

# TCA8418 I<sup>2</sup>C Controlled Keypad Scan IC Evaluation Module

## User's Guide



Literature Number: SCPU033

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## Preface

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### About This Manual

This user guide describes the functions and operation of TCA8418 Evaluation Module (EVM), including hardware design, graphical user interface (GUI), and EVM setup.

### How to Use This Manual

This document contains the following chapters:

- Chapter 1 – Introduction and Quick Start
- Chapter 2 – EVM Configuration and Description
- Chapter 3 – GUI Configuration and Description
- Chapter 4 – Schematic and Layout

### Information about Cautions and Warnings

The information in a caution or a warning is provided for your protection. Please read each caution and warning carefully.



#### CAUTION

This EVM contains components that can potentially be damaged by electrostatic discharge. Always transport and store the EVM in its supplied ESD bag when not in use. Handle using an antistatic wristband. Operate on an antistatic work surface. For more information on proper handling, see the application report *Electrostatic Discharge (ESD)* ([SSYA008](#))

#### CAUTION

By default, the I<sup>2</sup>C data and clock lines at TP3 and TP4 are pulled up internally to TCA8418 supply voltage (1.8 V to 3.3 V) through jumper JMP7 configuration. If external pullup resistors are used instead, make sure to pull up to 3.3 V only. Operation from 5 V is not specified and may permanently damage this EVM.

**FCC Warning**

This equipment is intended for use in a laboratory test environment only. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to subpart J of part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments may cause interference with radio communications, in which case the user at his/her own expense will be required to take whatever measures may be required to correct this interference.

# **TCA8418 I<sup>2</sup>C Controlled Keypad Scan IC Evaluation Module**

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## **1 Introduction**

The TCA8418 EVM is an evaluation module (EVM) for the Texas Instruments (TI) inter-integrated circuit (I<sup>2</sup>C) controlled keypad scan IC. The TCA8418 keypad scan IC operates from supply voltage range of 1.65 V to 3.3 V. It offers high level of electrostatic discharge (ESD) protection and supports 1-MHz Fast Mode Plus I<sup>2</sup>C bus. With 18 configurable GPIO pins, it can be configured to support 10x8 keypad array. This operation frees the processor from scanning the keypad for presses and releases, thus saving power and bandwidth of the system.

The TCA8418 EVM serves as an I<sup>2</sup>C interface adapter between a host PC (IBM compatible), the TCA8418, and/or other I<sup>2</sup>C compatible devices externally connected to the EVM. The communication between EVM and the host PC is via USB (through a standard type-A to type-B USB cable), while the communication between the EVM, the TCA8418, and/or other slave devices is via I<sup>2</sup>C bus. The EVM converts communication transactions between the USB and I<sup>2</sup>C.

### **1.1 List of Hardware Items for Operation**

To operate the TCA8418 EVM, these items are required:

- The TCA8418 EVM
- Standard type-A to type-B USB cable
- IBM compatible PC with Microsoft Windows XP or later operating system installed

### **1.2 List of Software Items for Operation**

In addition to the hardware items listed in [Section 1.1](#), this software is required:

- Demo GUI Software (TCA8418.exe)

The software can be downloaded from the TI website at [www.ti.com](http://www.ti.com).

The EVM is recognized by a PC as a generic human interface device (HID), which is supported by the built-in USB/HID drivers of the Windows XP or later operating system. Therefore, it is plug-and-play and no proprietary USB driver is required.

### **1.3 Step-by-step Instructions for Operation and Troubleshooting**

After downloading and installing the GUI demo software, follow these steps to operate the EVM:

1. Plug the USB cable into both the PC and the EVM and wait for the LED to illuminate.  
Troubleshooting: If the LED does not illuminate after 30 seconds, make sure that the USB cable is securely connected. If the connection is secure, try a different USB port. If a different USB port does not solve the problem, try to reboot the computer. If rebooting the computer does not fix the problem, try a different USB cable. If a different USB cable does not solve the problem, contact TI technical support for help.
2. Run the TCA8418 EVM GUI software and follow the instructions for the GUI.

### **1.4 Hardware Uninstall Instructions**

Unplug the EVM from the USB port to uninstall the hardware from the host PC.

## 1.5 Software Uninstall Instructions

For Windows operating system, go to Control Panel > Add or Remove Programs to remove the TCA8418 GUI software.

## 2 EVM Configuration and Description

### 2.1 EVM Options

The hardware is based on a USB peripheral chip from TI (TUSB3210). The TUSB3210 has an 8052 core with enhanced performance. The PCB is a simple two-layer top-side populated board (see the schematic in [Section 2.6](#)). The major features of the hardware design are detailed in the following sections.

### 2.2 EEPROM (U1) and JMP10

The embedded firmware is stored in a 64-kbit EEPROM (see U1 in the schematic in [Section 2.6](#)). The firmware is field programmable. Jumper JMP10 is normally closed and is used for firmware development only. On power up, the TUSB3210 downloads the firmware image from the EEPROM to the internal static RAM and starts firmware execution (first with USB enumeration) from there.

### 2.3 LED (D1) Indication of USB Attached

A white LED is mounted next to the TUSB3210 IC (U4) on the evaluation board. Every time the USB interface adapter is attached to a PC via a USB cable, and if the host PC detects it and goes through USB enumeration successfully, the embedded firmware illuminates the white LED (D1); otherwise, the LED remains off. After unplugging the USB cable, the LED turns off immediately.

### 2.4 Test Point Connectors (TP1 through TP5)

Test point connectors TP1 through TP5 allow the users to connect both external signal sources and external I<sup>2</sup>C slave devices to the EVM. [Table 1](#) describes the functions of all of the test points in the EVM.

