VSC7810
Data Sheet

Photodetector/Transimpedance Amplifier for Optical Communication

FEATURES

- Integrated Photodetector/Transimpedance Amplifier Optimized for High-Speed Optical Communications Applications
- Integrated AGC
- Fibre Channel/Gigabit Ethernet-Compatible
- High Bandwidth: 1200MHz Typ
- Low Input Noise Equivalent Power: 0.45µWrms
- 100µm Optically Active Area
- Single +5V Power Supply
- Temperature Range: 0°C to +90°C (case)
- 1.25Gb/s Data Rate
- Packages: TO-46, TO-56, Bare Die

APPLICATIONS

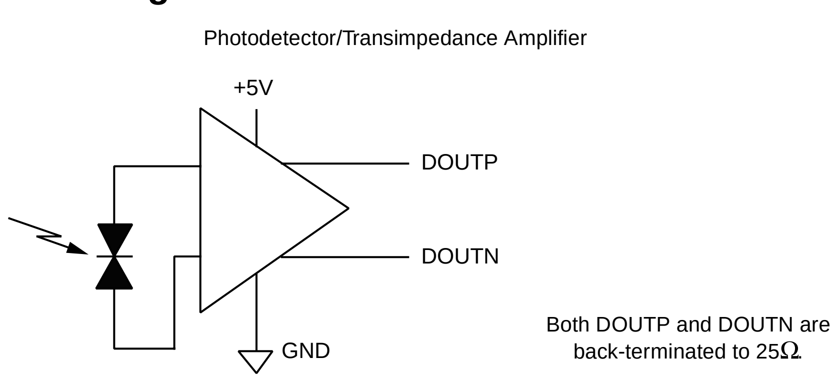
- Gigabit Ethernet Optical Receivers
- Fibre Channel Optical Receivers
- ATM Optical Receivers
- System Interconnect

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. The VSC7810 can easily be used in developing Fibre Channel Electro-Optic Receivers which exhibit very high performance and ease of use.

VSC7810 Block Diagram



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SPECIFICATIONS

Typical conditions of +25°C.

Table 1. DC Characteristics—0°C Ambient to +90°C Case, 3.3V Power Supply

Symbol	Parameter	Min	Typ	Max	Unit	Condition
V_{DD}	Supply Voltage	4.5	5.0	5.5	V	
I_{DD}	Supply Current	13	26	40	mA	
PSRR	Power Supply Rejection Ratio	35	-	-	dB	Frequencies up to 40MHz. Use external filter to get PSRR of -35dB.
λ	Wavelength	700	840	850	nm	
F_c	Low Frequency Cutoff	-	-	1.8	MHz	-3dB, P[1] = -15dBm at 50MHz
BW	Optical Modulation Bandwidth: **Normal Range: 0°C ambient to +70°C case**	800	1200	1300	MHz	-3dB, P = -15dBm at 50MHz
	Extended Range: 0°C ambient to +90°C case	800	900		MHz	
S	Sensitivity	-22	-25	-27	dBm	1.25Gb/s, $BER10^{-12}$
R_o	Single-Ended Output Impedance	25	-	60	Ω	
V_D	Differential Output Voltage	0.35	0.52	0.65	V	P = -4.5 dBm, R_L= 100Ω differential
R_D	Differential Responsivity	0.8	2.2	-	mV/µW	R_L = 100Ω P = -15dBm at 50MHz
V_{DC}	Output Bias Voltage	1.0	1.5	2.5	V	
ΔV_{DC}	Bias Offset Voltage	-	40	200	mV	
NEP_O	Input Noise Equivalent Power	0.35	0.45	0.93	µW rms	P = 0mW
V_{NO}	Output Noise Voltage	0.55	0.66	0.75	mV rms	P = 0mW
DCD	Duty Cycle Distortion	-	1.5	4.5	%	P = -4.5dBm
I_{OUT}	Output Drive Current	2.5	-	8	mA	P = -4.5dBm
PDJ	Pattern Dependent Jitter	20	40	60	ps	P = -4.5dBm +/-10% Voltage Window
	Optically Active Area	-	100	-	µm	Diameter
PPJ	Peak-to-Peak Jitter	120	160	200	ps	P = -5dBm
t_R	Rise Time	310	355	400	ps	20% to 80% P = -4.5dBm
t_F	Fall Time	280	325	3470	ps	20% to 80% P = -4.5dBm

1. P = Incident Optical Power.

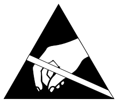
Table 2. Recommended Operating Conditions

Symbol	Parameter	Min	Typ	Max	Unit	Condition
V_{DD}	Power Supply Voltage	4.5	5.0	5.5	V	
P_{MAX}	Optical Power			0	dBm	
T_A	Operating Temperature	0 Case		+90 Ambient	°C	

Table 3. Absolute Maximum Ratings

Symbol	Parameter	Min	Typ	Max	Unit	Condition
V_{DD}	Power Supply Voltage			6	V	
H_{STG}	Storage Humidity (relative humidity including condensation	5		95	%	
H_{OP}	Operating Humidity (relative humidity excluding condensation)	8		80	%	
	Incident Optical Power			+3	dBm	
T_S	Storage Temperature(case temperature under bias)	-55		+125	°C	
V_{ESD}	ESD Voltage (HBM)			500	V	

Stresses listed under Absolute Maximum Ratings may be applied to devices one at a time without causing permanent damage. Functionality at or above the values listed is not implied. Exposure to these values for extended periods may affect device reliability.



