LTC3882EUJ High Efficiency Step-Down DC/DC Converter with Digital Power System Management

DESCRIPTION

Demonstration circuit 2291A is a high current, high efficiency, PolyPhase® synchronous buck converter featuring the LTC®3882EUJ, a dual output voltage mode controller. This demo board incorporates two LTC3882 controllers which provide four phases to deliver up to 140A. The default output voltage is 1V and can be adjusted from 0.5V to 2V. The LTC3882 has the PMBus interface and digital power system management functions.

The DC2291A powers up to default settings and produces power based on configuration resistors or with its nonvolatile memory without the need for any serial bus communication. This allows easy evaluation of the DC/DC converter. To fully explore the extensive power system management features of the parts, download the GUI software LTpowerPlay™ onto your PC and use LTC's I^2C/SMBus/PMBus Dongle DC1613A to connect to the board. LTpowerPlay allows the user to reconfigure the part on-the-fly and store the configuration settings within its onboard EEPROM, along with viewing telemetry parameters that include voltage, current, temperature and fault status.

GUI DOWNLOAD

The software can be downloaded from:

http://www.linear.com/LTpowerPlay

Design files for this circuit board are available at http://www.linear.com/demo/DC2291A

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Input Supply Range		7	12	14	V
V_{OUT0}	Output Voltage Range	I_{OUT0} = 0A to 140A, V_{IN} = 7V to 14V	0.5	1.0	2.0*	V
I_{OUT0}	Output Current Range		0		140**	A
F_{SW}	Factory Default Switching			450		kHz
EFFICIENCY	Full Load Efficiency	V_{OUT0} = 1.0V, I_{OUT0} = 140A, See Figure 4.		88.6		%

*Note: The DC2291A uses 2.5V-rated low ESR PosCAP (Part No. 2R5TPE470M7) as output capacitors for optimized load transient performance. If >2.0V V_{OUT} is needed, 4V or 6.3V-rated output capacitors should be used.

**Note: When continuously running at full load, forced air flow is needed.

QUICK START PROCEDURE

Demonstration circuit 2291A makes it easy to set up to evaluate the performances of the LTC3882. Refer to Figure 2 for proper measurement equipment setup and follow the procedure below:

Note. When measuring the input or output voltage ripple, care must be taken to avoid a long ground lead on the oscilloscope probe. Measure the output voltage ripple by touching the probe tip directly across the C50. See Figure 3 for proper scope probe technique.

1. Make sure jumpers are in the following positions:

JUMPER	POSITION	FUNCTION
JP5	ON	External 5V VDR for DrMOS
JP7	ON	External 5V V_{CC} for LTC3882

2. With power off, connect the input power supply to V_{IN} and GND. Connect active load to the output (through J3 and J18 for V_{OUT} and J4 and J19 for GND).
3. Make sure RUN switch (SW4) is OFF.
4. Turn on the power at the input.

   Note. Make sure that the input voltage does not exceed 15V.
5. Turn on RUN switch (SW4) as desired.
6. Check for the correct output voltage from V_{OUT0}^{+} to V_{OUT0}^{-}.

   Note. If there is no output, temporarily disconnect the load to make sure that the load is not set too high.
7. Once the proper output voltage is established, adjust the loads within the operating range and observe the output voltage regulation, ripple voltage, efficiency and other parameters.
8. Connect the dongle and control the output voltages from the GUI. See "LTpowerPlay QUICK START" session for details.

CONNECTING A PC TO DC2291A

You can use a PC to reconfigure the power management features of the LTC3882 such as: nominal V_{OUT}, margin set points, OV/UV limits, temperature fault limits, sequencing parameters, the fault log, fault responses, GPIO and other functionality. The DC1613A dongle may be plugged in regardless of whether or not V_{IN} is present. Dongle can be hot plugged.

