Non-Linear Output Current, Low Power Ambient Light Photo Detect IC

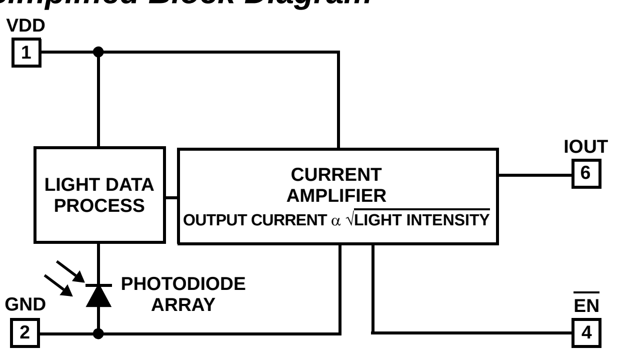
The ISL29009 is a light-to-current silicon optical sensor combining a photodiode and current amplifiers on a single monolithic IC. Similar to human eyes, the photodiode has peak sensitivity at 550nm and spans from 400nm to 700nm, rejecting UV light and IR light. The input luminance range is from 0.3 lux to 10,000 lux.

The integrated non-linear current amplifier boosts and converts the photodiode signal in a square root fashion, extending the light input dynamic range while maintaining excellent sensitivity at dim conditions with low lux levels. The device consumes minimal power over a wide range of ambient lux levels because the current consumption ramps at a square root fashion. A dark current compensation circuit aids the photodiode to minimize temperature dependent leakage currents in the absence of light, improving the light sensitivity at low lux levels.

In addition, the ISL29009 has an $\overline{EN}$ pin that can be used for a polling scheme extending portables' battery life.

The ISL29009 is housed in an ultra compact 2mmx2.1mm ODFN plastic case surface mount package. Operation is rated from -40°C to +85°C.

Simplified Block Diagram



Ordering Information

PART NUMBER (Note)	TEMP. RANGE (°C)	PACKAGE (Pb-free)	PKG. DWG. #
ISL29009IROZ-T7*	-40 to +85	6 Ld ODFN	L6.2x2.1

*Please refer to TB347 for details on reel specifications.

NOTE: These Intersil Pb-free plastic packaged products employ special Pb-free material sets; molding compounds/die attach materials and NiPdAu plate - e4 termination finish, which is RoHS compliant and compatible with both SnPb and Pb-free soldering operations. Intersil Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J STD-020.

Features

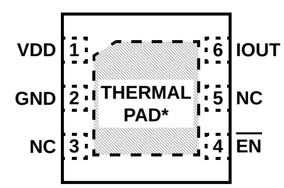
- Non-linear current output
- 0.3 lux to 10,000 lux range
- Dark current compensation
- Temperature compensated
- Human eye response
- 1.8V to 3.3V supply range
- Low supply current
- Fast response time
- 6 Ld ODFN: 2mmx2.1mmx0.7mm
- Pb-free (RoHS compliant)

Applications

- Display and keypad dimming for:
  - Mobile devices: smart phone, PDA, GPS
  - Computing devices: notebook PC, webpod
  - Consumer devices: LCD-TV, digital picture frame, digital camera
- Industrial and medical light sensing

Pinout

ISL29009
(6 LD ODFN)
TOP VIEW



***THERMAL PAD CAN BE CONNECTED TO GND OR ELECTRICALLY ISOLATED**

Pin Descriptions

PIN NUMBER	PIN NAME	DESCRIPTION
1	VDD	Supply, 1.8V to 3.3V
2	GND	Ground
3	NC	No connect
4	$\overline{EN}$	Active LO enable
5	NC	No connect
6	IOUT	Current output

Absolute Maximum Ratings (T_A = +25°C)

Supply Voltage between VDD and GND 3.6V
Pin Voltage (IOUT and $\overline{EN}$) . . . . -0.2V to V_{DD}
Maximum Continuous Output Current 6mA
Operating Temperature . . . .-40°C to +85°C
ESD Rating
  Human Body Model 2kV
  Machine Model. 200V

Thermal Information

Thermal Resistance θ_{JA} (°C/W)
  6 Ld ODFN. 90
Maximum Die Temperature . . . . +90°C
Storage Temperature . . . .-40°C to +100°C
Operating Temperature . . . .-40°C to +85°C
Pb-free reflow profile . . . . .see link below
  http://www.intersil.com/data/tb/TB477.pdf

CAUTION: Do not operate at or near the maximum ratings listed for extended periods of time. Exposure to such conditions may adversely impact product reliability and result in failures not covered by warranty.

