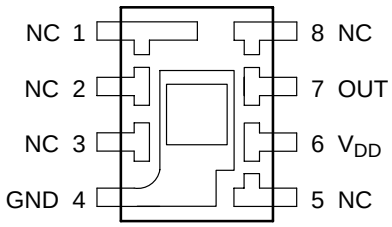
- **Monolithic Silicon IC Containing Photodiode, Operational Amplifier, and Feedback Components**
- **Converts Light Intensity to a Voltage**
- **High Irradiance Responsivity, Typically**
  - **69 mV/(μW/cm^2) at λ_p = 640 nm (TSL250RD)**
  - **62 mV/(μW/cm^2) at λ_p = 940 nm (TSL260RD)**
- **Single 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**
- **Low-Profile Surface-Mount Package:**
  - **Clear Plastic for TSL250RD and TSL251RD**
  - **Visible Light-Cutoff Filter Plastic for TSL260RD and TSL261RD**

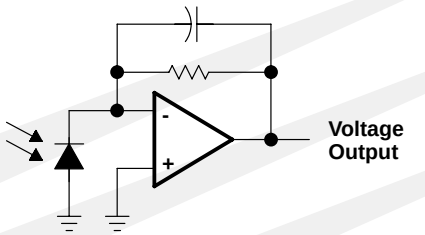
PACKAGE D
8-LEAD SOIC
(TOP VIEW)



Description

The TSL250RD, TSL251RD, TSL260RD, and TSL261RD are light-to-voltage optical sensors, each combining a photodiode and a transimpedance amplifier on a single monolithic IC. The TSL250RD and TSL260RD have an equivalent feedback resistance of 16 MΩ and a photodiode measuring 1 square mm. The TSL251RD and TSL261RD have an equivalent feedback resistance of 8 MΩ and a photodiode measuring 0.5 square mm. 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.

Functional Block Diagram



Terminal Functions

TERMINAL NAME	TERMINAL NO.	DESCRIPTION
GND	4	Ground (substrate). All voltages are referenced to GND.
OUT	7	Output voltage.
V_{DD}	6	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 (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
Solder conditions in accordance with JEDEC J-STD-020A, maximum temperature . . . . . 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, R_L = 10 kΩ (unless otherwise noted) (see Notes 3, 4, 5, and 6)

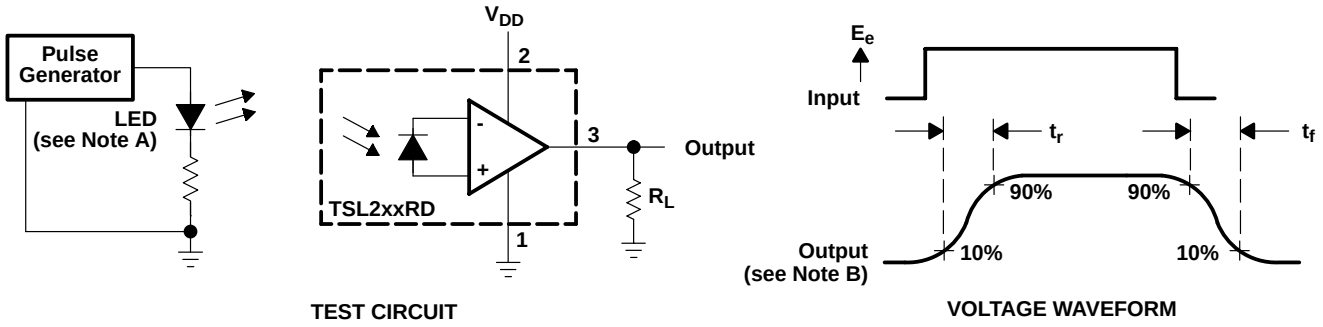
PARAMETER		TEST CONDITIONS	λp = 640 nm						λp = 940 nm						UNIT
			TSL250RD			TSL251RD			TSL260RD			TSL261RD			
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_D	Dark voltage	E_e = 0	0	5	10	0	5	10	0	5	10	0	5	10	mV
V_{OM}	Maximum output voltage	V_{DD} = 4.5 V	3	3.3		3	3.3		3	3.3		3	3.3		V
V_O	Output voltage	E_e = 29 μW/cm²	1.5	2	2.5										V
		E_e = 116 μW/cm²				1.5	2	2.5							
		E_e = 32 μW/cm²							1	2	3				
		E_e = 124 μW/cm²										1	2	3	
R_e	Irradiance responsivity	See Note 7		69			17			62			16		mV/(μW/cm²)
Temperature coefficient of output voltage (V_O)		V_O = 2 V @ 25°C, T_A = 0°C to 70°C (see Note 8)		2			2			8			8		mV/°C
				0.1			0.1			0.4			0.4		%/°C
I_{DD}	Supply current	E_e = 29 μW/cm²		1.1	1.7										mA
		E_e = 116 μW/cm²					1.1	1.7							
		E_e = 32 μW/cm²								1.1	1.7				
		E_e = 124 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 640 nm input irradiance E_e is supplied by an AlInGaP LED with peak wavelength λ_p = 640 nm.
6. The 940 nm input irradiance E_e is supplied by a GaAs LED with peak wavelength λ_p = 940 nm.
7. Irradiance responsivity is characterized over the range V_O = V_D to 3 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 temperature coefficient of output voltage measurement is made by adjusting irradiance such that V_O is approximately 2 V at 25°C and then with irradiance held constant, measuring V_O while varying the temperature between 0°C and 70°C.

