DEMO MANUAL DC2475A-A

LT4295, LT4321

High Efficiency IEEE802.3bt (PoE++, Type 3, 40W) PD with PoE Ideal Diode Bridge

DESCRIPTION

Demonstration circuit 2475A-A is an IEEE802.3bt (Draft 2.0) compliant Power over Ethernet (PoE) powered device (PD). It features the LT®4295 PD interface and switching regulator controller with the LT4321 PoE ideal diode bridge controller.

The LT4295 provides IEEE802.3af (PoE, Type 1), IEEE802.3at (PoE+, Type 2), and IEEE802.3bt (PoE++, Type 3 and 4) compliant interfacing and power supply control. It utilizes an external, low $R_{DS(ON)}$ (57mΩ typical) N-channel FET for the Hot Swap function to improve efficiency. The LT4295 controls a DC/DC converter that utilizes a highly efficient flyback topology with synchronous rectification.

The LT4321 controls eight low $R_{DS(ON)}$ (57mΩ typical) N-channel FETs to further improve end-to-end power delivery efficiency and ease thermal design. This solution replaces the eight diodes typically found in a passive PoE rectifier bridge.

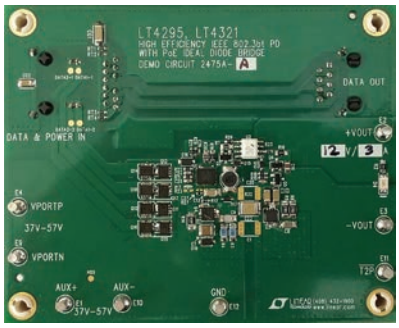
The DC2475A-A accepts up to 40W of delivered power from a power sourcing equipment (PSE) via the RJ45 connector (J1) or a local 48VDC power supply using the auxiliary supply input. When both supplies are connected, the auxiliary supply input has priority over the PoE input. The DC2475A-A supplies a 12V output at up to 3A.

Design files for this circuit board are available at http://www.linear.com/demo/DC2475A-A

PERFORMANCE SUMMARY

PARAMETER	CONDITIONS	VALUE
Port Voltage (V_{PORT})	At RJ45	37V to 57V
Auxiliary Voltage	From AUX+ to AUX– Terminals	37V to 57V
Output Voltage (V_{OUT})		12V (Typical)
Output Current (I_{OUT})		3A (Max)
Output Voltage Ripple	V_{PORT} = 44V, I_{OUT} = 3A	85mV_{P-P} (Typical)
Load Regulation		±0.1% (Typical)
Efficiency	V_{PORT} = 50V, I_{OUT} = 3A, End-to-End	92% (Typical)
Switching Frequency		250kHz (Typical)

