

# LTC7813EUH

## 4V to 56V $V_{IN}$ , Step-Up/Step-Down Power Supply

### DESCRIPTION

Demonstration circuit DC2435A is a step-up/down supply featuring the **LTC®7813EUH**. The LTC7813 is a high performance dual output (buck and boost) synchronous DC/DC switching regulator controller. The board has three different configurations:

DC2435A-A: Regulated output voltage of 24 Volt

DC2435A-B: Narrowed output voltage between 20V and 28V

DC2435A-C: Dual output voltages of 24V (Boost  $V_{BUS}$  channel) and 5V (Buck  $V_{OUT1}$  channel)

The circuit enables a drop-in layout where the total circuit area is only 1½" by 1½". The LTC7813EUH is in a 32-lead exposed pad QFN package.

The main features of the board include rail tracking (buck channel only), an internal 5V linear regulator for bias, separate RUN pins for each output and a Mode selector that allows the converter to run in CCM, pulse-skipping or Burst Mode operation. Synchronization to an external clock is also possible.

The LTC7813 buck input is supplied from the Boost output for the DC2435A-A and DC2435A-B only. With this boost-then-buck topology, the buck outputs maintain regulation over the entire input range of 4V to 56V, making it suitable for automotive or other battery fed applications where low quiescent current is important.

The DC2435A-B is designed such that  $V_{OUT}$  is partially regulated between 20V and 28V for higher efficiency (Figure 5a), reduced power loss, and switching noise. When  $V_{IN}$  is between 20V and 28V, it operates in pass-thru mode with the boost synchronous FET fully on and the buck in drop-out with >99% duty cycle. When  $V_{IN}$  is below 20V, the boost is activated and when  $V_{IN}$  is above 28V, the buck is activated as shown in Figure 5b.

The LTC7813 data sheet gives a complete description of the part, operation and application information and must be read in conjunction with this quick start guide.

**Design files for this circuit board are available at <http://www.linear.com/demo/DC2435A>**

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

Table 1

SYMBOL	PARAMETER		CONDITIONS	MIN	TYP	MAX	UNITS
$V_{IN}$	Input Supply Range			4		56	V
$V_{OUT1}$	Output1 Voltage Range	-A	$V_{IN} = 4V^* - 56V, I_{OUT1} = 0A \text{ to } 5A\#$	23.5	24	24.5	V
		-B		19		28.6	V
		-C		4.9	5**	5.1	V
$V_{BUS}$	$V_{BUS}$ Voltage Range (-C only)		$V_{IN} < 24V$	23.5	24	24.5	V
$f_{SW}$	Typical Free Running Switching Frequency			200			kHz
	See Figures 4, 5, 6 and 7 for efficiency curves	-A	$V_{IN} = 14V, V_{OUT1} = 24V, I_{OUT1} = 5A$ $V_{IN} = 48V, V_{OUT1} = 24V, I_{OUT1} = 5A$		94.6		%
		-B	$V_{IN} = 14V, V_{OUT1} = 20V, I_{OUT1} = 5A$ $V_{IN} = 24V, V_{OUT1} = 24V, I_{OUT1} = 5A$		96.3		%
			$V_{IN} = 48V, V_{OUT1} = 28V, I_{OUT1} = 5A$		98.5		%
-C	$V_{IN} = 14V, V_{BUS} = 24V, I_{BUS} = 3A$ $V_{IN} = 14V, V_{OUT1} = 5V, I_{OUT1} = 8A$		97.1		92.8	%	
	$V_{IN} = 48V, V_{OUT1} = 5V, I_{OUT1} = 8A$		88.9			%	

#  $I_{OUT1}$  starts to de-rate when  $V_{IN} < 14V$ . \*  $V_{IN}$  needs to be  $> 8V$  to start up. \*\*  $V_{OUT1}$  follows  $V_{IN}$  when  $V_{IN} < 5V$ .

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## DEMO BOARD OPTIONS

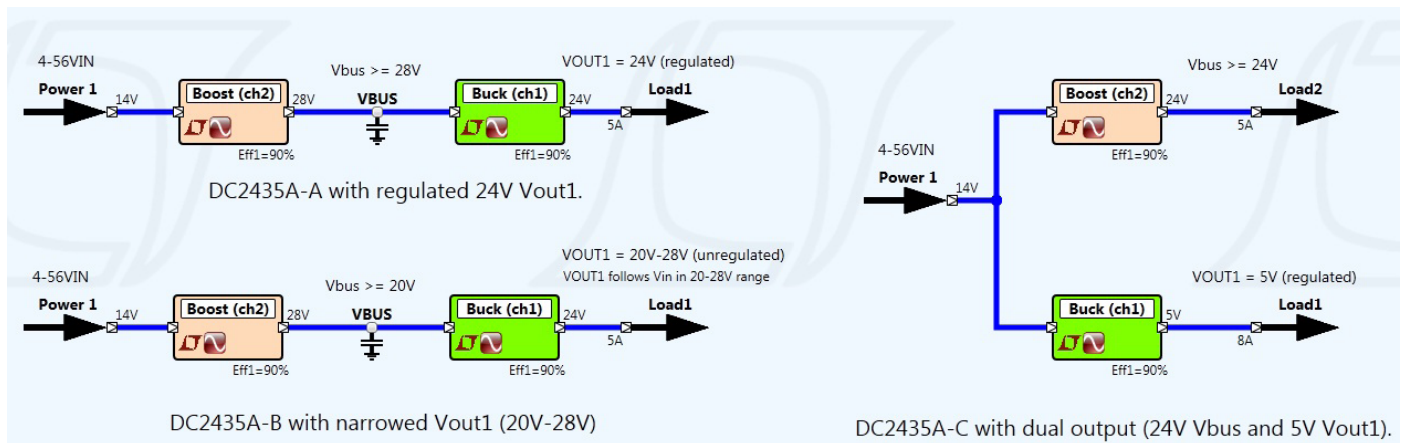


Figure 1. DC2435A/LTC7813 Demo Board Options

## QUICK START PROCEDURE

DC2435A is easy to set up to evaluate the performance of the LTC7813EUH. 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 input or output voltage ripple by touching the probe tip directly across the  $V_{IN}$  or  $V_{OUT}$  and GND terminals or directly across relevant capacitor. See Figure 3 for proper scope probe technique.

- Place jumpers in the following positions:
  - JP1** ON
  - JP2** ON
  - JP3** FCM
- With power off, connect the input power supply to  $V_{IN}$  and GND.

