



## **4.25G SFP transceiver module with DDM function**

### ***RTXM178-550***

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#### **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*
- *850nm VCSEL laser transmitter*
- *International Class 1 laser safety certified*
- *RoHS Compliant*
- *Up to 500m on 50/125 $\mu$ m MMF, 300m on 62.5/125 $\mu$ m MMF*
- *Operating temperature range: -40 $^{\circ}$ C~85 $^{\circ}$ C*
- *RoHS Compliant*

## Application

- 1x/2x/4x Fiber Channel applications

## Standard

- Compliant with SFP MSA (INF-8074i)
- Compliant with SFF-8472 v9.5
- Compliant with FC-P1-2 v7.0

## Absolute Maximum Ratings

Parameter	Symbol	Unit	Min	Max
Storage Temperature Range	T <sub>s</sub>	°C	-40	85
Relative Humidity	RH	%	5	95
Power Supply Voltage	V <sub>CC</sub>	V	-0.5	4.0

## Recommended Operating Conditions

Parameter	Symbol	Unit	Min	Typ	Max
Case Operating Temperature Range	T <sub>c</sub>	°C	-40		85
Power Supply Voltage	V <sub>CC</sub>	V	3.0	3.3	3.6
Data rate	BR	Gb/s		1.0625 /2.125 /4.25	

## Specifications

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

Parameter	Symbol	Unit	Min	Typ	Max	Notes
<b>General Specifications</b>						
Bit Error Rate	BER				10 <sup>-12</sup>	1
Fiber Length on 50/125µm MMF@4.25Gb/s	L	m			150	
Fiber Length on 50/125µm MMF@2.125Gb/s	L	m			300	
Fiber Length on 50/125µm MMF@1.0625Gb/s	L	m			500	
Fiber Length on 62.5/125µm MMF@4.25Gb/s	L	m			70	
Fiber Length on 62.5/125µm MMF@2.125Gb/s	L	m			150	
Fiber Length on 62.5/125µm MMF@1.0625Gb/s	L	m			300	
<b>Electrical Characteristics</b>						
Supply Current	Tx Section	I <sub>CC</sub>	mA	120	300	2

		Rx Section					
Differential Input Voltage Swing	$V_{IN, PP}$	mV	200	800	2400	3	
Differential Output Voltage Swing	$V_{OUT, PP}$	mV	700	850	1000		
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			
<b>Optical transmitter Characteristics</b>							
Output Optical Power	$P_O$	dBm	-9	-2.5	4		
Optical Wavelength	$\lambda$	nm	830	860			
Spectral Width	$\Delta\lambda$	nm	0.85				
Optical Modulation Amplitude@4.25Gb/s	OMA	$\mu W$	247	5			
Optical Modulation Amplitude@2.125Gb/s	OMA	$\mu W$	196	6			
Optical Modulation Amplitude@1.0625Gb/s	OMA	$\mu W$	156	7			
Deterministic Jitter Contribution @4.25Gb/s	Tx,DJ	UI	0.26			8	
Deterministic Jitter Contribution @2.125Gb/s	Tx,DJ	UI	0.26			8	
Deterministic Jitter Contribution @1.0625Gb/s	Tx,DJ	UI	0.21			8	
Total Jitter Contribution@4.25 Gb/s	Tx,TJ	UI	0.44			8	
Total Jitter Contribution@2.125 Gb/s	Tx,TJ	UI	0.44			8	
Total Jitter Contribution@1.0625 Gb/s	Tx,TJ	UI	0.43			8	
Relative Intensity Noise@4.25 Gb/s	RIN	dB/Hz	-118				
Relative Intensity Noise@2.125 Gb/s	RIN	dB/Hz	-117				
Relative Intensity Noise@1.0625 Gb/s	RIN	dB/Hz	-116				
Optical Rise/Fall Time@4.25 Gb/s	$t_r / t_f$	ps	90			9	
Optical Rise/Fall Time@2.125 Gb/s	$t_r / t_f$	ps	150			9	
Optical Rise/Fall Time@1.0625 Gb/s	$t_r / t_f$	ps	300			9	
Mask Margin						20%	
<b>Optical receiver Characteristics</b>							
Center Wavelength Range	$\lambda_c$	nm	770	860			
Receiver Sensitivity = 4.25Gb/s	S	dBm	-15			10	
Receiver Sensitivity = 2.125Gb/s	S	dBm	-18			10	
Receiver Sensitivity = 1.0625Gb/s	S	dBm	-20			10	
Average received power, max	$P_{in}$	dBm	0				
Return Loss			dB	12			

