

NCP1060FLBKGEVB

NCP1060 Flyback Converter Evaluation Board User's Manual



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Universal AC Mains, Up to 7 Watt Isolated Power Supply

EVAl BOARD USER'S MANUAL

Introduction

This evaluation board manual describes a simple, low power (up to 7 W), universal AC mains Flyback converter. The converter provides constant voltage output. The supply can be used for powering utility electric meters, white goods or similar industrial equipments where isolation from the AC mains is required. The main benefits of provided solution are high efficiency, cost effectiveness and low no-load power consumption. The converter is utilizing monolithic ON Semiconductor switcher NCP1060 with integrated 34 Ω MOSFET in a PDIP7 package. The evaluation board manual provides complete circuit diagram and bill of materials. The current capability of provided converter is user adjustable.

Circuit Description

The varistor R4 together with resistor R3 form simple protection that enhances application robustness against line over-voltage and voltage spikes. Resistor R3 also limits the inrush current when the power supply is connected to mains. The EMC filter is implemented to reduce conducted electromagnetic emissions to the mains.

The Flyback converter itself is formed by the high voltage switching regulator IC1, transformer TR1, freewheeling diode D3 and coil L1 (L3). Capacitors C5, C6, C7 and C8 are used as the output filtering and energy storage bank. Resistor R1 and capacitor C2 for filter, C1, R2 and D2 are forming voltage clamp for the switcher drain. Opto-coupler OK1 (NCP431) is used in feedback network. Resistors R8, R12 and R13 form resistive divider and sets output voltage.

Diode D7 and resistor R14 provide supply voltage for IC1 Vcc from auxiliary winding. The capacitor C10 is the energy storage element that keeps IC1 powered during light load conditions, when the switching frequency drops and energy from auxiliary winding refills Vcc capacitors less often.

Pin LIM/OPP is connected through resistor R6 to auxiliary winding and sets over-power protection. Resistor R9 decreases maximal peak current. The frequency compensation of the feedback loop system is ensured by external capacitor C8 that is connected to the IC OTA output.

Key Features

- Universal AC Input Range (85 – 265 Vac)
- Input Filter for Conducted EMI Attenuation
- Very Low Standby and No-load Power Consumption
- Frequency Fold-back for Improved Efficiency at Light Load
- Inherent Over-current, Over-voltage and Over-temperature Protections
- Frequency Jittering for Better EMI Signature
- Adjustable Peak Current to Set the Required Level of Over-current Protection

Table 1.

| Description | Output Specification |
|-----------------------------|------------------------|
| Output Voltage | 12 Vdc |
| Output Ripple | < 25 mV @ Full Load |
| Max Output Current | 0.6 A |
| Min Output Current | 0 A |
| Efficiency | See Efficiency Charts |
| Input Protection | Fuse |
| Operating Temperature Range | 0°C to +50°C |
| Cooling Method | Passive Cooling |
| No-load Power Consumption | < 75 mW @ 85 – 265 Vac |

Table 2.

| Device | Application | Input Voltage | Output Power | Topology | I/O Isolation |
|---------------|--------------------------|---------------|--------------|----------|---------------|
| NCP1060AP060G | White Goods, E-Meters | 85 to 265 Vac | 5 to 7 W | Flyback | Yes |

