

360W Isolated Forward Converter with Synchronous Rectification

DESCRIPTION

Demonstration circuit 2199A-B is a 360W isolated forward converter with synchronous rectification featuring the [LTC3765/LTC3766](#) chip-set. It produces a regulated 24V, 15A output from an input voltage range of 36V to 60V.

This circuit was designed to demonstrate the high levels of performance, efficiency, and small solution size attainable using these parts in an active-clamp-reset forward converter power supply, suitable for telecom, industrial, and other applications. It has a 4.7in² solution footprint area. Synchronous rectification helps to attain an efficiency

approaching 96%. Secondary-side control eliminates complex opto-coupler feedback, providing fast transient response with minimum output capacitance. For other output requirements, see the LTC3765 and LTC3766 data sheets or contact the LTC sales.

Design files for this circuit board are available at <http://www.linear.com/demo/DC2199A-B>

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PERFORMANCE SUMMARY Specifications are at T_A = 25°C

| SYMBOL | PARAMETER | CONDITIONS | MIN | TYP | MAX | UNITS |
|-----------------------------------|----------------------------------|---|-----|--------------------------|-----|-------------------|
| V _{IN} | Input Supply Range | | 36 | | 60 | V |
| V _{OUT} | Output Voltage | | | 24.0 | | V |
| I _{OUT} | Output Current Range, Continuous | 300LFM | 0 | | 15 | A |
| f _{SW} | Switching (Clock) Frequency | | | 200 | | kHz |
| V _{OUT(P-P)} | Output Ripple | V _{IN} = 48V, I _{OUT} = 30A (20MHz BW) | | 60 | | mV _{P-P} |
| I _{REG} | Output Regulation | Line and Load (36V _{IN} to 60V _{IN} , 0A _{OUT} to 15A _{OUT}) | | ±0.02 | | % |
| P _{OUT} /P _{IN} | Efficiency (See Figure 3) | V _{IN} = 48V, I _{OUT} = 15A | | 96 | | % |
| | Isolation | Basic | | 1500 | | VDC |
| | Approximate Solution Size | Component Area × Top Component Height | | 4.7in ² × 0.6 | | Inches |

OPERATING PRINCIPLES

The LTC3765 active clamp forward controller and gate driver is used on the primary and provides start-up, gate drive, and protection functions. Once start-up is accomplished, the LTC3766 high efficiency, secondary-side synchronous forward controller takes over, and provides the LTC3765 with timing information and bias power through a small pulse transformer.

When input voltage is applied, the LTC3765 commences soft-start of the output voltage. When the output reaches the RUN threshold, the LTC3766 comes alive and takes control by sending encoded PWM gate pulses to the LTC3765 through T2. These pulses also provide primary bias power efficiently over a wide input voltage range.

The transition from primary to secondary control occurs at some fraction of the nominal output voltage. From then on, operation and design is reduced to that of a simple

buck converter. Secondary control eliminates delays, tames large-signal overshoot, and reduces output capacitance needed to meet transient response requirements.

An optional LC filter stage on the input lowers RMS input current. The filter must have output impedance that is less than the converter input impedance to assure stability. This may require a damping impedance, which is provided by R1. (See Linear Technology Application Note 19 for a discussion of input filter stability.) R1 is coupled through a tiny 2mm × 2mm inductor L1, and provides damping with arbitrarily low source impedance. For bench testing, an electrolytic capacitor has been added at the input terminals to provide suitable ripple current capability. The values selected have a filter resonant frequency that is below the converter switching frequency, thus avoiding high circulating currents in the filter.

QUICK START PROCEDURE

Demonstration circuit 2199A-B is easy to set up to evaluate the performance of the LTC3765/LTC3766. Refer to Figure 1 for proper measurement equipment setup and follow the procedure below:

NOTE: When measuring the output voltage ripple, care must be taken to avoid a long ground lead on the oscilloscope probe. Measure the output voltage ripple by touching the probe tip and ground ring directly across the last output capacitor as shown in Figure 1.

1. Set an input power supply that is capable of 36V to 60V to 36V. Then turn off the supply.
2. Direct an airflow of 300LFM across the unit for sustained operation at full load.
3. With power off, connect the supply to the input terminals $+V_{IN}$ and $-V_{IN}$.
 - a. Input voltages lower than 36V can keep the converter from turning on due to the undervoltage lockout feature of the LTC3765/LTC3766.

- b. If efficiency measurements are desired, an ammeter capable of measuring 15ADC or a resistor shunt can be put in series with the input supply in order to measure the DC2199A-B's input current.
 - c. A voltmeter with a capability of measuring at least 60V can be placed across the input terminals in order to get an accurate input voltage measurement.
4. Turn on the power at the input.

NOTE: Make sure that the input voltage never exceeds 60V.

5. Check for the proper output voltage of 24V. Turn off the power at the input.
6. Once the proper output voltages are established, connect a variable load capable of sinking 15A at 12V to the output terminals $+V_{OUT}$ and $-V_{OUT}$. Set the current for 0A.
 - a. If efficiency measurements are desired, an ammeter or a resistor shunt that is capable of handling 15ADC can be put in series with the output load in order to measure the DC2199A-A's output current.

QUICK START PROCEDURE

- b. A voltmeter with a capability of measuring at least 24V can be placed across the output terminals in order to get an accurate output voltage measurement.
7. Turn on the power at the input.
8. Once the proper output voltage is again established, adjust the load within the operating range and observe the output voltage regulation, ripple voltage, efficiency and other desired parameters.

