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Design Note – DN05134/D

# Universal AC Input, 0.45 Watt Non-isolated Power Supply

| Device | Application | Input Voltage | Output Power | Topology | I/O Isolation |
|---|---|---|---|---|---|
| NCP10671BD060G | White Goods, E-meter, etc. | 90 to 265 Vac | 0.45 W | Buck | No |

| | Output Specification |
|---|---|
| **Output Voltage** | 5 V |
| **Output Ripple** | 18 mV @ max current |
| **Max Current** | 90 mA |
| **Min Current** | 0 A |

| | |
|---|---|
| **Efficiency** | See Efficiency chart |
| **Input Protection** | No |
| **Operating Temp. Range** | 0 to +50 °C |
| **Cooling Method** | Convection |
| **No-load Power Consumption** | See No load chart |

## Circuit Description text

This design note describes a simple 0.45 W, universal AC input, non-isolated buck converter. The key parameters of the power supply are dimensions and fast transient responds with given output filter. It is recommended to modify the power supply to fit application needs, like standby consumption, output voltage ripple etc.

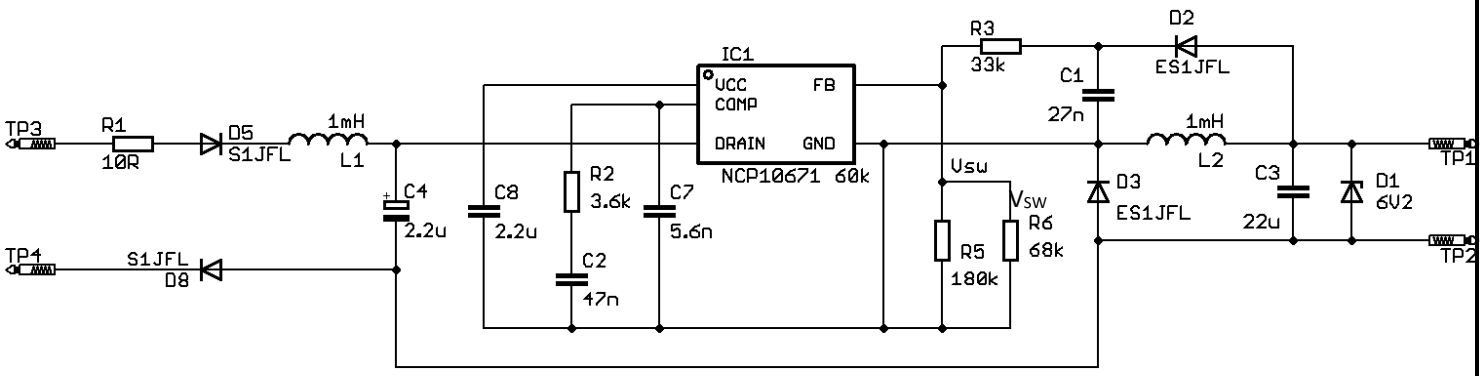
The power supply is a simple non-isolated buck topology utilizing ON Semiconductor's new NCP10671 monolithic switcher with integrated 34 Ω MOSFET in a SOIC7 package (IC1). This Design Note provides the complete circuit schematic and BOM.

The AC voltage is rectified (D5, D8) and connected to bulk capacitor C4. The rising voltage allows DSS to charge Vcc capacitor C8. Once the voltage on C8 crosses UVLO level, the NCP10671 starts to switch. When the internal MOSFET is on, the current flows from C4 to Drain pin, from GND pin through L2 into C3, then via negative line back to C4. When the MOSFET is turned off, the current flows from L2 to C3, then via D3 back to the coil. During demagnetization period the output voltage is copied on C1 (through D2). The C1 value affects no load consumption, transient response etc. The reason is, the capacitor can be only charged via D2, but discharging is done by FB resistor divider. Moreover, the charging is done only during demagnetization period of L2. If lower value of C1 is used, in skip mode, the C1 is faster discharged so IC1 switches frequently to check the output value, on the other hand, if a bigger value is used, less switching period is placed. As a result the higher value of C1 decrease no load consumption and improves load regulation. The lower value of C1 increase transient response. The C1 value selection depends on designer's priorities. A resistor divider composed of R3, R5 and R6 reduces voltage for FB pin (3.3 V). Compensation network composes from R2, C2 and C7. The output diode D1 is a dummy load to clamp high output voltage in no load or low load conditions.

