Using the LM36923EVM Evaluation Module

User's Guide

Literature Number: SNVU459
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LM36923EVM User's Guide

1 Introduction

The Texas Instruments LM36923EVM evaluation module (EVM) helps designers evaluate the operation and performance of the LM36923 Highly Efficient Triple-String White LED driver. The device offers configurability via I²C-compatible interface. The module can be easily configured to support 1, 2 or 3 parallel LED strings with 2, 3, 4, 5, 6, 7 or 8 series LEDs.

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

Table 1. Device and Package Configurations

LED DRIVER	IC	PACKAGE
U1	LM36923	0.4 mm-pitch, 12-Bump DSBGA

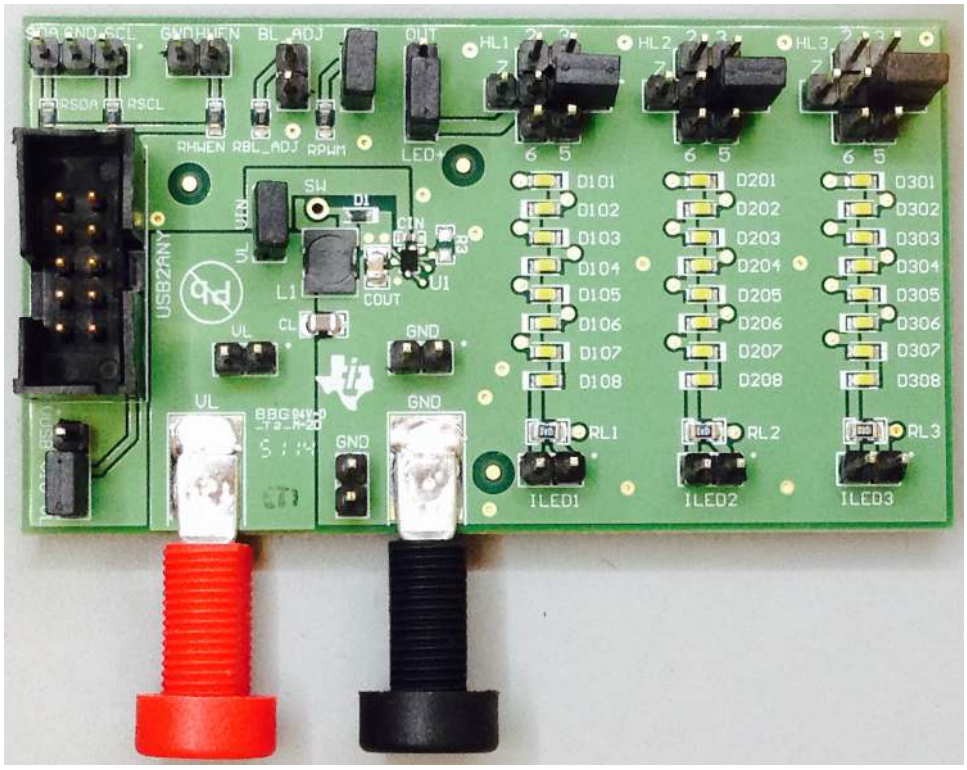

Figure 1. LM36923EVM Photo

2 Setup

This section describes the jumpers and connectors on the EVM as well as how to properly connect, set up, and use the LM36923EVM.

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 I^2C 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 I^2C interface may not be possible if the supply voltage to the LED driver is below approximately 3 V.

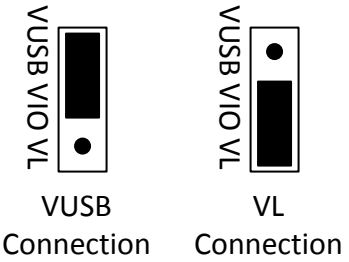

Figure 2. VIO Jumper Settings

SDA SCL - These connections allow the user to externally control the I^2C lines. For independent control of the I^2C 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).

BL_ADJ - This pin provides a method for connecting either the USB2ANY or an external signal to the BL_ADJ input. The BL_ADJ pin is connected to ground via a 4.7-kΩ resistor (RBL_ADJ). The LM36923EVM GUI provides a method for controlling BL_ADJ when a jumper is inserted between connector pins 1 and 2. When connecting an external signal remove the jumper between pins 1 and 2 and connect the signal generator to pin 1 and GND.

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 LM36923EVM 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.

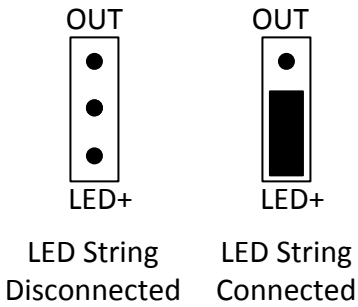

Figure 3. OUT Jumper Settings

HL1, HL2, HL3 - This connector provides a star connection to the LED string allowing the user to configure the LED string for 2, 3, 4, 5, 6, 7 or 8 series LEDs.

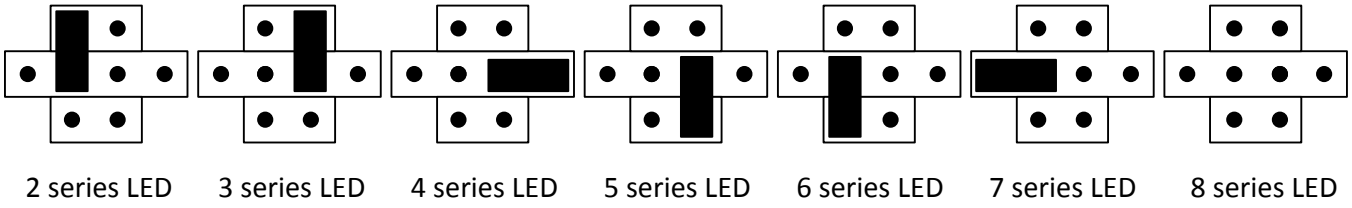

Figure 4. HL1, HL2, HL3 star jumper configuration settings

ILED1, ILED2, ILED3 -The LM36923EVM 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 LM36923 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 LM36923EVM, the jumpers should be properly configured. The recommended setting, using shorting blocks is:

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

In this configuration, the device will power up when power is applied.

