Advance Data Sheet
August 1999

microelectronics group

Lucent Technologies
Bell Labs Innovations

E2530-Type Stabilized, Tunable EML Modules

The advanced 2.5 Gbits/s 1550 nm EML, with its separate GEM module, can be remotely programmed to operate at any of four ITU-T wavelength channels.

Features

- Integrated Fabry-Perot Etalon Stabilizer
  — Replaces external wavelength lockers
- Remotely programmable over four or more 50 GHz ITU-T channels
- Electronic Control Module for short design cycle
  — Saves space and fiber handling vs. external locker
- Very low dispersion penalty up to 640 km
- Wavelengths available to ITU-T standards covering up to 88 channels at 50 GHz spacing
- Low modulation voltage
- High ESD rating

Applications

- SONET/SDH extended-reach applications
- Very dense WDM (≤50 GHz channel spacing) extra long-haul and metropolitan applications
- High-speed data communications
- Digitized video

Description

The E2530 EML is a 1.5 μm laser with an integrated electroabsorptive modulator and an integrated stabilizer. Each device can be remotely programmed to operate at least four ITU-T wavelength channels. The EML chip and stabilization optics are manufactured in a 20-pin package with external package dimensions identical to the industry-standard (14-pin) E2500-series EML. The device is capable of 360 km or 640 km transmission at 2.5 Gbits/s in DWDM systems at channel spacings of 50 GHz or less.
The electroabsorptive modulator can replace external modulators in many applications. The nominal input impedance for the modulator is 50 Ω. By integrating the modulator with the laser chip, the device offers a compact, cost-effective solution for extended-reach transmission. Devices are provided at wavelengths that are compatible with the ITU-T wavelength standards at 200 GHz, 100 GHz, and 50 GHz. The package also contains a thermoelectric cooler, thermistor, back-facet monitor, and optical isolator.

Generic Electronic Module (GEM)

Electronic control functionality is contained in a separate Generic Electronic Module (GEM). The GEM is generic in the sense that any GEM will operate with any optical (EML) module, i.e. no pairing of units is required. It controls the locking and tuning functions in the optical module, and offers to the user analog outputs for wavelength, power, and temperature, as well as a digital input for the channel request.

Description (continued)

Generic Electronic Module (continued)

The user provides a control circuit for power as well as a control circuit for the thermoelectric cooler, which uses the analog output for wavelength to achieve wavelength locking. The analog output for temperature is provided for user information only and need not form part of a control loop.

The provision of the GEM eliminates the need for complex control circuitry in the system, and can reduce the duration of the design and implementation cycle for the end user's system. By integrating the stabilization optics inside the EML package, the on-board fiber handling associated with the use of an external locker is eliminated, and considerable board space is typically saved.

An out-of-lock alarm and laser-off alarm are also provided.

Temperature and Wavelength Control

The analog output for wavelength from the GEM is incorporated by the user into a feedback loop, which controls the thermoelectric cooler. In such a circuit, the selected center-channel wavelength is achieved when the wavelength output reaches a unique target voltage of 1.25 V, irrespective of the channel selected, with a typical sensitivity (voltage vs. frequency coefficient) of 25 mV/GHz.

An analog output for temperature is provided for monitoring purposes and is not required for basic device operation.

Power Control

The analog output for optical output power is incorporated by the end user into a feedback loop, which enables constant power control. A voltage level, which is proportional to the power, is provided.

Digital Input and Alarm functions

The definitions of the digital input as well as the out-of-lock and laser-off alarms is to be determined. The digital input for evaluation units will be RS232 compatible. Feedback on the preferred definitions is invited.

Module Characteristics

Table 1. Module Characteristics

Parameter	Description
Package Type	20-pin butterfly package with separate electronic control board.
Fiber	Standard single-mode fiber.
Connector	*ST*®; other connectors available on request.
RF Input Impedance	50 Ω.
Power Supply	5 Vdc to Generic Electronic Module.
Bit Rate	2.5 Gbits/s.
Channel Request	Digital interface: RS232-compatible for evaluation units. To be determined for product.

