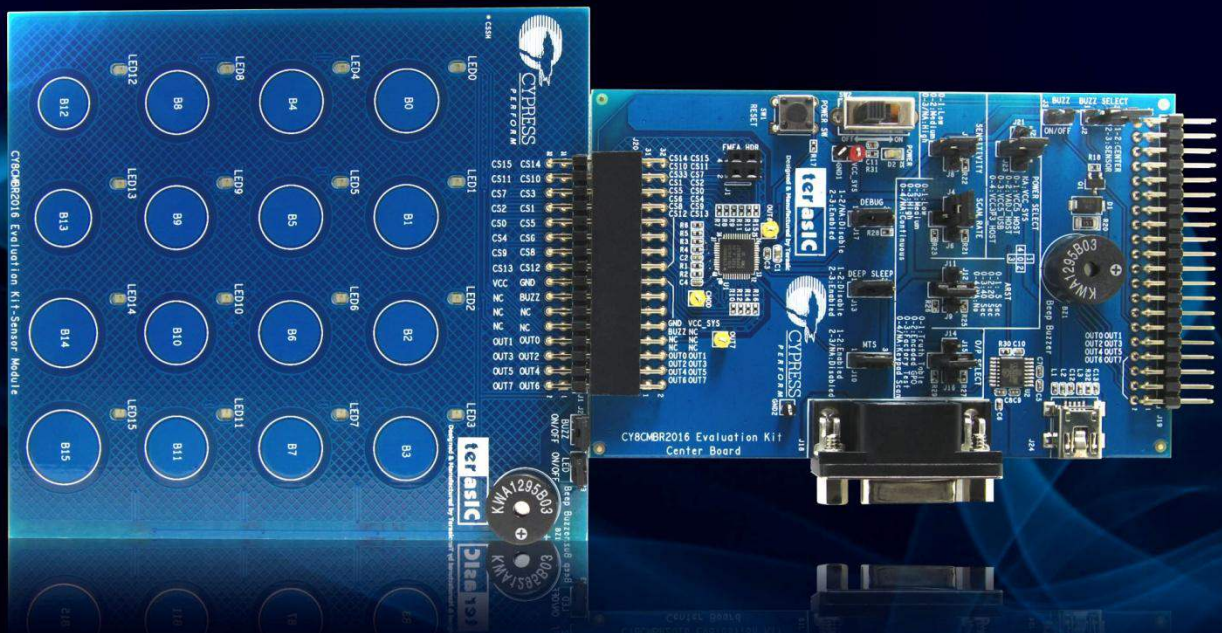


# CapSense CY8CMBR2016 Evaluation Kit

## User Manual



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# Chapter 1

## *Introduction of the CY8CMBR2016 EVK*

The CY8CMBR2016 EVK includes a Center Board and a Sensor Module. This kit is designed to enable users to easily implement a matrix keypad user interface solution using Cypress’s CY8CMBR2016 CapSense® controller with SmartSense™ Auto-Tuning technology. This CY8CMBR2016 CapSense controller is a hardware configurable device that does not require any software tools, firmware coding, or device programming. Cypress's revolutionary SmartSense™ auto-tuning algorithm eliminates the need to manually tune the user interface during development and production ramp. This reduces time to volume and saves valuable engineering time, test time, and production yield loss. The kit contains 16 capacitive touch buttons organized in a matrix-style format appropriate for such as fire alarm control panels, security systems, and door locks.

### 1.1 Features

Figure 1-1 shows a photograph of the CapSense CY8CMBR2016 Evaluation kit.

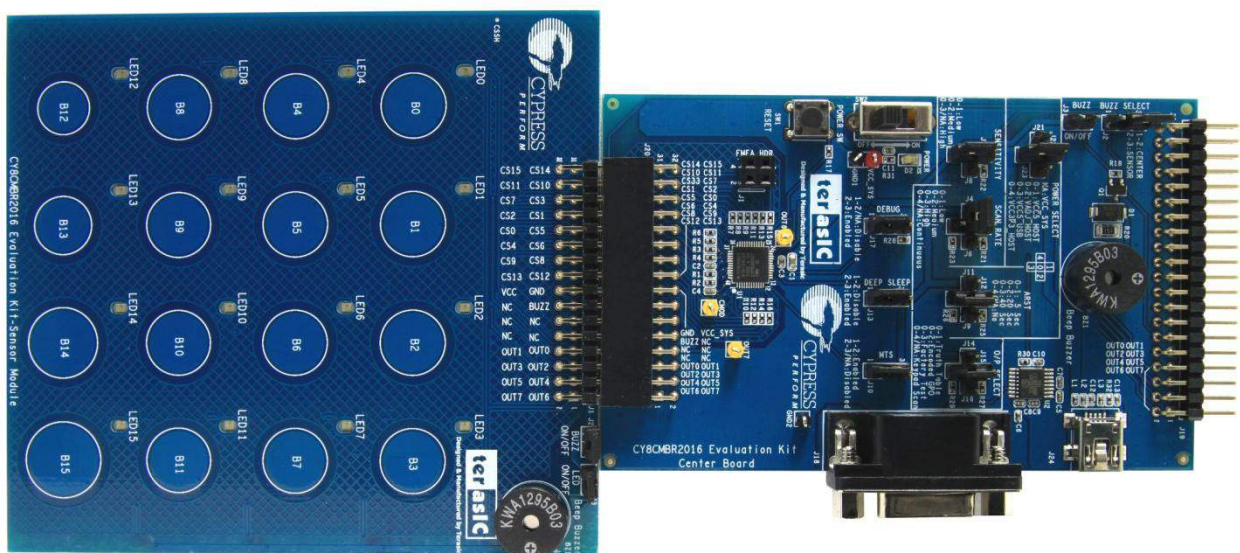


Figure 1-1 Layout of the CapSense CY8CMBR2016 Evaluation kit



Key features of the evaluation kit include:

