

LT3964  
36V Synchronous Dual LED  
Driver with I<sup>2</sup>C**DESCRIPTION**

The DC2424A is a 36V synchronous dual LED driver with I<sup>2</sup>C featuring the LT<sup>®</sup>3964. It drives two separate LEDs (or channels of LEDs) at 1A when  $V_{IN}$  is between 5V and 36V. DC2424A runs at 2MHz switching frequency. Its two channels can drive separate LED strings which can have different currents, voltages, or dimming ratios. It can be controlled with I<sup>2</sup>C communications or it can be run in non-I<sup>2</sup>C mode with proper ADDR pin settings. It is protected against both open and short LED conditions and reports the faults. In I<sup>2</sup>C mode, faults can be enabled or disabled. Up to 9 different DC2424As can be placed on the same I<sup>2</sup>C bus with unique addresses. A graphical user interface (GUI) is available through QuikEval™ when connected to a DC2026C Linduino® One demo circuit.

The LT3964 has an input voltage range from 4V to 36V. It has two independent 1.6A, 40V bucks with internal, synchronous 40V switches for high efficiency and small size. It has adjustable switching frequency between 200kHz and 2MHz. It can be synchronized to an external source or programmed with a clock output (CLKOUT) from the serial interface. The PWM TG high side PWM MOSFET drivers assist with short-circuit protection and versatility. Although the demo circuit is optimized for just one LED per channel, it can be altered to be buck regulators with as high as 33V of LEDs if  $V_{IN}$  is high enough and circuit components are changed appropriately.

In non-I<sup>2</sup>C mode, each channel can separately be PWM- and analog-dimmed by placing a PWM signal or CTRL voltage on the provided turrets. In I<sup>2</sup>C mode, each channel can be dimmed to up to 8192:1 and analog dimmed to a high ratio using serial communications.

Small ceramic input and output capacitors are used to save space and cost. The open LED overvoltage protection uses the IC's constant voltage regulation loop to regulate the output to approximately 4.2V if the LED string is opened. There is a protection diode from each LED+ to GND to prevent negative ringing during a short-circuit condition.

Undervoltage lockout can be adjusted on the circuit with a few simple resistor choices. The output voltage (overvoltage protection) can be adjusted by changing the feedback resistors for higher string voltages. Other components may need to be changed to accommodate higher voltages also.

The LT3964 data sheet gives a complete description of the device, operation and applications information. The data sheet must be read in conjunction with this demo manual for DC2424A. The LT3964EUHE is assembled in a 36-lead plastic 5mm × 6mm QFN package with a thermally enhanced ground pad. Proper board layout is essential for maximum thermal performance. See the data sheet Layout Considerations section.

**Design files for this circuit board are available at**  
<http://www.linear.com/demo/DC2424A>

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# DEMO MANUAL

## DC2424A

### PERFORMANCE SUMMARY Specifications are at $T_A = 25^\circ\text{C}$

PARAMETER	CONDITION	MIN	TYP	MAX
Input Voltage $PV_{IN}$ Range	Operating	5V		36V
Switching Frequency	$R8 = 27.4k$		2.0MHz	
$I_{LED1}, I_{LED2}$	$R12 = R16 = 0.1\Omega$		1.0A	
Open LED Voltage $V_{OUT}$ (V COUT)	$R10 = R14 = 1M$ $R11 = R15 = 383k$		4.2V	
Efficiency (100% PWM DC)	12.0V $PV_{IN}$ , 2MHz, $I_{LED1} = I_{LED2} = 1.0A$ , 1 LED		81%	
$V_{LED}$ Range	$R10 = R14 = 1M$ $R11 = R15 = 383k$	2.5V		3.6V
I <sup>2</sup> C PWM Dimming Frequency	$R8 = 27.4k$		244Hz	
$PV_{IN}$ Undervoltage Lockout (Falling)	$R1 = 332k$ $R2 = 102k$		5.0V	
$PV_{IN}$ Turn-On Voltage (Rising)	$R1 = 332k$ $R2 = 102k$		6.0V	

## QUICK START PROCEDURE

### How to Operate in Non-I<sup>2</sup>C Mode

The DC2424A is easy to set up to evaluate the performance of the LT3964 in non-I<sup>2</sup>C mode. Follow the procedure below:

1. With power off, connect a single LED between LED1+ and LED1– terminals and the same for LED2+ and LED2–. Connect the EN/UVLO terminal to GND to keep the circuit shut down. With power off, connect the input power supply to the  $V_{IN}$  and GND terminals. Make sure that the input voltage will not exceed 36V.
2. For non-I<sup>2</sup>C mode operation, set both JP1 and JP2 (ADDR1 and ADDR2) to 0. The 00 address pins setting is for non-I<sup>2</sup>C mode, but all other settings are for I<sup>2</sup>C serial communications mode.
3. Turn the input power supply on and make sure the voltage is between 8V and 36V to start operation.
4. Release the EN/UVLO-to-GND connection.
5. Observe the LED string running at the programmed LED current.
6. To change the brightness with analog dimming in non-I<sup>2</sup>C mode, simply attach a voltage source the CTRL1 and/or CTRL2 terminals and set the voltage between 0V and 1.5V. See data sheet for details.

7. To change brightness with external PWM dimming in non-I<sup>2</sup>C mode, simply attach a rectangular waveform with varying duty cycle to the PWM1 and/or PWM2 terminals.

### How to Operate with Graphical User Interface (GUI) – I<sup>2</sup>C Serial Communications Mode

1. With power off, connect a single LED between LED1+ and LED1– terminals and the same for LED2+ and LED2–. Connect the EN/UVLO terminal to GND to keep the circuit shut down. With power off, connect the input power supply to the  $V_{IN}$  and GND terminals. Make sure that the input voltage will not exceed 36V.
2. For I<sup>2</sup>C serial communications operation, set JP1 (ADDR1) to 0 and JP2 (ADDR2) to 1. The 01 address setting works seamlessly with the DC2424A GUI in QuikEval. In general, serial communications can be used with the LT3964 as long as ADDR1 and ADDR2 settings are anything other than 00. There are three states to each ADDR pin, 0, 1, or float. There are 9 unique I<sup>2</sup>C address settings.
3. Connect a ribbon cable between the J1 serial communications connection and a Linduino One (DC2026C) demo circuit.
4. Connect a USB cable between a PC and the DC2026C.
5. Turn on 12V power to the  $PV_{IN}$  and GND pins of the DC2424A.

### QUICK START PROCEDURE

- Launch QuikEval (find installation instructions on the [www.linear.com](http://www.linear.com) website) and the LT3964 DC2424A GUI launches.
- Use the DC2424A GUI in QuikEval to test the performance of the LT3964 demo circuit.

NOTE: A DC2424A LT3964 GUI user guide is posted on the landing page for the LT3964 and DC2424A. It contains the GUI pages, commands, and other details. Please contact Linear support for help with the GUI and User Guide.

