Using the LM36923HEVM Evaluation Module

User's Guide

Literature Number: SNVU509
January 2016

Contents

Copyright © 2016, Texas Instruments Incorporated

List of Figures

Copyright © 2016, Texas Instruments Incorporated

List of Tables

Copyright © 2016, Texas Instruments Incorporated

LM36923HEVM User's Guide

1 Introduction

The Texas Instruments LM36923HEVM evaluation module (EVM) helps designers evaluate the operation and performance of the LM36923H Highly Efficient Triple-String White LED driver. The device offers configurability via I²C-compatible interface. The EVM contains six dual-LED and a single LED per string which can be easily configured to support 1, 2 or 3 parallel LED strings with 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 or 13 series LEDs.
Notes:
1) **Not all combinations of VIN, LED strings and Number of Series LEDs are supported by the LM36923H. Refer to the data sheet to ensure the proper configuration.**
2) **The dual-LED are very bright, they are not diffused and are capable of ~21 lumens per package. Appropriate LED light diffusion or eye protection must be provided by the user.**

The EVM contains one LED Backlight Driver (See Table 1).

Table 1. Device and Package Configurations

LED DRIVER	IC	PACKAGE
U1	LM36923H	0.4 mm-pitch, 12-Bump DSBGA

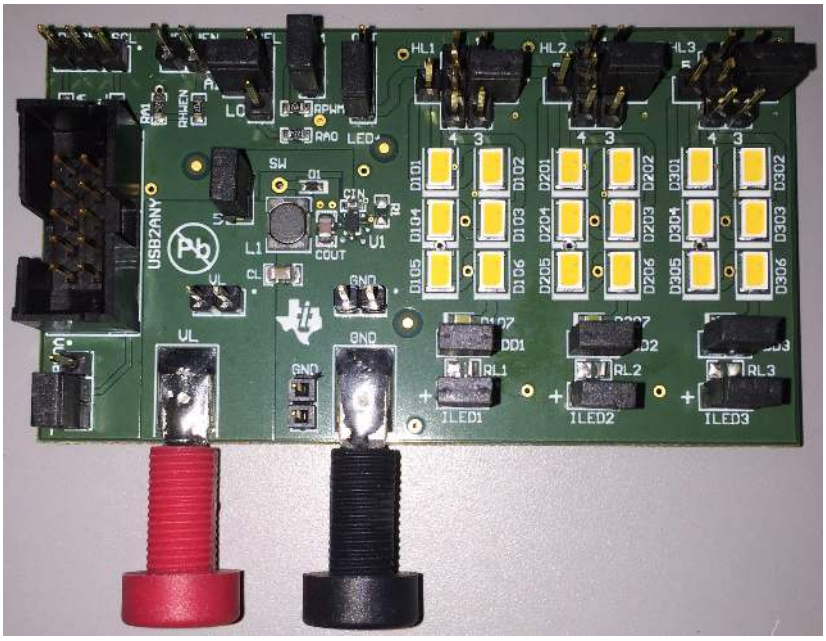

Figure 1. LM36923HEVM Photo

Copyright © 2016, Texas Instruments Incorporated

2 Setup

This section describes the jumpers and connectors on the EVM as well as how to properly connect, set up, and use the LM36923HEVM.

2.1 Input/Output Connector Description

VL / **GND -** These are the power input terminals for the driver. The terminal block provides a power (VIN) and ground (GND) connection to allow the user to attach the EVM to a cable harness.

VUSB VIO VL - This pin provides power for the I²C and HWEN pullup resistors (RSCL, RSDA, RHWEN). It is recommended that this pin is connected to the VIN pin. If desired, it can be connected to the USB2ANY 3.3-V line provided by the USB interface connector. When VIO is connected to VIN communication via the I²C interface may not be possible if the supply voltage to the LED driver is below approximately 3 V.

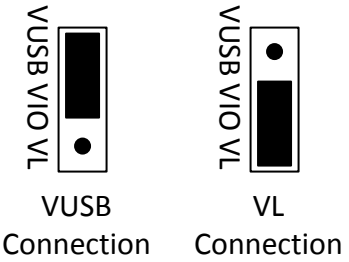

Figure 2. VIO Jumper Settings

SDA SCL - These connections allow the user to externally control the I²C lines. For independent control of the I²C lines, **do not** connect the VIO jumper to either the 3.3 V or the VIN pin.

HWEN - This is the jumper used to enable the LED driver (HWEN pin). The driver will be enabled when the HWEN pin is high (VIO) and disabled when it is low (GND).

VL VIN - The user can measure the Backlight Driver Input Current by omitting this jumper and inserting a current meter between pins 1 (VIN) and 2 (VL).

ASEL - This connector provides a method for controlling the ASEL input to configure the I²C slave address. A jumper is required to operate the EVM. The LM36923HEVM GUI provides a method for setting ASEL when a jumper is inserted between pins 2 and 4. When a jumper is inserted between pins 1 and 2 ASEL is connected to VIO through a 4.7-kΩ resistor (RA1). When a jumper is inserted between pins 2 and 3 ASEL is connected to GND through a 4.7-kΩ resistor (RA0).

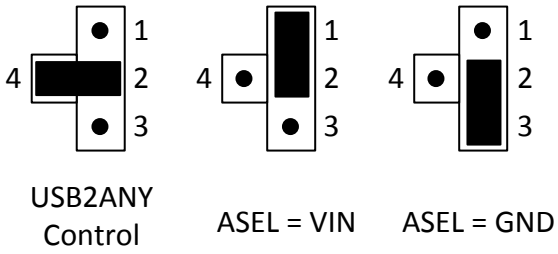

Figure 3. ASEL Jumper Settings

PWM - This pin provides a method for connecting either the USB2ANY or an external signal generator to the PWM input. The PWM pin is connected to ground via a 4.7-kΩ resistor (RPWM). The LM36923HEVM GUI provides a method for generating a PWM signal when a jumper is placed between connector pins 1 and 2. When connecting an external signal generator remove the jumper between pins 1 and 2 and connect the signal generator to pin 1 and GND.

OUT - This connector provides a way to disconnect the output voltage to each LED string and access to the regulated output of the driver. The user can measure VOUT with reference to GND while connecting and disconnecting the LED strings.

Copyright © 2016, Texas Instruments Incorporated

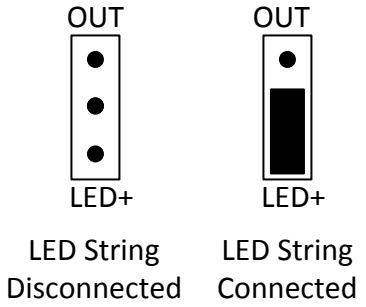

Figure 4. OUT Jumper Settings

HL1, HL2, HL3 - This connector provides a star connection to the LED string allowing the user to configure the LED string for 1, 2, 3, 4, 5 or 6 series dual-LEDs.

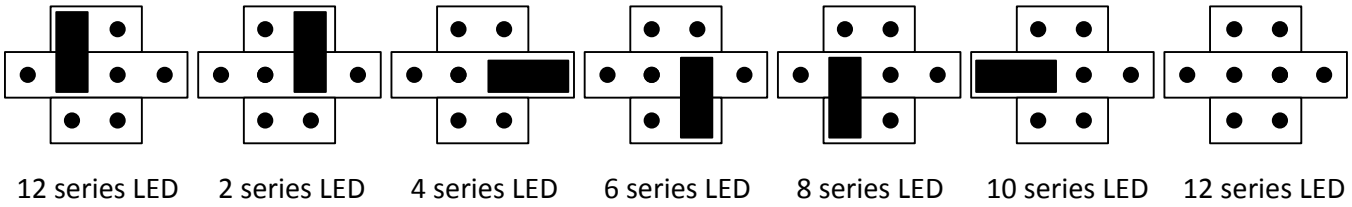

Figure 5. HL1, HL2, HL3 star jumper configuration settings

ODD1, ODD2, ODD3 - These connectors provide a method for inserting a single LED in each string. When the jumper is removed from ODD1, ODD2 ,ODD3 the single LED D107, D207, D307 is part of the respective LED string. When a jumper is inserted on ODD1, ODD2, ODD3 the single LED D107, D207, D307 is bypassed in the respective LED string.

ILED1, ILED2, ILED3 -The LM36923HEVM provides a way to accurately measure the LED current through each LED string on board. Resistors RL1 , RL2 and RL3 (10 Ω) are placed between the cathode of last LED in each respective string and the LM36923H Current Sink Output.

2.2 Setup

The input voltage range for the backlight driver is 2.5 volts to 5.5 volts. The on-board LEDs or an LED module should be connected for proper operation.

2.3 Operation

For proper operation of the LM36923HEVM, the jumpers should be properly configured. The recommended setting, using shorting blocks is:

ASEL to USB2ANY: install jumper between pins 2 and 4

VIO to VIN: install jumper between pins 2 and 3

VL to VIN: jumper installed

OUT to LED+: install jumper between pins 2 and 3.

PWM from USB2ANY: jumper installed

HL1, HL2, HL3: install jumper in position 3 for each string

ODD1, ODD2, ODD3: jumper installed (odd LED bypassed)

Using these settings the device will be configured for USB2ANY control with 2 dual-led (4 LEDs) per string.

