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# Evaluation Board for the 1.2 A, 20 V Nonsynchronous Step-Down Regulators

## FEATURES

**1.2 A maximum load current**
**±2% output accuracy over temperature range**
**Wide input voltage range: 3.0 V to 20 V**
**Output voltage from 0.8 V to 0.85 × $V_{IN}$**
**700 kHz (ADP2300) or 1.4 MHz (ADP2301) switching frequency options**
**Automatic PFM/PWM mode switching**
**Precision enable pin with hysteresis**
**Integrated high-side MOSFET**
**Integrated bootstrap diode**
**ADIsimPower™ online design tool**
**Available in ultrasmall, 6-lead TSOT package**

## GENERAL DESCRIPTION

The ADP2300/ADP2301 are compact, constant-frequency, current-mode, step-down dc-to-dc regulators with an integrated power MOSFET. The ADP2300/ADP2301 evaluation boards are complete solutions that allow the user to evaluate the performance of the regulators. There are two frequency options available: the ADP2300 runs at 700 kHz, and the ADP2301 runs at 1.4 MHz. These options allow the user to make design decisions based on the trade-off between efficiency and the size of the total solution.

The ADP2300/ADP2301 provide accurate (±2%) output regulation for load currents up to 1.2 A. Current-mode control provides fast and stable line and load transient performance. The precision, EN pin, threshold voltage allows the ADP2300/ADP2301 to be sequenced from other input/output supplies. The EN pin can also be used as a programmable UVLO input by using a resistive divider.

## DEMONSTRATION BOARD

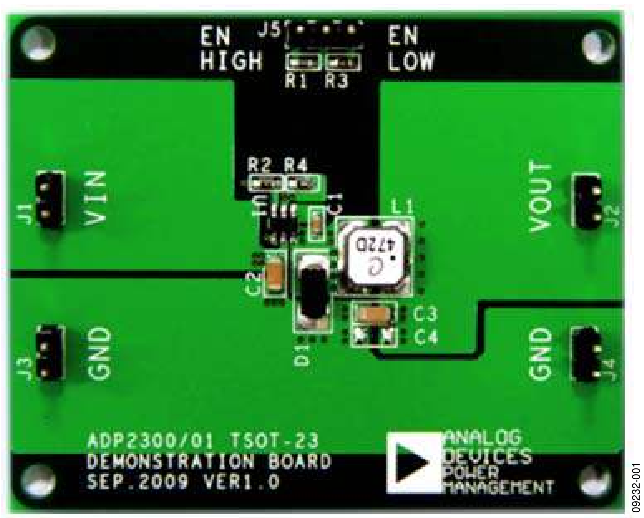


*Figure 1.*

# TABLE OF CONTENTS



## REVISION HISTORY

**8/10—Revision 0: Initial Version**

# USING THE EVALUATION BOARD

The ADP2300/ADP2301 evaluation boards are fully assembled and tested. Before applying power to the evaluation boards, follow the procedures in this section.

## JUMPER SETTING

Jumper J5 enables the part. Connect a jumper between Position 1 and Position 2 to enable the part. Connect a jumper between Position 2 and Position 3 to disable the part. Leave Jumper J5 open to obtain an approximately 7.8 V $V_{IN}$ start-up voltage.

**Table 1. Jumper J5 (EN) Setting**

| State | Function |
|---|---|
| High | Enable the part |
| Low | Disable the part |
| Open | Program the $V_{IN}$ start-up voltage to be about 7.8 V |

## INPUT POWER SOURCE CONNECTION

Before connecting the power source to the ADP2300/ADP2301 evaluation board, make sure that the evaluation board is turned off. 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 the VIN terminal (J1) on the evaluation board, and the negative terminal of the power source to the GND terminal (J3) of the 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 terminal of the power source to the current meter's positive lead (+), the negative terminal of the power source to the GND terminal (J3) on the evaluation board, and the negative lead (−) of the current meter to the VIN terminal (J1) on the board.

