NCP5424DEMO/D

Demonstration Board Manual for the NCP5424

5.0 V and 3.3 V to 1.5 V/17 A Buck Regulator with Input Current Sharing

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DEMONSTRATION BOARD

DESCRIPTION

The NCP5424 demonstration board is a 4.3″ by 4.1″, two-layer printed circuit board with an actual circuit area of 2.6″ by 1.7″. This demonstration circuit can be used to evaluate the performance and functionality of NCP5424, Dual Synchronous Buck Controller with current sharing. Three voltages power this application: 12 V, 5 V, and 3.3 V. The 12 V supplies the V_{CC} and Boost of the IC, while the 5 V and 3.3 V supply the input power. The current sharing feature is demonstrated in this application by increasing the 5 V input power burden to 60%, while decreasing the 3.3 V to 40%.

The NCP5424 controller contains all the circuitry required for a two-phase Buck regulator. The NCP5424 also provides under-voltage lockout, soft start, built-in adaptive FET non-overlap, and Hiccup Mode overcurrent protection.

Features

- Dual Synchronous Buck Topology
- V^2 Control Method
- Out-Of-Phase Synchronization Between the Channels
- Hiccup Mode Overcurrent Protection
- Under-Voltage Lockout
- Low Output Voltage Ripple

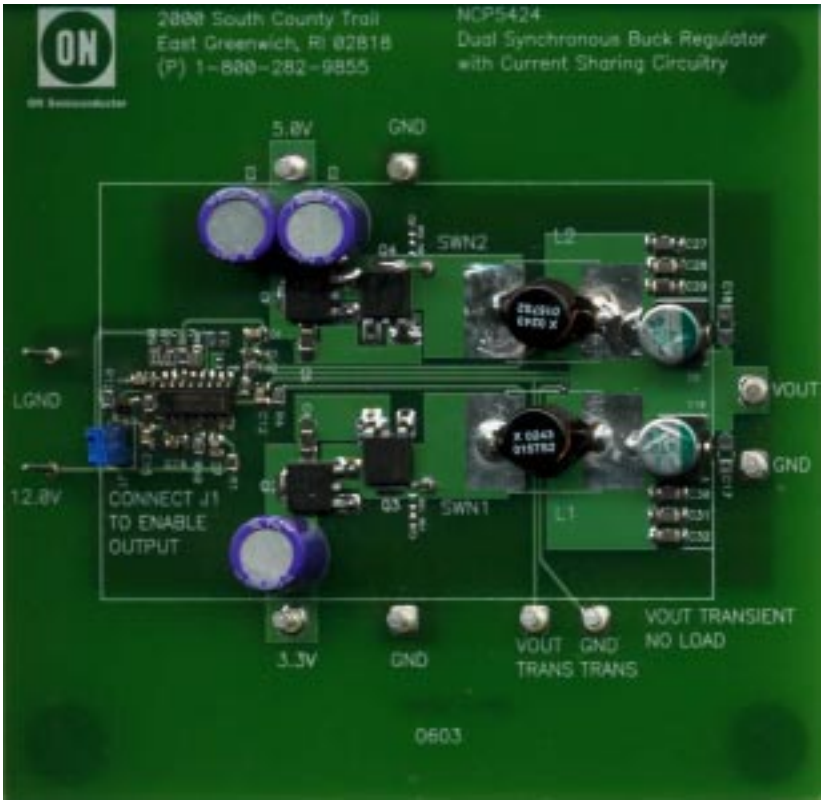


Figure 1. Dual Input to Single Output Buck Converter

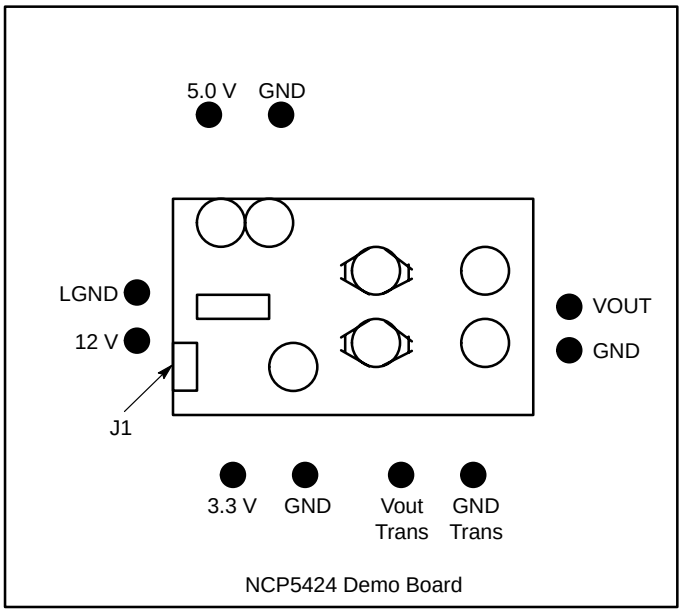


Figure 2. Application Diagram

ABSOLUTE MAXIMUM RATINGS

Pin Name	V_{max}	V_{min}	I_{source}	I_{sink}
VIN	16 V	-0.3 V	N/A	60 mA
RTN	0.3 V	-0.3 V	60 mA	N/A
5 V	6.3 V	0 V	N/A	17 A
3.3 V	6.3 V	0 V	N/A	17 A
VOUT	2.5 V	-0.3 V	21 A	N/A
GND_VOUT	0.3 V	-0.3 V	N/A	17 A

TERMINAL DESCRIPTION

Terminal Name	Description
VIN	Input supply, 12 V recommended
LGND	Return of the input supply.
5 V	Supplying 60% of the input power.
GND (5 V)	Return of the 5 V input, master side.
3.3 V	Supplying 40% of the input power.
GND (3.3 V)	Return of the 3.3 V input, slave side.
VOUT	1.5 V/17 A output, 60% from master side and 40% from the slave side.
GND	Return of the 1.5/17 A Output
J1	Shorting J1 enables the controller.

