SX9306 Evaluation Kit

User's Guide

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1 Introduction

The purpose of this User Guide is to describe the usage of the evaluation platform for the SX9306. The figures presented in this document are based on the SX9306EVKA board, the GUI and the firmware.
The GUI requires a PC running Windows XP/Vista/7 with at least one USB available for connecting to the EVK.

1.1 *SX9306 Main Features*

- 2.7 – 5.5V Input Supply Voltage
- Up to 4 Capacitive Sensor Inputs
    - Patent Pending On-Chip Smart Engine for Human Detection and Advanced SAR Control
    - High Resolution Capacitive Sensing down to 0.08fF
    - Capacitance Offset Compensation up to 30pF
    - Configurable Proximity Detection (single/combined)
    - Integrated High Performance RF Shield for Enhanced Noise Immunity
    - Extremely Low Temperature Drift for Stable Measurement
    - Reduced VDD Ripple Susceptibility
- Active Sensor Guarding
- Automatic Calibration
- Ultra Low Power Consumption:
    - Active Mode: 170 uA
    - Doze Mode: 18 uA
    - Sleep Mode: 2.5 uA
- 400kHz I2C Serial Interface
    - Four programmable I2C Sub-Addresses
    - Input Levels Compatible with 1.8V Host Processors
- Open Drain NIRQ Interrupt pin
- Up to Three Reset Sources: POR, Soft Reset, NRST
- -40°C to +85°C Operation
- 1.617x1.217 mm WLCSP or 3x3mm Thin QFN package
- QFN version pin-to-pin compatible with SX9300/SX9500
- Pb & Halogen Free, RoHS/WEEE compliant

1.2 Getting Started

1.2.1 Kit Contents

The SX9306 Evaluation kit consists of:

- SX9306EVKA board
- SX9306EVKA CDROM including all necessary PC software and documentation (requires min Windows XP)
- Mini USB cable to connect the SX9306EVKA board to the PC

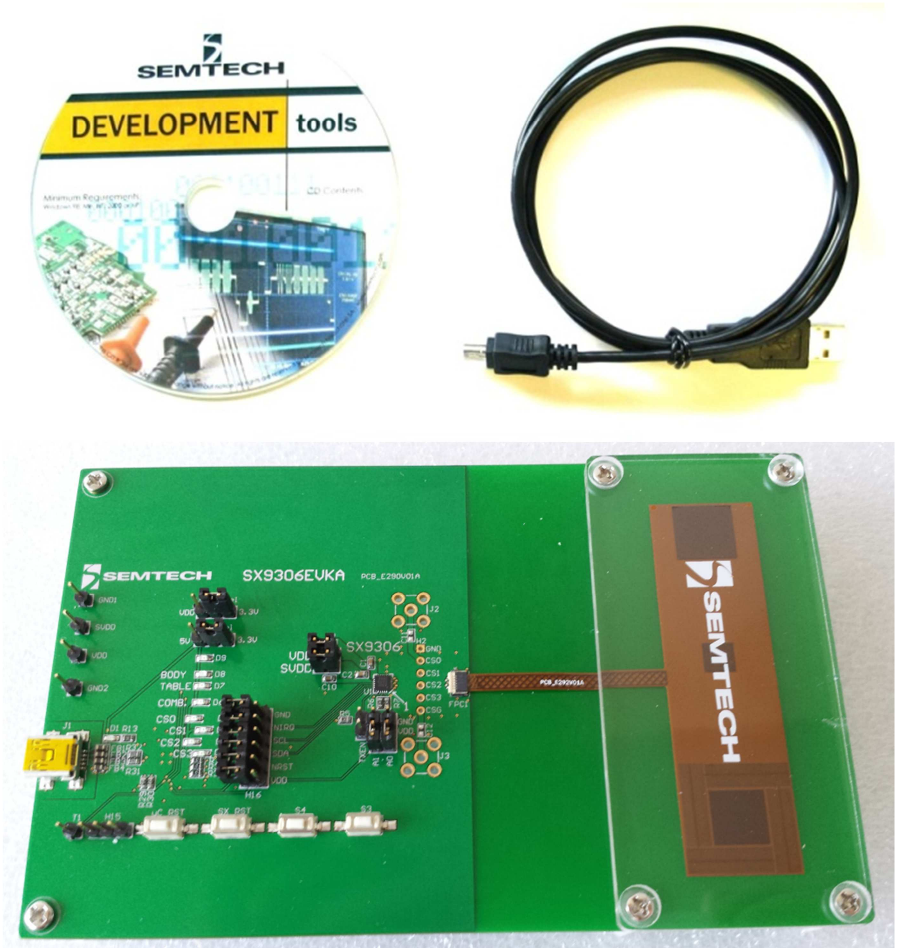


Figure 1 SX9306EVKA Contents

1.2.2 Installation

1.2.2.1 Stand-Alone Demo

1- Connect the SX9306EVKA board to a USB port/supply via the cable provided.
2- Wait for a few seconds.
3- SX9306EVKA is now ready to be used!

1.2.2.2 PC Software

1. Run the “SX9306EvaluationKit Setup.exe” file contained in the included CDROM.
2. After installation is completed, connect the SX9306EVKA board to the PC via the mini USB cable.

3. Launch "Semtech->SX9306Evaluation->SX9306Evaluation" from Start menu.
4. The SX9306EVKA and GUI are now ready to use!

1.2.2.3 Hardware

The EVK's jumpers are setup to work out of the box. Simply connect the EVK using the USB cable and start the GUI on the PC.

2 Hardware Description

The SX9306EVKA is described in this chapter. Full schematics and layout are provided at the end of this document for additional reference.

2.1 Overview

The following pictures show an overview of the SX9306EVKA's Top. The SX9306 is soldered on the top side of the PCB and the microcontroller is soldered on the bottom side of the PCB.

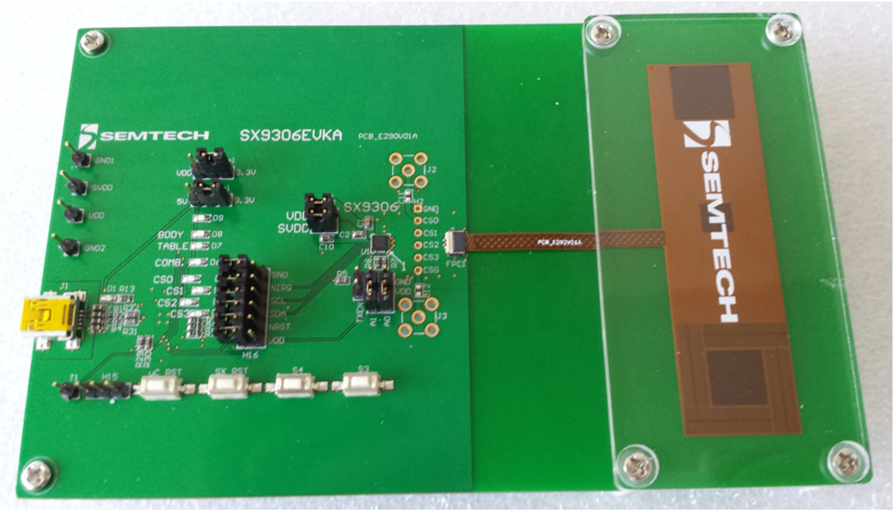


Figure 2 SX9306EVKA BOARD PICTURE (TOP)

2.2 USB Connector

The USB connector provides the power to the EVK and the communication to the GUI for evaluation. J1 is the USB connector which is located on the lower left edge of the PCB.

