NCP1568DC48WGEVB

48 W Server AUX Power Supply Solution Evaluation Board User's Manual

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EVAL BOARD USER'S MANUAL

Circuit Description

This design note describes a 48 W, wide range DC input, constant voltage power supply, NCP1568DC48WGEVB, intended for Server AUX power supply and others DC input applications requiring fixed voltage output, low profile, high efficiency and high power density.

The NCP1568DC48WGEVB uses an Active Clamp Flyback (ACF) topology utilizing ON Semiconductor NCP1568 ACF controller, NCP51530A half−bridge driver, NCP4306 synchronous rectified controller and secondary NTMFS6B03 synchronous MOSFET. This Design Note provides the complete circuit schematic details, PCB and BOM for the NCP1568 48 W DC input Power adapter solution that supports fixed 12 V output voltage and 4 A current.

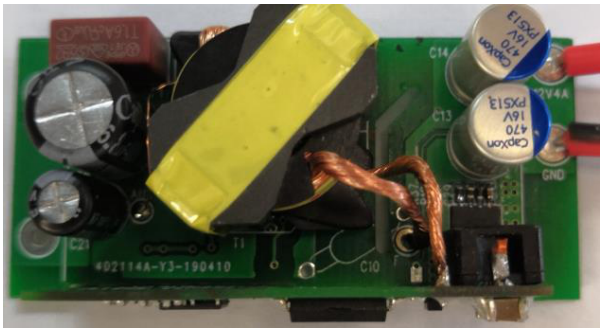
This design uses an ACF topology to implement a Zero Voltage Switching (ZVS) operation with high switching frequency and secondary CLC circuitry to implement secondary Zero Current Switching (ZCS). In order to keep cost low, (2) SJ MOSFETs are used on the primary side for power switching.

Key Features

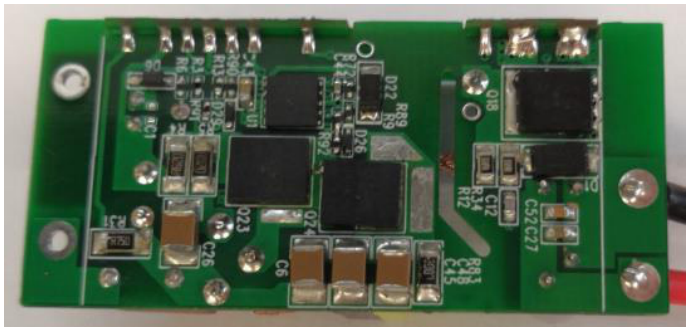
- DC Input from 120 V to 400 V
- ACF Topology with ZVS Operation
- High Voltage Startup Current eliminates Startup Resistor
- High Frequency Operation to allow Low Profile Transformer: RM7 Transformer
- ACF Operation Frequency Range from 110 kHz to 400 kHz
- Quite Skip and Flyback DCM Operation with Frequency Foldback at No Load and Light Load
- Rated Output Power: 12 V, 4 A
- Ripple and Noise <80 mV
- Efficiency: >94% at 156 Vdc and 320 Vdc @ Full Load
- Output OVP
- Output OCP, SCP
- Open Loop Protection
- Board Size: 40 mm x 24 mm x 17 mm
- Power Density: 48 W/inch^3

	Output Specification
Output Voltage	12 V
Nominal Current	4 A
Max Current	4 A
Min Current	Zero
Avg. Efficiency	>94% @ 12 V / 4 A at board end, 160 & 320 Vdc
Ripple	<80 mV
Standby Power	<150 mW
Power Density	48 W/in^3
Protection	Adaptive UVP, OVP, OVP, SCP, OTP
Size	40 mm x 24 mm x 17 mm

Device	Application	Input Voltage	Output Power	Topology	I/O Isolation
NCP1568S02DBR2G NCP51530AMNTWG NCP4306AADZZZAMNTWG NTMFS6B03NT1G	Server AUX power supply and other DC input applications	120 Vdc to 400 Vdc	48 W	Flyback	Isolated (3 kV)