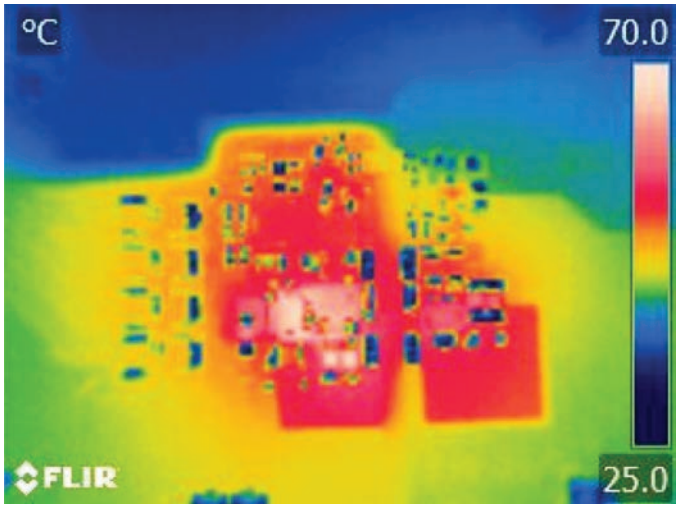
BOARD PHOTO



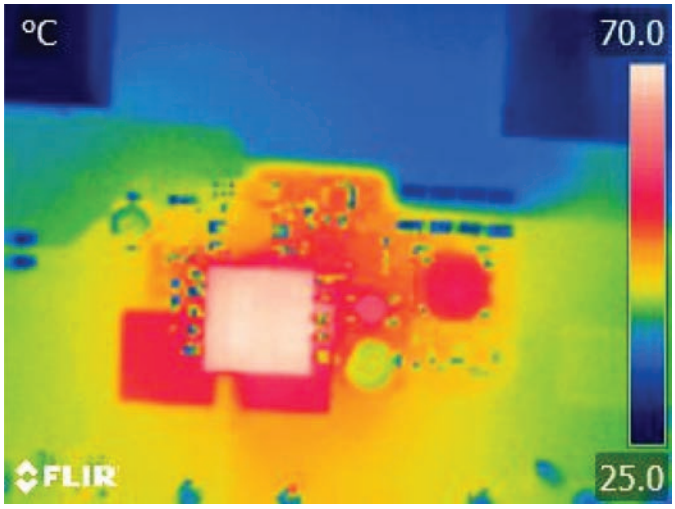
Top Side

Bottom Side

TYPICAL PERFORMANCE CHARACTERISTICS



Top Side



Bottom Side

Figure 1. Thermal Pictures (Conditions: V_{PORT} = 44V, V_{OUT} = 12V, I_{OUT} = 3A)

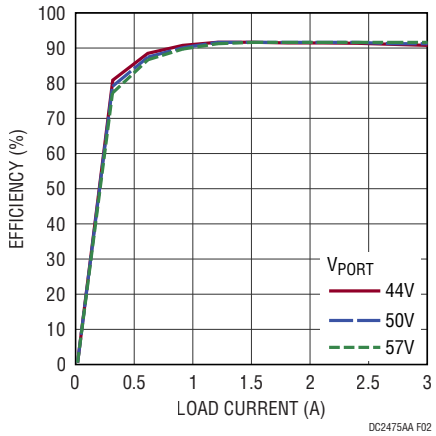


Figure 2. Efficiency (End-to-End)

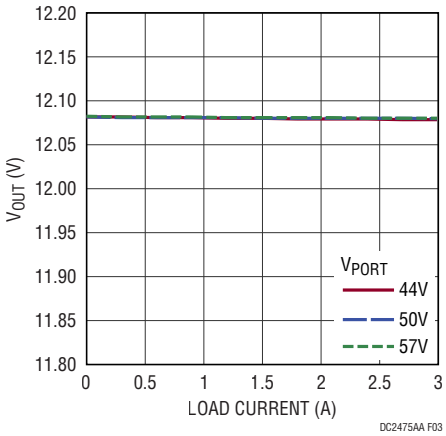


Figure 3. Load Regulation

TYPICAL PERFORMANCE CHARACTERISTICS

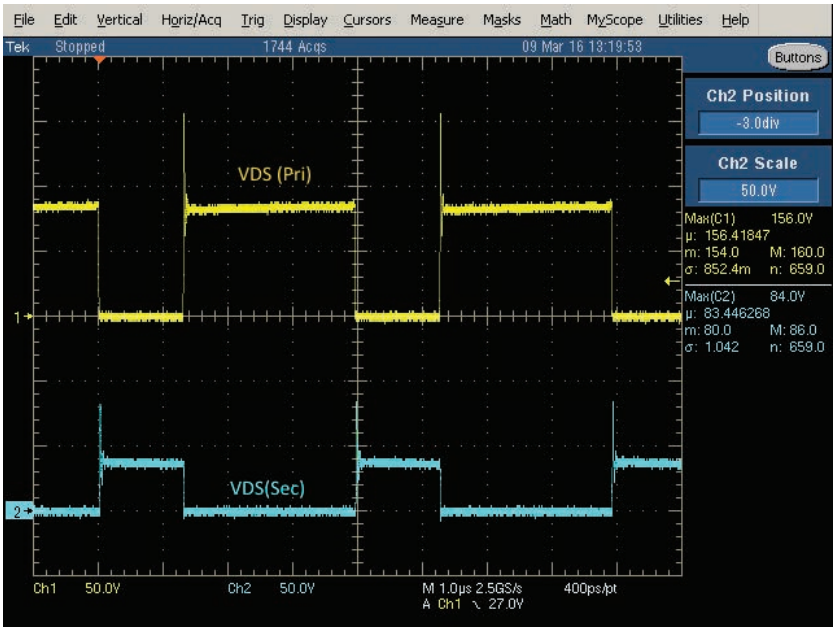


Figure 4. Switch Node Waveforms (Conditions: V_{PORT} = 57V, V_{OUT} = 12V, I_{OUT} = 3A)

