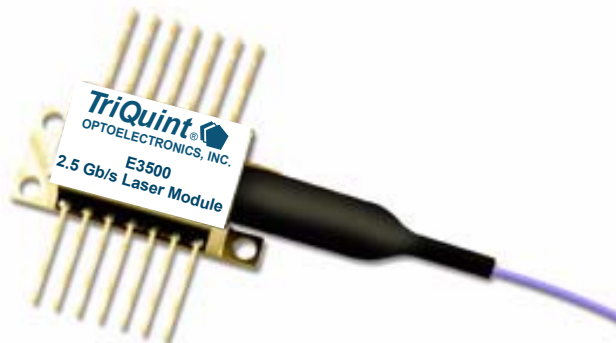


## E3500-Type 2.5 Gb/s Electroabsorption Modulated Isolated Laser Module (EM-ILM) with Internal Wavelength Stabilizer for Metro and Long-Reach Applications

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The E3500 EM-ILM, the newest generation of the award-winning 266-Type EM-ILM, features an integrated modulator and laser chip, and provides a compact, cost-effective solution for extended-reach transmissions.

### Features

- Integrated electroabsorptive modulator
- Internal wavelength stabilizer,  $\pm 2.5$  GHz
- Temperature tunable up to four channels with 50 GHz spacing (E3505)
- 1.5  $\mu\text{m}$  wavelength
- Characterized for 2.5 Gb/s operation
- Very low dispersion penalty over 600 km
- Low modulation voltage
- Temperature stabilized
- Wavelengths selectable to ITU-T standards
- Hermetic, industry-standard, 14-pin butterfly package
- Compatible with MSA pinout

### Applications

- SONET/SDH extended-reach applications
- High-capacity DWDM system applications
- High-speed data communications
- Digitized video

### Description

The E3500-Type EM-ILM is a 1.5  $\mu\text{m}$  laser with an integrated electroabsorptive modulator packaged in an industry-standard, 14-pin butterfly package. The device is designed for use in 2.5 Gb/s extended-reach applications where the distances between regenerators is in the range of 150 km—1000 km. The package also contains a wavelength stabilizer, thermoelectric cooler, thermistor, back-facet monitor, and an optical isolator.

To ensure optimum system performance in long-distance applications, the E3500 output power typically can be increased by coupling the module with an erbium-doped fiber amplifier (EDFA) such as the TriQuint 1724 EDFA. The standard product is specified for use up to 360 km (E3505 Series) and 600 km (E3502 Series).

The E3500 EM-ILM can replace external modulators in many applications. The nominal input impedance for the modulator is 50  $\Omega$ . By integrating the modulator with the laser chip, the device offers a compact, cost-effective solution for extended-reach transmission applications. It can also be specified for WDM applications where wavelength selection is required. TriQuint is providing devices compatible with the ITU-T wavelength standards.

Description (continued)

The use of an internal wavelength stabilizer greatly enhances long-term wavelength reliability. The etalon wavelength stabilizer used in E3500-type laser module is temperature insensitive, which ensures superior long-term wavelength stability. The maximum wavelength drift for E3500-type EML laser module is ±20 pm over 20 years of lifetime.

In addition, the E3500-type package is MSA compatible.

Module Characteristics

Package Type	14-pin butterfly with internal isolator
Fiber	Standard single mode
Connector	ST
RF Input	50 Ω nominal
Bit Rate	2.5 Gb/s

Pin Information

Table 1. Pin Assignments

Pin Number	Description
1	Thermistor
2	Thermistor
3	Laser anode
4	Power Monitor PD Anode (-)
5	Common PD Cathode (+)
6	TEC (+)
7	TEC (-)
8	Case ground
9	Case ground
10	Wavelength Monitor PD Anode (-)
11	Laser modulator ground
12	Modulator anode (-)/50 Ω RF input
13	Laser/modulator ground
14	Case ground