Copyright © 2016, Texas Instruments Incorporated

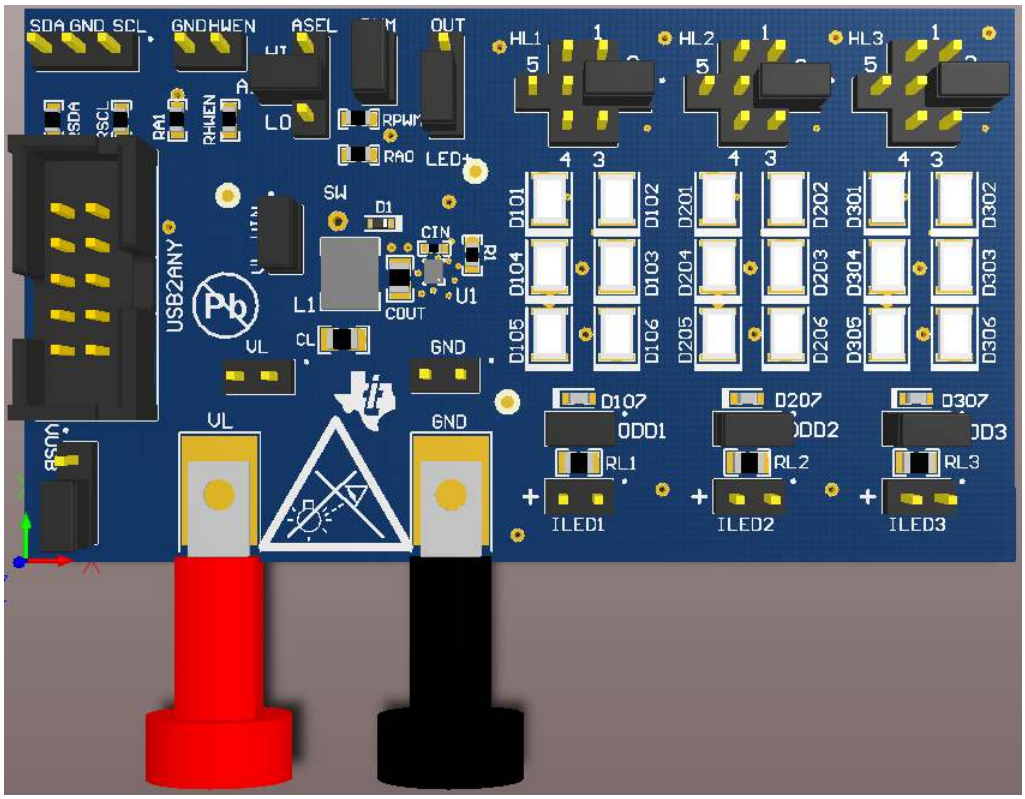

Figure 6. Jumper Configuration

3 Board Layout

Figure 7, Figure 8, Figure 9 and Figure 10 show the board layout for the LM36923HEVM. The EVM offers resistors, capacitors, and jumpers to enable the device and to configure it as desired.

The LM36923H will dissipate power, especially during high brightness maintained for a long duration. Power will also be dissipated on the series LEDs in each LED strings. The EVM layout is designed to minimize temperature rise during operation, however prolonged usage at high brightness should be avoided.

