LT3743 High Current Synchronous Step-Down LED Driver with Three-State Control

DESCRIPTION

Demonstration circuit 1470A is a high current synchronous step-down LED driver with three-state control featuring the LT®3743EUFD. The demo board is optimized for 20A output from a 12V input. Being an LED driver, the output current is being regulated until the output voltage reaches a programmed voltage limit. This voltage limit on this demo board is set to around 6V by R5 and R6. The 6V is chosen because of the 6.3V voltage rating of the output capacitors. The ideal load to be used with this demo board is a single LED, such as PT120 from Luminus Devices. Smaller LEDs may not be able to handle the high current, even for a short period of time. At 20A, the demo circuit can operate continuously. However, it is necessary to mount the LED load on a proper heat sink and possibly with a fan to avoid exceeding its maximum temperate rating.

Note: The DC470A will drive a LED with its cathode grounded. Grounding cathode of the LED allows customers to use positive input supply.

The input voltage range of the LT3743 itself is 6V to 36V. However, the demo board utilizes 30V MOSFETs to demonstrate best efficiency so the maximum recommended input voltage is 24V for the demo board. When input is above 20V during PWM dimming, a slightly larger inductance may be needed. The typical efficiency of the demo board is 94% from a 12V input to 5V, 20A load. The lower the input voltage, the higher the efficiency tends to be with a given load. At output power level of 100W, a couple of percent of efficiency improvement is a huge advantage in minimizing temperature rise. If an efficiency measurement is needed in an application, the output voltage must be measured at the output capacitors instead of at the LED load. This prevents cable loss from being counted as a loss of the board. If efficiency measurement is required during PWM dimming, the average current and voltage values should be measured with proper equipment. All LT3743 circuits turn off unnecessary circuits during PWM off period to minimize power losses. As a result, efficiency in many PWM dimming applications is almost the same as efficiency of the constant current applications.

The DC1470A uses a split output capacitor configuration to achieve <2µs current rise time from 0A to 20A. To see the real rise time, connecting wires between the LED and the board should be minimized to no more than 2 inches

Design files for this circuit board are available at http://www.linear.com/demo/DC1470A

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PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
PV_{IN}*	Input Supply Range, $P_{VIN} = V_{IN}$	L1 is Optimized for 12V		12	26.4	V
V_{OUT}*	Output Voltage	With One PT120 LED, 6V is the Over Voltage Limit		4.5	6	V
I_{OUT}	Output Current	CTRL_SEL > 1V	18.8	20	21.2	A
f_{SW}	Switching Frequency		400	430	460	kHz
I_{RISE}	Current Rise Time	Following a PWM Rising Edge		2		µs
EFF	Efficiency at DC	V_{IN} = 12V, V_{OUT} = 5V, I_{OUT} = 20A		94		%

*PV_{IN} and V_{IN} of the demo circuit are limited to 24V typical by the selection of MOSFETs. The LT3743 input range is 6V to 36V. V_{OUT} maximum of the demo circuit is limited to 6V due to the selection of the output capacitors.

DESCRIPTION

total to minimize the wire inductance. 1-inch is even better. The cathode of the LED should return to LED– with R25 populated with a resistor in a few mΩ. It is recommended to measure the voltage on R25 with a short 50Ω coax cable directly into a BNC connector on the oscilloscope. The current can then be calculated from the measured voltage. To get accurate current, R25 should be measured before it is mounted on the board. A current probe adds more delays to the rise time so using a current probe is not recommended. If fast rise time measurement is not necessary, the cathode of the LED can be connected to GND as shown in Figure 1.

R27 can be used to slow down the gate drive. Slower gate drive helps to reduce ringing on the SW node without noticeable effect on the efficiency. A 10Ω is usually more than enough to completely damp any ringing.

R15, R16 and C15 help filtering out voltage spikes seen on the $SENSE^+$ or $SENSE^-$ pin. It is critical to have those components on a board.

The LT3743 has a three-state control. It can change output current among zero, a low level and a high level, all in a few µs. The low current level of the demo board is set to around 5A. The high current level is 20A. Both levels can be adjusted by changing the voltage dividers on CTRL_H and CTRL_L. Applying a PWM signal to CTRL_SEL will toggle the output between 5A to 20A. While applying a PWM signal to the PWM pin will toggle the output between either 0A to 5A or 0A to 20A depending on the CTRL_SEL level.

The LT3743 data sheet gives a complete description of the part, operation and application information. The data sheet must be read in conjunction with this demo manual for DC1470A.

