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**Non-Isolated, 8 Watt Dual Output, Off-line Power Supply**

ON Semiconductor

| Device | Application | Input Voltage | Output Power | Topology | I/O Isolation |
|---------------------|--------------------------------------|----------------|-----------------|-------------------------|----------------------------|
| NCP1075 NST45011 | White Goods, Industrial Equipment | 180 to 270 Vac | 8 Watts Nominal | Non-Isolated Flyback | No isolation from mains |

Other Specification

| | Output 1 | Output 2 | Output 3 | Output 4 |
|------------------------|----------------|----------------|----------|----------|
| Output Voltage | 5.0 Vdc +/- 2% | 8.5 Vdc +/- 5% | N/A | N/A |
| Ripple | 200 mV p/p | 200 mV p/p | N/A | N/A |
| Nominal Current | 1 A | 200 mA | N/A | N/A |
| Max Current | 1.25 A | 300 mA | N/A | N/A |
| Min Current | 1% | 1% | N/A | N/A |

| | |
|--|----------------------------------|
| PFC (Yes/No) | No |
| Efficiency | 76% at 8 watts output |
| Inrush Limiting / Fuse | Yes – limiting resistor and fuse |
| Operating Temp. Range | 0 – 50 C |
| Cooling Method / Supply Orientation | Convection NA |
| No Load Standby Power | 68 mW @ 230 Vac |

| | |
|---------------|---|
| Others | Optional high regulation sense circuit using NCP431 |
|---------------|---|

Circuit Description

This Design Note features an 8 watt, off-line, dual output, flyback power supply intended for powering white goods or industrial equipment circuitry which does not require output isolation from the AC mains. The flyback converter is designed around ON Semiconductor's 100 kHz NCP1075 monolithic switching controller. A simple voltage sensing and feedback scheme utilizing a current mirror transistor pair (Q1), and zener diode (Z1) is utilized for low cost yet effective output regulation for most typical applications.

This particular design example provides output voltages of 5V and 8.5V but these can be tailored to other voltages to accommodate the specific requirements by appropriate transformer turns ratio changes and alterations to voltage setting zener Z1 and resistor R6.

The regulation loop is closed around the 5 volt main output while the 8.5 volt output is configured using a "slave" secondary winding on the transformer. The slave secondary is tightly coupled to the main 5V winding via bifilar winding techniques which assures reasonable load and cross regulation without requiring dedicated regulation circuitry. Other 2nd channel voltages are possible by changing the turns of the slave secondary winding.

Logic power (Vcc) for the control chip is derived via diode D9 directly from the slave output. Since the control IC needs a minimum of about 8 volts to maintain efficient operation, Schottky D6 is provided as an optional logic Vcc source instead of D9 in the event it is required that the second output is somewhat less than 8 volts. At Vcc voltages less than about 8 volts, the controller will operate in DSS mode and there will be some degradation in overall circuit efficiency.

