Technical Data Sheet

August 2002

SAMSUNG ELECTRONICS
FIBEROPTICS DIVISION

TR117FA
155Mbps 1310nm Small Form Factor Pluggable(SFP) LC Duplex Single Mode Transceiver

Features

- Links of 15 or 40km with 9/125μm single mode fiber
- 1.3μm InGaAsP MQW FP laser
- Highly sensitive InGaAs PIN Photodiode
- Operating temperature range of -40~85°C
- Single +3.3V power supply
- Supports serial ID
- Fully compatible MSA with LC duplex Receptacle
- AC coupled input and output data signal
- TTL Loss of Signal (LOS)
- Digital monitoring Function (LD bias current, LD power, PD received power, Temperature, and applied bias voltage)

Applications

SONET/SDH equipment interconnect, SONET OC-3 / SDH STM-1 rate, and Inter/intra-office ATM/SONET links

Product Code

Product Code	Extinction Ratio	Output Power	Distance
TR117FA-0D30S	≥8.2dB	-15~-8dBm	15Km
TR117FA-0D40S	≥10dB	-5~0dBm	40Km

Description

Samsung's TR117FA of small form factor pluggable transceiver are uncooled transceiver modules operated over the temperature range of -40°C to 85°C. These transceiver modules are designed for single mode fiber and operate at a nominal wavelength of 1300nm. They are incorporated with a high performance optical subassembly (OSA), a reliable circuit board (PCB) and a low cost plastic package. The transmitter section of TR137FA-0D40S is 1.3μm InGaAsP MQW Fabry Perot (FP) laser diode. The receiver section uses a highly sensitive InGaAs PIN photodiode. Transceiver also conforms to the industry SFP Multi-source agreement (MSA). For the good EMI performance, this transceiver uses the metal cover.

This module will meet the growing demand on the optical network unit (ONU) for access network and local area network (LAN) for SONET OC-3 and SDH STM-1.

Pin Information

Pin	Symbol	Sequence	Type	Functional Description
1	VeeT	1	Ground	Transmitter signal ground
2	TX Fault	3	Signal Out	Transmitter fault indication
3	TX Disable	3	Signal In	Transmitter disable
4	MOD_DEF2	3	Input/Output	Module definition 2
5	MOD_DEF1	3	Input/Output	Module definition 1
6	MOD_DEF0	3	Input/Output	Module definition 0
7	Rate Select	3	Not Connected	Select between full or reduced receiver bandwidth
8	Los	3	Signal Out	Loss of signal
9	VeeR	1	Ground	Receiver ground
10	VeeR	1	Ground	Receiver ground
11	VeeR	1	Ground	Receiver ground
12	RD-	3	Data Out	Received data inverted output
13	RD+	3	Data Out	Received data non-inverted output
14	VeeR	1	Ground	Receiver ground
15	VccR	2	Power	+3.3V Receiver power supply
16	VccT	2	Power	+3.3V Transmitter power supply
17	VeeT	1	Ground	Transmitter ground
18	TD+	3	Data In	Transmitter data non-inverted output
19	TD-	3	Data In	Transmitter data inverted output
20	VeeT	1	Ground	Transmitter ground

Notes:

1) **TX Fault** is an open collector/drain output, which should be pulled up with a 4.7k – 10kΩ resistor on the host board. When high, output indicates a laser fault of some kind. Low indicates normal operation. In the low state, the output will be pulled to < 0.8V.

2) **TX disable** is an input that is used to shut down the transmitter optical output. It is pulled up within the module with a 4.7k – 10kΩ resistor. Its states are:
Low (0 – 0.8V): Transmitter on
(>0.8, < 2.0V): Undefined
High (2.0 – 3.465V): Transmitter Disabled
Open: Transmitter Disabled

3) **Mod-Def 0,1,2.** These are the module definition pins. They should be pulled up with a 4.7k – 10kΩresistor on the host board. The pull-up voltage shall be VccT or VccR.
Mod-Def 0 is grounded by the module to indicate that the module is present Mod-Def 1 is the clock line of two wire serial interface for serial ID Mod-Def 2 is the data line of two wire serial interface for serial ID.