- 4x4 Matrix Solution
  - Simultaneous key press enabled
  - Mechanical matrix interface enabled for backwards compatibility
- Uses Cypress's CY8CMBR2016-24LQXI CapSense Express controller
- SmartSense Auto-Tuning
  - Auto-tuning for PCB manufacturing variance
  - Adaptive Threshold Auto-tuning for different overlays
  - SNR Optimization to obtain robust performance
- Configurable
  - Pin configurable buttons
- Expansion Headers
  - Host communication header
  - Sensor module header
- Audio Feedback
  - Includes a buzzer for feedback
- Switches and Indicators
  - 16 LEDs
  - One reset push-button switch
- Connectors
  - USB Type mini-AB Port
- System Ready
  - BOM included
  - Layout/Gerber files included

## 1.2 About the KIT

The kit comes with the following:

- Cypress CY8CMBR2016 EVK – Center Board
- Cypress CY8CMBR2016 EVK – Sensor Module
- Quick Start Guide
- Acrylic Board (3 mm and 1.5 mm)
- System CD
- USB A to Mini-B Cable
- Portable Battery-Powered USB Charger (AA)

Figure 1-2 shows the photograph of the Cypress CY8CMBR2016 EVK content.

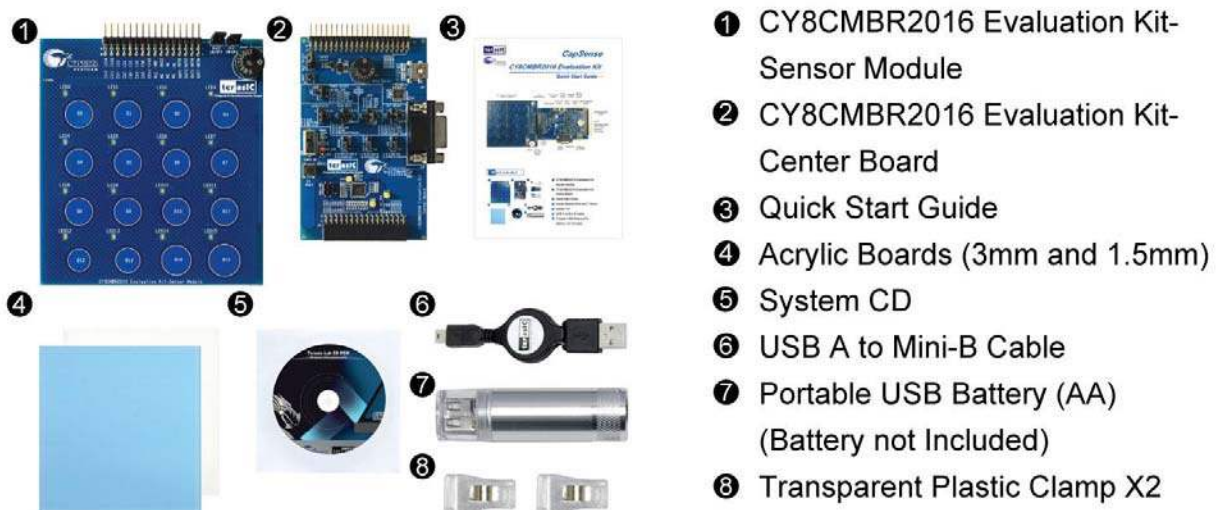


Figure 1-2 CY8CMBR2016 EVK Package Contents

## 1.3 Getting Help

For support, please visit:

[CapSense Matrix Keypad Solution - From Terasic Technologies](#)

## 1.4 Reference Documents

[CY8CMBR2016 CapSense Design Guide](#)

