

# LTC7813EUH

## 4V to 56V $V_{IN}$ , Step-Up/Step-Down Power Supply

### DESCRIPTION

Demonstration circuit DC2435A is a step-up/down supply featuring the **LTC®7813EUH**. The LTC7813 is a high performance dual output (buck and boost) synchronous DC/DC switching regulator controller. The board has three different configurations:

DC2435A-A: Regulated output voltage of 24 Volt

DC2435A-B: Narrowed output voltage between 20V and 28V

DC2435A-C: Dual output voltages of 24V (Boost  $V_{BUS}$  channel) and 5V (Buck  $V_{OUT1}$  channel)

The circuit enables a drop-in layout where the total circuit area is only 1½" by 1½". The LTC7813EUH is in a 32-lead exposed pad QFN package.

The main features of the board include rail tracking (buck channel only), an internal 5V linear regulator for bias, separate RUN pins for each output and a Mode selector that allows the converter to run in CCM, pulse-skipping or Burst Mode operation. Synchronization to an external clock is also possible.

The LTC7813 buck input is supplied from the Boost output for the DC2435A-A and DC2435A-B only. With this boost-then-buck topology, the buck outputs maintain regulation over the entire input range of 4V to 56V, making it suitable for automotive or other battery fed applications where low quiescent current is important.

The DC2435A-B is designed such that  $V_{OUT}$  is partially regulated between 20V and 28V for higher efficiency (Figure 5a), reduced power loss, and switching noise. When  $V_{IN}$  is between 20V and 28V, it operates in pass-thru mode with the boost synchronous FET fully on and the buck in drop-out with >99% duty cycle. When  $V_{IN}$  is below 20V, the boost is activated and when  $V_{IN}$  is above 28V, the buck is activated as shown in Figure 5b.

The LTC7813 data sheet gives a complete description of the part, operation and application information and must be read in conjunction with this quick start guide.

**Design files for this circuit board are available at <http://www.linear.com/demo/DC2435A>**

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### PERFORMANCE SUMMARY

Specifications are at  $T_A = 25^\circ\text{C}$

Table 1

| SYMBOL     | PARAMETER                                       |    | CONDITIONS                                             | MIN  | TYP  | MAX  | UNITS |
|------------|-------------------------------------------------|----|--------------------------------------------------------|------|------|------|-------|
| $V_{IN}$   | Input Supply Range                              |    |                                                        | 4    |      | 56   | V     |
| $V_{OUT1}$ | Output1 Voltage Range                           | -A | $V_{IN} = 4V^* - 56V, I_{OUT1} = 0A \text{ to } 5A^\#$ | 23.5 | 24   | 24.5 | V     |
|            |                                                 | -B |                                                        | 19   |      | 28.6 | V     |
|            |                                                 | -C |                                                        | 4.9  | 5**  | 5.1  | V     |
| $V_{BUS}$  | $V_{BUS}$ Voltage Range (-C only)               |    | $V_{IN} < 24V$                                         | 23.5 | 24   | 24.5 | V     |
| $f_{SW}$   | Typical Free Running Switching Frequency        |    |                                                        | 200  |      |      | kHz   |
|            | See Figures 4, 5, 6 and 7 for efficiency curves | -A | $V_{IN} = 14V, V_{OUT1} = 24V, I_{OUT1} = 5A$          |      | 94.6 |      | %     |
|            |                                                 |    | $V_{IN} = 48V, V_{OUT1} = 24V, I_{OUT1} = 5A$          |      | 96.9 |      | %     |
|            |                                                 | -B | $V_{IN} = 14V, V_{OUT1} = 20V, I_{OUT1} = 5A$          |      | 96.3 |      | %     |
|            |                                                 |    | $V_{IN} = 24V, V_{OUT1} = 24V, I_{OUT1} = 5A$          |      | 98.5 |      | %     |
|            |                                                 |    | $V_{IN} = 48V, V_{OUT1} = 28V, I_{OUT1} = 5A$          |      | 97.3 |      | %     |
|            |                                                 | -C | $V_{IN} = 14V, V_{BUS} = 24V, I_{BUS} = 3A$            |      | 97.1 |      | %     |
|            |                                                 |    | $V_{IN} = 14V, V_{OUT1} = 5V, I_{OUT1} = 8A$           |      | 92.8 |      | %     |
|            |                                                 |    | $V_{IN} = 48V, V_{OUT1} = 5V, I_{OUT1} = 8A$           |      | 88.9 |      | %     |

#  $I_{OUT1}$  starts to de-rate when  $V_{IN} < 14V$ . \*  $V_{IN}$  needs to be > 8V to start up. \*\*  $V_{OUT1}$  follows  $V_{IN}$  when  $V_{IN} < 5V$ .

dc2435af

# DEMO MANUAL DC2435A-A/ DC2435A-B/DC2435A-C

## DEMO BOARD OPTIONS

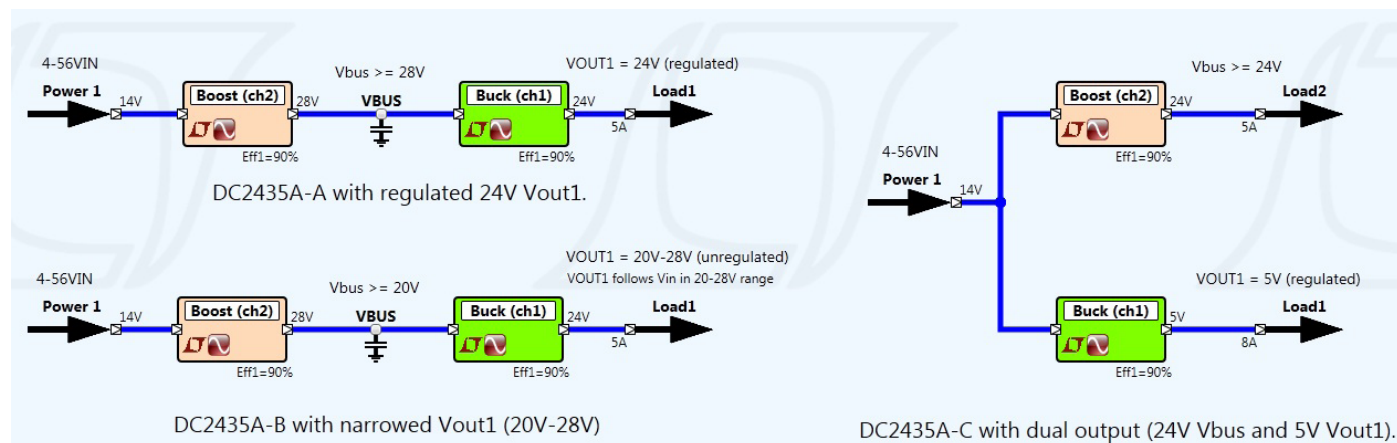


Figure 1. DC2435A/LTC7813 Demo Board Options

## QUICK START PROCEDURE

DC2435A is easy to set up to evaluate the performance of the LTC7813EUH. Refer to Figure 2 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 or directly across relevant capacitor. See Figure 3 for proper scope probe technique.

1. Place jumpers in the following positions:

**JP1** ON

**JP2** ON

**JP3** FCM

2. With power off, connect the input power supply to  $V_{IN}$  and GND.

3. Turn on the power at the input.

NOTE: Make sure that the input voltage is higher than 8V and does not exceed 56V.

