LTC3887EUJ Dual Phase Step-Down DC/DC Controller with Digital Power System Management

DESCRIPTION

Demonstration circuit 2263A is a high current, high efficiency, synchronous buck converter featuring the LTC®3887EUJ, a dual-phase current mode controller. The LTC3887 has the PMBus interface and power system management functions.

The DC2263A uses discrete MOSFETs in the power stage. The input range of this board is from 7V to 14V. The output voltage can be programmed from 0.8V to 1.8V with an output current up to 25A per phase. The DC2263A has two versions: The DC2263A-A uses a sense resistor and provides two outputs while the DC2263A-B uses DCR current sensing and provides a dual-phase single output. The factory default setting for the output voltage is 1.0V. The DC2263A also has an onboard dynamic load circuit, which makes it easy for the customer to evaluate the transient performances.

The DC2263A 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 LTC3887. To fully explore the extensive power system management features of the parts, 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

For more details and instructions along with downloading LTpowerPlay, go to the following link.

http://www.linear.com/ltpowerplay

Design files for this circuit board are available at http://www.linear.com/demo/DC2263A

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PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

DC2263A-A Assembly (Dual Output)

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Input Supply Range		7	12	14	V
F_{SW}	Factory Default Switching			425		kHz
V_{OUT0}	CH0 Output Voltage Range	I_{OUT0} = 0A TO 25A, V_{IN} = 7.0V to 14V	0.8	1.0	1.8	V
I_{OUT0}	CH0 Output Current Range		0		25	A
EFF	CH0 Peak Efficiency	V_{OUT0} = 1.0V, See Figures 4		86.5		%
V_{OUT1}	CH1 Output Voltage Range	I_{OUT1} = 0A TO 25A, V_{IN} = 7.0V to 14V	0.8	1.0	1.8	V
I_{OUT1}	CH1 Output Current Range		0		25	A
EFF	CH1 Peak Efficiency	V_{OUT1} = 1.0V, See Figures 4		86.5		%

DC2263A-B Assembly (Single Output)

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Input Supply Range		7	12	14	V
V_{OUT0}	Output Voltage Range	I_{OUT} = 0A TO 50A, V_{IN} = 7.0V to 14V	0.8	1.0	1.8	V
I_{OUT0}	Output Current Range		0		50	A
F_{SW}	Factory Default Switching			425		kHz
EFF	Peak Efficiency	V_{OUT} = 1.0V, See Figures 5		87.8		%

QUICK START PROCEDURE

Demonstration circuit 2263A makes it easy to set up to evaluate the performances of the LTC3887. 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 C34 for CH0 and C32 for CH1. See Figure 3 for proper scope probe technique.

1. Make sure jumpers are in the following positions:

JUMPER	POSITION	FUNCTION
JP1	C	GPIO0B to GPIO1B
JP2	NC for -A, C for -B	RUN0 to RUN1
JP3	OFF	EXTVCC_DRV

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. Turn on the power at the input.

   NOTE: Make sure that the input voltage does not exceed 16V.
5. Turn on both SW1 (for RUN0), and SW2 (for RUN1) switches as desired.
6. Check for the correct output voltage from TP4 to TP16 for CH0, TP3 to TP20 for CH1. V_{OUT0}/V_{OUT1} = 1.0V ±0.5% (1.005V ~ 0.995V)

   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 session for details.

Connecting a PC to DC2263A

You can use a PC to reconfigure the power management features of the LTC3887 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.

