

Attracting Tomorrow



Technologies & Products Press Conference 2018

# World's first MEMS ultrasonic time-of-flight sensors

Miniature high-performance range finding, presence detection and more

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CTO

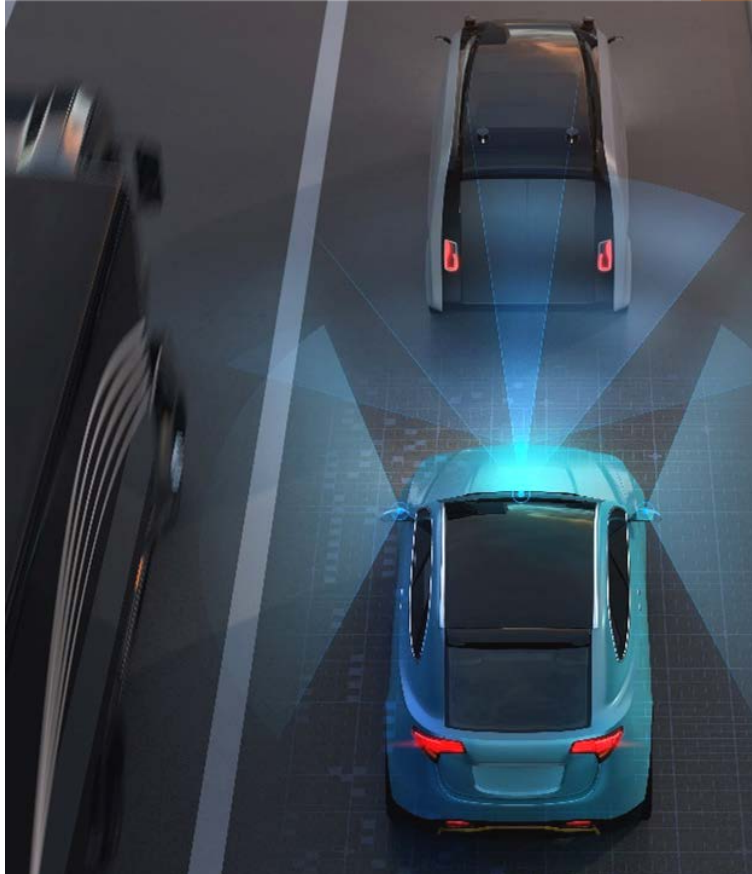
Chirp Microsystems, Inc.

