Evaluating the ADL5920 Arduino Shield

FEATURES
Full featured evaluation kit for the ADL5920, specified from 9 kHz to 7 GHz
Integrated bidirectional bridge that measures forward and reverse power
Integrated dual channel rms power detector that measures forward and reverse RF power
PC-based GUI that provides instant forward power, reverse power, and return loss information

GENERAL DESCRIPTION
The demonstration circuit (DC2847A) is a dual rms power detector with an integrated bidirectional bridge featuring the ADL5920 IC. The Arduino shield evaluates the ADL5920 with the Linduino board (DC2026C). The graphical user interface (GUI) allows the PC to measure and to monitor the forward and reverse power. Return loss is calculated and displayed on the PC.

The ADL5920 simultaneously measures forward and reverse rms power up to 7 GHz and provides return loss results. The ADL5920 detector has 50 dB of dynamic range at 1 GHz. The DC2847A-KIT requires an external power supply that connects to the DC2026C by setting Jumper JP1.

EVALUATION KIT CONTENTS
EVAL-ADL5920-ARDZ
DC2026C Linduino board
ADL5920
9 V wall power adapter

EQUIPMENT NEEDED
DC2847A-KIT
PC running Windows 10, or higher
USB cable for a PC
Signal generator

DOCUMENTS NEEDED
ADL5920 data sheet

SOFTWARE NEEDED
QuikEval software

DC2847A-KIT CONNECTION DIAGRAM

Figure 1.
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REVISION HISTORY

1/2020—Revision 0: Initial Version
DC2847A-KIT EVALUATION HARDWARE

POWER SUPPLIES
A wall power adapter for the DC2847A-KIT is included with the kit. If the wall power adapter is not available, a 5 V, 200 mA supply can power the ADL5920 shield through the screw terminal block, PWR1.

INPUT SIGNALS

Signal Generator
The RF input source is a signal generator capable of generating a continuous wave (CW) signal up to 7 GHz.

RF Load
The RF load is connected to the RF_OUT port on the DC2847A-KIT. RF power is delivered to RF_OUT. The ADL5920 measures the magnitude of the forward and reflected power from the impedance mismatch between the integrated bridge and the RF load.

OUTPUT SIGNALS
A PC is required to run the QuikEval software. After the DC2847A-KIT is plugged into the PC with a USB cable, the QuikEval software opens and runs the GUI, as shown in Figure 2.

FILTER CAPACITORS
The C3 and C4 capacitors on the EVAL-ADL5920-ARDZ are high-pass filter capacitors for the internal offset compensation loop. These capacitors are required for low frequency operation. When the RF input signal (RFIN) is above 2 GHz, remove these capacitors to improve directivity.

Figure 2. QuikEval GUI Window
DC2847A-KIT SETUP PROCEDURES

CONFIGURING THE DC2847A-KIT

The DC2847A-KIT provides the necessary hardware to evaluate the ADL5920 functionality with the QuikEval software. Download the QuikEval software from the Analog Devices, Inc., website by taking the following steps:

1. Go to www.analog.com. Search for QuikEval and click the QuikEval entry, which prompts the user to run ltcqev.exe. Click the Save button to download and install the software.
2. Short JP1 and connect the wall power supply included in the evaluation kit to the DC2847A-KIT. See Figure 1 for connection details.
3. Connect the PC to the DC2847A-KIT with a USB cable. See Figure 1 for connection details.
4. Connect the signal generator to RFIN (J1) on the DC2847A-KIT. Set the signal generator frequency between 9 kHz to 7 GHz. Set the signal generator power to 0 dBm to begin measurements. See Figure 2 for GUI usage details.
5. Connect the RF load to RF_OUT on the DC2847A-KIT. For a minimal reflection condition, the 50 Ω RF load is matched to the ADL5920 output. See Figure 1 connection details.

