Avoiding False Touch Inputs Using Atmel® Capacitive Touch Sense ICs

1. Introduction

One of the challenges of designing any hand-held device is to find a way of avoiding inadvertent control inputs caused during normal handling. These false control inputs can lead to consequences for end users that are irritating or embarrassing.

Ensuring that the product strongly resists false inputs can be a critical part of the product design effort. There are a number of standard approaches to doing this, but they are not always appropriate for use with capacitive touch controlled devices.

Atmel capacitive touch control ICs provide an alternative solution known as the guard channel (or guard band). Used on its own, or in combination with conventional techniques, can make it easier to discriminate between intentional and unintentional (false) inputs.

This application note describes how to implement a guard channel using a QTouch™ IC.

2. The Limitations of the Traditional Approach

Traditional approaches to solving this problem with mechanical-switch based products include the well known technique of using software to lock the keys after a short time-out period and then using a specific key input sequence to unlock the device.

This approach can occasionally be defeated when the key sequence is accidentally duplicated by random inputs, even with conventional switches. The simple act of putting the device in a pocket has the potential to cause dozens of signals that could be interpreted as inputs; an accidental match for the correct unlock sequence could be disasterous. Therefore, the designer must balance the need for complex key combinations that are unlikely to be triggered accidentally against the ease-of-use of the product.

Another possibility is to use a hardware switch to activate the keys, as is often seen on portable music players. An extension of this is in the folding keypad found on a mobile telephone. In this case the keys are not just disabled, but also physically hidden, making false touches impossible. However, it clearly adds to the complexity and overall cost of the finished product.

Avoiding False Touch Inputs

Application Note QTAN0031

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3. The Guard Channel

Touch control technology provides a low-cost method (known as a guard channel) that can be used to boost the reliability of the key locking in a way that would not be possible with mechanical switches.

A guard channel is a large sensor region that surrounds the keypad area in such a way that it is activated if the keys are not accurately touched. The QTouch IC is configured so that outputs from other keys are suppressed when the guard channel detects a touch and, for this sensor only, the $\overline{\text{CHG}}$ (Change) signal to the host MCU is suppressed so that false touches do not cause interrupts.

The effect is that any input that includes the guard channel is ignored. The device only accepts a touch if it is deliberately and precisely made on the keys.

4. Using the Guard Channel Operation

Some of Atmel's touch sense ICs allow a guard channel to be configured by adjusting a setup option. Some chips do not have this option, but can be configured to have a guard channel function by adjusting a number of independent settings. Atmel's AT42QT1060 (QT1060) touch sense IC is a good example of this. It can provide a guard channel feature by combining Atmel's patented Adjacent Key Suppression™ (AKS™) technology with the ability to suppress the $\overline{\text{CHG}}$ signals that are usually generated when a key changes state.

5. How AKS Technology Works

AKS technology is a feature that is normally used to provide more precise discrimination between closely spaced keys, but in this application it is used to suppress output from the keypad keys when the guard channel sensor is in detect.

AKS technology works by controlling the interaction between a specific group of touch keys, known as the AKS Group. Only one key in the group can be in detect at any one time and this will be key with the largest touch signal.

Depending on the IC used, the AKS technology can be locking or non-locking.

For locking AKS, the first key touched will stay in detect until it is released, even if the signal from another key rises above the first key's signal.

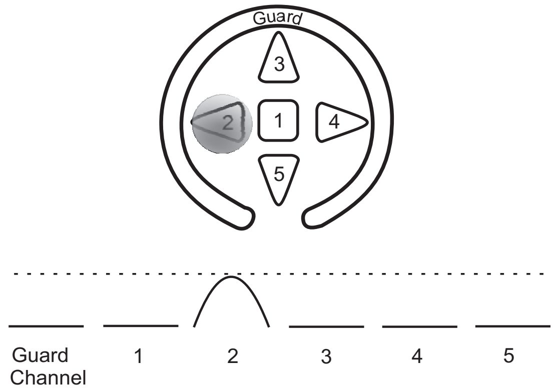
For non-locking AKS (as provided by the QT1060), when the signal from an adjacent key rises above the first key's signal, the second key becomes the dominant one, forcing the first key out of detect without it being released.

6. Guard Channel Operation

The Guard Channel is designed so that it is likely to be activated unless a key is accurately touched.

