

Waveform Technology Product Specification

of

10 Gbps SFP+ DWDM ER 40 km Optical Transceiver

1. General Description

The Waveform's SFP+ DWDM ER is a very compact 10 Gbps optical transceiver module for serial optical communication applications at 10 Gbps. The module converts a 10Gbps serial electrical data stream to 10Gbps optical output signal and a 10 Gbps optical input signal to 10 Gbps serial electrical data streams. The high speed 10 Gbps electrical interface is fully compliant with SFI specification. The high performance DWDM EML transmitter and high sensitivity PIN receiver provide superior performance for Ethernet applications at up to 40km links.

The SFP+ Module is compliant with SFF-8431, SFF-8432 and IEEE 802.3ae 10GBASE-ER. Digital diagnostics functions are available via a 2-wire serial interface, as specified in SFF-8472.

2. Features

- Supports 9.95 to 11.3 Gbps bit rates
- Hot-Pluggable
- SFP MSA package with Duplex SMF LC connector
- Center Wavelength 1550nm
- 100GHz ITU Grid, C Band
- DWDM EML transmitter, PIN photo-detector
- SMF links up to 40km
- 2-wire interface for management specifications compliant with SFF 8472 digital diagnostic monitoring interface
- Power Supply :+3.3V
- Power consumption<1.8W
- Temperature Range: 0~ 70°C
- RoHS compliant

3. Applications

- 10GBASE-ER/EW Ethernet
- SONET OC-192/SDH
- 10G Fibre channel
- DWDM Networks

4. Absolute Ratings

Absolute Maximum Ratings					
Parameter	Symbol	Min.	Max.	Unit	Note
Supply Voltage	Vcc	-0.5	4.0	V	
Storage Temperature		-40	85	°C	
Relative Humidity			85	%	

Note: Stress in excess of the maximum absolute ratings can cause permanent damage to the module.

5. Specification

Recommended Operating Conditions						
Parameter	Symbol	Min.	Typical	Max.	Unit	Note
Data Rate	Ethernet		10.3125		Gbps	
	SDH / Sonet		9.953			
Supply Voltage	Vcc	3.13	3.3	3.47	V	
Supply Current	Icc			500	mA	
Operating Case Temp.	Tc	0		70	°C	

Optical Characteristics						
Transmitter						
Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Operating Wavelength	λ_c	$\lambda_c - 0.1$		$\lambda_c + 0.1$	nm	
Ave. output power (Enabled)	Po	-1		+4	dBm	1
Laser Off Power	Poff			-30	dBm	
Extinction Ratio	ER	8.2			dB	1
Relative Intensity Noise	Rin			-128	dB/Hz	3
Dispersion penalty				3	dB	
Optical Return Loss		20			dB	
Optical Characteristics						
Receiver						
Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Operating Wavelength	λ	1480		1580	nm	

Sensitivity	P _{sen}			-16	dBm	2
Stressed Sensitivity OMA	Sen _{ST}			-14.5	dBm	4
Min. overload	P _{imax}	0			dBm	5
LOS Assert	Pa	-27			dBm	
LOS De-assert	Pd			-17	dBm	
LOS Hysteresis	Pd-Pa	0.5			dB	
Receiver Reflectance	R _{rx}			-12	dB	

Note:

1. Average power figures are informative only, per IEEE802.3ae.
2. TWDP figure requires the host board to be SFF-8431 compliant. TWDP is calculated using the Matlab code provided in clause 68.6.6.2 of IEEE802.3ae.
3. 12dB reflection.
4. Conditions of stressed receiver tests per IEEE802.3ae. CSRS testing requires the host board to be SFF-8431 compliant.
5. Receiver overload specified in OMA and under the worst comprehensive stressed condition.