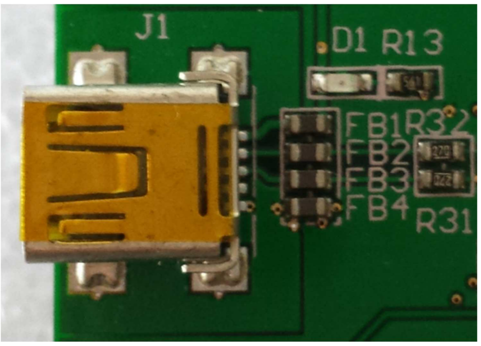


Figure 3 USB connector on Left side

2.3 Microcontroller (µC)

The microcontroller (C8051F387) implements the firmware that provides the USB communication to the SX9306 (through I2C) and drives the associated LEDs.

2.4 LEDs

1. D1, on the left side is the Power LED. When the EVK is connected to USB port of a computer, this LED is ON.
2. D2 to D8 LEDs are controlled by the microcontroller. They show the status of the touch/proximity bits in register 0x01, RegStat. When Bit 7 goes high, D2 is turned on, Bit 6 will turn on D3, Bit 5 will turn on D4 and Bit 4 will turn on D5. When the smart SAR engine is enabled, D7 is turned on if the table is detected. D8 is turned on if the body is detected. When the combined mode is enabled, D6 is turned on if proximity is detected.
3. All other LEDs are reserved for future use.

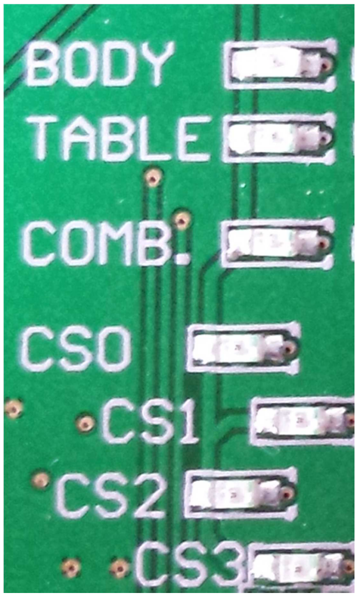


Figure 4 Proximity/Touch LEDs on EVK

2.5 Sensors FPC and Jumpers

2.5.1 Sensors FPC

There are two individual sensors (CS0, CS1) and a pair of sensors for the smart SAR engine (CS2/CS3):

Figure 5 Sensors FPC

2.5.2 Power Supply Jumpers

VDD and SVDD can be utilized in two ways. The first way (default method) is to use the power from the USB connection. The second way is to use an external power supply.

2.5.2.1 Power from the USB

VDD Sel and SVDD Sel jumpers are used to select the on board voltage sources. If VDD Sel is connected on the left (as shown in the picture), VDD of the chip is 5 volts or if it is on the right side then VDD is 3.3 volt.
SVDD Sel determines the SVDD voltage. SVDD can be 3.3 volt or a voltage that is selected on VDD by jumper (VDD Sel). The orange and yellow on the right side of the picture disconnect the VDD or SVDD supplies once they are removed.

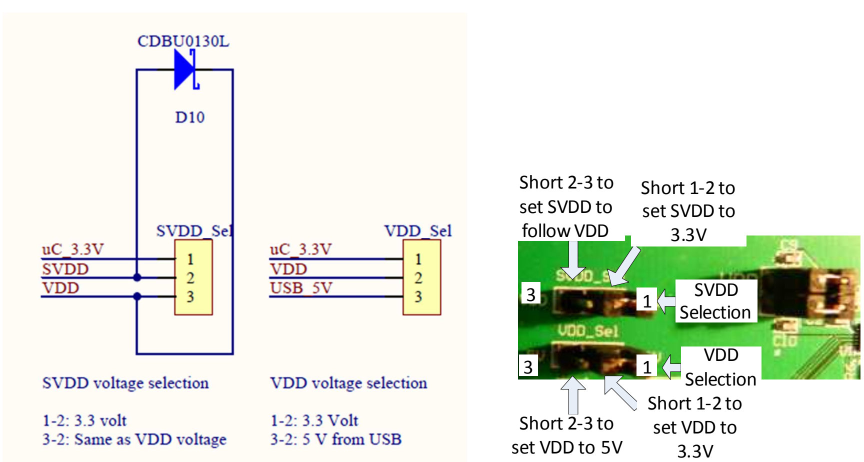


Figure 6 Power supply Jumpers

2.5.2.2 Power from External Power Supply

In order to connect the board to external supplies, you MUST first remove both jumpers VDD Sel and SVDD Sel and then connect external supply to the chip. It may cause permanent damage to the board if these jumpers are in and external supplies are connected. Diode D10 (picture above) in EVK circuit is used for protection as SVDD cannot be higher than VDD. It should be noted that even though an external supply is used for the SX9306, a USB cable is still needed for powering and communicating with the microcontroller. Note, SCL and SDA have MOSFETS for level shifting since the microcontroller's I/Os work off of the USB 5V line. In order to avoid communication issues, please keep SVDD to at most the 5V level from the USB.

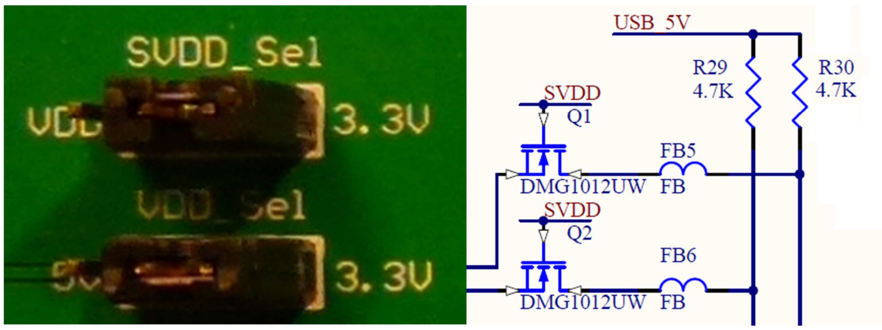


Figure 7 External supply pins

2.5.3 Microcontroller to SX9306 header and jumper

There are four jumpers needed for communications between the microcontroller and the SX9306.

1- NIRQ connection is for microcontroller operation based on interrupt services.
2- SCL - I2C clock, normally input on SX9306 side and output on microcontroller side.
3- SDA, Bidirectional Data serial link between SX9306 and microcontroller.
4- NRST - Reset line to SX9306.
   This jumper connects this link from microcontroller on left side to SX9306 on right side as shown in the figure below.

There are VDD and GND provided on this header. Two pins labeled GND are internally connected together. Same is true for two other pins labeled VDD that are connected together internally. This is shown by two red circles on left picture.

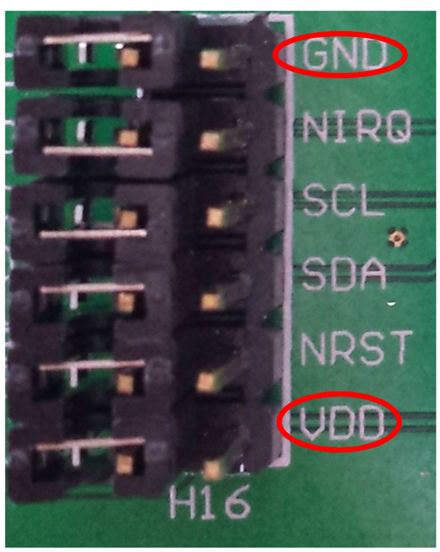


Figure 8 Direct Connect Jumpers

2.5.4 A1, A0 and TXEN jumpers

A1 and A0 can be individually connected to high or low through the jumpers as shown in the figure below to either voltage levels. The default values set in the EVK's GUI and firmware for addressing the device is A1 = A0 = High (or "1" or "VDD").
TX_EN jumper is used to set TXEN low to pause cap sensing. For normal operation, the jumper must be removed so that cap sensing can occur.