ELECTROSTATIC DISCHARGE

This device can be damaged by ESD. Vitesse recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures may adversely affect reliabiility of the device.

Frequency response of VSC7810 upper 3dB frequency is measured with respect to response at 50MHz

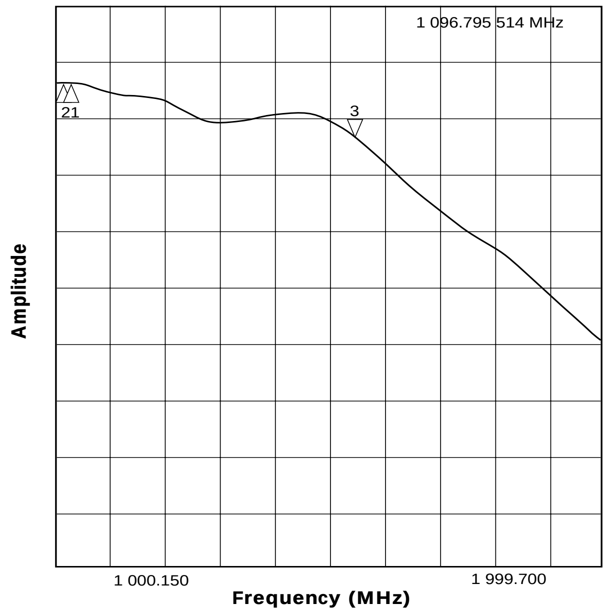
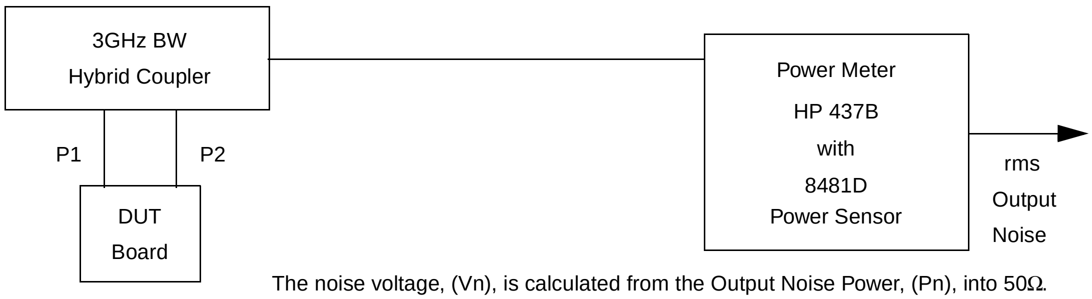


Figure 1. Amplitude vs. Frequency

NOTES ON MEASUREMENT CONDITIONS AND APPLICATIONS

Note 1: Noise Measurement Method



The noise voltage, (Vn), is calculated from the Output Noise Power, (Pn), into 50Ω.

$$Vn = \sqrt{Pn \bullet 50}$$

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

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

The bit error rate can be expressed as:

$$BER = \frac{e^{(-Q_2/2)}}{\sqrt{2\pi Q}} \quad .$$

where,

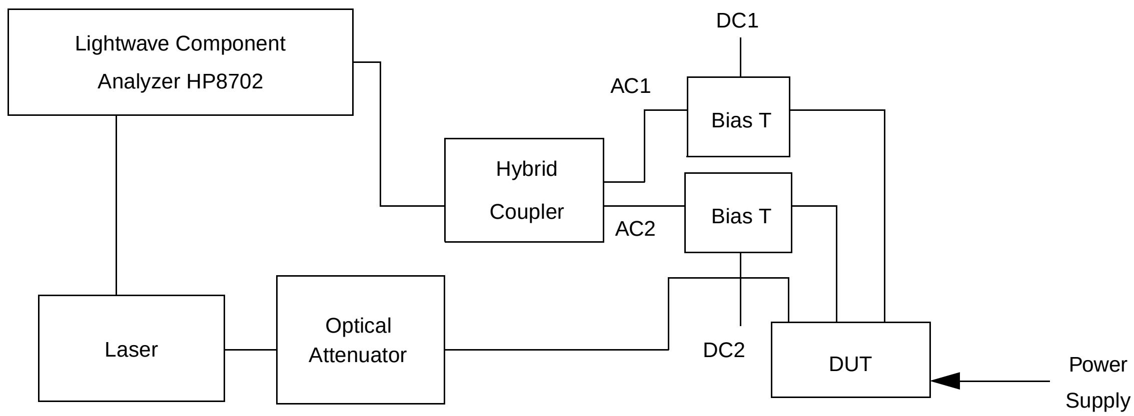
For a $BER = 1 \times 10^{-12}$, the parameter Q = 7.

