

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

### DESCRIPTION

Demonstration Circuit 2046A-C 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-C supplies a 12V output at up to 1.9A. It also demonstrates the use of an optional auxiliary power supply input of 48V. 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-C>**

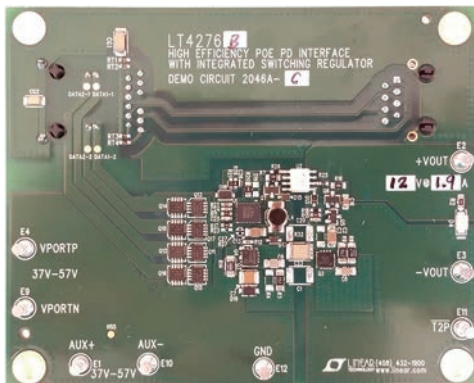
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### PERFORMANCE SUMMARY

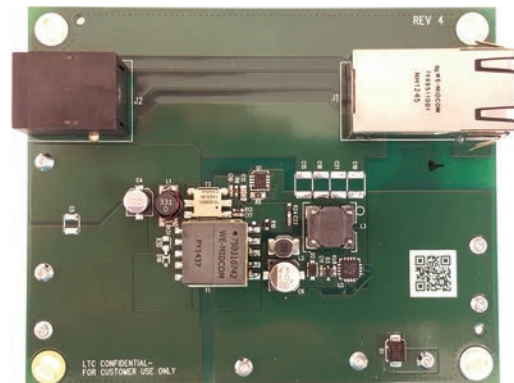
Specifications are at  $T_A = 25^\circ\text{C}$

PARAMETER	CONDITIONS	VALUE
Port Voltage ( $V_{\text{PORT}}$ )	At Ethernet Port	37V to 57V
Auxiliary Voltage	From AUX+ to AUX- Terminals	37V to 57V
Output Voltage		12V (Typ)
Output Current		1.9A (Max)
Output Voltage Ripple	$V_{\text{PORT}} = 42.5\text{V}$ , $I_{\text{OUT}} = 6.8\text{A}$	85mV <sub>p-p</sub> (Typ)
Output Regulation		±0.6% (Typ)
Efficiency	$V_{\text{PORT}} = 50\text{V}$ , $I_{\text{OUT}} = 1.9\text{A}$ , End to End	92% (Typ)
Switching Frequency		250kHz (Typ)

### BOARD PHOTOS



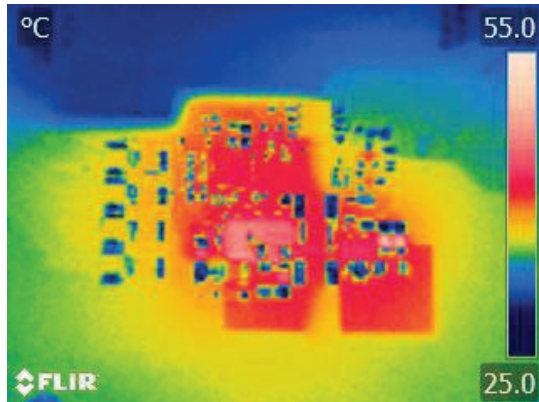
Top Side



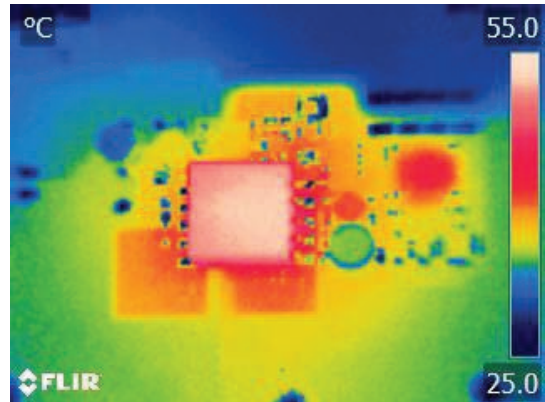
Bottom Side

dc2046acf

## TYPICAL PERFORMANCE CHARACTERISTICS



Top Side



Bottom Side

Figure 1. Thermal Pictures –  $V_{PORT} = 57V, 12V/1.9A$

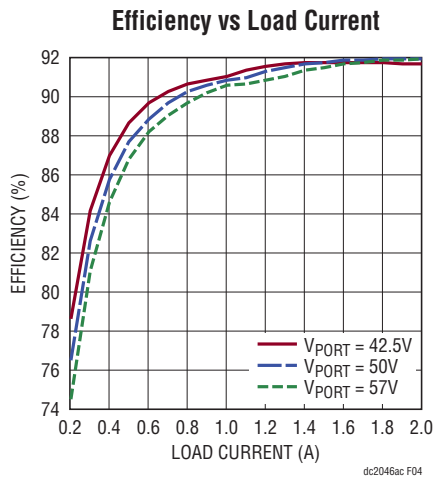


Figure 2. Efficiency (End to End)

