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Evaluation Board for the ADP5090 Ultralow Power Boost Regulator

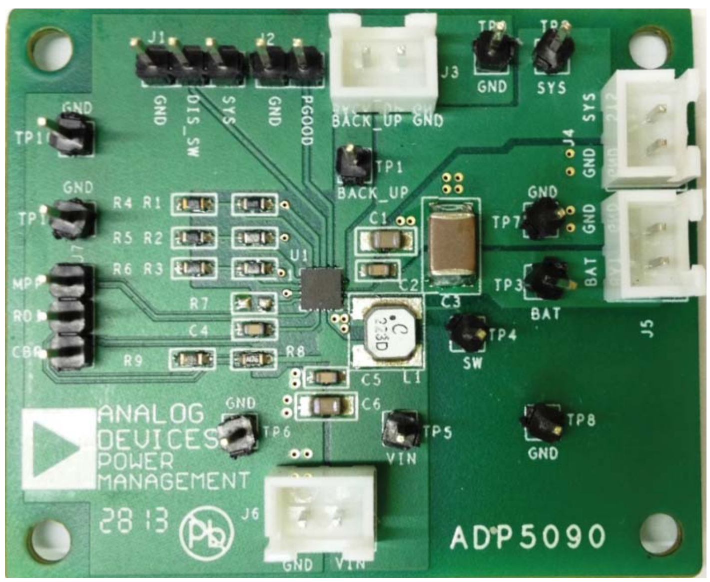
GENERAL DESCRIPTION

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



12384-001

Figure 1. Photograph of the EVAL-ADP5090 Evaluation Board

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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	Disables the main boost
	GND	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	With MPPT sensing function
	Floating	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.

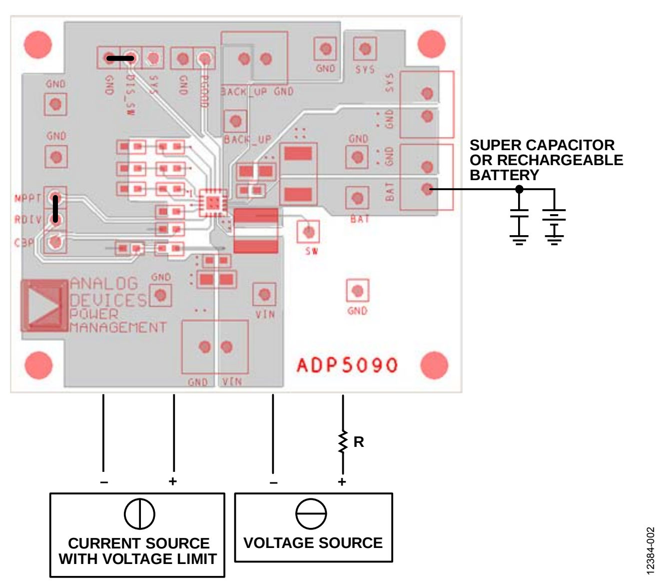

Figure 2. Setup for the EVAL-ADP5090 Evaluation Board

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 μW 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 μsec/division time base. The switching waveform alternates between 0 V and the approximate SYS voltage.

Measuring Efficiency

Measure the efficiency, η, 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.

