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Gigabit Interface Converter (GBIC)

Revision 4.5

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4.3	Modify dimension L Correct Annex F parameters Extend MOD_DEF meanings Add LW 1.25 Gabbed MOD_DEF Improve Serial stream definition	08/22/97
4.4	Add GBIC MM/SM color coding Update jitter values and define them by reference to appropriate standards. Clarify MOD_DEF support for 6 and 7. Modified definition of MOD_DEF 1 and 2 to separate intracabinet and intercabinet connections. Included long-wave power trade-off charts. Add SONET parameters for MOD_DEF 4. Correct receptacle dimensions and drawing.	12/01/97
4.5	Assorted editorial and terminology corrections. Improve MOD_DEF 3 and 6 transmitter curves. Update MOD_DEF 3, 6 sensitivity numbers. Define RX_LOS, TX_DISABLE for MOD_DEF 1. Correct MOD_DEF 1 and 2 connector pinouts. Clarify 3.3 volt interface requirements. Update references. Complete text of Annex D, removing notes.	1/28/98

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Foreword

AMP Incorporated, Compaq Computers, Sun Microsystems, and Vixel Corporation have created a design for a serial transceiver module. The module provides a single very small form factor for a wide variety of standard Fibre Channel connectors and transmission media. The module can be inserted in or removed from a host or switch chassis without powering off the receiving socket. Any copper and optical transmission technologies consistent with the form factor may be used.

AMP Incorporated, Compaq Computers, Sun Microsystems, and Vixel Corporation expect that this design will prove useful to the disk drive, computer system, networking, and communications industries and will make the design available to interested companies.

The document is considered stable and suitable as a design specification. The status of each section of the document is shown in table 1.

Table 1: Status of document sections

Chapter/ Annex	Title	Status
1	Scope	Stable, suitable for design specification
2	Applicable Documents	Stable, suitable for design specification
3	Introduction and Overview	Stable, suitable for design specification
4	Electronic Specification for All GBICs	Stable, suitable for design specification
5	Operational Description	Stable, suitable for design specification
6	Mechanical interface for all GBICs	Stable, suitable for design specification
7	Environmental Requirements for all GBICs	Stable, suitable for design specification
Annex A	Module definition 1 (copper DB-9)	Stable, suitable for design specification
Annex B	Module definition 2 (copper HSSDC)	Stable, suitable for design specification
Annex C	Module definition 3 (single mode laser)	Stable, suitable for design specification
Annex D	Module definition 4 (Serial Identification)	Stable, suitable for design specification
Annex E	Module definition 5 (short wave laser, FC)	Stable, suitable for design specification
Annex F	Module definition 6 (single mode laser, FC and Ethernet)	Stable, suitable for design specification
Annex G	Module definition 7 (short wave laser, FC and Ethernet)	Stable, suitable for design specification

Gigabit Interface Converter (GBIC)

1 Scope

This document defines the electronic, electrical, and physical interfaces of a removable serial transceiver module designed to provide gigabaud capability for Fibre Channel (FC) and other protocols that use the same physical layer. The contents of this document represent a cooperative design effort among AMP, Inc., Compaq Computer Corporation, Sun Microsystems Computer Company, and Vixel Corporation.

2 Applicable Documents

Fibre Channel Physical and Signaling Interface (FC-PH), X3.230-1995
Fibre Channel Physical and Signaling Interface - 2 (FC-PH-2), X3T11/Project 901D/Rev 7.4, (September, 1996)
Fibre Channel Physical and Signaling Interface - 3 (FC-PH-3), X3T11/Project 1119/Rev 9.1, (October, 1996)
Fibre Channel Low Cost 10 km Optical 1063 MBaud Interface (100-SM-LC-L), NCITS T11.2 Project xxx, Revision 1.0, (December, 1997)
Fibre Channel - Jitter Methodologies, draft proposed Technical Report, Project 1230-DT, Revision 1.1
Safety of laser products - Part 1: Equipment classification requirements and user's guide, IEC 825-1
Supplement to Carrier Sense Multiple Access with Collision Detection (CMSA/CD) "Access Method & Physical Layer Specifications: Media Access Control (MAC) Parameters, Physical Layer, repeater and Management Parameters for 1000 Mb/s Operation", IEEE *DRAFT* P802.3z/D1, Clause 38.
Title 21, Code of Federal Regulations, Chapter I, Subchapter J (CDRH)

3 Introduction and overview

This document describes the Gigabit Interface Converter (GBIC). Although originally designed for Fibre Channel implementations using the Fibre Channel Arbitrated Loop (FC-AL), the design is practical for point-to-point Fibre Channel implementations and for other high performance serial technologies, including 1000 Mbit Ethernet. The body of the document describes the mechanical and electrical properties of the GBIC and its interface with the host board. Annexes provide technical details of individual implementations of the GBIC supporting a variety of high performance serial technologies, including:

100-M5-SN-I	100 Mbyte multi-mode short wave laser without OFC
100-SM-LC-L	100 Mbyte single-mode long-wave laser with 10 km range.
100-TW-EL-S	Style 1 intra-enclosure differential ECL
100-TW-EL-S	Style 2 intra-enclosure differential ECL

Since the GBIC is hot pluggable, a suitably designed enclosure could be changed from one type of external interface to another simply by plugging in a GBIC having the alternative external interface.

The form factor, connectorization, and functionality of the GBIC have been selected to allow the device to be produced for a very low cost. The connector structure has been selected to allow reliable operation at 1 Gbit/second. Testing at 2 Gbit/second and above has been performed and indicates that a data rate of 2.5 Gbit/second can be achieved with normal design care.

A block diagram of a typical 100-M5-SN-I GBIC is shown in figure 1.

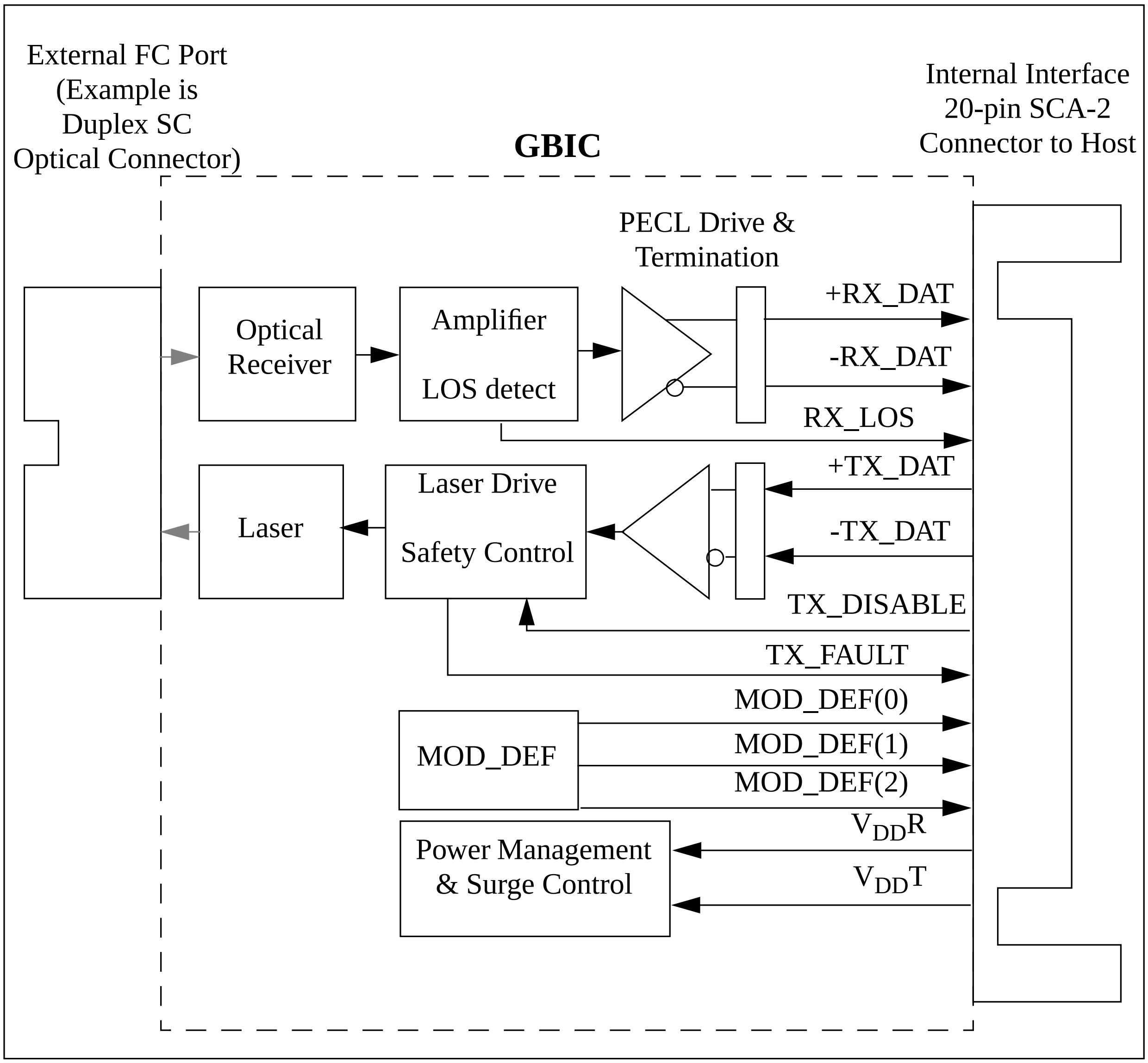

Figure 1: Functional diagram of typical shortwave laser GBIC

3.1 Connection to external Fibre Channel

The external Fibre Channel connection is selected to be appropriate for the cable plant technology selected. The dimensions provided in this document describe a GBIC with a connector no larger than the Fibre Channel duplex SC connector. Note that certain connectors (notably the style 1 copper connector) may extend outside the basic form factor and require that the host sockets for allowing such GBICs to have slightly greater spacing than the minimum required for smaller connectors.

3.2 Connection of GBIC to host enclosure

The connection of the GBIC to the circuit board in the host enclosure (the host board) is identical for all implementations, regardless of external media type. The mechanical form factor of the GBIC with reference to the host board is always the same. While not requiring a fixed form factor guide-rail or slot, common components are available that will suffice for most applications. Special socketing components can be built as required. Every GBIC will fit in a socket designed for any other GBIC.

The power interface includes 2 guide tabs integrated into the connector structure. The guide tabs shall be connected to circuit ground on both the host and GBIC. If the TGND and RGND pins are separated on the GBIC, one guide tab shall be connected to TGND and the other to RGND. The guide tabs shall engage before any of the connector pins. This harmlessly discharges any stray static charges and establishes a reference voltage for the voltage supplies that are sequenced later. The connector itself has two stages of contact sequencing, sequence stage 1 making contact before sequence 2 during insertion. Grounds and certain signals make contact in sequence stage 1. Power makes contact in stage 2.

Chassis grounds and external electromagnetic interference shields should not be attached to circuit ground.

The control interface provides controls for the transmitter, monitors for the transmitter and receiver, and identification information indicating the GBIC module definition. These signals are level compatible with TTL as shown in table 7.

The serial transfer interface uses 150 Ohm differential PECL signaling that is AC coupled.

The GBIC uses a 20-pin connector to the host circuit board. The pin assignments are shown in table 2.

Table 2: GBIC to host connector pin assignment

Pin Name	Pin #	Sequence	Sequence	Pin #	Pin Name
RX_LOS	1	2	1	11	RGND
RGND	2	2	1	12	-RX_DAT
RGND	3	2	1	13	+RX_DAT
MOD_DEF(0)	4	2	1	14	RGND
MOD_DEF(1)	5	2	2	15	$V_{DD}R$
MOD_DEF(2)	6	2	2	16	$V_{DD}T$
TX_DISABLE	7	2	1	17	TGND
TGND	8	2	1	18	+TX_DAT
TGND	9	2	1	19	-TX_DAT
TX_FAULT	10	2	1	20	TGND

3.3 Overview of internal interface signal functions

The electrical signals at the internal interface are defined in table 3.

Table 3: Signal Definitions

Pin Name	Pin #	Name/Function	Signal Specification
RECEIVER SIGNALS			
RGND	2, 3, 11, 14	Receiver Ground (may be connected with TGND in GBIC)	Ground, to GBIC
$V_{DD}R$	15	Receiver +5 volt (may be connected with $V_{DD}T$ in GBIC)	Power, to GBIC
-RX_DAT	12	Receive Data, Differential PECL	High speed serial, from GBIC
+RX_DAT	13	Receive Data, Differential PECL	High speed serial, from GBIC
RX_LOS	1	Receiver Loss of Signal, logic high, open collector compatible, 4.7 K to 10 K Ohm pullup to $V_{DD}T$ on host	Low speed, from GBIC
TRANSMITTER SIGNALS			
TGND	8, 9, 17, 20	Transmitter Ground (may be connected with RGND internally)	Ground, to GBIC
$V_{DD}T$	16	Transmitter +5 volt (may be connected with $V_{DD}R$ in GBIC)	Power, to GBIC
+TX_DAT	18	Transmit Data, Differential PECL	High speed serial, to GBIC
-TX_DAT	19	Transmit Data, Differential PECL	High speed serial, to GBIC
TX_DISABLE	7	Transmitter Disable, logic high, open collector compatible, 4.7 K to 10 K Ohm pullup to $V_{DD}T$ on GBIC	Low speed, to GBIC
TX_FAULT	10	Transmitter Fault, logic high, open collector compatible, 4.7 K to 10 K Ohm pullup to $V_{DD}T$ on host	Low speed, from GBIC
CONTROL SIGNALS			
MOD_DEF(0)	4	GBIC module definition and presence, bit 0, 4.7 K to 10 K Ohm pullup to $V_{DD}T$ on host	Low speed, from GBIC
MOD_DEF(1)	5	GBIC module definition and presence, bit 1, 4.7 K to 10 K Ohm pullup to $V_{DD}T$ on host	Low speed, from GBIC
MOD_DEF(2)	6	GBIC module definition and presence, bit 2, 4.7 K to 10 K Ohm pullup to $V_{DD}T$ on host	Low speed, from GBIC

4 Electronic Specification for all GBICs

The electronic interface between GBICs of all module definitions and the host enclosure socket is specified in this section.

