

LT4276, LT4321 PoE PD with Synchronous Flyback and Ideal Diode Bridge

DESCRIPTION

Demonstration Circuit 2046A-E is a PoE Powered Device (PD) with an isolated power supply using synchronous flyback topology, featuring the [LT®4276](#) and Ideal diode bridge controller ([LT4321](#)).

The LT4276 provides IEEE802.3af (PoE, Type 1), IEEE802.3at (PoE+, Type 2), and LTPoE++™ PD interfacing and power supply control. When the PD is fully powered, the PD interface switches power over from the Power Sourcing Equipment (PSE) to the switcher through an external, low resistance, high power N-channel FET. The highly integrated LT4276 controls a high power, small-sized power

supply that utilizes a highly efficient flyback topology with synchronous rectification. The LT4321 provides further efficiency improvement by minimizing the bridge losses.

The DC2046A-E supplies a 5V output at up to 7A. It also demonstrates the use of an optional auxiliary power supply input of 50V. When present, the auxiliary supply becomes the dominant supply over PoE to provide power.

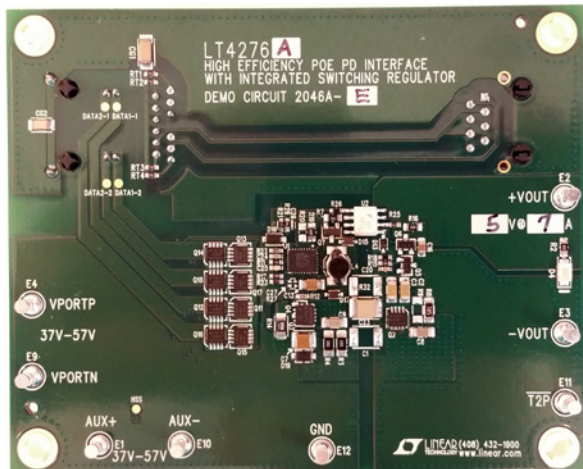
Design files for this circuit board are available at <http://www.linear.com/demo/DC2046A-E>

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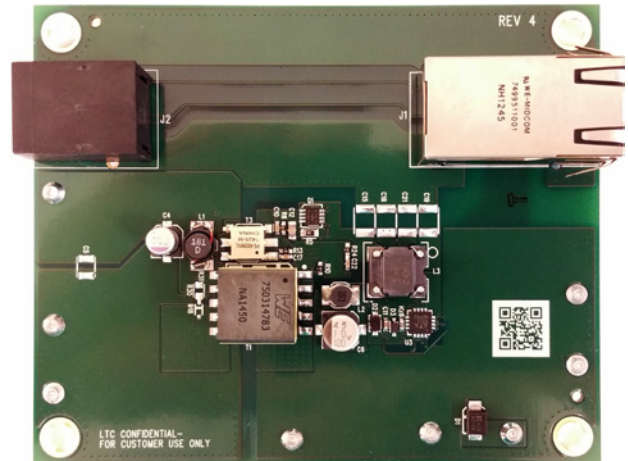
PERFORMANCE SUMMARY Specifications are at T_A = 25°C

| PARAMETER | CONDITIONS | VALUE |
|-----------------------------------|--|---------------------------|
| Port Voltage (V _{PORT}) | At Ethernet Port | 37V to 57V |
| Auxiliary Voltage | From AUX+ to AUX- Terminals | 37V to 57V |
| Output Voltage | | 5V (Typ) |
| Output Current | | 7A (Max) |
| Output Voltage Ripple | V _{PORT} = 50V, I _{OUT} = 7A | 25mV _{P-P} (Typ) |
| Output Regulation | | ±0.06% (Typ) |
| Efficiency | V _{PORT} = 50V, I _{OUT} = 7A, End to End | 91.5% (Typ) |
| Switching Frequency | | 250kHz (Typ) |