Electrical Input / Output Characteristics						
Transmitter						
Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Input differential impedance	R _{in}		100		Ω	1
Diff. input voltage swing		120		700	mVpp	2
Tx Disable input	H	V _{IH}	2.0	V _{cc} +0.3	V	3
	L	V _{IL}	V _{ee}	V _{ee} +0.8		
Tx Fault output	H	V _{OH}	2.0	V _{cc} +0.3	V	2
	L	V _{OL}	V _{ee}	V _{ee} +0.8		
Electrical Input / Output Characteristics						
Receiver						
Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Single Ended Output Voltage Tolerance	V	-0.3		4	V	
Diff. output voltage swing		300		850	mVpp	
Rx Output Rise and Fall Time	Tr/Tf	30			ps	4
LOS Fault	V _{LOS fault}	2		V _{CCHOST}	V	5
LOS Normal	V _{LOS norm}	V _{ee}		V _{ee} +0.8	V	5

Note:

1. Connected directly to TX data input pins. AC coupling from pins into laser driver IC.
2. Per SFF-8431 Rev 3.0

3. Into 100 ohms differential termination.
4. 20%~80%
5. LOS is an open collector output. Should be pulled up with 4.7k – 10kΩ on the host board.
Normal operation is logic 0; loss of signal is logic 1. Maximum pull-up voltage is 5.5V.

Timing Characteristics

Parameter	Symbol	Min.	Typical	Max.	Unit
TX_Disable Assert Time	t_off			10	us
TX_Disable Negate Time	t_on			1	ms
Time to Initialize Include Reset of TX_FAULT	t_int			300	ms
TX_FAULT from Fault to Assertion	t_fault			100	us
TX_Disable Time to Start Reset	t_reset	10			us
Receiver Loss of Signal Assert Time	T _A ,RX_LOS			100	us
Receiver Loss of Signal Deassert Time	T _d ,RX_LOS			100	us
Rate-Select Chage Time	t_ratesel			10	us
Serial ID Clock Time	t_serial-clock			100	kHz

Serial Interface for ID and DDM

The SFP modules implement the 2-wire serial communication protocol as defined in the SFP MSA. The serial ID information of the SFP modules and Digital Diagnostic Monitor parameters can be accessed through the I2C interface at address A0h and A2h. The memory is mapped in Table 1. Detailed ID information(A0h) is listed in Table 2. And the DDM specification (A2h) is described in Table 3. For more details of the memory map and byte definitions, please refer to the SFF-8472 (Rev 9.3, Aug. 2002), “Digital Diagnostic Monitoring Interface for Optical Transceivers”. **The DDM parameters have been internally calibrated.**

Table 1. Digital Diagnostic Memory Map (Specific Data Field Descriptions)

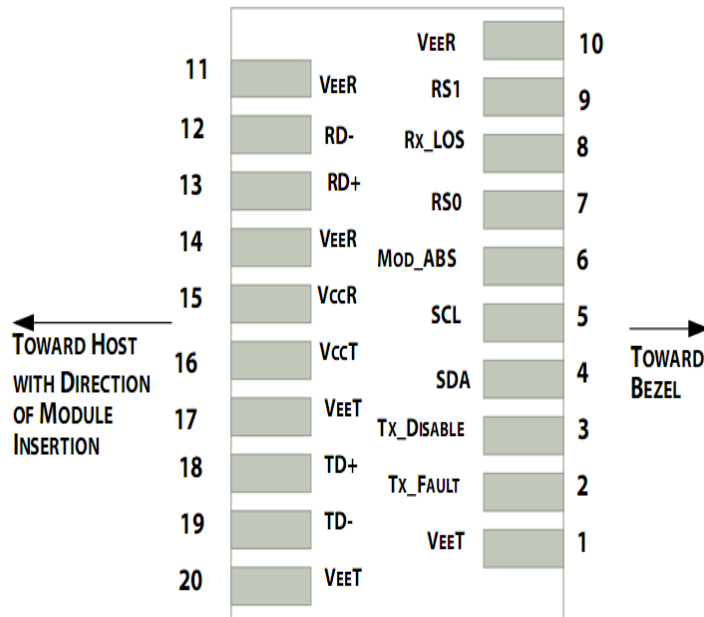
2 wire address 1010000X (A0h)		2 wire address 1010001X (A2h)	
Address	Information	Address	Information
0~95	Serial ID Defined by SFP MSA (96 bytes)	0~55	Alarm and Warning Thresholds (56 bytes)
		56~95	Calibration Constants (40 bytes)
96~127	Vendor Specific (32 bytes)	96~119	Real Time Diagnostic Interface (24 bytes)
		120~127	Vender Specific (8 bytes)
128~255	Reserved,SFF8079 (128 bytes)	128~247	User Writable EEPROM (120 bytes)
		248~255	Vender Specific (8 bytes)

