



Visible Light Sensor

PRODUCTION DATA SHEET

DESCRIPTION

The LX1970 is a new technology light sensor with spectral response that emulates the human eye.

This device is ideal for monitoring ambient light for brightness control systems in flat panel displays. It has a unique photo diode arrangement (patents pending) with a peak response at 520 nm while sharply attenuating both ultra violet and infrared wavelengths.

The photo sensor is a PIN diode array with an accurate, linear, and very repeatable current transfer function.

Photo current is multiplied by integrated high gain amplifiers and is made available at two output pins; one a current source and the other a current sink.

These currents can easily be converted to voltage by adding a single resistor at either or both outputs. Voltage gain is determined by the resistor value typically in the 10KΩ to 50KΩ range.

With accurate internal gain amplifiers, design complexity and cost are greatly reduced.

The LX1970 is available in the 8-pin MSOP.

IMPORTANT: For the most current data, consult MICROSEMI's website: <http://www.microsemi.com>

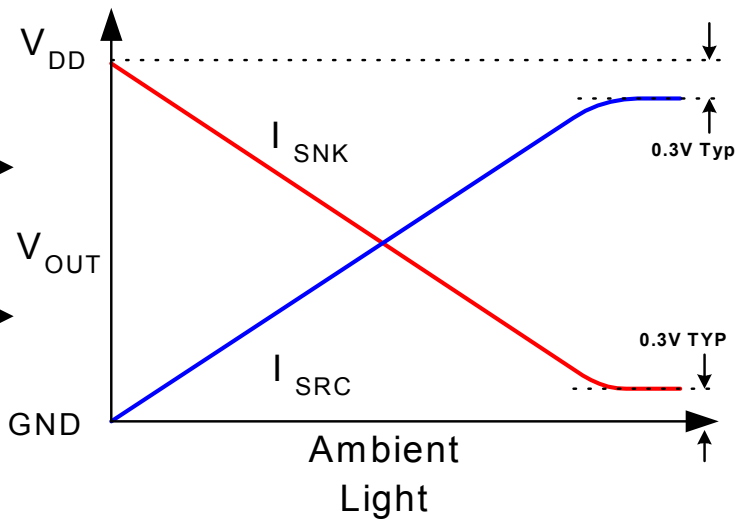
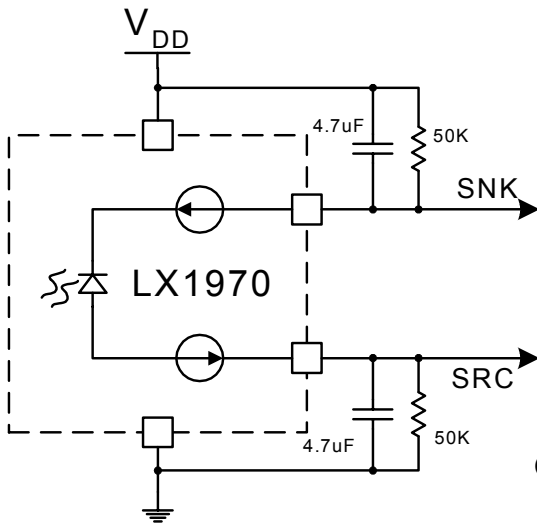
KEY FEATURES

- Approximate Human Eye Spectral Response
- Low IR Sensitivity
- Highly Accurate & Repeatable Output Current vs. Light
- Voltage Scalable
- Temperature Stable
- Integrated High Gain Photo Current Amplifiers
- Complementary Current Outputs
- No Optical Filters Needed

APPLICATIONS

- PDA
- Notebook PC
- LCD TV
- Tablet PC
- Cell phones

PRODUCT HIGHLIGHT



PACKAGE ORDER INFO

T_A (°C)	DU	Plastic MSOP 8-Pin
-40 to 85		LX1970IDU

Note: Available in Tape & Reel.
Append the letter "T" to the part number. (i.e. LX1970IDUT)



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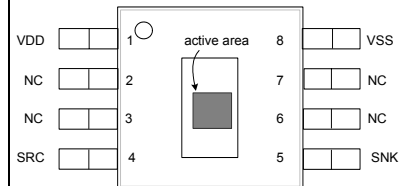
ABSOLUTE MAXIMUM RATINGS

V _{DD}	-0.3 to 6 V _{DC}
SNK/SRC (Output Compliance Voltage).....	-0.3 to V _{DD} + 0.3V _{DC}
SNK/SRC (Maximum Output Current).....	Internally Limited
Operating Temperature Range.....	-40 to +85°C
Storage Temperature Range.....	-55 to 125°C
Solder Reflow Peak Temperature (Soldering 10-30 seconds).....	240°C

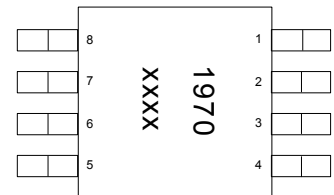
Notes: Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of specified terminal.

