



# Intel<sup>®</sup> TXN31111 Tri-rate 850 nm Optical Transceiver - SFP\* MSA Compatible

## Datasheet

The LC Small Form Factor Pluggable (SFP) optical transceivers are high-performance integrated modules for bi-directional communication over multimode optical fiber.

The Intel<sup>®</sup> TXN31111 Tri-Rate 850 nm Optical Transceiver (called hereafter the TXN31111 Optical Transceiver) is specifically designed for high-speed multi-rate operation. The TXN31111 Optical Transceiver is provided with an LC receptacle that is compatible with the industry-standard LC connector.

The TXN31111 Optical Transceiver has an LC receptacle compatible with the industry-standard LC connector. The TXN31111 Optical Transceiver is a Class 1 Laser product that complies with FDA Radiation Performance Standards, 21 CFR Subchapter J and international standards IEC 60825-1 and IEC 60825-2.

## Product Features

- n Compliant with 1x and 2x Fibre Channel (1.0625/2.125 Gbps) FC-PI standard
- n Compliant with 1.25 Gbps IEEE 802.3z Ethernet standard
- n Compliant with the SFP MSA specification
- n Hot pluggable
- n 850 nm VCSEL emitter
- n TTL Loss of Signal (LOS) Output
- n Transmitter Disable Input
- n AC-coupled CML level Input/Output
- n Single +3.3 V Power Supply
- n Class 1 Laser Product
- n IEC/UL 60950-1 Safety Certified
- n Designed and verified as RoHS compliant

## Applications

- n Fibre Channel Switches
- n Ethernet Stackable Switches
- n Ethernet Enterprise Switches

**Notice:** This document contains preliminary information on new products in production. The specifications are subject to change without notice. Verify with your local Intel sales office that you have the latest datasheet before finalizing a design.

Order Number: 280049, Revision: 007  
20-September-2006



INFORMATION IN THIS DOCUMENT IS PROVIDED IN CONNECTION WITH INTEL® PRODUCTS. NO LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE, TO ANY INTELLECTUAL PROPERTY RIGHTS IS GRANTED BY THIS DOCUMENT. EXCEPT AS PROVIDED IN INTEL'S TERMS AND CONDITIONS OF SALE FOR SUCH PRODUCTS, INTEL ASSUMES NO LIABILITY WHATSOEVER, AND INTEL DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY, RELATING TO SALE AND/OR USE OF INTEL PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT. Intel products are not intended for use in medical, life saving, life sustaining, critical control or safety systems, or in nuclear facility applications.

Intel may make changes to specifications and product descriptions at any time, without notice.

Intel Corporation may have patents or pending patent applications, trademarks, copyrights, or other intellectual property rights that relate to the presented subject matter. The furnishing of documents and other materials and information does not provide any license, express or implied, by estoppel or otherwise, to any such patents, trademarks, copyrights, or other intellectual property rights.

The TXN31111 Optical Transceiver may contain design defects or errors known as errata which may cause the product to deviate from published specifications. Current characterized errata are available on request.

Contact your local Intel sales office or your distributor to obtain the latest specifications and before placing your product order.

Copies of documents which have an order number and are referenced in this document, or other Intel literature may be obtained by calling 1-800-548-4725 or by visiting Intel's website at <http://www.intel.com>.

Intel and the Intel logo are trademarks or registered trademarks of Intel Corporation or its subsidiaries in the United States and other countries.

\*Other names and brands may be claimed as the property of others.

Copyright © 2006, Intel Corporation. All Rights Reserved.

# Contents

---

<b>1.0</b>	<b>Introduction</b> .....	6
<b>2.0</b>	<b>Specifications</b> .....	7
2.1	Maximum Ratings and Recommended Operating Conditions .....	7
2.2	Specifications – Electrical .....	9
2.3	Specifications – Optical .....	10
<b>3.0</b>	<b>Electrical Interface</b> .....	12
<b>4.0</b>	<b>Termination</b> .....	14
4.1	Types of I/O Interfaces .....	14
4.2	CML Termination .....	15
<b>5.0</b>	<b>SFP Timing Parameters</b> .....	17
<b>6.0</b>	<b>Serial Identification</b> .....	18
6.1	Identifier .....	20
6.2	Connector .....	21
6.3	Encoding.....	21
6.4	Transceiver .....	22
<b>7.0</b>	<b>Mechanical Specification</b> .....	25
<b>8.0</b>	<b>Regulatory Compliance</b> .....	26
8.1	Electromagnetic Compatibility Compliance .....	26
8.2	Safety Compliance.....	27
8.3	Lead-Free Conformance.....	28
8.4	Compliance with Restriction of Hazardous Substances .....	28
8.5	Product Certification Markings and Compliance Statements.....	29
<b>9.0</b>	<b>Ordering Information</b> .....	30
<b>10.0</b>	<b>Acronyms</b> .....	31

## Figures

1	Diagram of Host Board Connector Block Pin Numbers and Names.....	12
2	Circuit Diagram for CML Termination on Receiver Output .....	15
3	Circuit Diagram for CML Termination on Transmitter Input.....	16
4	SFP Mechanical Specifications .....	25



## Tables

1	Absolute Maximum Ratings .....	7
2	Recommended Operating Conditions .....	7
3	Electrical Characteristics .....	8
4	Transmitter – Electrical Specifications.....	9
5	Receiver – Electrical Specifications.....	9
6	Fiber Length Specifications .....	10
7	Optical Specifications – Transmitter .....	10
8	Receiver – Optical Specifications .....	11
9	Plug Sequence: Pin Engagement Sequence During Hot Plugging .....	12
10	Timing Parameters for SFP Management .....	17
11	Serial Identification Field Descriptions.....	18
12	Identifier Values .....	20
13	Connector Values .....	21
14	Encoding Codes .....	21
15	Transceiver Codes .....	22
16	Option Values .....	23
17	Date Code .....	24
18	Electromagnetic Compatibility Compliance .....	26
19	Safety Compliance .....	27
20	Lead-Free 2 <sup>nd</sup> -Level Interconnect Markings.....	28
21	Product Certification Markings and Compliance Statements .....	29
22	Ordering Information.....	30
23	Acronyms.....	31

