

## Evaluating the **ADM3055E** 5 kV rms, Signal and Power Isolated, CAN Transceiver for CAN FD

### FEATURES

- ADM3055E** with *isoPower* integrated, isolated, dc-to-dc converter
- 2-layer PCB with low radiated emissions, passes EN55022 Class B
- On-board LDO for 6 V to 9 V supply, providing 5 V to the **ADM3055E**  $V_{CC}$  pin
- Screw terminal connectors include
  - 6 V to 9 V LDO, 5 V power supply to the  $V_{CC}$  pin and the  $V_{IO}$  pin
  - 5 V direct power supply to  $V_{CC}$  pin
  - 1.7 V to 5.5 V direct power supply to the  $V_{IO}$  pin
  - TXD pin, RXD pin, STBY pin, SILENT pin, AUX<sub>IN</sub> pin, AUX<sub>OUT</sub> pin, and RS pin signals
- Divided PCB return planes for GND<sub>1</sub> and GND<sub>2</sub>
- SMA connectors for TXD pin and RXD pin signals

### EVALUATION KIT CONTENTS

- EVAL-ADM3055EEBZ evaluation board
- ADM3055EBRIZ**
- ADP7104**
- LTC6900**

### DOCUMENTS NEEDED

- ADM3055E** and **ADM3057E** data sheets

### GENERAL DESCRIPTION

The EVAL-ADM3055EEBZ allows the user to evaluate the **ADM3055E** and the **ADM3057E** isolated signal and power transceivers for controller area network (CAN) or CAN with flexible data rate (CAN FD) networks. The EVAL-ADM3055EEBZ allows all of the input and output functions to work without the need for external components.

Based on the Analog Devices, Inc., *iCoupler*® technology, the **ADM3055E** and the **ADM3057E** integrate logic side on-off keying (OOK) signal isolation channels and an Analog Devices *isoPower*® dc-to-dc converter to provide regulated, isolated power that is well below EN55022 Class B limits when transmitting on a 2-layer printed circuit board (PCB) with ferrites.

The EVAL-ADM3055EEBZ comes populated with an **ADM3055E**.

Full specifications of the **ADM3055E** and the **ADM3057E** can be found in the **ADM3055E** and the **ADM3057E** data sheets, available from Analog Devices and must be consulted in conjunction with this user guide when using the EVAL-ADM3055EEBZ.

The EVAL-ADM3055EEBZ is compatible and can be used to evaluate the **ADM3057E**. The **ADM3055E** and the **ADM3057E** differ by package and isolation capabilities, but both devices are functionally equivalent for evaluation.

### PHOTOGRAPH OF EVAL-ADM3055EEBZ

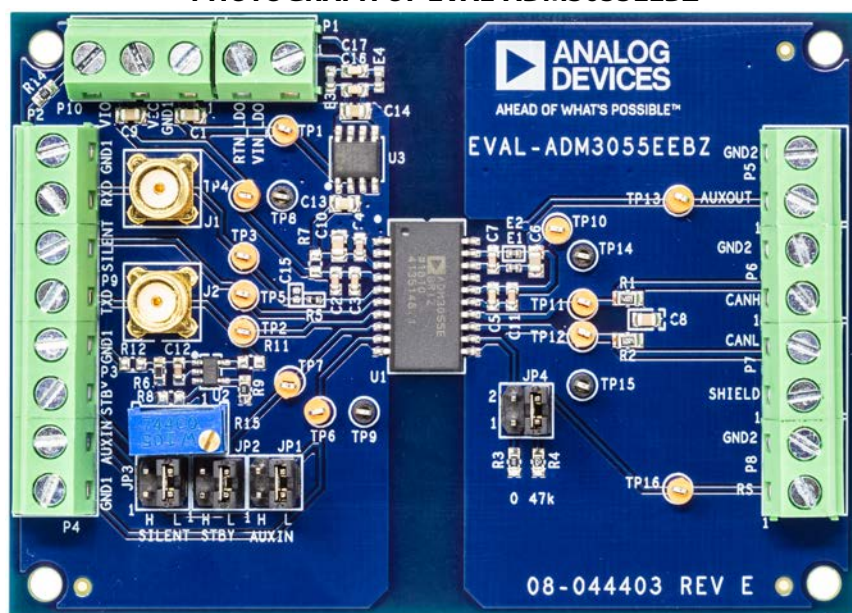


Figure 1.

