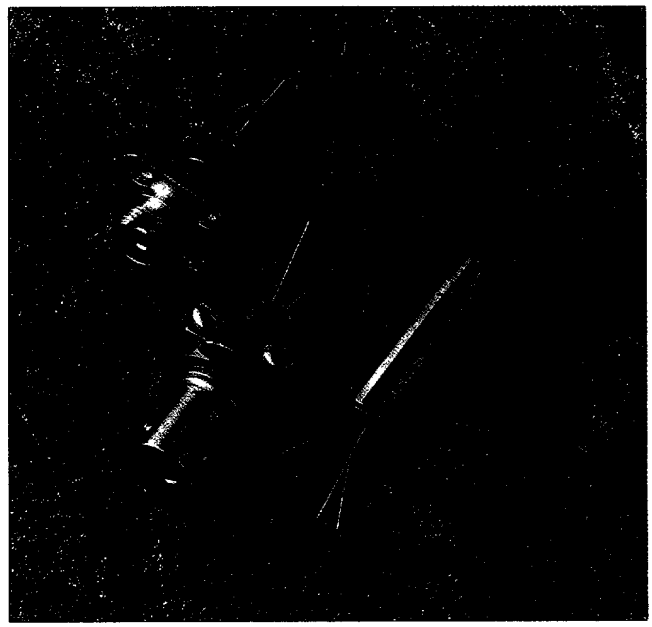
ERM501
ERM504

EPITAXX

Sonet OC-1 & OC-3 PIN-Transimpedance Amplifier Receiver Modules

Features

- InGaAs PIN Photodiode and GaAs Transimpedance Amplifier
- Exceeds Sonet sensitivity and overload requirements
- Integrated 4-pin package
- Single +5 V operation
- Connector receptacle and fiber pigtailed versions



Applications

- Sonet receivers
  - Add/Drop Multiplexers
  - Digital Loop Carriers
  - Digital Crossconnects
  - Optical Network Units
- Fiber optic receivers from 10 to 220 Mbps

Description

The ERM501 and ERM504 are optical receiver modules that use a high-speed P-I-N photodetector coupled with a hybrid, low noise transimpedance amplifier (TIA) for 1300 nm or 1550 nm optical communications. The PIN, which is made of InGaAs, has an active diameter of 75 µm; the TIA is based on GaAs FET technology.

The function of the PIN-TIA module is to detect input optical power, to transduce the incident radiation into current, and then to convert the current into a voltage. The amplifier in each PIN-TIA is selected to make the receiver module compliant with a specific transmission rate of the Synchronous Optical Network (SONET) standard. The ERM501 uses a transimpedance amplifier with a bandwidth for 51.84 Mbps, OC-1 transmission; the ERM504 incorporates an amplifier designed for the OC-3 rate of 155.52 Mbps. These detector/amplifiers also incorporate an integrated automatic gain control function for enhancing their dynamic range.

The ERM501 and ERM504 are designed to exceed Sonet receiver specifications. The low input noise current density of the transimpedance amplifiers provides the optical receiver modules, when used with appropriate filtering, with ample sensitivity for realizing minimum input power requirements. At a bit error rate of 1×10^{-10}, the OC-1 ERM501 has a typical sensitivity of -43 dBm; the OC-3 ERM504 has a sensitivity of -38 dBm. In addition, the AGC function enables the PIN-TIAs to surpass the specifications for overload input power. The OC-1 ERM501 and the OC-3 ERM504 have a typical optical overload of Ø dBm.

Designers of OC-1 and OC-3 receivers can use EPITAXX Sonet PIN-TIAs in any application that benefits from integration of the photodiode and TIA/AGC into a TO-18 coaxial package. Typical of such applications are receivers for digital crossconnects, digital loop carriers, add/drop multiplexers, and optical network units. The ERM501 and ERM504 are also beneficial because they operate from a single +5 volt supply and are packaged in a compact, hermetically sealed module. In addition, the ERM501 and ERM504, which have four leads, require fewer electrical connections than PIN-FET receivers or than discrete implementations of the photodetection/TIA/AGC functions. These features make EPITAXX optical receiver modules of benefit in other fiber optic receiver applications from 10 Mbps to 220 Mbps.

