LTC3889EUKG 60V Dual Output Step-Down DC/DC Controller with Digital Power System Management

DESCRIPTION

Demonstration circuit 2595A is a high voltage, dual output step-down synchronous buck converter featuring the LTC®3889EUKG, a 60V dual-phase current mode controller. The LTC3889 has the PMBus interface and the power system management functions.

The DC2595A uses discrete MOSFET as the power stage. The input range of this board is from 36V to 54V, and the default outputs are 12V/20A (V_{OUT0}) and 24V/20A (V_{OUT1}). DC2595A also has an on-board dynamic load circuit, which makes it easy for the customer to evaluate the transient performances.

Please be aware that the DC2595A default connects V_{OUT0} (12V) to the LTC3889 $EXTV_{CC}$ pin through R168. As a result, the DRVCC can be adjusted to 6.3V, 7.4V or 9V by setting DRVSET to 0, 1 or 2 in LTpowerPlay®. If you want to adjust V_{OUT0} to a voltage higher than 12V, R168 must be removed first to avoid damaging the IC.

The DC2595A powers up to default settings and produces power based on configuration resistors or NVM without the need for any serial bus communication. This allows easy evaluation of the DC/DC converter aspects of the LTC3889. 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 in EEPROM, view telemetry of voltage, current, temperature and fault status.

GUI Download

The software can be downloaded from:

LTpowerPlay

For more details and instructions of LTpowerPlay, please refer to LTpowerPlay Quick Start Procedure for LTC3889 demo board.

Design files for this circuit board are available.

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Input Supply Range		36	48	54	V
F_{SW}	Factory Default Switching Frequency			150		kHz
V_{OUT0}	CH0 Output Voltage Range	I_{OUT0} = 0A TO 20A, V_{IN} = 36V to 54V		12		V
I_{OUT0}	CH0 Output Current Range		0		20	A
EFF	CH0 Full Load Efficiency	V_{OUT0} = 12V, I_{OUT0} = 20A, $EXTV_{CC}$ = 12V, DRVCC = 9V, See Figure 4.		97.0		%
V_{OUT1}	CH1 Output Voltage Range	I_{OUT1} = 0A to 20A, V_{IN} = 36V to 54V		24		V
I_{OUT1}	CH1 Output Current Range		0		20	A
EFF	CH1 Full Load Efficiency	V_{OUT1} = 24V, I_{OUT1} = 20A, $EXTV_{CC}$ = 12V, DRVCC = 9V, See Figure 4.		98.2		%

QUICK START PROCEDURE

Demonstration circuit 2595A makes it easy to set up to evaluate the performances of the LTC3889. 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 C10 for CH0 and C26 for CH1. See Figure 3 for proper scope probe technique.

1. Make sure jumpers are in the following positions:

JUMPER	POSITION	FUNCTION
JP1	OFF	Ext 5.5V (On-Board Bias Supply) for $EXTV_{CC}$
JP2	NC	FAULT0B to FAULT1B
JP3	NC	RUN0 to RUN1
JP5	INT	External or On-Board Pulse Generator for Transient Circuit
JP6	OFF	On-Board Pulse Generator On/Off

2. With power off, connect the input power supply to V_{IN} and GND. Connect active load to the output.
3. Make sure both RUN switches (SW1, SW2) are OFF.
4. Set the input power supply between 36V to 54V; turn on the power at the input.

   Note: Make sure that the input voltage does not exceed 54V.
5. Turn on both SW1 (for RUN0), and SW2 (for RUN1) switches as desired.
6. Check for the correct output voltage from E5 to E6 for CH0, E7 to E8 for CH1. V_{OUT0} = 12.0V ± 0.5% (11.94V ~ 12.06V), V_{OUT1} = 24V ± 0.5% (23.88V ~ 24.12V).

   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 voltage from the GUI. See LTpowerPlay Quick Start Procedure section for details.

QUICK START PROCEDURE

Connecting a PC to DC2595A

You can use a PC to reconfigure the power management features of the LTC3889 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.

