



- High-Resolution Conversion of Light Intensity to Frequency With No External Components
- Communicates Directly With a Microcontroller
- Compact Three-Leaded Clear-Plastic Package
- Single-Supply Operation Down to 2.7 V
- Nonlinearity Error Typically 0.2% at 100 kHz
- Stable 150 ppm/°C Temperature Coefficient
- Single-Supply Operation
- RoHS Compliant (–LF Package Only)

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### Description

The TSL235R 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 device has been temperature compensated for the ultraviolet-to-visible light range of 320 nm to 700 nm and responds over the light range of 320 nm to 1050 nm. The TSL235R is characterized for operation over the temperature range of –25°C to 70°C and is supplied in a 3-lead clear plastic side-looker 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 <sub>A</sub>	PACKAGE – LEADS	PACKAGE DESIGNATOR	ORDERING NUMBER
TSL235R	–25°C to 70°C	3-lead Sidelooker	S	TSL235R
TSL235R	–25°C to 70°C	3-lead Sidelooker—Lead (Pb) Free	S	TSL235R–LF
TSL235R	–25°C to 70°C	3-lead Surface-Mount Sidelooker—Lead (Pb) Free	SM	TSL235RSM–LF

### Terminal Functions

TERMINAL NAME	NO.	TYPE	DESCRIPTION
GND	1		Power supply ground (substrate). All voltages are referenced to GND.
OUT	3	O	Output frequency.
V <sub>DD</sub>	2		Supply voltage.

# TSL235R LIGHT-TO-FREQUENCY CONVERTER

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## Absolute Maximum Ratings over operating free-air temperature range (unless otherwise noted)<sup>†</sup>

Supply voltage, $V_{DD}$ (see Note 1)	6 V
Operating free-air temperature range, $T_A$	–25°C to 70°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

<sup>†</sup> 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.

NOTE 1: All voltage values are with respect to GND.

## Recommended Operating Conditions

	MIN	NOM	MAX	UNIT
Supply voltage, $V_{DD}$	2.7	5	5.5	V
Operating free-air temperature range, $T_A$	–25		70	°C

## Electrical Characteristics at $V_{DD} = 5\text{ V}$ , $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{OH}$ High-level output voltage	$I_{OH} = -4\text{ mA}$	4	4.5		V
$V_{OL}$ Low-level output voltage	$I_{OL} = 4\text{ mA}$		0.25	0.4	V
$I_{DD}$ Supply current			2	3	mA
Full-scale frequency <sup>‡</sup>		500			kHz
Temperature coefficient of output frequency	Wavelength < 700nm		±150		ppm/°C
$k_{SVS}$ Supply-voltage sensitivity	$V_{DD} = 5\text{ V} \pm 10\%$		±0.5		%/V

<sup>‡</sup> Full-scale frequency is the maximum operating frequency of the device without saturation.

## Operating Characteristics at $V_{DD} = 5\text{ V}$ , $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$f_O$ Output frequency	$E_e = 430\text{ }\mu\text{W}/\text{cm}^2$ , $\lambda_p = 635\text{ nm}$	200	250	300	kHz
	$E_e = 0\text{ }\mu\text{W}/\text{cm}^2$		0.4	10	Hz
Nonlinearity <sup>§</sup>	$f_O = 0\text{ kHz to }10\text{ kHz}$		±0.1%		%F.S.
	$f_O = 0\text{ kHz to }100\text{ kHz}$		±0.2%		%F.S.
Step response to full-scale step input			1 pulse of new frequency plus 1 $\mu\text{s}$		

<sup>‡</sup> Full-scale frequency is the maximum operating frequency of the device without saturation.

<sup>§</sup> 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.

