

# 42V Quad Monolithic Synchronous Step-Down Regulator

## DESCRIPTION

Demonstration circuit 1949A is a quad power supply featuring the [LT<sup>®</sup>8602](#). LT8602 is a 42V quad monolithic synchronous step-down regulator. The demo circuit is designed for 5.0V, 3.3V, 1.8V, and 1.2V outputs from a nominal 12V input, with switching frequency set at 2MHz to avoid audio band. The 1.8V and 1.2V converters are powered from the 3.3V output. The 5V, 3.3V are powered from a wide range of 5.5V to 42V. The current capability is 2.5A for the 3.3V output, 1.5A for the 5V output, and 1.8A for the other outputs when running individually. Up to 1A load current can be applied to all the channels simultaneously without special cooling.

Individual soft-start, current limit, input voltage, power good for each output simplify the complex design of quad-output power converters. All regulators are synchronized to a common external clock input or a resistor programmable 250kHz to 2.2MHz internal oscillator. At all frequencies, a 180° phase shift is maintained between 1 and 3, 2 and 4 channels, reducing the input peak current and voltage ripple. Programmable frequency allows optimization between efficiency and external component

size. Each output can be independently disabled using its own TRKSS or RUN pin and be placed in a low quiescent current shutdown mode. Table 1 summarizes the performance of the demo board at room temperature. The circuit can be easily modified for different applications.

Figure 6 shows the typical thermal performance of the circuit.

The demo board has an EMI filter installed on the bottom layer. The conducted and radiated EMI performance of the board is shown on Figure 4. The limit in Figure 4 is CISPR Class 5, Peak. It shows the circuit passes the CISPR Class 5, Peak test with a wide margin.

The LT8602 data sheet gives a complete description of the part, operation and application information. The data sheet must be read in conjunction with this quick start guide for DC1949A.

**Design files for this circuit board are available at <http://www.linear.com/demo/DC1949A>**

LT, LT, LTC, LTM, Linear Technology and the Linear Logo are registered trademarks of Linear Technology Corporation. All other trademarks are the property of their respective owners.

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

Table 1

| PARAMETER                                | CONDITIONS                                            | MIN  | TYP | MAX  | UNITS |
|------------------------------------------|-------------------------------------------------------|------|-----|------|-------|
| Input Voltage*                           |                                                       | 5.5  | 12  | 42   | V     |
| Standby Current When Switching           | I <sub>OUT1,2,3,4</sub> = 0mA, V <sub>IN</sub> = 12V  |      | 60  |      | μA    |
| Output Voltage V <sub>OUT1</sub>         | V <sub>IN</sub> = 12V, I <sub>OUT1</sub> = 1A         | 4.80 | 5   | 5.20 | V     |
| Output Voltage V <sub>OUT2</sub>         | I <sub>OUT2</sub> = 1A                                | 3.17 | 3.3 | 3.43 | V     |
| Output Voltage V <sub>OUT3</sub>         | I <sub>OUT3</sub> = 1A                                | 1.73 | 1.8 | 1.87 | V     |
| Output Voltage V <sub>OUT4</sub>         | I <sub>OUT4</sub> = 1A                                | 1.15 | 1.2 | 1.25 | V     |
| Maximum Output Current I <sub>OUT1</sub> | V <sub>IN</sub> = 12V, No Load on Other Channels      | 1.5  |     |      | A     |
| Maximum Output Current I <sub>OUT2</sub> | V <sub>IN</sub> = 12V, No Load on Other Channels      | 2.5  |     |      | A     |
| Maximum Output Current I <sub>OUT3</sub> | No Load on Other Channels                             | 1.8  |     |      | A     |
| Maximum Output Current I <sub>OUT4</sub> | No Load on Other Channels                             | 1.8  |     |      | A     |
| Switching Frequency                      | V <sub>IN</sub> = 12V, I <sub>OUT1,2,3,4</sub> = 1.0A | 1.85 | 2   | 2.15 | MHz   |
| Efficiency                               | V <sub>IN</sub> = 12V, I <sub>OUT1,2,3,4</sub> = 1.0A |      | 80  |      | %     |

Refer to Figure 6 to determine the maximum input voltage and load. If IC temperature exceeds target, reduce input voltage, output current or switching frequency.

dc1949af

## QUICK START PROCEDURE

DC1949A is easy to set up to evaluate the performance of the LT8602. Refer to Figure 1 for proper equipment setup and follow the procedure below.