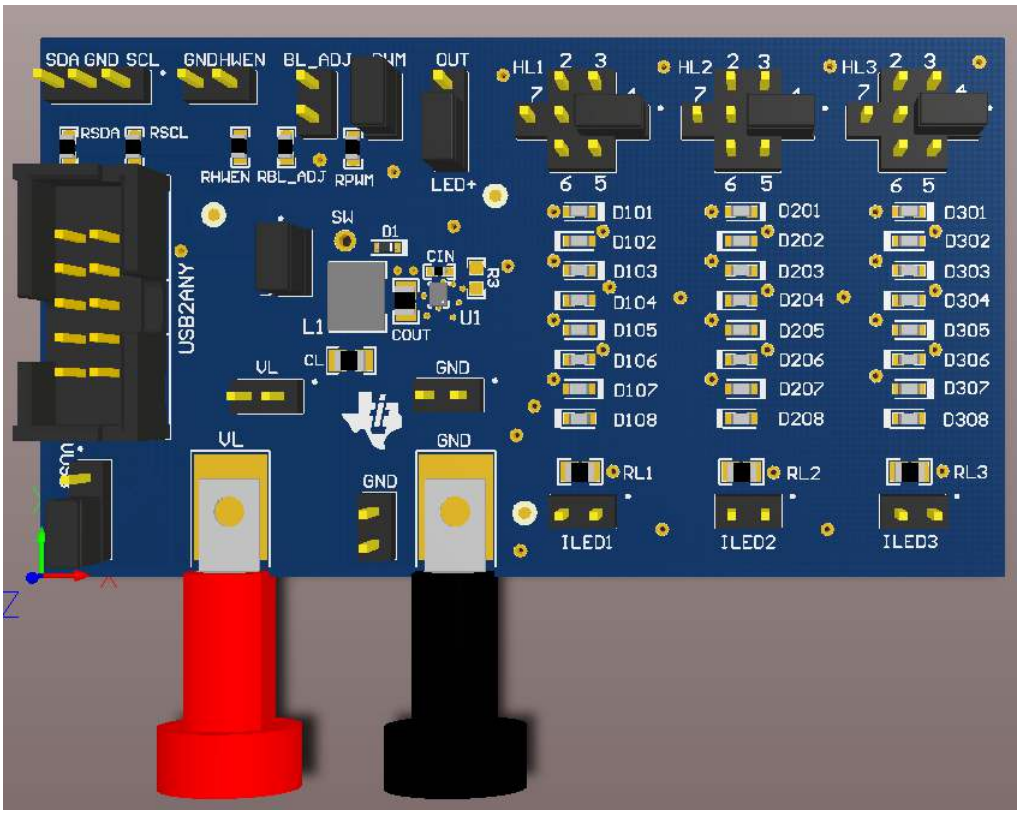

Figure 5. Jumper Configuration

3 Board Layout

Figure 6, Figure 7, Figure 8 and Figure 9 show the board layout for the LM36923EVM. The EVM offers resistors, capacitors, and jumpers to enable the device and to configure it as desired.

The LM36923 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.