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REVISION HISTORY

11/2018—Rev. 0 to Rev. A

Changes to Features Section and General Description Section . 1

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8/2018—Revision 0: Initial Version

## EVALUATION BOARD HARDWARE

### USING THE EVALUATION BOARD

Figure 1 shows the EVAL-ADM3055EEBZ. The  $V_{CC}$  and  $V_{IO}$  supply pins of the [ADM3055E](#) device must be supplied with input power. The  $V_{CC}$  and  $V_{IO}$  pins can be powered directly with separate supplies or through the fixed output 5 V on-board low dropout regulator (LDO). The LDO input supply requires a power supply voltage of 6 V to 9 V and connects to Pin 1 of Screw Terminal P1 (marked VIN\_LDO on the silkscreen) and Pin 2 of Screw Terminal P1 (marked RTN\_LDO on the silkscreen). As shipped in the default configuration, the 5 V LDO output is routed to the  $V_{CC}$  pin only. To route the 5 V LDO output to the  $V_{IO}$  pin, populate R7 with a 0  $\Omega$  resistor.

Using the LDO, the complete board can be powered by a 9 V battery (when testing for electromagnetic compatibility (EMC), for example). The [ADP7104](#) LDO features reverse current protection and can be left unpowered and connected to the evaluation board VCC trace when supplying power directly to the  $V_{CC}$  pin of the [ADM3055E](#).

Start with 100 mil jumpers on JP2 and JP1, pulling the SILENT pin and STBY pin signals low for normal operation. Select either the 0  $\Omega$  R3 resistor for full speed mode or the 47 k $\Omega$  R4 resistor for slope control mode with the 100 mil jumper on JP4. Do not leave the RS signal floating because this disables the transceiver and is not a valid mode of operation.

### PCB LAYOUT RECOMENDATIONS

The [ADM3055E](#) and the [ADM3057E](#) use a 180 MHz oscillator frequency to pass power through their 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 and required to be connected directly adjacent to the  $V_{ISOOUT}$  pin and the  $GND_{ISO}$  pin and directly adjacent to the  $V_{CC}$  pin and the  $GND_1$  pin. To suppress noise and reduce ripple, a parallel combination of at least two capacitors is required. The recommended capacitor values for  $V_{ISOOUT}$  are 0.22  $\mu$ F and 10  $\mu$ F. The recommended capacitor values for the  $V_{CC}$  pin are 0.1  $\mu$ F and 10  $\mu$ F. The smaller capacitors must have low equivalent series resistance (ESR) and have a total lead length between the capacitor and the respective input power supply pin of less than 2 mm to be effective.

To reduce the level of electromagnetic radiation, increase the impedance to high frequency currents between the  $V_{ISOOUT}$  pin and the  $V_{ISOIN}$  pin and between the  $GND_{ISO}$  pins and the  $GND_2$  pins and PCB connections. Using this method of emissions suppression controls the radiating signal at its source by placing surface-mount ferrite beads in series with the  $V_{ISOOUT}$  pin and the  $GND_{ISO}$  pins (see E1 and E2 ferrites in Figure 5). The impedance of the ferrite bead is approximately 1.8 k $\Omega$  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 1 for examples of appropriate surface-mount ferrite beads.

**Table 1. Surface-Mount Ferrite Beads**

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

Note that the [ADM3055E](#) and the [ADM3057E](#) are self contained solutions. The devices are not rated for supplying external power to additional bus side circuitry beyond the [ADM3055E](#) or the [ADM3057E](#) power requirements. Supplying power to additional external loads beyond the [ADM3055E](#) or the [ADM3057E](#) devices themselves causes higher operating temperatures, increased emissions, and is not supported.

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

- Place ferrite beads between the PCB trace or plane connections and  $V_{ISOOUT}$  (Pin 19) and  $GND_{ISO}$  (Pin 18 and Pin 20).
- Do not connect  $V_{ISOOUT}$  (shown in Figure 5) to a power plane. Connect  $V_{ISOOUT}$  to  $V_{ISOIN}$  using a PCB trace.
- Ensure that  $V_{ISOOUT}$  (Pin 19) is connected first through a ferrite before connecting the pin to the  $V_{ISOIN}$  (Pin 16), as shown in Figure 2.
- Ensure that  $GND_{ISO}$  (Pin 18) is connected by a trace to the other  $GND_{ISO}$  pin (Pin 20) on the inside (device side) of the C4 0.22  $\mu$ F capacitor, as shown in Figure 2.
- Ensure that the 0.22  $\mu$ F capacitor is connected between  $V_{ISOOUT}$  (Pin 19) and  $GND_{ISO}$  (Pin 18 and Pin 20) on the device side of the ferrite beads.
- Ensure that there is a keep out area in the PCB layout around the ferrites, as shown in Figure 2 (no PCB planes under or alongside E1 and E2).
- Place the power delivery circuit in close proximity to the [ADM3055E](#) device to ensure that the VCC trace is as short as possible. The EVAL-ADM3055EEBZ PCB has a power delivery circuit located on the PCB with a short trace from the [ADP7104](#) regulator output (Pin 1, U3) to  $V_{CC}$  (Pin 3, U1). 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.

