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## DESCRIPTION

Demonstration circuit DC2218A is a matrix LED dimmer system featuring the [LT3965](#) 8-switch matrix LED dimmer IC. There are 16 500mA LEDs that can be individually turned on, off, or PWM dimmed with two 8-switch LED dimmer LT3965 ICs. The two strings of LEDs are driven with two buck LED driver outputs of the LT3797 triple LED controller IC. The third channel of the LT3797 serves as a 30V pre-boost voltage regulator to provide a proper input voltage to the two buck LED driver channels. DC2218A can be driven from a 9V to 30V input and can survive transients up to 36V.

A pre-programmed DC2026C Linduino™ One demo circuit is attached to the DC2218A matrix LED dimmer shield to create a full matrix LED dimmer system. With the Linduino One attached as an under-shield microcontroller board, the entire system can be powered from either a 9V to 36V lab power supply or battery connected to the EMIVIN banana jacks or from a 12V 4A+ AC/DC converter connected to the J7 barrel jack connector.

DC2218A can be operated by connecting 12V power to the input and selecting 7 pre-programmed patterns with rotary switch S1. When connected to a PC through a USB cable, an eighth setting of S1 (position 7) allows DC2218A to be operated with a graphical user interface (GUI).

The LT3965 data sheet gives a complete description of the part, operation and applications information. The data sheet must be read in conjunction with this demo manual for demonstration circuit DC2218A. The LT3965EFE is assembled in a 28-lead plastic TSSOP (FE) package with a thermally enhanced ground pad. Proper board layout is essential for maximum thermal performance. See the data sheet section Layout Considerations.

**Design files for this circuit board are available at <http://www.linear.com/demo/DC2218A>**

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

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Voltage (EMIVIN or J7 Barrel Connector)		8		36	V
RTCLK Switching Frequency	Set by LTC6900		350		kHz
PWM Dimming Frequency	Switching Frequency Divided by 2048		170		Hz
$I_{LED}$	16 LEDs, 8 LEDs Each LT3965		500		mA
$30V_{OUT}$ LT3797 CH3 Pre-Boost Voltage			30		V
I <sup>2</sup> C Serial Communications Frequency			400		kHz
Barrel Jack Connector Size (for 12V 4A+ Supply)	PJ-002AH Power Jack Connector J7		2.1		mm ID

## QUICK START PROCEDURE

### How to Operate Pre-Programmed Patterns 0-6 (S1)

Demonstration circuit DC2218A is easy to set up to evaluate the performance of the LT3965 matrix LED dimming system and its pre-programmed patterns.

NOTE: The included DC2026C Linduino One is pre-programmed to work with DC2218A. If the .ino code is mistakenly changed or overwritten, new .ino code must be uploaded from Linear's website.

NOTE: An acrylic shield has been assembled over the LEDs to protect the user's eyes from extremely bright light. Please make sure that the shield is in place and any necessary protective eyewear is worn before looking directly at the bright LEDs and their patterns.

Follow the procedure below:

1. Set the PATTERN SELECT rotary switch S1 to any position between 0 and 6. Position 7 is reserved for use with the GUI (graphical user interface).
2. Connect 12V power to either the EMIVIN and GND banana jacks or to the J7 2.1mm (inside diameter) barrel jack.
3. Observe the red LED indicator light (D32). When it begins flashing, then the board is ready to start up.
4. When the red LED (D32) is flashing, push the Push to Start button S3.
5. Observe the LED patterns and adjust the speed, brightness and pattern of the LEDs with the manual blue potentiometer R14.

6. Change the Pattern Select rotary switch to positions 0-6 to observe different patterns.

7. Press the Reset button S2 to start over again.

### How to Operate with Graphical User Interface (GUI)

Demonstration circuit DC2218A can be connected with a PC via USB cable and controlled with a GUI.

NOTE: The included DC2026C Linduino One is pre-programmed to work with DC2218A and to interface with the LT3965 GUI. If the .ino code is mistakenly changed or overwritten, new .ino code must be uploaded from Linear's website.

NOTE: An acrylic shield has been assembled over the LEDs to protect the user's eyes from extremely bright light. Please make sure that the shield is in place and any necessary protective eyewear is worn before looking directly at the bright LEDs and their patterns.

Follow the procedure below:

1. If never done before, download and install QuikEval™ from Linear's website under design tools and software at <http://www.linear.com/designtools/software/#Data>

QuikEval is your link to receiving the latest LT3965 GUI software and to run the GUI. Installation of QuikEval properly initializes the serial port driver on the computer to work with the Linduino One USB connection.

*If QuikEval is already installed, skip step 1, or update QuikEval to get the LT3965 GUI.*

## QUICK START PROCEDURE

2. Remove power and the USB cable from the DC2218A inputs.
3. Turn the PATTERN SELECT rotary switch S1 to position 7 for the GUI.
4. Connect 12V power to either the EMIVIN and GND banana jacks or to the J7 2.1mm (inside diameter) barrel jack.
5. Connect a USB cable between a PC and the USB connector on the under-shield DC2026C (which arrives included in the DC2218A package and pre-programmed with DC2218A .ino code).
6. Launch the LT3965 GUI from QuikEval.
7. Click Connect to DC2218A to connect to the DC2218A with the GUI.
8. Observe the GUI program starts at ALL CHANNEL MODE screen and the LEDs on the PCB are all off.
9. Start creating and testing I<sup>2</sup>C commands with ALL CHANNEL MODE, SINGLE CHANNEL MODE, BROADCAST, DIGITAL WRITE, READ REGISTERS, and LED SETTINGS pages.