# Revision History

Date	Revision	Description
20-Sept-2006	007	Title page change Added standard references on <a href="#">Table 1.0 "Introduction" on page 6</a> Modified <a href="#">Table 3 "Electrical Characteristics" on page 8</a> Modified <a href="#">Table 5 "Receiver – Electrical Specifications" on page 9</a> Modified <a href="#">Table 6 "Fiber Length Specifications" on page 10</a> Modified <a href="#">Table 7 "Optical Specifications – Transmitter" on page 10</a> Modified <a href="#">Table 6 "Fiber Length Specifications" on page 10</a>
24-May- 2006	006	Title change <a href="#">Table 7 "Optical Specifications – Transmitter" on page 10</a> -Corrected document-only error - Output Rise/Fall Time.
25-Aug-2005	005	<ul style="list-style-type: none"> <li>Modified Title Page:</li> <li>Modified datasheet description on Page 1</li> <li>Rearranged the Product Features and Applications sections on Page 1.</li> <li>Added first paragraph under <a href="#">Section 2.0, "Specifications" on page 7</a>.</li> <li>Modified <a href="#">Table 1 "Absolute Maximum Ratings" on page 7</a>: Removed Operating Temperature and Note 1. Added Caution note.</li> <li>Modified <a href="#">Table 5 "Receiver – Electrical Specifications" on page 9</a>: Added total jitter TJ parameter.</li> <li>Modified <a href="#">Table 8 "Receiver – Optical Specifications" on page 11</a>: Added "Stressed Sensitivity Compliant with Fibre Channel – Physical Interfaces (FC-PI-2) specs, IEEE 802.3z* Gigabit Ethernet 1000 BASE-SX standard."</li> <li>Modified <a href="#">Section 7.0, "Mechanical Specification" on page 25</a>: Added "Note: Aqueous wash is not applicable for this product."</li> <li>Modified <a href="#">Table 21 "Product Certification Markings and Compliance Statements" on page 29</a>: Modified Electromagnetic Interference (EMI) Performance to: "Module meets FCC class B. System margins depend on the PCB layout of customer board and chassis designs.</li> </ul>
14 Jan 2005	004	Modified <a href="#">Table 3 "Electrical Characteristics" on page 8</a> : added Power Dissipation values.
17 Nov 2004	003	Replaced <a href="#">Figure 4 "SFP Mechanical Specifications" with a corrected drawing.</a>
17 Aug 2004	002	<p><b>Updated the Transmitter Values for Max Field:</b></p> <ul style="list-style-type: none"> <li>–Single Ended, was 1100</li> <li>–Differential, was 2200</li> <li>–Output rise/fall time, was 115</li> </ul> <p><b>Updated the Receiver Values:</b></p> <ul style="list-style-type: none"> <li>–Max:Total Jitter row was TBD</li> <li>–Min:Receiver Sensitivity was -22, -20, LOS - Asserted was -30, LOS - Hysteresis not defined</li> <li>–Typ:Receiver Sensitivity was -19, -17</li> </ul>
29 Jun 2004	001	Initial document release

## 1.0 Introduction

---

The Intel® TXN31111 Tri-Rate 850 nm Optical Transceiver (called hereafter the TXN31111 Optical Transceiver) is specifically designed for high-speed data links at 2.125 Gbps (2x Fibre Channel rate).

This document discusses the following TXN31111 Optical Transceiver topics:

- [Section 2.0, “Specifications” on page 7](#)
- [Section 3.0, “Electrical Interface” on page 12](#)
- [Section 4.0, “Termination” on page 14](#)
- [Section 5.0, “SFP Timing Parameters” on page 17](#)
- [Section 6.0, “Serial Identification” on page 18](#)
- [Section 7.0, “Mechanical Specification” on page 25](#)
- [Section 8.0, “Regulatory Compliance” on page 26](#)
- [Section 9.0, “Ordering Information” on page 30](#)
- [Section 10.0, “Acronyms” on page 31](#)

For information on standards that apply to the TXN31111 Optical Transceiver, see the following references:

- IEEE Std 802.3, 2002 Edition, Clause 38, PMD Type 1000BASE-SX. IEEE Standards Department, 2002
- IEEE Std 802.3z, 1998 Edition. Gigabit Interface Converter (GBIC) Ethernet Standard.
- Small Form-Factor Pluggable (SFP) Transceiver Multisource Agreement (MSA)
- Telcordia Technologies\* GR-63 Section 4.2
-

## 2.0 Specifications

Specifications include the following:

- Section 2.1, “Maximum Ratings and Recommended Operating Conditions” on page 7
- Section 2.2, “Specifications – Electrical” on page 9
- Section 2.3, “Specifications – Optical” on page 10

### 2.1 Maximum Ratings and Recommended Operating Conditions

Table 1 lists the absolute maximum ratings for the TXN31111 Optical Transceiver.

**Table 1. Absolute Maximum Ratings**

Parameter	Symbol	Min.	Max.	Unit	Notes
Storage Temperature	$T_S$	-40	85	°C	–
Relative Humidity	$R_H$	5	95	%	–
Module Supply Voltage	$V_{CC,T,R}$	-0.5	4	V	–
Data AC Voltage	TD+, TD-	–	2.6	$V_{PP}$	Differential
Control Input Voltage	$V_I$	-0.5	$V_{CC} + 0.3$	V	–

**Caution:** Exceeding these values may cause permanent damage. Functional operation under these conditions is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

Table 2 lists the recommended operating conditions. (Minimum and maximum values listed in Table 3 through Table 8 apply over the recommended operating conditions specified in Table 2.)

**Table 2. Recommended Operating Conditions**

Parameter	Symbol	Min.	Typ.	Max.	Unit
Case Temperature	$T_C$	-20	–	85	°C
Module Supply Voltage	$V_{CC,T,R}$	2.97	3.3	3.63	VDC
Data Rate	–	1.0625	–	2.5	Gbps

Table 3 lists the TXN31111 Optical Transceiver electrical characteristics.

**Table 3. Electrical Characteristics**

Parameter	Symbol	Min.	Typ.	Max.	Units	Notes
Supply Current	$I_{CC}$	–	150	180	mA	$T_C = 25^\circ\text{C}$ , $V_{CC} = 3.3\text{ V}$
	$I_{CC}$	–	–	200	mA	$-20^\circ\text{C} < T_C < 85^\circ\text{C}$ , $2.97\text{ V} < V_{CC} < 3.63\text{ V}$
Power Dissipation	$P_{diss}$	–	500	726	mW	$-20^\circ\text{C} < T_C < 85^\circ\text{C}$ , $2.97\text{ V} < V_{CC} < 3.63\text{ V}$
Supply Noise Rejection	–	100	–	–	mV	10 kHz to 4 MHz with supply filter
Inrush Current	–	–	–	30	mA	Hot plugging of the TXN3111101 Optical Transceiver results in the inrush current of no more than 30 mA greater than the steady state value.



## 2.2 Specifications – Electrical

Table 4 lists the TXN31111 Optical Transceiver transmitter electrical specifications.

**Table 4. Transmitter – Electrical Specifications**

Parameter	Symbol	Min.	Typ.	Max.	Units	Notes
CML Input (Single Ended)	–	200	–	1000	mVpp	AC Coupled Input
CML Input (Differential)	–	400	–	2000	mVpp	Peak to Peak Voltage
Input Impedance (differential)	$Z_{IN}$	85	100	115	$\Omega$	–
TX_DISABLE input voltage - High	$V_{IH}$	2	–	$V_{CC}+0.3$	V	–
TX_DISABLE input voltage - Low	$V_{IL}$	0	–	0.8	V	–
TX_Fault Output Voltage - High	$V_{OH}$	2.0	–	$V_{CC} + 0.3$	V	$I_{OH} = 40\mu A$ , 1 TTL Unit Load
TX_Fault Output Voltage - Low	$V_{OL}$	0	–	0.8	V	$I_{OH} = -1.69\text{ mA}$ , 1 TTL Unit Load

Table 5 lists the TXN31111 Optical Transceiver receiver electrical specifications.

