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DN05134/D

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.

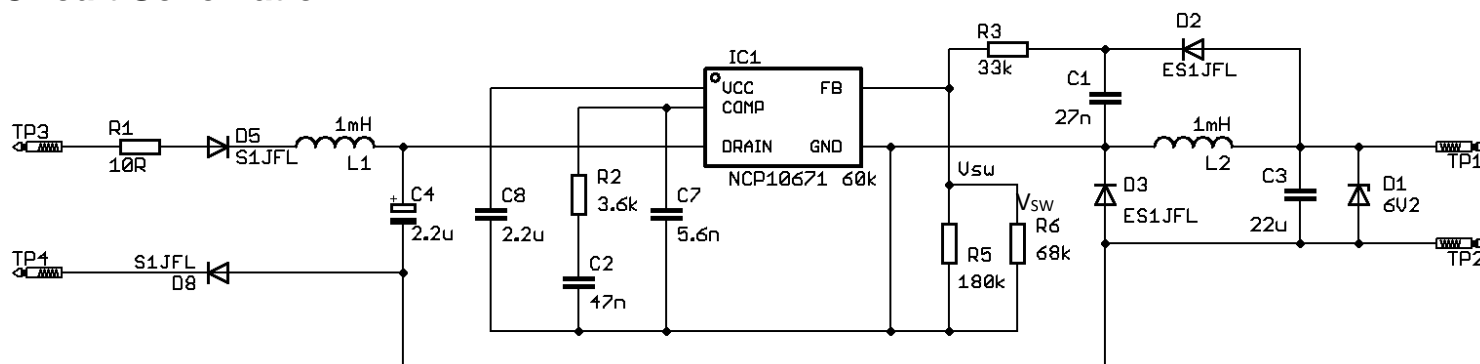
The AC voltage is rectified (D5, D8) and connected to bulk capacitor C4. The rising voltage allows DSS to charge Vcc capacitor C8. Once the voltage on C8 crosses UVLO level, the NCP10671 starts to switch. When the internal MOSFET is on, the current flows from C4 to Drain pin, from GND pin through L2 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.

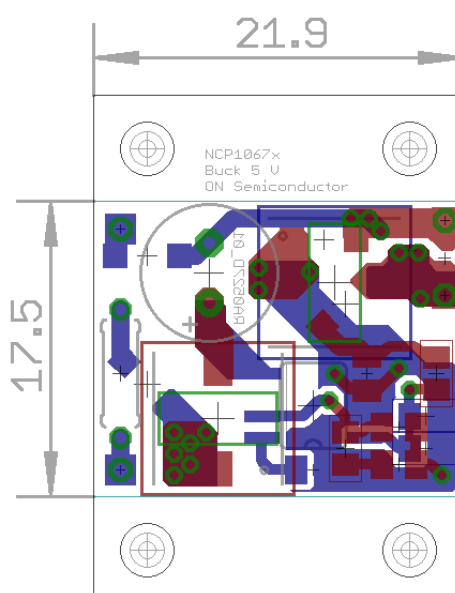
Key Features

- 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).