NOTE: An LT3965 GUI user guide is posted on the Linear blog site. It contains the GUI commands and details. Please contact Linear support for help with the GUI and User Guide.

# DEMO MANUAL DC2218A

## QUICK START PROCEDURE

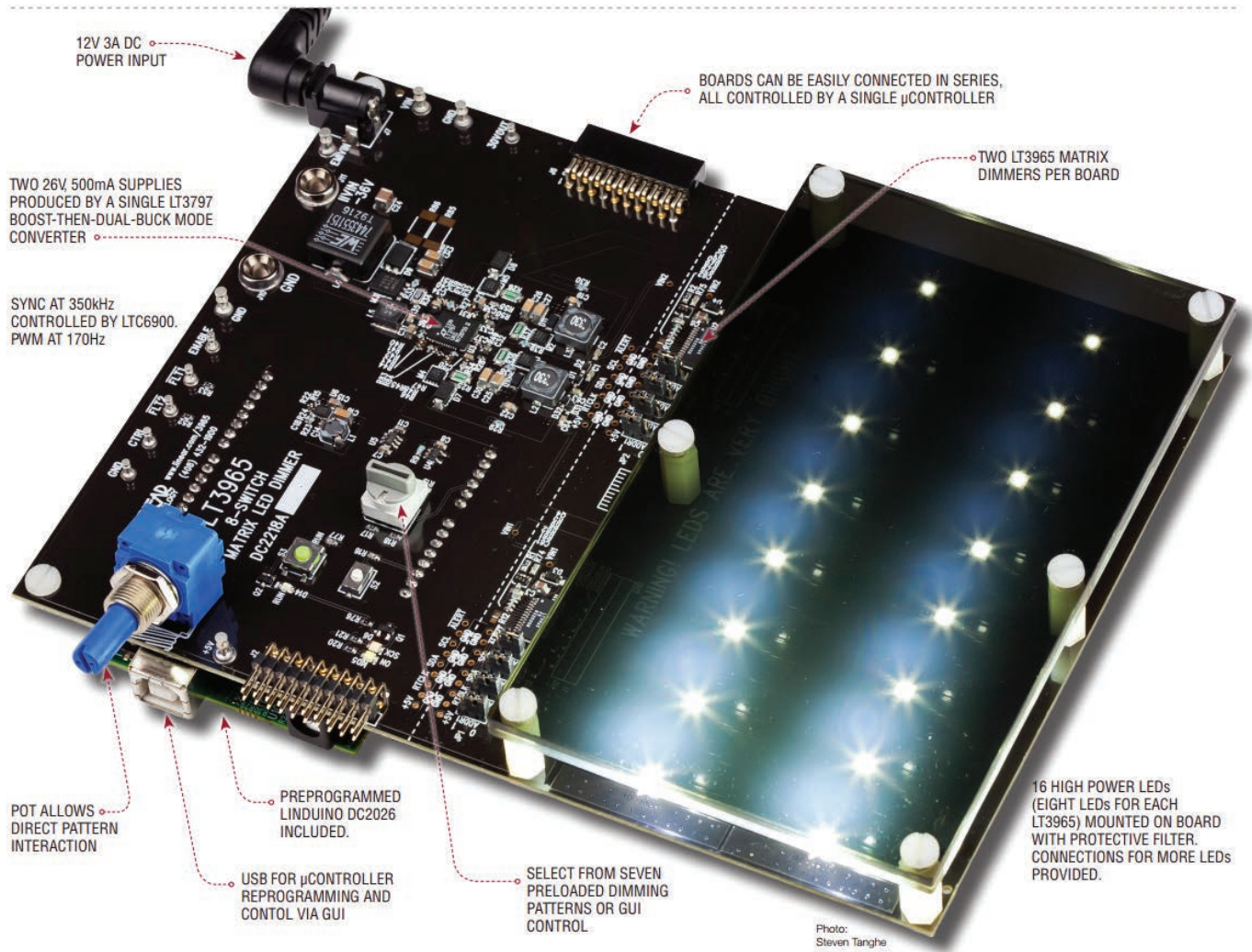


Figure 1. DC2218A Test Setup Photo

## QUICK START PROCEDURE

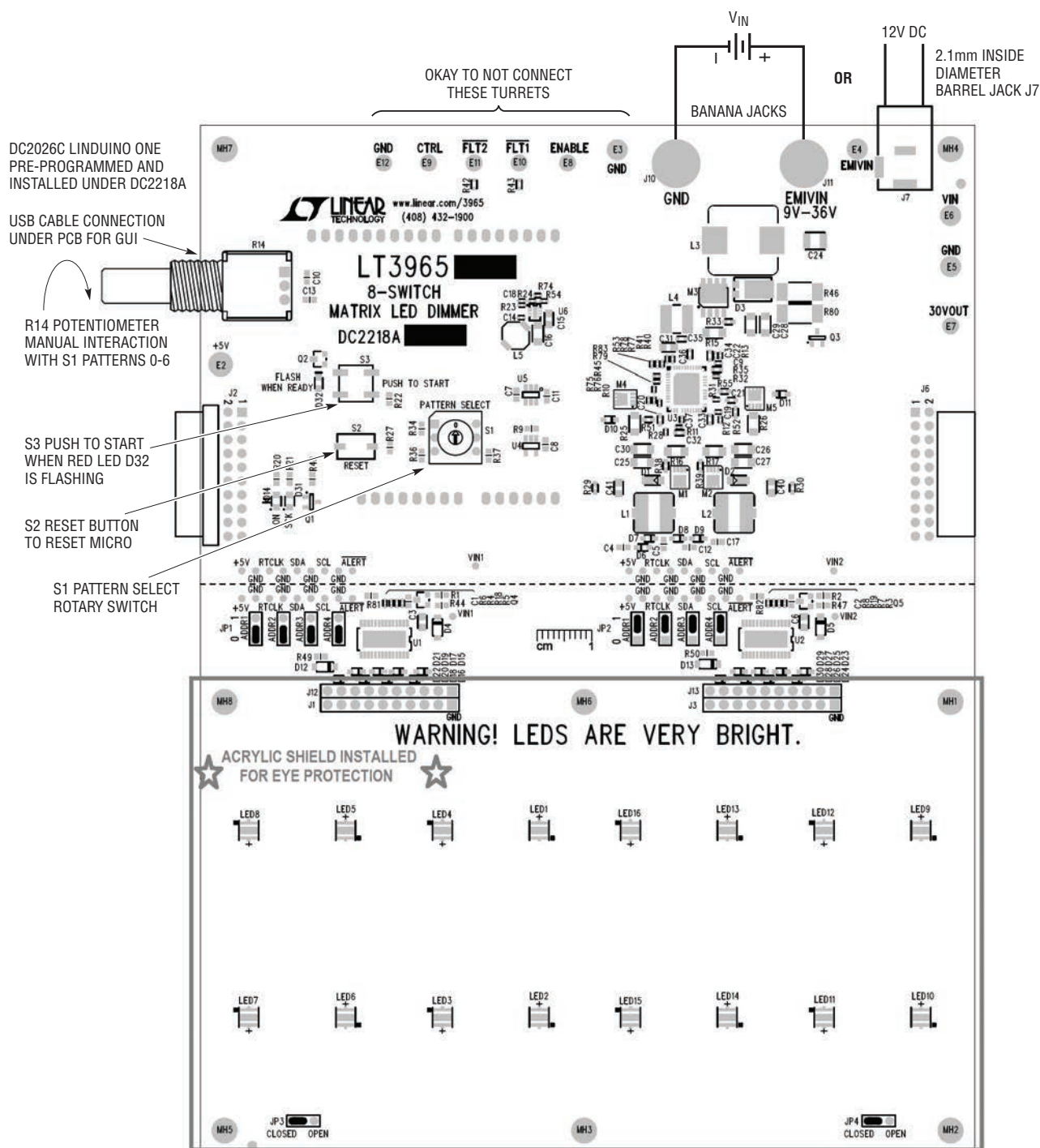


Figure 2. DC2218A Top Silkscreen and Component Reference Drawing

## PRE-PROGRAMMED PATTERNS

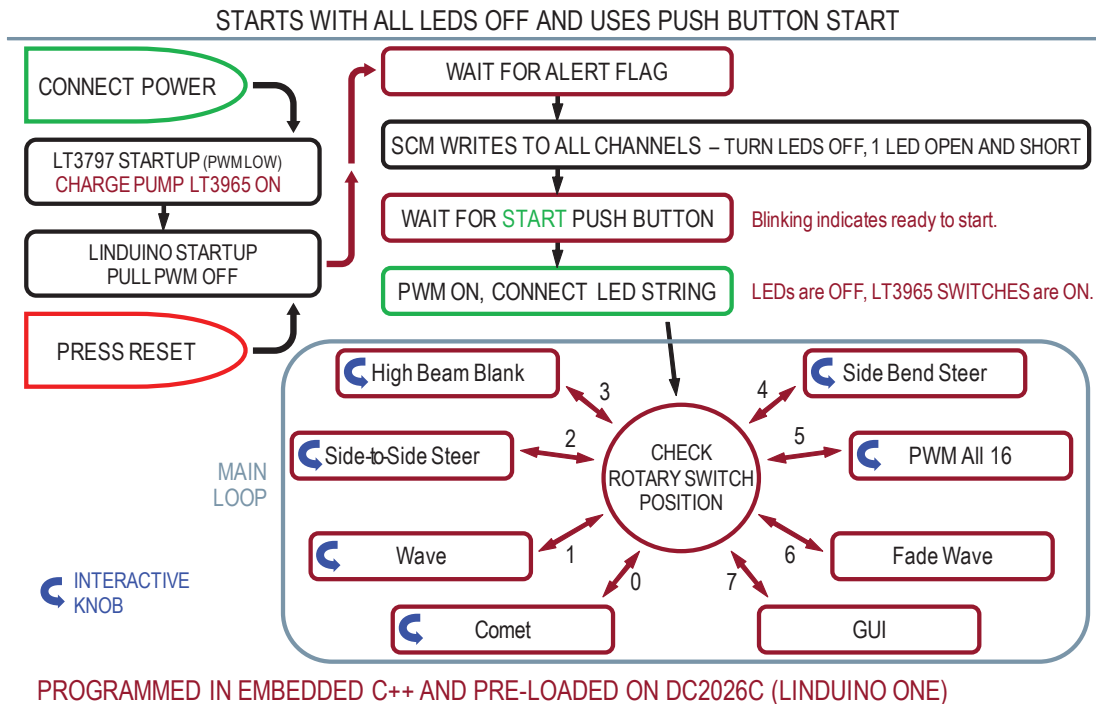


Figure 3. DC2218A Attached Linduino One Pre-Programmed Software Flow-Chart

### S1 Pattern Select Position

**0. Comet:** A comet of light runs around the sixteen LEDs changing PWM dimming brightness quickly increasing and decreasing at rates that look like a ball of fire zipping around the LEDs. The interactive potentiometer controls the speed of the comet.