4.1 Power

Table 4: +5V Electrical Power Interface

Parameter	Symbol	Min.	Nom.	Max.	Unit	Conditions (measured at host side of connector)
Maximum voltage	$V_{DD}T$ $V_{DD}R$			6	V	Laser safety circuit shall operate from 0 to this voltage.
Operating voltage	$V_{DD}T$, $V_{DD}R$	4.75	5	5.25	V	Inclusive of ripple from 0 to 500 KHz.
Current	I			300	mA	Steady state, after t_init
Surge Current	I_{surge}			+30	mA	Hot plug, above actual steady state current

The electronic interface shall be designed to allow hot plugging into the host board without damage to the GBIC or the host board circuitry. Surge currents shall be limited using a built-in slow-start circuit and pin sequencing.

4.2 High speed serial interface electronic characteristics

The PECL transmitter and receiver characteristics have been selected so that passive circuitry can be used to meet the requirements of the intra-enclosure balanced differential interface specified in FC-PH-3. For the transmitter specifications a small margin is provided for the transfers of ECL signals between the internal point b (corresponding to the SCA-2 connector between the host and the GBIC) and the external point S (corresponding to the external connector between the GBIC and the transmission cables). For the receiver specifications, sufficient margin is provided to allow the GBIC to receive signals from a driver meeting the intra-enclosure specifications.

The specifications for the electrical signals transmitted to the GBIC from the host board for the high speed serial transmission circuit are shown in table 5.

Table 5: Electrical signal interface from host board, high speed serial transmitter

Parameter	Symbol	Min.	Max.	Unit	Conditions (measured at GBIC side of connector)
PECL amplitude	V_i	650	2000	mV	differential, pk-pk
Deterministic Jitter	$DJ_{elec\text{-}xmt}$		0.12	UI	pk-pk [a]
Total Jitter	$TJ_{elec\text{-}xmt}$		0.25	UI	pk-pk [a]
PECL rise/fall		100	350	ps	20 - 80%, differential
differential skew			20	ps	

a. DJ is defined as deterministic jitter, RJ as random jitter, and TJ as total jitter. For jitter definitions and testing procedures, see Fibre Channel - Jitter Methodologies, Technical Report. These values are informative. The latest revision of the appropriate standard should be checked for any changes.

For other details of eye pattern requirements for the transmitter, see FC-PH-3.

The specifications for the electrical signals received from the GBIC by the host board for the high speed serial receiver circuit are shown in table 6.

Table 6: Electrical signal interface to host board, high speed serial receiver

Parameter	Symbol	Min.	Max.	Unit	Conditions (measured at host side of connector)
PECL amplitude	V_o	370	2000	mV	differential, pk-pk
Deterministic Jitter	$DJ_{elec\text{-}rcv}$		0.36	UI	pk-pk [b]
Total Jitter [a]	$TJ_{elec\text{-}rcv}$		0.56	UI	pk-pk [b]
PECL skew			205	psec	

a. A host should tolerate up to 0.1 UI of additional jitter due to EMI and other noise effects.
b. DJ is defined as deterministic jitter, RJ as random jitter, and TJ as total jitter. For jitter definitions and testing procedures, see Fibre Channel - Jitter Methodologies, Technical Report. These values are informative. The latest revision of the appropriate standard should be checked for any changes

For other details of eye pattern requirements for the receiver, see FC-PH-3.

The specifications for the differential line characteristic impedance of a passive copper GBIC shall meet the requirements of FC-PH-3. The exception window of 800 psec should include both the GBIC to host connector and the GBIC external connector. FC-PH-3 specifies the maximum range of characteristic impedance in the exception window to be 100 to 200 ohms.

The specifications for the differential line characteristic impedance of a GBIC with active PECL circuitry shall meet the requirements of FC-PH-3. The exception window is restricted in length to the impedance discontinuities, if any, related to the GBIC internal connector.

Impedance measurements shall be made with a 100 psec (20-80%) time domain reflectometer (TDR) as specified in FC-PH-3.

4.3 Low Speed signals, electronic characteristics

Table 7: Low speed control and sense signals, electronic characteristics

Parameter	Symbol	Min.	Max.	Unit	Conditions
Output from GBIC	V_{OL}	0.0	0.50	V	4.7K to 10K Ohms pullup to host_Vcc, measured at host side of connector
	V_{OH}	host_Vcc - 0.5	host_Vcc + 0.3	V	
Input to GBIC	V_{IL}	0	0.8	V	4.7K to 10K Ohms to $V_{DD}T$, measured at GBIC side of connector
	V_{IH}	2.0	$V_{DD}T + 0.3$	V	

Note that host_Vcc may be either + 5 volts or + 3.3 volts. Hosts that support the serial module definition protocol shall use a pullup resistor connected to a host_Vcc of +5 volts (4.75 to 5.25 volts) on the MOD_DEF_1 (SCL) and MOD_DEF_2 (SDA) signals to assure proper operation of the serial EEPROMs.

The GBIC or host may provide a TTL LOW level for a signal that has a fixed value by grounding the signal.

Total load capacitance should not exceed 100 pF.

4.4 Termination

The following figure provides examples of termination circuits for the PECL drivers and receivers in the host and the GBIC.

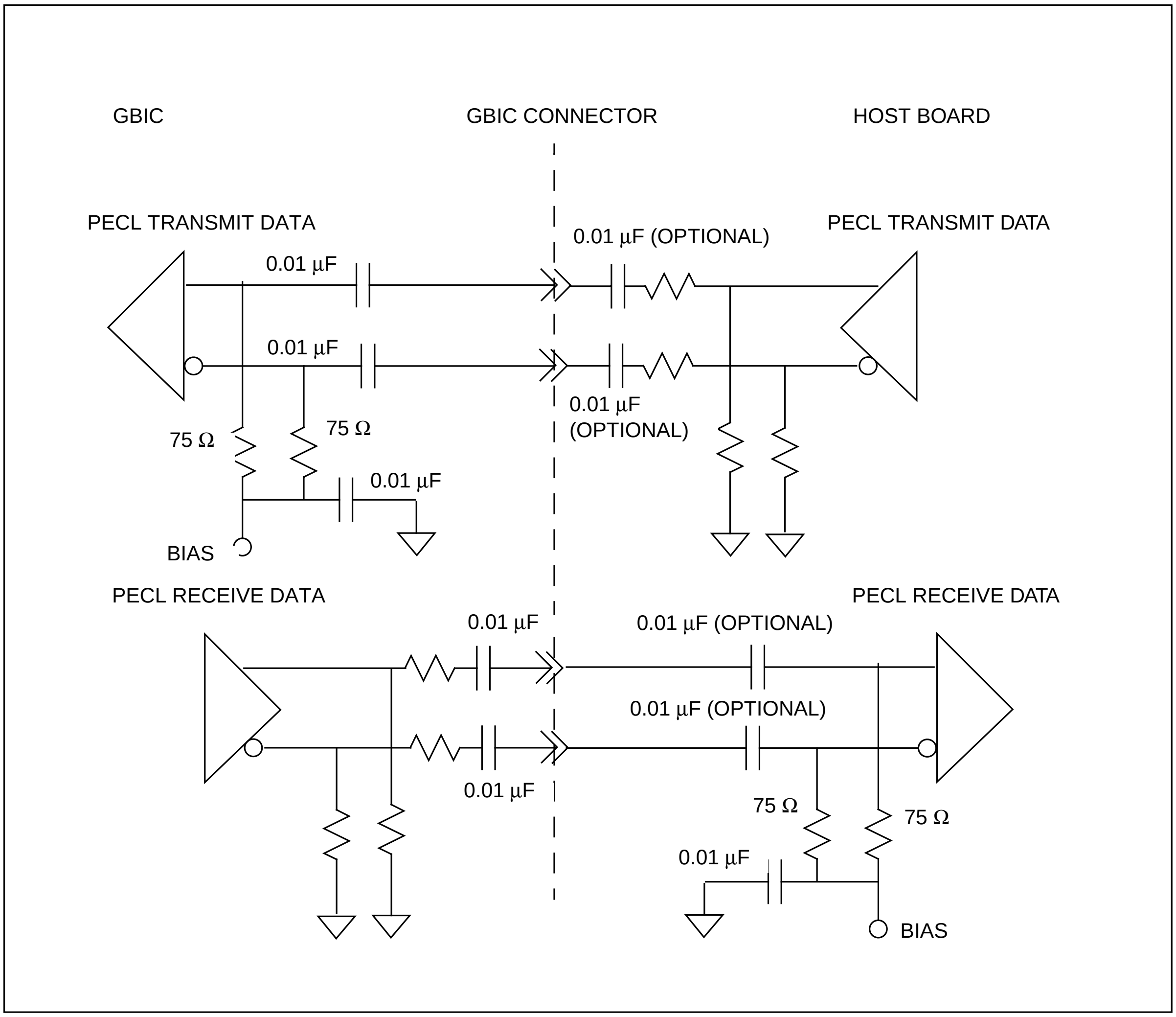

Figure 2: Termination Circuit Examples

The impedance of the terminations shall comply with FC-PH-3. Source termination is recommended for PECL drivers.

Blocking capacitors shall be provided as shown in the circuit diagrams above. Blocking capacitors are desirable, but optional, in the host board PECL circuits.

4.5 Safety requirements

For GBICs providing external optical interfaces, the manufacturer shall ensure that the optical power emitted from an open connector or fiber is compliant with IEC825-1 and CDRH during initialization procedures, during error reset procedures, during normal operation, and in the event of any reasonable single fault condition.

Any electrical power provided to the external interface shall meet applicable safety regulations, including fusing requirements.

5 Operational Description

The following descriptions of GBIC operation apply to all module definitions of GBIC.

5.1 Overview of data transfer

The GBIC is driven from the host board with serial differential PECL signals applied to +TX_DAT and -TX_DAT. The signals may drive either a transmission conversion circuit providing a standard serial output or may directly drive an intra-enclosure connection compatible with FC-PH-3. The output from the transmission conversion circuit may optionally be disabled via the TX_DISABLE pin. The TX_FAULT pin indicates a failure has been detected in the transmission conversion circuit. If a safety fault occurs in the transmitter, the fault condition shall be latched and the output shall be controlled to a safe condition. The latch may be reset according to the protocol defined in clause 5.3.7. TX_FAULT shall also indicate loss of +5V power at the transmit circuit or that some pins of the GBIC to host enclosure socket are not making contact or meeting their contact resistance specifications. Those two fault conditions are not latched.

The serial receiver detects the incoming signals and amplifies and converts them as required. Output from the GBIC to the host board consists of serial differential PECL data signals on +RX_DAT and -RX_DAT, compatible with the received signal from a copper intra-enclosure connection. A receiver loss of signal function on the RX_LOS pin may optionally indicate that the incoming data signal amplitude is not acceptable to achieve the specified Bit Error Rate (BER). In addition, the RX_LOS signal shall indicate loss of +5 volt power at the receiver circuit or that some pins of the GBIC to host enclosure socket are either not making contact or not meeting their contact resistance specifications. The PECL output signals may optionally be disabled when RX_LOS is active. The circuitry receiving the RX_DAT signals should not make use of the signals when the RX_LOS signal is asserted, since the data value is not guaranteed to be stable in magnitude or frequency.

The annex for each module definition indicates which of the control and status signals, TX_DISABLE, TX_FAULT, and RX_LOS, are mandatory.

5.2 GBIC module definition determination

The module definition of GBIC that is installed is indicated by the 3 module definition pins. The information about the external serial interface for each GBIC module definition is included in the appropriate annex.

The assigned values for the MOD_DEF(0:2) bits are provided below.

Table 8: MOD_DEF(0:2)

Module Definition	MOD_DEF(0) pin 4	MOD_DEF(1) pin 5	MOD_DEF(2) pin 6	Interpretation by host	Reference
0	NC	NC	NC	GBIC not present	clause 5.2
1	NC	NC	TTL LOW	Copper Style 1 or Style 2 connector, 1.0625 Gbd, 100-TW-EL-S or 100-TP-EL-S, active inter-enclosure connection. and IEEE802.3 1000BASE-CX	Annex A
2	NC	TTL LOW	NC	Copper Style 1 or Style 2 connector, 1.0625 Gbd, 100-TW-EL-S, or 100-TP-EL-S, active or passive intra-enclosure connection	Annex B
3	NC	TTL LOW	TTL LOW	Optical LW, 1.0625 Gbd 100-SM-LC-L	Annex C
4	TTL LOW	SCL	SDA	Serial module definition protocol	clause 5.2.1 Annex D
5	TTL LOW	NC	TTL LOW	Optical SW, 1.0625 Gbd 100-M5-SN-I or 100-M6-SN-I	Annex E
6	TTL LOW	TTL LOW	NC	Optical LW, 1.0625 Gbd 100-SM-LC-L and similar to 1.25 Gbd IEEE802.3z 1000BASE-LX, single mode	Annex F
7	TTL LOW	TTL LOW	TTL LOW	Optical SW, 1.0625 Gbd 100-M5-SN-I or 100-M6-SN-I and 1.25 Gbd, IEEE 802.3z, 1000BASE-SX	Annex G

The value NC indicates that the GBIC makes no connection to the pin.

5.2.1 Serial module definition protocol

Definition 4 specifies a serial definition protocol. For this definition, upon power up, the MOD_DEF(1:2) shall appear as NC. If the host system detects definition number 4, the serial protocol may then be activated using MOD_DEF(1:2). The protocol uses the 2-wire serial CMOS E^2PROM protocol typical of the ATMEL AT24C01A/02/04/08/16 family of parts.