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

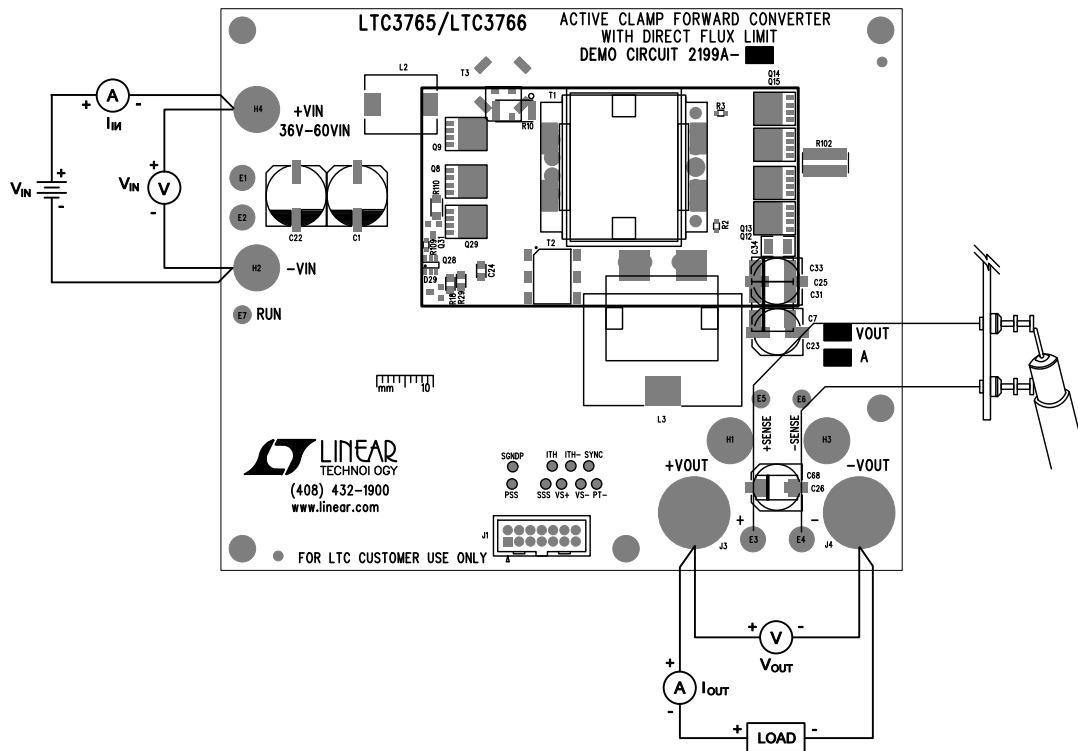


Figure 1. Proper Measurement Equipment Setup

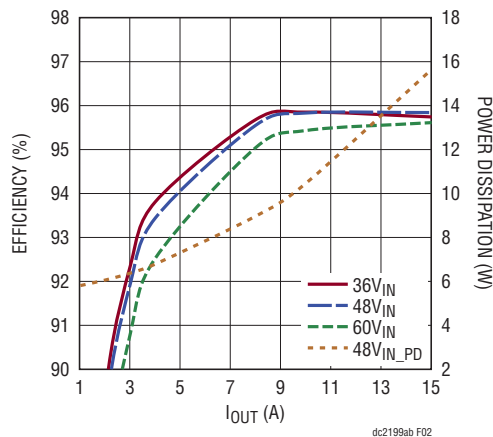


Figure 2. Efficiency and Power Dissipation

QUICK START PROCEDURE

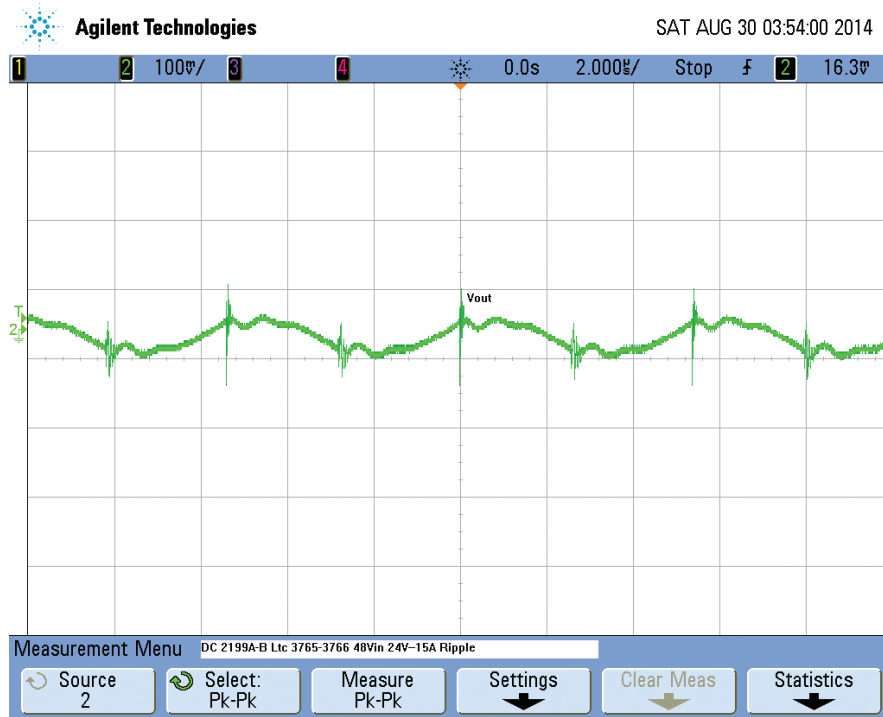


Figure 3. Output Ripple at 48V_{IN} and 15A_{OUT} (100mV, 2µs/DIV, 20MHz)

