

# TSL257

## High-Sensitivity Light-to-Voltage Converter

### General Description

The TSL257 is a high-sensitivity low-noise light-to-voltage optical converter that combines a photodiode and a transimpedance amplifier on a single monolithic CMOS integrated circuit. Output voltage is directly proportional to light intensity (irradiance) on the photodiode. The TSL257 has a transimpedance gain of  $320\text{M}\Omega$ . The device has improved offset voltage stability and low power consumption and is 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.

*Ordering Information and Content Guide appear at end of datasheet.*

### Key Benefits & Features

The benefits and features of TSL257, High-Sensitivity Light-to-Voltage Converter are listed below:

**Figure 1:**  
Added Value of Using TSL257

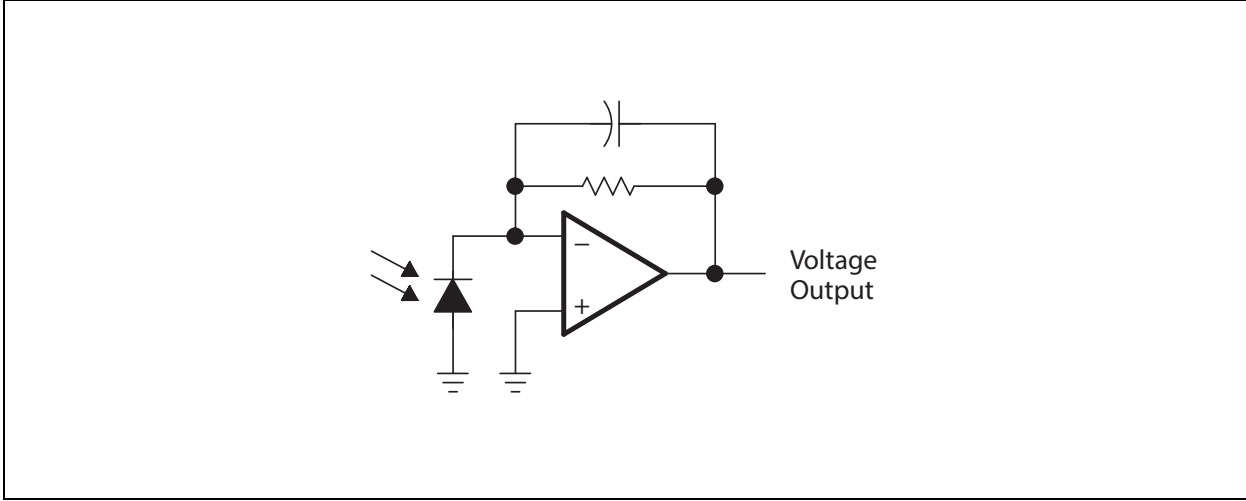
Benefits	Features
<ul style="list-style-type: none"> <li>Enables Extremely Fast Response to Change</li> </ul>	<ul style="list-style-type: none"> <li>Single Photo-Diode and Trans Impedance Architecture</li> </ul>
<ul style="list-style-type: none"> <li>Enables Fast Response to Visible Light in Range of 400nm to 700nm Wavelengths</li> </ul>	<ul style="list-style-type: none"> <li>160<math>\mu\text{s}</math> Output Rise-Time Response</li> </ul>
<ul style="list-style-type: none"> <li>Provides for High Sensitivity to Detect a Small Change in Light</li> </ul>	<ul style="list-style-type: none"> <li>High Irradiance Responsivity: Typically <math>1.68\text{V}/(\mu\text{W}/\text{cm}^2)</math> at <math>\lambda_p = 645\text{nm}</math></li> </ul>
<ul style="list-style-type: none"> <li>Provides Additional Sensitivity Advantages</li> </ul>	<ul style="list-style-type: none"> <li>2x Gain Lens</li> </ul>
<ul style="list-style-type: none"> <li>Provides Full Dynamic Range</li> </ul>	<ul style="list-style-type: none"> <li>Rail-To-Rail Output Swing</li> </ul>