When the serial protocol is activated, the serial clock signal (SCL) is generated by the host. The positive edge clocks data into the GBIC into those segments of the E^2PROM that are not write protected. The negative edge clocks data from the GBIC.

The serial data signal (SDA) is bidirectional for serial data transfer. The host uses SDA in conjunction with SCL to mark the start and end of serial protocol activation.

The data transfer protocol and the details of the mandatory and vendor specific data structures are defined in Annex D.

5.3 GBIC management algorithms

All GBICs, regardless of module definition, shall successfully operate if the management and error recovery protocols defined in the following clauses are used. Since some GBIC functions are not implemented for some module definitions, GBICs of some module definitions may not invoke certain recovery procedures or may appear to provide instantaneous responses to host actions.

5.3.1 GBIC timing parameters

The following timing parameters (see table 9) are used in procedures defined in this section. Details that depend on the module definition are provided in the appropriate annexes.

Table 9: Timing parameters for GBIC management

Parameter	Symbol	Min.	Max.	Unit	Conditions
TX_DISABLE assert time	t_off		10	µsec	rising edge of TX_DISABLE to fall of output signal below 10% of nominal
TX_DISABLE negate time	t_on		1	msec	Falling edge of TX_DISABLE to rise of output signal above 90% of nominal
Time to initialize, includes reset of TX_FAULT	t_init		300	msec	From power on or hot plug after $V_{DD}T$ > 4.75 volts or From negation of TX_DISABLE during reset of TX_FAULT.
TX_FAULT from fault to assertion	t_fault		100	µsec	From occurrence of fault (output safety violation or $V_{DD}T$ < 4.5 volts)
TX_DISABLE time to start reset	t_reset	10		µsec	TX_DISABLE HIGH before TX_DISABLE set LOW
RX_LOS assert delay	t_loss_on		100	µsec	From detection of loss of signal to assertion of RX_LOS
RX_LOS negate delay	t_loss_off		100	µsec	From detection of presence of signal to negation of RX_LOS

5.3.2 GBIC power on initialization procedure, TX_DISABLE negated.

During power on of the GBIC, TX_FAULT, if implemented, may be asserted (High) as soon as power supply voltages are within specification. For GBIC initialization with TX_DISABLE negated, TX_FAULT shall be negated when the transmitter safety circuitry, if implemented, 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 $V_{DD}T$ exceeds the specified minimum operating voltage (see table 4). If TX_FAULT remains asserted beyond the period t_init, the host may assume that a transmission fault has been detected by the GBIC.

If no transmitter safety circuitry is implemented, the TX_FAULT signal may be tied to its negated state.

The power on initialization timing for a GBIC with TX_DISABLE negated is shown in figure 3.

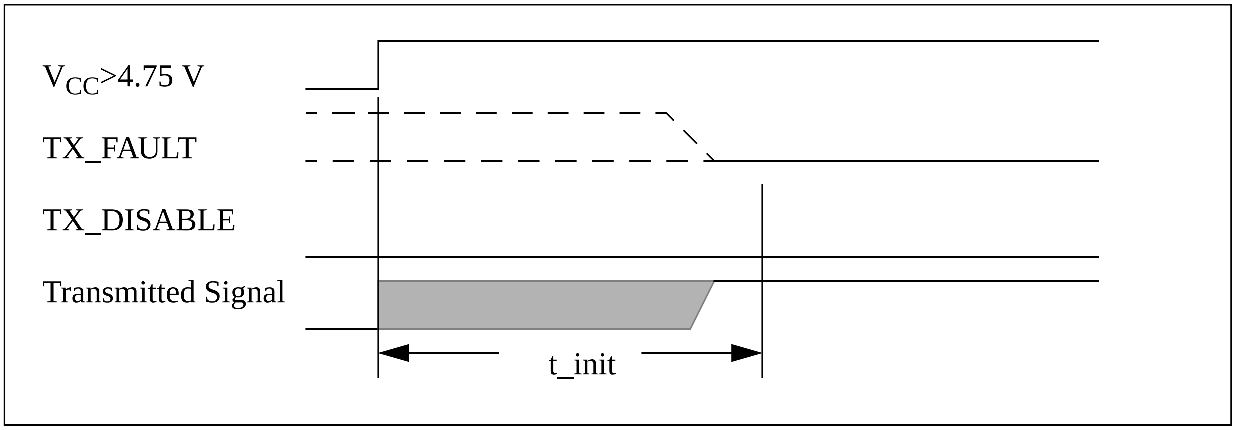

Figure 3: Power on initialization of GBIC, TX_DISABLE negated

5.3.3 GBIC power on initialization procedure, TX_DISABLE asserted.

For GBIC 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, if implemented, 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 GBIC.

If no transmitter safety circuitry is implemented, the TX_FAULT signal may be tied to its negated state.

The power on initialization timing for a GBIC with TX_DISABLE asserted is shown in figure 4.

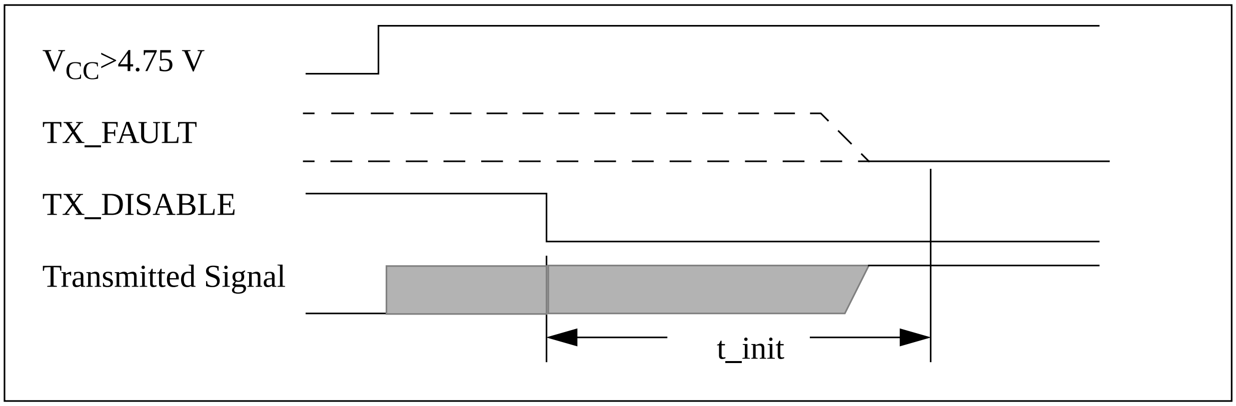

Figure 4: Power on initialization of GBIC, TX_DISABLE asserted

Note that the management of the transmit signal by TX_DISABLE is not required for GBICs of some module definitions, so that the transmitted signal may appear while TX_DISABLE is asserted.

5.3.4 Initialization during hot plugging of GBIC.

When a GBIC is not installed, TX_FAULT is held to the asserted state by the pull up circuits on the host (see table 3). As the GBIC is installed, contact is made with the ground, voltage, and signal contacts in the specified order. After the GBIC has determined that V_{DD}T has reached the specified value, the power on initialization takes place as described in clause 5.3.2 and clause 5.3.3.

An example of initialization during hot plugging is provided in figure 5.

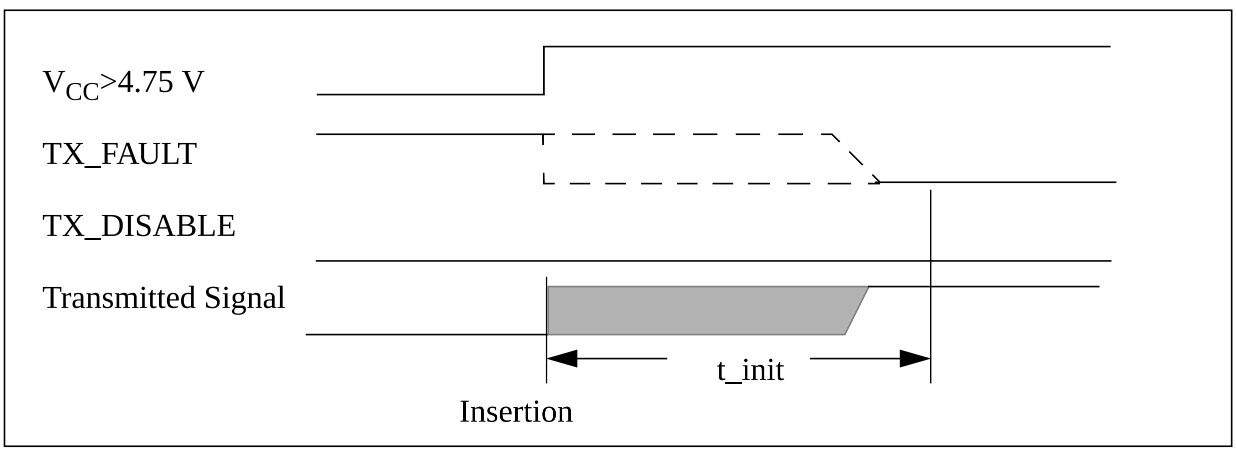

Figure 5: Example of initialization during hot plugging, TX_DISABLE negated.

5.3.5 GBIC transmitter management

If implemented, the TX_DISABLE may be asserted to disable the transmitter for diagnostic, configuration, or security purposes. Since control of the transmit signal by TX_DISABLE is not required for all module definitions, the software managing the GBIC transmitter must consider the MOD_DEF value to determine how the interface will respond when TX_DISABLE is asserted.

The timing requirements for the management of optical outputs from the GBIC using the TX_DISABLE signal are shown in figure 6. Implementation of the TX_DISABLE signal is required for module definitions that use TX_DISABLE to clear a latched TX_FAULT condition and is optional for other module definitions unless specifically required by the appropriate annex.

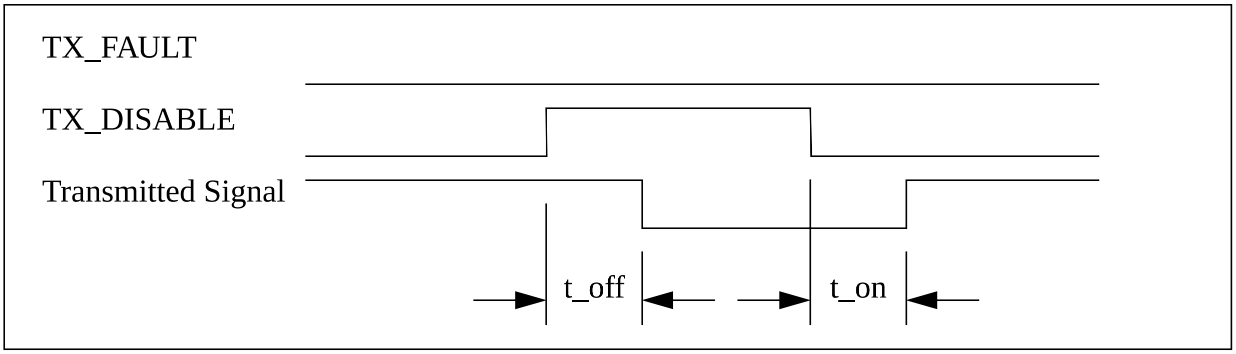

Figure 6: Management of GBIC during normal operation, TX_DISABLE implemented

5.3.6 GBIC fault detection and presentation

TX_FAULT shall be implemented by those module definitions of GBIC supporting safety circuitry. If TX_FAULT is not implemented, the signal shall be held to the low state by the GBIC.

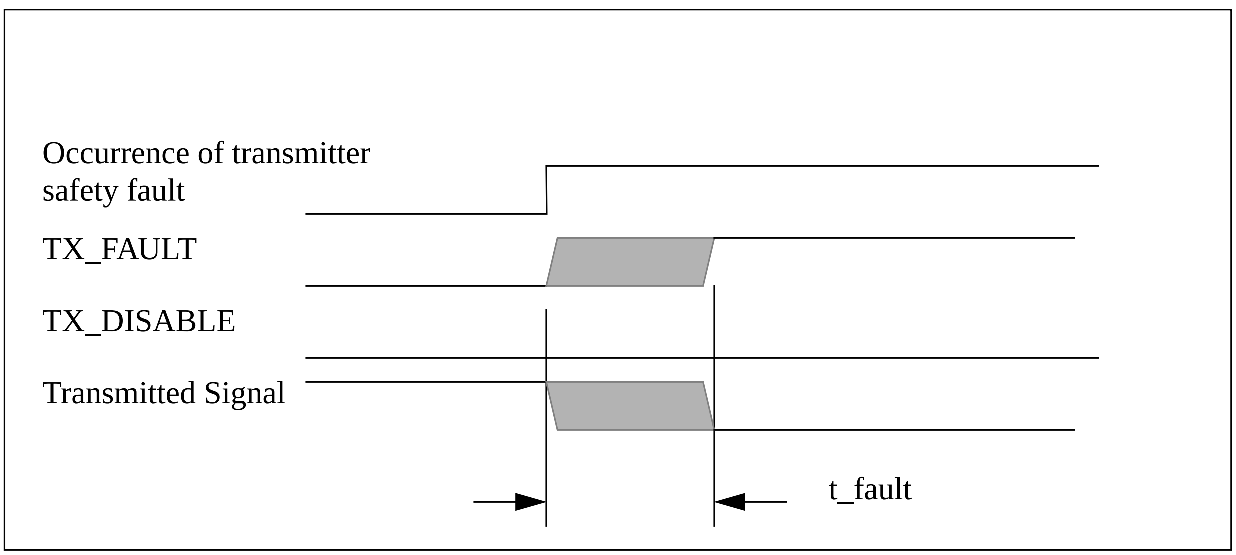

Figure 7: Detection of transmitter safety fault condition

5.3.7 GBIC 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 GBIC 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 GBIC 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.

