CS5323DEMO/D

Demonstration Note for CS5323

12 V to 1.45 V, 65 A Three–Phase Synchronous Buck Converter Demonstration Board for Pentium® 4 Processors

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DEMONSTRATION NOTE

Features

- Three–Phase Architecture
- Lossless Active Current Sharing
- Lossless Adaptive Positioning
- 5–Bit DAC with 1% Tolerance
- 230 kHz Constant Frequency Design
- Hiccup Mode Current Limit
- Individual Current Limits for Each Phase
- Adaptable to Intel® Voltage Transient Test (VTT) Tool

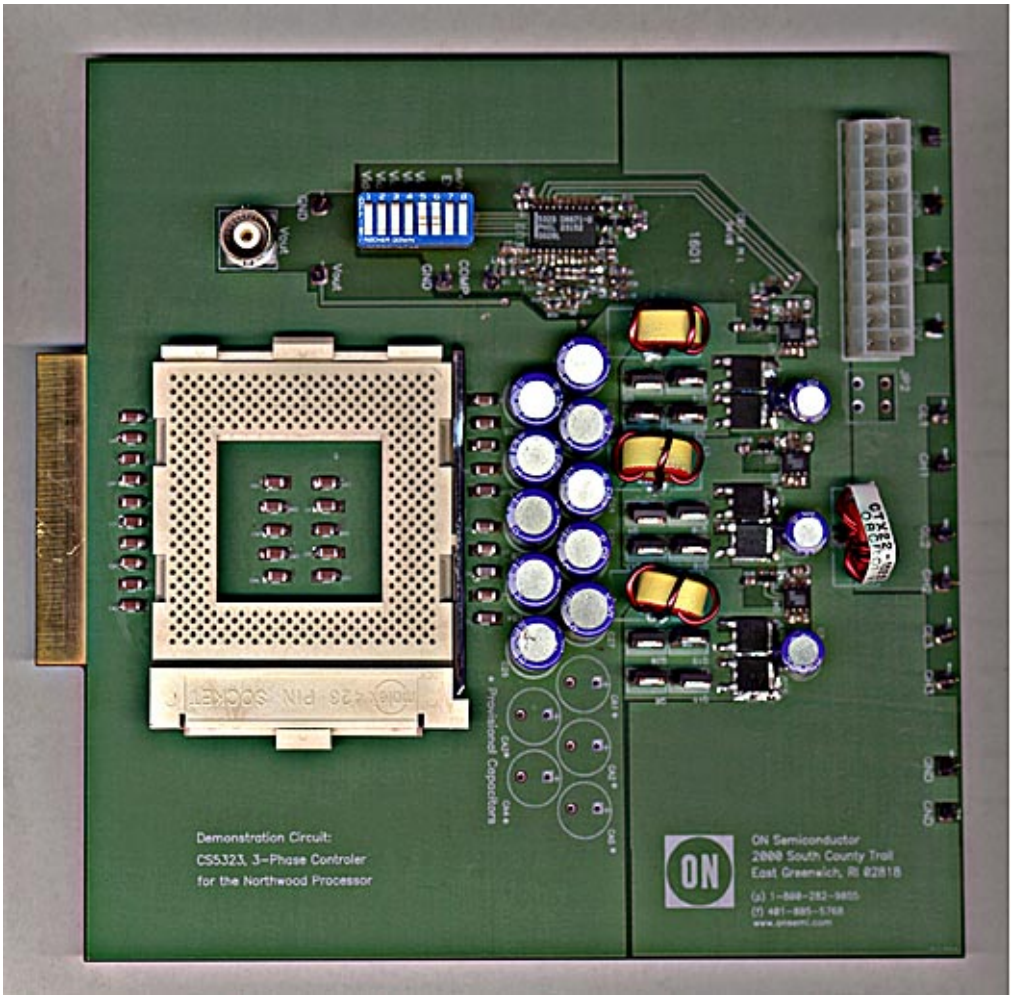

Figure 1. CS5323 Demonstration Board

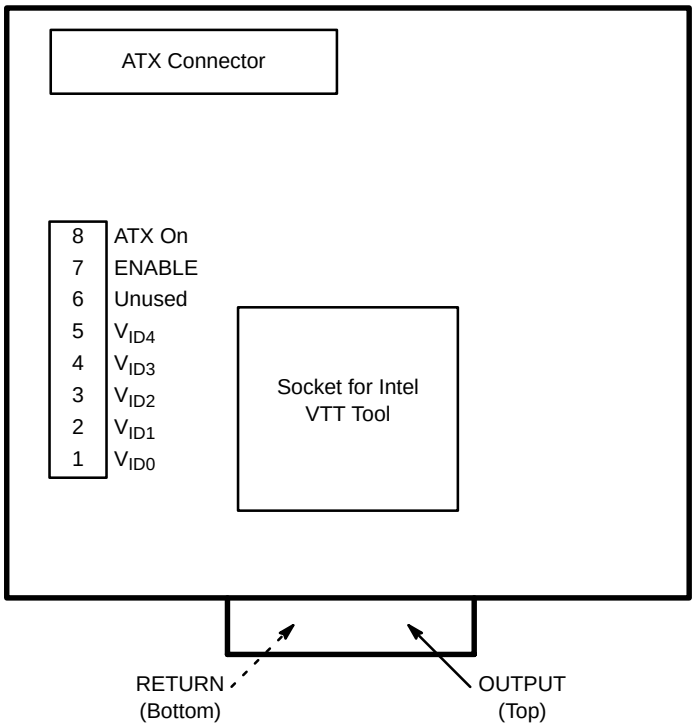

Figure 2. Layout

MAXIMUM RATINGS (T_A = 25°C)

Input/Output Name	Minimum	Maximum	Unit
5.0 V Input	–0.3	7.0	V
12 V Input	–0.3	14	V
Output Current	–	Internally Limited	A

ELECTRICAL CHARACTERISTICS (T_A = 25°C, Still Air, 4.75 V < 5.0 V_{IN} < 5.25 V, 9.0 V < 12 V_{IN} < 13.2 V)

Parameter	Test Conditions	Min	Typ	Max	Unit
Output Voltage	0 A Load, DAC = 10000	–	1.45	–	V
Output Voltage	65 A Load, DAC = 10000	–	1.37	–	V
V_{OUT} Peak Transient Response	Step between 0 A and 65 A @ 400 A/μs	–	95	–	mV_{PK}
Output Ripple and Noise	65 A Load	–	12	–	mV_{P-P}
Current Sharing Between Phases	Difference between the Phases with Highest and Lowest Current	–	0.54	–	A
Conversion Efficiency from 12 V Supply	1.45 V, 50 A Out	–	85.6	–	%
5.0 V Supply Current	–	–	116	–	mA
Switching Frequency	–	–	212	–	kHz
Enable/Soft Start Time	–	–	2.0	–	ms
Overcurrent Threshold	–	–	75	–	A
5.0 V UVLO Start	–	4.05	4.6	4.7	V

