

# NCP5181BAL36WEVB

## NCP5181 36 W Ballast Evaluation Board User's Manual



ON Semiconductor®

<http://onsemi.com>

### 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).

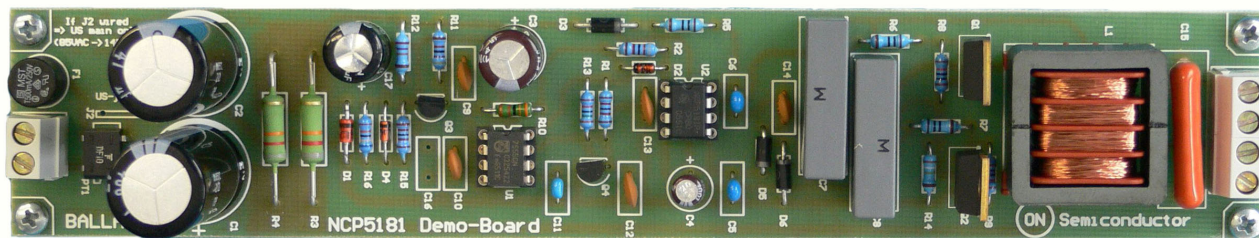


Figure 1. NCP5181 Evaluation Board

**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.

# NCP5181BAL36WEVB

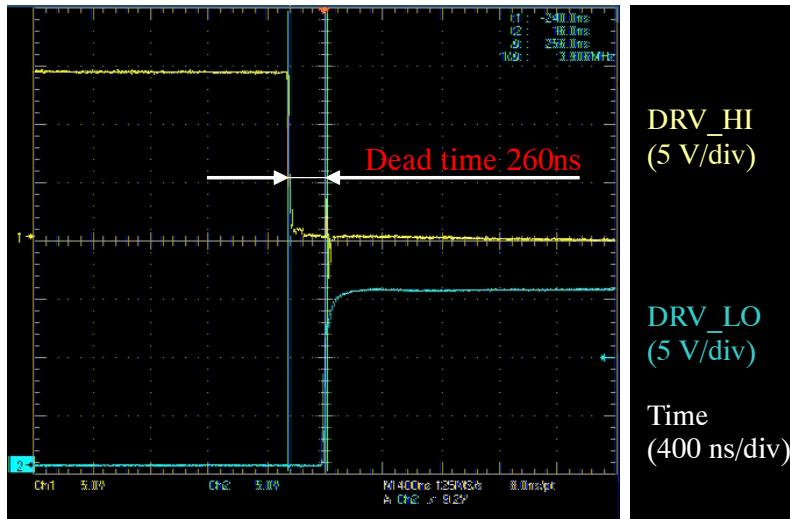


Figure 2. Dead Time Between the High and Low Side Driver

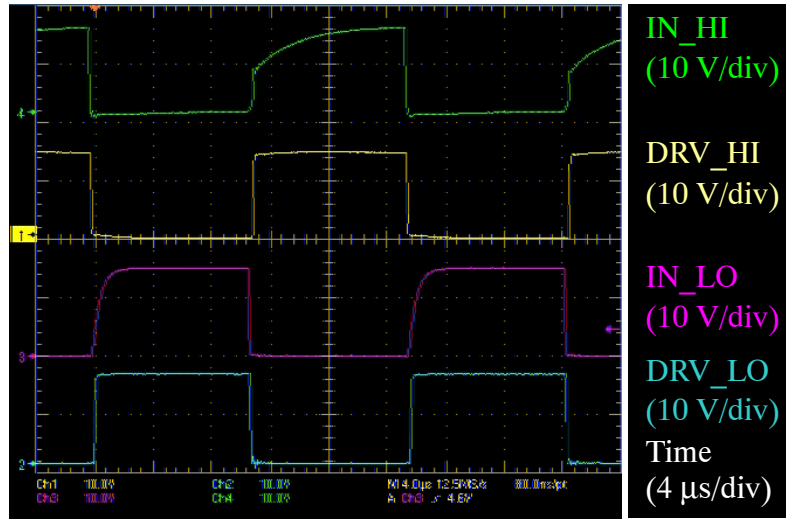
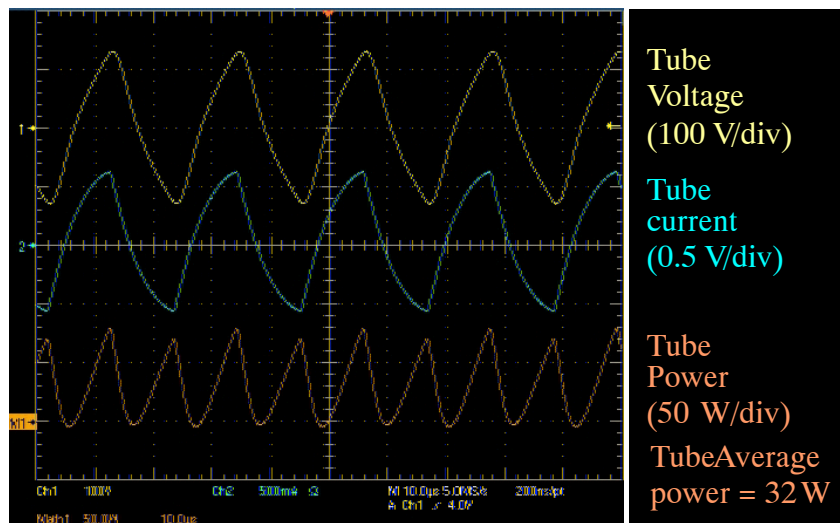


