LT3753
Active Clamp Forward Converter with Synchronous Rectification

DESCRIPTION

Demonstration circuits 2324A-A, 2324A-B, and 2324A-C are active clamp forward converters with synchronous rectification featuring the LT®3753.

These circuits were designed to demonstrate the high level of performance, efficiency and small solution size attainable using this part. They operate at 240kHz. The DC2324A-A produces a 24V/5A output from an input voltage range of 36V to 72V. The DC2324A-B produces a 24V/5A output from an input voltage range of 18V to 36V. The DC2324A-C produces a 24V/4A output from an input voltage range of 9V to 18V, making it suitable for telecom, industrial and other isolated power supply applications. They all have an eighth-brick footprint area. Synchronous rectification helps to attain efficiency exceeding 94% (exceeding 95% for the DC2324A-A and DC2324A-B).

The DC2324A circuits feature soft-start which prevents output voltage overshoot during startup or when recovering from an overload condition.

The DC2324A also has a precise overcurrent protection circuit that allows for continuous operation and low power dissipation during short circuit conditions which ensures high reliability.

Please refer to the LT3753 data sheet for design details and applications information.

Design files for this circuit board are available at http://www.linear.com/demo/DC2324A

PERFORMANCE SUMMARY DC2324A-A

Specifications are at T_A = 25°C

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Input Supply Range		36		72	V
V_{OUT}	Output Voltage		21.6	24	26.4	V
I_{OUT}	Maximum Output Current, Continuous		5			A
f_{SW}	Switching (Clock) Frequency			240		kHz
$V_{OUT\ P-P}$	Output Ripple	V_{IN} = 48V, I_{OUT} = 5A (20MHz BW)		40		mV_{P-P}
P_{OUT}/P_{IN}	Efficiency (see Figure 2)	V_{IN} = 48V, I_{OUT} = 5A		95.6		%

PERFORMANCE SUMMARY DC2324A-B

Specifications are at T_A = 25°C

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Input Supply Range		18		36	V
V_{OUT}	Output Voltage		21.6	24	26.4	V
I_{OUT}	Maximum Output Current, Continuous		5			A
f_{SW}	Switching (Clock) Frequency			240		kHz
$V_{OUT\ P-P}$	Output Ripple	V_{IN} = 24V, I_{OUT} = 5A (20MHz BW)		30		mV_{P-P}
P_{OUT}/P_{IN}	Efficiency (see Figure 3)	V_{IN} = 24V, I_{OUT} = 5A		95.7		%

PERFORMANCE SUMMARY DC2324A-C

Specifications are at T_A = 25°C

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Input Supply Range		9		18	V
V_{OUT}	Output Voltage		21.6	24	26.4	V
I_{OUT}	Maximum Output Current, Continuous		4			A
f_{SW}	Switching (Clock) Frequency			240		kHz
$V_{OUT\ P-P}$	Output Ripple	V_{IN} = 12V, I_{OUT} = 4A (20MHz BW)		30		mV_{P-P}
P_{OUT}/P_{IN}	Efficiency (see Figure 4)	V_{IN} = 12V, I_{OUT} = 4A		94.8		%

QUICK START PROCEDURE

Demonstration circuit 2324A is easy to set up to evaluate the performance of the LT3753. Refer to Figure 1 for proper measurement equipment setup and follow the procedure below:

1. Set an input power supply that is capable of covering the input voltage range of the DC2324A (see the Performance Summary table) to one of these voltages:

   48V for the DC2324A-A,

   24V for the DC2324A-B,

   12V for the DC2324A-C.

   Then turn off the supply.

2. With power off, connect the supply to the input terminals $+V_{IN}$ and $–V_{IN}$. If efficiency measurements are desired, an ammeter with proper rating can be put in series with the input supply in order to measure the DC2324A's input current.

3. Turn on the power at the input.

   NOTE: Make sure that the input voltage does not exceed 100V.

