EVAL-ADUM5020EBZ User Guide
UG-1219

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Evaluating the ADuM5020 Low Emission Isolated DC-to-DC Converter

FEATURES

- ADuM5020 with *iso*Power integrated isolated dc-to-dc converter
- 2-layer PCB with low radiated emissions; passes CISPR22/EN55022 Class B
- On-board LDO for 6 V to 9 V supply, providing 5 V to the ADuM5020 V_{DDP} pin
- 5 V input and 5 V or 3.3 V output operation
- Screw terminal connectors for the following:
  - 6 V to 9 V LDO power supply
  - 5 V direct power supply
  - Off board PDIS control
  - Isolated output supply

EVALUATION KIT CONTENTS

- EVAL-ADuM5020EBZ evaluation board
- ADuM5020-5BRWZ

DOCUMENTS NEEDED

- ADuM5020 data sheet

GENERAL DESCRIPTION

The EVAL-ADUM5020EBZ allows the user to evaluate the ADuM5020 isolated power solution. The ADuM5020 eliminates the need to design and build an isolated dc-to-dc converter in 500 mW applications. The *i*Coupler® chip scale transformer technology is used for the inductive component of the dc-to-dc converter. The result is a small form factor, isolated solution.

Based on the Analog Devices, Inc., *i*Coupler technology, the ADuM5020 dc-to-dc converter provides regulated, isolated power that is well below CISPR22/EN55022 Class B limits when at full load on a 2-layer printed circuit board (PCB) with ferrites. Available supply voltages and the associated output current levels are shown in Table 1.

Full specifications of the ADuM5020 or ADuM6020 can be found in the ADuM5020 or ADuM6020 data sheet, available from Analog Devices, Inc., and must be consulted in conjunction with this user guide when using the evaluation board.

Table 1. ADuM5020/ADuM6020 Output Current Levels

Model	Isolation Voltage (kV rms)	V_{IN} (V)	V_{OUT} (V)	85°C I_{OUT} (mA)	105°C I_{OUT} (mA)	125°C I_{OUT} (mA)
ADuM5020-5BRWZ	3	5	5	100	65	30
ADuM5020-5BRWZ	3	5	3.3	100	65	30
ADuM6020-5BRIZ	5	5	5	100	65	30
ADuM6020-5BRIZ	5	5	3.3	100	65	30