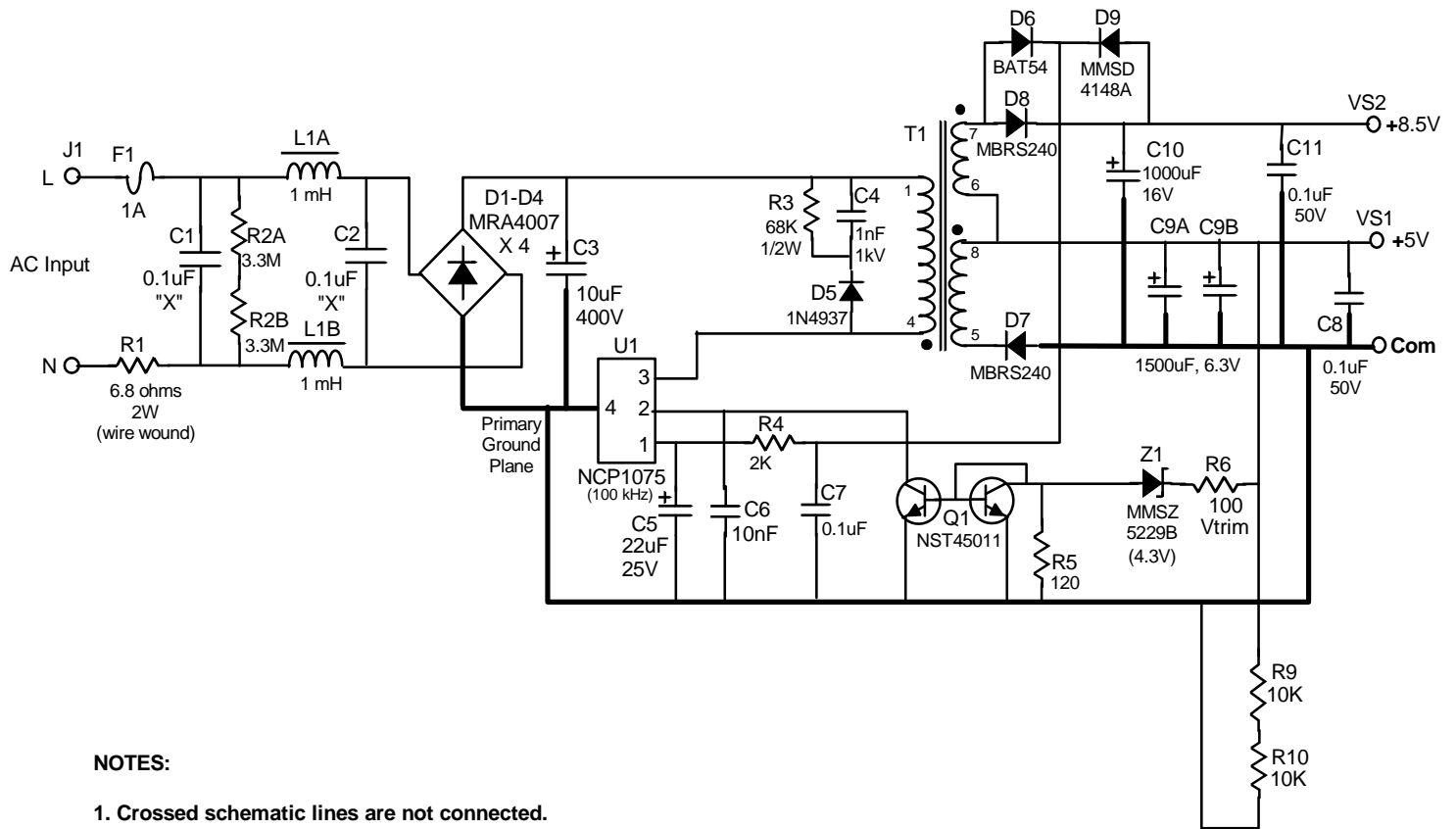
Although this design is for European mains voltage, a transformer design for a universal AC input version is available on request. A 5V/12V transformer design is also included in the information below.

Key Features

- Schottky diodes (D6, D7) on both outputs for high efficiency
- Dual sensing options depending on desired regulation accuracy
- Input EMI filter for conducted emission compliance
- Input fuse and inrush limiting resistor (R1)
- Good load and cross regulation on 8.5V_{out} due to secondary winding technique on transformer

DN05038/D

Schematic



NOTES:

1. Crossed schematic lines are not connected.
2. R4 value dependent on VS2 nominal output voltage.
3. R1 is optional inrush limiting resistor.
4. U1 tab (pin 4) should have heatsinking clad pours and be part of a ground plane area for best noise immunity.
5. Heavy lines indicate recommended ground plane areas.
6. L1A/L1B are Wurth 7447728102.
7. Z1 sets nominal 5Vout. R6 can trim Vout upward.

Non-Isolated, 8 Watt, Dual Output NCP1075 PSU
with Universal AC Input (Rev 8)

MAGNETICS DESIGN DATA SHEET

Project / Customer: ON Semiconductor - NCP1014/1075, 8W dual output PSU

Part Description: 8 watt flyback transformer, 100kHz, 5V/9V outputs (Rev 5 - Euro version)

Schematic ID: T1

Würth Electronics Part # 750313309 Rev 02

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

Core Gap: Gap for 5.5 mH +/- 5% inductance across primary (pins 1 - 4)

Inductance: 5 to 6 mH when measuring from pin 1 to pin 4

Bobbin Type: 8 pin horizontal mount for EF16

Windings (in order):

Winding # / type

Turns / Material / Gauge / Insulation Data

Primary A (4 - 2)

78 turns of #38 mag wire wound over 1 layer.
Insulate with Mylar tape for at least 1kV breakdown.

