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SX8634/35/44/45 Evaluation Kit

User's Guide

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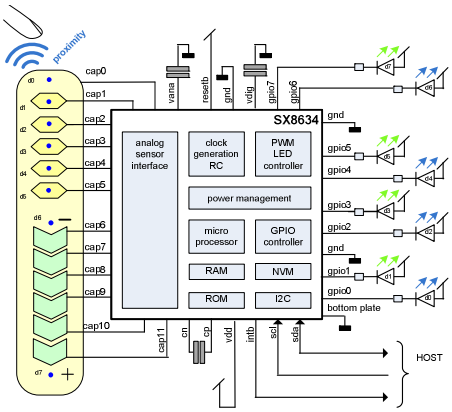
1 Introduction

This document describes the evaluation kits of the:

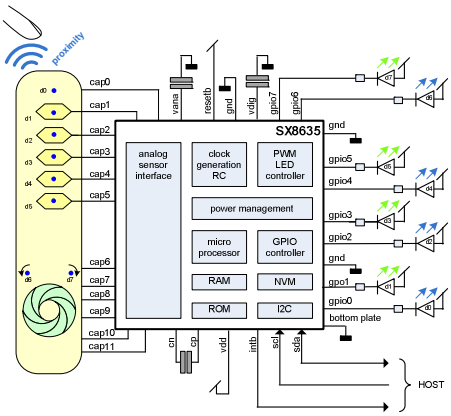
- SX8634 (proximity, buttons and slider)
- SX8635 (proximity, buttons and wheel)
- SX8644 (buttons and slider)
- SX8645 (buttons and wheel)

In this user guide the term EVK refers to the SX8634EVK, SX8635EVK SX8644EVK and SX8645EVK

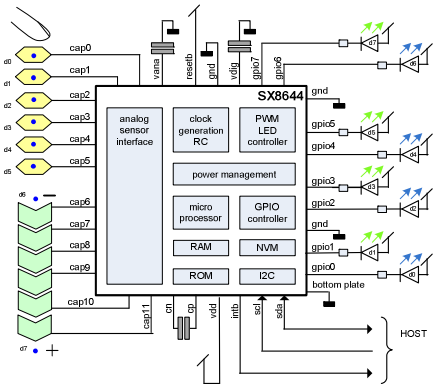
The SX863x and SX864x family (see references [1] to [13]), is an ultra low power, fully integrated 12 (or 8) -channel solution for capacitive touch-buttons, slider and wheel and proximity applications with enhanced LED drivers. The SX863x/4x family features dedicated capacitive sense inputs (that requires no external components) in addition to 8 general purpose I/O ports (GPIO). Each GPIO is typically configured as LED driver with independent PWM source for enhanced lighting control such as intensity and fading. SX863x offers additionally proximity detection.



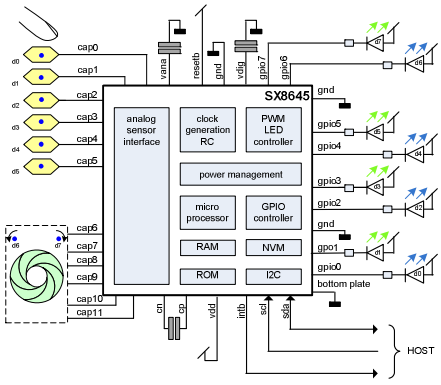
SX8634



SX8635



SX8644



SX8645

Figure 1: Typical Application

SX863x and SX864x main features include:

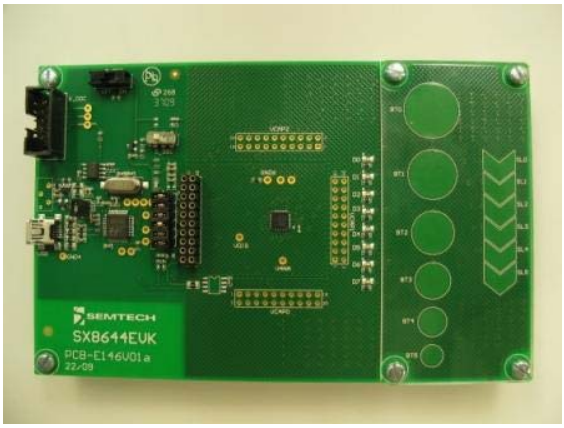
- Proximity Sensing (for SX863x Family)
- Complete 12 Sensors Capacitive Touch Controller for Buttons and Slider
  - Pre-configured for 6 Buttons and a Slider (SX8644), Wheel (SX8645)
  - 8 LED Drivers with Individual Intensity, Fading Control and Autolightening Mode
  - 256 steps PWM Linear and Logarithmic control
- High Resolution Capacitive Sensing
  - Up to 100pF of Offset Capacitance Compensation at Full Sensitivity
  - Capable of Sensing through Overlay Materials up to 5mm thick
- Extremely Low Power Optimized for Portable Application
  - 8uA (typ) in Sleep Mode
  - 80uA (typ) in Doze Mode (Scanning Period 195ms)
  - 260uA (typ) in Active Mode (Scanning Period 30ms)
- Programmable Scanning Period from 15ms to 1500ms
- Auto Offset Compensation
  - Eliminates False Triggers due to Environmental Factors (Temperature, Humidity)
  - Initiated on Power-up and Configurable Intervals
- Multi-Time In-Field Programmable Firmware Parameters for Ultimate Flexibility
  - On-chip user programmable memory for fast, self contained start-up
- "Smart" Wake-up Sequence for Easy Activation from Doze
- No External Components per Sensor Input
- Internal Clock Requires No External Components
- Differential Sensor Sampling for Reduced EMI
- 400 KHz Fast-Mode I²C Interface with Interrupt

2 Getting Started

2.1 Kit Contents

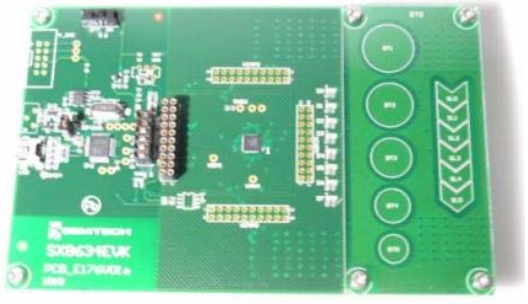
As illustrated in the figure below, the Evaluation kit is composed of:

- SX8634EVK, SX8635EVK , SX8644EVK, SX8645EVK board with 2mm acrylic glass overlay.
- CDROM including all necessary PC software and documentation (requires min. Windows XP)
- Mini USB cable to connect the SX8634EVK, SX8635EVK, SX8644EVK, SX8645EVK board to the PC



SX8644EVK

SX8645EVK



SX8634EVK

SX8635EVK

Figure 2: EVK Contents

2.2 Installation/Quick Start

1- Put the CDROM in your computer. If the installation does not start automatically, launch "SX863xSX864xEvaluationKitSetup.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- For SX864x only: Assure the switch #5 is always in the left position.
4- Set the ON/OFF switch (#4) to OFF (left position).
5- Connect the EVK board to the PC with the mini USB cable to connecter #1.

