

LTC3859AIFE

Triple Output Synchronous Step-Up/Dual Step-Down Supply

DESCRIPTION

Demonstration circuit DC1425A is a triple output synchronous step-up/dual step-down supply featuring the LTC[®]3859AIFE. The circuit size of both buck regulators fit in an area of ¾" by 1½", while the main boost circuit area is ¾" by 1¾". The package style for the LTC3859AIFE is a 38-pin exposed pad TSSOP package.

The main features of the board include rail tracking (buck channels only), an internal 5V linear regulator for bias, separate RUN pins for each output, a PGOOD signal (CH1 only), an over voltage indicator for CH3 and a mode selector that allow the converter to run in CCM, pulse-skipping or Burst Mode[®] operation. Synchronization to an external clock is also possible.

The LTC3859AIFE buck inputs are supplied from the boost output. With this boost-then-buck topology, the buck outputs maintain regulation over the entire input range. The resultant wide input voltage range of 4.5V to 36V is suitable for automotive or other battery fed application where low quiescent current is important. The LTC3859AIFE data sheets give a complete description of these parts, operation and application information. The data sheets must be read in conjunction with this quick start guide for demo circuit 1425A.

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

LT, LT, LTC, LTM, Burst Mode, 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_A = 25°C.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V _{IN}	Input Supply Range		4.5		36	V
V _{OUT1}	Output1 Voltage Range	V _{IN} = 4.5V to 36V, I _{OUT1} = 0A to 5A	4.90	5.0	5.10	V
V _{OUT2}	Output2 Voltage Range	V _{IN} = 4.5V to 36V, I _{OUT2} = 0A to 3A	8.33	8.5	8.67	V
V _{OUT3}	Output3 Voltage Range	V _{IN} = 4.5V to 10V [†] , I _{OUT3} = 0A to 7A*, I _{OUT1,2} = 0A	9.80	10.0	10.20	V
f _{SW}	Typical Free Running Switching Frequency			350		kHz
	Efficiency See Figures 3, 4 and 5 for Efficiency Curves	V _{IN} = 10V, V _{OUT1} = 5.0V, I _{OUT1} = 5A V _{IN} = 36V, V _{OUT1} = 5.0V, I _{OUT1} = 5A V _{IN} = 10V, V _{OUT2} = 8.5V, I _{OUT2} = 3A V _{IN} = 36V, V _{OUT2} = 8.5V, I _{OUT2} = 3A V _{IN} = 4.5V, V _{OUT3} = 10.0V, I _{OUT3} = 7A*		97.8 92.0 95.4 92.8 94.4		% % % % %

[†]When V_{IN} > V_{OUT3} then V_{OUT3} follows V_{IN}

*Maximum output current roughly equivalent to 2A from V_{OUT3} plus full load from V_{OUT1} and V_{OUT2}

DEMO MANUAL DC1425A

QUICK START PROCEDURE

Demonstration circuit DC1425A is easy to set up to evaluate the performance of the LTC3859AIFE. 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 or directly across relevant capacitor. See Figure 2 for proper scope probe technique.

1. Place jumpers in the following positions:

- JP1** ON
- JP2** ON
- JP3** Burst Mode
- JP4** ON

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 does not exceed 36V.

4. Check for the proper output voltages.

$$V_{OUT1} = 4.900V \text{ to } 5.100V,$$

$$V_{OUT2} = 8.330V \text{ to } 8.670V$$

$$V_{OUT2} = 9.800V \text{ to } 10.200V$$

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.