- Converts Light Intensity to Output Voltage
- Monolithic Silicon IC Containing Photodiode, Operational Amplifier, and Feedback Components
- High Sensitivity
- Single Voltage Supply Operation (2.7V to 5.5V)
- Low Noise (200 $\mu\text{Vrms}$  Typ to 1kHz)
- High Power-Supply Rejection (35dB at 1kHz)
- Compact 3-Leaded Plastic Package
- RoHS Compliant (-LF Package Only)

### Functional Block Diagram

The functional blocks of this device are shown below:

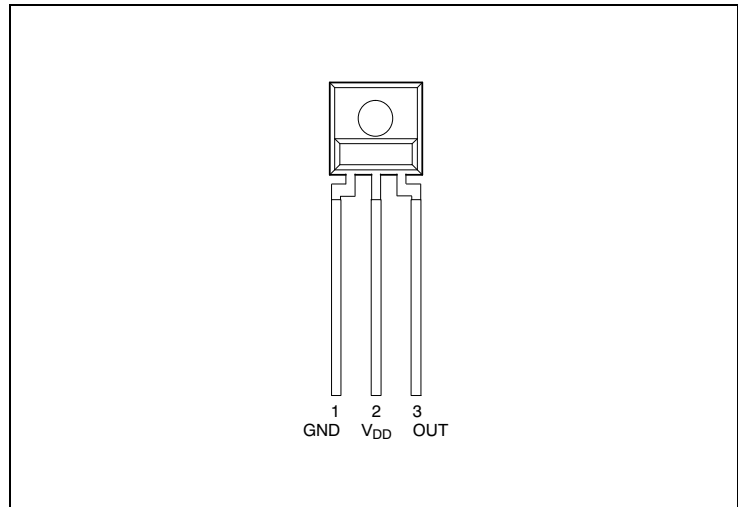
Figure 2:  
TSL257 Block Diagram



## Pin Assignment

The TSL257 pin assignments are described below.

**Figure 3:**  
Pin Diagram of Package S Sidelooker (Front View)



**Figure 4:**  
Terminal Functions

Terminal		Description
No.	Name	
1	GND	Ground (substrate). All voltages are referenced to GND.
2	V <sub>DD</sub>	Supply voltage
3	OUT	Output voltage

## Absolute Maximum Ratings

Stresses beyond those listed under [Absolute Maximum Ratings](#) may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated under [Operating Conditions](#) is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

**Figure 5:**  
**Absolute Maximum Ratings over Operating Free-Air Temperature Range (unless otherwise noted)**

Symbol	Parameter	Min	Max	Unit
$V_{DD}$	Supply voltage <sup>(1)</sup>		6	V
$I_O$	Output current		±10	mA
	Duration of short-circuit current at (or below) 25°C		5	s
$T_A$	Operating free-air temperature range	-25	85	°C
$T_{STRG}$	Storage temperature range	-25	85	°C
	Lead temperature 1.6mm (1/16 inch) from case for 10 seconds (S Package)		260	°C

**Note(s):**

1. All voltages are with respect to GND.

## Electrical Characteristics

All limits are guaranteed. The parameters with min and max values are guaranteed with production tests or SQC (Statistical Quality Control) methods.

### Operating Conditions

All defined tolerances for external components in this specification need to be assured over the whole operation condition range and also over lifetime.

