

### SAM C20 QTouch Robustness Demo

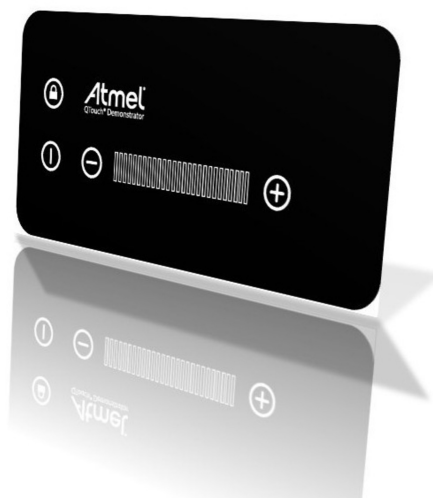
#### USER GUIDE

## Description

The Atmel® | SMART SAM C20 QTouch® Robustness Demo demonstrates the high performance capacitive touch support of the Peripheral Touch Controller (PTC) while achieving best-in-class conducted immunity and moisture tolerance. The demo implements a robust solution that allows customers to easily incorporate the Atmel QTouch technology into designs that require a high level of noise immunity and moisture tolerance.

## Features

- Four self-capacitance buttons with Philipp Spring
- One self-capacitance slider using six Philipp Spring
- One seven segment LED to display slider position
- Buzzer for audio feedback
- On-board Embedded Debugger module for programming/debugging and QDebug data streaming
- Connectivity with the Atmel QTouch Analyzer



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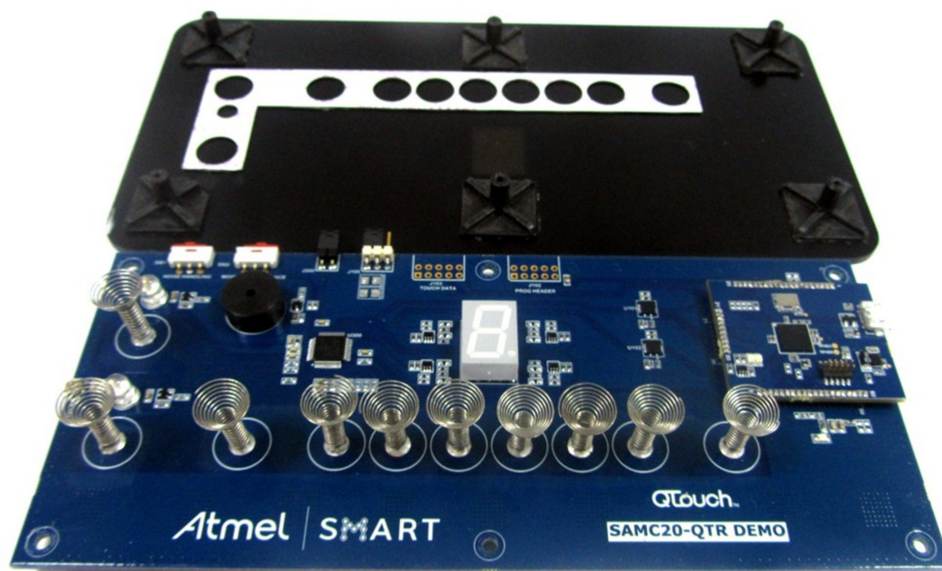
## 1. Overview

This document describes the SAM C20 QTouch Robustness demo kit. The demo kit demonstrates self capacitance button and slider implemented using Philipp springs. The associated package for SAM C20 QTouch Robustness Demo contains schematics, Gerber, BoM, and firmware.

The demo kit consists of a base board and a front panel. The front panel is mechanically fixed on the base board by using plastic spacers.

The demo kit is designed to be used as a standalone unit with its own on-board microcontroller to evaluate the noise immunity and moisture tolerance performance. The SAM C20 QTouch Robustness demo kit running its associated firmware can pass Test Level 3 (10Vrms) of IEC/EN 61000-4-6 specification for conducted immunity.

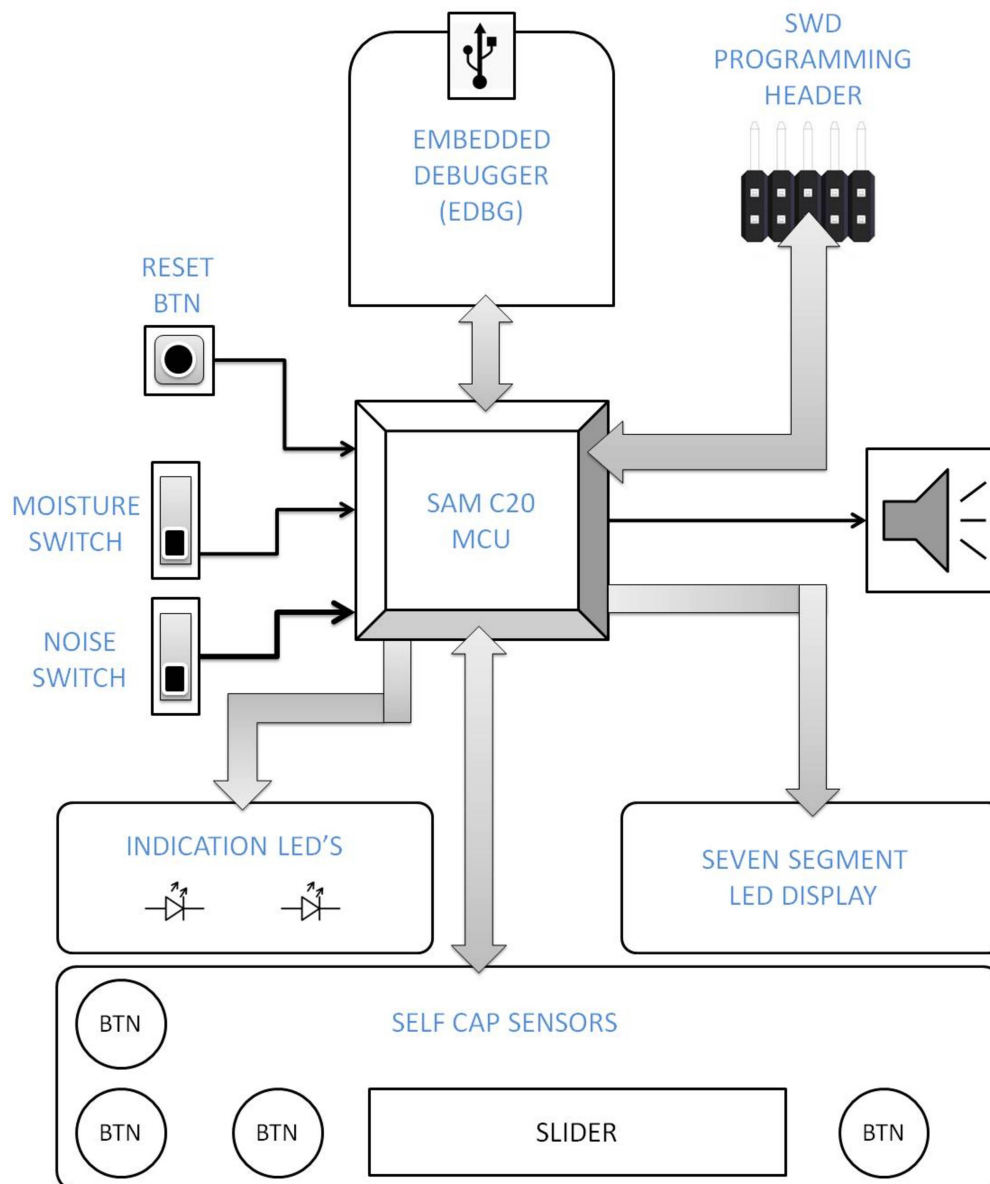
**Figure 1-1 Internal View of the Demo Kit**



## 2. Hardware Description

### 2.1. Block Diagram

Figure 2-1 Block Diagram of SAM C20 QTouch Robustness Demo Kit



## 3. Pin Configuration

### 3.1. Self Capacitance

The demo kit has one slider and four touch buttons, which are based on self-capacitance technology. There are ten Y-lines used. The slider is composed of six channels. Six individual buttons are arranged in the format of slider. Philipp Spring is used to bridge the air gap between the PCB and front panel. The Philipp Spring design is patented by Atmel and design specifications of the Philipp Springs can be obtained from Atmel.

