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DESCRIPTION

The LS3505 is a low cost visible light sensor, with a current output which is directly proportional to the light level. It has a built in optical filter to provide a response which is close to the human eye, or "photopic".

The output current can be converted to a voltage by connecting it in series with a resistor. The dynamic range is determined by the external resistor and power supply (10KΩ and 5V gives a range of 0 to 200 Lux or 1KΩ and 5V gives a range of 0 to 1000 Lux). The internal dark current cancellation enables high accuracy over the full temperature range, even at low light levels.

FEATURES

- Near human eye photopic response
- High IR rejection – integrated optical filter
- Current output highly linear vs light level
- Temperature stable
- Integrated high gain photo-current amplifier
- Dark-current cancellation

APPLICATIONS

- Dawn/dusk sensing
- Security lighting
- Display backlighting in laptops, mobile phones, LCD TVs
- Night-lights

1.0 Basic application & test circuit

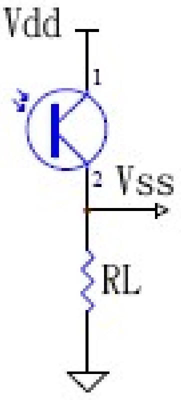


Fig. 1

Vdd = 5V DC

RL = 10 K Ohm

Light Range	RL
0 to 100 Lux	25KΩ
0 to 200 Lux	10KΩ
0 to 900 Lux	1KΩ

2.0 ABSOLUTE MAXIMUM RATINGS

PARAMETER	RATING	UNITS
Supply input voltage	-0.3 to 10	V
Supply current	Internally limited	mA
Operating Temperature, T_O	-40C to +85C	°C
Storage Temperature, T_S	-40C to +100C	°C

