ON Semiconductor

Design Note – DN06028/D

7 W, Non-Isolated Buck AC-DC Converter

Device	Application	Input Voltage	Output Power	Topology	I/O Isolation
NCP1055	1 Output AC to DC converter	108-132 Vac	7 Watts	Non-Isolated Buck Converter	No

Other Specifications

	Output
Output Voltage	91 V
Ripple	3 V
Nominal Current	75 mA
Max Current	100 mA
Min Current	8 mA

PFC (Yes/No)	No
Inrush Limiting / Fuse	None
Cooling Method/Supply Orientation	Convection

Circuit Description

This design note explains the changes required to modify the NCP1052 Buck Demo Board's (AND8098/D) output from 12V/100mA into 91V/75mA. Please read the original NCP1052 evaluation board manual for reference[1].

Design Considerations

NCP105X and Inductor

The first step in the design process is determining which version of the NCP105x to use. Refer to the "NCP105x Discontinuous Mode Flyback Design Worksheet"[2]. The desired input voltages of this particular board range from 108 to 132 Vac (about 150 Vdc to 190 Vdc). The inductor is chosen to be around 390 μH, a slightly reduced value compared to the original NCP1052 circuit. The result from table 1 of the Worksheet indicates that the NCP1055 at 136 kHz can be used for the desired output power of 7 W. A different version NCP105X may be suggested by the Worksheet by simply changing the inductor value. The NCP1055 136 kHz version is used in this design.

Zener Diodes

The output voltage of the converter is set by the breakdown voltage of Z1. The breakdown voltage of the diode is calculated using the equation below:

$$V_{Z1} = Vout - 5V$$

This equation comes from application note AND8098/D. A 91 V output is achieved using an 86 V Zener. The breakdown of zener diodes can be added in series to obtain the desired breakdown voltage. In this design two 43 V Zeners in series are used for Z1. Zener diode Z1 is used in the original NCP1052 board to clamp the voltage down at light or no load. However, the higher voltage of this design requires a higher power dummy load (R2) to maintain the output in regulation when no load is present. It may be possible to use a lower frequency version of the NCP1055 and reduce the power rating of R2.

Capacitors

Since the output voltage is increased to 91V, the output capacitor (C5) must be changed. An electrolytic capacitor is used as they are more readily available at this voltage level. The value of C5 is reduced to reduce cost. The value of the bulk input capacitor (C3) is increased from 10 μF to 33 μF to reduce the input voltage ripple to 3 V. C3 and C5 can be increased to reduce the output voltage ripple, or they may be reduced to reduce cost. Capacitor C2 is increased to increase the startup time. Finally, a filtering capacitor (C4) is added between the feedback pin and source pin to reduce noise into the feedback pin; this is a very important addition to the board.

Unchanged Components

Diodes D1, D2, D3, D4 and Capacitor C1 remain the same as the original NCP1052 board.

[1] *Available at http://www.onsemi.com/pub/Collateral/NCP1052EVB_MANUAL.PDF.*

[2] *Available at http://www.onsemi.com/pub/Collateral/NCP105X_WORKSHEET.XLS*

Key Features

- Low-cost, simple design
- Relatively few changes for output voltage change
- Self-powered from high input voltage
- Frequency jittering for low electromagnetic interference(EMI)
- Thermal and short circuit fault protection