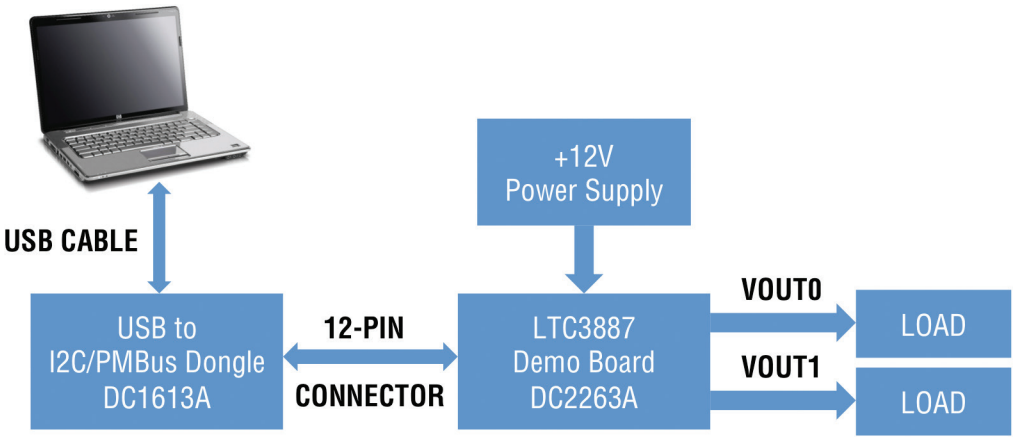


Figure 1. Demo Setup with PC

QUICK START PROCEDURE

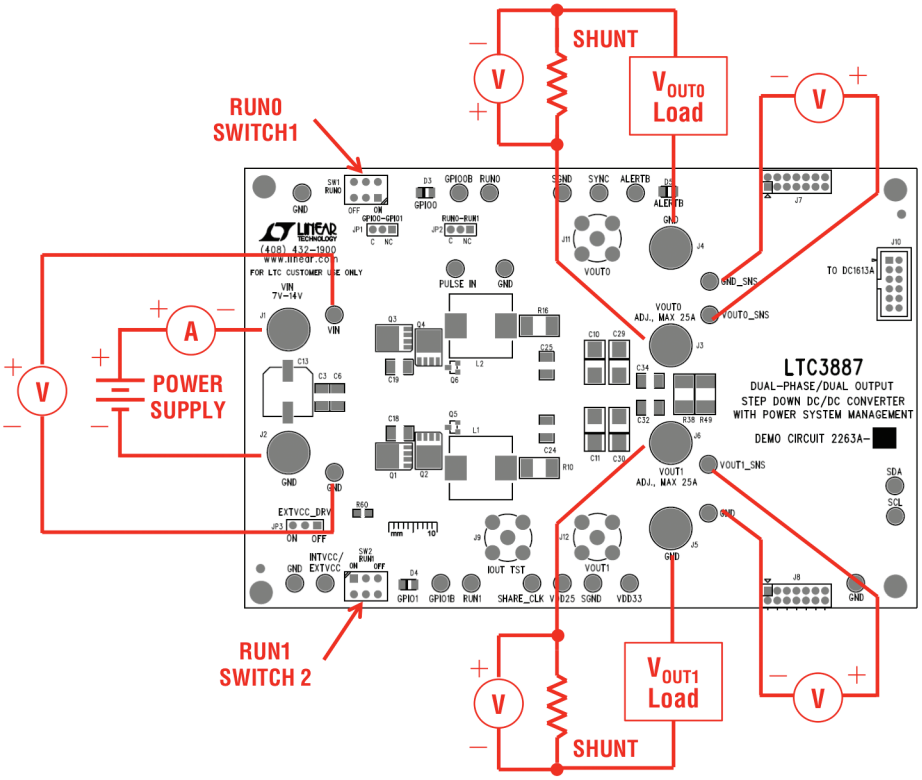


Figure 2. Power Test Setup

Measuring Efficiency

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

- Set JP3 to OFF position to disable the auxiliary circuits.
- DC2263A-A version. Measure V_{IN} across the input ceramic capacitor (C19 for CH0, C18 for CH1). Measure V_{OUT} across the output ceramic capacitor (C25 for CH0, C24 for CH1).
- DC2263A-B version. Measure V_{IN} across the input ceramic capacitor C19. Measure V_{OUT} across the output ceramic capacitor C25.

Measuring Output Ripple Voltage

An accurate ripple measurement may be performed by using the configuration across C34 as shown in Figure 3.

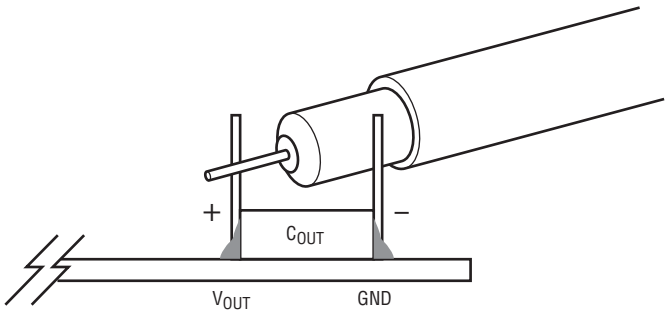


Figure 3. Measuring Output Voltage Ripple

QUICK START PROCEDURE

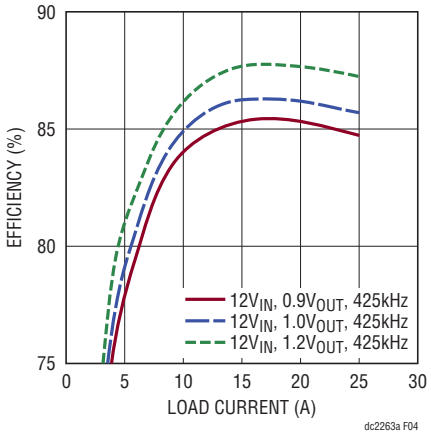


Figure 4. Typical Efficiency Curves DC2263A-A, f_{SW} = 425kHz

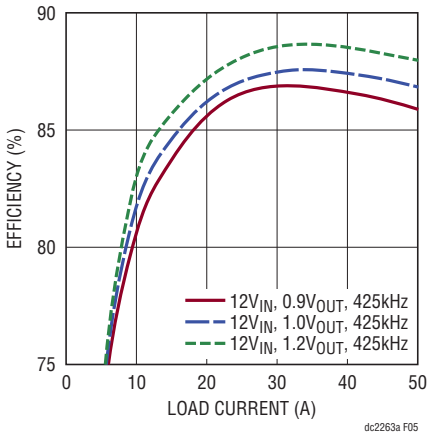


Figure 5. Typical Efficiency Curves DC2263A-B, f_{SW} = 425kHz

LTpowerPlay SOFTWARE GUI

LTpowerPlay is a powerful Windows based development environment that supports Linear Technology power system management ICs, including the LTC3880, LTC3883, LTC3882 and LTC3887. 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 LTC3887's DC2263A 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.