Solder reflow to follow: IPC/JEDEC J-STD-020B 7/02 Sn-Pb Small Body Profile

PACKAGE PIN OUT



DU PACKAGE
(Top View)



DU PACKAGE
(Bottom View)

xxxx = Denotes Date Code / Lot Information

THERMAL DATA

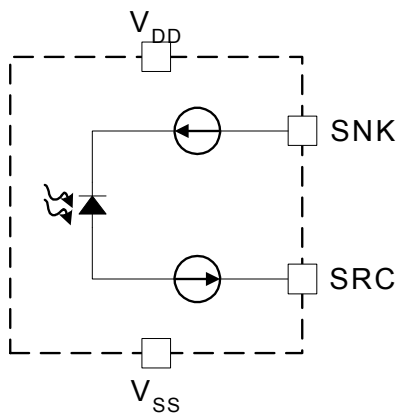
DU Plastic MSOP 8-Pin

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	206°C/W
THERMAL RESISTANCE-JUNCTION TO CASE, θ_{JC}	39°C/W

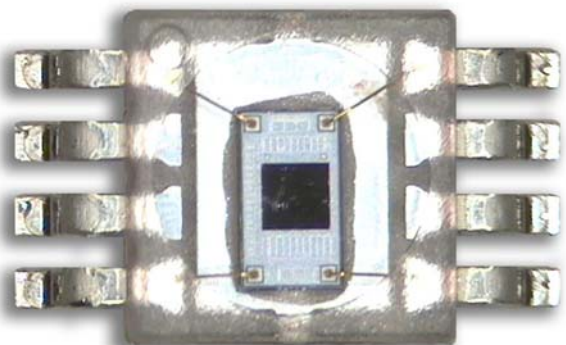
FUNCTIONAL PIN DESCRIPTION

NAME	DESCRIPTION
V _{DD}	Input Supply Voltage
V _{SS}	Ground Reference for Power and Signal Output
SNK	Output Current Sink
SRC	Output Current Source

SIMPLIFIED BLOCK DIAGRAM



PACKAGE PHOTO





RECOMMENDED OPERATING CONDITIONS

Parameter	LX1970			Units
	Min	Typ	Max	
Supply Voltage (V_{DD})	2 ¹		5.5	V
SNK Compliance Voltage Range	$V_{SS} + 0.5$		V_{DD}	V
SRC Compliance Voltage Range	V_{SS}		$V_{DD} - 0.5$	V
SNK/SRC Output Resistor Range	10		1000	K Ω

Note 1: SRC output will work down to $V_{DD}=1.8V$

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, the following specifications apply over the operating ambient temperature $-40^{\circ}C \leq T_A \leq 85^{\circ}C$, $V_{DD} = 2V$ to $5.5V$, $R_{LOAD} = 50Kohms$, Direct Light Input² of $14.6\mu W/cm^2$ except where otherwise noted.

Parameter	Symbol	Test Conditions	LX1970			Units
			Min	Typ	Max	
Supply Voltage Range	V_{DD}		2		5.5	V_{DC}
Input Supply Current	I_{DD}	$V_{DD} = 3.0V$, $I_{SRC} = 38\mu A$, $I_{SNK} = \text{open}$	60	85	110	μA
Output Current ³	I_{SRC}	$V_{DD} = 3.0V$	30	38	46	μA
	I_{SNK}	$V_{DD} = 3.0V$	-30	-38	-46	μA
Output SNK/SRC Current Matching	I_{MATCH}	$V_{DD} = 3.0V$		0.5	2	%
SNK Minimum Compliance Voltage	SNK_{VMIN}	$V_{DD} = 3.0V$, @ 95% of nominal output current		$V_{SS} + 0.3$	$V_{SS} + 0.5$	V
SRC Maximum Compliance Voltage	SRC_{VMAX}	$V_{DD} = 3.0V$, @ 95% of nominal output current		$V_{DD} - 0.3$	$V_{DD} - 0.5$	V
SNK/SRC Output Dark Current	I_{DARK}	$V_{DD} = 5.5V$, No Light		10	300	nA
Wavelength of Peak Sensitivity	λ_{PS}			520		nm
Half Reception Angle	$\theta_{1/2}$			± 60		deg
Supply Voltage Coefficient of Output Current	PSRR	$V_{DD} = 2V$ to $5.5V$		2.2	5	%/V
Resolution Limit Due To Random Noise		Minimum usable resolution		146		nW/cm ²
Sensitivity @ 540nm (peak)		Irradiance current responsivity		2.6		A/(W/cm ²)
Sensitivity Change @ 910nm ⁴		Current responsivity change with additional direct light input of $14.6\mu W/cm^2$ at 910nm	-5	0	5	% of peak
Radiant Sensitive Area		Photodiode area		0.369		mm ²