IMPORTANT NOTE: All parameters having Min/Max specifications are guaranteed. Typical values are for information purposes only. Unless otherwise noted, all tests are at the specified temperature and are pulsed tests, therefore: $T_J = T_C = T_A$

Electrical Specifications

V_{DD} = 3V, T_A = +25°C, $\overline{EN}$ = 0, R_L = 100kΩ at IOUT pin, green LED light, unless otherwise specified.

PARAMETER	DESCRIPTION	CONDITION	MIN	TYP	MAX	UNIT
E	Range of Input Light Intensity			0.3 to 10k		lux
VDD	Power Supply Range		1.8		3.3	V
I_{DD}	Supply Current	E = 1000 lux		9	14	µA
		E = 100 lux		3		µA
		E = 0 lux		0.25		µA
I_{SD}	Supply Current when Shut Down	$\overline{EN}$ = V_{DD}		250	350	nA
I_{OUT1}	Light-to-Current Accuracy	E = 100 lux		1.8		µA
I_{OUT2}	Light-to-Current Accuracy	E = 1000 lux	4.6	5.7	6.8	µA
I_{DARK}	Dark Current Output in the Absence of Light	E = 0 lux, R_L = 10MΩ		2	5	nA
ΔI_{OUT}	Output Current Variation Over Three Light Sources: Fluorescent, Incandescent and Halogen			10		%
V_{O-MAX}	IOUT Max Output Compliance Voltage at 95% of Nominal Output	E = 1000 lux		V_{DD} - 0.2		V
t_R	IOUT Rise Time (Note 1)	R_L = 100kΩ, E = 300 lux from 0 Lux		70		µs
		R_L = 100kΩ, E = 1000 lux from 0 Lux		20		µs
t_F	IOUT Fall Time (Note 1)	R_L = 100kΩ, E = 300 lux to 0 Lux		2410		µs
		R_L = 100kΩ, E = 1000 lux to 0 Lux		1290		µs
t_D	IOUT Delay Time for Rising Edge (Note 1)	R_L = 100kΩ, E = 300 lux from 0 Lux		600		µs
		R_L = 100kΩ, E = 1000 lux from 0 Lux		280		µs
t_S	IOUT Delay Time for Falling Edge (Note 1)	R_L = 100kΩ, E = 300 lux to 0 Lux		75		µs
		R_L = 100kΩ, E = 1000 lux to 0 Lux		5		µs
V_{LO}	Maximum Voltage at $\overline{EN}$ pin to Enable			0.5		V
V_{HI}	Minimum Voltage at $\overline{EN}$ pin to Disable			V_{DD} - 0.5		V
I_{LO}	Input Current at $\overline{EN}$ pin	$V_{\overline{EN}}$ = 0V		1		nA
I_{HI}	Input Current at $\overline{EN}$ pin	$V_{\overline{EN}}$ = 3V		1		nA

Electrical Specifications V_{DD} = 3V, T_A = +25°C, $\overline{EN}$ = 0, R_L = 100kΩ at IOUT pin, green LED light, unless otherwise specified. **(Continued)**

PARAMETER	DESCRIPTION	CONDITION	MIN	TYP	MAX	UNIT
t_{EN}	Enable Time	R_L = 100kΩ, E = 100 lux		20		µs
t_{DIS}	Disable Time	R_L = 100kΩ, E = 100 lux		200		µs

NOTE:

1. Switching time measurement is based on Figures 1 and 2.

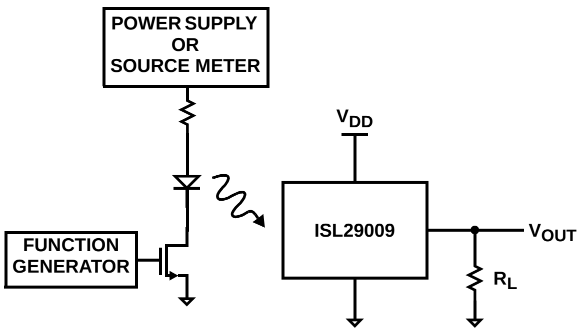


FIGURE 1. TEST CIRCUIT FOR RISE/FALL TIME MEASUREMENT

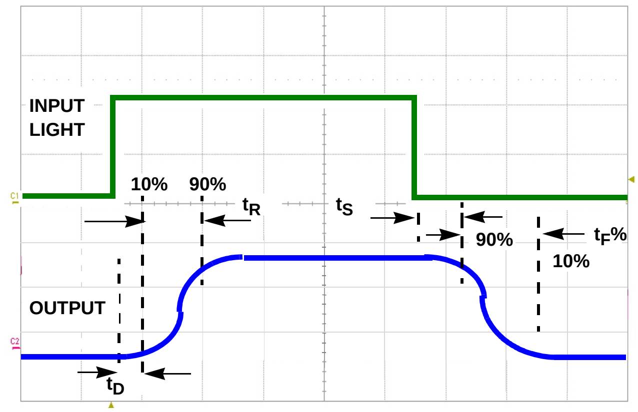


FIGURE 2. TIMING DIAGRAM

Typical Performance Curves

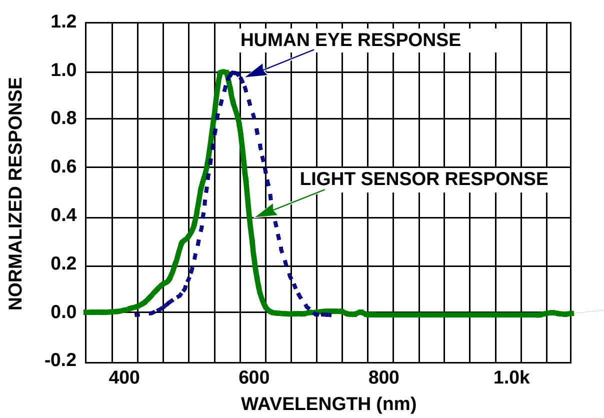


FIGURE 3. SPECTRAL RESPONSE

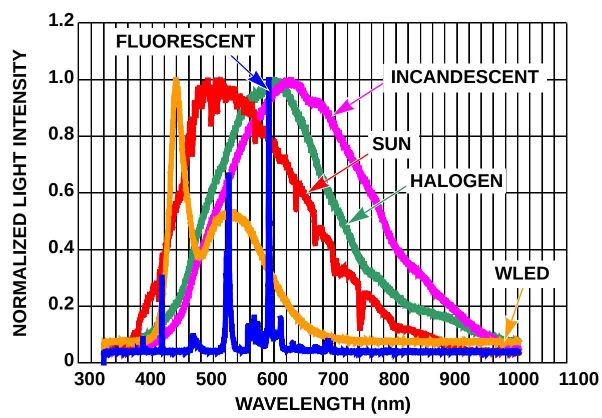


FIGURE 4. SPECTRUM OF LIGHT SOURCES

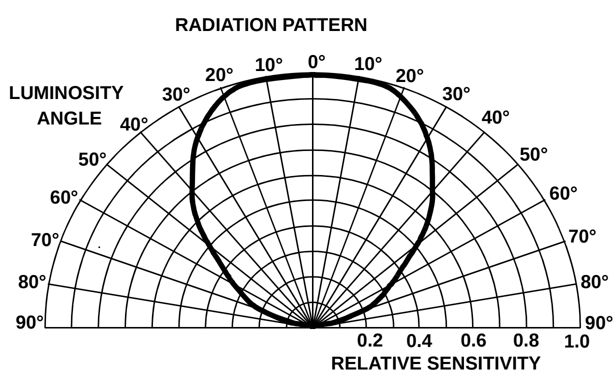


FIGURE 5. RADIATION PATTERN

Typical Performance Curves (Continued)