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C, Still Air, 4.75 V < 5.0 V_{IN} < 5.25 V, 9.0 V < 12 V_{IN} < 13.2 V)

Parameter					Test Conditions	Min	Typ	Max	Unit
5.0 V UVLO Stop					–	3.75	4.4	4.65	V
5.0 V UVLO Hysteresis					–	100	200	300	mV
VID Codes (VID Code Sets Max Output Voltage; 0 = Connected to V_{SS}, 1 = Open or Pull–Up to 3.3 V)									
Accuracy (All Codes)					Measure V_{FB} = COMP	–	–	±1.0	%
V_{ID4}	V_{ID3}	V_{ID2}	V_{ID1}	V_{ID0}					
1	1	1	1	1	Note 1.	1.064	1.075	1.086	V
1	1	1	1	0	Note 1.	1.089	1.100	1.111	V
1	1	1	0	1	Note 1.	1.114	1.125	1.136	V
1	1	1	0	0	Note 1.	1.139	1.150	1.162	V
1	1	0	1	1	Note 1.	1.163	1.175	1.187	V
1	1	0	1	0	Note 1.	1.188	1.200	1.212	V
1	1	0	0	1	Note 1.	1.213	1.225	1.237	V
1	1	0	0	0	Note 1.	1.238	1.250	1.263	V
1	0	1	1	1	Note 1.	1.262	1.275	1.288	V
1	0	1	1	0	Note 1.	1.287	1.300	1.313	V
1	0	1	0	1	Note 1.	1.312	1.325	1.338	V
1	0	1	0	0	Note 1.	1.337	1.350	1.364	V
1	0	0	1	1	Note 1.	1.361	1.375	1.389	V
1	0	0	1	0	Note 1.	1.386	1.400	1.414	V
1	0	0	0	1	Note 1.	1.411	1.425	1.439	V
1	0	0	0	0	–	1.436	1.450	1.465	V
0	1	1	1	1	–	1.460	1.475	1.490	V
0	1	1	1	0	–	1.485	1.500	1.515	V
0	1	1	0	1	–	1.510	1.525	1.540	V
0	1	1	0	0	–	1.535	1.550	1.566	V
0	1	0	1	1	–	1.559	1.575	1.591	V
0	1	0	1	0	–	1.584	1.600	1.616	V
0	1	0	0	1	–	1.609	1.625	1.641	V
0	1	0	0	0	–	1.634	1.650	1.667	V
0	0	1	1	1	–	1.658	1.675	1.692	V
0	0	1	1	0	–	1.683	1.700	1.717	V
0	0	1	0	1	–	1.708	1.725	1.742	V
0	0	1	0	0	–	1.733	1.750	1.768	V
0	0	0	1	1	–	1.757	1.775	1.793	V
0	0	0	1	0	–	1.782	1.800	1.818	V
0	0	0	0	1	–	1.807	1.825	1.843	V
0	0	0	0	0	–	1.832	1.850	1.869	V
Input Threshold					V_{ID4}, V_{ID3}, V_{ID2}, V_{ID1}, V_{ID0}	1.0	1.25	1.5	V
Input Pull–Up Resistance					V_{ID4}, V_{ID3}, V_{ID2}, V_{ID1}, V_{ID0}	25	50	100	kΩ
Pull–Up Voltage					–	3.15	3.3	3.45	V

1. Operation may require a lower (than 12 V) input voltage or a lower switching frequency.

CONTROL SWITCH DESCRIPTION

Symbol	Description
Output	Low impedance connection for output voltage.
Return	Low impedance return for output voltage.
SW1 Position 1–5	VID switches 1–5. Place switch in the open position for “1.” If VTT tool is used to set the output voltage, place switches 1–5 in open position.
SW1 Position 7	ENABLE converter function. This pin grounds the CS5301 COMP pin. Place this switch in the open position to enable the converter.
SW1 Position 8	ON/Off function. Place this switch in the closed position to enable the ATX power supply.

TEST SIGNAL DESCRIPTION

Symbol	Description
GND	Ground of power supply test point.
5 V	5.0 V supply connection test point.
12 V	12 V supply connection test point.
Gate(L)1–3	Gate drive signals for bottom MOSFETs of phases 1–3.
Gate(H)1–3	Gate drive signals for top MOSFETs of phases 1–3.
COMP	Output of the error amplifier.
V_{OUT}(BNC)	Output voltage of power supply.

OPERATING INSTRUCTIONS

Input Power

ATX Power Supply or separate +5.0 and +12 V supplies. The 12 V supply must be capable of supplying 10 A to power full load.

Output Load

The converter will run with any load between 0 A and 65 A. The gold plated area on component side provides a low impedance connection for the converter output. The gold plated area on the solder side is a low impedance return connection.

Voltage Transient Test Tool

The PGA–423 socket is intended to accept Intel Voltage Transient Test Tool.