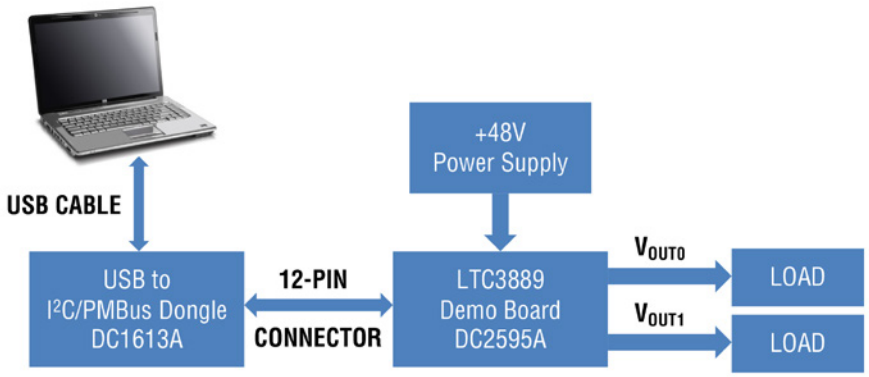


Figure 1. Demo Setup with PC for DC2595A

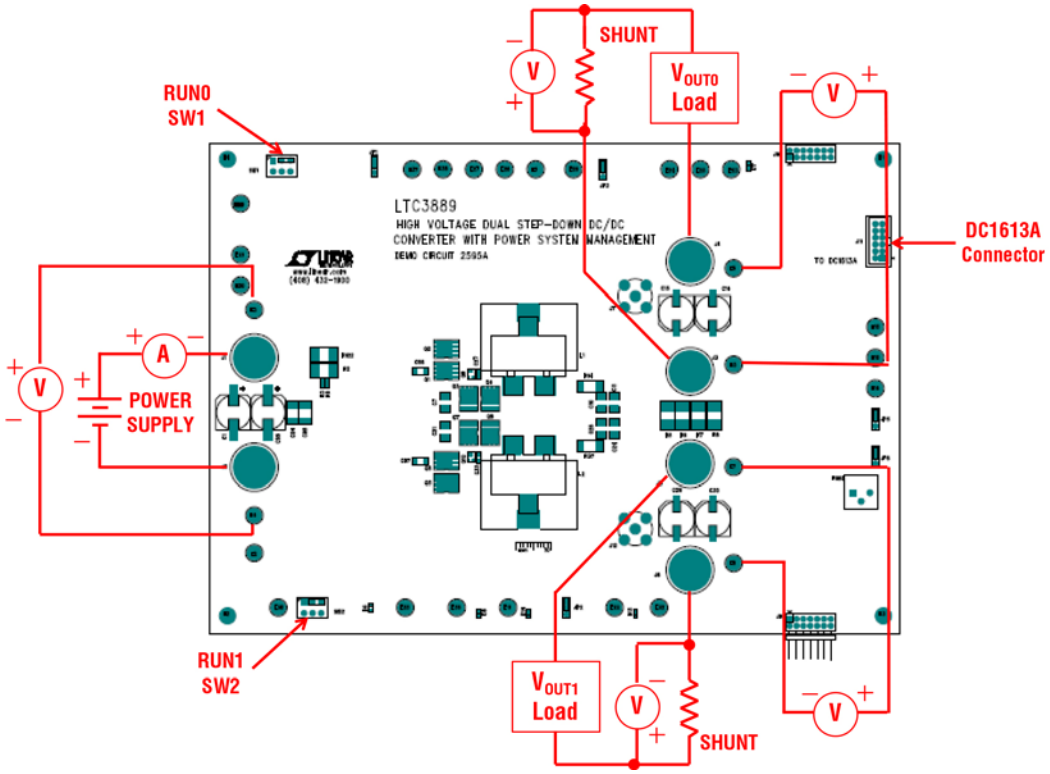


Figure 2. Power Test Setup for DC2595A

QUICK START PROCEDURE

Measuring Efficiency

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

- Set JP6 to OFF Position to Disable the Pulse Generator Circuits.
- Measure V_{IN} Across the Input Ceramic Capacitor (C7 for CH0, C21 for CH1). Measure V_{OUT} across the output ceramic capacitor (C10 for CH0, C26 for CH1).

Measuring Output Ripple Voltage

An accurate ripple measurement may be performed by using the configuration shown in Figure 3 across C10/C26.

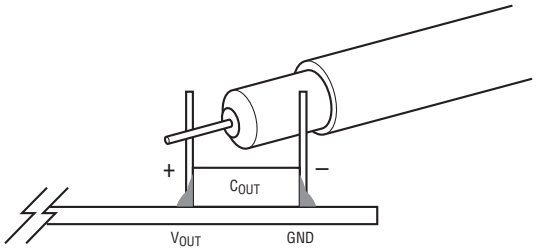


Figure 3. Measuring Output Voltage Ripple

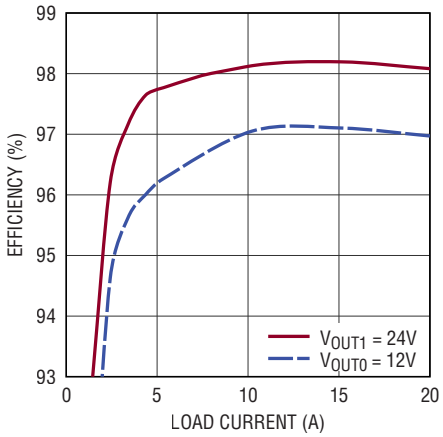


Figure 4. Typical Efficiency Curves DC2595A, V_{IN} = 48V, F_{SW} = 150kHz, CCM, $EXTV_{CC}$ = 12V, DRVCC = 9V

QUICK START PROCEDURE

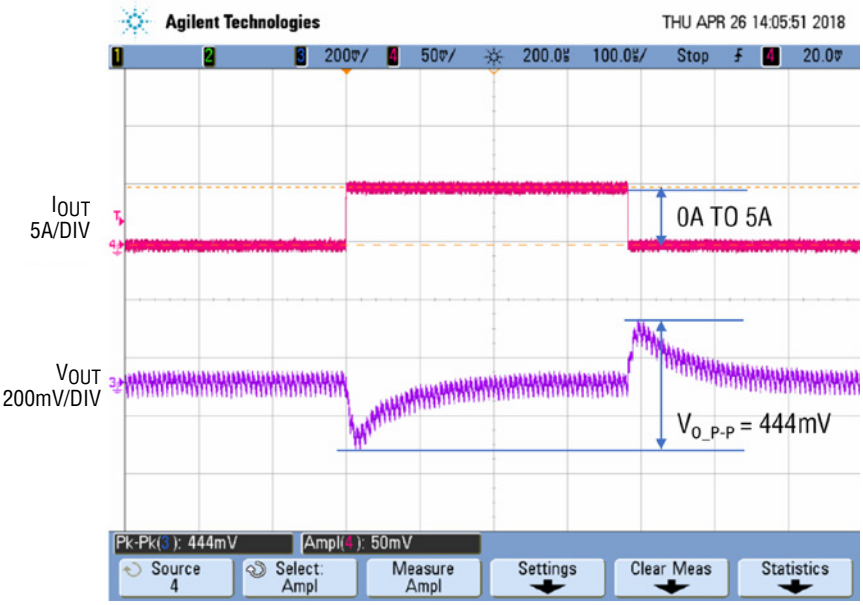


Figure 5. Load Transient Waveform DC2595A, V_{IN} = 48V, V_{OUT0} = 12V, F_{SW} = 150kHz, 0% to 25% (5A) Load Step