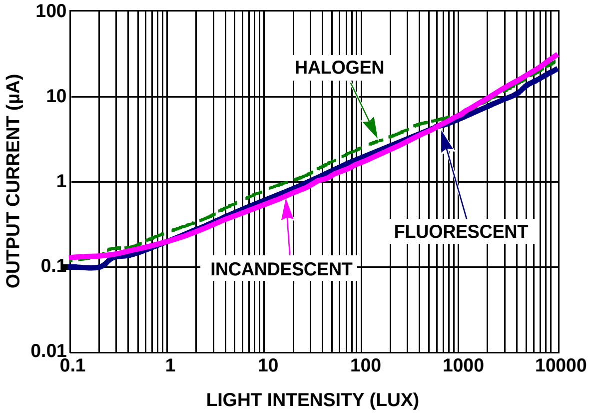


FIGURE 6. OUTPUT CURRENT vs LIGHT INTENSITY

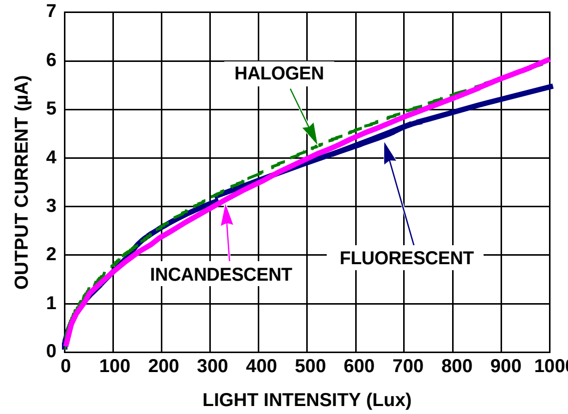


FIGURE 7. OUTPUT CURRENT vs LIGHT INTENSITY

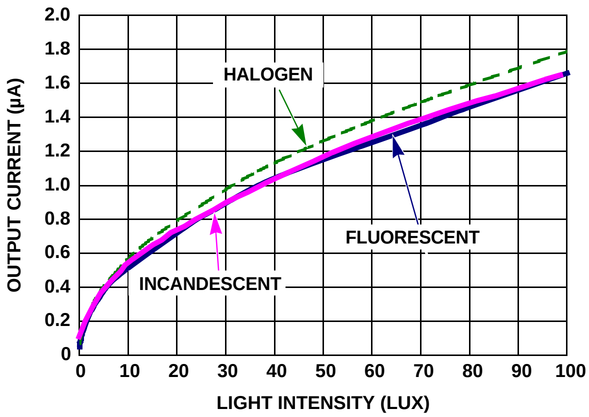


FIGURE 8. OUTPUT CURRENT vs LIGHT INTENSITY

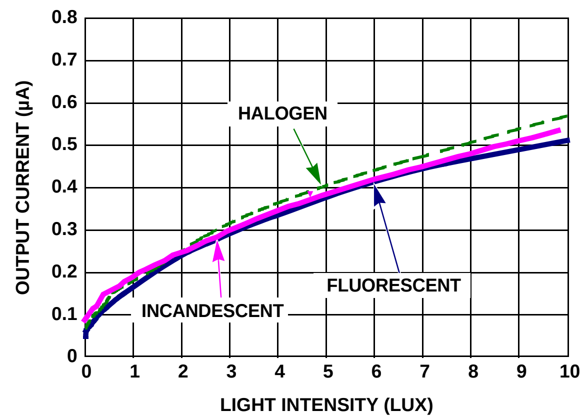


FIGURE 9. OUTPUT CURRENT vs LIGHT INTENSITY

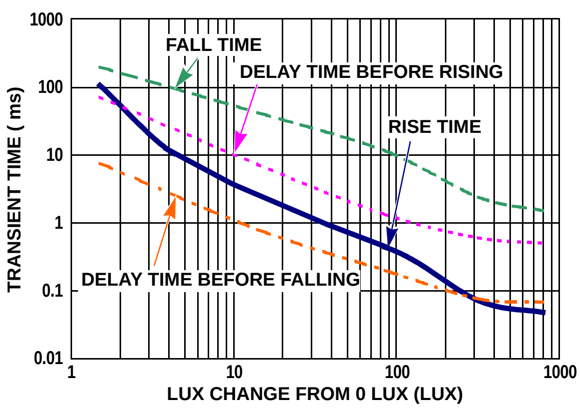


FIGURE 10. TRANSIENT TIME vs LUX CHANGE FROM 0 LUX

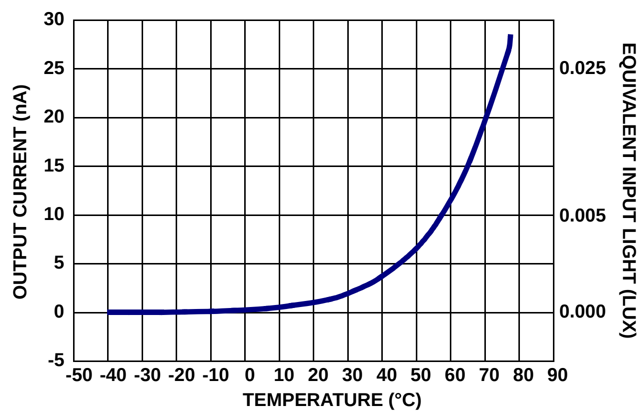


FIGURE 11. OUTPUT CURRENT vs TEMPERATURE AT 0 LUX

Typical Performance Curves (Continued)

