

## Application Overview

### COMPATIBILITY TO EXISTING APPLICATIONS

Normally, Vishay IR receiver modules are used in systems in which the data format and the decoding software are already specified by the customer. The TSOP receiver modules will in most cases work correctly the first time they are “dropped” into the system.

In the event the receiver module does not operate as well as expected, the following items should be checked:

- Table 1 in the chapter “Data Formats for IR Remote Control” lists the most popular IR remote control data formats and the IR receiver types suitable for receiving them. If a data format is not mentioned then Carrier frequency, Burst length and Gap length of the data signal (see table 1 - in “Data Formats for IR Remote Control”) should be cross checked against the receiver type. If there is uncertainty regarding the selection of the type, we recommend the general purpose TSOP343xx series.
- Possible disturbance sources (ambient light, EMI, noise or ripple on the power supply) as described in the chapter “Disturbance Sources”.
- Attenuation due to an optical window in front of the sensitive area of the receiver or due to light guide coupling.
- Output pulse timing tolerances of the decoding software.

### OUTPUT PULSE WIDTH TOLERANCES

The decoding software must accept and evaluate the output pulses of the IR receiver. In figure 1 there is example data of the output pulse width versus the optical input power. This diagram also gives an indication of the output pulse width jitter (the difference between the min. pulse width and the max. pulse width at a given irradiance).

The tolerances of the output pulse width ( $t_{po}$ ) with respect to the input burst length ( $t_{pi}$ ) is given in the expression:

$$\left( t_{pi} - \frac{6}{f_0} \right) < t_{po} < \left( t_{pi} + \frac{6}{f_0} \right) \quad 20505$$

This tolerance includes variations over the entire range of temperature, supply voltage, irradiance and jitter. The jitter alone (output pulse width variation during the transmission of a data command) is much less than the above tolerances. Typical figures for the jitter are shown in figure 1, where the difference between maximum and minimum pulse width is calculated for each irradiance value.

If there is a decoding software compatibility problem because of the output pulse voltage level or the output pulse switching time, then an external pull up resistor (10 kΩ, see figure 7 in the chapter “Disturbance Sources”) may solve the problem.

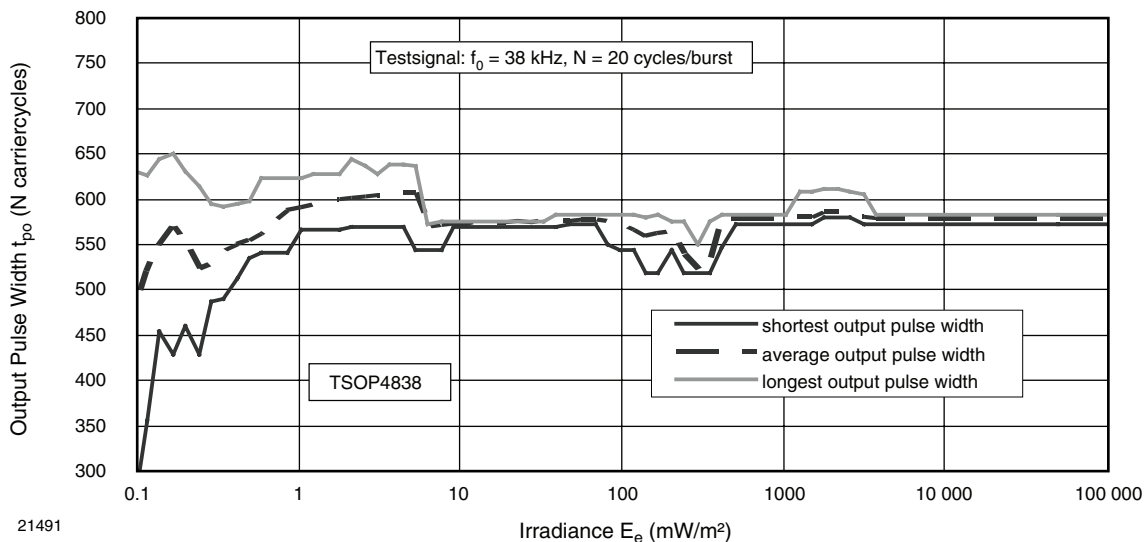


Fig. 1 - Statistical Evaluation of 1000 Output Pulses at each Irradiance

## APPLICATION CIRCUIT FOR OPERATION IN HARSH ENVIRONMENTS

The Vishay IR receivers include protection circuitry against electrostatic discharge (ESD) or electrical overstress (EOS), which is sufficient in most applications. In case the electrical environment of the IR receiver has serious over-voltage

transients (e.g. in automotive or motor control applications) the addition of several components can improve the EOS protection, as shown in figure 2.

