## Using the LM36923HEVM Evaluation Module

# **User's Guide**



Literature Number: SNVU509 January 2016



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## 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 I<sup>2</sup>C-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

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## Setup

## 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 I<sup>2</sup>C 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<sup>2</sup>C interface may not be possible if the supply voltage to the LED driver is below approximately 3 V.



**SDA SCL** - These connections allow the user to externally control the I<sup>2</sup>C lines. For independent control of the I<sup>2</sup>C 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 I<sup>2</sup>C 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-k $\Omega$  resistor (RA1). When a jumper is inserted between pins 2 and 3 ASEL is connected to GND through a 4.7-k $\Omega$  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  $4.7 \cdot k\Omega$  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.

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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.





**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  $\Omega$ ) 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.

Setup





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.





Figure 7. Top Assembly Layer



Figure 8. Middle Layer 1 Routing

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Board Layout

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Figure 9. Middle Layer 2 Routing



Figure 10. Bottom Assembly Layer (MIRRORED)



Schematic

## 4 Schematic



Figure 11. LM36923EVM Schematic

## 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 $\mu$ H, 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



## 5 USB Interface Board and I<sup>2</sup>C-Compatible Interface Program

Texas Instruments has created an I<sup>2</sup>C-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 I<sup>2</sup>C-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.

Read FW:	2.7,0.0 DLL: 2.7	.0.0 📄 📄 Ignore	i2c fault 📄 History x36	PWM Enable	Frequency     Duty Cycle       5kHz     50
Revision (0x00) Re	set (0x01)	lacklight Brightness	1		Current
00 Read	Reset	Hex 2:0] 7	Hex [7:0] Brite MSE	8 Hex E	rightness FF 🔄 Read
Enable Reg (0x10) Rsvd LED3 Enable [7:4] [3]	LED2 Enable [2]	LED1 Enable [1]	Device Enable [0]		A: 0x00 D: 0x00-000
0 1 = Enabled -	1 = Enabled 👻	1 = Enabled 👻	1 = Enabled 👻	0F Read	A 0x01 D 0x00-000
Brightness Control (0x11 Mapping Brigh Mode [7] Mode	) tness Ramp [6:5] Enab	o Ramp le [4] per Si	Rate Rsvd ep [3:1] [0]		A: 0x10 D: 0x0F-015
0 = Lin 👻 11 = ramp r	mult 👻 0 = Disa	bled 👻 010 = 5	00us 👻 0	64 Read	
PWM Control (0x12) PWM Sample Rate [7:6]	PWM Polarity [5]	PWM Hysteresis [4:2]	PWM Pulse Filter [1:0]		A: 0x11 D: 0x64-100
10 = 24MHz 👻 1 =	active high 👻	100 = 4 LSB 👻	11 = 200ns 👻	B3 Read	
Boost Control 1 (0x13) Frequency Frequen Shift [6] Select [	icy Minimum 5] Inductor [4	Over Voltage 4] Protection [3:2	Current Limit [1:0]		A: 0x13 D: 0x6F-111
1 = None 👻 1 = 1MHz	▼ 0 = 4.7uH	✓ 11 = 38V ✓	11 = 1500mA 👻	6F Read	A: 0x14 D: 0x50-080
Boost Control 2 (0x14) Inte Gair	gral Proporti 1 [7:6] Gain [5:	onal Rsvd 4] [3]	Light Load Adjust [2:0]		A: 0x15 D: 0x00-000
01	▼ 01	▼ 0 ▼	000 🗸	50 Read	A: 0x16 D: 0x00-000
Auto Frequency High (0) Threshold [7:0] (Hex) Curren	:15) t	Au Th [7	to Frequency Low (0) reshold 0] (Hex) Curre	:16) nt	A: 0x18 D: 0x07-007
0 🔔 OmA	Read	0	0mA	Read	
Fault Control (0x1E) Rsvd LED Short [7:4] Fault Detect [3]	TSD Shutdown [2]	OCP Shutdown [1]	OVP Open Shutdown [0]		A 0x19 D. 0xPF-255
0 0 = Disabled -	1 = Disabled $\bullet$	1 = Disabled 👻	1 = Disabled 👻	07 Read	
Fault Flags (0x1F) LED Open LED Short TSI [4] [3] [2	D OCP OVP ] [1] [0]				A: 0x1F D: 0x00-000

