USER GUIDE

AT08578: SAM D20 QTouch Robustness Demo

Atmel QTouch

Description

The Atmel® | SMART SAM D20 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 robustness solution that allows customers to easily incorporate the Atmel QTouch technology into designs that require high levels of noise immunity and moisture tolerance.

Features

- Six self-capacitance buttons with Philipp Spring
- Four mutual-capacitance buttons
- Individual LEDs for indicating button status
- One 8-channel mutual-capacitance slider
- Seven LEDs to indicate slider position
- Buzzer for audio feedback
- On-board Embedded Debugger module
- Connectivity with QTouch Analyzer
- On-board Embedded Debugger module for programming/debugging and QDebug data streaming



Table of Contents

1 Overview 3
2 Hardware Description 4
2.1 Block Diagram 4
3 Pin Configuration 5
3.1 Mutual Capacitance Sensors 5
3.2 Self Capacitance Sensors 5
3.3 Indication 6
3.4 Communication Interface 6
4 Unit Assembly 7
5 Powering up the Kit 8
5.1 USB Port 8
5.2 External DC Power Supply 8
6 Embedded Debugger (EDBG) 9
7 Connecting to QTouch Analyzer 10
8 Switch Operation 12
8.2 Noise Handling 12
8.3 Moisture Tolerance 12
9 Board Operation 13
9.1 Product Layout 13
9.2 Button Description 13
9.2.1 Power Button 13
9.2.2 Lock Button 13
9.3 Operating Modes of the Kit 14
9.3.1 Application Flow 14
9.3.2 Normal Mode 14
9.3.3 Mode Change 14
9.3.4 Settings Mode 15
9.3.4.1 LED Brightness Adjustment 15
9.3.4.2 Buzzer Volume Adjustment 15
10 Schematic 17
10.1 MCU and Sensor Configuration Section 17
10.2 LED, Buzzer, and Switch Section 18
10.3 Power Supply Section 19
10.4 Sensor Board 19
11 PCB Design 20
11.1 Main MCU PCB – Top Layer 20
11.2 Main MCU PCB – Bottom Layer 21
11.3 Sensor PCB – Top Layer 22
11.4 Sensor PCB – Bottom Layer 23
12 Bill of Materials 24
13 References 25
14 Revision History 26

1 Overview

This document describes the SAM D20 QTouch Robustness demo kit. The demo kit showcases both self-capacitance (with springs) sensors and mutual-capacitance sensors running on the same Atmel SAM D20 microcontroller. The associated package for SAM D20 QTouch Robustness Demo contains the schematic, Gerber, BoM, and firmware.

The demo kit consists of two different PCBs. The mutual capacitance sensors and LEDs are kept on the top PCB. The self capacitance sensors and other electronics are kept on the bottom PCB. The PCBs are electrically connected to each other by means of a flex cable. The PCBs are mechanically held by hex screw mount standoffs. The front panel is pasted over the top sensor PCB.

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 D20 QTouch Robustness demo kit running its associated firmware can pass Test Level 3 ($10V_{RMS}$) of IEC/EN 61000-4-6 specifications for conducted immunity.

Figure 1-1. Internal View of the Demo Kit

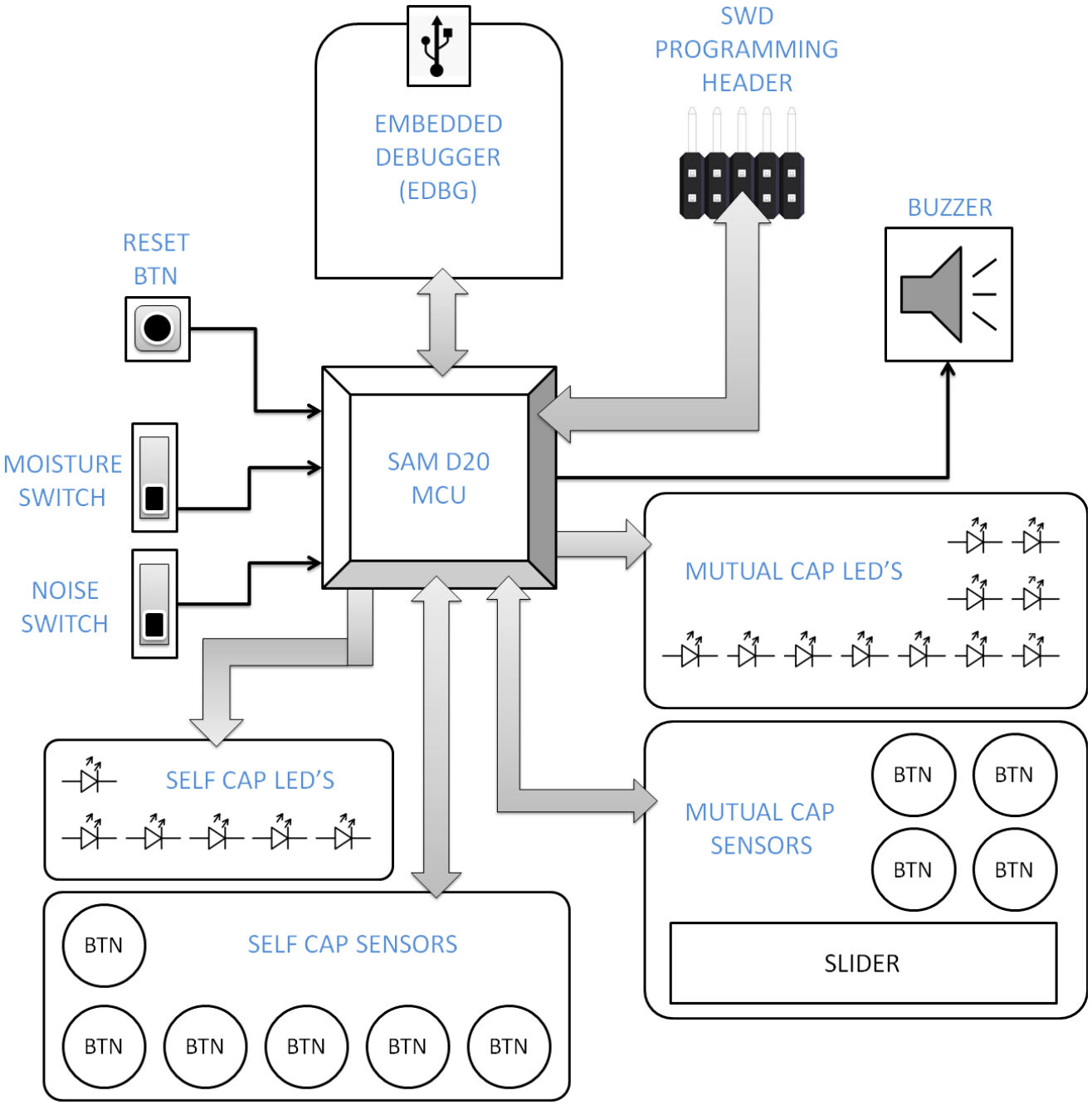


2 Hardware Description

2.1 Block Diagram

Figure 2-1 shows the various modules of the SAM D20 QTouch Robustness Demo Kit.

Figure 2-1. Block Diagram of SAM D20 QTouch Robustness Demo Kit



3 Pin Configuration

3.1 Mutual Capacitance Sensors

The demo kit has one slider and four buttons which are based on mutual-capacitance sensing technology. The slider is composed of eight channels. There are eight X-lines and two Y-lines.

Table 3-1. Pin Configuration of the Mutual Capacitance Sensors

FUNCTIONALITY	MCU PIN #	MCU PIN NAME
X0	17	PA08
X1	18	PA09
X2	19	PA10
X3	20	PA11
X12	25	PB12
X13	26	PB13
X14	27	PB14
X15	28	PB15
Y4	15	PA06
Y15	16	PA07

3.2 Self Capacitance Sensors

The demo kit has six buttons which are based on self capacitance sensing technology. Philipp Spring is used to bridge the air gap between the PCB and front panel. The Philipp Spring design is patented by Atmel. The design specification of the Philipp Spring can be obtained from Atmel.

Table 3-2. Pin Configuration of the Self Capacitance Sensors

FUNCTIONALITY	MCU PIN #	MCU PIN NAME
Y1	4	PA03
Y10	5	PB04
Y11	6	PB05
Y12	9	PB06
Y13	10	PB07
Y14	11	PB08

3.3 Indication

This demo kit has seventeen LEDs and a buzzer for audio visual indication of touch detection. Each button has its corresponding LED that glows as long as the button is in detect. The slider has seven LEDs to indicate the touch position on the slider.

The buzzer beeps when there is a valid touch detect.

Table 3-3. Pin Configuration for LEDs and Buzzer

FUNCTIONALITY	MCU PIN #	MCU PIN NAME
LED BUTTON MC 0	36	PA17
LED BUTTON MC 1	35	PA16
LED BUTTON MC 2	38	PA19
LED BUTTON MC 3	37	PA18
LED SLIDER 0	45	PA24
LED SLIDER 1	44	PA23
LED SLIDER 2	43	PA22
LED SLIDER 3	42	PA21
LED SLIDER 4	41	PA20
LED SLIDER 5	40	PB17
LED SLIDER 6	39	PB16
LED BUTTON SC 0	2	PA01
LED BUTTON SC 1	1	PA00
LED BUTTON SC 2	64	PB03
LED BUTTON SC 3	63	PB02
LED BUTTON SC 4	62	PB01
LED BUTTON SC 5	61	PB00
BUZZER	60	PB31

3.4 Communication Interface

The communication pins of the Touch MCU are connected to the Data Gateway Interface (DGI) of the Embedded Debugger (EDBG) module that acts as a bridge between PC and SAM D20 MCU. Touch data is sent using Bit Bang SPI mode.

