



**THE DATASHEET OF  
ADP5090-1-EVALZ**



## Evaluation Board for the **ADP5090** Ultralow Power Boost Regulator

### GENERAL DESCRIPTION

The **ADP5090** is an ultralow, power synchronous, dc-to-dc boost regulator in a compact 3 mm × 3 mm LFCSP\_WQ package. The **ADP5090** runs from input voltages of 0.38 V to 3.3 V and requires minimal external components to provide a high efficiency solution with an integrated power switch, a synchronous rectifier, and battery management.

The **EVAL-ADP5090** evaluation board provides an easy way to evaluate the device. This user guide describes how to quickly set up the board and deliver up to 3.5 V maximum voltage to the

SYS output using an external resistor divide. The internal switches turn on if the storage element voltage at the BAT pin is above the externally programmed SETSD voltage of 2.4 V. The PGOOD indicator toggles high when the SYS pin ramps up to 3 V.

Complete information about the **ADP5090** is available in the corresponding data sheet. Consult the data sheet in conjunction with this user guide when using the evaluation board.

### THE **EVAL-ADP5090** EVALUATION BOARD

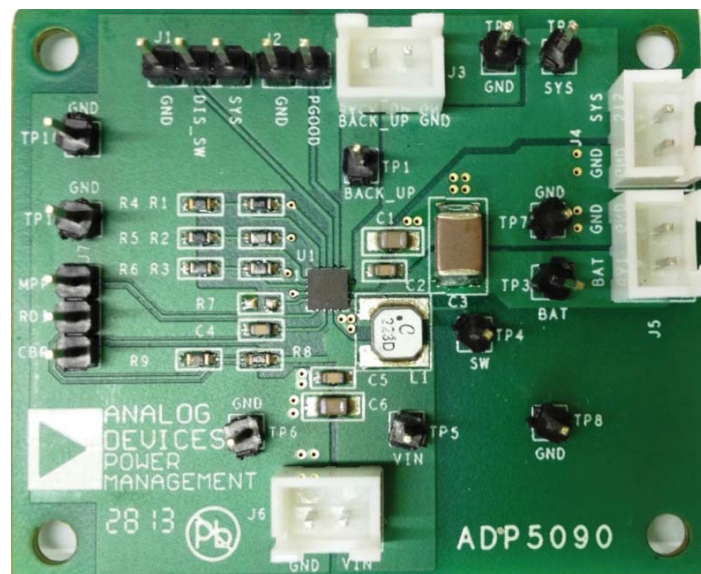


Figure 1. Photograph of the **EVAL-ADP5090** Evaluation Board

**TABLE OF CONTENTS**

|   |   |  |   |
|---|---|--|---|
| General Description .....               | 1 | Measuring the EVAL-ADP5090 Performance ..... | 4 |
| The EVAL-ADP5090 Evaluation Board ..... | 1 | Evaluation Board Schematics.....             | 6 |
| Revision History .....                  | 2 | Evaluation Board Layout .....                | 7 |
| Setting Up the Evaluation Board .....   | 3 | Ordering Information.....                    | 8 |
| Powering Up the Evaluation Board.....   | 3 | Bill of Materials.....                       | 8 |

**REVISION HISTORY**

**9/14—Revision 0: Initial Version**

# SETTING UP THE EVALUATION BOARD

## POWERING UP THE EVALUATION BOARD

The [ADP5090](#) evaluation board is fully assembled and tested. Use the following setup procedures before applying power to the evaluation board,

### Jumper Settings

Table 1 describes the jumper settings.

**Table 1. Jumper Settings**

| Jumper      | State or Connection | Function  |
|-------------|---------------------|---|
| J1 (DIS_SW) | SYS<br>GND          | Disables the main boost<br>Enables the main boost   |
| J2 (PGOOD)  | Not applicable      | Pull high when the SYS voltage ramps up to preset the SETPG rising threshold  |
| J3 (RDIV)   | MPPT<br>Floating    | With MPPT sensing function<br>Without MPPT sensing function; provide an external voltage at the CBP pin as the MPPT voltage |

### Input Power Source Connection

Energy harvesting power sources are high impedance sources. As Figure 2 shows, a source meter configured as a current source with a voltage limit set to the open circuit voltage of the harvester is the best way to simulate the harvester. For a low output impedance power supply (voltage source), it is necessary to simulate the impedance of the harvester with a physical resistor, R, between the supply and the VIN pin. If the input current source includes a voltage meter, use the meter to monitor the input voltage as follows:

1. Connect the positive terminal of the power source to the VIN terminal (J6) on the evaluation board.
2. Connect the negative terminal of the power source to the GND terminal (J6) on the evaluation board.