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

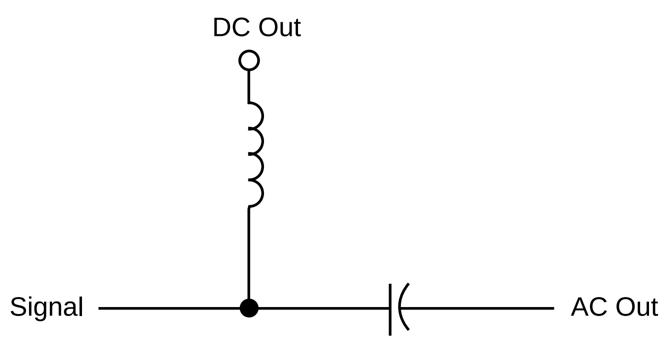
$$S = 10 \log_{10} \left(Q \frac{NEP}{1mW} \right) ,$$

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

Note 2: Measurement Setup for Frequency Response

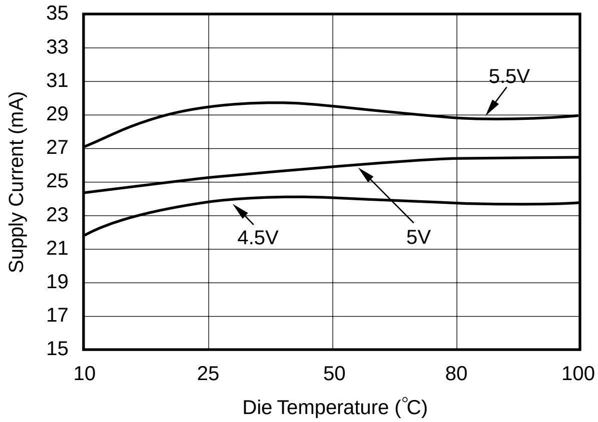


Note 3: Bias T Schematic

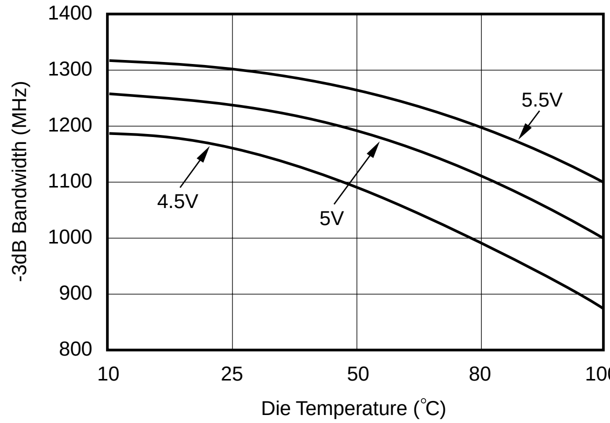


TYPICAL OPERATING CHARACTERISTICS

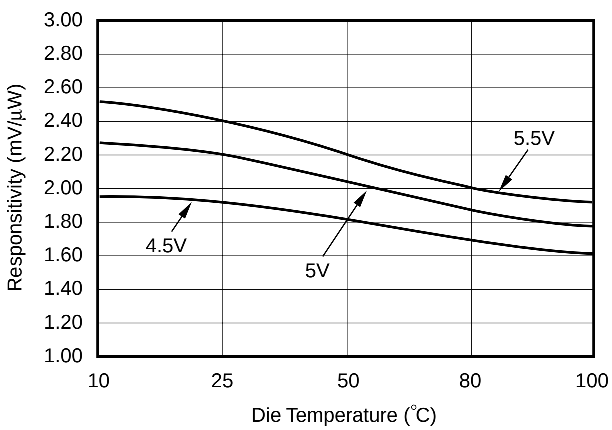
I_{DD} vs. Die Temperature



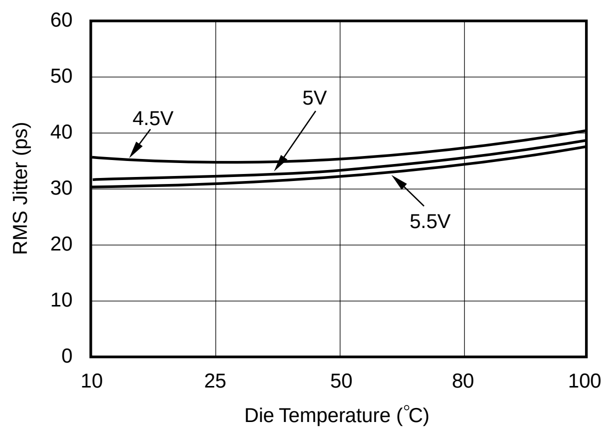
Bandwidth vs. Die Temperature



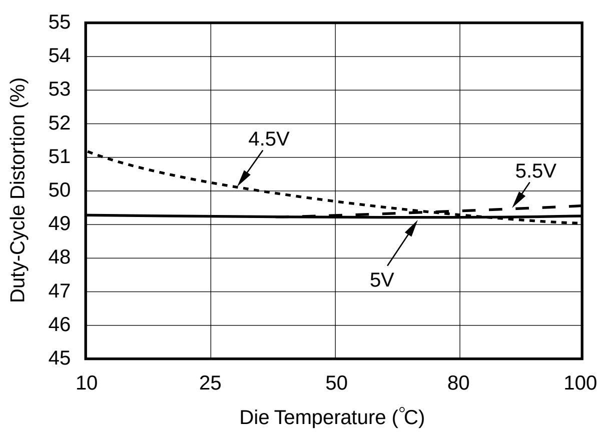
Responsivity vs. Die Temperature
(Small-Signal Optical Responsitivity at 850nm)



