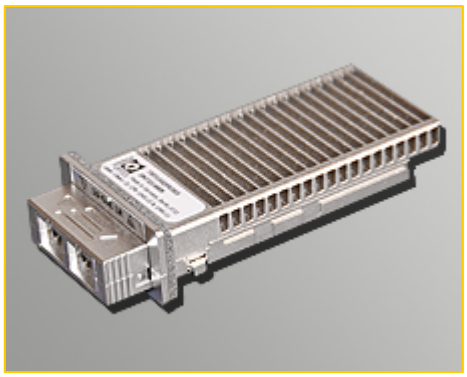
10Gbit/s X2 1550 nm Transponder (TRP10GEP3003)

Features



- Compatible with X2 MSA Rev. 2.0b
- Compliant to IEEE 802.3ae 10GBASE-ER at 10.3125 Gbit/s
- Transmission distance up to 40km over single mode fiber
- Low Power Consumption 3,0 W (typ.)
- Temperature Range 0°C to + 70°C
- Laser Class 1 compliant
- External Modulated Laser (EML)
- SC duplex connector
- Hot pluggable 70-pin connector with XAUI electrical interface
- Management and control via MDIO 2-wire interface
- Compliant with the EU RoHS 6 environmental requirements

General Description and Applications

Standard	*Description*	*Nominal Baud Rate*	*Unit*
IEEE 802.3ae	10 GBASE-ER Ethernet	10.3125	GBd

The TRP10GEP3003 is a highly integrated, serial optical transponder module designed for high-speed, 10Gbit/s data transmission applications. The module is fully compliant to the IEEE 802.3ae standard for 10GBASE-ER making it ideally suited for 10 GbE datacom applications (belly-to-belly for high density applications). Designed for long range distances, the transponder module comprises a transmitter with a cooled, 1550nm EML (externally modulated laser), a receiver with a PIN photodiode, a XAUI-Attachment Interface, an integrated Coder / Decoder and multiplexer / demultiplexer (SERDES: Serializer / Deserializer). The transponder operates within a wide temperature range of 0°C to +70°C and offers optimum heat dissipation and excellent electromagnetic shielding which enables high port densities for 10 GbE systems. A 70 pin electrical connector and a duplex SC connector optical interface assure that connectivity is compliant to the X2 and XENPAK MSA

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Absolute Maximum Ratings

Rating	*Conditions/Remark*	*Symbol*	*Min*	*Max*	*Units*
Storage Ambient Temperature	non condensing	ϑ_{stg}	-40	+85	°C
Powered Case Temperature	non condensing	ϑ_{c}	-10	+75	°C
Adaptable Power Supply (APS)	Voltage @ Pin APS Sense	$V_{APSsense}$	-0,5	1.5	V
Supply Voltage 3.3V Rail		V_{CC3}	-0,5	4.0	V
Supply Voltage 5V Rail		V_{CC5}	-0,5	6.0	V
CMOS Input Voltage Low Speed Signals	RESET, TxOn/Off, PRTADR4.0, LASI MDIO, MDC,	V_{I}	-0.5	3.6	V
CMOS Sink Current CMOS Low Speed Signals	Continuous Sink Current	I_{QL}		20	mA
Differential XAUI Input Amplitude	AC coupled (U_{DC} 6,3V)	$\|V_{IDXAUI}\|$		2500	mV
XAUI Input Level	AC coupled (U_{DC} 6,3V)	V_{IXAUI}	-0.4	2.3	V
Optical Receiver Input Power	Maximum receive power for demage	P_{Rx}		+4.0	dBm
Static Discharge Voltage	MIL STD 883 Method 3015.1			500	V

