

LT8708/LT8708-1 80V V_{IN} and V_{OUT} Synchronous 4-Switch Buck-Boost DC/DC Controller with Flexible Bidirectional Capability

DESCRIPTION

Demonstration circuit 2719A is a high performance bidirectional buck-boost converter featuring the [LT®8708/LT8708-1](#) that can operate from input voltages above, below or equal to the output voltage. The demo board input range is 10.5V to 14.5V ($25V_{MAX}$). The output voltage is set at 14.5V and the output current limit at 40A. The board can operate in both forward and reverse mode.

The controller has integrated input voltage and output voltage regulators and two sets of input and output current regulators that control current flow in forward or reverse direction. Features are included that simplify bidirectional power conversion in battery/capacitor backup systems and other applications that may need regulation of V_{IN} , V_{OUT} , I_{IN} and/or I_{OUT} .

While the current mode control limits the inductor current both in normal and in reverse direction these current limits have some variation as input/output voltage changes. The forward and reverse input and output current regulators offer four accurate current limits that can be set individually.

The input voltage regulator is often used in applications with high impedance power sources and will reduce the forward current if the input voltage drops below the set point. When operating with reverse current flow, the input voltage regulator regulates the voltage at the input side.

The operating mode of the controller is determined through the MODE pin (jumper JP9 Pins 5 to 12) and can be set to discontinuous mode, hybrid discontinuous mode, forced continuous mode and Burst Mode® operation.

The LT8708 is capable of bidirectional operation when operating in the continuous conduction mode (CCM). DCM, HCM and Burst Mode operation only allow power to flow in one direction. Additional circuitry may be needed depending on the application.

[Design files for this circuit board are available.](#)

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PERFORMANCE SUMMARY Specifications are at $T_A = 25^\circ\text{C}$

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Input Supply Range		10.5	14.5	25	V
V_{OUT}	Output Voltage			14.5		V
I_{IN}	Input Current Limit			46.5		A
I_{OUT}	Output Current Limit			40		A
F_{SW}	Switching Frequency			120		kHz
EFF	Efficiency at DC Input	$V_{IN} = 11V, V_{OUT} = 14.5V, I_{OUT} = 35A$		96.7		%
		$V_{IN} = 12V, V_{OUT} = 14.5V, I_{OUT} = 35A$		97.2		%
		$V_{IN} = 14.5V, V_{OUT} = 14.5V, I_{OUT} = 35A$		97.6		%

QUICK START PROCEDURE

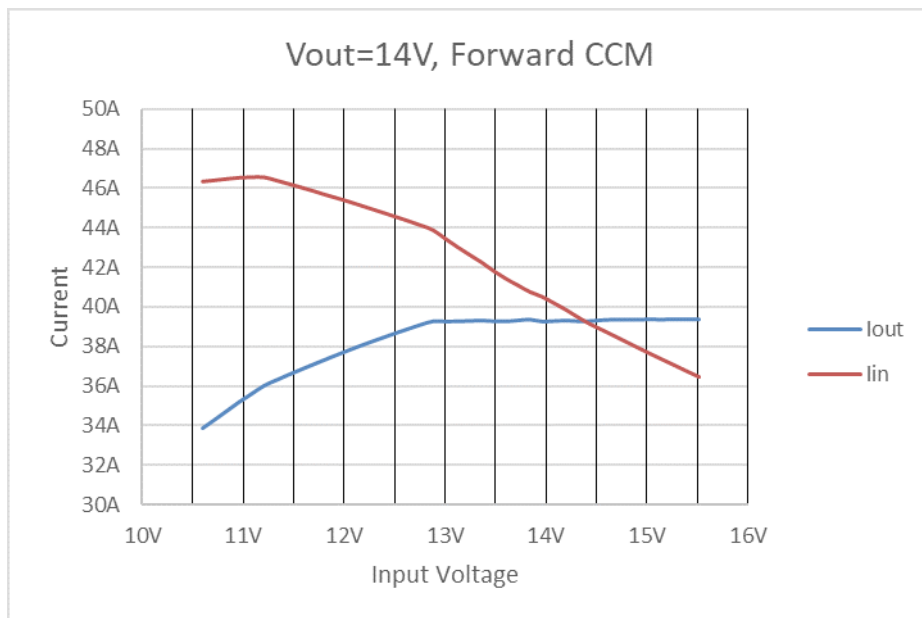


Figure 1. Input and Output Currents as Function of Input Voltage, with a Constant Voltage Load Set at 14.0V Connected to V_{OUT} . Forward CCM Mode. Output Current is Lower than Set Point when V_{IN} is Below 13V Because the Input Current Limit is Activated