## OUTPUT LOAD CONNECTION

Make sure that the board is turned off before connecting the load. If the load includes a current meter, or if the current is not measured, connect the load directly to the demonstration board with the positive (+) load connection to the VOUT terminal (J2) and negative (−) load connection to the GND terminal (J4). If a current meter is used, connect it in series with the load; connect the positive (+) current meter terminal to the evaluation board VOUT terminal (J2), the negative (−) current meter terminal to the positive (+) load terminal, and the negative (−) load terminal to the evaluation board GND terminal (J4).

## INPUT AND OUTPUT VOLTMETER CONNECTIONS

Measure the input and output voltages with voltmeters. Make sure that the voltmeters are connected to the appropriate test point on the board. If the voltmeters are not connected to the right test point, the measured voltages will be incorrect due to the voltage drop across the leads and/or connections between the board, the power source, and/or the load.

Connect the input voltage measuring the voltmeter's positive terminal (+) to the input capacitor (C2) positive terminal and the negative (−) terminal to the input capacitor (C2) negative terminal.

Connect the output voltage measuring the voltmeter's positive (+) terminal to the output capacitor (C3 or C4) positive terminal and the negative (−) terminal to the output capacitor (C3 or C4) negative terminal.

## POWER ON THE EVALUATION BOARD

When the power source and load are connected to the ADP2300/ADP2301 evaluation board, they can be powered up for operation. If the input power source voltage goes higher than 7.8 V with Jumper J5 open, the output voltage goes up to 3.3 V.

## MEASURING EVALUATION BOARD PERFORMANCE

### *Measuring the Switching Waveform*

To observe the switching waveform with an oscilloscope, place the oscilloscope probe tip at the end of inductor connected to the SW pin with the probe ground at GND. Set the scope to dc, 5 V/division, and 1 μs/division time base. The switching waveform should alternate between 0 V and approximately the input voltage.

### *Measuring Load Regulation*

Load regulation should be tested by increasing the load current at the output and measuring the output voltage across the output capacitor (C3 or C4).

### *Measuring Line Regulation*

Vary the input voltage and measure the output voltage at a fixed output current. The input voltage can be measured across the input capacitor (C2), and the output voltage can be measured across the output capacitor (C3 or C4).

### *Measuring Efficiency*

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

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

### *Measuring Inductor Current*

The inductor current is measured by removing one end of the inductor from the pad on the board and using a wire connected between the pad and the inductor. Then a current probe is used to measure the inductor current.

### Measuring Output Voltage Ripple

To observe the output voltage ripple, place an oscilloscope probe across the output capacitor (C3 or C4) with the probe ground lead at the negative (−) capacitor terminal and the probe tip at the positive (+) capacitor terminal. Set the oscilloscope to ac, 1 mV/division, and 1 µs/division time base, 20 MHz bandwidth.

The 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. Make sure to keep the ground lengths on the oscilloscope probe as short as possible to get a clean voltage ripple measurement.

### Varying the Output voltage

The ADP2300/ADP2301 demonstration board output is preset to 3.3 V; however, the output voltage can be adjusted to other output voltages using the following equation:

$$V_{OUT} = 0.800\ \text{V} \times \left(1 + \frac{R_2}{R_4}\right)$$

# TYPICAL PERFORMANCE CHARACTERISTICS

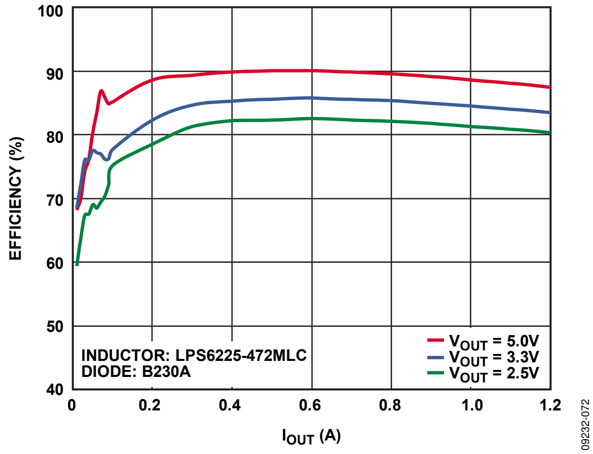


Figure 2. Efficiency Curve, $V_{IN}$ = 12 V, $f_{SW}$ = 1.4 MHz

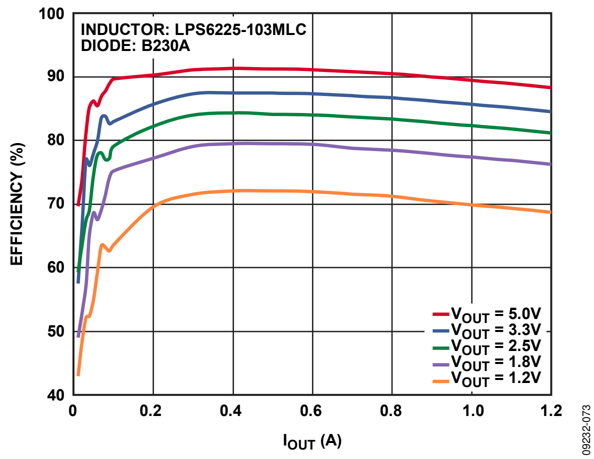


Figure 3. Efficiency Curve, $V_{IN}$ = 12 V, $f_{SW}$ = 700 kHz

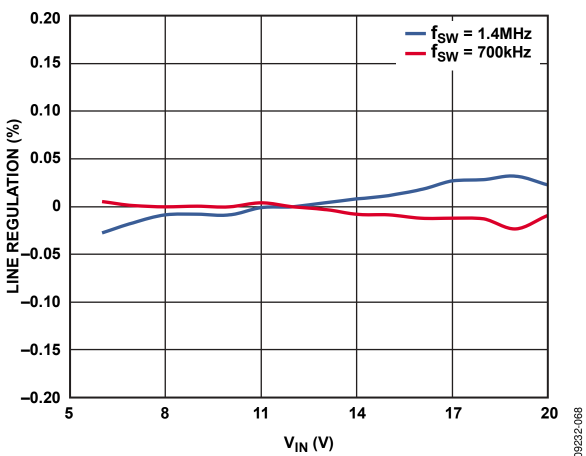


Figure 4. Line Regulation, $V_{OUT}$ = 3.3 V, $I_{OUT}$ = 500 mA

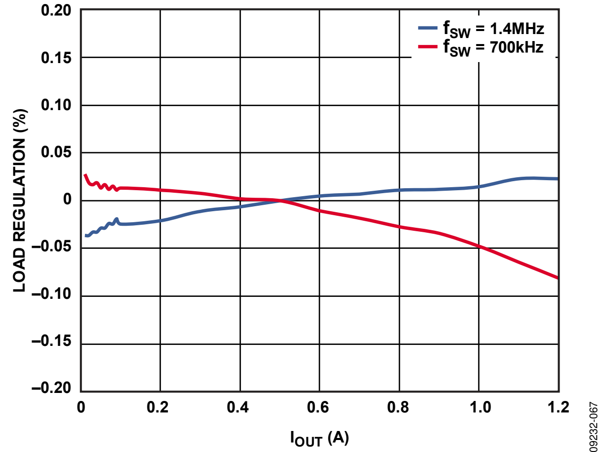


Figure 5. Load Regulation, $V_{OUT}$ = 3.3 V, $V_{IN}$ = 12 V

