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# Evaluation Board for the ADP2311, Dual, 1 A, 18 V Synchronous Step-Down Regulator with Fail-Safe Voltage Monitoring

## FEATURES

**Input voltage: 4.5 V to 18 V**
**±1.0% output accuracy**
**Integrated MOSFET: 110 mΩ/60 mΩ typical**
**Continuous output current: 1 A/1 A**
**Power fail comparator generates warning**
**Power-on reset with programmable delay timer**
**Adjustable voltage monitor for power-down**
**Watchdog refresh input**
**Dual phase with 180° out of phase operation**
**Fixed switching frequency: 300 kHz**
**Internal compensation and soft start**
**Stable with low effective series resistance (ESR) output ceramic capacitors**
**Precision enable input**
**Power feedback during power off**
**Undervoltage lockout (UVLO), overcurrent protection (OCP), overvoltage protection (OVP), and thermal shutdown (TSD)**

## GENERAL DESCRIPTION

The ADP2311 evaluation board is a complete, dual, 1 A step-down regulator solution that allows users to evaluate the performance of the ADP2311 with a near ideal printed circuit board (PCB) layout.

The outputs of the ADP2311 evaluation board are preset to 1.2 V and 3.3 V for Channel 1 and Channel 2, respectively. The VIN threshold of the power fail input is set at 8.99 V. Different output and power fail input voltages can be achieved by changing the appropriate passive components.

Full details on the ADP2311 dual regulator are provided in the ADP2311 data sheet, available from Analog Devices, Inc., which should be consulted in conjunction with this user guide.

## ADP2311 EVALUATION BOARD

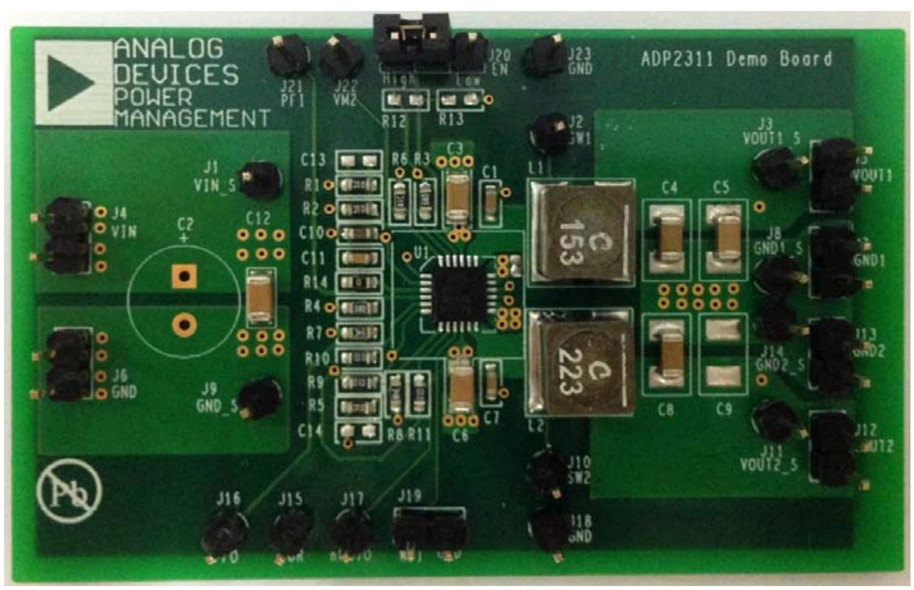


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*Figure 1.*

# TABLE OF CONTENTS



## REVISION HISTORY

**3/14—Revision 0: Initial Version**

# USING THE EVALUATION BOARD

## POWERING UP THE EVALUATION BOARD

The ADP2311 evaluation board is supplied fully assembled and tested. Before applying power to the evaluation board, follow the procedures in this section.

### *Jumper J20 Setting (Enable)*

Jumper J20 is used to control the ADP2311. Use one of the following methods to enable or to disable the device:

- To enable the ADP2311, short the middle pin of J20 (EN) to high.
- To disable the ADP2311, short the middle pin of J20 (EN) to low.

