

## Evaluation Board for the ADP5033 Micro PMU

### FEATURES

Full-featured evaluation board for the [ADP5033](#)

Standalone capability

Simple device measurements, including line and load regulation, demonstrable with

A voltage supply

A voltmeter

An ammeter

Load resistors

Easy access to external components

Cascading options to supply the LDO from either buck

Dedicated enable option for each channel

Mode option to change bucks from PSM to PWM operation

### DOCUMENTS NEEDED

[ADP5033](#) data sheet

### GENERAL DESCRIPTION

The [ADP5033](#) evaluation board is a two-step-down regulator with a two-LDO solution that enables evaluation of the [ADP5033](#). The evaluation board is available in standard voltage options.

The [ADP5033](#) uses a proprietary high speed, current mode, constant frequency PWM control scheme for excellent stability and transient response. To ensure the longest battery life in portable applications, the [ADP5033](#) features a power save mode (PSM) that reduces the switching frequency under light load conditions, as well as the option to change the mode to fixed PWM operation. The 3 MHz switching frequency minimizes the size of the external components.

The low quiescent current, low dropout voltage, and wide input voltage range of the [ADP5033](#) LDO extends the battery life of portable devices.

Full details on the [ADP5033](#) are provided in the [ADP5033](#) data sheet available from Analog Devices, Inc., which should be consulted in conjunction with this evaluation board user guide.

### TOP LAYER OF THE EVALUATION BOARD

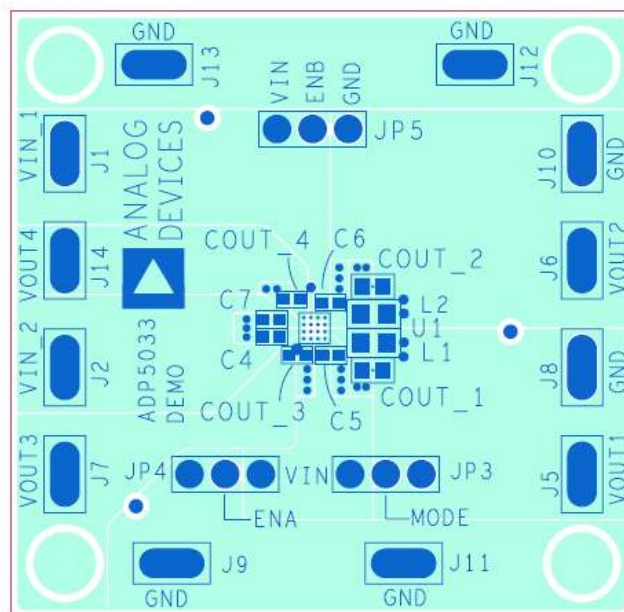


Figure 1. Top Layer, Recommended Layout

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**TABLE OF CONTENTS**

Features .....	1	Measuring Evaluation Board Performance .....	3
Documents Needed .....	1	Measuring Output Voltage .....	6
General Description .....	1	Measuring Ground Current .....	7
Top Layer of the Evaluation Board.....	1	Evaluation Board Schematics and Artwork.....	8
Revision History .....	2	Ordering Information.....	10
Using the Evaluation Board.....	3	Bill of Materials.....	10
Powering Up the Evaluation Board.....	3		

**REVISION HISTORY**

**8/11—Revision 0: Initial Version**

## USING THE EVALUATION BOARD

### POWERING UP THE EVALUATION BOARD

The [ADP5033](#) evaluation board is supplied fully assembled and tested. Before applying power to the evaluation board, follow the procedures in this section.

#### **Enable JP4 (EnA) and JP5 (EnB)**

When the [ADP5033](#) has an input voltage above the minimum UVLO setting, the [ADP5033](#) BUCK2 and LDO1 are enabled by connecting JP4 (EnA) from Pin 1 to Pin 2. BUCK1 and LDO2 are enabled by connecting JP5 (EnB) from Pin 1 to Pin 2.