If the input power supply does not include a current meter, connect a current meter in series with the input power supply as follows:

1. Connect the external series resistor of the power source to the positive terminal (+) of the current meter.
2. Connect the negative terminal of the power source to the GND terminal (J6) on the evaluation board.
3. Connect the negative terminal (-) of the current meter to the VIN terminal (J6) on the evaluation board.

### Output Load Connection

Before connecting the load to the [EVAL-ADP5090](#) evaluation board, ensure that the SYS voltage is higher than the end of the cold-startup threshold ( $V_{SYS\_TH}$ , 1.93 V typical), or that the PGOOD signal is high. If the load includes a current meter or if the current is not measured, connect the load directly to the evaluation board as follows:

1. Connect the positive load connection (+) to the SYS terminal (J4) on the evaluation board.
2. Connect the negative load connection (-) to the GND terminal (J4) on the evaluation board.

If a current meter is used, connect it in series with the load as follows:

1. Connect the positive terminal (+) of the current meter to the SYS terminal (J4) on the evaluation board.
2. Connect the negative terminal (-) of the current meter to the positive terminal (+) of the load.
3. Connect the negative terminal (-) of the load to the GND terminal (J4) on the evaluation board.

### Storage Elements Connection

The [EVAL-ADP5090](#) can charge some types of energy storage elements, such as rechargeable batteries, super capacitors, and conventional capacitors. In general, the storage elements maintain constant power or peak power of the system that cannot directly come from the input source. It is necessary to consider any significant leakage current of batteries and super capacitors. For applications information, refer to the [ADP5090](#) data sheet.

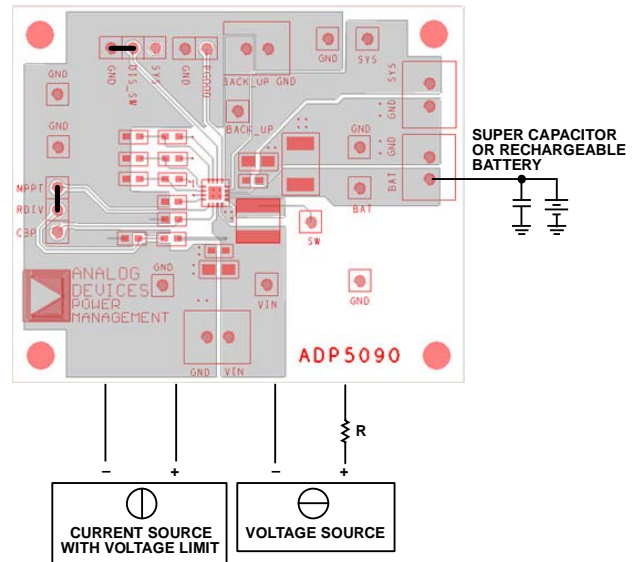


Figure 2. Setup for the [EVAL-ADP5090](#) Evaluation Board

### Input and Output Voltmeter Connections

Measure the input and output voltages with voltmeters. Ensure that the voltmeters connect to the appropriate test points on the board. If the voltmeters are not connected to the correct test points, the measured voltages may be incorrect due to the voltage drop across the leads, or due to the connections between the board, the power source, and/or the load. To connect the voltmeters, use the following procedure:

1. Connect the positive terminal (+) of the input voltage measuring voltmeter to Test Point TP5 on the evaluation board.
2. Connect the negative terminal (–) of the input voltage measuring voltmeter to Test Point TP6 on the board.
3. Connect the positive terminal (+) of the output voltage measuring voltmeter to Test Point TP2 on the board.
4. Connect the negative terminal (–) of the output voltage measuring voltmeter to Test Point TP9 on the board.

### Powering On the Evaluation Board

If the open circuit voltage (OCV) of the input current source is above a minimum input voltage of 0.38 V for cold-start (typical), and the input power is above the 16  $\mu$ W minimum input power of cold-start (typical), the [EVAL-ADP5090](#) enters cold-startup when the SYS voltage is below  $V_{SYS\_TH}$ . When the SYS voltage is above  $V_{SYS\_TH}$ , the board exits cold-startup and enables the main boost.

After cold-startup, the MPPT sampling circuit is active and the harvester OCV is detectable because there is no input current to create a droop across the impedance. The main boost runs and draws current until the VIN voltage drops to the sampled MPPT voltage stored at the CBP pin.

