# LTC3869EUFD
## Dual, 2-Phase Synchronous Step-Down DC/DC Controllers

# DESCRIPTION

Demonstration circuit 1807A is a dual output, dual phase synchronous buck converter featuring the LTC3869EUFD. The demo board uses a high density, two sided drop-in layout. The power components, excluding the bulk output and input capacitors, fit within a 1.35" × 0.75" area on the top layer. The control circuit resides in a 0.60" × 0.75" area on the bottom layer. The package style for the LTC3869EUFD is a 4mm × 5mm 28-lead QFN with an exposed ground pad.

The main features of the board include an internal 5V linear regulator for bias, RUN pins for each output, an EXTV$_{CC}$ pin and a PGOOD signal. The board can be configured for either CCM (original setting), Burst Mode operation, or pulse-skipping operation with the mode jumper. The board also has optional resistors for single output/dual phase operation, rail tracking and synchronization to an external clock.

Two versions of the board are available. DC1807A-A has an on-board sense resistor for current feedback, while the DC1807A-B is configured with a DCR sense circuit that allows the converter to use the inductors DCR as the sense element instead of the on-board sense resistors to save cost and board space and improves efficiency.

The input voltage range is 4.5V to 14V, output voltages and currents are 1.5V/15A and 1.2V/15A. The LTC3869 datasheet gives a complete description of the part, operation and application information. The datasheet must be read in conjunction with this demo manual for DC1807A.

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

# PERFORMANCE SUMMARY ($T_A$ = 25°C)

| PARAMETER | CONDITIONS | VALUE | |
|---|---|---|---|
| Minimum Input Voltage | | 4.5V | |
| Maximum Input Voltage | | 14V | |
| Output Voltage V$_{OUT1}$ | V$_{IN}$ = 4.5V to 14V, I$_{OUT1}$ = 0A to 15A | 1.5V±2% | |
| Output Voltage V$_{OUT2}$ | V$_{IN}$ = 4.5V to 14V, I$_{OUT2}$ = 0A to 15A | 1.2V±2% | |
| Typical Output Ripple V$_{OUT}$ | V$_{IN}$ = 12V, I$_{OUT1}$ = 15A (20MHz BW) | <30mV$_{P-P}$* | |
| | V$_{IN}$ = 12V, I$_{OUT2}$ = 15A (20MHz BW) | <30mV$_{P-P}$* | |
| Nominal Switching Frequency | | 400kHz | |
| | | DC1807A-A | DC1807A-B |
| Efficiency | V$_{OUT1}$ = 1.5V, I$_{OUT1}$ = 15A; V$_{IN}$ = 12V | 88.7%** Typical | 86.7%** Typical |
| | V$_{OUT2}$ = 1.2V, I$_{OUT2}$ = 15A; V$_{IN}$ = 12V | 89.1%** Typical | 87.4%** Typical |

*Measured at bulk output capacitor
**See Figures 3 and 4 for efficiency curves

# QUICK START PROCEDURE

Demonstration circuit 1807A is easy to set up to evaluate the performance of the LTC3869EUFD. Refer to Figure 1 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 2 for proper scope probe technique.