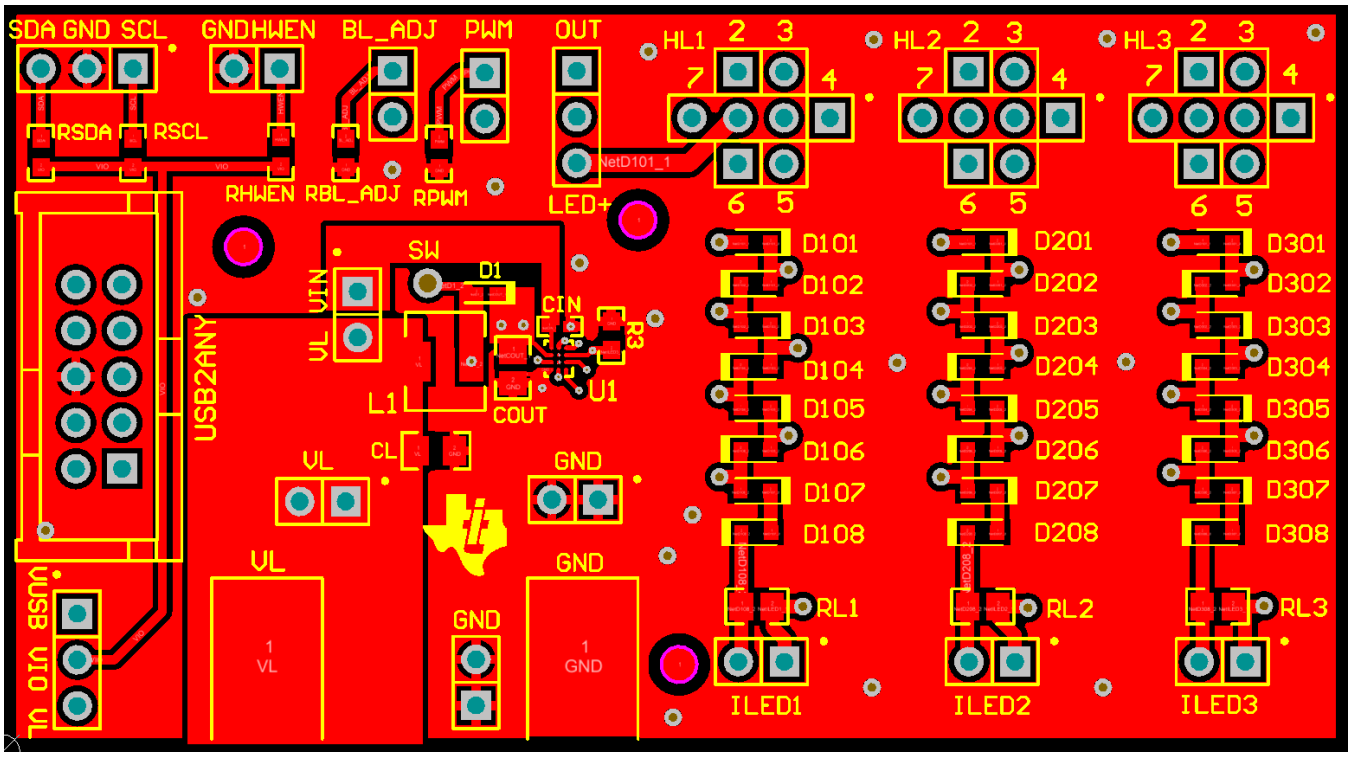

Figure 6. Top Assembly Layer

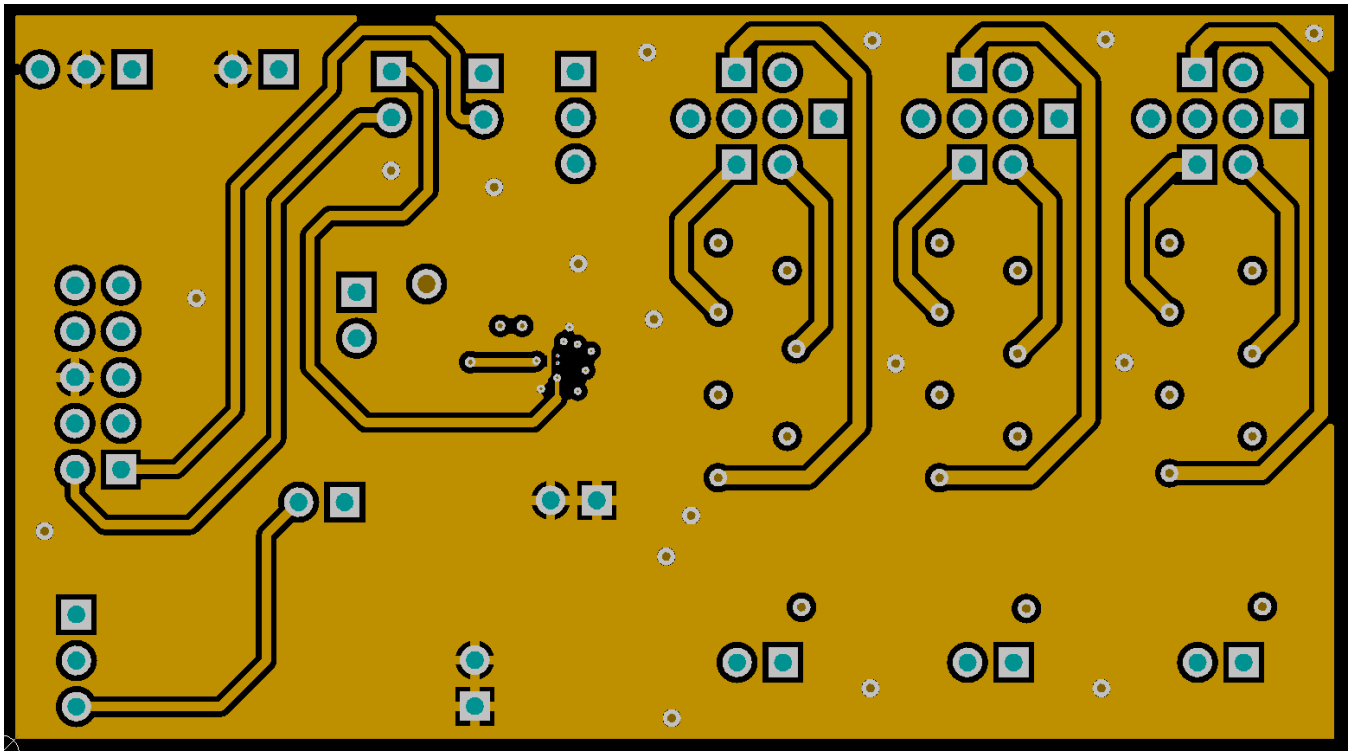

Figure 7. Middle Layer 1 Routing

