SFF specifications are available at http://www.snia.org/sff/specifications
or ftp://ftp.seagate.com/sff

This specification was developed by the SFF Committee prior to it becoming the SFF TA (Technology Affiliate) TWG (Technical Working Group) of SNIA (Storage Networking Industry Association).

The information below should be used instead of the equivalent herein.

POINTS OF CONTACT:

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If you are interested in participating in the activities of the SFF TWG, the membership application can be found at:
http://www.snia.org/sff/join

The complete list of SFF Specifications which have been completed or are currently being worked on can be found at:
http://www.snia.org/sff/specifications/SFF-8000.TXT

The operations which complement the SNIA's TWG Policies & Procedures to guide the SFF TWG can be found at:
http://www.snia.org/sff/specifications/SFF-8032.PDF

Suggestions for improvement of this specification will be welcome, they should be submitted to:
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SFF Committee

INF-8479i Specification for

POP4 Four Channel Pluggable Optical Transceiver

Rev 1.0 September 4 2002

Secretariat: SFF Committee

Abstract: This specification describes the POP4 Four Channel (parallel optic) Pluggable Optical transceiver. It was developed by the MSA (Multiple Source Agreement) group in which the following companies participated:

Agilent Technologies
Emcore
OptolC Technology
Primarion
Zarlink

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EXPRESSION OF SUPPORT BY MANUFACTURERS

The following member companies of the SFF Committee voted in favor of this industry specification.

The following member companies of the SFF Committee voted against this industry specification.

The following member companies of the SFF Committee voted to abstain on this industry specification.

SFF COMMITTEE

The SFF Committee is an industry group. The membership of the committee since its formation in August 1990 has included a mix of companies which are leaders across the industry.

When 2 1/2" diameter disk drives were introduced, there was no commonality on external dimensions e.g. physical size, mounting locations, connector type, connector location, between vendors.

The first use of these disk drives was in specific applications such as laptop portable computers and system integrators worked individually with vendors to develop the packaging. The result was wide diversity, and incompatibility.

The problems faced by integrators, device suppliers, and component suppliers led to the formation of the SFF Committee as an industry ad hoc group to address the marketing and engineering considerations of the emerging new technology.

During the development of the form factor definitions, other activities were suggested because participants in the SFF Committee faced more problems than the physical form factors of disk drives. In November 1992, the charter was expanded to address any issues of general interest and concern to the storage industry. The SFF Committee became a forum for resolving industry issues that are either not addressed by the standards process or need an immediate solution.

Those companies which have agreed to support a specification are identified in the first pages of each SFF Specification. Industry consensus is not an essential requirement to publish an SFF Specification because it is recognized that in an emerging product area, there is room for more than one approach. By making the documentation on competing proposals available, an integrator can examine the alternatives available and select the product that is felt to be most suitable.

SFF Committee meetings are held during T10 weeks (see www.t10.org), and Specific Subject Working Groups are held at the convenience of the participants. Material presented at SFF Committee meetings becomes public domain, and there are no restrictions on the open mailing of material presented at committee meetings.

Most of the specifications developed by the SFF Committee have either been incorporated into standards or adopted as standards by EIA (Electronic Industries Association), ANSI (American National Standards Institute) and IEC (International Electrotechnical Commission).

Suggestions for improvement of this specification will be welcome. They should be sent to the SFF Committee, 14426 Black Walnut Ct, Saratoga, CA 95070.

The complete list of SFF Specifications which have been completed or are currently being worked on by the SFF Committee can be found at:

ftp://ftp.seagate.com/sff/SFF-8000.TXT

If you wish to know more about the SFF Committee, the principles which guide the activities can be found at:

ftp://ftp.seagate.com/sff/SFF-8032.TXT

If you are interested in participating or wish to follow the activities of the SFF Committee, the signup for membership and/or documentation can be found at:

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or the following application can be submitted.

Name: _____ Title: _____

Company: _____

Address: _____

_____

Phone: _____ Fax: _____

Email: _____

Please register me with the SFF Committee for one year.

___ Voting Membership w/Electronic documentation $ 2,160

___ Voting Membership w/Meeting documentation $ 1,800

___ Non-voting Observer w/Electronic documentation $ 660 U.S.
$ 760 Overseas

___ Non-voting Observer w/Meeting documentation $ 300 U.S.
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Check Payable to SFF Committee for $_____ is Enclosed

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POP4 MSA
pluggable transceiver

Four Channel
Pluggable Optical Transceiver
Multi-Source Agreement

—

POP4 MSA

Technical Specification
Revision 1.0

This MSA provides a common specification for 4-channel pluggable, parallel optic transceivers with data rates up to 2.7Gbps per channel. The technical specification defines the package outline, front panel cutout, printed circuit board footprint, electrical and optical interface and general performance characteristics. It is intended for public use by Networking Equipment Manufacturers, system integrators and component vendors alike.

Features of the pluggable 4 channel transceiver parallel fiber optic modules defined by this document include:

- 4 Transmit Channels and 4 Receive Channels
- 1 to 2.7 GBd (per channel) Signal Rate
- Data I/O is CML compatible with DC blocking capacitors
- Link length up to 300 m with 50/125 µm, 500 MHz•km multi-mode fiber at 2.5 Gbps
- Channel BER 10^{-12}
- Standard MTP™(MPO) ribbon fiber connector interface
- Pluggable MegArray™ ball grid array connector

This specification and additional information are available at:

www.popoptics.org

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1 Package Outline

Tolerancing per ASME Y-14.5-1994.
All dimensions are in millimeters.