LOS	De-Assert	LOS <sub>D</sub>	dBm	-20
	Assert	LOS <sub>A</sub>		-30
LOS Hysteresis			dB	0.5

**Note1:** 4.25Gb/s with PRBS 2<sup>7</sup>-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:** Class 1 Laser Safety per FDA/CDRH, and EN (IEC) 60825 laser safety standards.

**Note5:** An OMA of 247μW is approximately equal to an average power of -8dBm with an Extinction Ratio of 9 dB.

**Note6:** An OMA of 196μW is approximately equal to an average power of -9dBm with an Extinction Ratio of 9 dB.

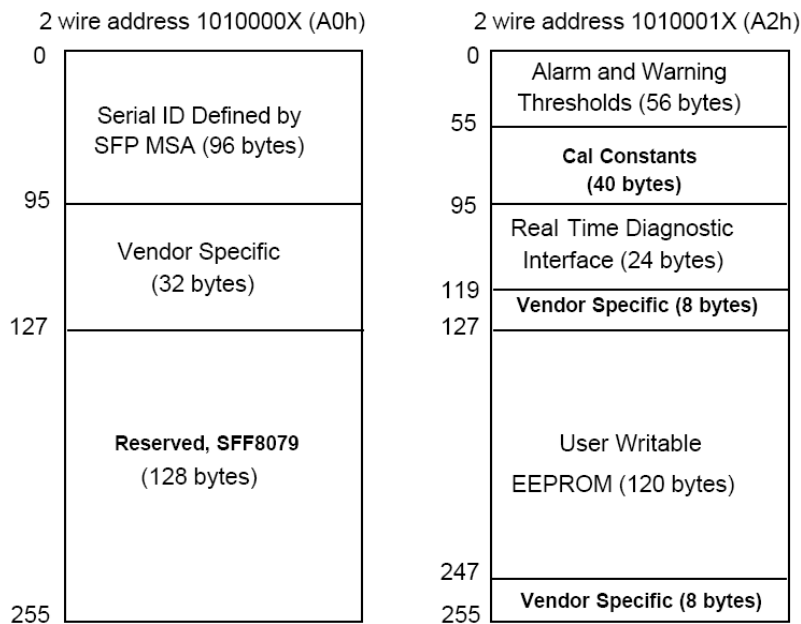
**Note7:** An OMA of 156μW is approximately equal to an average power of -10dBm with an Extinction Ratio of 9 dB.

**Note8:** Measured on an oscilloscope in average mode with 50% threshold and K28.5 pattern.

**Note9:** Unfiltered, 20-80%.

**Note10:** Specifications are for 50 micro-meter or 62.5 micro-meter fiber.

## 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( Bytes)	Name of Field	Contents(Hex)	Description
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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 20 40 0C 15	400-M5(M6)-SN-I
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	00	Not compliant
15	1	Length(9μm)100m	00	
16	1	Length(50μm)10m	0F	150m
17	1	Length(62.5μm)10m	07	70m
18	1	Length(Copper)	00	Not compliant
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 00 00	
40-55	16	Vendor PN	52 54 58 4D 31 37 38 2D 35 35 30 20 20 20 20 20	RTXM178-550
56-59	4	Vendor rev	33 2E 30 20	3.0
60-61	2	Wavelength	03 52	850nm
62	1	Reserved	00	
63	1	CC_BASE	B8	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	Serial Number of transceiver (ASCII).For example"Z179546"

