Tech Note 436 Detail

E-mail Page

Principle of Operation - Motion Sensor

Affected Products:

CI-6742 Motion Sensor II
PS-2103 PASPORT Motion Sensor

Problem/Symptom:

What is the principle of operation of the motion sensor?

PASCO Solution:

Both the CI-6742 Motion Sensor II and PS-2103 PASPORT Motion Sensor have the same basic principle of operation: They determine distance to the first object of reflection by emitting a train of 16 square wave pulses at a sound frequency of about 49.4 kHz and detecting their echoes. The distance d is calculated from $d = v\,(t-t_0)\,/2$, where v is the local velocity of sound, t_0 is a small correction for electronic delays, and t is the round-trip time interval between the emitted pulse train and the returning pulse train. There is a dead time of about 0.85 ms, where the sensor will not detect a return, which accounts for the inability of the sensor to measure distances less than 15 cm.

Changing the setting of the switch on the motion sensor adjusts the sensitivity of the receiver to pulses. On the "far" setting, the receiver is less sensitive to return pulses than on the "near" setting.

Accuracy

Although t is measured to within one microsecond or better than 0.05 %, the value of the speed of sound in air v is much less accurate, even with calibration: Consider that the speed of sound varies from 331 m/s at 0C, 0% humidity - 351 m/s at 30 C, 100% humidity or +/-6% error. Normally, the room temperature and humidity will not vary this drastically, but may be expected to vary from 343 to 349 m/s without calibration. 344 m/s is the default value, so this leads to +/- 0.8 % error. If one calibrates the sensor at one meter, the speed of sound will typically not change more than 0.2 % during the course of the experiment. *When determining distance remember that the distance is determined from the front surface of the detector, which is visible behind the metal screen.*

CI-6742 Specific Technical Details

The signal to and from the Motion Sensor II are normally both high (5 V). To initiate a sensor cycle, the trigger signal is held low (0 V) for about 0.13 milliseconds. This then causes the return echo signal to also go low. A series of ultrasonic pulses are then emitted by the Motion Sensor II when the trigger signal goes back to high. There will be a period of 'Dead Time' of about 0.85 milliseconds where the motion sensor does not receive a signal. Thus, the return echo should not return to the Motion Sensor II during this time. When the return echo is detected, the return echo line is forced high.

The CI-6742 Motion sensor II has two different stereo plugs, in which five of six conductors are used.

These two plugs connect to a British telecom style connector at the sensor end. The pins are as follows, with pin 1 numbered from the side of the plug furthest away from the retaining clip:

Yellow plug:

1. **Tip:** NC (No connection.)
2. **Ring:** Trigger Signal
3. **Sleeve:** GND.

Black plug:

1. **Tip:** + 5 V
2. **Ring:** Echo Signal
3. **Sleeve:** GND.

The signal protocol is as follows: Input signal to the sensor is normally +5 VDC. The signal drops to 0 VDC for 0.13 ms. At the falling edge of the input signal, the output signal from the sensor drops from +5 VDC to 0 VDC.

When the echoes have been detected, the output signal rises from 0 VDC to +5 VDC.

The trigger rate can be adjusted from 5 Hz to 120 Hz. Receiver gain is a step routine that is built into the Motion Sensor II.

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