ANALOG DEVICES AD5140-EVALZ Evaluation Board User Guide

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ANALOG DEVICES AD5140-EVALZ Evaluation Board

FEATURES

- Fully featured evaluation board for the ADP5140 Compact solution size
- 4-layer, high glass transition temperature (TG) PCB for superior thermal performance
- Connections through vertical, printed circuit, tail pin headers Supply voltage: 3.5 V to 4.1 V (3.7 V typical)
- Adjustable output for Buck2 and Buck3 regulators
- Fixed output for Buck1, Buck4, boost, and all LDO regulators Fixed start-up sequence
- Voltage monitor and watchdog function
- RESET, FAULT, and STATUS outputs
- SPI communication protocol

EVALUATION KIT CONTENTS

- ADP5140-EVALZ
- USB-SDP-CABLEZ serial interface cable
- ADP5140 GUI software

DOCUMENT NEEDED

- ADP5140 data sheet

SOFTWARE NEEDED

- ADP5140 GUI software

EQUIPMENT NEEDED

- DC power supply
- Electronic load
- Oscilloscope

GENERAL DESCRIPTION

- The ADP5140-EVALZ provides a complete and compact solution that allows users to evaluate the

performance of the ADP5140 with a near ideal printed circuit board (PCB) layout.

- The main device on the ADP5140-EVALZ, the ADP5140, integrates four high performance, synchronous step-down buck regulators (Buck1 to Buck4), one boost regulator, and seven low noise low dropout (LDO) regulators (LDO1 to LDO7). Each voltage rail is monitored internally and any fault event is reported to the system through the RESET pin, FAULT pin, and STATUS pin.
- The ADP5140-EVALZ has enable and sequence controls for all regulators that allow every voltage rail to start up with a fixed sequence.
- The ADP5140-EVALZ has a serial peripheral interface (SPI) for system control and diagnostics. A dedicated graphical user interface (GUI) software is associated with the ADP5140-EVALZ for flexible evaluation of the ADP5140.
- For full details on the ADP5140, see the ADP5140 data sheet, which must be consulted in conjunction with this user guide when using the ADP5140-EVALZ.

USING THE EVALUATION BOARD

POWERING UP THE ADP5140-EVALZ

The ADP5140-EVALZ is supplied fully assembled and tested. Before applying power to the ADP5140-EVALZ, take the following steps:

1. Short the two pins on the S1 jumper to connect the VOUT2 pin to the PVIN56 pin on the ADP5140-EVALZ and provide the power supply to Regulator5 and Regulator6.
2. Short the two pins on the S2 jumper to connect the VOUT3 pin to the PVIN78 pin on the ADP5140-EVALZ and provide the power supply to Regulator7 and Regulator8.
3. Short the two pins on the S3 jumper to connect the VOUT3 pin to the PVIN9 pin on the ADP5140-EVALZ and provide the power supply to Regulator9.
4. Short the EN pin to the VIN pin on the J10 jumper to enable all regulators.
5. Short the SEQ pin to the VIN pin on the J2 jumper for all regulators to start up in sequence.
6. Short the VIO pin to the VOUT11 pin on the J21 jumper to select 3.3 V as the input/output voltage if the USB-SDP-CABLEZ serial interface is used. If the VIO pin is shorted to the VOUT5 pin on the J21 jumper, a 1.8 V input/output voltage is used.

Input Power Source

If the input dc power source includes a current meter, use the meter to monitor the input current. Connect the positive terminal of the power source to J3 (VIN) of the ADP5140-EVALZ and connect the negative terminal of the power source to J1 (GND) of the ADP5140-EVALZ. If the dc 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, connect the negative lead of the power source to J1 (GND), and connect the negative lead of the ammeter to J3 (VIN).

Output Load

Before connecting the load, ensure that all regulators are turned off. Connect an electronic load or resistor for each regulator to set the load current. Using the Buck1 regulator as an example, connect the positive terminal of the load to J4 (VOUT1) of the ADP5140-EVALZ and connect the negative terminal of the load to J6 (GND).

