

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

DESCRIPTION

Demonstration circuit 2046A-A is an Ethernet Alliance™ certified 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-A supplies a 3.3V output at up to 6.8A. 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.

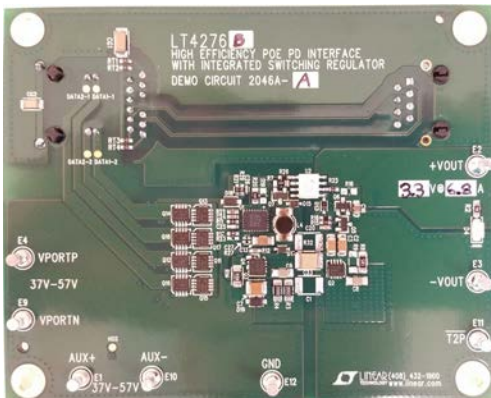
[Design files for this circuit board are available.](#)

All registered trademarks and trademarks are the property of their respective owners.

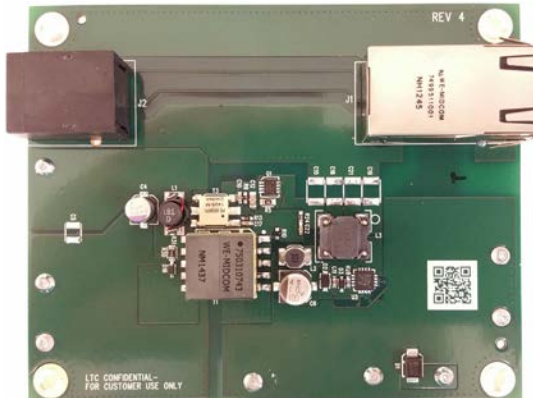
PERFORMANCE SUMMARY Specifications are at T_A = 25°C

| 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 | | 3.3V (Typ) |
| Output Current | | 6.8A (Max) |
| Output Voltage Ripple | V _{PORT} = 42.5V, I _{OUT} = 6.8A | 25mV _{P-P} (Typ) |
| Output Regulation | | ±0.15% (Typ) |
| Efficiency | V _{PORT} = 50V, I _{OUT} = 6.8A, End to End | 90% (Typ) |
| Switching Frequency | | 250kHz (Typ) |