Pin Information

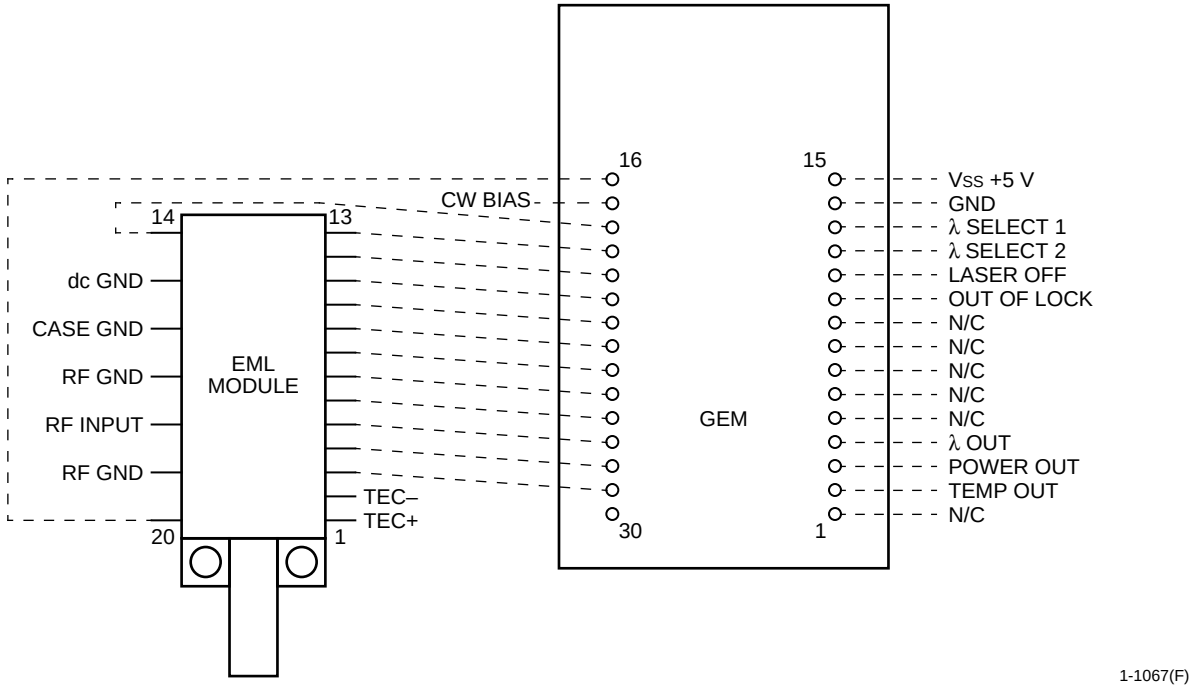


Figure 1. Electrical Schematic

Table 2. Pin Descriptions (EML Module)

Pin	Function	Pin	Function
1	TEC anode	11	Control function (to GEM pin 21)
2	TEC cathode	12	Control function (to GEM pin 20)
3	Thermistor (to GEM pin 29)*	13	Control function (to GEM pin 19)
4	Control function (to GEM pin 28)	14	5 Vdc supply (to GEM pin 18)
5	Laser CW bias (to GEM pin 27)	15	dc GND
6	Etalon #1 (to GEM pin 26)	16	Case GND
7	Etalon #2 (to GEM pin 25)	17	RF GND
8	Reference PIN diode (to GEM pin 24)	18	Modulator signal (RF input)
9	Control function (to GEM pin 23)	19	RF GND
10	Control function (to GEM pin 22)	20	Control function (to GEM pin 16)

* One thermistor is connected to ground

Pin Information (continued)

Table 3. Pin Descriptions (Generic Electronic Module)

Pin	Function	Pin	Function
1	No user connect	16	Control function (to EML pin 20)
2	Laser temperature out (V)	17	Laser CW bias (input to GEM)
3	Laser power out (V)	18	5 Vdc supply (to EML pin 14)
4	Laser wavelength out (V)	19	Control function (to EML pin 13)
5	No user connect	20	Control function (to EML pin 12)
6	No user connect	21	Control function (to EML pin 11)
7	No user connect	22	Control function (to EML pin 10)
8	No user connect	23	Control function (to EML pin 9)
9	No user connect	24	Reference PIN diode (V) (to EML pin 8)
10	Out of lock	25	Etalon #2 (V) (to EML pin 7)
11	Laser off	26	Etalon #1 (V) (to EML pin 6)
12	Channel select #1	27	Laser CW bias (to EML pin 5 and GEM pin 17)
13	Channel select #2	28	Control function (to EML pin 4)
14	GND	29	Thermistor (to EML pin 3)*
15	5 V input to GEM	30	No user connect

* One thermistor is connected to ground.

