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Design Note – DN05028/D

20 Watt, High Efficiency, Off-line Power Supply Using Synchronous Output Rectification

Device	Application	Input Voltage	Output Power	Topology	I/O Isolation
NCP1251B NCP4303 NCP431	White Goods, Small Instruments, E-Meters, Industrial Equipment	90 – 267 Vac	20 to 25 Watts	DCM Flyback With Synchronous Rectifier	3 kV

Other Specification

	Output 1	Output 2	Output 3	Output 4
Output Voltage	12 Vdc	N/A	N/A	N/A
Ripple	< 2%	N/A	N/A	N/A
Nominal Current	1 to 1.8 Amps	N/A	N/A	N/A
Max Current	1.8 Amps	N/A	N/A	N/A
Min Current	zero	N/A	N/A	N/A

PFC (Yes/No)	No
Typical Efficiency	84% at full load
Inrush Limiting / Fuse	Yes
Operating Temp. Range	0 to 50C
Cooling Method / Supply Orientation	Convection NA
Signal Level Control	No

Others	Input EMI filter

Circuit Description

This Design Note describes a very simple, low cost, yet high efficiency off-line flyback power supply using ON Semiconductor's NCP1251B current mode controller (TSOP6 package) in conjunction with the NCP4303 synchronous MOSFET rectifier controller. This Design Note is an extension of DN05012/D for engineers who require the highest possible efficiency for a 12 volt, 15 to 25 watt application. Other output voltages from up to 28 Vdc are easily implemented by modifying the values (or ratings) of the secondary circuit components and T1's secondary turns.

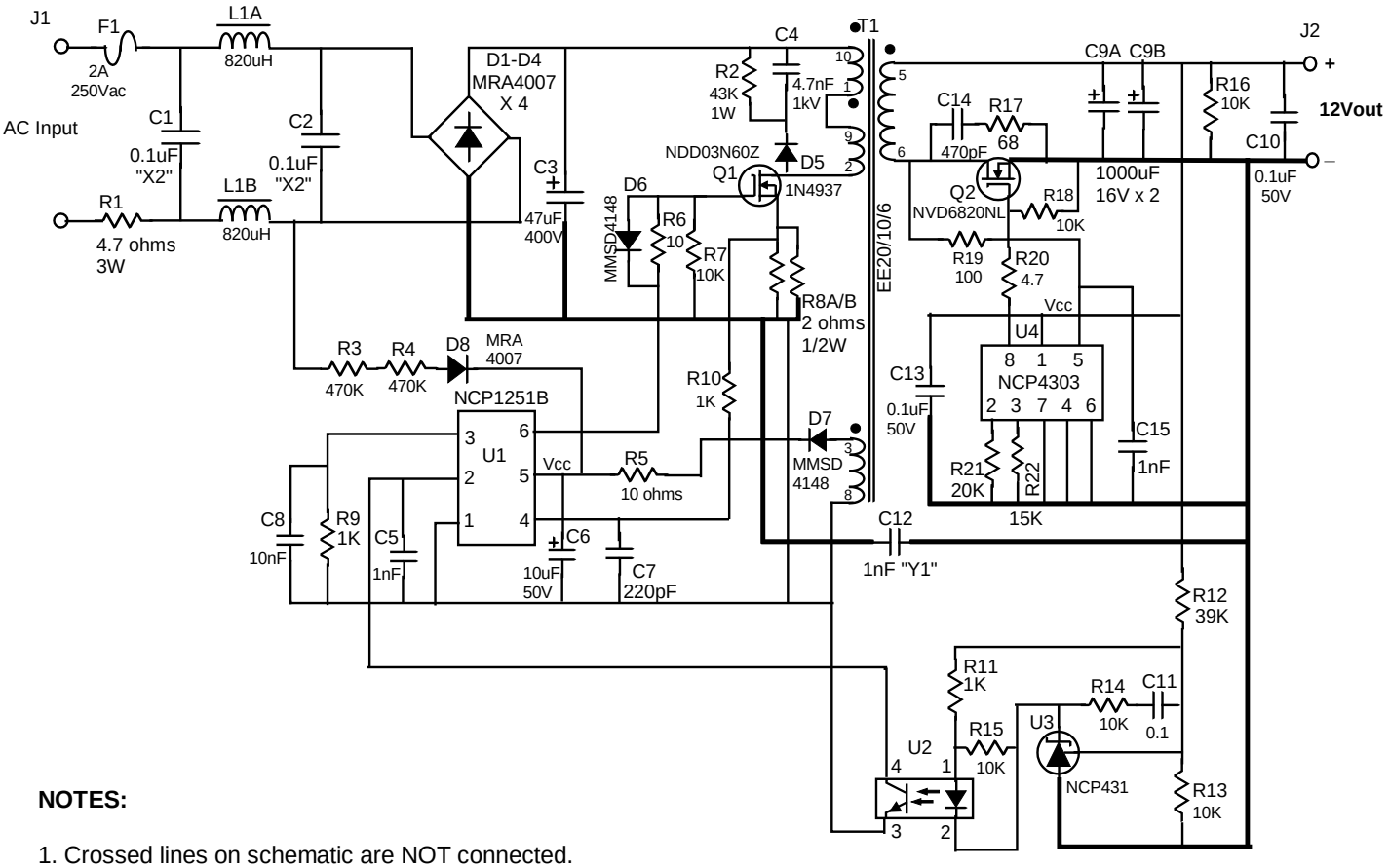
The primary power circuitry and transformer design is identical to the circuit of DN05012/D. The secondary circuitry contains the NCP4303 controller driving synchronous MOSFET rectifier Q3. Details of the various features and parameters of this controller can be found in the devices' data sheet available at the ON Semiconductor web site.