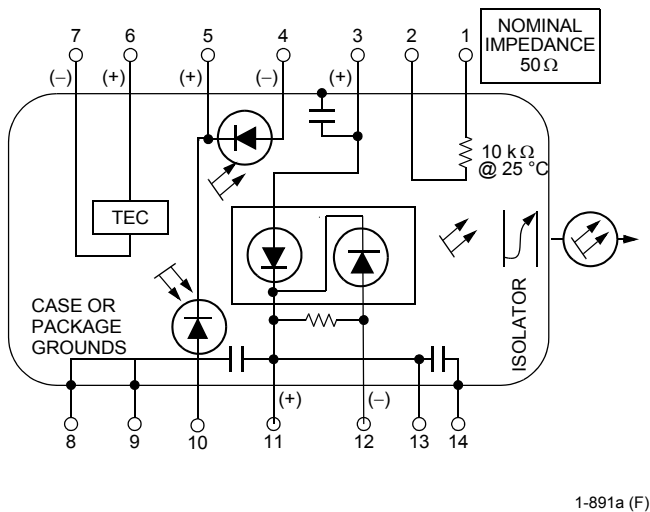


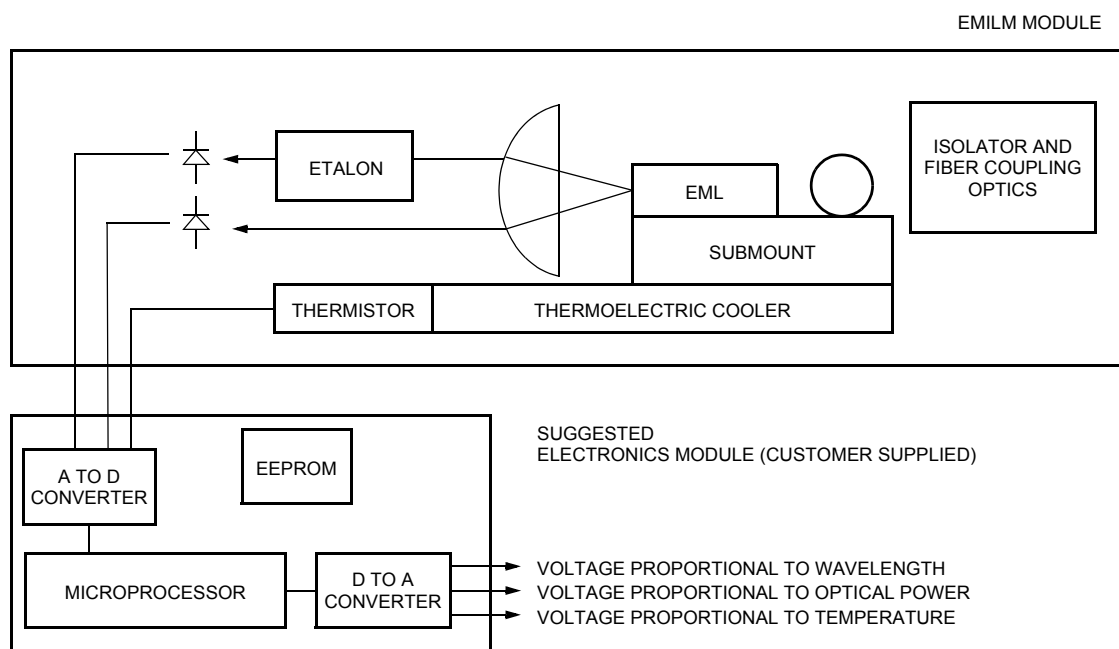
Figure 1. E3500 EM-ILM Schematic

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

Parameter	Conditions	Limit	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
Monitor Diode Reverse Voltage	—	10	V
Monitor Diode Forward Current	—	1	mA
Storage Temperature Range	—	–40 to +85	°C
Operating Temperature Range	—	0 to 70	°C

