

# TSL250, TSL251, TSL252 LIGHT-TO-VOLTAGE OPTICAL SENSORS

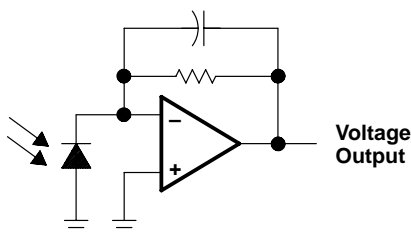
SOES004C – AUGUST 1991 – REVISED NOVEMBER 1995

- Monolithic Silicon IC Containing Photodiode, Operational Amplifier, and Feedback Components
- Converts Light Intensity to Output Voltage
- High Irradiance Responsivity Typically 80 mV/( $\mu\text{W}/\text{cm}^2$ ) at  $\lambda_p = 880 \text{ nm}$  (TSL250)
- Compact 3-Leaded Clear Plastic Package
- Low Dark (Offset) Voltage . . . 10 mV Max at 25°C,  $V_{DD} = 5 \text{ V}$
- Single-Supply Operation
- Wide Supply-Voltage Range . . . 3 V to 9 V
- Low Supply Current . . . 800  $\mu\text{A}$  Typical at  $V_{DD} = 5 \text{ V}$
- Advanced LinCMOS™ Technology

## description

The TSL250, TSL251, and TSL252 are light-to-voltage optical sensors, each combining a photodiode and a transimpedance amplifier (feedback resistor = 16 M $\Omega$ , 8 M $\Omega$ , and 2 M $\Omega$  respectively) on a single monolithic IC. The output voltage is directly proportional to the light intensity (irradiance) on the photodiode. These devices utilize Texas Instruments silicon-gate LinCMOS™ technology, which provides improved amplifier offset-voltage stability and low power consumption.

## functional block diagram



## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, $V_{DD}$ (see Note 1)	10 V
Output current, $I_O$	$\pm 10 \text{ mA}$
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, $V_{DD}$	3	5	9	V
Operating free-air temperature, $T_A$	0		70	°C



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electrical characteristics at  $V_{DD} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ ,  $\lambda_p = 880\text{ nm}$ ,  $R_L = 10\text{ k}\Omega$  (unless otherwise noted) (see Note 3)

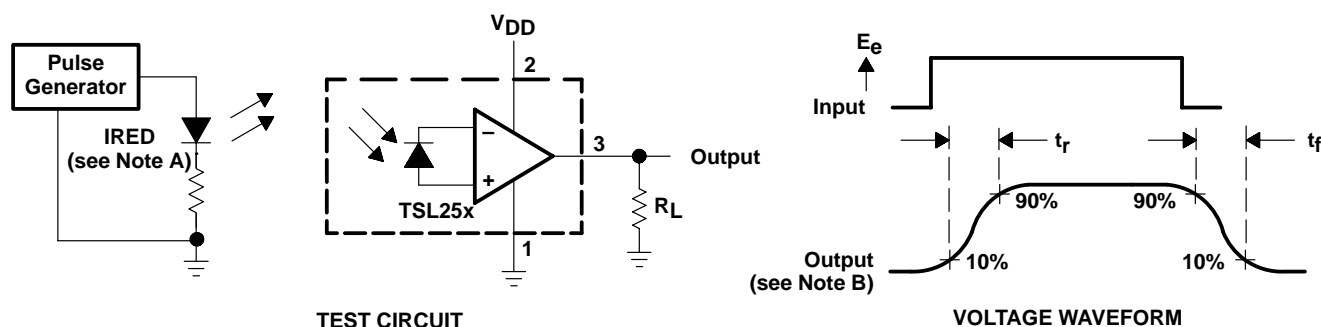
PARAMETER	TEST CONDITIONS	TSL250			TSL251			TSL252			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
$V_D$ Dark voltage	$E_e = 0$		3	10		3	10		3	10	mV
$V_{OM}$ Maximum output voltage swing	$E_e = 2\text{ mW/cm}^2$	3.1	3.5		3.1	3.5		3.1	3.5		V
$V_O$ Output voltage	$E_e = 25\text{ }\mu\text{W/cm}^2$	1	2	3							V
	$E_e = 45\text{ }\mu\text{W/cm}^2$				1	2	3				
	$E_e = 285\text{ }\mu\text{W/cm}^2$							1	2	3	
$\alpha_{vo}$ Temperature coefficient of output voltage ( $V_O$ )	$E_e = 25\text{ }\mu\text{W/cm}^2$ , $T_A = 0^\circ\text{C to } 70^\circ\text{C}$		$\pm 1$								mV/ $^\circ\text{C}$
	$E_e = 45\text{ }\mu\text{W/cm}^2$ , $T_A = 0^\circ\text{C to } 70^\circ\text{C}$				$\pm 1$						
	$E_e = 285\text{ }\mu\text{W/cm}^2$ , $T_A = 0^\circ\text{C to } 70^\circ\text{C}$							$\pm 1$			
$N_e$ Irradiance responsivity	See Note 4		80			45			7		mV/( $\mu\text{W/cm}^2$ )
$I_{DD}$ Supply current	$E_e = 25\text{ }\mu\text{W/cm}^2$		900	1600							$\mu\text{A}$
	$E_e = 45\text{ }\mu\text{W/cm}^2$					900	1600				
	$E_e = 285\text{ }\mu\text{W/cm}^2$								900	1600	

