

## EMC Layout Recommendations for Dual Field Bus Ports Using the **ADM3053** and the **ADM2582E** Signal and Power Isolated Transceivers

### FEATURES

- ADM3053** signal and power isolated CAN transceiver
- ADM2582E** signal and power isolated full/half duplex RS-485 transceiver
- 2-layer PCB with low radiated emissions, passes EN 55032 Class A
- Independent on-board LDO regulators for 6 V to 9 V supply, providing 5 V to the **ADM3053** and **ADM2582E** supply pins
- Screw terminal connectors include
  - A 6 V to 9 V external supply input to LDO regulators
  - Direct power supply to  $V_{CC}$  pins (**ADM2582E**)
  - Direct power supply to the  $V_{IO}$  pins (**ADM3053** and **ADM2582E**)
  - TXD pin, RXD pin, RE\_N pin, and DE pin signals
  - CAN fieldbus pins, CANH and CANL
  - RS-485 fieldbus pins, Y, Z, A, and B
- Galvanically isolated CAN and RS-485 fieldbus ports

### EVALUATION KIT CONTENTS

- EVAL-2LCANRS485EBZ evaluation board
- ADM3053**
- ADM2582E**
- ADP7104**
- LTC6900**

### DOCUMENTS NEEDED

- ADM3053** data sheet
- ADM2582E** data sheet

### GENERAL DESCRIPTION

Based on the Analog Devices, Inc., iCoupler® technology, the **ADM3053** and the **ADM2582E** integrate logic side, signal isolation channels with an Analog Devices isoPower® dc-to-dc converter to provide regulated, isolated power. The EVAL-2LCANRS485EBZ evaluation board demonstrates best practices for layout on a 2-layer printed circuit board (PCB). This board has been tested according to EN 55032 and has passed Class A limits.

The EVAL-2LCANRS485EBZ, as shipped, is populated with the **ADM3053** signal and power isolated transceiver for controller area network (CAN) and the **ADM2582E** signal and isolated transceiver for RS-485. The EVAL-2LCANRS485EBZ allows access to all of the input and output functions of both transceivers.

While the **ADM3053** and the **ADM2582E** are not directly pin-compatible, the EVAL-2LCANRS485EBZ can be alternately populated with either two **ADM3053** devices or two **ADM2582E** devices.

Full specifications on the **ADM3053** and the **ADM2582E** can be found in the **ADM3053** and the **ADM2582E** data sheets, available from Analog Devices, and must be consulted in conjunction with this user guide when using the EVAL-2LCANRS485EBZ.