- Turn on the power at the input.
  - NOTE: Make sure that the input voltage is higher than 8V and does not exceed 56V.
- Check for the proper output voltages for different boards.
  - A:  $V_{OUT1} = 23.5V$  to  $24.5V$ ,
  - B:  $19V < V_{OUT1} < 28.6V$ ,
  - C:  $V_{OUT1} = 4.9V$  to  $5.1V$ ;  
 $V_{BUS} = 23.5V$  to  $24.5V$  ( $V_{IN} < 24V$ )

NOTE: If there is no output, temporarily disconnect the load to make sure that the load is not set too high.

- Once the proper output voltages are established, adjust the loads within the operating range and observe the output voltage regulation, ripple voltage, efficiency and other parameters.

## QUICK START PROCEDURE

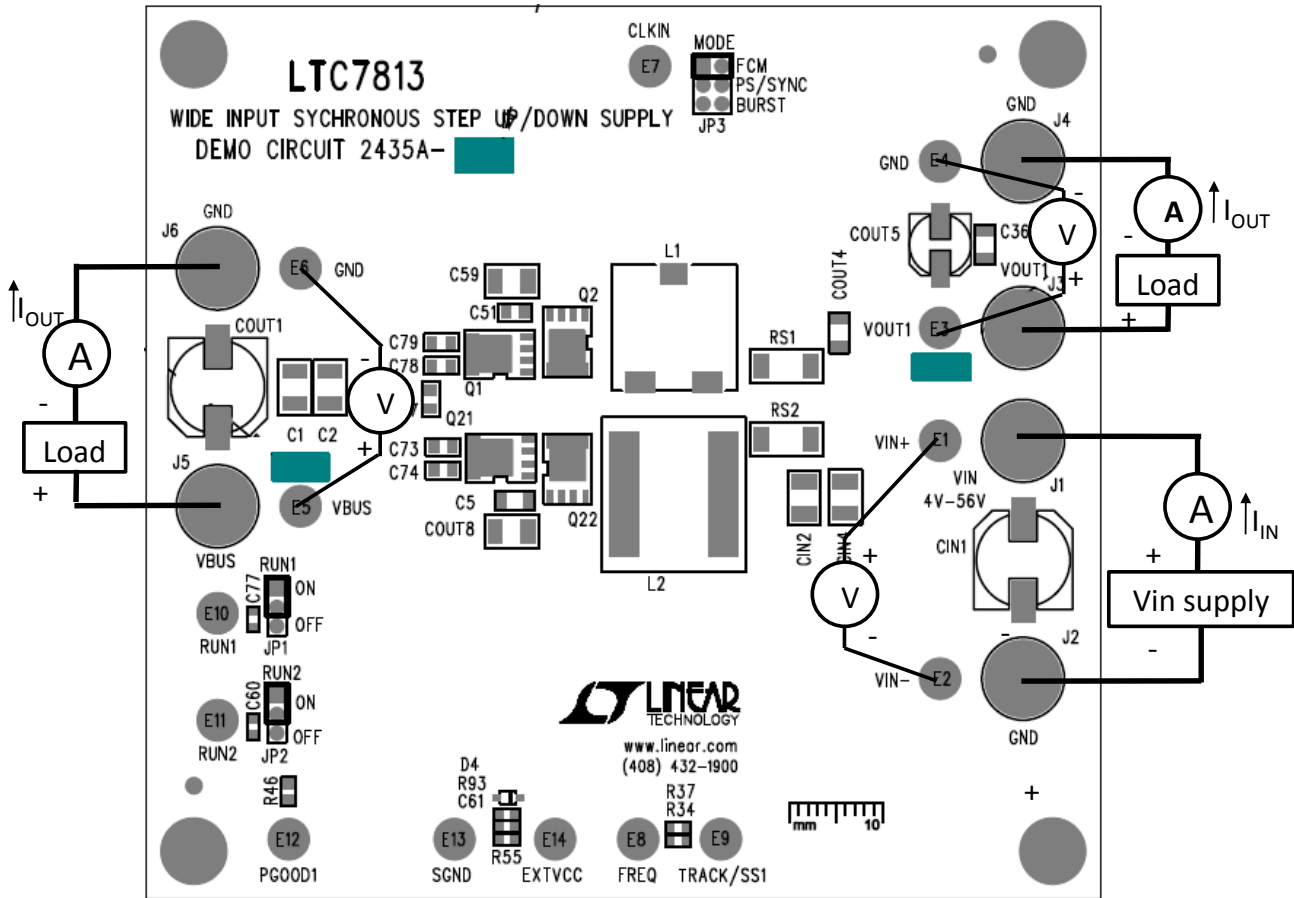


Figure 2. Proper Measurement Equipment Setup

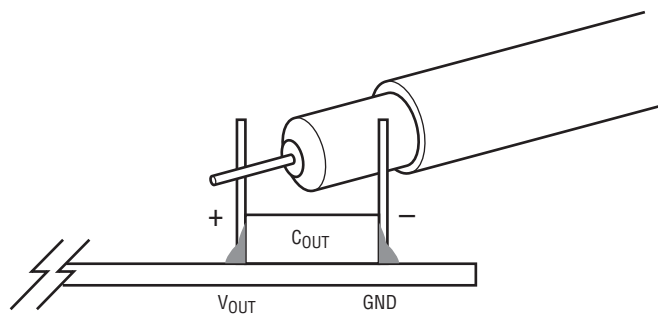


Figure 3. Measuring Input or Output Ripple Across Terminals or Directly Across Ceramic Capacitor

## FREQUENCY SYNCHRONIZATION AND MODE SELECTION

DC2435A's mode selector allows the converter to run in forced continuous operation, pulse skip operation, Burst Mode or be synchronizing to an external clock by changing the position of JP3.

**Table 2. Mode Selection and Synchronized Operation Options**

CONFIGURATION	JP3
Forced Continuous Operation	FCM
Pulse-Skipping Operation	PS/Sync
Synchronized to External Clock Applied to CLKIN Pin	PS/Sync
Burst Mode Operation	Burst

## RAIL TRACKING

DC2435A is configured for an on board soft start circuit. The soft start ramp rate can be adjusted by changing the value of C47. DC2435A can also be modified to track an external reference. Refer to Table 3 for tracking options and to the data sheet for more details.

**Table 3. V<sub>OUT1</sub> Tracking Options**

CONFIGURATION	R34	R37	C47	TRK/SS1 TURRET
Soft-Start Without Tracking (Default)	OPEN	OPEN	0.1μF	OPEN
V <sub>OUT1</sub> Tracking Scaled External Reference	Resistor	Divider	OPEN	External Reference

## OPTIONAL INDUCTOR DCR CURRENT SENSING

DC2435A provides an optional circuit for Inductor DCR Current Sensing. Inductor DCR Current Sensing uses the DCR of the inductor to sense the inductor current instead of discrete sense resistors. The advantages of DCR sensing are lower cost, reduced board space and higher efficiency, but the disadvantage is a less accurate current limit. If

DCR sensing is used, be sure to select an inductor current with a sufficiently high saturation current or use an iron powder type material.