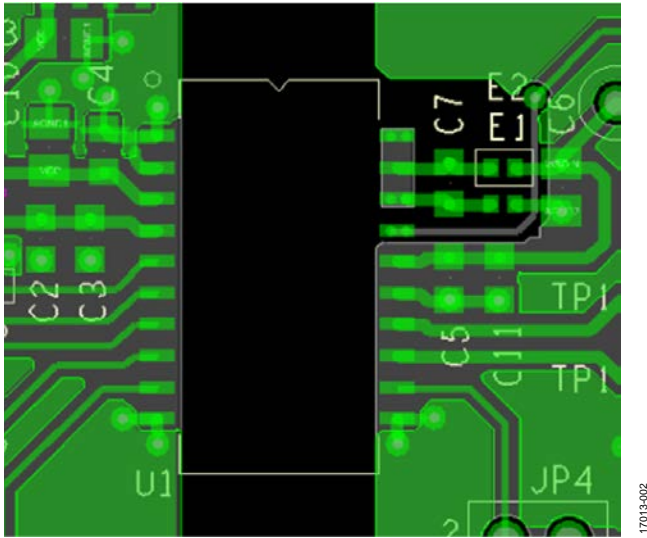


Figure 2. Layout Example for EVAL-ADM3055EEBZ

### EN55022 RADIATED EMISSIONS TEST RESULTS

The EVAL-ADM3055EEBZ passes the EN55022 Class B standard. Table 2 provides the EN55022 emissions test results summary of the EVAL-ADM3055EEBZ.

The EVAL-ADM3055EEBZ was configured and tested with 5.0 V power supplied to the  $V_{CC}$  pin and the  $V_{IO}$  pin from the ADP7104 regulator output. The on-board LTC6900 generates the clock signal input to the TXD pin and can be set to a given frequency with the on-board potentiometer at R15. The ADP7104 regulator input is supplied from a standard 9 V battery.

Figure 3 shows the measurements carried out according to the EN55032 Class B standard in a semianechoic chamber at 10 m from 30 MHz to 1 GHz. 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 2 shows the tabulated quasi peak (QP) results. These results demonstrate that the ADM3055E has a greater than 6.0 dB margin below EN55032 Class B limits on a 2-layer PCB with the use of ferrite beads.

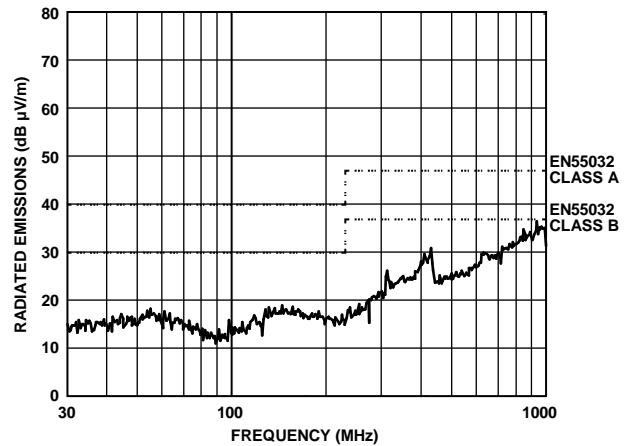
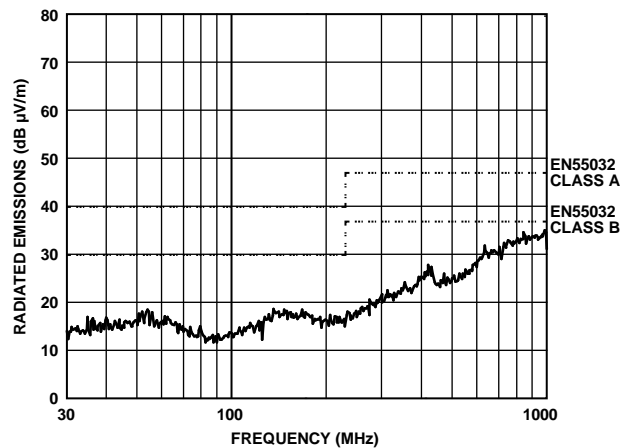
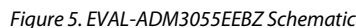
Figure 3. Peak Horizontal Scan from 30 MHz to 1 GHz with 5 Mbps Signal to TXD with 60  $\Omega$  TerminationFigure 4. Peak Vertical Scan from 30 MHz to 1 GHz with 5 Mbps Signal to TXD with 60  $\Omega$  Termination