4. Check for the proper output voltages for different boards.

-A:  $V_{OUT1} = 23.5V$  to  $24.5V$ ,

-B:  $19V < V_{OUT1} < 28.6V$ ,

-C:  $V_{OUT1} = 4.9V$  to  $5.1V$ ;  
 $V_{BUS} = 23.5V$  to  $24.5V$  ( $V_{IN} < 24V$ )

NOTE: If there is no output, temporarily disconnect the load to make sure that the load is not set too high.

5. Once the proper output voltages are established, adjust the loads within the operating range and observe the output voltage regulation, ripple voltage, efficiency and other parameters.

## QUICK START PROCEDURE

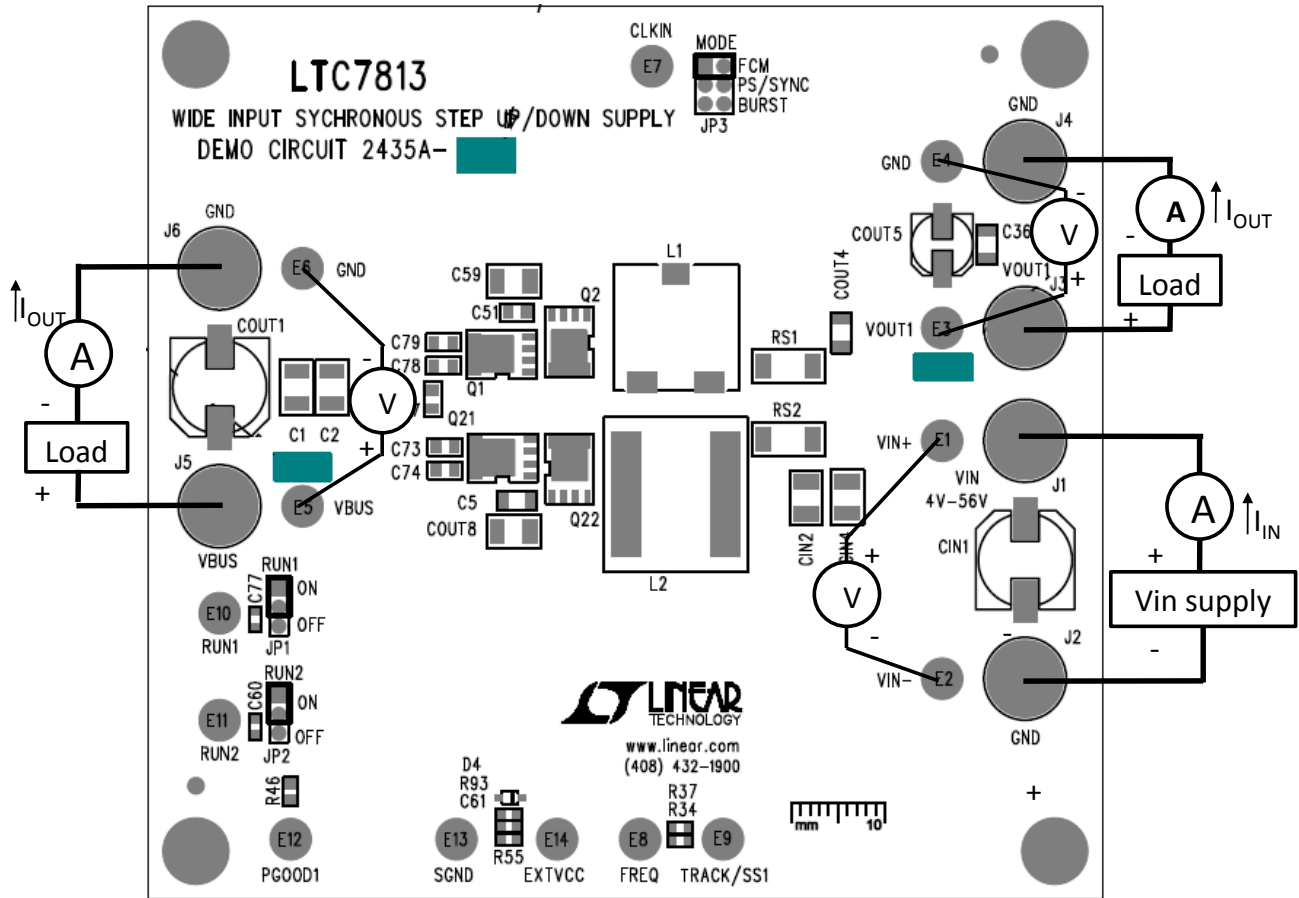


Figure 2. Proper Measurement Equipment Setup

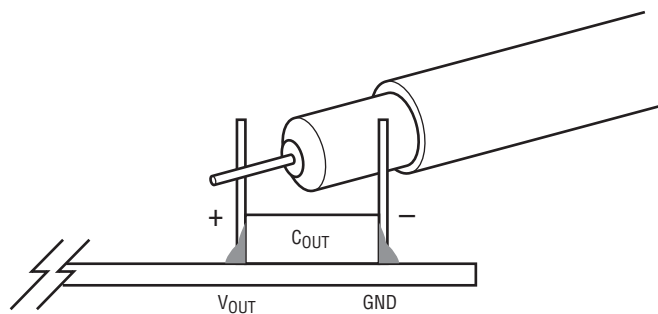


Figure 3. Measuring Input or Output Ripple Across Terminals or Directly Across Ceramic Capacitor

## FREQUENCY SYNCHRONIZATION AND MODE SELECTION

DC2435A's mode selector allows the converter to run in forced continuous operation, pulse skip operation, Burst Mode or be synchronizing to an external clock by changing the position of JP3.

**Table 2. Mode Selection and Synchronized Operation Options**

| CONFIGURATION                                       | JP3     |
|-----------------------------------------------------|---------|
| Forced Continuous Operation                         | FCM     |
| Pulse-Skipping Operation                            | PS/Sync |
| Synchronized to External Clock Applied to CLKIN Pin | PS/Sync |
| Burst Mode Operation                                | Burst   |

## RAIL TRACKING

DC2435A is configured for an on board soft start circuit. The soft start ramp rate can be adjusted by changing the value of C47. DC2435A can also be modified to track an external reference. Refer to Table 3 for tracking options and to the data sheet for more details.

**Table 3.  $V_{OUT1}$  Tracking Options**

| CONFIGURATION                                 | R34      | R37     | C47         | TRK/SS1 TURRET     |
|-----------------------------------------------|----------|---------|-------------|--------------------|
| Soft-Start Without Tracking (Default)         | OPEN     | OPEN    | 0.1 $\mu$ F | OPEN               |
| $V_{OUT1}$ Tracking Scaled External Reference | Resistor | Divider | OPEN        | External Reference |

## OPTIONAL INDUCTOR DCR CURRENT SENSING

DC2435A provides an optional circuit for Inductor DCR Current Sensing. Inductor DCR Current Sensing uses the DCR of the inductor to sense the inductor current instead of discrete sense resistors. The advantages of DCR sensing are lower cost, reduced board space and higher efficiency, but the disadvantage is a less accurate current limit. If

DCR sensing is used, be sure to select an inductor current with a sufficiently high saturation current or use an iron powder type material.

Refer to Table 4 for Optional Inductor DCR Current Sensing setup and to the data sheet for more details.

