LTC3884ERHE-1, LTC3874EUF-1
Polyphase Single 120A Output Synchronous Buck Converter with Power System Management

DESCRIPTION

Demonstration circuit 2605A is a high efficiency, high density, single-output buck converter with 7V to 14V input range. The output voltage is adjustable from 0.5V to 1.5V, and can supply up to 120A of load current with a 1V output. The demo board features the LTC®3884-1 paired with a slave controller LTC3874-1 to provide a 4-phase buck converter solution. The LTC3884-1 is a dual output poly phase step-down controller for ultra-low DCR sensing with digital power system management. The LTC®3874-1 is a dual PolyPhase® current mode synchronous step-down slave controller. Please see LTC3884-1 data sheet for more detailed information.

DC2605A powers up to default settings and produces power based on configuration resistors or with its non-volatile 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 part, download the GUI software LTpowerPlay® onto your PC and use LTC's I²C/SMBus/PMBus dongle DC1613A to connect to the board. LTpowerPlay allows the user to reconfigure the part on the fly and store the configuration in EEPROM, view telemetry of voltage, current, temperature and fault status.

GUI Download

The software can be downloaded from:

http://www.linear.com/ltpowerplay

For more details and instructions of LTpowerPlay, please refer to LTpowerPlay GUI for LTC3884-1 demo manual.

Design files for this circuit board are available at http://www.linear.com/demo/DC2605A

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PERFORMANCE SUMMARY   Specifications are at T_A = 25°C

PARAMETER	CONDITIONS	VALUE
Input Voltage Range		7V to 14V
Output Voltage, V_{OUT}	V_{IN} = 7-14V, Single Output, I_{OUT} = 0A to 120A	Default: 1V
Maximum Output Current, I_{OUT}	V_{IN} = 7-14V, Single Output, V_{OUT} = 0.5V to 1.5V	120A
Typical Efficiency	V_{IN} = 12V, Single Output, V_{OUT} = 1.0V, 120A Load	90.2%
Peak Efficiency	V_{IN} = 12V, Single Output, V_{OUT} = 1.0V, 70A Load	92.2%
Default Switching Frequency		425kHz

dc2605af

QUICK START PROCEDURE

Demonstration circuit 2605A is easy to set up to evaluate the performance of the LTC3884-1. Refer to Figure 1 for the proper measurement equipment setup and follow the procedure below.

1. With power off, connect the input power supply to V_{IN} (7V-14V) and GND (input return).

2. Connect the output loads between V_{OUT} and GND (Initial load: no load). Refer to Figure 1.

3. Connect the DVMs to the input and output.

4. Check the default jumper/switch position: JP1: OFF; JP2: LOWDCR; JP3: RANGE_LOW; JP4: ON; JP5: EXT; SW2: OFF.

5. Turn on the input power supply and adjust voltage to 12V.

   NOTE: Make sure that the input voltage does not exceed 14V.

6. Turn on the switch: SW2: ON.

7. Check for the proper output voltages from V_{OUT}^+ to V_{OUT}^-.

8. Once the proper output voltage is established, adjust the loads within the operating range and observe the output voltage regulation, ripple voltage and other parameters.

9. Connect the dongle and control the output voltage from the GUI. See "LTpowerPlay Quick Start Guide" session for details.

Note: When measuring the output or input voltage ripple, do not use the long ground lead on the oscilloscope probe. See Figure 2 for the proper scope probe technique. Short, stiff leads need to be soldered to the (+) and (−) terminals of an output capacitor. The probe's ground ring needs to touch the (−) lead and the probe tip needs to touch the (+) lead.