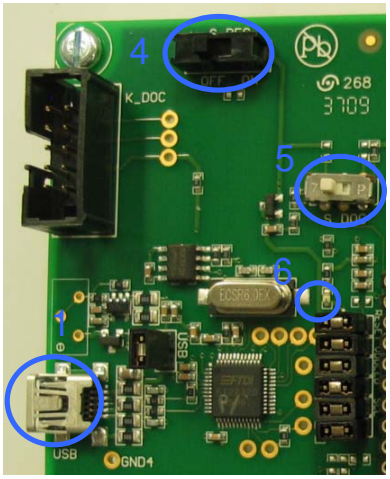


Figure 3: EVK startup

6- The PC will recognize the EVK.
7- Set the ON/OFF switch (#4) to ON (right position).
8- The red LED (#6) will light up

The EVK is now read to be used in stand alone demo mode (without GUI).
Touching the buttons BT0 to BT5 (#12) will enable the corresponding green LEDs (#11), D0 to D5.
Releasing the buttons will turn off the LEDs.

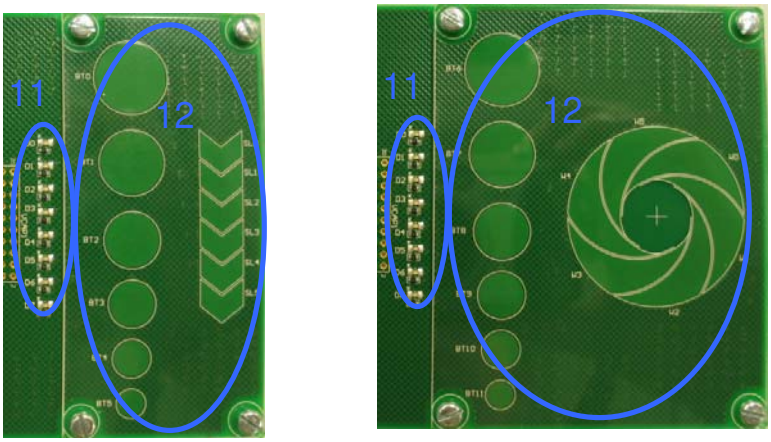


Figure 4: SX864x EVK LEDs and sensors

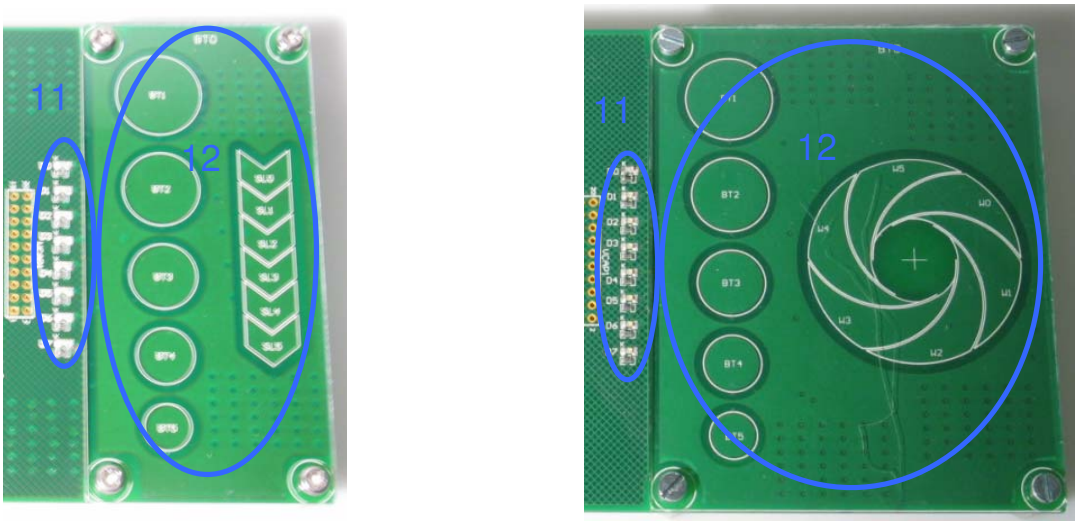


Figure 5: SX863x EVK LEDs and sensors

Moving a finger on the slider or wheel (#12) will enable the green LEDs (#11), D6 and D7 depending on the direction of the finger.
For the SX863x the orange LED (d0) will show proximity as soon as the user approaches the EVK.

For more detailed evaluation and changing the default configuration of the EVK the GUI needs to be started.

9- Launch "Sx863xSX864xEVK" from PC Start menu.
10- The EVK will be connected automatically and the following window will appear.
(In case the auto connect did not succeed: Click on "Disconnect/Connect" button  in toolbar or select 'Connect' in File menu)

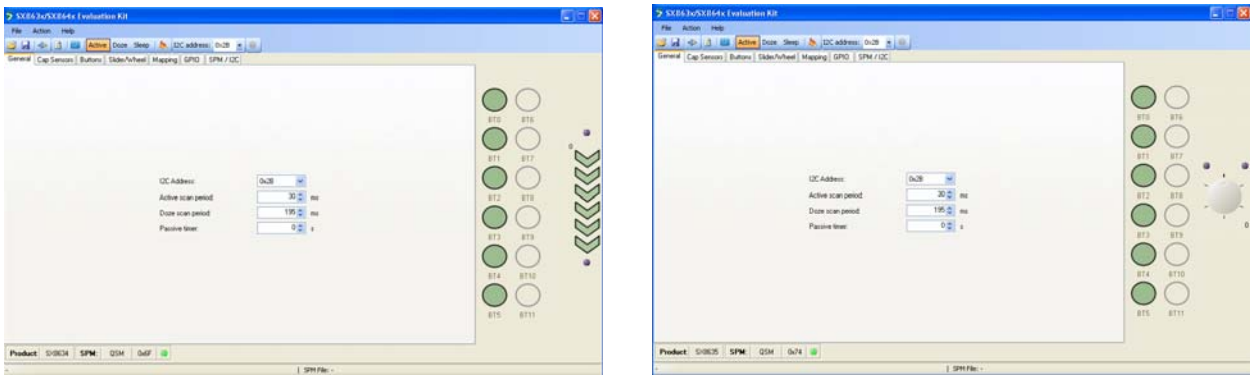


Figure 6: EVK GUI window

The product is shown in the left bottom corner of the GUI.