Top View



Bottom View

Figure 1. Evaluation Board Photos

CIRCUIT SCHEMATIC

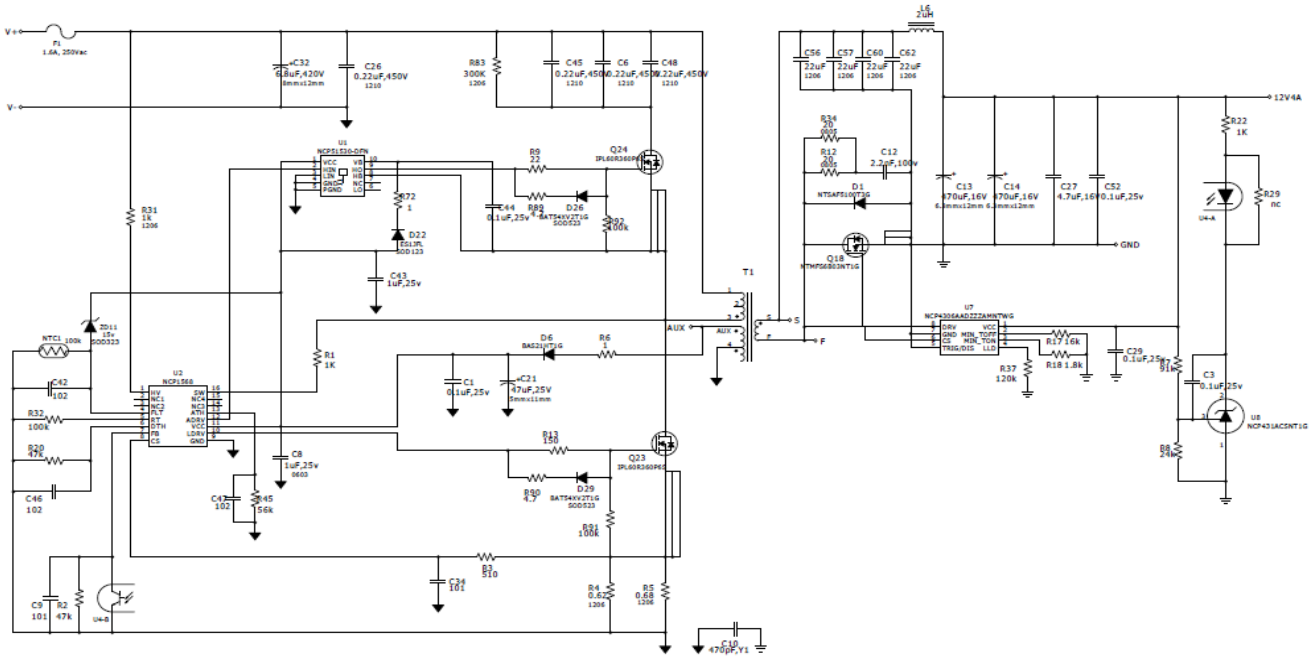


Figure 2. Circuit Schematic

PCB

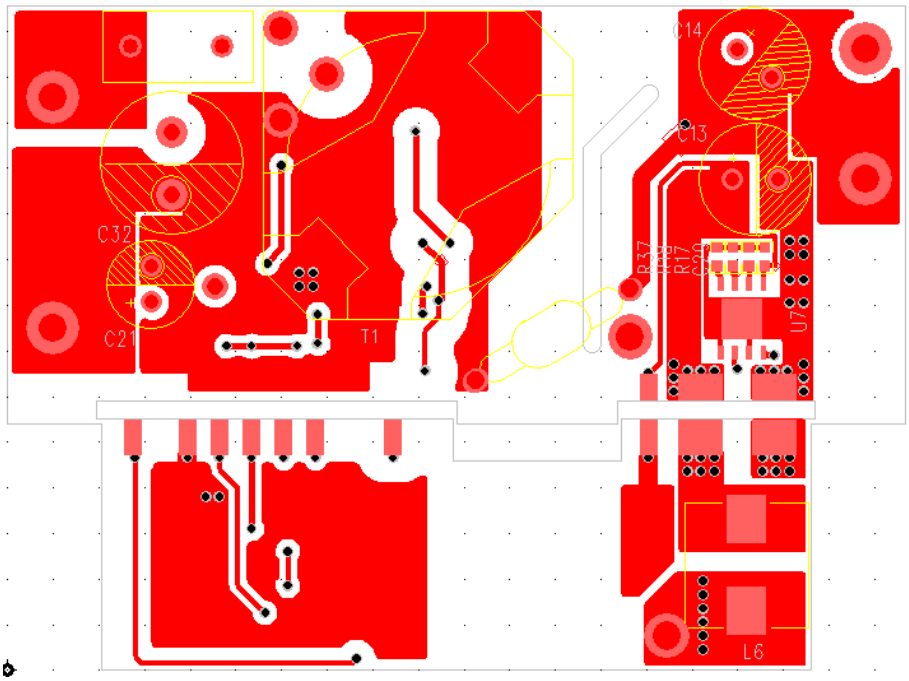


Figure 3. Top View of Mainboard PCB

