# LT8616

# Dual 42V Synchronous Monolithic Step-Down Regulator with 6.5µA Quiescent Current

## DESCRIPTION

Demonstration circuit 2169A is a dual monolithic step-down DC/DC switching regulator featuring the LT®8616. The LT8616 is a high efficiency, high speed, dual synchronous monolithic step-down switching regulator that consumes only 6.5µA of quiescent current with both channels enabled. The demo circuit is designed for 5V, 1.5A and 3.3V, 2.5A outputs. Both channels contain all switches and necessary circuitry to minimize the external components and solution size. Fast minimum ON time of 35ns enables high $V_{IN}$ to low $V_{OUT}$ conversion at high switching frequency. Independent input voltage, feedback, soft-start and power good pins for each channel simplify complex power supply tracking/sequencing requirements.

The inputs of the two channels are connected on the demo board by default. They can also be separated by removing the 0Ω resistor (R13) from the board. Each output can be independently disabled using its own EN/UV pin, while $V_{IN1}$ must be connected to 3.4V or above even if only channel 2 is in use. The demo board has an EMI filter installed between $V_{IN2}$ and $V_{EMI}$. To use the EMI filter, the inputs should be tied to $V_{EMI}$.

The switching frequency of both channels can be programmed either via an oscillator resistor or a common external clock up to 3MHz.The SYNC pin on the demo board is grounded by default for Burst Mode® operation.

To synchronize to an external clock, move JP1 to SYNC/MODE and apply the external clock to the SYNC/MODE turret. The $R_T$ resistor (R5) should be chosen to set the LT8616 internal switching frequency at least 20% below the lowest synchronization input.

Low ripple Burst Mode operation increases the efficiency at the light load while keeping the output ripple low. Figure 1 and Figure 2 show the demo board efficiency for each channel at 12V input voltage in Burst Mode operation. Figure 3 shows the temperature rising on DC2169A demo board with different input voltages under full load conditions on both channels.

The LT8616 data sheet gives a complete description of the part, operation and application information. The data sheet must be read in conjunction with this demo manual for DC2169A. The LT8616 is assembled in a 28-lead plastic TSSOP package. Proper board layout is essential for both low EMI operation and maximum thermal performance. See the data sheet sections for details.

**Design files for this circuit board are available at http://www.linear.com/demo/DC2169A**

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## PERFORMANCE SUMMARY

**Specifications are at $T_A$ = 25°C**

| SYMBOL | PARAMETER | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| $V_{IN1}$ | Channel 1 Input Supply Range | | 5.8 | | 42 | V |
| $V_{IN2}$ | Channel 2 Input Supply Range | | 4.1 | | 42 | V |
| $V_{OUT1}$ | Channel 1 Output Voltage | | 4.88 | 5.02 | 5.15 | V |
| $V_{OUT2}$ | Channel 2 Output Voltage | | 3.21 | 3.29 | 3.37 | V |
| $f_{SW}$ | Switching Frequency | $R_T$ = 14.7kΩ | 1.85 | 2.05 | 2.25 | MHz |
| $I_{OUT1}$ | Channel 1 Max Output Current | | 1.5 | | | A |
| $I_{OUT2}$ | Channel 2 Max Output Current | | 2.5 | | | A |
| EFE | Efficiency at DC | $V_{IN1}$ = $V_{IN2}$ = 12V, $I_{OUT1}$ = 1.5A, $I_{OUT2}$ = 2.5A | | 85.1 | | % |