BOARD PHOTO



Top Side



Bottom Side

dc2046aef

TYPICAL PERFORMANCE CHARACTERISTICS

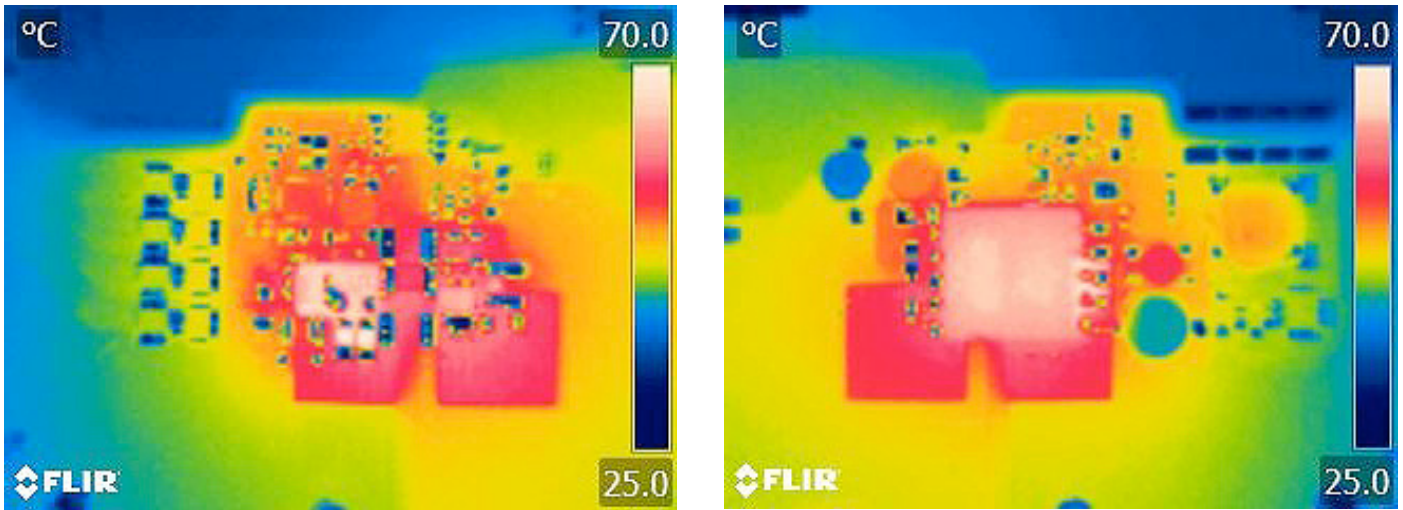


Figure 1. Thermal Pictures – $V_{PORT} = 50V, 5V/7A$

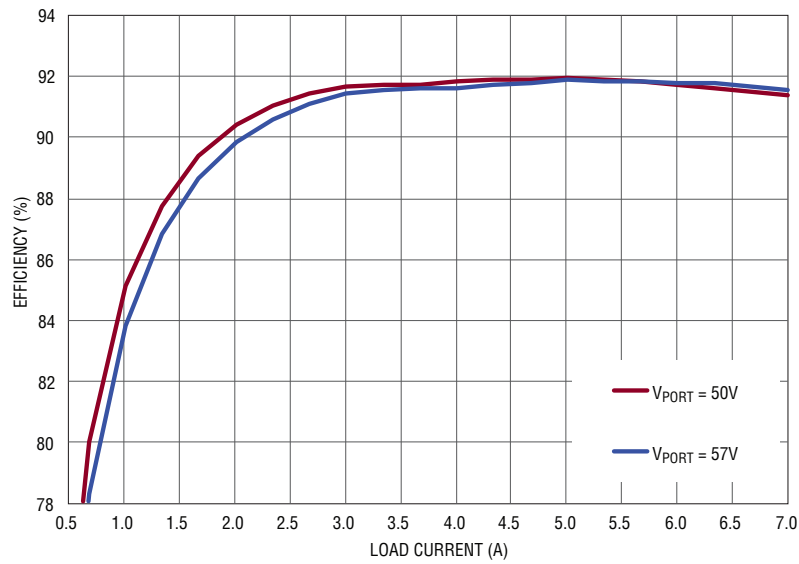


Figure 2. Efficiency (End to End)

TYPICAL PERFORMANCE CHARACTERISTICS

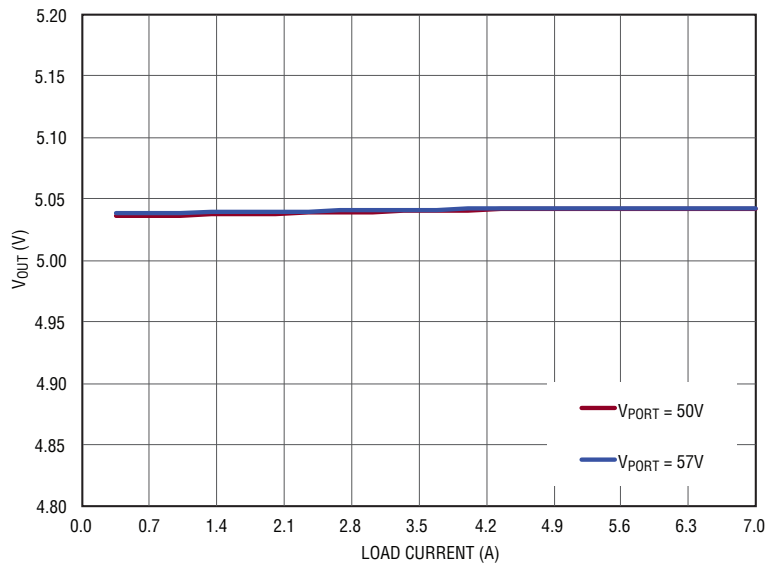


Figure 3. Output Voltage Regulation

TYPICAL PERFORMANCE CHARACTERISTICS

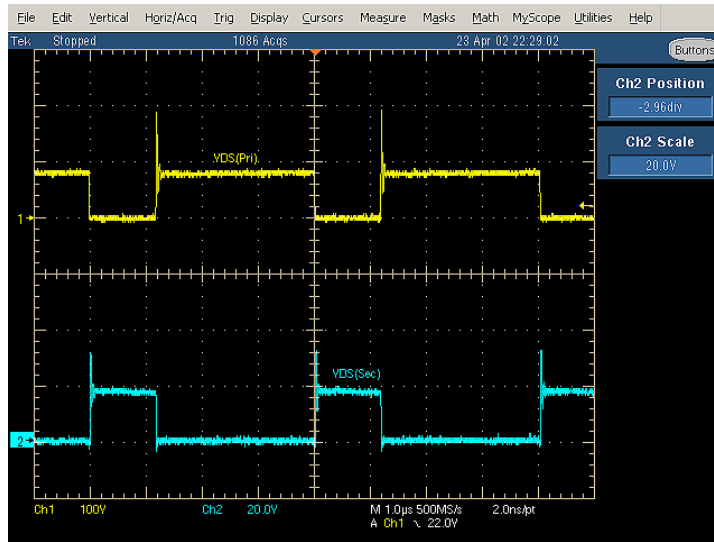


Figure 4. Stresses ($V_{PORT} = 57V, 5V/7A$)