Figure 12. LM36923H General User Interface



## 5.2 LM36923H Software Reset

Selecting the "Reset" button sends the I<sup>2</sup>C Software Reset command which sets all registers to their default values and updates all GUI fields.

ile I2C Optio	ns Help			DW/U Control	
		<u></u>		PWM Control PWM Enable Frequence	cy Duty Cycle
All	FW: 2.7,0.0		e i2c fault 🔄 History	5kHz	▼ 50
	Pullup OFF, 12C	speed 400 KHZ, I2C Addr	JX36		
Revision (0x00)	Reset (0x01)	Backlight Brightnes	s	-	Current
00 Read				U	0 mA
	Reset	Hex Brite LSB	Hex Brite MSB	Hex Brightness	Bead
		[2:0]	[7:0] [FF	[10:0] /FF	Read
Enable Reg (0x10	) ble LED2E	able ( ED1 Enable	Device Enable		
[7:4] [3]	[2]	[1]	[0]		
0 1 = Enable	ed 👻 1 = Enat	iled 👻 1 = Enabled 👻	1 = Enabled 👻 OF	Read	0x01 D 0x00-000
Brightness Contro	l (0x11)				
Mapping Mode [7]	Brightness Mode [6:5]	Ramp Ran Enable [4] per 1	pRate Rsvd Step [3:1] [0]	A: (	0x10 D: 0x0F-015
0 = Lin 👻 11 =	ramp mult 👻	0 = Disabled - 010 =	500us 🗸 0 64	Read	
PWM Control (0x1	2)		Contraction of the second second		0x11 D: 0x64-100
PWM Sample	PWM Polarity (5	PWM	PWM Pulse		
10 = 24MHz +	1 = active hig	h + 100 = 4 LSB +	11 = 200ns ¥ B	Read A	0x12 D: 0x83-179
Boost Control 1 (C	-				249 D- 0-CE 111
Frequency F	requency N	linimum Over Voltage	Current		
Shift [6]	Select [5] Ir 1MH 7 - 0 =	iductor [4] Protection [3:	2] Limit [1:0] 11 = 1500mA - 6F	Read	0x14 D: 0x50-080
Boost Control 2 (C	Integral	Proportional Rsvd	Light Load		0x15 D: 0x00-000
	Gain [7:6]	Gain [5:4] [3]	Adjust [2:0]		
	01 -	• • •	000 <del>-</del> 50		0x16 D: 0x00-000
Auto Frequency H	ligh (0x15)	A	uto Frequency Low (0x16 hreshold		
[7:0] (Hex)	Current	[	(Hex) Current		X18 D. 0X07-007
0 🔶 On	nA	Read	0 🔶 OmA	Read	x19 D: 0xFF-255
Fault Control (0x1	E)	tdown OCD Shutdown	OV/R Occas		
[7:4] Fault Dete	ect [3] [2]	[1]	Shutdown [0]		0x1E D: 0x07-007
0 0 = Disabl	ed 👻 1 = Disa	bled $\checkmark$ 1 = Disabled $\checkmark$	1 = Disabled - 07	Read	
-	(			A.	0x1F D: 0x00-000
Fault Flags (0x1F)	ort TSD OCP	OVP			
LED Open LED Shi	[2] [1]	[0]			
LED Open LED Shi [4] [3]	[2] [1] 0 0	[0] 0 00 Read	1		

