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Design Note – DNxxxxx/D

300W lighting Solution with NCL30125

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

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

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

Circuit Description

This design note 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 MOSFET 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 3mH. 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 One of the classical freewheel diode has been replaced by a MOSFET Q3 driven by the controller in order to refresh the bootstrap capacitor.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 .

Key Features

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

Block Diagram and BOARD Photos

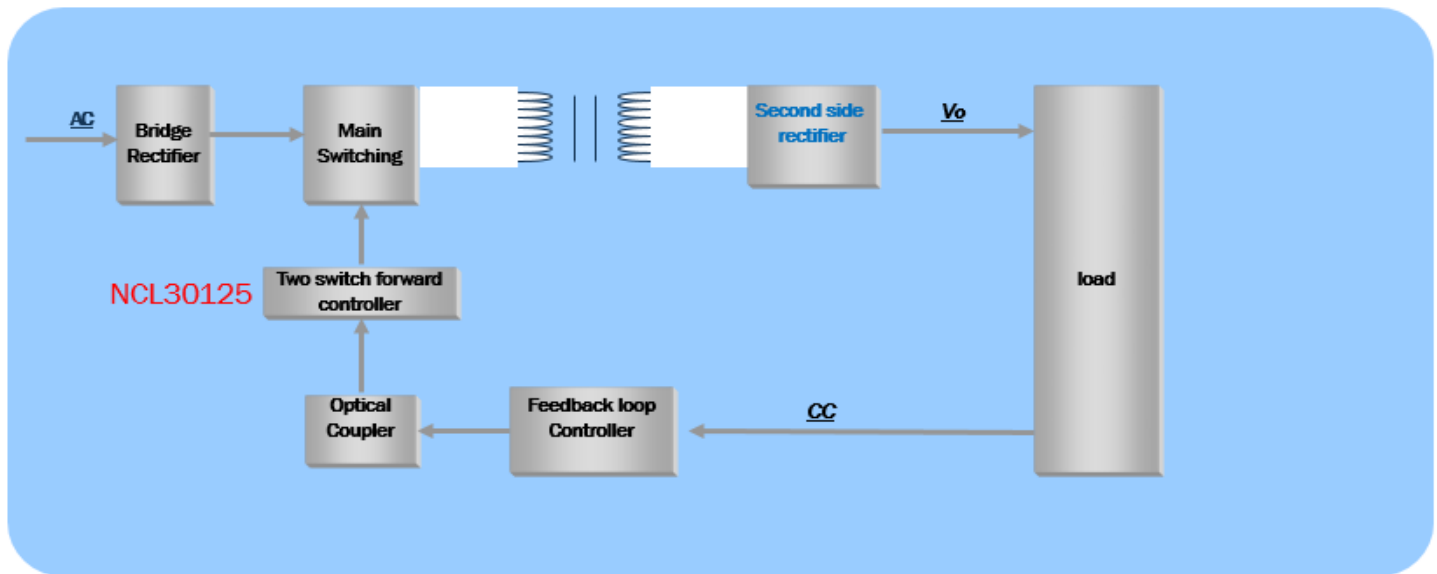


Figure 1, Overall circuit of 300 W lighting Solution

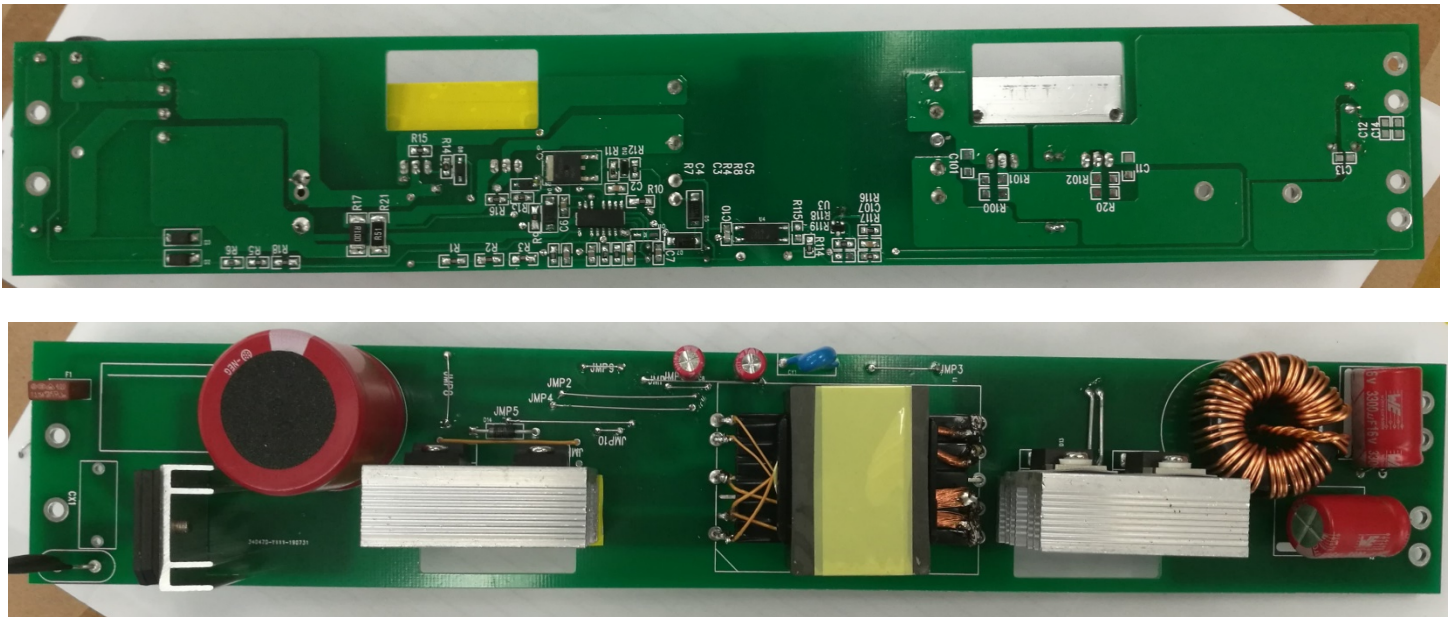
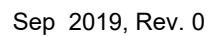


Figure 2, Demo board Pictures

Circuit Schematic



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PCB

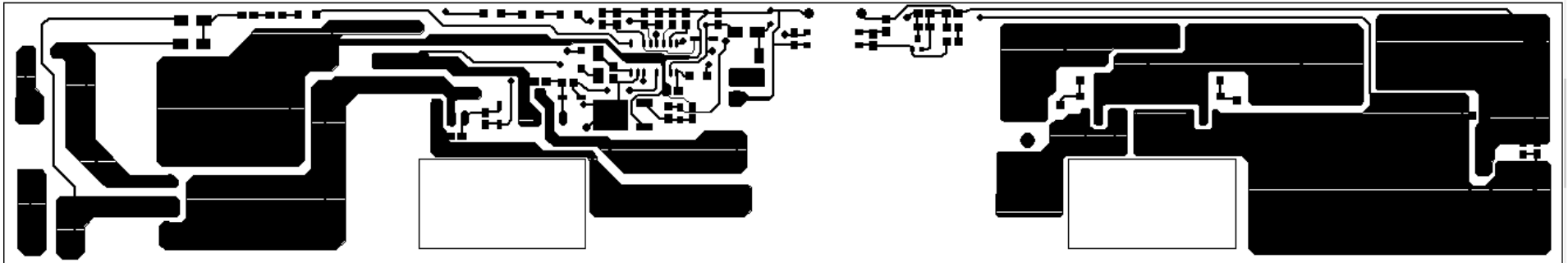
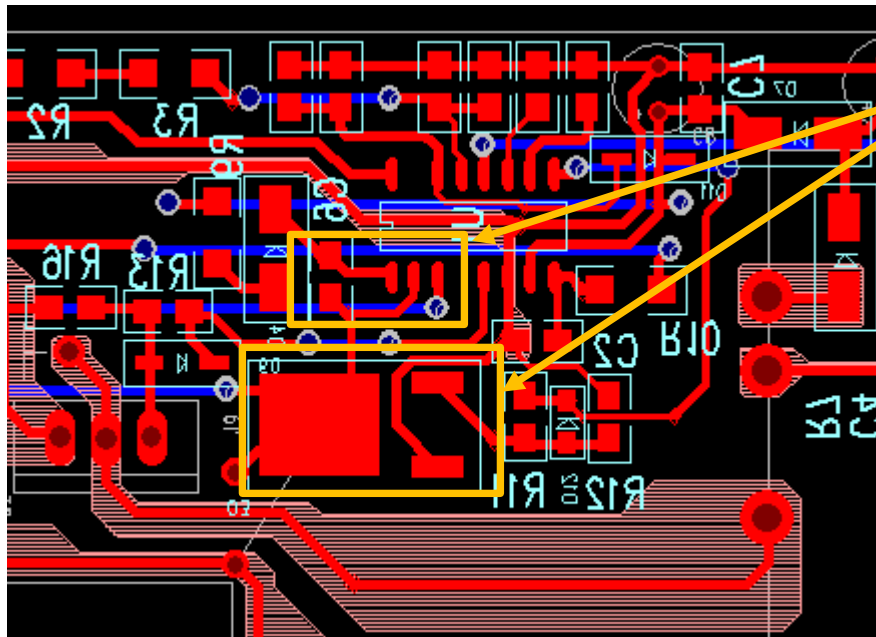