Copyright © 2016, Texas Instruments Incorporated

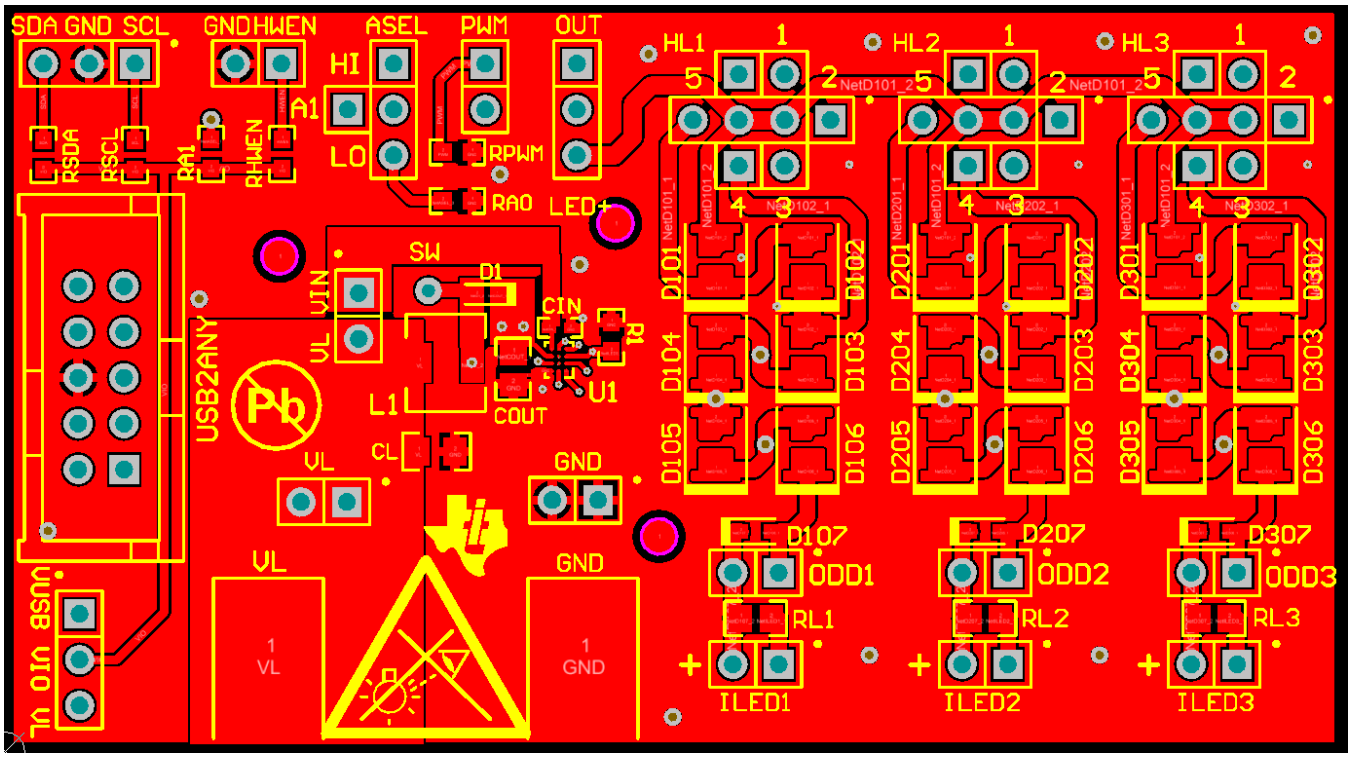

Figure 7. Top Assembly Layer

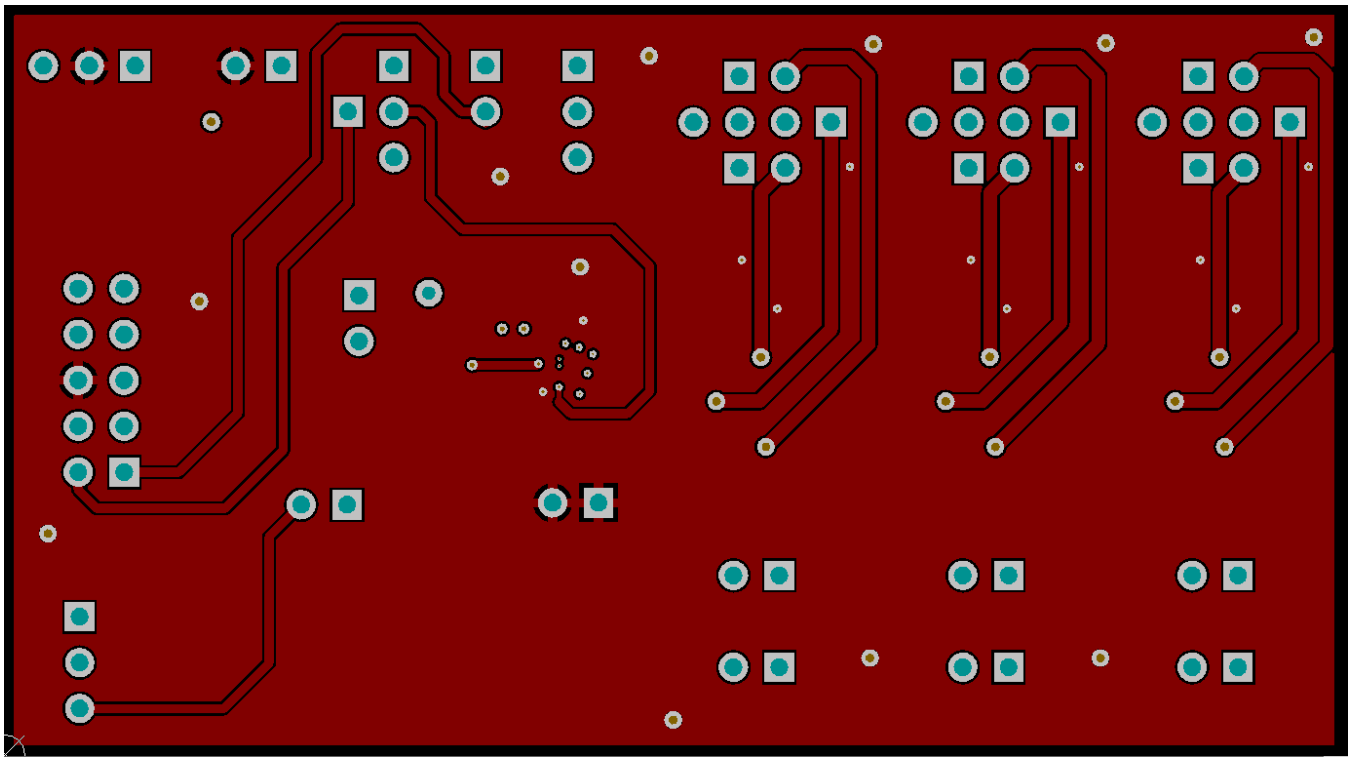

Figure 8. Middle Layer 1 Routing

Copyright © 2016, Texas Instruments Incorporated

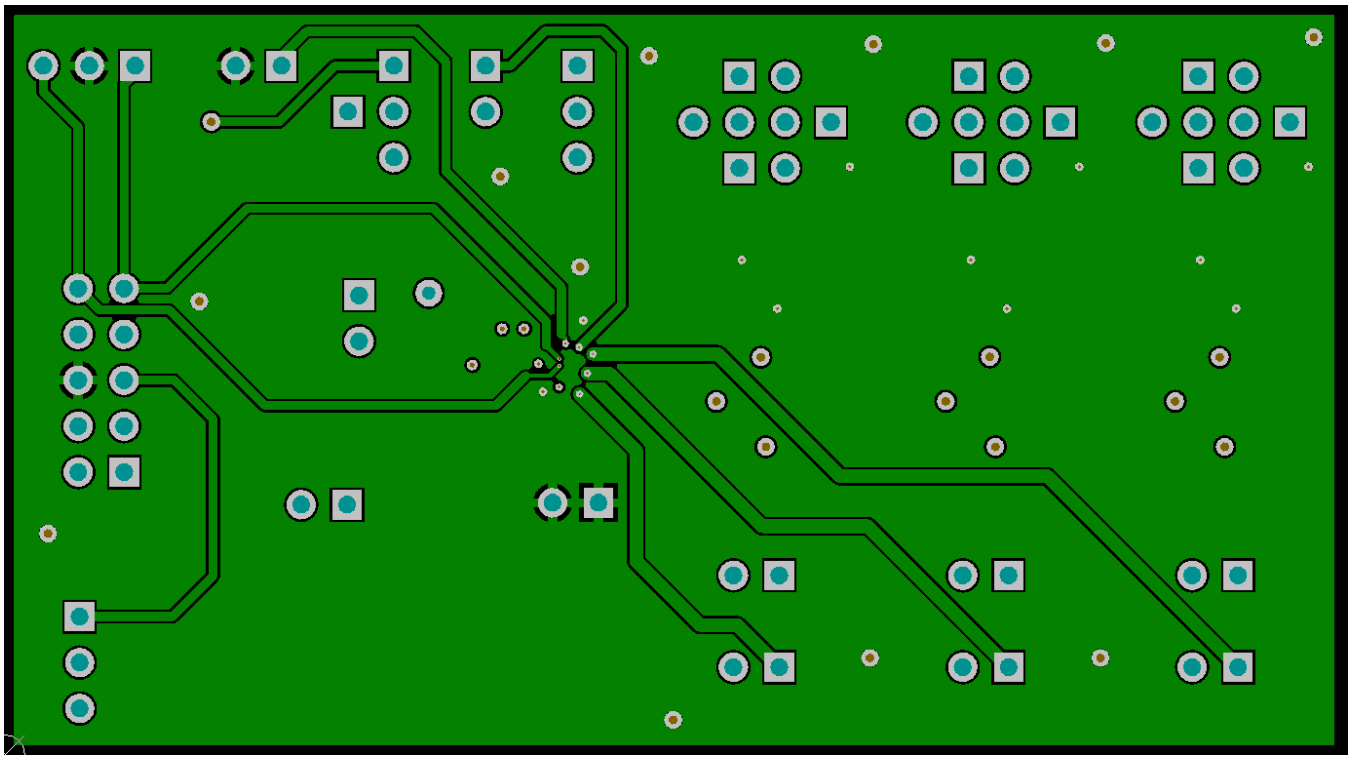

Figure 9. Middle Layer 2 Routing

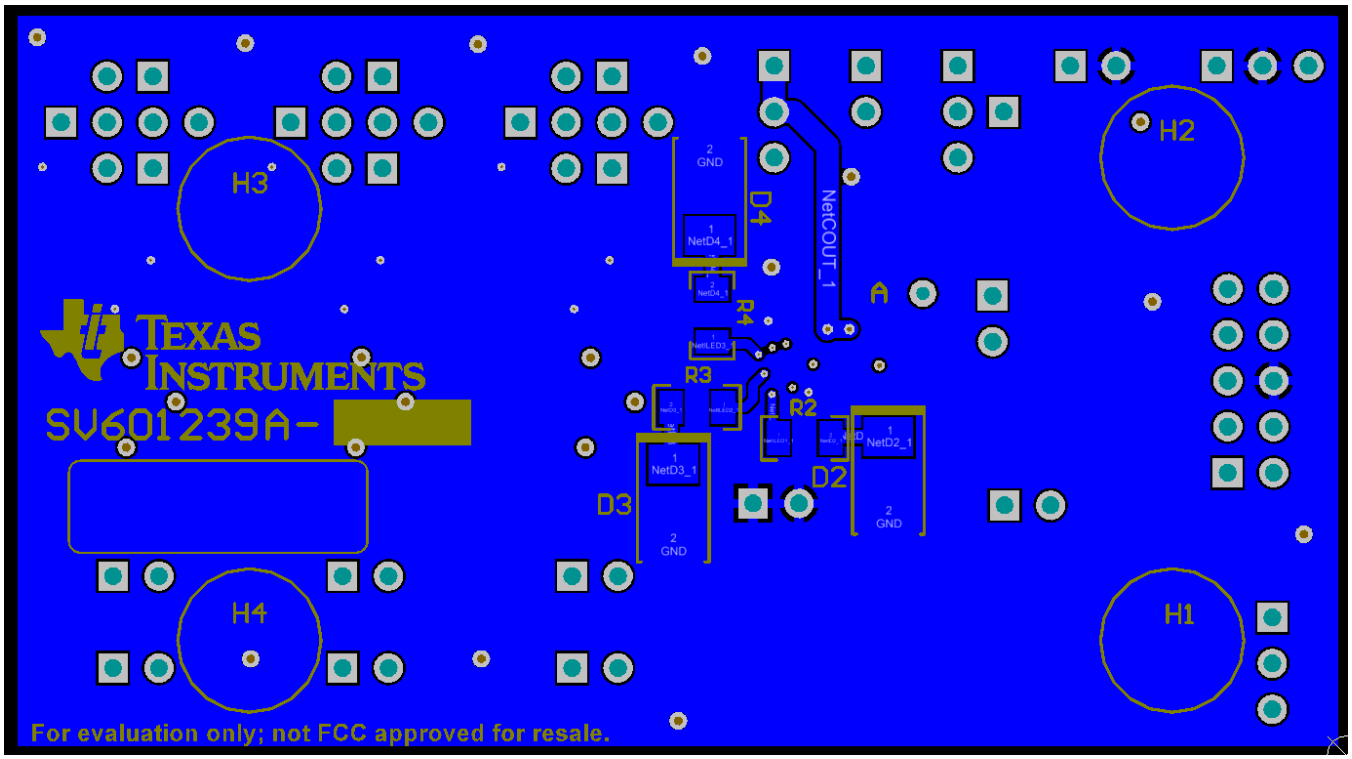

Figure 10. Bottom Assembly Layer (MIRRORED)