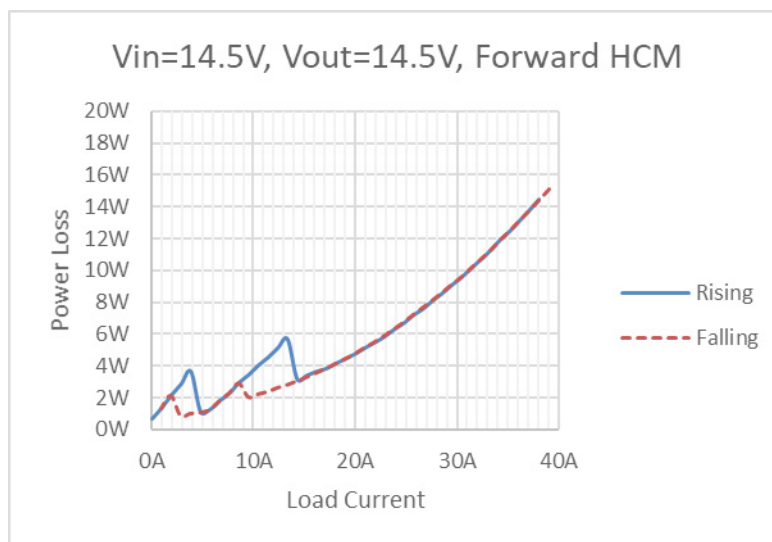


Figure 2. Power Loss in Forward HCM Buck-Boost Mode as Function of Load Current. $V_{IN} = V_{OUT} = 14.5V$. Constant Current Load Connected to V_{OUT} . The Measurement is Done by Increasing Load Current (Blue Line) Until Current Limit, then Decreasing the Current to Zero (Red Line)

QUICK START PROCEDURE

1. Demonstration circuit 2719A is easy to set up to evaluate the performance of the LT8708. Refer to Figure 3 for proper measurement equipment setup and follow the procedure below.
2. With power off, connect the input power supply to V_{IN} (J1) and GND (J2). Attach the load to V_{OUT} (J3) and GND (J4). Use short and thick cables because the current level is high. If batteries are used when testing the demo board, always use suitable circuit breakers for safety.
3. Set the power supply at 12V. The power source must have the current limit set at 50A or higher if you want to evaluate the board with full load over the input range. Monitor circuit board temperature when running with full power for extended time, and if necessary add some airflow for cooling.
4. Once the proper output voltage is established, adjust the load and the input voltage within the operating range and observe the output voltage regulation, ripple voltage and efficiency and other parameters as needed. For reverse power flow testing, see data sheet. When measuring input/output voltages, measure at the input/output terminals of the board to avoid measurement error caused by voltage drops in cables.

