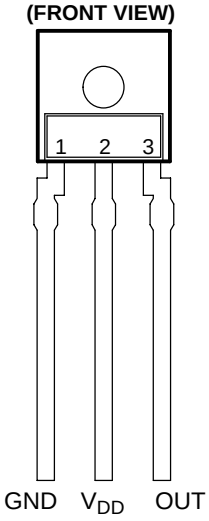
TSLB257, TSLG257, TSLR257 HIGH-SENSITIVITY COLOR LIGHT-TO-VOLTAGE CONVERTERS

TAOS027B – MARCH 2002

- **Converts Light Intensity to Output Voltage**
- **Integral Color Filter in Blue, Green, or Red**
- **Monolithic Silicon IC Containing Photodiode, Operational Amplifier, and Feedback Components**
- **High Sensitivity**
- **Single Voltage Supply Operation**
- **Low Noise (200 μVrms Typ to 1 kHz)**
- **Rail-to-Rail Output**
- **High Power-Supply Rejection (35 dB at 1 kHz)**
- **Compact 3-Leaded Plastic Package**

PACKAGE (FRONT VIEW)

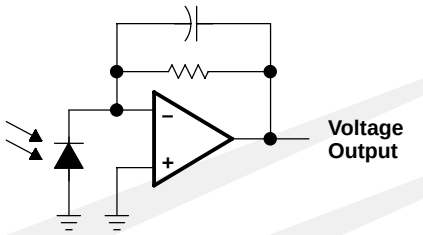


Description

The TSLB257, TSLG257, and TSLR257 are high-sensitivity low-noise light-to-voltage optical converters that incorporate onboard blue, green, and red optical filters, respectively. These devices combine a photodiode and a transimpedance amplifier on a single monolithic CMOS integrated circuit with a color filter over the photodiode. Output voltage is directly proportional to light intensity (irradiance) on the photodiode. Each device has a transimpedance gain of 320 MΩ with improved offset voltage stability and low power consumption, and is supplied in a 3-lead clear plastic sidelooker package with an integral lens.

These devices are ideal for applications such as colorimetry, printing process control, display color correction, and selectively ambient light detection or rejection.

Functional Block Diagram



Terminal Functions

TERMINAL NAME	TERMINAL NO.	DESCRIPTION
GND	1	Ground (substrate). All voltages are referenced to GND.
OUT	3	Output voltage
V_{DD}	2	Supply voltage

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Absolute Maximum Ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, V_{DD} (see Note 1) . . . . . 6 V
Output current, I_O . . . . . ±10 mA
Duration of short-circuit current at (or below) 25°C . . . . . 5 s
Operating free-air temperature range, T_A . . . . . –25°C to 85°C
Storage temperature range, T_{stg} . . . . . –25°C to 85°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds . . . . . 240°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: All voltages are with respect to GND.

Recommended Operating Conditions

	MIN	MAX	UNIT
Supply voltage, V_{DD}	2.7	5.5	V
Operating free-air temperature, T_A	0	70	°C

Electrical Characteristics at V_{DD} = 5 V, T_A = 25°C, R_L = 10 kΩ (unless otherwise noted) (see Notes 2 and 3)

PARAMETER		TEST CONDITIONS	TSLB257			TSLG257			TSLR257			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_D	Dark voltage	E_e = 0	0		15	0		15	0		15	mV
V_{OM}	Maximum output voltage swing	V_{DD} = 4.5 V, No Load		4.49			4.49			4.49		V
		V_{DD} = 4.5 V, R_L = 10 kΩ	4	4.2		4	4.2		4	4.2		
V_O	Output voltage	E_e = 1.7 μW/cm², λ_p = 470 nm, Note 4	1.3	2	2.7							V
		E_e = 1.6 μW/cm², λ_p = 524 nm, Note 5				1.3	2	2.7				
		E_e = 1.1 μW/cm², λ_p = 635 nm, Note 6							1.3	2	2.7	
α_{VD}	Temperature coefficient of dark voltage (V_D)	T_A = 0°C to 70°C		–15			–15			–15		μV/°C
R_e	Irradiance responsivity	λ_p = 470 nm, see Notes 4 and 7		1.18			0.35			0.09		V/(μW/cm²)
		λ_p = 524 nm, see Notes 5 and 7		0.53			1.25			0.14		
		λ_p =565 nm, see Notes 7 and 8		0.09			1.17			0.36		
		λ_p = 635 nm, see Notes 6 and 7		0.05			0.14			1.82		
R_V	Illuminance responsivity	λ_p = 470 nm, see Notes 4 and 7		1.57			0.47			0.12		V/lx
		λ_p = 524 nm, see Notes 5 and 7		0.10			0.24			0.027		
		λ_p = 565 nm, see Notes 7 and 8		0.015			0.20			0.06		
		λ_p = 635 nm, see Notes 6 and 7		0.033			0.093			1.21		
PSRR	Power supply rejection ratio	f_{ac} = 100 Hz, see Note 10		55			55			55		dB
		f_{ac} = 1 kHz, see Note 10		35			35			35		
I_{DD}	Supply current	V_O = 2 V (typical)		1.9	3.5		1.9	3.5		1.9	3.5	mA

