

# 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>

LT, LT, LTC, LTM, Linear Technology and the Linear logo, PolyPhase and Burst Mode are registered trademarks of Linear Technology Corporation. All other trademarks are the property of their respective owners.

### 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<br>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<br>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.

$V_{OUT} = 11.8V$  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<br>(DC2190A-A ONLY) |
|-------------------------------------------------------------|---------------------------|-------------------------|
| Forced Continuous Conduction Operation                      | Int. SYNC                 | Int.                    |
| Pulse-Skip Mode Operation                                   | Ext. SYNC/<br>Pulse-Skip. | Ext./Pulse-Skip         |
| Burst Mode Operation                                        | Burst                     | Ext./Pulse-Skip         |
| Synchronize to Ext. Clock (Ext. Clock Apply to SYNC Turret) | Ext. SYNC/<br>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 EXT $V_{CC}$ FROM EXTERNAL SUPPLY

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

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



QUICK START PROCEDURE

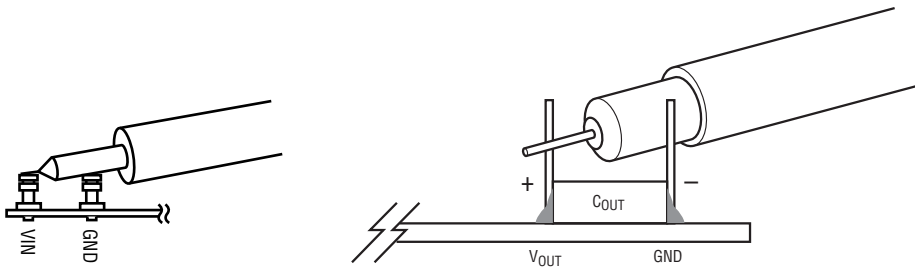
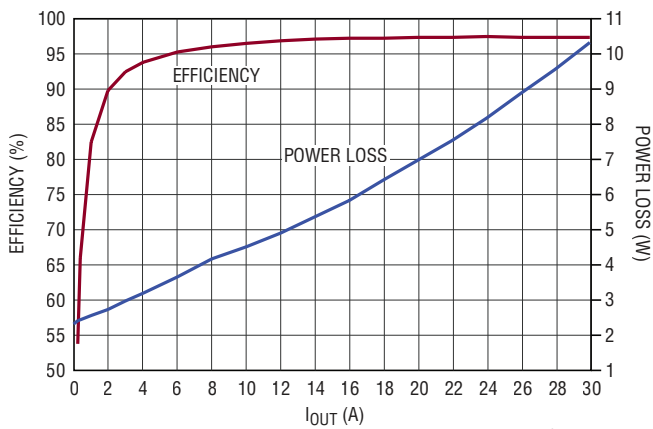
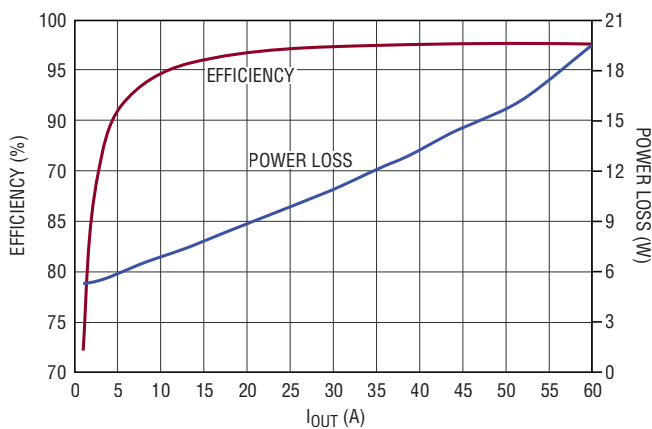


Figure 2. Measuring Input or Output Ripple Across Terminals or Directly Across Bulk Capacitor



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,  $V_{IN} = 48V$ )