			20 20 20 20	
84-91	8	Date code	30 37 30 33 31 35 20 20	Manufactory date code.For example“070315”
92	1	Diagnostic Monitoring Type	68	Digital diagnostic monitoring implemented, “internally calibrated” is implemented, RX measurement type is “Average Power”
93	1	Enhanced Options	F8	Optional Alarm/Warning flags implemented for all monitored quantities, Optional Soft TX_DISABLE control and monitoring implemented, Optional Soft TX_FAULT monitoring implemented, Optional Soft RX_LOS monitoring implemented Optional Soft RATE_SELECT control and 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
<b>Alarm and Warning Thresholds</b>			
00-01	2	Temperature High Alarm	Set to 85 °C
02-03	2	Temperature Low Alarm	Set to -40°C
04-05	2	Temperature High Warning	Set to 75 °C

06-07	2	Temperature Low Warning	Set to -30°C
08-09	2	V <sub>CC</sub> High Alarm	Set to 3.6V
10-11	2	V <sub>CC</sub> Low Alarm	Set to 3.0V
12-13	2	V <sub>CC</sub> High Warning	Set to 3.5V
14-15	2	V <sub>CC</sub> Low Warning	Set to 3.1V
16-17	2	Bias High Alarm	Set to 28mA
18-19	2	Bias Low Alarm	Set to 1mA
20-21	2	Bias High Warning	Set to 18mA
22-23	2	Bias Low Warning	Set to 2mA
24-25	2	TX Power High Alarm	Set to -2.5dBm
26-27	2	TX Power Low Alarm	Set to -9dBm
28-29	2	TX Power High Warning	Set to -3.5dBm
30-31	2	TX Power Low Warning	Set to -8dBm
32-33	2	RX Power High Alarm	Set to 0dBm
34-35	2	RX Power Low Alarm	Set to -15dBm
36-37	2	RX Power High Warning	Set to -3dBm
38-39	2	RX Power Low Warning	Set to -12dBm
40-55	16	Reserved	
<b>Calibration Constants</b>			
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 <sub>CC</sub> Calibration Data1	Set to 1
90-91	2	V <sub>CC</sub> 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 <sub>CC</sub>	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 <sub>CC</sub> MSB	Internally measured supply voltage. Compliant with Internal Calibration of SFF-8472
99	V <sub>CC</sub> 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	Read/write bit that allows software disable of laser
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	Read/write bit that allows software RX rate select
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.

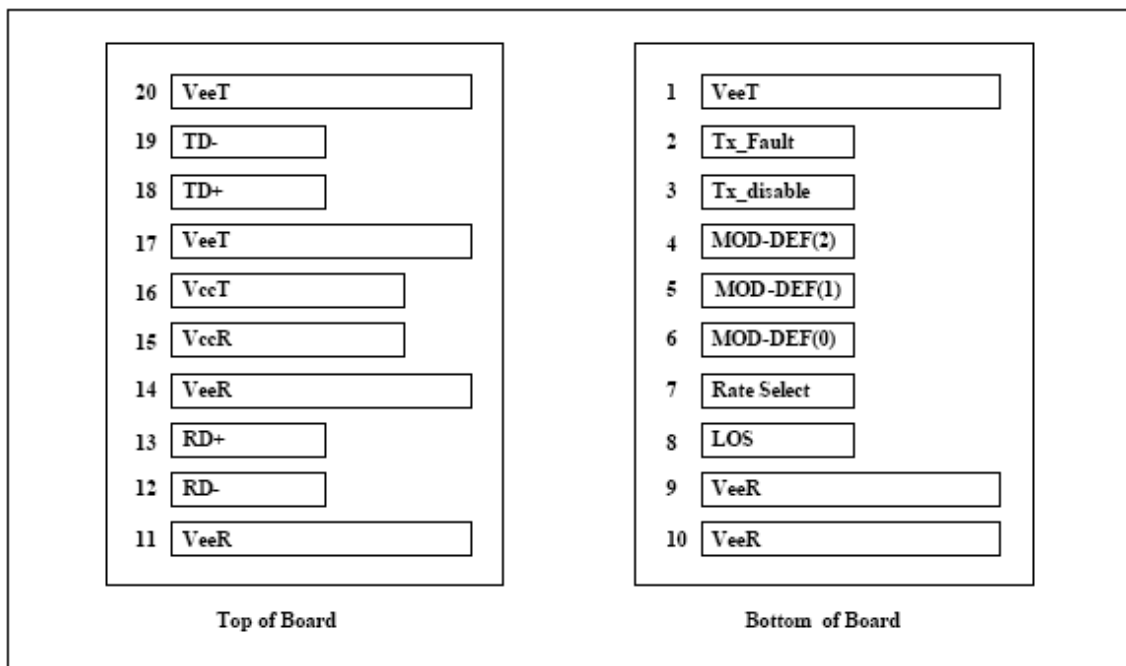
(2) Warning flags indicate conditions outside the guaranteed operating specification of transceiver but not necessarily causes of immediate link failures.