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 operational sections of the data sheet. Exposure to absolute maximum ratings for extended periods can adversely affect device reliability.

Parameter	Conditions	Min	Max	Unit
Laser Diode Reverse Voltage	CW	—	2	V
Laser Diode Forward Current	CW	—	150	mA
Optical Output Power	CW	—	10	mW
Modulator Reverse Voltage	—	—	5	V
Modulator Forward Voltage	—		1	V
Input Voltage (supply to GEM)	—	0.3	6	V
Loading Resistance (GEM analog outputs*)	—	5	—	kΩ
Loading Capacitance (GEM analog outputs*)	—	—	100	pF
Storage Temperature	—	–40	85	°C
Operating Temperature	—	0	70	°C

* Resistance and capacitance in parallel. Applicable to GEM pins 2, 3, and 4.

Notes:
The digital inputs (GEM pins 12 and 13) are TTL compatible.
The EML module and the GEM are ESD Class 2 capable.

Characteristics

Table 4. Optical and Electrical Specifications (Chip operating temp. = 15 °C to 35 °C, except where noted.)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Laser: T_{OP} (laser submount temperature) = 5 °C to 35 °C.						
Threshold Current (BOL)	I_{TH}	$T_{LASER\ CHIP} = T_{OP}$	5	—	35	mA
Forward Voltage	V_F	$I_F = I_{OP}$ @ T_{OP}	—	—	2	V
Operating Current	I_{OP}	$T_{LASER\ CHIP} = T_{OP}$	50	—	100	mA
Threshold Power	P_{TH}	$T_{LASER\ CHIP} = T_{OP}$ $I_F = I_{TH}, V_M = 0$ V	—	—	80	µW
Fiber Output Power (Peak)	P_{PK}	$T_{LASER\ CHIP} = T_{OP}$ $I_F = I_{OP}, V_M = 0$ V	1	—	—	dBm
Side-mode Suppression Ratio	SMSR	$I_F = I_{OP}, V_M = 0$ V	30	—	—	dB
Peak-to-Peak Chirp (time-resolved spectroscopy) E2535 series (360 km)*	TRS_{P-P}	2.5 Gbits/s V_{LOW} = –1.5 to –3.0 V V_{HIGH} = –0.3 V $I_F = I_{OP}$ @ T_{OP}	—	—	0.25	A
Peak-to-Peak Chirp (time-resolved spectroscopy) E2532 series (640 km)†	TRS_{P-P}	2.5 Gbits/s V_{LOW} = –1.5 to –3.0 V V_{HIGH} = –0.3 V $I_F = I_{OP}$ @ T_{OP}	—	—	0.15	A
Dispersion Penalty	DP	2.5 Gbits/s 360 km (E2535 series) 640 km (E2532 series) V_{LOW} = –1.5 to –3.0 V, V_{HIGH} = –0.3 V $I_F = I_{OP}$ @ T_{OP}	—	—	2.0	dB
Modulator						
RF Extinction Ratio	ER_{RF}	2. 5 Gbits/s (E2580) V_M = 0 V to –3.0 V	10	—	—	dB
RF Return Loss (0 GHz to 2 GHz)	S_{11}	$V_M = -V_{P-P}/2$ $I_F = I_{OP}$	10	—	—	dB
RF Return Loss (2 GHz to 3 GHz)	S_{11}	$V_M = -V_{P-P}/2$ $I_F = I_{OP}$	7	—	—	dB
RF Return Loss (3 GHz to 5 GHz)	S_{11}	$V_M = -V_{P-P}/2$ $I_F = I_{OP}$	3	—	—	dB
–3 dB Bandwidth	—	$V_M = -V_{P-P}/2$ $I_F = I_{OP}$	3.5	—	—	GHz
Modulator Current	—	V_M = 0. V, I_F = 50 mA	—	—	15	dB
Rise/Fall Time	t_R/t_F	(20%—80%)	—	—	125	ps
Thermistor (For information only. There is no user interface to the thermistor)						
Resistance	R_T	T = 25 °C	9.5	10.0	10.5	kΩ

* Over 6480 ps/nm of fiber dispersion (360 km).
† Over 11520 ps/nm of fiber dispersion (640 km).