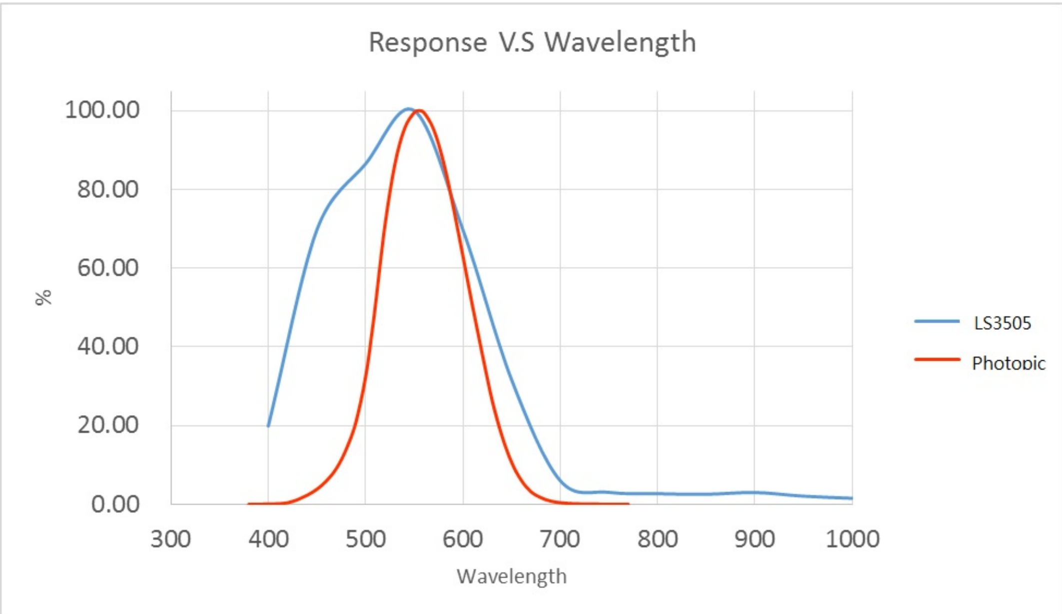
3.0 ELECTRICAL SPECIFICATION

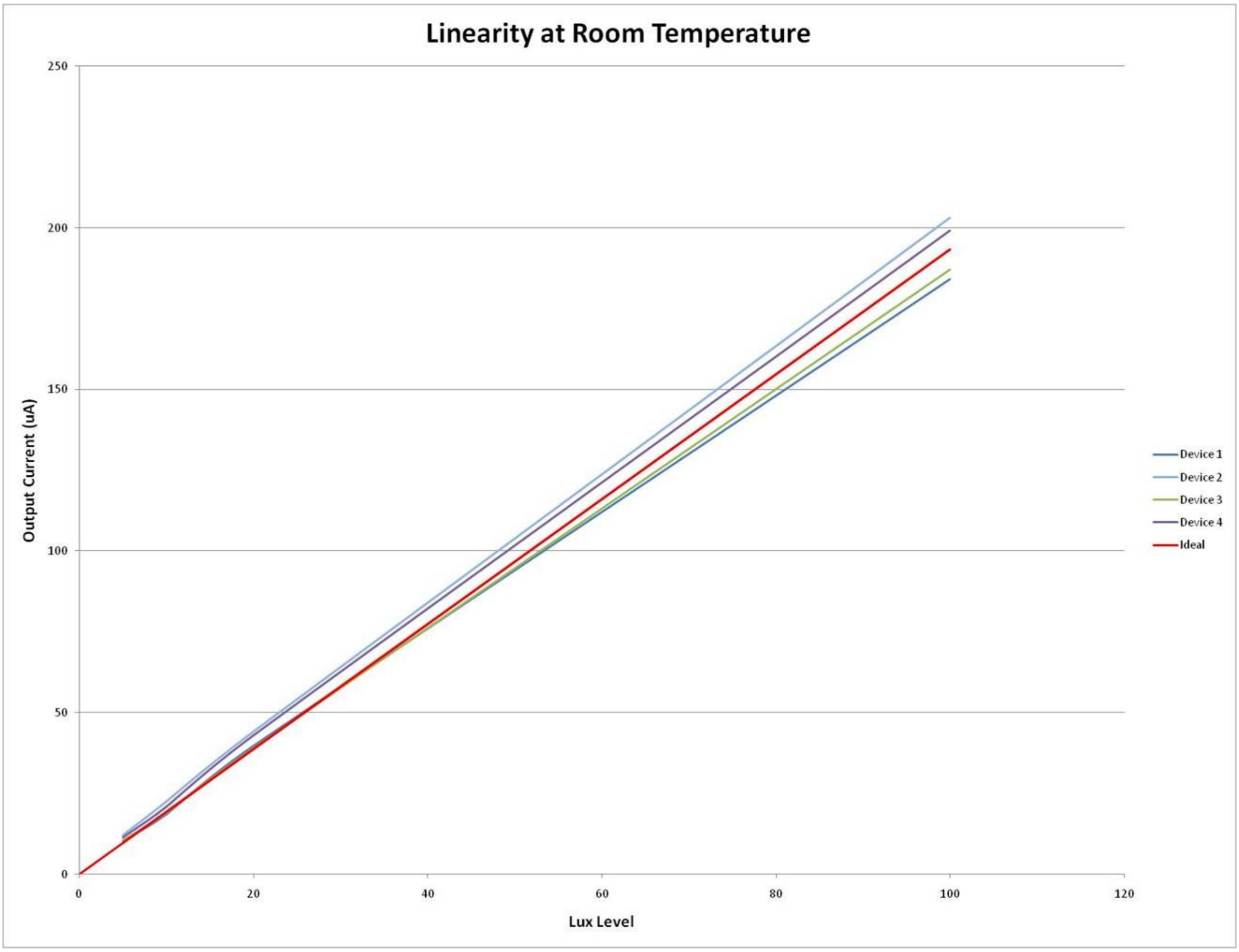
The following parameters apply over the operating temperature range –40°C to +85 °C, and with RL=10 K-Ohms and Vdd= 5V, as per Fig. 1.