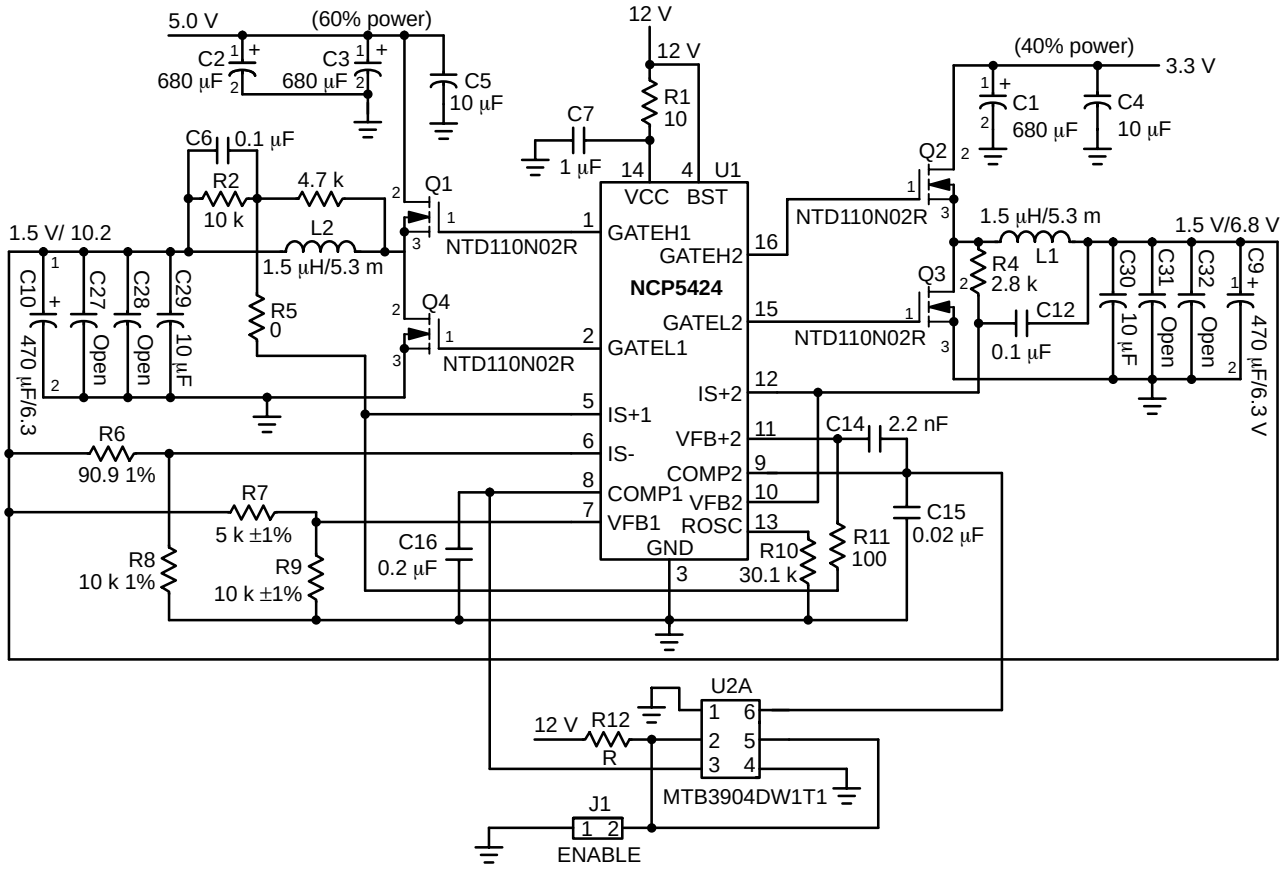


Figure 3. Demonstration Circuit Schematic

Operation Guidelines

- To power up the demo board, two adjustable high current DC power supply is required. In order to fully examine the capabilities of this board, a 5 V/4 A and a 3.3 V/5 A power supply should be selected.
- To insure proper soft start, output rising at the same rate as the COMP1, the 12 V supply should not be applied before the 5 V and 3.3 V supplies.
- The VIN and LGND terminals are located on the left side of the board. The positive and negative terminals of the 12 V input power supply should be connected to VIN and LGND respectively. This provides the V_{CC} and boost voltage to the NCP5424.
- The demo board will start up once the voltage delivered to the VIN pin reaches 8.6 V.
- The 5 V and 3.3 V are located at the top and bottom of the demo board respectively.
- The VOUT and GNDvout terminals are located on the right side of the board. The output voltage is 1.5 V and it can provide up to 17 A current.
- The demo board will go into hiccup mode overcurrent protection when the current reaches 22 A at room temperature and 21 A when at operating temperatures. If other current limits are required, the value of R6 must be changed. Please refer to the datasheet for details.