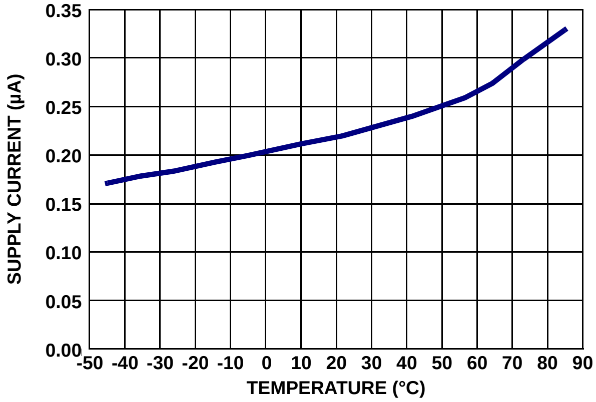


FIGURE 12. SUPPLY CURRENT vs TEMPERATURE AT 0 LUX

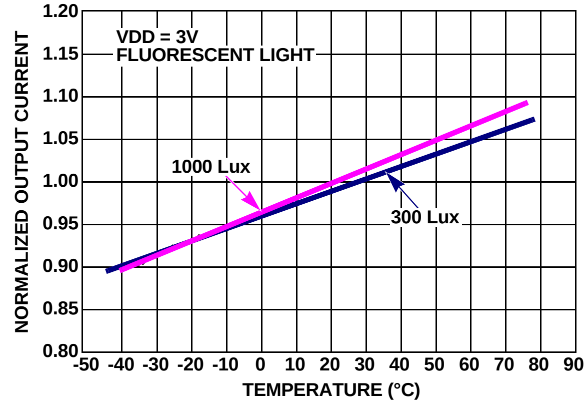


FIGURE 13. NORMALIZED OUTPUT CURRENT vs TEMPERATURE

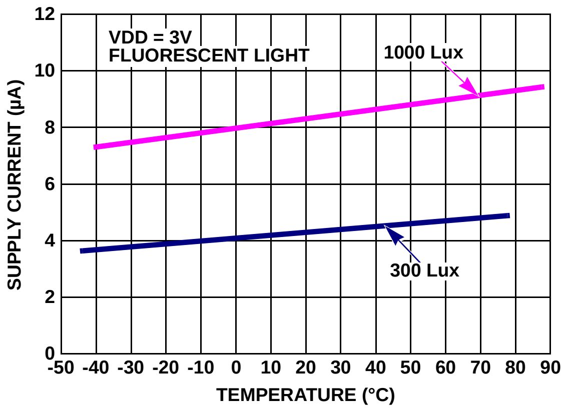


FIGURE 14. SUPPLY CURRENT vs TEMPERATURE

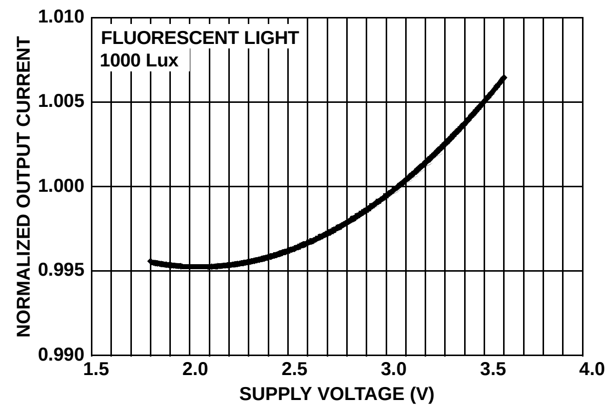


FIGURE 15. NORMALIZED OUTPUT CURRENT vs SUPPLY VOLTAGE

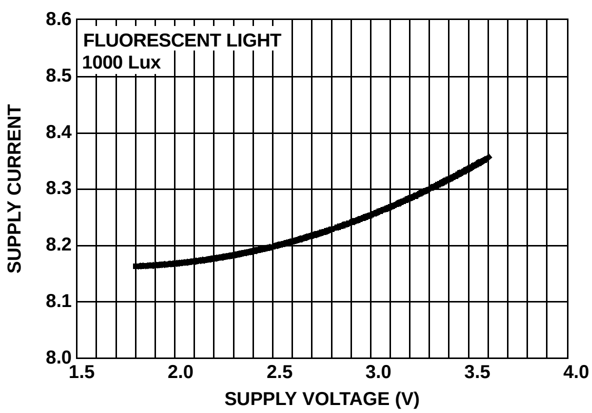


FIGURE 16. SUPPLY CURRENT vs SUPPLY VOLTAGE

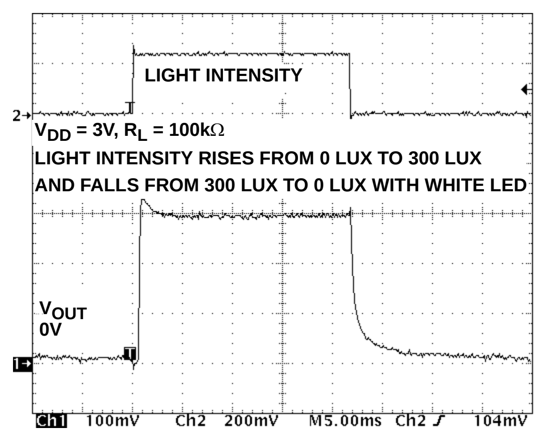


FIGURE 17. TRANSIENT RESPONSE OF ISL29009 TO CHANGE IN LIGHT INTENSITY

Application Information

Light-to-Current and Voltage Conversion

The ISL29009 has responsiveness that is a square-root function of the light intensity intercepted by the photodiode in lux. Because the photodiode has a responsivity that resembles the human eye, conversion rate is independent of the light source (fluorescent light, incandescent light or direct sunlight).

$$I_{OUT} = \frac{1.8\mu A}{\sqrt{100 lux}}\sqrt{E} \quad \text{(EQ. 1)}$$

Here, I_{OUT} is the output current in µA, and E is the input light in lux.

A load resistor R_L is added to convert I_{OUT} into V_{OUT}. The output voltage can be expressed in Equation 2:

$$V_{OUT} = I_{OUT} \times R_L = \frac{1.8\mu A}{\sqrt{100 lux}}\sqrt{E} \times R_L \quad \text{(EQ. 2)}$$

Here, V_{OUT} is the output voltage and R_L is the value of the load resistor added. The compliance of the ISL29009's output circuit may result in premature saturation of the output current and voltage when an excessively large R_L is used. The output compliance voltage is 200mV below the supply voltage as listed in V_{O-MAX} of the "Electrical Specifications" table on page 2.

