



4.25G SFP transceiver module with DDM function

RTXM178-6xx

Features

- *Up to 4.25Gbps data rate*
- *Duplex LC receptacle optical interface compliant*
- *Single +3.3V power supply*
- *DDM function implemented*
- *Internal calibration*
- *Hot-pluggable*
- *CWDM DFB laser transmitter*
- *International Class 1 laser safety certified*
- *Up to 40km on 9/125 μ m SMF*
- *Operating temperature range: 0 $^{\circ}$ C~70 $^{\circ}$ C*
- *RoHS Compliant DDM Function implemented*
- *Compliant with RoHs&WEEE*

Application

- *4xFiber Channel CWDM applications*

Standard

- *Compliant with SFP MSA(INF-8074i)*
- *Compliant with SFF-8472 v9.5*
- *Compliant with FC-PI-2 v8.0*

Absolute Maximum Ratings

Parameter	Symbol	Unit	Min	Max
Storage Temperature Range	T _s	°C	-40	85
Relative Humidity	RH	%	5	95
Power Supply Voltage	V _{CC}	V	-0.5	4.0

Recommended Operating Conditions

Parameter	Symbol	Unit	Min	Typ	Max
Case Operating Temperature Range	T _c	°C	0		70
Power Supply Voltage	V _{CC}	V	3.0	3.3	3.6
Data rate	BR	Gb/s		4.25	

Specifications (tested under recommended operating conditions, unless otherwise noted)

Parameter	Symbol	Unit	Min	Typ	Max	Notes
General Specifications						
				1471		
				1491		
				1511		
Optical Wavelength	λ	nm	-6.5	1531	+6.5	
				1551		
				1571		
				1591		
				1611		
Bit Error Rate	BER				10 ⁻¹²	1
Fiber Length on 9/125μm SMF	L	km			40	
Electrical Characteristics						
Supply Current	Tx Section		I _{CC}	mA	300	2
	Rx Section					

Differential Input Voltage Swing	$V_{IN, PP}$	mV	200	2400	3
Differential Output Voltage Swing	$V_{OUT, PP}$	mV	400	820	
TX_fault/LOS output(TTL)	VOH	V	2.0	V_{CC}	
	VOL		0	0.8	
TX_disable input(TTL)	VOH	V	2.0	V_{CC}	
	VOL		0	0.8	

Optical transmitter Characteristics

Output Optical Power	P_O	dBm	+1	+3	+5
Optical Extinction Ratio	ER	dB	5		4
Spectral Width(-20dB down from peak level)	$\Delta\lambda$	nm		1	1
Side Mode Suppression Ratio	SMSR	dB	30		
Transmitter Jitter(peak to peak)		ps		59.8	5
Relative Intensity Noise	RIN	dB/Hz		-120	
Optical Rise/Fall Time(20%/80%)	t_r/ t_f	ps		90	6
Mask Margin				20%	

Optical receiver Characteristics

Receiver Sensitivity =4.25Gb/s	S	dBm		-17.5	7
Deterministic Jitter Contribution@4.25Gb/s	RX Δ DJ	ps		25.9	
Total Jitter Contribution@4.25Gb/s	RX Δ TJ	ps		61.2	
Average received power, max	P_{in}	dBm	0		
LOS	Optical De-Assert			-19	
	Optical Assert			-30	
LOS Hysteresis		dB	0.5	4.0	

Note1: 4.25Gb/s with PRBS 2^7-1 .

Note2: The supply current includes SFP module's supply current and test board working current.

Note3: We recommend <1200mV for best EMI performance.