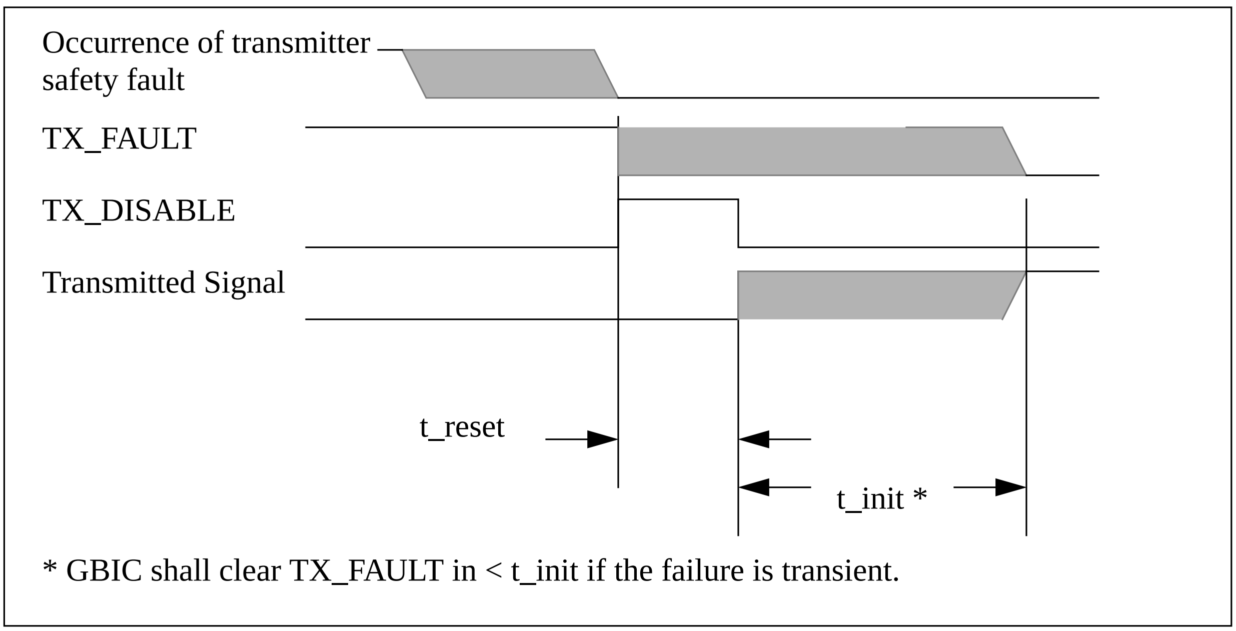

Figure 8: Successful recovery from transient safety fault condition

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

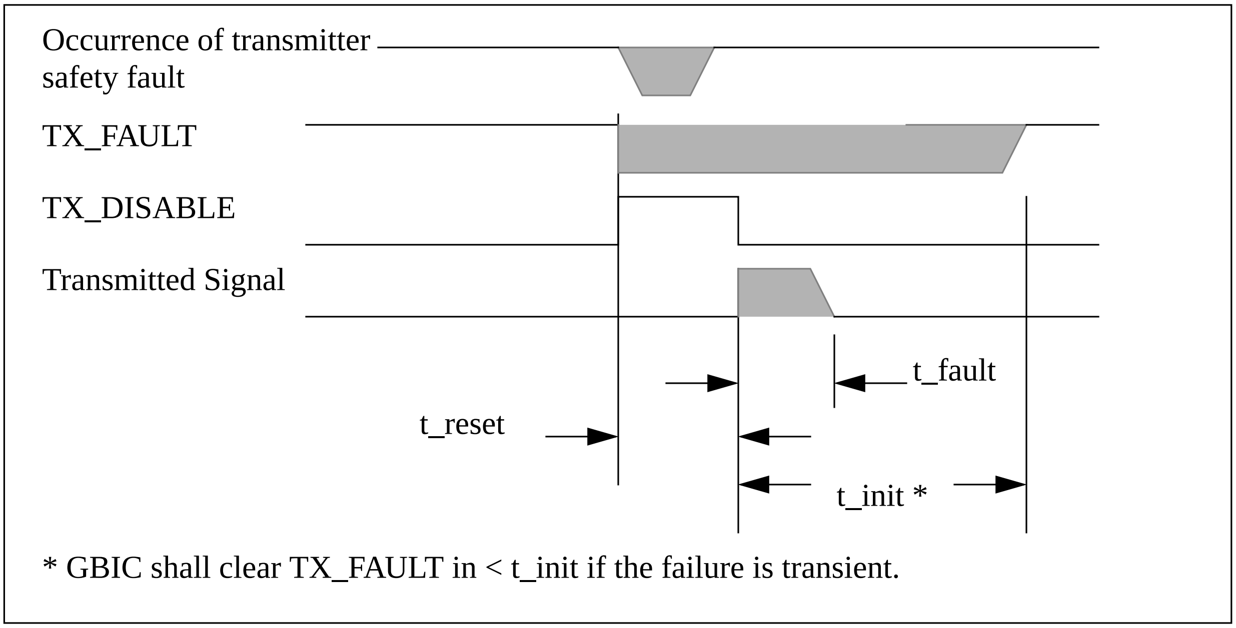

Figure 9: Unsuccessful recovery from safety fault condition

5.3.8 GBIC loss of signal indication

If RX_LOS is not implemented on a GBIC, it shall be held to the low state by the GBIC. If the module definition of the GBIC is specified as implementing RX_LOS, the timing is specified in figure 10.

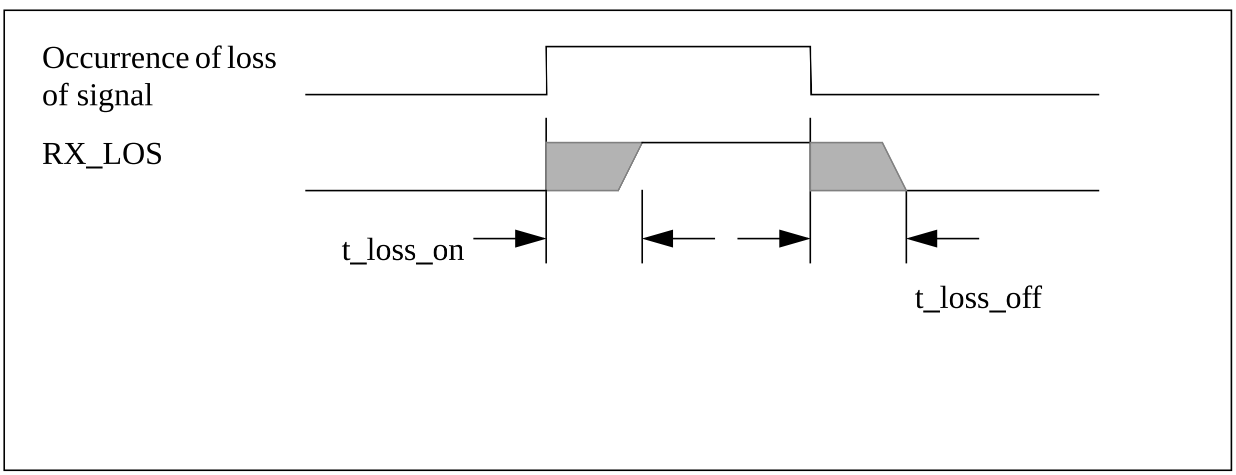

Figure 10: Timing of RX_LOS detection

6 Mechanical interface for all GBICs

A common mechanical outline is used for all GBICs. The outline of the GBIC is described in figure 11 and table 10.

Table 10: Dimension table for drawing of GBIC

Designator	Dimension (mm)	Tolerance (mm)	Comments
A	57.15	+0.25 -0.25	GBIC length from stop to end of connector
B	10.00	+0.10 -0.15	GBIC height- main body
C	12.01	+0.00 -0.15	GBIC height- overall
D	8.18	Reference	SC connector beyond stop
E	3.05	+0.00 -0.15	Latch arm height
F	30.48	+0.00 -0.15	GBIC width- main body
G	0.91	Basic	Center line of latch
H	33.91	Maximum	Latch release tabs, installed position
J	31.50	+0.00 -0.15	Latch arm and retention recess width, installed position
K	33.27	+0.10 -0.10	Latch retention detail width, installed position
	31.45	Maximum	Latch retention detail width, during compression while being inserted/removed
	35	Maximum	Latch retention detail width, uninstalled position
L	14.5	Maximum	Latch arm length
M	4.34	Maximum	Latch retention detail length
N	1.17	+0.10 -0.00	Retention detail to stop
P	0.40	Maximum	Retention recess to stop
Q	1.52	+0.10 -0.00	Guide slot height
R	3.05	Basic	Guide slot centerline
S	13.56	Maximum	Guide slot length - to stop
T	27.69	+0.15 -0.15	Guide slot width (depth)
U	5.08	Minimum	Chassis ground contact zone
V		Reference	

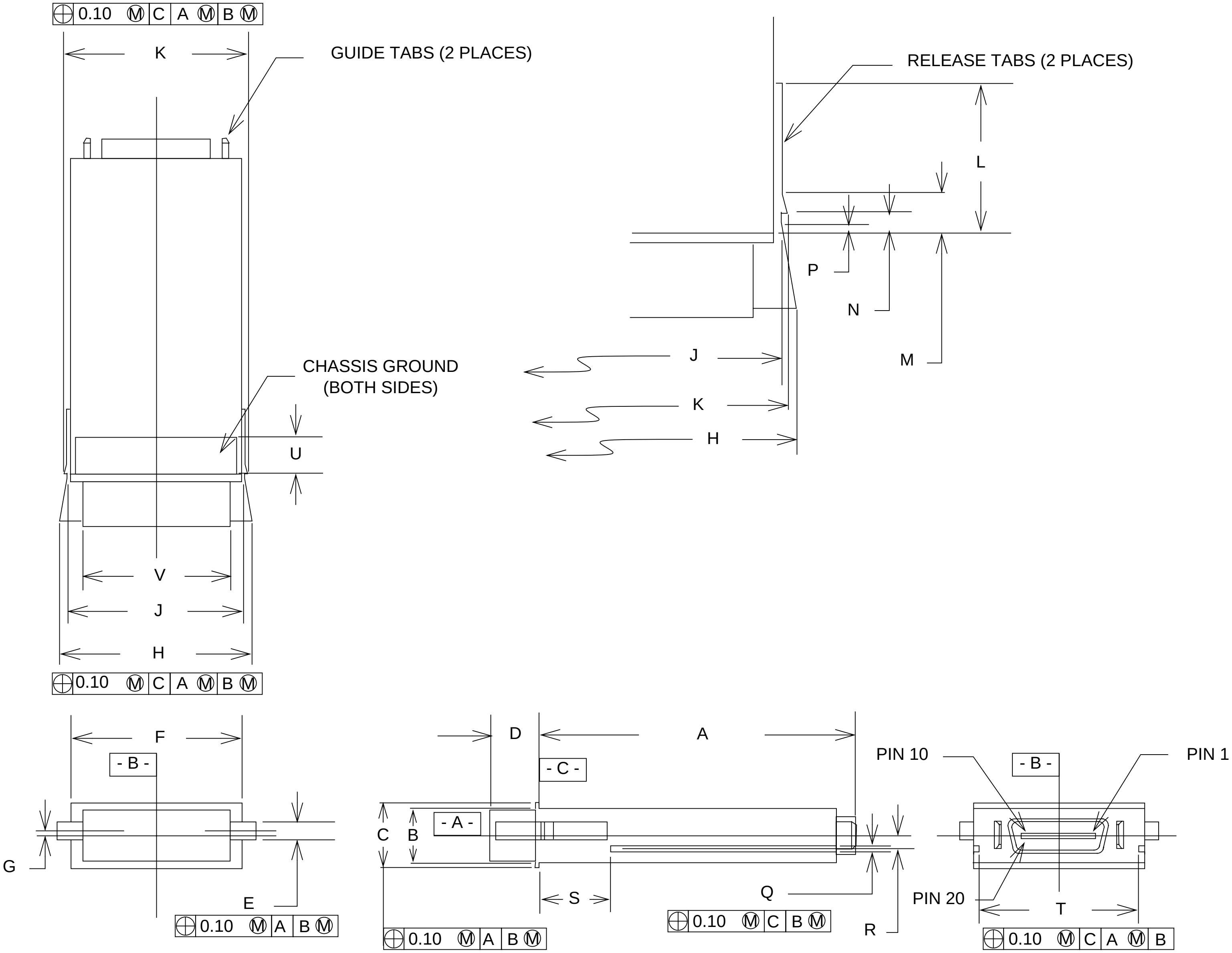

Figure 11: Drawing of GBIC

The required host board mechanical layout for attaching a typical guide-rail and connector to receive a GBIC is shown in figure 12. Dimensions in this figure are in inches.