NOTES: 3. The input irradiance  $E_e$  is supplied by a GaAlAs infrared-emitting diode with  $\lambda_p = 880\text{ nm}$ .  
4. Irradiance responsivity is characterized over the range  $V_O = 0.05\text{ to } 3\text{ V}$ .

operating characteristics at  $T_A = 25^\circ\text{C}$  (see Figure 1)

PARAMETER	TEST CONDITIONS	TSL250			TSL251			TSL252			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
$t_r$ Output pulse rise time	$V_{DD} = 5\text{ V}$ , $\lambda_p = 880\text{ nm}$		360			90			7		$\mu\text{s}$
$t_f$ Output pulse fall time	$V_{DD} = 5\text{ V}$ , $\lambda_p = 880\text{ nm}$		360			90			7		$\mu\text{s}$
$V_n$ Output noise voltage	$V_{DD} = 5\text{ V}$ , $f = 20\text{ Hz}$		0.6			0.5			0.4		$\mu\text{V}/\sqrt{\text{Hz}}$

## PARAMETER MEASUREMENT INFORMATION



NOTES: A. The input irradiance is supplied by a pulsed GaAlAs infrared-emitting diode with the following characteristics:  $\lambda_p = 880\text{ nm}$ ,  $t_r < 1\text{ }\mu\text{s}$ ,  $t_f < 1\text{ }\mu\text{s}$ .  
B. The output waveform is monitored on an oscilloscope with the following characteristics:  $t_r < 100\text{ ns}$ ,  $Z_i \geq 1\text{ MHz}$ ,  $C_i \leq 20\text{ pF}$ .

