NCL30125FW300WGEVB

300 W Lighting Solution with NCL30125 Evaluation Board User's Manual

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EVAL BOARD USER'S MANUAL

Circuit Description

This user's manual provides elementary information about a two−switch forward converter built with the NCL30125 operated in current−mode control. This controller offers many features to build an energy efficient converter with all the needed protections like cycle−by−cycle current limit with a 500−mV sense voltage, over temperature protection with a dedicated NTC pin and brown−out feature. In addition to the low side MSOFET drive, the controller integrates also a high−side section to drive the floating N−channel power MOSFET. Dedicated pins are available to adjust the switching frequency (RT pin – pin 6) or the soft−start duration (SS pin – pin 7). Finally, a high−voltage current source with Dynamic−Self Supply (DSS) is embedded to quickly start the power supply and maintain the Vcc voltage in light load or standby. The primary−side section drives a transformer whose primary inductance is 3 mH. The energy accumulated in this inductance is sending back to the bulk capacitor thanks to the freewheel components. One of the classical freewheel diode has been replaced by a MOSFET Q3 driven by the controller in order to refresh the bootstrap capacitor. The current is sensed via a 83−mΩ resistance. The switching frequency of 100 kHz and the soft−start duration are set by two individual components (R8 for fSW and C5 for SS).

The power stage is made of two switching N−channel transistors Q1 and Q2. These two transistors are switched in same time and seen the input voltage as maximum. In the secondary side, D13 and D15 constitute Rectifier and Freewheel part. The regulation is ensured by a TL431.

Table 1.

Device	Application	Input Voltage	Output Power	Topology	I/O Isolation
NCL30125	Lighting	180 to 264 Vac	300 W	Two−Switch Forward	Isolated

Table 2.

	Output Specification
Output Voltage	12 V
Nominal Current	12 V/25 A
Max Current	12 V/30 A
Min Current	zero

Table 3.

Avg. Efficiency	>88% @ 12 V 25 A at board end, 230 Vac
Ripple	<240 mV
Standby Power	<0.3 W @ 12 V & 230 Vac
Power Density	2 W/cm^3
Protection	OCP, OVP
Size	L x W x H = 300 x 50 x 35 mm

Key Features

- Two−Switch topology current mode control
- A simple control circuit without a driver transformer
- Rated Output power: 300 W
- Standby power: <0.3 W in Universal AC input voltage
- Full load Efficiency: >88% @ at board end, 230 Vac input
- Completed protection: OCP,OVP
- Brown−out protection
- Switching frequency: ~100 kHz