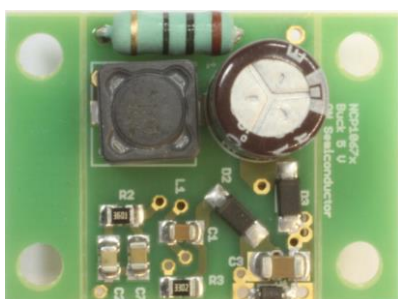
Circuit Schematic



PCB layout



Demo-board Photo



Top



Bottom

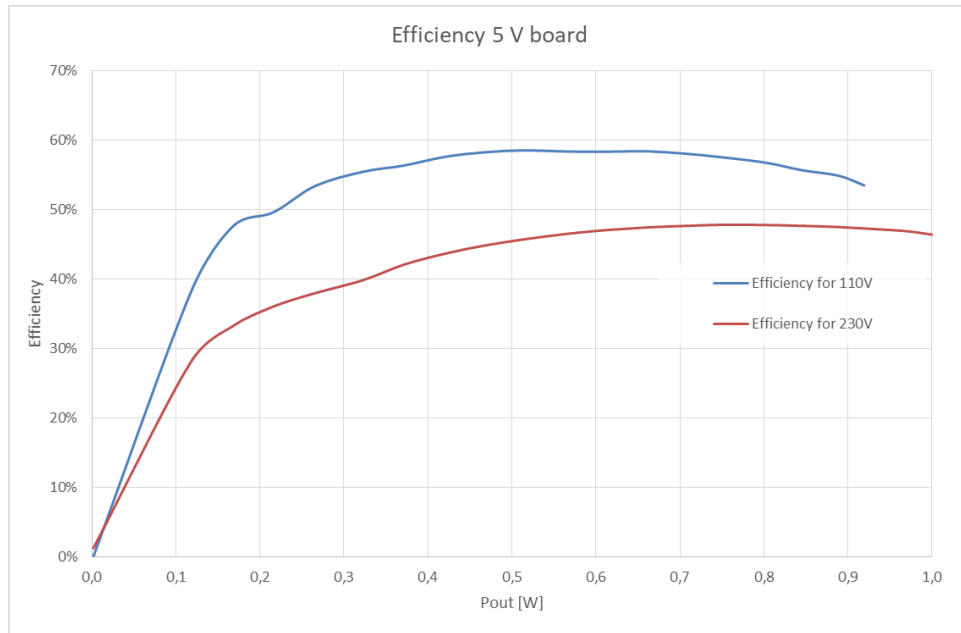


Figure 1 Efficiency for different input voltage