Figure 3, Bottom View of PCB



The MOSFET close to the
IC high side controller

Figure 4, PCB layout pay attention to Q3 MOSFET position

Transformer Designs

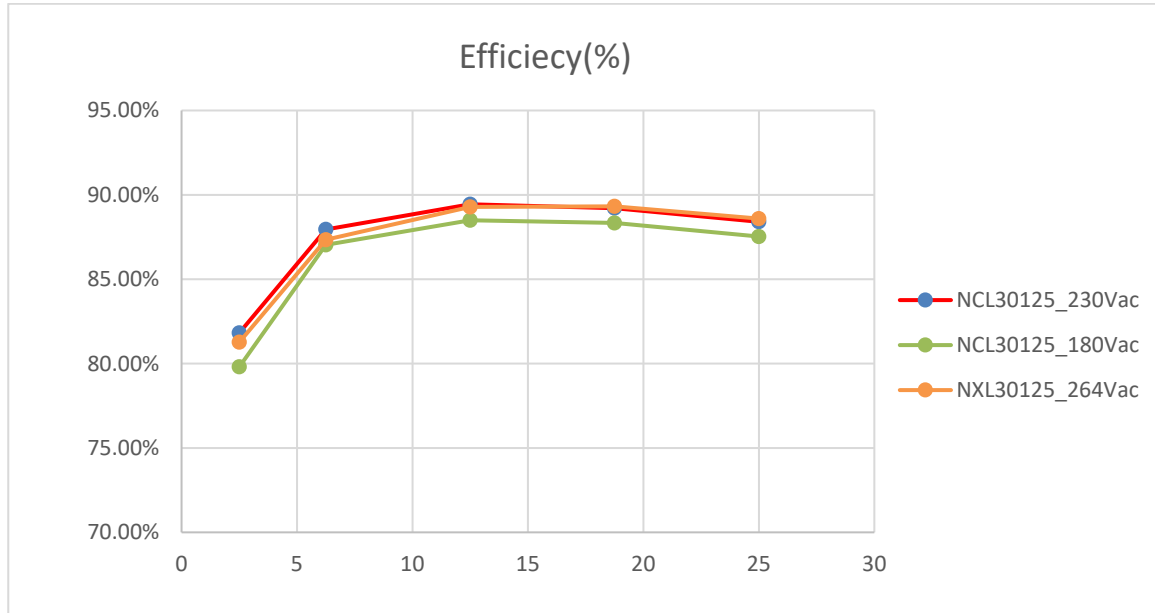
Pos.	Identification	Material	Turns	Turns in Total	Size	Winding Allowance	Tensile force required	Speed	Winding point		Remarks
									Beginning	End	
1	NP	THL-F	12	12	0.5mm				9	11	
2	Z1	Tape	1	1	7mm						
3	NH	THL-F	1	1	0.2mm				7	6	
4	Z2	Tape	2	2	7mm						
5	NS	Litz wire	3	3	0.1mm*150*2				4, 5start, 1, 2 end		
6											
7	Z3	Tape	2	2	7mm						
8	NP	THL-F	7	7	0.5mm				11	12	
9	Z4	Tape	1	1	7mm						
Bobbin: EQ4020											
Cores:											
LH = 3mH , no gap											