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## REVISION HISTORY

7/2019—Revision 0: Initial Version

### EVAL-2LCANRS485EBZ PHOTOGRAPH

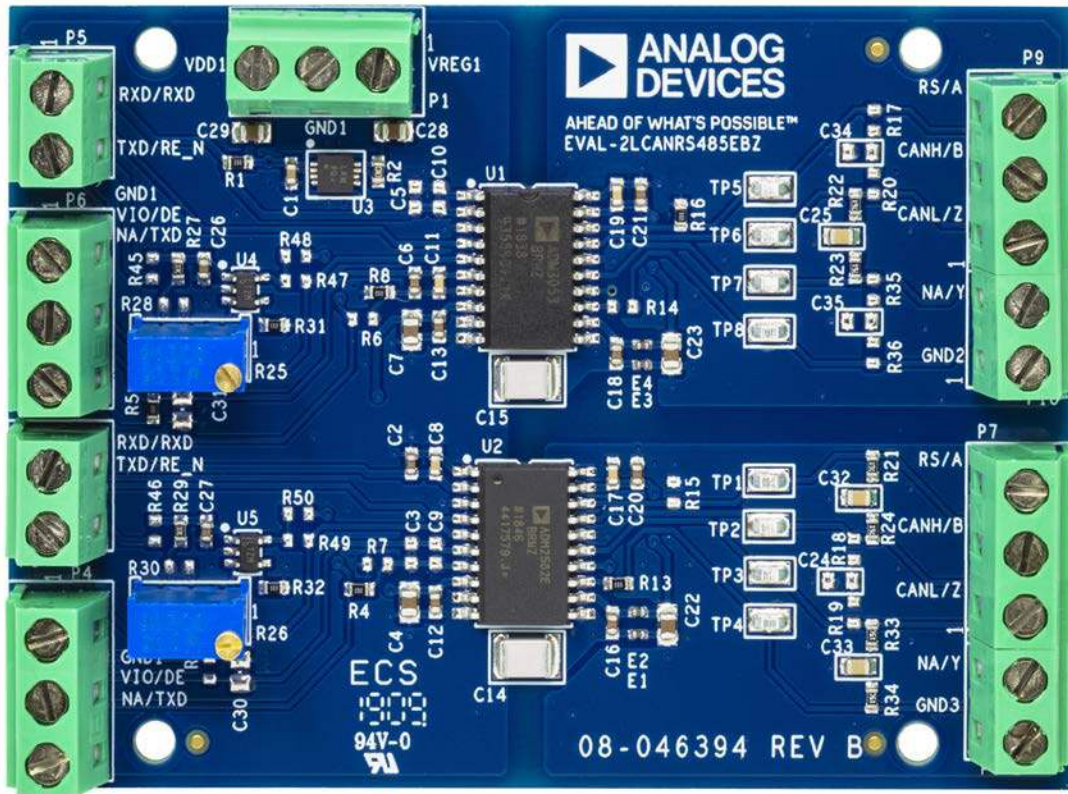


Figure 1.

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## EVALUATION BOARD HARDWARE

### POWERING THE EVALUATION BOARD

Figure 1 shows the EVAL-2LCANRS485EBZ field bus evaluation board. The  $V_{CC}$  and  $V_{IO}$  supply pins of the [ADM3053](#) (U1) and the  $V_{CC}$  supply pins of the [ADM2582E](#) (U2) must be supplied with input power from an external source. The  $V_{CC}$  and  $V_{IO}$  pins can be powered directly with separate supplies or through the fixed 5 V output of the on-board [ADP7104](#) (U3) low dropout (LDO) regulator. The LDO input supply requires a power supply voltage of 6 V to 9 V on Terminal P1, Pin 1. Alternately, a user may supply the devices with nominal 5 V directly through Terminal P1, Pin 3. Modifications are not required to the evaluation board to supply power directly to the  $V_{CC}$  and  $V_{IO}$  supply pins because the [ADP7104](#) output pin has reverse current protection.

The digital isolation logic supplies can also be supplied directly from an external supply. Modification of the EVAL-2LCANRS485EBZ is necessary when interfacing with logic levels other than 5 V nominal. Supplying the logic pins directly requires removing some or all of the R1, R3, and R5 resistors depending on the specific power scheme required. See Figure 6 for schematic details. See the [ADM3053](#) and the [ADM2582E](#) data sheets for available valid power supply schemes.

### ON AND OFF BOARD SIGNAL ROUTING

To route logic side inputs and outputs on board, use the P3, P4, P5, and P6 screw terminal connectors. The default configuration is set up for 5 V input and output logic levels to and from both signal and power isolated transceivers. The EVAL-2LCANRS485EBZ can be modified for other logic levels. See the [ADM3053](#) and the [ADM2582E](#) transceiver data sheets for valid supply range information.

The EVAL-2LCANRS485EBZ also has bus side screw terminals available to route the field bus signals off board. Connections for the [ADM3053](#) CAN transceiver are routed to the P9 screw terminal (Pin 1 and Pin 2). Connections for the [ADM2582E](#) RS-485 transceiver are routed to the P7 screw terminal (Pin 2 and Pin 3) and the P8 screw terminal (Pin 1 and Pin 2). Signal names are shown in the schematic in Figure 6 and on the EVAL-2LCANRS485EBZ silkscreen adjacent to the screw terminals.

### BYPASS CAPACITANCE REQUIREMENTS

The isolated dc-to-dc converter in both the [ADM3053](#) and the [ADM2582E](#) uses a 180 MHz carrier frequency to transmit isolated power through the 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 bus side isolated power supply pin and isolated power return pins. To suppress noise and reduce ripple, a parallel combination of at least two capacitors is required. The recommended capacitor values for the isolated power output are 0.1  $\mu$ F and 10  $\mu$ F. The recommended capacitor values for the dc-to-dc converter input supply pins 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.