**Table 1. Test Point Descriptions**

Test Point	Functionality	Configuration
TP1	To either monitor or supply to TCA8418 IC reset signal	To supply TCA8418 IC reset externally , the external I/O logic level must be the same as TCA8418 IC.
TP2	To monitor TCA8418 IC interrupt signal	
TP3	To either monitor or supply to TCA8418 IC I <sup>2</sup> C SCL line	To supply TCA8418 IC SCL externally , the external I/O logic level must be the same as TCA8418 IC.
TP4	To either monitor or supply to TCA8418 IC I <sup>2</sup> C SDA line	To supply TCA8418 IC SDA externally , the external I/O logic level must be the same as TCA8418 IC.
TP5	To either monitor or supply to TCA8418 V <sub>CC</sub>	To supply TCA8418 IC V <sub>CC</sub> externally , U5 must be disabled by shunting 2-3 on JMP4.
TP6	Ground test point	
TP7	Ground test point	
TP8	Ground test point	

## External Microcontroller Control

The user can provide external microcontroller I<sup>2</sup>C and GPIO connections to the EVM by routing them to test points TP1 to TP4.

Before connecting the microcontroller, check the following:

- Make sure the I/O voltage of the external microcontroller is the same as the I/O voltage of the TCA8418. The power supply voltage of the TCA8418\_VCC can be adjusted through JMP5 or externally supplied through TP5 with U5 disabled by JMP4 (see [Section 2.5](#)).
- Make sure the external microcontroller is isolated from the TUSB3210 by disabling the TXS0104E level translator. Shorting jumper JMP2 can disable the level translator (see [Section 2.5](#)).

## External I<sup>2</sup>C Slave Devices

The user can connect external I<sup>2</sup>C slave devices to test points TP3 and TP4. The devices can be controlled through the TCA8418 graphical user interface (GUI) software. Under the GUI software control, the I<sup>2</sup>C bus operates at 400 kHz. Therefore, the external slave devices must support 400-kHz I<sup>2</sup>C bus.

## 2.5 Jumper Configuration (JMP1 through JMP6)

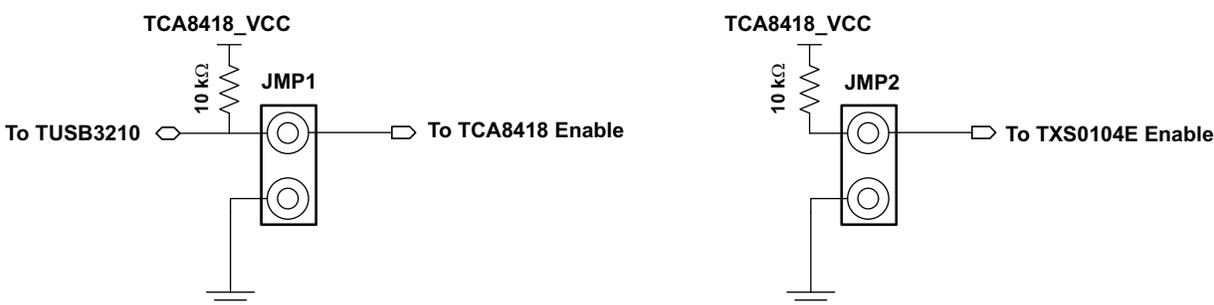
To use the full TCA8418 (GUI) software functionality, all jumpers except JMP5 must be at their default settings. [Table 2](#) describes all of the jumpers in the EVM and their respective functionality (all default settings are in bold).

**Table 2. Jumper Descriptions**

Jumper	Functionality	Configuration
JMP1	TCA8418 Keypad Scanner IC Disable	<b>Open JMP1 to allow GUI control</b> Shunt JMP1 to disable TCA8418 manually
JMP2	TXS0104E Level Translator Disable	<b>Open JMP2 to enable level translation</b> Shunt JMP2 to disable level translation
JMP3	LP2985-33 5V to 3.3V LDO Disable	<b>Shunt JMP3 in 1-2 position to enable the 3.3V LDO</b> Shunt JMP3 in 2-3 position to disable the 3.3V LDO
JMP4	TPS73101 5V to Variable Output LDO Disable	<b>Shunt JMP4 in 1-2 position to enable the Variable Output LDO</b> Shunt JMP4 in 2-3 position to disable the Variable Output LDO
JMP5	TPS73101 5V to Variable Output LDO Adjust	<b>Shunt 1-2 for TCA8418_VCC = 1.8V</b> Shunt 2-3 for TCA8418_Vcc = 3.3V Open all for TCA8418_Vcc = 2.4V
JMP6 <sup>(1)</sup>	TCA8418 ROW6 Function Selection	Shunt 1-2 for GPI functionality <b>Shunt 2-3 for Keypad functionality</b>
JMP7 <sup>(1)</sup>	TCA8418 ROW7 Function Selection	Shunt 1-2 for GPI functionality <b>Shunt 2-3 for Keypad functionality</b>
JMP8 <sup>(1)</sup>	TCA8418 COL8 Function Selection	Shunt 1-2 for GPO functionality <b>Shunt 2-3 for Keypad functionality</b>
JMP9 <sup>(1)</sup>	TCA8418 COL9 Function Selection	Shunt 1-2 for GPO functionality <b>Shunt 2-3 for Keypad functionality</b>
JMP10	EEPROM SCL Line Short	Open JMP6 to open EEPROM SCL line for firmware programming <b>Shunt JMP4 to short EEPROM SCL line</b>

<sup>(1)</sup> JMP6, JMP7, JMP8, and JMP9 must all have the same configuration for correct GUI operation.

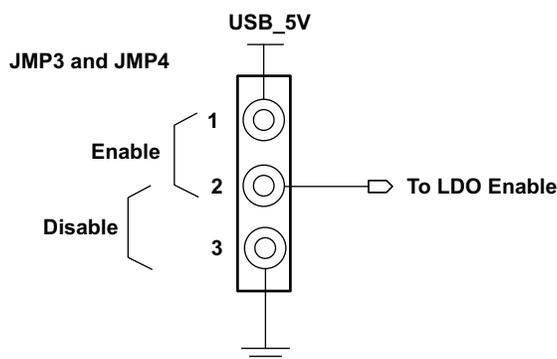
Jumpers JMP1, JMP2, JMP3, and JMP4 allow the user to manually enable and disable TCA8418 (U3), TXS0104E (U2), LP2988-33 (U7), and TPS73101 (U5), respectively. Jumpers JMP1 and JMP2 are two-pin headers with pin 1 pulled up to TCA8418\_VCC through 10-k $\Omega$  resistors (see Figure 1). Jumpers JMP3 and JMP4 are three-pin headers with two jumper configurations (see Figure 2).