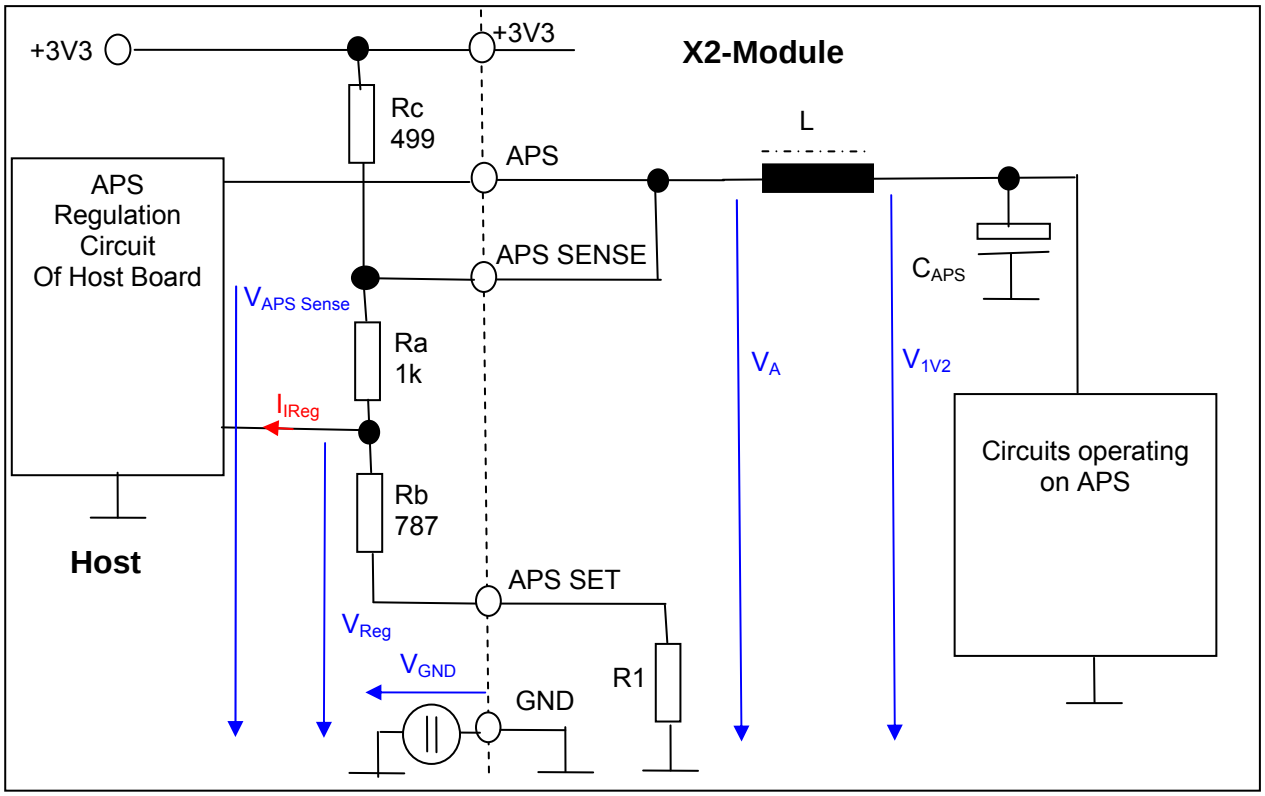
Any stress beyond the maximum ratings can result in permanent damage. The device specifications are guaranteed only under the recommended operating conditions.

Recommended Operating Conditions

Parameter	*Conditions / Remark*	*Symbol*	*Min*	*Typ*	*Max*	*Units*
Operating Case Temperature	worst case thermal location	ϑ_{Case}	0		+70	°C
APS Reg Voltage[1)2)3)]	Ra=1kΩ ±1,0%, Rb=787Ω±1,0%	V_{Reg}	786	800	812	mV
APS Sense Voltage[1)2)]	Just for informational purposes	$V_{APSsense}$	1.164	1.209	1.235	V
Power Supply Voltage @ 3.3V		V_{CC3}	3.135	3.3	3.465	V
Power Supply Voltage @ 5.0V		V_{CC5}	4.75	5.00	5.25	V

1) The device is supposed to operate in the APS control environment described and specified in the XENPAK-MSA (page 22 to 24 of Revision 3.0). In this environment the *APS-Sense Voltage* requirements will be automatically satisfied if *APS-Feedback Voltage* (Vreg) is within its recommended range. The operating *APS-Sense Voltage* is for informational purposes and is subject to be changed without further notice.
2) A more detailed description on the APS control circuit can also be found on the next page
3) R1 = 1,18KΩ ± 1,0%