**Figure 6:**  
Recommended Operating Conditions

Symbol	Parameter	Min	Nom	Max	Unit
$V_{DD}$	Supply voltage	2.7		5.5	V
$T_A$	Operating free-air temperature range	0		70	°C

**Figure 7:**  
Electrical Characteristics at  $V_{DD} = 5V$ ,  $T_A = 25^\circ C$ ,  $\lambda_p = 470nm$ ,  $R_L = 10k\Omega$  (unless otherwise noted) <sup>(1) (2)</sup>

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$V_D$	Dark voltage	$E_e = 0$	0		15	mV
$V_{OM}$	Maximum output voltage swing	$V_{DD} = 4.5V$ , No Load		4.49		V
		$V_{DD} = 4.5V$ , $R_L = 10k\Omega$	4	4.2		
$V_O$	Output voltage	$E_e = 1.54\mu W/cm^2$ , $\lambda_p = 470nm$ <sup>(4)</sup>	1.6	2	2.4	V
$\alpha_{VD}$	Temperature coefficient of dark voltage ( $V_D$ )	$T_A = 0^\circ C$ to $70^\circ C$		-15		$\mu V/^\circ C$
$N_e$	Irradiance responsivity	$\lambda_p = 428nm$ <sup>(3), (7)</sup>		1.18		V/ ( $\mu W/cm^2$ )
		$\lambda_p = 470nm$ <sup>(4), (7)</sup>		1.30		
		$\lambda_p = 565nm$ <sup>(5), (7)</sup>		1.58		
		$\lambda_p = 645nm$ <sup>(6), (7)</sup>		1.68		

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
PSRR	Power supply rejection ratio	$f_{ac} = 100\text{Hz}$ <sup>(8)</sup>		55		dB
		$f_{ac} = 1\text{kHz}$ <sup>(8)</sup>		35		dB
$I_{DD}$	Supply current	$E_e = 1.54\mu\text{W}/\text{cm}^2$ , $\lambda_p = 470\text{nm}$ <sup>(4)</sup>		1.9	3.5	mA

**Note(s):**

1. Measured with  $R_L = 10\text{k}\Omega$  between output and ground.
2. Optical measurements are made using small-angle incident radiation from a light-emitting diode (LED) optical source.
3. The input irradiance is supplied by a GaN/SiC light-emitting diode with the following characteristics: peak wavelength  $\lambda_p = 428\text{nm}$ , spectral halfwidth  $\Delta\lambda_{1/2} = 65\text{nm}$ .
4. The input irradiance is supplied by an InGaN light-emitting diode with the following characteristics: peak wavelength  $\lambda_p = 470\text{nm}$ , spectral halfwidth  $\Delta\lambda_{1/2} = 35\text{nm}$ .
5. The input irradiance is supplied by a GaP light-emitting diode with the following characteristics: peak wavelength  $\lambda_p = 565\text{nm}$ , spectral halfwidth  $\Delta\lambda_{1/2} = 28\text{nm}$ .
6. The input irradiance is supplied by an AlGaAs light-emitting diode with the following characteristics: peak wavelength  $\lambda_p = 645\text{nm}$ , spectral halfwidth  $\Delta\lambda_{1/2} = 25\text{nm}$ .
7. Irradiance responsivity is characterized over the range  $V_O = 0.1\text{V}$  to  $4.5\text{V}$ . 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. Power supply rejection ratio PSRR is defined as  $20 \log (\Delta V_{DD}(f)/\Delta V_O(f))$  with  $V_{DD}(f = 0) = 5\text{V}$  and  $V_O(f = 0) = 2\text{V}$ .

**Figure 8:**  
**Switching Characteristics at  $V_{DD} = 5V$ ,  $T_A = 25^\circ C$ ,  $\lambda_p = 470nm$ ,  $R_L = 10k\Omega$  (unless otherwise noted)**