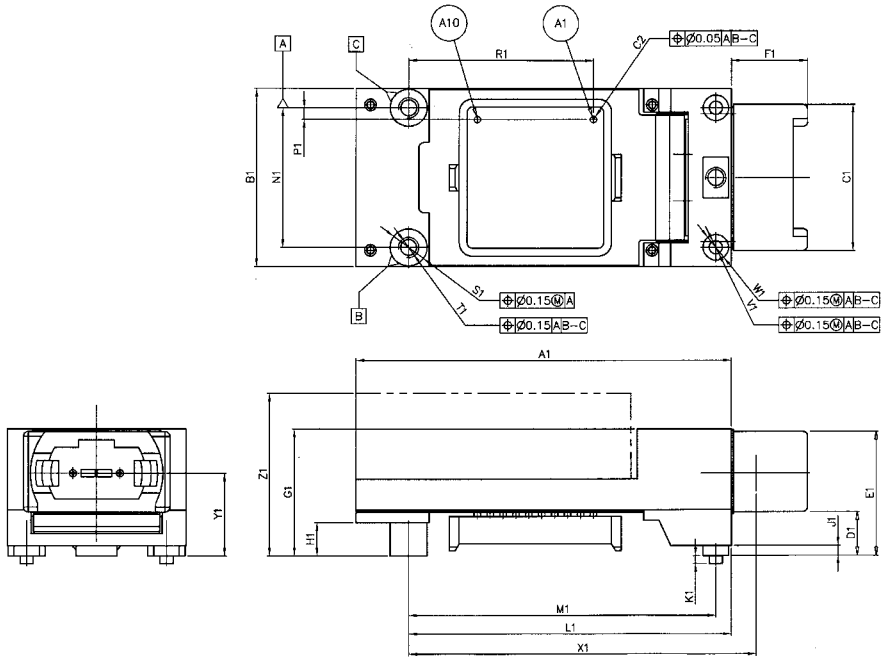

Figure 1 Module layout

Table 1 Module dimensions

Key	Dimension [mm]	Tolerance [mm]	Comments
A1	42.67	MAX	Length of module body, less optical receptacle assembly
B1	18.00	MAX	Width of module body
C1	15.25	MAX	Width of optical receptacle assembly
D1	2.70	MIN	Height of bottom of optical receptacle assembly
E1	15.70	MAX	Height of top of optical receptacle assembly
F1	7.40	MIN	Length of optical receptacle assembly
	10.00	MAX	
G1	15.55	MAX	Height of top of module
H1	3.00	MIN	Clearance over host board at rear of module
J1	0.31	MIN	Height of standoff boss on front posts
K1	0.76	±0.12	Height of front posts
L1	31.75	±0.50	Distance from rear post to front plane, less optical receptacle assembly
M1	30.23	BASIC	Distance from front to rear posts
N1	13.72	BASIC	Distance between posts, side-to-side
P1	1.14	BASIC	MegArray pin A1 location
R1	18.16	BASIC	MegArray pin A1 location
S1	Ø3.63	±0.25	Rear posts' diameter
T1	THREAD	—	2-56 UNC-2B threads, minimum 3.50 mm deep
V1	Ø1.30	±0.12	Front posts' diameter
W1	Ø2.50	±0.35	Diameter of standoff boss on front post
X1	—	—	Position of optical plane
Y1	—	—	Position of optical plane
Z1	16.00	MAX	Height of top of module, including optional vendor specific heatsink

2 Circuit Board Footprint

Tolerancing per ASME Y-14.5-1994.
All dimensions are in millimeters.