LTpowerPlay QUICK START PROCEDURE

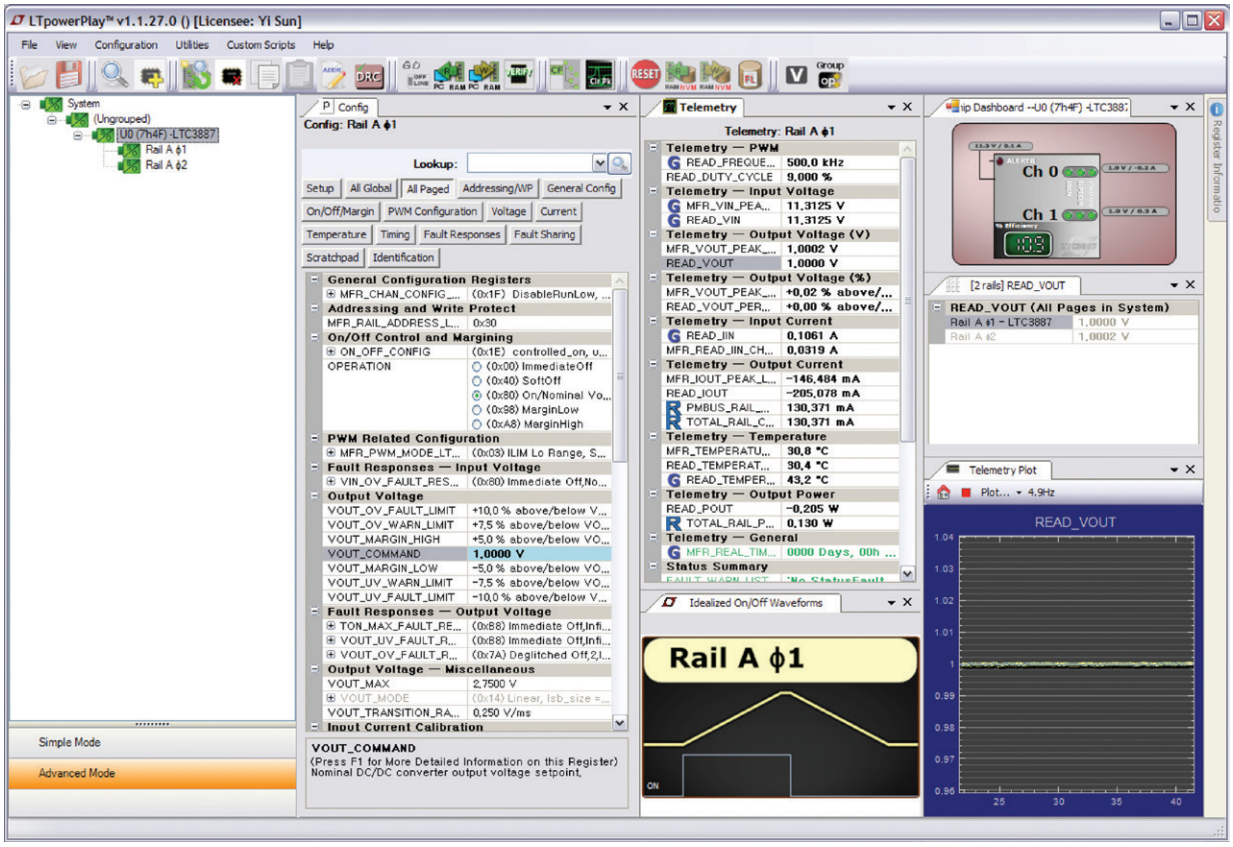


Figure 6. LTpowerPlay Main Interface

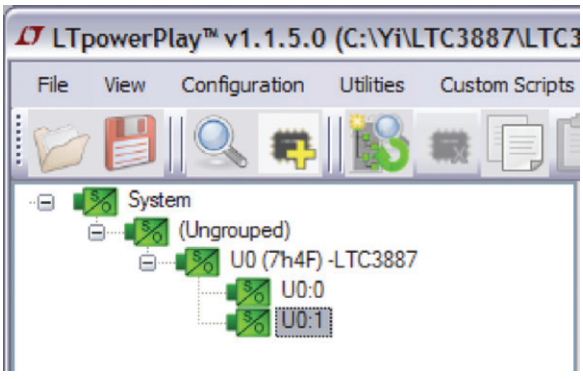
The following procedure describes how to use LTpowerPlay to monitor and change the settings of LTC3887.

1. Download and install the LTpowerPlay GUI:

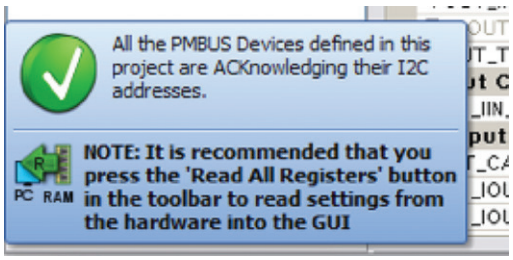
   http://www.linear.com/ltpowerplay

2. Launch the LTpowerPlay GUI.

   a. The GUI should automatically identify the DC2263A. The system tree on the left hand side should look like this:



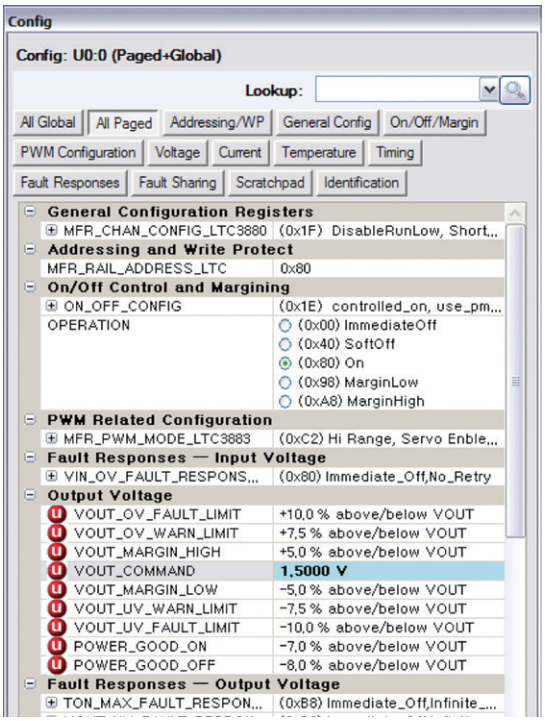
   b. A green message box shows for a few seconds in the lower left hand corner, confirming that the LTC3887 is communicating:



   c. In the Toolbar, click the “R” (RAM to PC) icon to read the RAM from the LTC3887. This reads the configuration from the RAM of LTC3887 and loads it into the GUI.

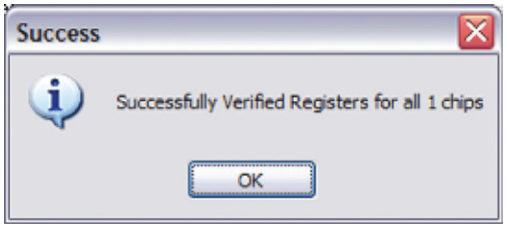
LTpowerPlay QUICK START PROCEDURE

d. If you want to change the output voltage to a different value, like 1.5V. In the Config tab, type in 1.5 in the VOUT_COMMAND box, like this:



Then, click the “W” (PC to RAM) icon to write these register values to the LTC3887. After finishing this step, you will see the output voltage will change to 1.5V.

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 new filename.

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components: DC2063A-A				
1	2	C1, C2	CAP., X5R, 100nF, 25V, 10%, 0603	AVX, 06033C104KAT2A
2	2	C21, C22	CAP., X7R 1nF 50V 0603	AVX 06035C102KAT2A
3	1	C5	CAP., 4.7µF, X5R, 25V, 10%, 0805	AVX, 08053D475KAT2A
4	1	C9	CAP., X5R, 1µF, 25V, 10%, 0603	AVX, 06033D105KAT2A
5	4	C10, C11, C29, C30	CAP., POSCAP 330µF 6V D3L	PANASONIC, 6TPF330M9L
6	2	C12, C14	CAP., X5R, 10nF, 16V, 10%, 0603	AVX, 0603YC103KAT2A
7	1	C13	CAP., OS-CON, 150µF, 35V	SUN ELECTRONIC INDUSTRIES CORP., 35HVP150M
8	2	C15, C16	CAP., X7R 47pF 5% 50V 0603	AVX, 06035C470JAT2A
9	2	C7, C8	CAP., C0G, 3300pF, 50V, 5%, 0603	KEMET, C0603C332J5GACTU
10	1	C17	CAP., 0.22µF, X7R, 16V, 10%, 0603	AVX, 0603YC224KAT2A
11	4	C18, C19, C27, C28	CAP., 22µF, X5R, 25V, 20%, 1210	AVX, 12103D226MAT2A
12	6	C20, C23, C24, C25, C32, C34	CAP., X5R, 100µF, 6.3V, 20%, 1210	AVX 12106D107MAT2A
13	1	C48	CAP., X5R, 4.7µF, 16V, 10%, 0603	TDK C1608X5R1C475K
14	2	D1, D2	DIODE, SCHOTTKY, SOD-323	CENTRAL SEMI., CMDSH-3TR
15	2	L1, L2	IND, 0.22µH	WURTH ELEKTRONIK, 744305022
16	2	Q1, Q3	XSTR, POWER MOSFET LFPAK	INFINEON, BSC050NE2LS
17	4	Q2, Q4	XSTR, POWER MOSFET LFPAK	INFINEON, BSC010NE2LSI
18	9	R8, R9, , R25, R45, R6, R29, R30, R34, R71, R76	RES., CHIP, 0Ω, 1% 0603	NIC, NRC06ZOTRF
19	11	R27, R28, R39, R40, R41, R42, R43, R44, R57	RES., CHIP, 10k, 1% 0603	NIC, NRC06F1002TRF
20	3	R52, R56, R59	RES., CHIP, 2Ω, 1%, 0603	NIC, NRC06F2R00TRF
21	2	R3, R4	RES., CHIP, 6.49k, 1% 0603	NIC, NRC06F6491TRF
22	2	R10, R16	RES SENSE., CHIP, 0.001Ω, 1% 2512	VISHAY, WSL25121L000FEA
23	4	R11, R12, R13, R14	RES., CHIP, 100Ω, 1% 0603	NIC NRC06F1000TRF
24	1	U1	IC, LTC3887EUJ, QFN 6mm × 6mm	LINEAR TECH.LTC3887EUJ#10C9-1PBF-ES
Additional Demo Board Circuit Components				
1	1	C31	CAP., X5R, 100nF, 25V, 10%, 0603	AVX, 06033C104KAT2A
2	0	C3, C6, C35, C36	CAP., OPT 1210	OPT
3	2	C26, C33	CAP., X5R, 10nF, 16V, 10%, 0603	AVX, 0603YC103KAT2A
4	0	C4, C38	CAP., OPT 0603	OPT
5	1	C40	CAP., X7R, 1µF, 50V, 10%, 1206	AVX 12065C105KAT2A
6	2	C41, C47	CAP., X5R, 2.2µF, 50V, 10%, 0805	MURATA GRM21BR61H225KA73L
7	0	C42, C43, C44, C45	CAP., POSCAP OPT D3L	OPT
8	1	C49	CAP., X5R, 4.7µF, 16V, 10%, 0603	TDK C1608X5R1C475K
9	1	C54	CAP., X7R, 1µF, 16V, 10%, 0805	MURATA GRM21BR71C105KA01L
10	2	D3, D4	LED 3×2mm 560nm GRN WTR CLR SMD	ROHM, SML-010FTT86
11	1	D5	LED 3×2mm 650nm RED WTR CLR SMD	ROHM, SML-010VTT86
12	0	D6, D7	LED OPT SOD-323	OPT
13	2	Q5, Q6	TRANS GP SS PNP 40V SOT23	ON SEMI, MMBT3906LT1G
14	0	Q7, Q8	OPT	OPT