Block Diagram and BOARD Photos

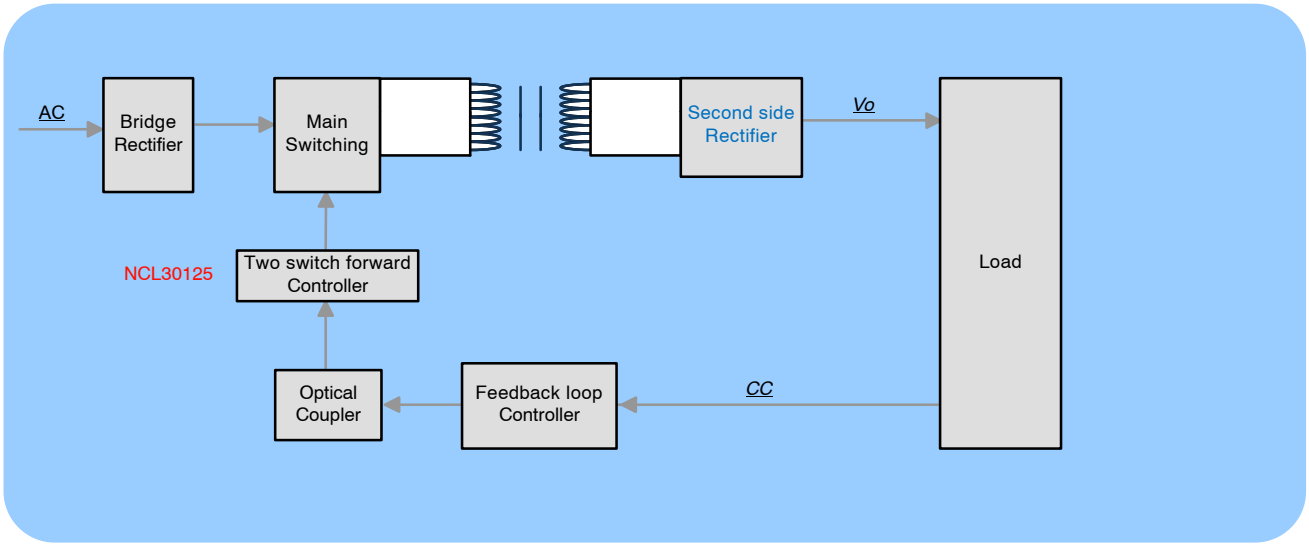

Figure 1. Overall Circuit of 300 W Lighting Solution

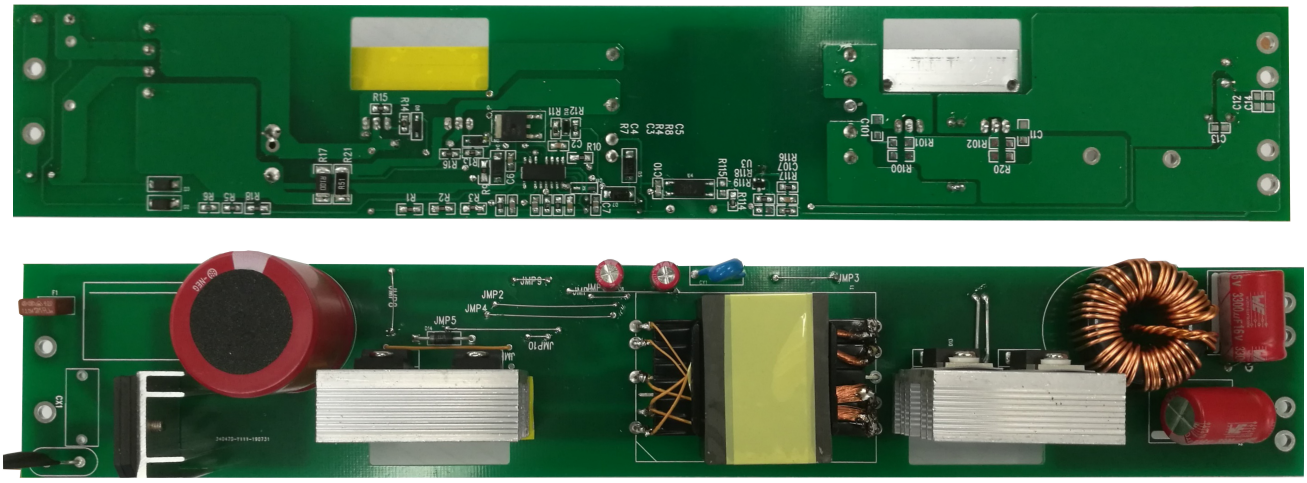

Figure 2. Demo Board Pictures

Circuit Schematic

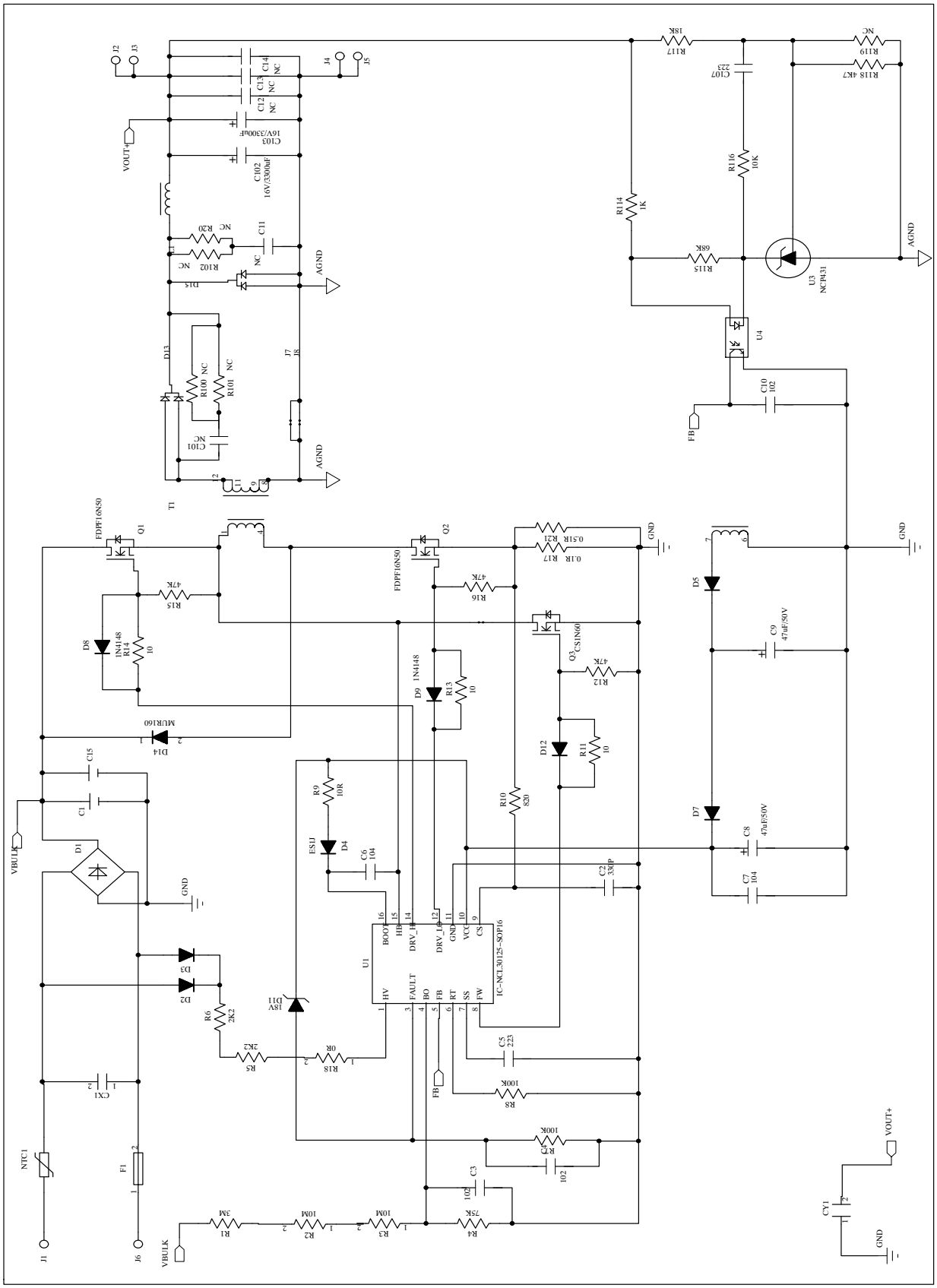

Figure 3. Circuit Schematic

PCB

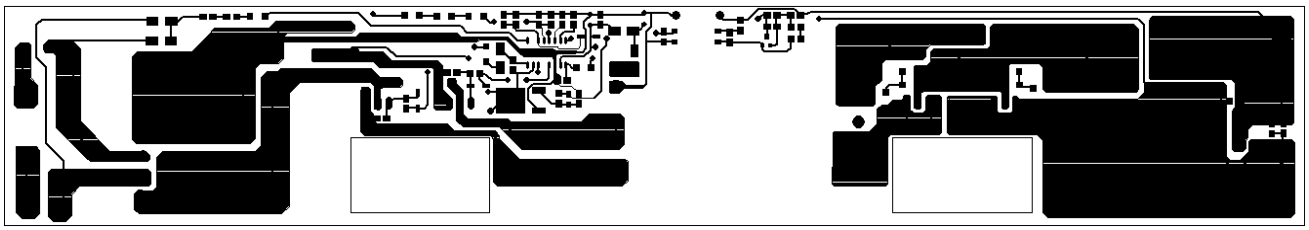