Note 2: The input irradiance is supplied from a white light-emitting diode (LED) optical source adjusted to impose $14.6\mu W/cm^2$ at 555nm on the sensor's surface.

Note 3: See Figure 1

Note 4: See Figure 2



MEASUREMENT CIRCUIT CONFIGURATIONS

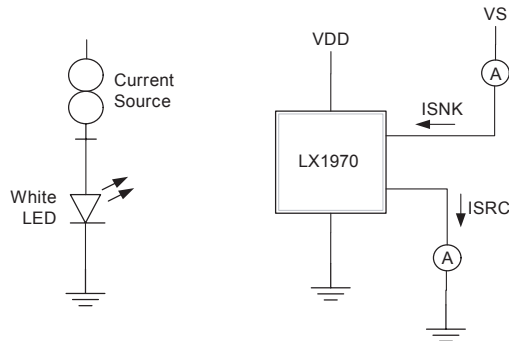


Figure 1 – Light Current Measurement Circuit

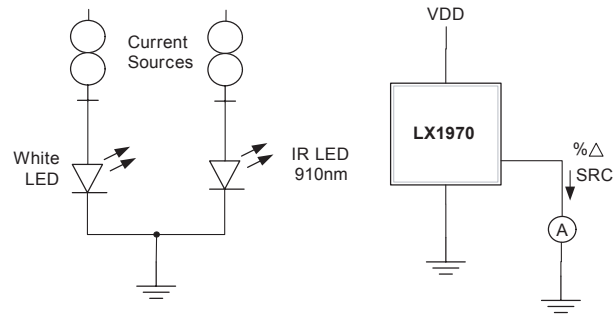


Figure 2 – IR sensitivity Measurement Circuit

APPLICATION NOTES

LIGHT UNITS

In converting from $\mu\text{W}/\text{cm}^2$ to Nits it is necessary to define the light source. Nits are units for a measurement of luminance, which is the apparent brightness of an illuminated flat surface. $\mu\text{W}/\text{cm}^2$ is a measurement of irradiance or the measurement of electromagnetic radiation flux both visible and invisible. The first step in the conversion process is to convert irradiance to illuminance, which essentially involves running the irradiant flux through a photopic filter. In normal ambient a photopic curve is used and in dark ambient a scotopic curve (dark adapted eye) is used. If the light is composed of only one wavelength, a conversion chart will tell the conversion factor to convert $\mu\text{W}/\text{m}^2$ to lux (lumens/ m^2). If more than one wavelength is used, the light spectrum of the irradiance must be applied to the photopic filter to determine the resultant illuminance. The most sensitive wavelength for the normal light adapted human eye is 555nm. At 555nm, the conversion factor is $683 \text{ Lux} = 1 \text{ W}/\text{m}^2 = 100 \mu\text{W}/\text{cm}^2$. Therefore $14.6 \mu\text{W}/\text{cm} = 100 \text{ lux}$ at 555nm.

The next step in the conversion process is to convert illuminance to luminance. The units for illuminance are lux or lumens/ m^2 . The units for luminance are Nits or lumens/ m^2 -steradian. Assuming the illuminance falls on a Lambertian surface which has perfect dispersion and total reflection, the conversion from lux to nits is 3.14 lux falling on a Lambertian reflector produces 1 Nit. Therefore 100 Lux will produce 31.4 Nits.

If the photo sensor had a truly photopic response, it would produce the same output current for the same number of nits or lux, regardless of the color of the light. However, because the match is not perfect, there is still wavelength dependency particularly at the ends of the visible spectrum.