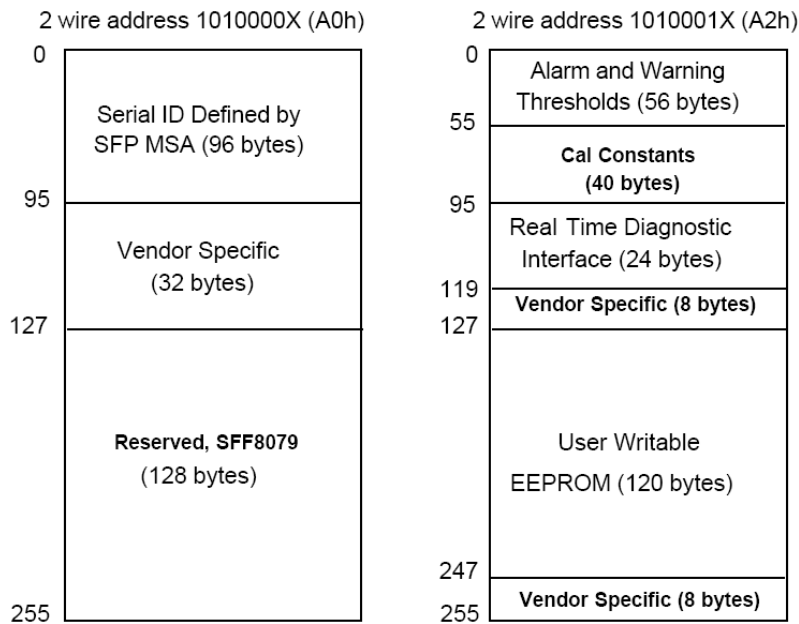
Note4: Filtered eye.

Note5: Measured on an oscilloscope in average mode with 50% threshold and K28.5 pattern.

Note6: Unfiltered, 20-80%.

Note7: Measured with PRBS 2^7-1 at 10^{-12} BER.

Digital Diagnostic Memory Map



EEPROM Serial ID Memory Contents

Accessing Serial ID Memory uses the 2 wire address 1010000X(A0). Memory Contents of Serial ID are shown in Table 2.

Table 2 Serial ID Memory Contents

Data Address	Size (Byte)	Name of Field	Contents(Hex)	Description
DASE ID FIELDS				
0	1	Identifier	03	SFP
1	1	Ext. Identifier	04	SFP function is defined by serial ID only
2	1	Connector	07	LC Connector
3-10	8	Transceiver	00 00 00 00 12 00 01 15	400-SM-LC-L
11	1	Encoding	01	8B/10B
12	1	BR,Nominal	2B	4.25Gbit/s
13	1	Reserved	00	Reserved for SFF-8079
14	1	Length(9μm)km	28	40km
15	1	Length(9μm)100m	FF	
16	1	Length(50μm)10m	00	Not compliant
17	1	Length(62.5μm)10m	00	

18	1	Length(Copper)	00	
19	1	Reserved	00	
20-35	16	Vendor name	57 54 44 20 20 20 20 20 20 20 20 20 20 20 20 20	"WTD"(ASCII)
36	1	Reserved	00	
37-39	3	Vendor OUI	00 1C AD	
40-55	16	Vendor PN		Transceiver part number
56-59	4	Vendor rev	33 2E 30 20	3.0
60-61	2	Wavelength		Transceiver wavelength
62	1	Reserved	00	
63	1	CC_BASE	Check Sum(Variable)	Check code for Base ID Field
EXTENDED ID FIELDS				
64-65	2	Options	00 3A	RATE_SELECT, TX_DISABLE, TX_FAULT and Loss of Signal implemented
66	1	BR,max	00	
67	1	BR,min	00	
68-83	16	Vendor SN	5A 31 37 39 35 34 36 20 20 20 20 20 20 20 20 20	Serial Number of transceiver (ASCII).For example"Z179546"
84-91	8	Date code	30 38 30 36 30 32 20 20	Manufactory date code.For example"080602"
92	1	Diagnostic Monitoring Type 68		Digital diagnostic monitoring implemented, "internally calibrated" is implemented, RX measurement type is "Average Power"
93	1	Enhanced Options	B0	Optional Alarm/Warning flags implemented for all monitored quantities, Optional Soft TX_ FAULT monitoring implemented, Optional Soft RX_LOS monitoring implemented
94	1	SFF-8472 Compliance	02	Includes functionality described in Rev9.5 SFF-8472

95	1	CC_EXT	Check Sum(Variable)	Check sum for Extended ID Field
VENDOR SPECIFIC ID FIELDS				
96-127	32	Vendor Specific	Read only	Depends on customer information
128-255	128	Reserved	Read only	Filled by zero

Diagnostic Monitor Functions

Diagnostic Monitor Functions interface uses the 2 wire address 1010001X(A2). Memory contents of Diagnostic Monitor Functions are shown in Table 3.