Design Guidelines

Please see the NCP5424 datasheet for guidelines on using and designing with the NCP5424. A complete, structured design checklist is presented there.

ELECTRICAL CHARACTERISTICS (0°C ≤ $T_{ambient}$ ≤ 50°C, 10 V ≤ VIN ≤ 13.2 V, f_{SW} = 300 kHz, unless otherwise noted)

Characteristic	Test Conditions	Min	Typ	Max	Unit
VOUT					
Output Voltage	0.5 A < I(VOUT) < 17 A	1.4953	1.50	1.5047	V
Line Regulation - 5.0 V	4.5 V ≤ VIN(5.0 V) ≤ 5.5 V		0.05		
Line Regulation - 3.3 V	2.97 V ≤ VIN(3.3 V) ≤ 3.63 V		0.1		%
Load Regulation	0.5 A < I(VOUT1) < 17 A		0.16		%
Ripple and Noise	0.5 A < I(VOUT1) < 10 A, 20 MHz Scope Bandwidth		30		mV(p-p)
Transient Regulation	7 A, 10 A/μs load step, 20 MHz Scope Bandwidth		100		mV
Transient Recovery Time	6 A load step, 20 MHz Scope Bandwidth. Measure the time when output exceeds DC limit		6.0		μs
Efficiency	I(VOUT)=17 A		86.8		%
Over-Current Threshold		20	22	24	A
VIN					
Start Threshold		7.8	8.6	9.4	V
Stop Threshold		7.0	7.8	8.6	V
General					
Efficiency	Full Load		86.8		%
Switching Frequency	Free running	224	300	376	kHz