Copyright © 2016, Texas Instruments Incorporated

4 Schematic

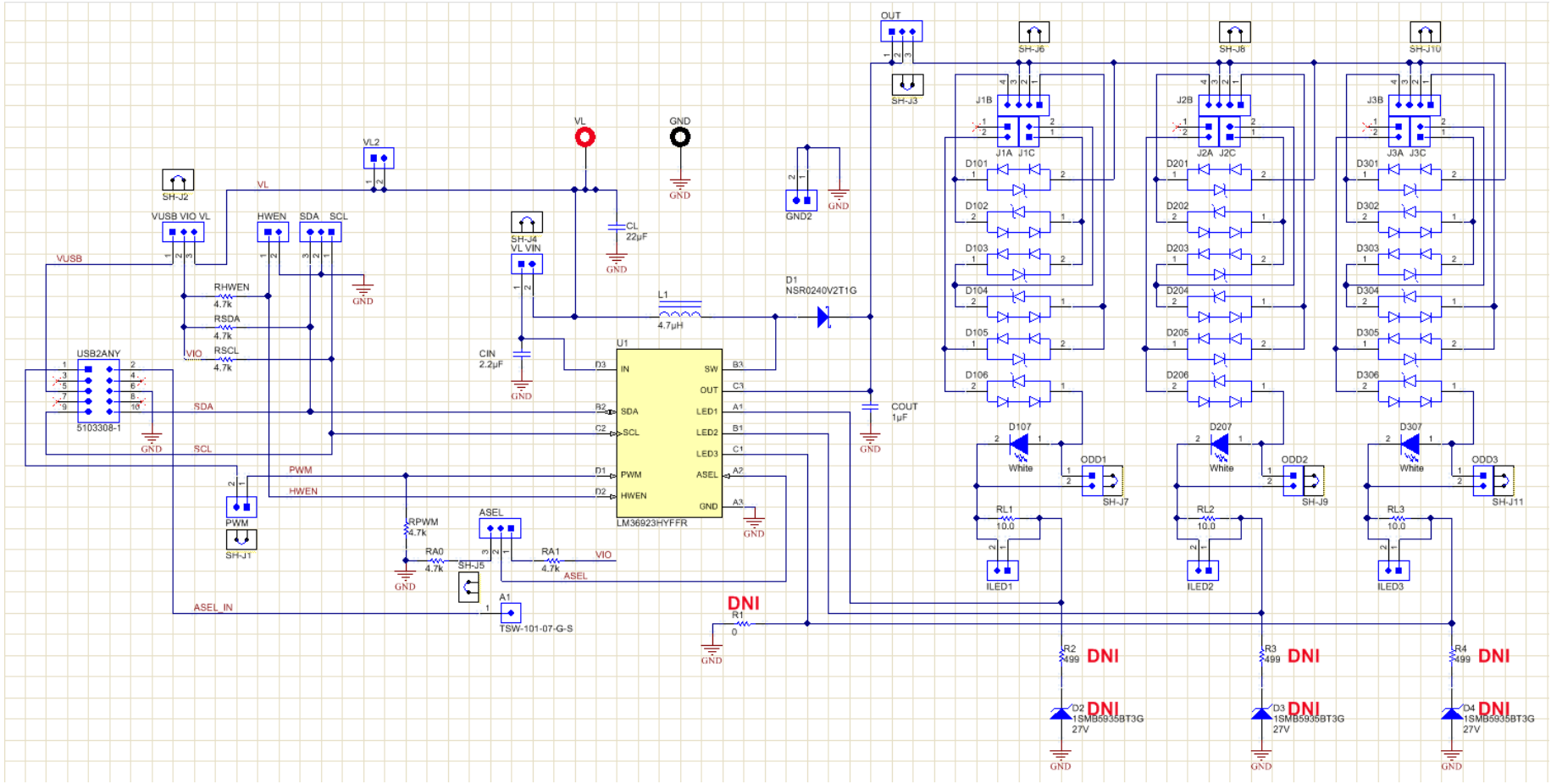

Figure 11. LM36923EVM Schematic

Copyright © 2016, Texas Instruments Incorporated

Table 2. Bill of Materials

DESIGNATOR	DESCRIPTION	MANUFACTURER	PART NUMBER	QTY
!PCB	Printed Circuit Board	Any	SV601239	1
A1	Header, 100mil, 1pos, Gold, TH	Samtec	TSW-101-07-G-S	1
ASEL, OUT, SDA SCL, VUSB VIO VL	Header, TH, 100mil, 3x1, Gold plated, 230 mil above insulator	Samtec	TSW-103-07-G-S	4
CIN	CAP, CERM, 2.2uF, 25V, +/-10%, X5R, 0402	TDK	C1005X5R1E225K050BC	1
CL	CAP, CERM, 22uF, 16V, +/-10%, X5R, 0805	TDK	C2012X5R1C226K125AC	1
COUT	CAP, CERM, 1uF, 50V, +/-10%, X7R, 0805	TDK	C2012X7R1H105K125AB	1
D1	Diode, Schottky, 40V, 0.25A, SOD-523	ON Semiconductor	NSR0240V2T1G	1
D101, D102, D103, D104, D105, D106, D201, D202, D203, D204, D205, D206, D301, D302, D303, D304, D305, D306	LED, White, SMD	Samsung	SPMWHT325AD5YBTMS0	18
D107, D207, D307	LED, White, SMD	Rohm	SML312WBCW1	3
GND	Standard Banana Jack, Insulated, Black	Keystone	6092	1
GND2, HWEN, ILED1, ILED2, ILED3, J1A, J1C, J2A, J2C, J3A, J3C, ODD1, ODD2 ,ODD3, PWM, VL2, VL VIN	Header, TH, 100mil, 2x1, Gold plated, 230 mil above insulator	Samtec	TSW-102-07-G-S	17
H1, H2, H3, H4	Bumpon, Cylindrical, 0.312 X 0.200, Black	3M	SJ61A1	4
J1B, J2B, J3B	Header, TH, 100mil, 4x1, Gold plated, 230 mil above insulator	Samtec	TSW-104-07-G-S	3
L1	Inductor, Shielded, Ferrite, 4.7 µH, 1.83 A, 0.1 ohm, SMD	TDK	VLF504012MT-4R7M	1
RA0, RA1, RHWEN, RPWM, RSCL, RSDA	RES, 4.7k ohm, 5%, 0.1W, 0603	Vishay-Dale	CRCW06034K70JNEA	6
RL1, RL2, RL3	RES, 10.0 ohm, 1%, 0.125W, 0805	Vishay-Dale	CRCW080510R0FKEA	3
R1	RES, 0, 5%, 0.1 W, 0603	Vishay-Dale	CRCW06030000Z0EA	0
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J9, SH-J10, SH-J11	Shunt, 100mil, Flash Gold, Black	Sullins Connector Solutions	SPC02SYAN	11
U1	Highly Efficient Triple-String White LED Driver, YFF0012AHAH	Texas Instruments	LM36923HYFFR	1
USB2ANY	Header (shrouded), 100mil, 5x2, Gold, TH	TE Connectivity	5103308-1	1
VL	Standard Banana Jack, Insulated, Red	Keystone	6091	1

Copyright © 2016, Texas Instruments Incorporated

5 USB Interface Board and I²C-Compatible Interface Program

Texas Instruments has created an I²C-compatible program and USB docking board (USB2ANY) that can help exercise the part in a simple way. Contained in this document is a description of how to use the USB2ANY interface box and interface software.

The LM36923HEVM has the means to “plug into” the USB docking board. The USB docking board provides all the control signals for the simple interface. Power to the part must be provided externally. A USB cable (provided) must be connected to the board from a PC.

The I²C-compatible interface program provides all of the control that the LM36923H part requires. For proper operation, the USB docking board should be plugged into the PC before the interface program is opened. Once connected, and the program is executed, a basic interface window will open. Figure 12 shows the default settings which are updated after the user clicks the Read All button.

5.1 User Interface

the LM36923H GUI provides the user with access to all of the registers found on the device. Through a combination of buttons, drop-down boxes and sliders, the user can configure the LM36923H to perform in the desired mode. Please note that each register is updated when the button, drop-down box, numeric updown box or slider is changed. Individual register read is completed by clicking the Read button associated with each register.

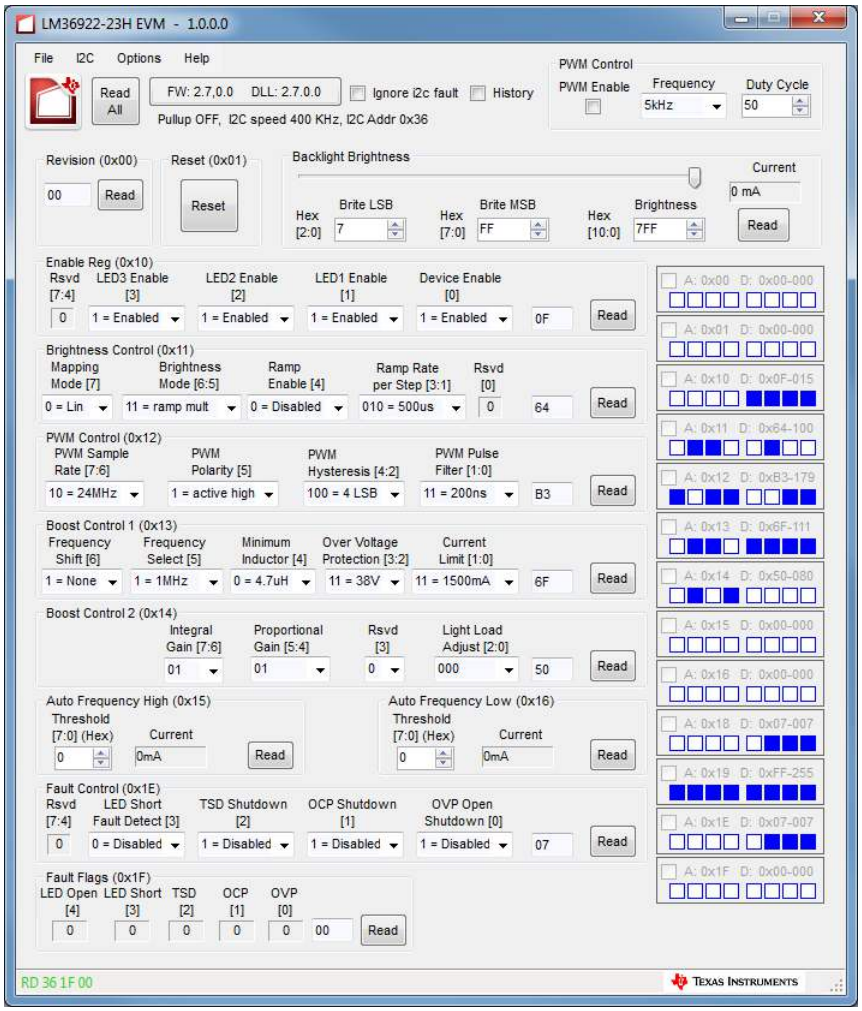

Figure 12. LM36923H General User Interface

Copyright © 2016, Texas Instruments Incorporated

5.2 LM36923H Software Reset

Selecting the "Reset" button sends the I²C Software Reset command which sets all registers to their default values and updates all GUI fields.