6. PIN Assignment

Pin	Symbol	Name/Description	Note
1	VEET	Transmitter Ground (Common with Receiver Ground)	1
2	TFAULT	Transmitter Fault.	2
3	TDIS	Transmitter Disable. Laser output disabled on high or open.	3
4	SDA	2-wire Serial Interface Data Line	4
5	SCL	2-wire Serial Interface Clock Line	4
6	MOD_ABS	Module Absent. Grounded within the module	4
7	RS0	Rate Select 0	5
8	LOS	Loss of Signal indication. Logic 0 indicates normal operation.	6
9	RS1	No connection required	1
10	VEER	Receiver Ground (Common with Transmitter Ground)	1
11	VEER	Receiver Ground (Common with Transmitter Ground)	1
12	RD-	Receiver Inverted DATA out. AC Coupled	
13	RD+	Receiver Non-inverted DATA out. AC Coupled	
14	VEER	Receiver Ground (Common with Transmitter Ground)	1
15	VCCR	Receiver Power Supply	
16	VCCT	Transmitter Power Supply	
17	VEET	Transmitter Ground (Common with Receiver Ground)	1
18	TD+	Transmitter Non-Inverted DATA in. AC Coupled.	
19	TD-	Transmitter Inverted DATA in. AC Coupled.	
20	VEET	Transmitter Ground (Common with Receiver Ground)	1

Notes:

1. Circuit ground is internally isolated from chassis ground.
2. TFAULT is an open collector/drain output, which should be pulled up with a 4.7kΩ– 10 kΩ resistor on the host board if intended for use. Pull up voltage should be between 2.0V to Vcc + 0.3V. A high output indicates a transmitter fault caused by either the TX bias current or the TX output power exceeding the preset alarm thresholds. A low output indicates normal operation. In the low state, the output is pulled to <0.8V.
3. Laser output disabled on TDIS >2.0V or open, enabled on TDIS <0.8V.
4. Should be pulled up with 4.7kΩ- 10kΩ on host board to a voltage between 2.0V and 3.6V. MOD_ABS pulls line low to indicate module is plugged in.
5. Internally pulled down per SFF-8431 Rev 4.1.
6. LOS is open collector output. It should be pulled up with 4.7kΩ – 10kΩ on host board to a voltage between 2.0V and 3.6V. Logic 0 indicates normal operation; logic 1 indicates loss of signal.



7. SFP Module EEPROM Information and Management

The SFP modules implement the 2-wire serial communication protocol as defined in the SFP -8472. The serial ID information of the SFP modules and Digital Diagnostic Monitor parameters can be accessed through the I²C interface at address A0h and A2h. The memory is mapped in Table 1. Detailed ID information (A0h) is listed in Table 2. And the DDM specification at address A2h. For more details of the memory map and byte definitions, please refer to the SFF-8472, “Digital Diagnostic Monitoring Interface for Optical Transceivers”. The DDM parameters have been internally calibrated.

Table 1. Digital Diagnostic Memory Map (Specific Data Field Descriptions)