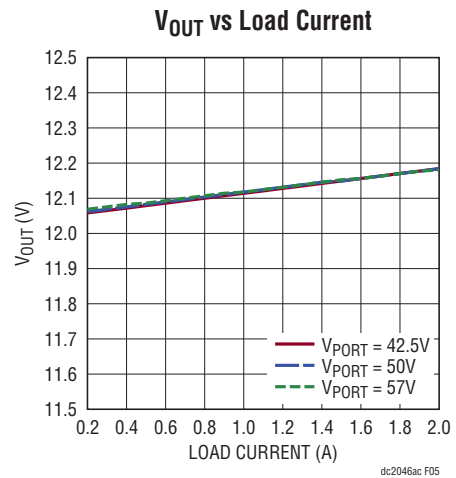


Figure 3. Output Voltage Regulation

## TYPICAL PERFORMANCE CHARACTERISTICS

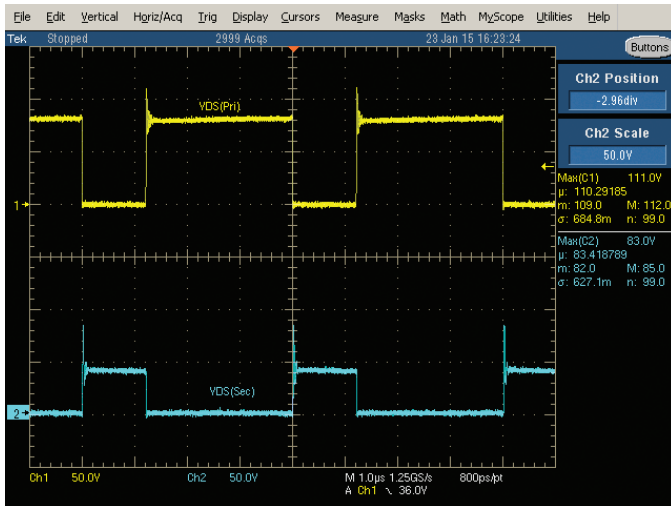


Figure 4. Stresses ( $V_{PORT} = 57V, 12V/1.9A$ )

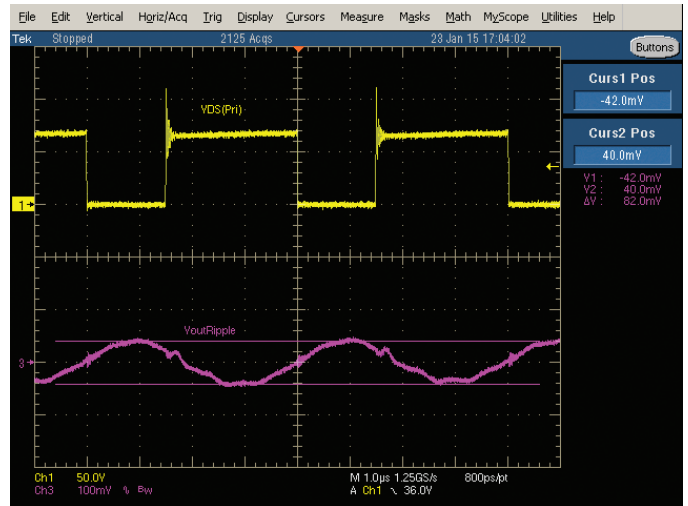


Figure 5. Output Voltage Ripple ( $V_{PORT} = 42.5V, 12V/1.9A$ )