**Table 3-1 Pin Configuration of the Self Capacitance Sensors**

| FUNCTIONALITY | MCU PIN | MCU PIN NAME |
|---------------|---------|--------------|
| Y1            | 4       | PA03         |
| Y14           | 7       | PB08         |
| Y15           | 8       | PB09         |
| Y2            | 9       | PA04         |
| Y3            | 10      | PA05         |
| Y5            | 12      | PA07         |
| Y16           | 13      | PA08         |
| Y17           | 14      | PA09         |
| Y8            | 47      | PB02         |
| Y9            | 48      | PB03         |

### 3.2. Indication

This demo kit has one seven segment LED display, one buzzer for touch detection, and two LEDs to indicate ON/OFF status of Power and Lock buttons.

**Table 3-2 Pin Configuration of LEDs and Buzzer**

| FUNCTIONALITY | MCU PIN | MCU PIN NAME |
|---------------|---------|--------------|
| LEDSEG1       | 25      | PA16         |
| LEDSEG2       | 26      | PA17         |
| LEDSEG3       | 27      | PA18         |
| LEDSEG4       | 28      | PA19         |
| LEDSEG5       | 29      | PA20         |
| LEDSEG6       | 30      | PA21         |
| LEDSEG7       | 31      | PA22         |
| LEDSEG8       | 32      | PA23         |
| LEDQT1        | 33      | PA24         |

| FUNCTIONALITY | MCU PIN | MCU PIN NAME |
|---------------|---------|--------------|
| LEDQT2        | 34      | PA25         |
| BUZZ-TC01     | 20      | PB11         |

### 3.3. Communication Interface

The communication pins of the Touch MCU are connected to the Data Gateway Interface (DGI) of the Embedded Debugger (EDBG) module through the level converter that acts as a bridge between PC and SAM C20 MCU. Touch data is sent by using the Bit Bang SPI mode.

**Table 3-3 Pin Configuration for Bit Bang SPI Communication Interface**

| FUNCTIONALITY | MCU PIN | MCU PIN NAME |
|---------------|---------|--------------|
| DBG_MOSI      | 21      | PA12         |
| DBG_SCK       | 22      | PA13         |
| DBG_SS        | 23      | PA14         |
| DBG_MISO      | 24      | PA15         |

## 4. Unit Assembly

There are two separate units for the demo kit:

- Acrylic Front Panel
- Base PCB

**Figure 4-1 Board Stack-up**



## 5. Powering Up the Kit

The demo kit can be powered either by using USB connected to the EDBG module or by using an external +5V supply. There are multiple components in the kit which can handle different voltage ratings. The SAM C20 is working in +5V for better noise immunity. The maximum safe operating rate of the SAM C20 is +5.5V. The LEDs are driven at +3.3V by default to ensure optimum brightness. +3.3V for LEDs and other components are supplied from the regulator on the EDBG module. LED also has an option for +5V operation by using jumper selection.

## 6. Embedded Debugger (EDBG)

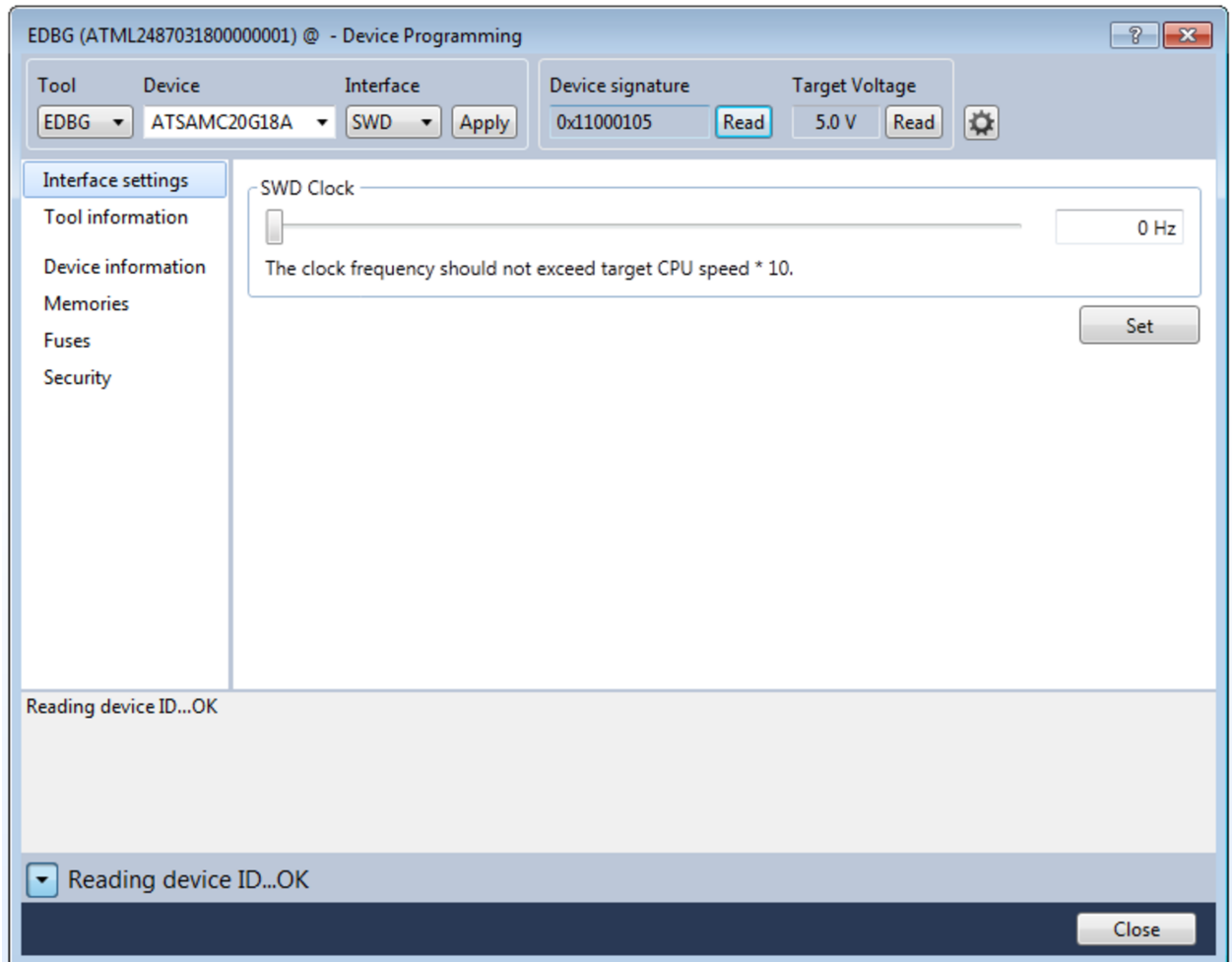
The demo kit features an on-board Embedded Debugger (EDBG) module. This can be used for programming and debugging the firmware using Atmel Studio. Additionally, it allows to stream touch data between the host PC and the kit using the Data Gateway Interface (DGI).