A TDK Group Company

Berkeley, CA, USA

November 14, 2018

# 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**

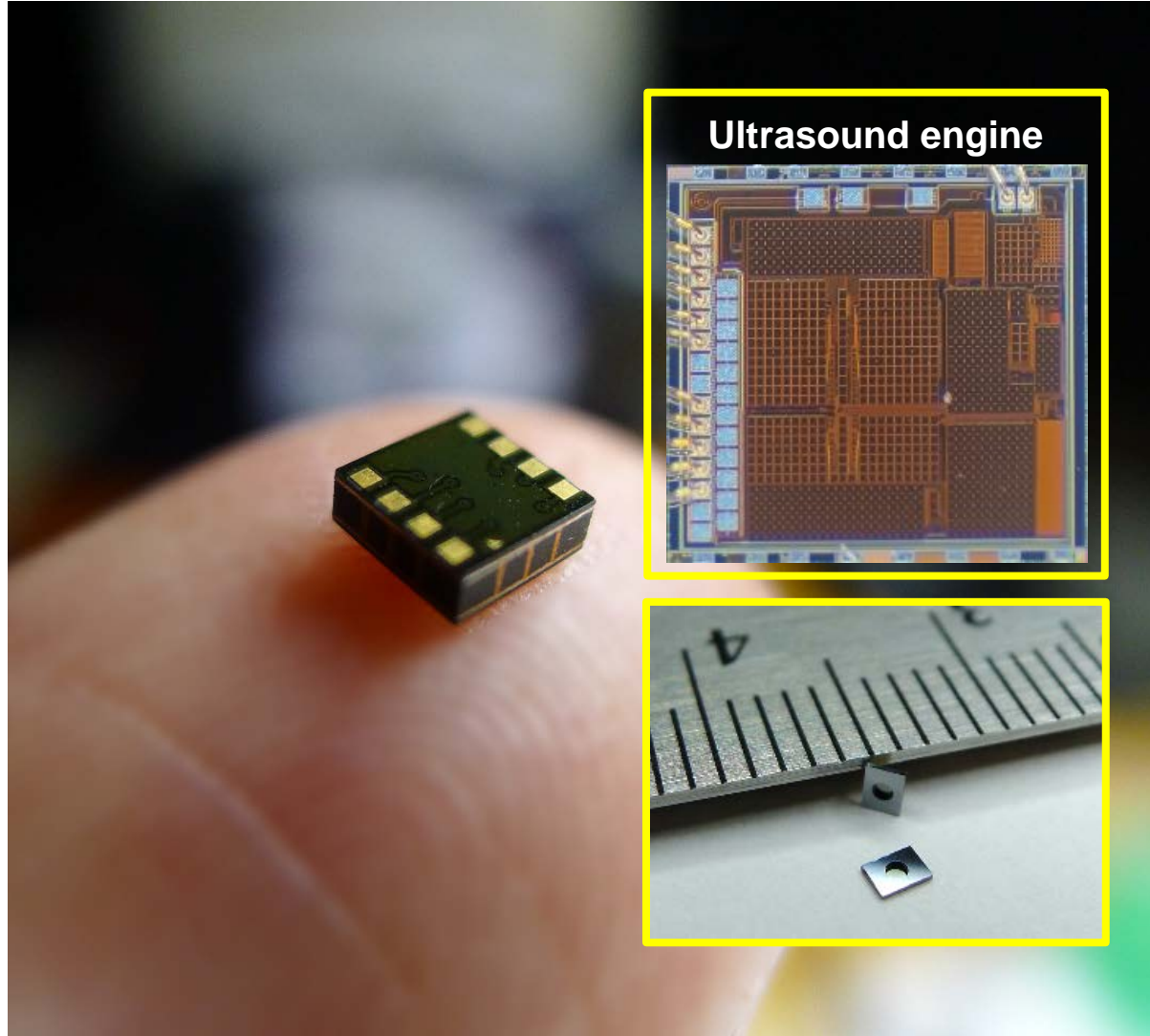
# Ultrasonic sensors offer the best performance for range finding applications

## Advantages of ultrasonic ToF sensors vs. infrared ToF sensors

<b>Power consumption</b>	Up to 500 times lower power consumption
<b>Sensitivity to lighting</b>	Range and accuracy not affected by ambient light or sunlight
<b>Detect dark or transparent objects</b>	Sense any color target and windows, mirrors
<b>Range noise</b>	Up to 100 times lower noise
<b>Field-of-view (FoV)</b>	Up to 5 times wider



# 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  $\mu$ W) up to 100 times lower than conventional solutions
- Measuring range of 1 cm to 500 cm
- Very low noise range measurement of <1 mm<sub>RMS</sub>
- Wide field-of-view (FoV) up to 180°
- Integrated DSP chip for ultrasonic signal processing
- I2C Interface



# MEMS ultrasonic ToF sensor specifications

## Features & benefits

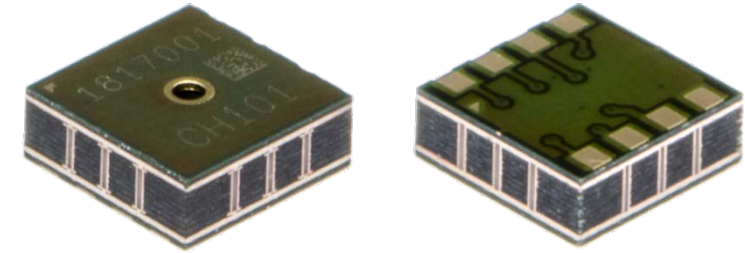
- Range, proximity, presence and gesture sensor in one
- Low always-on power
- High accuracy
- Programmable operating range
- Fast response time
- Wide and customizable FoV to customer requirements
- Insensitive to ambient light or color of objects

Specification	CH-101	CH-201
Dimensions	3.5 mm x 3.5 mm x 1.25 mm	
Operating range	≤1.2 m	≤5 m
Voltage	1.8 V	
Interface	I2C	
Power @ 1 sample/s and max. range	12 μA	20 μA
Power @ 30 samples/s and max. range	110 μA	330 μA
Sample rate	≤100/s @ 1 m	≤30/s @ 5 m
FoV	≤180 °	
Range noise	1 mm <sub>RMS</sub> @ 30 cm	0.2 mm <sub>RMS</sub> @ 1 m