Connecting a PC to DC2605A

You can use a PC to reconfigure the power management features of the LTC3884-1 such as: nominal V_{OUT}, margin set points, OV/UV limits, temperature fault limits, sequencing parameters, the fault log, fault responses and other functionality. The DC1613A dongle may be plugged when V_{IN} is present.
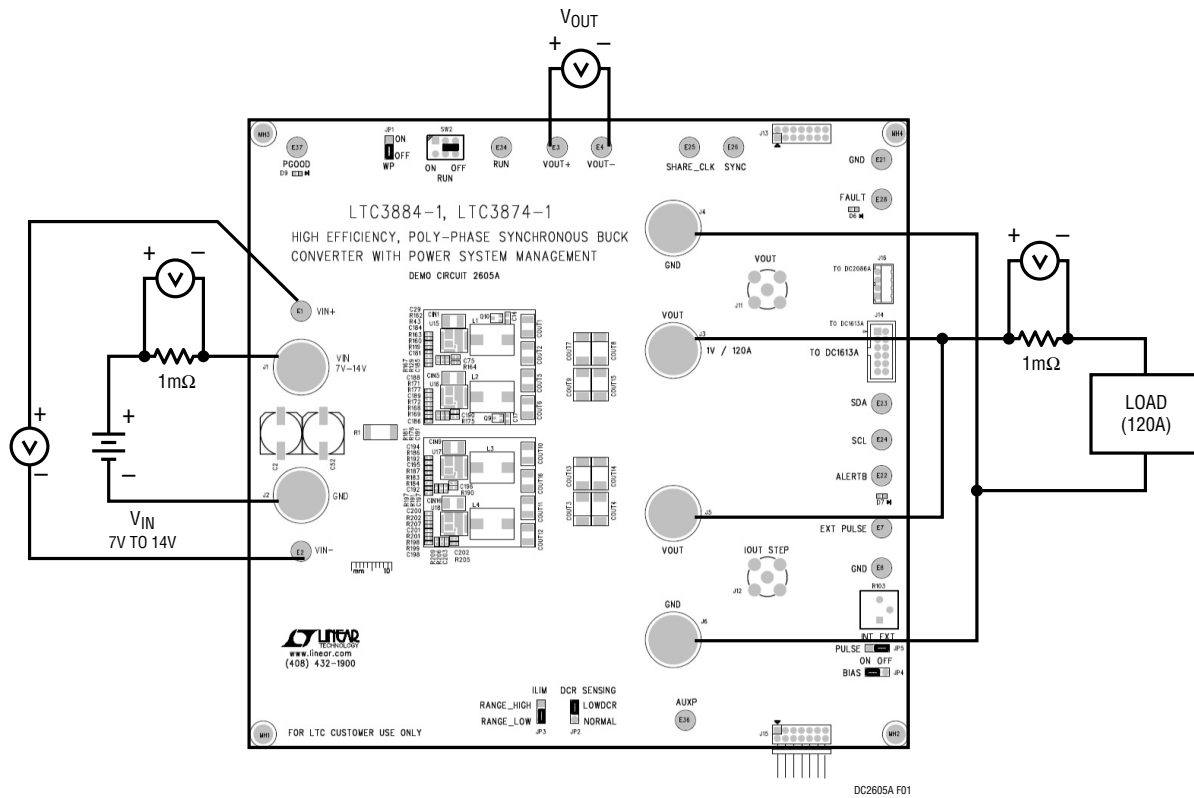
QUICK START PROCEDURE

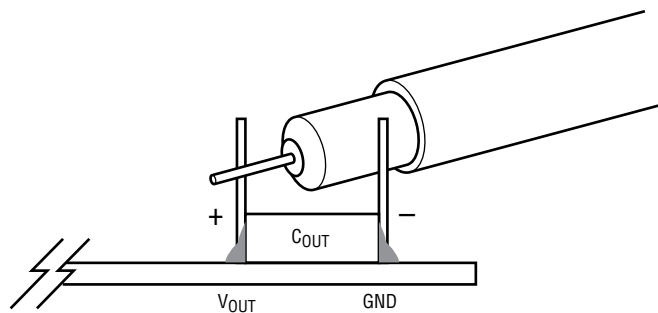

Figure 1. Proper Measurement Equipment Setup

Figure 2. Measuring Output Voltage Ripple
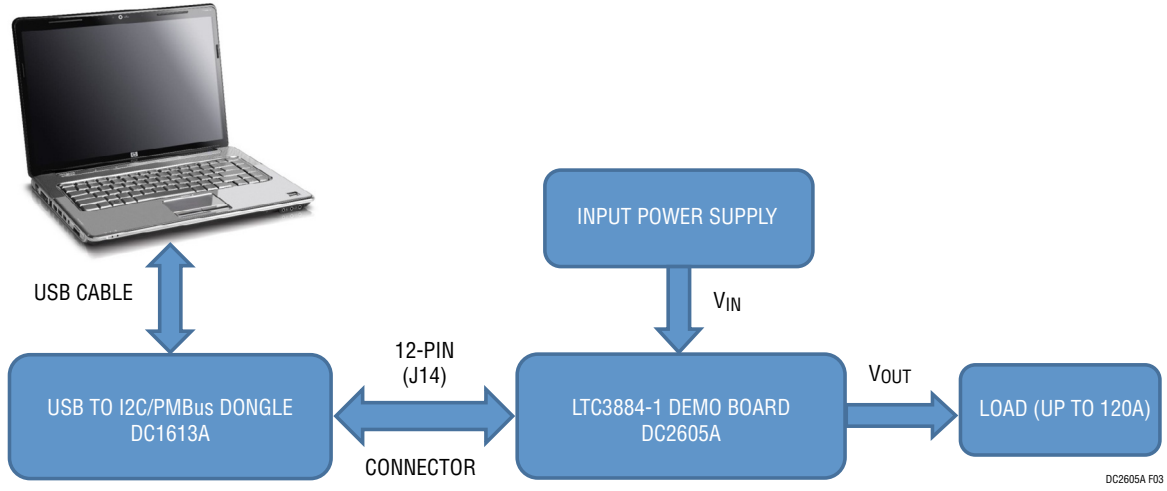
QUICK START PROCEDURE
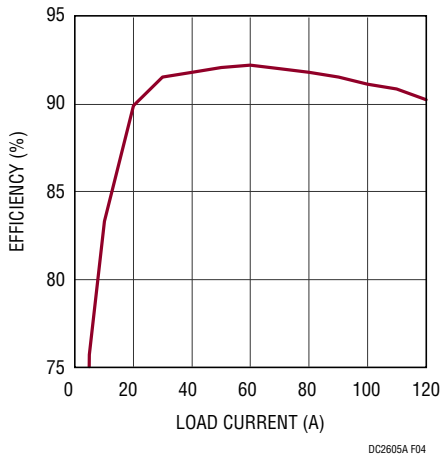

