

## Evaluating the **ADM2761E** 5.7 kV RMS Isolated, High Working Voltage, RS-485 Transceiver with $\pm 15$ kV IEC ESD

### FEATURES

- Simplified evaluation of the **ADM2761E** signal isolated, half duplex RS-485 transceiver with 1500 V peak working voltage**
- 2-layer PCB compliant to EN 55032 Class B radiated emissions**
- Footprint for standard half duplex, 16-lead, SOIC\_W package with 8.3 mm creepage and clearance**
- On-board **ADP7104** LDO regulators with jumper options for simplified evaluation in multiple supply configurations**
- Flexible, low voltage  $V_{DD1}$  supply rail for interfacing with input and output nodes as low as 1.7 V**
- Wide bus voltage  $V_{DD2}$  supply rail from 3.0 V to 5.5 V**
- IEC 61000-4-2 ESD protection on the A pin and B pin  $\geq \pm 12$  kV contact discharge and  $\geq \pm 15$  kV air discharge**
- SMA connector for TxD input signal**
- Optional on-board **LTC1799** oscillator for providing TxD signal**
- Screw terminal blocks for connecting power, digital, and RS-485 signals**
- Jumper-selectable enable and disable for digital input signals**
- Resistors and footprints for termination**
- Test points for measuring all signals**

### EVALUATION KIT CONTENTS

EVAL-ADM2761EEBZ

### EQUIPMENT NEEDED

- Oscilloscope**
- Signal generator**
- 3 V to 5.5 V supply**
- 1.7 V to 5.5 V supply**

### DOCUMENTS NEEDED

**ADM2761E** data sheet

### GENERAL DESCRIPTION

The EVAL-ADM2761EEBZ allows simplified, efficient evaluation of the **ADM2761E** 5.7 kV rms, high working voltage, half duplex signal isolated RS-485 transceiver.

The EVAL-ADM2761EEBZ comes with options for the evaluation of the **ADM2761E** device in an individual system. Digital and RS-485 bus signals are easily accessible via the screw terminal blocks on the EVAL-ADM2761EEBZ. Each digital input can be configured via the on-board jumper options.

Two on-board **ADP7104** low dropout (LDO) regulators accept an input voltage of up to 20 V and output a range of selectable supply voltages to the  $V_{DD1}$  pin and  $V_{DD2}$  pin that are configurable via jumper options. The LDO regulators can be bypassed to power the **ADM2761E**  $V_{DD1}$  supply pin and  $V_{DD2}$  supply pin directly from an external power supply.

The flexible  $V_{DD1}$  pin primary side logic supply allows the device to operate with a digital input/output (I/O) voltage from 1.7 V to 5.5 V, which enables communication with modern nodes using either a 1.8 V or 2.5 V power supply. The  $V_{DD1}$  pin can also be supplied from the **ADP7104** regulated supply.

Alternative methods can provide the transmit data input (TxD) data input signal to the device. An optional **LTC1799** oscillator is included on the EVAL-ADM2761EEBZ and can be configured to provide a clock signal as the TxD digital input within a 10 kHz to 250 kHz range. A terminal block allows an easy wired connection to a microcontroller or processor. For optimal signal integrity, use the on-board Subminiature Version A (SMA) connector to connect an external data signal.

The EVAL-ADM2761EEBZ has a footprint for the **ADM2761E** half duplex, isolated, RS-485 transceiver in a 16-lead, small outline, wide body (SOIC\_W) package.

For full details on the **ADM2761E**, see the **ADM2761E** data sheet, which must be used in conjunction with this user guide when using the EVAL-ADM2761EEBZ.

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## REVISION HISTORY

6/2020—Revision 0: Initial Version

### EVAL-ADM2761EEBZ EVALUATION BOARD PHOTOGRAPH



Figure 1.