Refer to Table 4 for Optional Inductor DCR Current Sensing setup and to the data sheet for more details.

**Table 4. Optional Inductor DCR Current Sensing**

CONFIGURATION	CHANNEL 1	RS1	R39	R40	C15	R51	R53	R62
	CHANNEL 2	RS2	R80	R81	C56	R89	R90	R91
Current Sense Resistor (Default)		Ref. Sch.	Ref. Sch.	Ref. Sch.	Ref. Sch.	OPEN	OPEN	OPEN
Inductor DCR Current Sensing		0Ω Copper	OPEN	OPEN	Calculated Value from Data Sheet			0Ω

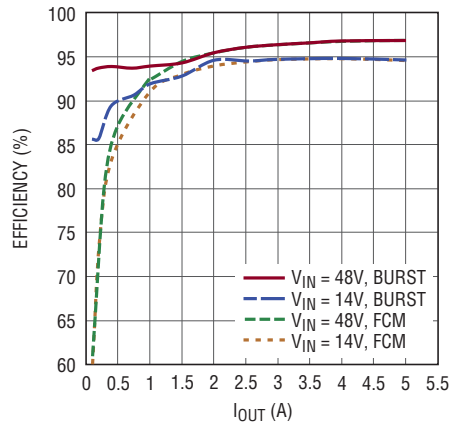
## LOW QUIESCENT CURRENT APPLICATIONS AND MEASUREMENT

The typical quiescent current (I<sub>Q</sub>) of the LTC7813 controller is 29μA in sleep mode as specified in the LTC7813 data sheet. However, the input current of the DC2435A board can be higher than this value because of additional circuit outside of the IC. To reduce the total input current, large value FB divider resistors should be used. In addition, some of the optional pull-up resistors should be removed from

the board. Refer to Table 5 for the low input quiescent current setup.

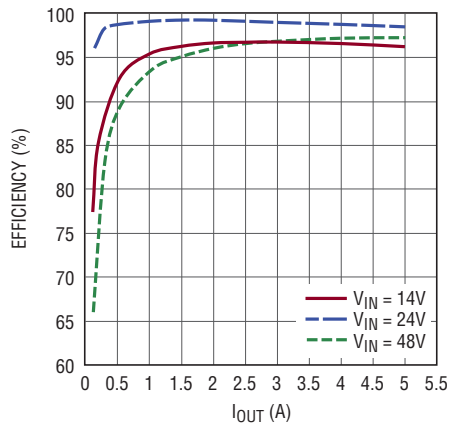
**Table 5. Low Input Quiescent Current Configuration**

Reference Designator	R46
Function	PGOOD1
Stuffing Option	OPEN



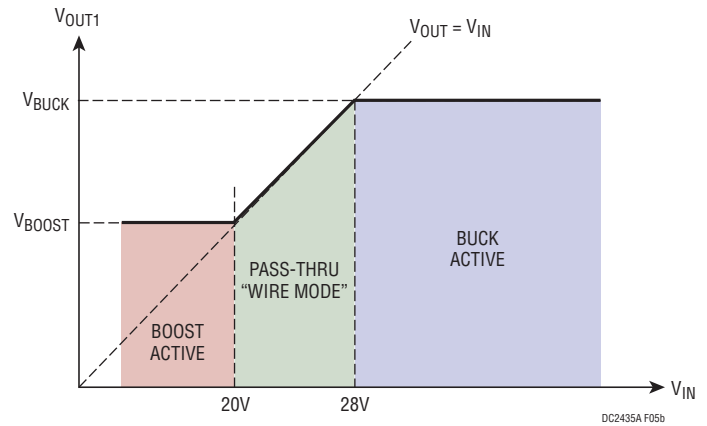
DC2435A F04

Figure 4. DC2435A-A  $V_{OUT1}$  Typical Efficiency vs Load Current



DC2435A F05a

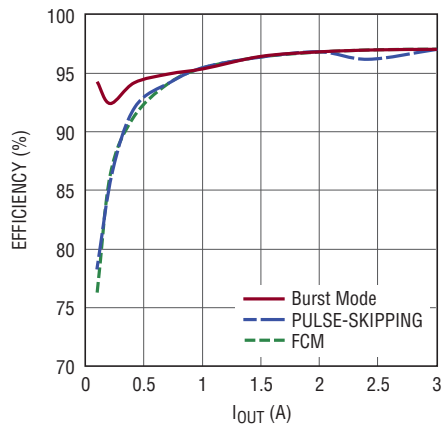
Figure 5a. DC2435A-B  $V_{OUT1}$  Typical Efficiency vs Load Current



DC2435A F05b

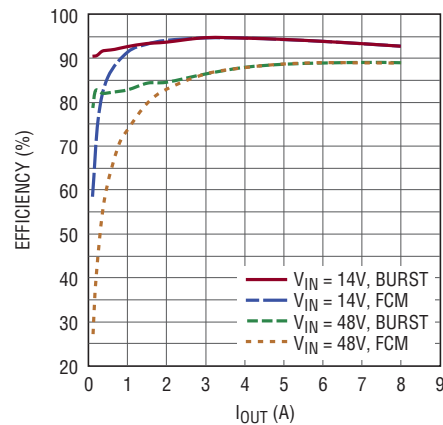
Figure 5b. DC2435A-B  $V_{OUT1}$  Operating Modes vs  $V_{IN}$

Figure 5.