Input and Output Voltmeter

Measure the input and output voltages using voltmeters. Ensure that the voltmeters are connected to the appropriate terminals of the ADP5140-EVALZ and not to the load or the power source. If the voltmeters are not connected directly to the ADP5140-EVALZ, the measured voltages are incorrect because of the voltage drop

across the leads and/or connections between the ADP5140-EVALZ, the power source, and/or the load. To measure the input voltage, connect the positive terminal of the voltmeter to the TP45 test point (VIN_SNS) and the negative terminal to the TP46 test point (GND_SNS). Using Buck1 as an example, to measure the output voltage of Buck1, connect the positive terminal of the voltmeter to the TP1 test point (VOUT1_SNS) and the negative terminal to the TP3 test point (GND_SNS). The measurement method of the output voltage for the other regulators is the same as for Buck1.

Turning On the ADP5140-EVALZ

When the power source and load are connected to the ADP5140-EVALZ, the ADP5140-EVALZ can be powered for operation.
Take the following steps to turn on the ADP5140-EVALZ:

1. Ensure that the S1, S2, S3, J10, J2, and J21 jumpers are connected correctly.
2. Set the input voltage to 3.7 V and turn on the power supply.
3. Ensure that each regulator outputs the correct voltage.
4. Turn on the load and ensure that the load is drawing the load current that was set.
5. Verify that the output voltage maintains its regulation.

MEASURING EVALUATION BOARD PERFORMANCE

Measuring the Switching Waveform

To observe the switching waveform of the ADP5140 with an oscilloscope, place the oscilloscope probe tip at the TP28 (SW1), TP33 (SW2), TP37 (SW3), TP29 (SW4), and TP44 (SW12) test points with the probe ground at any ground test point, such as TP39 (GND) or TP47 (GND). Set the oscilloscope to dc with the appropriate voltage and time divisions. The switching waveform limits alternate approximately between 0 V and the input voltage (for a buck regulator) or output voltage (for the boost regulator).

Measuring Load Regulation

To test the load regulation of the ADP5140, observe the change in each output voltage when increasing each output load current. To minimize the voltage drop, use short, low-resistance wires.

Load Transient Response

Generate a load current transient at each output and use an oscilloscope to observe the output voltage response. Attach the current probe to the wire between the output and the load to capture the current transient waveform of the ADP5140.

Measuring Efficiency

To measure the efficiency of the ADP5140, η, compare the input power to the output power. Measure the input and output voltages as close as possible to the input and output capacitors to reduce the effect of voltage drop. To measure the overall efficiency, enable all regulators and draw the proper load current. To calculate the overall efficiency, use the following equation:

$$\eta = \frac{V_{OUT1} \times I_{OUT1} + V_{OUT2} \times I_{OUT2} + \ldots + V_{OUT12} \times I_{OUT12}}{V_{IN} \times I_{IN}} \quad (1)$$

Measuring Inductor Current

To measure the inductor current, remove one end of the inductor from its pad and connect 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, a 2 µs/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 the noise into the measured output ripple. Figure 2 shows a simplified way to measure the output ripple properly. Remove the oscilloscope probe sheath and wrap an unshielded wire around the oscilloscope probe. Keeping the ground length of the oscilloscope probe as short as possible allows the true ripple to be measured.