**Figure 1. Jumper Configuration: JMP1 and JMP2**

To enable both the TCA8418 and the TXS0104E, leave both JMP1 and JMP2 open. Through the GUI software, the TUSB3210 microcontroller (U4) detects the on/off state of the TCA8418 IC (U3). When JMP1 is open, the TCA8418 EVM software has the full control of the TCA8418 IC through TUSB3210 microcontroller. To manually disable the TCA8418 IC, shunt JMP1 to drive the active-low reset input of the TCA8418 to logic low.

JMP2 controls the TXS0104E level translator. The TCA8418 IC and other externally connected I<sup>2</sup>C slave devices are on side A of the TXS0104E, while the TUSB3210 microcontroller is on side B of the TXS0104E. Side A logic level is referred to the power supply level of the TCA8418, which ranges from 1.65 V to 3.6 V. As mentioned in Section 2.4, the TCA8418\_VCC can be externally supplied through TP5 when TPS73101 (U5) is disabled through JMP4, or it can be supplied through the TPS73101 with output voltages of 1.8 V, 2.3 V, or 3.3 V depending on JMP5 configuration. Side B logic level remains fixed to the 3.3-V power supply voltage of the TUSB3210.



**Figure 2. Jumper Configuration: JMP3 and JMP4**

If external sources of SCL, SDA, interrupt, and reset signals to the TCA8418 IC are used, disable the TXS0104E and the TPS73101 ICs through JMP2 and JMP4 before connecting the external signals. JMP3 and JMP4 (see Figure 2) can enable or disable the output of the LP2985-33 or the TPS73101 LDO ICs. To enable the LDOs, shunt pins 1 and 2 of the JMP3 and JMP4 to tie the enable pins of the LDO ICs to USB\_5V. To disable the LDOs, shunt pins 2 and 3 of the JMP3 and JMP4 to tie the enable pins to ground.

Jumper JMP5 (see Figure 3) allows adjustment of the TCA8418\_VCC voltage to 1.8 V, 2.4 V, or 3.3 V. This provides the flexibility to evaluate TCA8418 under different supply voltages. Short pins 1 and 2 to provide 1.8-V output, and short pins 2 and 3 to provide 3.3-V output. Open the JMP5 to provide 2.4-V output.

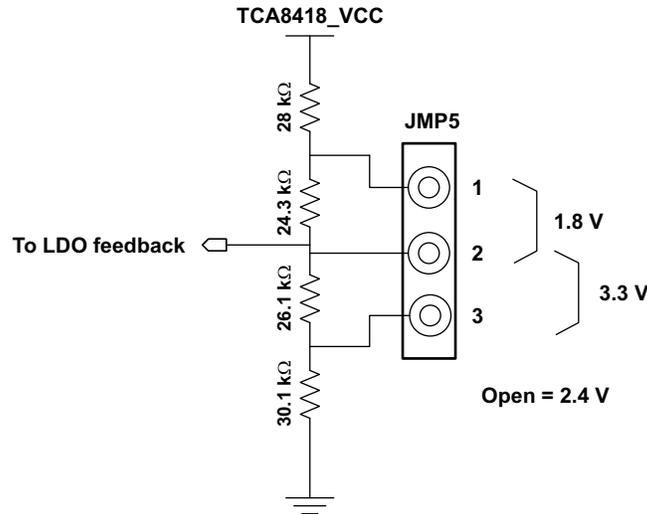


Figure 3. Jumper Configuration: JMP5

Jumpers JMP6, JMP7, JMP8, and JMP9 (see Figure 4) configure the TCA8418 EVM to either a 8x6 keypad controller with two GPIs and two GPOs or a full 10x8 keypad controller scanner.

- To configure Row 6 and Row 7 to be in GPI mode, shunt JMP6 and JMP7 in 1-2 position.
- To configure Column 8 and Column 9 to be in GPO mode, shunt JMP8 and JMP9 in 1-2 position.
- To configure the EVM to be in the full 10x8 keypad matrix mode, shunt JMP6 through JMP9 in 2-3 position.

