TCA8424 Evaluation Module

This document is the EVM user guide for the TCA8424. The device is a low-voltage keyboard scanner that can support up to 128 keys, with open drain outputs that can sink up to 12 mA of current for LEDs. The TCA8424 is fully HID over I²C™ compliant and is available with a pre-programmed keyboard map.

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1 About this Manual

This user's guide describes the TCA8424 Evaluation Module (EVM). This guide contains the EVM schematics, bill of materials, and top and bottom board layouts.

2 Information about Cautions and Warnings

This section describes the jumpers and connectors on the EVM as well and how to properly connect, set up, and use the TPS22985EVM.

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 Electrostatic Discharge (ESD) application note (SSYA008).

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

3 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 communications, in which case the user, at their own expense is required to take whatever measures necessary to correct this interference.

4 Items Required for Operation

The following items are required to program a TCA8424:

- TCA8424 EVM with un-programmed TCA8424 in socket
- Single 3.3-V supply
- MSP-EXP430G2 Rev 1.5 Launchpad with MSP430G2553 installed
- USB to mini-USB cable
- PC with Code Composer Studio installed running supplied firmware
- PC with Application GUI installed

The following items are required to evaluate at the system level:

- TCA8424 EVM with programmed TCA8424 in socket
- Breakout wires to connect to keyboard matrix rows and columns
- Keyboard matrix
- Host system with I^2C plus INT connected to board

5 Introduction

The benefits of the TCA8424 over other microcontroller-based solutions are lower development costs, smaller package, and lower power consumption. The lower development costs are seen due to the TCA8424 requiring programming of only 512 Bytes of OTP versus a full code stack on a microcontroller. The TCA8424 is fully compliant with HID over I^2C based systems with little to no host firmware development.

The TCA8424 can also be used in a non-Hid over I^2C environment by developing host drivers that mimic the HID over I^2C protocol to interpret the input reports. The EVM features a socket to allow easy programming of multiple units for testing. The code stack supplied with the EVM is designed to interface with the MSP430G2553 Launchpad to accomplish this. Once programmed, the EVM features breakout headers for the keyboard and I^2C connections to test in customer systems.

6 TCA8424 EVM Design Circuitry, Bill of Materials, and Connection Descriptions

6.1 TCA8424 EVM Schematic

Figure 1 shows the schematic for the EVM. The connections on the EVM are briefly explained in the subsequent sections.

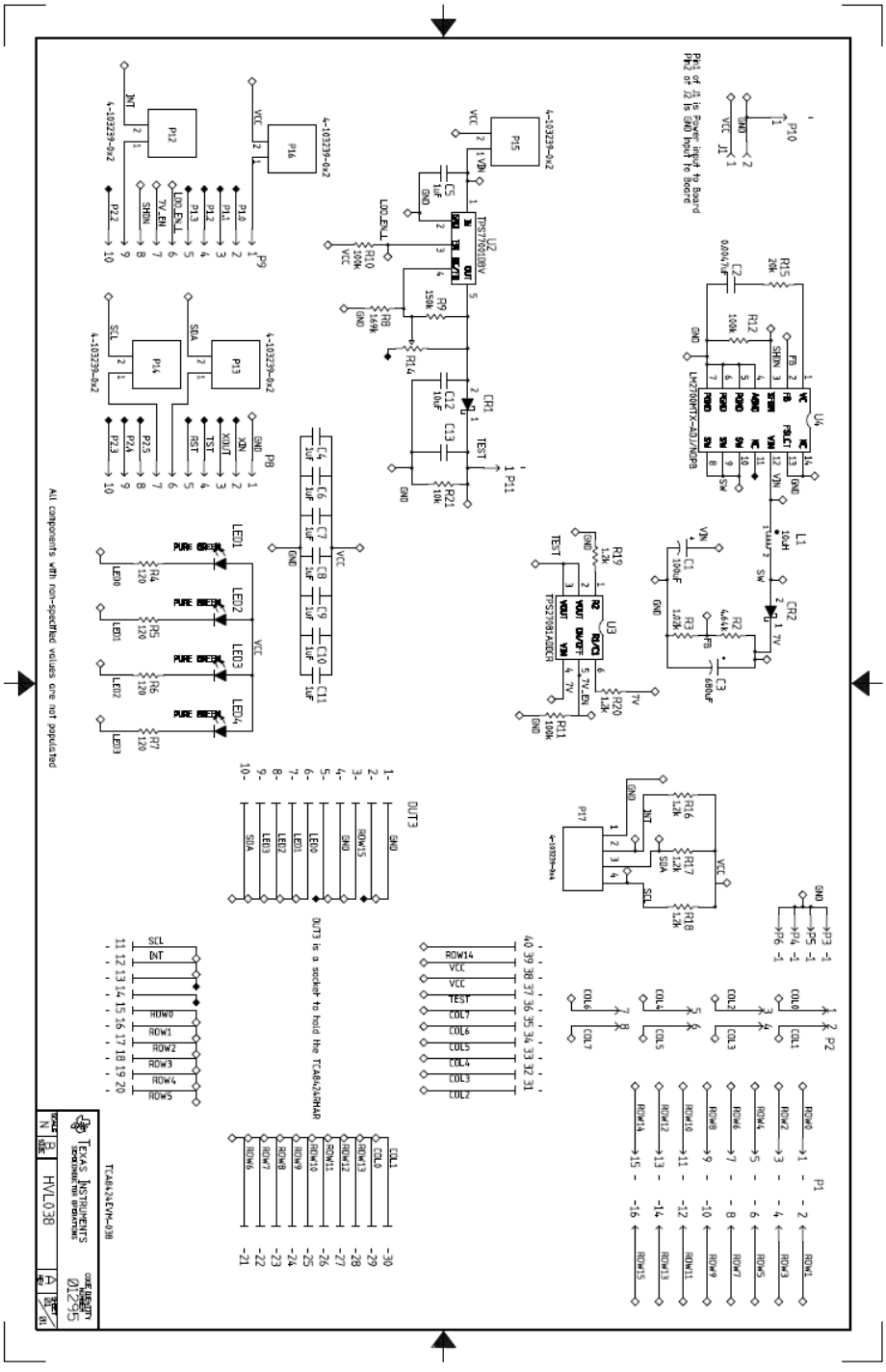


Figure 1. TCA8424 EVM Schematic

6.2 Printed-Circuit Board (PCB) Layout

Figure 2 to Figure 5 show the PCB layouts for the TCA8424 EVM.

