ISL76671

Low Power, <100 Lux Optimized, Analog Output Ambient Light Sensor

FN7716
Rev.4.0
May 21, 2021

The ISL76671 is a low cost, light-to-voltage silicon optical sensor combining a photodiode array, a non-linear current amplifier and a micro-power op amp on a single monolithic IC. Similar to the human eye, the photodiode array has peak sensitivity at 550nm and spans the wavelength range 400nm to 600nm, rejecting UV and IR light. The input luminance range is from 0.01 lux to 100 lux.

The integrated non-linear current amplifier boosts and converts the photodiode signal into a square root output format, extending dynamic range while maintaining excellent sensitivity in dimly lit conditions. As such, the part is ideal for measuring incident daylight when mounted behind heavily smoked bezels used around displays or behind mirrors.

The device consumes minimum power. A dark current compensation circuit minimizes the effect of temperature dependent leakage currents in the absence of light, improving the light sensitivity at low lux levels. The output gain has been optimized to require a relatively low value external bias resistor that falls within recommended automotive EMI limits. The built-in 1µA op amp gives the ISL76671 an output voltage driving advantage for heavier loads that can drive an ADC directly.

The ISL76671 is housed in an ultra compact 2mmx2.1mm ODFN plastic surface mount package. Operation is rated from -40°C to +105°C, Grade 2 per AEC-Q100.

Features

- Square root voltage output
- 0.01 lux to 100 lux range
- 1.8V to 3V supply range
- Close to human eye spectral response
- Fast response time
- Internal temperature compensation
- Good IR rejection
- Low supply current
- Operating temperature range -40°C to +105°C
- 6 Ld ODFN: 2mmx2.1mmx0.7mm
- Pb-free (RoHS compliant)
- AEC-Q100 Qualified

Applications

- Display backlight control - central info display and instrumentation
- Anti-glare mirror systems - specified to operate behind Bezel mounting

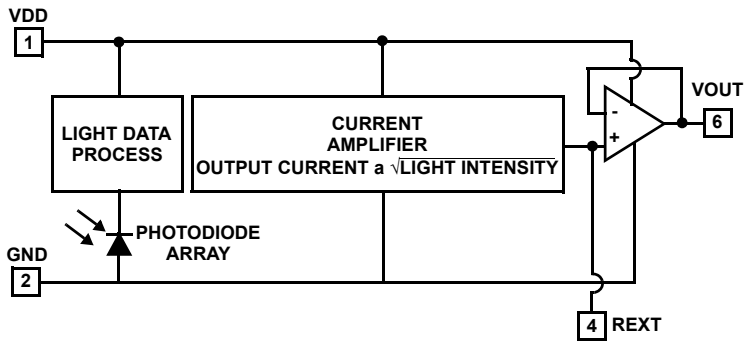
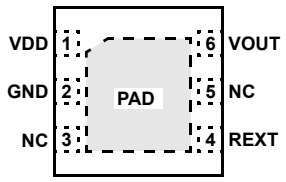


FIGURE 1. SIMPLIFIED BLOCK DIAGRAM

Pin Configuration

ISL76671
(6 LD ODFN)
TOP VIEW



Pin Descriptions

PIN NUMBER	PIN NAME	PIN DESCRIPTION
1	VDD	Voltage Supply (1.8V to 3V).
2	GND	Ground
3, 5	NC	No connect
4	REXT	Connected to an external resistor to GND, setting the light-to-voltage scaling constant. A R_{EXT} value of 100kΩ is recommended.
6	VOUT	Voltage Output.
-	PAD	Thermal Pad. The thermal pad can be connected to GND or electrically isolated.

Ordering Information

PART NUMBER (Notes 2, 3)	PACKAGE DESCRIPTION (RoHS Compliant)	PKG. DWG. #	CARRIER TYPE (Note 1)	TEMP RANGE
ISL76671AROZ-T7	6 Ld ODFN	L6.2X2.1Z	Reel, 3k	-40 to *105°C
ISL76671AROZ-T7A			Reel, 250	
ISL76671EVAL1Z	Evaluation Board			

NOTES:

1. See TB347 for details about reel specifications.
2. These 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. 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.
3. For Moisture Sensitivity Level (MSL), please see device information page for ISL76671. For more information about MSL, see TB477.