Figure 4. Bottom View of PCB

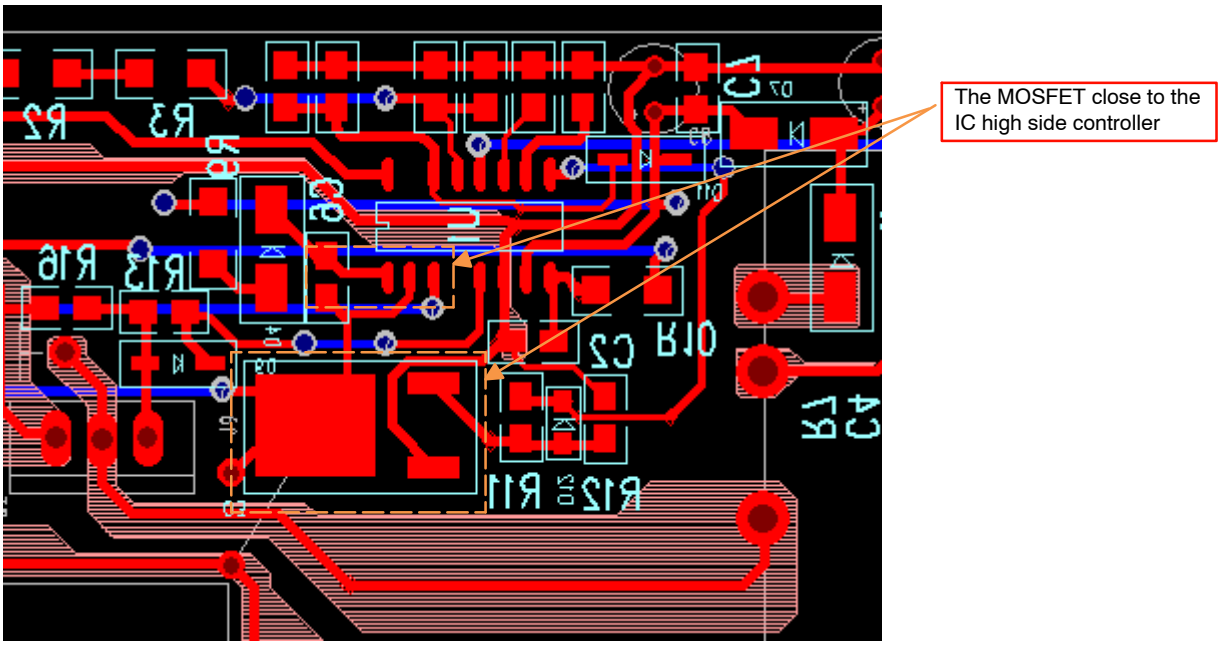

Figure 5. PCB Layout Pay Attention to Q3 MOSFET Position

Transformer Designs

Table 4.

Pos.	Identification	Material	Turns	Turns in Total	Size	Winding Allowance	Tensile Force Required	Speed	Winding Point		Remarks
									Beginning	End	
1	NP	THL−F	12	12	0.5 mm	–	–	–	9	11	