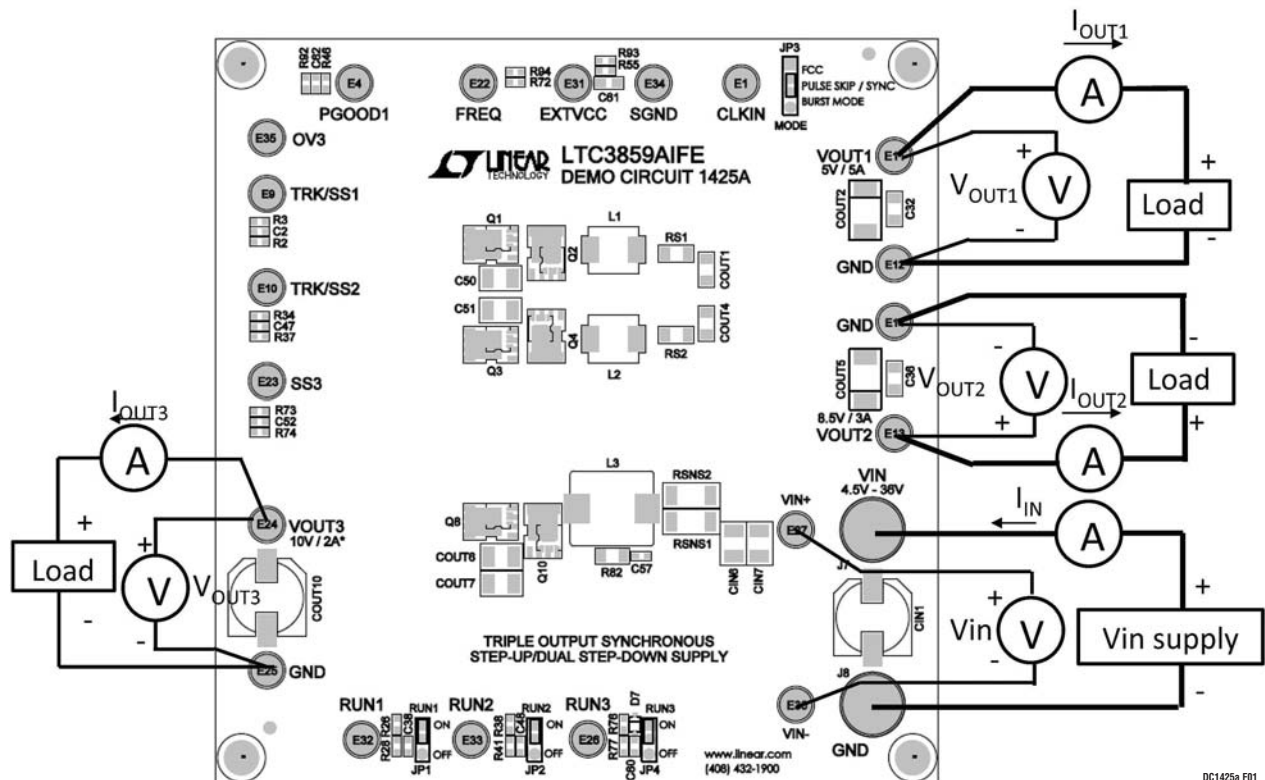


Figure 1. Proper Measurement Equipment Setup (Please Note Polarity on V_{OUT2})

DC1425a F01

QUICK START PROCEDURE

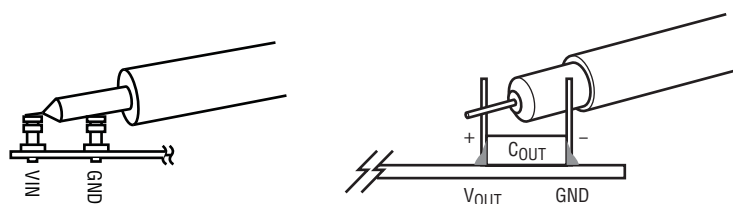


Figure 2. Measuring Input or Output Ripple Across Terminals or Directly Across Bulk Capacitor

FREQUENCY SYNCHRONIZATION AND MODE SELECTION

Demonstration circuit 1425A's mode selector allows the converter to run in FCC operation, pulse-skipping operation,

Burst Mode operation or be synchronizing to an external clock by changing the position of JP3.

Mode Selection and Synchronized Operation Options

CONFIGURATION	JP1
FCC Operation	FCC
Pulse-Skipping Operation	Pulse-Skipping/Sync
Synchronized to External Clock Applied to CLKIN Pin	Pulse-Skipping/Sync
Burst Mode Operation	Burst Mode Operation

RAIL TRACKING

Demonstration circuit 1425A is configured for an onboard soft-start circuit. The soft-start ramp rate can be adjusted by changing the value of C2 and C47. Demonstration circuit

1425A can also be modified to track an external reference. Refer to Table 3 and Table 4 for tracking options and to the data sheet for more details.

Table 3. V_{OUT1} Tracking Options

CONFIGURATION	R2	R3	C2	TRK/SS1 CAPACITOR
Soft-Start without Tracking (Default)	OPEN	OPEN	0.1 μ F	OPEN
V_{OUT1} Tracking Scaled V_{OUT2}	Resistor	Divider	OPEN	OPEN

Table 4. V_{OUT2} Tracking Options

CONFIGURATION	R34	R37	C47	TRK/SS2 CAPACITOR
Soft-Start without Tracking (Default)	0 Ω	OPEN	0.1 μ F	OPEN
V_{OUT2} Equals External Ramp	0 Ω	OPEN	OPEN	External Ramp
V_{OUT2} Tracking Scaled External Ramp	Resistor	Divider	OPEN	External Ramp

OPTIONAL INDUCTOR DCR CURRENT SENSING

Demonstration circuit 1425A 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 5 for optional inductor DCR current sensing setup and to the data sheet for more details.