Characteristics (continued)

Table 4. Optical and Electrical Specifications (Chip operating temp. = 15 °C to 35 °C, except where noted.) (continued)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Thermoelectric Cooler						
TEC Current	I_{TEC}	$T_{LASER\ CHIP}$ = 5 °C T_{CASE} = 70 °C	—	—	1.8	A
TEC Voltage	V_{TEC}	$T_{LASER\ CHIP}$ = 5 °C T_{CASE} = 70 °C	—	—	3	V
TEC Power	P_{TEC}	$T_{LASER\ CHIP}$ = 5 °C T_{CASE} = 70 °C	—	—	5.4	W
TEC Capacity	ΔT	T_{CASE} = 70 °C	—	—	65	°C
Laser Module						
Optical Isolation	—	T_{CASE} = 70 °C	34	—	—	dB
Stabilization and Tuning Performance						
Output Voltage (analog output for wavelength)	V_λ	λ = ITU center channel	—	1.25	—	V
Voltage: Frequency Coefficient (analog output for wavelength)	dV/dF	At maximum slope (near λ_{ITU}) (See Figure 5.)	—	25	—	mV/GHz
Wavelength Stability (over life)	—	$V_\lambda = 1.25 \pm 0.02$ V	–20	0	20	pm
Stabilization Time	—	Channel Switch	—	15	60	s

* Over 6480 ps/nm of fiber dispersion (360km).
† Over 11520 ps/nm of fiber dispersion (640km).

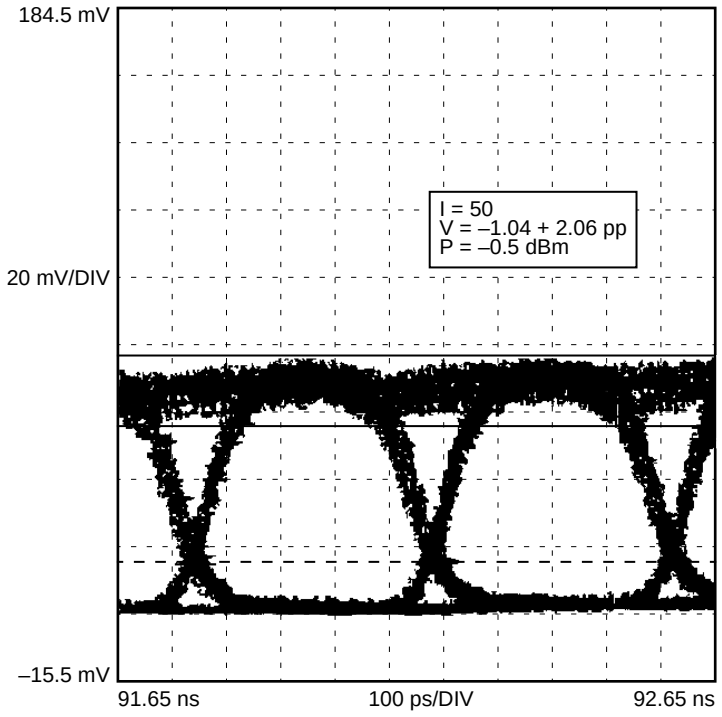


Figure 2. Typical Eye Pattern at 2.5 Gbits/s

Characteristics (continued)

