

## Occupancy Sensors

Occupancy Sensors detect rooms are occupied or vacant and turn lighting and air on and off for the room based on people being detected in the room. Occupancy sensors automatically turn the lights on when occupants are detected entering the room and turn lights off when the room is detected vacant.

Historically, occupancy sensors have used Passive Infrared (PIR) sensors. PIR sensors have limitations detecting occupancy in larger rooms. Newer sensors now incorporate both Ultrasonic and PIR sensors. Ultrasonic sensors employ a Doppler shift detection method that is effective at detecting motion in large rooms with barriers that are difficult for PIR-only solutions to detect.



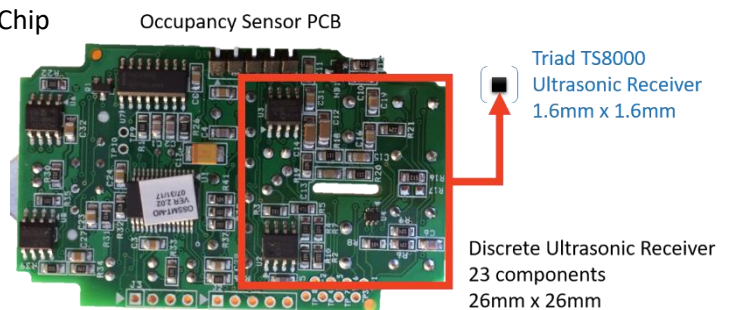
## Ultrasonic Transducers



Ultrasonic Solutions consist of a transmitter that sends 40kHz ultrasonic sounds into the room. These soundwaves bounce off objects in the room. As occupants move about the room, their movements create a Doppler shift in the returned echo signals. A 40kHz ultrasonic receiver detects the weak echo pulses that return to the sensor. A receiver circuit is required to amplify these weak signals, filter out audio sounds in the room (conversation, music, etc). An embedded microprocessor measures the frequency of the amplified and filtered return echoes measuring their frequency. Frequency shifts in the returned echoes indicate room occupancy.

## Triad's TS8000 Ultrasonic Receiver IC

- Complete 40kHz Ultrasonic Receiver on a Chip
- Cost savings
- Simplified manufacturing
- Improved reliability
- Smaller size

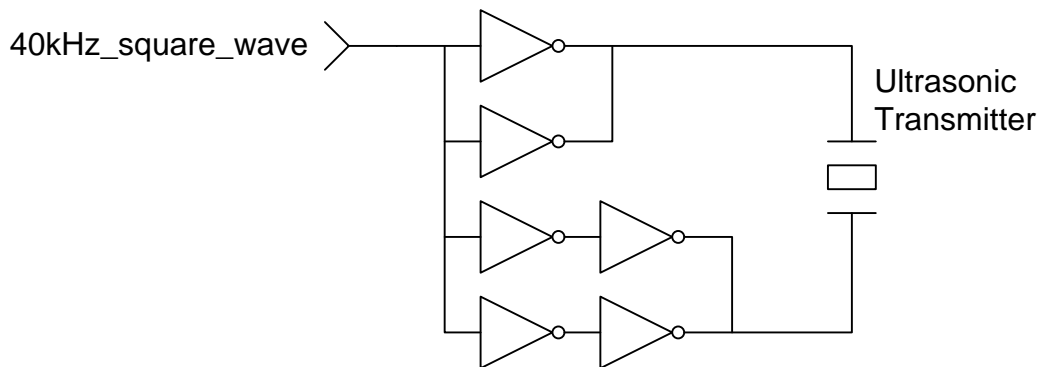


- **Programmable input gain amplifier** to extract weak echo pulses from large rooms
- **Configurable 40kHz bandpass filter** to reject room noise that could be mistaken for occupancy such as music, intercoms, AC units, etc.
- **Amplified analog output** for direct connection to embedded microprocessor for pulse processing.
- **Comparator with programmable slicing** levels to convert the received pulses into digital pulses for acquisition by a timer/capture unit of an embedded micro
- **Two package options**
  - 16-bump WLCSP, 1.6mm x 1.6mm, 0.4mm bump pitch, only 12 outer bumps used for I/O
  - QFN-12, 3mm x 3mm, 0.5mm or 0.65mm pad pitch

## Ultrasonic Transmit Circuit

The ultrasonic transmit circuit is a simple implementation with few components. Specific component selection will be determined by the required sound pressure level (SPL) for the room occupancy application, but the essential circuit functions remain the same.

Below is a schematic of a typical ultrasonic transmit circuit. The 40kHz\_square\_wave signal can be generated by a simple digital oscillator circuit or a microcontroller I/O pin. After the 40kHz waveform is generated, it must typically be buffered to create a high voltage drive signal to excite the ultrasonic transmitter to a level that achieves the desired SPL. A very simple and low-cost method to produce the high voltage drive signal is to use a high-voltage hex inverter package as shown in the schematic. The configuration of the individual inverters produces a 2x voltage across the ultrasonic transmitter by reversing the polarity at the transmitter pins for each phase of the 40kHz square wave. This will achieve a higher SPL than by driving the transmitter with only a single polarity.



## Cost Savings Analysis

### Discrete Ultrasonic Receiver Solution

Item	Cost Each	Qty	Total
MCP6021 <sup>1</sup>	\$0.70	3	\$2.100
Resistors <sup>2</sup>	\$0.007	20	\$0.140
Capacitors	\$0.008	7	\$0.056
Pick&Place <sup>3</sup>	\$0.005	30	\$0.150
<b>Total Assembly<sup>4</sup></b>			<b>\$2.346</b>

### Triad's TS8000 Ultrasonic IC Solution

Item	Cost Each	Qty	Total
TS8000	\$0.600	1	\$0.600
Resistors	\$0.007	1	\$0.007
Capacitors	\$0.008	2	\$0.016
Pick&Place	\$0.005	4	\$0.020
<b>Total Assembly</b>			<b>\$0.643</b>

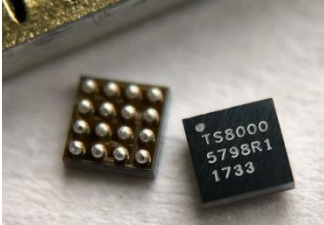
## \$1.70 Savings

Note <sup>1</sup> – 10kpcs MCP6021 pricing, Note <sup>2</sup> – 50kpcs resistor and capacitor pricing, Note <sup>3</sup> – \$0.005 pick & place  
Note <sup>4</sup> – PCB pricing not included. Assuming same size PCB for both solutions. Discrete circuit is 25mm x 25mm (625mm<sup>2</sup>). TS8000 circuit would be 2mm x 2mm (4mm<sup>2</sup>).

## More Information

TS8000 Product Page & Datasheet: <https://www.triadsemi.com/product/ts8000-ultrasonic-receiver-ic/>

TS8000 Distance Measurement Arduino Library: <https://github.com/TriadSemi/TS8000>



Triad is the fast analog and mixed signal semiconductor company. Our innovative technology delivers new analog ICs fast.

The TS8000 went from concept to working silicon in five months. And, from first silicon to full production in one additional month. Triad's **Fast IC™** tech is the ideal way to quickly achieve IC integration inexpensively. If you have an application that could benefit from integration please contact us to discuss your options.



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