Table 5. Optional Inductor DCR Current Sensing

CONFIGURATION	CHANNEL1	RS1	R29	R30	C14	R45	R47	R61
	CHANNEL2	RS2	R39	R40	C15	R51	R53	R62
	CHANNEL3	RSNS1, 2	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		0Ω Copper	OPEN	OPEN	Calculated Value from Data Sheet		0Ω	

LOW QUIESCENT CURRENT APPLICATIONS AND MEASUREMENT

The typical quiescent current (I_Q) of the LTC3859 controller is 55μA in sleep mode as specified in the LTC3859 data sheet. However, the input current of the DC1425A 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 6 for the low input quiescent current setup.

In this case, when only V_{OUT1} is on, the DC1425A board typical input quiescent current is 80μA. When both V_{OUT1} and V_{OUT2} are on, the typical input current is 105μA.

Table 6. Low Input Quiescent Current Configuration

Reference Designator	R46	R48	R92
Function	PGOOD1	MODE	OV3
Stuffing Option	OPEN	OPEN	OPEN

LOW QUIESCENT CURRENT APPLICATIONS AND MEASUREMENT

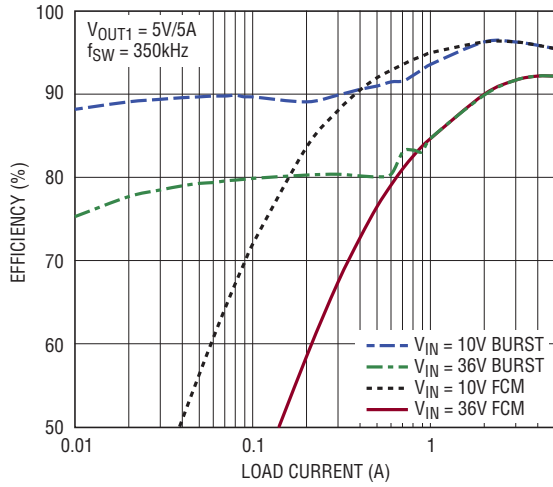


Figure 3. Channel 1 Typical Efficiency vs Load Current

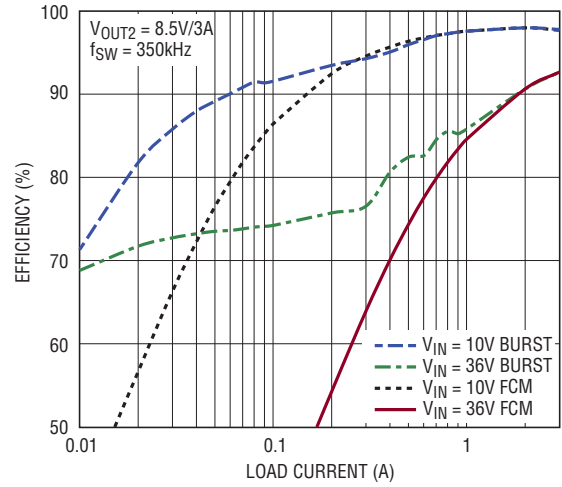


Figure 4. Channel 2 Typical Efficiency vs Load Current

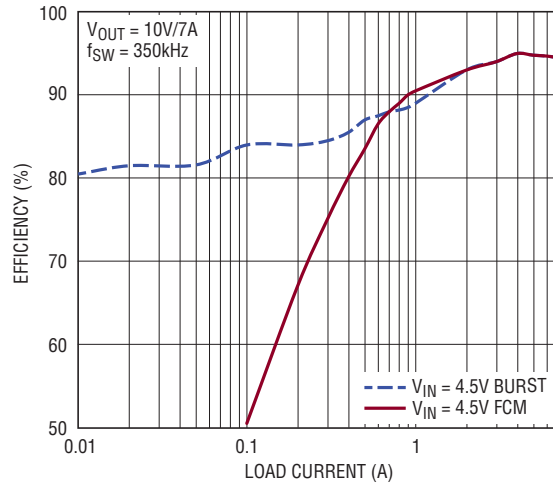


Figure 5. Channel 3 Typical Efficiency vs Load Current

DEMO MANUAL DC1425A

PARTS LIST

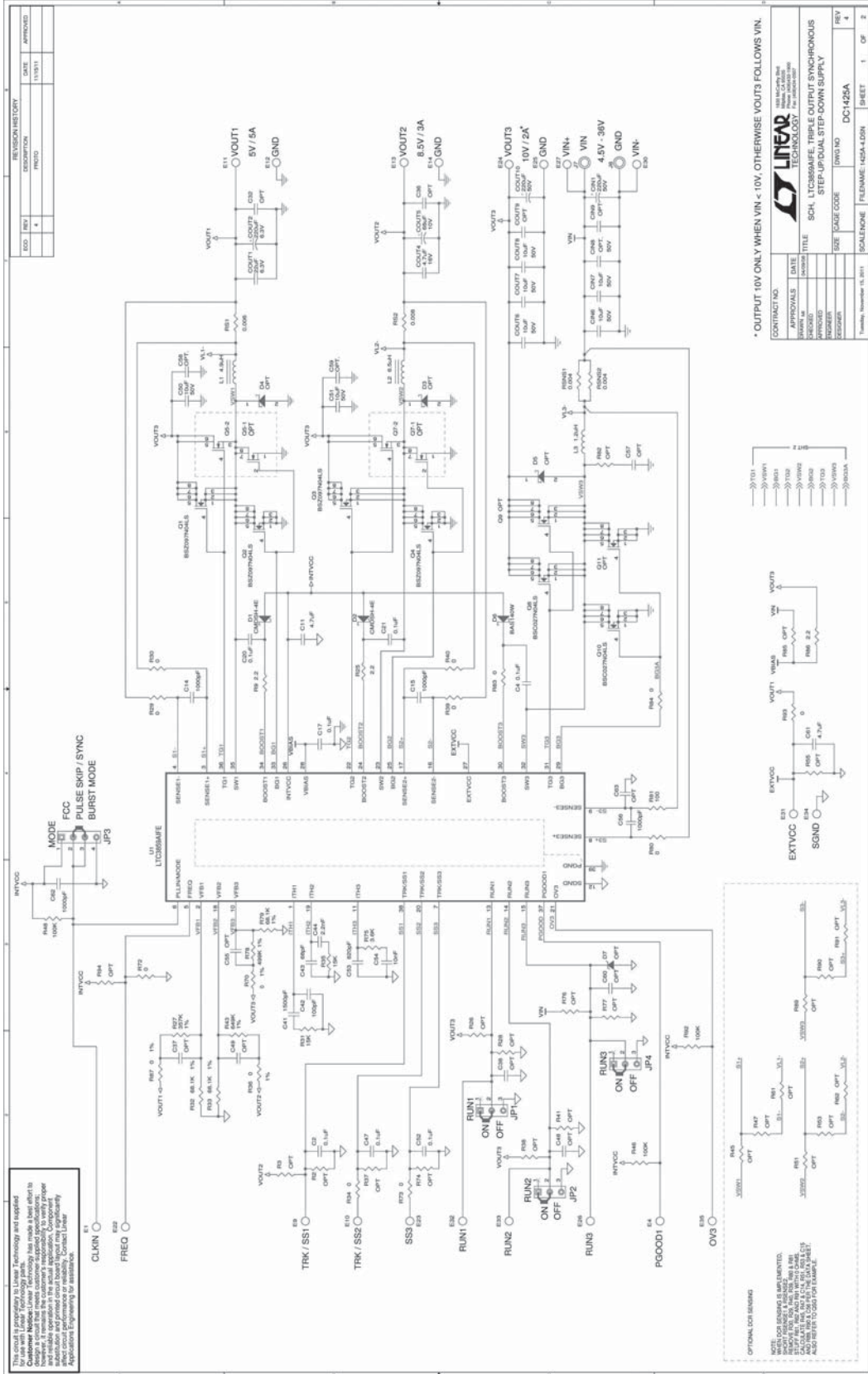
ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	2	CIN1, COUT10	CAP, 220 μ F 20% 50V ELEC	SANYO 50CE220LX
2	7	COUT6 TO COUT8, CIN6, CIN7, C50, C51	CAP, 1210 10 μ F 10% 50V X7S	TAIYO YUDEN UMK325C7106KM-T
3	1	COUT1	CAP, 1206 22 μ F 20% 10V X7R	TAIYO YUDEN LMK316BJ226MN-T
4	1	COUT2	CAP, 7343 220 μ F 20% 6.3V POSCAP	SANYO 6TPB220ML
5	1	COUT4	CAP, 1206 4.7 μ F 20% 16V X7R	TDK C3216X7R1C475M
6	1	COUT5	CAP, 7343 68 μ F 20% 10V POSCAP	SANYO 10TPC68M
