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:

$$\left(t_{pi} - \frac{5}{f_0}\right) < t_{po} < \left(t_{pi} + \frac{6}{f_0}\right)$$

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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.

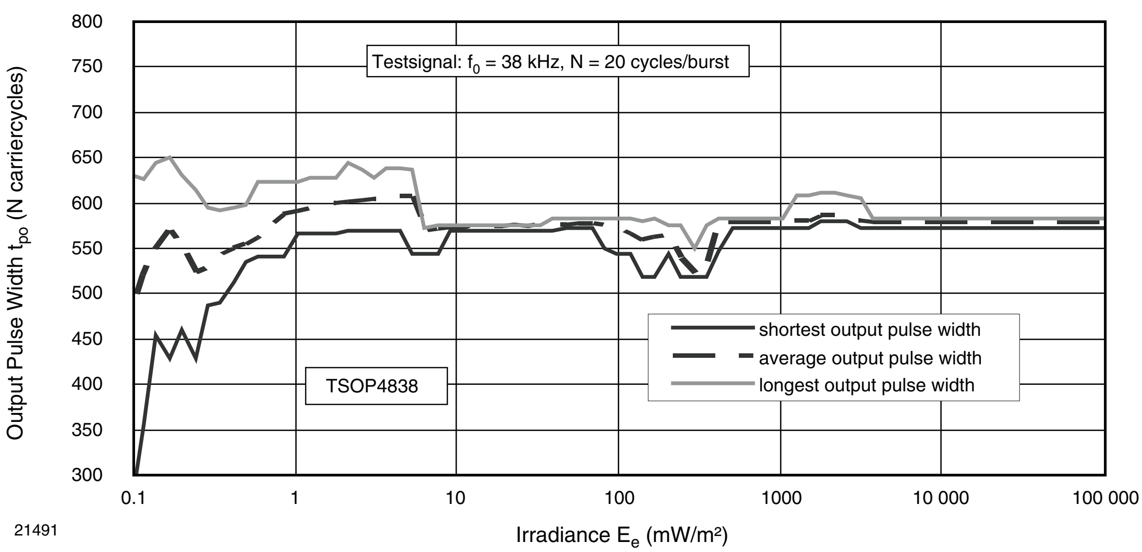

Fig. 1 - Statistical Evaluation of 1000 Output Pulses at each Irradiance

APPLICATION CIRCUIT FOR OPERATION IN HARSH ENVIRONMENTS

The Vishay IR receivers include an efficient protection circuitry against electrostatic discharge (ESD) or electrical overstress (EOS), which is sufficient for normal handling and assembly procedures according the common industry standards.

In case of serious over-voltage-transients it might be useful to add components for a further improvement of the protection.

If the robustness of the IR receiver for an air discharge ESD test needs to be improved then there are two options. The external ESD protection diodes as shown in figure 2 (GSOT05C or similar) are an efficient protection or an additional metal holder that is electrically connected to GND (e.g. TSOP38238PC1) can act like a lightning conductor to protect the IR receiver.

Both the resistors and the diodes as shown in figure 2 will improve the robustness against any overvoltage that might happen after soldering by PCB handling, PCB testing or during operation in the application (e.g. spikes from dimmer or motor control circuits).