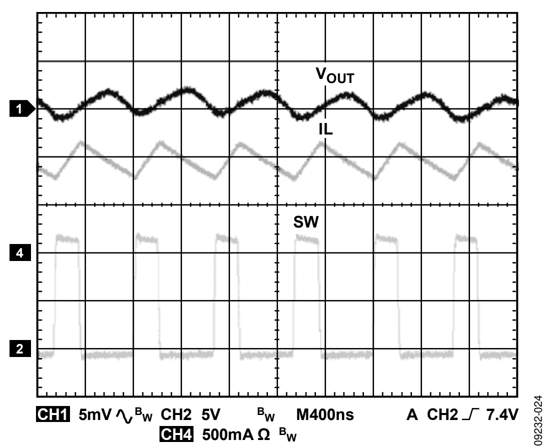


Figure 6. Steady State at Heavy Load, $f_{SW}$ = 1.4 MHz, $I_{OUT}$ = 1 A

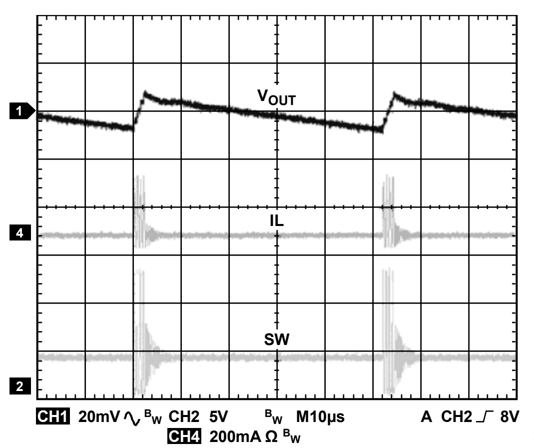


Figure 7. Steady State at Light Load, $f_{SW}$ = 1.4 MHz, $I_{OUT}$ = 40 mA

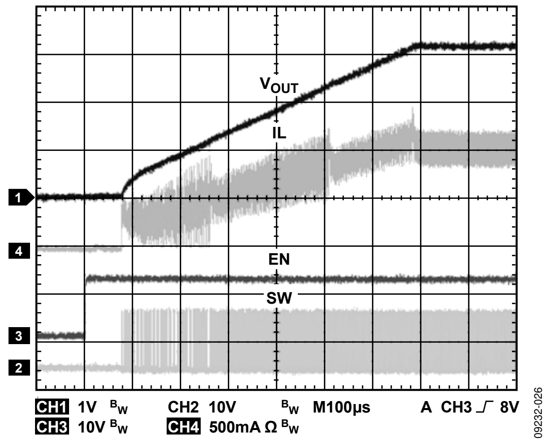


*Figure 8. Soft Start with 1 A Resistance Load, $f_{SW}$ = 1.4 MHz*

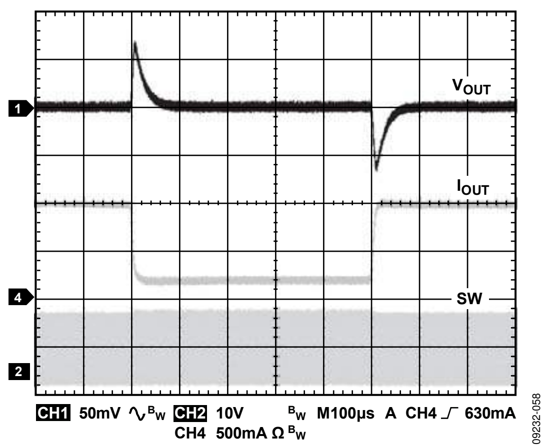


*Figure 9. ADP2301 Load Transient, 0.2 A to 1.0 A, $V_{OUT}$ = 3.3 V, $V_{IN}$ = 12 V ($f_{SW}$ = 1.4 MHz, L = 4.7 µH, $C_{OUT}$ = 22 µF)*

