Using the LM36274 Evaluation Module

User's Guide

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LM36274EVM User's Guide

1 Introduction

The Texas Instruments LM36274EVM evaluation module (EVM) helps designers evaluate the operation and performance of the LM36274 Backlight + Bias Power. The device offers configurability via I^2C-compatible interface. Both blocks can be enabled via the I^2C interface. In addition, the LCM Bias functions can be enabled externally using the LCM_EN pins. The module utilizes up to 4 strings of 8 backlight LEDs connected in series mounted on the EVM.

The EVM contains one LM36274 device (see Table 1).

Table 1. Device and Package Configurations

BACKLIGHT + LCD BIAS DRIVER	IC	PACKAGE
U1	LM36274	0.4 mm-pitch, 24-pin DSBGA

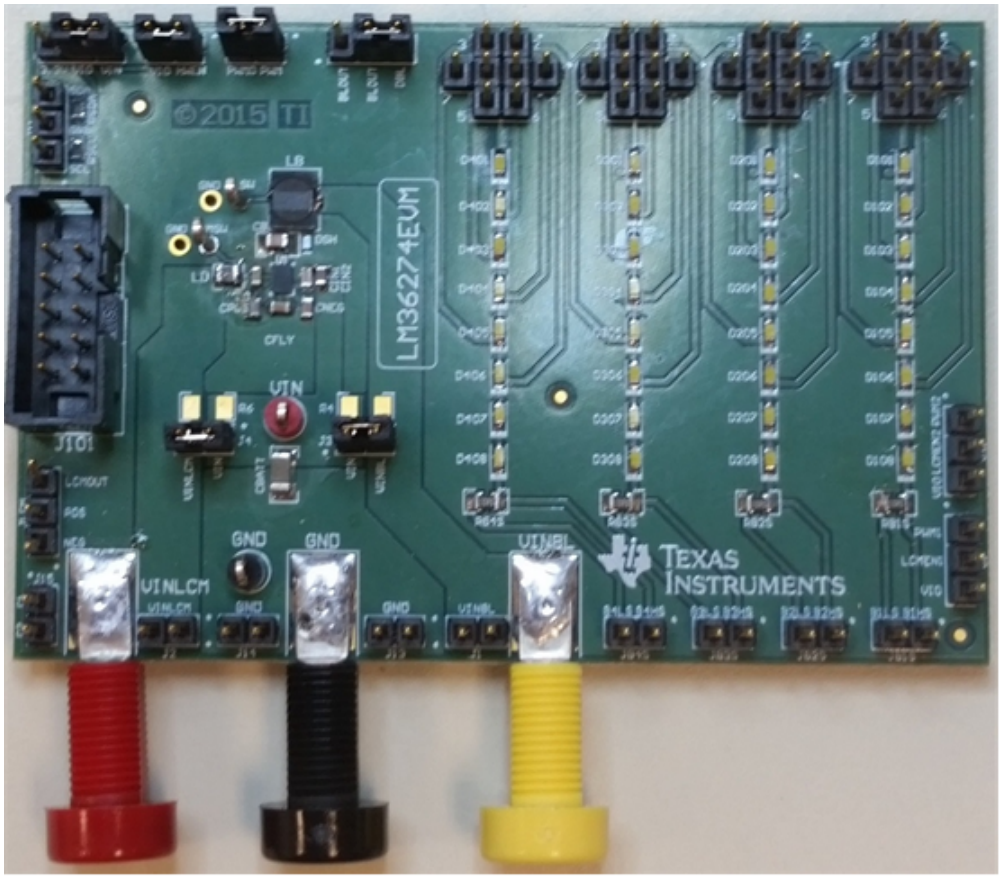


Figure 1. LM36274EVM Photo

2 Setup

This section describes the jumpers and connectors on the EVM as well as how to properly connect, set up, and use the LM36274EVM.

2.1 Input/Output Connector Description

2.1.1 Input / GND

There are two input terminals and one ground for the EVM, providing a power (VIN) and ground (GND) connection to allow the user to attach the EVM to a cable harness. The two input terminals allow the user to split the input to the two boost drivers so that the input power to each block can be measured independently. Both input terminals can be shorted together by jumpers J3 and J4 or by 0-Ω resistors R4 and R6. The default configuration has R4 and R6 assembled, so if the user desires to split the input power they need to be removed from the board.

2.1.2 HWEN (J7)

This is the jumper used to enable the device. The driver will be enabled when the HWEN pin is high (VIO) and disabled when it is floating. There is a 300-kΩ pulldown resistor to GND on this pin.

2.1.3 VIO (J12)

This pin provides power for the I^2C lines (clock and data), for the HWEN pin and for the LCM bias enable pins (LCM_EN1 and LCM_EN2). TI recommends that this pin is connected to the VIN pin. If desired, it can be connected to the 3.3-V line provided by the USB interface connector. In this configuration, communication via the I^2C interface may not be possible if the supply voltage to the LED driver is below approximately 3 V.

2.1.4 LCM1EN (J9) and LCM2EN (J10)

These jumpers can be used to externally enable the VPOS and VNEG outputs of the LCM Bias block. The outputs are enabled when the pins are high (VIO) and disabled when left floating. There are 300-kΩ pulldown resistors to GND on both of these pins. The LCM_EN1 and LCM_EN2 pins can also be controlled externally by applying a signal directly to the pins.

2.1.5 Backlight LED Connector (JBD)

This jumper connects the backlight LED strings to the output of the output pin of the backlight boost. Place jumper between BLOUT and DBL pins.

2.1.6 Backlight LED Configuration Connectors

The user can use these connectors to configure each string's number of LEDs. The default configuration is 8 LEDs in series (no jumpers). To achieve a configuration of 2 LEDs in series place a jumper on location "2", 3 LEDs on location "3" and so on. For example, placing the jumpers as shown on Figure 2, configures string 2 with 6 LEDs and string 1 with 7 LEDs.

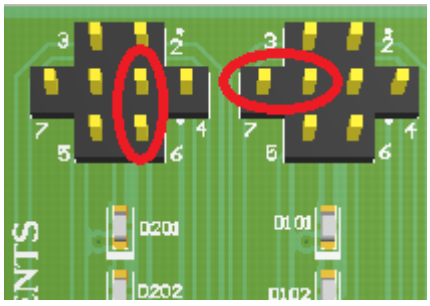


Figure 2. Backlight LED Configuration Example

2.1.7 PWM (J8)

This pin is the PWM input signal for backlight LED current adjustment. It can be driven externally or, if connected to pin PWM0 via a jumper, it can be driven by a using the General User Interface (GUI) software provided.

2.1.8 SDA / SCL (J11)

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 line or the VIN pin.

2.1.9 LCMOUT, VPOS (JLCM)

These provide access to the regulated output of the LCM bias boost, the VPOS, and the VNEG outputs. The user can measure LCMOUT, VPOS, and VNEG with reference to GND.

2.1.10 C1, C2 (J15)

These provide access to the charge pump positive and negative flying cap connections. The user can monitor the voltage waveforms at the flying cap terminals.

