

# LTC3833EFE

## Wide Input Range, High Efficiency Step-Down DC/DC Converter

### DESCRIPTION

Demonstration circuit 1516A is a 1.5V/15A synchronous buck converter operating with a switching frequency of 300kHz over an input voltage range of 4.5V to 24V. The demo board comes in two versions. The -A version uses inductor DCR current sensing with an iron powder inductor for highest efficiency. The -B version uses a 2.5mΩ/1% sense resistor for accurate current sensing with a low DCR ferrite inductor. The fixed on-time valley current mode control of the LTC®3833 allows for a fast load step response (see Figures 4 and 5). The load step response can be tested with the on-board load step circuit and a bench pulse generator.

Other features of the board include a MODE jumper to program either DCM or CCM with light or no load, a PLLIN input for synchronizing the converter to an external clock, a TRACK/SS pin, a PGOOD pin and an EXTV<sub>CC</sub> pin.

The demo board uses a high density, two-sided drop-in layout. The entire converter, excluding the bulk output and input capacitors, fits within a compact 1.25" × 0.5" area on the board. The package style for the LTC3833EFE is a 20-lead TSSOP with an exposed ground pad.

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

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### PERFORMANCE SUMMARY (T<sub>A</sub> = 0°C to 85°C)

PARAMETER	CONDITIONS/NOTES	VALUE
Minimum Input Voltage		4.5V
Maximum Input Voltage		24V
Output Voltage	I <sub>OUT</sub> = 0A to 15A	1.5V ±2%
Switching Frequency		300kHz
Efficiency	V <sub>IN</sub> = 12V, V <sub>OUT</sub> = 1.5V, I <sub>OUT</sub> = 15A See Figures 2 and 3	
DCR SENSE Version (-A)		89.4%
R <sub>SENSE</sub> Version (-B)		87.8%

# DEMO MANUAL DC1516A

## QUICK START PROCEDURE

Demonstration circuit 1516A is easy to set up to evaluate the performance of the LTC3833EFE. Please refer to Figure 1 for proper measurement equipment setup and follow the procedure below.

1. With power off, connect the input supply, load and meters as shown in Figure 1. Preset the load to 0A and  $V_{IN}$  supply to be 0V. Place jumpers in the following positions:

JP1 RUN ON

JP2 MODE CCM

2. Adjust the input voltage to be between 4.5V to 24V.  $V_{OUT}$  should be  $1.5V \pm 2\%$ .
3. Next, apply 15A load and re-check  $V_{OUT}$ .
4. Once the DC regulation is confirmed, observe the output voltage ripple, load step response, efficiency and other parameters.

Note 1. To measure the output voltage ripple, use the BNC connector labeled  $V_{OUT}$ .

Note 2. Do not apply the load from the  $VO_{SNS+}$  turret to the  $VO_{SNS-}$  turret. This will damage the converter. These turrets are only intended to monitor  $V_{OUT}$  across  $C_{OUT3}$  which is the point of regulation.

## LOAD STEP TRANSIENT TESTING (OPTIONAL)

Demonstration circuit 1516A has a simple load step circuit consisting of a MOSFET and sense resistor. To apply a load step, follow the steps below.

1. Pre-set the amplitude of a pulse generator to 0.0V and the duty cycle to 5% or less.
2. Connect the  $V_{OUT}$  and LOAD STEP BNC connectors to the oscilloscope.

3. Connect the output of the pulse generator to the PULSE GEN turret and connect the return to the GND turret.
4. With the converter running, slowly increase the amplitude of the pulse generator output to provide the desired load step pulse height. The scaling for the LOAD STEP signal is 10mV/Amp.