BOARD PHOTOS



Top Side



Bottom Side



TYPICAL PERFORMANCE CHARACTERISTICS

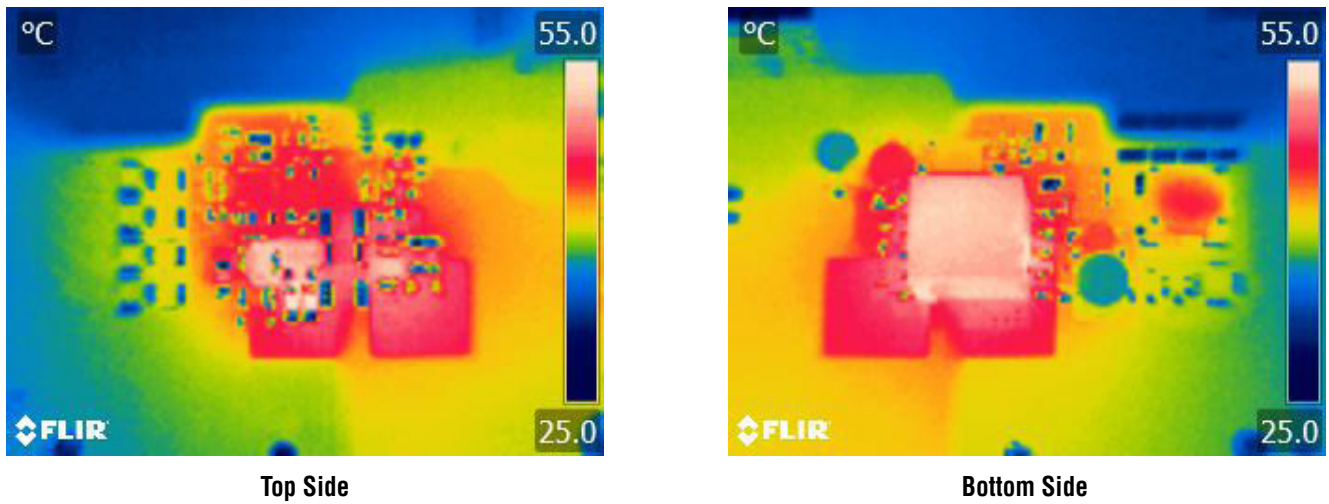


Figure 1. Thermal Pictures, $V_{PORT} = 57V$, $I_{OUT} = 6.8A$

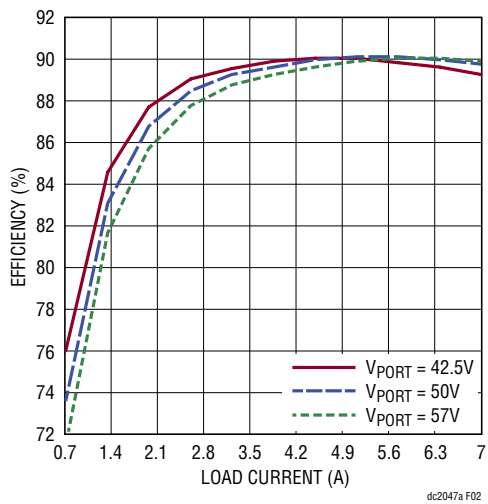


Figure 2. Efficiency (End to End)

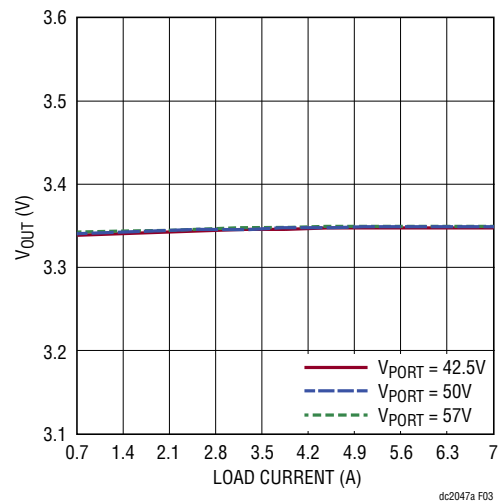


Figure 3. Output Voltage Regulation

TYPICAL PERFORMANCE CHARACTERISTICS

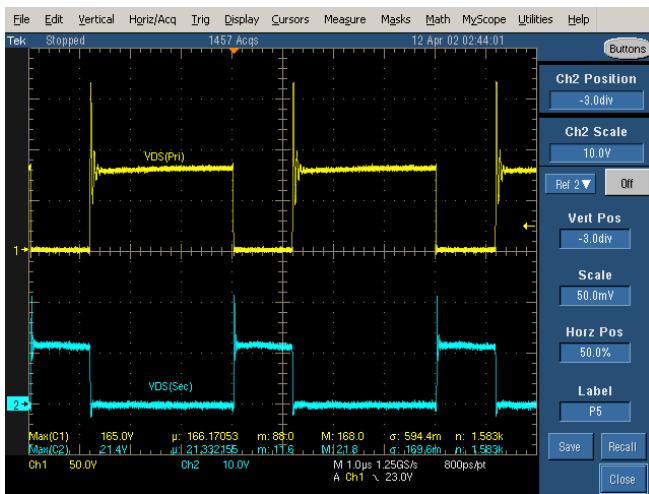


Figure 4. Stresses ($V_{PORT} = 57V, 3.3V/6.8A$)