**Table 5. Receiver – Electrical Specifications**

Parameter	Symbol	Min.	Typ.	Max.	Units	Notes
CML Output (Single Ended)	–	275	350	600	mVpp	AC Couple Outlets
CML Output (Differential)	–	550	700	1200	mVpp	Peak to Peak Voltage
CML Output (Rise/Fall Time)	–	–	–	150	ps	20% - 80%
Output Impedance (Differential)	$Z_{OUT}$	85	100	115	$\Omega$	–
TTL LOS Output - Low	$V_{IL}$	0	–	0.8	V	$I_{OH} = -1.69\text{ mA}$ , 1 TTL Unit Load
TTL LOS Output - High	$V_{OH}$	2.0	–	$V_{CC} + 0.3$	V	$I_{OH} = 40\mu A$ , 1 TTL Unit Load
Deterministic Jitter	DJ	–	–	47	ps	
Total Jitter	TJ	–	–	132	ps	–
MOD_DEF ( 0-2)	$V_{OH}$	2.5	–	$V_{CC} + 0.3$	V	With Serial ID
	$V_{OL}$	0	–	0.5	V	–
	NC	100 K	–	–	$\Omega$	Measured to RGND/ TGND

## 2.3 Specifications – Optical

Table 6 lists the TXN31111 Optical Transceiver fiber length specifications.

**Table 6. Fiber Length Specifications**

Parameter	Symbol	Min.	Typ.	Max.	Units	Notes
50 $\mu\text{m}$ /125 $\mu\text{m}$ MMF	–	0.5 0.5	–	500 1000	m	BER < 1.0E -12 @ 2.125 Gbps BER < 1.0E -12 @ 1.0625 Gbps
62.5 $\mu\text{m}$ /125 $\mu\text{m}$ MMF	–	0.5 0.5	–	300 500	m	BER < 1.0E -12 @ 2.125 Gb/s BER < 1.0E -12 @ 1.0625 Gb/s

Table 7 lists the TXN31111 Optical Transceiver transmitter optical specifications.

**Table 7. Optical Specifications – Transmitter**

Parameter	Symbol	Min.	Typ.	Max.	Units	Notes
Optical Transmit Power	Popt	-8	-5	-4	dBm	–
Optical Center	$\lambda$	830	850	860	nm	–
Spectral Width	$\Delta\lambda$	–	–	0.85	nm	RMS
Optical Modulation Amplitude	OMA	250	–	–	$\mu\text{W}$	pk-pk
Extinction Ratio	ER	9	–	–	dB	–
Relative Intensity Noise	RIN	–	–	-118	dB/Hz	–
Deterministic Jitter	DJ	–	–	30	ps	–
Total Jitter	TJ	–	–	65	ps	–
Output Rise/Fall Time	$t_R, t_F$	–	–	150	ps	20 - 80% values, measured unfiltered
<b>Note:</b> Eye Mask: Compliant with eye mask requirements of Fibre Channel – Physical Interfaces (FC-PI-2) specifications, IEEE 802.3z* Gigabit Ethernet 1000 BASE-SX standard						

Table 8 lists the TXN31111 Optical Transceiver receiver optical specifications.

**Table 8. Receiver – Optical Specifications**

Parameter	Symbol	Min.	Typ.	Max.	Units	Notes
Optical Input Wavelength	–	770	–	860	nm	–
Receiver Overload	–	–	–	0	dBm	–
Receiver Sensitivity	Pr	-19	-22	–	dBm	1.0625 Gbps Test conditions: <ul style="list-style-type: none"> <li>• 10<sup>-12</sup> BER</li> <li>• 9 dB ER input</li> <li>• 2<sup>7</sup> - 1 PRBS</li> </ul>
	Pr	-17	-20	–	dBm	2.125 Gb/s Test conditions: <ul style="list-style-type: none"> <li>• 10<sup>-12</sup> BER</li> <li>• 9 dB ER input</li> <li>• 2<sup>7</sup> - 1 PRBS</li> </ul>
Stressed Sensitivity	Compliant with Fibre Channel – Physical Interfaces (FC-PI-2) specifications, IEEE 802.3z* Gigabit Ethernet 1000 BASE-SX standard					
Optical Return Loss	ORL	12	–	–	dB	–
LOS - Asserted	Pa	-29	–	–	dB	Measured on transition – low to high
LOS - De-asserted	Pd	–	–	-17	dBm	Measured on transition – high to low
LOS - Hysteresis	Pa - Pd	1	–	5	dB	–

## 3.0 Electrical Interface

Figure 1 shows the TXN31111 Optical Transceiver electrical interface pin numbers and names.

**Figure 1. Diagram of Host Board Connector Block Pin Numbers and Names**

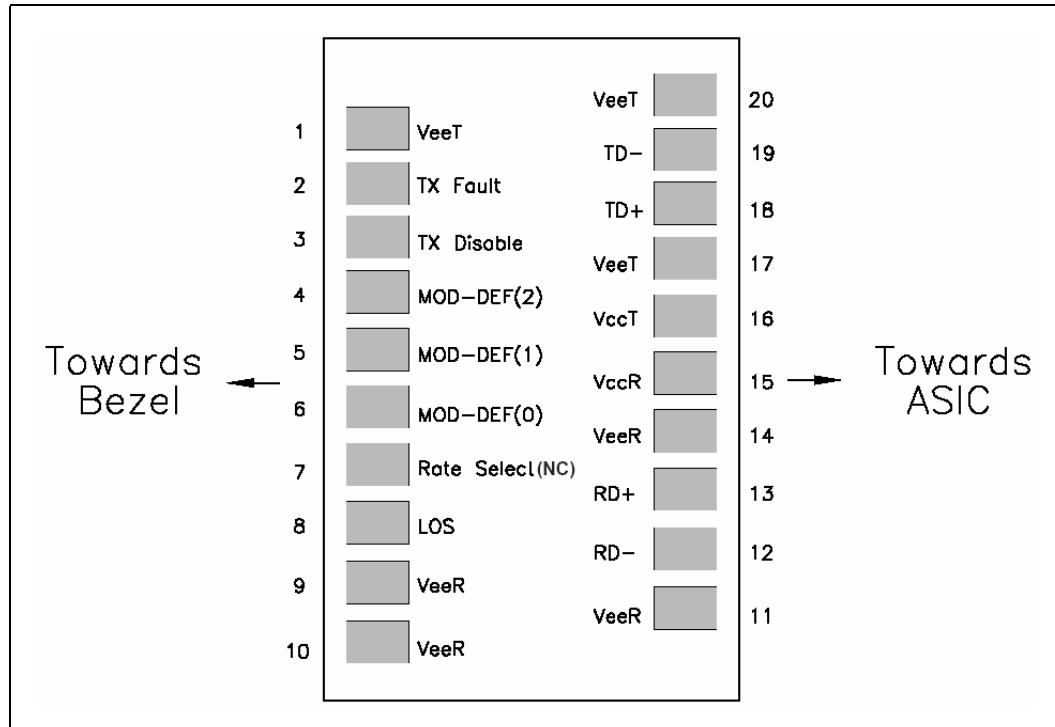


Table 9 lists the plug sequence to follow during hot plugging, as well as pin functions.