DC2435A F06

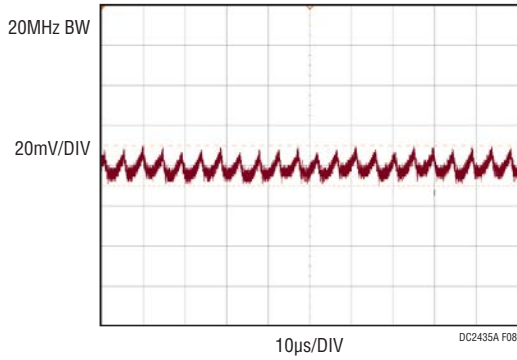
Figure 6. DC2435A-C  $V_{BUS}$  Typical Efficiency vs Load Current ( $V_{IN} = 14V$ )



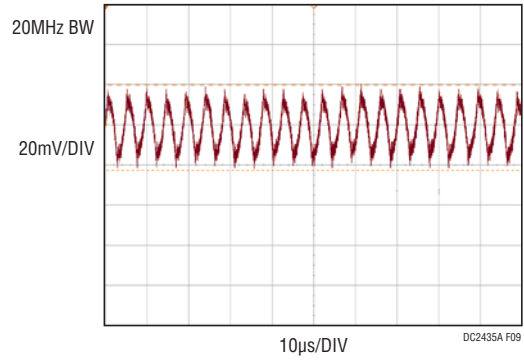
DC2435A F07

Figure 7. DC2435A-C  $V_{OUT1}$  Typical Efficiency vs Load Current

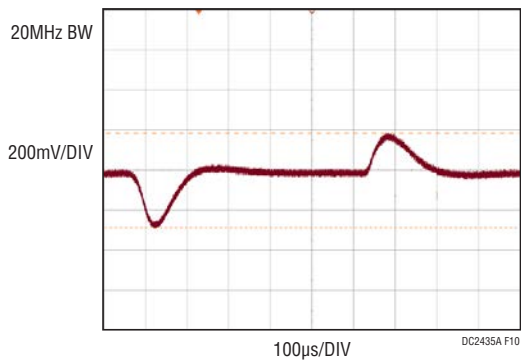
# DEMO MANUAL DC2435A-A/ DC2435A-B/DC2435A-C



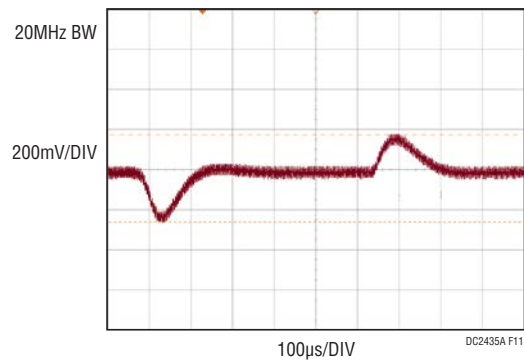
**Figure 8. DC2435A-A  $V_{OUT1}$  Voltage Ripple at  $V_{IN} = 14V$**



**Figure 9. DC2435A-A  $V_{OUT1}$  Voltage Ripple at  $V_{IN} = 48V$**



**Figure 10. DC2435A-A  $V_{OUT1}$  0A to 2.5A Load Transient at  $V_{IN} = 14V$**



**Figure 11. DC2435A-A  $V_{OUT1}$  0A to 2.5A Load Transient at  $V_{IN} = 48V$**

# DEMO MANUAL DC2435A-A/ DC2435A-B/DC2435A-C

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>DC2435A-A</b>				
<b>Required Circuit Components</b>				
1	2	CIN1, COUT1	CAP, 33 $\mu$ F, 63V, 20%, ELEC	SUN ELEC. 63HVH33M
2	1	COUT2	CAP, 100 $\mu$ F, 63V, 20%, ELEC	UNITED CHEMI CON, EMZA630ADA101MJA0G
3	6	CIN2, CIN3, CIN4, COUT6, COUT8, C80	CAP, 4.7 $\mu$ F, X7R, 100V, 10%,1210	MURATA, GRM32ER72A475KE14L
4	2	COUT4, C5	CAP, 2.2 $\mu$ F, X7R, 100V,10%,1206	MURATA, GRM31CR72A225KA73L
5	2	COUT5, COUT11	CAP, 68 $\mu$ F, 35V, 20%, D8	PANASONIC, EEHA1V680XP
6	5	C4, C17, C21, C47, C52	CAP, 0.1 $\mu$ F, X7R, 25V ,10%, 0603	TDK, C1608X7R1E104K
7	3	C15, C56, C62	CAP, 1nF, X7R, 50V,10%,0603	AVX, 06035C102KAT2A
8	1	C43	CAP, 68pF, NPO, 50V, 10%,0603	AVX, 06035A680KAT2A
9	1	C44	CAP, 4.7nF, X7R, 50V,10%,0603	AVX, 06035C472KAT2A
10	1	C49	CAP, 47pF X7R, 50V, 5%, 0603	AVX, 06035A470JAT2A
11	1	C53	CAP, 820pF X7R, 50V, 5%, 0603	AVX, 06035A821JAT2A
12	1	C54	CAP, 27nF, X7R, 50V,10%, 0603	AVX, 06035C273KAT2A
13	1	C61	CAP, 1 $\mu$ F, X5R, 25V, 20%, 0603	TDK, C1608X5R1E105M
14	2	C64, C81	CAP, 4.7 $\mu$ F X5R,10V, 20%, 0603	AVX, 0603ZD475MAT2A
15	1	L1	IND, 22 $\mu$ H	COILCRAFT, SER1390-223MLD
16	1	L2	IND, 15 $\mu$ H	COILCRAFT, XAL1510-153MED
17	1	Q1	XSTR, N-CHANNEL MOSFET	INFINEON, BSC123N08NS3G
18	1	Q2	XSTR, N-CHANNEL MOSFET	INFINEON, BSC042NE7NS3G
19	1	Q21	XSTR, N-CHANNEL MOSFET	INFINEON, BSC026N08NS5
20	1	Q22	XSTR, N-CHANNEL MOSFET	INFINEON, BSC072N08NS5
21	1	R33	RES., 11.5k $\Omega$ ,1/10W, 1%, 0603	VISHAY, CRCW060311K5FKEA
22	1	R35	RES., 7.5k $\Omega$ ,1/10W, 1%, 0603	VISHAY, CRCW06037K5FKEA
23	2	R43, R78	RES., 332k $\Omega$ ,1/10W, 1%, 0603	VISHAY, CRCW0603332KFKEA
24	2	R46, R48	RES., 100k $\Omega$ ,1/10W, 5%, 0603	VISHAY, CRCW0603100KJNEA
25	1	R72	RES., 37.4k $\Omega$ ,1/10W, 1%, 0603	VISHAY, CRCW060337K4FKEA
26	1	R75	RES., 3.6k $\Omega$ ,1/10W, 1%, 0603	VISHAY, CRCW06033K60FKEA
27	1	R79	RES., 14.7k $\Omega$ ,1/10W, 1%, 0603	VISHAY, CRCW060314K7FKEA
28	1	R81	RES., 100 $\Omega$ ,1/10W, 5%, 0603	VISHAY, CRCW0603100RJNEA
29	1	R86	RES., 2.2 $\Omega$ ,1/10W, 5%, 0603	VISHAY, CRCW06032R20JNEA
30	1	R92	RES., 90.9k $\Omega$ ,1/10W, 1%, 0603	VISHAY, CRCW060390K9FKEA
31	1	RS1	RES., SENSE, 0.008 $\Omega$ ,1/2W, 1%, 2010	VISHAY, WSL20108L000FEA18
32	1	RS2	RES., SENSE, 0.006 $\Omega$ ,1/2W, 1%, 2010	VISHAY, WSL20106L000FEA18
33	1	U1	IC, LOW I <sub>Q</sub> , 60V BOOST + BUCK SYNCHRONOUS CONTROLLER	LINEAR TECH. LTC7813EUH#PBF
<b>Additional Demo Board Circuit Components</b>				
1	0	C1, C2, C3, CIN5, C6, C59, C68	CAP, OPTION, 1210	OPTION
2	0	C36	CAP, OPTION, 1206	OPTION
3	0	C7, C39, C40, C51, C66, C67, C73, C74, C78, C79	CAP, OPTION, 0805	OPTION
4	0	C55, C57, C60, C63, C65, C77	CAP, OPTION, 0603	OPTION