5V/8.5V Secondaries (8,5 - 7,6)

7 turns of two pieces of #26 magnet wire (different colors) spiral wound bifilar over one layer. Remove two turns so winding terminating to pins 7/6 has only 5 turns. Triple Insulated wire can also be used if desired. Self-leads to pins.

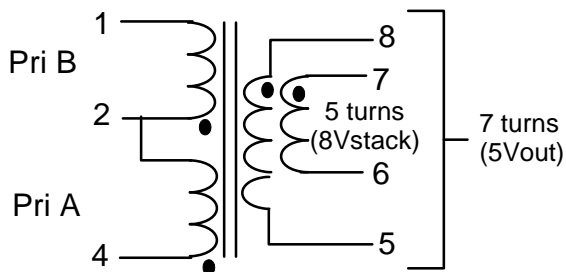
Primary B (2 - 1)

Same as primary A.

Varnish assembly

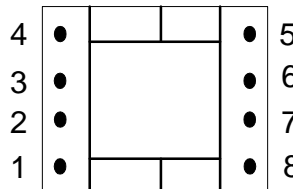
Hipot: 1 kV from primary to secondary - no agency primary/secondary insulation requirements

Schematic



Lead Breakout / Pinout

(Bottom View - facing pins)



MAGNETICS DESIGN DATA SHEET

Project / Customer: ON Semiconductor - NCP1014/1075, 8W dual output PSU

Part Description: 8 watt flyback transformer, 100kHz, 5V/12V outputs (Rev 1 - Euro version)

Schematic ID: T1

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

Core Gap: Gap for 5.5 mH +/- 5% inductance across primary (pins 1 - 4)

Inductance: 5 to 6 mH when measuring from pin 1 to pin 4

Bobbin Type: 8 pin horizontal mount for EF16

Windings (in order):

Winding # / type

Turns / Material / Gauge / Insulation Data

Primary A (4 - 2)

78 turns of #38 mag wire wound over 1 layer.
Insulate with Mylar tape for at least 1kV breakdown.

5V/12V Secondaries (8,5 - 7,6)

7 turns of two pieces of #26 magnet wire (different colors) spiral wound bifilar over one layer. Add two more turns so the winding terminating to pins 7/6 has 9 turns total (12V stack). Triple Insulated wire can also be used if desired. Self-leads to pins.

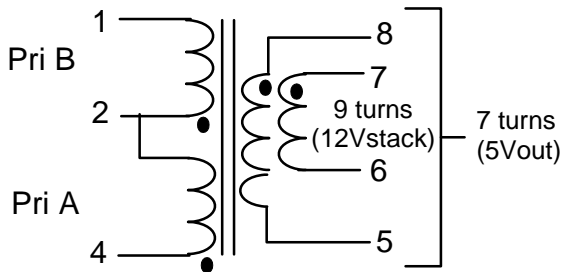
Primary B (2 - 1)

Same as primary A.

Varnish assembly

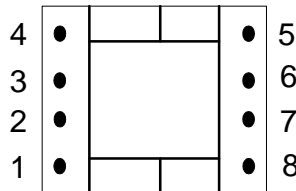
Hipot: 1 kV from primary to secondary - no agency primary/secondary insulation requirements