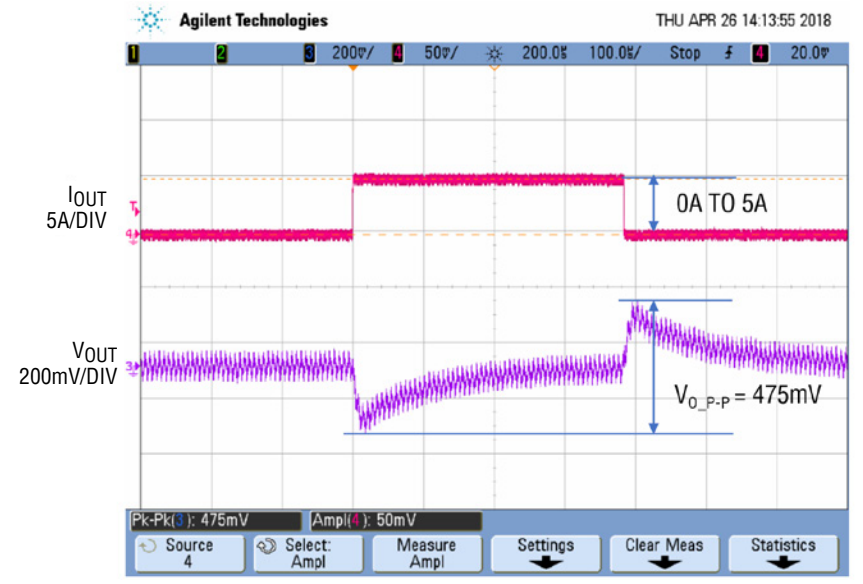


Figure 6. Load Transient Waveform DC2595A, V_{IN} = 48V, V_{OUT1} = 24V, F_{SW} = 150kHz, 0% to 25% (5A) Load Step

QUICK START PROCEDURE

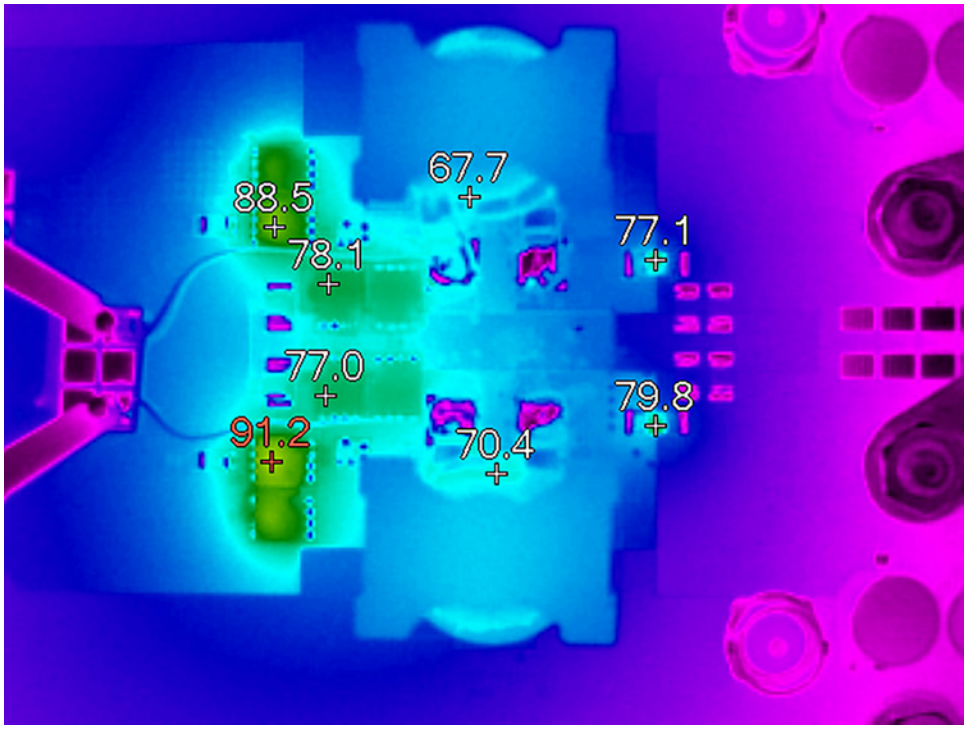


Figure 7. Thermal Image DC2595A, F_{SW} = 150kHz, V_{IN} = 48V, V_{OUT0} = 12V/20A, V_{OUT1} = 24V/20A, No Airflow

LTpowerPlay SOFTWARE GUI

LTpowerPlay is a powerful Windows-based development environment that supports Analog Devices power system management ICs, including the LTC3880, LTC3883, LTC3882, LTC3887 and LTC3889. The software supports a variety of different tasks. You can use LTpowerPlay to evaluate Analog Devices 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 LTC3889's DC2595A 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:

LTpowerPlay

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

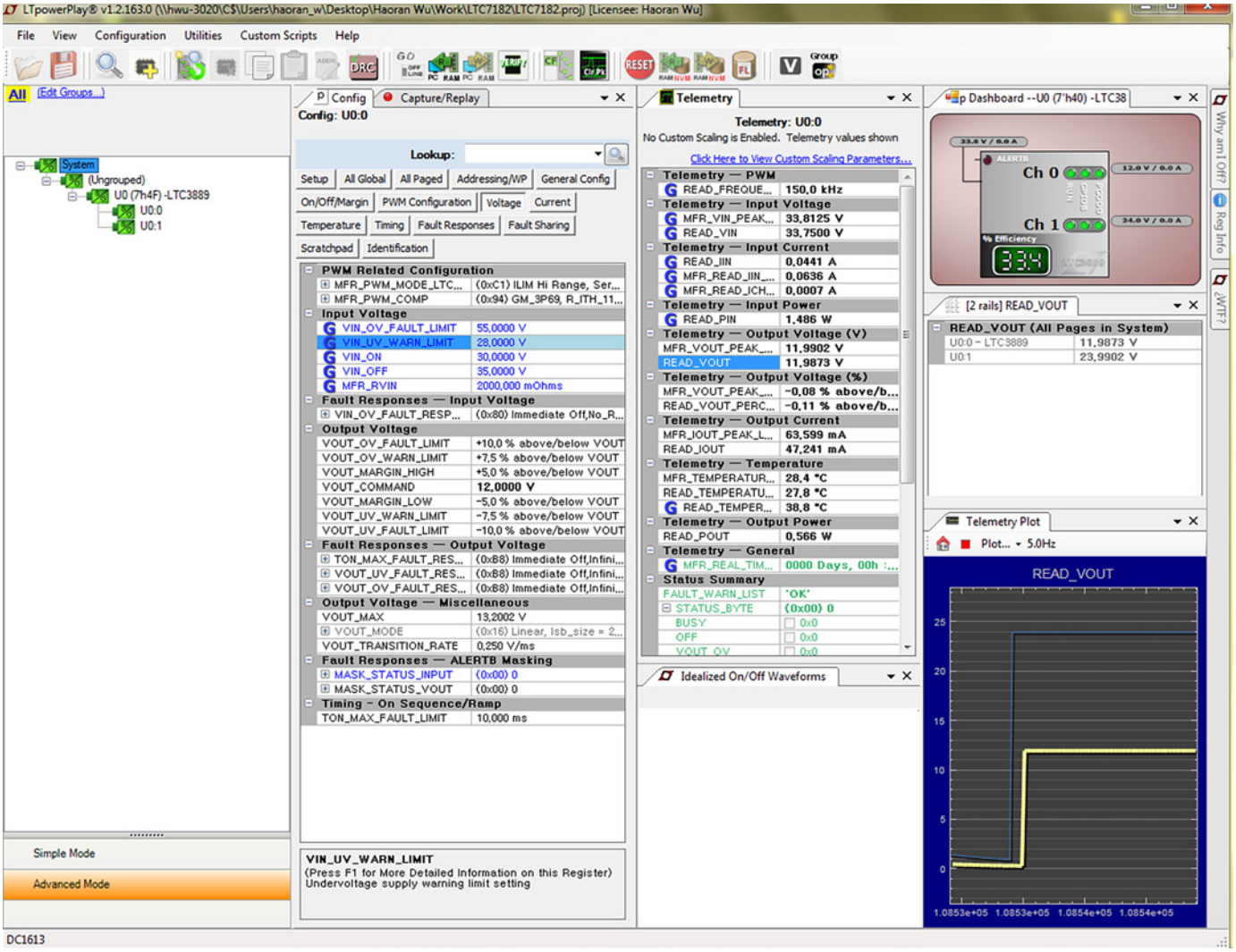


Figure 8. LTpowerPlay Main Interface

LTpowerPlay QUICK START PROCEDURE

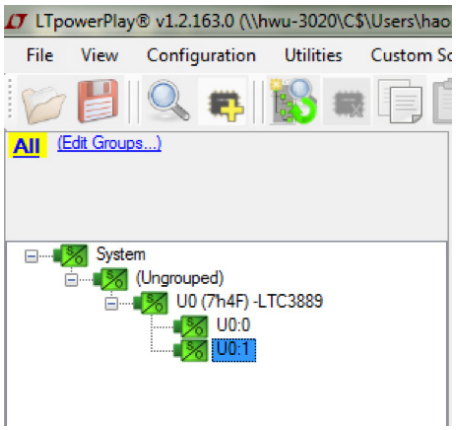
The following procedure describes how to use LTpowerPlay to monitor and change the settings of LTC3889.

1. Download and install the LTPowerPlay GUI:

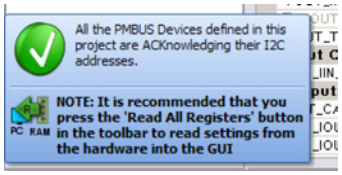
   LTpowerPlay

2. Launch the LTpowerPlay GUI.

   a. The GUI should automatically identify the DC2595A. The system tree on the left-hand side should look like this:

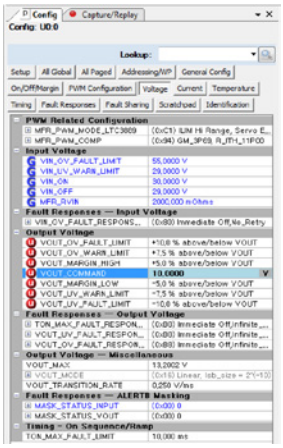


   b. A green message box shows for a few seconds in the lower left-hand side corner, confirming that the LTC3889 is communicating:

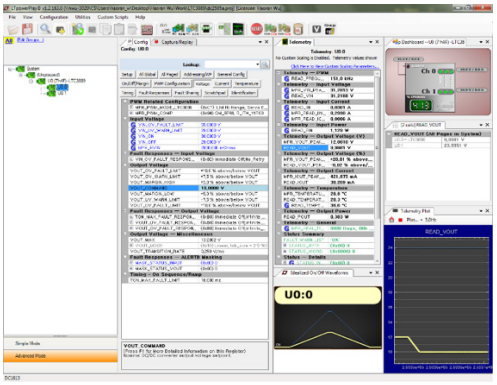


   c. In the Toolbar, click the “R” (RAM to PC) icon to read the RAM from the LTC3889. This reads the configuration from the RAM of LTC3889 and loads it into the GUI.

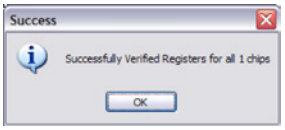
   d. If you want to change the output voltage to a different value, like 10V. In the Config tab, type in 10 in the VOUT_COMMAND box, like this:



Then, click the “W” (PC to RAM) icon to write these register values to the LTC3889. After finishing this step, you will see the output voltage will change to 10V.



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 follows:

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

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	14	R17, R21, R22, R27, R43, R44, R45, R98, R106, R109, R128, R129, R132, R168	RES., 0Ω, 1/10W, 0603, AEC-Q200	NIC, NRC06Z0TRF VISHAY, CRCW06030000Z0EA
2	3	R93, R171, R172	RES., 127Ω, 1%, 1/10W, 0603, AEC-Q200	NIC, NRC06F1270TRF PANASONIC, ERJ3EKF1270 VISHAY, CRCW0603127RFKEA
3	1	R99	RES., 220k, 5%, 1/10W, 0603	PANASONIC, ERJ3GEYJ224V VISHAY, CRCW0603220KJNEA
4	1	R161	RES., 20k, 5%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3GEYJ203V VISHAY, CRCW060320K0JNEA
5	1	R162	RES., 0Ω, 1/4W, 1206, AEC-Q200	NIC, NRC12Z0TRF PANASONIC, ERJ8GEY0R00V VISHAY, CRCW12060000Z0EA
6	5	R9, R12, R30, R38, R157	RES., 2, 5%, 1/10W, 0603	NIC, NRC06J2R0TRF VISHAY, CRCW06032R00JNEA
7	1	R152	RES., 681k, 1%, 1/10W, 0603	NIC, NRC06F6813TRF VISHAY, CRCW0603681KFKEA
8	1	R91	RES., 0.01Ω, 1%, 1/2W, 2010, SENSE, AEC-Q200	VISHAY, WSL2010R0100FEA
9	1	R158	RES., 27.4k, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW060327K4FKEA
10	1	R170	RES., 340Ω, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW0603340RFKEA
11	1	R154	RES., 82.5Ω, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW060382R5FKEA
12	1	R153	RES., 3.3Ω, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW06033R30FKEA
13	1	R146	RES., 4.7Ω, 1%, 1/8W, 0805, AEC-Q200	VISHAY, CRCW08054R70FKEA
14	1	R2	RES., 0.002Ω, 1%, 2W, 2512	STACKPOLE ELECTRONICS, CSNL2512FT2L00
15	2	R14, R37	RES., 0.002Ω, 1%, 1.5W, 2010	STACKPOLE ELECTRONICS, CSNL2010FT2L00
16	13	R10, R11, R13, R15, R16, R18, R23, R25, R28, R89, R97, R112, R113	RES., 10k, 5%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3GEYJ103V VISHAY, CRCW060310K0JNEA
17	2	R119, R120	RES., 4.99k, 1%, 1/10W, 0603	NIC, NRC06F4991TRF VISHAY, CRCW06034K99FKEA
18	3	R3, R4, R96	RES., 1k, 5%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW06031K00JNEA
19	5	R24, R26, R50, R51, R155	RES., 100Ω, 5%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3GEYJ101V VISHAY, CRCW0603100RJNEA
20	1	R159	RES., 226k, 1%, 1/10W, 0603	VISHAY, CRCW0603226KFKEA YAGEO, RC0603FR-07226KL
21	2	R114, R115	RES., 10Ω, 5%, 1/10W, 0603	NIC, NRC06J100TRF VISHAY, CRCW060310R0JNEA
22	2	R87, R88	RES., 200Ω, 5%, 1/10W, 0603	NIC, NRC06J201TRF VISHAY, CRCW0603200RJNEA
23	1	R151	RES., 1MΩ, 5%, 1/10W, 0603	NIC, NRC06J105TRF VISHAY, CRCW06031M00JNEA

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
24	1	R160	RES., 5k, 10%, 1/2W, THT 3/8 SQ, 1-TURN, TOP ADJ., TRIMPOT	BOURNS, 3386P-1-502-LF
25	1	C78	CAP., 0.22µF, X7R, 100V, 10%, 0805	MURATA, GRM21AR72A224KAC5L
26	1	C81	CAP., 220pF, X7R, 50V, 10%, 0603	AVX, 06035C221KAT2A
27	1	C72	CAP., 0.047µF, X7R, 25V, 10%, 0603	AVX, 06033C473KAT2A MURATA, GRM188R71E473KA01D NIC, NMC0603X7R473K25TRPF
28	2	C70, C103	CAP., 2.2µF, X7R, 50V, 10%, 0805	TDK, C2012X7R1H225K125AC
29	1	C102	CAP., 1µF, X5R, 25V, 20%, 0603	AVX, 06033D105MAT2A TAIYO YUDEN, TMK107BJ105MA-T TDK, C1608X5R1E105M080AC
30	3	C6,C13,C28	CAP.,1000pF, X7R, 100V, 10%, 0603	AVX, 06031C102KAT2A MURATA, GRM188R72A102KA01D
31	2	C94, C95	CAP., 10µF, X7S, 100V, 20%, 1812	TDK, CKG45NX7S2A106M500JH
32	2	C96, C97	CAP., 2.2µF, X7R, 100V, 10%, 1206	MURATA, GRM31CR72A225KA73L
33	4	C14, C15, C29, C30	CAP., 120µF, ALUM POLYMER, 50V, 20%, 10mm × 12.6mm	PANASONIC, 50SVPK120M
34	8	C10, C11, C12, C24, C25, C26, C88, C93	CAP., 10µF, X7R, 63V, 10%, 1210	MURATA, GRM32ER71J106KA12L
35	4	C7, C8, C21, C22	CAP., 4.7µF, X7S, 100V, 10%, 1210	TDK, C3225X7S2A475K200AB TDK, C3225X7S2A475K200AE
36	1	C100	CAP., 150pF, NP0, 50V, 5%, 0603	AVX, 06035A151JAT2A
37	1	C74	CAP., 2.2µF, X7R, 100V, 10%, 1210	AVX, 12101C225KAT2A MURATA, GRM32ER72A225KA35K MURATA, GRM32ER72A225KA35L NIC, NMC1210X7R225K100TRPLPF
38	2	C84, C101	CAP., 0.1µF, X7R, 16V, 20%, 0603	AVX, 0603YC104MAT2A MURATA, GRM188R71C104MA01D
39	2	C1, C85	CAP., 56µF, ALUM, ELECT, 63V, 20%, SMD	SUN ELECTRONIC INDUSTRIES CORP., 63HVH56M
40	2	C39, C40	CAP., 4.7µF, X5R, 16V, 10%, 0603	AVX, 0603YD475KAT2A MURATA, GRM188R61C475KE11D TDK, C1608X5R1C475K080AC
41	2	C79, C80	CAP., 100µF, X5R, 16V, 20%, 1210	TAIYO YUDEN, EMK325ABJ107MM-T
42	2	C20,C36	CAP., 33pF, C0G, 50V, 5%,0 603	AVX, 06035A330JAT2A TDK, C1608C0G1H330J080AA VISHAY, VJ0603Q330JXAPW1BC
43	4	C3, C9, C23, C76	CAP., 0.1µF, X7R, 100V, 10%, 0603	MURATA, GRM188R72A104KA35D
44	6	C4, C5, C27, C33, C82, C83	CAP., 0.01µF, X7R, 100V, 10%, 0603	AVX, 06031C103KAT2A
45	2	C18, C34	CAP., 6800pF, X7R, 50V, 10%, 0603	AVX, 06035C682KAT2A KEMET, C0603C682K5RAC7867 KEMET, C0603C682K5RACTU MURATA, GRM188R71H682KA01D

