Evaluating the ADM2495E 5.7kV$_{RMS}$ Isolated, Half-Duplex RS-485 Transceiver with Fault Protection

FEATURES

- Simplified evaluation of the ADM2495E/ADM2495E-1 250kbps half-duplex isolated RS-485 transceiver
- 2-layer PCB compliant to EN 55032 Class B radiated emissions
- Footprint for 10mm × 10mm, 16-lead SOIC_W package with >8.0mm 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 I/O nodes as low as 1.7V
- IEC 61000-4-2 ESD protection on the A pin and B pin
  - ±4kV contact discharge
- SMA connector for TxD input signal
- Optional on-board LTC6900 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 BOARD CONTENTS

- EVAL-ADM2495EEBZ

EQUIPMENT NEEDED

- Oscilloscope
- Signal generator (optional)
- 3 V to 5.5 V supply
- 1.7 V to 5.5 V supply (optional)

GENERAL DESCRIPTION

The EVAL-ADM2495EEBZ allows simplified, efficient evaluation of the ADM2495E 5.7kV$_{RMS}$, 250kbps half-duplex signal isolated RS-485 transceiver. The EVAL-ADM2495EEBZ can also be used to evaluate the higher speed 20Mbps ADM2495E-1 by replacing the low-speed part with the higher speed part.

The EVAL-ADM2495EEBZ comes with options for the evaluation of the ADM2495E/ADM2495E-1 device in an individual system. Digital and RS-485 bus signals are easily accessible via the screw terminal blocks on the EVAL-ADM2495EEBZ. 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 20V and output a range of selectable supply voltages to the V_{DD1} and V_{DD2} pins, configurable via jumper options. The LDO regulators can be bypassed to power the ADM2495E/ADM2495E-1 V_{DD1} and V_{DD2} supply pins directly from external power supplies.

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

Different methods can be used to provide the transmit data input (TxD) data input signal to the device. An optional LTC6900 oscillator is included on the EVAL-ADM2495EEBZ and can be configured to provide a clock signal as the TxD digital input within a 10kHz to 20MHz range. Jumper settings allows frequency selections of 10kHz, 100kHz, 1MHz, 10MHz or TBD based on the value of a customer installed 0603 resistor. Note that frequencies above 125kHz are intended for when the higher speed ADM2495E-1 part is installed. 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-ADM2495EEBZ has a footprint for the ADM2495E/ADM2495E-1 half-duplex, isolated, RS-485 transceiver in a 10mm × 10mm, 16-lead, small outline, wide-body (SOIC_W) package. Table 1 shows the available devices that can be evaluated using the EVAL-ADM2495EEBZ.

Table 1. List of Available Devices for Evaluation

Device	Isolation Rating	Maximum Data Rate
ADM2495E	5.7kV$_{RMS}$	250kbps
ADM2495E-1	5.7kV$_{RMS}$	20Mbps

For full details on the ADM2495E/ADM2495E-1, see the ADM2495E/ADM2495E-1 data sheet, which must be used in conjunction with this user guide when using the EVAL-ADM2495EEBZ.

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REVISION HISTORY

4/2025—Rev. 0 to Rev. A

Change to Features Section 1

1/2025—Revision 0: Initial Version

EVALUATION BOARD PHOTOGRAPH

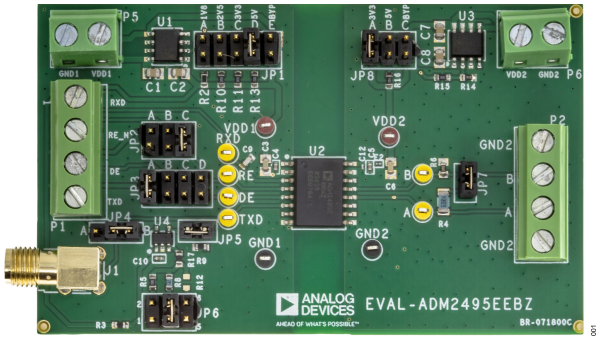

Figure 1. EVAL-ADM2495EEBZ Evaluation Board

EVALUATION BOARD HARDWARE

POWERING THE EVALUATION BOARD

The ADM2495E/ADM2495E-1 are an isolated RS-485 transceiver, which requires power supplies on both sides of the device. This is reflected by the EVAL-ADM2495EEBZ VDD1 and VDD2 inputs which are located on the P5 and P6 screw terminal connectors.