4. Check for the proper output voltage of 24V. Turn off the power at the input.

5. Once the proper output voltage is established, connect a variable load capable of sinking 5A at 24V to the output terminals $+V_{OUT}$ and $–V_{OUT}$. Set the current for 0A.

a. If efficiency measurements are desired, an ammeter that is capable of handling $5A_{DC}$ can be put in series with the output load in order to measure the DC2324A's output current.

b. A voltmeter can be placed across the output terminals in order to get an accurate output voltage measurement.

6. Turn on the power at the input.

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

7. Once the proper output voltage is again established, adjust the load within the operating range and observe the output voltage regulation, ripple voltage, efficiency and other desired parameters.

NOTE: When measuring the input or output voltage ripples, 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 $+V_{IN}$ and $–V_{IN}$, or $+V_{OUT}$ and $–V_{OUT}$ terminals.

QUICK START PROCEDURE

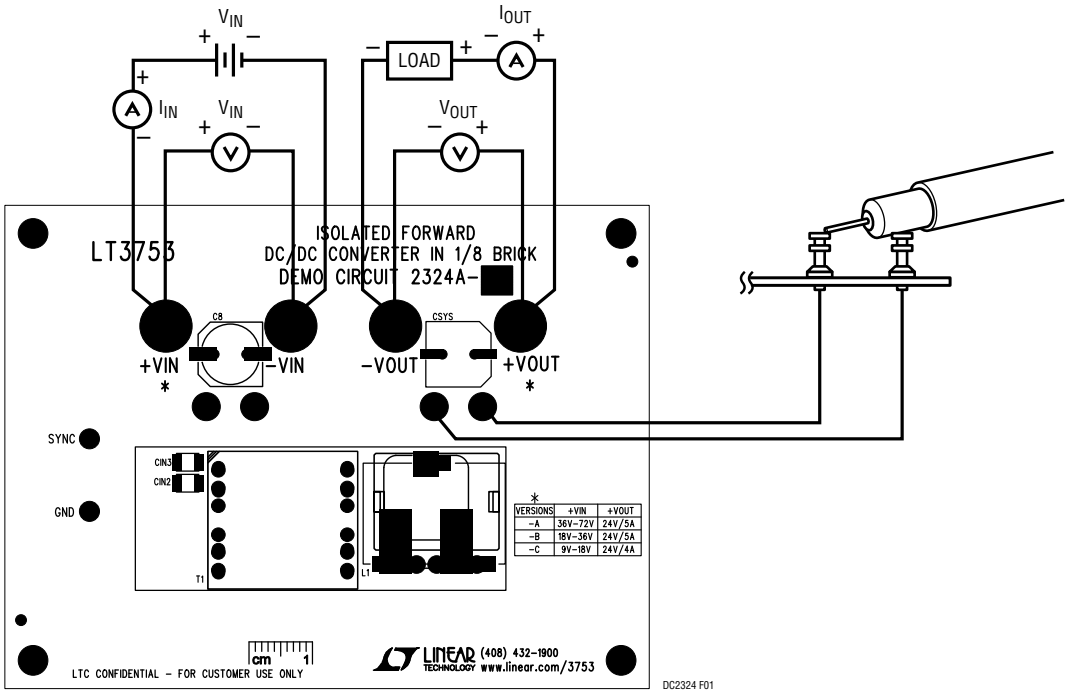


Figure 1. Proper Measurement Equipment Setup

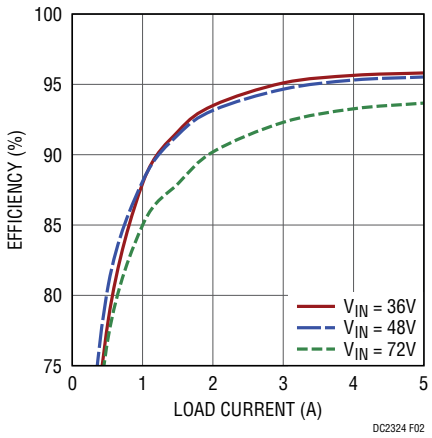


Figure 2. DC2324A-A Efficiency

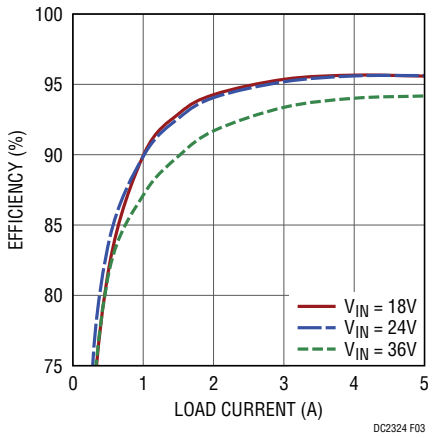


Figure 3. DC2324A-B Efficiency

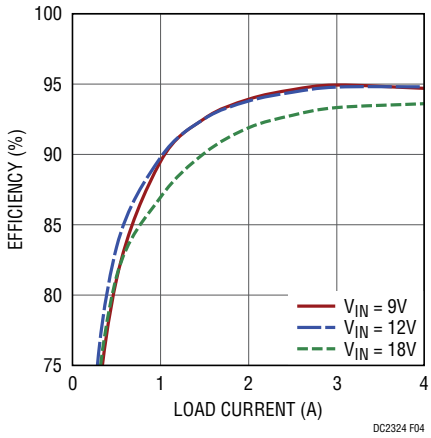


Figure 4. DC2324A-C Efficiency

QUICK START PROCEDURE

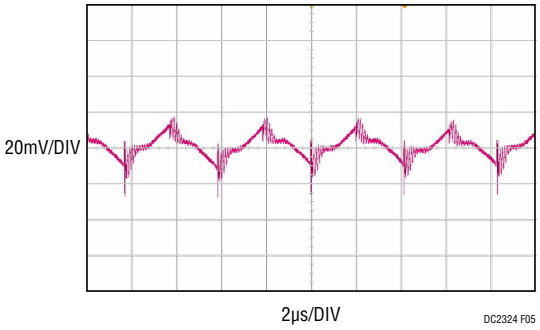


Figure 5. DC2324A-A Output Ripple at $48V_{IN}$ and $5A_{OUT}$ (20MHz BW)

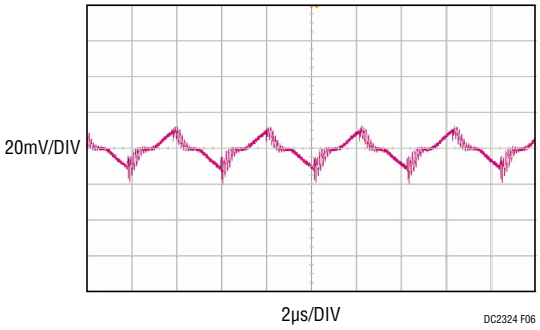


Figure 6. DC2324A-B Output Ripple at $24V_{IN}$ and $5A_{OUT}$ (20MHz BW)

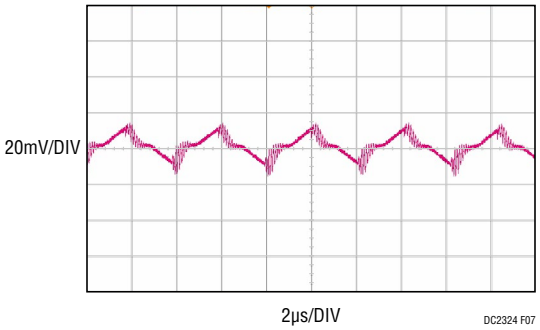


Figure 7. DC2324A-C Output Ripple at $12V_{IN}$ and $4A_{OUT}$ (20MHz BW)