1. With power off, connect the input power supply to the board through  $V_{IN}$  and GND terminals on the top layer. Connect the loads to the terminals  $V_{OUT1}$  and GND,  $V_{OUT2}$  and GND,  $V_{OUT3}$  and GND,  $V_{OUT4}$  and GND on the board. The default positions of the Headers are given in Table 2.

**Table 2. Default Positions of the Headers**

| NAME    |     | POSITION |
|---------|-----|----------|
| EN/UVLO | JP1 | ON       |
| TRKSS1  | JP4 | ON       |
| TRKSS2  | JP5 | ON       |
| RUN3    | JP2 | RUN      |
| RUN4    | JP3 | RUN      |

2. Turn on the power at the input. Increase  $V_{IN}$  to 12V.

**Note:** Make sure that the input voltage is always within spec. Refer to data sheet on the burst mode operation in light load and high  $V_{IN}$  condition.

3. Check for the proper output voltages. The output should be regulated at 5.0V ( $\pm 4\%$ ), 3.3V ( $\pm 4\%$ ), 1.8V ( $\pm 4\%$ ), 1.2V ( $\pm 4\%$ ).

**Note:** Do not overload unless proper thermal cooling method such as air flow or heat sink is applied.

**Note:** If there is no output, temporarily disconnect the load to make sure that the load is not set too high, and the Headers of EN/UVLO, TRKSS1, TRKSS2, RUN3, RUN4, are set in right positions.

4. Once the proper output voltage is established, adjust the input voltage and load currents within the operating range and observe the output voltage regulation, transient, ripple voltage, efficiency and other parameters.

**Note:** Refer to the thermal derating curves in LT8602 data sheet for high input voltage and/or high ambient temperature operations.

**Note:** By default, SYNC is grounded, and the circuit is set in low ripple burst mode operation. Remove R16, and add R25 of  $0\Omega$ , the circuit is set in pulse-skipping mode. The circuit runs in full frequency with lower load current. Refer to the data sheet on the input voltage and load current ranges the circuit runs in full frequency. To synchronize to an external clock, apply the external clock to the SYNC turret.

**Note:** When measuring the input or output voltage ripples, care must be taken to avoid a long ground lead on the oscilloscope probe. Measure the input or output voltage ripple by touching the probe tip directly across the  $V_{IN}$  or  $V_{OUT}$  capacitor terminals. See Figure 2 for proper scope probe technique.

**Note:** The EMI filter is assembled on the bottom layer of the demo circuit. For EMI test, connect the EMI test facility to the terminals of  $VEMI^+$ , and  $VEMI^-$  with very short wires.