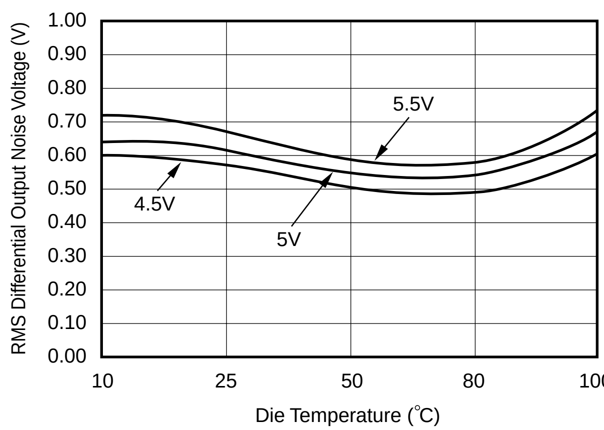
RMS Jitter with PRBS[7] Data vs. Die Temperature



Duty-Cycle Distortion vs. Die Temperature



RMS Differential Output Noise Voltage
vs. Die Temperature



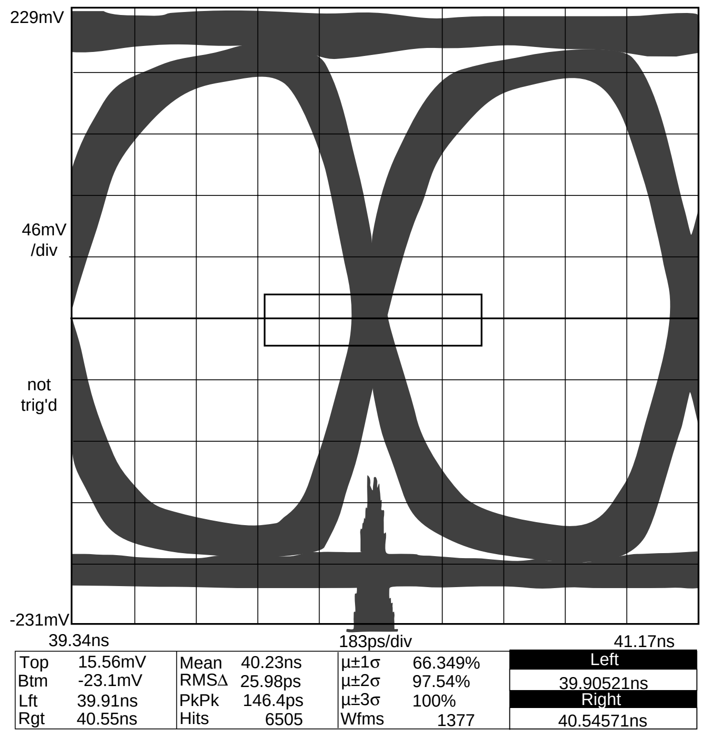
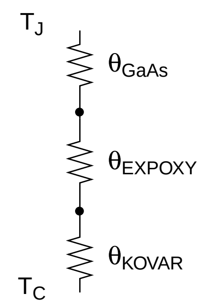


Figure 2. Data Eye Diagram

TEMPERATURE DEPENDENCE OF OPERATING PARAMETERS

This section describes the dependence of important operating parameters shown in Table 4 as a function of *die* (or equivalently junction) tempeature 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 4: Thermal Resistance Calculation for TO-56 and TO-46 Packages

Parameter	Value	Equivalent Circuit
Chip Size	0.168cm x 0.104cm	Thermal Path 
Chip Area A	0.015cm^2	
Die Height (T_{DIE})	0.066cm	
Epoxy Thickness (T_{EPOXY})	0.0076cm	
Header Thickness (T_{HEADER}) (Average for TO-46 and TO-56 package)	0.115cm	
Thermal Conductivities		
K GaAs	0.55W/cm °C	
K epoxy	0.0186W/cm °C	
K kovar	0.17W/cm °C	