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# DEMO MANUAL DC2435A-A/ DC2435A-B/DC2435A-C

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
5	0	D3	DIODE, OPTION, SMB	OPTION
6	0	D4	DIODE, OPTION, SOD323	OPTION
7	0	L3	IND, OPTION	OPTION
8	0	Q9, Q11, Q18, Q19	XSTR, OPTION, N-CHANNEL MOSFET	OPTION
9	11	R34, R36, R39, R40, R70, R80, R95, R96, R103, R105, R108	RES., 0 $\Omega$ , 1/10W, 0603	VISHAY, CRCW06030000Z0EA
10	0	R37, R51, R53, R55, R62, R85, R89, R90, R91, R93, R94, R104, R106, R107, R109, R110, R111	RES., OPTION, 0603	OPTION
11	0	R82	RES., OPTION, 1206	OPTION
12	0	R100	RES., OPTION, 0805	OPTION
13	0	R101	RES., OPTION, 2010	OPTION
14	1	R102	RES., 0 $\Omega$ , 2010	VISHAY, CRCW20100000Z0EF
15	0	RS3	RES., SENSE, OPT, 2010	OPTION

### Hardware: For Demo Board Only

1	14	E1-E14	TURRET	MILL-MAX, 2501-2-00-80-00-00-07-0
2	2	JP1, JP2	CONN., HEADER, 1x3, 2mm	WURTH ELEKTRONIK, 620-003-111-21
3	1	JP3	CONN., HEADER, 2x3, 2mm	WURTH ELEKTRONIK, 620-006-211-21
4	3	XJP1, XJP2, XJP3	SHUNT, 2mm	WURTH ELEKTRONIK, 608-002-134-21
5	6	J1, J2, J3, J4, J5, J6	JACK, BANANA	KEYSTONE, 575-4
6	0	J9, J10	PAD	NONE
7	4		STANDOFF, SNAP ON	KEYSTONE, 8832

### DC2435A-B

1	2	CIN1, COUT1	CAP, 33 $\mu$ F, 63V, 20%, ELEC	SUN ELEC. 63HVH33M
2	1	COUT2	CAP, 100 $\mu$ F, 63V, 20%, ELEC	UNITED CHEMI CON, EMZA630ADA101MJA0G
3	6	CIN2, CIN3, CIN4, COUT6, COUT8, C80	CAP, 4.7 $\mu$ F, X7R, 100V, 10%, 1210	MURATA, GRM32ER72A475KE14L
4	2	COUT4, C5	CAP, 2.2 $\mu$ F, X7R, 100V, 10%, 1206	MURATA, GRM31CR72A225KA73L
5	2	COUT5, COUT11	CAP, 68 $\mu$ F, 35V, 20%, D8	PANASONIC, EEHA1V680XP
6	5	C4, C17, C21, C47, C52	CAP, 0.1 $\mu$ F, X7R, 25V, 10%, 0603	TDK, C1608X7R1E104K
7	3	C15, C56, C62	CAP, 1nF, X7R, 50V, 10%, 0603	AVX, 06035C102KAT2A
8	1	C43	CAP, 68pF, NPO, 50V, 10%, 0603	AVX, 06035A680KAT2A
9	1	C44	CAP, 4.7nF, X7R, 50V, 10%, 0603	AVX, 06035C472KAT2A
10	1	C49	CAP, 47pF X7R, 50V, 5%, 0603	AVX, 06035A470JAT2A
11	1	C53	CAP, 820pF X7R, 50V, 5%, 0603	AVX, 06035A821JAT2A
12	1	C54	CAP, 27nF, X7R, 50V, 10%, 0603	AVX, 06035C273KAT2A
13	1	C61	CAP, 1 $\mu$ F, X5R, 25V, 20%, 0603	TDK, C1608X5R1E105M
14	2	C64, C81	CAP, 4.7 $\mu$ F X5R, 10V, 20%, 0603	AVX, 0603ZD475MAT2A
15	1	L1	IND, 22 $\mu$ H	COILCRAFT, SER1390-223ML
16	1	L2	IND, 15 $\mu$ H	COILCRAFT, XAL1510-153MED
17	1	Q1	XSTR, N-CHANNEL MOSFET	INFINEON, BSC123N08NS3G
18	1	Q2	XSTR, N-CHANNEL MOSFET	INFINEON, BSC042NE7NS3G
19	1	Q21	XSTR, N-CHANNEL MOSFET	INFINEON, BSC026N08NS5

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# DEMO MANUAL DC2435A-A/ DC2435A-B/DC2435A-C

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
20	1	Q22	XSTR, N-CHANNEL MOSFET	INFINEON, BSC072N08NS5
21	1	R33	RES., 9.76k $\Omega$ , 1/10W, 1%, 0603	VISHAY, CRCW06039K76FKEA
22	1	R35	RES., 7.5k $\Omega$ , 1/10W, 1%, 0603	VISHAY, CRCW06037K5FKEA
23	2	R43, R78	RES., 332k $\Omega$ , 1/10W, 1%, 0603	VISHAY, CRCW0603332KFKEA
24	2	R46, R48	RES., 100k $\Omega$ , 1/10W, 5%, 0603	VISHAY, CRCW0603100KJNEA
25	1	R72	RES., 37.4k $\Omega$ , 1/10W, 1%, 0603	VISHAY, CRCW060337K4FKEA
26	1	R75	RES., 3.6k $\Omega$ , 1/10W, 1%, 0603	VISHAY, CRCW06033K60FKEA
27	1	R79	RES., 21k $\Omega$ , 1/10W, 1%, 0603	VISHAY, CRCW060321K0FKEA
28	1	R81	RES., 100 $\Omega$ , 1/10W, 5%, 0603	VISHAY, CRCW0603100RJNEA
29	1	R86	RES., 2.2 $\Omega$ S, 1/10W, 5%, 0603	VISHAY, CRCW06032R20JNEA
30	1	R92	RES., 90.9k $\Omega$ , 1/10W, 1%, 0603	VISHAY, CRCW060390K9FKEA
31	1	RS1	RES., SENSE, 0.008 $\Omega$ , 1/2W, 1%, 2010	VISHAY, WSL20108L000FEA18
32	1	RS2	RES., SENSE, 0.006 $\Omega$ , 1/2W, 1%, 2010	VISHAY, WSL20106L000FEA18
33	1	U1	IC, LOW I <sub>Q</sub> , 60V BOOST + BUCK SYNCHRONOUS CONTROLLER	LINEAR TECH. LTC7813EUH#PBF