EVAL-ADUM5020EBZ EVALUATION BOARD LAYOUT

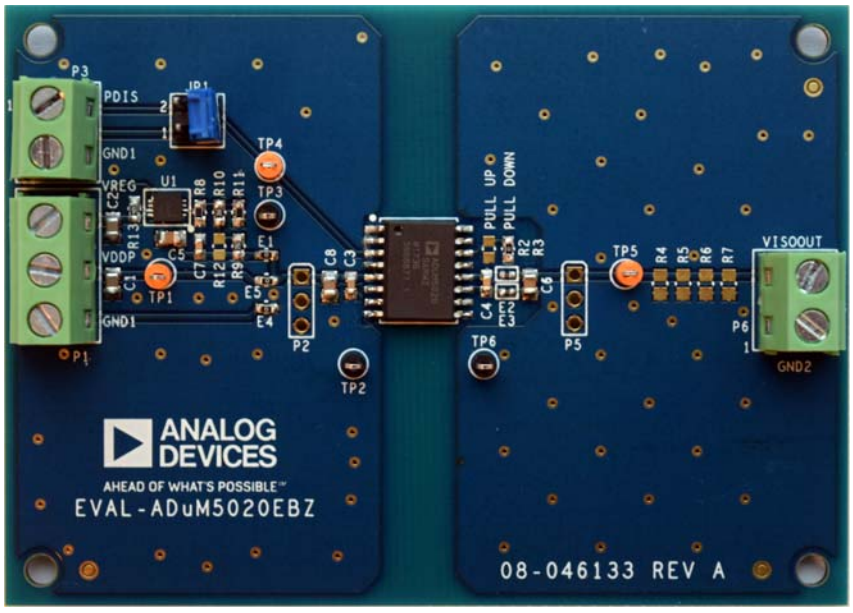

Figure 1. EVAL-ADUM5020EBZ Evaluation Board

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REVISION HISTORY

6/2018—Revision 0: Initial Version

EVALUATION BOARD HARDWARE

USING THE EVALUATION BOARD

Figure 1 shows the EVAL-ADUM5020EBZ evaluation board. The ADuM5020 sample device can be powered directly or through the on-board low dropout regulator (LDO). Either power scheme can be used without modification to the EVAL-ADUM5020EBZ evaluation board. The LDO input supply, Pin 1 of Screw Terminal P1 (marked VREG on the silkscreen), requires a power supply voltage of 6 V to 9 V. The LDO generates the required 5 V to the ADuM5020 V_{DDP} pin. The complete board can be powered by a 9 V battery (when testing for electromagnetic compatibility (EMC), for example). Alternatively, the ADuM5020 device can be powered directly with a 5 V supply through Pin 2 of Screw Terminal P1 (marked VDDP on the silkscreen). In both schemes, the power supply return connects to Pin 3 of Screw Terminal P1 (marked GND1 on the silkscreen). The jumper on JP1 must be installed to short JP1 Pin 3 and JP1 Pin 4 to pull the PDIS pin low and to enable the ADuM5020 when no external control signal is used. Installing the jumper on JP1 to short JP1 Pin1 and JP1 Pin 2 pulls the PDIS input pin high, which disables the ADuM5020 device. The V_{ISO} output voltage is set to 5.0 V by installing a 0 Ω resistor in the R2 pull-up position, or it is set to 3.3 V V_{ISO} output by installing a 0 Ω resistor in the R3 pull-down position.

PCB LAYOUT RECOMENDATIONS

The ADuM5020 uses a 180 MHz oscillator frequency to pass power through its chip scale transformers. Bypass capacitors are required for several operating frequencies. Noise suppression requires low inductance and a high frequency capacitor. Ripple suppression and proper regulation require a large value capacitor. These capacitors are most effective when connected directly adjacent to the V_{DDP} pin and the GND_1 pin, and directly adjacent to the V_{ISO} pin and the GND_{ISO} pin. To suppress noise and reduce ripple, a parallel combination of at least two capacitors is required. The recommended capacitor values for V_{DDP} are 0.1 µF and 10 µF. The smaller capacitor must have a low equivalent series resistance (ESR); use of a ceramic capacitor is advised. Note that the total lead length between the ends of the low ESR capacitor and the input power supply pin must not exceed 2 mm.

To reduce the level of electromagnetic radiation, increase the impedance to high frequency currents between the V_{ISO} and the GND_{ISO} pins and the PCB trace connections. Using this method of emissions suppression controls the radiating signal at its source by placing surface-mount ferrite beads in series with the V_{ISO} and GND_{ISO} pins (see Figure 5). The impedance of the ferrite bead is approximately 1.8 kΩ between the 100 MHz and 1 GHz frequency range. This impedance value reduces the emissions at the 180 MHz primary switching frequency and the 360 MHz secondary side rectifying frequency and harmonics. See Table 2 for examples of appropriate surface-mount ferrite beads.

Table 2. Surface-Mount Ferrite Beads

Manufacturer	Part No.
Taiyo Yuden	BKH1005LM182-T
Murata Electronics	BLM15HD182SN1

To pass CISPR22/EN55022 Class B on a 2-layer PCB, the following layout guidelines are recommended (refer to Figure 2 and the schematic in Figure 5):

- Place ferrite beads between the PCB trace or plane connections and V_{ISO} (Pin 12) and GND_{ISO} (Pin 11).
- Do not connect the V_{ISO} load (shown in Figure 5) to a power plane; connect using a PCB trace.
- Ensure that V_{ISO} (Pin 12) is connected first through the E2 ferrite before connecting it to the V_{ISO} load, as shown in Figure 2.
- Ensure that GND_{ISO} (Pin 11) is connected by a trace to the GND_{ISO} pins (Pin 9, Pin 13, Pin 15) on the inside (device side) of the C4 100 nF capacitor.
- Ensure that the C4 capacitor is connected between V_{ISO} (Pin 12) and GND_{ISO} (Pin 11) on the device side of the E3 and E2 ferrite beads.
- Ensure that there is a keep out area in the PCB layout around the E2 and E3 ferrites, as shown in Figure 2 (no PCB planes under or alongside E2 and E3).