## QUICK START PROCEDURE

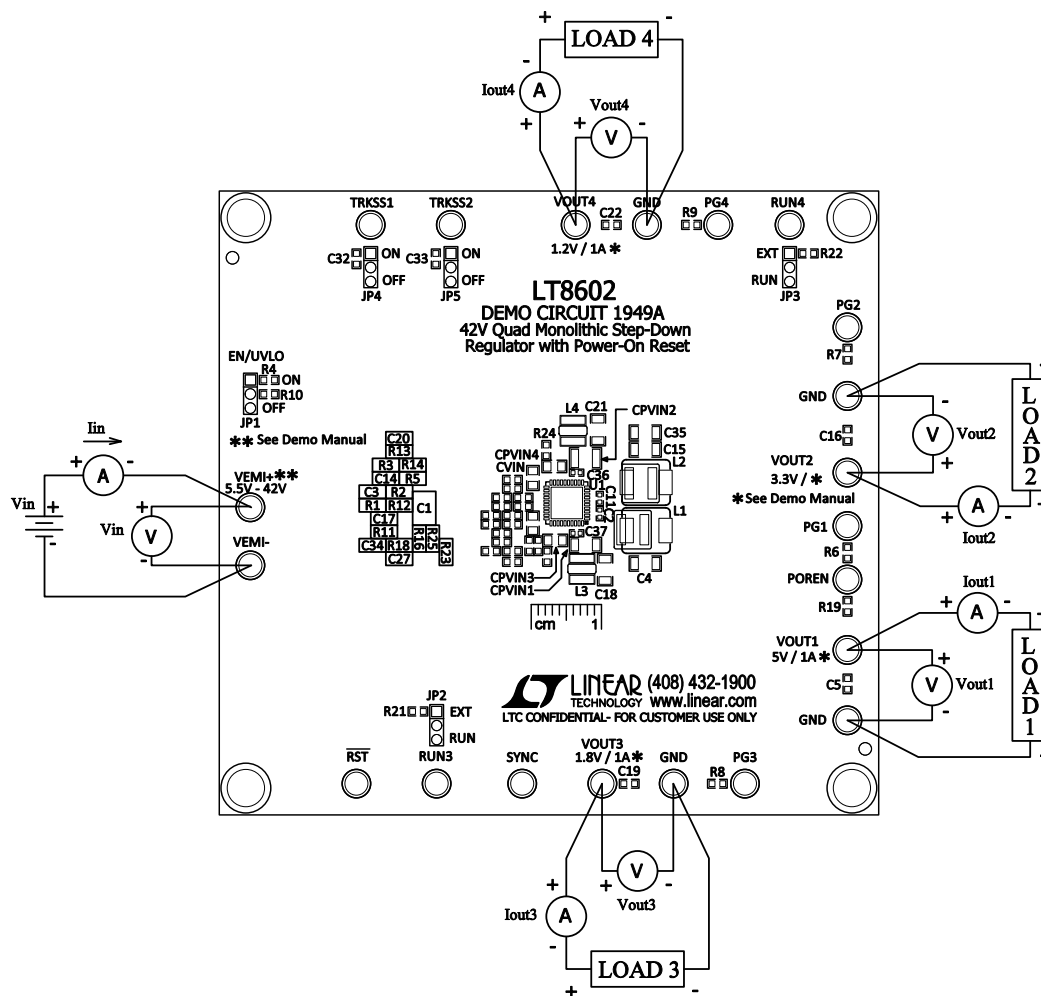


Figure 1. Proper Measurement Equipment Setup

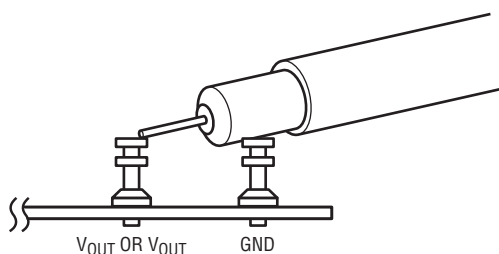


Figure 2. Proper Scope Probe Placement for Measuring Input or Output Ripple

QUICK START PROCEDURE

