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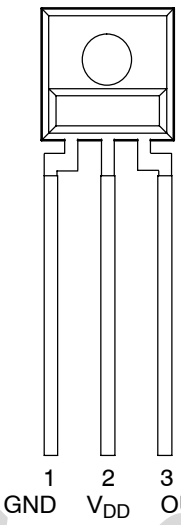
TSL250R, TSL251R, TSL252R
LIGHT-TO-VOLTAGE OPTICAL SENSORS

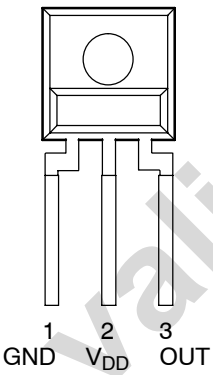
TAOS028H – SEPTEMBER 2007

- **Monolithic Silicon IC Containing Photodiode, Operational Amplifier, and Feedback Components**
- **Converts Light Intensity to a Voltage**
- **High Irradiance Responsivity, Typically 137 mV/(μW/cm²) at λ_p = 635 nm (TSL250R)**
- **Compact 3-Lead Clear Plastic Package**
- **Single Voltage Supply Operation**
- **Low Dark (Offset) Voltage....10 mV 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**
- **RoHS Compliant (–LF Package Only)**

PACKAGE S
SIDELOOKER
(FRONT VIEW)



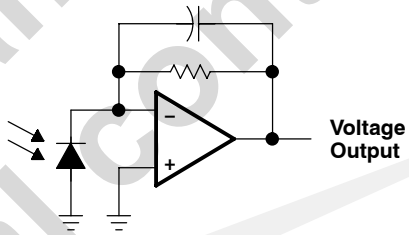
PACKAGE SM
SURFACE MOUNT
SIDELOOKER
(FRONT VIEW)



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. When supplied in the lead (Pb) free package, the device is RoHS compliant.

Functional Block Diagram



Available Options

DEVICE	T_A	PACKAGE – LEADS	PACKAGE DESIGNATOR	ORDERING NUMBER
TSL250R	0°C to 70°C	3-lead Sidelooker	S	TSL250R
TSL250R	0°C to 70°C	3-lead Sidelooker — Lead (Pb) Free	S	TSL250R–LF
TSL250R	0°C to 70°C	3-lead Surface-Mount Sidelooker — Lead (Pb) Free	SM	TSL250RSM–LF
TSL251R	0°C to 70°C	3-lead Sidelooker	S	TSL251R
TSL251R	0°C to 70°C	3-lead Sidelooker — Lead (Pb) Free	S	TSL251R–LF
TSL251R	0°C to 70°C	3-lead Surface-Mount Sidelooker — Lead (Pb) Free	SM	TSL251RSM–LF
TSL252R	0°C to 70°C	3-lead Sidelooker	S	TSL252R
TSL252R	0°C to 70°C	3-lead Sidelooker — Lead (Pb) Free	S	TSL252R–LF
TSL252R	0°C to 70°C	3-lead Surface-Mount Sidelooker — Lead (Pb) Free	SM	TSL252RSM–LF

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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

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 (S Package) . . . . . 260°C
Reflow solder, in accordance with J-STD-020C or J-STD-020D (SM Package) . . . . . 260°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)

