User's Guide

LP8864 Evaluation Module

ABSTRACT

The Texas Instruments LP8864EVM evaluation module helps designers to evaluate the operation and performance of the LP8864-Q1 device. This document includes a hardware setup instructions, software instructions, a complete schematic diagram, printed-circuit board (PCB) layout, and bill of materials (BOM) of the LP8864EVM.

Table of Contents

Trademarks

1 Introduction

The LP8864EVM helps designers to evaluate the characteristics, operation, and use of the LP8864-Q1 device, a high-performance LED driver for automotive lighting. The LP8864-Q1 device is a high-efficiency LED driver with boost controller. The four 200-mA high-precision current sinks support phase shifting that is automatically adjusted based on the number of channels in use. LED brightness can be controlled globally through the I2C interface or PWM input.

1.1 Features

The EVM has the following features:

- Up to 48-V V_{OUT} boost controller
- Four high-precision current sinks
- Supports built-in phase-shift PWM dimming, hybrid dimming, current dimming and direct PWM dimming mode
- LED brightness controlled globally through I2C interface or PWM input
- Extensive fault diagnostics

1.2 Applications

Backlight for:

- Automotive infotainment
- Automotive instrument clusters
- Smart mirrors
- Heads-Up Displays (HUD)
- Central Information Displays (CID)
- Audio-Video Navigation (AVN)

2 Test Setup

This section describes how to properly connect and setup the LP8864EVM.

2.1 LP8864EVM Kit

The LP8864EVM kit contains (see Figure 2-1):

- USB2ANY
  - Ribbon cable
  - USB cable
- LP8864EVM
- LP886X-LEDLOAD-EVM

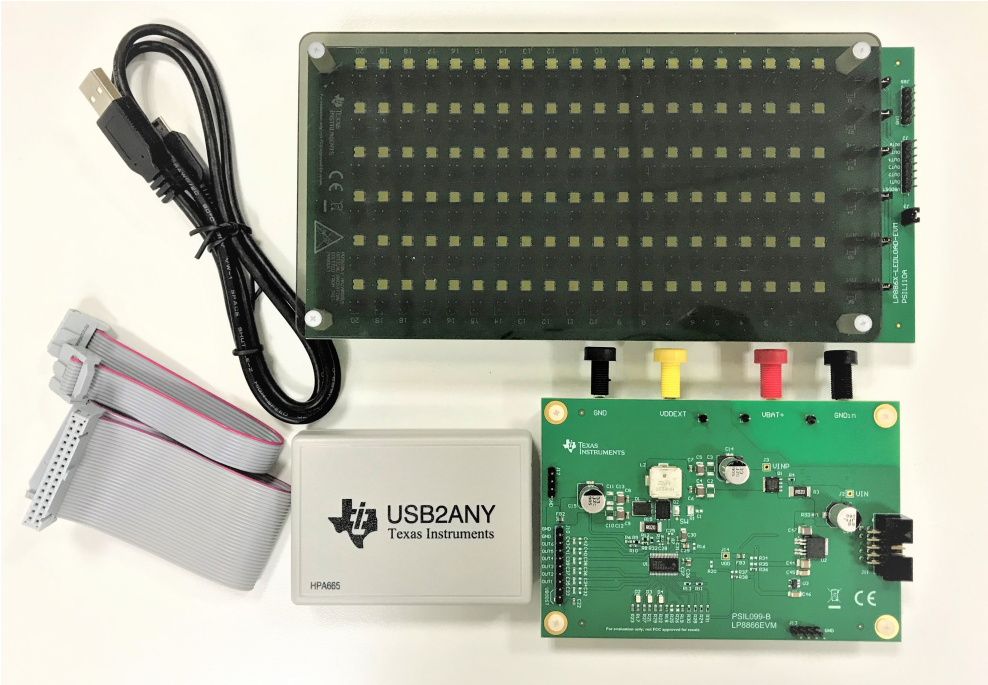

Figure 2-1. LP8864EVM Kit

2.2 System and Equipment Requirements

- DC power supply: 24 V or higher, 6 A or higher
- LED cable: 5-position ribbon cable
- PC to run GUI software
- GUI software

2.3 Hardware Setup

Figure 2-2 shows the hardware setup of the LP8864EVM.

- Connect a 12-V external power supply between the power input terminals VBAT+ and GNDin on the LP8864EVM
- Connect the USB2ANY module to the PC with the USB cable
- Connect the USB2ANY module to the LP8864EVM with the provided ribbon cable
- Connect the LP8864EVM to the LP886X-LEDLOAD-EVM with a 5-position ribbon cable