Figure 3. Demo Setup with PC

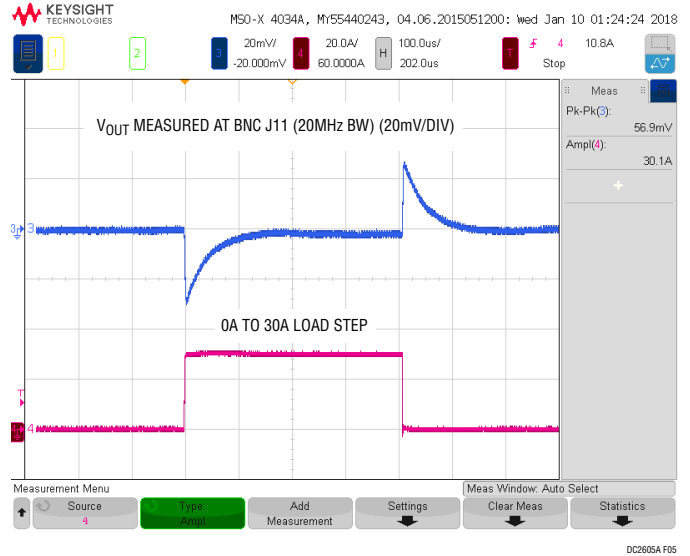**Figure 4. Efficiency vs Load Current at V_{IN} = 12V, V_{OUT} = 1V, f_{SW} = 425kHz**

Figure 5. Transient Response at V_{IN} = 12V, V_{OUT} = 1V, f_{SW} = 425kHz
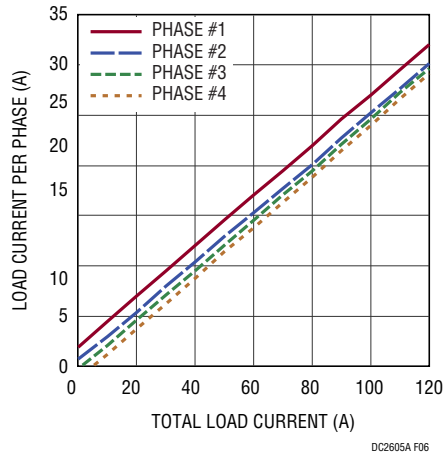
QUICK START PROCEDURE

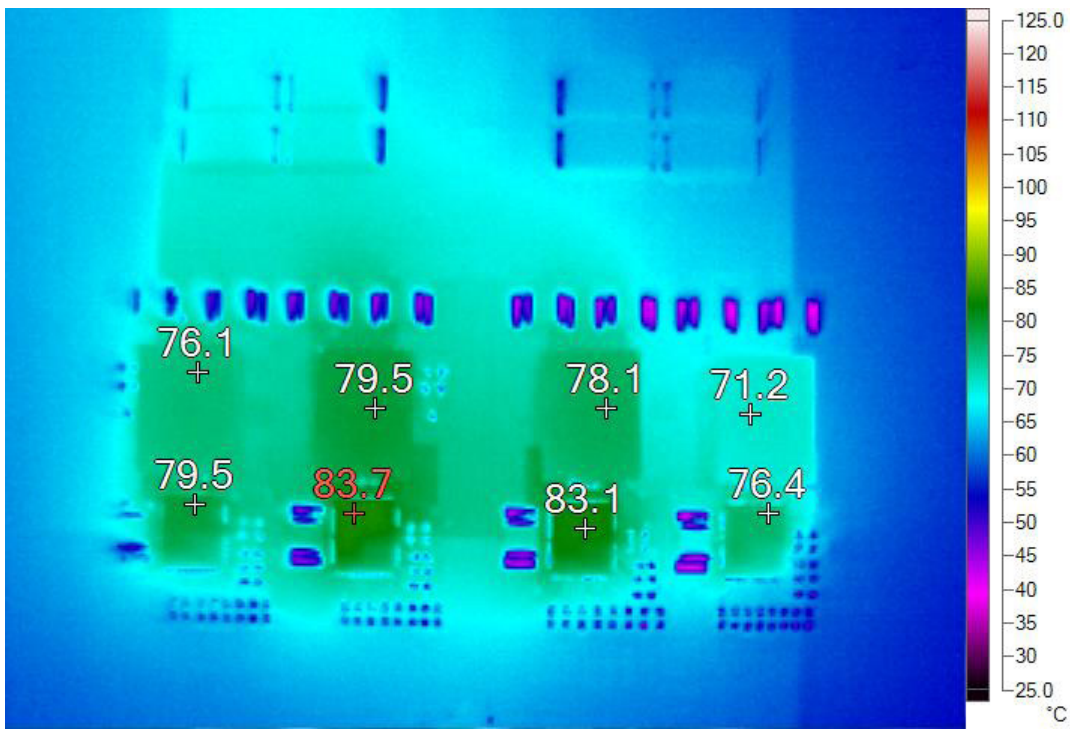Figure 6. Current Sharing vs Load Current at V_{IN} = 12V, V_{OUT} = 1V, f_{SW} = 425kHz