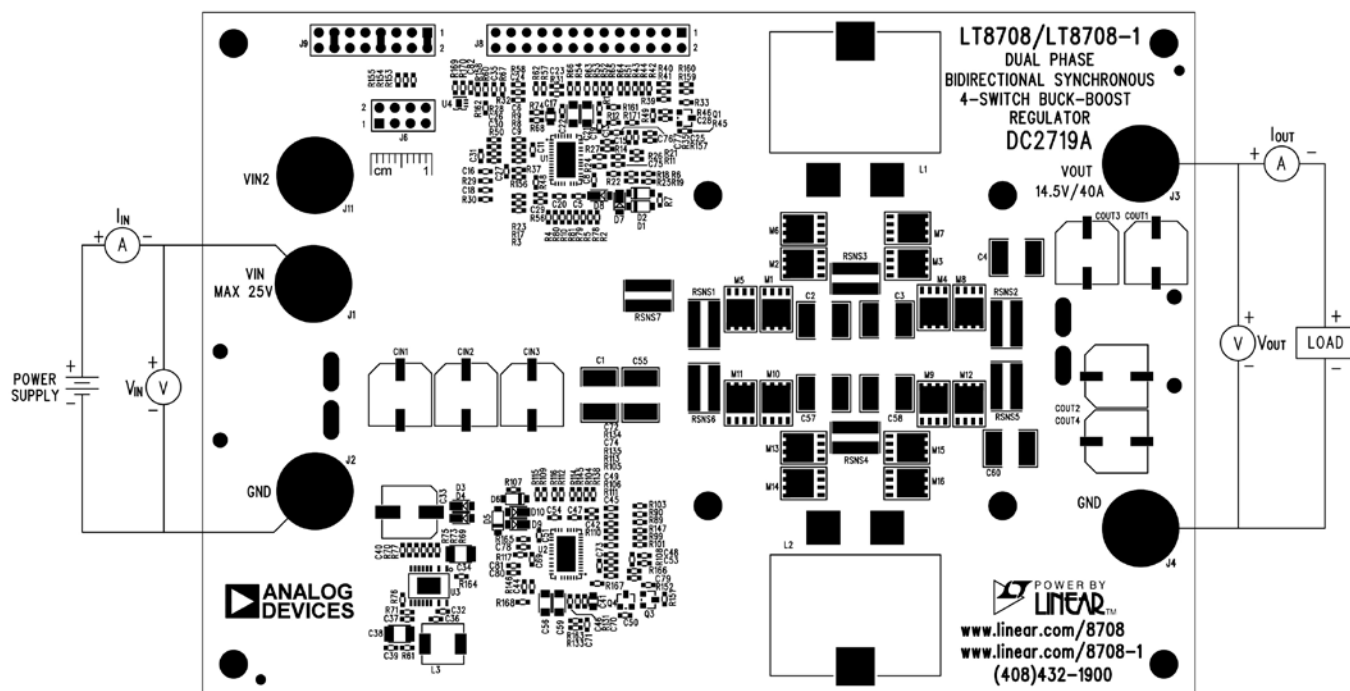


Figure 3. Test Setup

DEMO MANUAL DC2719A

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	7	COUT1, CIN1, COUT2, CIN2, COUT3, CIN3, COUT4	CAP, EP-CAP, 270µF, 25V, 20% 10×10.5	SUN ELEC. 25HVH270M
2	8	C1, C2, C3, C4, C55, C57, C58, C60	CAP, 10µF, X7S, 100V, 10%, 2220	TDK, CKG57KX7S2A106M335JH
3	4	C5, C8, C51, C54	CAP, 0.22µF, X7R, 16V, 10%, 0603	MURATA, GRM188R71C224KA01D
4	4	C6, C9, C45, C49	CAP, 1000pF, X7R, 25V, 10%, 0603	MURATA, GRM188R71E102KA01D
5	2	C11, C73	CAP, 3.3nF, X7R, 25V, 10%, 0603	MURATA, GRM188R71E332KA01D
6	2	C25, C27	CAP, 4.7nF, X7R, 25V, 10%, 0603	MURATA, GRM188R71E472KA01D
7	4	C13, C15, C44, C69	CAP, 47nF, X7R, 25V, 10%, 0603	MURATA, GRM188R71E473KA01D
8	8	C16, C18, C23, C24, C53, C70, C71, C74	CAP, 10nF, X7R, 25V, 10%, 0603	MURATA, GRM188R71E103KA01D
9	2	C17, C41	CAP, 4.7µF, X7R, 16V, 10%, 0805	MURATA, GRM21BR71C475KA73L
10	4	C19, C21, C56, C59	CAP, 4.7µF, X7S, 100V, 10%, 1206	AVX, 12061Z475KAT2A
11	4	C20, C22, C46, C47	CAP, 4.7µF, X5R, 10V, 10%, 0603	MURATA, GRM188R61A475KE15D
12	2	C26, C50	CAP, 1µF, X7R, 10V, 10%, 0603	MURATA, GRM188R71A105KA61D
13	3	C29, C42, C75	CAP, 100pF, C0G, 25V, 5%, 0603	WURTH ELEKTRONIK, 885012006038
14	2	C30, C48	CAP, 470pF, C0G, 25V, 5%, 0603	WURTH ELEKTRONIK, 885012006042
15	1	C31	CAP, 18nF, X7R, 25V, 10%, 0603	MURATA, GRM188R71E183JA01D
16	4	C76, C77, C80, C81	CAP, 0.1µF, X7R, 25V, 10%, 0603	MURATA, GRM188R71E104KA01D
17	2	C78, C79	CAP, 2.2nF, X7R, 25V, 10%, 0603	MURATA, GRM188R71E222KA01D
18	4	D1, D2, D5, D6	DIODE, 200V, 1A, SOD123F	CENTRAL SEMI., CMMR1U-02