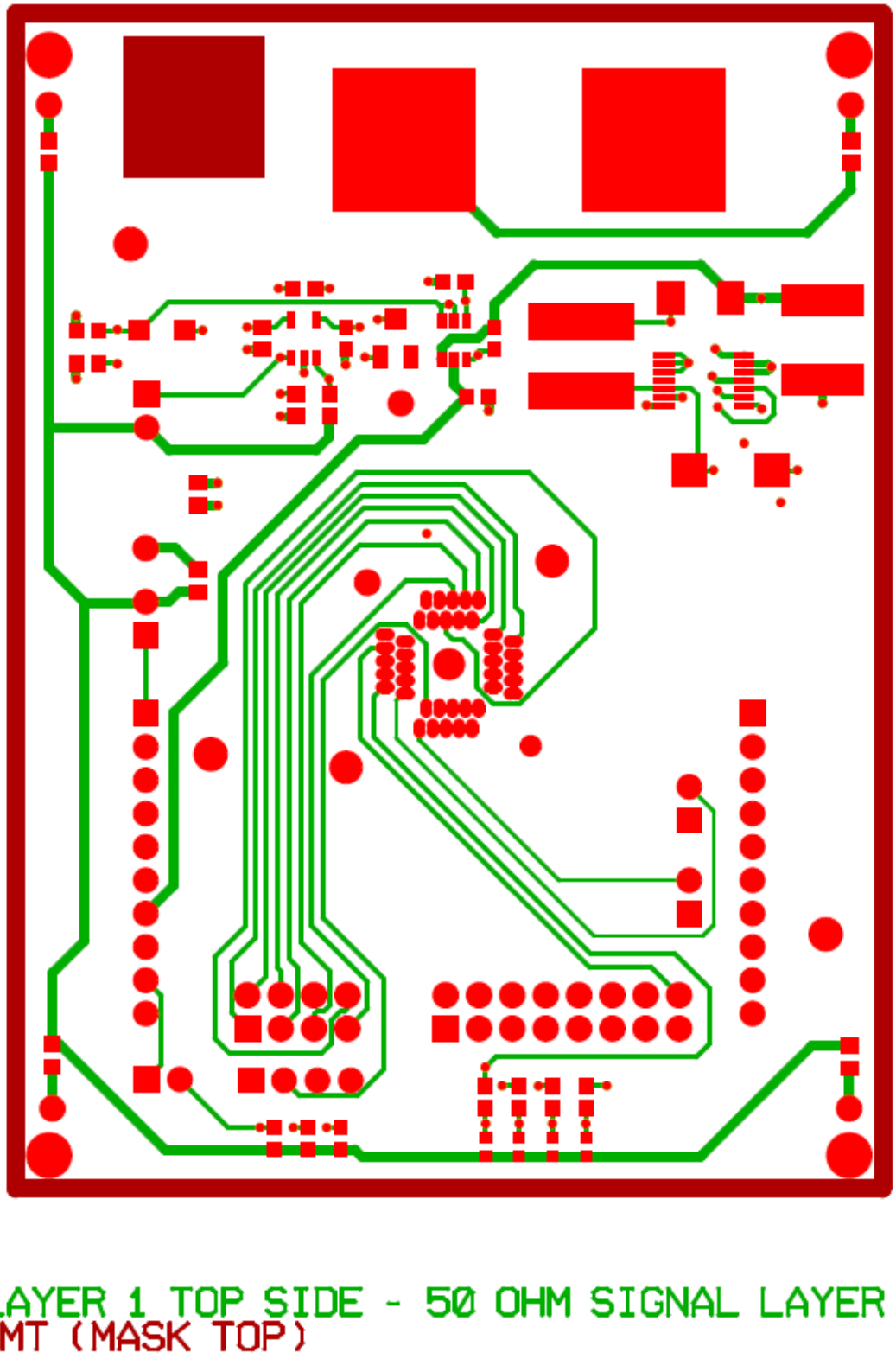


Figure 2. Layer 1 Top Side: 50-Ω Signal Layer

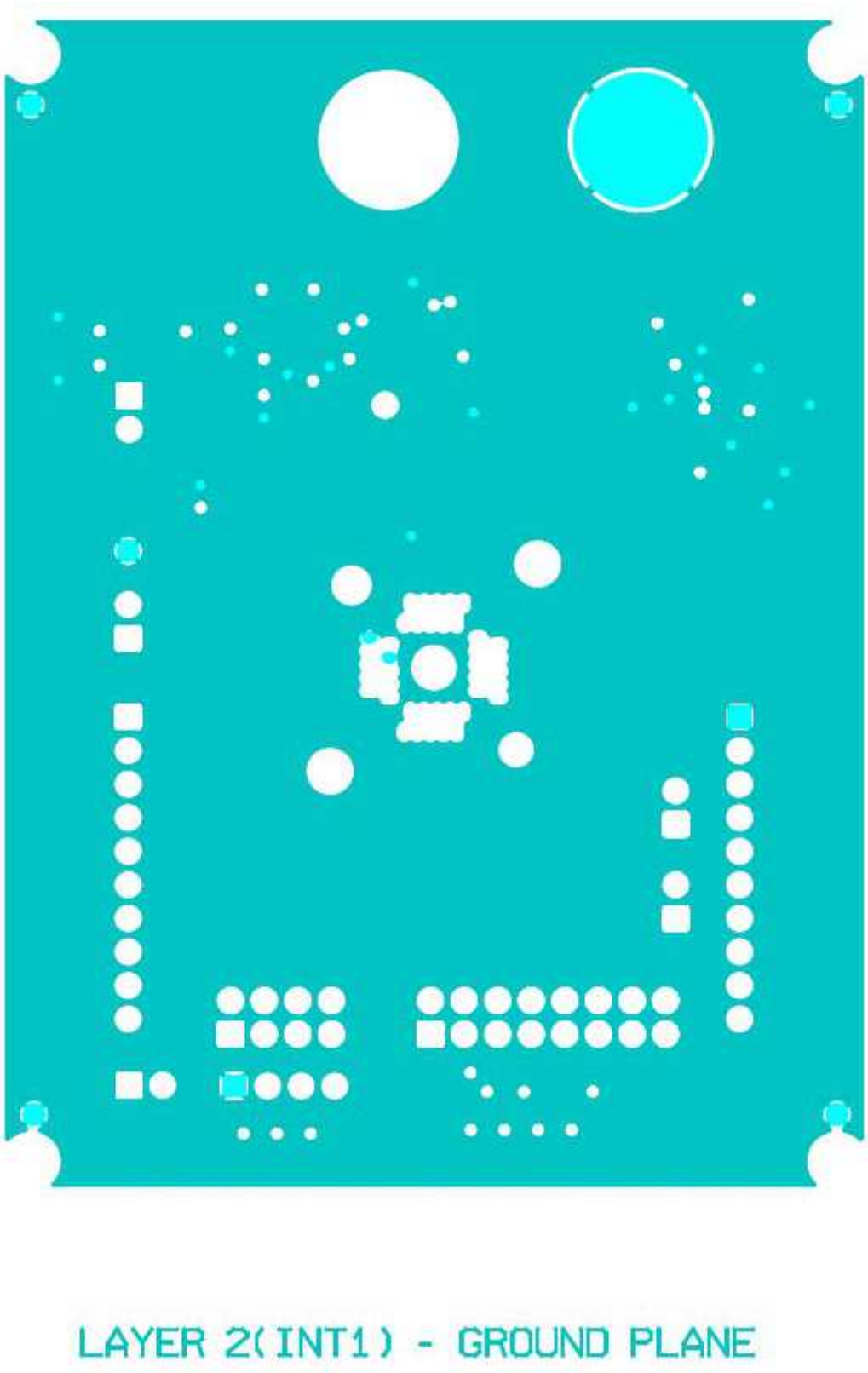


Figure 3. Layer 2 (Int1): Ground Plane

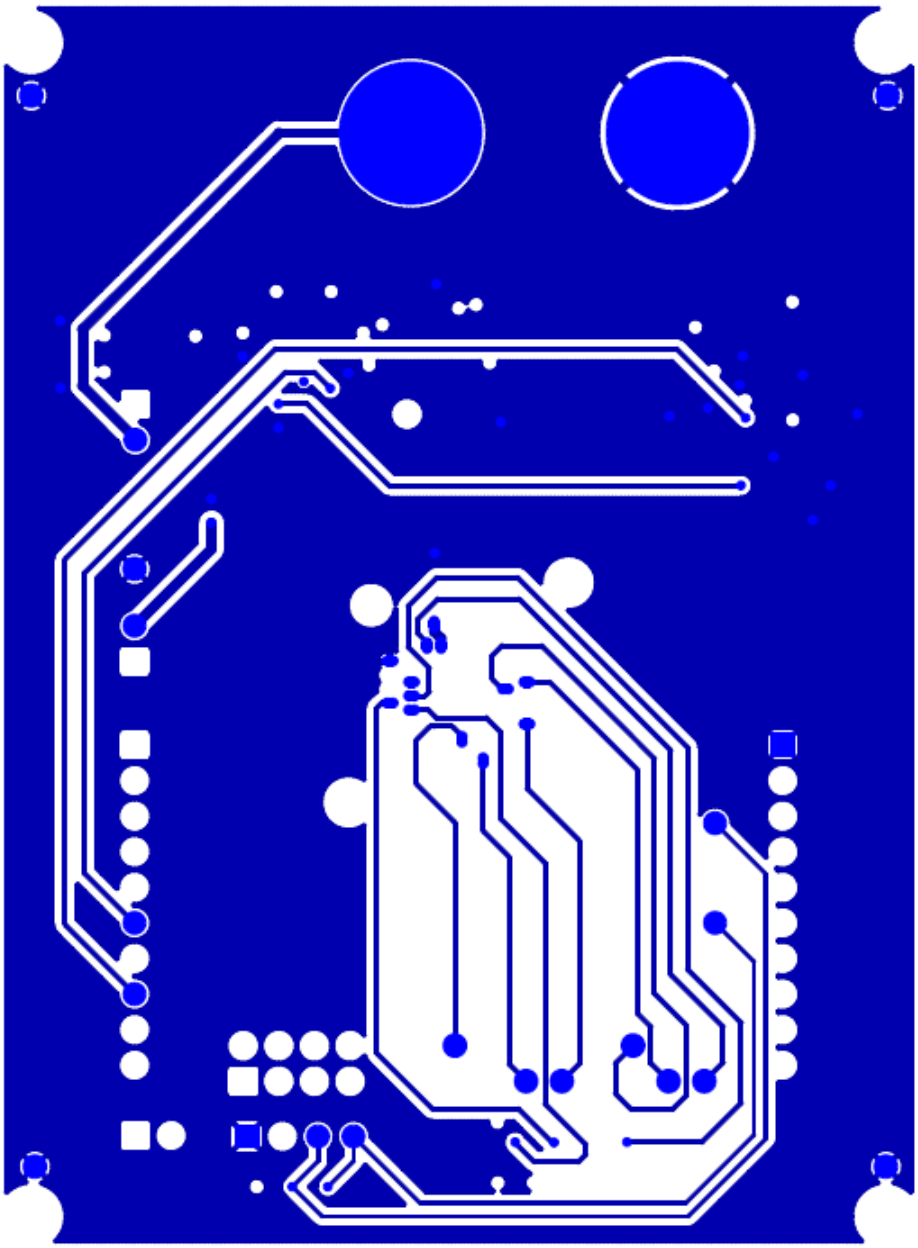


Figure 4. Layer 3 (Int2): 50-Ω Signal with Ground Fill

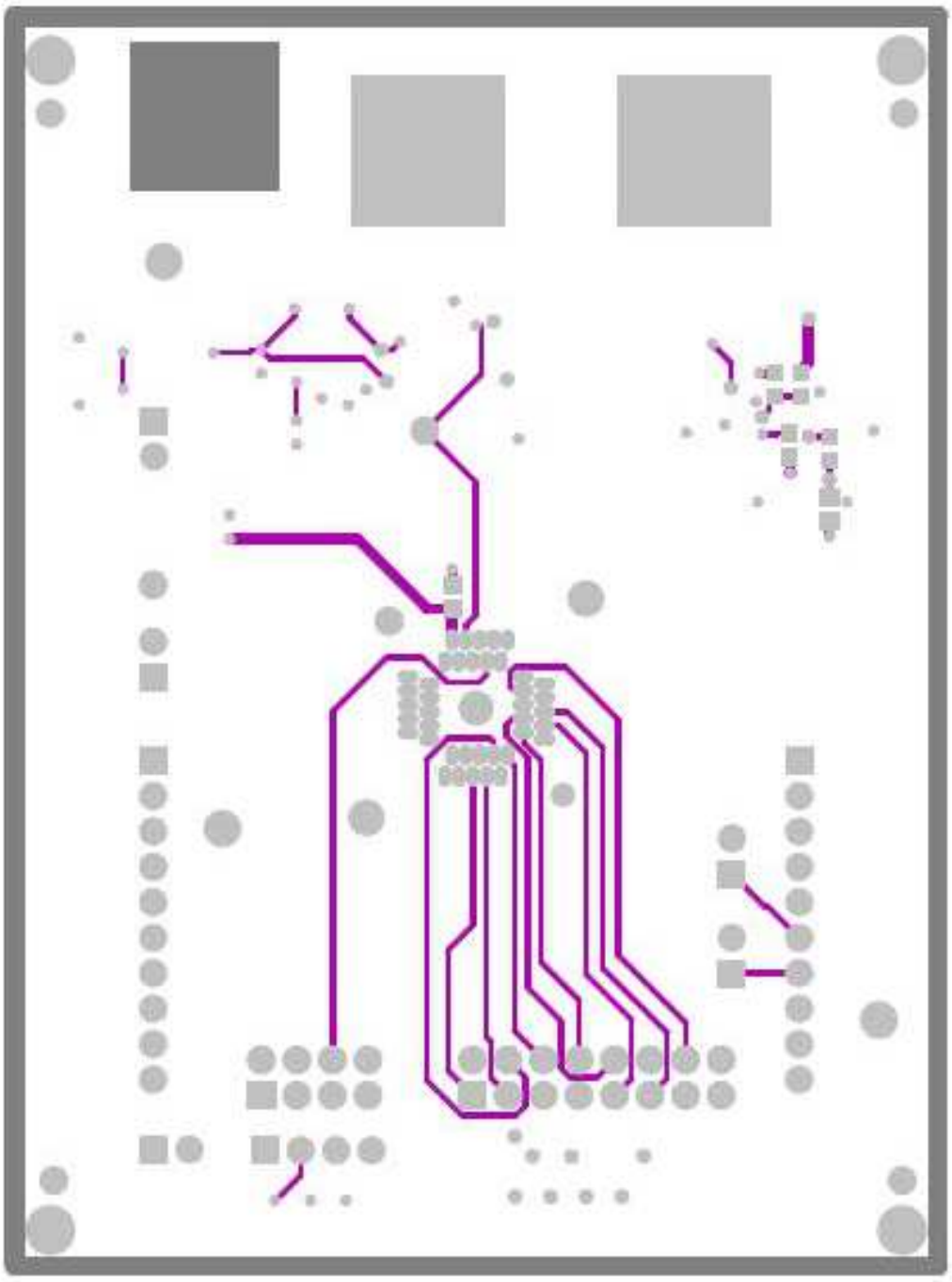


Figure 5. Layer 4 Bottom Layer

6.3 Bill of Materials

Table 1 is the bill of materials for this EVM.