4) **LOS**(**Loss of Signal)** is an open collector/drain output, which should be pulled up with a 4.7k – 10kΩresistor. When high, this output indicates the received optical power is below the worst-case receiver sensitivity. Low indicates normal operation. In the low state, the output will be pulled to < 0.8V.

5) **VeeR** and **VeeT** may be internally connected within the SFP module.

6) **Rx_Data-/+:** These are the differential receiver outputs. They are AC coupled 100Ωdifferential lines should be terminated with 100Ω(differential) at the user SERDES. The AC coupling is done inside the module and is thus not required on the host board. The voltage swing on these lines will be between 600 and 900 mV differential when properly terminated.

7) **VccR** and **VccT** are the receiver and transmitter power supplies. They are defined as 3.3V±5% at the SFP connector pin. Maximum supply current is 200 mA. Recommended host board power supply filtering is shown below. 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. 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. VccR and VccT may be internally connected within the SFP transceiver module.

8) **Tx_Data-/+:** These are the differential transmitter inputs. They are AC-coupled, differential lines with 100Ω termination inside the module. The AC coupling is done inside the module and is thus not required on the host board. The inputs will accept differential swings of 200 –

1800 mV, though it is recommended that values between 500 and 1200 mV differential be used for best EMI performance.

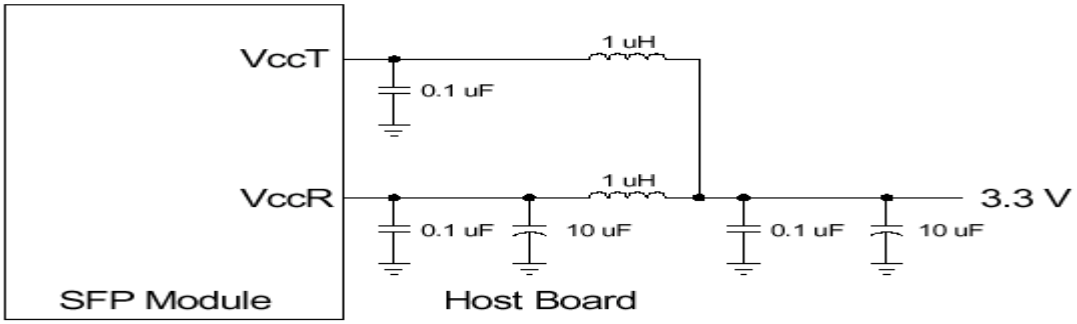


Figure 1. Recommended Host Board Supply Filtering Network

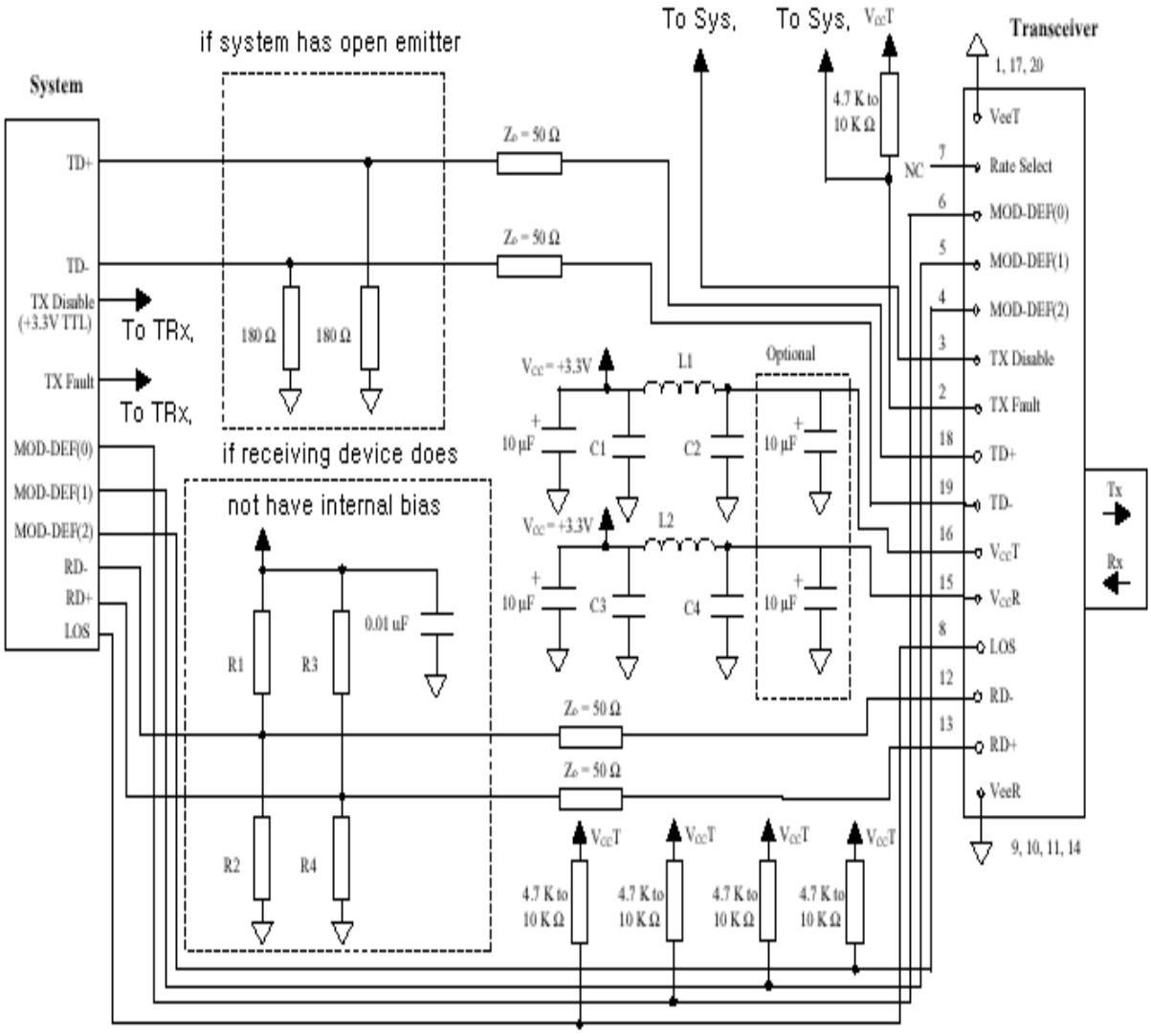


Figure 2. Example SFP Host Board Schematics

In order to prevent unwanted reflections between system and transceiver, it is necessary to have both a 50Ω impedance matched transmission line as well as a 50Ω termination load. The system board differential pair transmission lines must be designed with the same length.

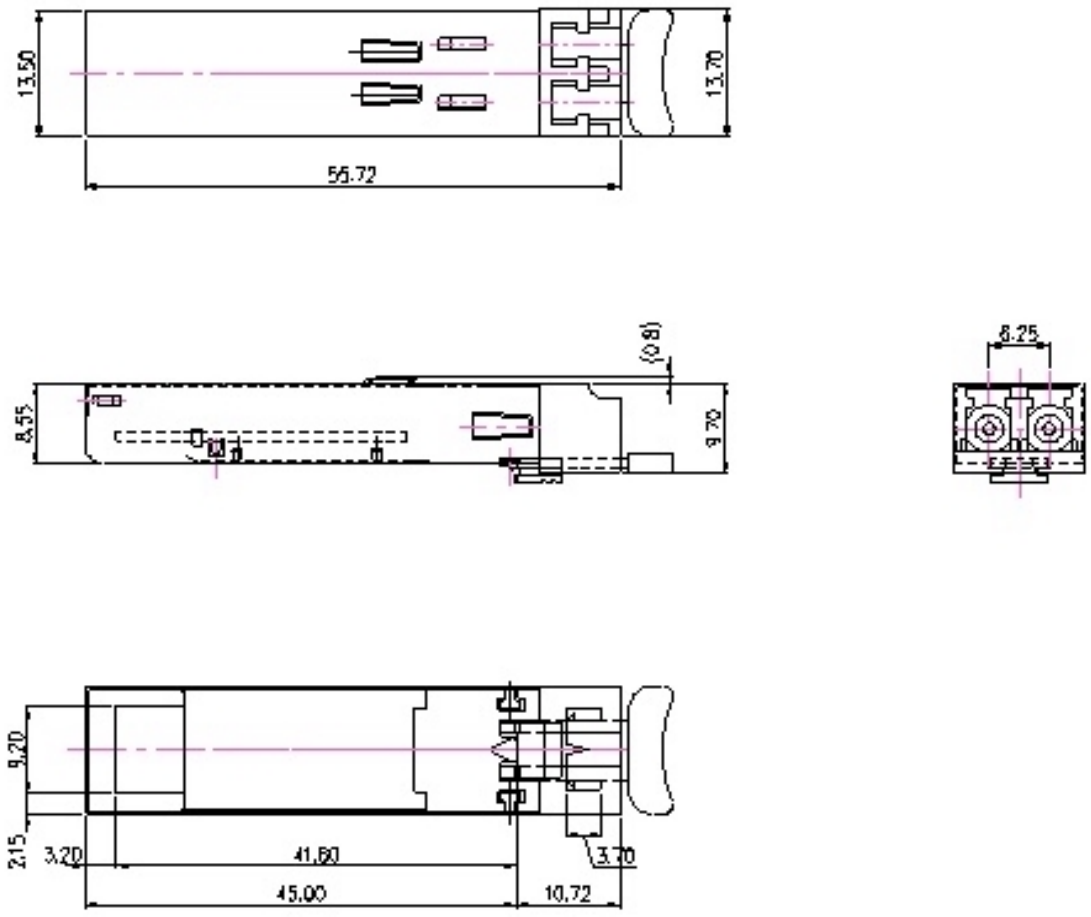
The transmitter internally includes a 100Ω differential termination for the two differential input lines (TD+, TD-). Therefore, additional 50Ω terminations should not be externally connected to the transmitter-input lines. The transmitter is disabled when the TX disable is TTL high and enabled when TTL low. If this feature is not needed, it should be connected to system ground.