2.1.11 BLSW, LCMSW

These connectors can be used to monitor the voltage waveforms at the switch pin of each boost circuit.

2.1.12 VINBL/VIN (J3), VINLCM/VIN (J4)

The user can monitor the inductor current and input current waveforms for each of the two boost blocks by omitting these jumpers, removing resistors R4 and R6 from the EVM and using separate wires from the power supply to the inductors and VIN. This removes the input capacitors from the Inductors and eliminate their filtering effect to the Inductor Current.

2.1.13 JJB1S, JB2S, JB3S, and JB4S: Backlight String Current Measurements

The LM36274EVM provides a way to accurately measure the current through the backlight LED strings on board. Resistor RB1S, RB2S, RB3S, and RB4S (10 Ω, 0.1%) are placed between the LED strings and the current sink inputs of the LM36274. The user can measure the voltage across the resistor(s) and calculate the current(s) through the resistor(s) by dividing the voltage by 10 Ω.

2.2 Setup

The input voltage range for the LM36274 is 2.7 V to 5 V. The on-board backlight LEDs should be connected, and the jumpers should be properly configured for proper operation. This is the recommended setting, using shorting blocks:

- VIO to VIN (J12)
- HWEN to VIO (J7)
- Backlight LEDs (JBD) shorted
- J3 shorted or R4 = 0 Ω
- J4 shorted or R6 = 0 Ω
- PWM to PWM0 (J8) or external signal

In this configuration, the device powers up when power is applied and all outputs can be enabled. Refer to Figure 3 for recommended jumper placement.

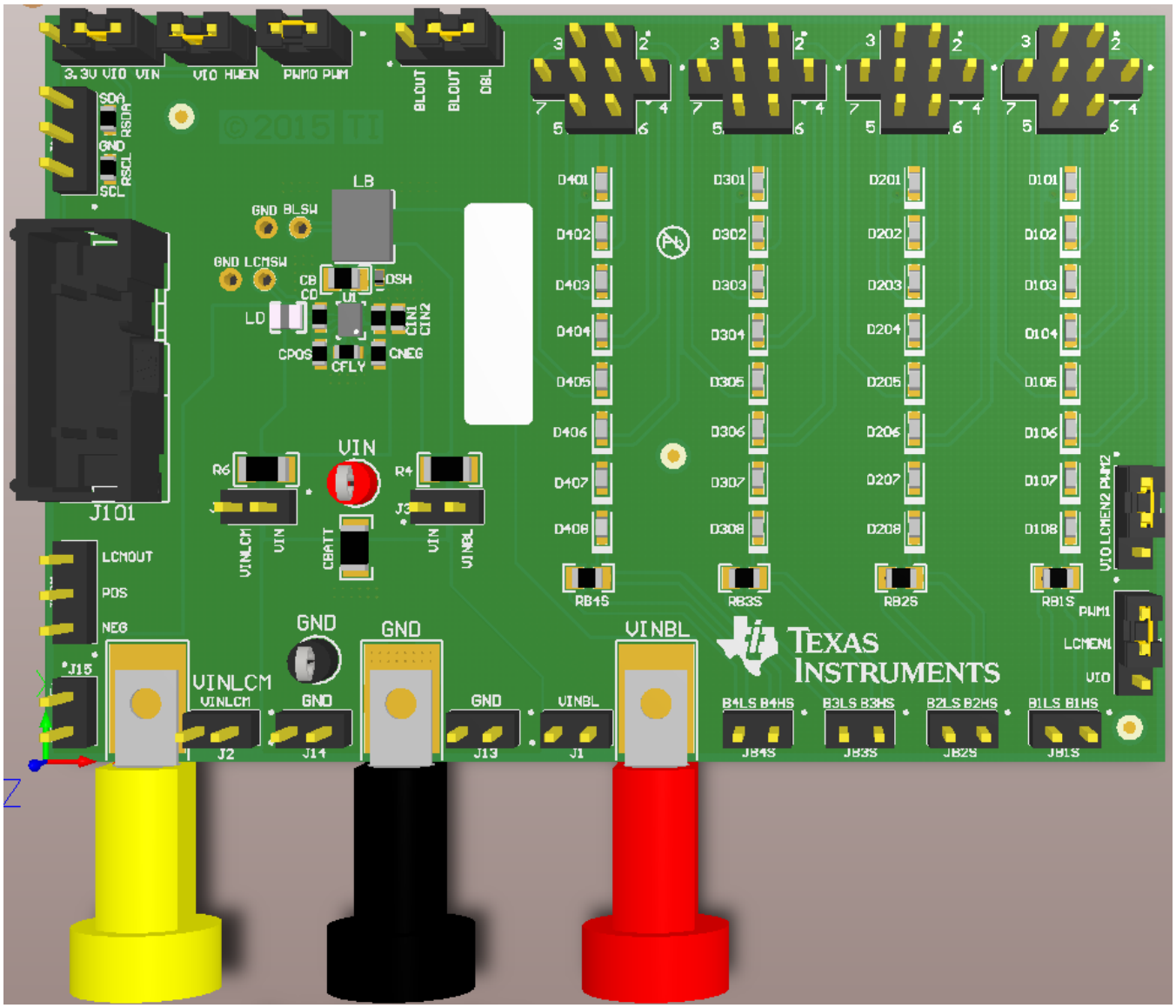
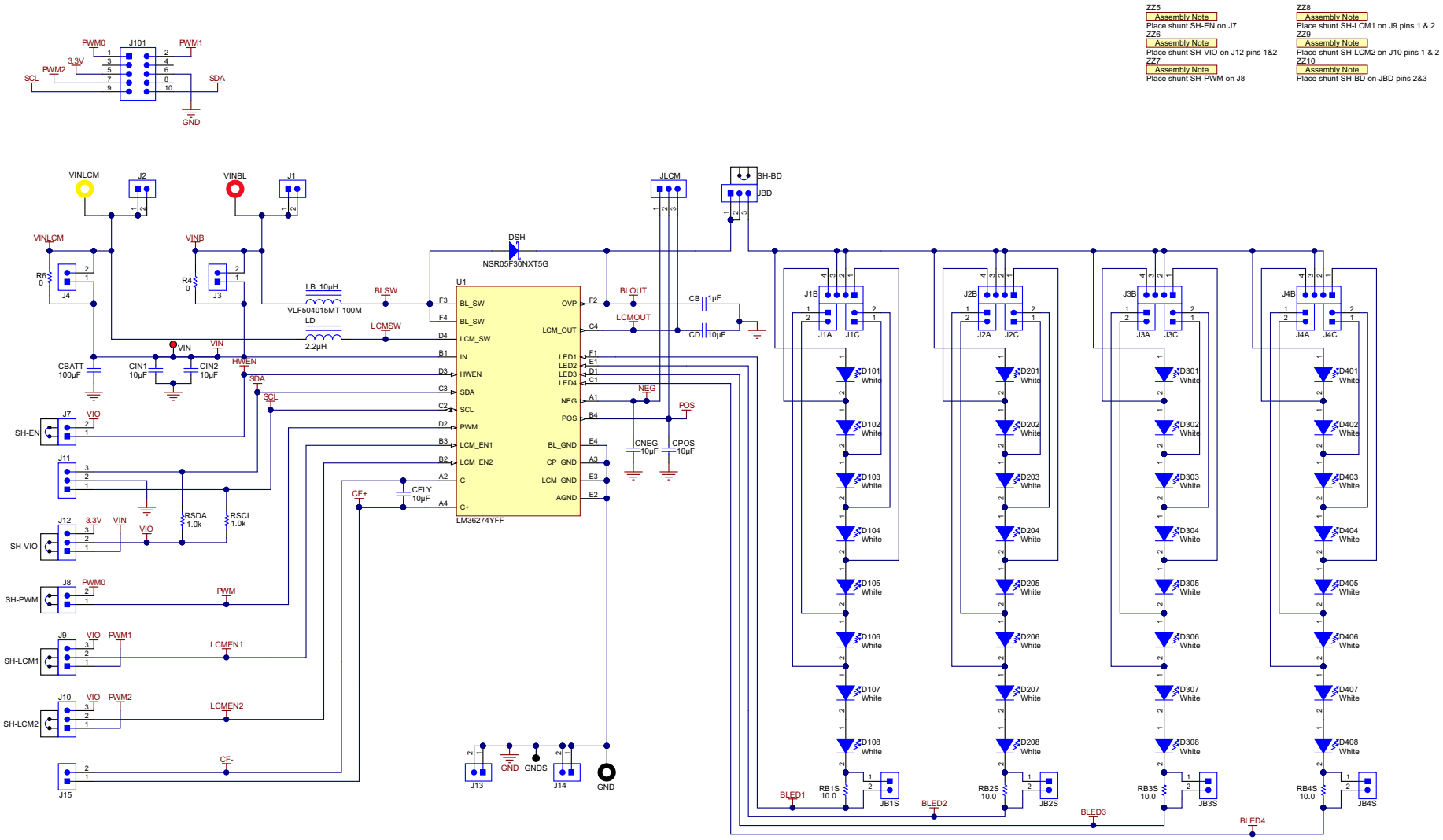