Functional Block Diagram of APS Regulation



Electrical Characteristics

DC-Characteristics

Parameter	*Conditions*	*Symbol*	*Min*	*Typ*	*Max*	*Units*
5V Supply Current	normal operation TXON =1, Reset =1,	I_{VCC5}		160	210	mA
3.3V Supply Current	normal operation TXON =1, Reset =1,	I_{VCC3}		330	650	mA
1,2V APS Supply Current	normal operation TXON =1, Reset =1,	I_{VCCAPS}		880	1,08	mA
Total Power Consumption	normal operation TXON =1, Reset =1,	P_{tot}		2,95	4,49	W
5V Supply Current	low power mode TXON =0, Reset =1,	I_{VCC5}		34	45	mA
3.3V Supply Current	low power mode TXON =0, Reset =1,	I_{VCC3}		260	340	mA
1,2V APS Supply Current	low power mode TXON =0, Reset =1,	I_{VCCAPS}		150	220	mA
Total Power Consumption	low power mode TXON =0, Reset =1,	P_{tot}		1,21	1,61	W
5V Supply Current	Reset mode TXON =1, Reset =0,	I_{VCC5}		56	70	mA
3.3V Supply Current	Reset mode TXON =1, Reset =0,	I_{VCC3}		260	340	mA
1,2V APS Supply Current	Reset mode TXON =1, Reset =0,	I_{VCCAPS}		817	1000	mA
Total Power Consumption	Reset mode TXON =1, Reset =0,	P_{tot}		2,18	2,67	W
CMOS Output low voltage	Iol = 4mA	V_{OL}			0,2	V
CMOS Output low current	Vol = 0.6V	I_{OL}	8			mA
CMOS Input low voltage	3,3V tolerant	V_{IL}			0,36	V
CMOS Input high voltage		V_{IH}	0,84			V
CMOS Open-drain output off-state leakage current		I_{off}			2,5	µA
CMOS input / output capacitance	Vio(dc) = 0.6V	Cio		5	10	pF
Pullup resistance (LASI, Reset, TxOn/Off)			10		22	kΩ

XAUI – Interface

XAUI Input Characteristics

Parameter	*Conditions*	*Symbol*	*Min*	*Typ*	*Max*	*Units*
Nominal XAUI Baud Rate				3.125		GBd
Nominal XAUI Baud Rate Tolerance	Relative Tolerance		-100		+100	ppm
Differential Input Voltage Swing	8B/10B Coded Input Signal	V_{ID}	220		1,600	mV_{P-P}
Differential Return Loss	100 MHz – 2.5 GHz (Referenced to 100Ω)	SDD11	10			dB
Common Mode Return Loss	100MHz – 2.5GHz (Referenced to 25Ω)	SCC11	6			dB
Input differential skew	At crossing point	T_{jRDS}			75	ps_{P-P}
Total Peak-to-Peak Jitter Tolerance	Sinusoidal Jitter @ 0 … 20MHz	T_{jRDS}	0.55			UI_{P-P}
Differential Input Impedance		R_{IND}	80	100	120	Ω

Note: XAUI-input-Lanes are ac-coupled

XAUI Output Characteristics (AC-coupled)

Parameter	*Conditions*	*Symbol*	*Min*	*Typ*	*Max*	*Units*
Nominal XAUI Baud Rate				3.125		GBd
Nominal XAUI Baud Rate Tolerance	Relative Tolerance		-100		+100	ppm
Differential Output Voltage Swing	R_{LOAD} = 100Ω ± 5%		900		1500	mV_{P-P}
Differential Output Skew		$t_{skew, out}$			15	ps
Differential Output Impedance		$Z_{XAUI, out}$	80	100	120	Ω
Differential Transition Time	20% - 80%		40		100	ps
Total Output Jitter	no pre-equalization	TJ_{XAUI}			0.35	UI
Total Deterministic Output Jitter	no pre-equalization	DJ_{XAUI}			0.17	UI
Differential Output Return Loss	312.5 to 625 MHz	S22	10			dB

Note: XAUI-output-Lanes are ac-coupled

Optical Interface

Recommended Operating Conditions

Parameter	*Conditions*	*Symbol*	*Min*	*Typ*	*Max*	*Units*
Operating Range	Single Mode Fiber	l_{OP}	2		40000	m
Input Data Rate	10GBASE-ER	f_{OPT}		10.3125		GBd
	relative tolerance	$\Delta DR/DR_{typ}$	-100		+100	ppm
Receiver Input Signal	Center Wavelength	λ_C	1530	1550	1565	nm
	Average Input Power	P_{IN}	-15,8		0	dBm

Transmitter Characteristics

if not otherwise mentioned under recommended operating conditions and standard compliant single mode fiber.

