

# LMT01EVM

The LMT01EVM allows users to evaluate the performance of the LMT01 2-pin digital temperature sensor. The EVM comes in a USB stick form factor package with an onboard MSP430F5528 microcontroller that interfaces with both the host computer and the LMT01 device. The EVM also comes with perforation at two locations on the EVM board. The first perforation allows the user to connect wires, cable, or header to both ends for remote temperature measurements. The second perforation allows the user to remove the level shifter transistor (Q1) from the EVM board.

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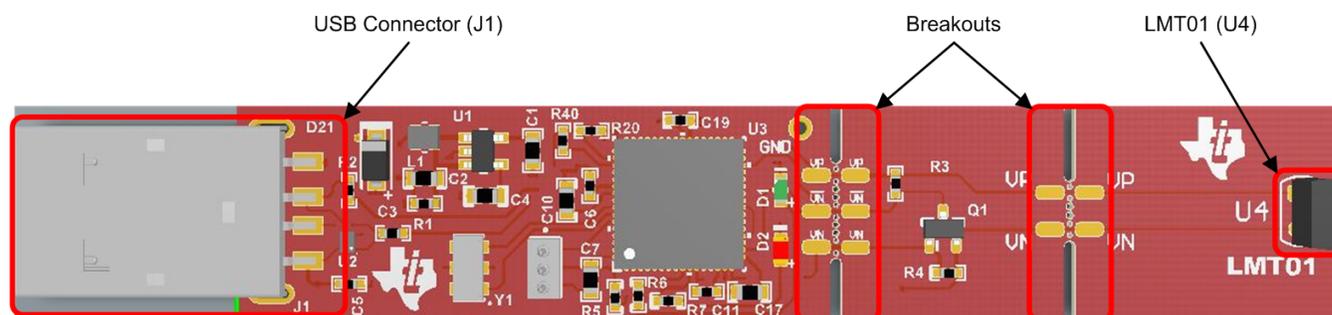
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# 1 LMT01EVM Components



**Figure 1. LMT01EVM Evaluation Board**

**Table 1. Device and Package Configurations**

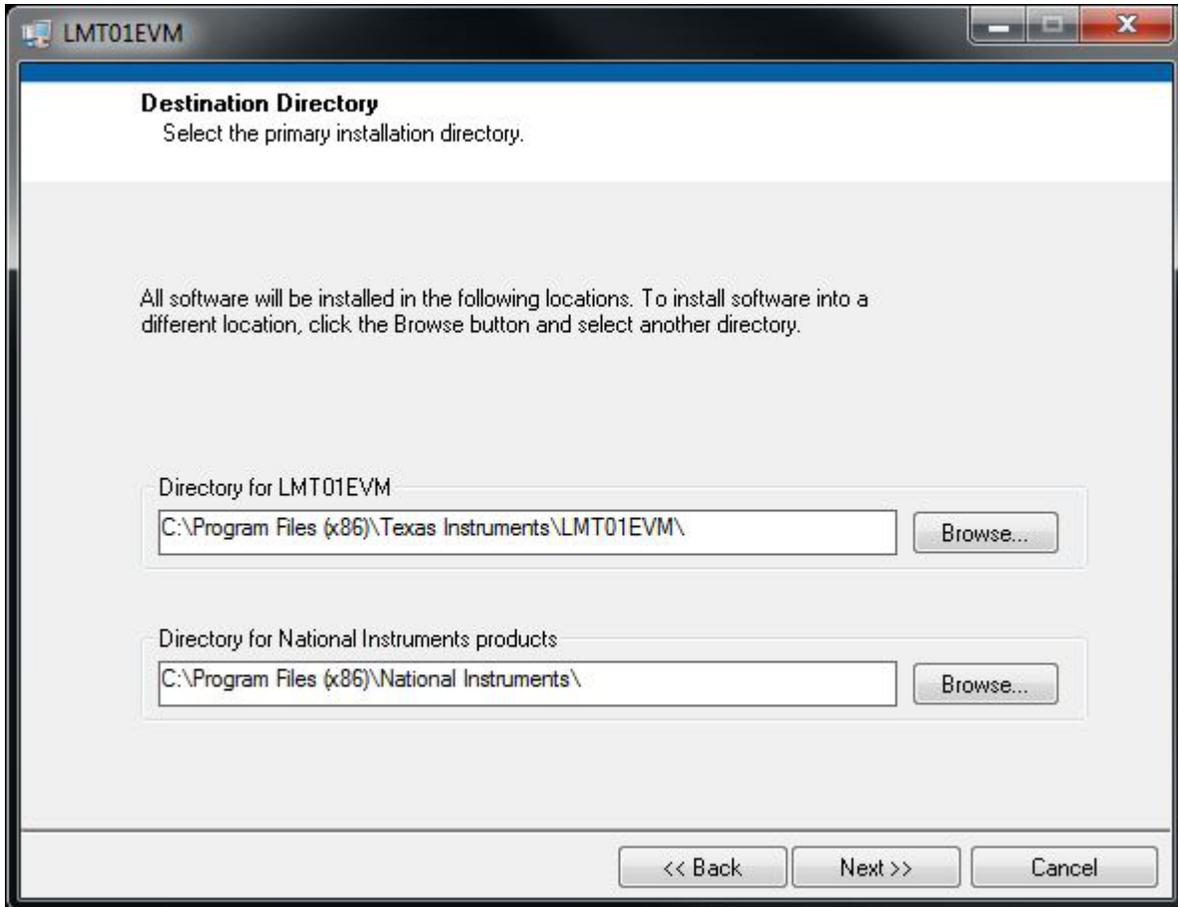
Device	IC	Package
U4	LMT01	TO-92S

## 2 Software Installation

### 2.1 Graphical User Interface (GUI)

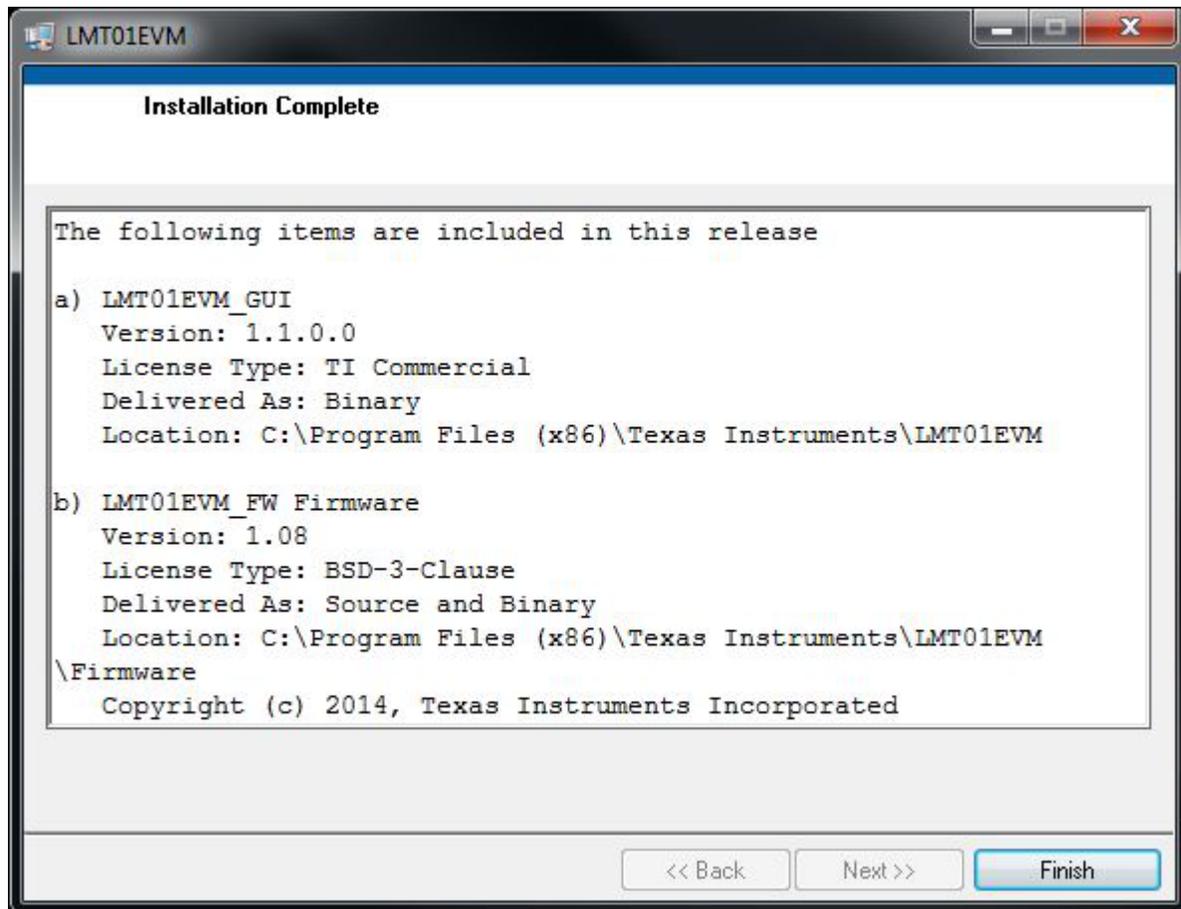
Install the LMT01EVM Software:

1. Go to the LMT01EVM webpage on the TI website: <http://www.ti.com/tool/LMT01EVM>. Scroll down to the “Software” section and download the latest evaluation software.
2. Unzip the downloaded file into a known directory, and run the “setup.exe” file located in [Unzip location]\LMT01EVM Installer-vx.x.x.xx\LMT01EVM Installer\Volume. Follow the pop-screen instructions by clicking the “Next” button to install the software and accept the license agreement.



