

# 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<sup>®</sup>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.

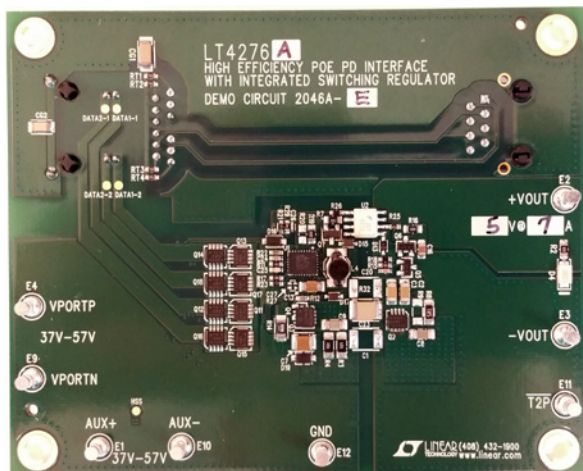
**Design files for this circuit board are available at <http://www.linear.com/demo/DC2046A-E>**

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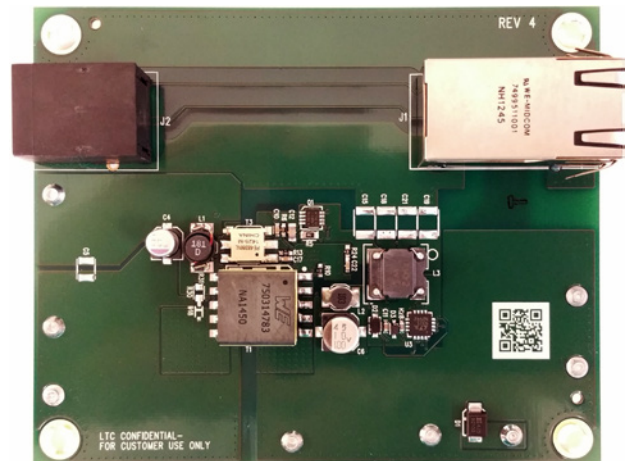
## PERFORMANCE SUMMARY Specifications are at T<sub>A</sub> = 25°C

PARAMETER	CONDITIONS	VALUE
Port Voltage (V <sub>PORT</sub> )	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 <sub>PORT</sub> = 50V, I <sub>OUT</sub> = 7A	25mV <sub>P-P</sub> (Typ)
Output Regulation		±0.06% (Typ)
Efficiency	V <sub>PORT</sub> = 50V, I <sub>OUT</sub> = 7A, End to End	91.5% (Typ)
Switching Frequency		250kHz (Typ)

