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# SX1509 Evaluation Kit

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## User's Guide

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# 1 Introduction

The purpose of this tool is to provide an evaluation platform for the SX1509 and more generally for the SX1507/8/9 family, World's Lowest Voltage Level Shifting GPIOs with LED Driver and Keypad Engine. The SX1507/8/9 family of GPIOs connects directly with low core voltage baseband chipsets in battery powered, handheld applications avoiding level translating circuits, minimizing cost and board space.

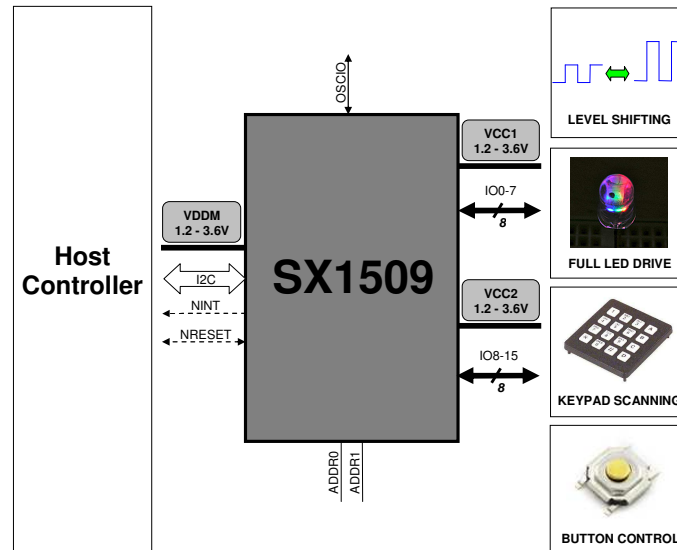


Figure 1: SX1509 Typical Applications

SX1507/8/9 main features include:

- 1.2V to 3.6V Low Operating Voltage with Dual Independent I/O Rails (VDDM, VCC1, VCC2)
  - Enable Direct Level Shifting Between I/O Banks and Host Controller
- 5.5V Tolerant I/Os, Up to 15mA Output Sink on All I/Os (No Total Sink Current Limit)
- Integrated LED Driver for Enhanced Lighting
  - Intensity Control (256-step PWM)
  - Blink Control (224 On/Off values)
  - Breathing Control (224 Fade In/Out values)
- On-Chip Keypad Scanning Engine
  - Support Up to 8x8 Matrix (64 Keys)
  - Configurable Input Debouncer
- 4/8/16 Channels of True Bi-directional Style I/O
  - Programmable Pull-up/Pull-down
  - Push/Pull or Open-drain outputs
  - Programmable Polarity
- Open Drain Active Low Interrupt Output (NINT)
  - Bit Maskable
  - Programmable Edge Sensitivity
- Built-in Clock Management (Internal 2MHz Oscillator/External Clock Input, 7 clock values)
  - OSCIO can be Configured as GPO
- 400kHz I<sup>2</sup>C Compatible Slave Interface
- 4 User-Selectable I<sup>2</sup>C Slave Addresses

## 2 Getting Started

### 2.1 Kit Contents

As illustrated in the figure below, the SX1509 Evaluation kit is composed of:

- SX1509EVK board
- SX1509EVK CDROM including all necessary PC software and documentation (requires min Windows XP)
- Mini USB cable to connect the SX1509EVK board to the PC



Figure 2: SX1509EVK Contents

### 2.2 Installation

- 1- Put the CDROM in your computer. If the installation does not start automatically, launch "SX1509EvaluationKitSetup.exe" manually.
- 2- Follow installation guidelines until the process is completed. Please note that .NET Framework 3.5 and the FTDI USB driver will be automatically downloaded/installed if not detected on your computer.
- 3- Connect the SX1509EVK board to the PC via the mini USB cable.
- 4- Launch "SX1509EVK" from Start menu.
- 5- SX1509EVK is now ready to be used. **Go to Demos menu to quickly show functionality** (follow instructions and click on Start, Cf. §4.3 for more details).

### 3 Hardware Description

SX1509EVK board is described in this chapter. Please refer to the schematics and layout provided at the end of the document for more details about the exact hardware implementation.