Figure 3. LM36274EVM Recommended Jumper Placement

3 Schematic



4 Bill of Materials (BOM)

Table 2. LM36274EVM BOM

DESIGNATOR	DESCRIPTION	MANUFACTURER	PART NUMBER
CB	CAP, CERM, 1 µF, 50 V, +/- 10%, X7R, 0805	TDK	C2012X7R1H105K125AB
CBATT	CAP, CERM, 100 µF, 6.3 V, +/- 20%, X5R, 1206	MuRata	GRM31CR60J107ME39L
CD	CAP, CERM, 10 µF, 6.3 V, +/- 20%, X5R, 0603	TDK	C1608X5R0J106M
CFLY	CAP, CERM, 10 µF, 6.3 V, +/- 20%, X5R, 0603	TDK	C1608X5R0J106M
CIN1	CAP, CERM, 10 µF, 6.3 V, +/- 20%, X5R, 0603	TDK	C1608X5R0J106M
CIN2	CAP, CERM, 10 µF, 6.3 V, +/- 20%, X5R, 0603	TDK	C1608X5R0J106M
CNEG	CAP, CERM, 10 µF, 6.3 V, +/- 20%, X5R, 0603	TDK	C1608X5R0J106M
CPOS	CAP, CERM, 10 µF, 6.3 V, +/- 20%, X5R, 0603	TDK	C1608X5R0J106M
D101	LED, White, SMD	Rohm	SML312WBCW1
D102	LED, White, SMD	Rohm	SML312WBCW1
D103	LED, White, SMD	Rohm	SML312WBCW1
D104	LED, White, SMD	Rohm	SML312WBCW1
D105	LED, White, SMD	Rohm	SML312WBCW1
D106	LED, White, SMD	Rohm	SML312WBCW1
D107	LED, White, SMD	Rohm	SML312WBCW1
D108	LED, White, SMD	Rohm	SML312WBCW1
D201	LED, White, SMD	Rohm	SML312WBCW1
D202	LED, White, SMD	Rohm	SML312WBCW1
D203	LED, White, SMD	Rohm	SML312WBCW1
D204	LED, White, SMD	Rohm	SML312WBCW1
D205	LED, White, SMD	Rohm	SML312WBCW1
D206	LED, White, SMD	Rohm	SML312WBCW1
D207	LED, White, SMD	Rohm	SML312WBCW1
D208	LED, White, SMD	Rohm	SML312WBCW1
D301	LED, White, SMD	Rohm	SML312WBCW1
D302	LED, White, SMD	Rohm	SML312WBCW1
D303	LED, White, SMD	Rohm	SML312WBCW1
D304	LED, White, SMD	Rohm	SML312WBCW1
D305	LED, White, SMD	Rohm	SML312WBCW1
D306	LED, White, SMD	Rohm	SML312WBCW1
D307	LED, White, SMD	Rohm	SML312WBCW1
D308	LED, White, SMD	Rohm	SML312WBCW1
D401	LED, White, SMD	Rohm	SML312WBCW1
D402	LED, White, SMD	Rohm	SML312WBCW1
D403	LED, White, SMD	Rohm	SML312WBCW1
D404	LED, White, SMD	Rohm	SML312WBCW1
D405	LED, White, SMD	Rohm	SML312WBCW1
D406	LED, White, SMD	Rohm	SML312WBCW1
D407	LED, White, SMD	Rohm	SML312WBCW1
D408	LED, White, SMD	Rohm	SML312WBCW1
DSH	Diode, Schottky, 30 V, 0.5 A, 0402 Diode	ON Semi	NSR05F30NXT5G

Table 2. LM36274EVM BOM (continued)