**Table 4. Optional Inductor DCR Current Sensing**

| CONFIGURATION                    | CHANNEL 1 | RS1               | R39       | R40       | C15                              | R51  | R53  | R62        |
|----------------------------------|-----------|-------------------|-----------|-----------|----------------------------------|------|------|------------|
|                                  | CHANNEL 2 | RS2               | R80       | R81       | C56                              | R89  | R90  | R91        |
| Current Sense Resistor (Default) |           | Ref. Sch.         | Ref. Sch. | Ref. Sch. | Ref. Sch.                        | OPEN | OPEN | OPEN       |
| Inductor DCR Current Sensing     |           | 0 $\Omega$ Copper | OPEN      | OPEN      | Calculated Value from Data Sheet |      |      | 0 $\Omega$ |

## LOW QUIESCENT CURRENT APPLICATIONS AND MEASUREMENT

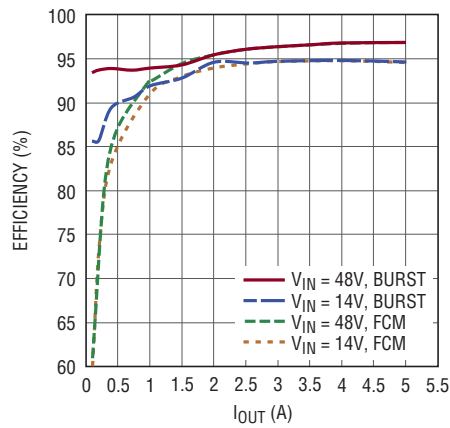
The typical quiescent current ( $I_Q$ ) of the LTC7813 controller is 29 $\mu$ A in sleep mode as specified in the LTC7813 data sheet. However, the input current of the DC2435A board can be higher than this value because of additional circuit outside of the IC. To reduce the total input current, large value FB divider resistors should be used. In addition, some of the optional pull-up resistors should be removed from

the board. Refer to Table 5 for the low input quiescent current setup.

**Table 5. Low Input Quiescent Current Configuration**

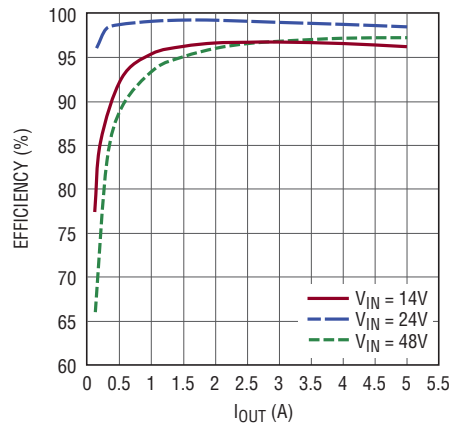
|                      |        |
|----------------------|--------|
| Reference Designator | R46    |
| Function             | PGOOD1 |
| Stuffing Option      | OPEN   |

# DEMO MANUAL DC2435A-A/ DC2435A-B/DC2435A-C



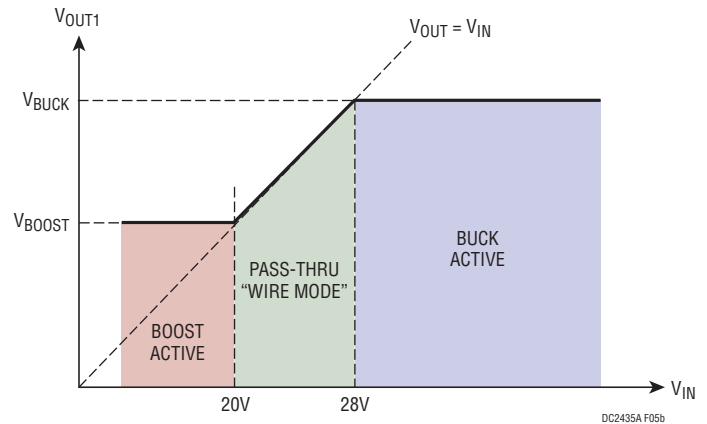
DC2435A F04

Figure 4. DC2435A-A  $V_{OUT1}$  Typical Efficiency vs Load Current



DC2435A F05a

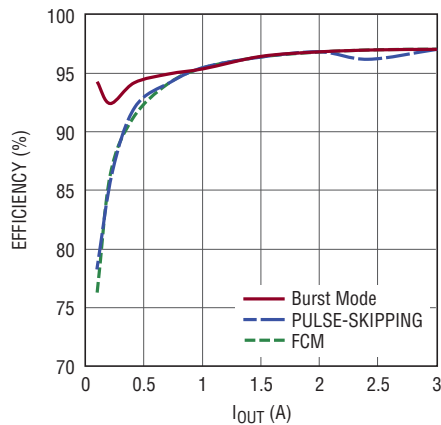
Figure 5a. DC2435A-B  $V_{OUT1}$  Typical Efficiency vs Load Current



DC2435A F05b

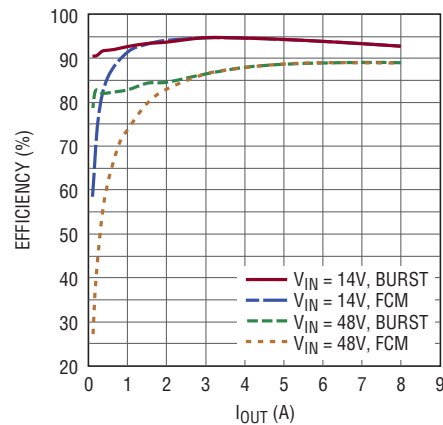
Figure 5b. DC2435A-B  $V_{OUT1}$  Operating Modes vs  $V_{IN}$

Figure 5.



DC2435A F06

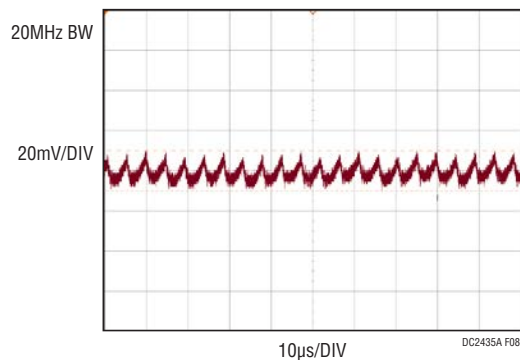
Figure 6. DC2435A-C  $V_{BUS}$  Typical Efficiency vs Load Current ( $V_{IN} = 14V$ )



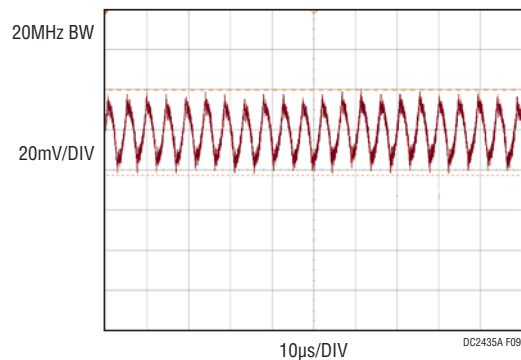
DC2435A F07

Figure 7. DC2435A-C  $V_{OUT1}$  Typical Efficiency vs Load Current

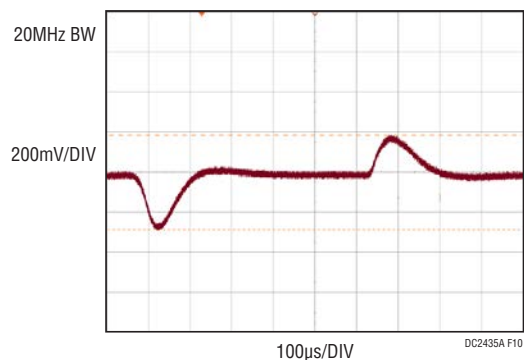
# DEMO MANUAL DC2435A-A/ DC2435A-B/DC2435A-C