In the case of the LX1970 the peak photo response is at 520nm, however depending on the light source, what the human eye perceives as 'white' light may actually be composed of peak wavelengths of light other than 520nm. For instance a typical fluorescent lamp includes dominant light not only near 550nm but also at 404 and 435nm. Incandescent light sources such as standard tungsten lights generate substantial IR radiation out beyond 2000nm.



APPLICATION EXAMPLES

The following examples present both fully automatic (no user input) and semi-automatic to fully manual override implementations. These general guidelines are applicable to a wide variety of potential light control applications. The LX1970 can be used to control the brightness input of CCFL inverters (like Microsemi's PanelMatch™ inverter family, or line of controller IC's). Likewise it can interface well with LED drivers like the LX1990 and LX1991 sink LED drivers, or boost drivers like the LX1992 and LX1993.

In each specific application it is important to recognize the need to correlate the sink and source current of the LX1970 for the target environment and its ambient light conditions. The mechanical mounting of the sensor, light aperture hole size, use of a light pipe or bezel are critical in determining the response of the LX1970 for a given exposure of light.

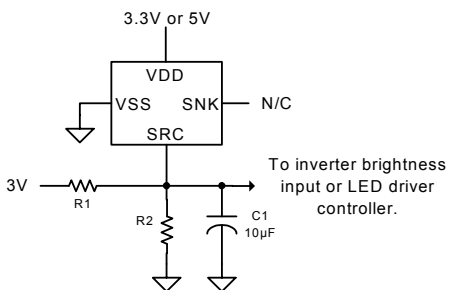


Figure 2

The example in figure 2 shows a fully automatic dimming solution with no user interaction. Choose R1 and R2 values for any desired minimum brightness and slope. Choose C1 to adjust response time and filter 50/60 Hz room lighting. As an example, let's say you wish to generate an output voltage from 0.25V to 1.25V to drive the input of an LED driver controller. The 0.25V represents the minimum LED brightness and 1.25V represents the maximum. The first step would be to determine the ratio of R1 and R2.

$$R1 = R2 \left[\frac{3.0V}{0.25V} - 1 \right] = 11 \times R2$$

Next the value of R2 can be calculated based on the maximum output source current coming from the LX1970 under the application's maximum light exposure, let's say this has been determined to be about 50µA. Thus R2 can be calculated first order as follows:

$$R2 = \left[\frac{1.25V}{50\mu A} \right] = 25K\Omega \therefore R1 = 11 \times R2 = 275K\Omega$$

The output node will actually reach 1.25V when the source current from the LX1970 is only about 44µA since about 6µA of current will be contributed from R1. This assumes a high impedance input to the LED driver. In Figure 3 user adjustable bias control has been added to allow control over the minimum and maximum output voltage. This allows the user to adjust the output brightness to personal preference over a limited range. The PWM input source could of course be replaced with an equivalent DC voltage.

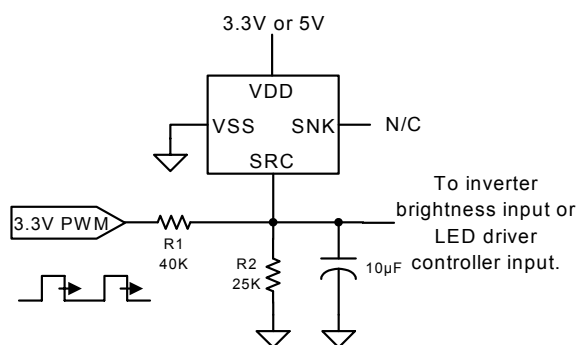


Figure 3

Figure 4 shows how a fully manual override can be quickly added to the example in figure 3. In addition to the gate to turn on and off the LX1970, a diode has been inserted to isolate the LX1970 when it is shut down.

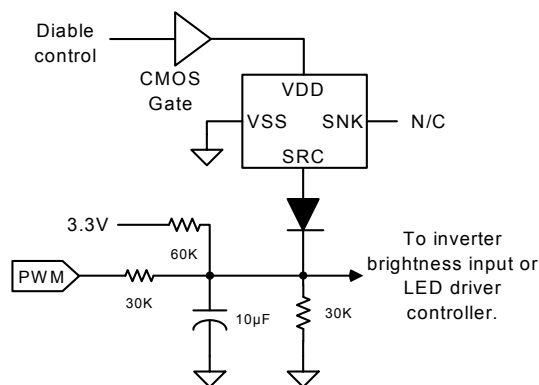


Figure 4

The preceding examples represent just a few of the many ways the sensor can be used. For example since there is also a complimentary sink output a resistor from VDD to SNK could develop a voltage that could be compared (with some hysteresis) to a fixed reference voltage and develop a logic shutdown signal. If the application is utilizing a transfective or reflective LCD display such a signal could disable the backlight or front light to the display when reaching sufficient ambient light.