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 <sub>CC</sub> High Alarm	Set when V <sub>CC</sub> monitor value exceeds high alarm level
112	4	V <sub>CC</sub> Low Alarm	Set when V <sub>CC</sub> 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 <sub>CC</sub> High Warning	Set when V <sub>CC</sub> monitor value exceeds high warning level
116	4	V <sub>CC</sub> Low Warning	Set when V <sub>CC</sub> 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~10KΩ resistor on the host board to supply <math>V\_{ccT}+0.3V</math> or <math>V\_{ccR}+0.3V</math>. 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 <math><0.8V</math>.

**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 >30kΩ 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

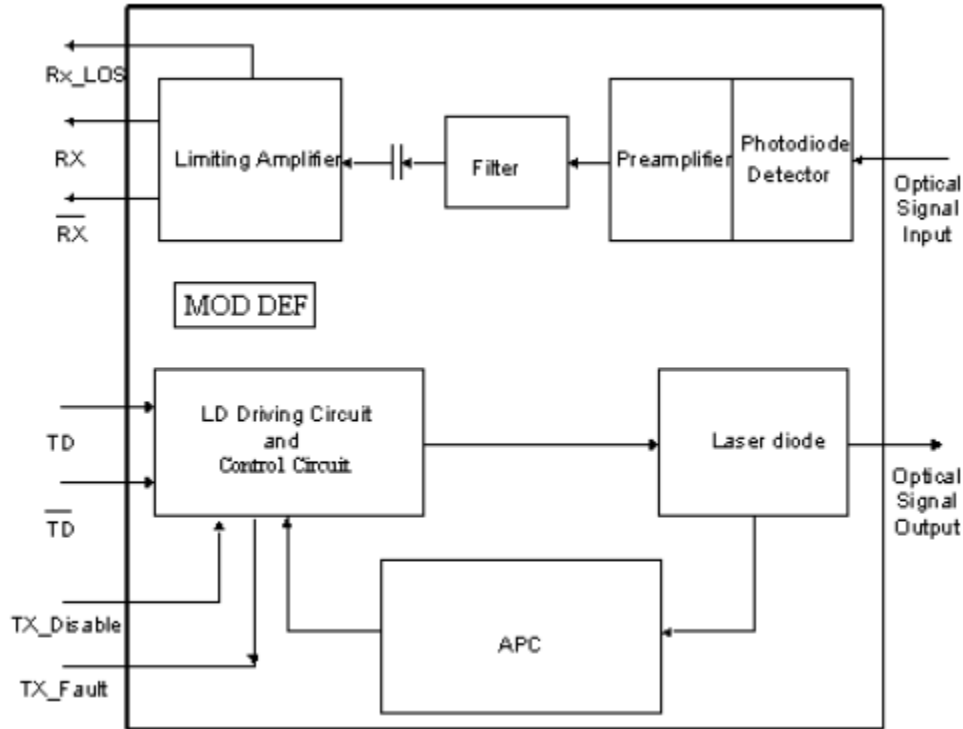
**Note5:** LOS (Loss of signal) is an open collector/drain output which should be pulled up externally with a 4.7~10K resistor on the host board to supply <math>V\_{ccT}+0.3V</math> or <math>V\_{ccR}+0.3V</math>. When high, this output indicates the received optical power is below the worst case receiver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

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

**Note7:** VccR and VccT are the receiver and transmitter power supplies. They are defined as 3.3V±5% at the SFP connector pin. The in-rush current will typically be no more than 30mA above steady state supply current after 500ns.