24156-001

## EVALUATION BOARD HARDWARE

### SETTING UP THE EVALUATION BOARD

The EVAL-ADM2761EEBZ is an isolated RS-485 transceiver that requires a power supply on both sides of the device. The device is powered via the VDD1 and VDD2 connections on the P3 and P4 screw terminal connectors. The supply voltages connected to these terminals can either be regulated or connected directly to the V<sub>DD1</sub> pin and V<sub>DD2</sub> pin of the [ADM2761E](#). Insert the LK5 jumper into Position E to power the V<sub>DD1</sub> pin directly from the VDD1 terminal on the P3 connector. Insert the LK6 jumper into Position C to power the V<sub>DD2</sub> pin directly from the VDD2 terminal on the P4 connector.

The two on-board [ADP7104](#) voltage regulators can be configured to provide a range of regulated supply voltages to the V<sub>DD1</sub> pin and V<sub>DD2</sub> pin of the [ADM2761E](#). Various voltage options can be selected using the LK5 and LK6 jumpers. The V<sub>DD1</sub> pin is fitted with a 10  $\mu$ F decoupling capacitor (C3) and a 0.1  $\mu$ F decoupling capacitor (C4). The V<sub>DD2</sub> pin is fitted with a 10  $\mu$ F decoupling capacitor (C6) and a 0.1  $\mu$ F decoupling capacitor (C5).

See Table 1, Table 2, and Table 3 for more details on the jumper and power supply connections. The corresponding labeled test points allow for monitoring of the EVAL-ADM2761EEBZ VDD1 and VDD2 supply voltages.

### INPUT AND OUTPUT CONNECTIONS

Digital input and output signals are connected via the P1 screw terminal block to allow wire connections from the EVAL-ADM2761EEBZ to a signal generator or microcontroller. The EVAL-ADM2761EEBZ includes screw terminals for TxD, receiver data output (RxD), receiver enable (RE), and driver enable (DE).

**Table 1. Jumper Configurations**

Link	Jumper Connection	Description
LK1	A	Connects the <a href="#">ADM2761E</a> $\overline{\text{RE}}$ input to the V <sub>DD1</sub> pin. This setting disables the receiver.
	B	Connects the <a href="#">ADM2761E</a> $\overline{\text{RE}}$ input to the $\overline{\text{RE}}$ terminal on the P1 connector.
	C	Connects the <a href="#">ADM2761E</a> $\overline{\text{RE}}$ input to the GND <sub>1</sub> pin. This setting enables the receiver.
LK2	A	Connects the <a href="#">ADM2761E</a> DE input to the V <sub>DD1</sub> pin. This setting enables the driver.
	B	Connects the <a href="#">ADM2761E</a> DE input to the DE terminal on the P1 connector.
	C	Connects the <a href="#">ADM2761E</a> DE input to the GND <sub>1</sub> pin. This setting disables the driver.
	D	Connects the <a href="#">ADM2761E</a> DE input to the $\overline{\text{RE}}$ input signal. Therefore, the input for both $\overline{\text{RE}}$ and DE is set by the LK1 jumper. This setting ensures that when the driver is enabled, the receiver is disabled, or when the driver is disabled, the receiver is enabled.
LK3	Inserted	Connects the 120 $\Omega$ R5 termination resistor across the <a href="#">ADM2761E</a> Pin A and Pin B.
	Not inserted	Disconnects the 120 $\Omega$ R5 termination resistor across the <a href="#">ADM2761E</a> Pin A and Pin B.
LK4	Inserted	Connects the 120 $\Omega$ R4 termination resistor across the <a href="#">ADM2761E</a> Pin A and Pin B.
	Not inserted	Disconnects the 120 $\Omega$ R4 termination resistor across the <a href="#">ADM2761E</a> Pin A and Pin B.

Alternatively, jumper connections can connect these signals to the V<sub>DD1</sub> pin or GND<sub>1</sub> pins of the [ADM2761E](#) (see Table 1).

Connections to the RS-485 bus are made via the P2 screw terminal block. The EVAL-ADM2761EEBZ has two bus signals: Pin A for the noninverting input and output signal and Pin B for the inverting input and output signal. The bus cables also include a common ground connection and can be connected to the P2 screw terminal block of the EVAL-ADM2761EEBZ. Test points are available on the EVAL-ADM2761EEBZ and are appropriately labeled for all digital and bus signals.