## Block Diagram



**Figure 2. Optics and Electronics Block Diagram**

## Characteristics

Table 2. Optical and Electrical Specifications

Parameter	Symbol	Conditions	Min	Max	Unit
Threshold Current (BOL)	$I_{TH}$	$T_{LASER\ CHIP} = T_{OP}$	5	35	mA
Forward Voltage	$V_F$	$I_f = I_{OP} @ T_{OP}$	—	2.0	V
Operating Current	$I_{OP}$	$T_{LASER\ CHIP} = T_{OP}$	50	100	mA
Threshold Power	$P_{TH}$	$T_{LASER\ CHIP} = T_{OP}$ $I_f = I_{TH}, V_M = 0\text{ V}$	—	80	$\mu\text{W}$
Fiber Output Power (peak)	$P_{PK}$	$T_{LASER\ CHIP} = T_{OP}$ $V_M = 0\text{ V}, I_f = I_{OP}$	1	—	dBm
Peak Wavelength (wavelength can be specified to the ITU-T wavelength channels)	$\lambda_0$	$V_M = 0\text{ V}$ $T_{LASER\ CHIP} = T_{OP}$ $I_f = I_{OP}$	1530	1563	nm
Side-mode Suppression Ratio	SMSR	$V_M = 0\text{ V}, I_f = I_{OP}, T_{OP}$	30	—	dB
Frequency Drift (EOL) <sup>1</sup>	$\Delta f_C$	Operation over 20-year lifetime	—	$\pm 2.5$	GHz
Time Resolved Spectroscopy (chirp): E3505 Series	TRSp-p	2.5 Gb/s $V_{LOW} = -1.5\text{ V to } -3.0\text{ V}$ $V_{HIGH} = 0\text{ V}$ $I_f = I_{OP} @ T_{OP}$	—	0.25	Å
Time Resolved Spectroscopy (chirp): E3502 Series	TRSp-p	2.5 Gb/s $V_{LOW} = -1.5\text{ V to } -3.0\text{ V},$ $V_{HIGH} = -0.3\text{ V}$ $I_f = I_{OP} @ T_{OP}$	—	0.15	Å
Dispersion Penalty	DP	2.5 Gb/s 360 km (E3505) 600 km (E3502) $V_{LOW} = -1.5\text{ V to } -3.0\text{ V}$ $V_{HIGH} = 0\text{ V (E3505), } -0.3\text{ V (E3502)}$ $I_f = I_{OP} @ T_{OP}$	—	2.0	dB
<b>Modulator</b>					
Extinction Ratio	$ER_{RF}$	$V_M = 0\text{ V to } -3.0\text{ V}, 2.5\text{ Gb/s}$	10	—	dB
RF Return Loss (0 GHz to 2 GHz)	$S_{11}$	$V_M = -V_{PP}/2$ $I_f = I_{OP}$	10	—	dB
RF Return Loss (2 GHz to 3 GHz)	$S_{11}$	$V_M = -V_{PP}/2$ $I_f = I_{OP}$	7	—	dB
RF Return Loss (3 GHz to 5 GHz)	$S_{11}$	$V_M = -V_{PP}/2$ $I_f = I_{OP}$	3	—	dB
–3 dB Bandwidth	BW	$V_M = -V_{PP}/2$ $I_f = I_{OP}$	3.5	—	GHz
Modulator Current @ $V_M = 0\text{ V}, I_f = 50\text{ mA}$	—	—	—	15	mA
Rise/Fall Time (20% to 80%)	$t_R/t_F$	—	—	125	ps

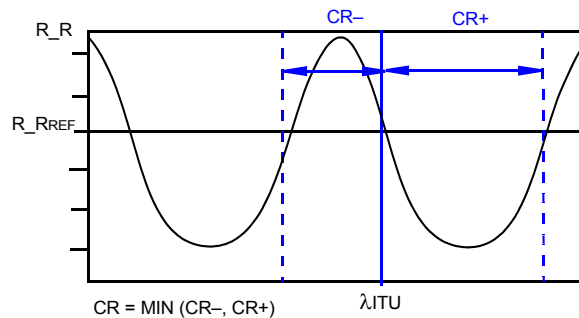
1. EOL (end of life) for a particular module is defined as the point in time when the laser drive current required to maintain the TriQuint-specified, single specific fiber power level has increased over time by 25% from its BOL value.