Table 1. Bill of Materials

ITEM	QTY	MFG	MFG PART#	REF DES	DESCRIPTION
1	4	PANASONIC	LNJ308G8PRA	LED1, LED2, LED3, LED4	LED,SMT,0603,PURE GREEN,2.03V
2	1	POMONA ELECTRONICS	2269-0	J1	DUAL INSULATED BANANA JACKS, BLACK, 0.75LS
3	1	PANASONIC	ECJ-1V41E105M	C4, C5, C6, C7, C8, C9, C10, C11,	CAPACITOR,SMT,0603,CERAMIC,1.0uF,25V,20%,X5S
4	1	PANASONIC	ECJ-1VB0J106M	C12	CAPACITOR,SMT,0603,CERAMIC,10uF,6.3V,20%,X5R
5	1	TAIYO YUDEN	TMK107SD472JA	C2	CAPACITOR,SMT,0603,CERAMIC,4700pF,25V,5%,SD
6	1	VISHAY SPRAGUE	594D687X0010R2T	C3	CAP,TAN,SMT,10V,20%, 680uF
7	1	PANASONIC	EEFUD0K101R	C1	CAP,SMT,ELE,100uf,8V,20%
8	1	DIODES INC	B230-13-F	CR2	DIODE,SCHOTTKY,SMT, DIODES,INC.
9	1	DIODES INC	SD103CW-13-F	CR1	SCHOTTKEY DIODE,SMT,20V,400mW,SOD-123
10	1	SAMTEC	TSW-104-07-G-D	P2	HEADER,THU,8P,2X4,MALE,DUAL ROW,100LS,100TL
11	1	SAMTEC	TSW-108-07-G-D	P1	HEADER,THU,16P,2X8,MALE,DUAL ROW,100LS,100TL
12	2	FCI	66951-010LF	P8, P9	HEADER,THU,10P,1X10,FEMALE,SINGLE ROW,100LS,200TL
13	6	SAMTEC	TSW-101-07-G-S	P3, P4, P5, P6, P10, P11	HEADER,THU,1P,MALE,SINGLE ROW,100TL
14	5	TE Connectivity	9-146281-0-02	P12, P13, P14, P15, P16	
15	1	TE Connectivity	9-146281-0-04	P17	
16	1	*ENPLAS CORPORATION	QFN-40B-0.5-01	DUT3	HTSOCKET,QFN,40P,35x29x16.7mm, w 2.1hole
17	1	TI	TPS77001DBV	U2	1.2~5.5V,ULTRA LOW-POWER 50mA LOW-DROP LINE REGULATOR
18	1	TI	TPS27081ADDCR	U3	HIGH SIDE LOAD SWITCH WITH LVL SHFT AND ADJ SLEW RATE
19	1	TI	LM2700MTX-ADJ/NOPB	U4	LM2700 600KHZ/1.25MHZ,2.5A, STEPUP PWM DC/DC CONVERTER
20	1	BOURNS	SDR0805-100ML	L1	INDUCTOR,SMT,2P,POWER,10uH,20%,RoHS
21	1	VISHAY	CRCW060310K0FKEA	R21	RESISTOR,SMT,0603,1%,1/10W,10.0K
22	3	VISHAY	CRCW0603100KFKEA	R10, R11, R12	RESISTOR,SMT,0603,1%,1/10W,100K
23	1	VISHAY	CRCW06031K02FKEA	R3	RESISTOR,SMT,0603,1%,1/10W,1.02K
24	1	VISHAY	CRCW0603150KFKEA	R9	RESISTOR,SMT,0603,1%,1/10W,150K
25	1	VISHAY	CRCW0603169KFKEA	R8	RESISTOR,SMT,0603,1%,1/10W,169K
26	1	VISHAY	CRCW060320K0FKEA	R15	RESISTOR,SMT,0603,1%,1/10W,20.0K
27	1	VISHAY	CRCW06034K64FKEA	R2	RESISTOR,SMT,0603,1%,1/10W,4.64K
28	4	PANASONIC	ERJ-3GSYJ121	R4, R5, R6, R7	RESISTOR,SMT,0603,5%,1/10W,120

Table 1. Bill of Materials (continued)

29	5	PANASONIC	ERJ-3GSYJ122	R16, R17, R18, R19, R20	RESISTOR,SMT,0603,5%,1/10W,1.2K
30	0	BOURNS	3313J-1-204	R14	PlaceHolder, DO NOT INSTALL
32	0	PANASONIC	ECJ-1V41E105M	C13	PlaceHolder, DO NOT INSTALL
33	1	Texas Instruments	TCA8424RHAR	U1	TI device to be used in Socket
34	5	TE Connectivity	382811-8	N/A	Jumpers to be installed over P12, P13, P14, P15, P16

6.4 VCC and GND Connections

Pin 1 of J1 is a power input to the board and Pin 2 is the GND connection for the board. There are also 4 other GND test points in the corners of the board.

The TCA8424 cannot be powered from the MSP430 Launchpad when programming and needs an external supply.

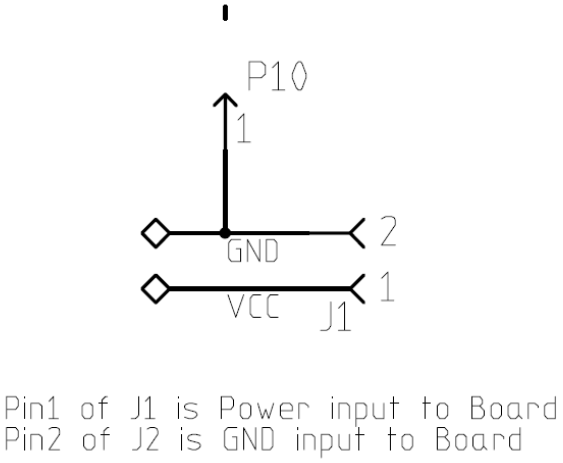


Figure 6. VCC and GND Connections

6.5 MSP430 Launchpad Interface

Headers P8 and P9 allow the EVM to interface with the MSP430 Launchpad. If not programming a unit, jumpers P12, P13, P14, and P16 may be installed, header P15 should be removed. When programming a unit, an external power supply is needed and all headers except P16 should be installed.

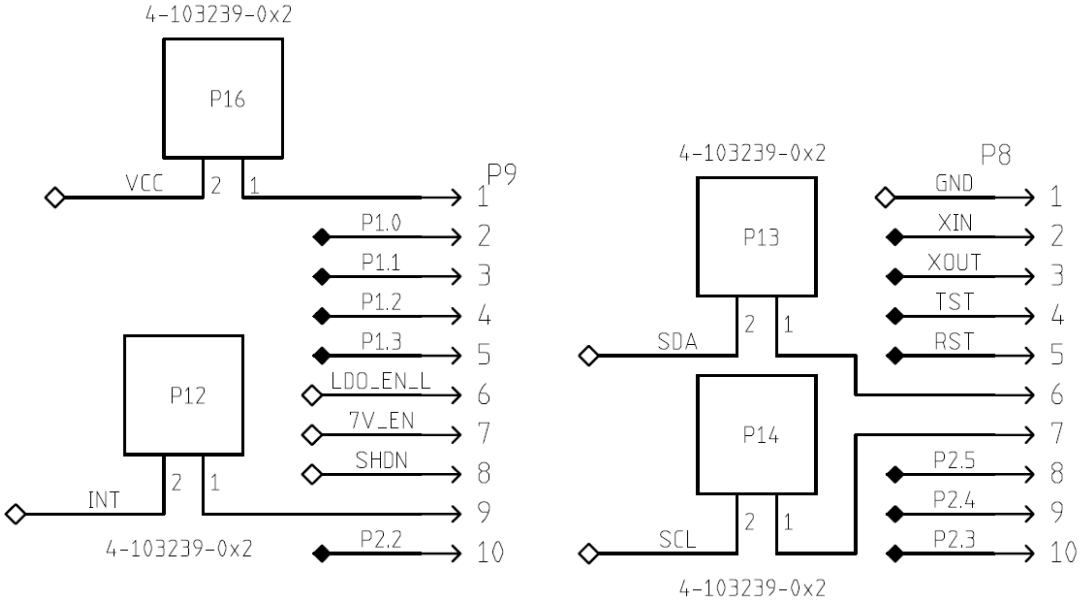


Figure 7. MSP430 Launchpad Interface

6.6 Breakout Pins

The breakout headers P1 and P2 allow connection of an external keyboard matrix to the EVM. P17 is connected to the I^2C lines of the TCA8424 allowing an external host to communicate to the TCA8424.

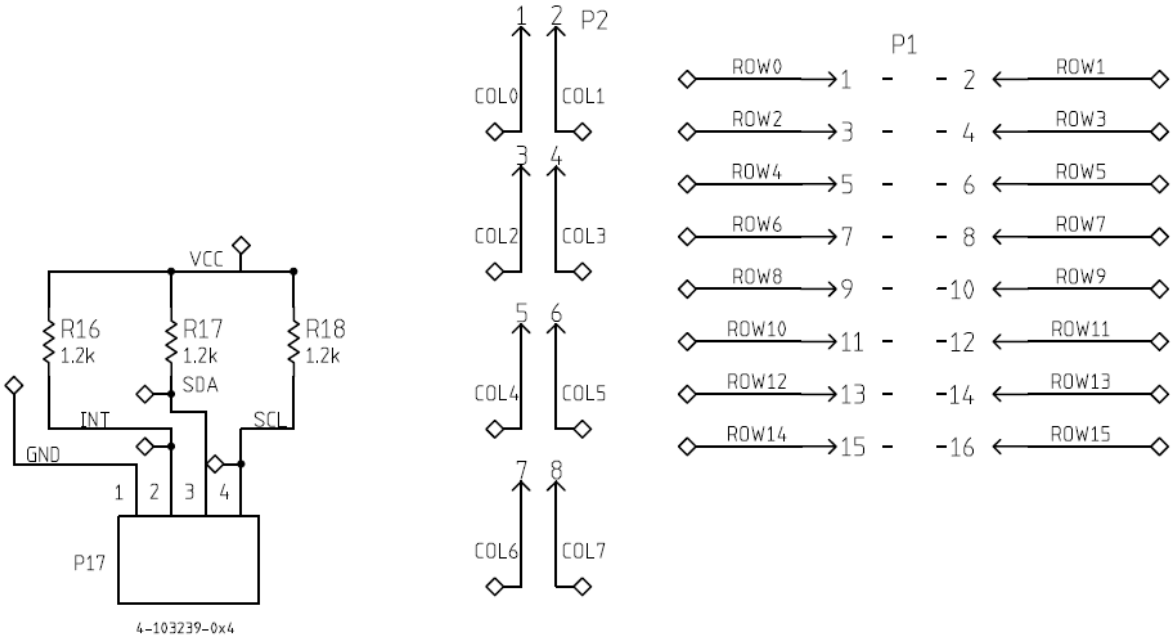


Figure 8. Breakout Pins

Table 2. Header Configurations for P1, P2, and P7

P1			**P2**			**P7**
Row15 (pin 16)	Row14		Col7	Col6		GND (pin 1)
Row13	Row12		Col5	Col4		/INT
Row11	Row10		Col3	Col2		SDA
Row9	Row8		Col1	Col0 (pin 1)		SCL
Row7	Row6					
Row5	Row4					
Row3	Row2					
Row1	Row0 (pin 1)					

6.7 LED Outputs

The TCA8424 features LED outputs that are set via the HID SET Report Command in the GUI, discussed in Section 9, part D.

