TSL245R

Infrared Light-to-Frequency Converter

General Description

The TSL245R light-to-frequency converter combines a silicon photodiode and a current-to-frequency converter on a single monolithic CMOS integrated circuit. Output is a square wave (50% duty cycle) with frequency directly proportional to light intensity (irradiance) on the photodiode. The digital output allows direct interface to a microcontroller or other logic circuitry. The TSL245R is characterized for operation over the temperature range of -25°C to 70°C and is supplied in a 3-lead plastic side-looker package with an integral visible-light cutoff filter and lens. When supplied in the lead (Pb) free package, the devices are RoHS compliant.

Ordering Information and Content Guide appear at end of datasheet.

Key Benefits & Features

The benefits and features of TSL245R, Infrared Light-to-Frequency Converter are listed below:

Figure 1:
Added Value of Using TSL245R

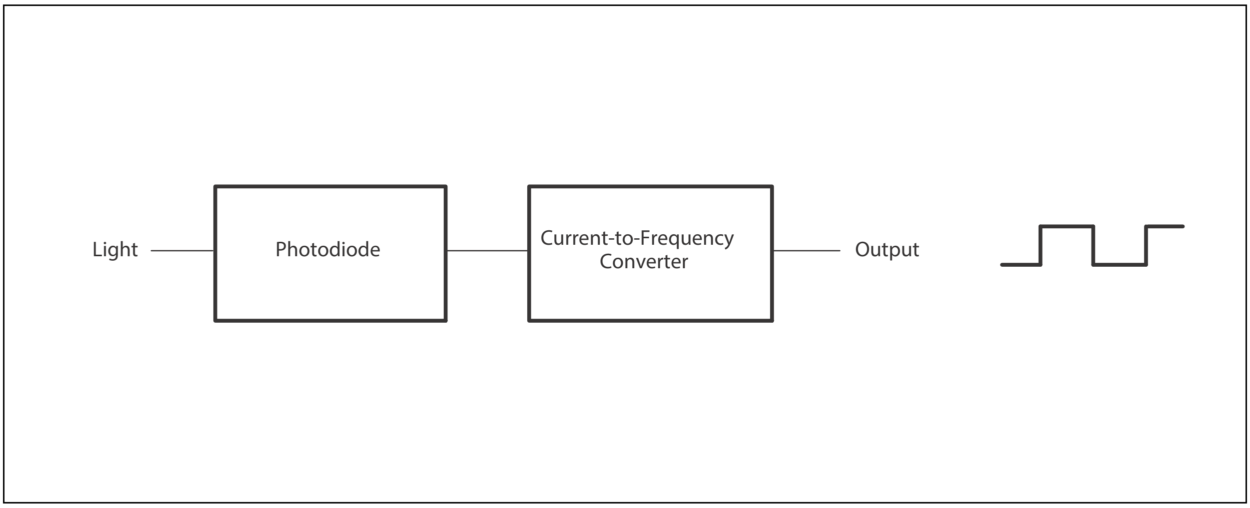
Benefits	Features
• High-Resolution Conversion of Light Intensity to Frequency with no External Components	• 1M:1 Input Dynamic Range
• Provides Low Light Level Operation	• Low Dark Frequency of 0.4 Hz (typical)
• Provides for High Sensitivity to Detect a Small Change in Light	• High Irradiance Responsivity: Typically 500Hz/(μW/cm2) at 940nm
• Provides Additional Sensitivity Advantages	• 2x Gain Lens
• Enables Infra-Red Sensing Capabilities	• Spectral Response from 850nm to 1000nm

- Communicates Directly With a Microcontroller
- Compact Three-Leaded Plastic Package
- Integral Visible-Light Cutoff Filter
- Single-Supply Operation: 2.7V to 5.5V
- Nonlinearity Error Typically 0.2% at 100kHz
- Available in Through-Hole and Surface Mount Three-Lead Sidelooker Packages
- Replacement for TSL245

Functional Block Diagram

The functional blocks of this device are shown below:

Figure 2:
TSL245R Block Diagram



Pin Assignment

Figure 3:
Pin Diagram

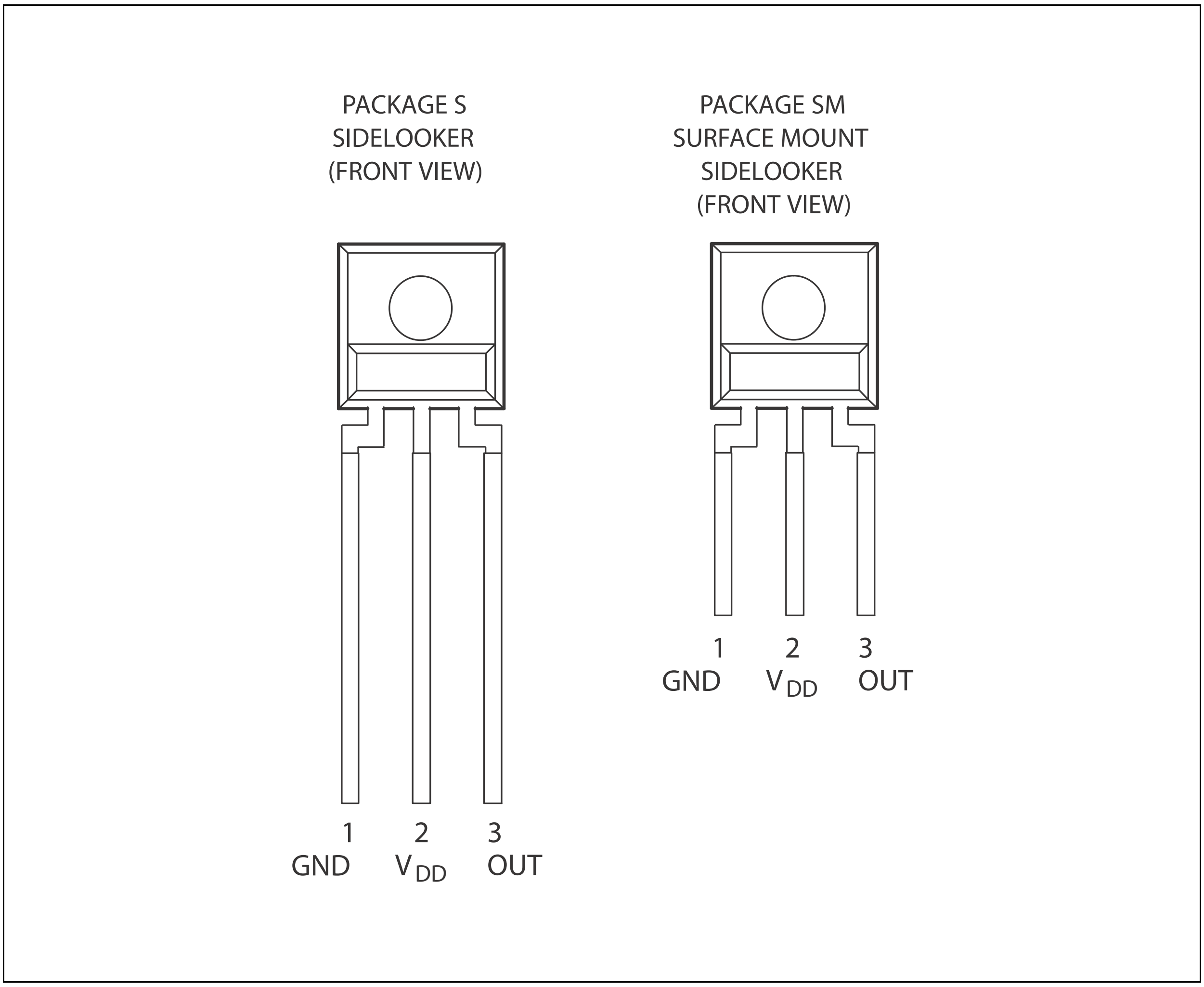


Figure 4:
Pin Description

Terminal		Description
No.	Name	
1	GND	Power supply ground (substrate). All voltages are referenced to GND.
2	V_{DD}	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 Recommended 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 [(1)]		6	V
T_A	Operating free-air temperature range	-25	70	°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
	Reflow solder, in accordance with J-STD-020C or J-STD-020D (SM 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.