**Table 9. Plug Sequence: Pin Engagement Sequence During Hot Plugging (Sheet 1 of 2)**

Pin	Name	Function	Plug Sequence	Notes
1	V <sub>ee</sub> T	Transmitter Ground	1	–
2	TX_FAULT	Transmitter Fault Indication	3	1
3	TX_DISABLE	Transmitter Disable	3	2: Module Disables on high or open
4	MOD_DEF (2)	Module Definition 2	3	3: Wire Serial ID interface
5	MOD_DEF (1)	Module Definition 1	3	3: Wire Serial ID interface
6	MOD_DEF (0)	Module Definition 0	3	3: Grounded Module
7	RATE SELECT	–	3	4
8	LOS	Loss of Signal	3	5
9	V <sub>ee</sub> R	Receiver Ground	1	6
10	V <sub>ee</sub> R	Receiver Ground	1	6
11	V <sub>ee</sub> R	Receiver Ground	1	6

**Table 9. Plug Sequence: Pin Engagement Sequence During Hot Plugging (Sheet 2 of 2)**

Pin	Name	Function	Plug Sequence	Notes
12	RD-	Inverted Received Data out	3	7
13	RD+	Non-Inverted Received Data out	3	7
14	V <sub>ee</sub> R	Receiver Ground	1	6
15	V <sub>cc</sub> R	Receiver Power	2	3.3 V +/- 10% (See also Note 8.)
16	V <sub>cc</sub> T	Transmitter Power	2	3.3 V +/- 10% (See also Note 8.)
17	V <sub>ee</sub> T	Transmitter Ground	1	6
18	TD+	Non-inverted Data In	3	9
19	TD-	Inverted Data In	3	9
20	V <sub>ee</sub> T	Transmitter Ground	1	6

**NOTES:**

- TX FAULT** is an open collector/drain output that is pulled up with a 4.7 K - 10 K  $\Omega$  resistor on the host board. Use a pull-up voltage between 2.0 V and V<sub>cc</sub>T, R+0.3 V.
  - Low: Indicates normal operation. In the low state, the output is pulled to < 0.8 V.
  - High: Indicates a laser fault.
- TX DISABLE** is an input used to shut down the transmitter optical output. It is pulled up within the TXN31111 Optical Transceiver with a 4.7K - 10K  $\Omega$  resistor. The states are as follows:
  - Low (0 - 0.6V): Transmitter Enabled
  - (>0.8, <2.0V): Undefined
  - High (2.0 - 3.465V): Transmitter Disabled
- MOD-DEF 0,1,2:** These pins are the definition pins for the TXN31111 Optical Transceiver. They are pulled up with 4.7K - 10K  $\Omega$  resistor on the host board. Use a pull-up voltage between 2.0V and V<sub>cc</sub>T, R + 0.3V.
  - MOD-DEF 0 is grounded by the TXN31111 Optical Transceiver to indicate the TXN31111 Optical Transceiver is present.
  - MOD-DEF 1 is the clock line of a two-wire serial interface for serial ID.
  - MOD-DEF 2 is the data line of a two-wire serial interface for serial ID.
- RATE SELECT:** This signal function not implemented in the TXN31111 Optical Transceiver. The TXN31111 Optical Transceiver is rate agile – that is, it meets the specifications for 1.0625 Gbps to 2.5 Gbps data rates without the use of a rate-select pin.
- LOS (Loss of Signal)** has an internal 8K pull-up resistor to V<sub>cc</sub>R. While LOS is defined per the SFP MSA,
  - When low, this output indicates normal operation. In the low state, the output is pulled to < 0.8V.
  - When high, this output indicates the received optical power is below the worst-case receiver sensitivity (as defined by the standard in use).
- RD-/+** are the differential receiver outputs. They are AC-coupled 100  $\Omega$  differential lines that are terminated with 100  $\Omega$  (differential) at the user SerDes. The AC coupling is performed inside the TXN31111 Optical Transceiver and is therefore not required on the host board.
- V<sub>cc</sub>R and V<sub>cc</sub>T:** are the receiver and transmitter power supplies. Their values, which are listed in [Table 2, "Recommended Operating Conditions" on page 7](#), are defined at the SFP connector pin. Maximum supply current is listed in [Table 3, "Electrical Characteristics" on page 8](#). Hot plugging of the TXN31111 Optical Transceiver result in the inrush current listed in [Table 3, "Electrical Characteristics" on page 8](#).
- TD-/+** are the differential transmitter inputs. They are AC-coupled differential lines with 100  $\Omega$  differential termination inside the TXN31111 Optical Transceiver. The AC coupling is done inside the TXN31111 Optical Transceiver and is therefore not required on the host board.

## 4.0 Termination

---

### 4.1 Types of I/O Interfaces

The TXN31111 Optical Transceiver has the following types of I/O interfaces.

- CML interface
- TTL interface

High-speed I/Os use the CML interface, while control signals use the TTL interface. Proper termination of I/Os is required for good signal integrity. If I/Os (particularly the CML I/Os) are not terminated properly, then jitter increases significantly due to reflection from impedance mismatches.

## 4.2 CML Termination

Figure 2 shows a circuit diagram for the CML termination for the TXN31111 Optical Transceiver receiver output. The TXN31111 Optical Transceiver has built in AC-coupling capacitors, which help prevent a direct current path from the TXN31111 Optical Transceiver power supply to the SerDes input. (A direct current path could damage the ESD diodes on the SerDes.)

- **Internal termination.** For the TXN31111 Optical Transceiver receiver output, the SerDes interface provides an internal termination resistor.
- **External termination.** For the proper external termination of the SerDes interface, refer to the SerDes specification.