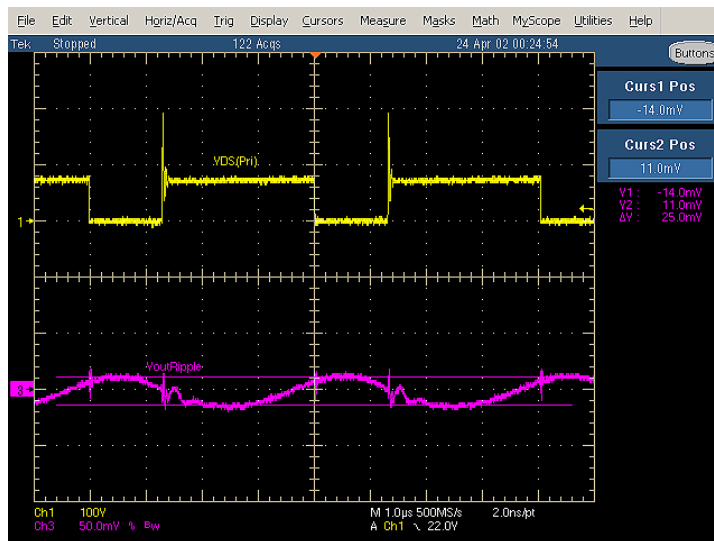


Figure 5. Output Voltage Ripple ($V_{PORT} = 50V, 5V/7A$)

TYPICAL PERFORMANCE CHARACTERISTICS

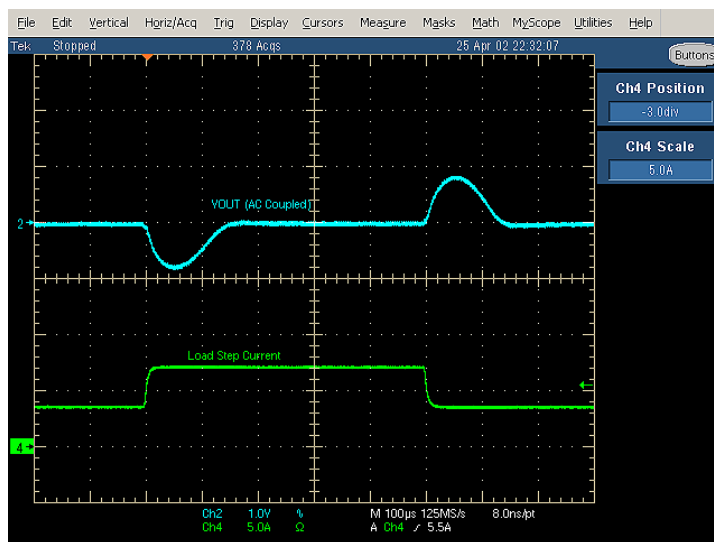


Figure 6. Load Transient Response ($V_{PORT} = 50V, 3.5A$ to $7A$ to $3.5A$)

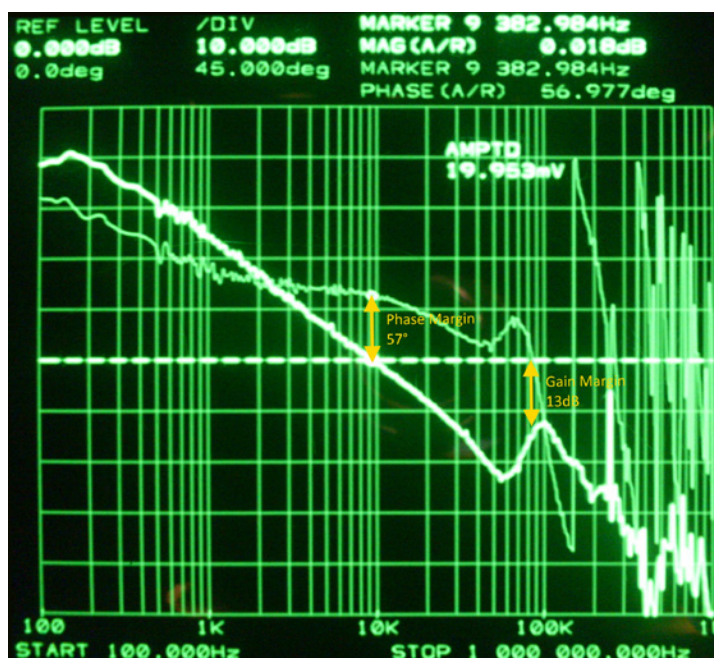


Figure 7. Gain and Phase Margin of the Flyback Loop ($V_{PORT} = 57V, 5V/0.7A$)

QUICK START PROCEDURE

Demonstration circuit 2046A-E is easy to set up to evaluate the performance of the LT4276 in a PoE+ application. Refer to Figure 8 for proper 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 output voltage ripple by touching the probe tip and probe ground directly across the V_{OUT}^+ and V_{OUT}^- terminals. See Figure 9 for proper scope probe technique.