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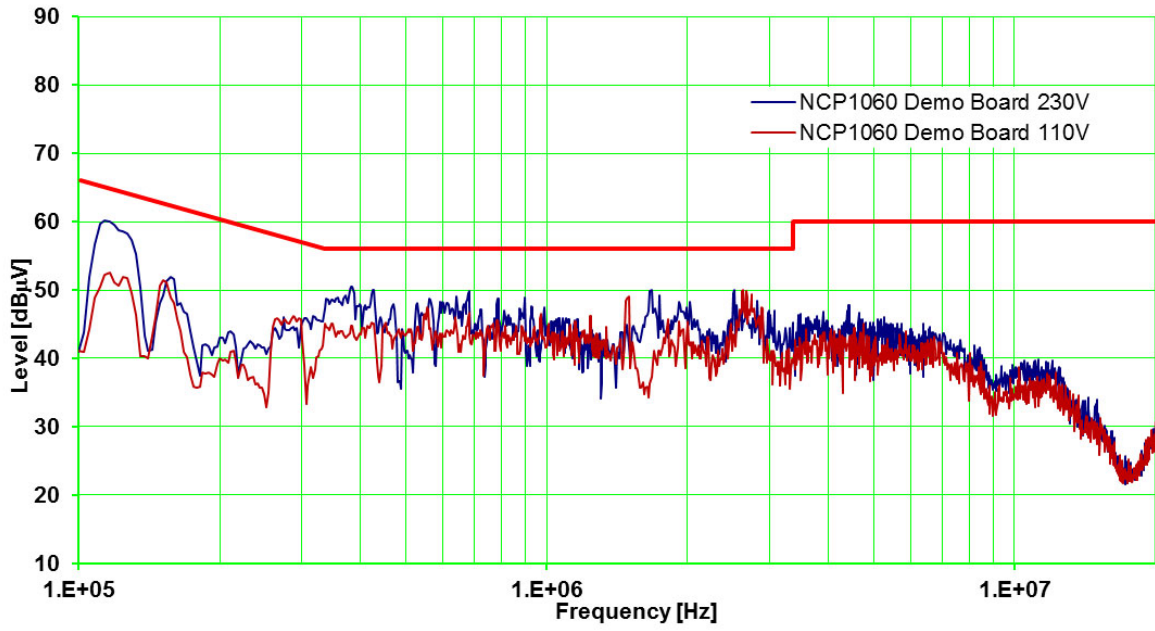


Figure 4. Conducted Emission Quasi-peak dBµV (Domestic)