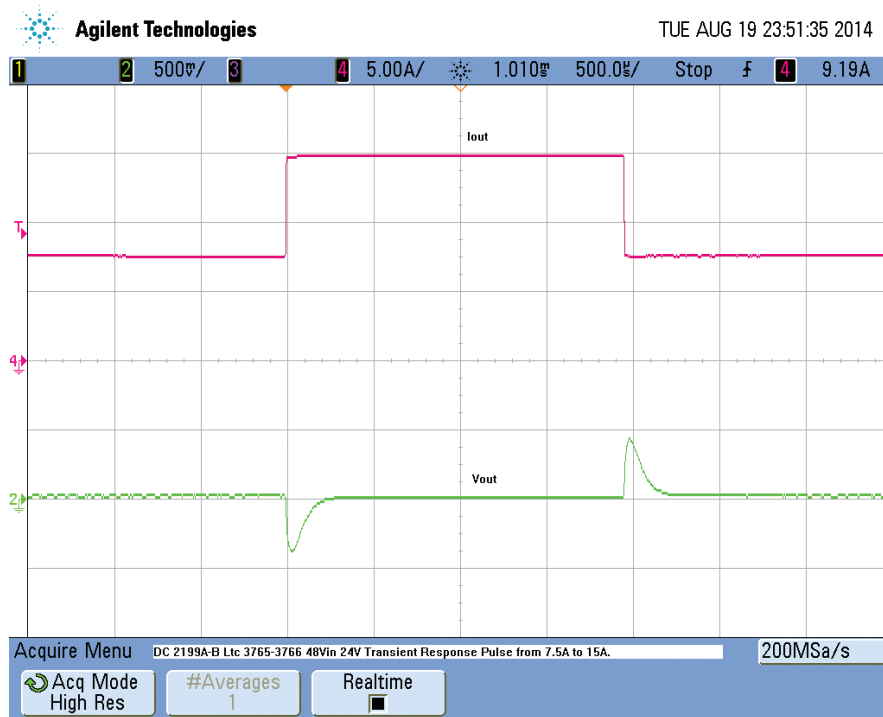


Figure 4. Transient Response Waveform at 48V_{IN} and 7.5A to 15A to 7.5A_{OUT} (5A, 500mV, 500µs/DIV)

QUICK START PROCEDURE

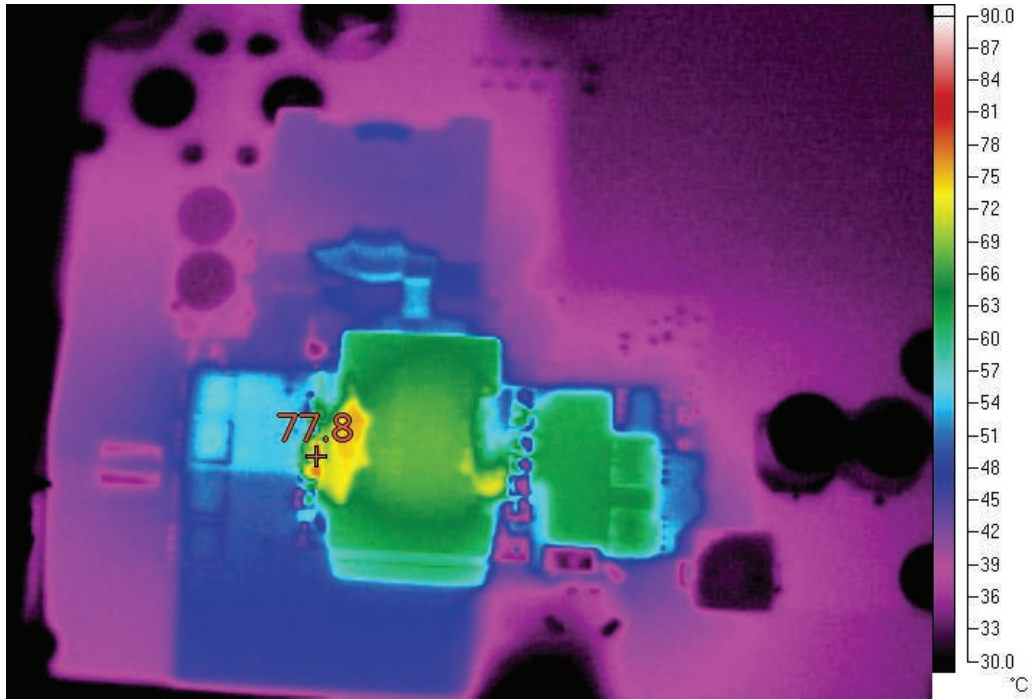


Figure 5. Thermal Map, Front Side at 48V_{IN} and 15A_{OUT} (T_A = 25°C, 300LFM)

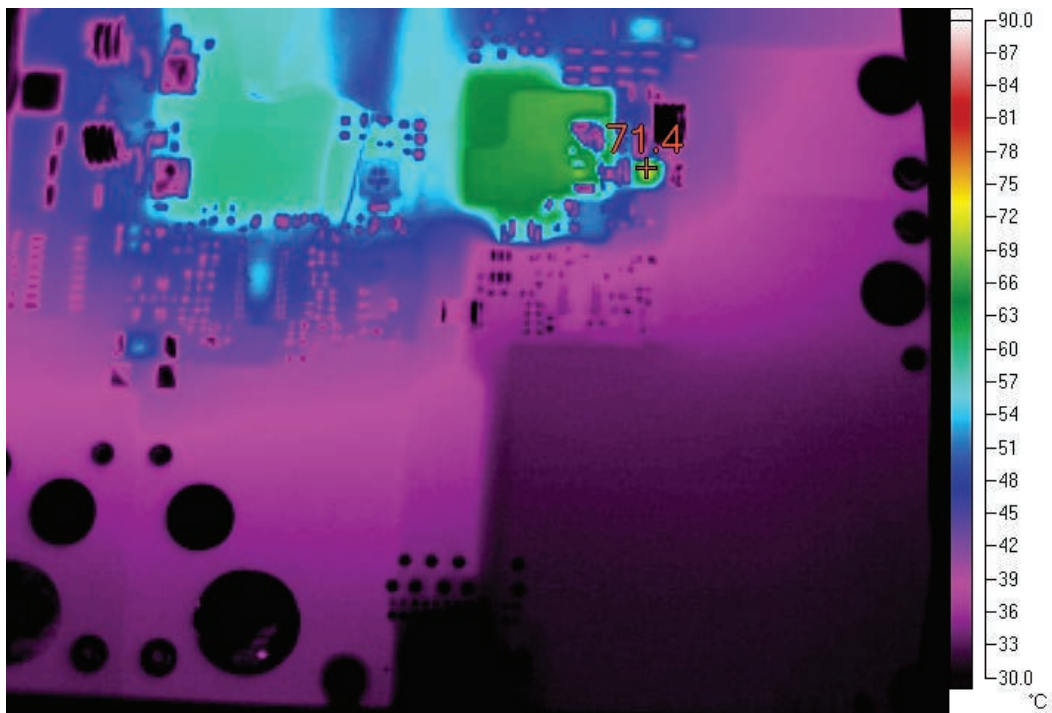


Figure 6. Thermal Map, Back Side at 48V_{IN} and 15A_{OUT} (T_A = 25°C, 300LFM)