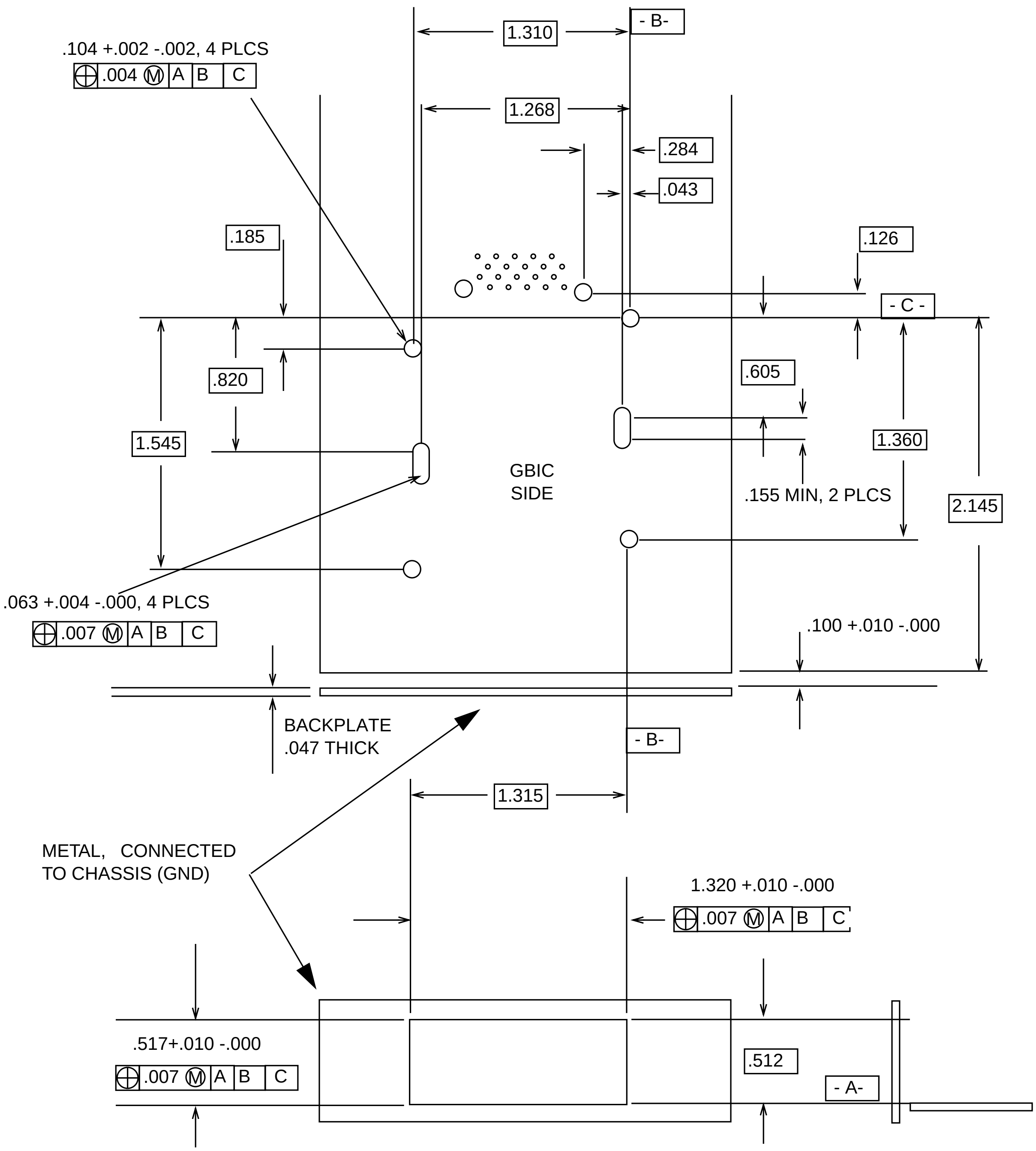

Figure 12: Typical Host Card Footprint

6.1 Insertion and removal

The requirements for insertion forces, extraction forces, and retention forces are specified in table 11.

Table 11: Insertion, extraction, and retention forces

Measurement	Minimum	Maximum	Units	Comments
GBIC insertion	0	20	newtons	(~4.5 lbs)
GBIC extraction	0	15	newtons	(~3.3 lbs)
GBIC retention	130	N/A	newtons	straight out (~29.3 lbs)
Insertion/removal cycles	100		cycles	

6.2 Labeling requirements

Color coding requirements for optical GBICs are specified in the appropriate annex.

Each GBIC should be clearly labeled. The complete labeling need not be visible when the GBIC is installed. Labeling should include appropriate manufacturing and part number identification, appropriate regulatory compliance labeling, and a clear specification of the external port characteristics. The external port characteristic label may include such information as optical wavelength, required fiber characteristics, operating data rate, interface standards supported, and link length supported.

6.3 Connector definition

The connector used by the GBIC is a 20-pin model of the AMP SCA-2 connector. The following AMP part numbers are given for reference purposes, but any licensed manufacturer of the connector may produce similar components.

Straddle mount male plug, placed on GBIC:

AMP 787643-1

Vertical receptacle, placed on backplane for connection of a GBIC perpendicular to surface of backplane.

AMP 787646-1

Right angle receptacle, placed on motherboard for connection of a GBIC parallel to surface of backplane as a daughter board.

AMP 787653-1

GBIC guide systems are presently being used by many applications. It is expected that those guide systems will be offered by a number of vendors. The following AMP part numbers are given for reference purposes.

GBIC guide system for PCB with thickness 0.062 +/- .008 inches

AMP 787663-1

GBIC guide system for PCB with thickness 0.100 +/- .008 inches

AMP 787663-2

A reference drawing describing the GBIC plug is provided in table 12 and figure 13.

1. INTERNAL CLEARANCE FOR MATING CONNECTOR
2. MEASURED AT A20 DIMENSION.
3. DISTANCE MEASURED ACROSS CONTACT MATING SURFACES ALONG EFFECTIVE MATING AREA
4. CONTACT MUST BE ABOVE PLASTIC ALONG EFFECTIVE MATING AREA.
5. 0.75MM MIN PLASTIC LEAD-IN PRIOR TO INITIAL POINT OF CONTACT (SIGNAL) A2±A22 THICKNESS REQUIRED FOR PRE-DEFLECTION OF RECEPTACLE CONTACTS

20 POSITION	
P1 = POSITION 1	P3 = POSITION 11
P2 = POSITION 10	P4 = POSITION 20

DIMENSION	MILLIMETERS	INCHES	
A1	13.07	.515	
A2	1.60	.063	
A3	0.10	.004	
A4	1.80 R	.071 R	
A5	15°	15°	
A6	19.77	.778	
A7	9.885	.389	
A8	17.17	.676	
A9	8.585	.338	
A10	0.20	.008	
A11	1.00 R	.039 R	
A12	7.00	.276	
A13	5.325	.210	2
A14	3.50	.138	
A15	2.663	.105	
A16	1.27	.050	
A17	5.715	.225	
A18	2.00	.079	
A19	0.60 MIN	.024 MIN	
A20	6.50 MIN	.256 MIN	
A21	0.10	.004	
A22	0.08	.003	
A23	27.28	1.074	
A24	24.18	.952	
A25	1.905	.075	
A26	4.00	.157	
A27	27.38	1.078	
A28	1.85	.073	
A29	0.90	.035	
A30	5.00	.197	
A31	0.28	.011	
A32	0.24	.009	
A33	0.25	.010	
A34	1.35	.053	
A35	0.05	.002	
A36	0.80	.031	
A37	0.15	.006	
A38	0.13	.005	

Table 12: Value of dimensions for GBIC plug reference drawing

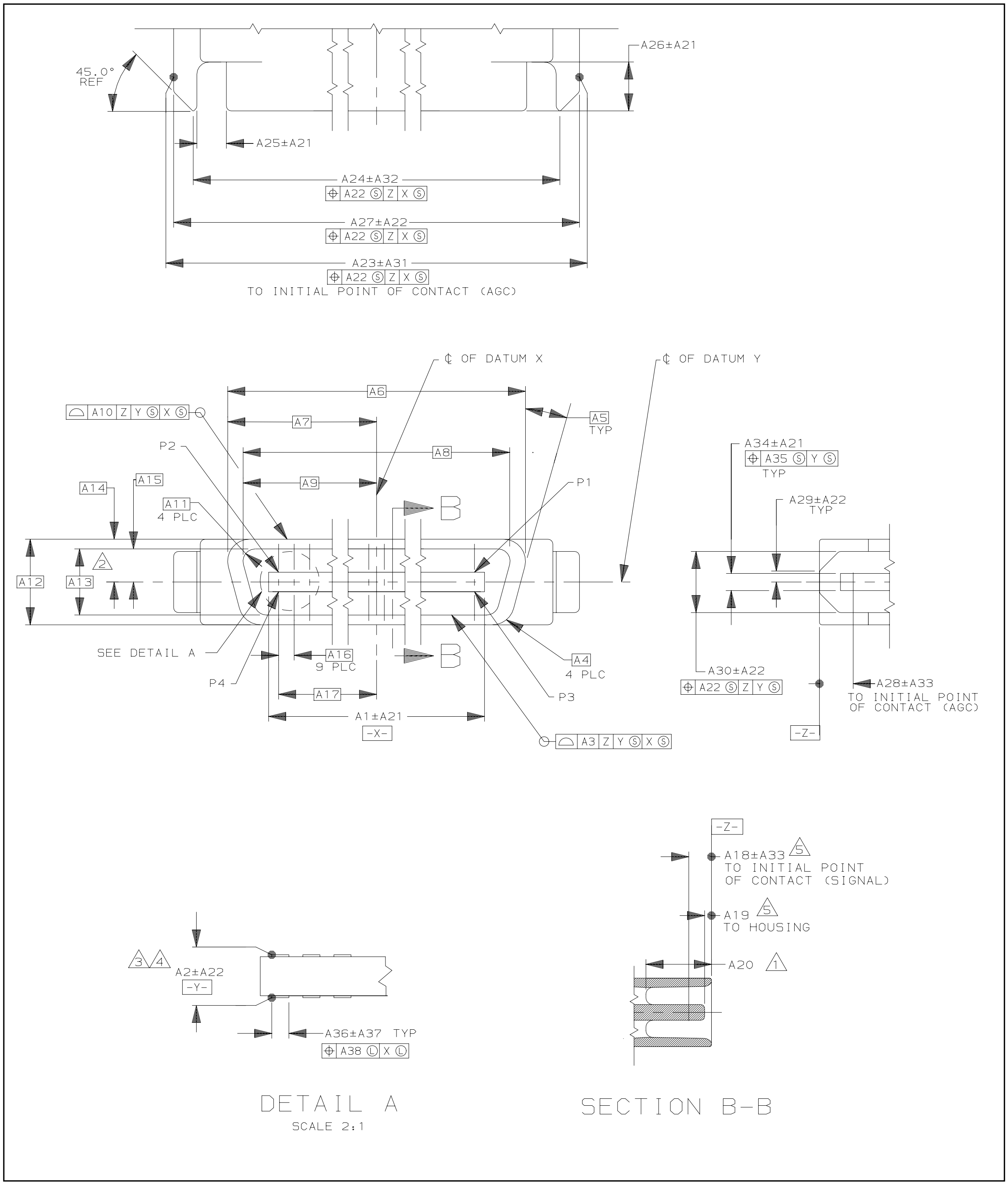

Figure 13: Reference drawing for GBIC plug

A reference drawing describing the GBIC receptacle is provided in table 13 and figure 14.

1. CONTACT GAP WILL ACCOMMODATE MATING CONNECTOR OF A13±A16.
2. INTERNAL CLEARANCE FOR MATING CONNECTOR
3. SEQUENCED (FIRST MATE) CONTACT
4. SEQUENCED (SECOND MATE) CONTACT
5. EXTERNAL CLEARANCE FOR MATING CONNECTOR
6. EFFECTIVE WIDTH OF THE POINT OF CONTACT ZONE

20 POSITION	
P1 = POSITION 1	P3 = POSITION 11
P2 = POSITION 10	P4 = POSITION 20

DIMENSION	MILLIMETERS	INCHES	
A1	13.33	.525	
A2	1.90	.075	
A3	1.00 R	.039 R	
A4	5.05	.199	
A5	2.525	.0995	
A6	15°	15°	
A7	16.97	.668	
A8	8.485	.334	
A9	5.715	.225	
A10	1.27	.050	
A11	0.10	.004	
A12	1.98	.078	3
A13	1.60	.063	
A14	5.70	.224	
A15	0.05	.002	
A16	0.08	.003	
A17	13.24	.521	
A18	0.98	.039	
A19	5.30	.209	
A20	27.68	1.090	
A21	1.45	.057	
A22	2.20	.087	
A23	0.40	.016	
A24	0.28	.011	
A25	0.15	.006	
A26	0.95	.037	
A27	0.15	.006	
A28	2.48	.098	4
A29	0.35 MIN	.014 MIN	
A30	6.50 MIN	.256 MIN	
A31	0.30	.012	

