

NCP5181BAL36WEVB

NCP5181 36 W Ballast Evaluation Board User's Manual



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EVAl BOARD USER'S MANUAL

Description

This document describes how the NCP5181 driver can be implemented in a ballast application. The scope of this evaluation board user's manual is to highlight the NCP5181 driver and not to explain or detail how to build an electronic ballast.

The NCP5181 is a high voltage power MOSFET driver providing two outputs for direct drive of two N-channel power MOSFETs arranged in a half-bridge (or any other high-side + low-side topology) configuration.

It uses the bootstrap technique to ensure a proper drive of the high-side power switch. The driver works with two independent inputs to accommodate with any topology (including half-bridge, asymmetrical half-bridge, active clamp and full-bridge).

Evaluation Board Specification

- Input Range: 85 – 145 Vac OR 184 – 265 Vac
- Ballast Output Power: 36 W (type PL–L 36 W)
- Pre-heating Current: 295 mA
- Pre-heating Time: 1 second
- Nominal Current: 414 mA

Detailed Operation

The lamp ballast is powered via a half bridge configuration. The two power MOSFETs are driven with the NCP5181 driver. The driver is supplied by the V_{CC} rail, and the high side driver is supplied by the bootstrap diode: when the low side power MOSFET (Q2) is switched ON, the BRIDGE pin is pulled down to the ground, thus the capacitor connected between the BRIDGE pin and VBOOT pin is refuelled via the diode D3 and the resistor R5 connected to V_{CC} . When Q2 is switched OFF, the bootstrap capacitor C6 supplies the high side driver with a voltage equal to V_{CC} level minus D3 forward voltage diode. Given the NCP5181 architecture, it is up to the designer to generate the right input signal polarity. This includes a dead time to avoid a short circuit between the high and low side power MOSFET.

The 555 timer generates only one signal for the driver, the second one, in opposite phase is built by inserting an NPN transistor (Q4) for inverting the signal. Afterwards, the dead time is built with R2, D2 and C13 (typically 260 ns, see Figure 2).

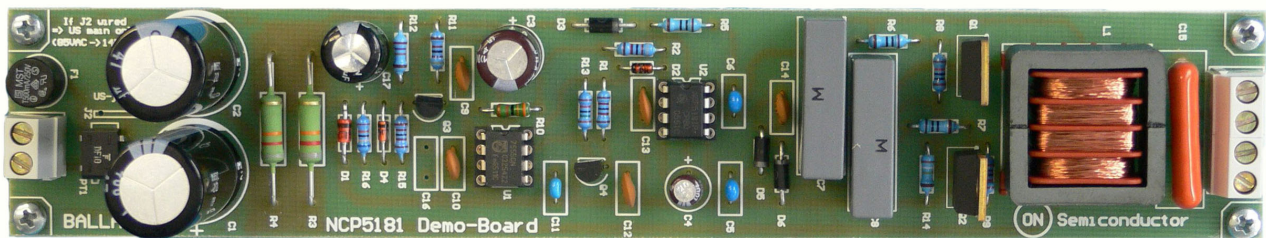


Figure 1. NCP5181 Evaluation Board

WARNING: BEFORE PLUGGING IN THE EVALUATION BOARD, MAKE SURE THE JUMPER IS IN THE CORRECT POSITION: IF J2 IS USED, THEN V_{in} MUST BE LOWER THAN 145 Vac.

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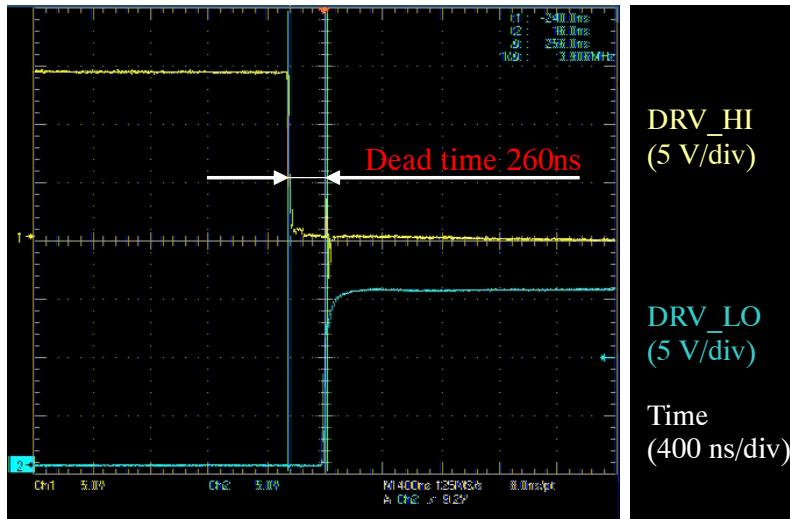