Table 3 Memory contents of Diagnostic Monitor Function

Data Address	Field Size (Bytes)	Name	Contents and Description
Alarm and Warning Thresholds			
00-01	2	Temperature High Alarm	Set to 70 °C
02-03	2	Temperature Low Alarm	Set to 0 °C
04-05	2	Temperature High Warning	Set to 60 °C
06-07	2	Temperature Low Warning	Set to 10 °C
08-09	2	V _{CC} High Alarm	Set to 3.6V
10-11	2	V _{CC} Low Alarm	Set to 3.0V
12-13	2	V _{CC} High Warning	Set to 3.5V
14-15	2	V _{CC} Low Warning	Set to 3.1V
16-17	2	Bias High Alarm	2xIBias(25 °C)+20
18-19	2	Bias Low Alarm	25%xIBias(25 °C)
20-21	2	Bias High Warning	2xIBias(25 °C)+10
22-23	2	Bias Low Warning	50%xIBias(25 °C)
24-25	2	TX Power High Alarm	Manufacture measurement plus 2dB
26-27	2	TX Power Low Alarm	Manufacture measurement minus 2dB
28-29	2	TX Power High Warning	Manufacture measurement plus 1dB
30-31	2	TX Power Low Warning	Manufacture measurement minus 1dB
32-33	2	RX Power High Alarm	Set to 0dBm
34-35	2	RX Power Low Alarm	Set to -17.5dBm
36-37	2	RX Power High Warning	Set to -3dBm
38-39	2	RX Power Low Warning	Set to -14.5dBm
40-55	16	Reserved	

Calibration Constants			
56-59	4	RX Power Calibration Data4	Set to 0
60-63	4	RX Power Calibration Data3	Set to 0
64-67	4	RX Power Calibration Data2	Set to 0
68-71	4	RX Power Calibration Data1	Set to 1
72-75	4	RX Power Calibration Data0	Set to 0
76-77	2	Bias Calibration Data1	Set to 1
78-79	2	Bias Calibration Data0	Set to 0
80-81	2	TX Power Calibration Data1	Set to 1
82-83	2	TX Power Calibration Data0	Set to 0
84-85	2	Temperature Calibration Data1	Set to 1
86-87	2	Temperature Calibration Data0	Set to 0
88-89	2	V _{CC} Calibration Data1	Set to 1
90-91	2	V _{CC} Calibration Data0	Set to 0
92-94	3	Reserved	Set to 0
95	1	Check Sum	Checksum of bytes 0-94
Real Time Diagnostic Monitor Interface			
96-97	2	Measured Temperature	Yield a 16-bit A/D value(see Table 3.1)
98-99	2	Measured V _{CC}	Yield a 16-bit A/D value(see Table 3.1)
100-101	2	Measured Bias	Yield a 16-bit A/D value(see Table 3.1)
102-103	2	Measured TX Power	Yield a 16-bit A/D value(see Table 3.1)
104-105	2	Measured RX Power	Yield a 16-bit A/D value(see Table 3.1)
106-109	4	Reserved	
110	1	Logic Status	See Table 3.2
111	1	Reserved	Reserved for SFF-8079
112-119	8	Alarm and Warning Flags	See Table 3.3
Vendor Specific			
120-127	8	Vendor Specific	Don't Access
128-247	120	User writable EEPROM	
248-255	8	Vendor Specific	Don't Access

The measured values located at bytes 96-105(in the 2 wire address 0xA2) are raw A/D values (16-bit integers) of transceiver temperature, supply voltage, laser bias current, laser optical output power and received power. All the measured values are "Internally Calibrated", and then it is necessary to convert raw A/D values to real world units by the manner as shown in Table 3.1.

Table 3.1 Real Time Diagnostic Monitor Value

Byte	Name	Description
96	Temperature MSB	Internally measured transceiver temperature. Compliant with Internal Calibration of SFF-8472
97	Temperature LSB	
98	V _{CC} MSB	Internally measured supply voltage. Compliant with Internal Calibration of SFF-8472
99	V _{CC} LSB	
100	Laser Bias MSB	Internally measured laser bias current. Compliant with Internal Calibration of SFF-8472
101	Laser Bias LSB	
102	Tx Power MSB	Measured Tx power. Compliant with Internal Calibration of SFF-8472
103	Tx Power LSB	
104	Rx Power MSB	Measured Rx power. Compliant with Internal Calibration of SFF-8472
105	Rx Power LSB	

This transceiver implements the optional status bytes "Logic States" at byte 110(0xA2)" as shown in Table 3.2.