QUICK START PROCEDURE

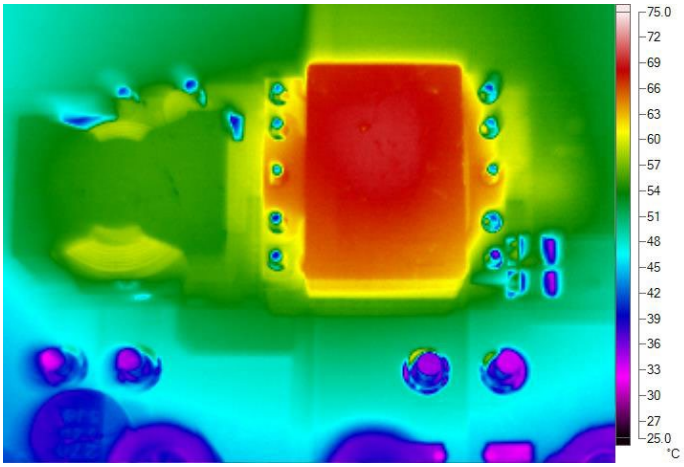


Figure 8. DC2324A-A Thermal Map, Front Side at $48V_{IN}$ and $5A_{OUT}$ (T_A = 25°C)

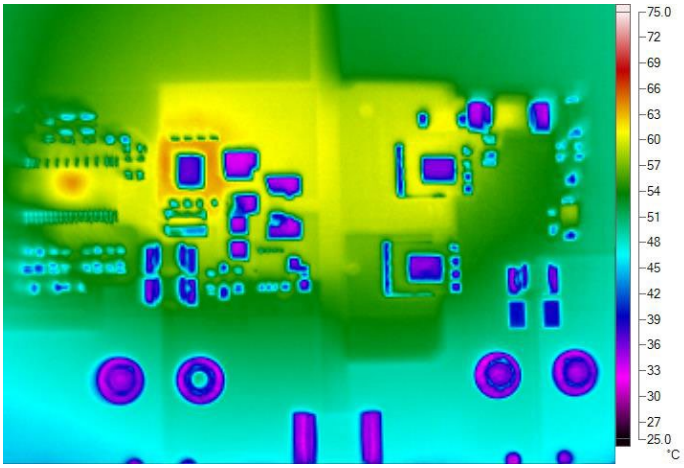


Figure 9. DC2324A-A Thermal Map, Back Side at $48V_{IN}$ and $5A_{OUT}$ (T_A = 25°C)

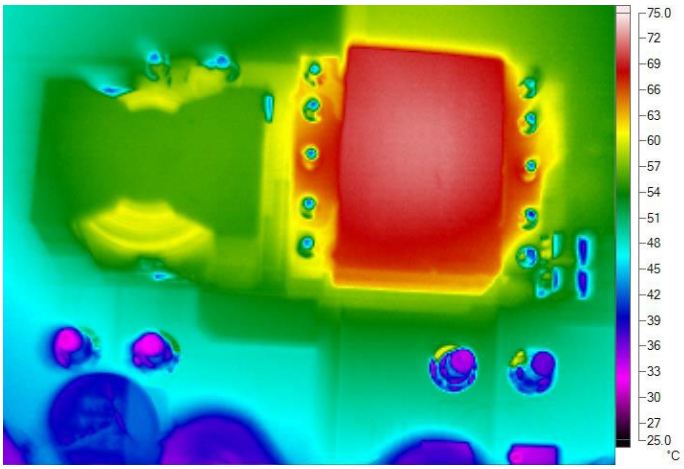


Figure 10. DC2324A-B Thermal Map, Front Side at $24V_{IN}$ and $5A_{OUT}$ (T_A = 25°C)