1. Place test equipment (voltmeter, ammeter, power supplies, and electronic load) as shown in Figure 8.

2. Input supplies:

- a. Connect a LTPoE++ capable PSE with a CAT-5 cable to the RJ45 connector, J1. See Figure 8.
- b. Or, connect a 37V to 57V capable power supply (Power Supply in Figure 8) across V_{PORTP} and V_{PORTN} .
- c. If evaluating the auxiliary power supply (Auxiliary Supply in Figure 8), connect a 37V to 57V capable power supply across AUX^+ to AUX^- .

3. Check for the proper output voltage of 5V.

4. Once the proper output voltage is confirmed, adjust the load within the operating range and observe the output voltage regulation, ripple voltage, efficiency, and other parameters.

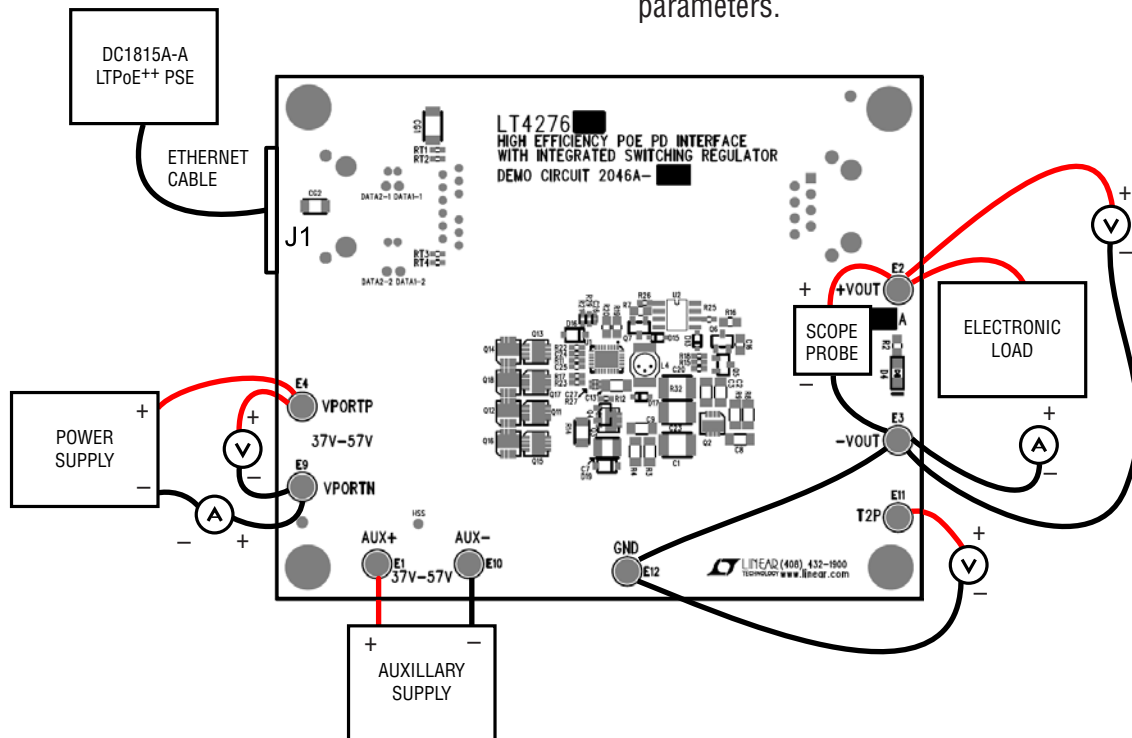


Figure 8. Proper Measurement Equipment Setup

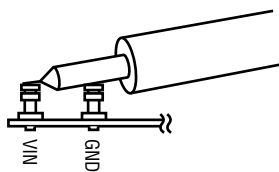


Figure 9. Measuring Output Ripple

PARTS LIST

| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|----------------------------|-----|--|--|--|
| DC2046A GENERAL BOM | | | | |
| 1 | 1 | CG1 | Cap, Cer, X7R, 1000pF, 2KV, 10%, 1808 | Murata GR442QR73D102KW01L |
| 2 | 1 | CG2 | Cap, Cer, X7R, 0.01µF, 100V, 20%, 1206 | AVX 12061C103AT2A |
| 3 | 0 | C1 | Cap, Cer, OPT, 2kV, 1812 | OPT |
| 4 | 0 | C5 | CAP, Cer, X7U, OPT, 6.3V, 10%, 1210 | OPT |
| 5 | 1 | C6 | CAP, Elec, 10µF, 100V, 10%, 6.3x7.7 | SunCon 100CE10BS |
| 6 | 1 | C7 | CAP, Cer, X7R, 2.2µF, 100V, 10%, 1210 | Murata GRM32ER72A225KA35 |
| 7 | 1 | C10 | Cap, Cer, X7R, 10nF, 100V, 20%, 0603 | Murata GRM188R72A103KA01D |
| 8 | 1 | C11 | CAP, Cer, X7R, 0.047µF, 100V, 20%, 0603 | KEMET C0603C473M1RACTU |
| 9 | 1 | C12 | Cap, Cer, X7R, 0.047µF, 100V, 10%, 0805 | Murata GRM21BR72A473KA01L |
| 10 | 1 | C13 | Cap, Cer, X7R, 10µF, 10V, 10%, 1206 | Murata GRM31CR71A106KA01L |
| 11 | 0 | C15, C18, C19, C21 | Cap, Cer, X5R, OPT, 2KV, 20%, 1812 | OPT |
| 12 | 1 | C17 | Cap, Cer, X7R, 1µF, 25V, 10%, 0603 | Murata GRM188R71E105KA12 |
