

## Data Sheet VSC7810

Photodetector/Transimpedance Amplifier  
Family for Optical Communication

### Features

- Integrated Photodetector/Transimpedance Amplifier Optimized for High Speed Optical Communications Applications
- Integrated AGC
- Fibre Channel/Gigabit Ethernet Compatible
- High Bandwidth
- Low Input Noise Equivalent Power
- Large Optically Active Area
- Single 5V Power Supply

Part Number	Data Rate	Bandwidth (MHz)	Input Noise ( $\mu\text{W rms}$ )	Optically Active Area ( $\mu\text{m diameter}$ )
VSC7810	Full Speed: 1.25 Gb/s	1200	0.45	100

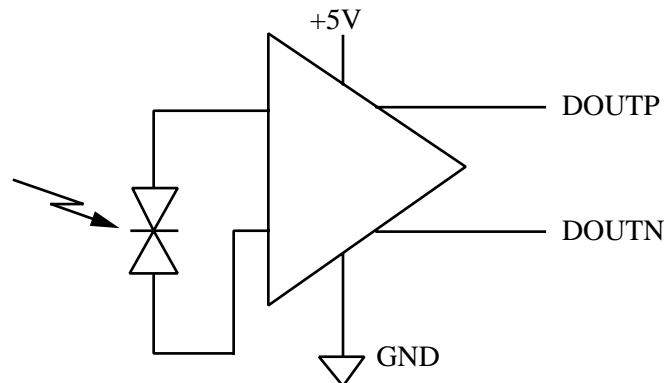
### General Description

The VSC7810 integrated Photodetector/Transimpedance Amplifier provides a highly integrated solution for converting light from a fiber optic communications channel into a differential output voltage. The benefits of Vitesse Semiconductor's Gallium Arsenide H-GaAs process are fully utilized to provide very high bandwidth and low noise in a product with a large optically active area for easy alignment. The sensitivity, duty cycle distortion and jitter meet or exceed all Fibre Channel and Gigabit Ethernet application requirements. Parts are available in either die form, flat-windowed packages or in ball-lens packages.

By using a metal-semiconductor-metal (MSM) photodetector with a monolithic integrated transimpedance amplifier, the input capacitance is lowered which allows for a larger optically active area than in discrete photodetectors. Integration also allows superior tracking over process, temperature and voltage between the photodetector and the amplifier, resulting in higher performance. This part can easily be used in developing Fibre Channel Electro-Optic Receivers which exhibit very high performance and ease of use.

### VSC7810 Block Diagram

#### Photodetector/Transimpedance Amplifier



Both DOUTP and DOUTN are back-terminated to 50 $\Omega$ .

**Table 1: Electro-Optical Specifications<sup>(1)</sup>**

<i>Symbol</i>	<i>Parameter</i>	<i>Min.</i>	<i>Typ.<sup>(2)</sup></i>	<i>Max.</i>	<i>Units</i>	<i>Conditions</i>
V <sub>SS</sub>	Supply Voltage	4.5	5.0	5.5	V	
I <sub>DD</sub>	Supply Current	13	26	40	mA	
PSRR	Power Supply Rejection Ratio	35	----	----	dB	f = 1 to 40 MHz (Includes External Filter)
λ	Wavelength	700	840	850	nm	
F <sub>c</sub>	Low Frequency Cutoff	----	----	1.8	MHz	-3db, P <sup>(5)</sup> = -15 dBm @ 50 MHz
BW	Optical Modulation Bandwidth	850	1200	1300	MHz	-3db, P = -15 dBm @ 50 MHz <sup>(3)</sup>
S	Sensitivity	-22	-25	-27	dBm	1.063Gb/s BER10 <sup>-12</sup> <sup>(3)</sup>
R <sub>o</sub>	Single Ended Output Impedance	25	----	60	Ω	
V <sub>d</sub>	Differential Output Voltage	0.35	0.52	0.65	V	P = -4.5 dBm, R <sub>load</sub> = 100 Ω differential
R <sub>d</sub>	Differential Responsivity	0.8	2.2	----	mV/μW	R <sub>load</sub> = 100 Ω P = -15 dBm @ 50 MHz
V <sub>dc</sub>	Output Bias Voltage	1.2	1.5	2.5	V	
ΔV <sub>dc</sub>	Bias Offset Voltage	----	40	150	mV	
NEP <sub>o</sub>	Input Noise Equivalent Power	0.35	0.45	0.93	μW rms	P = 0mW <sup>(4)</sup>
V <sub>no</sub>	Output Noise Voltage	0.55	0.66	0.75	mV rms	P = 0mW <sup>(4)</sup>
DCD	Duty Cycle Distortion	----	1.5	4.5	%	P = -4.5 dBm
I <sub>out</sub>	Output Drive Current	2.5	----	8	mA	
PDJ	Pattern Dependent Jitter	20	40	60	ps	P = -4.5 dBm +/-10% Voltage Window
----	Optically Active Area	----	100	----	μm	Diameter
PPJ	PP Jitter	120	160	200	ps	P = -4.5 dBm
T <sub>r</sub>	Rise Time	310	355	400	ps	20-80% P = -4.5 dBm
T <sub>f</sub>	Fall Time	280	325	370	ps	20-80% P = -4.5 dBm

Notes: (1) Specified over 0°C (ambient) to 70°C (case) . See also Note 1 - in section "Notes on Measurement Conditions & Applications" for extended temperature range operation.

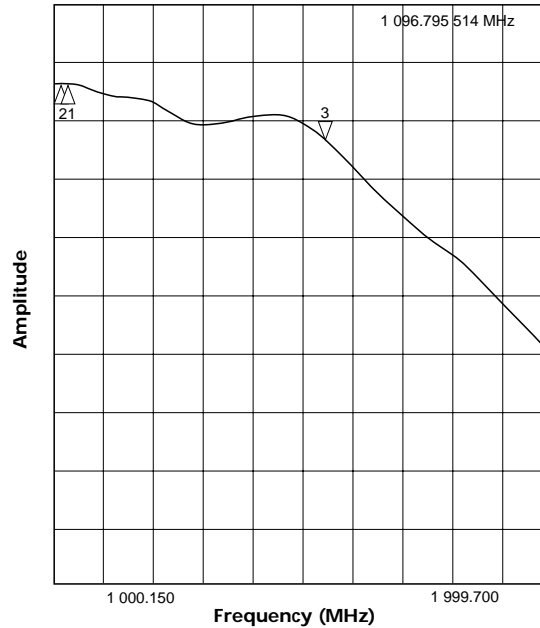
(2) Typical conditions 25°C (case) and 5V power supply.

(3) See Note 1 - in section "Notes on Measurement Conditions & Applications" .

(4) See Note 2 - in section "Notes on Measurement Conditions & Applications" .