# DEMO MANUAL

## DC2190A-A/DC2190A-B

### 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., 63HVB33M      |
| 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, NRPN032PAEN-RC          |
| 58 | 2  | JP2, JP3                                 | HEADER, 2mm, 3-PIN           | SULLINS, NRPN031PAEN-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 TDSO-8                | INFINEON BSC123N08NS3G        |
| 22                                           | 4   | Q5, Q6, Q7, Q8                                                                               | XSTR, MOSFET N-CH 80V 100A TDSO-8                | 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 |

dc2190afa

# DEMO MANUAL

## DC2190A-A/DC2190A-B

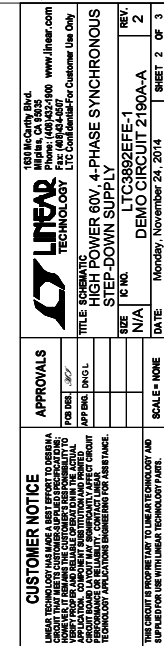
### PARTS LIST DC2190A-B

| 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, NRPN032PAEN-RC          |
| 61                                                        | 1   | JP2                                                                           | HEADER, 2mm, 3-PIN                                               | SULLINS, NRPN031PAEN-RC          |
| 62                                                        | 7   | J1, J2, J3, J4, J5, J7, J8                                                    | STUD, TESTPIN                                                    | PEM KFH-032-10                   |
| 63                                                        | 7   |                                                                               | LUG RING, #10                                                    | KEYSTONE 8205                    |