#### 3.1 Overview



Figure 3: SX1509EVK Board Picture

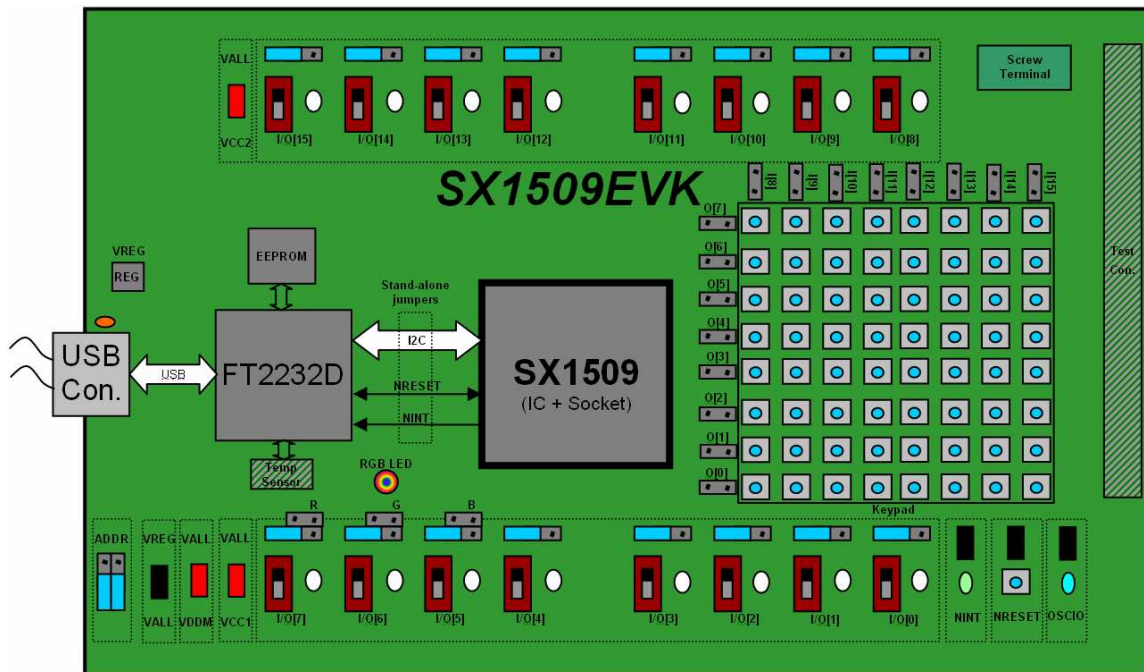


Figure 4: SX1509EVK Board Concept

### 3.2 USB Connector

The USB connector allows the EVK to be connected to a PC from which it will get its power and configuration/control commands via the dedicated software. It is associated to an LED to indicate the USB connection.

### 3.3 FT2232D

The FT2232D from FTDI will be used as a USB to I2C bridge between the PC and the SX1509; moreover it will also monitor and control NRESET and NINT signals. (similarly to what a host uC would do in a final application)

### 3.4 EEPROM

FT2232D is usually associated to an EEPROM which keeps the FTDI chip's parameters when power is turned off. The EEPROM is also used to customize USB device description.

### 3.5 VREG

VREG is fixed to the typical operating voltage of 3.3V, ensuring correct I2C communication between the SX1509 and the FT2232D.

### 3.6 VALL

By default, the VALL jumper is ON and thus connects VALL to VREG. Jumper can be removed and VALL supplied externally if needed.

### 3.7 VDDM, VCC1 and VCC2

By default, the VDDM, VCC1 and VCC2 jumpers are ON and thus connect all SX1509 supply lines to VALL (=VREG=3.3V by default). If needed, the jumpers can be independently removed and the SX1509 supplied externally either directly on the jumper sockets themselves or via the screw terminal (in this case make sure the equivalent jumper is removed before applying any external voltage).

Important: please note that although the SX1508 operates down to 1.2V, if VDDM falls below 1.9V (worst case input threshold spec of the FT2232D) the I2C communication to the FT2232D (and hence the GUI operation) may be compromised.

### 3.8 ADDR

ADDR jumpers are connected to the ADDR0 and ADDR1 pins of the SX1509. They are used to select one of the four I2C slave addresses available by connecting ADDR<sub>x</sub> pin to ground (down position, default) or VDDM (up position). As described later in the document, the jumpers setting must be coherent with the GUI setting to allow I2C communication.

### 3.9 IO [15-0]

Each IO of the SX1509 can be connected in 4 ways (5 for IO7-5):

- ⇒ Jumper on left position (Cf. *Figure 4*): IO is connected to a switch to control an input state. Switch up => VCC<sub>x</sub> applied; Switch down => GND applied. No hardware debouncing circuit is added (debouncing can be done inside the SX1509) but only a serial resistor to prevent potential short circuit when manipulating jumpers.



- ⇒ Jumper on right position (Cf. *Figure 3* and *Figure 10*): IO is connected to a 5V/15mA white LED structure to monitor an output state and illustrate static, intensity controlled, blinking, and breathing LED applications. Output high => LED OFF; Output low => LED ON.
- ⇒ Jumper on **upper** right position (Cf. *Figure 12*, IO7-5 only): IO is connected to a 5V/15mA RGB LED structure to illustrate color mixing applications (IO7=R, IO6=G, IO5=B).
- ⇒ Jumper on corresponding keypad position (Cf. *Figure 14*): IO is connected to the keypad's corresponding row or column to use the keypad scan engine.
- ⇒ Jumper removed : IO can be controlled or monitored externally

Please note that the jumpers do not modify the IO configuration of the SX1509 itself (i.e. Input or Output), this must be done via the PC software. User must make sure that the SX1509 registers configuration is always in line with the jumpers' configuration on the board.