(5) P = Incident Optical Power

**Figure 1: Amplitude vs. Frequency**



*Frequency response of VSC7810WB upper 3db frequency is measured with respect to response at 50 MHz*

**Table 2: Absolute Maximum Ratings**

<i>Symbol</i>	<i>Parameter</i>	<i>Limits</i>
V <sub>SS</sub>	Power Supply	6V
T <sub>stg</sub>	Storage Temperature	-55°C to 125°C (case temperature under bias)
H <sub>stg</sub>	Storage Humidity	5 to 95% R.H. (Including Condensation)
H <sub>op</sub>	Operating Humidity	8 to 80% R.H. (Excluding Condensation)
P <sub>inc</sub>	Incident Optical Power	+3 dBm
IS	Impact Shock	500 G. Half Sine Wave Pulse Duration 1 +/-0.5 ms 3 Blows in each direction
V <sub>ib</sub>	Vibration	20 > 2000 > 20 Hz, 10 Minutes 10 G. Peak Acceleration 4 Complete Cycles, 3 Perpendicular Axes

**Table 3: Recommended Operating Conditions**

<i>Symbol</i>	<i>Parameter</i>	<i>Limits</i>
V <sub>SS</sub>	Power Supply	4.5-5.5V (5.0V nominal)
T <sub>op</sub>	Operating Temperature	0°C (ambient) to 70°C case (normal range) and 90°C case (extended range)*

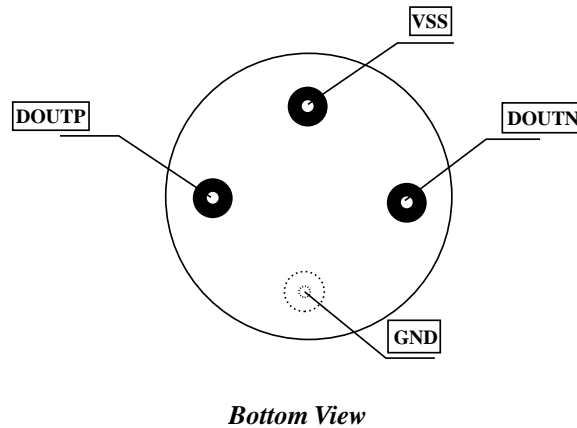
*Note: \*See Note 1 - in section "Notes on Measurement Conditions & Applications" for extended temperature range operation.*

**Table 4: Pin Table Specifications for TO-46(ball lens), TO-56 (flat window) Packages and Bare Die**

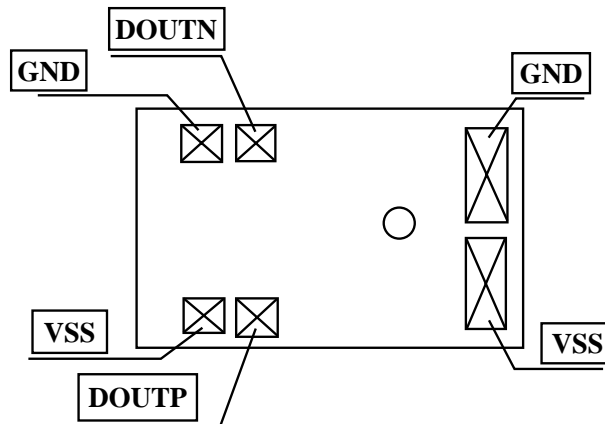
<i>Symbol</i>	<i>Description</i>
DOUTP	Data output normal (with reference to incident light)
DOUTN	Data output complement (inverting) (with reference to incident light)
VSS	Power supply
GND	Ground (package case)

Note: Pin Diagram is identical for both TO-46 and TO-56 package styles.

**Figure 2: Pin Diagram**



**Figure 3: Schematic View of Bare Die Pad Assignments**



Notes: 1) Refer to Figures 12-14 for mechanical assembly drawings for both ball lens and flat-window packages.  
2) Refer to Figure 11 for die layout detail.

## Temperature Dependence of Operating Parameters

This section describes the dependence of important operating parameters shown in Table 1 as a function of *die* (or equivalently junction) temperature and power supply. In order to relate the die temperature to an equivalent *case* temperature, the following thermal characteristics of the package are provided (note that the thermal conductivity is identical for TO-46 and TO-56 package styles).

**Table 5: Thermal Resistance Calculation for TO-56 and TO-46 Packages.**

Chip Size	0.168cm x 0.104cm	
Chip Area A	0.015 cm <sup>2</sup>	
Die height (T <sub>die</sub> )	0.066 cm	
Epoxy thickness (T <sub>epoxy</sub> )	0.0076 cm	
Header thickness (Theader) (ave. for TO-46 and TO-56)	0.115 cm	
Thermal Conductivities		
K GaAs	0.55W / cm °C	
K epoxy	0.0186W / cm °C	
K kovar	0.17W / cm °C	

$$\theta_{\text{GaAs}} = \frac{T_{\text{die}}}{K_{\text{GaAs}}A} = \frac{0.066}{0.55 \times 0.015} = 8 \text{ }^{\circ}\text{C/W}$$

$$\theta_{\text{epoxy}} = \frac{T_{\text{epoxy}}}{K_{\text{epoxy}}A} = \frac{0.0076}{0.0186 \times 0.015} = 27.24 \text{ }^{\circ}\text{C/W}$$

$$\theta_{\text{kovar}} = \frac{T_{\text{kovar}}}{K_{\text{kovar}}A} = \frac{0.12}{0.17 \times 0.015} = 47 \text{ }^{\circ}\text{C/W}$$

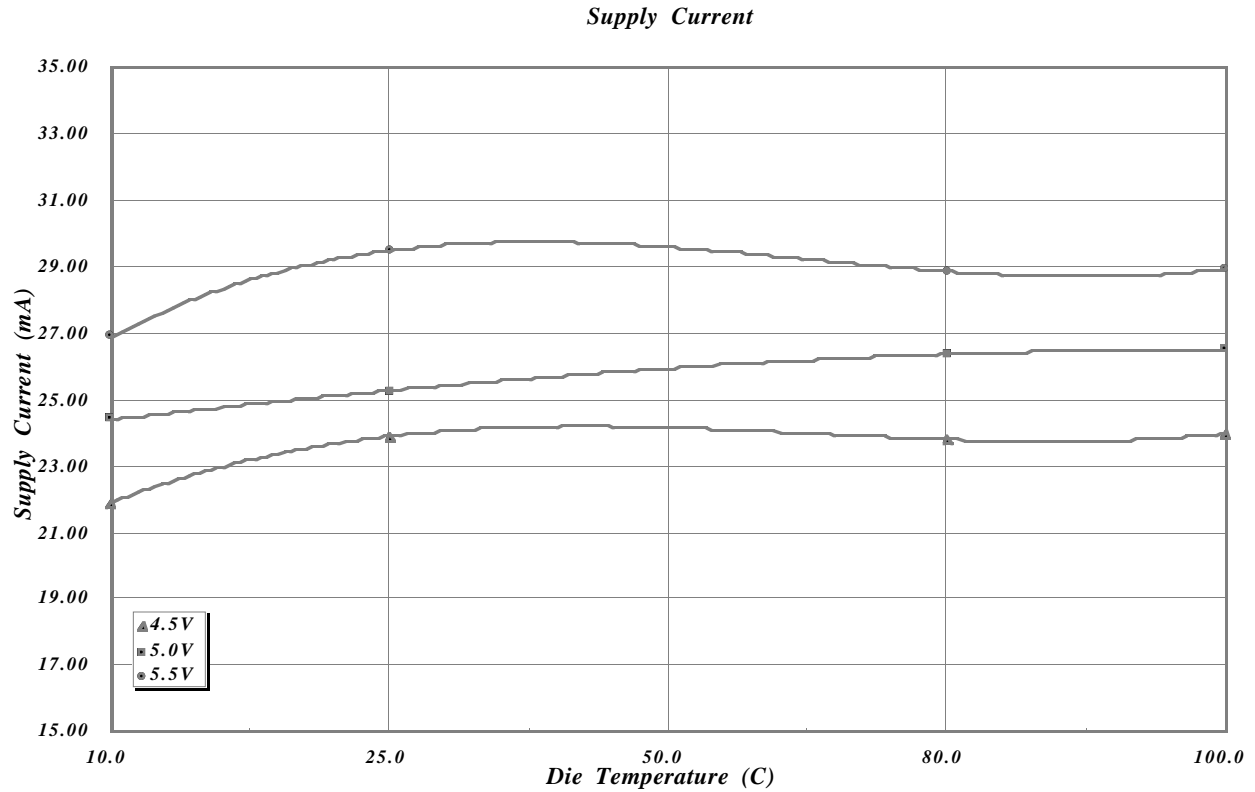
$$\theta_{\text{JC}} = \text{Thermal Resistance from Junction to Case} = (8 + 27.24 + 47) = 82.24 \text{ }^{\circ}\text{C/W}$$