Figure 6:
Recommended Operating Conditions

Symbol	Parameter	Min	Nom	Max	Unit
V_{DD}	Supply voltage	2.7	5	5.5	V
T_A	Operating free-air temperature range	-25		70	°C

Figure 7:
Electrical Characteristics at V_{DD} = 5V, T_A = 25°C (unless otherwise noted)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{OH}	High-level output voltage	I_{OH} = -4mA	4	4.5		V
V_{OL}	Low-level output voltage	I_{OL} = 4mA		0.25	0.4	V
I_{DD}	Supply current			2	3	mA
	Full-scale frequency [(1)]		500			kHz
k_{SVS}	Supply-voltage sensitivity	V_{DD} = 5V ± 10%		±0.5		%/V

Note(s):

1. Full-scale frequency is the maximum operating frequency of the device without saturation.

Figure 8:
Operating Characteristics at V_{DD} = 5V, T_A = 25°C, λ_p = 940nm

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
f_O	Output frequency	E_e = 40µW/cm^2	10	20	30	kHz
f_D	Dark frequency	E_e = 0µW/cm^2		0.4	10	Hz
R_e	Irradiance responsivity			0.5		kHz/ (µW/cm^2)
	Nonlinearity [(1)]	f_O = 0kHz to 10kHz		±0.1%		%F.S.
		f_O = 0kHz to 100kHz		±0.2%		%F.S.
	Step response to full-scale step input		1 pulse of new frequency plus 1µs			

Note(s):

1. Nonlinearity is defined as the deviation of f_O from a straight line between zero and full scale, expressed as a percent of full scale.