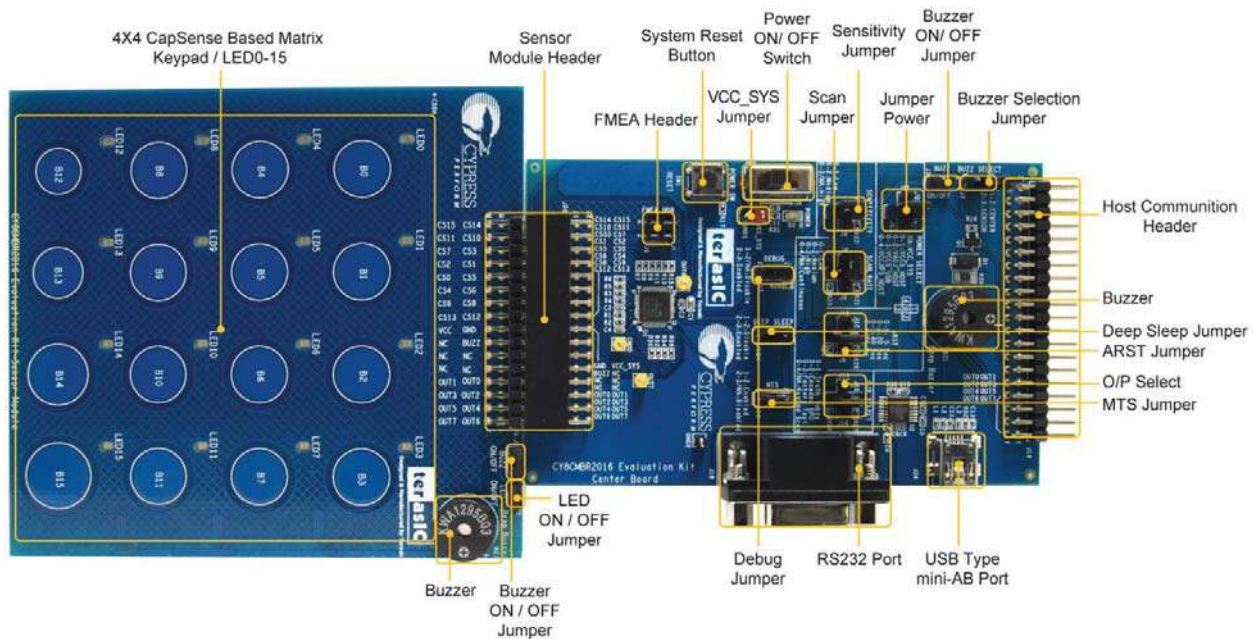
[CY8CMBR2016 Datasheet](#)

## *CY8CMBR2016 EVK Architecture*

This chapter covers the architecture of the kit including information on the components, how to power the kit, and default settings.

### 2.1 Layout and Components

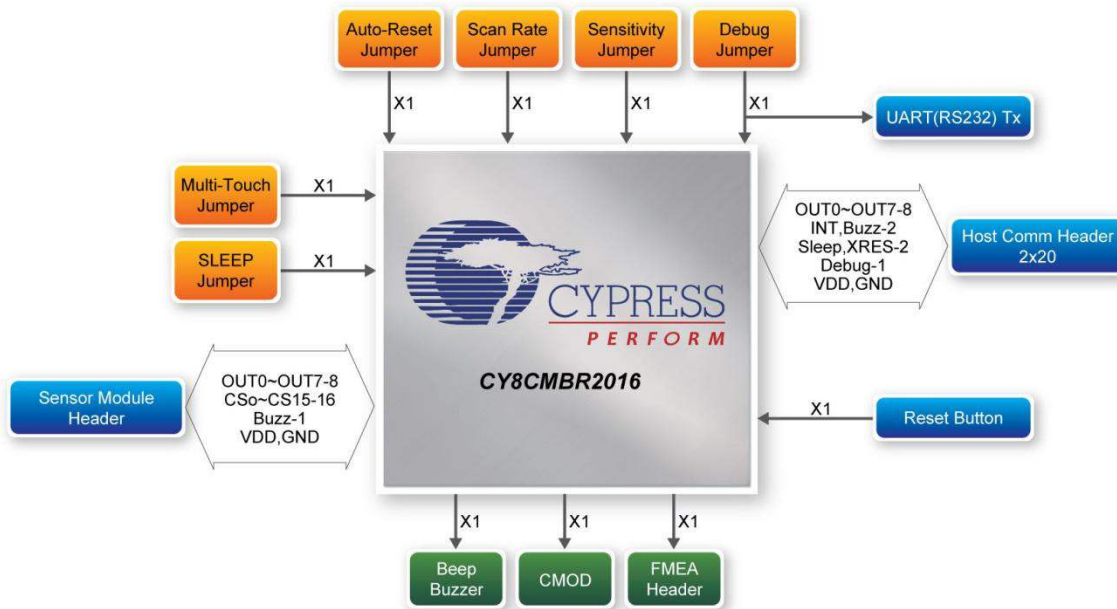
Figure 2-1 indicates the locations of the connectors and key components.



**Figure 2-1 CY8CMBR2016 EVK with Component Diagram**

## 2.2 Block Diagram

Figure 2-2 shows the block diagram.