USING THE QUIKEVAL SOFTWARE FOR TESTING

The QuikEval software measures the reflections from the RF load. Forward power and reverse power are measured and displayed on the PC using the GUI by taking the following steps:

1. Open the downloaded QuikEval software.
2. Use the GUI window that opens and click Read to measure the forward and reverse rms power with the default calibration shown in Figure 2.
3. Set the Frequency box to match the RF signal being measured under Forward Power and Reverse Power. Ensure Default Calibration is selected to use the typical slope and intercept stored in the GUI. Default calibration uses the typical slope and intercept values listed in the ADL5920 data sheet. However, using the default calibration settings introduces errors due to the part to part variations of the ADL5920.
4. Click Calibrate… to perform user calibration to improve the accuracy of the measured rms power. Taking this step calibrates the DC2847A-KIT across the RF input frequency from 1 MHz to 7 GHz using 3-point calibration.

The QuikEval software uses linear interpolation to calculate the rms power being measured through the bidirectional bridge by calculating the slope and intercept for frequencies between the calibration points. The calibration coefficients are stored in the GUI and can be reused later. See Figure 3 for calibration details.

Voltage Standing Wave Ratio

The measurements provided by the QuikEval software assists users with obtaining the voltage standing wave ratio (VSWR). The following equations detail how the VSWR is derived using the DC2847A-KIT reflection measurements:

\[
RL = (P_{\text{FORWARD}} - P_{\text{REVERSE}}) + IL
\]

where:
- \(RL\) is the return loss.
- \(P_{\text{FORWARD}}\) is the RF load forward power.
- \(P_{\text{REVERSE}}\) is the RF load reverse power.
- \(IL\) is the insertion loss. Note that insertion loss has a negative sign for a passive load.

From the RL calculation, use the following equation to obtain the VSWR:

\[
VSWR = \frac{1 + (10^{\frac{RL}{20}})}{1 - (10^{\frac{RL}{20}})}
\]
ALL RESISTORS ARE IN OHMS, 0402

ALL CAPACITORS ARE IN MICROFARADS, 0402

NOTE: UNLESS OTHERWISE SPECIFIED TO LINDUINO CONNECTORS

Figure 4. DC2847A-KIT Schematic
Figure 5. Layer 1 of the EVAL-ADLS920-ARDZ (DC2847A)

Figure 6. Layer 2 of the EVAL-ADLS920-ARDZ (DC2847A)

Figure 7. Layer 3 of the EVAL-ADLS920-ARDZ (DC2847A)
Figure 8. Layer 4 of the EVAL-ADL5920-ARDZ (DC2847A)

Figure 9. Layer Structure of the EVAL-ADL5920-ARDZ (DC2847A)
## ORDERING INFORMATION