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
15	2	Q12, Q13	MOSFET N-CH 60V 115MA SOT23	FAIRCHILD, 2N7002
16	2	Q14, Q19	MOSFET P-CH 20V 0.58A SOT23	VISHAY, SI2365EDS-T1-GE3
17	1	Q15	MOSFET SPEED SRS 30V 30A LFPAK	RENESAS, RJK0305DPB-00#J0
18	0	R5, R33, R62, R77, R81, R82, R84, R86, R96, R1, R2, R7, R15, R26, R69, R17, R18, R19, R20, R21, R22, R23, R24, R32, R67, R73, R74	RES., OPT 0603	OPT
19	3	R51, R79, R80	RES., CHIP, 0Ω, 1% 0603	NIC, NRC06Z0TRF
20	2	R58, R92	RES., CHIP, 10k, 1% 0603	NIC, NRC06F1002TRF
21	2	R36, R37	RES., CHIP, 4.99k, 1%, 0603	NIC, NRC06F4991TRF
22	2	R53, R54	RES., CHIP, 200Ω, 1% 0603	NIC, NRC06F2000TRF
23	1	R55	RES., CHIP, 127Ω, 1%, 0603	NIC, NRC06F1270TRF
24	0	R60	RES., OPT 0805	OPT
25	1	R61	RES., CHIP, 100k, 1% 0603	NIC NRC06F1003TRF
26	2	R63, R64	RES., CHIP, 10Ω, 1% 0603	NIC NRC06F10R0TRF
27	1	R68	RES SENSE., CHIP, 0.01Ω, 1% 2512	VISHAY, WSL2512R0100FEA
28	1	R93	RES., CHIP, 15.8k, 1% 0603	NIC, NRC06F1582TRF
29	0	R100	RES SENSE., OPT 2512	OPT
30	1	R101	RES SENSE., CHIP, 0Ω, 1%, 1W 2512	VISHAY WSL251200000ZEA9
31	4	R38, R46, R49, R50	RES SENSE., OPT 2512	OPT
32	1	U2	IC, 24LC05-I/ST TSSOP-8_4.4mm	MICROCHIP, 24LC025-I/ST
33	1	U3	IC, LT1129CS8-5, SO8NB	LINEAR TECH, LT1129CS8-5
Hardware: For Demo Board Only				
1	2	JP1, JP2	HEADER, 1×3 2mm	SULLIN, NRPN031PAEN-RC
2	2	XJP1, XJP2	SHUNT, 2mm	SAMTEC 2SN-BK-G
3	1	JP3	HEADER, 1×3 0.1"	WURTH ELEKTRONIK, 61300311121
4	1	XJP3	SHUNT, 0.1" BLK	WURTH ELEKTRONIK, 60900213421
5	6	J1, J2, J3, J4, J5, J6	CONN., JACK, BANANA, NON-INSULATED, 0.218"	KEYSTONE, 575-4
6	1	J7	CONN., HEADER, 2×7, 2mm, R/A (F)	SULLINS, NPPN072FJFN-RC
7	1	J8	CONN., HEADER, 2×7, 2mm, R/A (M)	MOLEX, 87760-1416
8	3	J9, J11, J12	CONN., BNC PC MOUNT RECEPT. JACK, 50Ω, TF-4 POST	AMPHENOL CONNEX, 112404
9	1	J10	HEADER, 2×6 2mm STR DL PCB	FCI 98414-G06-12ULF
10	4	STAND-OFF	STAND-OFF, NYLON 0.50" TALL	KEYSTONE, 8833(SNAP ON)
11	2		STENCILS TOP AND BOTTOM	STENCIL DC2263A