11- a) SX864x: Touch with your finger a button (e.g. BT0) on the EVK and the GUI shows BT0 is touched (white).
b) Sx863x: Approach with your finger the EVK and the Gui shows proximity detection (BT0 touched, white)

Figure 7: button BT0 touched (SX864x) or proximity detected (Sx863x)

The EVK and GUI are operational.

2.3 GUI tooltips and Help

All GUI buttons, LEDs, scroll bars, icons have tooltips which show briefly the functionality. The tooltips can be activated by the user by moving the mouse over the desired area (see example I2C address selection).

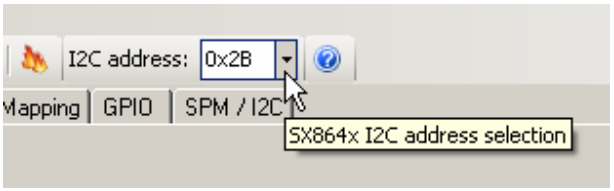


Figure 8: tooltip example

3 Hardware Description

The EVK boards are 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

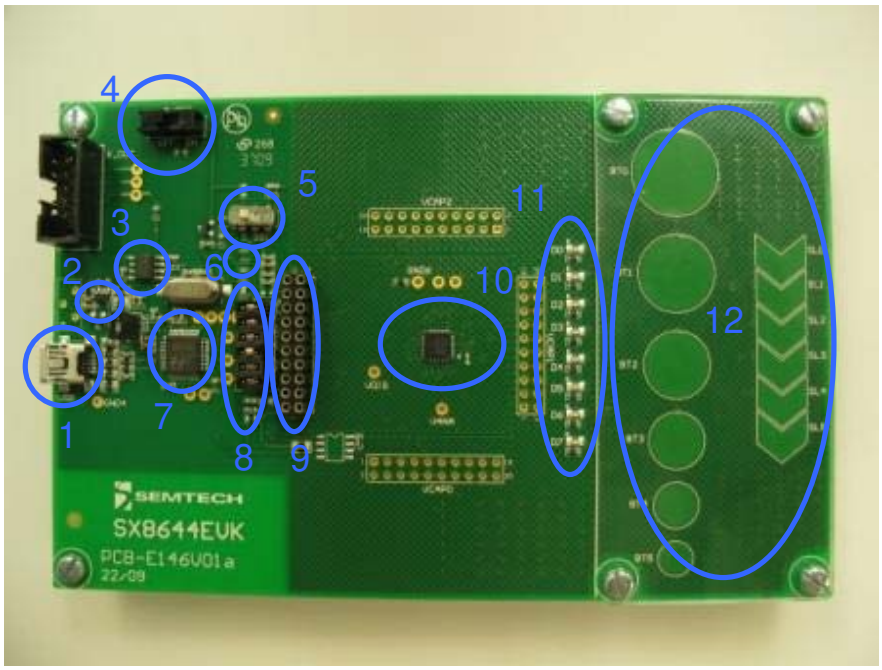


Figure 9: SX8644EVK Board Picture

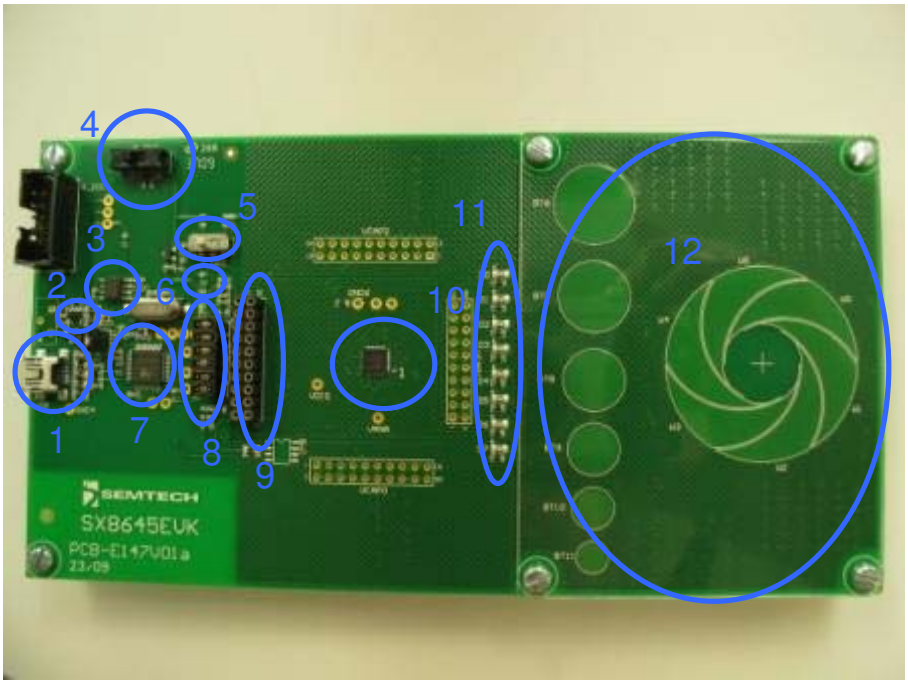


Figure 10: SX8645EVK Board Picture

3.1.1 USB Connector (#1)

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.

3.1.2 VREG (#2)

VREG is fixed to the typical operating voltage of 3.3V using the Semtech Sc153 voltage regulator, ensuring correct I2C communication between the SX863x/4x and the FT2232D.

3.1.3 EEPROM (#3)

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

3.1.4 ON/OFF switch (#4)

The ON/OFF switch turns ON (right position) or OFF (left position) the supply for the SX863x/4x and at the same time the red power indication LED (#6).

3.1.5 Test Switch (#5)

Only applicable for SX864x:
This switch is for Semtech internal use and needs to be always in the left position.
The EVK will not operate if this switch is in the wrong position.

3.1.6 Power Indication LED (#6)

The read LED indicates if the SX863x/4x are turned ON or OFF, according the position of switch (#4).