Outline Diagram

Dimensions are in millimeters (inches).

Tolerances : x.xx ± 0.025mm

x.x ± 0.05mm, unless otherwise specified



Module Performance Characteristics

Electrical characteristics					
Parameter	**Symbol**	**Min**	**Typ**	**Max**	**Unit**
Transmitter Section (Ambient operating temperature V_{CC}=3.1V to 3.5V)					
Power supply current	I_{CC}	-	-	150	mA
Differential input voltage[1]	$V_{IH} – V_{IL}$	300	-	1860	mV
Tx disable voltage-low	V_{IL}	-	-	0.8	V
Tx disable voltage-high	V_{IH}	2	-	-	V
[1] Differential input is recommended since data sheet spec. can only be guaranteed					
Receiver Section (Ambient operating temperature V_{CC}=3.1V to 3.5V)					
Power supply current[1]	I_{CC}	-	-	80	mA
Differential Data output voltage	V_O	600	-	900	mV
LOS output voltage-low	V_{OL}	-	-	0.8	V
LOS output voltage-high	V_{OH}	2	-	-	V
[1] Excludes output load current					

Optical characteristics					
Parameter	**Symbol**	**Min**	**Typ**	**Max**	**Unit**
Transmitter Section for TR117FA-0D30S (Ambient operating temperature V_{CC}=3.1V to 3.5V)					
Average output power [1]	P_O	-15	-11	-8	dBm
Center wavelength	λ_C	1261	1310	1360	nm
Output spectral width (RMS)	$\Delta\lambda_{RMS}$		2	7.7	nm
Extinction ratio	E_R	8.2	15		dB
Output eye	Comply with Bellcore TR-NWT-000253 and ITU G.957				
Optical rise time (20% to 80%)	t_R			1.0	ns
Optical fall time (80% to 20%)	t_F			1.0	ns
[1] 9/125μm SMF coupled					
Transmitter Section for TR117FA-0D40S (Ambient operating temperature V_{CC}=3.1V to 3.5V)					
Average output power [1]	P_O	-5	-2.5	0	dBm
Center wavelength	λ_C	1263	1310	1360	nm
Output spectral width (RMS)	$\Delta\lambda_{RMS}$		2	3	nm
Extinction ratio	E_R	10	18		dB
Output eye	Comply with Bellcore TR-NWT-000253 and ITU G.957				
Optical rise time (20% to 80%)	t_R			1	ns
Optical fall time (80% to 20%)	t_F			1	ns
[1] 9/125μm SMF coupled					