Table 3.2 Logic Status

Byte	Bit	Name	Description
110	7	Tx Disable State	Digital state of the Tx Disable input pin
110	6	Soft Tx Disable Control	Not supported(set to 0)
110	5	Reserved	Set to 0
110	4	Rx Rate Select State	Digital state of the SFP Rate Select Input Pin
110	3	Soft Rx Rate Select Control	Not supported
110	2	Tx Fault	Digital state of the Tx Fault Output Pin
110	1	LOS	Digital state of the LOS Output Pin
110	0	Power on logic	Bit will be 0 when the analog monitoring is active

Each of the measured values has a corresponding high alarm, low alarm, high warning and low warning threshold level at location 00-39(x0A2) written as the data format of a corresponding valued shown in Table 3.3. Alarm and warning flags at bytes 112-119(0xA2) are defined as follows.

(1) Alarm flags indicate conditions likely to result (or have resulted) in link failure and cause for immediate action.

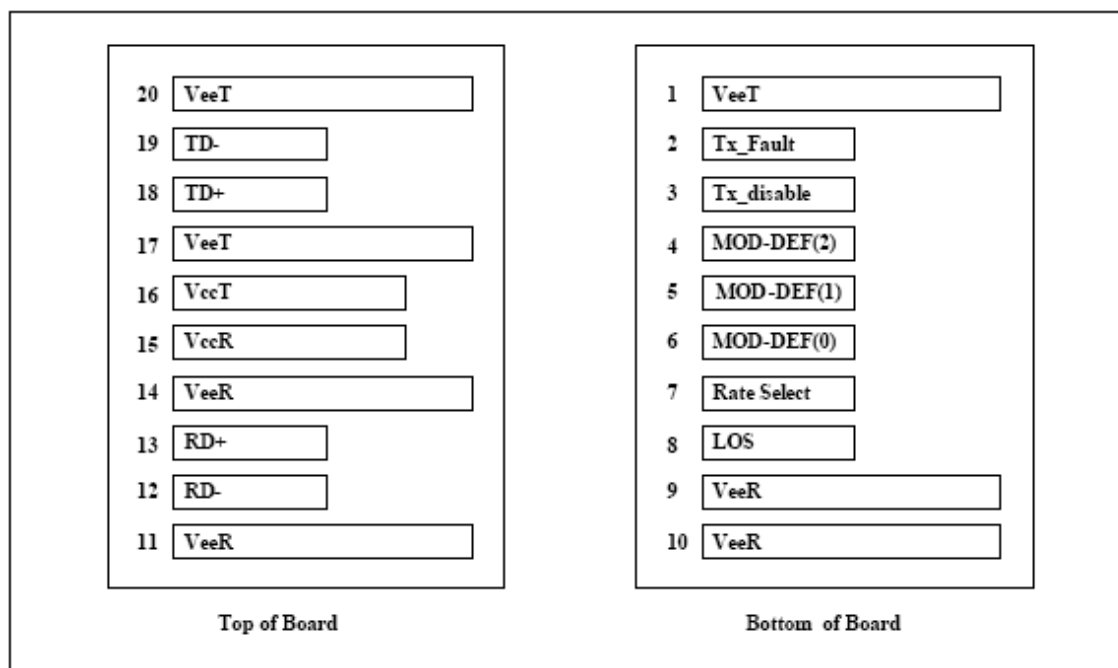
(2) Warning flags indicate conditions outside the guaranteed operating specification of transceiver but not necessarily causes of immediate link failures.

Table 3.3 Alarm and Warning Flags

Byte	Bit(s)	Name	Description
112	7	Temperature High Alarm	Set when temperature monitor value exceeds high alarm level
112	6	Temperature Low Alarm	Set when temperature monitor value exceeds low alarm level
112	5	V _{CC} High Alarm	Set when V _{CC} monitor value exceeds high alarm level
112	4	V _{CC} Low Alarm	Set when V _{CC} monitor value exceeds low alarm level