3.1.7 FT2232D (#7)

The FT2232D from FTDI will be used as a USB to I2C bridge between the PC and the SX863x/4x; moreover it will also monitor and control RESETB and INTB signals (similar to what a host would do in a final application).
The USB bridge is supplied directly over the USB cable.

3.1.8 Stand-alone Jumpers (#8)

These six jumpers are connecting the FT2232D bridge to the SX863x/4x.
Their purpose is, as their name suggests, being able to disconnect the SX863x/4x from the rest of the circuitry to access it externally (with an external host, sharing another I2C bus, etc.).

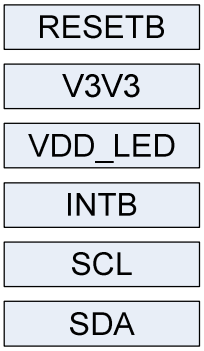


Figure 11: Jumpers

3.1.9 Header (#9)

The header, 2x 10 pins allows the user connect to the different signals on the board e.g. for monitoring purposes.

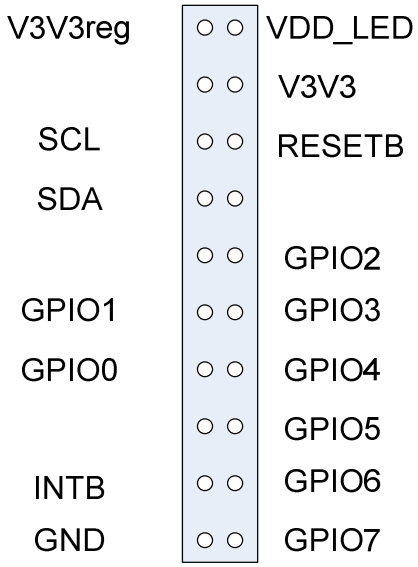


Figure 12: Header

3.1.10 SX8634, SX8635, SX8644, SX8645 (#10)

The Semtech Touch controller product.

3.1.11 LEDs on GPIO[7..0] (#11)

Eight green LEDs (D0..D7) are connected to the eight GPIOs of the SX8644 or SX8645 for visual feedback.
Seven green LEDs (D1..D7) and one orange LED (D0, proximity) are connected to the eight GPIOs of the SX8634 or SX8635 for visual feedback.

3.1.12 Touch Sensors (#12)

Different size touch buttons and slider, wheel are connected to the SX863x/4x.
The sensor area is covered by 2 mm thick transparent, acrylic glass.

3.2 Default EVK hardware settings.

Default settings of jumpers and switches:
- All jumpers need to be mounted.
- The ON/OFF switch (#4) can be in ON (right position) or OFF (left position).
- SX864x: The test switch (#5) needs to be in the left position.

4 Guided Tour of the GUI/EVK

4.1 Introduction

The paragraphs in this chapter allow the user to get to know the basics of the EVK and the SX863x/4x and to get the user acquainted with the GUI and the EVK and the way to use them.
The more technical details and functioning are described in following chapters and in the product datasheets (references [1] to [13]).

The steps in this chapter are straight forward and do not require a very detailed knowledge of the SX863x/4x neither of the EVK.

4.2 Active/Doze/Sleep Mode/Wake-up

Directly after a power up of the EVK the SX863x/4x will enter Active mode and sensor pins will be sensed every 30ms.
The user can change the operation mode by clicking on the icons.
The actual operation mode is then highlighted as shown below.

active mode doze mode sleep mode

Figure 13: Operating Modes

The sensor pins are sensed every 195 ms in Doze Mode.
There are 2 ways from Doze mode to Active mode.
1) Use the Operating mode icon Active
2) Touching the button BT0 for at least 195ms. After the release of BT0 the Active mode is entered automatically. This is the so-called automatic wakeup. In case other buttons are touched nothing happens and Doze mode is maintained.

4.3 LED fading on GPO pins

Touching BT0 will enable LED D0 on the EVK.
When BT0 is released the LED will remain on for some time and then go OFF slowly.
It is easy to change the LED behavior by the following steps.

- select the GPIO tab

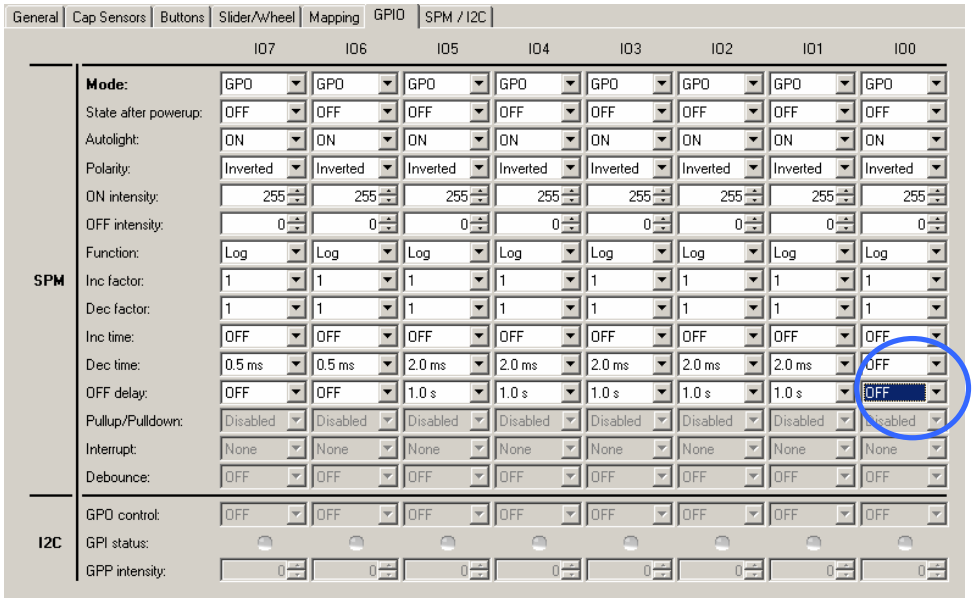


Figure 14: GPIO tab modified (i)

Change the Dec time (default 2ms) and OFF delay (default 1.0s) to OFF.
Each modification on this tab is immediately written to the EVK.
After this is done the LED will turn off directly after a release.