## BOARD PHOTO



Top Side



Bottom Side

dc2046aef

## TYPICAL PERFORMANCE CHARACTERISTICS

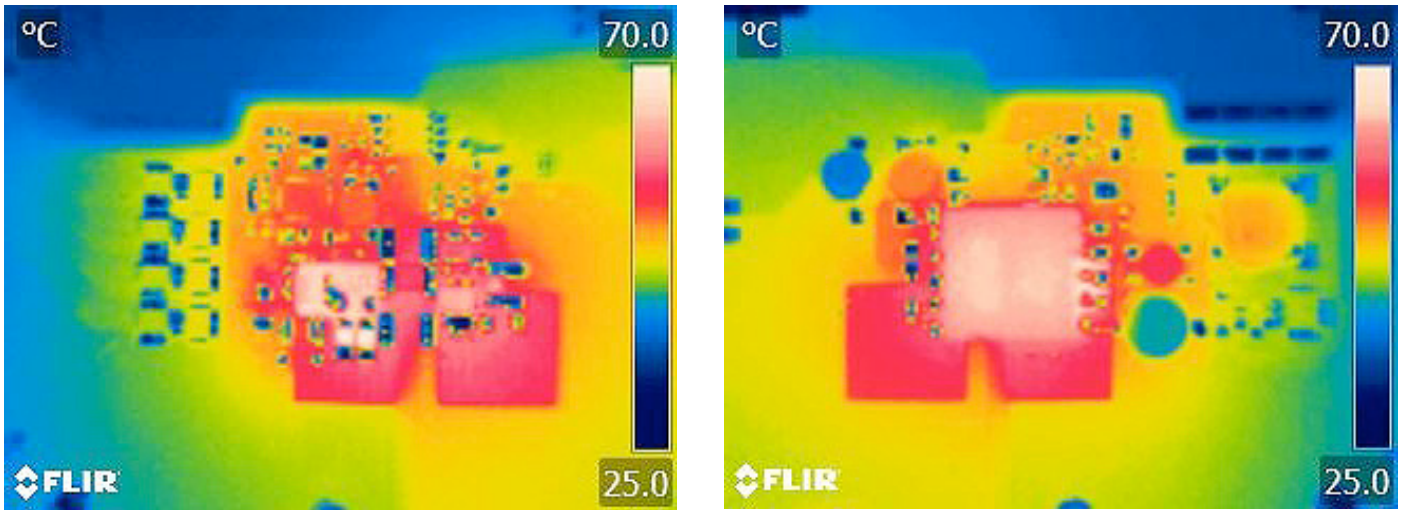


Figure 1. Thermal Pictures –  $V_{PORT} = 50V, 5V/7A$

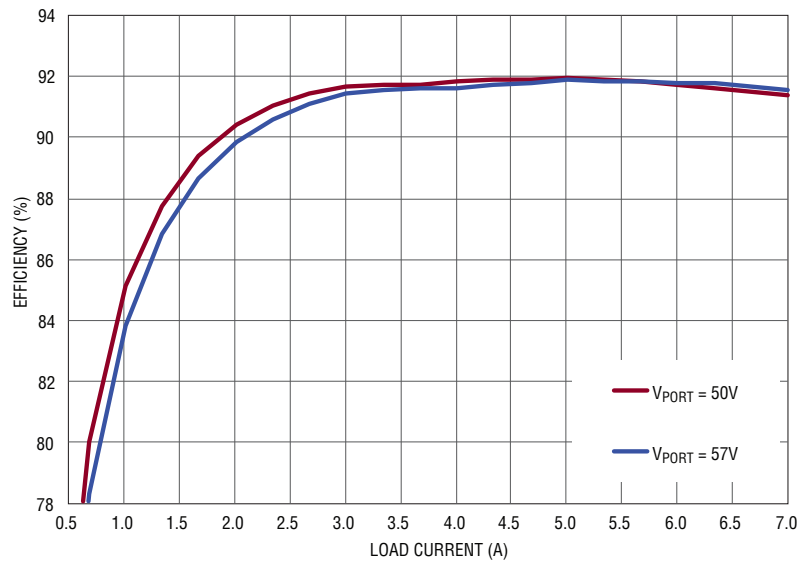


Figure 2. Efficiency (End to End)