Pin definition

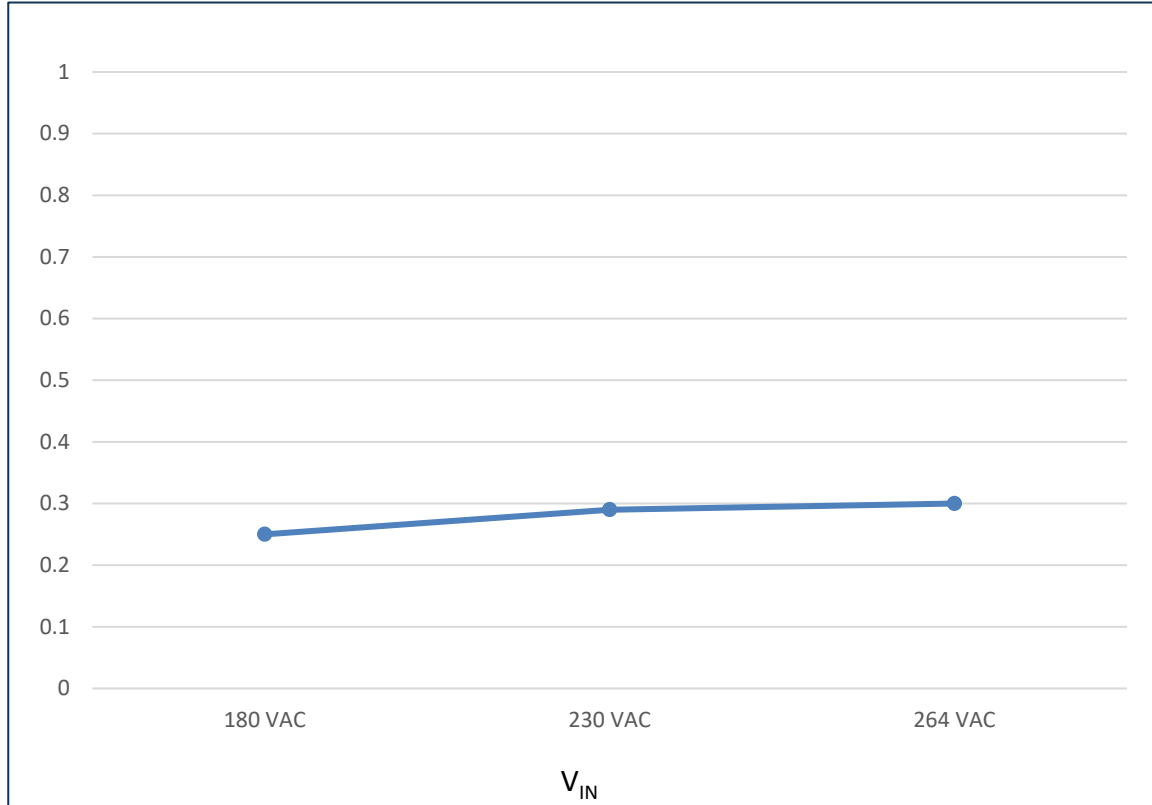
Efficiency Curve in different AC input voltage

Test condition: all efficiency are tested at board end

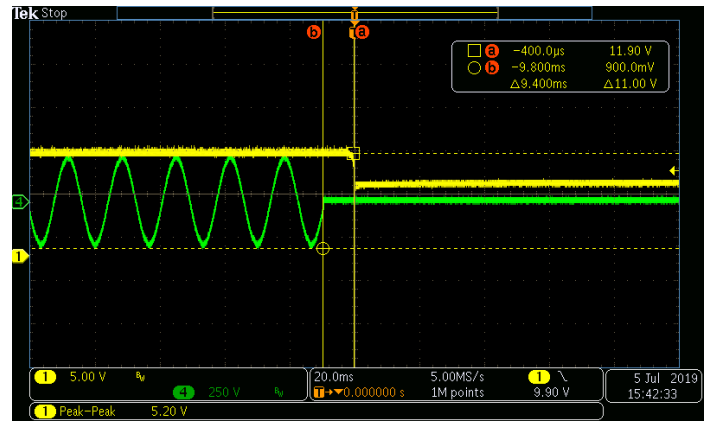
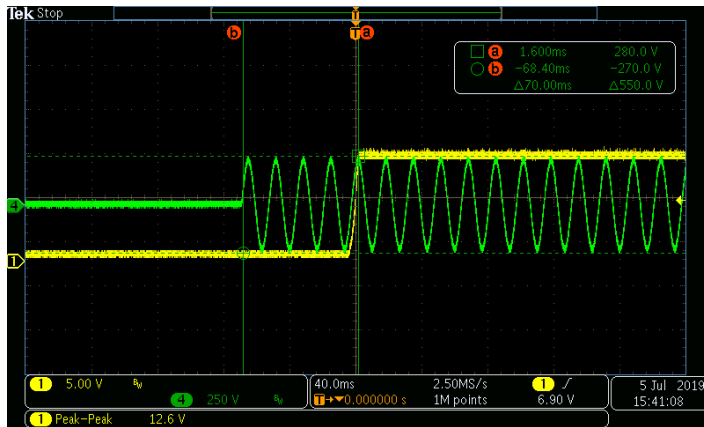