Table 3-4. Pin Configuration for Bit Bang SPI Communication Interface

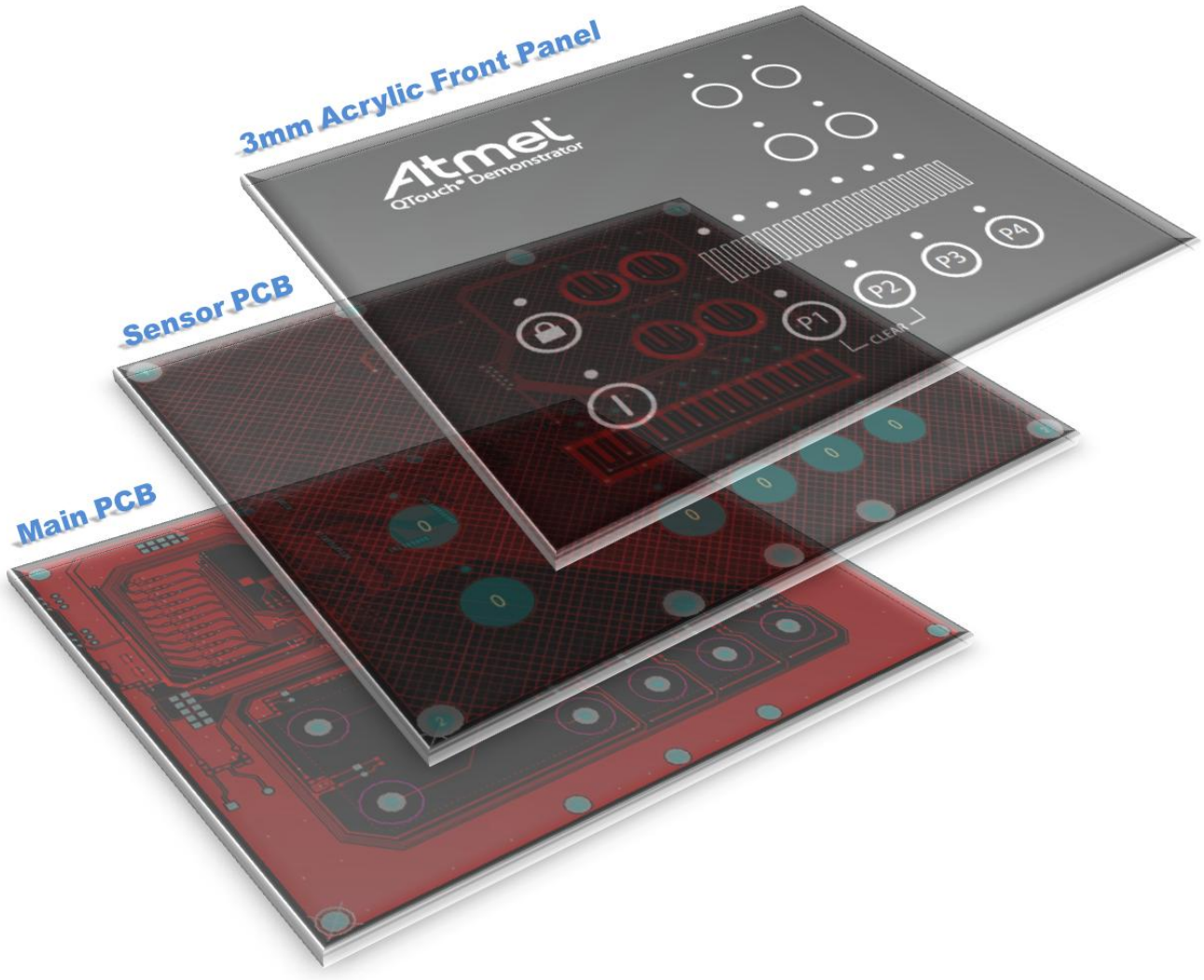
FUNCTIONALITY	MCU PIN #	MCU PIN NAME
BB-SS	31	PA14
BB-SCK	30	PA13
BB-MOSI	29	PA12
BB-MISO	32	PA15

4 Unit Assembly

There are three separate units for the demo kit:

- Acrylic Front Panel
- Sensor PCB
- Main MCU PCB

Figure 4-1. Board Stack-up



5 Powering up the Kit

There are multiple components in the kit which can handle different voltage ratings. The LEDs are driven at +3.3V by default to ensure optimum brightness. The maximum safe operating voltage of the SAM D20 is +3.6V. There is an on-board regulator in the kit to provide +3.3V supply to the SAM D20 MCU. There is provision in the board to bypass the on-board regulator.

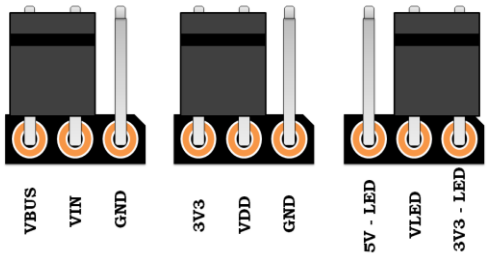
LED brightness can be increased by moving the PWR-LED jumper from 3.3V LED to 5V LED.

There are two ways to provide power to the kit. There is a set of jumpers in the Main MCU PCB to allow use of different powering options.

5.1 USB Port

This is the default power option for the kit. The USB is connected to the EDBG module, which in turn connects to the SAM D20 MCU. The +5V USB VBUS is fed to the on-board regulator of the Main MCU PCB which converts it to +3.3V for the SAM D20 MCU.

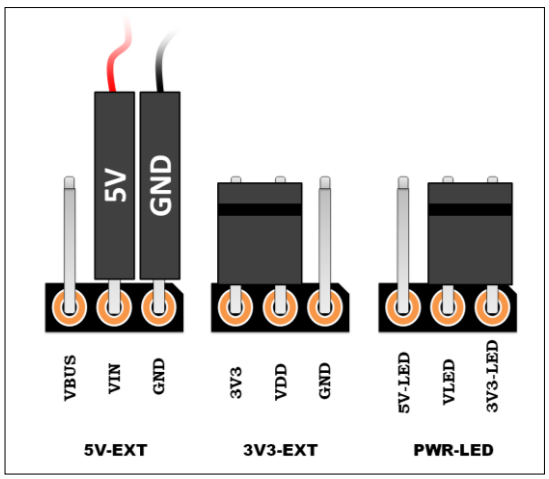
Figure 5-1. Default Jumper Configuration for USB as Power Supply

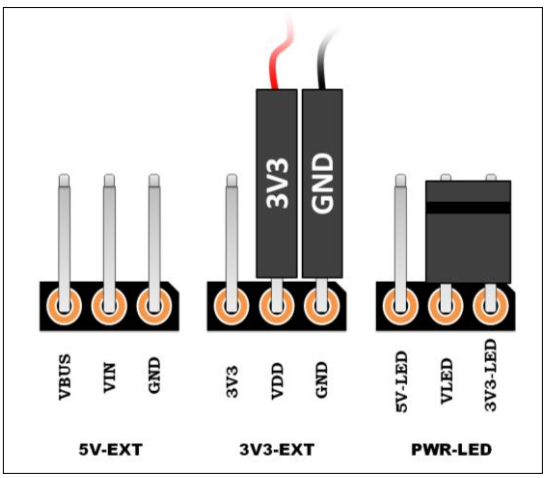


5.2 External DC Power Supply

There are two ways in which power can be provided to the kit externally:

- **[Configuration – I]** The user can choose to use the on-board regulator and provide voltage from +5V to +12V
- **[Configuration – II]** The user can choose to bypass the regulator and provide +3.3V directly to the chip

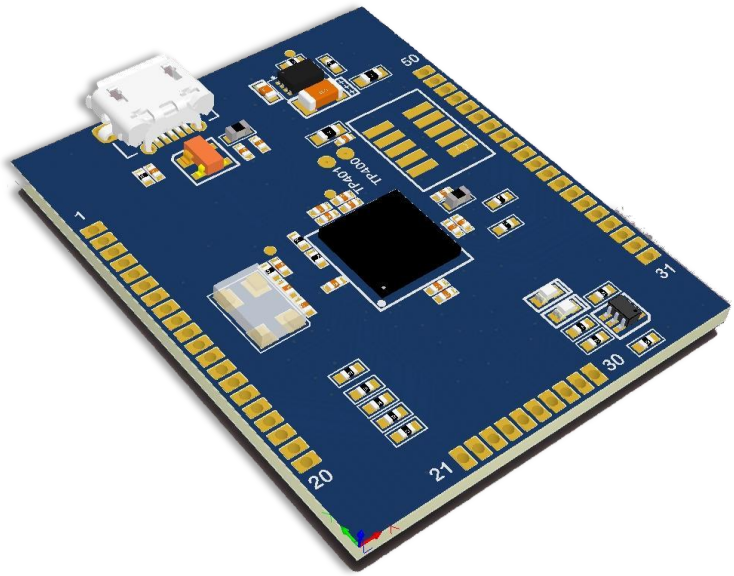




6 Embedded Debugger (EDBG)

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).