On the logic side, the bypass capacitors must be placed directly adjacent to the dc-to-dc converter power supply input and return pins

### EMC MITIGATION TECHNIQUES

Both the [ADM3053](#) and the [ADM2582E](#) feature a split bus side lead frame paddle. On the logic side, the dc-to-dc converter and digital isolation share a paddle. However, on the bus side, isolated power and isolated signal paths are galvanically isolated from each other. The isolated power output must be routed to the signal isolation input supply pins externally. This design feature can reduce the level of electromagnetic radiation when used in conjunction with the external components as is shown in Figure 2.

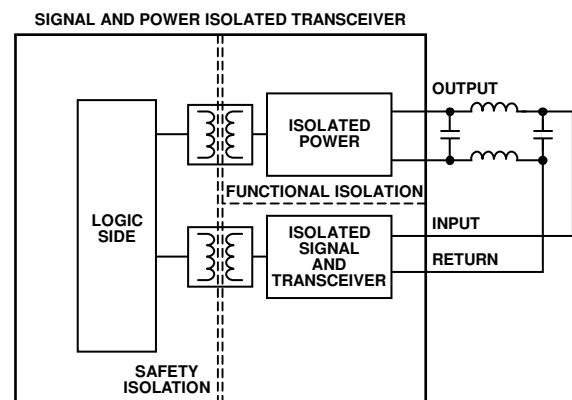


Figure 2. Split Paddle Diagram

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Increasing the impedance to high frequency currents between the bus side, isolated, power output supply pin and the transceiver input supply pin by inserting series ferrite beads is an effective first electromagnetic radiation mitigation technique. Because the transceiver and dc-to-dc converter output connection is made externally, any dc voltage drop across the ferrites does not cause signal degradation.

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. Table 1 provides part numbers for ferrite beads that have proven effective for this purpose.

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

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

Note that the [ADM3053](#) and the [ADM2582E](#) are self-contained solutions. The devices are not rated for supplying external power to additional bus side circuitry beyond the [ADM3053](#) or the [ADM2582E](#) power requirements. Supplying power to additional external loads beyond the [ADM3053](#) or the [ADM2582E](#) devices themselves causes higher operating temperatures, increased emissions, and is not supported.

Another electromagnetic capability (EMC) mitigation technique is providing a low impedance return path for high frequency common-mode currents emitted by the dc-to-dc converter. Creating a return path while maintaining the required level of isolation is the function of the safety capacitors, C14 and C15, on the EVAL-2LCANRS485EBZ.

In PCBs with four or more layers, safety capacitors can also be replaced or supplemented with stitching capacitance constructed with inner PCB layers. Stitching capacitance is covered in greater detail in the [AN-1349](#) and [AN-0971](#) application notes.

Although typically acceptable for industrial applications, capacitively coupling the logic and bus sides may not be suitable for all applications, especially medical applications where leakage current must be minimized to meet patient safety requirements.

For EMC purposes, it is also important to not allow high frequency common-mode currents to bypass either the ferrite bead filtering or the low impedance return path. Implement a metal keep out area around the dc-to-dc converter output supply pins, ferrite beads, and low impedance return path to avoid capacitive coupling of the unfiltered output.

**ALTERNATE PCB CONFIGURATIONS**

The EVAL-2LCANRS485EBZ comes populated with a single [ADM3053](#) (U1) and a single [ADM2582E](#) (U2) device. These two devices are not directly pin-compatible. However, the pinouts of these devices are close enough that several 0 Ω, 0603 resistors allow the isolated signal and power transceivers to be interchanged. It is also possible to configure the EVAL-2LCANRS485EBZ with two [ADM3053](#) devices or two [ADM2582E](#) devices.

**EN 55032 RADIATED EMISSIONS TEST RESULTS**

The EVAL-2LCANRS485EBZ has a power delivery circuit located on the PCB with a short trace from the [ADP7104](#) (U3) regulator output to the isolated signal and power transceiver power supply input. 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. For this testing, a battery with short leads was used.

The EVAL-2LCANRS485EBZ has two [LTC6900](#) devices (U4 and U5) providing an input clocking signal to the TXD pins of the [ADM3053](#) and the [ADM2582E](#). These signals were used for the testing.

The EVAL-2LCANRS485EBZ passes the EN 55022, Class A standard with margin. Table 2 provides the EN 55032 emissions test results summary of the EVAL-2LCANRS485EBZ.

To repeat the emissions testing, place the power delivery circuit in close proximity to the [ADM3053](#) device to ensure that the V<sub>CC</sub> trace is as short as possible.