### *Input Power Source*

If the input power source includes a current meter, use that meter to monitor the input current. Connect the positive terminal of the power source to J4 (VIN) of the evaluation board, and connect the negative terminal of the power source to J6 (GND) of the evaluation board.

If the power source does not include a current meter, connect a current meter in series with the input source voltage. Connect the positive lead (+) of the power source to the positive (+) ammeter terminal, the negative lead (−) of the power source to J6 (GND), and the negative lead (−) of the ammeter to J4 (VIN).

### *Output Load*

Before connecting the load, ensure that the board is turned off. Connect an electronic load or resistor to set the load current.

To connect a load to the output of Channel 1, connect the positive terminal of the load to J5 (VOUT1) of the evaluation board and connect the negative terminal of the load to J7 (GND).

To connect a load to the output of Channel 2, connect the positive terminal of the load to J12 (VOUT2) of the evaluation board and connect the negative terminal of the load to J13 (GND).

### *Input and Output Voltmeter*

Measure the input and output voltages using voltmeters. Make sure that the voltmeters are connected to the appropriate terminals of the evaluation board and not to the load or power source. If the voltmeters are not connected directly to the evaluation board, the measured voltages are incorrect due to the voltage drop across the leads and/or connections between the evaluation board, the power source, and/or the load.

To measure the input voltage, connect the positive terminal of the voltmeter to J1 (VIN_S) and the negative terminal to J9 (GND_S). Likewise, to measure the output voltage, connect the positive terminal of the voltmeter to J3 (VOUT1_S) or J11 (VOUT2_S) and the negative terminal to J8 (GND1_S) or J14 (GND2_S).

### *Turning On the Evaluation Board*

When the power source and load are connected to the evaluation board, it can be powered for operation.

To turn on the evaluation board, perform the following steps:

1. Ensure that the power source voltage is >4.5 V and <18 V.
2. Ensure that EN is high and monitor the output voltage.
3. Turn on the load, check that it is drawing the proper load current, and verify that the output voltage maintains its regulation.

## MEASURING EVALUATION BOARD PERFORMANCE

### *Measuring the Switching Waveform*

To observe the switching waveform with an oscilloscope, place the oscilloscope probe tip at Test Point J2 (SW1) and J10 (SW2) with the probe ground at GND. Set the scope to dc with the appropriate voltage and time divisions. The switching waveform must alternate approximately between 0 V and the input voltage.

### *Measuring Load Regulation*

Load regulation can be tested by observing the change in the output voltage with increasing output load current.

### *Measuring Line Regulation*

Vary the input voltage and examine the change in the output voltage with a fixed output current.

### *Line Transient Response*

Generate a step input voltage change and observe the behavior of the output voltage using an oscilloscope.

### *Load Transient Response*

Generate a load current transient at the output and observe the output voltage response using an oscilloscope. Attach the current probe to the wire between the output and the load to capture the current transient waveform.

### *Measuring Efficiency*

The efficiency, η, is measured by comparing the input power with the output power.

$$\eta = \frac{V_{OUT} \times I_{OUT}}{V_{IN} \times I_{IN}}$$

Measure the input and output voltages as close as possible to the input and output capacitors to reduce the effect of voltage drop.

### *Measuring Inductor Current*

The inductor current can be measured by removing one end of the inductor from its pad and by connecting a current loop in series. A current probe can be connected onto this wire.

### Measuring Output Voltage Ripple

To observe the output voltage ripple, place the oscilloscope probe across the output capacitor with the probe ground lead connected to the negative (−) capacitor terminal and the probe tip placed at the positive (+) capacitor terminal. Set the oscilloscope to ac, 10 mV/division, 2 µs/division time base, and 20 MHz bandwidth.

A standard oscilloscope probe has a long wire ground clip. For high frequency measurements, this ground clip picks up high frequency noise and injects it into the measured output ripple. Figure 2 shows an easy way to measure the output ripple properly. It requires removing the oscilloscope probe sheath and wrapping an unshielded wire around the oscilloscope probe. By keeping the ground length of the oscilloscope probe as short as possible, the true ripple can be measured.