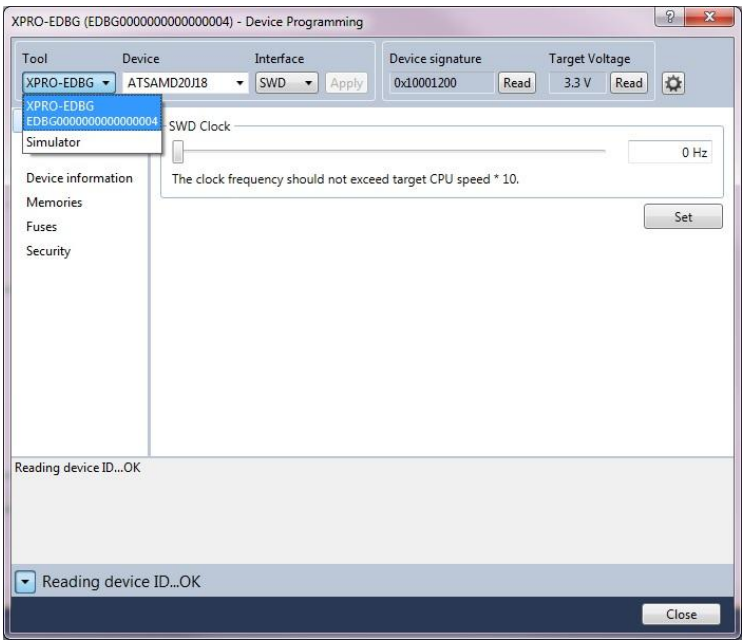
Figure 6-1. EDBG Board on SAM D20 QTouch Robustness Demo Kit



The EDBG is mounted on the kit as a separate module. Using the EDBG the user can connect to QTouch Analyzer and view the touch data. The EDBG has been pre-configured to support SAMD20J18 device using SWD interface for programming and debugging.

For streaming data to QTouch Analyzer it uses DGI which connects to SAM D20 over Bit Bang SPI.

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



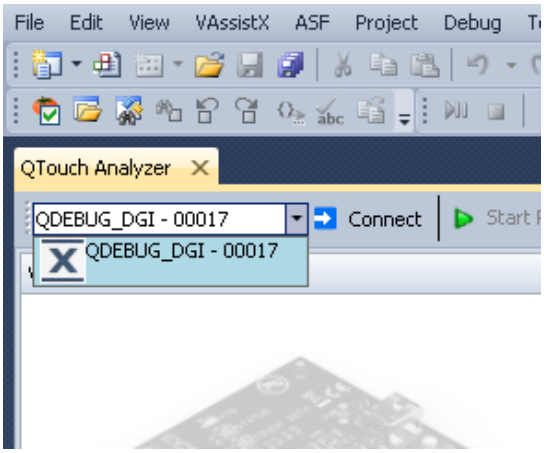
7 Connecting to QTouch Analyzer

The kit can be connected to the QTouch Analyzer to view touch data.

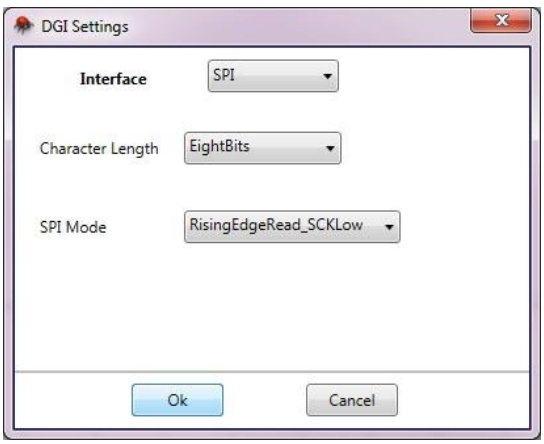
A. Connect the kit to PC using a mini USB cable.

B. Open QTouch Analyzer in Atmel Studio 6.

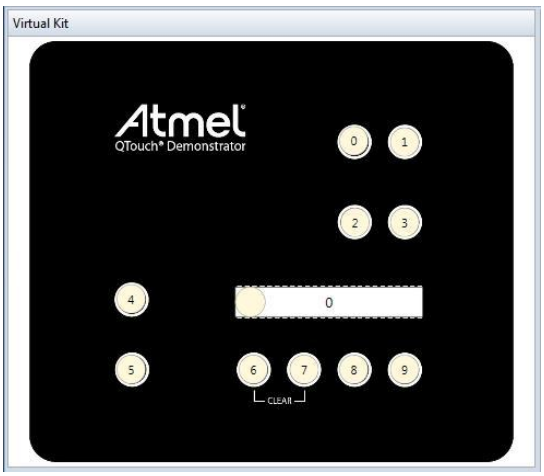
C. Select QDEBUG_DGI from the drop down menu and click on ***Connect***.



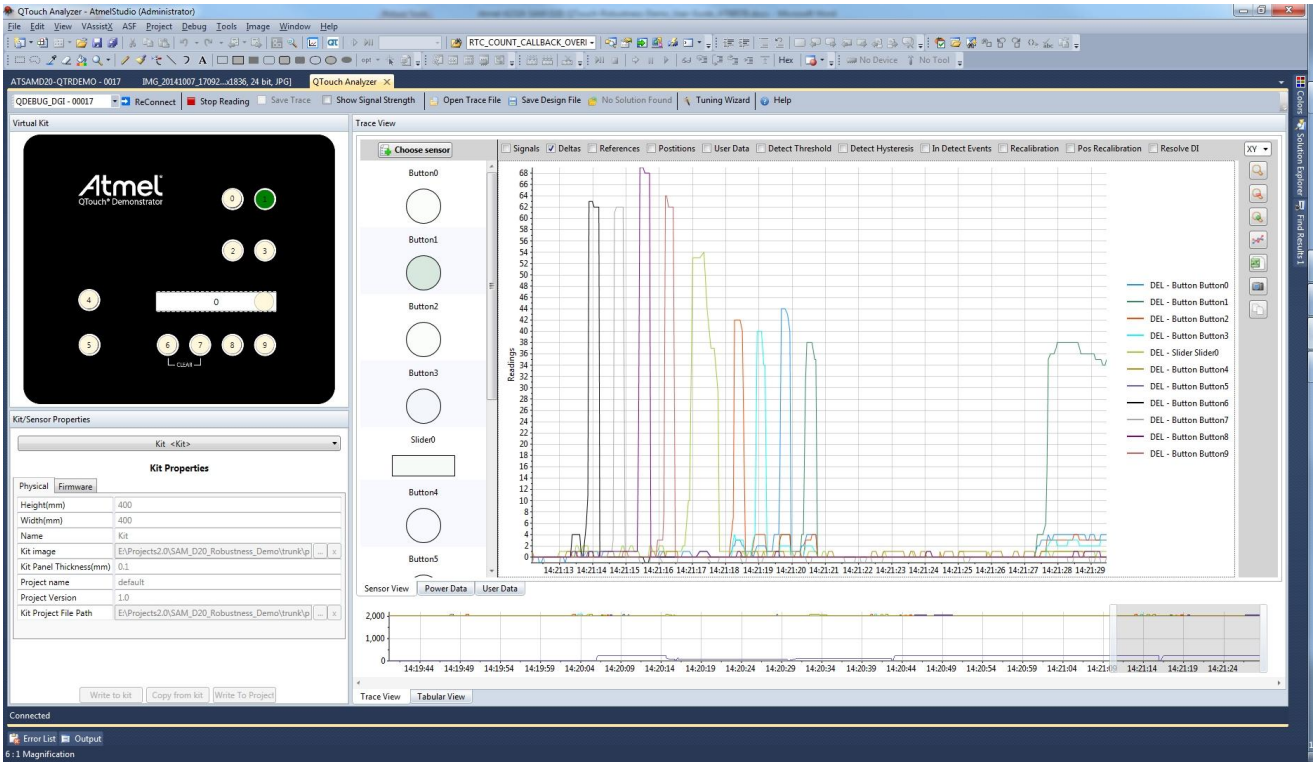
D. Click ***OK*** when the DGI Settings screen pops up.



E. Click ***Start Reading***.



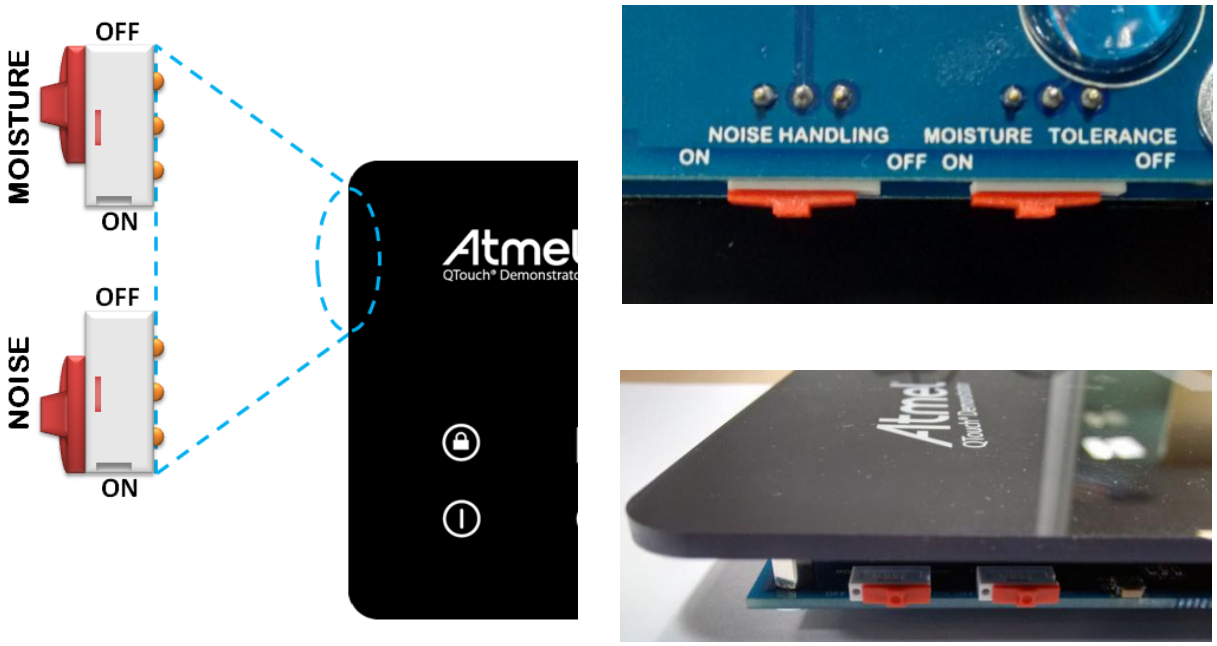
F. View touch signals in QTouch Analyzer.