Absolute Maximum Ratings (T_A = +25°C)

Supply Voltage Between V_{DD} and GND 3.6V
R_{EXT} . . . . . (-0.5V + GND) to (0.5V + V_{DD})
V_{OUT} . . . . . (-0.5V + GND) to (0.5V + V_{DD})
V_{OUT} Short Circuit Current . . . . . <10mA
ESD Rating
Human Body Model (Tested per AEC-Q100-002) 2.5kV
Machine Model (Tested per AEC-Q100-003) 250V
Charged Device Model (Tested per AEC-Q100-011) 1kV
Latch-up (Tested per AEC-Q100-004, Class II, Level A) 100mA

Thermal Information

Thermal Resistance (Typical)	θ_{JA} (°C/W)	θ_{JC} (°C/W)
6 Ld ODFN (Notes 4, 5)	88	7.94

Maximum Die Temperature . . . . . +105°C
Storage Temperature . . . . . -40°C to +105°C
Operating Temperature . . . . . -40°C to +105°C
Pb-Free Reflow Profile (*) . . . . . see TB477
*Peak temperature during solder reflow +260°C max

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

NOTES:

4. θ_{JA} is measured in free air with the component mounted on a high-effective thermal conductivity test board with direct attach features. See TB379.
5. For θ_{JC}, the case temperature location is the center of the exposed metal pad on the package underside.

Electrical Specifications

Unless otherwise noted, all parameter limits are established over the recommended operating conditions: V_{DD} = 3V, T_A = -40°C to +105°C, R_{EXT} = 100kΩ, no load at V_{OUT}, and green LED light. (Typical values are at T_A = +25°C). **Boldface limits apply across the operating temperature range, -40°C to +105°C.**

PARAMETER	DESCRIPTION	TEST CONDITIONS	MIN (Note 6)	TYP	MAX (Note 6)	UNITS
E	Range of Input Light Intensity for Square Root Relationship to be Held			0.01 - 100		Lux
V_{DD}	Operating Supply Voltage		**1.8**		**3**	V
I_{DD}	Supply Current	E = 0 lux, -40°C to +60°C		0.7	2	µA
		E = 0 lux, -40°C to +105°C			5	µA
		E = 100 lux		23	**35**	µA
V_{OUT}	Light-to-Voltage Accuracy	E = 10 lux		0.65		V
		E = 50 lux		1.35		V
		E = 100 lux	**1.4**	1.85	**2.3**	V
V_{DARK}	Voltage Output in the Absence of Light	E = 0 lux, -40°C to +60°C		0.95	20	mV
		E = 0 lux, -40°C to +105°C			120	mV
ΔV_{OUT}	Output Voltage Variation Over Three Light Sources: Fluorescent, Incandescent and Halogen			10		%
PSRR	Power Supply Rejection Ratio	E = 100 lux		0.12		mV/V
V_{O-CMPL}	Maximum Output Compliance Voltage at 95% of Nominal Output			V_{DD} - 0.7V		V
V_{O-MAX}	Maximum Output Voltage Swing				V_{DD}	V
t_R	Rise Time	E = 0 lux to 100 lux		95		µs
t_F	Fall Time	E = 100 lux to 0 lux		155		µs
t_D	Delay Time for Rising Edge	E = 0 lux to 100 lux		350		µs
t_S	Delay Time for Falling Edge	E = 100 lux to 0 lux		250		µs
ISC	Short Circuit Current of Op Amp			±12		mA
SR	Slew Rate of Op Amp			13		V/ms
V_{OS}	Offset Voltage of Op Amp			±0.9		mV

NOTE:

6. Parameters with MIN and/or MAX limits are 100% tested at +25°C, unless otherwise specified. Temperature limits established by characterization and are not production tested.