Figure 13. LM36923H Software Reset



## 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.

LM36922-23H EVM - 1.0.0.0	
ile I2C Options Help PWM Control	
Read FW: 2.7,0.0 DLL: 2.7.0.0 🔄 Ignore i2c fault 🔄 History PWM Enable	Frequency Duty Cycle
All Pullup OFF, 12C speed 400 KHz, 12C Addr 0x36	5kHz - 50 -
Revision (0x00) Reset (0x01) Backlight Brightness	
Reset Hex Brite LSB Brite MSB Hex Brite MSB Hex	rightness
[2:0] 7 🚖 [7:0] FF 🛬 [10:0] 7	FF 🚔 Read
Enable Reg (0x10) David JED2 Enable JED2 Enable JED1 Enable Davids Enable	
[7:4] [3] [2] [1] [0]	
0 1 = Enabled • 1 = Enabled • 1 = Enabled • 0F Read	A: 0x01 D: 0x00-000
Brightness Control (0x11)	
Mapping Brightness Ramp Ramp Rate Rsvd Mode [7] Mode [6:5] Enable [4] per Step [3:1] [0]	A: 0x10 D: 0x0F-015
0 = Lin • 11 = ramp mult • 0 = Disabled • 010 = 500us • 0 64 Read	
PWM Control (0x12)	A: 0x11 D: 0x64-100
PWM Sample PWM PWM PWM Pulse Rate [7:6] Polarity [5] Hysteresis [4:2] Filter [1:0]	
10 = 24MHz • 1 = active high • 100 = 4 LSB • 11 = 200ns • B3 Read	A DOCT 2 D: DOCB3-179
Boost Control 1 (0x13)	A: 0x13 D: 0x6F-111
Frequency Frequency Minimum Over Voltage Current Shift [6] Select [5] Inductor [4] Protection [3:2] Limit [1:0]	
1 = None    1 = 1MHz    0 = 4.7uH    11 = 38V    11 = 1500mA    6F    Read	A: 0x14 D: 0x50-080
Boost Control 2 (0x14)	
Integral Proportional Rsvd Light Load Gain [7:6] Gain [5:4] [3] Adjust [2:0]	
01 - 01 - 0 - 000 - 50 Read	A: 0x16 D: 0x00-000
Auto Frequency High (0x15) Auto Frequency Low (0x16)	
Threshold Threshold [7:0] (Hex) Current [7:0] (Hex) Current	A: 0x18 D: 0x07-007
0 - OmA Read 0 - OmA Read	
Fault Control (0x1E)	A: 0x19 D: 0xFF-255
Rsvd         LED Short         TSD Shutdown         OCP Shutdown         OVP Open           [7:4]         Fault Detect [3]         [2]         [1]         Shutdown [0]	A 0x1E D 0x07-007
0 0 = Disabled - 1 = Disabled - 1 = Disabled - 07 Read	
Fault Flags (0x1F)	A: 0x1F D: 0x00-000
LED Open LED Short TSD OCP OVP	
0 0 0 0 0 0 Read	
361F00	💠 TEXAS INSTRUMENTS

Figure 14. Fault Flags



## 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.

LM36922-23H EVM - 1.0.0.0	
File       I2C       Options       Help         Image: State of the state of	Frequency Duty Cycle kHz V 50
Revision (0x00) Reset (0x01) Backlight Brightness	Current
00         Read         Reset         Brite LSB         Brite MSB         Brite MSB         Hex         Brite LSB         Image: Comparison of the mail of the mai	ghtness 0 mA
Enable Reg (0x10) Rsvd LED3 Enable LED2 Enable LED1 Enable Device Enable [7:4] [3] [2] [1] [0] 0 1 = Enabled = 1 = Enabled = 1 = Enabled = 0 E Read	A: 0x00 D: 0x00-000
Brightness Control (0x11) Mapping Brightness Ramp Ramp Rate Rsvd Mode [7] Mode [6:5] Enable [4] per Step [3:1] [0]	A: 0x01 D: 0x00-000
0 = Lin 🗸 11 = ramp mult 🗸 0 = Disabled 🖌 010 = 500us 👻 0 64 Read	
PWM Control (0x12) PWM Sample PWM PWM PWM Pulse Rate [7:6] Polarity [5] Hysteresis [4:2] Filter [1:0]	A 0x12 D: 0x64-100
10 = 24MHz    1 = active high    100 = 4 LSB    11 = 200ns    B3    Read	
Boost Control 1 (0x13) Frequency Frequency Minimum Over Voltage Current Shift [6] Select [5] Inductor [4] Protection [3:2] Limit [1:0]	A: 0x13 D: 0x6F-111
1 = None   1 = 1MHz   0 = 4.7uH   11 = 38V   11 = 1500mA   6F   Read	A: 0x14 D: 0x50-080
Boost Control 2 (0x14) Integral Proportional Rsvd Light Load Gain [7:6] Gain [5:4] [3] Adjust [2:0]	A: 0x15 D: 0x00-000
01 - 01 - 000 - 50 Read	A: 0x16 D: 0x00-000
Auto Frequency High (0x15) Threshold Threshold Triol (Hex) Current Triol (Hex) Current Triol (Triol (Hex) Current Triol (Triol (Hex) Current Triol (Triol (Hex) Current Curren	A: 0x18 D: 0x07-007
	A: 0x19 D: 0xFF-255
Fault Control (0x1E)           Rsvd         LED Short         TSD Shutdown         OCP Shutdown         OVP Open           [7:4]         Fault Detect [3]         [2]         [1]         Shutdown [0]	A: 0x1E D: 0x07-007
0 0 = Disabled • 1 = Disabled • 1 = Disabled • 07 Read	
Fault Flags (0x1F)         OCP         OVP           LED Open LED Short TSD         OCP         OVP           [4]         [3]         [2]         [1]         [0]           0         0         0         0         0         Read	A: 0x1F D: 0x00-000
RD 36 1F 00	V TEXAS INSTRUMENTS