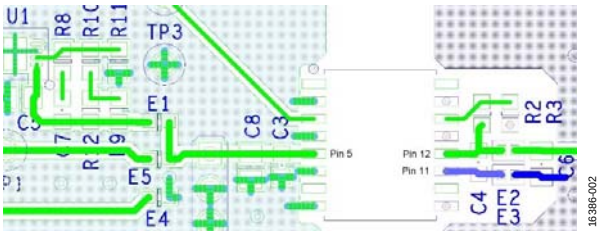

Figure 2. Layout Notes for EVAL-ADUM5020EBZ

- Locate the power delivery circuit in close proximity to the ADuM5020 device, to ensure that the V_{DDP} trace is as short as possible. The EVAL-ADUM5020EBZ PCB has a power delivery circuit located on the PCB with a short trace from the ADP7104ACPZ regulator output (U1) to V_{DDP} (Pin 5). This layout example minimizes the loop area in which high frequency current can flow. An increase in the loop area results in an increase in the emissions levels.
- To improve emissions, use Murata BLM18HE152SN1D ferrites (0603 size, SMD) for E1, E4, and E5, which are 1500 Ω at 100 MHz to 1 GHz. Other ferrites can be used for E1, E4, and E5; however, because of the input power requirements, the ferrites must be 0603 size.

CISPR22/EN55022 RADIATED EMISSIONS TEST RESULTS

The EVAL-ADUM5020EBZ evaluation board design has been tested to pass the CISPR22/EN55022 Class B standard. Table 3 provides a summary of the results. All CISPR22/EN55022 radiated emissions tests were performed with the PCB schematic and layout shown in Figure 5 to Figure 7.

The EVAL-ADUM5020EBZ evaluation board is configured and tested with 5.0 V power supplied to the V_{DDP} pin from the ADP7104ACPZ regulator output. The ADP7104ACPZ regulator input is supplied from a standard 9 V battery. V_{ISO} can be loaded with six 300 Ω, 0805 size, SMD resistors in parallel for a total load of 50 Ω or 100mA load at 5 V. Measurements carried out according to the CISPR22/EN55022 Class B standard in a semi anechoic chamber at 10 m from 30 MHz to 1 GHz are shown in Figure 3 and Figure 4. Figure 3 shows the results of the peak horizontal scan (the worst case), and Figure 4 shows the results of the peak vertical scan. Table 3 shows the tabulated quasi peak (QP) results. These results show that the ADuM5020 emissions at −4.0 dB margin are well below CISPR22/EN55022 Class B limits when at 5 V output and 100 mA load on a 2-layer PCB with the use of ferrites.