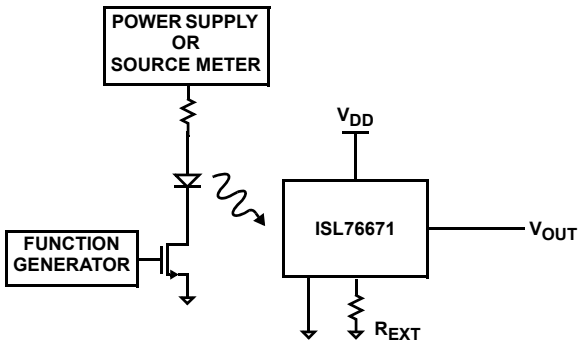


FIGURE 2. TEST CIRCUIT FOR RISE/FALL TIME MEASUREMENT

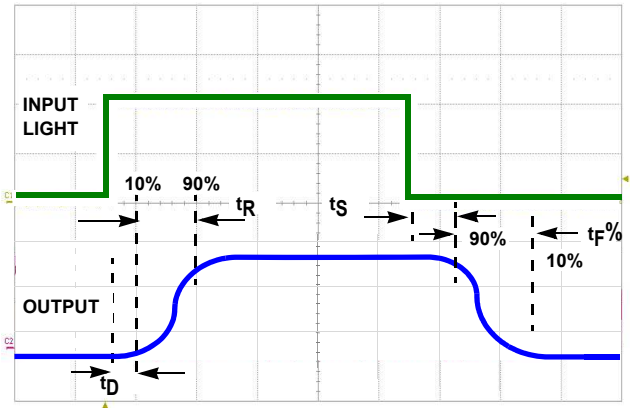


FIGURE 3. TIMING DIAGRAM

Typical Performance Curves

V_{DD} = 3V, T_A = +25°C, R_{EXT} = 100kΩ, no load at V_{OUT}, green LED light, unless otherwise specified.

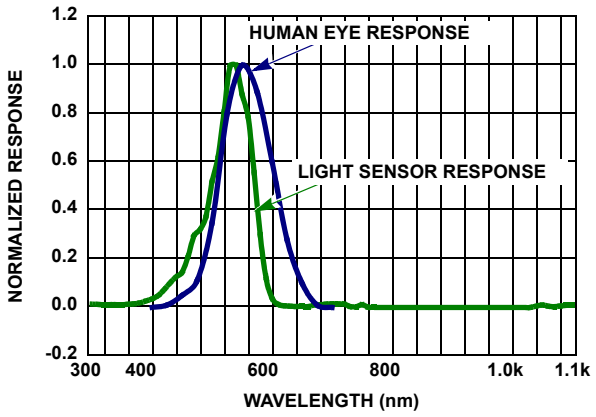


FIGURE 4. SPECTRAL RESPONSE

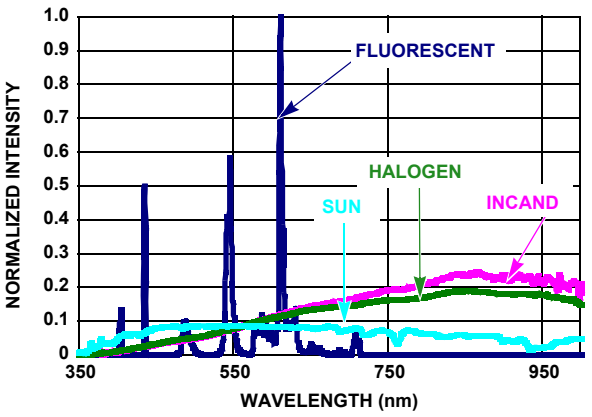


FIGURE 5. SPECTRUM OF FOUR LIGHT SOURCES NORMALIZED BY LUMINOUS INTENSITY (LUX)

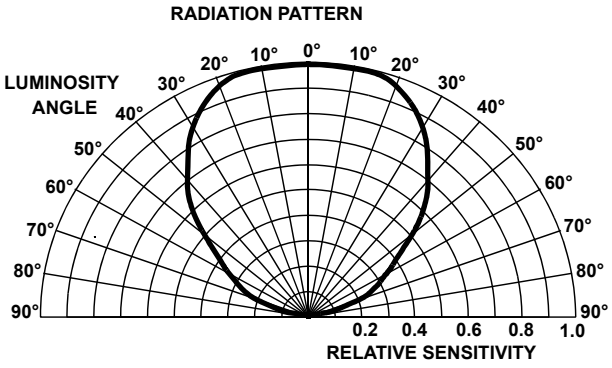


FIGURE 6. RADIATION PATTERN

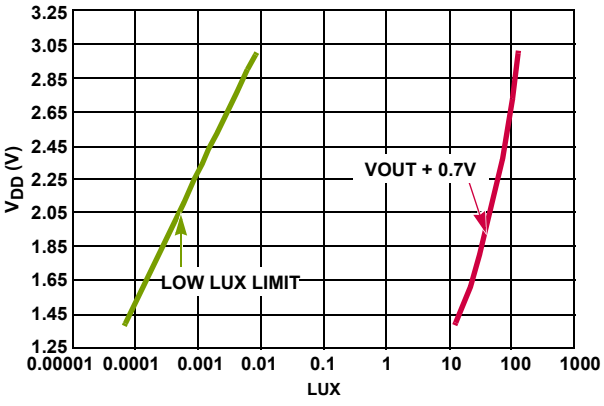


FIGURE 7. V_{DD} OPERATING RANGE (WHITE LED)

Typical Performance Curves V_{DD} = 3V, T_A = +25°C, R_{EXT} = 100kΩ, no load at V_{OUT}, green LED light, unless otherwise specified.