Figure 2. Circuit Diagram for CML Termination on Receiver Output

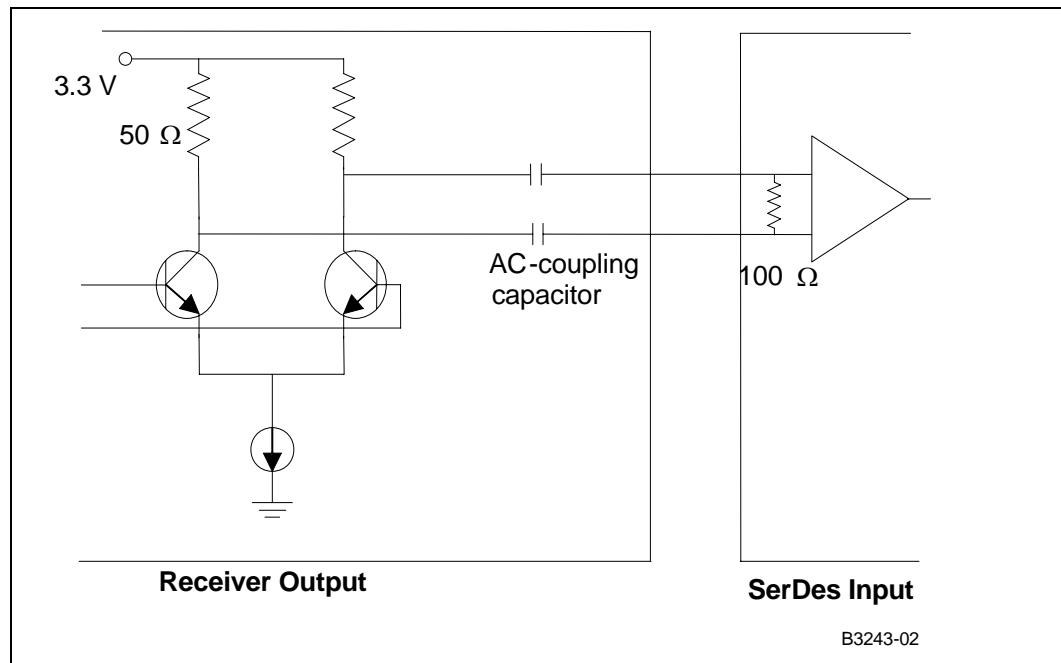
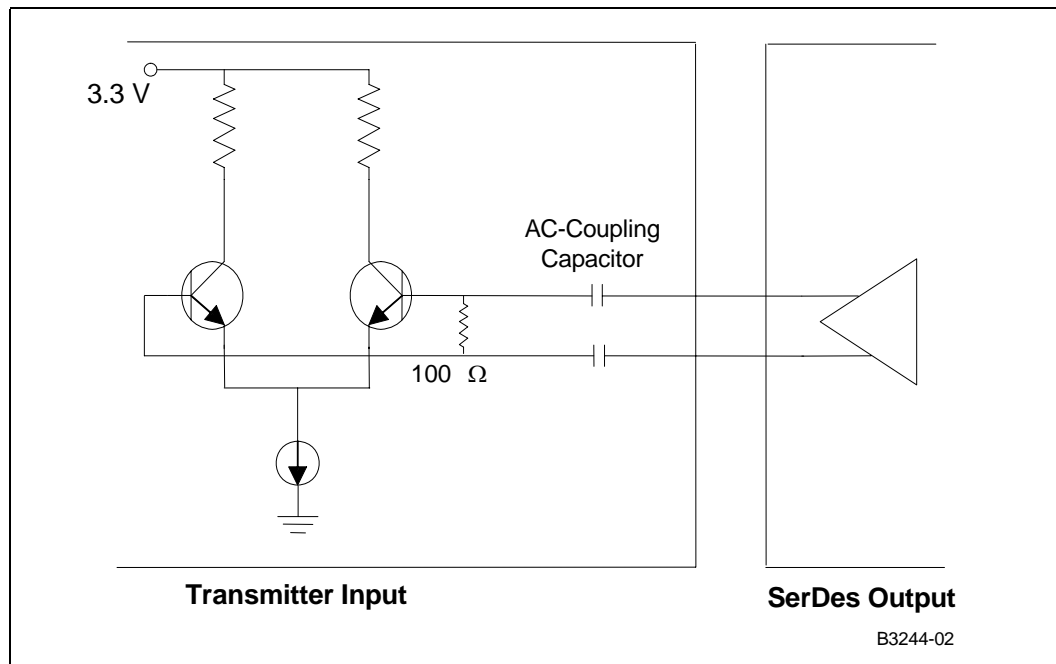


Figure 3 shows a circuit diagram for the CML termination for the TXN31111 Optical Transceiver transmitter input.

**Internal termination.** The TXN31111 Optical Transceiver transmitter input has an internal  $100\ \Omega$  termination between two inputs. AC-coupling capacitors are also built into the TXN31111 Optical Transceiver.

Figure 3. Circuit Diagram for CML Termination on Transmitter Input





## 5.0 SFP Timing Parameters

Table 10 lists the timing parameters for SFP management.

**Table 10. Timing Parameters for SFP Management**

Parameter	Symbol	Min.	Max.	Unit	Conditions
TX_DISABLE assert time	t_off	–	10	µs	Time from rising edge of TX_DISABLE to when the optical output falls below 10% of nominal
TX_DISABLE negate time	t_on	–	1	ms	Time 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	Time 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
RX_LOS Assert time	t_loss_on	–	100	µs	Time from LOS state to RX_LOS assert
RX_LOS De-assert time	t_loss_off	–	100	µs	Time from non-LOS state to RX_LOS de-assert
Rate-Select Change time	t_ratesel	–	10	µs	Time from rising or falling edge of Rate Select input until receiver bandwidth is in conformance with appropriate specification
Serial ID Clock Rate	f_serial_clock	–	100	KHz	–

## 6.0 Serial Identification

Table 11 lists the definitions from the different data stored in the TXN31111 Optical Transceiver EEPROM.

**Table 11. Serial Identification Field Descriptions (Sheet 1 of 3)**

Data Address	Field Size (Bytes)	Name of Field	Description of Field
<b>Base of Fields</b>			
0	1	Identifier	Type of serial identifier (see Table 12)
1	1	Ext. Identifier	Extended identifier of type of serial transceiver
2	1	Connector	Connector (see Table 13)
3-10	8	Transceiver	Optical Compatibility (see Table 15)
11	1	Encoding	Code for serial encoding algorithm (see Table 14)
12	1	BR, Nominal <sup>1</sup>	Nominal bit rate, units of 100Mbps
13	1	Reserved	–
14	1	Length (9 $\mu$ ) - km <sup>2</sup>	Link Length supported for 9/125 $\mu$ m fiber, units of km
15	1	Length (9 $\mu$ ) <sup>3</sup>	Link Length supported for 9/125 $\mu$ m fiber, units of 100 m
16	1	Length (50 $\mu$ ) <sup>4</sup>	Link Length supported for 50/125 $\mu$ m fiber, units of 10 m
17	1	Length (62.5 $\mu$ ) <sup>5</sup>	Link Length supported for 62.5/125 $\mu$ m fiber, units of 10 m
18	1	Length (Copper) <sup>6</sup>	Link Length supported for copper, units of meters
19	1	Reserved	–
20-35	16	Vendor name <sup>7</sup>	SFP vendor name (ASCII)
36	1	Reserved	–
37-39	3	Vendor OUI <sup>8</sup>	SFP vendor IEEE company ID
40-55	16	Vendor PN <sup>9</sup>	Part number provided by SFP vendor (ASCII)
56-59	4	Vendor rev <sup>10</sup>	Revision level for part number provided by vendor (ASCII)
60-62	3	Reserved	–
63	1	CC_BASE <sup>11</sup>	Check code for Base ID fields (address 0 to 62)
<b>Extended ID Fields</b>			
64-65	2	Options <sup>12</sup>	Indicates which optional SFP signals are implemented (see Table 16)
66	1	BR, Max <sup>13</sup>	Upper bit rate margin, units of %
67	1	BR, Min <sup>14</sup>	Lower bit rate margin, units of %
68-83	16	Vendor SN <sup>15</sup>	Serial number provided by vendor (ASCII)
84-91	8	Date Code <sup>16</sup>	Vendor manufacturing date code (see Table 17)
92-94	3	Reserved	–