Schematic

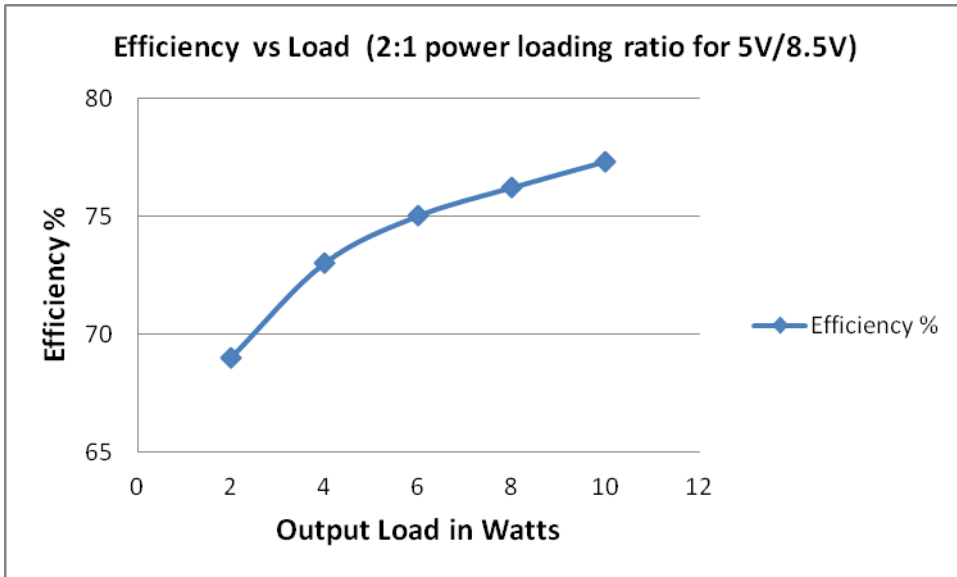


Lead Breakout / Pinout

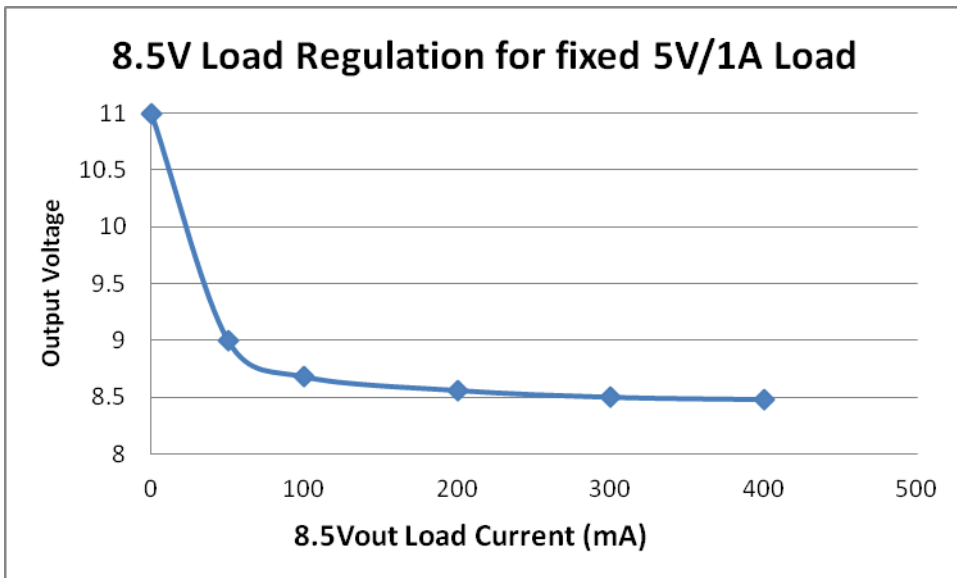
(Bottom View - facing pins)