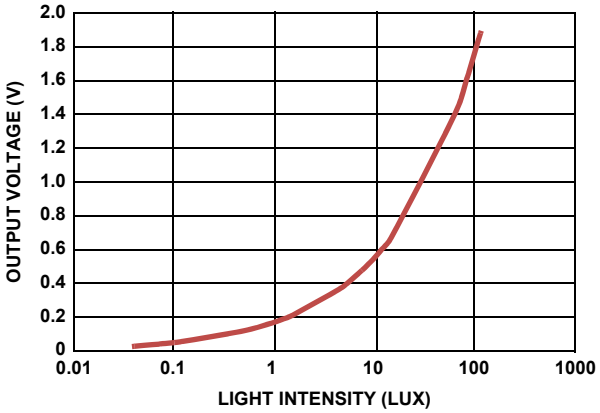


FIGURE 8. OUTPUT VOLTAGE vs LIGHT INTENSITY 0.1 LUX TO 100 LUX

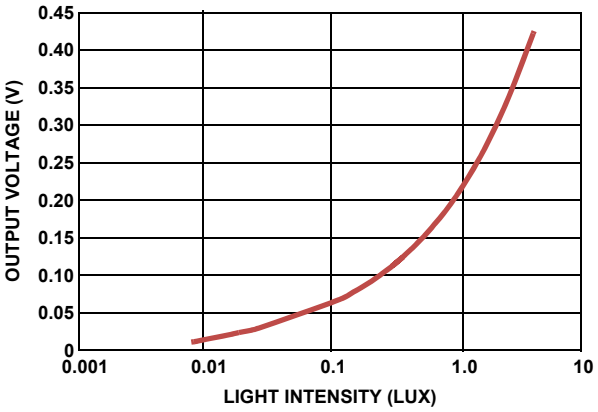


FIGURE 9. OUTPUT VOLTAGE vs LIGHT INTENSITY 0.01 LUX TO 5 LUX

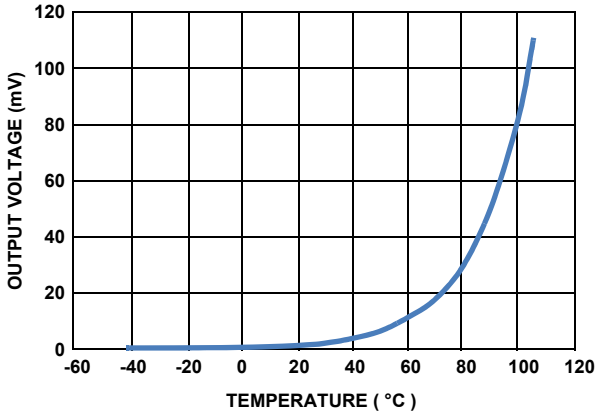


FIGURE 10. OUTPUT VOLTAGE vs TEMPERATURE AT 0 LUX

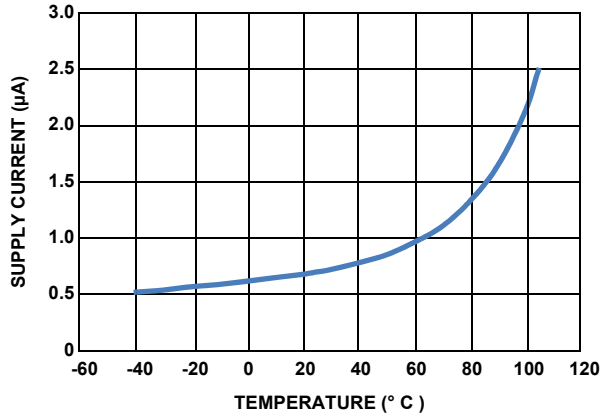


FIGURE 11. SUPPLY CURRENT vs TEMPERATURE AT 0 LUX

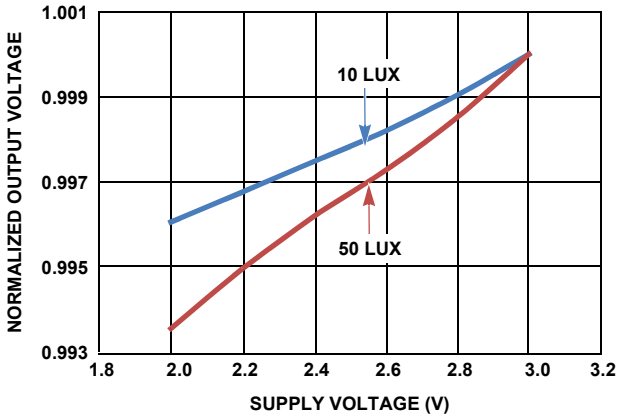


FIGURE 12. NORMALIZED OUTPUT VOLTAGE vs SUPPLY VOLTAGE

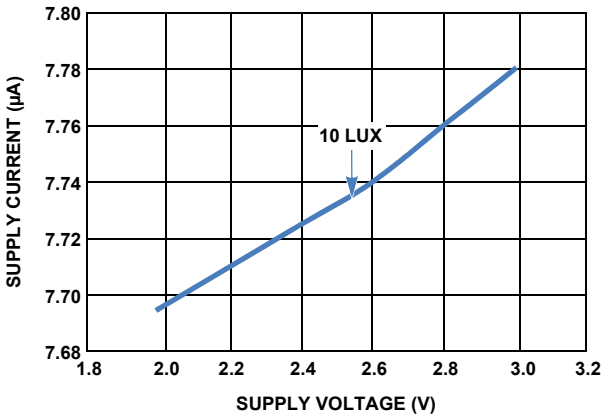


FIGURE 13. SUPPLY CURRENT vs SUPPLY VOLTAGE

Typical Performance Curves V_{DD} = 3V, T_A = +25°C, R_{EXT} = 100kΩ, no load at V_{OUT}, green LED light, unless otherwise specified.