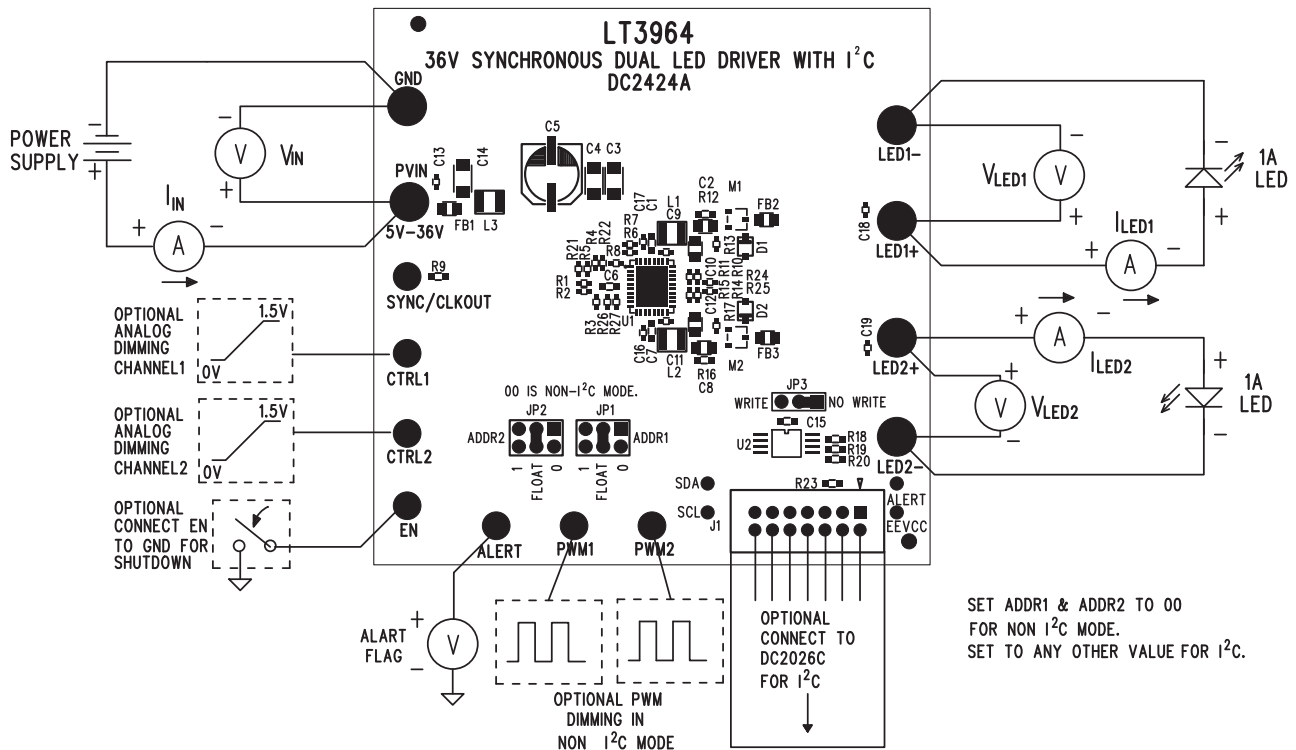


Figure 1. Test Procedure Setup Drawing for DC2424A

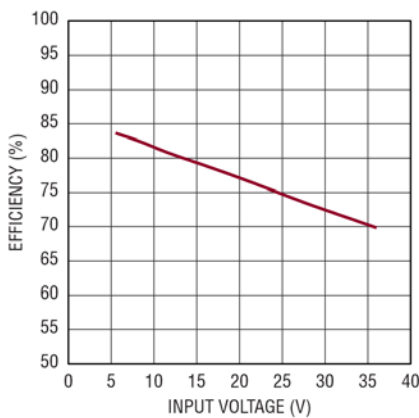


Figure 2. DC2424A Efficiency vs Input Voltage with 2MHz and Single 1A LED on Each Channel

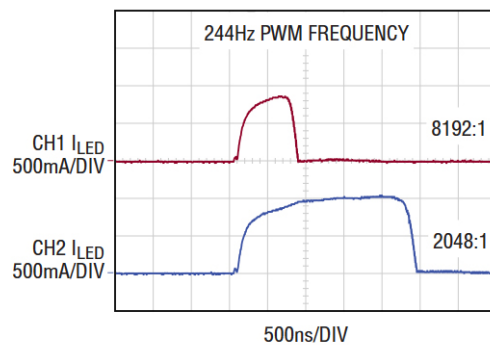


Figure 3. DC2424A PWM Dimming Using I²C Settings for 8192:1 and 2048:1 Dimming Ratios