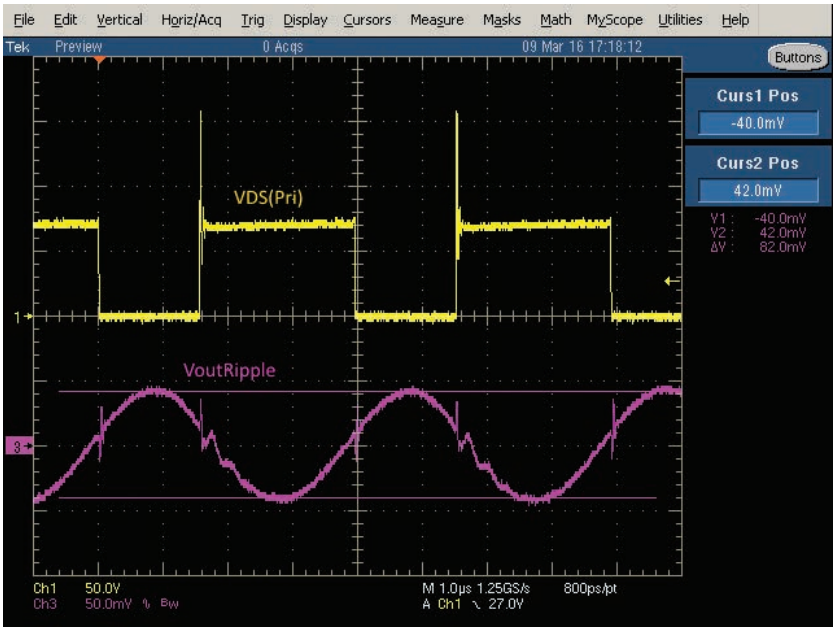


Figure 5. Output Voltage Ripple (Conditions: V_{PORT} = 44V, V_{OUT} = 12V, I_{OUT} = 3A)

TYPICAL PERFORMANCE CHARACTERISTICS

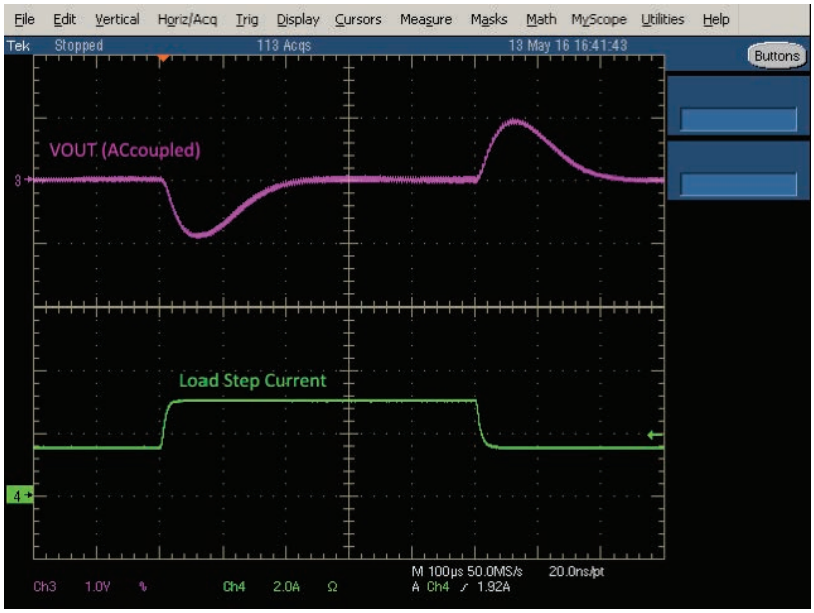


Figure 6. Load Transient Response (Conditions: V_{PORT} = 44V, Load Step: 1.5A to 3A to 1.5A)

