World’s first MEMS ultrasonic time-of-flight sensors

Miniature high-performance range finding, presence detection and more
Ultrasonic sensing today

- Measure distance by time-of-flight of an ultrasonic pulse
- Use multiple sensors to find object location (left, right, center…)
- Sense range to avoid objects and prevent collisions
- Detect human proximity and presence

Automotive • Automated guided vehicles • Robotics • Communication devices • Drones • Consumer robots
Ultrasonic sensors offer the best performance for range finding applications

<table>
<thead>
<tr>
<th>Advantage</th>
<th>Description</th>
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<tbody>
<tr>
<td>Power consumption</td>
<td>Up to 500 times lower power consumption</td>
</tr>
<tr>
<td>Sensitivity to lighting</td>
<td>Range and accuracy not affected by ambient light or sunlight</td>
</tr>
<tr>
<td>Detect dark or transparent objects</td>
<td>Sense any color target and windows, mirrors</td>
</tr>
<tr>
<td>Range noise</td>
<td>Up to 100 times lower noise</td>
</tr>
<tr>
<td>Field-of-view (FoV)</td>
<td>Up to 5 times wider</td>
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</table>
The new Chirp ultrasonic ToF sensor
Sonar on a chip

Main features

- Miniature size up to 1000 times smaller than conventional solutions
- Ultra-low power consumption (<15 µW) up to 100 times lower than conventional solutions
- Measuring range of 1 cm to 500 cm
- Very low noise range measurement of <1 mm\text{RMS}
- Wide field-of-view (FoV) up to 180°
- Integrated DSP chip for ultrasonic signal processing
- I2C Interface

Ultrasound engine
MEMS ultrasonic ToF sensor specifications

Features & benefits
- Range, proximity, presence and gesture sensor in one
- Low always-on power
- High accuracy
- Programmable operating range
- Fast response time
- Wide and customizable FoV to customer requirements
-Insensitive to ambient light or color of objects

<table>
<thead>
<tr>
<th>Specification</th>
<th>CH-101</th>
<th>CH-201</th>
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<tbody>
<tr>
<td>Dimensions</td>
<td>3.5 mm x 3.5 mm x 1.25 mm</td>
<td></td>
</tr>
<tr>
<td>Operating range</td>
<td>≤1.2 m</td>
<td>≤5 m</td>
</tr>
<tr>
<td>Voltage</td>
<td>1.8 V</td>
<td></td>
</tr>
<tr>
<td>Interface</td>
<td>I2C</td>
<td></td>
</tr>
<tr>
<td>Power @ 1 sample/s</td>
<td>12 µA</td>
<td>20 µA</td>
</tr>
<tr>
<td>and max. range</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power @ 30 samples/s</td>
<td>110 µA</td>
<td>330 µA</td>
</tr>
<tr>
<td>and max. range</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample rate</td>
<td>≤100/s @ 1 m</td>
<td>≤30/s @ 5 m</td>
</tr>
<tr>
<td>FoV</td>
<td>≥180 °</td>
<td></td>
</tr>
<tr>
<td>Range noise</td>
<td>1 mm_{RMS} @ 30 cm</td>
<td>0.2 mm_{RMS} @ 1 m</td>
</tr>
</tbody>
</table>
SiP with wide range of programmable functionality

CH-101 and CH-201 are systems in package (SiP) with

- Piezoelectric micromachined ultrasonic transducer (PMUT) and
- Programmable system-on-chip (SoC) for all ultrasonic signal processing

Programmable firmware for many functionalities, such as range-finding, proximity sensing and presence detection
Easy to interface to microcontrollers

Features

- CH-101 and CH-201 sensors feature an I2C interface and operate from a 1.8 V supply
- Multiple sensors can share the same I2C bus
- CH-101 and CH-201 are pin-compatible and have the same API

Platform-independent C driver software helps customers with embedded software development
CH-201 ultrasonic ToF sensor performance

Range measurement up to 5 m

Range (mm) vs. Stage Distance

Field of view (FoV) with narrow FoV housing

Range and FoV can be optimized with customized housings serving as apertures
CH-201 range and range noise

Noise up to 100x lower than competing IR ToF sensors at 120 cm range

Range noise @120 cm

Range noise vs. target range

±0.35 mm 1σ
Solutions from component to system level

**Unique sensor components**
- Piezoelectric micromachined ultrasonic transducer (PMUT)
- Ultrasound SoC
- Custom package

**On-chip sensing algorithms**
- Programmable SoC enables customized sensing

**Complete system solutions**
- Application-specific software enables
  - Fast time to market
  - Design of solutions with multiple Chirp sensors
6-DoF controller reference design

Features & Benefits
- Provides 6-DoF controller tracking based on sensor fusion
- Fuses ultrasonic ToF with IMU acceleration/rotation rate for low-latency, high accuracy tracking
- Mobile-ready (no base station required)
- Near zero computation load
- Very low power consumption
- Works in any lighting condition