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# CY3280-MBR2 CapSense<sup>®</sup> Express<sup>™</sup> with SmartSense<sup>™</sup> Auto-Tuning Kit Guide

Doc. # 001-71857 Rev. \*C

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# 1. Introduction



Thank you for your interest in the CY3280-MBR2 CapSense® Express™ with SmartSense™ Auto-Tuning Kit. This kit is designed to showcase the abilities of the CY8CMBR2110 register configurable CapSense controller. The CY8CMBR2110 controller is equipped with SmartSense, which enables engineers to go from prototyping to mass production without tuning for manufacturing variations in PCB and overlay material properties.

This guide provides details on the kit contents, installation procedure, hardware descriptions, sample configurations, schematics, and the bill of materials.

The kit package includes the EZ-Click customizer tool, which is required to configure the kit. For more information and to download the tool, visit <http://www.cypress.com/go/ez-click>.

## 1.1 Kit Contents

- CY3280-MBR2 kit
- Two AAA batteries (unassembled)
- Overlay (3-mm thickness)
- A to Mini-B USB cable
- Screw driver
- Five samples of CY8CMBR2110-LQXI
- CY3280-MBR2 kit CD/DVD
- Flex-PCB (with 1-mm overlay)
- Quick start guide

## 1.2 Factory Default Configuration

The kit installation folder includes three configuration files that demonstrate several features. The [Sample Configurations chapter on page 35](#) provides details of these configuration files. When shipped, the CY3280-MBR2 board is configured with Sample Configuration1 file.

## 1.3 Reference Documents

The following documents can be used for reference:

- [CY8CMBR2110 CapSense Design Guide](#)
- [CY8CMBR2110 Datasheet](#)
- [EZ-Click Customizer Tool User Guide](#)
- [CY3280-BSM](#)
- [Getting Started with CapSense Guide](#)

## 1.4 Acronyms

Acronym	Definition
BSM	Simple Button Module
CSD	CapSense Sigma-Delta
ESD	Electrostatic Discharge
GUI	Graphic User Interface
IIC	Inter Integrated Circuit
LED	Light Emitting Diode
MBR	Mechanical Button Replacement
NC	Not Connected
PCB	Printed Circuit Board
PC	Personal Computer
USB	Universal Serial Bus

## 1.5 Document Revision History

Table 1-1. Revision History

Revision	PDF Creation Date	Origin of Change	Description of Change
**	04/04/2012	ZINE	Initial version of kit guide
*A	11/16/2012	ZINE	Updated <a href="#">Getting Started chapter on page 9</a> . Updated all images.
*B	03/04/2013	ZINE	Updated Title Updated all images in Chapter 2 Updated Procedure in <a href="#">Configuring CY8CMBR2110 CapSense Controller on page 14</a> Updated <a href="#">Configuring CY8CMBR2110 CapSense Controller on page 14</a> and <a href="#">Kit Features on page 16</a> Updated <a href="#">Table 4-1 on page 32</a> Updated <a href="#">Appendix chapter on page 39</a>
*C	05/22/2013	ZINE	Updated <a href="#">Kit Operation chapter on page 13</a> .

## 1.6 Documentation Conventions

Table 1-2. Document Conventions for Guides

Convention	Usage
Courier New	Displays file locations, user entered text, and source code: C:\...cd\icc\
<i>Italics</i>	Displays file names and reference documentation: Read about the <i>sourcefile.hex</i> file in the <i>PSoC Designer User Guide</i> .
<b>[Bracketed, Bold]</b>	Displays keyboard commands in procedures: <b>[Enter]</b> or <b>[Ctrl] [C]</b>

Table 1-2. Document Conventions for Guides

Convention	Usage
File > Open	Represents menu paths: File > Open > New Project
<b>Bold</b>	Displays commands, menu paths, and icon names in procedures: Click the <b>File</b> icon and then click <b>Open</b> .
Times New Roman	Displays an equation: $2 + 2 = 4$
Text in gray boxes	Describes Cautions or unique functionality of the product.





## 2. Getting Started



This chapter describes the installation of the CY3280-MBR2 CapSense Express with SmartSense Auto-Tuning Kit.

### 2.1 Before you Begin

All Cypress software installations require administrator privileges, but this is not required to run the installed software.

1. Shut down any Cypress software that is currently running.
2. Disconnect ICE-Cube or MiniProg1 devices from your computer.

### 2.2 Installation Procedure

Install the EZ-Click customizer tool to load and run the sample configurations onto the board. You can also build your own configuration file using this tool. Follow these steps to install the CY3280-MBR2 kit package:

1. Insert the kit CD/DVD into the CD/DVD drive of your PC. The CD/DVD is designed to auto-run and the kit installer startup screen appears.

**Note** You can also download the latest kit installer from <http://www.cypress.com/go/CY3280-MBR2>. Three different types of installers are available for download.

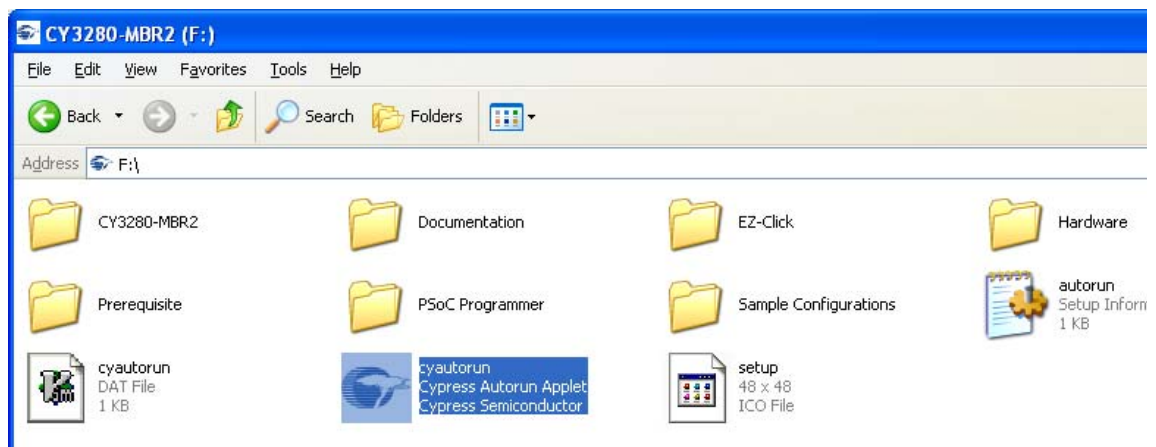
- a. CY3280-MBR2\_ISO: This file (ISO image) is an archive file of the optical disc provided with the kit. You can use this to create an installer CD/DVD or extract information using WinRar or similar tools.
  - b. CY3280-MBR2\_Single Package: This executable file installs the contents of the kit CD/DVD, which includes PSoC Programmer, PSoC Designer, kit code examples, kit hardware files, and user documents.
  - c. CY3280-MBR2\_Single Package (without prerequisites): This executable file installs only the kit contents, which includes kit code examples, hardware files, and user documents.
2. Click **Install CY3280-MBR2** to start the kit installation, as shown in [Figure 2-1](#).