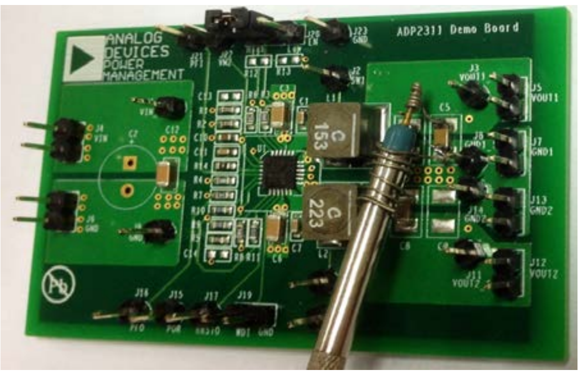


*Figure 2. Measuring Output Voltage Ripple*

## MODIFYING THE EVALUATION BOARD

To modify the ADP2311evaluation board configuration, unsolder and/or replace/remove the appropriate passive components or jumpers on the board.

### Changing the Output Voltages

The output voltage setpoints of the ADP2311 can be changed by replacing the R1, R2, R5, and R8 resistors with the resistor values shown in Table 1.

**Table 1. Resistive Divider for Various Output Voltages**

| $V_{OUT}$ (V) | R1/R5, ±1% (kΩ) | R2/R8, ±1% (kΩ) |
|---|---|---|
| 1.0 | 10 | 15 |
| 1.2 | 10 | 10 |
| 1.5 | 15 | 10 |
| 1.8 | 20 | 10 |
| 2.5 | 47.5 | 15 |
| 3.3 | 10 | 2.21 |
| 5.0 | 22 | 3 |

To limit the output voltage accuracy degradation due to the FBx bias current (0.1 µA maximum) to less than 0.5% (maximum), ensure that the bottom divider string resistors, R2 and R8, is less than 30 kΩ.

The top resistors, R1 and R5, value is calculated using the following equations:

For Channel 1,

$$R1 = R2 \times \left(\frac{V_{OUT1} - 0.6\text{ V}}{0.6\text{ V}}\right)$$

For Channel 2,

$$R5 = R8 \times \left(\frac{V_{OUT2} - 0.6\text{ V}}{0.6\text{ V}}\right)$$

When the output voltage of Channel 1 is changed, the values of the inductor (L1) and the output capacitors (C4 and C5) must be recalculated and changed to ensure stable operation (see the ADP2311 data sheet for details on external component selection). Likewise, if the output voltage of Channel 2 is changed, the values of the inductor (L2) and the output capacitors (C8 and C9) must be recalculated and changed.

### Changing the VIN Threshold of Power Fail (PFI)

The evaluation board sets the $V_{PFI\_RISING}$ at 8.99 V and the $V_{PFI\_FALLING}$ at 8.61 V. It can be changed with different R4 and R7 value.

Using the following equation to calculate the R4 and R7:

$$V_{PFI\_RISING} = 0.6\ V \times \frac{R4 + R7}{R7}$$

$$V_{PFI\_FALLING} = 0.575\ V \times \frac{R4 + R7}{R7}$$

### Changing the VIN Threshold of Voltage Monitoring (VM2)

The evaluation board sets the $V_{VM2\_RISING}$ at 5.41 V and the $V_{VM2\_FALLNG}$ at 5 V. It can be changed with different R3 and R6 value.

Using the following equation to calculate R3 and R6:

$$V_{VM2\_RISING} = 0.65\ V \times \frac{R3 + R6}{R6}$$

$$V_{VM2\_FALLING} = 0.6\ V \times \frac{R3 + R6}{R6}$$

# EVALUATION BOARD SCHEMATIC AND ARTWORK

## ADP2311 EVALUATION BOARD SCHEMATIC

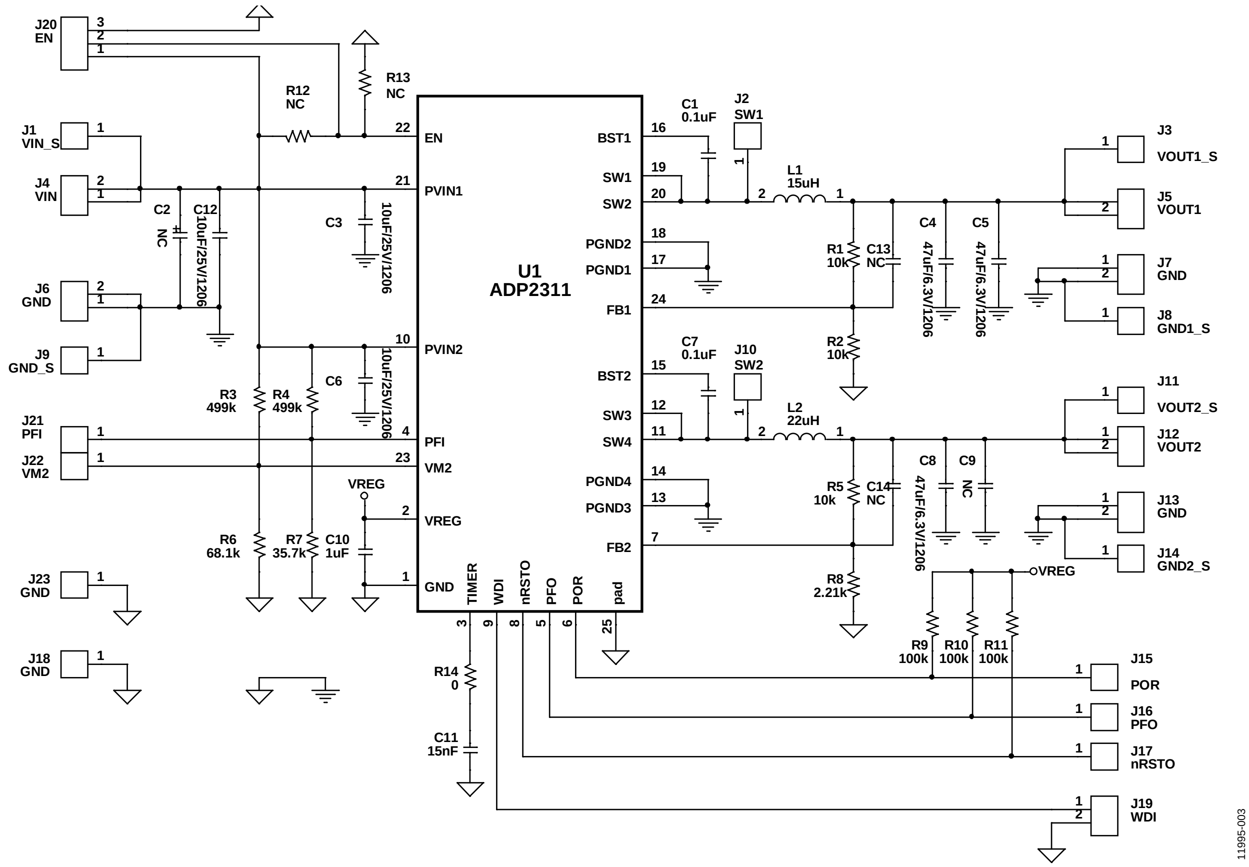


*Figure 3. Evaluation Board Schematic for the ADP2311*

## PCB LAYOUT

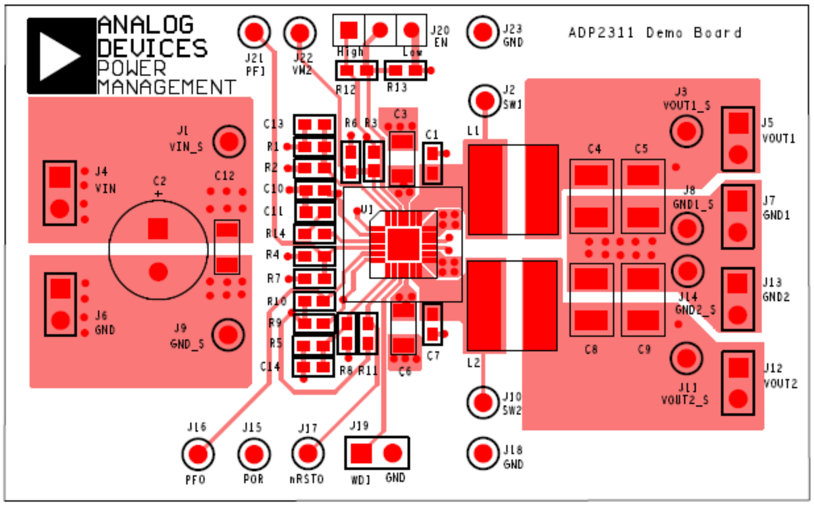


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*Figure 4. ADP2311 Evaluation Board Layer 1, Component Side*