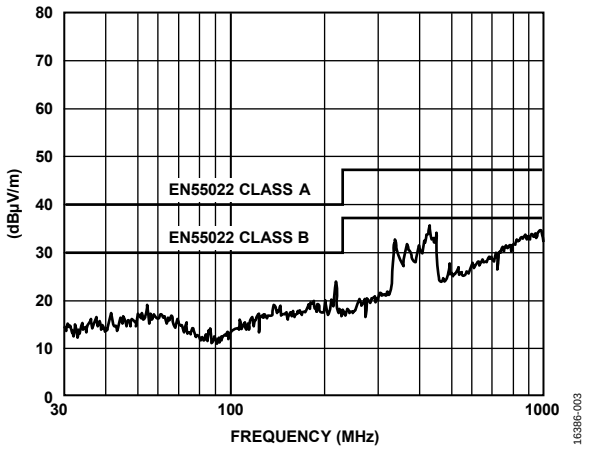

Figure 3. Horizontal Scan from 30 MHz to 1 GHz with 100 mA, 5 V Output

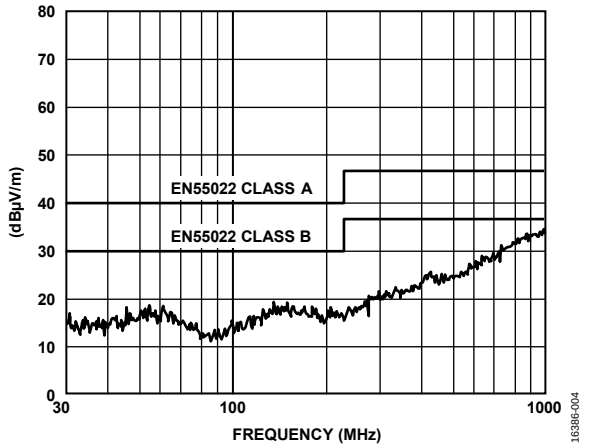

Figure 4. Vertical Scan from 30 MHz to 1 GHz with 100 mA, 5 V Output

Table 3. ADuM5020 Test Results (QP Measurements)

Frequency (MHz)	QP Level dB (µV/m)	Limit EN55022 Class B dB (µV/m)	QP Margin from limit EN55022 Class B dB (µV/m)	Antenna Position	Antenna Height (m)	5 V In, 5 V Out Output Current (mA)	Pass/Fail
221.54	24.5	30	−5.5	Horizontal	4.0	100	Pass
335.81	32.0	37	−5.0	Horizontal	2.8	100	Pass
436.70	33.0	37	−4.0	Horizontal	2.0	100	Pass
436	25.0	37	−12.0	Vertical	2.0	100	Pass