7	7	C2, C4, C17, C20, C21, C47, C52	CAP, 0603 0.1 μ F 10% 25V X7R	TDK C1608X7R1E104K
8	2	C11, C61	CAP, 0805 4.7 μ F 10% 6.3V X5R	AVX 08056D475KAT
9	4	C14, C15, C56, C62	CAP, 0603 1nF 10% 50V X7R	AVX 06035C102KAT
10	1	C41	CAP, 0603 1500pF 10% 50V X7R	AVX 06035C152KAT2A
11	1	C42	CAP, 0603 100pF 5% 50V NPO	NIC NMC0603NPO101J50TRPF
12	1	C43	CAP, 0603 68pF 10% 50V NPO	AVX 06035A680KAT
13	1	C44	CAP, 0603 2.2nF 10% 50V X7R	AVX 06035C223KAT
14	1	C53	CAP, 0603 820pF 5% 50V X7R	AVX 06035A821JAT2A
15	1	C54	CAP, 0603 10nF 10% 50V X7R	TDK C1608X7R1H103K
16	2	D2, D1	DIODE, SCHOTTKY SOD323	CENTRAL SEMI CMDSH-4E
17	1	D6	DIODE, SCHOTTKY SOD323	INFINEON BAS140W
18	1	L1	IND, 4.9 μ H	WÜRTH 744314490
19	1	L2	IND, 6.5 μ H	WÜRTH 744314650
20	1	L3	IND, 1.2 μ H	WÜRTH 744325120
21	4	Q1, Q2, Q3, Q4	XSTR, N-CHANNEL MOSFET	INFINEON BSZ097N04LS
22	2	Q8, Q10	XSTR, N-CHANNEL MOSFET	INFINEON BSC027N04LS
23	2	RSNS2, RSNS1	RES, 2010 0.004 Ω 1% 1/2W	VISHAY WSL20104L000FEA
24	1	RS1	RES, 1206 0.006 Ω 5% 1/4W	IRC LRF1206LF-01-R006-J
25	1	RS2	RES, 1206 0.008 Ω 5% 1/4W	IRC LRF1206LF-01-R008-J
26	3	R9, R25, R86	RES, 0603 2.2 Ω 5% 1/10W	VISHAY CRCW06032R20JNEA
27	1	R27	RES, 0603 357k 1% 1/10W	VISHAY CRCW0603357KFKEA
28	14	R29, R30, R34, R36, R39, R40, R70, R72, R73, R80, R83, R84, R87, R93	RES, 0603 0 Ω JUMPER	VISHAY CRCW06030000Z0EA
29	2	R35, R31	RES, 0603 15k 5% 1/10W	VISHAY CRCW060315K0JNEA
30	3	R32, R33, R79	RES, 0603 68.1k 1% 1/10W	VISHAY CRCW060368K1FKEA
31	1	R43	RES, 0603 649k 1% 1/10W	VISHAY CRCW0603649KFKEA
32	3	R46, R48, R92	RES, 0603 100k 5% 1/10W	VISHAY CRCW0603100KJNEB
33	1	R75	RES, 0603 3.6k 1% 1/10W	NIC NR06J362TRF
34	1	R78	RES, 0603 499k 1% 1/10W	VISHAY CRCW0603499KFKEA
35	1	R81	RES, 0603 100 Ω 5% 1/10W	VISHAY CRCW0603100RFKEA
36	1	U1	IC, LTC3859AIFE	LINEAR TECHNOLOGY LTC3859AIFE