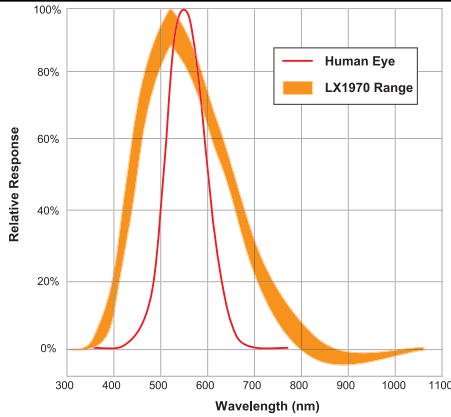


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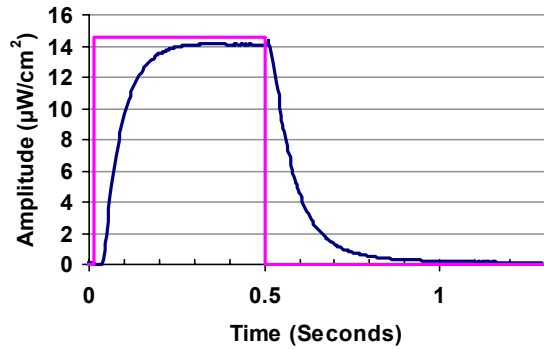
Visible Light Sensor

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RESPONSE VS WAVELENGTH

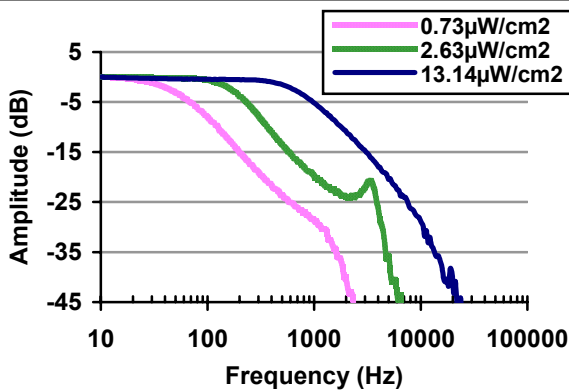


I_{SNK} STEP RESPONSE



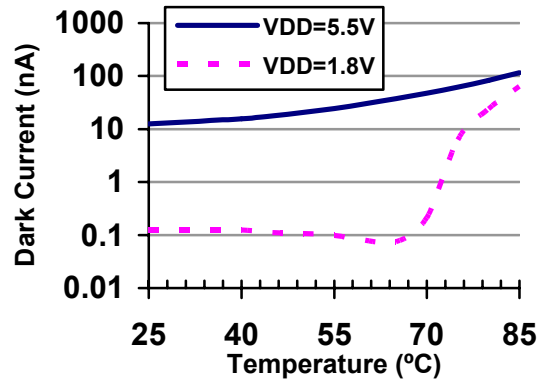
Load = 10kΩ and 1µF
Photo Step = Direct Light Input of 14.6µW/cm²