**Figure 2-2 Block Diagram of CY8CMBR2016 EVK**

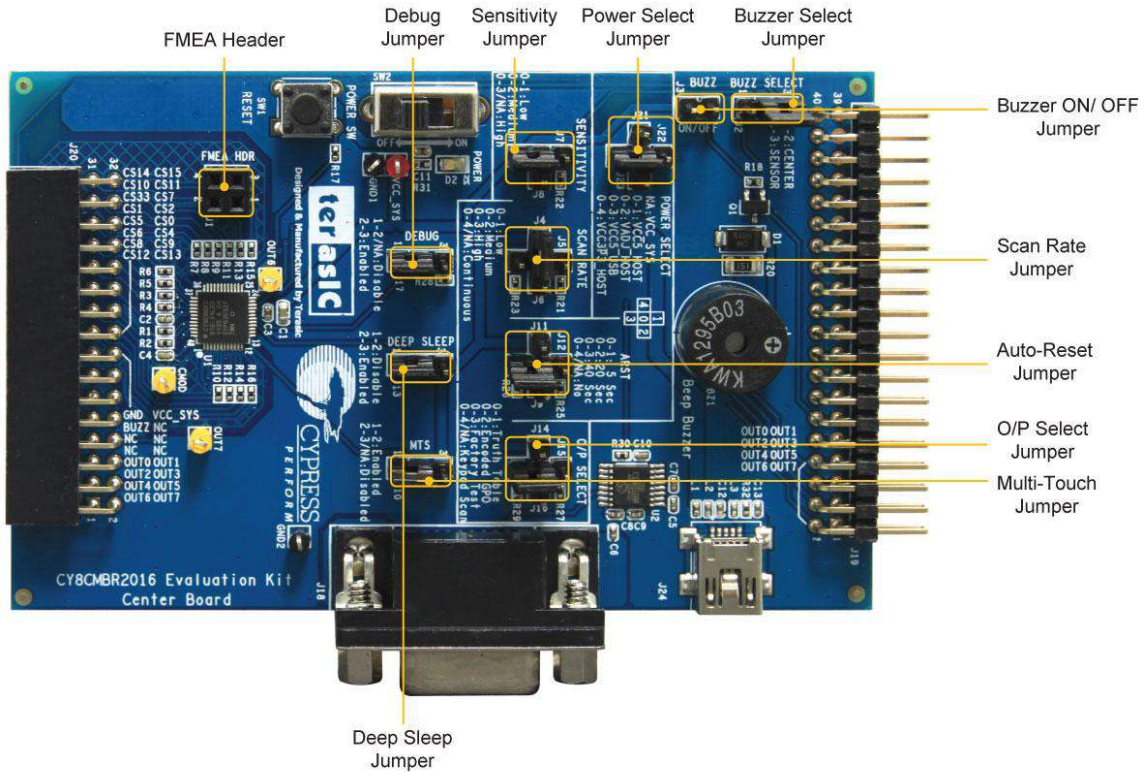
## 2.3 Kit Power

The CY8CMBR2016 EVK comes with a preloaded factory configuration to demonstrate the features of the kit. The factory configurations allow you to quickly ensure that the kit is working properly. To power-up the board:

1. Connect the Sensor Module to the sensor module header (J20) of the Center Board.
2. Make one of the following power connections:
  - a. Connect the USB A to Mini-B cable to a USB (Type A) host port and to the board.
  - b. Connect the portable battery-powered USB connector.
  - c. Connect a host board to the host communication header (J19).
3. Set the power selection jumper (J22) to match your power connection.
4. Turn on the power switch (SW2).
5. The power LED (D2) should immediately turn on.
6. To get audio and visual feedback when you touch the CapSense buttons, short pins 2 and 3 of the buzzer select jumper (J2) on the Sensor Module. LEDs will indicate which button you are touching, and a buzzer will sound.



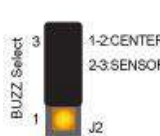

## 2.4 Default Switch and Jumper Settings

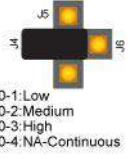
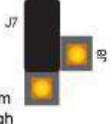
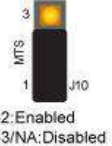
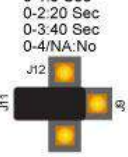

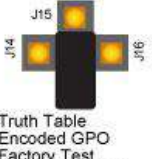




**Figure 2-3 Jumper locations**

Table 2-1 describes the default jumper settings on the CY8CMBR2016 EVK and its description.


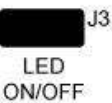
**Table 2-1 Default Jumper Setting and Description of Center Board**

Jumper	Default Setting	Description
Buzz Select (J2)		Select buzzer of Center Board or buzzer of Sensor Module.
Buzz ON/OFF (J3)		Enable/disable the on-board Buzzer.

<p>Scan Rate (J4,J5,J6)</p>	 <p>0-1:Low 0-2:Medium 0-3:High 0-4:NA-Continuous</p>	<p>Configure the Scan Rate between High, Medium, Low, and Continuous. This jumper configures the rate at which the sensors are scanned – the higher the rate, faster the response and higher the power consumption.</p>
<p>Sensitivity (J7,J8)</p>	 <p>0-1:Low 0-2:Medium 0-3/NA:High</p>	<p>Configure the Sensitivity between High, Medium, and Low. This jumper tunes the sensitivity of all the sensors and helps set the smallest change in capacitance desired to be sensed by the system.</p>
<p>MTS (J10)</p>	 <p>1-2:Enabled 2-3/NA:Disabled</p>	<p><b>Configure the Enable/Disable Multi-Touch Support (MTS). The MTS jumper enables/disables simultaneous key detections. This function can be used when at a given instance more than one key touch is required by the end application.</b></p>
<p>ARST (J9,J11,J12)</p>	 <p>0-1:5 Sec 0-2:20 Sec 0-3:40 Sec 0-4/NA:No</p>	<p><b>Configure the Auto Reset (ARST) between 5s/20s/40s/disable, which indicates the maximum time a sensor can be active. The ARST sets the auto reset target for all the sensors, which helps reset stuck sensors.</b></p>
<p>Deep Sleep (J13)</p>	 <p>1-2:Disable 2-3:Enabled</p>	<p><b>Enable/Disable Deep Sleep on board. This jumper is used to put the device in deep sleep. When the keys are not used this pin can be used to put the device to sleep to save power.</b></p>
<p>O/P Select (J14,J15,J16)</p>	 <p>0-1:Truth Table 0-2:Encoded GPO 0-3:Factory Test 0-4/NA:Keypad Scan</p>	<p>Configure the Output Select between Keypad Scan Interface, Truth Table Interface, LED and Encoded General Purpose Output (GPO) output. This jumper helps select the output interface the user needs. Based on the system requirements, the user can select the required output mode.</p>
<p>Debug (J17)</p>	 <p>1-2/NA:Disable 2-3:Enabled</p>	<p>Enable/disable the debug data out through the RS232 port.</p>

Power Select (J21,J22,J23)		Select the power source from VCC5_HOST or VADJ_HOST or VCC3P3_HOST or VCC5_USB.
-------------------------------	---	---

**Table 2-2** Default Jumper Setting and Description of Sensor Module

Jumper	Default Setting	Description
Buzz ON/OFF (J2)		Enable/disable the buzzer of Sensor Module.
LED ON/OFF (J3)		Enable/disable the 16 LEDs of Sensor Module.