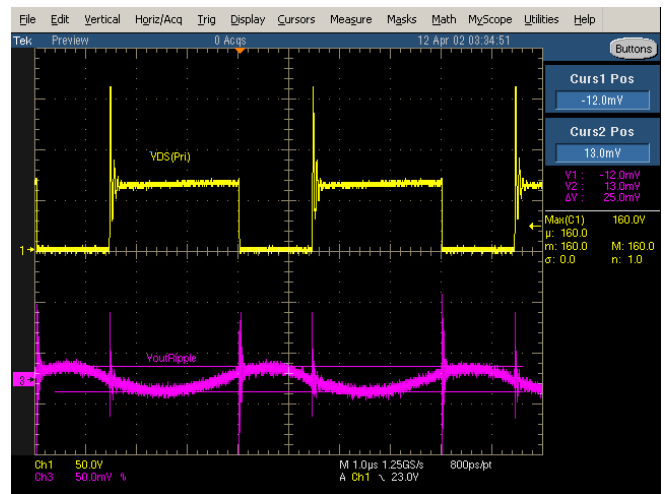


Figure 5. Output Voltage Ripple ($V_{PORT} = 42.5V, 3.3V/6.8A$)

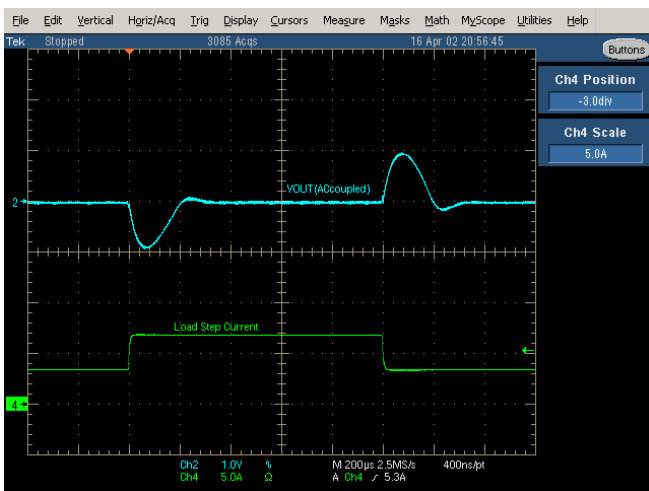


Figure 6. Load Transient Response ($V_{PORT} = 42.5V, 3.8A$ to $6.8A$ to $3.8A$)

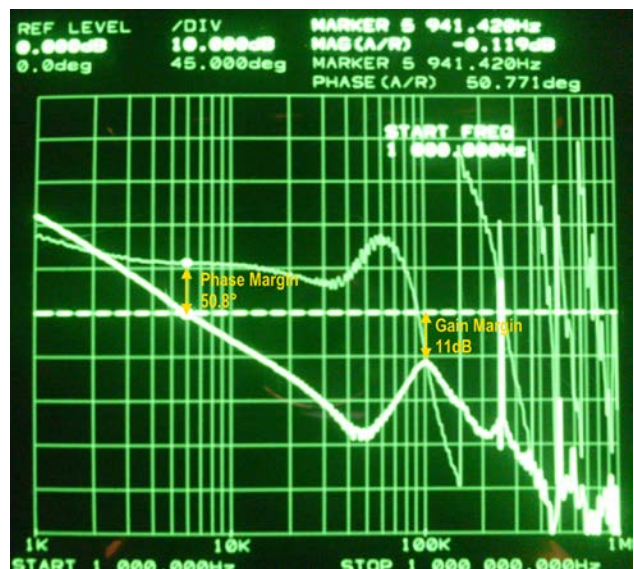


Figure 7. Gain and Phase Margin of the Flyback Loop ($V_{PORT} = 42.5V, 3.3V/0.7A$)

QUICK START PROCEDURE

Demonstration circuit 2046A-A 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 VPORTP and VPORTN.
 - 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 3.3V.
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.