EVALUATION BOARD SCHEMATIC AND ARTWORK

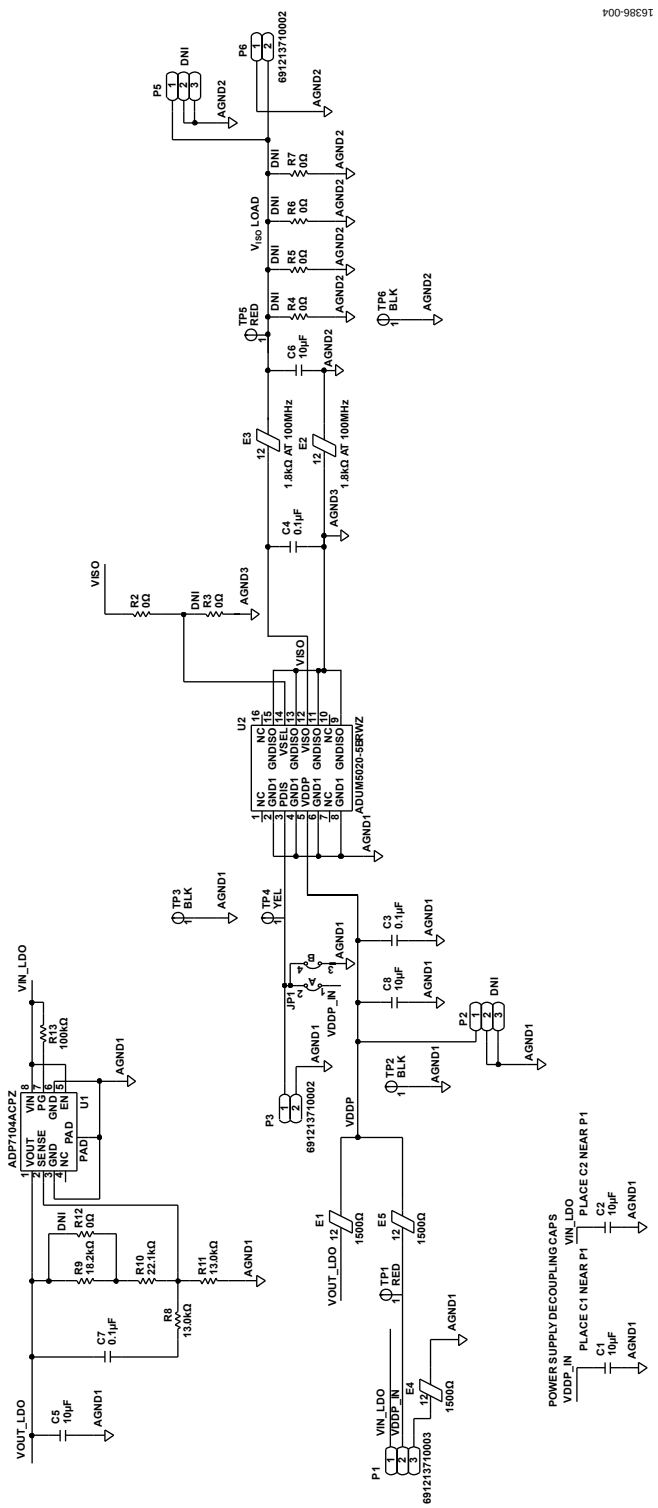

Figure 5. EVAL-ADuM5020EBZ Evaluation Board Schematic

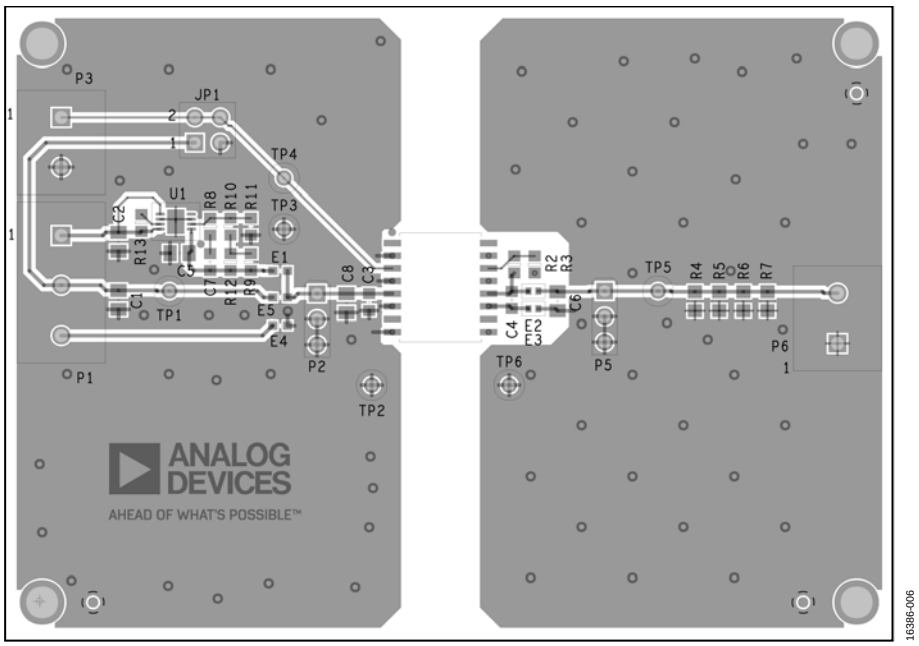

Figure 6. EVAL-ADUM5020EBZ Evaluation Board Top Layer and Silkscreen

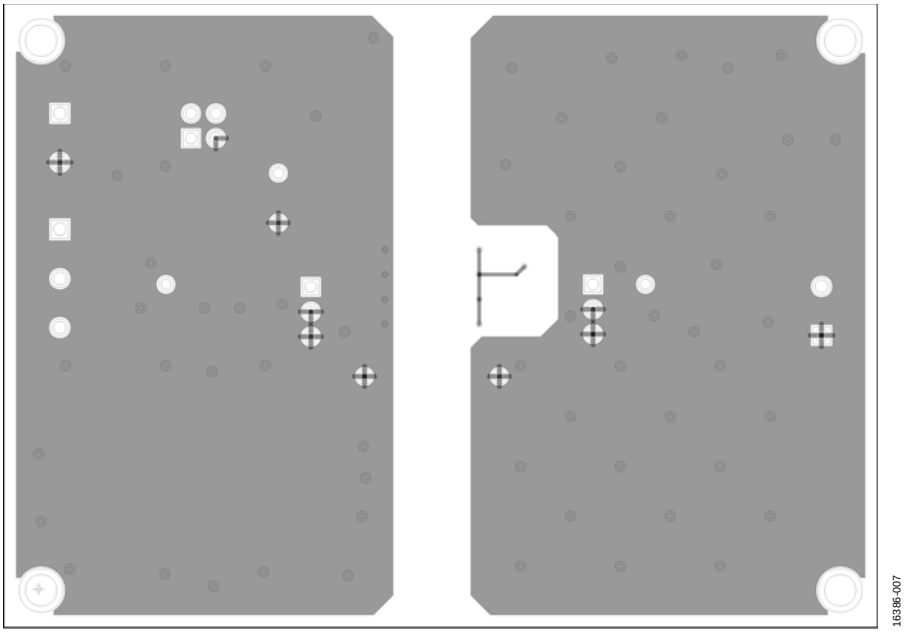

Figure 7. EVAL-ADUM5020EBZ Evaluation Board Bottom Layer and Silkscreen

ORDERING INFORMATION

BILL OF MATERIALS

Table 4.

Name	Description	Supplier	Part No.
U2	ADuM5020 isolated dc-to-dc converter	Analog Devices	ADuM5020-5BRWZ
U1	ADP7104 20 V, 500 mA, low noise, complimentary metal-oxide semiconductor (CMOS) LDO	Analog Devices	ADP7104ACPZ
C1, C2, C5, C6, C8	Capacitors, X7R, 10 µF, 0805	Wurth Elektronik	885012207026
C3, C4, C7	Capacitors, X7R, 0.1 µF, 0603	Wurth Elektronik	885012206046
E1, E4, E5	Ferrite beads, 1500 Ω, 0603	Murata	BLM18HE152SN1D
E2, E3	Ferrite beads, 1.8 K at 100 MHz, 0402	Taiyo Yuden	BKH1005LM182-T
JP1	100 mil (2.54 mm) connector, PCB, HDR	Wurth Elektronik	61300421121
N/A[1]	100 mil (2.54 mm) jumper	FCI	65474-001LF
P1	Connector, PCB, terminal block, 5.0 mm pitch, 16-26 AWG	Wurth Elektronik	691213710003