Figure 1. Switching Times

TYPICAL CHARACTERISTICS

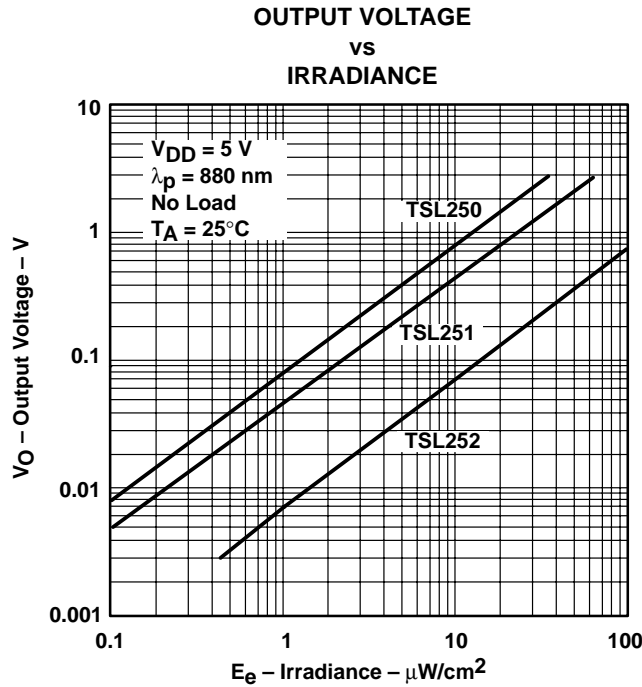


Figure 2

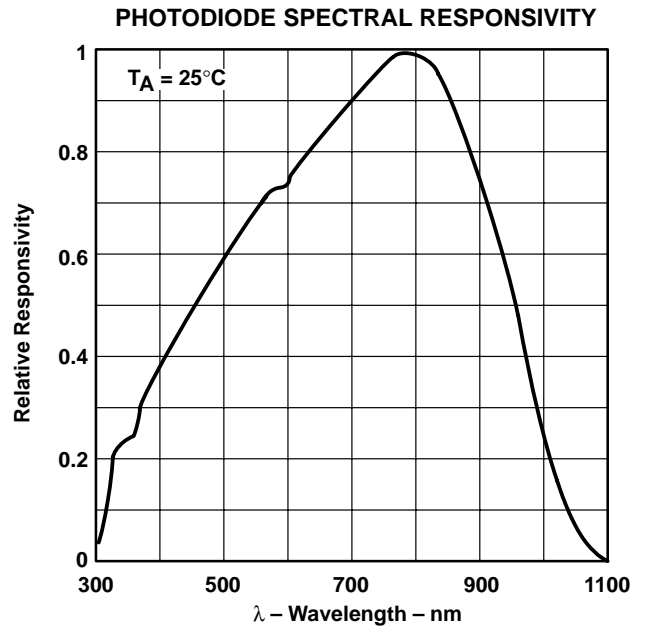


Figure 3

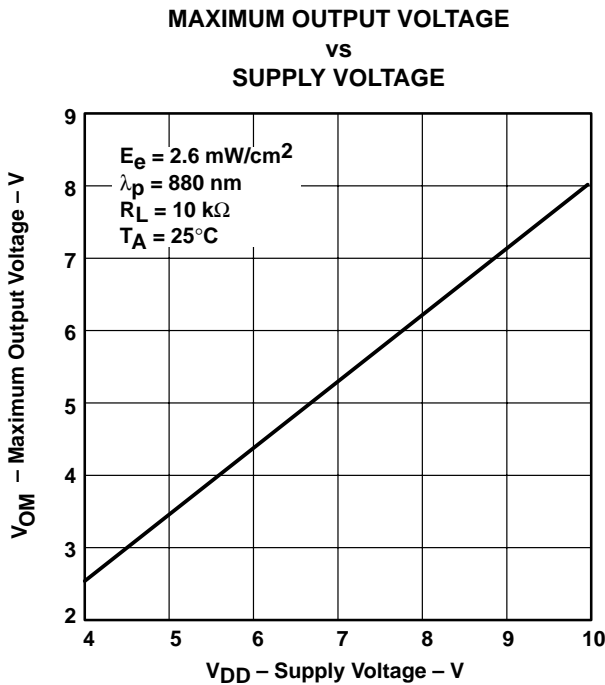


Figure 4

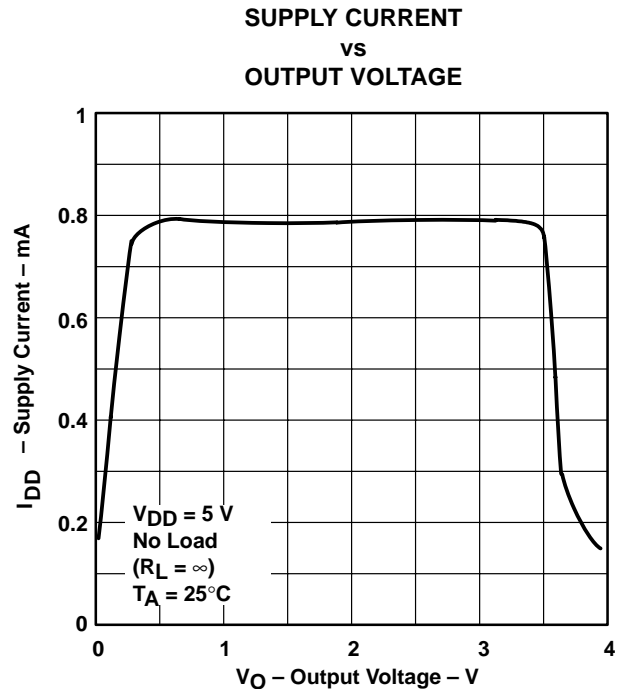


Figure 5

# TSL250, TSL251, TSL252 LIGHT-TO-VOLTAGE OPTICAL SENSORS

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## TYPICAL CHARACTERISTICS

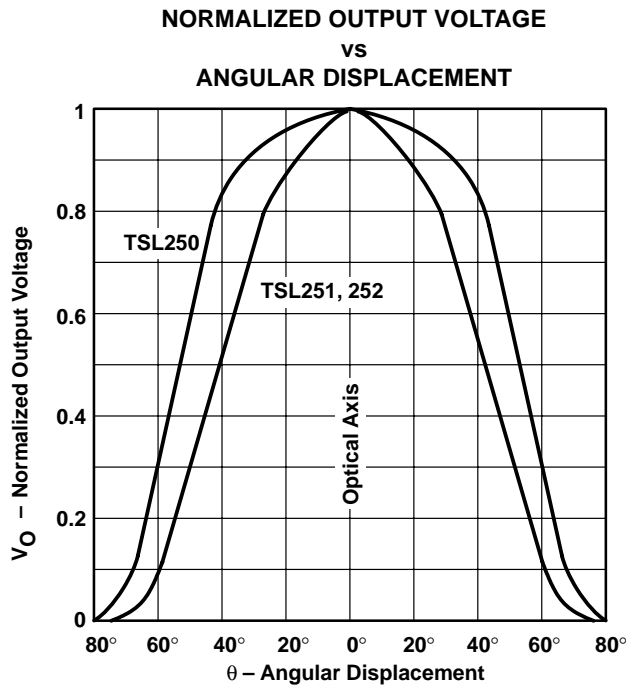


Figure 6