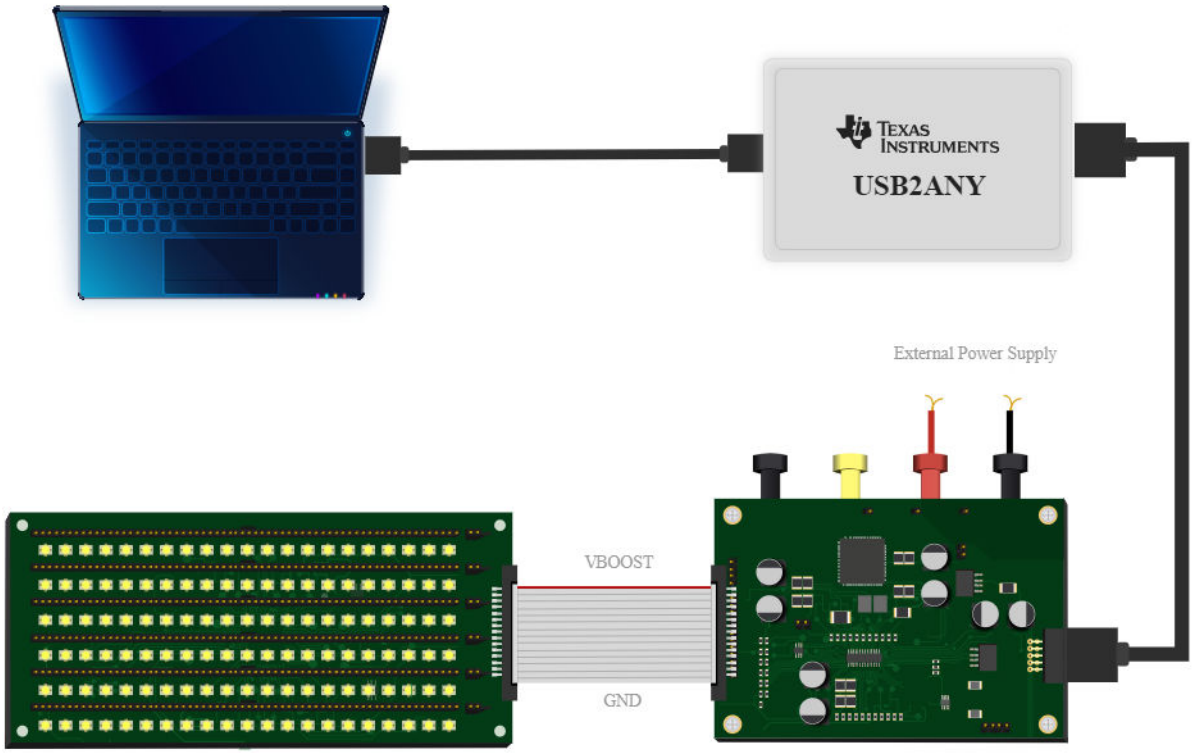

Figure 2-2. LP8864EVM Hardware Setup

2.4 Software Installation

Download the GUI software from the LP8864EVM tools folder. Follow the instructions to finish the GUI installation. Once installed, a shortcut to the GUI is found on the desktop and also in the start-up menu under the Texas Instruments folder.

2.5 Quick Start-Up Procedure

1. After the hardware is connected successfully, run the GUI software. Turn on the 12-V external power supply. Select the right device variant of the EVM, which is LP8864, as shown in Figure 2-3.

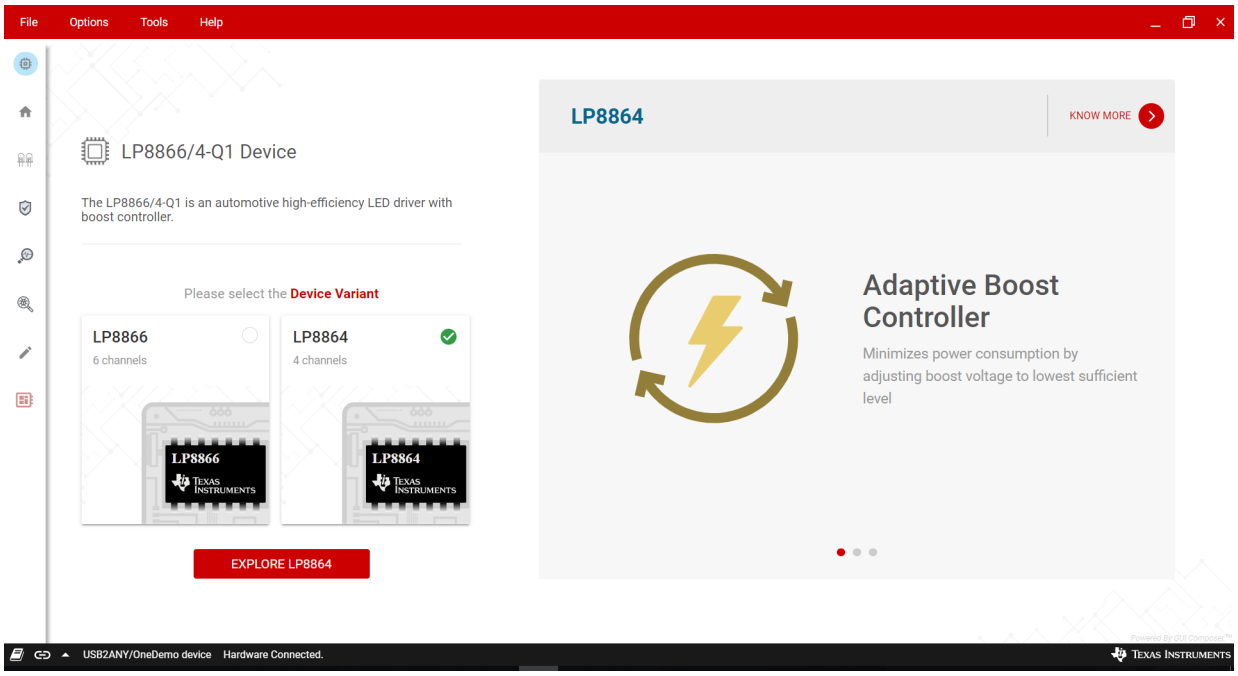

Figure 2-3. LP8866/4 Family GUI Landing Page

2. Check the connection status button on the bottom left corner of the GUI. The button should be like the one shown in Figure 2-3. There should be a *Hardware Connected* message on the status bar next to the button. If it shows *Hardware not Connected*, click the button to manually connect the hardware. This button can be used to connect or disconnect the GUI to the hardware during the evaluation. Besides the connection status button, the device should be enabled to be connected to the GUI. Ensure the *Enable* button on the LED Control Page (see Figure 2-5) is enabled.