### Optional BACK\_UP Setup

An optional primary battery connected to the BACK\_UP pin can accelerate the cold-startup or maintain the system load. When the voltage at the BACK\_UP pin is higher than the voltage at the BAT pin, the [ADP5090](#) turns on the internal power MOSFETs between the BACK\_UP pin and the SYS pin. When the BACK\_UP pin voltage is lower than the BAT pin voltage, the internal power MOSFETs turn off.

## MEASURING THE [EVAL-ADP5090](#) PERFORMANCE

### Measuring the Switching Waveform

To observe the switching waveform with an oscilloscope, place the oscilloscope probe tip at Test Point TP4 with the probe ground connected to the GND pin. Set the oscilloscope to a dc coupling, 2 V/division, 10  $\mu$ sec/division time base. The switching waveform alternates between 0 V and the approximate SYS voltage.

### Measuring Efficiency

Measure the efficiency,  $\eta$ , by comparing the input power with the output power. Figure 3 shows the test setup. Float the RDIV jumper (J3) and provide an external voltage at the CBP pin as the MPPT voltage so that the input voltage is regulated to this voltage. With a voltage source meter capable of sinking current to connect to the SYS pin, obtain the output voltage and output current.

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

### Measuring the Inductor Current

Measure the inductor current 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, use a current probe to measure the inductor current.

### Measuring the Output Voltage Ripple

To observe the output voltage ripple, place an oscilloscope probe across Output Capacitor C1 with the probe ground lead placed at the negative capacitor terminal (–) and the probe tip placed at the positive capacitor terminal (+). Set the oscilloscope to an ac coupling, 50 mV/division, 1 sec/division time base and a 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.

To eliminate the noise injection, remove the oscilloscope probe sheath and wrap a nonshielded wire around the oscilloscope probe. By keeping the ground lengths of the oscilloscope probe as short as possible, the true ripple can be measured.

**Output Voltage Change**

The output voltage of the EVAL-ADP5090 is preset to 3.5 V. However, the output voltage can be adjusted using the following equation:

$$V_{SYS} = \frac{3}{2} V_{REF} \left( 1 + \frac{R3}{R6} \right)$$

To prevent deeply discharging storage elements at the BAT pin, the voltage threshold can be programmed using the following equation:

$$V_{SETSD} = V_{REF} \left( 1 + \frac{R2}{R5} \right)$$

where  $V_{REF}$ , the typical internal reference voltage, is 1.21 V.