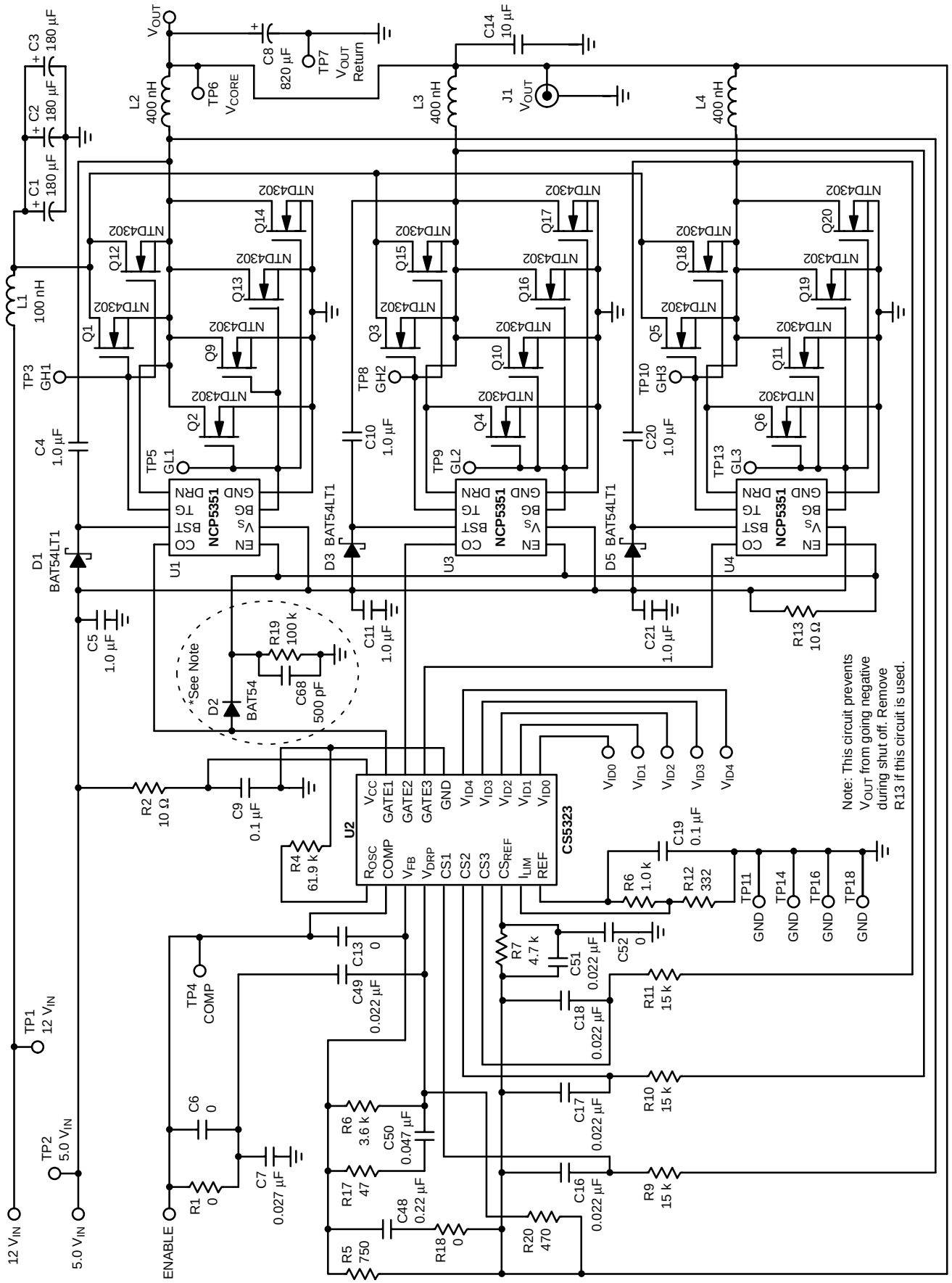

Figure 3. Circuit Schematic

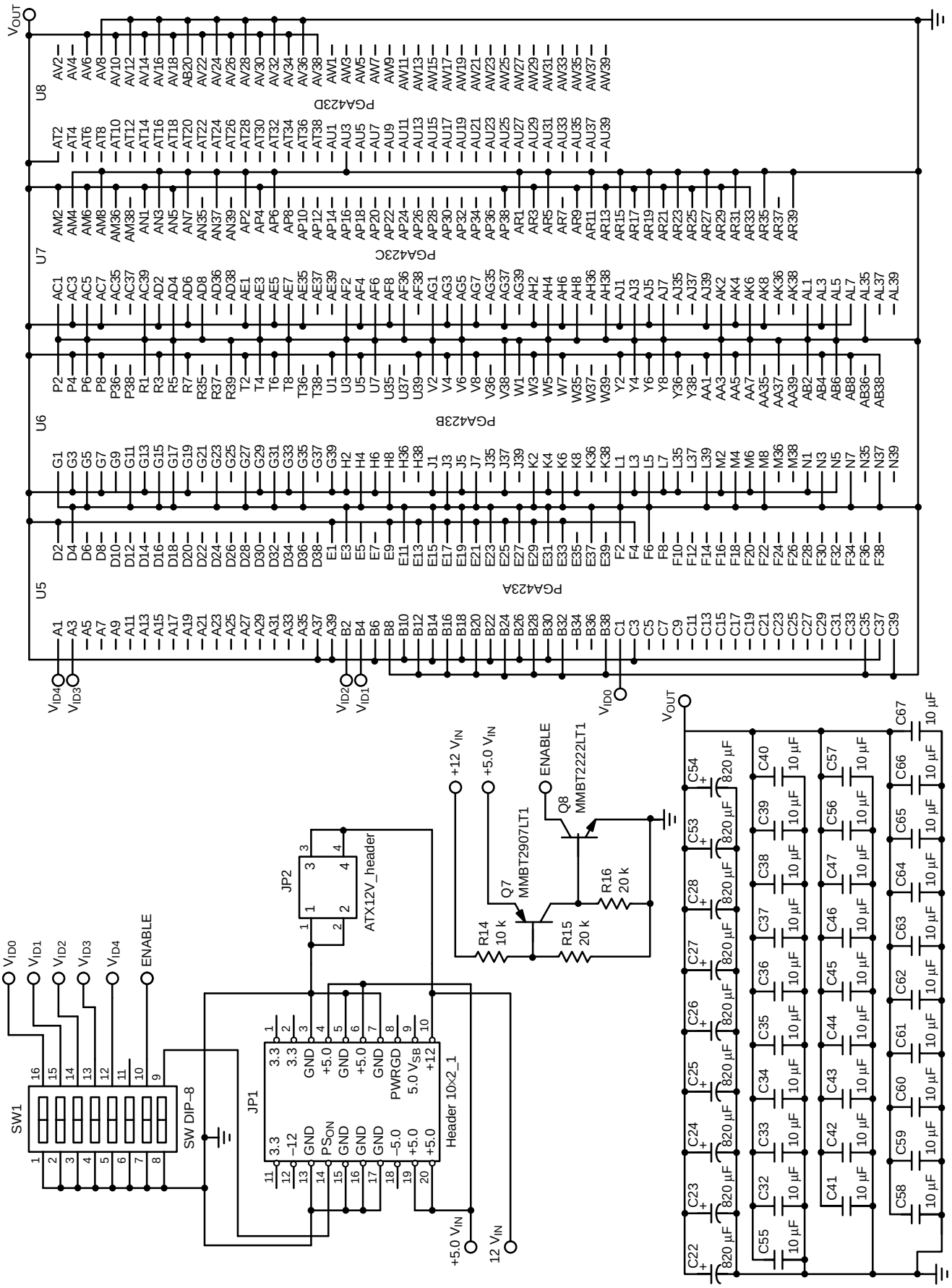

Figure 4. Circuit Schematic (continued)

