LTC3838EFE
Wide Input Range, High Efficiency Step-Down DC/DC Converter

DESCRIPTION

Demonstration circuit 1626A is a dual output 1.5V/15A and 1.2V/15A synchronous buck converter operating with a switching frequency of 300kHz over an input voltage range of 4.5V to 26V. The demo board comes in two versions. The -A version uses inductor DCR current sensing with an iron powder inductor for high efficiency. The -B version uses a 2.5mΩ sense resistor for accurate current sensing with a low DCR ferrite inductor. The fixed on-time valley current mode architecture of the LTC3838 allows for a fast load step response (see Figures 6 to 9). The load step response can be tested with the on-board load step circuit and a bench pulse generator.

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 1.5" × 1.0" area on the board. The package style for the LTC3838EFE is a 38-lead TSSOP with an exposed ground pad.

The main features of the board are listed below:

- MODE jumper to program either DCM or FCM at light or no load
- EXTVCC pin
- PLLIN pin to synchronize the converter to an external clock
- Remote sensing for V_{OUT1}
- Optional resistors to tie the two phases together
- Each rail has its own RUN pin, PGOOD pin and TRACK/SS pin

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

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PERFORMANCE SUMMARY (T_A = 25°C)

PARAMETER	CONDITION	VALUE
Minimum Input Voltage		4.5V
Maximum Input Voltage		26V
Output Voltage V_{OUT1}	I_{OUT1} = 0A to 15A, V_{IN} = 4.5V to 26V	1.2V ±2%
Output Voltage V_{OUT2}	I_{OUT2} = 0A to 15A, V_{IN} = 4.5V to 26V	1.5V ±2%
V_{OUT1} Maximum Output Current, I_{OUT1}	V_{IN} = 4.5V to 26V, V_{OUT1} = 1.2V	15A
V_{OUT2} Maximum Output Current, I_{OUT2}	V_{IN} = 4.5V to 26V, V_{OUT2} = 1.5V	15A
Nominal Switching Frequency		300kHz
-A Efficiency See Figures 2 and 3	V_{OUT1} = 1.2V, I_{OUT1} = 15A, V_{IN} = 12V	89.1% Typical
	V_{OUT2} = 1.5V, I_{OUT2} = 15A, V_{IN} = 12V	90.2% Typical
-B Efficiency See Figures 4 and 5	V_{OUT1} = 1.2V, I_{OUT1} = 15A, V_{IN} = 12V	85.9%
	V_{OUT2} = 1.5V, I_{OUT2} = 15A, V_{IN} = 12V	88.2%

QUICK START PROCEDURE

Demonstration circuit 1626A is easy to set up to evaluate the performance of the LTC3838EFE. 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:

   JP4 RUN1 ON

   JP1 RUN2 ON

   JP3 MODE FCM

2. Adjust the input voltage to be between 4.5V to 26V. V_{OUT1} should 1.2V ±2%.

   V_{OUT2} should 1.5V ±2%.

3. Next, apply 15A load and recheck V_{OUT}.

4. Once the DC regulation is confirmed, observe the output voltage ripple, load step response, efficiency and other parameters.

Note 1. Use the BNC connectors labeled V_{OUT1} or V_{OUT2} to measure the output voltage ripple.

Note 2. Do not apply the load from the VO1_SNS+ turret to the VO1_SNS– turret or from the VO2+ turret to the VO2– turret. These turrets are only intended to monitor the voltage across COUT1 and COUT5 respectively. Heavy load currents applied across these turrets may damage the converter.

Load Step Transient Testing

Demonstration circuit 1626A provides a simple load step circuit consisting of a MOSFET and sense resistor for each rail. To apply a load step, follow the steps below.

1. Preset the amplitude of a pulse generator to 0.0V and the duty cycle to 5% or less.

2. Connect the scope to the V_{OUT} BNC connectors for the rail under test with a coax cable. To monitor the load step current, connect the scope probe across the IOSTEP+/IOSTEP– turrets for that rail.

3. Connect the output of the pulse generator to the PULSE GEN turret for the rail under test and connect the return to one of the GND turrets.

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/A.