1. Make sure jumpers are in the following positions:

| JUMPER | POSITION |
|--------|----------|
| JP1 | ON |
| JP2 | ON |
| JP3 | CCM |

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

3. Turn on the power at the input.

   **NOTE.** Make sure that the input voltage does not exceed 28V.

4. Check for the proper output voltages.

   $V_{OUT1}$ = 1.470V to 1.530V,

   $V_{OUT2}$ = 1.176V to 1.224V,

   **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.

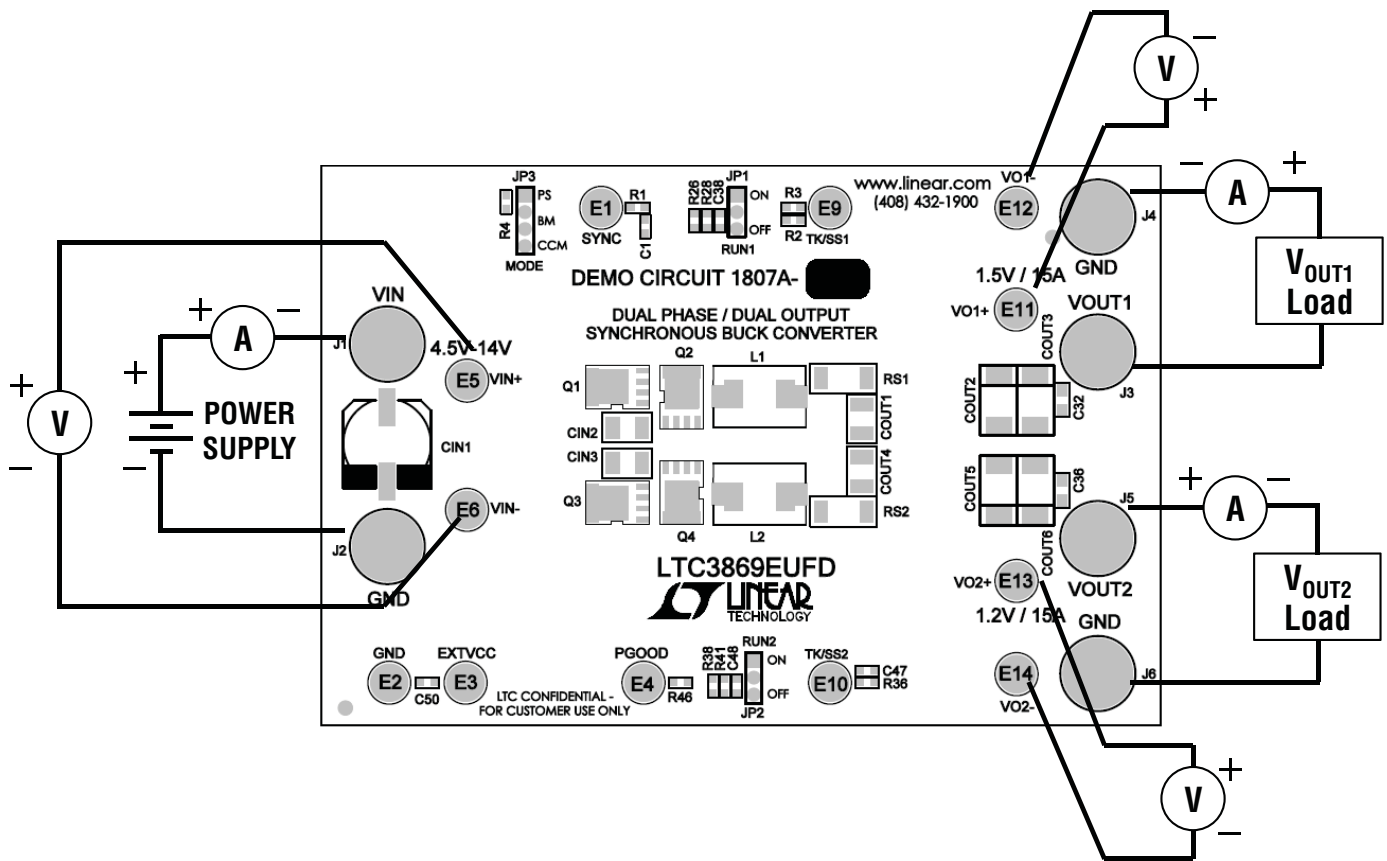6. Different operating modes can be evaluated by changing position of jumper JP3.