The VDD1 input is connected to the ADP7104 low dropout regulator to provide a range of regulated supply voltages to the V_{DD1} pin of the ADM2495E/ADM2495E-1. Different voltages are selected using the JP1 jumper (including a total bypass of the ADP7104). The output of the ADP7104 voltage regulator has a 1µF decoupling capacitor (C2). The ADM2495E/ADM2495E-1 V_{DD1} pin is fitted with a 10µF reservoir capacitor (C3) and a 0.1µF decoupling capacitor (C4).

The VDD2 input is connected to the ADP7104 low dropout regulator to provide a range of regulated supply voltages to the V_{DD2} pin of the ADM2495E/ADM2495E-1. Different voltages are selected using the JP8 jumper (including a total bypass of the ADP7104). The output of the ADP7104 voltage regulator has a 1µF decoupling capacitor (C8). The ADM2495E/ADM2495E-1 V_{DD2} pin is fitted with a 10µF reservoir capacitor (C6), a 0.1µF decoupling capacitor (C5) and a high-frequency 2.2pF decoupling capacitor (C12).

See 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 V_{DD1} and V_{DD2} supply voltages.

SIGNAL INPUT AND OUTPUT CONNECTIONS

Digital input and output signals are connected via the P1 screw terminal block to allow wire connections from the EVAL-ADM2495EEBZ to a signal generator or microcontroller for input and a load for output. The P1 terminal block includes screw terminals for receiver data output (RxD), receiver enable input ($\overline{RE}$), driver enable input (DE), and transmitter data input (TxD).

Jumper connection on JP2 and JP3 configure the $\overline{RE}$ and DE input pins of the ADM2495E/ADM2495E-1 allowing these input signals to be connected to the screw terminals of P1, together, to V_{DD1} or to GND_1 (see Table 2).

The TxD input is configured by jumper JP4 which allows connection of this input to either the TxD terminal of P1 or an LTC6900 oscillator (see On-Board LTC6900 Oscillator section for more details on the oscillator configuration). The SMA connector J1 can be used for either monitoring the TxD input or as an alternate input format to the screw terminals of P1.

Connections to the RS-485 bus are made via the P2 screw terminal block. The EVAL-ADM2495EEBZ has two bus signals: Pin A for the non-inverting input/output signal and Pin B for the inverting input/output signal. The bus cables also include a common ground connection and can be connected to the P2 screw terminal block. Test points are available on the EVAL-ADM2495EEBZ and are appropriately labeled for all digital and bus signals.

RADIATED EMISSIONS

The ADM2495E/ADM2495E-1 encode data across the isolation barrier using an on-off keying (OOK) modulation scheme using nominal carrier frequencies of 3.8GHz and 4.2GHz. The OOK modulation is optimized for both high noise immunity and minimal radiated emissions.

The EVAL-ADM2495EEBZ is a 2-layer printed circuit board (PCB) that meets the EN 55032 Class B radiated emissions requirements under full load while operating at data rates above 6kbps up to the maximum data rate of 250kbps (or 20Mbps when the ADM2495E-1 is present). To maximize the margin to the EN 55032 Class B specification in other designs, adhere to the following guidelines which have been followed in the design of EVAL-ADM2495EEBZ:

- Place a 0.1µF capacitor (C4) between the V_{DD1} pin and GND_1 pin.
- Place decoupling capacitors with 2.2pF (C12) and 0.1µF (C5) between the V_{DD2} pin and GND_2 pin.
- Capacitor C12 must be selected to have a self-resonant frequency above 4.3GHz.
- Ensure that the decoupling capacitors are placed as close as possible to the corresponding ADM2495E/ADM2495E-1 pins.

