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Design Note – DN05036/D

A 12V, Monolithic Off-line Power Supply With Primary Side Regulation (PSR)

Device	Application	Input Voltage	Output Power	Topology	I/O Isolation
NCP1075	White Goods, E-Meters, Industrial Equipment	90 – 267 Vac	10 Watts	Flyback	2.5 kV primary to secondary

	Output 1
Output Voltage	12 Vdc +/- 5%
Ripple	100 mV
Nominal Current	800 mA
Max Current	1.2 Amps
Min Current	50 mA for Vout < 13V

Others	Input EMI filter

Circuit Description

This Design Note describes a very simple, primary side controlled, 10 watt, off-line flyback power supply using ON Semiconductor's NCP1075 current mode controller (SO-223 package). The power supply design is intended for low power applications such as E-meters, white goods, instruments, and industrial equipment where an output voltage regulation of +/-5% over a load range of 5% to 100% is acceptable with a Vout of 12 volts or greater. .

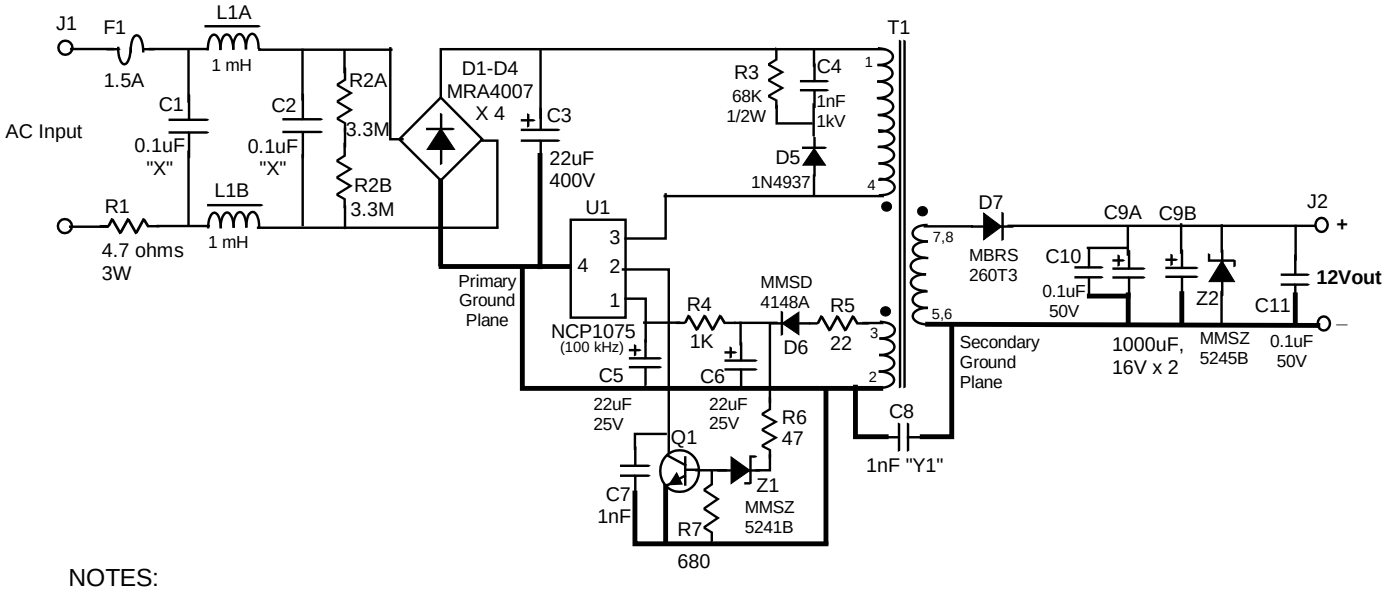
The design dispenses with the conventional TL431 and optocoupler sensing/feedback scheme and uses primary side voltage sensing on the NCP1075's Vcc rail which is derived from an aux winding on the transformer. This scheme provides tight line regulation and a typical load regulation of +/- 5% which is more than adequate for most applications. The acceptable load regulation is achieved by tight coupling (bifilar winding) between the main 12V secondary and the 12V aux winding in the transformer. The voltage sensing circuit is comprised of Z1 and Q1. The zener voltage of Z1 plus the V_{BE} drop of Q1 sets the nominal output voltage. The regulation over the usable load range and the nominal output voltage can be further optimized by adjusting the values of resistors R5 and R6, respectively.