#### **Jumper JP3 (Mode)**

Jumper JP3 (Mode) pulled high to J1 (VIN\_1) forces BUCK1 and BUCK2 into forced PWM operation. JP3 (Mode) pulled low to J11 (GND1) allows BUCK1 and BUCK2 to operate in automatic PWM/PSM operation.

#### **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 J1 (VIN\_1) on the evaluation board, and the negative terminal of the power source to J11 (GND1).

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 ammeter positive (+) connection, the negative lead (-) of the power source to J11 (GND1) on the evaluation board, and the negative lead (-) of the ammeter to J1 (VIN\_1) on the board. Be aware that the current meters add resistance to the input source and this voltage reduces with high output currents.

#### **Output Load**

Connect an electronic load or resistor to set the load current. If the load includes an ammeter, or if the current is not measured, connect the load directly to the evaluation board, with the positive (+) load connected to one of the channels. For example, connect BUCK1, J5 (VOUT1) and the negative (-) load connection to J8 (PGND).

If an ammeter is used, connect it in series with the load. Connect the positive (+) ammeter terminal to the evaluation board for BUCK1, J5 (VOUT1), the negative (-) ammeter terminal to the positive (+) load terminal, and the negative (-) load terminal to the evaluation board J8 (PGND).

#### **Input and Output Voltmeters**

Measure the input and output voltages with voltmeters. Make sure that the voltmeters are connected to the appropriate evaluation board terminals and not to the load or power source themselves.

If the voltmeters are not connected directly to the evaluation board, the measured voltages will be incorrect due to the voltage drop across the leads and/or connections between the evaluation board, the power source, and/or the load.

Connect the input voltage measuring voltmeter positive terminal (+) to the evaluation board via J1 (VIN\_1), and the negative (-) terminal to the evaluation board via J11 (GND1).

Connect the output voltage measuring voltmeter positive (+) terminal to the evaluation board via J5 (VOUT1) for measuring the output voltage of BUCK1 and the negative (-) terminal to the evaluation board via J8 (PGND).

#### **Turning On the Evaluation Board**

When the power source and load are connected to the [ADP5033](#) evaluation board, the board can be powered for operation.

Perform the following steps:

1. Ensure that the power source voltage is greater than 4.2 V but less than 5.5 V.
2. Ensure that the desired channel is enabled, and monitor the output voltage.

If the load is not already enabled, enable the load; check that it is drawing the proper current, and that the output voltage maintains voltage regulation.

## MEASURING EVALUATION BOARD PERFORMANCE

### **Measuring Output Voltage Ripple on the Buck Regulator**

To observe the output voltage ripple of BUCK1, place an oscilloscope probe across the output capacitor (COUT\_1) with the probe ground lead at the negative (-) capacitor terminal and the probe tip at the positive (+) capacitor terminal. Set the oscilloscope to ac, 20 mV/division, and 2  $\mu$ s/division time base.

### **Measuring the Switching Waveform**

To observe the switching waveform with an oscilloscope, place the oscilloscope probe tip at the end of the inductor with the probe ground at GND. Set the oscilloscope to dc, 2 V/division, and 2  $\mu$ s/division time base.

**Measuring Load Regulation**

Test the load regulation by increasing the load at the output and looking at the change in output voltage. To minimize voltage drop, use short low resistance wires, especially for loads approaching maximum current.

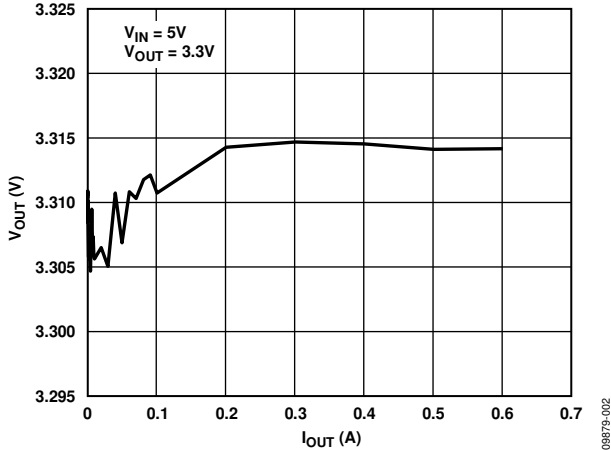


Figure 2. Buck Load Regulation

**Measuring Line Regulation**

Vary the input voltage and examine the change in the output voltage.

