Data Sheet
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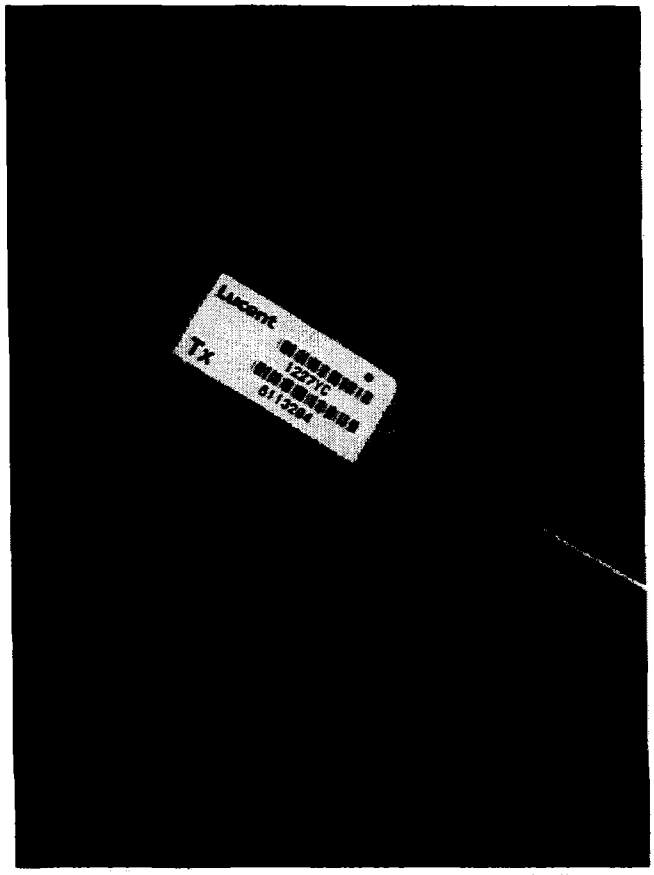
microelectronics group

Lucent Technologies
Bell Labs Innovations

1227-Type *ASTROTEC*® Lightwave Transmitter



The 1227-Type Lightwave Transmitter is manufactured in a 20-pin DIP with a single-mode fiber pigtail.

Features

- Uses field-proven, reliable InGaAsP MQW laser
- Requires single 5 V power supply
- Space-saving, self-contained, 20-pin DIP
- SONET/SDH compatible
- Uncooled laser with automatic optical power control for constant output power over case temperature range
- No thermoelectric cooler required; reduces size and power consumption
- Uses low-power dissipation CMOS technology
- Adheres to Lucent Technologies Microelectronics Group's Reliability and Qualification Program standards for built-in quality
- Operates over data rates to 650 Mbits/s (NRZ)
- Operation at 1.3 μm wavelength
- Typical average output power options of –11 dBm to 0 dBm guaranteed over temperature range and to end-of-life
- ECL compatible inputs
- Operating case temperature: –40 °C to + 85 °C
- Transmitter-disable option

Applications

- Telecommunications
  - — Inter- and intraoffice SONET/ITU-T SDH
  - — Subscriber loop
  - — Metropolitan area networks
- Data communication
  - — High-speed data links
  - — Single-mode FDDI
  - — ATM

Description

The 1227-type *ASTROTEC* Lightwave Transmitter is designed for use in transmission systems and medium- to high-speed data communication applications. Used in intraoffice and intermediate-reach applications, the transmitter operates at SONET OC-1, OC-3, and OC-12 rates, as well as at ITU-T Synchronous Digital Hierarchy (SDH) rates of STM-1 and STM-4.

The transmitter meets all present Bellcore GR-253-CORE requirements, ANSI T1.117-1991 SONET single-mode, short-reach specifications, and the ITU-T G.957 and G.958 recommendations. (See Table 5 to select transmitters for the various SONET/SDH segments.) The transmitter is also ideally suited for extended distance data and networking communications such as single-mode FDDI.

The transmitter requires a single power supply (+5 V or –5 V) and operates over data rates of 1 Mbits/s to 650 Mbits/s (NRZ). Automatic power control circuitry provides constant optical output power over the operating case temperature range. The automatic power control circuitry also compensates for laser aging. The optical wavelength tolerance at 25 °C is 1308 nm ± 20 nm unless otherwise noted. The temperature coefficient of wavelength is approximately 0.4 nm/°C. Transmitters are available for operation over the 0 °C to 65 °C or –40 °C to +85 °C temperature range.