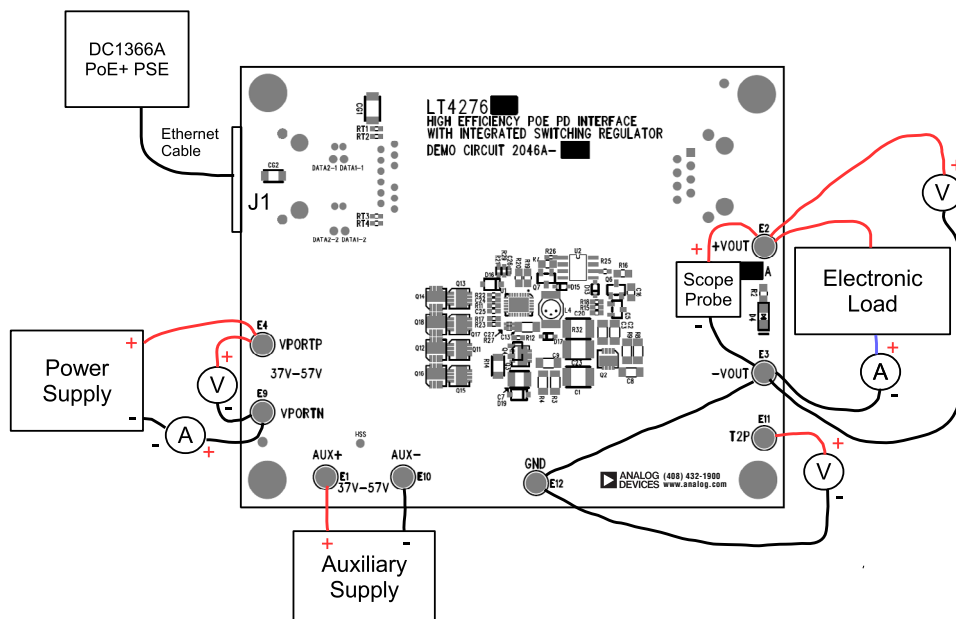


Figure 8. Proper Measurement Equipment Setup

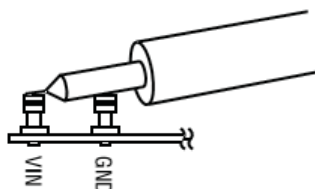


Figure 9. Measurement Input or Output Ripple

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 | 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 | Transistor, PNP, MMBT3906 40V SOT23 | Fairchild MMBT3906 |
| 33 | 1 | Q6 | Transistor, NPN, MMBT3904 40V SOT23 | Fairchild MMBT3904 |
| 34 | 1 | Q7 | Transistor, PNP, FM723 100V SOT23 | Diodes Inc FM723TA |
| 34 | 0 | Q7 (Alternate) | Transistor, PNP, PBSS9110T 100V SOT23 | NXP PBSS9110T |
| 35 | 4 | RT1, RT2, RT3, RT4 | Res, Chip, 75 5% 0603 | NIC NRC06J750TRF |

DEMO MANUAL DC2046A-A

PARTS LIST

| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|------|-----|----------------|--------------------------------------------------|--------------------------|
| 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, 2k 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 | ANALOG DEVICES LT4321IUF |