No load input power:

Test condition: no load

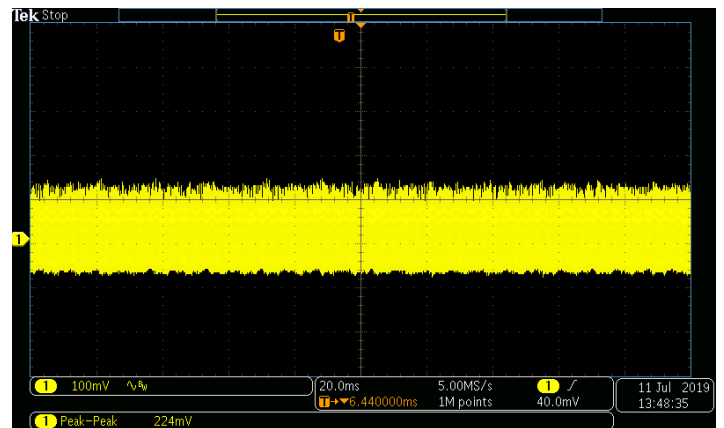
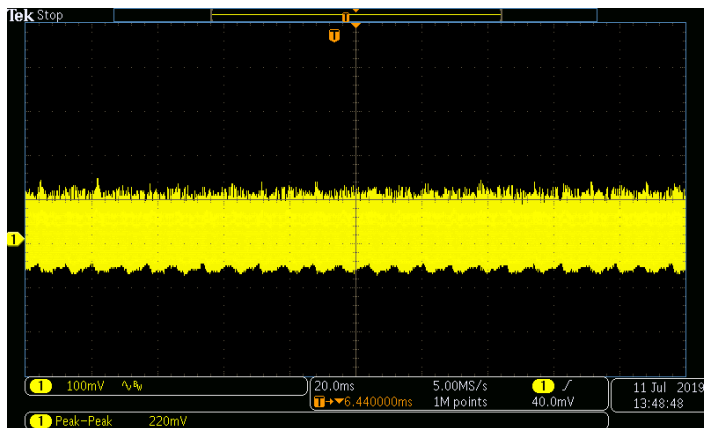


Start up time and Hold-up time:



Start up Time

Hold-up Time



Output Ripple @ 180 Vac Input, 25A Output

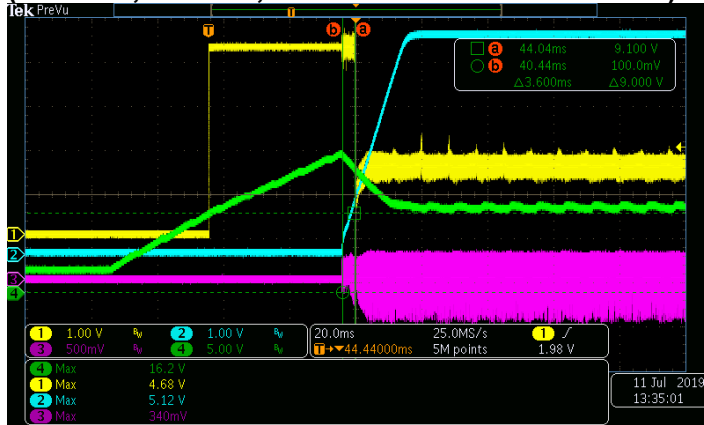
Output Ripple @ 230 Vac Input, 25A Output