Manufactured in a 20-pin DIP, the transmitter consists of a hermetic, 1.3 µm, InGaAs laser and a single CMOS driver IC. The low power consumption circuit provides modulation, automatic optical output power control, and data reference. The module can be driven by either ac- or dc-coupled data in single-ended or differential configuration. (See Recommended User Interfaces section for typical connection schemes.) The laser bias and backface monitor currents are electrically accessible for transmitter performance monitoring. The transmitter optical output may be disabled by a logic-level input.

Functional Overview

Transmitter Circuit Description and Operation

Figure 1 shows a simplified schematic of the transmitter; pin information is listed in Table 1. The laser within the 1227 transmitter is driven by a single CMOS integrated circuit, that provides the input data signal reference level with automatic, temperature-compensated laser bias, and modulation-current control. A backface photodetector diode within the laser capsule provides an indication of the laser's average optical output power. The backface diode current is accessible as a voltage proportional to photocurrent through pins 17 and 19 on the transmitter. The backface diode also forms part of the feedback control circuit, which helps maintain constant output power. Because the backface diode forms part of the laser's automatic power control circuitry, the voltage measured across pins 17 and 19 will remain relatively constant (±5%) over the operating temperature range and useful lifetime of the transmitter. The laser bias current is accessible as a dc-voltage by measuring the voltage developed across pins 2 and 4 of the transmitter. Dividing this voltage by 10 Ω will yield the value of the laser bias current. This value will change up or down in response to operating temperature, power supply voltage, data pattern, and laser aging characteristics.

Table 1. Pin Descriptions

Pin Number	Name
1	No user connection
2	Laser bias monitor (+)*
3	No user connection
4	Laser bias monitor (–)*
5	V_{EE}
6	V_{CC}
7	Transmitter disable
8	V_{CC}
9	V_{CC}
10	No user connection
11	Case ground
12	V_{CC}
13	Case ground (RF ground)
14	V_{EE}
15	$\overline{\text{DATA}}$
16	DATA
17	Laser backface monitor (–)*
18	V_{CC}
19	Laser backface monitor (+)*
20	No user connection

* Laser backface and bias monitor functions are customer-use options that are not required for normal operations of the transmitter. They are normally used during manufacture and for diagnostics.

Functional Overview (continued)

Transmitter Circuit Description and Operation (continued)

