LTC3374AEUHF
High Accuracy 8-Channel Parallelable 1A Buck DC/DC

DESCRIPTION

Demonstration circuit 2440A is an 8-output power supply featuring the LTC®3374A with improved efficiency and accuracy compared to the LTC3374. The LTC3374A has eight synchronous buck regulators each with an independent V_{IN} supply. Up to four buck regulators may be paralleled together to create a higher power buck regulator with a single inductor. The input range of the LTC3374A is ideal for single cell Li-Ion/Polymer battery applications.

The buck regulators can be enabled via external precision threshold enable pins to allow hardwired power-up sequences.

The LTC3374A has a default operating frequency of 2MHz or it can be set between 1MHz and 3MHz using an external resistor. The LTC3374A also has a SYNC pin which allows the internal oscillator to synchronize to an external clock from 1MHz to 3MHz.

Refer to the LTC3374A data sheet for more details on the electrical and timing specifications.

Design files for this circuit board are available at http://www.linear.com/demo/DC2440A

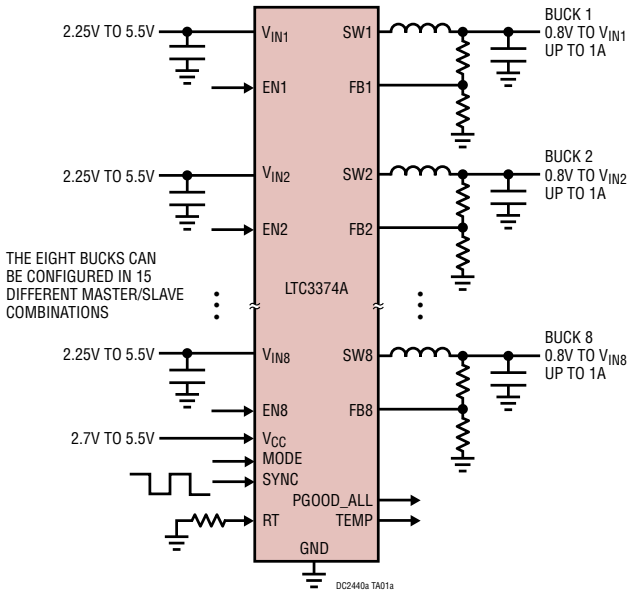
PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

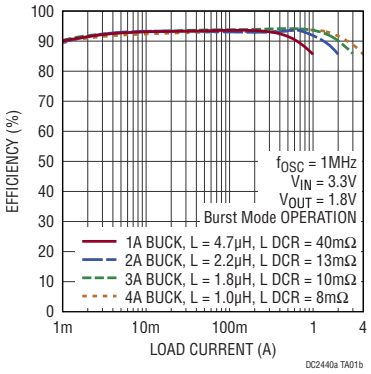
PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Supply Range ($V_{IN1\ TO\ IN8}$)		2.25		5.5	V
V_{CC}		2.7		5.5	V
V_{OUT1}	I_{VOUT1} 0A to 1A		1.2		V
V_{OUT2}	V_{IN2} > 3V, I_{VOUT2} 0A to 1A		3.0		V
V_{OUT3}	V_{IN3} > 2.5V, I_{VOUT3} 0A to 1A		2.5		V
V_{OUT4}	I_{VOUT4} 0A to 1A		2.0		V
V_{OUT5}	I_{VOUT5} 0A to 1A		1.8		V
V_{OUT6}	I_{VOUT6} 0A to 1A		1.5		V
V_{OUT7}	I_{VOUT7} 0A to 1A		1.0		V
V_{OUT8}	V_{IN1} > 3.3V, I_{VOUT8} 0A to 1A		3.3		V

TYPICAL APPLICATION

Eight Synchronous 1A Buck Regulators



Buck Efficiency vs I_{LOAD}



QUICK START PROCEDURE

The DC2440A is easy to set up to evaluate the performance of the LTC3374A. Refer to Figure 1 and Figure 2 for proper measurement equipment setup and follow the evaluation 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. Set the JP1 to JP8 jumpers on the DC2440A board to the OFF position.
2. Set the MODE jumper, JP9, to the BURST position.
3. With power off, connect a 0V to 6V, 100mA power supply to V_{CC} and GND with a voltmeter as shown in Figure 1.
4. With power off, connect a 0V to 6V, 2A power supply to each V_{IN} and GND with a series ammeter and a voltmeter as shown in Figure 1. A single 0V to 6V, 10A supply can be used instead to supply all V_{IN} inputs simultaneously.
5. Turn on and set the V_{CC} input power supply to 3.3V and turn on and set the V_{IN1} supply to 5V.

Note: Make sure that the input voltages do not exceed 6V.

6. Set the JP1 jumper, EN1, to the ON position and observe the V_{OUT1} regulator turns on and the $\overline{\text{PGOOD\_ALL}}$ LED extinguishes.

Note: All regulators not powered or set up as a slave must have their EN pins tied to GND to allow the $\overline{\text{PGOOD\_ALL}}$ LED to extinguish.