**NOTE:** JMP6, JMP7, JMP8, and JMP9 must have the same configuration for a correct GUI operation.

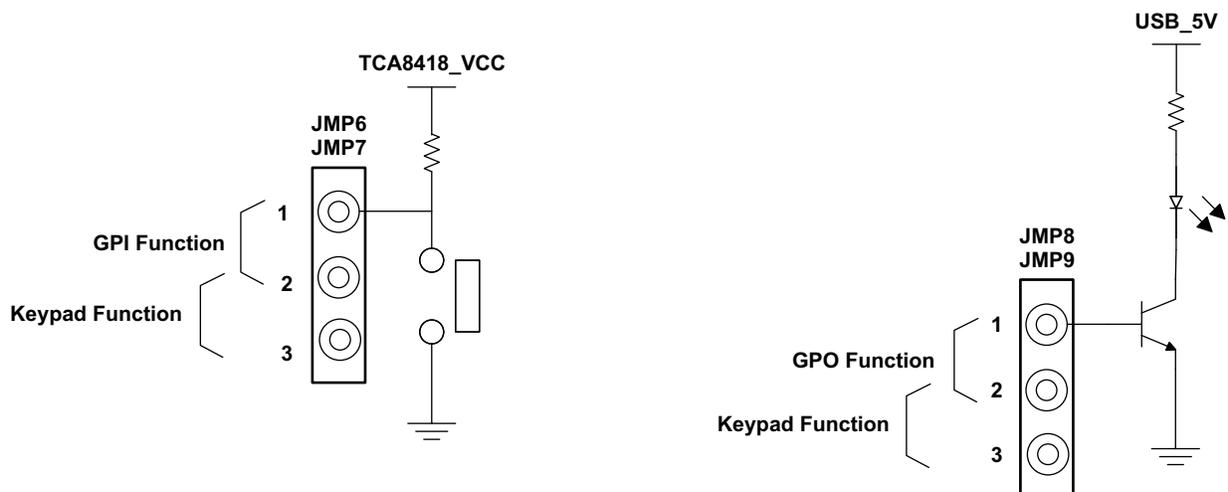


Figure 4. Jumper Configuration: JMP6, JMP7, JMP8, JMP9

2.6 Schematics

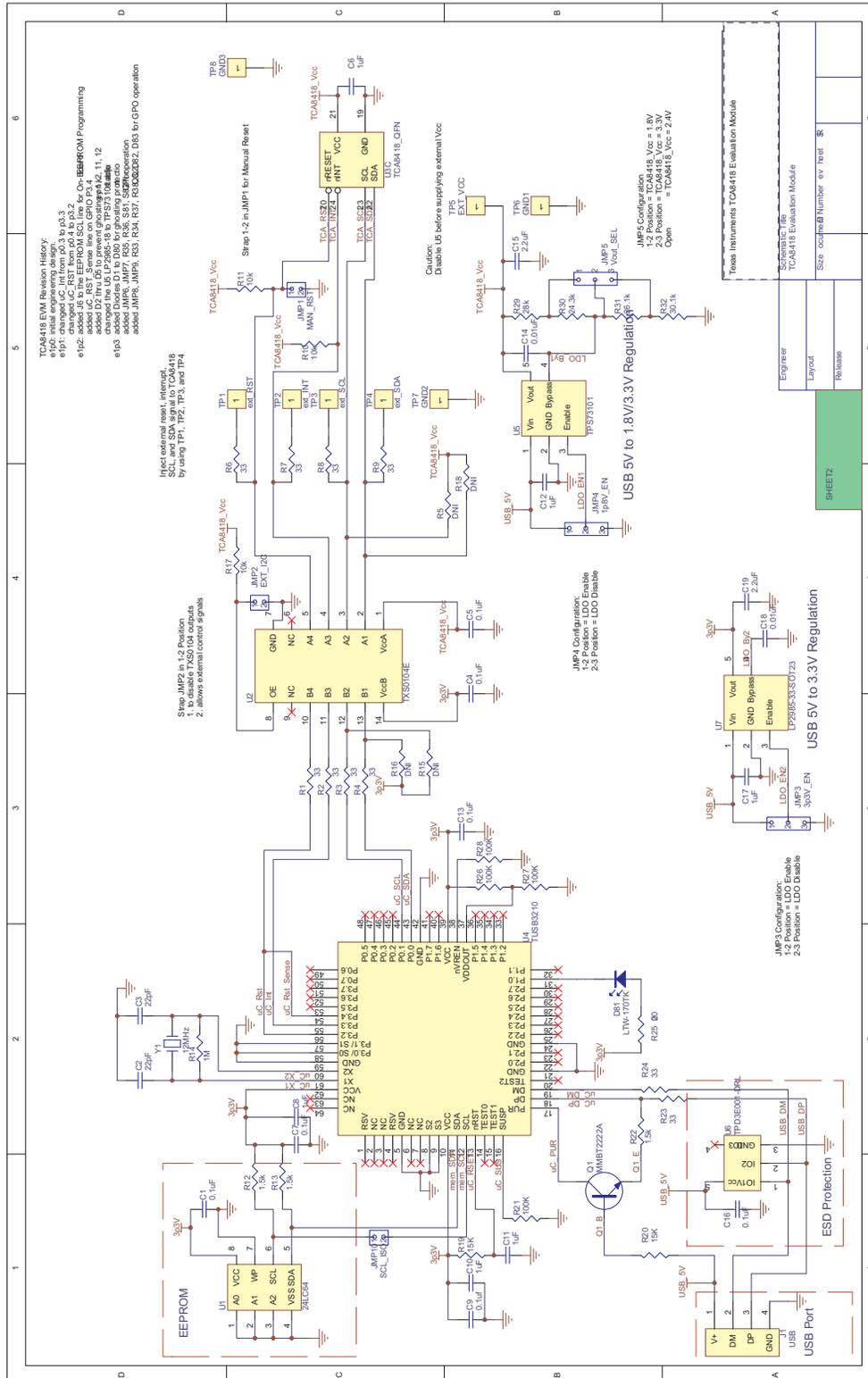


Figure 5. Schematics (1 of 2)



## 2.7 Bill of Materials

**Table 3. Bill of Materials<sup>(1)(2)(3)(4)(5)</sup>**

Count	RefDes	Value	Description	Size	Part Number	Manufacturer
1	–	–	Two-Layer, 7200mil by 4800mil, PCB	7200mil x 4800mil	TCA8418 EVM E2	Any
7	C1, C4, C5, C7, C9, C13, C16	0.1uF	Capacitor, Ceramic, 0.1uF, X7R, 10%	0603	Std	Std
2	C14, C18	0.01uF	Capacitor, Ceramic, 0.01uF, X7R, 10%	0603	Std	Std
2	C15, C19	2.2uF	Capacitor, Ceramic, 2.2uF, X7R, 10%	0603	Std	Std
2	C2, C3	22pF	Capacitor, Ceramic, 22pF, 50V, C0G, 10%	0603	C1608C0G1H220KT	TDK
6	C6, C8, C10, C11, C12, C17	1.0uF	Capacitor, Ceramic, 1.0uF, X7R, 10%	0603	Std	Std
80	D1 through D80	Diodes	Switching Diode, 75V, 150mA, 0603	0603	CDSU4148	Comchip Technology
3	D81 through D83	LED	White LED, 0805	0805	LTW-170TK	Lite-On Inc.
1	J1	–	USB Right Angle Recept. Type B	–	67068-9000	MOLEX/ WALDOM ELECTRONICS
3	JMP1, JMP2, JMP10	–	Header, 2x1pin, 100mil spacing	100mil x 100mil	PEC36SAAN	Sullins Connector Solutions
7	JMP3, JMP4, JMP5, JMP6, JMP7, JMP8, JMP9	–	Header, 3x1pin, 100mil spacing	100mil x 100mil	PEC36SAAN	Sullins Connector Solutions
3	Q1, Q2, Q3	BJT	Transistor, NPN, High Performance, 500mA	SOT-23	MMBT2222A	Fairchild
10	R1, R2, R3, R4, R6, R7, R8, R9, R23, R24	33Ω	Resistor, Chip, 33Ω, 1/8W, 5%	0603	Std	Std
5	R10, R11, R17, R35, R36	10kΩ	Resistor, Chip, 10kΩ, 1/8W, 5%	0603	Std	Std
3	R12, R13, R22	1.5kΩ	Resistor, Chip, 1.5kΩ, 1/8W, 5%	0603	Std	Std
1	R14	1MΩ	Resistor, Chip, 1MΩ, 1/8W, 5%	0603	Std	Std
2	R19, R20	15kΩ	Resistor, Chip, 15kΩ, 1/8W, 5%	0603	Std	Std
4	R21, R26, R27, R28	100kΩ	Resistor, Chip, 100kΩ, 1/8W, 5%	0603	Std	Std
3	R25, R33, R34	200Ω	Resistor, Chip, 200Ω, 1/8W, 5%	0603	Std	Std
1	R29	28.0kΩ	Resistor, Chip, 28.0kΩ, 1/8W, 5%	0603	Std	Std
1	R30	24.3kΩ	Resistor, Chip, 24.3kΩ, 1/8W, 5%	0603	Std	Std
1	R31	26.1kΩ	Resistor, Chip, 26.1kΩ, 1/8W, 5%	0603	Std	Std
1	R32	30.1kΩ	Resistor, Chip, 30.1kΩ, 1/8W, 5%	0603	Std	Std
2	R37, R38	22.1kΩ	Resistor, Chip, 22.1kΩ, 1/8W, 5%	0603	Std	Std
4	R5, R15, R16, R18	DNI	Resistor, Chip, 10kΩ, 1/8W, 5%	0603	Std	Std
82	SW1 through SW82	Switch	4 terminal tactile switch	6mm x 6mm	EVQ-PAC04M	Panasonic
8	TP1 through TP8	Test Point	Test Point 5011 Series	63mil in diameter	5011	Keystone Electronics

