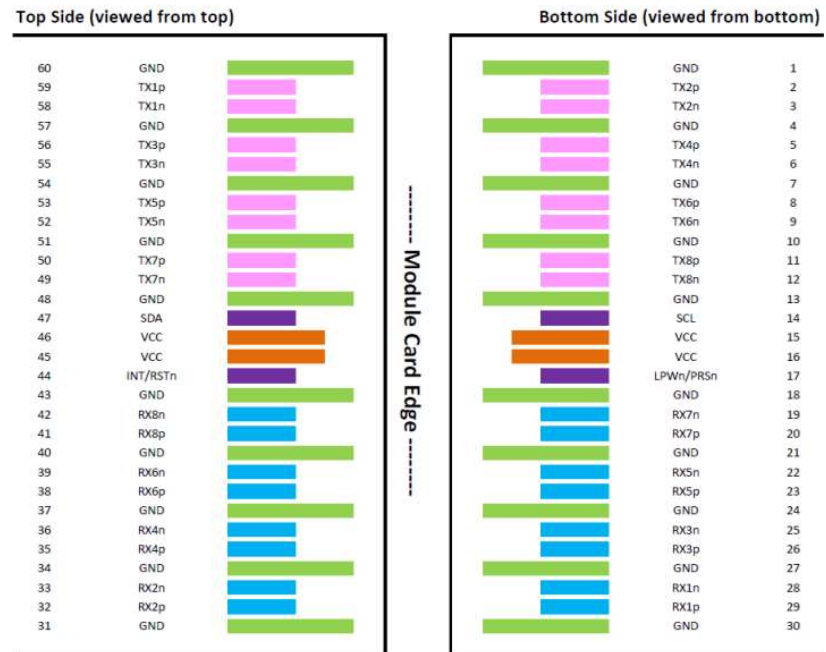
Optical Characteristics @TP3 Test Point

Parameter	Symbol	Min.	Typical	Max.	Unit
Signaling speed per lane			53.125± 100ppm		GBd
Center wavelength	λ	1304.5	1311	1317.5	nm
Damage threshold		5			dBm
Average receiver power per lane		-5.9		4	dBm
Saturation receive power (OMAouter) per Lane				4.2	dBm
Unstressed receiver sensitivity (OMAouter) per Lane	Sen*14			-4.4	dBm
LOS Assert (Avg.)	LOSA	-15			dBm
LOS De-Assert (Avg.)	LOSD			-10	dBm
RSSI accuracy		-2		+2	dB
Receiver reflectance				-26	dB

Receiver sensitivity (OMAouter), each lane (max) is informative and is defined for a transmitter with TDECQ of 0.9 dB.

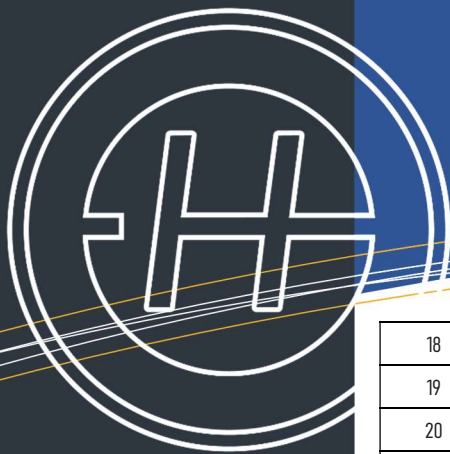


OSFP Transceiver Electrical Pad Layout



Pin Arrangement and Definition

PIN	Logic	Symbol	Description	Plug Seq.	Notes
1		GND	Ground	1	1
2	CML-I	Tx2p	Transmitter Data Non-Inverted	3	
3	CML-I	Tx2n	Transmitter Data Inverted	3	
4		GND	Ground	1	1
5	CML-I	Tx4p	Transmitter Data Non-Inverted	3	
6	CML-I	Tx4n	Transmitter Data Inverted	3	
7		GND	Ground	1	1
8	CML-I	Tx6p	Transmitter Data Non-Inverted	3	
9	CML-I	Tx6n	Transmitter Data Inverted	3	
10		GND	Ground	1	1
11	CML-I	Tx8p	Transmitter Data Non-Inverted	3	
12	CML-I	Tx8n	Transmitter Data Inverted	3	
13		GND	Ground	1	1
14	LVC MOS-I/O	SCL	2-wire Serial interface clock	3	2
15		VCC	+3.3V Power	2	
16		VCC	+3.3V Power	2	
17	Multi-Level	LPWn/PRSn	Low-Power Mode/Module Present	3	