2	Z1	Tape	1	1	7 mm	–	–	–	–	–	
3	NH	THL−F	1	1	0.2 mm	–	–	–	7	6	
4	Z2	Tape	2	2	7 mm	–	–	–	–	–	
5	NS	Litz wire	3	3	0.1 mm x 150 x 2	–	–	–	4, 5 start, 1, 2 end		
6						–	–	–			
7	Z3	Tape	2	2	7 mm	–	–	–	–	–	
8	NP	THL−F	7	7	0.5 mm	–	–	–	11	12	
9	Z4	Tape	1	1	7 mm	–	–	–	–	–	

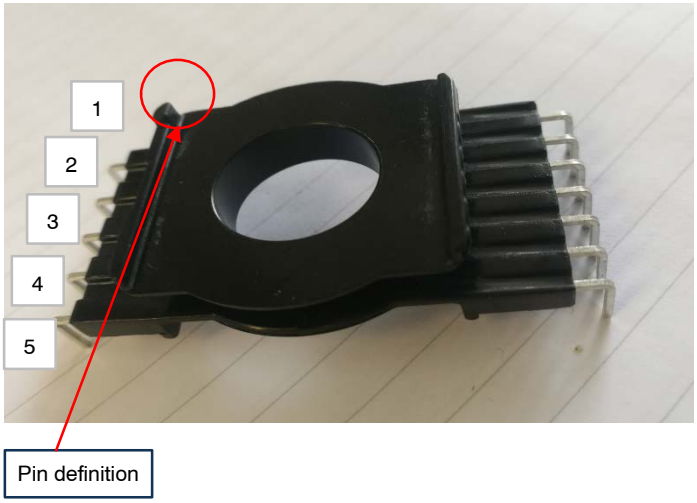

Figure 6.

