APPLICATION NOTE

Photointerrupter (ITR) Object Detection Application Manual

1. Introduction :

With the advancement of technology, the degree of automation of various electronic products has also increased. Products with a higher degree of automation also include more sensing elements. In order to prevent the human eye from being interfered by light emitted by various products or devices in the environment. Therefore, infrared (IR) products that cannot be detected by human eye is used as sensor. This application note will introduce how to use Infrared Emitter and Infrared Receiver for object detection applications.

The most common infrared emitting and receiving components are IR light-emitting diodes (IR LEDs) and phototransistors (PTs). Figure 1 shows a basic IR LED with PT application circuit.

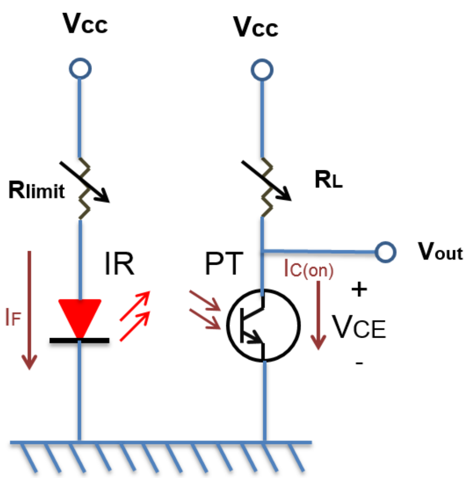

Figure 1. IR LED and PT application circuit

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Principle：

- IR LED is the source of emission. The greater the forward current(I_F), the greater the intensity of the emitted radiation.。
- PT is receiving. The larger the received irradiance, the larger the photocurrent IC (on) generated.
- Adjust the R_{limit} value to control the voltage of IF.
- Adjust the RL value to control the voltage of Vout.
- Vout is connected to the MCU's ADC (Analog-to-Digital Converter) or GPIO for level judgment.

Judgment description：

- No irradiance, the PT is turned off and the Vout output is high (Vcc)
- Low irradiance, the PT is turned on and the Vout output is high (Vcc-(Ic x RL))
- When irradiance is high, PT is saturated and Vout output is low potential (VCE (sat))

Note: VCE (sat) is the saturation voltage of PT.

2. Object detection method using reflective ITR：

IR LED is usually used with PT as an object detection or interrupt detection application. Figure 2 is a schematic diagram of using IR LED to emit IR to an object, and the object reflects IR to PT for object detection. In order to avoid the misjudgment of IR directly transmitted to the PT in the mechanism, the IR LED must be effectively isolated from the PT. Using the two features as below, distance detection of reflectors can be achieved.

- The closer the reflector is, the stronger the reflected irradiance received by the PT, and the higher the output current.
- Different materials have different reflectivity. Generally, the darker the object and the rougher the surface, the lower the reflectivity. At the same distance, the current output from the receiving end will be relatively reduced.

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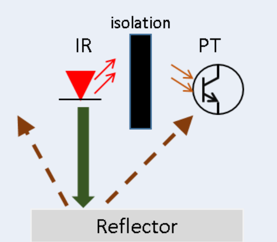
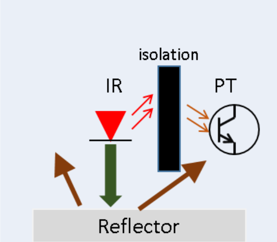
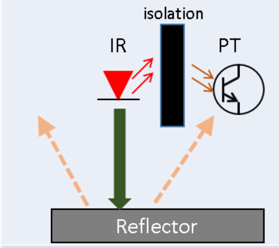
Reflector			
Distance	Far	Near	Far
Surface	Smooth	Smooth	Rough
Color	Light	Light	Dark
schematic diagram			
Reflection intensity	medium	Strong	weak

Figure 2. Effects of distance and material of reflective objects on object detection