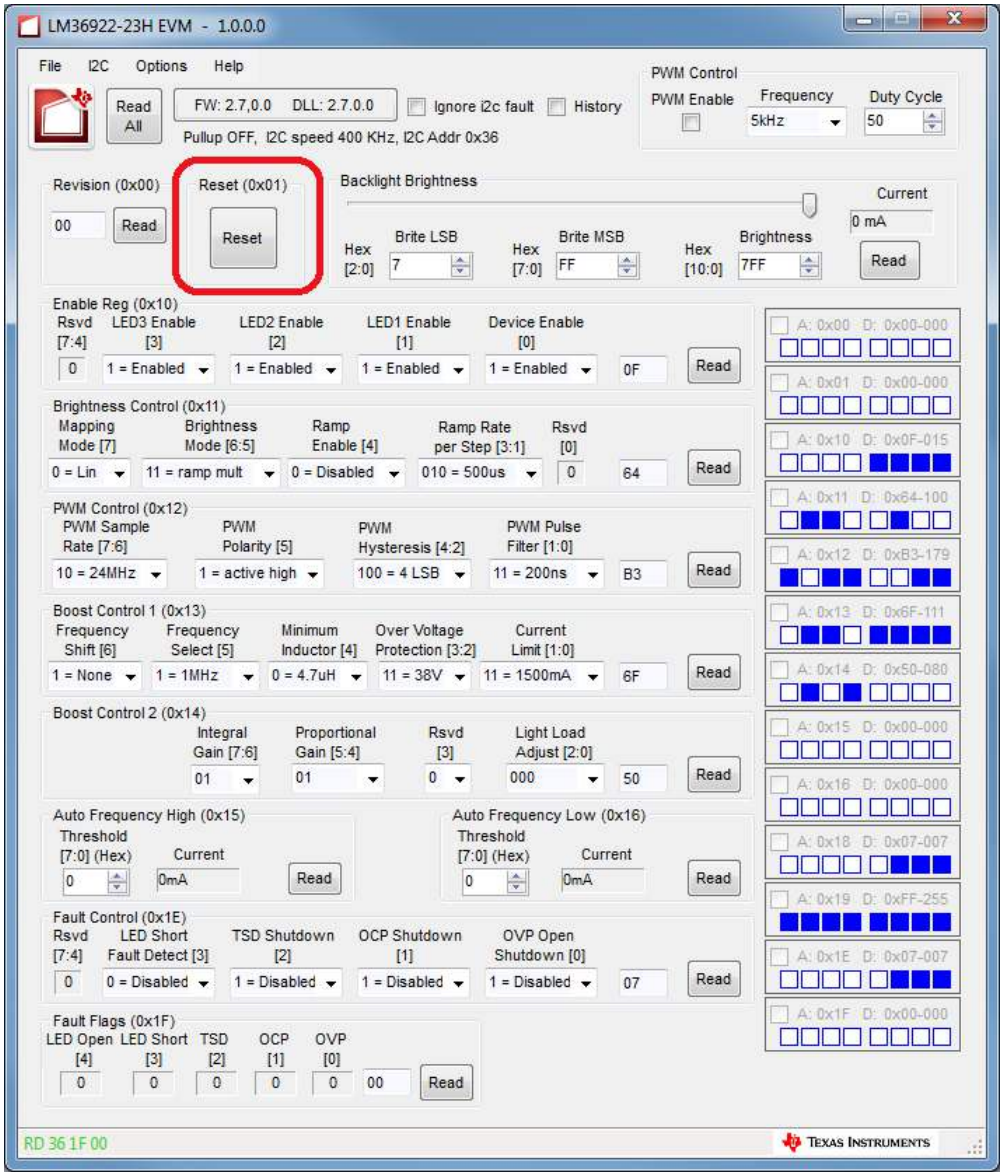

Figure 13. LM36923H Software Reset

Copyright © 2016, Texas Instruments Incorporated

5.3 LM36923H Fault Flags

The contents of the LM36923H fault registers are read upon clicking the “Read” button. The registers are cleared upon read back.

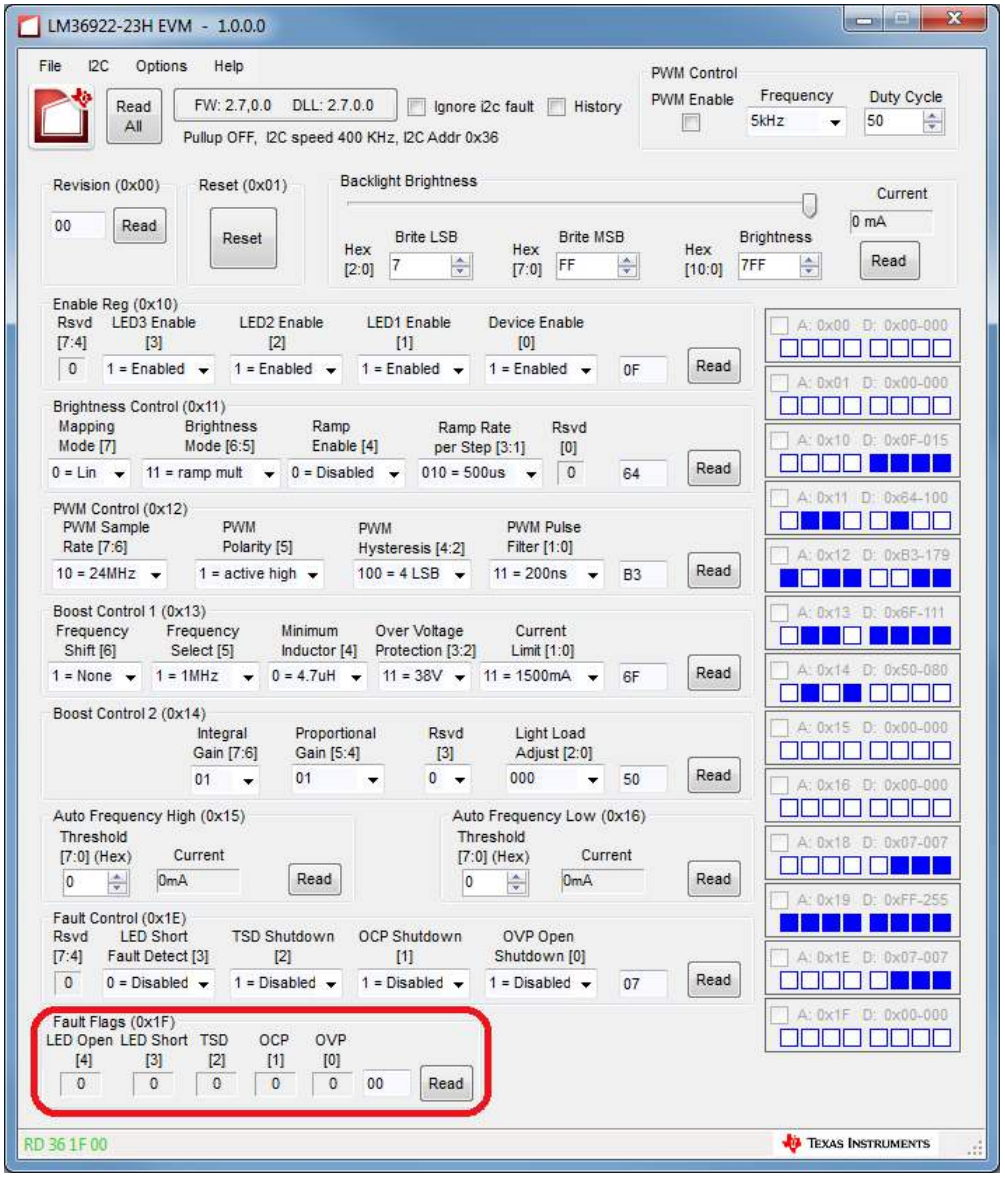

Figure 14. Fault Flags

Copyright © 2016, Texas Instruments Incorporated

5.4 PWM Pin Control

The LM36923HEVM provides the user with the capability to control the PWM input without the need of an external source. The PWM signal will be low until the "PWM Enable" button is clicked or whenever the "Duty Cycle" value is set to 0. In order to change the PWM duty cycle the user can either type the desired duty cycle in the "Duty Cycle" box or click on the up/down buttons associated with the numeric updown box. The PWM frequency can be changed by selecting the desired setting via the Frequency drop-down box.