- Board LED1 = TCA8424 LED0
- Board LED2 = TCA8424 LED1
- Board LED3 = TCA8424 LED2
- Board LED4 = TCA8424 LED3

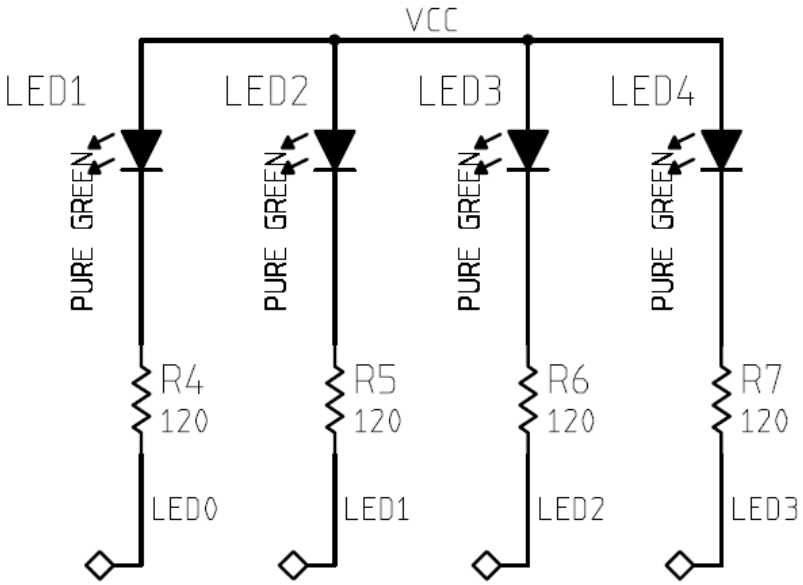
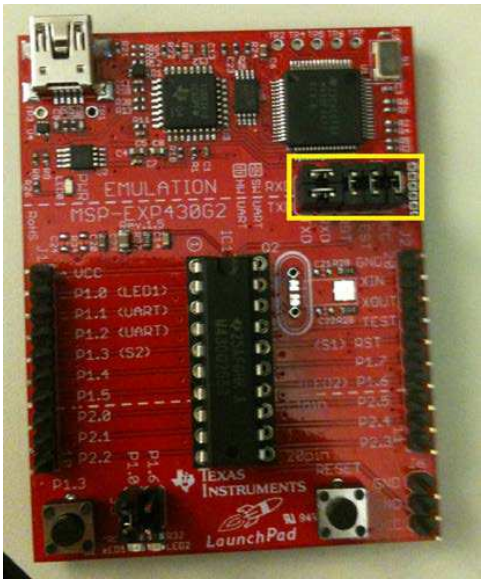


Figure 9. LED Outputs

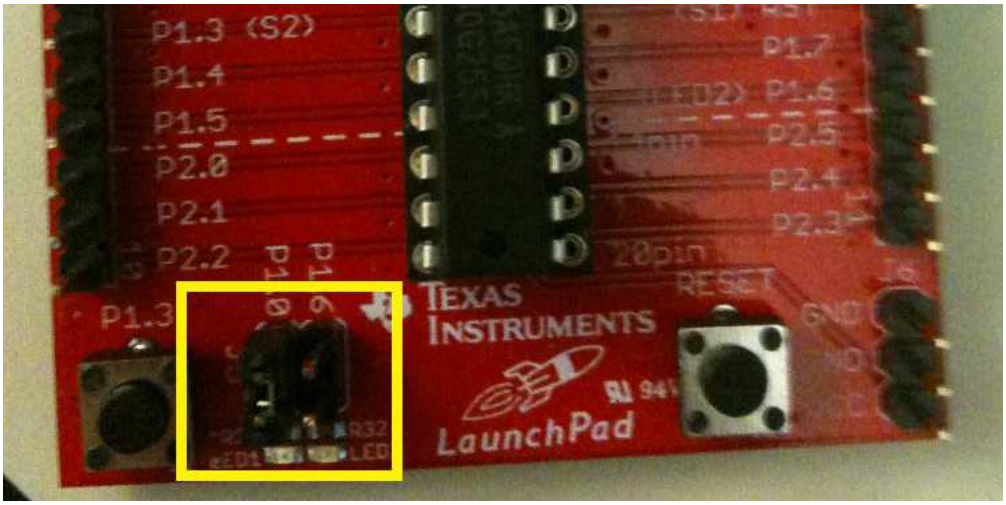
7 Launchpad Software Setup

Use the following steps to set up the Launchpad software:

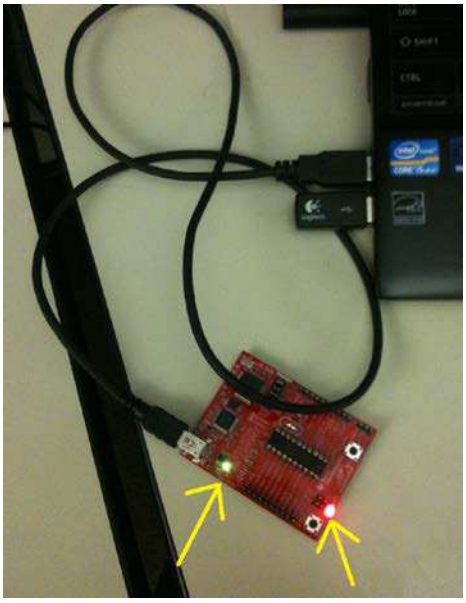
1. Download Code Composer Studio from the Texas Instruments link.
2. With the Launchpad unplugged, configure the headers on the Launchpad to match the yellow box in the image below:
   - The right 3 headers are vertical and the left 2 are horizontal



3. With the Launchpad still unplugged, remove the right-most jumper on the J5 header to match the yellow box below:



4. Connect the Launchpad to your computer with a USB to mini cable. A green LED and a red LED should be on as shown below:

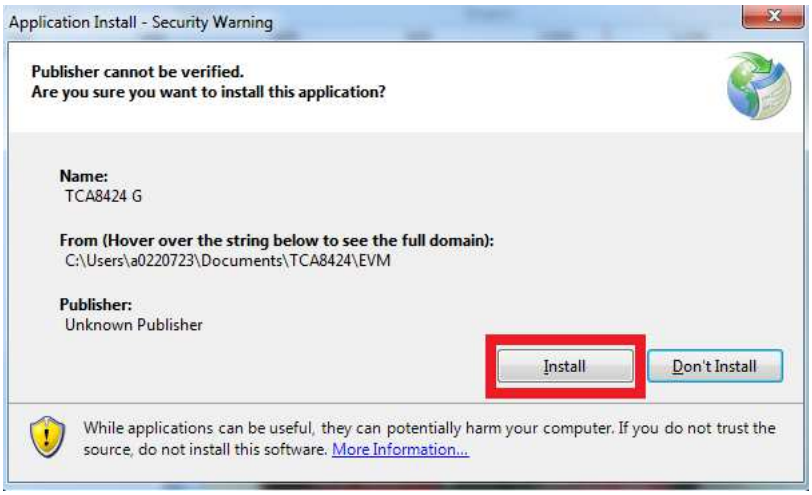


5. Open Code Composer Studio and create a new workspace. Select the “Project” drop down menu and click on “Import existing CCS/CCE Eclipse Project.” Select Browse on the “Select-search directory” option and select the location where the source code is stored. Click "Finish" and then select “debug launch” to load the code to the MSP430G2553 microcontroller. Once completed, disconnect the USB cable from the LaunchPad.
6. After completing steps 1–5, to load the code at any point for any reason, simply open the workspace that was created. Ensure that the source code is the active project and the LaunchPad is connected through USB. Then select “debug launch” to load the code.

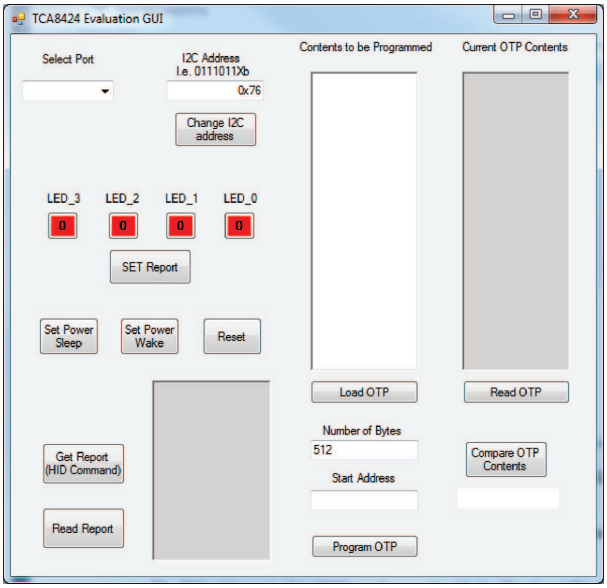
If the Launchpad is running and VCC is not connected, the I^2C communication will fail. You must pause the debugger, reset the MSP430 with the "reset CPU" button and then press “play” again.

8 GUI Software Setup

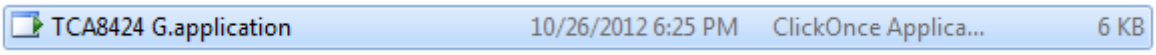
1. Extract the “TCA8424 GUI.zip” contents to the destination folder of your choice.
2. Double click the setup.exe folder that was extracted in step 1.
3. The following window pops up. Click “Install”.



4. After finishing the installation, the GUI opens and looks like this:



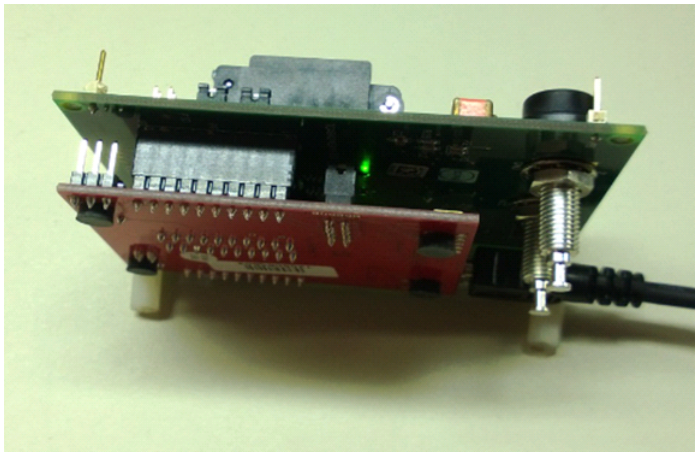
5. To open the GUI in the future, simply double click on the “TCA8424 G.application” file that was unzipped in step 1.



9 GUI Walkthrough Guide

A. Connecting the Launchpad to the EVM and PC

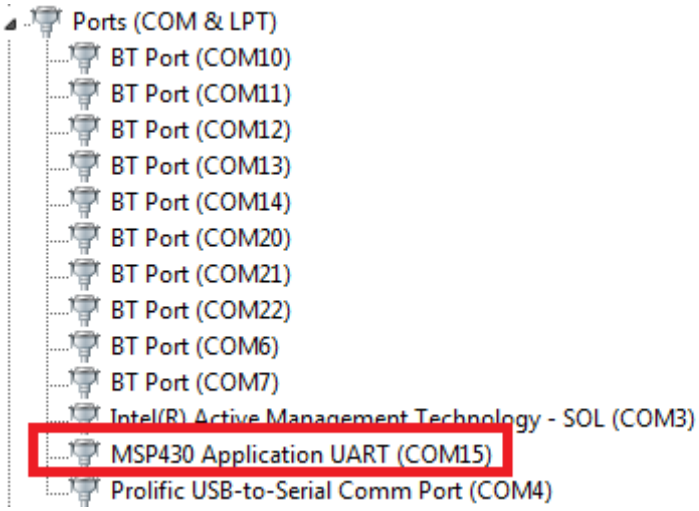
1. Install all headers except P16, place an un-programmed TCA8424 in the socket, and power the EVM board with 3.3 V.
2. Connect the MSP430 Launchpad to the EVM as shown below:
   - The connection point is under the board and the USB connector should open towards J1.



