Application Note: AZD012
Effects of water and steam on ProxSense^{TM} sensors
IQ Switch® - ProxSense^{TM} Series

Table of Contents

1 Introduction

This document describes the various water exposed type applications where ProxSense^{TM} capacitive sensing technologies have been tested, and the results obtained within these scenarios.

The focus is on three different yet related capacitive sensing technologies namely surface capacitive sensing, projected capacitive sensing, and capacitive pressure only (CAPPO).

The corresponding ProxSense^{TM} controller ICs utilised for each of the three technology types are listed in Table 1.1 below.

Table 1.1 Technologies with corresponding ProxSense^{TM} controller ICs

Technology	ProxSense^{TM} IC
Surface Capacitive	IQS316
Projected Capacitive	IQS156
Capacitive Pressure Only	IQS127C

2 Water Scenario Summary

A summary of the three capacitive sensing technologies as well as applicable performance specifications in various water type applications are presented in Table 2.1 below, for easy reference.

Table 2.1 Water Testing Summary

Water state and composition		Technology			
		Surface Capacitive (high charge transfer frequency)		Projected Capacitive	CAPPO™
		No Guard Channel	Guard Channel		
Steam		✓✓	✓✓	✓✓	✓✓
Droplets (Horizontal)	Fresh	✓✓	✓✓	✓✓	✓✓
	Salt	×	×	✓✓	✓✓
Droplets (Vertical)	Fresh	✓✓✦	✓✓✦	✓✓✦	✓✓
	Salt	×	×	✓	✓✓
Spills	Fresh	✓✓✦	✓	✓✓✦	✓✓
	Salt	×	✓✦	✓	✓✓
Submerge	Fresh	×	✓✦	×	✓✓
	Salt	×	✓✦	×	✓✓

× False touches not prevented

✓ False touches prevented

✓✦ False touches prevented (Logical decision by MCU required to reject unwanted touches) (§4.1)

✓✓ False touches prevented and able to sense through water medium

✓✓✦ False touches prevented (Logical decision by MCU required to sense through water medium) (§4.2)

3 Application environments and scenarios

3.1 Surface Capacitive Sensing

The IQS316 16 channel proximity and touch sensor was utilised for the tests. In order to minimise the ability of water to influence the touch sensors, the charge transfer frequency of this particular IC was set to operate at a high frequency (4 Mhz).

The IQS316 and touch panel are illustrated in Figure 3.1

Figure 3.1 IQS316 and touch panel

A typical application where steam could come into contact with the touch panel is a household oven. With the touch panel and overlay mounted vertically, the IQS316 touch sensors are unaffected by a steam cloud that is brought into contact with the touch panel overlay, as depicted in Figure 3.2. The touch sensor is able to correctly detect intended user touches through this steam cloud, and through the water film produced by the condensation of water on the touch panel surface.

Figure 3.2 Steam cloud in contact with touch panel

Fresh water droplets on the touch panel such as those from a spray of water produce no false touches, and the IQS316 touch sensor is able to correctly sense an intended user touch through these water droplets.

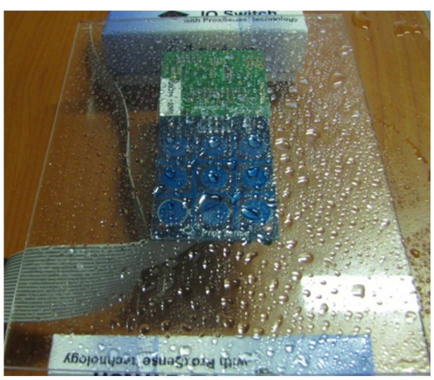

Figure 3.3 Water droplets (horizontal touch panel)

When the touch panel is mounted vertically as illustrated in Figure 3.4, fresh water droplets run down the touch panel. No false touches are produced; however, a logical decision by an MCU is required to correctly detect an intended user touch (see section 4 of this application note).

Figure 3.4 Water droplets (vertical touch panel)

Fresh water spills on the touch panel may form static puddles or continuous streams, but no false touches are produced. To be able to sense a correct intended user touch through these water puddles or continuous water streams, a logical decision by an MCU is required to extract the strongest touch (see section 4 of this application note).

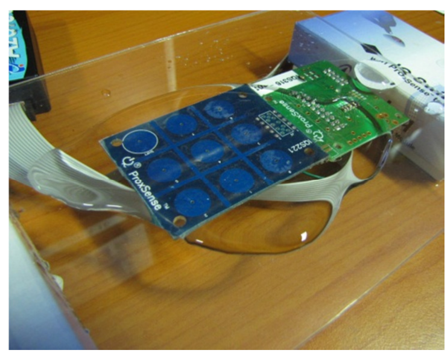

Figure 3.5 Water spill on touch panel

A guard channel is a touch sensor interlaced between touch keys. By utilising a proper guard channel, sudden fresh or salt water spills on the touch panel (such as those from a pot boiling over) can be suitably detected by an MCU and false touches rejected. A typical guard channel is depicted in Figure 3.6.