112	3	Laser Bias High Alarm	Set when laser bias monitor value exceeds high alarm level
112	2	Laser Bias Low Alarm	Set when laser bias monitor value exceeds low alarm level
112	1	Tx Power High Alarm	Set when Tx power monitor value exceeds high alarm level
112	0	Tx Power Low Alarm	Set when Tx power monitor value exceeds low alarm level
113	7	Rx Power High Alarm	Set when Rx power monitor value exceeds high alarm level
113	6	Rx Power Low Alarm	Set when Rx power monitor value exceeds low alarm level
113	5-0	Reserved	All bits set to 0
114	7-0	Reserved	All bits set to 0
115	7-0	Reserved	All bits set to 0
116	7	Temperature High Warning	Set when temperature monitor value exceeds high warning level
116	6	Temperature Low Warning	Set when temperature monitor value exceeds low warning level
116	5	V _{CC} High Warning	Set when V _{CC} monitor value exceeds high warning level
116	4	V _{CC} Low Warning	Set when V _{CC} monitor value exceeds low warning level
116	3	Laser Bias High Warning	Set when laser bias monitor value exceeds high warning level
116	2	Laser Bias Low Warning	Set when laser bias monitor value exceeds low warning level
116	1	Tx Power High Warning	Set when Tx power monitor value exceeds high warning level
116	0	Tx Power Low Warning	Set when Tx power monitor value exceeds low warning level
117	7	Rx Power High Warning	Set when Rx power monitor value exceeds high warning level
117	6	Rx Power Low Warning	Set when Rx power monitor value exceeds low warning level
117	5-0	Reserved	All bits set to 0
118	7-0	Reserved	All bits set to 0
119	7-0	Reserved	All bits set to 0

Pin Description



As Viewed Through Top of Board

Pin	Name	Function/Description	Engagement order	Note
1	VeeT	Transmitter Ground	1	
2	TX Fault	Transmitter Fault Indication	3	1
3	TX Disable	Transmitter Disable-Module disables on high or open	3	2
4	MOD-DEF2	Module Definition2-Two wire serial ID interface	3	3
5	MOD-DEF1	Module Definition1-Two wire serial ID interface	3	3
6	MOD-DEF0	Module Definition0-Two wire serial ID interface	3	3
7	Rate Select	Select between full or reduced receiver bandwidth	3	4
8	LOS	Loss of Singal	3	5
9	VeeR	Receiver Ground	1	
10	VeeR	Receiver Ground	1	
11	VeeR	Receiver Ground	1	
12	RD-	Inversed Received Data Out	3	6
13	RD+	Received Data Out	3	6
14	VeeR	Receiver Ground	1	
15	VccR	Receiver Power —— +3.3V±5%	2	7
16	VccT	Transmitter Power —— +3.3V±5%	2	7
17	VeeT	Transmitter Ground	1	

18	TD+	Transmit Data In	3	8
19	TD-	Inversed Transmit Data In	3	8
20	VeeT	Transmitter Ground	1	

Note1: TX Fault is open collector/drain output which should be pulled up externally with a 4.7K~10K Ω resistor on the host board to supply $<V_{ccT}+0.3V$ or $V_{ccR}+0.3V$. When high, this output indicates a laser fault of some kind. Low indicates normal operation. In the low state, the output will be pulled to $<0.8V$.

Note2: TX Disable input is used to shut down the laser output per the state table below. It is pulled up within the module with a 4.7~10K resistor.

Low (0 – 0.8V): Transmitter on

Between (0.8V and 2V): Undefined

High (2.0 – V_{ccT}): Transmitter Disabled

Open: Transmitter Disabled

Note3: Mod-Def 0, 1, 2. These are the module definition pins. They should be pulled up with a 4.7~10K resistor on the host board to supply less than $V_{ccT}+0.3V$ or $V_{ccR}+0.3V$.

Mod-Def 0 is grounded by the module to indicate that the module is present.

Mod-Def 1 is clock line of two wire serial interface for optional serial ID.

Mod-Def 2 is data line of two wire serial interface for optional serial ID.