DEMO MANUAL DC2199A-B

PARTS LIST

| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|------------------------------------|-----|---------------------|---|----------------------------|
| Required Circuit Components | | | | |
| 1 | 2 | C1, C22 | CAP., ALUM., ELECT., 33µF, 80V, CAP-10X12.5 | PANASONIC, EEHZA1K330P |
| 2 | 5 | C2, C3, C4, C5, C6 | CAP., X7R, 4.7µF, 100V, 10%, 1210 | MURATA, GRM32ER72A475KE14 |
| 4 | 1 | C10 | CAP., X7R, 2.2nF, 630V, 5%, 1206 | MURATA, GRM31A7U2J222JW31 |
| 5 | 1 | C11 | CAP., X7R, 0.015µF, 25V, 10%, 0603 | AVX, 06033C153KAT2A |
| 7 | 2 | C24, C71 | CAP., X7R, 1.0µF, 16V 10%, 0805 | MURATA, GRM21BR71C105KA01 |
| 4 | 2 | C25, C26 | CAP., OSCON, 82µF, 35V, 20%, CAP-SVPF-E12 | PANASONIC, 35SVPF82M |
| 8 | 1 | C30 | CAP., X7R, 2200pF, 250V, 10%, 1812 | MURATA, GA343QR7GD222KW01L |
| 8 | 1 | C34 | CAP., X5R, 10µF, 50V, 20%, 1210 | MURATA, GRM32ER61H106MA12 |
| 9 | 1 | C51 | CAP., COG, 330pF, 630V, 5%, 1206 | MURATA, GRM31A5C2J331JW01 |
| 12 | 4 | C55, C73, C80, C119 | CAP., X7R, 1nF, 25V, 10%, 0603 | MURATA, GRM188R71E102KA01 |
| 9 | 1 | C66 | CAP., X7R, 0.047µF, 200V, X7R, 10%, 1206 | MURATA, GRM31CR72D473KW03 |
| 11 | 2 | C72, C102 | CAP., X7R, 0.1µF, 25V, 10%, 0805 | AVX, 08053C104KAT2A |
| 14 | 1 | C75 | CAP., NPO, 100pF, 25V, 5%, 0603 | AVX, 06033A101JAT2A |
| 10 | 1 | C76 | CAP., X7R, 3.3nF, 25V, 10%, 0603 | AVX, 06033C332KAT2A |
| 15 | 1 | C77 | CAP., X7R, 4.7µF, 25V, 10%, 1206 | AVX, 12063C475KAT2A |
| 16 | 1 | C78 | CAP., NPO, 0.033µF, 25V, 5%, 0805 | TDK, C2012C0G1E333J |
| 17 | 1 | C79 | CAP., X7R, 4.7nF, 25V, 10%, 0603 | MURATA, GRM188R71E472KA01 |
| 18 | 1 | C101 | CAP., NPO, 220pF, 25V, 5%, 0603 | AVX, 06033A221JAT2A |
| 10 | 1 | C103 | CAP., NPO, 470pF, 25V, 5%, 0603 | AVX, 06033A471JAT2A |
| 19 | 1 | C106 | CAP., COG, 150pF, 250V, 5%, 0603 | TDK, C1608C0G2E151J080AA |
| 20 | 1 | C112 | CAP., X7R, 0.22µF, 250V, 10%, 1206/1210 | TDK C3225X7R2E224K |
| 21 | 1 | C113 | CAP., X7R, 0.033µF, 25V, 10%, 0603 | AVX, 06033C333KAT2A |
| 11 | 1 | C116 | CAP., X7R, 4.7µF, 25V, 10%, 1206 | AVX, 12063C475KAT2A |
| 22 | 1 | C118 | CAP., NPO, 1500pF, 5%, 0603 | AVX, 06033A152JAT2A |
| 23 | 2 | D1, D34 | DIODE ULTRA FAST 1A 200V SMP | VISHAY, ES1PD-M3 / 84A |
| 25 | 3 | D29, D30 | DIODE SCHOTTKY 60V 0.5A, SOT23 | DIODES INC, ZHCS506TA |
| 27 | 1 | D40 | DIODE, 1N4148WS, SOD323 | VISHAY, 1N4148WS-E3-08 |
| 14 | 2 | D37, D38 | DIODE, BAS21, SOT23 | DIODES INC., BAS21 |
| 15 | 1 | L3 | INDUCTOR, 6.8µH, 10% | COILCRAFT, SER2915L-682KL |
| 16 | 1 | L4 | INDUCTOR, 680µH, DO1606T | COILTRONICS SD25-681 |
| 19 | 4 | Q12, Q13, Q14, Q15 | MOSFET, N-CH, 120V, POWERPAK-SO-8 | FAIRCHILD FDMS86201 |
| 35 | 1 | L1 | INDUCTOR, 1.0µH, 20% | COILCRAFT, XPL2010-102ML |
| 36 | 1 | L2 | INDUCTOR, 2.0µH, 20% | VISHAY, IHLP4040DZER2R0M11 |
| 40 | 2 | Q8, Q9 | MOSFET, N-CH 150V, POWERPAK-SO-8 | INFINEON, BSC190N15NS3 G |
| 42 | 1 | Q27 | TRANS., NPN, 40V, 1A, SOT-89 | DIODE INC., FCX491ATA |
| 43 | 1 | Q28 | MOSFET, N-CH, SUPER, SOT-6 | FAIRCHILD, FDC2512-NL |
| 44 | 1 | Q29 | MOSFET, P-CH, IRF6217, POWERPAK-SO-8 | IR, IRF6217TRPBF |
| 45 | 1 | R1 | RES., CHIP, 0.33Ω, 1/4W, 5%, 2512 | PANASONIC, ERJ-1TRQJR33U |
| 47 | 1 | R4 | RES., CHIP, 8.2k, 1W, 5%, 2512 | PANASONIC, ERJ-1TYJ822U |
| 51 | 1 | R18 | RES., 102k, 1/8W, 1%, 0805 | VISHAY, CRCW0805102KFKEA |
| 52 | 1 | R22 | RES., 3.74k, 1/16W, 1%, 0603 | VISHAY, CRCW06033K74FKEA |