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

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

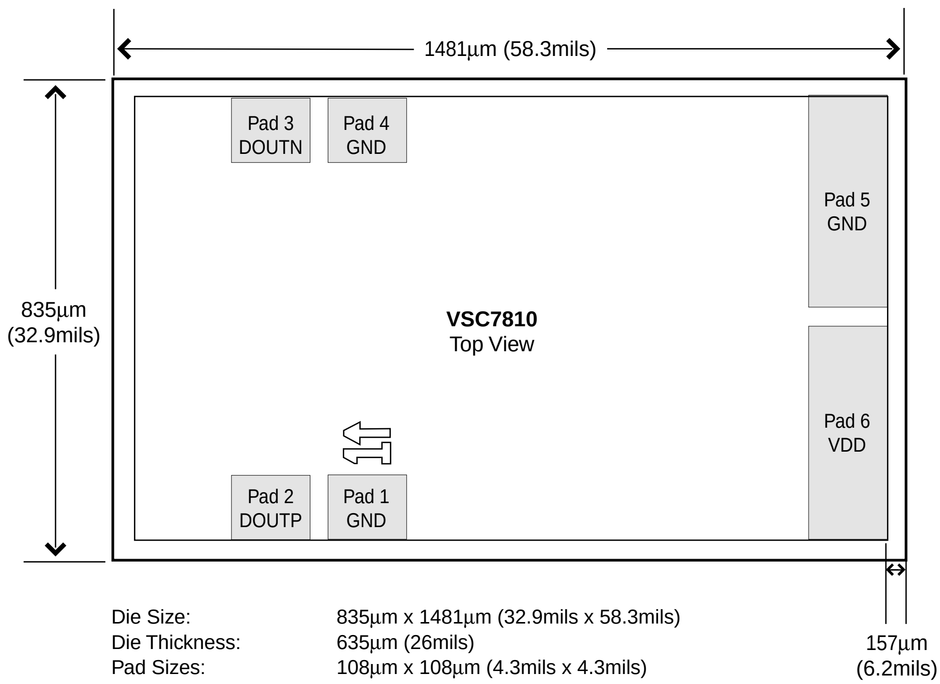
$$\theta_{kovar} = \frac{T_{kovar}}{K_{kovar}A} = \frac{0.12}{0.17 \times 0.015} = 47\ °C/W$$

θ_{JC} = Thermal Resistance from Junction to Case = (8 + 27.24 + 47) = 82.24 °C/W

Example:

For VSC7810 at nominal supply current of 25mA and Vss = 5V
Temperature rise from junction to case = 0.025A x 5V x 82.24 °C/W = 10.28 °C

Bare Die and Package Information



Die Size: 835µm x 1481µm (32.9mils x 58.3mils)
Die Thickness: 635µm (26mils)
Pad Sizes: 108µm x 108µm (4.3mils x 4.3mils)
244µm x 108µm (9.6mils x 4.3mils)
Pad Passivation Openings: 86µm x 86µm (3.4mils x 3.4mils)
223µm x 86µm (8.8mils x 3.4mils)
Scribe Size: 157µm (6.2mils)

Figure 3. Pad Diagram for Bare Die (-X)

Table 5. Pad Coordinates for Bare Die (-X)

Signal Name	Pad Number	Coordinates (µm)		Description
		X	Y	
GND	1	55	943.6	Ground
DOUTP	2	55	1093.6	Data output, true (with reference to incident light)
DOUTN	3	780	1093.6	Data output, complement (with reference to incident light)
GND	4	780	943.6	Ground
GND	5	596.7	61.4	Ground
VDD	6	244.2	61.4	+5V Power Supply

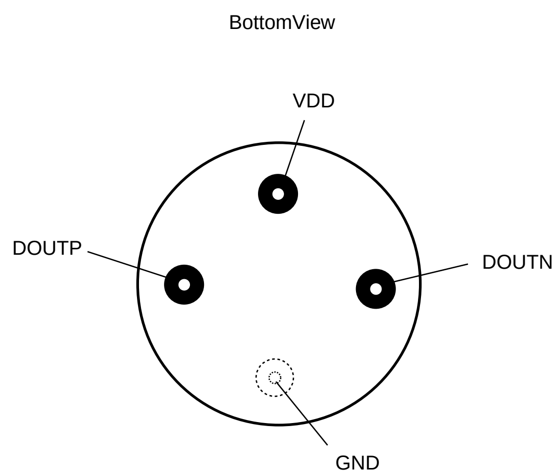


Figure 4. Pin Diagram for TO-46 and TO-56 Packages

Table 6. Pin Identification for TO-46 and TO-56 Packages

Signal Name	Description
DOUTP	Data output, true (with reference to incident light)
DOUTN	Data output, complement (inverting) (with reference to incident light)
VDD	+5V Power supply
GND	Ground (package case)

