

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

DESCRIPTION

Demonstration circuit 2046A-D 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-D supplies a 24V output at up to 0.95A. 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.

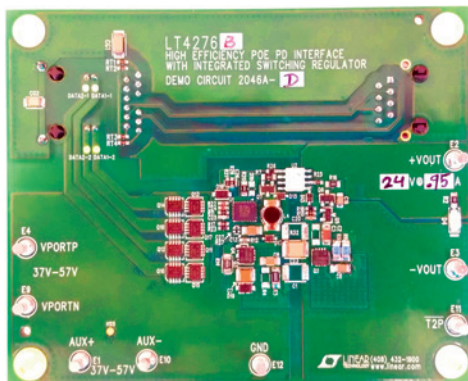
Design files for this circuit board are available at <http://www.linear.com/demo/DC2046A-D>

LT, LT, LTC, LTM, Linear Technology and the Linear logo are registered trademarks and LTPoE++ is a trademark of Linear Technology Corporation. All other trademarks are the property of their respective owners.

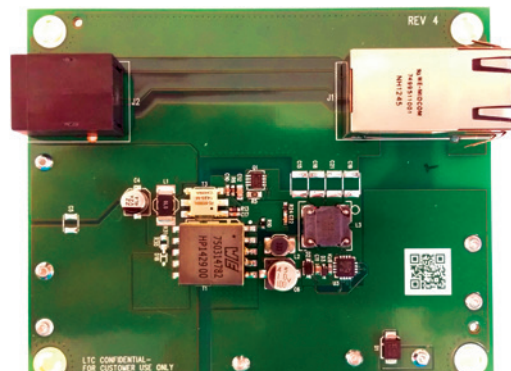
PERFORMANCE SUMMARY Specifications are at T_A = 25°C

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		24V (Typ)
Output Current		0.95A (Max)
Output Voltage Ripple	V _{PORT} = 42.5V, I _{OUT} = 1A	100mV _{P-P} (Typ)
Output Regulation		±0.03% (Typ)
Efficiency	V _{PORT} = 50V, I _{OUT} = 1A, End to End	91.5% (Typ)
Switching Frequency		250kHz (Typ)