## TYPICAL PERFORMANCE CHARACTERISTICS

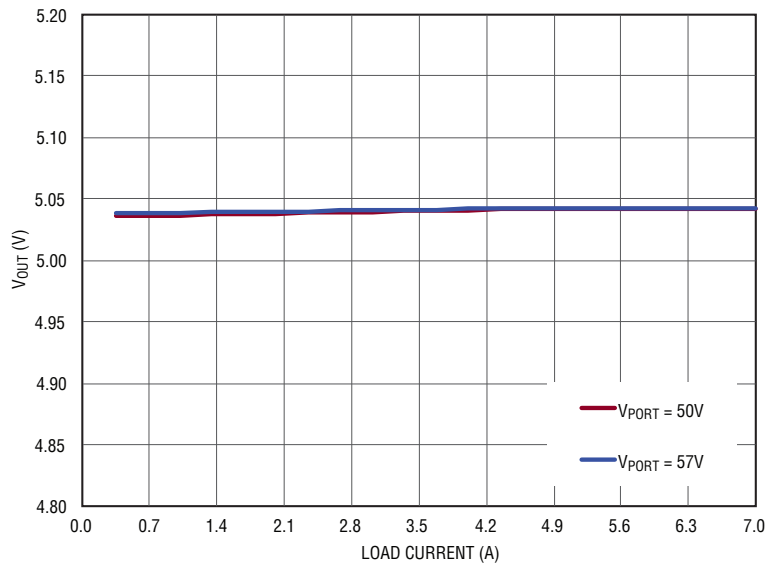


Figure 3. Output Voltage Regulation

## TYPICAL PERFORMANCE CHARACTERISTICS

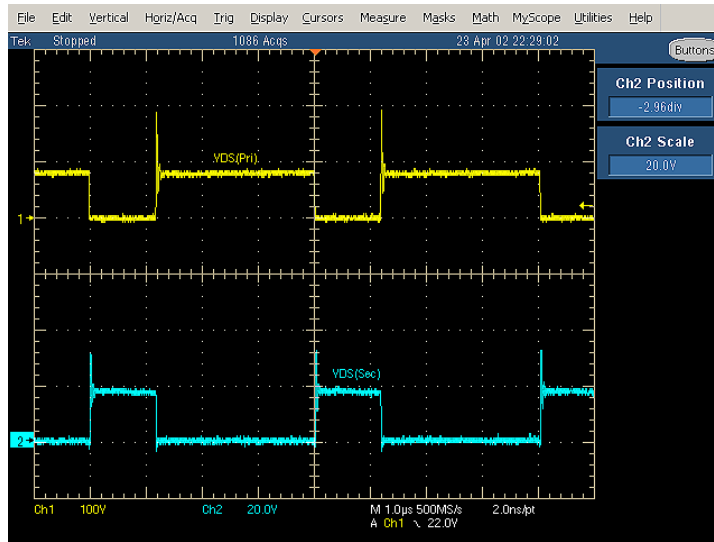


Figure 4. Stresses ( $V_{PORT} = 57V, 5V/7A$ )

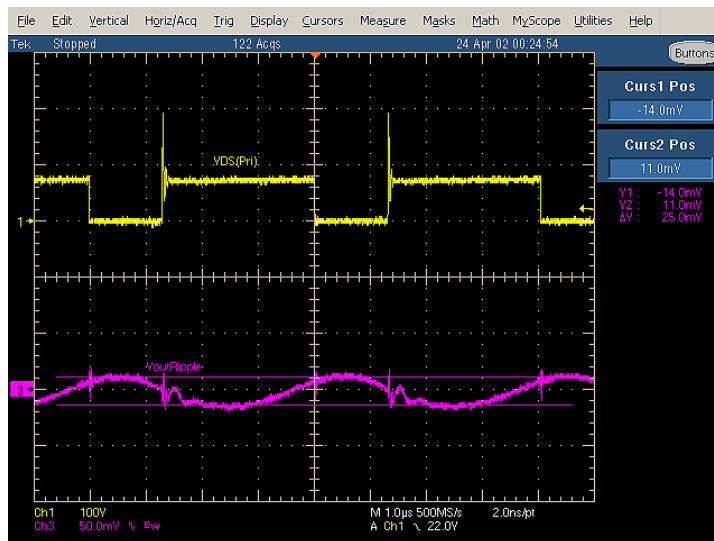


Figure 5. Output Voltage Ripple ( $V_{PORT} = 50V, 5V/7A$ )