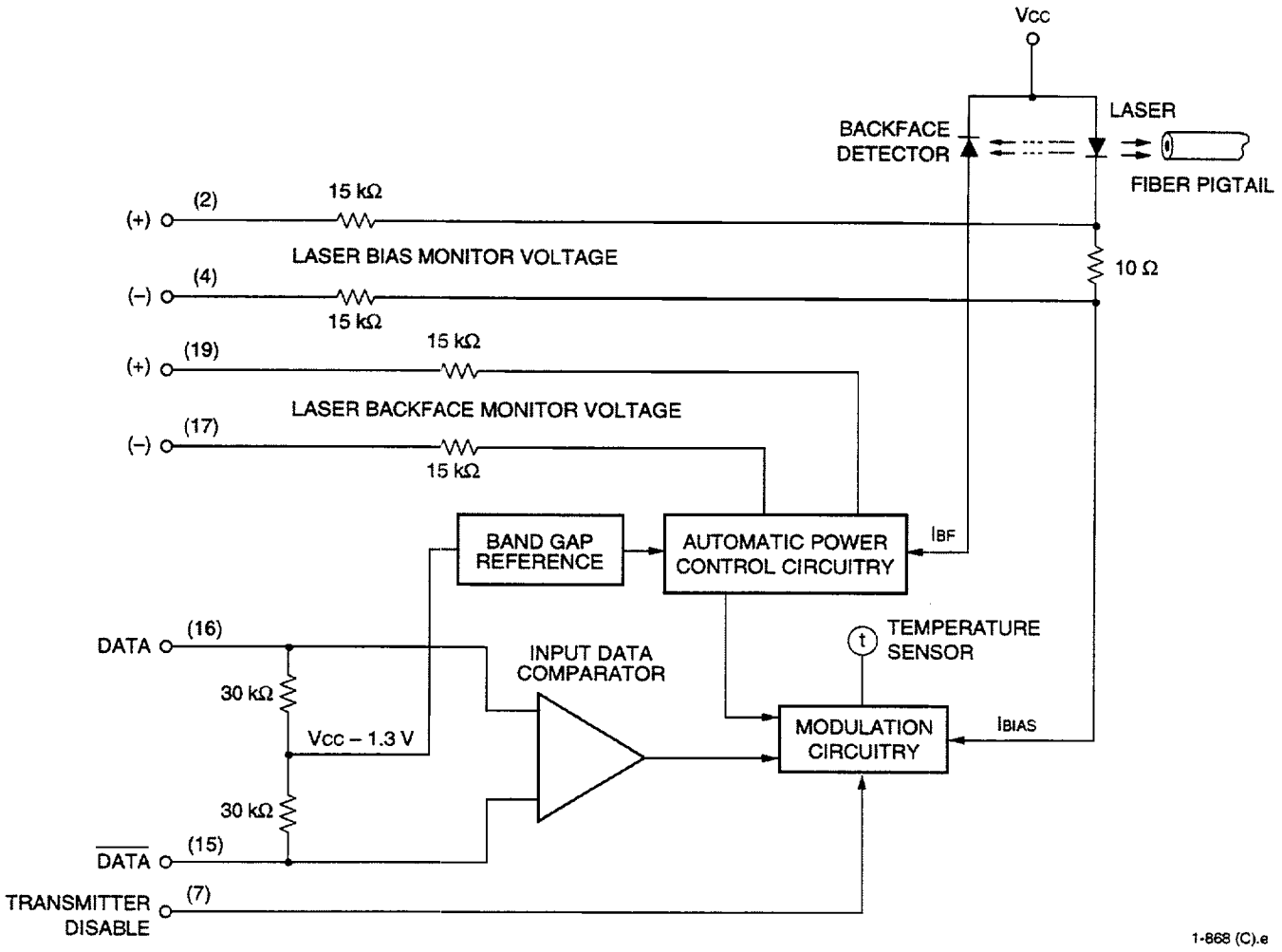


Figure 1. Simplified Transmitter Schematic

Input Data

Data enters the transmitter through a comparator. These inputs have internal pull-down resistors to a voltage reference that is 1.3 V below Vcc. This configuration allows the transmitter to be driven from either a single-ended or a differential input signal. Since the input is a comparator instead of a gate, the absolute input signal levels are not important when the inputs are driven differentially. When driven single-ended, the input signal voltage should be centered around Vcc – 1.3 V to eliminate pulse-width distortion. With a single-ended input, either input can be used and the unused input can be left as an open circuit due to the internal reference shown in Figure 1. The optical output signal will be in the same sense as the input data—an input logic high turns the laser diode on and an input logic low turns the laser diode off. However, if the negative input is used with a single-ended data input signal, the optical signal will be the complement of the data input signal.

Functional Overview (continued)

Input Data (continued)

Minimum Data Rate

Because the modulation and bias control circuitry are influenced by the input data pattern, the standard 1227 transmitter cannot be used in burst-mode type applications. For burst-mode applications, please contact your Lucent Account Manager. The minimum data rate (pseudorandom data, 50% average duty cycle) for the 1227 transmitter is approximately 500 kHz.

Since most applications operate at very high data rates, high-frequency design techniques need to be used to ensure optimum performance from the transmitter and interfacing circuitry. Input signal paths should be kept as short and as straight as possible; differential signal lines should be equal in length, and controlled-impedance stripline or microstrip construction should always be used when laying out the printed-wiring board traces for the data lines. The Recommended User Interfaces section of this data sheet shows several methods of interfacing to the 1227 transmitter.

Power Supplies

The 1227 transmitter is configured for operation from either a single +5 V power supply or a single –5 V power supply. For positive power supply operation, connect Vcc to the +5 V power supply and connect V_{EE} to ground or circuit common. For operation from a –5 V power supply, connect Vcc to ground and connect V_{EE} to the –5 V power supply. Whichever option is chosen, the Vcc or V_{EE} connection to the transmitter should be well filtered to prevent power supply noise from interfering with transmitter operation.

Transmitter Specifications

Optical Output Power

During manufacture, the optical output power of every transmitter is tuned to the typical value specified in the data sheet for that particular transmitter code. The tuning is performed at room ambient (23 °C ± 3 °C) and a power supply voltage of 5 V. The minimum and maximum values listed in the data sheet for each code group reflect the worst-case limits that the transmitter is expected to operate within over its lifetime and over allowed power supply and operating temperature range.