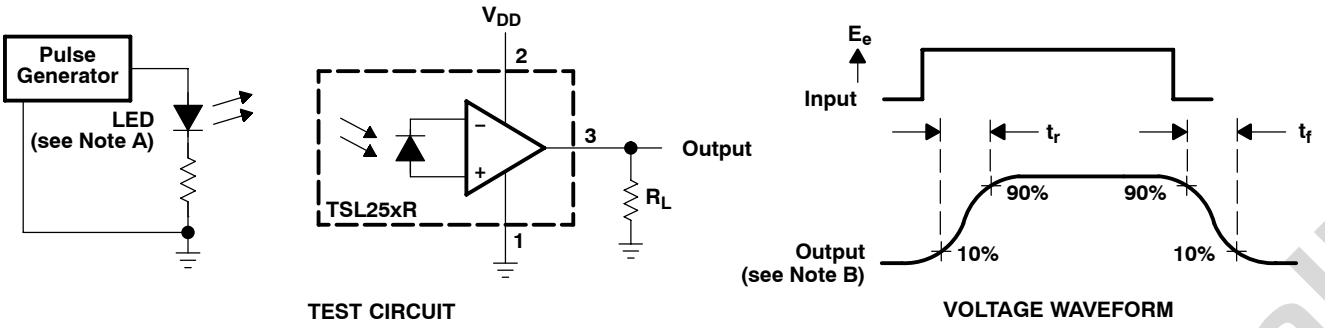
PARAMETER		TEST CONDITIONS	TSL250R			TSL251R			TSL252R			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_D	Dark voltage	E_e = 0	0	4	10	0	4	10	0	4	10	mV
V_{OM}	Maximum output voltage	V_{DD} = 4.5 V	3.0	3.3		3.0	3.3		3.0	3.3		V
V_O	Output voltage	E_e = 14.6 μW/cm²	1.5	2	2.5							V
		E_e = 38.5 μW/cm²				1.5	2	2.5				
		E_e = 196 μW/cm²							1.5	2	2.5	
α_{vo}	Temperature coefficient of output voltage (V_O)	E_e = 14.6 μW/cm², T_A = 0°C to 70°C		1.6								mV/°C
				0.08								%/°C
		E_e = 38.5 μW/cm², T_A = 0°C to 70°C					1.6					mV/°C
							0.08					%/°C
		E_e = 196 μW/cm², 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/cm²)
		λ_p = 880 nm, See Notes 6 and 7		127			48			9.4		
I_{DD}	Supply current	E_e = 14.6 μW/cm²		1.1	1.7							mA
		E_e = 38.5 μW/cm²					1.1	1.7				
		E_e = 196 μW/cm²								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		μV/√Hz

PARAMETER MEASUREMENT INFORMATION



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 ≥ 1 MΩ, C_i ≤ 20 pF.

