

# TSL245 INFRARED LIGHT-TO-FREQUENCY CONVERTER

SOES018 – MAY 1995

- High-Resolution Conversion of Light Intensity to Frequency With No External Components
- Direct Interface With a Microcontroller
- Compact Three-Leaded Plastic Package
- Single-Supply Operation Down to 2.7 V
- Nonlinearity Error Typically 0.2% at 100 kHz
- Advanced LinCMOS™ Technology
- Integral Visible-Light Cutoff Filter

## description

The TSL245 infrared 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 the output is TTL compatible, it allows direct interface to a microcontroller or other logic circuitry. The device responds over the infrared light range of 800 nm to 1100 nm. The TSL245 is characterized for operation over the temperature range of  $-25^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ .

The TSL245 is offered in a black, infrared-transmissive package (see Figure 1). The photodiode area is  $1.36\text{ mm}^2$  ( $0.0029\text{ in}^2$ ).

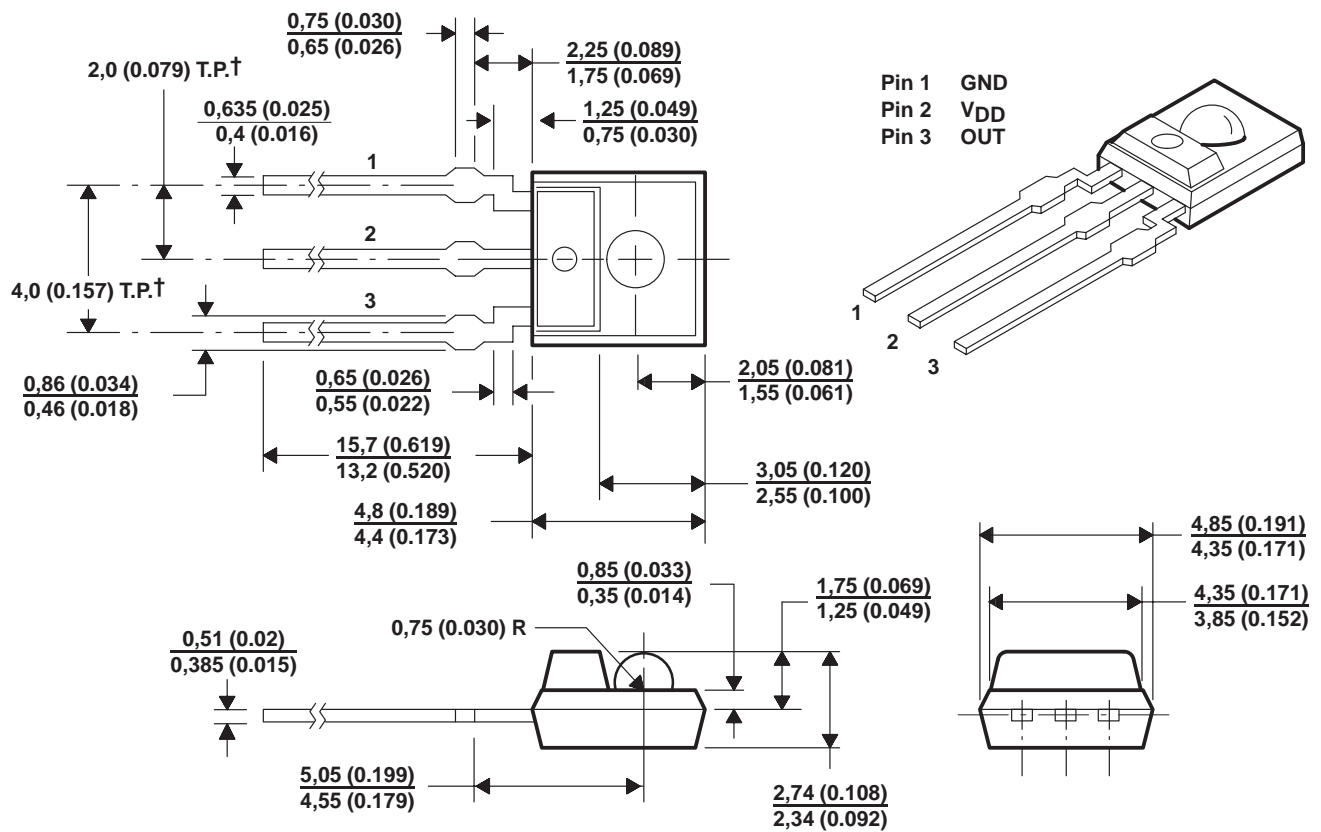


Figure 1. TSL245 Packaging Configuration

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.



POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Copyright © 1995, Texas Instruments Incorporated

# TSL245 INFRARED LIGHT-TO-FREQUENCY CONVERTER

SOES018 – MAY 1995

## functional block diagram



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

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, $T_{stg}$	-25°C to 85°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	260°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.

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{OH}$	High-level output voltage	$I_{OH} = -4\text{ mA}$	4	4.3		V
$V_{OL}$	Low-level output voltage	$I_{OL} = 4\text{ mA}$		0.17	0.26	V
$I_{DD}$	Supply current			2	3	mA
	Full-scale frequency‡		500			kHz
$k_{SVS}$	Supply-voltage sensitivity	$V_{DD} = 5\text{ V} \pm 10\%$		0.5		%/V

‡ 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	$E_e = 920\ \mu\text{W}/\text{cm}^2$ , $\lambda_p = 940\text{ nm}$	200	250	300	kHz
		$E_e = 0$		0.25	10	Hz
Nonlinearity§		$f_O = 0\text{ kHz to }10\text{ kHz}$		$\pm 0.1\%$		%F.S.
		$f_O = 0\text{ kHz to }100\text{ kHz}$		$\pm 0.2\%$		%F.S.
Step response to full-scale step input			1 pulse of new frequency plus 1 $\mu\text{s}$			