Figure 7. Thermal Performance at V_{IN} = 12V, V_{OUT} = 1V, I_{OUT} = 120A, T_A = 23°C, No Forced Airflow

LTPOWERPLAY SOFTWARE GUI

LTpowerPlay is a powerful Windows based development environment that supports Linear Technology power system management ICs, including the LTM4676, LTC3880, LTC3883, LTC3884/LTC3884-1, LTC2974 and 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 manage-ment 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 LTM4676, the LTC3880, LTC3884 and the LTC3883's 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://linear.com/ltpowerplay

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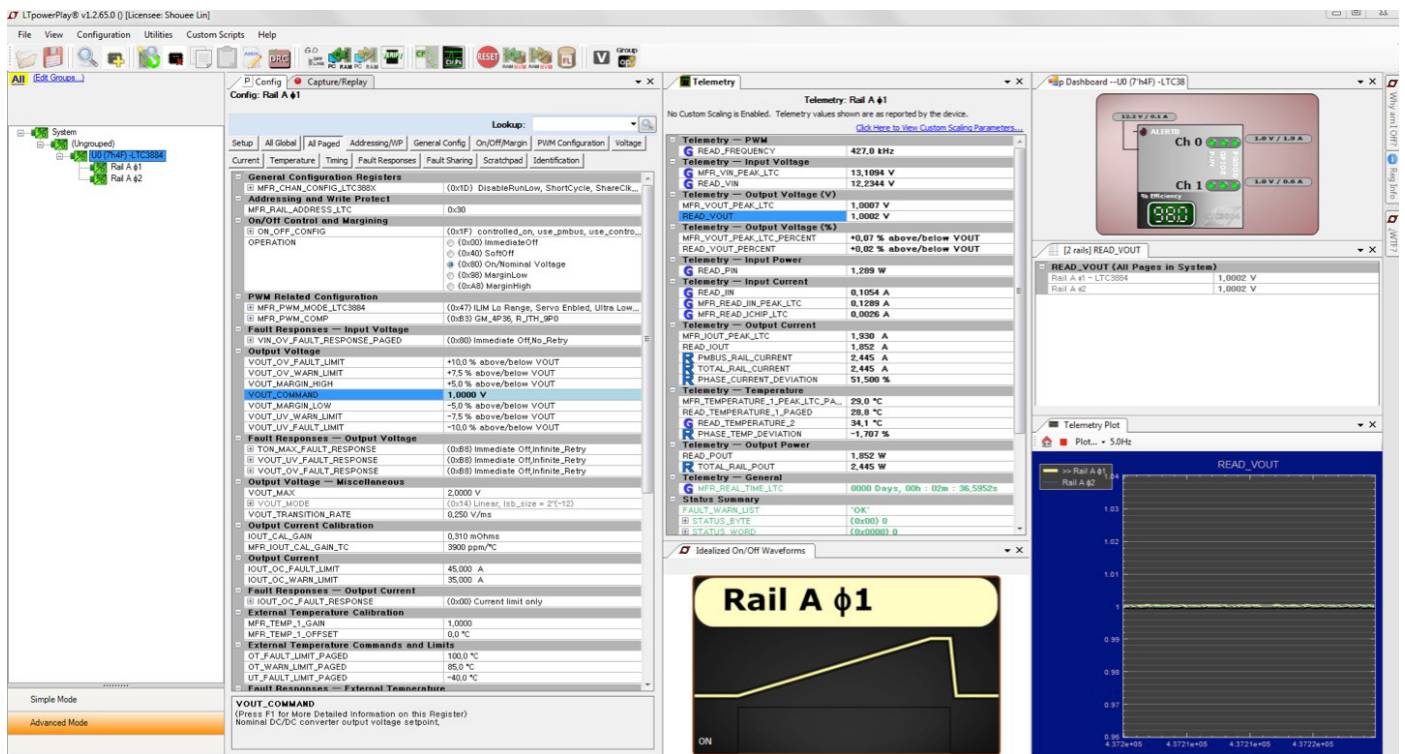

Figure 8. LTpowerPlay Main Interface
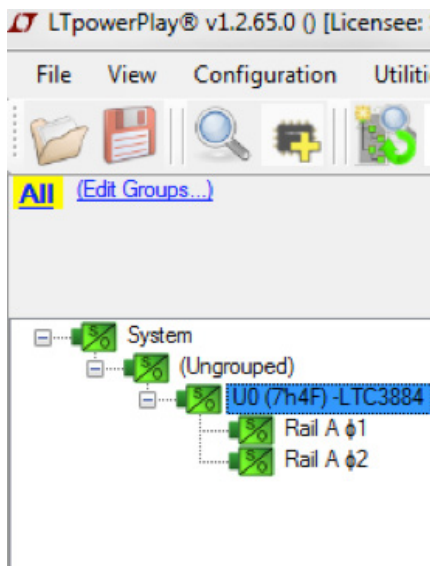
LTPOWERPLAY QUICK START PROCEDURE

The following procedure describes how to use LTpower-Play to monitor and change the settings of LTC3884-1.