3. Click the *EXPLORE LP8864* button to go to the LP8864EVM GUI home page (see Figure 2-4).

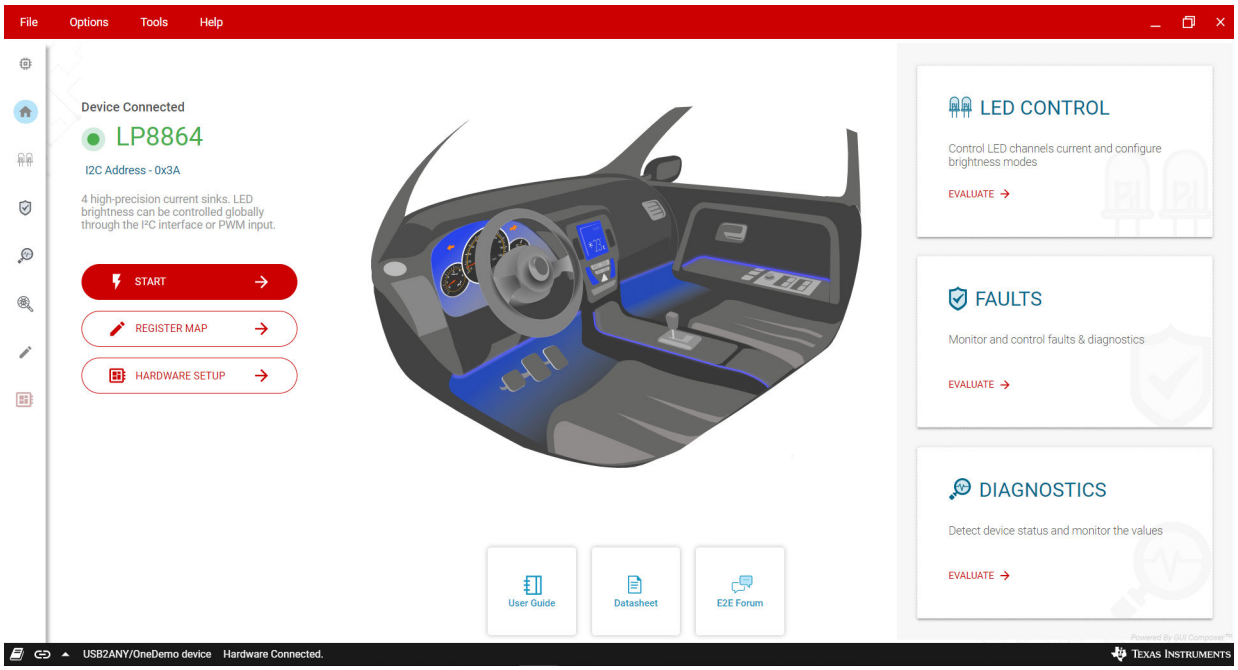

Figure 2-4. LP8864EVM GUI Home Page

4. Click the *START* button to go to the LED Control page (see Figure 2-5). On the LED Control page, the user can control all the register-based control functions of the device, like brightness control, current control, sloper control, dither control, boost synchronization configuration, and spread spectrum configuration.

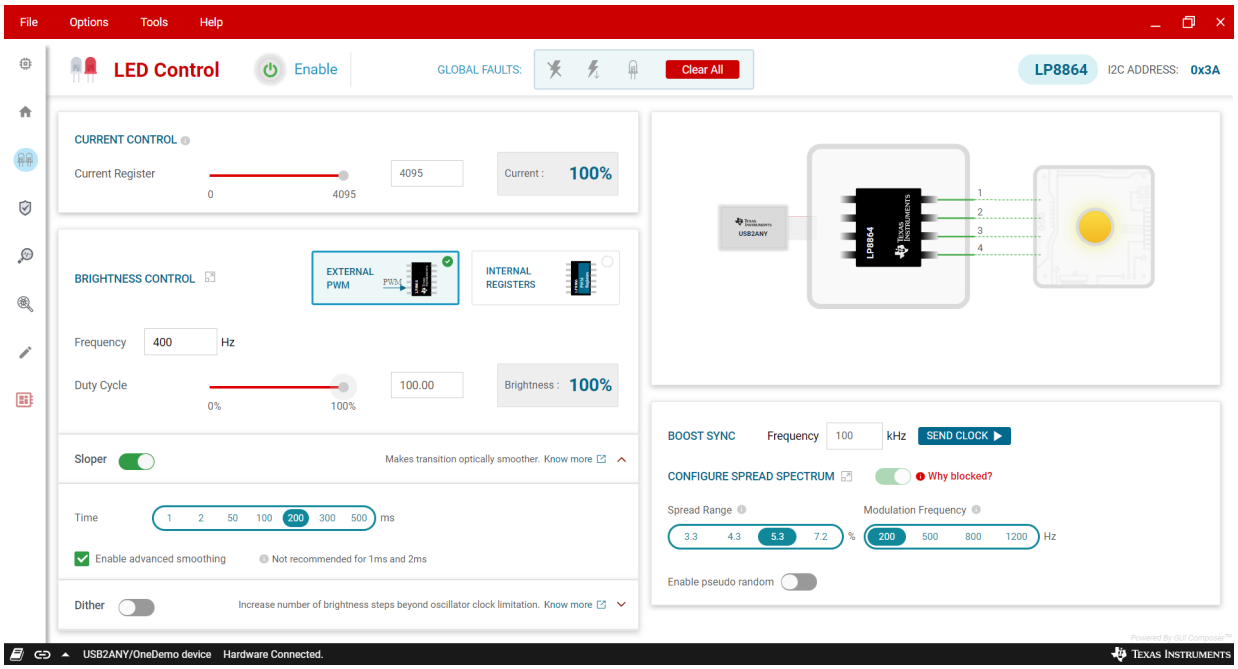

Figure 2-5. LP8864EVM LED Control Page

2.6 Additional GUI Functions

In the selection tab on the left-hand side, the user can switch between LED Control, Monitor Faults, Diagnostics and Register Map tabs. This section introduces GUI functions provided in the Monitor Faults, Diagnostics, and Register Map tabs.

2.6.1 Monitor Faults Page

From the Monitor Faults page (see Figure 2-6), the user has access to LP8864-Q1 fault status bits. Faults can be cleared by software by clicking the *Clear All* button. Fault interrupt can be enabled or disabled globally by toggling the *Interrupt All* button. Besides that, each fault interrupt and each fault status can be controlled individually.

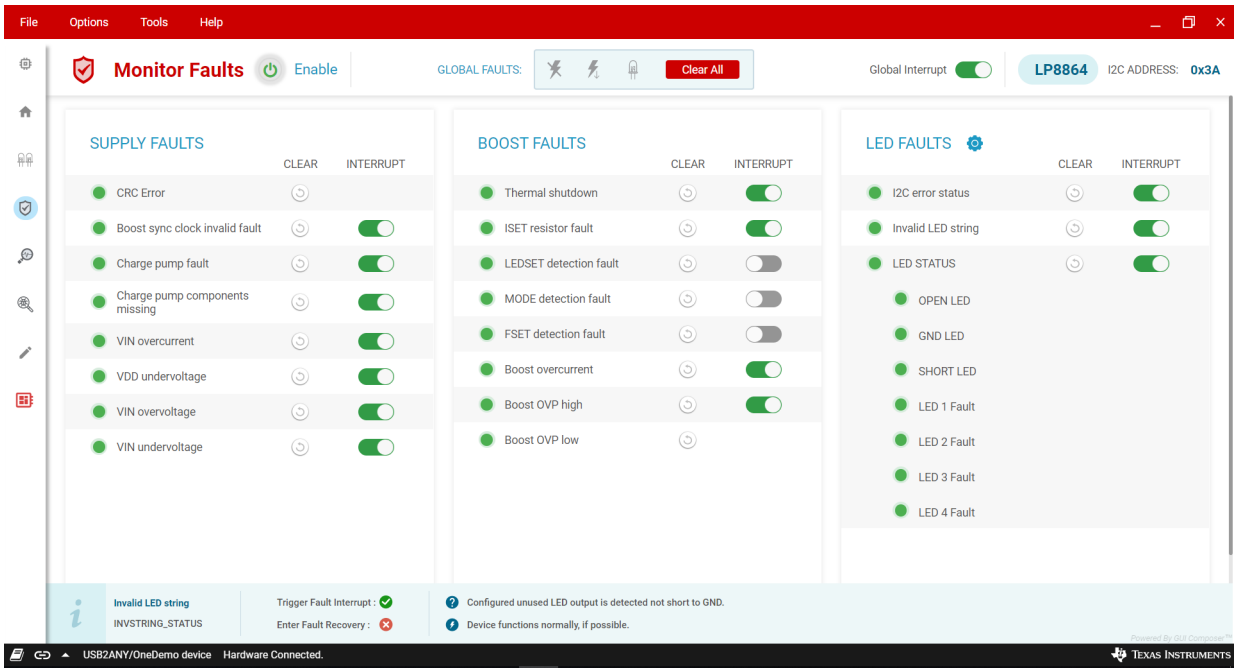

Figure 2-6. LP8864EVM Monitor Faults Page

2.6.2 Diagnostics Page

From the Diagnostics page (see Figure 2-7), the user can read back the following diagnostics register values and corresponding device status.