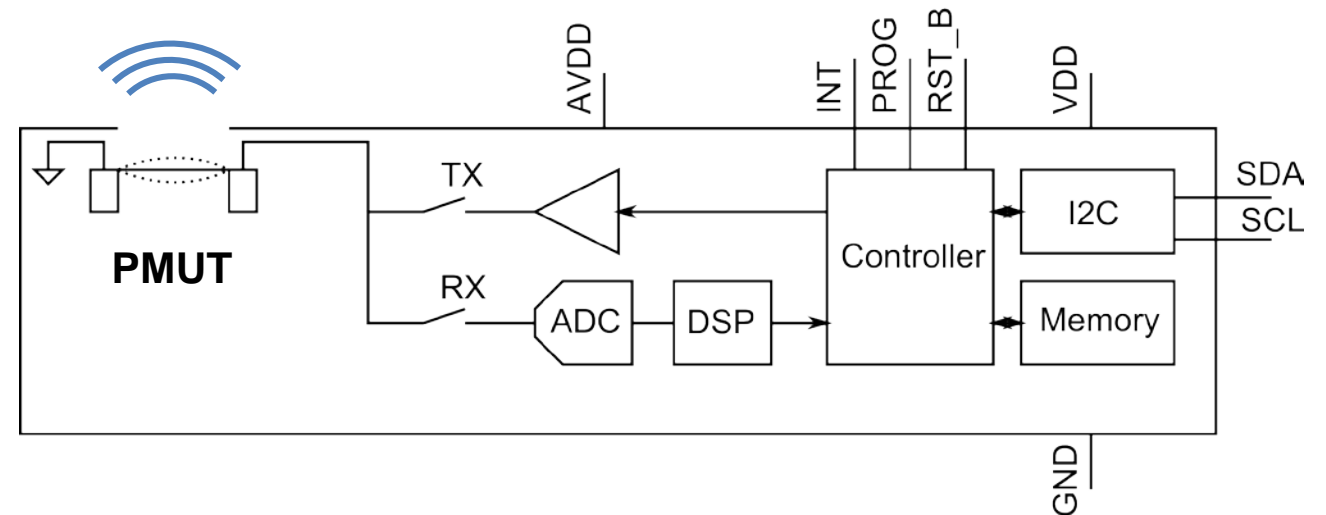
# SiP with wide range of programmable functionality

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



## Ultrasonic pulse

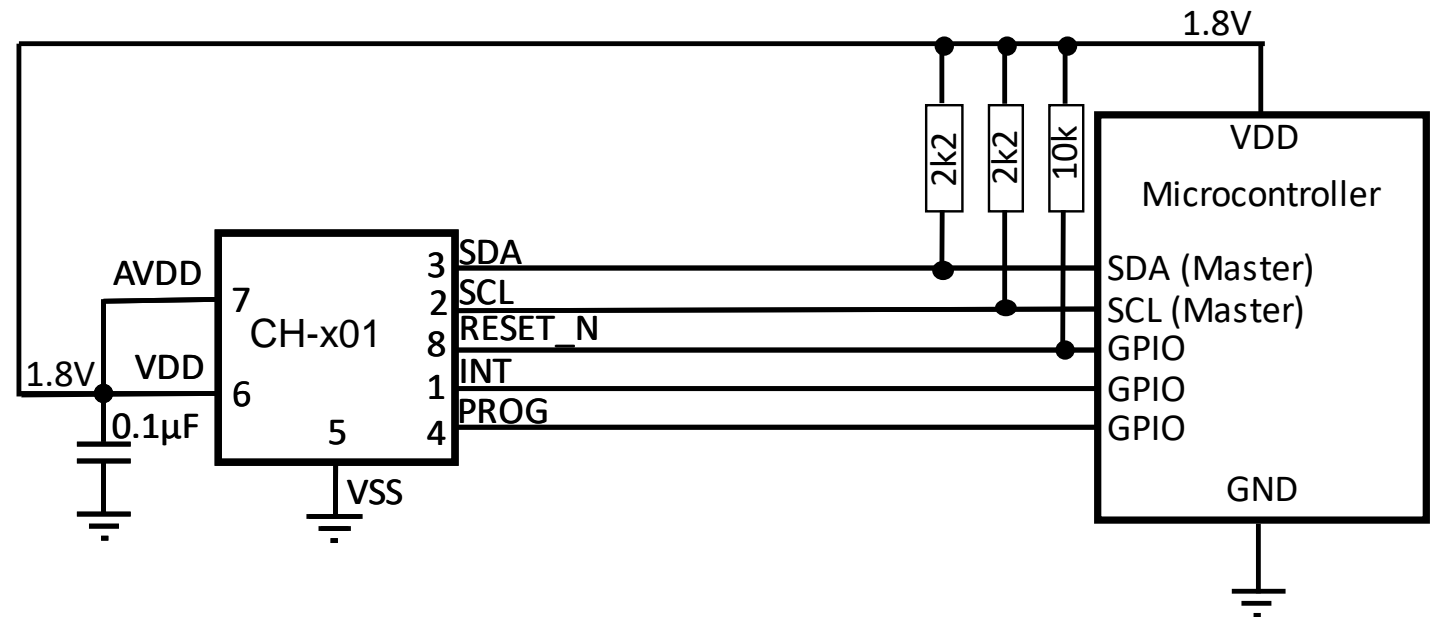
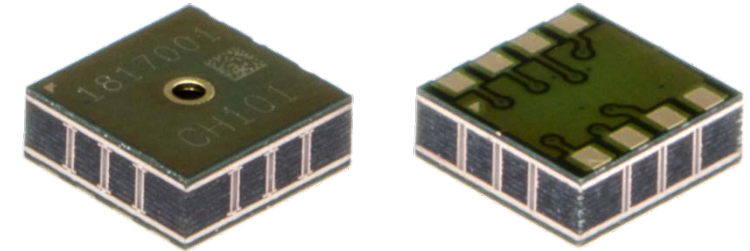