QUICK START PROCEDURE

Single Output/Dual Phase Operation

A single output/dual phase converter may be preferred for high output current applications. The benefits of single output/dual phase operation is lower ripple current through the input and output capacitors, faster load step response and simplified thermal design. To implement single output/dual phase operation, make the following modifications:

- Tie V_{OUT1} to V_{OUT2} by tying together the exposed copper pads on the V_{OUT} shapes with pieces of heavy copper foil.
- Tie VFB2 to INTVCC by stuffing 0Ω at R1. This will disable the error amp for phase 2 and internally tie the two ITH signals together.
- Remove the ITH compensation network, VFB divider and TRACK/SS cap for phase 2.
- Tie VRNG1 to VRNG2 by stuffing 0Ω at R4.
- Tie RUN1 to RUN2 by stuffing 0Ω at R7.
- If the optional transient detect circuit is used, externally tie the DTR1 pin to the DTR2 pin.
- Re-compensate if necessary.

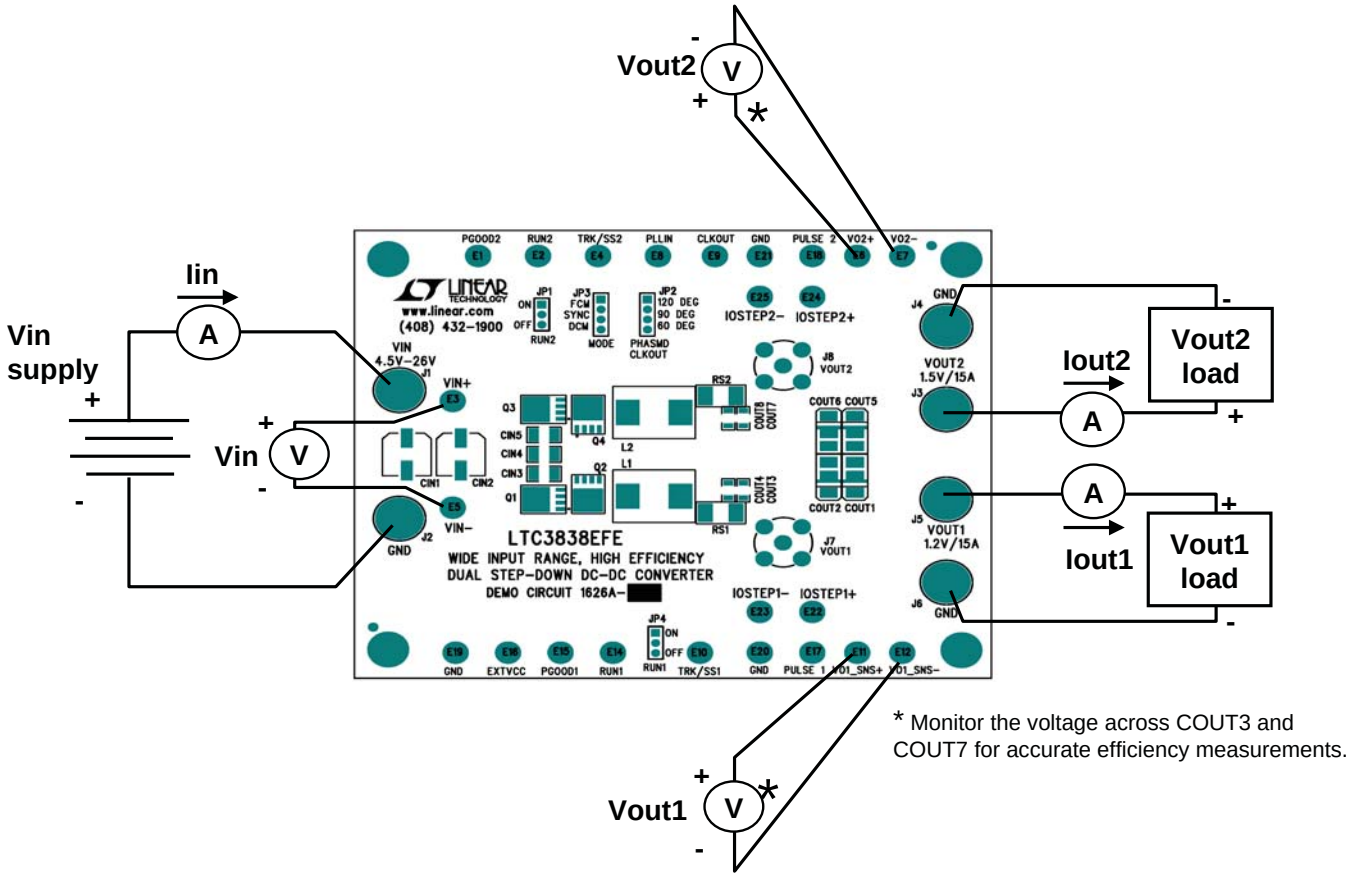
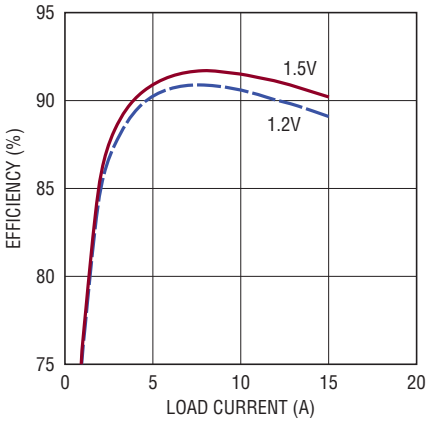