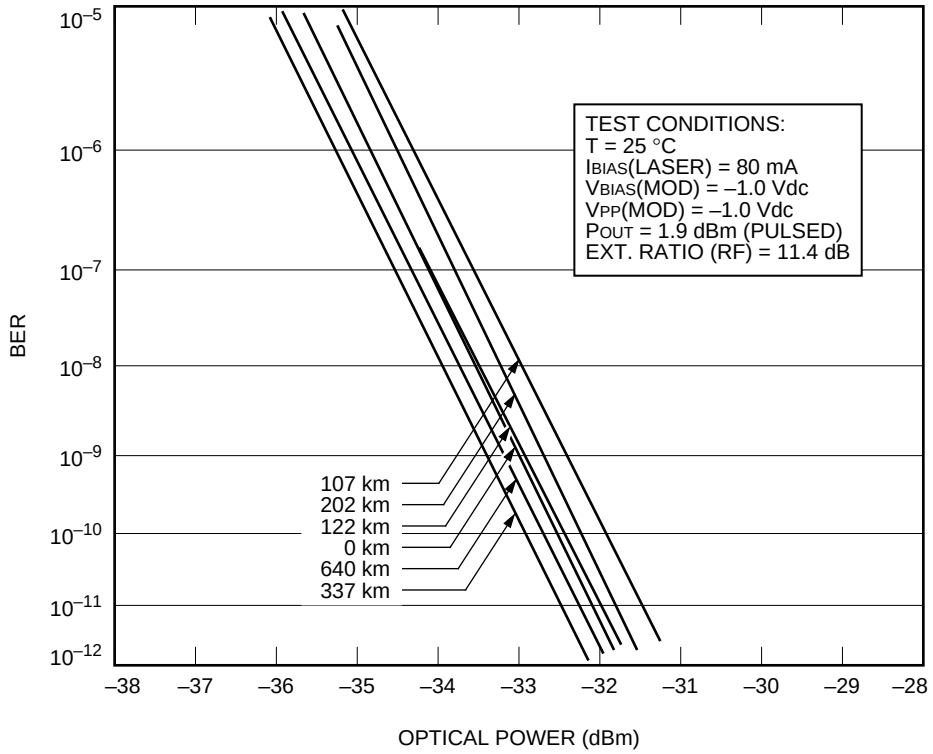


Figure 3. BER vs. Optical Power (typical)

.

Characteristics (continued)

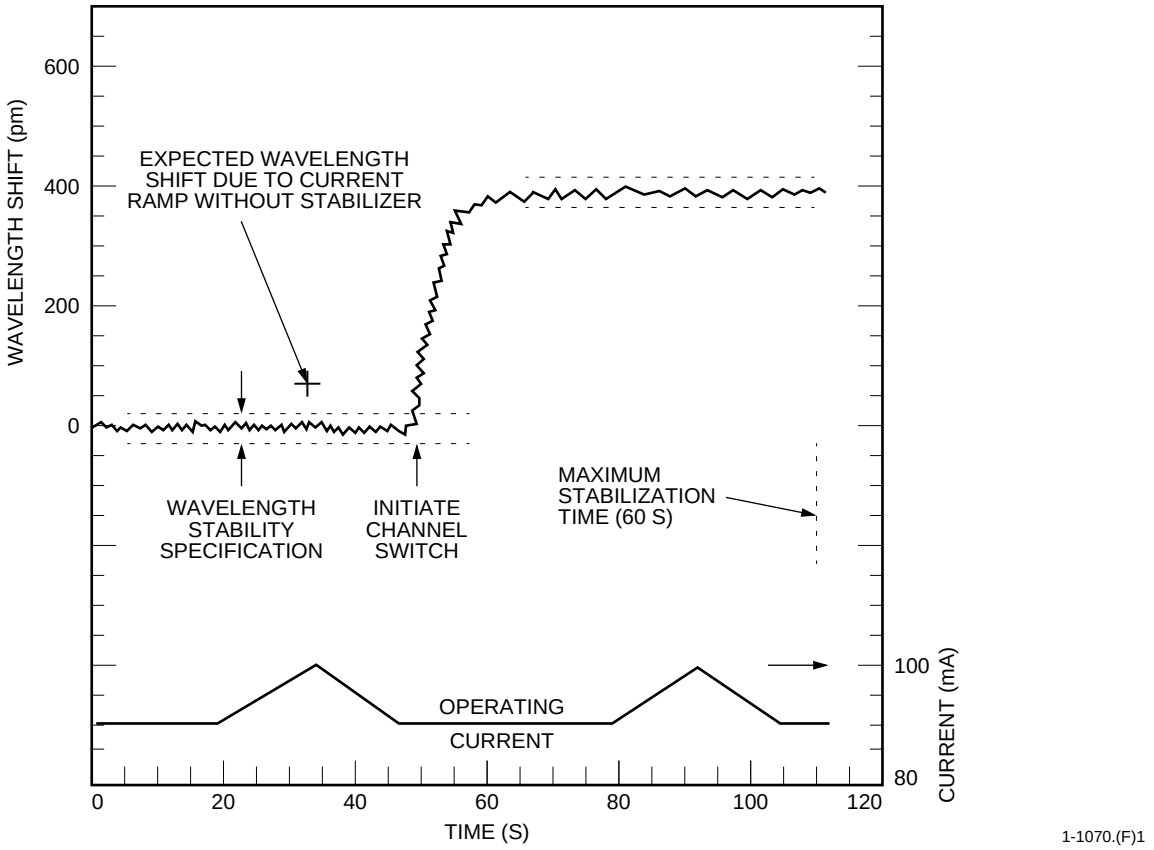


Figure 4. Typical Channel Stabilization and Stabilization Performance

Figure 4 shows the typical stability performance of the E2530 product, and demonstrates a channel-to-channel switch. At time = 0, the device is operating at a given ITU-T wavelength. Operation within the (±20 pm) specification for wavelength stability is shown. At time = 20 s, a ramp in the operating (CW DFB) current in the EML is affected.