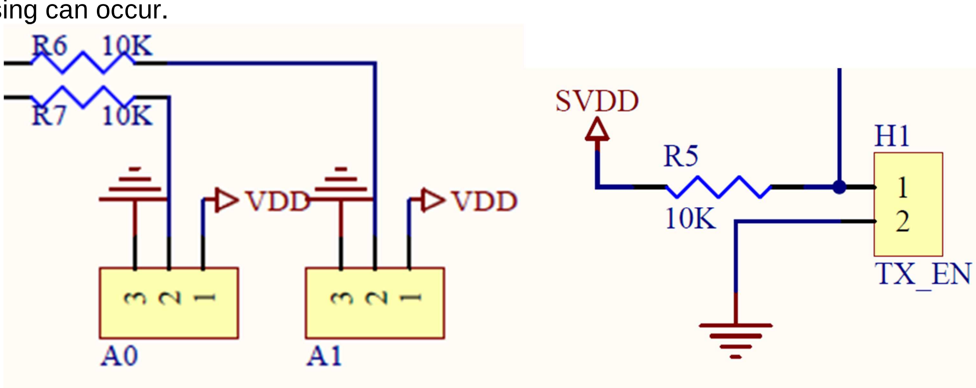


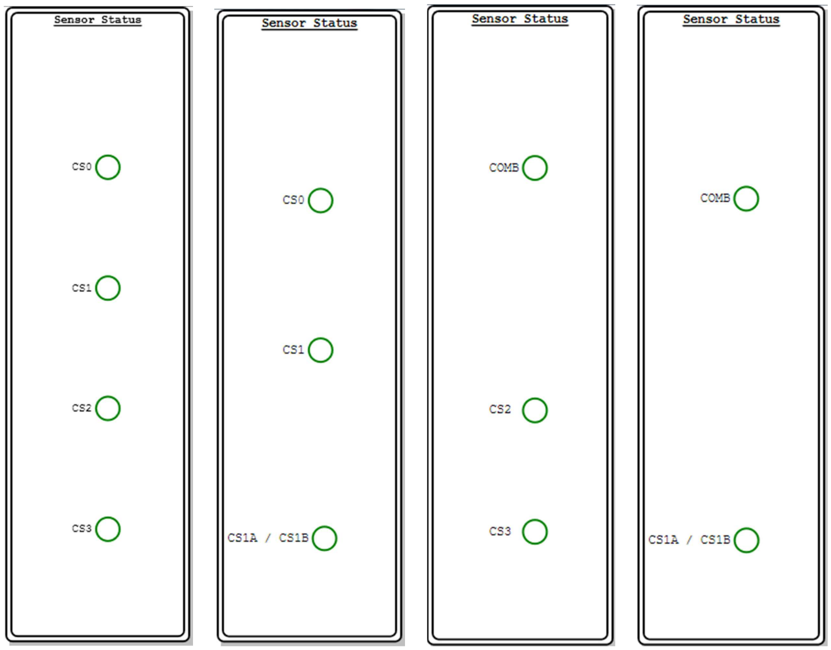
Figure 9 A1, A0 and TXEN jumper

3 Graphical User Interface (GUI)

There are four main areas on the GUI.

1. Right hand side (Sensor Status) which is a feedback for touch or proximity detection.
2. Left hand side shows the raw registers
3. Middle section contains the main configuration area where the registers are broken up to a more visual format and an area for graphs to display raw cap sensing data.
4. Status Area provides a way to get general status items along with other various items.

3.1 Sensor Status



a- b- c- d-

Figure 10 Sensor Status

a- Combined mode OFF, Smart SAR engine OFF
b- Combined mode OFF, Smart SAR engine ON
c- Combined mode ON, Smart SAR engine OFF
d- Combined mode ON, Smart SAR engine ON

Here, CS (Cap Sensor) is labeled as Channel so we have CS0 being Channel 0, CS1 being Channel 1, and so on. When a touch is detected, the corresponding channel is set to green. When the smart SAR engine is enabled, when a body or a table is detected, the corresponding image appears next to the smart SAR indicator. When the combined mode is enabled, the corresponding channel appears as a single sensor labelled "COMB".

If the smart SAR engine is enabled, there are 2 possible statuses. When human body is detected:

Figure 11 Smart SAR engine status – human body detected

When a table is detected:

Figure 12 Smart SAR engine status – human body detected

3.2 Registers

The Registers section allows reading and writing to the registers directly. Registers are either read only or read/write capable which is shown by the "Read" and "Write" buttons on the Access column. To write to a register that is read/write capable, you should double click of the data area of the same register and type your desired value of that register. After the data has been entered in (press enter or click elsewhere on the screen to accept the change), the text color will turn to red to indicate that it has not yet been written to the device. When you click on "Write", the value will go back to black to indicate it has been written to the device. Reading a register works similar in that when clicking the "Read" button, the register's data will be updated.

Name	Address	Data	Access
Interrupt and Status			
RegIrqSrc	0x00	0x01	Write Read
RegStat	0x01	0x00	Read
RegIrqMsk	0x03	0x60	Write Read
Proximity Sensing Control			
RegProxCtrl0	0x06	0x0D	Write Read
RegProxCtrl1	0x07	0x40	Write Read
RegProxCtrl2	0x08	0x47	Write Read
RegProxCtrl3	0x09	0x01	Write Read
RegProxCtrl4	0x0A	0x40	Write Read
RegProxCtrl5	0x0B	0x0F	Write Read
RegProxCtrl6	0x0C	0x04	Write Read
RegProxCtrl7	0x0D	0x00	Write Read
RegProxCtrl8	0x0E	0x00	Write Read
Smart SAR Engine Control			
RegSarCtrl0	0x0F	0xC0	Write Read
RegSarCtrl1	0x10	0xA0	Write Read
Sensor Data Readback			
RegSensorSel	0x20	0x00	Write Read
RegUseMsb	0x21	0x00	Read
RegUseLsb	0x22	0x7E	Read
RegAvgMsb	0x23	0x00	Read
RegAvgLsb	0x24	0x6A	Read
RegDiffMsb	0x25	0x00	Read
RegDiffLsb	0x26	0x01	Read
RegOffsetMsb	0x27	0x03	Write Read
RegOffsetLsb	0x28	0xE7	Write Read
RegSarDelta	0x29	0x00	Read
RegSarRatio	0x2A	0x00	Read
Software Reset			
RegReset	0x7F	0xDE	Write

Figure 13 Register Area

3.3 *Cap Sensing Settings*

The scope of this paragraph is to describe the different parameters that can be changed by the user during evaluation. We recommend forcing a manual compensation of the sensors offset after changing one of these parameters:

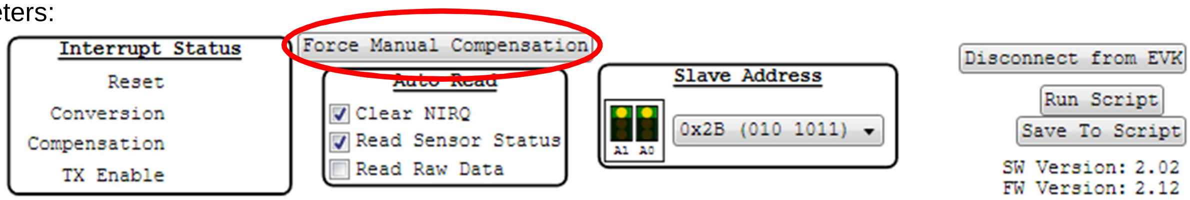


Figure 14 Force Manual Compensation

3.3.1 Analog Block

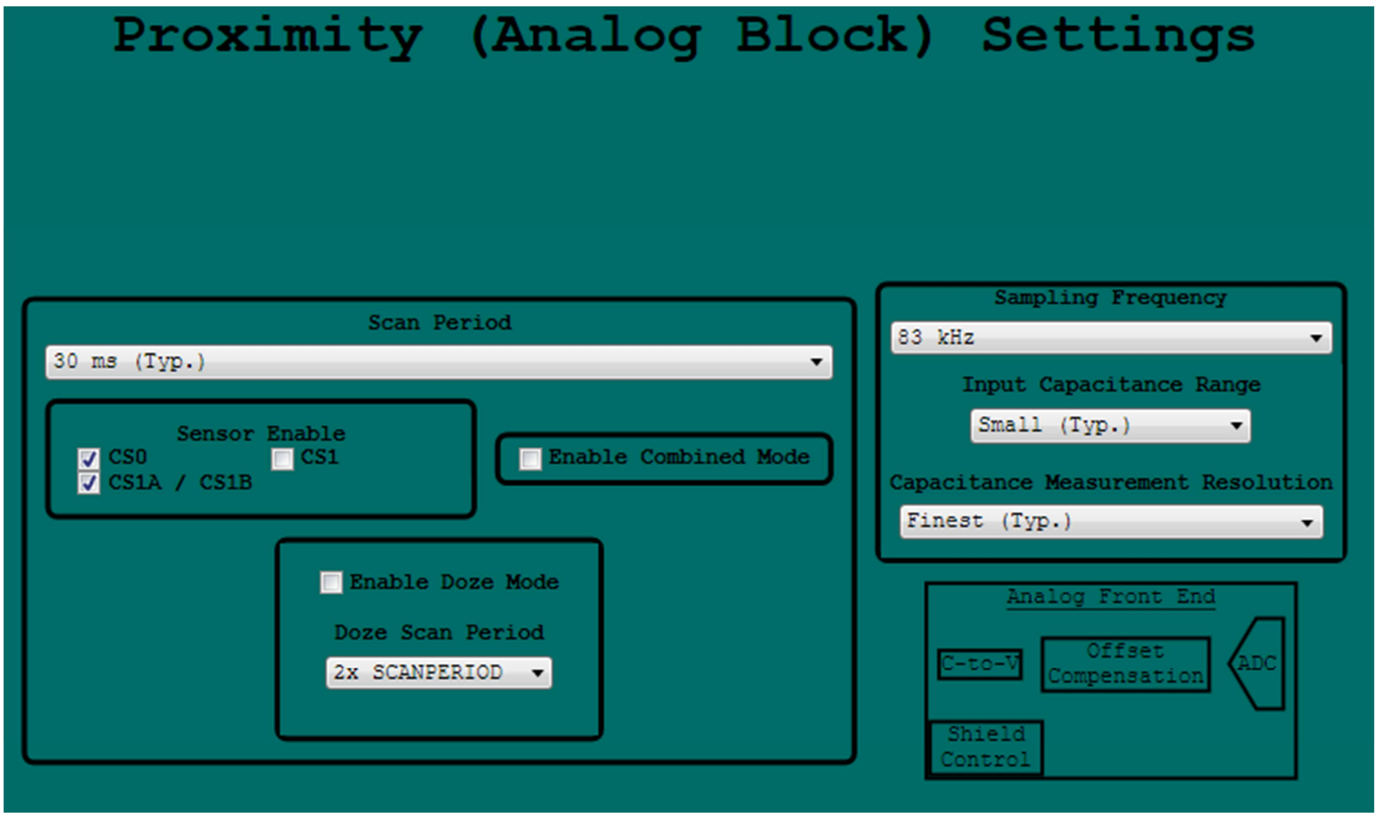


Figure 15 PROXIMITY (ANALOG) SECTION

The Analog settings can be changed here. In this section you can

1- Set Scan period to be from 30ms to 300 ms.
2- Turn On or Off the Cap sensors.
3- Sampling Frequency can be fixed at 167kHz(Typical value), 125kHz or 83kHz.
4- Set Input Capacitance Range between Large to Small(Typical value).
5- Set Capacitance Measurement Resolution between Coarsest to Finest(Typical value).
6- Enable the doze mode with different doze scan period
7- Enable the combined mode

3.3.2 Digital Block

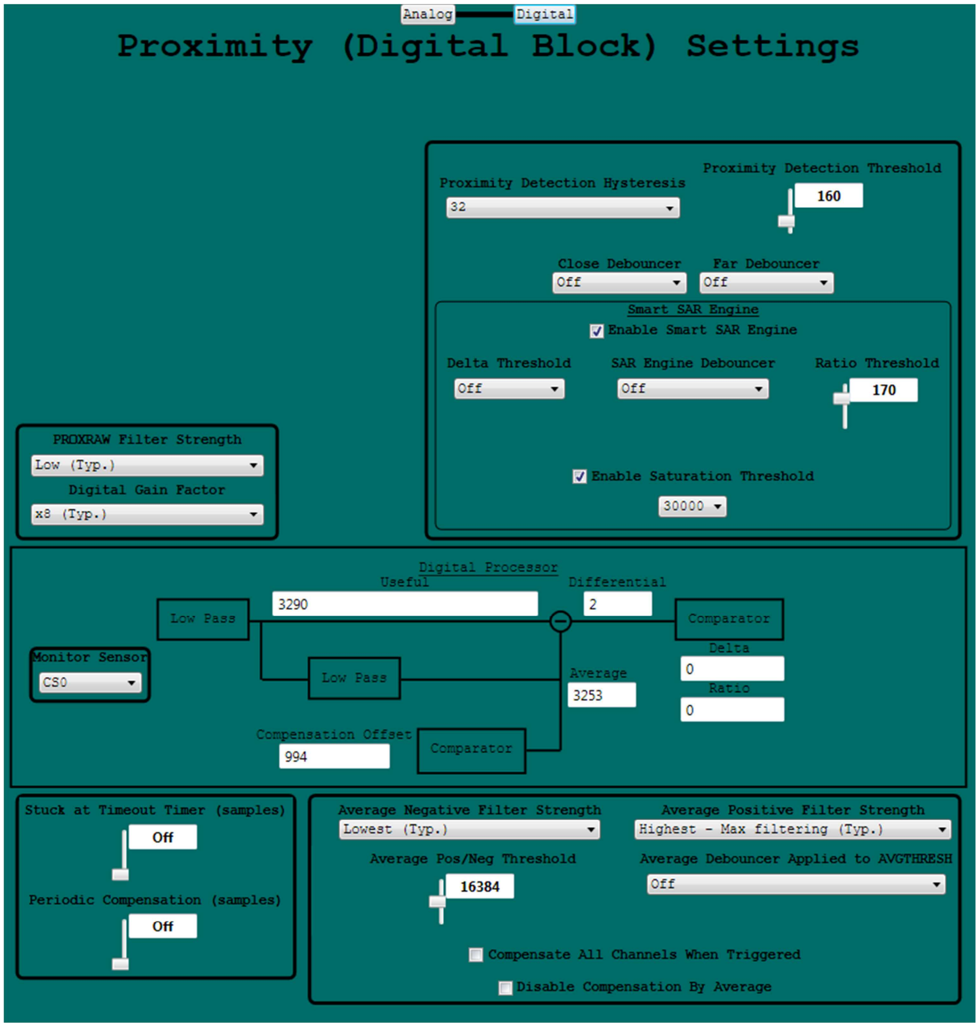


Figure 16 PROXIMITY (DIGITAL) Section

In the digital section, you can set the following variables:

1- Proximity Detection Hysteresis
2- Proximity Detection Threshold
3- Far and Close Debounce
4- Smart SAR engine options
   a. Enable smart SAR engine
   b. Delta threshold
   c. Ratio threshold
   d. SAR Engine Debouncer
   e. Saturation threshold
5- PROXRAW filter Strength
6- Digital Gain Factor
7- You can select the sensor and monitor the data in the digital processor box
8- Setup for Periodic, Stuck, Average, and Compensate all settings
9- Negative and positive threshold and debounce values.