**1. Wave:** A wave of light from right to left and from left to right changing PWM dimming brightness quickly increasing and decreasing at rates that look like a wave running from one side of the LEDs to the other. The interactive potentiometer controls the speed of the wave.

**2. Side-to-Side Steer:** Center headlight LEDs stay on to face directly forward while the right and left side LEDs turn on with brightness proportional to the amount that the steering wheel (interactive potentiometer) is turned.

**3. High Beam Blank:** While the low beam is on 100% brightness, the sections of the high beam turn OFF. Although the blank spots would be controlled by a sophisticated camera detecting an object in front of a car to determine which high beam LEDs to turn off or dim, the section on DC2218A is controlled by turning the interactive potentiometer.

**4. Side Bend Steer:** All sixteen LEDs adjust PWM dimming duty cycle and brightness based upon the position of the steering wheel (interactive potentiometer). This pattern represents a light that bends around the side of a car, projecting a turning headlight pattern that is linked to the steering wheel.

**5. PWM All 16:** All sixteen LEDs have the same PWM dimming and brightness level that is set by the interactive potentiometer. They range from OFF to ON in increments of 1/256 PWM dimming.

**6. Fade Wave:** Using the PWM dim WITH FADE commands, a wave of light is created by fading the LED brightnesses up and down. WITH FADE option uses the logarithmic fade function of the LT3965 and allows the brightness to fade from low to high or from high to low with a single I<sup>2</sup>C bus command. This pattern has low bus traffic.

**7. GUI:** GRAPHICAL USER INTERFACE position setting – Use this position when connecting to the GUI. See details above for downloading and connecting to the GUI via the USB cable connection of DC2026C.