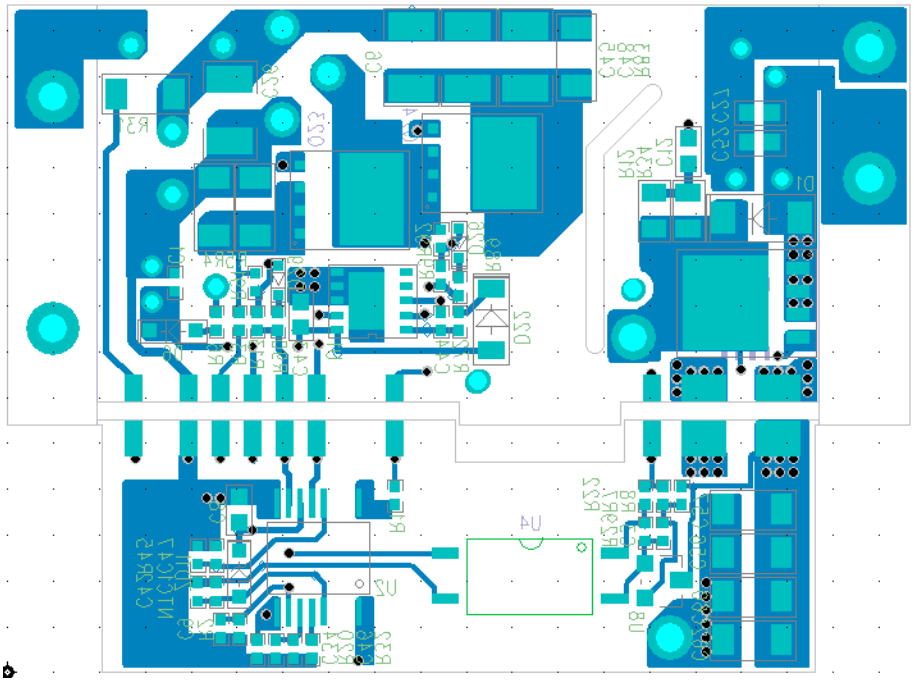


Figure 4. Bottom View of Mainboard PCB

T1 TRANSFORMER DESIGNS

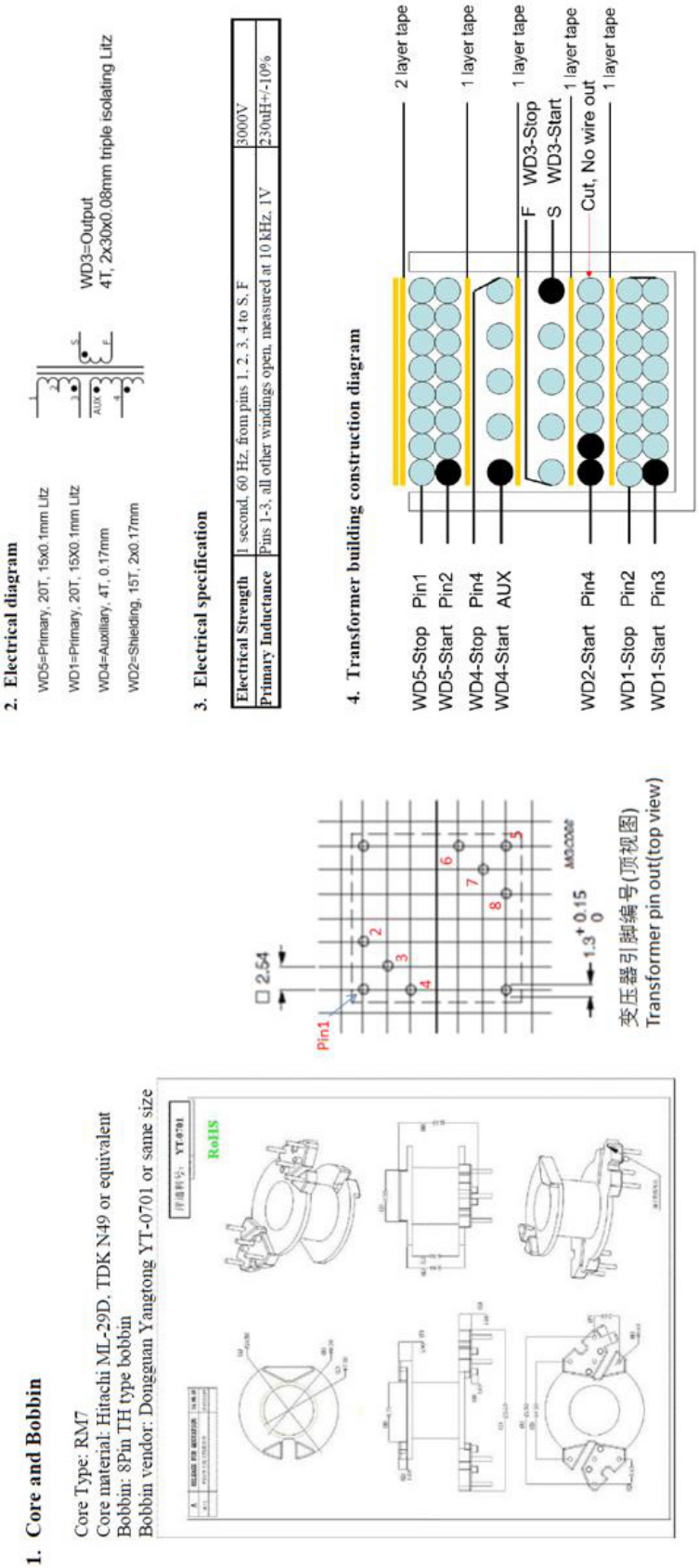
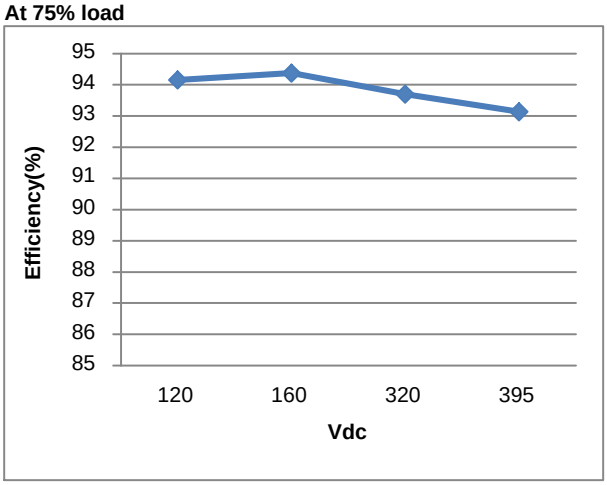


Figure 5.