3.4 Graph

In this section, we are able to graph the sensor data

a) Average
b) Useful
c) Differential
d) Useful/Average

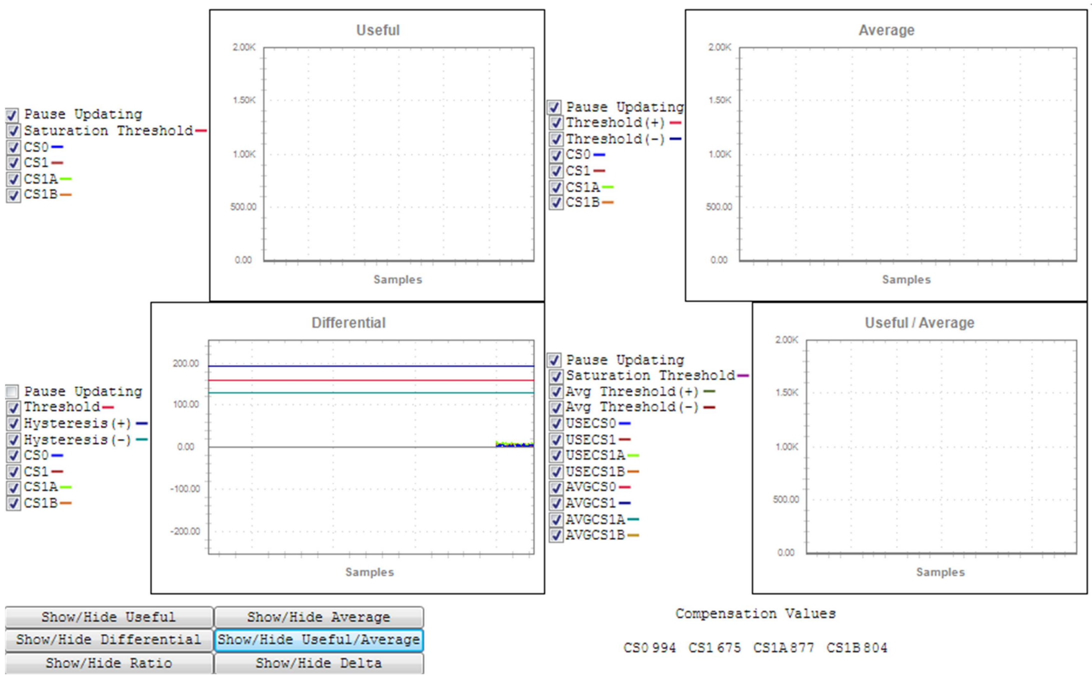


Figure 17 GUI screen in Graphs

Data graphs allow observing the progress of the proximity sensing's parameters in real time. Each graph has the ability to hide individual sensors from being displayed. Note that all sensors can be displayed, as well as the programmed thresholds. Right clicking on the graph provides other options such as the ability to zoom in.

3.5 Status Area

The status area provides a way to view various status items and controls. The Interrupt Status box shows other interruptible items other than the sensor status. The Auto Read box allows programming the microcontroller's firmware to automatically clear events. "Clear NIRQ", for example, allows handling the NIRQ event. When you click on the "Run Script", a windows dialog box will open and asks for the name and location of script file. "Save To Script" provides a way to save the current registers to a script that can be loaded by "Run Script" for later use. If "Disconnect from EVK" button is clicked, GUI will disconnect from the EVK and change the button to display "Connect to EVK". "Force Manual Compensation" allows a way to force a manual compensation. If "Read Raw Data" is enabled, GUI will display Graphs (cf Graphs Tab Section).

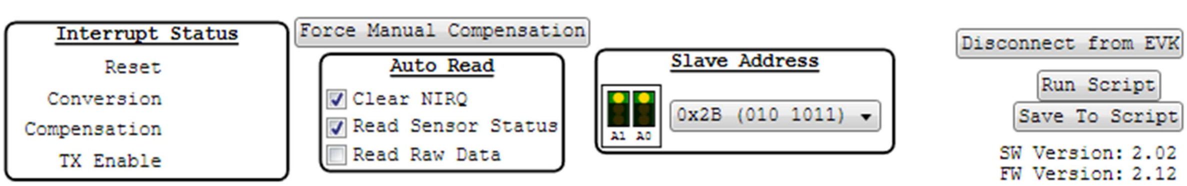


Figure 18 Script buttons

4 Scripts

4.1 Introduction to Scripting

The GUI provides a way to automate tasks by implementing a script language. Scripts are run by using the "Run Script" button. A startup script is also used to initialize registers to a default working setup once the EVK is connected. This script is described more in detail later in this document. It can be used as a reference.

4.2 Scripting Language

The following sections describe briefly some common functions that can be used in the scripting language.

4.2.1 Necessary Header information

The very first line must only contain the string "-3-" without any quotes. This tells the scripting language that it is a version 3 script.

```
-3-


```

Figure 19 Header Information

4.2.2 Variables

Variables are defined when a "$" (without the quotes) prefixes a string. The scripting language will automatically decode the type used so there is no need to specify a type. The following pictures show a variable called $test being assigned a value of 4.

```
$test = 4;

```

Figure 20 Variables

4.2.3 Register Write and Reads

The device uses an object oriented like method for the register access. First, the EVK BASE device is written, then i2c signifying it is for i2c and then write or read. The write command consists of an address and value to set. The read command consists of an address and a variable of where to save the value. Variables can be used for address or setting the register if needed.

```
sx9306evk.i2c.write(0x09,0x01);
sx9306evk.i2c.read(0x0A,$test);
```

Figure 21 Register Write and Reads Commands

4.2.4 Display Command

Another useful core command is display. This will display a string to the screen.

```
display $test;

