LT3752/LT8311
Active Clamp Forward Converter with Synchronous Rectification

DESCRIPTION

Demonstration circuit 2175A is an active clamp forward converter with synchronous rectification featuring the LT®3752/LT8311 chipset.

This circuit was designed to demonstrate the high levels of performance, efficiency and high power. It operates at 200kHz and produces a regulated 12V at 13A output from a wide input voltage range of 9V to 36V, making it well suited for automotive, industrial, and military applications. Synchronous rectification helps to attain an efficiency exceeding 93%.

The DC2175 circuit features soft-start which prevents output voltage overshoot on startup or when recovering from overload condition.

The DC2175 also has a precise overcurrent protection circuit that allows for continuous operation under short circuit conditions. The low power dissipation under a short circuit ensures high reliability even during prolonged short circuit conditions.

The LT3752 includes an internal constant frequency flyback controller for creating a housekeeping voltage supply. The housekeeping supply is able to efficiently provide bias for both primary and secondary ICs, and eliminates the need to generate bias supplies from auxiliary windings in the main forward transformer. The housekeeping supply also allows bias to any secondary side IC before the main forward converter starts switching.

Please refer to the LT3752 data sheet for design details and applications information.

Design files for this circuit board are available at http://www.linear.com/demo/DC2175A

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Input Supply Range		9		36	V
V_{OUT}	Output Voltage		11.76	12	12.24	V
I_{OUT}	Maximum Output Current		13			A
f_{SW}	Switching (Clock) Frequency			200		kHz
$V_{OUT(P-P)}$	Output Ripple	V_{IN} = 24V, I_{OUT} = 13A (20MHz BW)		100		mV_{P-P}
I_{REG}	Output Regulation	Line and Load ($9V_{IN}$ to $36V_{IN}$, $0A_{OUT}$ – $13A_{OUT}$)		±0.1		%
P_{OUT}/P_{IN}	Efficiency (see Figure 3)	V_{IN} = 24V, I_{OUT} = 13A		93		%

QUICK START PROCEDURE

Demonstration circuit 2175 is easy to set up to evaluate the performance of the LT3752/LT8311 chipset. Refer to Figure 1 for proper measurement equipment setup and follow the procedure below:

1. Set an input power supply that is capable of 9V to 36V to 9V. Then turn off the supply.
2. With power off, connect the supply to the input terminals +VIN and –VIN.
   a. Input voltages lower than 9V can keep the converter from turning on due to the undervoltage lockout feature of the LT3752/LT8311.
   b. If efficiency measurements are desired, an ammeter capable of measuring $20A_{DC}$ can be put in series with the input supply in order to measure the DC2175A's input current.
   c. A voltmeter with a capability of measuring at least 36V can be placed across the input terminals in order to get an accurate input voltage measurement.
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 12V. Turn off the power at the input.
5. Once the proper output voltages are established, connect a variable load capable of sinking 13A at 12V to the output terminals +VOUT and –VOUT. Set the current for 0A.
   a. If efficiency measurements are desired, an ammeter that is capable of handling $13A_{DC}$ can be put in series with the output load in order to measure the DC2175A'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 VIN and GND, or +VOUT and –VOUT terminals. See Figure 2 for proper scope probe technique.