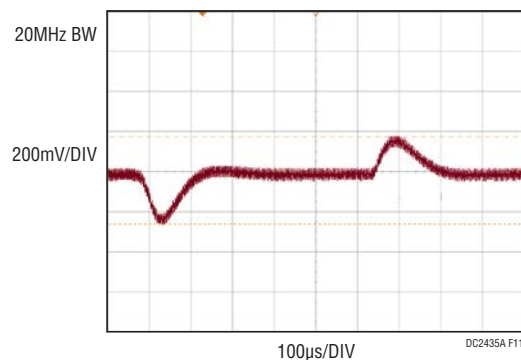
**Figure 8. DC2435A-A  $V_{OUT1}$  Voltage Ripple at  $V_{IN} = 14V$**



**Figure 9. DC2435A-A  $V_{OUT1}$  Voltage Ripple at  $V_{IN} = 48V$**



**Figure 10. DC2435A-A  $V_{OUT1}$  0A to 2.5A Load Transient at  $V_{IN} = 14V$**



**Figure 11. DC2435A-A  $V_{OUT1}$  0A to 2.5A Load Transient at  $V_{IN} = 48V$**

# DEMO MANUAL DC2435A-A/ DC2435A-B/DC2435A-C

## PARTS LIST

| ITEM                                            | QTY | REFERENCE                                       | PART DESCRIPTION                                                 | MANUFACTURER/PART NUMBER                |
|-------------------------------------------------|-----|-------------------------------------------------|------------------------------------------------------------------|-----------------------------------------|
| <b>DC2435A-A</b>                                |     |                                                 |                                                                  |                                         |
| <b>Required Circuit Components</b>              |     |                                                 |                                                                  |                                         |
| 1                                               | 2   | CIN1, COUT1                                     | CAP, 33 $\mu$ F, 63V, 20%, ELEC                                  | SUN ELEC. 63HVH33M                      |
| 2                                               | 1   | COUT2                                           | CAP, 100 $\mu$ F, 63V, 20%, ELEC                                 | UNITED CHEMI CON,<br>EMZA630ADA101MJA0G |
| 3                                               | 6   | CIN2, CIN3, CIN4, COUT6, COUT8, C80             | CAP, 4.7 $\mu$ F, X7R, 100V, 10%,1210                            | MURATA, GRM32ER72A475KE14L              |
| 4                                               | 2   | COUT4, C5                                       | CAP, 2.2 $\mu$ F, X7R, 100V,10%,1206                             | MURATA, GRM31CR72A225KA73L              |
| 5                                               | 2   | COUT5, COUT11                                   | CAP, 68 $\mu$ F, 35V, 20%, D8                                    | PANASONIC, EEHA1V680XP                  |
| 6                                               | 5   | C4, C17, C21, C47, C52                          | CAP, 0.1 $\mu$ F, X7R, 25V ,10%, 0603                            | TDK, C1608X7R1E104K                     |
| 7                                               | 3   | C15, C56, C62                                   | CAP, 1nF, X7R, 50V,10%,0603                                      | AVX, 06035C102KAT2A                     |
| 8                                               | 1   | C43                                             | CAP, 68pF, NPO, 50V, 10%,0603                                    | AVX, 06035A680KAT2A                     |
| 9                                               | 1   | C44                                             | CAP, 4.7nF, X7R, 50V,10%,0603                                    | AVX, 06035C472KAT2A                     |
| 10                                              | 1   | C49                                             | CAP, 47pF X7R, 50V, 5%, 0603                                     | AVX, 06035A470JAT2A                     |
| 11                                              | 1   | C53                                             | CAP, 820pF X7R, 50V, 5%, 0603                                    | AVX, 06035A821JAT2A                     |
| 12                                              | 1   | C54                                             | CAP, 27nF, X7R, 50V,10%, 0603                                    | AVX, 06035C273KAT2A                     |
| 13                                              | 1   | C61                                             | CAP, 1 $\mu$ F, X5R, 25V, 20%, 0603                              | TDK, C1608X5R1E105M                     |
| 14                                              | 2   | C64, C81                                        | CAP, 4.7 $\mu$ F X5R,10V, 20%, 0603                              | AVX, 0603ZD475MAT2A                     |
| 15                                              | 1   | L1                                              | IND, 22 $\mu$ H                                                  | COILCRAFT, SER1390-223MLD               |
| 16                                              | 1   | L2                                              | IND, 15 $\mu$ H                                                  | COILCRAFT, XAL1510-153MED               |
| 17                                              | 1   | Q1                                              | XSTR, N-CHANNEL MOSFET                                           | INFINEON, BSC123N08NS3G                 |
| 18                                              | 1   | Q2                                              | XSTR, N-CHANNEL MOSFET                                           | INFINEON, BSC042NE7NS3G                 |
| 19                                              | 1   | Q21                                             | XSTR, N-CHANNEL MOSFET                                           | INFINEON, BSC026N08NS5                  |
| 20                                              | 1   | Q22                                             | XSTR, N-CHANNEL MOSFET                                           | INFINEON, BSC072N08NS5                  |
| 21                                              | 1   | R33                                             | RES., 11.5k $\Omega$ ,1/10W, 1%, 0603                            | VISHAY, CRCW060311K5FKEA                |
| 22                                              | 1   | R35                                             | RES., 7.5k $\Omega$ ,1/10W, 1%, 0603                             | VISHAY, CRCW06037K5FKEA                 |
| 23                                              | 2   | R43, R78                                        | RES., 332k $\Omega$ ,1/10W, 1%, 0603                             | VISHAY, CRCW0603332KFKEA                |
| 24                                              | 2   | R46, R48                                        | RES., 100k $\Omega$ ,1/10W, 5%, 0603                             | VISHAY, CRCW0603100KJNEA                |
| 25                                              | 1   | R72                                             | RES., 37.4k $\Omega$ ,1/10W, 1%, 0603                            | VISHAY, CRCW060337K4FKEA                |
| 26                                              | 1   | R75                                             | RES., 3.6k $\Omega$ ,1/10W, 1%, 0603                             | VISHAY, CRCW06033K60FKEA                |
| 27                                              | 1   | R79                                             | RES., 14.7k $\Omega$ ,1/10W, 1%, 0603                            | VISHAY, CRCW060314K7FKEA                |
| 28                                              | 1   | R81                                             | RES., 100 $\Omega$ ,1/10W, 5%, 0603                              | VISHAY, CRCW0603100RJNEA                |
| 29                                              | 1   | R86                                             | RES., 2.2 $\Omega$ ,1/10W, 5%, 0603                              | VISHAY, CRCW06032R20JNEA                |
| 30                                              | 1   | R92                                             | RES., 90.9k $\Omega$ ,1/10W, 1%, 0603                            | VISHAY, CRCW060390K9FKEA                |
| 31                                              | 1   | RS1                                             | RES., SENSE, 0.008 $\Omega$ ,1/2W, 1%, 2010                      | VISHAY, WSL20108L000FEA18               |
| 32                                              | 1   | RS2                                             | RES., SENSE, 0.006 $\Omega$ ,1/2W, 1%, 2010                      | VISHAY, WSL20106L000FEA18               |
| 33                                              | 1   | U1                                              | IC, LOW I <sub>Q</sub> , 60V BOOST + BUCK SYNCHRONOUS CONTROLLER | LINEAR TECH. LTC7813EUH#PBF             |
| <b>Additional Demo Board Circuit Components</b> |     |                                                 |                                                                  |                                         |
| 1                                               | 0   | C1, C2, C3, CIN5, C6, C59, C68                  | CAP, OPTION, 1210                                                | OPTION                                  |
| 2                                               | 0   | C36                                             | CAP, OPTION, 1206                                                | OPTION                                  |
| 3                                               | 0   | C7, C39, C40, C51, C66, C67, C73, C74, C78, C79 | CAP, OPTION, 0805                                                | OPTION                                  |
| 4                                               | 0   | C55, C57, C60, C63, C65, C77                    | CAP, OPTION, 0603                                                | OPTION                                  |