## PERFORMANCE SUMMARY

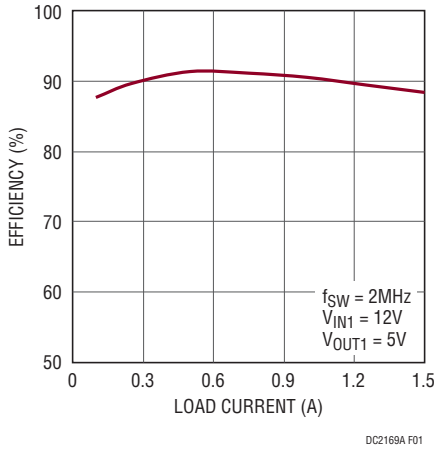



**Figure 1. LT8616 Channel 1 Efficiency vs Load Current**

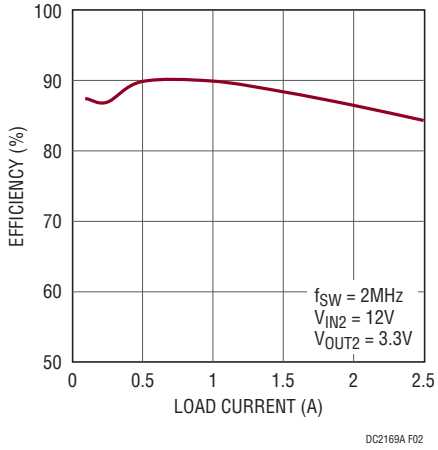



**Figure 2. LT8616 Channel 2 Efficiency vs Load Current**

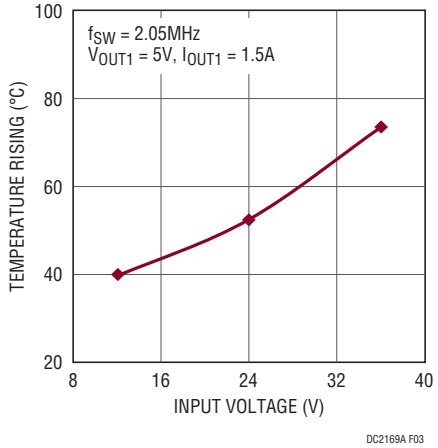



**Figure 3. LT8616 Temperature Rising vs Input Voltage**

## QUICK START PROCEDURE

DC2169A is easy to set up to evaluate the performance of the LT8616. Refer to Figure 4 for proper measurement 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 input or output voltage ripple by touching the probe tip directly across the $V_{IN}$ or $V_{OUT}$ and GND terminals. See Figure 5 for the proper scope technique.

1. Place JP1 on the Burst Mode position.
2. With power off, connect the input power supply to $V_{EMI}$ and GND. Make sure that the input voltage does not exceed 42V.
3. With power off, connect loads from $V_{OUT1}$ to GND, and $V_{OUT2}$ to GND.
4. Turn on the power at the input.
5. Check for the proper output voltages (5V and 3.3V).

   NOTE: If there is no output, temporarily disconnect the load to make sure that the load is not set too high or is shorted.
6. Once the proper output voltages are established, adjust the load within the operating ranges and observe the output voltage regulation, ripple voltage, efficiency and other parameters.
7. An external clock can be added to the SYNC terminal when SYNC function is used (JP1 on the SYNC/MODE position). Please make sure that the SYNC frequency is at least 20% higher than the set switching frequency. See the data sheet section Synchronization.