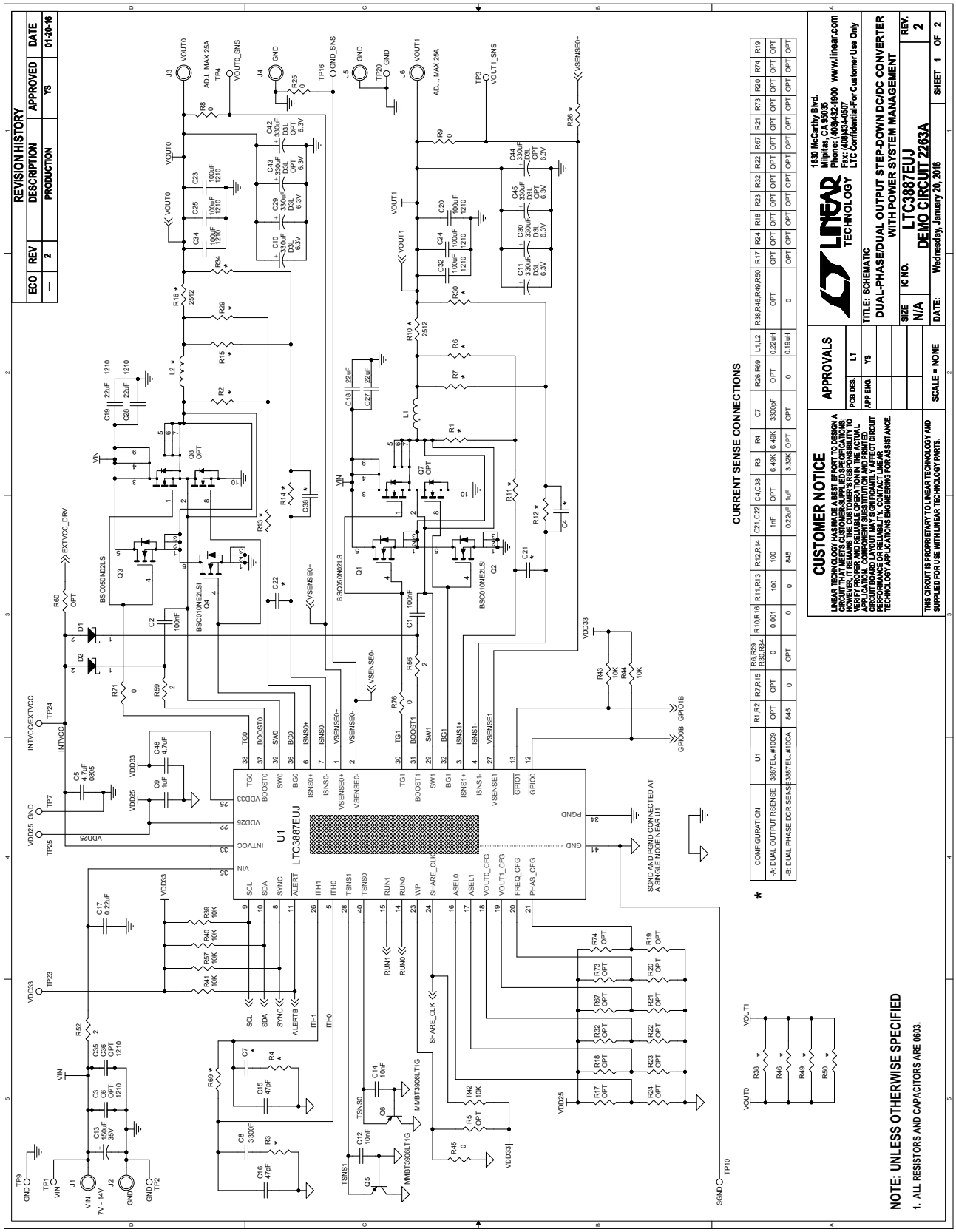
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components: DC2063A-B				
1	2	C1, C2	CAP., X5R, 100nF, 25V, 10%, 0603	AVX, 06033C104KAT2A
2	1	C5	CAP., X5R, 4.7µF, 25V 0805	AVX, 08053D475KAT2A
3	1	C9	CAP., X5R, 1µF, 25V, 10%, 0603	AVX, 06033D105KAT2A
4	2	C4, C38	CAP., X5R 1µF 25V 10% 0603	MURATA GRM188R61E105KA12D
5	1	C8	CAP., C0G, 3300pF, 50V, 5%, 0603	KEMET, C0603C332J5GACTU
6	4	C10, C11, C29, C30	CAP., POSCAP 330µF 6V D3L	PANASONIC, 6TPF330M9L
7	2	C12, C14	CAP., X5R, 10nF, 16V, 10%, 0603	AVX, 0603YC103KAT2A
8	1	C13	CAP., OS-CON, 150µF, 35V	SUNCON, 35HVP150M
9	2	C15, C16	CAP., 47PF, X7R, 50V, 5%, 0603	AVX, 06035C470JAT2A
10	1	C17, C21, C22	CAP., 0.22µF, X7R, 16V, 10%, 0603	AVX, 0603YC224KAT2A
11	4	C18, C19, C27, C28	CAP., 22µF, X5R, 25V, 20%, 1210	AVX, 12103D226MAT2A
12	6	C20, C23, C24, C25, C32, C34	CAP., X5R, 100µF, 6.3V, 20%, 1210	AVX 12106D107MAT2A
13	1	C48	CAP., X5R, 4.7µF, 16V, 10%, 0603	TDK C1608X5R1C475K
15	2	D1, D2	DIODE, SCHOTTKY, SOD-323	CENTRAL SEMI., CMDSH-3TR
16	2	L1, L2	IND, 0.19µH	WURTH ELECTRONIC, 744355019
17	2	Q1, Q3	XSTR, POWER MOSFET LFPAK	INFINEON, BSC050NE2LS
18	4	Q2, Q4	XSTR, POWER MOSFET LFPAK	INFINEON, BSC010NE2LSI
19	9	R8, R9, R25, R45, R7, R15, R26, R69, R71, R76	RES., 0Ω, 0603	NIC, NRC06ZOTRF