dc2199abf

PARTS LIST

| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|------|-----|------------------------|------------------------------------|---------------------------------|
| 27 | 2 | R23, R24 | RES., CHIP, 20Ω, 1/4W, 5%, 1206 | VISHAY, CRCW120620R0JKEA |
| 54 | 1 | R29 | RES., CHIP, 100k, 1/8W, 5%, 0805 | VISHAY, CRCW0805100KJNEA |
| 28 | 1 | R41 | RES., CHIP, 23.7k, 1/16W, 1%, 0603 | VISHAY, CRCW060323K7FKEA |
| 55 | 1 | R42 | RES., CHIP, 1k, 1/16W, 1%, 0603 | VISHAY, CRCW06031K00FKEA |
| 56 | 1 | R46 | RES., CHIP, 604Ω, 1/16W, 1%, 0603 | VISHAY, CRCW0603604RFKEA |
| 57 | 1 | R53 | RES., CHIP, 6.8Ω, 1/2W, 1%, 1206 | PANASONIC, ERJ-8RQF6R8V |
| 58 | 1 | R68 | RES., CHIP, 2.15k, 1/16W, 1%, 0603 | VISHAY, CRCW06032K15FKEA |
| 59 | 1 | R69 | RES., CHIP, 46.4k, 1/16W, 1%, 0603 | VISHAY, CRCW060346K4FKEA |
| 29 | 1 | R75 | RES., CHIP, 2.87k, 1/8W, 1%, 0805 | VISHAY, CRCW08052K87FKEA |
| 60 | 4 | R101, R148, R149, R151 | RES., CHIP, 100Ω, 1/16W, 1%, 0603 | VISHAY, CRCW0603100RFKEA |
| 32 | 1 | R102 | RES., CHIP, 0.003Ω, 3W, 1%, 1225 | SUSUMU, KRL6432D-M-R003-F-T5 |
| 33 | 2 | R106, R107 | RES., CHIP, 100Ω, 1/16W, 1%, 0603 | VISHAY, CRCW0603100RFKEA |
| 34 | 1 | R108 | RES., CHIP, 5.62k, 1/4W, 1%, 1206 | VISHAY, CRCW12065K62FKEA |
| 61 | 1 | R109 | RES., CHIP, 10k, 1/16W, 1%, 0603 | VISHAY, CRCW060310K0FKEA |
| 62 | 1 | R110 | RES., CHIP, 1.20Ω, 1/2W, 1%, 1206 | SUSUMU, RL1632S-1R20-F |
| 63 | 1 | R114 | RES., CHIP, 28.7k, 1/16W, 1%, 0603 | VISHAY, CRCW060328K7FKEA |
| 35 | 1 | R115 | RES., CHIP, 4.42k, 1/4W, 1%, 1206 | VISHAY, CRCW12064K42FKEA |
| 64 | 1 | R117 | RES., CHIP, 12.7k, 1/16W, 1%, 0603 | VISHAY, CRCW060312K7FKEA |
| 65 | 1 | R118 | RES., CHIP, 681k, 1/16W, 1%, 0603 | VISHAY, CRCW0603681KFKEA |
| 66 | 1 | R121 | RES., CHIP, 133k, 1/16W, 1%, 0603 | VISHAY, CRCW0603133KFKEA |
| 36 | 1 | R123 | RES., CHIP, 86.6k, 1/16W, 1%, 0603 | VISHAY, CRCW060386K6FKEA |
| 67 | 1 | R125 | RES., CHIP, 17.4k, 1/16W, 1%, 0603 | VISHAY, CRCW060317K4FKEA |
| 37 | 1 | R127 | RES., CHIP, 10k, 1/4W, 1%, 1206 | VISHAY, CRCW120610K0FKEA |
| 68 | 1 | R136 | RES., CHIP, 0.005Ω, 1W, 1%, 1225 | SUSUMU, KRL6432D-M-R005-F-T5 |
| 69 | 1 | R139 | RES., CHIP, 26.7k, 1/16W, 1%, 0603 | VISHAY, CRCW060326K7FKEA |
| 70 | 1 | R140 | RES., CHIP, 274Ω, 1/8W, 1%, 0805 | PANASONIC, ERJ-6ENF2740V |
| 71 | 1 | R150 | RES., CHIP, 14.3k, 1/16W, 1%, 0603 | VISHAY, CRCW060314K3FKEA |
| 38 | 1 | T1 | TRANSFORMER, 4T:4T:2T | CHAMPS TECH., LTC-PQ26-0404-S02 |
| 73 | 1 | T2 | TRANSFORMER, 1.25:1 | PULSE, PA3493NL |
| 74 | 1 | U1 | I.C. LTC3765EMSE, MSOP-16PIN | LINEAR TECH., LTC3765EMSE#PBF |
| 75 | 1 | U2 | I.C. LTC3766EGN, SSOP-GN28 | LINEAR TECH., LTC3766EGN#PBF |

Additional Demo Board Circuit Components

| | | | | |
|----|---|------------------------------|-------------------------|--------------------------|
| 2 | 0 | C7, C31, C33, C68 | CAP., OPT, 7343 | OPT |
| 3 | 0 | C8, C9, C18, C19, C111 | CAP., OPT, 0603 | OPT |
| 5 | 0 | C12, C13, C14, C16, C20, C70 | CAP., OPT, 0603 | OPT |
| 6 | 0 | C15 | CAP., OPT, 0805 | OPT |
| 7 | 0 | C17, C69 | CAP., OPT, 1206 | OPT |
| 6 | 0 | C21, C114 | CAP., OPT, 0805 | OPT |
| 3 | 0 | C23 | CAP., OPT, CAP-SVPF-E12 | OPT |
| 13 | 2 | C74, C105 | CAP, 0Ω, JUMPER, 0603 | VISHAY, CRCW06030000Z0EA |
| 12 | 0 | D2 | DIODE, TBD, SOD323 | OPT |
| 24 | 0 | D4, D35 | DIODE, OPT, SOD323 | OPT |