- FSM_LIVE_STATUS: current status of the functional state machine
- PWM_INPUT_STATUS: 16-bit value for detected duty cycle of PWM input signal
- PWM_OUTPUT_STATUS: 16-bit value for configured duty cycle of PWM output signal
- LED_CURRENT_STATUS: 12-bit current DAC code that brightness path is driving to OUT1-4 output
- VBOOST_STATUS: 11-bit boost voltage code that adaptive voltage control loop sending to analog boost block
- AUTO_PWM_FREQ_SEL: LED PWM frequency value from PWM_SEL resistor detection
- AUTO_LED_STRING_CFG: LED string configuration from LED_SET resistor detection
- AUTO_BOOST_FREQ_SEL: boost switching frequency value from PWM_FSET resistor detection
- MODE_SEL: LED dimming mode value from MODE resistor detection

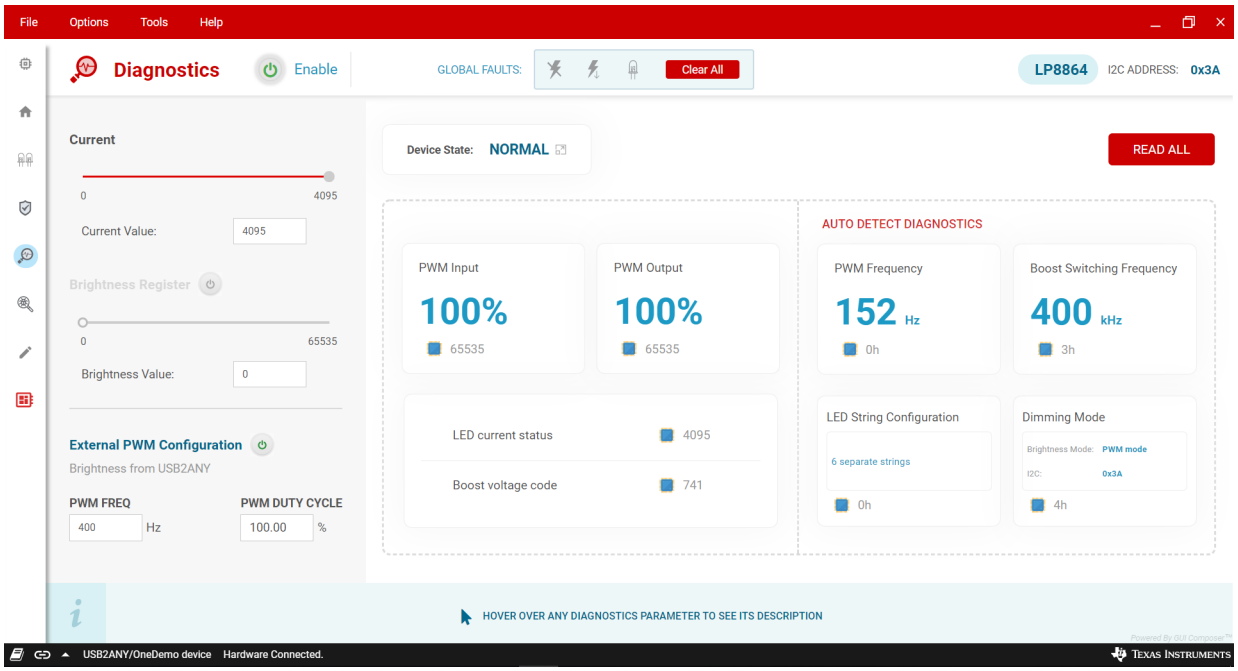

Figure 2-7. LP8864VM Diagnostics Page

2.6.3 Register Map Page

Figure 2-8 shows the registers map page. All the registers are available on this page. When *Auto Read* is set to other than "Off", all the registers will be read automatically and periodically according to the interval time the user selects. Otherwise, the user needs to click the *READ REGISTER* button to read the selected register or click the *READ ALL REGISTERS* button to read all of the registers.

Clicking on the row of a register automatically updates the corresponding field view on the right side of the page. The register value can be updated by modifying the hexadecimal value in the *Value* column or by double-clicking the corresponding bit in the *Bits* column. The modified value is effective immediately if "Immediate Write" is selected in the drop-down menu. When "Deferred Write" is selected, the modified value will not take effect until the user clicks the *WRITE REGISTER* button. The value of all the registers can be updated together by clicking the *WRITE ALL REGISTERS* button.