GND	Standard Banana Jack, Insulated, Black	Keystone	6092
GNDS	Test Point, Compact, Black, TH	Keystone	5006
J1	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S
J1A	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S
J1B	Header, 100mil, 4x1, Gold, TH	Samtec	TSW-104-07-G-S
J1C	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S
J2	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S
J2A	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S
J2B	Header, 100mil, 4x1, Gold, TH	Samtec	TSW-104-07-G-S
J2C	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S
J3	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S
J3A	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S
J3B	Header, 100mil, 4x1, Gold, TH	Samtec	TSW-104-07-G-S
J3C	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S
J4	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S
J4A	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S
J4B	Header, 100mil, 4x1, Gold, TH	Samtec	TSW-104-07-G-S
J4C	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S
J7	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S
J8	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S
J9	Header, 100mil, 3x1, Gold, TH	Samtec	TSW-103-07-G-S
J10	Header, 100mil, 3x1, Gold, TH	Samtec	TSW-103-07-G-S
J11	Header, 100mil, 3x1, Gold, TH	Samtec	TSW-103-07-G-S
J12	Header, 100mil, 3x1, Gold, TH	Samtec	TSW-103-07-G-S
J13	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S
J14	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S
J15	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S
J101	Header (shrouded), 100mil, 5x2, High-Temperature, Gold, TH	3M	N2510-6002-RB
JB1S	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S
JB2S	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S
JB3S	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S
JB4S	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S
JBD	Header, 100mil, 3x1, Gold, TH	Samtec	TSW-103-07-G-S
JLCM	Header, 100mil, 3x1, Gold, TH	Samtec	TSW-103-07-G-S
LB	Inductor, Shielded, Ferrite, 10 µH, 1.44 A, 0.12 ohm, SMD	TDK	VLF504015MT-100M
LBL1	Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	Brady	THT-14-423-10
LD	Inductor, Shielded, Metal Composite, 2.2 µH, 1.5 A, 0.12 ohm, SMD	Toko	DFE201612P-2R2M=P2
R4	RES, 0, 5%, 0.25 W, 1206	Yageo America	RC1206JR-070RL
R6	RES, 0, 5%, 0.25 W, 1206	Yageo America	RC1206JR-070RL
RB1S	RES, 10.0, 0.1%, 0.1 W, 0805	Bourns	CRT0805-BY-10R0ELF
RB2S	RES, 10.0, 0.1%, 0.1 W, 0805	Bourns	CRT0805-BY-10R0ELF
RB3S	RES, 10.0, 0.1%, 0.1 W, 0805	Bourns	CRT0805-BY-10R0ELF
RB4S	RES, 10.0, 0.1%, 0.1 W, 0805	Bourns	CRT0805-BY-10R0ELF
RSCL	RES, 1.0 k, 5%, 0.1 W, 0603	Vishay-Dale	CRCW06031K00JNEA
RSDA	RES, 1.0 k, 5%, 0.1 W, 0603	Vishay-Dale	CRCW06031K00JNEA
SH-BD	Shunt, 100mil, Gold plated, Black	3M	969102-0000-DA

Table 2. LM36274EVM BOM (continued)

SH-EN	Shunt, 100mil, Gold plated, Black	3M	969102-0000-DA
SH-LCM1	Shunt, 100mil, Gold plated, Black	3M	969102-0000-DA
SH-LCM2	Shunt, 100mil, Gold plated, Black	3M	969102-0000-DA
SH-PWM	Shunt, 100mil, Gold plated, Black	3M	969102-0000-DA
SH-VIO	Shunt, 100mil, Gold plated, Black	3M	969102-0000-DA
U1	FOUR CHANNEL LED DRIVER + LCD BIAS SUPPLY, YFF0024ADAC	Texas Instruments	LM36274YFF
VIN	Test Point, Compact, Red, TH	Keystone	5005
VINBL	Standard Banana Jack, Insulated, Red	Keystone	6091
VINLCM	BANANA JACK, 15A, Insulated, Nylon,Yellow	Emerson Network Power	108-0907-001

5 Board Layout

Figure 4, Figure 5, Figure 6, Figure 7, Figure 8 and Figure 9 show the board layout for the LM36274EVM. The EVM offers resistors, capacitors, and jumpers to enable the device and to configure it as desired.