QUICK START PROCEDURE

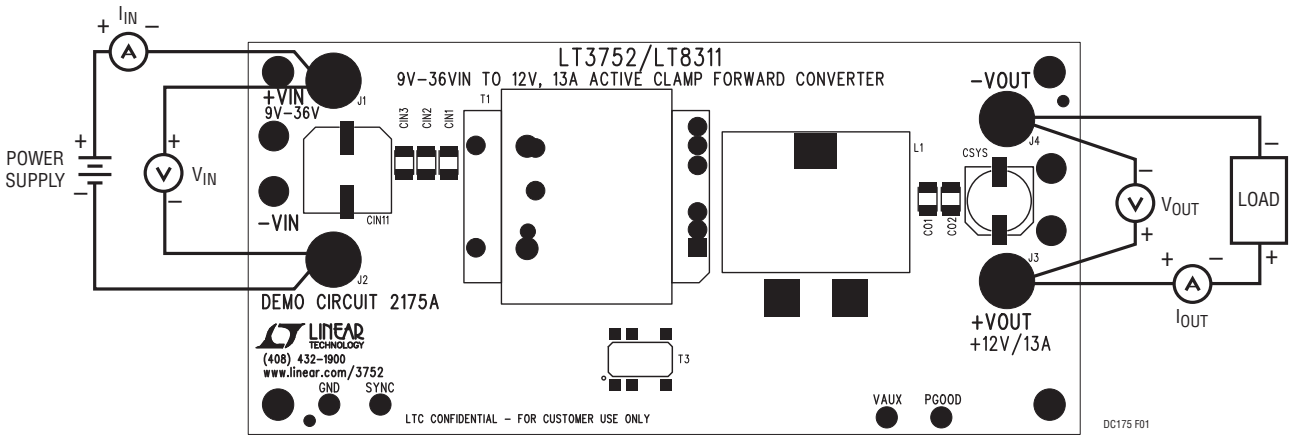


Figure 1. Proper Measurement Equipment Setup

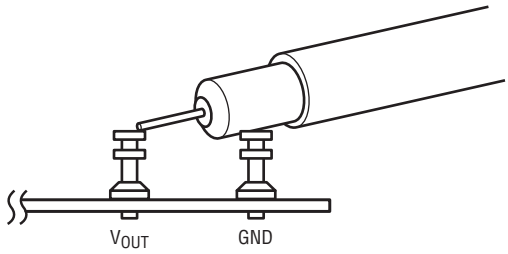


Figure 2. Proper Scope Placement for Measuring Input or Output Ripple

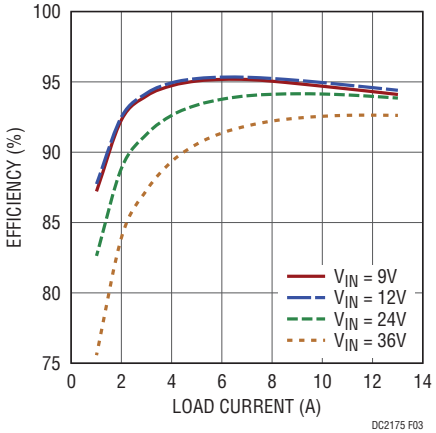


Figure 3. Efficiency

QUICK START PROCEDURE

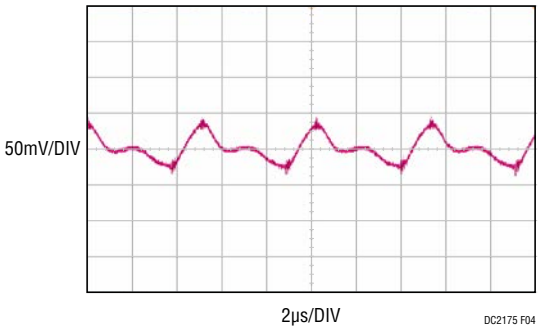


Figure 4. Output Ripple at $24V_{IN}$ and $13A_{OUT}$ (20MHz BW)

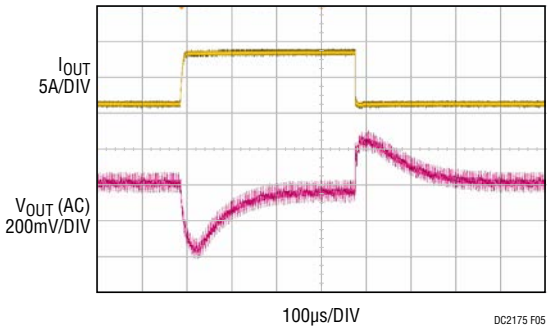


Figure 5. Transient Response Waveform at $24V_{IN}$ and $6.5A_{OUT}$ to $13A_{OUT}$