The ERM501 and ERM504 are mounted in rugged coaxial packages. They are available within a connector receptacle or with a fiber pigtail. Standard choices for connector receptacles are ST and FC. The customer can specify the pigtail to be either fiber jacketed (FJ) or cabled fiber (FC) and the fiber to be singlemode or multimode. EPITAXX engineers are available for evaluating any special packaging requirement.

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Specifications

AC/Optical Characteristics

(V_{dd} = 5.0 V, T_A = 25°C, R_L = 50 Ω)

Model	ERM501FJ-S/M			ERM501RFC/RST			ERM504FJ-S/M			ERM504RFC/RST			
Parameter	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Units
Gain	15	20		13	18		5	7		4.5	6.5		V/mW
Bandwidth[1]	50	60		50	60		150	200		150	200		MHz
Sensitivity[2]	-41.5	-43.0		-41.0	-42.5		-37.0	-38.5		-36.5	-38.0		dBm
Overload	-3	0		-3	0		-3	0		-3	0		dBm
AGC Threshold Power		5			5			20			20		µW
Output Impedance	35	50	65	35	50	65	35	50	65	35	50	65	Ω
AGC Time Constant		0.1			0.1			0.1			0.1		mSec

DC Electrical Characteristics

Model	All Models			
Parameter	Min.	Typ.	Max.	Units
Supply Voltage V_{dd}	4.5	5.0	6.0	V
Output Offset Voltage V_{os}	1.3	1.8	2.2	V
Supply Current	15	35	50	mA

Maximum Ratings

Parameter	All Models	Units
Supply Voltage V_{dd}	7.0	V
Optical Power[3]	2	mW
Operating Temperature T_A	-40 / +85	°C
Storage Temperature	-40 / +85	°C

Notes:

1. Input optical power below AGC threshold.
2. Bit error rate of 1E-10. Noise bandwidth of 35 MHz for ERM501; 120 MHz for ERM504.
3. Damage may occur if maximum power rating is exceeded.

