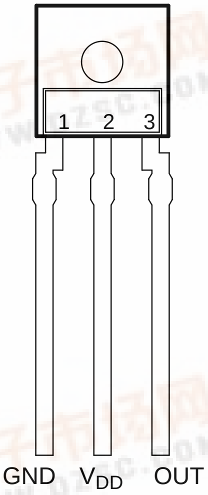
TSL250R, TSL251R, TSL252R
LIGHT-TO-VOLTAGE OPTICAL SENSORS

TAOS028A – MAY 2001

- **Monolithic Silicon IC Containing Photodiode, Operational Amplifier, and Feedback Components**
- **Converts Light Intensity to a Voltage**
- **High Irradiance Responsivity, Typically 137 mV/(μW/cm^2) at λ_p = 635 nm (TSL250R)**
- **Compact 3-Lead Clear Plastic Package**
- **Single Voltage Supply Operation**
- **Low Dark (Offset) Voltage....10mV Max**
- **Low Supply Current......1.1 mA Typical**
- **Wide Supply-Voltage Range.... 2.7 V to 5.5 V**
- **Replacements for TSL250, TSL251, and TSL252**

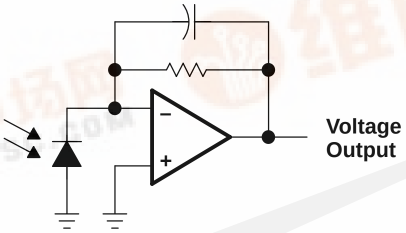
PACKAGE
(FRONT VIEW)



Description

The TSL250R, TSL251R, and TSL252R are light-to-voltage optical sensors, each combining a photodiode and a transimpedance amplifier (feedback resistor = 16 MΩ, 8 MΩ, and 2.8 MΩ respectively) on a single monolithic IC. Output voltage is directly proportional to the light intensity (irradiance) on the photodiode. These devices have improved amplifier offset-voltage stability and low power consumption and are supplied in a 3-lead clear plastic sidelooker package with an integral lens

Functional Block Diagram



Terminal Functions

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

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 (see Note 2)	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.

NOTES: 1. All voltages are with respect to GND.
2. Output may be shorted to supply.

Recommended Operating Conditions

	MIN	NOM	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, λp = 635 nm, R_L = 10 kΩ (unless otherwise noted) (see Notes 3, 4, and 5)

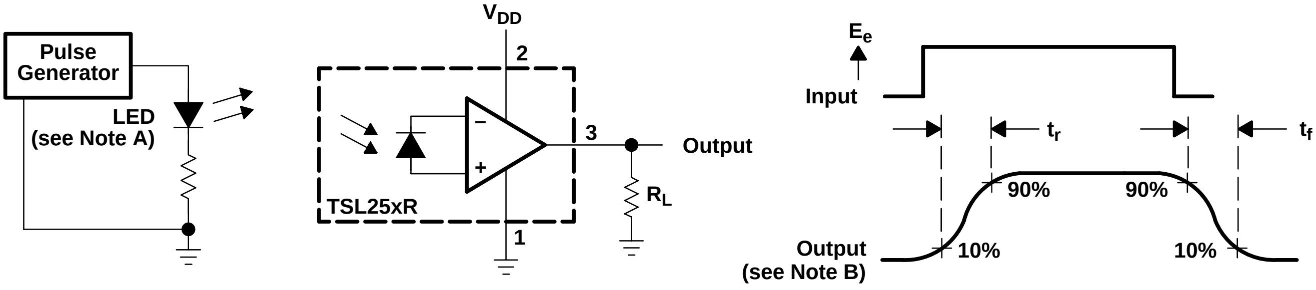
PARAMETER		TEST CONDITIONS	TSL250R			TSL251R			TSL252R			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_D	Dark voltage	E_e = 0	0	4	10	0	4	10	0	4	10	mV
V_{OM}	Maximum output voltage	V_{DD} = 4.5 V	3.0	3.3		3.0	3.3		3.0	3.3		V
V_O	Output voltage	E_e = 14.6 µW/cm^2	1.5	2	2.5							V
		E_e = 38.5 µW/cm^2				1.5	2	2.5				
		E_e = 196 µW/cm^2							1.5	2	2.5	
α_{vo}	Temperature coefficient of output voltage (V_O)	E_e = 14.6 µW/cm^2, T_A = 0°C to 70°C		1.6								mV/°C
				0.08								%/°C
		E_e = 38.5 µW/cm^2, T_A = 0°C to 70°C					1.6					mV/°C
							0.08					%/°C
		E_e = 196 µW/cm^2, T_A = 0°C to 70°C								1.6		mV/°C
										0.08		%/°C
N_e	Irradiance responsivity	λ_p = 635 nm, See Notes 5 and 7		137			52			10.2		mV/(µW/cm^2)
		λ_p = 880 nm, See Notes 6 and 7		127			48			9.4		
I_{DD}	Supply current	E_e = 14.6 µW/cm^2		1.1	1.7							mA
		E_e = 38.5 µW/cm^2					1.1	1.7				
		E_e = 196 µW/cm^2								1.1	1.7	