Efficiency Curve in different AC Input Voltage

Test condition: all efficiency are tested at board end

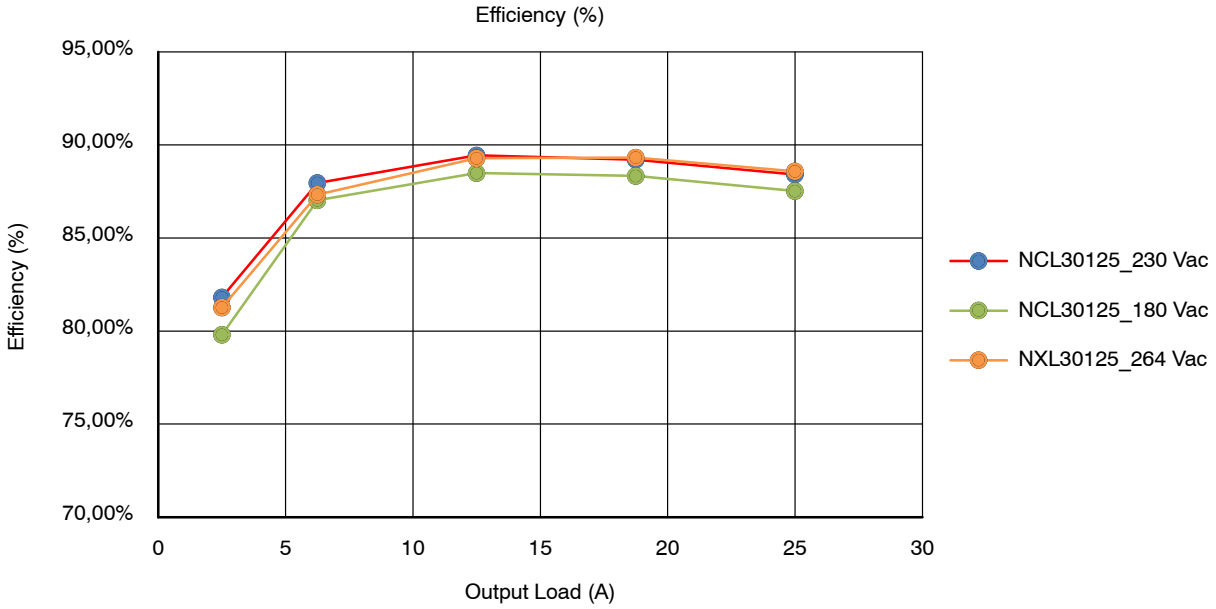

Figure 7.

No Load Input Power

Test condition: no load

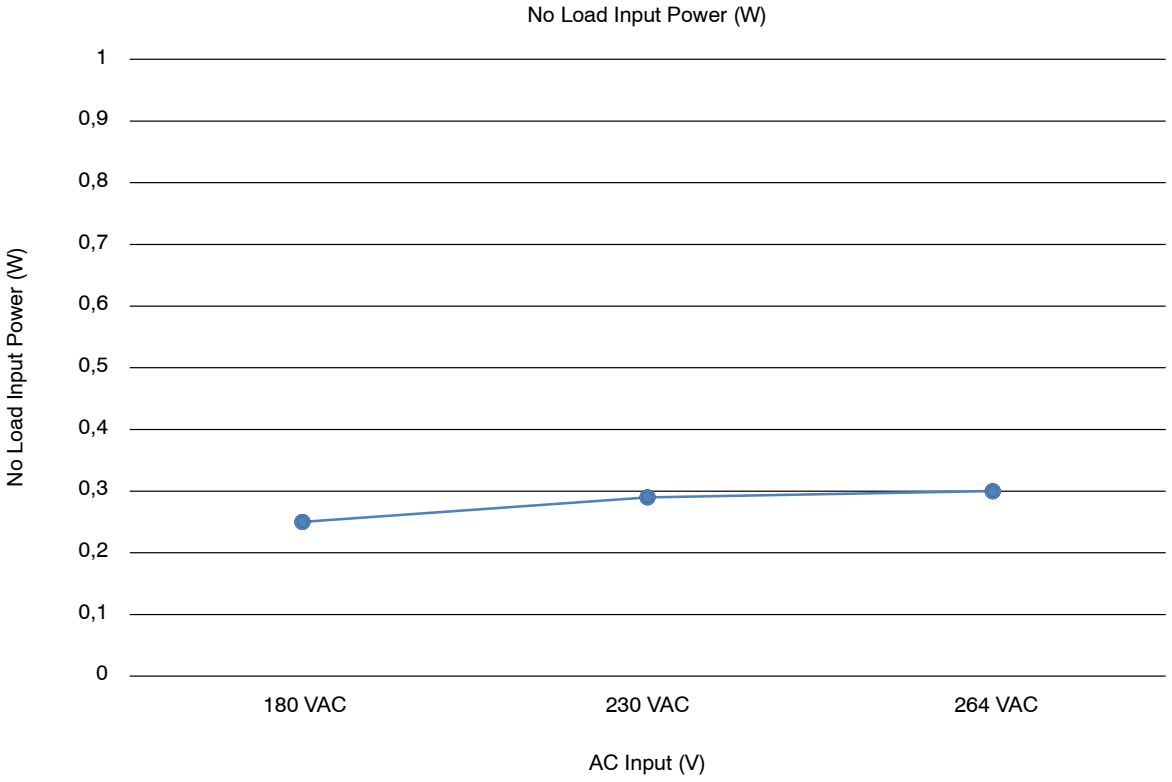

Figure 8.