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Figure 1

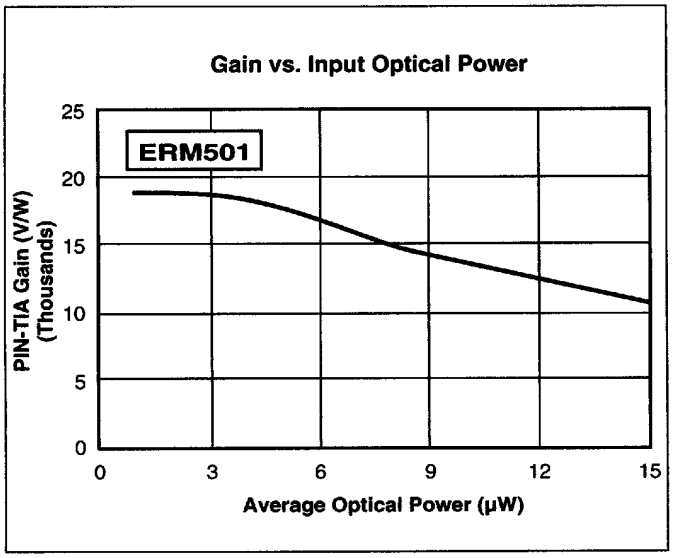


Figure 2

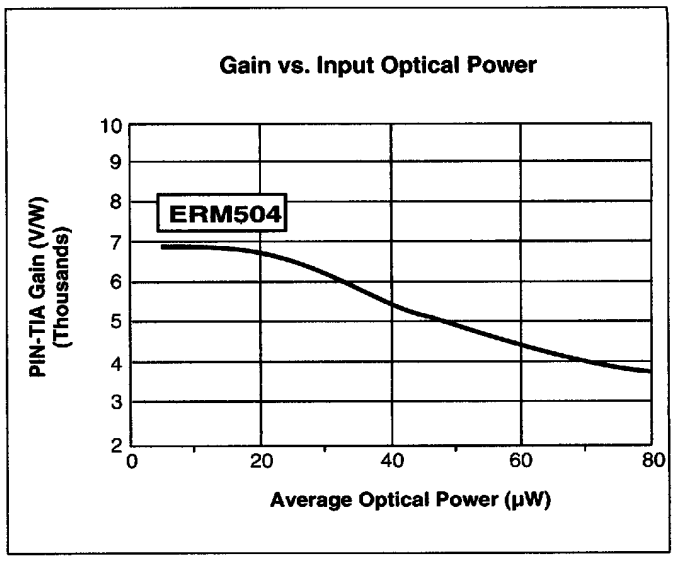


Figure 3

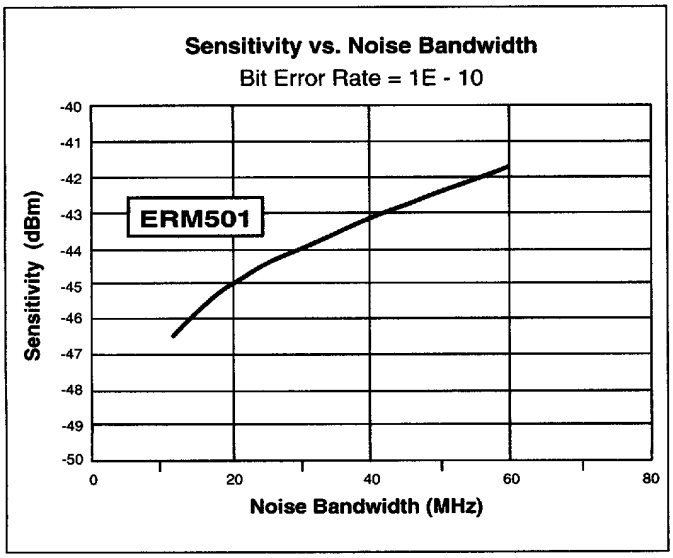


Figure 4

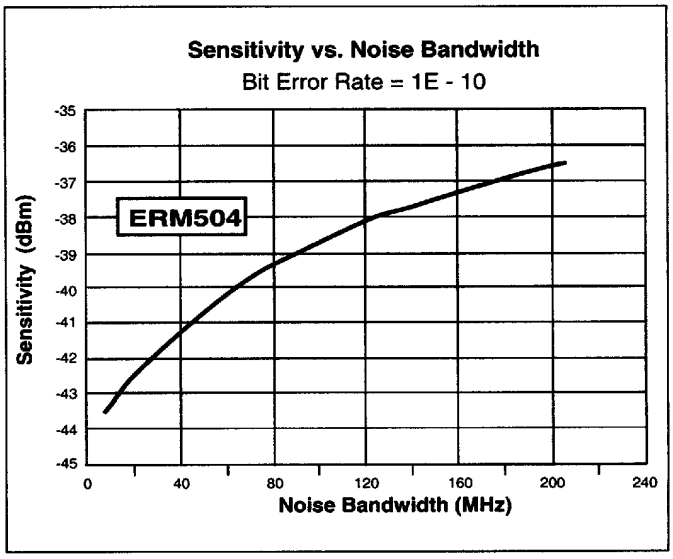
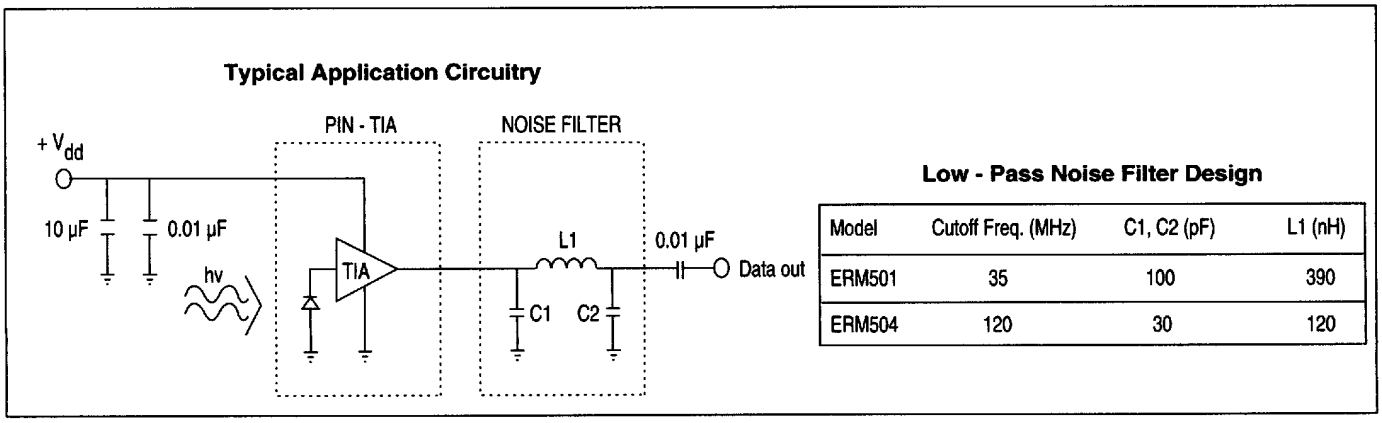


Figure 5



Low - Pass Noise Filter Design

Model	Cutoff Freq. (MHz)	C1, C2 (pF)	L1 (nH)
ERM501	35	100	390
ERM504	120	30	120

OC-1 and OC-3 PIN-TIA Modules

The ERM501 and ERM504 PIN-TIAs provide significant benefits over hybrid designs and 14-pin receivers. Integration of the transimpedance amplifier with the PIN detector into the TO can reduces parasitic capacitances and lead inductances. These reductions improve sensitivity over that attainable by designs that place the amplifier outside the can, away from the detector. The ERM501 and ERM504, which have four pins, are advantageous over 14-pin receivers because they require less board space. In addition, the ERM501 and ERM504 operate from a single +5 volt supply, whereas typical optical receivers need at least two supplies. The reduction of board space and need for just a single supply make EPITAXX PIN-TIAs a less expensive, high performance alternative to other kinds of optical receivers.

External Circuitry Requirements

When designing the ERM501 or ERM504 into an optical receiver, the engineer should observe standard high speed PC board design practices. For example, we urge bypassing of the power supply so as to reduce noise that appears at the output of the PIN-TIA. Fig. 5 shows a standard bypass filter using parallel capacitors.

If signal traces are relatively long, use impedance matching techniques to maximize power transfer from the PIN-TIA to its load: for microstrip design, use 50 Ω as the output impedance of the PIN-TIA. Note as well that the output of the PIN-TIA is DC coupled. Since most applications require AC coupled stages, the engineer should place a high Q RF chip capacitor on the output of the module (see Fig. 5). A 0.1 µF capacitor should be sufficient to avoid excessively attenuating low frequency components of the transmitted data.

To eliminate oscillations, we recommend mounting the PIN-TIA on a circuit board with a large, low impedance ground plane. Ensure proper RF grounding by connecting the case lead (Pin 4) to the electrical ground. In addition, shorten the length of all the module's leads so as to reduce excess inductances.

Noise Filtering

The bandwidth of each PIN-TIA is greater than that required for receiving the corresponding Sonet optical carrier for which each module was designed. For example, the ERM504 has a minimum bandwidth of 150 MHz, whereas reception of an OC-3 transport necessitates a bandwidth of just 70% of the 155.52 Mbps rate. Any frequency component above this bandwidth contributes excess noise to the output. The excess noise needlessly reduces the sensitivity of the receiver.