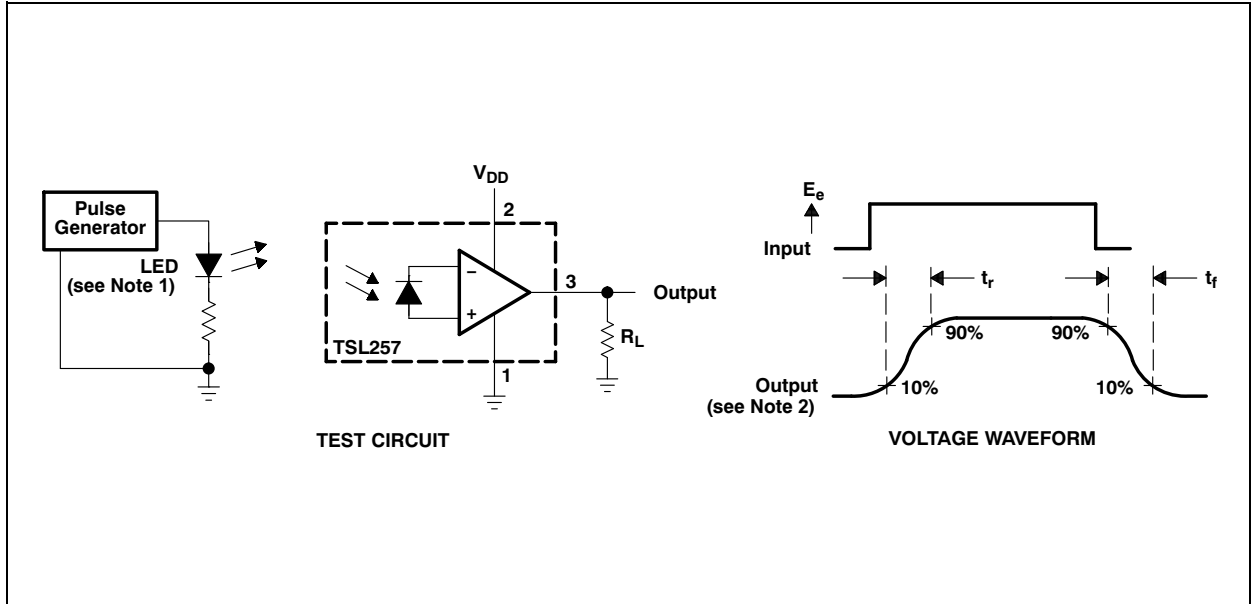
Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$t_r$	Output pulse rise time, 10% to 90% of final value	See note (1) and Figure 9		160	250	$\mu s$
$t_f$	Output pulse fall time, 10% to 90% of final value	See note (1) and Figure 9		150	250	$\mu s$
$t_s$	Output settling time to 1% of final value	See note (1) and Figure 9		330		$\mu s$
	Integrated noise voltage	$f = dc$ to 1kHz, $E_e = 0$		200		$\mu V_{rms}$
$V_n$	Output noise voltage, rms	$f = 10Hz$ , $E_e = 0$		6		$\frac{\mu V}{\sqrt{Hz}}$ (rms)
		$f = 100Hz$ , $E_e = 0$		6		
		$f = 1kHz$ , $E_e = 0$		7		

**Note(s):**

- Switching characteristics apply over the range  $V_O = 0.1V$  to 4.5V.

## Parameter Measurement Information

Figure 9:  
Switching Times



**Note(s):**

1. The input irradiance is supplied by a pulsed InGaN light-emitting diode with the following characteristics:  $\lambda_p = 470\text{nm}$ ,  $t_r < 1\mu\text{s}$ ,  $t_f < 1\mu\text{s}$ .
2. The output waveform is monitored on an oscilloscope with the following characteristics:  $t_r < 100\text{ns}$ ,  $Z_i \geq 1\text{M}\Omega$ ,  $C_i \leq 20\text{pF}$ .