## Characteristics (continued)

**Table 2. Optical and Electrical Specifications (continued)**

Parameter	Symbol	Conditions	Min	Max	Unit
<b>Monitor Diode</b>					
Monitor Current	$I_{RMON}$	$T_{LASER\ CHIP} = T_{OP}$ $V_{BD} = V_{RMON}, I_f = I_{OP}$	10	1000	$\mu A$
Power Monitor $\lambda$ Monitor PD	$I_{\lambda PD}$		10	1000	$\mu A$
Dark Current	$I_D$	$T_{LASER\ CHIP} = T_{OP}, V_{BD} = V_{RMON}$	—	0.1	$\mu A$
Monitor Reverse-bias Voltage <sup>2</sup>	$V_{RMON}$	—	3	10	V
Etalon Slope <sup>3</sup> (Relative to Peak)	—	—	0.5	8	%/GHz
Frequency Capture Range <sup>4</sup>	CR	Measured from $f_{ITU}$ toward increasing $f$ and decreasing $f$	6.5	—	GHz
Thermistor B Constant	B	—	3700	4100	—
<b>Thermoelectric Cooler</b>					
TEC Current	$I_{TEC}$	$T_{LASER\ CHIP} = 15\ ^\circ C$ $T_{CASE} = 70\ ^\circ C$	—	1.3	A
TEC Voltage	$V_{TEC}$	$T_{LASER\ CHIP} = 15\ ^\circ C$ $T_{CASE} = 70\ ^\circ C$	—	2.6	V
TEC Power	$P_{TEC}$	$T_{LASER\ CHIP} = 15\ ^\circ C$ $T_{CASE} = 70\ ^\circ C$	—	3.0	W
TEC Capacity <sup>5</sup>	$\Delta T$	$T_{CASE} = 70\ ^\circ C$	— <sup>5</sup>	—	$^\circ C$
<b>Laser Module</b>					
Optical Isolation	—	$T_{CASE} = 0\ ^\circ C$ to $65\ ^\circ C$	30	—	dB

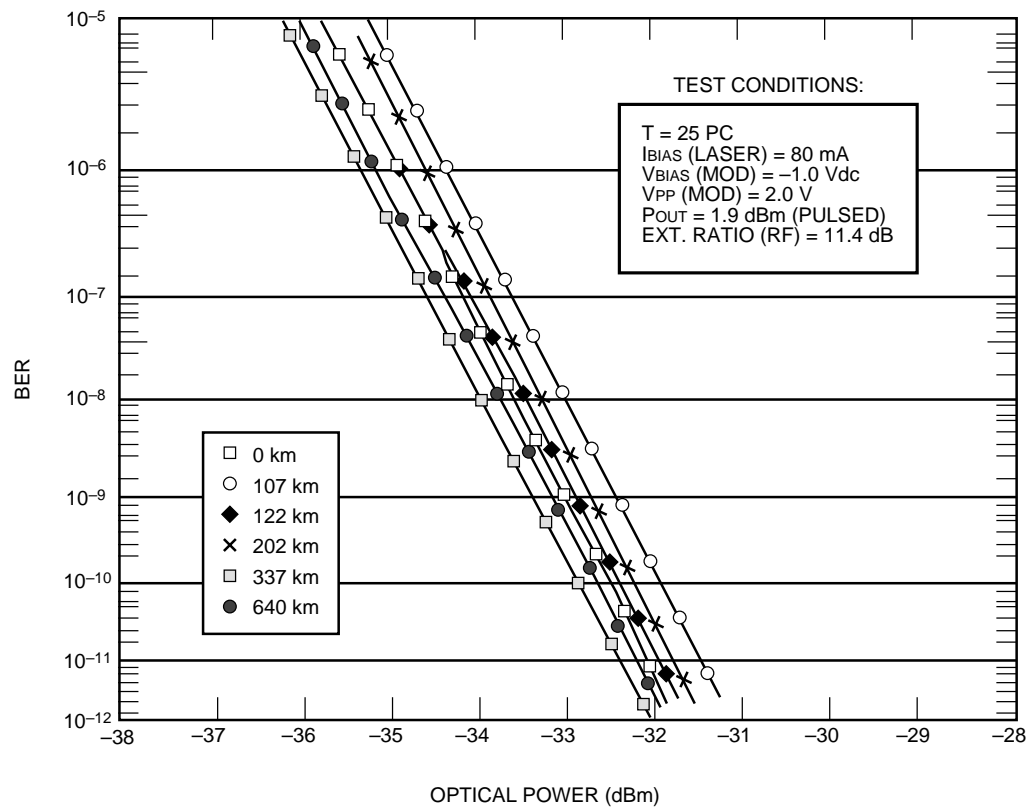
1. EOL (end of life) for a particular module is defined as the point in time when the laser drive current required to maintain the TriQuint-specified, single specific fiber power level has increased over time by 25% from its BOL value.
2. Standard operating condition is 5.0 V reverse bias.
3. The (relative) etalon slope is defined as the local slope (in  $GHz^{-1}$ ) at the TriQuint-specified ITU operating point, divided by the  $R_{REF}$  (the response ratio) value at the ITU operating point for the particular module under consideration. Note that the value of this (relative) slope provides information on the precision required by the customer to maintain control of the  $R_{REF}$  ratio to provide frequency locking. For example, 1%/GHz minimum would mean that the  $R_{REF}$  ratio must be controlled to  $\leq \pm 2.5\%$  of its BOL TriQuint-specified value in order to provide  $\pm 2.5$  GHz frequency stability for the module.
4. The frequency capture range (CR) is the spectral area in which the emitted wavelength must be before launching the automated wavelength control mode. This ensures that, when going from automated power control to automated wavelength control mode, the locked wavelength will be the targeted ITU wavelength. CR is the minimum of CR<sup>−</sup> and CR<sup>+</sup> (see Figure 3).
5. Operation at a  $\Delta T$  of  $70\ ^\circ C - T_{SET}$  is guaranteed, where  $T_{SET}$  is the laser temperature required to achieve the required ITU wavelength, over life, in a DWDM system ( $T_{SET}$  range is  $15\ ^\circ C$  to  $35\ ^\circ C$ ). In a non-WDM application,  $T_{SET}$  is  $25\ ^\circ C$ .