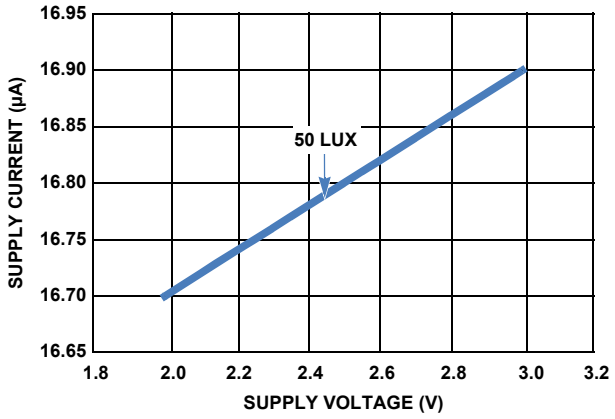


FIGURE 14. SUPPLY CURRENT vs SUPPLY VOLTAGE

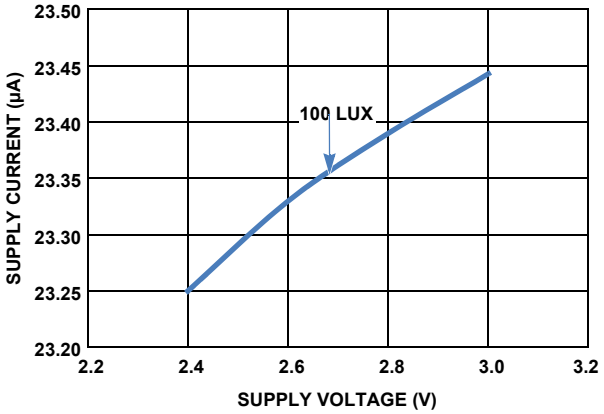


FIGURE 15. SUPPLY CURRENT vs SUPPLY VOLTAGE

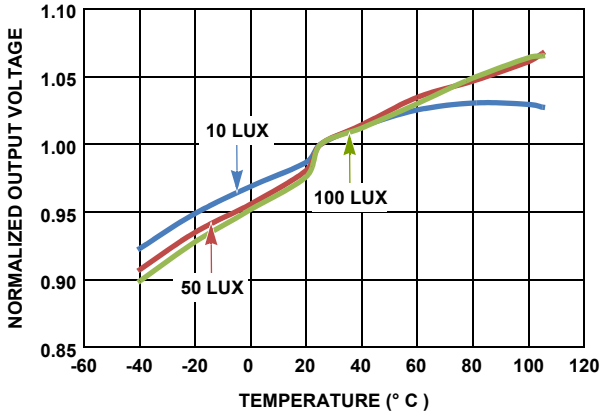


FIGURE 16. NORMALIZED OUTPUT VOLTAGE vs TEMPERATURE

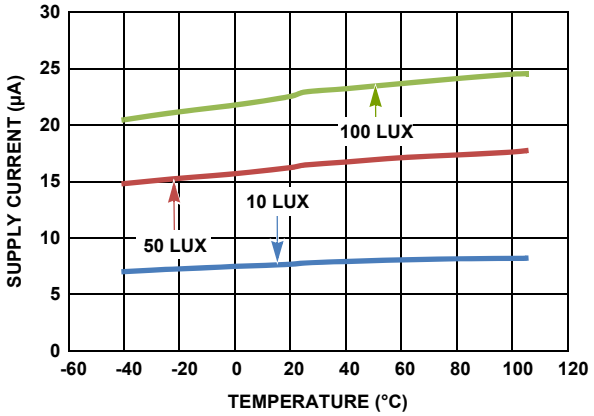


FIGURE 17. SUPPLY CURRENT vs TEMPERATURE

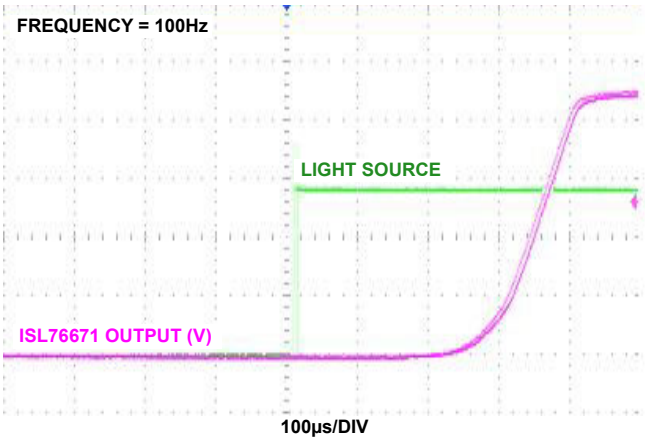


FIGURE 18. DELAY TIME vs LUX CHANGE FROM 0 LUX

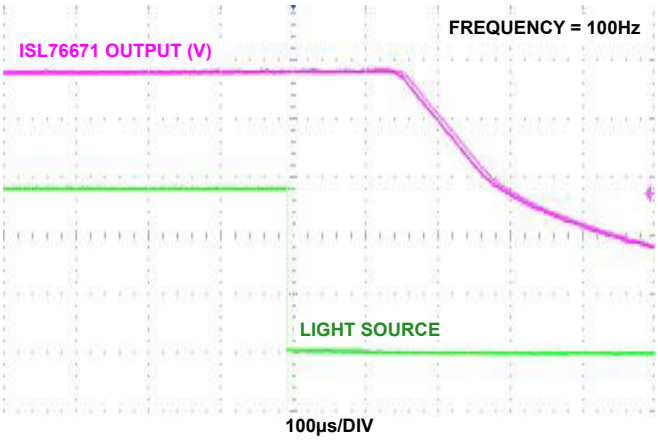


FIGURE 19. DELAY TIME vs LUX CHANGE TO 0 LUX

Application Information

Light-to-Voltage Conversion

The ISL76671 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).

$$V_{OUT} = \frac{18\mu A}{\sqrt{100lux}} \sqrt{E} \times R_{EXT} \quad \text{(EQ. 1)}$$

In Equation 1, V_{OUT} is the output voltage, E is the light intensity and R_{EXT} is the value of the external resistor. The R_{EXT} is used to set the light-to-voltage scaling constant. The compliance of the ISL76671's output circuit may result in premature saturation when an excessively large R_{EXT} is used. A R_{EXT} value of 100kΩ is recommended for automotive applications. The output compliance voltage is 700mV below the supply voltage as listed in V_{O-MAX} of the “Electrical Specifications” table on page 3.

Optical Sensor Location Outline

The green area in Figure 20 shows the optical sensor location outline of ISL76671. Along the pinout 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 pinout 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.