BOARD PHOTOS

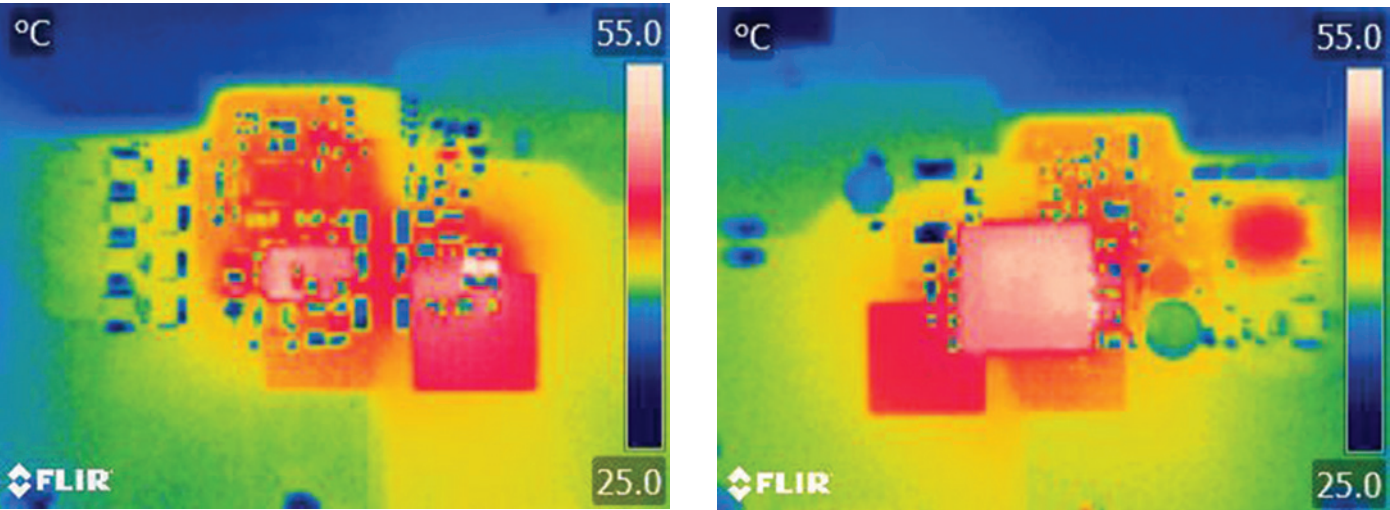


Top Side



Bottom Side

TYPICAL PERFORMANCE CHARACTERISTICS



Top Side Bottom Side

Figure 1. Thermal Pictures – $V_{PORT} = 57V, 24V/0.95A$

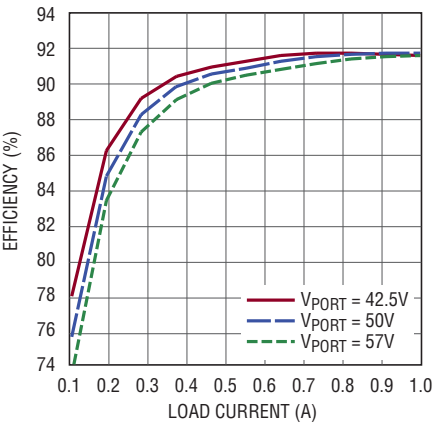


Figure 2. Efficiency (End to End)

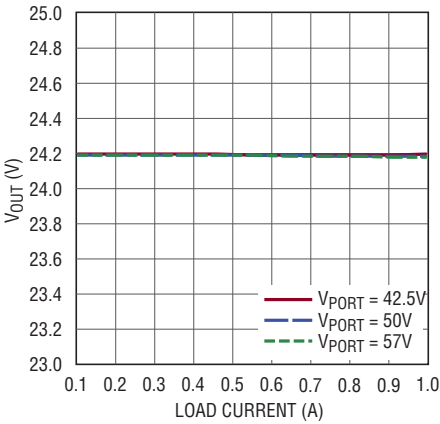


Figure 3. Output Voltage Regulation

TYPICAL PERFORMANCE CHARACTERISTICS

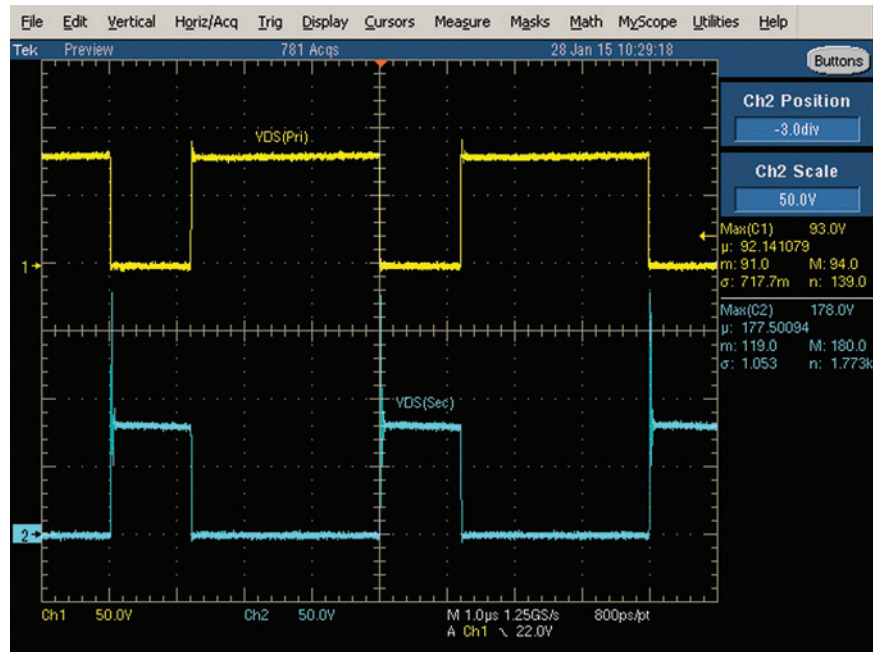


Figure 4. Stresses ($V_{PORT} = 57V$, $24V/0.95A$)

