

# TSL235 LIGHT-TO-FREQUENCY CONVERTER

SOES012 – SEPTEMBER 1994

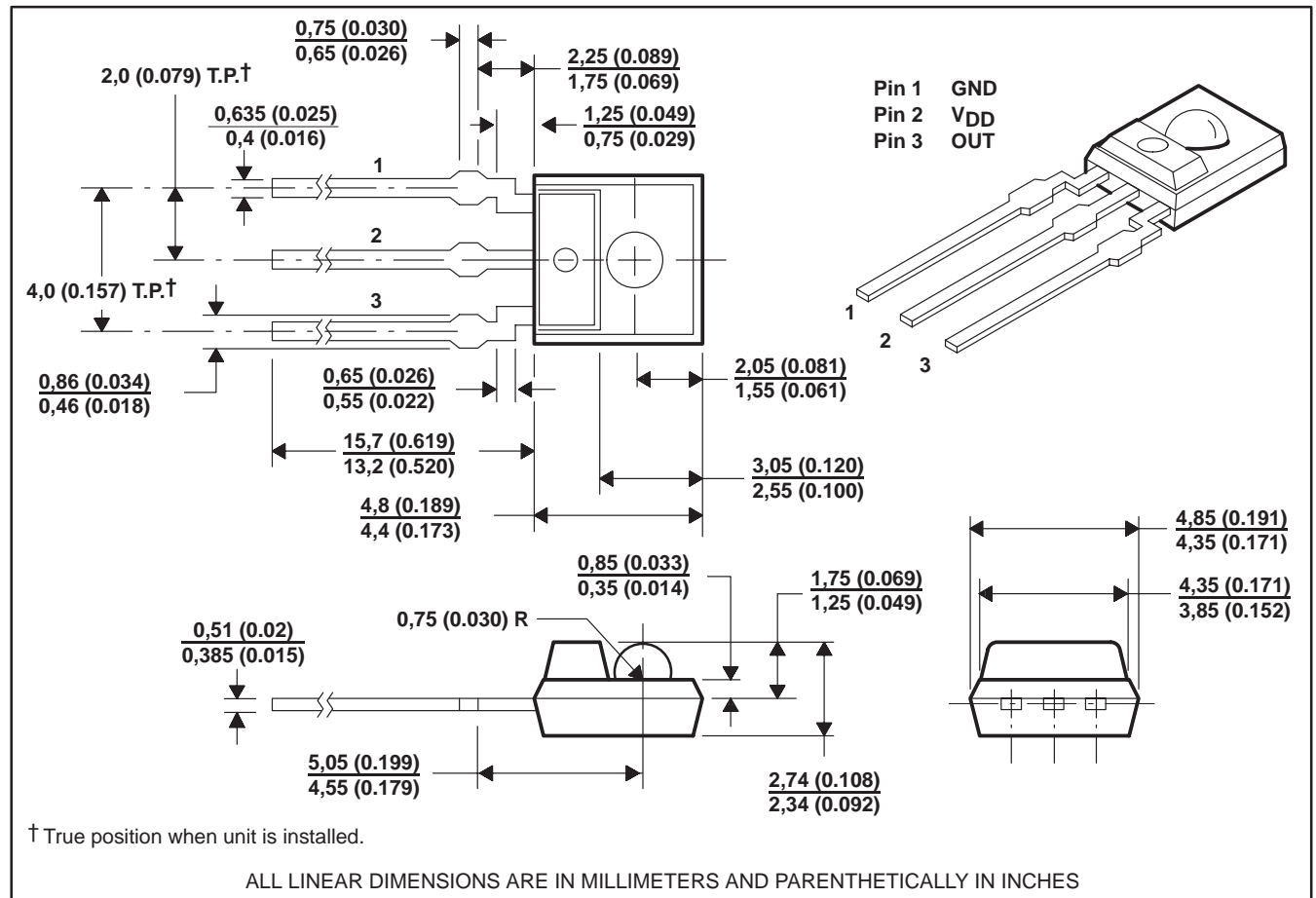
- High-Resolution Conversion of Light Intensity to Frequency With No External Components
- Communicates Directly With a Microcontroller
- Compact Three-Leaded Clear-Plastic Package
- Single-Supply Operation Down to 2.7 V
- Nonlinearity Error Typically 0.2% at 100 kHz
- Stable 100 ppm/°C Temperature Coefficient
- Advanced LinCMOS™ Technology