| 13 | 1 | C20 | Cap, Cer, X7R, 2.2nF, 25V, 10%, 0603 | Murata GRM188R71E222KA01 |
| 14 | 1 | C23 | Cap, Cer, X7R, 4.7nF, 2kV, 10%, 1812 | Murata GR443DR73D472KW01L |
| 15 | 1 | C26 | Cap, Cer, X5R, 100pF, 16V, 10%, 0402 | AVX 0402YC101KAT2A |
| 16 | 0 | C27 | Cap, Cer, X7R, OPT, 6.3V, 10%, 0402 | OPT |
| 17 | 1 | D1 | Diode, Schottky, B2100, 100V, SMB | Diodes Inc B2100-13-F |
| 18 | 1 | D2 | Diode, TVS, PTVS58VS1UR, 58V, SOD123 | NXP PTVS58VS1UR |
| 19 | 1 | D3 | Diode, Zener, MMSZ5252BS, 24V, SOD323 | DIODES INC MMSZ5252BS |
| 20 | 1 | D4 | Diode, LED GREEN | ROHM SML-010FTT86L |
| 21 | 1 | D13 | Diode, Schottky, NXP, BAT46W, 100V, SOD323 | NXP BAT46WJ,115 |
| 22 | 1 | D15 | Diode, DIODE INC, BAV19WS 120V, SOD323 | DIODE INC BAV19WS |
| 23 | 1 | D16 | Diode, TVS, PTVS58VS1UR, 58V, SOD123 | NXP PTVS58VS1UR |
| 24 | 1 | D17 | Diode, Schottky, BAT54WS, 30V, SOD323 | Diodes Inc BAT54WS |
| 25 | 1 | D19 | Diode, TVS, PTVS58VS1UR, 58V, SOD123 | NXP PTVS58VS1UR |
| 26 | 7 | E1, E2, E3, E4, E9, E10, E12 | TP, TURRET, PAD150-094, 0.094" | MILL-MAX 2501-2-00-80-00-00-07-0 |
| 27 | 1 | J1 | CONN, Integrated Jack, 7499511001 | Würth 7499511001 |
| 28 | 1 | J2 | CONN, RJ45 Jack, SS-6488-NF-K1 | Stewart Connector SS-6488-NF-K1 ALTERNATE SS-6488S-A-NF |
| 29 | 1 | L2 | IND, 10µH | Coilcraft DO1608C-103 |
| 30 | 1 | L4 | IND, 100µH | Coilcraft DO1608C-104 |
| 31 | 9 | Q1, Q11, Q12, Q13, Q14, Q15, Q16, Q17, Q18 | MOSFET, N-CH, PSMN075-100MSE 100V LFPK33 | NXP PSMN075-100MSE |
| 32 | 1 | Q5 | TRANSISTOR, PNP, MMBT3906, 40V, SOT23 | FAIRCHILD MMBT3906 |
| 33 | 1 | Q6 | TRANSISTOR, NPN, MMBT3904, 40V, SOT23 | FAIRCHILD MMBT3904 |
| 34 | 1 | Q7 | Tran, PNP, FMMT723 100V SOT23 | Diodes Inc FMMT723TA |
| 34 | 0 | Q7 (ALTERNATE) | Tran, PNP, PBSS9110T 100V SOT23 | NXP PBSS9110T |
| 35 | 4 | RT1, RT2, RT3, RT4 | Res, Chip, 75, 5%, 0603 | NIC NRC06J750TRF |
| 36 | 1 | R5 | Res, Chip, 8.2, 5%, 0805 | NIC NRC10J8R2TRF |
| 37 | 1 | R6 | Res, Chip, 3.3k, 5%, 0603 | NIC NRC06J332TRF |