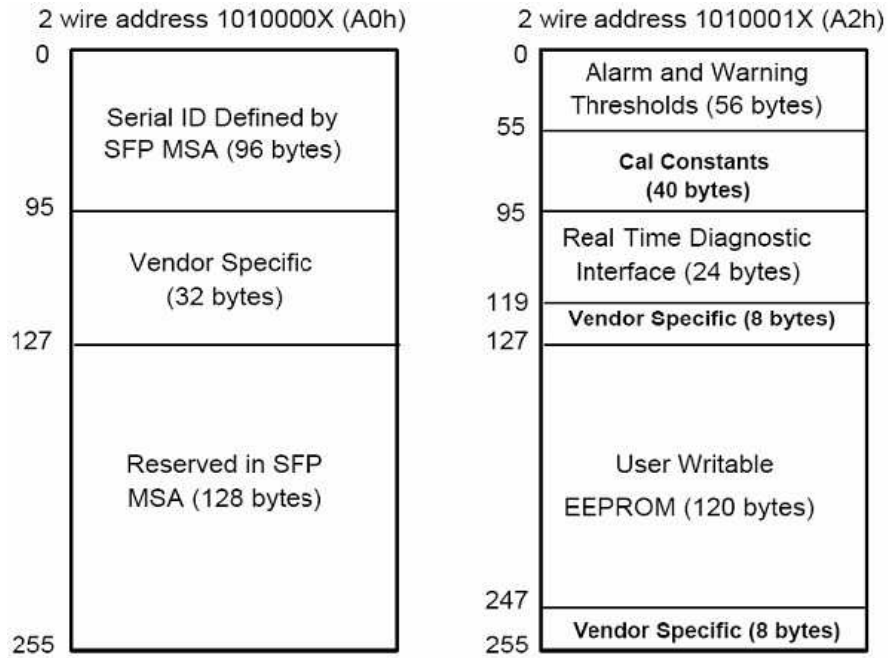


Table 2 - EEPROM Serial ID Memory Contents (A0h)

Data Address	Length (Byte)	Name of Length	Description and Contents
Base ID Fields			
0	1	Identifier	Type of Serial transceiver (03h=SFP)
1	1	Reserved	Extended identifier of type serial transceiver (04h)
2	1	Connector	Code of optical connector type (07=LC)
3-10	8	Transceiver	10G Base-ER
11	1	Encoding	64B/66B
12	1	BR, Nominal	Nominal baud rate, unit of 100Mbps
13-14	2	Reserved	(0000h)
15	1	Length(9um)	Link length supported for 9/125um fiber, units of 100m
16	1	Length(50um)	Link length supported for 50/125um fiber, units of 10m
17	1	Length(62.5um)	Link length supported for 62.5/125um fiber, units of 10m
18	1	Length(Copper)	Link length supported for copper, units of meters
19	1	Reserved	
20-35	16	Vendor Name	SFP vendor name

36	1	Reserved	
37-39	3	Vendor OUI	SFP transceiver vendor OUI ID
40-55	16	Vendor PN	Part Number (ASCII)
56-59	4	Vendor rev	Revision level for part number
60-62	3	Reserved	
63	1	CCID	Least significant byte of sum of data in address 0-62
Extended ID Fields			
64-65	2	Option	Indicates which optical SFP signals are implemented (001Ah = LOS, TX_FAULT, TX_DISABLE all supported)
66	1	BR, max	Upper bit rate margin, units of %
67	1	BR, min	Lower bit rate margin, units of %
68-83	16	Vendor SN	Serial number (ASCII)
84-91	8	Date code	Manufacturing date code
92-94	3	Reserved	
95	1	CCEX	Check code for the extended ID Fields (addresses 64 to 94)
Vendor Specific ID Fields			
96-127	32	Readable	specific date, read only
128-255	128	Reserved	Reserved for SFF-8079