Receiver Section for TR117FA-0D30S (Ambient operating temperature V_{CC}=3.1V to 3.5V)					
Receiver sensitivity [1]			-38	-36	dBm
Maximum input power	P_{MAX}	-3			dBm
Link status switching threshold Decreasing light Increasing light	 LST_D LST_I	 -50		 -36.5 -36	 dBm dBm
Link status hysteresis		0.5	2		dB
[1] Measured at $1x10^{-10}$ BER with 2^{23}-1 PRBS					
Receiver Section for TR117FA-0D40S (Ambient operating temperature V_{CC}=3.1V to 3.5V)					
Receiver sensitivity [1]			-38	-36	dBm
Maximum input power	P_{MAX}	-3			dBm
Link status switching threshold Decreasing light Increasing light	 LST_D LST_I	 -50		 -36.5 -36	 dBm dBm
Link status hysteresis		0.5	2		dB
[1] Measured at $1x10^{-10}$ BER with 2^{23}-1 PRBS					

Absolute Maximum Ratings

These are absolute maximum ratings only. Higher stress than these ratings may adversely affect device reliability or cause permanent damage to the device.

Parameter	**Symbol**	**Min**	**Typ**	**Max**	**Unit**	**Note**
Storage temperature	T_S	-40		85	°C	
Soldering temperature				260	°C	6sec.on leads only
Supply voltage	V_{CC}	0		5	V	

Operating Environment

Parameter	**Symbol**	**Min**	**Typ**	**Max**	**Unit**	**Note**
Ambient temperature	T_A	-40		85	°C	
Supply voltage	V_{CC}-V_{ee}	3.1	3.3	3.5	V	
Transmitter differential input voltage	V_D	0.3		2.4	V	

Timing requirements of control and status I/O

Parameter	Symbol	Min	Max	Unit	Conditions
Tx Disable assert time	t_{off}		10	µs	Timing from rising edge of Tx Disable to when the optical output falls below 10% of nominal
Tx Disable Negate time	t_{on}		1	ms	Timing from falling edge of Tx Disable to when the modulated optical output rises above 90% of nominal
Time to initialize Includes reset of Tx Fault	t_{init}		300	ms	From power on or negation of Tx Fault using Tx Disable
Tx Fault Assert time	t_{fault}		100	µs	Time from fault to Tx Fault on
Tx Disable to Reset	t_{reset}	10		µs	Time Tx Disable must be held high to reset Tx Fault
Los Assert time	$t_{loss-on}$		100	µs	Time from LOS state to Rx Los assert
Los Deassert time	$t_{loss-off}$		1000	µs	Time from non-LOS state to Rx Los deassert
Rate select Change time	$t_{ratesel}$		100	µs	Timing from rising or falling edge of rate select input until receiver bandwidth is in conformance with appropriate specification
Serial ID clock rate	$F_{s-clock}$		100	kHz	

SFP transceiver power on initialization procedure, TX_DISABLE negated.

During power on of the SFP transceiver, TX_FAULT may be asserted (High) as soon as power supply voltages are within specification. For transceiver initialization with TX_DISABLE negated, TX_FAULT shall be negated when the transmitter safety circuitry has detected that the transmitter is operating in its normal state. If a transmitter fault has not occurred, TX_FAULT shall be negated within a period t_init from the time that VCCT exceeds the specified minimum operating voltage. If TX_FAULT remains asserted beyond the period t_init, the host may assume that a transmission fault has been detected by the transceiver. The power on initialization timing for a transceiver with TX_DISABLE negated is shown in Figure 3.

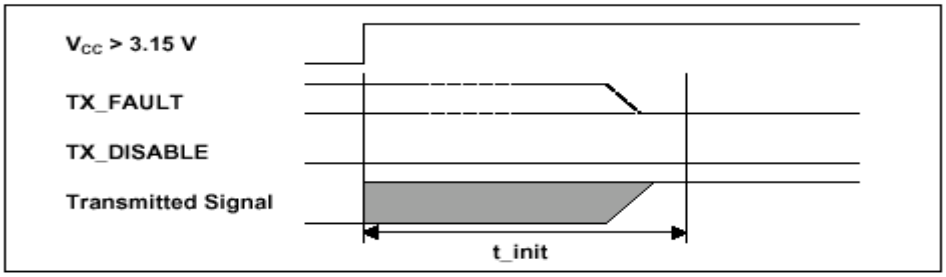


Figure 3. Power on initialization of SFP transceivers, Tx Disable negated

SFP transceiver power on initialization procedure, TX_DISABLE asserted.