Figure 2. Dead Time Between the High and Low Side Driver

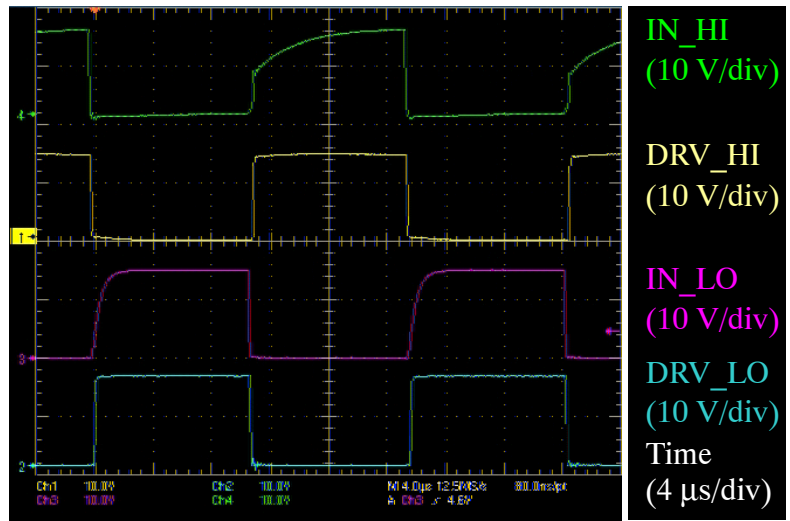
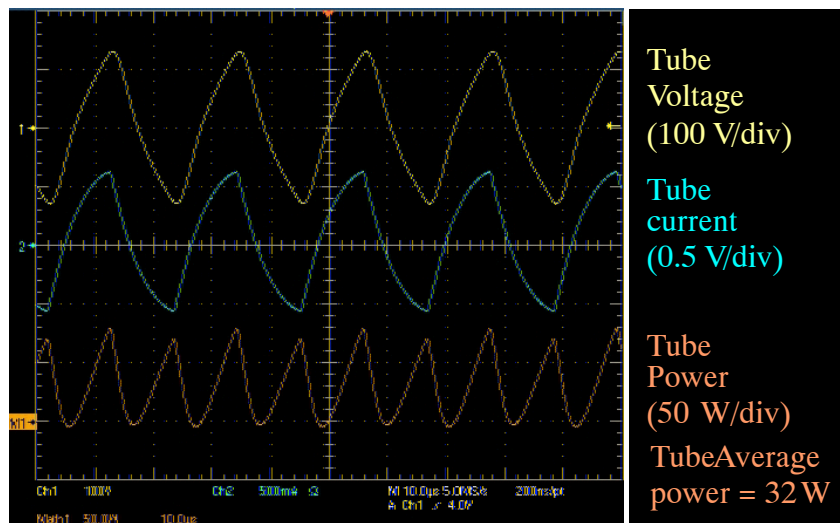


Figure 3. Input Output Timing Diagram



Tube Voltage (100 V/div)
 Tube current (0.5 V/div)
 Tube Power (50 W/div)
 TubeAverage power = 32 W