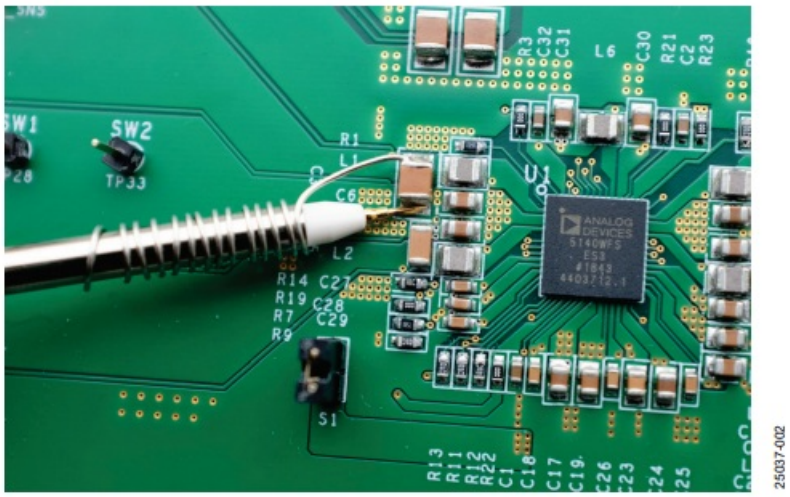

Figure 2. Measuring Output Voltage Ripple

SOFTWARE INSTALLATION

The ADP5140-EVALZ supports SPI communication with a host. A dedicated GUI is associated with the ADP5140-EVALZ for the user to access the registers in the ADP5140 for function evaluation and system configuration. To use this GUI, the USB-SDP-CABLEZ hardware is required.

Install the ADP5140 GUI

To install the ADP5140 GUI and the USB-SDP-CABLEZ driver on the PC, take the following steps:

1. Launch the setup.exe file in the ADP5140 GUI file.
2. In the destination directory window that appears, it is recommended to use the default values.
3. Click Next.
4. In the start installation window that appears, it is recommended to use the default values.
5. Click Next.
6. In the installation complete window that appears, click Next and then click Finish to complete the installation.

Installing the USB-SDP-CABLEZ driver

Attach the USB-SDP-CABLEZ to any USB port of the PC. The operating system finds the new device and searches its driver automatically. When the driver installation is complete, the cable is recognized as USB-SDP-CABLEZ.

QUICK SETUP

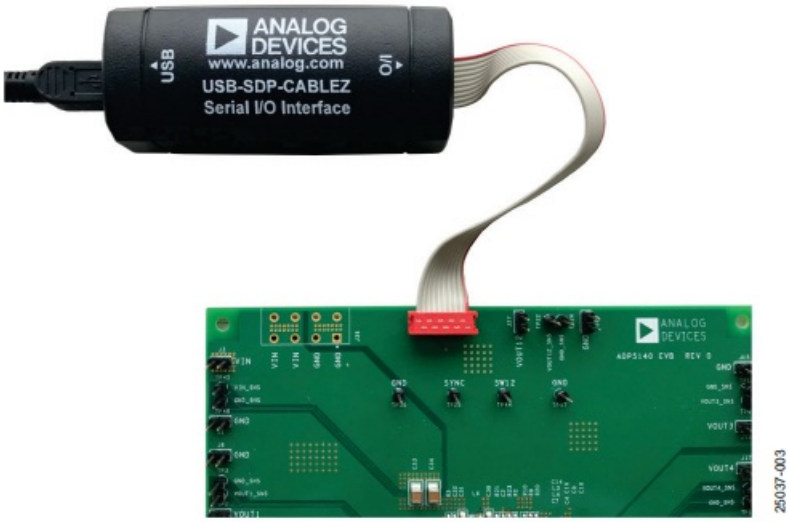

Figure 3. USB-SDP-CABLEZ Connection

For a quick setup for evaluation using the GUI, take the following steps:

1. Install the ADP5140 GUI software and USB-SDP-CABLEZ driver on the PC, as described in the Software Installation section.
2. Connect the dc power source to VIN (J3) and GND (J1) with power-off status and set the voltage to 3.7 V.
3. Connect the USB-SDP-CABLEZ to P1, as shown in Figure 3.
4. Turn on the dc power source.
5. Start the GUI on the PC. The ADP5140-EVALZ is ready for SPI communication.

ADP5140 GUI INTRODUCTION

Start the GUI either from Start > Programs > Analog Devices > ADP5140 or from the shortcut icon on the PC desktop. When the ADP5140-EVALZ is powered up and the USB-SDP-CABLEZ is connected properly to the ADP5140-EVALZ, SDP appears in the Device Type text box in the GUI Device Info window (see Figure 4).