**Figure 2. LMT01EVM Installation Directory**

3. When the installation is finished, click “Finish” button.



**Figure 3. LMT01EVM Installation Finish**

## 2.2 Firmware

### 2.2.1 Firmware Check

Connect the LMT01EVM to a PC. Run the aforementioned LMT01EVM GUI. The version number of the current firmware is shown on the upper right hand corner. A pop-up window will appear if the current firmware on the EVM needs to be upgraded. If the pop-up window appears proceed to [Section 2.2.2](#), otherwise proceed to [Section 4](#).

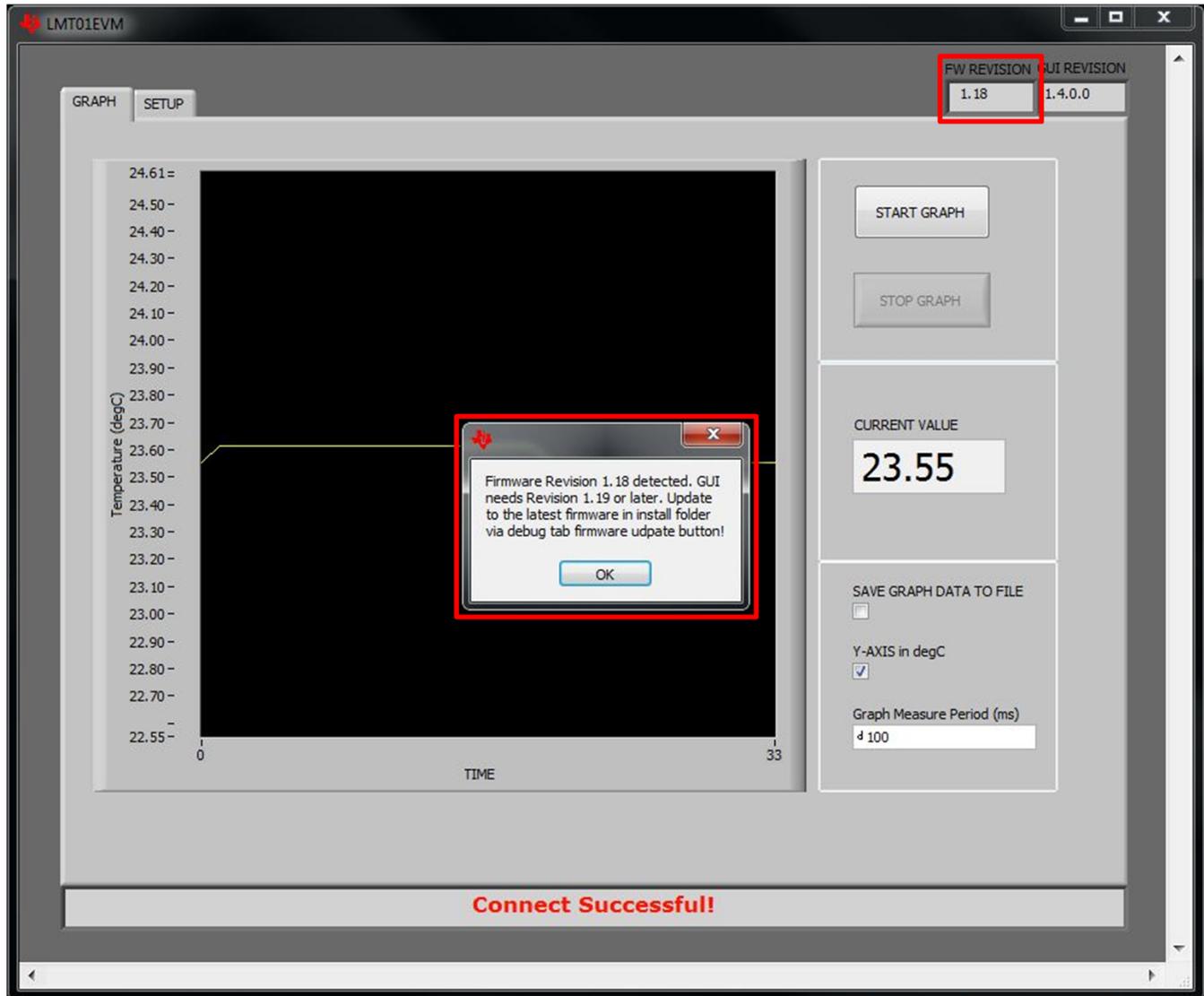
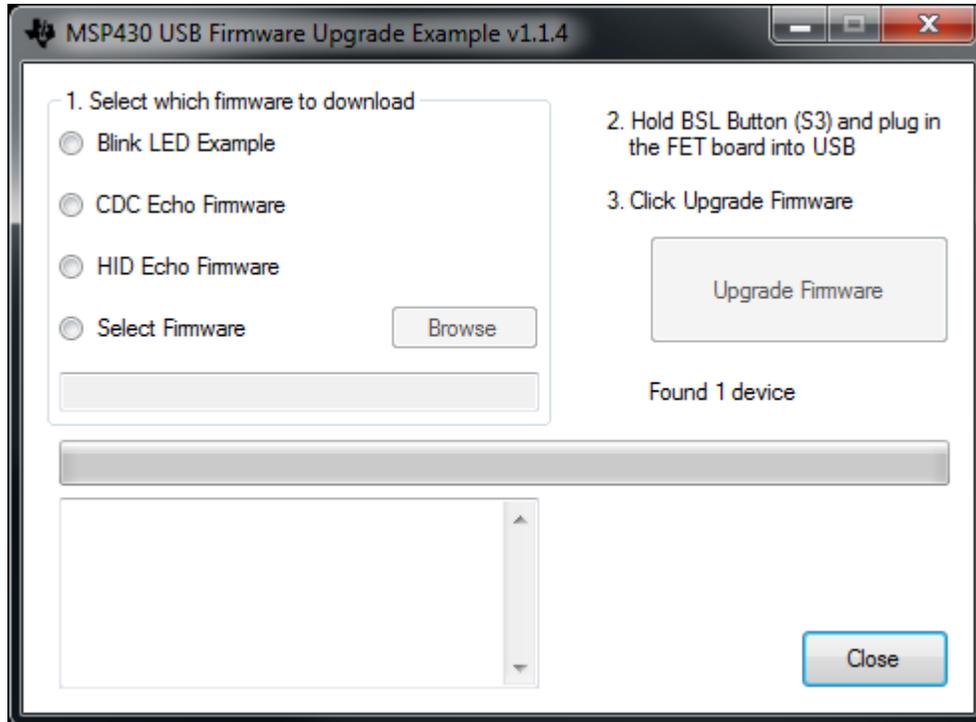


Figure 4. Firmware Revision Number

### 2.2.2 Firmware Installation

1. Open the LMT01EVM GUI and go to the “Setup” tab. Click on the “Update Firmware” button. The MSP430 USB Firmware Upgrade program will launch.
2. Click “Next” to proceed on the first prompt; read and accept the license agreement and click “Next” to continue.



**Figure 5. USB Firmware Upgrade Window**

3. Make sure the MSP430 USB Firmware Upgrade Example window shows “Found 1 device”.
4. Enable the Select Firmware button and browse to open the downloaded firmware. The firmware is located at C:\Program Files (x86)\Texas Instruments\LMT01EVM\Firmware\LMT01EVM-vx.xx.txt.
5. Click on the Upgrade Firmware button to program the LMT01EVM. Close and relaunch the application when done.

### 3 LMT01 Setup and Operation

#### 3.1 Quickstart Guide

1. Connect the LMT01EVM to a USB port on a PC.
2. One red and one green LED should turn on and not blink when the EVM is initially plugged into the PC. The red LED will blink if the power on reset tests on the MSP430 microcontroller fails on startup or if the Test LED button is toggled. The green LED will blink when the Start Graph button is pressed.
3. Launch the LMT01EVM software by clicking on Start >> All Program >> Texas Instruments >> LMT01EVM >> LMT01EVM. The LMT01EVM GUI should automatically connect to the appropriate COM port. A successful connection will show "Connect Successful!" on the bottom of the GUI. If there is a connection problem check in the Control Panel >> Device Manager >> Ports and verify if the LMT01EVM has an established connection with the PC.