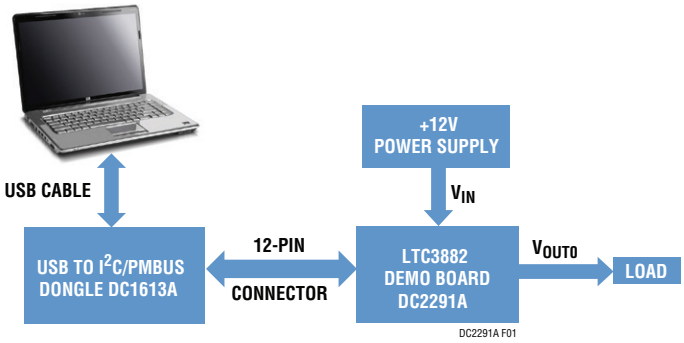


Figure 1. Demo Setup with PC

QUICK START PROCEDURE

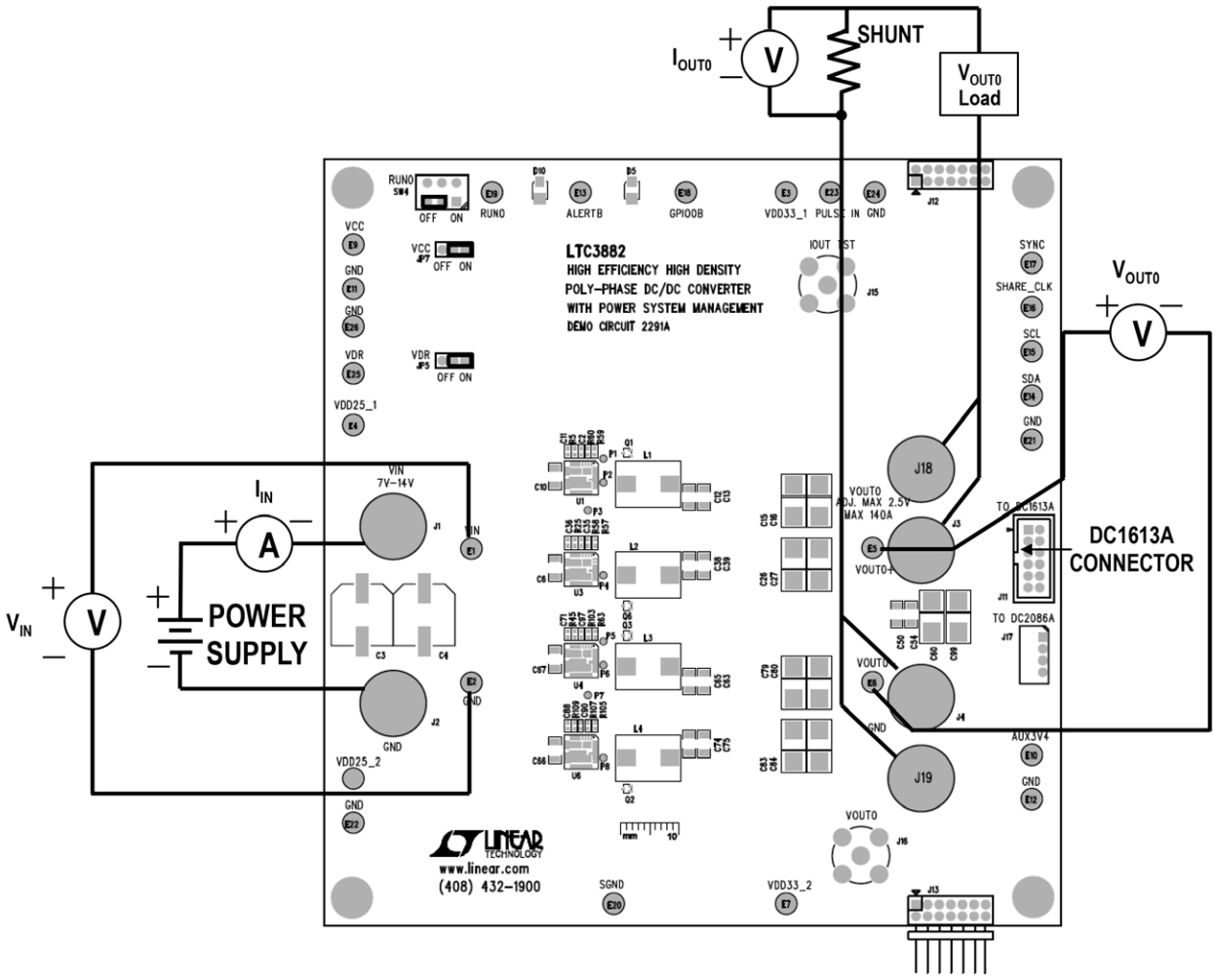


Figure 2. Power Test Setup

QUICK START PROCEDURE

COMBINING DC2291A WITH OTHER DIGITAL POWER DEMO BOARDS

The DC2291A may be plugged together in a multi-board array with other LTC power system management boards using J12 and J13.

MEASURING EFFICIENCY (SEE FIGURE 4)

To accurately measure efficiency of any configuration, do the following:

- Set JP5 and JP7 on the "OFF" position;
- Connect external 5V supply to VDR and V_{CC} turrets and measure its input current;
- Measure V_{IN} across the input ceramic capacitor (C6). Measure V_{OUT} across the output ceramic capacitor (C38);
- Add the loss from external 5V supply into the efficiency calculation.

MEASURING OUTPUT RIPPLE VOLTAGE

An accurate ripple measurement may be performed by using the configuration across C50 as shown in Figure 3.

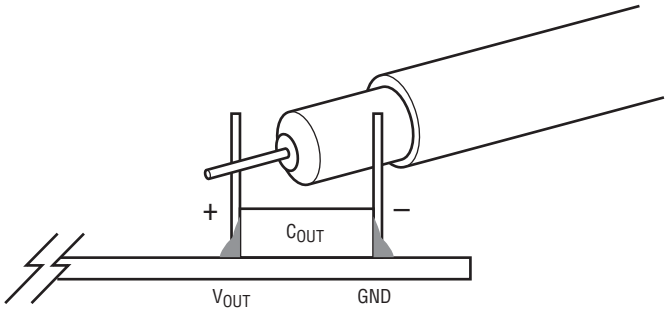


Figure 3. Measuring Output Voltage Ripple

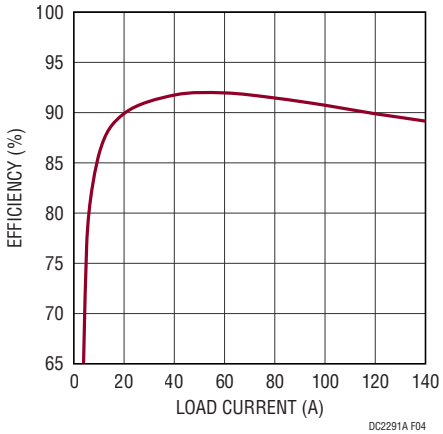


Figure 4. Typical Efficiency Curves of DC2291A, V_{IN} = 12V, V_0 = 1.0V, F_{SW} = 450kHz, CCM

QUICK START PROCEDURE

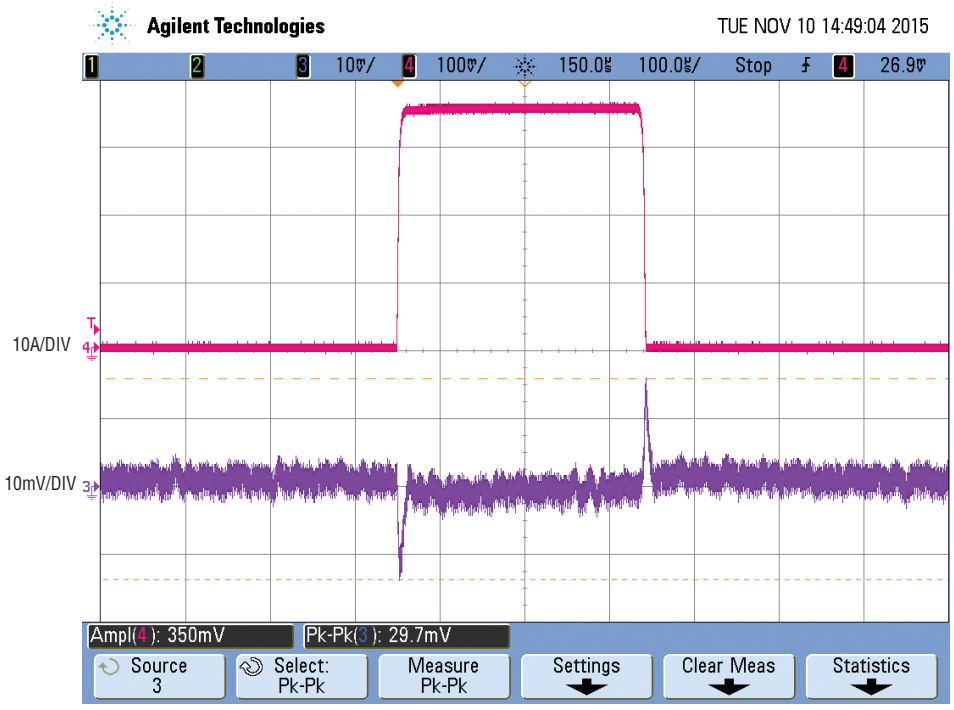


Figure 5. Load Transient Waveform of DC2291A, V_{IN} = 12V, V_O = 1.0V, F_{SW} = 450kHz, 0% to 25% (0A to 35A) Load Step