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Additional Demo Board Circuit Components				
1	0	CIN8, C58, C59	CAP, 1210 OPTION	OPTION
2	0	COU9, CIN9	CAP, 1210 10µF 10% 50V X7R OPTION	TAIYO YUDEN GMK316BJ106ML-T OPTION
3	0	C32, C36	CAP, 1206 OPTION	OPTION
4	0	C37, C38, C48, C49, C55, C57, C60, C63	CAP, 0603 OPTION	OPTION
5	0	D3, D4, D5	DIODE, SCHOTTKY 40V 3A OPTION	DIODES INC. B340B-13-F OPTION
6	0	D7	DIODE, ZENER OPTION	OPTION
7	0	Q5	XSTR, N-CHANNEL MOSFET OPTION	VISHAY Si4910DY OPTION
8	0	Q7, Q9, Q11	XSTR, N-CHANNEL MOSFET OPTION	OPTION
9	0	Q12 TO Q19	XSTR, OPTION	OPTION
10	0	R2, R3, R26, R28, R37, R38, R41, R45, R47, R51, R53, R55, R61, R62, R74, R76, R77, R85, R89, R90, R91, R94	RES, 0603 OPTION	OPTION
11	0	R82	RES, 1206 OPTION	OPTION
Hardware				
1	20	E1, E4, E9 TO E14, E22 TO E27, E30 TO E35	TURRET	MILL-MAX 2501-2-00-80-00-00-07-0
2	3	JP1, JP2, JP4	HEADER, 3PIN, 2mm	SAMTEC TMM-103-02-L-S
3	1	JP3	HEADER, 4PIN	SAMTEC TMM-104-02--L-S
4	2	J8, J7	JACK, BANANA	KEYSTONE 575-4
5	4	XJP1, XJP2, XJP3, XJP4	SHUNT, 2mm	SAMTEC 2SN-BK-G
6	4		STANDOFF, SNAP ON	KEYSTONE_8833