The Sonet optical link designer can improve receiver sensitivity by using a low-pass noise filter to remove frequency components above the required bandwidth. By placing a 35 MHz low-pass noise filter on the output of the ERM501, the designer can increase OC-1 sensitivity by 2 dB, as shown in Fig. 3. Similarly, a 120 MHz low-pass filter enhances OC-3 sensitivity of the ERM504 also by 2 dB, as depicted in Fig. 4. The sensitivities shown in Figs. 3 and 4 are based on the Sonet bit error rate of 1×10^{-10}. Fig. 5 illustrates a low-pass noise filter design that provides these sensitivity improvements at OC-1 or OC-3. The filter design assumes that the output impedance of the PIN-TIA is 50 Ω and the load impedance is also 50 Ω.

In applications at data rates and sensitivities other than those required by Sonet, the optical link designer can apply Figs. 3 and 4 to determine sensitivities at other noise bandwidths. The designer can then use Fig. 5 to design a low-pass noise filter that achieves the required sensitivity at the necessary data rate. For example, at a cutoff frequency of 100 MHz, an appropriate cutoff for a 140 Mbps input, the ERM504 has a typical sensitivity of -39 dBm at a bit error rate of 1×10^{-10}. To realize this 100 MHz cutoff, the designer can use a 33 pF capacitor for C1 and C2 and a 180 nH inductor for L1.

Quality and Reliability

EPITAXX maintains a strict quality control program throughout the design and manufacturing process of all product lines. All PIN-TIA receiver modules are subjected to a multitude of stringent tests such as temperature cycling, mechanical shock, vibration and wire bond strength.

Precautions for Use

- Do not exceed any maximum ratings.
- Double check electrical connections with device pin-out.
- **ESD PROTECTION IS IMPERATIVE.**

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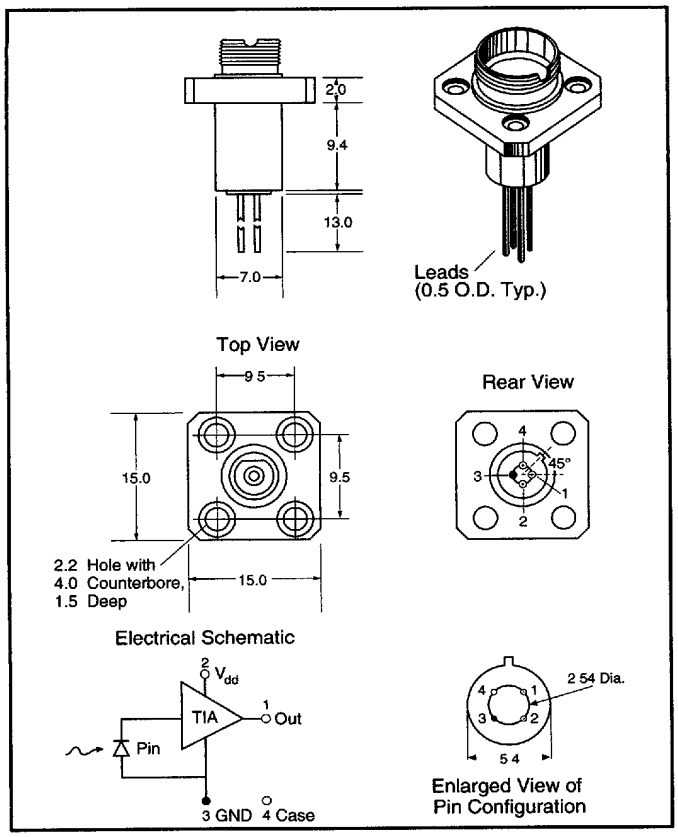
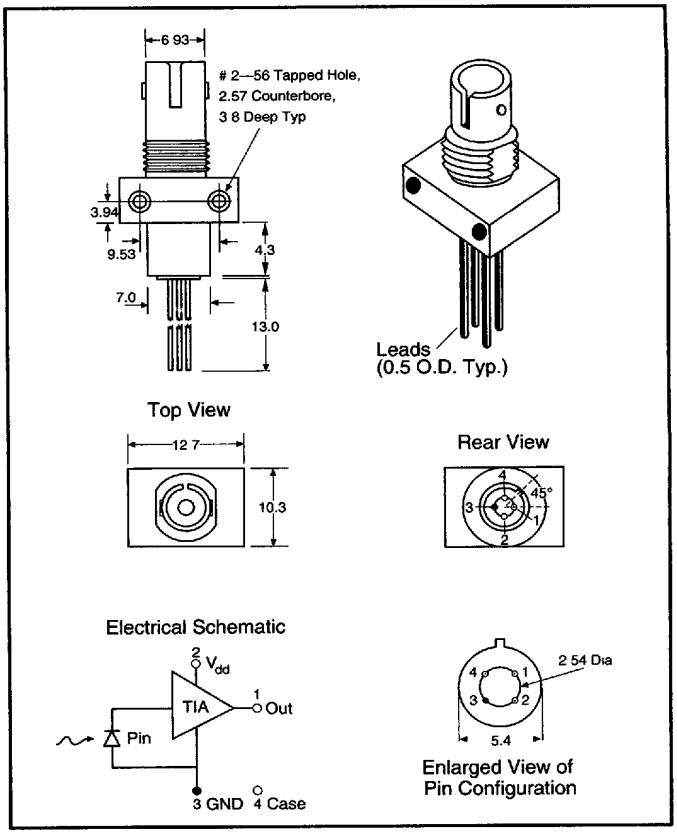
Mechanical Dimensions - All Dimensions in mm