QUICK START PROCEDURE

Demonstration circuit 1470A is easy to set up to evaluate the performance of the LT3743. Refer to Figure 1 for proper measurement equipment setup and follow the procedure below:

1. With power off, connect the input power supply to PV_{IN} and GND. The input power supply should have a current limit of 10A or more.
2. With power off, connect a LED between V_{OUT} and GND or between V_{OUT} and LED–, if fast rise time is to be verified. When returning LED to LED–, R25 needs to be populated. To check voltage across R25, the best set up is to solder a short 50Ω coax cable across R25. Connect the other end of the cable directly into a BNC connector on an oscilloscope. A less perfect but easier set up is to touch the probe tip directly across the IS+ and IS– terminals with out the probe ground wire. See Figure 2 for setup. The latter set up tends to have more noise but is ok for non-critical measurements. The LED connecting wires should be as short as possible, 1 inch total being ideal.
3. Turn on the power at the input.
4. At this time, the output current will be slightly below 5A. If no output current is observed, turn off PV_{IN} and check the connections.
5. To increase the load current to 20A, turn off PV_{IN}. Pull CTRL_SEL high either by populating R21 or by using an external voltage source. Make sure the load can handle 20A continuously and the load voltage is not too high for the board. Then turn on PV_{IN}.
6. Both the low current level, 5A and the high current level 20A can be adjusted by changing the voltage on CTRL_L and CTRL_H terminals between 0V and 2V.
7. To evaluate the transient between 0A and a non-zero current level, apply a PWM signal to the PWM terminal. The nonzero current level is dictated by the CTRL_SEL and CTRL_H or CTRL_L voltages.
8. To evaluate the transient between two non-zero cur rent levels, apply a PWM signal to the CTRL_SEL terminal.