## TYPICAL PERFORMANCE CHARACTERISTICS

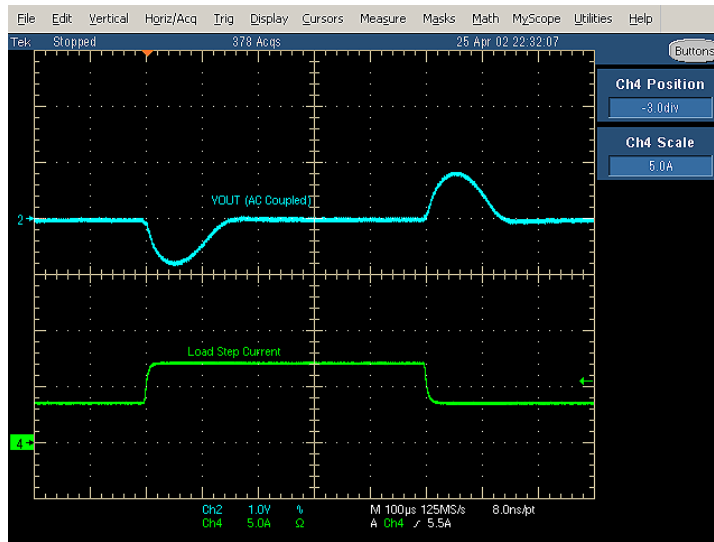


Figure 6. Load Transient Response ( $V_{PORT} = 50V$ , 3.5A to 7A to 3.5A)

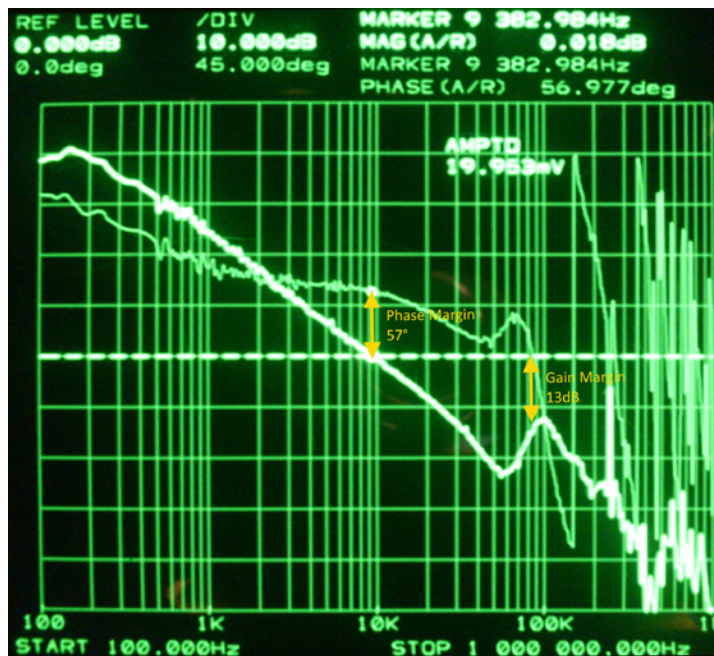


Figure 7. Gain and Phase Margin of the Flyback Loop ( $V_{PORT} = 57V$ , 5V/0.7A)