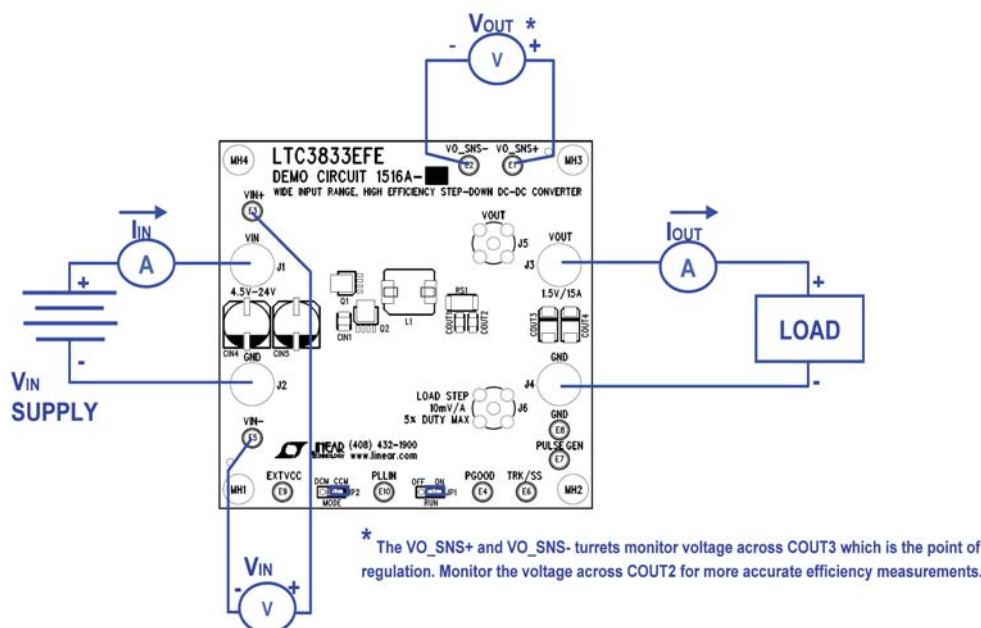
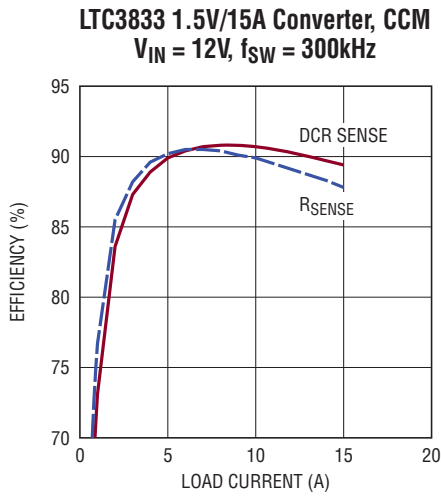


Figure 1. Proper Measurement Equipment Setup

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LOAD STEP TRANSIENT TESTING (OPTIONAL)



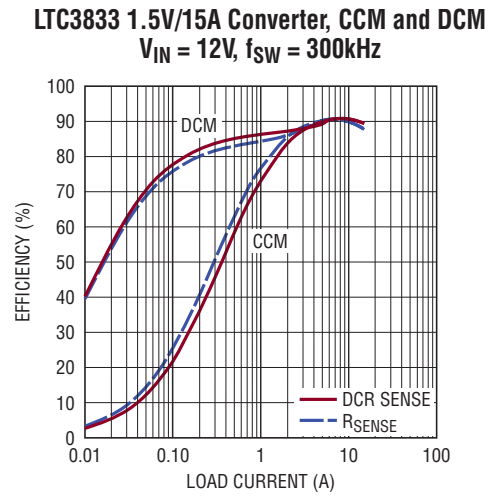
$Q_{TOP} = RJK0305DPB$   
 $Q_{BOTTOM} = RJK0330DPB$

DCR SENSE VERSION (-A):  
 $L = VISHAY IHLP4040DZ-01 \ 0.56\mu H$   
 $DCR = 1.7m\Omega \ TYP, 1.8m\Omega \ MAX$

RSENSE VERSION (-B):  
 $L = WURTH 7443330068 \ 0.68\mu H$   
 $DCR = 1.35m\Omega \ \pm 10\%$   
 $R_{SENSE} = 2.5m\Omega$

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Figure 2. Efficiency Curves for the DC1516A in CCM