### Additional Demo Board Circuit Components

1	0	C1, C2, C3, CIN5, C6, C59, C68	CAP, OPTION, 1210	OPTION
2	0	C36	CAP, OPTION, 1206	OPTION
3	0	C7, C39, C40, C51, C66, C67, C73, C74, C78, C79	CAP, OPTION, 0805	OPTION
4	0	C55, C57, C60, C63, C65, C77	CAP, OPTION, 0603	OPTION
5	0	D3	DIODE, OPTION, SMB	OPTION
6	0	D4	DIODE, OPTION, SOD323	OPTION
7	0	L3	IND., OPTION	OPTION
8	0	Q9, Q11, Q18, Q19	XSTR, OPTION, N-CHANNEL MOSFET	OPTION
9	11	R34, R36, R39, R40, R70, R80, R95, R96, R103, R105, R108	RES., 0 $\Omega$ , 1/10W, 0603	VISHAY, CRCW06030000Z0EA
10	0	R37, R51, R53, R55, R62, R85, R89, R90, R91, R93, R94, R104, R106, R107, R109, R110, R111	RES., OPTION, 0603	OPTION
11	0	R82	RES., OPTION, 1206	OPTION
12	0	R100	RES., OPTION, 0805	OPTION
13	0	R101	RES., OPTION, 2010	OPTION
14	1	R102	RES., 0 $\Omega$ , 2010	VISHAY, CRCW20100000Z0EF
15	0	RS3	RES., SENSE, OPT, 2010	OPTION

### Hardware: For Demo Board Only

1	14	E1-E14	TURRET	MILL-MAX, 2501-2-00-80-00-00-07-0
2	2	JP1, JP2	CONN., HEADER, 1x3, 2mm	WURTH ELEKTRONIK, 620-003-111-21
3	1	JP3	CONN., HEADER, 2x3, 2mm	WURTH ELEKTRONIK, 620-006-211-21
4	3	XJP1, XJP2, XJP3	SHUNT, 2mm	WURTH ELEKTRONIK, 608-002-134-21
5	6	J1, J2, J3, J4, J5, J6	JACK, BANANA	KEYSTONE, 575-4
6	0	J9, J10	PAD	NONE
7	4		STANDOFF, SNAP ON	KEYSTONE, 8832

# DEMO MANUAL DC2435A-A/ DC2435A-B/DC2435A-C

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>DC2435A-C</b>				
1	2	CIN1, COUT1	CAP, 33 $\mu$ F, 63V, 20%, ELEC	SUN ELEC. 63HVH33M
2	1	COUT2	CAP, 100 $\mu$ F, 63V, 20%, ELEC	UNITED CHEMI CON, EMZA630ADA101MJA0G
3	6	CIN2, CIN3, CIN4, COUT6, COUT8, C80	CAP, 4.7 $\mu$ F, X7R, 100V, 10%, 1210	MURATA, GRM32ER72A475KE14L
4	2	COUT4, C5	CAP, 2.2 $\mu$ F, X7R, 100V, 10%, 1206	MURATA, GRM31CR72A225KA73L
5	2	COUT5, COUT11	CAP, 68 $\mu$ F, 35V, 20%, D8	PANASONIC, EEHZA1V680XP
6	5	C4, C17, C21, C47, C52	CAP, 0.1 $\mu$ F, X7R, 25V, 10%, 0603	TDK, C1608X7R1E104K
7	3	C15, C56, C62	CAP, 1nF, X7R, 50V, 10%, 0603	AVX, 06035C102KAT2A
8	1	C43	CAP, 68pF, NPO, 50V, 10%, 0603	AVX, 06035A680KAT2A
9	1	C44	CAP, 4.7nF, X7R, 50V, 10%, 0603	AVX, 06035C472KAT2A
10	1	C49	CAP, 47pF X7R, 50V, 5%, 0603	AVX, 06035A470JAT2A
11	1	C53	CAP, 820pF X7R, 50V, 5%, 0603	AVX, 06035A821JAT2A
12	1	C54	CAP, 27nF, X7R, 50V, 10%, 0603	AVX, 06035C273KAT2A
13	1	C61	CAP, 1 $\mu$ F, X5R, 25V, 20%, 0603	TDK, C1608X5R1E105M
14	2	C64, C81	CAP, 4.7 $\mu$ F X5R, 10V, 20%, 0603	AVX, 0603ZD475MAT2A
15	1	L1	IND, 10 $\mu$ H	COILCRAFT, SER1390-103ML
16	1	L2	IND, 15 $\mu$ H	COILCRAFT, XAL1510-153MED
17	1	Q1	XSTR, N-CHANNEL MOSFET	INFINEON, BSC123N08NS3G
18	1	Q2	XSTR, N-CHANNEL MOSFET	INFINEON, BSC042NE7NS3G
19	1	Q21	XSTR, N-CHANNEL MOSFET	INFINEON, BSC026N08NS5
20	1	Q22	XSTR, N-CHANNEL MOSFET	INFINEON, BSC072N08NS5
21	1	R33	RES., 63.4k $\Omega$ , 1/10W, 1%, 0603	VISHAY, CRCW060363K4FKEA
22	1	R35	RES., 4.99k $\Omega$ , 1/10W, 1%, 0603	VISHAY, CRCW06034K99FKEA
23	2	R43, R78	RES., 332k $\Omega$ , 1/10W, 1%, 0603	VISHAY, CRCW0603332KFKEA
24	2	R46, R48	RES., 100k $\Omega$ , 1/10W, 5%, 0603	VISHAY, CRCW0603100KJNEA
25	1	R72	RES., 37.4k $\Omega$ , 1/10W, 1%, 0603	VISHAY, CRCW060337K4FKEA
26	1	R75	RES., 3.6k $\Omega$ , 1/10W, 1%, 0603	VISHAY, CRCW06033K60FKEA
27	1	R79	RES., 17.4k $\Omega$ , 1/10W, 1%, 0603	VISHAY, CRCW060317K4FKEA
28	1	R81	RES., 100 $\Omega$ , 1/10W, 5%, 0603	VISHAY, CRCW0603100RJNEA
29	1	R86	RES., 2.2 $\Omega$ , 1/10W, 5%, 0603	VISHAY, CRCW06032R20JNEA
30	1	R92	RES., 90.9k $\Omega$ , 1/10W, 1%, 0603	VISHAY, CRCW060390K9FKEA
31	1	RS1	RES., SENSE, 0.008 $\Omega$ , 1/2W, 1%, 2010	VISHAY, WSL20108L000FEA18
32	1	RS2	RES., SENSE, 0.010 $\Omega$ , 1/2W, 1%, 2010	VISHAY, WSL201010L000FEA18
33	1	U1	IC, LOW I <sub>Q</sub> , 60V BOOST + BUCK SYNCHRONOUS CONTROLLER	LINEAR TECH. LTC7813EUH#PBF