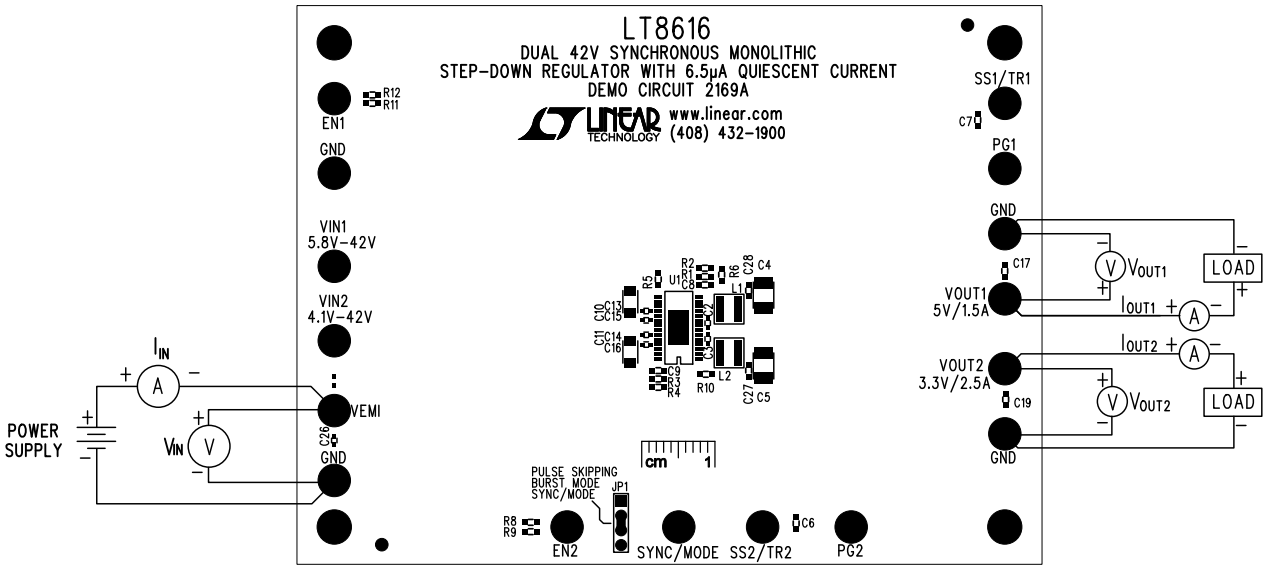



**Figure 4. Proper Measurement Equipment Setup**

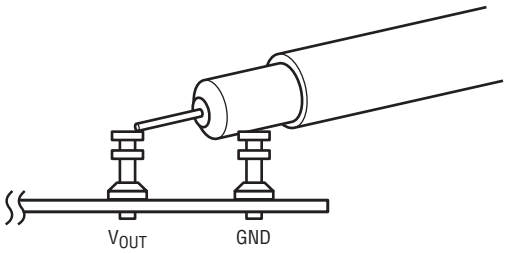
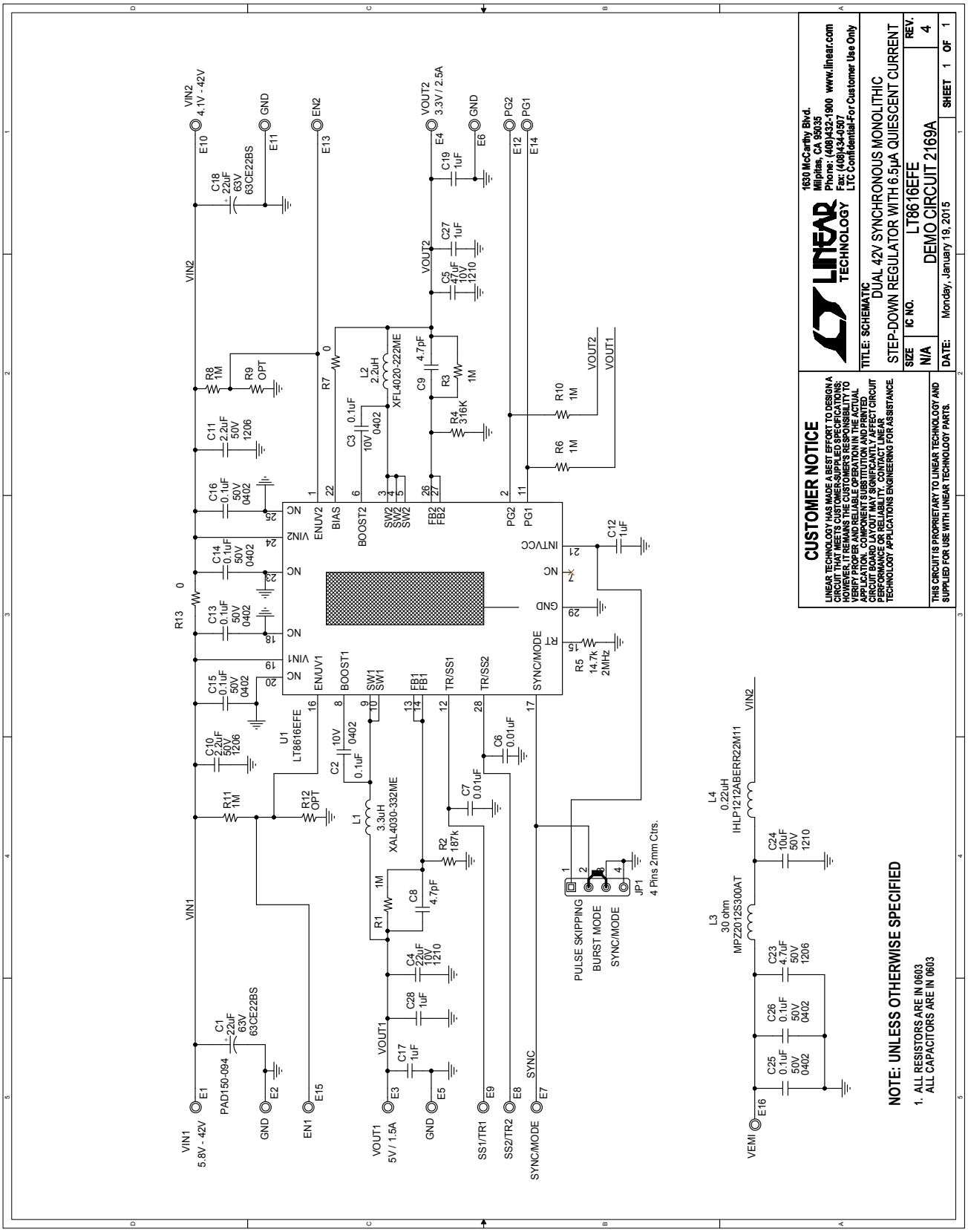