1. Download and install the LTPowerPlay GUI:

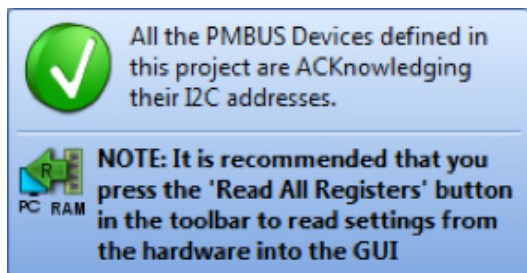   http://linear.com/ltpowerplay

2. Launch the LTpowerPlay GUI.

a. The GUI should automatically identify the DC2605A. 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 LTC3884-1 is communicating:

c. In the Toolbar, click the "R" (RAM to PC) icon to read the RAM from the LTC3884-1. This reads the configuration from the RAM of LTC3884-1 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:
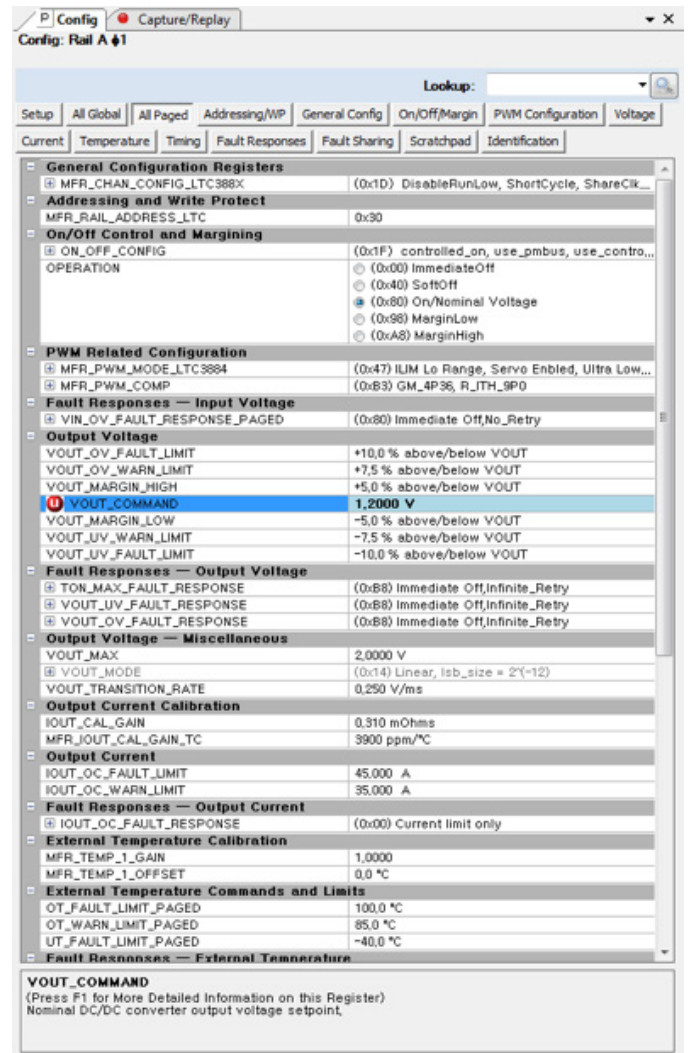
LTPOWERPLAY QUICK START PROCEDURE

Then, click the "W" (PC to RAM) icon to write these register values to the LTC3884-1. 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:
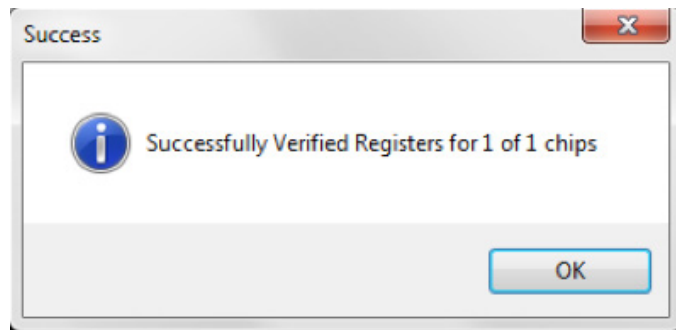
e. You can save the changes into the NVM. In the tool bar, click "RAM to NVM" button, as following

f. Save the demo board configuration to a (*.proj) file. Click the Save icon and save the file with a user filename.