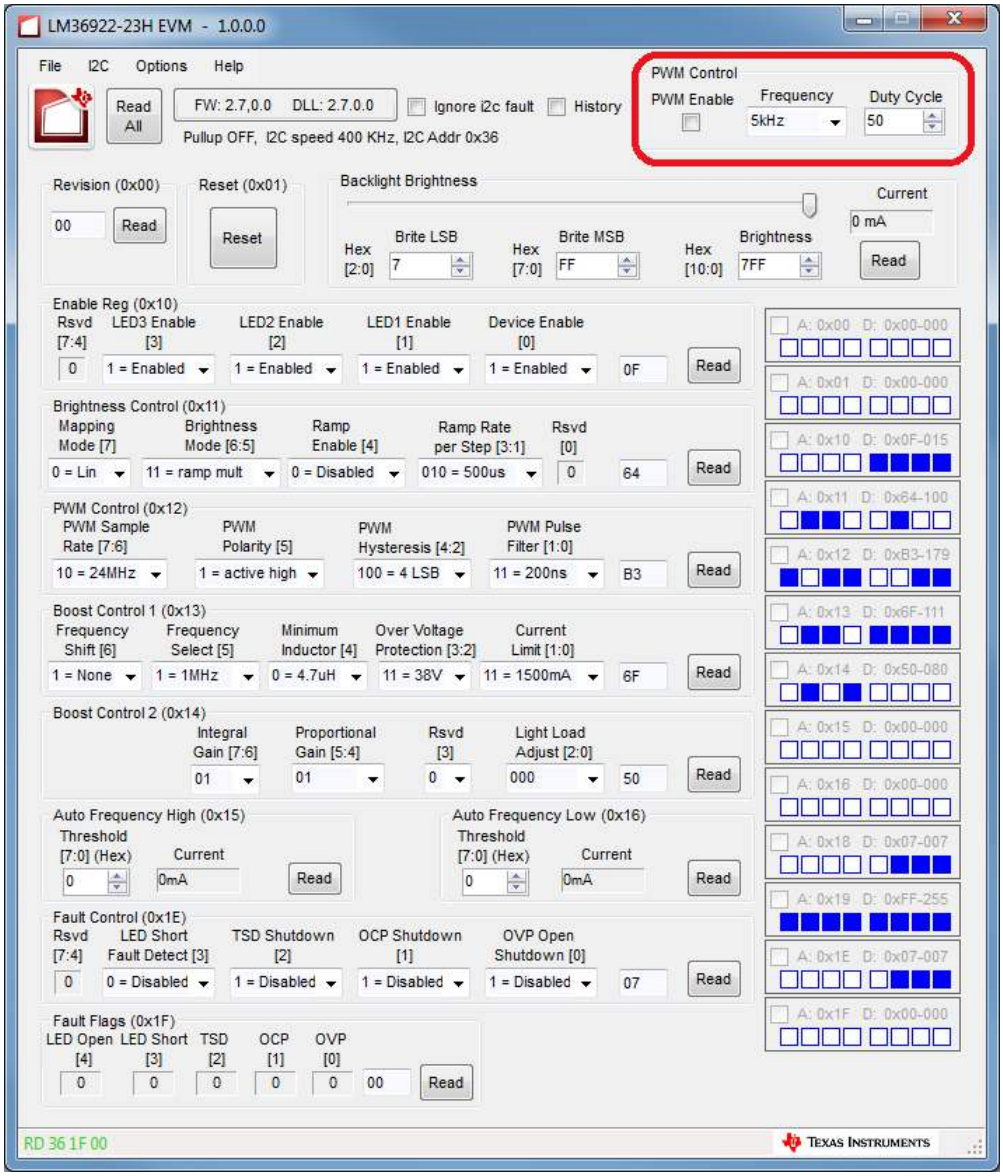

Figure 15. PWM Input Pin Control

Copyright © 2016, Texas Instruments Incorporated

5.5 ASEL Pin Control

The ASEL input to the LM36923HEVM is set via the GUI in the I²C options dialog. When unchecked ASEL will be low and the I²C slave address used by the GUI is set to 0x36. When checked ASEL will be high and the I²C slave address used by the GUI is set to 0x37. If the LM36923HEVM ASEL jumper is set to a fixed setting the user will need to verify that the GUI Address Select setting matches the jumper on the EVM.

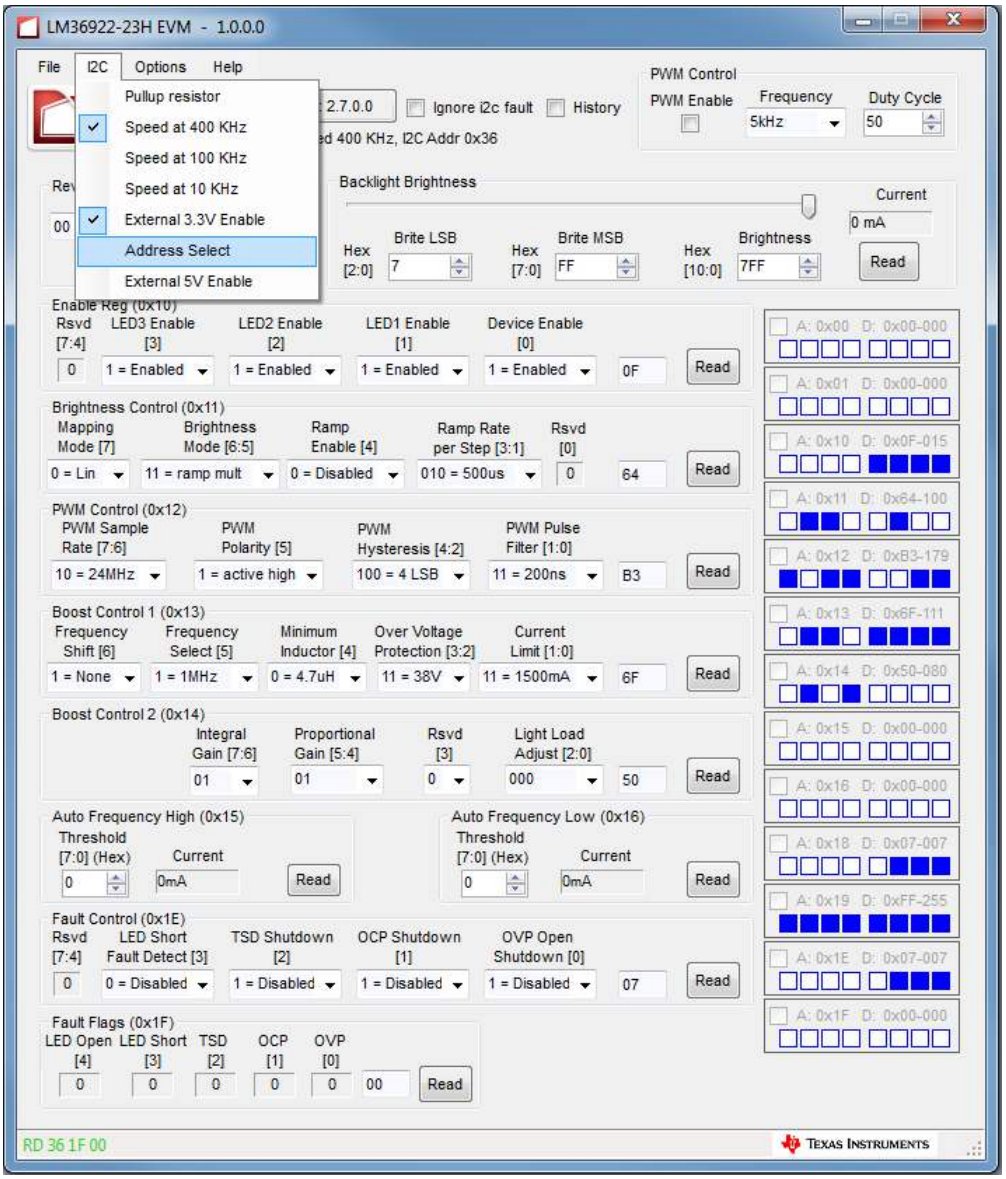

Figure 16. ASEL Input Pin Control

Copyright © 2016, Texas Instruments Incorporated

5.6 History & Macro Tab

The LM36923HEVM GUI provides history, register access and macro capability when the "History" checkbox is checked. The history information can be cleared by clicking the "Clear" button or saved to file by clicking the "Save to file ..." button. Clicking the "Save to file ..." button will open up a dialog box to select the file location and file name.

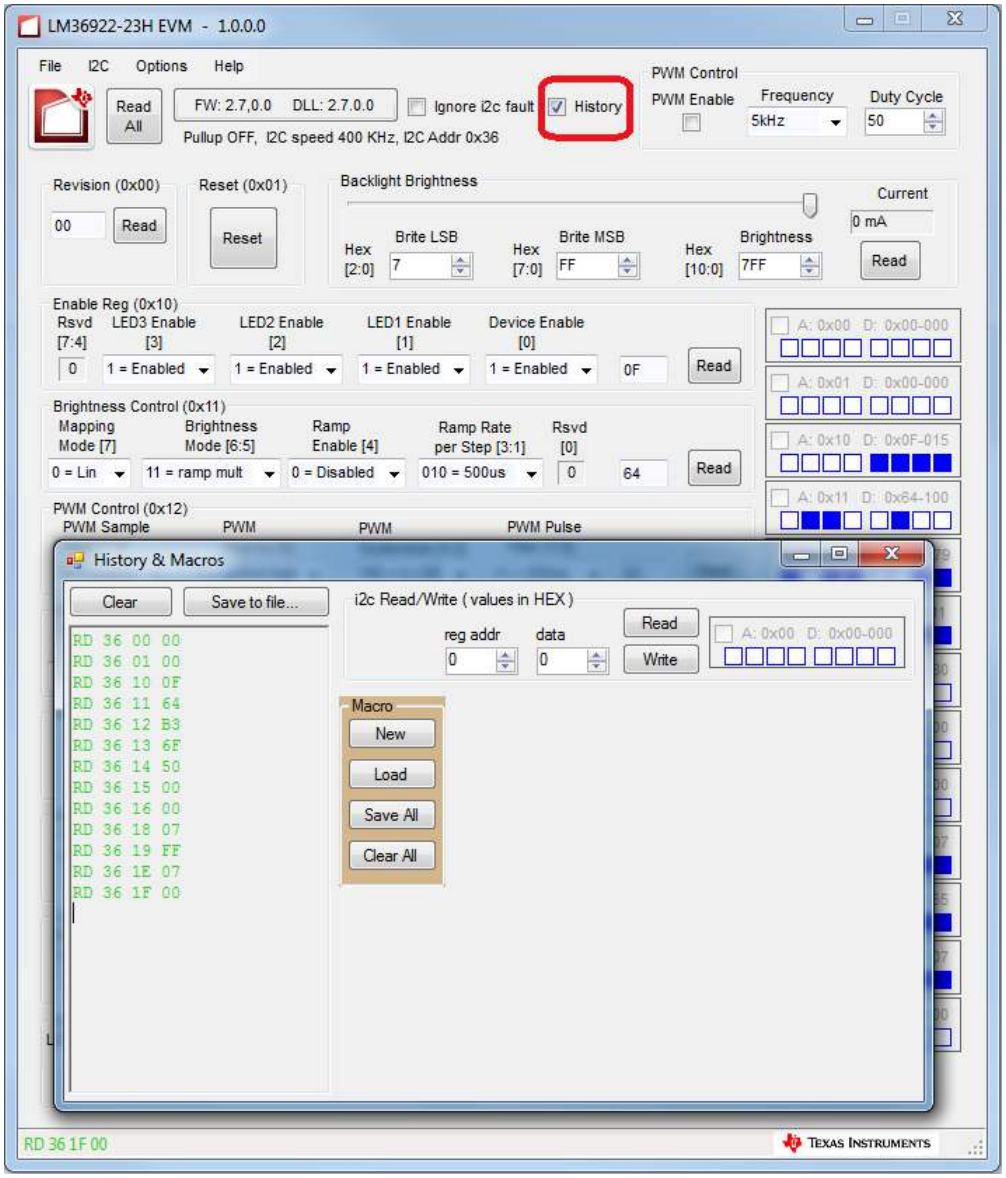

Figure 17. GUI History following Read All button clicked

Copyright © 2016, Texas Instruments Incorporated

5.7 Individual register read/write access

When the History & Macros tab is enabled the user can read or write to individual registers in the LM36923H. Any read or write access is reflected in the history section in addition to the register box located to the right of the "Read" and "Write" buttons.