Table 13: Value of dimensions for GBIC receptacle reference drawing

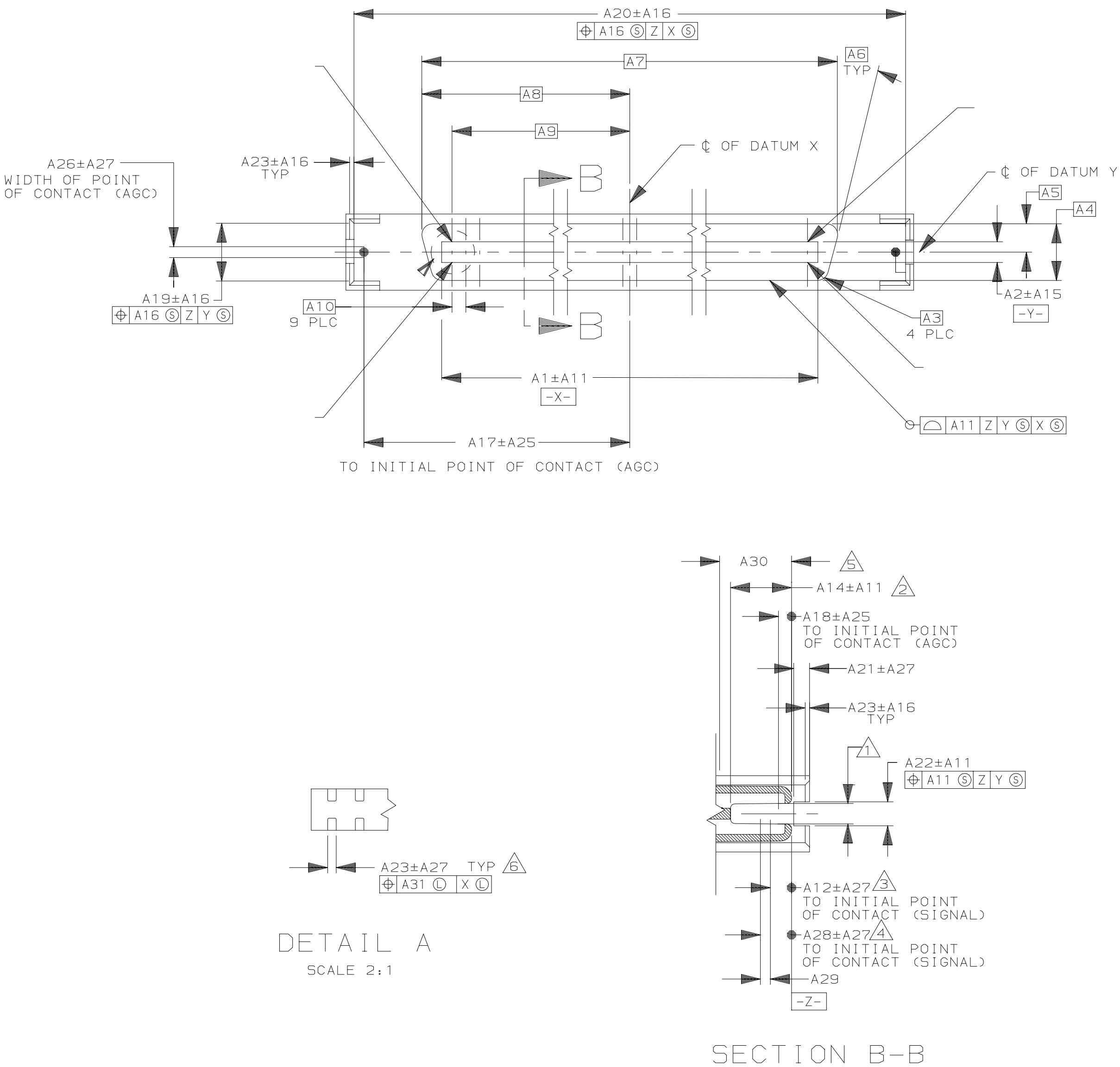

Figure 14: Reference drawing for GBIC receptacle

7 Environmental Requirements for all GBICs

The environmental requirements for all GBICs are specified in this section. All GBICs should meet their mechanical, electronic, optical, and timing specifications for all specified environments.

7.1 Temperature

The specifications shall apply for operating temperatures from 0 to 50˚C in moving air. More or less restrictive temperature ranges may be specified as required. Cooling shall be provided as appropriate.

Annex A: Module definition “1” GBIC (copper inter-enclosure)

(normative annex)

A.1 Overview of module definition 1 GBIC

A GBIC having module definition 1 presents a standard copper interface having the same characteristics as the Fibre Channel 100-TP-EL-S and 100-TW-EL-S inter-enclosure interface using the style 1 or style 2 balanced cable connector. This GBIC is also compatible with the Gigabit Ethernet definition IEEE802.3, 1000BASE-CX. The transmitter and receiver specifications for the inter-enclosure interface will usually require additional electronic buffering to adapt the PECL signals available on the host side of the GBIC to the inter-enclosure requirements. The copper transmitter and receiver specification is defined by FC-PH-3. An overview of the copper Fibre Channel characteristics is provided in table A.1.

Table A.1: Overview, module definition 1 GBIC

Parameter	Value
Application	Fibre Channel, 100-TW-EL-S or 100-TP-EL-S, style 1 or 2 balanced connector, intra-enclosure and 1.25 Gbd IEEE802.3z, 1000BASE-CX
Distance, 100-XX-EL-S	TP cable, 0 - 28 meters TW cable, 0 - 33 meters
Data Rate	1062.5 Mbaud +/- 100 ppm (100-TW-EL-S) 1062.5 Mbaud +/- 100 ppm (100-TP-EL-S) 1.25 Gbd IEEE802.3z, 1000BASE-CX
Data Format	8B/10B
Link Characteristic Impedance	150 +/- 10 Ohms
Transmitted signal	1100 - 2000 mv, differential PECL (inter-enclosure)
Received signal	400 - 2000 mv, differential PECL

The GBIC to host connection is modified for use with the inter-enclosure balanced cable GBIC.

The signals provided to the host by the GBIC are defined in table A.2.

Table A.2: GBIC pin usage, style 1 or style 2 balanced cable connectors,

Pin Name	Pin #	Description	Pin Name	Pin #	Description
RX_LOS	1	Receiver Loss of Signal	RGND	11	GND
RGND	2	GND	-RX_DAT	12	- RX, ext. connector
RGND	3	GND	+RX_DAT	13	+ RX, ext. connector
MOD_DEF(0)	4	NC	RGND	14	GND
MOD_DEF(1)	5	NC	V_{DD}R	15	V_{DDR} or NC
MOD_DEF(2)	6	TTL LOW from GBIC	V_{DD}T	16	V_{DD}T
TX_DISABLE	7	Transmitter Disable	TGND	17	GND
TGND	8	GND	+TX_DAT	18	+ TX, ext. connector
TGND	9	GND	-TX_DAT	19	- TX, ext. connector
TX_FAULT	10	TTL LOW or Transmit Fault from GBIC	TGND	20	GND
* Signals may optionally be implemented as specified in 3.3.					

A.2 Operation

The protocols and timing specified in clause 5 shall be used by module definition 1 GBICs.

A GBIC having a MOD_DEF of 1 shall implement the RX_LOS and TX_DISABLE signals. The GBIC may fix the TX_FAULT signal at a TTL LOW level. As a result of tying the TX_FAULT to the negated level, the GBIC behaves as if the t_init period is very short and as if no transmitter faults ever occur.

The signal levels and signal quality shall meet the requirements of FC-PH-3. The protocols and timing specified in clause 5 shall be used.

Additional information is shown in table A.3.

Table A.3: RX_LOS detection

Parameter	Symbol	Min.	Max.	Unit	Conditions
RX_LOS negate threshold level		100	400	mv	Differential peak to peak tested with 531 MHz square wave signal.
RX_LOS hysteresis		50		mv	No chattering

A.3 External Connector Definition

The external connector shall be the style 1 or style 2 balanced cable connector defined by FC-PH-3.

Table A.4 defines the pin assignments for style 1 balanced cable connectors.

Table A.4: Pin assignment for style 1 balanced cable connector

Pin Name	Pin #
+ TX	1
No connection	2
No connection	3
No connection	4
+ RX	5
- TX	6
No connection	7
No connection	8
- RX	9

Table A.5 defines the pin assignments for style 2 balanced cable connectors.

Table A.5: Pin assignment for style 2 balanced cable connector

Pin Name	Pin #
+ TX	1
No connection	2
- TX	3
No connection	4
No connection	5
- RX	6
No connection	7
+ RX	8

A.4 Special considerations

The style 1 connector may project beyond the standard GBIC form factor. Host slots may require additional spacing to facilitate removal of GBICS having module definition of 1.

Annex B: Module definition ‘2’ GBIC (copper intra-enclosure)

(normative annex)

B.1 Overview of module definition 2 GBIC

A GBIC having module definition 2 presents a standard copper interface having the same characteristics as the Fibre Channel 100-TP-EL-S or 100-TW-EL-S intra-enclosure interface using the style 1 or style 2 balanced cable connector. The GBIC is not compliant with the Gigabit Ethernet definition IEEE802.3, 1000BASE-CX, but should operate on short cables that do not require the higher signals of the inter-enclosure transmitters. The PECL transmitter and receiver specifications (see 4.2) have been selected so that a MOD_DEF 2 GBIC may use passive circuitry to pass the signals to the GBIC’s interface with the host. Additional functionality can be provided by using active circuitry. The copper transmitter and receiver specification is defined by FC-PH-3. An overview of the copper Fibre Channel characteristics is provided in table B.1.

Table B.1: Overview, module definition 2 GBIC

Parameter	Value
Application	Fibre Channel, 100-TW-EL-S or 100-TP-EL-S, Style 2 balanced connector, intra-enclosure
Distance, 100-TW-EL-S	0 - 13 meters
Data Rate	1062.5 Mbaud +/- 100 ppm (100-TW-EL-S) 1062.5 Mbaud +/- 100 ppm (100-TP-EL-S) 1.25 Gbd IEEE802.3z, 1000BASE-CX
Data Format	8B/10B
Link Characteristic Impedance	150 +/- 10 Ohms
Transmitted signal	600 - 2000 mv, differential PECL (note maximum is higher than standard intra-enclosure connections)
Received signal	400 - 2000 mv, differential PECL (note maximum is higher than standard intra-enclosure connection)

The GBIC to host connection is modified for use with the intra-enclosure balanced cable GBIC. The signals provided to the host by GBIC are defined in table B.2.

Table B.2: GBIC pin usage for style 1 and style 2 balanced cable connectors

Pin Name	Pin #	Description	Pin Name	Pin #	Description
RX_LOS	1	TTL LOW from GBIC*	RGND	11	GND
RGND	2	GND	-RX_DAT	12	- RX, ext. connector
RGND	3	GND	+RX_DAT	13	+ RX, ext. connector
MOD_DEF(0)	4	NC	RGND	14	GND
MOD_DEF(1)	5	TTL LOW from GBIC	$V_{DD}R$	15	$V_{DD}R$ or NC
MOD_DEF(2)	6	NC	$V_{DD}T$	16	$V_{DD}T$
TX_DISABLE	7	Pull-up on GBIC*	TGND	17	GND
TGND	8	GND	+TX_DAT	18	+ TX, ext. connector
TGND	9	GND	-TX_DAT	19	- TX, ext. connector
TX_FAULT	10	TTL LOW from GBIC*	TGND	20	GND
* Signals may optionally be implemented as specified in 3.3.					

B.2 Initialization and error management

The protocols and timing specified in clause 5 shall be used by module definition 2 GBICs.

A passive GBIC having a MOD_DEF of 2 shall fix the TX_FAULT and the RX_LOS signals at a TTL LOW level. As a result of tying the TX_FAULT to the negated level, the GBIC behaves as if the t_init period is very short and as if no transmitter faults ever occur. As a result of tying the RX_LOS signal to the negated level, the GBIC behaves as if no receiver faults or loss of signal occur. The host shall be responsible for determining that a signal is not being received. The GBIC shall ignore the state of the TX_DISABLE signal.

A GBIC having a MOD_DEF of 2 may use active circuits to implement TX_FAULT, TX_DISABLE, and/or RX_LOS. The signal levels and signal quality shall meet the requirements of FC-PH and shall be interoperable with a passive GBIC. The protocols and timing specified in clause 5 shall be used by active GBICs. Note that a disabled transmitter may not guarantee the receipt of RX_LOS, since no RX_LOS signal levels are specified for GBICs having a MOD_DEF of 2..

B.3 External Connector Definition

The external connector shall be the style 1 or style 2 balanced cable connector defined by FC-PH-3.

Table B.3 defines the pin assignments for style 1 balanced cable connectors.

Table B.3: Pin assignment for style 1 balanced cable connector

Pin Name	Pin #
+ TX	1
No connection	2
No connection	3
No connection	4
+ RX	5
- TX	6
No connection	7
No connection	8
- RX	9

Table B.4 defines the pin assignments for style 2 balanced cable connectors.

Table B.4: Pin assignment for style 2 balanced cable connector

Pin Name	Pin #
+ TX	1
No connection	2
- TX	3
No connection	4
No connection	5
- RX	6
No connection	7
+ RX	8

B.4 Special considerations

The style 1 connector may project beyond the standard GBIC form factor. Host slots may require additional spacing to facilitate removal of GBICS having module definition of 1.

Annex C: Module definition “3” GBIC (single mode laser) (normative annex)

C.1 Overview of module definition 3 GBIC

A GBIC having module definition 3 presents the 100-SM-LC-L interface as defined in revision 1.0 of the Fibre Channel Low Cost 10 km Optical 1063 MBaud Interface document. The characteristics are summarized in table C.1.

Table C.1: Overview, module definition 3 GBIC

Parameter	Value
Application	Fibre Channel single-mode transceiver, 100-SM-LC-L
Distance	2 meters to 10 kilometers
Data Rate	1062.5 Mbaud +/- 100 ppm
Data Format	8B/10B
Fiber Type	9 µm core, single mode, 1310 nm, < 0.45 db/km loss
Nominal link budget	7.8 dB, including all connectors, splices, cable
Transmitter	Laser
Spectral center	see 100-SM-LC-L standard
Spectral width, RMS	see 100-SM-LC-L standard
Transmitter, launched power	non-OFC, see 100-SM-LC-L standard
Extinction ratio	9 dB minimum
RIN_12	-116 dB/Hz
Received power	-20 dBm to -3 dBm average power. as specified by 100-SM-LC-L standard.
Power penalties	see 100-SM-LC-L standard
Receiver return loss	12 dB minimum
Laser safety features	Transmit power level management with laser overdrive protection circuit.

The standard GBIC pinout and pin definitions shall be used.

C.2 Optical transmitter power

The optical power launched by the transmitter is a function of the wavelength deviation from the zero dispersion value of the fiber and the spectral width of the source laser as specified by the 100-SM-LC-L standard.

C.3 Optical signal definitions

The relationship between the states of the transmitter, receiver, and the received optical power is shown in table C.2.

Table C.2: Relationship between electrical signal polarity and optical power

Signal state	+TX_DAT	-TX_DAT	Optical Power	+RX_DAT	-RX_DAT
“1”	HIGH	LOW	HIGH	HIGH	LOW
“0”	LOW	HIGH	LOW	LOW	HIGH

For electrical signals “LOW” is a less positive (more negative) signal than the “HIGH” signal in the same differential pair. For the optical power signal, “LOW” is the minimum optical power state, corresponding to minimum drive to the laser, while “HIGH” is the maximum optical power state, corresponding to maximum laser drive.

C.4 Optical transceiver timing

The optical transceiver interface is defined by the 100-SM-LC-L standards document. Additional information is shown in table C.3.