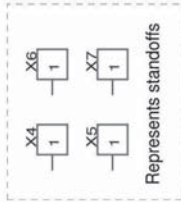
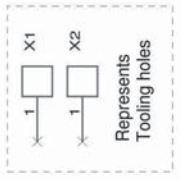
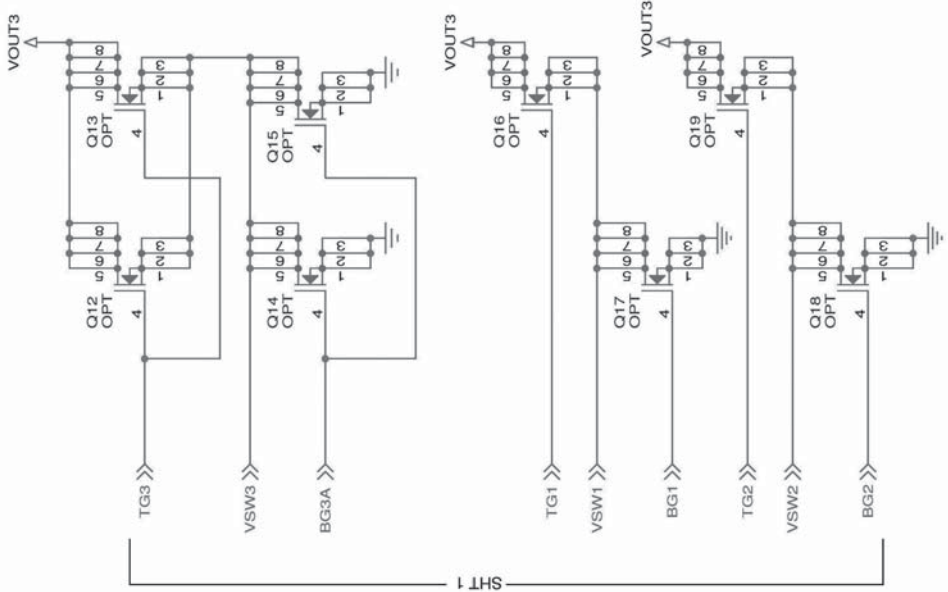
DEMO MANUAL DC1425A

SCHEMATIC DIAGRAM



SCHEMATIC DIAGRAM

This circuit is proprietary to Linear Technology and supplied for use with Linear Technology parts.
Customer Notice: Linear Technology has made a best effort to design a circuit that meets customer-supplied specifications; however, it remains the customer's responsibility to verify proper and reliable operation in the actual application. Component substitution and printed circuit board layout may significantly affect circuit performance or reliability. Contact Linear Applications Engineering for assistance.



CONTRACT NO.		APPROVALS		DATE
		DRAWN: MI		04/09/08
		CHECKED		
		APPROVED		
		ENGINEER		
		DESIGNER		
Tuesday, November 15, 2011				
TITLE		SCH, LTC3859AIFE, TRIPLE OUTPUT SYNCHRONOUS STEP-UP/DUAL STEP-DOWN SUPPLY		
SIZE	CAGE CODE	DWG NO	DC1425A	REV 4
SCALE NONE	FILENAME: 1425A-4.DSN	SHEET 2	OF 2	



DEMO MANUAL DC1425A

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