Figure 3. Input Output Timing Diagram



TubeAverage power = 32 W

Figure 4. Tube Signals

# NCP5181BAL36WEVB

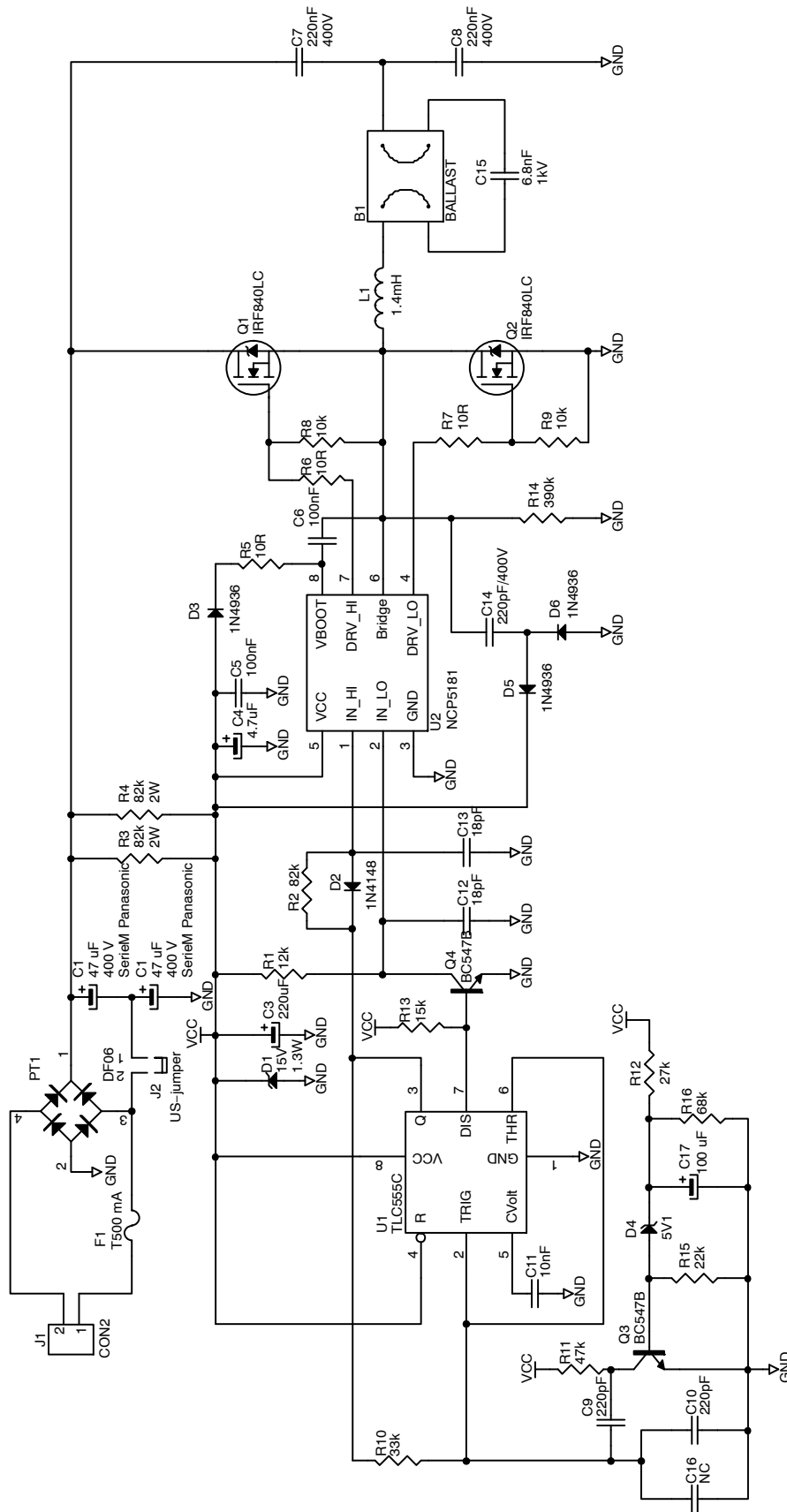


Figure 5. Evaluation Board Schematic

NCP5181BAL36WEVB

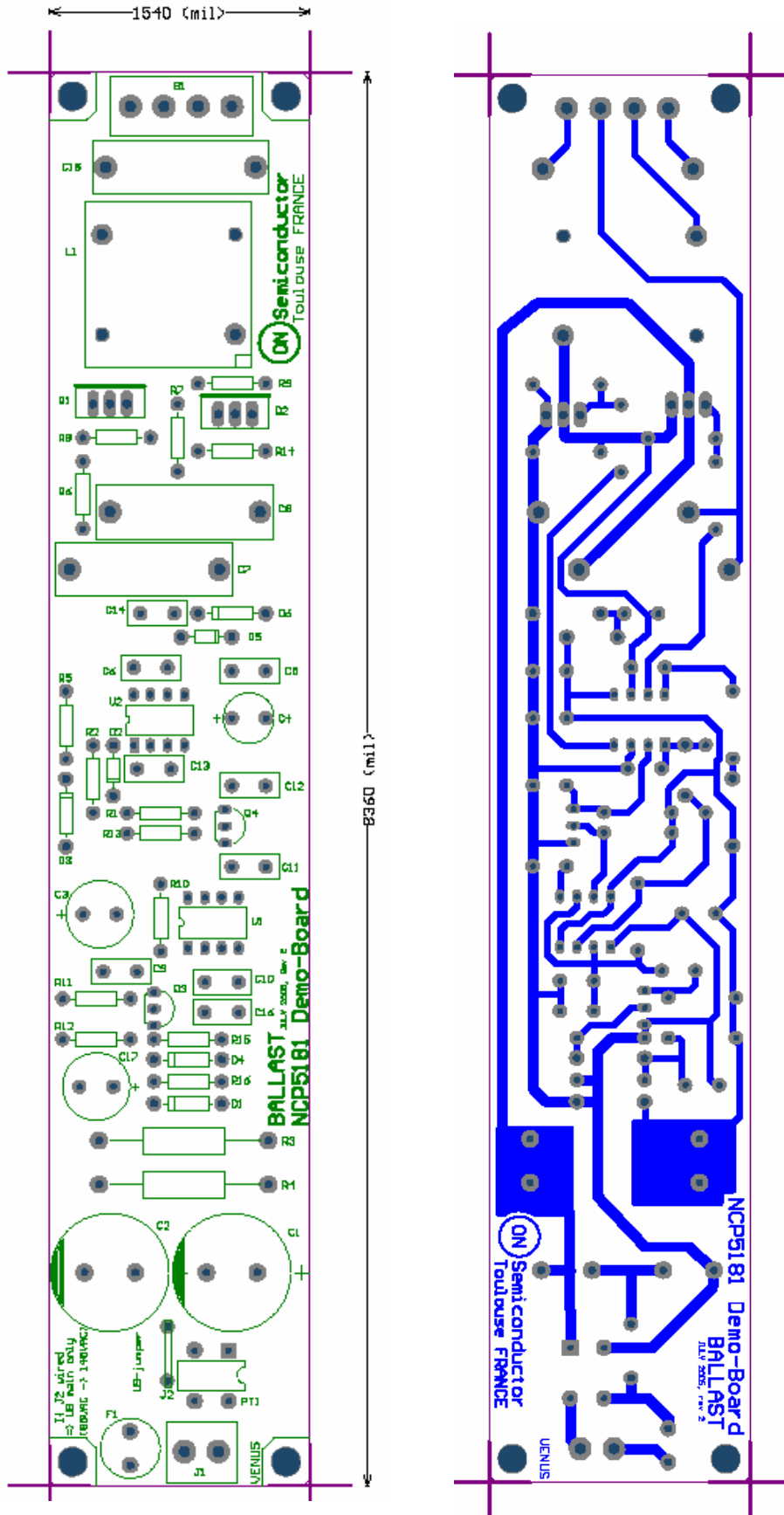


Figure 6. PCB Printout: Top and Bottom View

# NCP5181BAL36WEVB

## TEST PROCEDURE

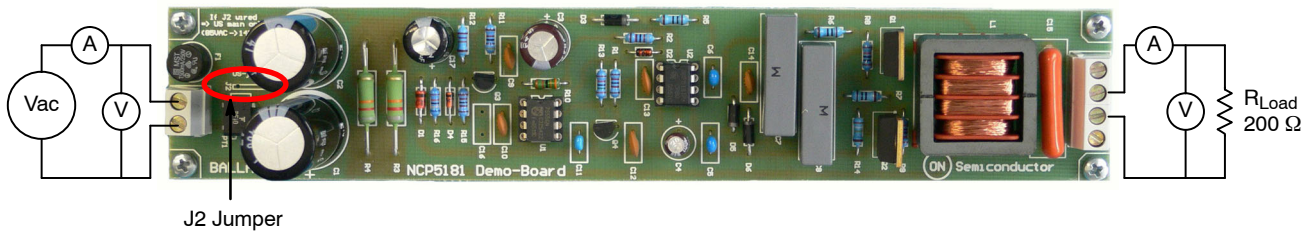


Figure 7. Test Setup Connection

Table 1. REQUIRED EQUIPMENT

AC Power Source can be able to deliver 230 V <sub>rms</sub> or 110 V <sub>rms</sub>	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<sub>Load</sub> and V<sub>Load</sub> 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 <sub>in</sub> (V <sub>rms</sub> )	I <sub>in</sub> (A <sub>rms</sub> )	V <sub>Load</sub> (V <sub>rms</sub> )	I <sub>Load</sub> (A <sub>rms</sub> )