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# DEMO MANUAL DC2435A-A/ DC2435A-B/DC2435A-C

## PARTS LIST

| ITEM | QTY | REFERENCE                                                                                 | PART DESCRIPTION               | MANUFACTURER/PART NUMBER |
|------|-----|-------------------------------------------------------------------------------------------|--------------------------------|--------------------------|
| 5    | 0   | D3                                                                                        | DIODE, OPTION, SMB             | OPTION                   |
| 6    | 0   | D4                                                                                        | DIODE, OPTION, SOD323          | OPTION                   |
| 7    | 0   | L3                                                                                        | IND, OPTION                    | OPTION                   |
| 8    | 0   | Q9, Q11, Q18, Q19                                                                         | XSTR, OPTION, N-CHANNEL MOSFET | OPTION                   |
| 9    | 11  | R34, R36, R39, R40, R70, R80, R95, R96, R103, R105, R108                                  | RES., 0 $\Omega$ , 1/10W, 0603 | VISHAY, CRCW06030000Z0EA |
| 10   | 0   | R37, R51, R53, R55, R62, R85, R89, R90, R91, R93, R94, R104, R106, R107, R109, R110, R111 | RES., OPTION, 0603             | OPTION                   |
| 11   | 0   | R82                                                                                       | RES., OPTION, 1206             | OPTION                   |
| 12   | 0   | R100                                                                                      | RES., OPTION, 0805             | OPTION                   |
| 13   | 0   | R101                                                                                      | RES., OPTION, 2010             | OPTION                   |
| 14   | 1   | R102                                                                                      | RES., 0 $\Omega$ , 2010        | VISHAY, CRCW20100000Z0EF |
| 15   | 0   | RS3                                                                                       | RES., SENSE, OPT, 2010         | OPTION                   |

### Hardware: For Demo Board Only

|   |    |                        |                         |                                   |
|---|----|------------------------|-------------------------|-----------------------------------|
| 1 | 14 | E1-E14                 | TURRET                  | MILL-MAX, 2501-2-00-80-00-00-07-0 |
| 2 | 2  | JP1, JP2               | CONN., HEADER, 1x3, 2mm | WURTH ELEKTRONIK, 620-003-111-21  |
| 3 | 1  | JP3                    | CONN., HEADER, 2x3, 2mm | WURTH ELEKTRONIK, 620-006-211-21  |
| 4 | 3  | XJP1, XJP2, XJP3       | SHUNT, 2mm              | WURTH ELEKTRONIK, 608-002-134-21  |
| 5 | 6  | J1, J2, J3, J4, J5, J6 | JACK, BANANA            | KEYSTONE, 575-4                   |
| 6 | 0  | J9, J10                | PAD                     | NONE                              |
| 7 | 4  |                        | STANDOFF, SNAP ON       | KEYSTONE, 8832                    |

### DC2435A-B

|    |   |                                     |                                       |                                      |
|----|---|-------------------------------------|---------------------------------------|--------------------------------------|
| 1  | 2 | CIN1, COUT1                         | CAP, 33 $\mu$ F, 63V, 20%, ELEC       | SUN ELEC. 63HVH33M                   |
| 2  | 1 | COUT2                               | CAP, 100 $\mu$ F, 63V, 20%, ELEC      | UNITED CHEMI CON, EMZA630ADA101MJA0G |
| 3  | 6 | CIN2, CIN3, CIN4, COUT6, COUT8, C80 | CAP, 4.7 $\mu$ F, X7R, 100V, 10%,1210 | MURATA, GRM32ER72A475KE14L           |
| 4  | 2 | COUT4, C5                           | CAP, 2.2 $\mu$ F, X7R, 100V,10%,1206  | MURATA, GRM31CR72A225KA73L           |
| 5  | 2 | COUT5, COUT11                       | CAP, 68 $\mu$ F, 35V, 20%, D8         | PANASONIC, EEHA1V680XP               |
| 6  | 5 | C4, C17, C21, C47, C52              | CAP, 0.1 $\mu$ F, X7R, 25V ,10%, 0603 | TDK, C1608X7R1E104K                  |
| 7  | 3 | C15, C56, C62                       | CAP, 1nF, X7R, 50V,10%,0603           | AVX, 06035C102KAT2A                  |
| 8  | 1 | C43                                 | CAP, 68pF, NPO, 50V, 10%,0603         | AVX, 06035A680KAT2A                  |
| 9  | 1 | C44                                 | CAP, 4.7nF, X7R, 50V,10%,0603         | AVX, 06035C472KAT2A                  |
| 10 | 1 | C49                                 | CAP, 47pF X7R, 50V, 5%, 0603          | AVX, 06035A470JAT2A                  |
| 11 | 1 | C53                                 | CAP, 820pF X7R, 50V, 5%, 0603         | AVX, 06035A821JAT2A                  |
| 12 | 1 | C54                                 | CAP, 27nF, X7R, 50V,10%, 0603         | AVX, 06035C273KAT2A                  |
| 13 | 1 | C61                                 | CAP, 1 $\mu$ F, X5R, 25V, 20%, 0603   | TDK, C1608X5R1E105M                  |
| 14 | 2 | C64, C81                            | CAP, 4.7 $\mu$ F X5R,10V, 20%, 0603   | AVX, 0603ZD475MAT2A                  |
| 15 | 1 | L1                                  | IND, 22 $\mu$ H                       | COILCRAFT, SER1390-223ML             |
| 16 | 1 | L2                                  | IND, 15 $\mu$ H                       | COILCRAFT, XAL1510-153MED            |
| 17 | 1 | Q1                                  | XSTR, N-CHANNEL MOSFET                | INFINEON, BSC123N08NS3G              |
| 18 | 1 | Q2                                  | XSTR, N-CHANNEL MOSFET                | INFINEON, BSC042NE7NS3G              |
| 19 | 1 | Q21                                 | XSTR, N-CHANNEL MOSFET                | INFINEON, BSC026N08NS5               |