DEMO MANUAL DC2199A-B

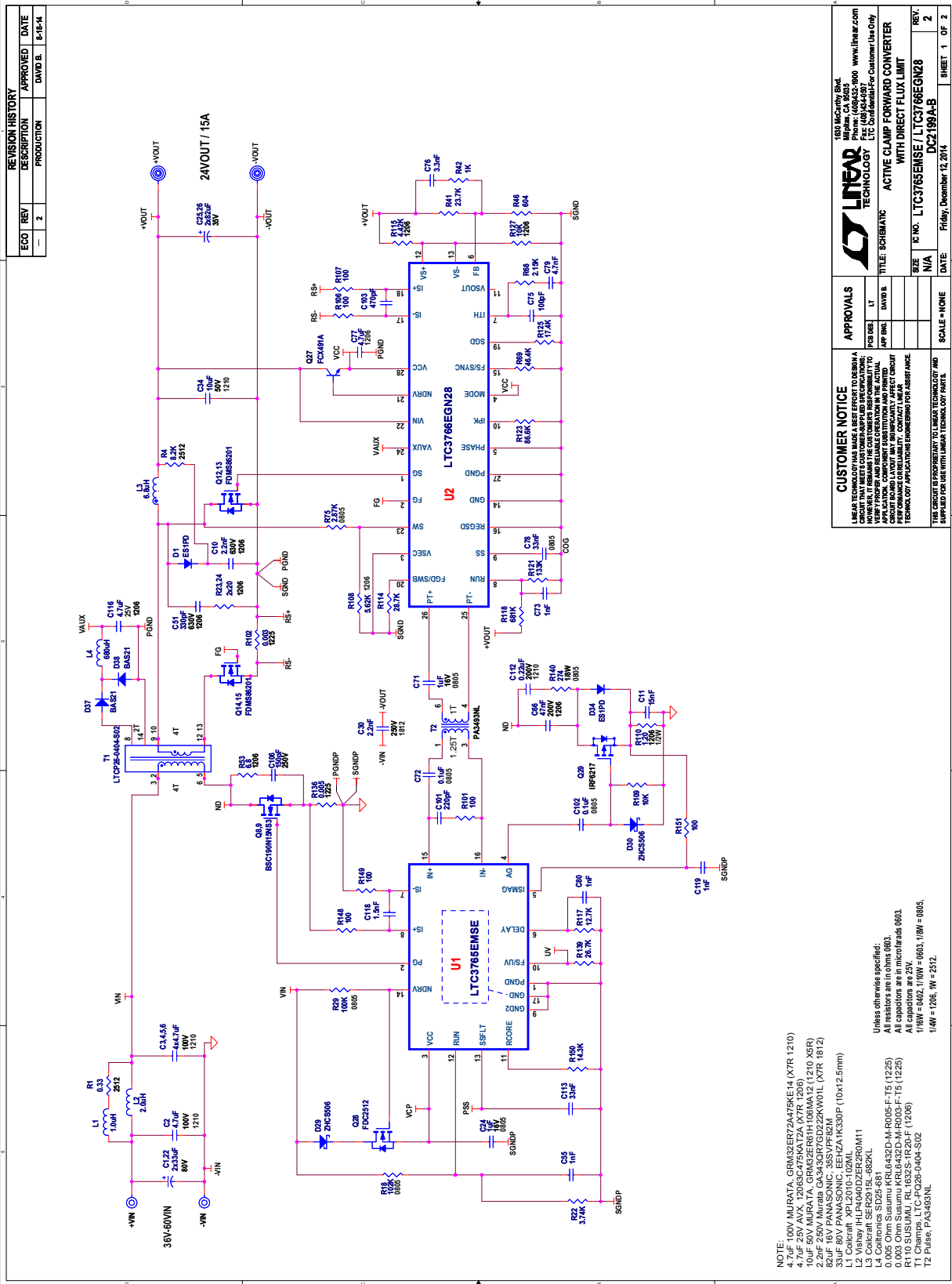
PARTS LIST

| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|------|-----|--|------------------------------|--------------------------|
| 13 | 0 | D27 | DIODE OPT, SOT23 | OPT |
| 26 | 0 | D28 | DIODE, OPT, SOT23 | OPT |
| 17 | 0 | Q1 | MOSFET, OPT, SOT23-6 | OPT |
| 18 | 0 | Q4 | MOSFET, OPT, D-PAK | OPT |
| 20 | 0 | Q23 | MOSFET, OPT, POWERPAK-SO-8 | OPT |
| 21 | 0 | Q24 | MOSFET, OPT, POWERPAK-SO-8 | OPT |
| 37 | 0 | Q2 | MOSFET, OPT, SOT23-6 | OPT |
| 38 | 0 | Q3 | MOSFET, OPT, SOT23 | OPT |
| 39 | 0 | Q31 | TRANS, OPT, SOT23 | OPT |
| 41 | 0 | Q11 | MOSFET, OPT, POWERPAK-SO-8 | OPT |
| 22 | 3 | R2, R3, R43 | RES., CHIP, 0Ω, 0603 | VISHAY, CRCW06030000Z0EA |
| 48 | 0 | R5 | RES., OPT, 2512/2010 | OPT |
| 23 | 0 | R6, R9, R11, R12, R19, R113, R124 | RES., OPT, 0603 | OPT |
| 49 | 9 | R7, R8, R49, R103, R111, R112 | RES., CHIP, 0Ω, 0603 | VISHAY, CRCW06030000Z0EA |
| 24 | 1 | R10 | RES., CHIP, 0.00Ω, 1225 | TEPRO, RN5326 |
| 25 | 0 | R13, R14, R15 | RES., OPT, 2512 | OPT |
| 26 | 0 | R17, R51, R52 | RES., OPT, 1206 | OPT |
| 46 | 0 | R25, R26, R27, R28, R30, R31, R32, R33, R34, R35, R119, R120, R126, R138, R147 | RES., OPT, 0603 | OPT |
| 50 | | R122, R137, R146 | | |
| 30 | 0 | R76, R84 | RES., OPT, 0805 | OPT |
| 31 | 1 | R77 | RES., CHIP, 0Ω, 1/8W, 0805 | VISHAY, CRCW08050000Z0EA |
| 53 | 0 | R116 | RES., OPT, 1206 | OPT |
| 72 | 0 | R152 | RES., OPT, 0805 | OPT |
| 39 | 0 | T3 | TRANSFORMER, 1:100, CT02-100 | OPT |
| 40 | 0 | U3 | I.C. OPT, SO16 | OPT |