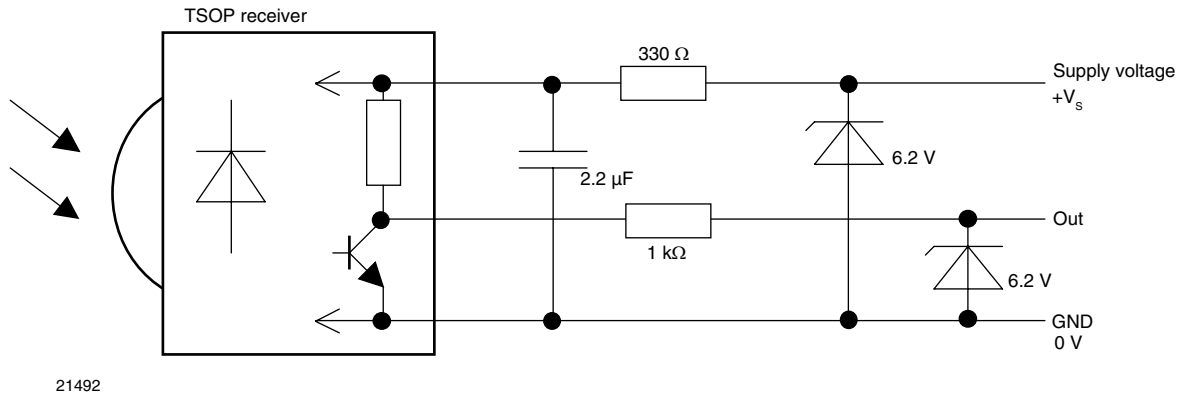


Fig. 2 - Protection Circuit against Over Voltage Spikes

## APPLICATION IN SENSORS

Although the main application of the TSOP modules is IR remote control, they also exhibit good properties for use as sensors or in light barrier systems. A light barrier width of up to 20 m or a reflective sensor of up to 1 m detection distance is feasible. Some special features in these applications are: high sensitivity, low interference to ambient disturbance sources, compact outline, and low supply current consumption. Because these applications exhibit a continuously received signal, there are some limitations for the optical signal to prevent the AGC from being triggered and reducing the gain of the receiver.

Unlike for remote control in sensor applications the irradiance of the signal may vary a great deal during reception. For example, the irradiance may increase slowly from below 0.1 mW/m<sup>2</sup> (i.e. from a level too weak to be received). This can happen when an obstacle is removed slowly out of a light barrier. In such cases there are different limitations for the IR signal than in remote control applications. Table 1 shows the recommended burst length and burst repetition parameters for the IR signal when used in sensor applications with the different receiver series.

TABLE 1 - IR SIGNAL LIMITATION IN SENSOR APPLICATIONS					
AGC CATEGORY	AGC1	AGC2/8	AGC3	AGC4	FIX GAIN VERSION
EXAMPLES OF IR RECEIVER TYPES	TSOP41xx TSOP321xx TSOP361xx	TSOP12xx TSOP48xx TSOP352xx	TSOP323xx TSOP383xx TSOP353xx	TSOP44xx TSOP384xx TSOP584xx	TSOP4038 TSOP5038 TSOP58038
Minimum burst length (number of cycles in a burst)	6	10	6	10	10
Minimum burst repetition time using the shortest burst	3 ms	6 ms	11 ms	17 ms	no limit

The "fix gain version" overcomes the main issues of our standard IR receiver modules in light barrier applications. There is no restriction regarding the fastest burst repetition rate, it can even work with a continuous carrier signal (e.g. a continuous 38 kHz signal). The reaction time is therefore much faster and the circuit becomes simpler. A further problem of the standard IR receivers in sensor applications is the variable detection threshold. Standard IR

receivers adjust their detection threshold depending on the amount of ambient light and optical noise present in the environment in order to avoid emission of spurious pulses. In a sensor application, the power of the emitter is normally adjusted according to the maximum brightness level of the light barrier environment, which corresponds to the lowest gain of the IR receiver. However, when the IR receiver is then subjected to lower light levels, the AGC adjusts the gain and

the receiver becomes too sensitive and even detects reflected or stray light.