dc2435af

# DEMO MANUAL DC2435A-A/ DC2435A-B/DC2435A-C

## PARTS LIST

| ITEM | QTY | REFERENCE | PART DESCRIPTION                                                 | MANUFACTURER/PART NUMBER    |
|------|-----|-----------|------------------------------------------------------------------|-----------------------------|
| 20   | 1   | Q22       | XSTR, N-CHANNEL MOSFET                                           | INFINEON, BSC072N08NS5      |
| 21   | 1   | R33       | RES., 9.76k $\Omega$ , 1/10W, 1%, 0603                           | VISHAY, CRCW06039K76FKEA    |
| 22   | 1   | R35       | RES., 7.5k $\Omega$ , 1/10W, 1%, 0603                            | VISHAY, CRCW06037K5FKEA     |
| 23   | 2   | R43, R78  | RES., 332k $\Omega$ , 1/10W, 1%, 0603                            | VISHAY, CRCW0603332KFKEA    |
| 24   | 2   | R46, R48  | RES., 100k $\Omega$ , 1/10W, 5%, 0603                            | VISHAY, CRCW0603100KJNEA    |
| 25   | 1   | R72       | RES., 37.4k $\Omega$ , 1/10W, 1%, 0603                           | VISHAY, CRCW060337K4FKEA    |
| 26   | 1   | R75       | RES., 3.6k $\Omega$ , 1/10W, 1%, 0603                            | VISHAY, CRCW06033K60FKEA    |
| 27   | 1   | R79       | RES., 21k $\Omega$ , 1/10W, 1%, 0603                             | VISHAY, CRCW060321K0FKEA    |
| 28   | 1   | R81       | RES., 100 $\Omega$ , 1/10W, 5%, 0603                             | VISHAY, CRCW0603100RJNEA    |
| 29   | 1   | R86       | RES., 2.2 $\Omega$ S, 1/10W, 5%, 0603                            | VISHAY, CRCW06032R20JNEA    |
| 30   | 1   | R92       | RES., 90.9k $\Omega$ , 1/10W, 1%, 0603                           | VISHAY, CRCW060390K9FKEA    |
| 31   | 1   | RS1       | RES., SENSE, 0.008 $\Omega$ , 1/2W, 1%, 2010                     | VISHAY, WSL20108L000FEA18   |
| 32   | 1   | RS2       | RES., SENSE, 0.006 $\Omega$ , 1/2W, 1%, 2010                     | VISHAY, WSL20106L000FEA18   |
| 33   | 1   | U1        | IC, LOW I <sub>Q</sub> , 60V BOOST + BUCK SYNCHRONOUS CONTROLLER | LINEAR TECH. LTC7813EUH#PBF |

### Additional Demo Board Circuit Components

|    |    |                                                                                           |                                |                          |
|----|----|-------------------------------------------------------------------------------------------|--------------------------------|--------------------------|
| 1  | 0  | C1, C2, C3, CIN5, C6, C59, C68                                                            | CAP, OPTION, 1210              | OPTION                   |
| 2  | 0  | C36                                                                                       | CAP, OPTION, 1206              | OPTION                   |
| 3  | 0  | C7, C39, C40, C51, C66, C67, C73, C74, C78, C79                                           | CAP, OPTION, 0805              | OPTION                   |
| 4  | 0  | C55, C57, C60, C63, C65, C77                                                              | CAP, OPTION, 0603              | OPTION                   |
| 5  | 0  | D3                                                                                        | DIODE, OPTION, SMB             | OPTION                   |
| 6  | 0  | D4                                                                                        | DIODE, OPTION, SOD323          | OPTION                   |
| 7  | 0  | L3                                                                                        | IND., OPTION                   | OPTION                   |
| 8  | 0  | Q9, Q11, Q18, Q19                                                                         | XSTR, OPTION, N-CHANNEL MOSFET | OPTION                   |
| 9  | 11 | R34, R36, R39, R40, R70, R80, R95, R96, R103, R105, R108                                  | RES., 0 $\Omega$ , 1/10W, 0603 | VISHAY, CRCW06030000Z0EA |
| 10 | 0  | R37, R51, R53, R55, R62, R85, R89, R90, R91, R93, R94, R104, R106, R107, R109, R110, R111 | RES., OPTION, 0603             | OPTION                   |
| 11 | 0  | R82                                                                                       | RES., OPTION, 1206             | OPTION                   |
| 12 | 0  | R100                                                                                      | RES., OPTION, 0805             | OPTION                   |
| 13 | 0  | R101                                                                                      | RES., OPTION, 2010             | OPTION                   |
| 14 | 1  | R102                                                                                      | RES., 0 $\Omega$ , 2010        | VISHAY, CRCW20100000Z0EF |
| 15 | 0  | RS3                                                                                       | RES., SENSE, OPT, 2010         | OPTION                   |

### Hardware: For Demo Board Only

|   |    |                        |                         |                                   |
|---|----|------------------------|-------------------------|-----------------------------------|
| 1 | 14 | E1-E14                 | TURRET                  | MILL-MAX, 2501-2-00-80-00-00-07-0 |
| 2 | 2  | JP1, JP2               | CONN., HEADER, 1x3, 2mm | WURTH ELEKTRONIK, 620-003-111-21  |
| 3 | 1  | JP3                    | CONN., HEADER, 2x3, 2mm | WURTH ELEKTRONIK, 620-006-211-21  |
| 4 | 3  | XJP1, XJP2, XJP3       | SHUNT, 2mm              | WURTH ELEKTRONIK, 608-002-134-21  |
| 5 | 6  | J1, J2, J3, J4, J5, J6 | JACK, BANANA            | KEYSTONE, 575-4                   |
| 6 | 0  | J9, J10                | PAD                     | NONE                              |
| 7 | 4  |                        | STANDOFF, SNAP ON       | KEYSTONE, 8832                    |