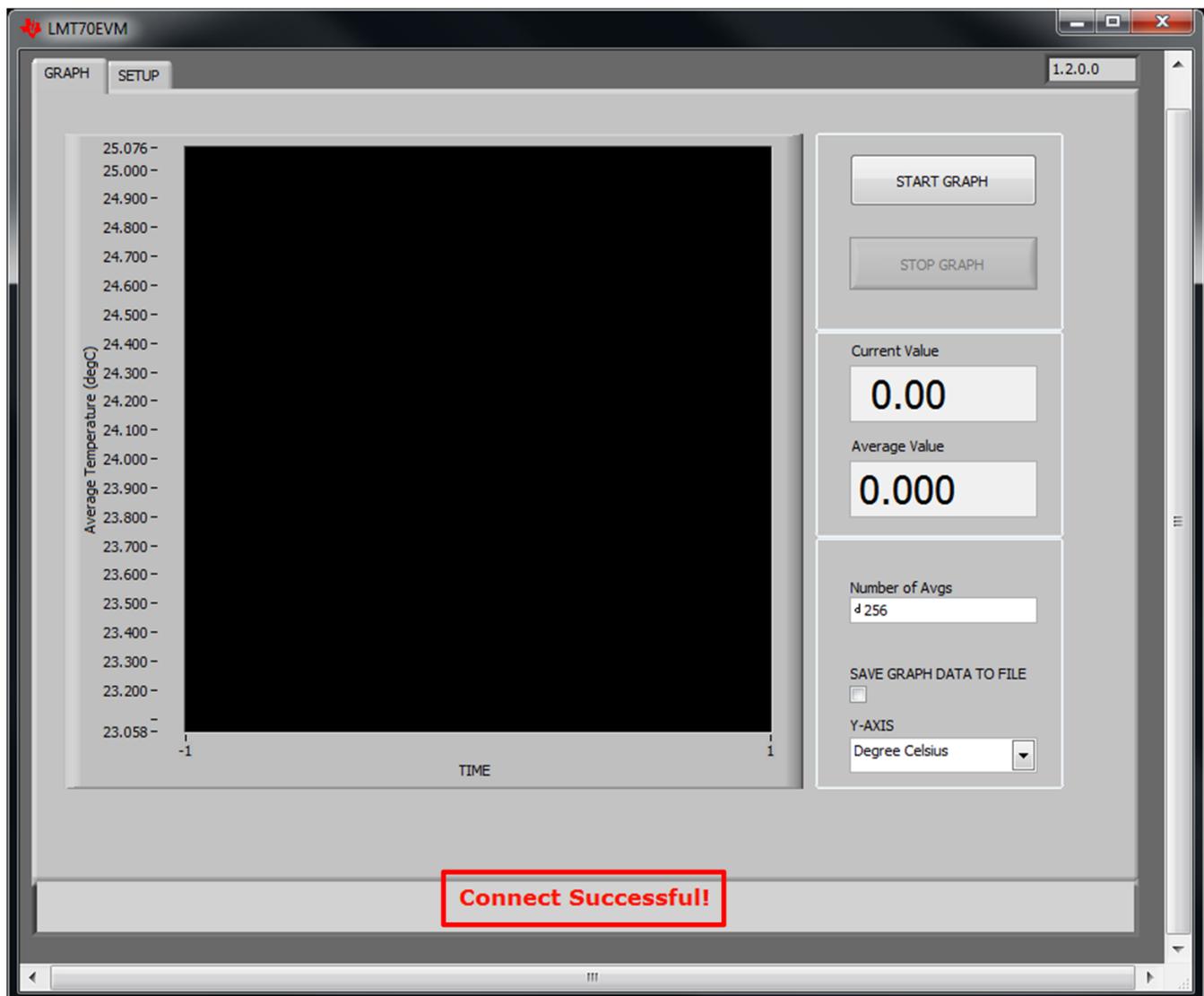


Figure 6. LMT01EVM Successful Connection with PC

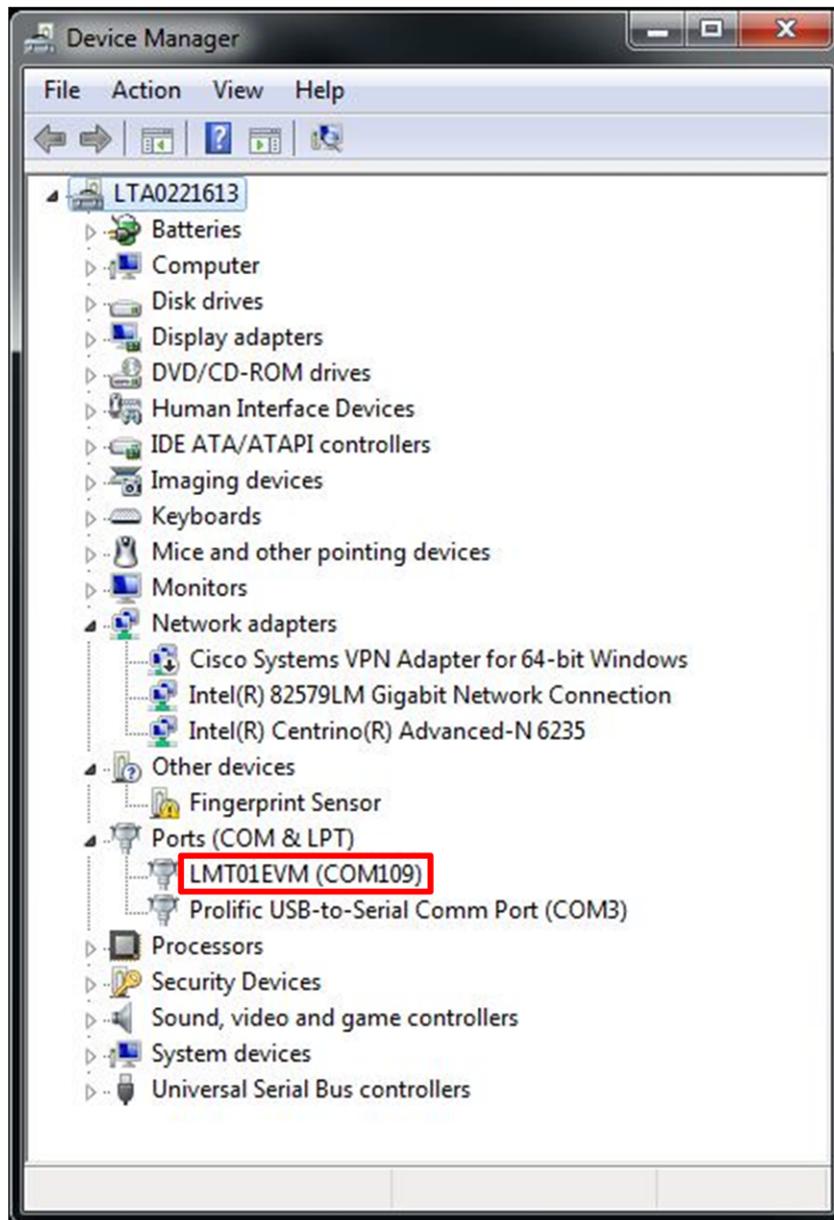
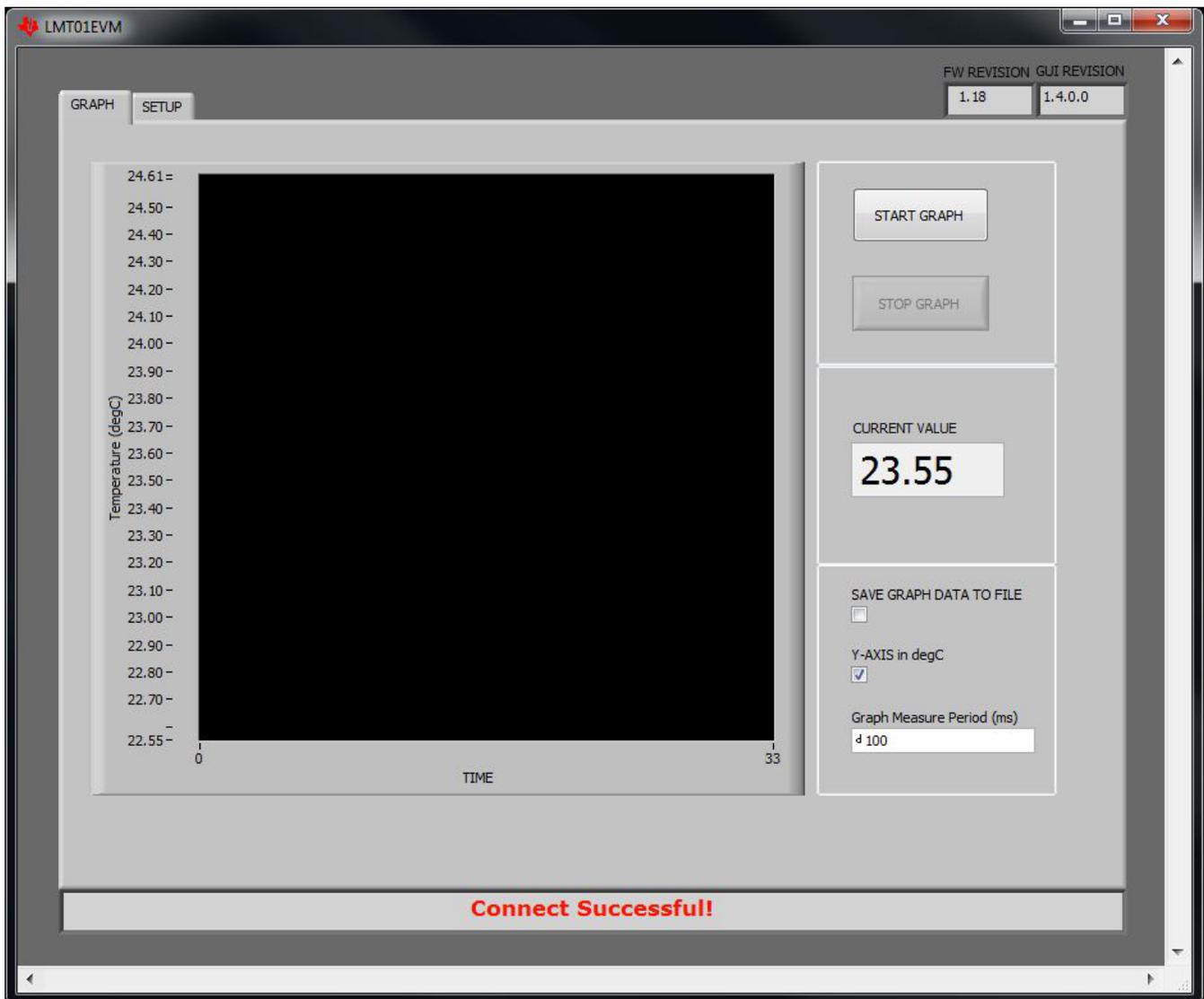


Figure 7. LMT01EVM COM Port

#### 4. GUI Descriptions

- GRAPH Tab
  - Start Graph: Graph displays temperature or pulse count. One data point on the graph corresponds to one temperature reading or pulse count in the time interval specified in the “Graph Measure Period (ms)”
  - Stop Graph: Stops the graph from updating temperature or pulse count
  - Current Value: Shows the current temperature or pulse count value
  - Save Graph Data to File: Saves the pulse count data to a .csv file
  - Y-Axis in °C: Toggle between the Y-Axis to be in temperature or # of pulse counts
  - Graph Measure Period (ms): One measurement will be made every period specified in the box



**Figure 8. GRAPH Tab Page**

- LMT01 Silicon: Select between Pre-Final and Final silicon
- Comparator Reference: Select voltage reference for comparator threshold settings, default is 1.5V