*Example:*

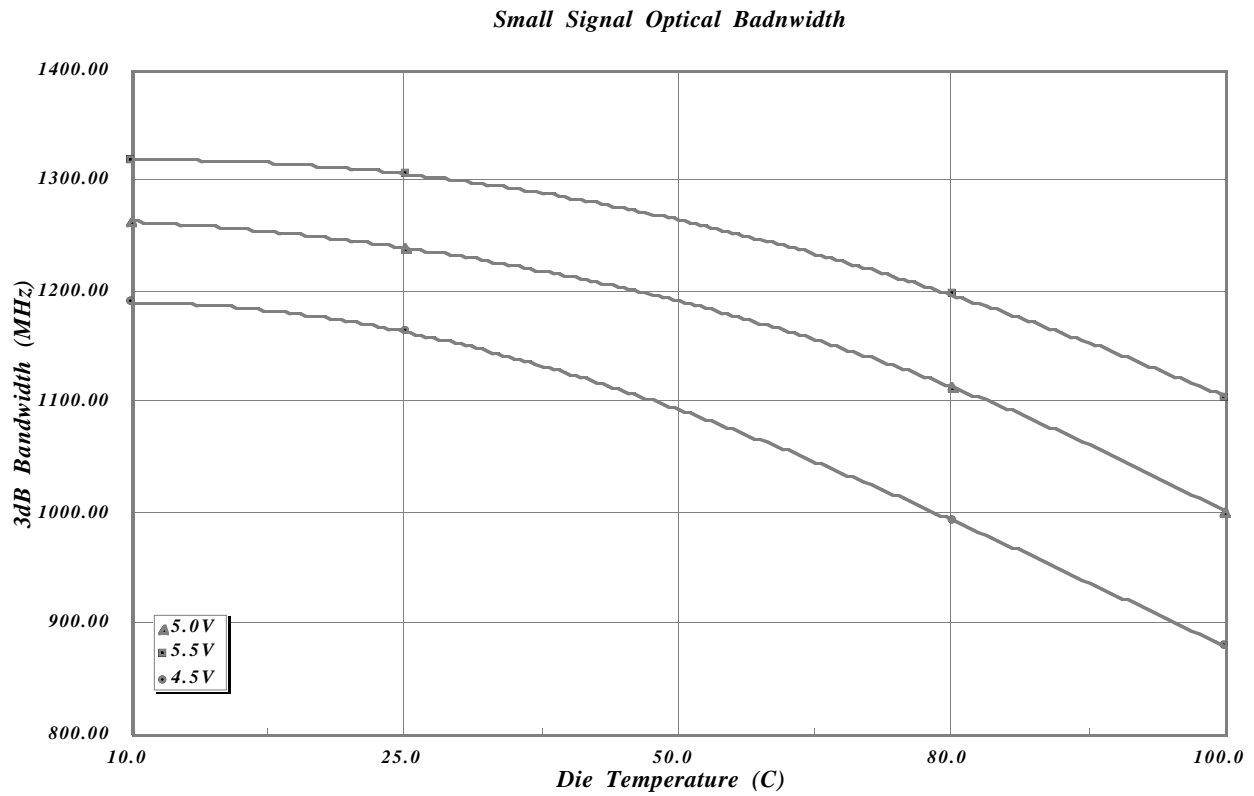
For VSC7810 at nominal supply current of 25mA and V<sub>ss</sub> = 5V

Temperature rise from junction to case = 0.025A x 5V x 82.24 °C/W = 10.28 °C

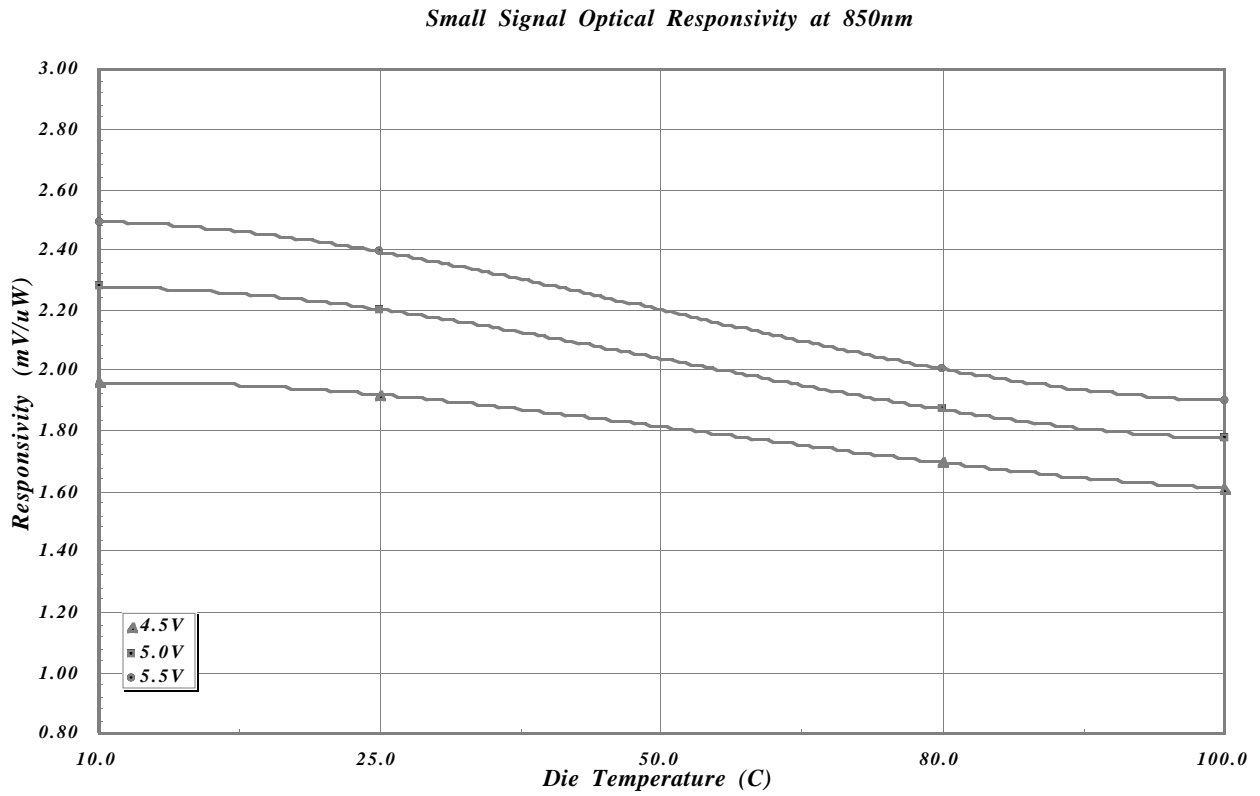
Figure 4:  $I_{DD}$  vs. Die Temperature