Dynamic Characteristics at V_{DD} = 5 V, T_A = 25°C, R_L = 10 kΩ (unless otherwise noted) (see Figure 1)

PARAMETER		TEST CONDITIONS	λp = 640 nm						λp = 940 nm						UNIT
			TSL250RD			TSL251RD			TSL260RD			TSL261RD			
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t_r	Output pulse rise time	$V_{O(peak)}$ = 2 V		260			70			260			70		µs
t_f	Output pulse fall time	$V_{O(peak)}$ = 2 V		260			70			260			70		µs
V_n	Output noise voltage	E_e = 0, f = 1000 Hz		0.8			0.7			0.8			0.7		µV/(√(Hz))

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT VOLTAGE WAVEFORM

NOTES: A. The input irradiance is supplied by a pulsed light-emitting diode with 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

OUTPUT VOLTAGE vs IRRADIANCE

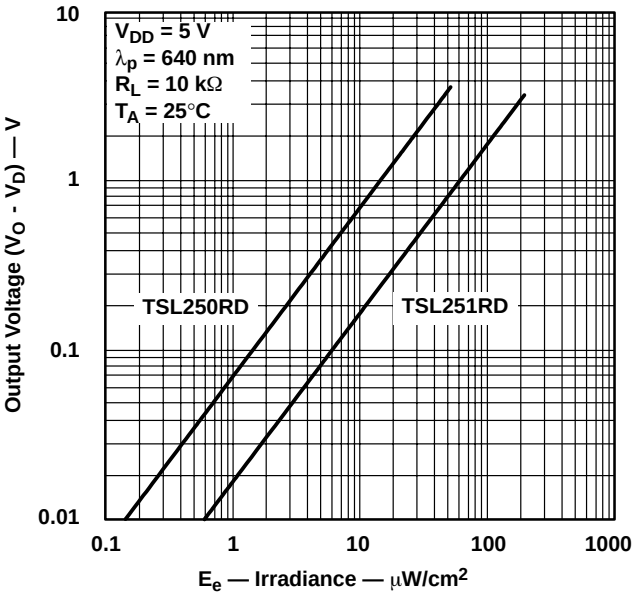


Figure 2

OUTPUT VOLTAGE vs IRRADIANCE