Figure 4. Tube Signals

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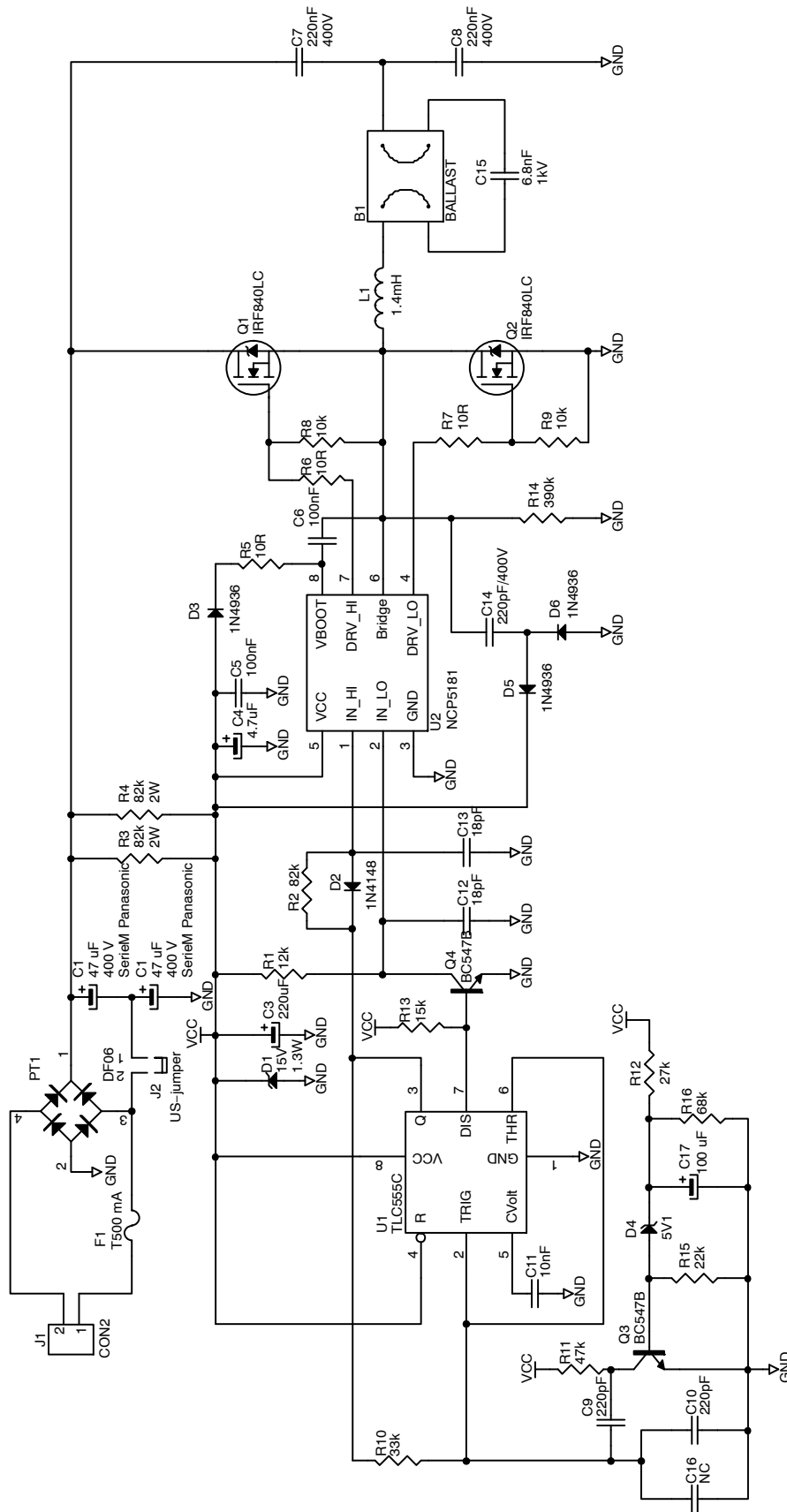