QUICK START PROCEDURE

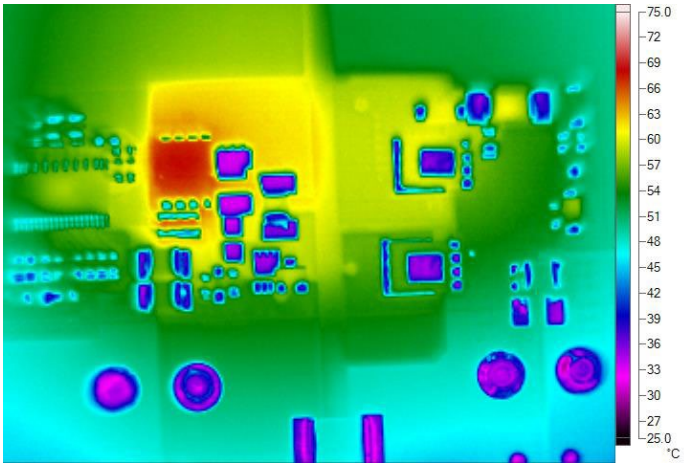


Figure 11. DC2324A-B Thermal Map, Back Side at $24V_{IN}$ and $5A_{OUT}$ (T_A = 25°C)

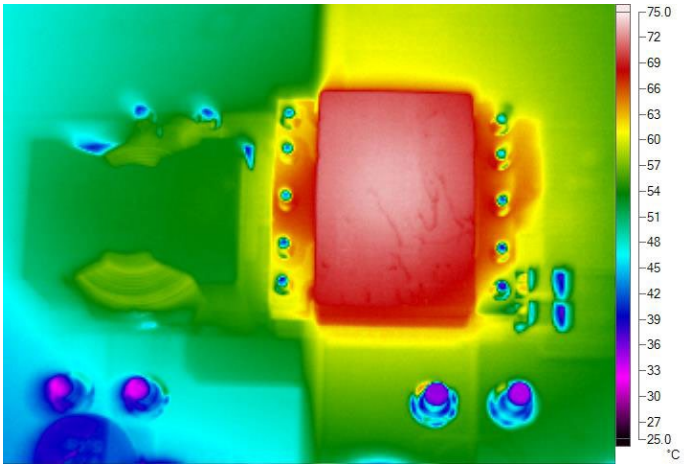


Figure 12. DC2324A-C Thermal Map, Front Side at $12V_{IN}$ and $4A_{OUT}$ (T_A = 25°C)

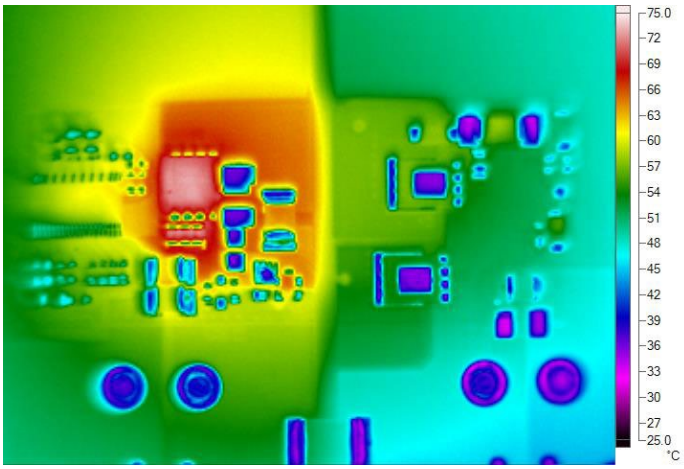


Figure 13. DC2324A-C Thermal Map, Back Side at $12V_{IN}$ and $4A_{OUT}$ (T_A = 25°C)