Efficiency

Test Condition: all efficiency are tested at board end

At 75% load



At 100% load

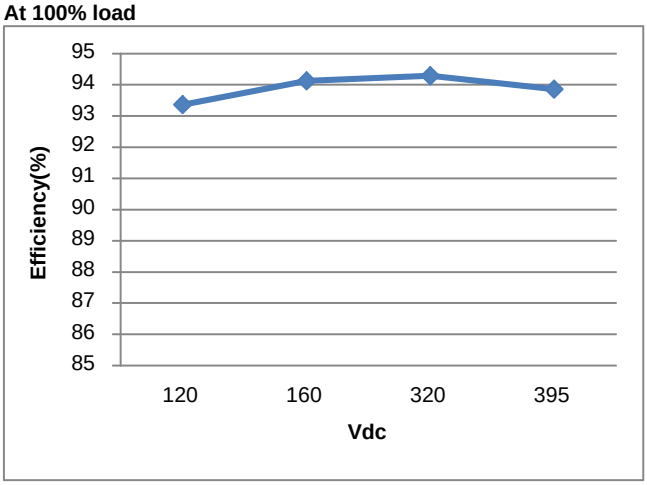
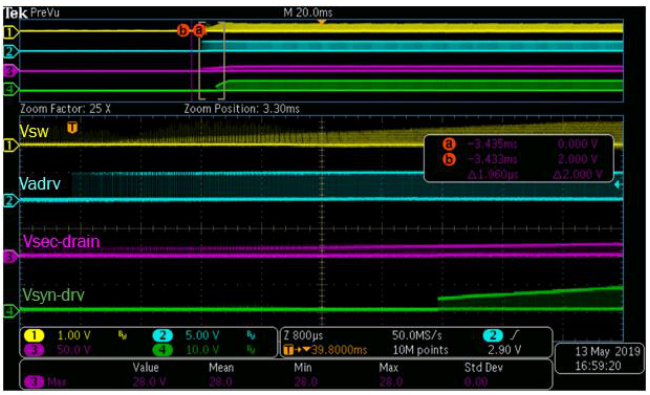
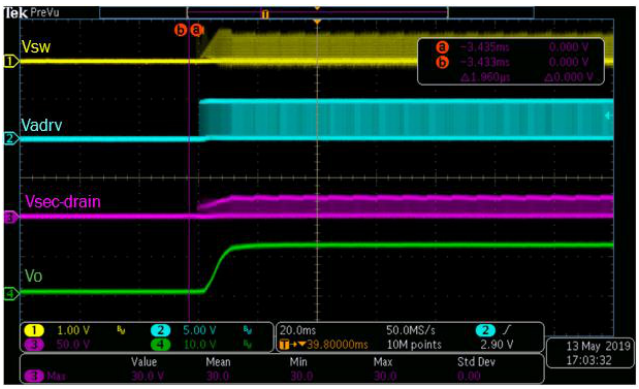


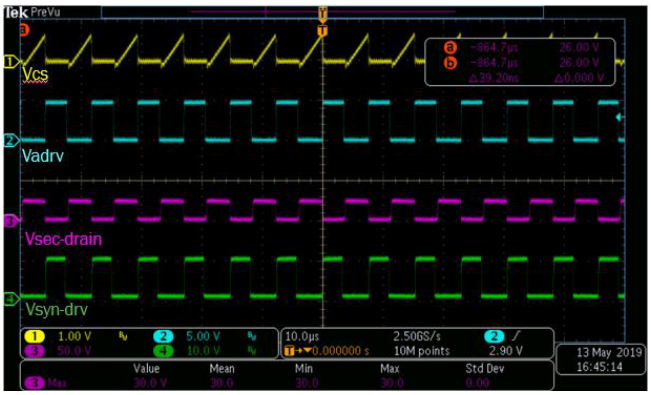
Figure 6. Efficiency

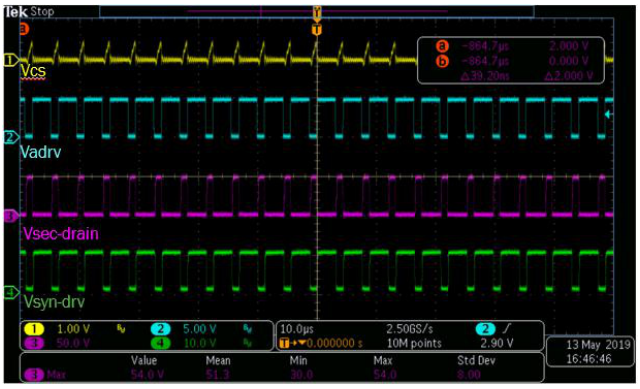




(CH1 Vsw, CH2: Vadrv, CH3: Vsec−drain, CH4: Vsyn−drv)