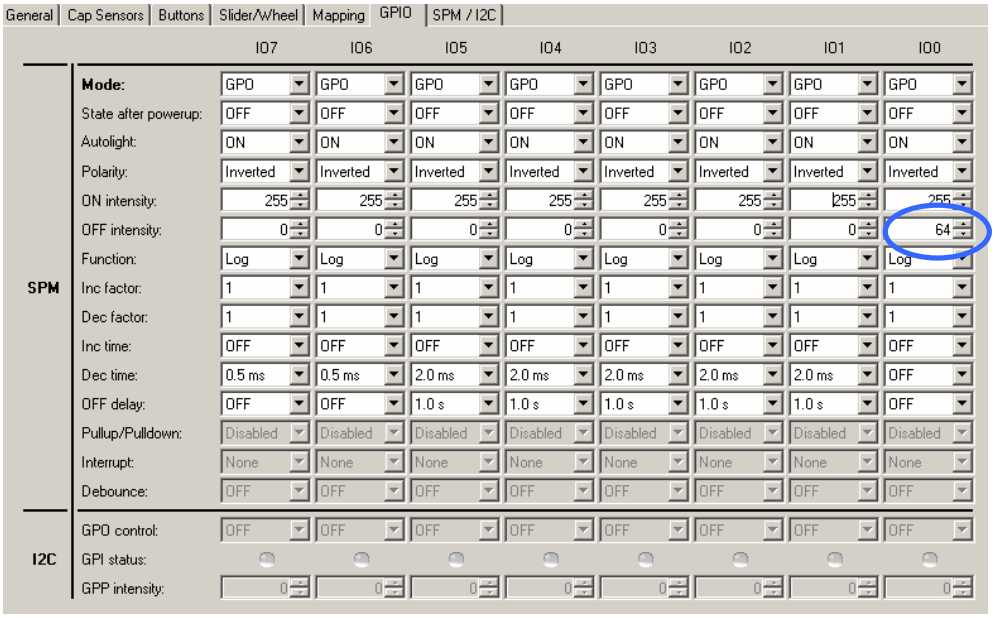


Figure 15: GPIO tab modified (ii)

Change the OFF intensity (default 0) to 64. The LED D0 will be enabled at very low brightness in the OFF state.

4.4 LED mapping on GPO pins

LED D0 on the EVK is mapped to button BT0.
It is easy to map LED D0 to another button and e.g. swap with button1

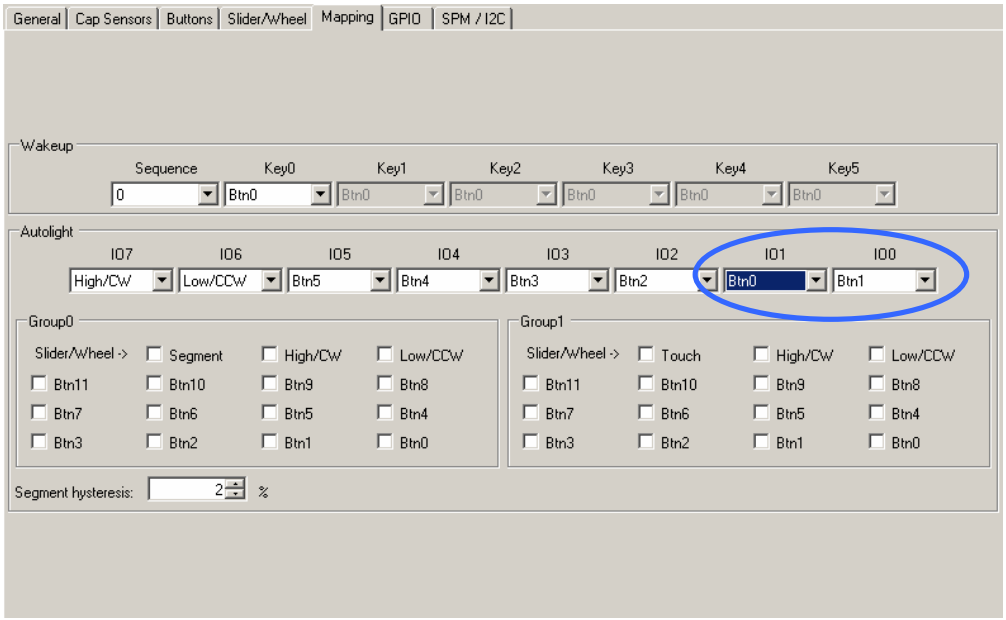


Figure 16: Mapping tab modified

In the example above LED D0 is mapped to Button 1 (default is button 0) and LED D1 is mapped to button 0 (default is button 1).

4.5 Sensors for buttons, slider or wheel

The SX8634/44 and SX8635/45 start up with six buttons and six sensors in the slider or wheel.
This can be easily changed in the Cap Sensor tab.

The configuration below shows a example which uses a slider with 5 sensors (6 per default), the buttons 0, 2, and 4 were turned off to save power consumption and button 6 was enabled.