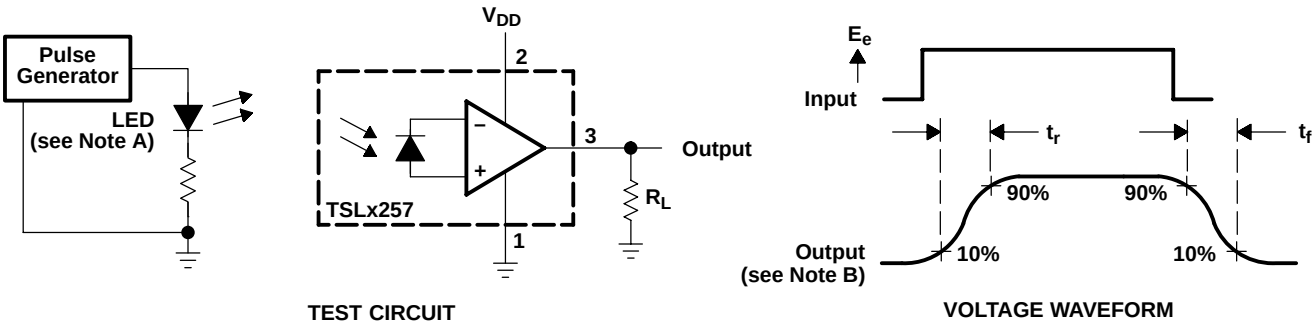
NOTES:
2. Measured with R_L = 10 kΩ between output and ground.
3. Optical measurements are made using small-angle incident radiation from a light-emitting diode (LED) optical source.
4. The input irradiance is supplied by an InGaN light-emitting diode with the following characteristics: peak wavelength λ_p = 470 nm, spectral halfwidth $\Delta\lambda$½ = 35 nm, luminous efficacy = 75 lm/W.
5. The input irradiance is supplied by an InGaN light-emitting diode with the following characteristics: peak wavelength λ_p = 524 nm, spectral halfwidth $\Delta\lambda$½ = 47 nm, luminous efficacy = 520 lm/W.
6. The input irradiance is supplied by an AlInGaP light-emitting diode with the following characteristics: peak wavelength λ_p = 635 nm, spectral halfwidth $\Delta\lambda$½ = 17 nm, luminous efficacy = 150 lm/W.
7. Responsivity is characterized over the range V_O = 0.1 V to 4.5 V. The best-fit straight line of Output Voltage V_O versus Irradiance E_e over this range will typically have a positive extrapolated V_O value for E_e = 0.
8. The input irradiance is supplied by a GaP light-emitting diode with the following characteristics: peak wavelength λ_p = 565 nm, spectral halfwidth $\Delta\lambda$½ = 28 nm, luminous efficacy = 595 lm/W.
9. Illuminance responsivity R_V is calculated from the irradiance responsivity by using the LED luminous efficacy values stated in Notes 4, 5, 6, and 8, and using 1 lx = 1 lm/m².
10. Power supply rejection ratio PSRR is defined as 20 log ($\Delta V_{DD}(f)/\Delta V_O(f)$) with $V_{DD}(f = 0)$ = 5 V and $V_O(f = 0)$ = 2 V.

Switching Characteristics at V_{DD} = 5 V, T_A = 25°C, R_L = 10 kΩ (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
t_r	Output pulse rise time, 10% to 90% of final value	See Note 11 and Figure 1			160	250	µs
t_f	Output pulse fall time, 10% to 90% of final value	See Note 11 and Figure 1			150	250	µs
t_s	Output settling time to 1% of final value	See Note 11 and Figure 1			330		µs
	Integrated noise voltage	f = dc to 1 kHz	E_e = 0		200		µVrms
V_n	Output noise voltage, rms	f = 10 Hz	E_e = 0		6		µV/√Hz rms
		f = 100 Hz	E_e = 0		6		
		f = 1 kHz	E_e = 0		7		

NOTE 11: Switching characteristics apply over the range V_O = 0.1 V to 4.5 V.

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT VOLTAGE WAVEFORM

NOTES: A. The input irradiance is supplied by a pulsed light-emitting diode with the following characteristics: t_r < 1 µs, t_f < 1 µs.
B. The output waveform is monitored on an oscilloscope with the following characteristics: t_r < 100 ns, Z_i ≥ 1 MΩ, C_i ≤ 20 pF.