Figure 2-1. Kit Installer Startup Screen



**Note** If auto-run does not execute, double-click *cyautorun.exe* file on the root directory of the CD/DVD, as shown in Figure 2-2. To access the root directory, click **Start > My Computer > CY3280-MBR2 <drive:>**.

Figure 2-2. Root Directory of CD/DVD



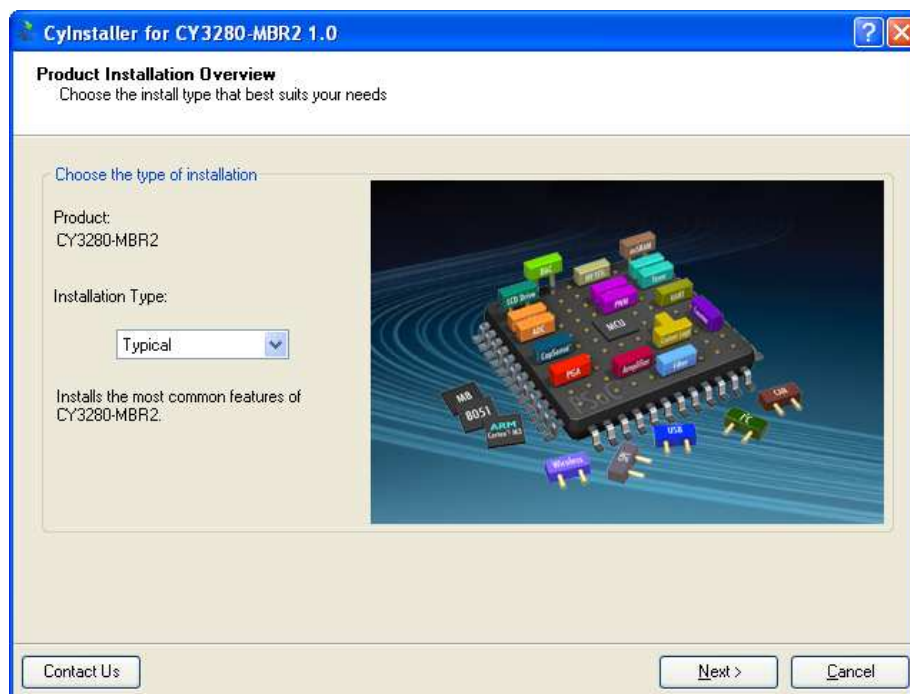
3. On the startup screen, click **Next** to start the installer.
4. The **InstallShield Wizard** screen appears. On this screen, choose the folder location to install the setup files. You can change the folder location for setup files using **Change**, as shown in Figure 2-3.
5. Click **Next** to launch the kit installer.

Figure 2-3. InstallShield Wizard



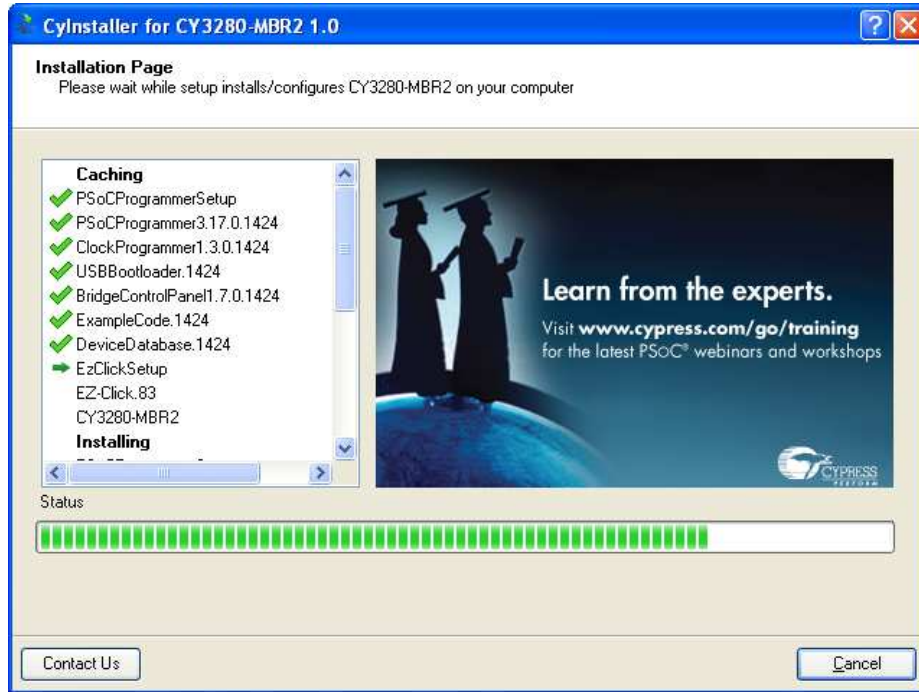
6. On the **Product Installation Overview** screen, select the installation type that best suits your requirement. The drop-down menu has three options: **Typical**, **Complete**, and **Custom**, as shown in [Figure 2-4](#). If you are uncertain, proceed with the default setting (Typical).
7. Click **Next** to start the installation.

Figure 2-4. Installation Type Options



8. When the installation begins, a list of all packages appear on the **Installation Page**. A green checkmark appears against every package that is downloaded and installed, as shown in [Figure 2-5](#).
9. Wait until all the packages are downloaded and installed successfully.

Figure 2-5. Installation Page



10. Click **Finish** to complete the installation.

Figure 2-6. Installation Complete



### 3. Kit Operation



The CY8CMBR2110 CapSense controller supports multiple features. The CY3280-MBR2 CapSense Express Kit package includes the hardware required to demonstrate these features. This chapter details these features along with how to use them with the kit.

To start using the kit, open the case using the screw driver and insert the two AAA batteries in the battery holder. Assemble the case using the screw driver provided with the kit. Touch the power button first and ensure the power button, LED1, and LED2 light up. Each CapSense button is mapped to an LED such that activation of a button can be verified by monitoring the LED status. The ON status of LEDs indicate that the CapSense buttons are active.

The Flex-PCB with 10 buttons can be connected to the kit via the 44-pin expansion connector (see [Hardware chapter on page 31](#) for details). Power off the kit before connecting the Flex-PCB. When the kit is powered, a finger touch on the Flex-PCB buttons lights up the respective LED on the kit.