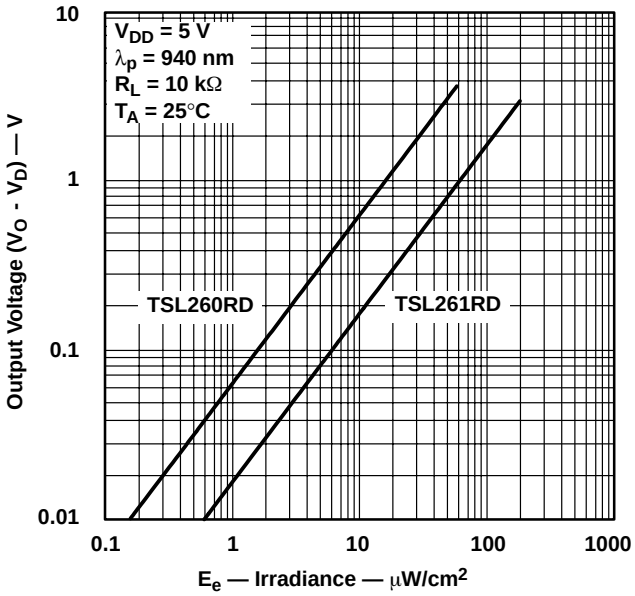


Figure 3

PHOTODIODE SPECTRAL RESPONSIVITY

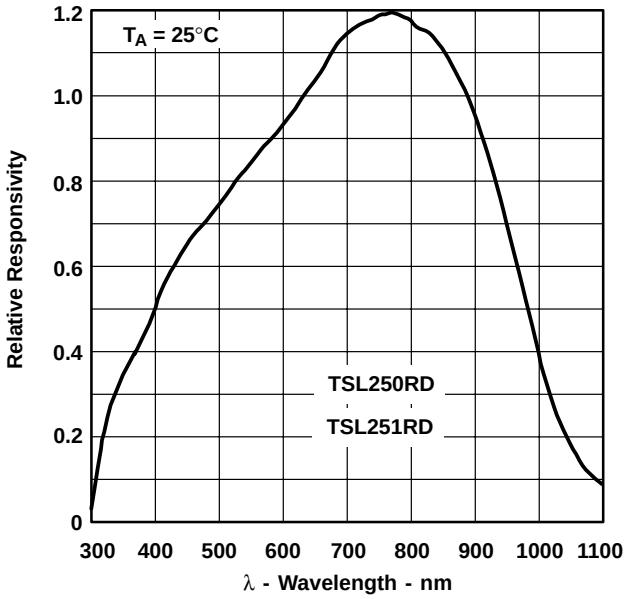


Figure 4

PHOTODIODE SPECTRAL RESPONSIVITY

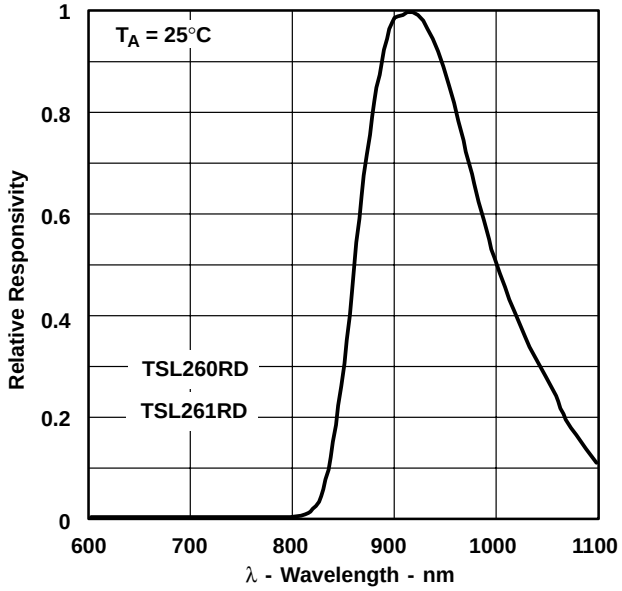


Figure 5

TYPICAL CHARACTERISTICS

MAXIMUM OUTPUT VOLTAGE vs SUPPLY VOLTAGE

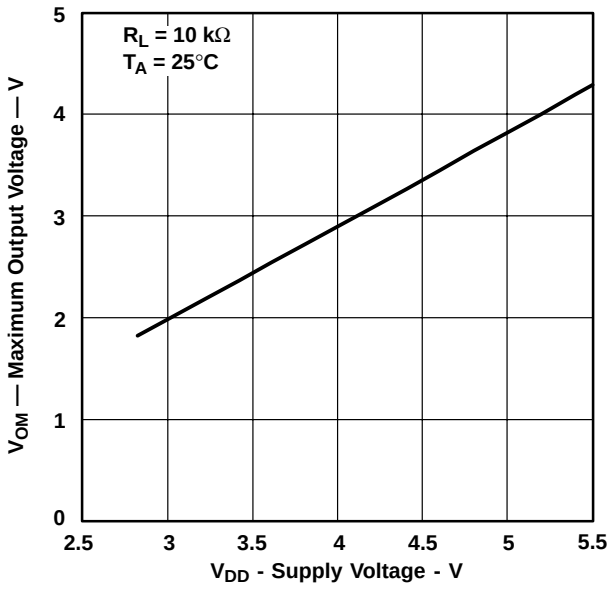


Figure 6

SUPPLY CURRENT vs OUTPUT VOLTAGE

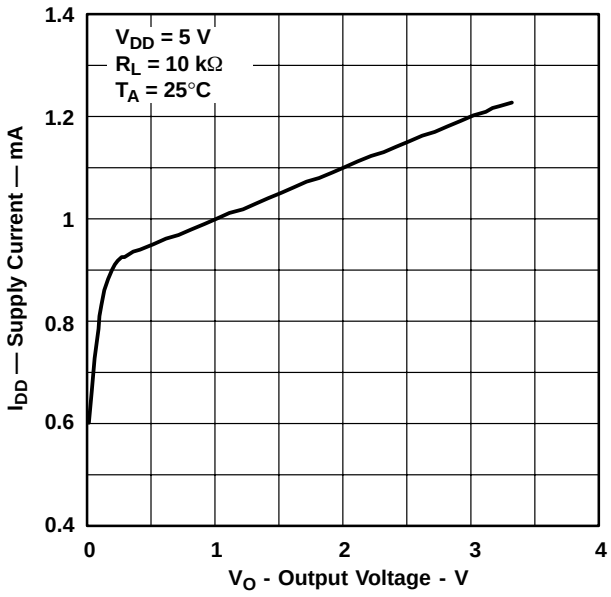


Figure 7

APPLICATION INFORMATION

Power Supply Considerations

For optimum device performance, power-supply lines should be decoupled by a 0.01-μF to 0.1-μF capacitor with short leads connected between VDD and GND mounted close to the device package.

Device Operational Details

The voltage developed at the output pin (OUT) is given by:

$$V_O = V_D + (R_e)(E_e)$$

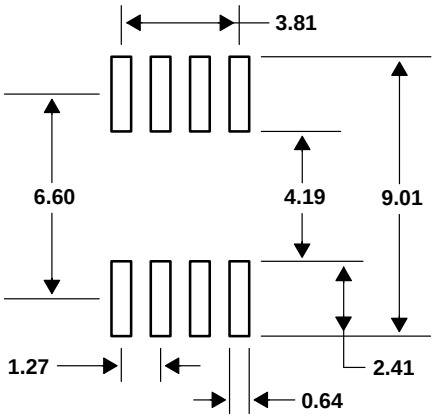
where:

V_O	is the output voltage
V_D	is the output voltage for dark condition ($E_e = 0$)
R_e	is the device responsivity for a given wavelength of light given in mV/(μW/cm^2)
E_e	is the incident irradiance in μW/cm^2

V_D is a fixed offset voltage resulting primarily from the input offset voltage of the internal op amp. As shown in the equation above, this voltage represents a constant, light-independent term in the total output voltage V_O. At low light levels, this offset voltage can be a significant percentage of V_O. For optimum performance of any given device over the full output range, the value of V_D should be measured (in the absence of light) and later subtracted from all subsequent light measurements (see Figures 2 and 3).

PCB Pad Layout

Suggested PCB pad layout guidelines for the D package is shown in Figure 8.