The EVAL-2LCANRS485EBZ was configured and tested with a 5.0 V power supplied to the VCC pin and the VIO 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, Figure 4, and Figure 5 show the measurements carried out according to the EN 55032 standard in a semianechoic chamber at 10 m from 30 MHz to 1 GHz. Figure 3, Figure 4, and Figure 5 show the results of the peak horizontal scan (the worst case) at various data rates. Table 2 shows the tabulated quasi peak results. These results demonstrate that the [ADM3053](#) has a greater than 6.0 dB margin below EN 55032, Class A limits on a 2-layer PCB with the use of ferrite beads.

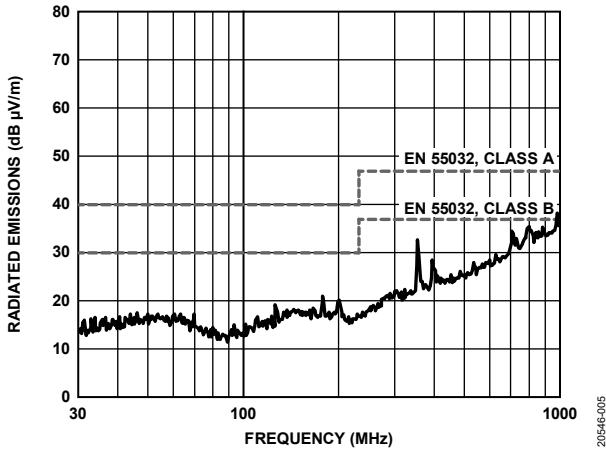


Figure 3. Peak Horizontal Scan from 30 MHz to 1 GHz with 1 Mbps Signal to [ADM3053 TXD](#) and 1 Mbps Signal to [ADM2582E](#)

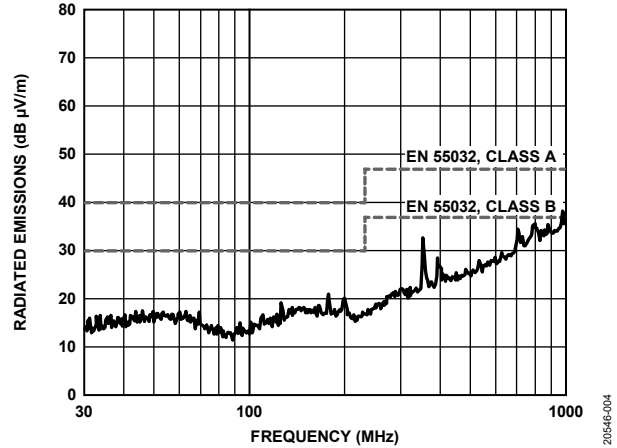


Figure 4. Peak Horizontal Scan from 30 MHz to 1 GHz with 1 Mbps Signal to [ADM3053 TXD](#) and 5 Mbps Signal to [ADM2582E](#)

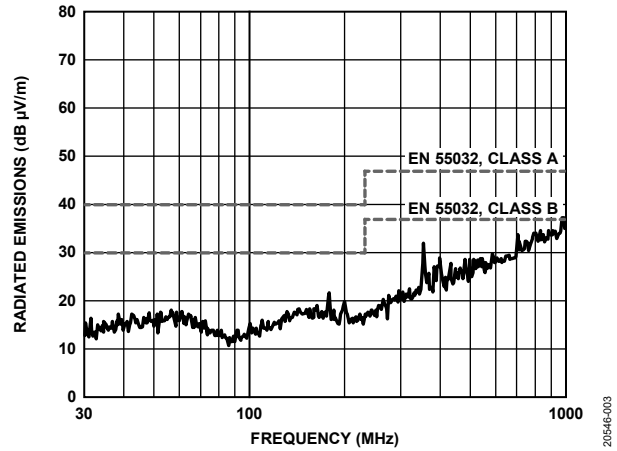


Figure 5. Peak Horizontal Scan from 30 MHz to 1 GHz with 1 Mbps Signal to [ADM3053 TXD](#) and 16 Mbps Signal to [ADM2582E](#)

Table 2. EVAL-2LCANRS485EBZ Test Results (Quasi Peak Measurements)