DC2046A-A BOM

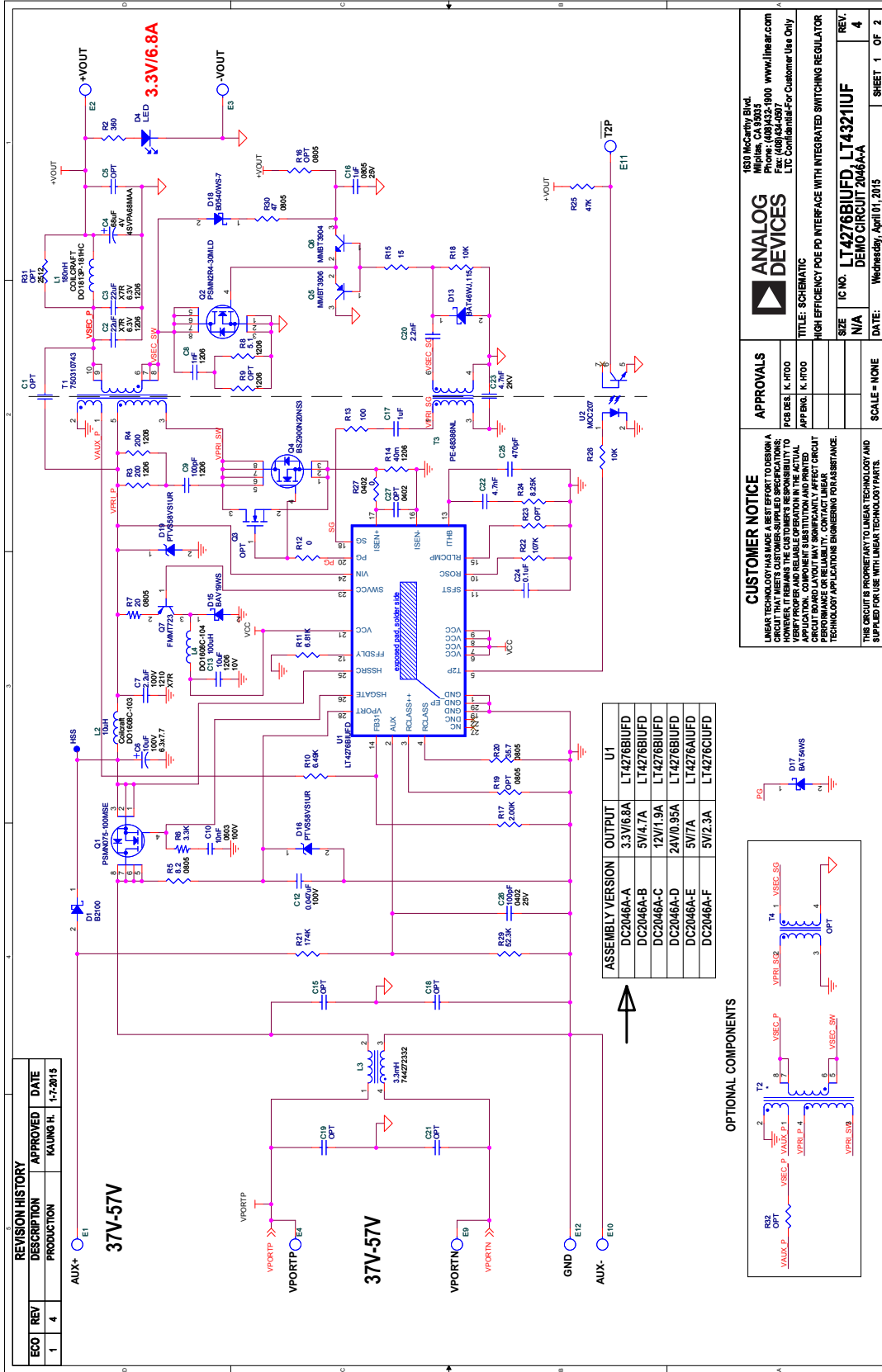
| | | | | |
|----|---|----------------|----------------------------------------|----------------------------------|
| 1 | 1 | C2 | Cap, Cer, X7R 22μF 6.3V 10% 1206 | Murata GRM31CR70J226KE19 |
| 2 | 1 | C3 | Cap, Cer, X7R 22μF 6.3V 10% 1206 | Murata GRM31CR70J226KE20 |
| 3 | 1 | C4 | Cap, Elec, 68μF 4V 20% 5.0X5.3 | Panasonic 4SVPA68MAA |
| 4 | 1 | C8 | Cap, Cer, U2J 1nF 630V 5% 1206 | Murata GRM31A7U2J222JW31 |
| 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 4.7nF 25V 10% 0603 | Murata GRM18871E472KA01D |
| 8 | 1 | C24 | Cap, Cer, X7R 0.1μF 25V 20% 0603 | Murata GRM188R71E104KA01D |
| 9 | 1 | C25 | Cap, Cer, X7R 470pF 25V 5% 0603 | AVX 06033A471JAT2A |
| 10 | 1 | D18 | Diode, Diode Inc, B0540WS-7 40V SOD323 | Diode Inc B0540WS-7 |
| 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, 3.3mH | Würth 744 272 332 |
| 13 | 0 | L3 (Alternate) | IND, CMC, 3.3mH | PCA EPA4411 |
| 14 | 1 | Q2 | MOSFET, N-CH, PSMN2R4-30MLD 30V LFPK33 | NXP PSMN2R4-30MLD |
| 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, 360 5% 0805 | NIC NRC10J381TRF |
| 18 | 1 | R3 | Res, Chip, 200 5% 1206 | Vishay CRCW1206200RFKEA |
| 19 | 1 | R4 | Res, Chip, 200 5% 1206 | Vishay CRCW1206200RFKEA |
| 20 | 1 | R8 | Res, Chip, 5.1 5% 1206 | NIC NRC12J5R1TRF |