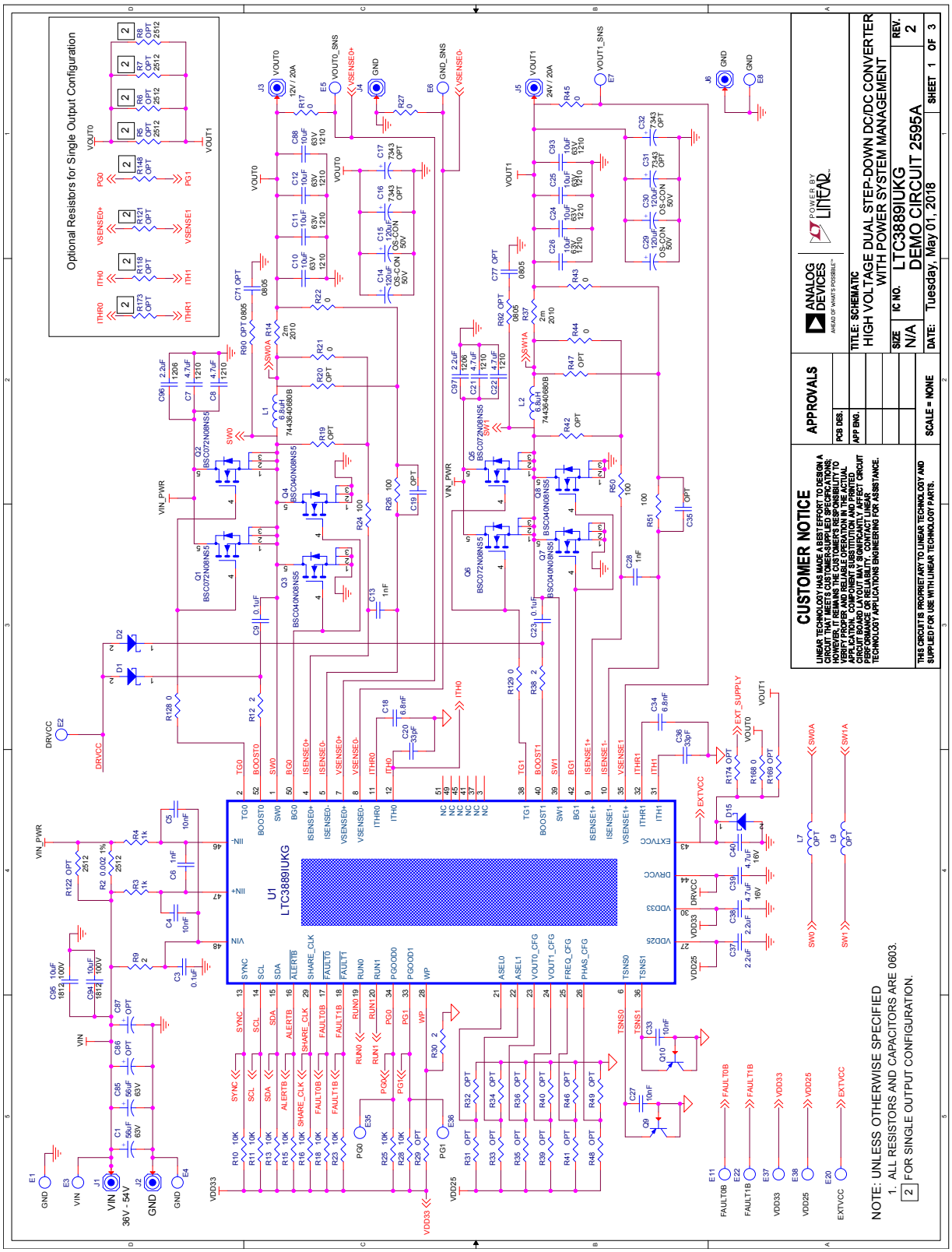
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
46	2	C37, C38	CAP., 2.2µF, X5R, 16V, 10%, 0603	AVX, 0603YD225KAT2A MURATA, GRM188R61C225KE15D TDK, C1608X5R1C225K080AB
47	2	L1, L2	IND., 6.8µH, POWER SHIELDED, ±15%, 40A, 0.88mΩ DCR, 28 × 27mm × 18.5mm	WURTH ELEKTRONIK, 7443640680B
48	4	Q3, Q4, Q7, Q8	XSTR., MOSFET, N-CH, 80V, 100A, PG-TDSON-8	INFINEON, BSC040N08NS5ATMA1
49	4	Q1, Q2, Q5, Q6	XSTR., POWER N-CHAN, 80V, 74A, 8-Pin TDSON	INFINEON, BSC072N08NS5 INFINEON, BSC072N08NS5ATMA1
50	1	U4	IC, MEMORY, EEPROM, 2Kb (256 × 8), TSSOP-8, 400kHz	MICROCHIP, 24LC025-I/ST MICROCHIP, 24LC025T-I/ST
51	1	U6	IC, SINGLE R TO R IN/OUT OP AMP, TSOT23-5, 100V/µs, 85MHz	ANALOG DEVICES, LT1803IS5#PBF ANALOG DEVICES, LT1803IS5#TRPBF
52	1	U3	IC, SYNCHR. STEP-DOWN CONVERTER, MSOP-16	ANALOG DEVICES, LTC3630EMSE#PBF ANALOG DEVICES, LTC3630EMSE#TRPBF
53	1	U1	IC, WIDE I/O DC/DC CONVERTER, 52-PIN QFN	ANALOG DEVICES, LTC3889IUKG#PBF ANALOG DEVICES, LTC3889IUKG#TRPBF
54	1	U5	IC, TIMERBLOX: VOLTAGE CTRL PWM, TSOT-23-6	ANALOG DEVICES, LTC6992IS6-1#PBF ANALOG DEVICES, LTC6992IS6-1#TRPBF
Additional Demo Board Circuit Components				
1	0	R5, R6, R7, R8, R19, R20, R29, R31, R32, R33, R34, R35, R36, R39, R40, R41, R42, R46, R47, R48, R49, R90, R92, R100, R101, R102, R103, R104, R105, R107, R108, R110, R111, R116, R117, R118, R121, R144, R145, R147, R148, R163, R169, R173	RES., OPTION, 0603	
2	0	R122	RES., OPTION, 2512	
3	0	C16, C17, C19, C31, C32, C35, C71, C73, C77, C75, C86, C87	CAP., OPTION, 0603	
4	1	L5	IND., 68µH, PWR, ±30%, 1.65A, 201mΩ, SMD 10.5 × 10.3 × 5.1mm	SUMIDA, CDRH105RNP-680NC
5	0	L7, L9	IND, OPTION 10.5mm × 10.3mm	
6	3	D1, D2, D15	DIODE, SCHOTTKY, 100V, 1A, POWERDI-123	DIODES INC., DFLS1100-7
7	2	Q22, Q23	XSTR., MOSFET N-CHAN, 60V, 115mA, SOT-23	FAIRCHILD SEMI, 2N7002
8	0	Q27	XSTR., MOSFET, P-CH, 60V, 185mA, SOT-23	VISHAY, TP0610K-T1-GE3
9	3	Q20, Q28, Q29	XSTR., MOSFET, P-CH, 20V, 5.9A, TO-236 (SOT23-3)	VISHAY, SI2365EDS-T1-GE3
10	2	Q9, Q10	XSTR., PNP, 40V, 0.2A, SC70-3	DIODES, INC., MMST3906-F DIODES, INC, MMST3906-7-F
11	1	Q19	XSTR., MOSFET N-CHAN, 60V, 30A, 8-PIN TDSON EP	INFINEON, BSC014N06NS
12	2	D5, D6	LED, GREEN, COLORLESS DIFFUSED, 0603	OSRAM, LG L29K-G2J1-24-Z