Figure 7. Startup Waveform at 120 Vdc





120 Vdc (CH1 Vsw, CH2: Vadrv, CH3: Vsec−drain, CH4: Vsyn−drv)

395 Vdc (CH1 Vsw, CH2: Vadrv, CH3: Vsec−drain, CH4: Vsyn−drv)

Figure 8. Working Waveform at Full Load

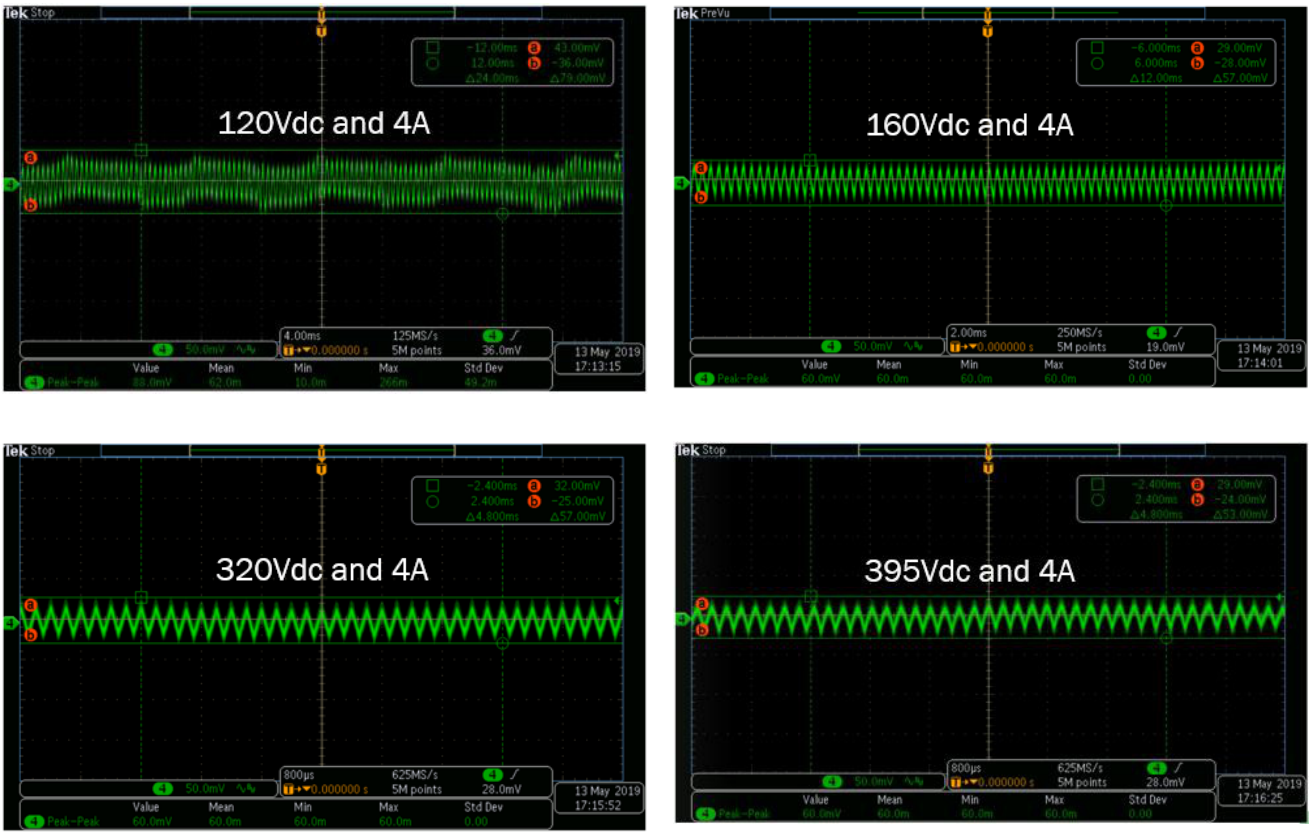
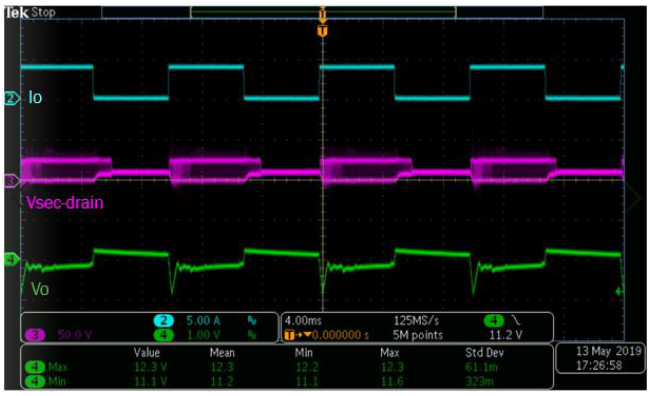


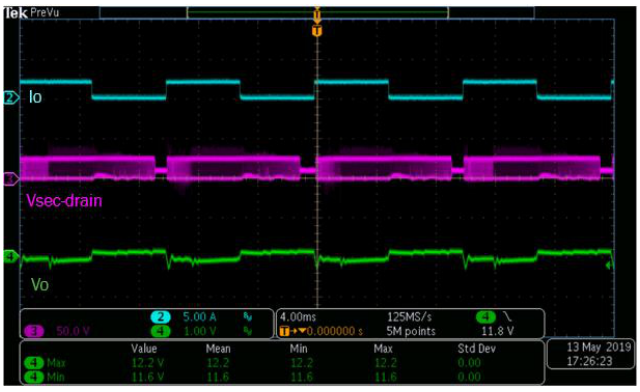
Figure 9. Output Ripple at Full Load

(CH2: Io, CH3: Vsec−drain, CH4: Vo)



Test condition: 0 − 4 A, 10 ms cycle, 125 mA/μs, 1 m cable, tested at E−load

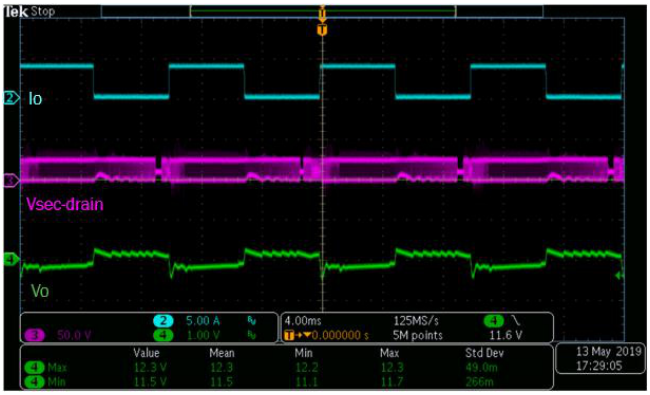
(CH2: Io, CH3: Vsec−drain, CH4: Vo)