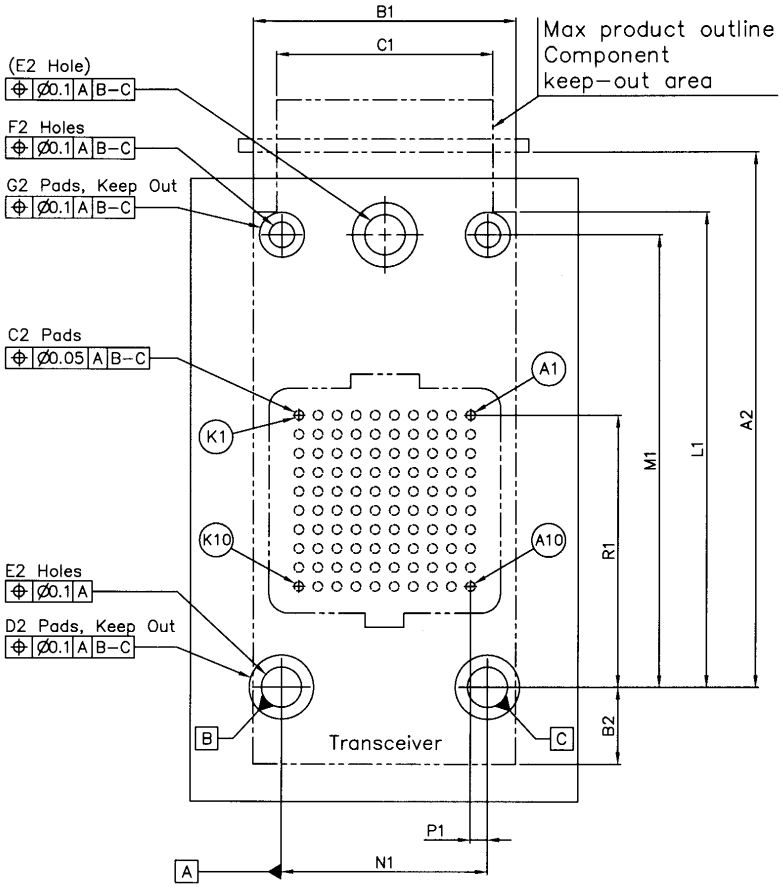

Figure 2 Host circuit board footprint layout

Table 2 Host circuit board footprint mechanical dimensions

Key	Dimension [mm]	Tolerance [mm]	Comments
A2	35.31	±0.75	Distance from rear post to inside surface of bezel
B2	10.92	MAX	Distance from rear post to rear of module keep-out area
C2	Ø0.58	±0.05	Diameter of pad in BGA pattern
D2	Ø4.30	MIN	Diameter of keep-out pad for posts: two rear and one front
E2	Ø2.69	±0.12	Diameter of hole for mounting screws: two rear and one front
F2	Ø1.70	±0.12	Diameter of hole for front post
G2	Ø3.00	MIN	Diameter of keep-out pad for front post

3 Host Frontplate Layout for Panel Accessed Modules

Tolerancing per ASME Y-14.5-1994.
All dimensions are in millimeters.

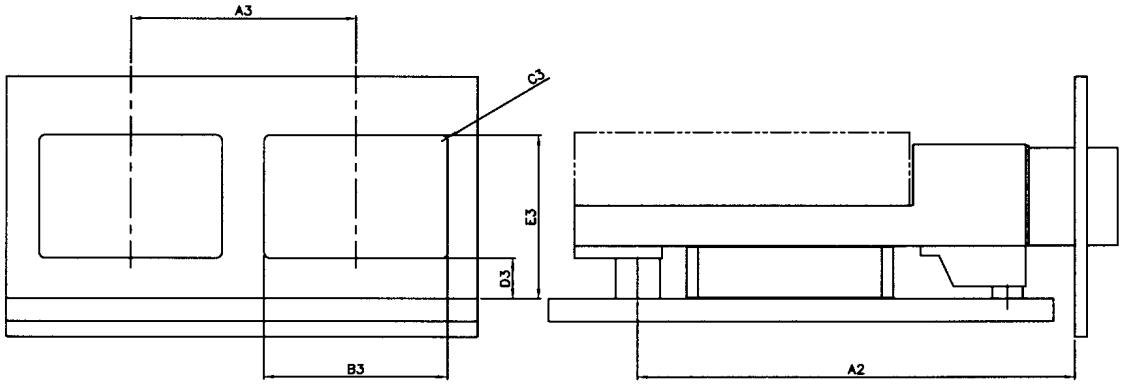

Figure 3 Host frontplate layout

Table 3 Host frontplate dimensions

Key	Dimension [mm]	Tolerance [mm]	Comments
A3	19.02	MIN	Center-to-center spacing for adjacent modules
B3	15.70	±0.25	Width of opening in frontplate
C3	0.50	MAX	Corner radius of opening in frontplate
D3	3.60	±0.2	Height from host PCB to bottom of frontplate opening
E3	13.40	±0.2	Height from host PCB to top of frontplate opening

4 Transceiver Module Signals

The pluggable parallel optical transceivers shall use a 100 position FCI Meg Array receptacle (FCI PN: 84513-101) or equivalent electrical connector.

The modules shall use an industry standard MTP™(MPO) optical connector compliant with IEC 61754-7.

4.1 Tranceiver Pad Assignments

Top of table toward front of module.

Table 4 Transceiver module pad assignment

	K	J	H	G	F	E	D	C	B	A
1	DOUT00-	VEE Rx	DOUT03+	VEE Rx	VEE Rx	VEE Tx	VEE Tx	DIN03-	VEE Tx	DIN00+
2	DOUT00+	VEE Rx	DOUT03-	VEE Rx	VEE Rx	VEE Tx	VEE Tx	DIN03+	VEE Tx	DIN00-
3	VEE Rx	VEE Rx	VEE Rx	VEE Rx	VEE Rx	VEE Tx	VEE Tx	VEE Tx	VEE Tx	VEE Tx
4	DOUT01+	VEE Rx	DOUT02-	DNC	DNC	DNC	DNC	DIN02+	VEE Tx	DIN01-
5	DOUT01-	VEE Rx	DOUT02+	DNC	DNC	DNC	DNC	DIN02-	VEE Tx	DIN01+
6	VEE Rx	VEE Rx	VEE Rx	DNC	DNC	DNC	DNC	VEE Tx	VEE Tx	VEE Tx
7	VCCB Rx	VCCB Rx	VCCB Rx	DNC	DNC	DNC	DNC	VCC Tx	VCC Tx	VCC Tx
8	DNC	Reserved TBD MSA	Reserved TBD MSA	Reserved TBD MSA	[RX_EN]	TX_DIS	TX_EN	DNC	DNC	DNC
9	DNC	Reserved TBD MSA	Reserved TBD MSA	SD	[SQ_EN]	RESET*	FAULT*	DNC	DNC	DNC
10	VCCA Rx	VCCA Rx	VEE Rx	DNC	DNC	DNC	DNC	VEE Tx	VCC Tx	VCC Tx

TOP VIEW (Host Printed Circuit Board layout)

4.2 Transceiver MTP Connector

Front view – MTP key is up											
Tx0	Tx1	Tx2	Tx3	-	-	-	-	Rx3	Rx2	Rx1	Rx0
Host printed circuit board											

5 Definitions: Signals, Pad Functions, Posts

DIN00+/- through DIN03+/- Transmitter differential data inputs for channels 0 through 3. Data inputs are CML compatible.