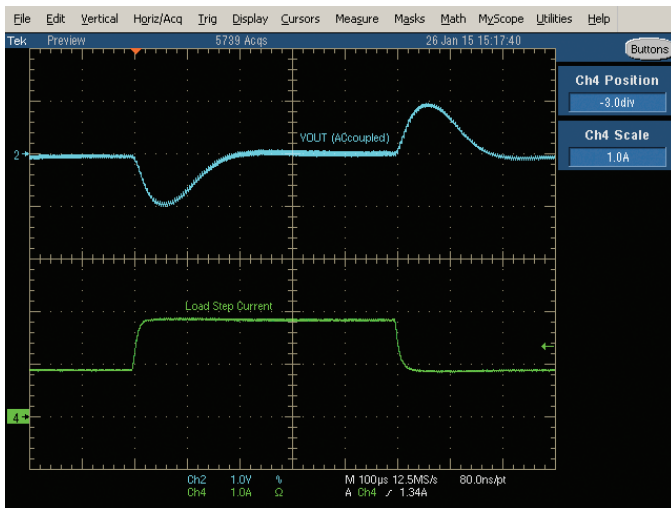


Figure 6. Load Transient Response ( $V_{PORT} = 42.5V, 0.95A$  to  $1.9A$  to  $0.95A$ )

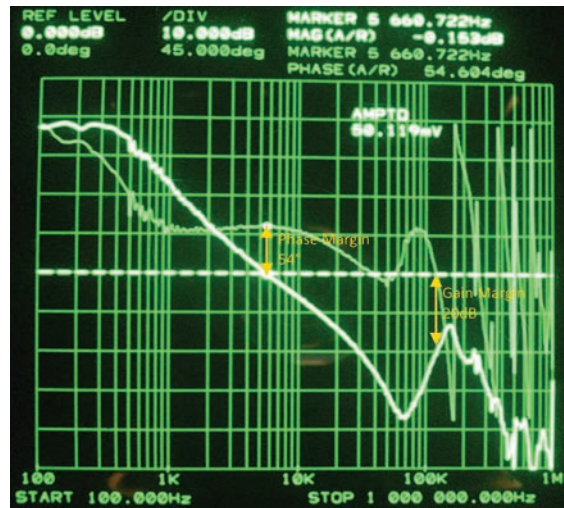


Figure 7. Gain and Phase Margin of the Flyback Loop ( $V_{PORT} = 57V, 12V/0.2A$ )

## QUICK START PROCEDURE

Demonstration circuit 2046A-C 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 PoE+ 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 12V.
  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.

