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

<table>
<thead>
<tr>
<th>Windings (in order):</th>
<th>Winding # / type</th>
<th>Turns / Material / Gauge / Insulation Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary A (1 - 10)</td>
<td>30T of #28HN over 1 layer (25 TPL). Insulate for 1 kV to next winding. Self leads to pins.</td>
<td></td>
</tr>
<tr>
<td>Vcc (3 - 8)</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>12V Secondary (5 - 6)</td>
<td>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)</td>
<td></td>
</tr>
<tr>
<td>Primary B (2 - 9)</td>
<td>Same as Primary A. Insulate with tape and self-leads to pins.</td>
<td></td>
</tr>
</tbody>
</table>

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

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Schematic

[Diagram of the schematic showing primary and secondary connections and the number of turns for each winding]

Lead Breakout / Pinout

(Top View of Bobbin)

[Diagram of the lead breakout and pinout with 0.15" pin separation (8 places) and 0.60" pin rows]

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February 2012, Rev. 0  www.onsemi.com
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