TX_DIS Transmitter Disable. Control input used to turn off the transmitter optical outputs. High Active. VCSEL array is off when High. Normal operation is enabled when Low and TX_EN High. Internal pull-down

TX_EN Transmitter Enable. Control input used to enable the transmitter optical outputs. High Active. VCSEL array is off when Low. Normal operation is enabled when High and TX_DIS Low. Internal pull-up.

FAULT* Transmitter Laser Fault. Status output indicating VCSEL driving condition faults on all channels. Low Active. One channel or more not functional when Low. Normal operation when High. Disables all channels when active, clear with Reset.

RESET* Transmitter Reset. Control input used to clear Fault. Low Active. Optical output is off when Low. Normal operation is enabled when High. Internal pull-up.

DOUT00+/- through DOUT03+/- Receiver differential data outputs for channels 0 through 3. Data outputs are CML compatible.

RX_EN Receiver Enable. Control input used to enable the receiver. High Active. Receiver is powered down when Low. Normal operation is enabled when High. Internal pull-up. (Optional)

SD Signal Detect. Receiver status output indicating valid signal on all channels. High Active. High output indicates valid optical inputs on all channels. Low output state indicates loss of signal on at least one of the channels. Internal pull-up.

SQ_EN Squelch Enable. Control input used to enable squelch on the electrical output signal. High Active. When active, data out is squelched on any channels that have loss of incoming signal. Internal pull-up. (Optional)

V_{EE} Rx Receiver signal common. All receiver voltages are referenced to this potential unless otherwise stated. Directly connect these pads to the PC board receiver ground plane.

V_{EE} Tx Transmitter signal common. All transmitter voltages are referenced to this potential unless otherwise stated. Directly connect these pads to the PC board transmitter ground plane.

DNC Do Not Connect. Do not connect to any electrical potential.

V_{CCA} Rx PIN preamplifier power supply rail

V_{CCB} Rx Receiver quantizer power supply rail

V_{CCA} Rx and V_{CCB} Rx can be connected to the same power supply. However, to insure maximum receiver sensitivity and minimize the impact of noise from the power supply, it is recommended to keep the power supplies separate and to use the recommended power supply filtering network on V_{CCA} Rx, see Figure 4.

V_{CC} Tx Transmitter power supply rail.

Reserved TBD MSA Reserved for future MSA defined functions.

Module Case Transceiver Case Common. Transceiver Case Common is electrically isolated from Transmitter Signal Common and Receiver Signal Common. Connection through mounting screw holes or frontplate whichever is applicable. Make the appropriate electrical connection for EMI shield integrity.

6 Transceiver Specifications

6.1 General Specifications

Parameter	Symbol	Min	Typ	Max	Units	Reference
Power Supply Voltage	V_{CC}	3.135	3.3	3.465	V	
Operating Case Temperature	T_{CASE}	0		80	°C	
Signaling Rate (per channel)	f_D	1		2.7	GBd	1
Control Input Voltage High	V_{IH}	2.0			V	
Control Input Voltage Low	V_{IL}			0.8	V	
Status Output Voltage High	V_{OH}	2.4			V	
Status Output Voltage Low	V_{OL}			0.4	V	
Data I/O DC Blocking Capacitors	C_{BLK}	100			nF	2
Power Supply Noise	PSN			200	mV_{p-p}	3

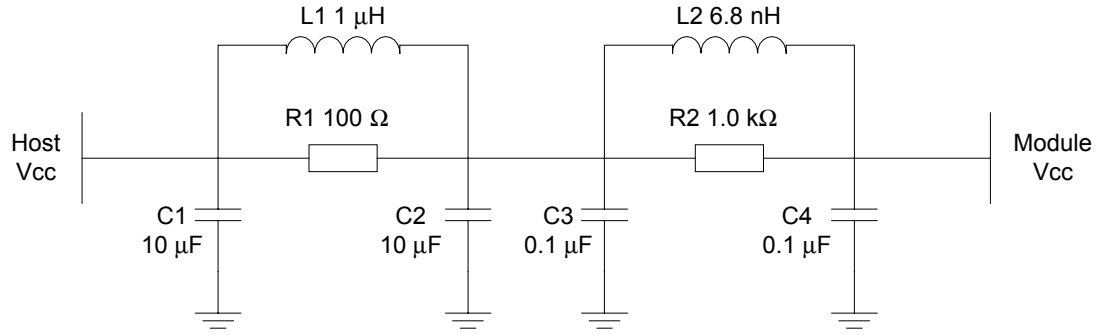

Figure 4 Recommended power supply filter network for both transmitter and receiver

1 Data patterns are to have maximum run lengths and DC balance shifts no worse than that of a Pseudo Random Bit Sequence of length 2^{23}-1 (PRBS-23).