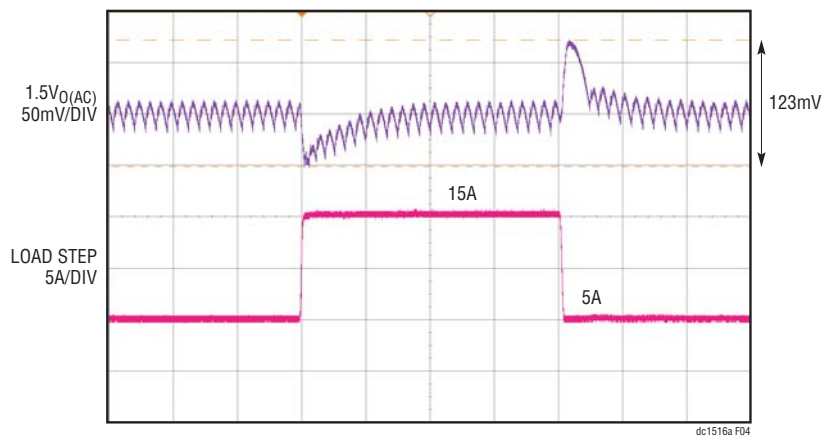
$Q_{TOP} = RJK0305DPB$   
 $Q_{BOTTOM} = RJK0330DPB$

DCR SENSE VERSION (-A):  
 $L = VISHAY IHLP4040DZ-01 \ 0.56\mu H$   
 $DCR = 1.7m\Omega \ TYP, 1.8m\Omega \ MAX$

RSENSE VERSION (-B):  
 $L = WURTH 7443330068 \ 0.68\mu H$   
 $DCR = 1.35m\Omega \ \pm 10\%$   
 $R_{SENSE} = 2.5m\Omega$

dc1516a F03

Figure 3. Efficiency Curves for the DC1516A in CCM and DCM



dc1516a F04

Figure 4. Load Step Response of the DC1516A-A (DCR SENSE) at  $V_{IN} = 12V$ .  
 $C_{OUT} = 2 \times \text{Sanyo 2R5TPE330M9} \parallel 2 \times 100\mu F \ X5R \ 6.3V \ 1206, L = 0.56\mu H, f_{SW} = 300kHz$

## LOAD STEP TRANSIENT TESTING (OPTIONAL)

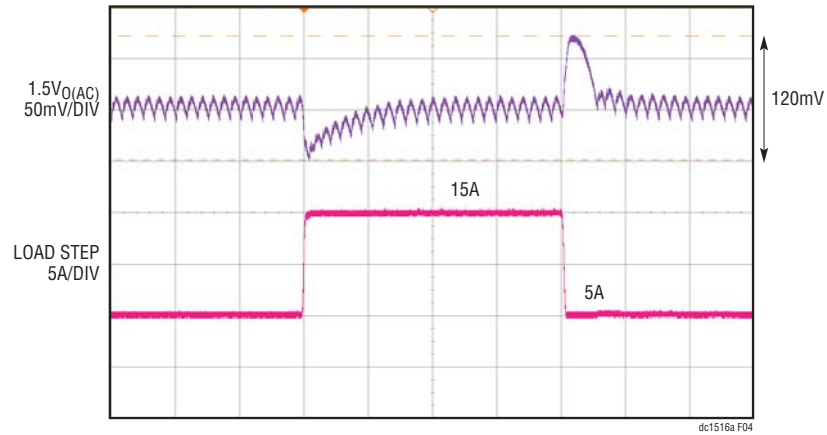


Figure 5. Load Step Response of the DC1516A-B ( $R_{SENSE}$ ) at  $V_{IN} = 12V$ .  
 $C_{OUT} = 2 \times$  Sanyo 2R5TPE330M9 ||  $2 \times 100\mu F$  X5R 6.3V 1206,  $f_{SW} = 300kHz$ ,  $L = 0.68\mu H$ ,  $f_{SW} = 300kHz$