Typical Operating Characteristics

Figure 9:
Output Frequency vs. Irradiance

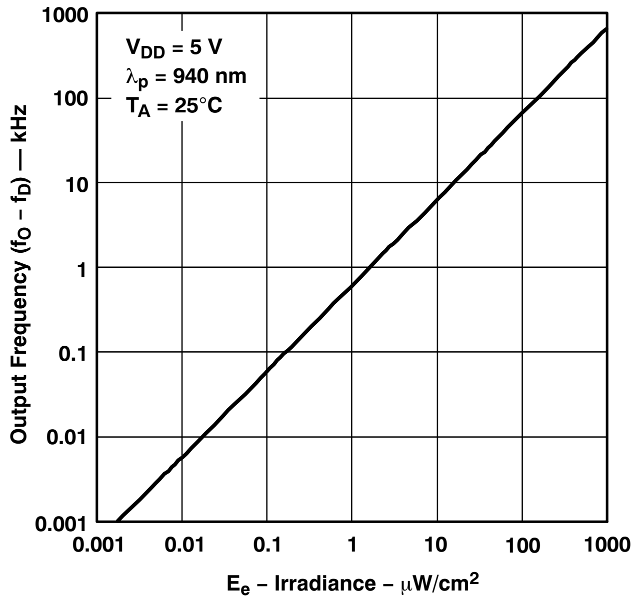


Figure 10:
Photodiode Spectral Response

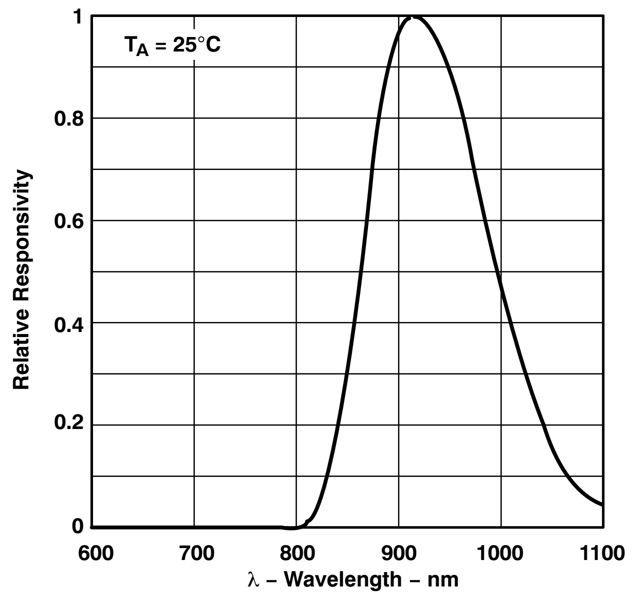


Figure 11:
Dark Frequency vs. Temperature

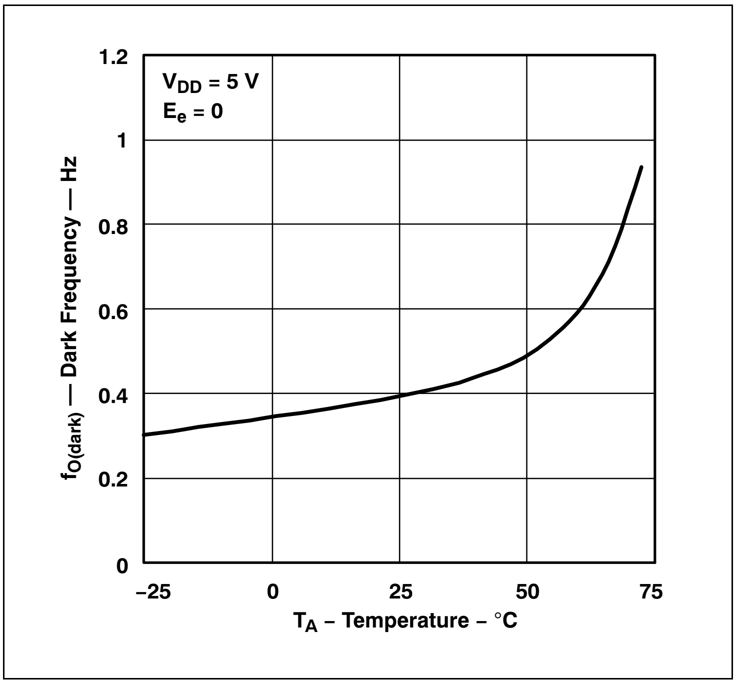
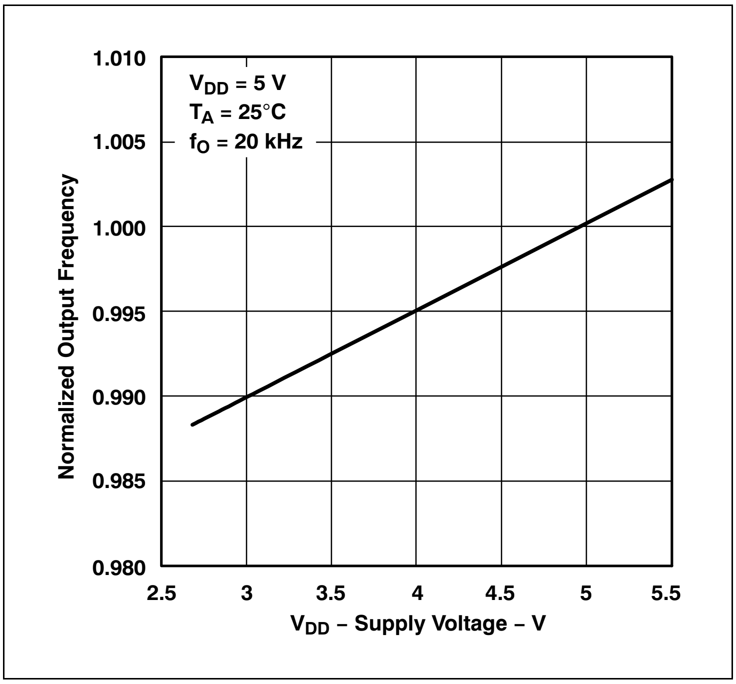


Figure 12:
Output Frequency vs. Supply Voltage

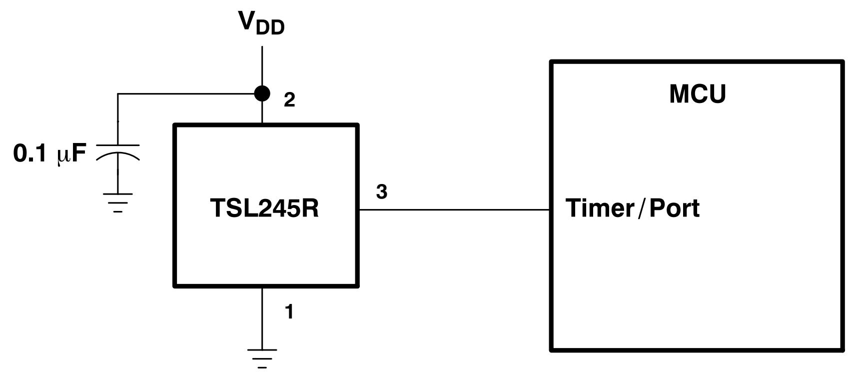


Application Information

Power-Supply Considerations

Power-supply lines must be decoupled by a 0.01µF to 0.1µF capacitor with short leads placed close to the TSL245R (Figure 13). A low-noise power supply is required to minimize jitter on output pulse.

Figure 13:
Typical TSL245R Interface to a Microcontroller



Device Operational Details

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

(EQ1) $f_O = f_D + (R_e)\ (E_e)$

where:

- f_O is the output frequency
- f_D is the output frequency for dark condition ($E_e = 0$)
- R_e is the device responsivity for a given wavelength of light given in kHz/(µW/cm^2)
- E_e is the incident irradiance in µW/cm^2

f_D is an output frequency resulting from leakage currents. As shown in the equation above, this frequency represents a light-independent term in the total output frequency f_O. At very low light levels, this dark frequency can be a significant portion of f_O. The dark frequency is temperature dependent. For optimum performance of any given device over the full output range, the value of f_D should be measured (in the absence of light) and later subtracted from subsequent light measurement (see Figure 9).