**Figure 6-1 EDBG on SAM C20 QTouch Robustness Demo Kit**



The EDBG is mounted on the kit as a separate module. Using the EDBG the user can connect to a QTouch Analyzer and view the touch data. The EDBG has been pre-configured to support a SAMC20G18 device using SWD interface for programming and debugging. For streaming data to the QTouch Analyzer it uses DGI, which connects to SAM C20 over Bit Bang SPI.

Figure 6-2 Connecting with EDBG for Programming using Atmel Studio

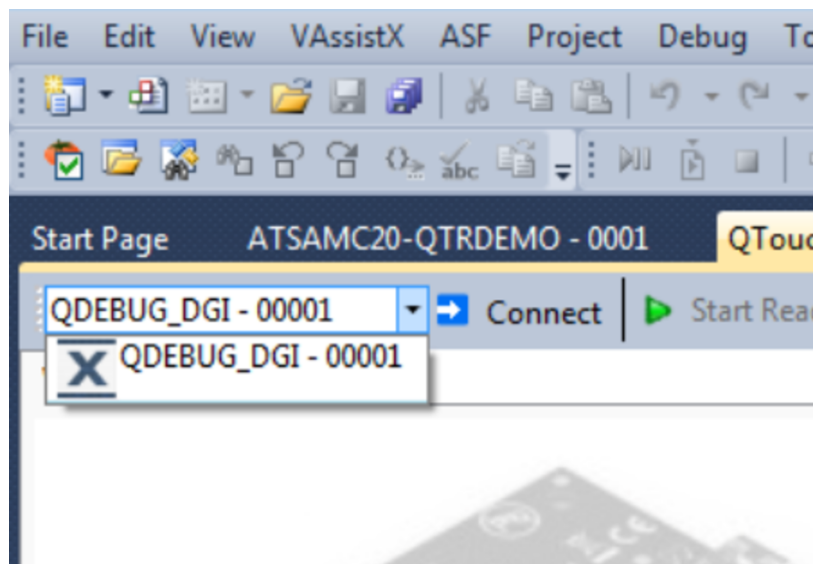


## 7. Connecting to QTouch Analyzer

Follow the steps below to connect the QTouch Analyzer to view touch data.

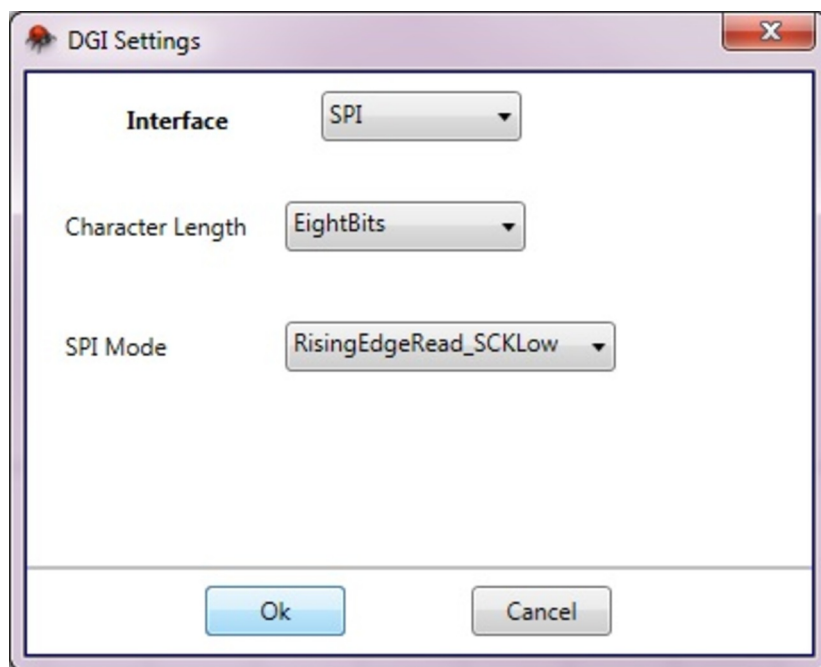
1. Connect the kit to PC using an mini USB cable.
2. Open QTouch Analyzer in Atmel Studio 6.
3. Select QDEBUG\_DGI from the drop down menu and click on **Connect**.

**Figure 7-1 Select QDEBUG\_DGI**



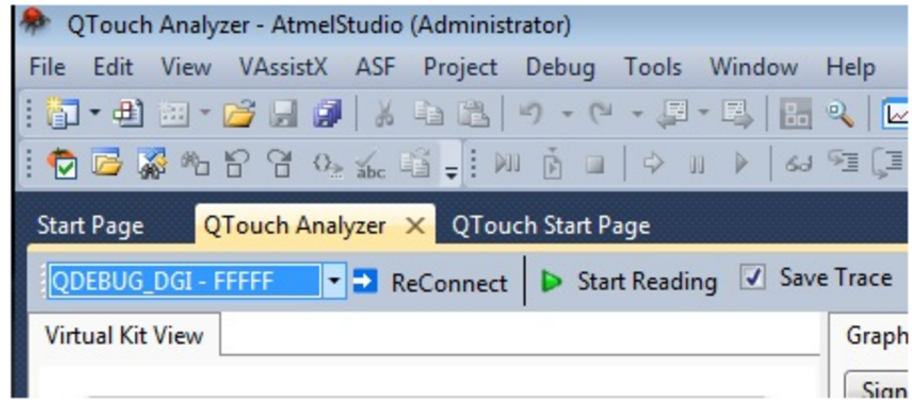
4. Click **OK** when the DGI settings screen pops up.