Figure 1. Switching Times

TYPICAL CHARACTERISTICS

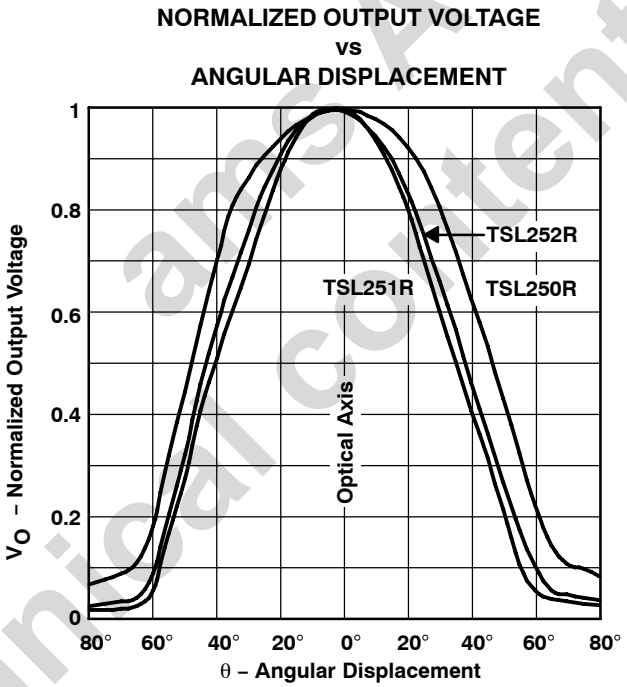


Figure 2

TYPICAL CHARACTERISTICS

OUTPUT VOLTAGE vs IRRADIANCE

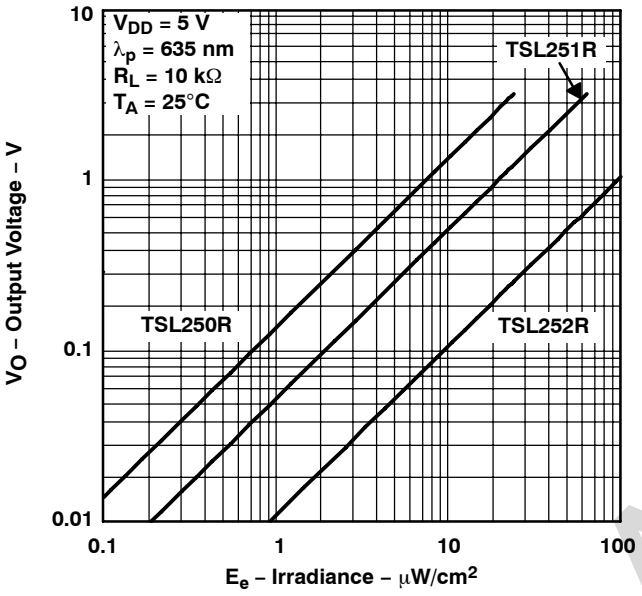


Figure 3

PHOTODIODE SPECTRAL RESPONSIVITY

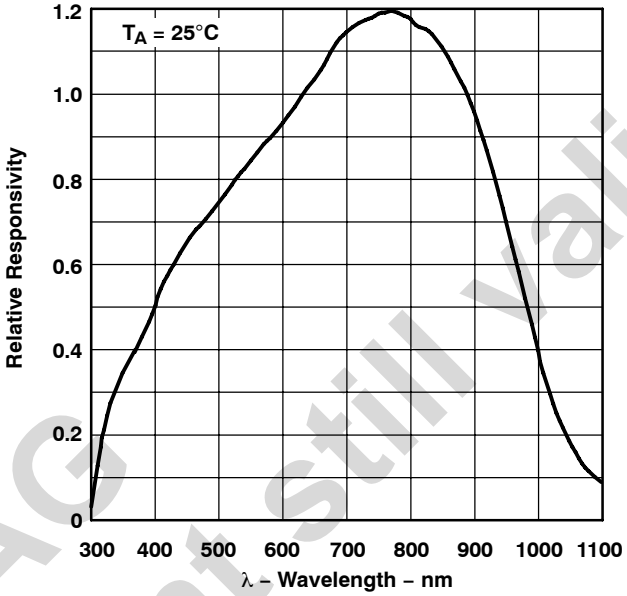


Figure 4

MAXIMUM OUTPUT VOLTAGE vs SUPPLY VOLTAGE

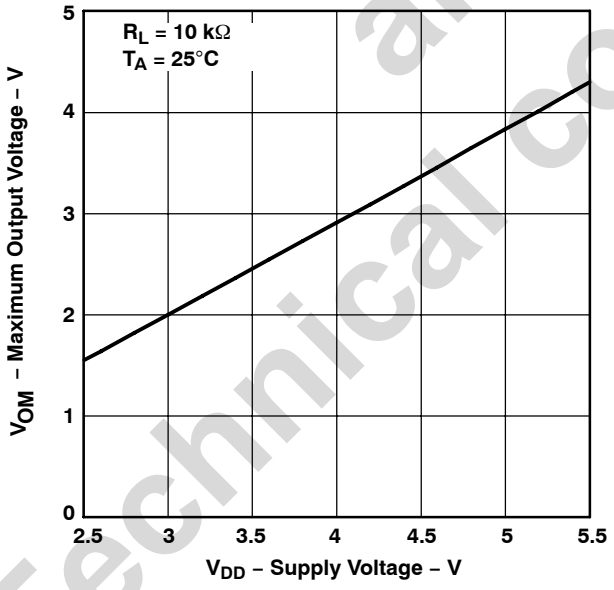


Figure 5

SUPPLY CURRENT vs OUTPUT VOLTAGE

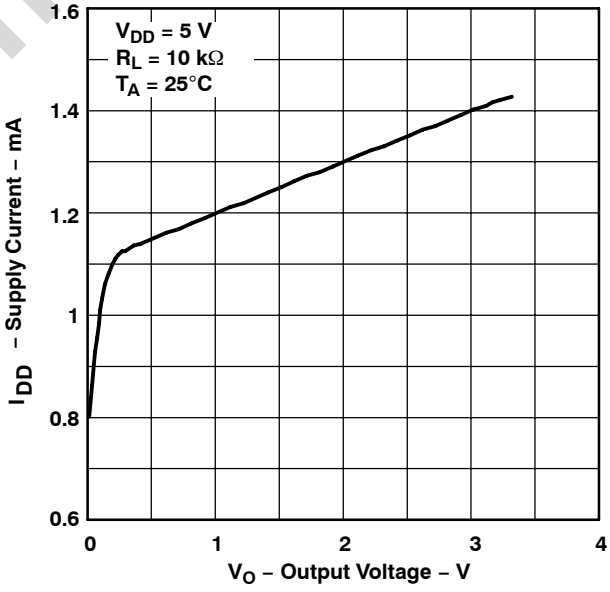
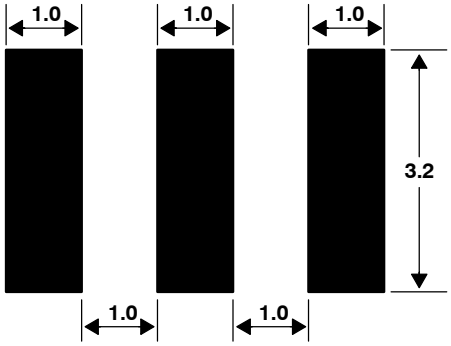