Every transmitter shipped receives a final test, which includes a SONET eye-mask test at either the OC-3 (STM-1) data rate of 155.52 Mbits/s or the OC-12 (STM4) data rate of 622.08 Mbits/s. The eye-mask test is meant to examine the performance of the transmitter's output optical waveform relative to a minimum data pattern eye opening.

Connector Options

The standard optical fiber pigtail is 8 µm core single-mode fiber having a 0.036 in. (914 µm) PVC outer-jacket diameter. The standard length is 39 in. ± 4 in. (1 m ± 10 cm) and can be terminated with either an *ST*®, SC, or FC-PC optical connector. Other connector options may be available on special order. Please contact your Lucent Account Manager for ordering information.

Handling Precautions

CAUTION: This device is susceptible to damage as a result of electrostatic discharge (ESD). Take proper precautions during both handling and testing. Follow guidelines such as JEDEC Publication No. 108-A (Dec. 1988).

Although protection circuitry is designed into the device, take proper precautions to avoid exposure to ESD.

Lucent employs a human-body model (HBM) for ESD-susceptibility testing and protection-design evaluation. ESD voltage thresholds are dependent on the critical parameters used to define the model. A standard HBM (resistance = 1.5 kΩ, capacitance = 100 pF) is widely used and, therefore, can be used for comparison purposes. The HBM ESD withstand voltage established for the 1227-type transmitter is ±1000 V.

Transmitter Processing

The 1227 transmitter can withstand normal wave soldering processes. The complete transmitter module is not hermetically sealed; therefore, it should not be immersed in or sprayed with any cleaning solution or solvents. The process cap and fiber pigtail jacket deformation temperature is 85 °C. The transmitter pins can be wave-soldered at 250 °C for 10 seconds.

Absolute Maximum Ratings

Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. These are absolute stress ratings only. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operations sections of the data sheet. Exposure to absolute maximum ratings for extended periods can adversely affect device reliability.

Parameter	Symbol	Min	Max	Unit
Supply Voltage*	—	—	6.0	V
Operating Case Temperature Range†	T_C	–40	85	°C
Storage Case Temperature Range	T_{stg}	–40	85	°C
Lead Soldering Temperature/Time	—	—	250/10	°C/s
Relative Humidity (noncondensing)	RH	—	85	%
Minimum Fiber Bend Radius	—	1.25 (31.8)	—	in. (mm)

* With V_{EE} connected to –5 V, V_{CC} must be at 0 V; with V_{CC} connected to +5 V, V_{EE} must be at 0 V.
† Specification depends upon the code ordered. The device is capable of a cold start at –40 °C; specifications are met after a warm-up time determined by the system thermal design.

Characteristics

Minimum and maximum values specified over operating case temperature range at 50% duty cycle data signal. Typical values are measured at room temperature unless otherwise noted.

Table 2. Electrical Characteristics

Parameter	Symbol	Min	Typ	Max	Unit
dc Power Supply Voltage[1]	V	4.75	5.0	5.50	V
dc Power Supply Current Drain	I_{TOTAL}	—	70	130	mA
Input Data Voltage:[2]					
Low	V_{IL}	–1.81	—	–1.47	V
High	V_{IH}	–1.16	—	–0.88	V
Input Transition Time[3]	t_I	—	t/4	—	ns
Transmitter Disable Voltage[4]	V_D	V_{CC} – 2.0	—	V_{CC}	V
Transmitter Enable Voltage	V_{EN}	V_{EE}	—	V_{EE} + 0.8	V
Output Disable Time[5]	t_D	—	—	0.20	µs
Output Enable Time[6]	t_{EN}	—	—	2.00	µs
Laser Bias Voltage (T_A = 25 °C)[7]	V_B	0.01	0.06	0.70	V
Laser Monitor Voltage (50% duty cycle)[8]	V_{BF}	0.01	0.050	0.20	V

1. With V_{EE} connected to –5 V, V_{CC} must be at 0 V; with V_{CC} connected to +5 V, V_{EE} must be at 0 V.
2. Input measured from V_{CC} with 50 Ω load to (V_{CC} – 2) V. 10K, 10K H, and 100K ECL compatible.
3. Between 10% and 90% (50% duty cycle) where t is the bit period in ns.
4. The transmitter is normally enabled and only requires an external voltage to disable.
5. Time measured from rising edge of disable signal until optical output (laser diode) has turned off.
6. Time measured from falling edge of enable signal until optical output has stabilized at nominal output power level.
7. The laser bias current is obtained by dividing the bias voltage by the 10 Ω current-sensing resistors. (See Figure 1.) When measuring these voltages or using them in conjunction with alarm circuits, use a high-input impedance device.
8. The laser backface monitor voltage is a scaled output that tracks the average transmitter optical output power.