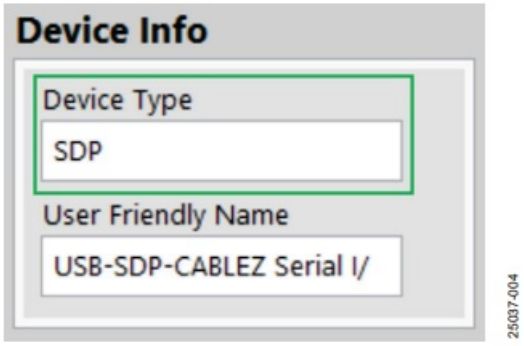

Figure 4. USB-SDP-CABLEZ Connected to the ADP5140-EVALZ

Before performing a write or read operation on any register, click UNLOCK to write the correct password to the ADP5140 and to validate the register access, which allows all registers to be accessed through SPI (see Figure 5).

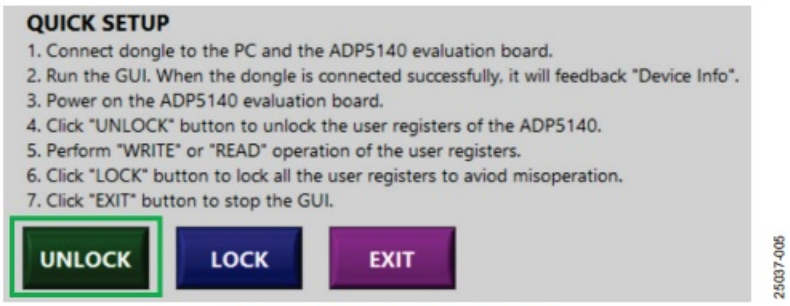

Figure 5. Unlock the ADP5140

User Register Tabs

The registers in the user register tabs (USER REG1 to USER REG4) contain functional control registers such as output voltage adjusting, frequency configuration, or warning and faulting window settings (see Figure 6).

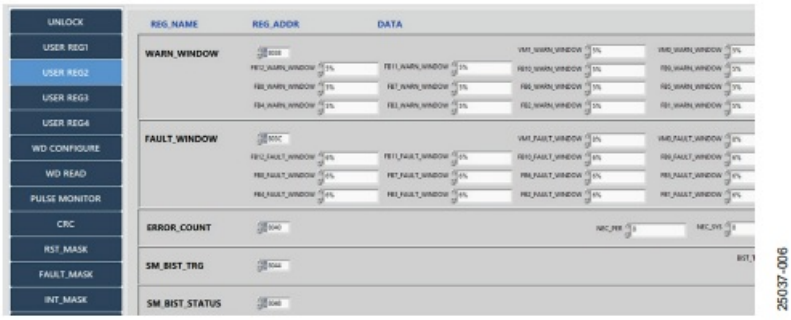

Figure 6. User Register Tabs

Mask Tabs

The mask tabs (RST_MASK, FAULT_MASK, INT_MASK, and TRANSITION MASK) contain all fault handler registers that enable/disable the multiplexer operation to the RESET pin, FAULT pin, and STATUS pin if any fault occurs (see Figure 7).

Figure 7. Mask Register Tabs

Status Tab and Latch Tabs

The status and latch registers can be read in the STATUS READ, LATCH READ, and LATCH READ 2 tabs to show the status of the ADP5140, such as feedback pin (FBx) undervoltage, regulator overtemperature, or AVDD overvoltage lockout (OVLO) (see Figure 8).

Figure 8. Status Read Tab

Refer to the ADP5140 data sheet for more detailed information on all device registers.