Table 2. Jumper Configurations

Link	Jumper Connection[1]	Description
JP1		Configures the ADP7104 voltage regulator, U1, to supply a regulated voltage to the ADM2495E/ADM2495E-1 V_{DD1} pin.
	A	1.8V.
	B	2.5V.
	C	3.3V.
	D*	5V.
	E	Bypasses the ADP7104 voltage regulator, U1, and powers the ADM2495E/ADM2495E-1 V_{DD1} supply pin from the VDD1 terminal on the P1 connector.
JP2		$\overline{RE}$ input connection configuration.
	A	V_{DD1} pin. This setting disables the receiver.
	B	$\overline{RE}$ terminal on the P1 connector.

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Table 2. Jumper Configurations (Continued)

Link	Jumper Connection[1]	Description
	C*	GND_1 pin. This setting enables the receiver.
JP3		DE input connection configuration.
	A*	V_{DD1} pin. This setting enables the driver.
	B	DE terminal on the P1 connector.
	C	GND_1 pin. This setting disables the driver.
	D	$\overline{RE}$ input signal. This means that the input for both $\overline{RE}$ and DE is set by the JP2 jumper. This setting ensures that when the driver is enabled, the receiver is disabled, or when the driver is disabled, the receiver is enabled.
JP4		TxD pin input source selection.
	A	P1 pin 4.
	B*	LTC6900 oscillator output.
JP5		LTC6900 oscillator frequency range configuration.
	Inserted*	high frequency range operation, N=1.
	Not Inserted	low frequency range operation, N=10.
JP6		Sets LTC6900 oscillator frequency to:
	A	10MHz (JP5 inserted) or 1MHz (JP5 not inserted).
	B*	100kHz (JP5 inserted) or 10kHz (JP5 not inserted).
	C	TBD Hz based on value of customer installed resistor R12.
JP7		RS-485 Bus termination resistor configuration.
	Inserted*	Connects R4, the 60.4Ω termination resistor, across the ADM2495E/ADM2495E-1 Pin A and Pin B.
	Not Inserted	Disconnects R4, the 60.4Ω termination resistor, across the ADM2495E/ADM2495E-1 Pin A and Pin B.
JP8		Configures the ADP7104 voltage regulator, U3, to supply a regulated voltage to the ADM2495E/ADM2495E-1 V_{DD2} pin.
	A*	3.3V.
	B	5V.
	C	Bypasses the ADP7104 voltage regulator, U3, and powers the ADM2495E/ADM2495E-1 V_{DD2} supply pin from the VDD2 terminal on the P6 connector.

[1] * shows the default setting.

BUS TERMINATION AND BUS IDLE FAIL-SAFE BIAS RESISTORS

The EVAL-ADM2495EEBZ has a 1206 sized package footprint for a termination resistor (R4). A 60.4Ω termination resistor is fitted to R4 on the EVAL-ADM2495EEBZ, but this resistor can be removed or replaced with a resistor of a different value as needed. Insert the JP7 jumper to connect the R4 resistor and add the 60.4Ω load to the RS-485 driver/receiver.

The ADM2495E/ADM2495E-1 have a built in receiver fail-safe for the bus idle condition which typically does not require an external fail-safe biasing network. However, the EVAL-ADM2495EEBZ includes provisions for this network via R6 and R7. R7 is a pull-up resistor from the ADM2495E/ADM2495E-1 Pin A to the V_{DD2} supply and R6 is a pull-down resistor from Pin B to the GND_2. These resistors can be fitted if the user is connecting to other devices which require external biasing resistors on the bus. The resistor value depends on the minimum bus idle voltage for the other device(s), the minimum supply voltage, and the termination scheme.

The EVAL-ADM2495EEBZ comes with 1.2kΩ resistors installed in a 0805 sized package.

See the AN-960 Application Note for more information about the bus idle fail-safe.