### RADIATED EMISSIONS

The [ADM2761E](#) encodes data across the isolation barrier using an amplitude shift keying (ASK) modulation scheme that is optimized for both high noise immunity and minimal radiated emissions. The EVAL-ADM2761EEBZ is a 2-layer printed circuit board (PCB) that meets the EN 55032 Class B radiated emissions requirements under full load while operating at a maximum data rate of 500 kbps. To maximize the margin to the EN 55032 Class B specification, adhere to the following guidelines:

- Place a 0.1  $\mu$ F capacitor (C4) between the V<sub>DD1</sub> pin and GND<sub>1</sub> pin.
- Place a 0.1  $\mu$ F capacitor (C5) between the V<sub>DD2</sub> pin and GND<sub>1</sub> pin.
- Ensure that the decoupling capacitors are placed as close as possible to the corresponding [ADM2761E](#) pins.

The EVAL-ADM2761EEBZ, designed according to these guidelines, meets EN 55032 Class B requirements with margin.

Link	Jumper Connection	Description
LK5	A	Configures the <a href="#">ADP7104</a> voltage regulator, U1, to supply a regulated 1.8 V to the <a href="#">ADM2761E</a> V <sub>DD1</sub> pin.
	B	Configures the <a href="#">ADP7104</a> voltage regulator, U1, to supply a regulated 2.5 V to the <a href="#">ADM2761E</a> V <sub>DD1</sub> pin.
	C	Configures the <a href="#">ADP7104</a> voltage regulator, U1, to supply a regulated 3.3 V to the <a href="#">ADM2761E</a> V <sub>DD1</sub> pin.
	D	Configures the <a href="#">ADP7104</a> voltage regulator, U1, to supply a regulated 5 V to the <a href="#">ADM2761E</a> V <sub>DD1</sub> pin.
	E	Bypasses the <a href="#">ADP7104</a> voltage regulator, U1, and powers the <a href="#">ADM2761E</a> V <sub>DD1</sub> supply pin directly from the VDD1 terminal on the P3 connector.
LK6	A	Configures the <a href="#">ADP7104</a> voltage regulator, U3, to supply a regulated 3.3 V to the <a href="#">ADM2761E</a> V <sub>DD2</sub> pin.
	B	Configures the <a href="#">ADP7104</a> voltage regulator, U3, to supply a regulated 5 V to the <a href="#">ADM2761E</a> V <sub>DD2</sub> pin.
	C	Bypasses the <a href="#">ADP7104</a> voltage regulator, U3, and powers the <a href="#">ADM2761E</a> V <sub>DD2</sub> supply pin directly from the VDD2 terminal on the P4 connector.
LK7	Inserted	Connects the output of the <a href="#">LTC1799</a> oscillator to the <a href="#">ADM2761E</a> TxD pin.
	Not inserted	Disconnects the output of the <a href="#">LTC1799</a> oscillator from the <a href="#">ADM2761E</a> TxD pin.

### OTHER BOARD COMPONENTS

The EVAL-ADM2761EEBZ has footprints for an R4 and R5 termination resistor. A 120 Ω termination resistor is fitted to both R4 and R5 on the EVAL-ADM2761EEBZ, but this resistor can be removed or replaced with a resistor of a different value as needed. Insert the LK4 jumper to connect the R4 resistor and add a 120 Ω load to the RS-485 driver/receiver. Insert the LK3 jumper to connect the R5 resistor and add an additional 120 Ω load to the RS-485 driver/receiver.

#### Biasing Resistors for Bus Idle Fail-Safe

The [ADM2761E](#) has a built in receiver fail-safe for the bus idle condition, but there are footprints on the EVAL-ADM2761EEBZ for fitting an R7 pull-up resistor to the DD2 supply on the [ADM2761E](#) Pin A, as well as the R6 pull-down resistor to the GND<sub>2</sub> supply on Pin B. These resistors can be fitted if the user is connecting to other devices that require external biasing resistors on the bus. The exact value required for a 200 mV minimum differential voltage in bus idle condition depends on the minimum supply voltage and the termination scheme. For 5 V transceiver operation, 1140 Ω is recommended. For 3.3 V transceiver operation, 900 Ω is recommended.