Figure 6

APPLICATION INFORMATION

PCB Pad Layout

Suggested PCB pad layout guidelines for the SM surface mount package are shown in Figure 7.



NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.

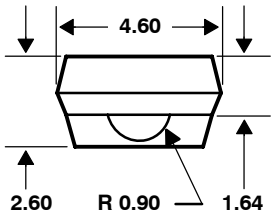
Figure 7. Suggested SM Package PCB Layout

MECHANICAL INFORMATION

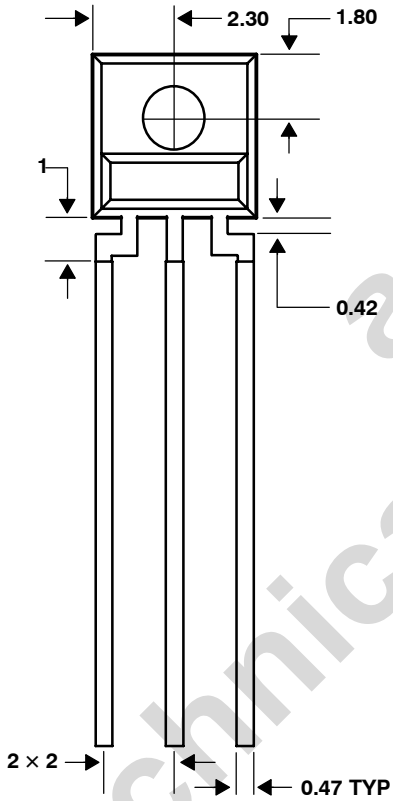
The devices are supplied in a clear plastic three-lead package (S). The integrated photodiode active area is typically 1,0 mm^2 (0.0016 in^2) for TSL250R, 0,5 mm^2 (0.00078 in^2) for the TSL251R, and 0,26 mm^2 (0.0004 in^2) for the TSL252R.

PACKAGE S **PLASTIC SINGLE-IN-LINE SIDE-LOOKER PACKAGE**

TOP VIEW

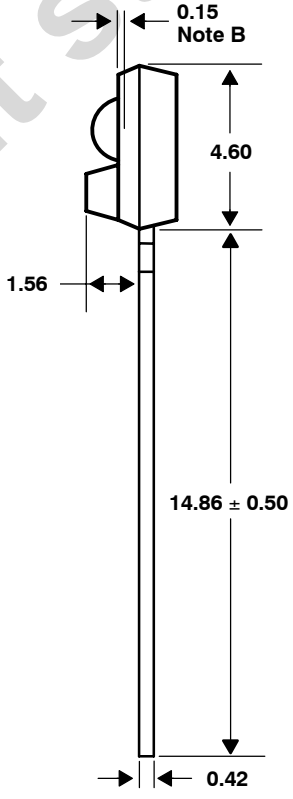


FRONT VIEW



Pb
Lead Free
Available

SIDE VIEW



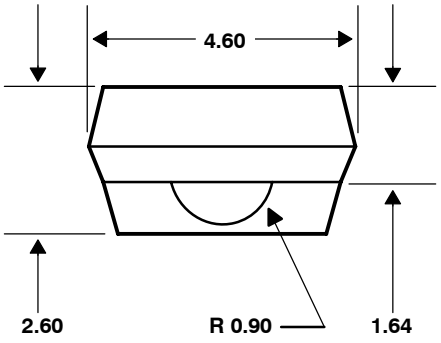
NOTES: A. All linear dimensions are in millimeters; tolerance is ± 0.25 mm unless otherwise stated.
B. Dimension is to center of lens arc, which is located below the package face.
C. The integrated photodiode active area is typically located in the center of the lens and 0.97 mm below the top of the lens surface.
D. Index of refraction of clear plastic is 1.55.
E. Lead finish for TSL25xR: solder dipped, 63% Sn/37% Pb. Lead finish for TSL25xR–LF: solder dipped, 100% Sn.
F. This drawing is subject to change without notice.