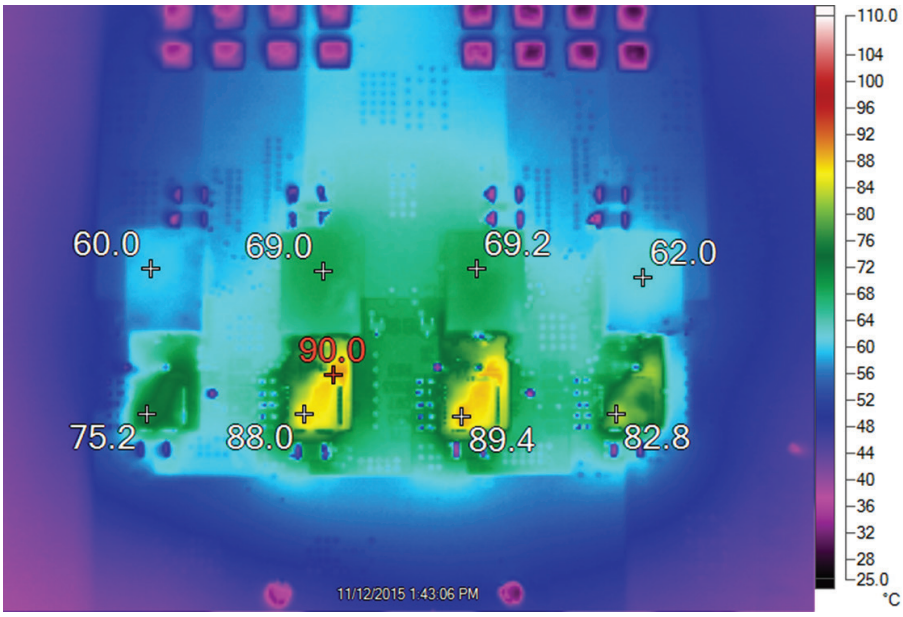


Figure 6. Thermal Picture of DC2291A, V_{IN} = 12V, V_O = 1.0V, I_O = 140A, F_{SW} = 450kHz, 400LFM Airflow, T_A = 25°C

LTpowerPlay SOFTWARE GUI

LTpowerPlay is a powerful Windows-based development environment that supports Linear Technology's power system management ICs, including the LTC3880, LTC3882, LTC3883, LTM®4676, LTC2974, LTC2978 etc. The software supports a variety of different tasks. You can use LTpowerPlay to evaluate Linear Technology ICs by connecting to a demo board system. LTpowerPlay can also be used in an offline mode (with no hardware present) in order to build a multichip configuration file that can be saved and reloaded at a later time. LTpowerPlay provides unprecedented diagnostic and debug features. It becomes a valuable diagnostic tool during board bring-up to program or tweak the power management scheme in a system, or to diagnose power issues when bringing up rails. LTpowerPlay utilizes the DC1613A USB-to-SMBus controller to communicate with one of many potential targets, including the LTC3882's DC2291A demo system, or a customer board. The software also provides an automatic update feature to keep the software current with the latest set of device drivers and documentation. The LTpowerPlay software can be downloaded from:

http://www.linear.com/LTpowerPlay

To access technical support documents for LTC Digital Power Products visit Help. View online help on the LTpowerPlay menu.