**Figure 5: Bandwidth vs. Die Temperature**

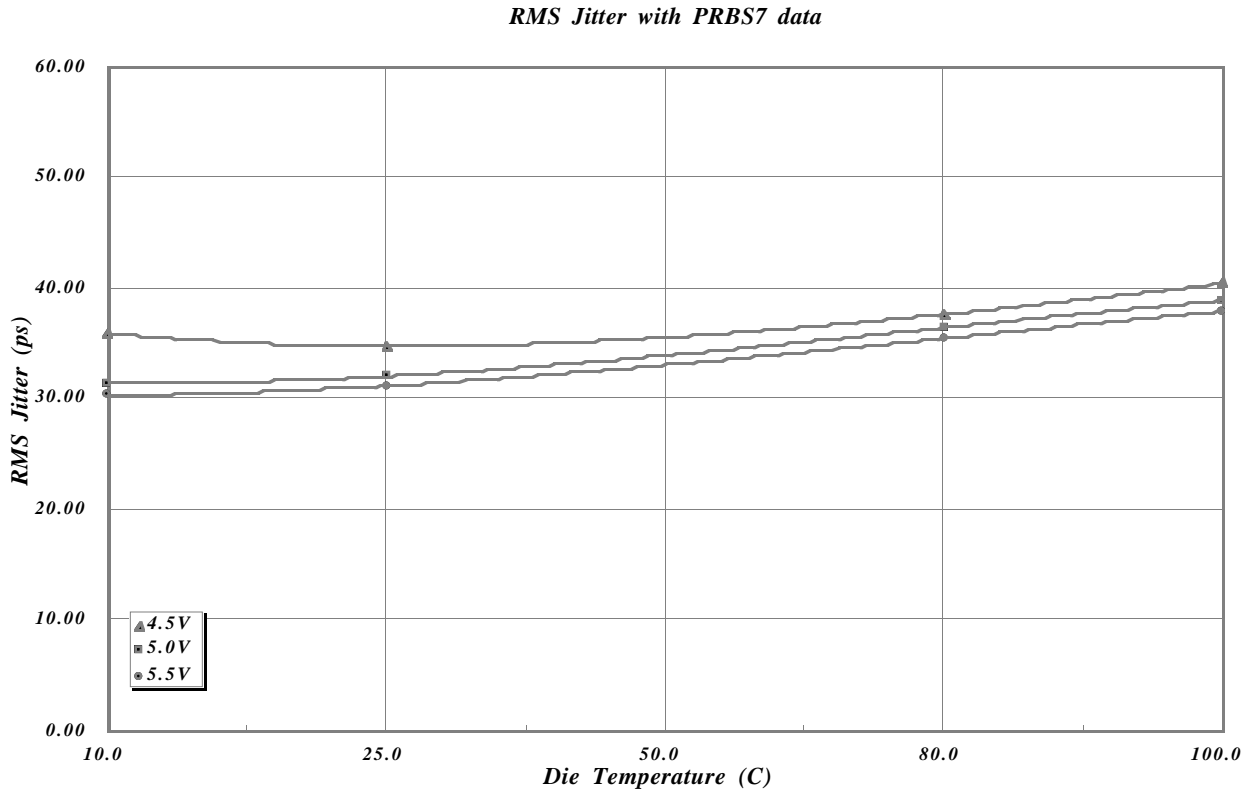


**Figure 6: Responsivity vs. Die Temperature**





**Figure 7: PRBS Jitter vs. Die Temperature**



**Figure 8: Duty Cycle Distortion vs. Die