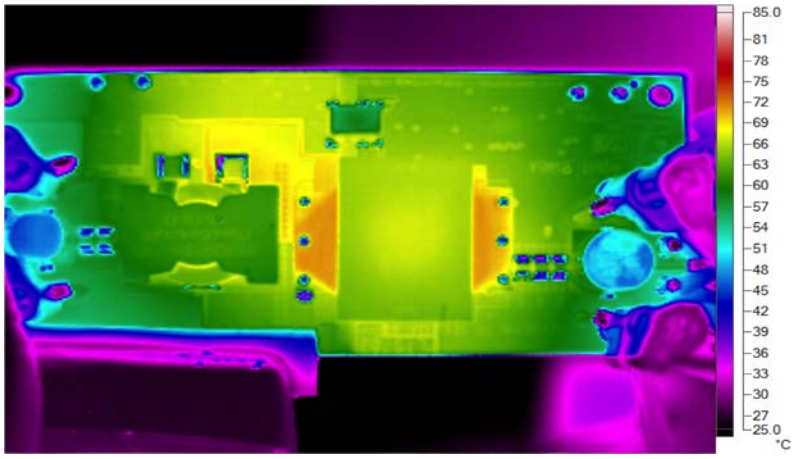


Figure 6. Thermal Map, Front Side at $24V_{IN}$ and $13A_{OUT}$ (T_A = 25°C)

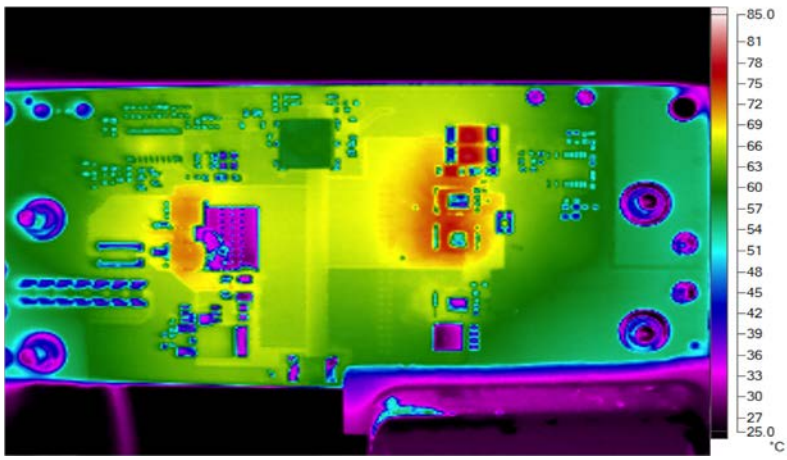


Figure 7. Thermal Map, Back Side at $24V_{IN}$ and $13A_{OUT}$ (T_A = 25°C)