Table C.3: Optical Transceiver Interface

Parameter	Symbol	Min.	Max.	Unit	Conditions
Optical Output, TX_DISABLE asserted	P_{off}		-35	dBm	Into fiber, average, steady state
RX_LOS negate threshold level		-31	-20	dBm	average power
RX_LOS hysteresis		1	4	dB	No chattering

C.5 Initialization and error management

The protocols and timing specified in clause 5 shall be used by module definition 3 GBICs. The TX_DISABLE, TX_FAULT, and RX_LOS signals shall be implemented and operate with the specified protocols.

C.6 External connector definition and color coding

The external optical connector shall be the duplex SC connector defined by FC-PH. Exposed surfaces of the external SC connector and/or retention mechanism shall be blue to indicate that only single-mode fiber should be connected to this GBIC.

C.7 Recommended external plug color coding

For compliance with international standards and to simplify error free configuration of systems, fibre optic plugs that are used with this GBIC should have blue exposed connector surfaces to indicate that the fibre optic cable is a single-mode cable. Overmolding of the connector is not required to be color coded, but the plug should be clearly identified as single mode by appropriate additional labeling or color coding.

Annex D: Module definition "4" GBIC (Serial Identification) (normative annex)

D.1 Overview of module definition 4 GBIC

A GBIC having module definition 4 provides access to sophisticated identification information that describes the GBIC's capabilities, standard interfaces, manufacturer, and other information. The serial interface uses the 2-wire serial CMOS E^2PROM protocol defined for the ATMEL AT24C01A/02/04 family of components (see 5.2.1). The memories are organized as a series of 8-bit data words that can be addressed individually or sequentially.

This annex defines the information structures that are obtained from the GBIC.

D.2 Serial information definition

The 2-wire serial CMOS E^2PROM provides sequential or random access to 8 bit parameters, addressed from 0000h to the maximum address of the memory. All numeric values in the information fields are big-endian binary values. All character strings are ordered with the first character to be displayed located in the lowest address of the memory space. All character strings will be padded on the right with ASCII spaces (20h) to fill empty bytes. A minimum of 96 bytes shall be readable by the serial identification process.

The maximum clock rate of the serial interface shall be 100 KHz.

The following tables define the contents of the serial CMOS E^2PROM. The first table is a summary of all the data fields in the serial ID chip. The remaining tables contain detailed descriptions of the individual data fields.

.

Table D.1: Serial ID: Data Fields

Data Address	Field Size (Bytes)	Name of field	Description of field
BASE ID FIELDS			
0	1	Identifier	Type of serial transceiver (see table D.2)
1	1	Reserved	
2	1	Connector	Code for connector type (see table D.3)
3-10	8	Transceiver	Code for electronic compatibility or optical compatibility (see table D.4)
11	1	Encoding	Code for serial encoding algorithm (see table D.5)
12	1	BR, Nominal	Nominal baud rate, units of 100 MHz
13-14	2	Reserved	
15	1	Length (9µ)	Link length supported for 9/125 µm fiber, units of 100 m
16	1	Length (50µ)	Link length supported for 50/125 µm fiber, units of 10 m
17	1	Length (62.5µ)	Link length supported for 62.5/125 µm fiber, units of 10 m
18	1	Length (Copper)	Link length supported for copper, units of meters
19	1	Reserved	
20-35	16	Vendor name	GBIC vendor name (ASCII)
36	1	Reserved	
37-39	3	Vendor OUI	GBIC vendor IEEE company ID
40-55	16	Vendor PN	Part number provided by GBIC vendor (ASCII)
56-59	4	Vendor rev	Revision level for part number provided by vendor (ASCII)
60-62	4	Reserved	
63	1	CC_BASE	Check code for Base ID Fields (addresses 0 to 62)
EXTENDED ID FIELDS			
64-65	2	Options	Indicates which optional GBIC signals are implemented (see table D.6)
66	1	BR, max	Upper baud rate margin, units of %
67	1	BR, min	Lower baud rate margin, units of %
68-83	16	Vendor SN	Serial number provided by vendor (ASCII)
84-91	8	Date code	Vendor’s manufacturing date code (see table D.7)
92-94	4	Reserved	
95	1	CC_EXT	Check code for the Extended ID Fields (addresses 64 to 94)
VENDOR SPECIFIC ID FIELDS			
96-127	32	Readable	Vendor specific data, read only

Identifier

The identifier value specifies the physical device described by the serial information. This value shall be included in the serial data. The defined identifier values are shown in table D.2.

Table D.2: Identifier values

Value	Description of physical device
00h	Unknown or unspecified
01h	GBIC
02h	Module/connector soldered to motherboard
03-7Fh	Reserved
80-FFh	Vendor specific

Connector

The Connector value indicates the external connector provided on the interface. This value shall be included in the serial data. The defined connector values are shown in table D.3.

Table D.3: Connector values

Value	Description of connector
00h	Unknown or unspecified
01h	Fibre Channel definition of SC connector
02h	Fibre Channel definition of style 1 copper connector
03h	Fibre Channel definition of style 2 copper connector
04h	Fibre Channel definition of BNC/TNC
05h	Fibre Channel definition of coaxial headers
06-7Fh	Reserved
80-FFh	Vendor specific

Transceiver

The following bit significant indicators define the electronic or optical interfaces that are supported by the GBIC. At least one bit shall be set in this field. For Fibre Channel GBICs, the Fibre Channel speed, transmission media, transmitter technology, and distance capability shall all be indicated.

Table D.4: Transceiver codes

Bit Position (0-31)	Description of transceiver	Bit Position (32-63)	Description of transceiver
Fibre Channel speed (Bits 0-8)		Gigabit Ethernet Compliance Codes (Bits 32 - 39)	
0	100 MBytes/Sec	32	1000BASE-SX
1	Reserved	33	1000BASE-LX
2	200 MBytes./Sec	34	1000BASE-CX
3	Reserved	35	1000BASE-T
4	400 MBytes/Sec	36-39	Reserved
5-7	Reserved		
Fibre Channel transmission media (Bits 8-19)		SONET Compliance Codes (Bits 40 - 47)	
8	Single Mode (SM)	40	OC 3, multi-mode short reach
9	Reserved	41	OC 3, single mode intermediate reach
10	Multi-mode, 50 µ (M5)	42	OC 3, single mode long reach
11	Multi-mode, 62.5µ (M6)	43	Reserved
12	Video Coax (TV)	44	OC 12 multi-mode short reach
13	Miniature Coax (MI)	45	OC 12, single mode intermediate reach
14	Shielded Twisted Pair (TP)	46	OC 12, single mode long reach
15	Twin Axial Pair (TW)	47	Reserved
16 - 19	Reserved		
Fibre Channel transmitter technology (Bits 20-27)		Reserved Standard Compliance Codes (Bits 48 - 63)	
20	Longwave laser (LL)	48-63	Reserved
21	Shortwave laser w/ OFC (SL)		
22	Shortwave laser w/o OFC (SN)		
23	Electrical intra-enclosure (EL)		
24	Electrical inter-enclosure (EL)		
25 - 27	Reserved		
Fibre Channel link length (Bits 28-31)			
28	long distance (L)		
29	intermediate distance (I)		
30	short distance (S)		
31	Reserved		

Encoding

The encoding value indicates the serial encoding mechanism that is the nominal design target of the particular GBIC. The value shall be contained in the serial data. The defined encoding values are shown in table D.5.

Table D.5: Encoding codes

code	Description of encoding mechanism
0	Unspecified
1	8B10B
2	4B5B
3	NRZ
4	Manchester
5-256	Reserved

BR, nominal

The nominal baud rate (BR, nominal) is specified in units of 100 Megabaud per second, rounded off to the nearest 100 Megabaud per second. A value of 0 indicates that the baud rate is not specified and must be determined from the transceiver technology.

Length (9μ)

This value specifies the link length that is supported by the GBIC while operating in compliance with the applicable standards using single mode fiber. The value is in units of 100 meters. A value of 255 means that the GBIC supports a link length greater than 25.4 km. A value of zero means that the GBIC does not support single mode fiber or that the length information must be determined from the transceiver technology.

Length (50μ)

This value specifies the link length that is supported by the GBIC while operating in compliance with the applicable standards using 50 micron multi-mode fiber. The value is in units of 10 meters. A value of 255 means that the GBIC supports a link length greater than 2.54 km. A value of zero means that the GBIC does not support 50 micron multi-mode fiber or that the length information must be determined from the transceiver technology.

Length (62.5μ)

This value specifies the link length that is supported by the GBIC while operating in compliance with the applicable standards using 62.5 micron multi-mode fiber. The value is in units of 10 meters. A value of 255 means that the GBIC supports a link length greater than 2.54 km. A value of zero means that the GBIC does not 62.5 micron multi-mode fiber or that the length information must

Options

The bits in the option field shall specify the options implemented in the GBIC as described in table D.6.

Table D.6: Option values

bit	Description of option
0	Reserved
1	Loss of Signal implemented, signal as defined in 3.3
2	Loss of Signal implemented, signal inverted from definition in 3.3 NOTE: This is not standard GBIC behavior and should be avoided, since non-interoperable behavior results.
3	TX_FAULT signal implemented. (Reset as defined in 5.3)
4	TX_DISABLE is implemented and disables the serial output.
5 - 15	Reserved for future use

BR, max

The upper baud rate limit at which the GBIC will still meet its specifications (BR, max) is specified in units of 1% above the nominal baud rate. A value of zero indicates that this field is not specified.

BR, min

The lower data rate limit at which the GBIC will still meet its specifications (BR, min) is specified in units of 1% below the nominal data rate. A value of zero indicates that this field is not specified.

Vendor SN

The vendor serial number (vendor SN) is a 16-byte field that contains ASCII characters, left-aligned and padded on the right with ASCII spaces (20h), defining the vendor’s serial number for the GBIC. A value of all zero in the 16-byte field indicates that the vendor PN is unspecified.

Date Code

The date code is an 8-byte field that contains the vendor’s date code in ASCII characters. The date code is mandatory. The date code shall be in the format specified by table D.7.

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Table D.7: Date Code

Data Address	Description of field
84-85	ASCII code, two low order digits of year. (00 = 2000).
86-87	ASCII code, digits of month (01 = Jan through 12 = Dec)
88-89	ASCII code, day of month (01 - 31)
90-91	ASCII code, vendor specific lot code

CC_EXT

The check code is a one byte code that can be used to verify that the first 32 bytes of extended serial information in the GBIC is valid. The check code shall be the low order 8 bits of the sum of the contents of all the bytes from byte 64 to byte 94, inclusive.

Readable

This area may contain vendor specific information which can be read from the GBIC.

D.3 Color coding of optical connectors

If the transceiver code (data addresses 3-10, bits 8, 10, 11, or 33) specifies a single mode medium, exposed surfaces of the external connector and/or retention mechanism shall be blue to indicate that single-mode fiber should be connected to this GBIC.

If the transceiver code (data addresses 3-10, bits 10, 11, or 32) specifies a multi-mode medium, exposed surfaces of the external connector and/or retention mechanism shall be beige or black to indicate that multi-mode fiber should be connected to this GBIC.

If conflicting values are specified, the transceiver shall have the color for the most appropriate transceiver code.

D.4 Recommended external plug color coding

For compliance with international standards and to simplify error free configuration of systems, fibre optic plugs that are used with this GBIC's receptacle should have exposed connector surfaces of the proper color to indicate that the fibre is single-mode or multi-mode. Overmolding of the connector is not required to be color coded, but the plug should be clearly identified as the proper mode by appropriate additional labeling or color coding.

Annex E: Module definition “5” GBIC (shortwave laser) (normative annex)

E.1 Overview of module definition 5 GBIC

A GBIC having module definition 5 presents a standard optical interface compatible with the Fibre Channel 100-M5-SN-I and 100-M6-SN-I interfaces. Those characteristics are summarized in table E.1.

Table E.1: Overview, module definition 5 GBIC

Parameter	Value
Application	Fibre Channel, 100-M5-SN- I or 100-M6-SN-I, no OFC or compatible physical interface
Distance	500 meters maximum using 50 micron fiber. 300 meters maximum using 62.5 micron fiber.
Data Rate	1062.5 Mbaud +/- 100 ppm
Data Format	8B/10B
Fiber Type	50 µm or 62.5 µm, multimode
Wavelength	770-860 nm
Minimum Power into Fiber	-10 dBm average
Worst Case Receiver Sensitivity	-16 dBm average power. BER shall be $<10^{-12}$ when the data is sampled across a +/- 10% UI window centered in the receiver eye.
Laser safety features	Transmit power level management with laser overdrive protection circuit.

The standard GBIC pinout and pin definitions shall be used.

E.2 Optical signal definitions

The relationship between the states of the transmitter, receiver, and the received optical power is shown in table E.2.

Table E.2: Relationship between electrical signal polarity and optical power

Signal state	+TX_DAT	-TX_DAT	Optical Power	+RX_DAT	-RX_DAT
“1”	HIGH	LOW	HIGH	HIGH	LOW
“0”	LOW	HIGH	LOW	LOW	HIGH

For electrical signals “LOW” is a less positive (more negative) signal than the “HIGH” signal in the same differential pair. For the optical power signal, “LOW” is the minimum optical power state, corresponding to minimum drive to the laser, while “HIGH” is the maximum optical power state, corresponding to maximum laser drive.

E.3 Optical transceiver

The optical transceiver interface is defined by FC-PH-2. Additional information is shown in table E.3.

Table E.3: Optical Transceiver Interface

Parameter	Symbol	Min.	Max.	Unit	Conditions
Optical Output, TX_DISABLE asserted	P_{off}		-35	dBm	Into fiber, average, steady state
RX_LOS negate threshold level		-31	-16	dBm	average power
RX_LOS hysteresis		1	4	dB	No chattering

E.4 Initialization and error management

The protocols and timing specified in clause 5 shall be used by module definition 5 GBICs. The TX_DISABLE, TX_FAULT, and RX_LOS signals shall be implemented and operate with the specified protocols.