7. With power off, connect a 0A to 2A load to each V_{OUT} and GND with a series ammeter and a voltmeter as shown in Figure 1.
8. Slowly increase LOAD1 from 0A to 1A and observe the output voltage. The output ripple may also be observed using an oscilloscope with the probe connected as shown in Figure 2.
9. When done evaluating V_{OUT1}, repeat steps 5 through 8 for each regulator.
10. Refer to the LTC3374A data sheet for more details on how the LTC3374A operates.
11. When done, turn off all loads and power supplies.

QUICK START PROCEDURE

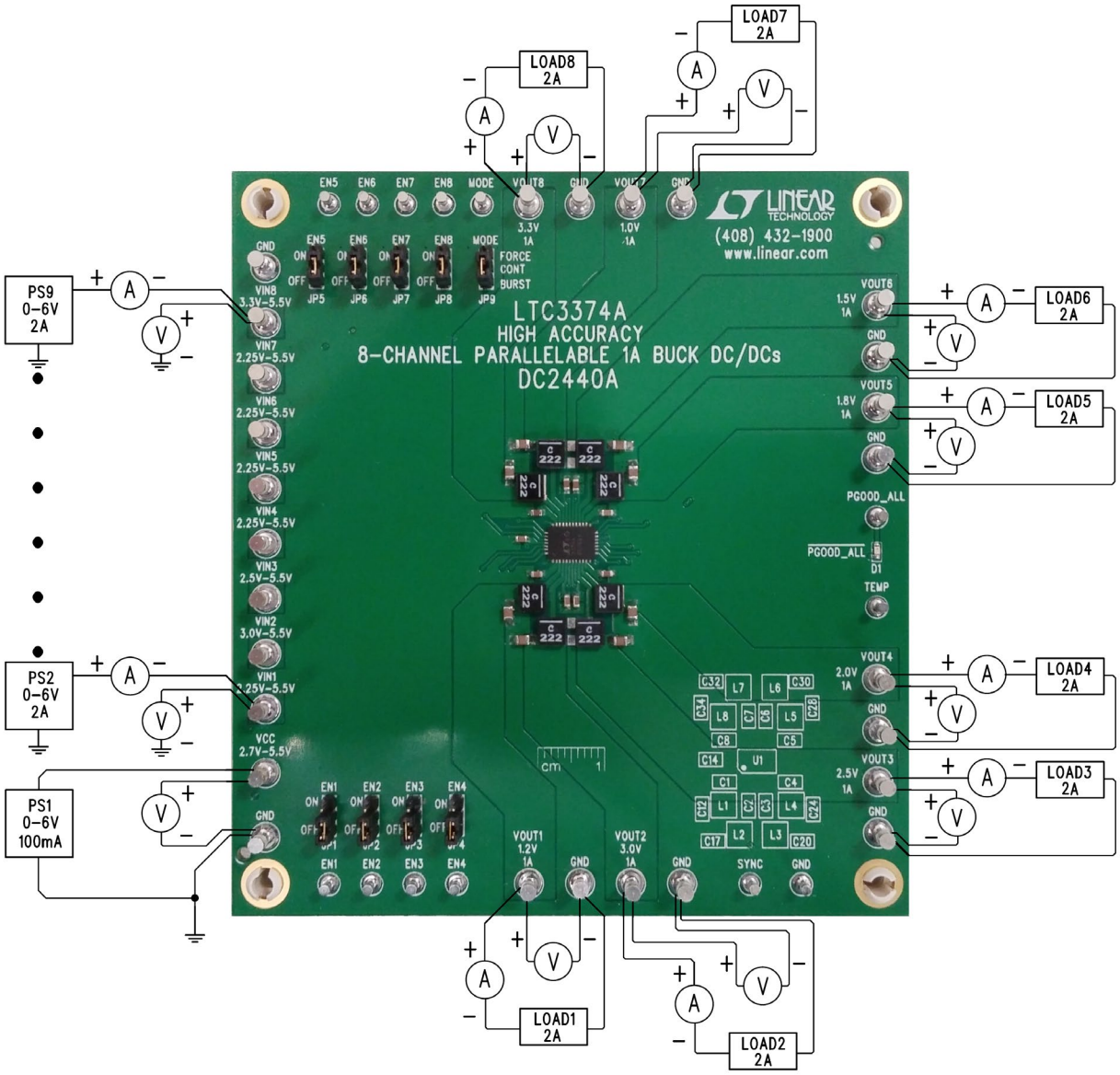


Figure 1. Proper Measurement Equipment Setup

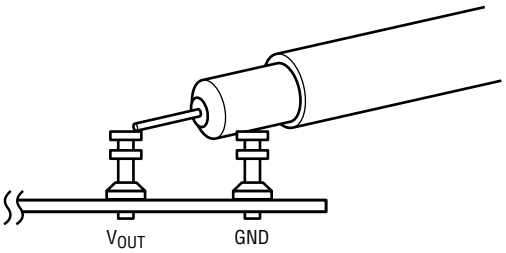


Figure 2. Measuring Input or Output Ripple

CHANGING FREQUENCY AND OUTPUT VOLTAGES

The frequency and output voltages are easily changed on the DC2440A by changing the associated resistors. A minimum size 0603 pad size was used for these resistors to enable easier 0603 component changes while keeping the layout as tight as possible. These pads will also accommodate 0402 resistors if preferred.