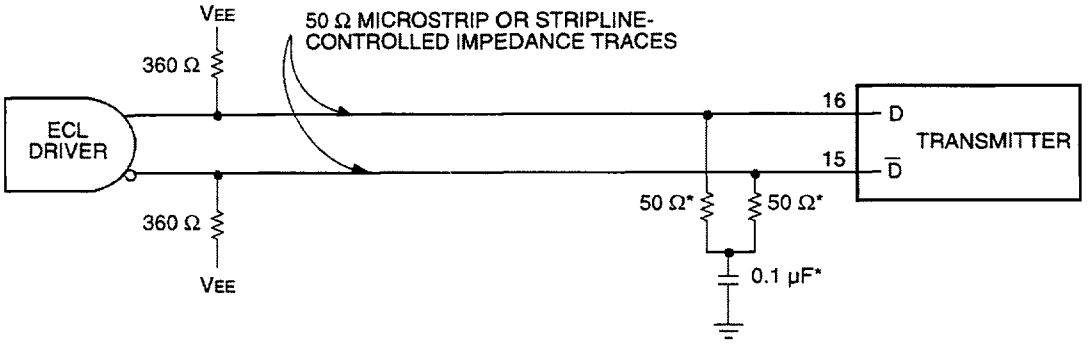
Characteristics (continued)

Table 3. Optical Characteristics

Parameter	Symbol	Min	Typ	Max	Unit
Average Power Output Options[1]	Po	See Ordering Information.			dBm
Extinction Ratio[2]	EXT	10	—	—	dB
Optical Rise and Fall Times[3]	t_R, t_F	—	—	1	ns
Center Wavelength	λ	See Ordering Information.			nm
RMS Spectral Width[4]	Δλ	—	—	4	nm
Duty-cycle Distortion[5, 7]	DCD	—	800	1000	ps
Random Jitter[5, 7]	RJ	—	100	760	ps
Data-dependent Jitter[5, 6, 7]	DDJ	—	200	600	ps

1. Output power definitions and measurement per ITU-T Recommendation G.957 and G.958.
2. Ratio of logic 1 to logic 0 power levels.
3. Between 10% and 90% (50% duty cycle) where t is the bit period in ns.
4. Root-mean-square spectral width accounts for modes up to and including those 20 dB down from the central mode.
5. At Tc = 65 °C.
6. As defined by FDDI SMF-PMD Standard.
7. Jitter parameters are measured for codes designated as SM-FDDI products. See Table 6, 1227-Type Transmitter Ordering Information, for details. All other codes are tested per SONET/SDH eye-mask requirements at the appropriate data rate.

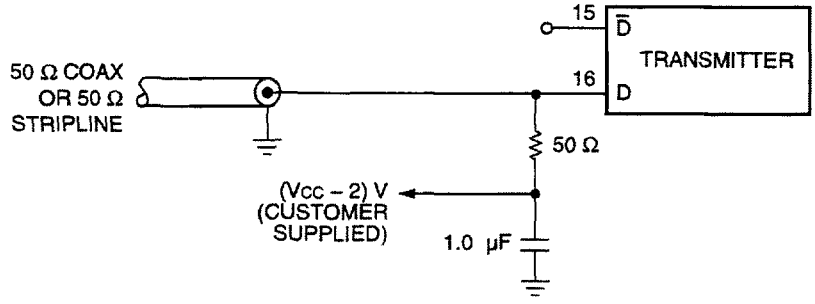
Recommended User Interfaces



* Locate these components as close to DATA/$\overline{\text{DATA}}$ inputs as possible.