**Figure 7-2 DGI Settings Screen Pops Up**



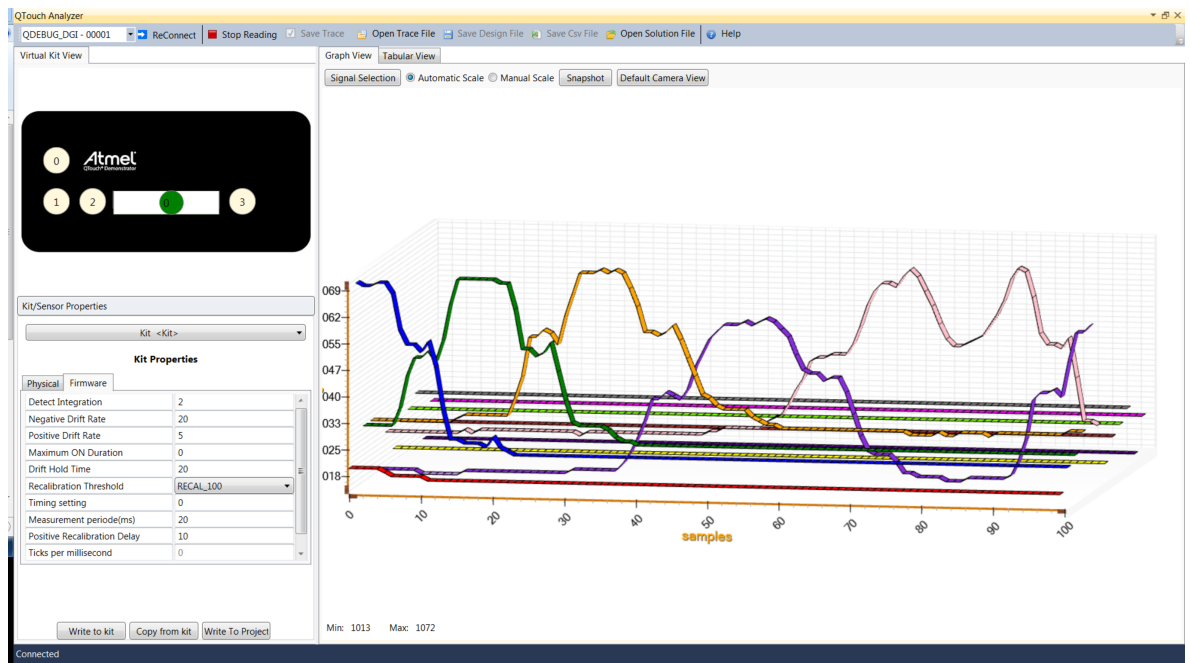
5. Click **Start Reading**.

**Figure 7-3 Capturing Touch Signal**



6. View the touch signal in the QTouch Analyzer.

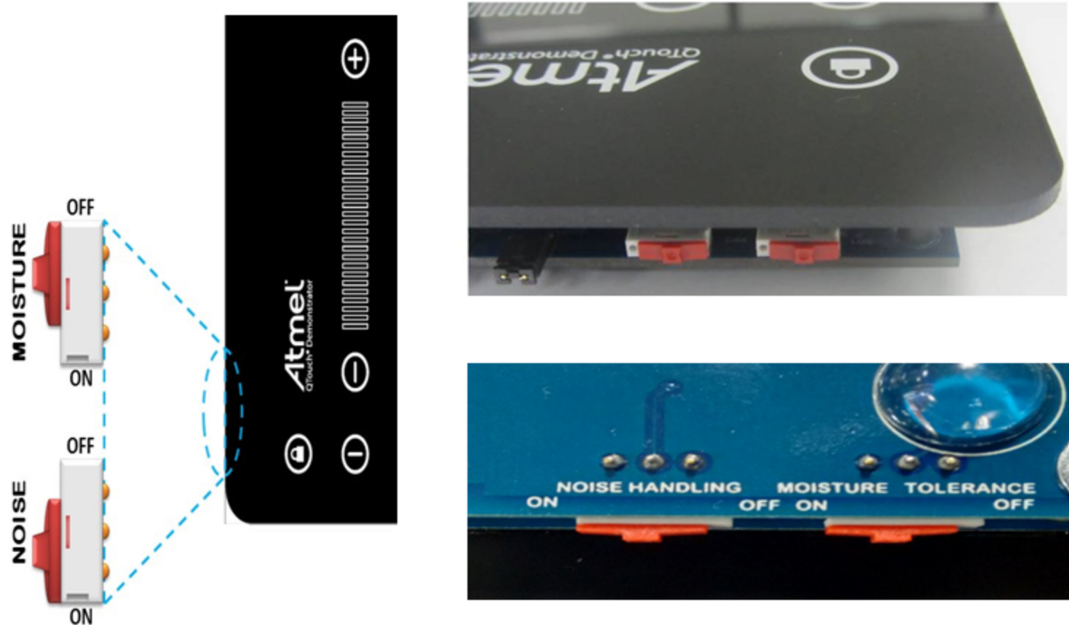
**Figure 7-4 Touch Signal View in QTouch Analyzer**



## 8. Switch Operation

There are two slide switches available on the board that can be used to enable or disable the countermeasures in the firmware. These switches are present on the top side of the board.

Figure 8-1 Switch Position in the Kit



### 8.1. Noise Handling

The NOISE HANDLING switch is used to enable or disable the noise countermeasures in the firmware. The position of the switch should be kept at ON when the demo kit is subjected to Conducted Immunity noise testing or powered from noisy power supply.

There is a beep sound when the switch is moved from ON to OFF or vice versa.

### 8.2. Moisture Tolerance

The MOISTURE TOLERANCE switch is provided to enable or disable the moisture tolerance countermeasures in the firmware. The firmware is designed to detect the presence of moisture and lock the sensors to prevent false detects.

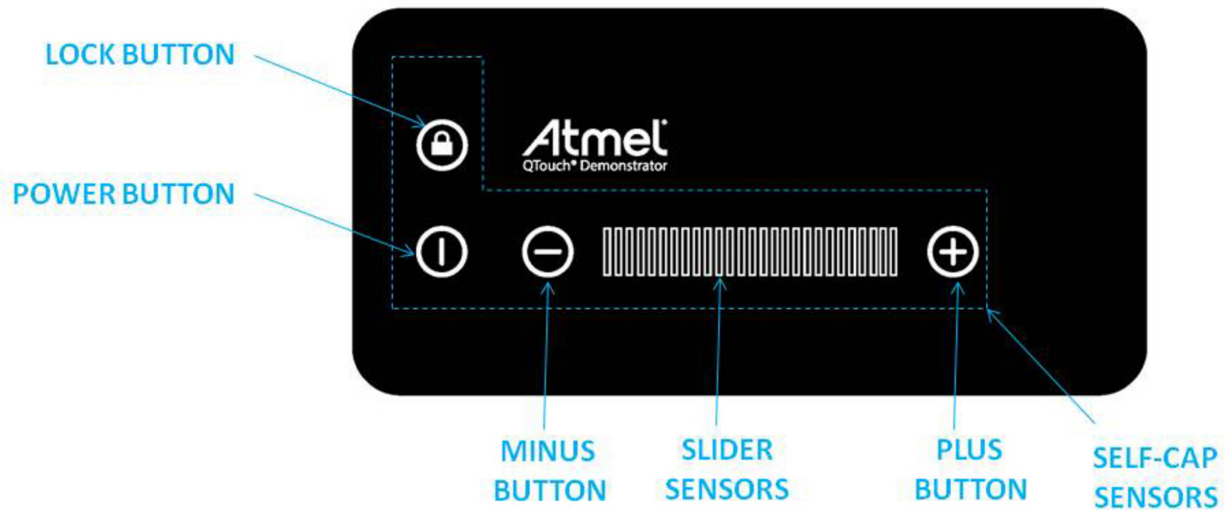
There is a beep sound when the switch is moved from ON to OFF or vice versa.

**Note:** Touch on multiple sensors simultaneously is not supported when this switch is in ON position.

## 9. Board Operation

### 9.1. Product Layout

Figure 9-1 Layout of Sensors on the Kit



### 9.2. Lock Button

The lock button is used to enable or disable all other touch sensors in the kit. While lock is enabled, the other sensors will not respond to touch.

The LED for lock the button will remain glowing to indicate the locked state of the touch panel. Touching the Lock button in lock state will release the lock and the LED will turn OFF.

There is a long beep when the button detection put the panel in locked state and there will be a short beep when the panel is released from the lock state.

### 9.3. Button Description

#### 9.3.1. Minus Button

This minus button is used to decrement the slider position and the value will be displayed on the seven segment LED display. A single tap on the button decrements the displayed position value by one count. Continuous touch on the **minus** button will decrement the position value one by one until it reaches the minimum value as "0".