```

Figure 22 Display command

5 Schematics and Layout

5.1 Schematics

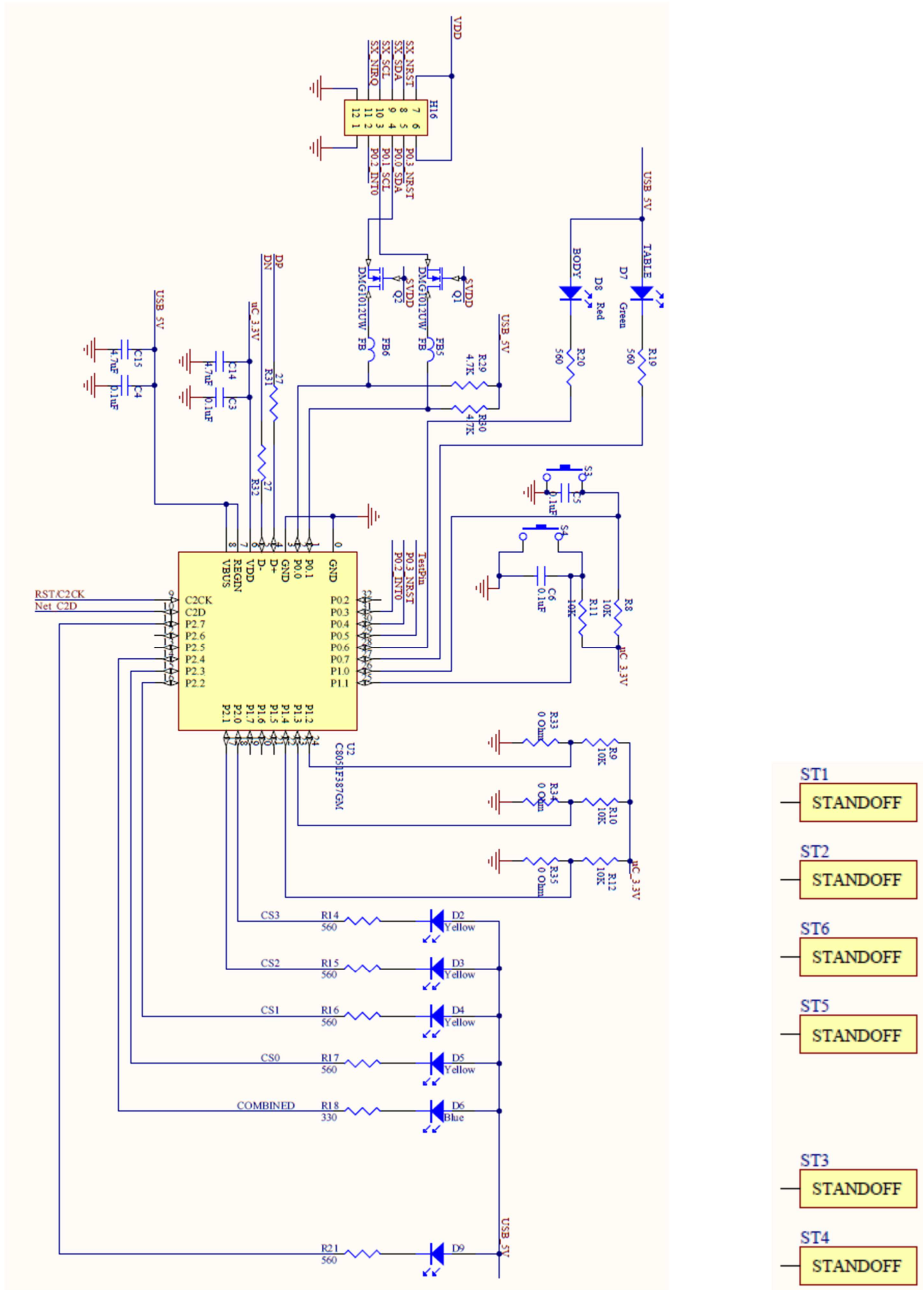


Figure 23 Microcontroller section

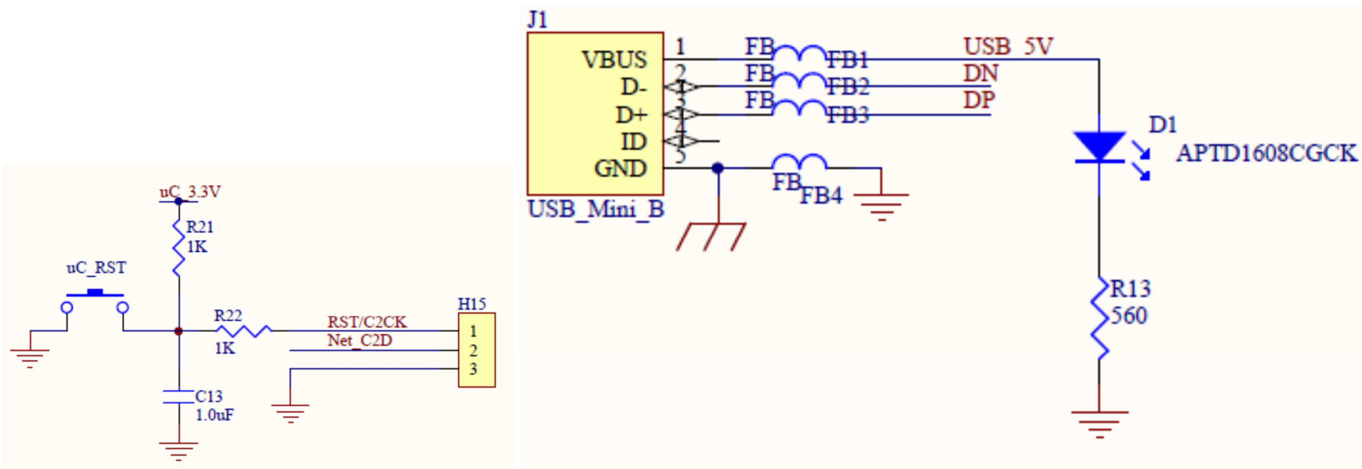


Figure 24 USB power supply and calibration connector