3. Connect the Launchpad to your PC.

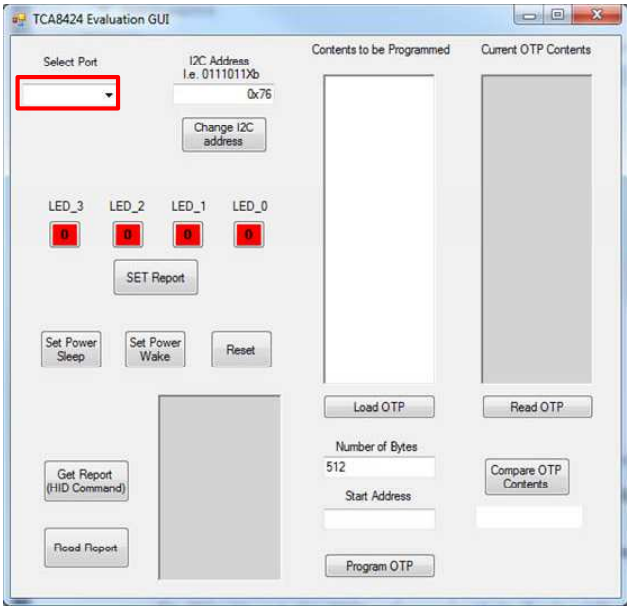
B. Initiating the connection from the GUI to the Launchpad

1. Open up the device manager on your PC and find which of the COM ports is associated with the Launchpad.
   - COM15 is the COM port associated with Launchpad as shown in the below image (using a local installation for illustration purposes only):

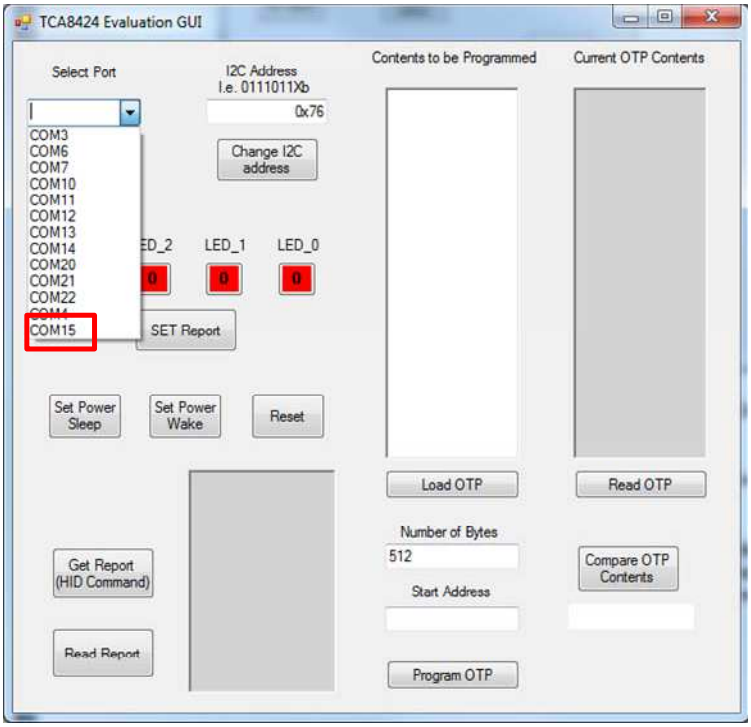


2. Open the GUI.

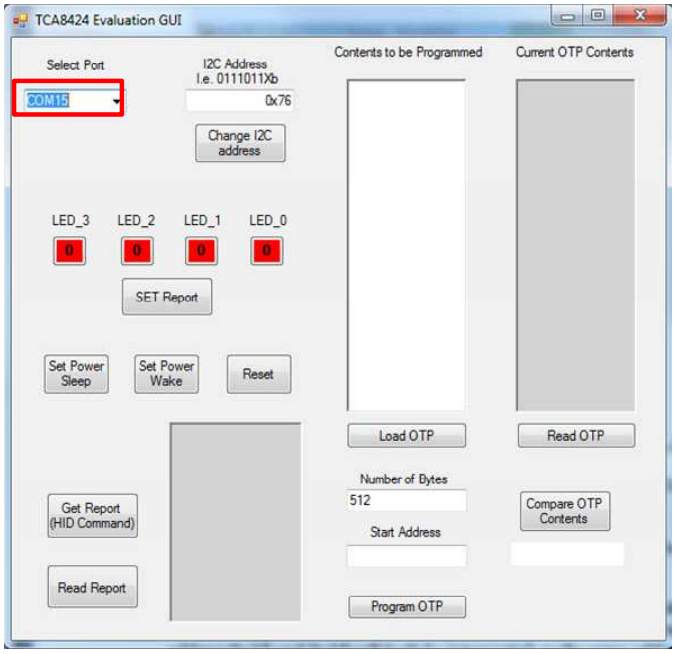
3. Under the "Select Port", there is a drop down menu box which is blank on startup, by default, as shown below:



4. Click this box, and a list of COM ports will pop up. Select the COM port that is associated with the Launchpad which was identified in step 1.
   - COM 15 from a local installation is shown for illustration purposes:



5. Now the GUI has opened a connection to the Launchpad and the COM port remains in the drop down menu box as shown below:

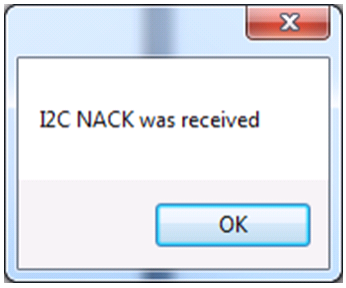


After the connection the Launchpad has been established and the GUI can be fully utilized. The remaining sections give basic steps on how to use each of the GUI buttons and inputs.

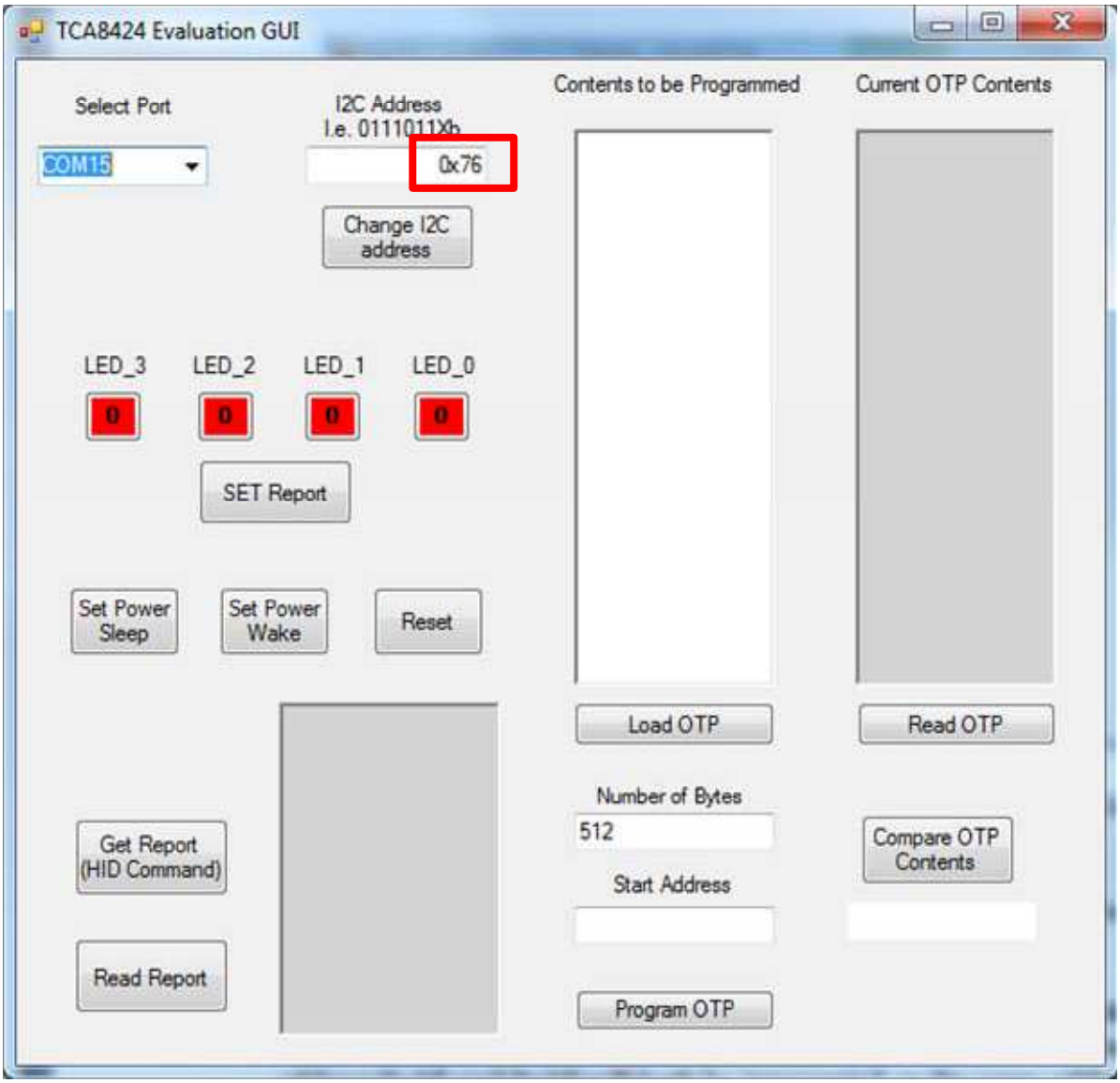
C. Changing the I²C Address

The I²C address in this GUI is referenced with the Read and Write bit included. An address of 0xA8 is represented in binary as 1010100Xb with the last bit being a 'don't care'. Address 0xA8 and 0xA9 are both interpreted as the same address.