19	2	D3, D4	DIODE, DFLS1100, POWERDI123	DIODES., DFLS1100-7
20	2	L1, L2	IND., PWR., 3.3µH, ±10%	COILCRAFT, SER2915L-332KL
21	8	M1, M2, M3, M4, M9, M10, M13, M15	N-CH., 25V, PG-TDSON-8	INFINEON, BSC009NE2LS5
22	2	Q3, Q4	N-CH., 30V, SOT23	NEXDERIA, PMV40UN2
23	6	RSNS1, RSNS2, RSNS3, RSNS4, RSNS5, RSNS6	RES, CHIP, SENSE, 0.002Ω, 3W, 1%, WIDE 2512	SUSUMU, KRL6432E-M-R002-F-T1
24	8	R2, R4, R5, R10, R104, R115, R112, R114	RES, CHIP, 1Ω, 1/10W, 0603	VISHAY, CRCW06031R00FKEA
25	2	R7, R107	RES, CHIP, 3.3Ω, 1/10W, 1%, 0603	VISHAY, CRCW06033R30FKEA
26	9	R8, R9, R12, R14, R89, R106, R111, R117, R146	RES, CHIP, 10Ω, 1/10W, 1%, 0603	VISHAY, CRCW060310R0FKEA
27	1	R11	RES, CHIP, 261k, 1/10W, 1%, 0603	VISHAY, CRCW0603261KFKEA
28	2	R17, R18	RES, CHIP, 93.1k, 1/10W, 1%, 0603	VISHAY, CRCW060393K1FKEA
29	1	R19	RES, CHIP, 133k, 1/10W, 1%, 0603	VISHAY, CRCW0603133KFKEA
30	3	R23, R25, R28	RES, CHIP, 12.1k, 1/10W, 1%, 0603	VISHAY, CRCW060312K1FKEA
31	1	R24	RES, CHIP, 178k, 1/10W, 1%, 0603	VISHAY, CRCW0603178KFKEA
32	1	R26	RES, CHIP, 21.5k, 1/10W, 1%, 0603	VISHAY, CRCW060321K5FKEA
33	1	R27	RES, CHIP, 68.1k, 1/10W, 1%, 0603	VISHAY, CRCW060368K1FKEA
34	7	R29, R32, R35, R37, R131, R133, R135	RES, CHIP, 17.4k, 1/10W, 1%, 0603	VISHAY, CRCW060317K4FKEA
35	3	R30, R31, R108	RES, CHIP, 20.0k, 1/10W, 1%, 0603	VISHAY, CRCW060320K0FKEA
36	1	R33	RES, CHIP, 665k, 1/10W, 1%, 0603	VISHAY, CRCW0603665KFKEA
37	7	R39, R41, R45, R56, R110, R152, R162	RES, CHIP, 100k, 1/10W, 1%, 0603	VISHAY, CRCW0603100KFKEA
38	2	R48, R103	RES, CHIP, 365k, 1/10W, 1%, 0603	VISHAY, CRCW0603365KFKEA