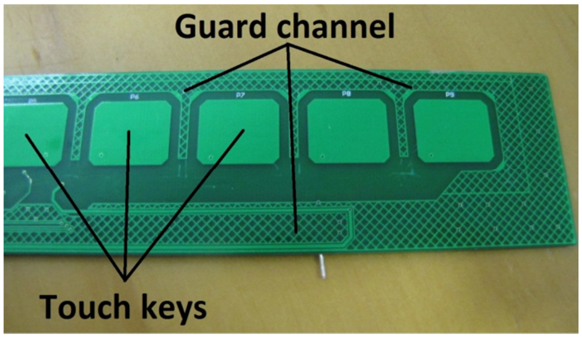

Figure 3.6 Typical guard channel

The guard channel can also be employed to detect whether the touch panel is being submerged under water, to reject false touches by the use of an appropriate MCU.

3.2 Projected Capacitive Sensing

The IQS156 6 channel touch and proximity sensor utilises projected capacitive sensing technology, and is depicted in Figure 3.7, with an appropriate touch panel and overlay.

The IQS156 touch sensor is unaffected by steam coming into direct contact with the touch panel overlay, and is able to successfully detect intended touches through this steam cloud and through the water film produced by the condensation of water on the touch panel surface.

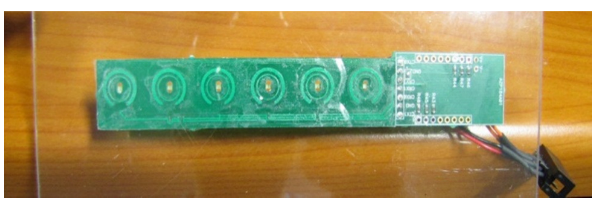

Figure 3.7 IQS156, touch panel and overlay

Fresh and salt water droplets on the touch panel such as those from a spray of water produce no false touches, and the IQS156 touch sensor is able to correctly sense an intended user touch through these water droplets.

Fresh water and salt water spills on the touch panel may form static puddles or continuous streams, but no false touches are produced. To be able to sense a correct intended user touch through fresh water puddles or continuous streams, manual ATI adjustment and a logical decision by an MCU is required to extract the strongest touch.

3.3 Capacitive Pressure Only

Capacitive pressure sensing measures a microscopic deflection in the touch panel overlay. As this deflection requires a force of approximately 130g to activate the corresponding touch sensor, water by default cannot produce false touches, and intended touches are always detected through fresh and salty water.

Figure 3.8 illustrates a prototype ProxSense™ CAPPO™ touch panel.

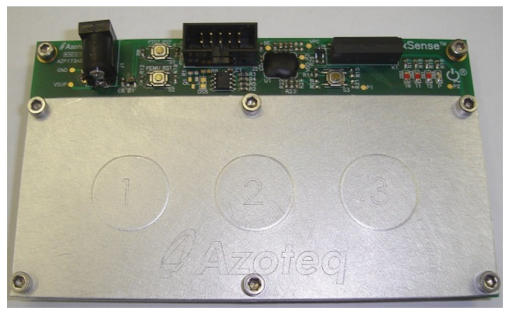

Figure 3.8 CAPPO™ touch panel

Figure 3.9 illustrates a prototype ProxSense™ CAPPO™ touchpanel in separated form.

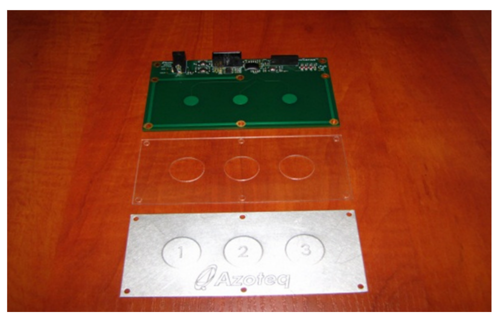

Figure 3.9 CAPPO™ touch panel, with layers separated

4 Logical decision making with a microcontroller

In some water type applications it is necessary to employ a microcontroller to make a logical decision based on the incoming sensor data.

Referring to Table 1.1, two scenarios exist where a logical decision is necessary:

- Sensing through the fresh water medium
- Rejecting unwanted touches

4.1 Rejecting unwanted touches

Rejecting unwanted touches can be done in two ways:

1. Ignoring all the touch inputs when multiple touches are detected.
2. Ignoring all the touch inputs when a guard channel is triggered.

Both methods can be easily implemented with a suitable MCU. The MCU can trigger a display to "wipe the sensor clean" before any touches are reported.

4.2 Sensing through the fresh water medium

As multiple touch keys will be capacitively linked by fresh water puddles or streams, multiple touches could be registered by the ProxSense™ sensors when a user touches a key. The key that the user is touching however, will have the greatest deviation from its LTA (Long Term Average) value, and can be easily extracted and registered as the intended touch by a suitable MCU to ensure reliable operation. Therefore: The MCU should calculate the key with the greatest delta value, and only output that key.

The following patents relate to the device or usage of the device: US 6,249,089 B1, US 6,621,225 B2, US 6,650,066 B2, US 6,952,084 B2, US 6,984,900 B1, US 7,084,526 B2, US 7,084,531 B2, US 7,265,494 B2, US 7,291,940 B2, US 7,329,970 B2, US 7,336,037 B2, US 7,443,101 B2, US 7,466,040 B2, US 7,498,749 B2, US 7,528,508 B2, US 7,119,459 B2, EP 1 120 018 B1, EP 1 206 168 B1, EP 1 308 913 B1, EP 1 530 178 B1, ZL 99 8 14357.X, AUS 761094

WWW.AZOTEQ.COM

ProxSenseSupport@azoteq.com