Test condition: 0 − 2 A, 10 ms cycle, 125 mA/μs, 1 m cable, tested at E−load

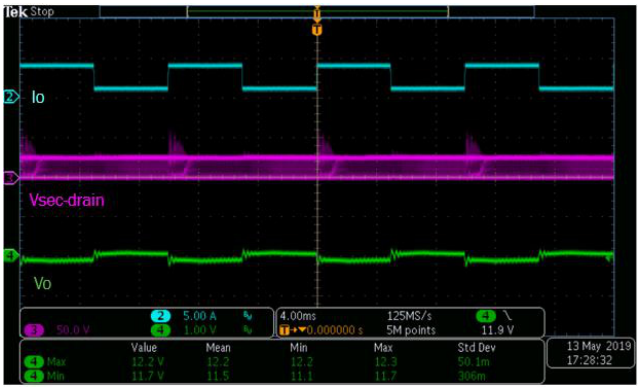
Figure 10. Dynamic Test at 160 Vdc

(CH2: Io, CH3: Vsec−drain, CH4: Vo)



Test condition: 0.1 A − 4.0 A, 10 ms cycle, 125 mA/μs, 1 m cable, tested at E−load

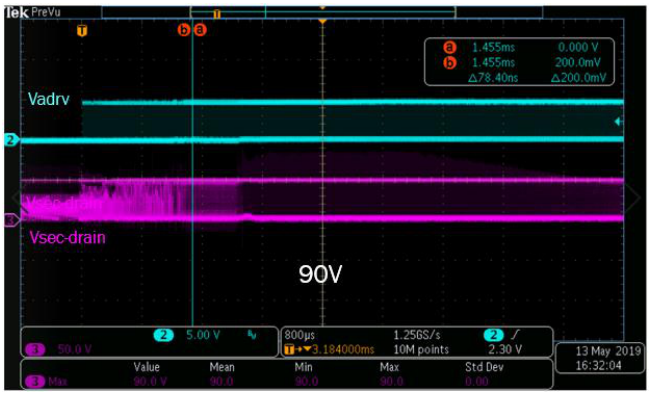
(CH2: Io, CH3: Vsec−drain, CH4: Vo)



Test condition: 1 A − 4 A, 10 ms cycle, 125 mA/μs, 1 m cable, tested at E−load

Figure 11. Dynamic Test at 160 Vdc

395 Vdc input, 500 MHz BW
(CH2: Vadrv, CH3: Vsec−drain)



395 Vdc input, 20 MHz BW
(CH2: Vadrv, CH3: Vsec−drain)

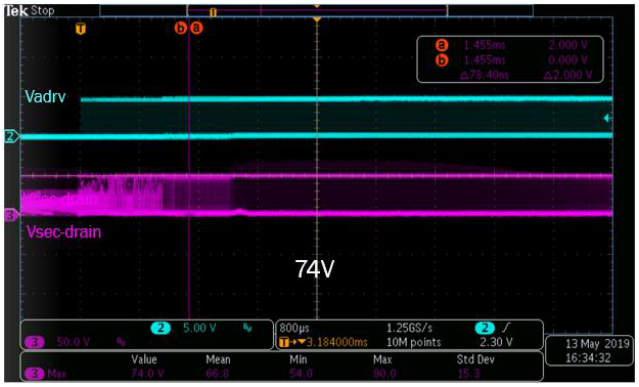


Figure 12. Secondary Voltage Stress during DCM to ACF Mode Transition

Table 1. THERMAL IMAGE @ 12 V / 4 A Output

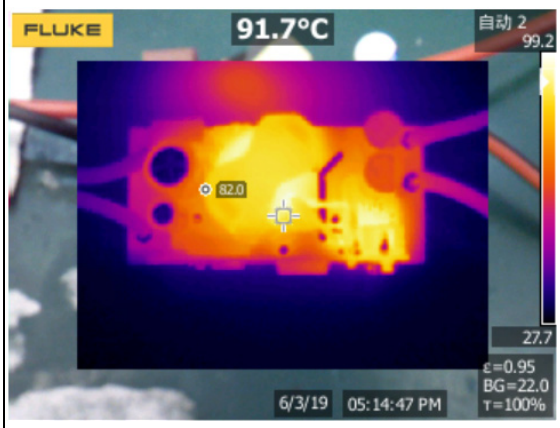
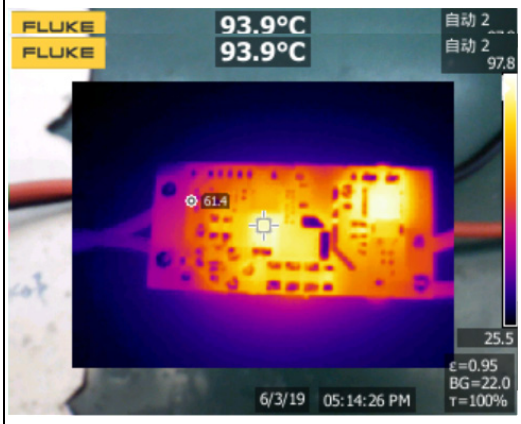
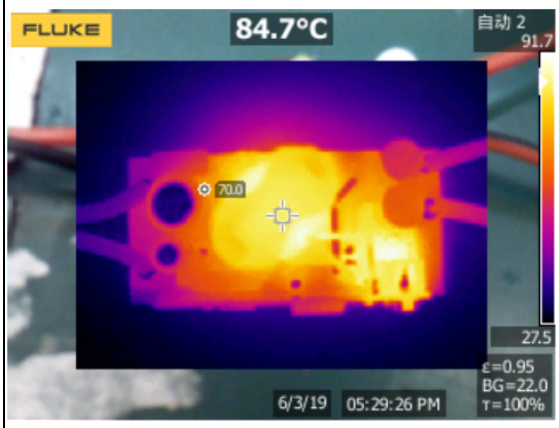
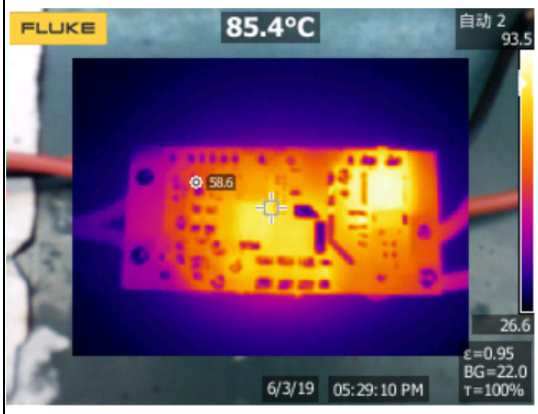
Input	Component Side	Back side
120 Vdc		
160 Vdc		