Temperature**

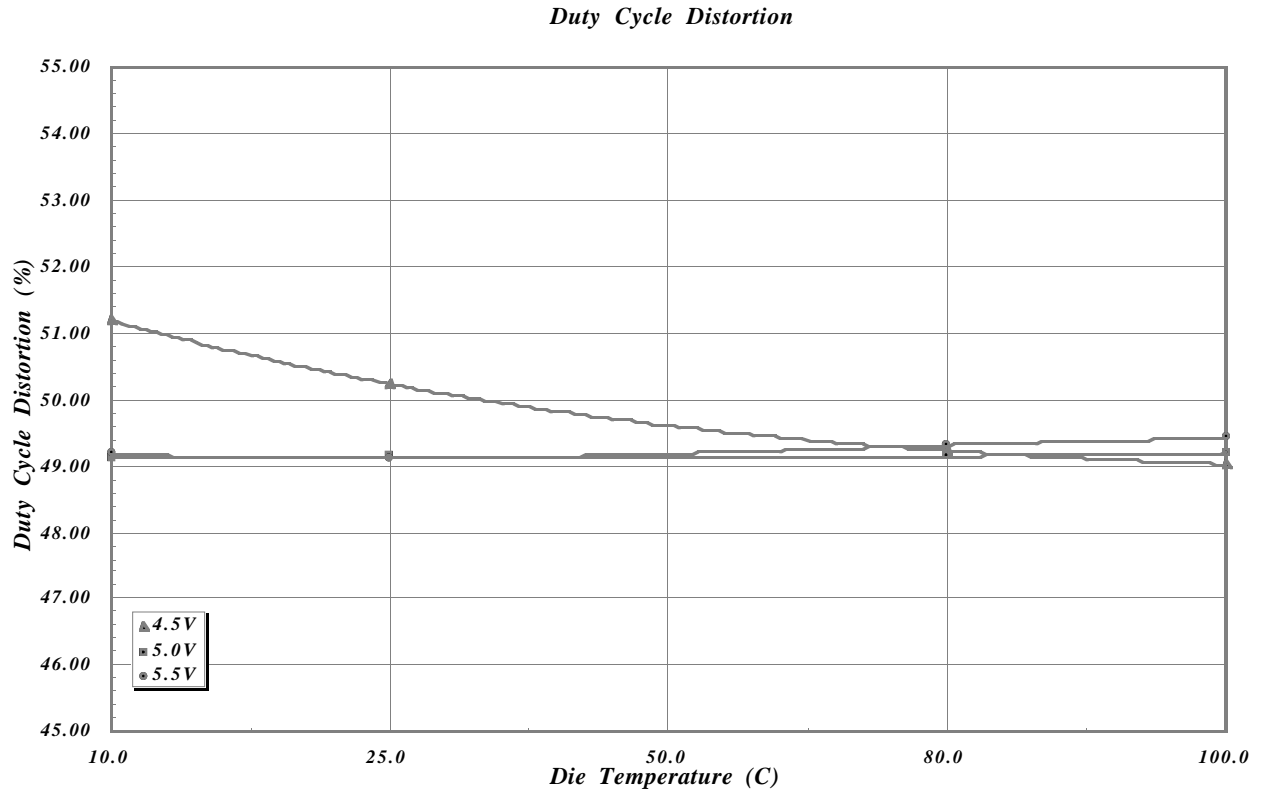


Figure 9: RMS Output Noise Voltage vs. Die Temperature

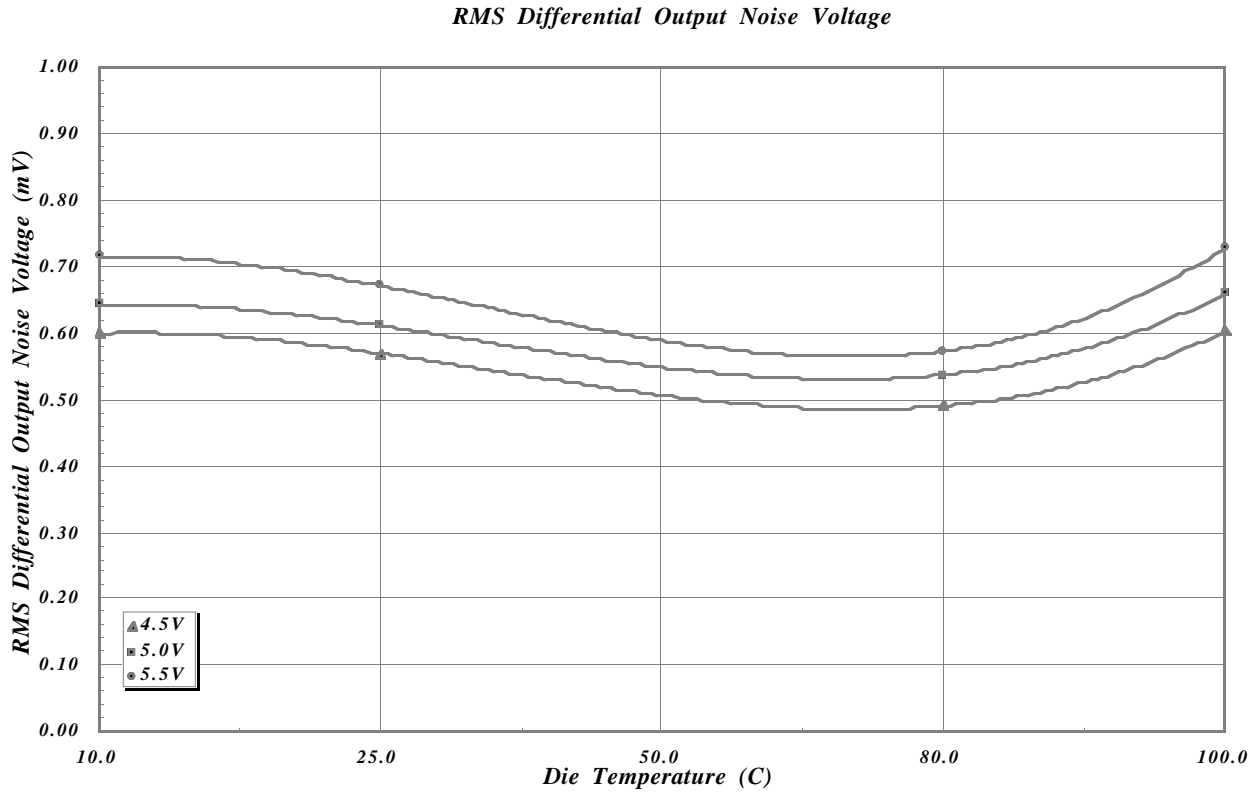
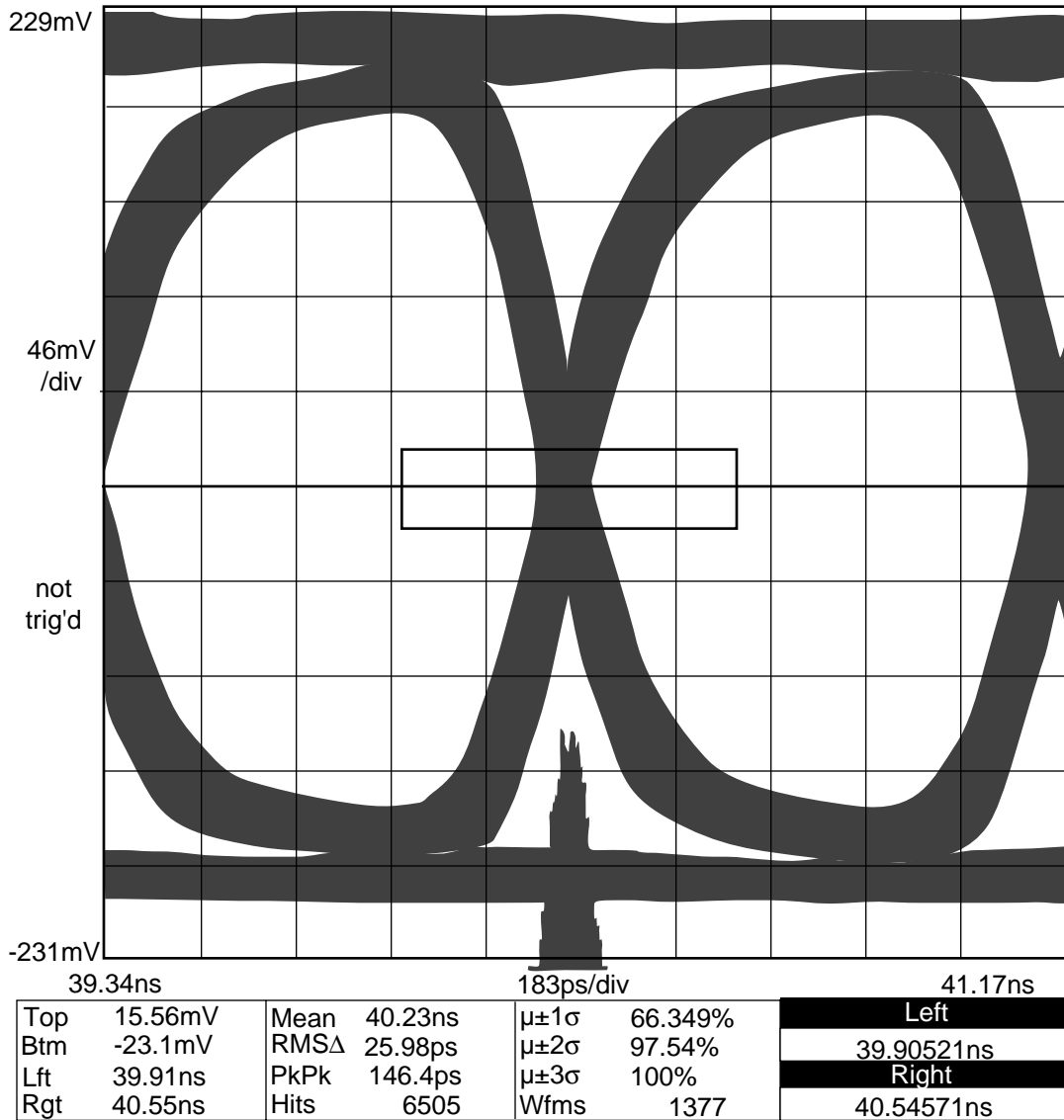
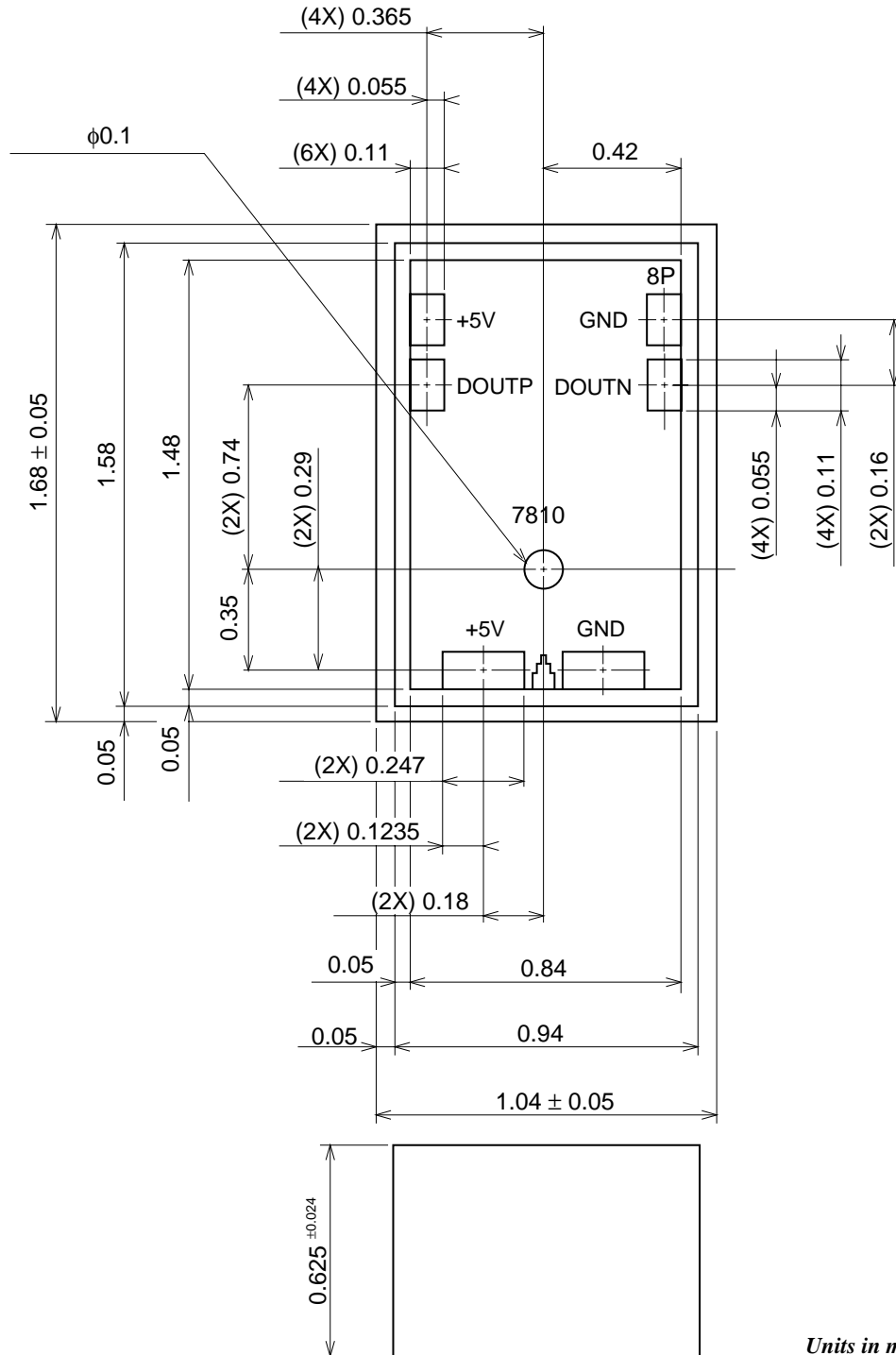