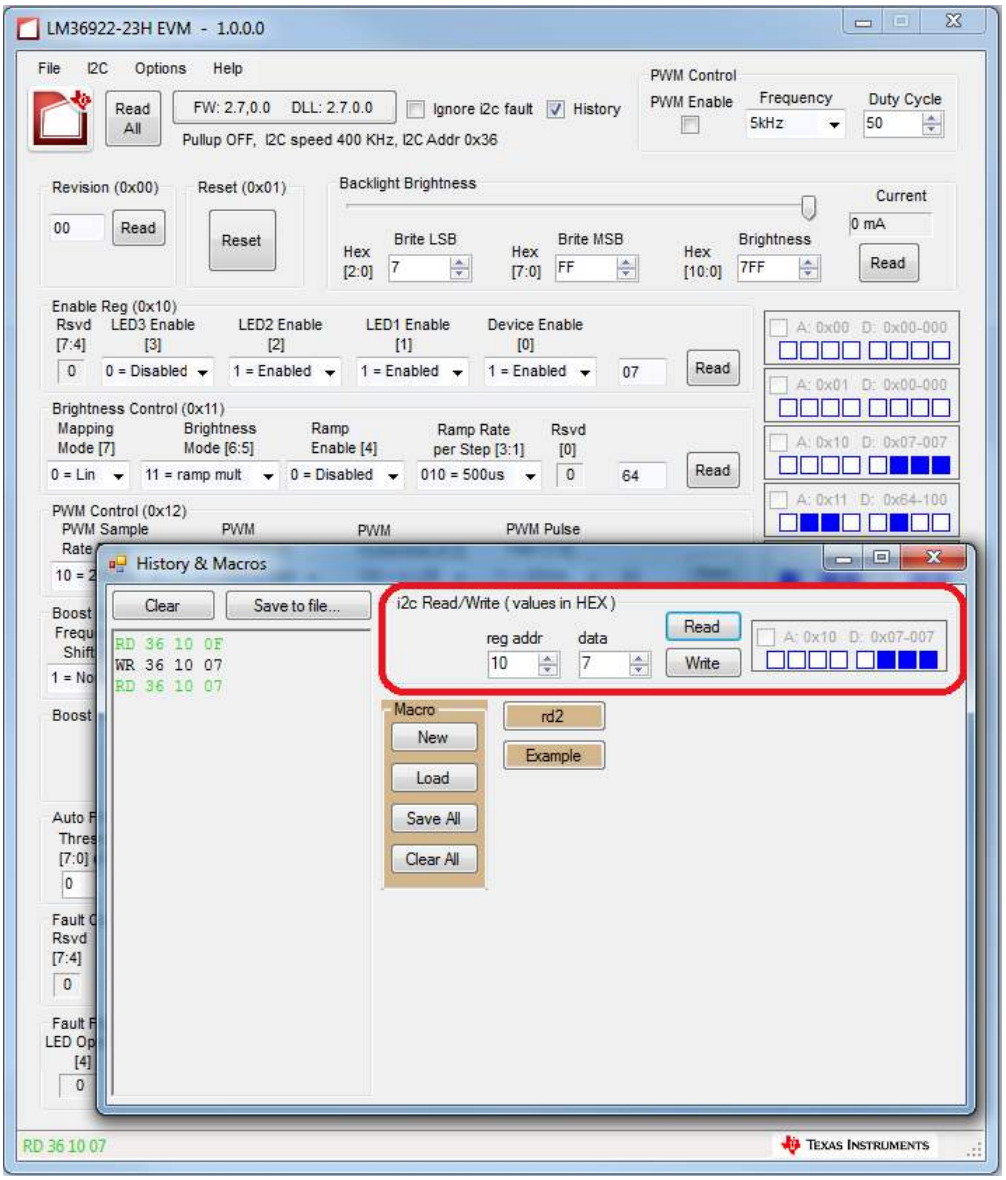

Figure 18. Register read/write access

Copyright © 2016, Texas Instruments Incorporated

5.8 Macro Example

The LM36923HEVM GUI provides the user with the ability to create custom macros to configure the LM36923H with a single button click. Multiple macros can be created and saved in a single file as shown in Figure 19.

Table 3. Macro commands

Macro command	Macro function	Syntax	Description
rem	Remark	none	Optional keyword, allows user to enter comments which are not executed
RD	read register	two fields required, register hex address and variable for return data	Optional keyword, allows user to read any register, value appears in history section
WR	write register	two fields required, register hex address and register hex data	Optional keyword, allows user to write any register, value written appears in history section
MDLY	millisecond delay	one field, decimal delay	Optional keyword. allows user to insert a millisecond delay between commands
title	macro title	one field, macro title	Required keyword to initiate macro, allows user to set descriptive name to macro
end	macro end	all macro commands between "title" and "end" included in macro	Required keyword to terminate macro
OK	pop up dialog box	one field, text to appear in dialog box	Optional keyword, allows user prompt and halts macro execution until user response

```
rem "Macro title"
title rd2
rem "Read reg 0x10"
RD 10 temp1
rem "Read reg 0x11"
RD 11 temp2
rem "End of first macro"
end
rem "Next macro title"
title Example
rem "Pop up message box"
OK your description
rem "Write reg 0x10 with 0x07"
WR 10 07
rem enable LED 1 & 2
rem "Millisecond delay"
MDLY 10
rem "Write reg 0x10 with 0x0F"
WR 10 0F
rem enable LED 1, 2 & 3
rem "End of second macro"
end
```

Figure 19. Example macro

Copyright © 2016, Texas Instruments Incorporated

Figure 20 illustrates the successful load of the Example macro shown above. Note that two new buttons named "rd2" and "Example" appear on the GUI . The user can clear all macro buttons by clicking the "Clear All" button. The user can also add additional macros by clicking the "New" button which will open a macro editor. The editor will verify that the correct syntax is used and will prompt the user if any error is discovered. Clicking the "Save All" button will save all defined macros into a single output file.

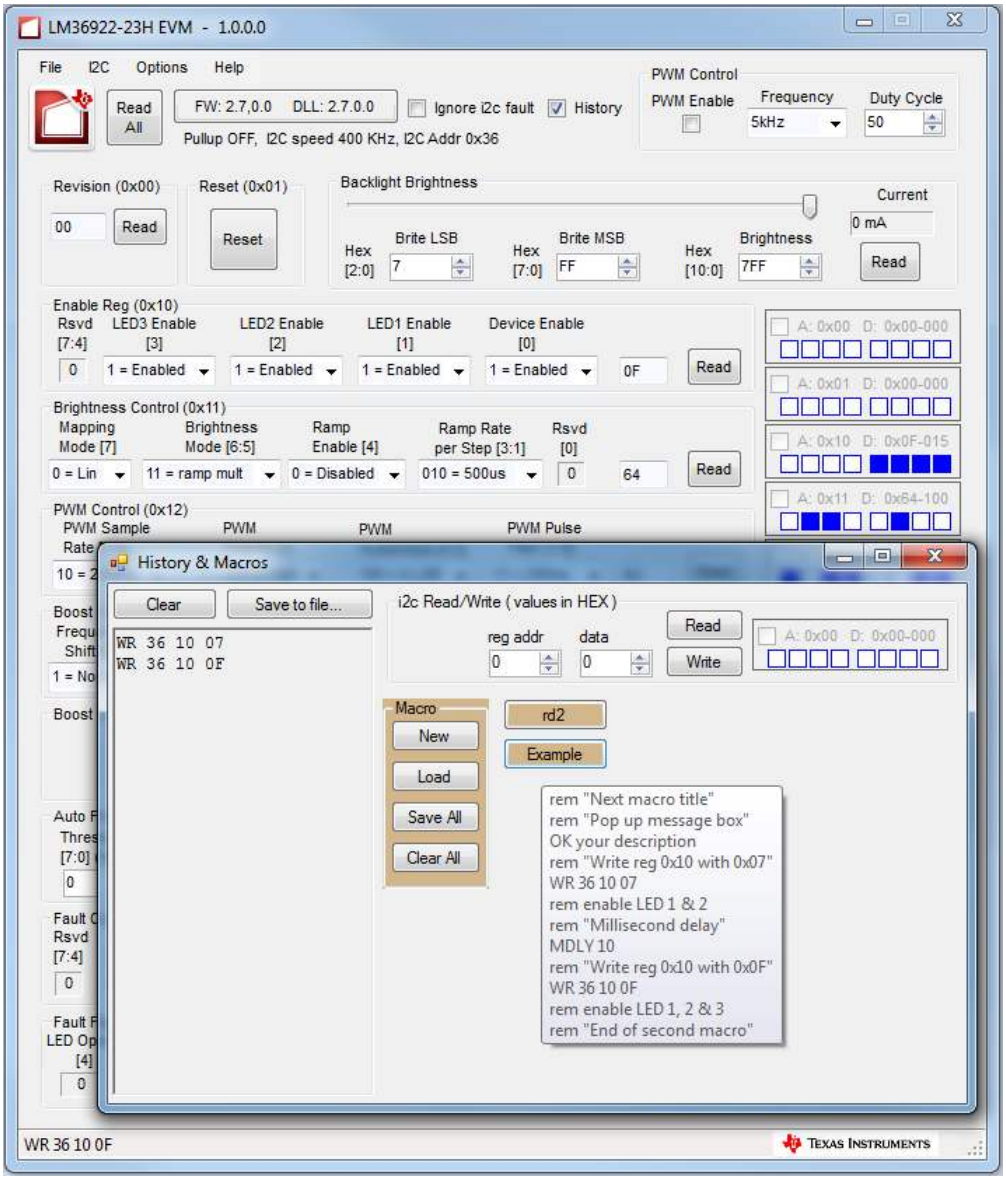

Figure 20. Example macro loaded (tool tip enabled)

Copyright © 2016, Texas Instruments Incorporated

The message box opens when the "OK" keyword is executed in the Example macro. Macro execution is halted until the message box is closed by clicking the "OK" button.