Parameter	*Conditions*	*Symbol*	*Min*	*Typ*	*Max*	*Units*
Data Rate	10GBASE-ER module	DR		10.3125		Gbps
	relative tolerance	$\Delta DR/DR_{typ}$	-100		100	ppm
Nominal Wavelength		λ_{TRP}	1530	1550	1565	nm
Side Mode Suppression Ratio		SMSR	30			dB
Optical Output Power		Popt, avg	-4.7	-.0,5	4	dBm
Optical Output Power , TX = OFF		Popt, avg OFF			-30	dBm
Extinction Ratio		ER	8,2	10		dB
Optical Modulation Amplitude		OMA	500			µW
Transmitter and Dispersion Penalty		TDP			3	dB
Relative Intensity Noise		RIN			-128	dB/Hz

Receiver Characteristics

if not otherwise mentioned under recommended operating conditions and standard compliant single mode fiber.

Parameter	*Conditions*	*Symbol*	*Min*	*Typ*	*Max*	*Units*
Data Rate	10GBASE-ER module	DR		10.3125		Gbps
	relative tolerance	$\Delta DR/DR_{typ}$	-100		100	ppm
Receiver Sensitivity[1)]	OMA, BER 10^{-12} @ 2^{31}-1	P_{INpp}			-14.1	dBm
Stressed Receiver Sensitivity	OMA	P_{INpp}			-11.3	dBm
Saturation Input Power		P_{SAT}	0	+3		dBm
Optical Backreflection		OBR	27			dB

Note: [1)]with ideal transmitter

Note: The specified characteristics are met within the recommended range of operating conditions and under the default settings of output power and modulation amplitude. Changing the settings of the optical output power will affect the dynamic behavior of the output signal. Unless otherwise noted, typical data is quoted at nominal voltages and +25°C ambient temperature.

MDIO Interface

DC Characteristics

if not otherwise mentioned under the recommended operating conditions.

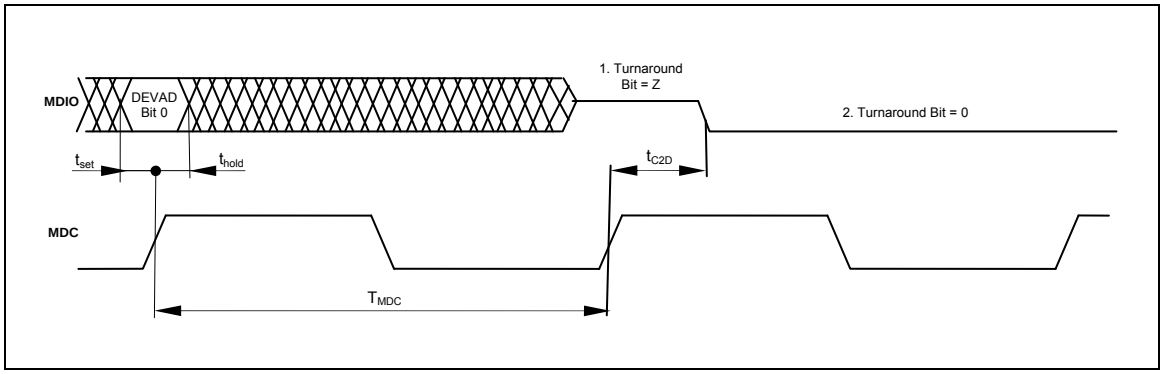
Characteristic	Condition	Symbol	Minimum	Typ	Maximum	Unit
Pull-up supply voltage		V_{pu}		1.2		V
Input high voltage	3,3V tolerant	V_{IH}	0.84			V
Input low voltage		V_{IL}			0.36	V
Output low voltage	I_{OL} = 4mA	V_{QL}			0.2	V
Output high voltage	I_{OH} = - 100µA	V_{QH}			V_{pu}	V
Input capacitance	V_I = 0…V_{pu}	C_{in}			10	pF
Load capacitance	V_I = 0…V_{pu}	C_{load}			470	pF
Pull-up resistance	with 1.2V pull-up voltage	R_{pu}	180			Ω
	with 3.3V pull-up voltage	R_{pu}	500			Ω

AC Characteristics

not less than 310ns and the sum of input currents of loads on the bus does not exceed 256µA at high and at low not below -320µA.