Figure 3. IR LED + PT combination element ITR with isolation mechanism

If the direct current (DC) detection method is used, it is easy to cause misjudgment when the ITR is illuminated by ambient light. The reason is that the PT end cannot distinguish whether the received irradiance is from ambient light or whether the IR is reflected by the object. The improvement method is shown in Figure 4. Change the IR transmission mode from DC to Pulse, and then the PT needs to detect the voltage values Vout (Off) and Vout (On) at each IR Off and IR On respectively. At this time, Vout (Off) represents the offset value (Offset) caused by ambient light, and Vout (On) represents the ambient light plus the voltage value at the time of IR emission, so between Vout (On) and Vout (Off) The voltage difference is the voltage value caused by pure IR emission. In addition to reducing the interference of ambient light, this method also uses Pulse to light up for a short time, so it can use a stronger current drive to detect longer distances.

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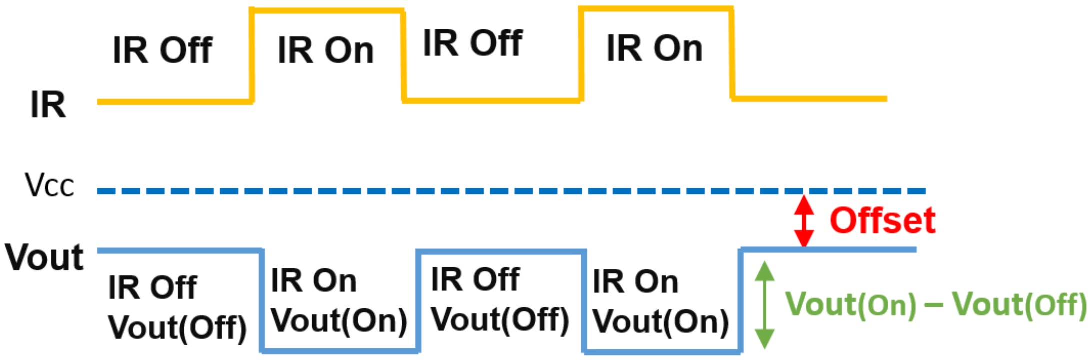

Figure 4. Ways to improve ambient light interference

Figure 5 is an example of the actual output waveform of the PT. It can be found that when the IR switches from On to Off, the PT will have a delay time. Therefore, when sampling Vout (Off), you need to confirm that the PT output voltage has stabilized to avoid subsequent calculation of object detection Misjudgment when measuring variation.

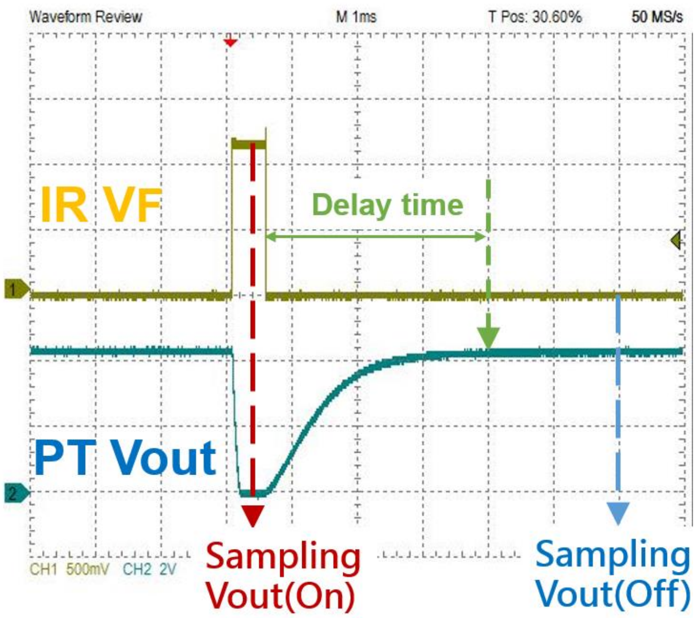

Figure 5. PT output voltage waveform detection

3. Example Reference

Figure 6 is an example of an application circuit diagram. The MCU's GPIO is used to control the on and off of the MOSFET to control the IR transmission pulse, and Vout is connected to the MCU's ADC pin. The resistance of R limit and RL is adjusted to confirm the distance of object detection. Finally, the difference between Vout (Off) and Vout (On) read by

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ADC is used to set the threshold of object detection.