### Additional Demo Board Circuit Components

1	0	C1, C2, C3, CIN5, C6, C59, C68	CAP, OPTION, 1210	OPTION
2	0	C36	CAP, OPTION, 1206	OPTION
3	0	C7, C39, C40, C51, C66, C67, C73, C74, C78, C79	CAP, OPTION, 0805	OPTION
4	0	C55, C57, C60, C63, C65, C77	CAP, OPTION, 0603	OPTION

# DEMO MANUAL DC2435A-A/ DC2435A-B/DC2435A-C

## PARTS LIST

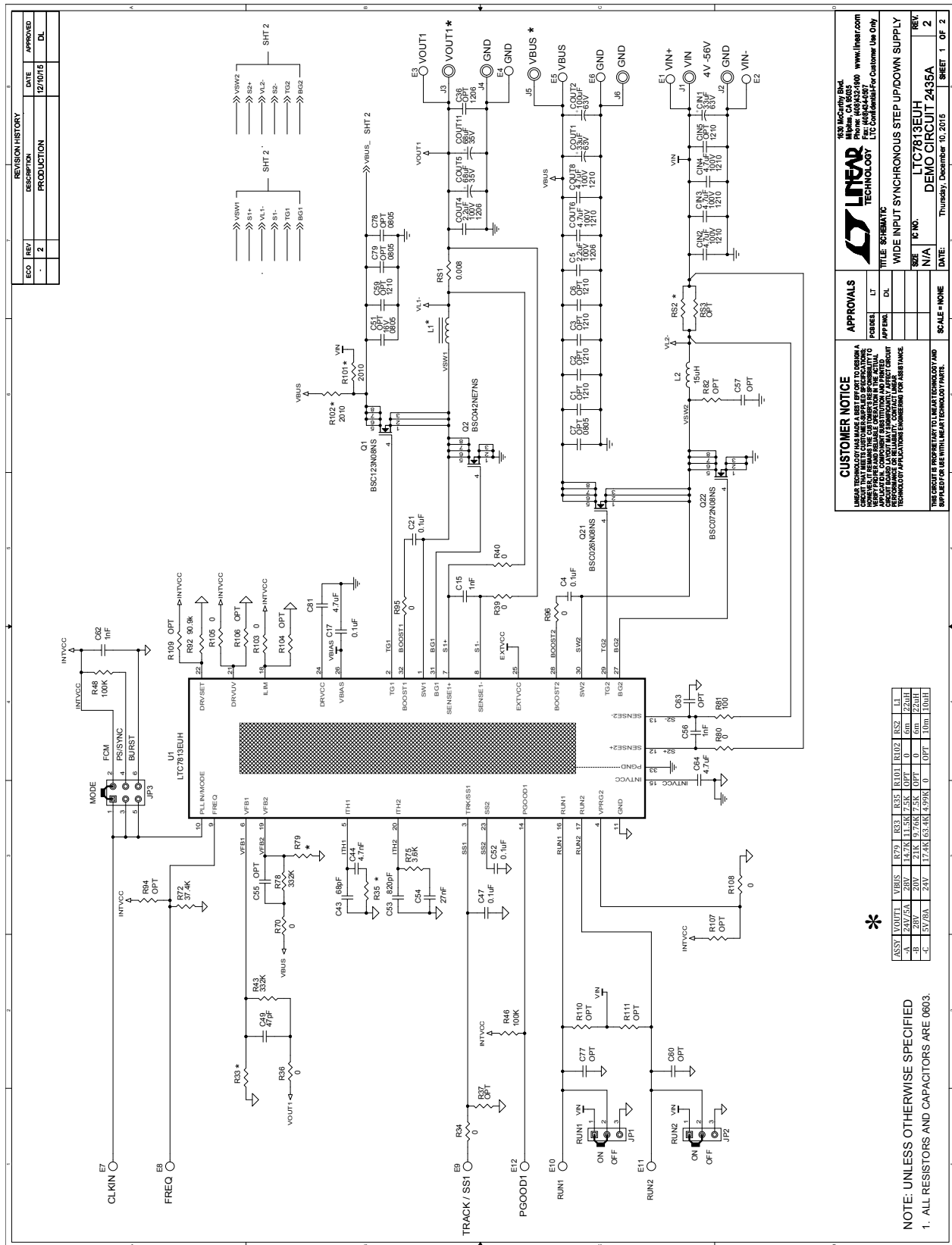
ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
5	0	D3	DIODE, OPTION, SMB	OPTION
6	0	D4	DIODE, OPTION, SOD323	OPTION
7	0	L3	IND, OPTION	OPTION
8	0	Q9, Q11, Q18, Q19	XSTR, OPTION, N-CHANNEL MOSFET	OPTION
9	11	R34, R36, R39, R40, R70, R80, R95, R96, R103, R105, R108	RES., 0 $\Omega$ , 1/10W, 0603	VISHAY, CRCW06030000Z0EA
10	0	R37, R51, R53, R55, R62, R85, R89, R90, R91, R93, R94, R104, R106, R107, R109, R110, R111	RES., OPTION, 0603	OPTION
11	0	R82	RES., OPTION, 1206	OPTION
12	0	R100	RES., OPTION, 0805	OPTION
13	1	R101	RES., 0 $\Omega$ , 2010	VISHAY, CRCW20100000Z0EF
14	0	R102	RES., OPTION, 2010	OPTION
15	0	RS3	RES., SENSE, OPT, 2010	OPTION