Output Ripple @ 264 Vac Input, 25A Output

Start up @ 230 Vac Input, 12 Vdc Output

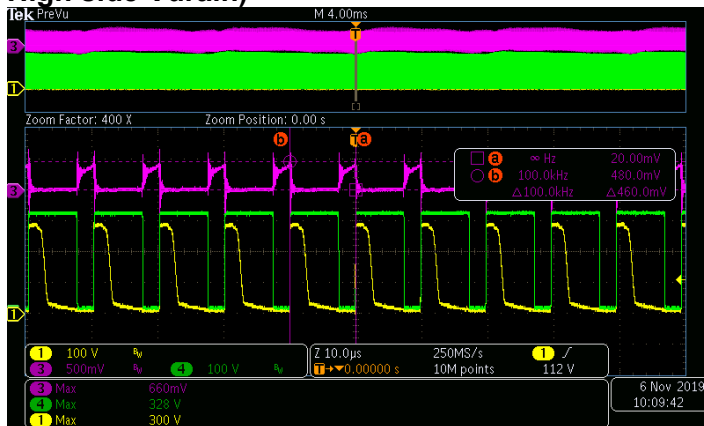
(CH1: FB, CH2:SS,CH3:Current sense CH4: Vcc)



Switch MOSFET wave form

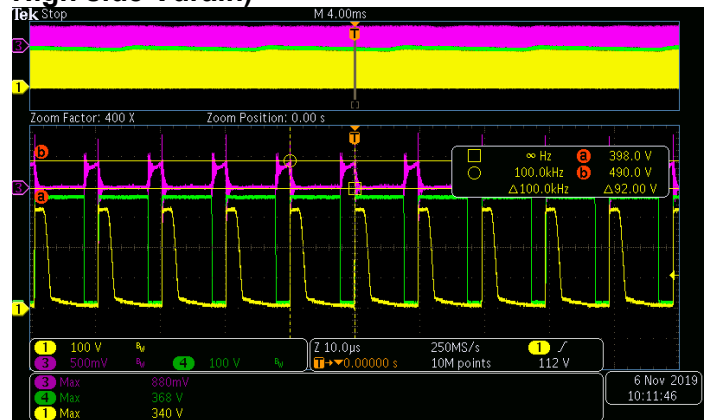
230 Vac input, 12V25A output

(CH1-Low side Vdrain CH3- Current sense CH4- High side Vdrain)



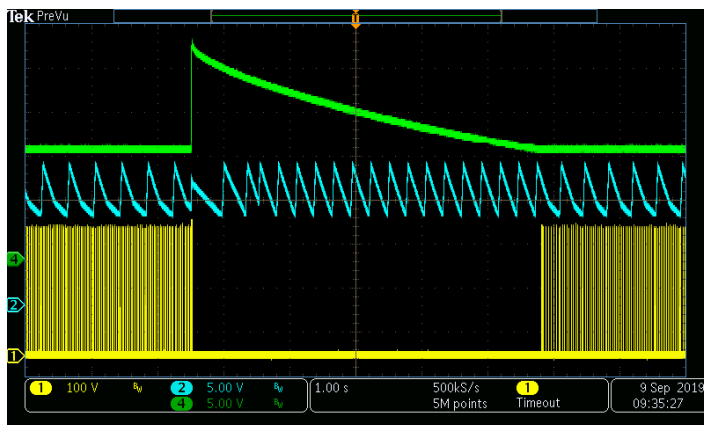
264 Vac input, 12V25A output

(CH1-Low side Vdrain CH3- Current sense CH4- High side Vdrain)

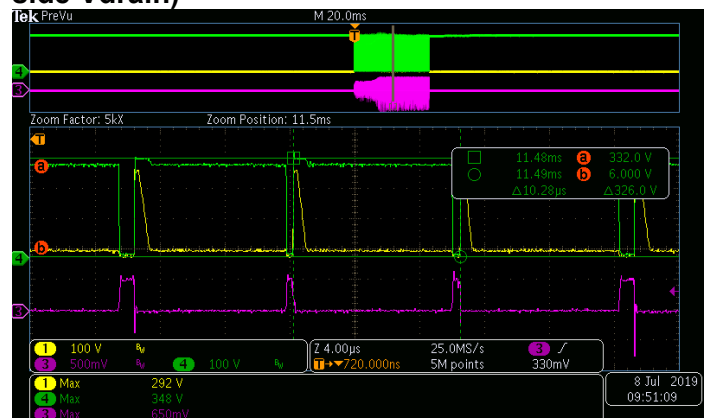


Output OVP, OCP & short circuit protection:

(Output OVP:CH1-VHB CH2- Vcc CH4- Output voltage)



(Output OCP:CH1-Low side Vdrain CH3- Primary Current sense C2 voltage CH4- High side Vdrain)



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BOM

Item	Qty	Reference	Type	Part Name	MFR	Value	Package	Description
1	1	NTC1	NTC	SPNL09D1R5MBI	SUNLORD	1.5ohm		
2	1	F1	FUSE	3.15A/250VAC	littelfuse	Micro Fuse 3.15A/250VAC		L8.5mm*W4mm*H8mm
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	3M/1206	1206	
6	2	R2,R3	Resistor	Std	Std	10M/1206	1206	
7	1	R4	Resistor	Std	Std	75K/0805	0805	
8	1	R18	Resistor	Std	Std	0R/1206	1206	
9	2	R5,R6	Resistor	Std	Std	2K2/0805	0805	
10	2	R7,R8	Resistor	Std	Std	100K/0805	0805	
11	1	R9	Resistor	Std	Std	10R/0805	0805	
12	1	R10	Resistor	Std	Std	820R/1206	1206	
13	3	R11,R13,R14	Resistor	Std	Std	10R/0805	0805	
14	3	R12,R15,R16	Resistor	Std	Std	47K/0805	0805	
15	1	R17	Resistor	ERJ1TRSJR10U	Panasonic	0R1	2512	Panasonic NO.:ERJ1TRSJR10U
16	1	R21	Resistor	ERJ1TRQFR51U	Panasonic	0.51R	2512	Panasonic NO.:ERJ1TRQFR51U
17	1	R114	Resistor	Std	Std	1K/0805	0805	
18	1	R116	Resistor	Std	Std	10K/0805	0805	
19	1	R117	Resistor	Std	Std	18K/0805	0805	
20	1	R118	Resistor	Std	Std	4K7/0805	0805	
21	1	C15	E-cap	861011385023	WE	400V/330uF	E-CAP	WE ORDER NO.:861011385023
22	2	C102,C103	E-cap	860080575018	WE	16V/3300uF	E-CAP	WE ORDER No.:860080575018
23	2	C8,C9	E-cap	860010673012	WE	50V/47uF	E-CAP	WE ORDER NO.:860010673012
24	1	C2	Ceramic cap	Std	Std	330pF/25V	0805	
25	3	C3,C4,C10	Ceramic cap	Std	Std	102/25V	0805	
26	2	C5,C107	Ceramic cap	Std	Std	223/25V	0805	
27	2	C6,C7	Ceramic cap	Std	Std	104/25V	0805	
28	2	Q1,Q2	MOSFET	FDP26N50	ON	500V/20A/TO-220	TO-220	
29	1	Q3	MOSFET	CS1N60	ON	600V/1A/D-PARK	D-PARK	

DNxxxxx/D

30	2	D13,D15	DIODE	MBR30L60CTG	ON	60V/30A/TO-220	TO-220	
31	3	D2,D3,D4	Diode	ES1J	ON	1KV/1A/SMA	SMA	
32	3	D8,D9,D12	DIODE	MMSD4148T1G	ON	100V/200mA	SOD123	
33	2	D5,D7	Diode	RS1D	ON	1KV/1A/SMA	SMA	
34	1	D1	Diode bridge	GBU8K	ON	8 A Bridge Rectifier	Micro-DIP	
35	1	D14	DIODE	MUR160	ON	Ultra-Fast Recovery/600V/1A	Axial Lead-2	
36	1	U1	Controller	NCL30125B2	ON	Two switch forward Controller		
37	1	U4	Optical coupler	FODM1007	ON	Optical coupler	LSOP4	
38	1	U3	Programmable Precision Reference	NCP431	ON	NCP431	SOT-23	
39	1	D11	Zener	MMSZ22T1G	ON	NC	SOD123	
40	5	M3 screw(螺丝)	M3 screw	Std	Std	M3 screw		For D1,Q1,Q2,D13,D15 assemble to heatsink
41	2	Isolation pads (绝缘垫片)		Std	Std		TO-220	For D13, D15 assemble to heatsink
42	2	Insulating rubber particles (绝缘胶粒)		Std	Std			For D13, D15 assemble to heatsink

References

ON Semiconductor datasheet for NCL30125.

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