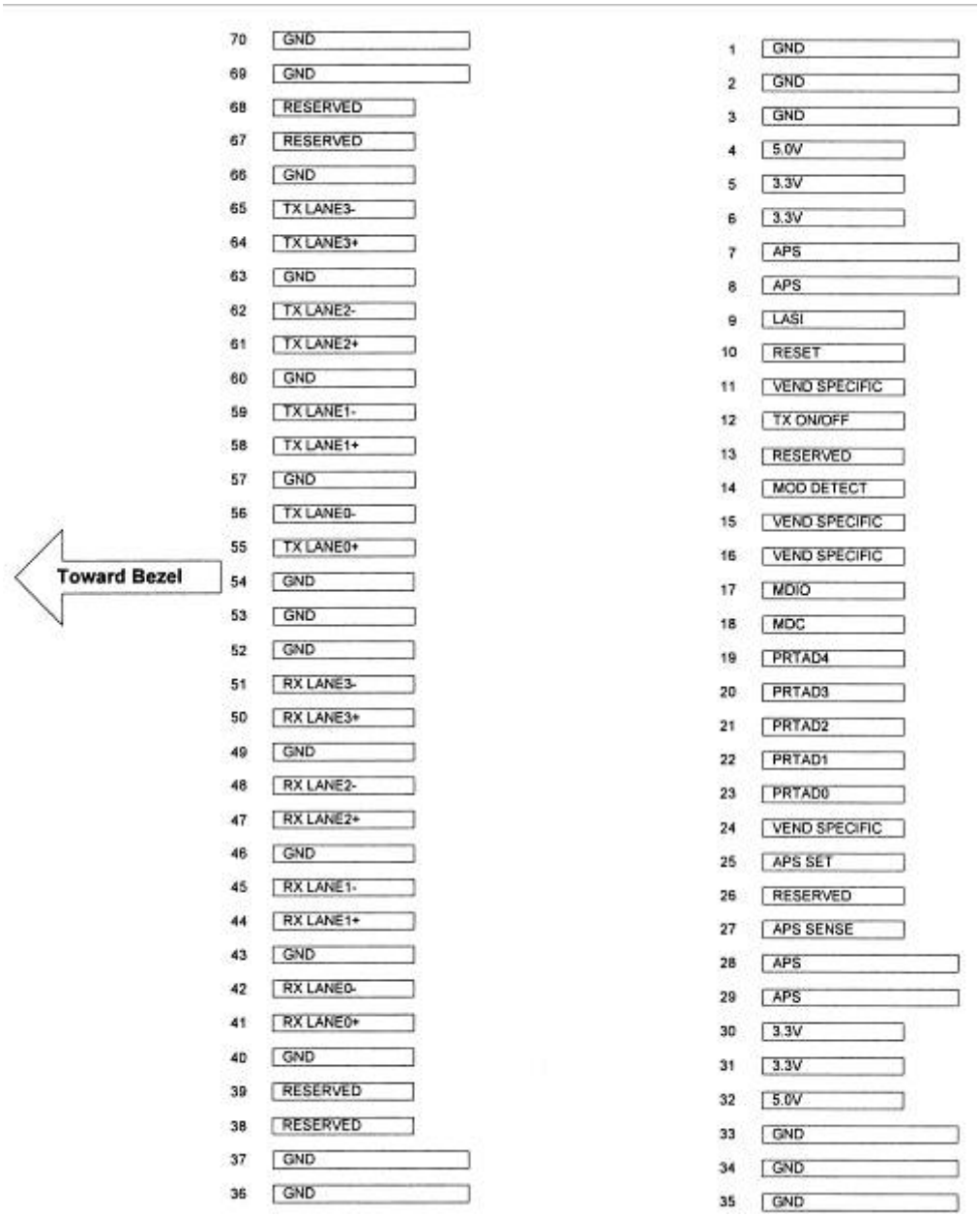
Characteristic	Condition	Symbol	Minimum	Maximum	Unit
Set Up Time	wrt MDC rising edge	t_{set}		10	ns
Hold Time	wrt MDC rising edge	t_{hold}		10	ns
Clock to Data Time[1)]	V_{pu} = 1.2V, R_{pu} = 400Ω ±1%, C_{BUS} ≤ 470pF	t_{C2D}	0	300	ns
Clock to Data Time[1)]	V_{pu} = 1.2V, R_{pu} = 400Ω ±1%, C_{BUS} ≤ 50pF	t_{C2D}		30	ns
MDC clock rate	V_{pu} = 1.2V, R_{pu} = 400Ω ±1%, C_{BUS} ≤ 470pF	F_{max}		3.125	MHz
MDC H and L times	V_{pu} = 1.2V, R_{pu} = 400Ω ±1%, C_{BUS} ≤ 470pF	t_H , t_L	160		ns
Clock to Data Time[1)]	V_{pu} = 1.2V, R_{pu} = 180Ω ±1%, C_{BUS} ≤ 100pF	t_{C2D}	0	32	ns
Clock to Data Time[1)]	V_{pu} = 1.2V, R_{pu} = 180Ω ±1%, C_{BUS} ≤ 50pF	t_{C2D}		20	ns
MDC clock rate	V_{pu} = 1.2V, R_{pu} = 180Ω ±1%, C_{BUS} ≤ 100pF	F_{max}		25	MHz
MDC H and L times	V_{pu} = 1.2V, R_{pu} = 180Ω ±1%, C_{BUS} ≤ 100pF	t_H , t_L	20		ns