Digital Diagnostic Monitor Characteristics

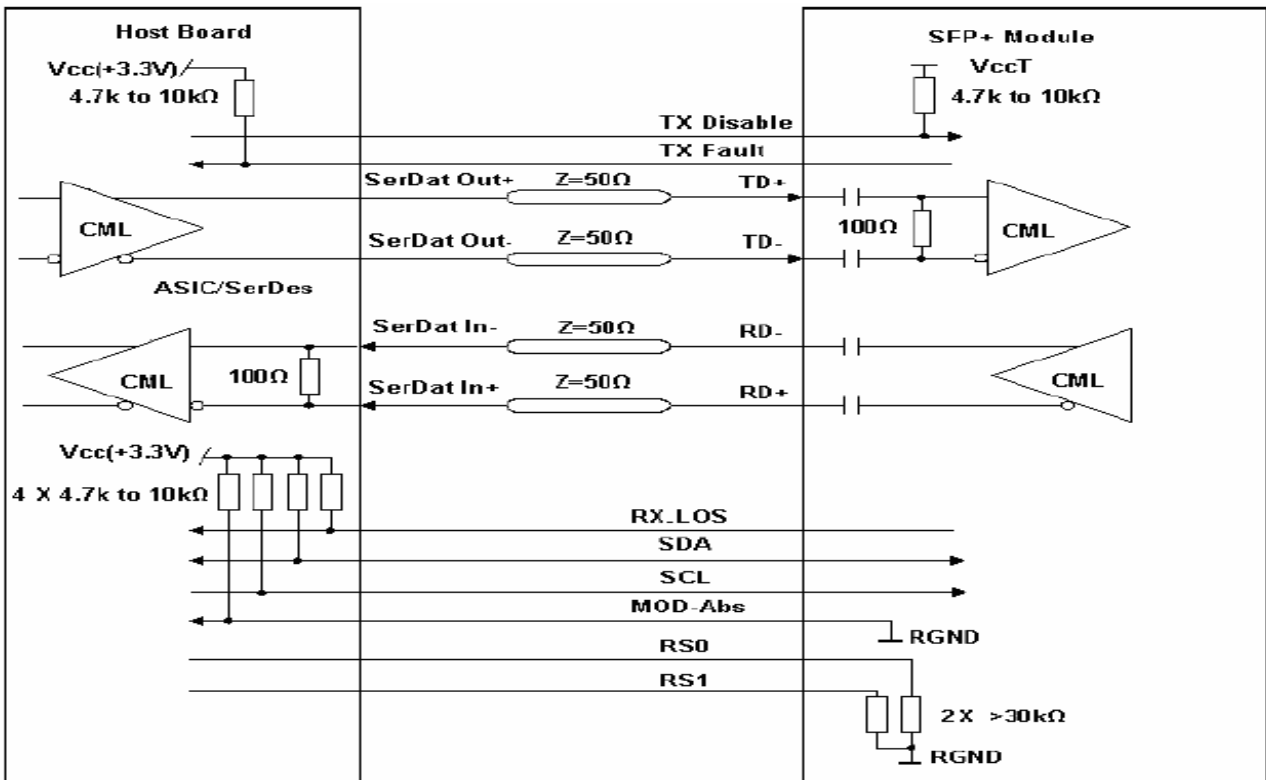
Data Address	Parameter	Accuracy	Unit
96-97	Transceiver Internal Temperature	±3.0	°C
98-99	VCC3 Internal Supply Voltage	±3.0	%
100-101	Laser Bias Current	±10	%
102-103	Tx Output Power	±3.0	dBm
104-105	Rx Input Power	±3.0	dBm

8. Regulatory Compliance

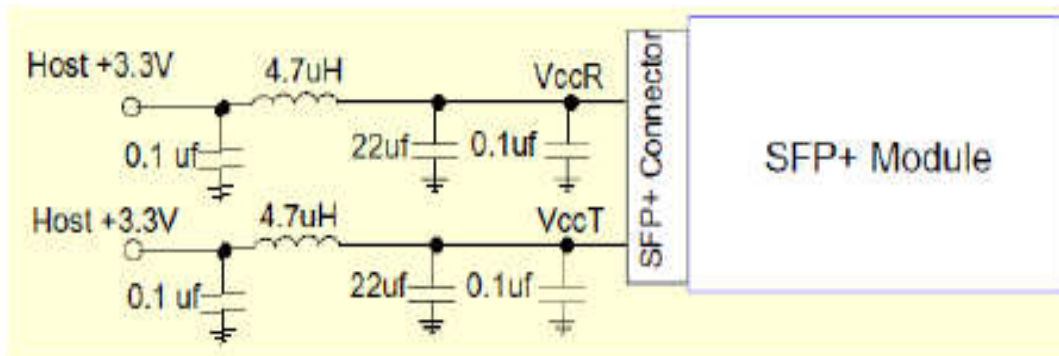
Complies with international Electromagnetic Compatibility (EMC) and international safety requirements and standards (see details in Table following).