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

§ 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

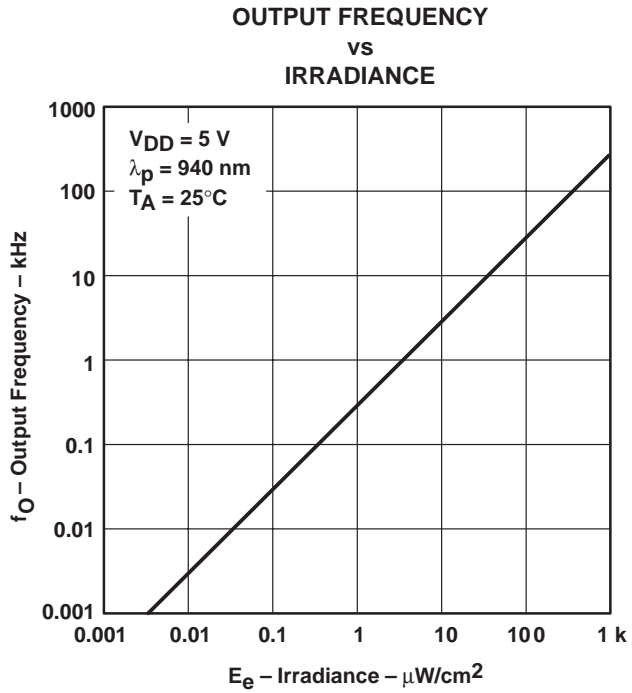


Figure 2

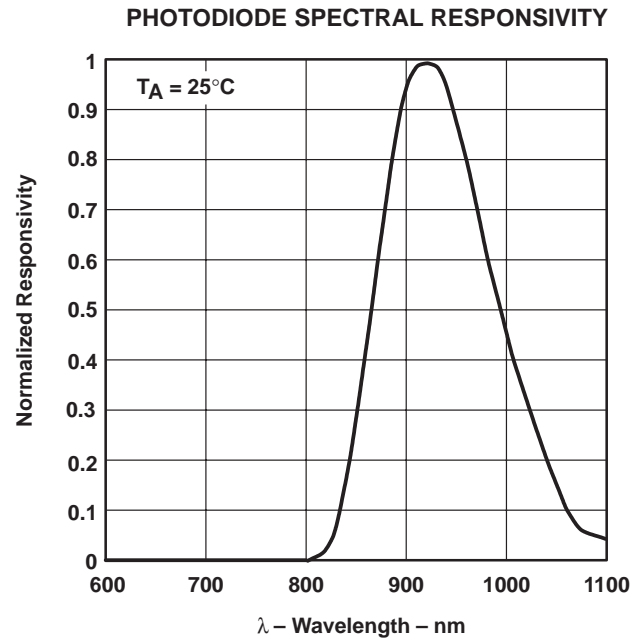


Figure 3

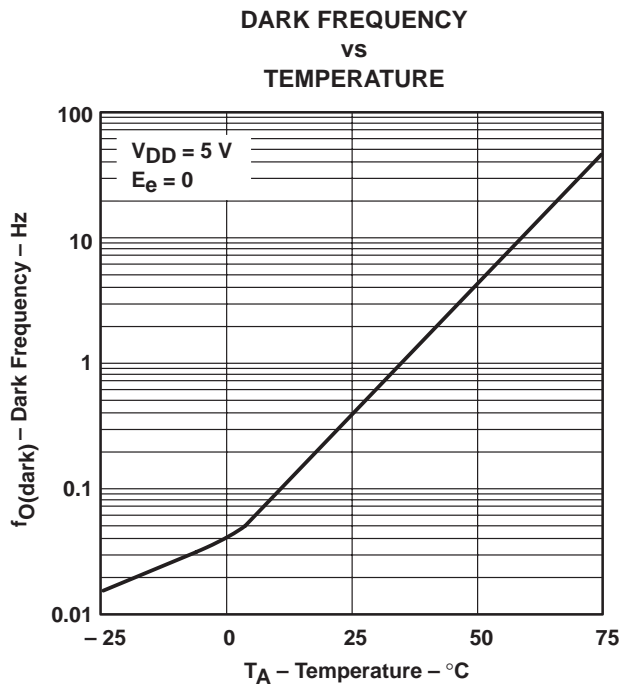


Figure 4

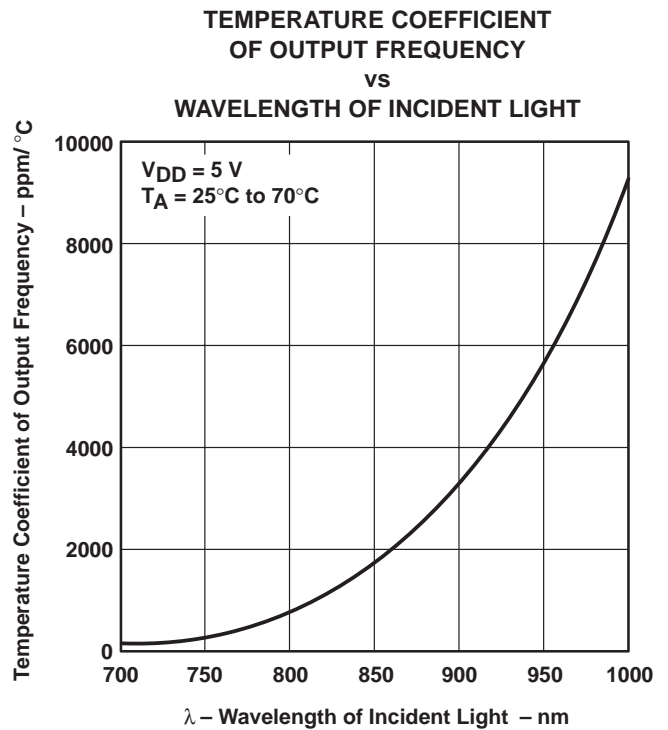


Figure 5

# TSL245 INFRARED LIGHT-TO-FREQUENCY CONVERTER

SOES018 – MAY 1995

## TYPICAL CHARACTERISTICS

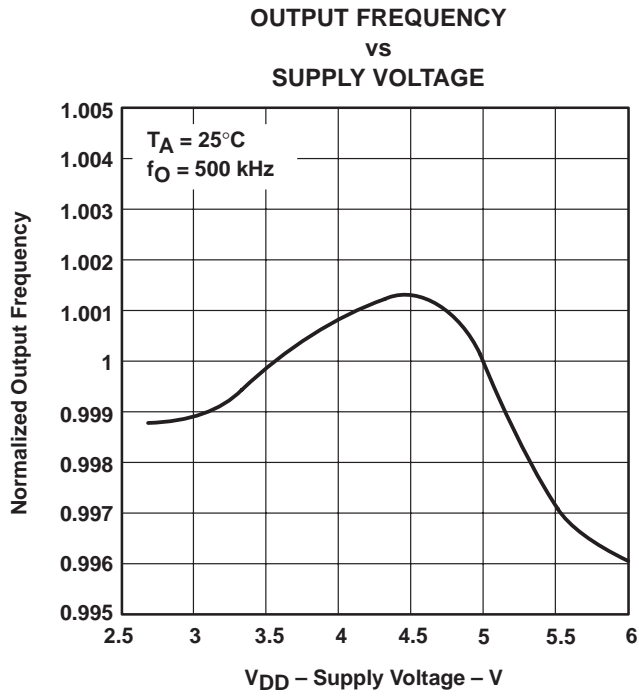


Figure 6

## 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 7).

### output interface

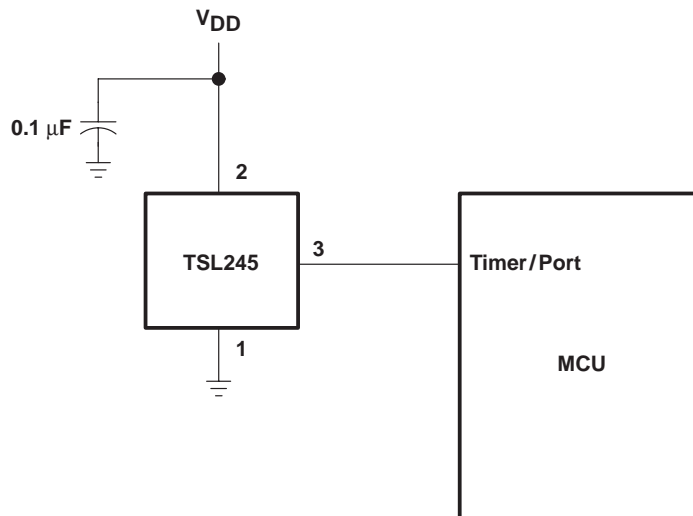
The output of the device is designed to drive a standard TTL or CMOS logic input over short distances. If lines greater than 12 inches are used on the output, a buffer or line driver is recommended.

### measuring the frequency

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

Period measurement requires using a fast reference clock with available resolution directly related to reference clock rate. The technique measures rapidly varying light levels or provides a fast measurement of a constant light source.

Maximum resolution and accuracy can be obtained using frequency-measurement, pulse-accumulation, or integration techniques. Frequency measurements provide the added benefit of averaging random- or high-frequency variations (jitter) resulting from noise in the light signal. Resolution is limited primarily 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 7. Typical TSL245 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>
TSL245	OBSOLETE	TO/SOT	LL	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) 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.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

**Important Information and Disclaimer:**The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

<b>Products</b>		<b>Applications</b>	
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>	Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>	Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>	Broadband	<a href="http://www.ti.com/broadband">www.ti.com/broadband</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>	Digital Control	<a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>	Military	<a href="http://www.ti.com/military">www.ti.com/military</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>	Optical Networking	<a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>	Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
		Telephony	<a href="http://www.ti.com/telephony">www.ti.com/telephony</a>
		Video & Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>
		Wireless	<a href="http://www.ti.com/wireless">www.ti.com/wireless</a>

Mailing Address: Texas Instruments  
Post Office Box 655303 Dallas, Texas 75265