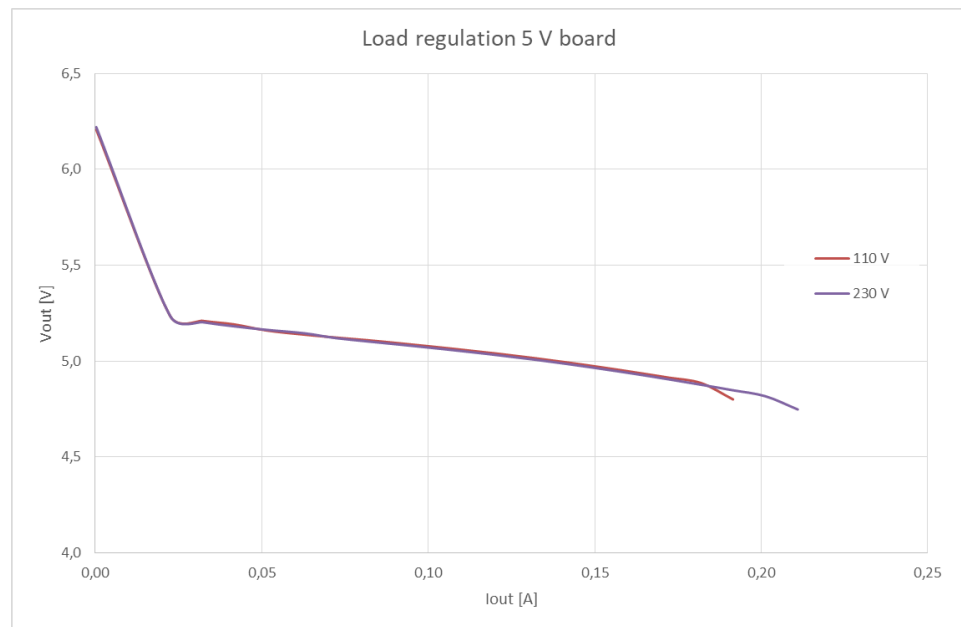


Figure 2 Load regulation for different input voltage

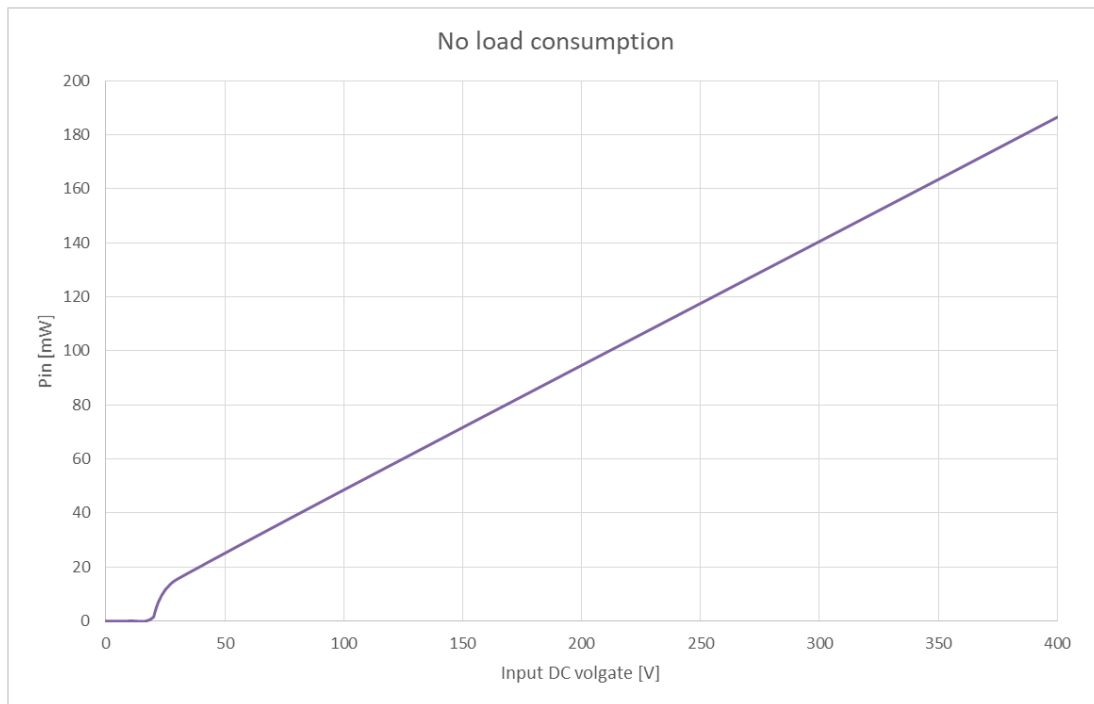


Figure 3 No load consumption.