Output Interface

The output of the device is designed to drive a standard TTL or CMOS logic input over short distances. If lines greater than 12 inches are used on the output, a buffer or line driver is recommended.

Measuring the Frequency

The choice of interface and measurement technique depends on the desired resolution and data-acquisition rate. For maximum data-acquisition rate, period-measurement techniques are used.

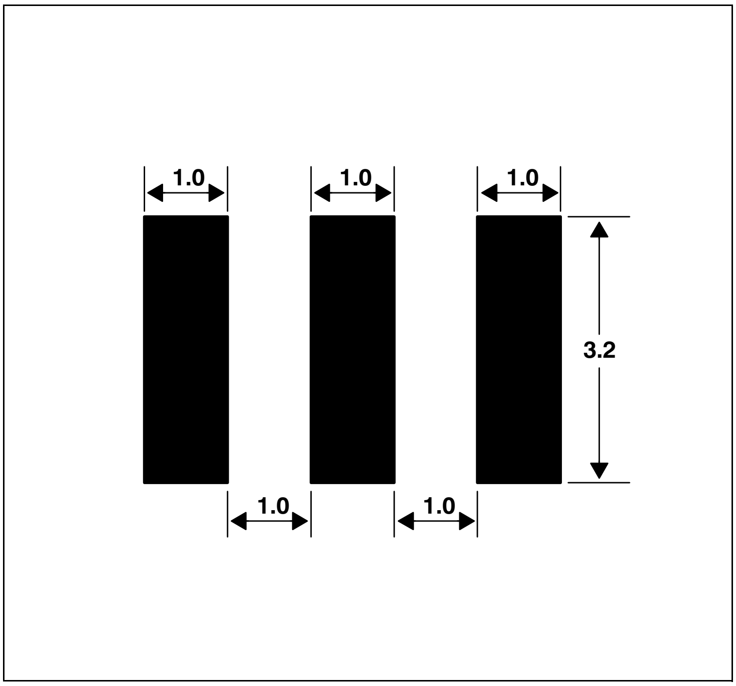
Period measurement requires the use of a fast reference clock with available resolution directly related to reference-clock rate. The technique is employed to measure rapidly varying light levels or to make a fast measurement of a constant light source.

Maximum resolution and accuracy may be obtained using frequency-measurement, pulse-accumulation, or integration techniques. Frequency measurements provide the added benefit of averaging out random- or high-frequency variations (jitter) resulting from noise in the light signal. Resolution is limited mainly by available counter registers and allowable measurement time. Frequency measurement is well suited for slowly varying or constant light levels and for reading average light levels over short periods of time. Integration, the accumulation of pulses over a very long period of time, can be used to measure exposure - the amount of light present in an area over a given time period.

PCB Pad Layout

Suggested PCB pad layout guidelines for the SM surface mount package are shown in Figure 14.