Table 2. EVAL-ADM3055EEBZ Test Results (QP Measurements)

TXD Data Rate (Mbps)	Frequency (MHz)	QP Level (dB $\mu$ V/m)	Limit EN55032 Class B (dB $\mu$ V/m)	QP Margin from Limit EN55032 Class B (dB $\mu$ V/m)	Antenna Position	Antenna Height (m)	Pass/Fail
5	313.375	23.5	37	-13.5	Horizontal	3	Pass
5	410.541	28.5	37	-8.5	Horizontal	1.8	Pass
5	428.412	26.7	37	-10.3	Horizontal	2.2	Pass
5	431.666	27.7	37	-9.3	Horizontal	2	Pass
5	849.536	28.8	37	-8.2	Horizontal	1	Pass
5	934.5	29.5	37	-7.5	Horizontal	1	Pass

## 17013-007



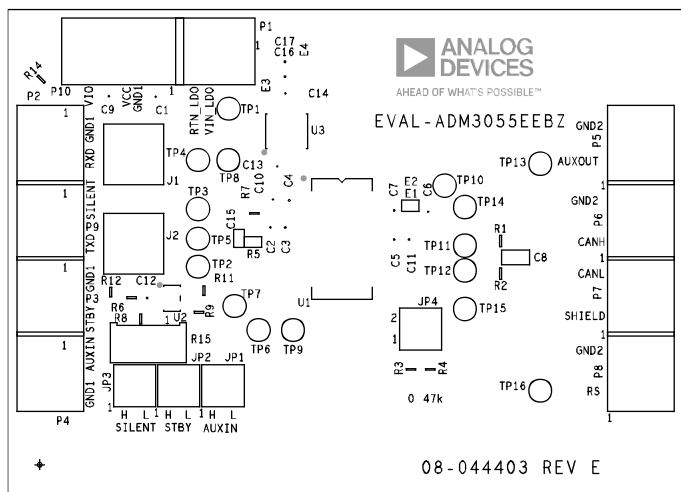


Figure 6. EVAL-ADM3055EEBZ Primary Silkscreen

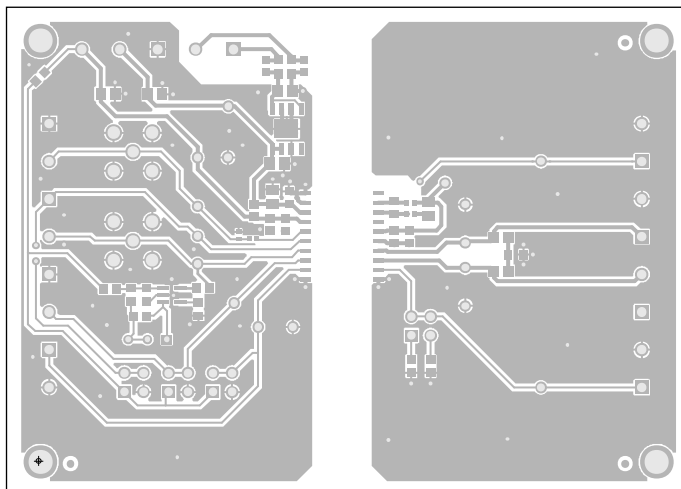


Figure 7. EVAL-ADM3055EEBZ Top Layer

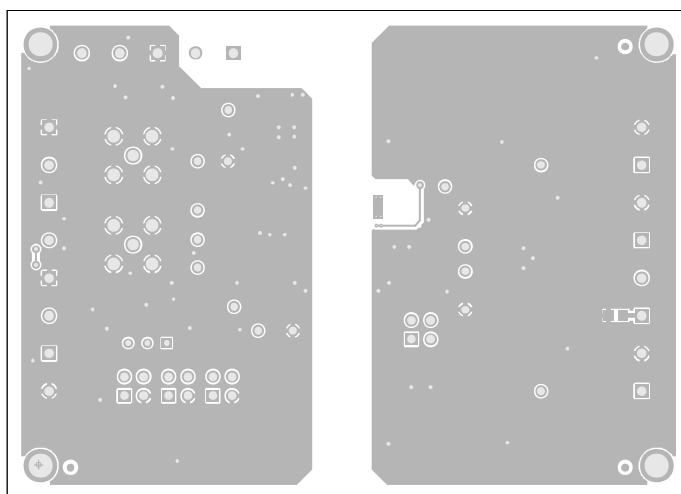


Figure 8. EVAL-ADM3055EEBZ Bottom Layer



Figure 9. EVAL-ADM3055EEBZ Bottom Silkscreen



## ORDERING INFORMATION

## BILL OF MATERIALS

Table 3.

Name	Description	Supplier	Part No.
U1	5 kV rms signal and power isolated CAN FD transceiver	Analog Devices	<a href="#">ADM3055EBRIZ</a>
U2	Low power, 1 kHz to 20 MHz resistor set SOT-23 oscillator	Analog Devices	<a href="#">LTC6900CS5#PBF</a>
U3	20 V, 500 mA, low noise, complimentary metal-oxide semiconductor (CMOS) LDO	Analog Devices	<a href="#">ADP7104ARDZ-5.0</a>
C1, C6, C9, C10, C13, C14	Capacitors, 10 $\mu$ F, X7R, 0805	Wurth Elektronik	885012207026
C2, C4, C7, C11, C12	Capacitors, 0.1 $\mu$ F, X7R, 0603	Wurth Elektronik	885012206046
C16, C17	Capacitors, 390 pF, X7R, 0603	AVX	0603YC391KAT2A
C3, C5	Capacitors, 0.01 $\mu$ F, X7R, 0603	Wurth Elektronik	885012206014
C8	Capacitor, 4.7 nF, X7R, 0805	Wurth Elektronik	885012207090
E1, E2	Ferrite beads, 1.8 k $\Omega$ at 100 MHz, 0402	Taiyo Yuden	BKH1005LM182-T
E3, E4	Ferrite beads, 1500 $\Omega$ , 0603	Murata	BLM18HE152SN1D