ON-BOARD LTC6900 OSCILLATOR

The LTC6900 clock oscillator is provided on the EVAL-ADM2495EEBZ to allow the convenient evaluation of the ADM2495E/ADM2495E-1 without the need for an external signal source. The oscillator frequency may be selected via a jumper setting and/or a customer supplied resistor.

The LTC6900 oscillator is powered from the V_{DD1} supply, and can only be used when the V_{DD1} supply voltage is between 2.7 V and 5.5 V. By removing the 0Ω R3 resistor, the LTC6900 is disconnected from the V_{DD1} supply.

To use the LTC6900 oscillator for evaluation, confirm the V_{DD1} supply is properly configured, insert the JP4 jumper in position B. This setting connects the output of the clock oscillator to the ADM2495E/ADM2495E-1 TxD input pin.

Jumper JP5 allows selection of the oscillator frequency to either the preconfigured 100kHz (position B) or 10MHz (position A) when

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jumper JP5 is present. Removing jumper JP5 reduces the frequencies by 10x.

Other frequencies are possible by setting JP6 to position C and populating an 0603 resistor in R12. The oscillator frequency may be calculated using the following equation

$$F_{OSC} = 10\text{MHz}\frac{20\text{k}}{N \times \text{R}_{12}} \quad (1)$$

where R_{12} is in ohms and *N*=1,10.

The value of *N* is controlled with the JP5 link. Insert the JP5 link to set *N* = 1 for higher frequency operation and remove the link to set *N*=10 for lower frequency operation. The EVAL-ADM2495EEBZ ships with the JP5 link populated, *N* = 1.

ADP7104 LDO REGULATOR

The EVAL-ADM2495EEBZ features two on-board ADP7104 LDO regulators which allows flexible power supply configurations during evaluation.

The V_{DD1} regulator, U1, is powered from the VDD1 terminal on connector P5 and is configured using the JP1 jumper. This jumper position selects the regulator output to the V_{DD1} pin. Options of 1.8V, 2.5V, 3.3V or 5V are available. To bypass the output of the ADP7104 regulator, U1, and power the V_{DD1} pin directly from the VDD1 terminal, insert the JP1 jumper to Position E.

The V_{DD2} regulator, U3, is powered from the VDD2 terminal on connector P6 and is configured using the JP8 jumper. This jumper position selects the regulator output to the V_{DD2} pin. Options of 3.3V or 5V are available. To bypass the output of the ADP7104 regulator, U3, and power the V_{DD2} pin directly from the VDD2 terminal, insert the JP8 jumper to Position C.

Table 3 lists the supported power supply configurations and the associated jumper positions for the input side LDO U1. Table 4 lists the supported power supply configurations and the associated jumper positions for the isolated side LDO U3.

Table 3. Primary Side Input Supply Configurations

Jumper JP1	VDD1 Input Voltage Range	V_{DD1} 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	1.7 V to 5.5V	Supplied directly from the VDD1 terminal on P5

Table 4. Isolated Side Input Supply Configurations

Jumper JP8	VDD2 Input Voltage Range	V_{DD2} Supply
A	3.7V to 20V	Regulator provides 3.3V
B	5.4V to 20V	Regulator provides 5V
C	3.0 V to 5.5V	Supplied directly from the VDD2 terminal on P6

GETTING STARTED

HALF-DUPLEX LOOPBACK TEST

The ADM2495E/ADM2495E-1 is a half-duplex RS-485 transceiver which means that the bus pins for 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 theADM2495E/ADM2495E-1 is transmitted by driver and is then received on the RxD output pin of the ADM2495E/ADM2495E-1. This loopback configuration can be used to evaluate both the transmitter and receiver of the ADM2495E/ADM2495E-1 on the EVAL-ADM2495EEBZ.