1) Note: delay is measured from MDC rising edge Vih_min level (0.84V) to MDIO rising edge Vih_min level (0.84V) or MDIO falling edge Vil_max level (0.36V



Example Timing Diagram: Turnover Timing at Read Cycle

Edge-Board-Connector-Pinning and Layout



Top of Transceiver PCB **Bottom of Transceiver PCB**

(as viewed through the top)

Electrical Pin Definition page 1 of 2

Symbol	*Logic*	*I/O*	*PIN*	*Name / Description*	*Note*
3.3V	+3.3 V DC		5, 6, 30, 31	Power Supply of Optical Receiver and Transmitter and Control Circuits	2
5.0V	+5.0 V DC		4, 32	Power Supply of Optical Receiver Front-end	2
APS	+1.2 V		7, 8, 28, 29	Adaptive Power Supply, Supply of PHY XS and PCS Layer Devices	2
APS SENSE			27	APS Sense Output for APS Control Circuit	
APS SET			25	Feedback Input for APS, Input of APS Setting Resistor	
GND			1, 2, 3, 33, 34, 35, 36, 37, 40, 43, 46, 49, 52, 53, 54, 57, 60, 63, 66, 69, 70	Common Electrical Ground	1
LASI	1.2V CMOS Open Drain	O	9	Link Alarm Status Indicator, low active, Open Drain Output A pull-up resistor with 10-22KΩ to 1,2V is expected. Logic High: Normal Operation Logic Low: Link Alarm is indicated	
MDC	1.2 V CMOS	I	18	Management Clock Input	3
MDIO	Open Drain	I/O	17	Management Data I/O. Requires external 10-22 kΩ pull-up to 1.2 V on host.	3
MOD DETECT		O	14	1kΩ it Ground for APS Circuit Environment	
PRTADO	1.2V CMOS	I	23	Port Address Bit 0	
PRTAD1	1.2V CMOS	I	22	Port Address Bit 1	
PRTAD2	1.2V CMOS	I	21	Port Address Bit 2	
PRTAD3	1.2V CMOS	I	20	Port Address Bit 3	
PRTAD4	1.2V CMOS	I	19	Port Address Bit 4	
RESERVED			13, 38, 39, 67, 68	Reserved for future use, pins w/o function, leave unconnected	
RESERVED			26	Reserved for Avalanche Photodiode use, not in use	5
RESET	1.2V CMOS Open Drain	I	10	Low active Reset Input 10KΩ pull-up on Transceiver Logic high = Normal Operation Logic Low = Reset asserted	
TX ON/OFF	1.2V CMOS Open Drain	I	12	High active Transmitter Enable Input 10KΩ pull-up on Transceiver Logic high = Transmitter active (normal Operation) And Register Bit 1.9.0 set to low as well Logic Low = shut down of Transmitter	
VEND SPECIFIC			11, 15, 16, 24	Vendor Specific Pin. Leave unconnected.	

Electrical Pin Definition page 2 of 2

Symbol	*Logic*	*I/O*	*PIN*	*Name / Description*	*Note*
RX LANE0+	AC-coupled, internally based differential CML	O	41	Module XAUI Output Lane 0+	4
RX LANE0-		O	42	Module XAUI Output Lane 0-	4
RX LANE1+		O	44	Module XAUI Output Lane 1+	4
RX LANE1-		O	45	Module XAUI Output Lane 1-	4
RX LANE2+		O	47	Module XAUI Output Lane 2+	4
RX LANE2-		O	48	Module XAUI Output Lane 2-	4
RX LANE3+		O	50	Module XAUI Output Lane 3+	4
RX LANE3-		O	51	Module XAUI Output Lane 3-	4
TX LANE0+	AC-coupled, internally based differential CML	I	55	Module XAUI Input Lane 0+	4
TX LANE0-		I	56	Module XAUI Input Lane 0-	4
TX LANE1+		I	58	Module XAUI Input Lane 1+	4
TX LANE1-		I	59	Module XAUI Input Lane 1-	4
TX LANE2+		I	61	Module XAUI Input Lane 2+	4
TX LANE2-		I	62	Module XAUI Input Lane 2-	4
TX LANE3+		I	64	Module XAUI Input Lane 3+	4
TX LANE3-		I	65	Module XAUI Input Lane 3-	4