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## TYPICAL CHARACTERISTICS

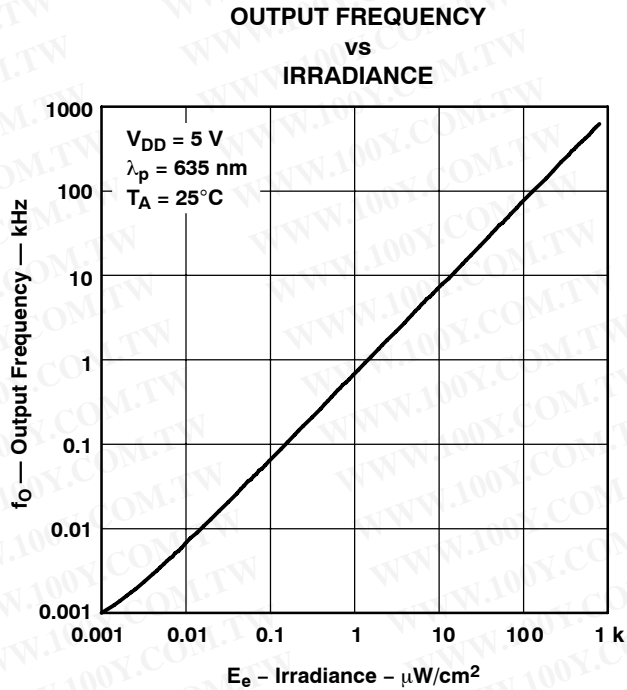


Figure 1

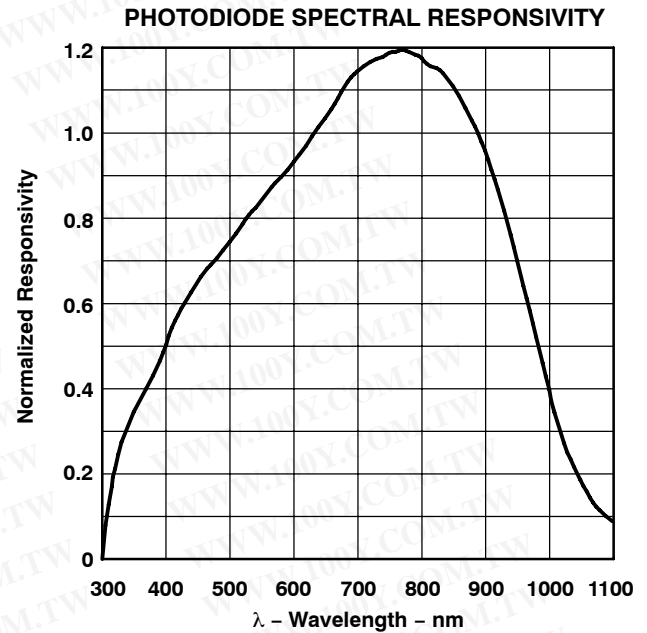


Figure 2

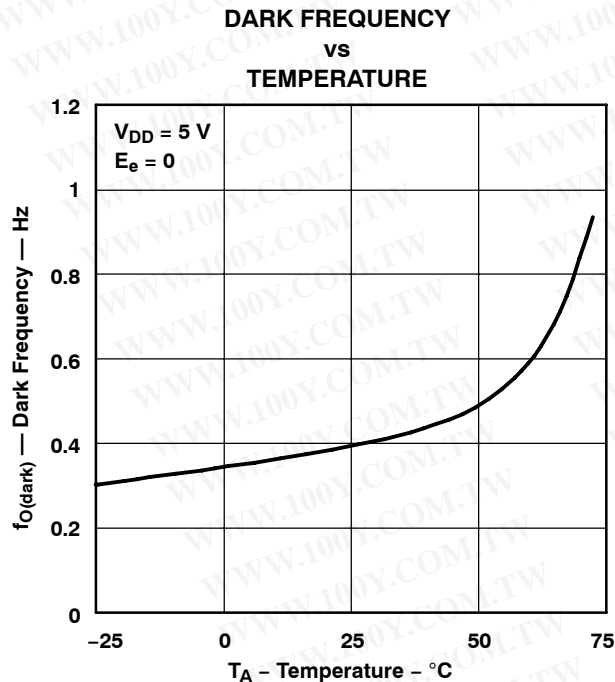


Figure 3

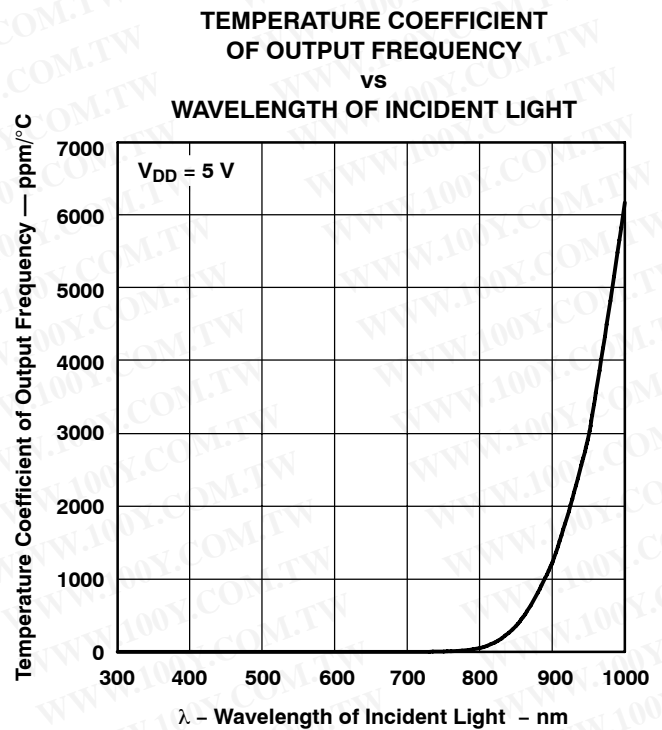


Figure 4

TSL235R  
LIGHT-TO-FREQUENCY CONVERTER