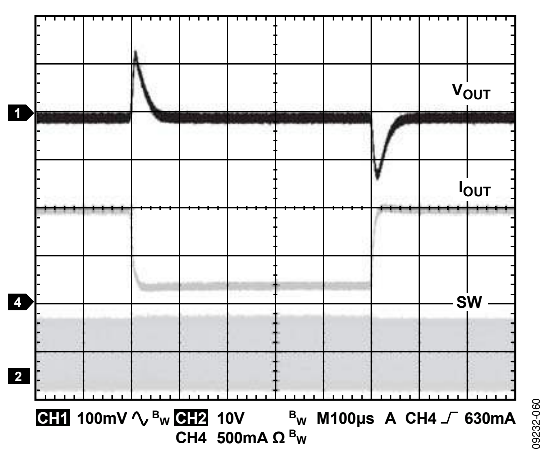


*Figure 10. ADP2300 Load Transient, 0.2 A to 1.0 A, $V_{OUT}$ = 3.3 V, $V_{IN}$ = 12 V ($f_{SW}$ = 700 kHz, L = 10 µH, $C_{OUT}$ = 22 µF)*

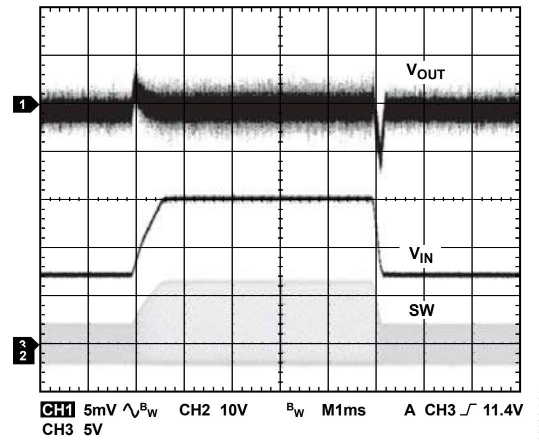


*Figure 11. ADP2301 Line Transient, 7 V to 15 V, $V_{OUT}$ = 3.3 V, $I_{OUT}$ = 1.2 A, $f_{SW}$ = 1.4 MHz*

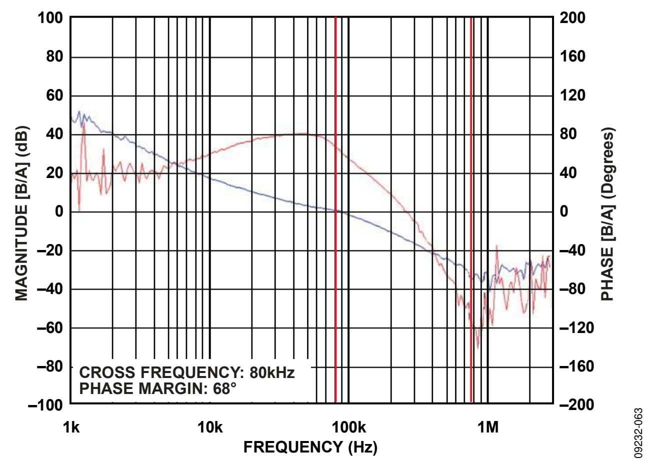


*Figure 12. ADP2301 Bode Plot, $V_{OUT}$ = 3.3 V, $V_{IN}$ = 12 V ($f_{SW}$ = 1.4 MHz, L = 4.7 µH, $C_{OUT}$ = 22 µF)*

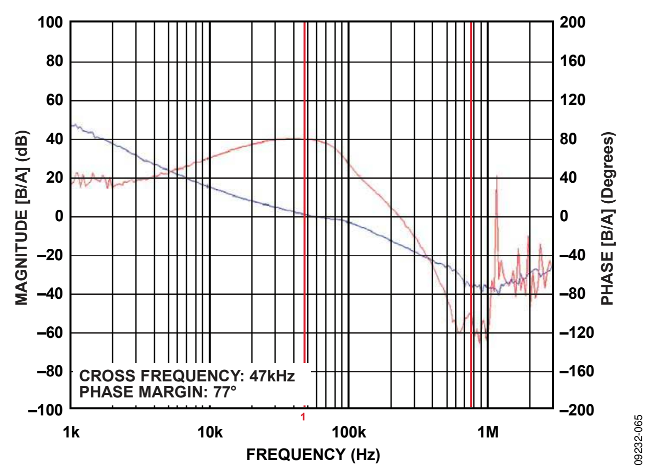


*Figure 13. ADP2300 Bode Plot, $V_{OUT}$ = 3.3 V, $V_{IN}$ = 12 V ($f_{SW}$ = 700 kHz, L = 10 µH, $C_{OUT}$ = 22 µF)*