#### 9.3.2. Plus Button

This plus button is used to increment the slider position and the value will be displayed on the seven segment LED display. A single tap on the button increments the displayed position value by one count. Continuous touch on the **plus** button will increment the position value one by one until reach of the maximum value as "b".

### 9.3.3. Power Button

The power button is used to turn the panel ON or OFF

The LED for power button will remain glowing to indicate the ON state of the touch panel. The seven segment LED display shows zero when the power button is in ON state. Touching the power button again, the touch panel will be put to OFF state and the LED will stop glowing.

There is a long beep when the button in OFF state comes into detect and the touch panel is activated. A short beep is made when the button comes in to detect in ON state and the touch panel is deactivated.

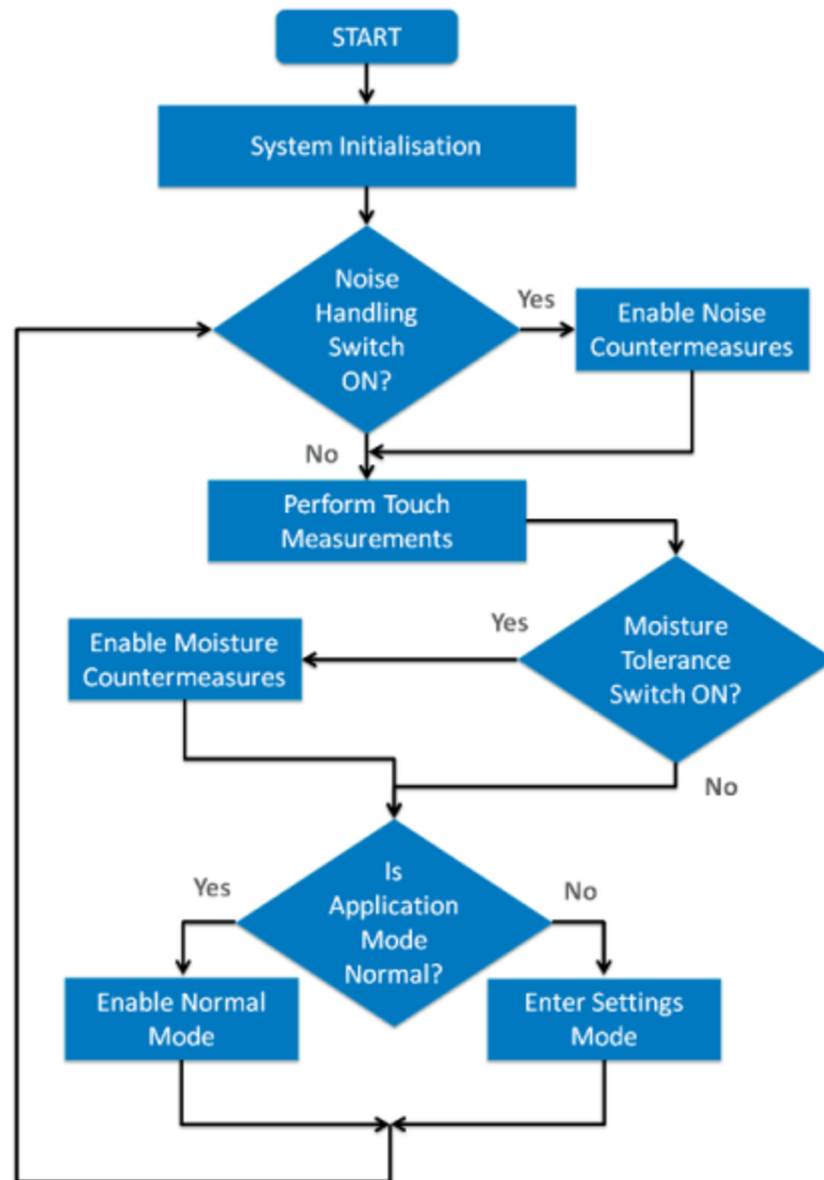
### 9.3.4. Slider Sensors

The slider is made of six individual self-capacitance button sensors and is interpreted as a low resolution slider in the application. The number of positions reported is 11; from 0 to 9, and b. The reported position in the application will be displayed on the seven segment LED display.

## 10. Operating Modes of the Kit

### 10.1. Application Flow

Figure 10-1 Top Level Application Flowchart of SAM C20 QTouch Robustness Demo Firmware



### 10.2. Normal Mode

In this mode all sensors are operational. For every valid touch there is a short beep. If you touch the slider the corresponding position will display on the seven segment LED display. The slider position can also be changed by touching the plus or minus button.

### 10.3. Mode Change

To change the application mode, press and hold both the plus and the minus buttons for one second. This will change the mode to Settings mode if the current mode is Normal and vice versa.