Hardware: For Demo Board Only

| | | | | |
|----|---|----------------|-------------------------------|-----------------------------------|
| 1 | 4 | E1, E2, E3, E4 | TESTPOINT, TURRET, 0.094" | MILL-MAX, 2501-2-00-80-00-00-07-0 |
| 2 | 3 | E5, E6, E7 | TESTPOINT, TURRET, 0.061" | MILL-MAX, 2308-2-00-80-00-00-07-0 |
| 3 | 0 | J1 | HEADER, OPT, 2X7PIN, 0.079CC | OPT, MOLEX, 87331-1420 |
| 4 | 2 | J3, J4 | STUD, TEST PIN | PEM, KFH-032-10 |
| 5 | 4 | J3, J4(2 EACH) | NUT, BRASS, #10-32 | ANY #10-32 |
| 6 | 2 | J3, J4 | WASHER, STAR #10 BRASS NICKEL | ANY, #10EXT BZ TN |
| 7 | 2 | J3, J4 | RING, LUG RING #10 | KEYSTONE, 8205 |
| 8 | 0 | TP1-TP6 | PAD-SMD | PAD-SMD |
| 9 | 4 | (STAND-OFF) | STAND-OFF, NYLON 0.25" | KEYSTONE, 8831 (SNAP ON) |
| 10 | 1 | | FAB, PRINTED CIRCUIT BOARD | DEMO CIRCUIT 2199A |

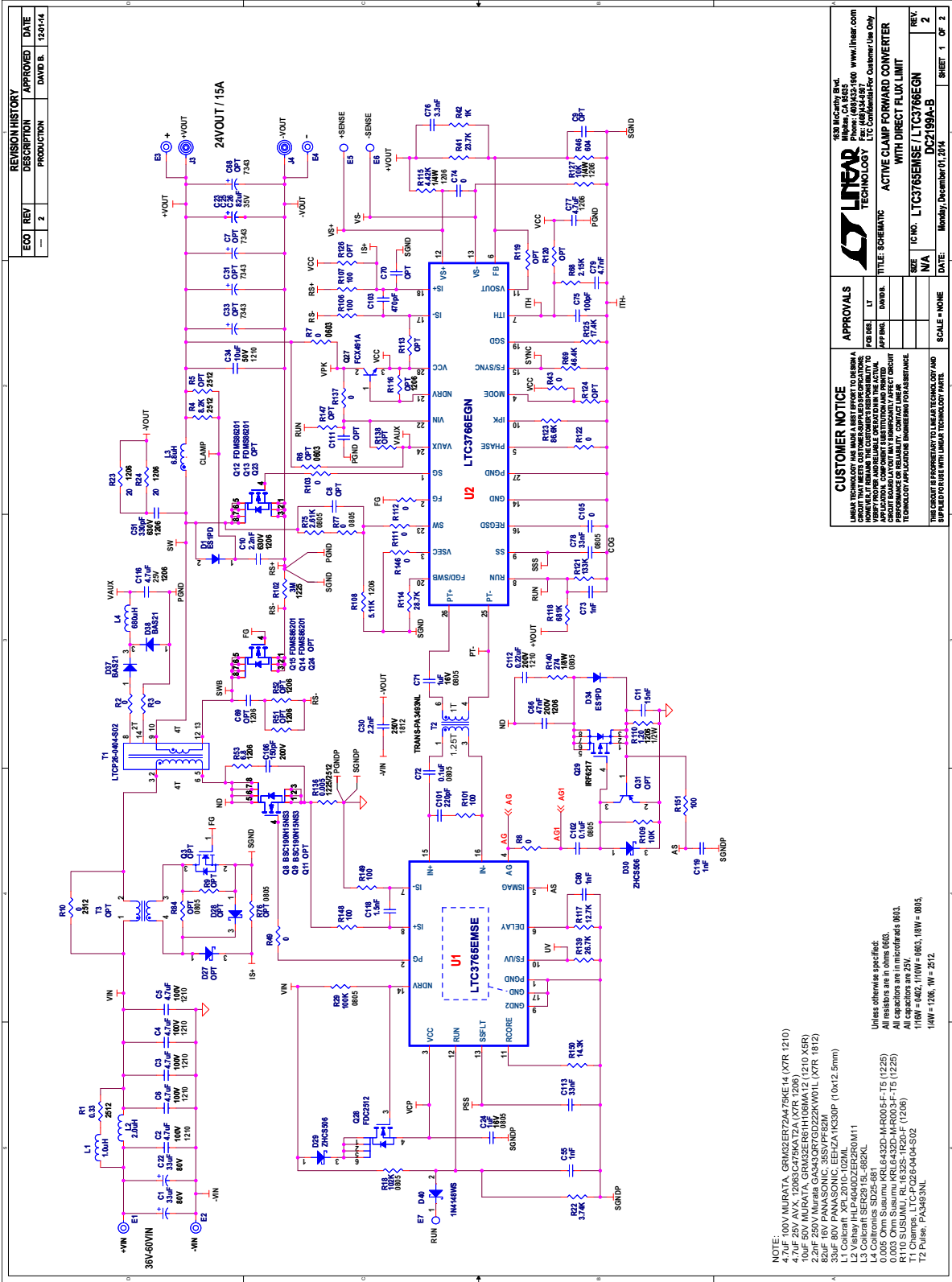
SCHEMATIC DIAGRAM



Simplified Schematic (without Unneeded Components)

DEMO MANUAL DC2199A-B

SCHEMATIC DIAGRAM



| ECO | REV | DESCRIPTION | APPROVED | DATE |
|-----|-----|-------------|----------|----------|
| | 2 | PRODUCTION | DAVID B. | 12/01/14 |

