

## LTC3892EFE-1 PolyPhase High $V_{OUT}$ Synchronous Buck Converter

### DESCRIPTION

Demonstration circuit 2190A is a high output voltage, high efficiency synchronous PolyPhase<sup>®</sup> buck converter featuring the LTC<sup>®</sup>3892EFE-1. This demo circuit is available in two versions. The input voltage range of both versions is from 16V to 55V. The DC2190A-A is configured using two each LTC3892EFE-1 devices with 4-phase interleaving operation which provides a 12V/60A output, while the DC2190A-B is configured using one LTC3892EFE-1 device with 2-phase interleaving operation which provides a 12V/30A output.

Both boards have a mode selection jumper that allows the converter to run in forced CCM mode, pulse-skip mode or Burst Mode<sup>®</sup> operation. Synchronization to an external clock (frequency range 100kHz to 300kHz) is also possible on this board.

The demo circuit senses inductor current with a sense resistor but also has an optional DCR sense circuit that allows using the inductor's DCR as the current sensing element to save cost, footprint and improve efficiency.

The LTC3892EFE-1 data sheet gives a complete description of these parts, operation and application information and must be read in conjunction with this quick start guide for DC2190A.

**Design files for this circuit board are available at <http://www.linear.com/demo/DC2190A>**

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### PERFORMANCE SUMMARY

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

#### DC2190A-B

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
$V_{IN}$	Input Supply Range		16		55	V
$V_{OUT}$	Output Voltage Range	$V_{IN} = 16\text{V to } 55\text{V}$ , $I_{OUT} = 0\text{A to } 30\text{A}/2\text{-Phase}$	11.8	12	12.2	V
$f_{SW}$	Typical Free Running Switching Frequency			140		kHz
Efficiency	2-Phase Efficiency See Figure 3 for Efficiency Curves	$V_{IN} = 48\text{V}$ , $V_{OUT1} = 12\text{V}$ , $I_{OUT} = 30\text{A}$		97.2		%

#### DC2190A-A

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
$V_{IN}$	Input Supply Range		16		55	V
$V_{OUT}$	Output Voltage Range	$V_{IN} = 16\text{V to } 55\text{V}$ , $I_{OUT} = 0\text{A to } 60\text{A}/4\text{-Phase}$	11.8	12	12.2	V
$f_{SW}$	Typical Free Running Switching Frequency			140		kHz
Efficiency	4-Phase Efficiency See Figure 4 for Efficiency Curves	$V_{IN} = 48\text{V}$ , $V_{OUT1} = 12\text{V}$ , $I_{OUT} = 60\text{A}$		97.2		%

# DEMO MANUAL

## DC2190A-A/DC2190A-B

### QUICK START PROCEDURE

Demonstration circuit DC2190A is easy to set up to evaluate the performance of the LTC3892-1. Refer to Figure 1 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 2 for proper scope probe technique.

1. Place jumpers in the following positions:

**JP1:** Int. SYNC

**JP2:** ON

**JP3:** Int. (DC2190A-A Only)

2. With power off, connect the input power supply to  $V_{IN}$  and GND. Connect the load to the output. The load current should be smaller than 60A for DC2190A-A and smaller than 30A for DC2190A-B.

3. Turn on the power at the input.

**NOTE:** Make sure that the input voltage is between 16V and 55V.

4. Check for the proper output voltages.

$$V_{OUT} = 11.8V \text{ to } 12.2V$$

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

5. 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.

### FREQUENCY SYNCHRONIZATION AND MODE SELECTION

The DC2190A's mode selector allows the converter to run in FCC operation, pulse-skip operation, Burst Mode or be synchronizing to an external clock by changing the position of JP1 and JP3.

For synchronizing to an external clock source, apply the external clock from SYNC turret to GND.

Refer to Table 1 and to the data sheet for more details.

**Table 1. Mode Selection and Synchronizing Operation Options**

CONFIGURATION	JP1	JP3 (DC2190A-A ONLY)
Forced Continuous Conduction Operation	Int. SYNC	Int.
Pulse-Skip Mode Operation	Ext. SYNC/ Pulse-Skip.	Ext./Pulse-Skip
Burst Mode Operation	Burst	Ext./Pulse-Skip
Synchronize to Ext. Clock (Ext. Clock Apply to SYNC Turret)	Ext. SYNC/ Pulse-Skip	Ext./Pulse-Skip

### OPTIONAL INDUCTOR DCR CURRENT SENSING

Demonstration circuit 2190A 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 with sufficiently high saturation current or use an iron powder type material.

Refer to Table 2 for optional inductor DCR current sensing setup and to the data sheet for more details.

### POWER THE EXTV<sub>CC</sub> FROM EXTERNAL SUPPLY

The DC2190A EXTV<sub>CC</sub> turret is tied to the 12V  $V_{OUT}$  by default. To power the EXTV<sub>CC</sub> from external supply:

1. Remove the R7.
2. Solder a 16V, 1 $\mu$ F MLCC between EXTV<sub>CC</sub> and GND turret.
3. Apply a DC voltage (<14V) between the EXTV<sub>CC</sub> and GND turret, after the input voltage is established. Ensure that  $EXTV_{CC} \leq V_{IN}$ .