## description

The TSL235 light-to-frequency converter combines a silicon photodiode and a current-to-frequency converter on a single monolithic CMOS integrated circuit. The output is a square wave (50% duty cycle) with frequency directly proportional to light intensity. Because it is TTL compatible, the 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 300 nm to 700 nm and responds over the light range of 300 nm to 1100 nm. The TSL235 is characterized for operation over the temperature range of -25°C to 70°C.

## mechanical data

The TSL235 is offered in a clear-plastic three-leaded package. The photodiode area is 1.36 mm<sup>2</sup> (0.0029 in<sup>2</sup>).



Advanced LinCMOS is a trademark of Texas Instruments Incorporated.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.



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# TSL235

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### functional block diagram



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

Supply voltage, $V_{DD}$ (see Note 1)	6.5 V
Operating free-air temperature range, $T_A$	–25°C to 70°C
Storage temperature range	–25°C to 85°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	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	6	V
Operating free-air temperature range, $T_A$	–25		70	°C

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

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{OH}$ High-level output voltage	$I_{OH} = -4$ mA	4	4.3		V
$V_{OL}$ Low-level output voltage	$I_{OL} = 4$ mA		0.17	0.26	V
$I_{DD}$ Supply current			2	3	mA
Full-scale frequency <sup>‡</sup>		500			kHz
Temperature coefficient of output frequency	$\lambda \leq 700$ nm, $-25^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$		$\pm 100$		ppm/°C
$k_{SVS}$ Supply-voltage sensitivity	$V_{DD} = 5$ V $\pm 10\%$		0.5		%/V

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

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

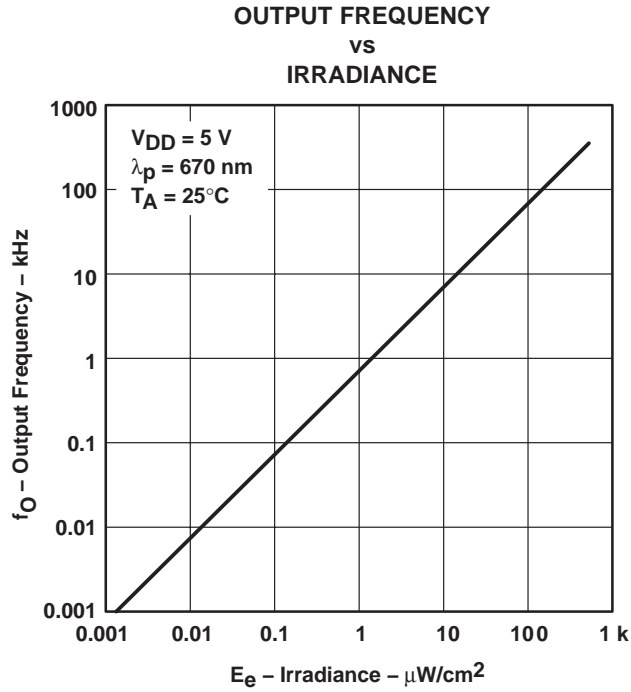
PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$f_O$ Output frequency	$E_e = 375 \mu\text{W}/\text{cm}^2$ , $\lambda_p = 670$ nm	200	250	300	kHz
	$E_e = 0$		0.25	10	Hz
Nonlinearity <sup>§</sup>	$f_O = 0$ kHz to 10 kHz		$\pm 0.1\%$		%F.S.
	$f_O = 0$ kHz to 100 kHz		$\pm 0.2\%$		%F.S.
Step response to full-scale 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.