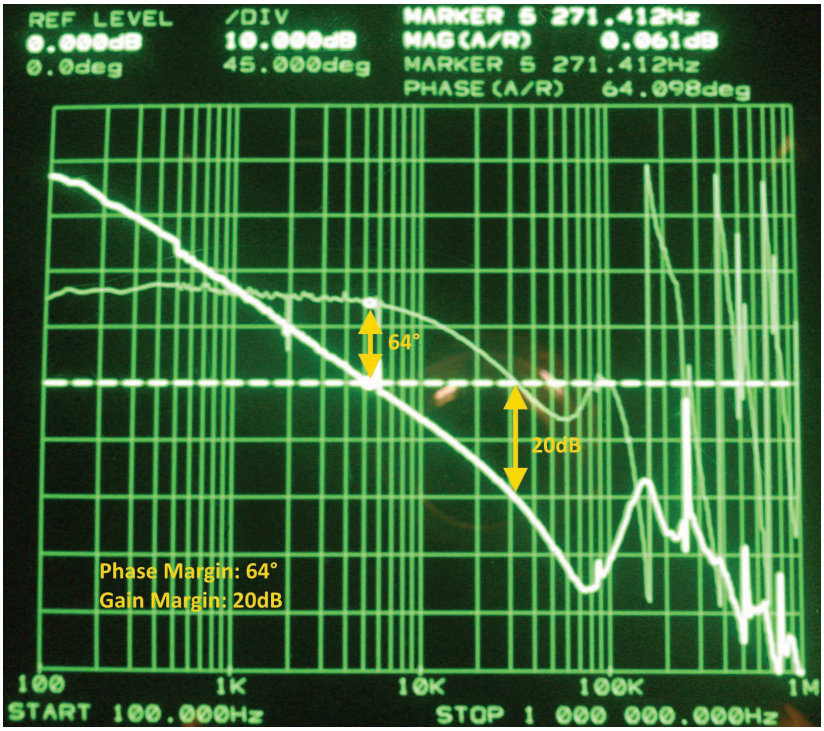


Figure 7. Gain and Phase Margin of the Flyback DC/DC Converter (Conditions: V_{PORT} = 44V, V_{OUT} = 12V, I_{OUT} = 3A)

CROSSOVER FREQUENCY (kHz)	GAIN MARGIN (dB)	PHASE MARGIN (deg)
5	20	64

QUICK START PROCEDURE

Power over Ethernet (PoE) Input

1. Disconnect auxiliary supply if it is connected to AUX+ and AUX– inputs of the DC2475A-A.
2. Place and connect test equipment (voltmeter, ammeter, oscilloscope, and electronic load) as shown in Figure 8.
3. Turn down the electronic load to a minimum value and turn off the electronic load.
4. Connect the DC power supply to the DC1814A-B. Turn on the DC power supply and set its current limit to 2A. Then increase its output voltage to 57V.

   Note: In the interim, an LTPoE++® compliant PSE (DC1814A-B) is used to provide power to the DC2475A-A. $\overline{T2P}$ output of the DC2475A-A is different from the behavior stated in Table 1.

   It is recommended to use an IEEE802.3bt compliant PSE for the proper handshaking sequence and the correct $\overline{T2P}$ output behavior when such a PSE is available in the market.
5. Connect the output of the DC1814A-B to the RJ45 connector (J1) of the DC2475A using a CAT5e or CAT6 Ethernet cable.
6. After the LED (D4) on the DC2475A is lit, check the output voltage using a voltmeter. Output voltage should be within 12.0V ± 0.2V.
7. Turn on the electronic load and increase its load current up to 3A. Observe the output voltage regulation, efficiency, and other parameters.
8. Verify $\overline{T2P}$ response with an oscilloscope as shown in Figure 8. The $\overline{T2P}$ response to the type of PSE connected to the DC2475A-A is provided in Table 1.