### QUICK START PROCEDURE

**Table 2. Optional Inductor DCR Current Sensing**

Configuration	CHANNEL1	RS1	R18	R20	C13	C29	R23	R26	R24
	CHANNEL2	RS2	R17	R19	C12	C28	R22	R25	R21
	CHANNEL3	RS3	R63	R64	C63	C45	R77	R79	R65
	CHANNEL4	RS4	R66	R67	C57	C48	R53	R54	R55
Current Sense Resistor (Default)		Ref. Sch.	Ref. Sch.	Ref. Sch.	Ref. Sch.	Open	Open	Open	Open
Inductor DCR Current Sensing		0Ω Copper	Open	Open	Ref. Sch.	Calculated Value from Data Sheet		0Ω	

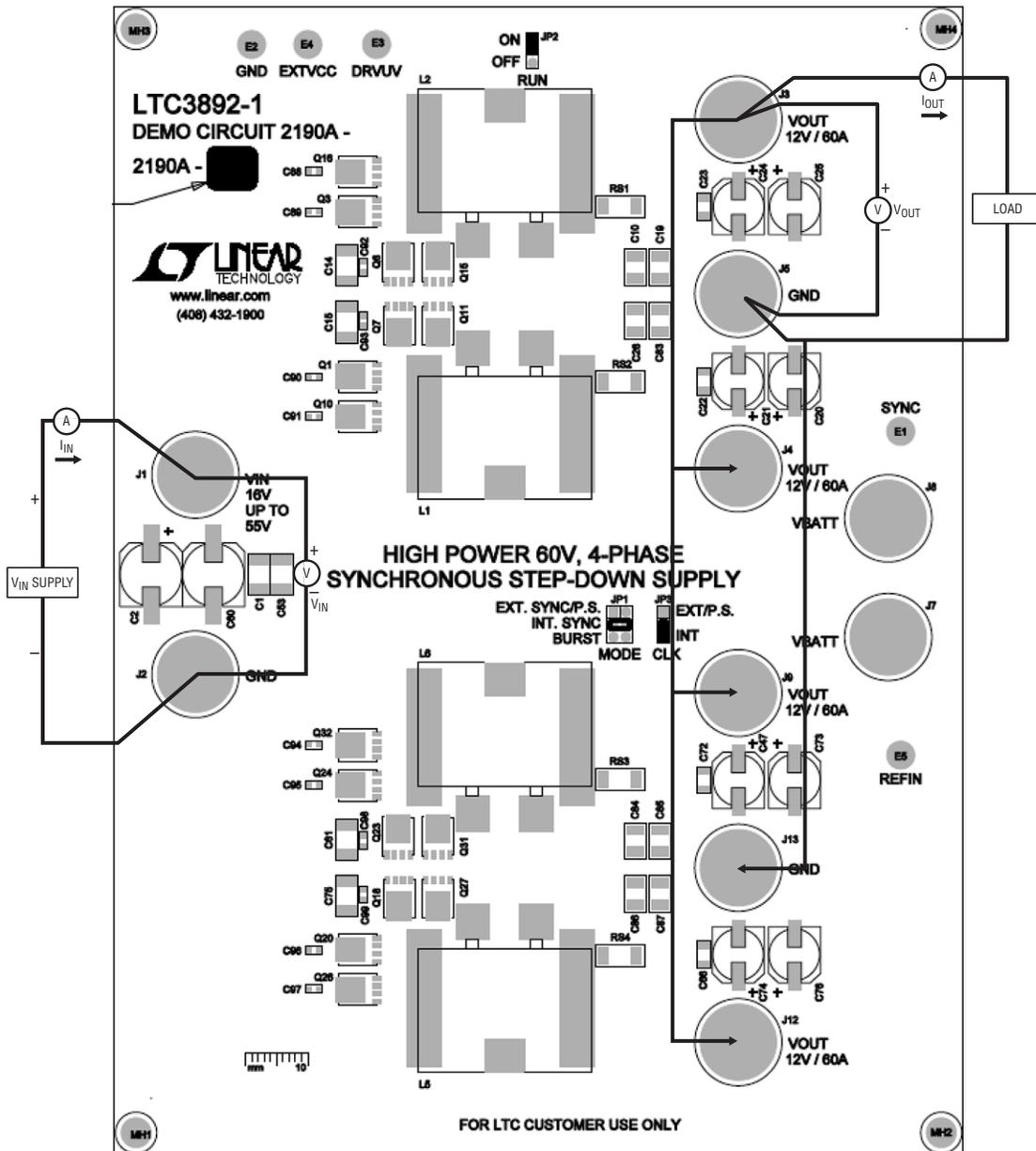


Figure 1. Proper Measurement Equipment Setup

### QUICK START PROCEDURE

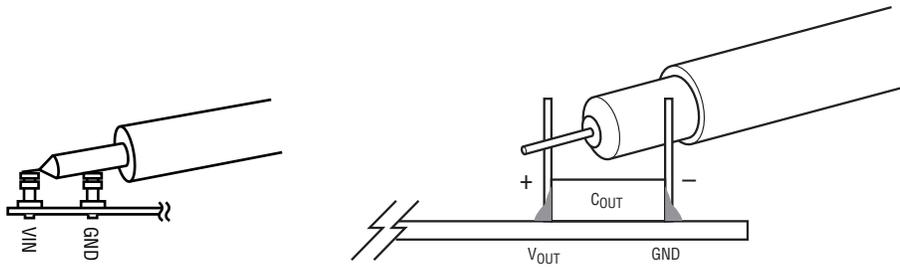
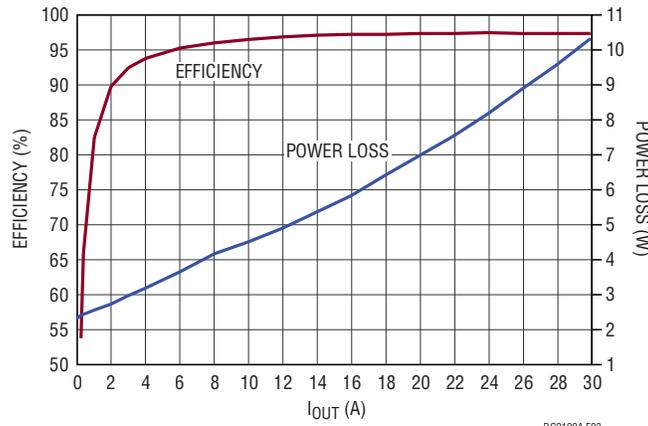
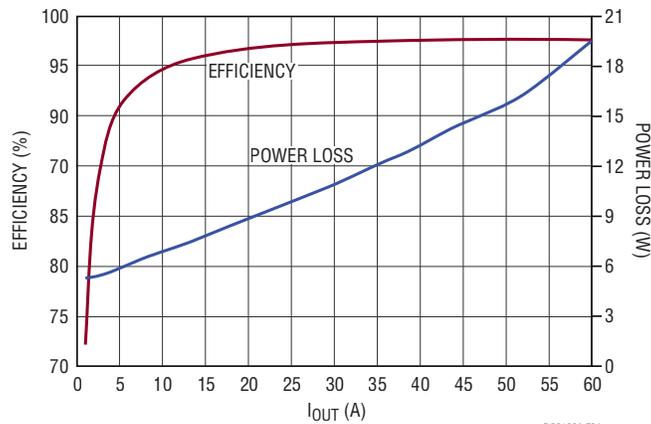


Figure 2. Measuring Input or Output Ripple Across Terminals or Directly Across Bulk Capacitor



DC2190A F03

Figure 3. Typical Efficiency vs Load Current (DC2190A-B, 2-Phase Solution,  $V_{IN} = 48V$ )



DC2190A F04

Figure 3. Typical Efficiency vs Load Current (DC2190A-A, 4-Phase Solution,  $V_{IN} = 48V$ )

### PARTS LIST DC2190A-A

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>DC2190A-A Required Circuit Components</b>				
1	10	C1, C14, C15, C16, C17, C53, C54, C55, C61, C75	CAP, 1812 2.2µF 10% 100V X7R	TDK C4532X7R2A225K
2	2	C2, C60	CAP, 100µF 20% 63V ELEC	SUN ELECT. 63CE100KX
3	2	C3, C49	CAP, 0805 0.1µF 10% 100V X7R	TDK C2012X7R2A104K
4	2	C4, C64	CQP, 0805 4.7µF 10% 16V X7R	AVX, 0805YC475KAT2A
4	8	C5, C32, C33, C39, C67, C78, C79, C80	CAP, 0603 0.1µF 10% 50V X7R	TDK C1608X7R1H104K
6	1	C6	CAP, 0603 470pF 10% 50V X7R	MURATA GRM188R71H471KA01D
7	1	C7	CAP, 0603 10pF 5% 50V NPO	AVX, 06035A100JAT2A
8	3	C8, C46, C62	CAP, 0603 47pF 5% 100V NPO	AVX 06031A470JAT2A
9	2	C9, C34	CAP, 0603 10nF 10% 100V X7R	AVX, 06031C103KAT2A
10	2	C11, C68	CAP, 0603 0.1µF 10% 100V X7R	MURATA GRM188R72A104KA35D