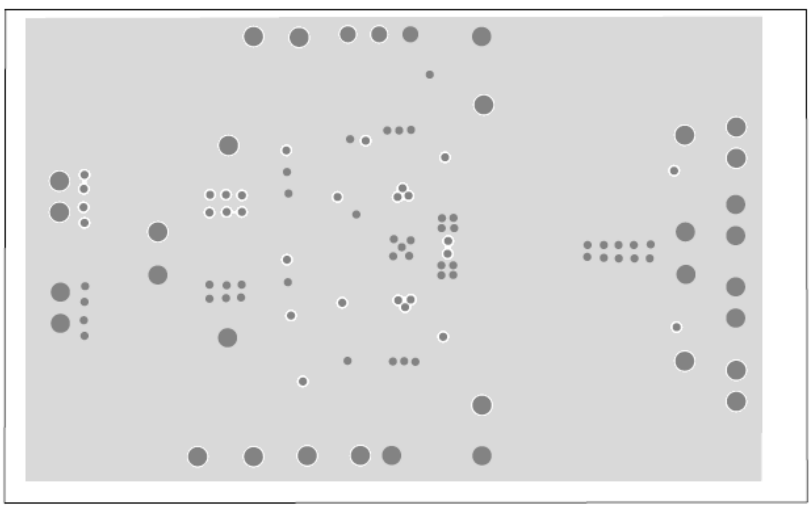

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*Figure 5. ADP2311 Evaluation Board Layer 2, Ground Plane*