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
39	3	R50, R154, R155	RES, CHIP, 10k, 1/10W, 1%, 0603	VISHAY, CRCW060310K0FKEA
40	1	R151	RES, CHIP, 27.4k, 1/10W, 1%, 0603	VISHAY, CRCW060327K4FKEA
41	1	R153	RES, CHIP, 14.7k, 1/10W, 1%, 0603	VISHAY, CRCW060314K7FKEA
42	1	R163	RES, CHIP, 200, 1/10W, 1%, 0603	VISHAY, CRCW0603200RFKEA
43	1	U1	IC., BUCK-BOOST DC/DC CONTROLLER. 40L-5x8-UHG	ANALOG DEVICES, LT8708EUHG#PBF
44	1	U2	IC., BUCK-BOOST DC/DC CONTROLLER. 40L-5x8-UHG	ANALOG DEVICES, LT8708-1EUHG#PBF

Additional Demo Board Circuit Components

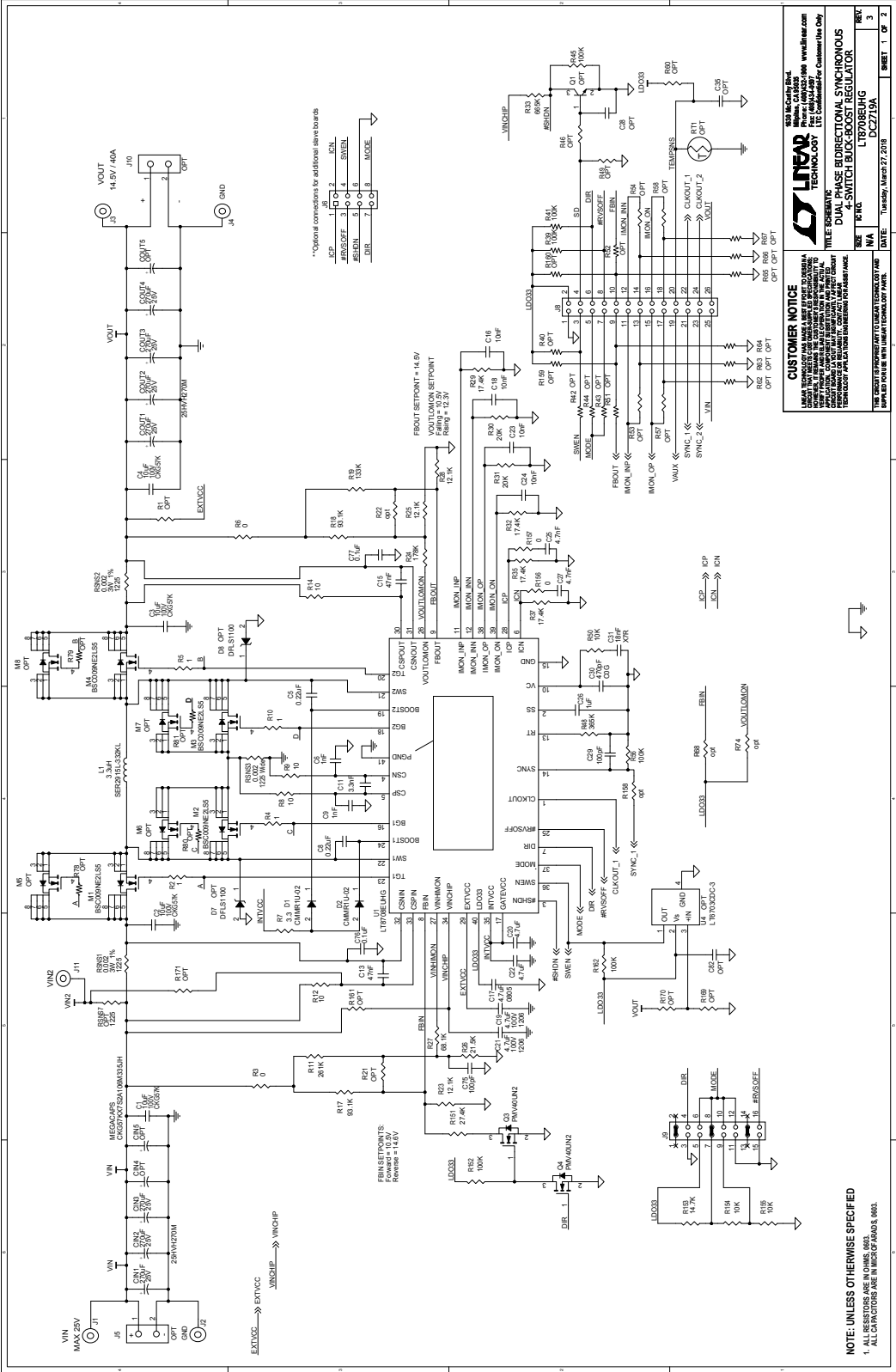
45	0	COUT5, CIN4, CIN5 (OPT)	CAP, OPTION	
46	0	C28, C32, C35, C36, C37, C39, C40, C72, C82 (OPT)	CAP, OPTION 0603	
47	0	C33 (OPT)	CAP, ALUM, 8x10.2, OPTION	
48	0	C34, C38 (OPT)	CAP, OPTION, 1210	MURATA, GRM32ER72A105KA01L