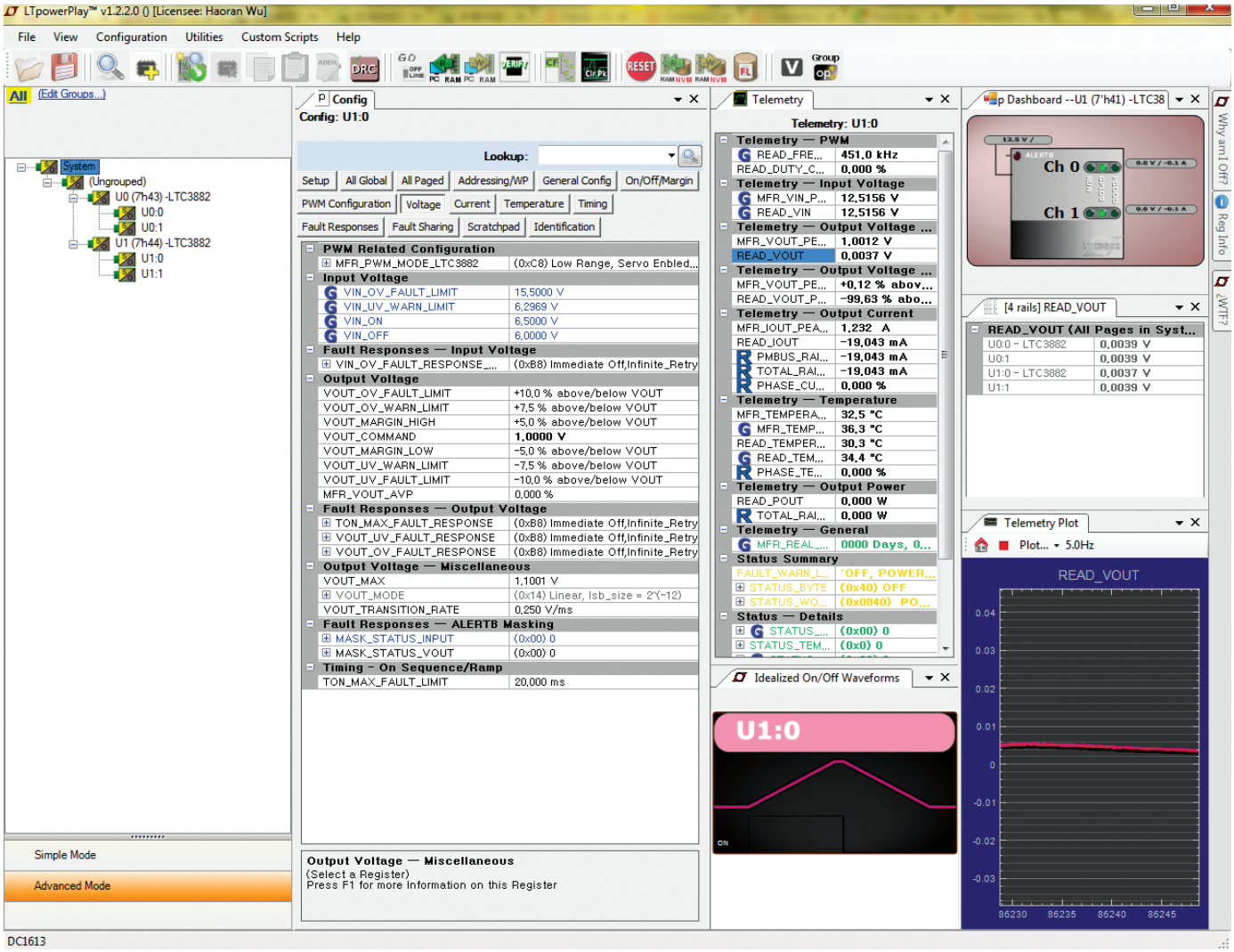


Figure 7. LTpowerPlay Main Interface

LTpowerPlay QUICK START PROCEDURE

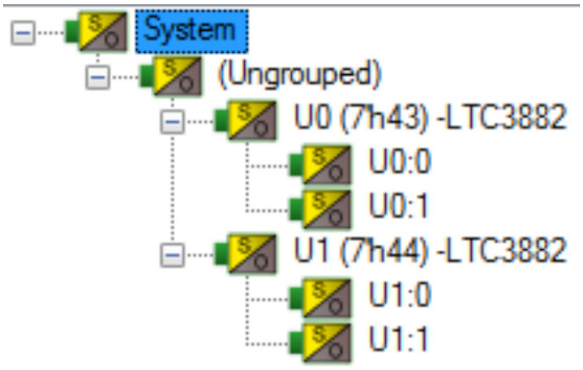
The following procedure describes how to use LTpowerPlay to monitor and change the settings of LTC3882.

1. Download and install the LTpowerPlay GUI:

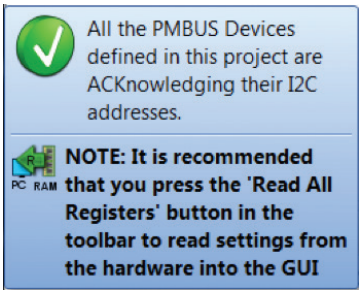
   http://www.linear.com/LTpowerPlay

2. Launch the LTpowerPlay GUI.

   a. The GUI should automatically identify the DC2291A. The system tree on the left hand side should look like this:

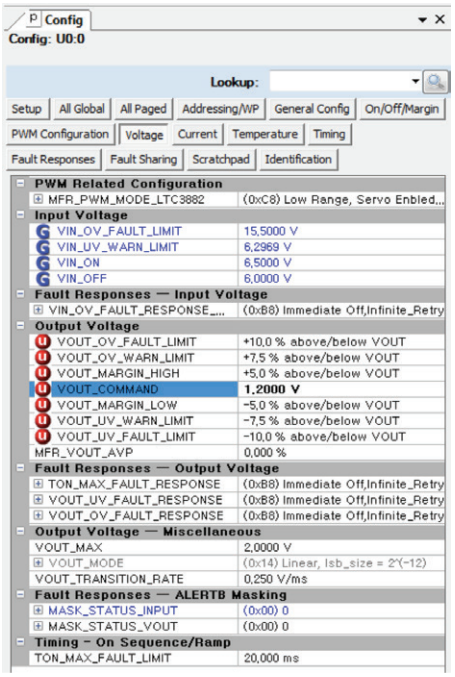


   b. A green message box shows for a few seconds in the lower left hand corner, confirming that the LTC3882 is communicating:



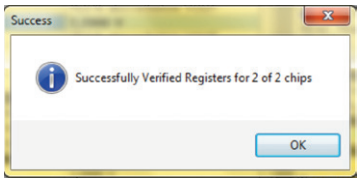
   c. In the Toolbar, click the "R" (RAM to PC) icon to read the RAM from the LTC3882. This reads the configuration from the RAM of LTC3882 and loads it into the GUI.

   d. If you want to change the output voltage to a different value, like 1.2V. In the Config tab, type in 1.2 in the VOUT_COMMAND box, like this:



   Then, click the "W" (PC to RAM) icon to write these register values to the LTC3882. After finishing this step, you will see the output voltage will change to 1.2V.

If the write is successful, you will see the following message:



   e. You can save the changes into the NVM. In the tool bar, click "RAM to NVM" button:

   f. Save the demo board configuration to a (*.proj) file. Click the Save icon and save the file. Name it whatever you want.

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	2	CFFW1, CFFW2	CAP., 22pF, C0G, 50V, 10%, 0402	KEMET, C0402C220K5GACTU
2	1	CIN1	CAP., TANT., 22µF, X5R, 35V, 20%, 7343	AVX, TPSY226M035R0200
3	8	C6, C10, C33, C34, C66, C67, C86, C87	CAP., 22µF, X5R, 25V, 10%, 1206	MURATA, GRM31CR61E226KE15L
4	1	CIN5	CAP., 10µF, X5R, 35V, 20%, 1206	TAIYO YUDEN, GMK316BJ106ML-T
5	2	COUT9, COUT7	CAP., 47µF, X5R, 16V, 20%, 1206	TDK, C3216X5R1C476M160AB
6	4	C3, C4, C24, C46	CAP., OSCON, 330µF, 16V, 20%, F12	PANASONIC, 16SVP330M