Start up time and Hold−up Time

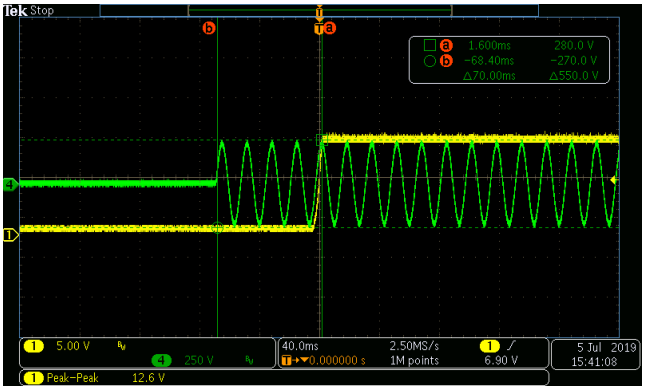

Figure 9. Start Up Time

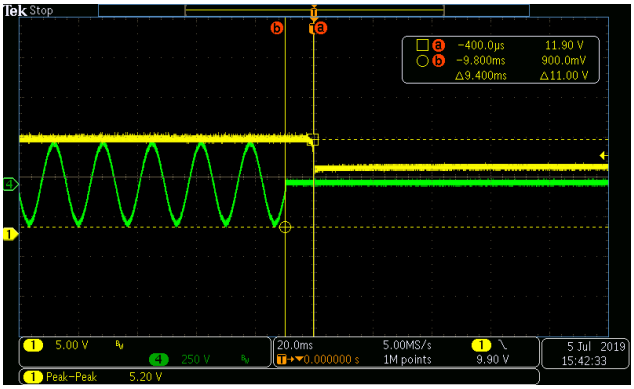

Figure 10. Hold−up Time

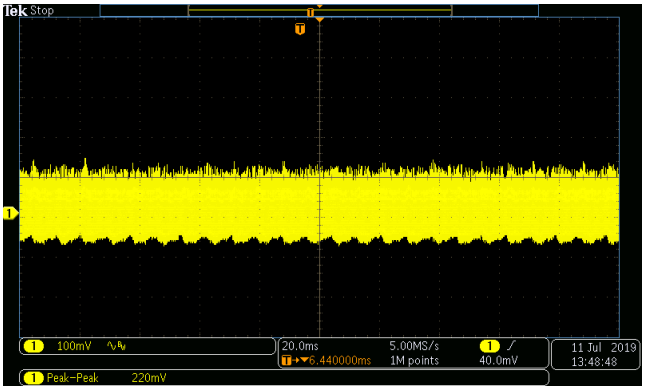

Figure 11. Output Ripple @ 180 Vac Input, 25 A Output

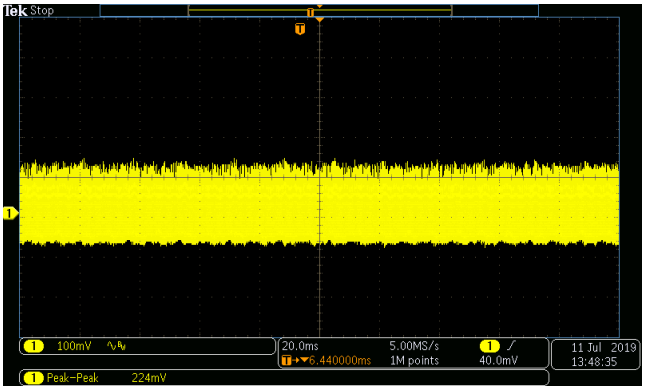

Figure 12. Output Ripple @ 230 Vac Input, 25 A Output

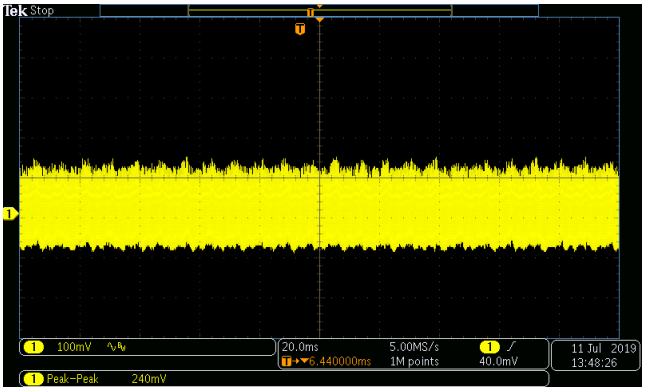

Figure 13. Output Ripple @ 264 Vac Input, 25 A Output

Start Up @ 230 Vac Input, 12 Vdc Output

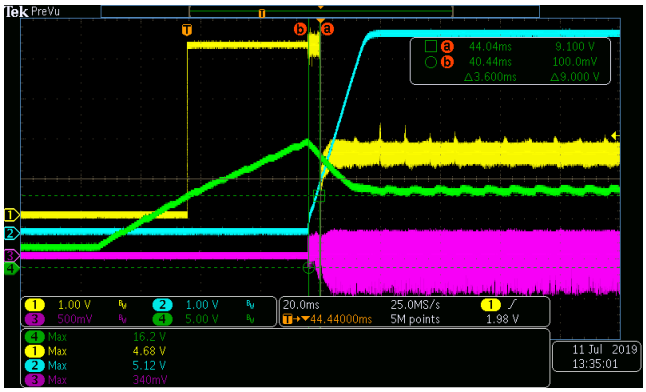

Figure 14. CH1: FB, CH2: SS, CH3: Current Sense, CH4: Vcc