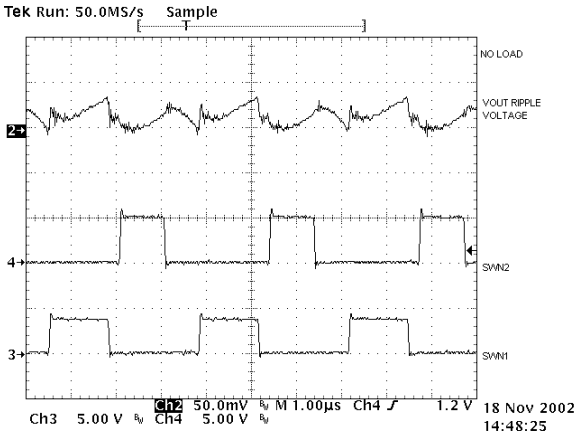


Figure 4. Normal Operation with No Load

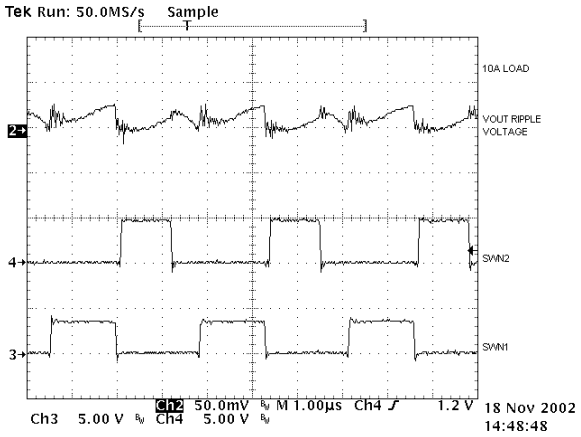


Figure 5. Normal Operation with 10 A Load

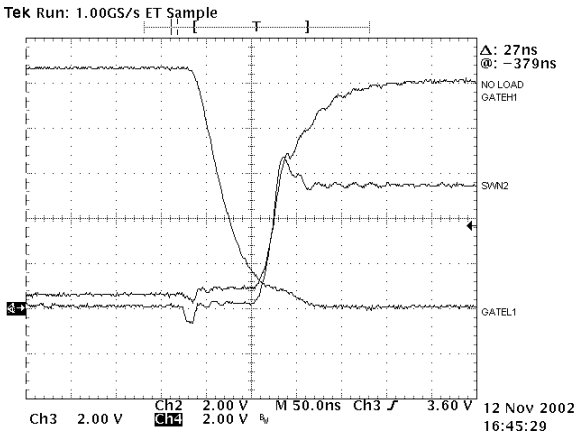


Figure 6. GATEL1-GA TEH1 Transition Showing Rise, Fall and Non-overlap Times with No Load

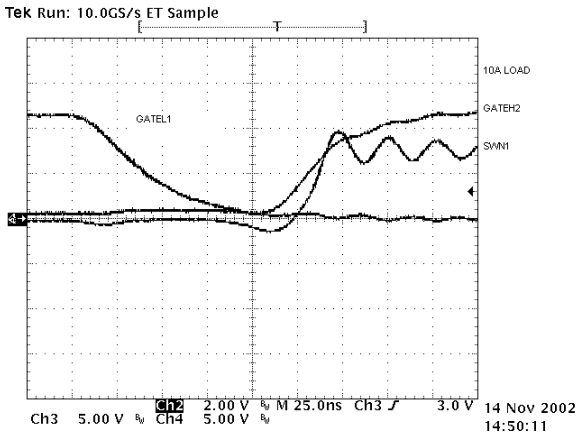


Figure 7. GATEL1-GA TEH1 Transition Showing Rise, Fall and Non-overlap with 10 A Load

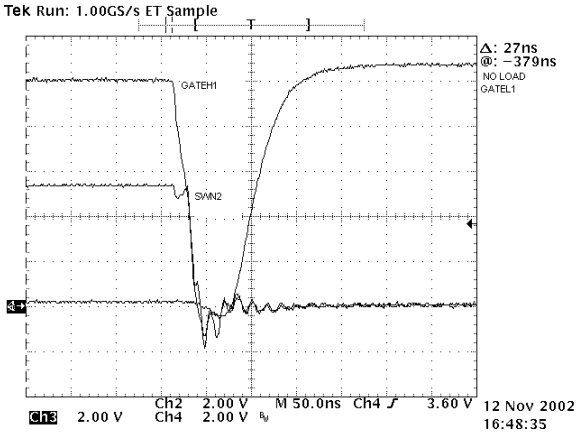


Figure 8. GATEH1-GA TEL1 Transition Showing Rise, Fall and Non-overlap Times with No Load

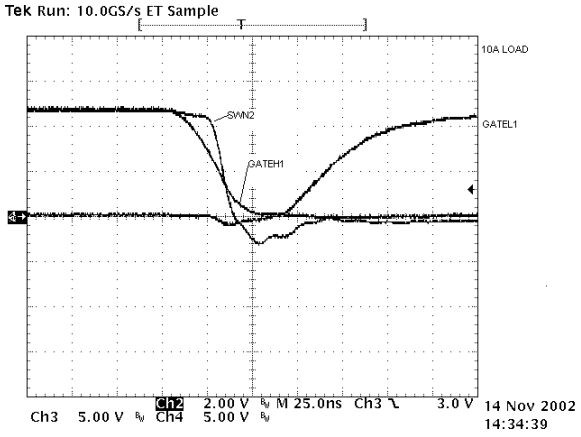


Figure 9. GATEH1-GA TEL1 Transition Showing Rise, Fall and Non-overlap Times with 10 A Load