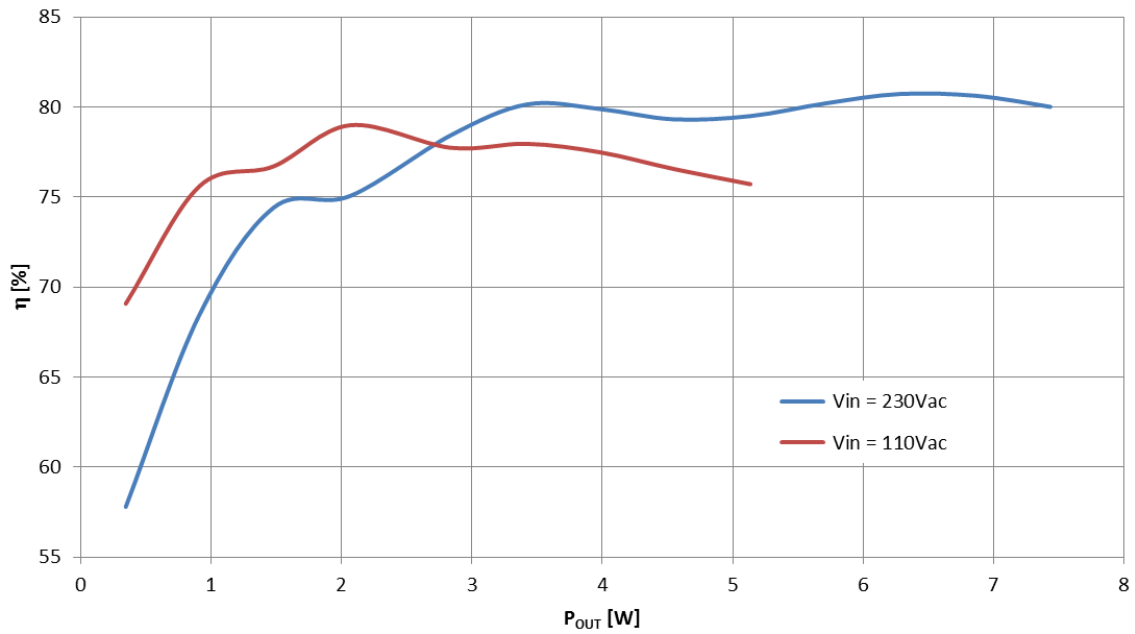


Figure 5. Efficiency vs. Output Load Curves

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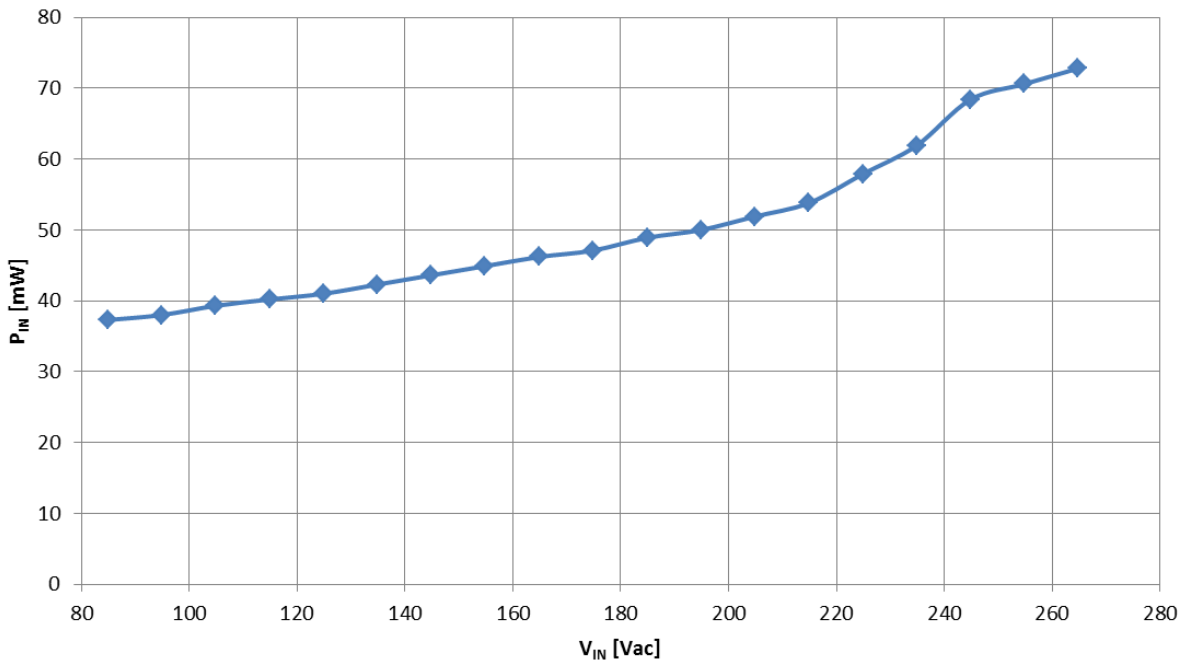