Figure 14:
Suggested SM Package PCB Layout

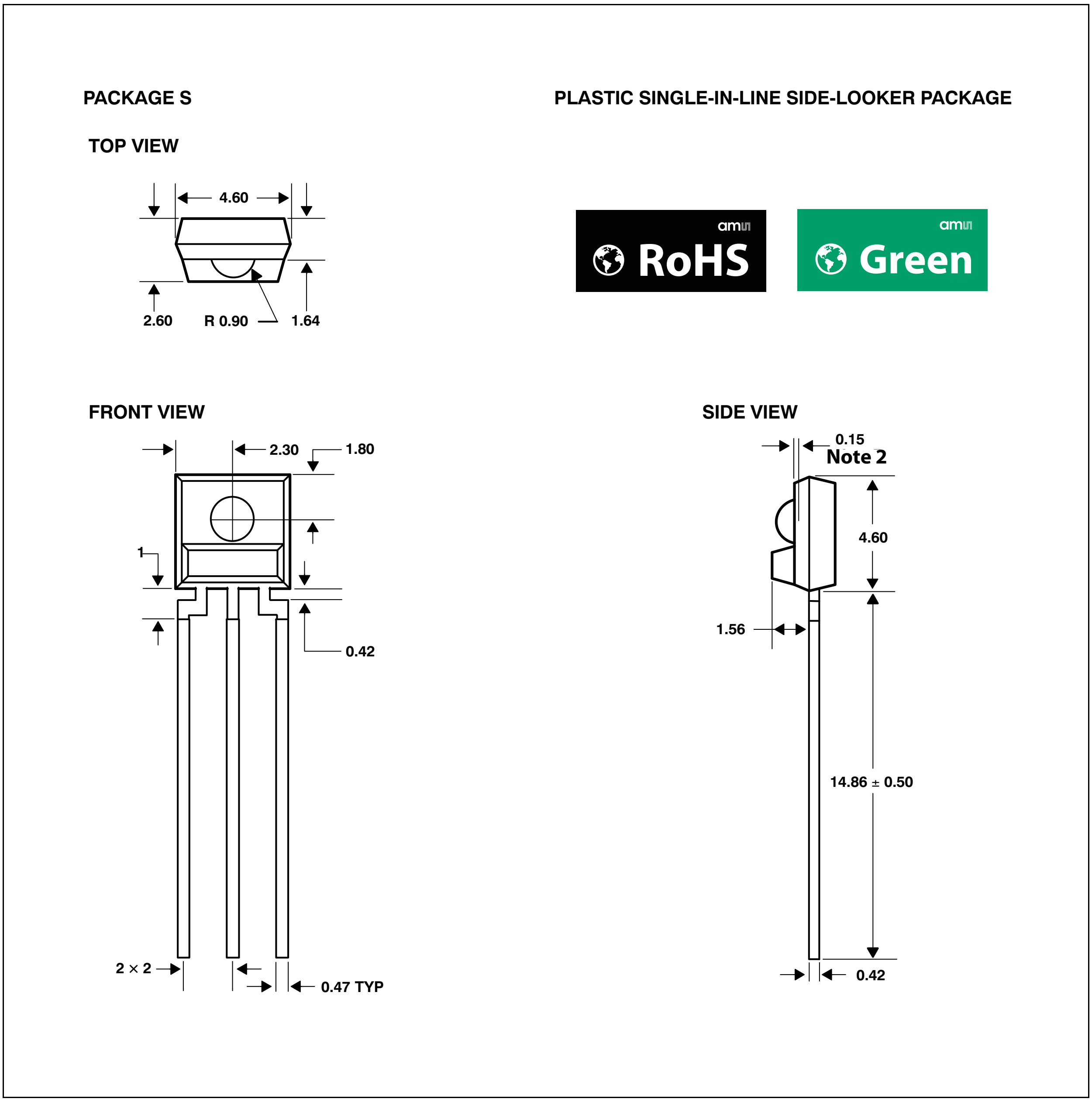


Note(s):