The frequency is set up to run at the default 2MHz by the RT pin to V_{CC} via R54. The frequency can be change top operate from 1MHz to 3MHz. To change the frequency, first remove R54 and then place the desired R_T resistor on the R50 pads. Use the following equation to calculate R_T, R50:

$$f_{OSC} = 2MHz\left(\frac{400k\Omega}{R_T}\right)$$

For the optimal performance, the inductors should also be changed when the frequency is changed. Refer to Tables 1 thru 4 for the recommended inductors.

The output voltage can also be adjusted by changing the associated feedback resistor divider ratio. The feedback divider for V_{OUT1} is R2 and R3. $V_{OUT1} = V_{FB}(R2/R3 + 1)$ where $V_{FB} = 0.8V$. This equation can be used to solve for the desired resistor change.

COMBINING BUCK REGULATORS WITH MULTIPLE OUTPUT FILTERS

The LTC3374A has the ability to combine up to four consecutively numbered bucks to achieve output currents of 1A, 2A, 3A or 4A. The easiest way to configure the DC2440A with combined outputs is to use an output inductor and output capacitor on each switch node. While combining stages with multiple filters is not ideal for performance or minimization of components, it does provide the easiest way to prototype with the desired current levels. Follow the steps below to make an output a slave to the adjacent regulator:

1. Remove the desired slave regulator's associated FB resistors and feed forward capacitor.
2. Add the associated 0Ω resistor to tie the FB pin to its V_{IN} pin.
3. Connect the outputs together at the output capacitors.
4. Connect the V_{IN} of the slave regulator to the V_{IN} of the master regulator.

For example, to make regulator 2 a slave of regulator 1:

1. Remove R6, R7 and C16.
2. Solder a 0Ω resistor to R5.
3. Connect V_{IN1} to V_{IN2} at the V_{IN} terminals.
4. Connect V_{OUT1} to V_{OUT2} at the output capacitors C12 and C17.

Regulator 3 can also be combined with regulator 1 and regulator 2 to create a 3A output by:

1. Removing FB3 components, R10, R11 and C19.
2. Solder a 0Ω resistor to R9.
3. Connect V_{IN3} to V_{IN2} and V_{IN1} at the V_{IN} terminals.
4. Connect V_{OUT3} to V_{OUT2} and V_{OUT1} at the output capacitors.

Regulator 4 can also be added to this combination by following the same steps with regulator 4's associated components.

The higher number regulator is always a slave to the adjacent lower number regulator; therefore regulator 1 can never be a slave and regulator 8 can never be a master.

COMBINING BUCK REGULATORS WITH MULTIPLE OUTPUT FILTERS

Table 1. Recommended Inductors for 1A Buck Regulators

f_{OSC}	PART NUMBER	L (µH)	MAX I_{DC} (A)	MAX DCR (mΩ)	SIZE IN mm (L × W × H)	MANUFACTURER
1MHz	XFL4020-472ME	4.7	2.7	57.4	4 × 4 × 2.1	CoilCraft
	74408943047	4.7	2.2	52	4.8 × 4.8 × 3.8	Wurth Elektronik
2MHz	XFL4020-222ME	2.2	3.7	23.5	4 × 4 × 2.1	CoilCraft
	DFE252012P-2R2M	2.2	2.2	84	2.5 × 2.0 × 1.2	Toko
	IHLP1212BZER2R2M-11	2.2	3	46	3 × 3.65 × 2.0	Vishay
3MHz	74438336015	1.5	3.7	39	3 × 3 × 2	Wurth Elektronik
	DFE252012F-1R5M	1.5	2.7	58	2.5 × 2 ×1.2	Toko

Table 2. Recommended Inductors for 2A Buck Regulators

f_{OSC}	PART NUMBER	L (µH)	MAX I_{DC} (A)	MAX DCR (mΩ)	SIZE IN mm (L × W × H)	MANUFACTURER
1MHz	XEL4020-222ME	2.2	5.5	38.7	4 × 4 × 2.1	CoilCraft
	74438356022	2.2	4.7	35	4.1 × 4.1 × 2.1	Wurth Elektronik
2MHz	XFL4020-102ME	1	5.4	11.9	4 × 4 × 2.1	CoilCraft
	IHLP1212BZER1R0M-11	1	4.5	24	3 × 3.65 × 2.0	Vishay
	SPM4020T-1R0M-LR	1	5.6	28.1	4.1 × 4.4 × 2	TDK
3MHz	744383360068	0.68	4.5	27	3 × 3 × 2	Wurth Elektronik
	IHLP1212AEERR68M-11	0.68	5.4	22	3 × 3.65 × 1.5	Vishay

Table 3. Recommended Inductors for 3A Buck Regulators

f_{OSC}	PART NUMBER	L (µH)	MAX I_{DC} (A)	MAX DCR (mΩ)	SIZE IN mm (L × W × H)	MANUFACTURER
1MHz	XEL4020-152ME	1.5	7.4	23.6	4 × 4 × 2.1	CoilCraft
	IHLP2020CZER1R5M11	1.5	7	18.5	5.18 × 5.49 × 3	Vishay
2MHz	XEL4020-821ME	0.82	10.2	13	4 × 4 × 2	CoilCraft
	FDV0530-H-R75M	0.75	9.7	7.6	6.2 × 5.8 × 3	Toko
	744383560068	0.68	8.2	9	4.1 × 4.1 × 2.1	Wurth Elektronik
3MHz	FDSD0420D-R47M	0.47	6.8	18	4.2 × 4.2 × 2	Toko
	IHLP1212AEERR47M-11	0.47	6.7	15	3 × 3.65 × 1.5	Vishay