Figure 3-1. CY8CMBR2110 CapSense Controller Kit with Flex-PCB

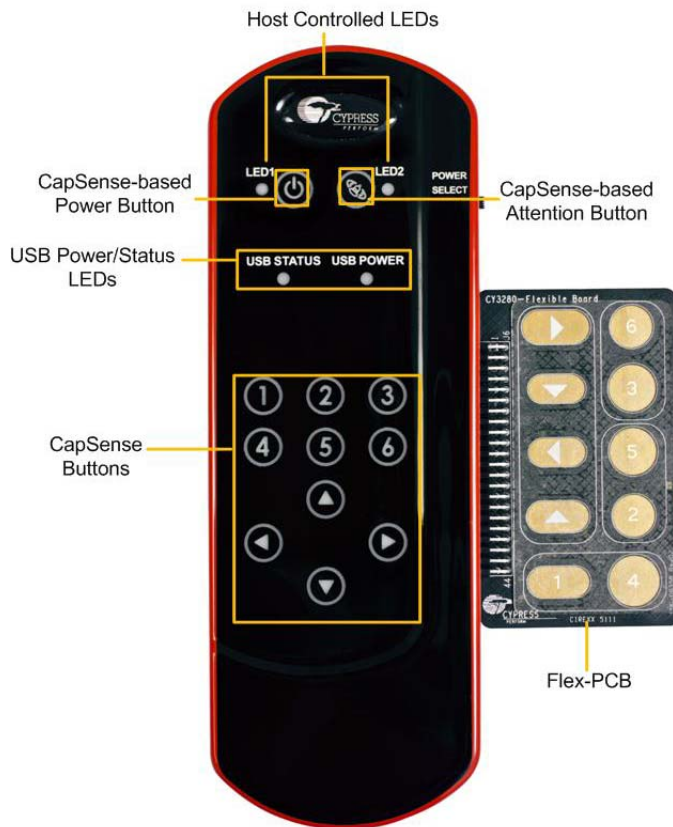
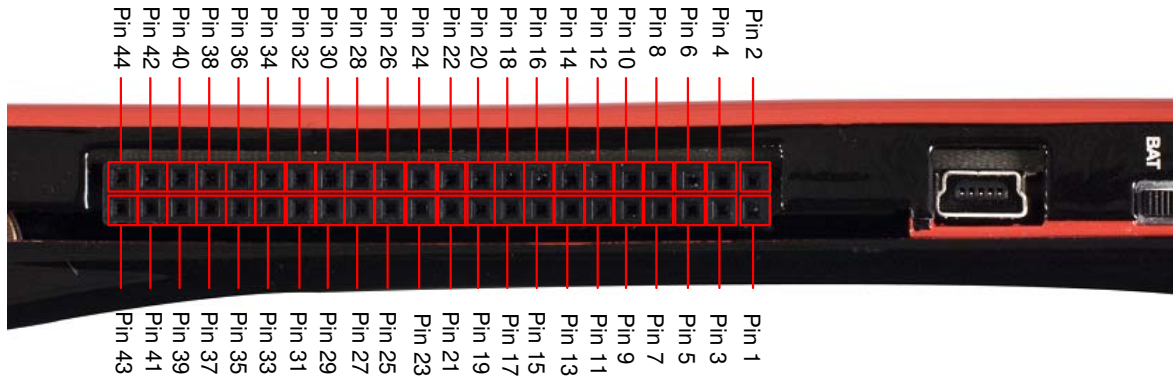


Figure 3-2. Expansion Connector



### 3.1 CY8CMBR2110 CapSense Controller Features

The CY8CMBR2110 controller has the following features:

- SmartSense Auto-Tuning - Supports auto-tuning
- Toggle (Touch ON/OFF) - Allows mechanical button replacement
- Flanking sensor suppression - Provides discrimination between closely spaced sensors
- LED ON time - Provides better visual feedback based on button press
- Button auto reset - Prevents stuck sensor, caused by placing a metal object close to the sensor
- Debounce control - Prevents false button trigger
- Buzzer signal output - Enables connecting the buzzer directly to the device
- Host controlled general-purpose output (GPO) - Enables control by the host (I2C master)
- Power-on LED effects
- Button controlled LED effects
- System diagnostics - supports production testing and debugging

See the [CY8CMBR2110 datasheet](#) for more details on these features.

The CY3280-MBR2 CapSense Express Kit can be configured using the EZ-Click customizer tool. Three configuration file projects are included with the kit. Additional configurations can be generated using the tool.

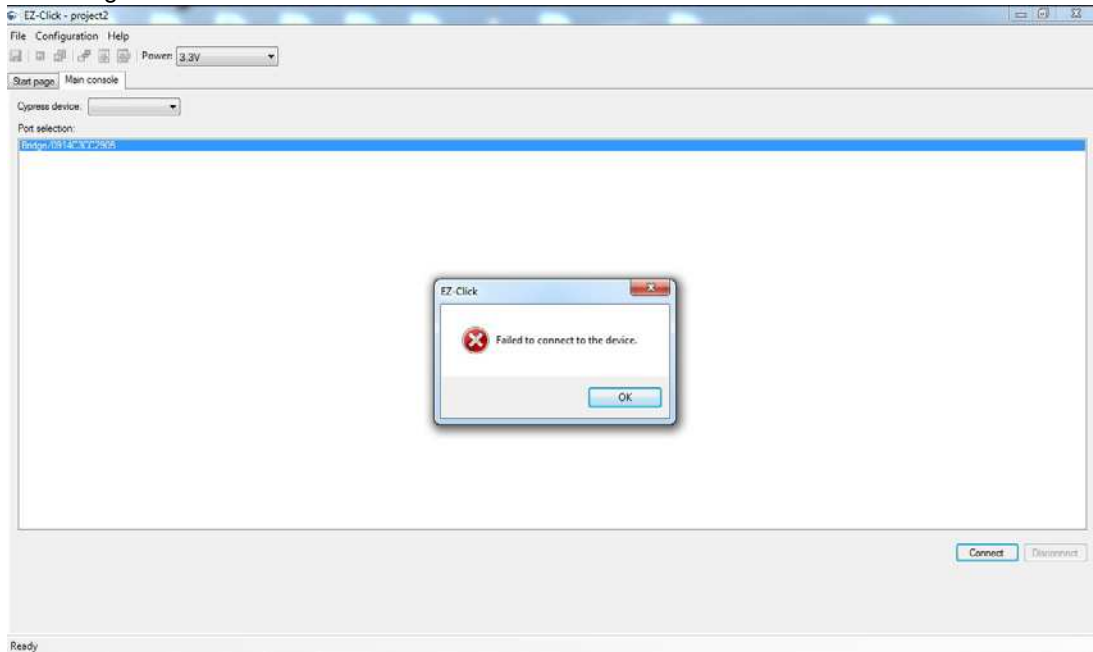
#### 3.1.1 Configuring CY8CMBR2110 CapSense Controller

Follow these steps to configure the CY8CMBR2110 controller:

To configure the kit and test the features supported by it, follow these steps:

1. Connect the CY3280-MBR2 kit to the PC via the USB port using the USB cable and move the switch position to GUI. Ensure USB Status LED glows.
2. Open the EZ-Click customizer tool from the default location: **Start > All Programs > Cypress > EZ-Click <version> > EZ-Click.**
3. Create a new project in the EZ-Click customizer tool by clicking on **New Project** under **File** menu.
4. In the Main console tab, choose the **Cypress device** to be **CY8CMBR2110**.