Programmable firmware for many functionalities, such as range-finding, proximity sensing and presence detection

# Easy to interface to microcontrollers

## Features

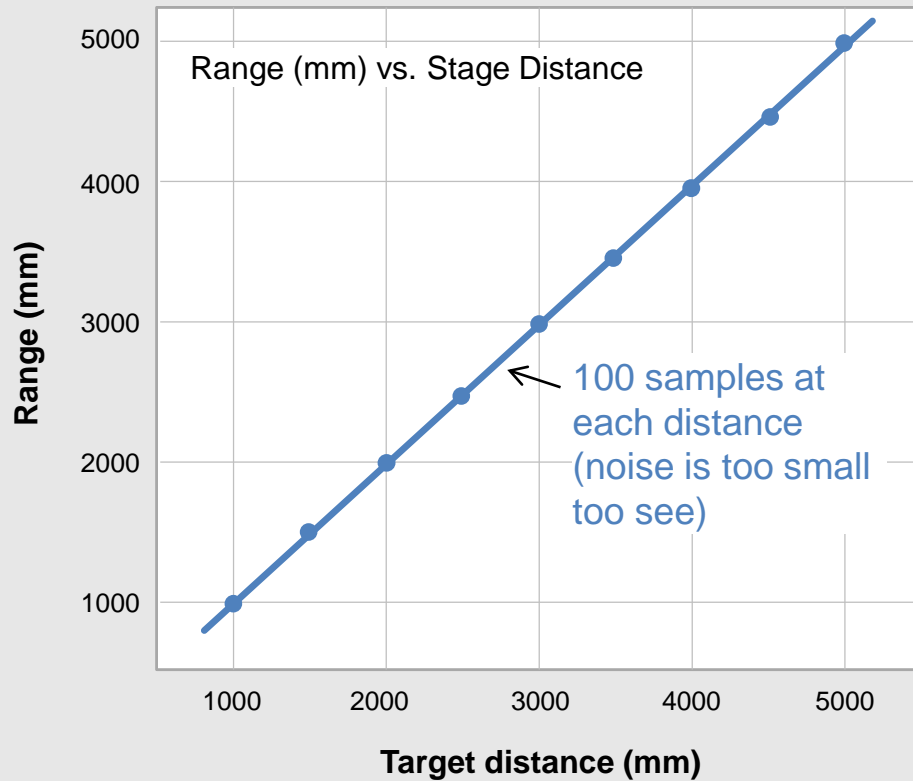
- CH-101 and CH-201 sensors feature an I2C interface and operate from a 1.8 V supply
- Multiple sensors can share the same I2C bus
- CH-101 and CH-201 are pin-compatible and have the same API