Output Ripple Voltage

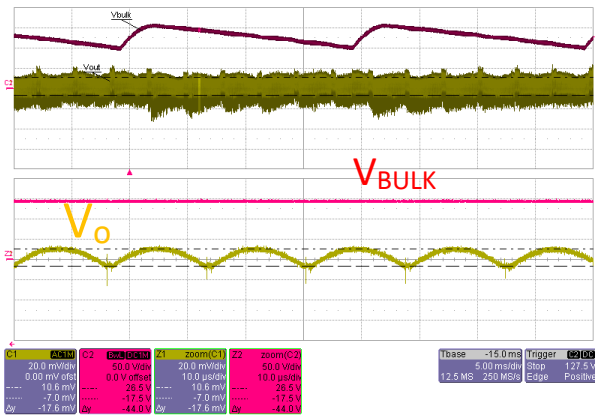


Figure 4 Vin 110 Vac, load 90 mA



Figure 5 Vin 230 Vac, load 90 mA

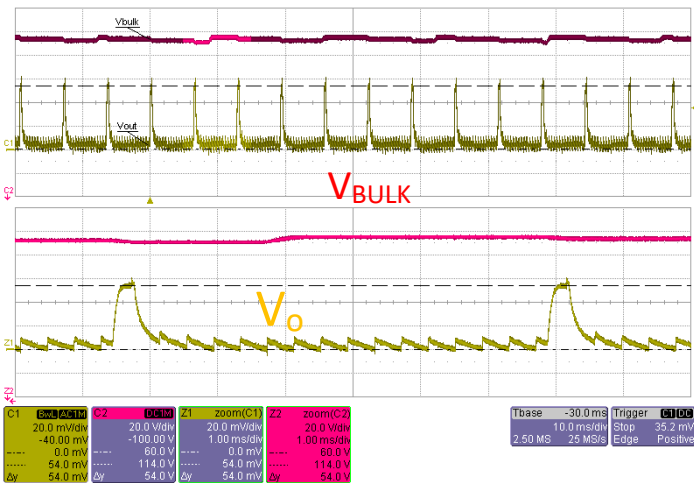


Figure 6 Vin 110 Vac, no load

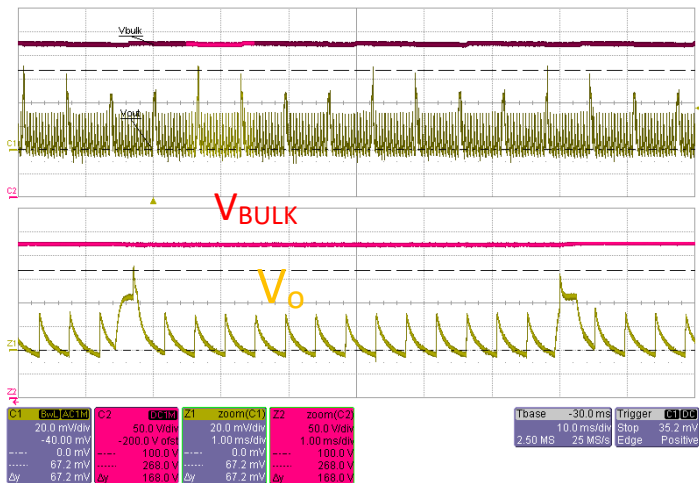


Figure 7 Vin 230 Vac, no load

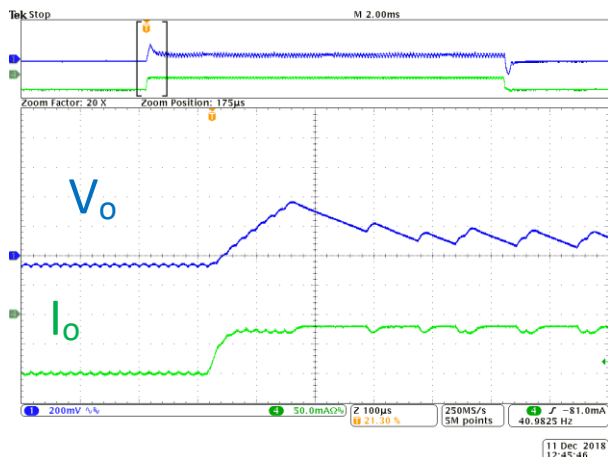


Figure 8 230 Vac, step load from 22 mA to 90 mA

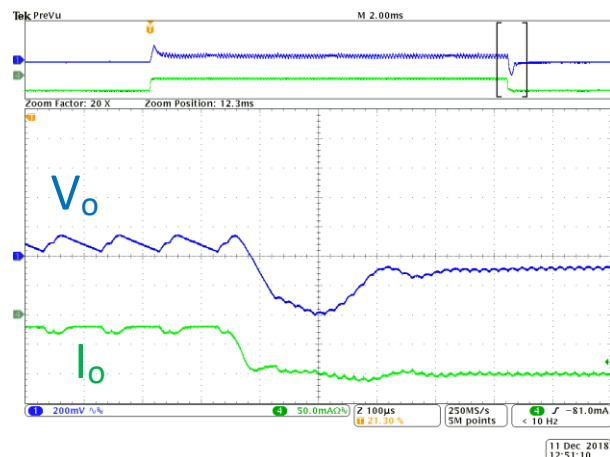


Figure 9 230 Vac, step load from 90 mA to 22 mA

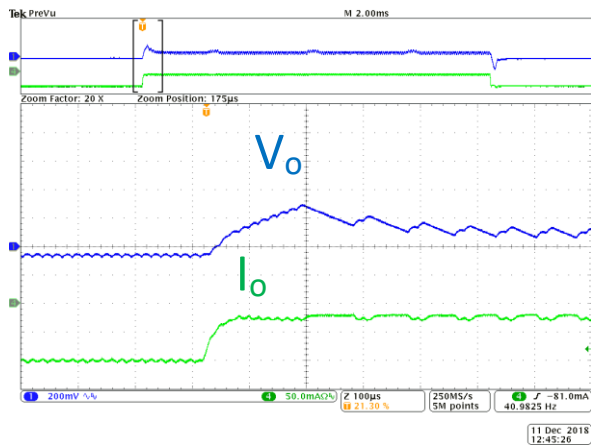


Figure 10 110 Vac, step load from 22 mA to 90 mA

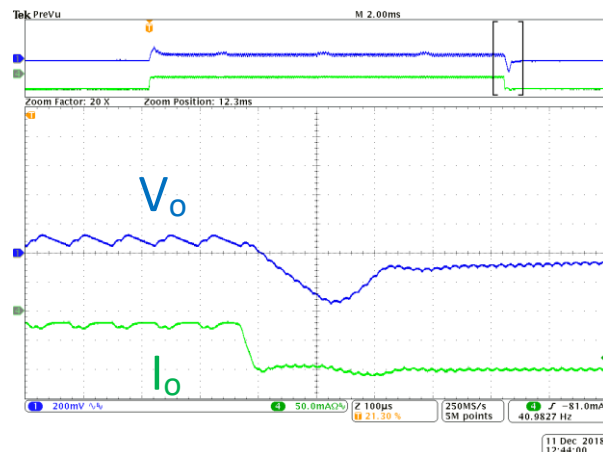