E.5 External connector definition and color coding

The external optical connector shall be the duplex SC connector defined by FC-PH. Exposed surfaces of the external SC connector and/or retention mechanism shall be beige or black to indicate that only multi-mode fiber should be connected to this GBIC.

E.6 Recommended external plug color coding

For compliance with international standards and to simplify error free configuration of systems, fibre optic plugs that are used with this GBIC should have beige or black exposed connector surfaces to indicate that the fibre optic cable is a multi-mode cable. Overmolding of the connector is not required to be color coded, but the plug should be clearly identified as multi-mode by appropriate additional labeling or color coding.

Annex F: Module definition “6” GBIC (single mode laser) (normative annex)

F.1 Overview of module definition 6 GBIC

A GBIC having module definition 6 presents a standard optical interface that is fully compliant with the Fibre Channel 100-SM-LC-L interface. When used as a Fibre Channel interface, a compliant GBIC shall interoperate with GBICs having a module definition of 3 or 6.

The GBIC will also operate on single mode fibers transmitting the IEEE 802.3 Gigabit Ethernet signals over a 10 kilometer distance. While this GBIC operates at 1.25 GBd and is compatible with the electrical and jitter specifications for operation with IEEE 802.3z compliant hardware, it is not compliant with the 1000BASE-LX specification. Interoperability between this specification and 1000BASE-LX may be possible under carefully restricted circumstances

The present characteristics are summarized in table F.1.

Table F.1: Overview, module definition 6 GBIC

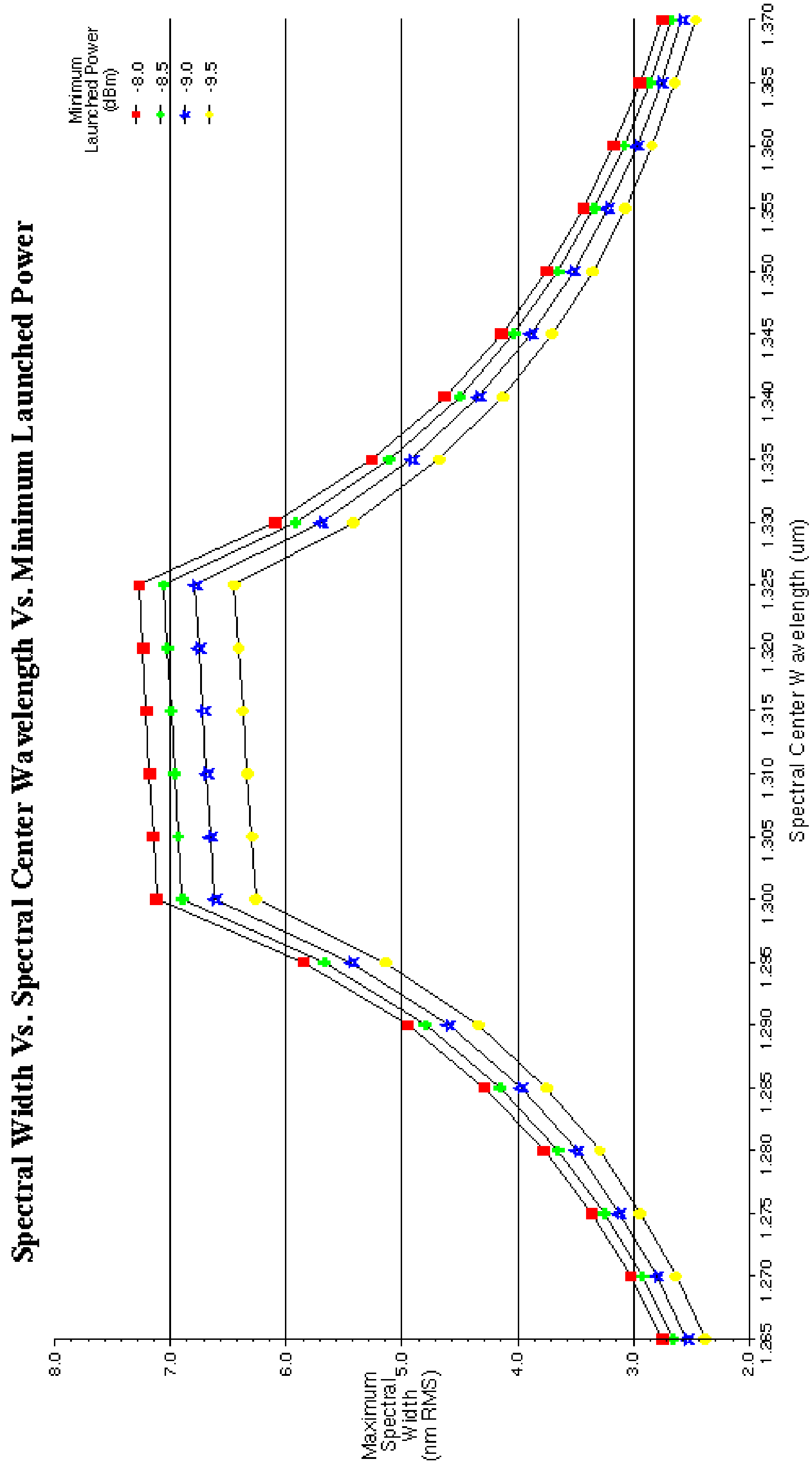
Parameter	Value
Application	Fibre Channel single-mode transceiver, 100-SM-LC-L and 10 km IEEE802.3 Gigabit Ethernet similar to 1000BASE-LX, but modified for longer distance.
Distance	2 meters to 10 kilometers
Data Rate	1062.5 Mbaud +/- 100 ppm and 1250 Mbaud
Data Format	8B/10B
Fiber Type	9 µm core, single mode, 1310 nm, < 0.45 db/km loss
Nominal link budget	7.8 dB, including all connectors, splices, cable
Transmitter	Laser
Spectral center	from Figure F.1
Spectral width, RMS	from Figure F.1
Transmitter, launched power	non-OFC, from Figure F.1
Extinction ratio	9 dB minimum
RIN_12	-116 dB/Hz
Received power	-20 dBm to -3 dBm average power. BER shall be $<10^{-12}$ when the data is sampled across a +/- 10% UI window centered in the receiver eye.
Power penalties	from Figure F.1
Receiver return loss	12 dB minimum
Laser safety features	Transmit power level management with laser overdrive protection circuit.

The standard GBIC pinout and pin definitions shall be used.

F.2 Optical transmitter power

The optical power required to be launched by the transmitter is a function of the wavelength deviation from the zero dispersion value of the fiber and the spectral width of the source laser. The required optical power can be calculated based on Figure F.1.

Figure F.1: Spectral Width vs. Spectral Center Wavelength vs. Launched Power



The information contained in Figure F.1 is presented in tabular form in table F.2 and table F.3.

Table F.2: Spectral Width vs. Spectral Center Wavelength vs. Launched Power, 1 of 2

Minimum Launched Power (dB)	Center Wavelength (µm)										
	1.265	1.270	1.275	1.280	1.285	1.290	1.295	1.300	1.305	1.310	1.315
-8.0	2.75	3.02	3.36	3.77	4.29	4.95	5.85	7.12	7.15	7.18	7.21
-8.5	2.66	2.92	3.25	3.65	4.15	4.80	5.67	6.90	6.93	6.96	7.00
-9.0	2.54	2.80	3.12	3.49	3.97	4.60	5.44	6.62	6.65	6.69	6.72
-9.5	2.38	2.63	2.94	3.29	3.75	4.34	5.14	6.26	6.30	6.34	6.37
	Spectral Width (nm)										

Table F.3: Spectral Width vs. Spectral Center Wavelength vs. Launched Power, 2 of 2

Minimum Launched Power (dB)	Center Wavelength (µm)										
	1.320	1.325	1.330	1.335	1.340	1.345	1.350	1.355	1.360	1.365	1.370
-8.0	7.24	7.27	6.10	5.26	4.63	4.14	3.75	3.43	3.17	2.94	2.75
-8.5	7.03	7.06	5.92	5.11	4.50	4.03	3.65	3.34	3.08	2.86	2.67
-9.0	6.76	6.79	5.70	4.92	4.34	3.88	3.52	3.22	2.97	2.76	2.58
-9.5	6.41	6.45	5.42	4.68	4.13	3.70	3.35	3.07	2.84	2.64	2.46
	Spectral Width (nm)										

F.3 Optical signal definitions

The relationship between the states of the transmitter, receiver, and the received optical power is shown in table F.4.

Table F.4: Relationship between electrical signal polarity and optical power

Signal state	+TX_DAT	-TX_DAT	Optical Power	+RX_DAT	-RX_DAT
“1”	HIGH	LOW	HIGH	HIGH	LOW
“0”	LOW	HIGH	LOW	LOW	HIGH

For electrical signals “LOW” is a less positive (more negative) signal than the “HIGH” signal in the same differential pair. For the optical power signal, “LOW” is the minimum optical power state, corresponding to minimum drive to the laser, while “HIGH” is the maximum optical power state, corresponding to maximum laser drive.

F.4 Optical transceiver timing

The optical transceiver interface is defined by the Fibre Channel 100-SM-LC-L standard. Additional information is shown in table F.5.

Table F.5: Optical Transceiver Interface

Parameter	Symbol	Min.	Max.	Unit	Conditions
Optical Output, TX_DISABLE asserted	P_{off}		-35	dBm	Into fiber, average, steady state
RX_LOS negate threshold level		-31	-20	dBm	average power
RX_LOS hysteresis		1	4	dB	No chattering

F.5 Initialization and error management

The protocols and timing specified in clause 5 shall be used by module definition 6 GBICs. The TX_DISABLE, TX_FAULT, and RX_LOS signals shall be implemented and operate with the specified protocols.

F.6 External connector definition and color coding

The external optical connector shall be the duplex SC connector defined by FC-PH. Exposed surfaces of the external SC connector and/or retention mechanism shall be blue to indicate that only single-mode fiber should be connected to this GBIC.

F.7 Recommended external plug color coding

For compliance with international standards and to simplify error free configuration of systems, fibre optic plugs that are used with this GBIC should have blue exposed connector surfaces to indicate that the fibre optic cable is a single-mode cable. Overmolding of the connector is not required to be color coded, but the plug should be clearly identified as single mode by appropriate additional labeling or color coding.

Annex G: Module definition “7” GBIC (shortwave laser) (normative annex)

G.1 Overview of module definition 7 GBIC

A GBIC having module definition 7 presents a standard optical interface that is fully compliant with the Fibre Channel 100-M5-SN-I interface, the 100-M6-SN-I interface, and with the IEEE802.3 Gigabit Ethernet 1000BASE-SX interface. When used as a Fibre Channel interface, a compliant GBIC shall interoperate with GBICs having a module definition of 5 or 7. The characteristics are summarized in table G.1

A GBIC having module definition 7 presents a standard optical interface compatible with the Gigabit Ethernet 1000BASE-SX interface. Those characteristics are summarized in table G.1.

Table G.1: Overview, module definition 7 GBIC

Parameter	Value
Application	Gigabit Ethernet, 1000BASE-SX interface and Fibre Channel 100-M5-SN-I and 100-M6-SN-I interface
Distance	In 1000BASE-SX environment, 550 meters maximum using 50 micron fiber and 260 meters maximum using 62.5 micron fiber. In Fibre Channel environment, see Annex E.
Data Rate	1250 Mbaud +/- 100 ppm and 1062.5 Mbaud +/- 100 ppm
Data Format	8B/10B
Fiber Type	50 µm or 62.5 µm, multimode
Wavelength	770-860 nm
Minimum Power into Fiber	-10 dBm average
Worst Case Receiver Sensitivity	- 17 dBm average power. BER shall be $<10^{-12}$ when the data is sampled across a +/- 10% UI window centered in the receiver eye.
Laser safety features	Transmit power level management with laser overdrive protection circuit.

The standard GBIC pinout and pin definitions shall be used.

G.2 Optical signal definitions

The relationship between the states of the transmitter, receiver, and the received optical power is shown in table G.2.

Table G.2: Relationship between electrical signal polarity and optical power

Signal state	+TX_DAT	-TX_DAT	Optical Power	+RX_DAT	-RX_DAT
“1”	HIGH	LOW	HIGH	HIGH	LOW
“0”	LOW	HIGH	LOW	LOW	HIGH

For electrical signals “LOW” is a less positive (more negative) signal than the “HIGH” signal in the same differential pair. For the optical power signal, “LOW” is the minimum optical power state, corresponding to minimum drive to the laser, while “HIGH” is the maximum optical power state, corresponding to maximum laser drive.

G.3 Optical transceiver

The optical transceiver interface is defined by IEEE P802.3z, clause 38. Additional information is shown in table G.3.

Table G.3: Optical Transceiver Interface

Parameter	Symbol	Min.	Max.	Unit	Conditions
Optical Output, TX_DISABLE asserted	P_{off}		-35	dBm	Into fiber, average, steady state
RX_LOS negate threshold level		-31	-17	dBm	average
RX_LOS hysteresis		1	4	dB	No chattering

G.4 Initialization and error management

The protocols and timing specified in clause 5 shall be used by module definition 7 GBICs. The TX_DISABLE, TX_FAULT, and RX_LOS signals shall be implemented and operate with the specified protocols.

G.5 External connector definition and color coding

The external optical connector shall be the duplex SC connector defined by P802.3z. Exposed surfaces of the external SC connector and/or retention mechanism shall be beige or black to indicate that only multi-mode fiber should be connected to this GBIC.

G.6 Recommended external plug color coding

For compliance with international standards and to simplify error free configuration of systems, fibre optic plugs that are used with this GBIC should have beige or black exposed connector surfaces to indicate that the fibre optic cable is a multi-mode cable. Overmolding of the connector is not required to be color coded, but the plug should be clearly identified as multi-mode by appropriate additional labeling or color coding.