European	Removed	230 V	278 mA	303 V	370 mA
US	Yes → Max Input Voltage: 132 V <sub>rms</sub>	110 V	514 mA	263 V	340 mA

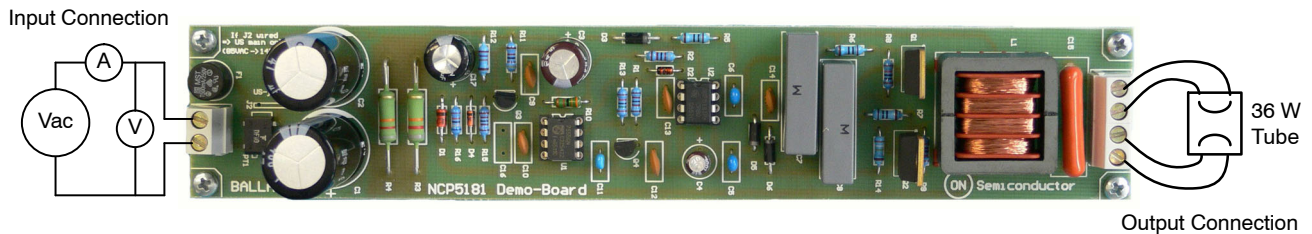


Figure 8. Ballast Connection

# NCP5181BAL36WEVB

**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 $\mu$ F, 400 V	20%	Radial	Panasonic	ECA2GM470	Yes	No
C3	1	Electrolytic Capacitor	220 $\mu$ F, 16 V	20%	Radial	Panasonic	ECA1CM221	Yes	No
C4	1	Electrolytic Capacitor	4.7 $\mu$ 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 $\mu$ 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 $\Omega$ , 0.33 W	5%	Axial	Vishay	CFA020712K	Yes	No
R2	1	Resistor	82 k $\Omega$ , 0.33 W	5%	Axial	Vishay	CFA020782K	Yes	No