7	2	C9, C25	CAP., 4.7µF, X5R, 6.3V, 20%, 0402	SAMSUNG, CL05A475MQ5NRNC
8	16	C12, C13, C14, C29, C38, C39, C40, C41, C50, C54, C63, C64, C65, C74, C75, C91	CAP., 100µF, X5R, 6.3V, 20%, 1206	MURATA, GRM31CR60J107ME39L
9	12	C17, C18, C19, C28, C55, C60, C69, C76, C81, C82, C99, C100	CAP., POSCAP, 470µF, 2.5V, 0.007Ω, 4400mA, D2E CASE	PANASONIC, 2R5TPE470M7
10	4	C20, C42, C58, C85	CAP., 0.22µF, X5R, 16V, 10%, 0402	TDK, C1005X5R1C224K050BB
11	1	C21	CAP., 2200pF, X7R, 50V, 10%, 0402	MURATA, GRM155R71H222KA01D
12	1	C22	CAP., 220pF, X7R, 50V, 10%, 0402	MURATA, GRM155R71H221KA01D
13	1	C30	CAP., 47pF, NP0, 25V, 10%, 0402	MURATA, GRM1555C1E470KA01D
14	4	L1, L2, L3, L4	IND., PWR., 0.17µH, 10%, 61A	COOPER BUSSMANN, FP1007R3-R17-R
15	4	R2, R3, R15, R110	RES., 24.9k, 1/16W, 1%, 0402	VISHAY, CRCW040224K9FKED
16	5	R29, R31, R37, R42, R64	RES., 24.9k, 1/10W, 1%, 0603	VISHAY,CRCW060324K9FKEA
17	9	R5, R25, R41, R45, R109, R114, R115, R116, R117	RES., 0Ω, 1/16W, 0402	VISHAY, CRCW04020000Z0ED
18	5	R24, R51, R71, R73, R83,	RES., 0Ω, 1/10W, 0603	VISHAY, CRCW06030000Z0EA
19	4	R7, R27, R93, R111	RES., 2.67k, 1/16W, 1%, 0402	VISHAY, CRCW04022K67FKED
20	1	R9	RES., 180Ω, 1/16W, 1%, 0402	VISHAY, CRCW0402180RFKED
21	7	R10, R11, R13, R19, R20, R43, R86	RES., 10k, 1/10W, 1%, 0603	VISHAY, CRCW060310K0FKEA
22	1	R12	RES., 7.32k, 1/16W, 1%, 0402	VISHAY, CRCW04027K32FKED
23	2	R14, R17	RES., 2k, 1/10W, 1%, 0603	VISHAY, CRCW06032K00FKEA
24	9	R26, R57, R58, R59, R60, R63, R103, R105, R107	RES., 1k, 1/16W, 1%, 0402	VISHAY, CRCW04021K00FKED
25	1	R30	RES., 4.32k, 1/10W, 1%, 0603	VISHAY, CRCW06034K32FKEA
26	3	R32, R44, R65	RES., 5.76k, 1/10W, 1%, 0603	VISHAY, CRCW06035K76FKEA
27	1	R38	RES., 9.09k, 1/10W, 1%, 0603	VISHAY, CRCW06039K09FKEA
28	4	U1, U3, U4, U6	I.C., MODULE, 60A, 31-LEAD, CLIP BOND PQFN, SPS, 5 × 5mm	FAIRCHILD SEMI., FDMF5820DC
29	1	U2	I.C., LTC3882EUJ#PBF, QFN, 6 × 6mm	LINEAR TECH., LTC3882EUJ#10EG-1PBF-ES
30	1	U8	I.C., LTC3882EUJ#PBF, QFN, 6 × 6mm	LINEAR TECH., LTC3882EUJ#10EH-1PBF-ES