## PARTS LIST

### Demo Circuit 1516A-A (DCR SENSE)

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>Required Circuit Components</b>				
1	1	C2	CAP X7R 0.1 $\mu$ F 16V 10% 0603	AVX 0603YC104KAT2A
2	2	C1, C8	CAP X7R 0.1 $\mu$ F 25V 20% 0603	AVX 06033C104MAT2A
3	1	C10	CAP X7R 1 $\mu$ F 16V 10% 0603	AVX 0603YC105KAT2A
4	1	C5	CAP X5R 4.7 $\mu$ F 16V 10% 0805	KEMET C0805C475K4PAC
5	1	C6	CAP C0G 68pF 50V 10% 0603	AVX 06035A680KAT2A
6	1	C7	CAP X7R 0.01 $\mu$ F 16V 10% 0603	AVX 0603YC103KAT2A
7	1	C9	CAP C0G 470pF 50V 10% 0603	AVX 06035A471KAT2A
8	2	CIN1, CIN2	CAP X7R 10 $\mu$ F 25V 20% 1210	TDK C3225X7R1E106M
9	2	CIN4, CIN5	CAP SVPD 47 $\mu$ F 35V 20%	SANYO 35SVPD47M
10	2	COU1, COU2	CAP X5R 100 $\mu$ F 6.3V 20% 1206	MURATA GRM31CR60J107ME39L
11	2	COU4, COU3	CAP POSCAP 330 $\mu$ F, 2.5V 20% 7343	SANYO 2R5TPE330M9
12	1	D1	DIODE SCHOTTKY 30V SOD323	CENTRAL SEMI CMDSH3-TR
13	1	L1	IND PWR 0.56 $\mu$ H, L-IHLP4040DZ-01	VISHAY IHLP4040DZERR56M01
14	1	Q1	MOSFET POWER N-CH LPAK	RENESAS RJK0305DPB
15	1	Q2	MOSFET POWER N-CH LPAK	RENESAS RJK0330DPB
16	1	R1	RES 100k 1/16W 5% 0603	VISHAY CRCW0603100KJKEA
17	1	R10	RES 15k 1/16W 1% 0603	VISHAY CRCW060315K0FKEA
18	2	R11, R23	RES 10k 1/16W 1% 0603	VISHAY CRCW060310K0FKEA
19	1	R13	RES 2.2 $\Omega$ 1/16W 5% 0603	VISHAY CRCW06032R20JNEA
20	1	R15	RES 33.2k 1/16W 5% 0603	VISHAY CRCW060333K2JNEA
21	1	R18	RES 137k 1/16W 1% 0603	VISHAY CRCW0603137KFKEA
22	3	R2, R12, R24	RES CHIP 0 $\Omega$ 1/16W 0603	VISHAY CRCW06030000Z0EA
23	1	R3	RES 4.02k 1/16W 1% 0603	VISHAY CRCW06034K02FKEA

dc1516af

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
24	2	R4, R5	RES 10Ω 1/16W % 0603	VISHAY CRCW060310R0JNEA
25	1	R7	RES CHIP 13.3k 1/16W 1% 0603	VISHAY CRCW060313K3FKEA
26	2	R9, R17	RES 0Ω 1/16W 0603	VISHAY CRCW06030000Z0EA
27	1	RS1	RES 0.000Ω 2512	TEPRO RN5326
28	1	U1	IC LTC3833EFETSSOP20FE-CB	LINEAR TECH LTC3833EFE

### Additional Circuit Components

1	0	R6, R8, R16, R14, R19, R21, R25	RES 0603	OPT
2	0	C3	CAP 0805	OPT
3	0	C4, C11	CAP 0603	OPT
4	0	CIN3	CAP 1210	OPT
5	0	COU5, COU6	CAP 1206	OPT
6	0	D2	DIODE SMA	OPT
7	0	Q4, Q3	MOSFET POWER N-CH LFPAK	OPT
8	1	Q5	MOSFET N-CH DPAK-T0252AA	VISHAY SILICONIX SUD50N03-12P
9	2	R20	RES 10k 1/16W 1% 0603	VISHAY CRCW060310K0FKEA
10	1	R22	RES 0.01Ω 2% 2010	IRC LR2010-01-R010-G

### Hardware

1	10	E1 - E10	TESTPOINT TURRET 094"	MILL-MAX 2501-2-00-80-00-00-07-0
2	4	J1, J2, J3, J4	JACK BANANA	KEYSTONE 575-4
3	2	J6, J5	CONN BNC 5 PINS	CONNEX 112404
4	2	JP1 & JP2 (1 & 2)	SHUNT .079" CENTER	SAMTEC 2SN-BK-G
5	2	JP1, JP2	JMP 3-PIN 1 ROW 0.079CC	SAMTEC TMM-103-02-L-S
6	4	MH1 - MH4	STAND-OFF NYLON 0.50"	KEYSTONE 8833 (SNAP-ON)