The plot shown below compares the efficiency curves of the original design using Schottky rectifiers with this synchronous rectifier version.

Key Features

- Input EMI filter for conducted EMI compliance
- Simple, single switch DCM flyback topology
- Very high efficiency with synchronous output rectification
- Current mode control with adjustable output current
- Low cost components

Schematic



NOTES:

1. Crossed lines on schematic are NOT connected.
2. U2 is NEC PS2561L-1 or equivalent optocoupler (CTR > 50%).
3. R1 is for inrush limiting - use carbon comp or wire wound.
4. L1A/L1B are Wurth 7447728215 components (820 uH, 500mA).
5. Output caps (C9A/B) are radial lead, low impedance types (UCC LXV series or similar).
6. Heavy schematic lines are recommended ground plane areas.
7. R5 is for Vcc trimming (< 28Vmax), typically 10 ohms.
8. R8A/B sets max output current (primary peak current sense).
9. See drawing for T1 details.

20 Watt NCP1251 Power Supply with Output Synchronous Rectifier (Rev 1)

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DN05028/D

MAGNETICS DESIGN DATA SHEET

Project / Customer: ON Semiconductor - 24 watt, 12 vout NCP1251 Flyback

Part Description: 24 watt flyback transformer, 12vout (Wurth Electronics part # 750312495)

Schematic ID: T1

Core Type: EE20/10/6 ferrite core; 3C90 material or similar

Core Gap: Gap for 190 +/- 200uH across Primary A (pins 1 - 10)

Inductance: 750 uH total (+/- 5%) measured from pin 1 to pin 9 with pins 2 and 10 connected

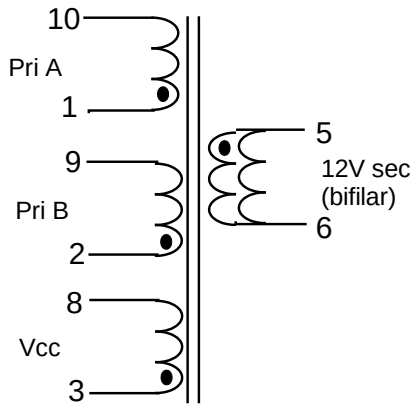
Bobbin Type: 10 pin horizontal mount for EE20/10/6

Windings (in order):

Winding # / type	Turns / Material / Gauge / Insulation Data
Primary A (1 - 10)	30T of #28HN over 1 layer (25 TPL). Insulate for 1 kV to next winding. Self leads to pins.
Vcc (3 - 8)	7 turns of #28 HN over 1 layer, spiral wound over primary A. Self leads to pins. Insulate to 1 kV to next winding with tape.
12V Secondary (5 - 6)	6 turns bifilar of #24 triple insulated wire over one. layer (two strands). Self leads to pins. (Note: #26 is also acceptable here if the fit is too tight for one layer)
Primary B (2 - 9)	Same as Primary A. Insulate with tape and self-leads to pins.

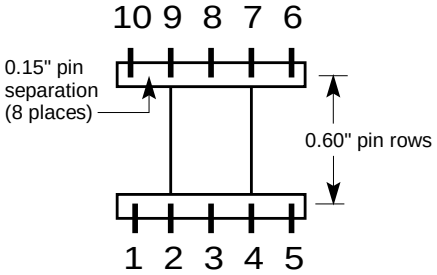
Hipot: 3 kV from primaries & Vcc to secondary for 1 minute.