Note4: This is an optional input used to control the receiver bandwidth for compatibility with multiple data rates. If implemented, the input will be internally pulled down with $>30k\Omega$ resistor. The input states are:

Low (0 – 0.8V): Reduced Bandwidth

($>0.8, < 2.0V$): Undefined

High (2.0 – 3.465V): Full Bandwidth

Open: Reduced Bandwidth

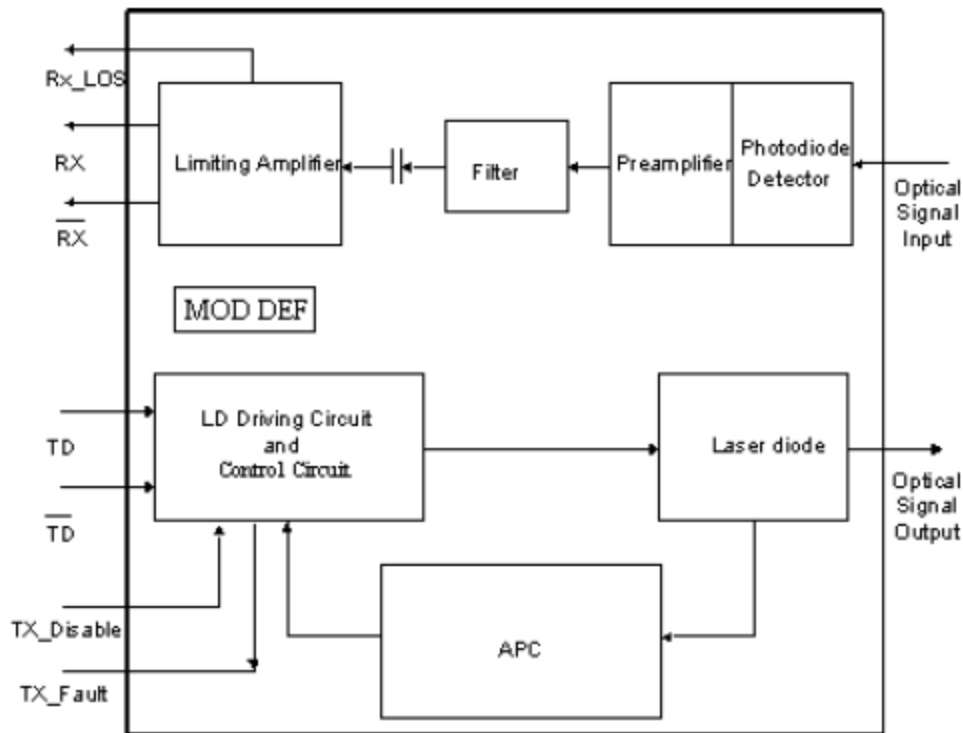
Note5: LOS (Loss of signal) is an open collector/drain output which should be pulled up externally with a 4.7~10K resistor on the host board to supply $<V_{ccT}+0.3V$ or $V_{ccR}+0.3V$. When high, this output indicates the received optical power is below the worst case receiver sensitivity (as defined by the standard in use). Low indicates normal operation. In the low state, the output will be pulled to $<0.8V$.

Note6: RD-/+: These are the differential receiver outputs. They are AC coupled 100 Ω differential lines which should be terminated with 100 Ω differential at the user SERDES. The AC coupling is done inside the module and thus not required on the host board.

Note7: V_{ccR} and V_{ccT} are the receiver and transmitter power supplies. They are defined as $3.3V\pm 5\%$ at the SFP connector pin. The in-rush current will typically be no more than 30mA above steady state supply current after 500ns.

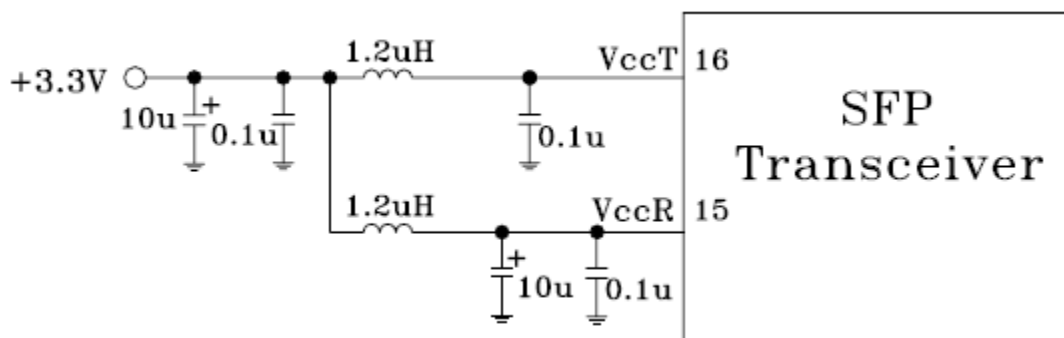
Note8: TD-/+: These are the differential transmitter inputs. They are AC coupled differential lines with 100 Ω differential termination inside the module. The AC coupling is done inside the module and is thus not required on host board.

