

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°C to 70°C.

The TSL245 is offered in a black, infrared-transmissive package (see Figure 1). The photodiode area is 1.36 mm² (0.0029 in²).

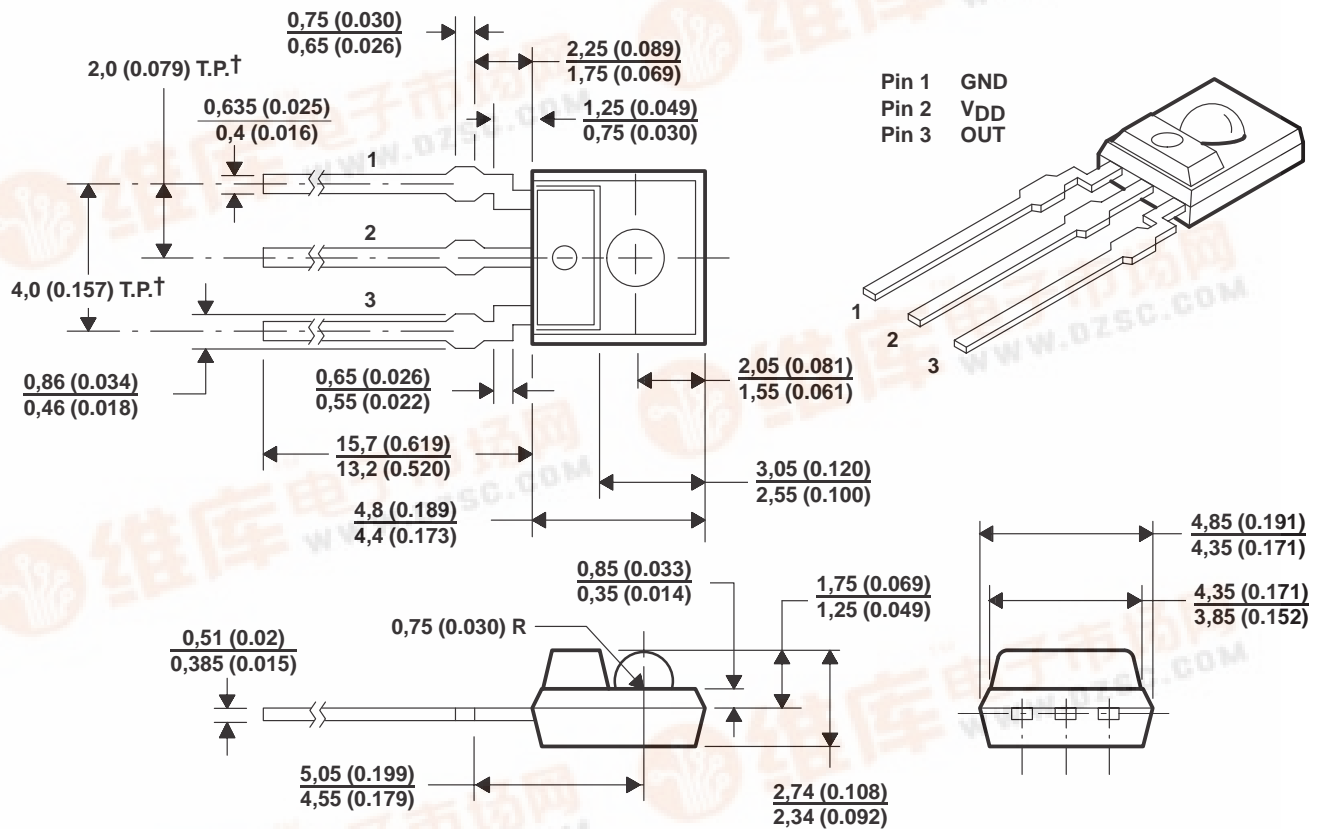


Figure 1. TSL245 Packaging Configuration



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 μs			

‡ 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

OUTPUT FREQUENCY
vs
IRRADIANCE

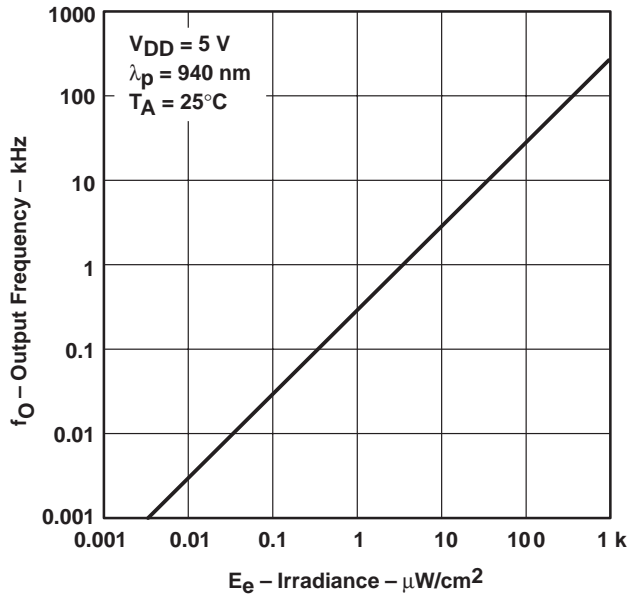


Figure 2

PHOTODIODE SPECTRAL RESPONSIVITY

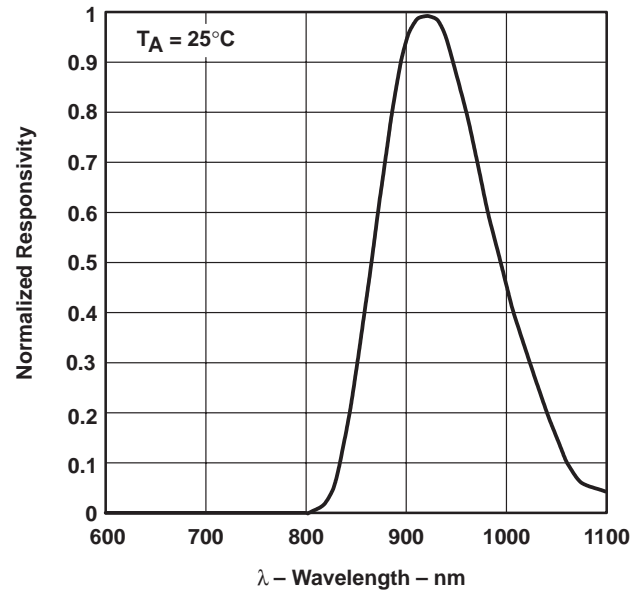


Figure 3

DARK FREQUENCY
vs
TEMPERATURE

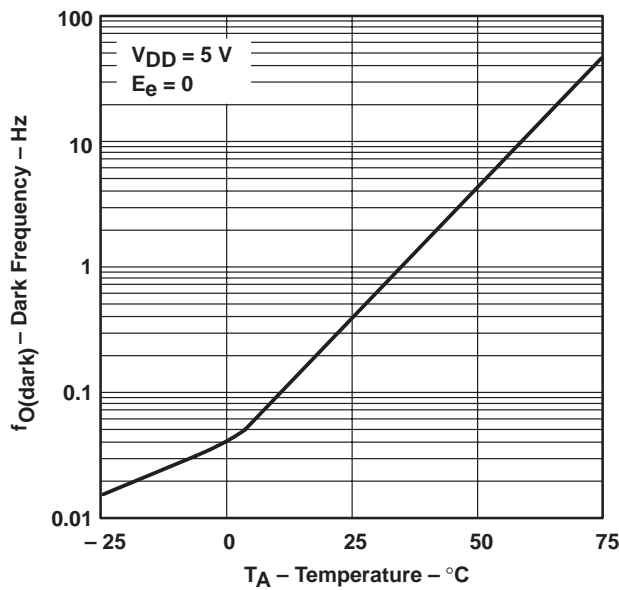