1. All linear dimensions are in millimeters.
2. This drawing is subject to change without notice.

Packaging Mechanical Data

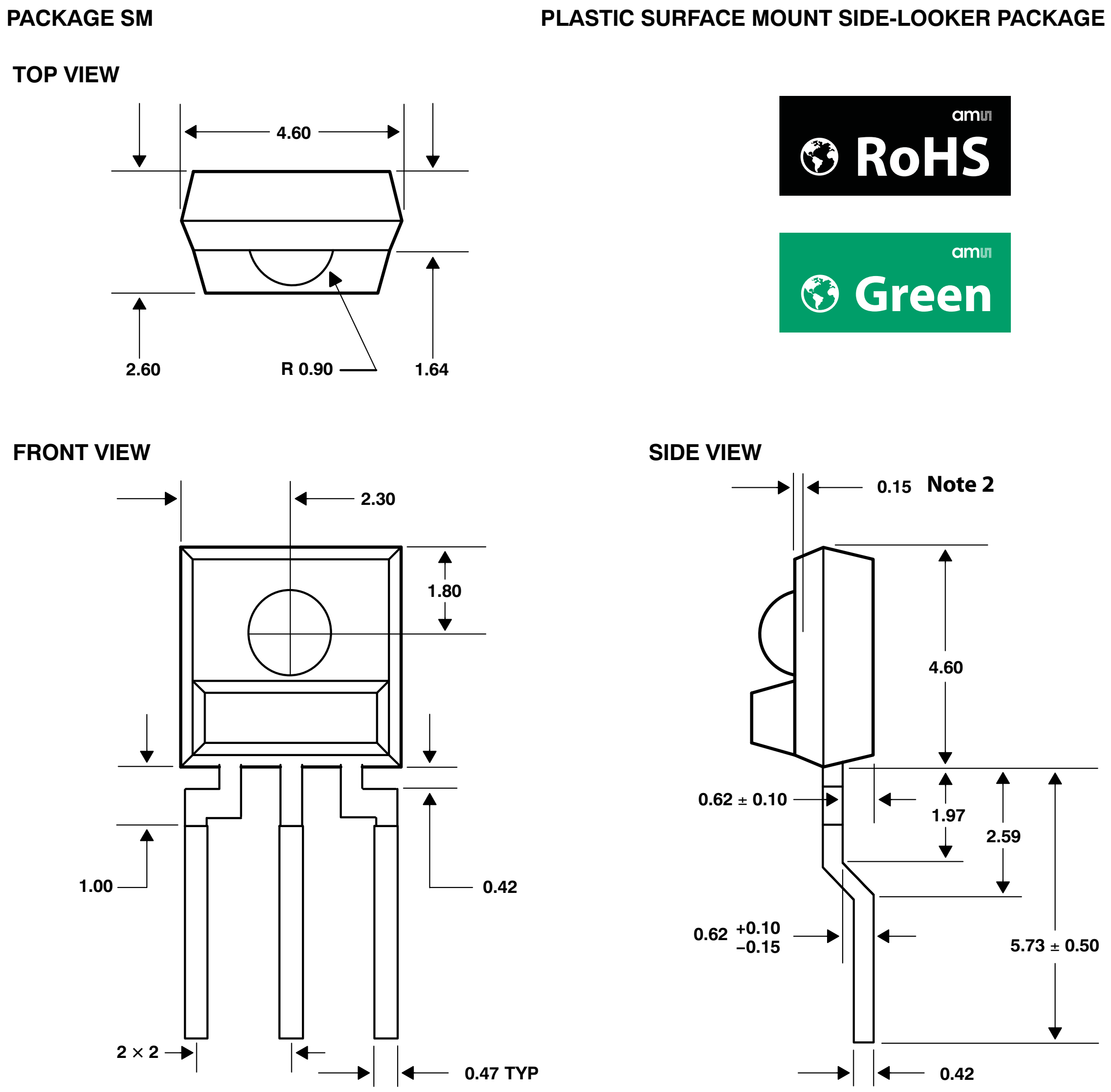
Figure 15:
Package S - Plastic Single-In-Line Side-Looker Package Configuration



Note(s):

1. All linear dimensions are in millimeters; tolerance is ±0.25mm unless otherwise stated.
2. Dimension is to center of lens arc, which is located below the package face.
3. The 0.96mm × 0.96mm integrated photodiode active area is typically located in the center of the lens and 0.97mm below the top of the lens surface.
4. Lead finish for TSL245xR-LF: solder dipped, 100% Sn.
5. This drawing is subject to change without notice.