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TYPICAL CHARACTERISTICS

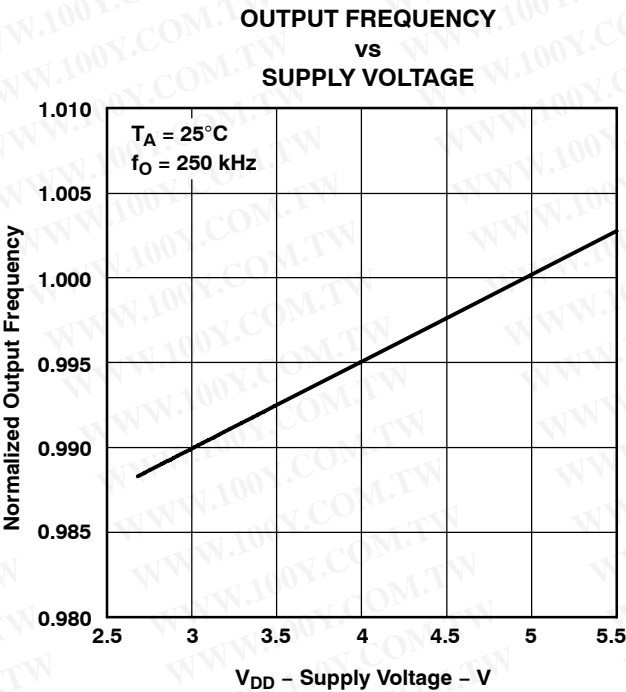


Figure 5

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## APPLICATION INFORMATION

### Power-supply considerations

Power-supply lines must be decoupled by a 0.01- $\mu$ F to 0.1- $\mu$ F capacitor with short leads placed close to the TSL235R (Figure 6).