The GUI indicates whether an I²C Nack is received by the Launchpad, by presenting a dialog box like shown below:



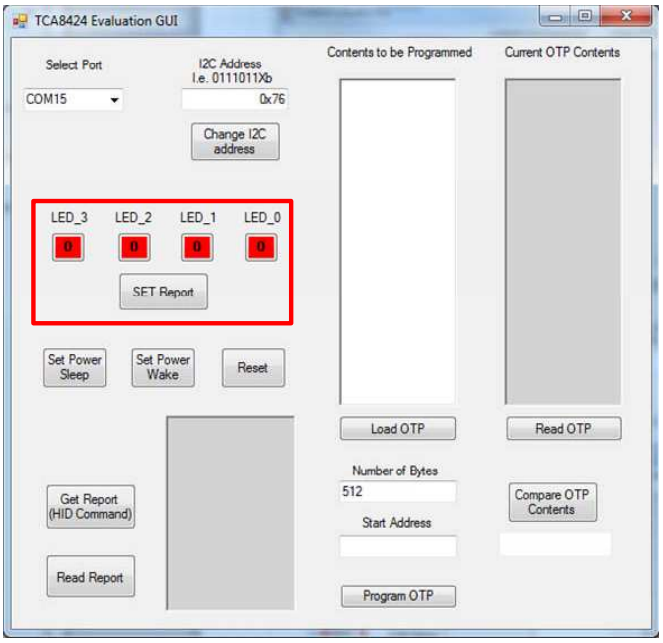
1. Both the Launchpad and GUI default the I²C addresses to 0x76 on startup as shown below:



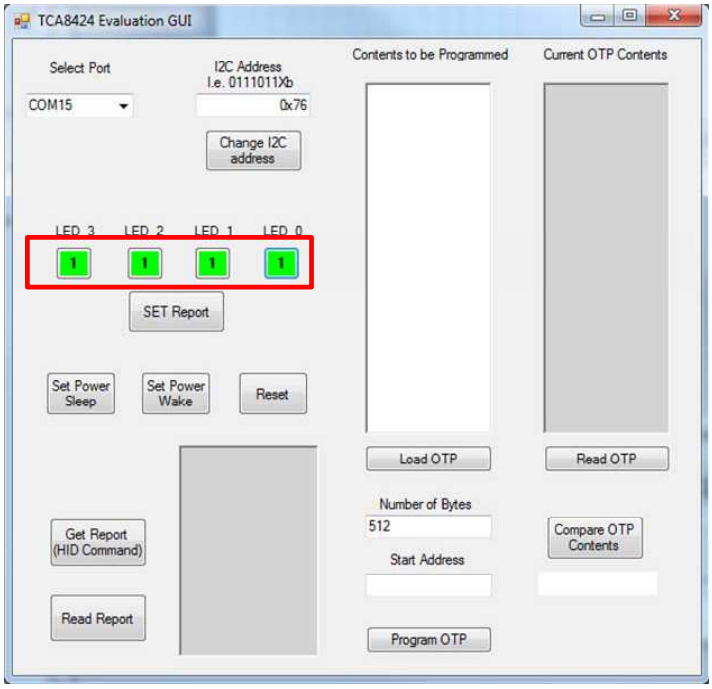
2. The I²C address must be written into the text box in the default format. Once an address has been entered, simply click on the “Change I2C address” button to communicate this to the Launchpad.
   - If the Launchpad is restarted, the I²C address will default again to 0x76 and must be changed again if you are working with a different I²C address.
3. Since the default address of the TCA8424 is 0x76 when the OTP is not programmed, leave the default address in the Launchpad.

D. HID commands and Read Report

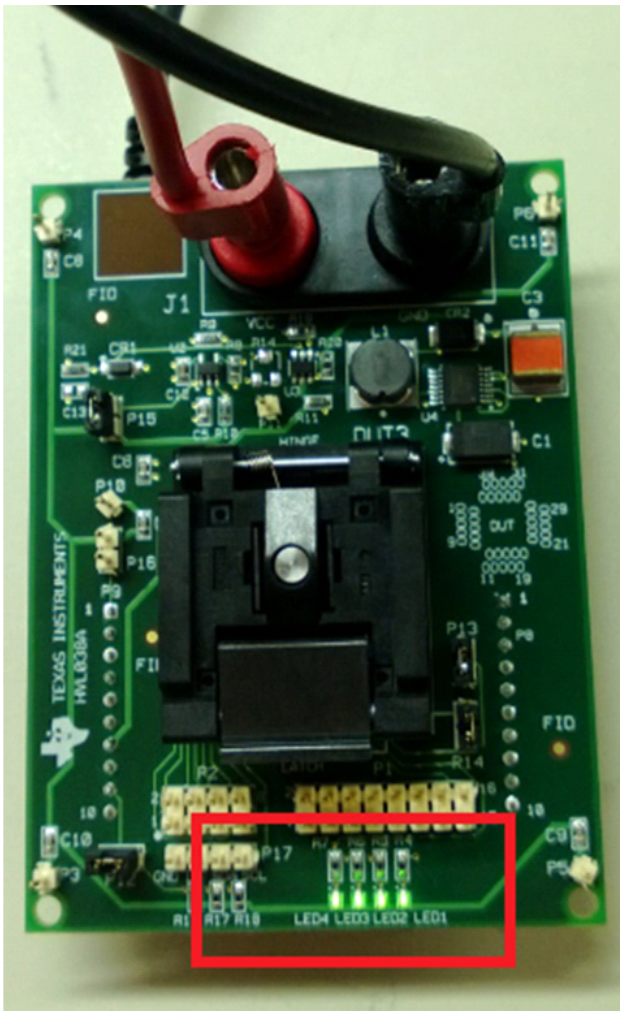
1. The LED outputs can be changed using the HID Command “SET Report” in the GUI which replicates an HID host issuing the command. The LED values are off, by default, and are changed by clicking the LED buttons.



2. The LED inputs for the SET Report command change to read ‘1’ with a green background when clicked, and change back to ‘0’ with a red background when clicked again.

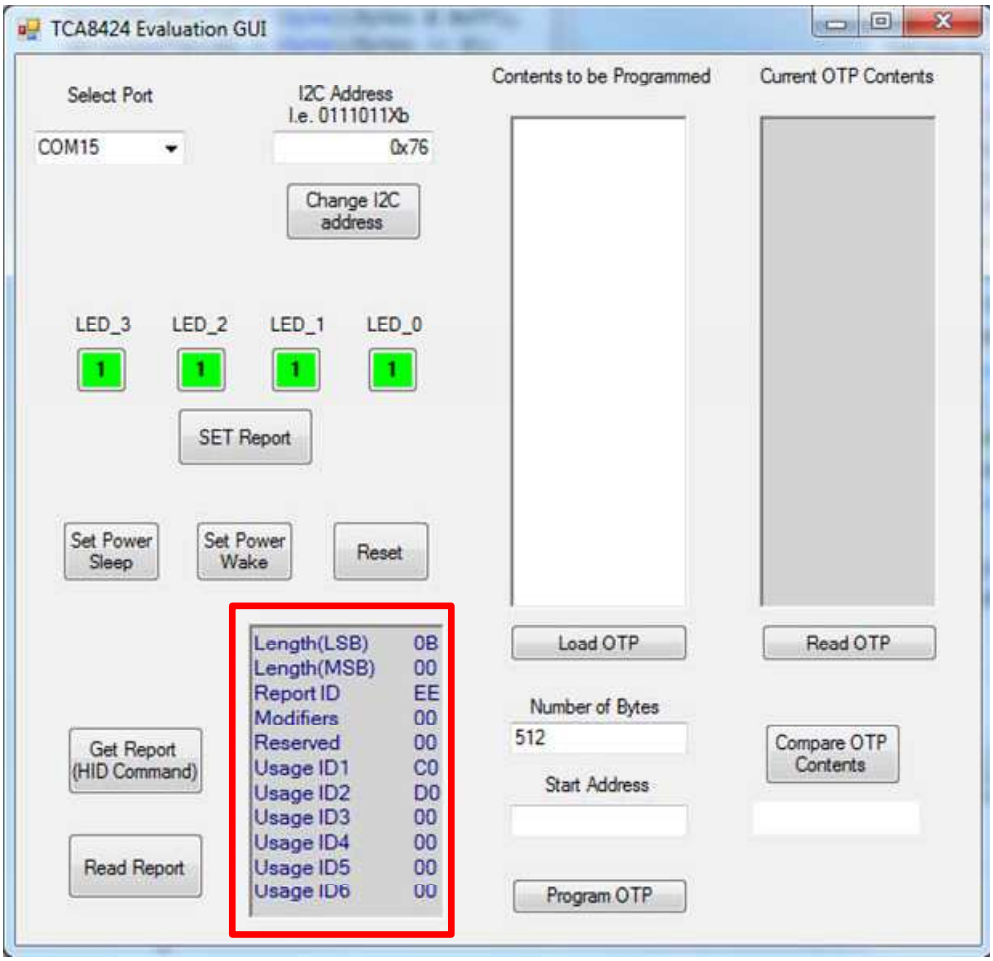


3. After inputting the LED values to be set, click the “SET Report button to set the output report and the LED’s turn on.



4. Clicking the “Set Power Sleep” issues the SET POWER = WAKE HID Command and puts the device to sleep. If the LED outputs are turned on when this command is issued, they will now turn off.
5. Issuing the SET POWER = WAKE command turns the LED’s back on after a Sleep command has been issued. This is done by clicking the “Set Power Wake” command
6. The “Reset” button issues the RESET HID Command and the device resets, this clears the output report. If LED’s were on previously, then they will turn off after this command is received.

7. The “Get Report” button issues the HID command GET REPORT. This retrieves the current contents of the input report and populates the text box below the button (red box). The GET REPORT command does not clear an interrupt.



For more information on how HID commands operate and the TCA8424’s device behavior, please see the “COMMAND and DATA REGISTER” section of the datasheet.

8. The “Read Report” button issues an unaddressed read command to the TCA8424. It populates the same text box as the “Get Report” button does with the contents of the input report, but it will clear an asserted interrupt.

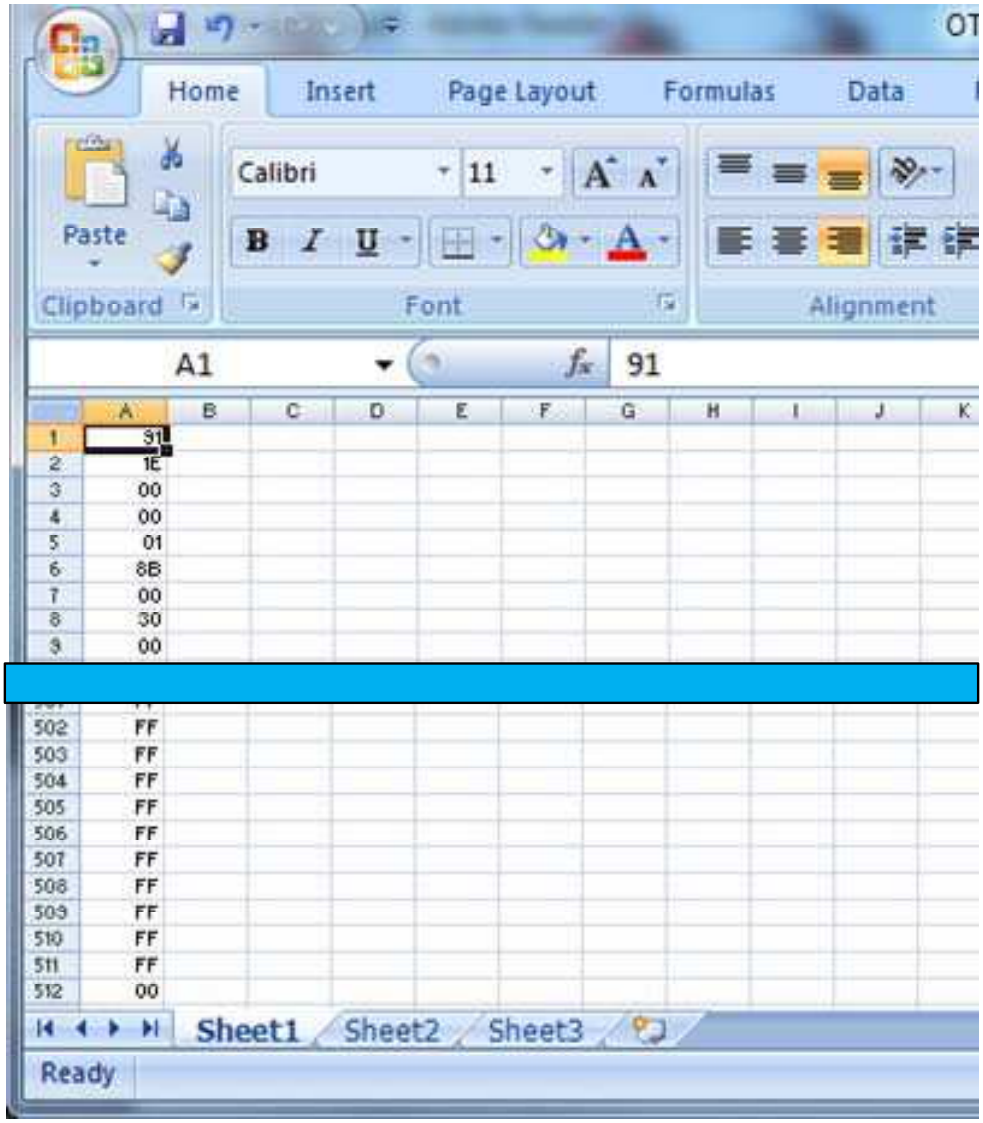
For more information on the Input Report behavior please see the “INPUT REPORT” section of the datasheet.