**Figure 1. Proper Measurement Equipment Setup**
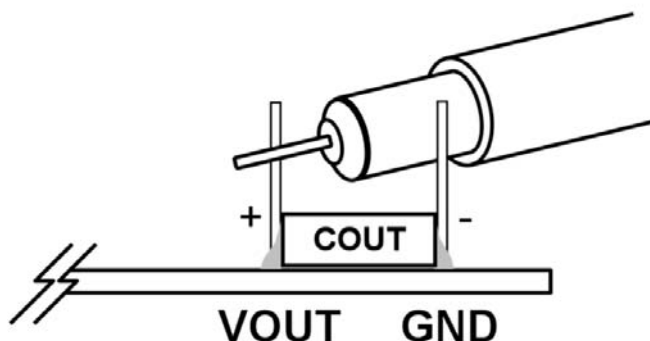
dc1807af

# QUICK START PROCEDURE



Figure 2. Measuring Output Voltage Ripple

## Rail Tracking

Demonstration circuit 1807A is setup for independent turn-on of $V_{OUT1}$ and $V_{OUT2}$. The ramp-rate for $V_{OUT1}$ is determined by the TRK/SS1 cap at C2 and the ramp-rate for $V_{OUT2}$ is determined by the TRK/SS2 cap at C47. The turn-on of one rail will not affect the other for the original demo board.

This board can be modified on the bench to allow $V_{OUT1}$ to track an external signal. It can also be modified to allow $V_{OUT2}$ to track $V_{OUT1}$ or to allow $V_{OUT2}$ to track an external signal. Tables 2 and 3 cover the rail tracking options for each rail, with the –B version used as an example.

Table.1 $V_{OUT1}$ Tracking Options for a 1.5V Output.

|  | TRACK 1 DIVIDER |  | TRK/SS1 CAPACITOR |
| --- | --- | --- | --- |
| CONFIGURATION | R3 | R2 | C2 |
| Soft Start Without Tracking | 0Ω | OPEN | 0.1µF |
| External Coincident Tracking | 17.8kΩ | 20.0kΩ | OPEN |

Table.2 $V_{OUT2}$ Tracking Options for a 1.2V Output.

|  | TRACK 2 DIVIDER |  |  | TRK/SS2 CAPACITOR |
| --- | --- | --- | --- | --- |
| CONFIGURATION | R36 | R34 | R37 | C47 |
| Soft Start Without Tracking | 0Ω | OPEN | OPEN | 0.1µF |
| Coincident Tracking to $V_{OUT1}$ (1.5V) | 0Ω | 10.0kΩ | 20.0kΩ | OPEN |
| External Coincident Tracking | 17.8kΩ | OPEN | 20.0kΩ | OPEN |

## Single Output/Dual Phase Operation

A single output/dual phase converter may be preferred for high output current applications. The benefits of single output/dual phase operation is lower ripple current through the input and output capacitors, improved load step response and simplified thermal design. To implement single output / dual phase operation, make the following modifications:

1. Tie $V_{OUT1}$ to $V_{OUT2}$ by tying together the exposed copper pads near J3 and J5 at the edge of the board. Use a piece of heavy copper foil.