# Using the CY8CMBR2016 EVK

This chapter provides detailed information on how to use the CY8CMBR2016 Evaluation kit.

### 3.1 User Input/ Output

The user input/ output provides a versatile and reliable drop-in replacement for mechanical matrix buttons using an output truth table. The pins are connected to LEDs for demonstration purposes, the LED feature is not available in the CY8CMBR2016 device.

#### LEDs

The Sensor Module features visual feedback using 16 red LEDs placed above each of the 4 x 4 Matrix CapSense touch buttons. Multiplexing reduces the number of pins required to drive an LED. The LEDs are arranged into four rows and four columns as shown in Figure 3-1. This allow you to use four row outputs and four column outputs.

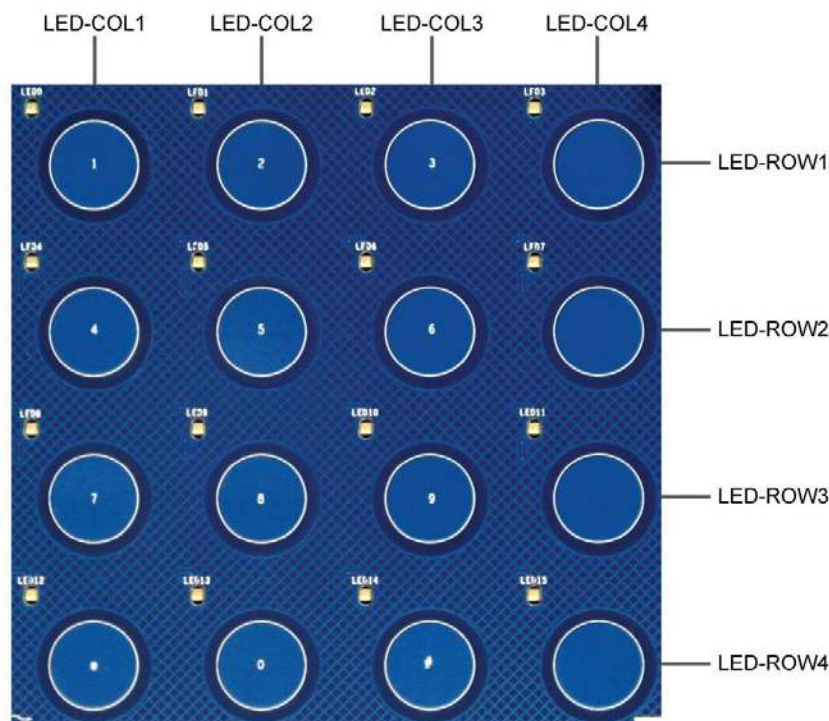


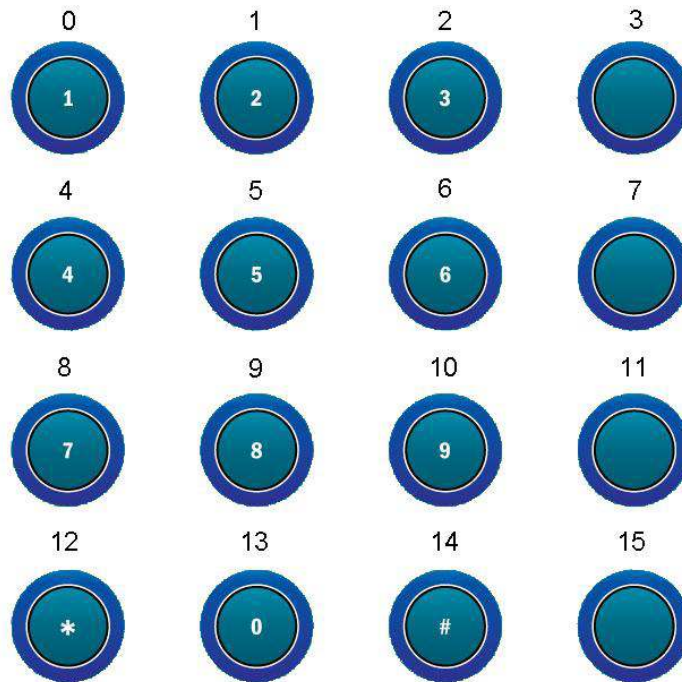
Figure 3-1 LED Arrangement

## Mechanical Matrix Truth Table Output

The truth table for the 4x4 matrix solution is shown below. The dots indicate LED terminal connections between rows and columns. The button locations are shown in Figure 3-2. GPO\_0 through GPO\_3 share connections with LED-COL1 through LED-COL4, and GPO\_4 through GPO\_7 share connections with LED-ROW1 through LED-ROW4.