E. Programming and verifying the OTP contents

1. The first thing that must be created is the .csv file that contains the OTP contents. If this has been created skip to step 2.

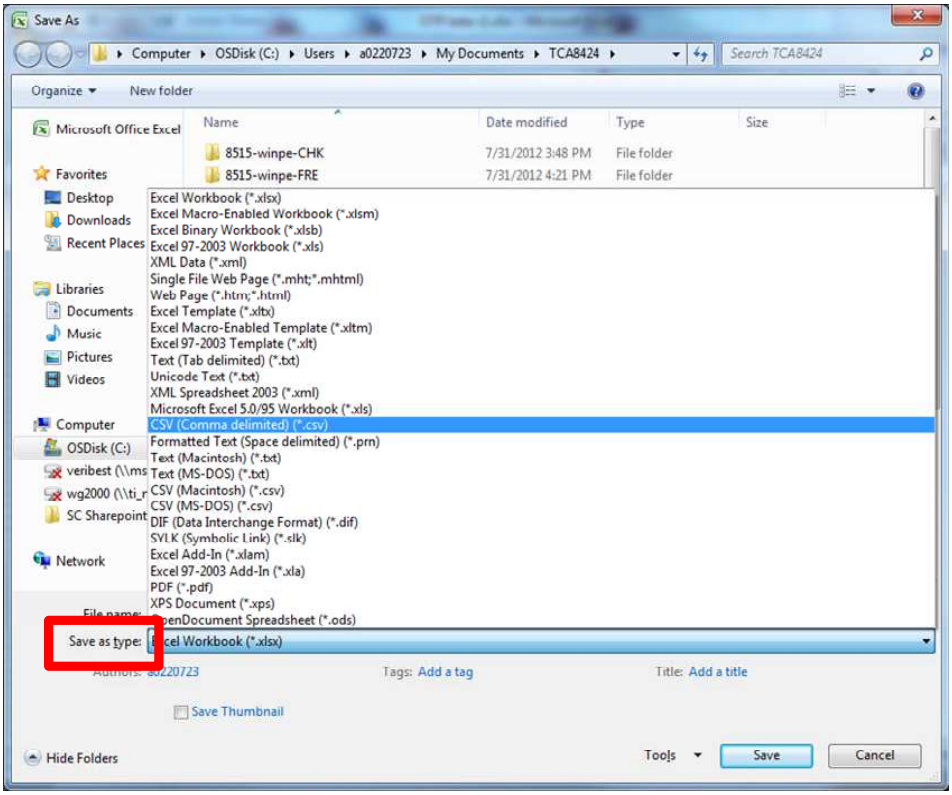
   (a) Open an excel workbook with a single column for the OTP contents.

   - The image below shows a properly formatted excel file with the blue box indicating a break in the 512 byte contents:

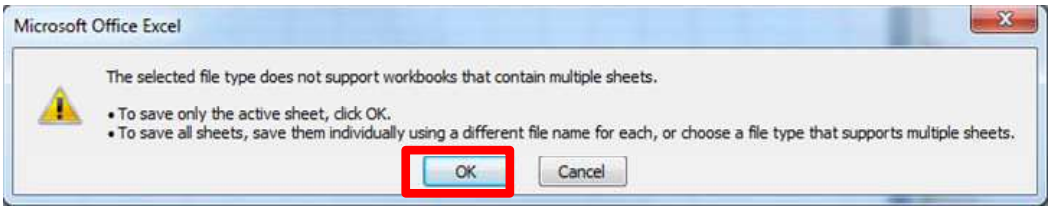


   (b) Click the "Office" button and then click “Save as”.

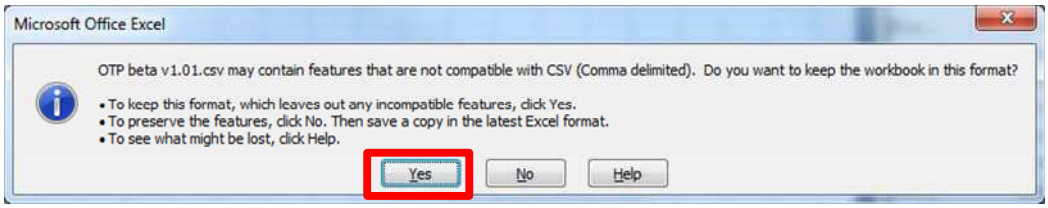
   (c) In the Save as window that pops up, choose the “CSV (Comma delimited) (*csv)” option under the “Save as type” menu (indicated by red box):



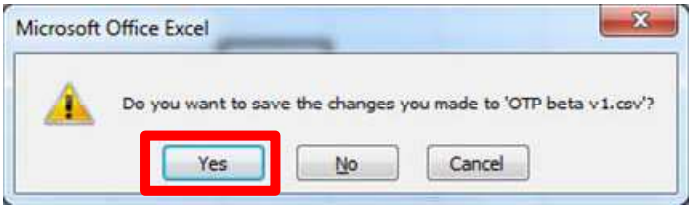
(d) Click “Save” and click "OK" to the message that pops up:

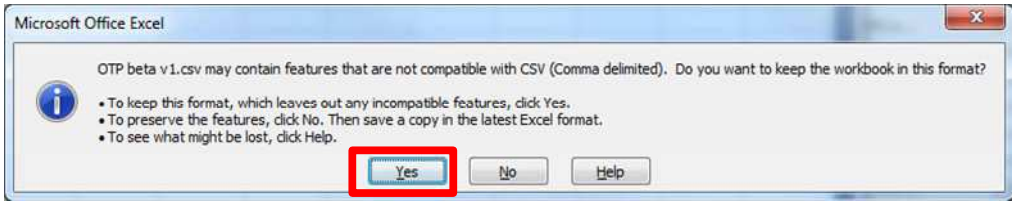


(e) Click "Yes" to the next dialog box that opens:

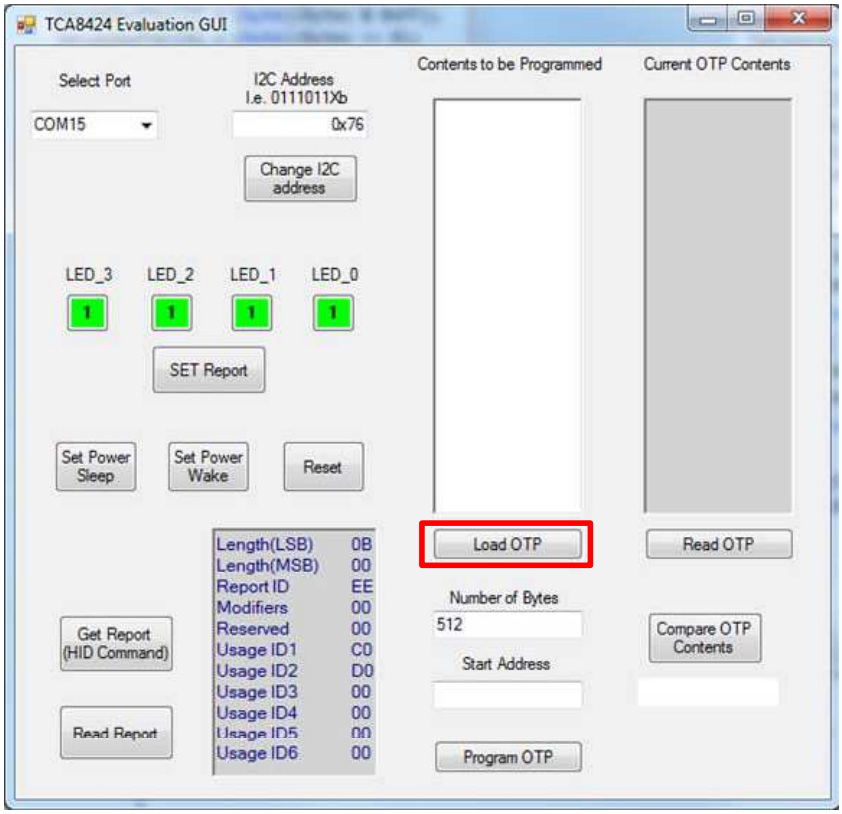


(f) Exit the .csv file and click "Yes" to the two dialog boxes that show up as shown below:

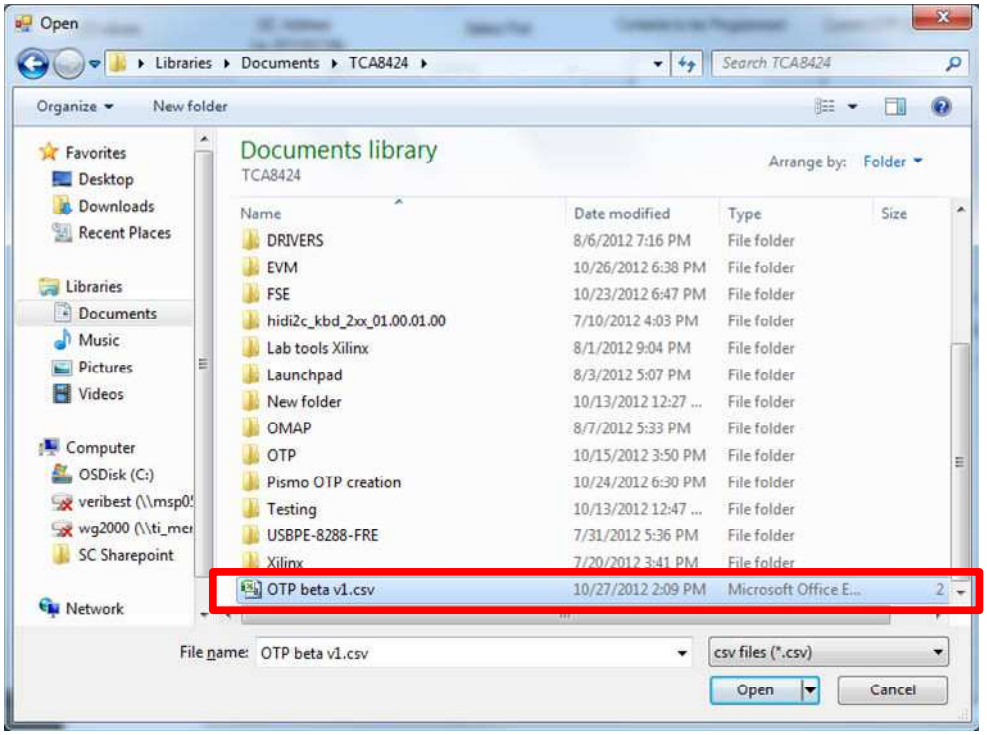




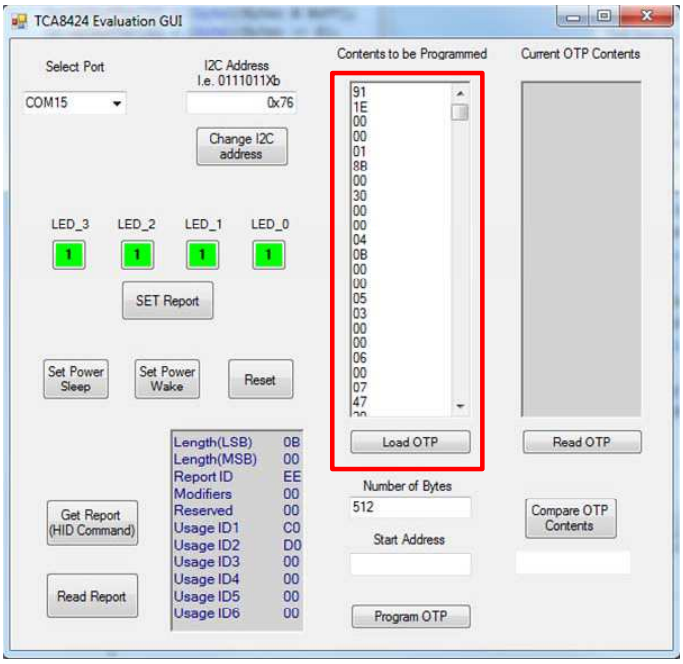
2. Now that we have a .csv, the OTP contents can be programmed. Click the “Load OTP” button as shown below:



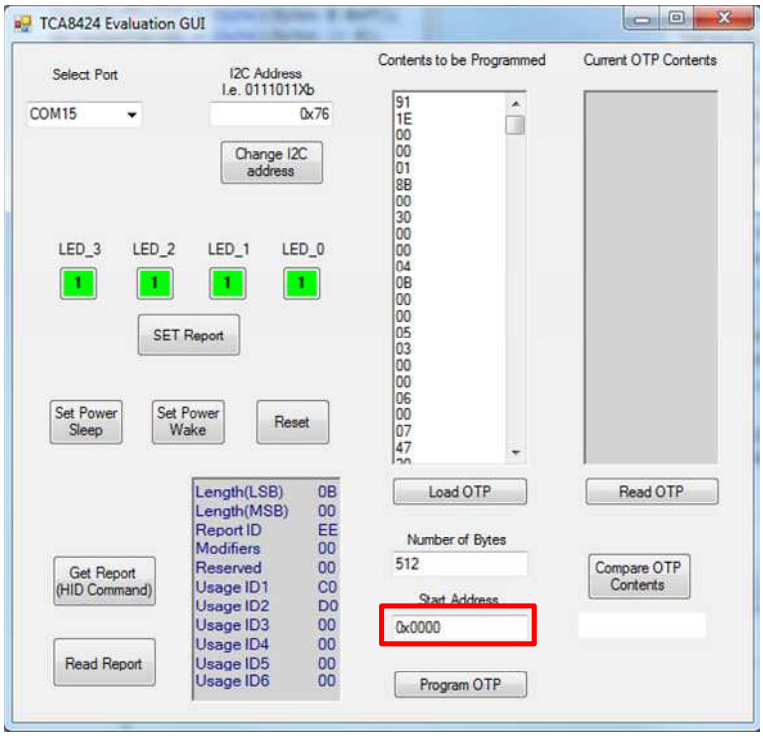
3. This opens a Windows® Explorer window that shows only .csv files. Navigate to the .csv file created earlier:



4. This populates the text box above the “Load OTP” button with the contents of the .csv file. This text box is fully editable, as long as the contents remain in the same format.

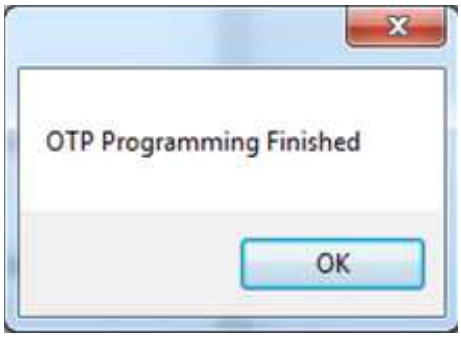


5. Now choose a start location for our OTP programming and the number of bytes to program.
   (a) The start location should be formatted as below and has no default contents. You must enter a value before programming the OTP.



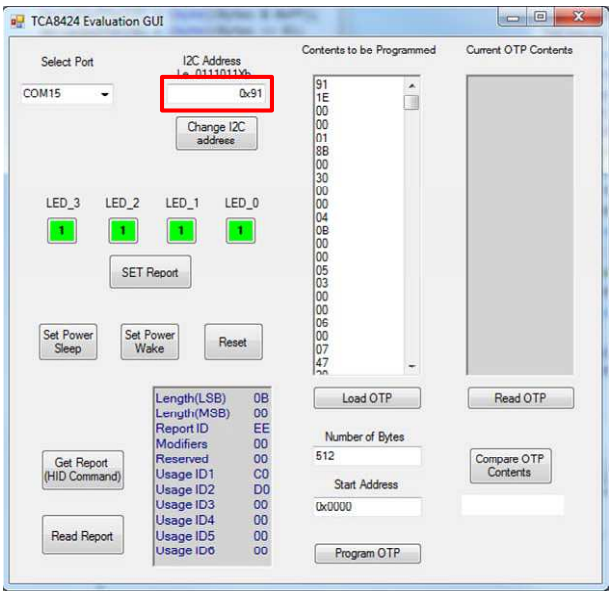
   (b) The number of bytes is defaulted to the value “512” and should be entered as a decimal value in the text box, if it needs to be changed.

6. Now that the start location, number of bytes, and the OTP contents are in place, we are ready to program the OTP. Upon completion, the following dialog box should appear:



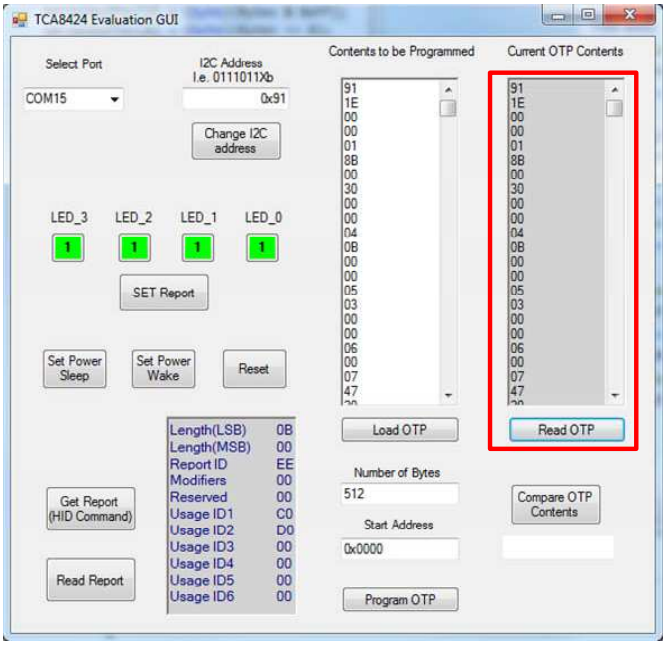
7. The first byte of the OTP (Address 0x0000) contains the I^2C address for the device including the R/W bit. **The R/W bit of the I^2C address must be programmed to a ‘1’ for the OTP contents to be used. If a ‘0’ is programmed at this bit, the OTP will program but the contents will not load into the digital core.**

8. Because we have now programmed a new I²C address into the device, we must change the I²C address in the Launchpad with the Change I²C address button.
   - In this case it will now be 0x91 as shown below:

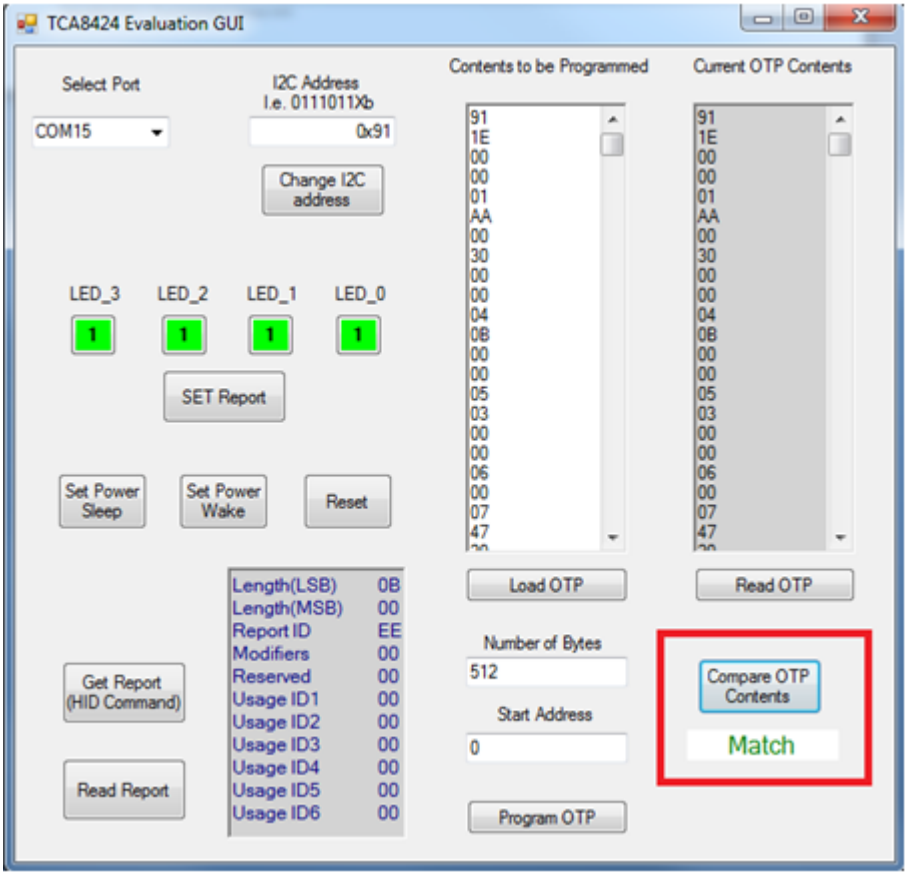


9. Now that the OTP contents are changed and the I²C address in the Launchpad is set, confirm that what was actually programmed, matches what we tried to program.

   (a) Click on the “Read OTP” button to read back the OTP contents in the device and populate the textbox above the “Read OTP” button as shown below:



(b) Now compare the contents to be programmed with the current OTP contents by clicking the “Compare OTP” button. If the "Contents to be Programmed" and the "Current OTP Contents" are the same, the dialog below the “Compare OTP” button changes accordingly, as shown below:



The Compare OTP button assumes the "Contents to be Programmed" and "Current OTP Contents" are the same length. They must match exactly for dialog box to change to “Match”.

After Programming the OTP, the device will be in "TEST" mode until powered down and then powered up again. This causes increased ICC outside of datasheet specifications. Once power cycled, the device ICC returns to normal.

10 Related Documentation

TCA8424 Low-Voltage 8x16 Keyboard Scanner with HID over I2C Compliant Interface Datasheet (SCDS341)

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