Over-current limiting is provided by sensing the peak current in the NCP1075's internal MOSFET. Once the 450 mA threshold level is exceeded, the circuit will go into a "hiccup" mode until the over-current condition is removed. An optional output OVP clamp is also implemented via Z2 to limit the maximum no load output voltage. The output at no load will typically rise to about 15 volts (for Vout nominal = 12V) where a small 500 mW zener will clamp it to an acceptable level. If desired the clamp level can be lowered to 13 or 14 volts with the appropriate zener diode.

Key Features

- Primary side voltage sensing – no optocoupler for feedback
- Up to 10 watts output
- Input EMI filter for conducted EMI compliance
- Schottky output rectifier for high efficiency
- Current mode control with 700 volt rated internal MOSFET

Schematic



NOTES:

1. Crossed schematic lines are not connected.
2. R4 value dependent on aux winding turns and Vout setpoint.
3. R1 is optional inrush limiting resistor.
4. U1 tab (pin 4) and D7 should have heatsinking clad pours.
5. Heavy lines indicate recommended ground plane areas.
6. L1A/L1B are Wurth 7447728102.
7. Q1 is MMBT2222A or similar.
8. Z1 sets Vout (Vout = Vz + 0.6V for Ns:Naux = 1:1).
9. R6 trims Vout (up only).
10. Z2 is optional no load OVP zener (Vz = Vout + 2V)

10 Watt NCP1075 Power Supply
with Primary Side Sensing (Rev 1)

Design note created by Frank Cathell, e-mail: f.cathell@onsemi.com

DN05036/D

MAGNETICS DESIGN DATA SHEET

Project / Customer: ON Semiconductor - NCP1014/1075 10W PSU

Part Description: 10W flyback transformer, Primary side sensing; 100kHz, 12V/1A out

Schematic ID: T1

Core Type: EF16 (E16/8/5); 3C90 material or similar

Core Gap: Gap for 1.7 to 2 mH inductance across primary (pins 1 - 4)

Inductance: 1.85 mH +/-5%

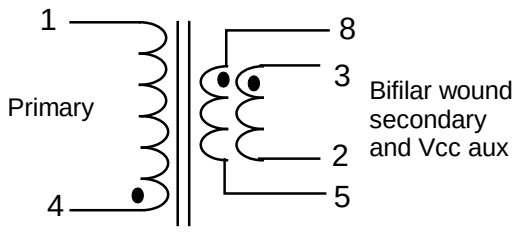
Bobbin Type: 8 pin horizontal mount for EF16

Windings (in order):

Winding # / type	Turns / Material / Gauge / Insulation Data
Primary (4 - 1)	100 turns of #35HN over 2 layers evenly. Insulate with a layer of Mylar tape.
12V Secondary/Vcc (8-5, 3-2)	7 turns bifilar of #24 triple insulated wire over one layer if possible. Terminate to pins as shown in schematic below. Pins 3 to 2 is the aux winding (primary side referenced).
Varnish assembly	

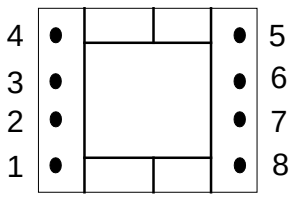
Hipot: 2.5 kV from primary to main secondary for 1 minute