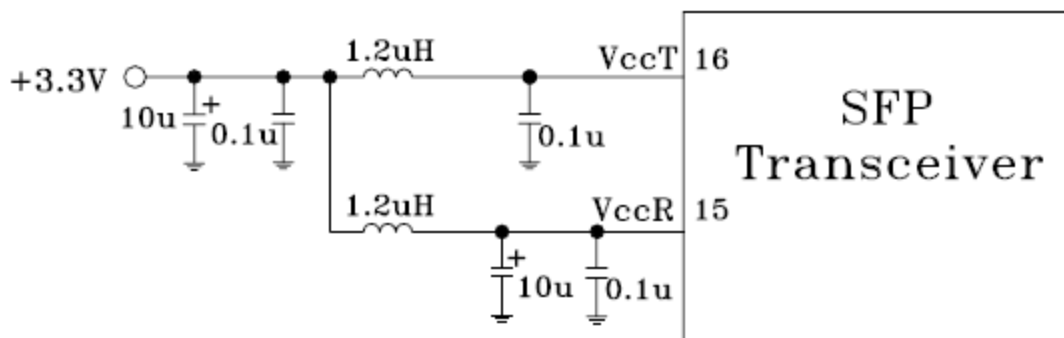
**Note8:** TD-/+: These are the differential transmitter inputs. They are AC coupled differential lines with 100Ω differential termination inside the module. The AC coupling is done inside the module and is thus not required on host board.