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>LT3965 Matrix LED Dimmer Circuit Components</b>				
1	2	C1, C2	CAP, 0.1 $\mu$ F, X7R, 50V, 10%, 0402	MURATA, GRM155R71H104KE14D
2	2	C3, C6	CAP, 1 $\mu$ F, X7R, 50V, 10%, 0805	MURATA, GRM21BR71H105KA12L
3	0	C42-C59(OPT)	CAP, OPTION, 0402	
4	2	D4, D5	SCHOTTKY, RECTIFIER, 60V, 1A, SOD-123F	NXP, PMEG6010CEH, 115
5	2	D12, D13	SCHOTTKY, RECTIFIER, 40V, 1A, SOD-123F	NXP, PMEG4010CEH, 115
6	16	D15-D30	DIODE, PMEG4010CEJ SOD-323	NXP, PMEG4010CEJ, 115
7	2	Q4, Q5	TRANSISTOR, SOT-23	DIODES INC., FM593TA
8	2	R1, R2	RES., 49.9k, 1/10W, 1% 0603	VISHAY, CRCW060349K9FKEA
9	2	R3, R5	RES., 9.09k, 1/10W, 1%, 0603	VISHAY, CRCW06039K09FKEA
10	7	R4, R6, R7, R8, R18, R19, R83	RES., 10k, 1/16W, 1% 0402	VISHAY, CRCW040210K0FKED
11	2	R44, R47	RES., 1k, 1/10W, 1%, 0603	VISHAY, CRCW06031K00FKEA
12	2	U1, U2	I.C. LT3965EFE TSSOP28	LINEAR TECH., LT3965EFE#PBF
<b>LT3977 Boost-then-Dual-Buck LED Driver Circuit Components</b>				
1	4	C4, C5, C12, C17	CAP, 0.1 $\mu$ F, X7R, 100V, 10%, 0603	MURATA, GRM188R72A104KA35D
2	1	C9	CAP, 22nF, X7R, 25V, 10%, 0402	MURATA, GRM155R71E223KA61D
3	2	C19, C37	CAP, 2200pF, X7R, 25V, 10%, 0402	MURATA, GRM155R71E222KA01D
4	2	C20, C21	CAP, 22 $\mu$ F, X5R, 10V 20%, 0603	MURATA, GRM188R61A226ME15D
5	1	C22	CAP, 1000pF, C0G, 25V, 5%, 0402	MURATA, GRM1555C1E102JA01D
6	1	C23	CAP, ALUM., 33 $\mu$ F, 50V, 6.3X7.7	PANASONIC, EEHA1H330XP
7	1	C24	CAP, 4.7 $\mu$ F, X7R, 50V 10%, 1210	MURATA, GRM32ER71H475KA88L
8	7	C25-C30, C39	CAP, 10 $\mu$ F, X5R, 50V 10%, 1206	MURATA, GRM31CR61H106KA12L
9	1	C31	CAP, 1 $\mu$ F, X7R, 50V, 10%, 0805	MURATA, GRM21BR71H105KA12L
10	2	C32, C33	CAP, 1 $\mu$ F, X7R, 16V, 10%, 0603	MURATA, GRM188R71C105KA12D
11	1	C34	CAP, 0.22 $\mu$ F, X5R, 10V 10%, 0603	MURATA, GRM188R61A224KA01D
12	1	C35	CAP, 0.1 $\mu$ F, X7R, 16V, 10%, 0603	MURATA, GRM188R71C104KA01D
13	1	C36	CAP, 10 $\mu$ F, X5R, 10V, 10%, 0603	MURATA, GRM188R61A106KE69D
14	1	C38	CAP, 0.1 $\mu$ F, X7R, 50V, 10%, 0402	MURATA, GRM155R71H104KE14D
15	0	C40, C41(OPT)	CAP, 0805	
16	2	D1, D2	DIODE, DFSL260, POWER-DI-123	DIODES/ZETEX, DFSL260-7
17	1	D3	DIODE, PDS360, POWER-DI-5	DIODES/ZETEX, PDS360-13
18	6	D6-D11	DIODE, PMEG6010CEJ SOD-323	NXP, PMEG6010CEJ, 115
19	1	FB1	BEAD, CHIP, 742792150	WURTH ELEKTRONIK, 742792150
20	2	L1, L2	INDUCTOR, 33 $\mu$ H,	WURTH ELEKTRONIK, 7447789133
21	1	L3	INDUCTOR, 15 $\mu$ H	WURTH ELEKTRONIK, 7443551151
22	1	L4	IND., 47 $\mu$ H, SD SERIES, IND-SD25	EATON BUSSMANN, SD25-470-R
23	1	L6	INDUCTOR, 10 $\mu$ H	WURTH ELEKTRONIK, 7443251000
24	2	M1, M2	N-CH MOSFET, Si7308DN, POWERPAK-1212-8	VISHAY, Si7308DN-T1-GE3
25	1	M3	N-CH MOSFET, Si7850DP, POWERPAK S08	VISHAY, Si7850DP-T1-GE3
26	2	M4, M5	P-CH MOSFET, Si7611DN, POWERPAK-1212-8	VISHAY, Si7611DN-T1-GE3 (LEAD-FREE #)



# DEMO MANUAL DC2218A

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
27	1	R10	RES., 47.5k, 1/16W, 1% 0402	VISHAY, CRCW040247K5FKED
28	2	R11, R12	RES., 5.6k, 1/16W, 5% 0402	VISHAY, CRCW04025K60JNED
29	1	R13	RES., 15k, 1/16W, 5% 0402	VISHAY, CRCW040215K0JNED
30	1	R15	RES., 0.02Ω, 0.5W, 1% 1206	SUSUMU, RL1632R-R020-F
31	2	R16, R17	RES., 0.05Ω, 0.5W, 1% 1206	SUSUMU, RL1632R-R050-F
32	2	R25, R26	RES., 0.5Ω, 0.5W, 1% 1206	SUSUMU, RL1632R-R500-F
33	2	R28, R31	RES., 44.2k, 1/16W, 1% 0402	VISHAY, CRCW040244K2FKED
34	3	R29, R30, R35	RES., 1M, 1/10W, 1% 0603	VISHAY, CRCW06031M00FKEA
35	1	R32	RES., 43.2k, 1/16W, 1% 0402	VISHAY, CRCW040243K2FKED
36	3	R33, R38, R39	RES., 10k, 1/10W, 1% 0603	VISHAY, CRCW060310R0FKEA
37	1	R40	RES., 249k, 1/16W, 1% , 0402	VISHAY, CRCW0402249KFKED
38	1	R41	RES., 38.3k, 1/16W, 1% , 0402	VISHAY, CRCW040238K3FKED
39	2	R42, R43	RES., 100k, 1/10W, 1%, 0603	VISHAY, CRCW0603100KFKEA
40	1	R45	RES., 100k, 1/16W, 1% , 0402	VISHAY, CRCW0402100KFKED
41	1	U3	I.C., LT3797EUKG QFN(52)(UKG)-7MMX8MM	LINEAR TECH., LT3797EUKG#PBF