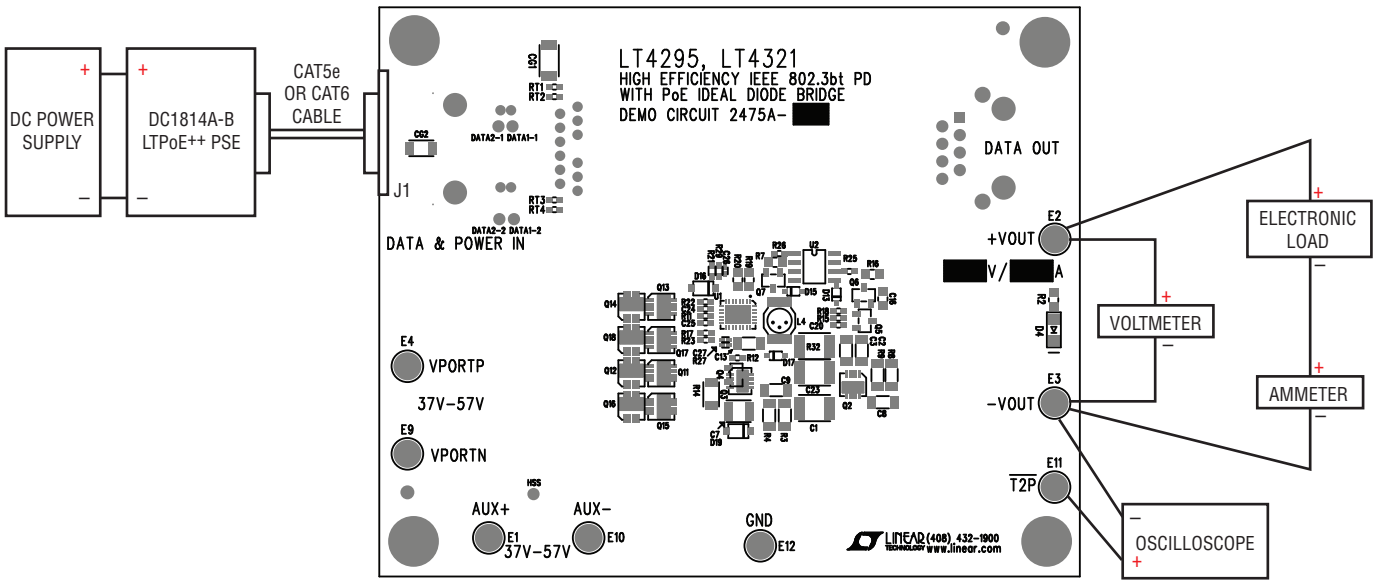


Figure 8. Setup Diagram for PoE Input

Table 1. $\overline{T2P}$ Response vs PSE Type

PSE TYPE	$\overline{T2P}$ RESPONSE	PD OUTPUT POWER (W)
1 (PoE, 15.4W)	Logic High	10.8
2 (PoE+, 30W)	Logic Low	22.8
3 (PoE++, 60W)	50% Logic High/50% Logic Low, Toggle at 970Hz ±7%	36
4 (PoE++, 90W)	75% Logic High/25% Logic Low, Toggle at 970Hz ±7%	36
LTPoE++, 52.7W	Logic Low	36

QUICK START PROCEDURE

Auxiliary Supply Input

1. Place and connect test equipment (voltmeter, ammeter, oscilloscope, and electronic load) as shown in Figure 9.
2. Turn down the electronic load to a minimum value and turn off the electronic load.
3. Connect the output of the auxiliary supply to the DC2475A as shown in Figure 9. Turn on the auxiliary supply and set its current limit to 2A. Then increase its output voltage to 48V.
4. Once the LED (D4) on the DC2475A is lit, check the output voltage using a voltmeter. Output voltage should be within 12.0V ± 0.2V.
5. Turn on the electronic load and increase its load current up to 3A. Observe the output voltage regulation, efficiency, and other parameters.
6. Verify $\overline{T2P}$ response with an oscilloscope as shown in Figure 9. The $\overline{T2P}$ response during auxiliary power operation is provided in Table 2.

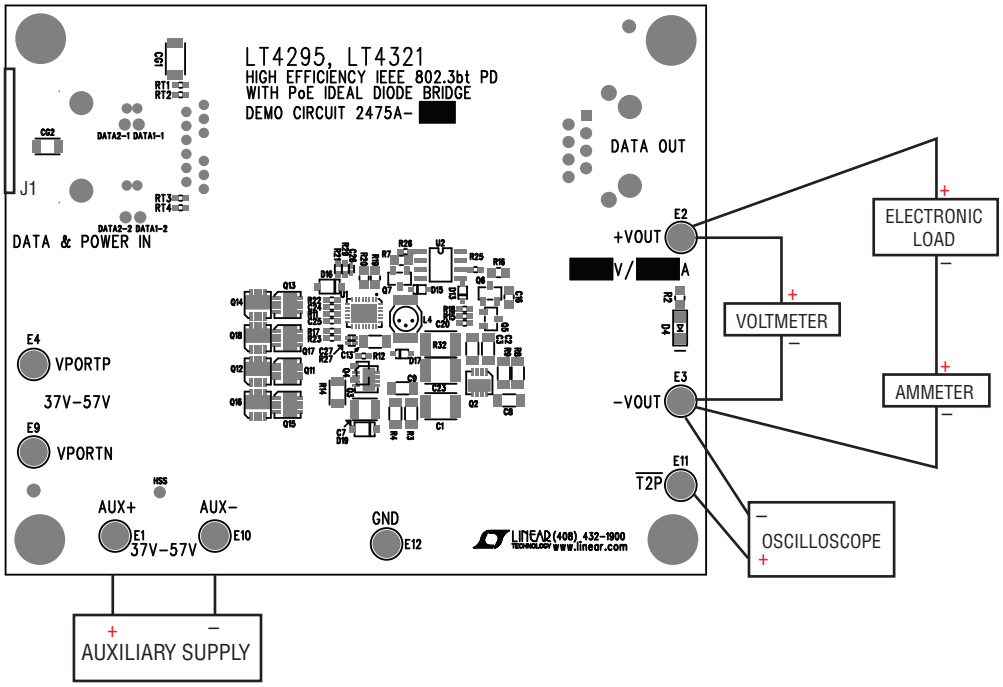


Figure 9: Setup Diagram for Auxiliary Supply Input

Table 2. $\overline{T2P}$ Response During Auxiliary Power Operation

$\overline{T2P}$ RESPONSE	PD OUTPUT POWER (W)
75% Logic High/25% Logic Low, Toggle at 976Hz ±7%	36