With a fix gain version it is easy to overcome this issue. The sensitivity can be reduced in the design of the application through the use of for example an aperture or an attenuation

filter such that the receiver does not suffer from spurious pulses due to light interference. Then the emitter intensity can be adjusted to the level required by the application. Such a system can function with the same reproducible characteristics in both dark and in bright ambient.

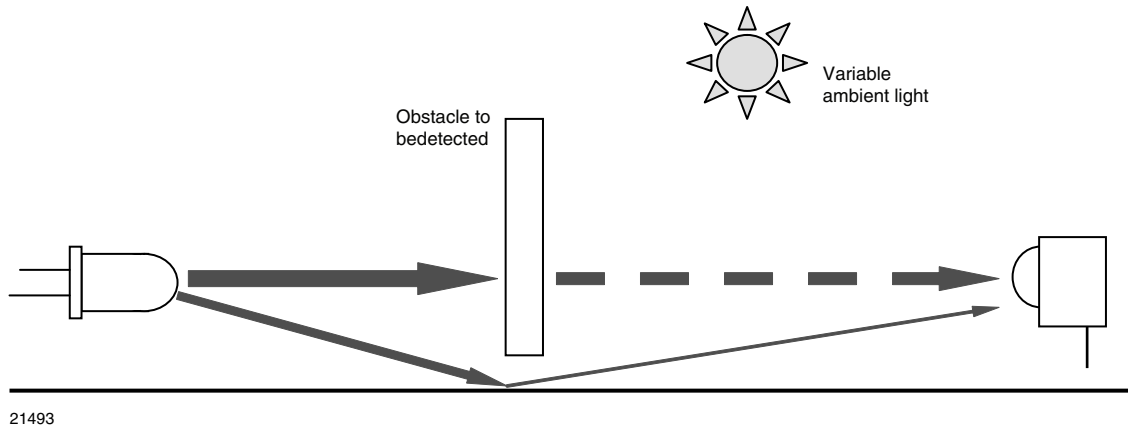


Fig. 3 - Stray Light in a Light Barrier Application can Produce a False Response

If the sensor application does not allow any spurious output pulses, then we recommend using an additional suppression circuit. Usually the internal AGC suppresses such unwanted pulses. However, there is a risk of false pulses when the illumination is not uniform. A very low rate of noise pulses

(< 15 pulses/min) is possible even in constant illumination. To overcome this problem, the signal bursts should be longer than 500  $\mu$ s. As the noise pulses are usually shorter than 400  $\mu$ s (in case of a 38 kHz receiver) a hardware or software filter can then be used to easily suppress the false pulses.

**APPLICATION IN BATTERY-POWERED SYSTEMS**

There are two critical paramters when using the IR receiver modules in battery-powered systems: the supply voltage and the supply current. The best properties regarding both parameters have the IR receivers of the TSOP3xxxx family. These devices have low supply current of about 0.35 mA only and they can work at low supply voltages to provide a function even with almost empty batteries. The lowest specified supply voltage is 2.5 V, however typically it can operate even below 2 V.

If the supply current of the IR receiver modules is too high for continuous operation then a pulsed supply voltage can help to further save battery power.

For the best response time, the duty cycle of the supply voltage should be selected such that the supply is pulsed once during the wake up signal of the IR command as shown in figure 4 and 5. If the IR receiver senses a signal in this time window, then the supply voltage is turned on for a longer period of time to receive the full data command.