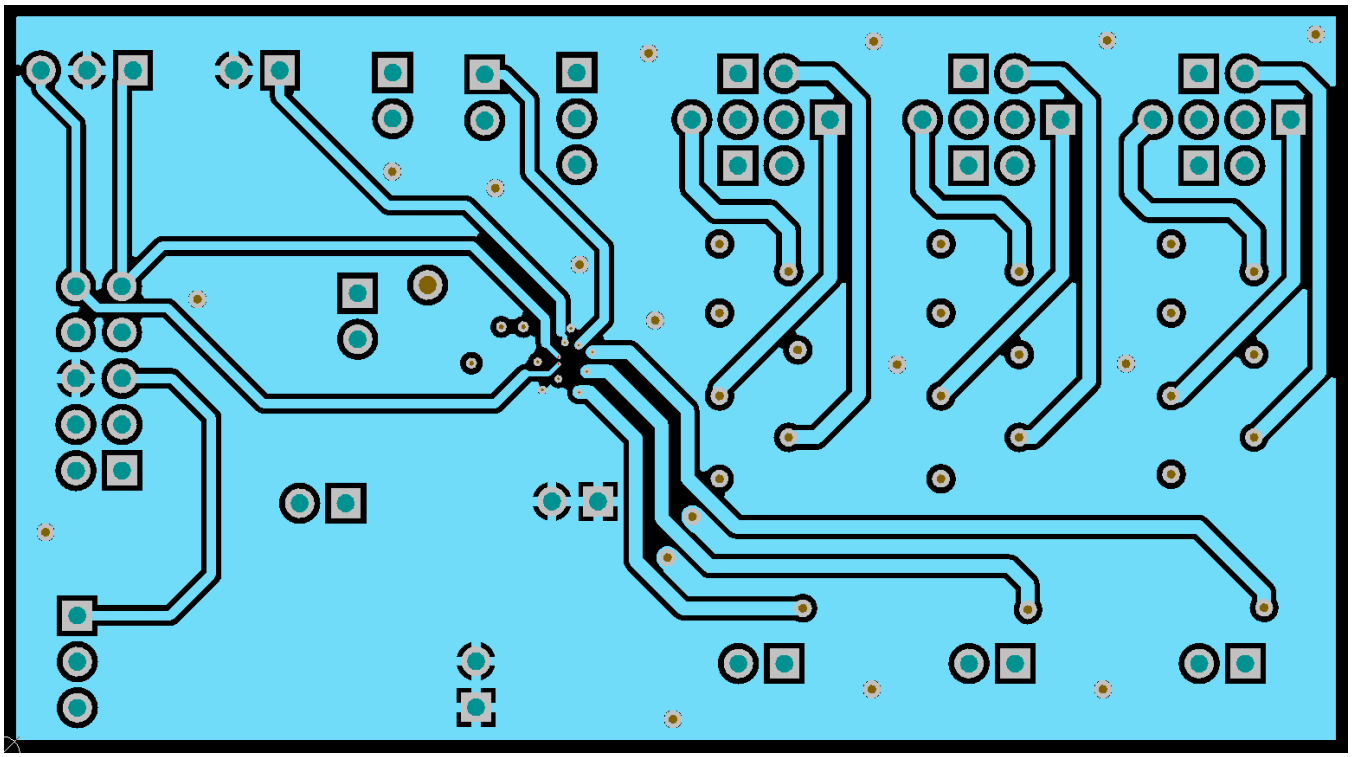

Figure 8. Middle Layer 2 Routing

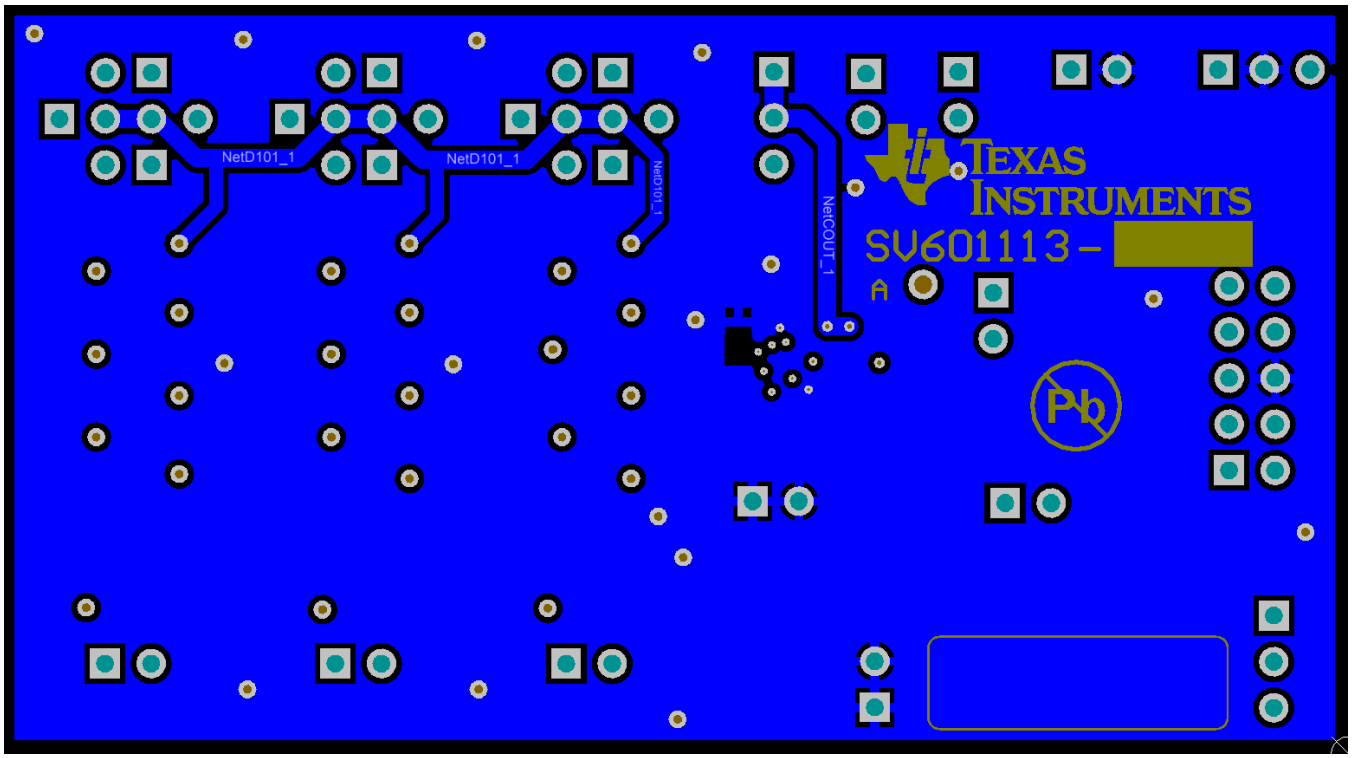

Figure 9. Bottom Assembly Layer (MIRRORED)