Figure 15. PWM Input Pin Control



USB Interface Board and I<sup>e</sup>C-Compatible Interface Program

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## 5.5 ASEL Pin Control

The ASEL input to the LM36923HEVM is set via the GUI in the I<sup>2</sup>C options dialog. When unchecked ASEL will be low and the I<sup>2</sup>C slave address used by the GUI is set to 0x36. When checked ASEL will be high and the I<sup>2</sup>C 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.

LM36922-23H EVM - 1.0.0.0	
File     I2C     Options     Help       Pullup resistor     2.7.0.0     Ignore I2C fault     History       Speed at 400 KHz     ad 400 KHz, I2C Addr 0x36	WM Control WM Enable Frequency Duty Cycle SkHz 50 +
Rev Speed at 10 KHz Backlight Brightness 00  External 3.3V Enable Brite LSB Brite MSB	0 mA
Address Select External 5V Enable Enable Reg (0x10)	Hex [10:0] 7FF 🔄 Read
Rsvd         LED3 Enable         LED2 Enable         LED1 Enable         Device Enable           [7:4]         [3]         [2]         [1]         [0]           0         1 = Enabled         1 = Enabled         1 = Enabled         0F	Read A: 0x00 - D: 0x00-000
Brightness Control (0x11)         Ramp         Ramp Rate         Rsvd           Modping         Brightness         Ramp         Lable [4]         per Step [3:1]         [0]           0 = Lin         11 = ramp mult         0 = Disabled         010 = 500us         0         64	Read
PWM Control (0x12)         PWM         PWM Pulse           PVMM Sample         PWM         PWM Pulse           Rate [7:6]         Polarity [5]         Hysteresis [4:2]         Filter [1:0]           10 = 24MHz         1 = active high         100 = 4 LSB         11 = 200ns         B3	A: 0x11 D: 0x64-100
Boost Control 1 (0x13) Frequency Frequency Minimum Over Voltage Current Shift [6] Select [5] Inductor [4] Protection [3:2] Limit [1:0]	A: 0x13 D: 0x6F-111
1 = None         1 = 1MHZ         0 = 4.7uH         11 = 38V         11 = 1500mA         6F           Boost Control 2 (0x14)         Integral         Proportional         Rsvd         Light Load           Gain [7:6]         Gain [5:4]         [3]         Adjust [2:0]	
01         01         0         000         50           Auto Frequency High (0x15)         Auto Frequency Low (0x16)         Threshold           [7:0] (Hex)         Current         [7:0] (Hex)         Current           0         0         0         0	Read         A: 0x16         D: 0x00-000           A: 0x18         D: 0x07-007           A: 0x18         D: 0x07-007
Fault Control (0x1E)         TSD Shutdown         OCP Shutdown         OVP Open           [7:4]         Fault Detect [3]         [2]         [1]         Shutdown [0]	A: 0x19 D: 0x07-007
0       0 = Disabled        1 = Disabled        1 = Disabled        07         Fault Flags (0x1F)         LED Open LED Short TSD       OCP       OVP       0 <td< td=""><td>Read</td></td<>	Read
0 36 1 F 00	No. 10 Texas Instruments