EVALUATION BOARD SCHEMATIC AND ARTWORK

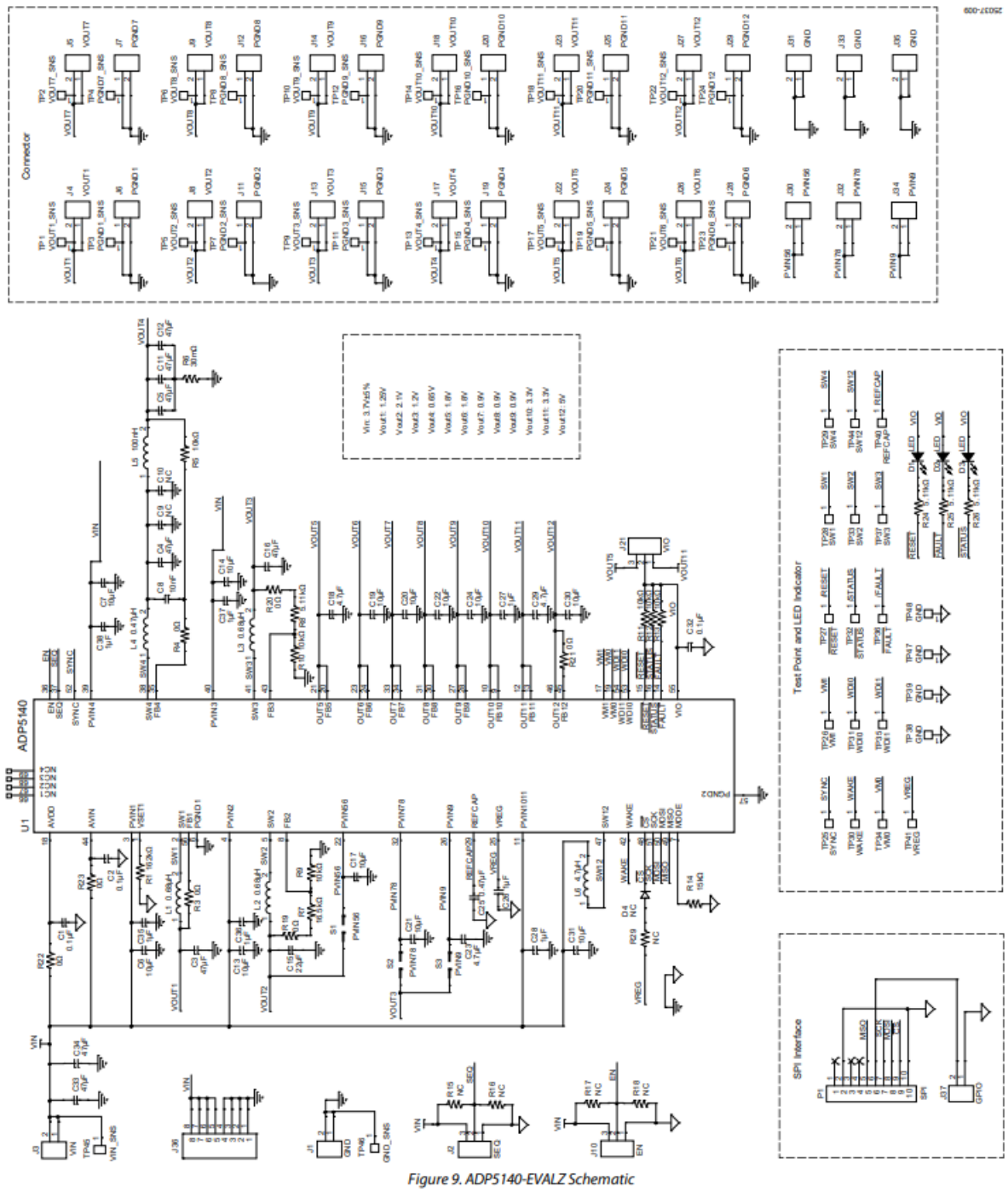

Figure 9. ADP5140-EVALZ Schematic

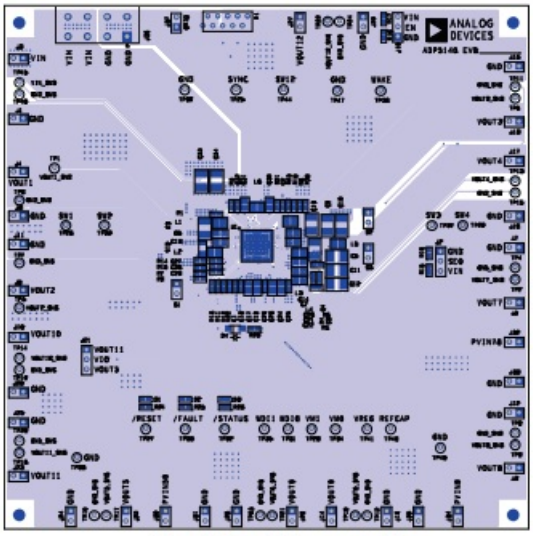

Figure 10. Layer 1, Component Side

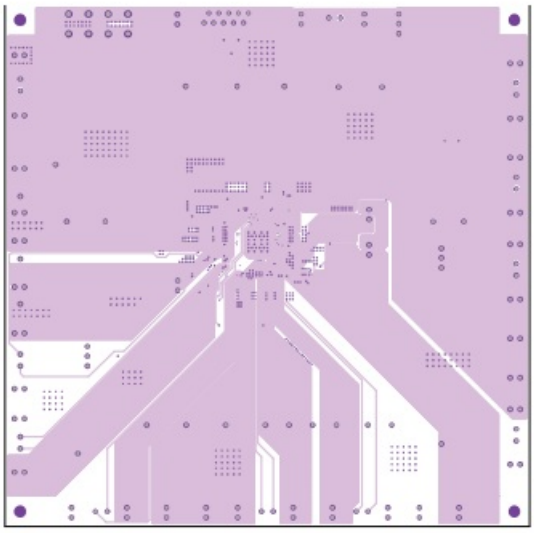

Figure 11. Layer 3, Power Plane

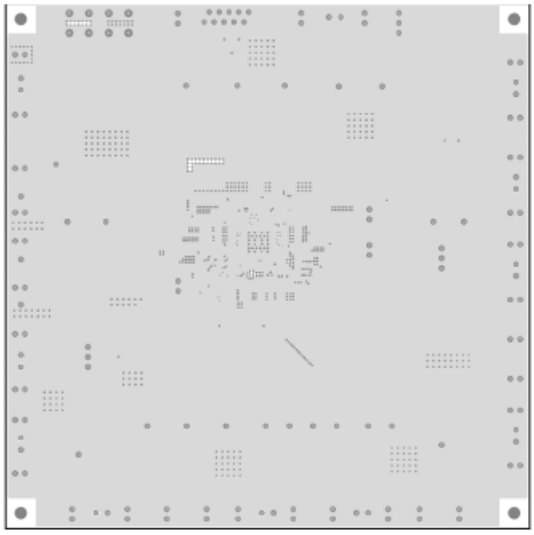

Figure 12. Layer 2, Ground Plane

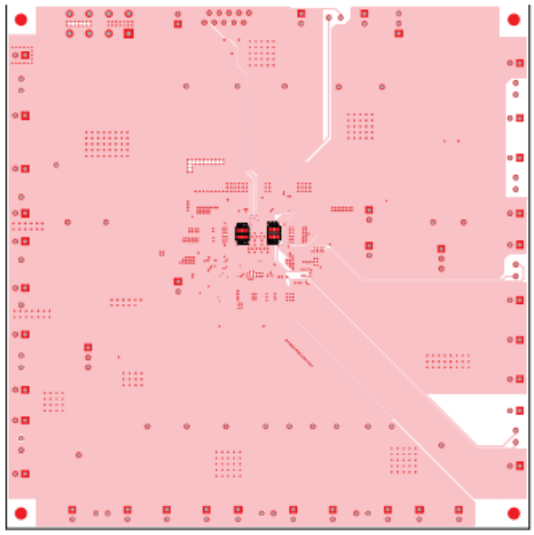

Figure 13. Layer 4, Bottom Side

ORDERING INFORMATION

BILL OF MATERIALS

Qty	Reference Designator	Description	Manufacturer	Part Number
3	C1, C2, C32	Capacitors, 0.1 µF, 16 V, 0603	Murata	GCM188R71C104KA37
8	C3 to C5, C11, C12, C16, C33, C34	Capacitors, 47 µF, 6.3 V, 1210	Murata	GCM32ER70J476KE19L
12	C6, C7, C13, C14, C17, C19 to C22, C24, C30, C31	Capacitors, 10 µF, 6.3 V, 0805	Murata	GCM21BR70J106KE22
1	C8	Capacitor, 10 nF, 50 V, 0603	Murata	GCM188R71H103KA37D
2	C9, C10	Optional capacitors, 1210	Murata	Optional
1	C15	Capacitor, 22 µF, 10 V, 1206	Murata	GCM31CR71A226KE02