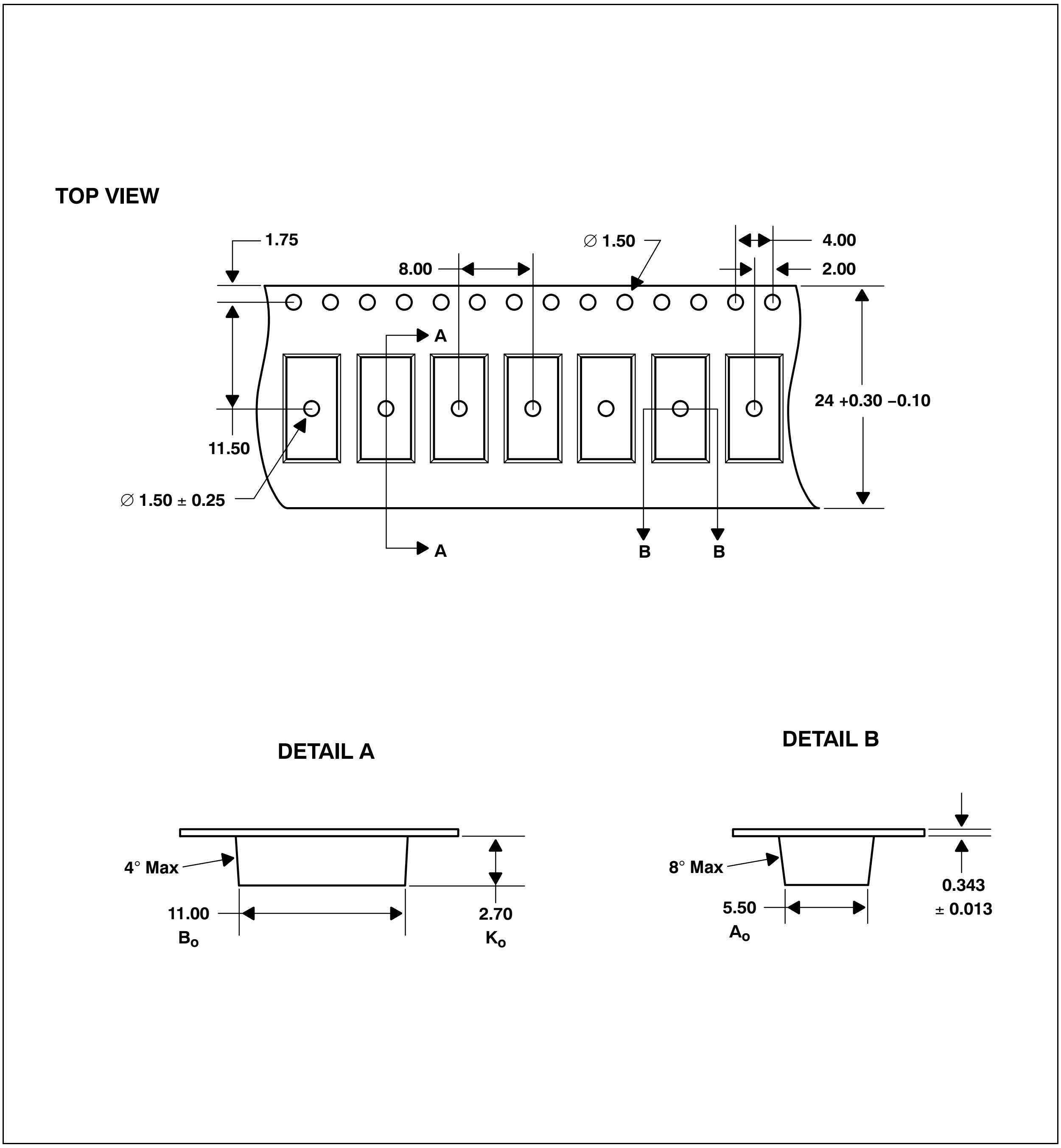
Figure 16:
Package SM - Plastic Surface Mount Side-Looker Package Configuration



Note(s):

1. All linear dimensions are in millimeters; tolerance is ±0.25mm unless otherwise stated.
2. Dimension is to center of lens arc, which is located below the package face.
3. The 0.96mm × 0.96mm integrated photodiode active area is typically located in the center of the lens and 0.97mm below the top of the lens surface.
4. Lead finish for TSL245xRSM-LF: solder dipped, 100% Sn.
5. This drawing is subject to change without notice.

Figure 17:
Package SM Carrier Tape



Note(s):

1. All linear dimensions are in millimeters, dimension tolerance is ±0.10mm unless otherwise noted.
2. The dimensions on this drawing are for illustrative purposes only. Dimensions of an actual carrier may vary slightly.
3. Symbols on drawing A_o, B_o, and K_o are defined in ANSI EIA Standard 481-B 2001.
4. Each reel is 33 millimeters in diameter and contains 2500 parts.
5. **ams** packaging tape and reel conform to the requirements of EIA Standard 481-B.
6. Only surface mount parts (package SM) are supplied in tape and reel.
7. This drawing is subject to change without notice.

Ordering & Contact Information

Figure 18:
Ordering Information

Ordering Code	Device	T_A	Package-Leads	Package Designator
TSL245R-LF	TSL245R	-25°C to 70°C	3-lead Sidelooker - Lead (Pb) Free	S
TSL245RSM-LF	TSL245R	-25°C to 70°C	3-lead Surface-Mount Sidelooker - Lead (Pb) Free	SM

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Document Status	Product Status	Definition
Product Preview	Pre-Development	Information in this datasheet is based on product ideas in the planning phase of development. All specifications are design goals without any warranty and are subject to change without notice
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Datasheet (discontinued)	Discontinued	Information in this datasheet is based on products which conform to specifications in accordance with the terms of ams AG standard warranty as given in the General Terms of Trade, but these products have been superseded and should not be used for new designs

Revision Information

Changes from 060D (2007-Sep) to current revision 1-00 (2016-Jul-27)	Page
Content of TAOS datasheet was converted to the latest **ams** design	
Added Figure 1	1
Updated note under Figure 15	12
Updated note under Figure 16	13
Updated Figure 18	15

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