Optical Sensor Location Outline

The green area in Figure 18 shows the optical sensor location outline of ISL29009. Along the pin-out direction, the center line (CL) of the sensor coincides with that of the packaging. The sensor width in this direction is 0.39mm. Perpendicular to the pin-out direction, the CL of the sensor has an 0.19mm offset from the CL of packaging away from pin-1. The sensor width in this direction is 0.46mm.

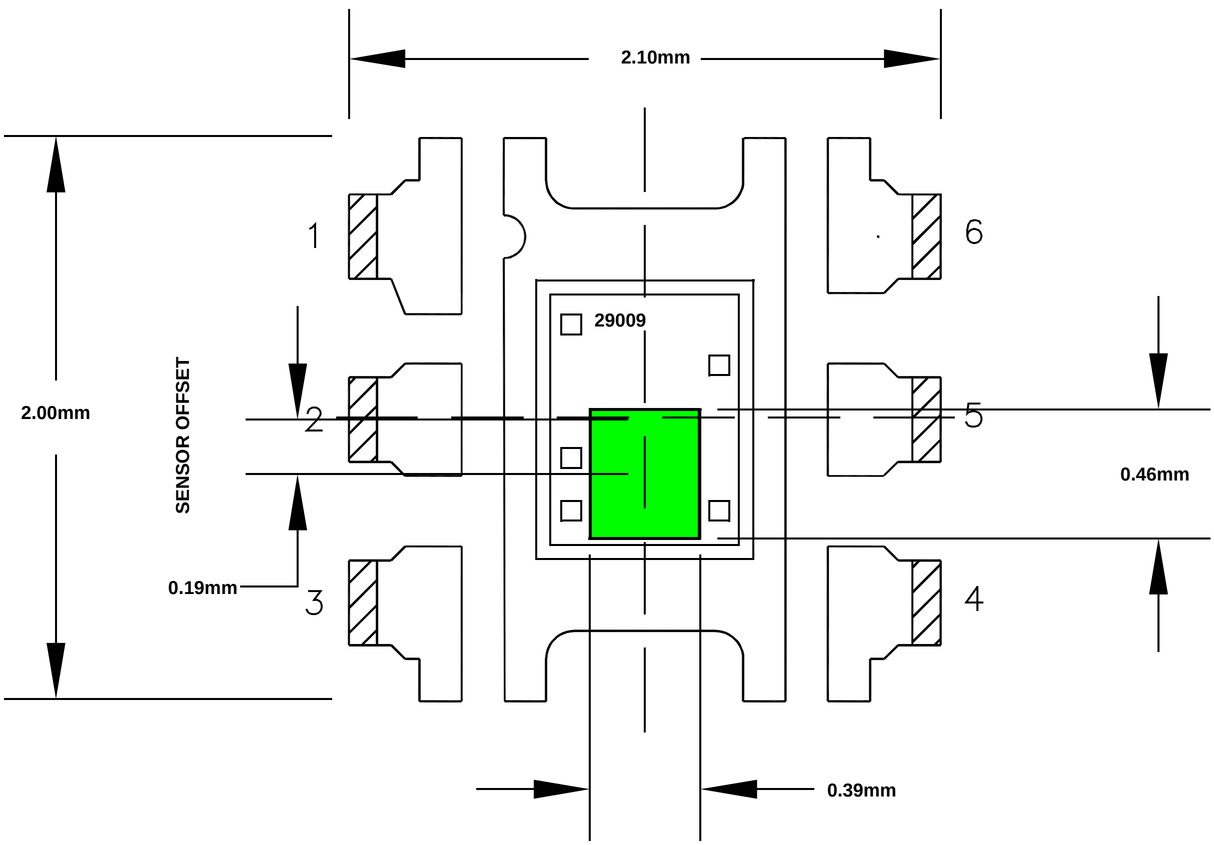


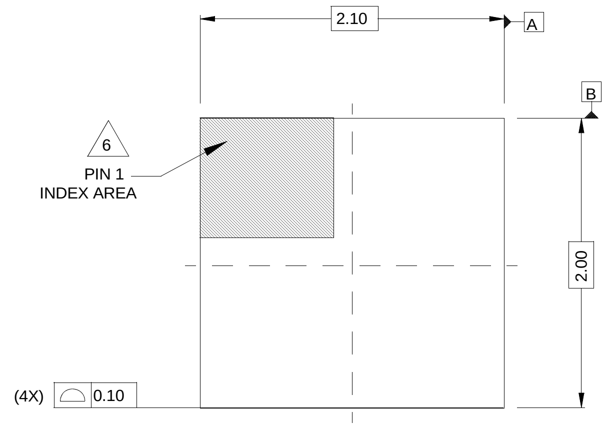
FIGURE 18. 6 LD ODFN SENSOR LOCATION OUTLINE

For additional products, see www.intersil.com/en/products.html

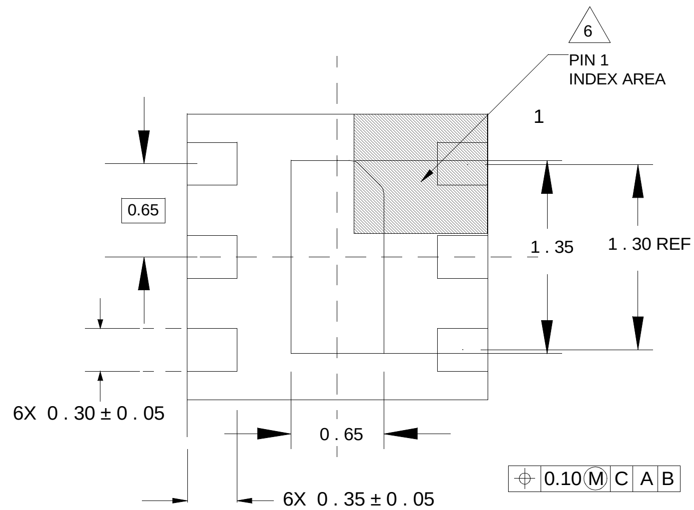
Package Outline Drawing

L6.2x2.1

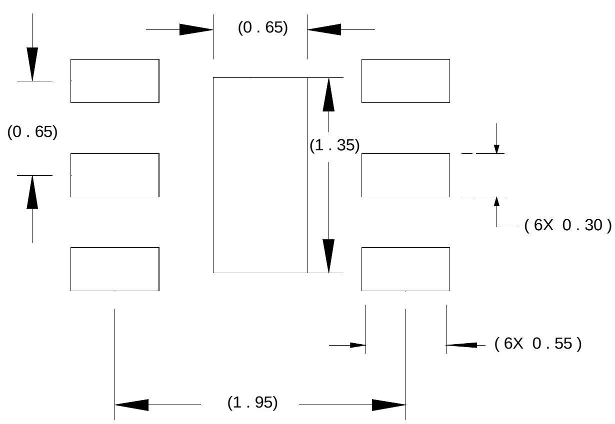