Schematic

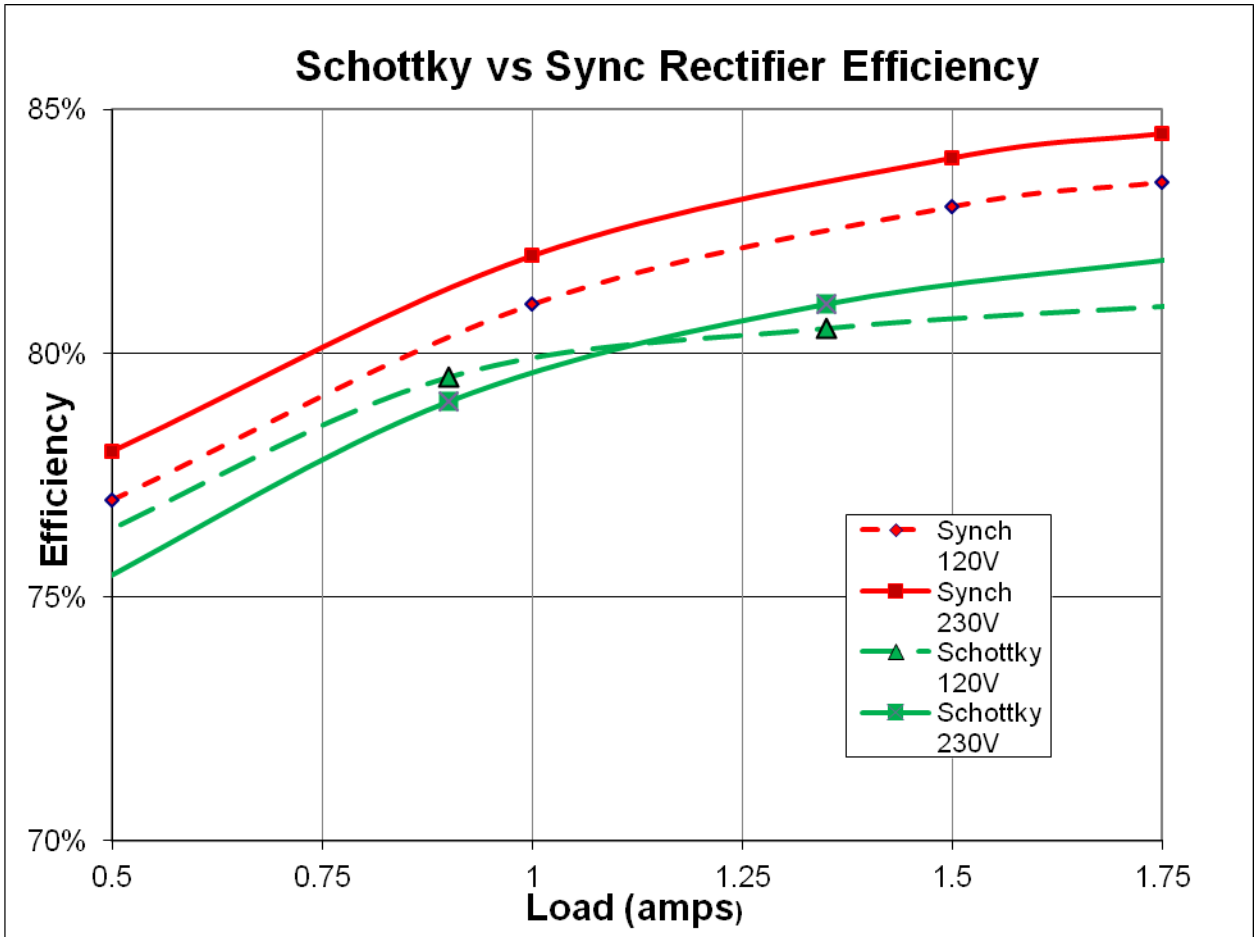


Lead Breakout / Pinout

(Top View of Bobbin)



Efficiency Plot Comparison (Schottky vs Synchronous Rectifiers)



References

ON Semiconductor Design Note DN05012/D
ON Semiconductor Design Note DN05017/D
ON Semiconductor NCP4303 Synchronous Rectifier Controller Data Sheet
ON Semiconductor NCP1251 Current Mode Controller Data Sheet
ON Semiconductor NCP431 Programmable Zener Data Sheet