## Typical Operating Characteristics

Figure 10:  
Photodiode Spectral Responsivity

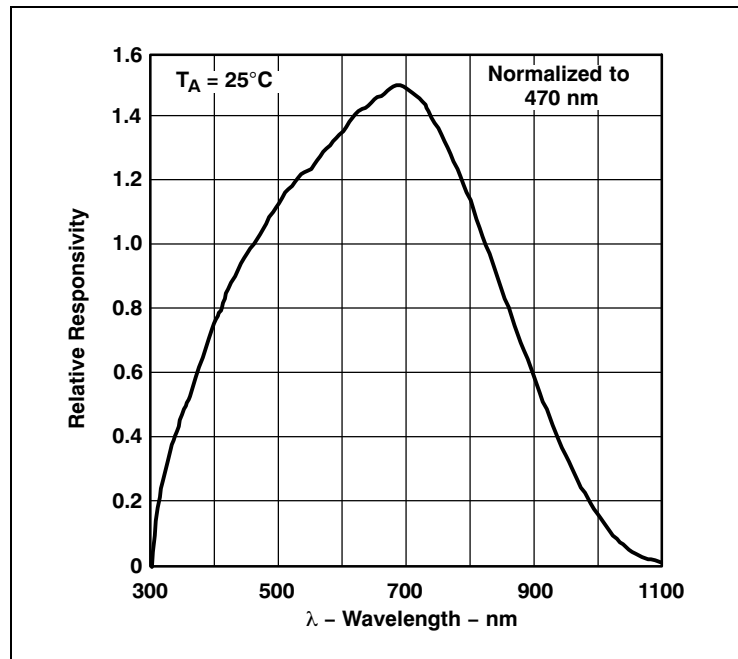
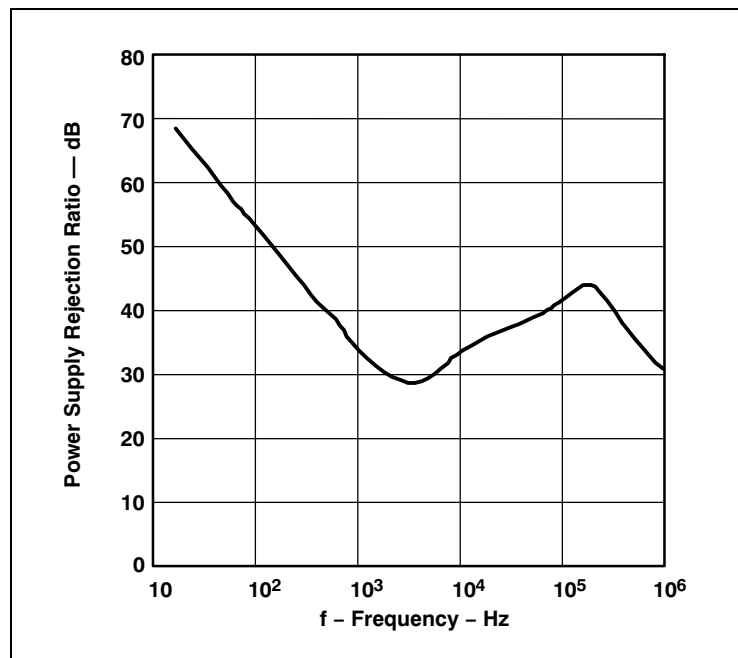
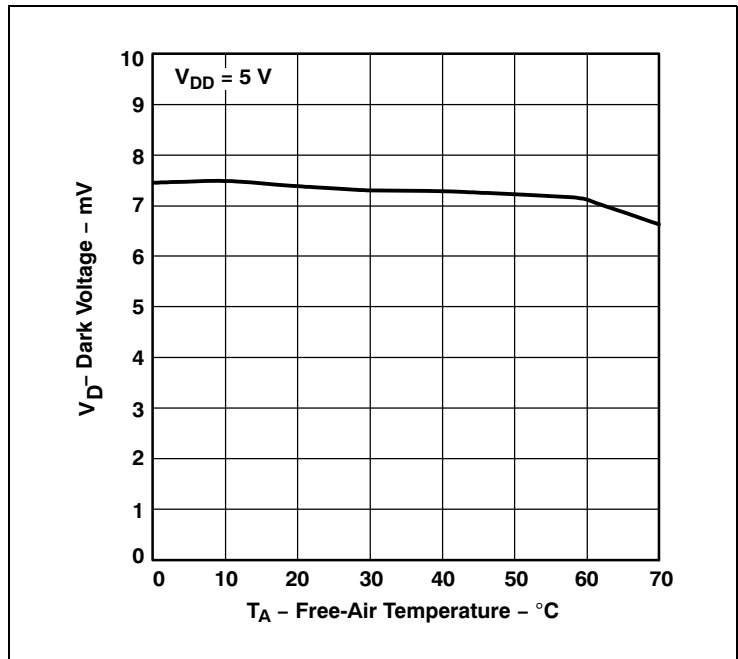