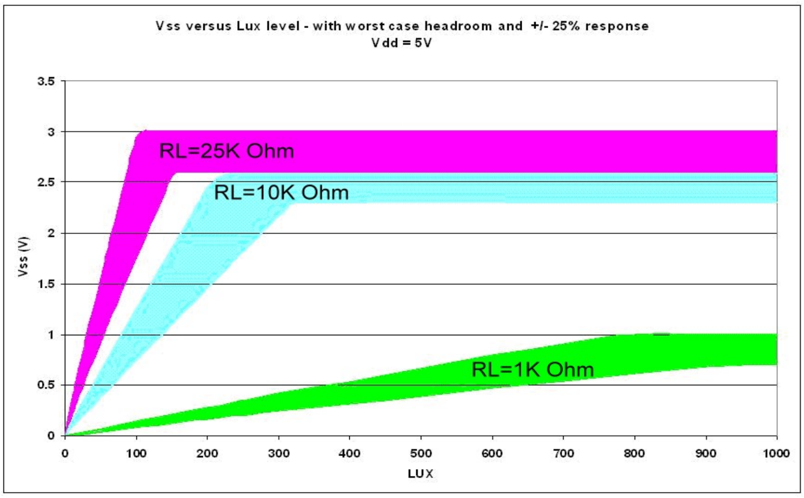
Parameter	Symbol	Test conditions	Min	Typ	Max	Units
Infra red response		900nm		1	5	% of peak
Minimum operational voltage	Vdd-Vss	160 Lux, Iss= 240uA 50 Lux, Iss= 75uA		2.4 6		V V
Light current	Iss	100 Lux 10 Lux	120 12	150 15	180 18	uA uA
Dark Current	Idd(dark)	0 Lux, Ta=25°C 0 Lux, Ta=80°C		<1 50		nA nA
Gain Linearity Peak spectral response			-10	 520	10	% nm
Sensitive area				0.054		mm^2

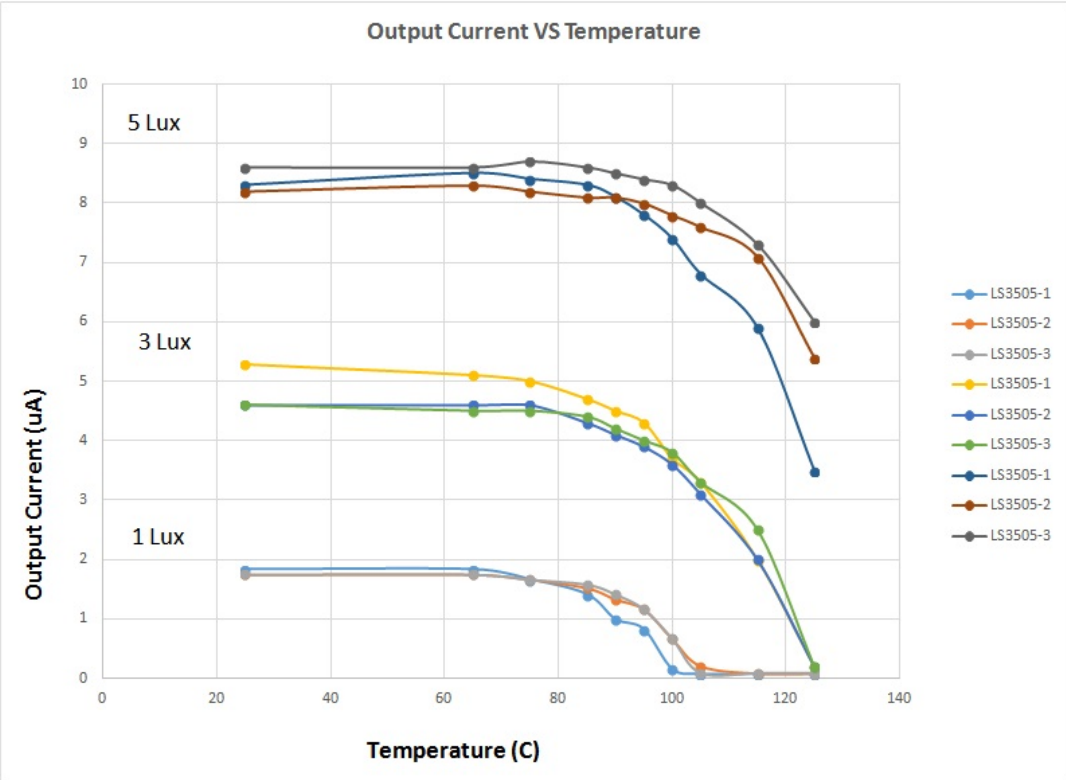
*****Note that with a lower Rss resistance, the linear light response range can be greatly increased. The final version of this datasheet will contain further information on the higher light level response.**