Figure 8. Package Configuration

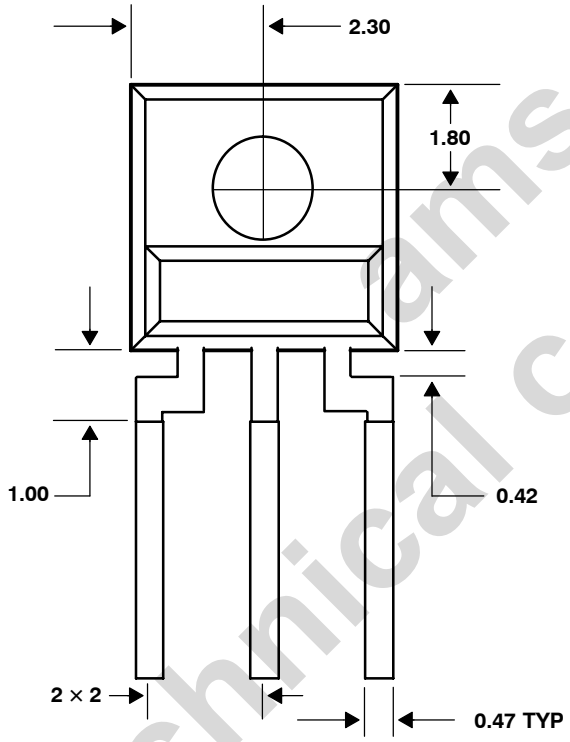
MECHANICAL DATA

PACKAGE SM **PLASTIC SURFACE MOUNT SIDE-LOOKER PACKAGE**

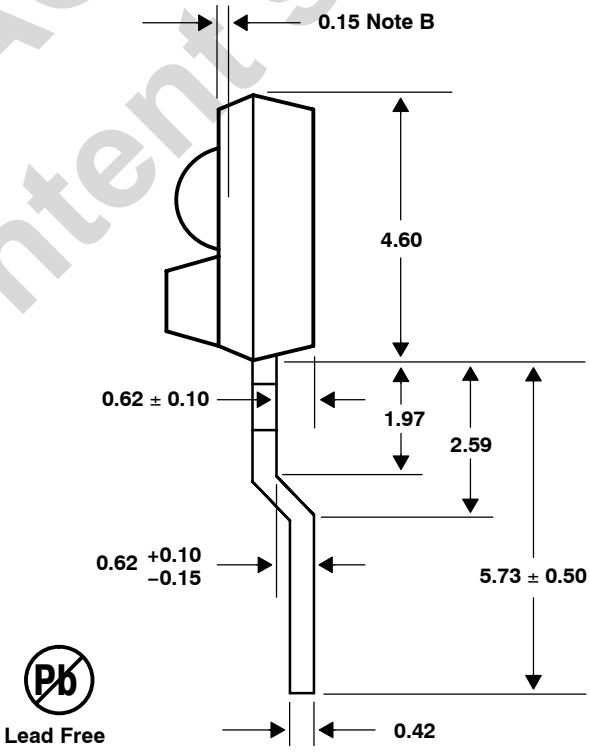
TOP VIEW



FRONT VIEW



SIDE VIEW



Pb
Lead Free

NOTES: A. All linear dimensions are in millimeters; tolerance is ± 0.25 mm unless otherwise stated.
B. Dimension is to center of lens arc, which is located below the package face.
C. The integrated photodiode active area is typically located in the center of the lens and 0.97 mm below the top of the lens surface.
D. Index of refraction of clear plastic is 1.55.
E. Lead finish for TSL25xRSM–LF: solder dipped, 100% Sn.
F. This drawing is subject to change without notice.

Figure 9. Package SM — Surface Mount Side-Looker Package Configuration

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