Supply Voltage (V)	CAN TXD Data Rate (Mbps)	RS-485 TXD Data Rate (Mbps)	CAN Termination Load	RS-485 Termination Load	RXD Switching	Frequency (MHz)	Quasi Peak Margin from Limit EN 55032, Class A (dBµV/m)
5	1	16	60	60	Yes	356.365	-10.4
5	1	5	60	60	Yes	356.869	-10.7
5	1	1	60	60	Yes	356.606	-10.3

EVALUATION BOARD SCHEMATIC

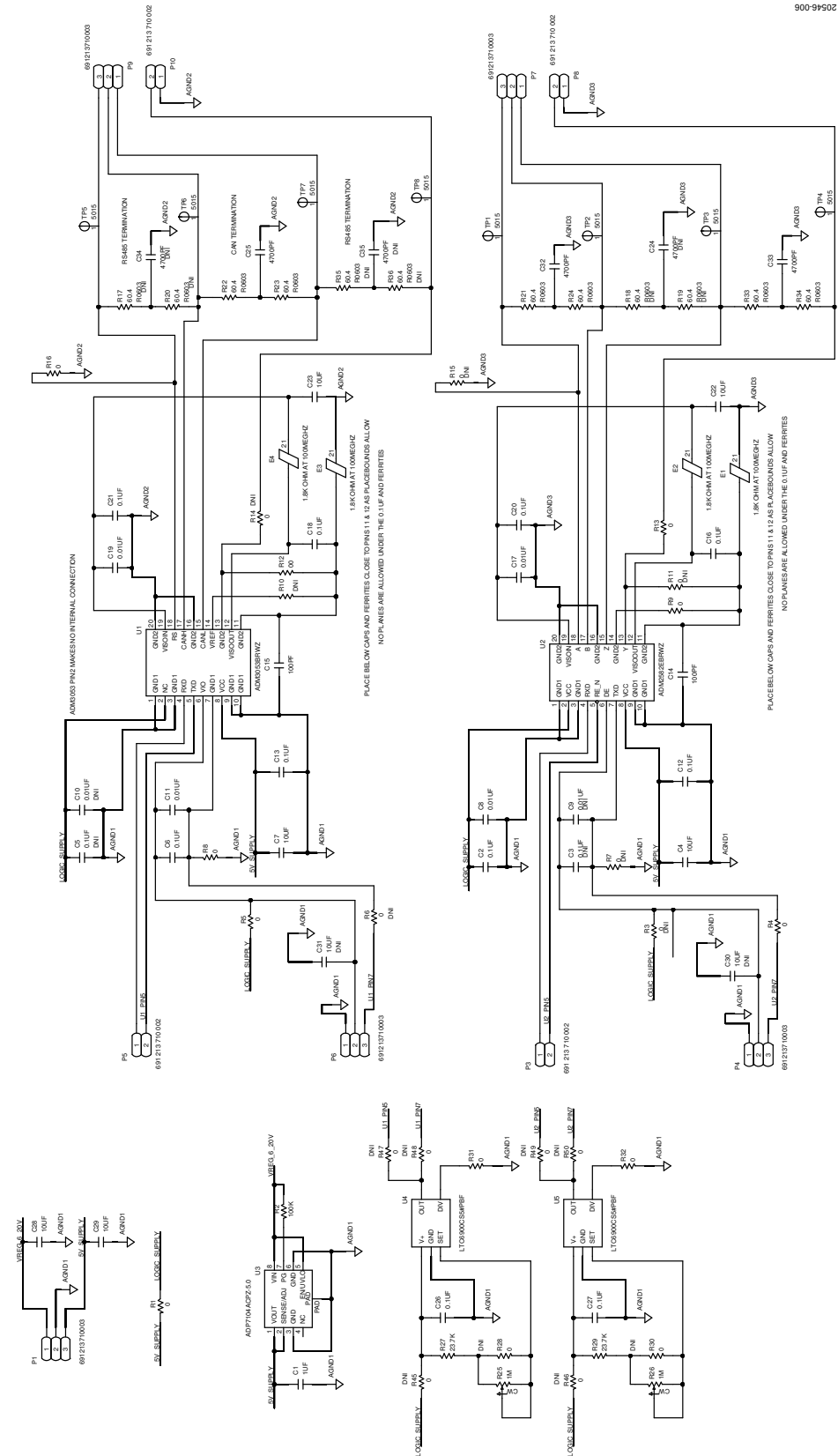


Figure 6. EVAL-2LCANRS485EBZ Evaluation Board Schematic

## ORDERING INFORMATION

## BILL OF MATERIALS

Table 3.