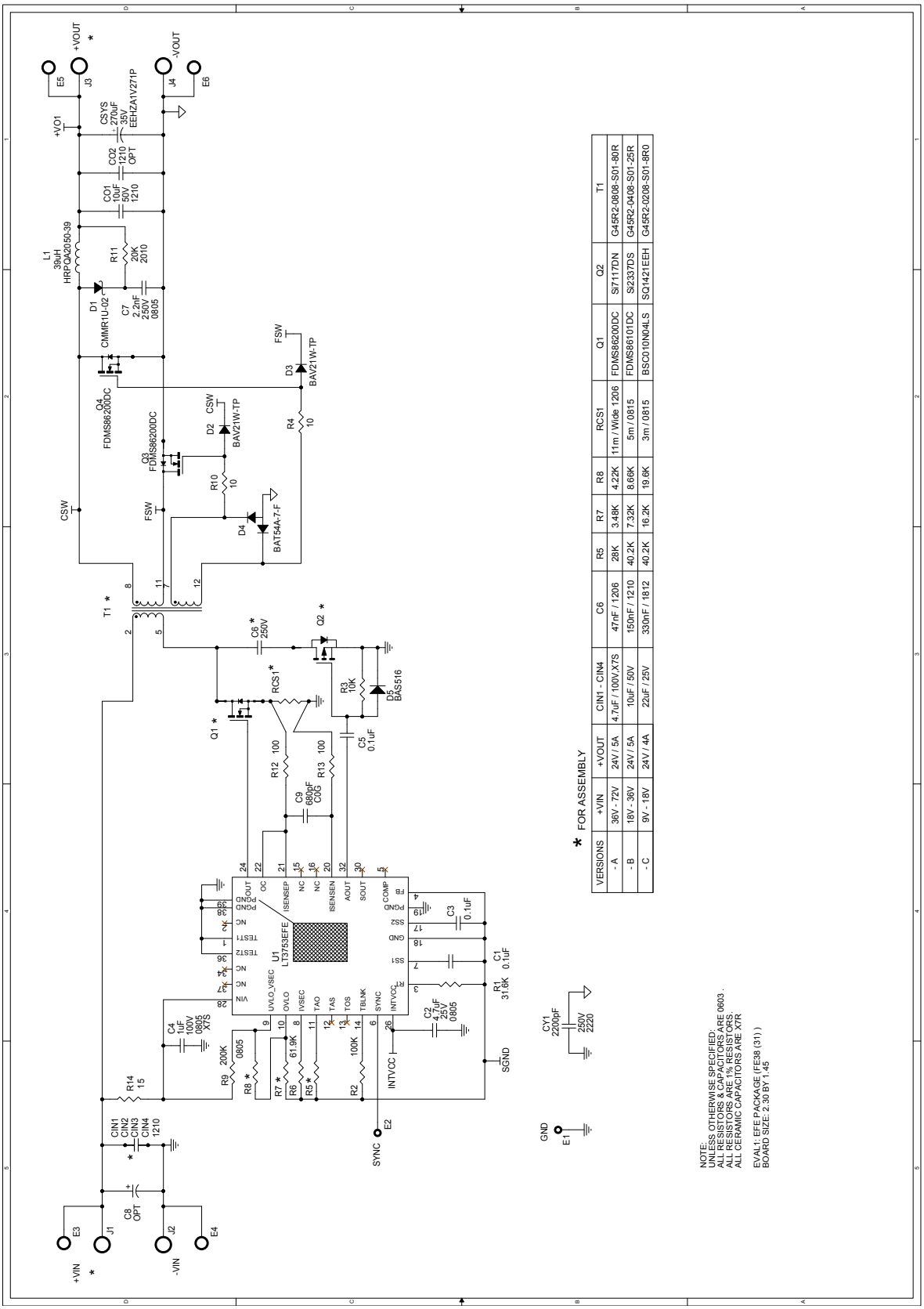
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components for DC2324A-A, DC2324A-B, and DC2324A-C				
1	1	CO1	CAP., X7R, 10µF, 50V, 10% 1210	MURATA, GRM32ER71H106KA12L
2	1	CSYS	CAP., ALUM., 270µF, 35V, G size	PANASONIC, EEHZA1V271P
3	1	CY1	CAP., X7R, 2200pF, 250V, 10% 2220	MURATA, GA355QR7GF222KW01L
4	3	C1, C3, C5	CAP., X7R, 0.1µF, 50V, 10% 0603	MURATA, GRM188R71H104KA93D
5	1	C2	CAP., X7R, 4.7µF, 25V, 10% 0805	MURATA, GRM21BR71E475KA73L
6	1	C4	CAP., X7S, 1µF, 100V, 10% 0805	MURATA, GRJ21BC72A105KE11L
7	1	C7	CAP., X7R, 2.2nF, 250V, 10% 0805	MURATA, GRM21AR72E222KW01D
8	1	C9	CAP., C0G, 680pF, 50V, 5% 0603	WURTH ELEKTRONIK, 885012006062
9	1	D1	DIODE, CMMR1U-02 SOD-123F	CENTRAL SEMI., CMMR1U-02
10	2	D2, D3	DIODE, BAV21W, SOD-123	MICRO COMMERCIAL CO., BAV21W-TP
11	1	D4	DIODE, BAT54A, SOT23	DIODES., BAT54A-7-F
12	1	D5	DIODE, HIGH-SPEED DIODE, SOD-523	NXP/PHILLIPS SEMI., BAS516
13	1	L1	INDUCTOR, 39µH,	CHAMPS, HRPQA2050-39
14	2	Q3, Q4	N-MOSFET, POWER 56	FAIRCHILD, FDMS86200DC
15	1	R1	RES., CHIP, 31.6k, 0.1W, 1% 0603	VISHAY, CRCW060331K6FKEA
16	1	R2	RES., CHIP, 100k, 0.1W, 1% 0603	VISHAY, CRCW0603100KFKEA
17	1	R6	RES., CHIP, 61.9k, 0.1W, 1% 0603	VISHAY, CRCW060361K9FKEA
18	1	R9	RES., CHIP, 200k, 0.125W, 1% 0805	VISHAY, CRCW0805200KFKEA
19	1	R14	RES., CHIP, 15Ω, 0.1W, 1% 0603	VISHAY, CRCW060315R0FKEA