5. Connect the kit to the EZ-Click tool using the following steps.
  - a. Click on the **Connect** button on the **Main Console** tab of the EZ-Click customizer tool. The EZ-Click will throw an error as shown. Click **OK** on the pop-up window. Ensure USB Power LED glows.



- b. Touch the **Power** button to turn **ON** the kit. Ensure Power button, LED1, LED2 and Attention button glows.
  - c. Click the **Connect** button on the **Main Console tab** of the EZ-Click customizer tool. Ensure you see the device connected in the status window of the Main Console tab.
6. Select the number of buttons as desired. You can select up to 10 buttons for any configuration. The numbering starts with 0 in the EZ-Click customizer tool and is mapped to button 1 of the kit. Button 1 in the tool maps to button 2 of the kit and so on.
7. Modify the project to enable features as mentioned in the sections [3.2.2](#) to [3.2.11](#).
8. Generate the configuration file by pressing Ctrl + G.
9. Click on **Apply Current Config** under **Configuration** menu in the EZ-Click customizer tool.
10. Touch the **Power** button to turn **ON** the kit and observe the feature as explained in the respective sections.

**Note:** A sample EZ-Click configuration file Sample Configuration1 file is pre-loaded into the kit. The kit will support the features mentioned in [5.1.1 Loading Configuration File 1 on page 35](#) by default. To know more about Sample configurations see [Sample Configurations on page 35](#).



## 3.2 Kit Features

The following sections demonstrate each feature of this device.

### 3.2.1 SmartSense Auto-Tuning

The CY8CMBR2110 CapSense controller is built with a robust CSD capacitive sensing method and patented SmartSense auto-tuning algorithm. SmartSense Auto-Tuning tunes each sensor automatically at power up; it then monitors and maintains optimum sensor performance during run time. This technology adapts for manufacturing variation in PCBs, environmental conditions, and noise sources such as LCD inverters, AC line noise, and switch-mode power supplies, and automatically tunes them out.

SmartSense auto-tuning feature does not need to be enabled using EZ-Click and is automatically enabled on power-up. This feature can be verified on all the buttons, which are enabled. This kit is pre-loaded with Sample Configuration1, which supports 10 buttons and all 10 buttons demonstrates SmartSense by default.

This feature is demonstrated as follows.

1. Ensure that the Power select switch is in BAT position. Power the kit by touching the Power button.
2. Touch any button and observe that the respective LED lights up without any manual tuning.
3. Power off the kit. Connect the Flex-PCB and then power the kit. When there is a finger touch on the Flex-PCB, the respective LED on the kit lights up without any tuning. The change in sensor parasitic capacitance ( $C_p$ ) due to the Flex-PCB and the overlay is auto tuned by the SmartSense Auto-Tuning algorithm. Hence, no manual tuning is required.
4. Flex-PCB has a 1 mm overlay pasted on top of it. You can also use the 3 mm overlay provided with the kit on top of 1mm overlay in the same way as explained above to verify SmartSense auto-tuning feature.

#### Notes

- Button 2, Left, and Up navigation buttons on the Flex-PCB may not work with 4 mm overlay (1 mm + 3 mm). The loss of sensitivity of these buttons is due to the overlay thickness and small size of these buttons. To find the required button diameter for particular overlay thinness, refer to the [CY8CMBR2110 Design Toolbox](#).
- It is recommended not to use the buttons on the main kit while the Flex-PCB is connected to the kit.
- The exposed Flex-PCB header pins should not be touched while the kit is powered ON. Touching these pins can act as adding the required finger capacitance. This will lead to false triggers.
- The Flex-PCB is for demonstrating SmartSense Auto-tuning feature and cannot be used for your product design.

Figure 3-3. Demonstration of SmartSense Auto-Tuning with Flex-PCB



SmartSense Auto-Tuning algorithm can also be tested on the Simple Button Module (BSM) board. The BSM board can be connected to the kit and tested for SmartSense Auto-Tuning in the same way as the Flex-PCB. BSM board is not provided as part of this kit. To purchase or know more about BSM board, refer to the [Cypress website](#). The Flex-PCB needs to be disconnected from the kit to test the features mentioned in the subsequent sections.

The following sections demonstrates how to enable and verify various visual and audio features of the kit. These features require the kit to be configured using the EZ-Click customizer tool.

Follow the steps below to observe the features discussed in sections 3.2.2 to 3.2.10.

- a. Create a new project in the EZ-Click customizer tool by following the steps 1-7 in section 3.1.1.
- b. Modify the project to enable features explained in the following sections.

- c. Apply the configuration to the kit by following step 7-9.
- d. Verify the feature as explained in the sections 3.2.2 to 3.2.10.

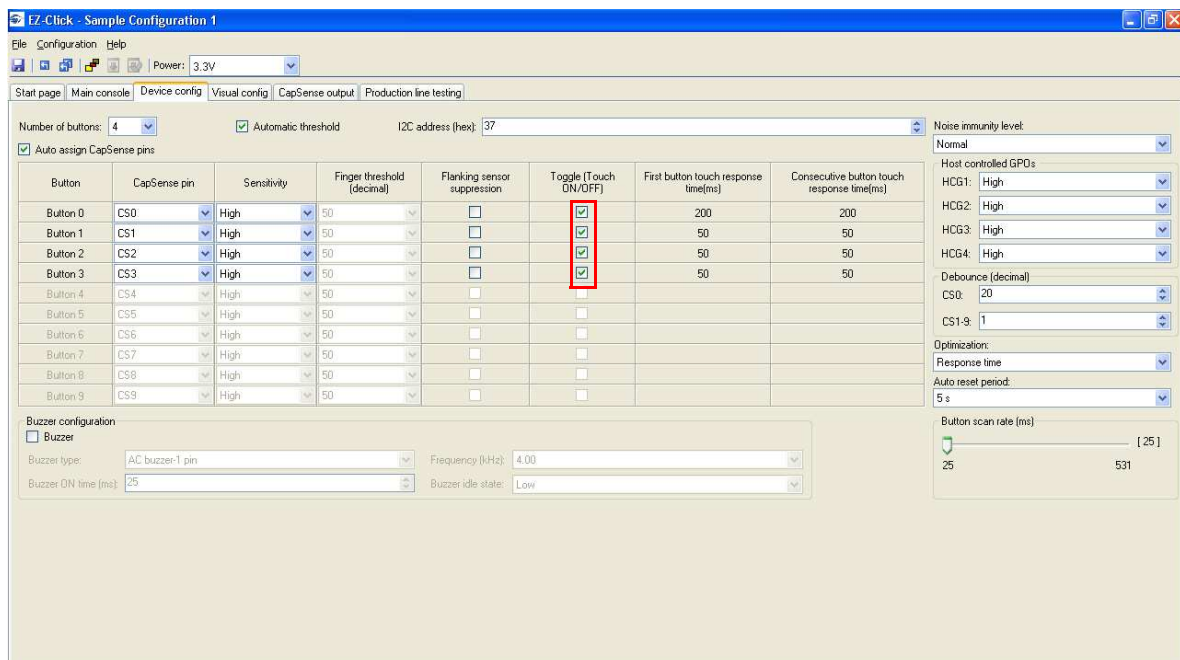
Ensure that you have a new project every time you verify a different feature. Enabling two or more features may or may not work at the same time. See the [CY8CMBR2110 datasheet](#) to know about the features, which will not work together.