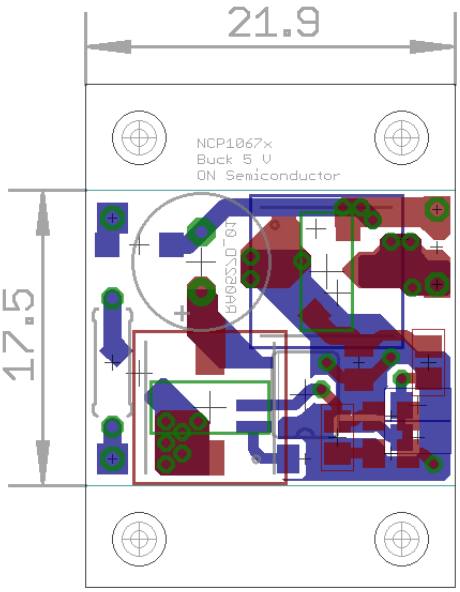
## Key Features

- Universal AC input range (90 – 265 Vac).
- Small dimensions.
- Low no load consumption (it requires a device change)
- Over-voltage and over temperature protection.
- Frequency Jittering for Better EMI Signature (EMI not tested).

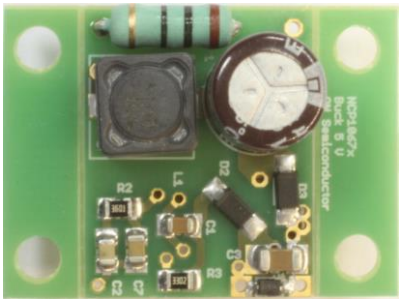
## Circuit Schematic




## PCB layout




## Demo-board Photo



Top

Bottom

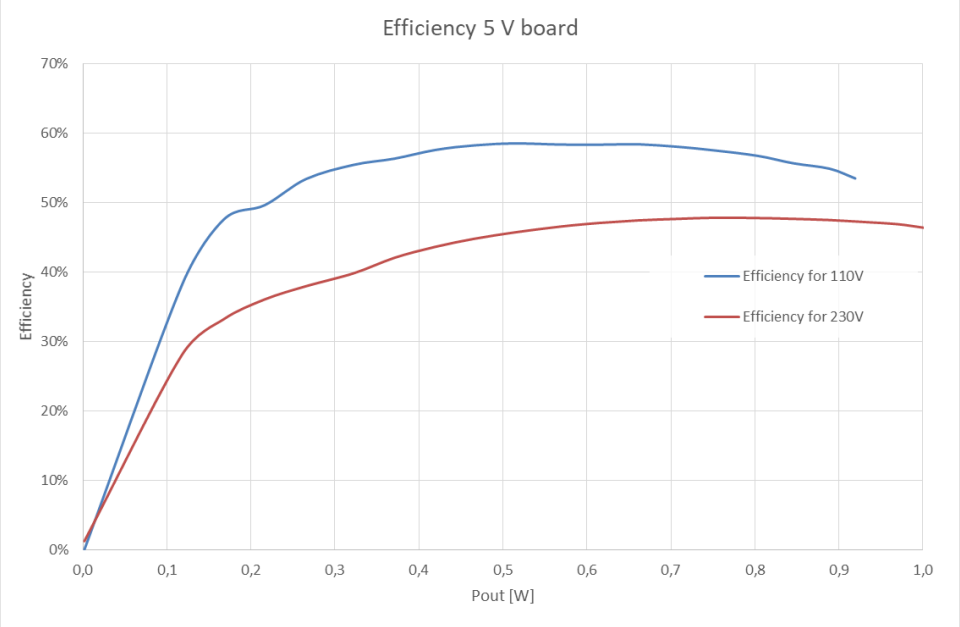



**Figure 1 Efficiency for different input voltage**

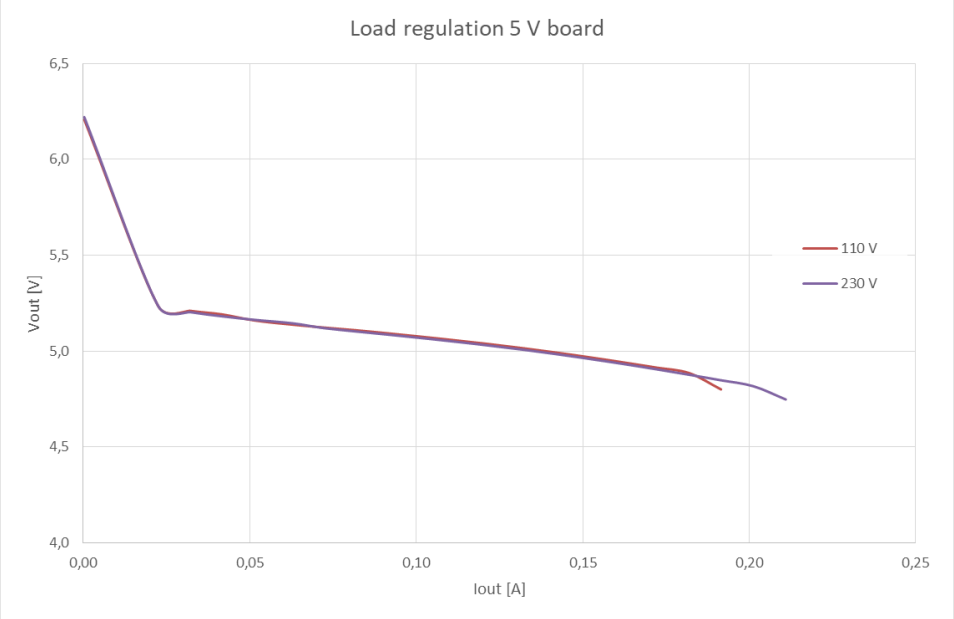



**Figure 2 Load regulation for different input voltage**

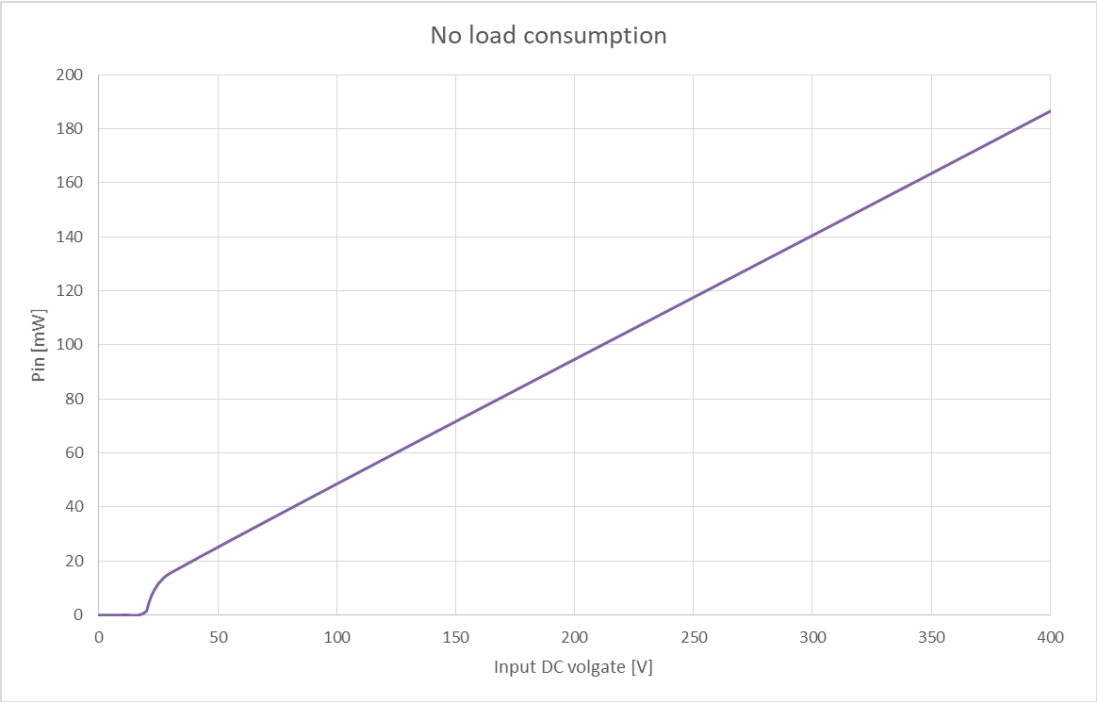