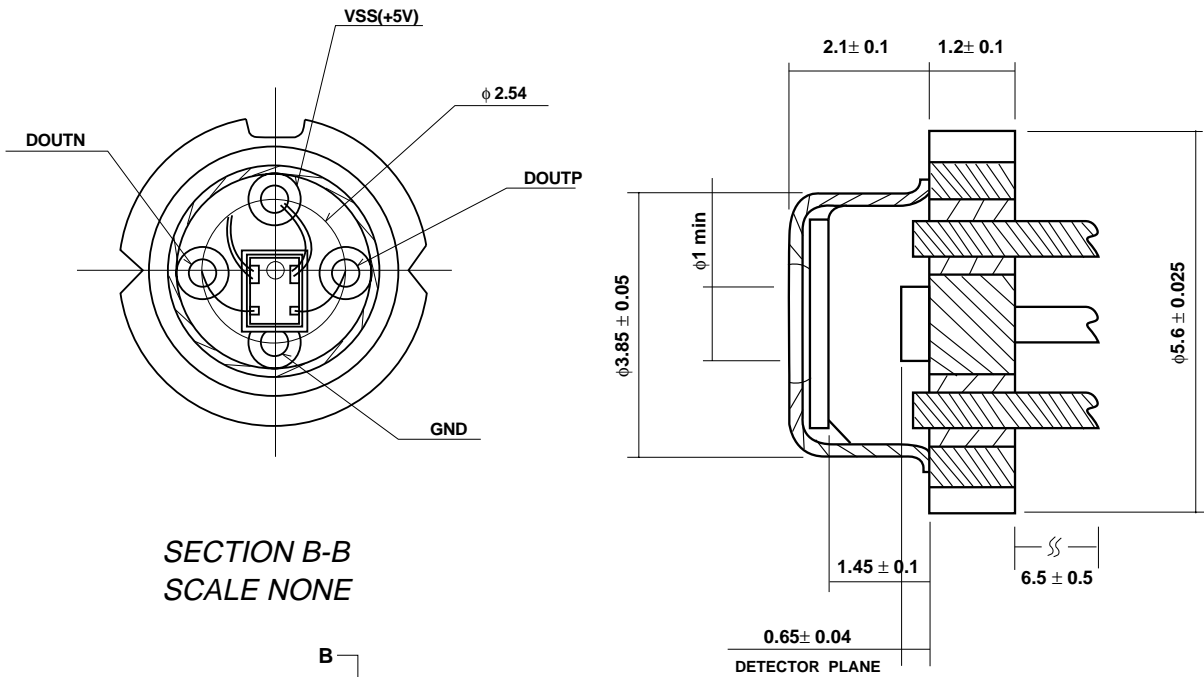
Figure 10: Eye Diagram



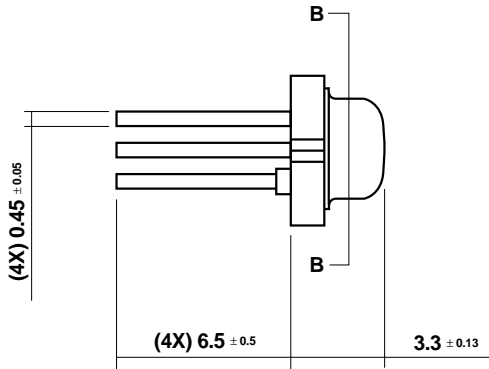
**Figure 11: Mechanical Specifications (Individual Die)**



