ON Semiconductor

Design Note – DN06058/D

Ultra-Wide Input Range Bias Power Supply

Device	Application	Input Voltage	Output Power	Topology	I/O Isolation
NCP1271	Electric Meters, Industrial Applications	40 to 300 Vac	12 watts nominal	Flyback	Yes – 3 kV

	Output
Output Voltage	12 V
Ripple	300 mV p/p
Nominal Current	1 A
Max Current	1.5 A
Min Current	0 A

PFC (Yes/No)	No
Minimum Efficiency	78% @ 40 Vac in
Inrush Limiting / Fuse	1.5A + inrush resistor
Operating Temp. Range	-40 to +85˚C
Cooling Method / Supply Orientation	Convection
Signal Level Control	No

Others	Operation at 40 Vac input indefinitely

Circuit Description

This power supply is a 12 volt, 12 watt nominal output, wide range AC input supply designed around the NCP1271 current mode controller in a DCM flyback topology. It is intended for low power logic bias applications (up to 15 watts) in industrial equipment. The circuit includes current limiting, an input EMI filter, a simple resistor (R1) inrush limiter, and optocoupled voltage feedback using a simple TL431 programmable zener error amplifier (U3). The dc bulk input capacitor (C3) is rated to manage continuous operation at 40 Vac input, yet handle the high dc bulk voltage when operated at 300 Vac. An input EMI composed of C1, C2, L1 and C8 is also included.

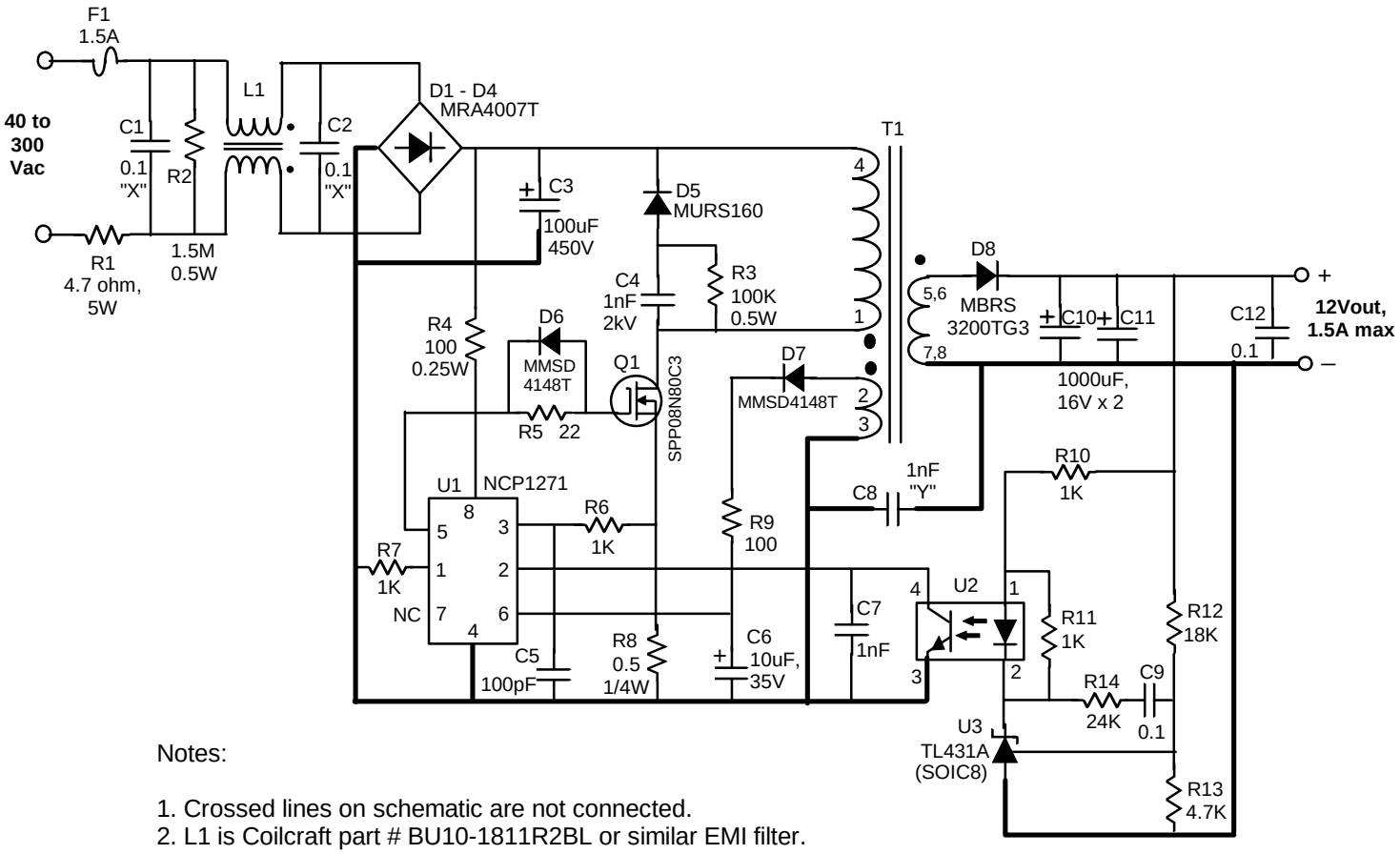
Once the supply has started, an auxiliary winding on the flyback transformer powers the control circuitry to maximize efficiency and to provide minimal power consumption at light or no-load conditions. A Schottky output rectifier (D8) is also used to maximize efficiency.

The flyback transformer (see design sheet) is a custom design implemented with a small EF-16 type ferrite core. The switching frequency was chosen at 100 kHz to minimize the core size.