PARTS LIST

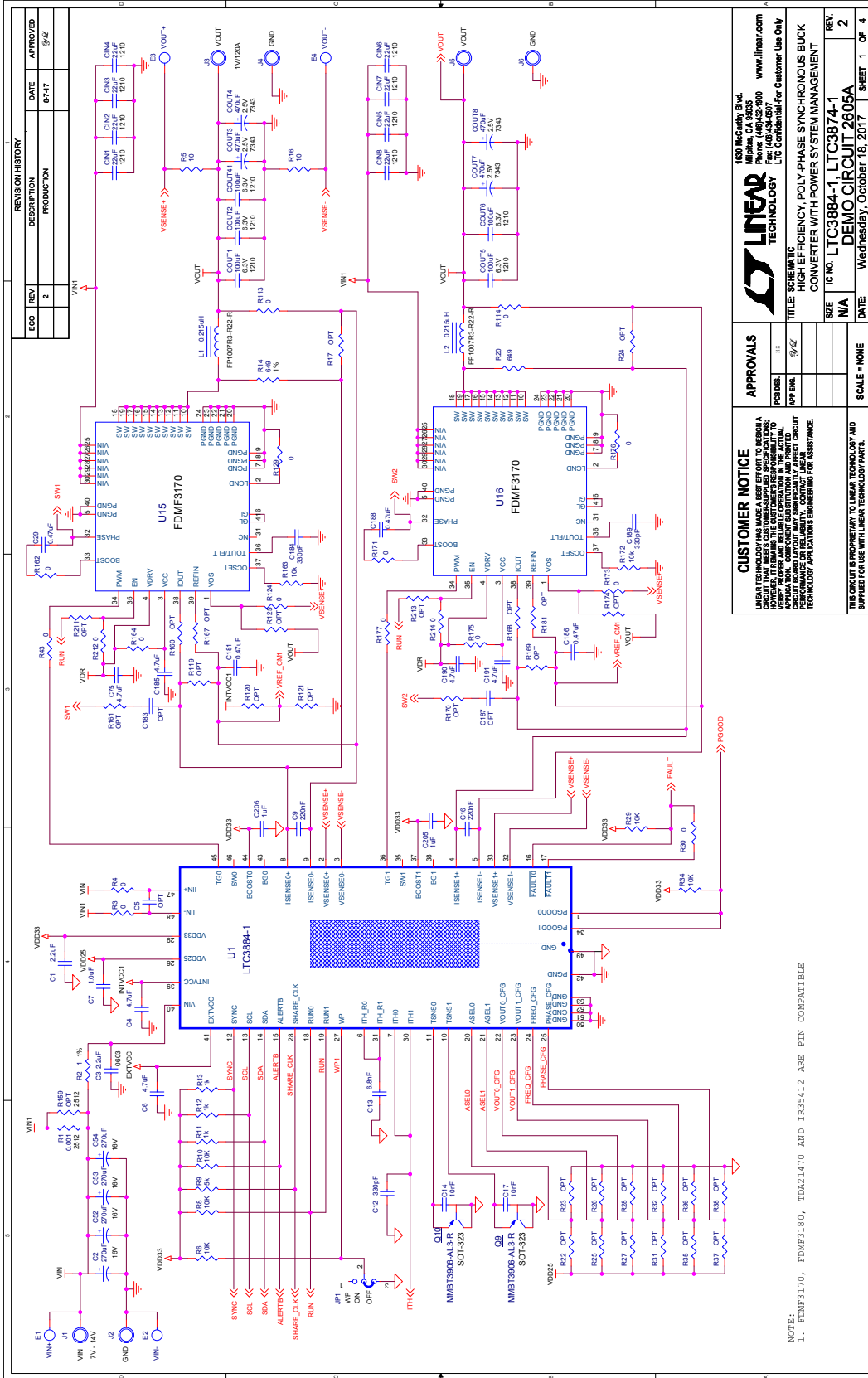| ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	16	CIN1, CIN2, CIN3, CIN4, CIN5, CIN6, CIN7, CIN8, CIN9, CIN10, CIN11, CIN12, CIN13, CIN14, CIN15, CIN16	CAP. 22µF X7R 25V 10% 1210	MURATA GRM32ER71E226KE15K
2	17	COUT1, COUT2, COUT5, COUT6, COUT10, COUT11, COUT12, COUT16, COUT19, COUT20, COUT24, COUT25, C30, C34, C35, COUT41, C44	CAP. 100µF X5R 6.3V 20% 1210	AVX, 12106D107MAT2A
3	8	COUT3, COUT4, COUT7, COUT8, COUT9, COUT13, COUT14, COUT15	CAP. 470µF 20% 2.5V TANT. POLYMER	PANASONIC ETPF470M5H
4	5	C7, C19, COUT26, C41, C42	CAP. 1µF X5R 25V 20% 0603	AVX 06033D105MAT2A
5	1	C1	CAP. 2.2µF X5R 6.3V 20% 0603	TDK C1608X5R0J225M
6	4	C2, C52, C53, C54	CAP. 270µF 20% 16V OSCON	PANASONIC 16SVPC270M
7	1	C3	CAP. 2.2µF X7S 16V 20% 0603	MURATA, GRM188C71C225KE11D
8	4	C4, C6, C18, C20	CAP. 4.7µF X5R 10V 10% 0603	AVX 0603ZD475KAT2A
9	4	C9, C16, C21, C33	CAP. 220nF X7R 25V 10% 0603	TDK C1608X7R1E224K
10	1	C12	CAP. 330pF C0G 50V 5% 0603	MURATA GRM1885C1H331JA01D
11	1	C13	CAP. 6.8nF X7R 50V 10% 0603	MURATA GRM188R71H682KA01B
12	3	C14, C17, C28	CAP. 10nF X7R 25V 10% 0603	AVX 06033C103KAT2A
13	1	C23	CAP. 22pF C0G 50V 5% C0G 0603	MURATA GRM1885C1H220JA01B
14	8	C29, C181, C186, C188, C192, C194, C198, C200	CAP. 0.47µF X5R 10V 10% 0402	MURATA GRM155R61A474KE15D
15	1	C31	CAP. 10µF X7R 16V 10% 1210	MURATA GRM32DR71C106KA01L
16	2	C39, C50	CAP. 100nF X7R 16V 20% 0603	AVX 0603YC104MAT2A
17	1	C40	CAP. 150pF X7R 50V 10% 0603	AVX 06035C151KAT2A
18	1	C43	CAP. 220pF X7R 50V 10% 0603	AVX 06035C221KAT2A
19	1	C49	CAP. 47nF X7R 25V 10% 0603	AVX 06033C473KAT2A
20	8	C75, C185, C190, C191, C196, C197, C202, C203	CAP. 4.7µF X5R 10V 10% 0402	TDK C1005X5R1A475K
21	4	C184, C189, C195, C201	CAP. 330pF X7R 50V 10% 0402	AVX 04025C331KAT2A
22	4	C204, C205, C206, C207	CAP. 1µF X5R 10V 10% 0402	TDK C1005X5R1A105K
23	2	D6, D9	LED 0603 GREEN	WURTH ELEKTRONIK 150060GS75000
24	1	D7	LED 0603 RED	WURTH ELEKTRONIK 150060SS75000
25	1	D13	DIODE ULTRA LOW SCHOTTKY RECTIEIER	NEXPERIA PMEG2005AEL,315
26	4	L1, L2, L3, L4	Power inductor	EATON., FP1007R3-R22-R
27	1	L5	IND 68µH Shielded Inductor 1.6A 201 mΩ	SUMIDA, CDRH105RNP-680NC
28	2	Q9, Q10	XSTR 40V PNP SMALL SIGNAL TRANSISTOR IN SOT323	DIODES INC, MMST3906-7-F
28	2	Q9, Q10	XSTR 40V PNP SMALL SIGNAL TRANSISTOR IN SOT323	DIODES INC, MMST3906-7-F
29	2	Q20, Q29	XSTR P-CHANNEL ENHANCEMENT MODE MOSFET	DIODES INC, DMP3130L-7
30	2	Q21, Q26	XSTR N-CHANNEL TRANSISTOR	FAIRCHILD 2N7002K
31	2	Q23, Q24	XSTR MOSFET N-CHANNEL 40V	VISHAY SUD50N04-8M8P-4GE3