Figure 11 110 Vac, step load from 90 mA to 22 mA

Startup Time

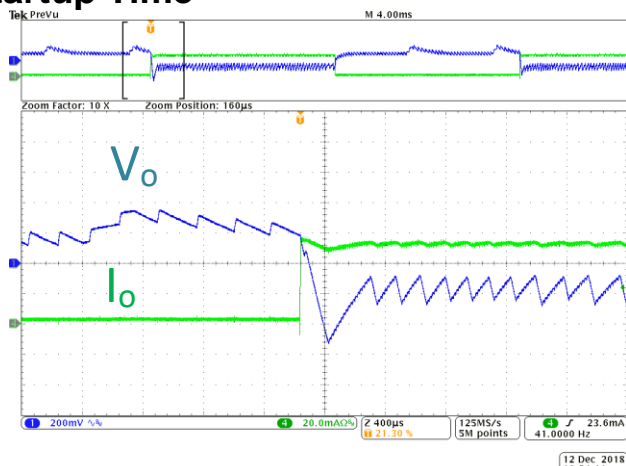


Figure 12 230 Vac, transient from 5 mA to 55 mA load

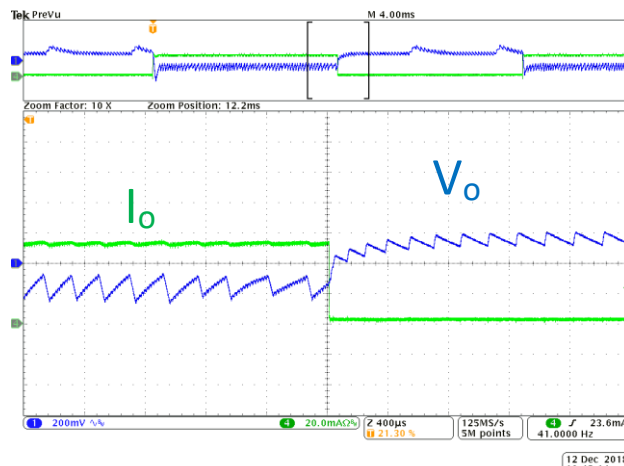


Figure 13 230 Vac, transient from 55 mA to 5 mA load

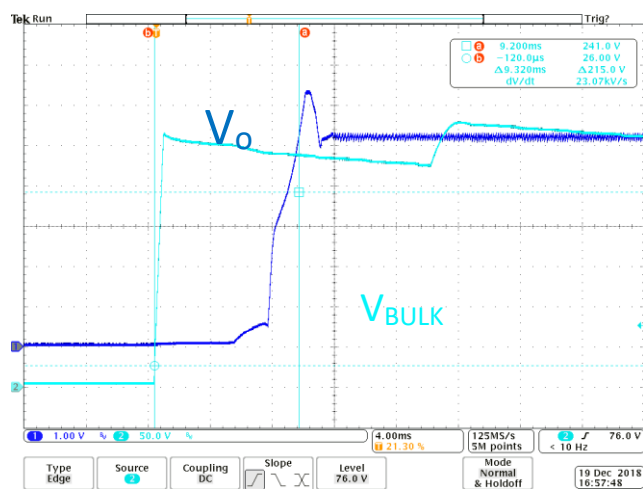


Figure 14 110 Vac, start to no load

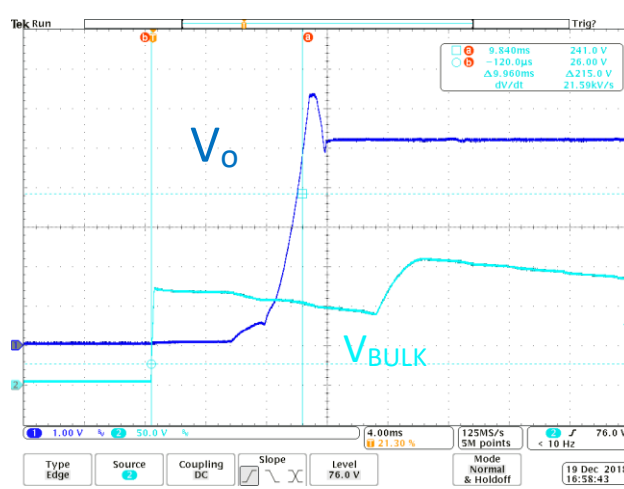


Figure 15 230 Vac, start to no load

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 uF / 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

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