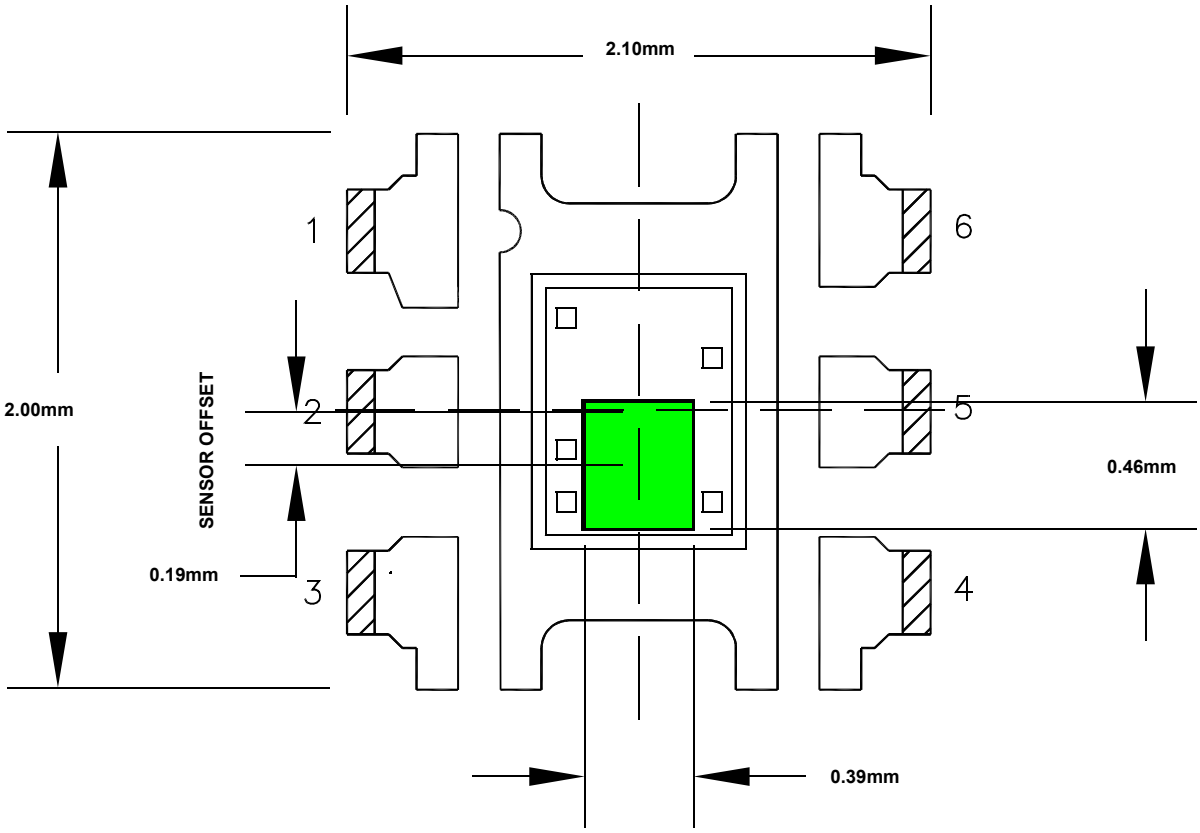


FIGURE 20. 6 LD ODFN SENSOR LOCATION OUTLINE

Revision History

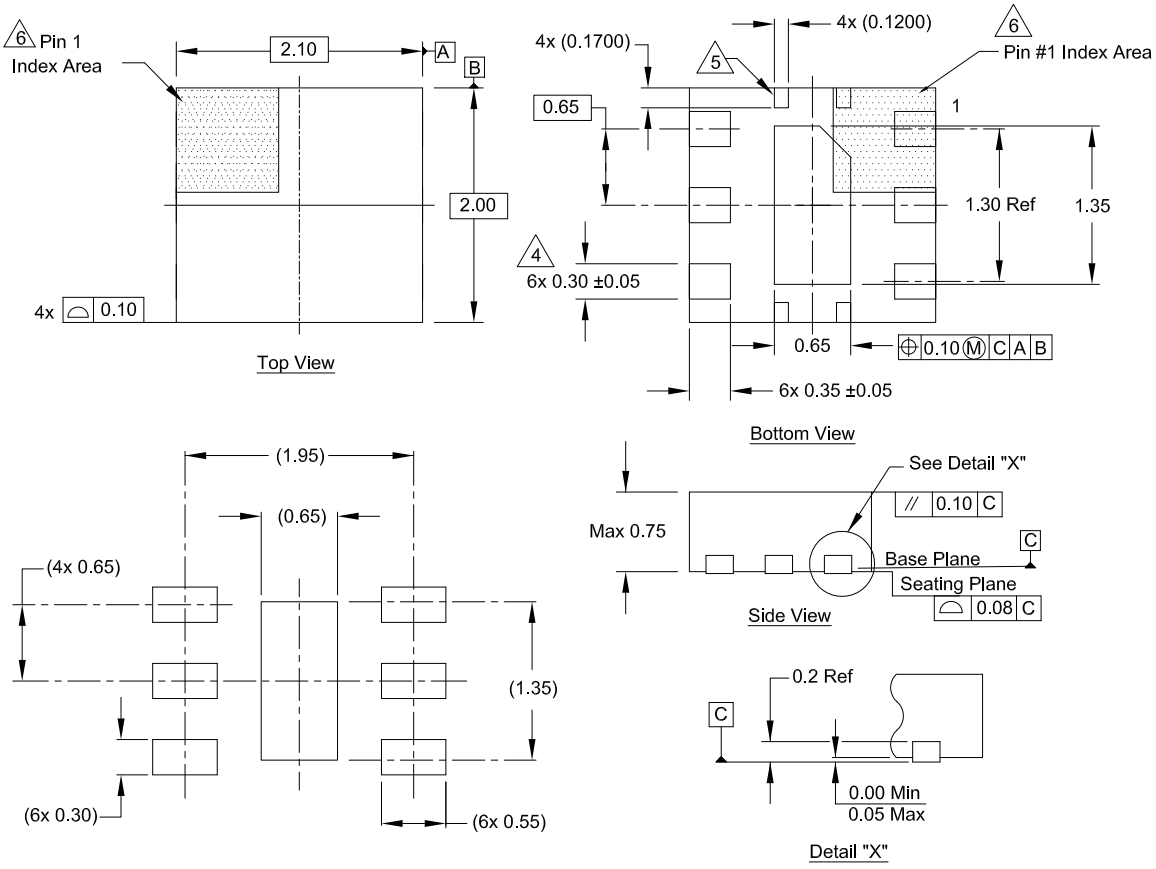
The revision history provided is for informational purposes only and is believed to be accurate, but not warranted. Please go to web to make sure you have the latest revision.

DATE	REVISION	CHANGE
May 21, 2021	4.0	Updated Links throughout. Updated Ordering information table. Removed About Intersil section Replaced POD L6.2x2.1 with POD L6.2X2.1Z.
Apr 20, 2015	3.0	Changed AEC Q100 to AEC-Q100 Updated ordering information on page 2 by adding T7A part and Evaluation Board. Updated ESD Ratings in “Absolute Maximum Ratings (T_A = +25°C)” on page 3 as follows: **From:** Human Body Model (Tested per JESD22-A114E). . . . . .. 3kV Machine Model (Tested per JESD22-A115C) . . . . . 300V Charged Device Model (Tested per JESD22-C101E). . . . . 1kV Latch Up (Tested per JESD78C) . . . . . 100mA **To:** Human Body Model (Tested per AEC-Q100-002). . . . . 2.5kV Machine Model (Tested per AEC-Q100-003) . . . . . 250V Charged Device Model (Tested per AEC-Q100-011) . . . . . 1kV Latch-up (Tested per AEC-Q100-004, Class II, Level A). . . . . 