11	4	C12, C13, C57, C63	CAP, 0603 2.2pF 10% 100V NPO	AVX, 06031A2R2KAT2A
12	4	C18, C27, C59, C71	CAP, 0603 1µF 10% 16V X7R	AVX, 0603YC105KAT2A
13	4	C20, C25, C73, C76	CAP, 150µF 20% 16V ALUM	PANASONIC 16SVPC150M
14	4	C22, C23, C66, C72	CAP, 1206 10µF 10% 16V X7R	AVX, 1206YC106KAT2A
15	4	C30, C31, C51, C58	CAP, 0603 0.22µF 10% 25V X5R	AVX 06033D224KAT2A
16	2	C35, C36	CAP, 0603 1nF 10% 25V X7R	AVX 06033C102KAT2A
17	1	C37	CAP, 0603 100pF 10% 100V NPO	AVX, 06031A101KAT2A
18	2	C40, C100	CAP, 33µF 20% 63V ELEC	SUN ELECT., 63HVH33M
19	1	C69	CAP, 0603 4.7nF 10% 25V X7R	AVX, 06033C472KAT2A
20	27	R7, R12, R16, R17, R18, R27, R28, R44, R45, R49, R51, R57, R60, R64, R67, R74, R76, R80, R81, C81, R82, C82, R83, R84, R85, R89, R90	RES, 0603 0Ω JUMPER	VISHAY CRCW06030000Z0EA
21	4	L1, L2, L5, L6	IND, 10µH	COILCRAFT SER2918H-103
22	8	Q1, Q2, Q3, Q4, Q17, Q20, Q22, Q24	XSTR, MOSFET N-CH 80V 100A TDSO8	INFINEON BSC123N08NS3 G
23	8	Q5, Q6, Q7, Q8, Q18, Q19, Q21, Q23	XSTR, MOSFET N-CH 80V 100A TDSO8	INFINEON BSC042NE7NS3
24	4	RS1, RS2, RS3, RS4	RES, 2010 0.003Ω 1% 1W	VISHAY WSL20103L000FEA18
25	2	R_PRG1, R_PRG	RES, 0603 29.4k 1% 1/10W	VISHAY, CRCW060329K4FKEA
26	2	R1, R62	RES. 1206 2.2Ω 1% 1/4W	VISHAY CRCW12062R20FKEA
27	1	R8	RES, 0603 100k 5% 1/10W	VISHAY CRCW0603100KJNEA
28	1	R9	RES, 0805 499k 1% 1/8W	VISHAY, CRCW0805499KFKEA
29	3	R10, R33, R37	RES, 0603 10Ω 1% 1/10W	VISHAY CRCW060310R0FKEA
30	1	R11	RES, 0603 35.7k 1% 1/10W	VISHAY CRCW060335K7FKEA
31	1	R14	RES, 0603 1.5k 1% 1/10W	VISHAY CRCW06031K50FKEA
32	4	R19, R20, R63, R66	RES, 0603 100Ω 5% 1/10W	VISHAY, CRCW0603100RJNEA
33	2	R30, R48	RES, 0603 90.9k 1% 1/10W	VISHAY CRCW060390K9FKEA
34	5	R32, R35, R38, R39, R40	RES, 0603 10k 1% 1/10W	VISHAY CRCW060310K0FKEA
35	4	R34, R43, R52, R86	RES, 2010 0.001Ω 1% 1W	VISHAY, WSL20101L000FEA18
36	2	R36, R41	RES, 0603 392k 1% 1/10W	VISHAY CRCW0603392KFKEA