Figure 6. No-load Power Consumption vs. Line Input Curves

OUTPUT RIPPLE VOLTAGE

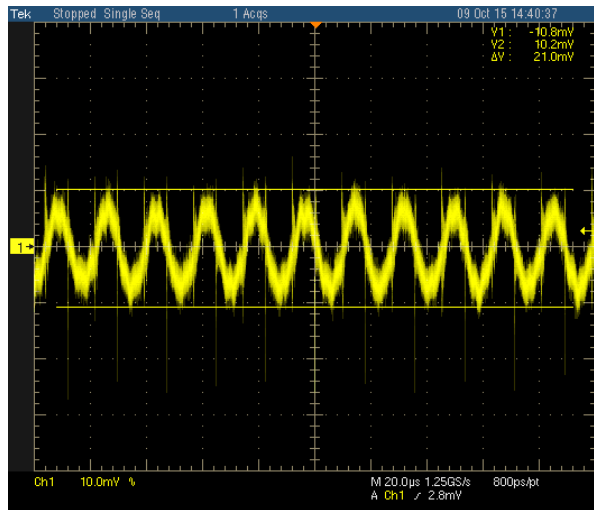


Figure 7. Input Voltage 85 Vac and 0.4 A Load

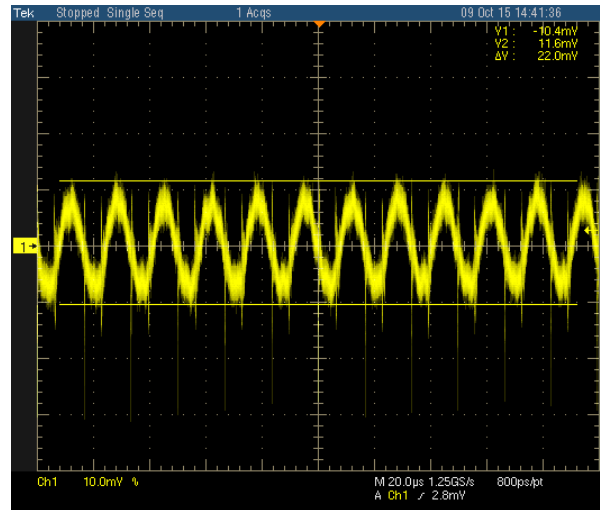


Figure 8. Input Voltage 110 Vac and 0.4 A Load

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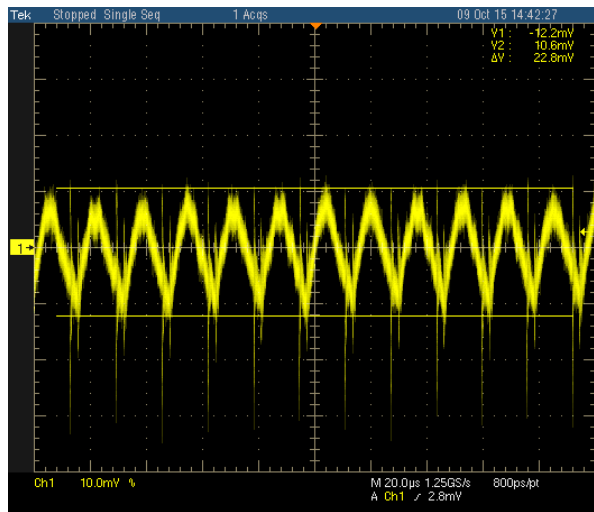