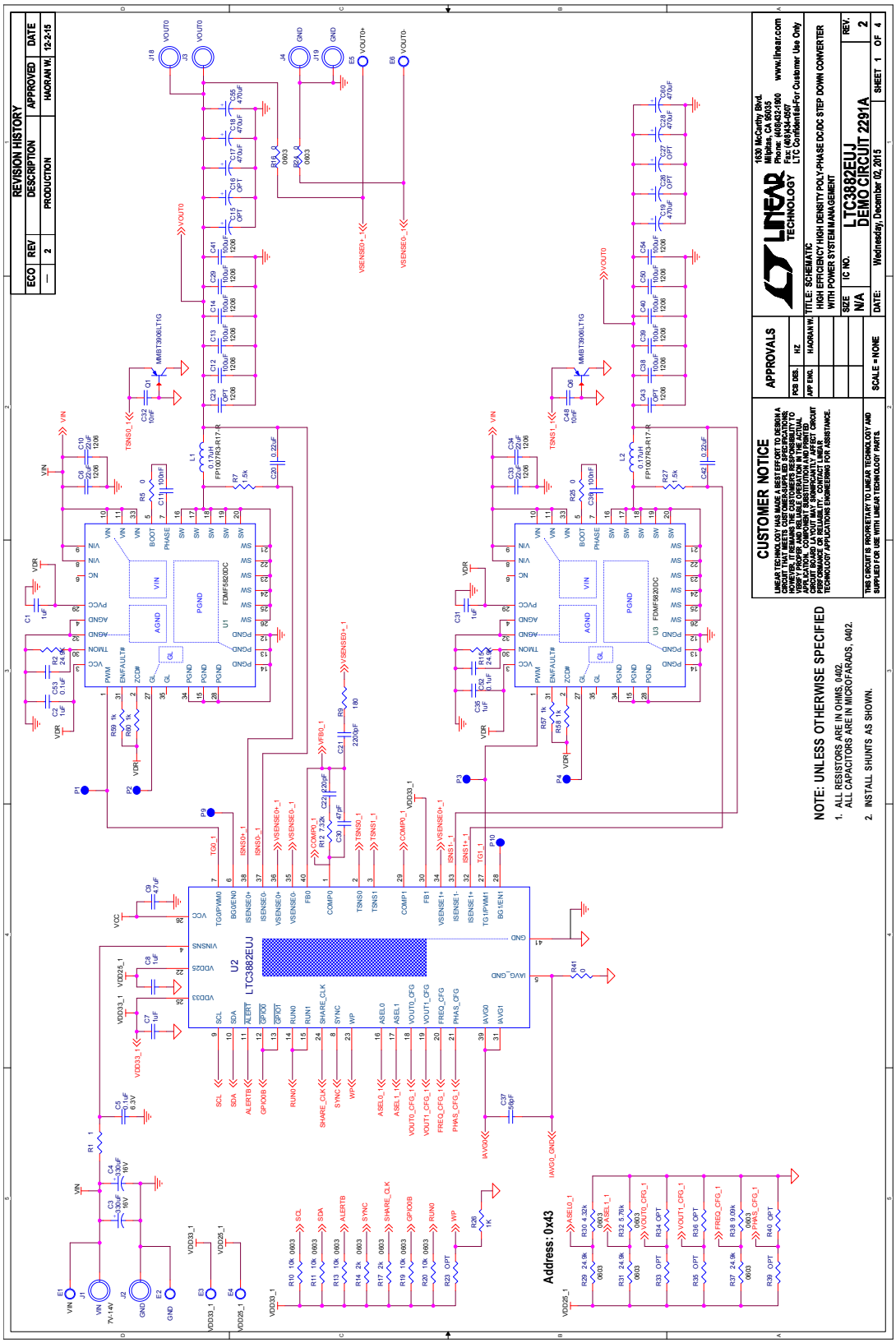
PARTS LIST

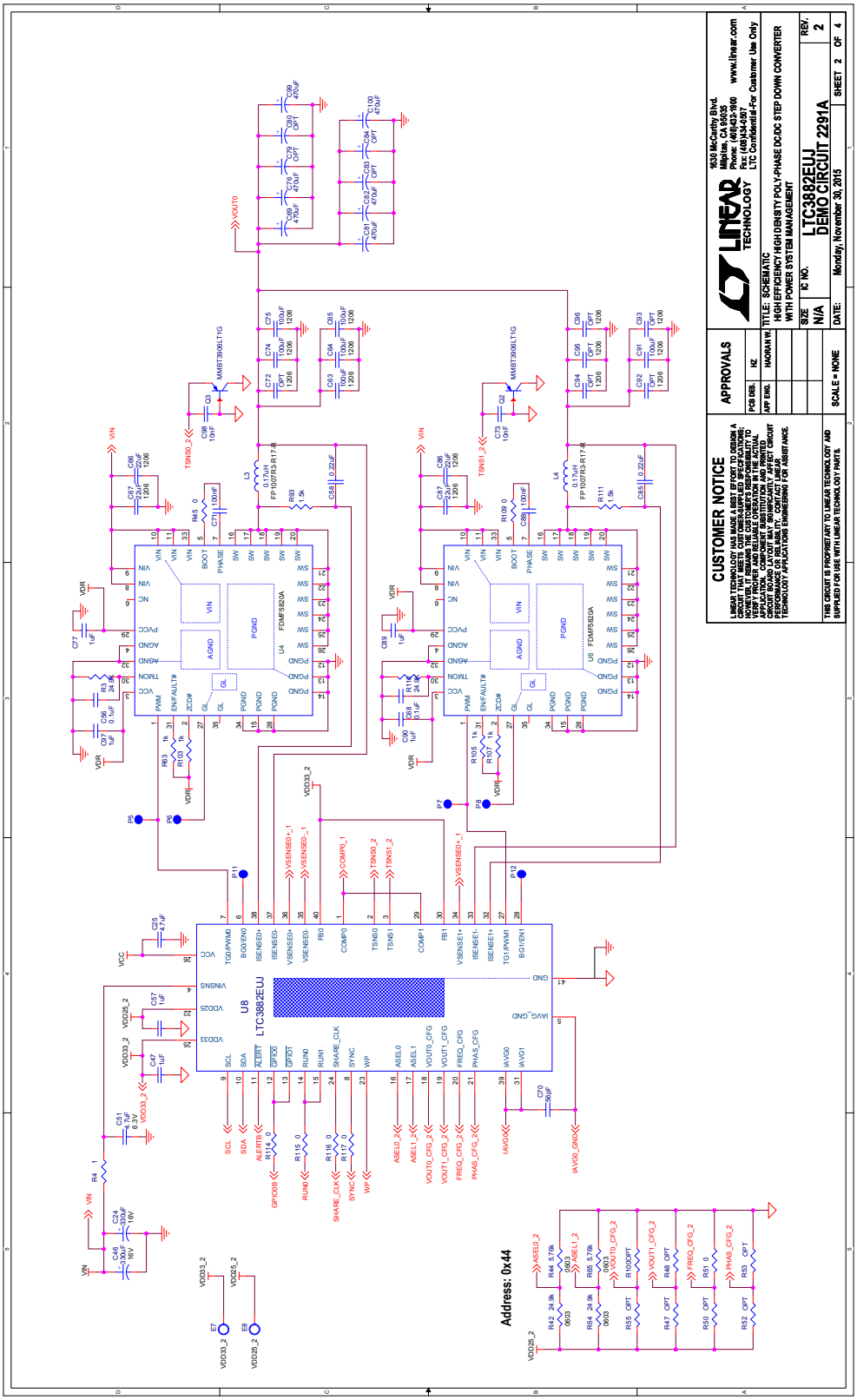
ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Additional Demo Board Circuit Components				
1	10	C5, C52, C53, C56, C68, C51, C11, C36, C71, C88	CAP., 0.1µF, X7R, 16V, 10%, 0402	AVX, 0402YC104KAT2A
2	3	COUT8, COUT10, C45	CAP., 0.1µF, X7R, 16V, 10%, 0603	AVX, 0603YC104KAT2A
3	1	C59	CAP., 0.1µF, X5R, 16V, 10%, 0805	AVX,0805YD104KAT2A
4	13	C1, C2, C7, C8, C31, C35, C47, C57, C61, C77, C89, C90, C97	CAP., 1µF, X5R, 10V, 20%, 0402	MURATA, GRM155R61A105ME15D
5	1	C49	CAP., 1µF, X5R, 16V, 10%, 0805	AVX, 0805YD105KAT2A
6	10	C5, C52, C53, C56, C68, C51, C11, C36, C71, C88	CAP., 0.1µF, X7R, 16V, 10%, 0402	AVX, 0402YC104KAT2A
7	3	COUT8, COUT10, C45	CAP., 0.1µF, X7R, 16V, 10%, 0603	AVX, 0603YC104KAT2A
8	1	C59	CAP., 0.1µF, X5R, 16V, 10%, 0805	AVX,0805YD104KAT2A
9	13	C1, C2, C7, C8, C31, C35, C47, C57, C61, C77, C89, C90, C97	CAP., 1µF, X5R, 10V, 20%, 0402	MURATA, GRM155R61A105ME15D
10	1	C49	CAP., 1µF, X5R, 16V, 10%, 0805	AVX, 0805YD105KAT2A
11	4	C32, C48, C73, C98	CAP., 0.01µF, X7R, 16V, 10%, 0402	AVX, 0402YC103KAT2A
12	1	C44	CAP., 0.01µF, X7R, 50V, 10%, 0603	AVX, 06035C103KAT2A
13	2	C37, C70	CAP., 56pF, NP0, 25V, 10%, 0402	KEMET, C0402C560K3GACTU
14	1	D5	LED, YELLOW GREEN, WATER CLEAR, 571nm, 0603	LITE-ON, LTST-C193KGKT-5A
15	3	D8, D9, D12	DIODE, ULTRA LOW SCHOTTKY RECTIFIER, 20V, 0.5A, SOD-882	NXP SEMI., PMEG2005AEL,315
16	1	D10	LED, RED, WATER CLEAR, 631nm, 0603	LITE-ON, LTST-C193KRKT-5A
17	2	L5, L6	IND., PWR., SHIELDED, 4.7µH, 20%	COILCRAFT, XFL4020-472MEC
18	4	Q1, Q2, Q3, Q6	XSTR., GP, PNP, 40V, 0.2A, SC75-3, SOT-416	ON SEMI, MMBT3906TT1G
19	1	Q4	XSTR., MOSFET, SWITCHING, PWR, N-CH, 30V, 30A, LFPAK	RENESAS ELECTRONICS, RJK0305DPB-00-J0
20	3	Q19, Q20, Q22	XSTR., MOSFET, P-CH, 20V, 5.9A, SOT-23, TO-236	VISHAY, SI2365EDS-T1-GE3
21	1	Q21	XSTR., MOSFET, N-CH, 60V, 115mA, SOT-23	DIODES INC., 2N7002-7-F
22	1	RPG1	RES., 100k, 1/16W, 1%, 0402	VISHAY, CRCW0402100KFKED
23	2	R1, R4	RES., 1Ω, 1/16W, 1%, 0402	VISHAY, CRCW04021R00FKED
24	2	R46, R49	RES., SENSE, 0.01Ω, 1W, 1%, 2512	PANASONIC, ERJM1WSF10MU
25	2	R66,R67	RES., 619k, 1/16W, 1%, 0402	VISHAY, CRCW0402619KFKED
26	2	R68, R69	RES., 84.5k, 1/16W, 1%, 0402	VISHAY, CRCW040284K5FKED
27	2	R70, R16	RES., 10Ω, 1/10W, 1%, 0603	VISHAY, CRCW060310R0FKEA