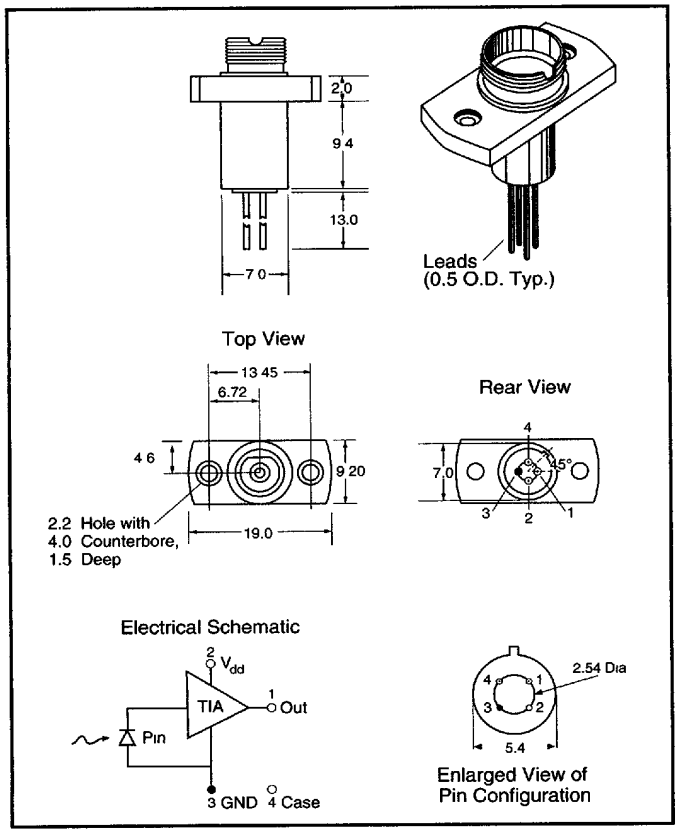
ERM501/504RFC



ERM501/504RST



ERM501/504RFC2



ERM501/504FJ