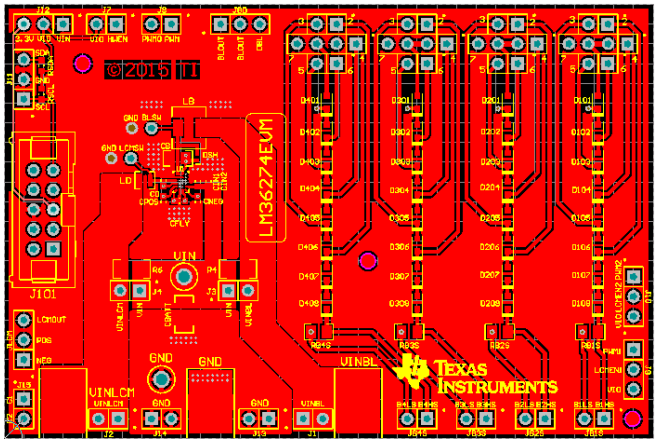


Figure 4. Top Assembly Layer

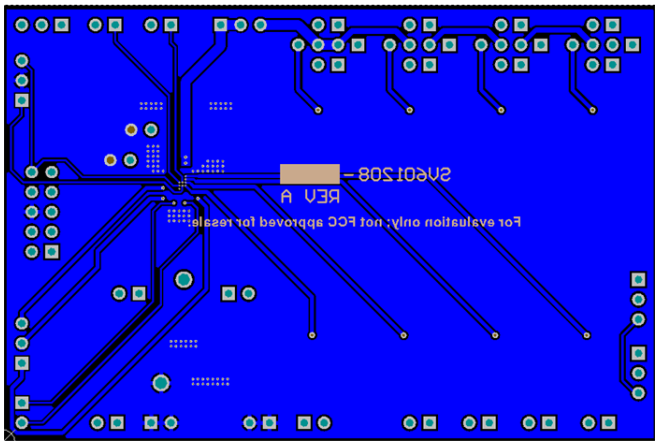


Figure 5. Bottom Assembly Layer

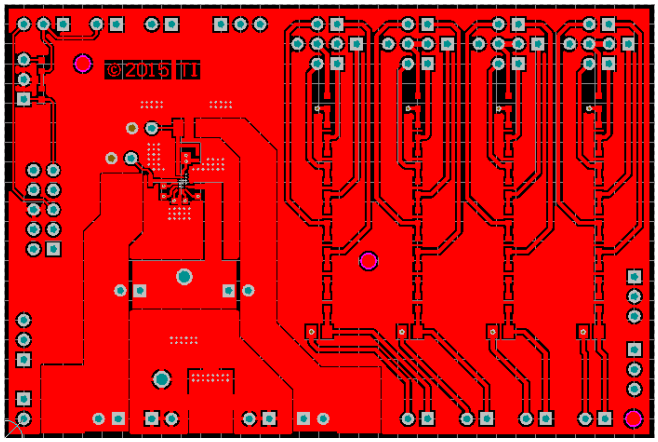


Figure 6. Top Layer Routing

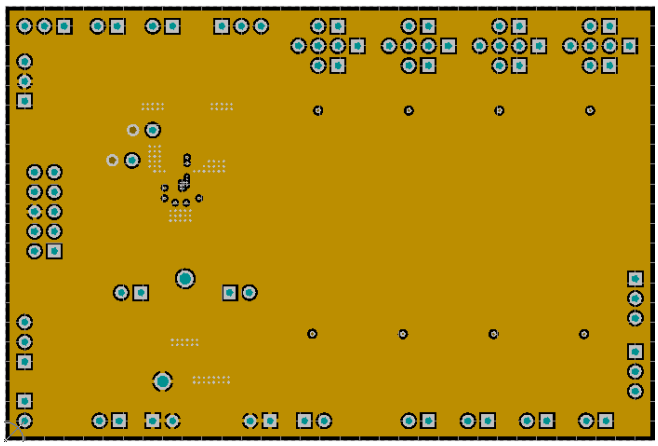


Figure 7. Middle Layer 1 Routing

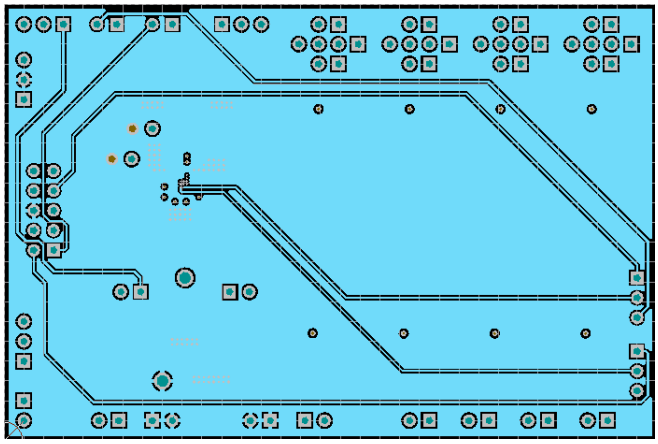


Figure 8. Middle Layer 2 Routing

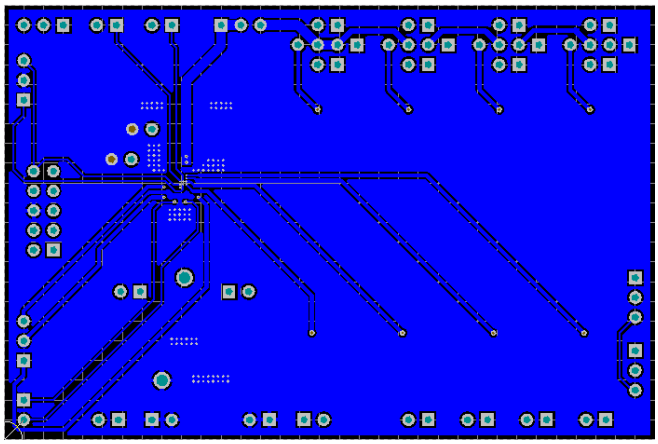


Figure 9. Bottom Routing

6 USB Interface Board and I²C-Compatible Interface Program

Texas Instruments has created an I²C-compatible program and USB docking board that helps exercise the part in a simple way. This section describes how to use the USB docking board and interface software.

The LM36274EVM 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 LM36274 device 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 10 shows the software interface upon start-up.

The GUI is configured in register blocks. Please refer to the *Register Maps* section of the LM36274 data sheet (SNVSAC0) for register configuration details.

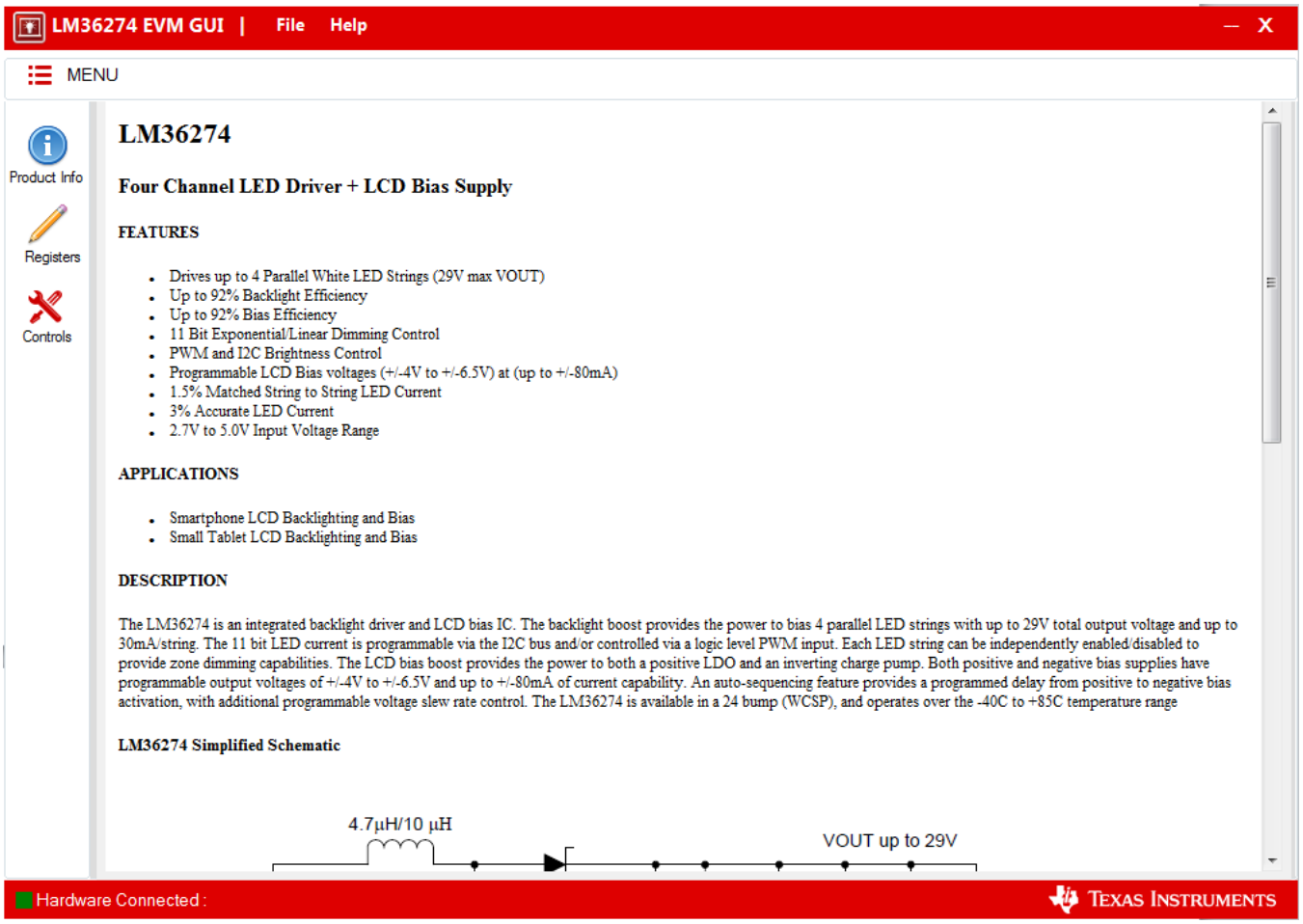


Figure 10. LM36274 General User Interface

6.1 Establishing I²C Communication

1. If the USB2ANY hardware is connected to the PC properly, the message displayed on the lower left corner of the GUI should display “Hardware Connected”. If the message is “Hardware Disconnected”, unplug and plug the USB cable on the USB2ANY box.
2. Select the “Controls” icon, and the “Backlight” tab on the page that pops-up, then perform a “Read” of register 0x01 (Revision/Vendor). The return values should be VENDOR = 01 and REV = 00. If it returns nothing it means communication is not established properly; ensure power supply is properly connected and the jumpers are in place.
3. Once I²C communication has been established, select one of the “BLED” boxes and “BL_EN” (they should display “ON”) on “Reg. 0x08 BACKLIGHT ENABLE REGISTER”. The field STATUS on the bottom right of the GUI should say “No error” or “Success” if the write command was properly received and the backlight LEDs should glow. **Note**: The default backlight OVP setting for the LM36274 is 21 V, so under default settings the backlight boost circuit operates in OVP mode, and the light is dim. Refer to *Section 6.6* for details.
4. If the backlight LEDs don’t glow, and there are no error messages in the “STATUS” window, close the GUI, recycle power to the LM36274, unplug, then plug the USB2ANY cable from the USB2ANY box and try again.