**Figure 3 No load consumption.**

## Output Ripple Voltage

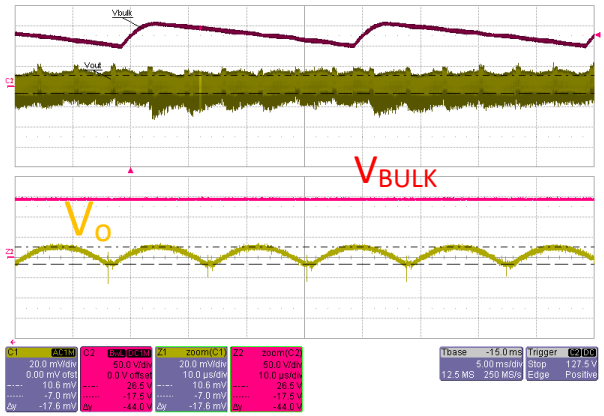



Figure 4 Vin 110 Vac, load 90 mA

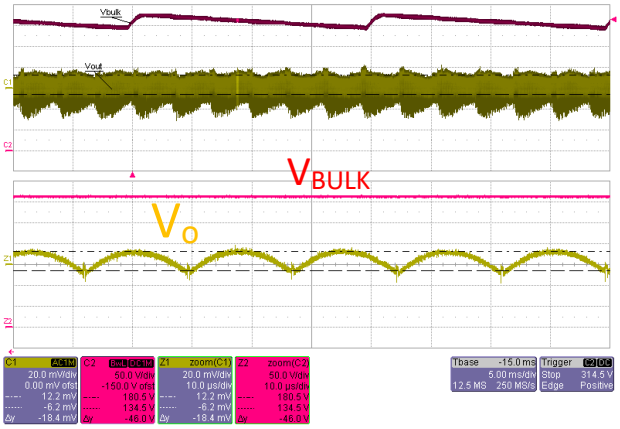



Figure 5 Vin 230 Vac, load 90 mA

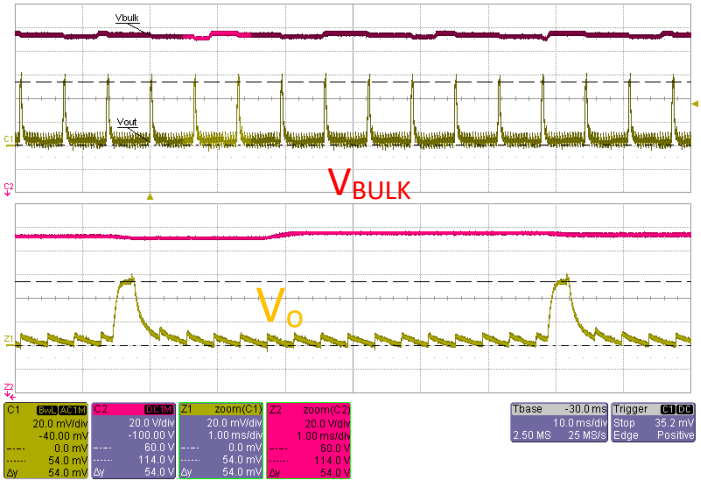



Figure 6 Vin 110 Vac, no load


Figure 7 Vin 230 Vac, no load

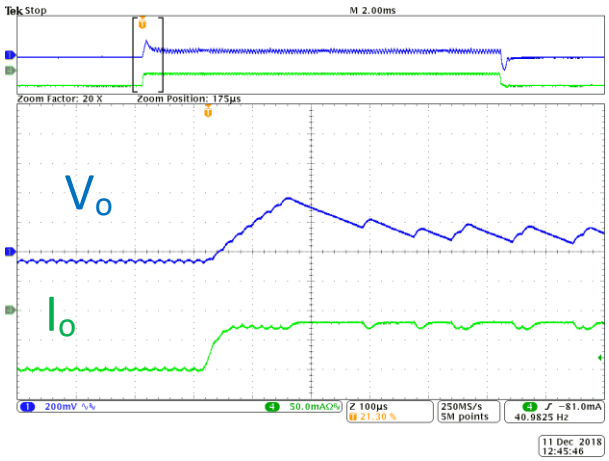



Figure 8 230 Vac, step load from 22 mA to 90 mA

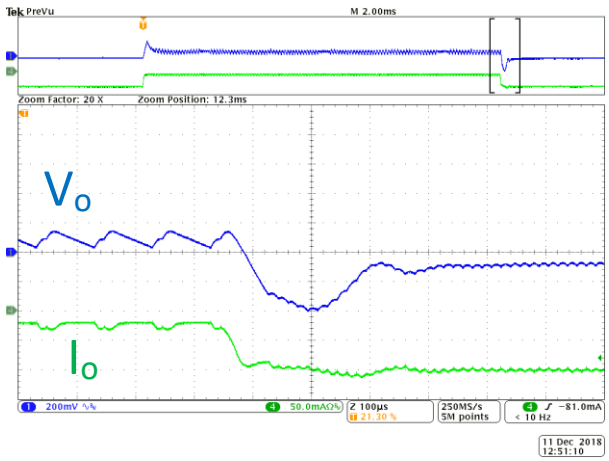



Figure 9 230 Vac, step load from 90 mA to 22 mA

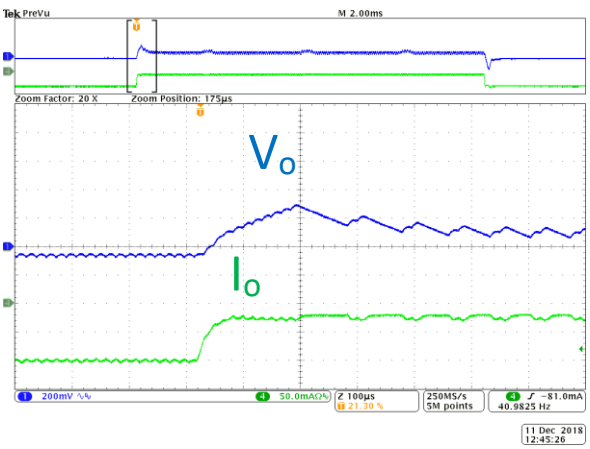



**Figure 10 110 Vac, step load from 22 mA to 90 mA**

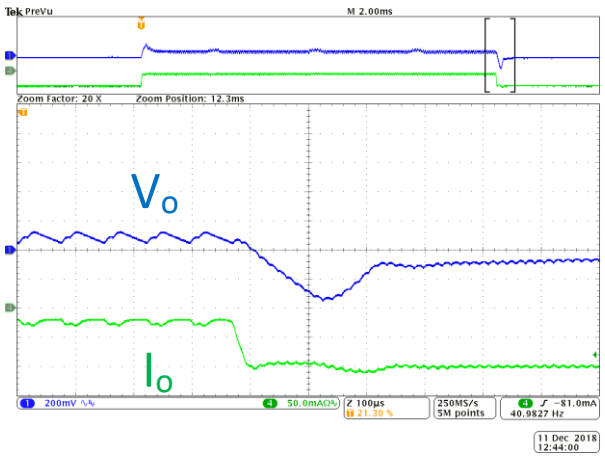