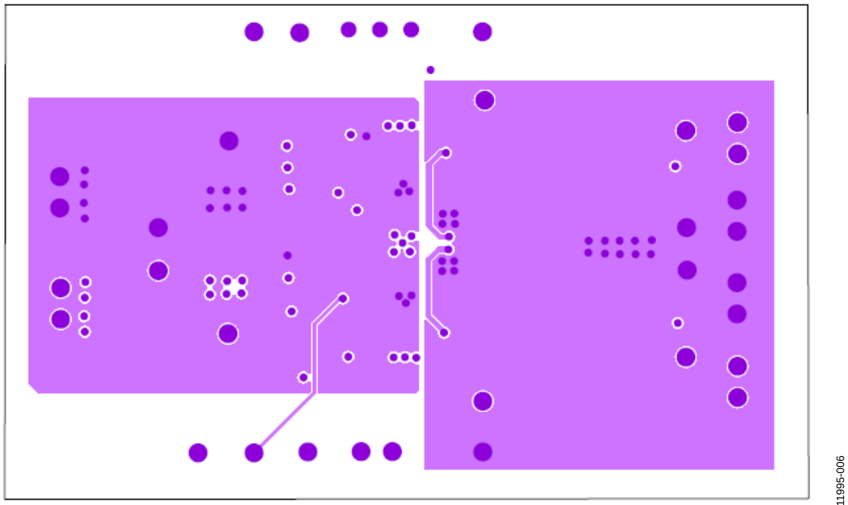


*Figure 6. ADP2311 Evaluation Board Layer 3, Power Plane*

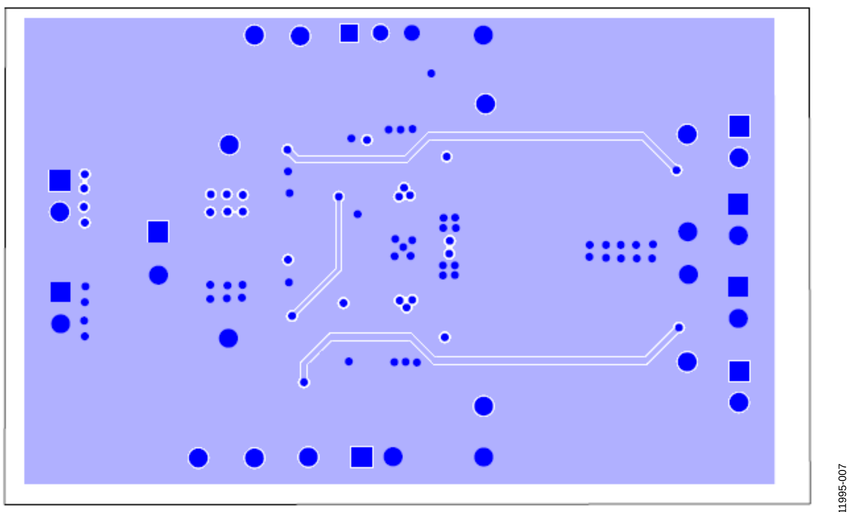


*Figure 7. ADP2311 Evaluation Board Layer 4, Bottom Side*

# ORDERING INFORMATION

## BILL OF MATERIALS

Table 2.

| Qty | Reference Designator | Description | Part Number/Vendor |
|---|---|---|---|
| 2 | C1, C7 | 0.1 µF, 50 V, capacitor, 0603 | GRM188F51H104ZA01/Murata |
| 1 | C2 | Optional, capacitor | Optional |
| 3 | C3, C6, C12 | 10 µF, 25 V, capacitor, 1206 | GRM31CR61E106KA12/Murata |
| 3 | C4, C5, C8 | 47 µF, 6.3 V, capacitor, 1206 | GRM31CR60J476ME19L/Murata |
| 1 | C10 | 1 µF, 16 V, capacitor, 0603 | GRM188F51C105ZA01/Murata |
| 1 | C11 | 15 nF, 50 V, capacitor, 0603 | GRM188F51H153ZA01/Murata |
| 1 | C9 | Optional, capacitor, 1206 | Optional |
| 2 | C13, C14 | Optional, capacitor, 0603 | Optional |
| 1 | L1 | Inductor, L = 15 µH, $I_{RAT}$ = 5.8 A, DCR = 43.75 mΩ | XAL6060-153ME/CoilCraft |
| 1 | L2 | Inductor, L = 22 µH, $I_{RAT}$ = 5.6 A, DCR = 60.63 mΩ | XAL6060-223ME/CoilCraft |
| 3 | R1, R2, R5 | 10 kΩ,1%, resistor, 0603 | CRCW060310K0FKEA/Vishay Dale |
| 2 | R3, R4 | 499 kΩ,1%,resistor, 0603 | CRCW0603499KFKEA/Vishay Dale |
| 1 | R6 | 68.1 kΩ,1%, resistor, 0603 | CRCW060368K1FKEA/Vishay Dale |
| 1 | R7 | 35.7 kΩ,1%,resistor, 0603 | CRCW060335K7FKEA/Vishay Dale |
| 1 | R8 | 2.21 kΩ,1%, resistor, 0603 | CRCW06032K21FKEA/Vishay Dale |
| 3 | R9, R10, R11 | 100 kΩ,1%, resistor, 0603 | CRCW0603100KFKEA/Vishay Dale |
| 2 | R12, R13 | Optional, resistor, 0603 | Optional |
| 1 | R14 | 0 Ω, resistor, 0603 | CRCW06030000Z0EA/Vishay Dale |
| 1 | U1 | Dual 1 A, 18 V synchronous, step-down regulator with failsafe voltage monitoring, 24-lead LFCSP_WQ | ADP2311ACPZ-1-R7/Analog Devices |
| 15 | J1, J2, J3, J8, J9, J10, J11, J14 ,J15, J16, J17, J18, J21, J22, J23 | Test point, 2.54 mm pitch SIL vertical PC tail pin header, 6.1 mm mating pin height, tin, SIP1 | M20-9990245/Harwin |
| 7 | J4, J5, J6, J7, J12, J13, J19 | Connector, 2.54 mm pitch SIL vertical PC tail pin header, 6.1 mm mating pin height, tin, 2-way, SIP2 | M20-9990245/Harwin |
| 1 | J20 | Jumper, 0.1-inch header, 3-way, SIP3 | M20-9990346/Harwin |


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