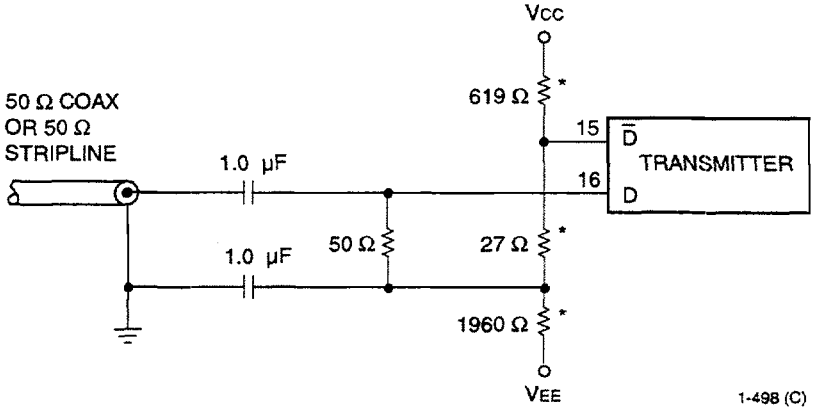
Figure 2. dc-Coupled Differential Input

Recommended User Interfaces (continued)



Note: Input can also be connected to $\overline{DATA}$; unused input pin remains unconnected.

Figure 3. dc-coupled, Single-Ended Input



* This network introduces a slight offset between D and $\overline{D}$, which turns the laser transmitter off when there is no data present at the inputs.

Figure 4. ac-Coupled, Single-Ended Input

Qualification and Reliability

To help ensure high product reliability and customer satisfaction, Lucent is committed to an intensive quality program that starts in the design phase and proceeds through the manufacturing process. Optoelectronic modules are qualified to Lucent internal standards using MIL-STD-883 test methods and procedures and using sampling techniques consistent with Bellcore requirements. The 1227 transmitter has undergone an extensive and rigorous set of qualification tests. The table of Qualification Tests below lists each of the stresses, the sample size, and the failure criteria for each stress that this transmitter was subjected to. The 1227 transmitter successfully passed each of these stresses without failure. This qualification program fully meets the intent of Bellcore reliability practices TR-NWT-000468 and TA-TSY-000983.

In addition, Lucent Technologies Microelectronics Group Optoelectronics Unit design, development, and manufacturing facility has been certified to be in full compliance with the latest ISO-9001 Quality System Standards.

Table 4. Qualification Tests

The 1227-Type Transmitter has successfully passed the following tests and meets the intent of Bellcore TR-NWT-000468 and TA-TSSY-000983.

Test	Conditions	Sample Size	Failure Criteria
Physical Dimensions	MIL-STD-883C-2016	90	Visual
External Visual	MIL-STD-883C-2009.8	90	Visual
Impact Shock	1500G, 5 hits, 6 dir., MIL-STD-883C-2002, Condition B	11	Electrical/Optical
Variable Frequency Vibration	20G, 20 Hz to 2 kHz, 4 cycles, 3 directions, 4 min./cycle, MIL-STD-883C-2007.1	11	Electrical/Optical
Solderability	MIL-STD-883C-2003.6	3 (60 leads)	Visual
Lead Integrity	MIL-STD-883C-2004.5	3 (60 leads)	Visual
Solvent Resistance	MIL-STD-883C-2015.7	5	Visual
Temperature Cycle	T_A = –40 °C to +85 °C, 500 cycles, MIL-STD-883C-1010.7	11	Electrical/Optical
High Temperature, High Humidity, with Bias	T_A = 85 °C, 85% relative humidity, rated bias, 2,000 hours	11	Electrical/Optical
High Temperature with Bias	T_A = 85 °C, rated bias, 5,000 hours, MIL-STD-883C-1005.5	25	Electrical/Optical
Low Temperature with Bias	T_A = –40 °C, rated bias, 2,000 hours, MIL-STD-883C-1005.5	25	Electrical/Optical
Internal Visual	MIL-STD-883C-2014	10	Visual
Electrostatic Discharge	Human-body model (to determine class)	3	Electrical/Optical
Fiber Pull	1 kg, 10 s, 3 times	11	Optical
Low-temperature Storage	T_A = –40 °C, 2,000 hours	11	Electrical/Optical
Voltage Stress	Maximum rated voltage	10	Electrical/Optical
Flammability	Fiber cable meets *UL**-listed OFN	—	—
Power Cycling	MIL-STD-1006	5	Electrical/Optical