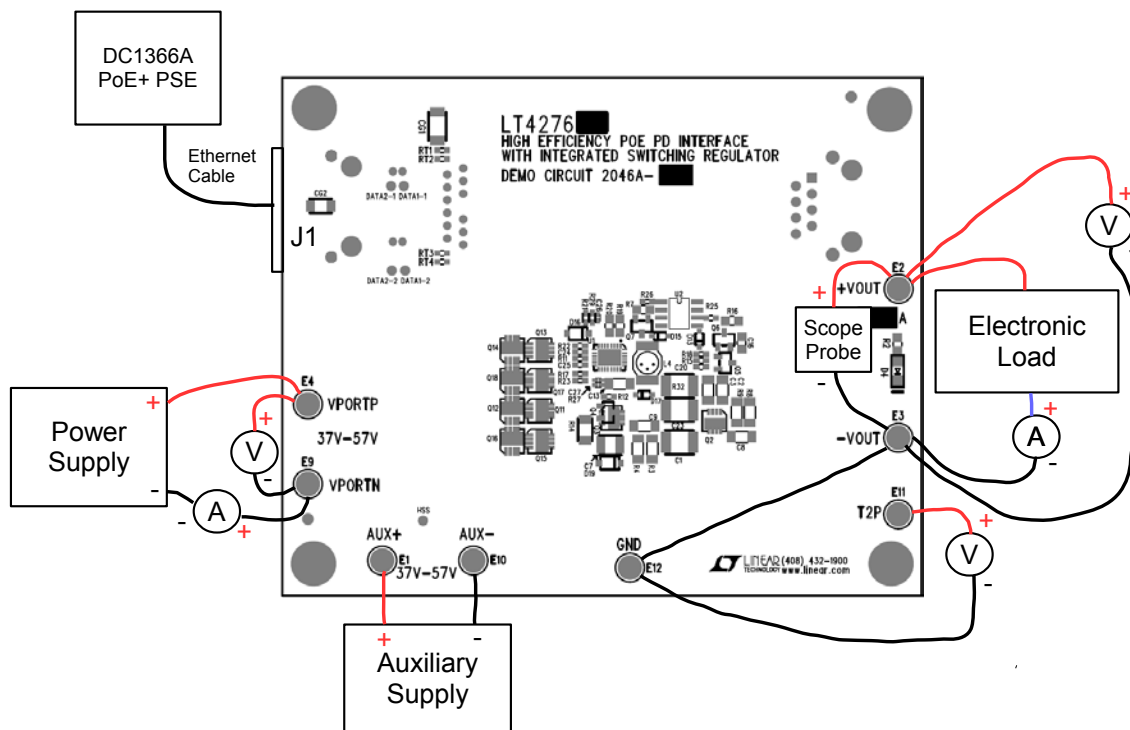


Figure 8. Proper Measurement Equipment Setup

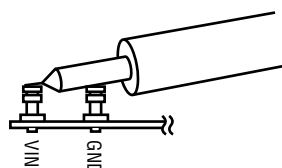


Figure 9. Measuring Output Ripple

## 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

# DEMO MANUAL DC2046A-C

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
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
38	1	R7	RES, CHIP, 20Ω 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

### DC2046A-C BOM

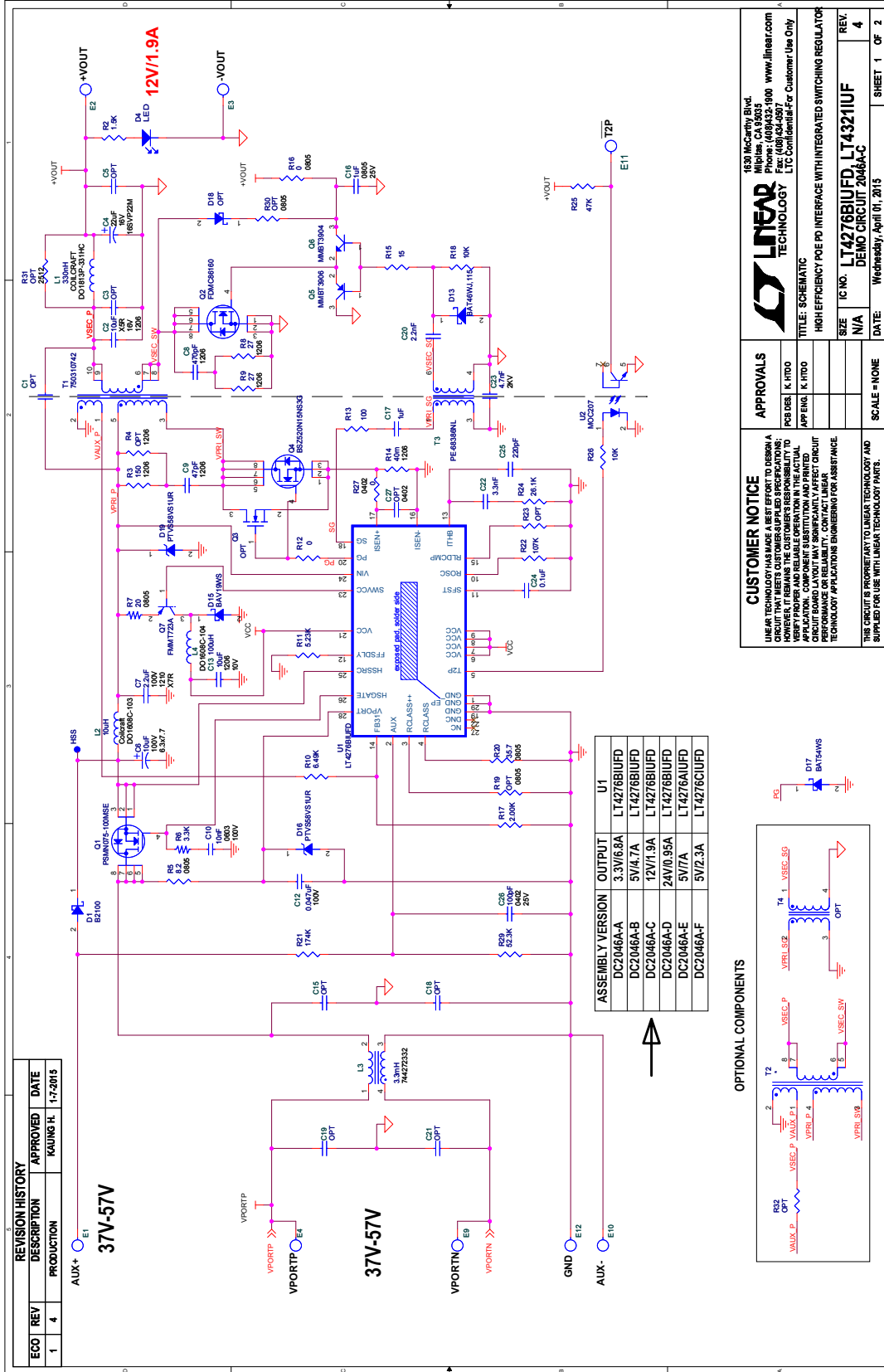
1	1	C2	CAP, CER, X5R 10μF 16V 10% 1206	MURATA GRM31CR61C106KA88
2	0	C3	CAP, CER, X7R OPT 25V 10% 1206	OPT
3	1	C4	CAP, ELEC, 22μF 16V 20% 5.0X5.3	PANASONIC 16SVP22M
4	1	C8	CAP, CER, U2J 470pF 630V 5% 1206	MURATA GRM31A7U2J471JW31D
5	1	C9	CAP, CER, U2J 47pF 630V 5% 1206	MURATA GRM31A7U2J470JW31D
6	1	C16	CAP, CER, X7R 1μF 25V 10% 0805	MURATA GRM21BR71E105KA99L
7	1	C22	CAP, CER, X7R 3.3nF 25V 10% 0603	MURATA
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, 330nH	COILCRAFT DO1813P-331HC
13	1	L3	IND, CMC, 3.3mH	WÜRTH 744 272 332
13	0	L3 (ALTERNATE)	IND, CMC, 3.3mH	PCA EPA4411
14	1	Q2	MOSFET, N-CH, FDMC86160 100V POWER-33	FAIRCHILD FDMC86160
15	0	Q3	MOSFET, N-CH, OPT SOT23	OPT