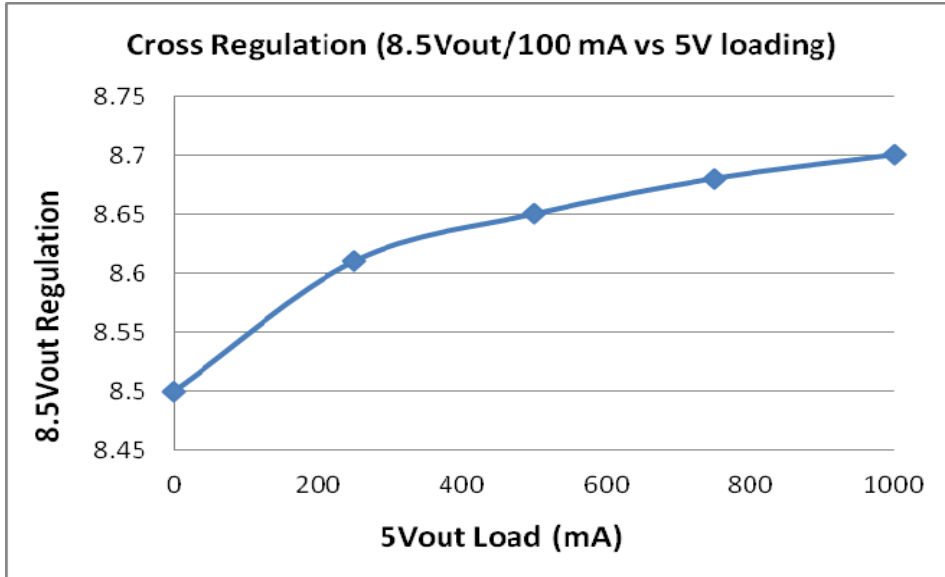
Efficiency versus Pout (5V:8.5V = 2:1 Loading Ratio Respectively)



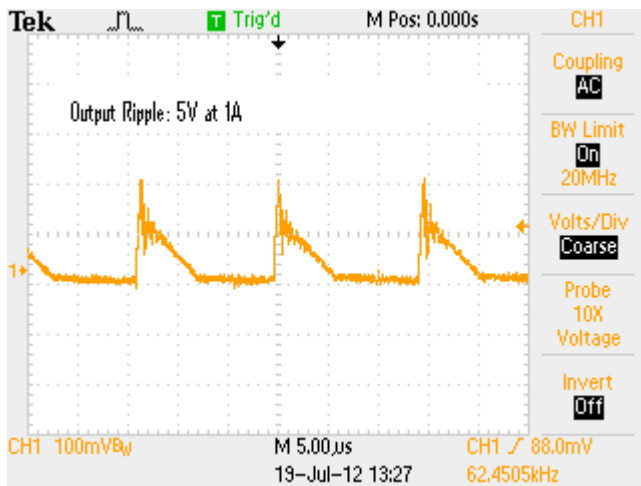
8.5 Vout Load Regulation (5 Vout set to 1A Load)



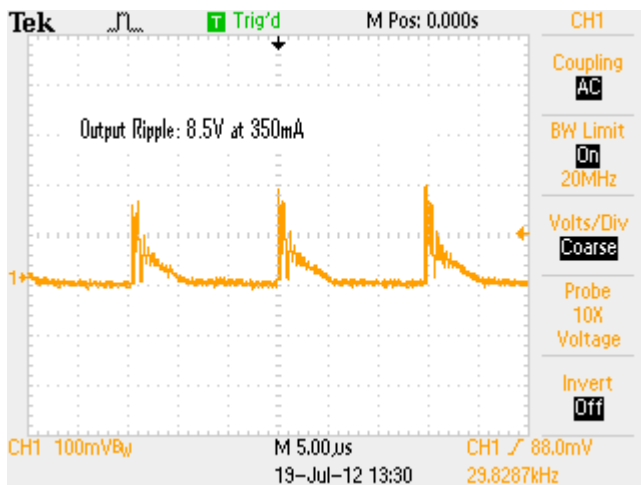
Cross Regulation (8.5Vout loaded at 100mA)



