TI Designs: TIDA-00151

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

System Description

The PGA450-Q1 is 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

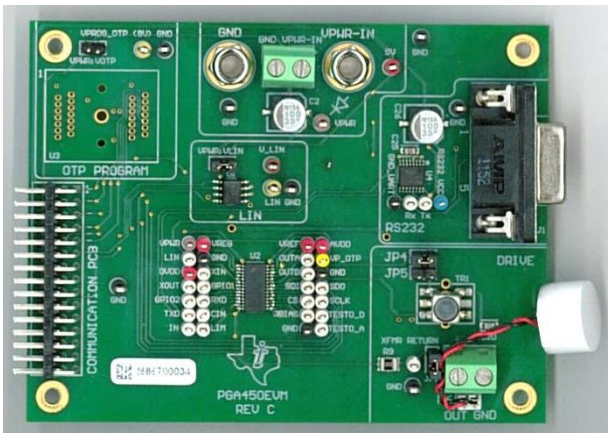
Design Resources

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

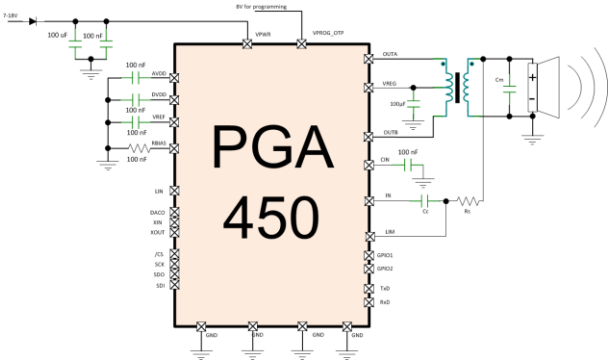
Design Features

- 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

Design Photo



Block Diagram



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 board range of applications including industrial, automotive, medical, consumer, and more. To explore the designs, go to http://www.ti.com/tidesigns

TI Designs: TIDA-00151

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

Associated Part Numbers

Part Number	Part Description	EVM Link
PGA450-Q1	Automotive Ultrasonic Sensor Signal Conditioner	EVM User's Guide

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

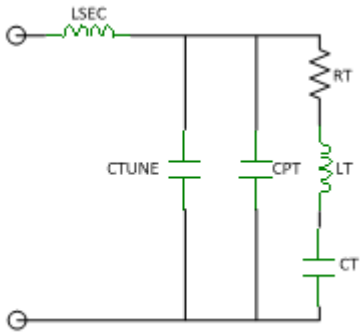
For outdoor automotive applications, waterproof ultrasonic sensors are used because of their ability to withstand environmental particles. Mesh ultrasonic sensors are more suitable for applications that do not pick up dust or water. Air temperature, humidity, and wind affect the speed of sound in air. 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 transformer. 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.

$$C_{tune} = \frac{C_T * L_T}{L_{sec}} - C_{PT}$$

TI Designs: TIDA-00151

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

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.

IMPORTANT NOTICE FOR TI REFERENCE DESIGNS

Texas Instruments Incorporated ("TI") reference designs are solely intended to assist designers (“Buyers”) who are developing systems that incorporate TI semiconductor products (also referred to herein as “components”). Buyer understands and agrees that Buyer remains responsible for using its independent analysis, evaluation and judgment in designing Buyer’s systems and products.

TI reference designs have been created using standard laboratory conditions and engineering practices. **TI has not conducted any testing other than that specifically described in the published documentation for a particular reference design.** TI may make corrections, enhancements, improvements and other changes to its reference designs.

Buyers are authorized to use TI reference designs with the TI component(s) identified in each particular reference design and to modify the reference design in the development of their end products. HOWEVER, NO OTHER LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE TO ANY OTHER TI INTELLECTUAL PROPERTY RIGHT, AND NO LICENSE TO ANY THIRD PARTY TECHNOLOGY OR INTELLECTUAL PROPERTY RIGHT, IS GRANTED HEREIN, including but not limited to any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services, or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

TI REFERENCE DESIGNS ARE PROVIDED "AS IS". TI MAKES NO WARRANTIES OR REPRESENTATIONS WITH REGARD TO THE REFERENCE DESIGNS OR USE OF THE REFERENCE DESIGNS, EXPRESS, IMPLIED OR STATUTORY, INCLUDING ACCURACY OR COMPLETENESS. TI DISCLAIMS ANY WARRANTY OF TITLE AND ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, QUIET ENJOYMENT, QUIET POSSESSION, AND NON-INFRINGEMENT OF ANY THIRD PARTY INTELLECTUAL PROPERTY RIGHTS WITH REGARD TO TI REFERENCE DESIGNS OR USE THEREOF. TI SHALL NOT BE LIABLE FOR AND SHALL NOT DEFEND OR INDEMNIFY BUYERS AGAINST ANY THIRD PARTY INFRINGEMENT CLAIM THAT RELATES TO OR IS BASED ON A COMBINATION OF COMPONENTS PROVIDED IN A TI REFERENCE DESIGN. IN NO EVENT SHALL TI BE LIABLE FOR ANY ACTUAL, SPECIAL, INCIDENTAL, CONSEQUENTIAL OR INDIRECT DAMAGES, HOWEVER CAUSED, ON ANY THEORY OF LIABILITY AND WHETHER OR NOT TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, ARISING IN ANY WAY OUT OF TI REFERENCE DESIGNS OR BUYER’S USE OF TI REFERENCE DESIGNS.

TI reserves the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products are sold subject to TI’s terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI’s terms and conditions of sale of semiconductor products. Testing and other quality control techniques for TI components are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers’ products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers’ products and applications, Buyers should provide adequate design and operating safeguards.

Reproduction of significant portions of TI information in TI data books, data sheets or reference designs is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards that anticipate dangerous failures, monitor failures and their consequences, lessen the likelihood of dangerous failures and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in Buyer’s safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed an agreement specifically governing such use.

Only those TI components that TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components that have ***not*** been so designated is solely at Buyer's risk, and Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265