**Table 11. Serial Identification Field Descriptions (Sheet 2 of 3)**

Data Address	Field Size (Bytes)	Name of Field	Description of Field
95	1	CC_EXT	Check code for the Extended ID fields (address 64 to 94)
<b>Vendor Specific ID Fields</b>			
96-127	32	Read-only	Vendor specific data, read only
128-511	384	Reserved	Vendor specific
512-n	–	–	–
<p><b>NOTES:</b></p> <ol style="list-style-type: none"> <li>1. The nominal bit rate (BR, nominal) is specified in units of 100 Mbps, rounded off to the nearest 100 Mbps. The bit rate includes bits necessary to encode and delimit the signal, and bits carrying data information. A value of zero indicates that the bit rate is not specified and must be determined from the transceiver technology. The actual information transfer rate depends on the encoding of the data, as defined by the encoding value.</li> <li>2. In addition to EEPROM data from the original GBIC definition, this value specifies the link length that is supported by the SFP while operating in compliance with the applicable standards using single-mode fiber. This value is in units of kilometers. A value of 255 means that the SFP supports a link length greater than 254 km. A value of zero means that the SFP does not support single-mode fiber or that the length information must be determined from the transceiver technology.</li> <li>3. This value specifies the link length that is supported by the SFP while operating in compliance with the applicable standards using single-mode fiber. This value is in units of 100 meters. A value of 255 means that the SFP supports a link length greater than 25.4 km. A value of zero indicates that the SFP does not support single-mode fiber, or the length information must be determined from the transceiver technology.</li> <li>4. This value specifies the link length that is supported by the SFP while operating in compliance with the applicable standards using 50 µm multi-mode fiber. This value is in units of 10 meters. A value of 255 means that the SFP supports a link length greater than 2.54 km. A value of zero indicates that the SFP does not support 50 µm multimode fiber, or the length information must be determined from the transceiver technology.</li> </ol>			

Table 11. Serial Identification Field Descriptions (Sheet 3 of 3)

Data Address	Field Size (Bytes)	Name of Field	Description of Field
			<p>5. This value specifies the link length that is supported by the SFP while operating in compliance with the applicable standards using 62.5 <math>\mu\text{m}</math> multi-mode fiber. This value is in units of 10 meters. A value of 255 means that the SFP supports a link length greater than 2.54 km. A value of zero indicates that the SFP does not support 62.5 <math>\mu\text{m}</math> multi-mode fiber or that the length information must be determined from the transceiver technology. It is common for the SFP to support both 50 <math>\mu\text{m}</math> and 62.5 <math>\mu\text{m}</math> fiber.</p> <p>6. This value specifies the minimum link length that is supported by the SFP while operating in compliance with the applicable standards using copper cabling. This value is in units of 1 meter. A value of 255 means that the SFP supports a link length greater than 254 meters. A value of zero means that the SFP does not support copper cables or that the length information must be determined from the transceiver technology. Further information about the cable design, equalization, and connectors is usually required to guarantee meeting a particular length requirement.</p> <p>7. The vendor name is a 16-character field that contains ASCII characters, left-aligned and padded on the right with ASCII spaces (20h). The vendor name is the full name of the corporation, a commonly accepted abbreviation of the name of the corporation, the SCSI company code for the corporation, or the stock exchange code for the corporation. At least one of the vendor names or the vendor OUI fields contain valid serial data.</p> <p>8. The vendor organizationally unique identifier field (vendor OUI) is a 3-byte field that contains the IEEE Company Identifier for the vendor. A value of zero in the 3-byte field indicates that the Vendor OUI is unspecified.</p> <p>9. The vendor part number (vendor PN) is a 16-byte field that contains ASCII characters, left-aligned and padded on the right with ASCII spaces (20h), defining the vendor part number or product name. A value of all zeros in the 16-byte field indicates that the vendor PN is unspecified.</p> <p>10. The vendor revision number (vendor rev) is a 4-byte field that contains ASCII characters, left-aligned and padded on the right with ASCII spaces (20h), defining the vendor product revision number. A value of all zeros in the 4-byte field indicates that the vendor PN is unspecified.</p> <p>11. The check code is a one-byte code that can be used to verify that the first 64 bytes of serial information in the SFP is valid. The check code is the low order 8 bits of the sum of the contents of all the bytes from byte 0 to 62, inclusive.</p> <p>12. The bits in the option field specify the options implemented in the SFP as described in <a href="#">Table 16, "Option Values" on page 23</a>.</p> <p>13. The upper bit rate limit at which the SFP still meets its specifications (BR, max) is specified in units of 1% above the nominal bit rate. A value of zero indicates that this field is not specified.</p> <p>14. The lower bit rate limit at which the SFP still meets its specifications (BR, min) is specified in units of 1% below the nominal bit rate. A value of zero indicates that this field is not specified.</p> <p>15. The vendor serial number (vendor SN) is a 16-character field that contains ASCII characters, left aligned and padded on the right with ASCII spaces (20h), defining the vendor serial number for the SFP. A value of all zeros in the 16-byte field indicates that the vendor PN is unspecified.</p> <p>16. The date code is an 8-byte field that contains the vendor date code in ASCII characters. The date code is mandatory. The date code is in a format specified in <a href="#">Section 17, "Date Code" on page 24</a>.</p>

## 6.1 Identifier

The identifier value specifies the physical device described by the serial information. This value is included in the serial data. [Table 12](#) shows the defined identifier values.

Table 12. Identifier Values

Value	Description of Physical Device
00h	Unknown or unspecified
01h	GBIC
02h	Module/connector soldered to motherboard
03h	SFP transceiver
04-7Fh	Reserved
80-FFh	Vendor specific

## 6.2 Connector

The connector value indicates the external connector provided on the interface. This value is included in the serial data. [Table 13](#) shows the defined connector values.

**Table 13. Connector Values**

Value	Description of Physical Device
00h	Unknown or unspecified
01h	SC
02h	Fibre Channel Style 1 copper connector
03h	Fibre Channel Style 2 copper connector
04h	BNC/TNC
05h	Fibre Channel Coaxial headers
06h	Fibre Jack
07h	LC
08h	MT-RJ
09h	MU
0Ah	SG
0Bh	Optical Pigtail
0C-1Fh	Reserved
20h	HSSDC II
21h	Copper Pigtail
22-7Fh	Reserved
80-FFh	Vendor specific
<b>NOTE:</b> 01h-05h are not SFP compatible, and are included for compatibility with GBIC standards.	

## 6.3 Encoding

The encoding value indicates the serial encoding mechanism that is the nominal design target of the TXN31111 Optical Transceiver. [Table 14](#) shows the defined encoding values.

**Table 14. Encoding Codes**

Value	Description of Physical Device
00h	Unspecified
01h	8B10B
02h	4B5B
03h	NRZ
04h	Manchester
05h-FFh	Reserved

## 6.4 Transceiver

Table 15 defines the method to interpret the transceiver type for the TXN31111 Optical Transceiver and its associated compatibility options.

**Table 15. Transceiver Codes (Sheet 1 of 2)**

Data	Bit (Note 1)	Description of Transceiver	Data Addr	Bit (Note 1)	Description of Transceiver
<b>Reserved Standard Compliance Codes</b>			<b>Fiber Channel Link Length</b>		
3	7-0	Reserved	7	7	Very Long Distance (V)
4	7-4	Reserved	7	6	Short Distance (S)
		SONET Compliance Codes	7	5	Intermediate Distance (S)
4	3	Reserved	7	4	Long Distance (L)
4	2	OC-48 long reach	<b>Fiber Channel Transmit Technology</b>		
4	1	OC-48 intermediate reach	7	3-2	Reserved
4	0	OC-48 short reach	7	1	Longwave Laser (LC)
5	7	Reserved	7	0	Electrical inter-enclosure (EL)
5	6	OC-12 single mode long reach	8	7	Electrical inter-enclosure (EL)
5	5	OC-12 single mode intermediate reach	8	6	Shortwave Laser w/o OFC (SL)
5	4	OC-12 short mode intermediate reach	8	5	Shortwave laser w/ OFC (SL)
5	3	Reserved	8	4	Longwave laser (LL)
5	2	OC-3, single mode long reach	8	0-3	Reserved
5	1	OC-3, single mode intermediate reach	<b>Fibre Channel Transmission Media</b>		
5	0	OC-3, single mode short reach	9	7	Twin Axel Pair (TW)