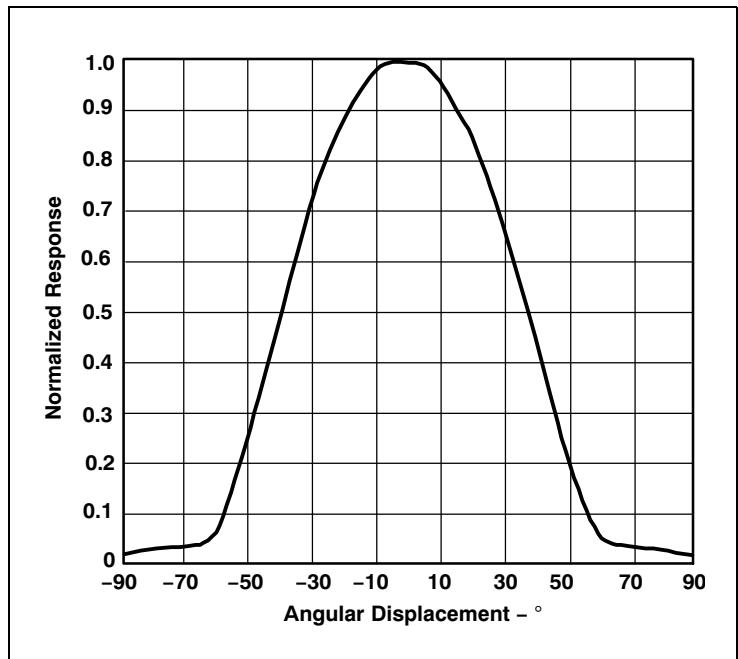
Figure 11:  
Power Supply Rejection Ratio vs. Frequency