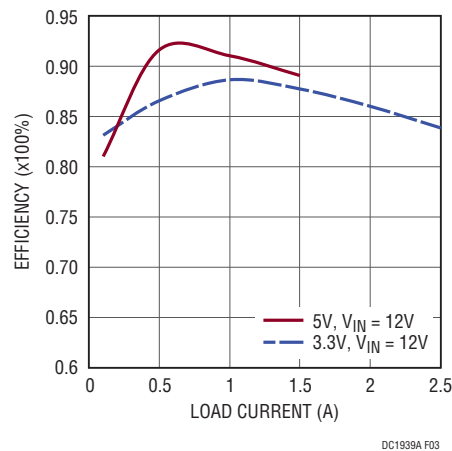
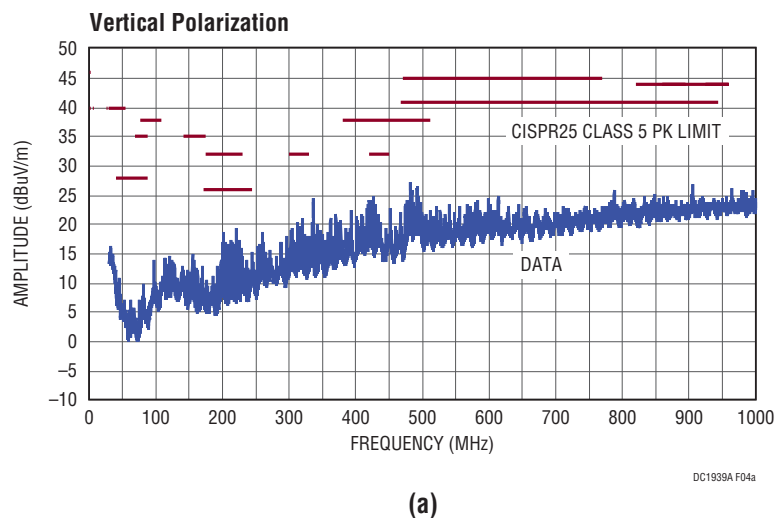
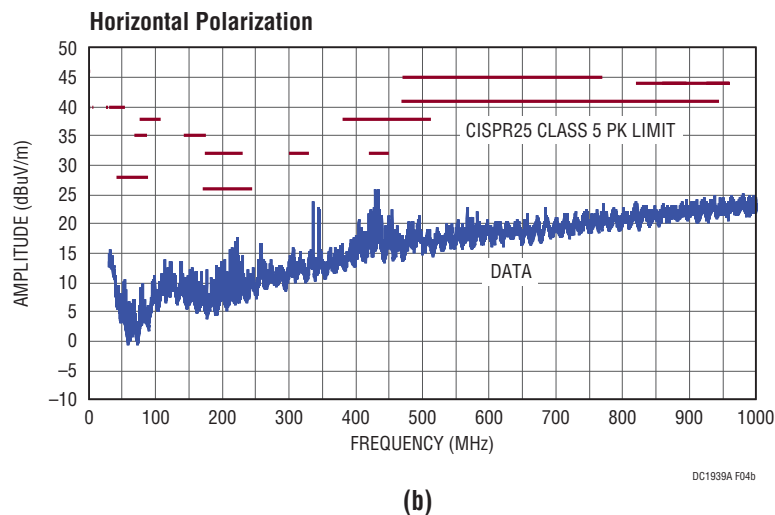


Figure 3. Typical Efficiency Curves of HV Bucks, at  $V_{IN} = 12V$



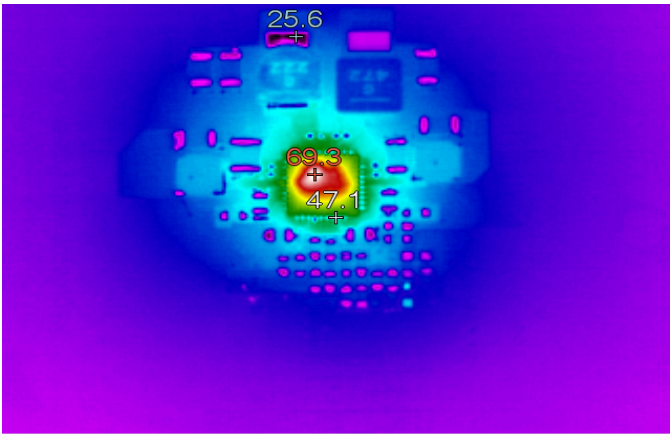
(a)