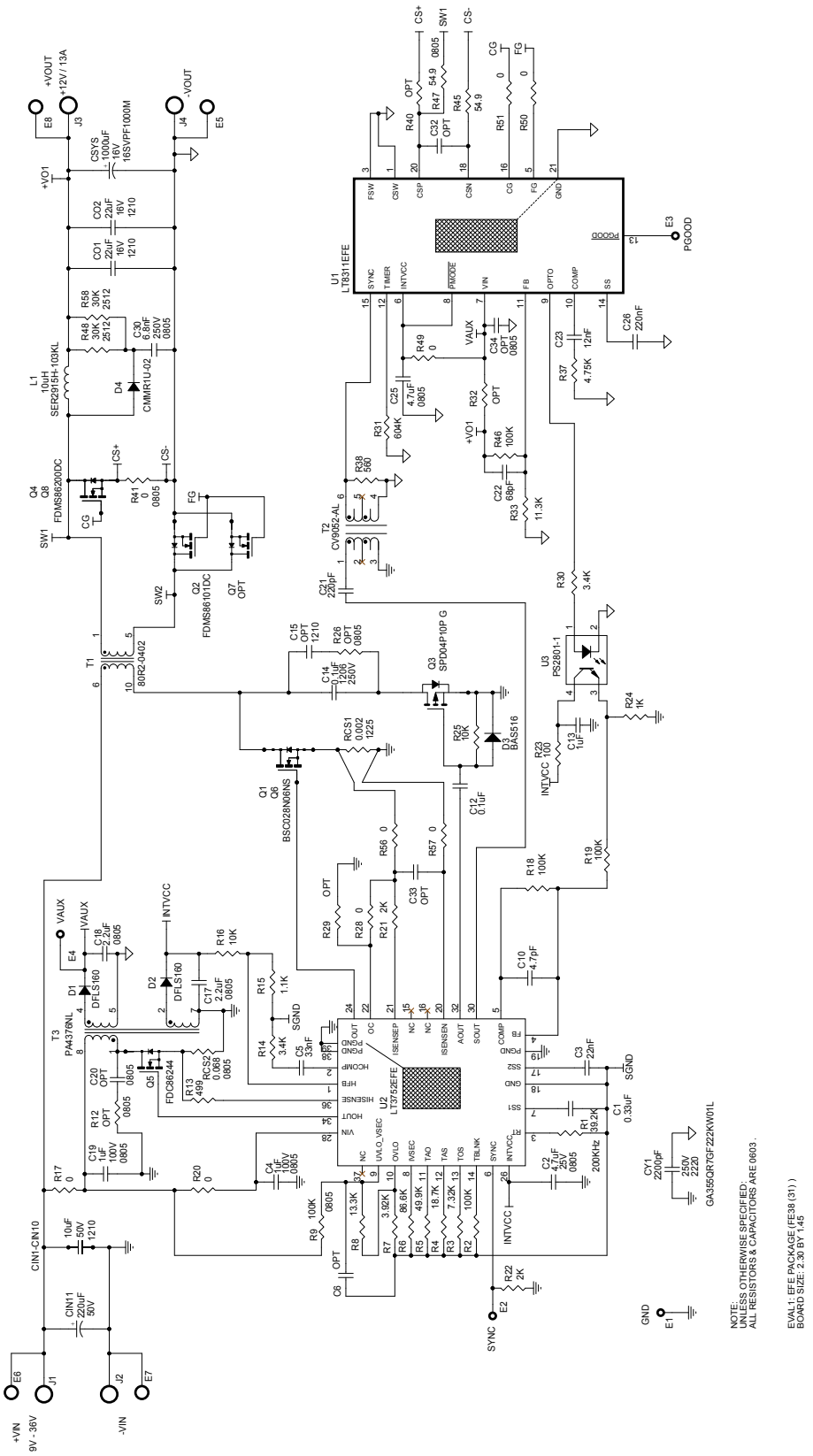
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	10	CIN1–CIN10	CAP., X7R, 10µF, 50V, 10% 1210	MURATA, GRM32ER71H106KA12L
2	1	CIN11	CAP., Alum., 220µF, 50V, 20%	NIPPON CHEM., EMVH500ARA221MKE0S
3	2	CO1, CO2	CAP., X7R, 22µF, 16V, 20% 1210	MURATA, GRM32ER71C226KE18L
4	1	CSYS	CAP., ALUM., 1000µF, 16V, SVPF series	PANASONIC, 16SVPF1000M
5	1	CY1	CAP., X7R, 2200pF, 250V, 10% 2220	MURATA, GA355QR7GF222KW01L
6	1	C1	CAP., X7R, 0.33µF, 10V, 5%, 0603	KEMET C0603C334J4RACTU
7	2	C2, C25	CAP., X5R, 4.7µF, 25V, 10% 0805	MURATA, GRM21BR61E475KA12L
8	1	C3	CAP., X7R, 22nF, 25V, 10% 0603	AVX, 06033C223KAT2A
9	2	C4, C19	CAP., X7S, 1µF, 100V, 10% 0805	TDK, C2012X7S2A105K
10	1	C5	CAP., X7R, 33nF, 25V, 10% 0603	MURATA, GRM188R71E333KA01D
11	1	C10	CAP., NP0, 4.7pF, 25V, ±0.25pF, 0603	AVX, 06033A4R7CAT4A
12	1	C12	CAP., X7R, 0.1µF, 25V, 10% 0603	AVX, 06033C104KAT2A
13	1	C13	CAP., X7R, 1µF, 16V, 10% 0603	AVX, 0603YC105KAT2A
14	1	C14	CAP., X7R, 0.1µF, 250V, 10% 1206	MURATA, GRM31CR72E104KW03L
15	2	C17, C18	CAP., X7R, 2.2µF, 25V, 20% 0805	AVX, 08053C225MAT2A
16	1	C21	CAP., NPO, 220pF, 25V, 10% 0603	AVX, 06033A221KAT2A
17	1	C22	CAP., NP0, 68pF, 25V, 10% 0603	AVX, 06033A680KAT2A
18	1	C23	CAP., X7R, 12nF, 25V, 10% 0603	MURATA, GRM188R71E123KA01D
19	1	C26	CAP., X7R, 220nF, 16V, 5% 0603	SAMSUNG, CL10B224JO8NNNC