## Block Diagram

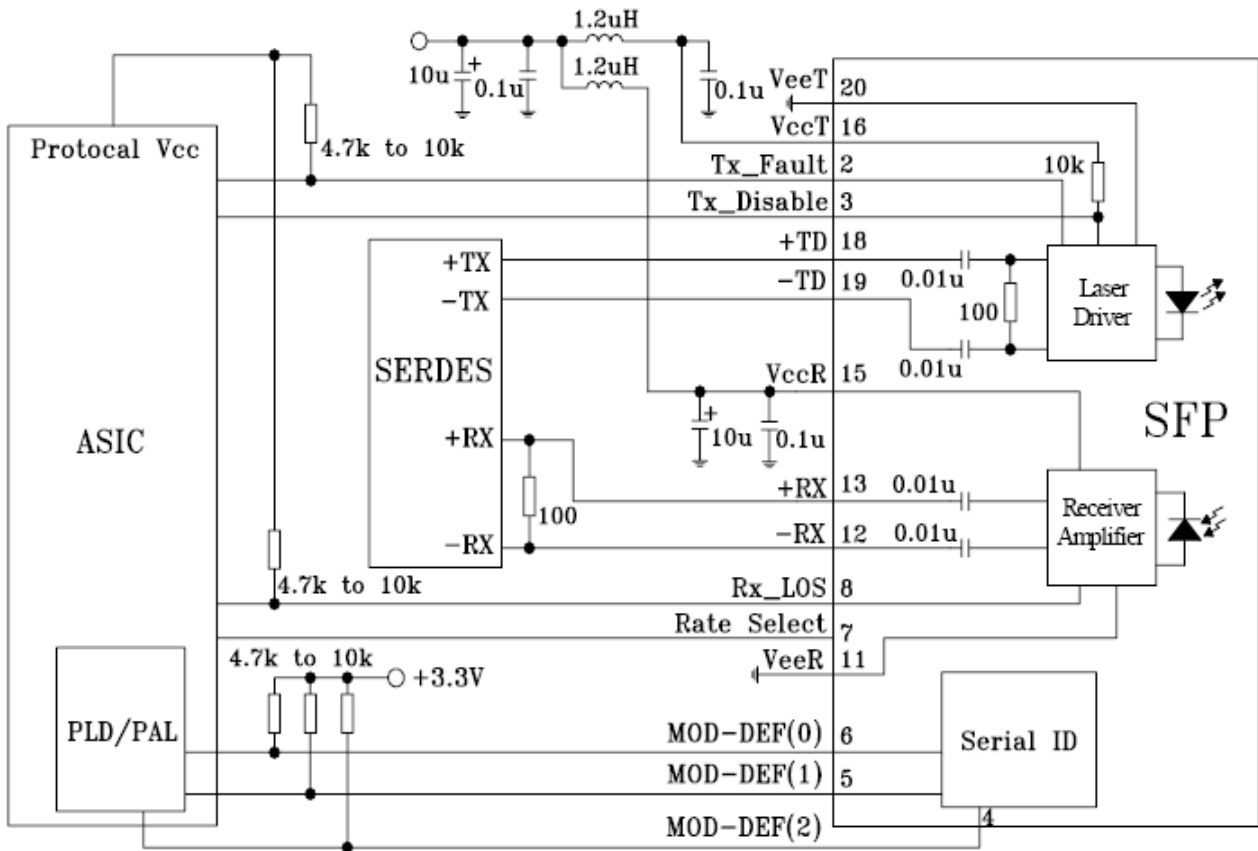


## Required Host Board Components

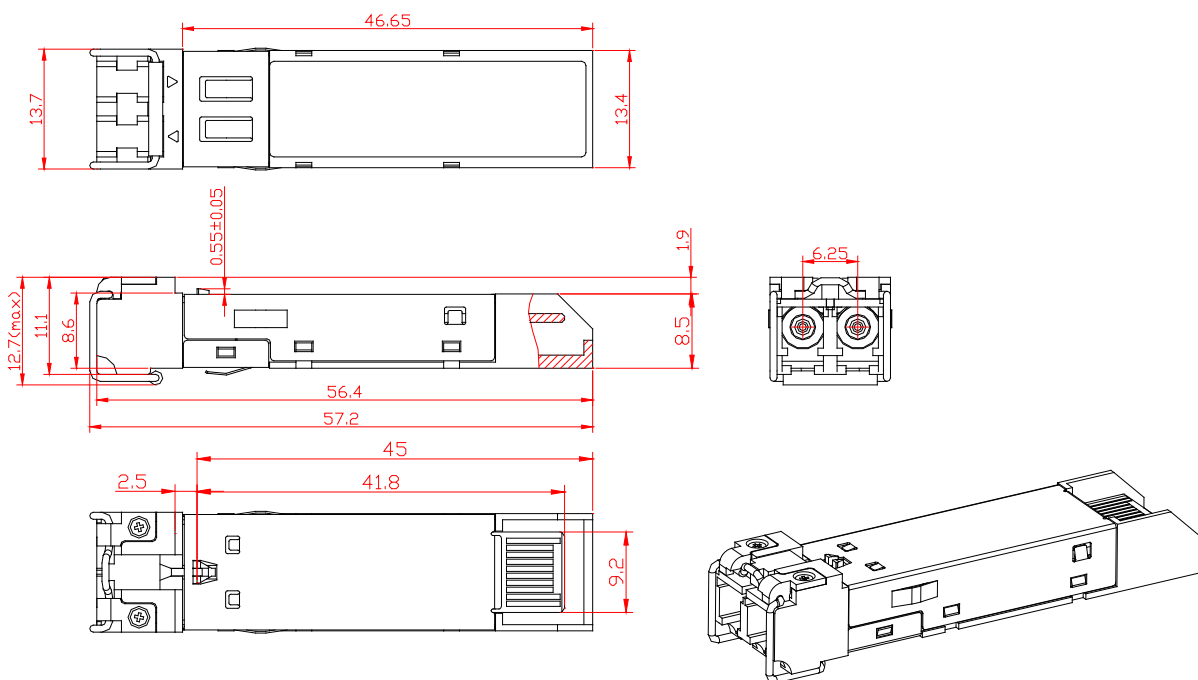
The MSA power supply noise rejection filter is required on the host PCB to meet data sheet performance. The MSA filter incorporates an inductor which should be rated 400mADC and 1Ωserial resistance or better. It should not be replaced with a ferrite. The required filter is illustrated in Figure 3. The MSA also specifies that 4.7KΩ to 10KΩ 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.