### Hardware: For Demo Board Only

1	14	E1-E14	TURRET	MILL-MAX, 2501-2-00-80-00-00-07-0
2	2	JP1, JP2	CONN., HEADER, 1x3, 2mm	WURTH ELEKTRONIK, 620-003-111-21
3	1	JP3	CONN., HEADER, 2x3, 2mm	WURTH ELEKTRONIK, 620-006-211-21
4	3	XJP1, XJP2, XJP3	SHUNT, 2mm	WURTH ELEKTRONIK, 608-002-134-21
5	6	J1, J2, J3, J4, J5, J6	JACK, BANANA	KEYSTONE, 575-4
6	0	J9, J10	PAD	NONE
7	4		STANDOFF, SNAP ON	KEYSTONE, 8832

# DEMO MANUAL DC2435A-A/ DC2435A-B/DC2435A-C

## SCHEMATIC DIAGRAM



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**APPROVALS**

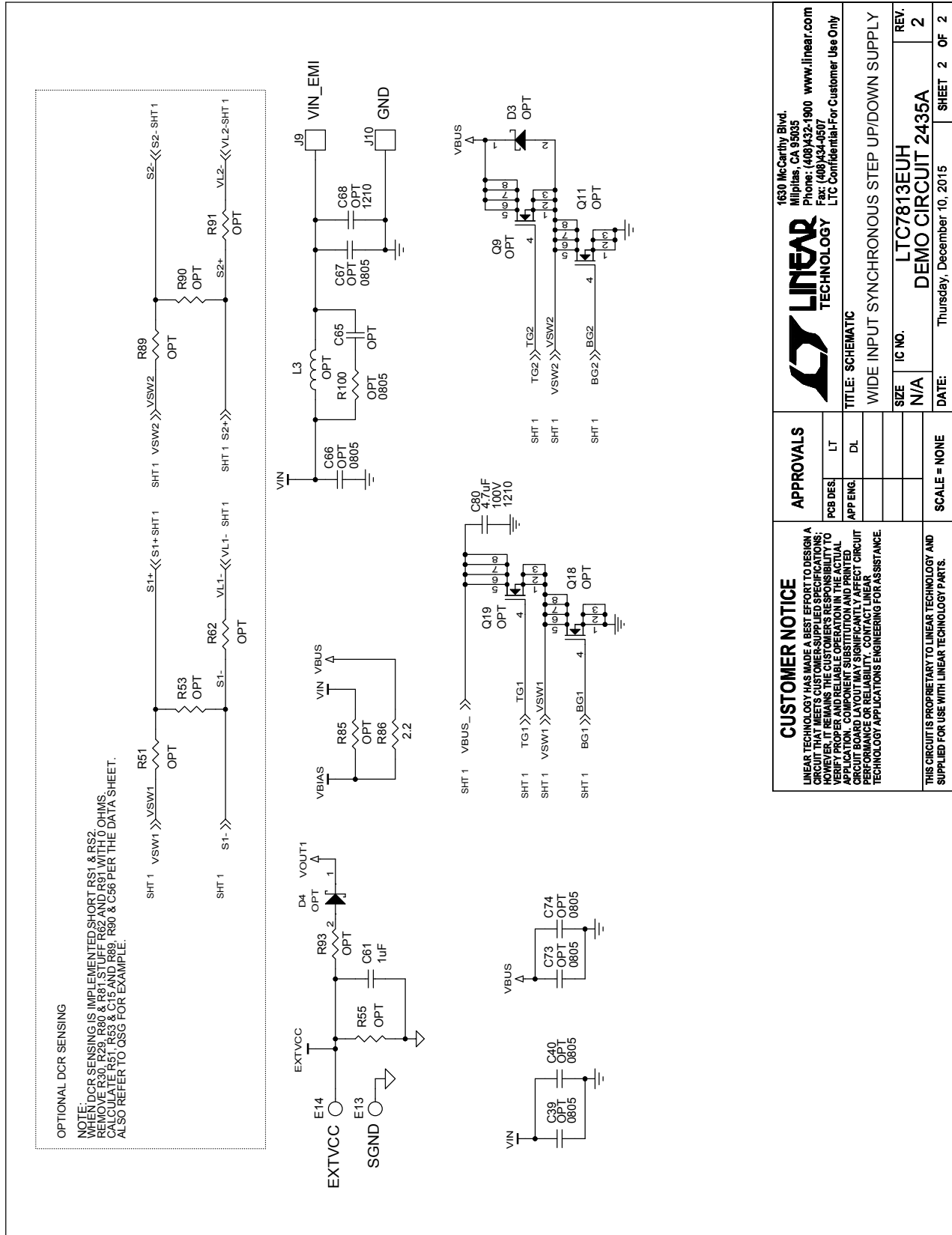
DESIGNER	DATE	APPROVED
LT		
DL		

**TITLE** SCHEMATIC  
**WIDE INPUT SYNCHRONOUS STEP-UP/DOWN SUPPLY**  
**IC NO.** LTC7813EUH  
**SCALE** NONE  
**DATE** Thursday, December 10, 2015  
**SHEET** 1 OF 2

ASSY	U001	VBUS	E7	ES	ES5	ES11	ES2	ES2	ES2	ES2	ES2
-A	20V	20V	24V	17.4AN	63.4K	4.97K	0	0	0	0	0
-B	20V	20V	24V	17.4AN	63.4K	4.97K	0	0	0	0	0
-C	5V/80A	24V	17.4AN	63.4K	4.97K	0	0	0	0	0	0

NOTE: UNLESS OTHERWISE SPECIFIED  
1. ALL RESISTORS AND CAPACITORS ARE 0603.

SCHEMATIC DIAGRAM



<b>CUSTOMER NOTICE</b>		<b>APPROVALS</b>		1630 McCarthy Blvd. Milpitas, CA 95035 Phone: (408)422-1900 www.linear.com Fax: (408)434-0507 LTC Confidential-For-Customer-Use Only	
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THIS CIRCUIT IS PROPRIETARY TO LINEAR TECHNOLOGY AND SUPPLIED FOR USE WITH LINEAR TECHNOLOGY PARTS.		APP ENG.	DL	WIDE INPUT SYNCHRONOUS STEP UP/DOWN SUPPLY	
		SCALE = NONE		SIZE	REV.
				N/A	LTC7813EUH
				DATE:	DEMO CIRCUIT 2435A
				Thursday, December 10, 2015	REV. 2
				SHEET 2	OF 2

# DEMO MANUAL DC2435A-A/ DC2435A-B/DC2435A-C

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