### Additional Demo Board Circuit Components

1	1	DC2026C	LINDUINO DEMO BOARD	
2	2	C7, C8	CAP, 0.1μF, X7R, 16V, 10%, 0603	MURATA, GRM188R71C104KA01D
3	3	C10, C11, C13	CAP, 1μF, X7R, 16V, 10%, 0603	MURATA, GRM188R71C105KA12D
4	1	C14	CAP, 0.22μF, X5R, 6.3V 10%, 0402	MURATA, GRM155R60J224KE01D
5	1	C15	CAP, 1μF, X7R, 50V, 10%, 0805	MURATA, GRM21BR71H105KA12L
6	1	C16	CAP, 22μF, X7R, 6.3V, 20%, 1206	MURATA, GRM31CR70J226KE19L
7	1	C18	CAP, 22pF, NPO, 5% 50V, 0402	MURATA, GRM1555C1H220JA01D
8	1	D14	LED, GREEN, DIFFUSED, 0805	AVAGO, HSMG-C170
9	1	D31	LED, YELLOW, DIFFUSED, 0805	AVAGO, HSMY-C170
10	1	D32	LED, RED	WURTH ELEKTRONIK, 150080SS75000
11	1	L5	IND, 33μH	TOKO, A914BYW-330M=P3
12	16	LED1-LED16	LED, XLAMP XP-E2 SERIES	CREE INC., XPEBWT-L1-0000-00D50
13	3	Q1, Q2, Q3	TRANSISTOR, MOSFET, N-CH 60V, 150mA, SOT-23	DIODES INC., VN10LFTA
14	1	R9	RES., 57.6k, 1/10W, 1%, 0603	VISHAY, CRCW060357K6FKEA
15	1	R14	POT, 10k, 10%, 1 TURN	BOURNS, 91A1A-B28-A15L
16	3	R20, R21, R48	RES., 1k, 1/10W, 1%, 0603	VISHAY, CRCW06031K00FKEA
17	1	R22	RES., 10k, 1/10W, 1%, 0603	VISHAY, CRCW060310K0FKEA
18	1	R23	RES., 604k, 1/16W, 1% , 0402	VISHAY, CRCW0402604KFKED
19	1	R24	RES., 200k, 1/16W, 1% , 0402	VISHAY, CRCW0402200KFKED
20	1	R27	RES., 100Ω, 1/10W, 5% 0603	VISHAY, CRCW0603100RJNEA
21	3	R34, R36, R37	RES., 5.1k, 1/10W, 5% 0603	VISHAY, CRCW06035K10JNEA
22	1	R46	RES., 2.49k, 1W, 5% 2512	VISHAY, CRCW25122K49FKEG
23	4	R49, R50, R51, R52	RES., 0Ω, 1/10W, 0603	VISHAY, CRCW06030000Z0EA
24	2	R53, R54	RES., 0Ω, 1/16W, 0402	VISHAY, CRCW04020000Z0ED

## PARTS LIST

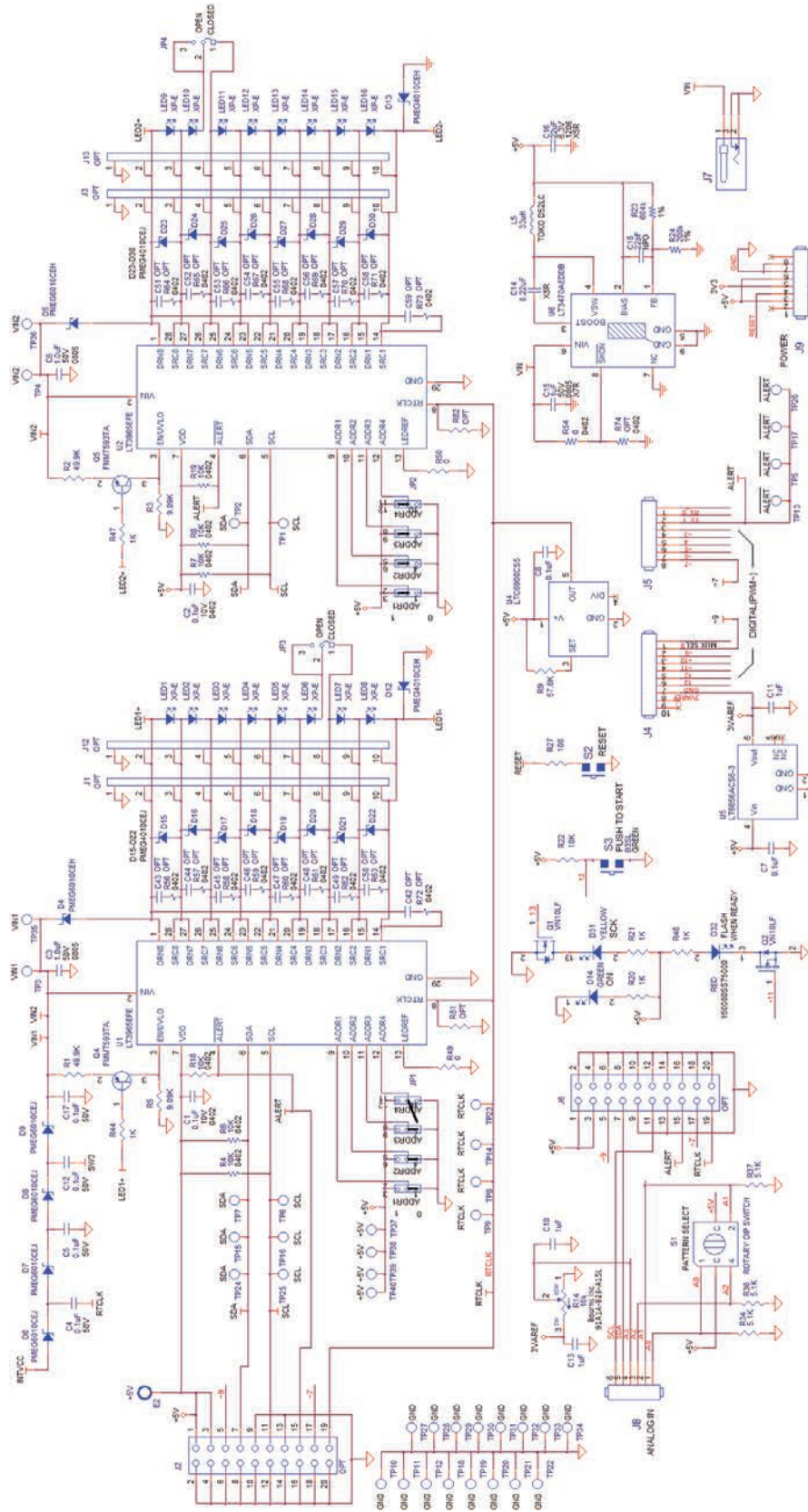
ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
25	0	R55, R81, R82(OPT)	RES., OPTION, 0603	
26	0	R56-R79(OPT)	RES., OPTION, 0402	
27	0	R80(OPT)	RES., OPTION, 2512	
28	1	U4	I.C., LTC6900, TSOT-23-5	LINEAR TECH., LTC6900CS5#PBF
29	1	U5	I.C., LT6656 TSOT-23-6	LINEAR TECH., LT6656ACS6-3#PBF
30	1	U6	I.C., LT3470AEDDB, DFN8DDB	LINEAR TECH., LT3470AEDDB#PBF