2 DC blocking capacitors are required; if on PC board, a minimum value of 100 nF is recommended.

3 Power supply noise is defined at the supply side of the recommended filter for all V_{CC} supplies over the frequency range of 500 Hz to 2700 MHz with the recommended power supply filter in place.

6.2 Transmitter Specifications

All parameters below require T_{CASE} = 0 to 80 °C, V_{CC} = 3.3 V ± 5%, and f_D = 2.7 GBd.

Parameter	Symbol	Min	Max	Units	Reference
Optical Parameters					
Launch Power	P_{OUT}	-8	-2	dBm	4
Extinguished Output Power	P_{OFF}		-30	dBm	
Extinction Ratio	ER	6		dB	
Center Wavelength	λ_C	830	860	nm	
Spectral Width	$\Delta\lambda$		0.85	nm_{rms}	
Relative Intensity Noise (OMA)	$RIN_{12}OMA$		-116	dB/Hz	5
Output Rise Time (20-80%)	t_{RO}		150	ps	
Output Fall Time (20-80%)	t_{FO}		150	ps	
Total Jitter (pk-pk) - Tx Contributed	TJ		120	ps	6
Deterministic Jitter (pk-pk) - Tx Contributed	DJ		50	ps	
Channel-Channel Skew	t_{SK}		100	ps	7
Electrical Parameters					
Supply Current	I_{CC}		150	mA	
Differential Input Voltage Amplitude	$\|\Delta V_{IN}\|$	100	800	mV	8
Differential Input Impedance	Z_{IN}	80	120	Ω	9
Input Rise Time (20-80%)	t_{RE}		160	ps	
Input Fall Time (20-80%)	t_{FE}		160	ps	

4 The output optical power is compliant with IEC 60825-1:2001, Class 1M Accessible Emission Limits.

5 Corresponds to a Relative Intensity Noise (RIN) of –120 dB/Hz.

6 Total Jitter, TJ, equals TP1 to TP2 as defined in IEEE 802.3 Gigabit Ethernet Specification, clauses 38.2 and 38.6.

7 Channel-Channel Skew is defined for the condition of equal amplitude, zero ps skew signals applied to the transmitter inputs.

8 Differential Input Voltage, $|\Delta V_{IN}|$, is defined as the absolute value of the differential voltage between Din+ and Din-. Data inputs are CML compatible.

9 Differential Input Impedance is measured between Din+ and Din-.

6.3 Receiver Specifications

All parameters below require T_{CASE} = 0 to 80 °C, V_{CC} = 3.3 V ± 5%, f_D = 2.7 GBd and a termination load of 100 Ω differential at the electrical output.

Parameter	Symbol	Min	Max	Units	Reference
Optical Parameters					
Receive Power (Average)	P_{IN}	-16	-2	dBm	10
Center Wavelength	λ_C	830	860	nm	
Return Loss	RL	12		dB	11
Stressed Receiver Sensitivity	P_{SS}	-11.7		dBm	12, 13
Channel-Channel Skew	t_{SK}		100	ps	14
Signal Detect Asserted	P_{SA}		-17	dBm	
Signal Detect De-asserted	P_{SD}	-31		dBm	
Signal Detect Hysteresis	P_{SA}-P_{SD}	0.5		dB	
Electrical Parameters					
Supply Current	I_{CC}		250	mA	
Differential Output Voltage Amplitude	$\|\Delta V_{OUT}\|$	250	400	mV	15
Stressed Receiver Eye Opening	P_{SE}	111		ps	16
Output Rise Time (20-80%)	t_{RE}		160	ps	
Output Fall Time (20-80%)	t_{FE}		160	ps	

10 Receive Power for a channel is measured for a BER of 10^{-12} and worst case Extinction Ratio. P_{IN}(Min) is measured using a fast rise/fall time source with low RIN and adjacent channel(s) operating with incident power of 6 dB above P_{IN}(Min) specification.

11 Return Loss is measured as defined in IEEE 802.3z Gigabit Ethernet Specification Section 38.5.

12 The stressed receiver sensitivity is measured using PRBS 2^{23}-1 pattern, 2.6 dB Inter-Symbol Interference, ISI, (Min), 30 ps Duty Cycle Dependent Deterministic Jitter, DCD DJ (Min) and 6 dB ER (ER Penalty = 2.2 dB). All channels not under test are receiving signals with an average input power of 6 dB above P_{IN}(Min) specification.

13 The optional high bandwidth fiber (2000 MHz*km), require the Stressed Receiver Sensitivity parameter to meet –12.5 dBm.

14 Channel-Channel Skew is defined for the condition of equal amplitude, zero ps skew signals applied to the transmitter inputs.

15 Differential Output Voltage, $|\Delta V_{OUT}|$, is defined as the absolute value of the differential voltage between Dout+ and Dout- and measured with a 100 Ω differential load connected between Dout+ and Dout-. Data outputs are CML compatible.

16 The stressed receiver eye opening represents the eye at TP4 as defined in IEEE 802.3 clauses 38.2 and 38.6 (Gigabit Ethernet). The stressed receiver eye opening is measured using PRBS 2^{23}-1 pattern, 2.6 dB ISI (Min), 30 ps DCD DJ (Min), 6 dB ER and an average input optical power of –11.2 dBm (0.5 dB above Minimum Stressed Receiver Sensitivity as defined in IEEE 802.3 clause 38.6). All channels not under test are receiving signals up to an average input power of 6 dB above P_{IN}(Min) specification.