For SFP transceiver power on initialization with TX_DISABLE asserted, the state of TX_FAULT is not defined while TX_DISABLE is asserted. After TX_DISABLE is negated, TX_FAULT may be asserted while safety circuit initialization is performed. TX_FAULT shall be negated when the transmitter safety circuitry has detected that the transmitter is operating in its normal state. If a transmitter fault has not occurred, TX_FAULT shall be negated within a period t_init from the time that TX_DISABLE is negated. If TX_FAULT remains asserted beyond the period t_init, the host may assume that a transmission fault has been detected by the transceiver. The power on initialization timing for a SFP transceiver with TX_DISABLE asserted is shown in Figure 4.

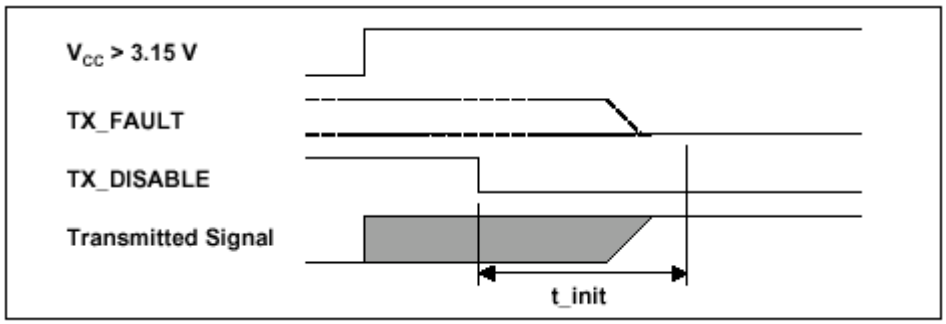


Figure 4. Power on initialization of SFP, Tx Disable asserted

Initialization during hot plugging of SFP Transceiver.

When a transceiver is not installed, TX_FAULT is held to the asserted state by the pull up circuits on the host. As the SFP transceiver is installed, contact is made with the ground, voltage, and signal contacts in the specified order. After the SFP has determined that VCCT has reached the specified value, the power on initialization takes place as described in the above sections. An example of initialization during hot plugging is provided in Figure 5.

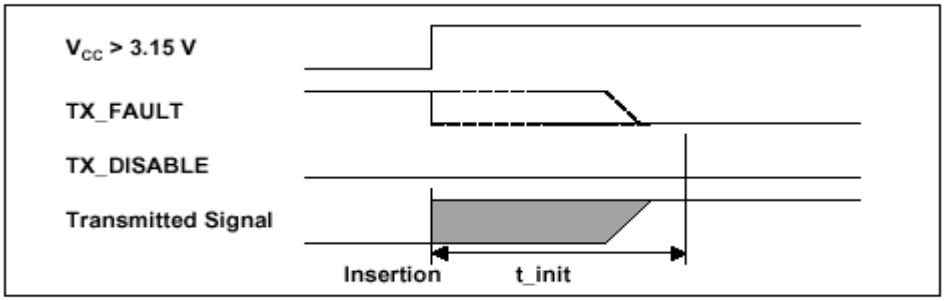


Figure 5. Example of initialization during hot plugging, Tx Disable negated

SFP transmitter management

The timing requirements for the management of optical outputs from the SFP

transceiver using the TX_DISABLE signal are shown in Figure 6. Note that the t_on time refers to the maximum delay until the modulated optical signal reaches 90% of the final value, not just the average optical power.