TYPICAL PERFORMANCE CHARACTERISTICS

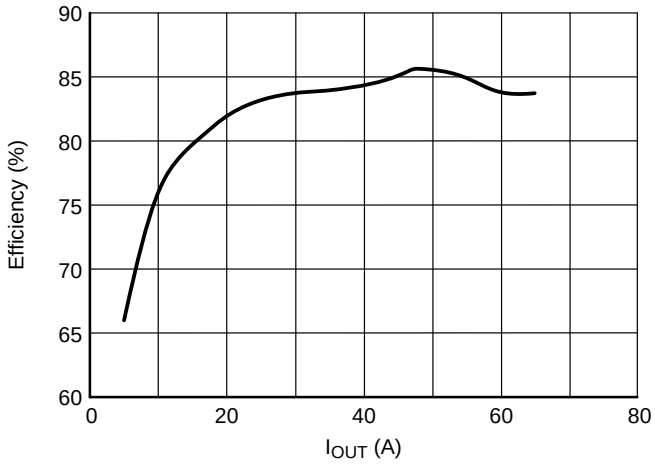

Figure 5. Efficiency vs. Output Current

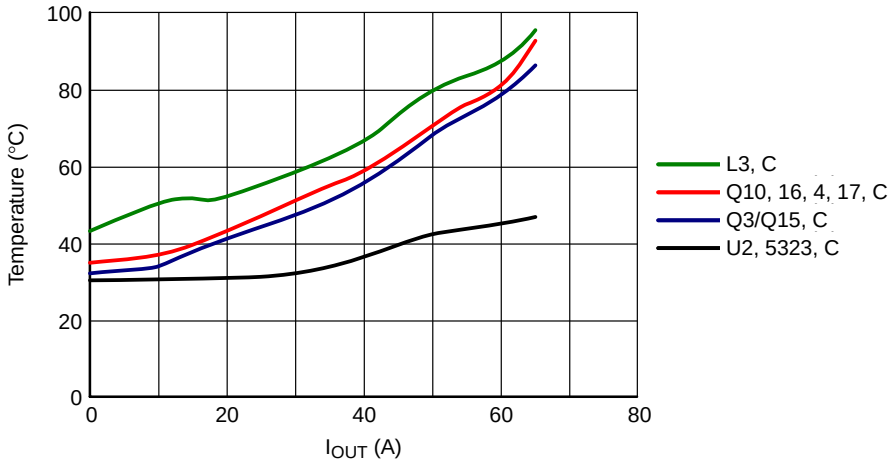

Figure 6. Temperature vs. Output Current

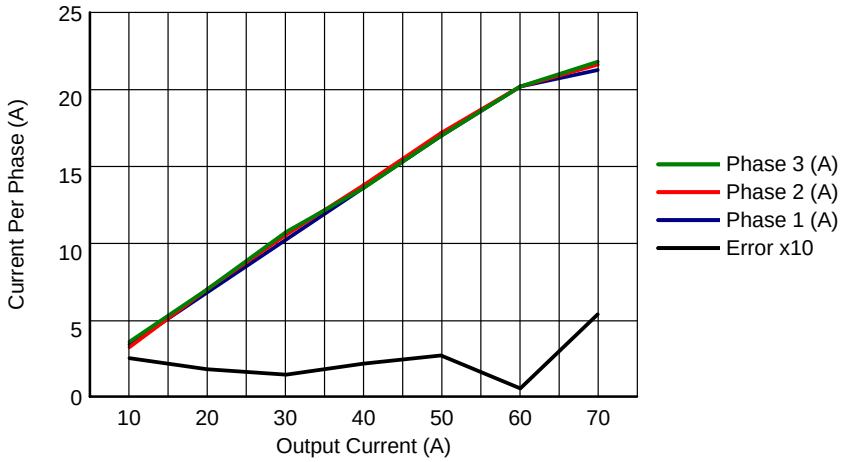

Figure 7. Phase Current Sharing

TYPICAL WAVEFORMS

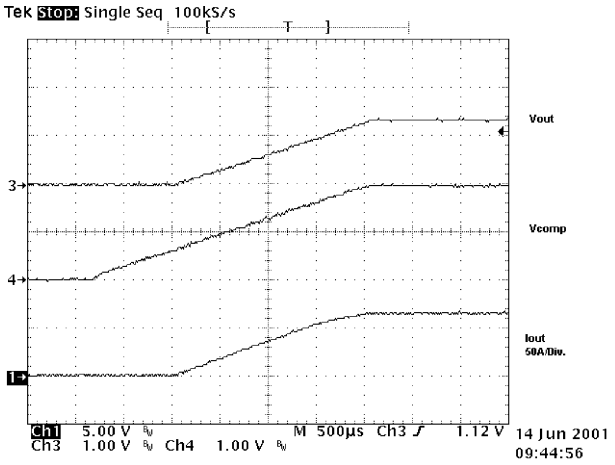

Figure 8. Start–Up with Full Load

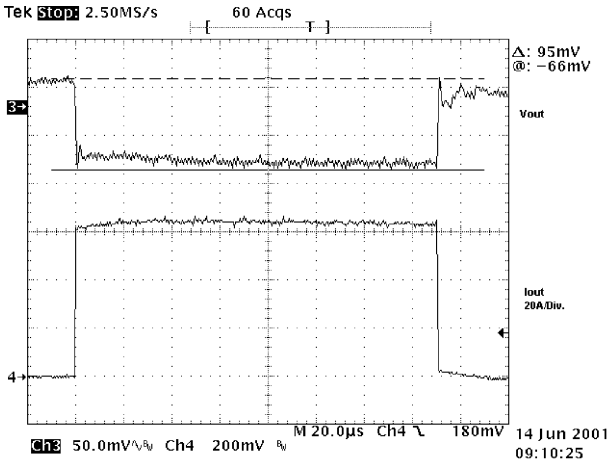

Figure 9. Transient with Pulse Load, between 0 A and 65 A

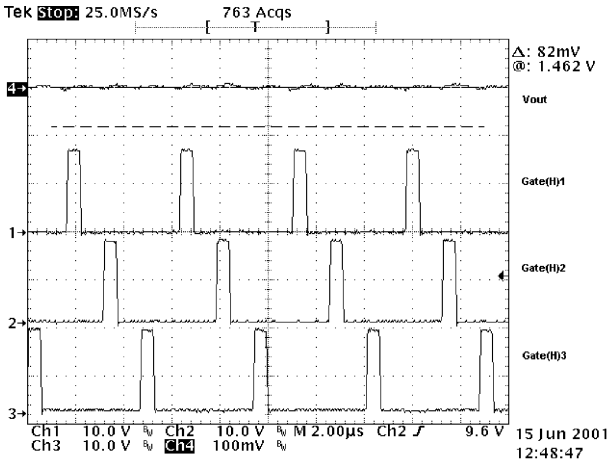

Figure 10. Steady State at No Load

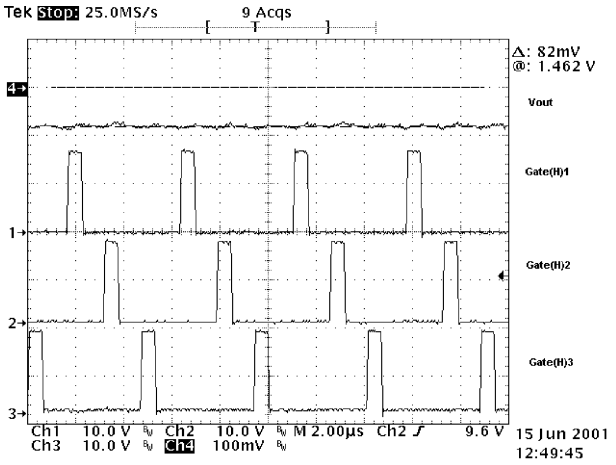

Figure 11. Steady State at Full Load, Io = 65 A

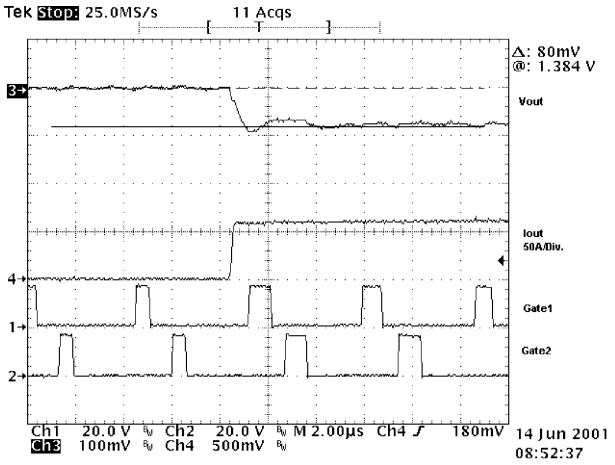

Figure 12. Trasneitn with Step Load, 0 A to 65 A, Slew Rate, 400 A/µs. Adaptive Positioning Set for 81 mV