### 3.2.2 Toggle (Touch ON/OFF)

#### 3.2.2.1 Enable Toggle (Touch ON/OFF)

Go to the **Device Config** tab; select the **Toggle (Touch ON/OFF)** checkbox to enable the toggle feature for the desired number of buttons. The [Figure 3-4](#) shows toggle feature enabled in four buttons.

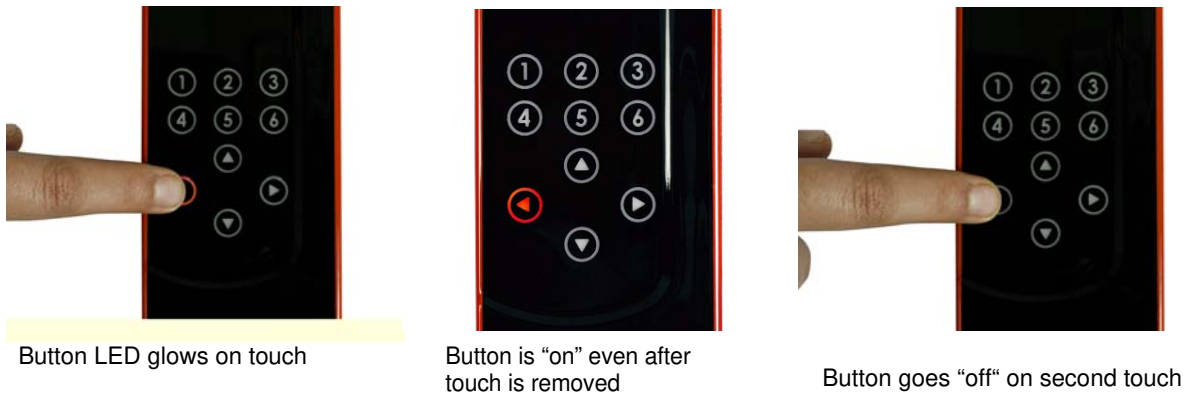
Figure 3-4. Toggle (Touch ON/OFF) Feature GUI



#### 3.2.2.2 Test CapSense Buttons with Toggle (Touch ON/OFF) Enabled

1. Touch a CapSense button for which the Toggle (Touch ON/OFF) feature is enabled; the respective LED turns on.
2. Touch the same button again; the LED turns off.
3. On the next touch, the LED goes on again.

Figure 3-5. Toggle (Touch ON/OFF) Enabled

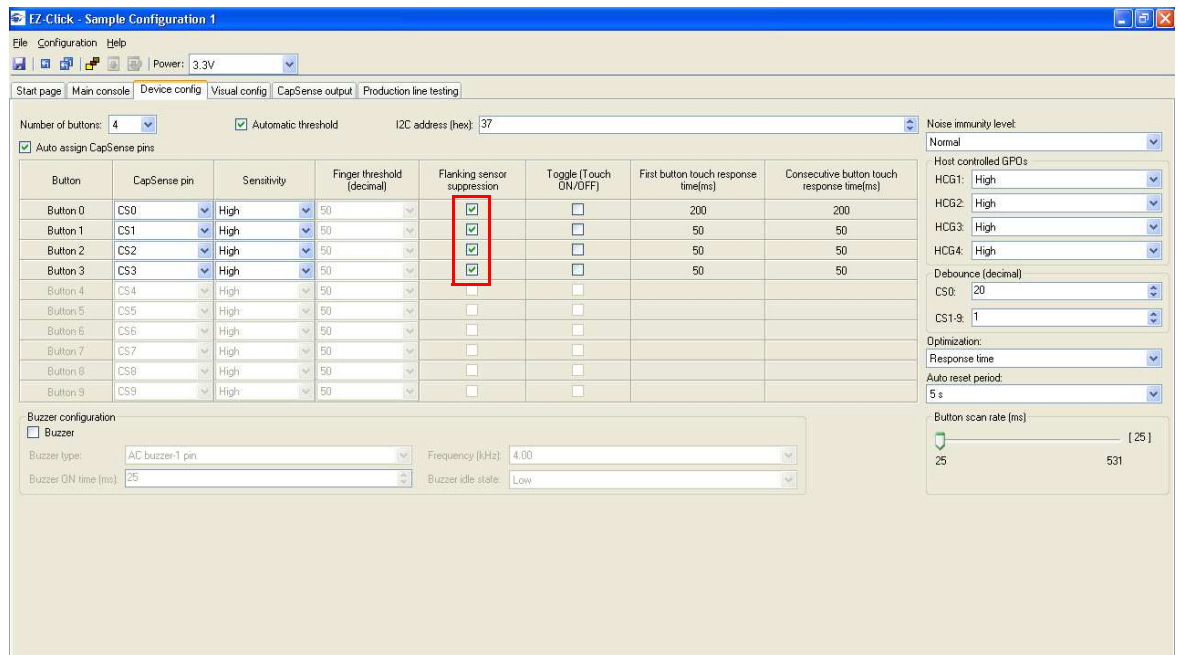


### 3.2.3 Flanking Sensor Suppression (FSS)

#### 3.2.3.1 Enable Flanking Sensor Suppression

Go to the **Device Config** tab; select the **Flanking Sensor Suppression** checkbox to enable the FSS feature for the desired number of buttons.

Figure 3-6. FSS Enabled



#### 3.2.3.2 Test CapSense Buttons with FSS Enabled

1. Touch a FSS-enabled CapSense button; the respective LED turns on.
2. Without removing the touch, touch another FSS-enabled button; the LED does not glow for the second button.
3. Remove the touch from the first button. Now, touch any other FSS-enabled button; the respective LED glows.