**Table 15. Transceiver Codes (Sheet 2 of 2)**

Data	Bit (Note 1)	Description of Transceiver	Data Addr	Bit (Note 1)	Description of Transceiver
			9	6	Shielded twisted pair (TP)
			9	5	Miniature coax (MI)
6	7-4	Reserved	9	4	Video coax (TV)
6	3	1000BASE-T	9	3	Multi-mode, 62.5µ (M6)
6	2	1000BASE-CX	9	2	Multi-mode, 50µ (M5)
6	1	1000BASE-LX	9	1	Reserved
6	0	1000BASE-SX	9	0	Single mode (SM)
			<b>Fibre Channel Speed</b>		
			10	7-5	Reserved
			10	4	400 MBytes/Sec
			10	3	Reserved
			10	2	200 MBytes/Sec
			10	1	Reserved
			10	0	100 MBytes/Sec

**Note:** Bit 7 is the high order bit and is transmitted first in each byte.

Table 16 defines the method to interpret and the optional SFP signals that are implemented in the TXN31111 Optical Transceiver.

**Table 16. Option Values**

Value	Bit	Description of Physical Device
64	7-0	Reserved
65	7-6	Reserved
65	5	RATE_SELECT is implemented if a bit is set. Active control of the rate select pin is required to change rates. If a bit is not set, no control of the pin is required. In all cases, compliance with multiple rate standards should be determined by the Transceiver Codes in Bytes 4,5,6, and 10. (See Table 15)
65	4	TX_DISABLE is implemented and disables the serial output.
65	3	TX_FAULT signal implemented. (Reset is defined in Section 4.0, "Termination" on page 14.)
65	2	Loss of signal is defined per the SFP MSA. Signal Detect is implemented, the signal is inverted. <b>NOTE:</b> This is not standard SFP behavior.
65	1	Loss of signal implemented (see Table 8)
65	0	Reserved

Table 17 defines the method to interpret the manufacturing date stored in the EEPROM Date Code section.

**Table 17. 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, may be blank

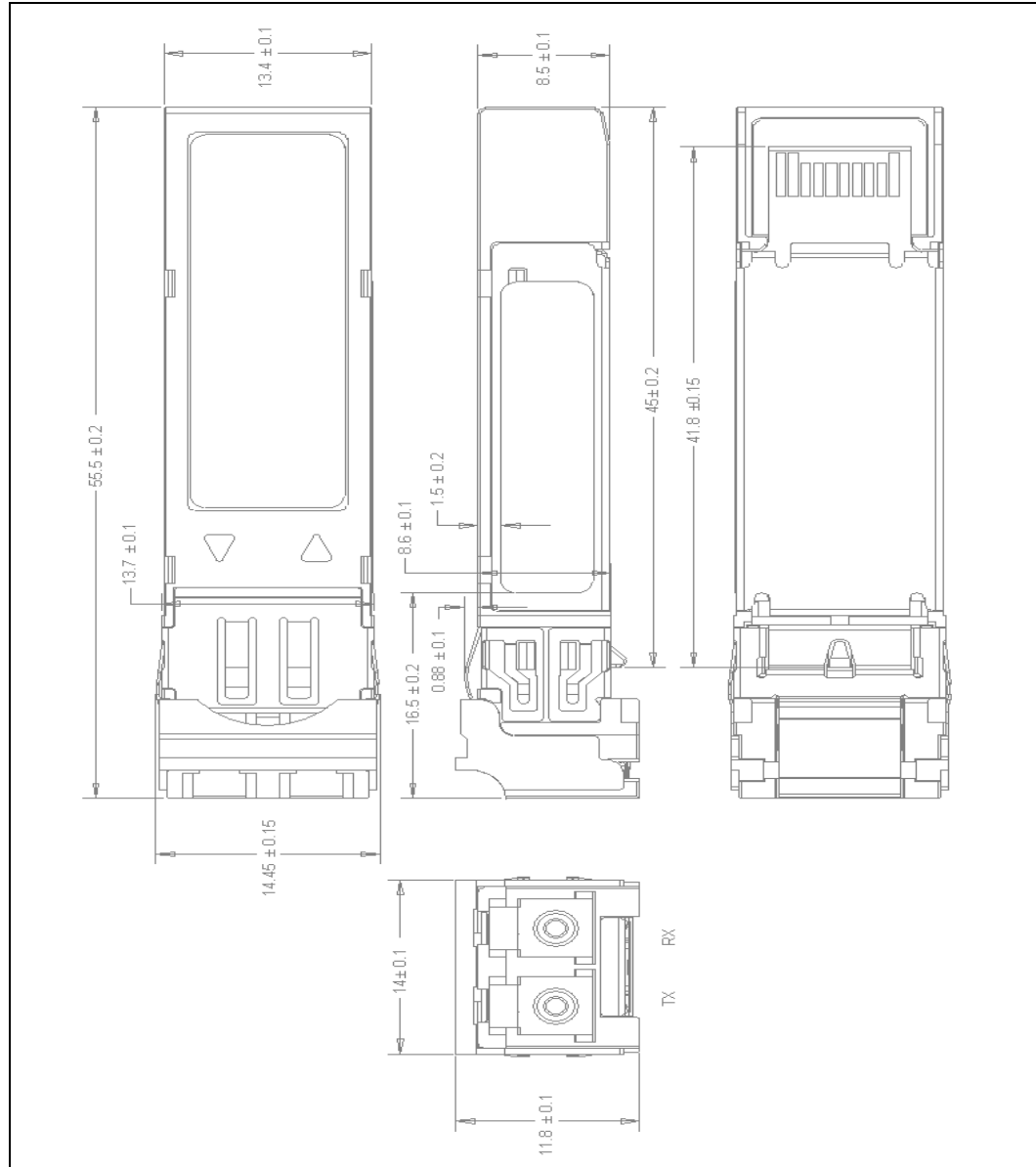


## 7.0 Mechanical Specification

Figure 4 shows the mechanical specifications of the TXN31111 Optical Transceiver. The dimensions comply with the SFP Multisource Agreement. All dimensions are in millimeters.

*Note:* Aqueous wash is not applicable for this product

**Figure 4. SFP Mechanical Specifications**



## 8.0 Regulatory Compliance

This section discusses the following topics:

- Section 8.1, “Electromagnetic Compatibility Compliance” on page 26
- Section 8.2, “Safety Compliance” on page 27
- Section 8.3, “Lead-Free Conformance” on page 28
- Section 8.4, “Compliance with Restriction of Hazardous Substances” on page 28
- Section 8.5, “Product Certification Markings and Compliance Statements” on page 29

### 8.1 Electromagnetic Compatibility Compliance

Table 18 lists emissions and immunity regulations with which the TXN31111 Optical Transceiver complies when tested in a representative chassis.