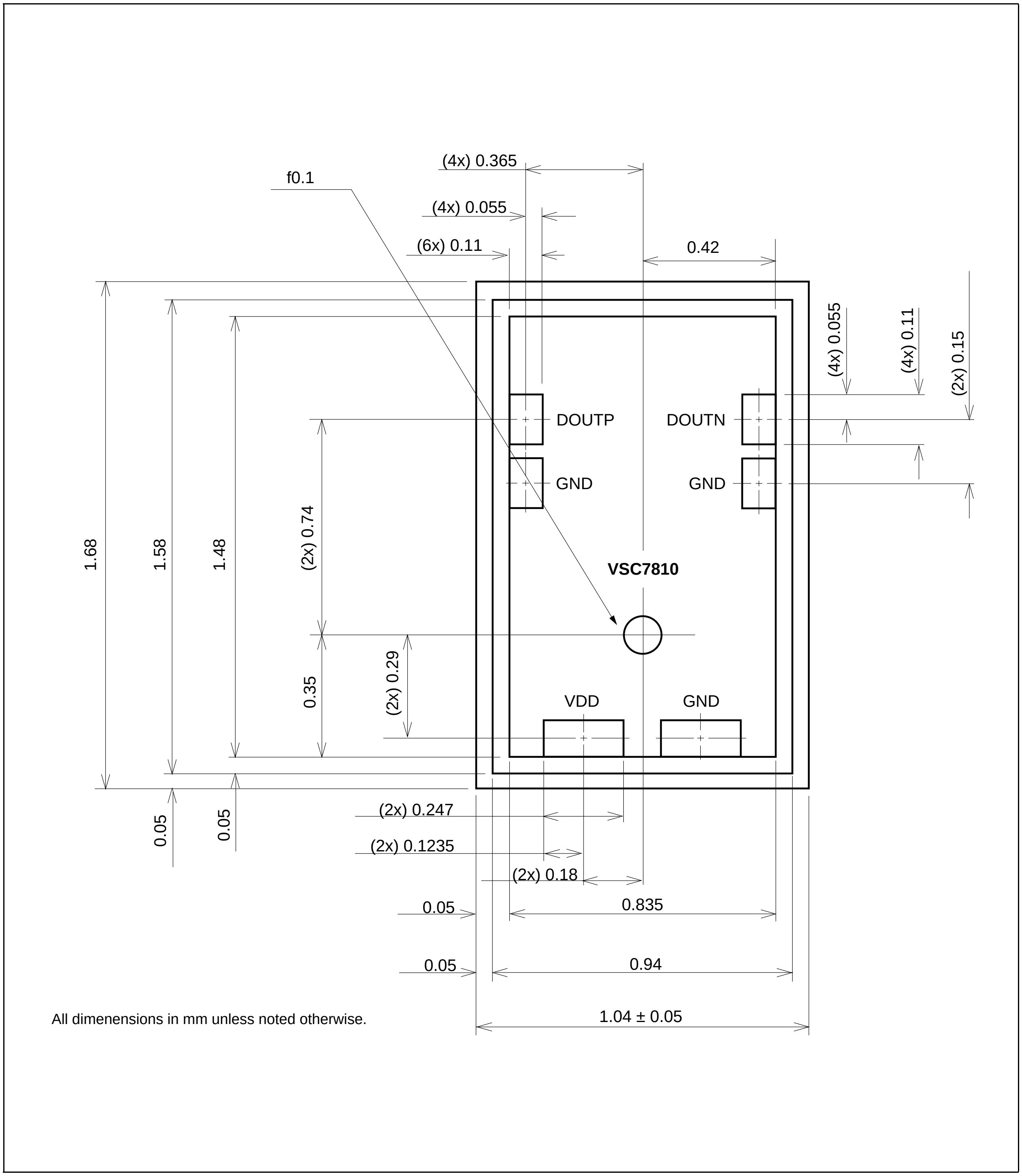


Figure 5. Detailed Pad Dimensions for Bare Die (-X)