<sup>(1)</sup> These assemblies are ESD sensitive, ESD precautions shall be observed.

<sup>(2)</sup> These assemblies must be clean and free from flux and all contaminants. Use of no clean flux is not acceptable.

<sup>(3)</sup> These assemblies must comply with workmanship standards IPC-A-610 Class 2.

<sup>(4)</sup> Ref designators marked with an asterisk (\*\*\*) cannot be substituted. All other components can be substituted with equivalent manufacturer's components.

<sup>(5)</sup> Maximum 30 grams placement pressure on WCSP-6 parts.

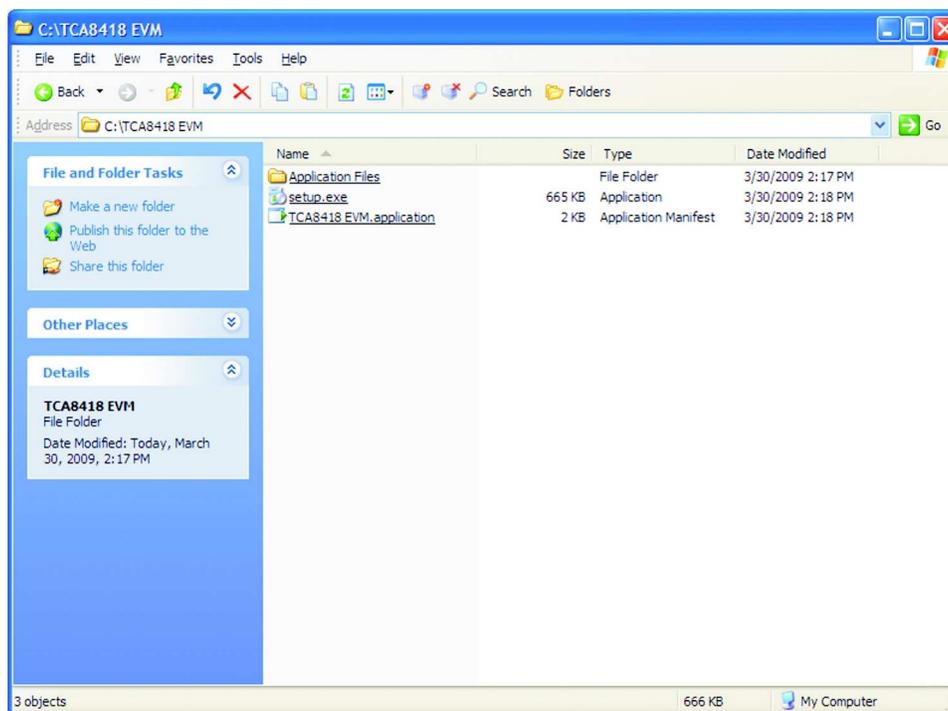
**Table 3. Bill of Materials<sup>(1)(2)(3)(4)(5)</sup> (continued)**

Count	RefDes	Value	Description	Size	Part Number	Manufacturer
1	U1	EEPROM	IC, Serial EEPROM 64kb, 1.8V to 5.5V, 400kHz I2C max	DIP	24LC64	Microchip
1	U2	TXS0104E	IC, 4-bit bidirectional voltage-level translator	SOIC-14	TXS0104ED	TI
1	U3	TCA8418	IC, I2C controlled keypad scanner	QFN	TCA8418RTWR	TI
1	U4	TUSB3210	IC, USB, General Purpose, Device Controller	480mil x 480mil 64-LQFP	TUSB3210PM	TI
1	U5	TPS73101	IC, 150mA LDO regulator	SOT23-5	TPS73101DBV	TI
1	U6	TPD3E001	IC, 3-Channel +/-15kV ESD protection array	SOT-5	TPD3E001DRL	TI
1	U7	LP2985-33	IC, 150mA LDO regulator	SOT23-5	LP2985-33DBV	TI
1	Y1	12MHz	Crystal, 12MHz, 18pF, SMD	500mil x 190mil	ABLS-12.000MHz-B2-T	Abracon

### 3 GUI Configuration and Description

#### 3.1 GUI Installation

1. Extract the zip file to a folder (see [Figure 7](#)).



**Figure 7. TCA8418 EVM GUI Files**

2. Open the setup.exe, and click Install to finish the GUI installation (see [Figure 8](#)).



**Figure 8. TCA8418 EVM Application Installation**

3. Open the GUI from Start > All Programs. For Windows XP, the link to run the TCA8418 EVM GUI is installed to Start > All Programs > Texas Instruments > TCA8418 EVM.