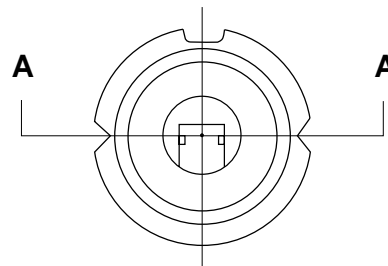
**Figure 12: Mechanical Package Specifications (5.6 mm Package)**



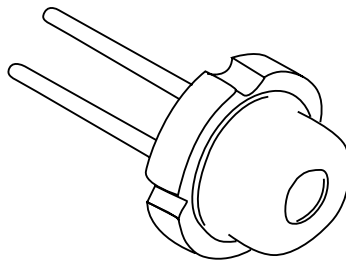
SECTION B-B  
SCALE NONE



SECTION A-A  
ROTATED CCW 90°  
SCALE NONE



REFERENCE ISOMETRIC  
SCALE NONE

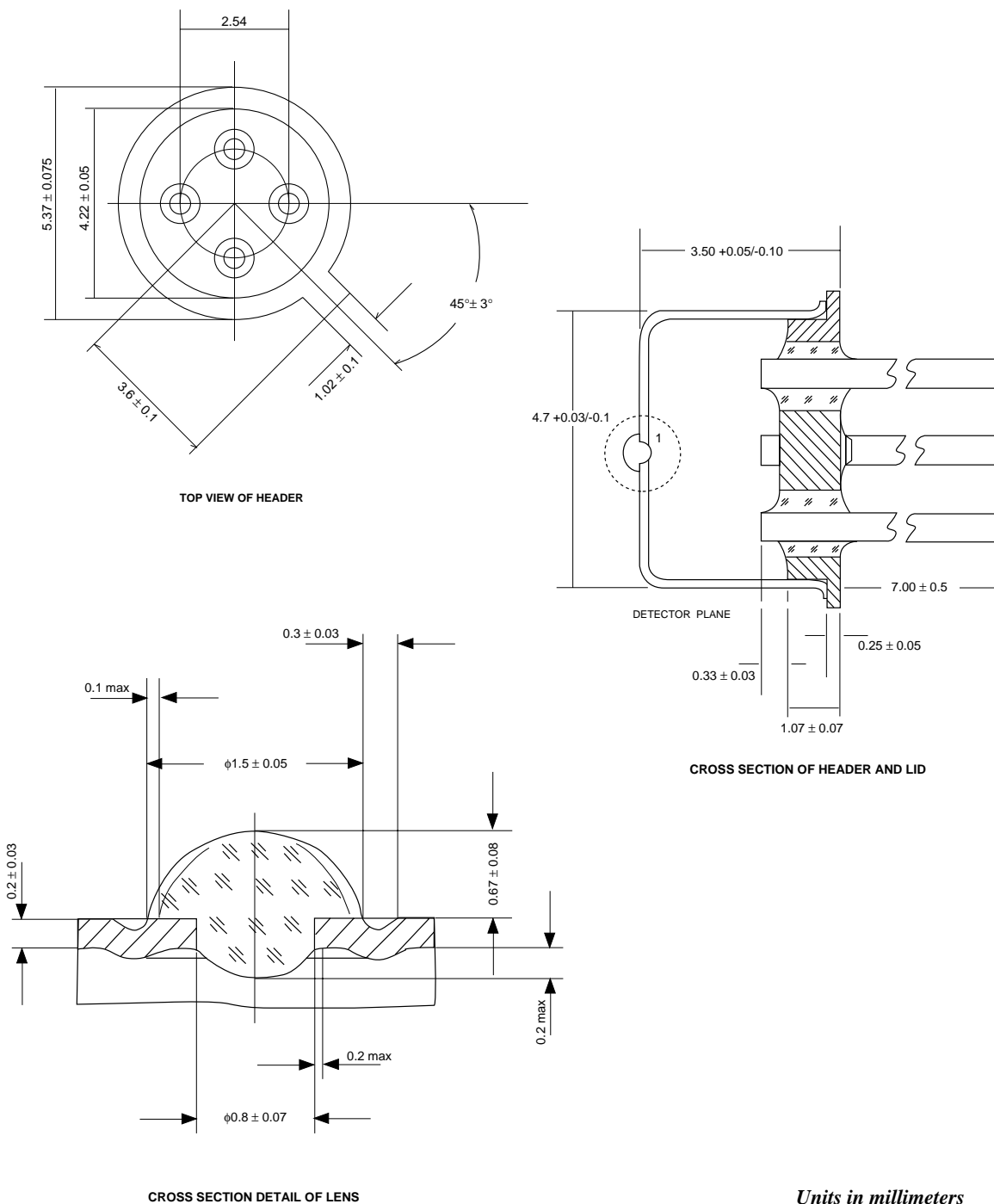


Note: All measurements in mm  
Refer to Figure 1 for pin assignments

**Data Sheet**  
**VSC7810**

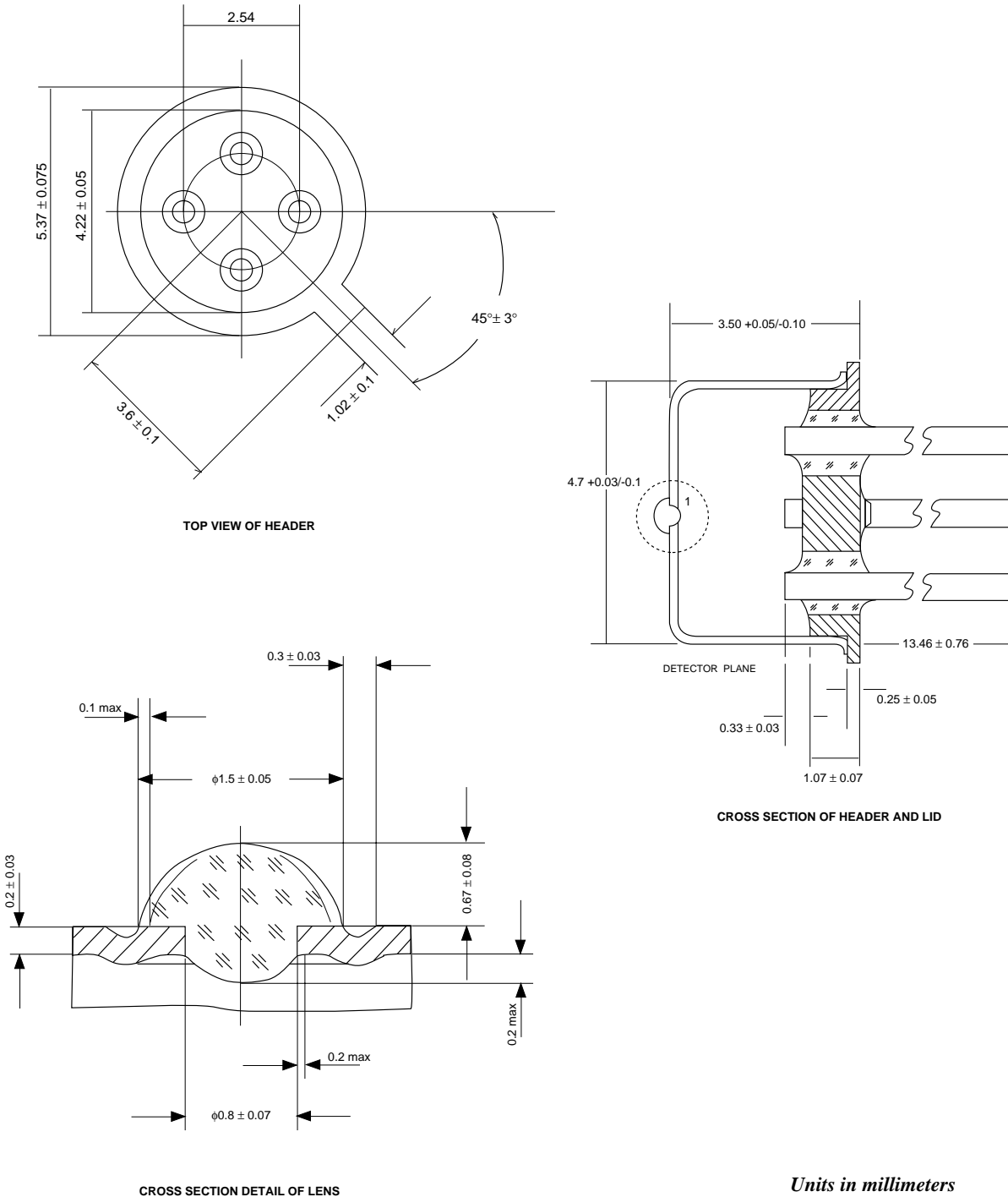
*Photodetector/Transimpedance Amplifier  
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**Figure 13: Mechanical Package Specifications (TO-46 Ball Lens Package with 7mm lead length)**