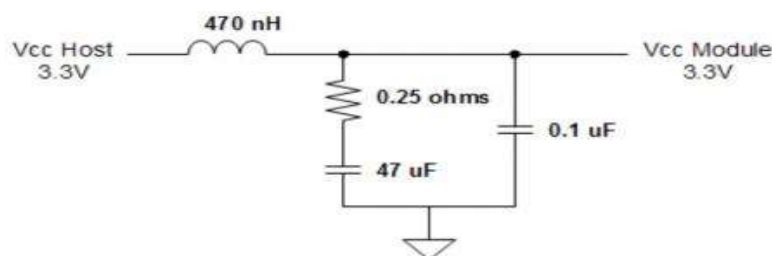
18	GND		Ground	1	1
19	CML-O	Rx7n	Receiver Data Inverted	3	
20	CML-O	Rx7p	Receiver Data Non-Inverted	3	
21		GND	Ground	1	1
22	CML-O	Rx5n	Receiver Data Inverted	3	
23	CML-O	Rx5p	Receiver Data Non-Inverted	3	
24		GND	Ground	1	1
25	CML-O	Rx3n	Receiver Data Inverted	3	
26	CML-O	Rx3p	Receiver Data Non-Inverted	3	
27		GND	Ground	1	1
28	CML-O	Rx1n	Receiver Data Inverted	3	
29	CML-O	Rx1p	Receiver Data Non-Inverted	3	
30		GND	Ground	1	1
31		GND	Ground	1	1
32	CML-O	Rx2p	Receiver Data Non-Inverted	3	
33	CML-O	Rx2n	Receiver Data Inverted	3	
34		GND	Ground	1	1
35	CML-O	Rx4p	Receiver Data Non-Inverted	3	
36	CML-O	Rx4n	Receiver Data Inverted	3	
37		GND	Ground	1	1
38	CML-O	Rx6p	Receiver Data Non-Inverted	3	
39	CML-O	Rx6n	Receiver Data Inverted	3	
40		GND	Ground	1	1
41	CML-O	Rx8p	Receiver Data Non-Inverted	3	
42	CML-O	Rx8n	Receiver Data Inverted	3	
43		GND	Ground	1	1
44	Multi-Level	INT/RSTn	Module input/Module Reset	3	
45		VCC	+3.3V Power	2	
46		VCC	+3.3V Power	2	
47	LVC MOS-I/O	SCL	2-wire Serial interface Data	3	2
48		GND	Ground	1	1
49	CML-I	Tx7n	Transmitter Data Inverted	3	
50	CML-I	Tx7p	Transmitter Data Non-Inverted	3	
51		GND	Ground	1	1
52	CML-I	Tx5n	Transmitter Data Inverted	3	
53	CML-I	Tx5p	Transmitter Data Non-Inverted	3	
54		GND	Ground	1	1
55	CML-I	Tx3n	Transmitter Data Inverted	3	



56	CML-I	Tx3p	Transmitter Data Non-Inverted	3	
57		GND	Ground	1	1
58	CML-I	Tx1n	Transmitter Data Inverted	3	
59	CML-I	Tx1p	Transmitter Data Non-Inverted	3	
60		GND	Ground	1	1

OSFP uses common ground (GND) for all signals and supply (power). All are common within the OSFP module and all module voltages are referenced to this potential unless otherwise noted.

Open-Drain with pull up resistor on Host.



Recommended Host Board Power Supply Filter

Note: For safety and protection of the host system, the power to each OSFP module may be protected by an electronic circuit breaker on the host board which is enabled with the H_PRSn signal such that power is only enabled when the module is fully engaged into the OSFP connector.

Regulatory Compliance Issues

Various standard and regulations apply to the EOLO-134HG-5H-DR modules. These include eye-safety, Component Recognition, RoHS, ESD, EMC and Immunity. Please note the transmitter module is a Class 1 laser product. See Regulatory Compliance Table for details.

Electrostatic Discharge (ESD)

The EOLO-134HG-5H-DR is complies with the ESD requirements described in the Regulatory Compliance Table. However, in the normal processing and operation of optical transceiver, the following two types of situations need special attention.

Case I: Before inserting the transceiver into the rack meeting the requirements of OSFP compliant cage, ESD preventive measures must be taken to protect the equipment. For example, the grounding wrist strap, workbench and floor should be used wherever the transceiver is handled.

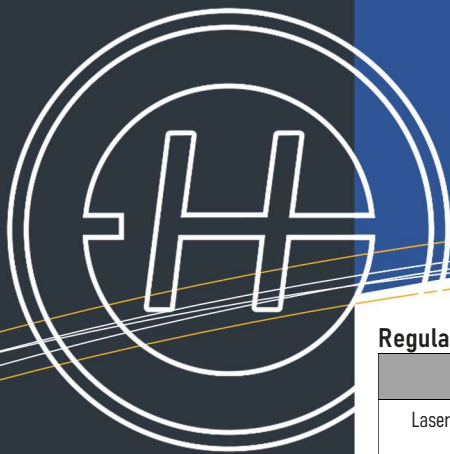
Case II: After the transceiver is installed, the electrostatic discharge outside the chassis of the host equipment shall be within the scope of system level ESD requirements. If the optical interface of the transceiver is exposed outside the host equipment cabinet, the transceiver may be subject to equipment system level ESD requirements.