NOTES: 3. Measurements are made with R_L = 10 kΩ between output and ground.
4. Optical measurements are made using small-angle incident radiation from an LED optical source.
5. The input irradiance E_e is supplied by an AlInGaP LED with peak wavelength λ_p = 635 nm
6. The input irradiance E_e is supplied by a GaAlAs LED with peak wavelength λ_p = 880 nm
7. Irradiance responsivity is characterized over the range V_O = 0.05 to 2.9 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.

Dynamic Characteristics at T_A = 25°C (see Figure 1)

PARAMETER		TEST CONDITIONS	TSL250R			TSL251R			TSL252R			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t_r	Output pulse rise time	V_{DD} = 5 V, λ_p = 635 nm		260			70			7		µs
t_f	Output pulse fall time	V_{DD} = 5 V, λ_p = 635 nm		260			70			7		µs
V_n	Output noise voltage	V_{DD} = 5 V, E_e = 0, f = 1000 Hz		0.8			0.7			0.6		$\mu V/\sqrt{Hz}$

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT

VOLTAGE WAVEFORM

NOTES: A. The input irradiance is supplied by a pulsed AlInGaP light-emitting diode with the following characteristics: λ_p = 635 nm, 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, $Z_i \geq 1$ MΩ, $C_i \leq 20$ pF.