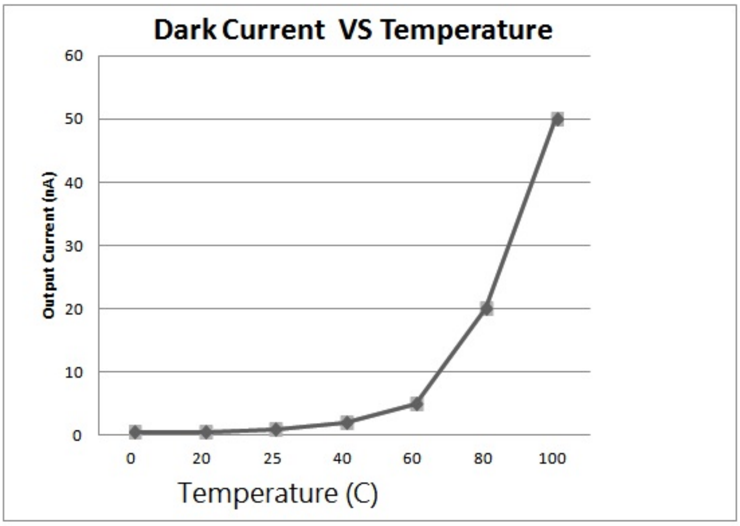
3.1 Characteristic Curves




Linearity at Room Temperature
Output Current (uA)
Lux Level
Device 1
Device 2
Device 3
Device 4
Ideal
0
50
100
150
200
250
20
40
60
80
100
120


Vss versus Lux level - with worst case headroom and +/- 25% response
Vdd = 5V
RL=25K Ohm
RL=10K Ohm
RL=1K Ohm
Vss (V)
LUX
0
0.5
1
1.5
2
2.5
3
3.5
100
200
300
400
500
600
700
800
900
1000


Output Current VS Temperature
5 Lux
3 Lux
1 Lux
Output Current (uA)
Temperature (C)
LS3505-1
LS3505-2
LS3505-3
LS3505-1
LS3505-2
LS3505-3
LS3505-1
LS3505-2
LS3505-3


Dark Current VS Temperature
Output Current (nA)
Temperature (C)

4.0 Application Examples

Automatic Night Light

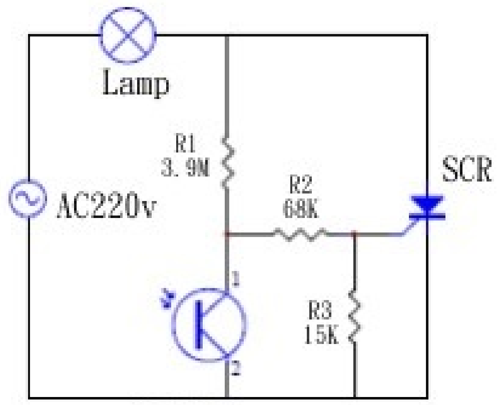


Fig. 2

Fig 2: This circuit show the LS35051 in an Automatic Night Light. The Lamp current is switched by a sensitive gate SCR. The Igt (TYP) of the SCR should be less than 10uA. When the light is above threshold, current flows between the Vdd and Vss pins of the ASIC which diverts current away from the gate of the SCR. The light-switching threshold can be adjusted by choosing different values for R2 and R3.

LED Drivers

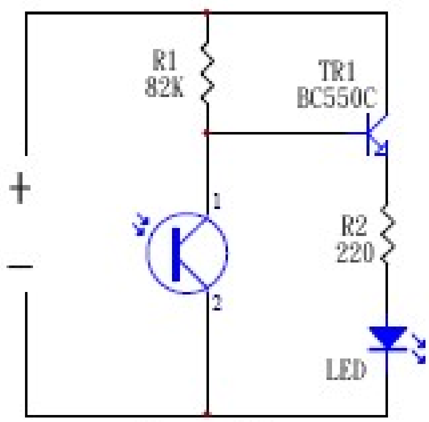


Fig. 3

Fig 3 is a very simple low cost circuit using the LS3505 to switch an LED. As the light increases, current flows between the Vdd and Vss pins of the ASIC which pulls down the base of TR1. In dark conditions R1 supplies current to the base of TR1 to switch on the LED. The base current of TR1 must be small compared to the photo current. This circuit should only be used when the current in the LED is less than 10mA. The DC current gain (hfe) of TR1 should be > 400 to minimise the base current. The BC550C or equivalent is a suitable transistor for TR1. This circuit is not suitable for VDC < 4V because of the headroom required for the LED and TR1. R1 should be adjusted by customers to obtain the switching threshold to suit the application. This circuit does not have a sharp switching threshold. The LED brightness decreases over a range of about 30 Lux as the ambient light level increases towards the cut-off point. The LED current will switch off completely when R1 is pulled down below about 2.5V. The advantage of this circuit is that it has the smallest number of components.