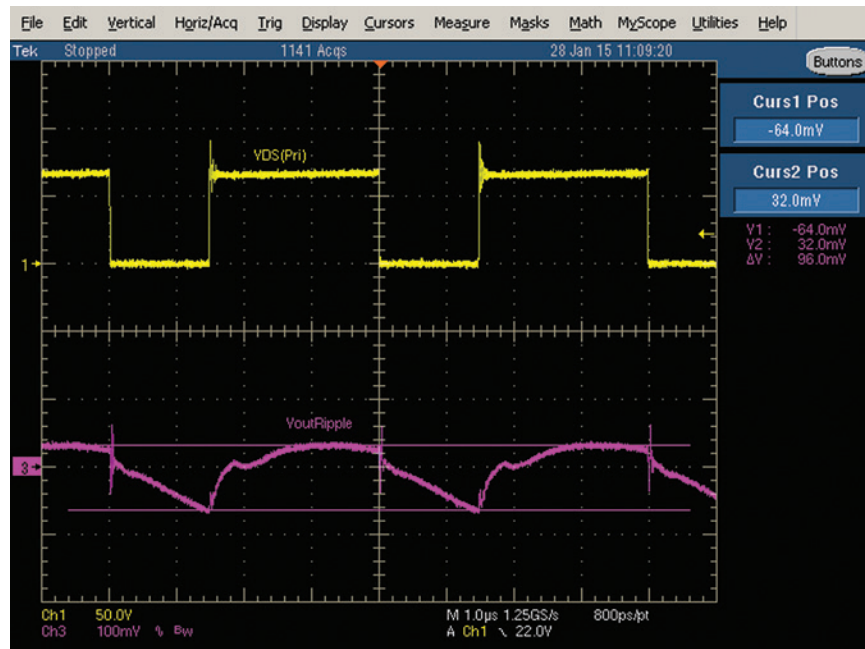


Figure 5. Output Voltage Ripple ($V_{PORT} = 42.5V$, $24V/0.95A$)

TYPICAL PERFORMANCE CHARACTERISTICS

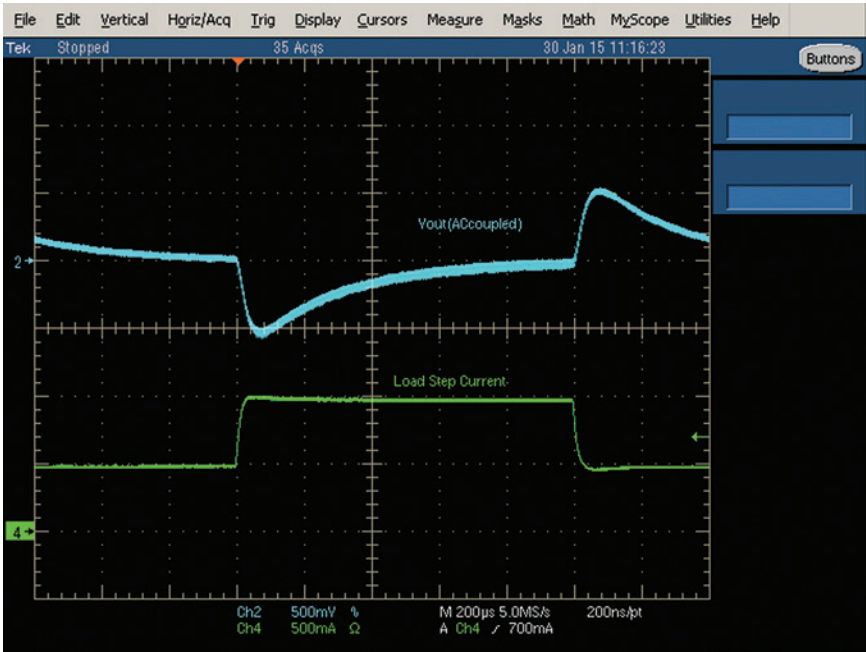


Figure 6. Load Transient Response ($V_{PORT} = 42.5V$, 0.5A to 1A to 0.5A)