### **3.10 NINT**

NINT is connected to the FT2232D for remote monitoring from the PC and is also connected to a green LED on-board. Please note that NINT is active low, i.e. the LED will turn OFF when an appropriate change is detected on the inputs. The LED can be disconnected via a jumper if needed.

### **3.11 NRESET**

NRESET is connected to the FT2232D for remote monitoring and control from the PC and is also connected to a push button on board (button low => GND applied). Please note that NRESET is active low. The push button can be disconnected via a jumper if needed.

### **3.12 Keypad**

SX1509EVK includes a 8x8 matrix keypad made of 64 individual push buttons. This keypad is meant to be used with the SX1509 keypad scan engine and hence is pre-connected appropriately (Cf. schematics). To avoid any conflict on the IO lines the keypad is associated with one jumper per row/column (i.e. per IO) which is empty by default. User hence needs to use the unique blue IO jumper on the top/bottom section to connect the appropriate row/column.

### **3.13 RGB LED**

SX1509EVK includes a (3x) 5V/15mA RGB LED structure (active low) to illustrate color mixing applications. (IO7=R, IO6=G, IO5=B).

### **3.14 OSCIO**

OSCIO section is made of a jumper and a 5V/15mA blue LED structure (active low) which allows visualizing oscillator activity (OSCOOUT) or applying an external oscillator input signal (OSCIN) when jumper is removed. Additionally, for lab measurements convenience, an SMA connector footprint has been planned.

### ***3.15 Stand-alone Jumpers***

These jumpers are placed on the four lines that are connected between FT2232D and SX1509 (SDA, SCL, NRESET, NINT). Their purpose is, as their name suggests, being able to disconnect the SX1509 from the rest of the circuitry to access it externally (with an external uC, sharing another I2C bus, etc.)

### ***3.16 Test Connector***

A 52-pin edge connector with all SX1509 pins and specific pinout is integrated on board for easy monitoring of all signals.