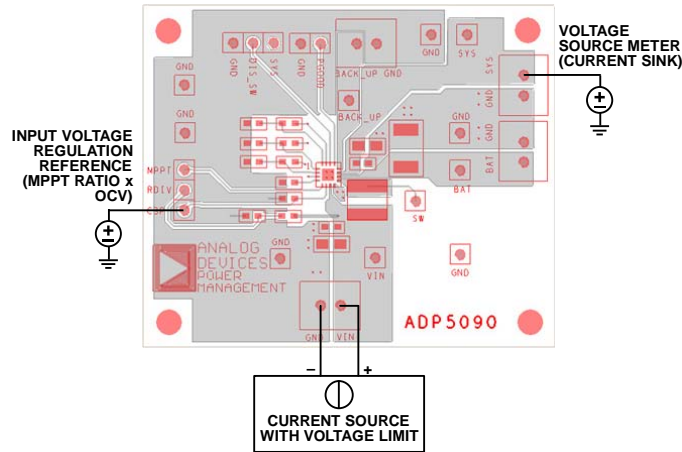


Figure 3. Test Setup for Measuring the Efficiency of the EVAL-ADP5090

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EVALUATION BOARD SCHEMATICS

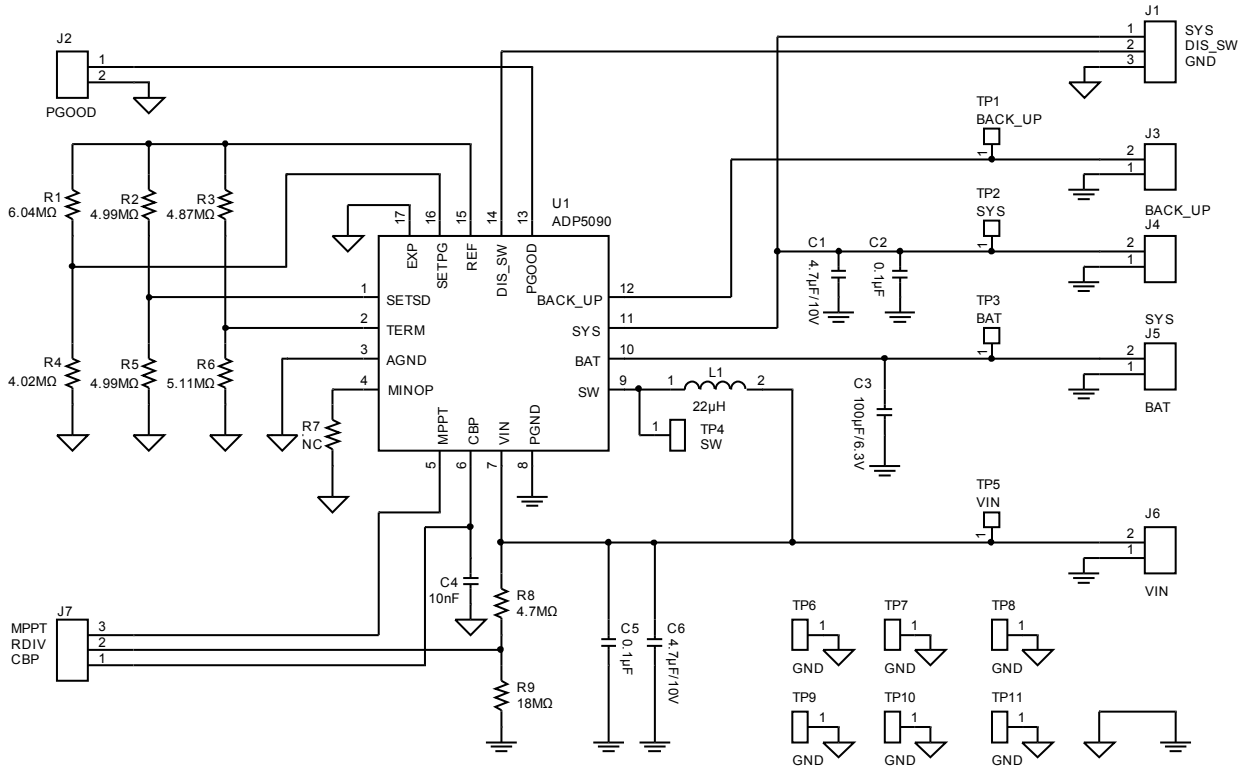


Figure 4. Schematic of the EVAL-ADP5090

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## EVALUATION BOARD LAYOUT

Figure 5 and Figure 6 show the top and bottom layers of the EVAL-ADP5090.