R3, R4	2	Resistor	82 k $\Omega$ , 3 W	5%	Axial	Vishay	CPF382K000JN	Yes	No
R5, R6, R7	3	Resistor	10 $\Omega$ , 0.33 W	5%	Axial	Vishay	CFA020710R	Yes	No
R8, R9	2	Resistor	10 k $\Omega$ , 0.33 W	5%	Axial	Yageo	CFA020710K	Yes	No
R10	1	Resistor	33 k $\Omega$ , 0.33 W	5%	Axial	Vishay	CFA020733K	Yes	No
R11	1	Resistor	47 k $\Omega$ , 0.33 W	5%	Axial	Vishay	CFA020747K	Yes	No
R12	1	Resistor	27 k $\Omega$ , 0.33 W	5%	Axial	Vishay	CFA020727K	Yes	No
R13	1	Resistor	15 k $\Omega$ , 0.33 W	5%	Axial	Vishay	CFA020715K	Yes	No
R14	1	Resistor	390 k $\Omega$ , 0.33 W	5%	Axial	Vishay	CFA0207390K	Yes	No
R15	1	Resistor	22 k $\Omega$ , 0.33 W	5%	Axial	Vishay	CFA020722K	Yes	No
R16	1	Resistor	68 k $\Omega$ , 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 $\Omega$ , 0.25 W	NA	Axial	Yageo	ZOR-25-B-52	Yes	No