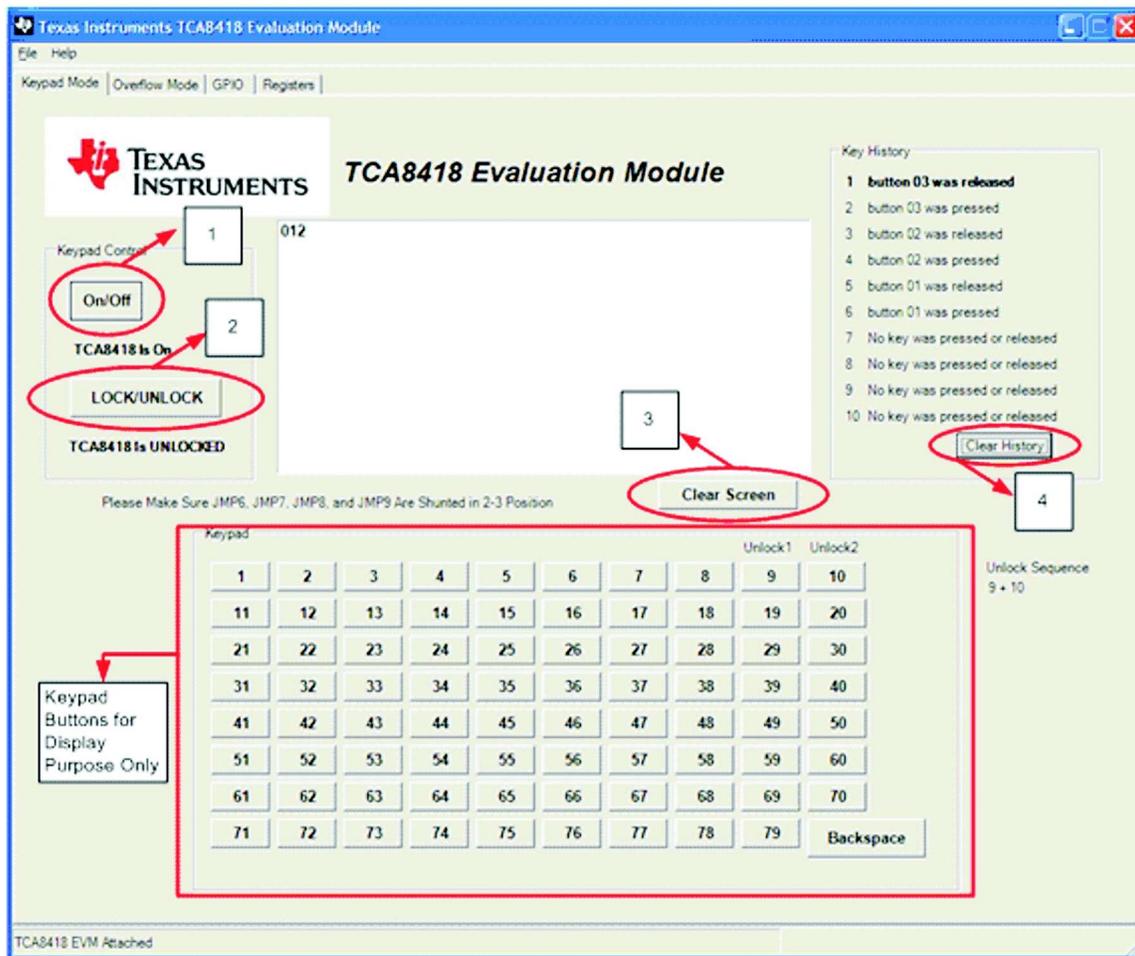
## 3.2 GUI Functionality

The TCA8418 EVM consists of four tabs:

- Keypad Mode: provides evaluation of the 10x8 keypad scanner functionality
- Overflow Mode: provides evaluation of the scanner overflow functionality
- GPIO Mode: provides evaluation of the GPIO functionality through push buttons and LEDs
- Registers and I<sup>2</sup>C: display register settings as well as providing I<sup>2</sup>C master read/write functionality

### 3.2.1 Keypad Mode

The keypad mode provides evaluation for the TCA8418 IC 10x8 keypad scanning mode (see [Figure 9](#)). Make sure that jumpers JMP6, JMP7, JMP8, and JMP9 are shunted in the 2-3 position in this mode. Note that the keypad buttons on the GUI are to display the button press/release actions corresponding to the EVM buttons. Therefore, they are for display purpose only and have no actions associated with them.



**Figure 9. TCA8418 EVM GUI: Keypad Mode**

The buttons for the keypad mode tab are:

On/Off: Enable or disable the TCA8418 EVM

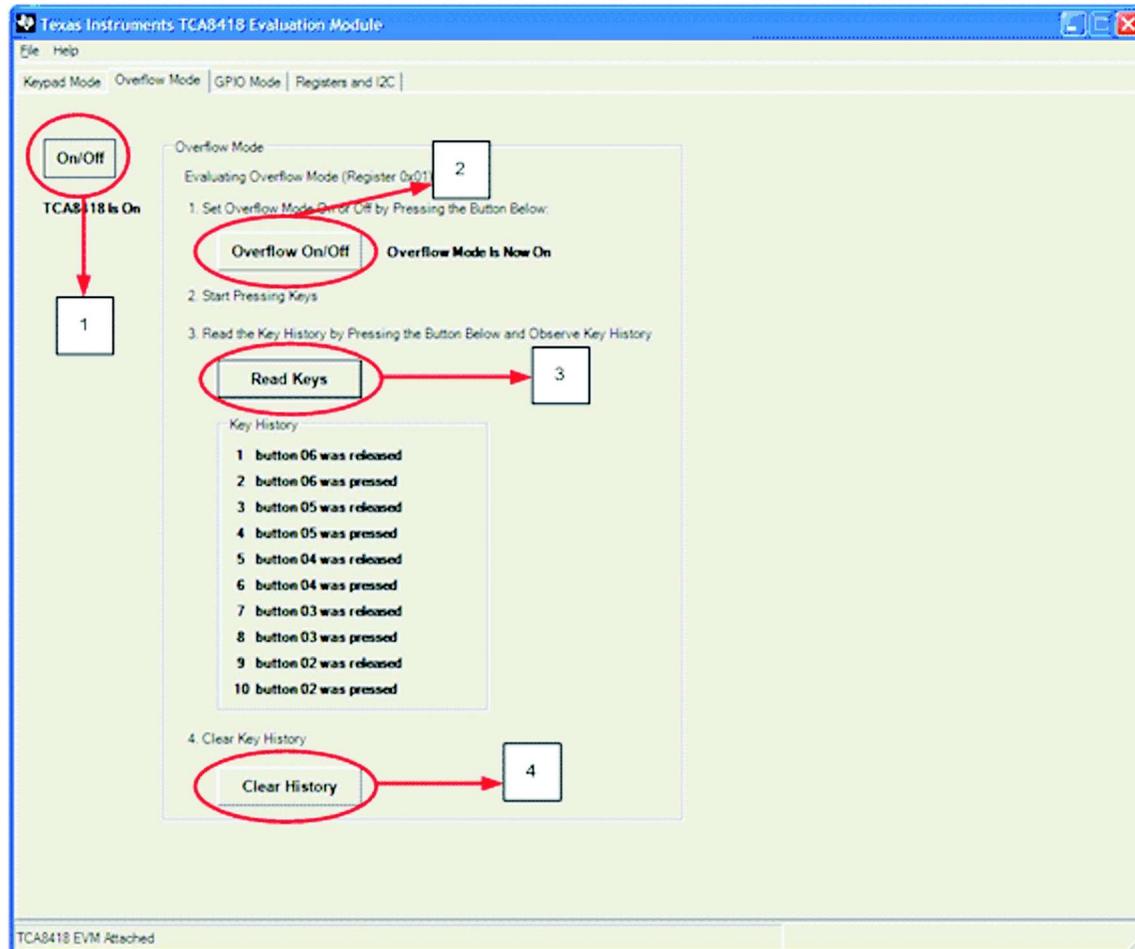
Lock/Unlock: Lock or unlock the TCA8418 EVM. During locked mode, press keys S9 and S10 on the EVM to unlock the EVM.

Clear Screen: Clear the key screen

Clear History: Clear the key history screen

### 3.2.2 Overflow Mode

The overflow mode provides evaluation for the TCA8418 overflow mode (see [Figure 10](#)). Make sure that jumpers JMP6, JMP7, JMP8, and JMP9 are shunted in the 2-3 position in this mode. Follow the instructions listed on the GUI to observe the change in key history as the key press/release actions exceed the 10 byte FIFO.



**Figure 10. TCA8418 EVM GUI: Overflow Mode**

The button for the overflow mode tab are:

On/Off: Enable or disable the TCA8418 EVM

Overflow On/Off: Enable or disable the overflow mode

Read Keys: Read the key events from the key event registers through I<sup>2</sup>C

Clear History: Clear the key history screen.

### 3.2.3 GPIO Mode

The GPIO mode provides evaluation for the TCA8418 with 2 inputs and 2 outputs (see Figure 11). Make sure that jumpers JMP6, JMP7, JMP8, and JMP9 are shunted in the 1-2 position in this mode.

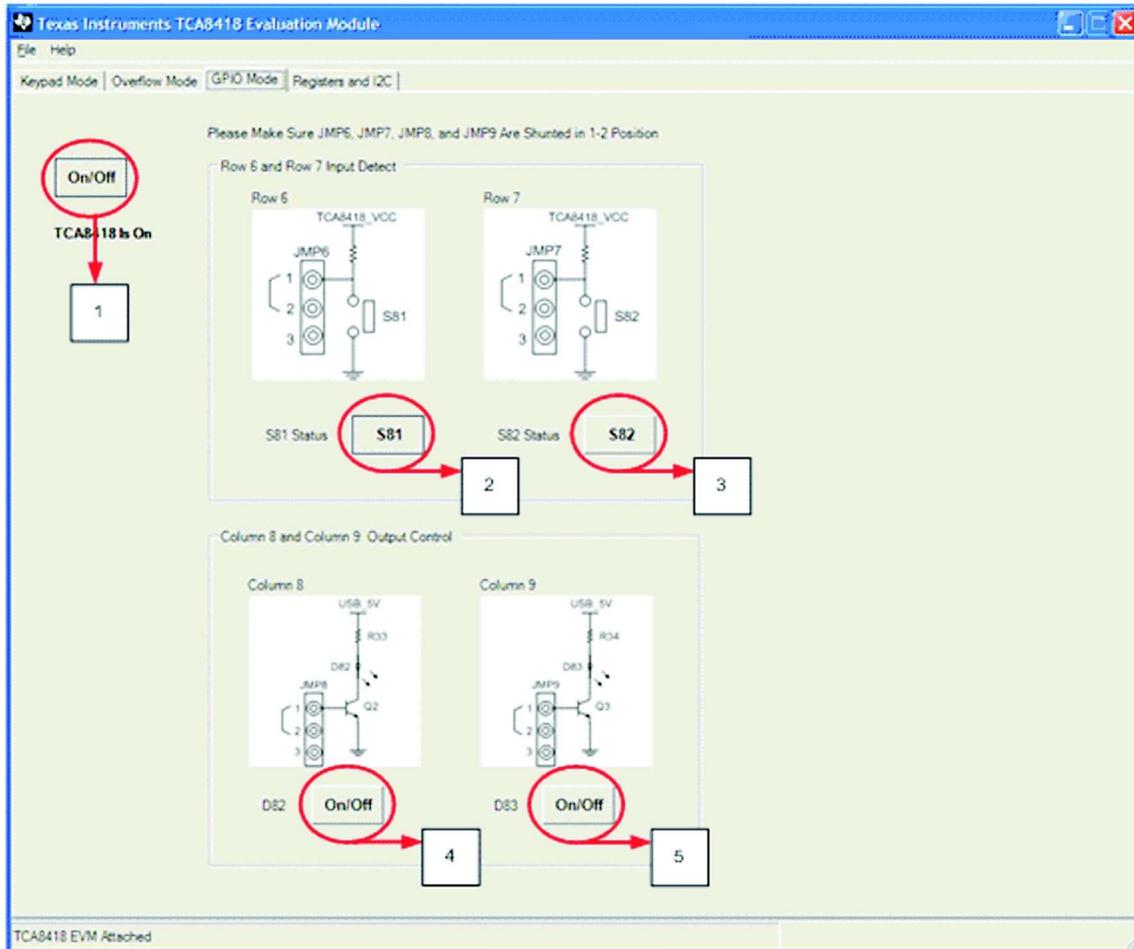


Figure 11. TCA8418 EVM GUI: GPIO Mode

The buttons for the GPIO mode tab are:

**On/Off:** Enable or disable the TCA8418 EVM. When the TCA8418 EVM is enabled through this button, it is configured in a 8x6 keypad matrix with two GPIs on Row 6 and Row 7 and two GPOs on Column 8 and Column 9.