Figure 16. ASEL Input Pin Control



## 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.

LM36922-23H EVM - 1.0.0.0	
ile I2C Options Help           Read         FW: 2.7,0.0         DLL:           All         Pullup OFF, I2C spee	2.7.0.0 Ignore I2c fault History PWM Control PWM Enable Frequency Duty Cycle SkHz V 50 +
Revision (0x00) Reset (0x01) 00 Read Reset	Backlight Brightness Current O mA Hex [2:0] FF T T T T T T T T T T T T T T T T T T
Enable Reg (0x10)     Rsvd     LED3 Enable     LED2 Enable       [7:4]     [3]     [2]       0     1 = Enabled     1 = Enabled       Brightness Control (0x11)       Mapping     Brightness     R       0 de [7]     Mode [6:5]     Ei       0 = Lin     11 = ramp mult     0 = C	LED1 Enable         Device Enable           [1]         [0]           • 1 = Enabled •         0F           amp         Ramp Rate           nable [4]         per Step [3:1]           [0]         64
PWM Control (0x12)         PWM           PWM Sample         PWM           Image: Save to file         RD 36 00 00           RD 36 01 00         RD 36 10 0F           RD 36 11 64         RD 36 12 B3           RD 36 13 6F         RD 36 14 50           RD 36 16 00         RD 36 16 00           RD 36 16 00         RD 36 16 00           RD 36 16 00         RD 36 16 00           RD 36 17 00         PF           RD 36 18 07         RD 36 19 FF           RD 36 19 00         PF	PWM       PWM Puise         i2c Read/Write (values in HEX)         reg addr       data         0       0         0       0         Macro         New         Load         Save All         Clear All
26.15.00	Tevas bastoi iusute

Figure 17. GUI History following Read All button clicked



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## 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.