4 Schematic

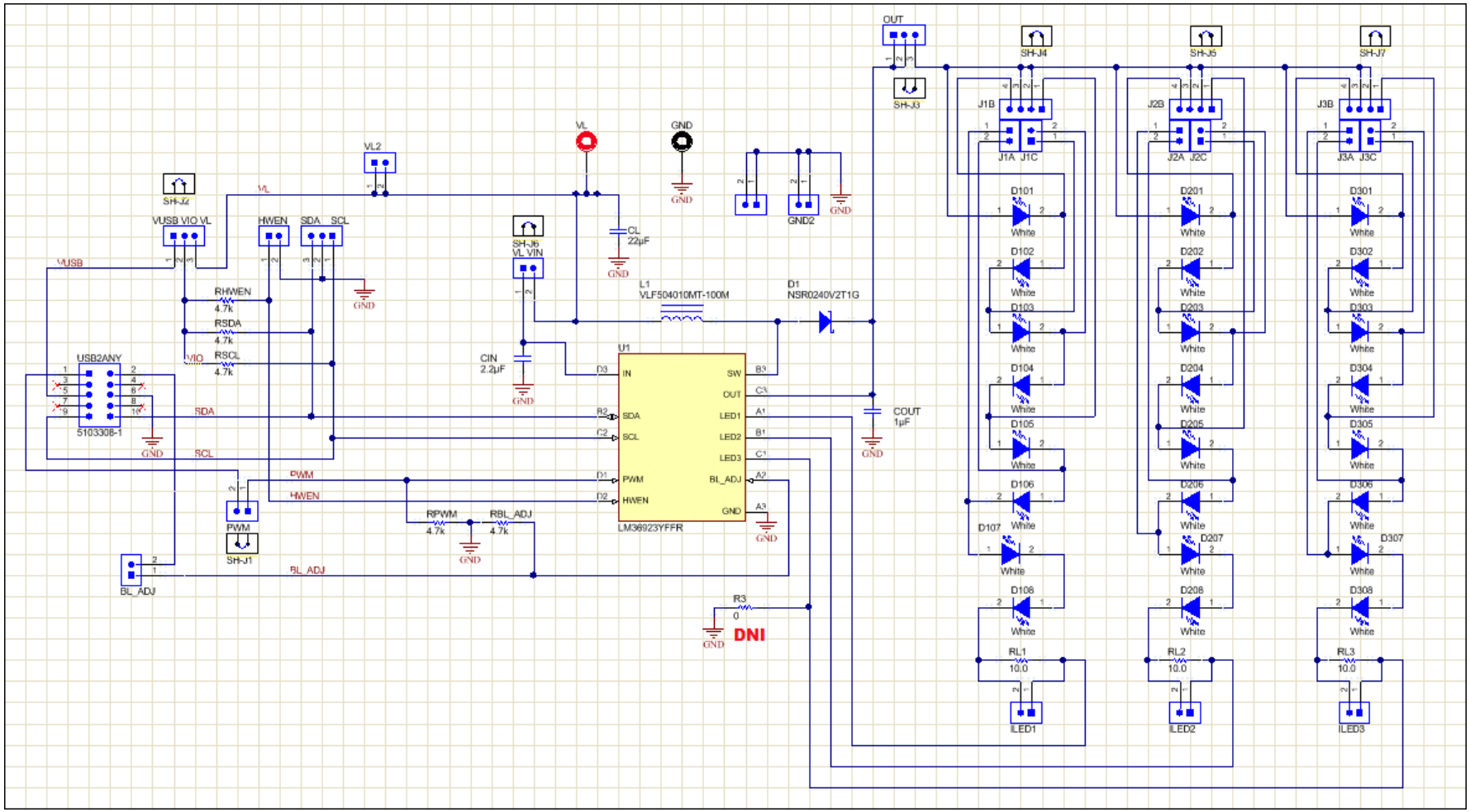

Figure 10. LM36923EVM Schematic

Table 2. Bill of Materials

DESIGNATOR	DESCRIPTION	MANUFACTURER	PART NUMBER	QTY
!PCB	Printed Circuit Board	Any	SV601113	1
BL_ADJ, GND2, GND3, HWEN, ILED1, ILED2, ILED3, J1A, J1C, J2A, J2C, J3A, J3C, PWM, VL2, VL VIN	Header, TH, 100mil, 2x1, Gold plated, 230 mil above insulator	Samtec	TSW-102-07-G-S	16
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, D107, D108, D201, D202, D203, D204, D205, D206, D207, D208, D301, D302, D303, D304, D305, D306, D307, D308	LED, White, SMD	Rohm	SML312WBCW1	24
GND	Standard Banana Jack, Insulated, Black	Keystone	6092	1
J1B, J2B, J3B	Header, TH, 100mil, 4x1, Gold plated, 230 mil above insulator	Samtec	TSW-104-07-G-S	3
L1	Inductor, Shielded, Ferrite, 10uH, 1A, 0.21 ohm, SMD	TDK	VLF504010MT-100M	1
OUT, SDA SCL, VUSB VIO VL	Header, TH, 100mil, 3x1, Gold plated, 230 mil above insulator	Samtec	TSW-103-07-G-S	3
RBL_ADJ, RHWEN, RPWM, RSCL, RSDA	RES, 4.7k ohm, 5%, 0.1W, 0603	Vishay-Dale	CRCW06034K70JNEA	5
RL1, RL2, RL3	RES, 10.0 ohm, 1%, 0.125W, 0805	Vishay-Dale	CRCW080510R0FKEA	3
R3	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	Shunt, 100mil, Flash Gold, Black	Sullins Connector Solutions	SPC02SYAN	7
U1	Highly Efficient Triple-String White LED Driver, YFF0012AHAH	Texas Instruments	LM36923YFFR	1
USB2ANY	Header (shrouded), 100mil, 5x2, Gold, TH	TE Connectivity	5103308-1	1
VL	Standard Banana Jack, Insulated, Red	Keystone	6091	1

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 LM36923EVM 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 LM36923 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. The image below shows the default settings.

