Application Report

Ultrasonic Applications With MSP430™ MCUs

1 Ultrasonic Applications

Ultrasonic sound waves are vibrations at a frequency above the range of human hearing (>20 kHz) that can travel through a variety of mediums (air or fluid). Techniques like time of flight or Doppler are used to measure flow, detect objects, perform concentration analysis, and measure distances, all without making physical contact. Ultrasonic sensors can be used to detect a wide variety of materials regardless of shape, transparency, or color

Texas Instruments MSP430™ microcontrollers offer a low-cost single-chip solution with integrated ultrasonic sensing analog front end that is easy to use and flexible for developing various applications. Its unique waveform-capturing technology with high-speed ADC and cross correlation method enables high-accuracy measurements with low power.

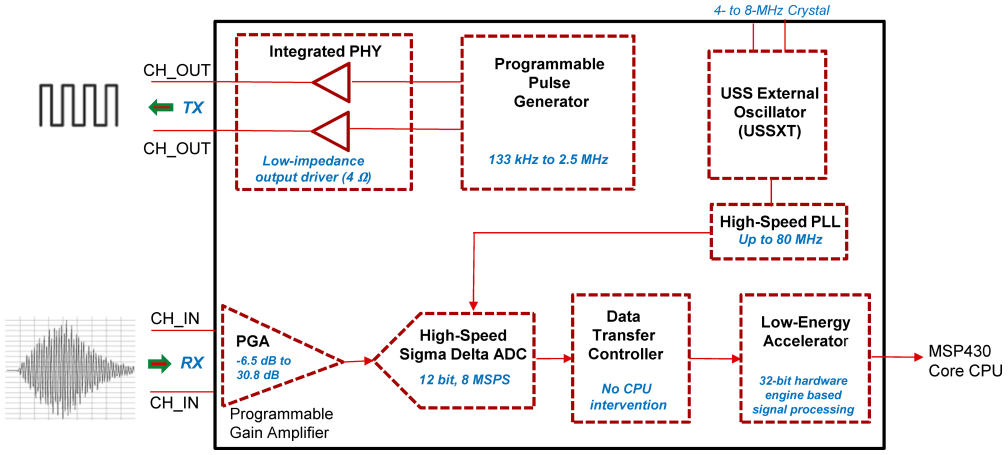

Figure 1-1. Ultrasonic Sensing Subsystem Analog Front End (AFE)

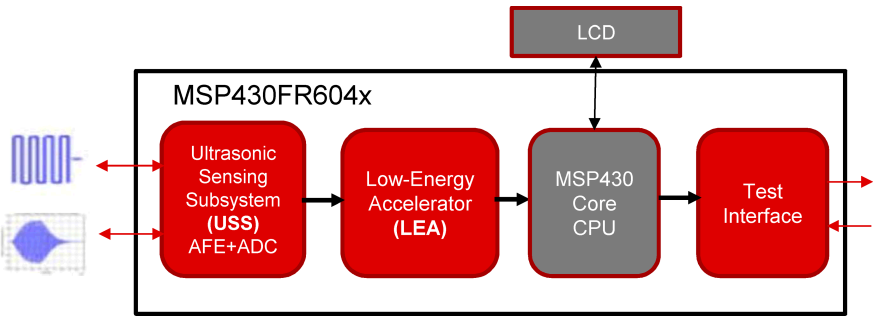

Figure 1-2. Single-Chip Integrated MCU With USS AFE

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Figure 1-3 shows various sensing modalities and applications that can be developed with MSP430 MCUs.