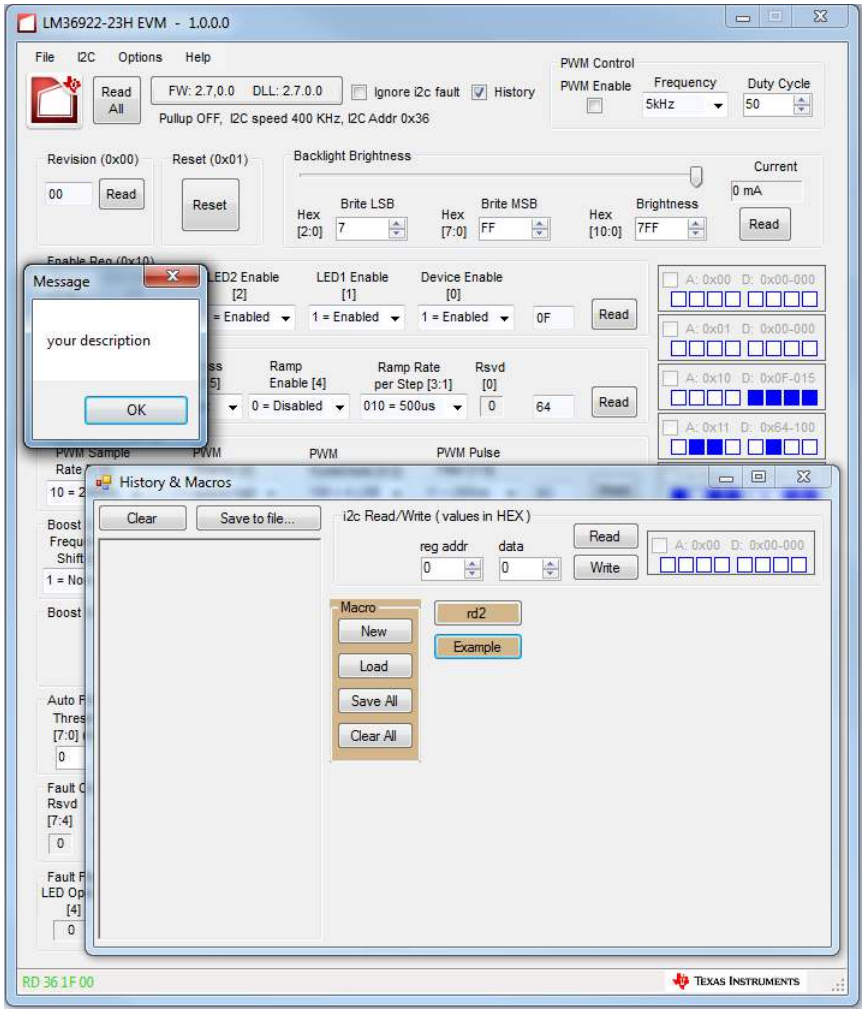

Figure 21. Example macro message box

Copyright © 2016, Texas Instruments Incorporated

5.9 Updating USB2ANY Firmware

When the LM36923HEVM GUI is launched the USB2ANY firmware is checked to verify that it contains the correct version. If the USB2ANY firmware version does not match the user will be prompted to update the USB2ANY firmware.

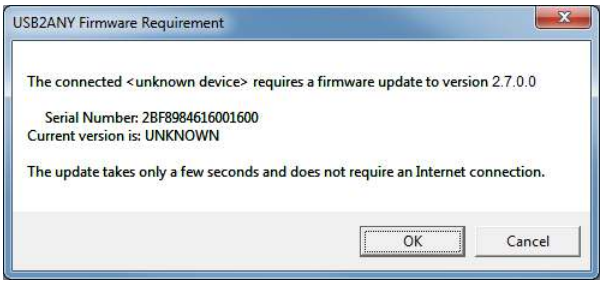

Figure 22. USB2ANY firmware unknown update

If power is applied to the LM36923HEVM it must be turned off before proceeding with the USB2ANY Firmware Loader instructions as noted in Figure 23.

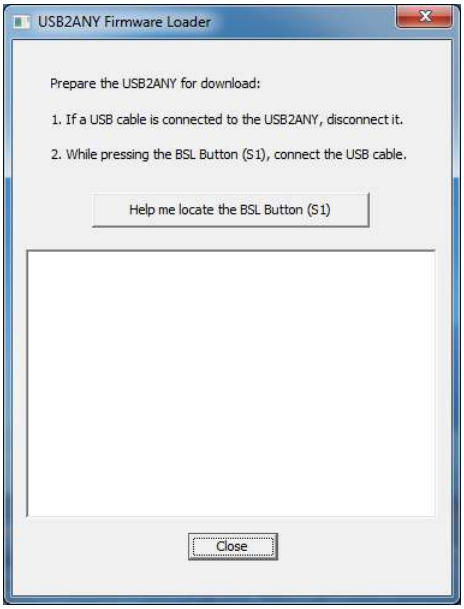

Figure 23. USB2ANY firmware update step 1

When the USB2ANY is ready for firmware update the USB2ANY Firmware Loader utility will be updated as shown below. The user must click the "Update Firmware" button to proceed.

Copyright © 2016, Texas Instruments Incorporated

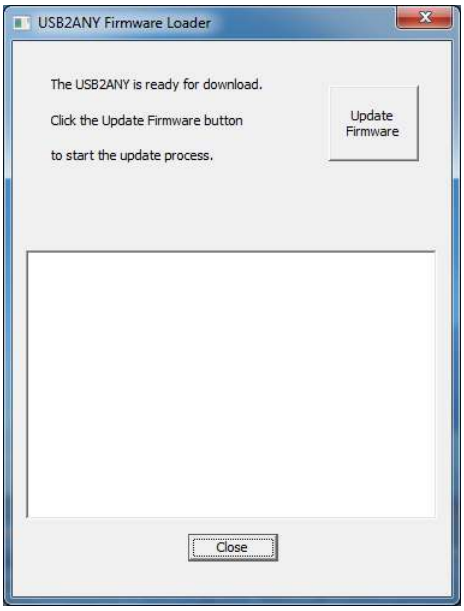

Figure 24. USB2ANY firmware update step 2

After the USB2ANY firmware is successfully updated the user must click the "Close" button to close the USB2ANY Firmware Loader and return control to the LM36923HEVM GUI.

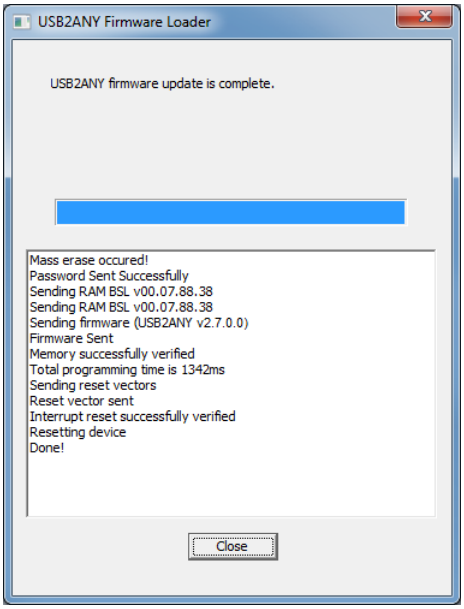

Figure 25. USB2ANY firmware update complete

Copyright © 2016, Texas Instruments Incorporated

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/lsds/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/lsds/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.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。 技術適合証明を受けていないもののご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。 日本テキサス・インスツルメンツ株式会社

東京都新宿区西新宿６丁目２４番１号

西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

6. *Disclaimers:*

   6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY WRITTEN DESIGN MATERIALS PROVIDED WITH THE EVM (AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

   6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS AND CONDITIONS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT MADE, CONCEIVED OR ACQUIRED PRIOR TO OR AFTER DELIVERY OF THE EVM.

7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS AND CONDITIONS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.

8. *Limitations on Damages and Liability:*

   8.1 *General Limitations*. IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS ANDCONDITIONS OR THE USE OF THE EVMS PROVIDED HEREUNDER, REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN ONE YEAR AFTER THE RELATED CAUSE OF ACTION HAS OCCURRED.

   8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY WARRANTY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS AND CONDITIONS, OR ANY USE OF ANY TI EVM PROVIDED HEREUNDER, EXCEED THE TOTAL AMOUNT PAID TO TI FOR THE PARTICULAR UNITS SOLD UNDER THESE TERMS AND CONDITIONS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM AGAINST THE PARTICULAR UNITS SOLD TO USER UNDER THESE TERMS AND CONDITIONS SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy*. Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2015, Texas Instruments Incorporated

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to TI’s terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI’s terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers’ products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers’ products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products		**Applications**	
Audio	www.ti.com/audio	Automotive and Transportation	www.ti.com/automotive
Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy
Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Applications Processors	www.ti.com/omap	**TI E2E Community**	e2e.ti.com
Wireless Connectivity	www.ti.com/wirelessconnectivity		

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2016, Texas Instruments Incorporated