# DEMO MANUAL

## DC2190A-A/DC2190A-B

### PARTS LIST DC2190A-A

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
37	1	R42	RES, 0603 3.3k 5% 1/10W	VISHAY CRCW06033K30JNEA
38	2	U1, U4	IC, DUAL OUTPUT HIGH VOLTAGE STEP-DOWN CONVERTER	LINEAR TECH. LTC3892EFE-1#PBF
39	0	C70	CAP, 100µF 20% 63V ELEC OPTION	SUN ELECT., 63CE100KX OPTION

#### DC2190A-A Additional Demo Board Circuit Components

40	1	U2	IC, HIGH VOLTAGE BIDIRECTIONAL CURRENT SENSE AMP	LINEAR TECH. LT1999CS8-10#PBF
41	1	U5	IC, OP AMP, COMPARATOR AND REFERENCE	LINEAR TECH. LTC1541CMS8#PBF
42	1	U6	IC, DUAL AND QUAD, SINGLE SUPPLY, PRECISION OP AMPS	LINEAR TECH. LT2078CS8#PBF
43	1	U7	IC, LOW POWER DUAL COMPARATORS WITH REFERENCE	LINEAR TECH. LTC1843CS8#PBF
44	1	U8	IC, MULTIPHASE OSCILLATOR WITH SPREAD SPECTRUM FREQUENCY MODULATION	LINEAR TECH. LTC6902CMS#PBF
45	0	Q9, Q10, Q11, Q12, Q13, Q14, Q15, Q16, Q25, Q26, Q27, Q28, Q29, Q30, Q31, Q32	XSTR, MOSFET OPTION	OPTION
46	1	Q33	XSTR, SMALL SIGNAL, NPN	DIODES INC. MMBT3904
47	0	Q34, R50, R59, R61	DO NOT STUFF	NONE
48	0	R2, R3, R4, R5, R13, R21, R22, R23, R24, R25, R26, R29, R31, R46, R53, R54, R55, R56, R65, R71, R72, R73, R77, R78, R79	RES, 0603 OPTION	OPTION
49	0	D1, D2, D3	DIODE, SCHOTTKY 30V, 100mA OPTION	CENTRAL SEMI CMDSH-3-TR OPTION
50	1	D4	DIODE, ZENER 5.1V	DIODES INC. MMSZ5231BS
51	0	L3, L4, L7, L8	IND, OPTION	OPTION
52	0	C28, C29, C45, C48, C50, C52, C56, C65, C77, C88, C89, C90, C91, C92, C93, C94, C95, C96, C97, C98, C99	CAP, 0603 OPTION	OPTION
53	0	C10, C19, C26, C38, C83, C84, C85, C86, C87	CAP, 1210 OPTION	OPTION
54	0	C21, C24, C41, C42, C43, C44, C47, C74	CAP, 150µF 20% 16V ALUM OPTION	PANASONIC 16SVPC150M OPTION
55	0	R47, R58	RES, 0603 10k 1% 1/10W OPTION	VISHAY CRCW060310K0FKEA OPTION