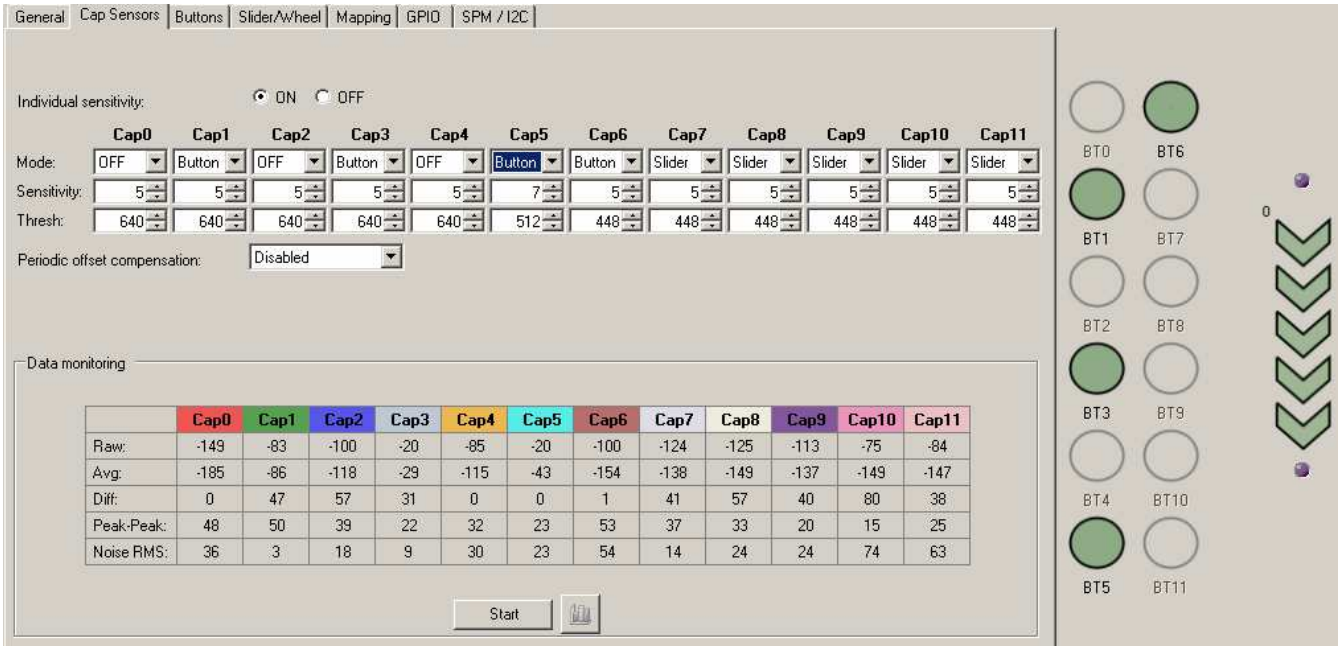


Figure 17: Cap Sensors modified

The GUI shows at the right side the modified users configuration.
Green icons are enabled sensors and the grey icons are disabled sensors.

4.6 Monitor mode

Touching a sensor does not always mean the EVK will consider this as a touch.
It might e.g. be that the touch is only partly on the sensor area or maybe the overlay material is replaced by something thicker.
The EVK parameters are set such that sensor area, overlay material and thickness are operational.
In case the user changes the hardware or just needs to observe raw signals the GUI can be set in monitor mode.

Follow the next steps:

-select the Cap Sensors tab

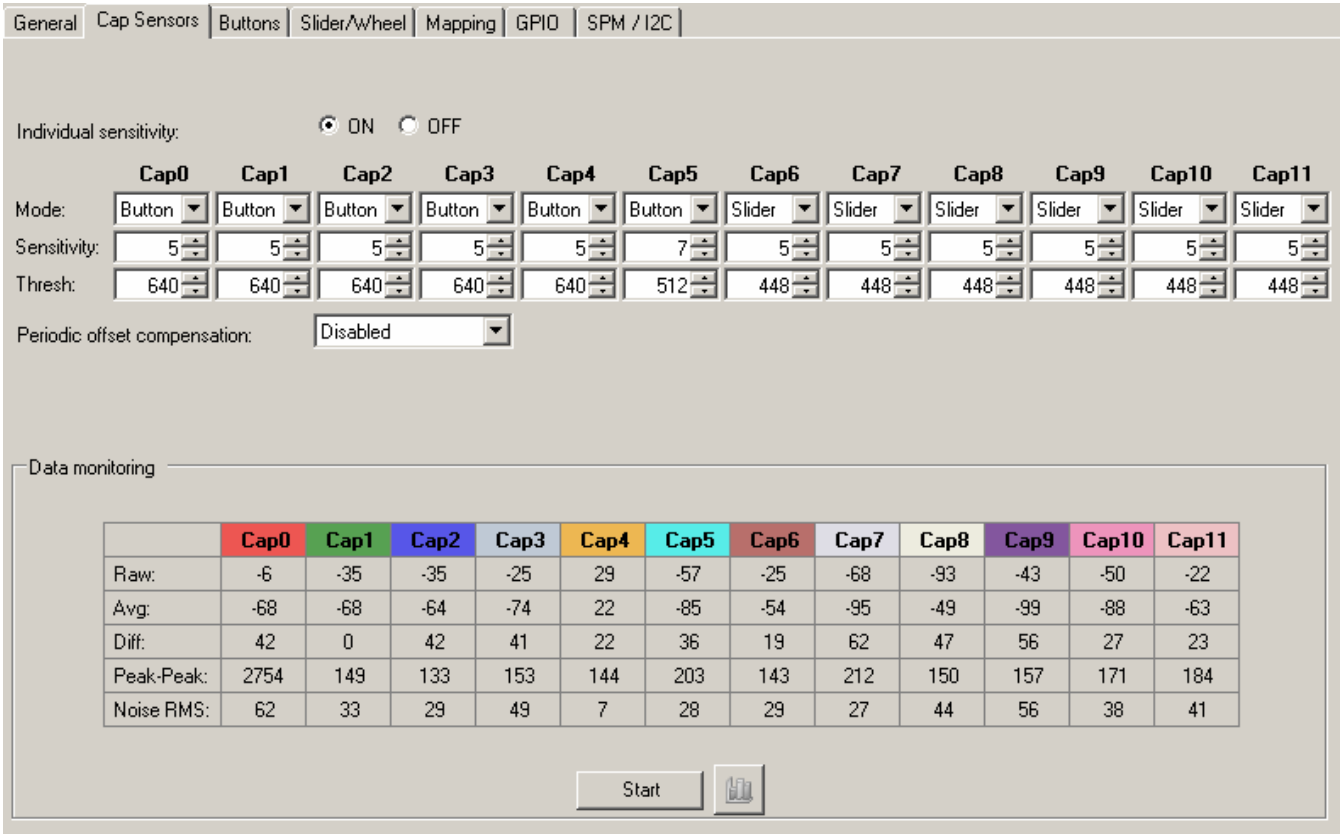


Figure 18: Cap Sensors tab

- then push the Start button at the bottom.

- a stop button 

and the monitor icon  will appear.

- click on the monitor icon.

- a window appears with the sensor data.