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 in the top left corner of the board.

Figure 8-1. Switch Position in the Kit



Slide Up for OFF and Slide Down for ON

8.2 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 a noisy power supply.

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

8.3 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 so as to prevent false detects.

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

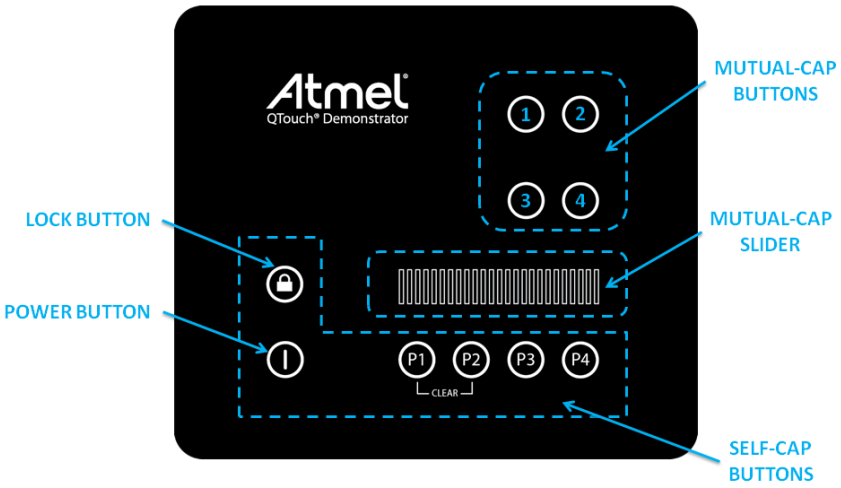
Note: Touch on multiple sensors simultaneously is not supported when this switch is in ON position.

9 Board Operation

9.1 Product Layout

Figure 9-1 shows the product layout of the demo kit and the placement of both self capacitance and mutual capacitance sensors.

Figure 9-1. Layout of Sensors on the Kit



9.2 Button Description

9.2.1 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. 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 into detect in ON state and the touch panel is deactivated.

9.2.2 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.

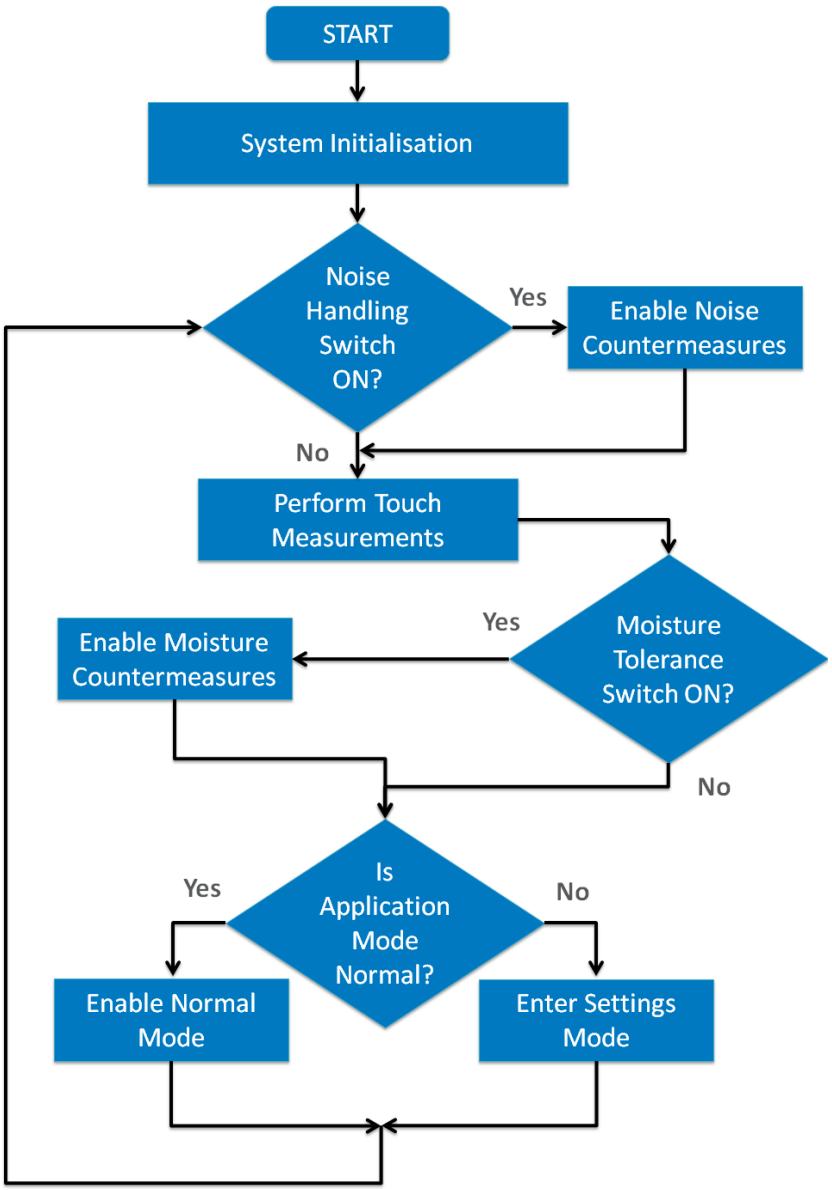
The LED for the Lock button will remain glowing to indicate the locked state of the touch panel. Touching the Lock button in lock state will release the lock and the LED will turn OFF.

Every valid touch to the button is accompanied by a beep.

9.3 Operating Modes of the Kit

9.3.1 Application Flow

Figure 9-2. Top Level Application Flowchart of the SAM D20 QTouch Robustness Demo Firmware



9.3.2 Normal Mode

In this mode all sensors are operational. Detect state of button and slider position is provided by the corresponding LEDs. For every valid touch there is a short beep.

This is the default mode of the touch panel.

9.3.3 Mode Change

To change the application mode, press and hold program buttons P3 and P4 for one second. This will change the mode to Settings mode if the current mode is Normal mode and vice versa.

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



There is a buzzer beep and LED activity for buttons P3 and P4 to indicate mode change. If Moisture Tolerance is enabled, it will appear that both LEDs blink for a moment along with the buzzer beep. If Moisture Tolerance is disabled, it will appear that both LEDs turn off after the buzzer beep.

9.3.4 Settings Mode

The Settings Mode allows adjustment of the audio visual impact of the kit. The kit provides feedback in form of LED glow and buzzer beep for a valid touch. This mode can be used for the following:

- Adjust the brightness of the LEDs for the mutual capacitance sensors
- Adjust the volume of the buzzer

9.3.4.1 LED Brightness Adjustment

Following are the steps to adjust the brightness of the LEDs for mutual-capacitance sensors.

Ensure that you are in Settings Mode

- Select the mutual capacitance button for which LED brightness is to be adjusted
- Adjust the required brightness level using the slider
- Save the LED brightness level by double tapping corresponding program button (P1 ~ P4)
- Press and hold program buttons P1 and P2 for one second. This restores LEDs to default brightness

Note: The LED brightness settings are saved temporarily in the RAM. A power cycle to the kit will restore the LED brightness to default settings.