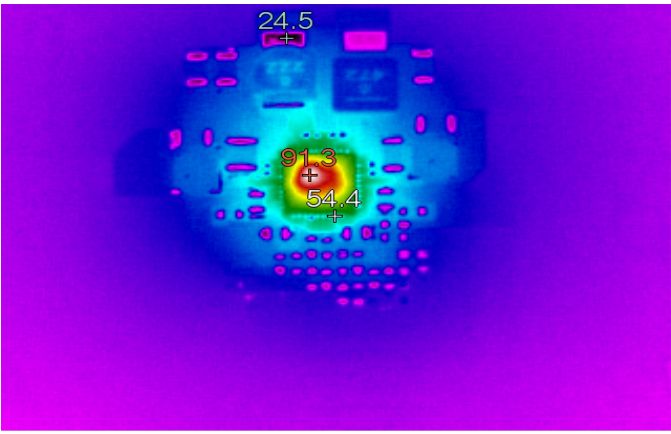
(b)

Figure 4. Radiated EMI (Vertical/Horizontal),  $V_{IN} = 12V$ ,  $I_{OUT1,2,3,4} = 1A$

# QUICK START PROCEDURE



$V_{IN} = 12V$



$V_{IN} = 24V$

Figure 5. Thermal Image Top View,  $I_{OUT1,2,3,4} = 1A$ ,  $T_A = 25^{\circ}C$ ,  $f_{SW} = 2MHz$