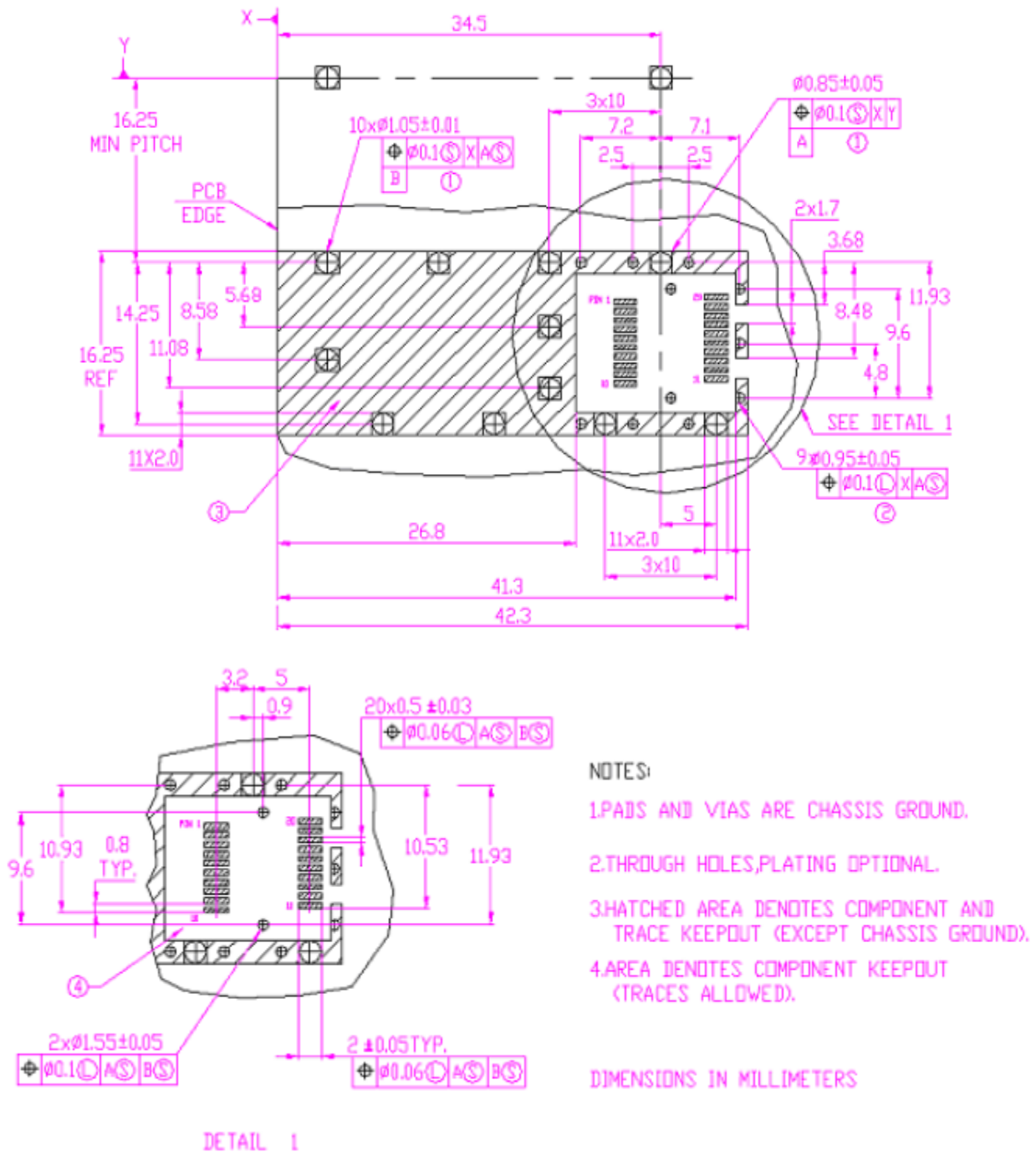
## Typical Application Circuit



## Package Outline



## PCB Layout Recommendation



## 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 FCC Class B CENELEC EN55022 VCCI Class 1	Compliant with standard
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		
RTXM178-550	SFP	4.25Gb/s	850nm VCSEL	-9~	-2.5dBm	PIN	<-15dBm	-40~85 °C	150m	DDM RoHS	1× /2× /4× Fiber Channel

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