Schematic

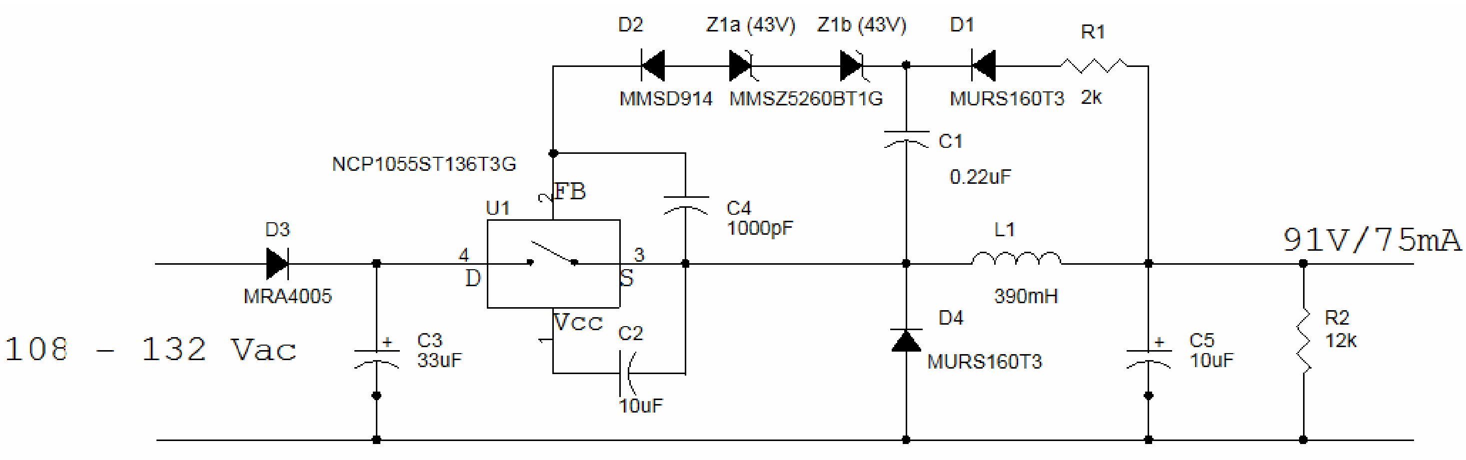

Figure 1: Circuit Schematic

Bill of Materials

Designator	Quantity	Description	Value	Tolerance	Manufacturer	Manufacturer Part Number
U1	1	Switching Regulator	680 mA / 136 kHz	N/A	ON Semiconductor	NCP1055ST136G
D1, D4	2	Ultrafast Diode	1 A / 600 V	N/A	ON Semiconductor	MURS160T3
D2	1	Switching Diode	200 mA / 100 V	N/A	ON Semiconductor	MMSD914T1
D3	1	General Diode	1 A / 600 V	N/A	ON Semiconductor	MRA4006T1
Z1a, Z1b	2	Zener Diode	43 V	5%	ON Semiconductor	MMSZ5260BT1G
R1	1	Chip Resistor	2 kΩ / 250 mW	5%	Vishay	CRCW12062K00JNEA
R2	1	Axial Resistor	12 kΩ / 1 W	10%	Ohmite	OX123KE
C1	1	Ceramic Capacitor	0.22 µF / 50 V	10%	Vishay	VJ1206Y224KXXA
C2	1	Tantalum Capacitor	10 µF / 25 V	10%	Vishay	595D106X9025B2T
C3	1	Electrolytic Capacitor	33 µF / 450 V	20%	Panasonic	ECA-2WM330
C4	1	Ceramic Capacitor	1000 pF / 50 V	10%	Vishay	VJ1206Y102KXXA
C5	1	Electrolytic Capacitor	10 µF / 250 V	20%	Panasonic	ECA-2EM100
L1	1	Inductor	390 µH / 450 mA	20%	Coilcraft	RFB0807-391L

Output Waveforms*

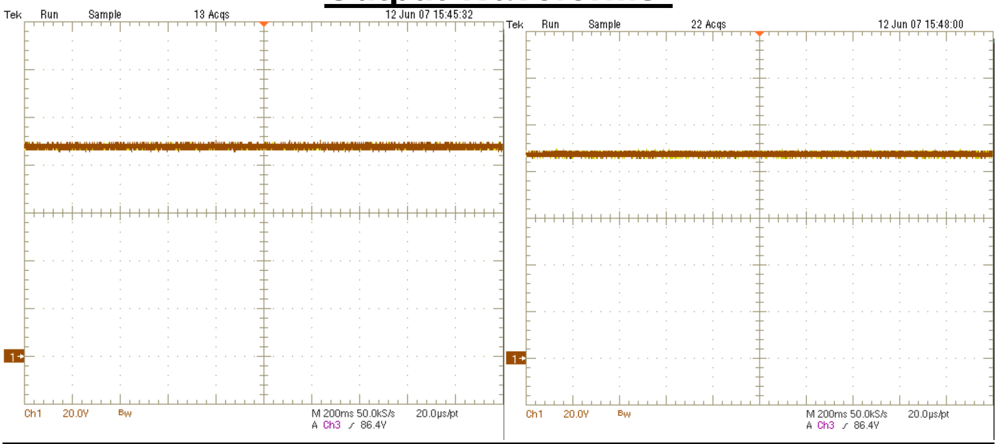

Figure 2: 89V Output at Full Load
(Left: Vin=108Vac, Right: Vin=132Vac)