File       EC       Options       Help         Image: Strategy of the stra	LM36922-23H EVM - 1.0.0.0	X = X
Read All       FW: 27.0.0       DLL: 27.0.0       Ignore iZ fault       History       PVM Enable       Frequency       Duty Cycle         Skifz       Subport       Backlight Brightness       Subport       Skifz       Subport         00       Read       Reset (0x01)       Backlight Brightness       Backlight Brightness       Current         00       Read       Reset (0x01)       Backlight Brightness       Current       0mA         00       Read       Reset (0x01)       Backlight Brightness       Current       0mA         00       Read       Reset (0x10)       Read       Brite LS8       Hex       Brite MS8       Hex       Brightness       Current         Read       LED2 Enable       LED1 Enable Device Enable       10       Action 0       Dox00-00       Action 0       Dox00-00         0       0       Disabled +       1 = Enabled +       1 = Enabled +       07       Read       Action 0       Dox00-00         Bightness Control (0x11)       Mapping       Brightness Control (0x11)       Mapping       PVM Action 0       Dox00-00       Action 0       Dox00-00         0       0       Disabled +       0       Disabled +       0       Disabled +       Disabled +       Disabled + </td <td>File I2C Options Help</td> <td>PWM Control</td>	File I2C Options Help	PWM Control
All       Pulup OFF, DC speed 400 KHz, DC Addr 0x36         Revision (0x00)       Reset (0x01)         Read       Reset (0x01)         Read       Backlight Brightness         U       PTF         Read       Reset (0x01)         Read       Explore the transmission of the transmission of transm	Read FW: 2.7,0.0 DLL: 2.7	0.0 Ignore i2c fault V History PWM Enable Frequency Duty Cycle
Revision (0x00)       Reset       Backlight Brightness       Current         00       Read       Reset       Hits       Brite LSB       Hex       Brite MSB       Hex       Brightness         Enable Reg (0x10)       Reset       LED2 Enable       LED1 Enable       Device Enable       A: 0x00       D: 0x00-000         [7:4]       [3]       [2]       [1]       [0]       A: 0x00       D: 0x00-000         [7:4]       [3]       [2]       [1]       [0]       A: 0x00       D: 0x00-000         [7:4]       [3]       [2]       [2]       [1]       [0]       A: 0x10       D: 0x00-000         [7:4]       [3]       [2]       [2]       [3]       [1]       [0]       A: 0x10       D: 0x00-000         [7:4]       [3]       [2]       Ramp Rate       Ravd       A: 0x10       D: 0x00-000         [7:4]       [3]       [2]       Enable[4]       Perspectad       Ravd       A: 0x10       D: 0x00-000         [7:4]       [3]       [2]       D: 100       500.5       [4]       64       D: 0x07-007         [3]       D: 100       Formation       [2]       Read       A: 0x10       D: 0x07-007         [4]	Pullup OFF, I2C speed 40	0 KHz, I2C Addr 0x36
00       Read       Rest       Hex       Brite LSB       Hex       Brite MSB       Hex       Brightness         Read       Read       III       IIII       IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	Revision (0x00) Reset (0x01) B	acklight Brightness
Rest       Hex       Brite LSB       Hex       Brite MSB       Hex       Brightness         Rade       [2:0]       7       ?       (7:0)       FF       (10:0)       7FF       Read         Enable Reg (0x10)       Ravd LED2 Enable       LED2 Enable       LED1 Enable       Device Enable       (0:0) <t< td=""><td>00 Read</td><td></td></t<>	00 Read	
Enable Reg (0x10)       ED2 Enable       LED2 Enable       LED1 Enable       Device Enable       (0)         [7]       0       D = Disabled $\checkmark$ 1 = Enabled $\checkmark$ 1 = Enabled $\checkmark$ 0 = Read         Brightness       Control (0x11)       Finabled $\checkmark$ 0 = Disabled $\checkmark$ 0 = Disabled $\checkmark$ 0 = Disabled $\checkmark$ 0 = Control (0x11)         PVML Control (0x12)       Finable       PVM       PVML PVML Pulse       A : 0x10       0 : 0x07-007         Bost       Image: Save to file       10 = Control (0x12)       PVML PVML Pulse       A : 0x10       0 : 0x07-007         PVML Control (0x12)       PVML       PVML PVML Pulse       Rate       A : 0x10       0 : 0x07-007         PVML Sample       PVML       PVML PVML Pulse       Rate       A : 0x10       0 : 0x07-007         PVML Sample       PVML PVML Pulse       Rate       Image: Note       Image: Note       Image: Note       Image: Note         Bost       Image: Note         Image: Note       Image: Note       Image: Note       Image: Note       Image: Note       Image: Note       Image: Note       Image: Note       Image: Note       Image: Note       Image:	Reset	lex Hex Hex Hex Hex Read
Ravd       LED2 Enable       LED2 Enable       [1]       [0]         [7:4]       [3]       [2]       [1]       [0]         [9]       0 = Disabled \u2017       1 = Enabled \u2017       1 = Enabled \u2017       [1]       [0]         Brightness       Control (0x11)       [1]       [1]       [1]       [1]       [1]       [2]       [2]       [3]       [1]       [0]       [3]	Enable Reg (0x10)	