Table 4. Recommended Inductors for 4A Buck Regulators

f_{OSC}	PART NUMBER	L (µH)	MAX I_{DC} (A)	MAX DCR (mΩ)	SIZE IN mm (L × W × H)	MANUFACTURER
1MHz	XEL4020-102ME	1	9	14.6	4 × 4 × 2.1	CoilCraft
	744316100	1	11.5	5.225	5.3 × 5.5 × 4.0	Wurth Elektronik
2MHz	XEL4020-561ME	0.56	11.3	8.8	4 × 4 × 2.1	CoilCraft
	FDV0530-H-R56M	0.56	11.1	6.3	6.2 × 5.8 × 3	Toko
	SPM4020T-R47M-LR	0.47	8.7	11.8	4.1 × 4.4 × 2	TDK
3MHz	XEL4014-331ME	0.33	9	12	4 × 4 × 1.4	CoilCraft
	744383560033	0.33	9.6	7.2	4.1 × 4.1 × 2.1	Wurth Elektronik

COMBINING BUCK REGULATORS WITH MULTIPLE OUTPUT FILTERS

In most applications it is more practical to use a single output filter on a combined regulator. To do this the switch nodes of the combined regulators need to be shorted together, and the output inductor and capacitor need to be sized correctly. Please refer to the Combined Buck Regulator section in the LTC3374A data sheet for more information on sizing the output capacitor and inductor.

Note: The DC2440A layout was optimized for eight 1A outputs. For applications with combined regulators the layout should be optimized for the components used, low and equal impedance on the combined switch nodes, and the shortest AC current paths possible.

To combine regulators 1 and 2 for a 2A output, perform the following steps and refer to Figure 3 and Figure 4:

1. Remove L2, R6, R7 and C16.
2. Add a 0Ω resistor to R5.
3. Replace L1 with an appropriate size inductor that can handle the 2A output at current limit. The inductance should be reduced in half for a 2A output. A 1µH inductor is recommended for a switching frequency of 2MHz. Refer to Table 2 for recommended inductors.
4. Replace C12 with at least a 47µF ceramic capacitor.
5. Short SW1 and SW2 together. To reduce the impedance on the SW node, cut the excess trace from SW2 to L2 as close to the short as possible.
6. Short V_{IN1} and V_{IN2} together near the V_{IN} terminals.

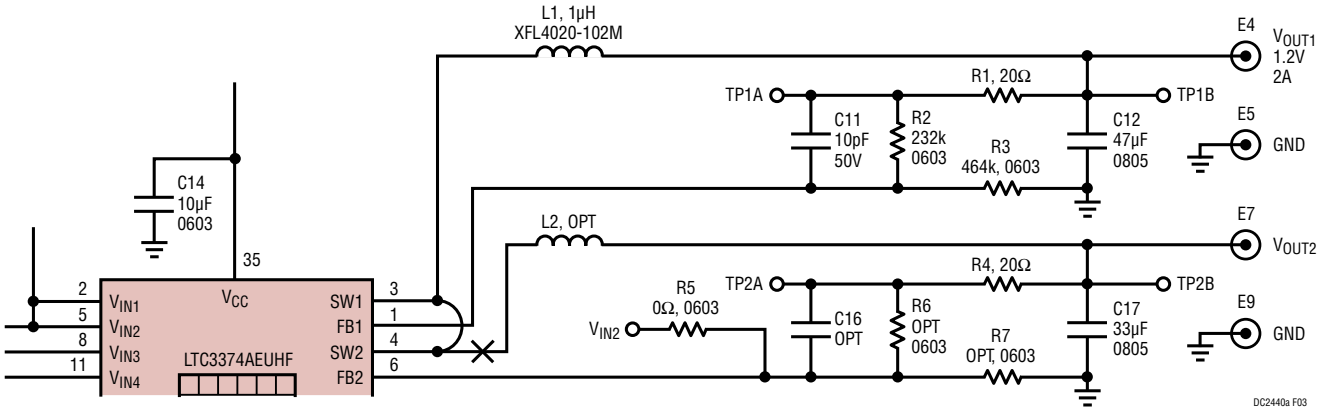


Figure 3. Combined 2A Output Regulators 1 and 2

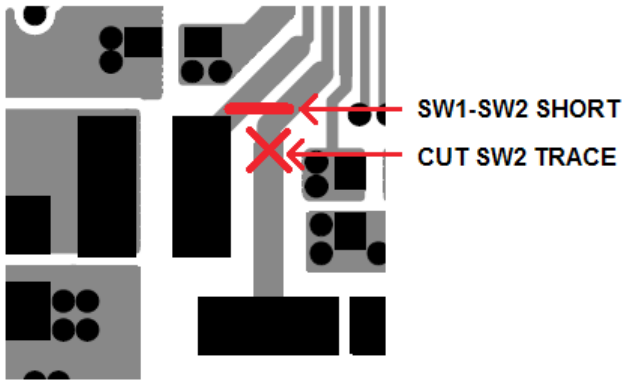


Figure 4. Combined 2A Regulators SW1 and SW2 Connections

COMBINING BUCK REGULATORS WITH MULTIPLE OUTPUT FILTERS

To combine regulators 2, 3 and 4 for a 3A output, perform the following steps and refer to Figure 5 and Figure 6:

1. Remove L2, L3 and L4.
2. Add an appropriate size inductor that can handle the 3A output at current limit. The inductor should be placed across the L2, L3, pads and the copper between the pads as shown in Figure 6. The inductance should be reduced to about 1/3 for a 3A output. A 0.75µH inductor is recommended for a switching frequency of 2MHz. Refer to Table 3 of for recommended inductors.
3. Short SW3 and SW4 together at the L3 and L4 SW pads as shown in Figure 6.
4. Remove R10, R11, R15, R17, C19 and C23.
5. Add 0Ω resistors to R9 and R14.
6. C17 and C20 must have at least 33µF ceramic capacitors.
7. Short V_{OUT2} and V_{OUT3} together with a 20AWG bus wire at the L2 and L3 output pads.
8. Connect V_{IN2}, V_{IN3} and V_{IN4} together at the V_{IN} terminals.

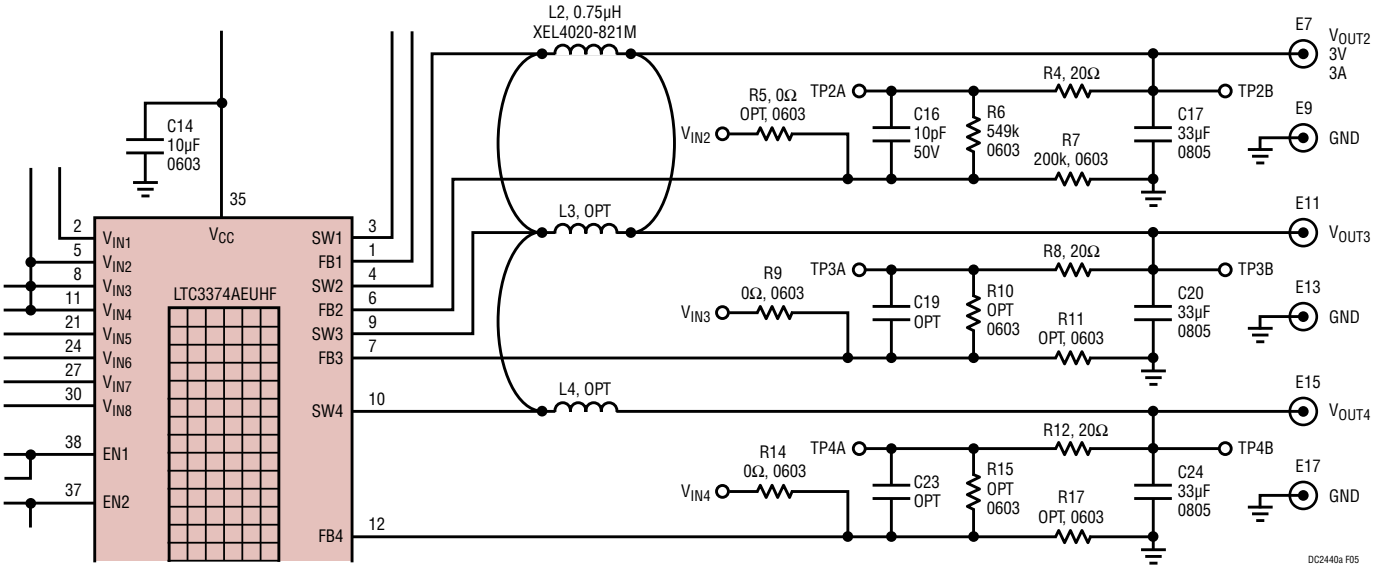


Figure 5. Combined 3A Output Regulators 2, 3, 4

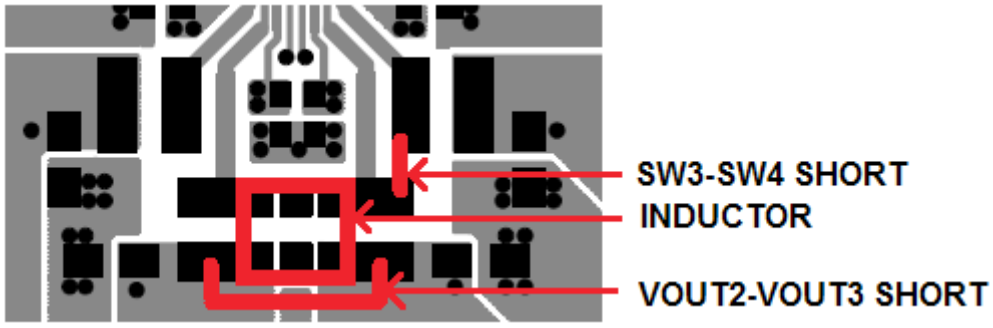


Figure 6. Combined 3A Regulator Inductor Placement and Connections

COMBINING BUCK REGULATORS WITH MULTIPLE OUTPUT FILTERS

To combine regulators 1, 2, 3, and 4 for a 4A output perform the following steps and refer to Figure 7 and Figure 8:

1. Remove L1, L2, L3 and L4.
2. Add an appropriate size inductor that can handle the 4A output at current limit. The inductor should be placed across the L2, L3, pads and the copper between the pads as shown in Figure 8. The inductance should be reduced by about 1/4 for a 4A output. A 0.55µH inductor is recommended for a switching frequency of 2MHz. Refer to table 4 for recommended inductors.
3. Short SW1 and SW2 together at the L1 and L2 SW pads. Then short SW3 and SW4 together at the L3 and L4 SW pads as shown in Figure 8.
4. Remove R6, R7, R10, R11, R15, R17, C16, C19 and C23.
5. Add 0Ω resistors to R5, R9 and R14.
6. Replace C17 and C20 with at least 47µF ceramic capacitors.
7. Connect TP1B with TP2B with a 26 AWG wire. This connects the 4A output voltage to the FB1 network.
8. Connect V_{IN1}, V_{IN2}, V_{IN3} and V_{IN4} together at the V_{IN} terminals.

Note: Connect the load to the V_{OUT2} and/or V_{OUT3} terminals and not the V_{OUT1} terminal. The 4A OUTPUT will be observed on the V_{OUT1} terminal, however it is only connected via the 26AWG wire and 10 mil FB traces.

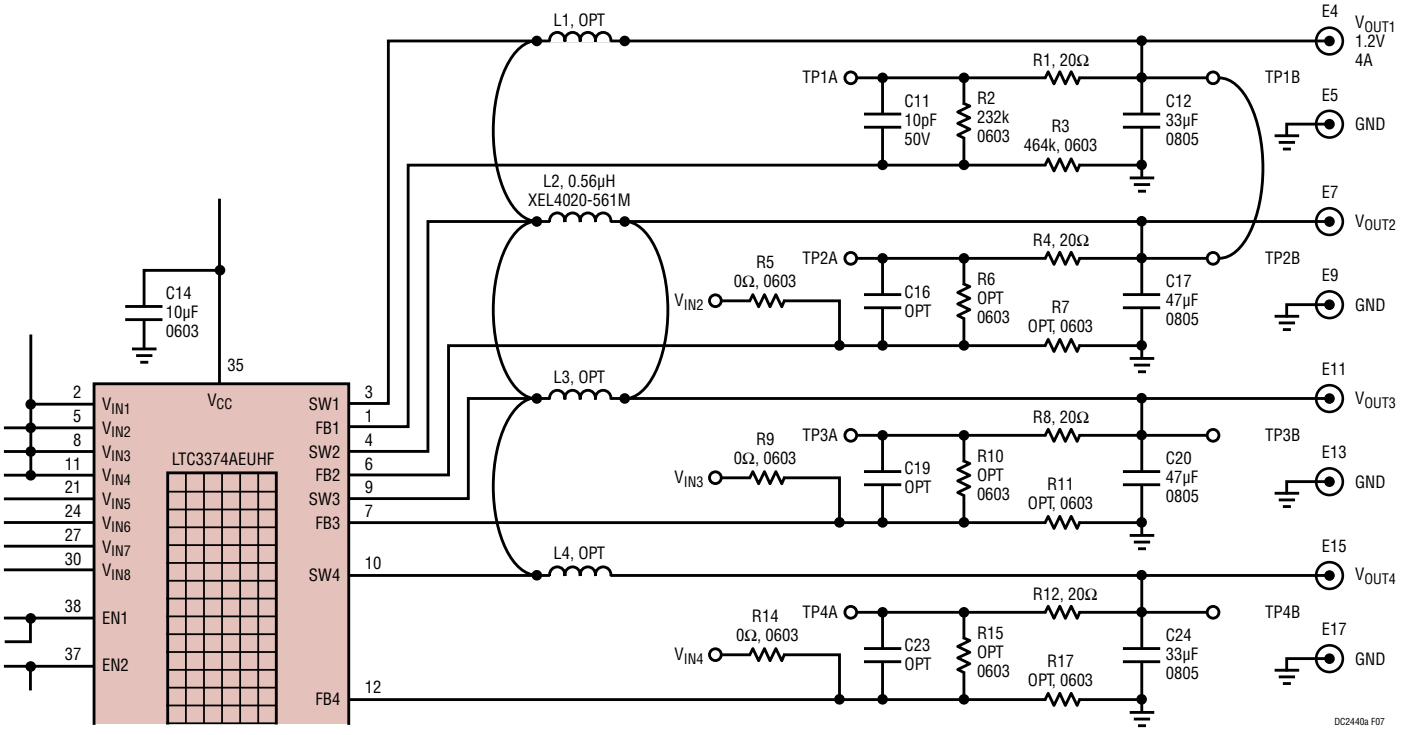


Figure 7. Combined 4A Output Regulators 1, 2, 3 and 4

COMBINING BUCK REGULATORS WITH MULTIPLE OUTPUT FILTERS

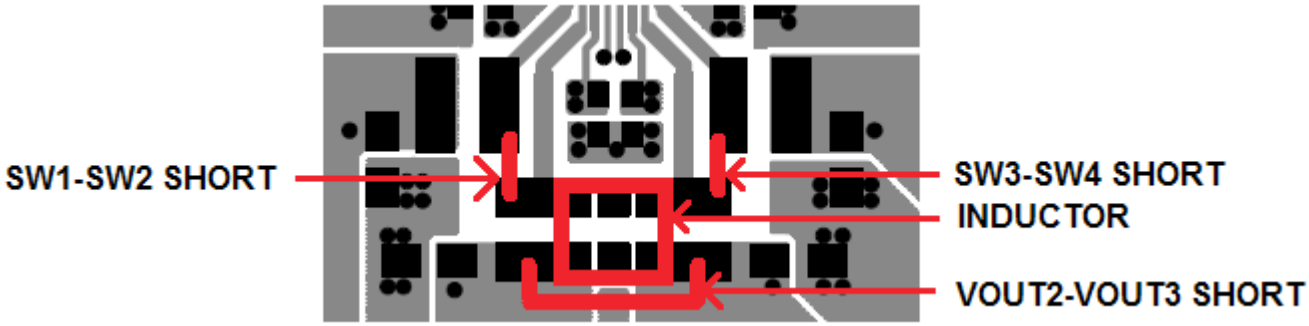
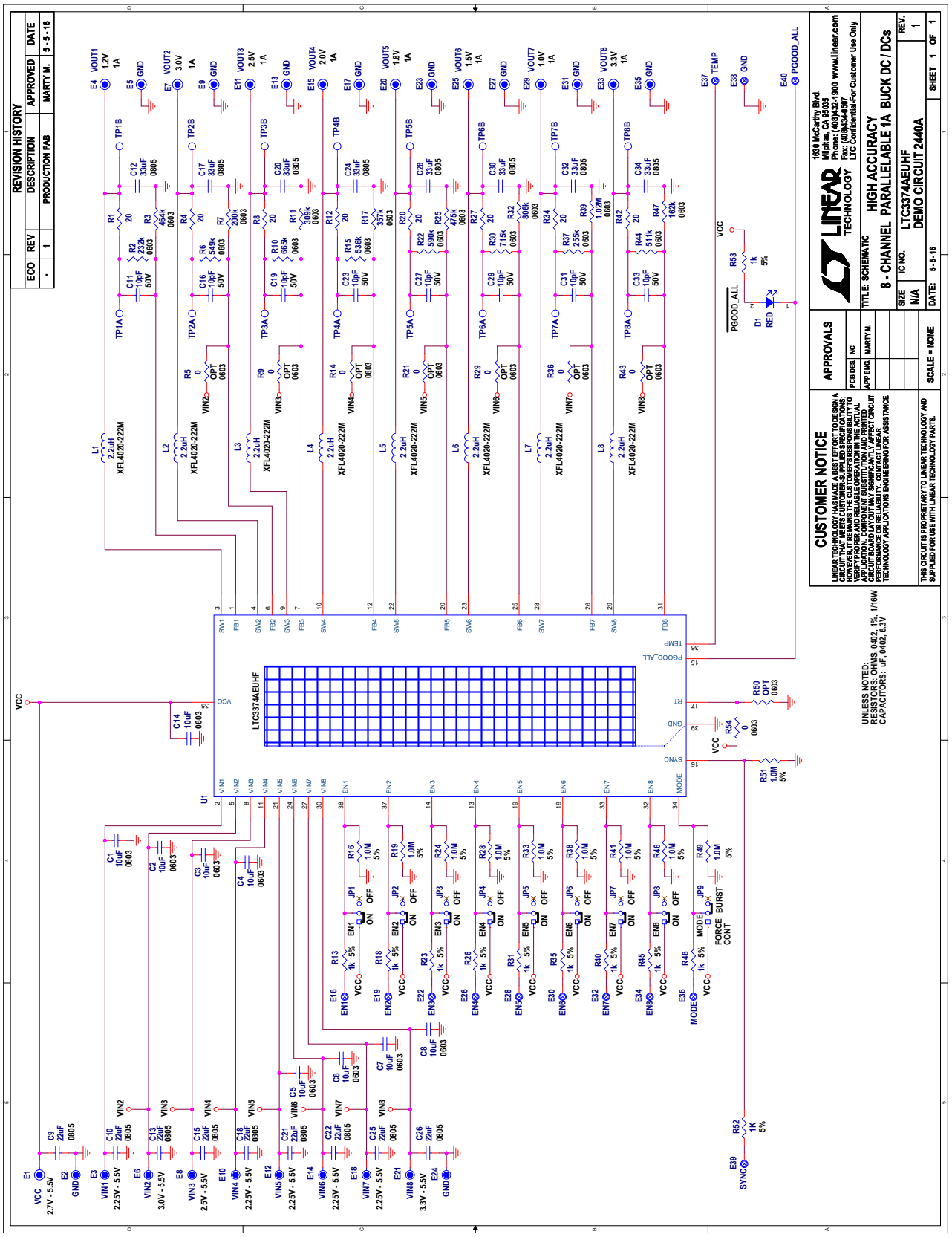