2. Tie ITH1 to ITH2 by stuffing 0 at R49. Turn on the power at the input.

3. Tie VFB1 to VFB2 by stuffing 0 at R50.

4. Tie TRK/SS1 to TRK/SS2 by stuffing 0 at R52.

5. Tie RUN1 to RUN2 by stuffing 0 at R55.

6. Remove the redundant ITH compensation network and VFB divider.

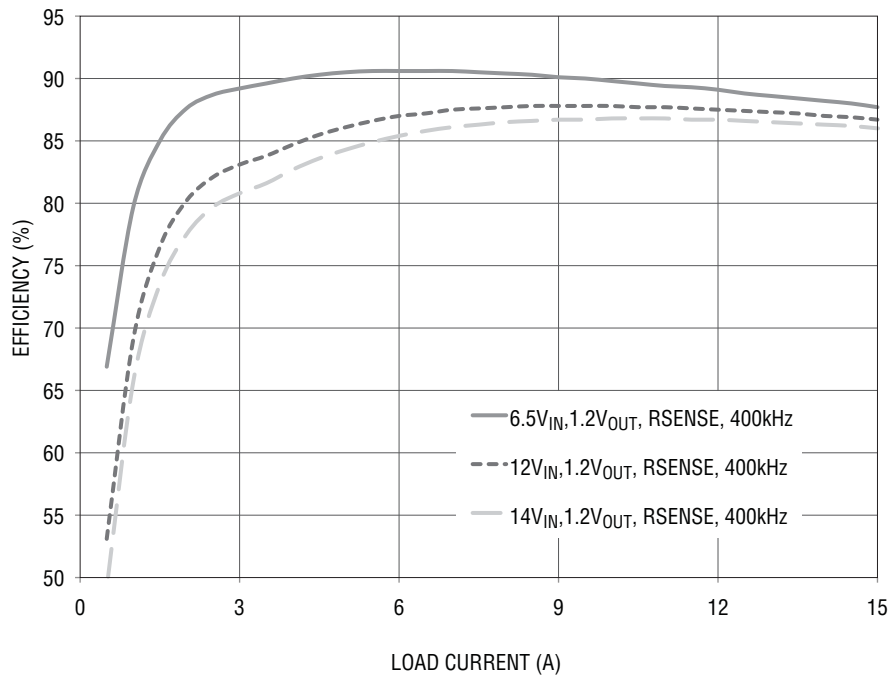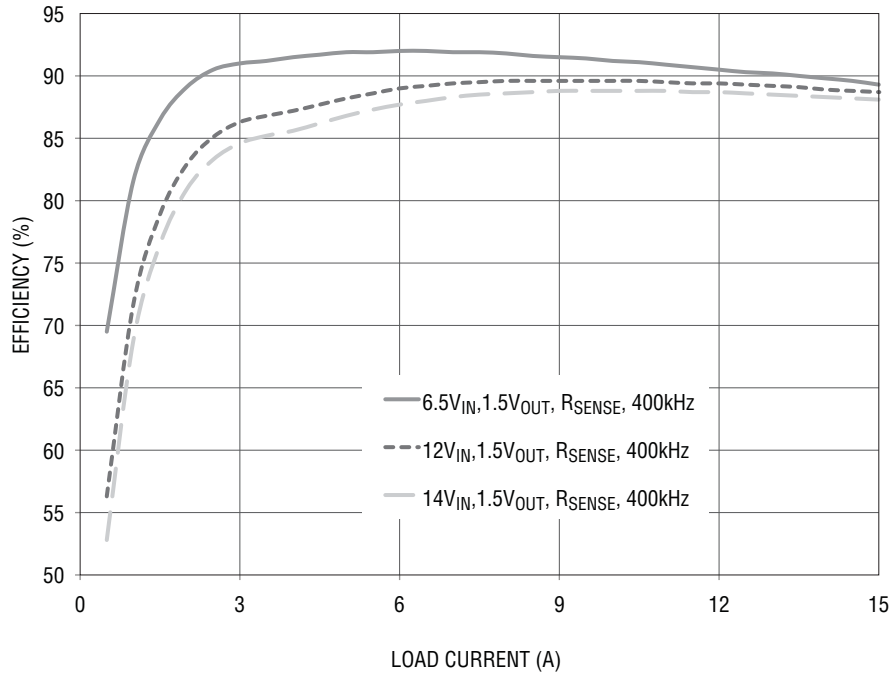dc1807af