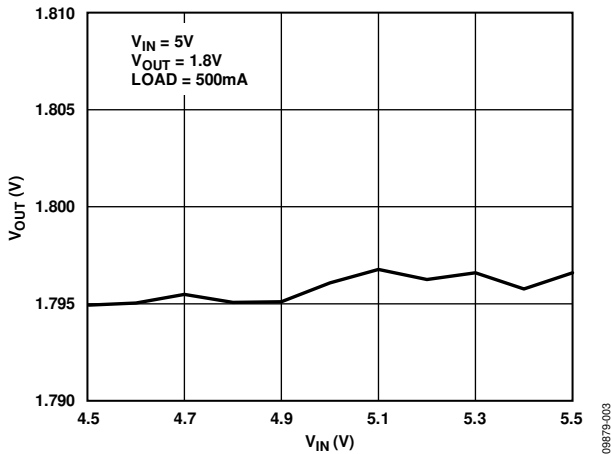


Figure 3. Buck Line Regulation

**Measuring Efficiency**

Measure the efficiency,  $\eta$ , 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 IR drops.

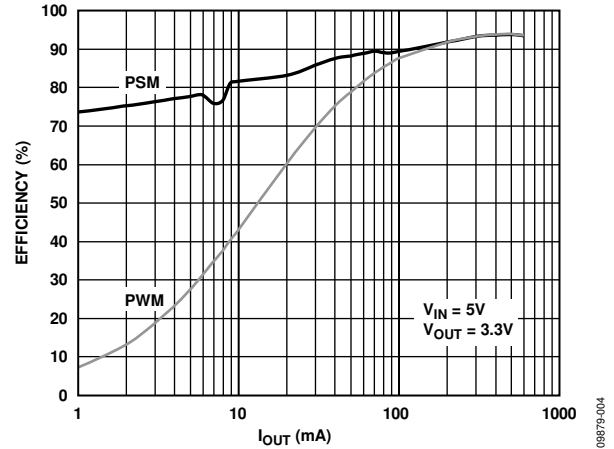


Figure 4. Buck Efficiency

**Measuring Inductor Current**

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

**Line Regulation of LDOs**

For line regulation measurements, the regulator output is monitored while its input is varied. For good line regulation, the output must change as little as possible with varying input levels. To ensure that the device is not in dropout mode during this measurement, V<sub>IN</sub> must be varied between V<sub>OUT</sub> nominal + 0.5 V (or 2.3 V, whichever is greater) and V<sub>IN</sub> maximum. For example, a fixed 2.8 V output needs V<sub>IN</sub> to be varied between 3.3 V and 5.5 V. This measurement can be repeated under different load conditions. Figure 5 shows the typical line regulation performance of the LDO with fixed 2.8 V output.