Table 1. THERMAL IMAGE @ 12 V / 4 A Output (continued)

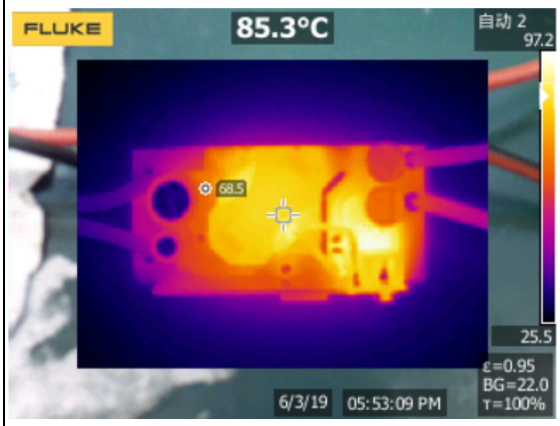
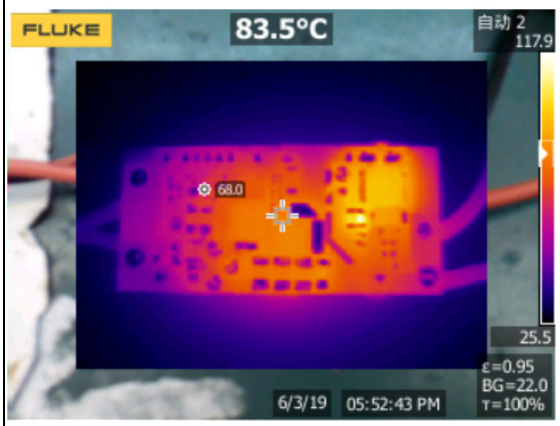
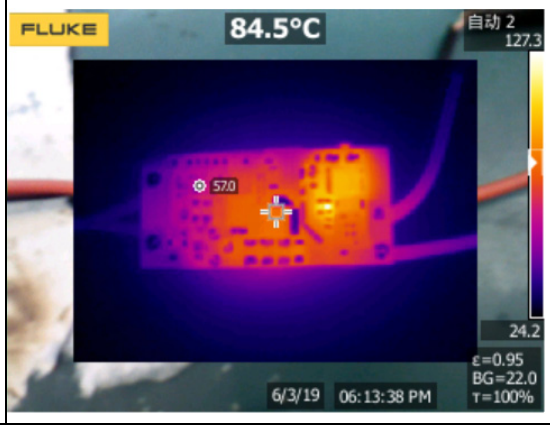
Input	Component Side	Back side
320 Vdc		
395 Vdc		