**Table 3-1 Truth Table**

4x4		Matrix Codes							
Button Location	0	•				•			
	1		•			•			
	2			•		•			
	3				•	•			
	4	•					•		
	5		•				•		
	6			•			•		
	7				•		•		
	8	•						•	
	9		•					•	
	10			•				•	
	11				•			•	
	12	•							•
	13		•						•
	14			•					•
	15				•				•
		1	2	3	4	1	2	3	4
		LED Column				LED Row			



**Figure 3-2 Button Location**

### Reset Push-Button

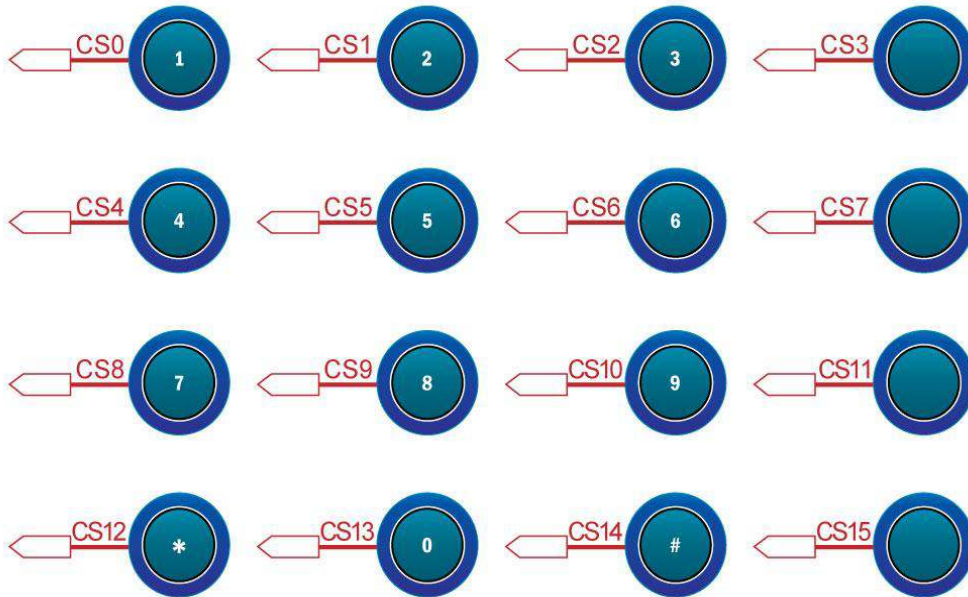
The CY8CMBR2016 EVK includes a reset push-button (SW1) to provide a system reset signal for designs loaded into the PSoC device. The push-button provides a high-logic level when it is pressed.

### Audio Beep Buzzer

The CY8CMBR2016 EVK contains two audio beep buzzers. One is on the Center Board, the other is on the Sensor Module. They provide audible feedback for button presses.

### 4x4 Capacitive Button Matrix

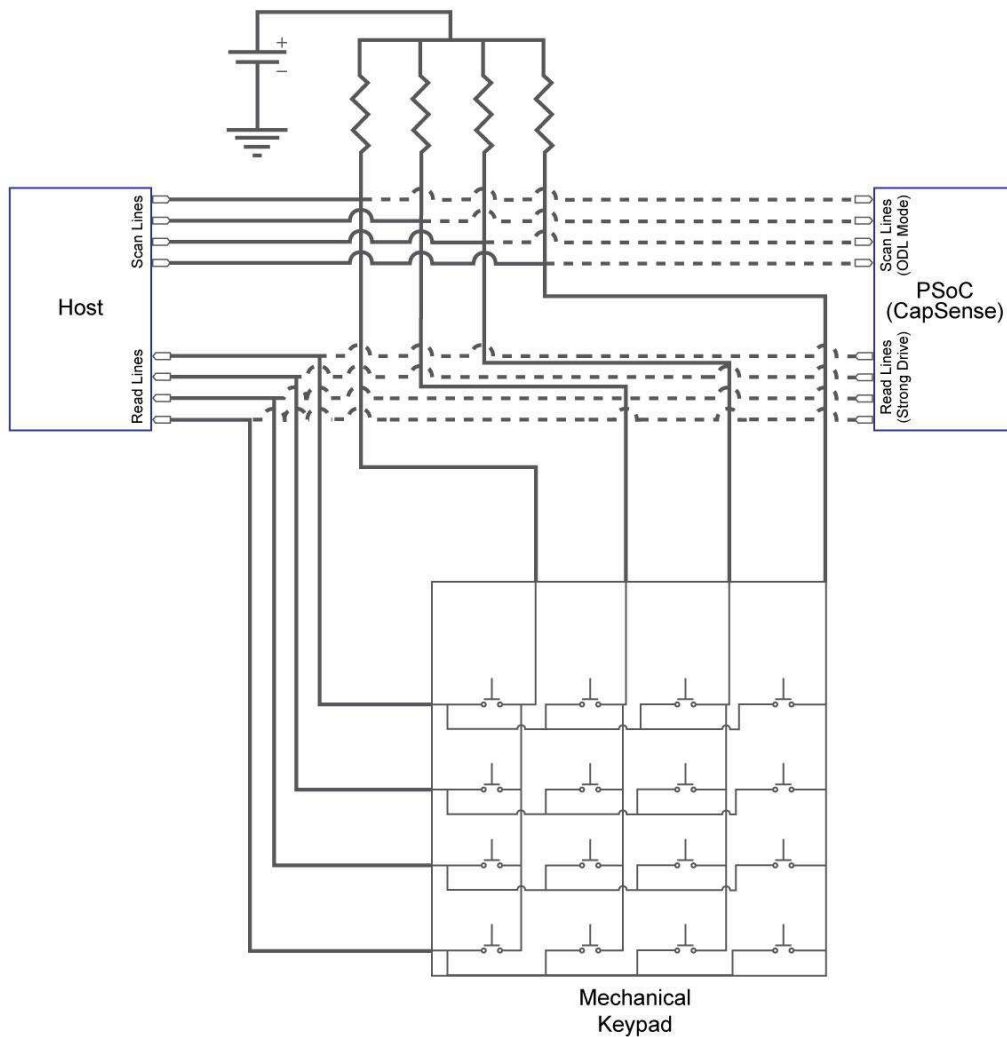
16 CapSense buttons are laid out in a 4x4 matrix on the Sensor Module as shown in Figure 3-3. 12 are standard buttons marked with 0-9, \*, and #. The remaining four buttons are unlabeled.