Block Diagram

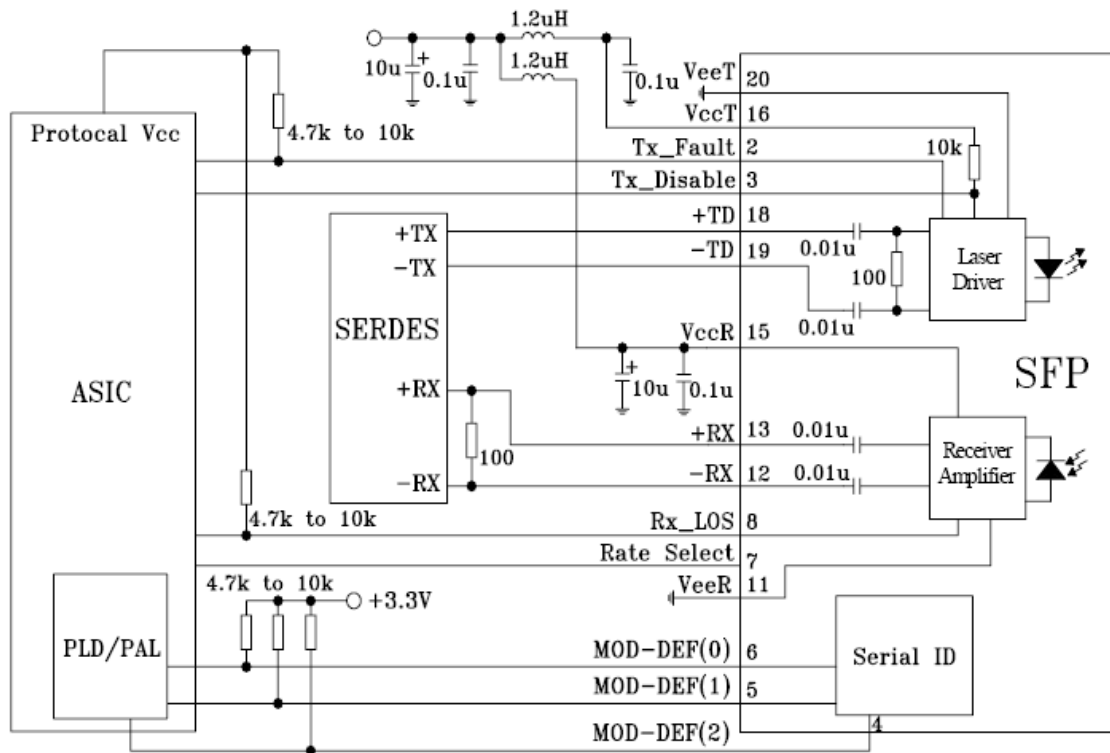


Required Host Board Components

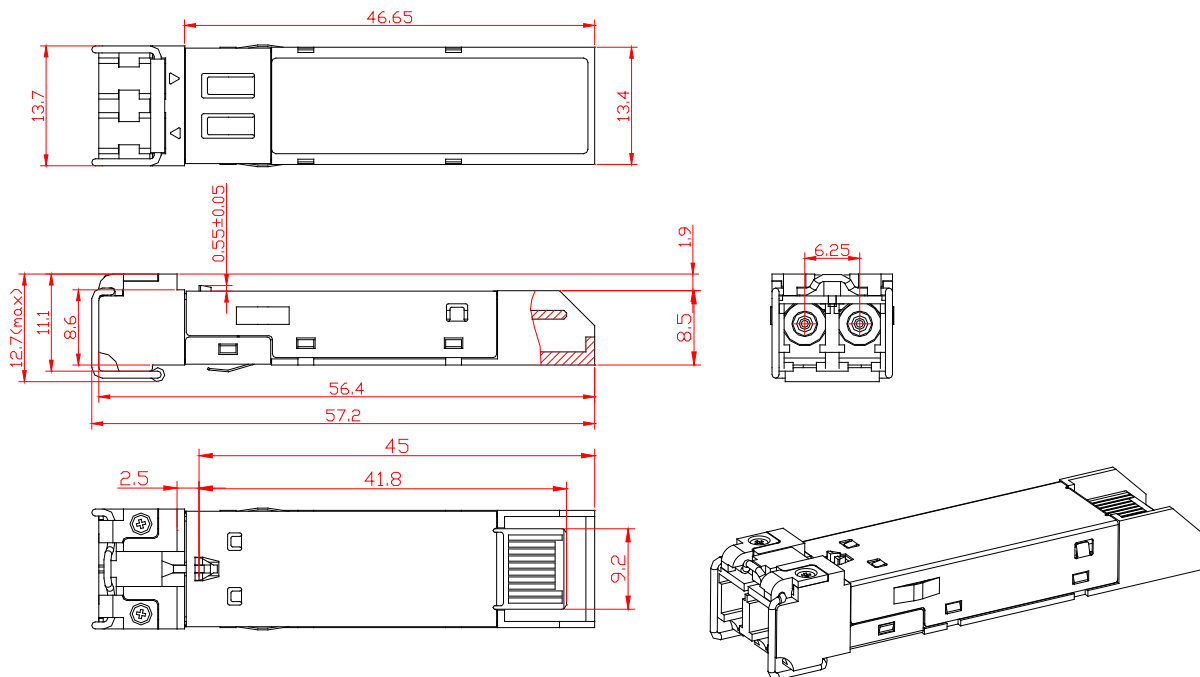
The MSA power supply noise rejection filter is required on the host PCB to meet data sheet performance. The MSA filter incorporates an inductor which should be rated 400mADC and 1 Ω serial resistance or better. It should not be replaced with a ferrite. The required filter is illustrated in Figure 3. The MSA also specifies that 4.7K Ω to 10K Ω pull-up resistors for TX_FAULT, LOS, and MOD_DEF0,1,2 are required on the host PCB. Figure is the suggested transceiver/host interface.



Typical Application Circuit



Package Outline



Regulatory Compliance

Feature	Test Method	Performance
Electrostatic Discharge (ESD) to the Electrical Pins	MIL-STD-883E Method 3015.7	Class 1 (>1.5kV) – Human Body Model
Electrostatic Discharge (ESD) Immunity	IEC61000-4-2	Class 2 (>4.0kV)
Electromagnetic Interference (EMI)	CISPR22 ITE Class B	Compliant with standard
	FCC Class B	
	CENELEC EN55022 VCCI Class 1	
Immunity	IEC61000-4-3 Class 2	Typically show no measurable effect from a 3V/m field swept from 80 to 1000MHz applied to the transceiver without a chassis enclosure