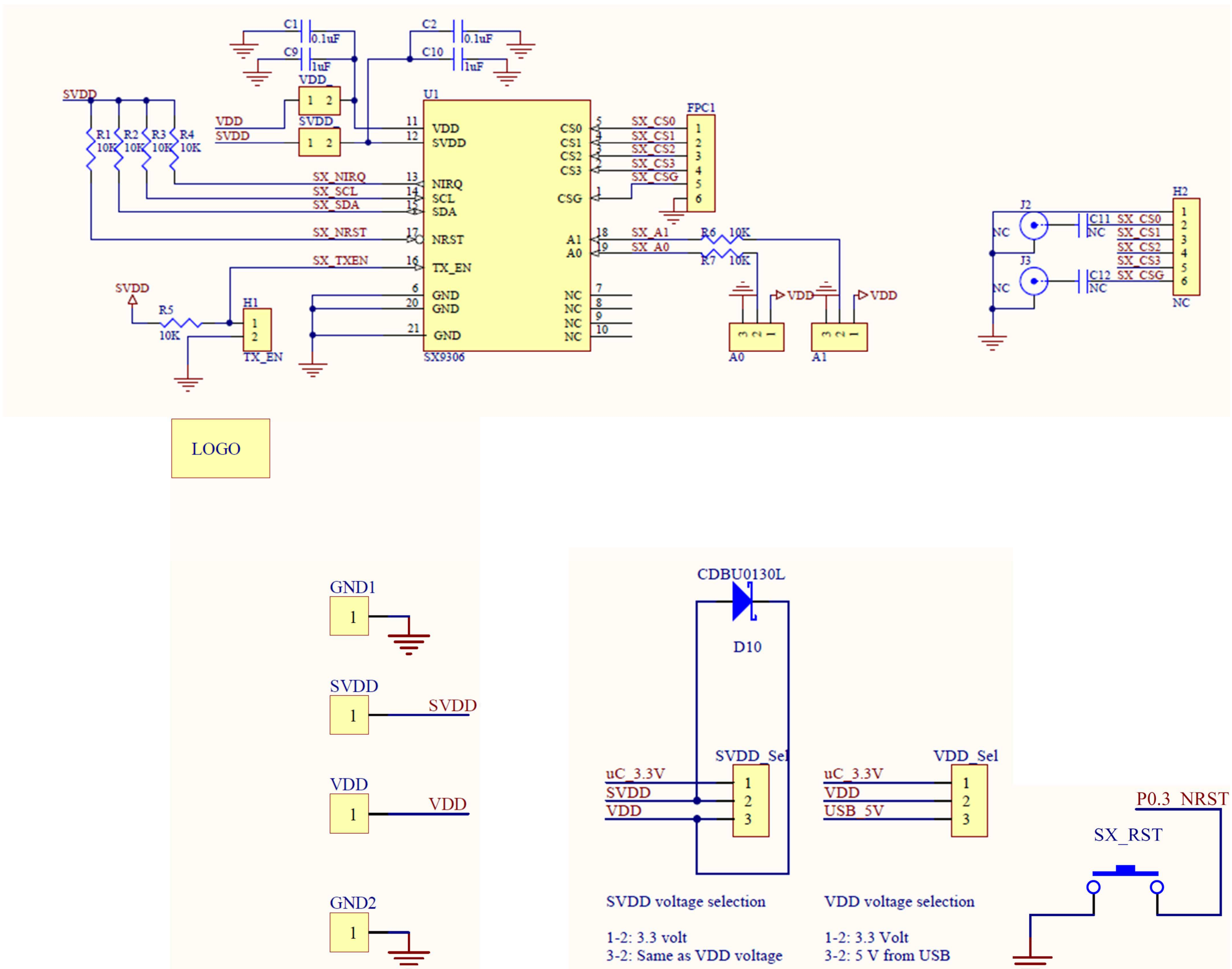


Figure 25 SX9306 Section

5.2 Layout

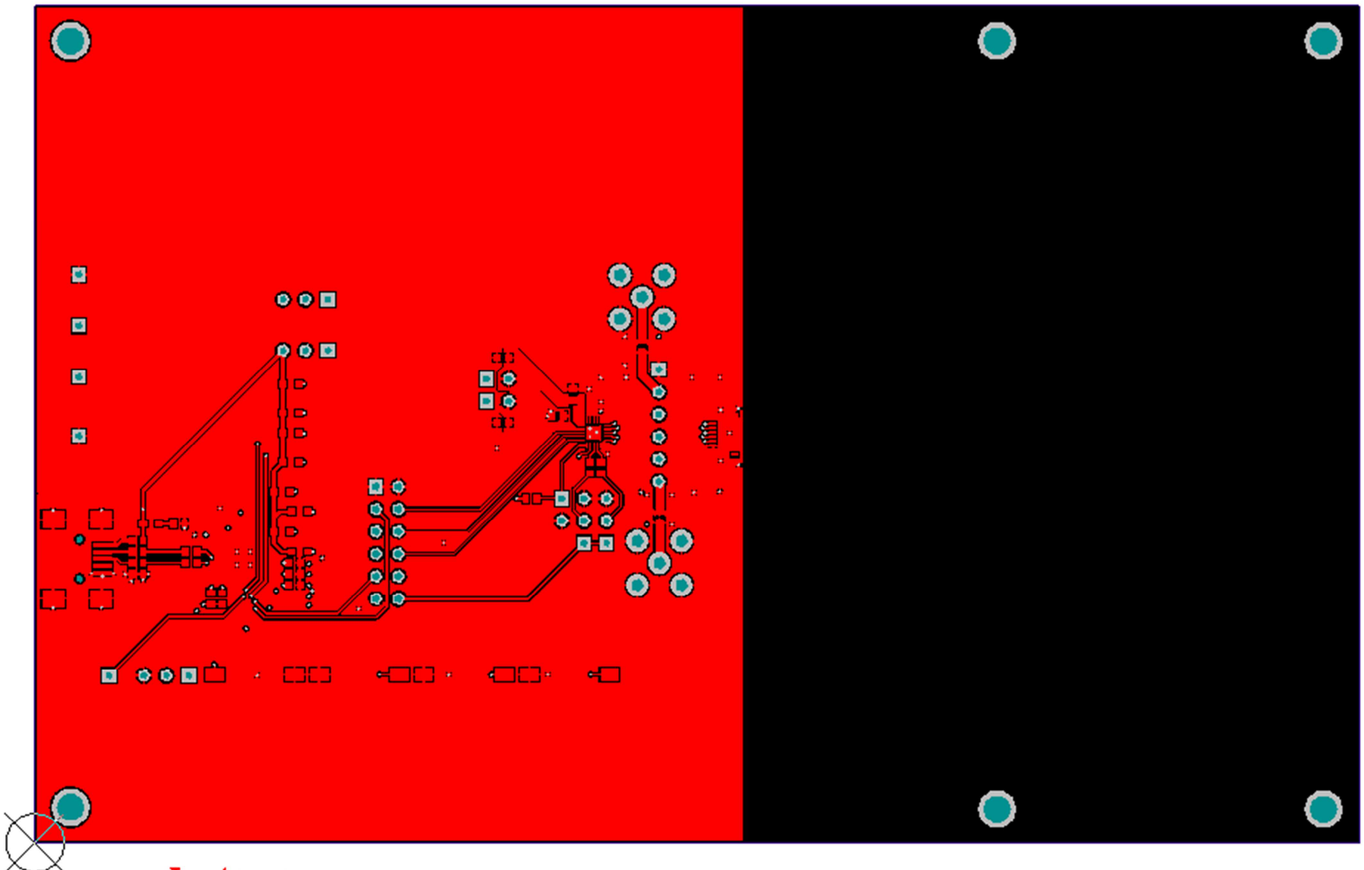


Figure 26 Layout: Top Layer

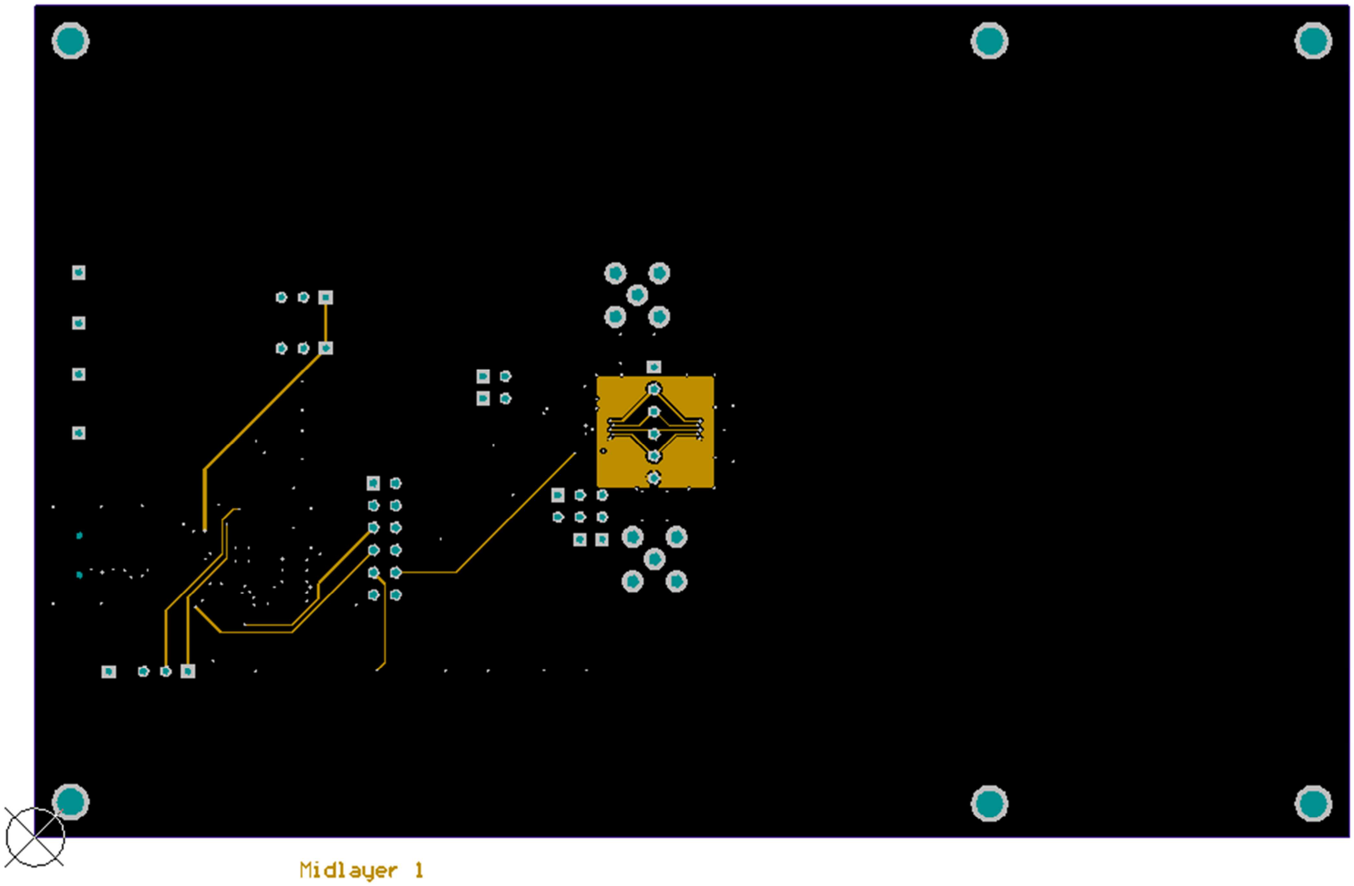


Figure 27 Layout: Midlayer 1