9.3.4.2 Buzzer Volume Adjustment

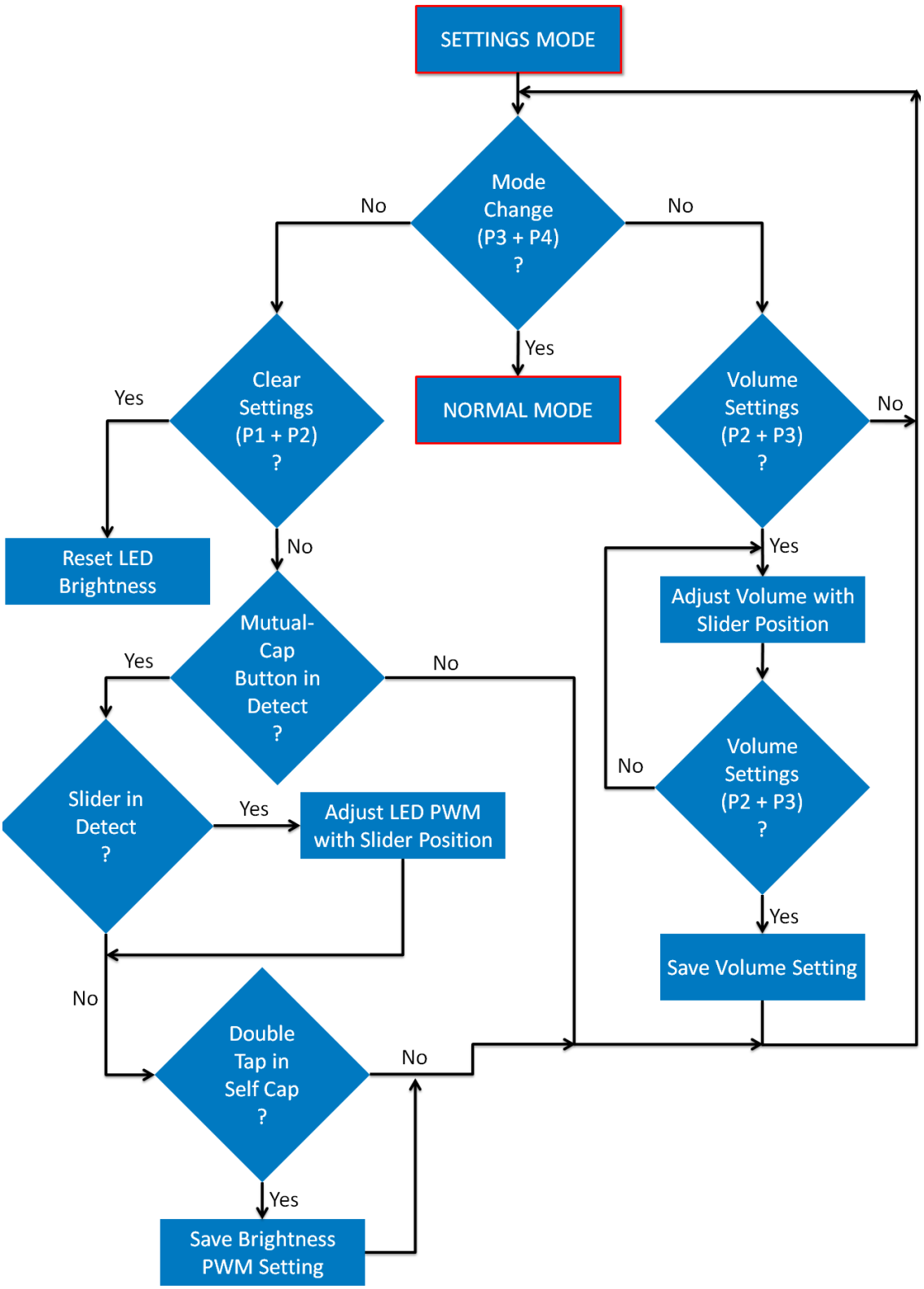
Following are the steps to adjust the volume of the buzzer.

Ensure that you are in Settings Mode

- Press and hold program buttons P2 and P3 for one second. A beep will indicate that you have entered into volume settings mode.
- The number of LEDs glowing on the slider indicates the current volume setting. Adjust the volume level using the slider. The buzzer sound is audible as long as the slider is touched.
- Press and hold program buttons P2 and P3 for one second. This will save the buzzer volume level.

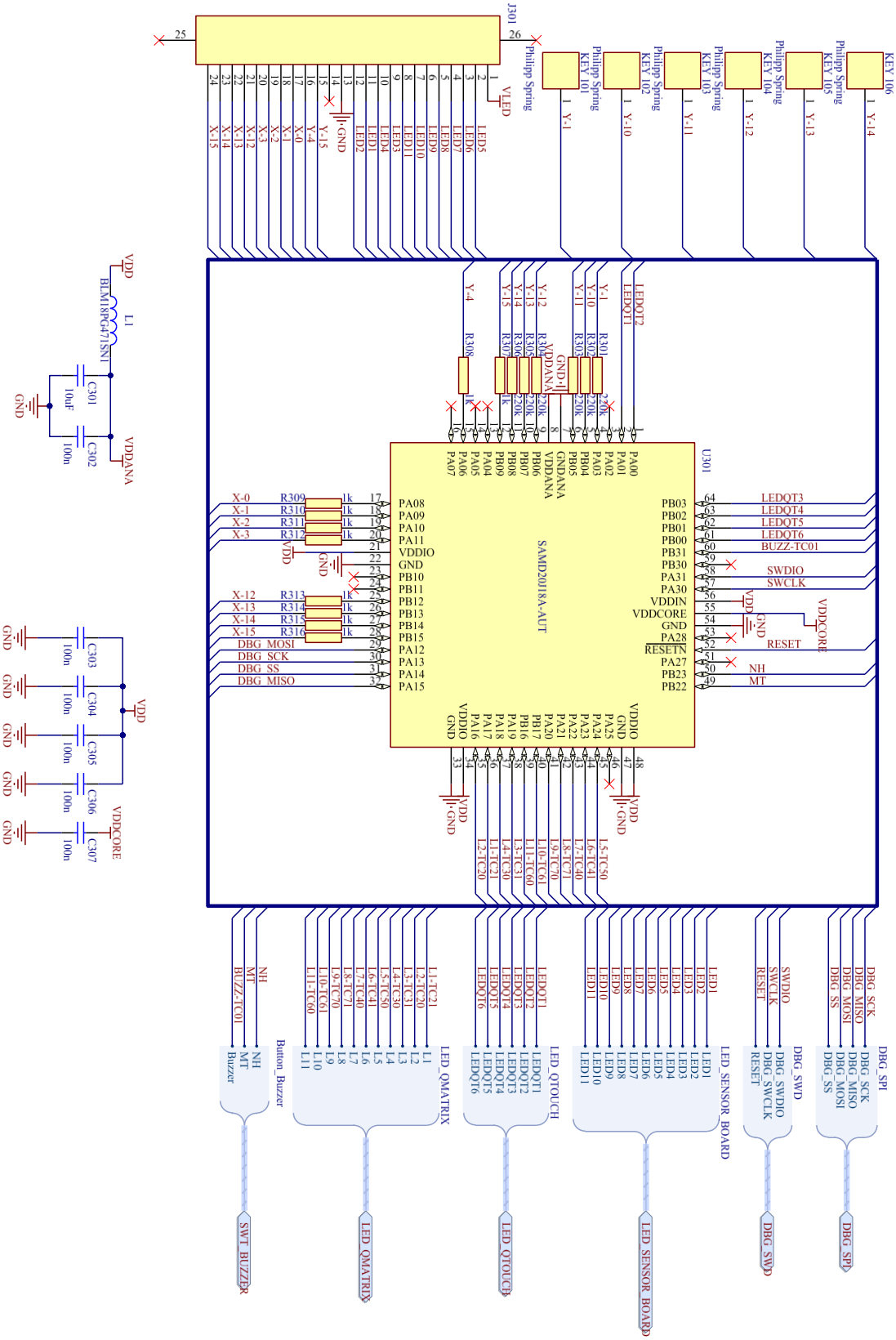
Note: The buzzer volume is saved into the NVM. The volume setting is retained in the memory even after power cycle. Buzzer volume is to be manually set; there is no provision for automatic reset of buzzer volume.