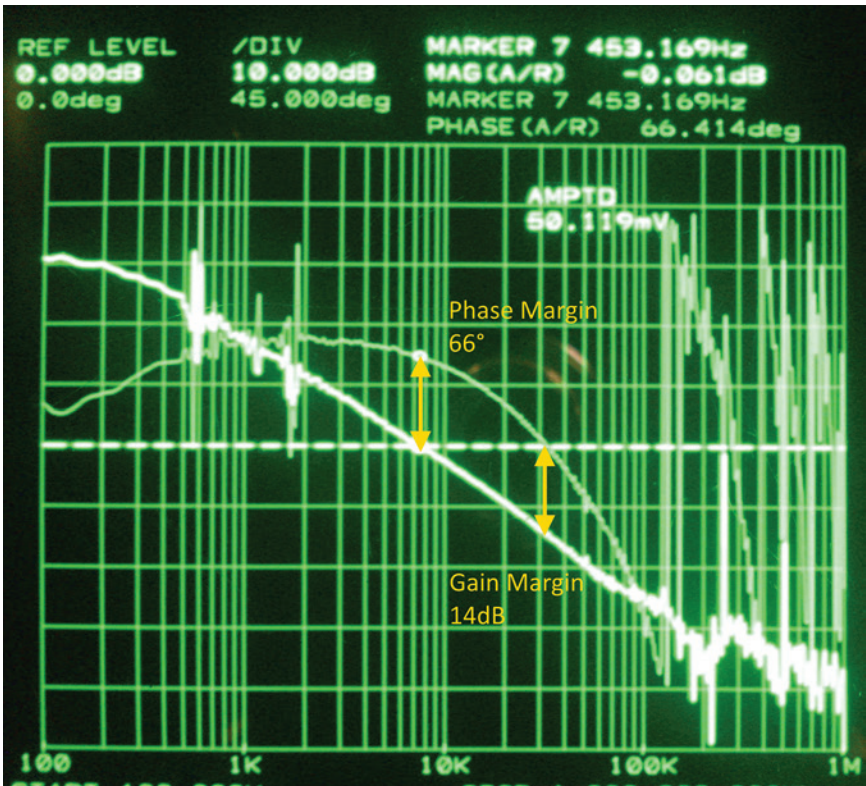


Figure 7. Gain and Phase Margin of the Flyback Loop ($V_{PORT} = 42.5V$, 24V/0.95A)

QUICK START PROCEDURE

Demonstration circuit 2046A-D 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 +VOUT and -VOUT 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:

- Connect a PoE+ capable PSE with a CAT-5 cable to the RJ45 connector, J1. See Figure 8.
- Or, connect a 37V to 57V capable power supply (Power Supply in Figure 8) across V_{PORTP} and V_{PORTN} .
- 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 24V.

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.