The purpose of the current ramp is to initiate a change in the EML chip temperature, which would normally (without stabilization) affect a change in the wavelength. A device without wavelength stabilization would be expected to experience a significant increase in wavelength (as shown), which would result in a violation of the specification for wavelength stability. However, with the integrated locker in use, the wavelength stays within the stated specification, without any visible perturbation in its magnitude.

At time = 50 s, a channel switch is initiated via the digital input for the channel request. The wavelength increases to the adjacent channel, and stabilizes well within the specified (60 s) time period. A further current ramp demonstrates stable operation in the new channel.

Characteristics (continued)

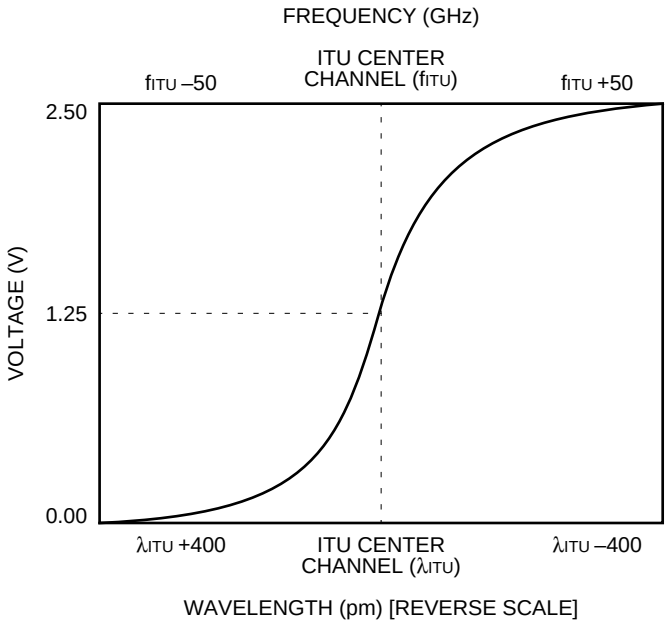
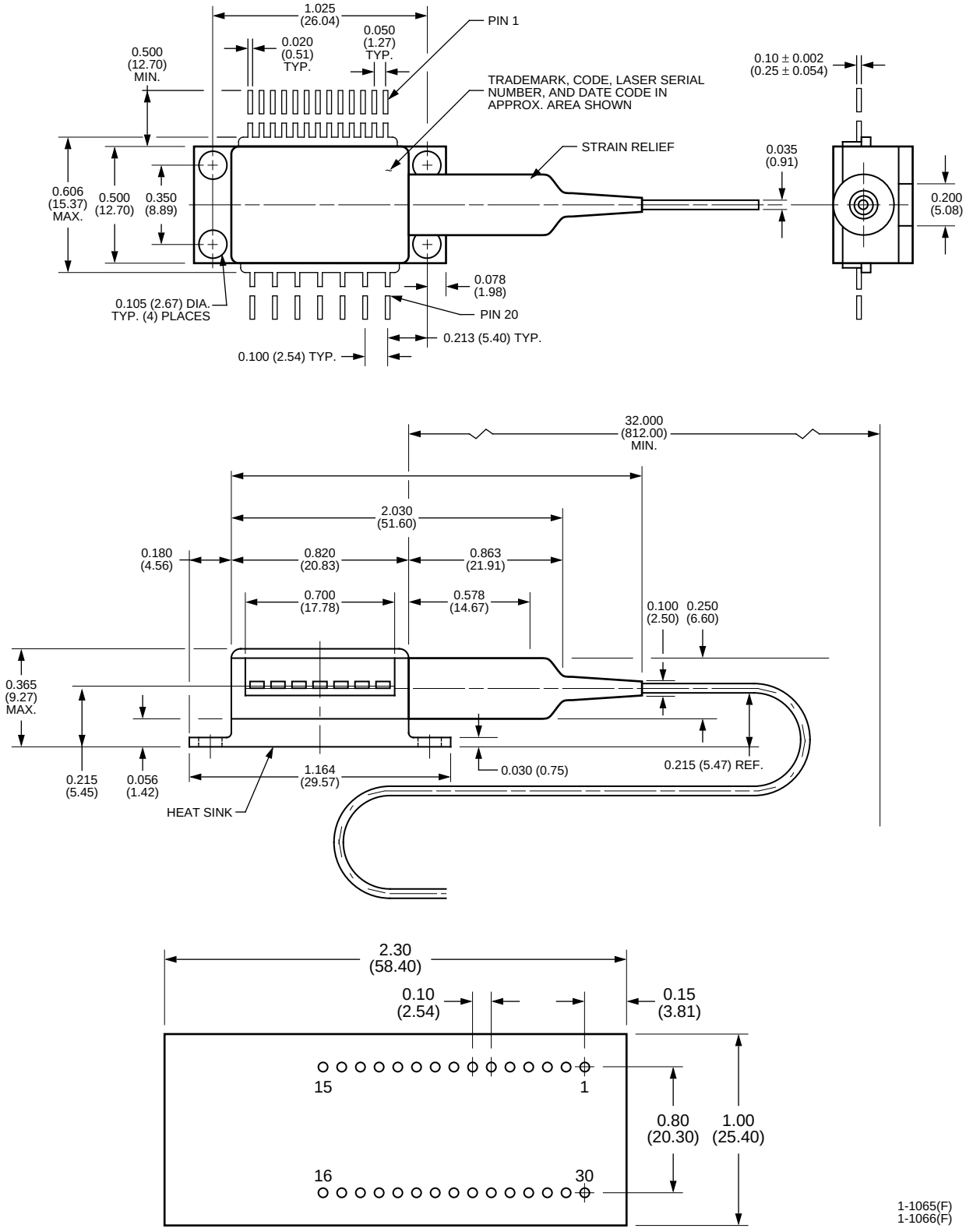