See the [AN-960 Application Note](#) for more information about the bus idle fail-safe.

#### On-Board LTC1799 Oscillator

An [LTC1799](#) clock oscillator is provided on the EVAL-ADM2761EEBZ to allow convenient evaluation of the [ADM2761E](#) without the need for an external signal source.

To use the [LTC1799](#) oscillator for evaluation, insert the LK7 jumper. This setting connects the clock oscillator output to the [ADM2761E](#) TxD input pin.

The sum of the R3 and R10 resistors can configure the switching frequency of the clock oscillator within the 100 kHz to 250 kHz range. The frequency is calculated using the following equation:

$$f_{OSC} = 10 \text{ MHz} \left( \frac{10 \text{ k}\Omega}{N(R3 + R10)} \right),$$

$$4 \text{ k}\Omega \leq (R3 + R10) \leq 1 \text{ M}\Omega, N = 1, 10$$

The value of N is controlled with the R16 resistor. When R16 is not inserted, N = 10. Insert a 0 Ω resistor at R16 to set N = 1 for higher frequency operation. The EVAL-ADM2761EEBZ ships with N = 10 and R3 + R10 = 40 kΩ, setting the oscillator output frequency to 250 kHz.

The [LTC1799](#) oscillator is powered from the V<sub>DD1</sub> supply and can only be used when the V<sub>DD1</sub> supply voltage is between 2.7 V and 5.5 V. By removing the 0 Ω R15 resistor, the [LTC1799](#) can be disconnected from the V<sub>DD1</sub> supply.

#### ADP7104 LDO Regulator

The EVAL-ADM2761EEBZ features two on-board [ADP7104](#) LDO regulators that allow flexible power supply configurations during evaluation.

The V<sub>DD1</sub> regulator (U1) is powered from the VDD1 terminal on Connector P3 and is configured using the LK5 jumper. This jumper position selects the regulator output to the V<sub>DD1</sub> pin. Options of 1.8 V, 2.5 V, 3.3 V, and 5 V are available. To bypass the V<sub>DD1</sub> regulator (U1) and power the V<sub>DD1</sub> pin directly from the VDD1 terminal, insert the LK5 jumper to Position E.

The V<sub>DD2</sub> regulator (U3) is powered from the VDD2 terminal on Connector P4 and is configured using the LK6 jumper. This jumper position selects the regulator output to the [ADM2761E](#) V<sub>DD2</sub> pin. Options of 3.3 V and 5 V are available. To bypass the V<sub>DD2</sub> regulator (U3) and power the V<sub>DD2</sub> pin directly from the VDD2 terminal, insert the LK6 jumper to Position C.

Table 2 and Table 3 list the supported power supply configurations and the associated jumper configurations.

**Table 2. Primary Side Input Supply Configurations**

Jumper LK5	V <sub>DD1</sub> Input Voltage Range	V <sub>DD1</sub> Supply
A	2.2V to 20V	Regulator provides 1.8V
B	2.9V to 20V	Regulator provides 2.5V
C	3.7V to 20V	Regulator provides 3.3V
D	5.4V to 20V	Regulator provides 5V
E	1.7V to 5.5V	Supplied directly from the VDD1 terminal on P3

**Table 3. Secondary Side Input Supply Configurations**

Jumper LK6	V <sub>DD2</sub> Input Voltage Range	V <sub>DD2</sub> Supply
A	3.7V to 20V	Regulator provides 3.3V
B	5.4V to 20V	Regulator provides 5V
C	3V to 5.5V	Supplied directly from the VDD2 terminal on P4

