PGA460-Q1 in Automotive Ultrasonic Kick-to-Open Liftgate Systems

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Also known as a Smart Trunk Opener (STO), the kick-to-open trunk application has grown significantly over recent years, especially in SUVs and high-end passenger vehicles. This feature allows the vehicle owner hands-free access to open the trunk with a simple kicking motion near the rear bumper.

The Kick to Open System

Traditional kick-to-open liftgate systems use capacitive sensing strips located across the bottom of the bumper. However, many automotive Tier-1 suppliers are exploring ultrasonic sensing for this application, with some systems already in mass production. The advantage of ultrasonic sensing versus capacitive sensing is the former's reliability and robustness against environmental factors such as dirt and water. Capacitive sensing, on the other hand, is very sensitive to environmental factors and may not work when a car is dirty.

Ultrasonic sensors in the kick-to-open application have good sensitivity in the acoustical zone of the transducer – a sensing element used in ultrasonic sensing - with a decrease in response as the angular distance (horizontal offset) from the transducer increases. This differs from capacitive based solutions which have less sensitivity to the location of the kick. One potential way to address this issue is by placing an LED or other indicator on the bumper or tailgate to indicate the place which the user should kick.

The repeatability of the kick detection depends on several factors, such as the distance to the kick, the type of shoe or other material covering the foot or leg, and the orientation and positioning of the shoe.

Key System Requirements

The following is a list of common requirements in ultrasonic solutions for kick-to-open systems:

1. Ability to detect objects from 15cm – 1m
2. Low quiescent current
3. Ability to operate off of a 12V car battery supply

1 - Ability to Detect Objects From 15cm - 1m

One of the challenges with using ultrasonic sensing in a kick-to-open liftgate application is the close distance detection range. The ability for an ultrasonic sensor to accurately detect near-field objects depends on the quality and specification of the transducer, the driver method and design, and the performance of the receive path (analog front-end and digital processing).

High-quality transducers such as Murata's MA58MF14-7N have more stable and reliable decay or "ringing" during transducer excitation. By selecting a high-quality transducer, you can reduce the length of time of the decay and more accurately predict the stability of the decay as well. (See Figure 1.)

Figure 1. Typical Ultrasonic Decay Profile

The method and design of the transducer driver can also significantly impact the ultrasonic decay period and profile. In kick-to-open applications requiring near-field performance, TI recommends using a transformer drive topology. Figure 2 is an example transformer drive schematic using the PGA460-Q1.

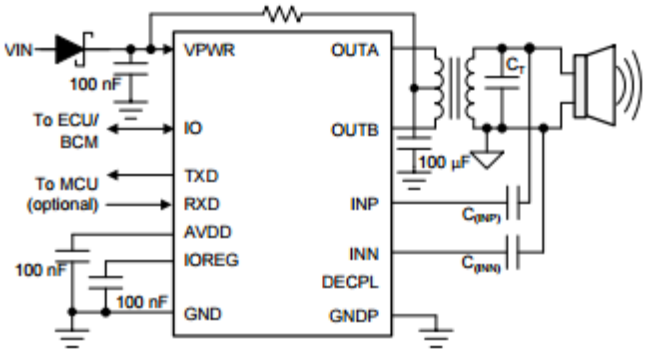

Figure 2. PGA460-Q1 Transformer Drive Schematic

When using a transformer to increase the supply voltage to excite the transducer, the decay profile is more predictable and less “choppy,” resulting in better near-range object-detection performance.

Finally, the performance of the AFE and digital processing affect both near and far object detection. For example, the PGA460-Q1 has a low-noise amplifier followed by a programmable time-varying gain stage feeding into a 12-bit successive approximation register analog-to-digital converter. The low-noise amplifier reduces noise from the received signal, and the programmable gain amplifier’s time-varying gain feature enables small gain applied to near-field objects and larger gain for far-field object detection. You can set the gain profile settings in the register for storage in electrically erasable programmable read-only memory (EEPROM).

2 - Low Quiescent Current

Since kick-to-open ultrasonic sensors must operate with the vehicle off, system quiescent current is critical and specified aggressively by OEMs. The PGA460-Q1 has a ~500µA sleep mode that you can leverage intermittently to bring the overall system’s current consumption to the necessary levels.

3 - Ability to Operate Off of a 12V Car Battery Supply

The PGA460-Q1 device is designed to operate from an input voltage supply range from 6V to 28V. In kick-to-open liftgate applications, the PGA460-Q1 device connects directly to a car battery. Proper external component safeguards such as a transient voltage suppression (TVS) diode help protect the device from battery transients and reverse-battery currents.

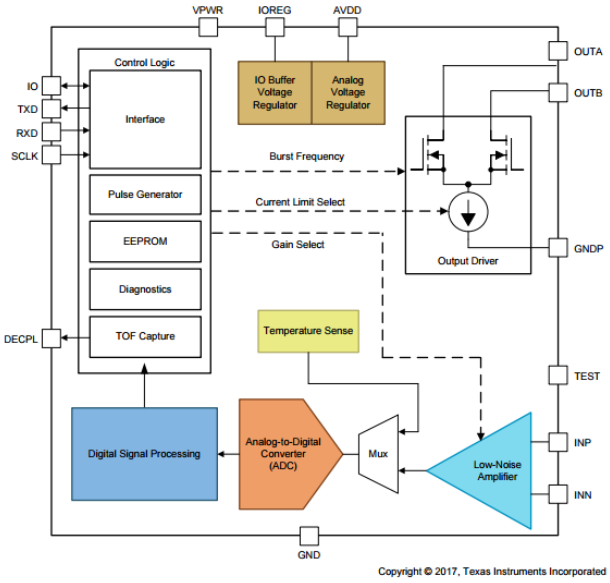

Figure 3. PGA460-Q1 Block Diagram

Additional Resources

- Order the PGA460-Q1 evaluation module (EVM).
- Watch PGA460-Q1 EVM training video series.
- Download the PGA460 frequently asked questions (FAQ) and EVM troubleshooting guide.
- Download the PGA460 ultrasonic module hardware and software optimization application report.

Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Original (July 2017) to A Revision	Page
• Added additional author Akeem Whitehead to document	1

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