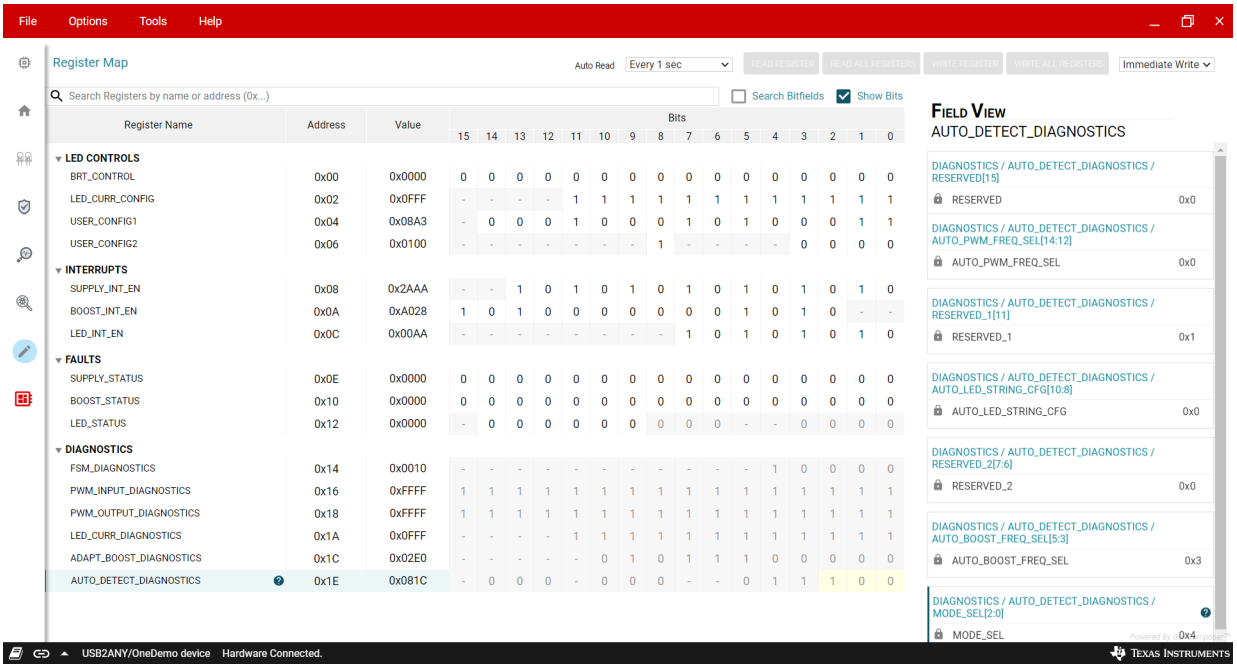

Figure 2-8. LP8864EVM Register Map Page

2.7 Instructions for Standalone Evaluation

The LP8864EVM can be used for standalone evaluation (without GUI software and PC connection). To support standalone mode, it must be modified from its default settings as described in the following list:

1. Mount R20 to pull up EN input.
2. Change pullup and pulldown resistors to select spread spectrum enable (R18) or disable (R25) option.
3. Mount R19 to pull up PWM input for 100% brightness. If brightness needs to be changed from 100%, connect external PWM source at PWM pin.

The minimum procedures for turning on the LEDs after the previously-listed modifications are as follows:

1. Connect a 12-V external power supply between the power input terminals VBAT+ and GNDin on the LP8864EVM.
2. Connect the LP886X-LEDLAOD-EVM board (4 strings, 8 LEDs per string) to J10 on the LP8864EVM.
3. Turn on the external power supply.

3 LP8864EVM Board Layout

Figure 3-1 and Figure 3-2 illustrate the EVM board layout.

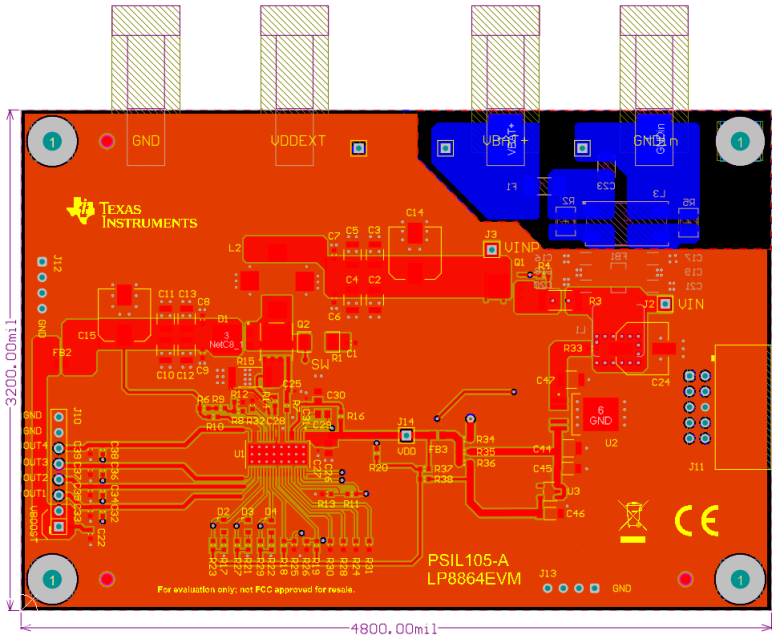

Figure 3-1. LP8864EVM Layout - Top

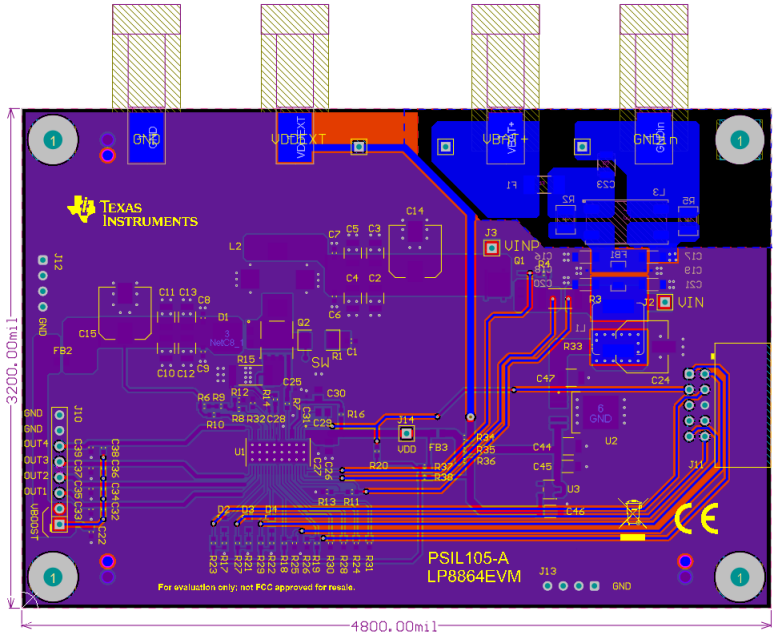

Figure 3-2. LP8864EVM Layout - Bottom

4 LP8864EVM Schematic

Figure 4-1 shows the LP8864EVM schematic.