6 LEAD OPTICAL DUAL FLAT NO-LEAD PLASTIC PACKAGE (ODFN)
Rev 0, 9/06



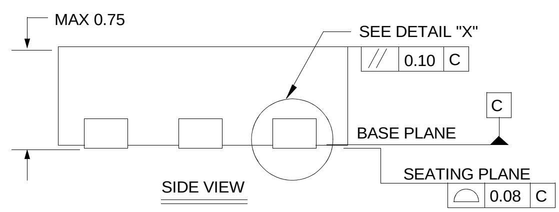
TOP VIEW



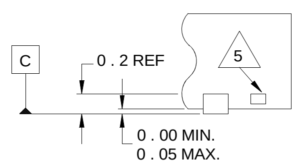
BOTTOM VIEW



TYPICAL RECOMMENDED LAND PATTERN



SIDE VIEW



DETAIL "X"

NOTES:

1. Dimensions are in millimeters.
   Dimensions in ( ) for Reference Only.
2. Dimensioning and tolerancing conform to AMSE Y14.5m-1994.
3. Unless otherwise specified, tolerance : Decimal ± 0.05
4. Dimension b applies to the metallized terminal and is measured between 0.15mm and 0.30mm from the terminal tip.
5. Tiebar shown (if present) is a non-functional feature.
6. The configuration of the pin #1 identifier is optional, but must be located within the zone indicated. The pin #1 identifier may be either a mold or mark feature.