### Output interface

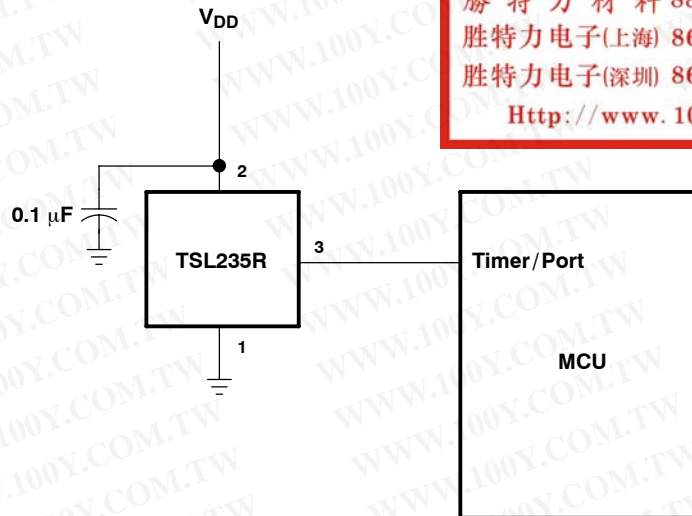
The output of the device is designed to drive a standard TTL or CMOS logic input over short distances. If lines greater than 12 inches are used on the output, a buffer or line driver is recommended.

### 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.



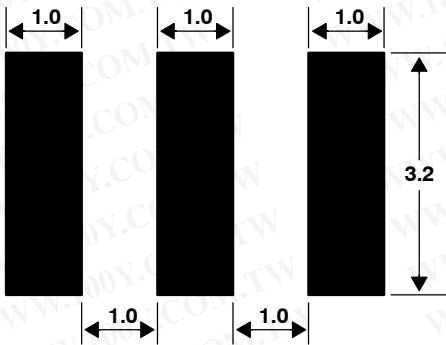
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Figure 6. Typical TSL235R Interface to a Microcontroller

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

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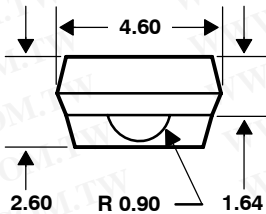
**MECHANICAL DATA**

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

**PACKAGE S**

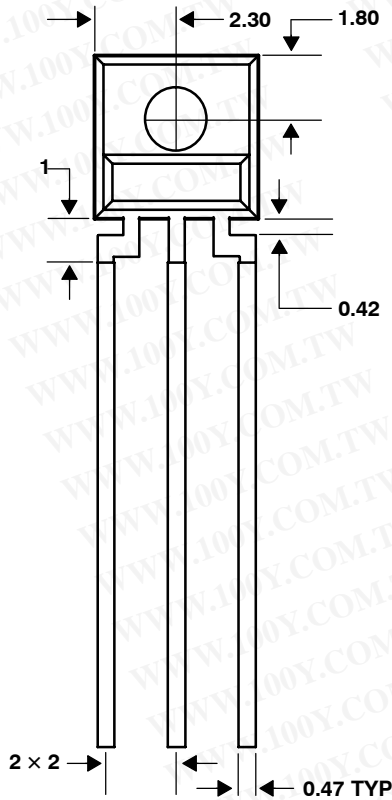
**PLASTIC SINGLE-IN-LINE SIDE-LOOKER PACKAGE**

**TOP VIEW**

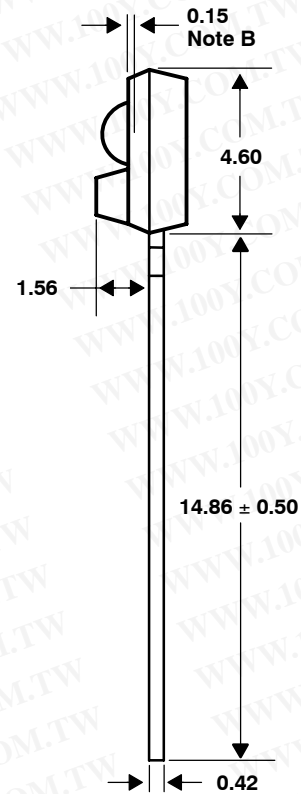


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**FRONT VIEW**



**SIDE VIEW**



Lead Free  
 Available

- NOTES: A. All linear dimensions are in millimeters; tolerance is  $\pm 0.25$  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  $0.92 \text{ mm}^2$  in size and is 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 TSL235R: solder dipped, 63% Sn/37% Pb. Lead finish for TSL235R-LF: solder dipped, 100% Sn.  
 F. This drawing is subject to change without notice.