Figure 5. Typical Voltage vs. Frequency (wavelength), GEM Analog Output for Wavelength

Outline Diagram

Dimensions are in inches and (millimeters)



1-1065(F)
1-1066(F)

Laser Safety Information

Class IIIb Laser Product

This product complies with 21 CFR 1040.10 and 1040.11.

Single-mode connector

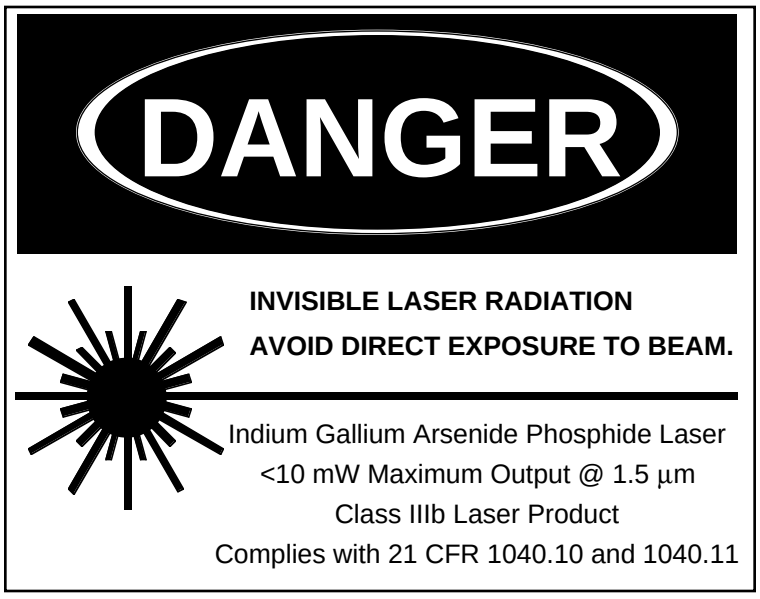
Wavelength = 1.5 µm

Maximum power = 10 mW

Because of size constraints, laser safety labeling is not affixed to the module but attached to the outside of the shipping carton.

Product is not shipped with power supply.

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



DANGER
INVISIBLE RADIATION IS EMITTED FROM THE END OF THE FIBER OR CONNECTOR. AVOID DIRECT EXPOSURE TO THE BEAM. DO NOT VIEW WITH OPTICAL INSTRUMENTS.