6.4 Timing Requirements of Control and Status Signals

The following figures and subsequent table show and tabulate the timing relationships of the status and control signals of the pluggable transceiver modules. As specified in the previous section, some of these signals are optional.

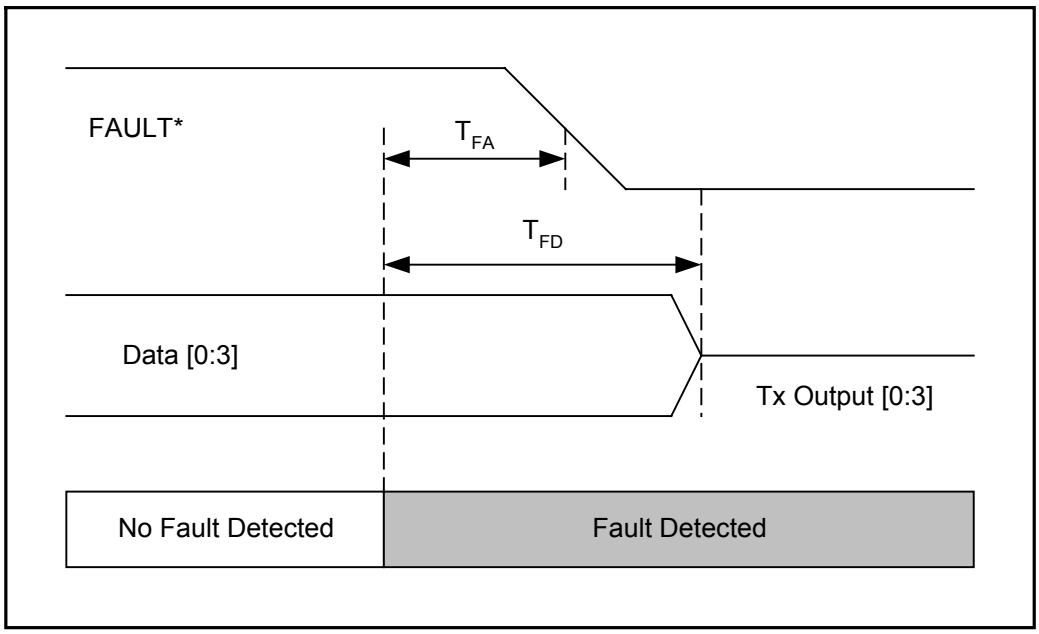

Figure 5 Transmitter FAULT* signal timing diagram

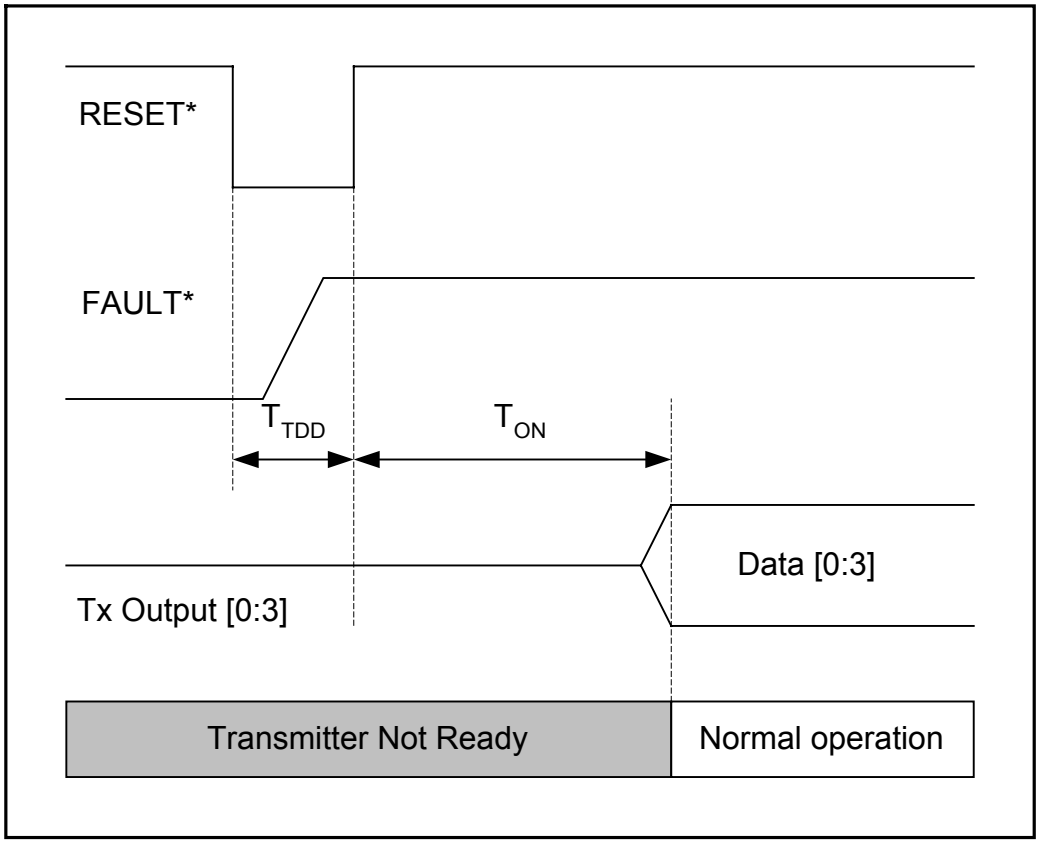

Figure 6 Transmitter RESET* signal timing diagram

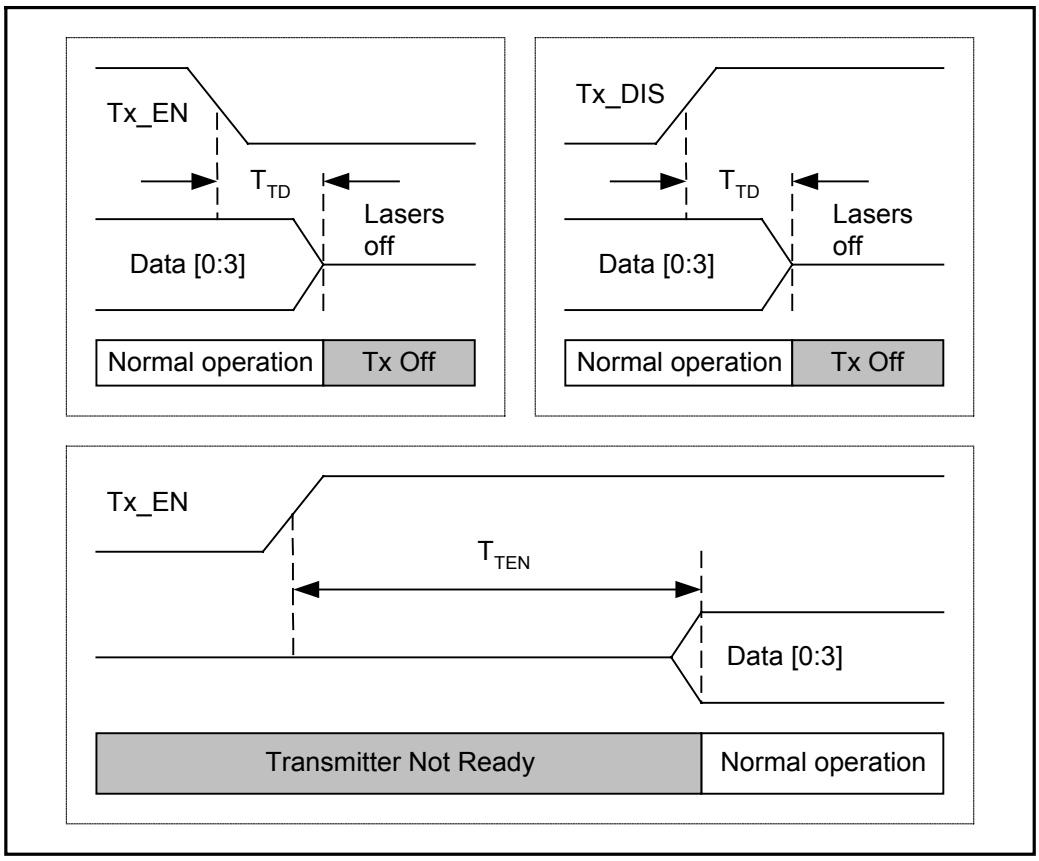

Figure 7 Transmitter ENABLE and DISABLE signal timing diagram

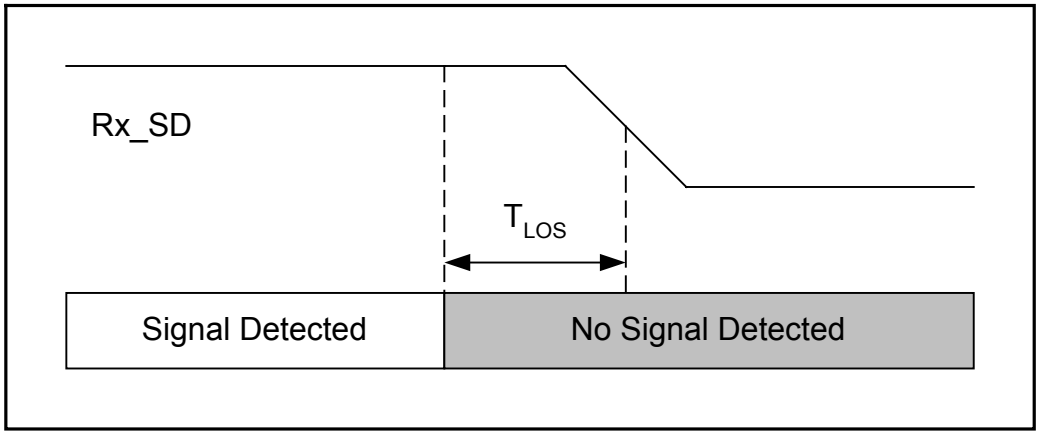

Figure 8 Receiver Signal Detect timing diagram

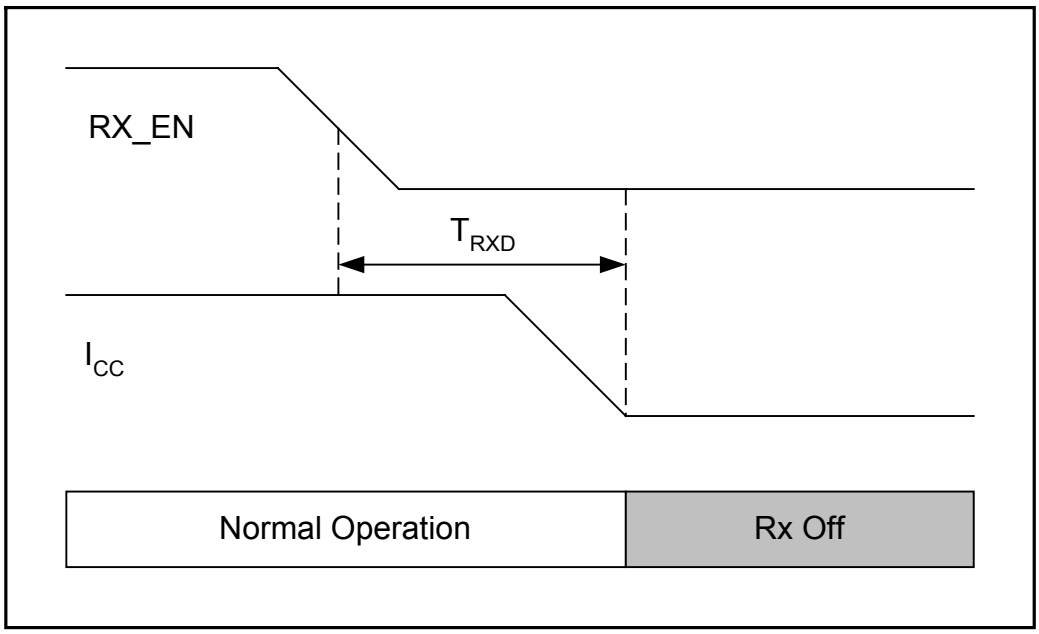

Figure 9 Receiver ENABLE signal timing diagram

Table 5 Timing requirements of control and status signals

Parameter	Symbol	Min	Typ	Max	Unit	Comment
FAULT* assert time	T_{FA}			100	µs	Time from occurance of a transmitter fault until the FAULT* signal goes active (Low)
FAULT* lasers off	T_{FD}			100	µs	Time from occurance of a transmitter fault to the lasers shutting off
RESET* duration	T_{TDD}	10			µs	Minimum hold time for RESET* active (Low) to clear a fault