**Figure 3. Definitions**



## Characteristics (continued)



1-930(C).c

Figure 5. BER vs. Optical Power (Typical)

0.500 (12.70) MIN

0.020 (0.51) TYP

1.025 (26.04)

PIN 1

TRADEMARK, CODE, LASER SERIAL NUMBER, AND DATE CODE IN APPROX. AREA SHOWN

STRAIN RELIEF

0.10 ± 0.002 (2.54 ± 0.051)

0.036 (0.91)

0.200 (5.08)

0.078 (1.98)

0.213 (5.40) TYP

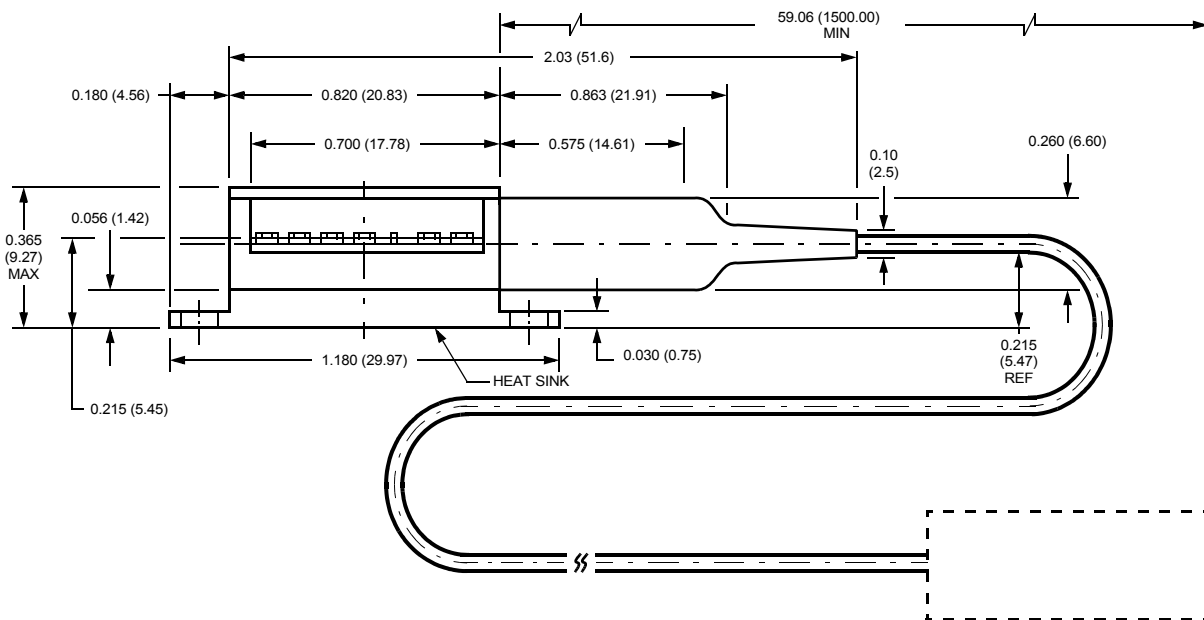
0.100 (2.54) TYP

0.105 (2.67) DIA TYP (4) PLACES

0.500 (12.70)

0.350 (8.89)

0.605 (15.37) MAX



For additional information and latest specifications, see our website: [www.triquint.com](http://www.triquint.com)



## Electrostatic Discharge

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

TriQuint 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 k $\Omega$ , capacitance = 100 pF) is widely used and can be used for comparison purposes.

## Laser Safety Information

### Class IIIb Laser Product

FDA/CDRH Class IIIb laser product. All versions are Class IIIb laser products per CDRH, 21 CFR 1040 Laser Safety requirements. All versions are classified Class 3B laser products consistent with *IEC*® 60825-1: 1993. This device family has been classified with the FDA under accession number 8720010. Measurements were made to classify the product per *IEC* 60825-1: 1993.

This product complies with 21 CFR 1040.10 and 1040.11.