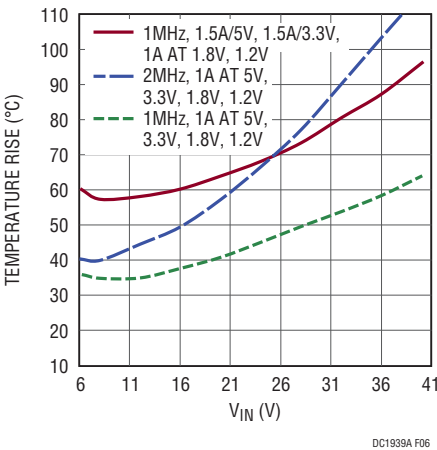


Figure 6. LT8602 Case Temperature Rise,  $T_A = 25^{\circ}C$

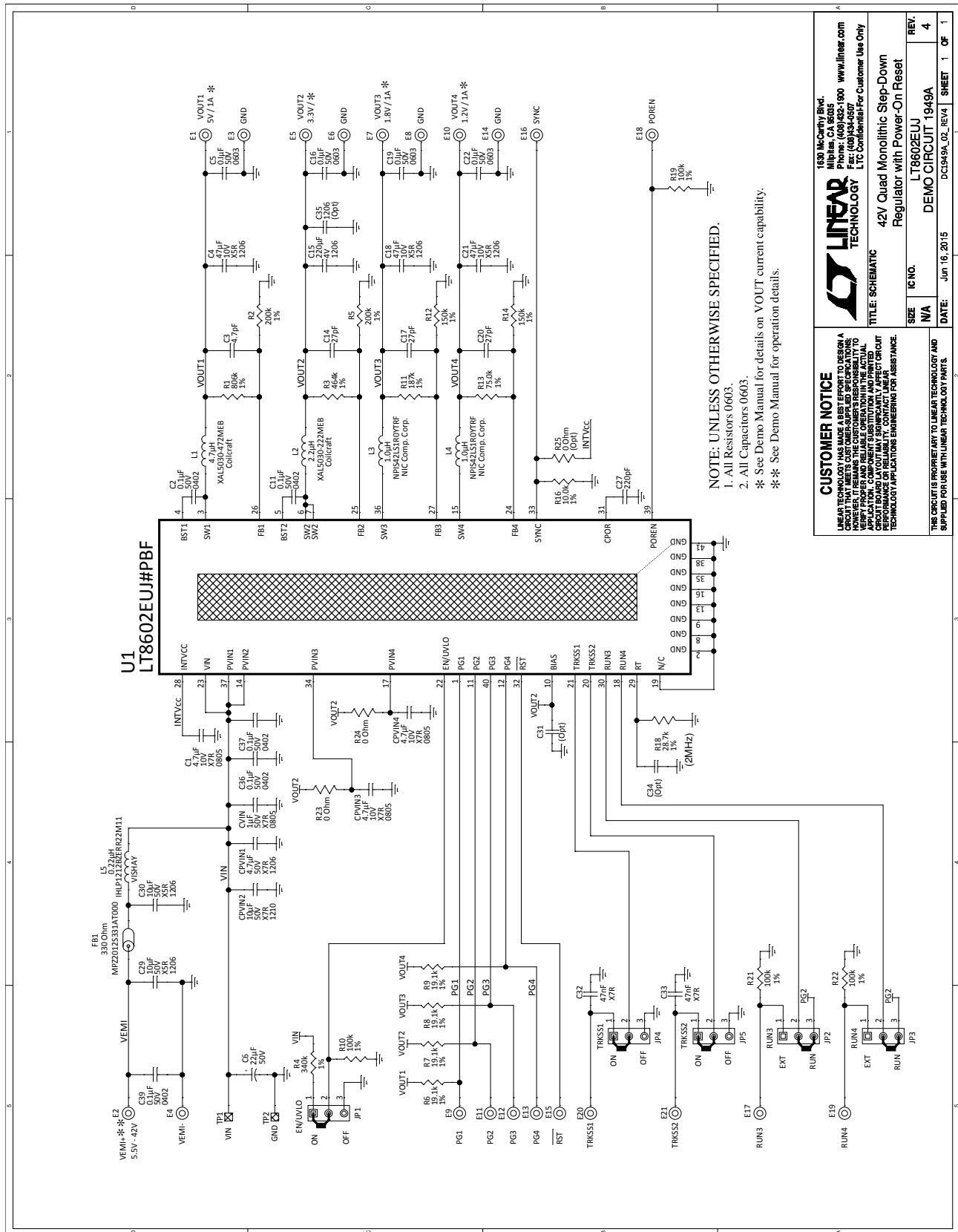
# DEMO MANUAL DC1949A

## PARTS LIST

| ITEM                                            | QTY | REFERENCE                                                                                      | PART DESCRIPTION                     | MANUFACTURER/PART NUMBER         |
|-------------------------------------------------|-----|------------------------------------------------------------------------------------------------|--------------------------------------|----------------------------------|
| <b>Required Circuit Components</b>              |     |                                                                                                |                                      |                                  |
| 1                                               | 1   | CPVIN1                                                                                         | Cap., X7R 4.7µF 50V 10% 1206         | Murata GRM31CR71H475KA12L        |
| 2                                               | 1   | CPVIN2                                                                                         | Cap., X7R 10µF 50V 10% 1210          | Murata ERIE GRM32ER71H106KA12L   |
| 3                                               | 3   | C1, CPVIN3, CPVIN4                                                                             | Cap., X7R 4.7µF 10V 10% 0805         | Murata GRM21BR71A475KA73L        |
| 4                                               | 1   | CVIN                                                                                           | Cap., X7R 1µF 50V 10% 0805           | TDK C2012X7R1H105KT              |
| 5                                               | 5   | C2, C11, C36, C37, C39                                                                         | Cap., X7R 0.1µF 50V 10% 0402         | TDK CGA2B3X7R1H104K050BB         |
| 6                                               | 1   | C3                                                                                             | Cap., NPO 4.7pF 25V 5% 0603          | AVX 06033A4R7JAT2A               |
| 7                                               | 3   | C14, C17, C20                                                                                  | Cap., NPO 27pF 25V 5% 0603           | AVX 06033A270JAT2A               |
| 8                                               | 3   | C4, C18, C21                                                                                   | Cap., X5R 47µF 10V 20% 1206          | Murata GRM31CR61A476ME15L        |
| 9                                               | 4   | C5, C16, C19, C22                                                                              | Cap., X7R 0.1µF 50V 10% 0603         | Murata GRM188R71H104KA93D        |
| 10                                              | 1   | C6                                                                                             | Cap., Alum 22µF 50V 10%              | Sun Elect. 50CE22BSS             |
| 11                                              | 1   | C15                                                                                            | Cap., X5R 220µF 4V 20% 1206          | Murata GRM31CR60G227ME11L        |
| 12                                              | 1   | C27                                                                                            | Cap., X7R 220pF 25V 10% 0603         | AVX 06033C221MAT2A               |
| 13                                              | 2   | C29, C30                                                                                       | Cap., X5R 10µF 50V 10% 1206          | Murata CGA5L3X5R1H106K160AB      |
| 14                                              | 2   | C32, C33                                                                                       | Cap., X7R 47nF 25V 20% 0603          | AVX 06033C473MAT2A               |
| 15                                              | 1   | FB1                                                                                            | Ferrite Bead, 330Ω                   | TDK Corp. MPZ2012S331AT000       |
| 16                                              | 1   | L1                                                                                             | Inductor, 4.7µH                      | Coilcraft XAL5030-472MEB         |
| 17                                              | 1   | L2                                                                                             | Inductor, 2.2µH                      | Coilcraft XAL5030-222MEB         |
| 18                                              | 2   | L3, L4                                                                                         | Inductor, 1.0µH ±30%                 | NIC Comp. Corp. NPIS42LS1R0YTRF  |
| 19                                              | 1   | L5                                                                                             | Inductor, 0.22µH                     | Vishay, IHLP1212BZERR22M11       |