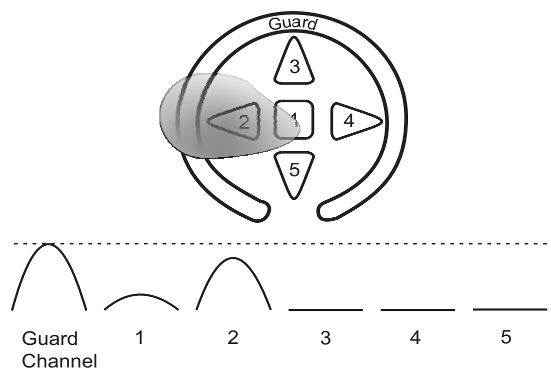
Figure 6-1 on page 3 shows the case of an accurate touch giving the desired response.

Figure 6-1. A Precisely Placed Finger Provides a Clear Touch Signal



The situation in Figure 6-2, on the other hand, shows a large area being activated, for example when the product is placed in a pocket. In this case, the guard channel blocks false touches from the other keys.

Figure 6-2. The Guard Channel's Signal Suppresses Smaller Signals From the Other Keys



The guard channel is effectively creating an automatic keypad lock and unlock function without requiring any extra effort from the user. In combination with a key-locking sequence, the chance of keys operating when they should not is dramatically reduced.

7. Adjusting Key Sensitivity

The guard channel sensor must be set up so that it is slightly more sensitive than the keys that it surrounds. The exact amount of increase depends on the application and is probably best determined by experimentation.

There are three methods of increasing the sensor sensitivity that can be used in combination:

- Increase the size of the key
- Increase the value of the sample capacitor (Cs)
- Adjust the detection threshold (NTHR) for the key

The key size and capacitor values should be altered to establish the base sensitivity for the key. Once these values have been established, the detection threshold can be used to fine tune the device's response.

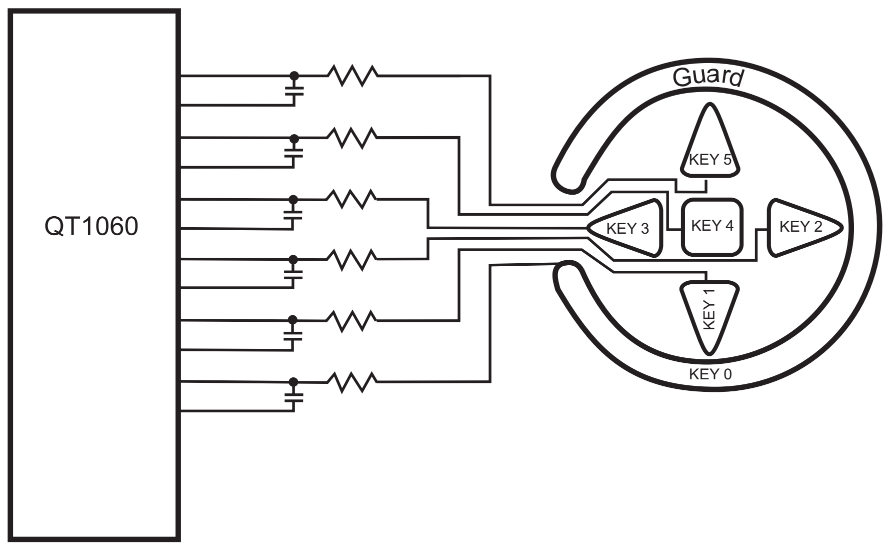
8. Sensor and Circuit Design

The QT1060 uses simple, single element electrodes and the requirements regarding sensor size and shape are very flexible. The sensors can be configured in many different ways, and the materials and dimensions of the substrate and the overlying panel can have an effect on sensitivity. Producing a prototype sensor array will allow its response to be fully tested before the design is finalized. It is important to test the design to make sure it provides an effective configuration before moving on to other details.

The sensor circuit can be constructed from a variety of materials, including FR-4, Flexible Printed Circuit Board (FPCB), silver silk-screened on to PET, punched single sided CEM-1 and FR-2. It is also possible to construct a sensor array from patterns printed in conductive materials on the inside of the product's outer casing.

Application note QTAN0002, *Secrets of a Successful QTouch™ Design* (available from www.atmel.com) contains specific advice about sensor design and details of the IC's circuit configuration. Figure 8-1 shows the general arrangement of the IC and sensor array.

Figure 8-1. Circuit Diagram for the QT1060 and Guard Channel Sensor Array



9. Configuring the Host Software

The QT1060 is configured and controlled by its host processor via the I^{2}C-compatible serial interface. Setup information can be written to, and key values or status information read from, specific register addresses, as detailed in the device's datasheet.

To use the device in a way described in this application note, the key threshold, key mask bitmap and AKS mask will all need to be set to suitable values.

10. Associated Publications

The following documents published by Atmel may also be of interest:

- QTAN0002 – Secrets of a Successful QTouch™ Design
- QTAN0015 – Power Supply Considerations for Atmel Capacitive-touch ICs
- AT42QT1060 Datasheet

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