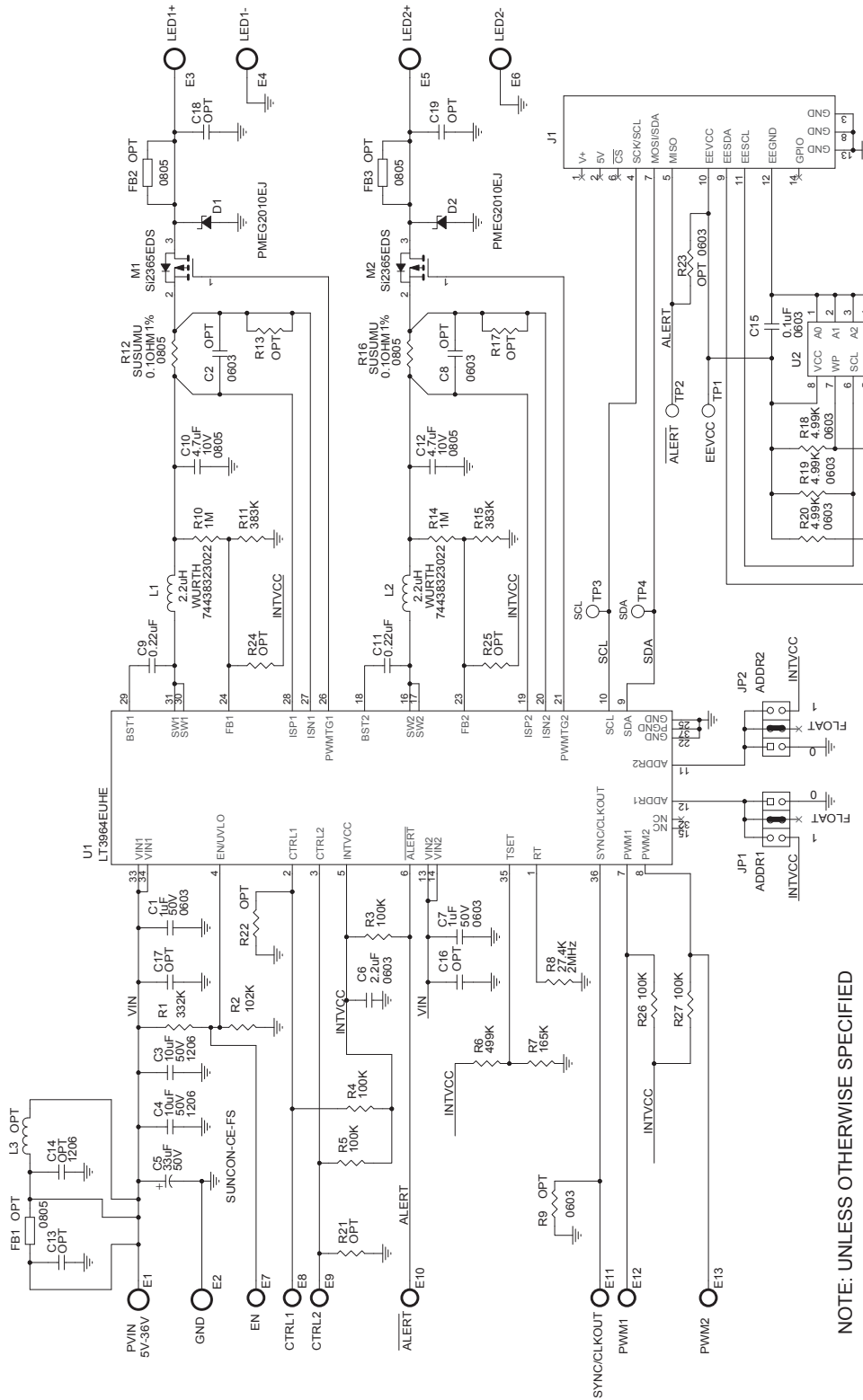
# DEMO MANUAL

## DC2424A

### PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>Required Circuit Components</b>				
1	2	C1, C7	CAP., 1 $\mu$ F, X5R, 50V, 10%, 0603	MURATA, GRM188R61H105KAALD
2	2	C10, C12	CAP., 4.7 $\mu$ F, X7R, 10V, 10%, 0805	MURATA, GRM21BR71A475KA73L
4	2	C3, C4	CAP., 10 $\mu$ F, X5R, 50V, 10%, 1206	MURATA, GRM31CR61H106KA12L
6	1	C6	CAP., 2.2 $\mu$ F, X5R, 25V, 10%, 0603	MURATA, GRM188R61E225ME84D
7	2	C9, C11	CAP., 0.22 $\mu$ F, X5R, 25V, 10%, 0402	MURATA, GRM155R61E224KE01D
19	2	L1, L2	INDUCTOR, 2.2 $\mu$ H	WURTH ELEKTRONIK, 74438323022
21	2	M1, M2	MOSFET P-CH, 20V, 5.9A, SOT-23	VISHAY, Si2365EDS-T1-GE3
22	1	R1	RES., 332k, 1/16W, 1%, 0402	VISHAY, CRCW0402332KFKED
24	1	R2	RES., 102k, 1/16W, 1%, 0402	VISHAY, CRCW0402102KFKED
25	1	R3	RES., 100k, 1/16W, 1%, 0402	VISHAY, CRCW0402100KFKED
23	1	R6	RES., 499k, 1/16W, 1%, 0402	VISHAY, CRCW0402499KFKED
26	1	R7	RES., 165K, 1/16W, 1%, 0402	VISHAY, CRCW0402165KFKED
27	1	R8	RES., 27.4k, 1/16W, 1%, 0402	VISHAY, CRCW040227K4FKED
28	2	R11, R15	RES., 383k, 1/16W, 1%, 0402	VISHAY, CRCW0402383KFKED
30	2	R10, R14	RES., 1M, 1/16W, 1%, 0402	VISHAY, CRCW04021M00FKED
31	2	R12, R16	RES., 0.1 $\Omega$ , 1/2W, 1%, 0805	SUSUMU, KRL1220E-M-R100-F-T5
34	1	U1	I.C. LED DRIVER QFN-5 $\times$ 6	LINEAR, LT3964EUHE#PBF
<b>Optional Electrical Components</b>				
3	0	C2, C8 (OPT)	CAP., 0603	OPTION
5	1	C5	CAP., ALUM., 33 $\mu$ F, 50V, 6.3 $\times$ 7.7	SUNCON, 50CE33FS
8	0	C13, C16, C18, C19 (OPT)	CAP., 0402	OPTION
9	0	C14 (OPT)	CAP., 1206	OPTION