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
28	2	R76, R77	RES., 4.99k, 1/10W, 1%, 0603	VISHAY, CRCW06034K99FKEA
29	1	R81	RES., 200Ω, 1/10W, 1%, 0603	VISHAY, CRCW0603200RFKEA
30	1	R84	RES., 127Ω, 1/10W, 1%, 0603	VISHAY, CRCW0603127RFKEA
31	1	R87	RES., 15.8k, 1/10W, 1%, 0603	VISHAY, CRCW060315K8FKEA
32	0	R23, R33, R34, R35, R36, R39, R40, R47, R48, R50, R52, R53, R55, R74, R75, R78, R82, R92, R100 (OPT)	RES., OPTION, 0603	
33	0	D7 (OPT)	DIODE, OPTION, SOD-323	
34	1	SW4	SWITCH, SUB-MINIATURE SLIDE, DPDT, 6VDC, 0.3A, THRU-HOLE	C&K COMPONENTS, JS202011CQN
35	1	U5	I.C., EEPROM SERIAL-I^{2}C, 2K-BIT, TSSOP-8	MICROCHIP, 24LC025-I/ST
36	1	U7	I.C., DUAL 1A, 17V, 5µA 1MHz SYNCH BUCK CONVERTER FOR THE 3622 AND DUAL 1A, 17V, 5µA 2.25MHz SYNCH BUCK CONVERTER	LINEAR TECH., LTC3622EDE#PBF
37	0	C23, C43, C72, C92, C93, C94, C95, C96	CAP., OPTIONAL 1206	
38	0	C15, C16, C26, C27, C79, C80, C83, C84	CAP., OPTIONAL D2E CASE	
Hardware for Demo Board Only				
1	26	E1-E26	TEST POINT, TURRET, .094" MTG. HOLE	MILL-MAX, 2501-2-00-80-00-00-07-0
2	2	JP5, JP7	CONN., HEADER, 1 × 3, 2mm	WURTH ELEKTRONIK 62000311121
3	2	JP5, JP7	SHUNT, 2mm	SAMTEC, 2SN-BK-G
4	6	J1, J2, J3, J4, J18, J19	STUD, FASTENER, #10-32	PENN ENGINEERING, KFH-032-10
5	12	J1, J2, J3, J4, J18, J19 (×2)	NUT, BRASS 10-32	ANY #10-32M/S BR PL
6	6	J1, J2, J3, J4, J18, J19	RING, LUG, CRIMP, #10	KEYSTONE, 8205
7	6	J1, J2, J3, J4, J18, J19	WASHER, TIN PLATED BRASS	ANY #10 EXT BZ TN
8	1	J11	CONN., HEADER, 2 × 6, 2mm, STR DL, THRU-HOLE	FCI, 98414-G06-12ULF
9	1	J12	CONN., HEADER, 2 × 7, 2mm, R/A (F)	SULLINS CONNECTOR SOLUTIONS, NPPN072FJFN-RC
10	1	J13	CONN., HEADER, 2 × 7, 2mm, R/A (M)	MOLEX, 87760-1416
11	2	J15, J16	CONN., BNC PC MOUNT RECEPT. JACK, 50Ω, TF-4 POST	CONNEX, 112404
12	1	J17	CONN., HEADER, SHROUDED, 4POS, 2mm, R/A THRU-HOLE	HIROSE, DF3A-4P-2DSA
13	4	MT1, MT2, MT3, MT4	STANDOFF, NYLON, SNAP-ON, 0.500"	KEYSTONE, 8833