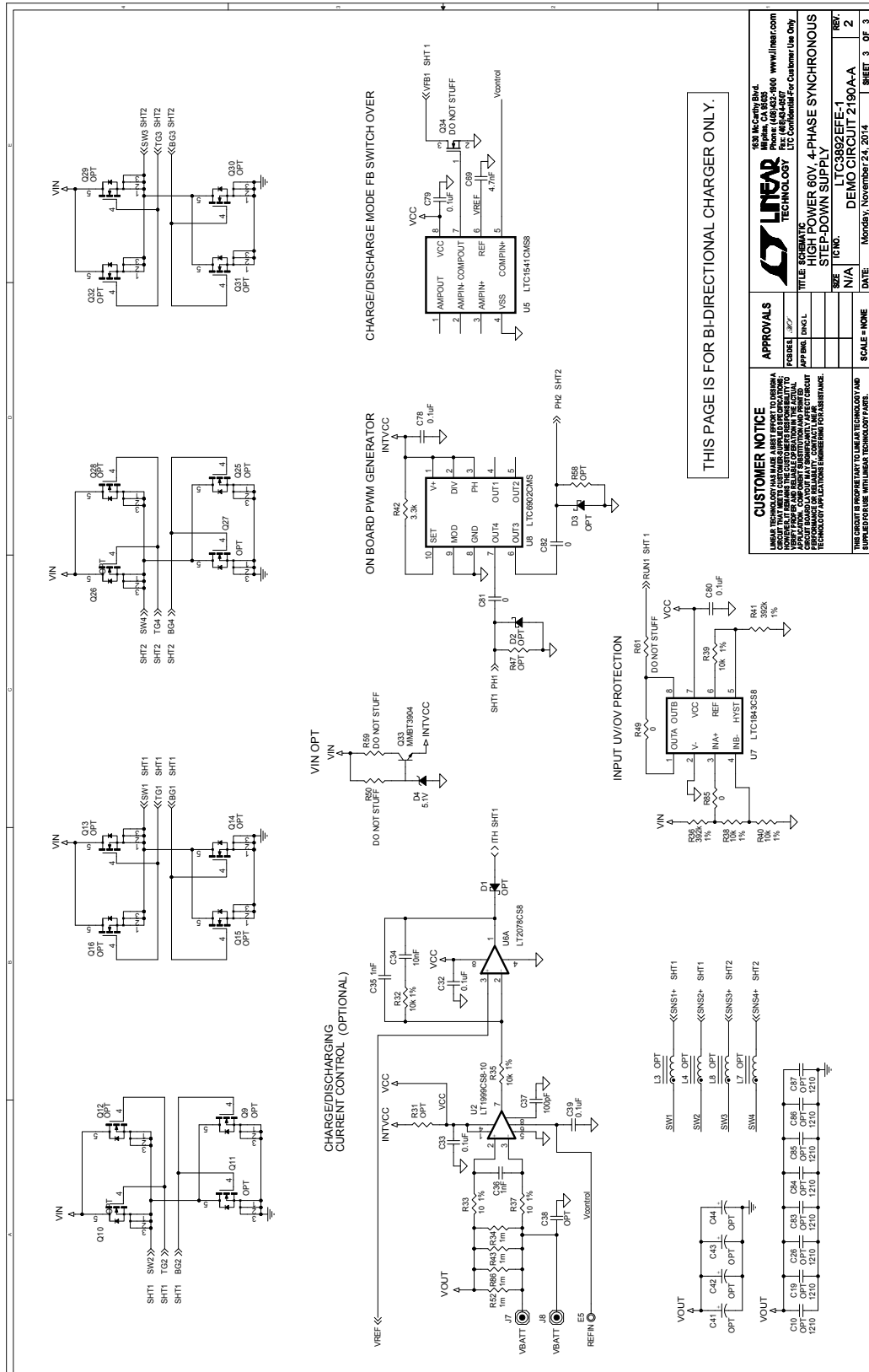
## SCHEMATIC DIAGRAM



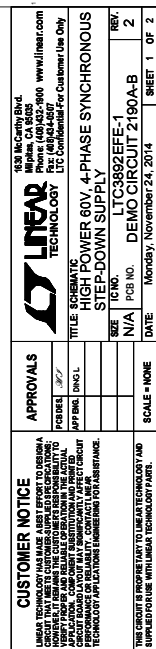
## SCHEMATIC DIAGRAM



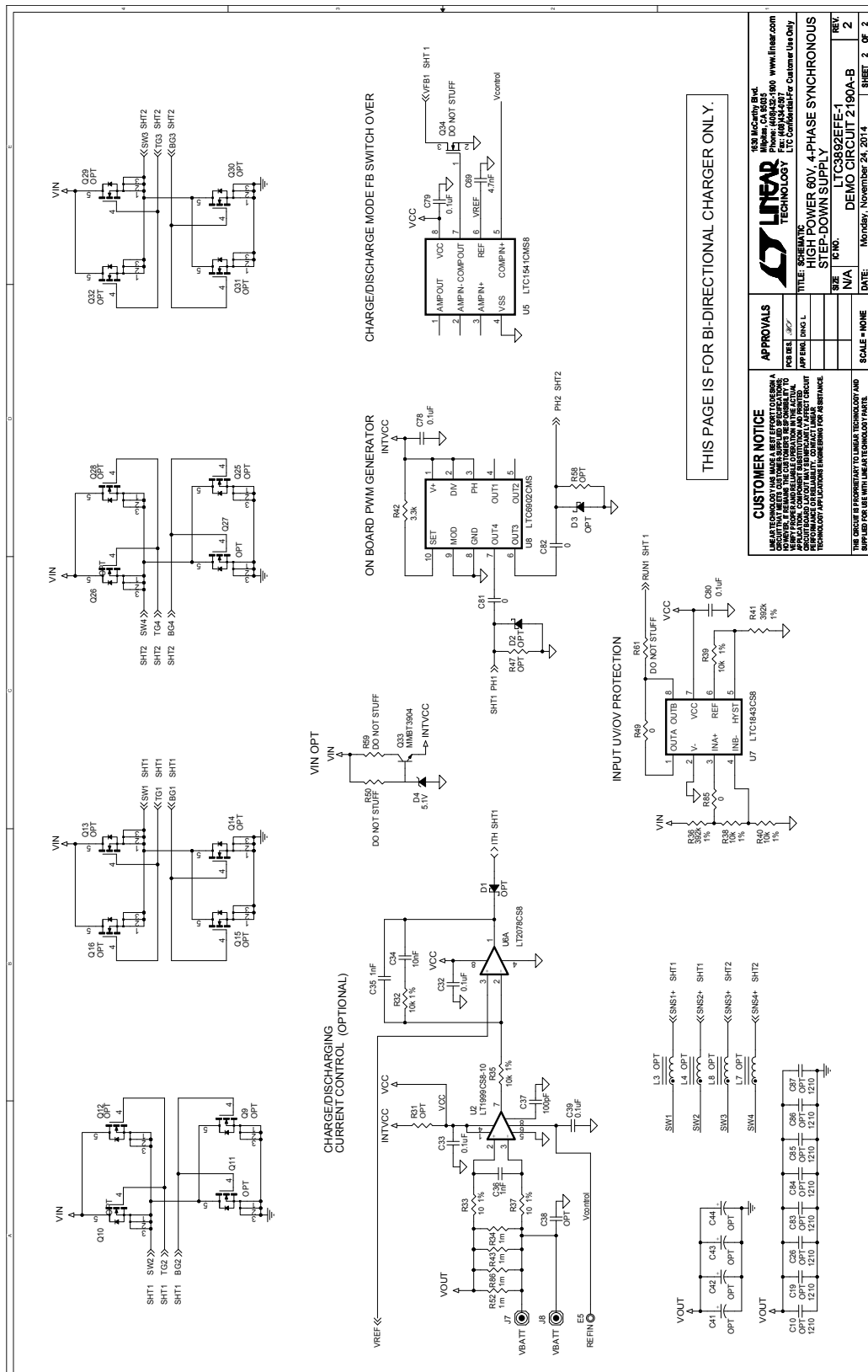
### SCHEMATIC DIAGRAM



## SCHEMATIC DIAGRAM



## SCHEMATIC DIAGRAM



# DEMO MANUAL

## DC2190A-A/DC2190A-B

---

### DEMONSTRATION BOARD IMPORTANT NOTICE

Linear Technology Corporation (LTC) provides the enclosed product(s) under the following **AS IS** conditions:

This demonstration board (DEMO BOARD) kit being sold or provided by Linear Technology is intended for use for **ENGINEERING DEVELOPMENT OR EVALUATION PURPOSES ONLY** and is not provided by LTC for commercial use. As such, the DEMO BOARD herein may not be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including but not limited to product safety measures typically found in finished commercial goods. As a prototype, this product does not fall within the scope of the European Union directive on electromagnetic compatibility and therefore may or may not meet the technical requirements of the directive, or other regulations.

If this evaluation kit does not meet the specifications recited in the DEMO BOARD manual the kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY THE SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. EXCEPT TO THE EXTENT OF THIS INDEMNITY, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user releases LTC from all claims arising from the handling or use of the goods. Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge. Also be aware that the products herein may not be regulatory compliant or agency certified (FCC, UL, CE, etc.).

No License is granted under any patent right or other intellectual property whatsoever. **LTC assumes no liability for applications assistance, customer product design, software performance, or infringement of patents or any other intellectual property rights of any kind.**

LTC currently services a variety of customers for products around the world, and therefore this transaction **is not exclusive**.

**Please read the DEMO BOARD manual prior to handling the product.** Persons handling this product must have electronics training and observe good laboratory practice standards. **Common sense is encouraged.**

This notice contains important safety information about temperatures and voltages. For further safety concerns, please contact a LTC application engineer.

Mailing Address:

Linear Technology  
1630 McCarthy Blvd.  
Milpitas, CA 95035

Copyright © 2004, Linear Technology Corporation

dc2190afa