# DEMONSTRATION BOARD SCHEMATICS AND BILL OF MATERIALS

## ADP2300 SCHEMATIC AND BILL OF MATERIALS

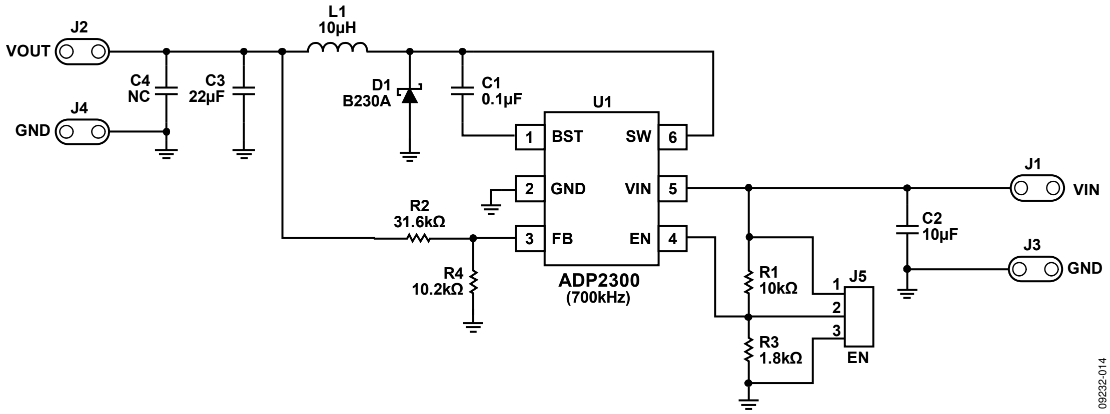


*Figure 14. ADP2300 Demonstration Board Schematic*

**Table 2. ADP2300 Demonstration Board Bill of Materials**

| Qty | Reference Designator | Description | Manufacturer | Part Number |
|---|---|---|---|---|
| 1 | C1 | Capacitor, 0.1 µF, 25 V, 0603, X7R | Murata | GRM188R71E104KA01 |
| 1 | C2 | Capacitor, 10 µF, 25 V, 1206, X5R | Murata | GRM31CR61E106KA12 |
| 1 | C3 | Capacitor, 22 µF, 6.3 V, 1206, X5R | Murata | GRM31CR60J226KE19 |
| 1 | C4 | No assembly | N/A[1] | N/A[1] |
| 1 | D1 | Schottky diode, 2 A, 30 V, SMA | Diodes, Inc. | B230A |
| 4 | J1, J2, J3, J4 | Header, 1 × 2, 0.1 pitch | Harwin | M20-9990246 |
| 1 | J5 | Header, 1 × 3, 0.1 pitch | Harwin | M20-9990346 |
| 1 | L1 | Shielded power inductor, 10 µH, 2.1 A | Coilcraft, Inc. | LPS6225-103MLC |
| 1 | R1 | Resistor, 10 kΩ, 1%, 0603 | Vishay | CRCW060310K0FKEA |
| 1 | R2 | Resistor, 31.6 kΩ, 1%, 0603 | Vishay | CRCW060331K6FKEA |
| 1 | R3 | Resistor, 1.8 kΩ, 1%, 0603 | Vishay | CRCW06031K80FKEA |
| 1 | R4 | Resistor, 10.2 kΩ, 1%, 0603 | Vishay | CRCW060310K2FKEA |
| 1 | U1 | 1.2 A, 20 V, 700 kHz nonsynchronous step-down switching regulator | Analog Devices, Inc. | ADP2300 |

[1] N/A is not applicable.