#### DC2190A-A Hardware

56	5	E1, E2, E3, E4, E5	TURRET	MIIL-MAX 2501-2-00-80-00-00-07-0
57	1	JP1	HEADER, 3-PIN, DBL ROW 2mm	SULLINS, NRPNO32PAEN-RC
58	2	JP2, JP3	HEADER, 2mm, 3-PIN	SULLINS, NRPNO31PAEN-RC
59	10	J1, J2, J3, J4, J5, J7, J8, J9, J12, J13	STUD, TESTPIN	PEM KFH-032-10
60	10		LUG RING, #10	KEYSTONE 8205
61	3	XJP1, XJP2, XJP3	SHUNT, 2mm	SAMTEC 2SN-BK-G
62	10		WASHER, #10 TIN PLATED BRASS	ANY #10 EXT BZ TN
63	4	MH1, MH2, MH3, MH4	STANDOFF, SNAP ON	KEYSTONE_8831
64	20		NUT, BRASS 10-32	ANY #10-32

# DEMO MANUAL

## DC2190A-A/DC2190A-B

### PARTS LIST DC2190A-B

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>DC2190A-B Required Circuit Components</b>				
1	5	C1, C14, C15, C16, C17	CAP, 1812 2.2μF 10% 100V X7R	TDK C4532X7R2A225K
2	1	C2	CAP, 100μF 20% 63V ELEC	SUN ELECT. 63CE100KX
3	1	C3	CAP, 0805 0.1μF 10% 100V X7R	TDK C2012X7R2A104K
4	1	C4	CQP, 0805 4.7μF 10% 16V X7R	AVX, 0805YC475KAT2A
5	7	C5, C32, C33, C39, C78, C79, C80	CAP, 0603 0.1μF 10% 50V X7R	TDK C1608X7R1H104K
6	1	C6	CAP, 0603 470pF 10% 50V X7R	MURATA GRM188R71H471KA01D
7	1	C7	CAP, 0603 15pF 5% 50V C0G	AVX 06035A150JAT4A
8	1	C8	CAP, 0603 47pF 5% 100V NPO	AVX 06031A470JAT2A
9	2	C9, C34	CAP, 0603 10nF 10% 100V X7R	AVX, 06031C103KAT2A
10	1	C11	CAP, 0603 0.1μF 10% 100V X7R	MURATA GRM188R72A104KA35D
11	2	C12, C13	CAP, 0603 2.2pF 10% 100V NPO	AVX, 06031A2R2KAT2A
12	2	C18, C27	CAP, 0603 1μF 10% 16V X7R	AVX, 0603YC105KAT2A
13	2	C20, C25	CAP, 150μF 20% 16V ALUM	PANASONIC 16SVPC150M
14	2	C22, C23	CAP, 1206 10μF 10% 16V X7R	AVX, 1206YC106KAT2A
15	2	C30, C31	CAP, 0603 0.22μF 10% 25V X5R	AVX 06033D224KAT2A
16	2	C35, C36	CAP, 0603 1nF 10% 25V X7R	AVX 06033C102KAT2A
17	1	C37	CAP, 0603 100pF 10% 100V NPO	AVX, 06031A101KAT2A
18	2	C40, C100	CAP, 33μF 20% 63V ELEC	SUN ELECT., 63HVH33M
19	1	C69	CAP, 0603 4.7nF 10% 25V X7R	AVX, 06033C472KAT2A
20	19	R7, R12, R16, R17, R18, R27, R28, R44, R45, R49, R81, C81, R82, C82, R83, R84, R85, R89, R90	RES, 0603 0Ω JUMPER	VISHAY CRCW06030000Z0EA
21	4	Q1, Q2, Q3, Q4	XSTR, MOSFET N-CH 80V 100A TDSO8	INFINEON BSC123N08NS3G
22	4	Q5, Q6, Q7, Q8	XSTR, MOSFET N-CH 80V 100A TDSO8	INFINEON BSC042NE7NS3
33	2	L1, L2	IND, 10μH	COILCRAFT SER2918H-103
24	2	RS1, RS2	RES, 2010 0.003Ω 1% 1W	VISHAY WSL20103L000FEA18
25	1	R_PRG	RES, 0603 29.4k 1% 1/10W	VISHAY, CRCW060329K4FKEA
26	1	R1	RES. 1206 2.2Ω 1% 1/4W	VISHAY CRCW12062R20FKEA
27	1	R8	RES, 0603 100k 5% 1/10W	VISHAY CRCW0603100KJNEA
28	1	R9	RES, 0805 499k 1% 1/8W	VISHAY, CRCW0805499KFKEA
29	3	R10, R33, R37	RES, 0603 10Ω 1% 1/10W	VISHAY CRCW060310R0FKEA
30	1	R11	RES, 0603 35.7k 1% 1/10W	VISHAY CRCW060335K7FKEA
31	1	R14	RES, 0603 4.02k 1% 1/10W	VISHAY CRCW06034K02FKEA
32	2	R19, R20	RES, 0603 100Ω 5% 1/10W	VISHAY, CRCW0603100RJNEA
33	1	R30	RES, 0603 90.9k 1% 1/10W	VISHAY CRCW060390K9FKEA
34	5	R32, R35, R38, R39, R40	RES, 0603 10k 1% 1/10W	VISHAY CRCW060310K0FKEA
35	4	R34, R43, R52, R86	RES, 2010 0.001Ω 1% 1W	VISHAY, WSL20101L000FEA18
36	2	R36, R41	RES, 0603 392k 1% 1/10W	VISHAY CRCW0603392KFKEA
37	1	R42	RES, 0603 3.3k 5% 1/10W	VISHAY CRCW06033K30JNEA
38	1	U1	IC, DUAL OUTPUT HIGH VOLTAGE STEP-DOWN CONVERTER	LINEAR TECH. LTC3892EFE-1#PBF