**S81:** Corresponds to the key S81 press/release action. Display purpose only, no response when pressed within the GUI.

**S82:** Correspond to the key S82 press/release action. Display purpose only, no response when pressed within the GUI.

**On/Off for D82:** Turn on or off LED D82.

**On/Off for D83:** Turn on or off LED D83.

### 3.2.4 Registers and I<sup>2</sup>C

The Registers and I<sup>2</sup>C mode provides a clear view on all of the TCA8418 IC register status on one page (see Figure 12). It also provides I<sup>2</sup>C bus master function, which can write and read other I<sup>2</sup>C slave devices on the same bus.

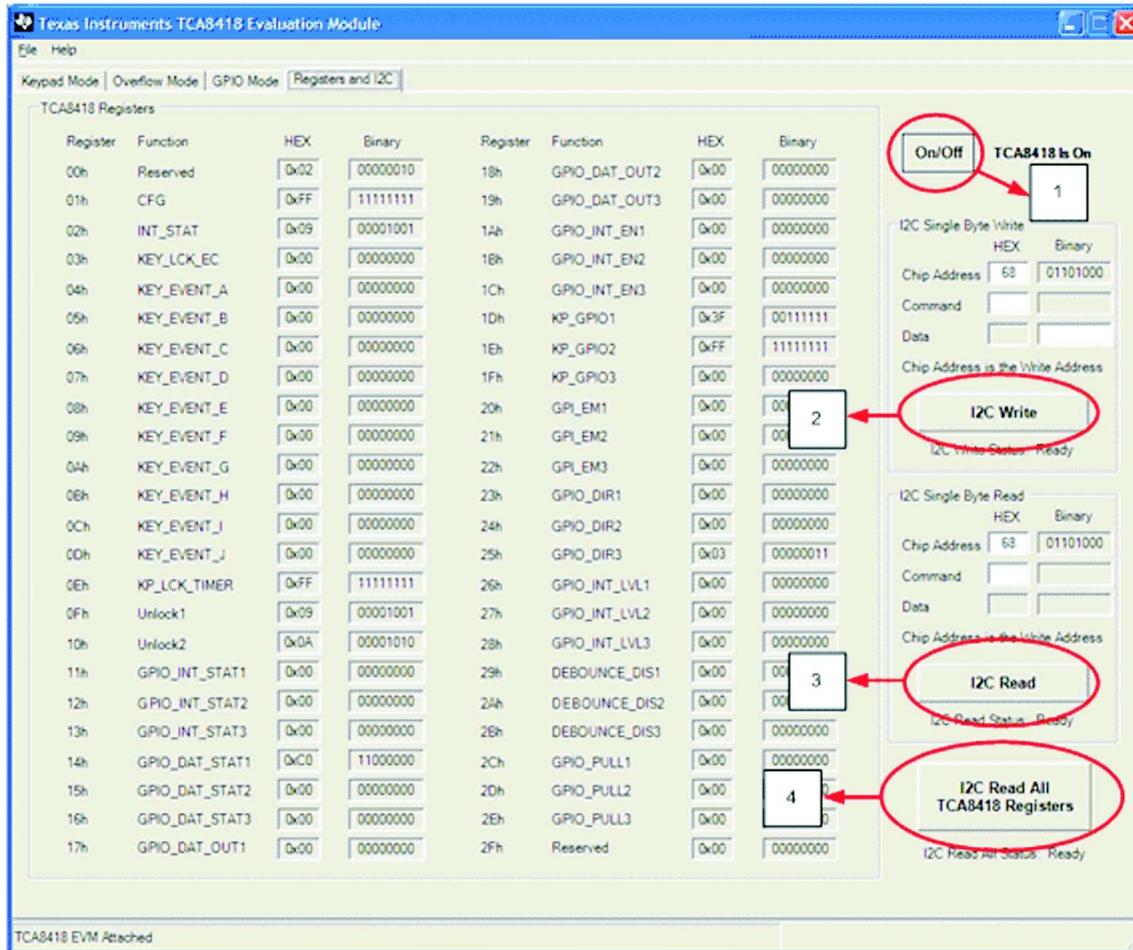


Figure 12. TCA8418 EVM GUI: Registers and I<sup>2</sup>C

The buttons for the overflow mode tab are:

On/Off: Enable or disable the TCA8418 EVM

I<sup>2</sup>C Write: Allow the TCA8418 EVM to behave like an I<sup>2</sup>C bus master to write to other I<sup>2</sup>C slave devices in addition to the TCA8418. Enter the chip address (in HEX), command byte (in HEX), and data (in binary) on the corresponding section and press I<sup>2</sup>C Write. The I<sup>2</sup>C Write Status indicates the I<sup>2</sup>C transaction result.

I<sup>2</sup>C Read: Allow the TCA8418 EVM to behave like an I<sup>2</sup>C bus master to read other I<sup>2</sup>C slave devices in addition to the TCA8418. Enter the chip address (in HEX), command byte (in HEX) and press I<sup>2</sup>C Read. The read results are displayed on the corresponding section, and the I<sup>2</sup>C Read Status indicates the I<sup>2</sup>C transaction result.

I<sup>2</sup>C Read All TCA8418 Registers: Read all of the TCA8418 registers

**4 Related Documentation from Texas Instruments**

TCA8418  $\mu$ C Controlled Keypad Scan IC with Integrated ESD Protection data sheet ([SCPS215](#))

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