Schematic



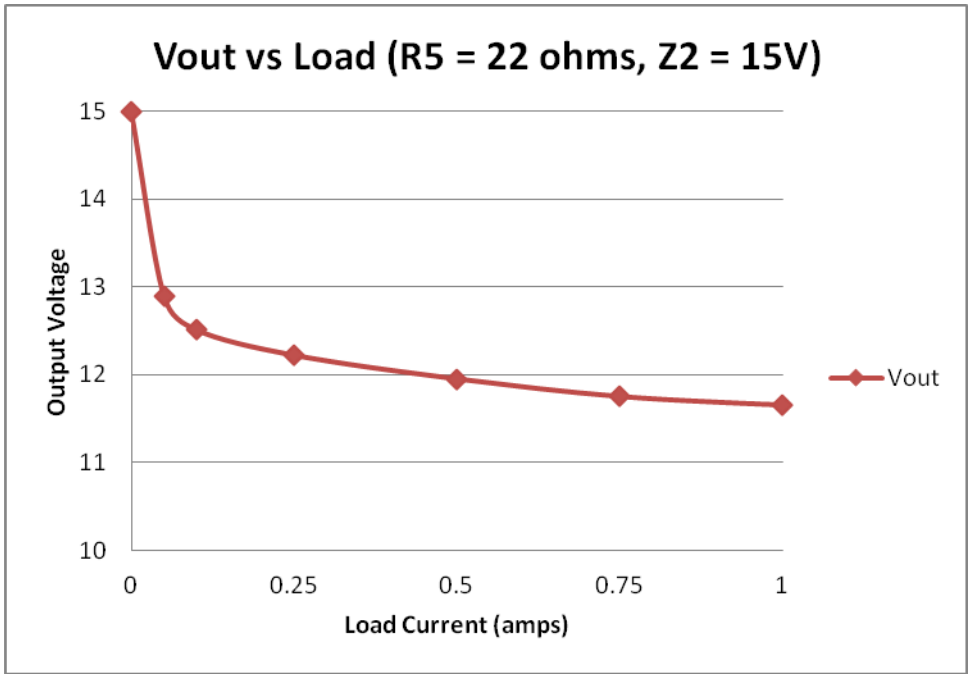
Lead Breakout / Pinout

(Bottom View - facing pins)

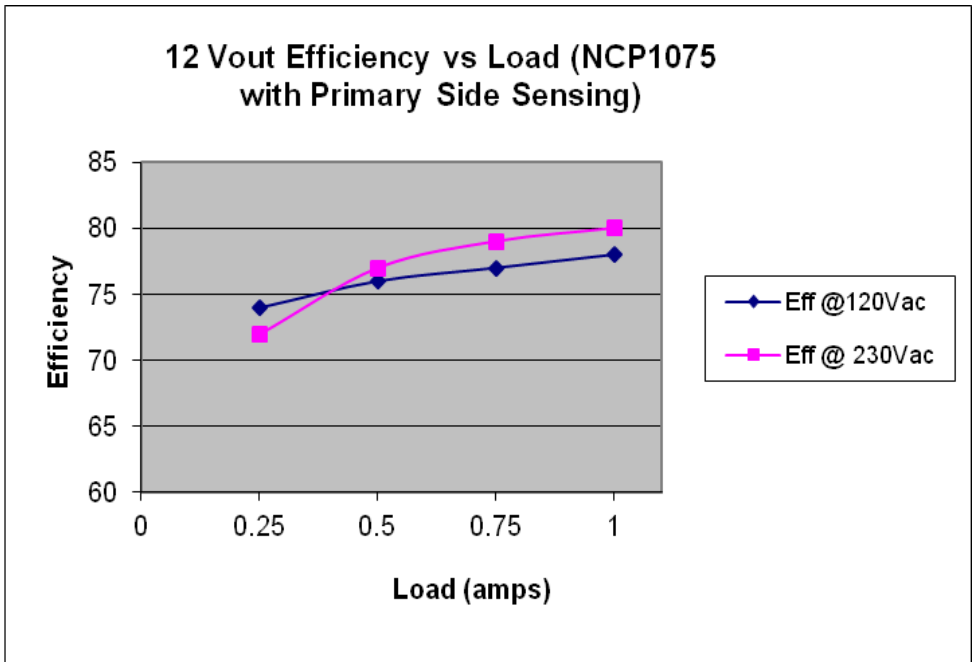


Wurth Electronics par # 750313390 Rev 00

Output Load Regulation



Efficiency Plot



References:

NCP1075 Data Sheet: http://www.onsemi.com/pub_link/Collateral/NCP1072-D.PDF

ON Semiconductor Applicable Design Notes: DN05018, DN05033
See also Design Notes for NCP1014 controller.

Flyback Transformer Design Aid:
http://www.onsemi.com/PowerSolutions/supportDoc.do?type=tools&rpn=NCP1075