Figure 4

TEMPERATURE COEFFICIENT
OF OUTPUT FREQUENCY
vs
WAVELENGTH OF INCIDENT LIGHT

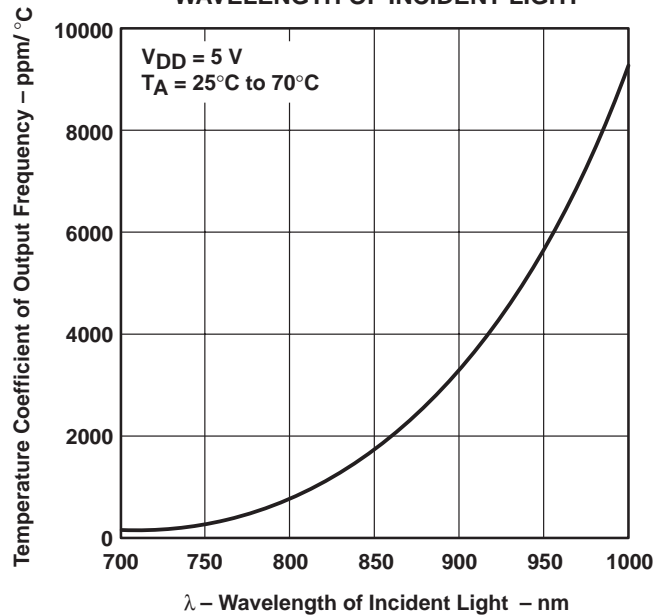


Figure 5

TSL245 INFRARED LIGHT-TO-FREQUENCY CONVERTER

SOES018 – MAY 1995

TYPICAL CHARACTERISTICS

OUTPUT FREQUENCY
vs
SUPPLY VOLTAGE

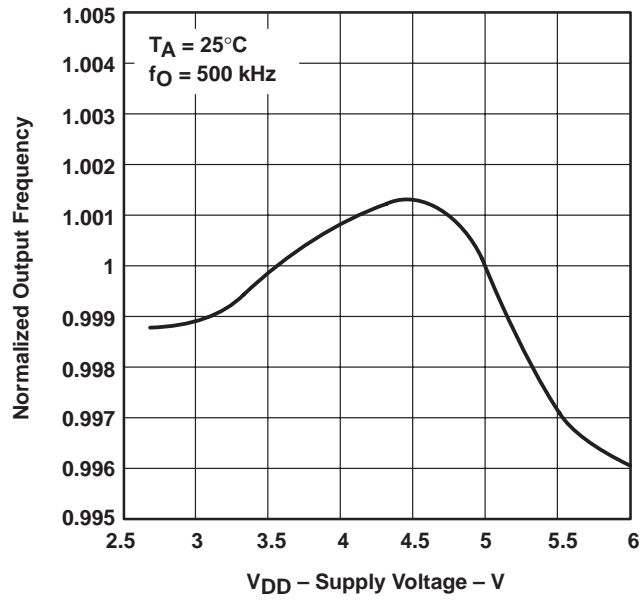


Figure 6

APPLICATION INFORMATION

power-supply considerations

For optimum device performance, power-supply lines should be decoupled by a 0.01- μF to 0.1- μF 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.

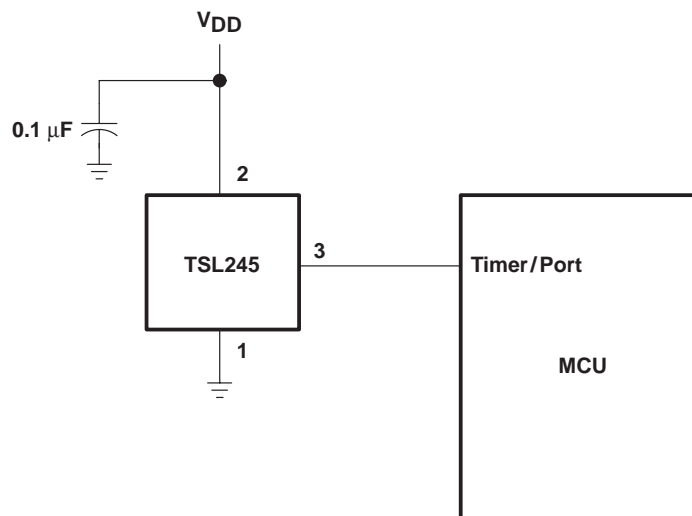


Figure 7. Typical TSL245 Interface to a Microcontroller

IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgement, including those pertaining to warranty, patent infringement, and limitation of liability.

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

CERTAIN APPLICATIONS USING SEMICONDUCTOR PRODUCTS MAY INVOLVE POTENTIAL RISKS OF DEATH, PERSONAL INJURY, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE ("CRITICAL APPLICATIONS"). TI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS. INCLUSION OF TI PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE FULLY AT THE CUSTOMER'S RISK.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, warranty or endorsement thereof.