# QUICK START PROCEDURE



**Figure 3. Typical Efficiency Curves vs Load Current with A-A (R$_{SENSE}$) Board for: (A) 1.5V Rail and (B) 1.2V Rail**
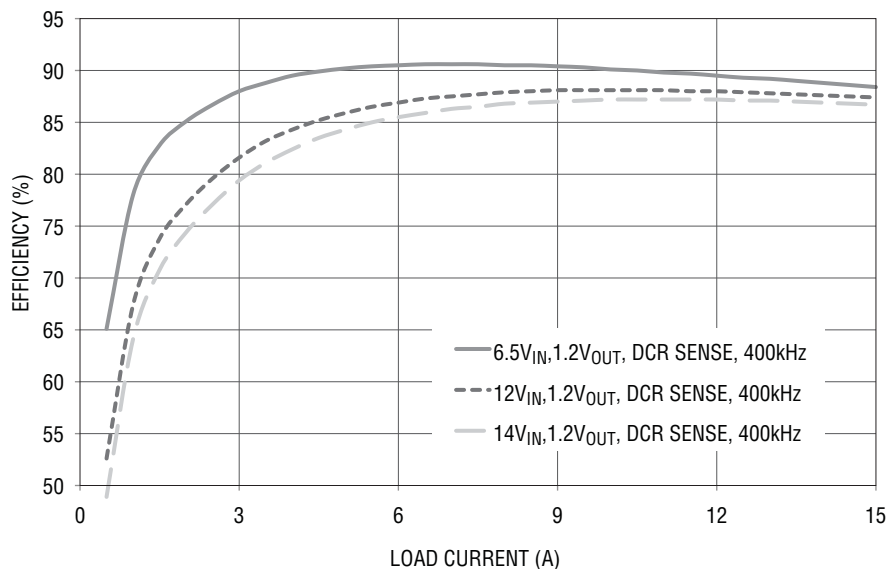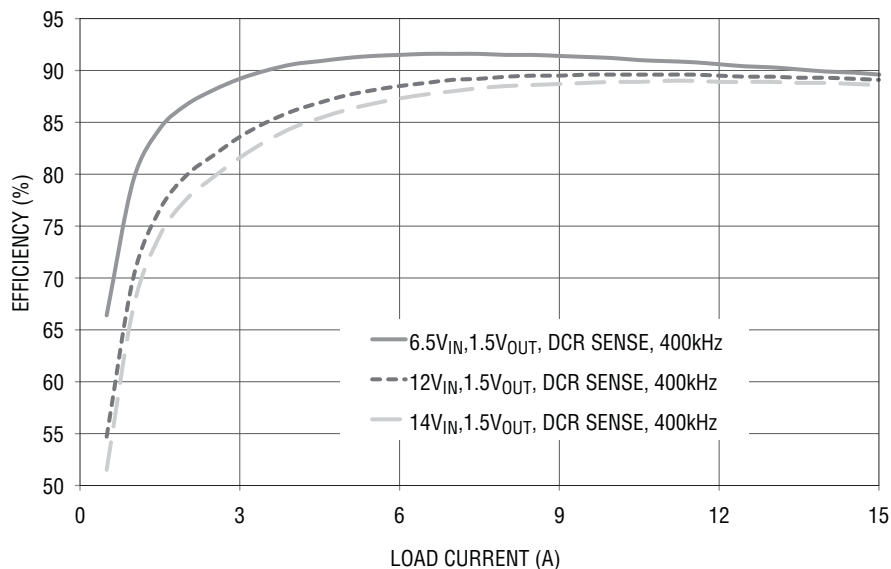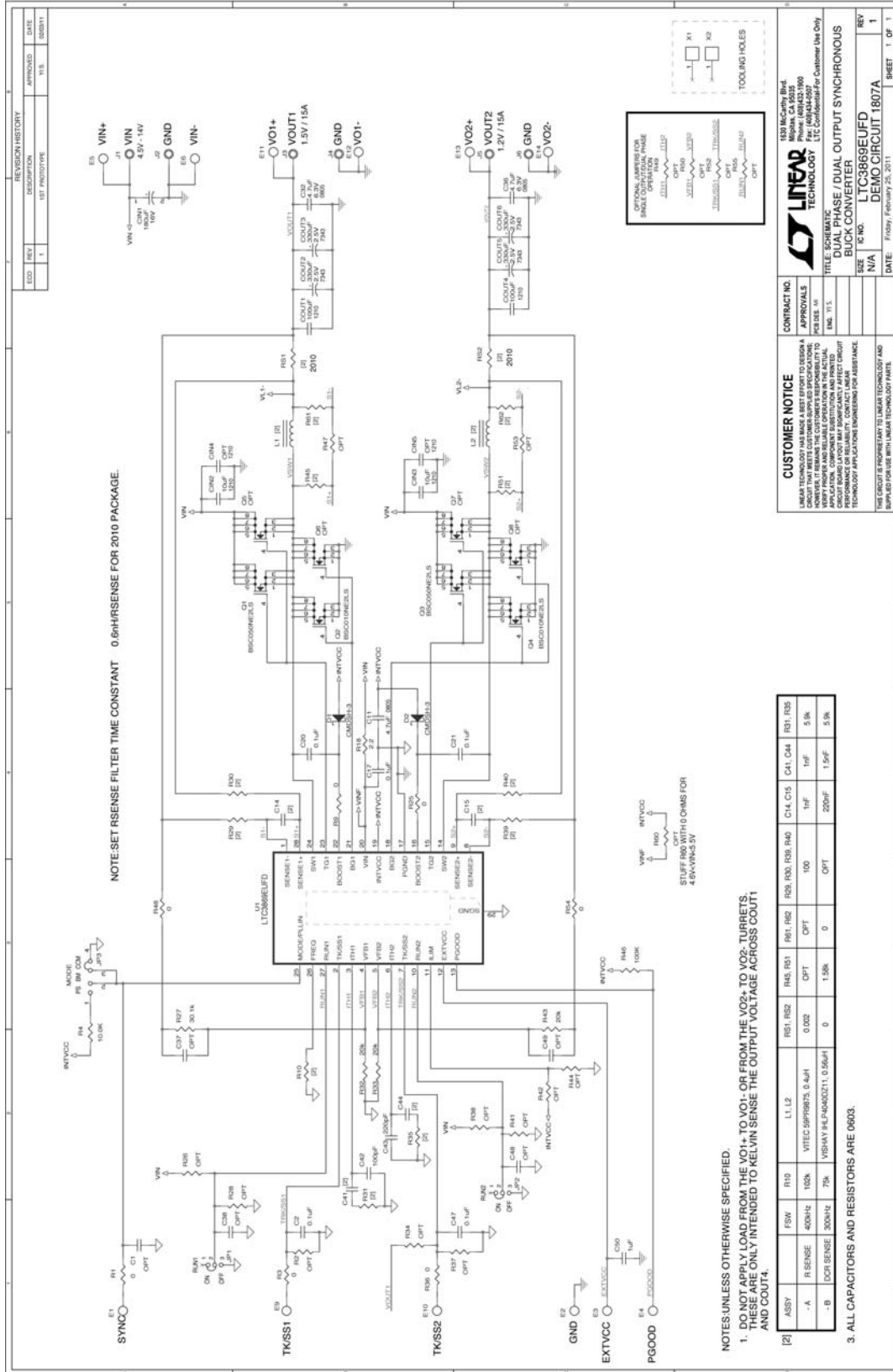
# QUICK START PROCEDURE