**Figure 12:**  
Dark Voltage vs. Free-Air Temperature



**Figure 13:**  
Normalized Response vs. Angular Displacement

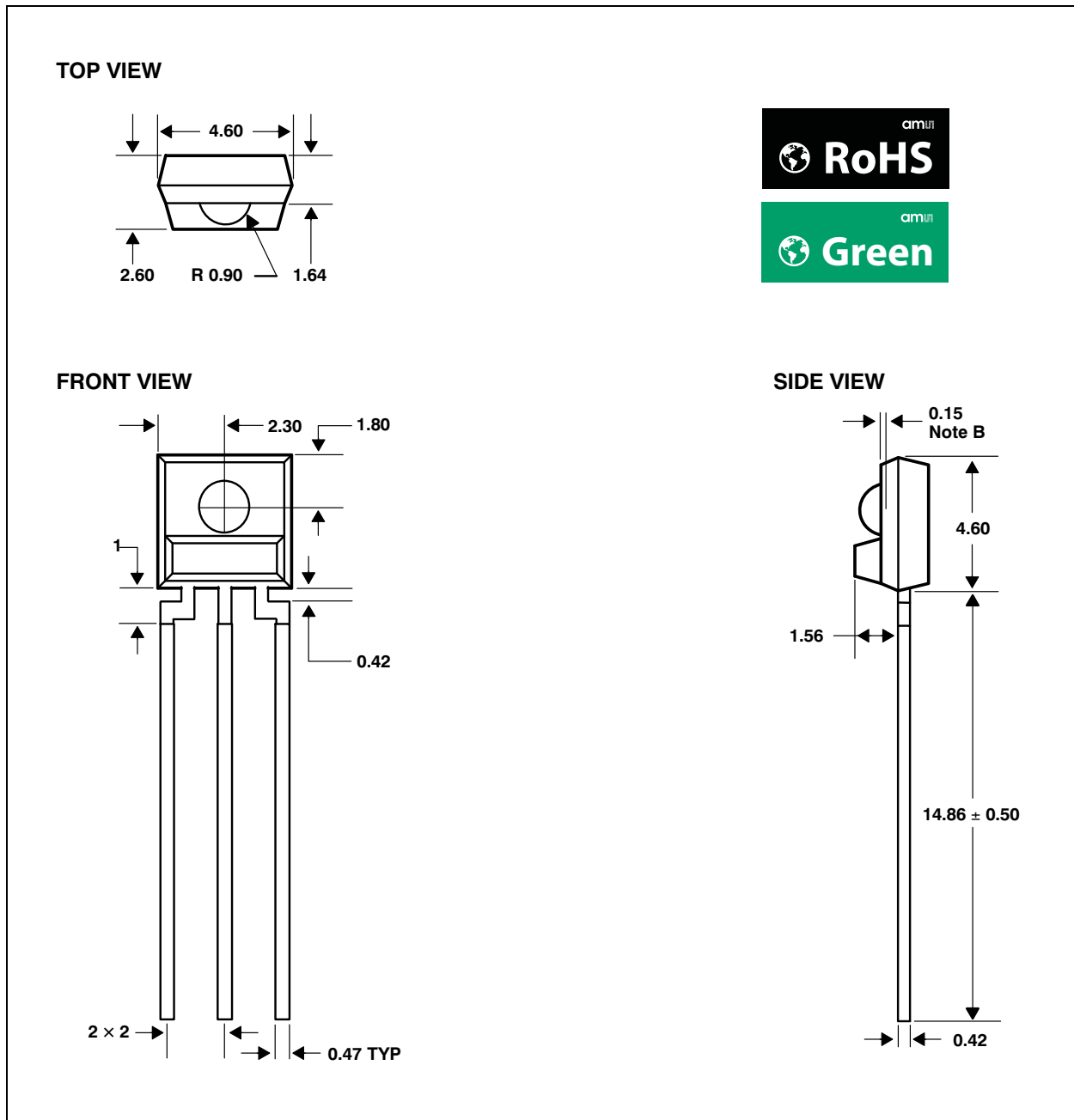


## Package Mechanical Data

The device is supplied in a clear plastic three-lead sidelooker through-hole package (S).

### Plastic Single-In-Line Side-Looker Package

**Figure 14:**  
Package S - Plastic Single-In-Line Side-Looker Package Configuration



#### Note(s):

1. All linear dimensions are in millimeters; tolerance is  $\pm 0.25\text{mm}$  unless otherwise stated.
2. Dimension is to center of lens arc, which is located below the package face.
3. The integrated photodiode active area is round with a typical diameter of 0.75mm and is typically located in the center of the lens and 0.97mm below the top of the lens surface.
4. Index of refraction of clear plastic is 1.55.
5. Lead finish for TSL257-LF: solder dipped, 100% Sn.
6. This drawing is subject to change without notice.

## Ordering & Contact Information

Figure 15:  
Ordering Information

Ordering Code	Device	T <sub>A</sub>	Package-Leads	Package Designator
TSL257-LF	TSL257	0°C to 70°C	3-lead Sidelooker - Lead (Pb) Free	S

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Document Status	Product Status	Definition
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## Revision Information

Changes from 1-00 (2016-Jul-25) to current revision 1-01 (2018-May-04)	Page
Removed Figure 4 (Pin Diagram of Package SM Surface Mount Sidelooker)	
Updated Figure 5	4
Removed Application Information including Figure (Suggested SM Package PCB Layout)	
Removed Plastic Surface Mount Side-Looker Package including figure (Package SM)	
Updated Figure 15	12

**Note(s):**

1. Page and figure numbers for the previous version may differ from page and figure numbers in the current revision.
2. Correction of typographical errors is not explicitly mentioned.



## Content Guide

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