**Figure 3-3 CapSense Button Layout**

### 3.2 Host Communication Header

The host communication header allows a host to control the kit. The header includes eight GPO interface pins for host communication plus one INT pin for generating an interrupt for the host controller. BUZZ\_CENTER, SLEEP, and DEBUG signals are also on the header. Because this header shares a pin connection with the LED interface only one can be used. **Figure 3-4** shows the block diagram for a Encoded Keyscan GPO interface.



**Figure 3-4 Encoded Keyscan GPO Interface Block Diagram**



### 3.3 Sensor Module Header

You can connect your own sensor module to the Center Board with the sensor module header.

### 3.4 Power Supply

Power is provided through the USB Type mini-AB connector (5V) or from a host board through the host communication header (5V, 3.3V, or VADJ). The Power Selection jumper must match the power source you are using with the kit.

#### Power Distribution System

Figure 3-5 shows the power distribution system on the Cypress CY8CMBR2016 EVK.

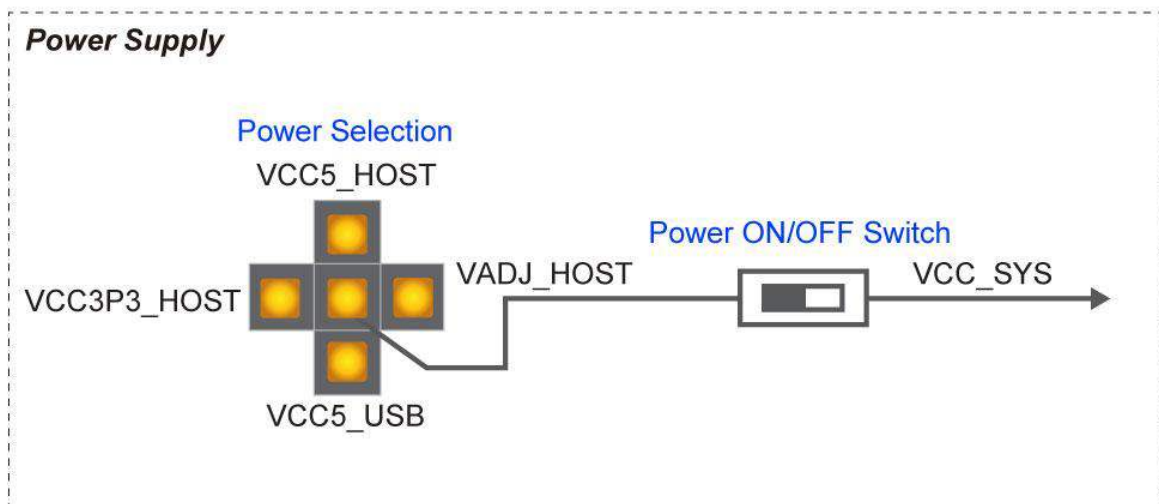


Figure 3-5 Power Distribution System

## Project Examples

This chapter introduces example projects and firmware features of the CY8CMBR2016 EVK.

### 4.1 LED Project Example

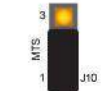
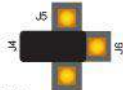
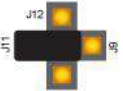
The first project example demonstrates how a PSoC device can integrate CapSense touch sensing and visual feedback. The CapSense buttons are configured so that when a button is touched the corresponding LED turns on. In addition, a buzzer activates whenever a button is pressed.

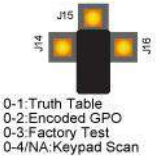
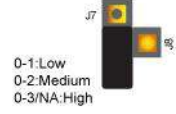
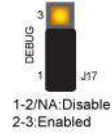
**Note:** The CY8CMBR2016 device does not support LED drive capability. The project example is for demonstration purposes only.