The details of this loopback test are shown in Figure 2. The internal oscillator is connected to the TxD pin via jumper JP4 being in position B. Jumpers JP5 and JP6 set the oscillator frequency to 100kHz which corresponds to a 200kbps effective bit rate. This allows the verification of the bus signals and the receiver output when the driver and receiver are enabled. The receiver is enabled when JP2 is Position C and the driver is enabled when JP3 is Position A. The JP7 jumper can be inserted to terminate the transmitter and receiver with a 60.4Ω resistor. See Table 3 and Table 4 for the jumper configurations for different power supply configurations.

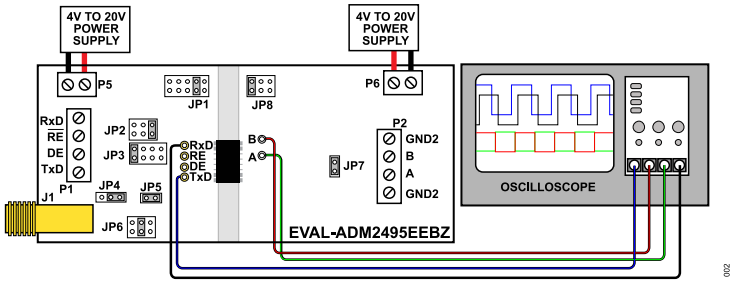

Figure 2. Half-Duplex RS-485 Loopback Test

PCB LAYOUT

The PCB layers are shown in Figure 3 through Figure 6.

