PIR Motion Detector Application Information

Sensitivity and Thresholds

Analog To Digital Conversion

The PIR input Signal is converted to a digital signal with a resolution of 3.5µV. The input voltage range of the analog to digital converter (ADC) is approx. +/-57mV. The resulting dynamic range is 14 bits.

Threshold Comparator

The Threshold comparator covers a total range of 1 .. 128. Eight different threshold values are available for selection. For threshold comparison, the signal from the ADC is truncated by 2 LSB, which means, that the value used for the threshold comparison has got a resolution of 14µV.

System Limitations

Sensor Noise
A typical PIR sensor generates noise voltages in excess of 20µV.
The lowest 2 ranges are therefore not suitable for selection, because the noise from the PIR sensor would activate an alarm condition.

Quality of Sensor Supply Voltage
The PIR sensor has got a typical supply rejection of less than 40dB. To avoid adding noise to the sensor signal, the peak to peak noise on the supply must be less than 20µV * 40dB = 2mV.

Low frequency Content / Drift
I a typical installation, the sensor outputs low frequency signals as a result of air movement, changes in temperature and other influence factors. These unwanted signals are suppressed with the second order high pass filter. However, the amount of attenuation depends on the frequency content and the cutoff frequency of the filter. The M2006C high pass filter cutoff frequency is 0.44 Hz. With every decade, lower frequencies are attenuated by a factor of 100. For example, a signal of 1mV with a frequency of 0.044Hz would be reduced to 10µV.

RF Interference
Depending on PCB layout and frequency of the RF interference, the output of the PIR sensor picks up more or less signal. The source follower in the sensor performs a demodulation, which yields in a signal representing the envelope of the RF signal interfering with the system. A PIR detection system based on the M2006C allows for maximum suppression of any RF interference, because the PIR sensor output can be connected directly to the input of the integrated circuit. As a result, there should be basically no sensitivity to RF interferences.

Temperature Influences
The M2006C as well as most available PIR sensors are temperature compensated to avoid any change in parameters with change in the environment temperature.
However, the passive infrared motion detection depends on the difference in temperature between the object and its environment. Theoretically, no detection would be possible if the object has the same temperature as the like it's background.
I practice, different surfaces emit different levels of infrared radiation. A simple example, nearly everybody has experienced, is the triggering of a sensor light by moving branches of a tree.
In general, the PIR detection of humans is most sensitive at low temperatures and becomes less sensitive towards 37 degree Celsius (body temperature). Above the body temperature, the sensitivity increases again.
The M2006C allows the adjustment of the threshold depending on the environment temperature. A temperature dependent voltage connected to the TCOMP input allows the threshold to be multiplied by a factors, which ranges from 1.875 (extreme low temperature) down to 0.5 (body temperature) and up to 0.75 (highest temperature). The sensitivity change is defined by the user, who defines the external resistor / NTC network.

Lenses

A PIR detection system requires a Fresnel lens to work. The lens breaks the image up in multiple concentrated images. If an object moves in front of the motion detector, the images are moving across the window of the PIR sensor creating a changing heat signal, which in return causes the PIR sensor to generate a changing output signal.

The detection range is mostly dependent on the characteristics of the lens. The sensitivity stays relatively constant, as long as the size of the image projected onto the PIR sensor is bigger than the window of the PIR sensor. With increasing distance to the object, the image becomes smaller. As soon as it drops below the size of the window(on the sensor), the sensitivity drops dramatically.

Typical motion detectors have detection ranges from approximately 8m to 16m.

Optimal Configuration for a Motion Detector

A motion detector is usually configured to achieve a maximum detection range. For the installer of the alarm system, a near far jumper has to be provided to allow a reduction of sensitivity in a problematic environment.

The following unwanted peak to peak signals have to be taken into account (after signal processing at threshold comparator):

Sensor Noise	20µV (Manufacturers Datasheet)
Supply Noise	20µV (assumed)
Low frequency content	20µV (depending on sensor, lens and environment)
RF Interference	0
Total	60µV

All voltages have to be added, because the worst case peak to peak value should not trigger an alarm condition.

If the temperature compensation is designed for a 2 x change in threshold (cold to body temperature), the above calculated value has to be doubled for the correct sensitivity selection. A threshold of 120µV corresponds to a digital value of 120/14 = 8.6.

Once would select the next higher level of 16, which correspond to Z on PT1 and 1 on PT0