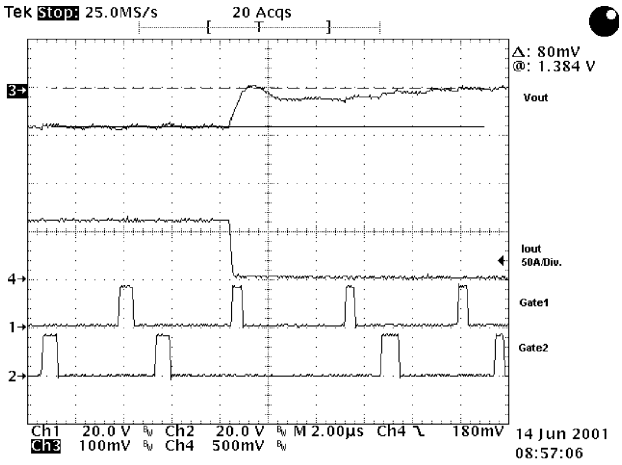

Figure 13. Transient with Step Load, 65 A to 0 A, Slew Rate, 400 A/µs. Adaptive Positioning Set for 81 mV

BILL OF MATERIALS

Item	Qty	Reference	Part	Mfg. & P/N	Distributor
Converter					
1	3	C1, C2, C3	capacitor, 16 V, 180 μF	Sanyo 16SP180M	Sanyo 630–775–0044
2	6	C4, C5, C10, C11, C20, C21	cer, 1.0 μF, 25 V, 0805	Panasonic ECJ–3YB1E105k	Digi–Key 800–344–4539
3	2	C9, C19	cer, 1.0 μF, 50 V, 0805	Panasonic ECU–V1H1	Digi–Key 800–344–4539
4	10	C8, C22,, C23, C24, C25, C26, C27, C28, C53, C54	capacitor, 4.0 V, 820 μF	Sanyo 4SP820M	Sanyo 630–775–0044
5	5	C16, C17, C18, C49, C51	cer, 0.022 μF, 50 V, 0805	Panasonic ECJ–2NB1H223k	Digi–Key 800–344–4539
6	1	C50	cer, 0.047 μF, 50 V, 0805	Panasonic ECU–V1H273KBX	Digi–Key 800–344–4539
7	1	C48	cer, 0.22 μF, 50 V, 0805	Panasonic ECJ–2YB1E224K	Digi–Key 800–344–4539
8	1	C7	cer, 0.027 μF, 50 V, 0805	Panasonic ECJ–2YB1H274k	Digi–Key 800–344–4539
9	30	C14, C33–C47, C55–C67	cer, 10 μF, 6.3 V, 1206	TDK C3216JB0106M	TDK 603–886–6600
10	3	D1, D3, D5	Schottky	ON Semiconductor BAT54LT1	Arrow
11	1	L1	Inductor, 100nH, 0.6 mΩ	Coiltronics CTX22–15224	Cooper Electronics 561–752–5036
12	3	L2, L3, L4	Inductor, 400nH, 0.7 mΩ	Coiltronics CTX22–15508	Cooper Electronics 561–752–5036
13	12	Q2, Q4, Q6, Q9, Q10, Q11, Q13, Q14, Q16, Q17, Q19, Q20	MOSFETs	ON Semiconductor NTD4302	Arrow
14	6	Q1, Q3, Q5, Q12, Q15, Q18	MOSFETs	ON Semiconductor NTD4302	Arrow
15	1	Q7	PNP	MMBT2907LT1	Newark 800–463–9275
16	1	Q8	NPN	MMBT2222LT1	Newark 800–463–9275
17	3	R9, R10, R11	res., 15 k, 1%, 0805	Panasonic ERJ–6ENF1502	Digi–Key 800–344–4539
18	1	R2	res., 10, 5%, 0805	Panasonic ERJ–6GEYJ100	Digi–Key 800–344–4539
19	1	R12	res., 332, 1%, 0805	Panasonic ERJ–6ENF3320	Digi–Key 800–344–4539
20	1	R7	res., 4.7 k, 5%, 0805	Panasonic ERJ–6GEYJ472	Digi–Key 800–344–4539
21	2	R13, R14	res., 10 k, 5%, 0805	Panasonic ERJ–6GEYJ103	Digi–Key 800–344–4539
22	1	R8	res., 1.0 k, 5%, 0805	Panasonic ERJ–6GEYJ102	Digi–Key 800–344–4539
23	1	R20	res., 470, 5%, 0805	Panasonic ERJ–6GEYJ471	Digi–Key 800–344–4539
24	1	R4	res., 62 k, 5%, 0805	Panasonic ERJ–6GEYJ623	Digi–Key 800–344–4539
25	1	R5	res., 750, 1%, 0805	Panasonic ERJ–6ENF7500	Digi–Key 800–344–4539
26	1	R17	res., 47, 5%, 0805	Panasonic ERJ–6GEYJ470	Digi–Key 800–344–4539
27	1	R6	res., 3.6 k, 1%, 0805	Panasonic ERJ–6ENF3601	Digi–Key 800–344–4539
28	2	R15, R16	res., 20 k, 5%, 0805	Panasonic ERJ–6GEYJ203	Digi–Key 800–344–4539
29	3	U1, U3, U4	Driver	SC1205	Arrow
30	1	U2	Multi–Phase Controller	CS5323DR20	Arrow

BILL OF MATERIALS (continued)

Item	Qty	Reference	Part	Mfg. & P/N	Distributor
Miscellaneous					
	6	–	Standoff	3M SJ5003–0–ND	Digi–Key
	1	S1	DIP–8 DAC Switch	Grayhill 76PSB08S	Digi–Key
	24	TP1–24	36 Pos. Header	Sullins PZC36SAAN	Digi–Key
	1	JP1	ATX Connector	Molex 039281203	Newark
	1	JP2	ATX 12 V Connector	Molex 039293046	Newark