### Demo Circuit 1516A-B (R<sub>SENSE</sub>)

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>Required Circuit Components</b>				
1	2	C1, C8	CAP X7R 0.1μF 25V 20% 0603	AVX 06033C104MAT2A
2	1	C10	CAP X7R 1μF 16V 10% 0603	AVX 0603YC105KAT2A
3	1	C2	CAP X7R 1000pF 16V 10% 0603	AVX 0603YC102KAT2A
4	1	C5	CAP X5R 4.7μF 16V 10% 0805	KEMET C0805C475K4PAC
5	1	C6	CAP C0G 68pF 50V 10% 0603	AVX 06035A680KAT2A
6	1	C7	CAP X7R 0.01μF 16V 10% 0603	AVX 0603YC103KAT2A
7	1	C9	CAP C0G 470pF 50V 10% 0603	AVX 06035A471KAT2A
8	2	CIN1, CIN2	CAP X7R 10μF 25V 20% 1210	TDK C3225X7R1E106M
9	2	CIN4, CIN5	CAP SVPD 47μF 35V 20%	SANYO 35SVPD47M
10	2	COU1, COU2	CAP X5R 100μF 6.3V 20% 1206	MURATA GRM31CR60J107ME39L
11	2	COU4, COU3	CAP POSCAP 330μF 2.5V 20% 7343	SANYO 2R5TPE330M9
12	1	D1	DIODE SCHOTTKY 30V SOD323	CENTRAL SEMI CMDSH3-TR
13	1	L1	IND PWR 0.68μH L-7443330068	WURTH 7443330068
14	1	Q1	MOSFET POWER N-CH LFPAK	RENESAS RJK0305DPB
15	1	Q2	MOSFET POWER N-CH LFPAK	RENESAS RJK0330DPB

# DEMO MANUAL DC1516A

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
16	1	R1	RES 100k 1/16W 5% 0603	VISHAY CRCW0603100KJKEA
17	1	R10	RES 15k 1/16W 1% 0603	VISHAY CRCW060315K0FKEA
18	2	R11, R23	RES 10k 1/16W 1% 0603	VISHAY CRCW060310K0FKEA
19	1	R13	RES 2.2 $\Omega$ 1/16W 5% 0603	VISHAY CRCW06032R20JNEA
20	1	R15	RES 33.2k 1/16W 5% 0603	VISHAY CRCW060333K2JNEA
21	1	R16	RES 0 $\Omega$ 1/16W 0603	VISHAY CRCW06030000Z0EA
22	1	R18	RES 137k 1/16W 1% 0603	VISHAY CRCW0603137KFKEA
23	3	R2, R12, R24	RES 0 $\Omega$ 1/16W 0603	VISHAY CRCW06030000Z0EA
24	2	R4, R5	RES 10 $\Omega$ 1/16W 5% 0603	VISHAY CRCW060310R0JNEA
25	2	R6, R8	RES 10 $\Omega$ 1/16W 5% 0603	VISHAY CRCW060310R0JNEA
26	1	RS1	RES SENSE 0.0025 $\Omega$ 2512	TEPRO TMF12R0025F150L
27	1	U1	IC TC3833EFE TSSOP20FE-CB	LINEAR TECH LTC3833EFE