*Units in millimeters*

**Figure 14: Mechanical Package Specifications (TO-46 Ball Lens Package with 13 mm lead length)**





**Ordering Information**

Part Numbering Scheme:

**VSC78XXYY**

XX = Speed Grade

10                    1.0625 Gbit/sec

YY = Package Style

X                    Individual Die

WB                  5.6mm Package

WC                  TO-46 Package with Ball Lens and 7mm lead length

WD                  TO-46 Package with Ball Lens and 13mm lead length

## Notes on Measurement Conditions & Applications

### Note 1: Extended Temperature Range Operation

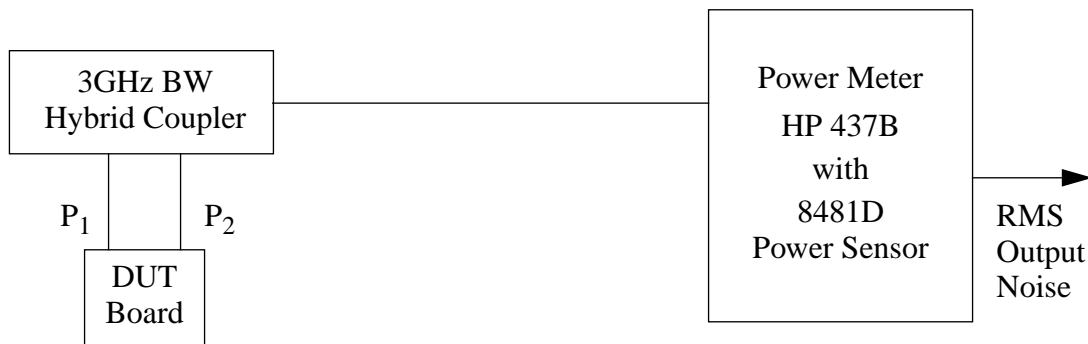
The VSC7810 is specified to operate in two ranges of temperature as follows: (a) “Normal” from 0°C (ambient) to 70°C (case) and (b) “Extended” from 0°C (ambient) to 90°C (case). In the extended range the operating parameters are specified as shown below:

**Table 6: Specifications Under Extended Temperature Range of Operation**

Symbol	Parameter	Min	Typ.	Max	Units	Conditions
BW	Optical Modulation Bandwidth	800	900	—	MHz	-3dB, P = -15dBm @ 50MHz

Note: All other operating parameters are as specified in Table 1.

### Note 2: Noise Measurement Method



The noise voltage, ( $V_n$ ), is calculated from the Output Noise Power, ( $P_n$ ), into 50 ohm.

$$V_n = \sqrt{P_n \cdot 50}$$

The noise voltage,  $V_n$ , at the output is referred back to the noise power at the input through the responsivity  $R$  (with  $R$  in volts/watts)

$$NEP = \frac{V_n}{R}$$

**Data Sheet**  
**VSC7810**

*Photodetector/Transimpedance Amplifier*  
*Family for Optical Communication*

The bit error rate can be expressed as

$$BER = \frac{\exp(-Q^2/2)}{\sqrt{2\pi}Q} .$$

Where:

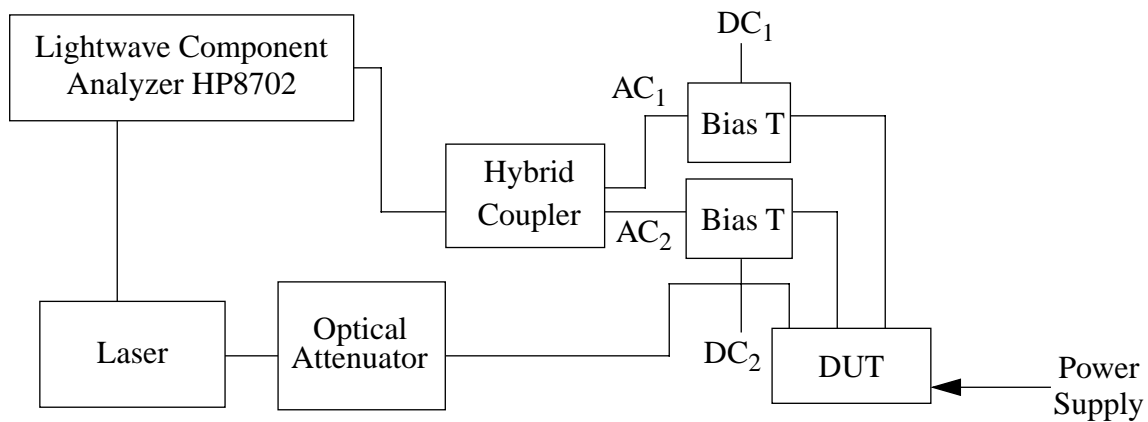
For a  $BER = 1 \times 10^{-12}$  the parameter  $Q = 7$ .

The sensitivity(s) at a bit error rate of  $1 \times 10^{-12}$  is calculated as follows:

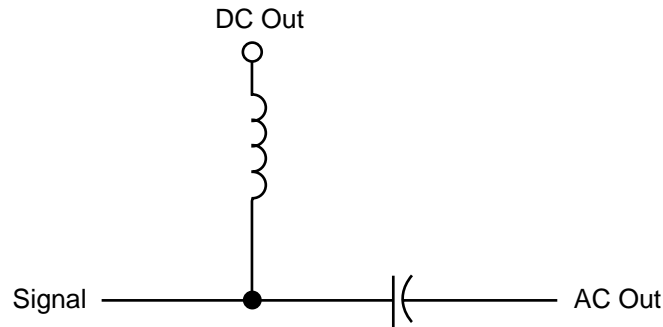
$$S = 10 \log_{10} \left( Q \frac{NEP}{1mW} \right) ,$$

where the NEP is in units of milliwatts and S is in dBm, respectively.

**Note 3: Measurement Setup for Frequency Response**



**Note 4: Bias T Schematic**



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