- SETUP Tab
  - Serial Port: Manually select which serial port the LMT01EVM is connected to
  - Firmware Revision: Check the firmware revision on the MSP430F5528 microcontroller
  - Test LED: Toggle the red LED (D2) on and off
  - One Shot Pulse Train Data: Single read shown in either pulse counts or temperature
  - Select Pulse Train Measurement Method: Select from 12 methods of counting pulse with a microcontroller. More details in [Section 4.2](#)
  - Comparator Low to High Threshold: Set the comparator threshold to determine a logic high level
  - Comparator High to Low Threshold: Set the comparator threshold to determine a logic low level

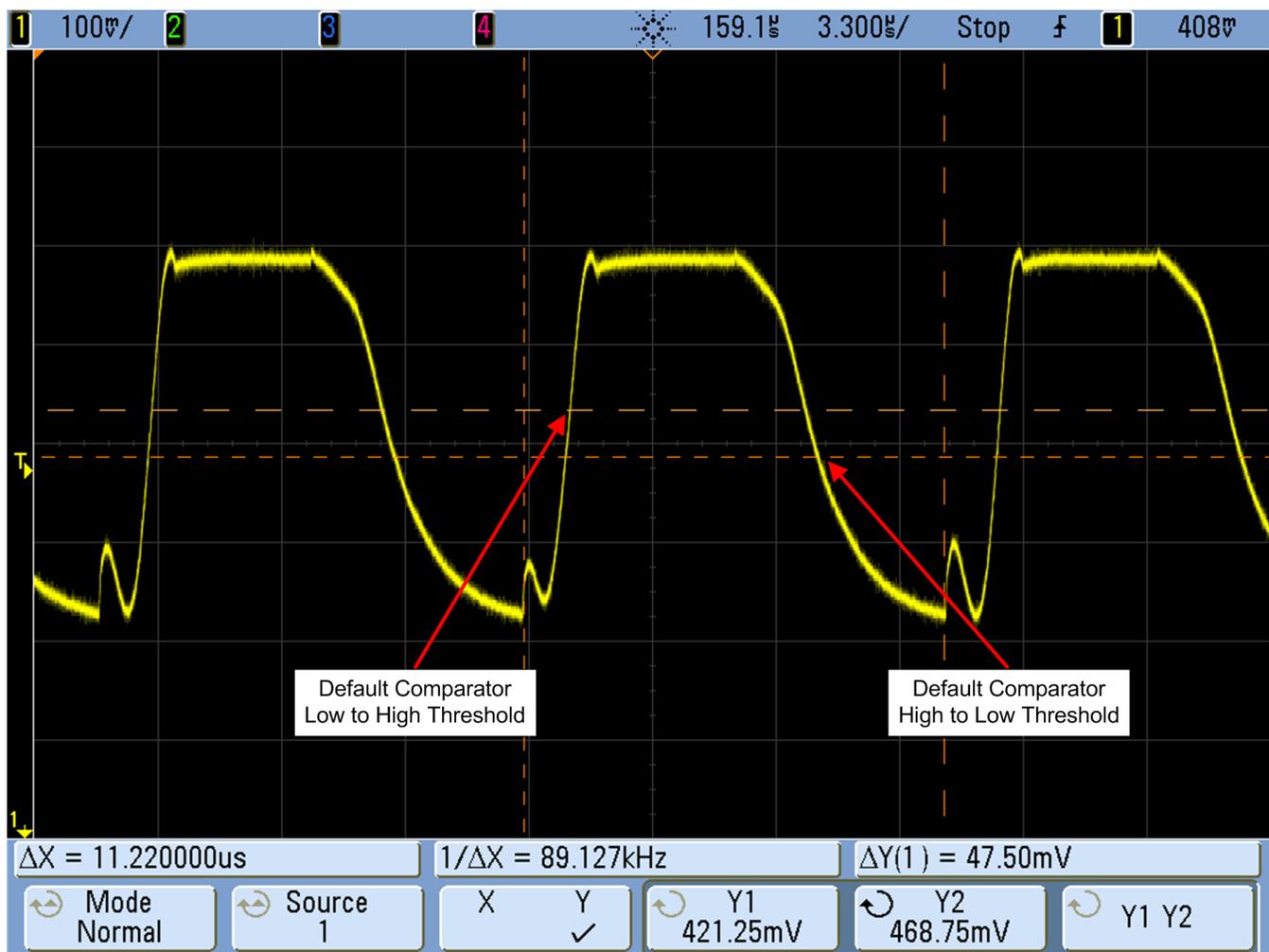


Figure 9. Comparator Threshold

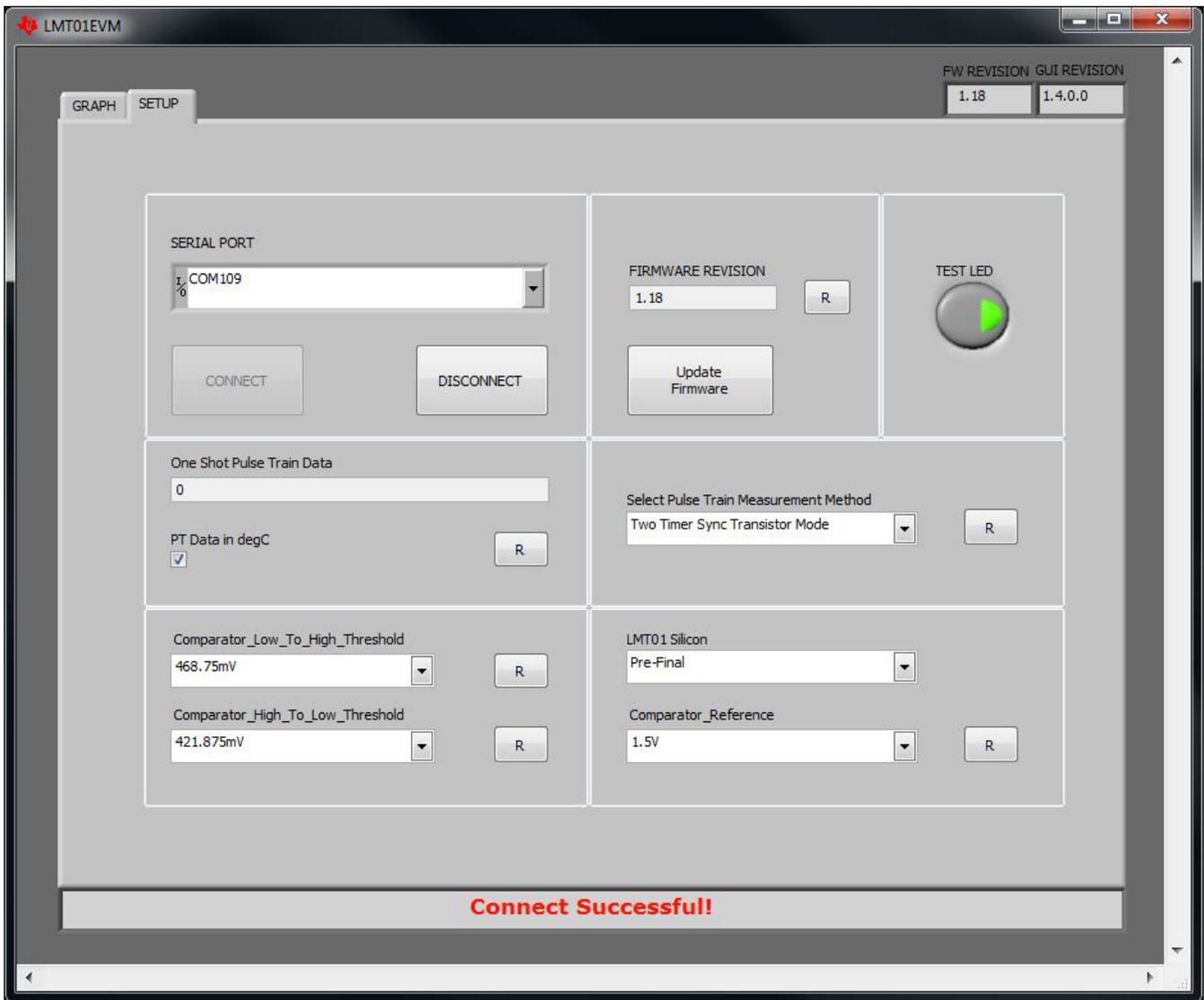


Figure 10. SETUP Tab page

5. Start the GUI by pressing the “Start Graph” button on the GRAPH tab. The graph should show updated temperature readings from the LMT01. Press a finger against the LMT01 part and observe the temperature change.