## APPLICATION INFORMATION

The photodiode/amplifier chip is packaged in a clear plastic three-leaded package. The integrated photodiode active area is typically 1,0 mm<sup>2</sup> (0.0016 in<sup>2</sup>) for TSL250, 0,5 mm<sup>2</sup> (0.00078 in<sup>2</sup>) for the TSL251, and 0,26 mm<sup>2</sup> (0.0004 in<sup>2</sup>) for the TSL252.

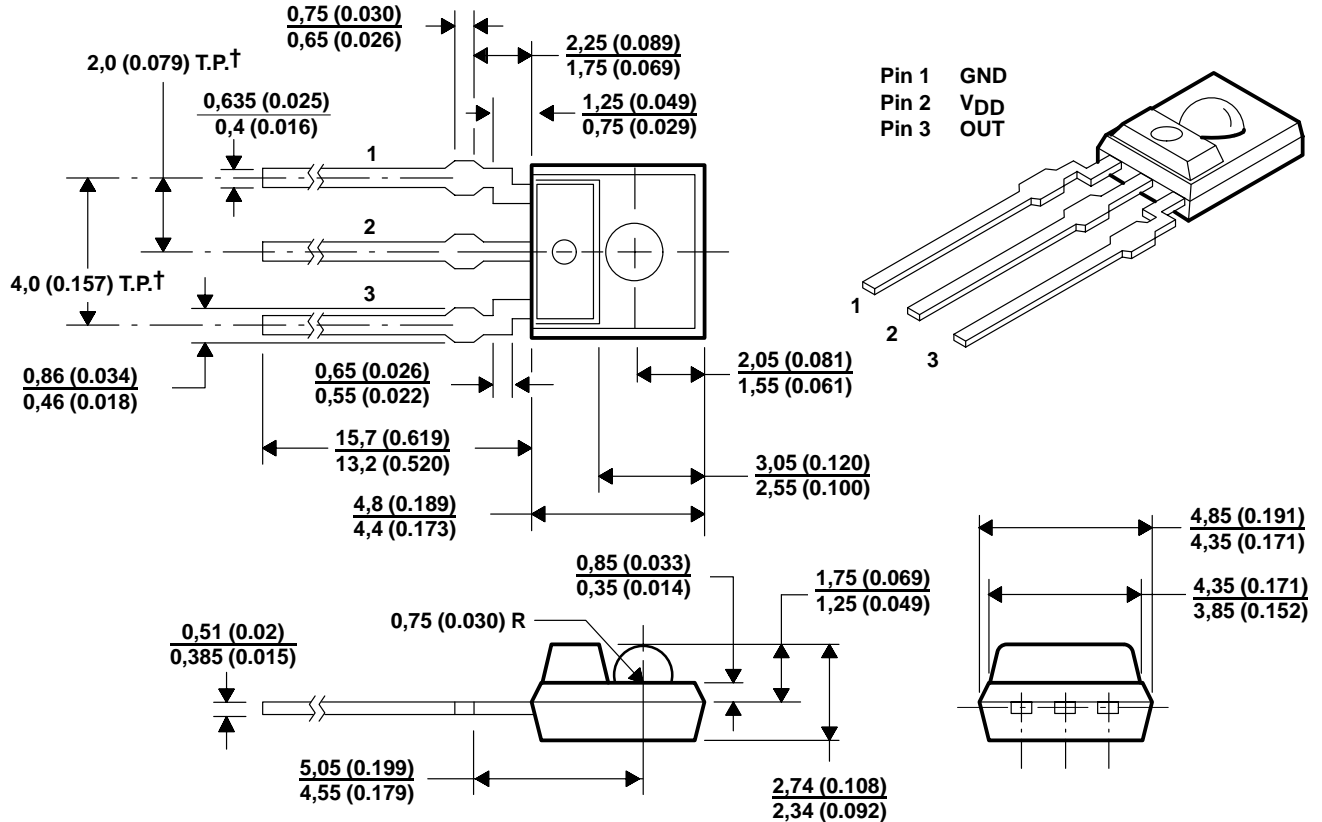


Figure 7. Mechanical Data

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