6.2 GUI Controls

There are two control views available: “Registers” and “Controls”. These fields are synchronized so any changes performed in one view are automatically updated in the other.

6.2.1 Registers View

Figure 11 shows the Registers interface. The user can either enter the desired hex value to the registers (“Current Value” column), perform a bit-wise configuration of any register fields by double-clicking on the corresponding register bit or configure a register field by selecting the desired entry in the "Value" drop-down box located under the "Field View". "Field View" displays the description of all fields of the selected register. Each register can be read independently or all registers can be read at once by utilizing the “Read” and “Read All” buttons, respectively. The data is written to the register(s) in one of two ways, depending on the “Update Mode” field selection: In Immediate mode, the register data is written immediately following a “Current Value”, an individual bit or a "Value" change. In “Deferred” mode, the displayed data is written to all registers upon depression of the “Write” button.

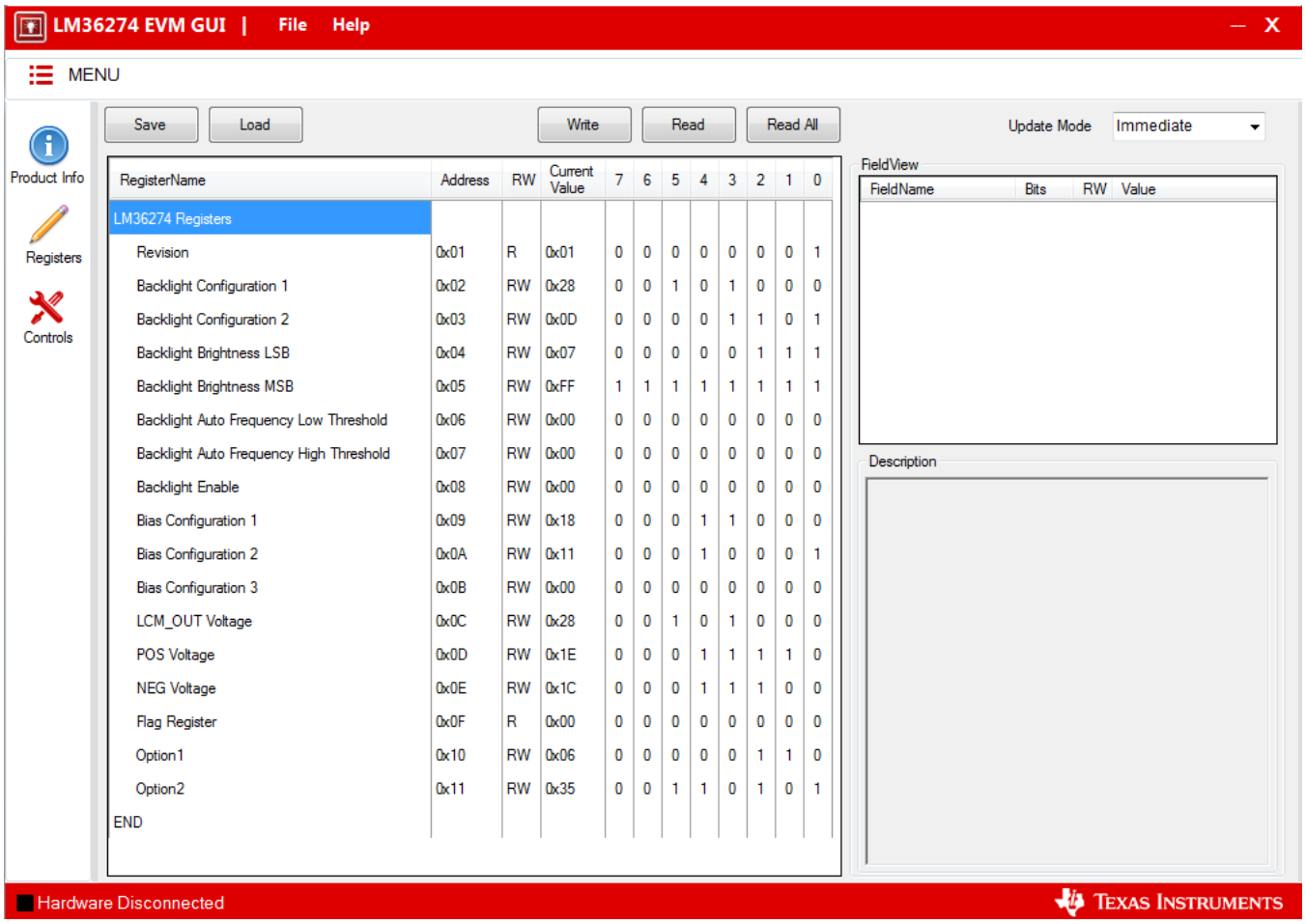


Figure 11. LM36274 Register Control View

6.2.2 Controls View

There are two tabs available under the “Controls” interface: "Backlight" (Figure 11) and "LCD Bias” (Figure 11). The left side of these tabs contains the controls for the corresponding block of the LM36274. The right side contains register controls and functions that are common to both blocks. Similarly to the Registers View control, the LM36274 GUI provides the ability to execute the I²C write commands immediately (one click execution) if the “Auto Write Registers” box is checked or upon performing a “WRITE ALL” operation if the “Auto Write Registers” box is not checked.

