**TI Designs: TIDA-00151**

**Automotive ultrasonic sensor interface for park assist or blind spot detection systems**

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**System Description**

The PGA450-Q1 is a System on Chip (SOC) sensor interface IC for automotive Ultrasonic sensors. It provides all signal conditioning and processing for the transducer echo signals and for calculating the distance between the transducer and objects. MCU & program memory & LIN allow for full configurability for the specific end application. Providing all functionality as system on Chip allows for smallest form factor ultrasonic sensor modules.

**Featured Applications**

- Ultrasonic park assist
- Self-parking
- Blind spot detection
- Valet parking
- Park distance warning

**Design Resources**

- PGA450-Q1 Product Folder
- EVM User’s Guide Document
- Application Note Document
- Firmware Document

**Design Features**

- Flexibility in transducer selection (40 kHz – 70 kHz)
- SoC that is highly programmable with integrated 8051 core
- LIN2.1 master transceiver
- Can be directly connected to car battery, no wide input range LDO required
- Load dump protection
- AEC Q-100

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Jump start system design and speed time to market

Comprehensive designs include schematics or block diagrams, BOMs, design files and test reports by experts with deep system and product knowledge. Designs span TI’s portfolio of analog, embedded processor and connectivity products and supports a broad range of applications including industrial, automotive, medical, consumer, and more. To explore the designs, go to [http://www.ti.com/tidesigns](http://www.ti.com/tidesigns)
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Associated Part Numbers

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<td>Automotive Ultrasonic Sensor Signal Conditioner</td>
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Design Considerations and Test Data:

The PGA450-Q1 interprets the sent and received signals from an ultrasonic sensor to determine information such as distance and time-of-flight. The PGA450-Q1 supports sensors between 40 kHz and 70 kHz. The PGA450 typically works with one transducer that will both transmit the sound wave and receive the echo.

Ultrasonic Sensing Advantages
The response is very repeatable and linear which translates well to visual representations of target distance as shown later in the test data. The response is also not dependent on surface color.

For object detection, ultrasonic sensing is a more cost-effective approach than cameras, which are poor at detecting at close distances. Infrared sensing is less expensive than ultrasonic but does not provide as accurate results and cannot function properly in direct sunlight.

System Considerations
For outdoor automotive applications, waterproof ultrasonic sensors are used because of their ability to withstand environmental particles. Mesh ultrasonic sensors are more suitable for applications that do not pick up dust or water. Air temperature, humidity, and wind affect the speed of sound in air. Therefore, the transmitted and echoed signal can be weakened or moved.

If multiple sensors are used, they must be spaced out enough so that the sensor signals do not interfere.

Transducer Considerations
The sensor used in this system is Murata’s MA58MF14-0N. Key ultrasonic sensor specifications are frequency, sensitivity, and directivity.

The system also includes a tunable Toko push-pull transformer. The transformer is used to excite the transducer. The transformer is center tapped to double the voltage.

Typically a tuning capacitor is needed to match the resonant frequency between the transducer and transformer. CPT, RT, LT, and CT are characteristics of the transducer, LSEC is the secondary inductance of the transformer, and CTUNE is an external capacitor placed across the terminals of the transducers.

\[ C_{tune} = \frac{C_T \cdot L_T}{L_{sec}} - C_{PT} \]
Quick Start Guide

What's Needed:
1. PGA450-Q1 EVM + TI communication (Tiger) board
2. PC with the PGA450-Q1 EVM GUI installed
3. 5V power supply

Before the system is powered up, please make sure all hardware is configured properly. Check that all jumpers and headers are connected appropriately. For a detailed description of configurations, see EVM user's guide.

To power the board:
1. Only one main power supply is needed. Apply 7 VDC to 18 VDC to the PGA450-Q1EVM that supplies power to the entire board, except for the USB communications board and LIN which are powered by the USB communication PCB.
2. Connect a power supply to the banana jacks, P1 “VPWR_IN” and P3 “GND” or use the screw terminal P2.

To test functionality of board:
1. Connect the PGA450-Q1 EVM to the interface board.
2. A Murata transducer is included with the EVM. Solder the transducer connector to the through-holes at P6. Alternatively, use the screw terminal to connect the transducer.
3. To program OTP bits, program registers, then take data, see PGA450-Q1 EVM user's guide.
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