Refer to the method in Figure 4 to control the GPIO and the waveform in Figure 5 to set the ADC sampling time. The following uses Everlight ITR20001 / T24 (Bin K) as an example. The IR on time is 350us, and Vout (On) is sampled at 300us. The IR Off time length is 50ms, and Vout (Off) is sampled at 6ms. Vcc = 5V, R limit = 82 ohm (IF ≒ 50mA), RL = 150k ohm. It is recommended that the threshold is set to about 1/3 of the ADC maximum value. This 1/3 value is reserved for the use of the Offset for light interference. The larger the value is, the stronger the light interference resistance is, but the object detection range will be relatively reduced. Figure 7 shows the comparison of different detected objects after Vout is set in the above manner (the Y-axis is the ADC reading of the difference between Vout (Off) and Vout (On)). It can be seen from the figure that the lighter the color of the reflective object, the higher the reflection amount, and the larger the range of the detectable distance. Generally, a gray card is used as a design reference. This picture is taken as an example. The judgeable range of the gray card is about It is 0.1 ~ 6cm, black card is 0.1 ~ 3.5cm, white card is 0.1 ~ 9.5cm.

Figure 8 shows the test of changing the IF by using the reflector gray card with 150k ohm RL. It can be found that when the IF increases to 100mA, the judgeable range will increase to 0.1 ~ 9cm.

Figure 9 is a test of changing the RL with a reflective gray card and a 50mA IF. It can be found that when the RL is reduced to 68k ohm, the judgeable range will be reduced to 0.1 ~ 4.5cm.

Note: 1. If the detection object is completely in close contact with the ITR, the reflection value will be zero because there is no reflection path.

2. The above test results are based on no cover on the ITR (single bare test).

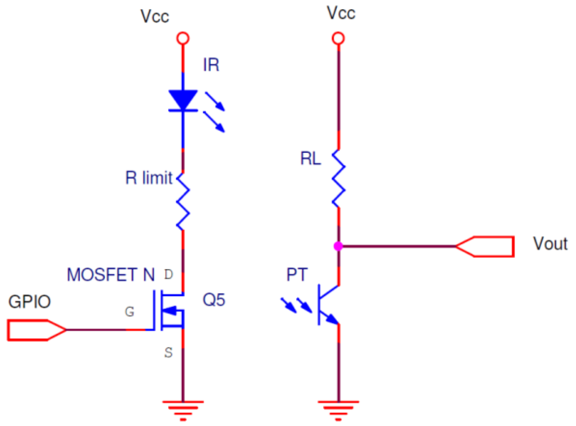

Figure 6. Application circuit diagram

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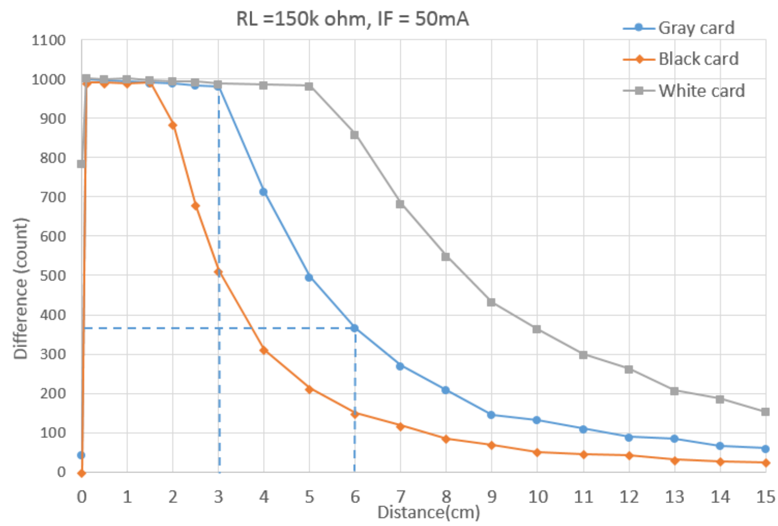