Figure 1. Proper Measurement Equipment Setup

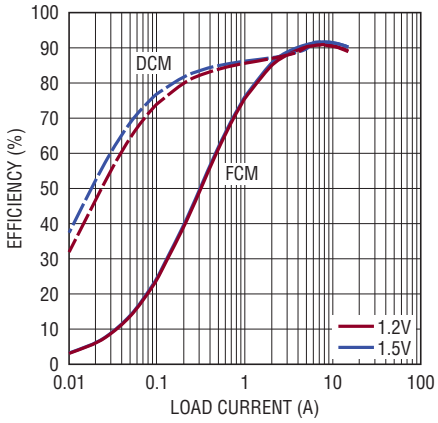
QUICK START PROCEDURE



BOTH RAILS:
QTOP = RJK0305DPB
QBOTTOM = RJK0330DPB
L = VISHAY IHLP4040DZ-01 0.56µH
DCR = 1.7mΩ TYP, 1.8mΩ MAX

dc1626a F02

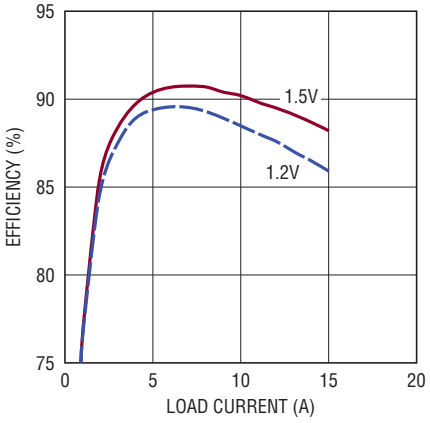
Figure 2. Efficiency Curves for the DC1626A-A (DCR Sense) in FCM



BOTH RAILS:
QTOP = RJK0305DPB
QBOTTOM = RJK0330DPB
L = VISHAY IHLP4040DZ-01 0.56µH
DCR = 1.7mΩ TYP, 1.8mΩ MAX

dc1626a F03

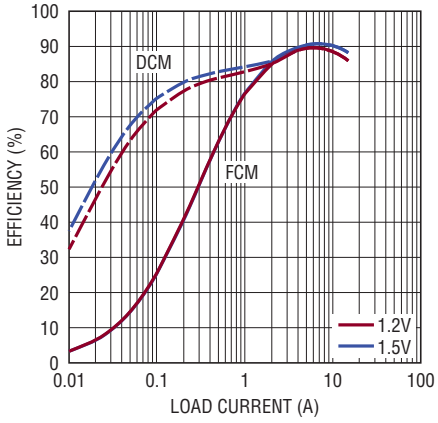
Figure 3. Efficiency Curves for the DC1626A-A (DCR Sense) in FCM and DCM.