PARTS LIST

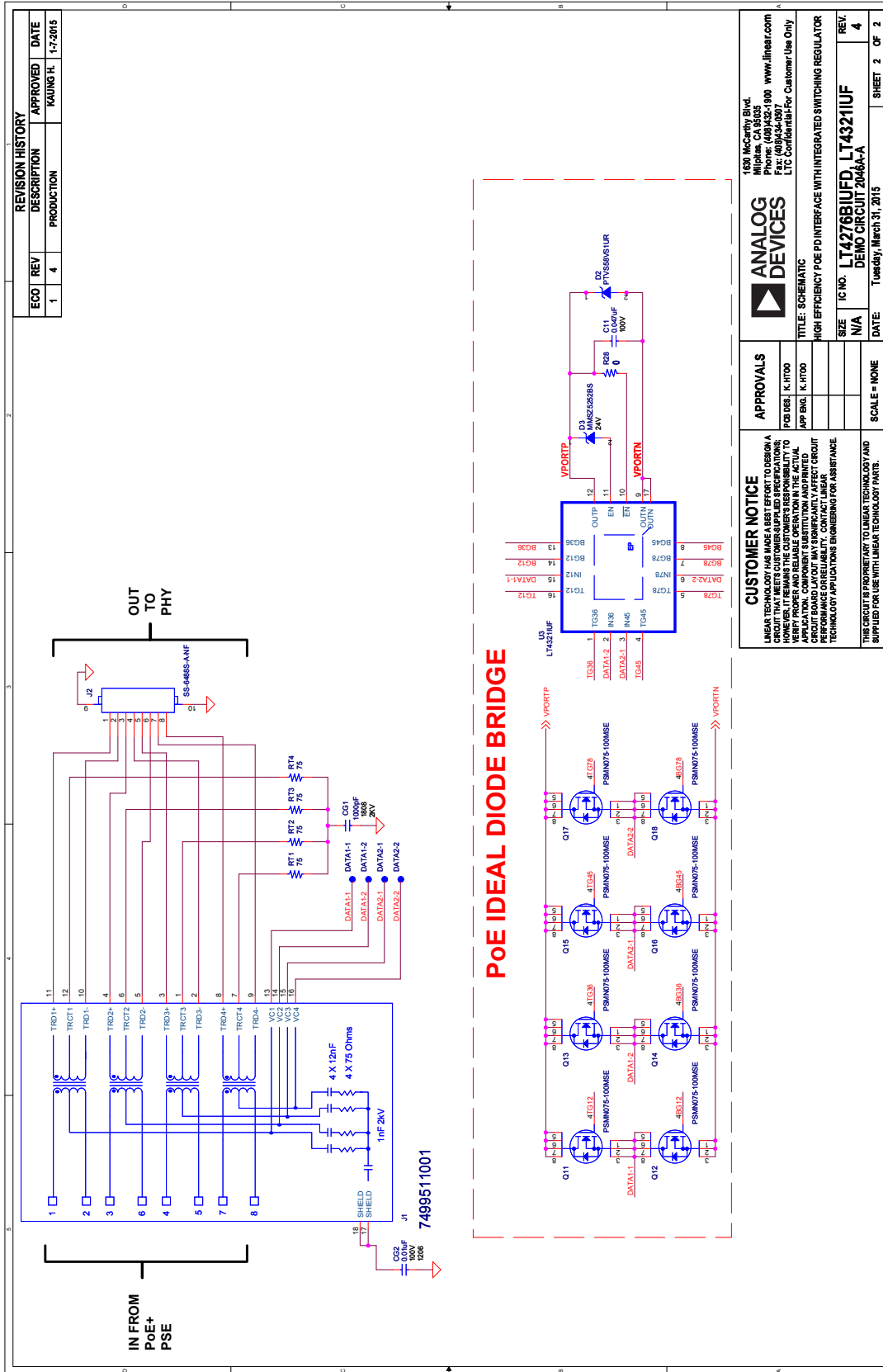
| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|------|-----|----------------|-------------------------------------------------|----------------------------|
| 21 | 0 | R9 | Res, Chip, OPT 5% 1206 | OPT |
| 22 | 1 | R10 | Res, Chip, 6.49k 1% 0603 | Vishay CRCW06036K49FKEA |
| 23 | 1 | R11 | Res, Chip, 6.81k 1% 0603 | Vishay CRCW06036K81FKEA |
| 24 | 1 | R14 | Res, Chip, 40m 1% 1206 | Vishay WSL1206R0400FEA |
| 25 | 0 | R16 | Res, Chip, OPT, Shunt, 0805 | OPT |
| 26 | 0 | R19 | Res, Chip, OPT 1% 0805 | OPT |
| 27 | 1 | R20 | Res, Chip, 35.7 Ω 1% 0805 | Vishay CRCW080535R7FKEA |
| 28 | 0 | R23 | Res, Chip, OPT 5% 0603 | OPT |
| 29 | 1 | R24 | Res, Chip, 8.25k 1% 0603 | Vishay CRCW06038K25FKEA |
| 30 | 1 | R25 | Res, Chip, 47k 5% 0603 | NIC NRC06J473TRF |
| 31 | 1 | R26 | Res, Chip, 10k 5% 0603 | YAGEO RC0603JR-0710KL |
| 32 | 1 | R30 | Res, Chip, 47 Ω 5% 0805 | Vishay CRCW080547R0JNEA |
| 33 | 0 | R31 | Res, Chip, OPT, Shunt, 2512 | OPT |
| 34 | 1 | T1 | XFMR, Flyback Tran, 750310743 | Würth 750310743 |
| 34 | 0 | T1 (Alternate) | XFMR, Flyback Tran, EPC3408G | PCA EPC3408G |
| 35 | 0 | T2 | XFMR, Flyback Tran, OPT | OPT |
| 36 | 1 | U1 | IC, PD & Switcher Controller, LT4276BIUFD QFN28 | ANALOG DEVICES LT4276BIUFD |
| 37 | 1 | U2 | OPTO, MOC207 S08 | Fairchild MOC207M |
| 38 | 1 | | FAB, Printrd Circuit Board | Demo Circuit 2046A |