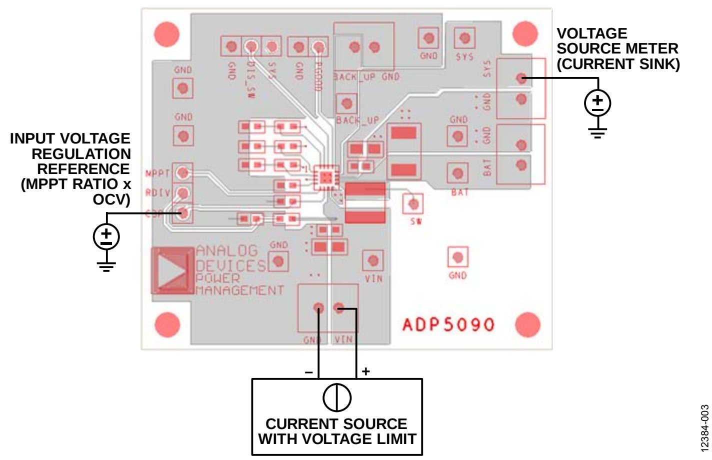

Figure 3. Test Setup for Measuring the Efficiency of the EVAL-ADP5090

EVALUATION BOARD SCHEMATICS

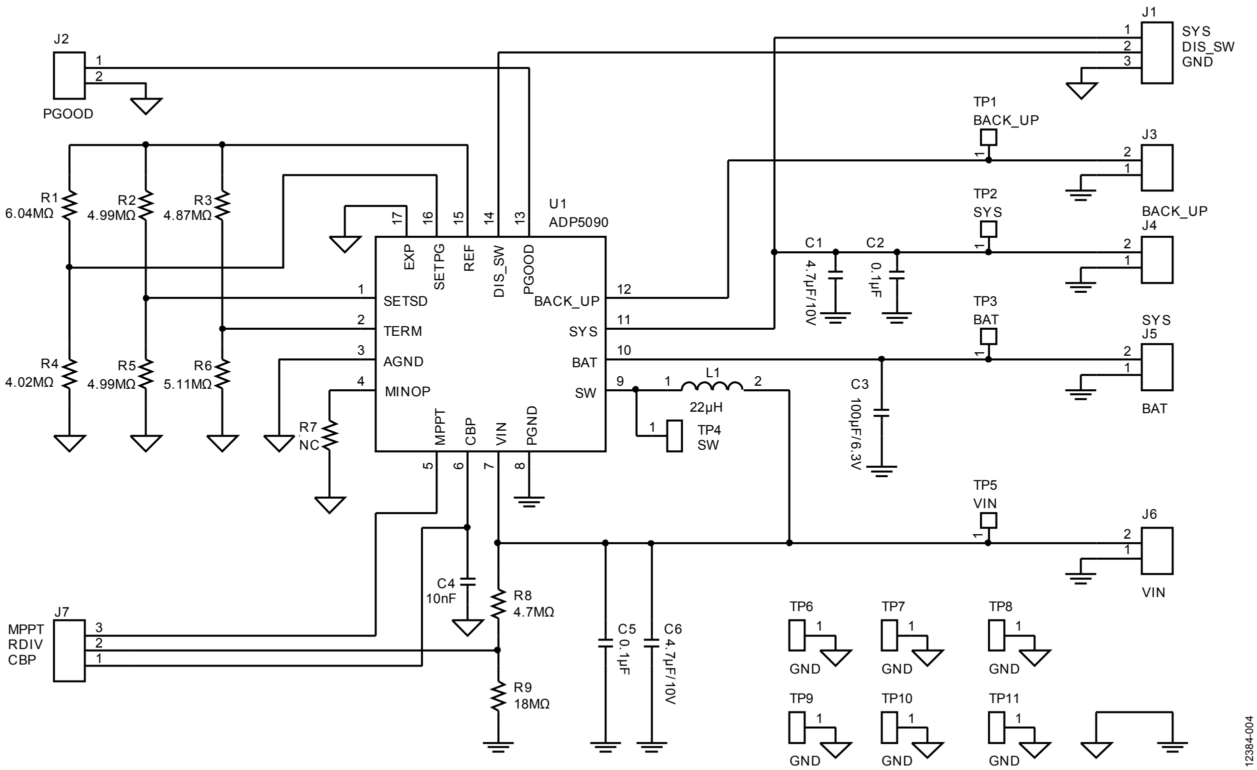

Figure 4. Schematic of the EVAL-ADP5090

EVALUATION BOARD LAYOUT

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

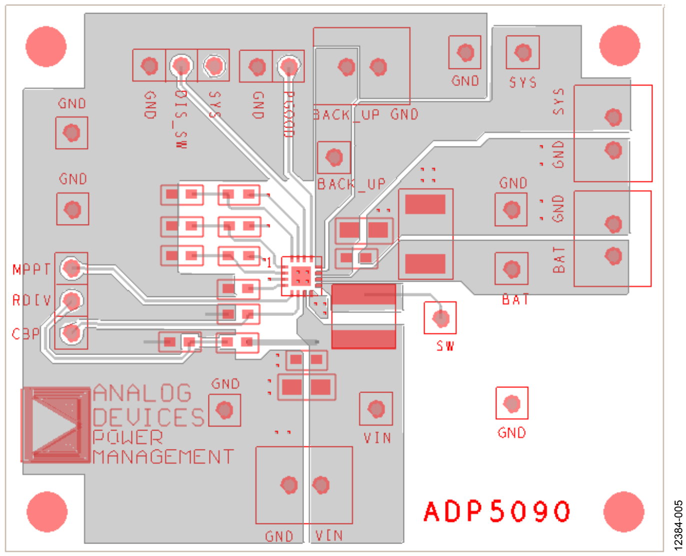

Figure 5. EVAL-ADP5090, Top Layer

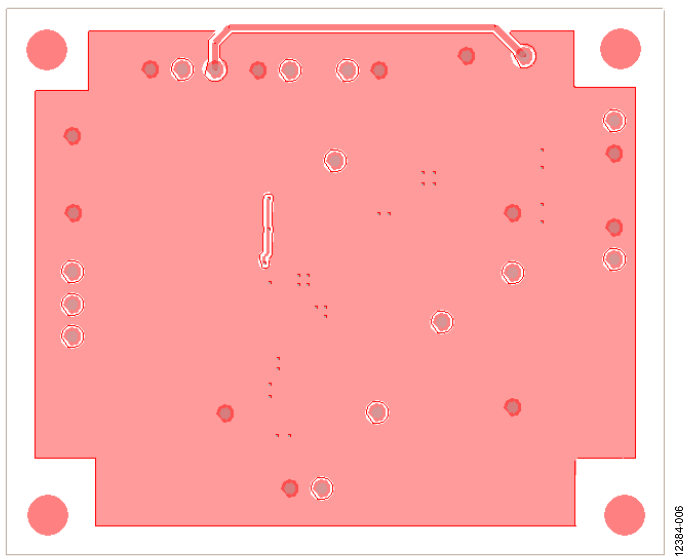

Figure 6. EVAL-ADP5090, Bottom Layer

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 µF, 10 V	GRM21BR61A475KA73	C0805	Murata
2	C2, C5	Capacitor, 0.1 µF	GRM188R71H104KA93	C0603	Murata
1	C3	Capacitor, 100 µF, 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 µH	LPS4018-223MLB	Inductor_4x4	Coilcraft
		Inductor, 22 µH	74437324220	Inductor_4x4	Wurth
1	R1	Resistor, 6.04 MΩ	CRCW06036M04FKTA	R0603	Vishay Dale
2	R2, R5	Resistor, 4.99 MΩ	CRCW06034M99FKEA	R0603	Vishay Dale
1	R3	Resistor, 4.87 MΩ	CRCW06034M87FKEA	R0603	Vishay Dale
1	R4	Resistor, 4.02 MΩ	CRCW06034M02FKEA	R0603	Vishay Dale
1	R6	Resistor, 5.11 MΩ	CRCW06035M11FKEA	R0603	Vishay Dale
1	R7	Resistor, 20k	CRCW060320K0FKEA	R0603	Vishay Dale
1	R8	Resistor, 4.7 MΩ	CRCW06034M70FKEA	R0603	Vishay Dale
1	R9	Resistor, 18 MΩ	RK73B1JTTD186J	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

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