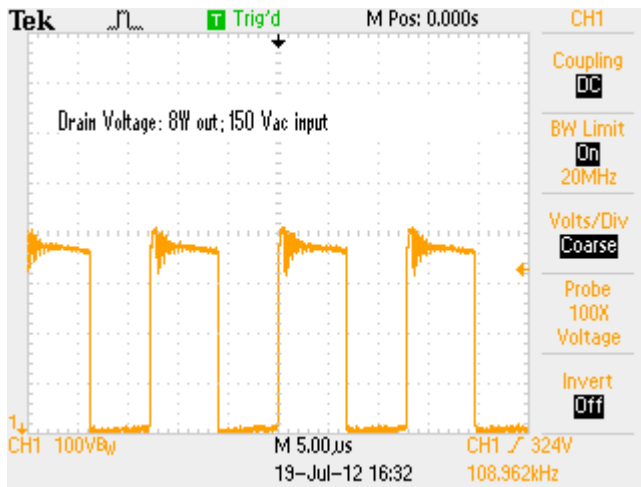
Output Ripple – 5 Vout at 1 Amp



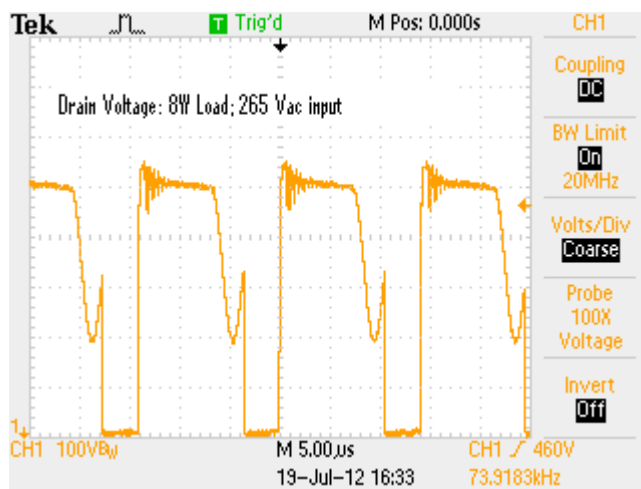
Output Ripple – 8.5 Vout at 350 mA



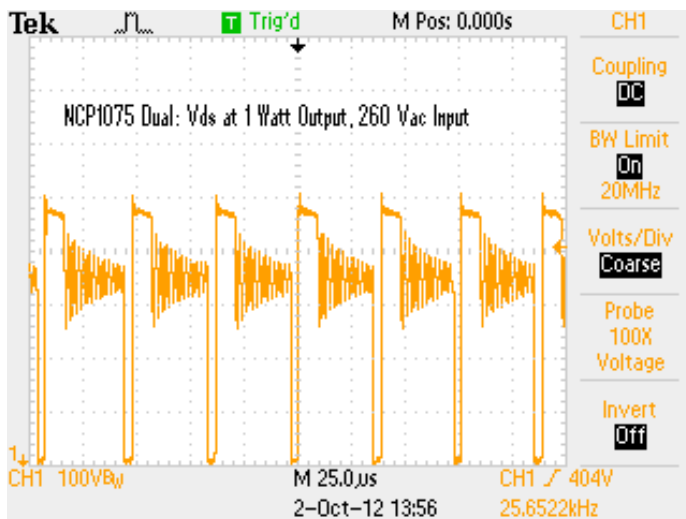
Mosfet Drain Voltage at 150 Vac Input and 8 Watt Load



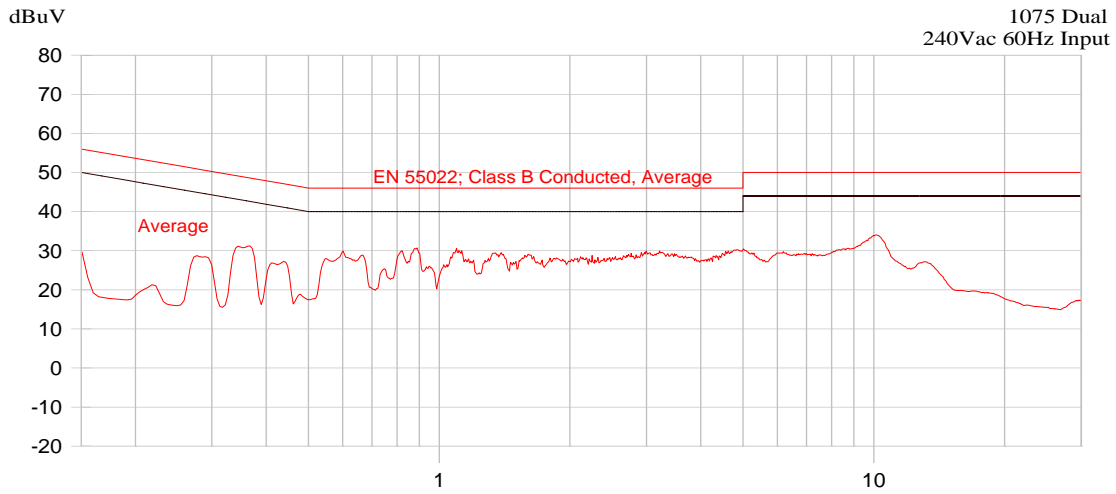
Mosfet Drain Voltage at 265 Vac Input and 8 Watt Load