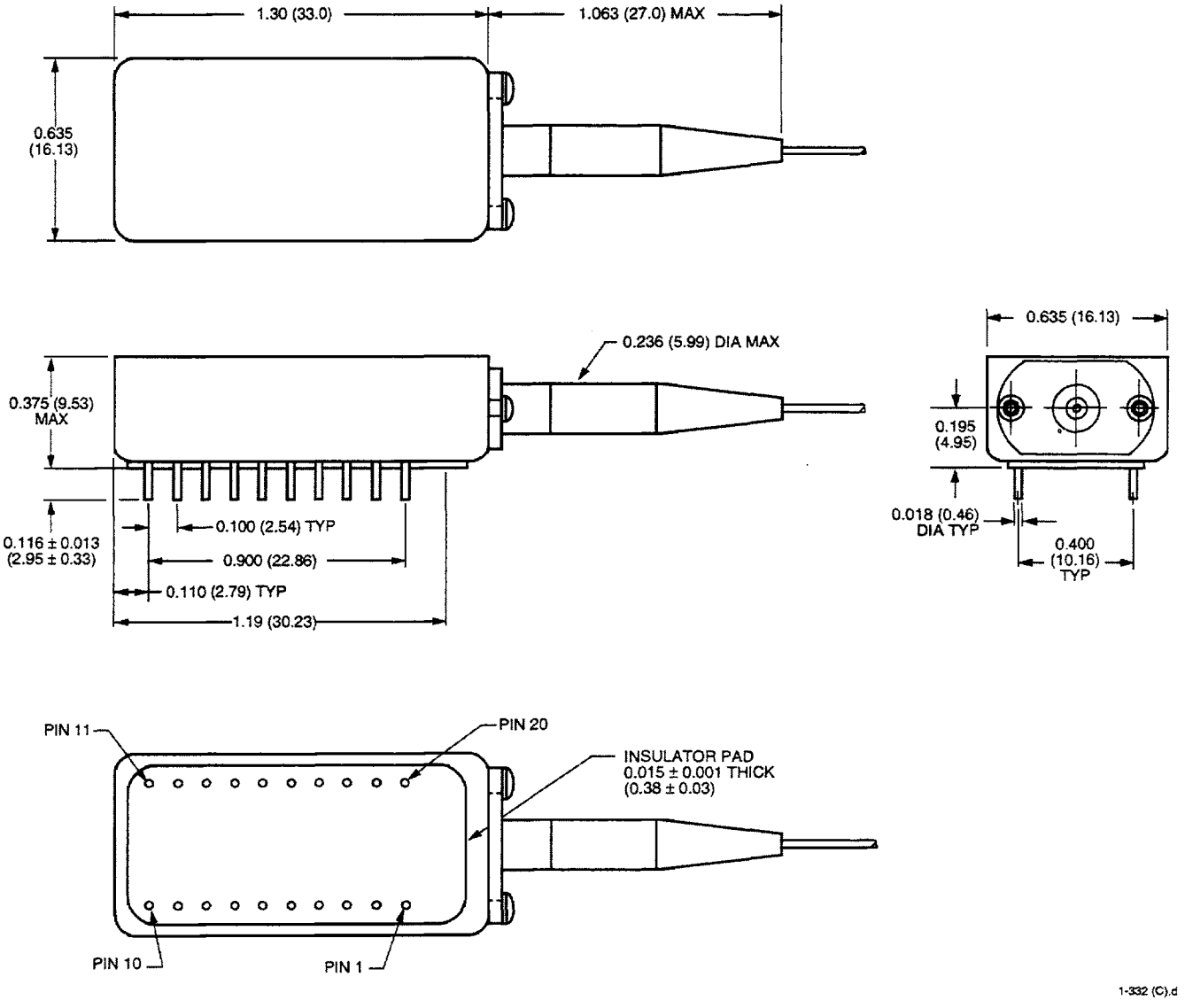
* *UL* is a registered trademark of Underwriters Laboratories, Inc.

Outline Diagram

Dimensions are in inches and (millimeters).

Unless noted otherwise, tolerances are ±0.005 in. (±0.127 mm).

Weight = 0.9 oz. (25 g).



Laser Safety Information

Class I Laser Product

All versions of the 1227 transmitter are Class I laser products per CDRH, 21 CFR 1040 Laser Safety requirements. The 1227 transmitters have been certified with the FDA under accession number 8720009.
All versions are Class I laser products per IEC 825-1:1993.

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

This product complies with 21 CFR 1040.10 and 1040.11.
8.8 µm single-mode pigtail with connector
Wavelength = 1.3 µm
Maximum Power = 1.6 mW

Notice

Unterminated optical connectors may emit laser radiation. Do not view with optical instruments.