Figure 9. Input Voltage 230 Vac and 0.4 A Load

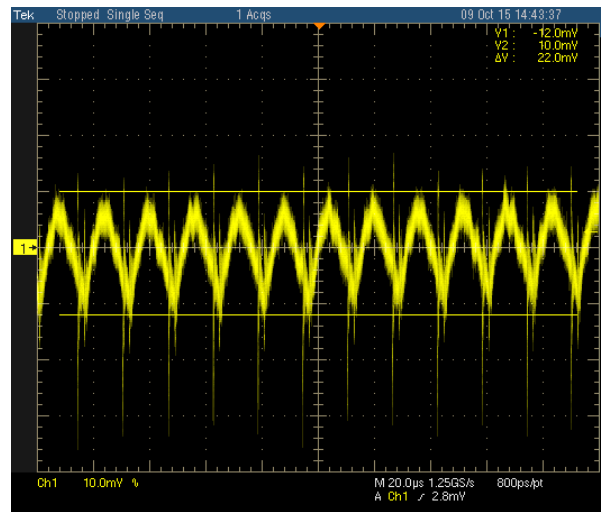


Figure 10. Input Voltage 265 Vac and 0.4 A Load

TRANSIENT RESPONSE

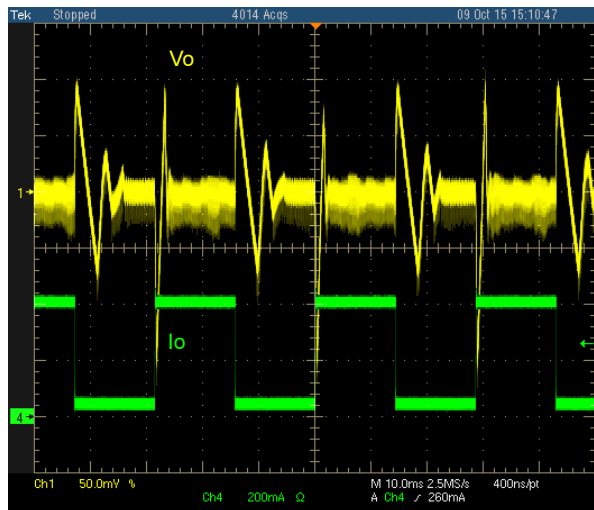


Figure 11. Test Condition: 30–400 mA, 28 ms Cycle, 110 Vac

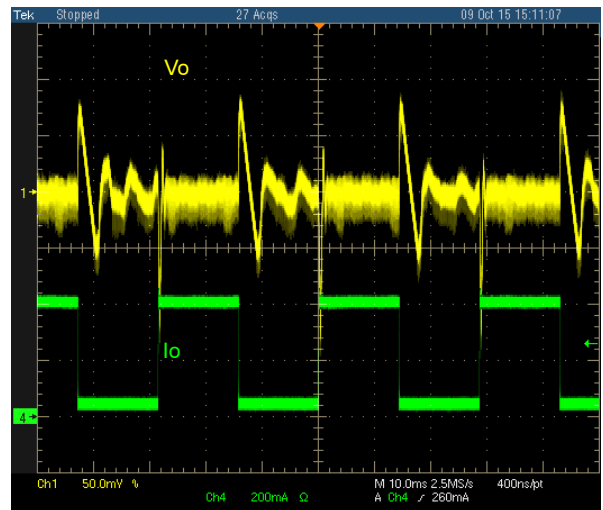


Figure 12. Test Condition: 30–400 mA, 28 ms Cycle, 230 Vac

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STARTUP TIME

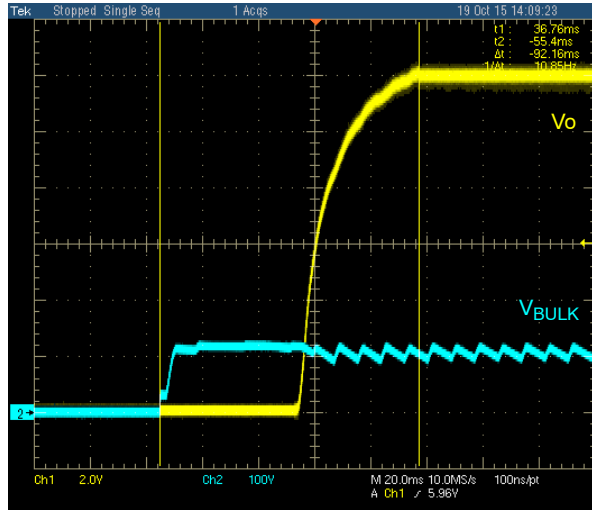


Figure 13. Input Voltage 85 Vac and 0.4 A Load

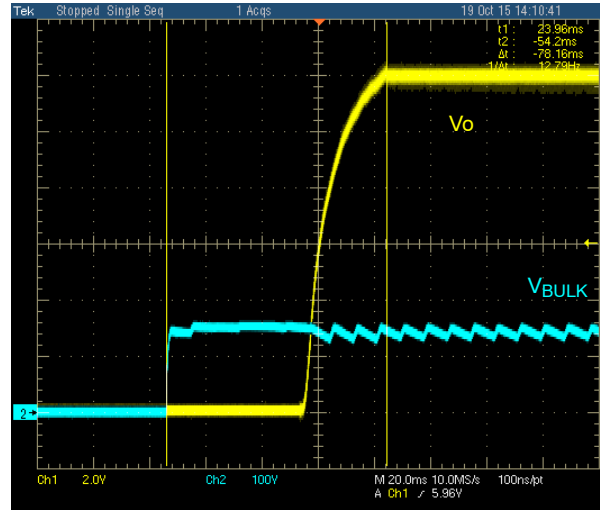


Figure 14. Input Voltage 110 Vac and 0.4 A Load

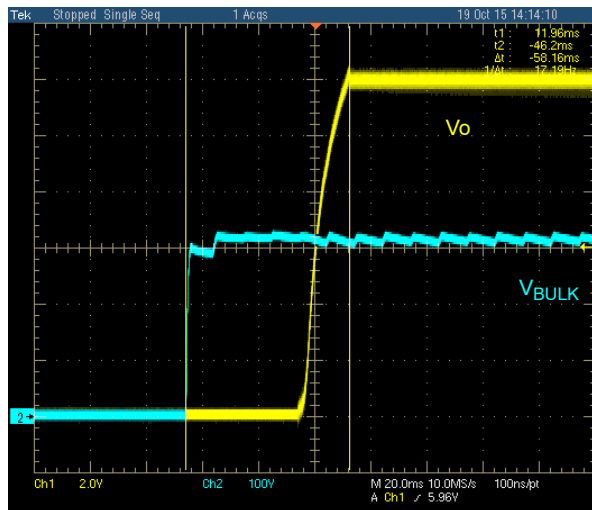


Figure 15. Input Voltage 230 Vac and 0.4 A Load

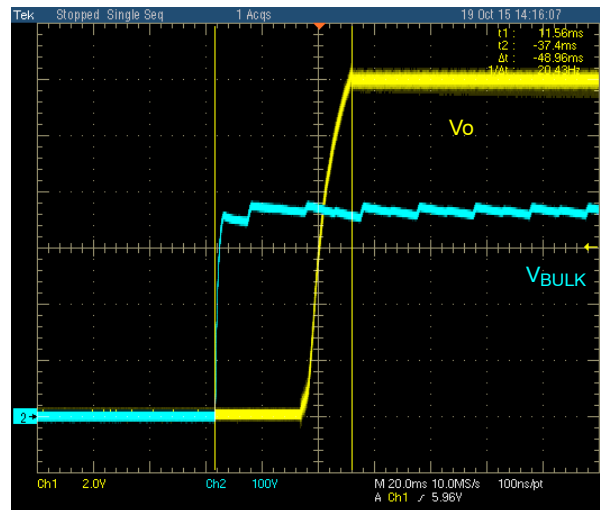


Figure 16. Input Voltage 265 Vac and 0.4 A Load

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POWER OFF

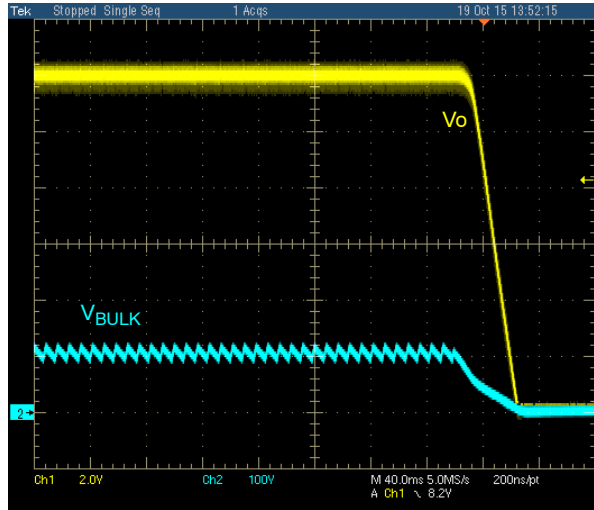


Figure 17. Input Voltage 85 Vac and 0.4 A Load

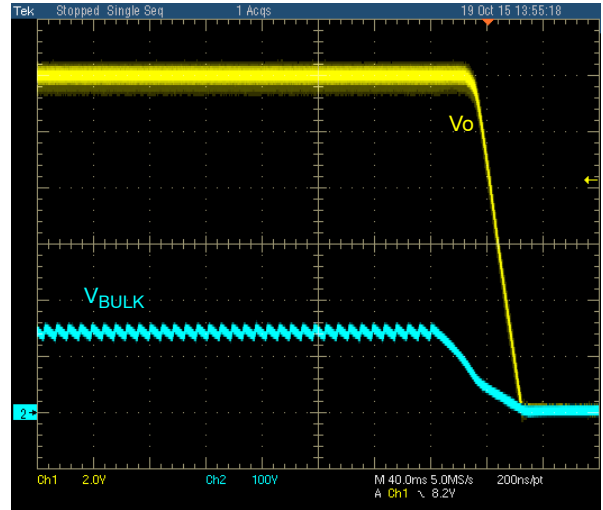


Figure 18. Input Voltage 110 Vac and 0.4 A Load

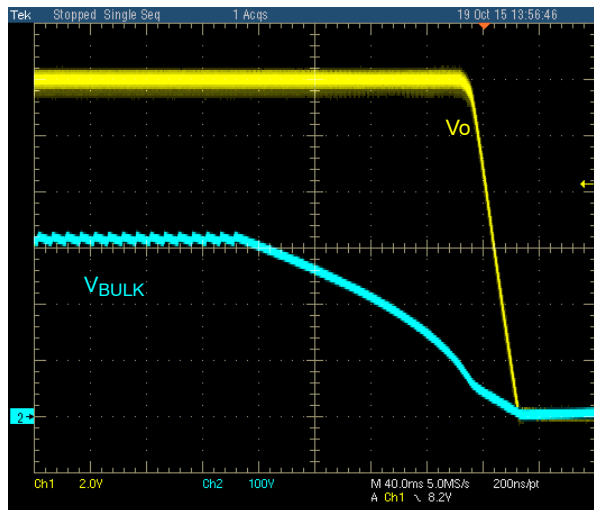


Figure 19. Input Voltage 230 Vac and 0.4 A Load

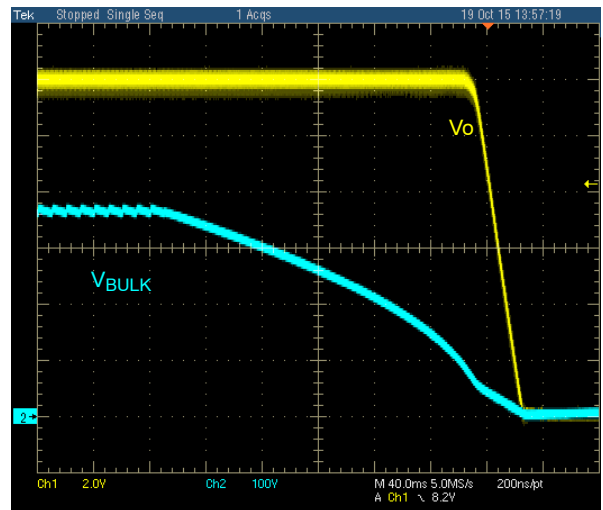


Figure 20. Input Voltage 265 Vac and 0.4 A Load

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Table 3. BILL OF MATERIALS

| Designator | Qty | Description | Value | Tolerance | Footprint | Manufacturer | Manufacturer Part Number | Substitution Allowed |