**Note:** If the kit is left in Settings mode for more than ten seconds, it will automatically switch to Normal mode.

### 10.4. Settings Mode

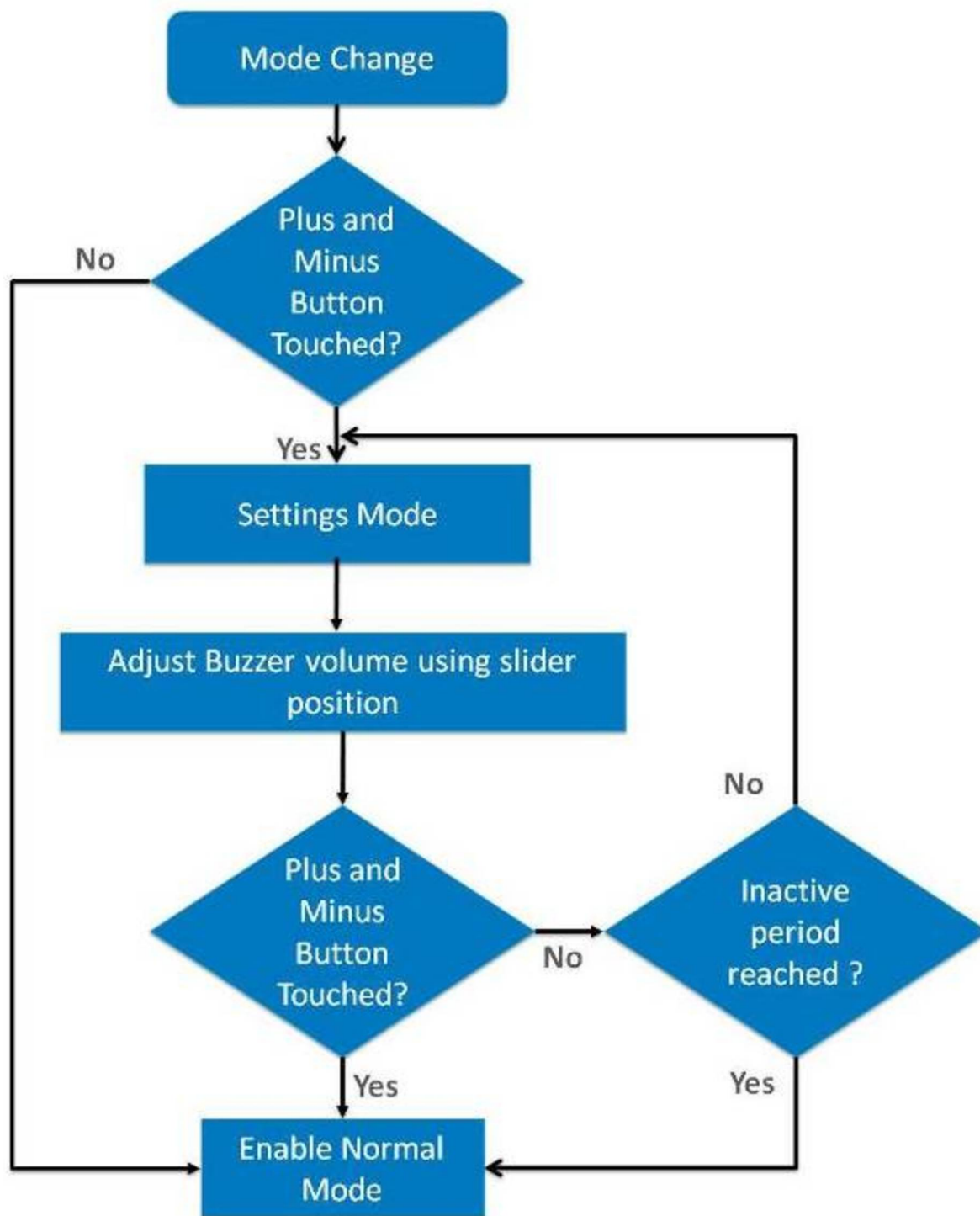
#### 10.4.1. Buzzer Volume Adjustment

Following are the steps to adjust the volume of the buzzer. Ensure that you are in Settings mode.

- Press and hold both the **plus** and the **minus** button for one second. A beep will indicate that you have entered into Settings mode.
- The LED segment display will indicate the corresponding digit of the current volume setting. Adjust the volume level by using the slider. The buzzer sound is audible as long as the slider is touched.
- Press and hold the **plus** and the **minus** button for one second. This will save the buzzer volume level.

**Note:** The buzzer volume is saved into the NVM. The volume setting is retained in the memory even after power cycle. The buzzer volume is to be manually set; there is no provision for automatic reset of buzzer volume.