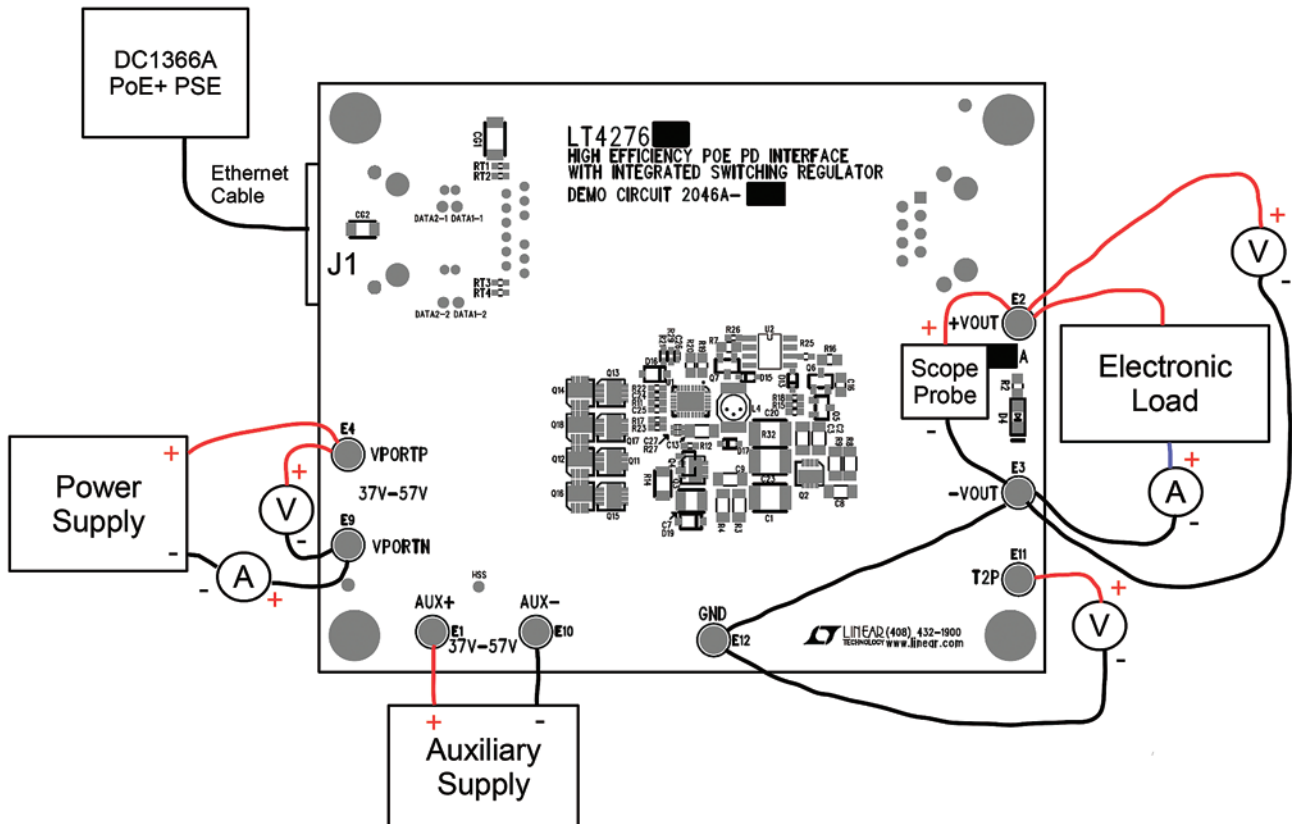


Figure 8. Proper Measurement Equipment Setup

QUICK START PROCEDURE

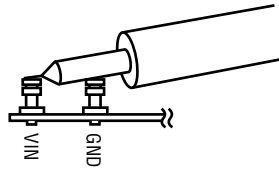


Figure 9. Measuring Output Ripple

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% 6.3 × 7.7	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, Diodes Inc., BAV19WS 120V SOD323	Diodes 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	Tran, PNP, MMBT3906 40V SOT23	Fairchild MMBT3906
33	1	Q6	Tran, 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, 75Ω 5% 0603	NIC NRC06J750TRF

DEMO MANUAL DC2046A-D

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
36	1	R5	Res, Chip, 8.2Ω 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, 0Ω 5% 0603	NIC NRC06Z0TRF
40	1	R13	Res, Chip, 100Ω 5% 0603	Vishay CRCW0603100RFKEA
41	1	R15	Res, Chip, 15Ω 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, 0Ω 5% 0402	NIC NRC04Z0TRF
47	1	R28	Res, Chip, 0Ω 5% 0603	NIC NRC06Z0TRF
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 Technology LT4321IUF