### 4.2 Jumper Configuration Example A

Table 4-1 gives the jumper configuration for Project Example A

**Table 4-1 Jumper Configuration for Example A**

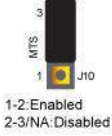
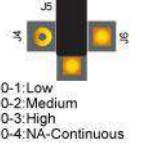
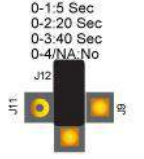
Jumper	Default Setting	Description
MTS (J10)	 <p>1-2: Enabled 2-3/NA: Disabled</p>	Configure the MTS (Multi-Touch Support) to Enable
Scan Rate (J4,J5,J6)	 <p>0-1: Low 0-2: Medium 0-3: High 0-4: NA-Continuous</p>	Configure the Scan Rate to Continuous
ARST (J9,J11,J12)	 <p>0-1: 5 Sec 0-2: 20 Sec 0-3: 40 Sec 0-4/NA: No</p>	Configure the Auto Reset (ARST) to Disable

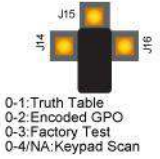
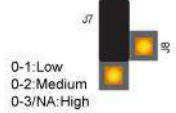

O/P Select (J14,J15,J16)	 <p>0-1: Truth Table 0-2: Encoded GPO 0-3: Factory Test 0-4/NA: Keypad Scan</p>	Configure the Output Select to Factory LED
Sensitivity (J7,J8)	 <p>0-1: Low 0-2: Medium 0-3/NA: High</p>	Configure the Sensitivity to High (0.2pF)
Debug (J17)	 <p>1-2/NA: Disable 2-3: Enabled</p>	Disable the debug data out through the RS232 port

### 4.3 Jumper Configuration Example B

Table 4-2 gives the jumper configuration for Project Example B

**Table 4-2 Jumper Configuration for Example B**

Jumper	Default Setting	Description
MTS (J10)	 <p>1-2: Enabled 2-3/NA: Disabled</p>	Configure the MTS (Multi-Touch Support) to Disable
Scan Rate (J4,J5,J6)	 <p>0-1: Low 0-2: Medium 0-3: High 0-4/NA: Continuous</p>	Configure the Scan Rate to High
ARST (J9,J11,J12)	 <p>0-1: 5 Sec 0-2: 20 Sec 0-3: 40 Sec 0-4/NA: No</p>	Configure the Auto Reset (ARST) to 5 seconds

<p>O/P Select (J14,J15,J16)</p>		<p>Configure the Output Select to Factory LED</p>
<p>Sensitivity (J7,J8)</p>		<p>Configure the Sensitivity to Low (0.4pF)</p>
<p>Debug (J17)</p>		<p>Enable the debug data out through the RS232 port, to use the UART port to see the debug data in Multi Chart Tool. The kit CD will include this tool.</p>

## 4.4 Firmware Functionality

The LED project example firmware includes the following functions:

### SmartSense Auto-Tuning

SmartSense Auto-Tuning automatically compensates for PCB variations, device process variations, PCB vendor changes, and environmental variations. The device supports a wide parasitic capacitance range (5 to 40 pF).

### Multi-Touch Support

Multi-touch support (MTS) allows multiple buttons to be triggered at the same time. Disabling MTS ensures that the CapSense controller only reports one button touch at a time.

**Note:** The [CY8CMBR2016 CapSense Design Guide](#) and [Datasheet](#) refer to this feature as Flanking Sensor Suppression (FSS). When MTS is disabled (FSS enabled) if two buttons are touched simultaneously, only the first button touch detected by the controller will be reported ON.

### Auto Reset

The Sensor Auto Reset time is controlled by the ARST jumper. When Auto Reset is enabled, if a key is pressed for more than 5, 20, or 40 seconds, the device resets the sensor.

## Scan Rate

The firmware reads the resistor value on the Scan Rate pin and sets the scan rate of the CapSense device. The four possible scan rate configurations are:

1. Pin grounded – low
2. 1.5 K $\Omega$  (5%) to ground – medium
3. 5 K $\Omega$  (5%) to ground – high
4. Pin connected to V<sub>DD</sub> or left floating – continuous

**Note:** The scan rate effects power consumption and response time. Response time is better at higher scan rates, however power consumption increases with scan rate. Changes in the scan rate may not be visually perceptible.

## Deep Sleep Control

The Deep Sleep jumper selects between active and deep sleep mode. The configurations are:

1. Pin grounded – Active Mode
2. VCC\_SYS – Deep Sleep Mode

## Sensitivity

Sensitivity is defined as the minimum change in capacitance which can be detected as a finger touch. Use a higher sensitivity if your board has a thick overlay. Use a lower sensitivity to reduce power consumption. The configurations are:

1. Pin grounded – Low sensitivity
2. 1.5 k $\Omega$ ( $\pm$ 5%) to ground – Medium sensitivity
3. VDD / Floating – High sensitivity

## C<sub>MOD</sub>

The CY8CMBR2016 Evaluation Kit Center Board uses a 2.2 nF modulating capacitor.

## FMEA

A built-in power on self test (POST) mechanism checks for several failure modes on reset (POR). Any failure is reported on the OUT\_6 and OUT\_7 pins. This can be useful in production testing.

**Note:** The [CY8CMBR2016 CapSense Design Guide](#) and [Datasheet](#) refer to this feature as System Diagnostics. Refer to section 3.13 of the [CY8CMBR2016 CapSense Design Guide](#) for more details about this feature.



## 4.5 Demonstration Setup

1. Power on the board using an USB A to Mini-B cable.
2. Experiment with the project examples and features by adjusting the jumper settings.

**Note:** Be careful not touch any connector or header pins during CapSense operation. It may add capacitance to the sensor lines and cause false triggering of the buttons.

## Chapter 5

# *Appendix*

---

### **5.1 Revision History**

<i>Version</i>	<i>Change Log</i>
V1.0	Initial Version (Preliminary)

### **5.2 Copyright Statement**

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