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
DC2475A 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 12061C103MAT2A
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 1812	MURATA GR443DR73D472KW01L
15	1	C26	CAP, CER, X7R 100pF 16V 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, PMEG1020EA 10V SOD323	NXP PMEG1020EA
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	WURTH 7499511001A
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

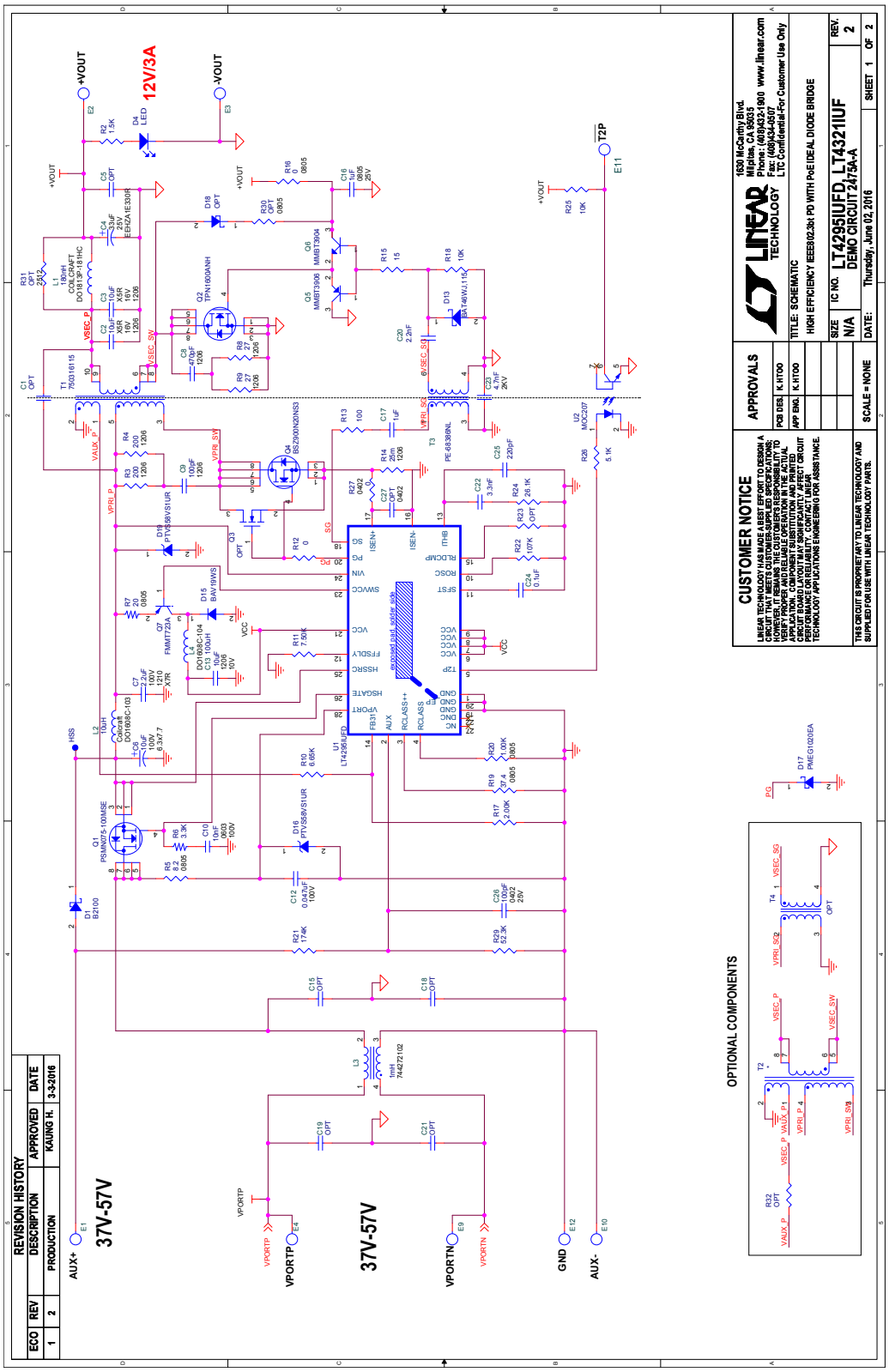
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
31	9	Q1, Q11, Q12, Q13, Q14, Q15, Q16, Q17, Q18	MOSFET, N-CH, PSMN075-100MSE 100V LFPAK33	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
35	0	Q7 (ALTERNATE)	TRAN, PNP, PBSS9110T 100V SOT23	NXP PBSS9110T
36	4	RT1, RT2, RT3, RT4	RES, CHIP, 75Ω 5% 0603	NIC NRC06J750TRF
37	1	R5	RES, CHIP, 8.2Ω 5% 0805	NIC NRC10J8R2TRF
38	1	R6	RES, CHIP, 3.3k 5% 0603	NIC NRC06J332TRF
39	1	R7	RES, CHIP, 20Ω 5% 0805	VISHAY CRCW080520R0JNEA
40	1	R12	RES, CHIP, 0Ω 5% 0603	NIC NRC06Z0TRF
41	1	R13	RES, CHIP, 100Ω 5% 0603	VISHAY CRCW0603100RFKEA
42	1	R15	RES, CHIP, 15Ω 5% 0603	NIC NRC06J150TRF