20	1	C30	CAP., X7R, 6.8nF, 250V, 10% 0805(1206)	MURATA, GRM21AR72E682KW01D
21	2	D1, D2	DIODE, 1A, POWERDI-123	DIODES., DFLS160-7
22	1	D3	DIODE, High-Speed Diode, SOD-523	NXP/PHILLIPS SEMI., BAS516
23	1	D4	DIODE, CMMR1U-02 SOD-123	CENTRAL SEMI., CMMR1U-02 TR
24	1	L1	INDUCTOR, 10µH	COILCRAFT, SER2915H-103KL
25	2	Q1, Q6	MOSFET, N-CH, 60V, PG-TDSON-8	INFINEON, BSC028N06NS
26	1	Q2	MOSFET, N-CH, 100V, 60A POWER 56	FAIRCHILD, FDMS86101DC
27	1	Q3	MOSFET, P-CH, 100V, PG-TO252-3	INFINEON, SPD04P10P G
28	1	Q4, Q8	MOSFET, N-CH, 150V, POWER 56	FAIRCHILD, FDMS86200DC
29	1	Q5	MOSFET, N-CH, SUPERSOT-6	FAIRCHILD, FDC86244
30	1	RCS1	RES., CHIP, 0.002Ω, 3W, 2% KRL6432	SUSUMU, KRL6432E-M-R002-G-T1
31	1	RCS2	RES., CHIP, 0.068Ω, 0.125W, 1% 0805	VISHAY, WSL0805R068FEA
32	1	R1	RES., CHIP, 39.2k, 0.1W, 1% 0603	VISHAY, CRCW060339K2FKEA
33	1	R3	RES., CHIP, 7.32k, 0.1W, 1% 0603	VISHAY, CRCW06037K32FKEA
34	1	R4	RES., CHIP, 18.7k, 0.1W, 1% 0603	VISHAY, CRCW060318K7FKEA
35	1	R5	RES., CHIP, 49.9k, 0.1W, 1% 0603	VISHAY, CRCW060349K9FKEA
36	1	R6	RES., CHIP, 86.6k, 0.1W, 1% 0603	VISHAY, CRCW060386K6FKEA
37	1	R7	RES., CHIP, 3.92k, 0.1W, 1% 0603	VISHAY, CRCW06033K92FKEA
38	1	R8	RES., CHIP, 13.3k, 0.1W, 1% 0603	VISHAY, CRCW060313K3FKEA
39	1	R9	RES., CHIP, 100k, 0.125W, 1% 0805	VISHAY, CRCW0805100KFKEA
40	1	R13	RES., CHIP, 499Ω, 0.1W, 1% 0603	VISHAY, CRCW0603499RFKEA
41	1	R14	RES., CHIP, 3.4k, 0.1W, 1% 0603	VISHAY, CRCW06033K40FKEA