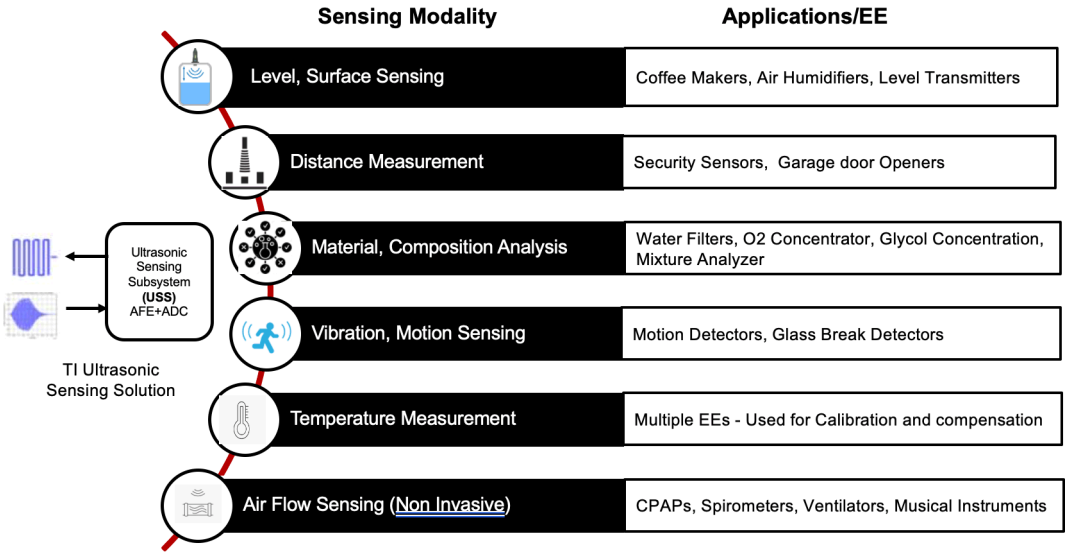

Figure 1-3. Ultrasonic Applications

TI offers development tools that help engineers for quick development and prototype.

Figure 1-4 shows the hardware EVM (EVM430-FR6043) and software development (Ultrasonic Design Center) ecosystem.

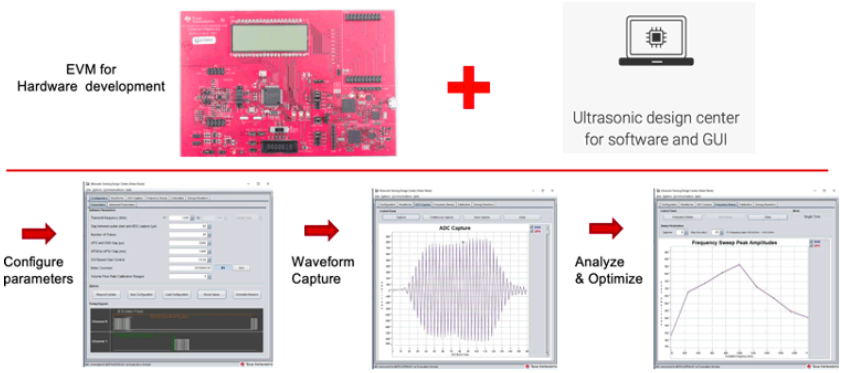

Figure 1-4. Development Ecosystem

Also, check out the following recently released application notes for quick demonstration and evaluation:

High resolution ultrasonic liquid level sensing

Cost-effective liquid level sensing measurements with 25 µA of current consumption and high resolution (20 microns).

Liquid concentration sensing

Uses frequency information to determine the ultrasonic time of flight with much higher accuracy than existing TDC based techniques (solution explained enables accuracies of ±0.01% when measuring salt concentrations).

High-resolution anemometer

Sense small changes in air currents sensitive enough to detect doors opening and closing inside a home, or to measure air flow and temperature in HVAC systems.

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Ultrasonic surface sensing

Contactless surface sensing solution useful for brake monitors, structural monitoring of bridges and buildings (during winds and earthquakes), machine material monitoring including paper counting for 2D printers, spool sensing for 3D printers, and production line profile scanning. The test setup described in this paper can sense changes in the absolute time of flight of less than 50 ns (0.01%).

Ultrasonic leak detection

Ultrasonic technology is well suited for leak detection because differences in the speed of sound in a water pipe can give enough resolution to detect small leaks that mechanical meters cannot. The experiment in this paper can sense a delta time of flight from a mean of 15 ps to 30 ps for 1 drop per second.

Oxygen Concentration Sensing

This document demonstrates the capability of sensing oxygen concentrations to within 0.8% of reading value at a scale of 21% to 96%, with a response time of 78 ms and power consumption of 660 µW at 10 samples/second. This technology is not limited to just oxygen sensing, it can also be used for other gases such as nitrogen, hydrogen, nitrous oxide, carbon dioxide, argon, and helium. These sensors are commonly found in ventilators, concentrators, and combustion monitors

For more information, visit www.ti.com/ultrasonicmcus, www.ti.com/product/msp430fr5043.

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