43	1	R17	RES, CHIP, 2.00k 1% 0603	NIC NRC06F2001TRF
44	1	R18	RES, CHIP, 10k 5% 0603	YAGEO RC0603JR-0710KL
45	1	R21	RES, CHIP, 174k 1% 0603	VISHAY CRCW0603174KFKEA
46	1	R22	RES, CHIP, 107k 1% 0603	NIC NRC06F1073TRF
47	1	R27	RES, CHIP, 0Ω 5% 0402	NIC NRC04Z0TRF
48	1	R28	RES, CHIP, 0Ω 5% 0603	NIC NRC06Z0TRF
49	1	R29	RES, CHIP, 52.3k 1% 0603	VISHAY CRCW060352K3FKEA
50	0	R32	RES, CHIP, OPT 5% 1812	OPT
51	1	T3	XFMR, SMD GATE DRIVE, PE-68386NL	PULSE PE-68386NL
52	0	T3 (ALTERNATE)	XFMR, SMD GATE DRIVE, EPA4271GE	PCA EPA4271GE
53	1	U3	IC, PoE IDEAL BRIDGE CONTROLLER, LT4321IUF QFN16	LINEAR TECH LT4321IUF#PBF
54	2		STENCIL (TOP AND BOTTOM)	STENCIL DC2475A
DC2475A-A				
1			DC2475A – GENERAL BOM	
1	1	C2	CAP, CER, X5R 10µF 16V 10% 1206	MURATA GRM31CR61C106KA88
2	1	C3	CAP, CER, X5R 10µF 16V 10% 1206	MURATA GRM31CR61C106KA88
3	1	C4	CAP, ELEC, 33µF 25V 20% 5.0X5.8	PANASONIC EEHZA1E330R
4	1	C8	CAP, CER, U2J 470pF 630V 5% 1206	MURATA GRM31A7U2J471JW31D
5	1	C9	CAP, CER, U2J 100pF 630V 5% 1206	MURATA GRM31A7U2J101JW31D
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 06033C221KAT4A
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	WURTH 744 272 102