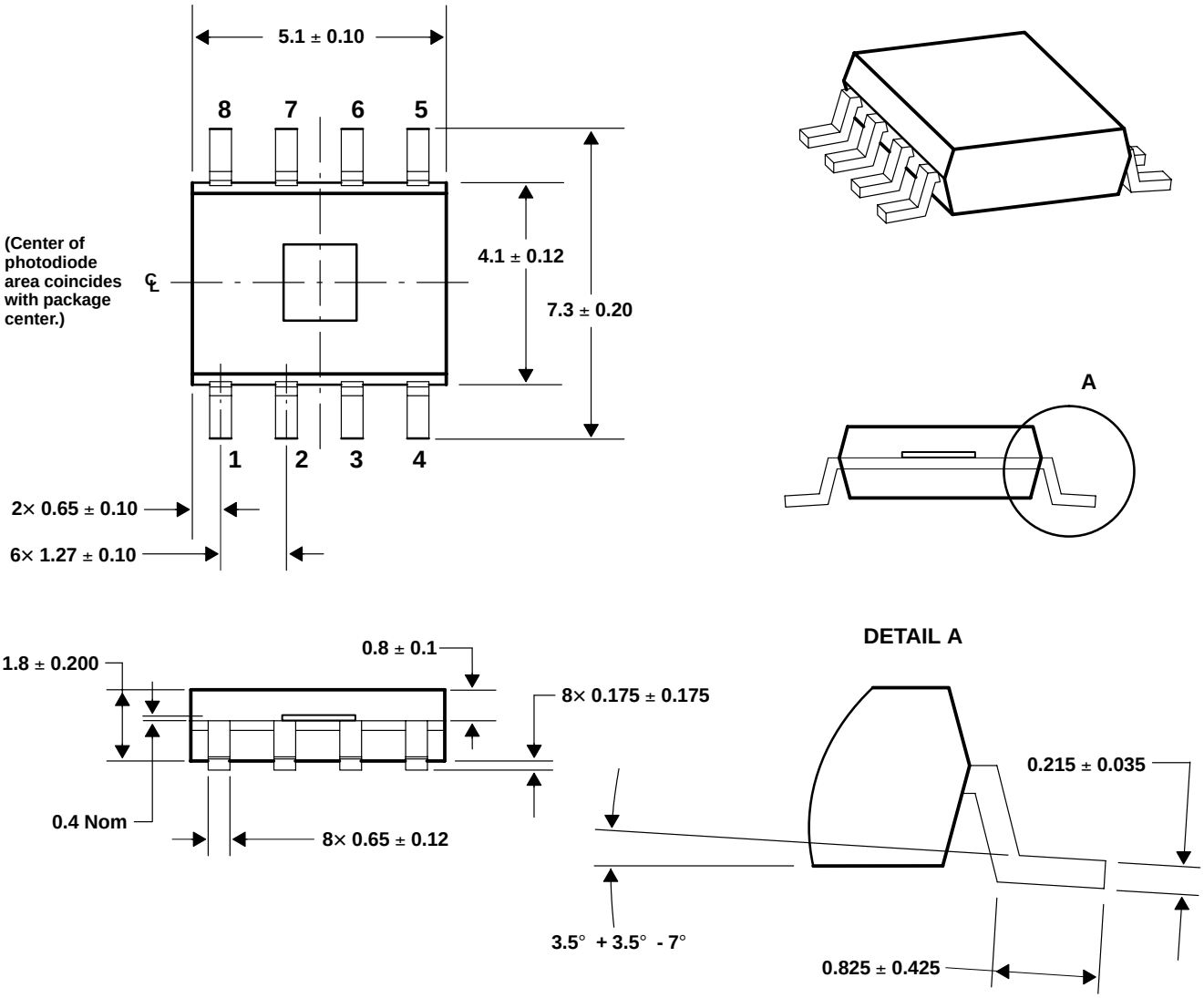
NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.

Figure 8. Suggested D Package PCB Layout

MECHANICAL DATA

This SOIC package consists of an integrated circuit mounted on a lead frame and encapsulated with an electrically nonconductive clear plastic compound. The photodiode area is typically 1 mm^2 for the TSL250RD and TSL260RD, and is typically 0.5 mm^2 for the TSL251RD and TSL261RD.

PACKAGE D **PLASTIC SMALL-OUTLINE**



NOTES: A. All linear dimensions are in millimeters.
B. Package is molded with an electrically nonconductive clear plastic compound having an index of refraction of 1.55.
C. Actual product will vary within the mechanical tolerances shown on this specification. Designs for use of this product MUST allow for the data sheet tolerances.
D. Pin 4 (GND) is mechanically connected to the die mount pad.
E. This drawing is subject to change without notice.

Figure 9. Package D — Plastic Small Outline IC Packaging Configuration

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