Figure 5. Evaluation Board Schematic

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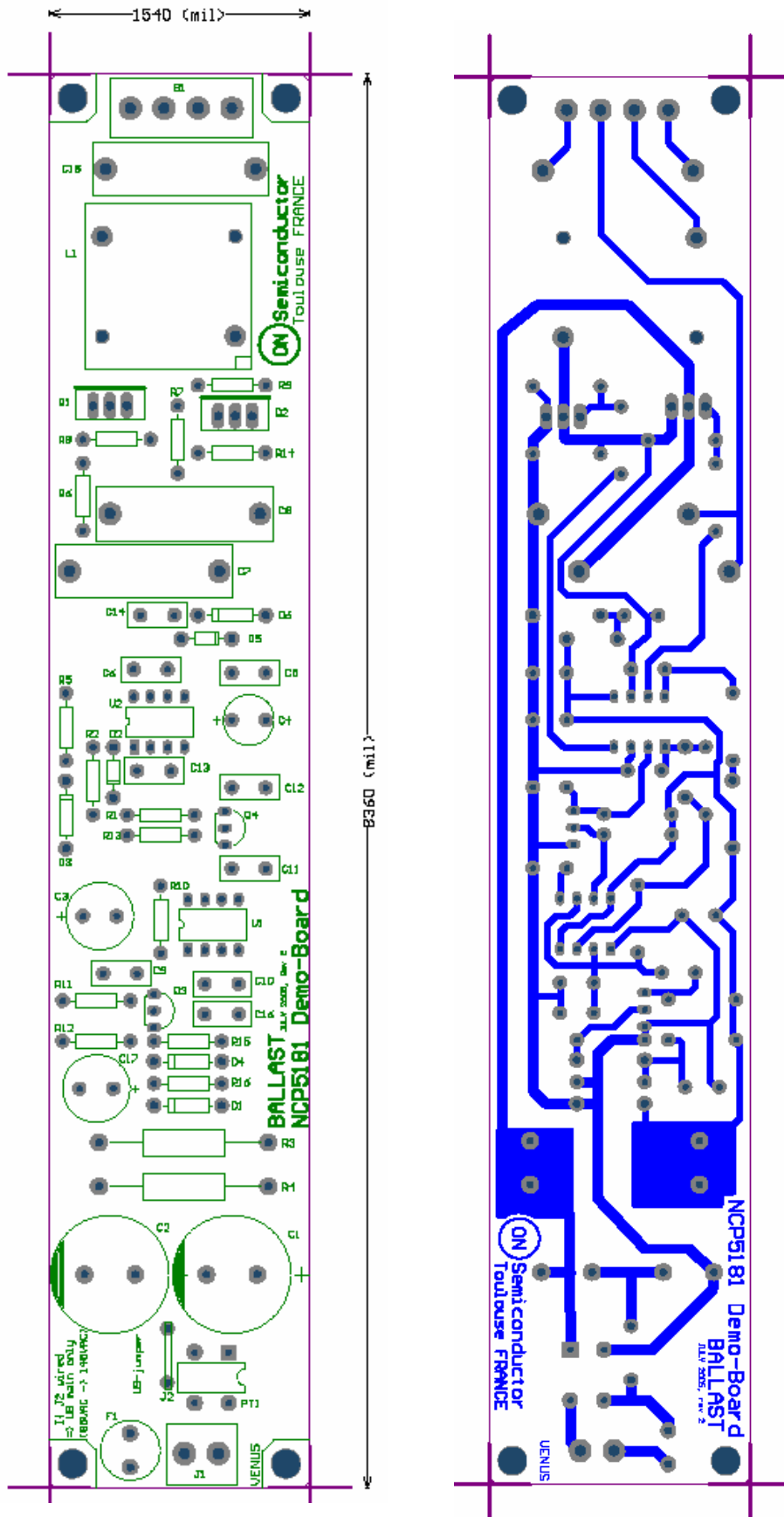


Figure 6. PCB Printout: Top and Bottom View

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TEST PROCEDURE

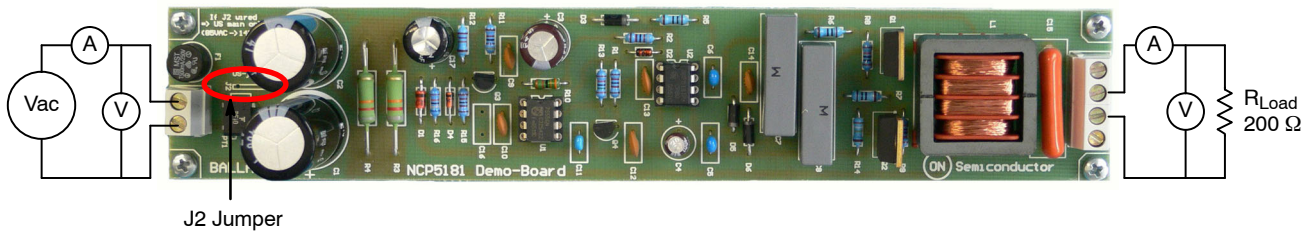


Figure 7. Test Setup Connection

Table 1. REQUIRED EQUIPMENT

| | | |
|---|------------------------------|-------------------|
| AC Power Source can be able to deliver 230 V _{rms} or 110 V _{rms} | Two Volt-meters | Two Ampere-meters |
| 1 Resistive Load: 200 Ω/50 W | One NCP5181 Evaluation Board | - |