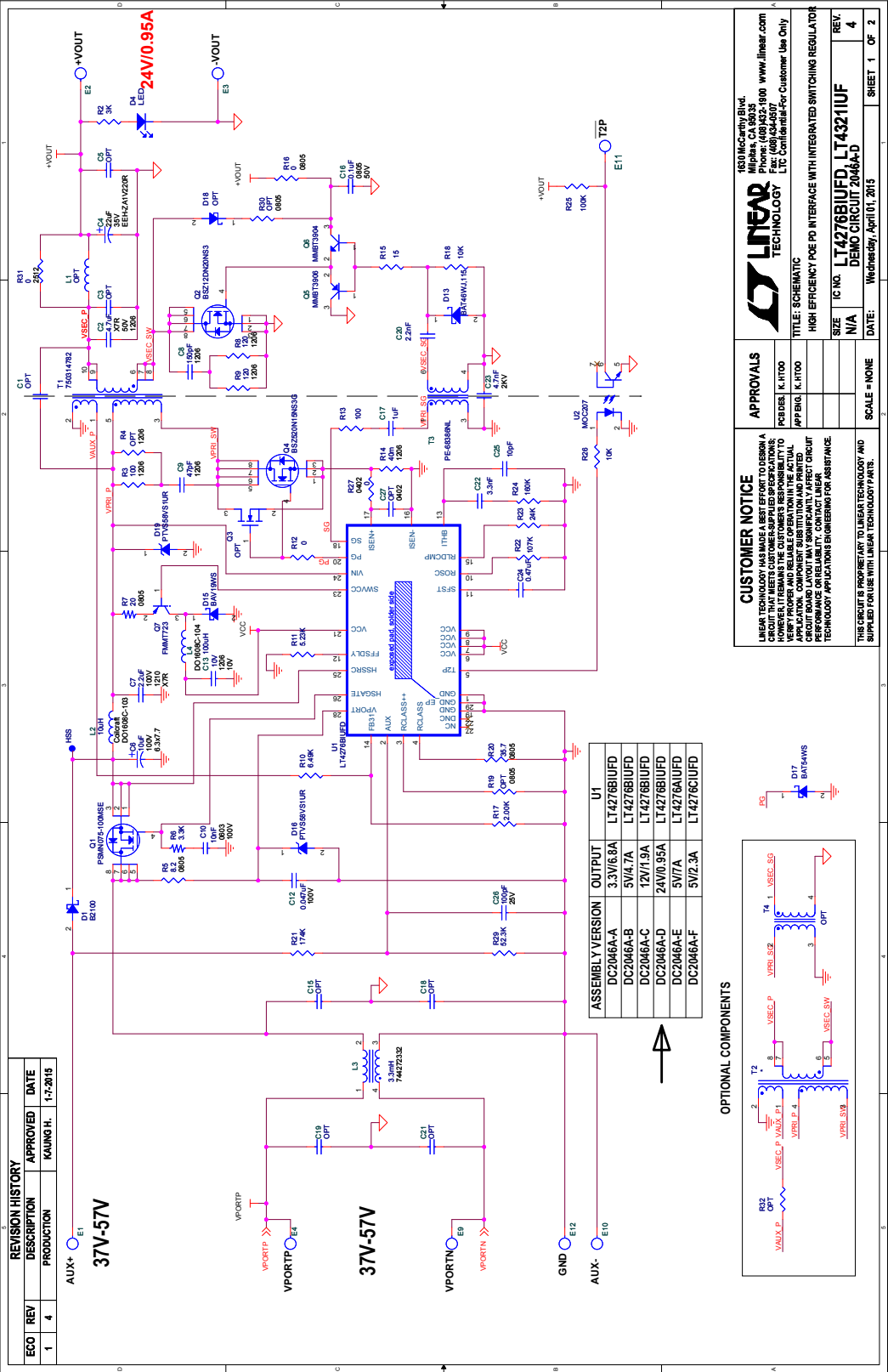
DC2046A-D BOM

1	1	C2	Cap, Cer, X7R 4.7μF 50V 10% 1206	Murata GRM31CR71H475KA12
2	0	C3	Cap, Cer, X7R Opt 25V 10% 1206	Opt
3	1	C4	Cap, Elec, 22μF 35V 20% 5.0X5.3	Panasonic EEH-ZA1V220R
4	1	C8	Cap, Cer, U2J 150pF 630V 5% 1206	Murata GRM31A7U2J151JW31D
5	1	C9	Cap, Cer, U2J 47pF 630V 5% 1206	Murata GRM31A7U2J470JW31D
6	1	C16	Cap, Cer, X7R 0.1μF 50V 10% 0805	Murata GRM21BR71H104KA01L
7	1	C22	Cap, Cer, X7R 3.3nF 25V 10% 0603	Murata GRM188R71E332KA01
8	1	C24	Cap, Cer, X7R 0.47μF 25V 20% 0603	Murata GRM188R71E474MA12
9	1	C25	Cap, Cer, X7R 10pF 25V 10% 0603	AVX 06033A100JAT2A
10	0	D18	Diode, Diodes Inc., Opt 40V SOD323	Diodes Inc. Opt
11	1	E11	TP, Turret, PAD150-094 0.094"	Mill-Max 2501-2-00-80-00-00-07-0
12	0	L1	Ind, Opt	Coilcraft Opt
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, BSZ12DN20NS3 200V PG-TSDSON-8	Infineon BSZ12DN20NS3
15	0	Q3	MOSFET, N-CH, Opt SOT23	Opt
16	1	Q4	MOSFET, N-CH, BSZ520N15NS3G 150V PG-TSDSON-8	Infineon BSZ520N15NS3G
17	1	R2	Res, Chip, 3k 5% 0805	Yageo RC0805JR-073KL
18	1	R3	Res, Chip, 100Ω 5% 1206	Vishay CRCW1206100RJNEA
19	0	R4	Res, Chip, Opt 5% 1206	Opt
20	1	R8	Res, Chip, 120Ω 5% 1206	Vishay CRCW1206120RJNEA
21	1	R9	Res, Chip, 120Ω 5% 1206	Vishay CRCW1206120RJNEA