|----------------|-----|--------------------------|--------------------|-----------|--------------|-------------------------|--------------------------|----------------------|
| C1 | 1 | Capacitor | 10 nF | 10% | Through hole | Vishay BC Components | BFC237261103 | Yes |
| C2 | 1 | Ceramic Capacitor | 1.0 nF | 10% | 805 | Kemet | C0805C102K5RACTU | Yes |
| C3, C4 | 2 | Electrolytic Capacitor | 10 μ F / 400 V | 20% | Through hole | Würth Elektronik | 860011375006 | Yes |
| C5 | 1 | Electrolytic Capacitor | NU | | Through hole | | | |
| C6 | 1 | Electrolytic Capacitor | 470 μ F / 16 V | 20% | Through hole | Würth Elektronik | 870235375008 | Yes |
| C7 | 1 | Electrolytic Capacitor | 470 μ F / 16 V | 20% | Through hole | Würth Elektronik | 870235375008 | Yes |
| C8, C11 | 2 | Ceramic Capacitor | 100 nF | 10% | 805 | Kemet | C0805C104K5RAC | Yes |
| C9 | 1 | Ceramic Capacitor | NU | | 805 | | | |
| C10 | 1 | Electrolytic Capacitor | 10 μ F / 35 V | 20% | Through hole | Würth Elektronik | 870055673001 | Yes |
| C12 | 1 | Ceramic Capacitor | 2.2 nF | 10% | 805 | Kemet | C0805C222K5RACTU | Yes |
| C13 | 1 | Ceramic Capacitor | 12 nF | 10% | 805 | Kemet | C0805C123K5RACTU | Yes |
| C14 | 1 | Electrolytic Capacitor | 4.7 μ F / 35 V | 20% | Through hole | Würth Elektronik | 860010572001 | Yes |
| CX1 | 1 | Capacitor X2 | 68 nF | 10% | Through hole | Würth Elektronik | 890334025013CS | Yes |
| CX2 | 1 | Capacitor X2 | 150 nF | 10% | Through hole | Würth Elektronik | 890334025022 | Yes |