Key Features

- Ultra-wide range AC input (40 to 300Vac)
- High efficiency (81% @ 120Vac)
- Input EMI filter
- Inherent overcurrent protection
- Simple current mode flyback design

Schematic



Notes:

1. Crossed lines on schematic are not connected.
2. L1 is Coilcraft part # BU10-1811R2BL or similar EMI filter.
3. Q1 is Infineon SPP08N80C3 or similar (8A, 800V Mosfet)
4. U2 is any opto with a minimum CTR of 50%. (Vishay SFH6156A-4)
5. R12/R13 sets Vout.
6. Heavy schematic lines represent recommended primary and secondary ground plane areas.
7. C1/C2 should be 350Vac minimum voltage rating "X" suppression caps.
8. Max Mosfet current (current limit point) set by R8.
9. C10 and C11 are low Z electrolytic output caps (UCC, Nichicon, etc.)
10. Light load skip mode level set by R7.

12Vout, 1A Flyback Schematic
40 - 300 Vac Input

MAGNETICS DESIGN DATA SHEET

Project: Ultra-wide range AC input logic bias power supply; 12V @ 1A output

Part Description: 12 watt flyback transformer, 100 kHz, 12 volts out

Schematic ID: T1

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

Core Gap: Gap for 125 to 145 uH inductance on primary

Inductance: 135 uH +/-5% nominal

Bobbin Type: 8 pin horizontal mount for EF16

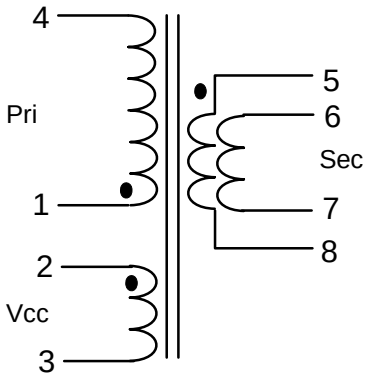
Windings (in order):

Winding # / type	Turns / Material / Gauge / Insulation Data
Vcc/Boost (2 - 3)	10 turns of #26HN wound over 1 layer. Insulate with 1 layer of tape (500V insulation to next winding)
Primary (1 - 4)	40 turns of #26HN over 2 layers. Insulate for 3 kV to the next winding with mylar tape.
12V Secondary (5, 6 - 7, 8)	9 turns of 2 strands of #26 bifilar wound over 1 layer with tape cuffed ends. Self-leads to separate pins as shown below.

Vacuum varnish assembly

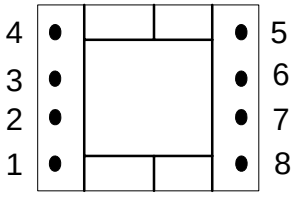
Hipot: 3 kV from Vcc/primary to secondary for 1 minute

Schematic



Lead Breakout / Pinout

(Bottom View - facing pins)

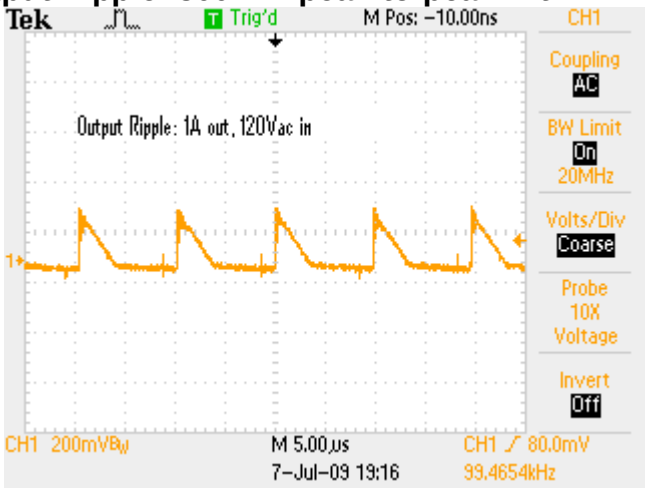


Transformer is Mesa Power Systems part # 13-1410

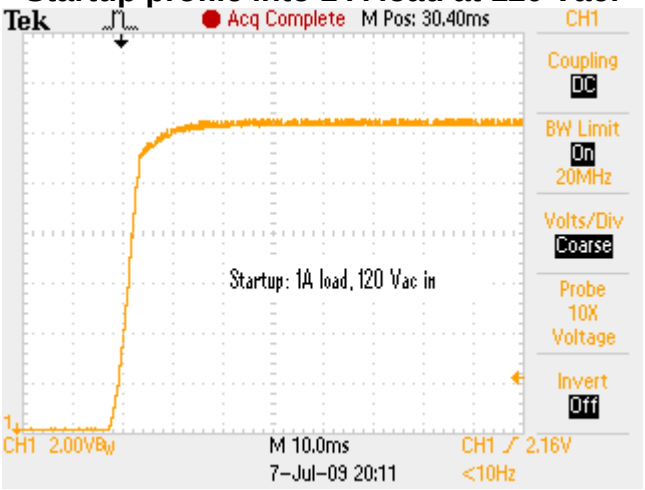
Breadboard Test Data

- Vout at 1 A load, 120 Vac in: 12.045 Vdc
- Vout at 100 mA load, 120 Vac in: 12.053 Vdc
- Regulation, line and load: Better than 2%
- Overcurrent trip point: 2.1 A
- Full load (1A) AC input drop out voltage: 33 Vac (line voltage where output starts to drop out of regulation)
- Efficiency with 1 A load: 78% at 40 Vac input; 81% at 120 Vac input; 80% at 240 Vac input

Output Ripple: 300 mV peak-to-peak with 1 A load



Startup profile into 1 A load at 120 Vac:



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