9. To modify the demo board for other applications, please contact Linear Applications Group for help.

QUICK START PROCEDURE

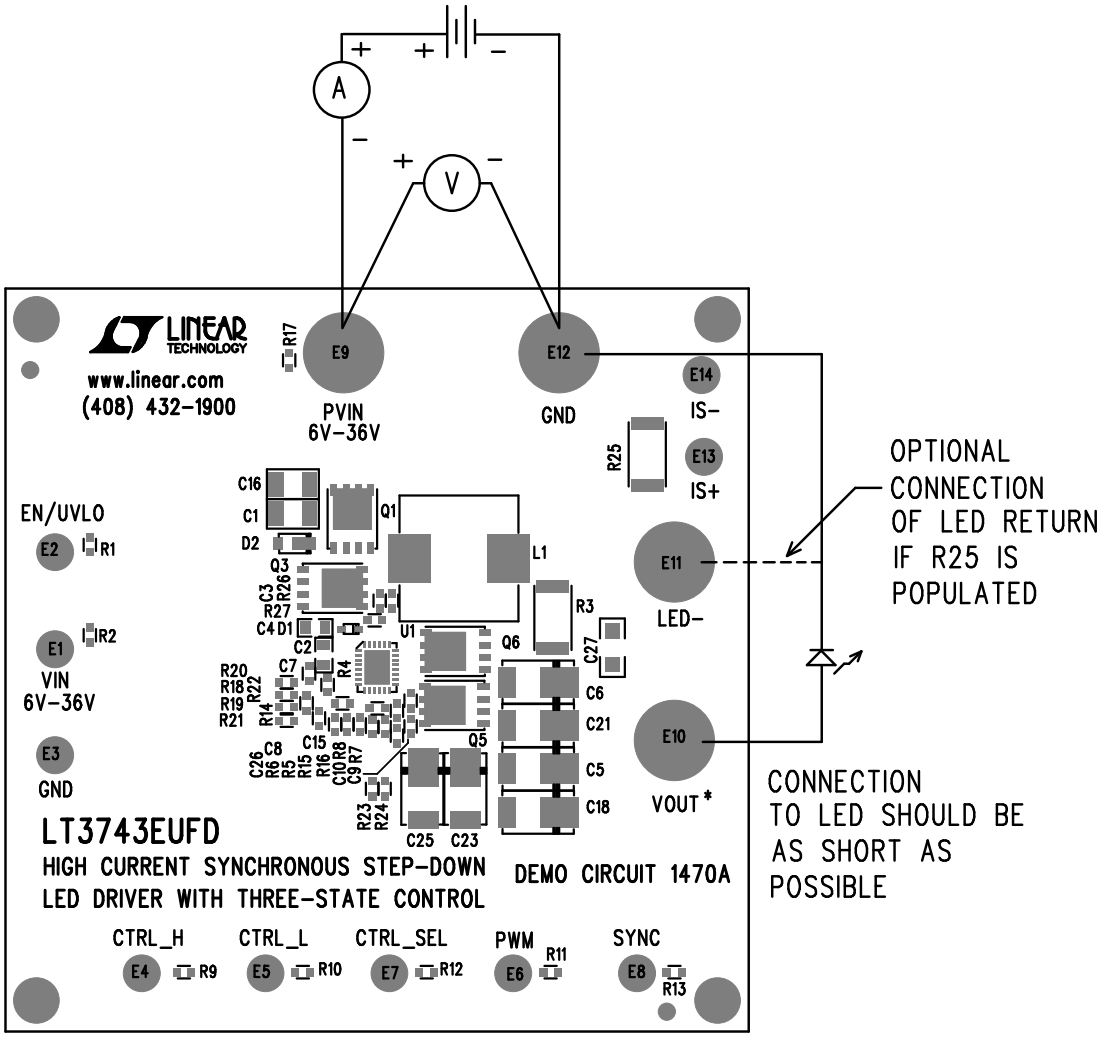


Figure 1. Proper Measurement Equipment Setup

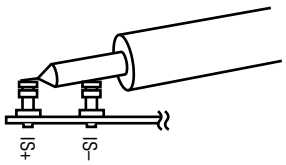
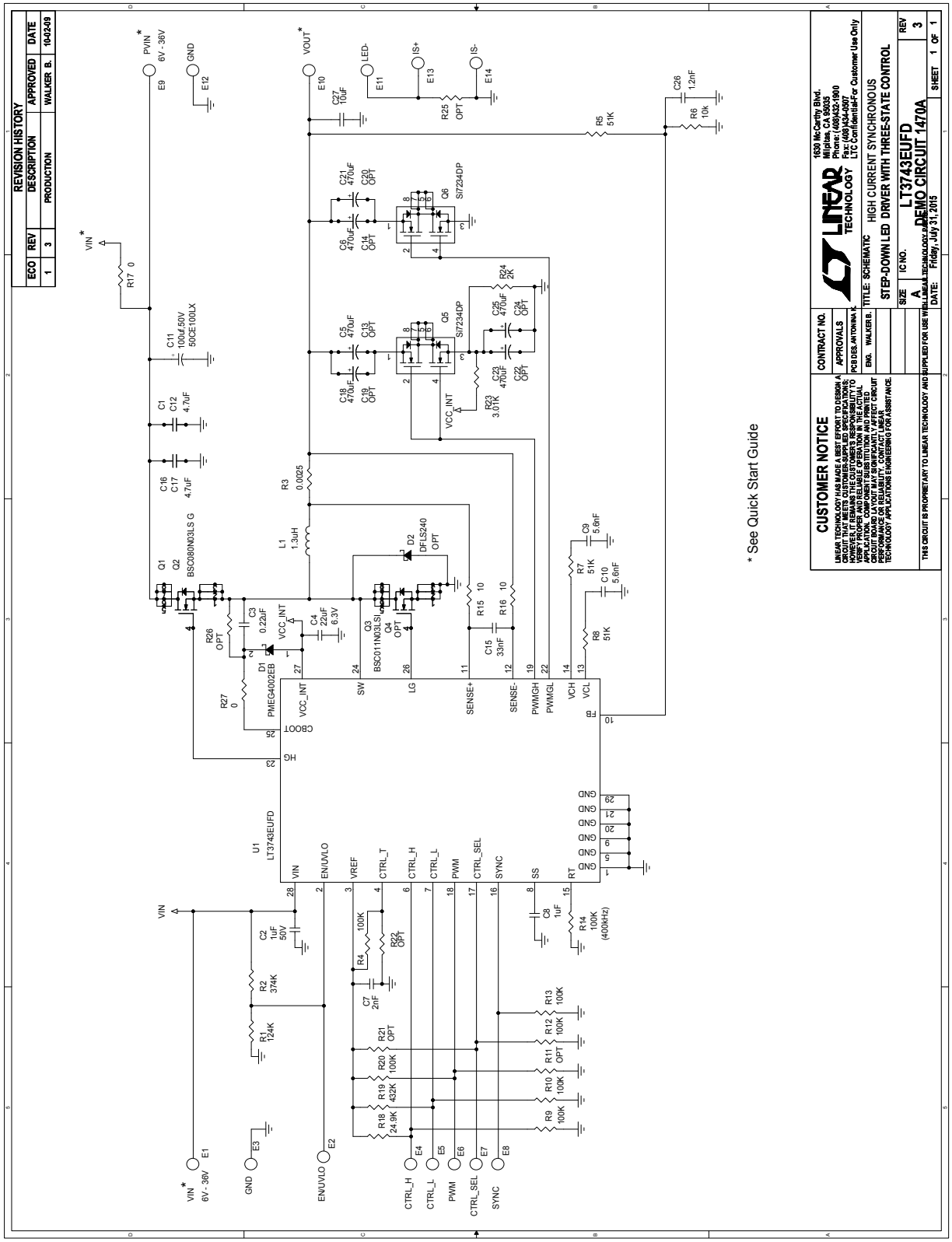