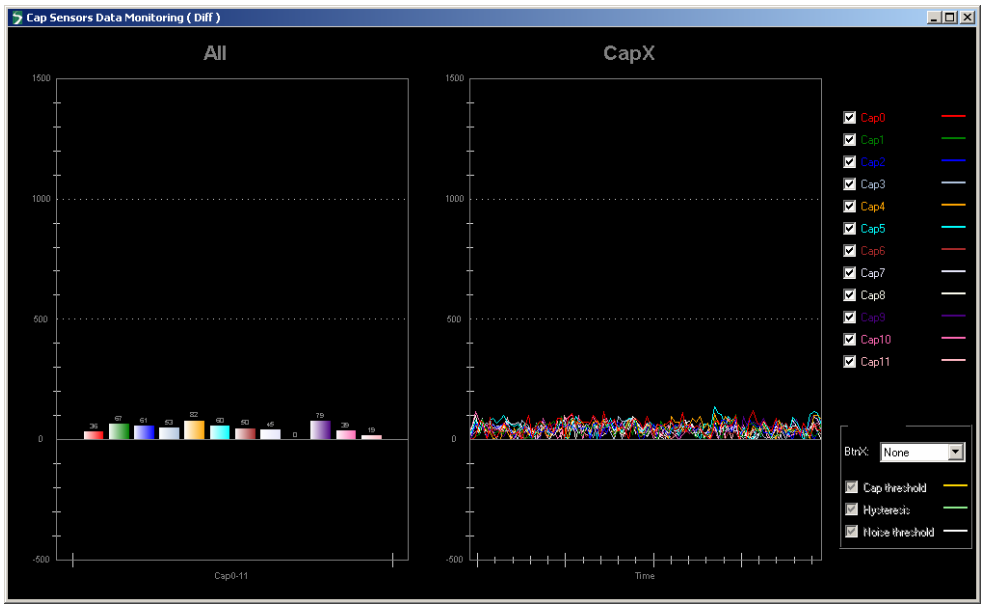


Figure 19: Monitor tab

The left graph shows the current values of all enabled sensors.
The right graph shows the sensor values over time (like an oscilloscope).

- select button 0 in the lower right corner

Figure 20: Select thresholds, hysteresis

This will superpose the detection threshold and hysteresis (yellow and green lines) on the graphs.
If one touches button0 and the red signal goes above the threshold+hysteresis the SX8644 or SX8645 considers that as a touch.
If the signal goes below the threshold – hysteresis the button is released.

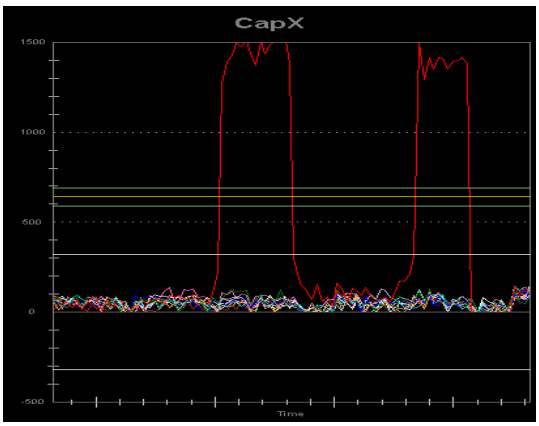


Figure 21: two successive touches on button 0

- click on the stop button  on the Cap Sensor tab to go back to normal mode.

4.7 Sensitivity

The sensor sensitivity needs to be adapted to the thickness of the overlay, permittivity of the overlay, the size of the buttons and detection thresholds.
The following shows a typical example of changing the sensitivity of the sensors using the EVK.

If the user touches button 0 as in the previous section then the sensor values are relatively large as the threshold is passed with a lot off margin.

The sensitivity of a button can be modified easily in the Cap Sensors Tab.

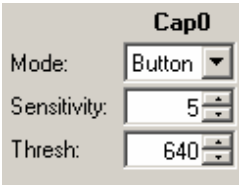


Figure 22: sensitivity (5) of button 0

The default sensitivity for button 0 is five. A lower sensitivity would operate as well for button 0.
Going into monitor mode as described in the previous section is required to observe the sensor signal and thresholds and hysteresis.

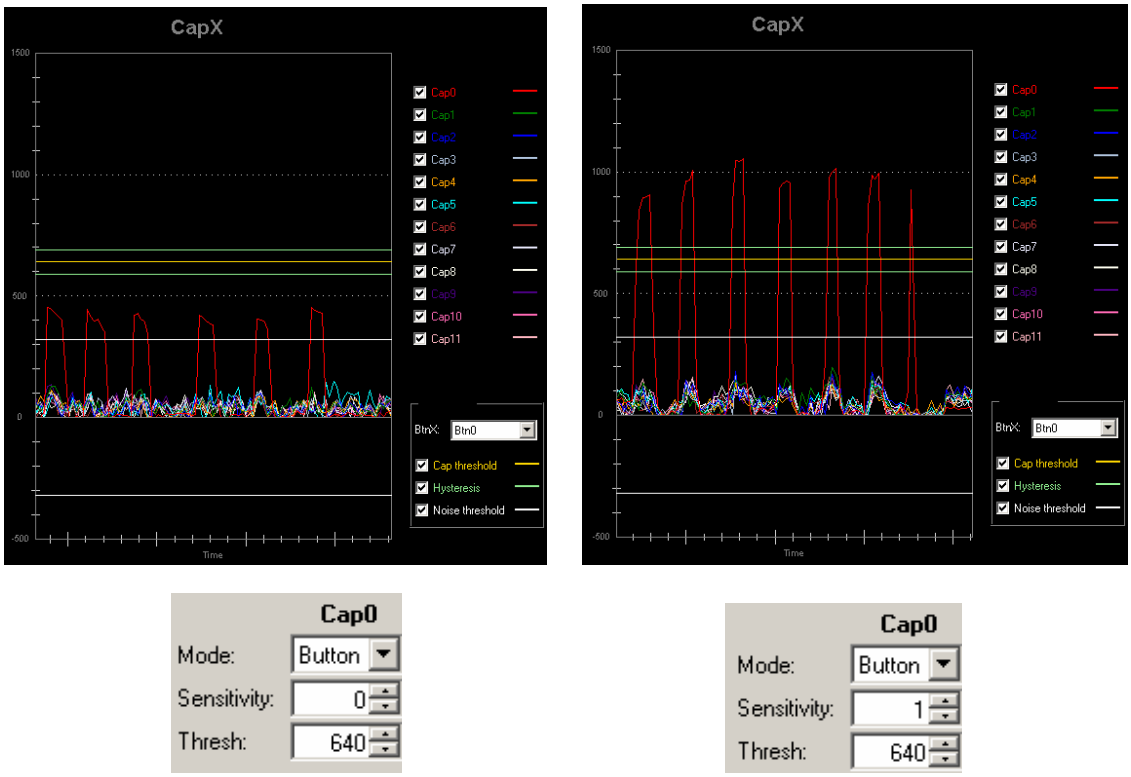


Figure 23: sensitivity (0) of button 0, sensitivity (1) of button 0

The above figures show that button 0 requires at least a sensitivity of 1 to pass the detection threshold and hysteresis (green)
If the sensitivity is set to 0 the sensor values are not large enough to exceed the threshold anda touch will never be detected.