BOTH RAILS:
QTOP = RJK0305DPB
QBOTTOM = RJK0330DPB
L = WURTH 7443330068 0.68µH
DCR = 1.35mΩ ±10%
R_{SENSE} = 2.5mΩ

dc1626a F04

Figure 4. Efficiency Curves for the DC1626A-B (R_{SENSE}) in FCM



BOTH RAILS:
QTOP = RJK0305DPB
QBOTTOM = RJK0330DPB
L = WURTH 7443330068 0.68µH
DCR = 1.35mΩ ±10%
R_{SENSE} = 2.5mΩ

dc1626a F05

Figure 5. Efficiency Curves for the DC1626A-B (R_{SENSE}) in FCM and DCM

QUICK START PROCEDURE

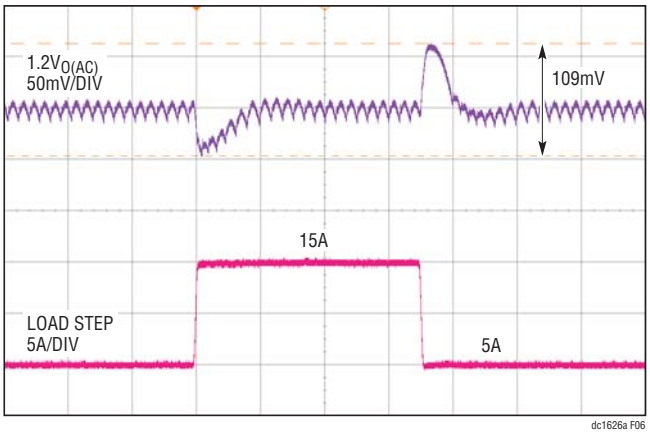


Figure 6. Load Step Response of the 1.2V Rail on the DC1626A-A (DCR Sense) at V_{IN} = 12V. C_{OUT} = 2× Sanyo 2R5TPE330M9 || 2× 100µF X5R 6.3V 1206, L = 0.56µH, f_{SW} = 300kHz

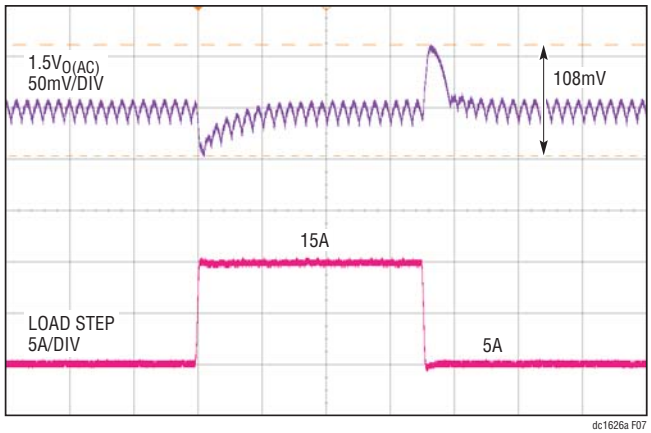


Figure 7. Load Step Response of the 1.5V Rail on the DC1626A-A (DCR Sense) at V_{IN} = 12V. C_{OUT} = 2× Sanyo 2R5TPE330M9 || 2× 100µF X5R 6.3V 1206, L = 0.56µH, f_{SW} = 300kHz

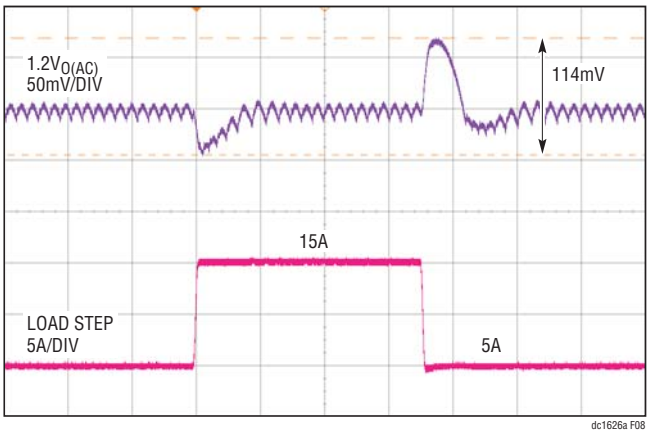


Figure 8. Load Step Response of the 1.2V Rail on the DC1626A-B (R_{SENSE}) At V_{IN} = 12V. C_{OUT} = 2× Sanyo 2R5TPE330M9 || 2× 100µF X5R 6.3V 1206, L = 0.68µH, f_{SW} = 300kHz