20	4	R1, R2, R12, R14	RES., 845Ω, 1% , 0603	NIC NRC06F8450TRF
21	1	R3	RES., 3.32k, 1%, 0603	NIC, NRC06F3321TRF
22	11	R27, R28, R39, R40, R41, R42, R43, R44, R57	RES., CHIP, 10k, 1% 0603 RES., 10k, 1%, 0603	NIC, NRC06F1002TRF
23	3	R52, R56, R59	RES., CHIP, 2, 1%, 0603	YAGEO, RC0603FR-072RL
24	6	R10, R16, R38, R46, R49, R50	RES SENSE., CHIP, 0, 1%, 1W 2512	VISHAY WSL251200000ZEA9
26	1	U1	IC, LTC3887EUJ, QFN 6mm × 6mm	LINEAR TECH.LTC3887EUJ#10CA-1PBF-ES
Additional Demo Board Circuit Components				
1	1	C31	CAP., X5R, 100nF, 25V, 10%, 0603	AVX, 06033C104KAT2A
2	0	C3, C6, C35, C36	CAP., OPT 1210	OPT
3	2	C26, C33	CAP., X5R, 10nF, 16V, 10%, 0603	AVX, 0603YC103KAT2A
4	0	C7	CAP., OPT 0603	OPT
5	1	C40	CAP., X7R, 1µF, 50V, 10%, 1206	AVX 12065C105KAT2A
6	2	C41, C47	CAP., X5R, 2.2µF, 50V, 10%, 0805	MURATA GRM21BR61H225KA73L
7	0	C42, C43, C44, C45	CAP., POSCAP OPT D3L	OPT
8	1	C49	CAP., X5R, 4.7µF, 16V, 10%, 0603	TDK C1608X5R1C475K
9	1	C54	CAP., X7R, 1µF, 16V, 10%, 0805	MURATA GRM21BR71C105KA01L
10	2	D3, D4	LED 3×2mm 560nm GRN WTR CLR SMD	ROHM, SML-010FTT86
11	1	D5	LED 3×2mm 650nm RED WTR CLR SMD	ROHM, SML-010VTT86
12	0	D6, D7	LED OPT SOD-323	OPT
13	2	Q5, Q6	TRANS GP SS PNP 40V SOT23	ON SEMI, MMBT3906LT1G
14	0	Q7, Q8	OPT	OPT