## 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.

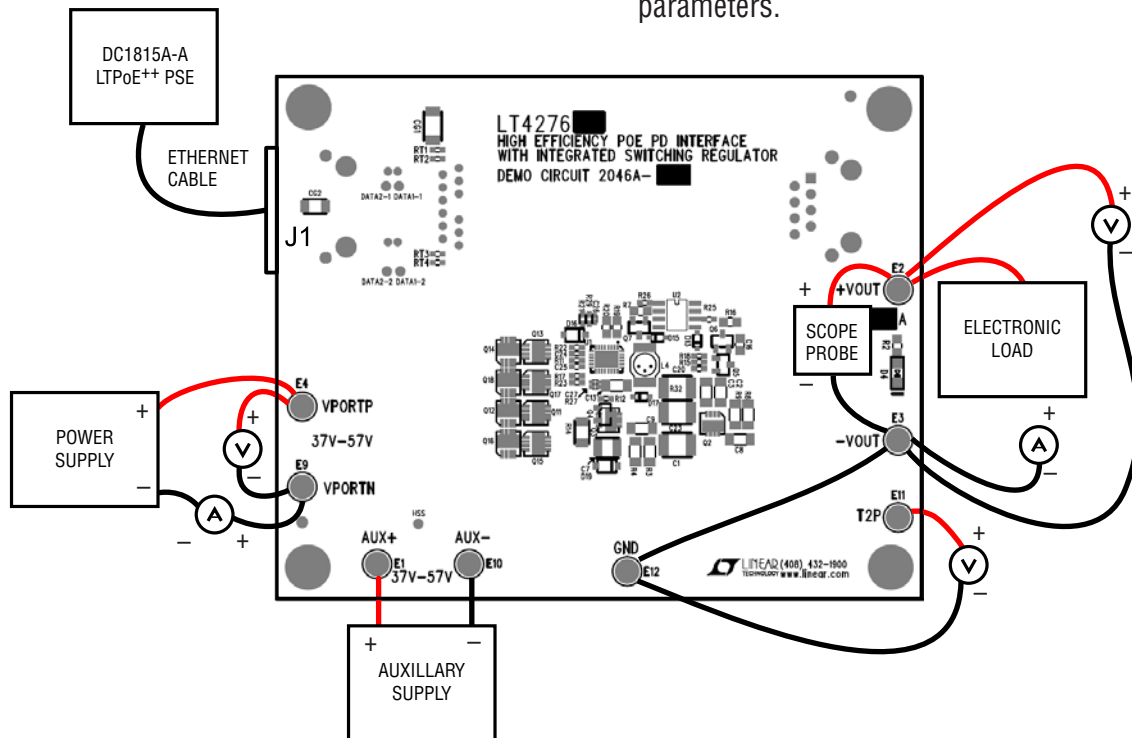


Figure 8. Proper Measurement Equipment Setup

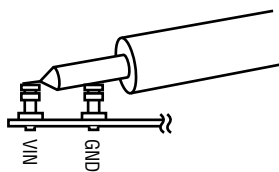


Figure 9. Measuring Output Ripple



## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>DC2046A GENERAL BOM</b>				
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
<b>DC2046A GENERAL BOM</b>				
38	1	R7	Res, Chip, 20 $\Omega$ , 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