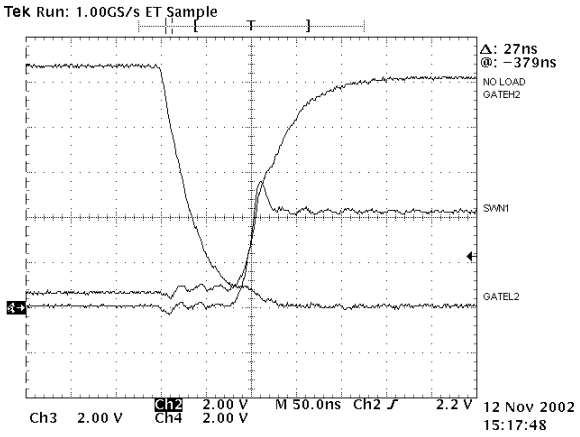


Figure 10. GATEL2-GA TEH2 Transition Showing Rise, Fall and Non-overlap with No Load

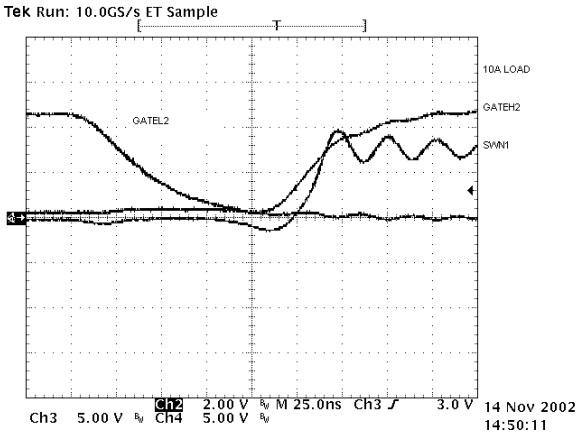


Figure 11. GATEL2-GA TEH2 Transition Showing Rise, Fall and Non-overlap Times with 10 A Load

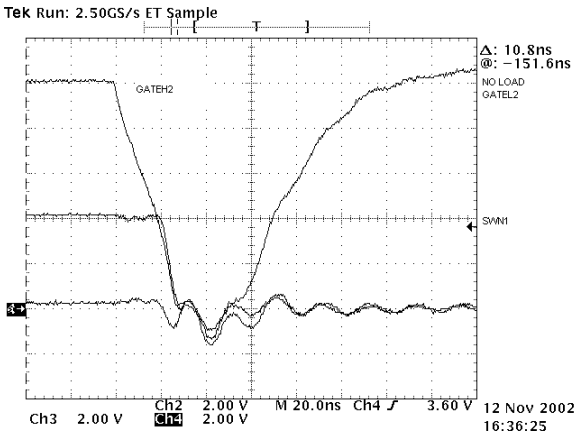


Figure 12. GATEH2-GA TEL2 Transition Showing Rise, Fall and Non-overlap Times with No Load

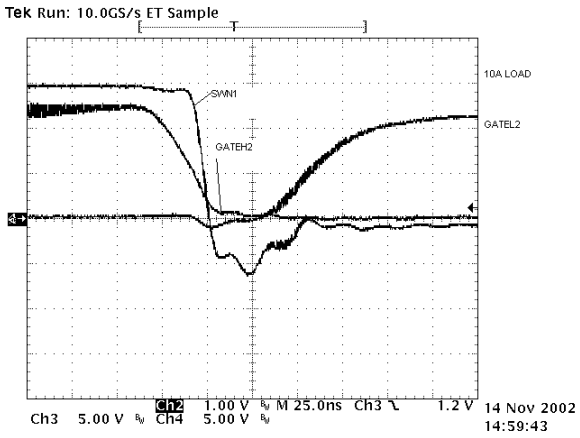


Figure 13. GATEH2-GA TEL2 Transition Showing Rise, Fall and Non-overlap Times with 10 A Load

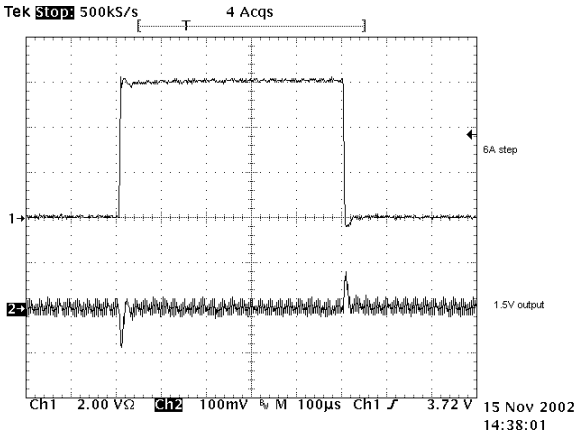


Figure 14. Dynamic Load Step Form 0 to 6.0 A with 10 A/µs Slew Rate, Showing I_{out} and V_{out}