Figure 3-7. FSS Enabled

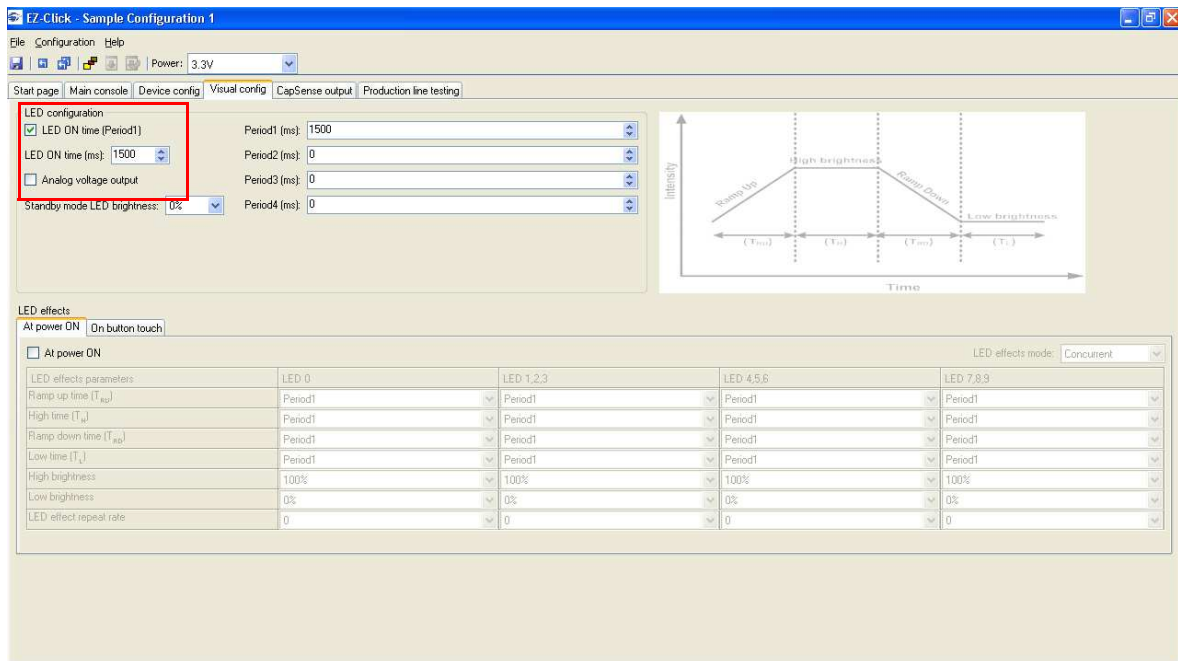


### 3.2.4 LED ON Time

#### 3.2.4.1 Enable LED ON Time

Go to the **Visual Config** tab; select the **LED ON time** checkbox to enable this feature. This is a global setting applicable for all CapSense buttons. To set the time, configure the **LED ON time** menu below the checkbox.

Figure 3-8. LED ON Time Enabled



#### 3.2.4.2 Test CapSense Buttons with LED ON Time Enabled

Touch any CapSense button; the respective LED turns on. When the finger is released, the LED turns off after the duration specified in **LED on time** (msec) in the **Visual Config** tab.

Figure 3-9. LED ON Time Enabled



Button LED glows on touch

Button is “on” even after touch is removed

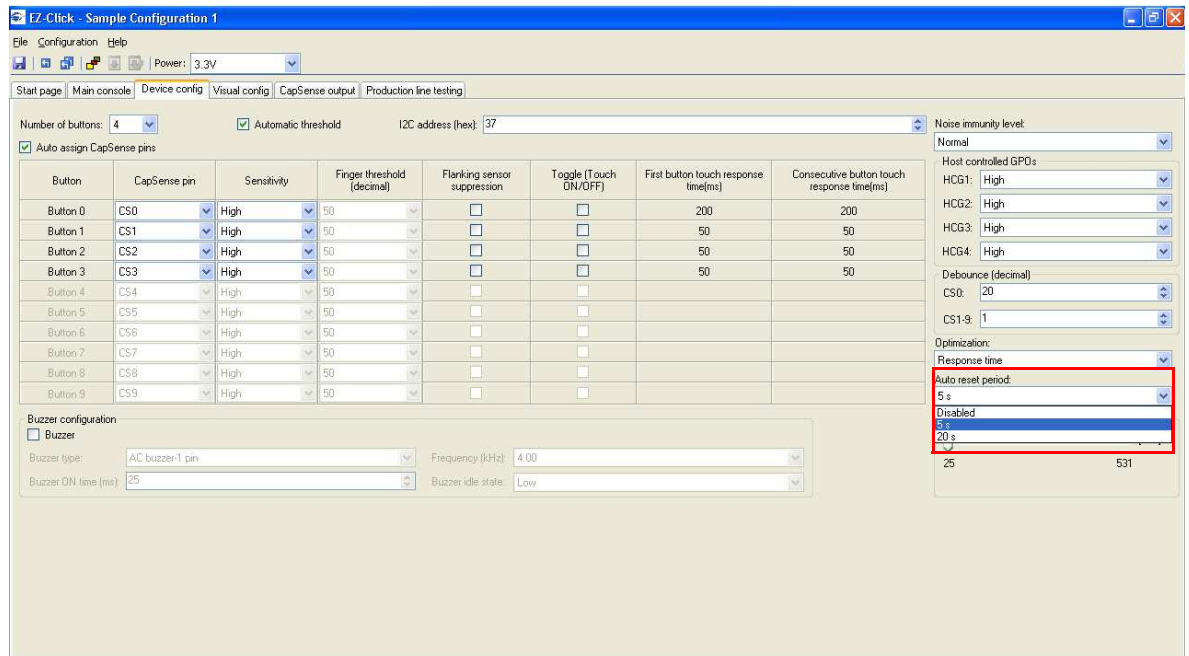
Button goes “off” after the LED On time

### 3.2.5 Button Auto Reset (ARST)

#### 3.2.5.1 Enable Button Auto Reset

Go to the **Device Config** tab; select the **Auto reset period** menu to enable this feature. The reset time can be set as either 5 or 20 seconds.

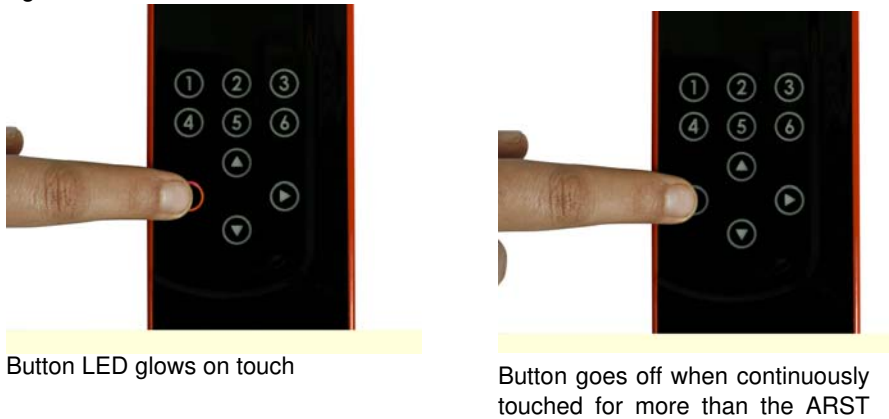
Figure 3-10. ARST Enabled



#### 3.2.5.2 Test CapSense Buttons with ARST Enabled

Touch any CapSense button; the respective LED turns on. Do not release the button; keep the finger pressed for 5 seconds or 20 seconds, as selected. Notice that the LED turns off automatically after 5 seconds or 20 seconds according to the setting applied. Release the buttons and touch the same buttons again, it works as usual.