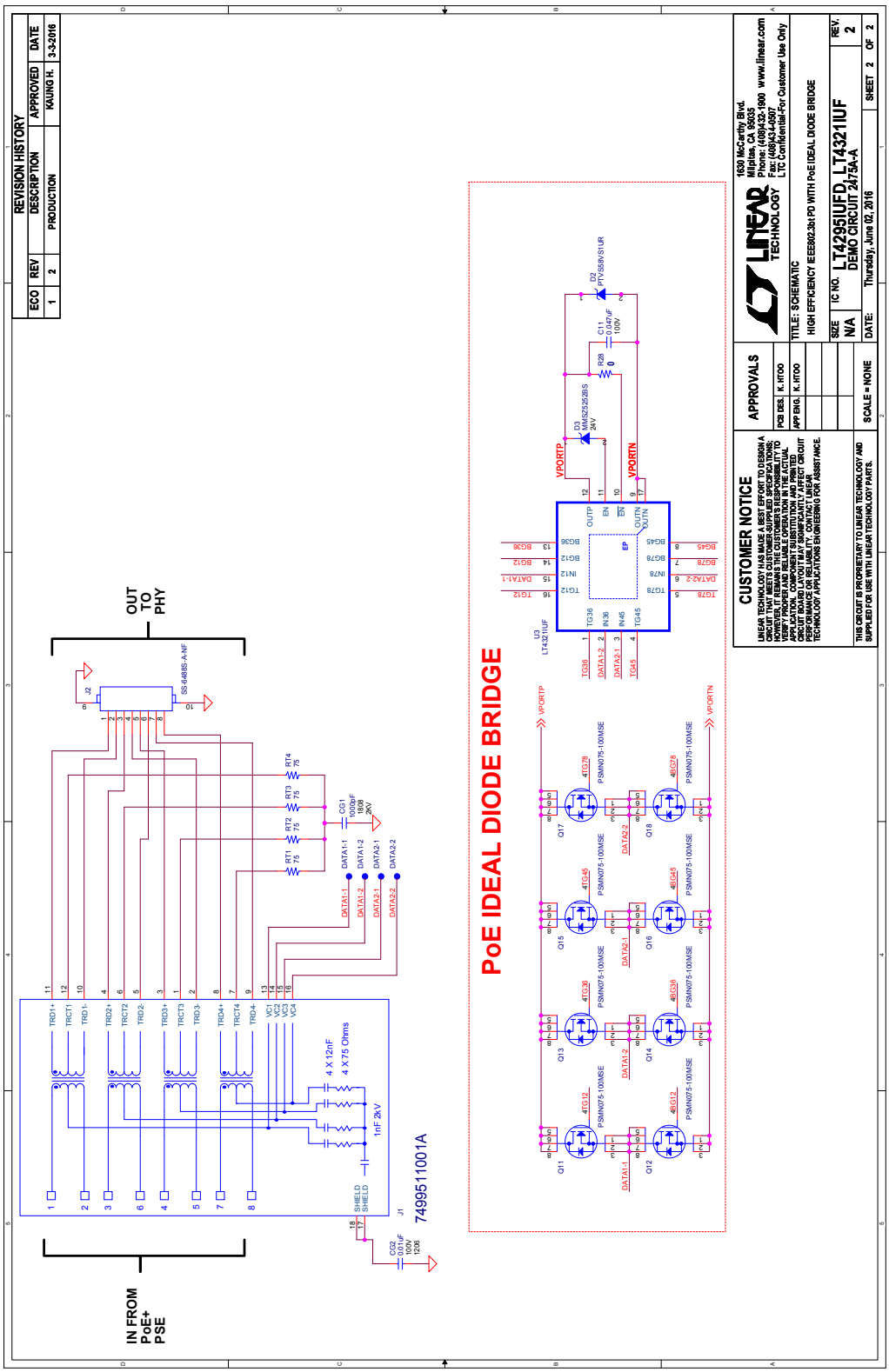
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
14	1	Q2	MOSFET, N-CH, 100V TSON	TOSHIBA TPN1600ANH
15	0	Q3	MOSFET, N-CH, OPT SOT23	OPT
16	1	Q4	MOSFET, N-CH, 200V TDSON-8	INFINEON BSZ900N20NS3
17	1	R2	RES, CHIP, 1.5k 5% 0805	NIC NRC10J152TRF
18	1	R3	RES, CHIP, 200Ω 5% 1206	NIC NRC12F2000TRF
19	1	R4	RES, CHIP, 200Ω 5% 1206	NIC NRC12F2000TRF
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, 6.65k 1% 0603	NIC NRC06F6651TRF
23	1	R11	RES, CHIP, 7.50k 1% 0603	VISHAY CRCW06037K50FKEA
24	1	R14	RES, CHIP, 25mΩ 1% 1206	VISHAY WSL1206R0250FEA
25	1	R16	RES, CHIP, 0Ω, SHUNT, 0805	VISHAY CRCW08050000Z0EA
26	1	R19	RES, CHIP, 37.4Ω 1% 0805	VISHAY CRCW080537R4FKEA
27	1	R20	RES, CHIP, 1.00Ω 1% 0805	VISHAY CRCW08051K00FKEA
28	0	R23	RES, CHIP, OPT 5% 0603	OPT
29	1	R24	RES, CHIP, 26.1k 5% 0603	VISHAY CRCW060326K1FKEA
30	1	R25	RES, CHIP, 10k 5% 0603	YAGEO RC0603JR-0710KL
31	1	R26	RES, CHIP, 5.1k 5% 0603	YAGEO RC0603JR-075K1L
32	0	R30	RES, CHIP, OPT 5% 0805	OPT
33	0	R31	RES, CHIP, SHUNT, 2512	OPT
34	1	T1	XFMR, FLYBACK TRAN, 750316115	WURTH 750316115
35	0	T1 (ALTERNATE)	XFMR, FLYBACK TRAN, EPC3634G	PCA EPC3634G
36	0	T2	XFMR, FLYBACK TRAN, OPT	OPT
37	1	U1	IC, PD AND SWITCHER CONTROLLER, LT4295IUFD QFN28	LINEAR TECH LT4295IUFD
38	1	U2	IC, TRANSISTOR OUTPUT OPTOCOUPLER, SO-8	FAIRCHILD SEMI, MOC207M
39	4	MH1-MH4	STAND-OFF, NYLON 0.50" TALL (SNAP ON)	KEYSTONE 8833
40	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT 2475A

SCHEMATIC DIAGRAM



SCHEMATIC DIAGRAM



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