10	1	C15	CAP., 0.1 $\mu$ F, X7R, 16V, 10%, 0603	MURATA, GRM188R71C104KA01D
11	2	D1, D2	DIODE SCHOTTKY, 20V, 1A, SOD323F	NXP, PMEG2010EJ, 115
14	0	FB1, FB2, FB3 (OPT)	FERRITE BEAD, CHIP, 0805	
20	0	L3 (OPT)	INDUCTOR, 2.2 $\mu$ H	WURTH ELEKTRONIK, 74438323022
25	4	R4, R5, R26, R27	RES., 100k, 1/16W, 1%, 0402	VISHAY, CRCW0402100KFKED
29	0	R9, R23 (OPT)	RES, OPT, 0603	
32	0	R13, R17, R21, R22, R24, R25	RES, 0402	OPTION
33	3	R18, R19, R20	RES., 4.99k, 1/10W, 1%, 0603	VISHAY, CRCW06034K99FKEA
35	1	U2	I.C., EEPROM 2-KBIT 400kHz 8-TSSOP	MICROCHIP, 24LC025-I/ST
<b>Hardware</b>				
1	6	E1-E6	TESTPOINT, TURRET, 0.094" PBF	MILL-MAX, 2501-2-00-80-00-00-07-0
2	7	E7-E13	TESTPOINT, TURRET, 0.061" PBF	MILL-MAX, 2308-2-00-80-00-00-07-0
3	2	JP1, JP2	HEADER, 2 $\times$ 3 PIN, 0.079 DOUBLE ROW	WURTH ELEKTRONIK, 62000621121
4	1	JP3	HEADOR, 3 $\times$ 1 PIN, 0.079", SINGLE ROW	WURTH ELEKTRONIK, 62000311121
5	3	XJP1, XJP2, XJP3	SHUNT, 0.079" CENTER	WURTH ELEKTRONIK, 60800213421
6	1	J1	HEADER, 2 $\times$ 7 DUAL ROW	MOLEX, 87831-1420

## SCHEMATIC DIAGRAM



NOTE: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTORS ARE 0402.
2. ALL CAPACITORS ARE 0402.

00 IS NON-1°C MODE.

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<p><b>LINEAR TECHNOLOGY</b></p>		<p>LT3964EUHE</p>	
<p>TITLE: SCHEMATIC</p>		<p>36V SYNCHRONOUS DUAL LED DRIVER WITH 1°C</p>	
SIZE	IC NO.	REV.	REV.
N/A	LT3964EUHE	3	3
DATE:	DATE:	SHEET	OF
Thursday, July 13, 2017	Thursday, July 13, 2017	1	1

# DEMO MANUAL

## DC2424A

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