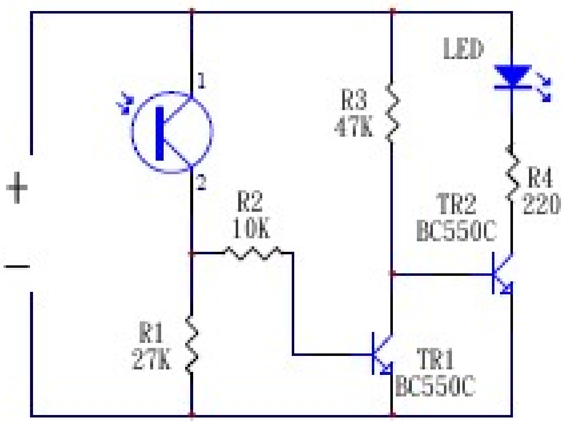


Fig. 4

FIG4 is a general purpose LED driver. The LED switches ON when the light is less than the switching threshold (Slux). The base current of TR1 will affect the switching threshold. To minimise this effect the base current into TR1 should be less than 10uA under all conditions of temperature and supply voltage. When the ambient light >Slux TR1 pulls down R3 and switches off TR2. For battery operated applications low current drain is important and the value of R3 should be as high as possible so that when the LED is off the circuit quiescent current is low. Slux is controlled by R1 and the base emitter voltage of TR1. R2 limits the base current into TR1 to prevent excess current with high illumination. R4 controls the LED current .

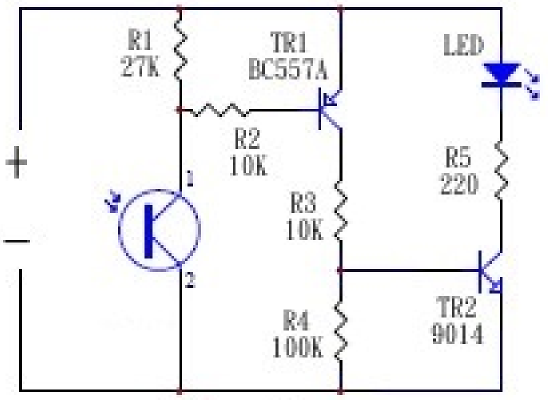


Fig. 5

Fig5 . In this circuit the LED switches ON when the light is above the switching threshold Slux. The value of R3 in this circuit can be lower than that in 3B because the current in TR1 is switched off in low light conditions .

Relay Drivers

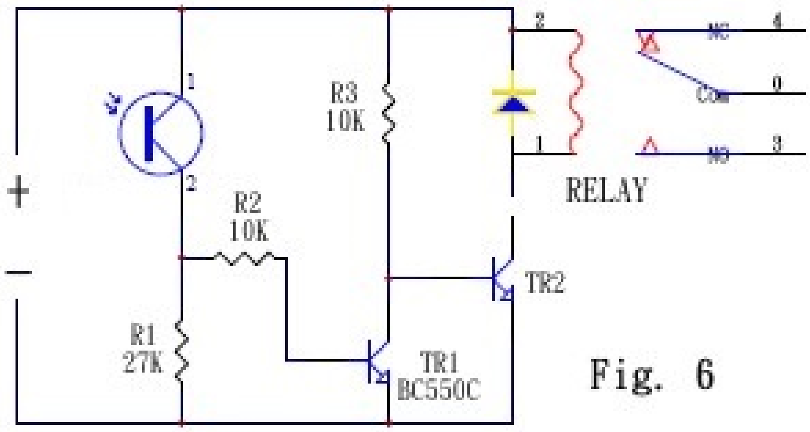


Fig. 6

Fig 6. The relay coil is energised when the light < Slux. The Slux threshold is set by R1 in the same way as explained in the description for circuit 3C. For battery operated circuits, the hfe of TR2 should be high to allow a high value for R3. The hfe of TR1 should be high so that a low base current will be able to pull R3 down.
Example :
VDC = 6V, relay coil resistance = 100R.
min hfe of TR2 = 100, min hfe of TR1 = 200
Coil current = 56mA. Min base current to switch on TR2 = 0.56ma. so R3 = 10K.