Figure 9-3. Application Flow for the Settings Mode

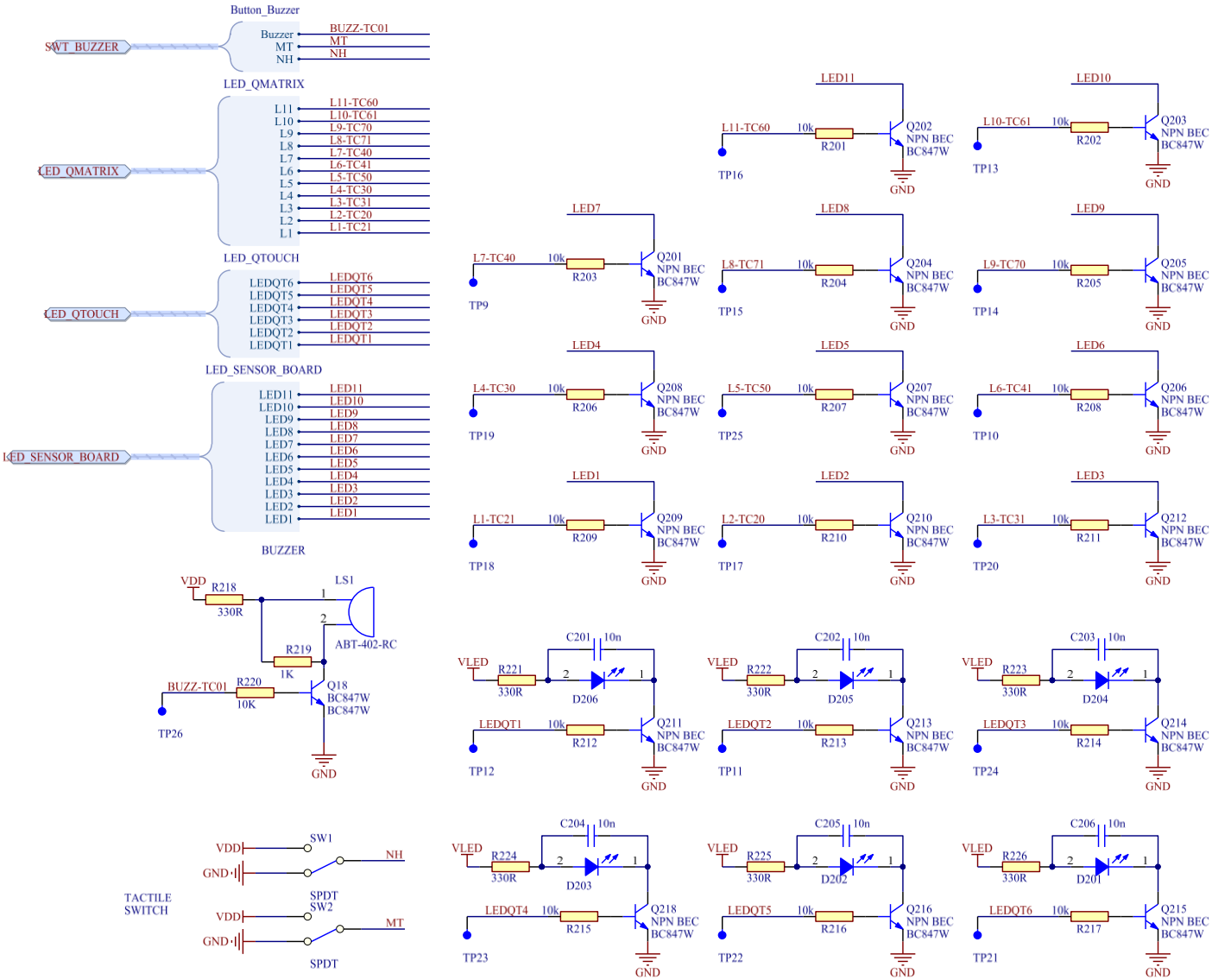


10 Schematic

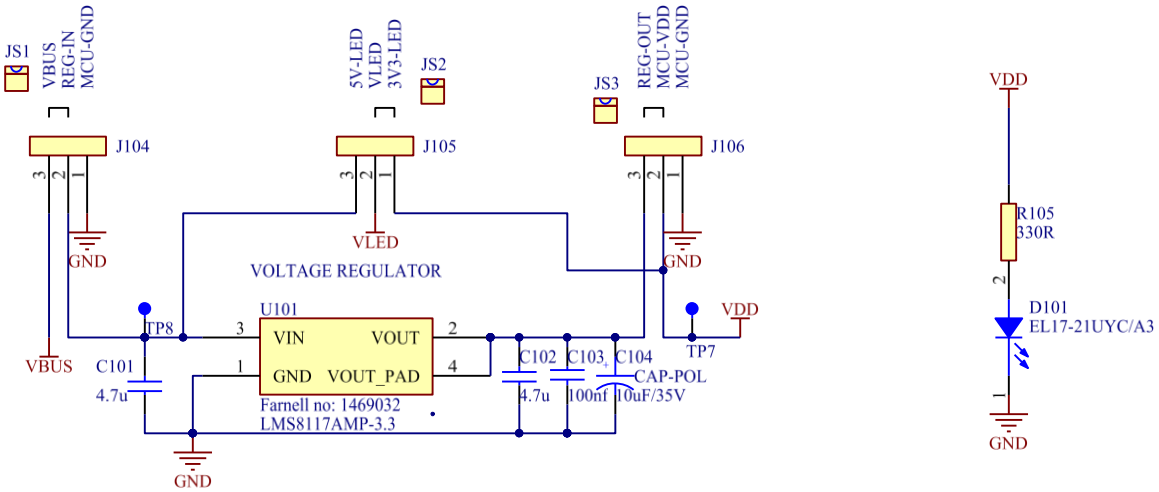
10.1 MCU and Sensor Configuration Section