Figure 1. Switching Times

TYPICAL CHARACTERISTICS

PHOTODIODE SPECTRAL RESPONSIVITY

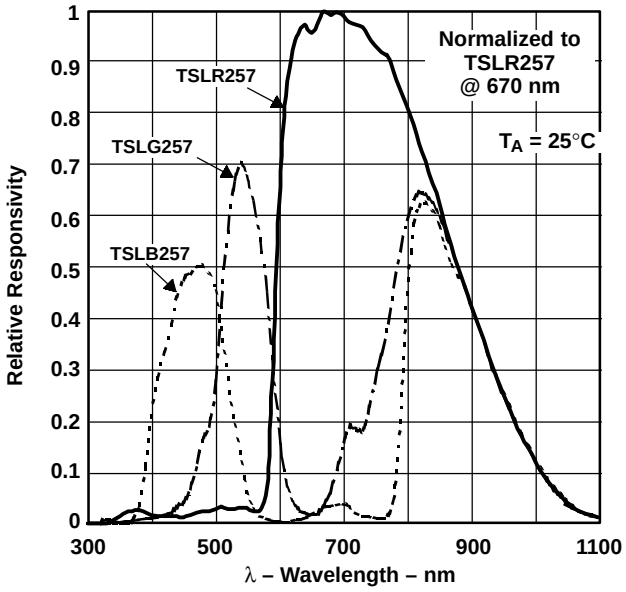


Figure 2

PHOTODIODE SPECTRAL RESPONSIVITY WITH EXTERNAL HOYA CM500 FILTER

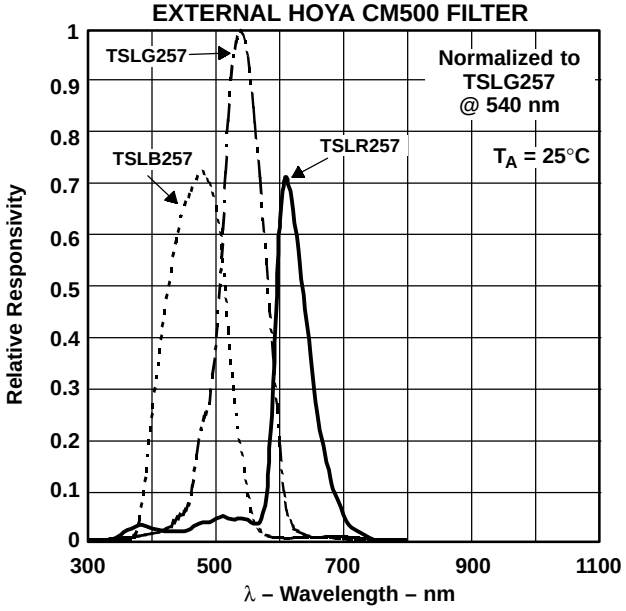


Figure 3

DARK VOLTAGE vs FREE-AIR TEMPERATURE

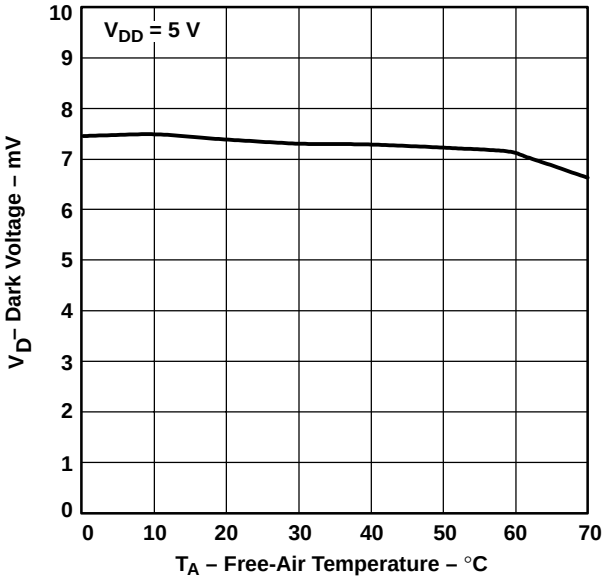


Figure 4

NORMALIZED RESPONSE vs ANGULAR DISPLACEMENT

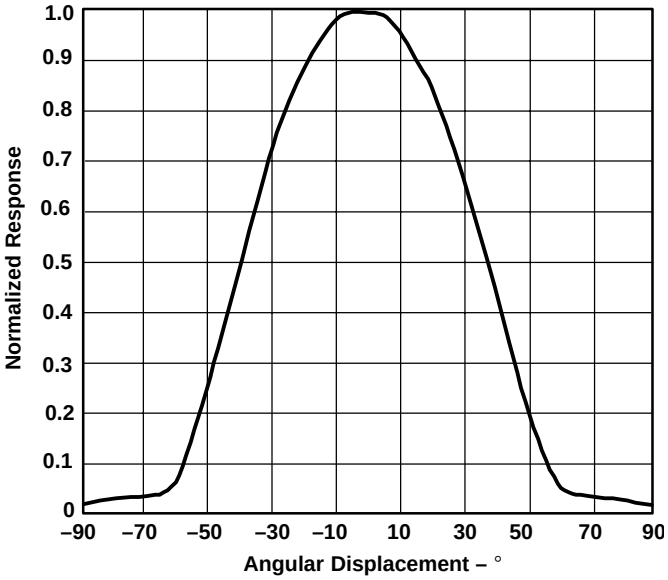


Figure 5