DEMO MANUAL DC2046A-E

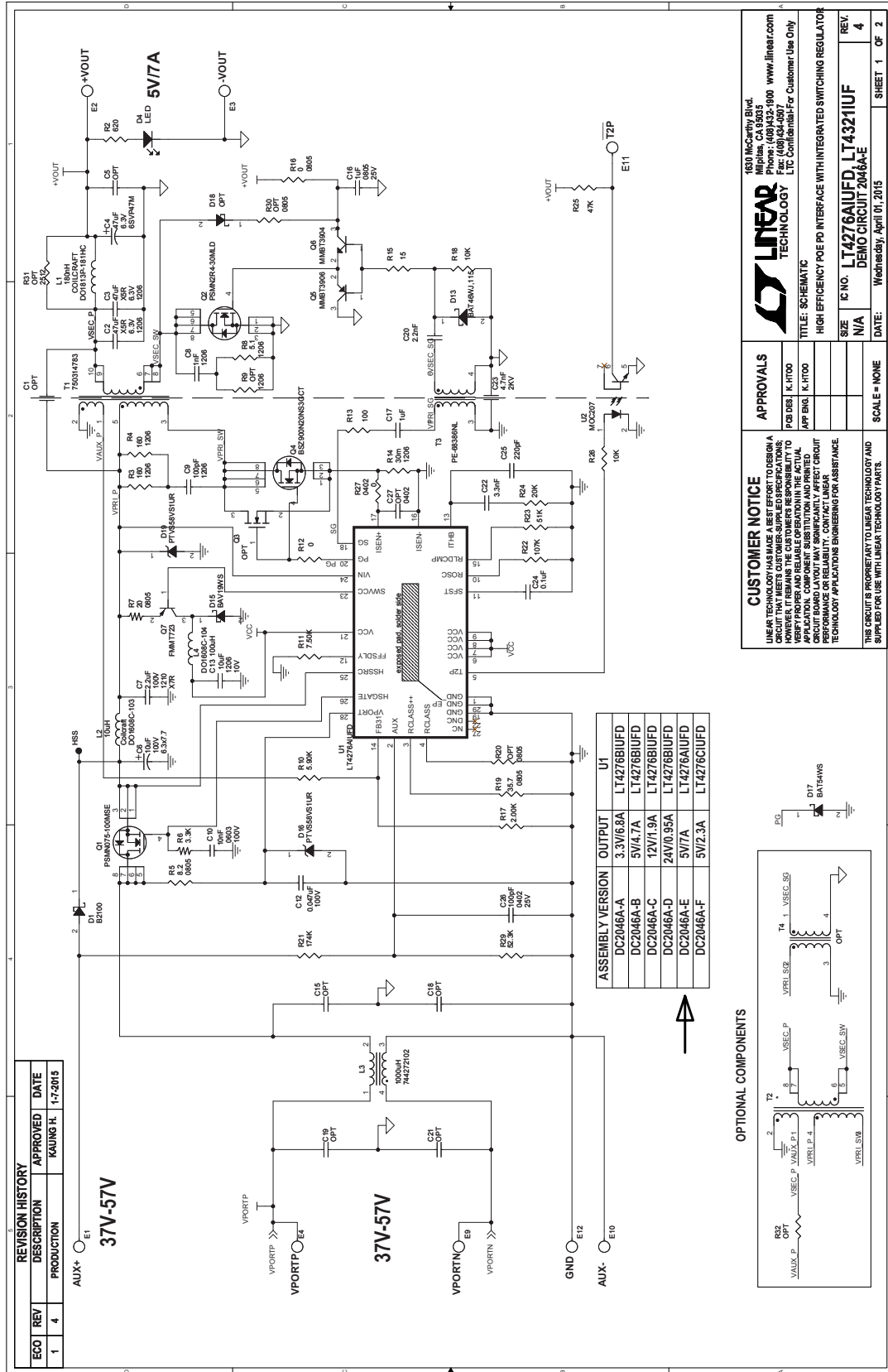
PARTS LIST

| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|----------------------------|-----|----------------|---|--------------------------|
| DC2046A GENERAL BOM | | | | |
| 38 | 1 | R7 | Res, Chip, 20 Ω , 5%, 0805 | VISHAY CRCW080520R0JNEA |
| 39 | 1 | R12 | Res, Chip, 0, 5%, 0603 | NIC NRC06ZOTRF |
| 40 | 1 | R13 | Res, Chip, 100, 5%, 0603 | VISHAY CRCW0603100RFKEA |
| 41 | 1 | R15 | Res, Chip, 15, 5%, 0603 | NIC NRC06J150TRF |
| 42 | 1 | R17 | Res, Chip, 2.00k, 1%, 0603 | NIC NRC06F2001TRF |
| 43 | 1 | R18 | Res, Chip, 10k, 5%, 0603 | YAGEO RC0603JR-0710KL |
| 44 | 1 | R21 | Res, Chip, 174k, 1%, 0603 | VISHAY CRCW0603174KFKEA |
| 45 | 1 | R22 | Res, Chip, 107k, 1%, 0603 | NIC NRC06F1073TRF |
| 46 | 1 | R27 | Res, Chip, 0, 5%, 0402 | NIC NRC04ZOTRF |
| 47 | 1 | R28 | Res, Chip, 0, 5%, 0603 | NIC NRC06ZOTRF |
| 48 | 1 | R29 | Res, Chip, 52.3k, 1%, 0603 | VISHAY CRCW060352K3FKEA |
| 49 | 0 | R32 | Res, Chip, OPT, 5%, 1812 | OPT |
| 50 | 1 | T3 | XFMR, SMD GATE DRIVE, PE-68386NL | PULSE PE-68386NL |
| 50 | 0 | T3 (ALTERNATE) | XFMR, SMD GATE DRIVE, EPA4271GE | PCA EPA4271GE |
| 51 | 0 | T4 | XFMR, SMD GATE DRIVE, OPT | OPT |
| 52 | 1 | U3 | IC, PoE Ideal Bridge Controller, LT4321IUF, QFN16 | Linear Tech LT4321IUF |