20	1	R3	RES., CHIP, 10k, 0.1W, 1% 0603	VISHAY, CRCW060310K0FKEA
21	2	R4, R10	RES., CHIP, 10Ω, 0.1W, 1% 0603	VISHAY, CRCW060310R0FKEA
22	1	R11	RES., CHIP, 20k, 3/4W, 1% 2010	VISHAY, CRCW201020K0FKEF
23	2	R12, R13	RES., CHIP, 100Ω, 0.1W, 1% 0603	VISHAY, CRCW0603100RFKEA
24	1	U1	I.C., LT3753EFE#TRPBF, TSSOP-38(31)	LINEAR TECH., LT3753EFE#TRPBF
DC2324A-A Required Circuit Components				
25	4	CIN1–CIN4	CAP., X7S, 4.7µF, 100V, 10% 1210	MURATA, GRJ32DC72A475KE11L
26	1	C6	CAP., X7R, 47nF, 250V, 10% 1206	MURATA, GRM31CR72E473KW03L
27	1	Q1	N-MOSFET POWER-56	FAIRCHILD, FDMS86200DC
28	1	Q2	P-MOSFET POWER-33	VISHAY, Si7117DN-T1-E3
29	1	RCS1	RES., CHIP, 0.011Ω, 1W, 1%, WIDE 1206	SUSUMU, PRL1632-R011-F-T5
30	1	R5	RES., CHIP, 28k, 0.1W, 1% 0603	VISHAY, CRCW060328K0FKEA
31	1	R7	RES., CHIP, 3.48k, 0.1W, 1% 0603	VISHAY, CRCW06033K48FKEA
32	1	R8	RES., CHIP, 4.22k, 0.1W, 1% 0603	VISHAY, CRCW06034K22FKEA
33	1	T1	TRANSFORMER,	CHAMPS, G45R2-0808-S01-80R
DC2324A-B Required Circuit Components				
25	4	CIN1-CIN4	CAP., X7R, 10µF, 50V, 10% 1210	MURATA, GRM32ER71H106KA12L
26	1	C6	CAP., X7R, 150nF, 250V, 10% 1210	MURATA, GRM32QR72E154KW01L
27	1	Q1	N-MOSFET POWER-56	FAIRCHILD, FDMS86101DC
28	1	Q2	P-MOSFET SOT23	VISHAY, Si2337DS-T1-GE3
29	1	RCS1	RES., CHIP, 0.005Ω, 1W, 1%, 0815	SUSUMU, RL3720WT-R005-F
30	1	R5	RES., CHIP, 40.2k, 0.1W, 1% 0603	VISHAY, CRCW060340K2FKEA