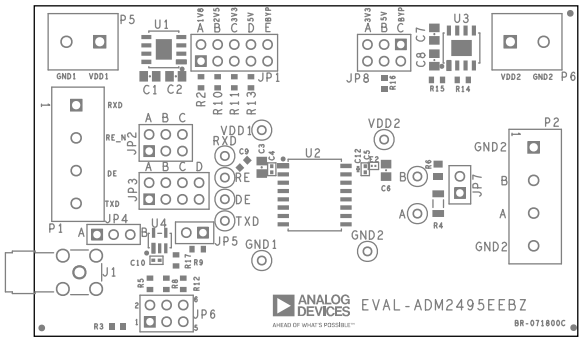

Figure 3. Top Silkscreen

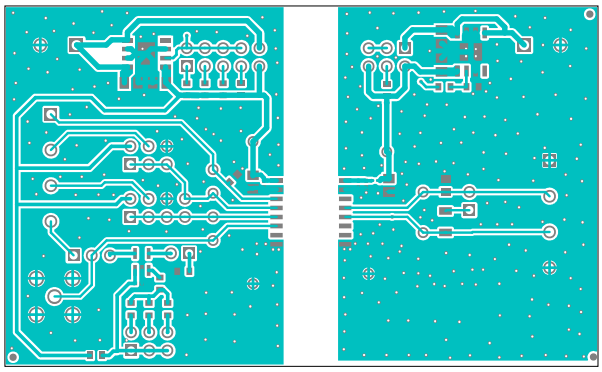

Figure 4. Top Copper

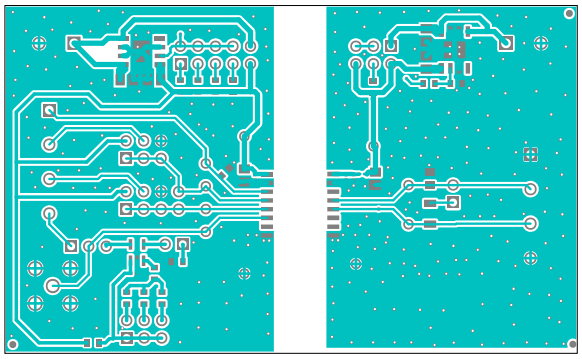

Figure 5. Bottom Copper

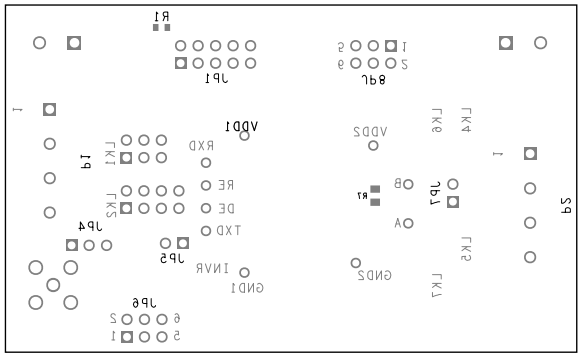

Figure 6. Bottom Silkscreen

SCHEMATIC

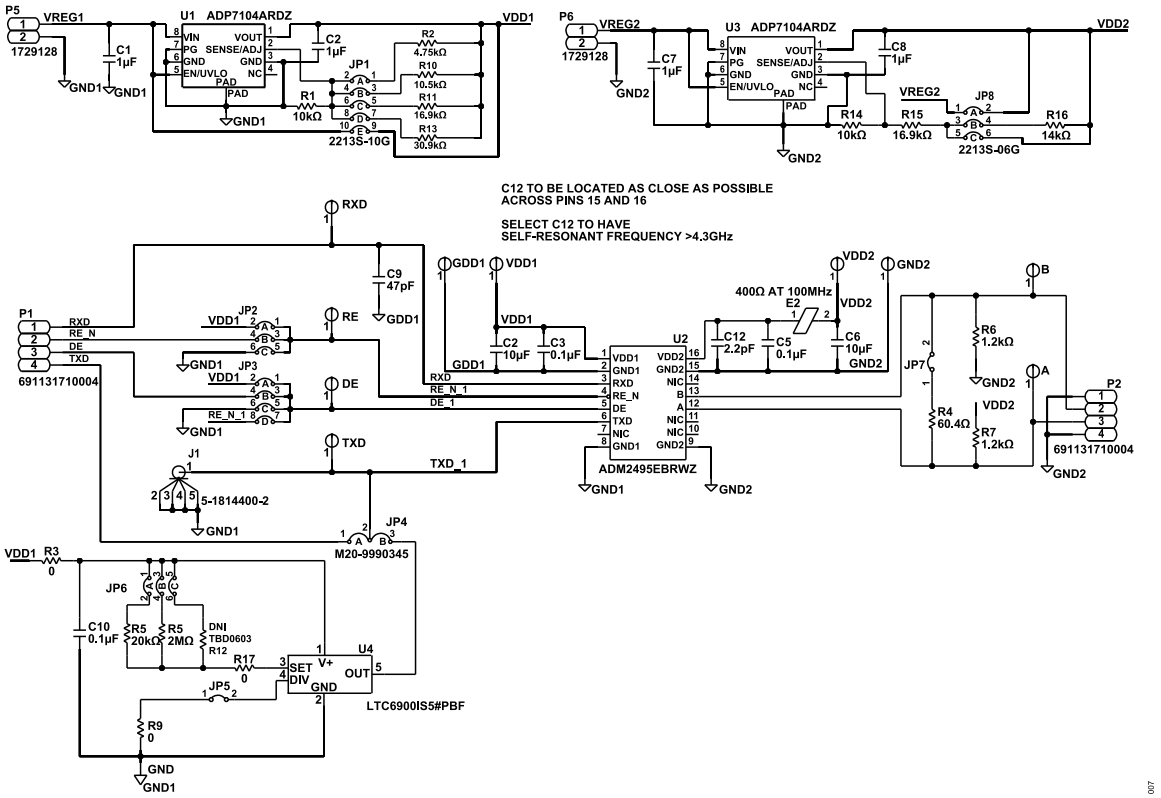

Figure 7. Evaluation Board Schematic

ORDERING INFORMATION

BILL OF MATERIALS

Qty	Designator	Description	Manufacturer	Part Number
6	A, B, DE, RE, RXD, TXD	Connectors, PCB test point yellow	Keystone Electronics	5004
4	C1, C2, C7, C8	Ceramic capacitors, 1µF 25V 10% X7R 0805 AEC-Q200	Murata	GCM21BR71E105KA56L
3	C4, C5, C10	Ceramic capacitors, 0.1µF 50V 10% X7R 0402 AEC-Q200 LOW ESR	TDK	CGA2B3X7R1H104K050BB
1	C12	Silicon capacitors, 2.2pF 25V 0.1pF 0201 AEC-Q200	AVX Corporation	02013J2R2BBSTR
2	C3, C6	Ceramic capacitors, 10µF 25V 10% X5R 0805	Murata	GRM21BR61E106KA73L
1	C9	Ceramic capacitors, 47pF 50V 5% C0G 0603	AVX Corporation	06035A470JAT2A
1	E2	Ferrite bead 400Ω 25% 100MHz 0.125A 2.8Ω DCR AEC-Q200	Murata	BLM03HB401SZ1D
2	GND1, GND2	Connectors-PCB test point black	Components Corporation	TP-105-01-00
1	J1	Connectors-PCB SMA RA die cast	TE Connectivity Ltd	5-1814400-2
1	JP1	Connectors-PCB header jumper, 5X M000385	Multicomp Company	2213S-10G
3	JP2, JP6, JP8	Connectors-PCB header jumper, 3X M000385	Multicomp Company	2213S-06G
1	JP3	Connectors-PCB header jumper, 4X M000385	Multicomp Company	2213S-08G
1	JP4	Connectors-PCB 3-postions male header unshrouded single row, 2.54mm pitch, 3mm solder tail	Harwin	M20-9990345
2	JP5, JP7	Connectors-PCB header 1 row 2 way	Harwin	M20-9990246