Min base current of TR1 = 0.56ma/200 = 2.8uA.
With the above value for R3, the quiescent current when the relay is off would be around 0.6mA which might be too high for some battery operated circuits.

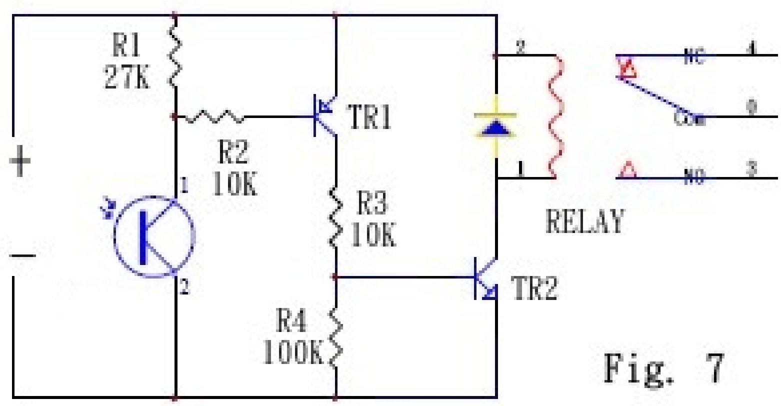


Fig. 7

Fig 7. The relay coil is energised when light > Slux. In this case the quiescent current is low in dark conditions because TR1 is switched OFF at the same time as TR2 and the relay coil. The customer can control the current to the application and the quiescent current by choosing a normally open (NO) or normally closed (NC) relay.

Interface Circuit Examples

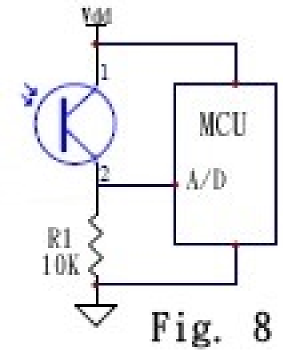


Fig. 8

Fig 8 shows an interface to a microprocessor. The voltage across R1 varies linearly with the illumination of the sensor. The current between the Vdd and Vss pins is approximately 1uA/lux, so with a 10K resistor the voltage at the A/D input will be 10mV per lux. The LS3505 was designed for low lux applications and the headroom required between Vdd and Vss becomes a problem at higher lux levels. These parts are not ideally suited to control room lighting applications especially if the microprocessor supply voltage is low. For higher lighting applications such as the control of room ambient lighting or backlighting applications for TVs, computers or mobile phones a lower gain version is planned.

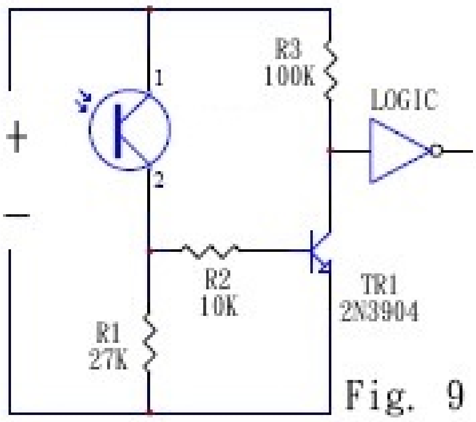


Fig. 9

Fig 9. This circuit uses a transistor to provide a light level switching interface between the LS3505 and CMOS logic. The switching threshold is set by R1 and the base of TR1 as explained for previous circuit examples. The OUT signal will be high when the illumination is above the threshold and low when it is below the threshold. Using a buffer instead of an inverter will change the polarity of the OUT signal

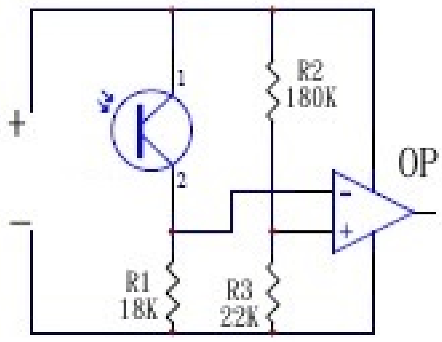


Fig. 10

Fig 10. This circuit uses a comparator (or op-amp) to provide a level switching interface for the LS3505. OUT will be high when the voltage at Vss < 0.1*Vdd.