### Hardware: For Demo Board Only

1	6	E1-E6	TESTPOINT, TURRET, 0.094" pbf	MILL-MAX, 2501-2-00-80-00-00-07-0
2	6	E7-E12	TESTPOINT, TURRET, 0.064" MTG. HOLE	MILL-MAX, 2308-2-00-80-00-00-07-0
3	10	JP1(4 ea), JP2(4 ea), JP3, JP4	HEADER, 3 PIN 0.079" SINGLE ROW	WURTH ELEKTRONIK, 62000311121
4	10	xJP1(4 ea), xJP2(4 ea), xJP3, xJP4	SHUNT, 0.079" CENTER	WURTH ELEKTRONIK, 60800213421
5	0	J1, J3, J12, J13(OPT)		
6	0	J2 (OPT)	R ANGLED HEADER, 2X10, 0.1"	WURTH ELEKTRONIK, 61302021021
7	1	J4	HEADER, 10PIN, 0.100 SINGLE ROW	WURTH ELEKTRONIK, 61301011121
8	2	J5, J9	HEADER, 8PIN, 0.100 SINGLE ROW	WURTH ELEKTRONIK, 61300811121
9	0	J6 (OPT)	R ANGLED SOCKET HEADER, 2X10, 0.1"	WURTH ELEKTRONIK, 613020243121
10	1	J7 THROUGH HOLE	CONNECTOR, POWER JACK, 2.1mm	CUI INC., PJ-002AH
11	1	J8	HEADER, 6PIN, 0.100 SINGLE ROW	WURTH ELEKTRONIK, 61300611121
12	2	J10, J11	CONNECTOR, BANANA JACK	KEYSTONE, 575-4
13	8	MH1-MH8	STAND-OFF, NYLON, 22.2mm	WURTH ELEKTRONIK, 702938000
14	2	ACRYLIC-SHIELD	ACRYLIC-SHIELD, 1/8" THICK, SMOKE (GRAY COLOR)	JB MACHINING, 2074
15	6	STANDOFF	NYLON, 0.75"	KEYSTONE, 1903D
16	6	SPACER	NYLON, 0.5"	KEYSTONE, 886
17	6	SCREW	NYLON, 1.25"	KEYSTONE, 9340
18	1	S1	SWITCH, ROTARY, 8 POSITIONS	APEM, PT65526
19	1	S2	SWITCH, PUSHBUTTON, MINIATURE	WURTH ELEKTRONIK, 434111025826
20	1	S3	SWITCH, B3SL SERIES	OMRON, B3SL-1002P