1) Ground connections are common for TX and RX.
2) All connector contacts are rated at 0.5A nominal.
3) MDIO and MDC timing must comply with IEEE 802.3ae clause 45.3.
4) XAUI output characteristics comply with IEEE 802.3ae clause 47.
5) Transceivers will be MSA compliant when no signals are present on the vendor specific pins

Electro Static Discharge (ESD)

The maximum electrostatic charge based on a human body model and the conditions as outlined below is:

Parameter	*Conditions*	*Symbol*	*Min*	*Typ*	*Max*	*Units*
Static Discharge Voltage	MIL STD 883 Method 3015.1				500	V

Thermal Management

The transponder is designed for -operation within a case temperature range between 0°C to +70°C at an altitude of < 3km. The built in heat-sink provides optimized thermal performance. The user needs to guarantee per system design not to exceed this temperature range. It has to be considered that in case of usage of multiple modules on a single host-board, the temperature will rise among the modules hosted side by side (see figure below). Airflow direction and air speed needs to be chosen accordingly. Please refer to the MSA document for further information.

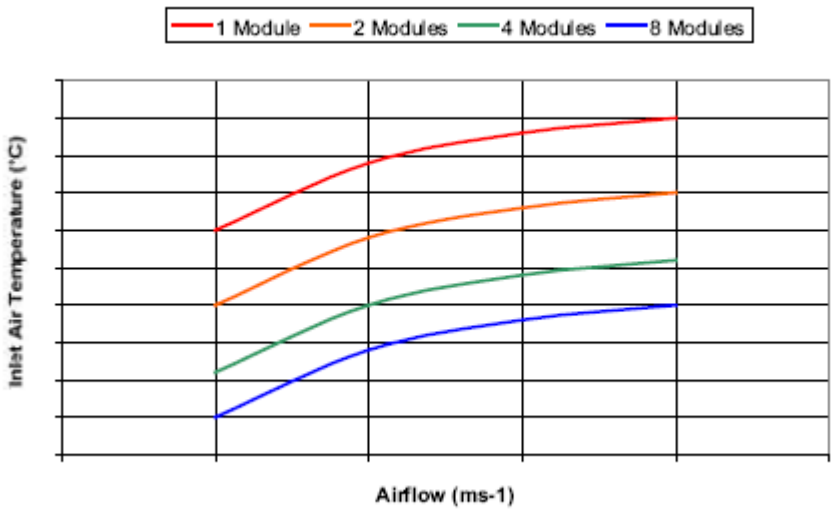


Figure 1 ***Thermal behaviour of multiple modules***

Eye Safety

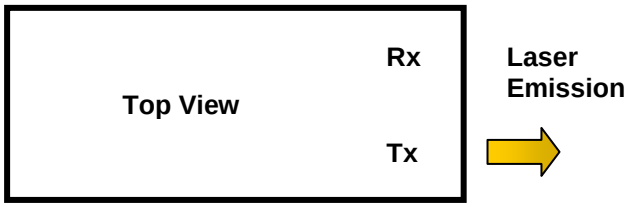
This laser based multimode transceiver is a Class 1 product. It complies with IEC 60825-1/A2: 2001 and FDA performance standards for laser products (21 CFR 1040.10 and 1040.11) except for deviations pursuant to Laser Notice 50, dated July 26, 2001.

CLASS 1 LASER PRODUCT

Caution: use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation.

Note: All adjustments have been made at the factory prior to shipment of the devices. No maintenance or alteration to the device is required. Tampering with or modifying the performance of the device will result in voided product warranty. Failure to adhere to the above restrictions could result in a modification that is considered an act of "manufacturing", and will require, under law, recertification of the modified product with the U.S. Food and Drug Administration (ref. 21 CFR 1040.10 (i)).