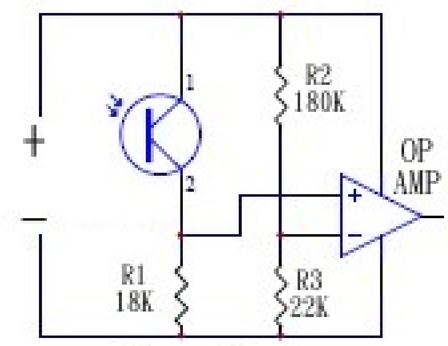


Fig. 11

FIG 11. Same as Fig 10 except that OUT will be high when the voltage Vss > 0.1*VDD

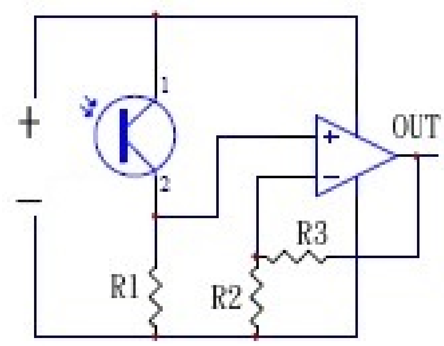
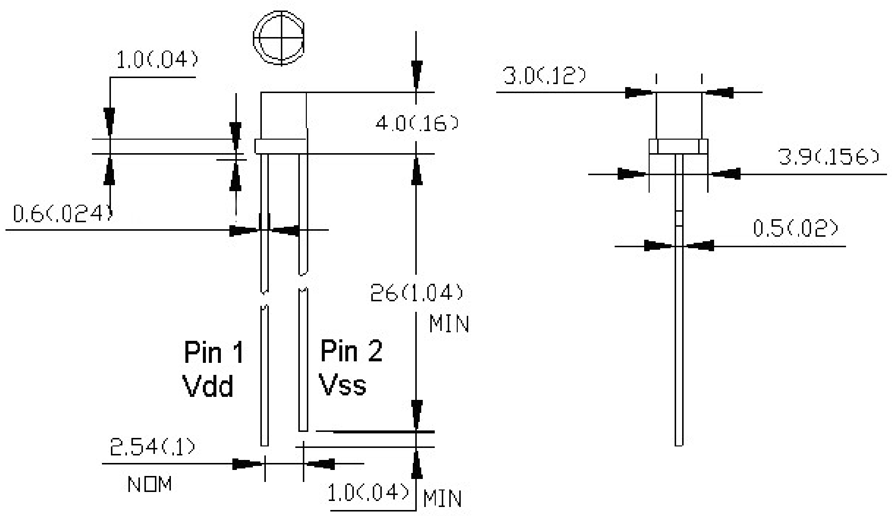


Fig. 12

FIG 12. The op-amp circuit amplifies the output voltage at Vss.
VOUT = (1 + R3/R2) Iphoto*R1

5.0 Package Dimension



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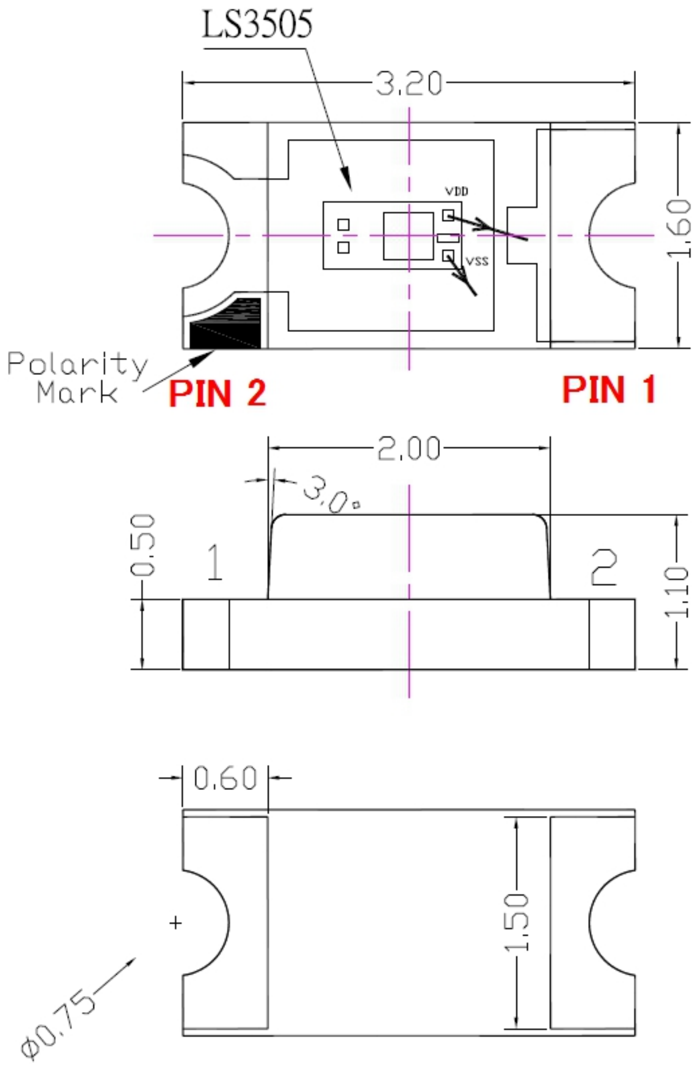