Figure 10-2 Application Flow for the Settings Mode



## 11. Schematic

Figure 11-1 MCU and Sensor Configuration Section

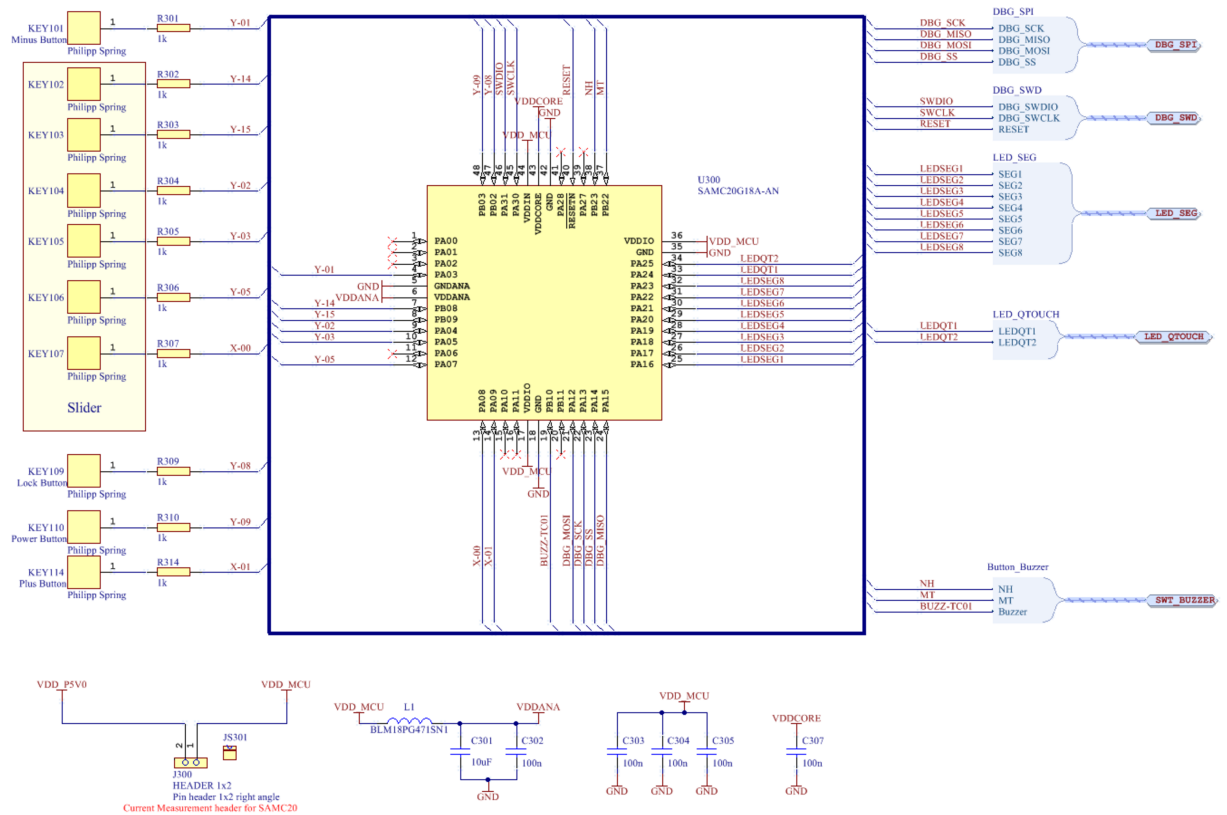


Figure 11-2 LED Segment, Buzzer, and Switch Section

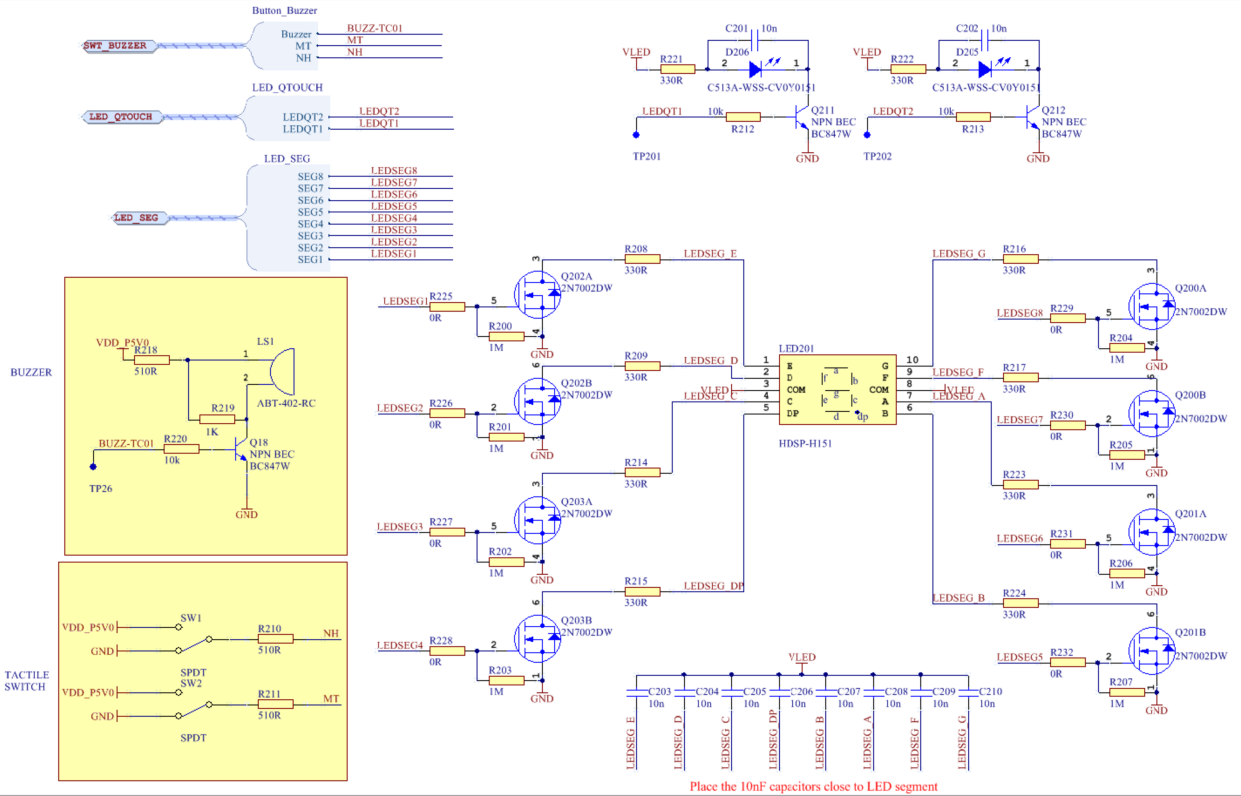
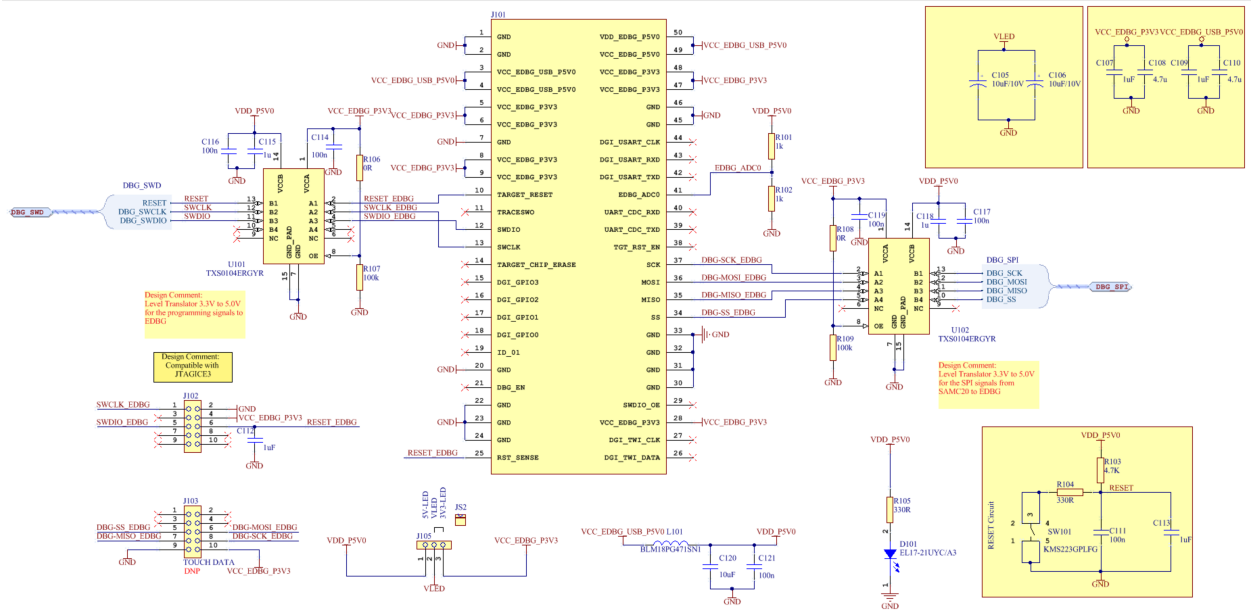


Figure 11-3 EDBG Headers and Connectors



## 12. PCB Design

Figure 12-1 Top Layer

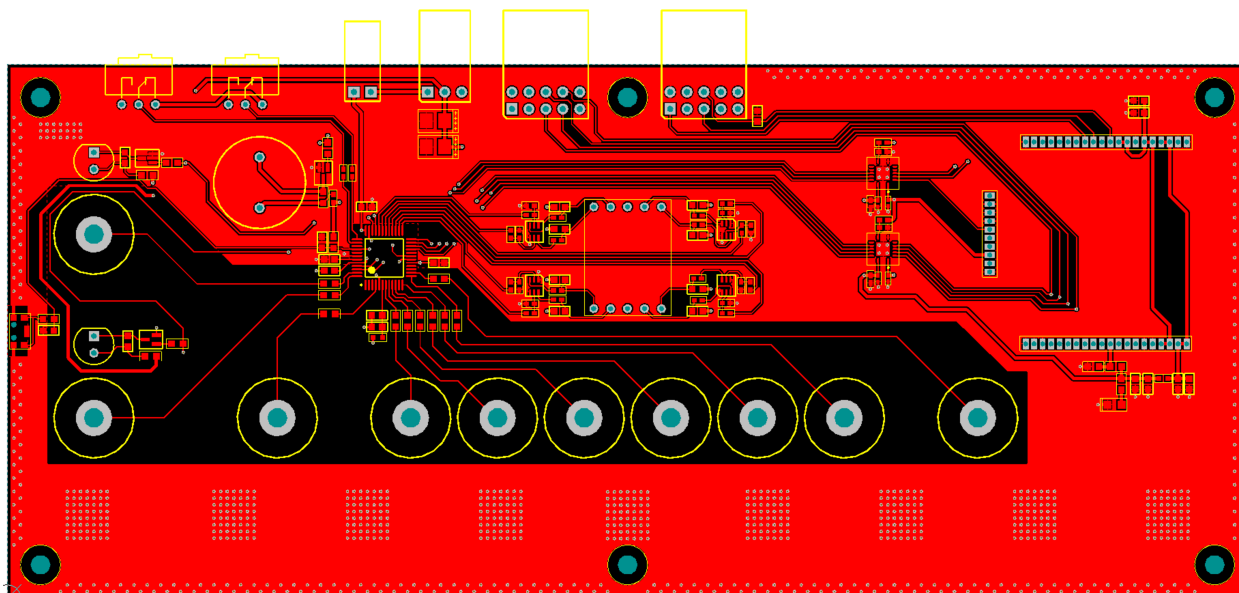
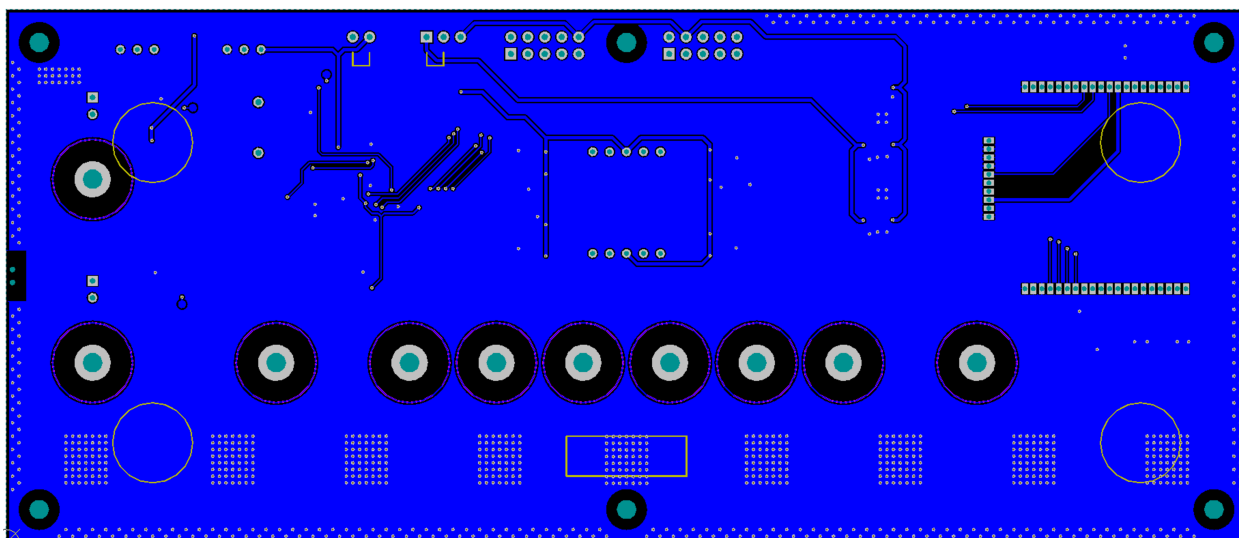