**Figure 11 110 Vac, step load from 90 mA to 22 mA**

## Startup Time

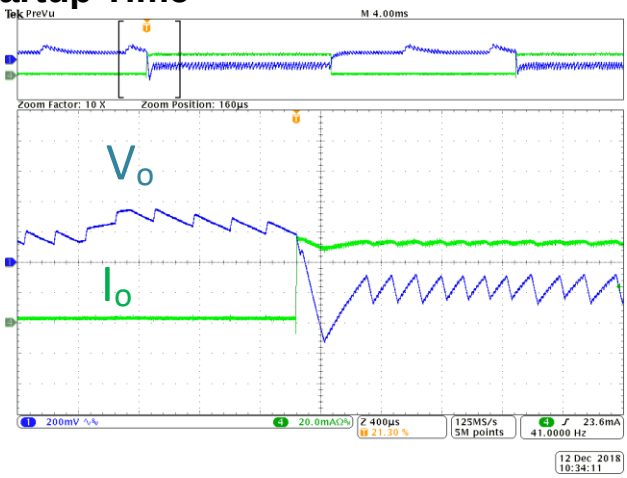



**Figure 12 230 Vac, transient from 5 mA to 55 mA load**

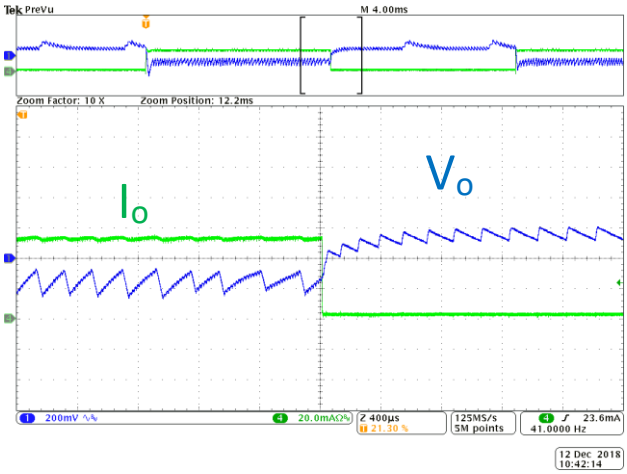



**Figure 13 230 Vac, transient from 55 mA to 5 mA load**

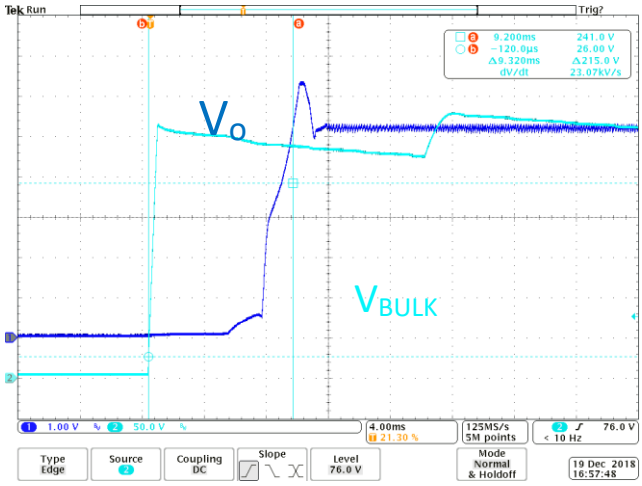



**Figure 14 110 Vac, start to no load**

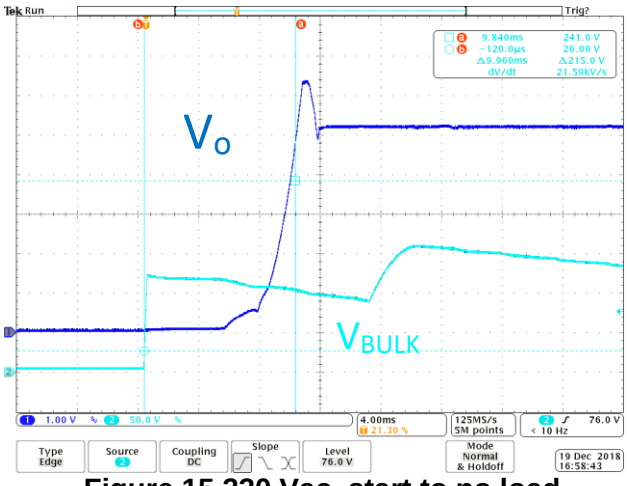



**Figure 15 230 Vac, start to no load**

# BOM

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## Bill of Materials for the NCP10671 Buck SOIC7 Demo Board 5 V