Figure 8. Combined 4A Regulator Inductor Placement and Connections

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	9	C1, C2, C3, C4, C5, C6, C7, C8, C14	CAP, CHIP, X5R, 10µF, ±20%, 6.3V, 0603	TDK, C1608X5R0J106M
2	8	C12, C17, C20, C24, C28, C30, C32, C34	CAP, CHIP, X5R, 33µF, ±20%, 6.3V, 0805	TDK, C2012X5R0J336M
3	8	L1 TO L8	IND, SMT, 2.2µH, 21mΩ, ±20%, 3.7A, 4mm × 4mm	COILCRAFT, XFL4020-222M
4	1	R2	RES, CHIP, 232kΩ, ±1%, 1/10W, 0603	VISHAY, CRCW0603232KFKED
5	1	R6	RES, CHIP, 549kΩ, ±1%, 1/10W, 0603	VISHAY, CRCW0603549KFKED
6	1	R7	RES, CHIP, 200kΩ, ±1%, 1/10W, 0603	VISHAY, CRCW0603200KFKED
7	1	R10	RES, CHIP, 665kΩ, ±1%, 1/10W, 0603	VISHAY, CRCW0603665KFKED
8	1	R11	RES, CHIP, 309kΩ, ±1%, 1/10W, 0603	VISHAY, CRCW0603309KFKED
9	1	R15	RES, CHIP, 536kΩ, ±1%, 1/10W, 0603	VISHAY, CRCW0603536KFKED
10	1	R17	RES, CHIP, 357kΩ, ±1%, 1/10W, 0603	VISHAY, CRCW0603357KFKED
11	1	R22	RES, CHIP, 590kΩ, ±1%, 1/10W, 0603	VISHAY, CRCW0603590KFKED
12	1	R25	RES, CHIP, 475kΩ, ±1%, 1/10W, 0603	VISHAY, CRCW0603475KFKED
13	1	R30	RES, CHIP, 715kΩ, ±1%, 1/10W, 0603	VISHAY, CRCW0603715KFKED
14	1	R32	RES, CHIP, 806kΩ, ±1%, 1/10W, 0603	VISHAY, CRCW0603806KFKED
15	1	R37	RES, CHIP, 255kΩ, ±1%, 1/10W, 0603	VISHAY, CRCW0603255KFKED
16	1	R39	RES, CHIP, 1.02MΩ, ±1%, 1/10W, 0603	VISHAY, CRCW06031M02FKED
17	1	R44	RES, CHIP, 511kΩ, ±1%, 1/10W, 0603	VISHAY, CRCW0603511KFKED
18	1	R47	RES, CHIP, 162kΩ, ±1%, 1/10W, 0603	VISHAY, CRCW0603162KFKED
19	1	U1	HIGH ACCURACY 8-CHANNEL PARALLELABLE 1A BUCK DC/DCs 5mm × 7mm QFN38	LINEAR TECHNOLOGY, LTC3374AEUHF
Additional Demo Board Circuit Components				
20	9	C9, C10, C13, C15, C18, C21, C22, C25, C26	CAP, CHIP, X5R, 22µF, ±20%, 6.3V, 0805	TAIYO YUDEN, JMK212ABJ226MG
21	8	C11, C16, C19, C23, C27, C29, C31, C33	CAP, CHIP, COG, 10pF, ±5%, 50V, 0402	AVX, 04025A100JAT
22	1	D1	DIODE, LED, SUPER RED DIFF, 0603 SMD	LUMEX, SML-LX0603SRW-TR
23	8	R1, R4, R8, R12, R20, R27, R34, R42	RES, CHIP, 20Ω , ±1%, 1/16W, 0402	VISHAY, CRCW040220R0FKED
24	11	R13, R18, R23, R26, R31, R35, R40, R45, R48, R52, R53	RES, CHIP, 1kΩ, ±5%, 1/16W, 0402	VISHAY, CRCW04021K00JNED
25	0	R5, R9, R14, R21, R29, R36, R43, OPT	RES, CHIP, 0Ω JUMPER, 1/10W, 0603	VISHAY, CRCW06030000Z0ED
26	10	R16, R19, R24, R28, R33, R38, R41, R46, R49, R51	RES, CHIP, 1MΩ, ±5%, 1/16W, 0402	VISHAY, CRCW04021M00JNED
27	0	R50 OPT	RES, CHIP, 1/10W, 0603	
28	1	R54	RES, CHIP, 0Ω JUMPER, 1/10W, 0603	VISHAY, CRCW06030000Z0ED
Hardware: For Demo Board Only				
29	27	E1 TO E15, E17, E18, E20, E21, E23 TO E25, E27, E29, E31, E33, E35	TURRET, 0.09 DIA	MILL-MAX, 2501-2-00-80-00-00-07-0
30	13	E16, E19, E22, E26, E28, E30, E32, E34, E36 TO E40	TURRET, 0.061 DIA	MILL-MAX, 2308-2-00-80-00-00-07-0
31	9	JP1 TO JP9	2mm HEADER 1 x 3, 2mm	WURTH ELEKTRONIK, 62000311121
32	9	JP1 TO JP9	SHUNT, 2mm	WURTH ELEKTRONIK, 60800213421
33	4		STAND-OFF NYLON, 0.375" TALL (SNAP-ON)	KEYSTONE, 8832 (SNAP ON)
34	1		FAB, PRINTED CIRCUIT BOARD	DC2440A-1

SCHEMATIC DIAGRAM



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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.

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Общество с ограниченной ответственностью «МосЧип» ИНН 7719860671 / КПП 771901001
Адрес: 105318, г.Москва, ул.Щербаковская д.3, офис 1107

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

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