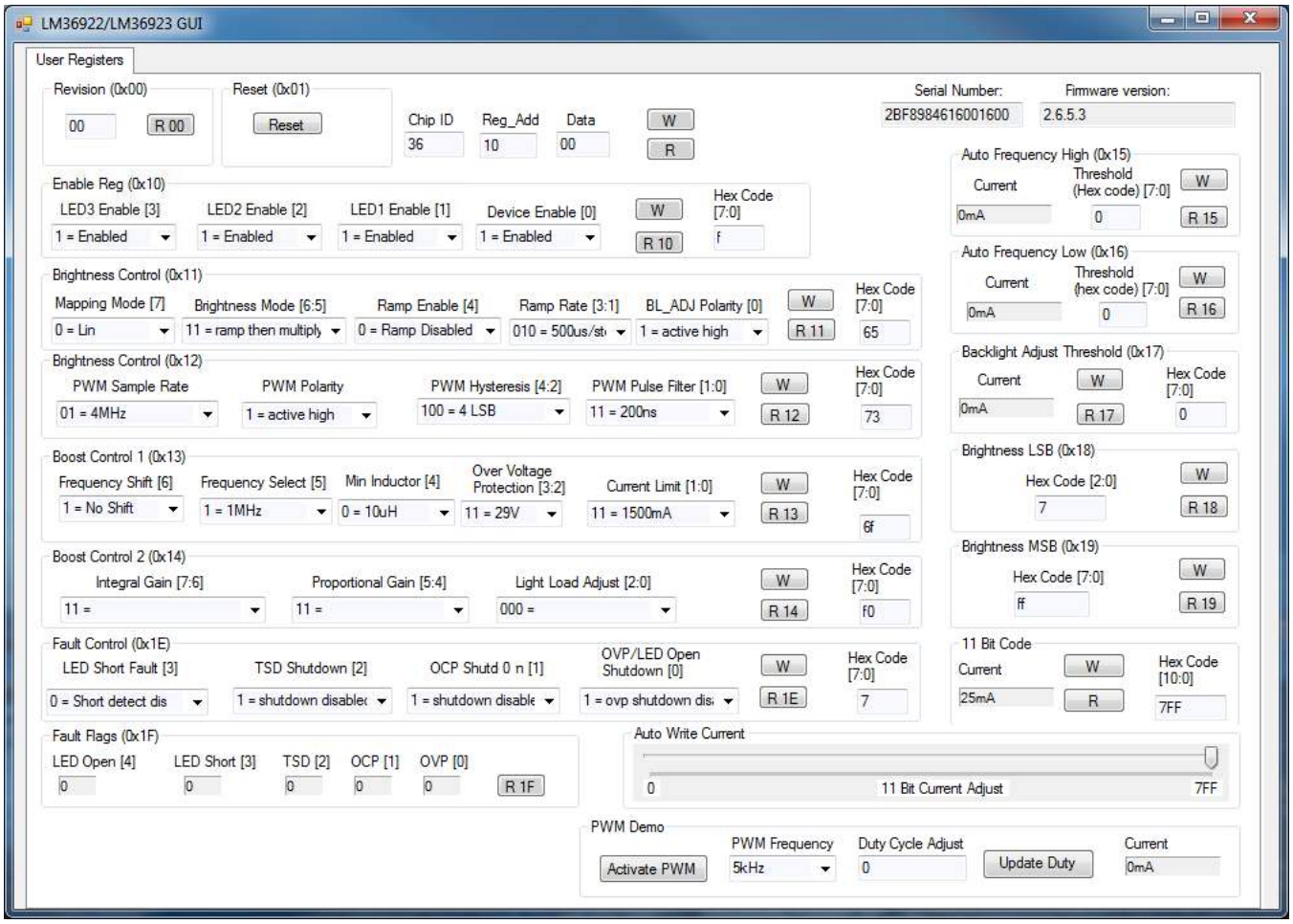

Figure 11. LM36923 General User Interface

The “I²C Interface” fields may be used to write or read any LM36923 register. Selecting the "Reset" button resets all registers to their default values and updates all GUI fields.

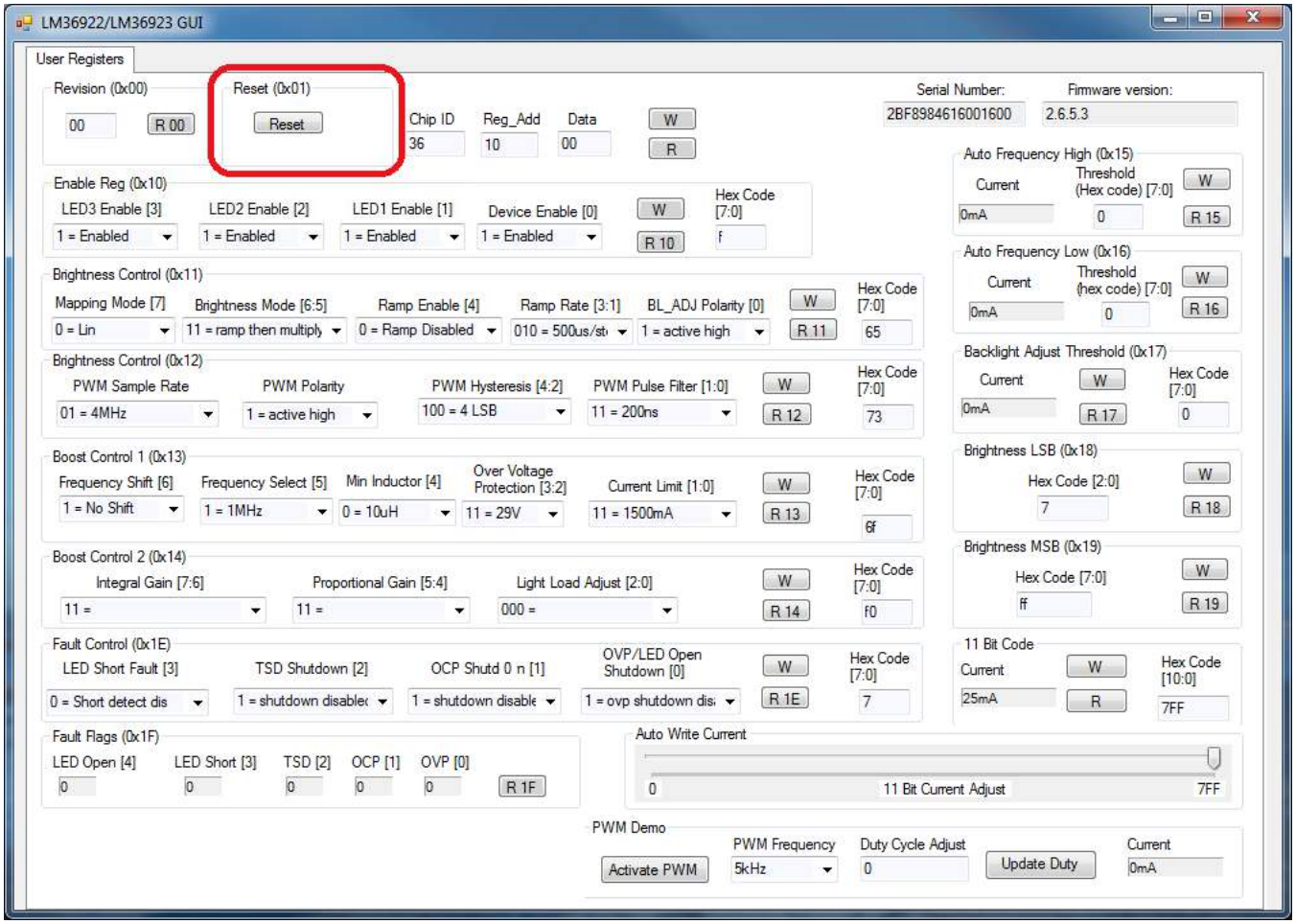

Figure 12. I²C interface Fields

5.1 User Interface

the LM36923 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 LM36923 to perform in the desired mode. Please note that no data is written to the device until the Write button found within the corresponding register is pressed, the one exception to this is the Auto Write Content slider.