5 GUI Description

5.1 GUI Overview

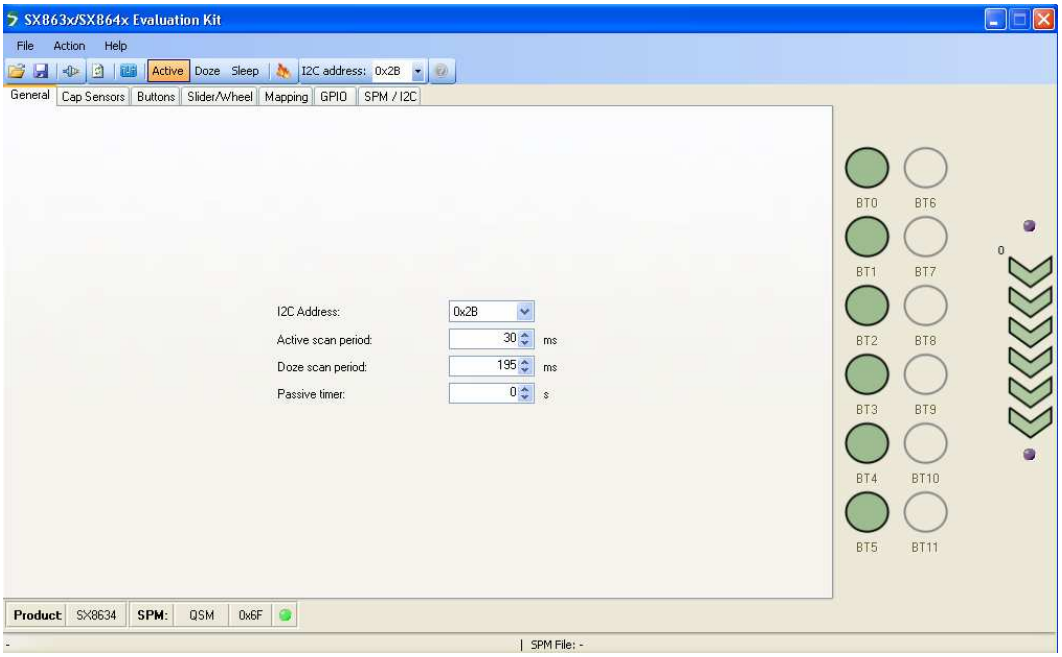


Figure 24: SX8634/44 GUI Overview

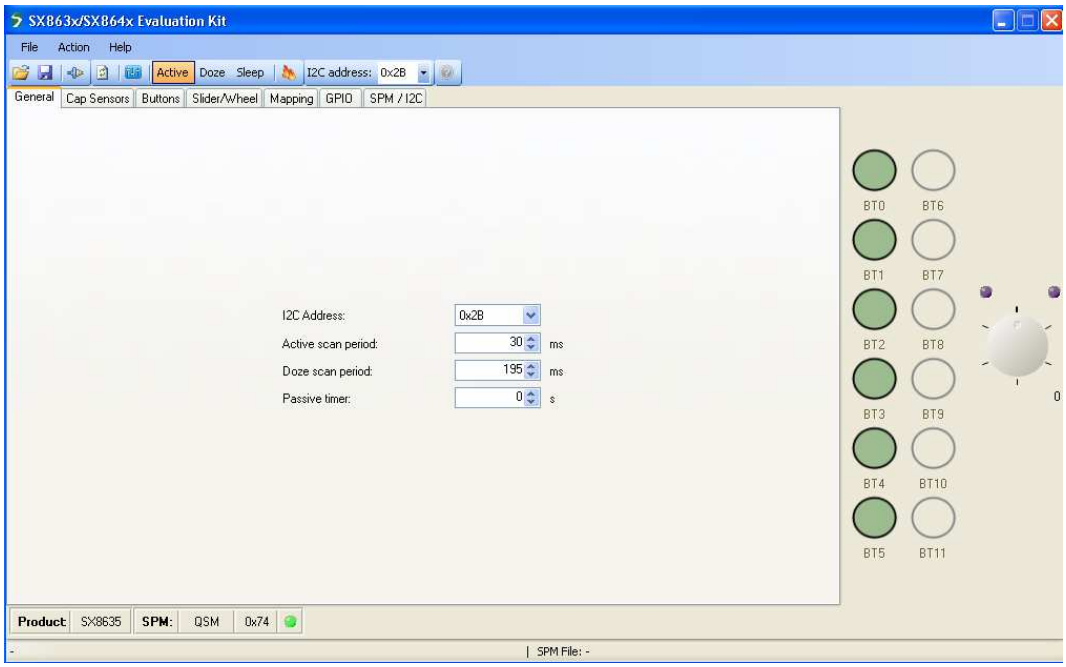


Figure 25: SX8635/45 GUI Overview

5.2 File Menu

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

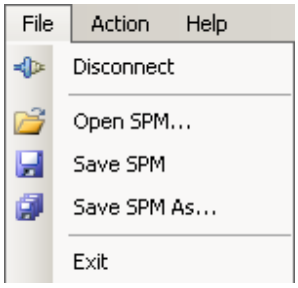


Figure 26: File Menu

5.2.1 Connect/Disconnect

This item is used to connect/disconnect the GUI to/from the EVK.
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. 

5.2.2 Open SPM

The GUI offers the possibility to save/load the SPM parameters into/from a file.

The "Open SPM" feature reads a SPM file, stored on the PC, and copies the content to the SPM of the SX863x/4x.

This feature is also available directly on the toolbar. 

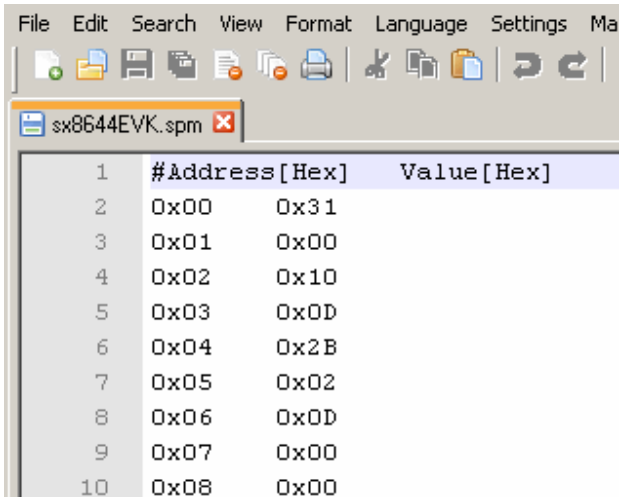


Figure 27: SPM File Example (begin)

The SPM files contain 128 data bytes for the address 0x00 to 0x7F.
The end of the SPM file is shown below.