0       0       Disabled \u2264       1 = Enabled \u2264       1 = Enabled \u2264       1 = Enabled \u2264       0       A: 0x01 D: 0x00-000         Mapping       Brightness       Ramp       Ramp Ramp Ramp Rate       Rsvd       A: 0x01 D: 0x00-000         Mode [7]       Mode [6:5]       Enable [4]       per Step [3:1]       [0]       A: 0x10 D: 0x00-000         0       = Lin \u2264       11 = ramp mut \u2064       0       D: 0 = 500us \u2064       0       64       Read       A: 0x10 D: 0x00-000         PVM Control (0x12)       PVM PVM       PVM PVM       PVM PVM       A: 0x11 D: 0x64-100       A: 0x11 D: 0x64-100         PVM Sample       PVM PVM       PVM PVM PVM PVM PVM PVM PVM PVM PVM PVM	Rsvd LED3 Enable LED2 Enable	LEDI Enable Device Enable
Brightness Control (0x11) Mapping Brightness Ramp Pamp Rate Rsvd Mode [7] Mode [6:5] Enable [4] Per Step [3:1] [0] 0 = Lin • 11 = ramp mut • 0 = Disabled • 010 = 500us • 0 64 Read PVMI Control (0x12) PVMI Sample PVM PVM PVM PVM Pulse Rate 10 = 1 Boost Rate PVM S 4 Macros Clear Save to file Frequer Save to file Frequer Save to file Read data Read Ar 0x10 D 0x07-007 RD 36 10 07 RD 40 RD 4	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	1 = Enabled V 1 = Enabled V 07 Read
Made [7]       Mode [6:5]       Enable [4]       per Step [3:1]       [0]         0 = Lin       11 = range mult       0 = Disabled       0 10 = 500us       0       64       Read         PWM Control (0x12)       PWM Sample       PWM       PWM       PWM Pulse       A : 0x10       0: 0x07-007         PMM Control (0x12)       PWM Sample       PWM       PWM       PWM Pulse       A : 0x10       0: 0x07-007         Rate       d=       History & Macros       Image addr       data       Read       A : 0x10       0: 0x07-007         Post       Frequ       Save to file       Image addr       data       Read       A : 0x10       0: 0x07-007         Shift       WR 36 10 07       Image addr       data       Read       A : 0x10       0: 0x07-007         Boost       Image addr       Image	Brightness Control (0x11)	
0 = Lin       11 = ramp mult       0 = Disabled       0 10 = 500us       0 64       Read         PWM Control (0x12)       PWM PWM       PWM PUISe       A ox11 0: 0x64-100         PMM Sample       PWM PWM       PWM PUISe       A ox11 0: 0x64-100         Rate       III = ramp mult       Q addition of the second of the seco	Mapping Brightness Ramp Mode [7] Mode [6:5] Enabl	Ramp Rate         Rsvd           [4]         per Step [3:1]         [0]
PWM Control (0x12)     PWM     PWM     PWM     PWM Pulse       PWM Sample     PWM     PWM     PWM Pulse       Rate     Image: Sample     Image: Sample     Image: Sample       Boost     Image: Sample     Image: Sample     Image: Sample       PD 36 10 0F     Image: Sample     Image: Sample     Image: Sample       Shift     Image: Sample     Image: Sample     Image: Sample       Shift     Image: Sample     Image: Sample     Image: Sample       Sample     Image: Sample     Image: Sample     Image: Sample       Auto F     Image: Sample     Image: Sample     Image: Sample       Auto F     Image: Sample     Image: Sample     Image: Sample       Image: Sample	0 = Lin 👻 11 = ramp mult 👻 0 = Disat	bled    010 = 500us    0 64 Read
Rate   10 = 2   Boost   Frequire   Shift   1 = No   Boost   WR 36 10 07   Boost   Boost   Auto F   Threes   [7:0]   0   Fault G   LD Op   [4]   0   Fault F   LED Op   [4]   0	PWM Control (0x12) PWM Sample PWM	PWM PWM Pulse
Boost   Frequest   Shift   RD 36 10 0F   RD 36 10 07   RD	Rate 10 = 2 History & Macros	
Freque       Read       A: 0x10 - D: 0x07-007         1 = N0       WR 36 10 07       To 2         Boost       Macro       rd2         Auto F       Macro       rd2         Image: Comparison of the state	Boost Clear Save to file	i2c Read/Write (values in HEX)
1 = No       WR 36 10 07         Boost       Macro         Auto F       Macro         Thres       Image: Constraint of the second	Frequ Shift RD 36 10 OF	reg addr data Read A: 0x10 D: 0x07-007
Boost Auto F Thres I7:01 0 Fault G Rsvd I7:41 0 Fault F LED Op [4] 0 Thas Instruments	1 = No RD 36 10 07	10 - / - Winte
Auto F Thres [7:0] 0 Fault C Rsvd [7:4] 0 Fault F LED Od [4] 0 Fault F LED Od [4] 0 Fault Save All Clear	Boost	Macro rd2
Auto F Thres (7:0) 0 Fault C Rsvd (7:4) 0 Fault F LED Oc [4] 0 East North International State St		Example
Auto F Three [7:0] 0 Fault C Rsvd [7:4] 0 Fault F LED Op [4] 0		Load
[7:0]       0       Fault G       Rsvd       [7:4]       0       Fault F       LED Op       [4]       0	Auto F Thres	Save All
Fault G Rsvd [7:4] 0 Fault F LED Op [4] 0	[7:0]	Clear All
Rsvd [7:4] 0 Fault F LED Op [4] 0 1 2 5 1007 1 1 1 1 1 1 1 1 1 1 1 1 1	Fault C	
Image: Sector	Rsvd [7:4]	
Fault F LED Op [4] 0 26 10 07	0	
	Fault F	
	[4]	
D 36 10.07		
	0 36 10 07	👋 Texas Instruments