**BILL OF MATERIALS**

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Reference Designator</th>
<th>Description</th>
<th>Manufacturer</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>C1 to C4</td>
<td>0.1 μF, broadband RF capacitors, 0201, 16 V, 10%, 0201, 10%, 16 kHz to 50 GHz</td>
<td>Passive Plus, Inc.</td>
<td>0201BB104KW160</td>
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<td>7</td>
<td>C5 to C8, C11, C14, C16</td>
<td>0.1 μF, 0402, capacitors, 50 V, 10%, X5R</td>
<td>AVX</td>
<td>0402SD104KAT2A</td>
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<td>C1005C581A475K050BC</td>
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<td>1 μF, 0402, capacitor, 10 V, 10%, X5R</td>
<td>Murata</td>
<td>GRM155R61A105KE15D</td>
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<td>100 pF, 0402, capacitors, 50 V, 10%, X7R</td>
<td>AVX</td>
<td>0402SC104KAT2A</td>
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<td>Kemet</td>
<td>C0402C103K3RACUT</td>
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<td>Murata</td>
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<td>9</td>
<td>E1 to E9</td>
<td>Turrets, 0.064 inches</td>
<td>Mill-Max</td>
<td>2308-2-00-80-00-00-07-0</td>
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<td>2</td>
<td>J1 and J2</td>
<td>50 Ω, Connected Subminiature Version A (SMA) jacks, female end launch connector</td>
<td>Cinch Connectivity</td>
<td>142-0761-871</td>
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<td>J3, J6</td>
<td>Socket headers receptacle, 1 × 8</td>
<td>Samtec</td>
<td>SSQ-108-03-G-S</td>
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<td>1</td>
<td>J4</td>
<td>Connected socket header receptacle, 1 × 10</td>
<td>Samtec</td>
<td>SSQ-110-03-G-S</td>
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<td>J5</td>
<td>Connected socket header, receptacles, 1 × 6, 1 row × 6 holes</td>
<td>Samtec</td>
<td>SSQ-106-03-G-S</td>
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<td>1</td>
<td>JP1</td>
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<td>TMM-102-02-L-S</td>
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<td>AC/dc adapter, 9 V output, 1.4 A, 12.6 W, dc plug, 5.5 mm × 2.1 mm × 9.5 mm</td>
<td>CUI, Inc.</td>
<td>SW115-9-N-P5</td>
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<td>Printed circuit board (PCB), DC2847A</td>
<td>Gorilla Circuits</td>
<td>600-DC2847A</td>
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<td>1</td>
<td>PWR1</td>
<td>Connected terminal block</td>
<td>TE Connectivity</td>
<td>282836-2</td>
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<td>R1</td>
<td>174 Ω, 0603, resistor, 1%, 1/10 W, AEC-Q200</td>
<td>Panasonic</td>
<td>ERJ3EKF1740V</td>
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<td>NIC, Inc.</td>
<td>NRC06F2001TRF</td>
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<td>R3 to R5, R26 to R28</td>
<td>0402, optional</td>
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<td>R6</td>
<td>0 Ω, 0603, resistor, 1/10 W</td>
<td>Yageo</td>
<td>RC0603FR-070RL</td>
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<td>R7 to R9</td>
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<td>R10 and R22</td>
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<td>NIC, Inc.</td>
<td>NRC04F1301TRF</td>
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<td>R12</td>
<td>3.6 kΩ, 0603, resistor, 1%, 1/10 W, AEC-Q200</td>
<td>Panasonic</td>
<td>ERJ3EKF3601V</td>
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<td>R13</td>
<td>0 Ω, 0805, resistor, 1/8 W</td>
<td>Yageo</td>
<td>RC0805JR-070RL</td>
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<td>R14</td>
<td>2.4 kΩ, 0603, resistor, 1%, 1/10 W, AEC-Q200</td>
<td>Panasonic</td>
<td>ERJ3EKF2401V</td>
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<td>R15</td>
<td>0 Ω, 0402, resistor, 1/16 W</td>
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<td>NRC04Z0TRF</td>
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<td>5</td>
<td>R16 to R18, R24, R25</td>
<td>1 kΩ, 0402, resistors, 1%, 1/16 W</td>
<td>NIC, Inc.</td>
<td>NRC04F1001TRF</td>
</tr>
<tr>
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<td>R23</td>
<td>0603, optional</td>
<td>Do not install</td>
<td>Do not install</td>
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<tr>
<td>1</td>
<td>STNCL1</td>
<td>Stencil tool</td>
<td>Analog Devices</td>
<td>830-DC2847A</td>
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<tr>
<td>1</td>
<td>U1</td>
<td>9 kHz to 7 GHz, bidirectional rms and VSWR detector</td>
<td>Analog Devices</td>
<td>ADL5920ACPZ-R2</td>
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<tr>
<td>1</td>
<td>U2</td>
<td>IC, memory, electronically erasable programmable read-only memory (EEPROM), 2 kB TSSOP-8, 400 kHz</td>
<td>Microchip</td>
<td>24LC025-IT</td>
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<td>U3</td>
<td>500 mA, low noise, LDO micropower regulator</td>
<td>Linear Technology</td>
<td>LT1763CS8-5#PBF</td>
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</tbody>
</table>
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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