| 20                                              | 1   | R1                                                                                             | Res., Chip 806k 0.06W 1% 0603        | Vishay CRCW0603806KFKEA          |
| 21                                              | 2   | R2, R5                                                                                         | Res., Chip 200k 0.06W 1% 0603        | Vishay CRCW0603200KFKEA          |
| 22                                              | 1   | R3                                                                                             | Res., Chip 464k 0.06W 1% 0603        | Vishay CRCW0603464KFKEA          |
| 23                                              | 1   | R4                                                                                             | Res., Chip 340k 0.06W 1% 0603        | Vishay CRCW0603340KFKEA          |
| 24                                              | 4   | R6, R7, R8, R9                                                                                 | Res., Chip 19.1k 0.06W 1% 0603       | Vishay CRCW060319K1FKEA          |
| 25                                              | 4   | R10, R19, R21, R22                                                                             | Res., Chip 100k 0.06W 1% 0603        | Vishay CRCW0603100KFKEA          |
| 26                                              | 1   | R11                                                                                            | Res., Chip 187k 0.06W 1% 0603        | Vishay CRCW0603187KFKEA          |
| 27                                              | 2   | R12, R14                                                                                       | Res., Chip 150k 0.06W 1% 0603        | Vishay CRCW0603150KFKEA          |
| 28                                              | 1   | R13                                                                                            | Res., Chip 75.0k 0.06W 1% 0603       | Vishay CRCW060375K0FKEA          |
| 29                                              | 1   | R16                                                                                            | Res., Chip 10.0k 0.06W 1% 0603       | Vishay CRCW060310K0FKEA          |
| 30                                              | 1   | R18                                                                                            | Res., Chip 28.7k 0.06W 1% 0603       | Vishay CRCW060328K7FKEA          |
| 31                                              | 2   | R23, R24                                                                                       | Res, Chip 0Ω 0.25W 5A 0603           | Vishay CRCW06030000Z0EA          |
| 32                                              | 1   | U1                                                                                             | Buck Regulator QFN(40)(UJ) 6mm × 6mm | Linear Tech. Corp. LT8602EUJ#PBF |
| <b>Additional Demo Board Circuit Components</b> |     |                                                                                                |                                      |                                  |
| 1                                               | 0   | R25 (Opt)                                                                                      | Res, Chip 0Ω 0.25W 5A 0603           | Vishay CRCW06030000Z0EA          |
| 2                                               | 0   | C31, C34 (Opt)                                                                                 | Cap., 0603                           |                                  |
| 3                                               | 0   | C35 (Opt)                                                                                      | Cap., 1206                           |                                  |
| <b>Hardware: For Demo Board Only</b>            |     |                                                                                                |                                      |                                  |
| 1                                               | 5   | XJP1, XJP2, XJP3, XJP4, XJP5                                                                   | Shunt, 2mm Ctrs.                     | Samtec 2SN-BK-G                  |
| 2                                               | 4   | MH1-MH4                                                                                        | Stand-Off, Nylon 0.25" Tall          | Keystone, 8831 (Snap On)         |
| 3                                               | 21  | E1, E2, E3, E4, E5, E6, E7, E8, E9, E10, E11, E12, E13, E14, E15, E16, E17, E18, E19, E20, E21 | Turret, Testpoint                    | Mill Max 2501-2-00-80-00-00-07-0 |
| 4                                               | 5   | JP1, JP2, JP3, JP4, JP5                                                                        | Headers, 3 Pins 2mm Ctrs.            | Samtec TMM-103-02-L-S            |