# DEMO MANUAL DC2435A-A/ DC2435A-B/DC2435A-C

## PARTS LIST

| ITEM             | QTY | REFERENCE                           | PART DESCRIPTION                                                 | MANUFACTURER/PART NUMBER                |
|------------------|-----|-------------------------------------|------------------------------------------------------------------|-----------------------------------------|
| <b>DC2435A-C</b> |     |                                     |                                                                  |                                         |
| 1                | 2   | CIN1, COUT1                         | CAP, 33 $\mu$ F, 63V, 20%, ELEC                                  | SUN ELEC. 63HVH33M                      |
| 2                | 1   | COUT2                               | CAP, 100 $\mu$ F, 63V, 20%, ELEC                                 | UNITED CHEMI CON,<br>EMZA630ADA101MJA0G |
| 3                | 6   | CIN2, CIN3, CIN4, COUT6, COUT8, C80 | CAP, 4.7 $\mu$ F, X7R, 100V, 10%, 1210                           | MURATA, GRM32ER72A475KE14L              |
| 4                | 2   | COUT4, C5                           | CAP, 2.2 $\mu$ F, X7R, 100V, 10%, 1206                           | MURATA, GRM31CR72A225KA73L              |
| 5                | 2   | COUT5, COUT11                       | CAP, 68 $\mu$ F, 35V, 20%, D8                                    | PANASONIC, EEHZA1V680XP                 |
| 6                | 5   | C4, C17, C21, C47, C52              | CAP, 0.1 $\mu$ F, X7R, 25V, 10%, 0603                            | TDK, C1608X7R1E104K                     |
| 7                | 3   | C15, C56, C62                       | CAP, 1nF, X7R, 50V, 10%, 0603                                    | AVX, 06035C102KAT2A                     |
| 8                | 1   | C43                                 | CAP, 68pF, NPO, 50V, 10%, 0603                                   | AVX, 06035A680KAT2A                     |
| 9                | 1   | C44                                 | CAP, 4.7nF, X7R, 50V, 10%, 0603                                  | AVX, 06035C472KAT2A                     |
| 10               | 1   | C49                                 | CAP, 47pF X7R, 50V, 5%, 0603                                     | AVX, 06035A470JAT2A                     |
| 11               | 1   | C53                                 | CAP, 820pF X7R, 50V, 5%, 0603                                    | AVX, 06035A821JAT2A                     |
| 12               | 1   | C54                                 | CAP, 27nF, X7R, 50V, 10%, 0603                                   | AVX, 06035C273KAT2A                     |
| 13               | 1   | C61                                 | CAP, 1 $\mu$ F, X5R, 25V, 20%, 0603                              | TDK, C1608X5R1E105M                     |
| 14               | 2   | C64, C81                            | CAP, 4.7 $\mu$ F X5R, 10V, 20%, 0603                             | AVX, 0603ZD475MAT2A                     |
| 15               | 1   | L1                                  | IND, 10 $\mu$ H                                                  | COILCRAFT, SER1390-103ML                |
| 16               | 1   | L2                                  | IND, 15 $\mu$ H                                                  | COILCRAFT, XAL1510-153MED               |
| 17               | 1   | Q1                                  | XSTR, N-CHANNEL MOSFET                                           | INFINEON, BSC123N08NS3G                 |
| 18               | 1   | Q2                                  | XSTR, N-CHANNEL MOSFET                                           | INFINEON, BSC042NE7NS3G                 |
| 19               | 1   | Q21                                 | XSTR, N-CHANNEL MOSFET                                           | INFINEON, BSC026N08NS5                  |
| 20               | 1   | Q22                                 | XSTR, N-CHANNEL MOSFET                                           | INFINEON, BSC072N08NS5                  |
| 21               | 1   | R33                                 | RES., 63.4k $\Omega$ , 1/10W, 1%, 0603                           | VISHAY, CRCW060363K4FKEA                |
| 22               | 1   | R35                                 | RES., 4.99k $\Omega$ , 1/10W, 1%, 0603                           | VISHAY, CRCW06034K99FKEA                |
| 23               | 2   | R43, R78                            | RES., 332k $\Omega$ , 1/10W, 1%, 0603                            | VISHAY, CRCW0603332KFKEA                |
| 24               | 2   | R46, R48                            | RES., 100k $\Omega$ , 1/10W, 5%, 0603                            | VISHAY, CRCW0603100KJNEA                |
| 25               | 1   | R72                                 | RES., 37.4k $\Omega$ , 1/10W, 1%, 0603                           | VISHAY, CRCW060337K4FKEA                |
| 26               | 1   | R75                                 | RES., 3.6k $\Omega$ , 1/10W, 1%, 0603                            | VISHAY, CRCW06033K60FKEA                |
| 27               | 1   | R79                                 | RES., 17.4k $\Omega$ , 1/10W, 1%, 0603                           | VISHAY, CRCW060317K4FKEA                |
| 28               | 1   | R81                                 | RES., 100 $\Omega$ , 1/10W, 5%, 0603                             | VISHAY, CRCW0603100RJNEA                |
| 29               | 1   | R86                                 | RES., 2.2 $\Omega$ , 1/10W, 5%, 0603                             | VISHAY, CRCW06032R20JNEA                |
| 30               | 1   | R92                                 | RES., 90.9k $\Omega$ , 1/10W, 1%, 0603                           | VISHAY, CRCW060390K9FKEA                |
| 31               | 1   | RS1                                 | RES., SENSE, 0.008 $\Omega$ , 1/2W, 1%, 2010                     | VISHAY, WSL20108L000FEA18               |
| 32               | 1   | RS2                                 | RES., SENSE, 0.010 $\Omega$ , 1/2W, 1%, 2010                     | VISHAY, WSL201010L000FEA18              |
| 33               | 1   | U1                                  | IC, LOW I <sub>Q</sub> , 60V BOOST + BUCK SYNCHRONOUS CONTROLLER | LINEAR TECH. LTC7813EUH#PBF             |

### Additional Demo Board Circuit Components

|   |   |                                                 |                   |        |
|---|---|-------------------------------------------------|-------------------|--------|
| 1 | 0 | C1, C2, C3, CIN5, C6, C59, C68                  | CAP, OPTION, 1210 | OPTION |
| 2 | 0 | C36                                             | CAP, OPTION, 1206 | OPTION |
| 3 | 0 | C7, C39, C40, C51, C66, C67, C73, C74, C78, C79 | CAP, OPTION, 0805 | OPTION |
| 4 | 0 | C55, C57, C60, C63, C65, C77                    | CAP, OPTION, 0603 | OPTION |

# DEMO MANUAL DC2435A-A/ DC2435A-B/DC2435A-C

## PARTS LIST

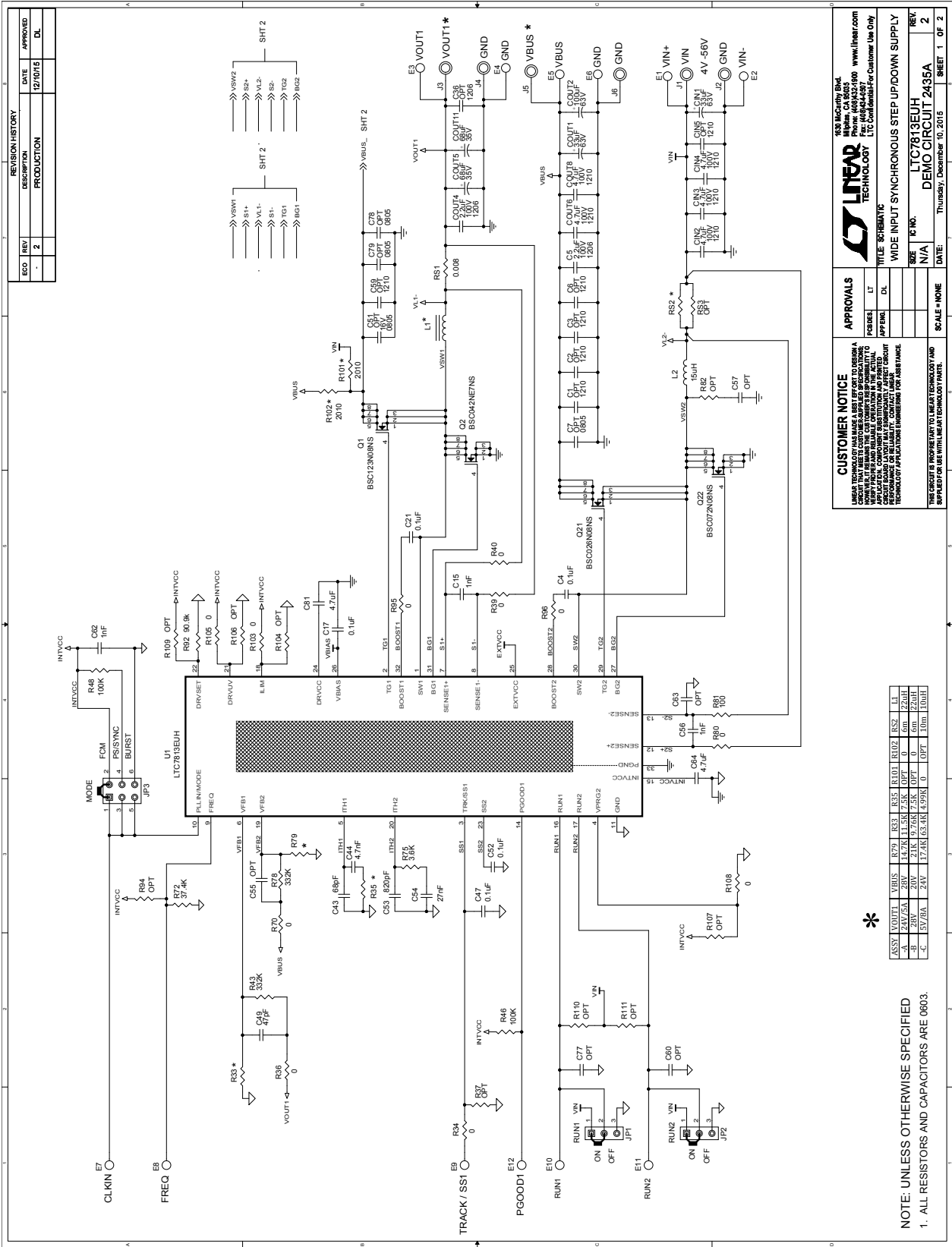
| ITEM | QTY | REFERENCE                                                                                 | PART DESCRIPTION               | MANUFACTURER/PART NUMBER |
|------|-----|-------------------------------------------------------------------------------------------|--------------------------------|--------------------------|
| 5    | 0   | D3                                                                                        | DIODE, OPTION, SMB             | OPTION                   |
| 6    | 0   | D4                                                                                        | DIODE, OPTION, SOD323          | OPTION                   |
| 7    | 0   | L3                                                                                        | IND, OPTION                    | OPTION                   |
| 8    | 0   | Q9, Q11, Q18, Q19                                                                         | XSTR, OPTION, N-CHANNEL MOSFET | OPTION                   |
| 9    | 11  | R34, R36, R39, R40, R70, R80, R95, R96, R103, R105, R108                                  | RES., 0 $\Omega$ , 1/10W, 0603 | VISHAY, CRCW06030000Z0EA |
| 10   | 0   | R37, R51, R53, R55, R62, R85, R89, R90, R91, R93, R94, R104, R106, R107, R109, R110, R111 | RES., OPTION, 0603             | OPTION                   |
| 11   | 0   | R82                                                                                       | RES., OPTION, 1206             | OPTION                   |
| 12   | 0   | R100                                                                                      | RES., OPTION, 0805             | OPTION                   |
| 13   | 1   | R101                                                                                      | RES., 0 $\Omega$ , 2010        | VISHAY, CRCW20100000Z0EF |
| 14   | 0   | R102                                                                                      | RES., OPTION, 2010             | OPTION                   |
| 15   | 0   | RS3                                                                                       | RES., SENSE, OPT, 2010         | OPTION                   |