Mosfet Drain Voltage at 260 Vac Input and 1 Watt Load



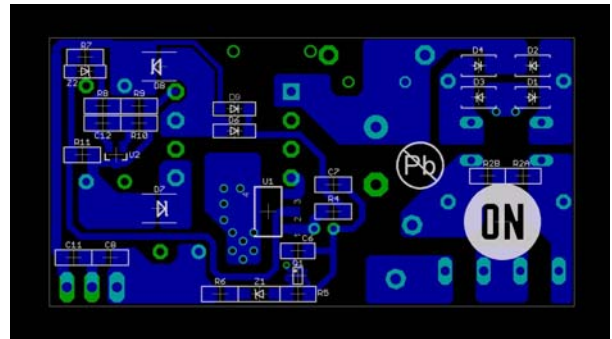
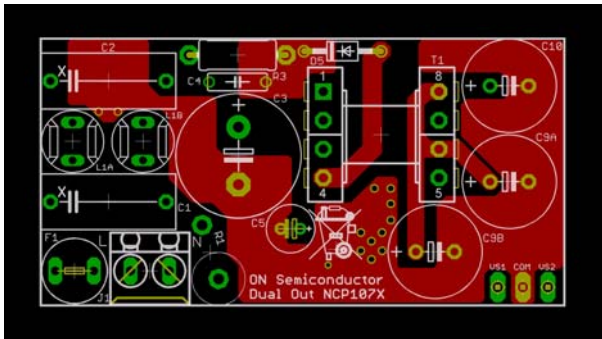
Conducted EMI Scan with 8 Watt Load (EN55022, Level B; Average)