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
42	1	R15	RES., CHIP, 1.10k, 0.1W, 1% 0603	VISHAY, CRCW06031K10FKEA
43	2	R16, R25	RES., CHIP, 10k, 0.1W, 5% 0603	VISHAY, CRCW060310K0JNEA
44	8	R17, R20, R28, R49, R50, R51, R56, R57	RES., CHIP, 0Ω, 0.1W, 0603	VISHAY, CRCW06030000Z0EA
45	4	R2, R18, R19, R46	RES., CHIP, 100k, 0.1W, 1% 0603	VISHAY, CRCW0603100KFKEA
46	2	R21, R22	RES., CHIP, 2k, 0.1W, 1% 0603	VISHAY, CRCW06032K00FKEA
47	1	R23	RES., CHIP, 100Ω, 0.1W, 5% 0603	VISHAY, CRCW0603100RJNEA
48	1	R24	RES., CHIP, 1k, 0.1W, 1% 0603	VISHAY, CRCW06031K00FKEA
49	1	R30	RES., CHIP, 3.4k, 0.1W, 1% 0603	VISHAY, CRCW06033K40FKEA
50	1	R31	RES., CHIP, 604k, 0.1W, 1% 0603	VISHAY, CRCW0603604KFKEA
51	1	R33	RES., CHIP, 11.3k, 0.1W, 1% 0603	VISHAY, CRCW060311K3FKEA
52	1	R37	RES., CHIP, 4.75k, 0.1W, 1% 0603	VISHAY, CRCW06034K75FKEA
53	1	R38	RES., CHIP, 560Ω, 0.1W, 5% 0603	VISHAY, CRCW0603560RJNEA
54	1	R41	RES., CHIP, 0Ω, 0.125W, 1% 0805(0815)	VISHAY, CRCW08050000Z0EA
55	1	R45	RES., CHIP, 54.9Ω, 0.1W, 1% 0603	VISHAY, CRCW060354R9FKEA
56	1	R47	RES., CHIP, 54.9Ω, 0.125W, 1% 0805	VISHAY, CRCW080554R9FKEA
57	2	R48, R58	RES., CHIP, 30k, 1W, 1% 2512	VISHAY, CRCW251230K0FKEG
58	1	T1	TRANSFORMER, 80R2-0402	CHAMPS., 80R2-0402
59	1	T2	TRANSFORMER, CV9052-AL	COILCRAFT, CV9052-AL
60	1	T3	TRANSFORMER, PA4376NL	PULSE, PA4376NL
		T3 (ALTERNATED)	TRANSFORMER, 750315379	WURTH ELEKTRONIK, 750315379
61	1	U1	I.C., LT8311EFE#PBF TSSOP-20(16)	LINEAR TECH., LT8311MPFE#PBF
62	1	U2	I.C., FORWARD CONVERTER TSSOP-38(31)	LINEAR TECH, . LT3752IFE#PBF
63	1	U3	I.C., PS2801C-1-P-A	NEC, PS2801C-1-P-A
Additional Demo Board Circuit Components				
1	0	C6, C32, C33	CAP., 0603	
2	0	C15	CAP., 1210	
3	0	C20, C34	CAP., 0805	
4	0	Q7	MOSFET, POWER 56	
5	0	R12, R26	RES., 0805	
6	0	R29, R32, R40	RES., CHIP, 0603	
Hardware: For Demo Board Only				
1	4	E1-E4	TESTPOINT, TURRET, .061"	MILL-MAX, 2308-2-00-80-00-00-07-0
2	4	E5-E8	TESTPOINT, TURRET, .094"	MILL-MAX, 2501-2-00-80-00-00-07-0
3	4	J1, J2, J3, J4	JACK BANANA	KEYSTONE, 575-4
4	4	MH1–MH4	STAND-OFF, NYLON 9.5mm	WURTH ELEKTRONIK, 702933000
5	1		PCB, DC2175A	DEMO CIRCUIT 2175A
6	2		STENCIL	STENCIL DC2175A(Top & Bottom)

SCHEMATIC DIAGRAM



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