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
16	1	Q4	MOSFET, N-CH, 150V TDSO8-8	INFINEON BSZ520N15NS3G
17	1	R2	RES, CHIP, 1.5k 5% 0805	NIC NRC06J152TRF
18	1	R3	RES, CHIP, 150Ω 5% 1206	YAGEO RC1206JR-07150RL
19	0	R4	RES, CHIP, OPT 5% 1206	OPT
20	1	R8	RES, CHIP, 27Ω 5% 1206	VISHAY CRCW120627R0JNEA
21	1	R9	RES, CHIP, 27Ω 5% 1206	VISHAY CRCW120627R0JNEA
22	1	R10	RES, CHIP, 6.49k 1% 0603	YAGEO RC0603-076K49L
23	1	R11	RES, CHIP, 5.23k 1% 0603	VISHAY CRCW06035K23FKEA
24	1	R14	RES, CHIP, 40mΩ 1% 1206	VISHAY WSL1206R0400FEA
25	1	R16	RES, CHIP, 0Ω, SHUNT, 0805	VISHAY CRCW08050000Z0EA
26	0	R19	RES, CHIP, OPT 1% 0805	OPT
27	1	R20	RES, CHIP, 35.7Ω 1% 0805	VISHAY CRCW080535R7FKEA
28	0	R23	RES, CHIP, OPT 5% 0603	OPT
29	1	R24	RES, CHIP, 26.1k 1% 0603	VISHAY CRCW060326K1FKEA
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, 750310742	WÜRTH 750 310 742
34	0	T1 (ALTERNATE)	XFMR, FLYBACK TRAN, EPC3410G	PCA EPC3410G
35	0	T2	XFMR, FLYBACK TRAN, OPT	OPT
36	1	U1	IC, PD AND SWITCHER CONTROLLER, LT4276BIUFD QFN28	LINEAR TECH LT4276BIUFD
37	1	U2	OPTO, MOC207 S08	FAIRCHILD MOC207M
38	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT 2046A

# DEMO MANUAL DC2046A-C

## SCHEMATIC DIAGRAM



**LINEAR TECHNOLOGY**  
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Folsom, CA 95630-9090 www.linear.com  
Tel: (916) 434-3000 Fax: (916) 941-0077  
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**TITLE: SCHEMATIC**  
HIGH EFFICIENCY POE PD INTERFACE WITH INTEGRATED SWITCHING REGULATOR

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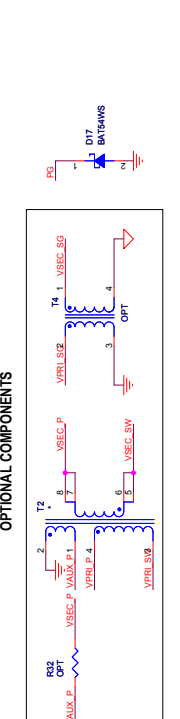
**APPROVALS**  
PCB DES. K. HOTO  
APP. ENG. K. HOTO