## 4 Software Description

### 4.1 Overview

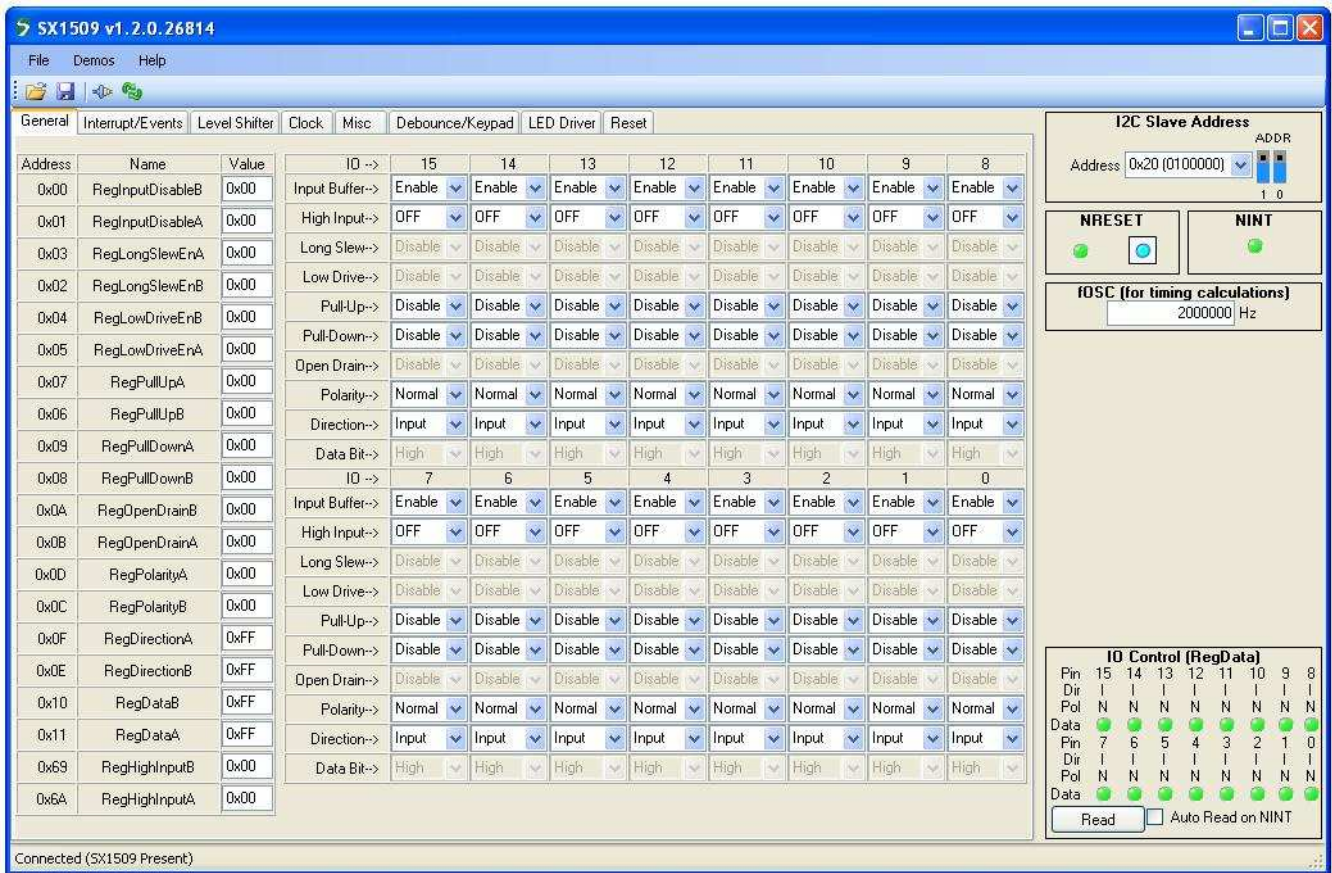


Figure 5: SX1509EVK GUI Overview

### 4.2 File Menu

#### 4.2.1 Overview

File menu contains some general purpose functions. Some of them can also be accessed on the toolbar by clicking directly on the icon.



Figure 6: SX1509EVK GUI File Menu

## 4.2.2 Connect/Disconnect

This item is used to connect/disconnect the SX1509EVK GUI to/from the SX1509EVK board. For connection, the I2C address selected on the GUI must be coherent with the ADDR jumper configuration on the board. The icon and name of the menu item dynamically changes depending on the current connection state. This feature is also available directly on the toolbar.

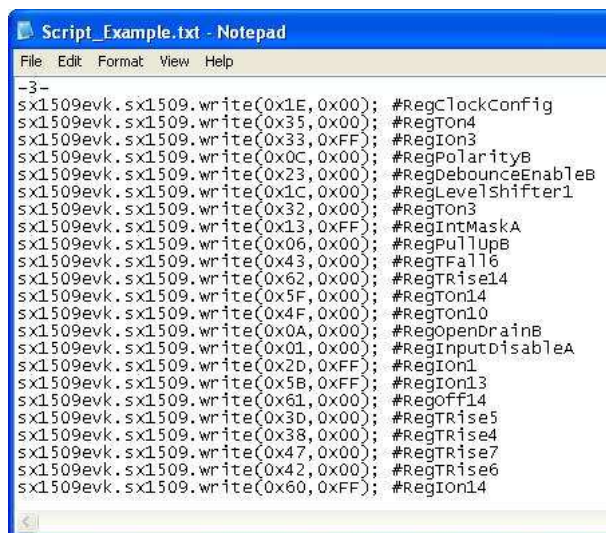
## 4.2.3 Refresh Registers

This item is used to manually read out all registers values from the SX1509EVK to update the GUI. This feature is also available directly on the toolbar.

## 4.2.4 Run Script

For user and support convenience, the SX1509EVK offers the possibility to save/load registers' current configuration into/from a file.

The "Run Script" feature loads "New" registers values from a previously saved script file. This feature is also available directly on the toolbar



```
Script_Example.txt - Notepad
File Edit Format View Help
-3-
sx1509evk.sx1509.write(0x1E,0x00); #RegClockConfig
sx1509evk.sx1509.write(0x35,0x00); #RegTon4
sx1509evk.sx1509.write(0x33,0xFF); #RegIon3
sx1509evk.sx1509.write(0x0C,0x00); #RegPolarityB
sx1509evk.sx1509.write(0x23,0x00); #RegDebounceEnableB
sx1509evk.sx1509.write(0x1C,0x00); #RegLevelShifter1
sx1509evk.sx1509.write(0x32,0x00); #RegTon3
sx1509evk.sx1509.write(0x13,0xFF); #RegIntMaskA
sx1509evk.sx1509.write(0x06,0x00); #RegPullUpB
sx1509evk.sx1509.write(0x43,0x00); #RegTFall6
sx1509evk.sx1509.write(0x62,0x00); #RegTRise14
sx1509evk.sx1509.write(0x5F,0x00); #RegTon14
sx1509evk.sx1509.write(0x4F,0x00); #RegTon10
sx1509evk.sx1509.write(0x0A,0x00); #RegOpenDrainB
sx1509evk.sx1509.write(0x01,0x00); #RegInputDisableA
sx1509evk.sx1509.write(0x2D,0xFF); #RegIon1
sx1509evk.sx1509.write(0x5B,0xFF); #RegIon13
sx1509evk.sx1509.write(0x61,0x00); #RegOff14
sx1509evk.sx1509.write(0x3D,0x00); #RegTRise5
sx1509evk.sx1509.write(0x38,0x00); #RegTRise4
sx1509evk.sx1509.write(0x47,0x00); #RegTRise7
sx1509evk.sx1509.write(0x42,0x00); #RegTRise6
sx1509evk.sx1509.write(0x60,0xFF); #RegIon14
```

Figure 7: SX1509EVK Script File Example

## 4.2.5 Save All Registers to Script

This item saves the "Current" registers values in a script file. This feature is also available directly on the toolbar.