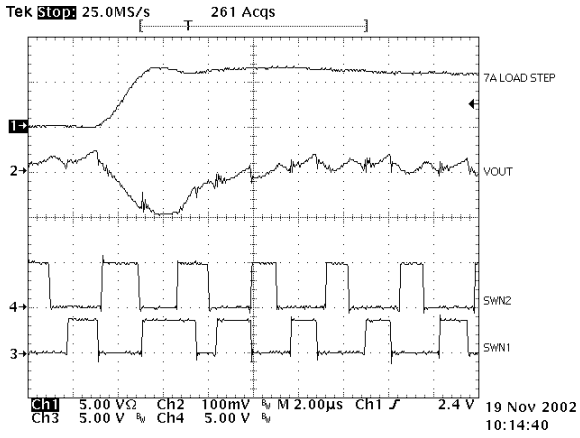


Figure 15. Turn-on of Dynamic Load Step from 0 to 7.0 A

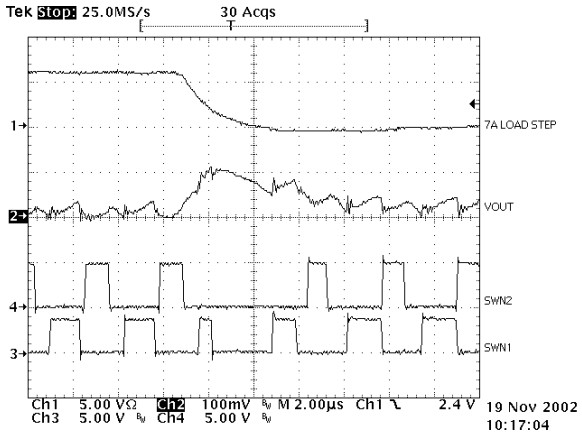


Figure 16. Turn-off of Dynamic Load Step from 7 to 0 A

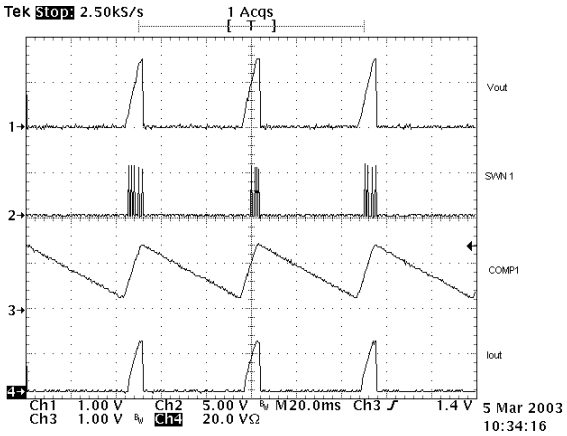


Figure 17. Hiccup-Mode Fault Mode with a 22 A Current Limit. Showing V_{out}, Switch Node1, COMP1, and I_{out}

COMPONENT TEMPERATURES

	Ch.1	Ch.2	Ch.1	Ch.2	
Load	0		17		A
Top FET	32	32	57	54	°C
Bottom FET	33	33	58	54	°C
Inductor	32	31	60	53	°C
Input Cap.	30	30	41	41	°C
Output Cap.	29	29	46	41	°C
IC	48	N/A	61	N/A	°C

Component temperatures measured in still air, and ambient temperature at 23°C.

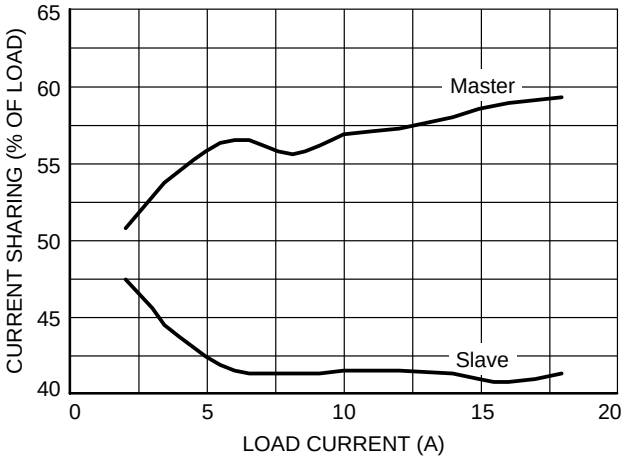


Figure 18. Share of Load Current

Master and Slave phase current sharing percentages over output load current.