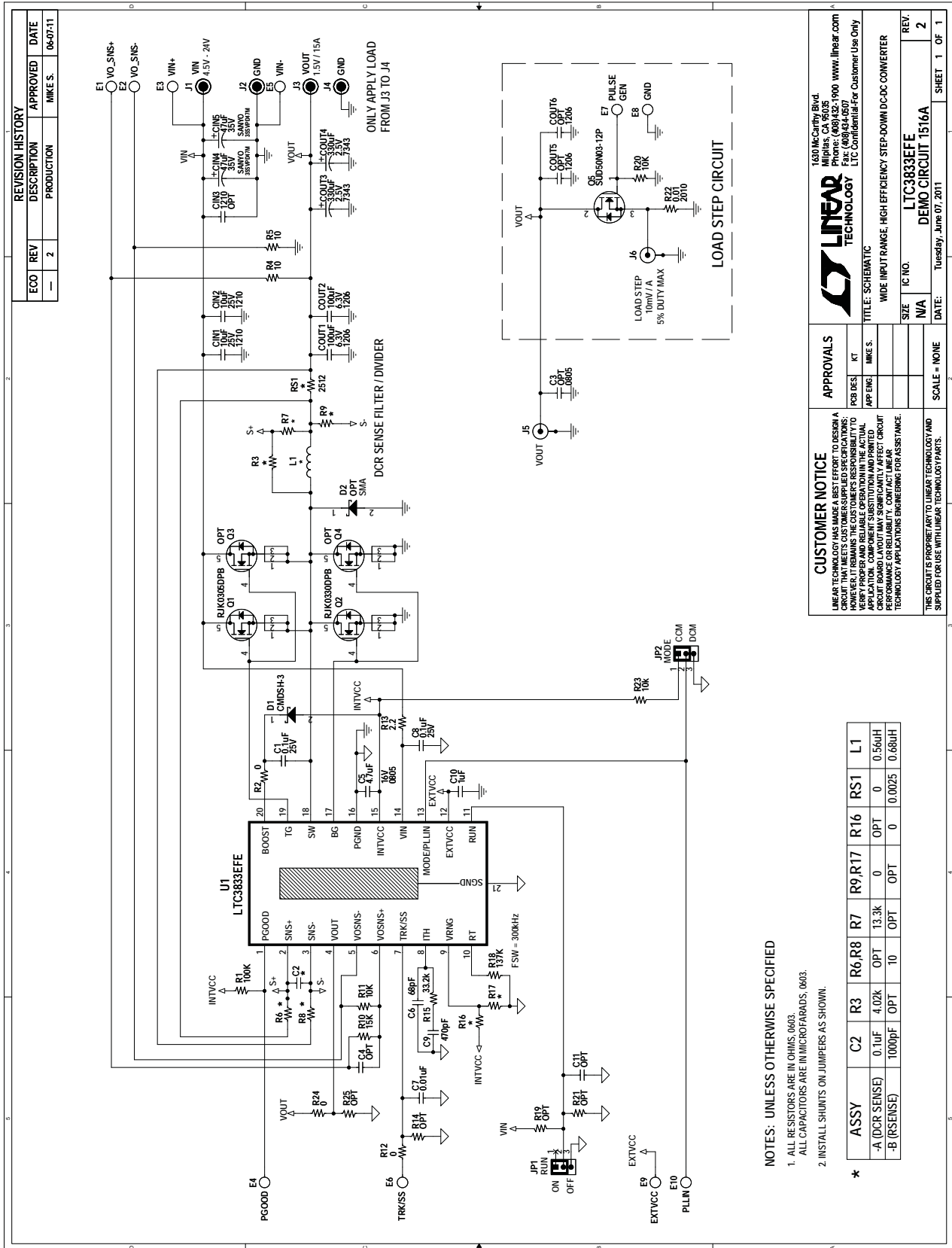
### Additional Circuit Components

1	0	C3	CAP 0805	OPT
2	0	C4, C11	CAP 0603	OPT
3	0	CIN3	CAP 1210	OPT
4	0	COU5, COU6	CAP 1206	OPT
5	0	D2	DIODE SMA	OPT
6	0	Q4, Q3	MOSFET POWER N-CH LPAK	OPT
7	1	Q5	MOSFET N-CH DPAK-T0252AA	VISHAY SILICONIX SUD50N03-12P
8	2	R20	RES 10k 1/16W 1% 0603	VISHAY CRCW060310K0FKEA
9	1	R22	RES 0.0 $\Omega$ 2% 2010	IRC LR2010-01-R010-G
10	0	R14, R19, R21, R25	RES 0603	OPT

### Hardware

1	10	E1 - E10	TESTPOINT TURRET 094"	MILL-MAX 2501-2-00-80-00-00-07-0
2	4	J1, J2, J3, J4	JACK BANANA	KEYSTONE 575-4
3	2	J6, J5	CONN BNC 5 PINS	CONNEX 112404
4	2	JP1 & JP2 (1 & 2)	SHUNT .079" CENTER	SAMTEC 2SN-BK-G
5	2	JP1, JP2	JMP 3-PIN 1 ROW 0.079CC	SAMTEC TMM-103-02-L-S
6	4	MH1 - MH4	STAND-OFF NYLON 0.50"	KEYSTONE 8833 (SNAP-ON)

SCHEMATIC DIAGRAM



# DEMO MANUAL DC1516A

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