SMALL SIGNAL FREQUENCY RESPONSE

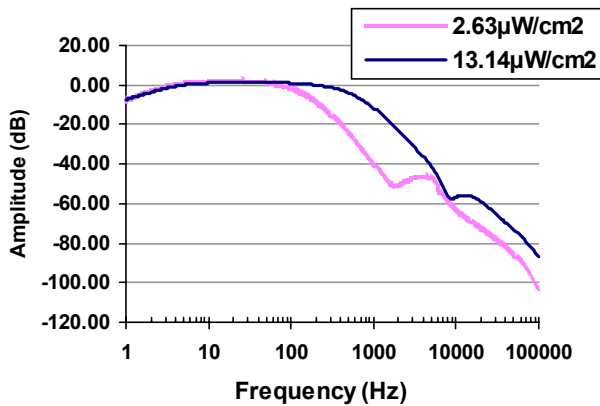


V_{DD} = 3.0V, SNK, Three Light Levels, No Filtering

DARK CURRENT VS TEMP

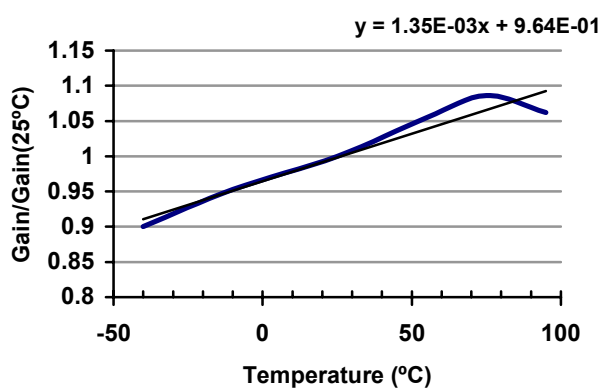


SNK OUTPUT PSRR



V_{DD} = 3.0V
Load = 10kΩ and 1µF to Ground

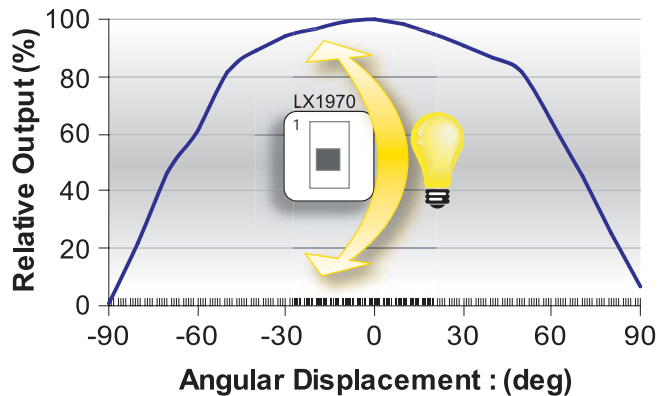
GAIN VS TEMP



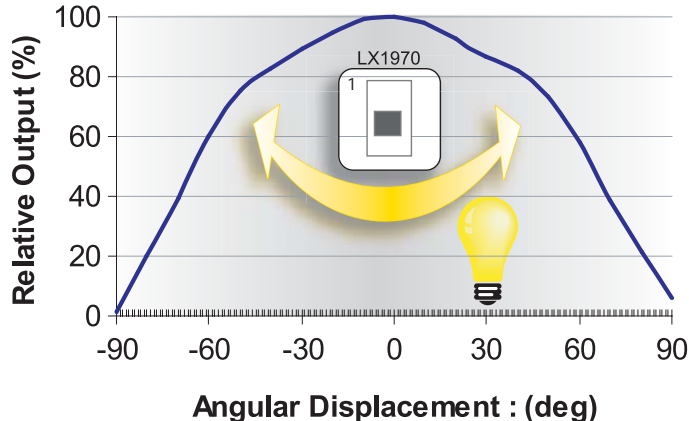
V_{DD} = 3.0V
Direct Light Input of 13.14µW/cm²