| Designator | Quantity | Description | Value | Tolerance | Footprint | Manufacturer | Manufacturer Part Number | Substitution Allowed | Lead Free | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| C1 | 1 | CAPACITOR | 27 nF | 10% | 0603 | Kemet | C0603C273K5RACTU | Yes | Yes | |
| C2 | 1 | CAPACITOR | 47 nF | 10% | 0603 | Kemet | C0603C473K5RACTU | Yes | Yes | |
| C3 | 1 | CAPACITOR | 22 uF | 20% | 1206 | Murata Electronics | GRT31CC81C226ME01L | Yes | Yes | |
| C4 | 1 | ELECTROLYTIC CAPACITOR | 2.2 µF / 400 V | 20% | THROUGH HOLE | Yageo | SE400M2R20B3S-0811 | Yes | Yes | |
| C7 | 1 | CAPACITOR | 5.6 nF | 10% | 0603 | Kemet | C0603C562K5RACTU | Yes | Yes | |
| C8 | 1 | CAPACITOR | 2.2 uF | 20% | 0603 | TDK | C1608JB1E225M080AB | Yes | Yes | |
| R1 | 1 | RESISTOR | 10 Ω | 5% | 0207 | Yageo | KNP1WSJT-52-10R | Yes | Yes | |
| R2 | 1 | RESISTOR | 3.6 kΩ | 1% | 0603 | Yageo | RT0603FRE073K6L | Yes | Yes | |
| R3 | 1 | RESISTOR | 33 kΩ | 1% | 0603 | Yageo | RT0603FRE0733KL | Yes | Yes | |
| R5 | 1 | RESISTOR | 180 kΩ | 1% | 0603 | Yageo | RT0603FRE07180KL | Yes | Yes | |
| R6 | 1 | RESISTOR | 68 kΩ | 1% | 0603 | Yageo | RT0603FRE0768KL | Yes | Yes | |
| D1 | 1 | ZENER DIODE | MM3Z6V2 | 5% | SOD323 | ON Semiconductor | MM3Z6V2 | No | Yes | |
| D2, D3 | 2 | DIODE | ES1JFL | - | SOD123 | ON Semiconductor | ES1JFL | No | Yes | |
| D5, D8 | 2 | DIODE | S1JFL | - | SOD123 | ON Semiconductor | S1JFL | No | Yes | |
| IC1 | 1 | SWITCHER | NCP10671 | - | SOIC7 | ON Semiconductor | NCP10671BD060R2G | No | Yes | |
| L1, L2 | 2 | INDUCTOR | 1.0 mH | 20% | SMD/SMT | Würth Elektronik | 744777930 | No | Yes | |
| BOARD STANDOFF | 4 | HEX STANDOFF M3 NYLON | 8.0 mm | - | - | Harwin | R30-1610800 | Yes | Yes | |

## References

ON Semiconductor datasheet for NCP1067x monolithic switcher.

ON Semiconductor Design Notes DN05012, DN05017, DN05018, DN05080, DN05129.

ON Semiconductor Design Note:
https://www.onsemi.com/pub/Collateral/LOOP%20STABILIZATION%20FOR%20106X.PDF

Würth Electronic Website: https://www.we-online.com/web/en/wuerth_elektronik/start.php