## ADP2301 SCHEMATIC AND BILL OF MATERIALS

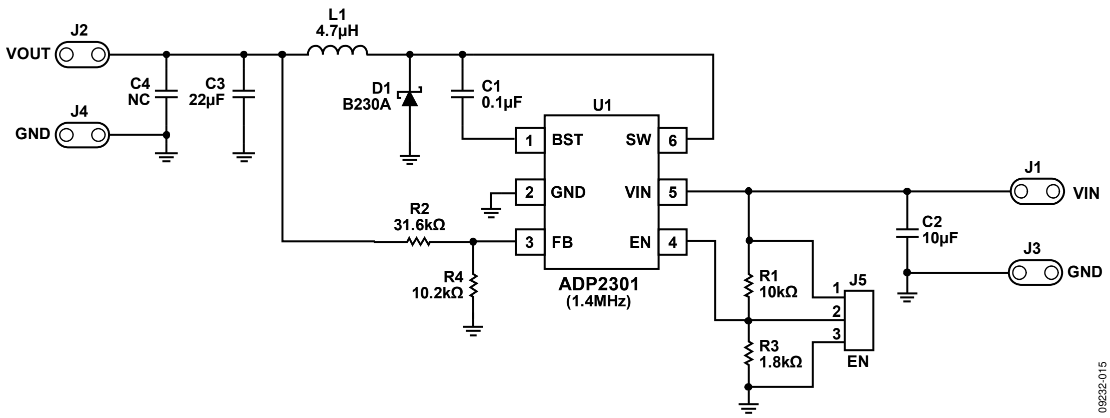


*Figure 15. ADP2301 Demonstration Board Schematic*

**Table 3. ADP2301 Demonstration Board Bill of Materials**

| Qty | Reference Designator | Description | Manufacturer | Part Number |
|---|---|---|---|---|
| 1 | C1 | Capacitor, 0.1 µF, 25 V, 0603, X7R | Murata | GRM188R71E104KA01 |
| 1 | C2 | Capacitor, 10 µF, 25 V, 1206, X5R | Murata | GRM31CR61E106KA12 |
| 1 | C3 | Capacitor, 22 µF, 6.3 V, 1206, X5R | Murata | GRM31CR60J226KE19 |
| 1 | C4 | No assembly | N/A[1] | N/A[1] |
| 1 | D1 | Schottky diode, 2 A, 30 V, SMA | Diodes, Inc. | B230A |
| 4 | J1, J2, J3, J4 | Header, 1 × 2, 0.1 pitch | Harwin | M20-9990246 |
| 1 | J5 | Header, 1 × 3, 0.1 pitch | Harwin | M20-9990346 |
| 1 | L1 | Shielded power inductor, 4.7 µH, 3.0 A | Coilcraft, Inc. | LPS6225-472MLC |
| 1 | R1 | Resistor, 10 kΩ, 1%, 0603 | Vishay | CRCW060310K0FKEA |
| 1 | R2 | Resistor, 31.6 kΩ, 1%, 0603 | Vishay | CRCW060331K6FKEA |
| 1 | R3 | Resistor, 1.8 kΩ, 1%, 0603 | Vishay | CRCW06031K80FKEA |
| 1 | R4 | Resistor, 10.2 kΩ, 1%, 0603 | Vishay | CRCW060310K2FKEA |
| 1 | U1 | 1.2 A, 20 V, 1.4 MHz nonsynchronous step-down switching regulator | Analog Devices, Inc. | ADP2301 |

[1] N/A is not applicable.