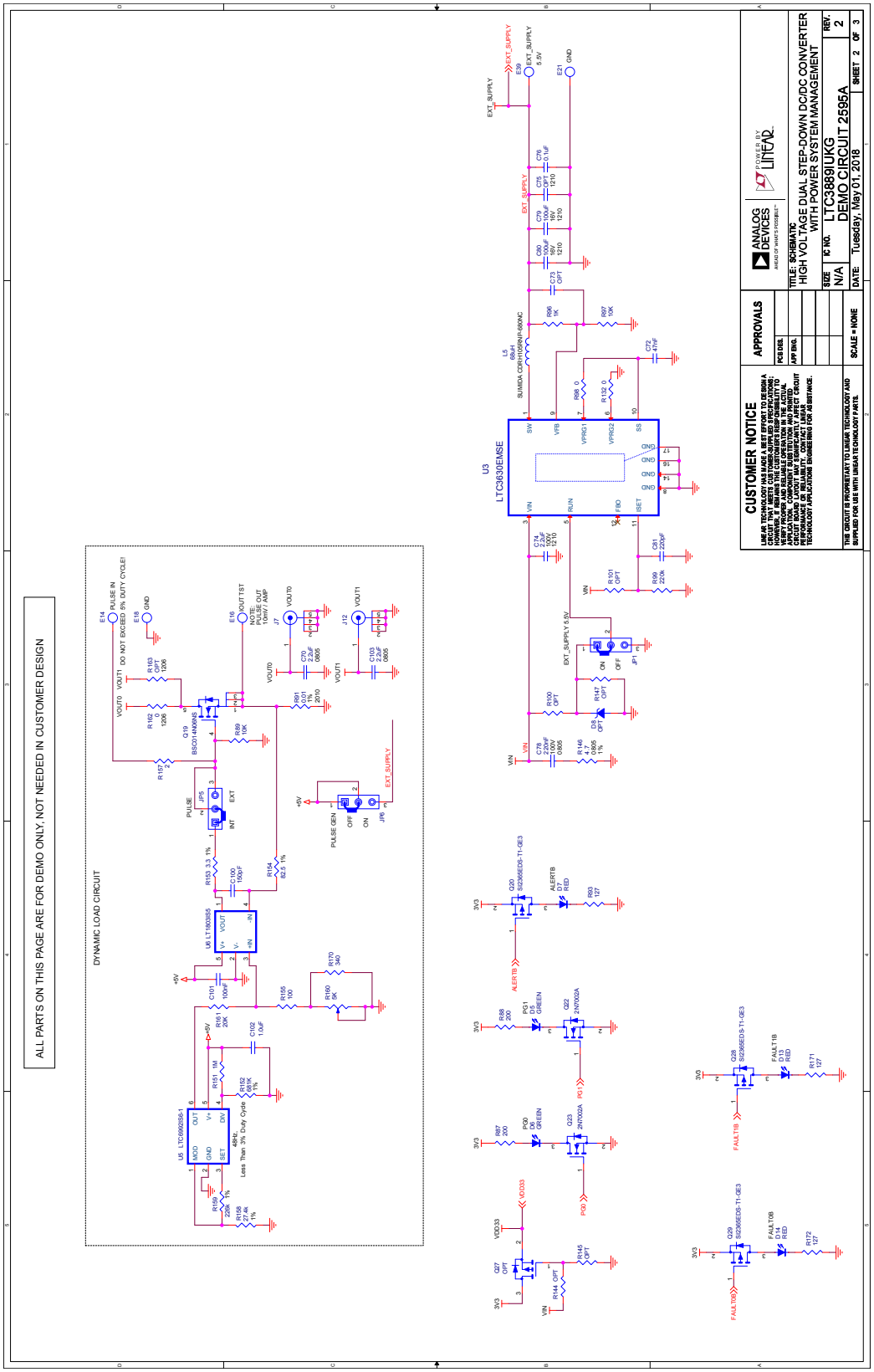
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
13	3	D7, D13, D14	LED, RED, COLORLESS DIFFUSED, 0603	OSRAM, LS L29K-H1J2-1-Z
14	0	D8, D9, D12	LED, 0603 OPTIONAL	
Hardware for Demo Board Only				
1	2	J7, J12	CONN., RF, BNC, RCPT JACK, 5-PIN, STR, THT, 50Ω	AMPHENOL RF, 112404
2	1	J11	CONN., SHROUDED HDR, MALE, 2 × 6, 2mm, VERT, STR, THT	FCI, 98414-G06-12ULF
3	1	J10	CONN., HDR, FEMALE, 2 × 7, 2mm, R/A THT	SULLINS CONNECTOR SOLUTIONS, NPPN072FJFN-RC
4	1	J9	CONN., HDR, MALE, 2 × 7, 2mm, R/A THT	MOLEX, 0877601416 MOLEX, 87760-1416
5	5	JP1, JP2, JP3, JP5, JP6	CONN., HDR, MALE, 1 × 3, 2mm, VERT, STR, THT	WURTH ELEKTRONIK, 62000311121
6	5	XJP1, XJP2, XJP3, XJP5, XJP6	CONN., SHUNT, FEMALE, 2 POS, 2mm	WURTH ELEKTRONIK, 60800213421
7	28	E1, E2, E3, E4, E5, E6, E7, E8, E11, E14, E16, E18, E20, E21, E22, E23, E24, E25, E26, E27, E29, E30, E32, E35, E36, E37, E38, E39	TEST POINT, TURRET, 0.094, MTG. HOLE	MILL-MAX, 2501-2-00-80-00-00-07-0
8	2	SW1, SW2	SWITCH, SLIDE, DPDT, 0.3A, 6VDC, PTH	C&K, JS202011CQN
9	12	J1, J_1, J_2, J2, J3, J_3, J4, J_4, J_5, J5, J_6, J6	NUT, HEX, STEEL, ZINC PLATE,10-32	KEYSTONE, 4705
10	6	J1, J2, J3, J4, J5, J6	WASHER, FLAT, STEEL, ZINC PLATE, OD: 0.436 [11.1]	KEYSTONE, 4703
11	4	MH1, MH2, MH3, MH4	STANDOFF, NYLON, SNAP-ON, 0.50	KEYSTONE, 8833
12	6	J1, J2, J3, J4, J5, J6	STUD, FASTENER, #10-32	PENNENGINEERING, KFH-032-10ET
13	6	J1, J2, J3, J4, J5, J6	RING, LUG, CRIMP, #10, NON-INSULATED, SOLDERLESS TERMINALS	KEYSTONE, 8205