Electromagnetic Interference (EMI)

Communication equipment with optical transceivers is usually regulated by FCC in the United States and CENELEC EN55032 (CISPR 32) in Europe. The compliance of EOLO-134HG-5H-DR with these standards is detailed in the regulatory compliance table. The metal shell and shielding design of EOLO-134HG-5H-DR will help equipment designers minimize the equipment level EMI challenges they face.

Flammability

EOLO-134HG-5H-DR optical transceiver meets UL certification requirements, its constituent materials have heat and corrosion resistance, and the plastic parts meet UL94V-0 requirements.

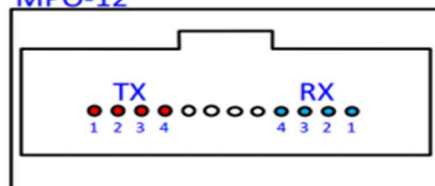


Regulatory Compliance Table

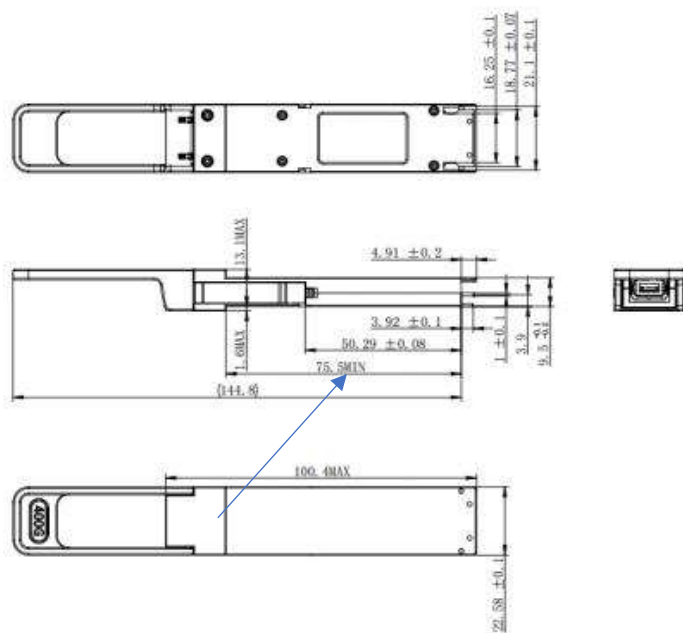
Feature	Test Method	Performance
Laser Eye Safety and Equipment Type Testing 	IEC EN 62368-1:2014+A11 (IEC) EN 60825-1:2014 (IEC) EN 60825-2:2004+A1+A2	CDRH Accession Number:2132182-000 TUV File: R 50457725 0001 CB File: JPTUV-100513
Component Recognition	Underwriters Laboratories (UL) and Canadian Standards Association (CSA) Joint Component Recognition for Information Technology Equipment including Electrical Business Equipment	UL File: E317337
RoHS Compliance	RoHS Directive 2011/65/EU&(EU)2015/863	Less than 100 ppm of cadmium. Less than 1000 ppm lead, mercury, hexavalent chromium, poly brominated biphenyls (PPB) , poly brominated biphenyl ethers (PBDE), dibutyl phthalate, butyl benzyl phthalate, bis (2-ethylhexyl) phthalate and diisobutyl phthalates.
Electrostatic Discharge (ESD) to the Electrical Contacts	JEDEC Human Body Model (HBM)	High speed contacts shall withstand 1000V. All other contacts shall withstand 2000 V
Electrostatic Discharge (ESD) to the Optical Connector Receptacle	IEC 61000-4-2:2008	When installed in a properly grounded housing and chassis the units are subjected to 15kV air discharges during operation and 8kV direct discharges to the case.
Electromagnetic Interference (EMI)	FCC Part 15 Class B; CISPR 32 (EN55032) 2015;	System margins are dependent on customer board and chassis design.
Immunity	IEC 61000-4-3:2010; EN55035:2017	Typically shows no measurable effect from a 10V/m field swept from 80 MHz to 6 GHz applied to the module without a chassis enclosure.

Dimension of Case

MPO-12



Module Optical Interface (looking into the optical port)



Mechanical Package Outline Unit:mm

Order Information

Part Number	Grade	Packing info
OSFP-21400005DR4X5-FT-SI	Commercial - 0~70 °C	400 pcs per carton (10pcs per tray, 10 tray per inner box, 4 inner box per carton)

Note:

X means compatible equipment code.