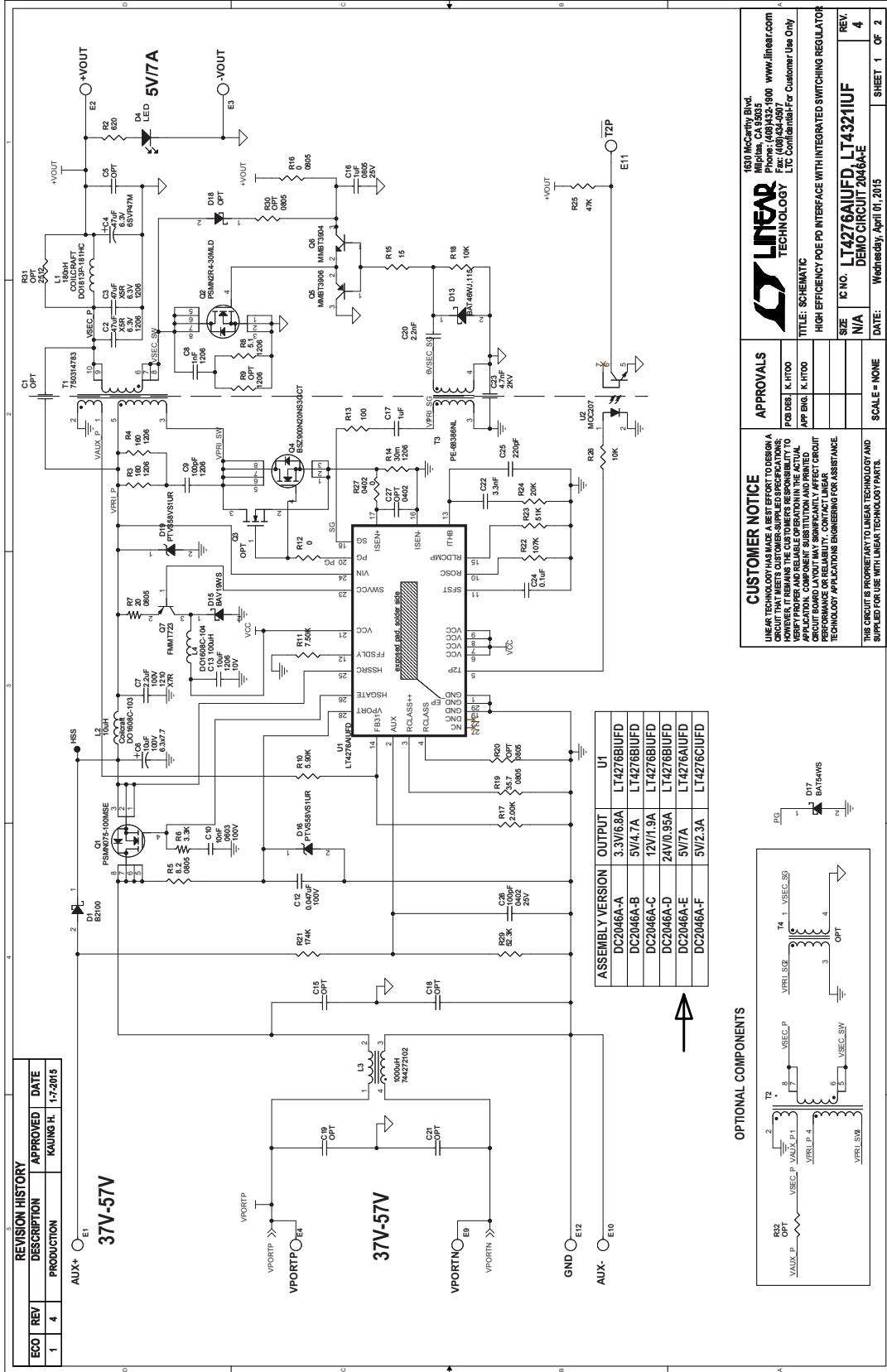


## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>DC2046A-E BOM</b>				
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

# DEMO MANUAL DC2046A-E

## SCHEMATIC DIAGRAM



**LINEAR TECHNOLOGY**  
 1630 McCarthy Blvd.  
 Milpitas, CA 95035  
 Tel: (415) 964-7000 www.linear.com  
 Fax: (415) 964-9977