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
32	1	R1	RES. 0.001Ω 1% 1W 2512	VISHAY WSL25121L000FEA
33	1	R2	RES. 1Ω 1% 1/10W 0603	VISHAY CRCW06031R0FKEA
34	15	R3, R4, R30, R51, R52, R56, R87, R91, R113, R114, R117, R127, R137, R138, R148	RES. 0Ω 1/10W 0603	VISHAY CRCW06030000Z0EA
35	3	R5, R16, R70	RES. 10Ω 1% 1/10W 0603	VISHAY CRCW060310R0FKEA
36	7	R6, R8, R10, R29, R34, R98, R123	RES. 10kΩ 1% 1/10W 0603	VISHAY CRCW060310K0FKEA
37	3	R9, R128, R150	RES. 4.99kΩ 1% 1/10W 0603	VISHAY CRCW06034K99FKEA
38	3	R11, R12, R13	RES. 1kΩ 1% 1/10W 0603	VISHAY CRCW06031K00FKEA
39	4	R14, R20, R135, R143	RES. 649Ω 1% 1/10W 0603	VISHAY CRCW0603649RFKEA
40	24	R43, R124, R129, R162, R164, R171, R173, R175, R176, R177, R186, R188, R190, R191, R192, R202, R203, R205, R206, R207, R212, R214, R216, R218	RES. 0Ω 1/10W 0402	VISHAY CRCW04020000Z0EA
41	2	R49, R89	RES. 2Ω 1% 1/10W 0603	VISHAY CRCW06032R0FKEA
42	1	R55	RES. 100KΩ 5% 1/10W 0603	VISHAY CRCW0603100KJNEA
43	3	R95, R96, R107	RES. 20kΩ 1% 1/10W 0603	VISHAY CRCW060320K0FKEA
44	2	R79, R130	RES. 402Ω 1% 1/10W 0603	VISHAY CRCW0603402RFKTA
45	1	R81	RES. 255Ω 1% 1/10W 0603	VISHAY CRCW0603255RFKEA
46	1	R85	RES. 27.4Ω 1% 2512	VISHAY CRCW06033R30FKEA
47	1	R92	RES. 3.3Ω 1% 1/10W 0603	VISHAY CRCW06033R30FKEA
48	1	R93	RES. 154kΩ 1% 1/10W 0603	VISHAY CRCW0603154KFKEA
49	1	R94	RES. 1MΩ 5% 1/10W 0603	VISHAY CRCW06031M00JNEA
50	1	R97	RES. 681kΩ 1% 1/10W 0603	VISHAY CRCW0603681KFKEA
51	1	R99	RES. 301Ω 5% 1/10W 0603	VISHAY CRCW0603301RFKEA
52	1	R100	RES. 82.5Ω 5% 1/10W 0603	VISHAY CRCW060382R5FKEA
53	2	R101, R102	RES. 0.01Ω 1%2512	VISHAY WSL2512R0100FEA
54	1	R103	RES. VARIABLE 5K	BOURNS 3386P-1-502-LF
55	1	R104	RES. 1.21kΩ 1% 1/10W 0603	VISHAY CRCW06031K21FKEA
56	2	R105, R106	RES. 118kΩ 1% 1/10W 0603	VISHAY CRCW0603118KFKEA
57	4	R147	RES. 15.8kΩ 1% 1/10W 0603	VISHAY CRCW060315K8FKEA
58	4	R163, R172, R187, R201	RES. 10kΩ 1% 1/10W 0402	VISHAY CRCW040210K0FKED
59	1	U1	IC. Dual Output PolyPhase Step-Down Controller with Sub-Milliohm DCR Sensing and Digital Power System Management	LINEAR TECH.LTC3884ERHE-1#10GV-1PBF-ES
60	1	U2	IC. PolyPhase Step-Down Synchronous Slave Controller with Sub-Milliohm DCR Sensing	LINEAR TECH.LTC3874EUF-1
61	1	U4	IC. High Efficiency, 65V 500mA Synchronous Step-Down Converter	LINEAR TECH. LTC3630EMSE#PBF
62	1	U5	IC. Voltage-Controlled Pulse Width Modulator	LINEAR TECH. LTC6992IS6-1#PBF
63	1	U6	IC. Single 100V/µs,85MHz, Rail-to-Rail Input and Output Op Amps	LINEAR TECH. LT1803IS5#PBF
64	1	U8	IC. SERIAL EEPROM	MICROCHIP 24LC024-I/ST
65	4	U15, U16, U17, U18	DrMOS	Fairchild FDMF3170