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
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, 40m Ω 1% 1206	Vishay WSL1206R0400FEA
25	1	R16	Res, Chip, 0 Ω , Shunt, 0805	Vishay CRCW08050000Z0EA
26	0	R19	Res, Chip, Opt 1% 0805	Opt
27	1	R20	Res, Chip, 35.7 Ω 1% 0805	Vishay CRCW080535R7FKEA
28	1	R23	Res, Chip, 24k 5% 0603	Vishay CRCW060324K0JNEA
29	1	R24	Res, Chip, 160k 5% 0603	Vishay CRCW0603160KJNEA
30	1	R25	Res, Chip, 100k 5% 0603	Vishay CRCW0603100KJNEA
31	1	R26	Res, Chip, 10k 5% 0603	Yageo RC0603JR-0710KL
32	0	R30	Res, Chip, Opt 5% 0805	Opt
33	1	R31	Res, Chip, 0 Ω , Shunt, 2512	Vishay CRCW25120000Z0EG
34	1	T1	XFMR, Flyback Tran, 750314782	Würth 750 314 782
34	0	T1 (Alternate)	XFMR, Flyback Tran, EPC3603G	PCA EPC3603G
35	0	T2	XFMR, Flyback Tran, Opt	Opt
36	1	U1	IC, PD & Switcher Controller, LT4276BIUFD QFN28	Linear Technology LT4276BIUFD
37	1	U2	Opto, MOC207 S08	Fairchild MOC207M
38	1		Fab, Printed Circuit Board	Linear Technology Demo Circuit 2046A

SCHEMATIC DIAGRAM



CUSTOMER NOTICE

LINEAR TECHNOLOGY ASSUMES NO RESPONSIBILITY FOR THE DESIGN OR PERFORMANCE OF ANY CIRCUIT THAT MEETS CUSTOMER-SPECIFIED REQUIREMENTS. THE USER ASSUMES ALL LIABILITY FOR THE DESIGN, CONSTRUCTION, AND PERFORMANCE OF ANY CIRCUIT. LINEAR TECHNOLOGY IS NOT RESPONSIBLE FOR ANY DAMAGE TO PERSONS OR PROPERTY, CONTACT DAMAGE, OR ANY OTHER DAMAGE, ARISING FROM THE USE OF ANY LINEAR TECHNOLOGY PRODUCT IN ANY APPLICATION. COMPONENT SUBSTITUTION AND PRINTED CIRCUIT BOARD LAYOUT MAY SIGNIFICANTLY AFFECT CIRCUIT PERFORMANCE. FOR RELIABILITY, CONTACT LINEAR TECHNOLOGY FOR APPLICATIONS ENGINEERING OR ASSISTANCE.