SCHEMATIC DIAGRAM




CUSTOMER NOTICE
APPROVALS
PCB DES.
APP ENG.
TITLE: SCHEMATIC
HIGH EFFICIENCY HIGH DENSITY POLY-PHASE DC/DC STEP DOWN CONVERTER WITH PMBUS POWER SYSTEM MANAGEMENT
SIZE
N/A
IC NO.
LTC3882EUJ
DEMO CIRCUIT 2291A
REV. 2
DATE:
Monday, November 30, 2015
SCALE = NONE
SHEET 2 OF 4
LINEAR TECHNOLOGY
1630 McCarthy Blvd.
Milpitas, CA 95035
Phone: (408)432-1900
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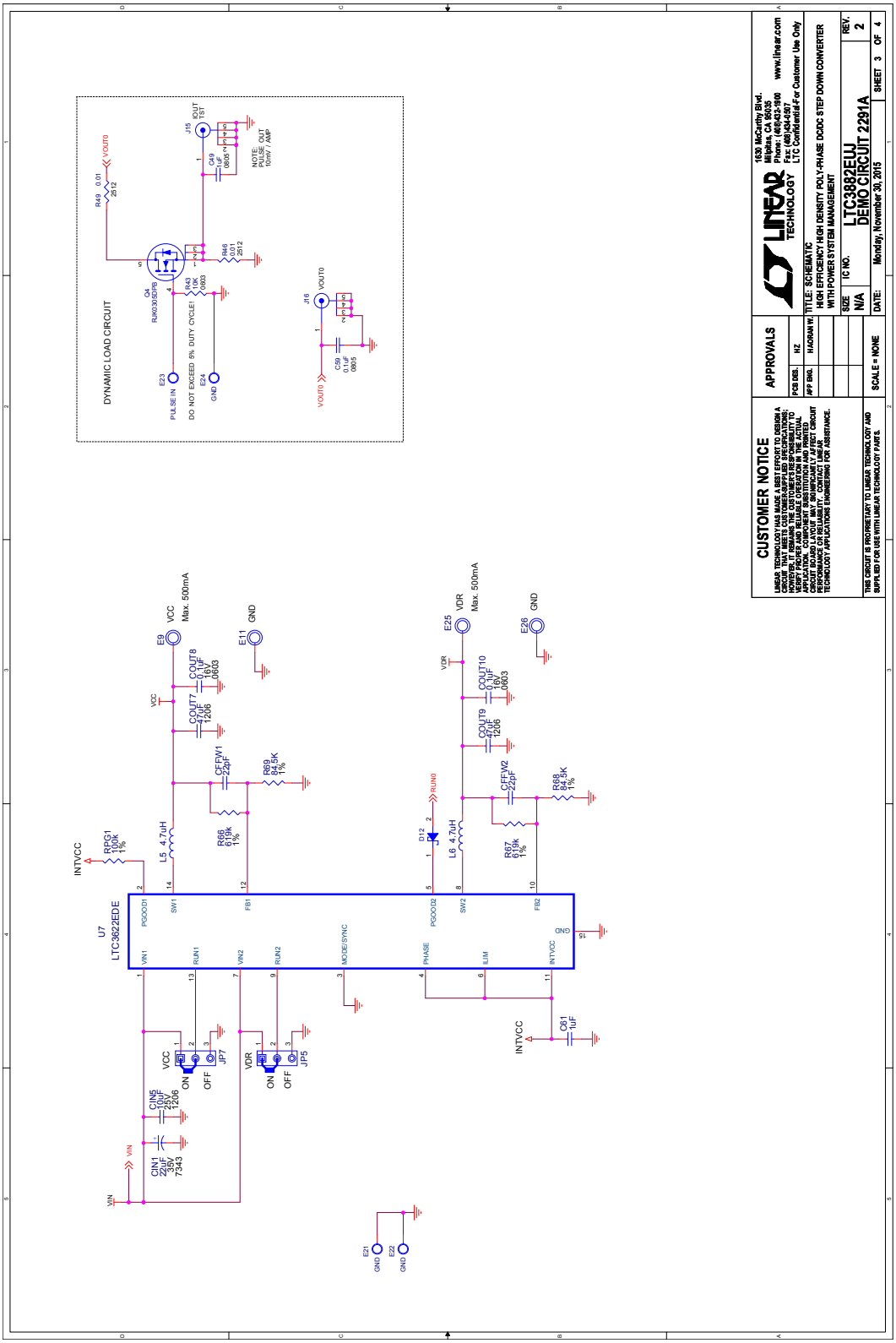
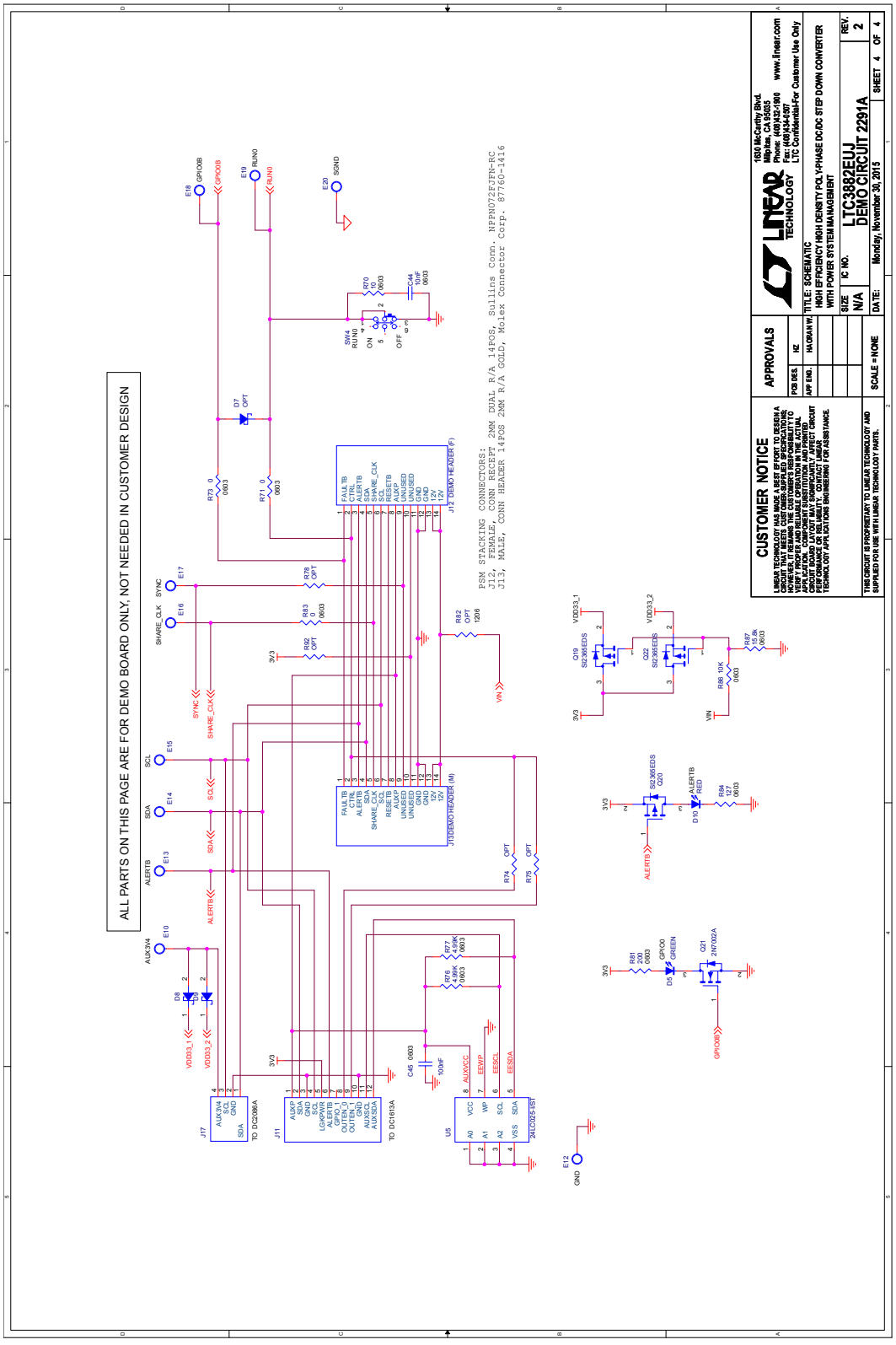
FDMF5820A
Address: 0x44


DYNAMIC LOAD CIRCUIT
DO NOT EXCEED 5% DUTY CYCLE!
PULSE IN
GND
VOUT0
NOTE: PULSE OUT 10mV / AMP
CUSTOMER NOTICE
APPROVALS
LINEAR TECHNOLOGY
1630 McCarthy Blvd.
Milpitas, CA 95035
Phone: (408)432-1900
Fax: (408)434-0507
www.linear.com
LTC Confidential-For Customer Use Only
TITLE: SCHEMATIC
HIGH EFFICIENCY HIGH DENSITY POLY-PHASE DCDC STEP DOWN CONVERTER WITH POWER SYSTEM MANAGEMENT
SIZE
IC NO.
LTC3882EUJ
DEMO CIRCUIT 2291A
REV. 2
DATE: Monday, November 30, 2015
SHEET 3 OF 4
SCALE = NONE
THIS CIRCUIT IS PROPRIETARY TO LINEAR TECHNOLOGY AND SUPPLIED FOR USE WITH LINEAR TECHNOLOGY PARTS.
U7
LTC3622EDE
INTVCC
VCC
VDR
VIN
JP7
JP5
ON
OFF



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