**onsemi**, **Onsemi**, and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi**'s product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). **onsemi** is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

The evaluation board/kit (research and development board/kit) (hereinafter the "board") is not a finished product and is not available for sale to consumers. The board is only intended for research, development, demonstration and evaluation purposes and will only be used in laboratory/development areas by persons with an engineering/technical training and familiar with the risks associated with handling electrical/mechanical components, systems and subsystems. This person assumes full responsibility/liability for proper and safe handling. Any other use, resale or redistribution for any other purpose is strictly prohibited.

**THE BOARD IS PROVIDED BY ONSEMI TO YOU "AS IS" AND WITHOUT ANY REPRESENTATIONS OR WARRANTIES WHATSOEVER. WITHOUT LIMITING THE FOREGOING, ONSEMI (AND ITS LICENSORS/SUPPLIERS) HEREBY DISCLAIMS ANY AND ALL REPRESENTATIONS AND WARRANTIES IN RELATION TO THE BOARD, ANY MODIFICATIONS, OR THIS AGREEMENT, WHETHER EXPRESS, IMPLIED, STATUTORY OR OTHERWISE, INCLUDING WITHOUT LIMITATION ANY AND ALL REPRESENTATIONS AND WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, TITLE, NON-INFRINGEMENT, AND THOSE ARISING FROM A COURSE OF DEALING, TRADE USAGE, TRADE CUSTOM OR TRADE PRACTICE.**

**onsemi** reserves the right to make changes without further notice to any board.

You are responsible for determining whether the board will be suitable for your intended use or application or will achieve your intended results. Prior to using or distributing any systems that have been evaluated, designed or tested using the board, you agree to test and validate your design to confirm the functionality for your application. Any technical, applications or design information or advice, quality characterization, reliability data or other services provided by **onsemi** shall not constitute any representation or warranty by **onsemi**, and no additional obligations or liabilities shall arise from **onsemi** having provided such information or services.

**onsemi** products including the boards are not designed, intended, or authorized for use in life support systems, or any FDA Class 3 medical devices or medical devices with a similar or equivalent classification in a foreign jurisdiction, or any devices intended for implantation in the human body. You agree to indemnify, defend and hold harmless **onsemi**, its directors, officers, employees, representatives, agents, subsidiaries, affiliates, distributors, and assigns, against any and all liabilities, losses, costs, damages, judgments, and expenses, arising out of any claim, demand, investigation, lawsuit, regulatory action or cause of action arising out of or associated with any unauthorized use, even if such claim alleges that **onsemi** was negligent regarding the design or manufacture of any products and/or the board.

This evaluation board/kit does not fall within the scope of the European Union directives regarding electromagnetic compatibility, restricted substances (RoHS), recycling (WEEE), FCC, CE or UL, and may not meet the technical requirements of these or other related directives.

FCC WARNING – This evaluation board/kit is intended for use for engineering development, demonstration, or evaluation purposes only and is not considered by **onsemi** to be a finished end product fit for general consumer use. It may generate, use, or radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment may cause interference with radio communications, in which case the user shall be responsible, at its expense, to take whatever measures may be required to correct this interference.

**onsemi** does not convey any license under its patent rights nor the rights of others.

LIMITATIONS OF LIABILITY: **onsemi** shall not be liable for any special, consequential, incidental, indirect or punitive damages, including, but not limited to the costs of requalification, delay, loss of profits or goodwill, arising out of or in connection with the board, even if **onsemi** is advised of the possibility of such damages. In no event shall **onsemi**'s aggregate liability from any obligation arising out of or in connection with the board, under any theory of liability, exceed the purchase price paid for the board, if any.

The board is provided to you subject to the license and other terms per **onsemi**'s standard terms and conditions of sale. For more information and documentation, please visit [www.onsemi.com](http://www.onsemi.com).

## ADDITIONAL INFORMATION

### TECHNICAL PUBLICATIONS:

Technical Library: [www.onsemi.com/design/resources/technical-documentation](http://www.onsemi.com/design/resources/technical-documentation)  
onsemi Website: [www.onsemi.com](http://www.onsemi.com)

ONLINE SUPPORT: [www.onsemi.com/support](http://www.onsemi.com/support)

For additional information, please contact your local Sales Representative at [www.onsemi.com/support/sales](http://www.onsemi.com/support/sales)