Figure 3-11. ARST Enabled

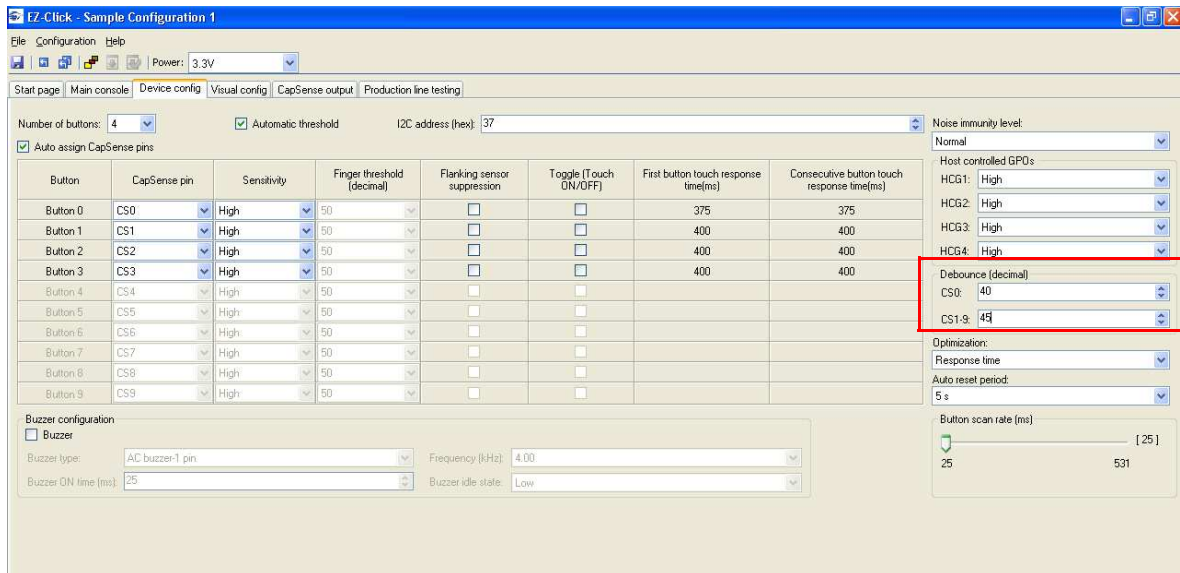


### 3.2.6 Debounce Control

#### 3.2.6.1 Enable Debounce Control

Go to the **Device Config** tab; enter the required debounce number in the **Debounce** menu. Enter a value from 1 to 255 in the option available for CS0 and CS1-CS9.

Figure 3-12. Setting Debounce Parameter

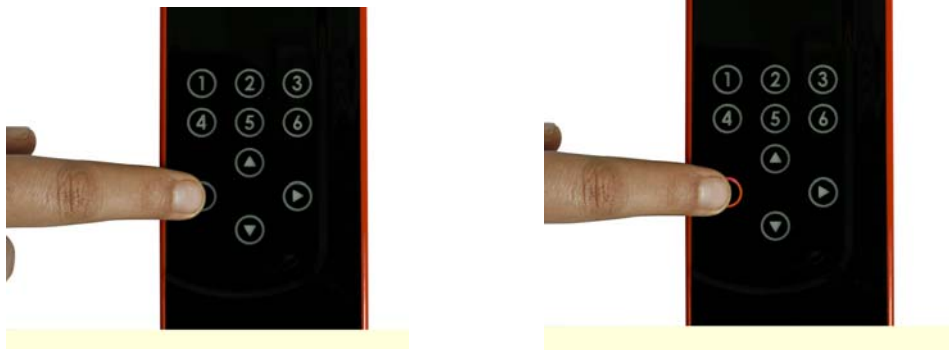


#### 3.2.6.2 Test CapSense Buttons for Debounce Control

This parameter determines the minimum duration for which the finger must be present on the button to report a "Sensor On".

For example, put 55 in the debounce parameter for CS1-CS9. To calculate the time in milliseconds, the factor 35 should be multiplied with the debounce parameter value. This factor value is only for default settings. For other settings, see the [CY8CMBR2110 datasheet](#). In this case, any CapSense button should be touched more than  $(35 \times 55) = 1925$  ms to turn it on.

Figure 3-13. Debounce Enabled



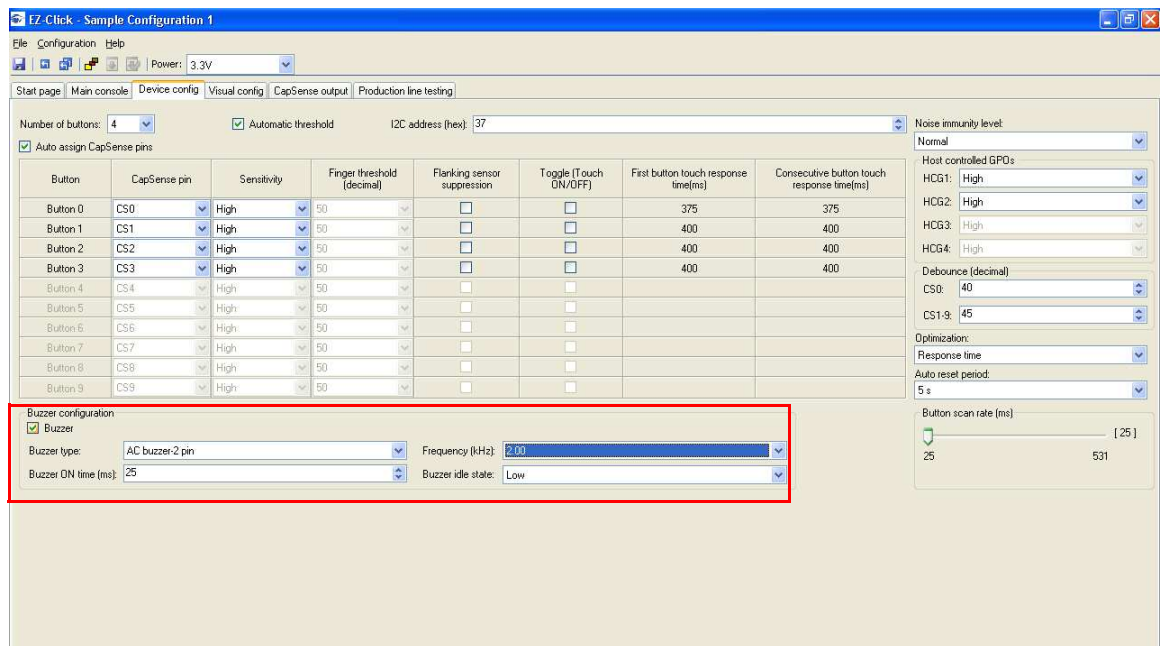
Button does not glow if pressed for less than the time set in the Debounce parameter settings

### 3.2.7 Buzzer Signal Output

#### 3.2.7.1 Enable Buzzer Signal Output

Go to the **Device Config** tab; enable the feature by selecting the **Buzzer** checkbox in the **Buzzer Configuration** section of the page. Set the frequency, number of pins, type (AC buzzer-1 pin or AC buzzer-2 pin), and output duration timing using the respective menu options. Buzzer idle state indicates the state of the buzzer pins when buzzer is not ON. You can configure your buzzer to be in sinking or sourcing mode by selecting HIGH or LOW respectively as your Buzzer Idle state.