# DEMO MANUAL

## DC2190A-A/DC2190A-B

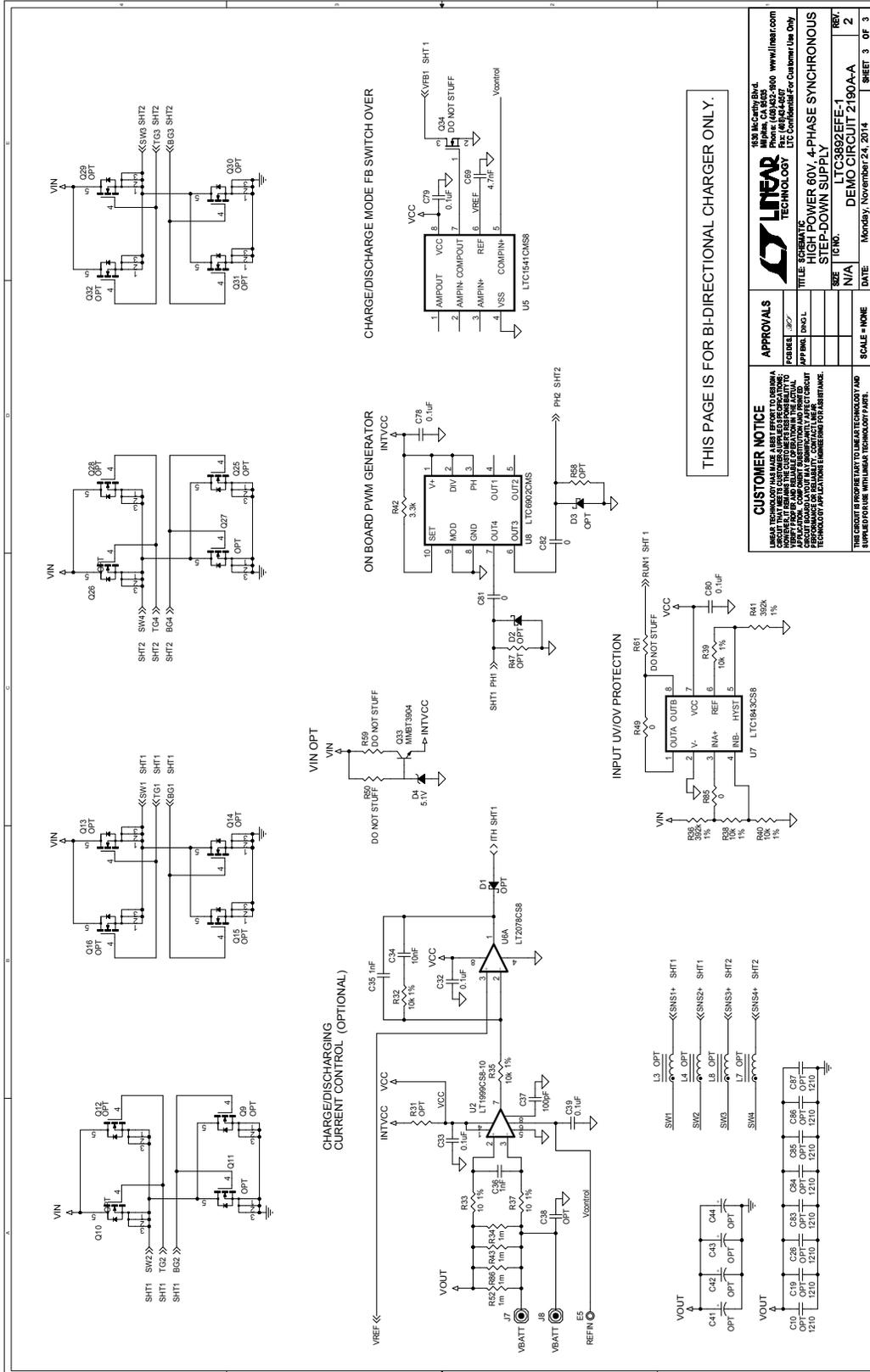
### PARTS LIST DC2190A-B

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>DC2190A-B Additional Demo Board Circuit Components</b>				
39	0	C10, C19, C26, C38, C83, C84, C85, C86, C87	CAP, 1210 OPTION	OPTION
40	0	C28, C29, C56, C77, C88, C89, C90, C91, C92, C93	CAP, 0603 OPTION	OPTION
41	0	L3, L4, L7, L8	IND, OPTION	OPTION
42	0	D1, D2, D3	DIODE, SCHOTTKY 30V, 100mA OPTION	CENTRAL SEMI CMDSH-3-TR OPTION
43	1	D4	DIODE, ZENER 5.1V	DIODES INC. MMSZ5231BS
44	0	C21, C24, C41, C42, C43, C44	CAP, 150µF 20% 16V ALUM OPTION	PANASONIC 16SVPC150M OPTION
45	0	Q9, Q10, Q11, Q12, Q13, Q14, Q15, Q16, Q25, Q26, Q27, Q28, Q29, Q30, Q31, Q32	XSTR, MOSFET OPTION	OPTION
46	1	Q33	XSTR, SMALL SIGNAL, NPN	DIODES INC. MMBT3904-7-F
47	0	Q34, R50, R59, R61	DO NOT STUFF	NONE
48	0	R2, R3, R4, R5, R13, R21, R22, R23, R24, R25, R26, R29, R31, R46	RES, 0603 OPTION	OPTION
49	0	R47, R58	RES, 0603 10k 1% 1/10W OPTION	VISHAY CRCW060310K0FKEA OPTION
50	1	U2	IC, HIGH VOLTAGE BIDIRECTIONAL CURRENT SENSE AMP	LINEAR TECH. LT1999CS8-10#PBF
51	1	U5	IC, MICROPOWER OP AMP, COMPARATOR AND REFERENCE	LINEAR TECH. LTC1541CMS8#PBF
52	1	U6	IC, DUAL AND QUAD, SINGLE SUPPLY, PRECISION OP AMPS	LINEAR TECH. LT2078CS8#PBF
53	1	U7	IC, LOW POWER DUAL COMPARATORS WITH REFERENCE	LINEAR TECH. LTC1843CS8#PBF
54	1	U8	IC, MULTIPHASE OSCILLATOR W/SPREAD SPECTRUM FREQUENCY MODULATION	LINEAR TECH. LTC6902CMS#PBF
<b>DC2190A-B Hardware</b>				