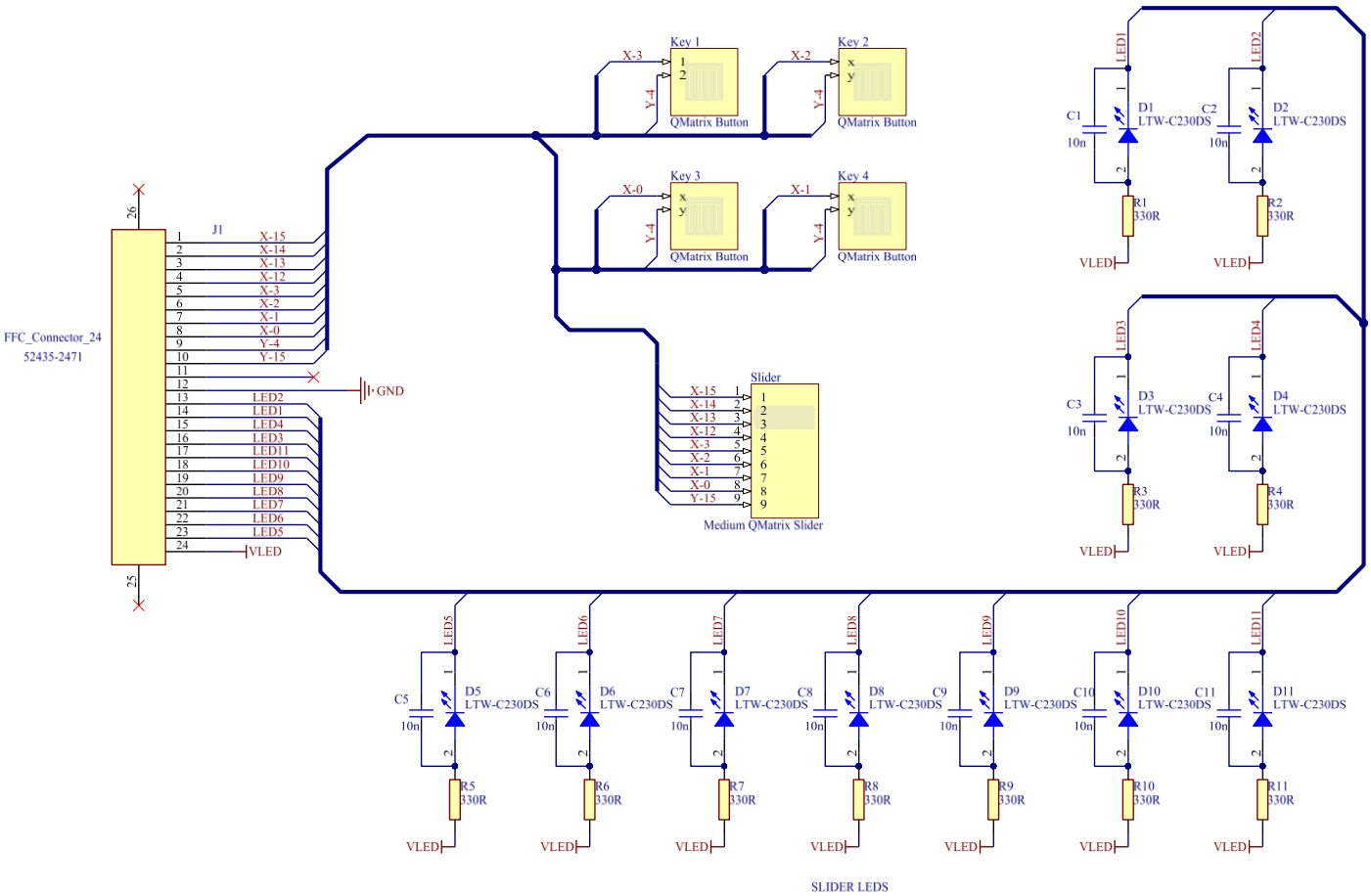
10.2 LED, Buzzer, and Switch Section



10.3 Power Supply Section

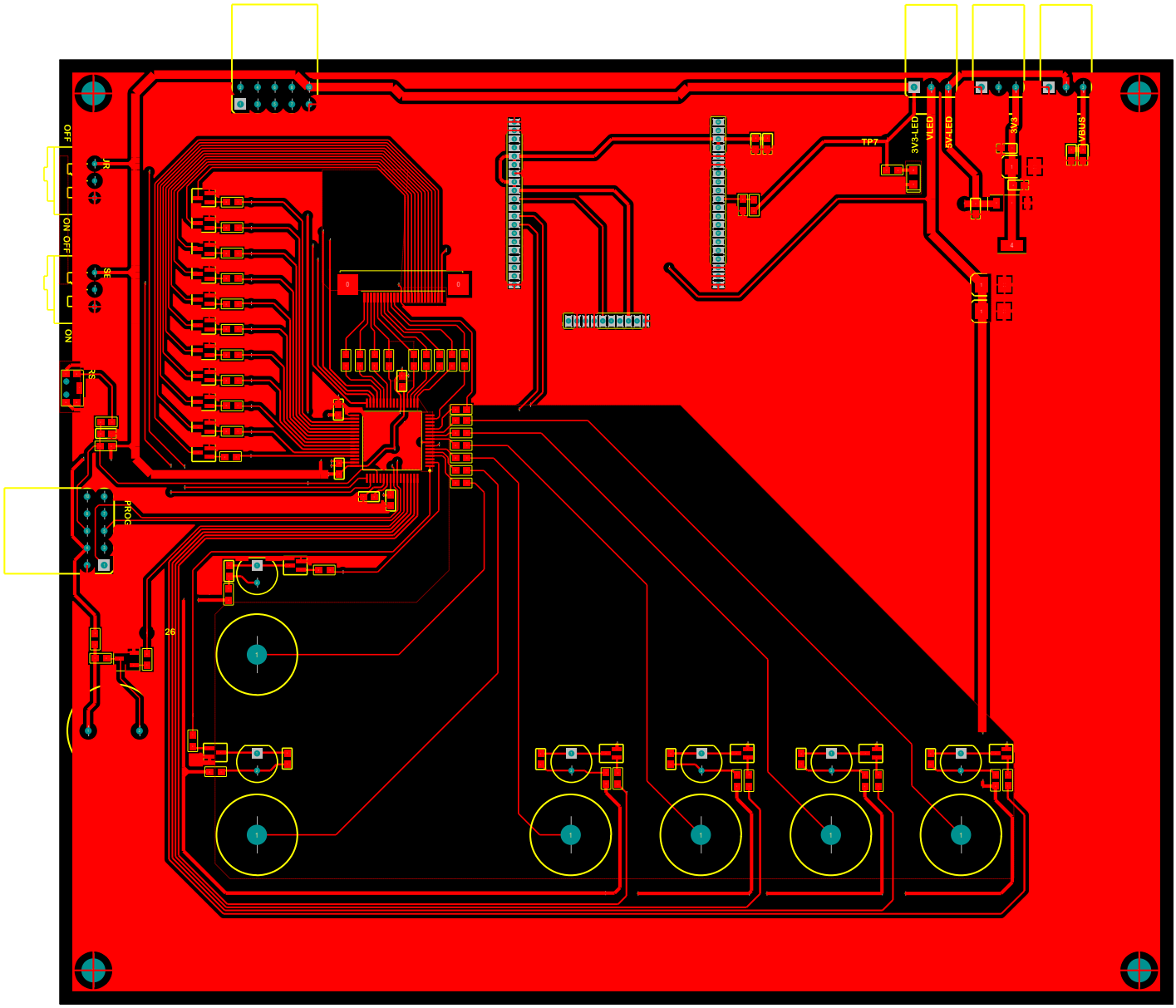


10.4 Sensor Board

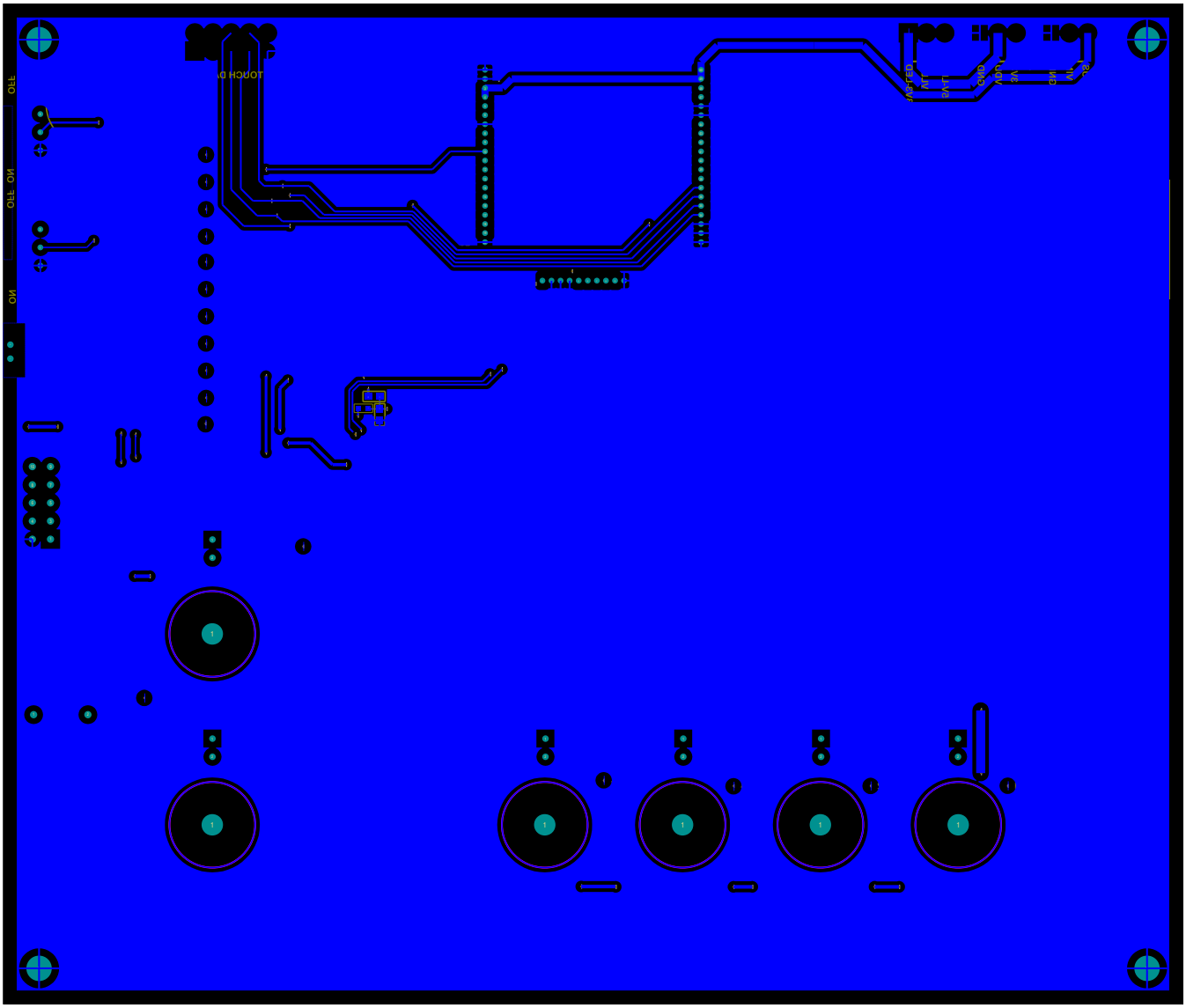


11 PCB Design

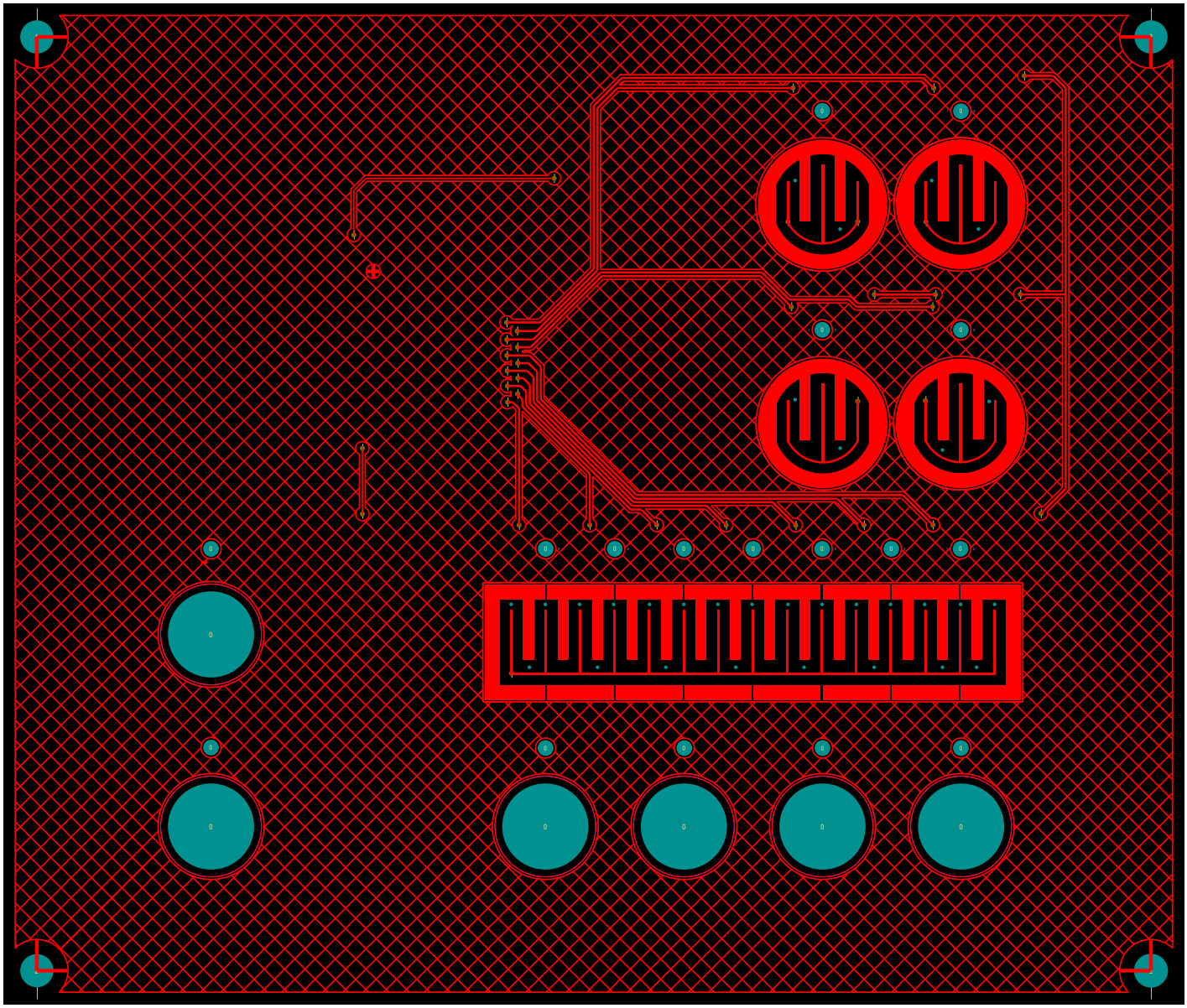
11.1 Main MCU PCB – Top Layer



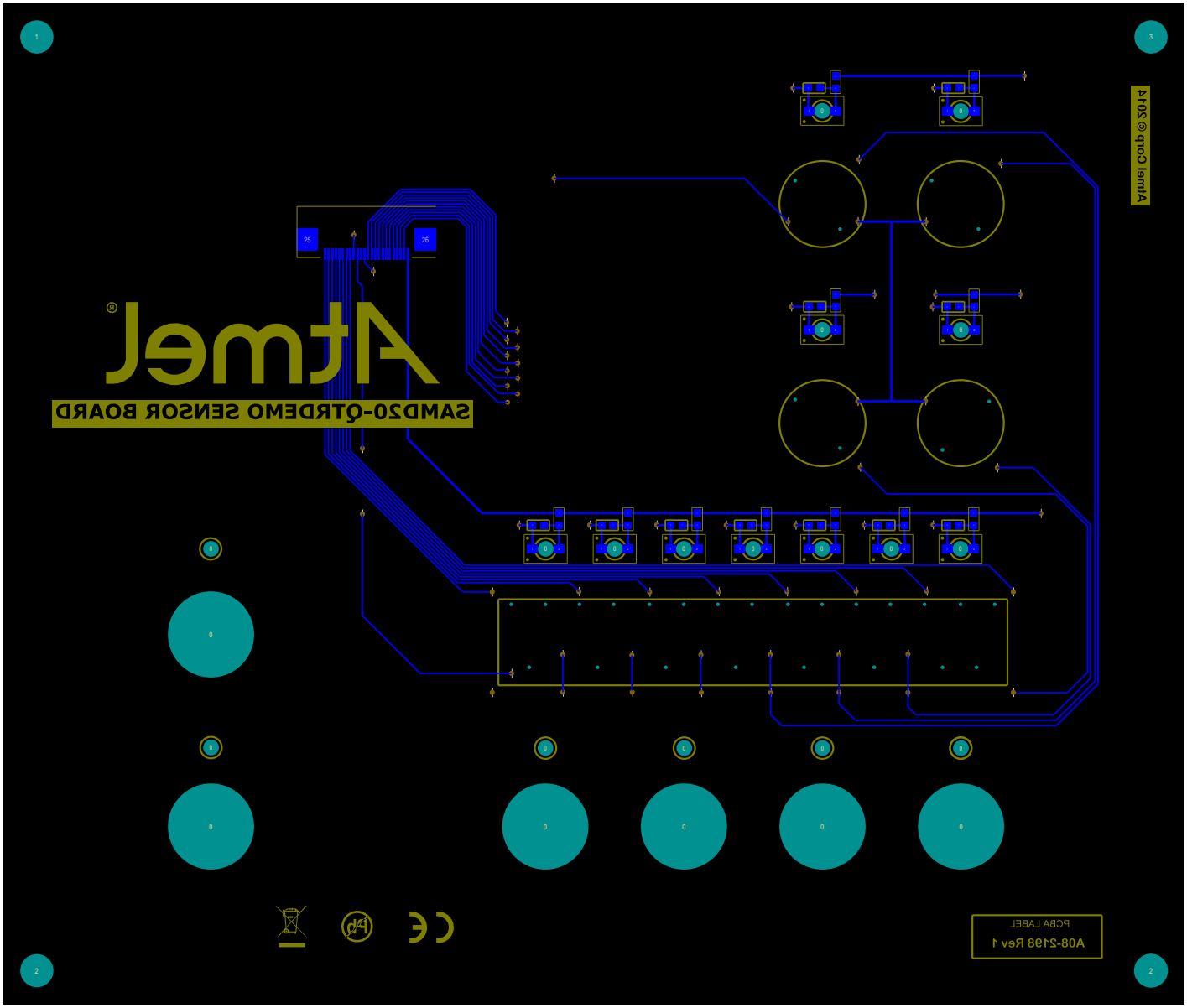
11.2 Main MCU PCB – Bottom Layer



11.3 Sensor PCB – Top Layer



11.4 Sensor PCB – Bottom Layer



12 Bill of Materials

Table 12-1. Top Level Bill of Materials

COMPONENT	QUANTITY
Acrylic Front Panel	1
SAM D20 QTouch Robustness Demo Main MCU Board – PCBA	1
SAM D20 QTouch Robustness Demo Main Sensor Board – PCBA	1
Atmel EDBG – PCBA	1
Flex Cable	1
Hex Standoff - 5mm M3	4
Screw M3	4
Washer	4
(Rubber Feet) Bump-on	4
3M Adhesive Sheet (3M767/768)	1

Table 12-2. Bill of Materials for the Sensor PCB

COMPONENT	VALUE	QUANTITY	DESIGNATOR
FCC Connector	Molex 52435-2471	1	Flex-Connector
SMD LED White	LTW-C230DS (703-1174)	11	D1, D2, D3, D4, D5, D6, D7, D8, D9, D10, D11
SMD Resistor 0603	330R	11	R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11
SMD Capacitor 0603	10nF	11	C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11
Broaching Sockets	KFE-M3-4ET	4	

Table 12-3. Bill of Materials for the Main MCU PCB

COMPONENT	VALUE	QUANTITY	DESIGNATOR
ROBUSTNESS DEMO SPRING	AIREDALE(15020-B)	6	KEY 101, KEY 102, KEY 103, KEY 104, KEY 105, KEY 106
Jumper	SNT-100-BK-G	3	JS1, JS2, JS3
FCC Connector	Molex 52435-2471	1	J301
Right Angle Header 1x3	STL1-1470ATT-003	3	J104, J105, J106
Right Angle Header 2x5	TSW-105-08-F-D-NA	1	J102
Voltage Regulator	LMS8117AMP-3.3/NOPB	1	U101
SMT Side Actuator	KMS223GPLFG	1	SW101
Slide Switch	EAO 09.10201.02	2	SW1, SW2
MCU	SAMD20J18A-AU	1	U301
Buzzer	ABT-402-RC	1	LS1
SMD Inductor	BLM18PG471SN1	1	L1

COMPONENT	VALUE	QUANTITY	DESIGNATOR
SMD BJT Transistor	BC847	18	Q18, Q201, Q202, Q203, Q204, Q205, Q206, Q207, Q208, Q209, Q210, Q211, Q212, Q213, Q214, Q215, Q216, Q218
SMD Capacitor 0603	100nF	7	C111, C302, C303, C304, C305, C306, C307
SMD Capacitor 0603	10nF	6	C201, C202, C203, C204, C205, C206
SMD Capacitor 0805	4.7µF	2	C101, C102
SMD Capacitor 0603	10µF	1	C301
SMD Resistor 0603	1k	12	R101, R102, R307, R308, R309, R310, R311, R312, R313, R314, R315, R316
SMD Resistor 1206	1k	1	R219
SMD Resistor 0603	10k	18	R201, R202, R203, R204, R205, R206, R207, R208, R209, R210, R211, R212, R213, R214, R215, R216, R217, R220
SMD Resistor 0603	4.7k	1	R103
SMD Resistor 0603	220k	6	R301, R302, R303, R304, R305, R306
SMD Resistor 0603	330R	8	R104, R105, R221, R222, R223, R224, R225, R226
5mm White LED_TH	C513A-WSS-CV0Y0151	6	D201, D202, D203, D204, D205, D206
Yellow SMD LED_0805	EL17-21UYC/A3	1	D101

13 References

The following documents can be used as reference for better understanding of the technology:

[1] Peripheral Touch Controller - User Guide.

[2] Atmel Embedded Debugger – User Guide.