dc1949af

## SCHEMATIC DIAGRAM



**CUSTOMER NOTICE**  
 LINEAR TECHNOLOGY AND ITS SUPPLIERS MAKE NO REPRESENTATION OR WARRANTY, EITHER EXPRESS OR IMPLIED, THAT THE CIRCUITRY SHOWN IN THIS DEMO MANUAL MEETS CUSTOMER'S SPECIFICATIONS OR THAT IT IS SUITABLE FOR ANY PARTICULAR APPLICATION. COMPONENT SUBSTITUTION AND PRINTED CIRCUIT BOARD LAYOUT MAY SIGNIFICANTLY AFFECT CIRCUIT PERFORMANCE. CUSTOMER IS ADVISED TO CONSULT WITH LINEAR TECHNOLOGY APPLICATIONS ENGINEERING FOR ASSISTANCE.

|                                                                                                                                                                                    |                         |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| <b>LINEAR TECHNOLOGY</b><br>1630 McCarthy Blvd.<br>Milpitas, CA 95055<br>Phone: (408) 422-1900 www.linear.com<br>E-Mail: info@linear.com<br>LTC Confidential For Customer Use Only |                         |
| <b>42V Quad Monolithic Step-Down Regulator with Power-On Reset</b>                                                                                                                 |                         |
| <b>LT8602EUJ</b>                                                                                                                                                                   | <b>REV. 4</b>           |
| <b>DEMO CIRCUIT 1949A</b>                                                                                                                                                          | <b>SHEET 1 OF 1</b>     |
| <b>DATE:</b> Jun 16, 2015                                                                                                                                                          | <b>DC1949A_02_REV14</b> |

# DEMO MANUAL DC1949A

---

## 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

dc1949af

## Данный компонент на территории Российской Федерации

**Вы можете приобрести в компании MosChip.**

Для оперативного оформления запроса Вам необходимо перейти по данной ссылке:

<http://moschip.ru/get-element>

Вы можете разместить у нас заказ для любого Вашего проекта, будь то серийное производство или разработка единичного прибора.

В нашем ассортименте представлены ведущие мировые производители активных и пассивных электронных компонентов.

Нашей специализацией является поставка электронной компонентной базы двойного назначения, продукции таких производителей как XILINX, Intel (ex.ALTERA), Vicor, Microchip, Texas Instruments, Analog Devices, Mini-Circuits, Amphenol, Glenair.

Сотрудничество с глобальными дистрибьюторами электронных компонентов, предоставляет возможность заказывать и получать с международных складов практически любой перечень компонентов в оптимальные для Вас сроки.

На всех этапах разработки и производства наши партнеры могут получить квалифицированную поддержку опытных инженеров.

Система менеджмента качества компании отвечает требованиям в соответствии с ГОСТ Р ИСО 9001, ГОСТ РВ 0015-002 и ЭС РД 009

### Офис по работе с юридическими лицами:

105318, г.Москва, ул.Щербаковская д.3, офис 1107, 1118, ДЦ «Щербаковский»

Телефон: +7 495 668-12-70 (многоканальный)

Факс: +7 495 668-12-70 (доб.304)

E-mail: [info@moschip.ru](mailto:info@moschip.ru)

Skype отдела продаж:

moschip.ru

moschip.ru\_4

moschip.ru\_6

moschip.ru\_9