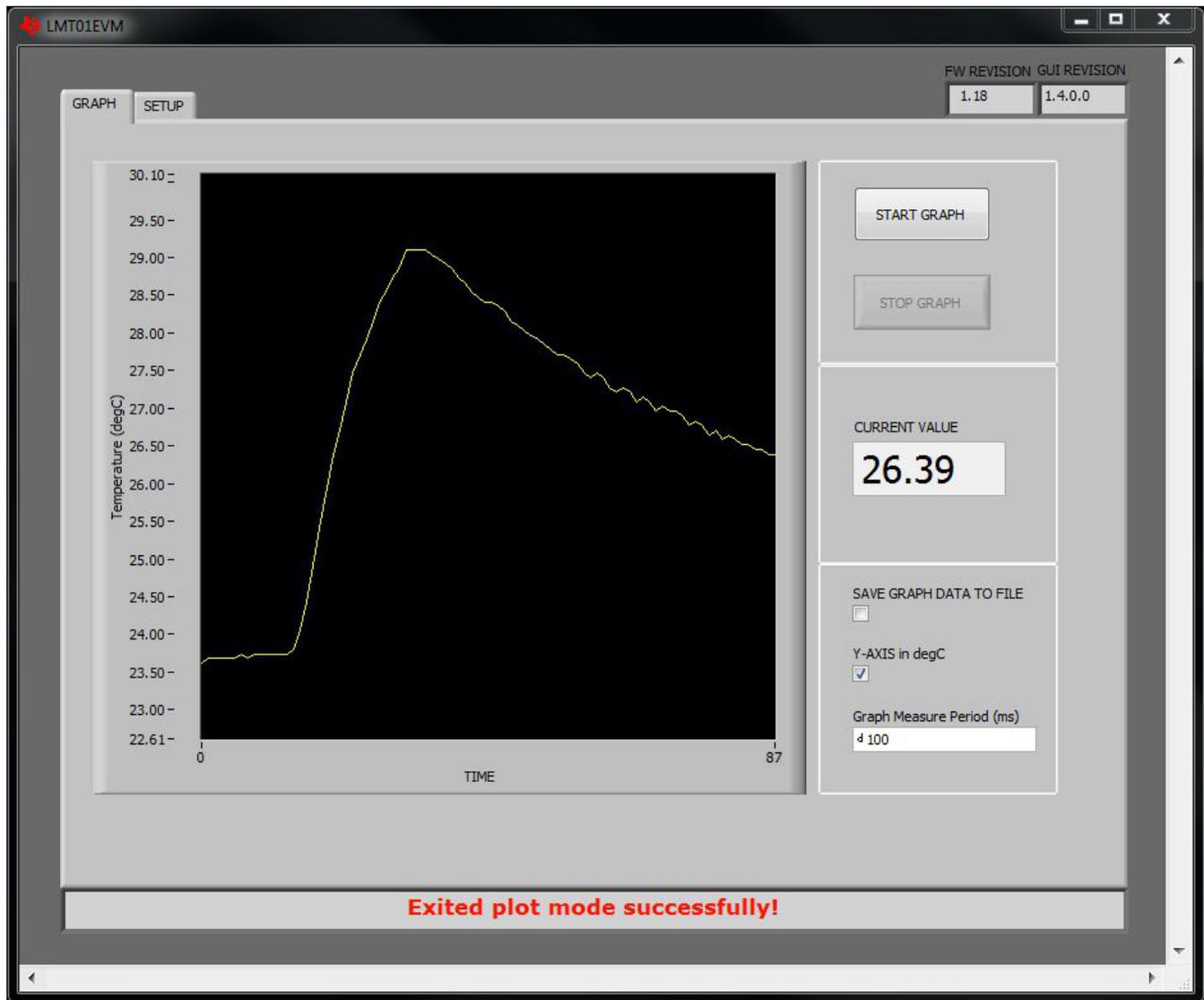


Figure 11. Temperature Change by Pressing Finger on LMT01

### 3.2 Pulse Train Measurement Methods

The LMT01EVM GUI comes with 12 methods of measuring the output pulse train from the LMT01. The user can select which measurement method to use for their application. The nomenclatures of these methods are described below:

- **Transistor Mode:** The LMT01 output is level shifted with a transistor to valid logic levels for the MSP430
- **Comparator Mode:** The LMT01 output is fed into the integrate comparator of the MSP430 and compared to a programmable voltage level to determine logic high and low
- **Synchronous Mode:** Power is applied to the LMT01 before a temperature measurement is taken and removed immediately afterwards
- **Asynchronous Mode:** The MSP430 is turned on and temperature measurements can be taken any time

More informational about the 12 different modes and their implementations can be found in the LMT01 installation directory in the Firmware folder.

### 3.3 Remote Temperature Sensing with the LMT01EVM

The LMT01EVM comes with perforated slots where the user can snap apart the LMT01 device board, transistor level shifter board, and microcontroller side of the EVM. The snapped off LMT01 device board and transistor level shifter board can either be soldered with wires or headers back onto the LMT01EVM for remote temperature measurements or the user can solder the boards onto their own PCB board.

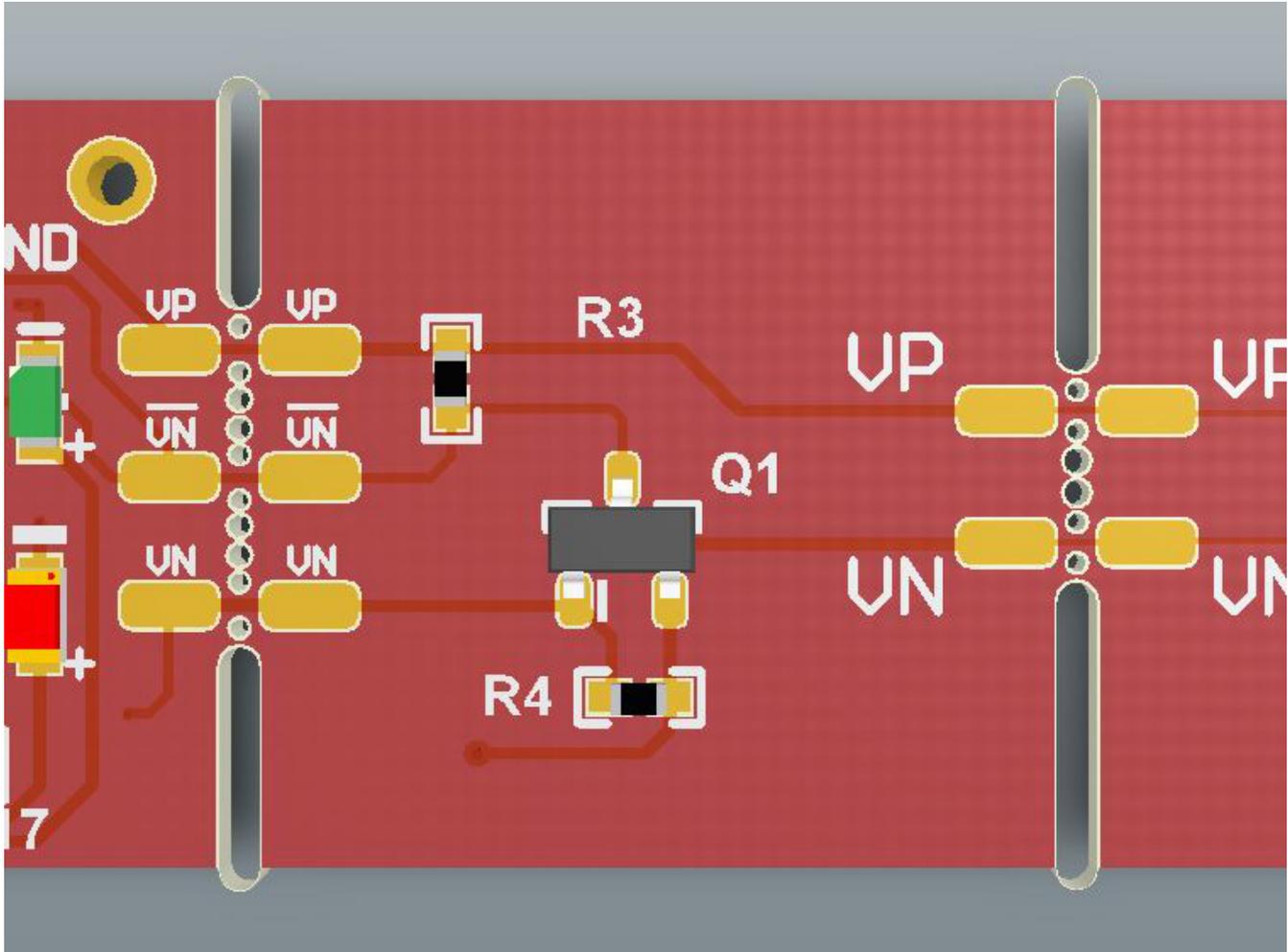
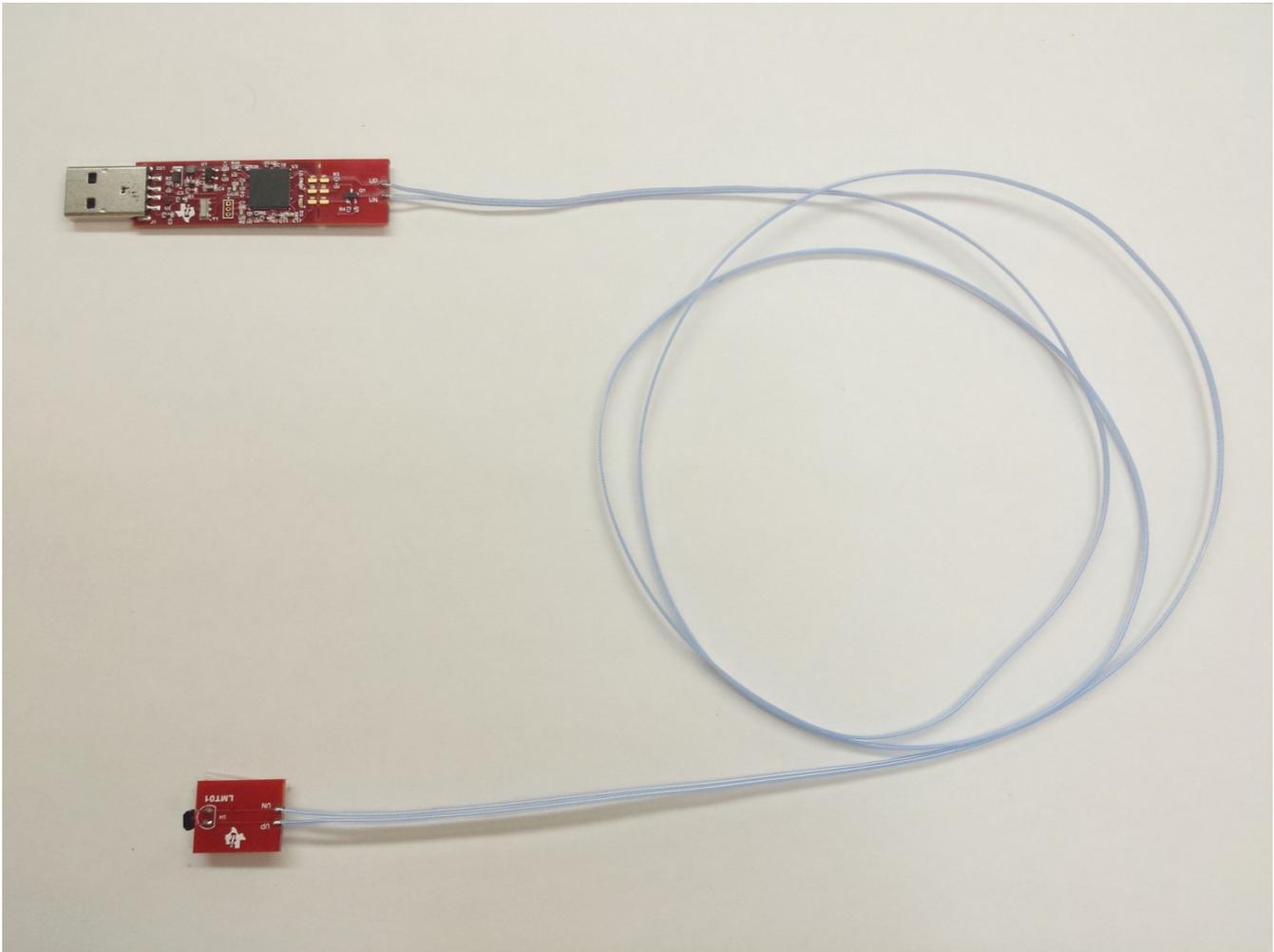