Figure 12-2 Bottom Layer



## 13. Bill of Materials

Table 13-1 Top Level Bill of Materials

| COMPONENT                                        | QUANTITY |
|--------------------------------------------------|----------|
| Acrylic Front Panel                              | 1        |
| SAM C20 QTouch Robustness Demo Base Board - PCBA | 1        |
| Atmel EDBG-PCBA                                  | 1        |
| (Rubber Feet) Bump-on                            | 4        |
| Plastic Spacers 11.8mm                           | 6        |
| Nylon Screw 4.3mm                                | 6        |

Table 13-2 Bill of Material for the Base Board

| Designator                                                                     | Quantity | Value                      | Description                     |
|--------------------------------------------------------------------------------|----------|----------------------------|---------------------------------|
| C107, C109, C112, C113                                                         | 4        | 1 $\mu$ F                  | SMD Capacitor 0603              |
| C108, C110                                                                     | 2        | 4.7 $\mu$ F                | SMD Capacitor 0603              |
| C111, C121, C302, C303, C304, C305, C307                                       | 7        | 100nF                      | SMD Capacitor 0603              |
| C114, C116, C117, C119                                                         | 4        | 100nF                      | SMD Capacitor 0402              |
| C115, C118                                                                     | 2        | 1 $\mu$ F                  | SMD Capacitor 0402              |
| C120, C301                                                                     | 2        | 10 $\mu$ F                 | SMD Capacitor 0603              |
| C201, C202, C203, C204, C205, C206, C207, C208, C209, C210                     | 10       | 10nF                       | SMD Capacitor 0603              |
| D101                                                                           | 1        | EL17-21UYC/A3              | Yellow LED SMD 0805             |
| D205, D206                                                                     | 2        | C513A-WSS-CV0Y0151         | 5mm White LED_TH                |
| E1, E2, E3, E4                                                                 | 4        | SJ-5303                    | Adhesive feet, diam. 11.1mm     |
| J101                                                                           | 1        | EDBG module                | Atmel Generic EDBG module       |
| J102                                                                           | 1        | RT Pin Header 2X5          | Right Angle Header 2x5          |
| J103                                                                           | 1        | RT Pin Header 2X5          | Right Angle Header 2x5          |
| J105                                                                           | 1        | RT Pin Header 1X3          | Right Angle Header 1x3          |
| J300                                                                           | 1        | Pin header 1x2 right angle | Right Angle Header 1x2          |
| JS2, JS301                                                                     | 2        | SNT-100-BK-G               | Jumper cap for 2.54mm pinheader |
| KEY101, KEY102, KEY103, KEY104, KEY105, KEY106, KEY107, KEY109, KEY110, KEY114 | 10       | Philipp Spring             | Spring for touch applications   |

| Designator                                                                   | Quantity | Value                                        | Description                                  |
|------------------------------------------------------------------------------|----------|----------------------------------------------|----------------------------------------------|
| L1, L101                                                                     | 2        | BLM18PG471SN1                                | SMD RF inductor 0603                         |
| LED201                                                                       | 1        | HDSP-H151                                    | LED 7-SEG, Red, Common Anode                 |
| LS1                                                                          | 1        | ABT-402-RC                                   | Buzzer                                       |
| PCB1                                                                         | 1        | SAMC20 QTR Demo Base Board PCB Documentation | SAMC20 QTR Demo Base Board PCB Documentation |
| Q18, Q211, Q212                                                              | 3        | BC847W                                       | NPN SMD BJT transistor                       |
| Q200, Q201, Q202, Q203                                                       | 4        | 2N7002DW                                     | Dual N-Channel MOSFET                        |
| R101, R102, R219, R301, R302, R303, R304, R305, R306, R307, R309, R310, R314 | 13       | 1k $\Omega$                                  | SMD Resistor 0603                            |
| R103                                                                         | 1        | 4.7k $\Omega$                                | SMD Resistor 0603                            |
| R104, R105, R221, R222                                                       | 4        | 330 $\Omega$                                 | SMD Resistor 0603                            |
| R106, R108, R225, R226, R227, R228, R229, R230, R231, R232                   | 10       | 0 $\Omega$                                   | SMD Resistor 0402                            |
| R107, R109                                                                   | 2        | 100k $\Omega$                                | SMD Resistor 0402                            |
| R200, R201, R202, R203, R204, R205, R206, R207                               | 8        | 1M $\Omega$                                  | SMD Resistor 0402                            |
| R208, R209, R214, R215, R216, R217, R223, R224                               | 8        | 330 $\Omega$                                 | SMD Resistor 0402                            |
| R210, R211, R218                                                             | 3        | 510 $\Omega$                                 | SMD Resistor 0402                            |
| R212, R213, R220                                                             | 3        | 10k $\Omega$                                 | SMD Resistor 0603                            |
| SW1, SW2                                                                     | 2        | SPDT                                         | Slide Switch                                 |
| SW101                                                                        | 1        | KMS223GPLFG                                  | SMT Side Actuator                            |
| U101, U102                                                                   | 2        | TXS0104ERGYR                                 | Voltage Level Translator                     |
| U300                                                                         | 1        | SAMC20G18A-AN                                | MCU                                          |

## 14. Reference

- [1]. QTAN0079: Buttons, Sliders and Wheels, Touch Sensor Design Guide - <http://www.atmel.com/Images/doc10752.pdf>
- [2]. SAM D Peripheral Touch Controller User Guide - [http://www.atmel.com/Images/Atmel-42195-QTouch-General-Library-Peripheral-Touch-Controller\\_User-Guide.pdf](http://www.atmel.com/Images/Atmel-42195-QTouch-General-Library-Peripheral-Touch-Controller_User-Guide.pdf)
- [3]. AT09363: PTC Robustness Design Guide, application note - [http://www.atmel.com/images/atmel-42360-ptc-robustness-design-guide\\_applicationnote\\_at09363.pdf](http://www.atmel.com/images/atmel-42360-ptc-robustness-design-guide_applicationnote_at09363.pdf)

## 15. Revision History

| Doc Rev. | Date    | Comments                  |
|----------|---------|---------------------------|
| 42525A   | 09/2015 | Initial document release. |



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