10/15/2012 11:24:00 AM

(Start = 0.15, Stop = 30.00) MHz

PC Board Layout/Photo



DN05038/D

| Designator | Qty | Description | Value | Tolerance | Footprint | Manufacturer | Manufacturer Part Number | Substitution Allowed | Lead Free | Comments |
|----------------|-----|----------------------------|----------------|-----------|-----------------------|-------------------|--------------------------|----------------------|-----------|-----------------------|
| D7, D8 | 2 | Schottky diode | 3A, 40V | | SMB | ON Semi | MBRS240L (or MBRS2040L) | No | | |
| D1, 2, 3, 4 | 4 | Diode - 60 Hz, | 1A, 800V | | SMA | ON Semi | MRA4007 | No | | |
| D5 | 1 | Diode - fast recov | 1A, 600V | | axial lead | ON Semi | 1N4937 | No | | |
| D6 | 1 | Schottky diode | 200mA, 30V | | SOD-123 | ON Semi | BAT54 | No | | |
| D9 | 1 | Signal diode | 100mA, 100V | | SOD-123 | ON Semi | MMSD4148A | No | | For 12Vout and higher |
| Z1 | 1 | Zener diode | 4.3V, 500 mA | | SOD-123 | ON Semi | MMSZ5229B | No | | |
| Z2 | 1 | Zener diode | 2.7V, 500 mA | | SOD-123 | ON Semi | MMSZ5223B | No | | |
| Q1 | 1 | Dual NPN matched xstr | 45V, 100 mA | | SOT-363 | ON Semi | NST45011 | No | | |
| U2 | 1 | Programmable zener | 2.5V | | SOIC8 / SOT23 | ON Semi | NCP431A | No | | |
| U1 | 1 | Switcher IC - NCP1075 | 100 kHz | | SOT223 | ON Semi | NCP1075ST100 | No | | |
| C1, C2 | 2 | "X" cap, box type | 100nF, X2 | | LS = 15 mm | Rifa, Wima | TBD | Yes | | |
| C4 | 1 | Ceramic cap, disc | 1 nF, 1kV | 5% | LS = 7.5 mm | Rifa, Wima | TBD | Yes | | |
| C6 | 1 | Ceramic cap, monolythic | 1 nF, 50V | 10% | 1206 | AVX, Murata | TBD | Yes | | |
| C7, 8, 11 | 3 | Ceramic cap, monolythic | 100nF, 50V | 10% | 1206 | AVX, Murata | TBD | Yes | | |
| C12 | 1 | Ceramic cap, monolythic | 100nF, 50V | 10% | 1206 | AVX, Murata | TBD | | | |
| C3 | 1 | Electrolytic cap | 10uF, 400/450V | 10% | LS=7.5mm, D=16mm | UCC, Panasonic | TBD | Yes | | |
| C10 | 1 | Electrolytic cap | 1000uF, 16V | 10% | LS=5 mm, D=12.5mm | UCC, Panasonic | TBD | Yes | | |
| C5 | 1 | Electrolytic cap | 22uF, 25V | 10% | LS=2.5mm, D=6.3mm | UCC, Panasonic | TBD | | | |
| C9A, C9B | 2 | Electrolytic cap | 1,500uF, 6.3V | 10% | LS=5mm, D=12.5mm | UCC, Panasonic | TBD | Yes | | 12V version |
| R1 | 1 | Resistor, 2W, Wire wound | 6.8 ohm, 2W | 10% | LS=7.5mm, D=7mm | Ohmite, Dale | TBD | Yes | | |
| R3 | 1 | Resistor, 0.5W, metal film | 68K, 0.5W | 10% | Axial lead; LS=12.5mm | Ohmite, Dale | TBD | Yes | | |
| R2A,R2B | 2 | Resistor, 1/4W SMD | 3.3 Meg | 5% | SMD 1206 | AVX, Vishay, Dale | TBD | Yes | | |
| R5 | 1 | Resistor, 1/4W SMD | 120 ohms | 1% | SMD 1206 | AVX, Vishay, Dale | TBD | Yes | | |
| R4 | 1 | Resistor, 1/4W SMD | 2.0K | 1% | SMD 1206 | AVX, Vishay, Dale | TBD | | | |
| R9, R10 | 2 | Resistor, 1/4W SMD | 10K | 1% | SMD 1206 | AVX, Vishay, Dale | TBD | Yes | | |
| R7 | 1 | Resistor, 1/4W SMD | 10K | 1% | SMD 1206 | AVX, Vishay, Dale | TBD | Yes | | |
| R6 | 1 | Resistor, 1/4W SMD | 100 ohms | 1% | SMD 1206 | AVX, Vishay, Dale | TBD | Yes | | |
| R8 | 1 | Resistor, 1/4W SMD | 1 Meg | 1% | SMD 1206 | AVX, Vishay, Dale | TBD | Yes | | |
| R11 | 1 | Resistor, 1/4W SMD | 4.7K | 1% | SMD 1206 | AVX, Vishay, Dale | TBD | Yes | | |
| F1 | 1 | Fuse, TR-5 style | 1A | | TR-5, LS=5mm | Minifuse | | Yes | | |
| L1A/B | 1 | Inductor (EMI choke) | 1 mH, 500 mA | | See Würth Drawing | LS=5mm, D=8mm | 7447728102 | Yes | | |
| T1 (5/8.5Vout) | 1 | Transformer | E20/10/6 core | | See Mag Drawing | Würth Magnetics | 750313309 Rev 02 | Yes | | |
| J1 | 1 | Screw Terminal | | | LS = 0.2" | DigiKey | # 281-1435-ND | Yes | | |

Yellow indicates parts for standard Vout sense scheme

Green indicates parts for alternate Vout sense scheme.

References:

NCP1075 data sheet: http://www.onsemi.com/pub_link/Collateral/NCP1072-D.PDF

NCP1075 Design Note: http://www.onsemi.com/pub_link/Collateral/DN05018-D.PDF

NCP1072 EVAL Board Documents:

<http://www.onsemi.com/PowerSolutions/supportDoc.do?type=boards&rpn=NCP1072>

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