Test Procedure

1. First of all check if you need jumper #2 (J2 on the board close the diode bridge). This jumper must be removed for use with European mains (230 Vac input voltage), and must be in place when using US mains (110 Vac). This jumper is used to build a voltage doubler just after the bridge diode in case one is using US mains input voltage range.
2. Connect the test setup as shown in Figure 7:
 - AC Source

- Voltmeter and Ammeter on the Load
 - Load on the Output
3. Apply 230 Vac for European mains or 110 Vac for US mains on the input connector.
 4. Check I_{Load} and V_{Load} with the appropriate value in the table below.
 5. If you get the correct output and input voltage, you can then connect a 36 W fluorescent tube on the output (see Figure 8).

Table 2. TEST RESULTS

| Input Mains | J2 | V _{in} (V _{rms}) | I _{in} (A _{rms}) | V _{Load} (V _{rms}) | I _{Load} (A _{rms}) |
|-------------|---|-------------------------------------|-------------------------------------|---------------------------------------|---------------------------------------|
| European | Removed | 230 V | 278 mA | 303 V | 370 mA |
| US | Yes → Max Input Voltage: 132 V _{rms} | 110 V | 514 mA | 263 V | 340 mA |

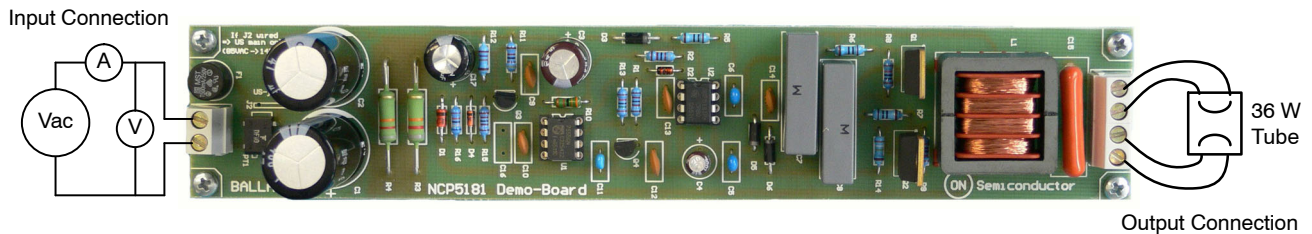


Figure 8. Ballast Connection

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Table 3. BILL OF MATERIAL FOR THE NCP5181 EVALUATION BOARD