Figure 1. Switching Times

TYPICAL CHARACTERISTICS

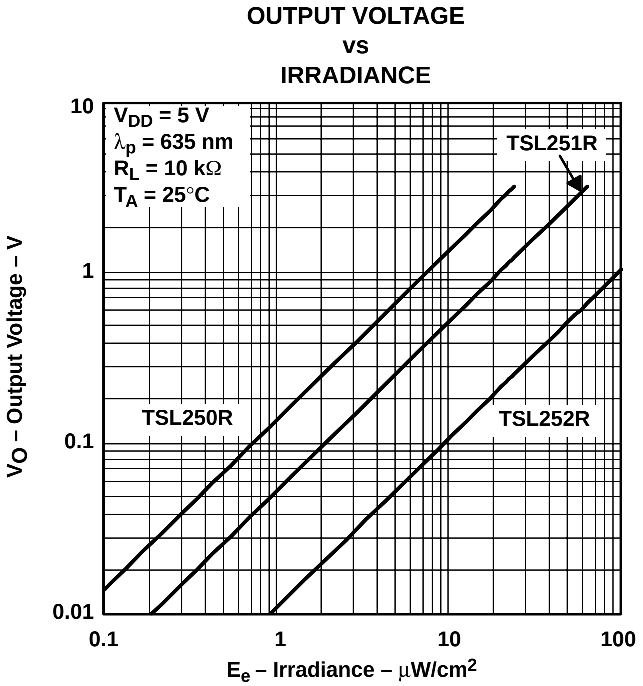


Figure 2

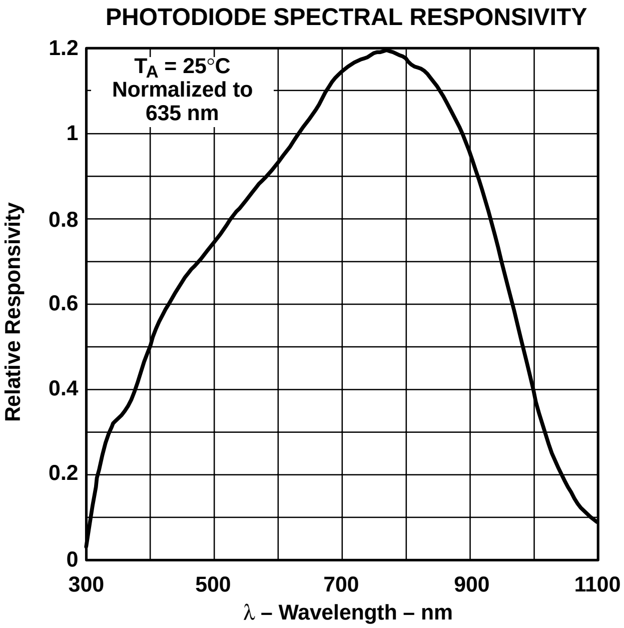


Figure 3

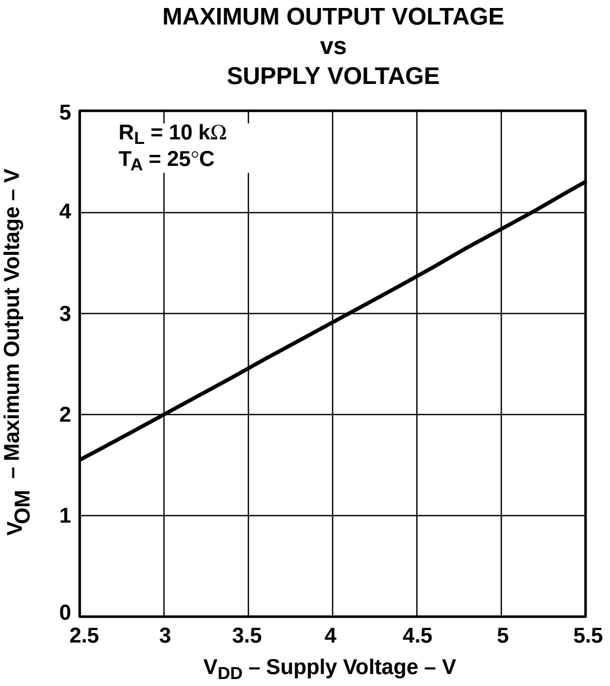


Figure 4

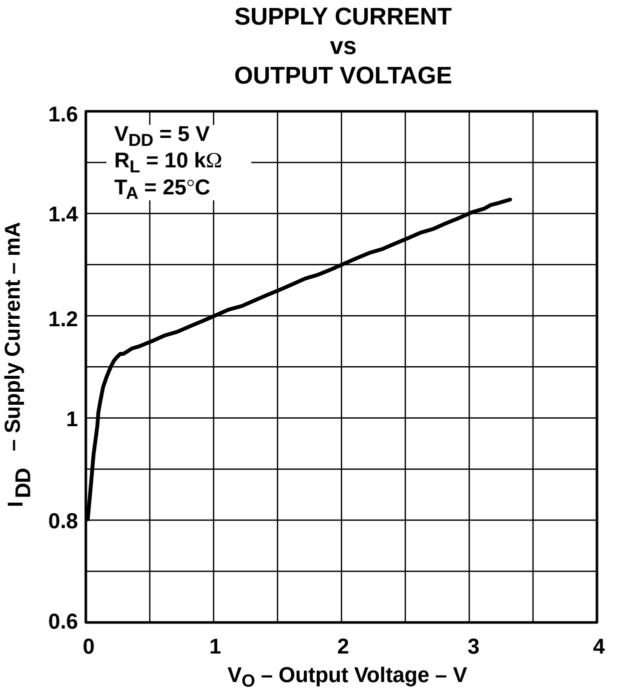


Figure 5

TYPICAL CHARACTERISTICS

NORMALIZED OUTPUT VOLTAGE
vs
ANGULAR DISPLACEMENT

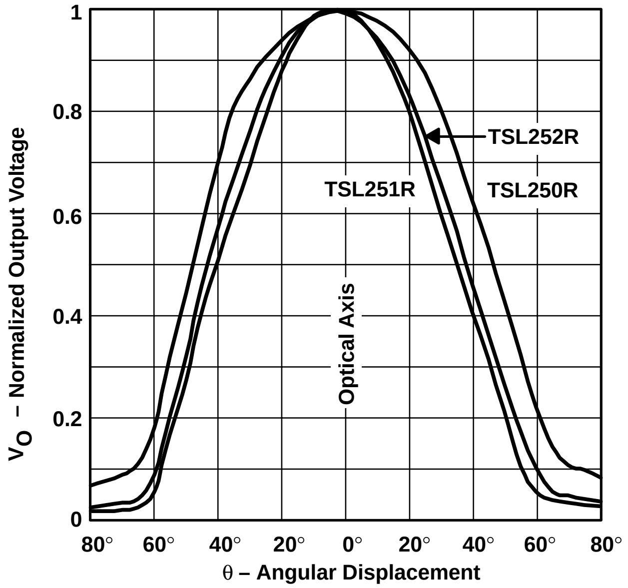


Figure 6

MECHANICAL INFORMATION

The device is supplied in a clear plastic three-lead package. The integrated photodiode active area is typically 1,0 mm^2 (0.0016 in^2) for TSL250R, 0,5 mm^2 (0.00078 in^2) for the TSL251R, and 0,26 mm^2 (0.0004 in^2) for the TSL252R.