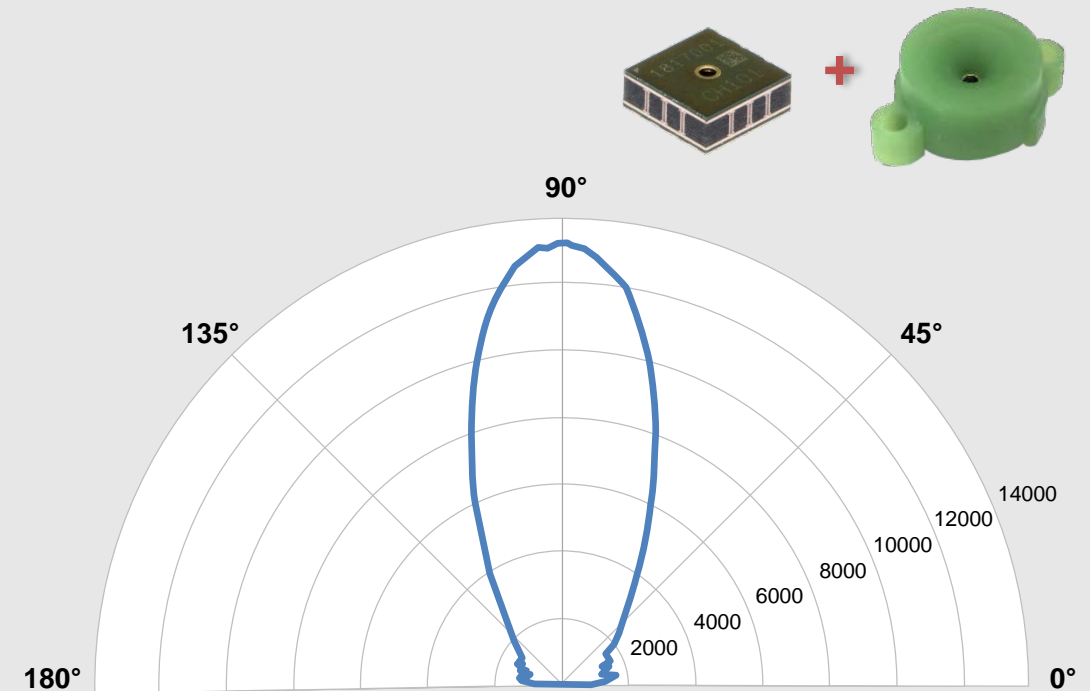
Platform-independent C driver software helps customers with embedded software development