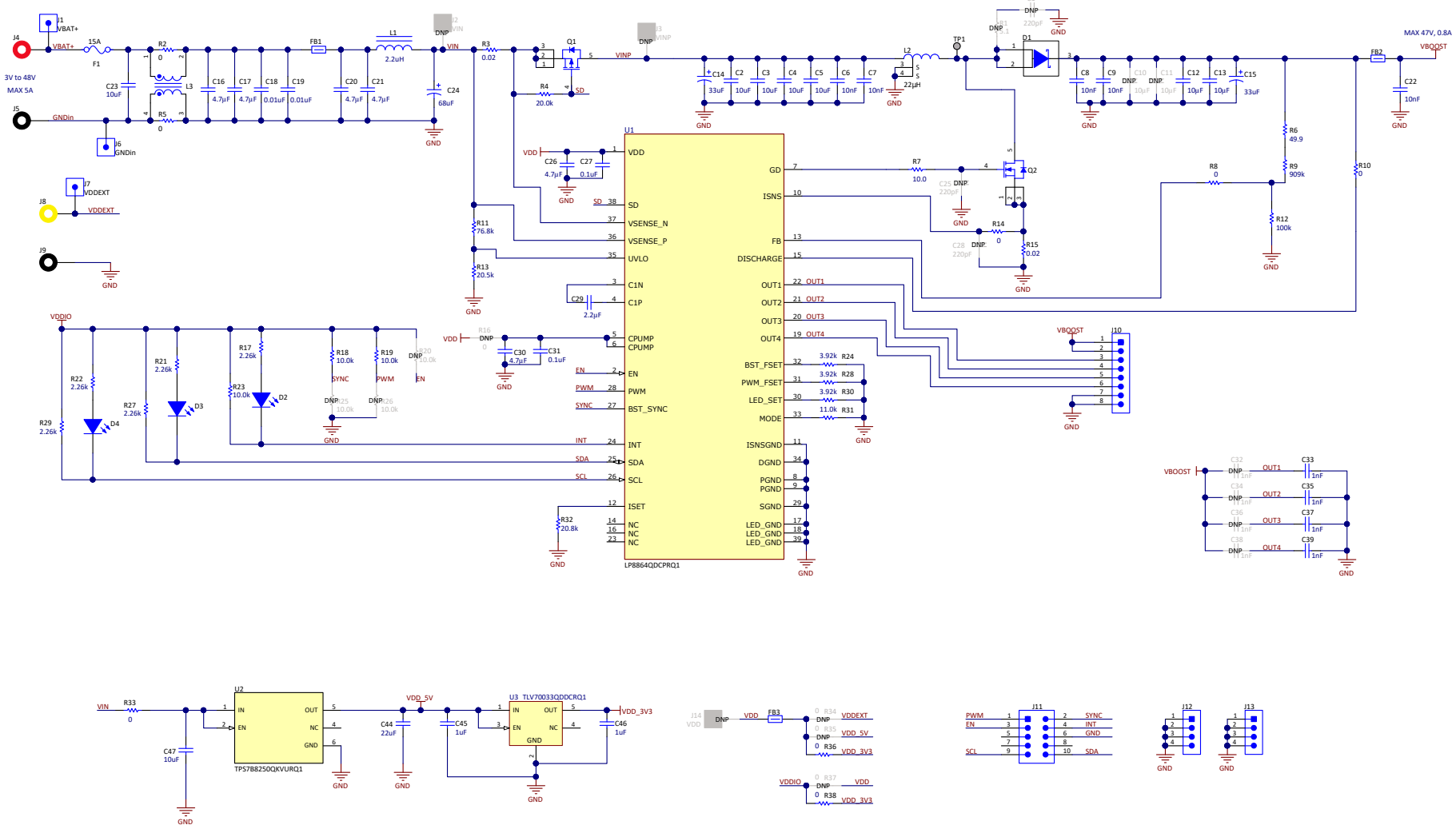

Figure 4-1. LP8864EVM Schematic

5 LP8864EVM Bill of Materials

Table 5-1 lists the bill of materials for the LP8864EVM.

Table 5-1. LP8864EVM Bill of Materials

Designator	QTY	Value	Part Number	Manufacturer	Description	Package Reference
!PCB1	1		PSIL105	Any	Printed Circuit Board	
C4, C5, C23, C47	4	10uF	UMK325AB7106KMHT	Taiyo Yuden	CAP, CERM, 10 uF, 50 V, ±10%, X7R, AEC-Q200 Grade 1, 1210	1210
C6, C7, C8, C9, C22	5	0.01uF	GCM188R72A103KA37J	MuRata	CAP, CERM, 0.01 µF, 100 V, ±10%, X7R, AEC-Q200 Grade 1, 0603	0603
C12, C13	2	10uF	CGA6P1X7R1N106M250AC	TDK	CAP, CERM, 10 µF, 75 V, ±20%, X7R, AEC-Q200 Grade 1, 1210	1210
C14, C15	2	33uF	EEH-ZC1J330P	Panasonic	CAP, Polymer Hybrid, 33 uF, 63 V, ±20%, 40 ohm, 8x10 SMD	8x10
C16, C17, C20, C21	4	4.7uF	CGA5L3X7R1H475K160AE	TDK	CAP, CERM, 4.7 µF, 50 V, ±10%, X7R, AEC-Q200 Grade 1, 1206	1206
C18, C19	2	0.01uF	GCM155R71H103KA55D	MuRata	CAP, CERM, 0.01 uF, 50 V, ±10%, C0G/NP0, 0402	0402
C24	1	68uF	EEE-FK1J680UP	Panasonic	CAP, AL, 68 uF, 63 V, ±20%, 0.65 ohm, AEC-Q200 Grade 2, SMD	SMT Radial F
C26, C30	2	4.7uF	GCM21BR71C475KA73L	MuRata	CAP, CERM, 4.7 uF, 16 V, ±10%, X7R, AEC-Q200 Grade 1, 0805	0805
C27, C31	2	0.1uF	C0402C104K4RACAUTO	Kemet	CAP, CERM, 0.1 uF, 16 V, ±10%, X7R, AEC-Q200 Grade 1, 0402	0402
C29	1	2.2uF	CGA4J3X7R1H225K125AB	TDK	CAP, CERM, 2.2 uF, 50 V, ±10%, X7R, AEC-Q200 Grade 1, 0805	0805
C33, C35, C37, C39	4	1000pF	CGA3E2X7R2A102K080AA	TDK	CAP, CERM, 1000 pF, 100 V, ±10%, X7R, AEC-Q200 Grade 1, 0603	0603
C44	1	22uF	CGA6P1X7R1C226M250AC	TDK	CAP, CERM, 22 uF, 16 V, ±20%, X7R, AEC-Q200 Grade 1, 1210	1210
C45, C46	2	1uF	CGA5L2X7R1E105M160AA	TDK	CAP, CERM, 1 uF, 25 V, ±20%, X7R, AEC-Q200 Grade 1, 1206_190	1206_190
D1	1	100V	FSV10100V	Fairchild Semiconductor	Diode, Schottky, 100 V, 10 A, AEC-Q101, TO-277A	TO-277A
D2, D3, D4	3	Super Red	VLMS20J2L1-GS08	Vishay-Semiconductor	LED, Super Red, SMD	2.2x1.3x1.4mm
F1	1		0679L9150-01	Bel Fuse	FUSE BRD MNT 15A 125VAC/VDC	2410
FB1	1	50 ohm	BLM31SN500SZ1L	MuRata	Ferrite Bead, 50 ohm @ 100 MHz, 12 A, 1206	1206
FB2, FB3	2	560 ohm	782853561	Wurth Elektronik	Ferrite Bead, 560 ohm @ 100 MHz, 1.5 A, 0805	0805
H1, H2, H3, H4	4		NY PMS 440 0025 PH	B&F Fastener Supply	Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw
H5, H6, H7, H8	4		1902C	Keystone		Standoff
H9	1		PSIL110		PSIL110, LP886X-LEDLOAD-EVM, CDDS#: 6631820	
H10	1		USB2ANY		USB2ANY, CDDS#: 6542513	
J1, J6, J7	3		TSW-101-07-G-S	Samtec	Header, 100mil, 1pos, Gold, TH	Testpoint
J4	1		6091	Keystone	Standard Banana Jack, Insulated, Red	6091
J5, J9	2		6092	Keystone	Standard Banana Jack, Insulated, Black	6092
J8	1		108-0907-001	Cinch Connectivity	BANANA JACK, 15A, Insulated, Nylon,Yellow	940x438x438mil
J10	1		TSW-108-07-G-S	Samtec	Header, 100mil, 8x1, Gold, TH	8x1 Header
J11	1		SBH11-PBPC-D05-RA-BK	Sullins Connector Solutions	Header(shrouded), 2.54mm, 5x2, Gold, R/A, TH	Header, 2.54mm, 5x2, R/A, TH
J12, J13	2		TSW-104-07-G-S	Samtec	Header, 100mil, 4x1, Gold, TH	4x1 Header
L1	1	2.2uH	IHLP3232DZER2R2M01	Vishay-Dale	Inductor, Shielded, Powdered Iron, 2.2 uH, 10.5 A, 0.0137 ohm, SMD	322x158x322mil
L2	1	22uH	IHLE4040DDER220M5A	Vishay-Dale	Inductor, Shielded, 22 µH, 4.1 A, 0.07544 ohm, AEC-Q200 Grade 0, SMD	Shielded Inductor