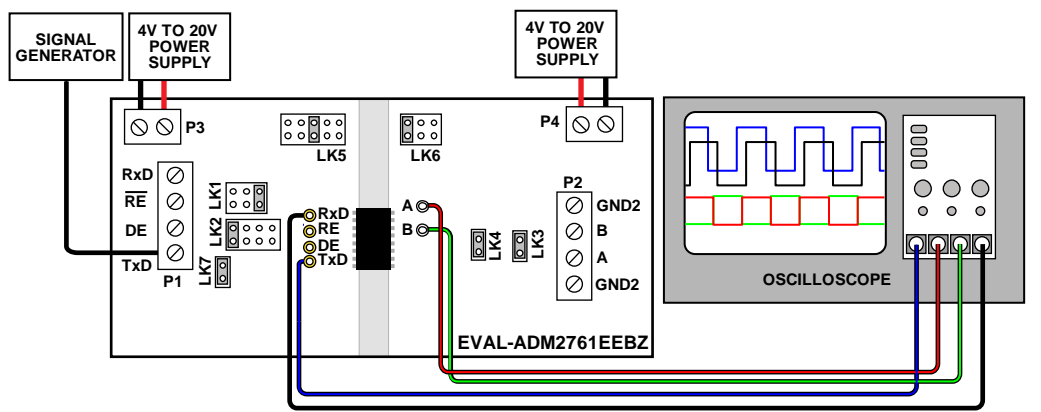


Figure 2. Half Duplex RS-485 Loopback Test

## HALF DUPLEX LOOPBACK TEST

The [ADM2761E](#) is a half duplex RS-485 transceiver within which the transmitter and receiver are connected together. In a half duplex device, when both the driver and receiver are enabled, data applied to the TxD input pin of the [ADM2761E](#) is transmitted by the driver and is then received on the RxD output pin of the [ADM2761E](#). This loopback configuration can be used to evaluate both the transmitter and receiver of the [ADM2761E](#) on the EVAL-ADM2761EEBZ.

The details of this loopback test are detailed in Table 1 and in Figure 2. A signal generator is connected to the TxD pin that allows verification of the bus signals and the receiver output. During the test, the jumper position for LK1 is Position C and for LK2 is Position A. The LK3 and LK4 jumpers can be inserted to terminate the transmitter and receiver with 120 Ω resistors.

## IEC 61000-4-2 ELECTROSTATIC DISCHARGE (ESD) PROTECTION

The EVAL-ADM2761EEBZ is tested and verified to achieve protection against IEC 61000-4-2 ESD to  $\geq \pm 12$  kV (contact discharge) and  $\geq \pm 15$  kV (air discharge) on the [ADM2761E](#) Pin A and Pin B.

The IEC 61000-4-2 ESD standard describes testing using two coupling methods known as contact discharge and air discharge. Contact discharge implies a direct contact between the discharge gun and the equipment under test (EUT). The [ADM2761E](#) is tested using both of these methods.

During testing, the [ADM2761E](#) Pin A and Pin B are subjected to at least 10 positive and 10 negative single discharges with a 1 sec interval between each pulse. The highest specified IEC 61000-4-2 ESD test is Level 4, which defines a contact discharge voltage of  $\geq \pm 8$  kV and an air discharge voltage of  $\geq \pm 15$  kV.