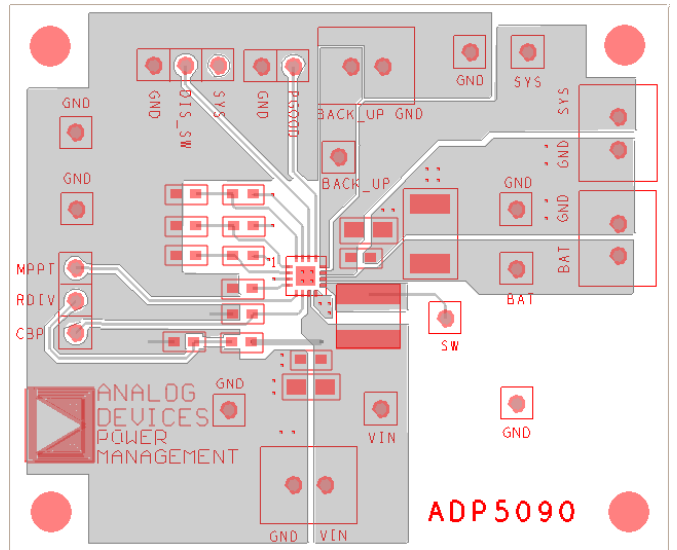


Figure 5. EVAL-ADP5090, Top Layer

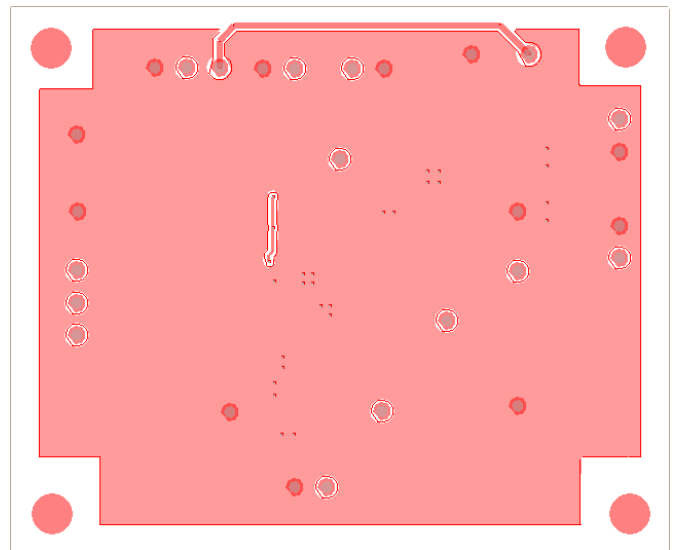


Figure 6. EVAL-ADP5090, Bottom Layer

## ORDERING INFORMATION

## BILL OF MATERIALS

Table 2. The ADP5090 Evaluation Board Bill of Materials

| Quantity | Reference Designator           | Description                   | Part Number         | PCB Footprint | Vendor         |
|----------|--------------------------------|-------------------------------|---------------------|---------------|----------------|
| 2        | C1, C6                         | Capacitor, 4.7 $\mu$ F, 10 V  | GRM21BR61A475KA73   | C0805         | Murata         |
| 2        | C2, C5                         | Capacitor, 0.1 $\mu$ F        | GRM188R71H104KA93   | C0603         | Murata         |
| 1        | C3                             | Capacitor, 100 $\mu$ F, 6.3 V | C4532X5R0J107M280KA | C1812         | TDK            |
| 1        | C4                             | Capacitor, 10 nF              | GRM188R71H103KA01   | C0603         | Murata         |
| 1        | J1                             | DIS_SW                        | M20-9990246         | SIP3          | Harwin         |
| 1        | J2                             | PGOOD                         | M20-9990245         | SIP2          | Harwin         |
| 1        | J3                             | BACK_UP                       |                     | SIP2_big      | Harwin         |
| 1        | J4                             | SYS                           |                     | SIP2_big      | Harwin         |
| 1        | J5                             | BAT                           |                     | SIP2_big      | Harwin         |
| 1        | J6                             | VIN                           |                     | SIP2_big      | Harwin         |
| 1        | J7                             | RDIV                          | M20-9990246         | SIP3          | Harwin         |
| 1        | L1                             | Inductor, 22 $\mu$ H          | LPS4018-223MLB      | Inductor_4x4  | Coilcraft      |
|          |                                | Inductor, 22 $\mu$ H          | 74437324220         | Inductor_4x4  | Wurth          |
| 1        | R1                             | Resistor, 6.04 M $\Omega$     | CRCW06036M04FKTA    | R0603         | Vishay Dale    |
| 2        | R2, R5                         | Resistor, 4.99 M $\Omega$     | CRCW06034M99FKEA    | R0603         | Vishay Dale    |
| 1        | R3                             | Resistor, 4.87 M $\Omega$     | CRCW06034M87FKEA    | R0603         | Vishay Dale    |
| 1        | R4                             | Resistor, 4.02 M $\Omega$     | CRCW06034M02FKEA    | R0603         | Vishay Dale    |
| 1        | R6                             | Resistor, 5.11 M $\Omega$     | CRCW06035M11FKEA    | R0603         | Vishay Dale    |
| 1        | R7                             | Resistor, 20k                 | CRCW060320K0FKEA    | R0603         | Vishay Dale    |
| 1        | R8                             | Resistor, 4.7 M $\Omega$      | CRCW06034M70FKEA    | R0603         | Vishay Dale    |
| 1        | R9                             | Resistor, 18 M $\Omega$       | RK73B1JTDD186J      | R0603         | KOA            |
| 1        | TP1                            | BACK_UP                       | M20-9990245         | SIP1          | Harwin         |
| 1        | TP2                            | SYS                           | M20-9990245         | SIP1          | Harwin         |
| 1        | TP3                            | BAT                           | M20-9990245         | SIP1          | Harwin         |
| 1        | TP4                            | SW                            | M20-9990245         | SIP1          | Harwin         |
| 1        | TP5                            | VIN                           | M20-9990245         | SIP1          | Harwin         |
| 6        | TP6, TP7, TP8, TP9, TP10, TP11 | GND                           | M20-9990245         | SIP1          | Harwin         |
| 1        | U1                             | IC                            | ADP5090ACPZ-1-R7    | LFCSP16-3x3PL | Analog Devices |

**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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