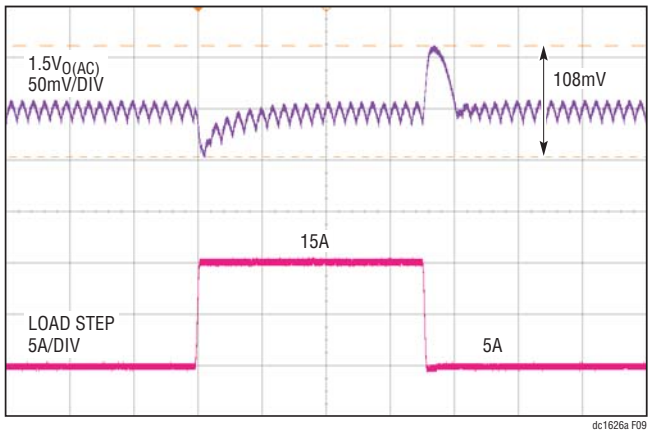


Figure 9. Load Step Response of the 1.5V Rail on the DC1626A-B (R_{SENSE}) at V_{IN} = 12V. C_{OUT} = 2× Sanyo 2R5TPE330M9 || 2× 100µF X5R 6.3V 1206, L = 0.68µH, f_{SW} = 300kHz

PARTS LIST

1626A-A (DCR Sense)

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	C12	CAP, X7R 330pF 50V 0603	AVX 06035C331KAT2A
2	5	C3, C16, C4, C10, C13	CAP, X5R 0.1µF 50V 0603	AVX 06035D104KAT2A
3	2	C5, C14	CAP, X5R 0.01µF 25V 0603	AAC 0603D103KAT2A
4	2	C6, C11	CAP, NPO 47pF 16V 0603	AVX 0603YA470KAT4A
5	1	C7	CAP, NPO 220pF 25V 0603	AVX 06033A221KAT2A
6	1	C8	CAP, X5R 4.7µF 16V 0805	AVX 0805YD475KAT2A
7	2	C9, C18	CAP, X5R 1µF 16V 0603	AVX 0603YD105KAT2A
8	2	CIN1, CIN2	CAP, 100µF 35V SIZE-F	SUNCON 35HVH100M
9	3	CIN3, CIN4, CIN5	CAP, X5R 10µF 35V 1210	TAIYO YUDEN GMK325BJ106MN-T
10	4	COUT1, COUT2, COUT5, COUT6	CAP, 330µF 2.5V SIZE 7343	SANYO 2R5TPE330M9
11	4	COUT3, COUT4, COUT7, COUT8	CAP, X5R 100µF 6.3V 1206	MURATA GRM31CR60J107ME39L
12	2	D1, D2	DIODE, SCHOTTKY SOD-323	CENTRAL SEMI. CMDSH-4ETR
13	2	L1, L2	IND, 0.56µH	VISHAY IHLP4040DZERR56M01
14	2	Q1, Q3	MOSFET, N-CHANNEL LFPAK	RENESAS RJK0305DPB-00-J0
15	2	Q2, Q4	MOSFET, N-CHANNEL LFPAK	RENESAS RJK0330DPB-00-J0
16	2	R12, R38	RES, 100k 1% 0603	VISHAY CRCW0603100KFKEA
17	1	R13	RES, 15k 1% 0603	VISHAY CRCW060315K0FKEA
18	4	R17, R23, R40, R46	RES, 10k 1% 0603	VISHAY CRCW060310K0FKEA
19	2	R18, R32	RES, 4.02k 1% 0603	VISHAY CRCW06034K02FKEA
20	2	R19, R34	RES, 11k 1% 0603	VISHAY CRCW06011K0FKEA
21	1	R21	RES, 40.2k 1%, 0603	VISHAY CRCW060340K2FKEA
22	2	R27, R25	RES, 2.2Ω 1% 0603	VISHAY CRCW06032R20FKEA
23	1	R28	RES, 137k 1% 0603	VISHAY CRCW0603137KFKEA
24	1	R31	RES, 17.4k 1% 0603	VISHAY CRCW06017K4FKEA
25	2	R42, R43	RES, 10Ω 1% 0603	VISHAY CRCW060310R0FKEA
26	9	R8, R11, R16, R35, R39, R48, R55, R20, R36, R30, R26	RES, 0Ω 0603	VISHAY CRCW06030000Z0EA
27	2	RS1, RS2	RES, 0.000Ω 1W 1% 2512	TEPRO RN5326
28	1	U1	LTC3838 38-LEAD TSSOP	LINEAR TECH. LTC3838EFE
Additional Circuit Components				
1	0	C1, C2, C15, C17	CAP, 0603	OPTIONAL
2	0	CIN6-CIN8	CAP, 1210	OPTIONAL
3	0	COUT13-COUT16	CAP, 7343	OPTIONAL
4	0	Q5-Q8	MOSFET, N-CHANNEL LFPAK	OPTIONAL
5	0	R1, R4, R7, R9, R47, R14, R15, R24, R29, R41, R45, R3, R6, R10, R37, R44, R49, R50	RES, 0603	OPTIONAL
6	2	Q9, Q10	MOSFET, N-CHANNEL DPAK	VISHAY SUD50N03-12P-E3
7	2	R51, R52	RES, 10k 1% 0603	VISHAY CRCW060310K0FKEA
8	2	R53, R54	RES, 0.01Ω 1/2W 1% 2010	VISHAY WSL2010R0100FEA