**SCALE: NONE**

**SIZE** IC NO. **LT4276BUFD, LT4321UFD**  
DEMO CIRCUIT **2046A-C**

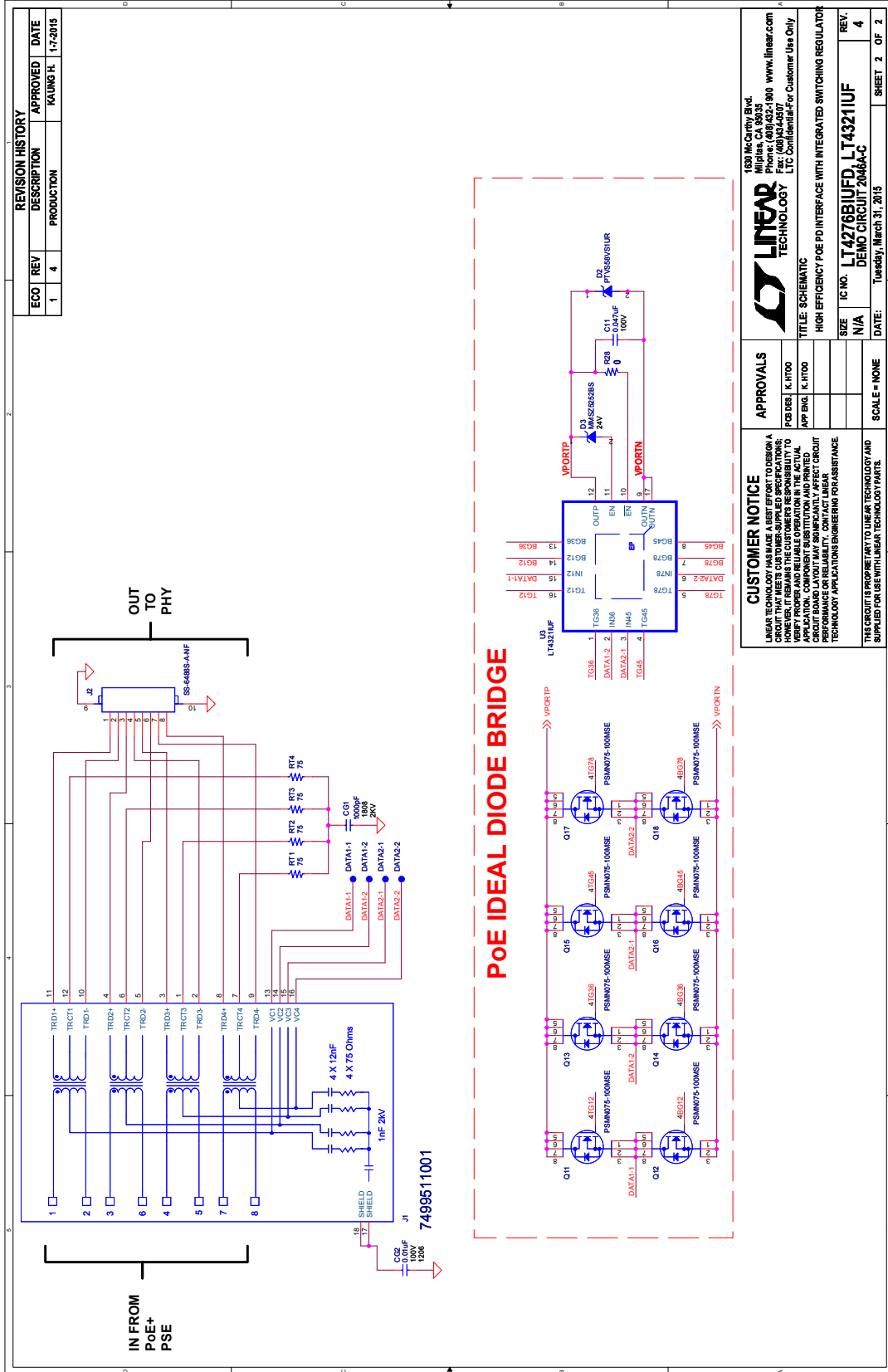
**DATE:** Wednesday, April 01, 2015

**REV. 4**  
**SHEET 1 OF 2**





SCHEMATIC DIAGRAM



# DEMO MANUAL DC2046A-C

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**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.

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