RESET* de-assert time	T_{ON}		33	100	ms	Time until data is valid after RESET* de-active (High)
TX_EN assert time	T_{TEN}			1	ms	Time until data is valid after TX_EN active (High)
TX_DIS de-assert time	T_{TEN}			1	ms	Time until data is valid after TX_DIS de-active (High)
SD assert time	T_{SD}		50		µs	Time after valid data until SD is valid (High)
SD de-assert time	T_{LOS}		50		µs	Time after data no longer valid until SD is de-active (Low)
RX_EN assert time	T_{RXEN}		33		ms	Time until data is valid after RX_EN active (High)
RX_EN de-assert time	T_{RXD}		5		µs	Time after RX_EN de-active (Low) during which data is still valid

6.5 Link Length

The following table lists the minimum reach distance of the pluggable optical transceiver modules for different multi-mode fiber (MMF) types and bandwidths. Each case includes a maximum of 2 dB per channel connection loss for path cables and other connectors.

Fiber Type [core / cladding μm]	**Modal Bandwidth @ 850 nm** [MHz*km]	**Reach Distance @ 2.5 Gbps** [m]	**Reach Distance @ 2.7 Gbps** [m]
62.5/125 MMF	200	135	115
62.5/125 or 50/125 MMF	400	260	220
50/125 MMF	500	300	270
50/125 MMF (Optional)	2000	600	500

6.5.1 Link Model Parameters

The link lengths above have been achieved with the following link model parameters.