PARTS LIST

1626A-A (DCR Sense)

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Hardware/Components (For Demo Board Only)				
1	4	STAND-OFF	STAND-OFF, NYLON 0.25"	KEYSTONE 8831 (SNAP ON)
2	23	E1-E12, E14-E25	TESTPOINT, TURRET 0.095"	MILL-MAX 2501-2-00-80-00-00-07-0
3	6	J1-J6	JACK, BANANA	KEYSTONE 575-4
4	2	J7, J8	CONN, BNC 5PINS	CONNEX 112404
5	2	JP1, JP4	2MM SINGLE ROW HEADER, 3-PIN	SAMTEC TMM-103-02-L-S
6	4	JP1-JP4	SHUNT	SAMTEC 2SN-BK-G
7	2	JP2, JP3	2MM SINGLE ROW HEADER, 4-PIN	SAMTEC TMM-104-02-L-S

1626A-B (R_{SENSE})

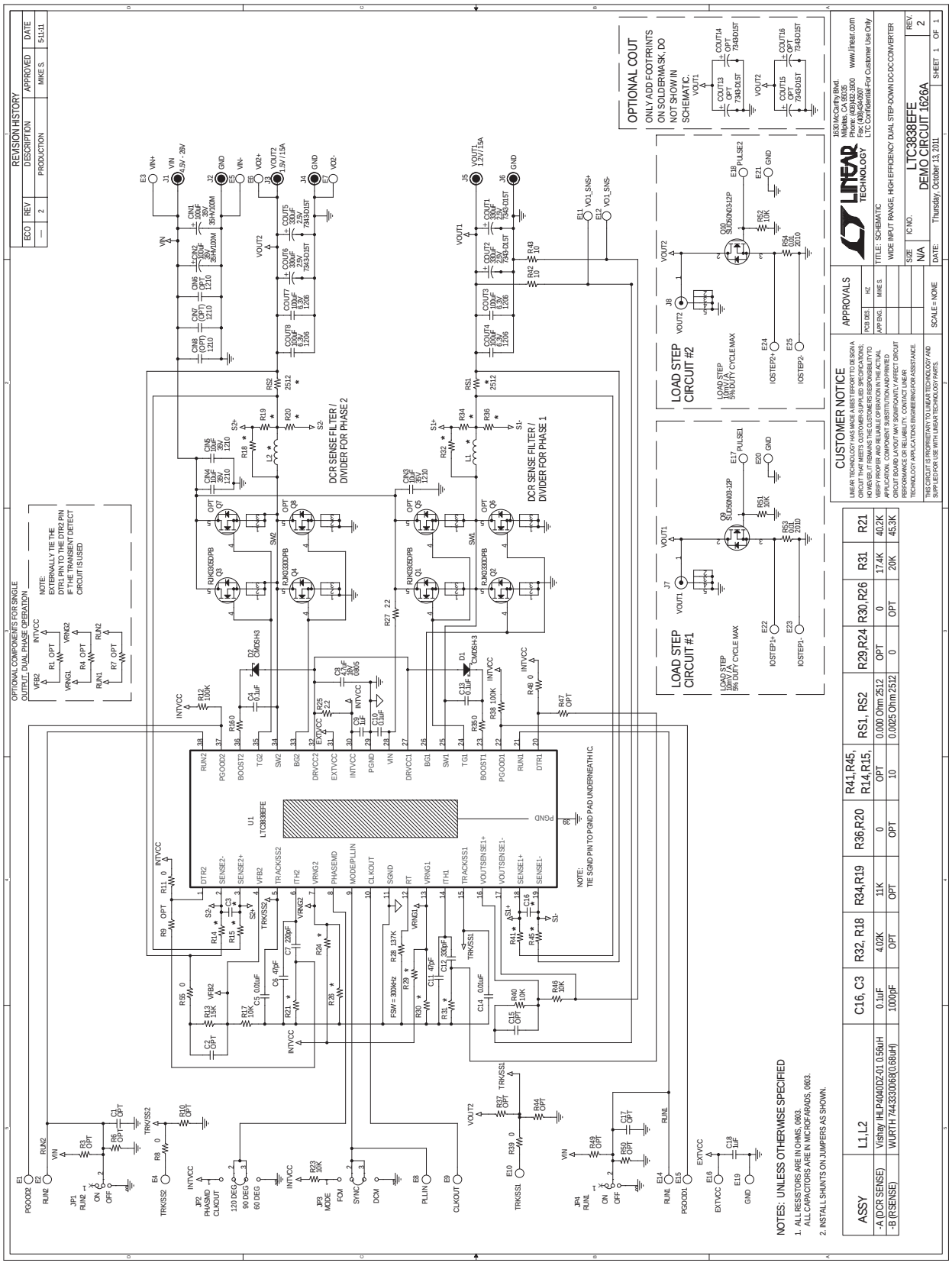
ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	C12	CAP, X7R 330pF 50V 0603	AVX 06035C331KAT2A
2	2	C3, C16	CAP, X7R 1000pF 16V 0603	AVX 0603YC102KAT2A
3	3	C4, C10, C13	CAP, X5R 0.1µF 50V 0603	AVX 06035D104KAT2A
4	2	C5, C14	CAP, X5R 0.01µF 25V 0603	AAC 0603D103KAT2A
5	2	C6, C11	CAP, NPO 47pF 16V 0603	AVX 0603YA470KAT4A
6	1	C7	CAP, NPO 220pF 25V 0603	AVX 06033A221KAT2A
7	1	C8	CAP, X5R 4.7µF 16V 0805	AVX 0805YD475KAT2A
8	2	C9, C18	CAP, X5R 1µF 16V 0603	AVX 0603YD105KAT2A
9	2	CIN1, CIN2	CAP, 100µF 35V SIZE-F	SUNCON 35HVH100M