J1, J2	Connectors, Subminiature, Version A (SMA)	TE Connectivity	5-1814832-1
JP1, JP2, JP3, JP4	100 mil (2.54 mm) connectors, PCB, HDR	Wurth Elektronik	61300421121
Not applicable	100 mil (2.54 mm) jumper	FCI	65474-001LF
P1, P2, P3, P4, P5, P6, P7, P8, P9	Connectors, 2-position screw terminal block	Wurth Elektronik	691 213 710 002
P10	Connector, 3-position screw terminal block	Wurth Elektronik	691213710003
R1, R2	Resistors, 60.4 $\Omega$ , 1/8 W, 0805	Panasonic	ERJ-6ENF60R4V
R3, R9, R14	Resistors, 0 $\Omega$ , 1/10 W, 0603	Panasonic	ERJ-3GEY0R00V
R15	Potentiometer, 1 M $\Omega$	Bourns	3296W-1-105LF
R4	Resistor, 47 k $\Omega$ , 1/4 W, 0603	Panasonic	ERJ-PA3F4702V
R5	Resistor, 0 $\Omega$ , 1/10 W, 0402	Panasonic	ERJ-2GE0R00X
R6	Resistor, 24.9 k $\Omega$ , 1/10 W, 0603	Panasonic	ERA-3AEB2492V
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP10, TP11, TP12, TP13, TP16	Orange test points	Keystone	5003
TP8, TP9, TP14, TP15	Black test points	Vero	20-2137
C15	Capacitor, 1 pF, 0402 (not installed)	AVX	04023A1R0BAT2A
R7, R8, R11, R12	Resistors, 0 $\Omega$ , 1/10 W, 0603 (not installed)	Panasonic	ERJ-3GEY0R00V
R13	Resistor, 0 $\Omega$ , 1/8 W, 0805 (not installed)	Panasonic	ERJ-6GEY0R00V

## RELATED LINKS

Resource	Description
<a href="#">ADM3055E</a>	5 kV rms, signal and power isolated, CAN transceiver for CAN FD
<a href="#">AN-1123</a>	Controller area network (CAN) implementation guide
<a href="#">AN-1349</a>	PCB implementation guidelines to minimize radiated emissions on the <a href="#">ADM2582E/ADM2587E</a> RS-485/RS-422 transceivers
<a href="#">AN-0971</a>	Recommendations for control of radiated emissions with <i>isoPower</i> 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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