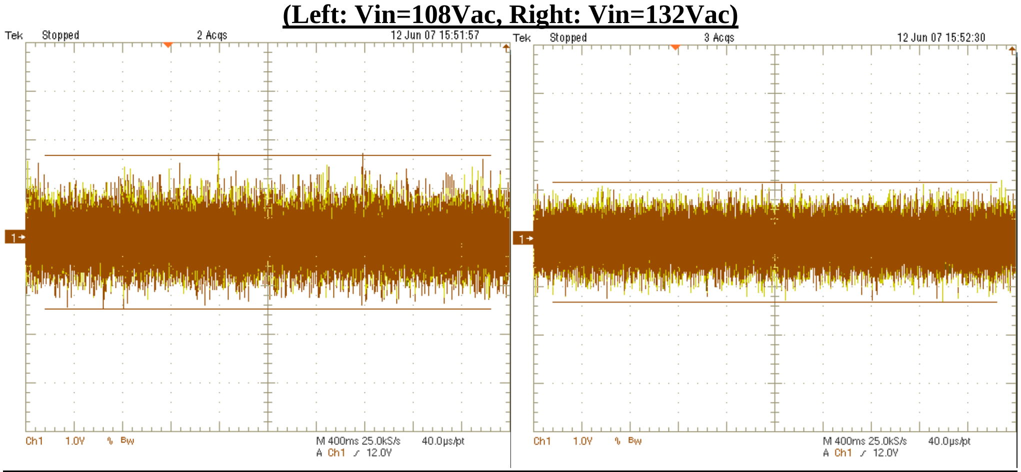

Figure 3: 89V Output 3V Ripple
(Left: Vin=108Vac, Right: Vin=132Vac)

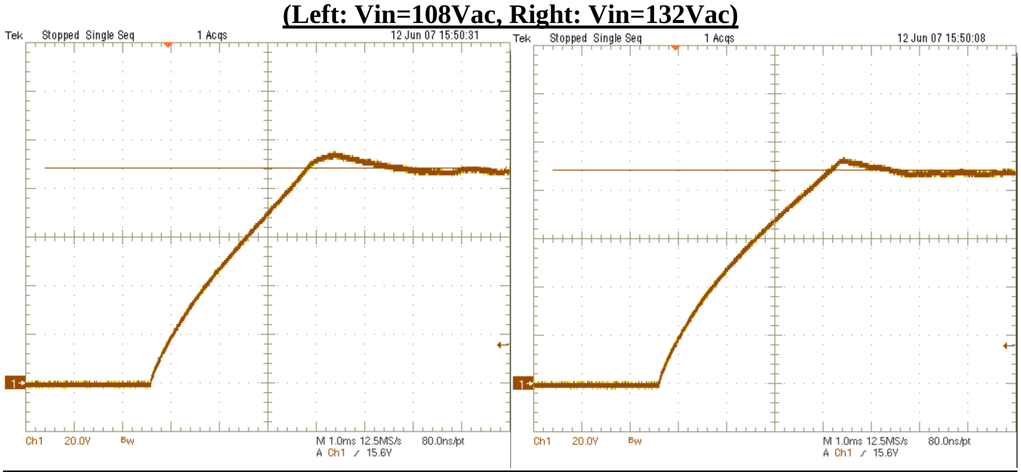

Figure 4: 89V Output at Startup
(Left: Vin=108Vac, Right: Vin=132Vac)

*Note: output waveforms in Figures 2 through 4 were taken using an 89 V version of the board. The only difference being the breakdown voltage of the Zener diodes.

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