## 4.2.6 Exit

This item closes the SX1509EVK GUI.

### 4.3 Demos Menu

#### 4.3.1 Overview

Demos menu contains three items: Light Show, Color Mixing (RGB) and Keypad. These demos associated with a specific jumpers' configuration on board allows the user to quickly show the functionality of the most important features of the SX1509.



Figure 8: SX1509EVK GUI Demos Menu

#### 4.3.2 Light Show

Pressing the "Start" button will launch the demo and play a pre-programmed light show on the SX1509EVK board white LEDs accordingly to the selected item (All, Classic, Intensity Control, Blinking or Breathing).



Figure 9: SX1509EVK Light Show Demo Window

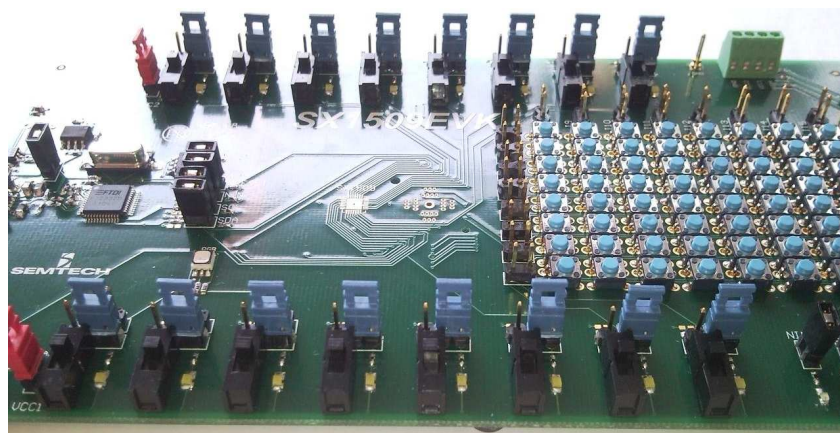


Figure 10: SX1509EVK Light Show Demo Jumpers Configuration (right position, default)

### 4.3.3 Color Mixing (RGB)

This demo can be used in two ways:

- Automatic: pressing the "Start" button will launch the automatic demo and perform a preprogrammed color mixing sequence on the SX1509EVK board's RGB LED.
- Manual: When "Start" button is not pressed the user can enter manually his R, G, and B settings and observe the color mixing result on board. Custom color can be typed directly in Register view on the left, clicked in the center section color panel (displayed colors depend on the primary color fixed on right section, in figure below -> Red), or selected from the right section sliders.

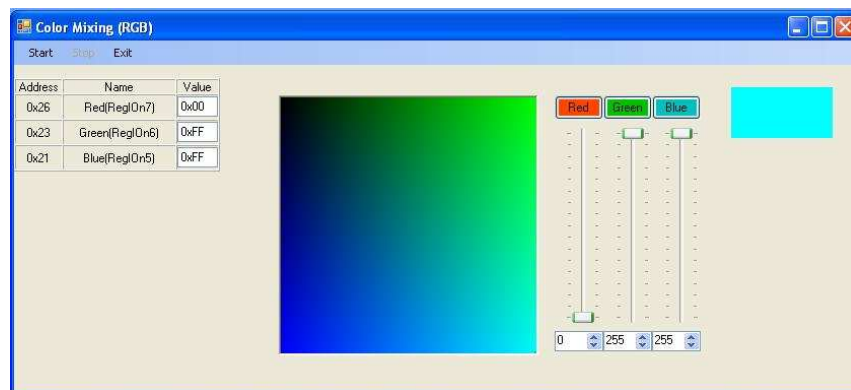


Figure 11: SX1509EVK Color Mixing (RGB) Demo Window

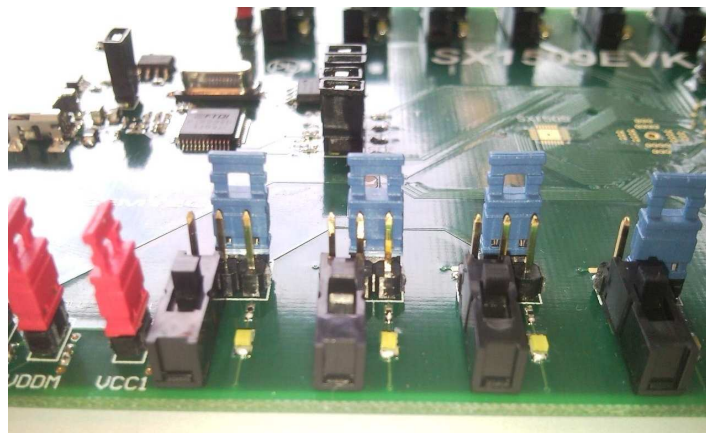


Figure 12: SX1509EVK Color Mixing (RGB) Demo Jumpers Configuration (upper right position)

### 4.3.4 Keypad

Pressing the "Start" button will launch the demo.