MECHANICAL DATA

The TSLx257 is implemented in a clear 3-leaded package with a molded focusing lens.

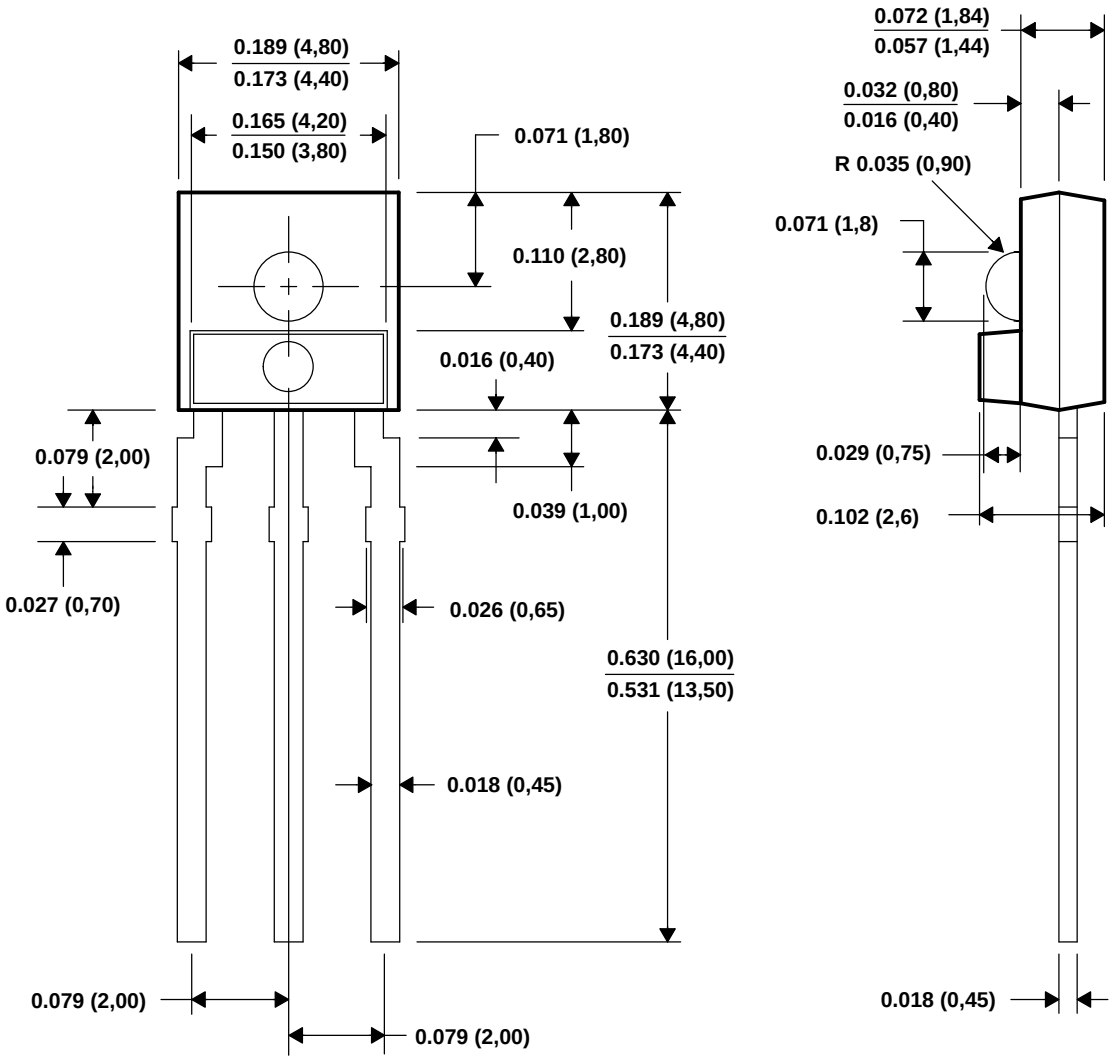


Figure 6. Package Configuration

NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. All dimensions apply before solder dip.
D. Package body is a clear nonfilled optically transparent material
E. Index of refraction of clear plastic is 1.55.

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