Figure 18. Register read/write access



## 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.

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
ОК	pop up dialog box	one field, text to appear in dialog box	Optional keyword, allows user prompt and halts macro execution until user response

#### Table 3. Macro commands

```
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 OF
rem enable LED 1, 2 & 3
rem "End of second macro"
end
```

Figure 19. Example macro



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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.

LM36922-23H EVM - 1.0.0.0		
File I2C Options Help           Read         FW: 2.7,0.0         DLL: 2.7.0.0           All         Pullup OFF, I2C speed 400 KH	] [] Ignore I2c fault [] History z, I2C Addr 0x36	PWM Control     Frequency     Duty Cycle       PWM Enable     5kHz     50
Revision (0x00) Reset (0x01) Backlin	ht Brightness	_ Current
00 Read Reset Hex [2:0]	Brite LSB Brite MSB 7 • [7:0] FF •	Brightness Hex [10:0] 7FF + Read
Enable Reg (0x10) Rsvd LED3 Enable LED2 Enable LE [7:4] [3] [2] 0 1 = Enabled  1 = Enabled  1 = Brightness Control (0x11) Mapping Brightness Ramp Mode [7] Mode [6:5] Enable [4] 0 = Lin  11 = ramp mult  0 = Disabled PWM Control (0x12) PWM Sample PWM PWI Rate 10 = 2 Boost Frequ Shifti 1 = No Boost Auto F Threes [7:0] 0 Fault C Rsvd [7:4] 0 Fault C Rsvd [7:4] 0 Fault C Rsvd [7:4] 0 [4]	D1 Enable [1] Device Enable [1] [0] Enabled ↓ 1 = Enabled ↓ 0F Ramp Rate Rsvd per Step [3:1] [0] ↓ 010 = 500us ↓ 0 64 A PWM Pulse i2c Read/Write (values in HEX) reg addr data 0 ↓ 0 ↓ Macro rd2 New Load Save All Ferm "Next m rem "Next m rem "Next m rem "Write rem "Writ	Read       A: 0x00       D: 0x00-000         A: 0x01       D: 0x00-000         A: 0x10       D: 0x0F-015         Read       A: 0x10       D: 0x0F-015         A: 0x11       D: 0x0F-015         Write       A: 0x00       D: 0x00-000         Write       O: 0x00       D: 0x00-000         ED 1 & 2 2:       cond delay"       ED 1, 2 & 3 second macro"
0		

Figure 20. Example macro loaded (tool tip enabled)



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.

LM36922-23H EVM - 1	0.0.0
File I2C Options H Read All Pullup	lp PWM Control 2.7,0.0 DLL: 2.7.0.0 □ Ignore i2c fault ♥ History PWM Enable Frequency Duty Cycle DFF, I2C speed 400 KHz, I2C Addr 0x36 50 ♀
Revision (0x00) Res	t (0x01) Backlight Brightness Current Leset Brite LSB Hex Brite MSB Hex Brightness Read
Vour description	LED2 Enable         LED1 Enable         Device Enable         □ <th□< th="">         □         <th□< th="">         &lt;</th□<></th□<>
OK Rate 10 = 2 Boost Frequ Shift 1 = No Boost	↓ 0 = Disabled ↓ 010 = 500us ↓ 0       64       Kead         WM       PWM       PWM Pulse         acros       Image: Save to file       Image: Save to file         12c: Read/Write (values in HEX)       reg addr       data         0       Image: Discover of the save to file       Image: Save to file         Macro       Image: Discover of the save to file       Image: Save to file
Auto F Thres [7:0] 0 Fault C Rsvd [7:4] 0	Load Save All Clear Al
Fault F LED Op [4] 0 20 36 1F 00	

Figure 21. Example macro message box



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## 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.

Prepare	the USB2ANY for download:
1. If a U	ISB cable is connected to the USB2ANY, disconnect it.
2. While	pressing the BSL Button (S1), connect the USB cable.
	Help me locate the BSL Button (S1)
-	

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.



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The USB2ANY is ready for download.	0
Click the Update Firmware button to start the update process.	Update Firmware

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.

USB2ANY Firmware Loader	
USB2ANY firmware update is complete.	
Mass erase occured! Password Sent Successfully Sending RAM BSL v00.07.88.38 Sending RAM BSL v00.07.88.38 Sending firmware (USB2AKY v2.7.0.0) Firmware Sent Memory successfully verified Total programming time is 1342ms Sending reset vectors Reset vector sent Interrupt reset successfully verified Resetting device Done!	
Close	

Figure 25. USB2ANY firmware update complete

## 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.
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- 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.
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- 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 <a href="http://www.tij.co.jp/lsds/ti\_ja/general/eStore/notice\_01.page">http://www.tij.co.jp/lsds/ti\_ja/general/eStore/notice\_01.page</a> 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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- 3.3.3 Notice for EVMs for Power Line Communication: Please see <a href="http://www.tij.co.jp/lsds/ti\_ja/general/eStore/notice\_02.page">http://www.tij.co.jp/lsds/ti\_ja/general/eStore/notice\_02.page</a> 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.
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