Switch MOSFET Wave Form

Figure 15. 230 Vac Input, 12 V 25 A Output (CH1 – Low Side Vdrain, CH3 – Current Sense, CH4 – High Side Vdrain)

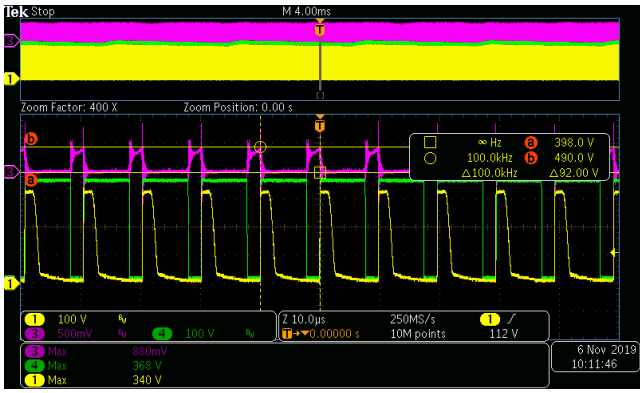

Figure 16. 264 Vac Input, 12 V 25 A Output (CH1 – Low Side Vdrain, CH3 – Current Sense, CH4 – High Side Vdrain)

Output OVP, OCP & Short Circuit Protection

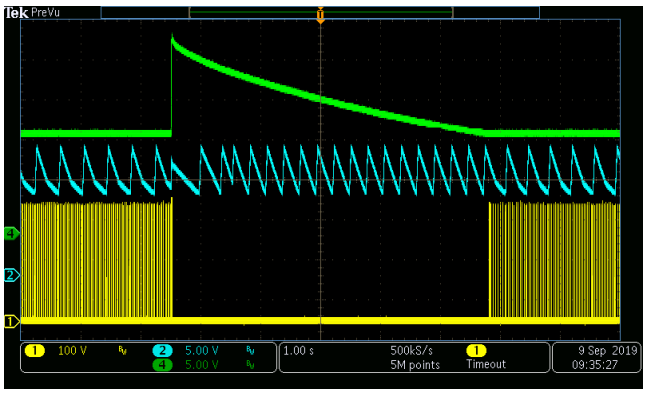

Figure 17. Output OVP: CH1 – VHB, CH2 – Vcc, CH4 – Output Voltage

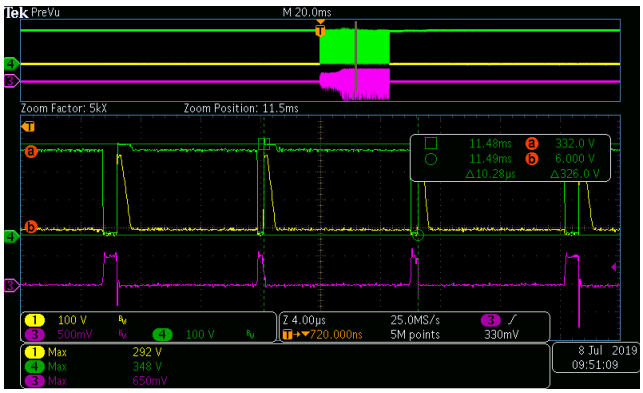

Figure 18. Output OCP: CH1 – Low side Vdrain, CH3 – Primary Current Sense C2 Voltage, CH4 – High Side Vdrain