User can press any button on the SX1509EVK board; it will be displayed accordingly on the GUI.

Please note that you will observe some delay essentially due to USB/PC reaction time.

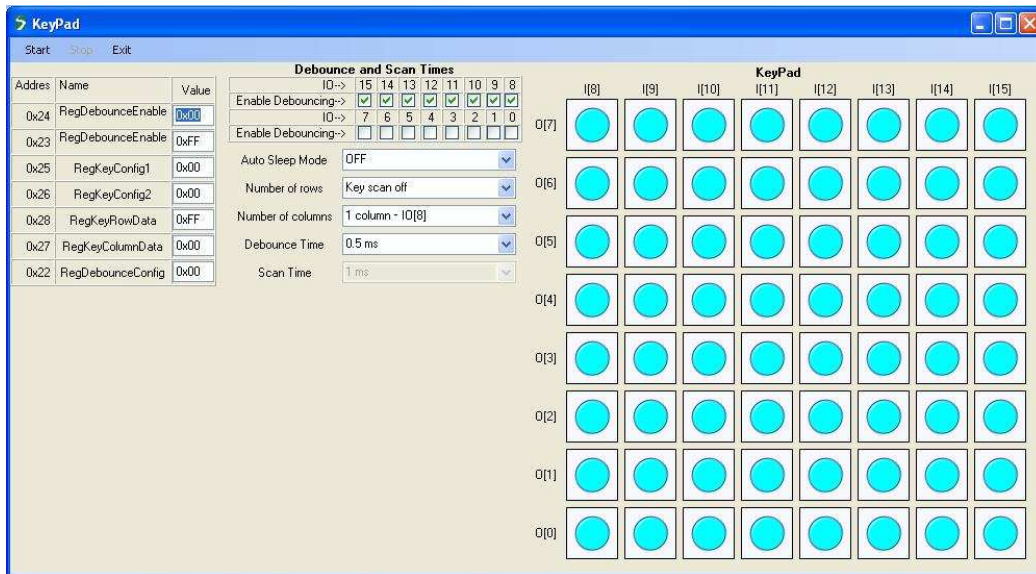


Figure 13: SX1509EVK Keypad Demo Window

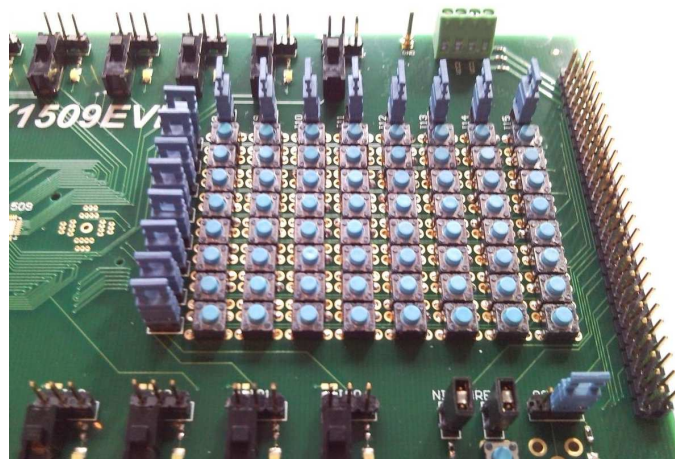


Figure 14: SX1509EVK Keypad Demo Jumpers Configuration (keypad position)

## 4.4 Help Menu

### 4.4.1 Overview

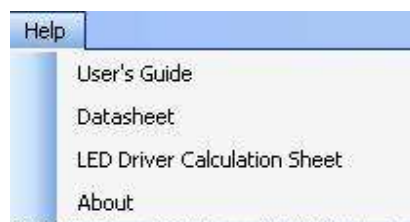


Figure 15: SX1509EVK GUI Help Menu

#### 4.4.2 User's Guide

This item opens the SX1509EVK User's guide.

#### 4.4.3 Datasheet

This item opens the SX1507/8/9 Datasheet.

#### 4.4.4 LED Driver Calculation Sheet

This item opens the LED Driver calculation sheet.

#### 4.4.5 About

This item gives access to some useful information such as the software version.

### 4.5 Registers Tabs

Registers are classified in several tabs depending on their function.