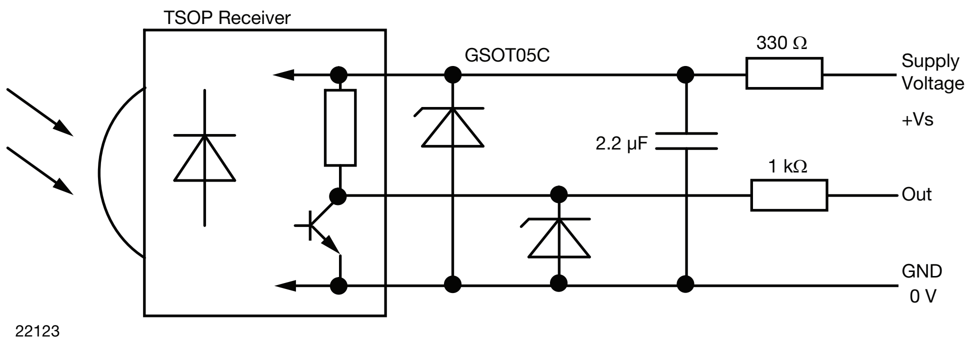

Fig. 2 - Protection Circuit against Over Voltage Spikes

APPLICATIONS 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^2 (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	AGC5	FIX GAIN
EXAMPLES OF IR RECEIVER TYPES	TSOP41xx TSOP321xx TSOP361xx	TSOP12xx TSOP48xx TSOP352xx	TSOP323xx TSOP383xx TSOP353xx	TSOP44xx TSOP384xx TSOP584xx	TSOP45XX TSOP385XX TSOP355XX	TSSP4038 TSSP58038 TSSP6038
Minimum burst length (number of cycles in a burst)	6	10	6	10	6	10
Minimum burst repetition time using the shortest burst	3 ms	6 ms	11 ms	17 ms	22 ms	no restriction

FIX GAIN RECEIVER

For many optical sensors it is sufficient to provide just a simple digital state like “reflection-yes” or “reflection-no” or whether a beam is interrupted. In this kind of applications the “fix gain receivers”, such as TSSP4038 and TSSP6038, are often a good solution. 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.

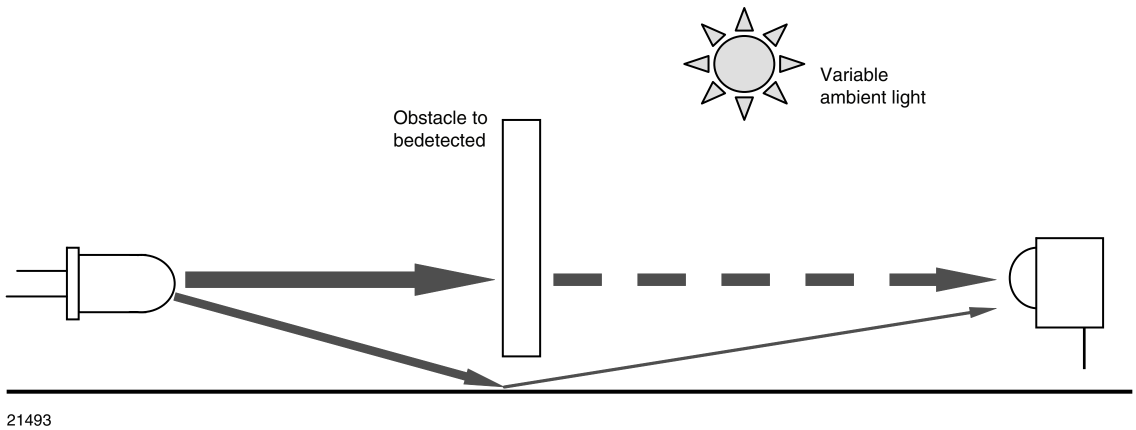

Fig. 3 - Stray Light in a Light Barrier Application can Produce a False Response

DETECTOR WITH ANALOG OUTPUT

The typical application of the TSSP4P38 is a reflective sensor with analog information contained in its output. Such a sensor is evaluating the time required by the AGC to suppress a quasi continuous signal. The time required to suppress such a signal is longer when the signal is strong than when the signal is weak, resulting in a pulse length corresponding to the distance of an object from the sensor.

This kind of analog information can be evaluated by a microcontroller. The absolute amount of reflected light depends much on the environment and is not evaluated. Only sudden changes of the amount of reflected light, and therefore changes in the pulse width, are evaluated using this application.

Example of a signal pattern:

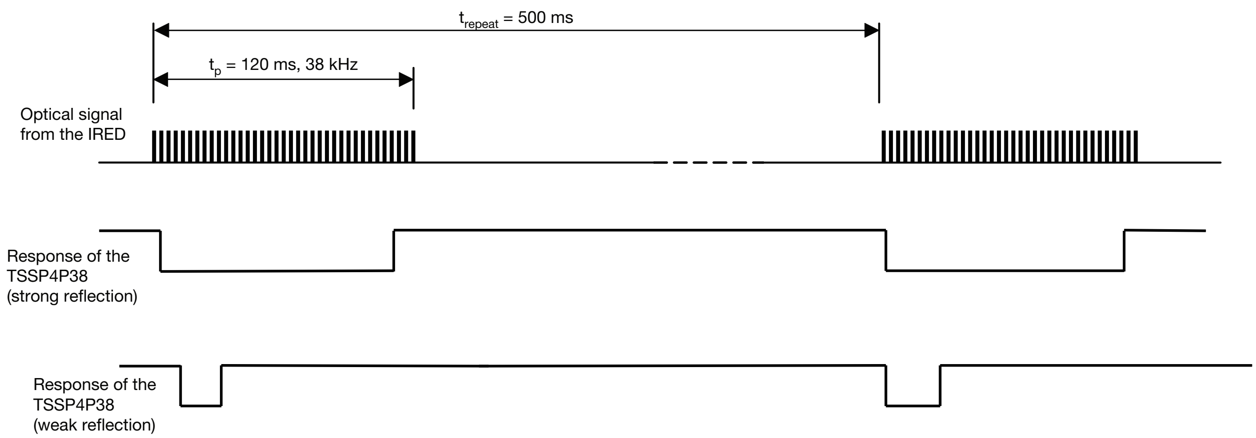

Fig. 4 - Protection Circuit against Over Voltage Spikes

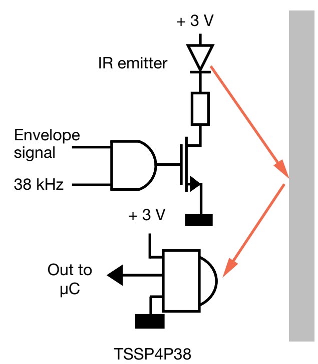

Fig. 5 - Proximity Sensing

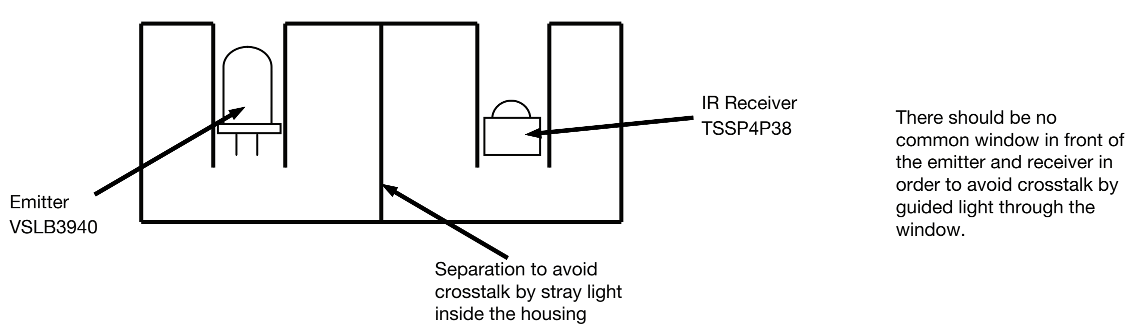

Fig. 6 - Example of a Sensor Housing for a Reflective Sensor

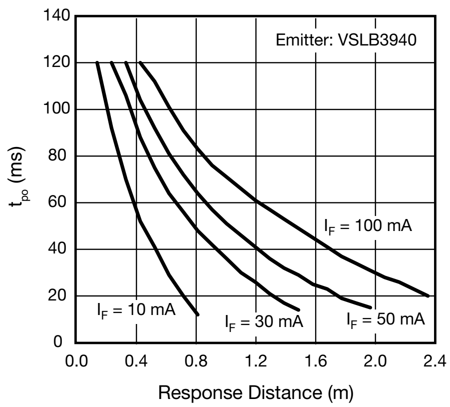

Fig. 7 - t_{po} vs. Distance Kodak Gray Card Plus 15 %

The logarithmic characteristic of the AGC in the TSSP4P38 results in an almost linear relationship between distance and pulse width. Ambient light has also some impact to the pulse width of this kind of sensor, making the pulse shorter.

APPLICATION IN BATTERY-POWERED SYSTEMS

There are two crictical paramters when using the IR receiver modules in battery-powerded 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 8 and 9. 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.