Name	Description	Supplier	Part No.
U1	5 kV rms, signal and power isolated, CAN transceiver for CAN FD (flexible data rate)	Analog Devices	<a href="#">ADM3053BRWZ</a>
U2	Signal and power isolated RS-485 transceiver with $\pm 15$ kV electrostatic discharge (ESD) protection	Analog Devices	<a href="#">ADM2582EBRWZ</a>
U3	20 V, 500 mA, low noise, complimentary metal-oxide semiconductor (CMOS) LDO	Analog Devices	<a href="#">ADP7104ACPZ-5.0-R7</a>
U4, U5	Low power, 1 kHz to 20 MHz resistor set SOT-23 oscillator	Analog Devices	<a href="#">LTC6900CS5#PBF</a>
C1	Capacitors, 1 $\mu$ F, X7R, 0603	Würth Elektronik	885012206076
C8, C11, C17, C19	Capacitors, 0.01 $\mu$ F, X7R, 0603	Würth Elektronik	885012206014
C2, C6, C12, C13, C16, C18, C20, C21, C26, C27	Capacitors, 0.1 $\mu$ F, X7R, 0603	Würth Elektronik	885012206046
C14, C15	High voltage capacitors, 100 pF, C0G, 1812	TDK	C4532C0G3F101K160KA
C4, C7, C22, C23, C28, C29	Capacitors, 10 $\mu$ F, X7R, 0805	Würth Elektronik	885012207026
C25, C32, C33	Capacitors, 4700 pF, X7R, 0805	Würth Elektronik	885012207090
E1, E2, E3, E4	Ferrite beads, 1800 $\Omega$ , 0402	Murata	BLM15HD182SN1D
P1, P4, P6, P7, P9	Connector, 3-position screw terminal blocks	Würth Elektronik	691213710003
P3, P5, P8, P10	Connector, 2-position screw terminal blocks	Würth Elektronik	691213710002
R1, R4, R5, R8, R9, R12, R13, R16, R31, R32	Resistors, 0 $\Omega$ , 1/10 W, 0603	Panasonic	ERJ-3GEY0R00V
R2	Resistor, 100 k $\Omega$ , 1/10 W, 0603	Panasonic	ERJ-3EKF1003V
R21, R22, R23, R24, R33, R34	Resistors, 60.4 $\Omega$ , 1/10 W, 0603	Panasonic	ERJ-3EKF60R4V
R25, R26	Potentiometers, 1 M $\Omega$	Bourns	3296W-1-105LF
R27, R29	Resistors, 23.7 k $\Omega$ , 1/10 W, 0603	Vishay	TNPW060323K7BEEN
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8	Test points	Keystone	5015
C9, C10	Capacitors, 0.01 $\mu$ F, X7R, 0603 (not installed)	Würth Elektronik	885012206014
C24, C34, C35	Capacitors, 4700 pF, X7R, 0805 (not installed)	Würth Elektronik	885012207090
C3, C5	Capacitors, 0.1 $\mu$ F, X7R, 0603 (not installed)	Würth Elektronik	885012206046
C30, C31	Capacitors, 10 $\mu$ F, X7R, 0805 (not installed)	Würth Elektronik	885012207026
R3, R6, R7, R10, R11, R14, R15, R28, R30, R45, R46, R47, R48, R49, R50	Resistors, 0 $\Omega$ , 1/10 W, 0603 (not installed)	Panasonic	ERJ-3GEY0R00V
R17, R18, R19, R20, R35, R36	Resistors, 60.4 $\Omega$ , 1/10 W, 0603 (not installed)	Panasonic	ERJ-3EKF60R4V



## RELATED LINKS

Resource	Description
<a href="#">ADM3053</a>	5 kV rms, signal and power isolated, CAN transceiver for CAN FD
<a href="#">ADM2582EBRWZ</a>	Signal and power isolated RS-485 transceiver with ±15 kV ESD protection
<a href="#">ADP7104</a>	20 V, 500 mA, low noise, CMOS LDO
<a href="#">LTC6900</a>	Low power, 1 kHz to 20 MHz resistor set SOT-23 oscillator
<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



### 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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