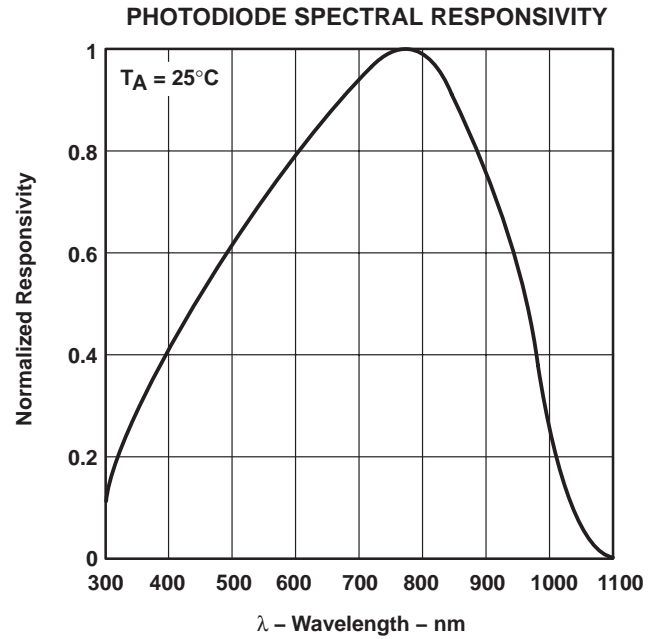
<sup>§</sup> Nonlinearity is defined as the deviation of  $f_O$  from a straight line between zero and full scale, expressed as a percent of full scale.