Laser Emission Data



Wavelength	1550 nm
Maximum total output power (as defined by IEC: 7 mm aperture at 14 mm distance)	<10 mW / <10 dBm
Beam divergence (full angle) / NA (half angle)	16° / 0.11 mrad

Required Labeling

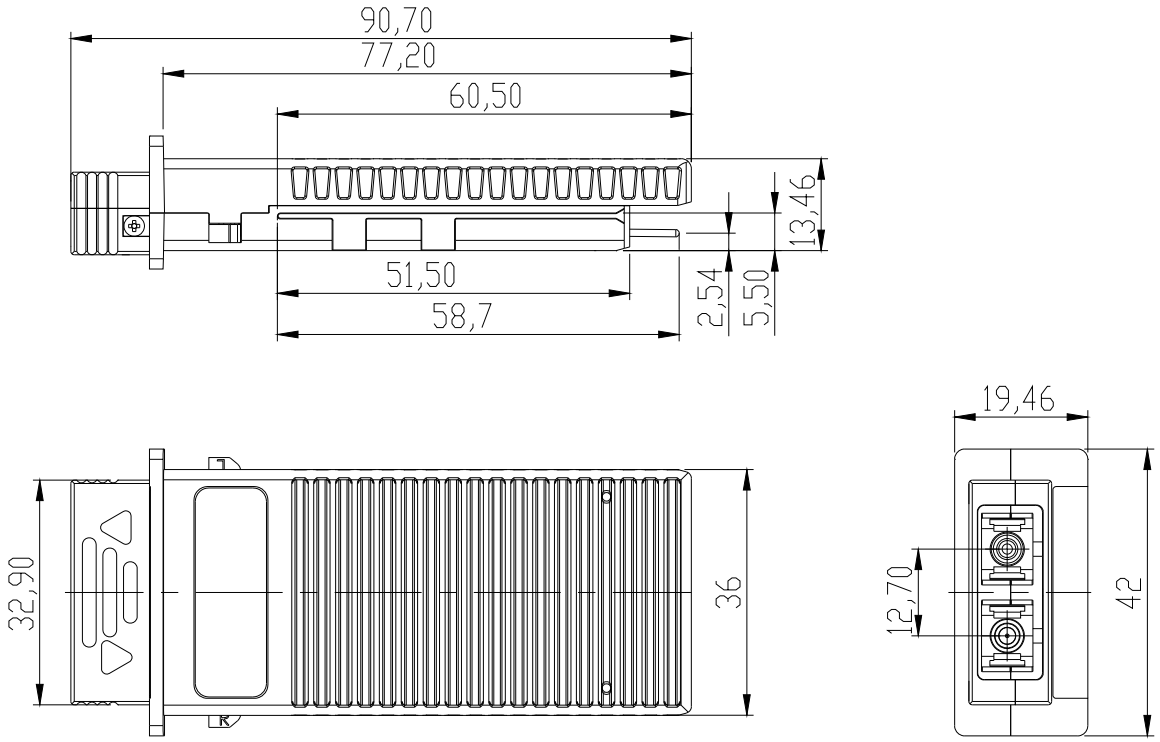
FDA

Compliant to 21 CFR 1040.10 and 1040.11

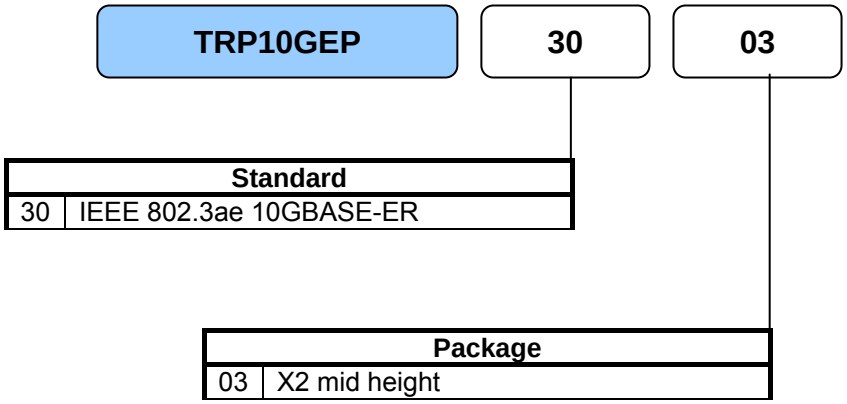
IEC

Class 1 Laser Product

Mechanical Drawing



Ordering Information



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