Each tab is split into two sections:

- Raw section (left) represents all the registers of the selected tab in hexadecimal.
- User friendly section (right) represents each of the registers settings/subdivisions in a user friendly way: radio buttons, rolling menu, check box, LED, etc...

A register value can be either modified in the user friendly section by selecting the right item (change is sent to the IC when the new item is clicked) or typed into the raw section (change is sent to the IC when Enter is pressed). Whatever method is used, raw and user friendly sections are dynamically attached and always displayed consistently.

Please note that oscillator operation is OFF by default and that LED Driver and Keypad/Debounce features are only available if oscillator operation is activated in "Clock" register tab.

**Please refer to the SX1507/8/9 datasheet [1] for detailed registers description.**

### 4.6 I2C Slave Address

Slave address can be selected from the four available ones and ADDR jumpers corresponding picture is dynamically modified accordingly. The user can then easily check that his jumpers' configuration is correct on the board.

### 4.7 NINT

The LED reflects the logical level of the NINT pin. Please note that NINT is active low, i.e. LED will turn OFF when a change is detected on the inputs.

### 4.8 NRESET

The LED reflects the logical level of the NRESET pin and the push button allows the user to force a reset by clicking on it (button pressed => NRESET forced to GND, button released => NRESET released). Please note that NRESET is active low, i.e. LED will turn OFF when reset is active.



## **4.9 IO Control (RegData)**

User can control the IO state via the switches for IOs set as outputs and via LEDs for IOs set as inputs (switch/LEDs configuration complementary to the boards' configuration).

Switch/LEDs configuration is dynamically attached to the RegDirB/A registers and is always displayed consistently. Switch/LEDs value is dynamically attached to the RegDataB/A registers and is always displayed consistently.

"Read" button reads RegDataB/A.

### **4.9.1 Auto Read on NINT**

To demonstrate the use of the NINT pin, it is possible for the user to enable "Auto Read on NINT": RegDataB/A registers will automatically be read when NINT goes low, without having to press the "Read" button.

Please note that by default no interrupt is enabled on any of the IOs. This can be modified in the "Interrupts/Events" registers tab.

## **4.10 FOSC**

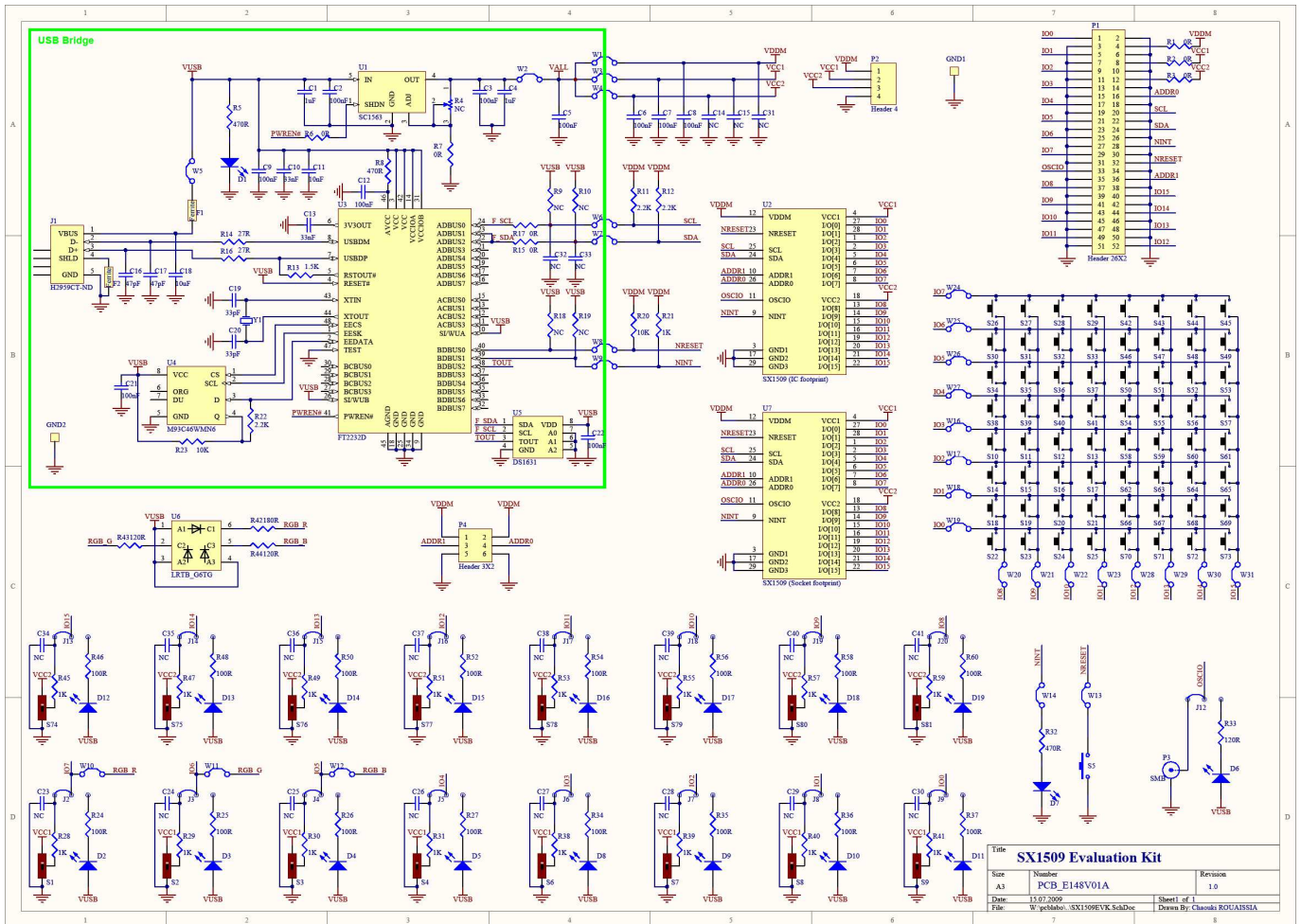
This user editable field (2MHz by default) is not linked to any register but is needed to do all oscillator frequency related calculations in the register tabs.