100mA Updated POD L6.2x2.1 to current rev with changes as follows: Changed Note 5 From: Tiebar shown (if present) is a non-functional feature. To: Tiebar shown (if present) is a non-functional feature and maybe located on any of the 4 sides (or ends). Updated Arrows to correct arrow type Updated datasheet with current Intersil standards.
December 23, 2013	2.0	Page 8 - 2nd line of the disclaimer changed from: "Intersil products are manufactured, assembled and tested utilizing ISO9001 quality systems as noted" to: "Intersil Automotive Qualified products are manufactured, assembled and tested utilizing TS16949 quality systems as noted"
December 12, 2011	1.0	“Thermal Information” on page 3, changed from: Pb-Free Reflow Profile (*) ..... see TB487 *Peak temperature during solder reflow +235°C max To Pb-Free Reflow Profile (*) ..... see TB477 *Peak temperature during solder reflow +260°C max “Electrical Specifications” on page 3: Added Min value of 1.4V and Max value of 2.3V for V_{OUT} where e = 100 lux
October 19, 2011	0.0	Initial Release

Package Outline Drawing

For the most recent package outline drawing, see L6.2x2.1Z.

L6.2x2.1Z
6 Lead Optical Dual Flat No-Lead Plastic Package (ODFN)
Rev 0, 5/20



Notes:

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

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