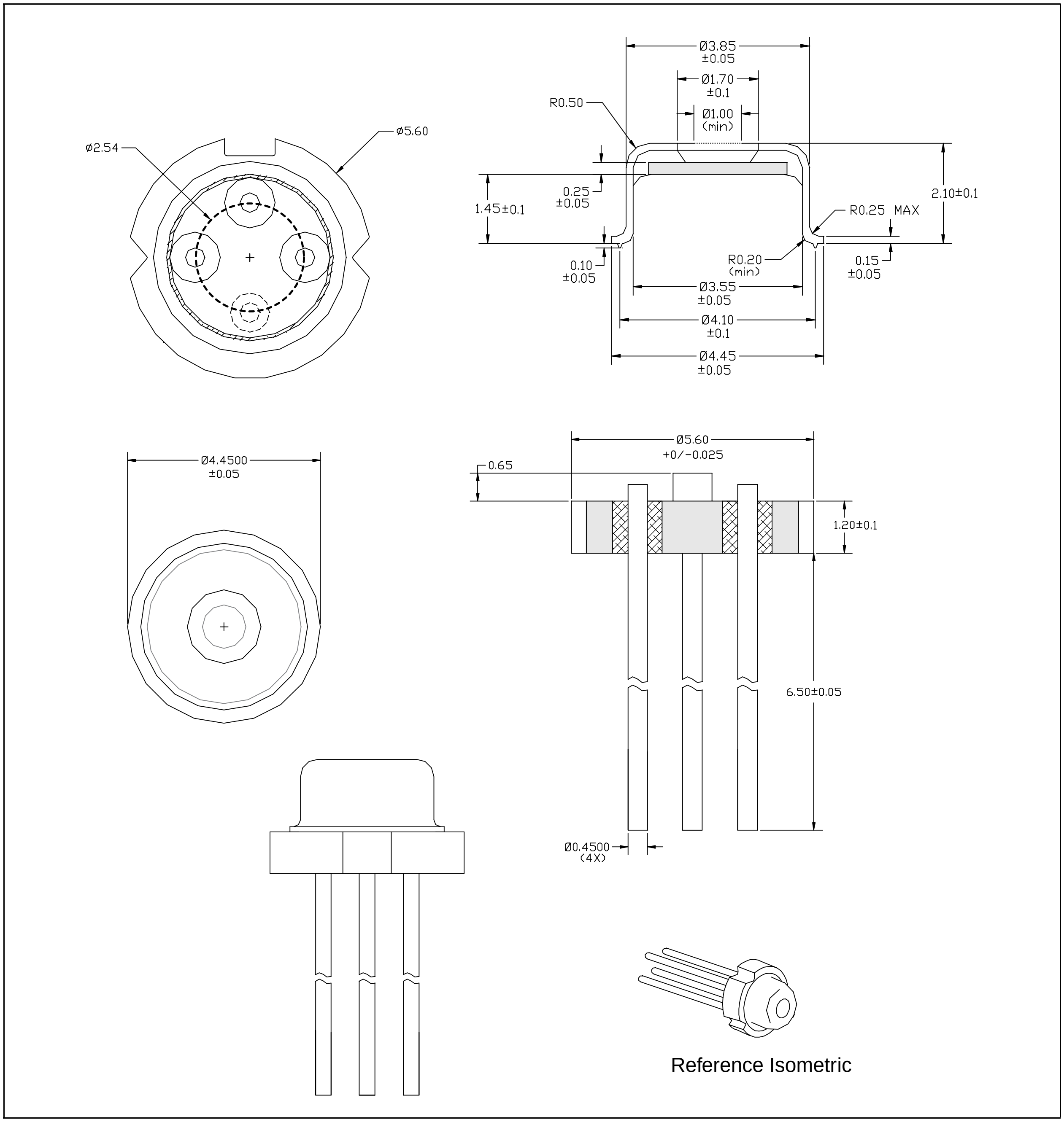


Figure 6. Package Drawing for TO-56 Flat Window (WB)

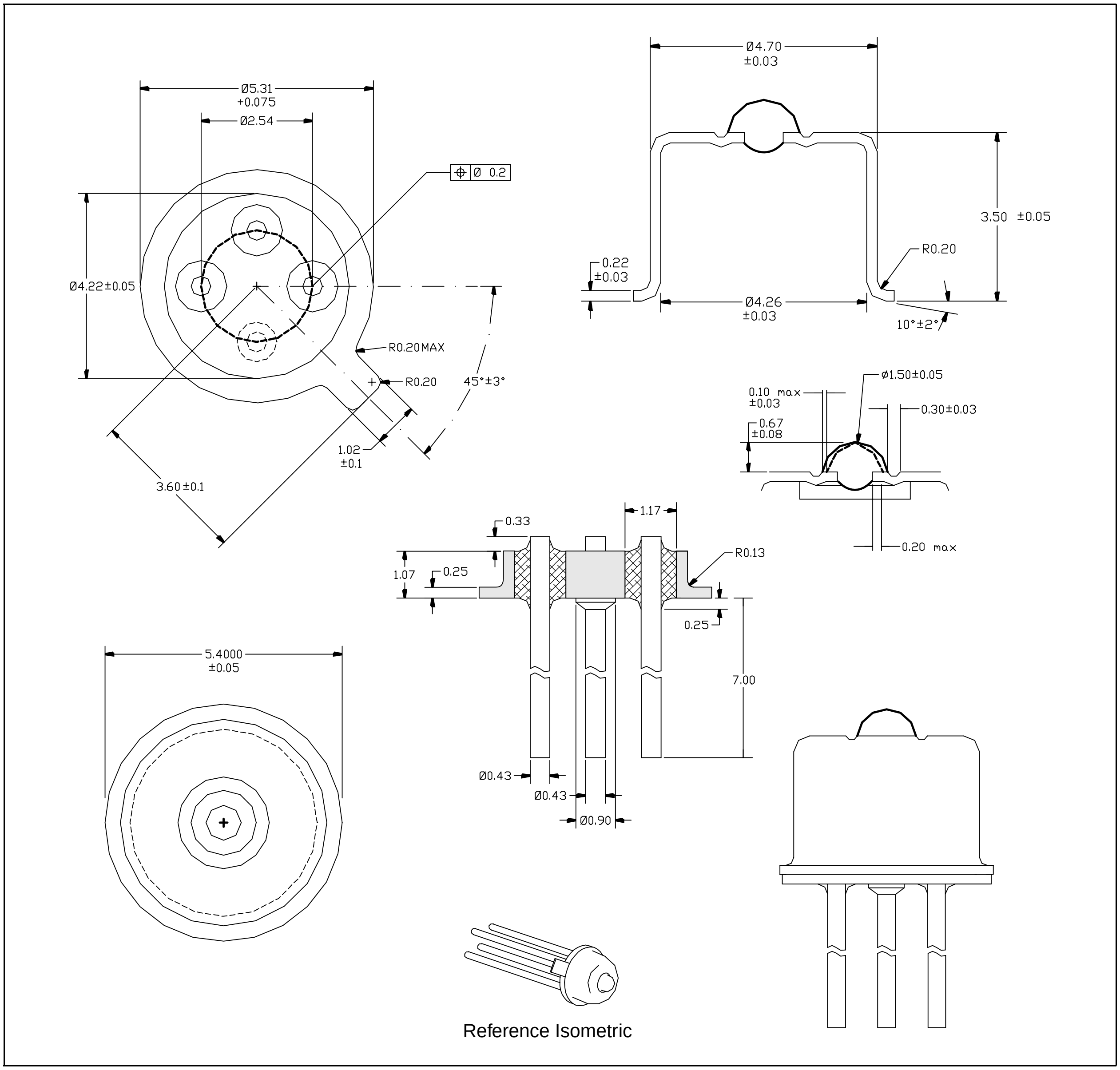


Figure 7. Package Drawing for TO-46 Ball Lens, 7mm Lead Length (WC)