Please note that oscillator operation is OFF by default and that LED Driver and Keypad/Debounce features are only available if oscillator operation is activated in "Clock" register tab.

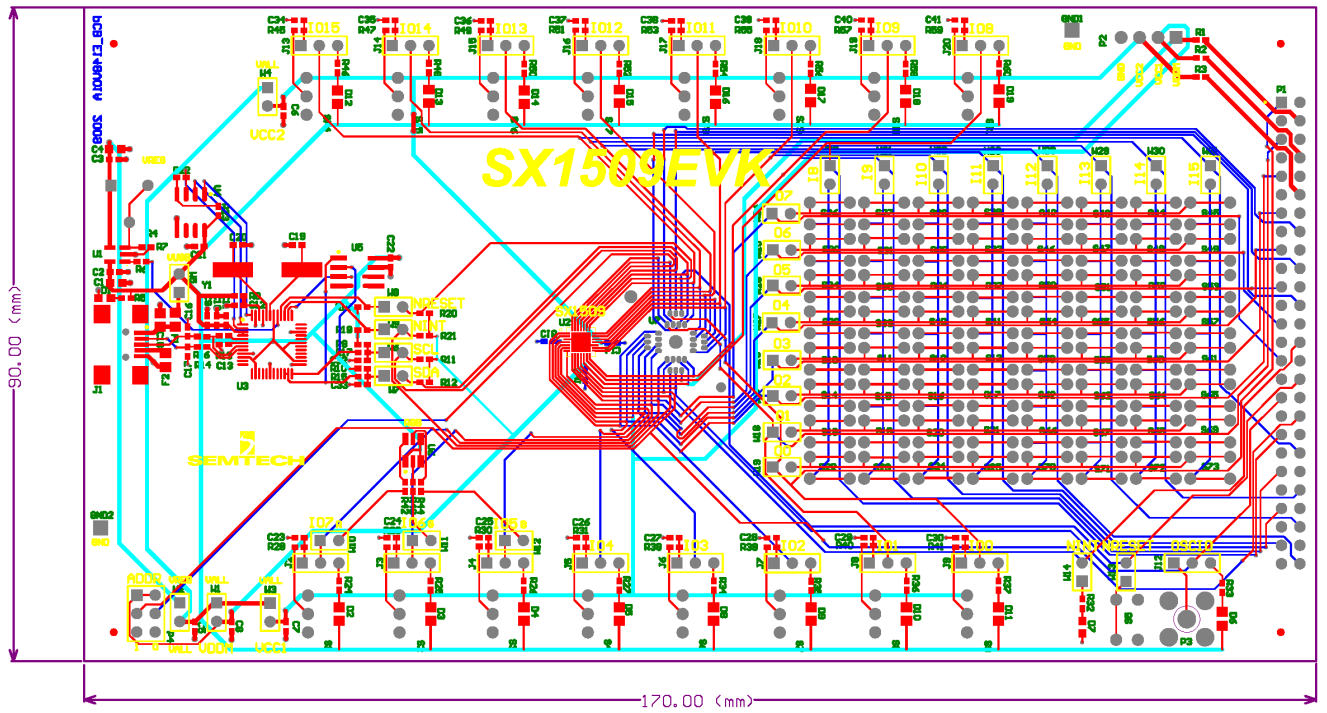
## **4.11 Status Bar**

The current status of the tool is displayed here.

# 5 Schematics



## 6 Layout



Legend is only  
 Drill Drawing.

Ground planes removed for clarity.

## 7 References

- [1] SX1507/8/9 Datasheet

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