**Figure 8. Package S — Single-In-Line Side-Looker Package Configuration**

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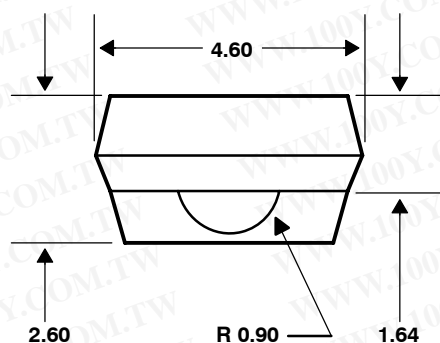
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## MECHANICAL DATA

### PACKAGE SM

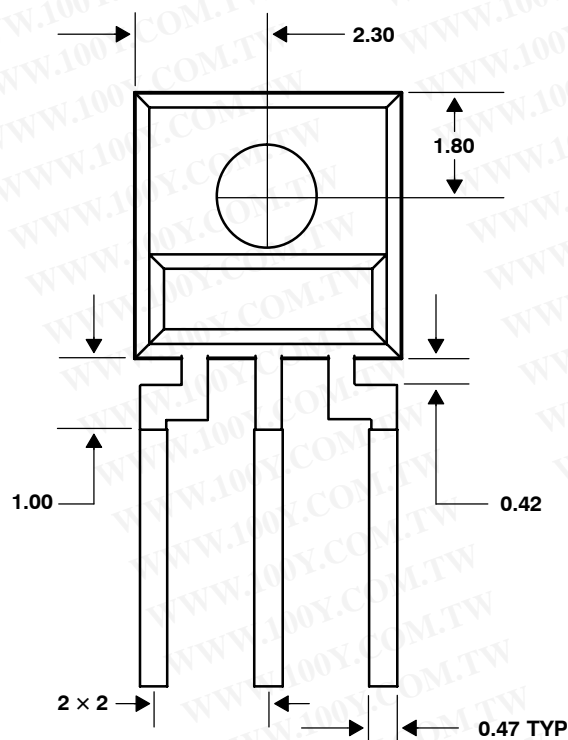
### PLASTIC SURFACE MOUNT SIDE-LOOKER PACKAGE

#### TOP VIEW

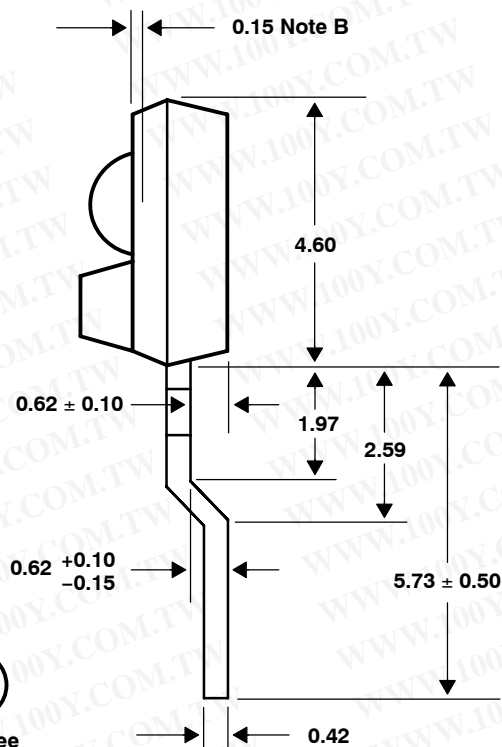


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#### FRONT VIEW



#### SIDE VIEW



Lead Free

- NOTES: A. All linear dimensions are in millimeters; tolerance is  $\pm 0.25$  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 TSL235RSM-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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