Figure 7. Effects of different color DUTs on ADC readings

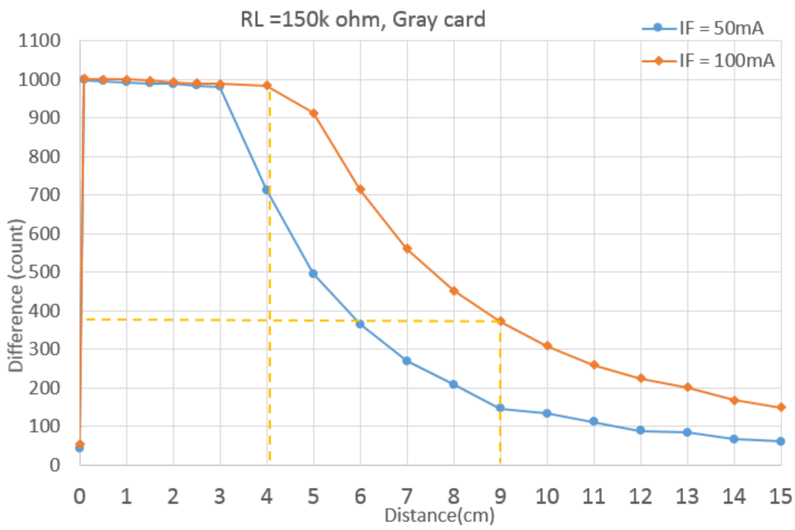

Figure 8. Effect of different IFs on detection distance

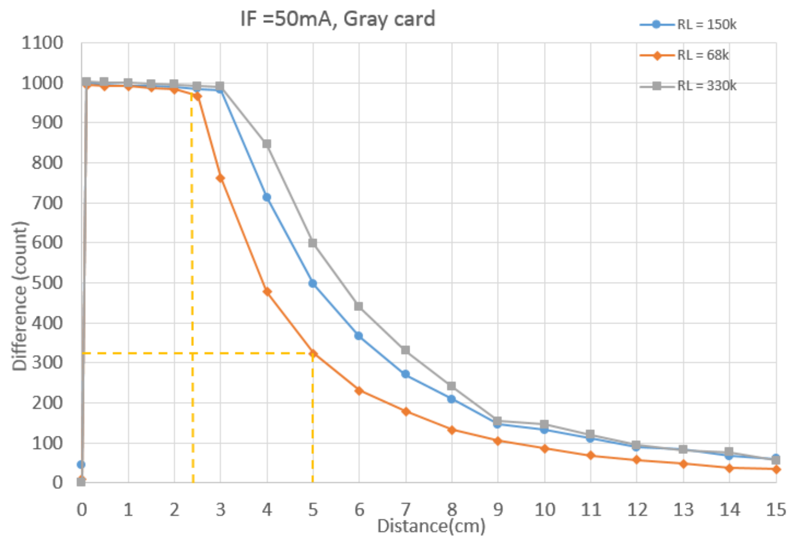

Figure 9.Effect of different RLs on detection distance

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4. Conclusion

Adjusting the IF or RL can adjust the object detection distance. If you want to increase the detection distance without power consumption considerations, it is recommended to increase the IF priority, because increasing the RL will also increase the intensity of light interference; if you want to reduce the detection distance, use the Lowering the RL resistance value is preferred, while reducing ambient light interference.

5. Suggestion Part List

Product	package	Size(L x W x H) (mm)
ITR20001/T24	Dip	6.4 x 4.9 x 6.5
ITR-9908	Dip	10.65 x 5.65 x 5.9
ITR8307	Dip	3.4 x 2.7 x 1.5
ITR8307/S18/TR8	SMD	3.4 x 2.7 x 1.5
ITR8307/L24/TR8	SMD	3.4 x 2.7 x 1.5
ITR1502SR40A	SMD	4 x 3 x 2

This application manual provides customer design reference. If there are design changes, system performance may be degraded. If there are any problems in the design of the system, please contact Everlight for further technical support.

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