DEMO MANUAL DC2046A-A

SCHEMATIC DIAGRAM



SCHEMATIC DIAGRAM





ESD Caution

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

Legal Terms and Conditions

By using the evaluation board discussed herein (together with any tools, components documentation or support materials, the "Evaluation Board"), you are agreeing to be bound by the terms and conditions set forth below ("Agreement") unless you have purchased the Evaluation Board, in which case the Analog Devices Standard Terms and Conditions of Sale shall govern. Do not use the Evaluation Board until you have read and agreed to the Agreement. Your use of the Evaluation Board shall signify your acceptance of the Agreement. This Agreement is made by and between you ("Customer") and Analog Devices, Inc. ("ADI"), with its principal place of business at One Technology Way, Norwood, MA 02062, USA. Subject to the terms and conditions of the Agreement, ADI hereby grants to Customer a free, limited, personal, temporary, non-exclusive, non-sublicensable, non-transferable license to use the Evaluation Board FOR EVALUATION PURPOSES ONLY. Customer understands and agrees that the Evaluation Board is provided for the sole and exclusive purpose referenced above, and agrees not to use the Evaluation Board for any other purpose. Furthermore, the license granted is expressly made subject to the following additional limitations: Customer shall not (i) rent, lease, display, sell, transfer, assign, sublicense, or distribute the Evaluation Board; and (ii) permit any Third Party to access the Evaluation Board. As used herein, the term "Third Party" includes any entity other than ADI, Customer, their employees, affiliates and in-house consultants. The Evaluation Board is NOT sold to Customer; all rights not expressly granted herein, including ownership of the Evaluation Board, are reserved by ADI. CONFIDENTIALITY. This Agreement and the Evaluation Board shall all be considered the confidential and proprietary information of ADI. Customer may not disclose or transfer any portion of the Evaluation Board to any other party for any reason. Upon discontinuation of use of the Evaluation Board or termination of this Agreement, Customer agrees to promptly return the Evaluation Board to ADI. ADDITIONAL RESTRICTIONS. Customer may not disassemble, decompile or reverse engineer chips on the Evaluation Board. Customer shall inform ADI of any occurred damages or any modifications or alterations it makes to the Evaluation Board, including but not limited to soldering or any other activity that affects the material content of the Evaluation Board. Modifications to the Evaluation Board must comply with applicable law, including but not limited to the RoHS Directive. TERMINATION. ADI may terminate this Agreement at any time upon giving written notice to Customer. Customer agrees to return to ADI the Evaluation Board at that time. LIMITATION OF LIABILITY. THE EVALUATION BOARD PROVIDED HEREUNDER IS PROVIDED "AS IS" AND ADI MAKES NO WARRANTIES OR REPRESENTATIONS OF ANY KIND WITH RESPECT TO IT. ADI SPECIFICALLY DISCLAIMS ANY REPRESENTATIONS, ENDORSEMENTS, GUARANTEES, OR WARRANTIES, EXPRESS OR IMPLIED, RELATED TO THE EVALUATION BOARD INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANTABILITY, TITLE, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS. IN NO EVENT WILL ADI AND ITS LICENSORS BE LIABLE FOR ANY INCIDENTAL, SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES RESULTING FROM CUSTOMER'S POSSESSION OR USE OF THE EVALUATION BOARD, INCLUDING BUT NOT LIMITED TO LOST PROFITS, DELAY COSTS, LABOR COSTS OR LOSS OF GOODWILL. ADI'S TOTAL LIABILITY FROM ANY AND ALL CAUSES SHALL BE LIMITED TO THE AMOUNT OF ONE HUNDRED US DOLLARS (\$100.00). EXPORT. Customer agrees that it will not directly or indirectly export the Evaluation Board to another country, and that it will comply with all applicable United States federal laws and regulations relating to exports. GOVERNING LAW. This Agreement shall be governed by and construed in accordance with the substantive laws of the Commonwealth of Massachusetts (excluding conflict of law rules). Any legal action regarding this Agreement will be heard in the state or federal courts having jurisdiction in Suffolk County, Massachusetts, and Customer hereby submits to the personal jurisdiction and venue of such courts. The United Nations Convention on Contracts for the International Sale of Goods shall not apply to this Agreement and is expressly disclaimed.

Компания «Океан Электроники» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Поставка оригинальных импортных электронных компонентов напрямую с производств Америки, Европы и Азии, а так же с крупнейших складов мира;
- Широкая линейка поставок активных и пассивных импортных электронных компонентов (более 30 млн. наименований);
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Компания «Океан Электроники» является официальным дистрибьютором и эксклюзивным представителем в России одного из крупнейших производителей разъемов военного и аэрокосмического назначения «JONHON», а так же официальным дистрибьютором и эксклюзивным представителем в России производителя высокотехнологичных и надежных решений для передачи СВЧ сигналов «FORSTAR».



JONHON

«JONHON» (основан в 1970 г.)

Разъемы специального, военного и аэрокосмического назначения:

(Применяются в военной, авиационной, аэрокосмической, морской, железнодорожной, горно- и нефтедобывающей отраслях промышленности)

«FORSTAR» (основан в 1998 г.)

ВЧ соединители, коаксиальные кабели, кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).



Телефон: 8 (812) 309-75-97 (многоканальный)

Факс: 8 (812) 320-03-32

Электронная почта: ocean@oceanchips.ru

Web: <http://oceanchips.ru/>

Адрес: 198099, г. Санкт-Петербург, ул. Калинина, д. 2, корп. 4, лит. А