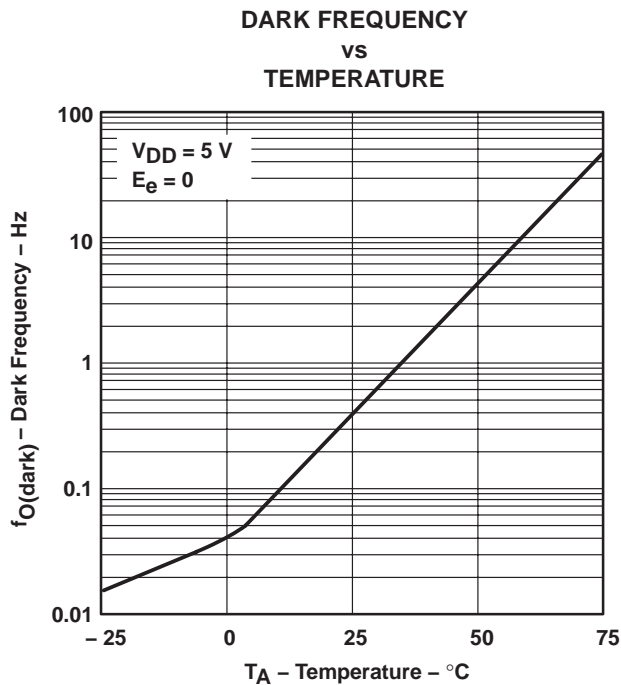
**TYPICAL CHARACTERISTICS**



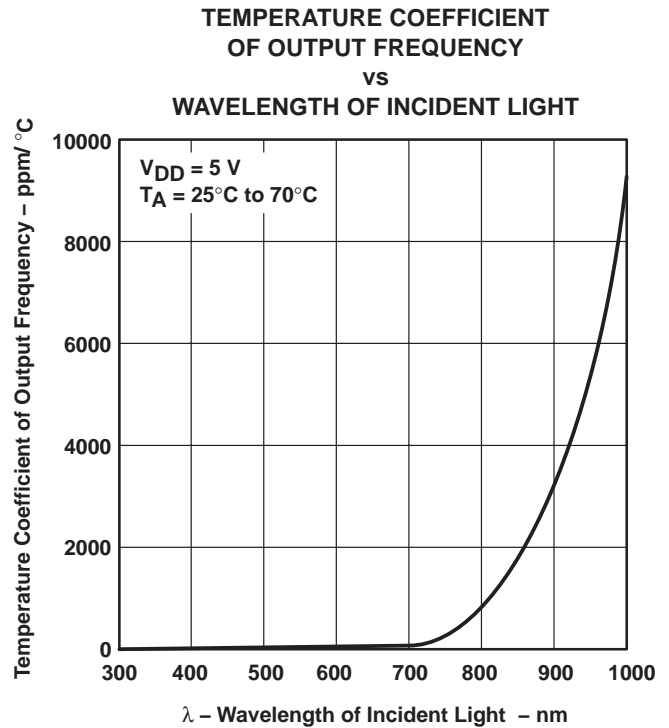
**Figure 1**



**Figure 2**



**Figure 3**



**Figure 4**

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## TYPICAL CHARACTERISTICS

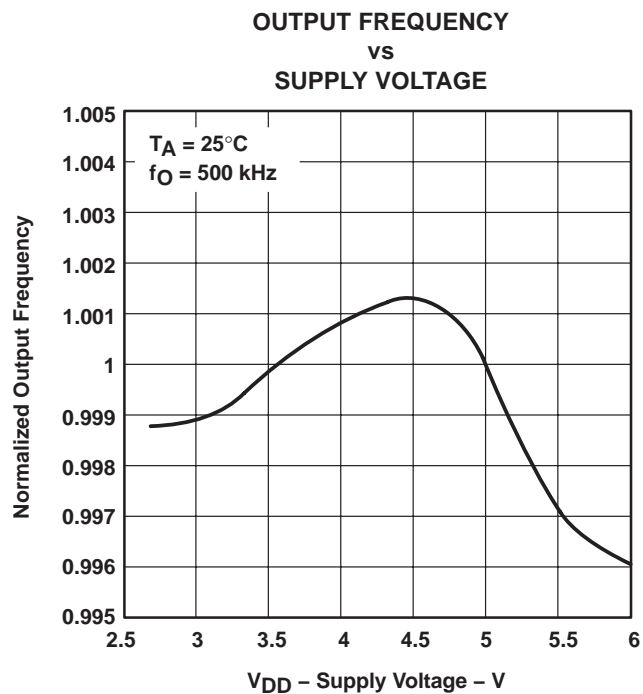


Figure 5



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## APPLICATION INFORMATION

### power-supply considerations

For optimum device performance, power-supply lines should be decoupled by a 0.01- $\mu$ F to 0.1- $\mu$ F capacitor with short leads (see Figure 6).

### output interface

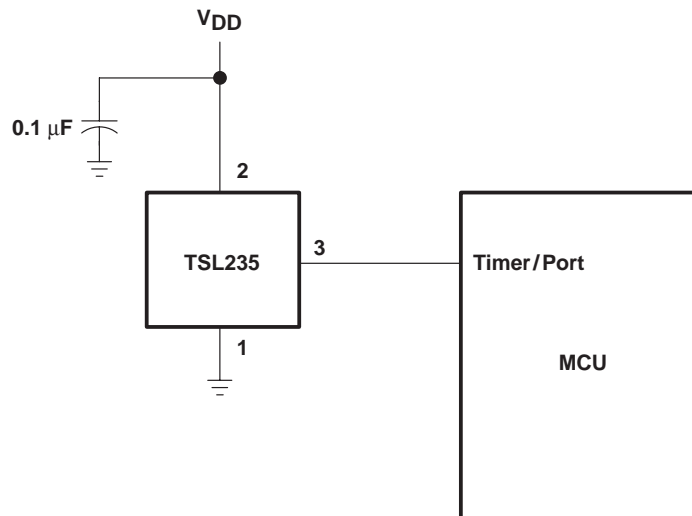
The output of the device is designed to drive a standard TTL or CMOS logic input over short distances. If lines greater than 12 inches are used on the output, a buffer or line driver is recommended.

### 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.



**Figure 6. Typical TSL235 Interface to a Microcontroller**

## PACKAGING INFORMATION

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
TSL235	OBSOLETE	PDIP	P	3		TBD	Call TI	Call TI

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

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**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

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<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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