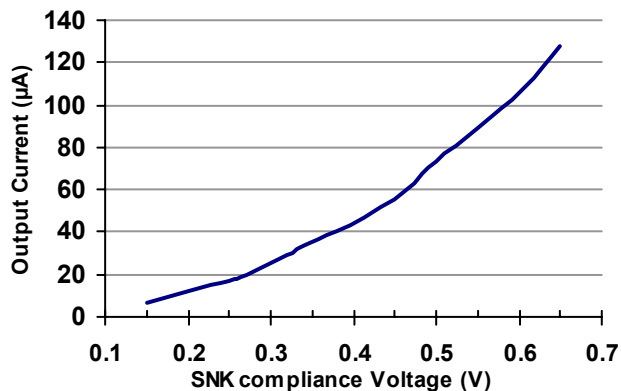
VERTICAL DIRECTION RESPONSE



HORIZONTAL DIRECTION RESPONSE

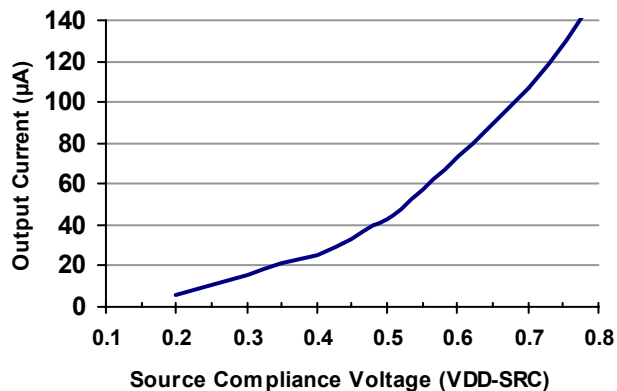


SNK COMPLIANCE VS CURRENT



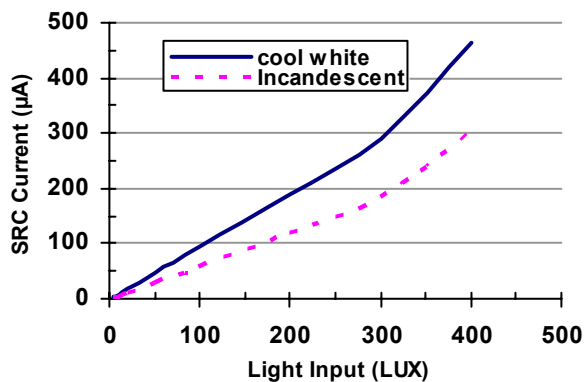
V_{DD} = 3.0V

SRC COMPLIANCE VS CURRENT



V_{DD} = 3.0V

SRC CURRENT VS LIGHT (LUX)

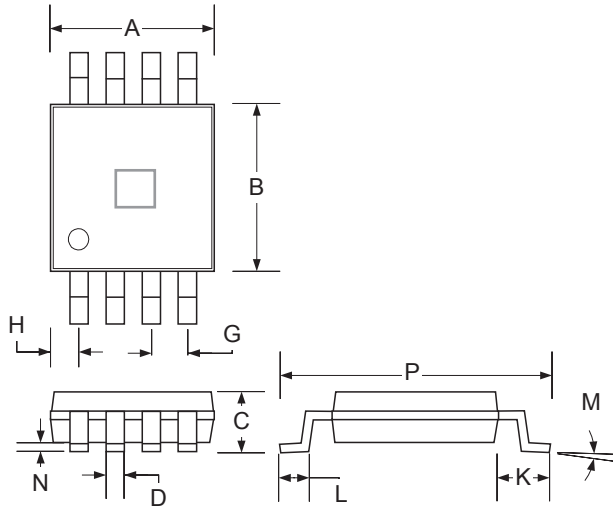


V_{DD} = 5.0V; SRC = 10K & 4.7µF to GND

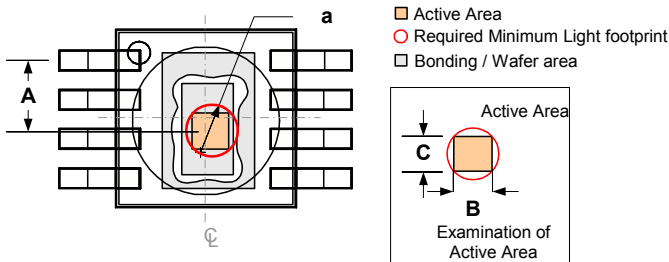


PACKAGE DIMENSIONS

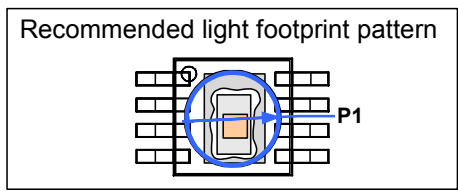
DU 8-Pin Miniature Shrink Outline Package (MSOP)



Dim	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.85	3.05	.112	.120
B	2.90	3.10	.114	.122
C	-	1.10	-	0.043
D	0.25	0.40	0.009	0.160
G	0.65 BSC		0.025 BSC	
H	0.38	0.64	0.015	0.025
J	0.13	0.18	0.005	0.007
K	0.95 BSC		0.037 BSC	
L	0.40	0.70	0.016	0.027
M	3°		3°	
N	0.05	0.15	0.002	0.006
P	4.75	5.05	0.187	0.198



Dim	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	1.22		0.048	
a	0.85		0.033	
B	0.60		0.024	
C	0.60		0.024	



P1	2.5	0.98
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Note:
P1 represents a possible light footprint and its dimensions are not subject to strict tolerances. Only the active area of the device is required to be covered with light. This larger footprint is designed to ensure coverage of the device's active area.



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LX1970

Visible Light Sensor

PRODUCTION DATA SHEET

NOTES

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