49	0	D7, D8, D9, D10 (OPT)	DIODE, OPTION, POWERDI123	DIODES., DFLS1100-7
50	0	L3 (OPT)	IND., OPTION, IHLP-2525CZ-11	
51	0	M5, M6, M7, M8, M11, M12, M14, M16 (OPT)	N-CH., OPTION PG-TDSON-8	
52	0	Q1 (OPT)	TRANSISTOR, OPTION, SOT23	
53	0	RSNS7 (OPT)	RES, CHIP, WIDE 2512 OPTION	
54	0	RT1 (OPT)	THERMISTOR, OPTION 0603	
55	0	R1, R21, R22, R40, R42, R43, R44, R46, R49, R51, R52, R53, R54, R57, R58, R60, R61, R62, R63, R64, R65, R66, R67, R68, R69, R70, R71, R73, R74, R75, R76, R77, R90, R99, R101, R113, R159, R160, R158, R78, R79, R80, R81, R109, R116, R138, R145, R161, R169, R170, R171	RES., OPTION, 0603	
56	12	R3, R6, R105, R134, R147, R156, R157, R164, R165, R166, R167, R168	RES, CHIP, 0Ω, 1/10W, 1%, 0603	VISHAY, CRCW06030000Z0EA
57	0	U3 (OPT)	I.C. LT8631EFE, 20-TSSOP	
58	0	U4 (OPT)	IC., LT6703-3 DC PACKAGE	