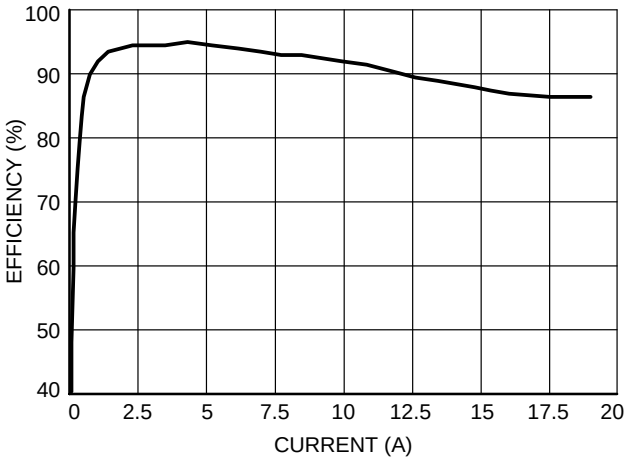


Figure 19. Efficiency versus Current

Graph shows the efficiency of the 5 V and 3.3 V to 1.5 V output power stage. The 12 V has not been accounted for in this efficiency graph; the I_{CC} is approximately 54 mA with both gates switching.

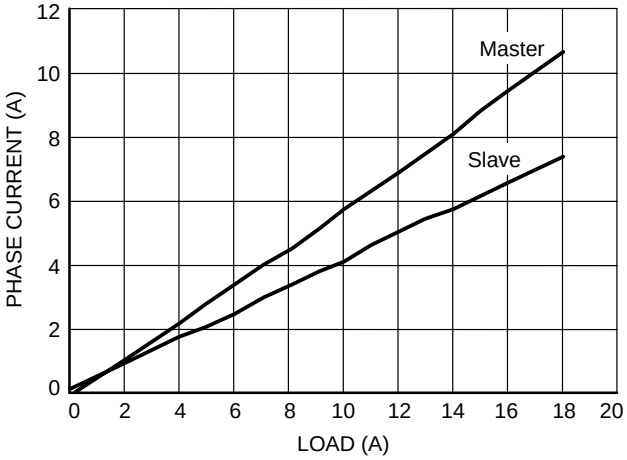
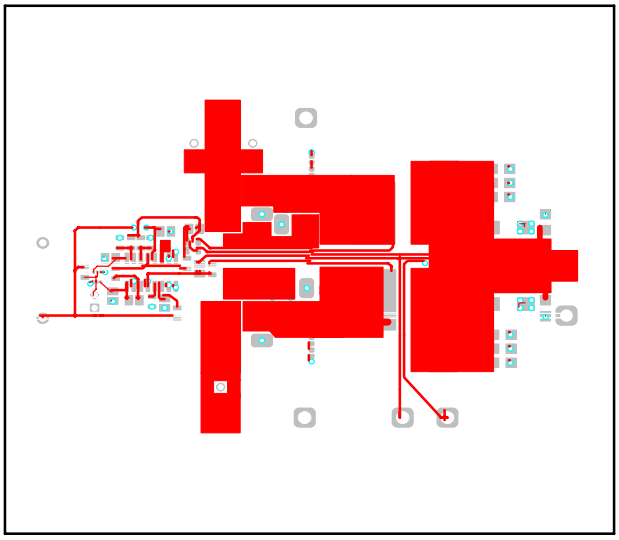
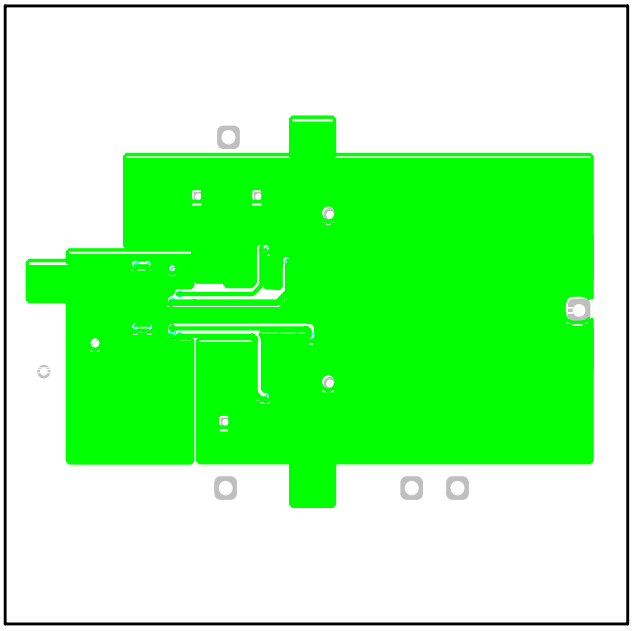


Figure 20. Current Sharing

Master and Slave phase current over output load.