**Figure 5. Measuring Input or Output Ripple**

## PARTS LIST

| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|---|---|---|---|---|
| **Required Circuit Components** | | | | |
| 1 | 2 | C2, C3 | CAP., X7R, 0.1µF, 10V, 10% 0402 | SAMSUNG, CL05B104KP5NNNC |
| 2 | 1 | C4 | CAP., X7R, 22µF, 10V, 10% 1210 | MURATA, GRM32ER71A226KE20L |
| 3 | 1 | C5 | CAP., X7R, 47µF, 10V, 10% 1210 | MURATA, GRM32ER71A476KE15L |
| 4 | 2 | C6, C7 | CAP., X7R, 0.01µF, 10V, 10% 0603 | AVX, 0603ZC103KAT2A |
| 5 | 2 | C8, C9 | CAP., C0G, 4.7pF, 50V, ±0.25pF 0603 | AVX, 06035A4R7CAT2A |
| 6 | 2 | C10, C11 | CAP., X7R, 2.2µF, 50V, 10% 1206 | MURATA, GRM31CR71H225KA88L |
| 7 | 5 | C12, C17, C19, C27, C28 | CAP., X7R, 1µF, 10V, 10% 0603 | AVX, 0603ZC105KAT2A |
| 8 | 4 | C13, C14, C15, C16 | CAP., X7R, 0.1µF, 50V, 10% 0402 | TDK, C1005X7R1H104K050BB |
| 9 | 1 | L1 | IND., 3.3µH, XAL4030 | COILCRAFT, XAL4030-332ME |
| 10 | 1 | L2 | IND., 2.2µH, XFL4020 | COILCRAFT, XFL4020-222ME |
| 11 | 6 | R1, R3, R6, R8, R10, R11 | RES., CHIP, 1M, 0.1W, 1%, 0603 | VISHAY, CRCW06031M00FKEA |
| 12 | 1 | R2 | RES., CHIP, 187k, 0.1W, 1%, 0603 | VISHAY, CRCW0603187KFKEA |
| 13 | 1 | R4 | RES., CHIP, 316k, 0.1W, 1%, 0603 | VISHAY, CRCW0603316KFKEA |
| 14 | 1 | R5 | RES., CHIP, 14.7k, 0.1W, 1%, 0603 | VISHAY, CRCW060314K7FKEA |
| 15 | 2 | R7, R13 | RES., CHIP, 0Ω, 0.1W, 0603 | VISHAY, CRCW06030000Z0EA |
| 16 | 1 | U1 | IC., LT8616EFE TSSOP-28/EB | LINEAR TECH., LT8616EFE#PBF |
| **Additional Demo Board Circuit Components** | | | | |
| 1 | 2 | C1, C18 | CAP., ALUM., 22µF, 63V, | SUN ELECTRONIC INDUSTRIES CORP., 63CE22BS |
| 2 | 1 | L3 | CHIP BEAD, 30Ω, MPZ2012 | TDK, MPZ2012S300AT |
| 3 | 1 | L4 | IND., 0.22µH, IHLP1212AB | VISHAY, IHLP1212ABERR22M11 |
| 4 | 1 | C23 | CAP., X7R, 4.7µF, 50V, 10% 1206 | SAMSUNG, CL31B475KBHNNNE |
| 5 | 1 | C24 | CAP., X7R, 10µF, 50V, 10% 1210 | MURATA, GRM32ER71H106KA12L |
| 6 | 2 | C25, C26 | CAP., X7R, 0.1µF, 50V, 10% 0402 | TDK, C1005X7R1H104K050BB |
| 7 | 0 | R9, R12 (OPT) | RES., CHIP, 0603 | |
| **Hardware: For Demo Board Only** | | | | |
| 1 | 16 | E1-E16 | TESTPOINT, TURRET, .094" PBF | MILL-MAX, 2501-2-00-80-00-00-07-0 |
| 2 | 1 | JP1 | 4 PIN 0.079 SINGLE ROW HEADER | SULLINS, NRPN041PAEN-RC |
| 3 | 1 | XJP1 | SHUNT, .079" CENTER | SAMTEC, 2SN-BK-G |

## SCHEMATIC DIAGRAM






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