| CY | 1 | Capacitor X1Y1 | 1.0 nF | 20% | Through hole | Murata | DE1E3KX102MA5BA01 | Yes |
| D1, D4, D5, D6 | 4 | Diode | MRA4007 | | SMA | ON Semiconductor | MRA4007T3G | No |
| D2 | 1 | Diode | MURA160 | | SMA | ON Semiconductor | MURA160T3G | No |
| D3 | 1 | Diode | MBRS1100 | | SMC | ON Semiconductor | MBRS1100T3G | No |
| D7 | 1 | Diode | MMSD4148 | | SOD123 | ON Semiconductor | MMSD4148T3G | No |
| IC1 | 1 | Switcher | NCP1060 | | PDIP-7 | ON Semiconductor | NCP1060AP060G | No |
| L1 | 1 | Inductor | 2.2 μ H | | WE-TPC_2828 | Würth Elektronik | 744025002 | No |
| L2 | 1 | Inductor | 1.0 mH | | RFB0807 | Würth Elektronik | 768772102 | No |
| L3 | 1 | Inductor | NU | | RFB0807 | | | |
| L4 | 1 | Common Mode Filter Choke | 12 mH | | WE-TFC | Würth Elektronik | 744862120 | No |
| OK1 | 1 | Optocoupler | FOD817 | | SMD-4 | Fairchild Semiconductor | FOD817CS | No |
| R1 | 1 | Resistor | 15 Ω | 1% | 805 | Rohm Semiconductor | MCR10ERTF15R0 | Yes |
| R2 | 1 | Resistor | 270 k Ω | 1% | 0207/10 | Vishay Dale | CMF55270K00FKEB | Yes |
| R3 | 1 | Resistor | 20 Ω | 5% | 613 | Vishay BC Components | AC03000002009JAC00 | Yes |
| R4 | 1 | Varistor | 820572711 | | Through hole | Würth Elektronik | 820572711 | No |
| R5 | 1 | Resistor | 4.7 k Ω | 1% | 805 | Rohm Semiconductor | MCR10ERTF4701 | Yes |
| R6 | 1 | Resistor | 560 k Ω | 1% | 805 | Rohm Semiconductor | MCR10ERTF5603 | Yes |
| R7 | 1 | Resistor | 1.0 k Ω | 1% | 805 | Rohm Semiconductor | MCR10ERTF1001 | Yes |