**Figure 4. Typical Efficiency Curves vs Load Current with A-B (DCR Sense) Board for: (A) 1.5V Rail and (B) 1.2V Rail**

## PARTS LIST

| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|---|---|---|---|---|
| **Required Circuit Components** | | | | |
| 1 | 1 | $C_{IN1}$ | CAP, 180µF 20% 16V OSCON | SANYO OSCON 16SVP180MX |
| 2 | 2 | $C_{IN2}$, $C_{IN3}$ | CAP, 1210 10µF 10% 16V X5R | TAIYO YUDEN EMK325BJ106KN-T |
| 3 | 2 | $C_{OUT1}$, $C_{OUT4}$ | CAP, 1210 100µF 20% 6.3V X5R | TDK C3225X5R0J107MT |
| 4 | 4 | $C_{OUT2}$, $C_{OUT3}$, $C_{OUT5}$, $C_{OUT6}$ | CAP, 7343 330µF 20% 2.5V POSCAP | SANYO 2R5TPE330M9 |
| 5 | 5 | C2, C17, C20, C21, C47 | CAP, 0603 0.1µF 10% 25V X7R | TDK C1608X7R1E104K |
| 6 | 3 | C11, C32, C36 | CAP, 0805 4.7µF 10% 6.3V X5R | AVX 08056D475KAT |
| 7 | 1 | C42 | CAP, 0603 100pF 5% 25V X7R | AVX 06033C101JAT |
| 8 | 1 | C43 | CAP, 0603 220pF 5% 25V X7R | AVX 06033C221JAT2A |
| 9 | 1 | C50 | CAP, 0603 1µF 20% 16V X7R | AVX 0603YC105MAT2A |
| 10 | 2 | C14, C15, C41, C44 | CAP, 0603 1nF 10% 50V X7R | AVX 06035C102KAT |
| 11 | 2 | D1, D2 | DIODE,CMDSH-3 SOD323 | CENTRAL CMDSH-3-LTC |
| 12 | 2 | Q1, Q3 | XSTR, N-CHANNEL MOSFET | INFINEON BC050NE2LS |
| 13 | 2 | Q2, Q4 | XSTR, N-CHANNEL MOSFET | INFINEON BSC010NE2LS |
| 14 | 2 | RS1, RS2 | RES, 2010 0.002Ω 5% 1/2W | VISHAY WSL20102L000FEA |
| 15 | 7 | R1, R3, R9, R25, R36, R48, R54 | RES, 0603 0Ω JUMPER | PANASONIC ERJ3GEY0R00V |
| 16 | 4 | R29, R30, R39, R40 | RES, 0603 100Ω 5% 1/10W | VISHAY CRCW0603100RJNEA |
| 17 | 1 | R4 | RES, 0603 10kΩ 1% 1/16W | VISHAY CRCW060310K0FKEB |
| 18 | 1 | R18 | RES, 0603 2.2Ω 5% 1/10W | YAYEO RC0603JR-072R2 |
| 19 | 1 | R27 | RES, 0603 30.1kΩ 1% 1/10W | YAYEO RC0603FR-0730K1 |
| 20 | 2 | R31, R35 | RES, 0603 5.9kΩ 1% 1/10W | VISHAY CRCW06035K9FKEA |
| 21 | 3 | R32, R33, R43 | RES, 0603 20kΩ 1% 1/10W | YAYEO RC0603FR-0720K |
| 22 | 1 | R10 | RES, 0603 102kΩ 5% 1/10W | VISHAY CRCW0603102KJNEA |
| 23 | 1 | R46 | RES, 0603 100kΩ 5% 1/10W | VISHAY CRCW0603100KJNEB |
| 24 | 1 | U1 | IC, Dual, 2-Phase Synchronous Step-Down DC/DC Controllers | LINEAR TECH.LTC3869EUFD |
| 25 | 2 | L1, L2 | IND, 0.47µH | VITEC 59PR9875, 0.4µH |
| **Additional Circuit Components** | | | | |
| 1 | 0 | $C_{IN4}$, $C_{IN5}$ | CAP, 1210 OPTION | OPTION |
| 2 | 0 | C1,C37,C38,C48,C49 | CAP, 0603 OPTION | OPTION |
| 3 | 0 | R2, R26, R28, R34, R37, R38, R41, R42, R44, R45, R47, R49, R50, R51, R52, R53, R55, R60, R61, R62 | RES, 0603 OPTION | OPTION |
| 4 | 0 | Q5, Q6, Q7, Q8 | DO NOT STUFF | OPTION |
| **Hardware** | | | | |
| 1 | 12 | E1-E6, E9-E14 | TURRET | MILL-MAX 2501-2-00-80-00-00-07-0 |
| 2 | 2 | JP1, JP2 | HEADER, 3 PIN, 2mm | SAMTEC TMM-103-02-L-S |
| 3 | 1 | JP3 | HEADER, 4 PIN | SAMTEC TMM-104-02--L-S |
| 4 | 6 | J1, J2, J3, J4, J5, J6 | JACK, BANANA | KEYSTONE 575-4 |
| 5 | 3 | JP1-JP3 | SHUNT, 2mm | SAMTEC 2SN-BK-G |

# SCHEMATIC DIAGRAM

dc1807af

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