Table 5-1. LP8864EVM Bill of Materials (continued)

Designator	QTY	Value	Part Number	Manufacturer	Description	Package Reference
L3	1	9uH	PLT10HH501100PNL	MuRata	Coupled inductor, 9 uH, 10A, 0.0036 ohm, SMD	12.9x6.6mm
Q1	1	-60V	SQJ459EP-T1_GE3	Vishay-Semiconductor	MOSFET, P-CH, -60 V, -52 A, AEC-Q101, PowerPAK_SO-8L	PowerPAK_SO-8L
Q2	1	60V	NVMFS5C673NLWFAFT1G	ON Semiconductor	MOSFET, N-CH, 60 V, 50 A, SO-8FL	SO-8FL
R2, R5	2	0	CRCW12100000Z0EAHP	Vishay-Dale	RES, 0, 1%, 0.75 W, AEC-Q200 Grade 0, 1210	1210
R3, R15	2	0.02	CRA2512-FZ-R020ELF	Bourns	RES, 0.02, 1%, 3 W, 2512	2512
R4	1	20.0k	ERJ-3EKF2002V	Panasonic	RES, 20.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603
R6	1	49.9	CRCW060349R9FKEA	Vishay-Dale	RES, 49.9, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603
R7	1	10.0	CRCW060310R0FKEA	Vishay-Dale	RES, 10.0, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603
R8, R10, R14, R33, R36, R38	6	0	RMCF0603ZT0R00	Stackpole Electronics Inc	RES, 0, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603
R9	1	909k	CRCW0603909KFKEA	Vishay-Dale	RES, 909 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603
R11	1	76.8k	CRCW060376K8FKEA	Vishay-Dale	RES, 76.8 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603
R12	1	100k	CRCW0603100KFKEA	Vishay-Dale	RES, 100 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603
R13	1	20.5k	CRCW060320K5FKEA	Vishay-Dale	RES, 20.5 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603
R17, R21, R22, R27, R29	5	2.26k	CRCW06032K26FKEA	Vishay-Dale	RES, 2.26 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603
R18, R19, R23	3	10.0k	RMCF0603FT10K0	Stackpole Electronics Inc	RES, 10.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603
R24, R28, R30	3	3.92k	CRCW06033K92FKEA	Vishay-Dale	RES, 3.92 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603
R31	1	11.0k	RMCF0603FT11K0	Stackpole Electronics Inc	RES, 11.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603
R32	1	20.8k	RT0603BRD0720K8L	Yageo America	RES, 20.8 k, 0.1%, 0.1 W, 0603	0603
U1	1		LP8864QDCPRQ1	Texas Instruments	Automotive display LED-backlight with Four 200-mA channels	HTSSOP38
U2	1		TPS7B8250QKVURQ1	Texas Instruments	Automotive 300-mA high-voltage ultra-low-Iq low-dropout (LDO) regulator, KVU0005A (TO-252-5)	KVU0005A
U3	1		TLV70033QDDCRQ1	Texas Instruments	Single Output Automotive LDO, 200 mA, Fixed 3.3 V Output, 2 to 5.5 V Input, with Low IQ, 5-pin SOT (DDC), -40 to 125 degC, Green (RoHS & no Sb/Br)	DDC0005A
C1	0	220pF	GRM188R72A221KA01D	MuRata	CAP, CERM, 220 pF, 100 V, ±10%, X7R, 0603	0603
C2, C3	0	10uF	UMK325AB7106KMHT	Taiyo Yuden	CAP, CERM, 10 uF, 50 V, ±10%, X7R, AEC-Q200 Grade 1, 1210	1210
C10, C11	0	10uF	CGA6P1X7R1N106M250AC	TDK	CAP, CERM, 10 µF, 75 V, ±20%, X7R, AEC-Q200 Grade 1, 1210	1210
C25, C28	0	220pF	CGA2B2X7R1H221K050BA	TDK	CAP, CERM, 220 pF, 50 V, ±10%, X7R, AEC-Q200 Grade 1, 0402	0402
C32, C34, C36, C38	0	1000pF	CGA3E2X7R2A102K080AA	TDK	CAP, CERM, 1000 pF, 100 V, ±10%, X7R, AEC-Q200 Grade 1, 0603	0603
FID1, FID2, FID3, FID4, FID5, FID6	0		N/A	N/A	Fiducial mark. There is nothing to buy or mount.	N/A
J2, J3, J14	0		TSW-101-07-G-S	Samtec	Header, 100mil, 1pos, Gold, TH	Testpoint
R1	0	5.1	CRCW20105R10JNEF	Vishay-Dale	RES, 5.1, 5%, 0.75 W, AEC-Q200 Grade 0, 2010	2010
R16, R34, R35, R37	0	0	RMCF0603ZT0R00	Stackpole Electronics Inc	RES, 0, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603
R20, R25, R26	0	10.0k	RMCF0603FT10K0	Stackpole Electronics Inc	RES, 10.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603

6 LED Load Board

An LED load board LP886X-LEDLOAD-EVM is included in the EVM kit. The LED board is intended to be used as the load for LED driver and can be configured for up to 6 strings and up to 20 LEDs in the string (Number of LEDs in use is defined by jumpers). The initial setting on the board is 8 LEDs in series per string. Cree XLamp ML-C LEDs with maximum current of 350 mA (for parallel use) and maximum forward voltage of 3.4 V at 100 mA (3.2-V typical) are used on the board.