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Additional Demo Board Circuit Components				
1	0	COUT17, COUT18, COUT22, COUT23, COUT35, COUT36, COUT37, COUT38, COUT39, COUT40	CAP., OPTION	
2	0	C5, C51, C183, C187, C193, C199	CAP., OPTION	
3	0	D11	DIODE., SOD323 OPTIONAL	
4	0	R119, R120, R125, R160, R161, R167, R168, R169, R170, R174, R181, R183, R184, R185, R189, R197, R198, R199, R200, R204, R209, R211, R213, R215, R217, R17, R22, R23, R24, R25, R26, R27, R28, R31, R32, R35, R36, R37, R38, R87, R122, R134, R136, R141, R142, R145, R151, R139, R85, R159, R121, R195, R194, R59	RES. OPTIONAL	
Hardware: For Demo Board Only				
1	16	E1-E4, E7, E8, E21-E26, E28, E34, E36, E37	TEST POINT TURRET, 0.094" MTG. HOLE	MILL-MAX 2501-2-00-80-00-00-07-0
2	5	JP1, JP2, JP3, JP4, JP5	CONN. HDR MALE 1×3 2mm THT STR	WURTH ELEKTRONIK 62000311121
3	2	J11, J12	CONN. BNC PC MOUNT RECEPT. JACK 50Ω TF-4 POST	AMPHENOL CONNEX 112404
4	1	J13	CONN. HEADER 2×7 2mm R/A (F)	SULLINS NPPN072FJFN-RC
5	1	J14	HEADER 12PIN 2mm STR DL	FCI 98414-G06-12ULF
6	1	J15	CONN. HEADER 2×7 2mm R/A (M)	MOLEX 87760-1416
7	1	J16	HEADER 4PIN 2mm STR DL	HIROSE DF3A-4P-2DSA
8	1	SW2	SWITCH Slide Switch DPDT Through Hole	C&K JS202011CQN
9	5	XJP1 XJP2 XJP3 XJP4 XJP5	CONN. SHUNT FEMALE 2 POS 2mm	WURTH ELEKTRONIK 60800213421
10	4	MH1 MH2 MH3 MH4	STANDOFF SNAP ON	KEYSTONE 8834

SCHEMATIC DIAGRAM

dc2605af

SCHEMATIC DIAGRAM

dc2605af

SCHEMATIC DIAGRAM

ALL PARTS ON THIS PAGE ARE FOR DEMO BOARD ONLY, NOT NEEDED IN CUSTOMER DESIGN

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LTC Confidential-For Customer Use Only

TITLE: SCHEMATIC
HIGH EFFICIENCY, POLY-PHASE SYNCHRONOUS BUCK
CONVERTER WITH POWER SYSTEM MANAGEMENT

IC NO. LTC3884-1, LTC3874-1
DEMO CIRCUIT 2605A

SIZE N/A
REV. 2
SHEET 4 OF 4

DATE: Thursday, August 17, 2017

SCALE = NONE

dc2605af

ESD Caution

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.