[3] QTAN0079 – Buttons, Sliders, and Wheels Sensor Design Guide.

14 Revision History

Doc Rev.	Date	Comments
42324A	10/2014	Initial document release.







Atmel Corporation 1600 Technology Drive, San Jose, CA 95110 USA **T:** (+1)(408) 441.0311 **F:** (+1)(408) 436.4200 | **www.atmel.com**

© 2014 Atmel Corporation. / Rev.: Atmel-42324A-SAM-D20-QTouch-Robustness-Demo_UserGuide_102014.

Atmel®, Atmel logo and combinations thereof, Enabling Unlimited Possibilities®, QTouch®, and others are registered trademarks or trademarks of Atmel Corporation in U.S. and other countries. Other terms and product names may be trademarks of others.

DISCLAIMER: The information in this document is provided in connection with Atmel products. No license, express or implied, by estoppel or otherwise, to any intellectual property right is granted by this document or in connection with the sale of Atmel products. EXCEPT AS SET FORTH IN THE ATMEL TERMS AND CONDITIONS OF SALES LOCATED ON THE ATMEL WEBSITE, ATMEL ASSUMES NO LIABILITY WHATSOEVER AND DISCLAIMS ANY EXPRESS, IMPLIED OR STATUTORY WARRANTY RELATING TO ITS PRODUCTS INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT. IN NO EVENT SHALL ATMEL BE LIABLE FOR ANY DIRECT, INDIRECT, CONSEQUENTIAL, PUNITIVE, SPECIAL OR INCIDENTAL DAMAGES (INCLUDING, WITHOUT LIMITATION, DAMAGES FOR LOSS AND PROFITS, BUSINESS INTERRUPTION, OR LOSS OF INFORMATION) ARISING OUT OF THE USE OR INABILITY TO USE THIS DOCUMENT, EVEN IF ATMEL HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. Atmel makes no representations or warranties with respect to the accuracy or completeness of the contents of this document and reserves the right to make changes to specifications and products descriptions at any time without notice. Atmel does not make any commitment to update the information contained herein. Unless specifically provided otherwise, Atmel products are not suitable for, and shall not be used in, automotive applications. Atmel products are not intended, authorized, or warranted for use as components in applications intended to support or sustain life.

SAFETY-CRITICAL, MILITARY, AND AUTOMOTIVE APPLICATIONS DISCLAIMER: Atmel products are not designed for and will not be used in connection with any applications where the failure of such products would reasonably be expected to result in significant personal injury or death (“Safety-Critical Applications”) without an Atmel officer's specific written consent. Safety-Critical Applications include, without limitation, life support devices and systems, equipment or systems for the operation of nuclear facilities and weapons systems. Atmel products are not designed nor intended for use in military or aerospace applications or environments unless specifically designated by Atmel as military-grade. Atmel products are not designed nor intended for use in automotive applications unless specifically designated by Atmel as automotive-grade.