EVALUATION BOARD SCHEMATICS AND ARTWORK

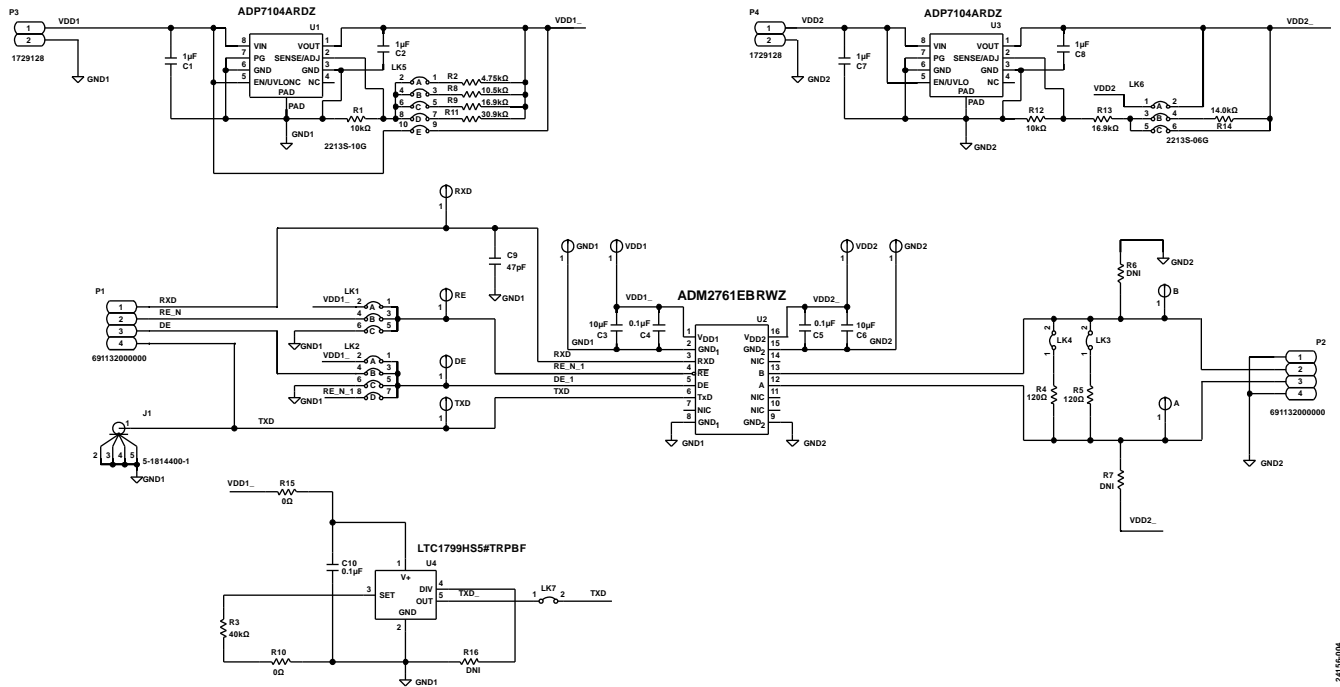


Figure 3. EVAL-ADM2761EEBZ Schematic

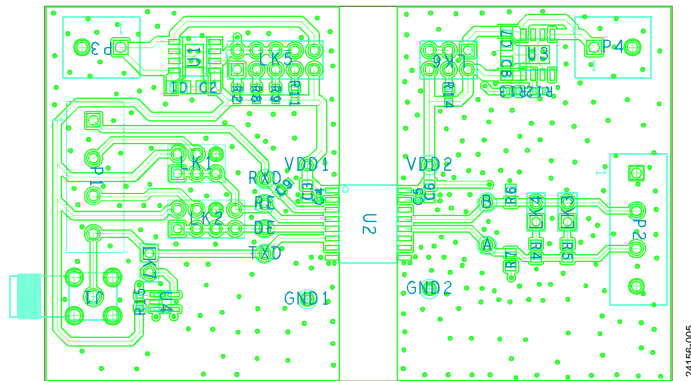


Figure 4. EVAL-ADM2761EEBZ Component Side, Layer 1

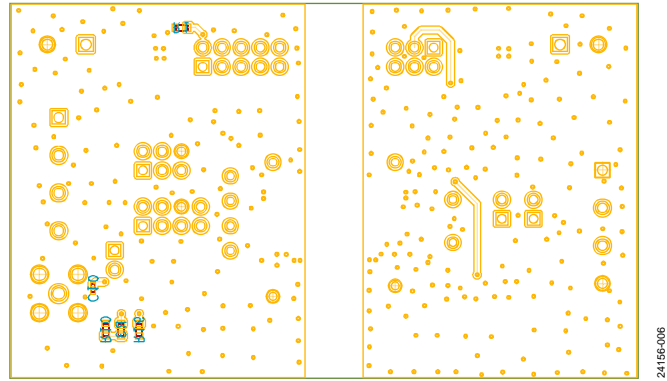


Figure 5. EVAL-ADM2761EEBZ, Layer 2

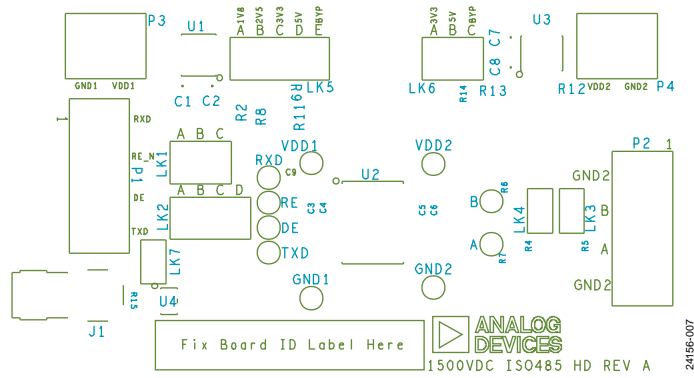


Figure 6. EVAL-ADM2761EEBZ, Silkscreen



## ORDERING INFORMATION

### BILL OF MATERIALS

Table 4.

Qty	Reference Designator	Description	Manufacturer	Part Number
6	A, B, DE, RE, RxD, TxD	Test points, yellow	Keystone Electronics	36-5004-ND
3	C4, C5, C10	Capacitors, 0.1 $\mu$ F, 0402	Murata	GRM155R61E104KA87D
4	C1, C2, C7, C8	Capacitors, 1 $\mu$ F, 0805	Murata	GCM21BR71E105KA56L
2	C3, C6	Capacitors, 10 $\mu$ F, 0805	TDK	C2012X5R1E106K085AC
1	C9	Capacitor, 47 pF, 0603	AVX Corporation	06035A470JAT2A
2	GND1, GND2	Test points, black	Components Corporation	TP-105-01-00
1	J1	Coaxial, right angle SMA connector	TE Connectivity	5-1814400-1
2	LK1, LK6	6-pin (3 $\times$ 2), 0.1 inch header and shorting blocks	Multicomp	2213S-06G
1	LK2	8-pin (4 $\times$ 2), 0.1 inch header and shorting block	Multicomp	2213S-08G
1	LK5	10-pin (5 $\times$ 2), 0.1 inch header and shorting block	Multicomp	2213S-10G
3	LK3, LK4, LK7	2-pin (1 $\times$ 2), 0.1 inch header and shorting blocks	Harwin	M20-9990246