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
31	1	R7	RES., CHIP, 7.32k, 0.1W, 1% 0603	VISHAY, CRCW06037K32FKEA
32	1	R8	RES., CHIP, 8.66k, 0.1W, 1% 0603	VISHAY, CRCW06038K66FKEA
33	1	T1	TRANSFORMER,	CHAMPS, G45R2-0408-S01-25R
DC2324A-C Required Circuit Components				
25	4	CIN1-CIN4	CAP., X7R, 22µF, 25V, 10% 1210	MURATA, GRM32ER71E226KE15L
26	1	C6	CAP., X7R, 330nF, 250V, 10% 1812	MURATA, GRM43DR72E334KW01L
27	1	Q1	N-MOSFET PG-TDSON	INFINEON, BSC010N04LSATMA1
28	1	Q2	P-MOSFET SC-70	VISHAY, SQ1421EEH-T1-GE3
29	1	RCS1	RES., CHIP, 0.003Ω, 1W, 1%, 0815	SUSUMU, RL3720WT-R003-F
30	1	R5	RES., CHIP, 40.2k, 0.1W, 1% 0603	VISHAY, CRCW060340K2FKEA
31	1	R7	RES., CHIP, 16.2k, 0.1W, 1% 0603	VISHAY, CRCW060316K2FKEA
32	1	R8	RES., CHIP, 19.6k, 0.1W, 1% 0603	VISHAY, CRCW060319K6FKEA
33	1	T1	TRANSFORMER,	CHAMPS, G45R2-0208-S01-8R0
Additional Demo Board Circuit Components for All Versions				
1	0	CO2(OPT)	CAP., 1210	
2	0	C8(OPT)	CAP., 100V, SIZE 12X10	
Hardware: For Demo Board Only (All Versions)				
1	2	E1, E2	TESTPOINT, TURRET, 0.061" PBF	MILL-MAX, 2308-2-00-80-00-00-07-0
2	4	E3, E4, E5, E6	TESTPOINT, TURRET, 0.094" PBF	MILL-MAX, 2501-2-00-80-00-00-07-0
3	4	J1-J4	BANANA JACK	KEYSTONE, 575-4
4	4	MH1-MH4	STAND-OFF, NYLON 9.5mm	WURTH ELEKTRONIK, 702933000

SCHEMATIC DIAGRAM



VERSIONS	+VIN	+VOUT	CIN1 - CIN4	C6	R5	R7	R8	RCS1	Q1	Q2	T1
- A	36V - 72V	24V / 5A	4.7uF / 100V,X7S	47nF / 1206	28K	3.48K	4.22K	11m / Wide 1206	FDMS86200DC	SI7117DN	G45R2-0808-S01-80R
- B	18V - 36V	24V / 5A	10uF / 50V	150nF / 1210	40.2K	7.32K	8.66K	5m / 0815	FDMS861101DC	SI2337DS	G45R2-0408-S01-25R
- C	9V - 18V	24V / 4A	22uF / 25V	330nF / 1812	40.2K	16.2K	19.6K	3m / 0815	BSC010N04LS	SQ1421EEH	G45R2-0208-S01-9R0

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