P3, P6	Connectors, PCB, terminal blocks, horizontal cable entry, 5 mm pitch	Wurth Elektronik	691 213 710 002
R10	Resistor, 22.1 kΩ, 060	Panasonic	ERJ-3EKF2212V
R8, R11	Resistors, 13.0 kΩ, 0603	Panasonic	ERJ-3EKF1302V
R13	Resistor, 100 kΩ, 0603	Panasonic	ERJ-3EKF1003V
R2	Resistor, 0 kΩ, 0603	Vishay	CRCW06030000Z0EA
R9	Resistor, 18.2 kΩ, 0603	Panasonic	ERJ-3EKF1822V
TP1 to TP6	Connectors, PCB test point	Vero Technology	20-2137
P2, P5	Connectors, PCB headers 2.54 mm, 3-position vertical (not installed)	MOLEX	22-03-2031
R12	Resistor, 0 Ω, 0603 (not installed)	Panasonic	ERJ-3GEY0R00V
R3	Resistor, 0 Ω, 0603 (not installed)	Vishay	CRCW06030000Z0EA
R4, R5, R6, R7	Resistors, 300 Ω, 0805 (not installed)	Panasonic	ERJ-6ENF3000V

[1] N/A means not applicable.

RELATED LINKS

Resource	Description
ADuM5020	Isolated dc-to-dc converter
AN-1349	PCB implementation guidelines to minimize radiated emissions on the ADM2582E/ADM2587E RS-485/RS-422 transceivers
AN-0971	Recommendations for control of radiated emissions with *iso*Power devices

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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