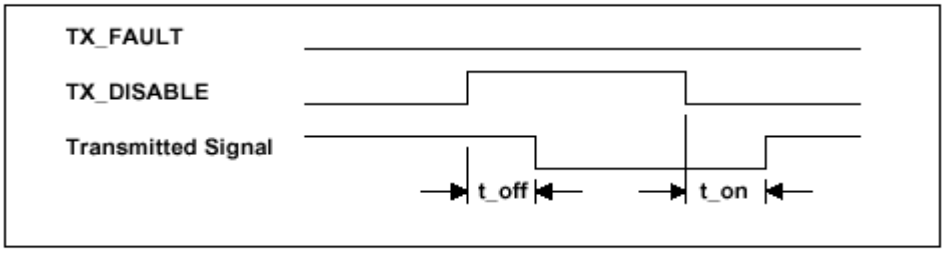


Figure 6. SFP Tx Disable timing during normal operation

SFP transceiver fault detection and presentation

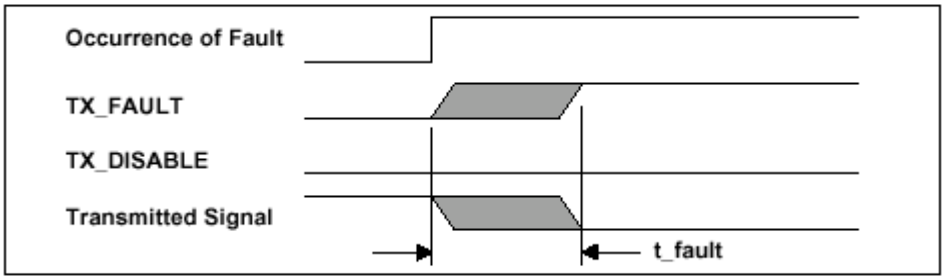


Figure 7. Detection of transmitter safety fault condition

SFP transceiver fault recovery

The detection of a safety-related transmitter fault condition presented by TX_FAULT shall be latched. The following protocol may be used to reset the latch in case the transmitter fault condition is transient. To reset the fault condition and associated detection circuitry, TX_DISABLE shall be asserted for a minimum of t_reset. TX_DISABLE shall then be negated. In less than the maximum value of t_init the optical transmitter will correctly reinitialize the laser circuits, negate TX_FAULT, and begin normal operation if the fault condition is no longer present. If a fault condition is detected during the reinitialization, TX_FAULT shall again be asserted, the fault condition again latched, and the optical transmitter circuitry will again be disabled until the next time a reset protocol is attempted. The manufacturer of the SFP shall ensure that the optical power emitted from an open connector or fiber is compliant with IEC825-1 and CDRH during all reset attempts, during normal operation or upon the occurrence of reasonable single fault conditions. The SFP transceiver may require internal protective circuitry to prevent the frequent assertion of the TX_DISABLE signal from generating frequent pulses of energy that violate the safety requirements. The timing for successful recovery from a transient safety fault condition is shown in Figure 8.

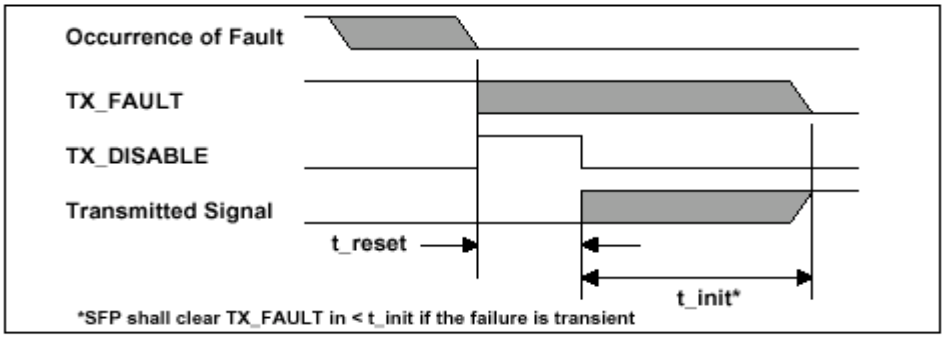


Figure 8. Successful recovery from transient safety fault condition

An example of an unsuccessful recovery, where the fault condition was not transient, is shown in Figure 9.