PCB LAYOUT

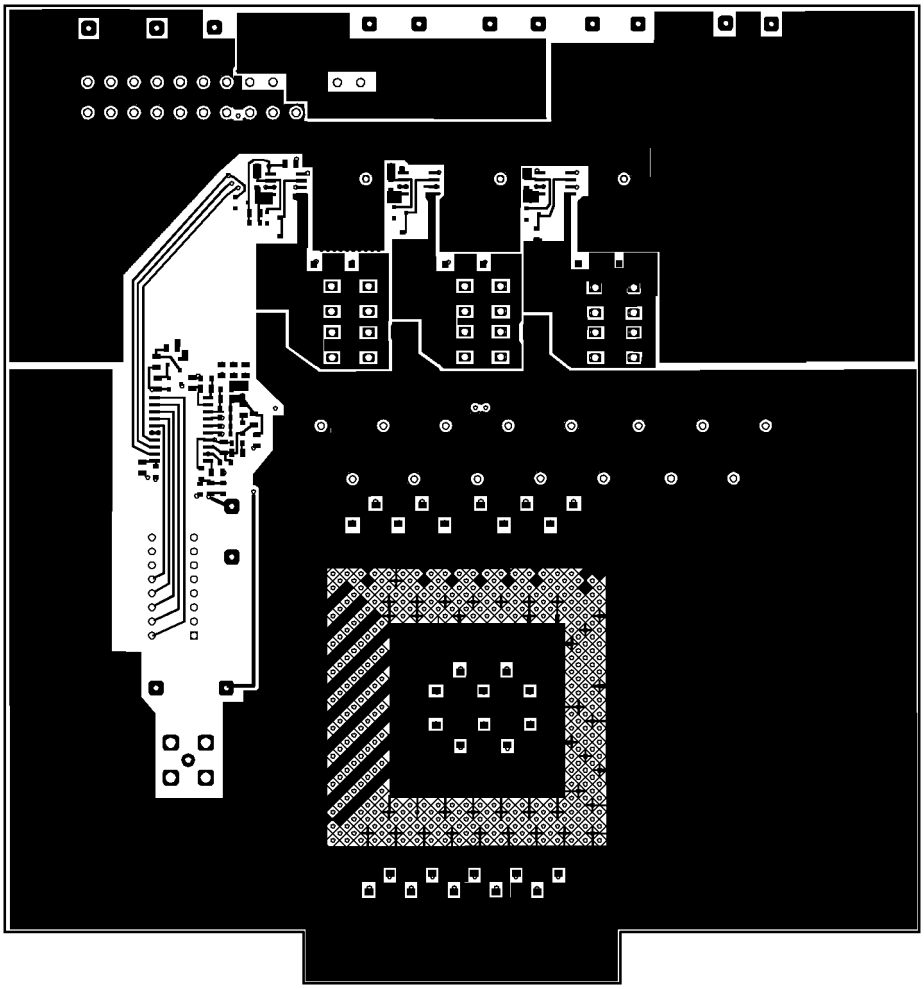

Figure 14. Top Layer

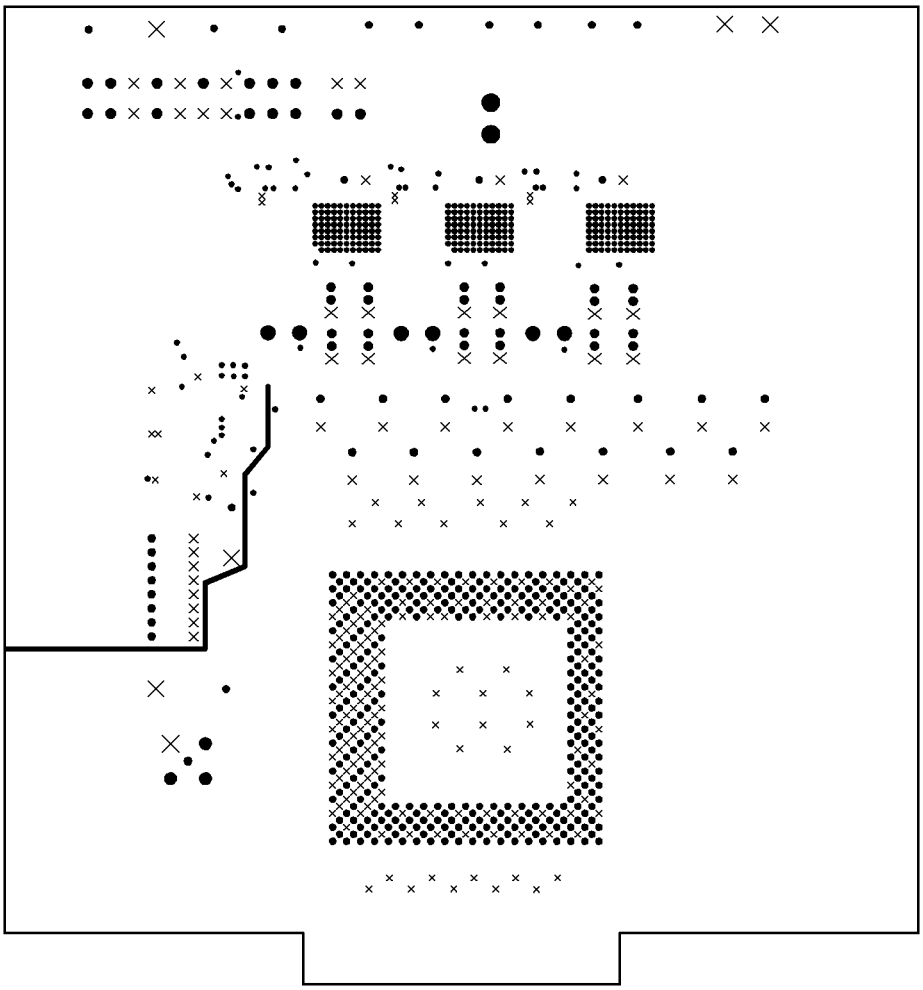

Figure 15. Ground Layer