2	P3, P4	Two position terminal blocks	Phoenix Contact	1729128
2	P1, P2	Four position terminal blocks	Würth Elektronik	691132000000
2	R10, R15	Resistors, 0 $\Omega$ , 0603	Multicomp	MC0603WG00000T5E-TC
1	R16	Resistor, do not install (DNI), 0603	Not applicable	Not applicable
2	R1, R12	Resistors, 10 k $\Omega$ , 0603	Panasonic	ERJ-3EKF1002V
1	R8	Resistor, 10.5 k $\Omega$ , 0603	Panasonic	ERA-3AEB1052V
2	R9, R13	Resistors, 16.9 k $\Omega$ , 0603	Panasonic	ERJ-3EKF1692V
1	R11	Resistor, 30.9 k $\Omega$ , 0603	Panasonic	ERJ-3EKF3092V
1	R14	Resistor, 14 k $\Omega$ , 0603	Panasonic	ERJ-3EKF1402V
1	R2	Resistor, 4.75 k $\Omega$ , 0603	Panasonic	ERJ-3EKF4751V
1	R3	Resistor, 40 k $\Omega$ , 0603	Vishay	CRCW060340K0FKEA
2	R6, R7	Resistors, DNI, 0805	Not applicable	Not applicable
2	R4, R5	Resistors, 120 $\Omega$ , 0805	Panasonic	ERJ-P6WF1200V
2	U1, U3	Low noise CMOS LDOs	Analog Devices, Inc.	<a href="#">ADP7104ARDZ-R7</a>
1	U2	5.7 kV rms isolated, high working voltage, RS-485 transceiver with $\pm$ 15 kV IEC ESD	Analog Devices	<a href="#">ADM2761EBRWZ</a>
1	U4	1 kHz to 33 MHz oscillator	Analog Devices	<a href="#">LTC1799HS5#TRPBF</a>
2	VDD1, VDD2	Test points, red	Components Corporation	TP-105-01-02

## 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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