Electrostatic Discharge (ESD) to the Electrical Pins	MIL-STD-883E Method 3015.7	Class 1(>1000 V)
Electrostatic Discharge (ESD) to the Duplex LC Receptacle	IEC 61000-4-2 GR-1089-CORE	Compatible with standards
Electromagnetic Interference (EMI)	FCC Part 15 Class B EN55022 Class B (CISPR 22B) VCCI Class B	Compatible with standards
Laser Eye Safety	FDA 21CFR 1040.10 and 1040.11 EN60950, EN (IEC) 60825-1,2	Compatible with Class 1 laser

9. Recommend Circuit



Recommended power supply filter



Note: Inductors with DC resistance of less than 1Ω should be used in order to maintain the required voltage at the SFP input pin with 3.3V supply voltage. When the recommended supply filtering network is used, hot plugging of the SFP transceiver module will result in an inrush current of no more than 30 mA greater than the steady state value

10. Ordering Information

2.8.5

10 Gbps DWDM SFP+ 40 Km DDM Internally Calibrated

P/N	Frequency (THz)	λ_c (nm)	ITU Channel	Temp. °C
F418M174 <u>917</u> -D	191.7	1563.86	C17	0 ~ 70
F418M174 <u>918</u> -D	191.8	1563.05	C18	0 ~ 70
F418M174 <u>919</u> -D	191.9	1562.23	C19	0 ~ 70
F418M174 <u>920</u> -D	192.0	1561.42	C20	0 ~ 70
F418M174 <u>921</u> -D	192.1	1560.61	C21	0 ~ 70
F418M174 <u>922</u> -D	192.2	1559.79	C22	0 ~ 70
F418M174 <u>923</u> -D	192.3	1558.98	C23	0 ~ 70
F418M174 <u>924</u> -D	192.4	1558.17	C24	0 ~ 70
F418M174 <u>925</u> -D	192.5	1557.36	C25	0 ~ 70
F418M174 <u>926</u> -D	192.6	1556.55	C26	0 ~ 70
F418M174 <u>927</u> -D	192.7	1555.75	C27	0 ~ 70
F418M174 <u>928</u> -D	192.8	1554.94	C28	0 ~ 70
F418M174 <u>929</u> -D	192.9	1554.13	C29	0 ~ 70
F418M174 <u>930</u> -D	193.0	1553.33	C30	0 ~ 70
F418M174 <u>931</u> -D	193.1	1552.52	C31	0 ~ 70
F418M174 <u>932</u> -D	193.2	1551.72	C32	0 ~ 70
F418M174 <u>933</u> -D	193.3	1550.92	C33	0 ~ 70
F418M174 <u>934</u> -D	193.4	1550.12	C34	0 ~ 70
F418M174 <u>935</u> -D	193.5	1549.32	C35	0 ~ 70
F418M174 <u>936</u> -D	193.6	1548.51	C36	0 ~ 70
F418M174 <u>937</u> -D	193.7	1547.72	C37	0 ~ 70

11. Cautions

Limited Warranty

Liverage Technology Inc. warrants the transceiver modules against defects in parts and workmanship for one full year after the delivery. This warranty shall be invalid by any abuse, misuse, misapplication or improper installation of the product.

Laser Safety

This laser based multimode transceiver is a Class 1 product. It complies with IEC 60825-1 Ed.2: 2007 and FDA performance standards for laser products (21 CFR 1040.10 and 1040.11) except for deviations pursuant to Laser Notice 50, dated June 24, 2007.

ESD

This transceiver is specified as ESD threshold 1kV for SFI pin and 2kV for all others electrical input pins, tested per MIL-STD-883, Method 3015.4 /JESD22-A114-A (HBM). However, normal ESD precautions are still required during the handling of this module. This transceiver is shipped in ESD protective packaging. It should be removed from the packaging and handled only in an ESD protected environment.

When the ambient is reaching 85C max as declared, the internal case is hot surface please don't touch.



12. Service Contact

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13. Record of Revisions

Record of Revisions		
Rev.	Date	Description of Change
VER R1A	2016.03.30	Original Specification issued.