**TITLE: SCHEMATIC**  
 HIGH EFFICIENCY POE PFC INTERFACE WITH INTEGRATED SWITCHING REGULATOR

**APPROVALS**  
 PCB DES. K. HTOO  
 APP ENG. K. HTOO

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**SCALE = NONE**

**DATE:** Wednesday, April 01, 2015

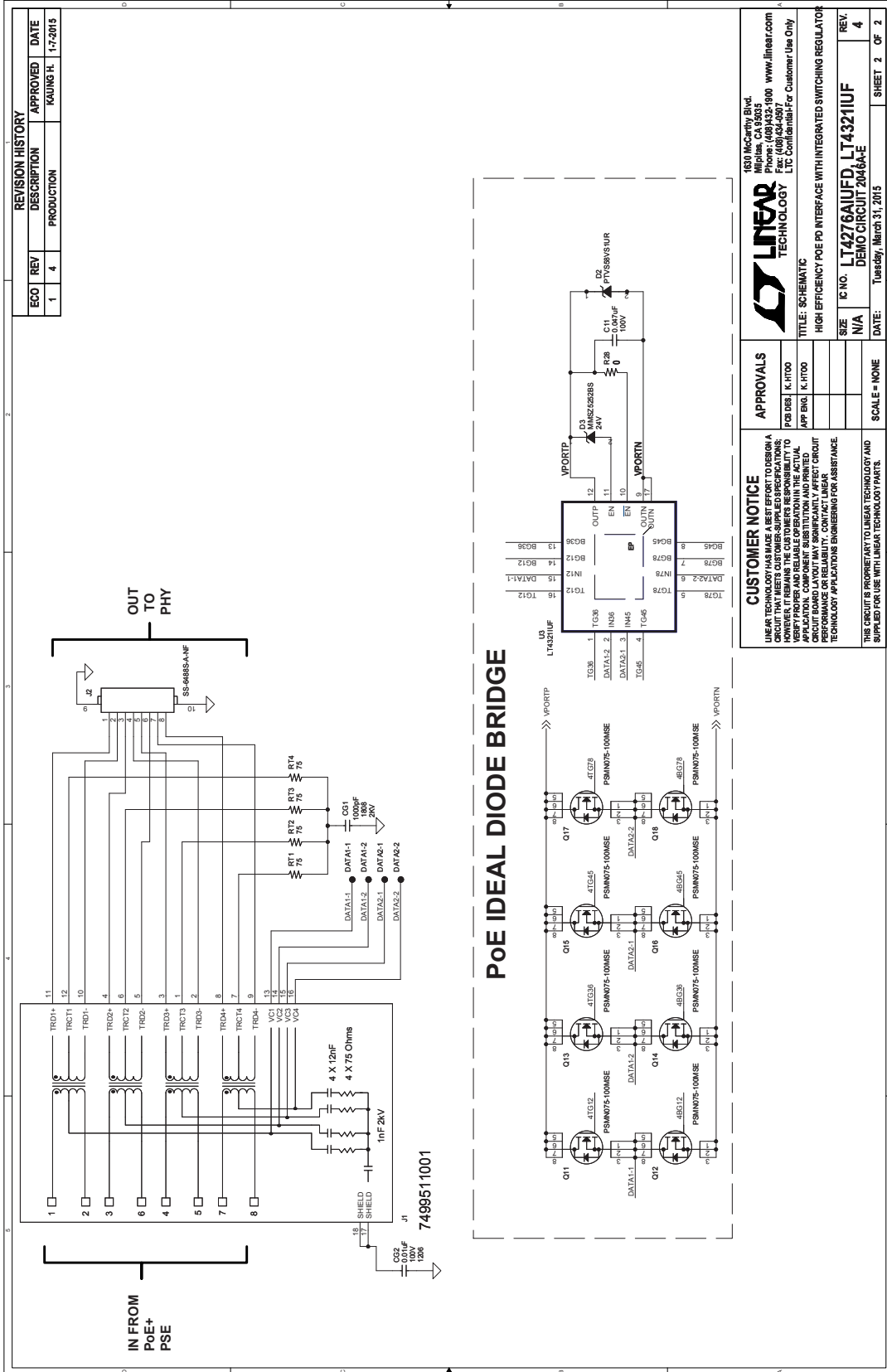
**SIZE** C.N.O. **LT4276AUFD** **LT4321UIF**

**N/A** **DC2046A-E**

**REV.** 4

**SHEET** 1 OF 2

SCHEMATIC DIAGRAM



REVISION HISTORY		APPROVED	DATE
ECO	REV	DESCRIPTION	
1	4	PRODUCTION	KAUNG H. 1-7-2015

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**APPROVALS**  
POB DES. K. HTOO  
APP ENG. K. HTOO

**SCALE = NONE**

**SIZE** C. NO. **LT4276A1UFD** **LT4321U1F**  
DEMO CIRCUIT 2046A-E

**REV.** 4  
**SHEET** 2 OF 2

**DATE:** Tuesday, March 31, 2015

**TITLE:** SCHEMATIC  
HIGH EFFICIENCY POE PD INTERFACE WITH INTEGRATED SWITCHING REGULATOR



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# DEMO MANUAL DC2046A-E

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