Figure 12. Breakout Slots and Exposed Pads

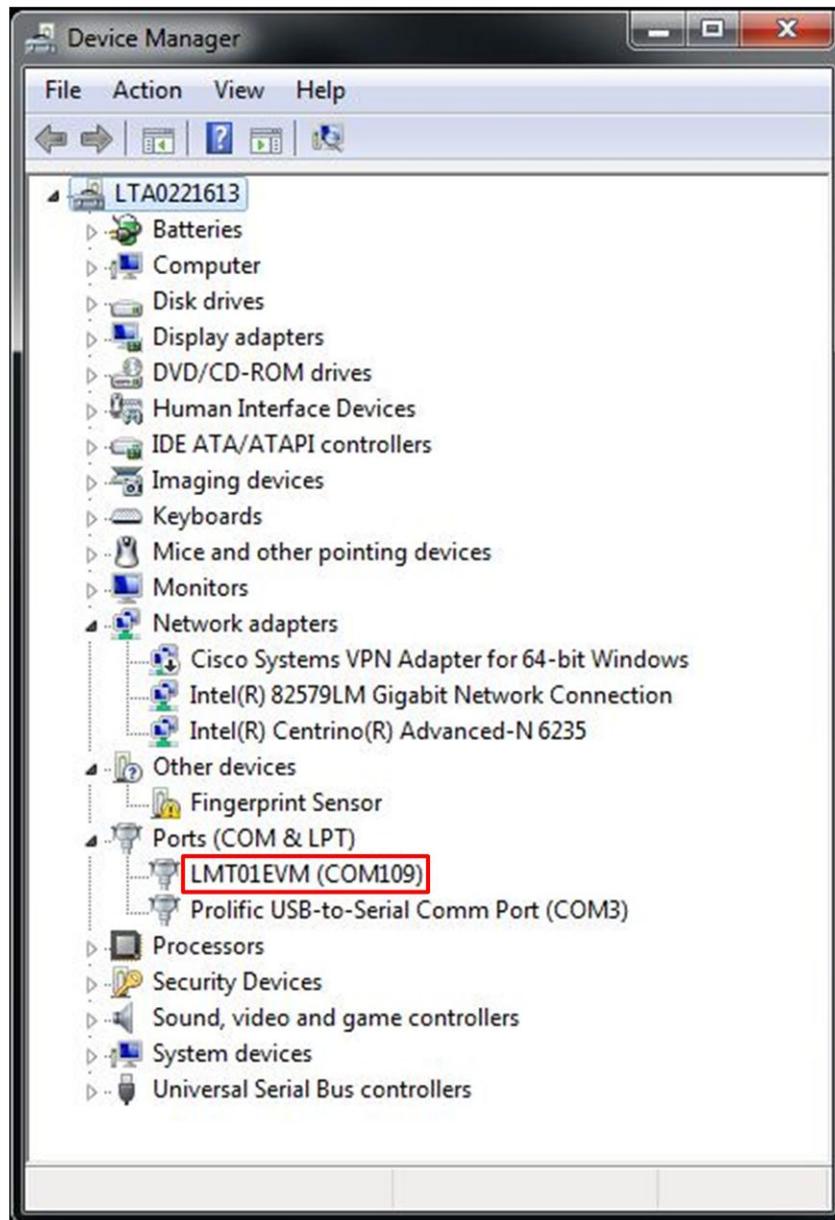


**Figure 13. LMT01EVM with LMT01 Device and Microcontroller Connected with Wires**

## 4 Troubleshooting

### 4.1 LMT01EVM Driver Installation

The LMT01EVM Driver automatically installs during the GUI installation. However, the LMT01EVM board may have been inserted into the USB port before the GUI installation. In such cases the EVM board could be associated with another driver. Complete the following steps if you do not see LMT01EVM and instead see MSP430-USB Example in the Device Manager window:



**Figure 14. Device Manager with COM Port Name**

1. Open the Device Manager and find the MSP430-USB Example device
2. Right click it and choose Update Driver Software
3. Select Browse my Computer for driver installation. Navigate to the installation directory, select the Firmware folder, and select the LMT01EVM\_DRIVER.inf file
4. Close the setup window when the installation is complete. The Device Manager should now display LMT01EVM followed by a COM port number.

#### **4.2 LMT01EVM Hard Firmware Installation**

During firmware flashing, the installation process could have been halted or quit unexpectedly. This process could put the EVM board into an unknown state and the EVM cannot be found in the Device Manager. To restore access to the EVM board complete the following steps:

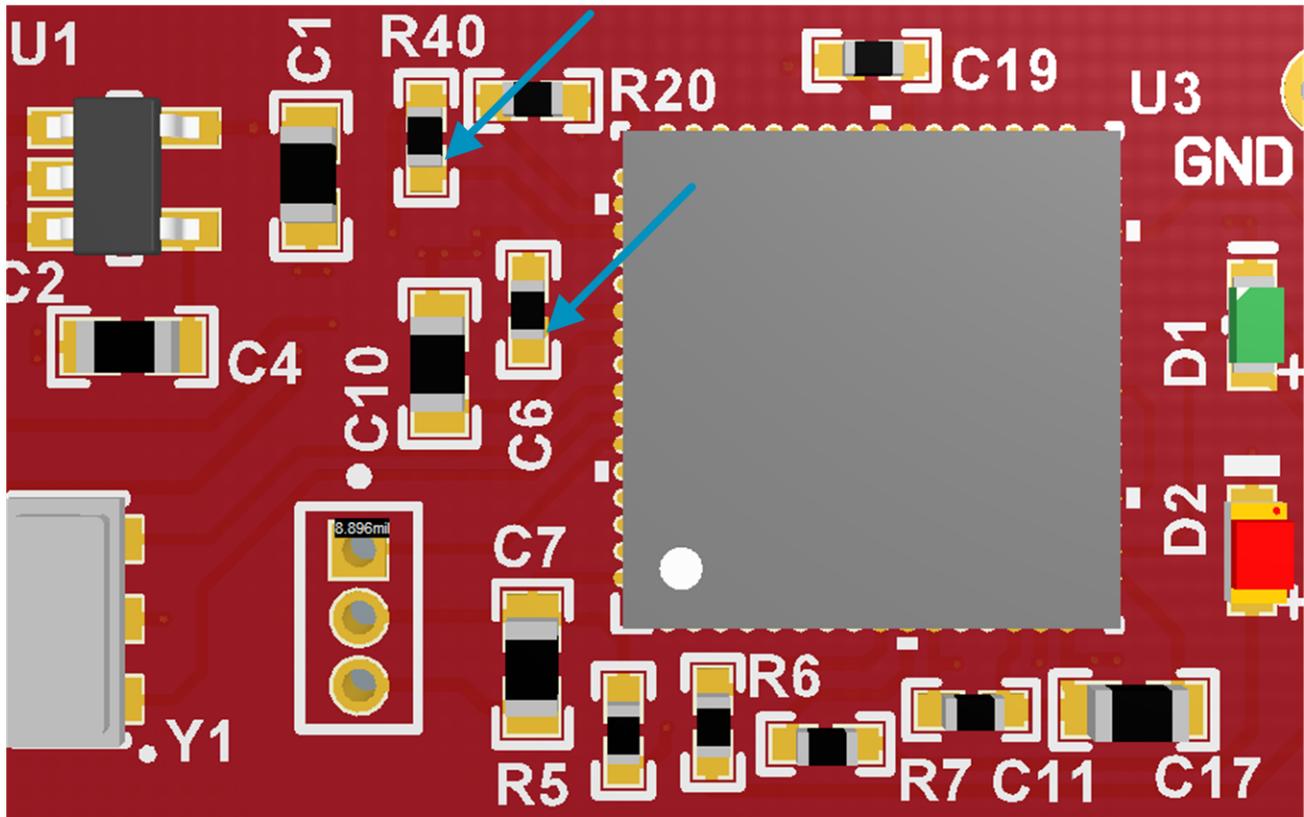


Figure 15. Short a Wire at these Locations

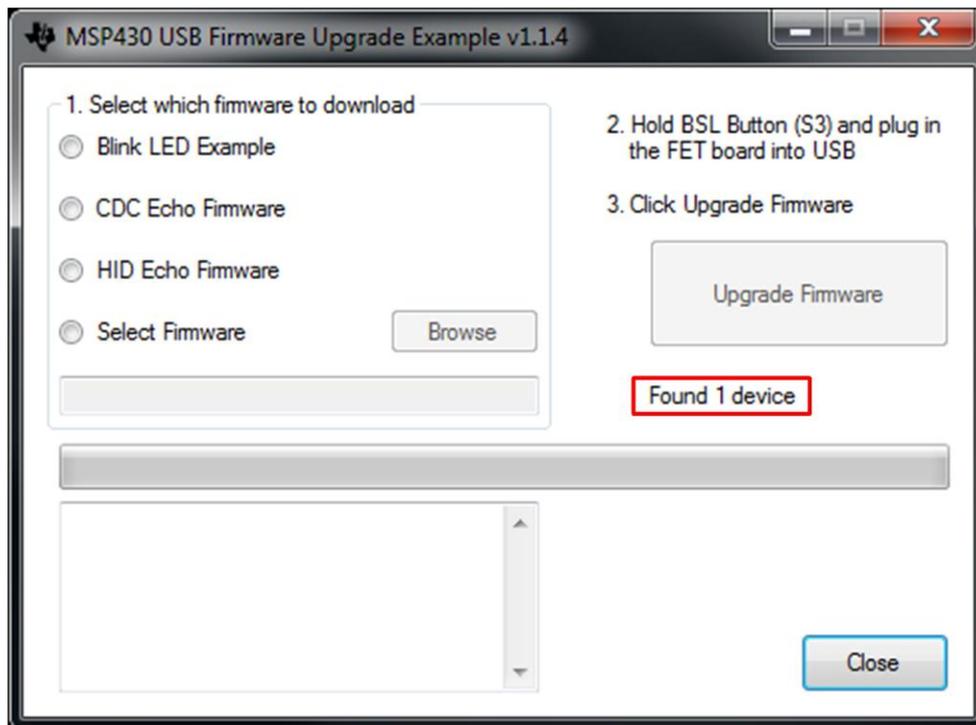


Figure 16. USB Firmware Upgrade Window

1. Short the two points as shown in [Figure 15](#)

2. Connect the LMT01EVM board to the USB port and disconnect the short
3. Start the LMT01EVM GUI. Press OK to the pop up error message “Auto Connect Failed! Check port number.”
4. Go to the “SETUP” tan and select “Update Firmware”. Select OK to the message “Update MSP430 Firmware?” Accept the license and the message “Found 1 device” should appear as in [Figure 16](#).
5. Choose “Select Firmware” and browse to the installation directory and go to the Firmware folder. Select “LMT01EVM\_Firmware-vx.xx.txt”. Click “Upgrade Firmware” and close when done.
6. Exit the GUI. Disconnect and reconnect the EVM board.
7. Relaunch the GUI. The EVM board should now be connected and the board should work properly with the latest firmware.