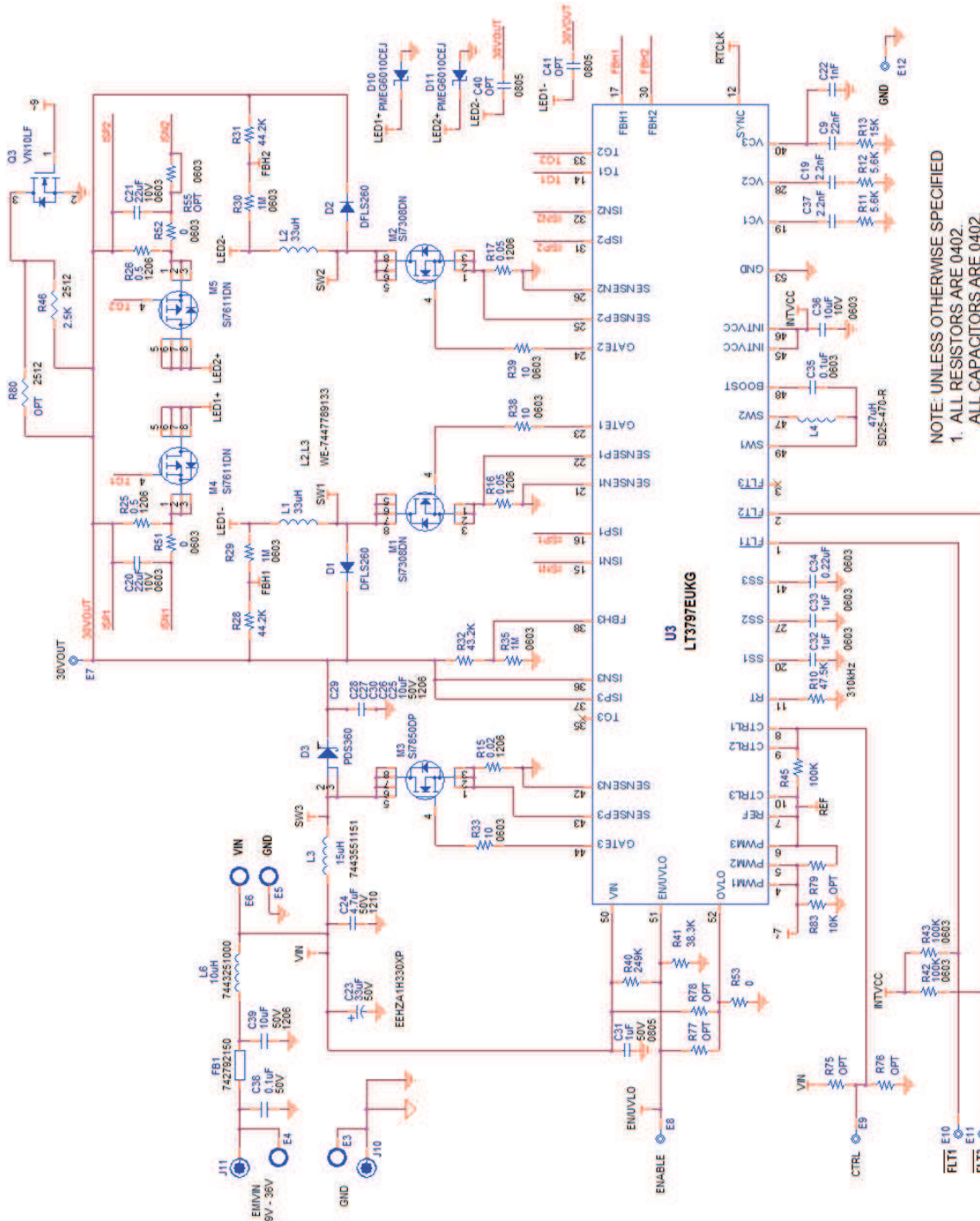
# DEMO MANUAL DC2218A

## SCHEMATIC DIAGRAM



NOTE: UNLESS OTHERWISE SPECIFIED  
1. ALL RESISTORS ARE 0603  
ALL CAPACITORS ARE 0603

**SCHEMATIC DIAGRAM**



NOTE: UNLESS OTHERWISE SPECIFIED  
 1. ALL RESISTORS ARE 0402.  
 ALL CAPACITORS ARE 0402.

# DEMO MANUAL DC2218A

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## DEMONSTRATION BOARD IMPORTANT NOTICE

Linear Technology Corporation (LTC) provides the enclosed product(s) under the following **AS IS** conditions:

This demonstration board (DEMO BOARD) kit being sold or provided by Linear Technology is intended for use for **ENGINEERING DEVELOPMENT OR EVALUATION PURPOSES ONLY** and is not provided by LTC for commercial use. As such, the DEMO BOARD herein may not be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including but not limited to product safety measures typically found in finished commercial goods. As a prototype, this product does not fall within the scope of the European Union directive on electromagnetic compatibility and therefore may or may not meet the technical requirements of the directive, or other regulations.

If this evaluation kit does not meet the specifications recited in the DEMO BOARD manual the kit may be returned within 30 days from the date of delivery for a full refund. **THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY THE SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. EXCEPT TO THE EXTENT OF THIS INDEMNITY, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.**

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LTC currently services a variety of customers for products around the world, and therefore this transaction **is not exclusive**.

**Please read the DEMO BOARD manual prior to handling the product.** Persons handling this product must have electronics training and observe good laboratory practice standards. **Common sense is encouraged.**

This notice contains important safety information about temperatures and voltages. For further safety concerns, please contact a LTC application engineer.

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