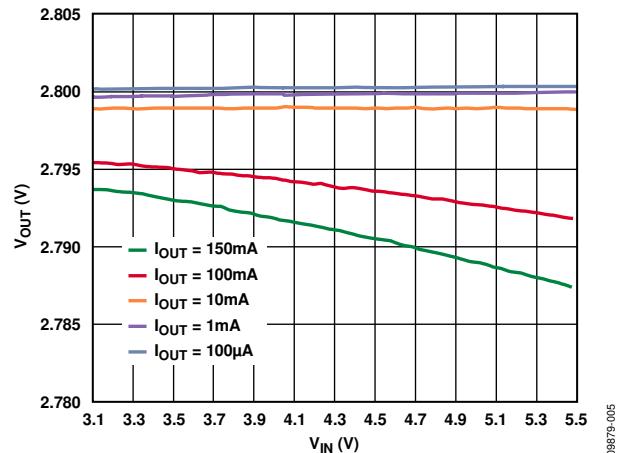


Figure 5. LDO Line Regulation

**Load Regulation of LDO**

For load regulation measurements, the regulator output is monitored while the load is varied. For good load regulation, the output must change as little as possible with varying loads. The input voltage must be held constant during this measurement. The load current can be varied from 0 mA to 150 mA. Figure 6 shows the typical load regulation performance of the LDO with fixed 2.8 V output for an input voltage of 3.3 V.

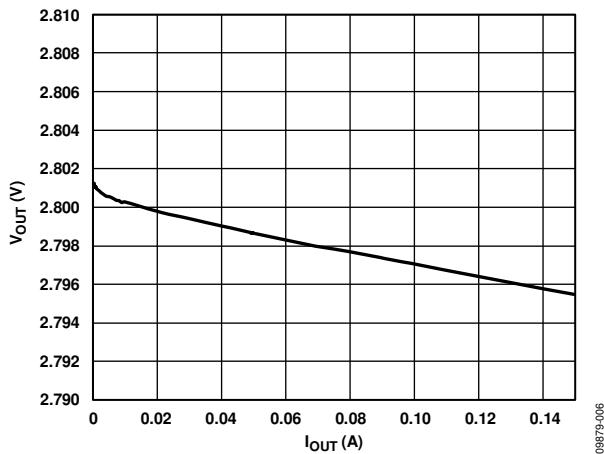


Figure 6. LDO Load Regulation

**Dropout Voltage of LDO**

Dropout voltage is defined as the input-to-output voltage differential when the input voltage is set to the nominal output voltage. This applies only for output voltages greater than 2.3 V. Dropout voltage increases with larger loads. For more accurate measurements, a second voltmeter can be used to monitor the input voltage across the input capacitor. The input supply voltage may need to be adjusted to account for IR drops, especially if large load currents are used.

**Ground Current Consumption of LDO**

Ground current measurements can determine how much current the internal circuits of the regulator consume while the circuits perform the regulation function. To be efficient, the regulator needs to consume as little current as possible. Typically, the regulator uses the maximum current when supplying its largest load level (300 mA). When the device is disabled, the ground current drops to less than 1 mA.

### MEASURING OUTPUT VOLTAGE

Figure 7 shows how the evaluation board can be connected to a voltage source and a voltmeter for basic output voltage accuracy measurements. A resistor can be used as the load for the regulator. Ensure that the resistor has a power rating adequate

to handle the power expected to be dissipated across it. An electronic load can also be used as an alternative. Ensure that the voltage source can supply enough current for the expected load levels.