PARTS LIST

| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|----------------------|-----|----------------|---|----------------------------------|
| DC2046A-E BOM | | | | |
| 1 | 1 | | DC2046A GENERAL BOM | |
| 1 | 1 | C2 | CAP, Cer, X5R, 47µF, 6.3V, 20%, 1206 | Murata GRM31CR60J476ME19 |
| 2 | 1 | C3 | CAP, Cer, X5R, 47µF, 6.3V, 20%, 1206 | Murata GRM31CR60J476ME19 |
| 3 | 1 | C4 | CAP, Elec, 47µF, 6.3V, 20%, 5.0X5.3 | PANASONIC 6SVP47M |
| 4 | 1 | C8 | Cap, Cer, U2J, 1nF, 630V, 5%, 1206 | Murata GRM31A7U2J102JW31 |
| 5 | 1 | C9 | Cap, Cer, U2J, 100pF, 630V, 5%, 1206 | Murata GRM31A7U2J101JW31 |
| 6 | 1 | C16 | Cap, Cer, X7R, 1µF, 25V, 10%, 0805 | Murata GRM21BR71E105KA99L |
| 7 | 1 | C22 | Cap, Cer, X7R, 3.3nF, 25V, 10%, 0603 | AVX 06033C332KAT2A |
| 8 | 1 | C24 | Cap, Cer, X7R, 0.1µF, 25V, 20%, 0603 | Murata GRM188R71E104KA01D |
| 9 | 1 | C25 | Cap, Cer, X7R, 220pF, 25V, 10%, 0603 | AVX 06033C221KAT2A |
| 10 | 0 | D18 | Diode, DIODE INC, OPT, 40V, SOD323 | DIODE INC OPT |
| 11 | 1 | E11 | TP, TURRET, PAD150-094, 0.094" | MILL-MAX 2501-2-00-80-00-00-07-0 |
| 12 | 1 | L1 | IND, 180nH | COILCRAFT DO1813P-181HC |
| 13 | 1 | L3 | IND, CMC, 1mH | Würth 744272102 |
| 14 | 1 | Q2 | MOSFET, N-CH, PSMN2R4-30MLD, 30V, LFPAK33 | NXP PSMN2R4-30MLD |
| 15 | 0 | Q3 | MOSFET, N-CH, OPT, SOT23 | OPT |
| 16 | 1 | Q4 | MOSFET, N-CH, BSZ900N20NS3G, 200V, PG-TSDSON-8 | INFINEON BSZ900N20NS3G |
| 17 | 1 | R2 | Res, Chip, 620, 5%, 0805 | NIC NRC10J621TRF |
| 18 | 1 | R3 | Res, Chip, 160, 5% 1206 | VISHAY CRCW1206160RNEA |
| 19 | 1 | R4 | Res, Chip, 160, 5%, 1206 | VISHAY CRCW1206160RNEA |
| 20 | 1 | R8 | Res, Chip, 5.1, 5%, 1206 | NIC NRC12J5R1TRF |
| 21 | 0 | R9 | Res, Chip, OPT, 5%, 1206 | OPT |
| 22 | 1 | R10 | Res, Chip, 5.90k, 1%, 0603 | VISHAY, CRCW06035K90FKEA |
| 23 | 1 | R11 | Res, Chip, 7.50k, 1%, 0603 | VISHAY CRCW06037K50FKEA |
| 24 | 1 | R14 | Res, Chip, 30m, 1%, 1206 | VISHAY WSL1206R0300FEA |
| 25 | 1 | R16 | Res, Chip, 0Ω, Shunt, 0805 | VISHAY CRCW08050000Z0EA |
| 26 | 1 | R19 | Res, Chip, 35.7Ω, 1%, 0805 | VISHAY CRCW080535R7FKEA |
| 27 | 0 | R20 | Res, Chip, OPT, 1%, 0805 | OPT |
| 28 | 1 | R23 | Res, Chip, 51k, 5%, 0603 | VISHAY, CRCW060351K0FKEA |
| 29 | 1 | R24 | Res, Chip, 20k, 5%, 0603 | VISHAY CRCW060320K0JNEA |
| 30 | 1 | R25 | Res, Chip, 47k, 5%, 0603 | NIC NRC06J473TRF |
| 31 | 1 | R26 | Res, Chip, 10k, 5%, 0603 | YAGEO RC0603JR-0710KL |
| 32 | 0 | R30 | Res, Chip, OPT, 5%, 0805 | OPT |
| 33 | 0 | R31 | Res, Chip, 0Ω, Shunt, 2512 | OPT |
| 34 | 1 | T1 | XFMR, Flyback Tran | Würth 750 314 783 |
| 34 | 1 | T1 (ALTERNATE) | XFMR, Flyback Tran | PCA EPC3586G |
| 35 | 0 | T2 | XFMR, Flyback Tran, OPT | OPT |
| 36 | 1 | U1 | IC, PD & Switcher Controller, LT4276AIUFD QFN28 | Linear Tech LT4276AIUFD |
| 37 | 1 | U2 | OPTO, MOC207 S08 | FAIRCHILD MOC207M |
| 38 | 1 | | FAB, PRINTED CIRCUIT BOARD | DEMO CIRCUIT 2046A |

SCHEMATIC DIAGRAM



LINTECH TECHNOLOGY
 1630 McCarthy Blvd.
 Milpitas, CA 95035
 Tel: (408) 441-2400 www.linear.com
 Fax: (408) 441-9977
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TITLE: SCHEMATIC
 HIGH EFFICIENCY POE PFC INTERFACE WITH INTEGRATED SWITCHING REGULATOR