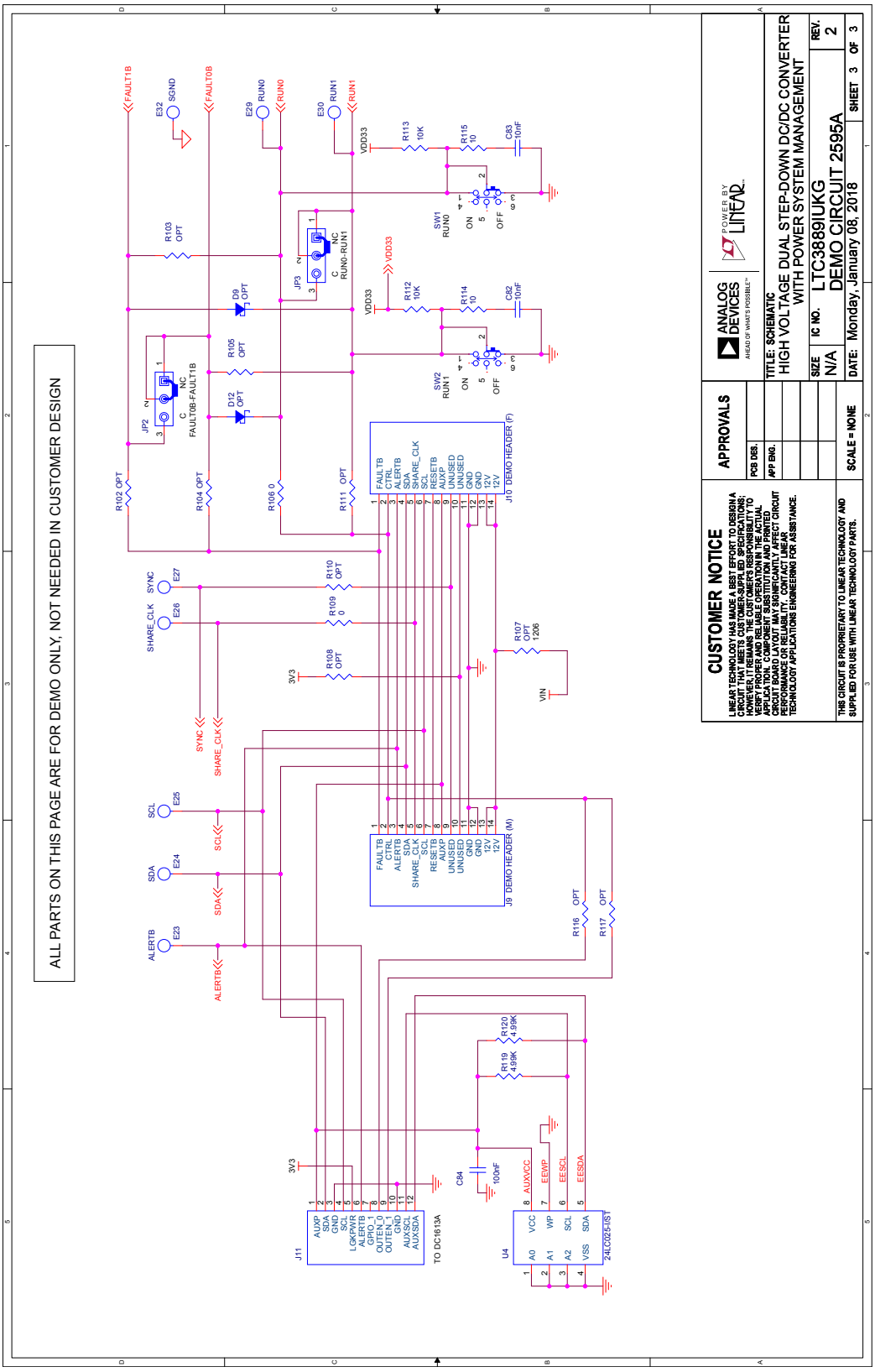
SCHEMATIC DIAGRAM



SCHEMATIC DIAGRAM



SCHEMATIC DIAGRAM



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.

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