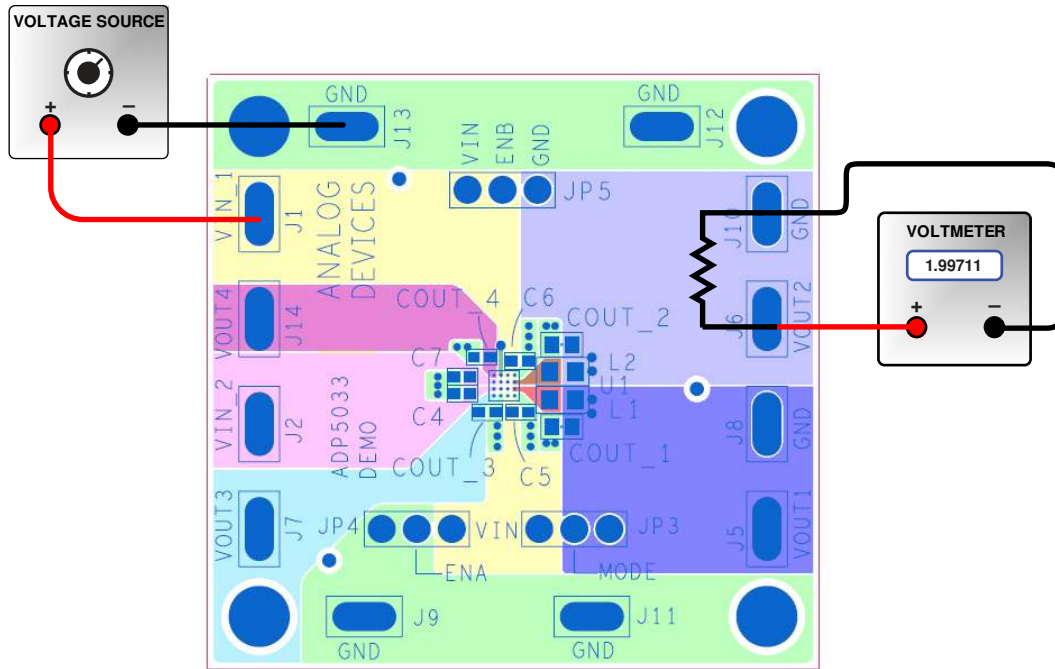


Figure 7. Output Voltage Measurement

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## MEASURING GROUND CURRENT

Figure 8 shows the evaluation board connected to a voltage source and an ammeter for ground current measurements. A resistor can be used as the load for the regulator. Ensure that the resistor has a power rating that is adequate to handle the power

expected to be dissipated across it. An electronic load can be used as an alternative. Ensure that the voltage source used can supply enough current for the expected load levels.