10	3	CIN3, CIN4, CIN5	CAP, X5R 10µF 35V 1210	TAIYO YUDEN GMK325BJ106MN-T
11	4	COUT1, COUT2, COUT5, COUT6	CAP, 330µF 2.5V SIZE 7343	SANYO 2R5TPE330M9
12	4	COUT3, COUT4, COUT7, COUT8	CAP, X5R 100µF 6.3V 1206	MURATA GRM31CR60J107ME39L
13	2	D1, D2	DIODE, SCHOTTKY SOD-323	CENTRAL SEMI. CMDSH-4ETR
14	2	L1, L2	IND, 0.68µH	WURTH 7443330068
15	2	Q1, Q3	MOSFET, N-CHANNEL LFPAK	RENESAS RJK0305DPB-00-J0
16	2	Q2, Q4	MOSFET, N-CHANNEL LFPAK	RENESAS RJK0330DPB-00-J0
17	2	R12, R38	RES, 100k 1% 0603	VISHAY CRCW0603100KFKEA
18	1	R13	RES, 15k 1% 0603	VISHAY CRCW060315K0FKEA
19	4	R14, R15, R41, R45	RES, 10Ω 1% 0603	VISHAY CRCW060310R0FKEA
20	4	R17, R23, R40, R46	RES, 10k 1% 0603	VISHAY CRCW060310K0FKEA
21	1	R21	RES, 45.3k 1% 0603	VISHAY CRCW060345K3FKEA
22	2	R27, R25	RES, 2.2Ω 1% 0603	VISHAY CRCW06032R20FKEA
23	1	R28	RES, 137k 1% 0603	VISHAY CRCW0603137KFKEA
24	1	R31	RES, 20k 1% 0603	VISHAY CRCW060320K0FKEA
25	2	R42, R43	RES, 10Ω 1% 0603	VISHAY CRCW060310R0FKEA
26	9	R8, R11, R16, R35, R39, R48, R55, R24, R29	RES, 0Ω 0603	VISHAY CRCW06030000Z0EA
27	2	RS1, RS2	RES, SENSE 0.0025 2512	VISHAY WSL25122L500FEA
28	1	U1	LTC3838 38-LEAD TSSOP	LINEAR TECH. LTC3838EFE