APPROVALS

| | |
|----------|---------|
| DESIGN | K. HTOO |
| APP ENG. | K. HTOO |

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SCALE = NONE

SIZE C.N.O. **LT4276AUFD** **LT4321UIF**

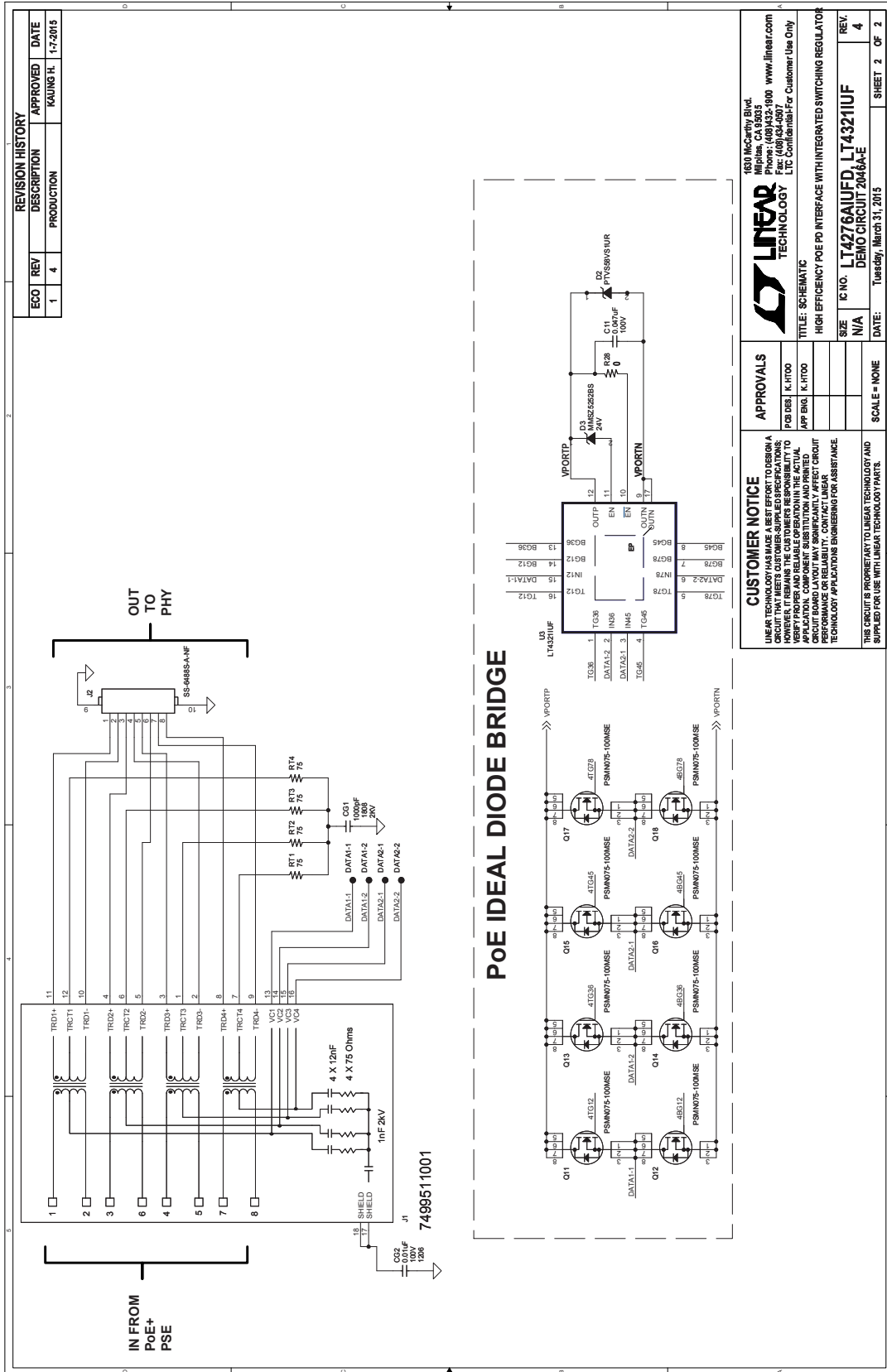
DATE: Wednesday, April 01, 2015

REVISION

| | |
|------|---|
| REV. | 4 |
| NO. | 4 |

SHEET 1 OF 2

SCHEMATIC DIAGRAM



| REVISION HISTORY | | APPROVED | DATE |
|------------------|-----|----------|----------|
| ECO | REV | | |
| 1 | 4 | KAUNG H. | 1/2/2015 |

LINEAR TECHNOLOGY
 1630 McCarty Blvd.
 Milpitas, CA 95035
 Tel: (415) 961-6000 www.linear.com
 Fax: (415) 434-9977
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TITLE: SCHEMATIC
 HIGH EFFICIENCY POE PD INTERFACE WITH INTEGRATED SWITCHING REGULATOR

APPROVALS

| | |
|----------|---------|
| POB DES. | K. HTOO |
| APP ENG. | K. HTOO |

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SIZE C.N.O. **LT4276A1UFD** **LT4321UUF**
REV. DEMO CIRCUIT 2046A-E **4**

DATE: Tuesday, March 31, 2015 **SHEET 2 OF 2**



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DEMO MANUAL DC2046A-E

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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.**

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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

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