# CH-201 ultrasonic ToF sensor performance

Range measurement up to 5 m



Field of view (FoV) with narrow FoV housing

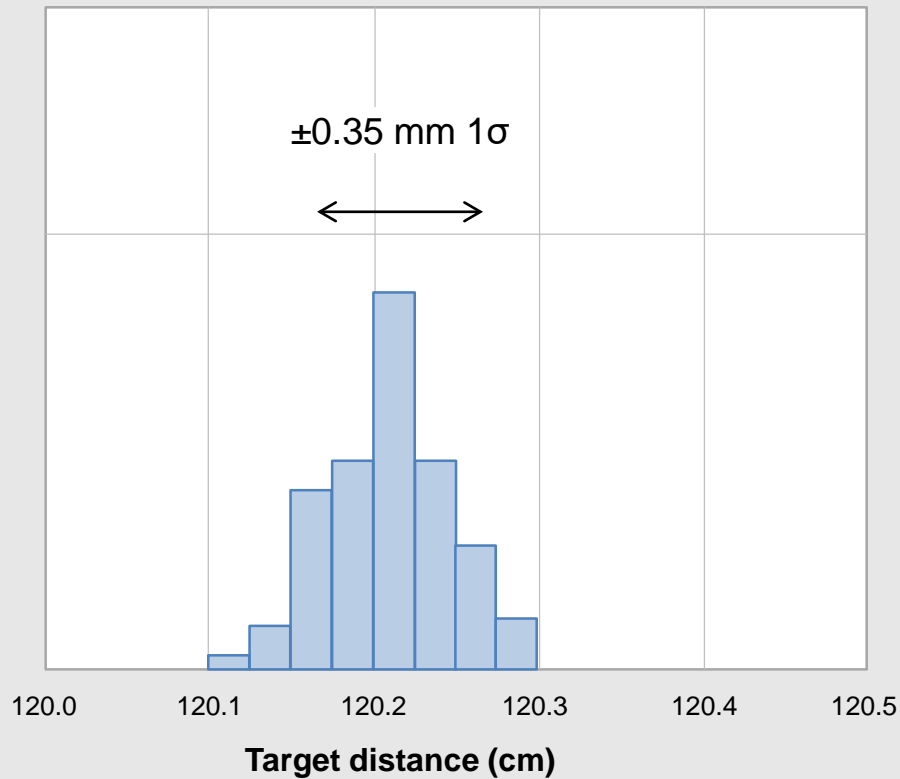


**Range and FoV can be optimized with customized housings serving as apertures**

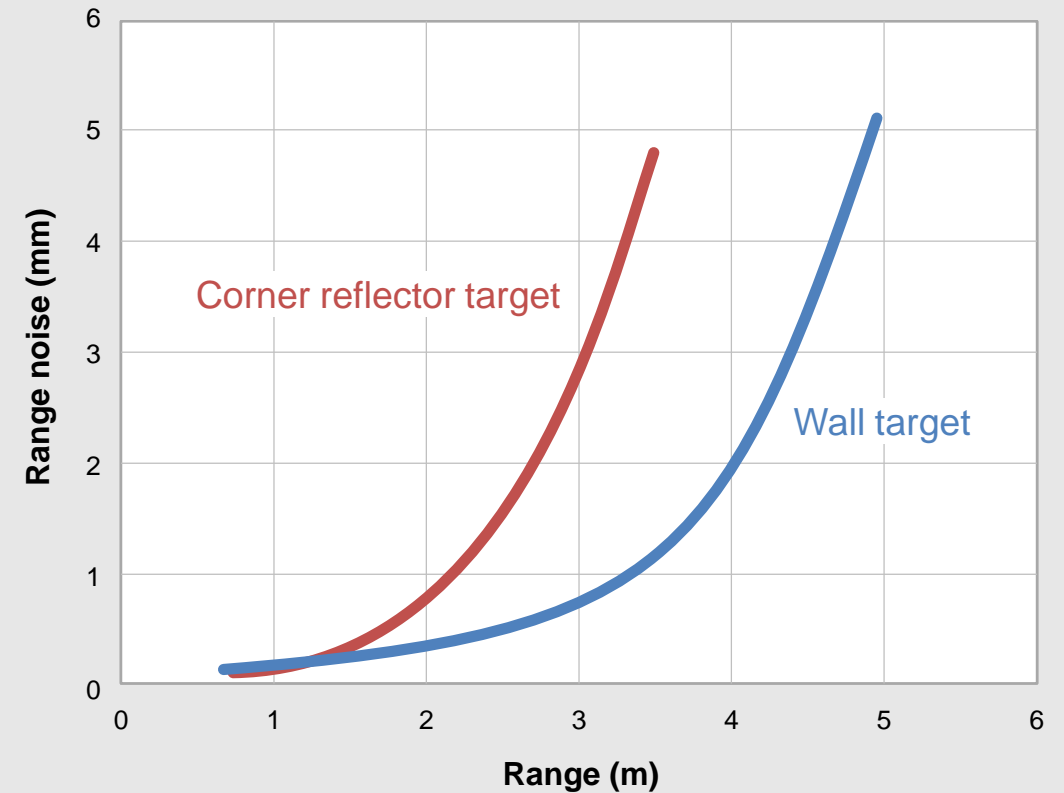


# CH-201 range and range noise

Range noise @120 cm



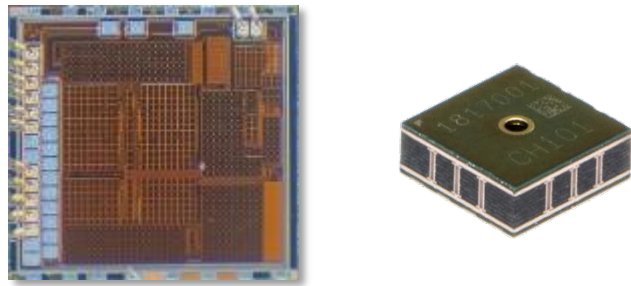
Range noise vs. target range



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

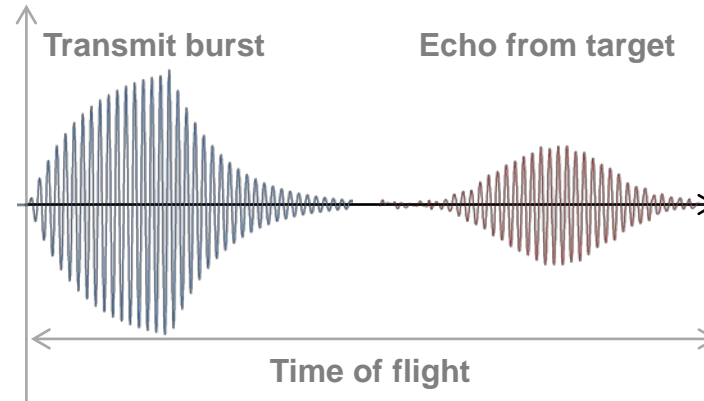