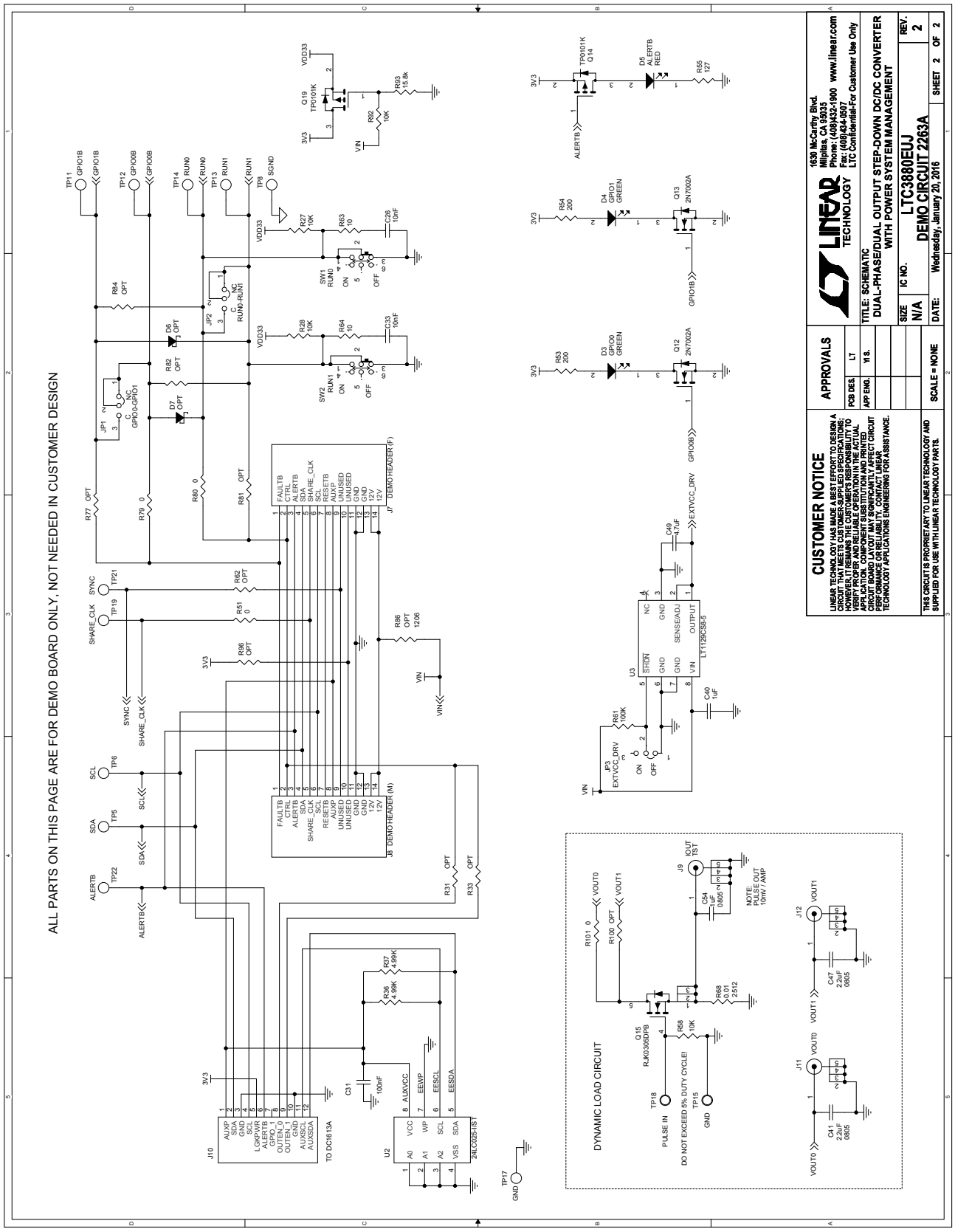
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
15	2	Q12, Q13	MOSFET N-CH 60V 115MA SOT23	FAIRCHILD, 2N7002
16	2	Q14, Q19	MOSFET P-CH 20V 0.58A SOT23	VISHAY, SI2365EDS-T1-GE3
17	1	Q15	MOSFET SPEED SRS 30V 30A LFPAK	RENESAS, RJK0305DPB-00#J0
18	0	R5, R33, R62, R77, R81, R82, R84, R86, R96, R4, R6, R11, R13, R29, R30, R34, R17, R18, R19, R20, R21, R22, R23, R24, R32, R67, R73, R74	RES., OPT 0603	OPT
19	3	R51, R79, R80	RES., 0Ω, 0603	NIC, NRC06Z0TRF
20	2	R58, R92	RES., 10k, 1%, 0603	NIC, NRC06F1002TRF
21	2	R36, R37	RES., CHIP, 4.99k, 1%, 0603	NIC, NRC06F4991TRF
22	2	R53, R54	RES., CHIP, 200Ω, 1% 0603	NIC, NRC06F2000TRF
23	1	R55	RES., CHIP, 127Ω, 1%, 0603	NIC, NRC06F1270TRF
24	0	R60	RES., OPT 0805	OPT
25	1	R61	RES., CHIP, 100k, 1% 0603	NIC NRC06F1003TRF
26	2	R63, R64	RES., CHIP, 10Ω, 1% 0603	NIC NRC06F10R0TRF
27	1	R68	RES SENSE., CHIP, 0.01Ω, 1% 2512	VISHAY, WSL2512R0100FEA
28	1	R93	RES., CHIP, 15.8k, 1% 0603	NIC, NRC06F1582TRF
29	0	R100	RES SENSE., OPT 2512	OPT
30	1	R101	RES SENSE., CHIP, 0Ω, 1%, 1W 2512	VISHAY WSL251200000ZEA9
31	1	U2	IC, 24LC05-I/ST TSSOP-8_4.4mm	MICROCHIP, 24LC025-I/ST
32	1	U3	IC, LT1129CS8-5, SO8NB	LINEAR TECH, LT1129CS8-5
Hardware: For Demo Board Only				
1	2	JP1, JP2	HEADER, 1×3 2mm	SULLIN, NRPN031PAEN-RC
2	2	XJP1, XJP2	SHUNT, 2mm	SAMTEC 2SN-BK-G
3	1	JP3	HEADER, 1×3 0.1"	WURTH ELEKTRONIK, 61300311121
4	1	XJP3	SHUNT, 0.1" BLK	WURTH ELEKTRONIK, 60900213421
5	6	J1, J2, J3, J4, J5, J6	CONN., JACK, BANANA, NON-INSULATED, 0.218"	KEYSTONE, 575-4
6	1	J7	CONN., HEADER, 2×7, 2mm, R/A (F)	SULLINS, NPPN072FJFN-RC
7	1	J8	CONN., HEADER, 2×7, 2mm, R/A (M)	MOLEX, 87760-1416
8	3	J9, J11, J12	CONN., BNC PC MOUNT RECEPT. JACK, 50Ω, TF-4 POST	AMPHENOL CONNEX, 112404
9	1	J10	HEADER, 2×6 2mm STR DL PCB	FCI 98414-G06-12ULF
10	4	STAND-OFF	STAND-OFF, NYLON 0.50" TALL	KEYSTONE, 8833(SNAP ON)
11	2		STENCILS TOP AND BOTTOM	STENCIL DC2263A

SCHEMATIC DIAGRAM



SCHEMATIC DIAGRAM



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Mailing Address:

Linear Technology
1630 McCarthy Blvd.
Milpitas, CA 95035

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Телефон: 8 (812) 309-75-97 (многоканальный)
Факс: 8 (812) 320-03-32
Электронная почта: ocean@oceanchips.ru
Web: http://oceanchips.ru/
Адрес: 198099, г. Санкт-Петербург, ул. Калинина, д. 2, корп. 4, лит. А