Hardware for Demo Board Only

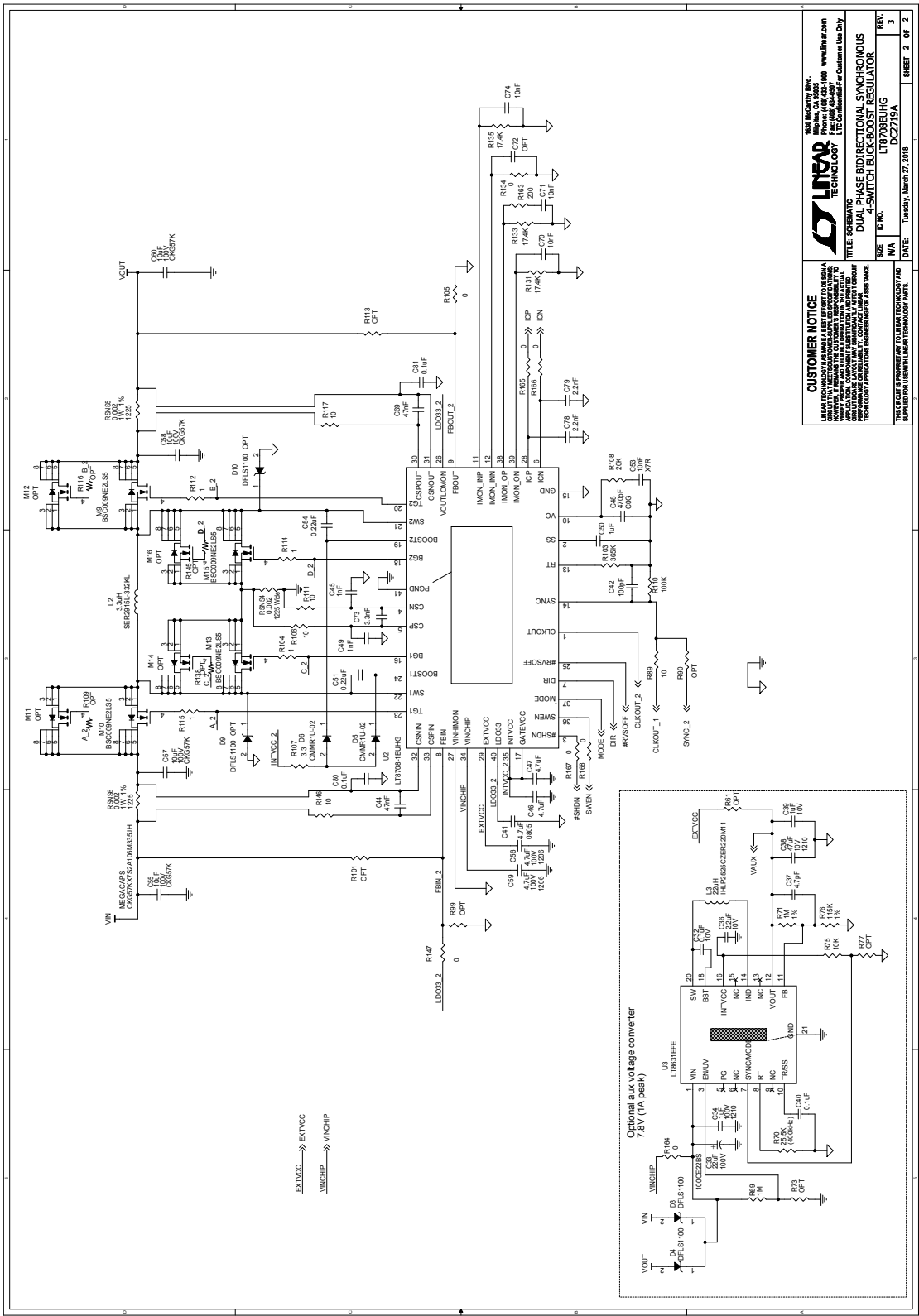
59	5	J1, J2, J3, J4, J11	STUD, TEST PIN	PEM, KFH-032-10ET
60	5	J1, J2, J3, J4, J11	NUT, BRASS NUTS # 10-32	ANY #10-32M/S BR PL
61	5	J1, J2, J3, J4, J11	RING, LUG RING # 10	KEYSTONE RING #10 8205
62	5	J1, J2, J3, J4, J11	WASHER, TIN PLATED BRASS	ANY #10 EXT BZ TN
63	0	J5, J10 (OPT)	CON., 2-PIN, POWERPOLE	
64	1	J6	HEADER 4-PIN 0.1 DOUBLE ROW	WURTH ELEKTRONIK, 61300821121
65	1	J8	HEADER 13-PIN 0.1 DOUBLE ROW	WURTH ELEKTRONIK, 61302621121
66	1	J9	HEADER 8-PIN 0.1 DOUBLE ROW	WURTH ELEKTRONIK, 61301621121
67	3	XJ9 (1-2), XJ9 (7-8), XJ9 (13-14)	SHUNT, 0.1 CENTER	WURTH ELEKTRONIK, 60900213421
68	4	MH1-MH4	STAND-OFF, NYLON 0.375"	WURTH ELEKTRONIK, 702933000
69	1		PRINTED CIRCUIT BOARD	DEMO CIRCUIT 2719A
70	1		STENCIL	STENCIL DC2719A

DEMO MANUAL DC2719A

SCHEMATIC DIAGRAM



SCHEMATIC DIAGRAM



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DC2719A

4-SWITCH BIDIRECTIONAL SYNCHRONOUS BUCK-BOOST REGULATOR

REV	DATE	DESCRIPTION
1	2018.03.27	Initial Release
2	2018.03.27	Updated Schematic
3	2018.03.27	Final Release

**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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