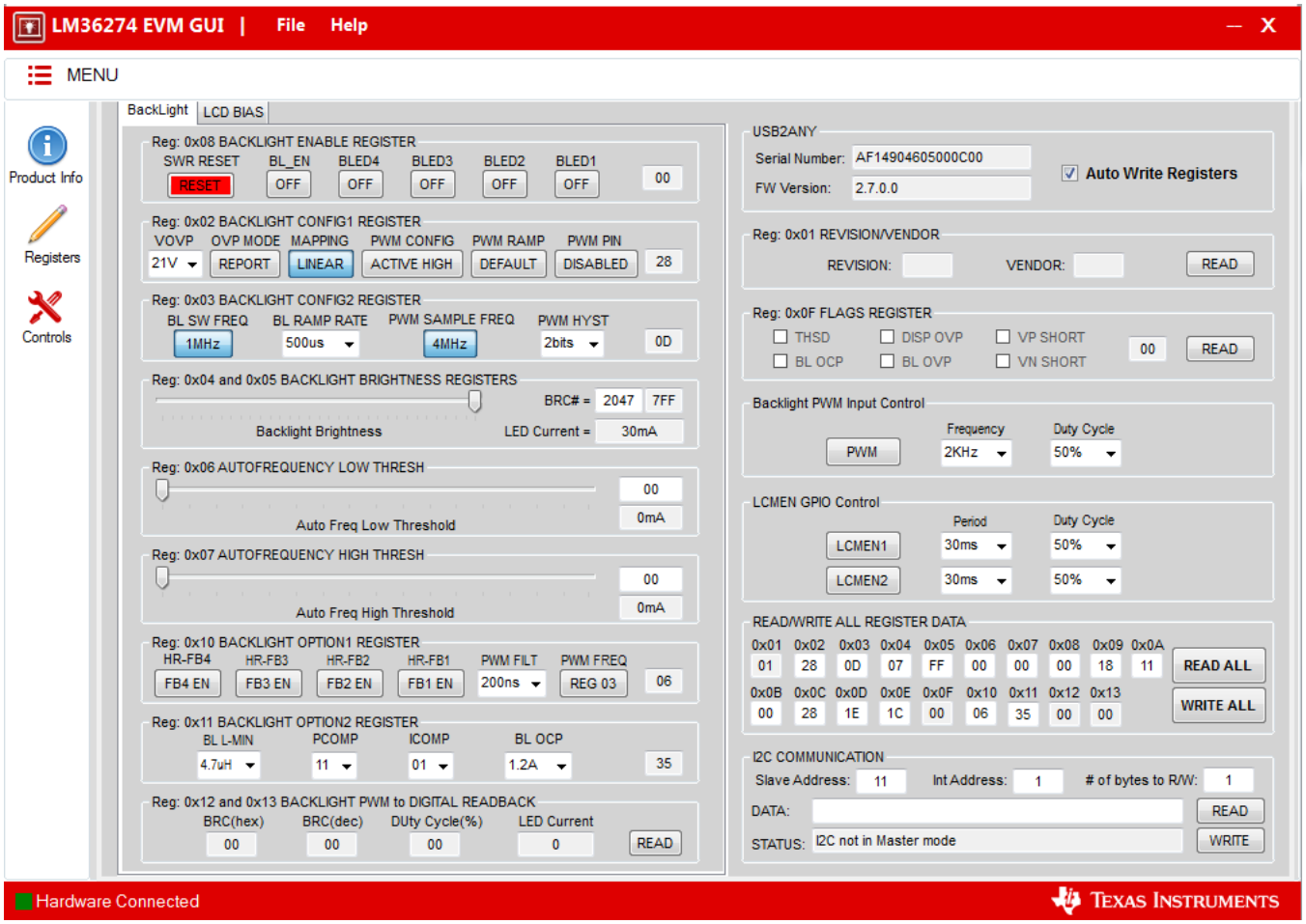


Figure 12. LM36274 Backlight Control View

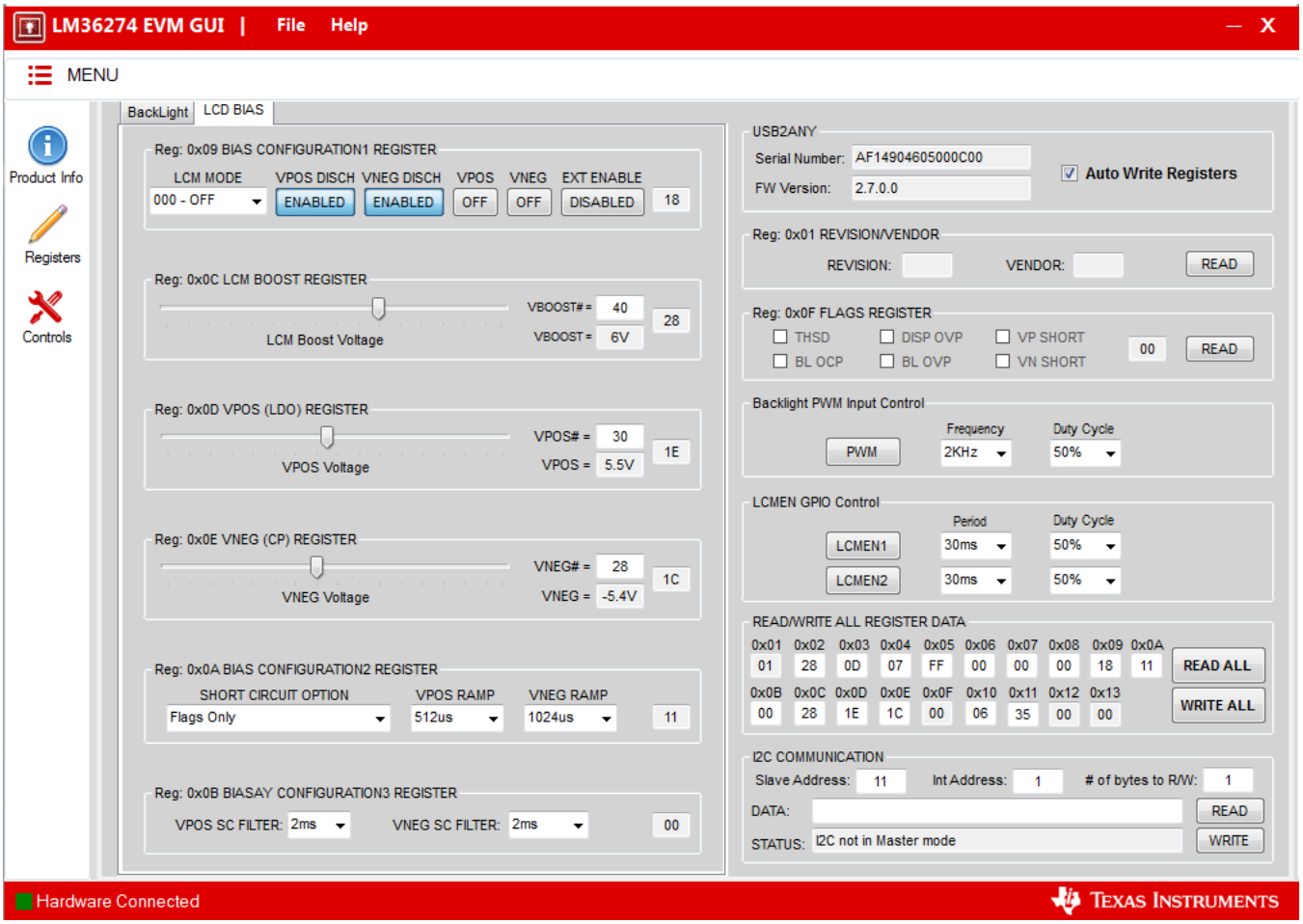


Figure 13. LM36274 LCD Bias Control View

6.3 Saving and Loading Register Settings

The LM36274 EVM GUI software provides the option to save all register settings and re-load them. The user can configure the registers and select “Save” in the “Registers” window of the GUI or can use the "Save Registers" option of the "File" drop-down menu. Enter a file path and file name when prompted and select “Save” to save all current register settings. Any saved register configuration can be loaded by selecting “Load” in the “Registers” window of the GUI or "Load Registers" in the "File" drop-down. Similarly to the save function, when prompted navigate to the location where the file that contains the desired register configuration is stored and select “Open” to load the register values.