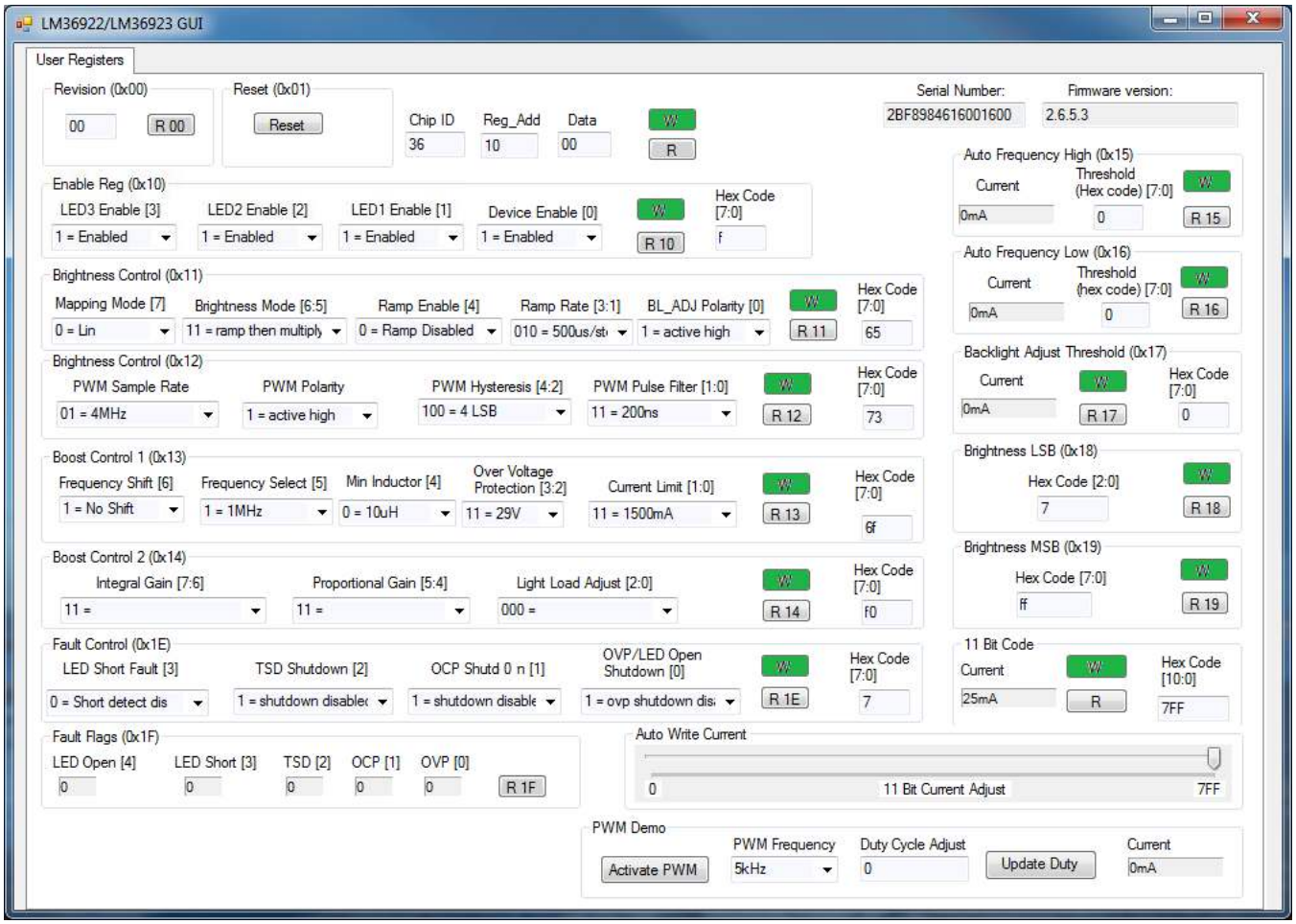

Figure 13. Write Buttons

5.2 Flags

The contents of the LM36923 fault registers are read upon clicking the “R 1F” button. The registers are cleared upon read back.