55	7		WASHER, #10 TIN PLATED BRASS	ANY #10 EXT BZ TN
56	2	XJP1, XJP2	SHUNT, 2mm	SAMTEC 2SN-BK-G
57	4	MH1, MH2, MH3, MH4	STANDOFF, SNAP ON	KEYSTONE_8831
58	14		NUT, BRASS 10-32	ANY #10-32
59	5	E1, E2, E3, E4, E5	TURRET	MIIL-MAX 2501-2-00-80-00-00-07-0
60	1	JP1	HEADER, 3-PIN, DBL ROW 2mm	SULLINS, NRPNO32PAEN-RC
61	1	JP2	HEADER, 2mm, 3-PIN	SULLINS, NRPNO31PAEN-RC
62	7	J1, J2, J3, J4, J5, J7, J8	STUD, TESTPIN	PEM KFH-032-10
63	7		LUG RING, #10	KEYSTONE 8205





### SCHEMATIC DIAGRAM



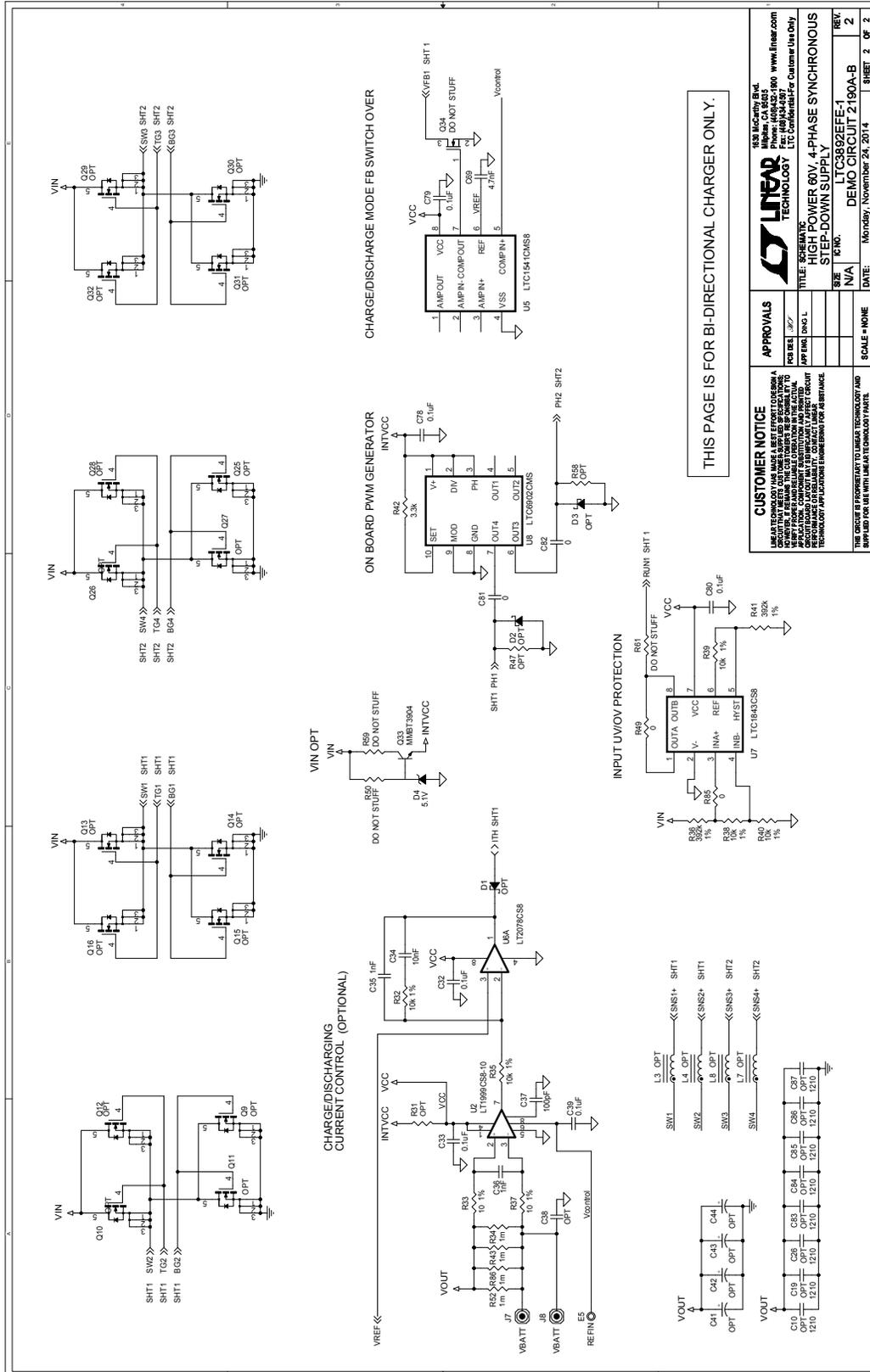
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<b>CUSTOMER NOTICE</b>		<b>APPROVALS</b>	
LINEAR TECHNOLOGY HAS MADE A BEST EFFORT TO DESIGN AND DEVELOP THIS SCHEMATIC FOR THE CUSTOMER'S USE. THE CUSTOMER IS RESPONSIBLE TO VERIFY THE SCHEMATIC'S ACCURACY AND TO PROVIDE THE NECESSARY INFORMATION TO LINEAR TECHNOLOGY TO ENSURE THE SCHEMATIC'S PERFORMANCE IS AS SPECIFIED. CONTACT LINEAR TECHNOLOGY FOR APPLICATIONS ENGINEERING FOR ASSISTANCE.		PCB DESIGNED BY: [ ] APP'D BY: [ ] DATE: [ ]	
LINEAR TECHNOLOGY HAS MADE A BEST EFFORT TO DESIGN AND DEVELOP THIS SCHEMATIC FOR THE CUSTOMER'S USE. THE CUSTOMER IS RESPONSIBLE TO VERIFY THE SCHEMATIC'S ACCURACY AND TO PROVIDE THE NECESSARY INFORMATION TO LINEAR TECHNOLOGY TO ENSURE THE SCHEMATIC'S PERFORMANCE IS AS SPECIFIED. CONTACT LINEAR TECHNOLOGY FOR APPLICATIONS ENGINEERING FOR ASSISTANCE.		TITLE: SCHEMATIC HIGH POWER 60V, 4-PHASE SYNCHRONOUS STEP-DOWN SUPPLY SIZE: 11x16 DEMO CIRCUIT 2190A-A SHEET 3 OF 3	