Table 5. Lucent *ASTROTEC* Transmitters for SONET/SDH Applications

Connector Type	Transmitter Type*					
	Short Reach <2 km		Intermediate Reach ~15 km		Long Reach ~40 km	
	OC-3/ STM-1	OC-12/ STM-4	OC-3/ STM-1	OC-12/ STM-4	OC-3/ STM-1	OC-12/ STM-4
FC-PC	1227H	1227AC	1227H	1227PG	1227YE	1229FA†
SC	1227HA	1227AD	1227HA	1227PH	1227YD	1229CA†
ST	1227P	—	1227P	1227PJ	1227YF	1229TA†

* Full SONET/SDH compliance, –40 °C to +85 °C.
† See 1229-type data sheet.

Ordering Information

Table 6. 1227-Type Transmitter Ordering Information

200 Mbits/s Transmitter Codes									
Operating Case Temp. Range (°C)		Average Output Power (dBM)			Center Wavelength (nm)		Connector	Product Order Code	Comcode
Min	Max	Min	Typ	Max	Min	Max			
0	+65	–3	0	+2	1290	1330	FC-PC	1227AE	106979307
0	+65	–3	0	+2	1290	1330	SC	1227AF	106984727
0	+65	–5	–2	0	1280	1335	FC-PC	1227YA	107032807
0	+65	–5	–2	0	1280	1335	SC	1227YB	107032799
0	+65	–8	–5	–2	1260	1360	*ST*	1227J*	106277296
0	+65	–8	–5	–2	1260	1360	SC	1227CA	107036329
0	+65	–8	–5	–2	1260	1360	FC-PC	1227C*	106191828
0	+65	–12	–8	–5	1260	1360	*ST*	1227L	106277312
0	+65	–12	–8	–5	1260	1360	SC	1227EA	106953938
0	+65	–12	–8	–5	1260	1360	FC-PC	1227E	106191844
0	+65	–15	–11	–8	1260	1360	*ST*	1227W*	106702590
0	+65	–15	–11	–8	1260	1360	SC	1227TA	107384372
0	+65	–15	–11	–8	1260	1360	FC-PC	1227T*	106633993
–40	+85	–5	–2	0	1280	1335	*ST*	1227YF	107645442
–40	+85	–5	–2	0	1280	1335	SC	1227YD	107603672
–40	+85	–5	–2	0	1280	1335	FC-PC	1227YE	107645434
–40	+85	–12	–8	–5	1260	1360	*ST*	1227M	106277338
–40	+85	–12	–8	–5	1260	1360	SC	1227FB	106985013
–40	+85	–12	–8	–5	1260	1360	FC-PC	1227F	106191851
–40	+85	–15	–11	–8	1260	1360	*ST*	1227P	106277353
–40	+85	–15	–11	–8	1260	1360	SC	1227HA	107384364
–40	+85	–15	–11	–8	1260	1360	FC-PC	1227H	106191877
650 Mbits/s Transmitter Codes									
0	+65	–3	0	+2	1290	1330	FC-PC	1227AK	107392615
0	+65	–8	–5	–2	1260	1360	*ST*	1227K	106277304
0	+65	–8	–5	–2	1260	1360	FC-PC	1227D	106191836
–40	+85	–12	–8	–5	1260	1360	*ST*	1227N	106277346
–40	+85	–12	–8	–5	1260	1360	FC-PC	1227G	106191869
–40	+85	–15	–11	–8	1260	1360	SC	1227AD	106967755
–40	+85	–15	–11	–8	1260	1360	FC-PC	1227AC	106965213
–40	+85	–15	–11	–8	1274	1356	FC-PC	1227PG†	107647141
–40	+85	–15	–11	–8	1274	1356	SC	1227PH†	107873820
–40	+85	–15	–11	–8	1274	1356	*ST*	1227PJ†	107873838

* Single-mode FDDI-compatible codes.
† $\Delta\lambda$ for these codes is 2.5 nm maximum. All other codes are 4 nm maximum.

Ordering Information (continued)

Table 7. Related Product Information

Description	Part Number	Document Number
Uncooled 1.3 µm or 1.55 µm DFB Laser Transmitter for SONET/ SDH Applications	1229-Type	DS97-087LWP
155 Mbits/s and 622 Mbits/s Receivers for SONET/SDH Applications	1310-Type	DS96-368LWP
OC-3/STM-1 Receiver Module with Integrated PLL Clock Recovery	1330-Type	DS96-240LWP
OC-12/STM-4 Receiver Module with Integrated SAW Filter Clock Recovery	1320	DS97-113LWP
2x9 Single-Mode Transceiver With Clock Recovery and Data Retiming	1418	DS96-379LWP

For additional information, contact your Microelectronics Group Account Manager or the following:
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