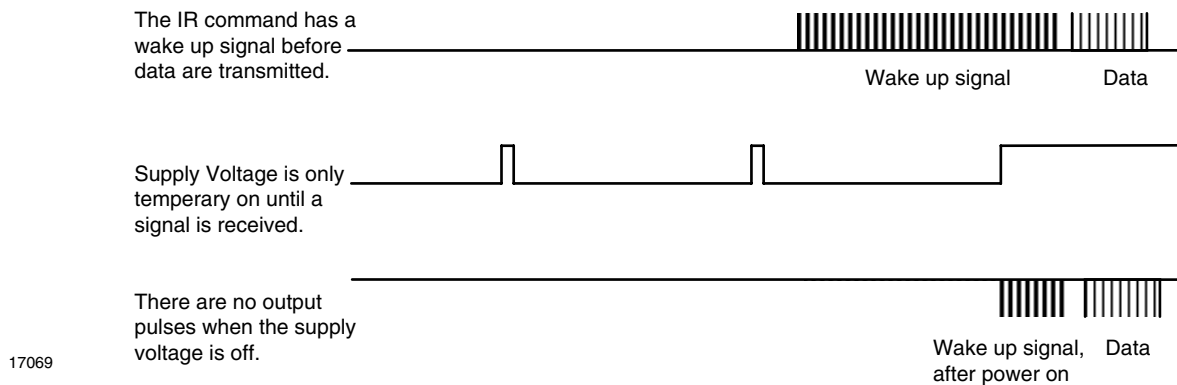


Fig. 4 - Example for a Battery-Saving Mode with Vishay IR Receiver Modules

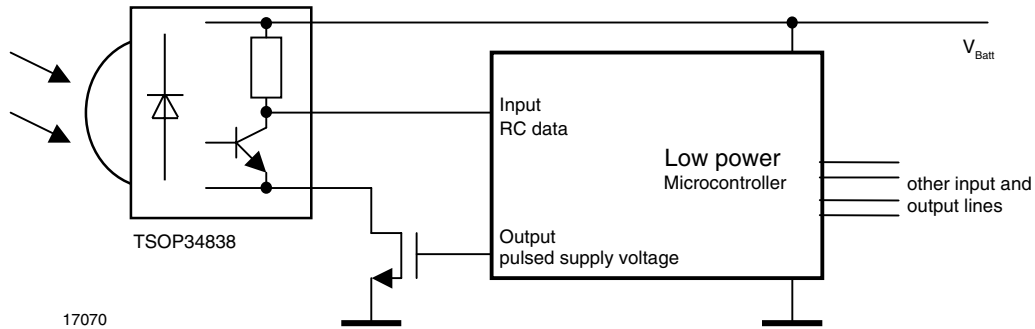


Fig. 5 - Circuit Example for Pulsing the Supply Current to Save Battery Power

The actual stand-by supply current of the IR receiver when used in this application depends on the ratio of "on/off time". In the case of a 2 ms on time and 200 ms off time, the stand-by supply current is about 3.5  $\mu$ A for the IR receiver. This would allow a battery life of more than 2 years. To achieve this performance, a pre-burst (wake up time) of 202 ms is needed in this example.

Note: After switching the power supply to the "on" state, the AGC initially sets the internal gain of the IR receiver module to the "half sensitivity" value, which assumes approximately twice the normal threshold irradiance in dark ambient. Since the AGC can only change the gain relatively slowly to a higher or lower sensitivity, operation in stand-by mode results in a fixed sensitivity which is less than in normal operation and dark ambient, but more than in normal operation and a highly illuminated ambient. Hence when subjected to strong disturbances, there may also be unwanted pulses because the sensitivity has not adapted to the ambient. These unwanted pulses may cause a false wake up, but they should not cause a false action because there is no valid data.

To overcome the issue with the improper gain setting due to the power on reset, Vishay offers also special parts that can memorize the gain level during the "off period".

## APPLICATIONS WITH BI DIRECTIONAL TRANSMISSION

A two-way communication in half duplex mode is possible with the Vishay IR receiver modules. Full duplex mode is not possible as the selectivity of the receivers using two IR channels (e.g. one at 30 kHz and one at 56 kHz) at the same time and in the same space is not sufficient.

In a bi-directional IR transmission, the receiver will usually see the transmitted signal of both sites, the signal that is sent from the other site as well as the signal that is sent from the receiver site. In such an application, the transmitted signal is usually much stronger than the received signal. In order to retain full sensitivity while receiving, we recommend an idle time of 15 ms between transmitting and receiving. In this idle time, the Automatic Threshold Control (ATC) of the IR receiver will recover its quiescent sensitivity.

The IR receiver modules with the AGC1 setting are the most suitable types for data communication because their AGC allows continuous reception.