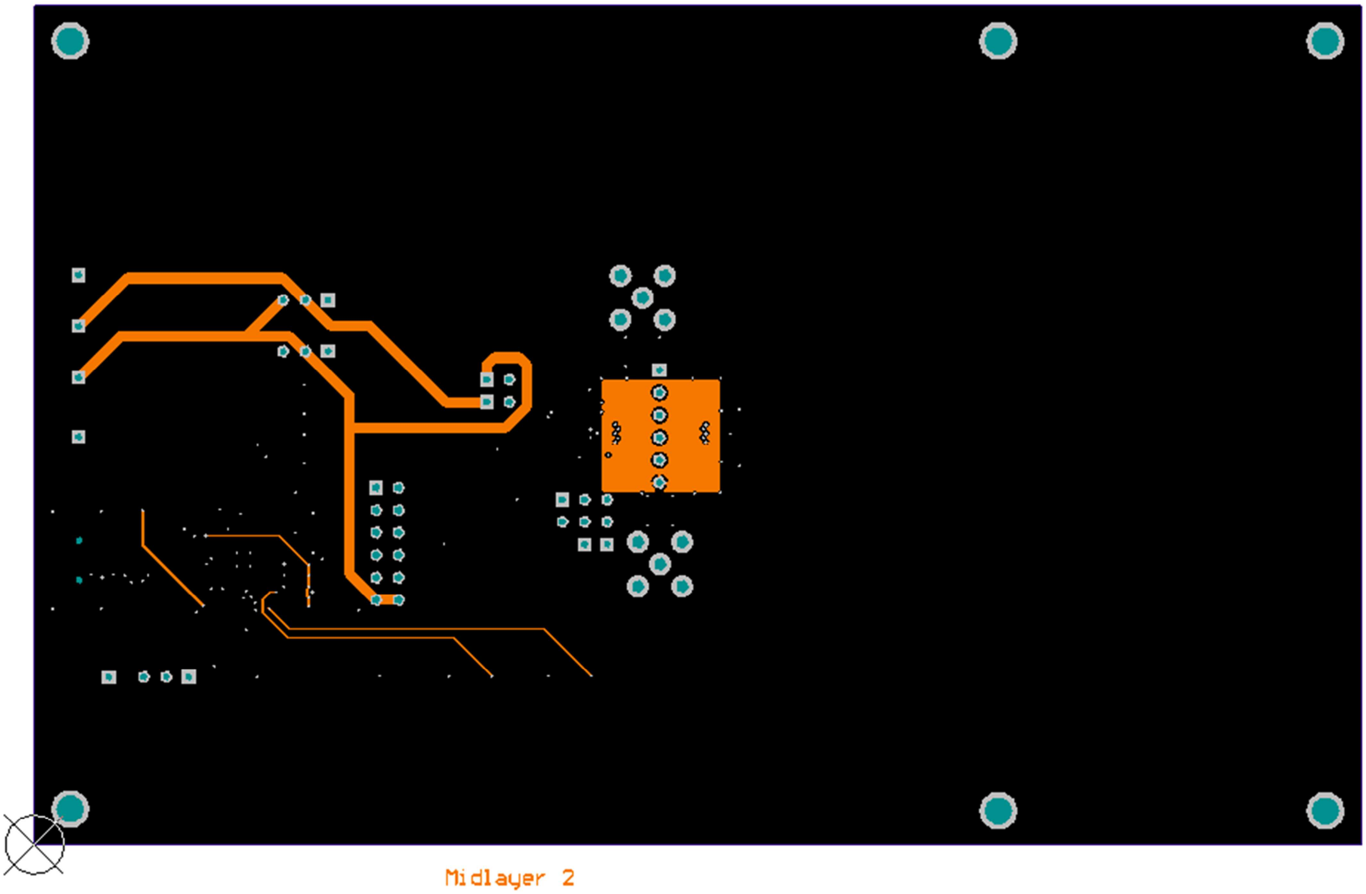


Figure 28 Layout: Midlayer 2

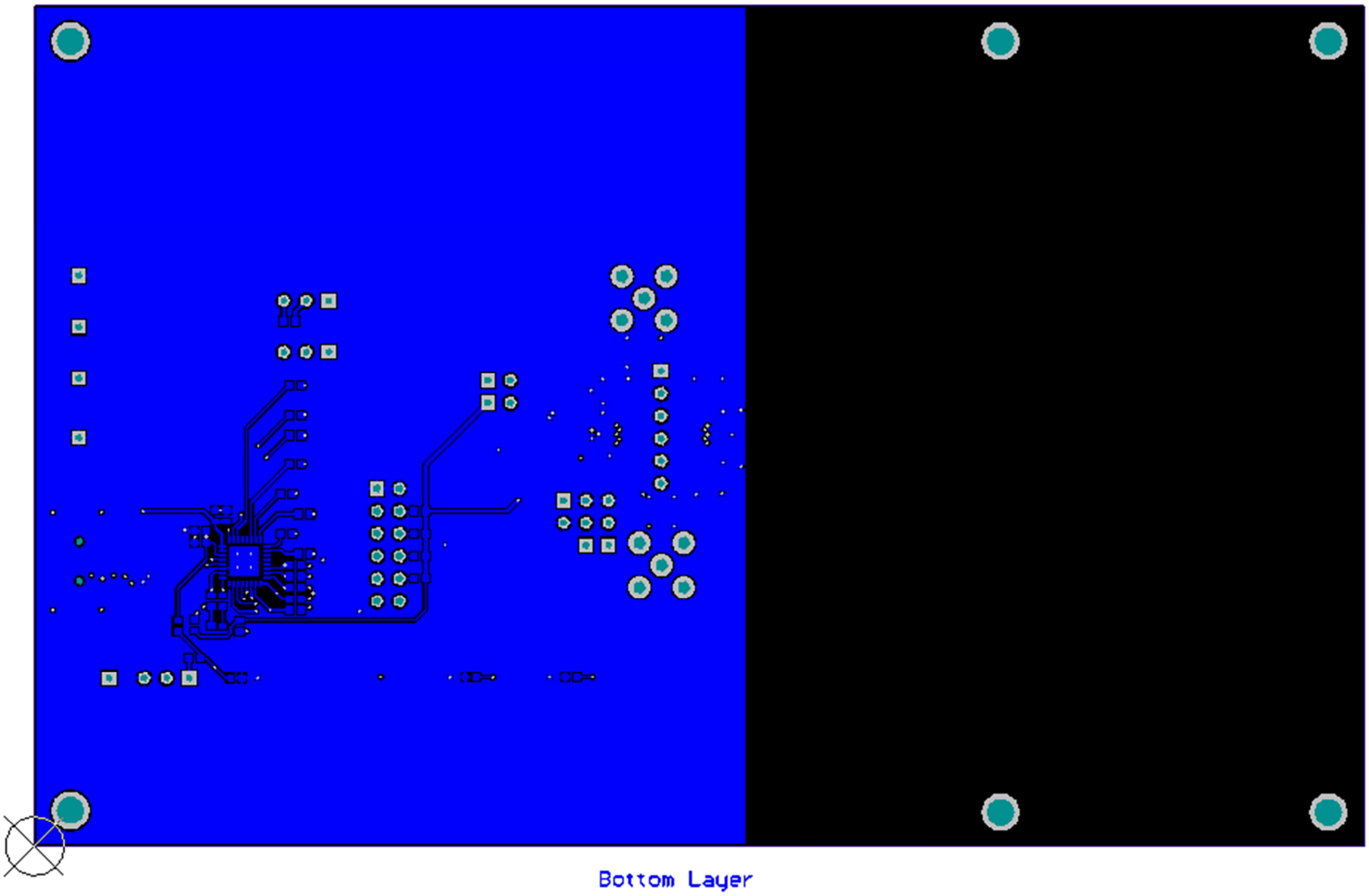


Figure 29 Layout: Bottom Layer

6 References

- [1] SX9306 Datasheet

Contact Information

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