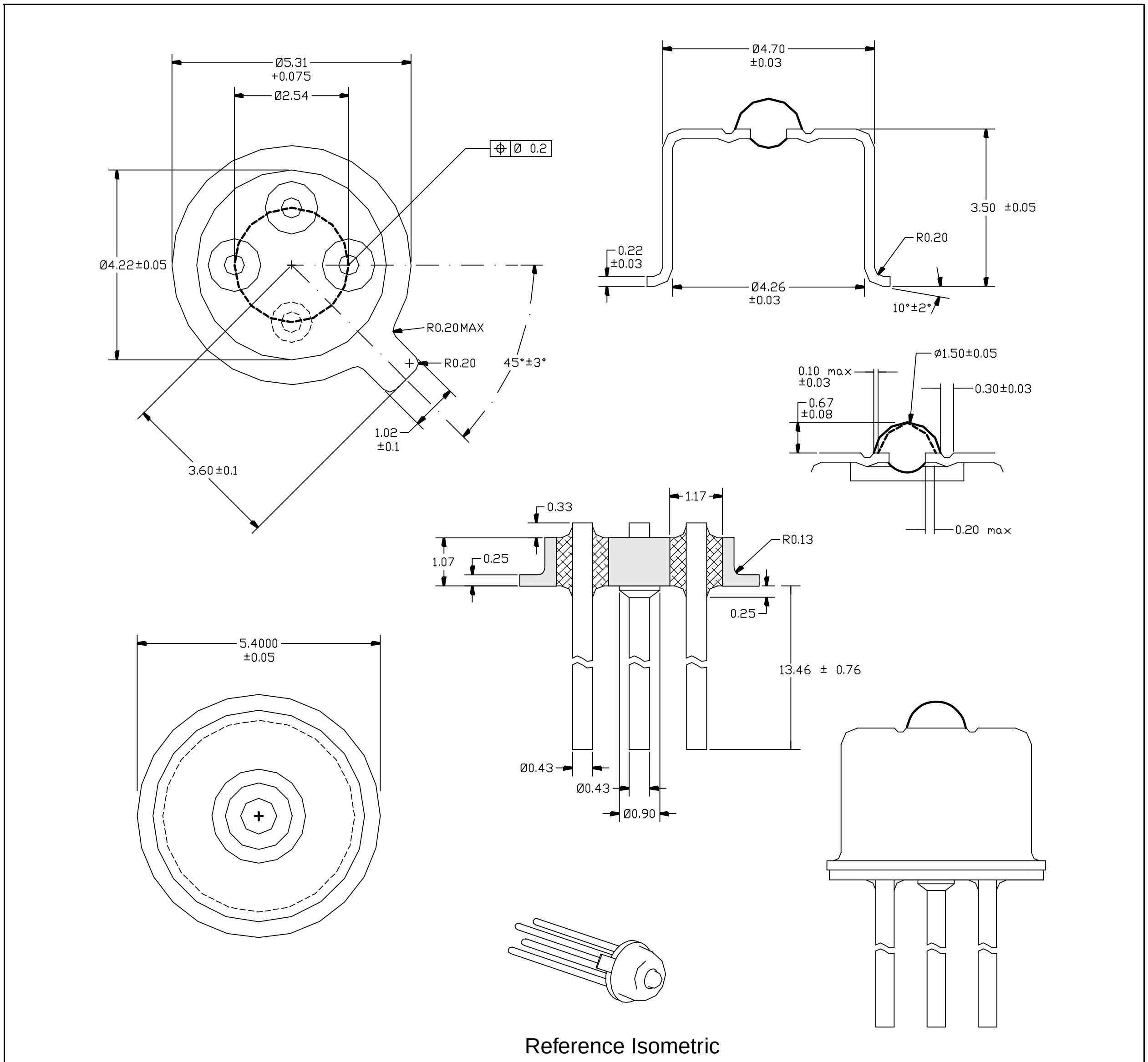


Figure 8. Package Drawing for TO-46 Ball Lens, 3mm Lead Length (WD)

ORDERING INFORMATION

VSC7810 Photodetector/Transimpedance Amplifier

Part Number	Description
VSC7810WB	TO-56 Flat Window
VSC7810WC	TO-46 Ball Lens, 7mm Lead Length
VSC7810WD	TO-46 Ball Lens, 13mm Lead Length
VSC7810-X	Bare Die in Gel Pack

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