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APPROVALS
 PCB DES: UT
 APP ENG: DMBL

SCALE NONE

DATE Monday, December 01, 2014

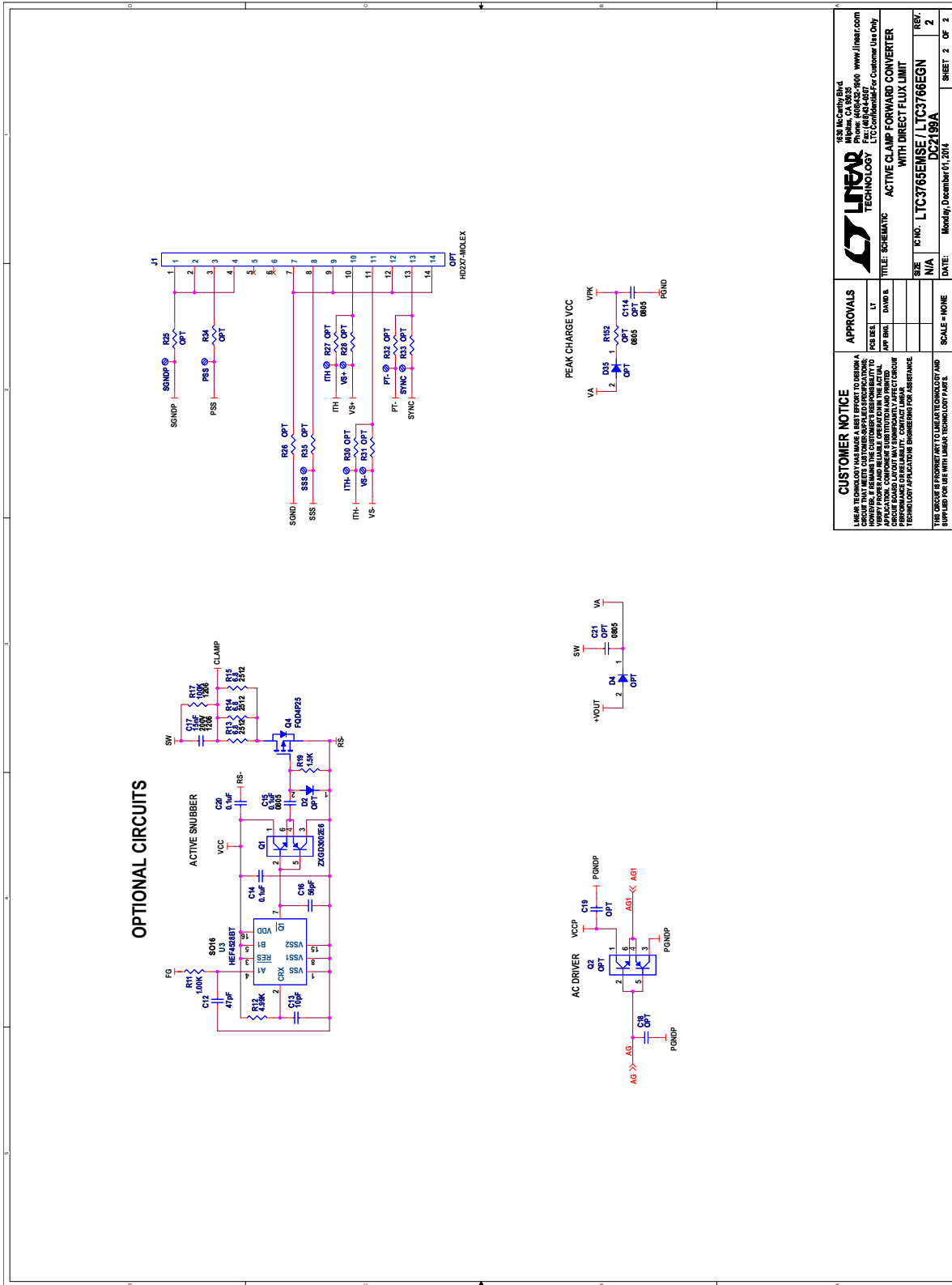
REV. 2
DC2199A-B
SHEET 1 OF 2

LINEAR TECHNOLOGY
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 Tel: (408) 255-3000
 Fax: (408) 255-3001
 www.linear.com

TITLE: SCHEMATIC
ACTIVE CLAMP FORWARD CONVERTER WITH DIRECT FLUX LIMIT

NOTE:
 4.7µF 100V MURATA, GRM32ERT2A475KE14 (XTR 1210)
 4.7µF 25V AVX, 12063C475KATZA (XTR 1206)
 10µF 50V MURATA, GRM32ER61H100MA12 (1210 XGR)
 10µF 50V MURATA, GRM32ER61H100MA12 (1210 XGR)
 82µF 16V PANASONIC, 35S5VFF82M
 33µF 80V PANASONIC, EEHZA1K33P (10412.5mm)
 L1 Coilcraft, XP21010-102ML
 L2 Coilcraft, SER2015L-8R2KL
 L3 Coilcraft, SER2015L-8R2KL
 L4 Coilcraft, SD25-681
 0.005 Ohm Summu KRI, 842D-MR005-F-15 (1225)
 All resistors are in ohms (Ω).
 All capacitors are in microfarads (µF).
 110V = 062, 110V = 063, 18V = 065, 18V = 065, 18V = 212

SCHEMATIC DIAGRAM



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 LINEAR TECHNOLOGY CORP. 1630 McCarty Blvd, Irvine, CA 92614, USA. Tel: (949) 464-5000, Fax: (949) 464-5057, www.linear.com

APPROVALS
 PCB DES: LT
 APP BNC: DVID TL
 SCALE: NONE

REV.
 1 N/A
 2 LTC3765ENSE / LTC3766EN WITH DIRECT FLUX LIMIT
 3 DC2199A

DATE: Monday, December 01, 2014
 SHEET 2 OF 3

DEMO MANUAL DC2199A-B

DEMONSTRATION BOARD IMPORTANT NOTICE

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

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