PARTS LIST

1626A-B (R_{SENSE})

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Additional Circuit Components				
1	0	C1, C2, C15, C17	CAP, 0603	OPTIONAL
2	0	CIN6-CIN8	CAP, 1210	OPTIONAL
3	0	COUT13-COUT16	CAP, 7343	OPTIONAL
4	0	Q5-Q8	MOSFET, N-CHANNEL LFPAK	OPTIONAL
5	2	Q9, Q10	SUD50N03-12P-E3	VISHAY SUD50N03-12P-E3
6	0	R1, R4, R7, R9, R47, R18, R19, R20, R32, R34, R20, R36, R3, R6, R10, R37, R44, R49, R50, R30, R26	RES, 0603	OPTIONAL
7	2	R51, R52	RES, 10k 1% 0603	VISHAY CRCW060310K0FKEA
8	2	R53, R54	RES, 0.01Ω 1/2W 1% 2010	VISHAY WSL2010R0100FEA
Hardware/Components (For Demo Board Only)				
1	4	STAND-OFF	STAND-OFF, NYLON 0.25"	KEYSTONE, 8831 (SNAP ON)
2	23	E1-E12, E14-E25	TESTPOINT, TURRET 0.095"	MILL-MAX 2501-2-00-80-00-00-07-0
3	6	J1-J6	JACK, BANANA	KEYSTONE 575-4
4	2	J7, J8	CONN, BNC 5-PINS	CONNEX 112404
5	2	JP1, JP4	2MM SINGLE ROW HEADER, 3-PIN	SAMTEC TMM-103-02-L-S
6	4	JP1-JP4	SHUNT	SAMTEC 2SN-BK-G
7	2	JP2, JP3	2MM SINGLE ROW HEADER, 4PIN	SAMTEC TMM-104-02-L-S

SCHEMATIC DIAGRAM



ASSY	L1,L2	C16, C3	R32, R18	R34,R19	R36,R20	R41,R45, R14,R15,	RS1, RS2	R29,R24	R30,R26	R31	R21
-A (DCR SENSE)	Vishay IHLP4040DZ-01 0.56uH	0.1uF	4.02K	11K	0	OPT	0.000 Ohm 2512	OPT	0	17.4K	40.2K
-B (RSENSE)	WURTH 744333006(0.68uH)	1000pF	OPT	OPT	OPT	10	0.0025 Ohm 2512	0	OPT	20K	45.3K

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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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