Figure 2. Measuring Voltage Across R25

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	4	C1, C12, C16, C17	CAP., X7R, 4.7µF, 50V, 10%, 1210	MURATA, GRM32ER71H475KA88L
2	1	C2	CAP., X7R, 1µF, 50V, 10%,0805	MURATA, GRM21BR71H105KA12L
3	1	C3	CAP., X7R, 0.22µF, 10V,10%,0603	MURATA, GRM188R71A224KA01D
4	1	C4	CAP., X5R, 22µF, 6.3V, 20%, 0805	MURATA, GRM21BR60J226ME39L
5	6	C5, C6, C18, C21, C23, C25	CAP., POSCAP, 470µF, 6.3V, D4D	PANSONIC, 6TPF470MAH
6	1	C7	CAP., C0G, 2nF, 50V, 0603	MURATA, GRM1885C1H202JA01
7	1	C8	CAP., X7R, 1µF, 16V, 10%,0603	MURATA, GRM188R71C105KA12D
8	2	C9,C10	CAP., C0G, 5600pF, 50V, 5% 0603	MURATA, GRM1885C1H562JA01D
9	1	C11	CAP., ALUM., ELECT., 100µF, 50V	SUN ELECTRONICS., 50CE100LX
10	1	C15	CAP., X5R, 0.033µF, 50V, 0603	AVX, 06035D333KAT2A
11	1	C26	CAP., X7R, 1200pF, 50V,5%, 0603	AVX, 06035C122JAT2A
12	1	C27	CAP., X7R, 10µF, 25V,10%,1206	MURATA, GRM31CR71E106KA12L
13	1	D1	SCHOTTKY RECTIFIER, 40V, SOD523	NXP SEMI., PMEG4002EB,115
14	1	D2	2.0A LOW VF SCHOTTKY RECTIFIER	DIODES INC., DFLS240L-7
15	1	L1	INDUCTOR, 1.3µH	WURTH ELECTRONICS, 7443551130
16	2	Q1,Q2	N-CHANNEL MOSFET, LFPAK	INFINEON, BSC080N03LS G
17	1	Q3	N-CHANNEL MOSFET, LFPAK	INFINEON, BSC011N03LSI
18	2	Q5,Q6	MOSFET, 40V, DUAL N-CHANEL, PPAK	VISHAY, Si7234DP
19	1	R1	RES., CHIP, 124k, 1%, 1/W, 0603	VISHAY, CRCW0603124KFKEA
20	1	R2	RES., CHIP, 374k, 1%, 1/W, 0603	VISHAY, CRCW0603374KFKEA
21	1	R3	RES., CHIP, 0.0025Ω, 1W, 1%, 2512	VISHAY, WSL25122L500FEA
22	7	R4, R9, R10, R12, R13, R14, R20	RES., CHIP, 100k, 1%, 1/W, 0603	VISHAY, CRCW0603100KFKEA
23	3	R5, R7, R8	RES., CHIP, 51k, 1%, 1/W, 0603	VISHAY, CRCW060351K0FKEA
24	1	R6	RES., CHIP, 10k, 1%, 1/W, 0603	VISHAY, CRCW060310K0FKEA
25	2	R15, R16	RES., CHIP, 10Ω, 1%, 1/W, 0603	VISHAY, CRCW060310R0FKEA
26	1	R18	RES., CHIP, 24.9k, 1%, 1/W, 0603	VISHAY, CRCW060324K9FKEA
27	1	R19	RES., CHIP, 432k, 1%, 1/W, 0603	VISHAY, CRCW0603432KFKEA
28	1	R23	RES., CHIP, 3.01k, 1%, 1/W, 0603	VISHAY, CRCW06033K01FKEA
29	1	R24	RES., CHIP, 2k, 1%, 1/W, 0603	VISHAY, CRCW06032K00FKEA
30	1	U1	I.C. LT3743EUFD, 28-PIN QFN-4×5	LINEAR TECH., LT3743EUFD#PBF
Additional Demo Board Circuit Components				
1	0	C13, C14, C19, C20, C22, C24	CAP., D4D, OPT	
2	0	R11, R21, R22, R26	RES., OPT, 0603	VISHAY, CRCW06030000Z0EA
3	2	R17, R27	RES., CHIP, 0Ω, 0603	
4	0	R25	RES., CHIP, 2512, OPT	
5	0	Q4 OPT		
Hardware for Demo Board Only				
1	10	E1-E8, E13, E14	TURRET, TESTPOINT, 091"	MILL MAX 2501-2-00-80-00-00-07-0
2	4	E9-E12	JACK BANANA	KEYSTONE, 575-4
3	4	STAND-OFF	STAND-OFF, NYLON 0.5" TALL	KEYSTONE, 8833(SNAP ON)

SCHEMATIC DIAGRAM



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