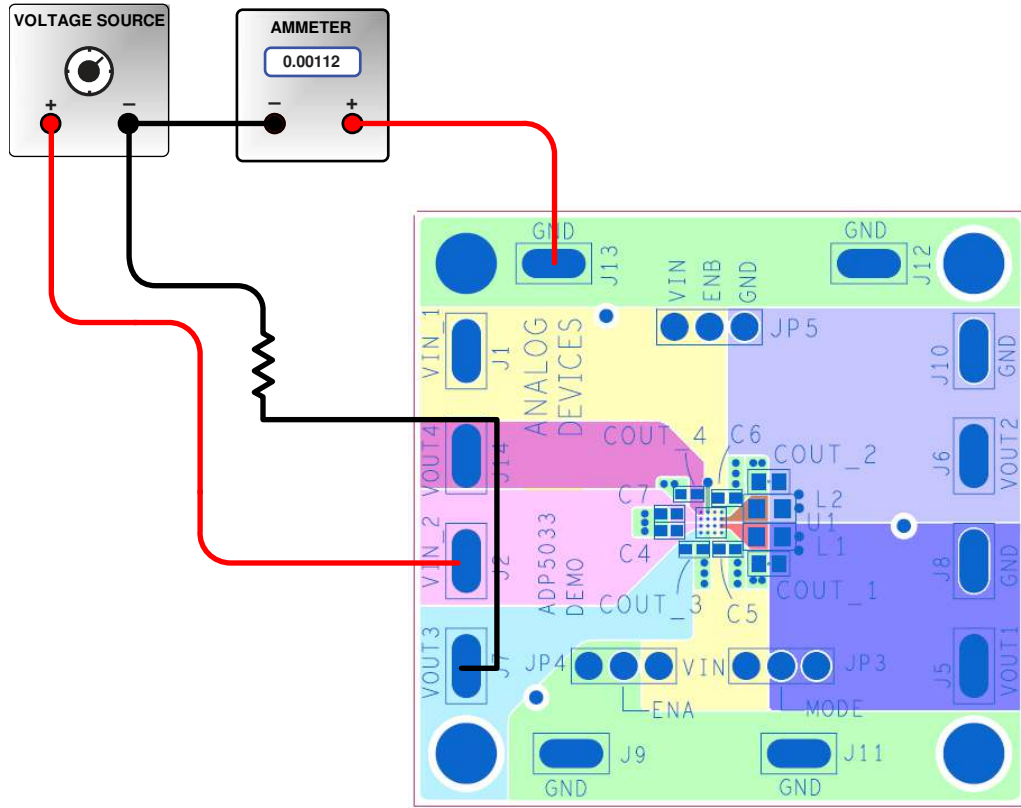
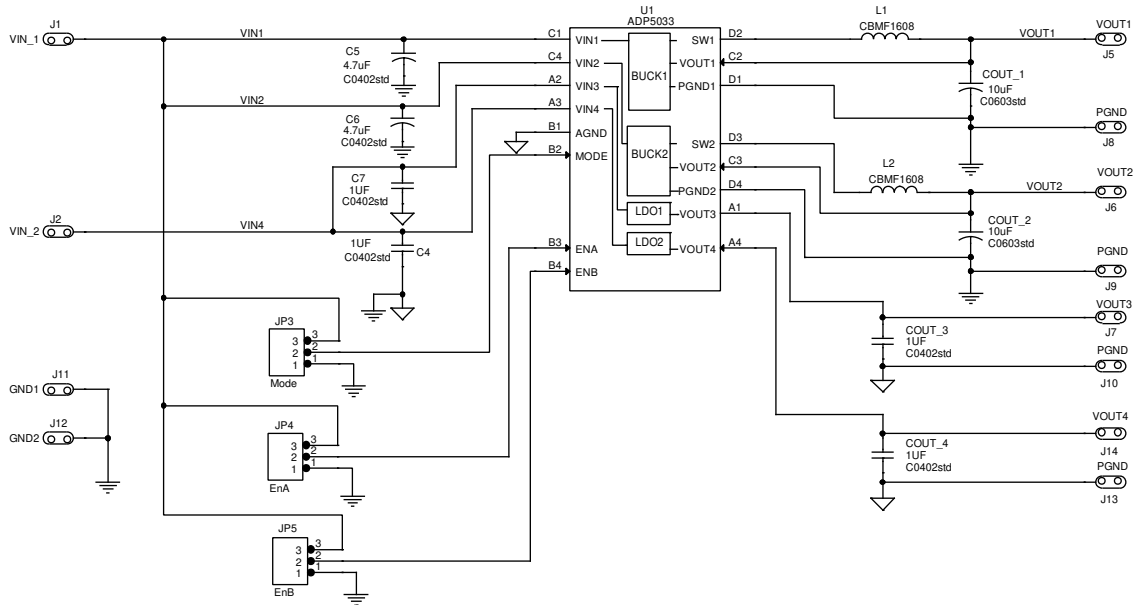


Figure 8. Ground Current Measurement

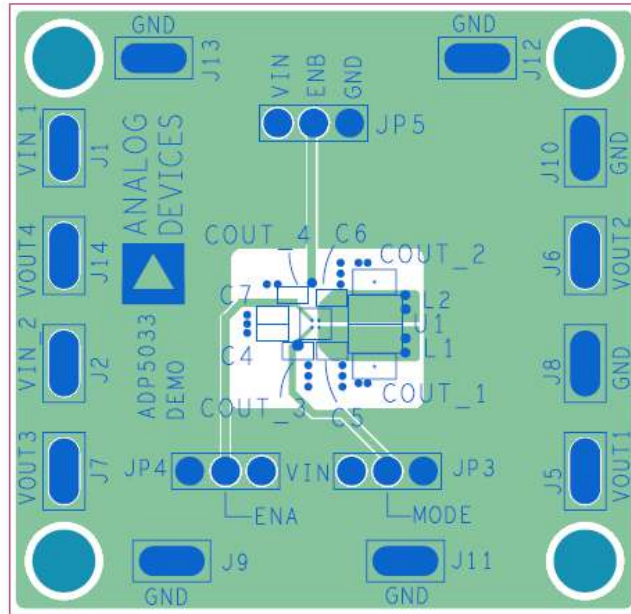
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EVALUATION BOARD SCHEMATICS AND ARTWORK