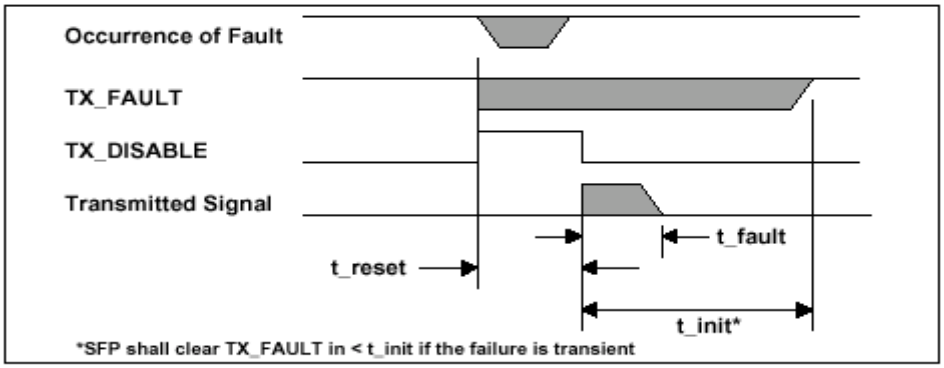


Figure 9. Unsuccessful recovery from safety fault condition

SFP transceiver loss of signal indication

The LOS signal is intended as a preliminary indication to the system in which the SFP transceiver is installed that the link signals are likely to be outside the required values for proper operation. Such indications typically point to non-installed cables, broken cables, or a disabled, failing or powered off transmitter at the far end of the cable. Additional indications are provided by the system in which the SFP transceiver is installed to verify that the information being transmitted is valid, correctly encoded, and in the correct format. Such additional indications are outside the scope of the SFP Transceiver MSA. The timing of the LOS function is specified in Figure 10.

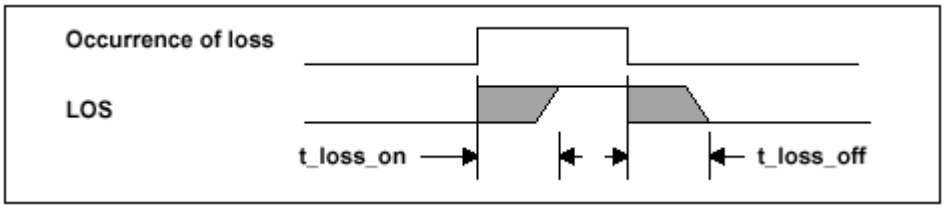


Figure 10. Timing of LOS detection

EEPROM Serial ID Memory Contents

Data Address	Length	Name of Field	Description
Base ID fields			
0	1	Identifier	03h=SFP
1	1	Ext. Identifier	04h=All SFP modules indicating serial ID module definition
2	1	Connector	07h=LC
3-10	8	Transceiver	SONET code - Reserved Gigabit Ethernet code - 1000BASE_SX FC(Fibre Channel) link length - Reserved FC transmitter technology - Reserved FC transmission media - Reserved FC speed - Reserved
11	1	Encoding	01h=8B10B
12	1	BR, Nominal	19h=100MHz*25=2.5GHz
13	1	Reserved	
14	1	9μ, distance	
15	1	9μ, distance	
16	1	50μ, distance	1Eh=30*10m=300m
17	1	62.5μ, distance	0Fh=15*10m=150m
18	1	CU, distance	
19	1	Reserved	
20-35	16	Vendor name	"SAMSUNG " =53/41/4D/53/55/4E/47/20/20/20/20/20/20/20/20/20h
36	1	Reserved	
37-39	3	Vendor OUI	86/01/00h=SAMSUNG OUI
40-55	16	Vendor PN	SAMSUNG part number
56-59	4	Vendor rev	SAMSUNG revision number
60-62	3	Reserved	
63	1	Check sum	Least significant byte of sum of data in addresses 0-62
Extended ID fields			
64-65	2	Options	001Ah=LOS, Tx_Fault, Tx_Disable all supported
66	1	BR, max	Unspecified
67	1	BR, min	Unspecified
68-83	16	Vendor SN	Unspecified
84-91	8	Date code	Date and lot number
92-94	3	Reserved	
95	1	Check sum	Least significant byte of sum of data in addresses 64-94
Vendor specific ID fields			
96-127	32	Readable	

Notes: The data can be read using the 2-wire serial Atmel AT24C01A EEPROM protocol

Laser Safety Information

Class I Laser Product

This product complies with IEC825-1, IEC825-2 laser safety requirements
Single-mode connector
Wavelength=1.3μm
Maximum power = 0.2mW (TR111SA-0D30S) / 1.0mW (TR111SA-0D40S)
Label is not affixed to the module because of size constraints but is contained in the shipping carton.
Product is not shipped with power supply

Caution: Use of controls, adjustments, and procedures other than those specified herein may result in hazardous laser radiation exposure

NOTICE

Unterminated optical connectors may emit laser radiation.

Do not view with optical instruments

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