LINEAR TECHNOLOGY HAS MADE A BEST EFFORT TO DESIGN AND DEVELOP THIS SCHEMATIC FOR THE CUSTOMER'S USE. THE CUSTOMER IS RESPONSIBLE TO VERIFY THE SCHEMATIC'S ACCURACY AND TO PROVIDE THE NECESSARY INFORMATION TO LINEAR TECHNOLOGY TO ENSURE THE SCHEMATIC'S PERFORMANCE IS AS SPECIFIED. CONTACT LINEAR TECHNOLOGY FOR APPLICATIONS ENGINEERING FOR ASSISTANCE.		THE CIRCUIT IS PROPRIETARY TO LINEAR TECHNOLOGY AND SUPPLIED FOR USE WITH LINEAR TECHNOLOGY PARTS.	
VIN OPT SW1 SW2 SW3 SW4 C10 C11 C12 C13 C14 C15 C16 C17 C18 C19 C20 C21 C22 C23 C24 C25 C26 C27 C28 C29 C30 C31 C32 C33 C34 C35 C36 C37 C38 C39 C40 C41 C42 C43 C44 C45 C46 C47 C48 C49 C50 C51 C52 C53 C54 C55 C56 C57 C58 C59 C60 C61 C62 C63 C64 C65 C66 C67 C68 C69 C70 C71 C72 C73 C74 C75 C76 C77 C78 C79 C80 C81 C82 C83 C84 C85 C86 C87 C88 C89 C90 C91 C92 C93 C94 C95 C96 C97 C98 C99 C100 C101 C102 C103 C104 C105 C106 C107 C108 C109 C110 C111 C112 C113 C114 C115 C116 C117 C118 C119 C120 C121 C122 C123 C124 C125 C126 C127 C128 C129 C130 C131 C132 C133 C134 C135 C136 C137 C138 C139 C140 C141 C142 C143 C144 C145 C146 C147 C148 C149 C150 C151 C152 C153 C154 C155 C156 C157 C158 C159 C160 C161 C162 C163 C164 C165 C166 C167 C168 C169 C170 C171 C172 C173 C174 C175 C176 C177 C178 C179 C180 C181 C182 C183 C184 C185 C186 C187 C188 C189 C190 C191 C192 C193 C194 C195 C196 C197 C198 C199 C200 C201 C202 C203 C204 C205 C206 C207 C208 C209 C210 C211 C212 C213 C214 C215 C216 C217 C218 C219 C220 C221 C222 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C1351 C1352 C1353 C1354 C1355 C1356 C1357 C1358 C1359 C1360 C1361 C1362 C1363 C1364 C1365 C1366 C1367 C1368 C1369 C1370 C1371 C1372 C1373			



## SCHEMATIC DIAGRAM



# DEMO MANUAL

## DC2190A-A/DC2190A-B

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Тел: +7 (812) 336 43 04 (многоканальный)

Email: [org@lifeelectronics.ru](mailto:org@lifeelectronics.ru)