Parameter	**Symbol**	**Value**	**Unit**
Mode partition noise k-factor	k	0.3	
Modal noise	MN	0.3	dB
Dispersion slope parameter	S_O	0.11	ps/nm^2*km
Wavelength of zero dispersion	U_O	1320	nm
Attenuation coefficient at 850 nm	α_{db}	3.5	dB/km
Conversion factor	C1	480	ns.MHz
Q-factor [BER 10^{-12}]	Q	7.04	
TP4 eye opening		0.3	UI
DCD allocation at TP3	DCD DJ	0.08	UI
RMS baseline wander S.D.	σ_{BLW}	0.025	
RIN coefficient	k_{rin}	0.70	
Conversion factor	c_rx	329	ns.MHz

6.5.2 Restricted Launch (Optional)

The transceiver would be guaranteed to meet the inner and outer requirements of encircled flux VCSEL launch specification defined in TIA/EIA-492AAAC *'Detailed Specification for 850 nm Laser Optimized 50 μm Core Diameter/125 μm Cladding Diameter, Class 1 a Graded Index Multimode Optical Fibers'.*

- Encircled flux launch at (inner) 4.5 μm radius <= 30%
- Encircled flux launch at (outer) 19 μm radius >= 86%

7 Eye Safety

The maximum optical output power is specified to comply to Class 1M in accordance with IEC 60825-1:2001. In addition the transceiver complies with FDA performance standards for laser products except for deviations pursuant to Laser Notice No.50, dated July 26, 2001.