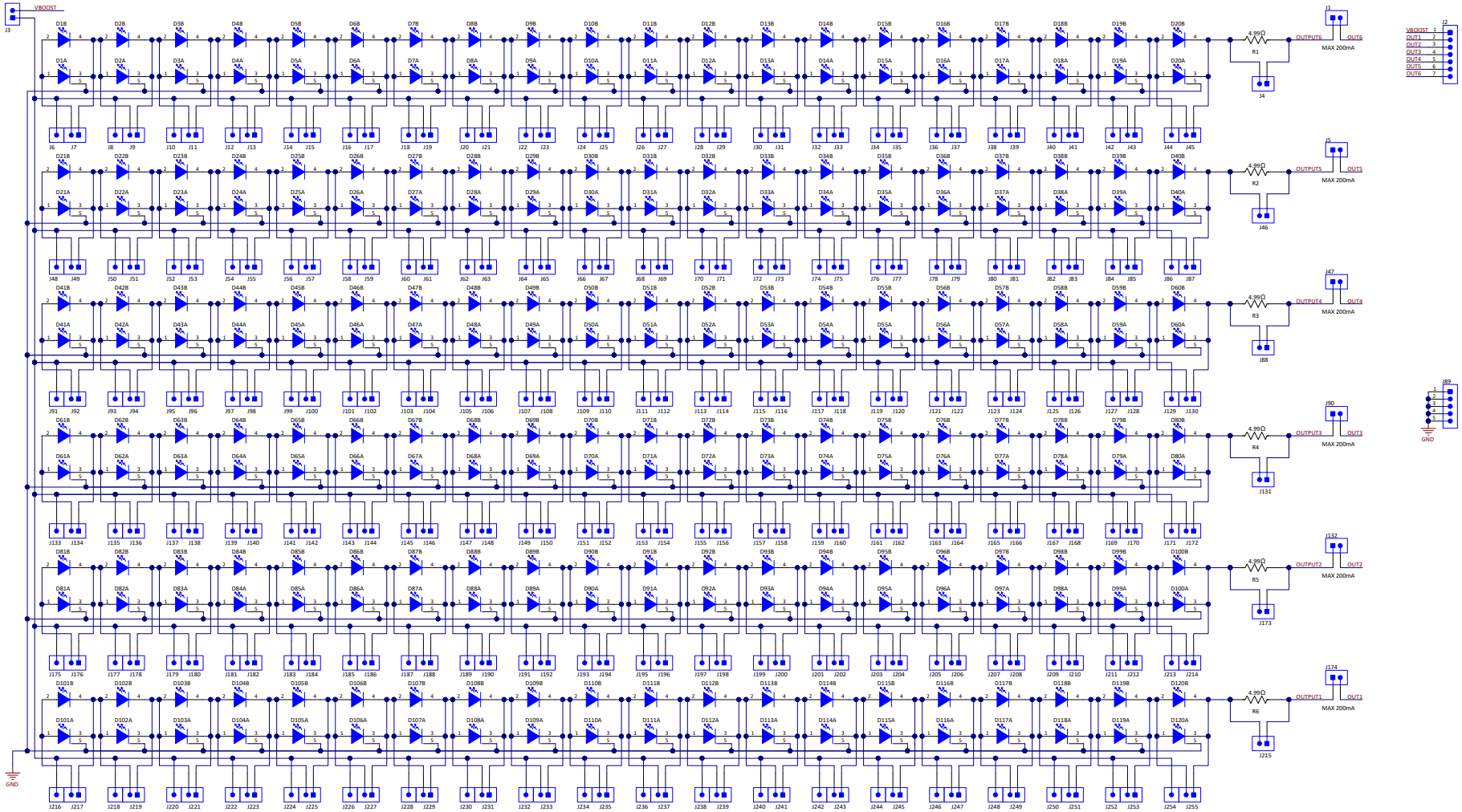

Figure 6-1. LP886X-LEDLOAD-EVM Schematic

Table 6-1. LP886X-LEDLOAD-EVM Bill of Materials

Designator	QTY	Part Number	Manufacturer	Description	Package Reference
!PCB1	1	PSIL110		Printed Circuit Board	
D1…D120	120	MLCAWT-A1-0000-000XE1	Cree Inc.	LED XLAMP COOL WHITE 6500K 4SMD	SMD4
H1, H2, H3, H4	4	NY PMS 440 0038 PH	B&F Fastener Supply		
H5, H6, H7, H8	4	1902C	Keystone		Standoff
H9, H10, H11, H12	4	4802	Keystone		
H13	1	MCH050		Gray smoked plexiglass, 0.125" THK. Must comply with REACH directive. Must meet or exceed UL94-V0	7.53" X 4" X 0.125"
J7, J9...J43, J45; J49, J51...J85, J87; J92, J94...J128, J130; J134, J136...J170, J172; J176, J178...J212, J214; J217, J219...J253, J255; J1, J3, J4, J5, J46, J47, J88, J90, J131, J132, J173, J174, J215	133	TSW-102-07-G-S	Samtec	Header, 100mil, 2x1, Gold, TH	2x1 Header
J2	1	TSW-107-07-G-S	Samtec	Header, 100mil, 7x1, Gold, TH	7x1 Header
J6, J8...J42, J44; J48, J50...J84, J86; J91, J93...J127, J129; J133, J135...J169, J171; J175, J177...J211, J213; J216, J218...J252, J254	120	TSW-101-07-G-S	Samtec	Header, 100mil, 1pos, Gold, TH	Testpoint
J89	1	TSW-105-07-G-S	Samtec	Header, 100mil, 5x1, Gold, TH	5x1 Header
R1, R2, R3, R4, R5, R6	6	CRCW12064R99FKEAHP	Vishay Dale	Res Thick Film 1206 4.99 Ohm 1% 0.75W(3/4W) ±100ppm/C Pad SMD Automotive T/R	1206
SH-J1...SH-J19	19	SPC02SYAN	Sullins Connector Solutions	Shunt, 100mil, Flash Gold, Black	Closed Top 100mil Shunt
FID1, FID2, FID3	0	N/A	N/A	Fiducial mark. There is nothing to buy or mount.	N/A

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