Top Layer



Bottom Layer

Figure 21. PCB Layout

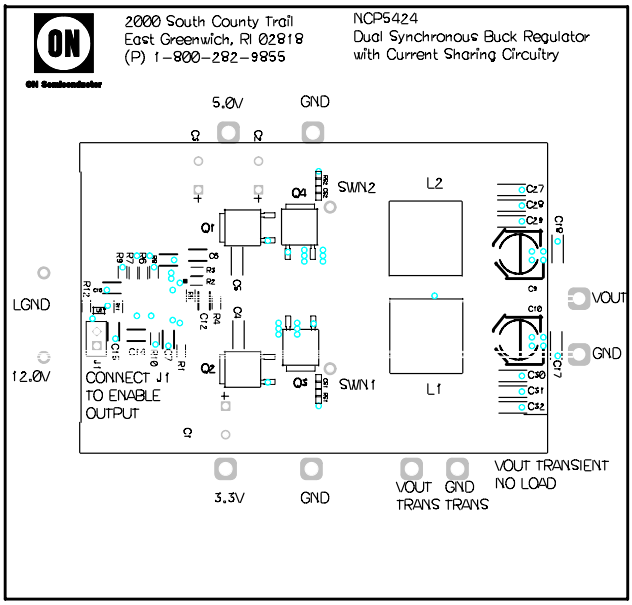


Figure 22. Silk Layer

BILL OF MATERIAL

Item	Qty	Reference	Part	Mfg.& P/N	Distributor
1	3	C1,C2,C3	OS-CON, 680 uF/6.3 V	Sanyo OS-CON 16SP680M	Sanyo 201-843-8100
2	2	C9,C10	Electrolytic, 470 uF/4 V	Sanyo 4CV470EX	Sanyo 201-843-8100
3	1	C15	Ceramic, 0.02 uF/25V 0805	Panasonic ECJ-2VF1E223Z	Digi-Key 800-344-4539
4	3	C6,12	Ceramic, 0.1 uF/25 V 0805	Panasonic ECJ-2VF1E104Z	Digi-Key 800-344-4539
5	4	C4,C5,C29,C30	Ceramic 10 uF/10 V 1206	Panasonic ECJ-3YF1A106Z	Digi-Key 800-344-4539
6	1	C16	Ceramic .22 uF/25 V 0805	Panasonic ECY-2VF1E224Z	Digi-Key 800-344-4539
7	1	C14	Ceramic, 2.2 nF/50 V 0805	Panasonic ECJ-2VC1H222J	Digi-Key 800-344-4539
8	1	C7	Ceramic, 1 uF/1 V 0805	Panasonic ECJ-2Vf1C105Z	Digi-Key 800-344-4539
9	2	L1,L2	Inductors, 1.5 uH/5.3 mÙ	XFMRS, XF0157S2	XFMRS 317-834-1066
10	4	Q1,Q2,Q3,Q4	N-Channel DPAK	ON Semiconductor NTD110N02R	ON Semiconductor 800-282-9855
11	4	R2,8,9,12	Resistor 10.0 KÙ 1% 0805	Panasonic ERJ-6ENF1002V	Digi-Key 800-344-4539
12	1	R3	Resistor 4.70 kΩ 1% 0805	Panasonic ERJ-6ENF4701V	Digi-Key 800-344-4539
13	1	R6	Resistor 90.9 Ω 1% 0805	Panasonic ERJ-6ENF90R9V	Digi-Key 800-344-4539
14	1	R7	Resistor 5.0 kΩ 1% 0805	Panasonic ERJ-6ENF5001V	Digi-Key 800-344-4539
15	1	R5	Resistor 0.0 Ω 0805	Panasonic ERJ-6GEY0R00V	Digi-Key 800-344-4539
16	1	R11	Resistor 100 Ω 5% 0805	Panasonic ERJ-6GEY101V	Digi-Key 800-344-4539
17	1	R1	Resistor 10 Ω 5%, 0805	Panasonic ERJ-6GEYJ100V	Digi-Key 800-344-4539
18	1	R10	Resistor 30.1 kΩ 1% 0805	Panasonic ERJ-6ENF301 1V	Digi-Key 800-344-4539
19	1	R4	Resistor 2.80 KΩ 1% 0805	Panasonic ERJ-6ENF2801V	Digi-Key 800-344-4539
20	1	U2A	Dual Transistor	ON Semiconductor MBT3904W1T1	ON Semiconductor 800-282-9855
21	1	U1	Dual Synchronous Buck Controller	ON Semiconductor NCP5424	ON Semiconductor 800-282-9855

Notes

PUBLICATION ORDERING INFORMATION

Literature Fulfillment:
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