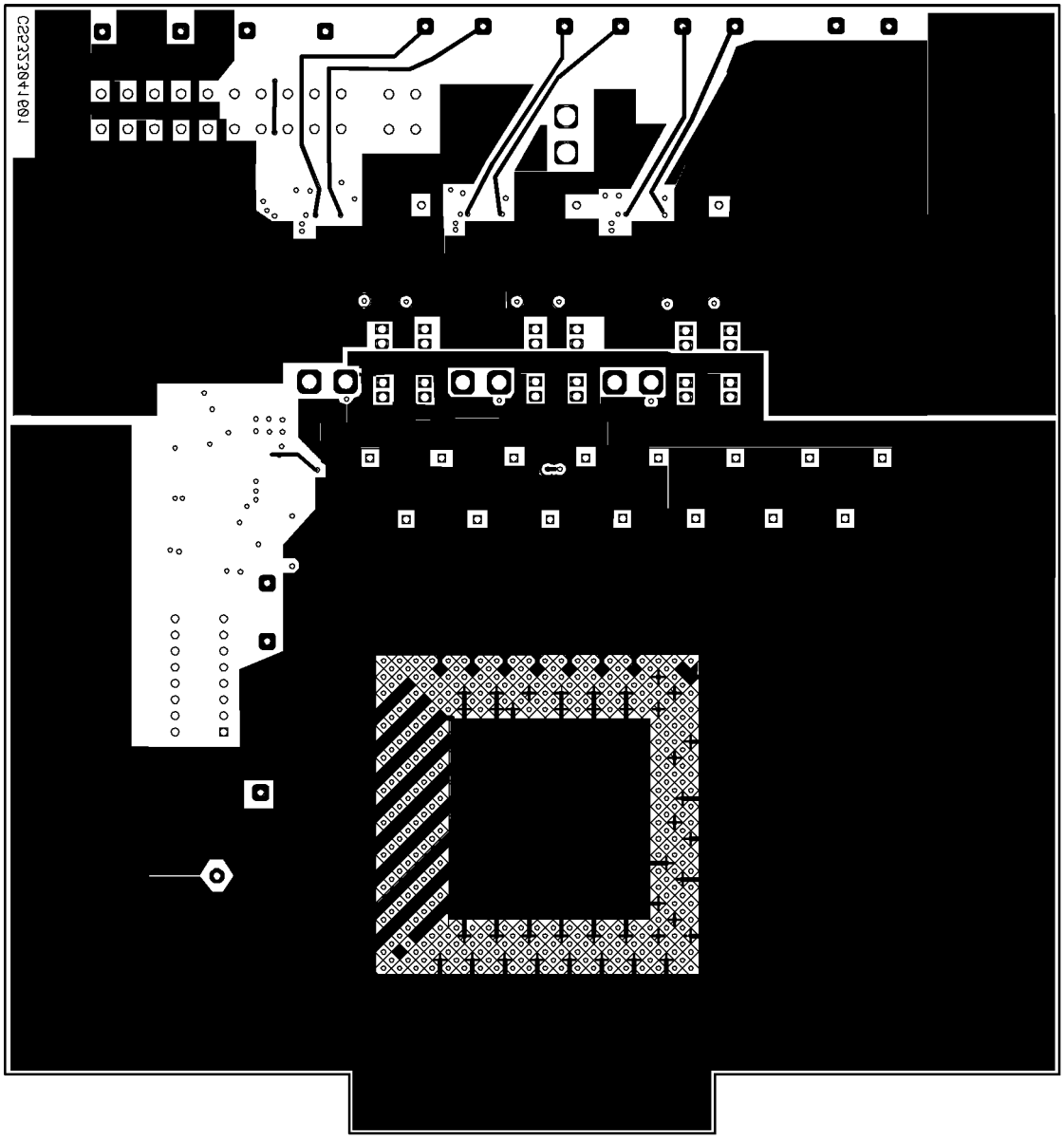

Figure 16. Bottom Layer

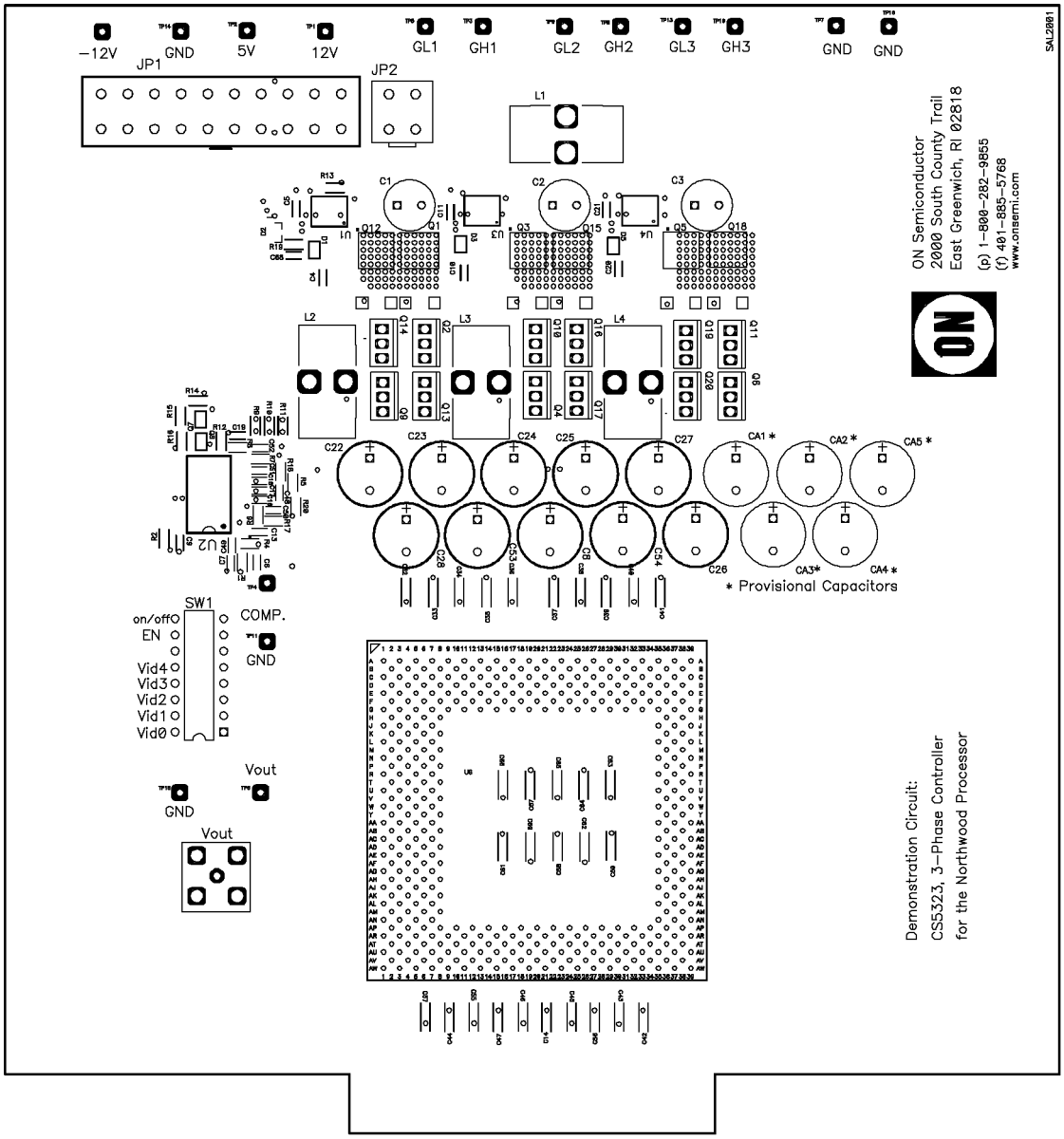

Figure 17. Component Layer

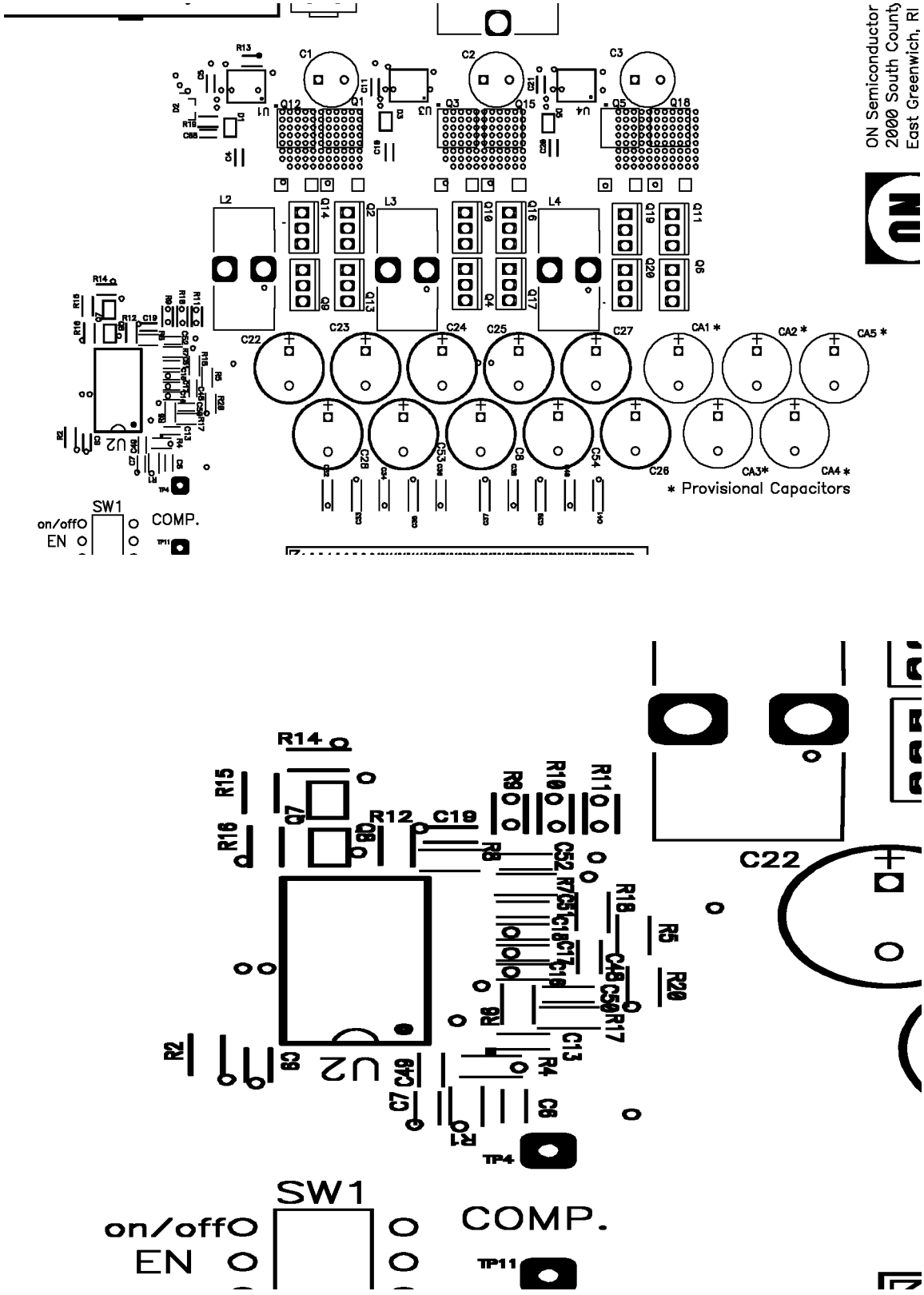