| Designator | Qty. | Description | Value | Tolerance | Footprint | Manufacturer | Manufacturer Part Number | Substitution Allowed | Lead Free |
|------------|------|------------------------|-------------------------|-----------|-----------|-------------------------|--------------------------|----------------------|-----------|
| U2 | 1 | NCP5181 | NA | NA | DIP8 | ON Semiconductor | NCP5181PG | No | Yes |
| U1 | 1 | CMOS IC | Analog/Timer | NA | DIP8 | Texas Instruments | TLC555CP | Yes | No |
| C1, C2 | 2 | Electrolytic Capacitor | 47 μ F, 400 V | 20% | Radial | Panasonic | ECA2GM470 | Yes | No |
| C3 | 1 | Electrolytic Capacitor | 220 μ F, 16 V | 20% | Radial | Panasonic | ECA1CM221 | Yes | No |
| C4 | 1 | Electrolytic Capacitor | 4.7 μ F, 63 V | 20% | Radial | Panasonic | EEUEB1J4R7 | Yes | No |
| C5, C6 | 2 | Capacitor | 100 nF, 50 V | 10% | Radial | Murata | RPER71H104K2M1A05U | Yes | No |
| C7, C8 | 2 | Capacitor | 220 nF, 400 V | 10% | Radial | Vishay | MKT1822422405 | Yes | No |
| C9, C10 | 2 | Capacitor | 220 nF, 100 V | 5% | Radial | Murata | RPE5C2A221J2M1Z05A | Yes | No |
| C11 | 1 | Capacitor | 10 nF, 100 V | 10% | Radial | Murata | RPER72A103K2M1B05A | Yes | No |
| C12, C13 | 2 | Capacitor | 18 pF, 100 V | 2% | Radial | Vishay | 2252 586 20154 | Yes | Yes |
| C14 | 1 | Capacitor | 220 pF, 400 V | 10% | Radial | Panasonic | ECKATS221KB | Yes | No |
| C15 | 1 | Capacitor | 6.8 nF, 1600 V | 5% | Radial | Vishay | 2222 375 30682 | Yes | No |
| C16 | 1 | Capacitor | NC | - | Radial | - | - | - | - |
| C17 | 1 | Electrolytic Capacitor | 100 μ F, 16 V | 20% | Radial | Panasonic | ECA1CM101 | Yes | No |
| D1 | 1 | Zener Diode | 15 V, 1.3 W | 5% | Axial | Vishay | BZX85C15 | Yes | No |
| D2 | 1 | High-speed Diode | 0.2 A, 75 V | NA | Axial | Philips Semiconductor | 1N4148 | Yes | No |
| D3, D5, D6 | 3 | Rectifier Diode | 1 A, 400 V | NA | Axial | ON Semiconductor | 1N4936G | Yes | Yes |
| D4 | 1 | Zener Diode | 5.1 V, 1.3 W | 5% | Axial | Vishay | BZX85C5V1 | Yes | No |
| F1 | 1 | Fuse | 500 mA, 250 V | NA | Radial | Schurter | 0034.6612 | Yes | No |
| L1 | 1 | Inductor | 1.4 mH | NA | NA | Vogt | 53-044 | No | No |
| PT1 | 1 | Diode Bridge | 600 V, 1 A | NA | DFM | Vishay | DF06M | Yes | No |
| R1 | 1 | Resistor | 12 k Ω , 0.33 W | 5% | Axial | Vishay | CFA020712K | Yes | No |
| R2 | 1 | Resistor | 82 k Ω , 0.33 W | 5% | Axial | Vishay | CFA020782K | Yes | No |
| R3, R4 | 2 | Resistor | 82 k Ω , 3 W | 5% | Axial | Vishay | CPF382K000JN | Yes | No |
| R5, R6, R7 | 3 | Resistor | 10 Ω , 0.33 W | 5% | Axial | Vishay | CFA020710R | Yes | No |
| R8, R9 | 2 | Resistor | 10 k Ω , 0.33 W | 5% | Axial | Yageo | CFA020710K | Yes | No |
| R10 | 1 | Resistor | 33 k Ω , 0.33 W | 5% | Axial | Vishay | CFA020733K | Yes | No |
| R11 | 1 | Resistor | 47 k Ω , 0.33 W | 5% | Axial | Vishay | CFA020747K | Yes | No |
| R12 | 1 | Resistor | 27 k Ω , 0.33 W | 5% | Axial | Vishay | CFA020727K | Yes | No |
| R13 | 1 | Resistor | 15 k Ω , 0.33 W | 5% | Axial | Vishay | CFA020715K | Yes | No |
| R14 | 1 | Resistor | 390 k Ω , 0.33 W | 5% | Axial | Vishay | CFA0207390K | Yes | No |
| R15 | 1 | Resistor | 22 k Ω , 0.33 W | 5% | Axial | Vishay | CFA020722K | Yes | No |
| R16 | 1 | Resistor | 68 k Ω , 0.33 W | 5% | Axial | Vishay | CFA020768K | Yes | No |
| Q1, Q2 | 2 | Power MOSFET N-channel | 8 A, 500 V | NA | TO220 | International Rectifier | IRF840LC | Yes | No |
| Q3, Q4 | 2 | NPN Transistor | 100 mA, 45 V | NA | TO-92 | ON Semiconductor | BC547BG | Yes | Yes |
| B1, J1 | 2 | Connector | 2" | NA | 5.08 mm | Weidmuller | PM5.08/2/90 (1760510000) | Yes | No |
| J2 | 1 | Jumper Resistor | 0 Ω , 0.25 W | NA | Axial | Yageo | ZOR-25-B-52 | Yes | No |

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