BOM

Table 5. BILL OF MATERIALS

Item	Qty	Reference	Type	Part Name	MFR	Value	Package	Description
1	1	NTC1	NTC	SPNL09D1R5MBI	SUNLORD	1.5 Ω		
2	1	F1	FUSE	3.15 A/250 VAC	littelfuse	Micro Fuse 3.15 A/250 VAC		L8.5 mm x W4 mm x H8 mm
3	1	L1	choke	Choke	Yongjieling	35uH	MKS270125	MKS270125/14TS
4	1	W	Forward transformer	Transformer	Yongjieling	3mH	PQ4020	
5	1	R1	Resistor	Std	Std	3 MΩ/1206	1206	
6	2	R2, R3	Resistor	Std	Std	10 MΩ/1206	1206	
7	1	R4	Resistor	Std	Std	75 kΩ/0805	0805	
8	1	R18	Resistor	Std	Std	0 Ω/1206	1206	
9	2	R5, R6	Resistor	Std	Std	2.2 kΩ/0805	0805	
10	2	R7, R8	Resistor	Std	Std	100 kΩ/0805	0805	
11	1	R9	Resistor	Std	Std	10 Ω/0805	0805	
12	1	R10	Resistor	Std	Std	820 Ω/1206	1206	
13	3	R11, R13, R14	Resistor	Std	Std	10 Ω/0805	0805	
14	3	R12, R15, R16	Resistor	Std	Std	47 kΩ/0805	0805	
15	1	R17	Resistor	ERJ1TRSJR10U	Panasonic	0.1 Ω	2512	Panasonic NO.: ERJ1TRSJR10U
16	1	R21	Resistor	ERJ1TRQFR51U	Panasonic	0.51 Ω	2512	Panasonic NO.: ERJ1TRQFR51U
17	1	R114	Resistor	Std	Std	1 kΩ/0805	0805	
18	1	R116	Resistor	Std	Std	10 kΩ/0805	0805	
19	1	R117	Resistor	Std	Std	18 kΩ/0805	0805	
20	1	R118	Resistor	Std	Std	4.7 kΩ/0805	0805	
21	1	C15	E−cap	861011385023	WE	400 V/330 μF	E−CAP	WE ORDER NO.: 861011385023
22	2	C102, C103	E−cap	860080575018	WE	16 V/3300 μF	E−CAP	WE ORDER No.: 860080575018
23	2	C8,C9	E−cap	860010673012	WE	50 V/47 μF	E−CAP	WE ORDER NO.: 860010673012
24	1	C2	Ceramic cap	Std	Std	330 pF/25 V	0805	
25	3	C3, C4, C10	Ceramic cap	Std	Std	102/25 V	0805	
26	2	C5, C107	Ceramic cap	Std	Std	223/25 V	0805	
27	2	C6, C7	Ceramic cap	Std	Std	104/25 V	0805	
28	2	Q1, Q2	MOSFET	FDP26N50	ON	500 V/20 A/TO−220	TO−220	
29	1	Q3	MOSFET	CS1N60	ON	600 V/1 A/D−PARK	D−PARK	
30	2	D13, D15	DIODE	MBR30L60CTG	ON	60 V/30 A/TO−220	TO−220	
31	3	D2, D3, D4	Diode	ES1J	ON	1 kV/1 A/SMA	SMA	
32	3	D8, D9, D12	DIODE	MMSD4148T1G	ON	100 V/200 mA	SOD123	
33	2	D5, D7	Diode	RS1D	ON	1 kV/1 A/SMA	SMA	
34	1	D1	Diode bridge	GBU8K	ON	8 A Bridge Rectifier	Micro−DIP	
35	1	D14	DIODE	MUR160	ON	Ultra−Fast Recovery/ 600 V/1 A	Axial Lead−2	
36	1	U1	Controller	NCL30125B2	ON	Two switch forward Controller		
37	1	U4	Optical coupler	FODM1007	ON	Optical coupler	LSOP4	

Table 5. BILL OF MATERIALS (continued)

Item	Qty	Reference	Type	Part Name	MFR	Value	Package	Description
38	1	U3	Programmable Precision Reference	NCP431	ON	NCP431	SOT−23	
39	1	D11	Zener	MMSZ22T1G	ON	NC	SOD123	
40	5	M3 screw	M3 screw	Std	Std	M3 screw		For D1, Q1, Q2, D13, D15 assemble to heatsink
41	2	Isolation pads		Std	Std		TO−220	For D13, D15 assemble to heatsink
42	2	Insulating rubber particles		Std	Std			For D13, D15 assemble to heatsink

References

ON Semiconductor datasheet for NCL30125.

ADDITIONAL INFORMATION

TECHNICAL PUBLICATIONS:
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