Figure 18. Component Location, Zoomed In

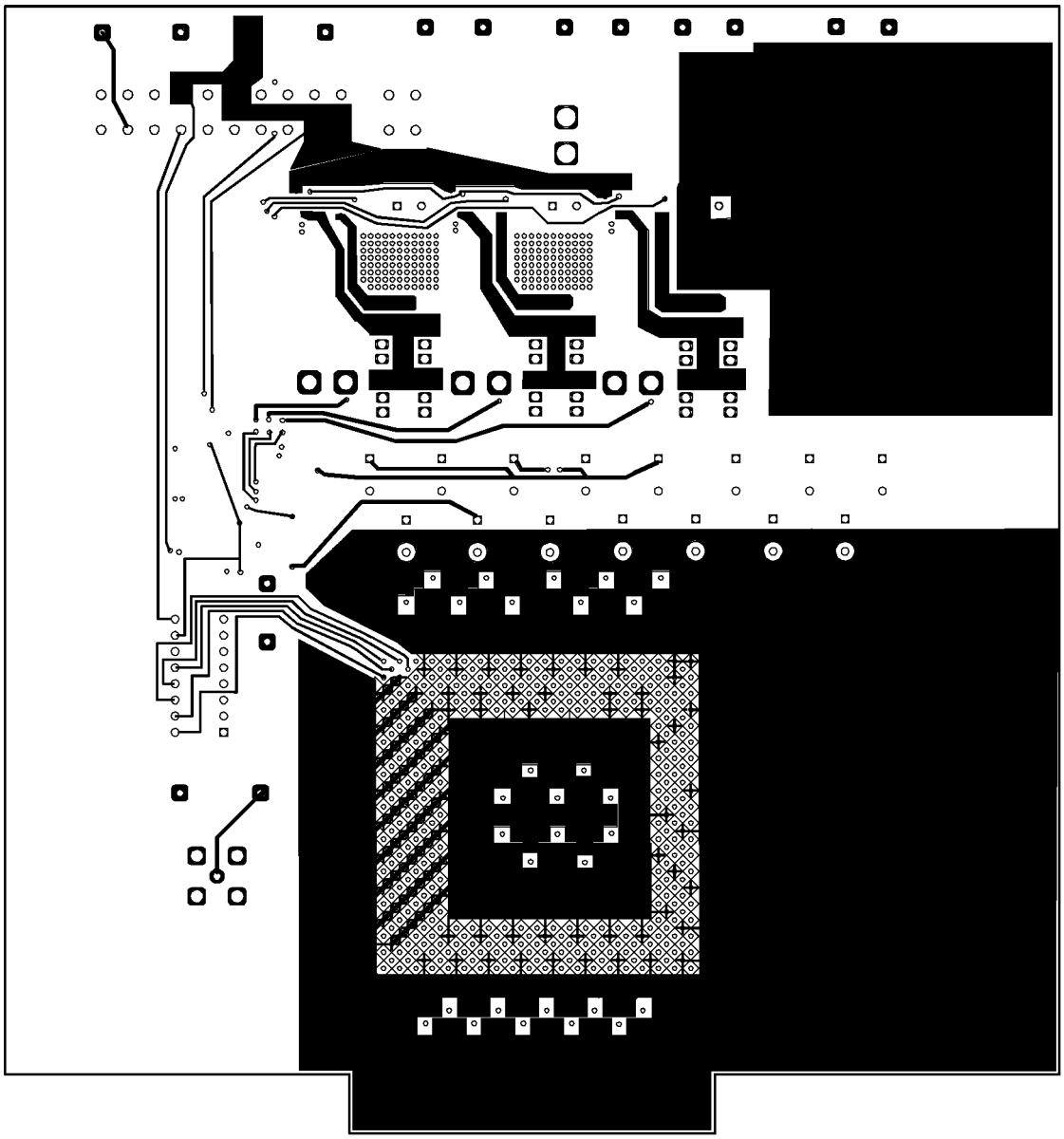

Figure 19. Mid Layer

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