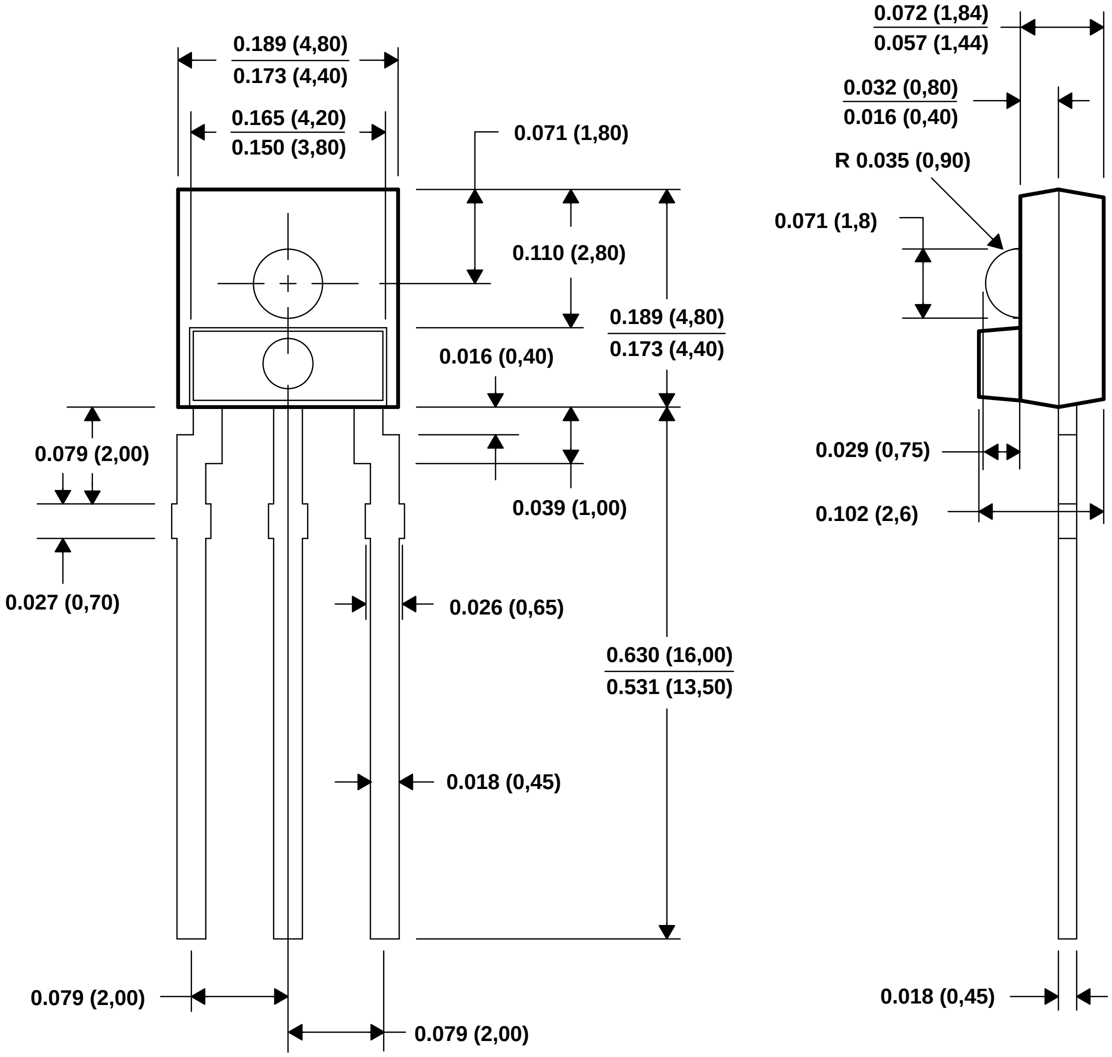


Figure 7. Package Configuration

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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