**Table 18. Electromagnetic Compatibility Compliance**

Requirement	Regulation	Performance Level
Electromagnetic interference (EMI)	<ul style="list-style-type: none"> <li>• FCC rules, Part 15, subpart B</li> <li>• EN 55022</li> </ul>	Meets Class B limits with a minimum 6 dB margin
Electrostatic discharge (ESD)	JEDEC JESD22-A114-B Human Body Model	± 2 kV contact discharge to connector electrical pins with no degradation in performance or loss of function
	EN 61000-4-2	<ul style="list-style-type: none"> <li>• ± 8 kV air discharge</li> <li>• ± 4 kV contact discharge to face plate</li> </ul> Meets Level A test criteria (that is, no degradation of performance or loss of function occurs)
Radio frequency electromagnetic field (Radiated immunity)	EN 61000-4-3, level A test criteria	10 V/m from 80 MHz to 1 GHz with no degradation of performance or loss of function

## 8.2 Safety Compliance

Table 19 lists and describes the relevant safety regulations with which the TXN31111 Optical Transceiver complies.

**Table 19. Safety Compliance**



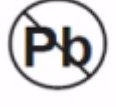
Requirement	Regulation	Title
Product Safety	UL 60950-1:2003 / CSA C22.2 No. 60950-1-03	Information Technology Equipment – Safety - Part 1: General Requirements (USA and Canada)
	EN 60950-1:2002	Information Technology Equipment – Safety - Part 1: General Requirements (European Union)
	IEC 60950-1:2001	Information Technology Equipment – Safety - Part 1: General Requirements (International)
Laser Safety	21CFR1040.10	Title 21 Chapter I Subchapter J – Radiological Health Part 1040: Performance Standards for Light-Emitting Products
	EN 60825-1: 1994 +A1 +A2	Safety of Laser Products - Part 1: Equipment Classification, Requirements and User's Guide
	IEC 60825-1: 1993 +A1 +A2	Safety of Laser Products - Part 1: Equipment Classification, Requirements and User's Guide
	EN 60825-2: 2000	Safety of Laser Products - Part 2: Safety of Optical Fiber Communication Systems
	IEC 60825-2: 2000	Safety of Laser Products - Part 2: Safety of Optical Fiber Communication Systems

### 8.3 Lead-Free Conformance

The TXN31111 Optical Transceiver uses a lead-free assembly, although certain discrete components within the assembly may contain lead, being necessary for either component performance or reliability. The TXN31111 Optical Transceiver is referred to as a “Lead-free 2<sup>nd</sup> Level Interconnect.” The enclosure, circuit board substrate, and the solder connections from the circuit board to the components (second-level connections) are all lead-free.

Table 20 lists various forms of the “Lead-Free 2<sup>nd</sup> Level Interconnect” marking for the TXN31111 Optical Transceiver and accompanying collateral.

**Table 20. Lead-Free 2<sup>nd</sup>-Level Interconnect Markings**

Description	Marking
<p><b>Lead-Free 2<sup>nd</sup> Level Interconnect:</b> The Lead-Free 2<sup>nd</sup> Level Interconnect symbol is used to identify electrical and electronic assemblies and components in which the lead (Pb) concentration level in the circuit board substrate and the solder connections from the circuit board to the components (second-level interconnect) are not greater than 0.1% by weight (1000 ppm).</p> <p><b>Note:</b> Any of the three symbols shown may be used, as space permits.</p>	<div style="display: flex; align-items: center;">  <div style="margin-left: 10px;">2<sup>nd</sup> Level Interconnect</div> </div> <p style="text-align: center;">or</p> <div style="display: flex; align-items: center;">  <div style="margin-left: 10px;">2<sup>nd</sup> lvl Intct</div> </div> <p style="text-align: center;">or</p> <div style="display: flex; align-items: center;">  <div style="margin-left: 10px;">2LI</div> </div>

### 8.4 Compliance with Restriction of Hazardous Substances

This product complies with the European Union directive for Restriction of Hazardous Substances (RoHS) – *Restriction on the Use of Certain Hazardous Substances in Electrical and Electronic Equipment*, Directive 2002/95/EC plus amendments.

However, certain discrete components do contain lead (a RoHS-restricted substance) in amounts that exceed threshold concentration levels. This product uses the following applicable RoHS technology exemptions:





- Lead in optical and filter glass, and
- Lead in glass of electronic components

*Note:* RoHS implementation details are subject to change.

## 8.5 Product Certification Markings and Compliance Statements

Table 21 lists the TXN31111 Optical Transceiver product certification markings and compliance statements.

**Table 21. Product Certification Markings and Compliance Statements**

Origin and Description	Markings and Compliance Statements
<b>Markings</b>	
CE mark. The CE (Conformité Européene*) mark indicates compliance to the European Union Low Voltage directive (73/23/EEC).	
TÜV Rheinland type approval mark for components and subassemblies for the European Union. The Technischer Überwachungsverein* (TÜV – German for “Technical Inspection Association”) Rheinland type approval mark is for components and subassemblies for the European Union. Where space does not permit, the smaller alternate TÜV mark (see the next row in this table) may be used.	
TÜV Rheinland type approval mark for components and subassemblies for the European Union – <i>Alternate</i> . This alternate mark may be used where space constraints exist that do not permit use of the TUV Rheinland mark in the previous row of this table.	Alternate TÜV mark: 
UL Recognized Component mark for the USA and Canada.	
<b>Compliance Statements</b>	
USA Food and Drug Administration (FDA), Center for Devices and Radiological Health compliance statement.	Complies with 21CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated July 26, 2001.
USA FDA, Center for Devices and Radiological Health compliance statement – <i>Alternate</i> . Use the alternate statement listed, as needed.	Alternate FDA compliance statement: Complies with FDA performance standards for laser products except for deviations pursuant to Laser Notice No. 50, dated July 26, 2001.

## 9.0 Ordering Information

---

Table 22 lists ordering information for the RoHS-compliant TXN3111101 Optical Transceiver.

**Table 22. Ordering Information**

Part Number	Description
Intel® TXN311110100xxx	Tri-rate 2/1 Gbps Fibre Channel and Gigabit Ethernet SFP module <sup>1</sup>
<b>Note:</b> 1. The last 3 characters of the part number ("xxx") are used to designate customer-specific customizations. The Intel standard part has "000" as the last three characters.	

## 10.0 Acronyms

**Table 23. Acronyms**

Acronym	Meaning
BER	Bit Error Rate
CFR	Code of Federal Relations
CML	Current Mode Logic
EMI	Electro-Magnetic Interference
ESD	Electro-Static Discharge
EU	European Union
FC-PI	Fiber Channel – Physical Interfaces
FCC	Federal Communications Commission
FDA	Food and Drug Administration
GBIC	GigaBit Interface Converter
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
LOS	Loss of Signal
MMF	Multi-Mode Fiber
MSA	Multisource Agreement
NRZ	Non-Return to Zero
Pb	Lead
PCB	Printed Circuit Board
PRBS	Pseudo Random Bit Sequence
RFI	Radio Frequency Immunity
SFF	Small-Form Factor
SCSI	Small Computer System Interface
SONET	Synchronous Optical Network
TOSA	Transmitter Optical Sub-Assembly
TTL	Transistor-Transistor Logic
TUV	Technischer Überwachungsverein
UL	Underwriter Laboratories*
VCSEL	Vertical Cavity Surface Emitting Laser

§ §