Table 2. BILL OF MATERIAL

Item	Qty	Reference	Type	Part Name	Package	MFR	Value	Description
1	4	C1 C3 C29 C44	Ceramic Capacitor	/885012105018	402	Wurth	0.1 uF, 25 V	Capacitor, Ceramic, 25 V, 10%
2	1	C52	Ceramic Capacitor	/885012206071	603	Wurth	0.1 uF, 25 V	Capacitor, Ceramic, 25 V, 10%
3	4	C6 C26 C45 C48	Ceramic Capcitor	C3225X7T2W224K	1210	TDK	0.22 uF, 450 V	Capacitor, Ceramic, Chip, 10%
4	2	C9 C34	Ceramic Capacitor	/885012205055	402	Wurth	101	Capacitor, Ceramic, 50 V, 10%
5	1	C42	Ceramic Capacitor	/885012205061	402	WE	102	Capacitor, Ceramic, 50 V, 10%
6	2	C46−47	Ceramic Capacitor	/885012205061	402	WE	102	Capacitor, Ceramic, 50 V, 5%
7	1	C8	Ceramic Capacitor	/885012206076	603	Wurth	1 uF, 25 V	Capacitor, Ceramic, 10%
8	1	C43	Ceramic Capacitor	/885012206076	603	WE	1 uF, 25 V	Capacitor, Ceramic, 25 V, 10%
9	1	C12	Ceramic Capacitor	C1608X7R2A222K	603	TDK	2.2 nF, 100 V	Capacitor, Ceramic, SMD, 5%
10	4	C56−57 C60 C62	Ceramic Capcitor	C3216X5R1V226M 160AC	1206	TDK	22 uF	Capacitor, Ceramic, SMD, 5%
11	1	C27	Ceramic Capacitor	C1608X6S1C475M	603	TDK	4.7 uF, 16 V	Capacitor, Ceramic, 16 V, 10%
12	1	C10	Ceramic Capcitor	CS65−B2GA101K-YNKA	Lead type	TDK	470 pF, Y1	Y Capacitor,safety standard approved, 10%
13	1	D6	Switching diode	BAS21HT1G	SOD323	ON	0.2 A, 250 V	Swiching diode, 0.2 A, 250 V
14	2	D26 D29	Schotty diode	BAT54XV2T1G	SOD523	ON	0.2 A, 30 V	Schotty diode, SMD
15	1	D22	Ultrafast diode	ES1JFL	SOD123	ON	1 A, 600 V	Ultrafast diode, SMD
16	1	D1	Schotty rectifier	NTSAF5100T3G	SOD123FL	ON	5 A, 100 V	Schotty Rectifier, 5 A, 100 V
17	1	F1	Fuse	20T−016H	Axial lead	Hollyfuse	1.6 A, 250 Vac	Micro Fuse, 1.6 A / 250 V
18	1	U8	voltage reference	NCP431ACSNT1G	SOT23	ON		PROGRAMMABLE PRECISION REFERENCE
19	1	U2	ACF controller	NCP1568S02ADBR2G	TSSOP16	ON		ACF controller
20	1	U7	Syn. rectified controller	NCP4306AADZZZAMNTWG	SO8	ON		Syn. Rectified Controller
21	1	U1	HB driver	NCP51530AMNTWG	DFN10 4X4	ON		HB driver
22	1	NTC1	NTC	SDNT1608X104J4250HTF	603	Shunlord	100k	replaced by 13k resistor
23	1	U4	Optical coupler	FODM1009	LSOP4	ON		optical coupler, standard SOP package
24	1	L6	SMD Inductor	/744314200	7050	WE	2.2 uH	WE−HCI SMD Flat Wire High Current Inductor
25	2	R6 R72	Resistor	Std	402	Std	1	Resistor, Chip, 1/16W, 1%
26	1	R18	Resistor	Std	402	Std	1.8k	Resistor, Chip, 1/16W, 1%

Table 2. BILL OF MATERIAL (continued)

Item	Qty	Reference	Type	Part Name	Package	MFR	Value	Description
27	3	R32 R91−92	Resistor	Std	402	Std	100k	Resistor, Chip, 1/16W, 1%
28	1	R37	Resistor	Std	402	Std	120k	Resistor, Chip, 1/16W, 1%
29	1	R13	Resistor	Std	402	Std	150	Resistor, Chip, 1/16W, 1%
30	1	R17	Resistor	Std	402	Std	16k	Resistor, Chip, 1/16W, 1%
31	2	R1 R22	Resistor	Std	402	Std	1K	Resistor, Chip, 1/16W, 1%,
32	1	R9	Resistor	Std	402	Std	22	Resistor, Chip, 1/16W, 1%
33	1	R8	Resistor	Std	603	Std	24k	Resistor, Chip, 1/16W, 1%
34	2	R89−90	Resistor	Std	402	Std	4.7	Resistor, Chip, 1/16W, 1%
35	2	R2 R20	Resistor	Std	402	Std	47k	Resistor, Chip, 1/16W, 1%
36	1	R3	Resistor	Std	402	Std	510	Resistor, Chip, 1/16W, 1%
37	1	R45	Resistor	Std	402	Std	56k	Resistor, Chip, 1/16W, 1%
38	1	R7	Resistor	Std	402	Std	91k	Resistor, Chip, 1/16W, 1%
39	1	R29	Resistor	Std	402	Std	nc	Resistor, Chip, 1/16W, 1%,
40	1	R4	Resistor	ERJ8BQFR062V	1206	Panasonic	0.62	Resistor, Chip, 1/2W, 1%
41	1	R5	Resistor	ERJ8BQFR068V	1206	Panasonic	0.68	Resistor, Chip, 1/2W, 1%
42	1	R31	Resistor	Std	1206	Std	1k	Resistor, Chip, 1/4W, 1%
43	2	R12 R34	Resistor	Std	805	Std	20	Resistor, Chip, 1/5W, 1%
44	1	R83	Resistor	Std	1206	Std	300K	Resistor, Chip, 1/4W, 1%
45	1	T1	Trans-former	RM7	TH type	Wurth		RM7, 8Pin
46	2	C13−14	Electrolyt-ic solid capacitor	PX471M016E120P	6.3 mm x 12 mm	CapXon	470 uF, 16 V	size: 6.3 mm x 12 mm
47	1	C21	ECAP	KF Series	5 mm x 11 mm	CapXon	47 uF, 25 V	size: 6.3 mm x 11 mm
48	1	C32	ECAP	KF Series	8 mm x 12 mm	CapXon	6.8 uF, 420 V	size: 8 mm x 12 mm
49	1	Q18	MOSFET	NTMFS6B03NT1G	QFN5X6	ON		MOSFET, NChan, 100 V
50	2	Q23−24	MOSFET	IPL60R360P6S	ThinkPAK5-X6	INFINEON		MOSFET, NChan, 600 V
51	1	ZD11	zener	MM3Z11VT1G	SOD323	ON	16v	GENERIC ZENER−DIODE
52	4	12V4A GND V+ V−	connec-tion terni-mal	Std	Ø1mm	Std		connection ternimal or wire

References

ON Semiconductor datasheet for NCP1568, NCP51530, NCP4306, NTMFS6B03
ON Semiconductor Design Notes DN05043

ADDITIONAL INFORMATION

TECHNICAL PUBLICATIONS:
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