# Solutions from component to system level

## 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

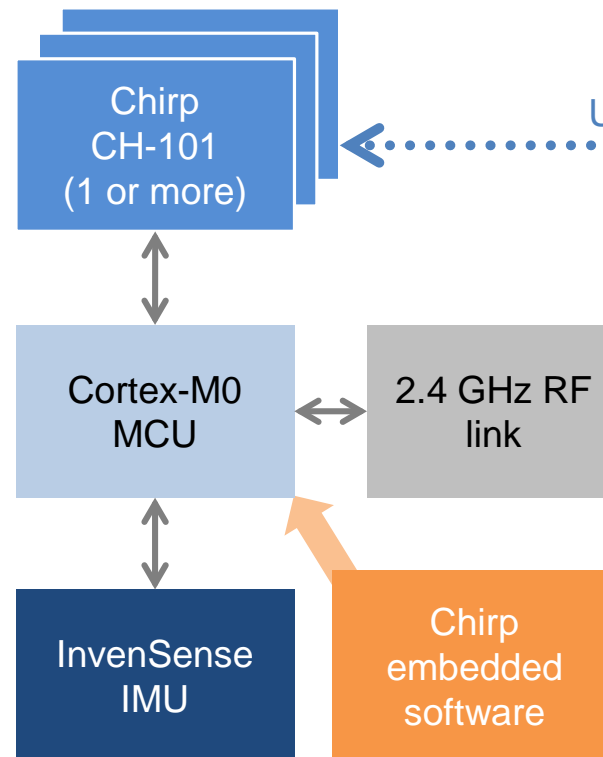
- Fast time to market
- Design of solutions with multiple Chirp sensors

# 6-DoF controller reference design

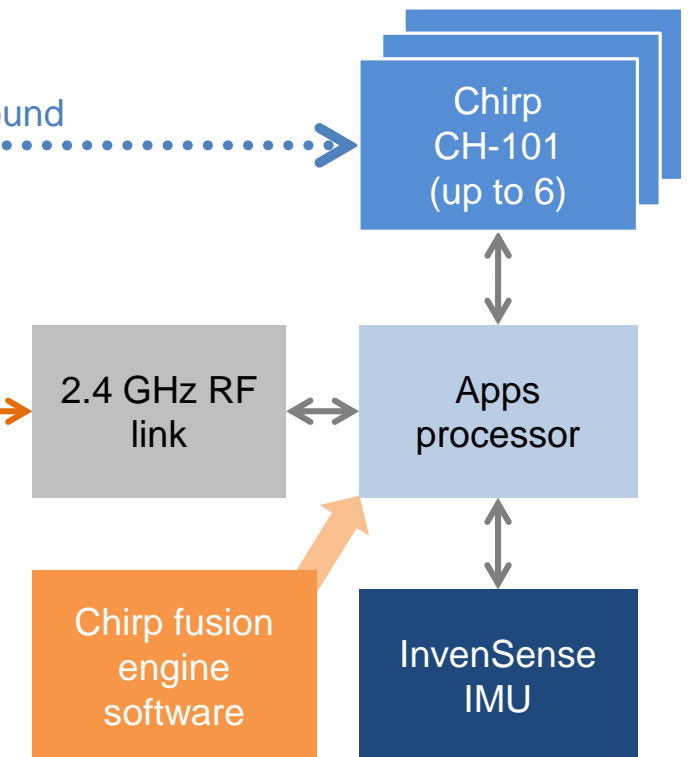
## Features & Benefits

- 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

## Hand-held controller



## Head-mounted display



Ultrasound



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