6.4 I2C Communication Block

The GUI provides fields that allow for general I²C interaction. Simply populate the fields with the desired internal register address and data (for write operation) and perform a read or write action. The general I2C communication interface allows for burst “write” and “read” operations. As an example, populating the internal address field with “03”, the “# of bytes to “READ/WRITE” field with “5” and the “DATA” field with “02 a5 80 13 2f”, then selecting “WRITE” would attempt to write data 0x02 to register 0x03, data 0xa5 to register 0x04, data 0x80 to register 0x05, data 0x13 to register 0x06 and data 0x2f to register 0x07. Field “STATUS” displays communication error messages. The I2C Communication block is available in the “Controls” interface.

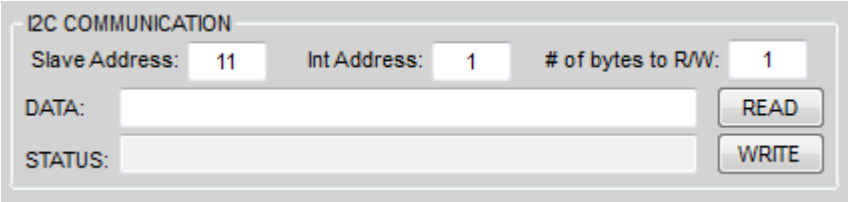


Figure 14. I²C Communication Fields

6.5 SWR RESET Button

Selecting the "RESET" button in register 0x08 sets bit[7] of register 0x08 to "1" which causes the LM36274 to configure all registers to their default values. The GUI fields are updated to reflect the register contents. Upon completion of its register updates, the LM36274 resets bit[7] to "0" (no further action by the user is required).

6.6 Backlight Operation

The steps below describe how to turn on the backlight LEDs using default settings. Refer to the LM36274 datasheet and/or the register field descriptions of the GUI to exercise the different configurations and options of the backlight block.

1. Configure the number of backlight LEDs for both strings as desired (refer to Section 2.1)
2. Select the desired BL OVP voltage level in register 0x02, based on the number of LEDs used.
3. Select the appropriate BL L-MIN value (inductor value used, 10-uH assembled) and BL OCP (backlight over-current limit) in register 0x11.
4. Turn on one or more backlight strings by selecting one or more of the "BLED1", "BLED2", "BLED3", "BLED4" boxes and box "BL_EN" in register 0x08.

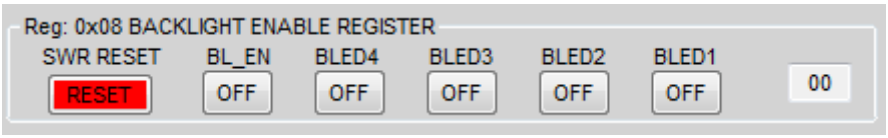


Figure 15. Backlight Enable Register Fields

6.7 VPOS/VNEG Operation

1. Select the desired LCM Mode from the drop-down menu in register 0x09.
2. I²C Mode: VPOS and VNEG can be enabled in I²C mode by the corresponding field in register 0x09. Field "EXT ENABLE" must be disabled in order to turn VPOS and/or VNEG on in I²C mode.
3. External Node: Enable "EXT EN" in register 0x09, then set pins LCMEN1 and LCMEN2 high to enable VPOS and VNEG, respectively.

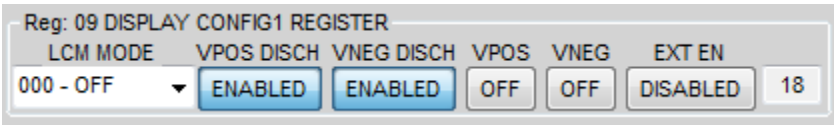


Figure 16. LCM Display Bias Configuration1 Register Fields

6.8 Flags Register

Register 0x0F (right side of GUI) contain the fault and flag bits of the LM36274. Some bits are report only while others are fault bits (see LM36274 datasheet (SNVSAC0) for fault/flag definitions and options). Faults inhibit subsequent enabling of the affected block, while flags do not. Select "READ" to read the fault/flag status and clear the register.

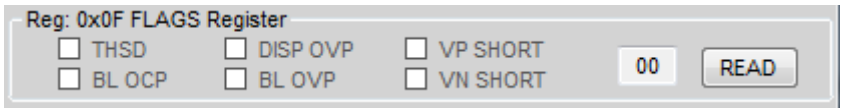


Figure 17. Flags Read Register

6.9 General Register Read/Write

The LM36274EVM GUI includes a block that allows for a quick register read or write action. Selecting the "READ ALL" button performs a read of all registers and updates the corresponding fields of the GUI. Populating the register fields with the desired data and performing a "WRITE ALL" writes the data to all registers and updates the corresponding GUI fields.

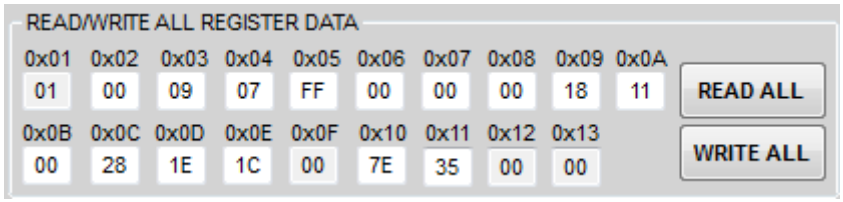


Figure 18. General Register Fields

6.10 GPIO Controls

The LM36274EVM provides the user with the capability to control the PWM, LCMEN1, and LCMEN2 inputs of the LM36274 without the need of an external supply. In order for the signals to be applied to the corresponding LM36274 input pin(s) the appropriate jumpers need to be placed (see Section 2.1 for PWM, LCMEN1, and LCMEN2 jumper placement).

The user can choose among a few frequencies and duty cycle increment combinations of continuous pulses for the backlight PWM input pin. A duty cycle of 0% sets the voltage low, and a duty cycle of 100% sets the voltage high.

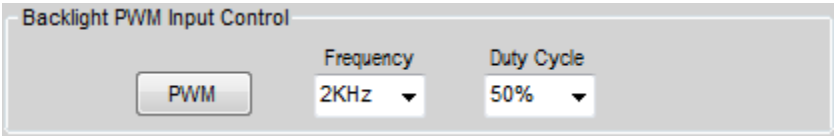


Figure 19. Backlight PWM Controls

To force continuous pulses on the LCMEN1 and LCMEN2 pins, the user can select a period and duty cycle from the drop-down menus then select the "LCMEN1" and "LCMEN2" buttons. A duty cycle of 0% sets the voltage low, and a duty cycle of 100% sets the voltage high.

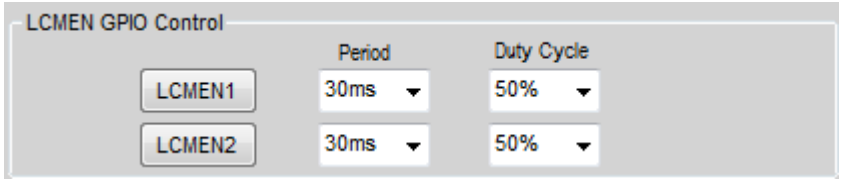


Figure 20. LCD Bias GPIO Controls

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- *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.*

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