2	C18, C29	Capacitors, 4.7 µF, 6.3 V, 0603	Murata	GCJ188C70J475KE02
1	C23	Capacitor, 4.7 µF, 16 V, 0805	Murata	GCM21BR71C475KA73
1	C25	Capacitor, 0.47 µF, 16 V, 0603	Murata	GCM188R71C474KA55
7	C26 to C28, C35 to C38	Capacitors, 1 µF, 16 V, 0603	Murata	GCM188R71C105KA64
3	D1 to D3	Light emitting diodes (LEDs), red, 1.7 V, 20 mA	LUMEX	SML-LX0603SRW-TR
1	D4	Optional diode, SOD-123 package	ON Semiconductor	Optional
36	J1, J3 to J9, J11 to J20, J22 to J35, J37, S1 to S3	2-position header connectors, 2.54 mm pitch, through-hole, gold	Wurth	61300211121
3	J2, J10, J21	3-position header connectors, 2.54 mm pitch, through-hole, gold	Wurth	61300311121
1	J36	4-position terminal block header, female socket, 5.08 mm pitch, 90°, right angle, through-hole	Phoenixus	1786420
2	L1, L2	Chip inductors, 0.68 µH, saturation current (ISAT) = 5.1 A, dc resistance = 37 mΩ	Murata	DFE252012PD-R68M
2	L3, L4	Chip inductors, 0.47 µH, ISAT = 6.1 A, dc resistance = 27 mΩ	Murata	DFE252012PD-R47M
1	L5	Chip inductor, 100 nH, ISAT = 13 A, dc resistance = 9 mΩ	TDK	TFM252012ALMAR10MTAA
1	L6	Chip inductor, 4.7 µH, ISAT = 2.2 A, dc resistance = 200 mΩ	Murata	DFE252012PD-4R7M
1	P1	10-position receptacle connector, 2.54 mm pitch, through-hole, tin	Wurth	690367181072
1	R1	Resistor, 162 kΩ, 1%, 0603	Vishay Dale	CRCW0603162KFKEA
7	R3, R4, R19 to R23	Resistors, 0 Ω, 0603	Vishay Dale	CRCW06030000Z0EA
6	R5, R9 to R13	Resistors, 10 kΩ, 1%, 0603	Vishay Dale	CRCW060310K0FKEA
1	R6	Resistor, 30 mΩ, 1%, 0603	Vishay Dale	RCWE060330L0FQEA
1	R7	Resistor, 16.5 kΩ, 1%, 0603	Vishay Dale	CRCW060316K5FKEA
4	R8, R24 to R26	Resistors, 5.11 kΩ, 1%, 0603	Vishay Dale	CRCW06035K11FKEA

1	R14	Resistor, 15 kΩ, 1%, 0603	Vishay Dale	CRCW060315K0FKEA
5	R15 to R18, R29	Optional resistors, 0603	Vishay Dale	Optional
46	TP1 to TP41, TP44 to TP48	1-position header connectors, through-hole, gold	Wurth	61300111121
1	U1	Power management IC for automotive application	Analog Devices, Inc.	ADP5140WFSACCZ-R7

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.

Legal Terms and Conditions

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exports. GOVERNING LAW. This Agreement shall be governed by and construed in accordance with the substantive laws of the Commonwealth of Massachusetts (excluding conflict of law rules). Any legal action regarding this Agreement will be heard in the state or federal courts having jurisdiction in Suffolk County, Massachusetts, and Customer hereby submits to the personal jurisdiction and venue of such courts. The United Nations Convention on Contracts for the International Sale of Goods shall not apply to this Agreement and is expressly disclaimed.

Documents / Resources

	ANALOG DEVICES AD5140-EVALZ Evaluation Board [pdf] User Guide AD5140-EVALZ Evaluation Board, AD5140-EVALZ, Evaluation Board, Board

References

- Mixed-signal and digital signal processing ICs | Analog Devices