Figure 3-14. Buzzer Signal Output Enabled



#### 3.2.7.2 Test CapSense Buttons for Buzzer Signal Output

The button touch gives an audio feedback. The characteristics of the buzzer sound, such as frequency and duration can be observed according to the settings.



### 3.2.8 Host Controlled GPOs

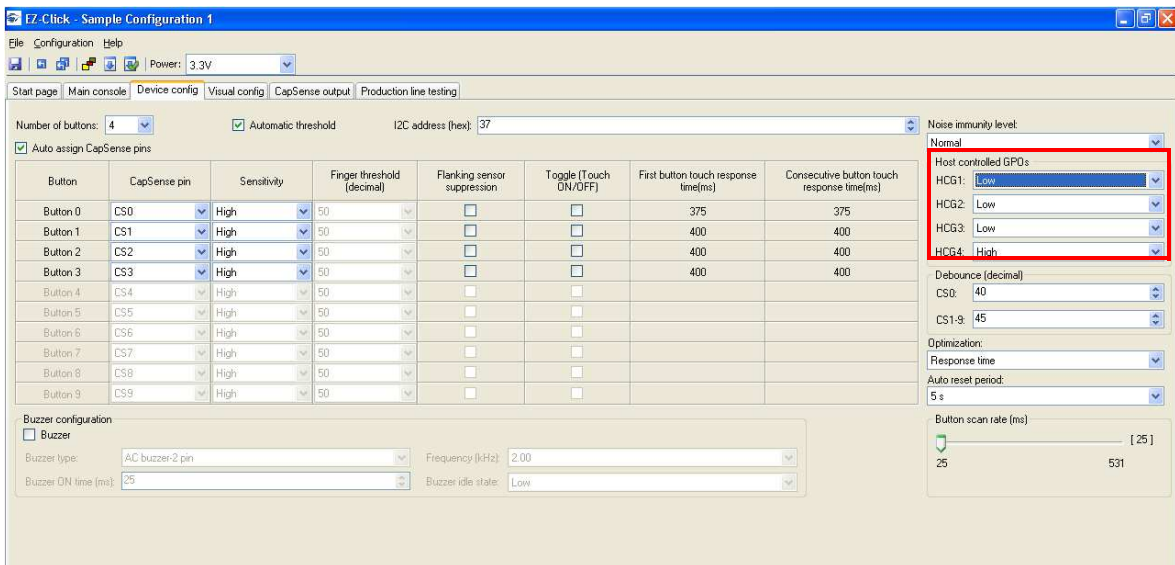
#### 3.2.8.1 Drive Host Controlled GPOs

Go to the **Device Config** tab; drive host controlled GPOs, HCG1 and HCG2, by selecting the **Low** or **High** options in the drop-down. The kit does not have any LEDs mapped to HCG3 and HCG4. These GPOs use the same pins as the buzzer output.

By default, the LEDs light up after the device is powered.

**Note** HCG3 and HCG4 are not available when the AC buzzer-2 pin is enabled. When the AC buzzer-1 pin is enabled, HCG4 is disabled.

Figure 3-15. Host Controlled GPOs GUI



#### 3.2.8.2 Test Host Controlled GPO LEDs

Drive the HCG1 and HCG2 to **Low** in the EZ-Click tool to see the respective LEDs light up. Driving the HCGs **High** will turn off the LEDs.

Figure 3-16. Host Controlled GPO LEDs

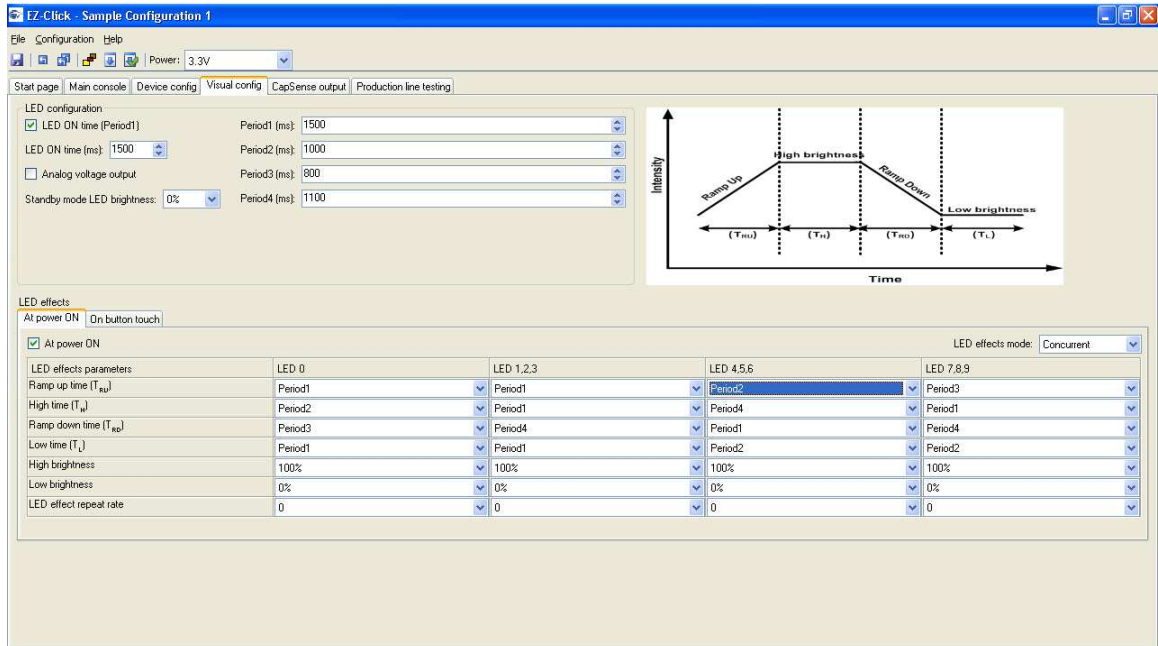


### 3.2.9 Power-On LED Effects

#### 3.2.9.1 Enable Power-On LED Effects

Go to the **Visual Config** tab; select the **At Power On** checkbox under **LED Effects** to enable the feature. Select the values for different parameters such as ramp up time, ramp down time, high time, low time, high brightness, low brightness, and LED effect repeat rate in the **At Power On** tab.

Figure 3-17. Power-On LED Effects Enabled



#### 3.2.9.2 Test CapSense Buttons with Power-On LED Effects Enabled

Observe the LED effects according to the configured setting at every power cycle.

Figure 3-18. Power-On LED Effect Pattern