APPROVALS

PCB DES.	K. HTOO
APP'G	K. HTOO

LINEAR TECHNOLOGY

1630 McCarthy Blvd.
Folsom, CA 95630
Tel: 916/343-4500
Fax: 916/343-4505
www.linear.com

LT4276BIUFD, LT4321UFD
DEMO CIRCUIT 2046A-D

DATE: Wednesday, April 01, 2015

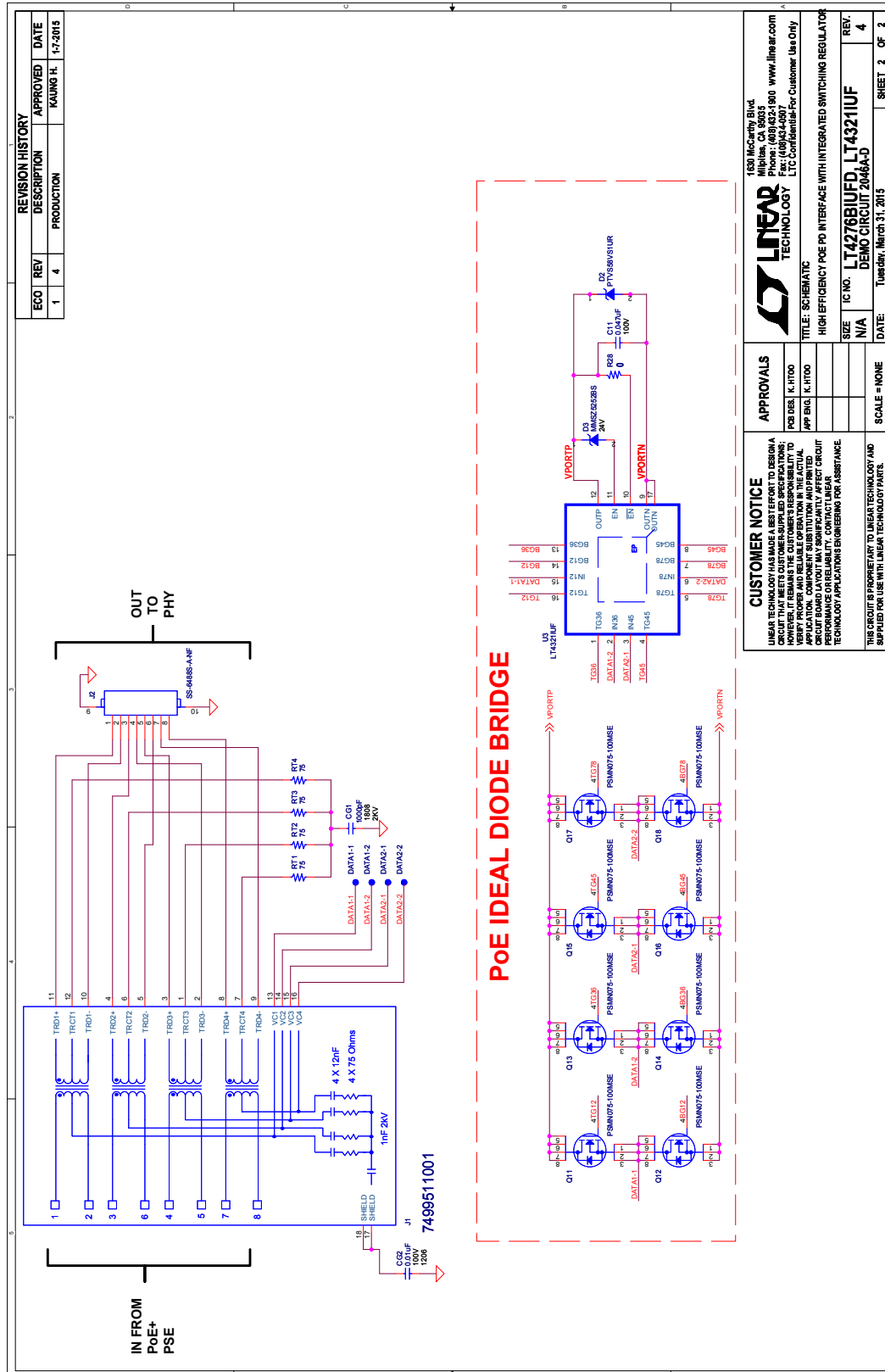
SCALE: NONE

SIZE: N/A

REV: 4

SHEET 1 OF 2

SCHEMATIC DIAGRAM



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

CUSTOMER NOTICE		APPROVALS	
LINEAR TECHNOLOGY HAS MADE A BEST EFFORT TO DESIGN A CIRCUIT THAT MEETS THE REQUIREMENTS OF THE APPLICATION. IT IS THE CUSTOMER'S RESPONSIBILITY TO VERIFY PROPER AND RELIABLE OPERATION IN THE ACTUAL APPLICATION. COMPONENT SUBSTITUTION AND PRINTED CIRCUIT BOARD MANUFACTURING VARIATIONS MAY AFFECT PERFORMANCE OR RELIABILITY. CONTACT LINEAR TECHNOLOGY APPLICATIONS ENGINEERING FOR ASSISTANCE.		PCB DES: K. HTOO APP ENG: K. HTOO	
		TITLE: SCHEMATIC HIGH EFFICIENCY POE PD INTERFACE WITH INTEGRATED SWITCHING REGULATOR	
		SIZE: N/A IC NO: LT4278BIUFD, LT4321IUF DEMO CIRCUIT 2046AD	
		DATE: Tuesday, March 31, 2015 SCALE: NONE SHEET 2 OF 2	

1530 McCarthy Blvd
 Milpitas, CA 95035
 Phone: (408) 432-1800 www.linear.com
 Fax: (408) 432-1807
 LTC Confidential - For Customers Use Only

LINEAR TECHNOLOGY
 TECHNOLOGY

THIS CIRCUIT IS PROPRIETARY TO LINEAR TECHNOLOGY AND SUPPLIED FOR USE WITH LINEAR TECHNOLOGY PARTS.

DEMO MANUAL DC2046A-D

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

dc2046adf