Ordering Information

Table 5. Ordering Information

Parameter		Device Description			
ITU-T Wavelength (nm)	Frequency (THz)	E2535Hxxx04 Series, 360 km		E2532Hxxx04 Series, 640 km	
		Code	Comcode	Code	Comcode
1530.33 to 1529.16	195.90 to 196.05	E2535H95904	TBD	E2532H95904	TBD
1531.90 to 1530.72	195.70 to 195.85	E2535H95704	TBD	E2532H95704	TBD
1533.47 to 1532.29	195.50 to 195.65	E2535H95504	TBD	E2532H95504	TBD
1535.04 to 1533.86	195.30 to 195.45	E2535H95304	TBD	E2532H95304	TBD
1536.61 to 1535.43	195.10 to 195.25	E2535H95104	TBD	E2532H95104	TBD
1538.19 to 1537.00	194.90 to 195.05	E2535H94904	TBD	E2532H94904	TBD
1539.77 to 1538.58	194.70 to 194.85	E2535H94704	TBD	E2532H94704	TBD
1541.35 to 1540.16	194.50 to 194.65	E2535H94504	TBD	E2532H94504	TBD
1542.94 to 1541.75	194.30 to 194.45	E2535H94304	TBD	E2532H94304	TBD
1544.53 to 1543.33	194.10 to 194.25	E2535H94104	TBD	E2532H94104	TBD
1546.12 to 1554.92	193.90 to 194.05	E2535H93904	TBD	E2532H93904	TBD
1547.72 to 1546.52	193.70 to 193.85	E2535H93704	TBD	E2532H93704	TBD
1549.32 to 1548.11	193.50 to 193.65	E2535H93504	TBD	E2532H93504	TBD
1550.92 to 1549.72	193.30 to 193.45	E2535H93304	TBD	E2532H93304	TBD
1552.52 to 1551.32	193.10 to 193.25	E2535H93104	TBD	E2532H93104	TBD
1554.13 to 1552.93	192.90 to 193.05	E2535H92904	TBD	E2532H92904	TBD
1555.75 to 1554.54	192.70 to 192.85	E2535H92704	TBD	E2532H92704	TBD
1557.36 to 1556.15	192.50 to 192.65	E2535H92504	TBD	E2532H92504	TBD
1558.98 to 1557.77	192.30 to 192.45	E2535H92304	TBD	E2532H92304	TBD
1560.61 to 1559.39	192.10 to 192.25	E2535H92104	TBD	E2532H92104	TBD
1562.23 to 1561.01	191.90 to 192.05	E2535H91904	TBD	E2532H91904	TBD
1563.86 to 1562.64	191.70 to 191.85	E2535H91704	TBD	E2532H91704	TBD

Related Product Information

Table 6. Related Product Information

Description	Part Number	Document Number
Erbium-Doped Fiber Amplifier	1724-Type	DS99-259LWP
2.5 Gbits/s Receiver	1319-Type	DS97-106LWP
2.5 Gbits/s Receiver with Clock Recovery	1320-Type	DS97-113LWP
2.5 Gbits/s EML	E2500-Type	DS98-368LWP
10 Gbits/s EML	E2560/E2580	DS99-305LWP

Notes

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

INTERNET: **http://www.lucent.com/micro**, or for Optoelectronics information, **http://www.lucent.com/micro/opto**
E-MAIL: **docmaster@micro.lucent.com**
N. AMERICA: Microelectronics Group, Lucent Technologies Inc., 555 Union Boulevard, Room 30L-15P-BA, Allentown, PA 18103
1-800-372-2447, FAX 610-712-4106 (In CANADA: **1-800-553-2448**, FAX 610-712-4106)
ASIA PACIFIC: Microelectronics Group, Lucent Technologies Singapore Pte. Ltd., 77 Science Park Drive, #03-18 Cintech III, Singapore 118256
Tel. (65) 778 8833, FAX (65) 777 7495
CHINA: Microelectronics Group, Lucent Technologies (China) Co., Ltd., A-F2, 23/F, Zao Fong Universe Building, 1800 Zhong Shan Xi Road, Shanghai 200233 P. R. China **Tel. (86) 21 6440 0468**, **ext. 316**, FAX (86) 21 6440 0652
JAPAN: Microelectronics Group, Lucent Technologies Japan Ltd., 7-18, Higashi-Gotanda 2-chome, Shinagawa-ku, Tokyo 141, Japan
Tel. (81) 3 5421 1600, FAX (81) 3 5421 1700
EUROPE: Data Requests: MICROELECTRONICS GROUP DATALINE: **Tel. (44)7000 582 368**, FAX (44) 1189 328 148
Technical Inquiries: OPTOELECTRONICS MARKETING: **(44) 1344 865 900** (Ascot UK)

August 1999
DS99-348LWP

microelectronics group

Lucent Technologies
Bell Labs Innovations