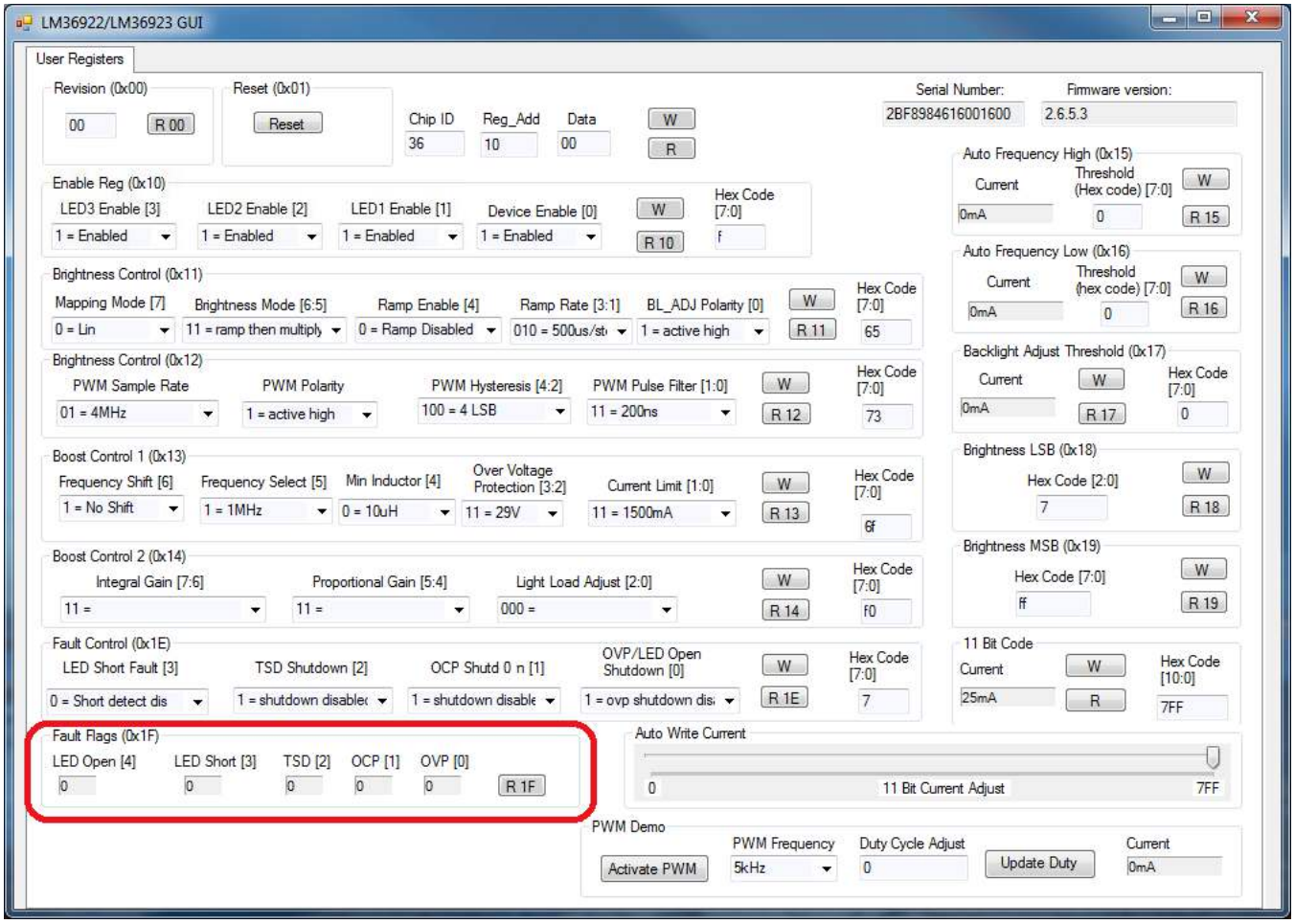

Figure 14. Fault Flags

5.3 I/O Pin Controls

The LM36923EVM 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 "Activate PWM" button is clicked or whenever the "Duty Cycle Adjust" value is set to 0. In order to change the PWM duty cycle the user needs to type the desired duty cycle in the "Duty Cycle Adjust" box then click the "Update Duty" button.

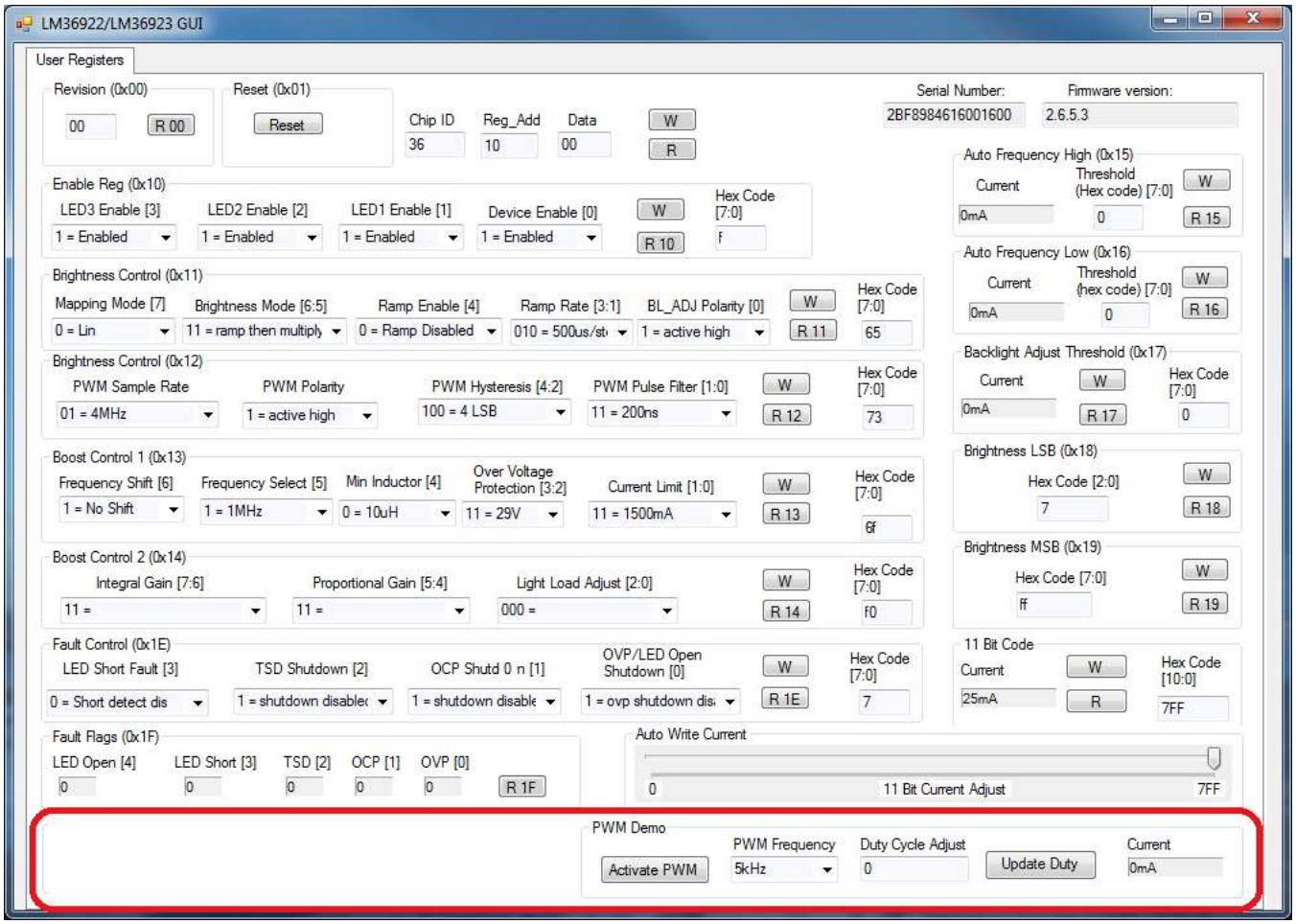

Figure 15. PWM Input Pin Control

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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.

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   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.

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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.

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