Single-mode connector.

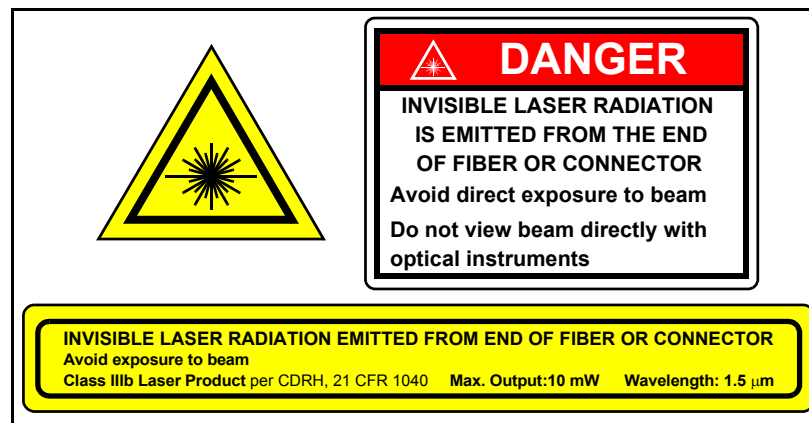
Wavelength = 1.5  $\mu$ m.

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.



## Ordering Information

To be determined.

## Related Product Information

Table 3. Related Product Information

Description	Part Number	Document Number
1.5 $\mu\text{m}$ EML	E2500-Type	DS01-281-1
1.5 $\mu\text{m}$ DFB Laser w/ Wavelength Stabilizer	D3587-Type	DS03-009
1.5 $\mu\text{m}$ Digital DFB Laser	D2500-Type	DS00-166-1
1.3 $\mu\text{m}$ Digital DFB Laser	D2300-Type	DS00-167-1
1.5 $\mu\text{m}$ EDFA	1724-Type	DS00-123-1
2.5 Gb/s Receiver	P172-Type	DS03-007
2.5 Gb/s Receiver with Clock Recovery	R485-Type	DS01-005-1

IEC is a registered trademark of The International Electrotechnical Commission.

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### Additional Information

For the latest specifications, additional product information, worldwide sales and distribution locations, and information about TriQuint:

Web: [www.triquint.com](http://www.triquint.com)

Tel: (503) 615-9000

E-mail: [info\\_opto@tqs.com](mailto:info_opto@tqs.com)

Fax: (503) 615-8902

For technical questions and additional information on specific applications:

E-mail: [info\\_opto@tqs.com](mailto:info_opto@tqs.com)

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DS03-010, March, 2003