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| Designator | Qty | Description | Value | Tolerance | Footprint | Manufacturer | Manufacturer Part Number | Substitution Allowed |
|----------------|-----|--|------------------|-----------|--------------|--------------------|--------------------------|----------------------|
| R8 | 1 | Resistor | 33 kΩ | 1% | 805 | Rohm Semiconductor | MCR10ERTF3302 | Yes |
| R9 | 1 | Resistor | NU | | 805 | | | Yes |
| R10 | 1 | Resistor | 0.0 Ω | | 805 | Vishay Dale | CRCW08050000Z0EA | Yes |
| R11 | 1 | Resistor | 4.7 MΩ | 5% | Axial Lead | Welwyn | VRW37-4M7JI | Yes |
| R12 | 1 | Resistor | 9.1 kΩ | 1% | 805 | Rohm Semiconductor | MCR10ERTF9101 | Yes |
| R13 | 1 | Resistor | 200 kΩ | 1% | 805 | Rohm Semiconductor | MCR10ERTF2003 | Yes |
| R14 | 1 | Resistor | 10 Ω | 1% | 805 | Rohm Semiconductor | MCR10ERTF10R0 | Yes |
| TR1 | 1 | Transformer | 750370026 | | Through hole | Würth Elektronik | 750370026 | No |
| VR1 | 1 | Voltage Regulator | NCP431 | 1% | TO-92 | ON Semiconductor | NCP431ACLPRAG | No |
| X1, X2 | 2 | Wago Screw Clamp 237-102 unknown 70K9898 | 69110171000 2 | | Through hole | Würth Elektronik | 691101710002 | No |
| - | 2 | Wire Strap (insulated) | - | | Wire strap | Various | | Yes |
| Board Standoff | 4 | Hex Standoff M3 Nylon | 8.0 mm | | | Harwin | R30-1610800 | Yes |

NOTE All components are lead free.

REFERENCES

- [1] ON Semiconductor datasheet for [NCP1060](#) monolithic switcher
- [2] ON Semiconductor design notes [DN05012](#), [DN05017](#), [DN05018](#), [DN05028](#), [DN05029](#)
- [3] Würth Elektronik <http://www.we-online.com/>

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