2	P1, P2	Connectors-PCB 4-positions header term black horizontal cable entry with press clamp, 5mm pitch, 4mm solder tail	Wurth Elektronik	691131710004
2	P5, P6	Connectors-PCB terminal block 2-position, 5.08mm pitch	Phoenix Contact	1729128
2	R1, R14	Resistors SMD 10kΩ 1% 1/10W 0603 AEC-Q200	Panasonic	ERJ-3EKF1002V
1	R10	Resistors SMD 10.5kΩ 0.1% 1/10W 0603 AEC-Q200 high reliability	Panasonic	ERA-3AEB1052V
2	R11, R15	Resistors SMD 16.9kΩ 1% 1/10W 0603 AEC-Q200	Panasonic	ERJ-3EKF1692V
1	R13	Resistors SMD 30.9kΩ 1% 1/10W 0603 AEC-Q200	Panasonic	ERJ-3EKF3092V
1	R16	Resistors SMD 14.0kΩ 1% 1/10W 0603 AEC-Q200	Panasonic	ERJ-3EKF1402V
3	R3, R9, R 17	Resistors SMD 0Ω jumper 1/10W 0603 AEC-Q200 precision power	Vishay	CRCW06030000Z0EA
1	R2	Resistors SMD 4.75kΩ 1% 1/10W 0603 AEC-Q200	Panasonic	ERJ-3EKF4751V
1	R4	Resistors SMD 60.4Ω 1% 1/4W 1206 AEC-Q200	Panasonic	ERJ-8ENF60R4V
1	R5	Resistors SMD 20kΩ 1% 1/10W 0603 AEC-Q200	Panasonic	ERJ-3EKF2002V
2	R6, R7	Resistors SMD 1.2kΩ 0.1% 1/8W 0805 AEC-Q200 high reliability	Panasonic	ERA-6AEB122V
1	R8	Resistors SMD 2MEGΩ 1% 1/10W 0603	Yageo	RC0603FR-072ML
2	U1, U3	IC-Analog Devices low noise, CMOS LDO adjustable	Analog Devices, Inc.	ADP7104ARDZ-R7
1	U2	5.7kV$_{RMS}$ isolated, high working voltage, RS-485 transceiver with fault protection	Analog Devices, Inc.	ADM2495EBRWZ
1	U4	IC, low power, 1kHz to 20MHz resistor set oscillator	Analog Devices, Inc.	LTC6900IS5#PBF
2	VDD1, VDD2	Connectors, PCB test point red	Components Corporation	TP-105-01-02

ORDERING INFORMATION

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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EVAL-ADM2495EEBZ