Safety	FDA	
	UL	
	TUV R5011 4729 0001	
	CE	

Ordering Information

Part No.	Specifications									Application
	Pack	Rate	Tx	Pout	Rx	S	Top	Reach	others	
RTXM178-647	SFP	4.25G	1471nm CWDM	+1~ +5dBm	PIN	<-17.5dBm	0~70 °C	40km	DDM RoHS	4x Fiber Channel CWDM
RTXM178-649	SFP	4.25G	1491nm CWDM	+1~ +5dBm	PIN	<-17.5dBm	0~70 °C	40km	DDM RoHS	4x Fiber Channel CWDM
RTXM178-651	SFP	4.25G	1511nm CWDM	+1~ +5dBm	PIN	<-17.5dBm	0~70 °C	40km	DDM RoHS	4x Fiber Channel CWDM
RTXM178-653	SFP	4.25G	1531nm CWDM	+1~ +5dBm	PIN	<-17.5dBm	0~70 °C	40km	DDM RoHS	4x Fiber Channel CWDM
RTXM178-655	SFP	4.25G	1551nm CWDM	+1~ +5dBm	PIN	<-17.5dBm	0~70 °C	40km	DDM RoHS	4x Fiber Channel CWDM
RTXM178-657	SFP	4.25G	1571nm CWDM	+1~ +5dBm	PIN	<-17.5dBm	0~70 °C	40km	DDM RoHS	4x Fiber Channel CWDM

RTXM178-659	SFP	4.25G	1591nm CWDM	+1~ +5dBm	PIN	<-17.5dBm	0~70 °C	40km	DDM RoHS	4x Fiber Channel CWDM
RTXM178-661	SFP	4.25G	1611nm CWDM	+1~ +5dBm	PIN	<-17.5dBm	0~70 °C	40km	DDM RoHS	4x Fiber Channel CWDM

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Edition 2009-12-1

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