## DEMONSTRATION BOARD LAYOUT

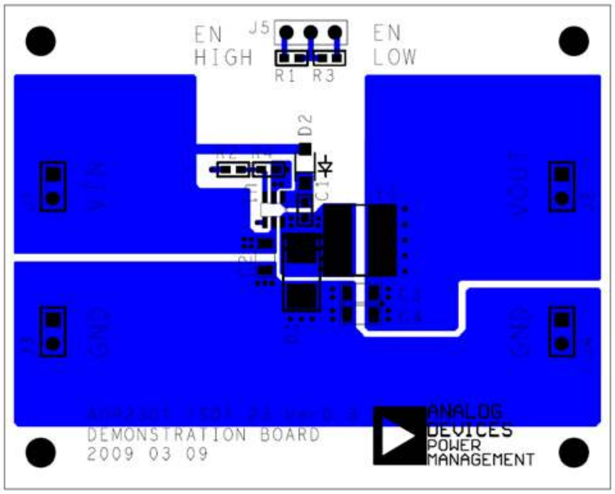


*Figure 16. Demonstration Board, Top Layer*

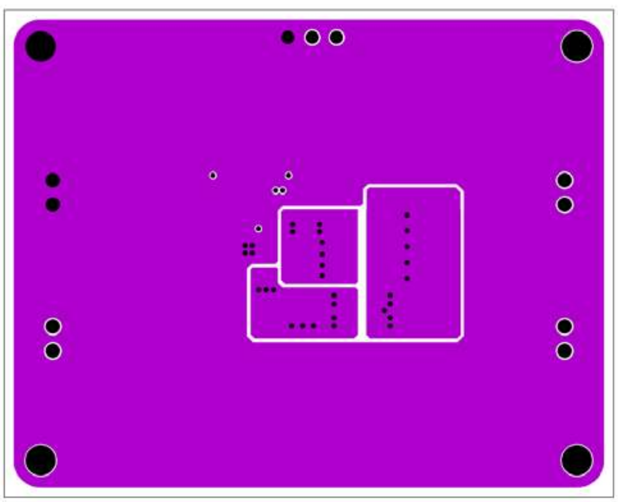


*Figure 17. Demonstration Board, Third Layer*

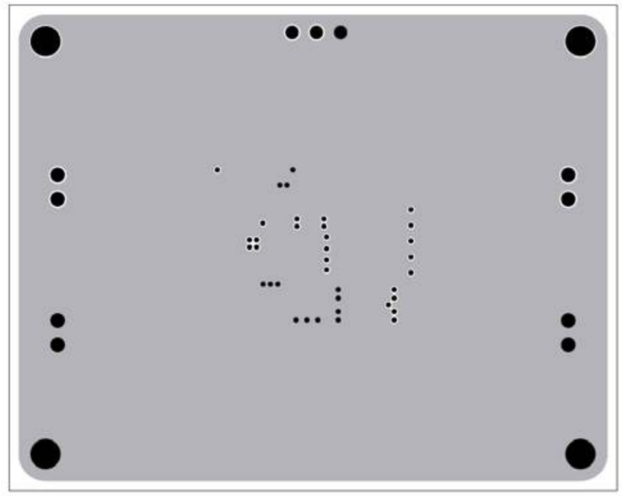


*Figure 18. Demonstration Board, Second Layer*

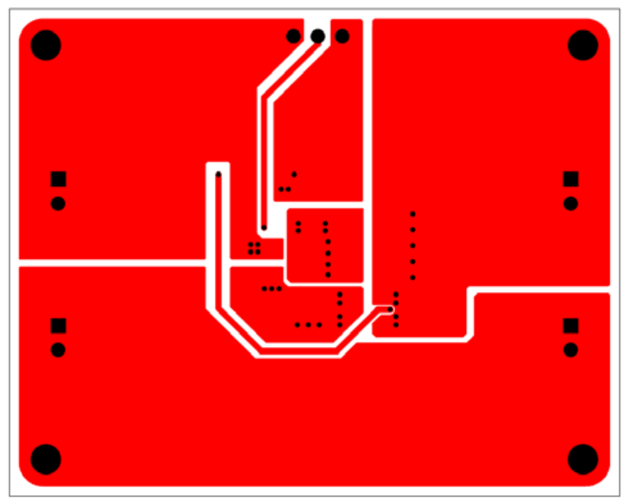


*Figure 19. Demonstration Board, Bottom Layer*

## NOTES

## NOTES

## NOTES

**ESD Caution**

**ESD (electrostatic discharge) sensitive device**. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.



**UG09232-0-8/10(0)**

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