## 5 Board Layout

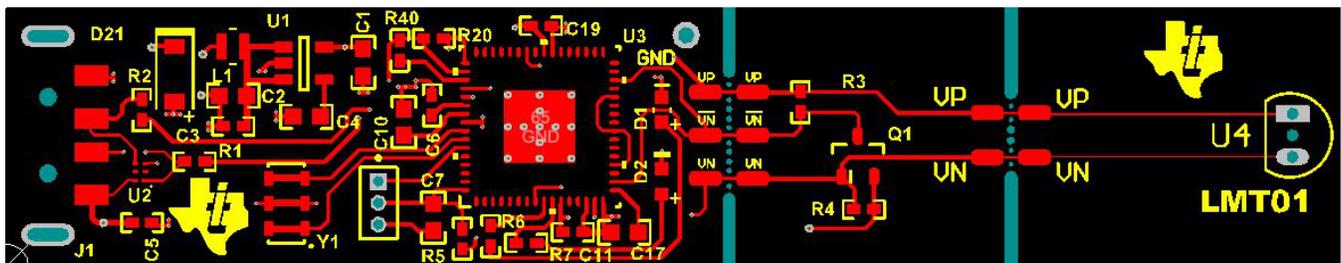


Figure 17. Top Assembly Layer

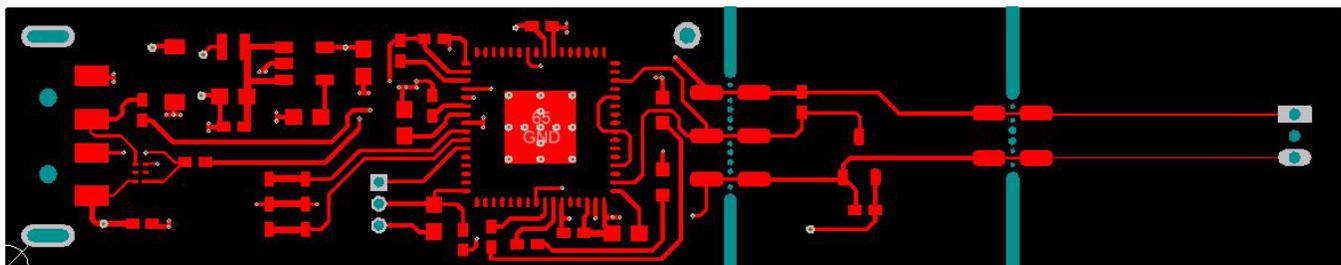


Figure 18. Top Layer Routing

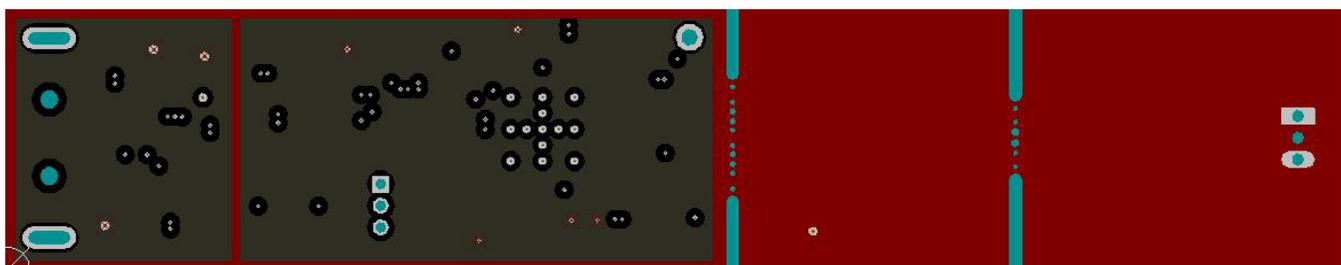


Figure 19. Power Layer Routing

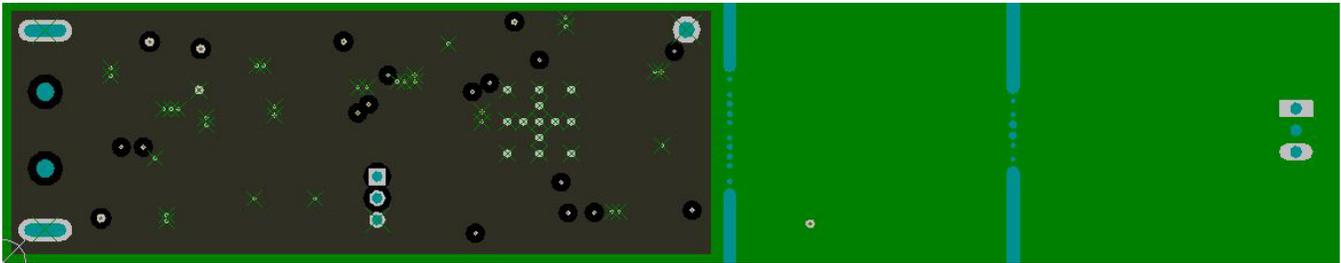


Figure 20. Ground Layer Routing

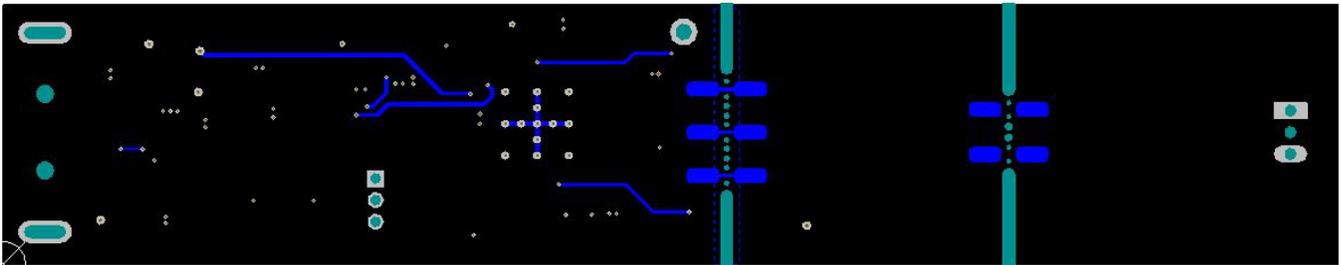


Figure 21. Bottom Layer Routing

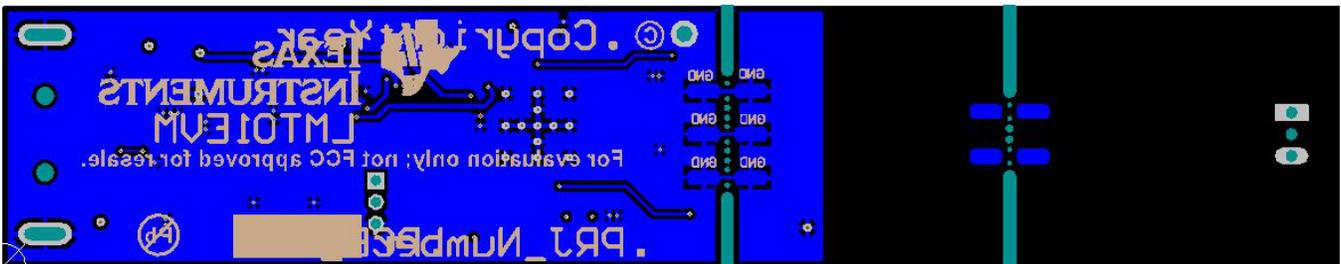


Figure 22. Bottom Assembly Layer

6 Schematic

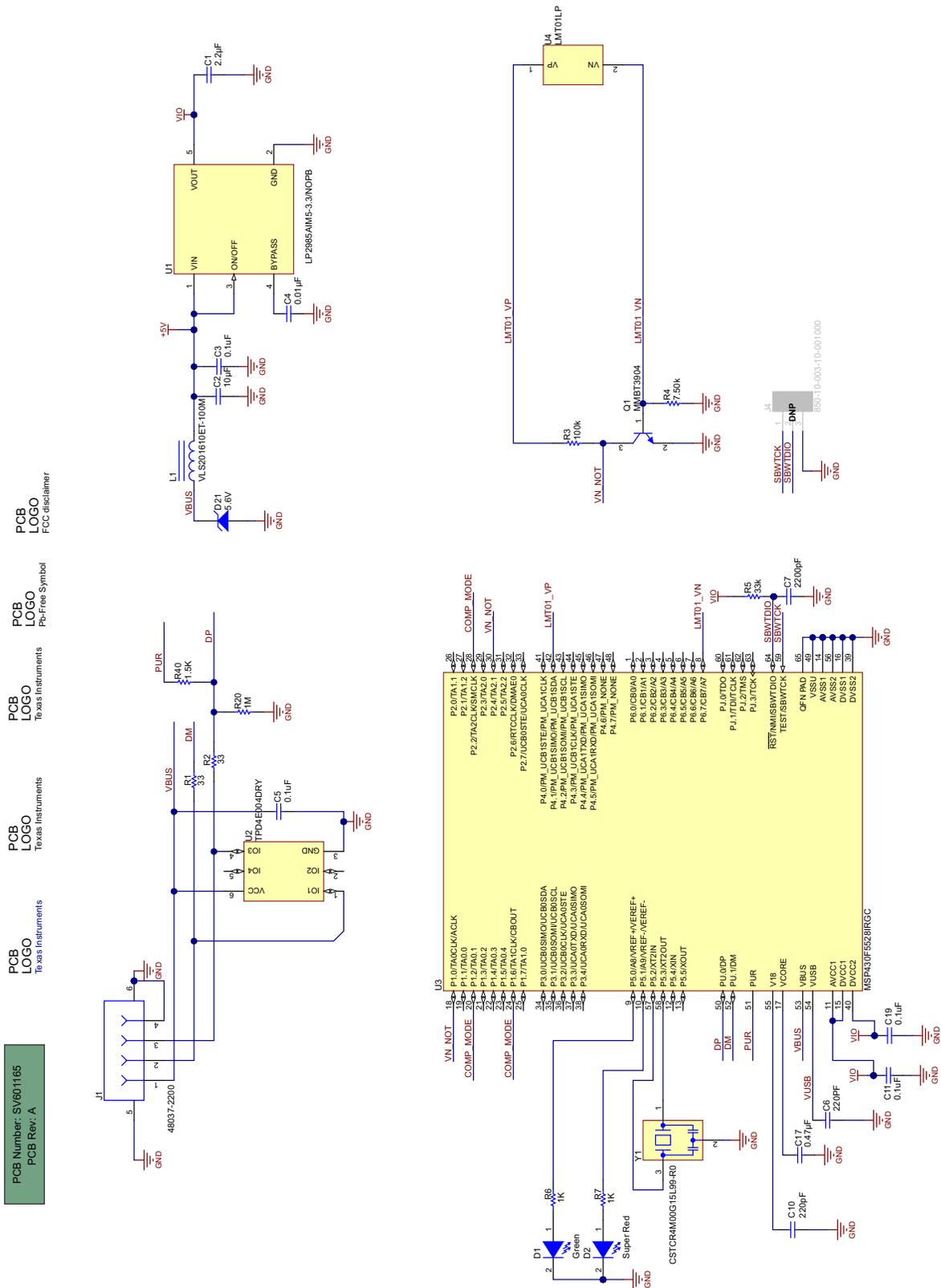


Figure 23. LMT01EVM Schematic

## 7 Bill of Materials

**Table 2. LMT01EVM Bill of Materials**

Designator	Qty.	Value	Description	Part Number	Manufacturer
PCB	1		Printed Circuit Board	SV601165	Any
C1	1	2.2 $\mu$ F	CAP, CERM, 2.2 $\mu$ F, 10V, $\pm$ 10%, X5R, 0603	C0603C225K8PACTU	Kemet
C2	1	10 $\mu$ F	CAP, CERM, 10 $\mu$ F, 10 V, $\pm$ 20%, X5R, 0603	C1608X5R1A106M	TDK
C3, C5, C11, C19	4	0.1 $\mu$ F	CAP CER 0.1UF 16 V 5% X7R 0402	GRM155R71C104JA88D	Murata Electronics North America
C4	1	0.01 $\mu$ F	CAP, CERM, 0.01 $\mu$ F, 25V, $\pm$ 5%, C0G/NP0, 0603	C1608C0G1E103J	TDK
C6	1	220 pF	CAP CER 220PF 50V 1% NP0 0402	C1005C0G1H221F050BA	TDK Corporation
C7	1	2200 pF	CAP, CERM, 2200 pF, 50V, $\pm$ 10%, X7R, 0603	C0603X222K5RACTU	Kemet
C10	1	220 pF	CAP, CERM, 220 pF, 50V, $\pm$ 1%, C0G/NP0, 0603	06035A221FAT2A	AVX
C17	1	0.47 $\mu$ F	CAP, CERM, 0.47 $\mu$ F, 10V, $\pm$ 10%, X7R, 0603	C0603C474K8RACTU	Kemet
D1	1	Green	LED, Green, SMD	LG L29K-G2J1-24-Z	OSRAM
D2	1	Super Red	LED, Super Red, SMD	SML-LX0603SRW-TR	Lumex
D21	1	5.6V	Diode, Zener, 5.6V, 500 mW, SOD-123	MMSZ5232B-7-F	Diodes Inc.
J1	1		Connector, Plug, USB Type A, R/A, Top Mount SMT	48037-2200	Molex
L1	1	10 $\mu$ H	Inductor, Shielded, Ferrite, 10 $\mu$ H, 0.4 A, 1.38 $\Omega$ , SMD	VLS201610ET-100M	TDK
Q1	1	40 V	Transistor, NPN, 40 V, 0.2 A, SOT-23	MMBT3904	Fairchild Semiconductor
R1, R2	2	33	RES, 33 ohm, 5%, 0.063W, 0402	CRCW040233R0JNED	Vishay-Dale
R3	1	100k	RES, 100 k, 5%, 0.063 W, 0402	CRCW0402100KJNED	Vishay-Dale
R4	1	7.50k	RES, 7.50 k, 1%, 0.063 W, 0402	CRCW04027K50FKED	Vishay-Dale
R5	1	33k	RES, 33k ohm, 5%, 0.063W, 0402	CRCW040233K0JNED	Vishay-Dale
R6, R7	2	1K	RES 1K OHM 1/10W 5% 0402 SMD	ERJ-2GEJ102X	Panasonic Electronic Components
R20	1	1M	RES,1M ohm, 5%, 0.063W, 0402	RC0402JR-071ML	Yageo
R40	1	1.5K	RES 1.5K OHM 1/16W 5% 0402 SMD	CRCW04021K50JNED	Vishay Dale
U1	1		Micropower 150 mA Low-Noise Ultra Low-Dropout Regulator in SOT-23 Package, DBV0005A	LP2985AIM5-3.3/NOPB	Texas Instruments
U2	1		4-Channel ESD-Protection Array for High-speed Data Interfaces, DRY006A	TPD4E004DRY	Texas Instruments
U3	1		Mixed Signal MicroController, RGC0064B	MSP430F5528IRGC	Texas Instruments
U4	1		High-Accuracy 2-pin Temperature Sensor with a Pulsed-Current Interface, LP0002A	LMT01LP	Texas Instruments
Y1	1		Resonator, 4MHz, 39pF SMD	CSTCR4M00G15L99-R0	Murata
J4	0		Header, 50mil, 3x1, Gold, TH	850-10-003-10-001000	Mill-Max

## Revision History

<b>Changes from Original (March 2015) to A Revision</b>	<b>Page</b>
• Added Troubleshooting section. ....	<a href="#">14</a>

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NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

## STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, or documentation (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms and conditions set forth herein. Acceptance of the EVM is expressly subject to the following terms and conditions.
  - 1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms and conditions that accompany such Software
  - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
2. *Limited Warranty and Related Remedies/Disclaimers:*
  - 2.1 These terms and conditions do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
  - 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for any defects that are caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI. Moreover, TI shall not be liable for any defects that result from User's design, specifications or instructions for such EVMs. Testing and other quality control techniques are used to the extent TI deems necessary or as mandated by government requirements. TI does not test all parameters of each EVM.
  - 2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.
3. *Regulatory Notices:*
  - 3.1 *United States*
    - 3.1.1 *Notice applicable to EVMs not FCC-Approved:*

This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.
    - 3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

### CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

### FCC Interference Statement for Class A EVM devices

*NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.*

## FCC Interference Statement for Class B EVM devices

*NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:*

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

### 3.2 Canada

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210

#### Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

#### Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

#### Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

#### Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

### 3.3 Japan

3.3.1 *Notice for EVMs delivered in Japan:* Please see [http://www.tij.co.jp/lstds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page) 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。  
[http://www.tij.co.jp/lstds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page)

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required by Radio Law of Japan to follow the instructions below with respect to EVMs:

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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#### 4 *EVM Use Restrictions and Warnings:*

- 4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.
- 4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.
- 4.3 *Safety-Related Warnings and Restrictions:*
  - 4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.
  - 4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.
- 4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

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