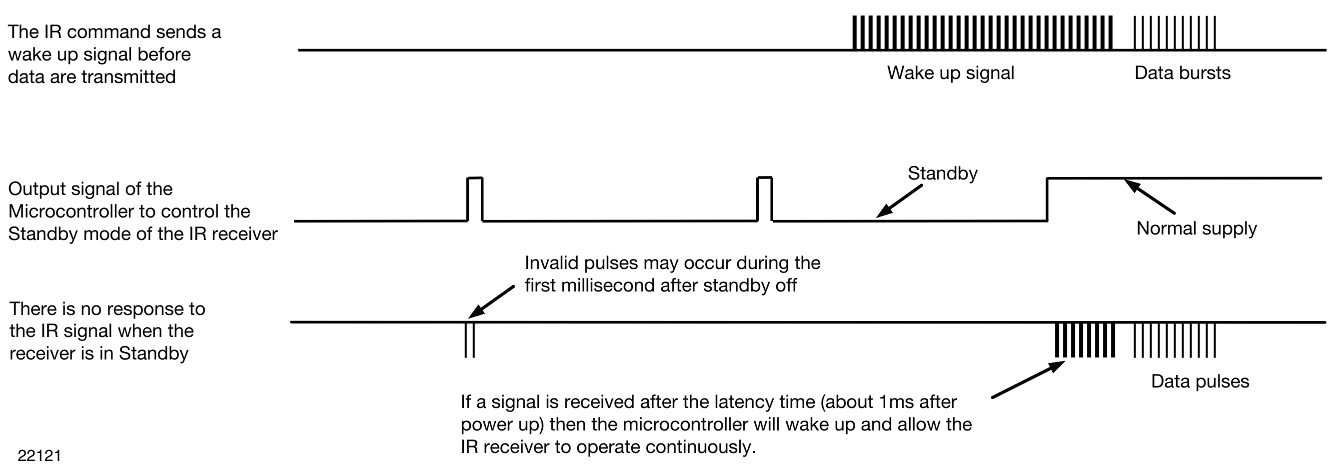

Fig. 8 - Example for a Battery-Saving Mode with TSOP3xxxx IR Receivers

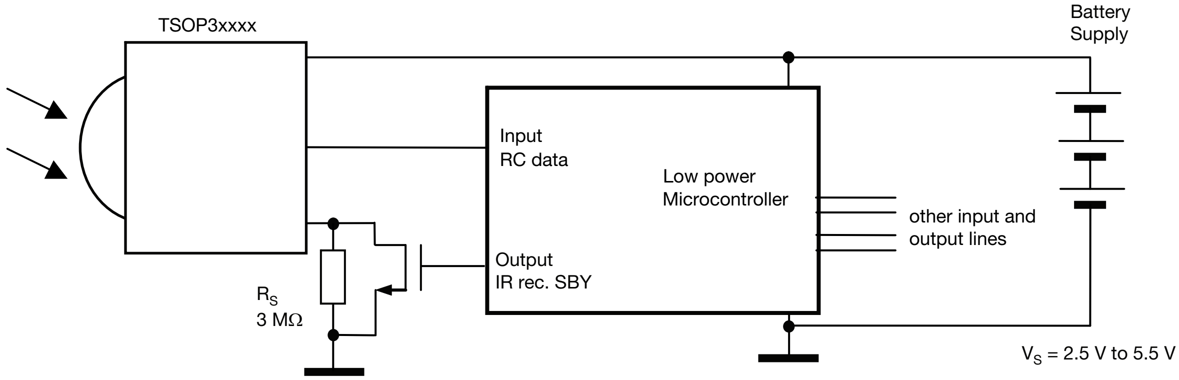

Fig. 9 - Circuit Proposal for Pulsing the Supply Voltage of the TSOP3xxxx

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 μA 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.

If the TSOP3xxxx is disconnected from supply voltage and reconnected again then the gain level is on a default value. It will last up to 100 ms until the gain has settled to an optimum level that is well adapted to the ambient noise level.

However, if the TSOP3xxxx is set to the standby mode (as shown in figure 9) then it can memorize the gain setting during the off period. Each time when it is powered up the gain is on the correct level. Hence there are no spurious pulses in bright ambient during the on period when the receiver is operated in this kind of power saving mode.

The standby mode of the TSOP3xxxx means that it is supplied through a high impedance serial resistor. In that case the circuit of the TSOP3xxxx is deactivated and the supply current becomes almost zero. However, the gain level of the AGC is still memorized.

The easiest way to activate the standby mode is to operate the TSOP3xxxx with a series resistor at about 2 MΩ in case of a 3 V supply voltage or 3 MΩ in case of a 5 V supply voltage.

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 allow a fast turn around time between sending and receiving we recommend the TSOP3xxxx or TSOP75xxx series. At these receivers a 1ms idle period is sufficient.