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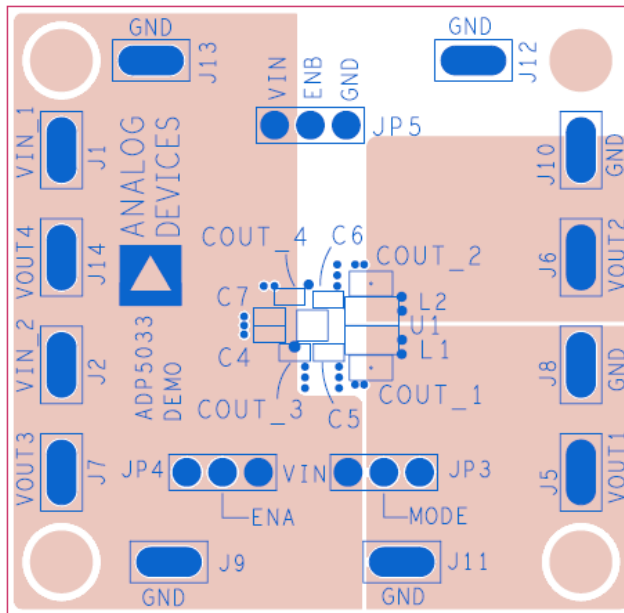
Figure 9. Evaluation Board Schematic of ADP5033



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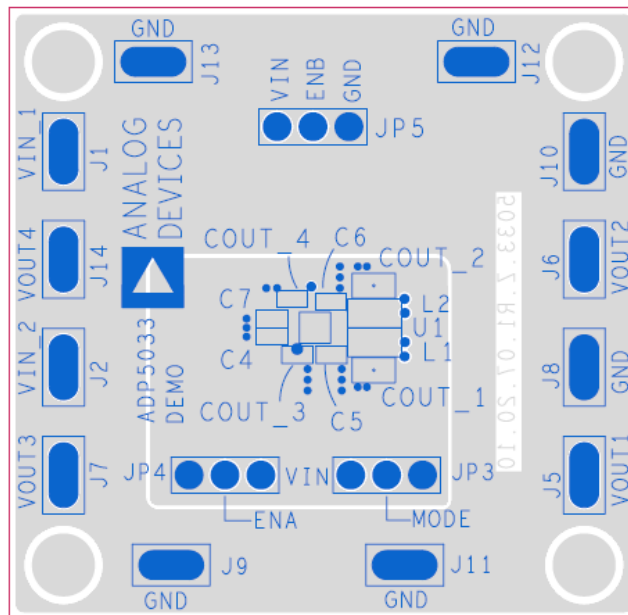
Figure 10. Second Layer, Recommended Layout





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Figure 11. Third Layer, Recommended Layout



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Figure 12. Bottom Layer, Recommended Layout

**ORDERING INFORMATION****BILL OF MATERIALS**

Table 1.

Qty.	Reference Designator	Description	Manufacturer	Part Number
1	U1	<a href="#">ADP5033</a> micro PMU—4 regulators	Analog Devices	<a href="#">ADP5033</a>
2	C5, C6	Capacitor, MLCC, 4.7 $\mu$ F, 6.3 V, 0402, X5R	Panasonic—ECG	ECJ-0EBOJ475M
3	C7, C4, COUT_3, COUT_4	Capacitor, MLCC, 1.0 $\mu$ F, 6.3 V, 0402, X5R	Taiyo Yuden	LMK105BJ105MV-F
2	COUT_2, COUT_1	Capacitor, MLCC, 10.0 $\mu$ F, 6.3 V, 0603, X5R	Taiyo Yuden	JMK107BJ106MA-T
2	L1, L2	Inductor, 1.0 $\mu$ H, 0.29 A, 90 m $\Omega$	Taiyo Yuden	CBMF1608T1R0M

**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.

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