### Hardware: For Demo Board Only

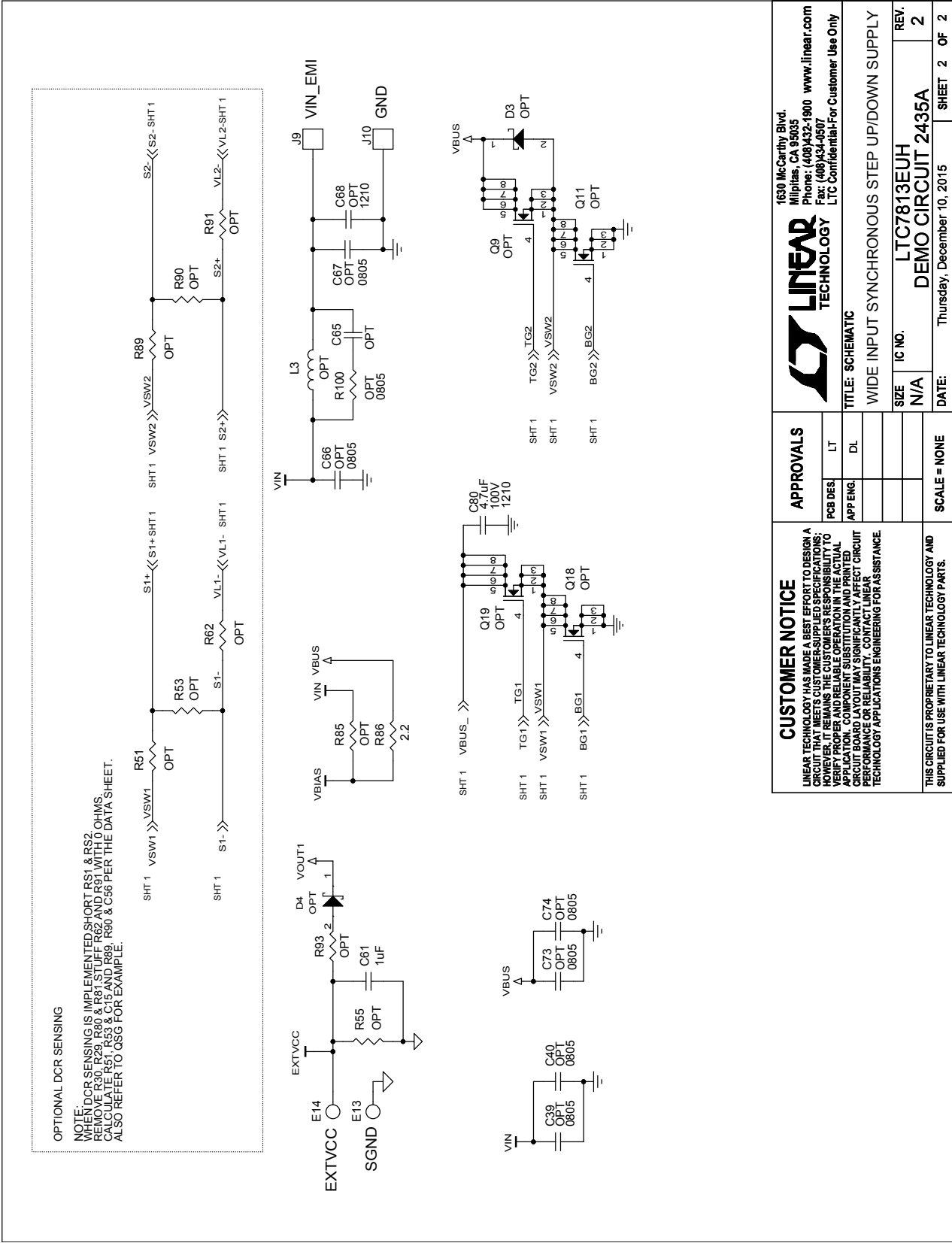
|   |    |                        |                                  |                                   |
|---|----|------------------------|----------------------------------|-----------------------------------|
| 1 | 14 | E1-E14                 | TURRET                           | MILL-MAX, 2501-2-00-80-00-00-07-0 |
| 2 | 2  | JP1, JP2               | CONN., HEADER, 1 $\times$ 3, 2mm | WURTH ELEKTRONIK, 620-003-111-21  |
| 3 | 1  | JP3                    | CONN., HEADER, 2 $\times$ 3, 2mm | WURTH ELEKTRONIK, 620-006-211-21  |
| 4 | 3  | XJP1, XJP2, XJP3       | SHUNT, 2mm                       | WURTH ELEKTRONIK, 608-002-134-21  |
| 5 | 6  | J1, J2, J3, J4, J5, J6 | JACK, BANANA                     | KEYSTONE, 575-4                   |
| 6 | 0  | J9, J10                | PAD                              | NONE                              |
| 7 | 4  |                        | STANDOFF, SNAP ON                | KEYSTONE, 8832                    |

# DEMO MANUAL DC2435A-A/ DC2435A-B/DC2435A-C

## SCHEMATIC DIAGRAM



SCHEMATIC DIAGRAM



dc2435af

# DEMO MANUAL DC2435A-A/ DC2435A-B/DC2435A-C

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