*All Tolerances are ±0.1mm unless otherwise noted.

6.0 Handling Instructions

Thank you for choose our Light Sensor LS3 Series products. Light Sensors are delicate semiconductor product that should be handle according to the below instructions.

A. Storage:

1. Light Sensors should be stored an environment with ambient temperature of 23 ± 5℃ and relative humidity of 40 ~ 70 %.

2. Light Sensors should be used within three months of being taken out of their original packages to avoid lead frame rusting.

B. **Cleaning:**

1. Do not use any unidentified chemical to clean Light Sensors, it could damage or crack the Light Sensor epoxy surface. If necessary, soak Light Sensor in alcohol for a time not exceeding one minute in normal temperature.

C. **Lead Frames Shaping & Trimming**

1. The shaping should be done underneath the wedge point. No pressure should be exerted to the epoxy shell of the Light Sensor during shaping.
2. Bending of the leads should be done at a point at least 4 mm from the base of the Light Sensor lens.
3. Shaping of the leads should be done before soldering.
4. Lead trimming should only be done at normal temperature.

D. Soldering

1. When soldering, the soldering iron needs to be at least 3mm away from the epoxy edge. After soldering, allow at least 3 minutes for Light Sensors to cool back to normal temperature. Do not apply any pressure to the epoxy encapsulation or the lead frame during the soldering process.
2. When reflow soldering or wave soldering, please solder once for less than 5 seconds at a maximum temperature of 260°C. During the soldering process, if the temperature or timing is not controlled within limits, it would cause the epoxy to deform or cause the die or wires within the Light Sensor to be damaged.
3. When using soldering iron, please solder once for less than 5 seconds at a maximum temperature of 300°C. When soldering a row of Light Sensor on a PCB, please do not solder both leads of a Light Sensor in sequence. (Solder all the positive lead first, then all the negative leads)
4. Do not dip the epoxy encapsulation part of Light Sensor into any soldering paste liquid.

5. After soldering, do not adjust the location of the Light Sensor anymore.
6. When attaching electronic parts to a PCB with Light Sensors, the curing time for the whole PCB should be less than 60 seconds, at less than a temperature of 120°C.

E. Installation

1. During the installation process, do not apply any pressure to the leads.
2. Please make sure the installation holes on the PCB matches the leads of the Light Sensor.

F. ESD (Electrostatic Discharge)

1. Light Sensor is very sensitive to ESD; please make sure during the whole usage and installation process, that no ESD exist to affect the Light Sensor. Excessive ESD could damage the Light Sensor chip and result in performance degradation.
2. Light Sensor can also be damaged by electrical surge, please make sure any driving electrical circuits are equipped with surge protection.
3. During the installation process, please make sure all the equipment and personnel are grounded properly. Make use ESD protection equipment such as anti-static gloves, anti-static wrist bands, anti-static mats, anti-static clothes, anti-static shoes, and anti-static containers.
4. When Light Sensor come into contact with low electrical resistance metallic surfaces, the ESD could damage the Light Sensor due to sudden discharge of ESD. Please make sure all surfaces that will be in contact with Light Sensor are covered with anti-static mats (Surface electrical resistance of 10^6~~10^8Ω/sq). Light Sensor should be placed in anti-static containers and anti-static bags.
5. All soldering irons should be grounded and production environment should make use of ion-blowers.