ADM2795E

Robust 5kV rms Isolated RS-485/RS-422 Transceiver with Level 4 EMC and Full ±42V Protection

FEATURES

- 5kV rms isolated RS-485/RS-422 transceiver
- ±42V AC/DC peak fault protection on RS-485 bus pins
- Certified Level 4 EMC protection on RS-485 A, B bus pins
  - IEC 61000-4-5 surge protection (±4kV)
  - IEC 61000-4-4 electrical fast transient (EFT) protection (±2kV)
  - IEC 61000-4-2 electrostatic discharge (ESD) protection
    - ±8kV contact discharge
    - ±15kV air discharge
  - IEC 61000-4-6 conducted radio frequency (RF) immunity (10V/m rms)
- Certified IEC 61000-4-x immunity across isolation barrier
  - IEC 61000-4-2 ESD, IEC 61000-4-4 EFT, IEC 61000-4-5 surge, IEC 61000-4-6 conducted RF immunity, IEC 61000-4-3 radiated immunity, IEC 61000-4-8 magnetic immunity
- RS-485 A, B pins human body model (HBM) ESD protection: >±30kV
- Safety and regulatory approvals
  - DIN EN IEC 60747-17 (VDE 0884-17)
    - V_{IORM} = 849V peak
  - UL 1577
    - V_{ISO} = 5000V rms for 1 minute
  - IEC/EN/CSA 60950-1
  - IEC/CSA 60601-1
  - IEC/CSA 61010-1
  - CQC GB4943.1
- TIA/EIA RS-485/RS-422 compliant over full supply range
  - 3V to 5.5V operating voltage range on V_{DD2}
  - 1.7V to 5.5V operating voltage range on V_{DD1} logic supply
- Common-mode input range of −25V to +25V
- High common-mode transient immunity: >75kV/µs
- Robust noise immunity (tested to the IEC 62132-4 standard)
- Passes EN55022 Class B radiated emissions by 6dBµV/m margin
- Receiver short-circuit, open-circuit, and floating input fail-safe
- Supports 256 bus nodes (96kΩ receiver input impedance)
- −40°C to +125°C temperature option
- Glitch free power-up/power-down (hot swap)

APPLICATIONS

- Heating, ventilation, and air conditioning (HVAC) networks
- Industrial field buses
- Building automation
- Utility networks

GENERAL DESCRIPTION

The ADM2795E is a 5kV rms signal isolated RS-485 transceiver that features up to ±42V of AC/DC peak bus overvoltage fault protection on the RS-485 bus pins. The device integrates Analog Devices, Inc., *i*Coupler® technology to combine a 3-channel isolator, RS-485 transceiver, and IEC electromagnetic compatibility (EMC) transient protection in a single package. The ADM2795E is a RS-485/RS-422 transceiver that integrates IEC 61000-4-5 Level 4 surge protection, allowing up to ±4kV protection on the RS-485 bus pins (A and B). The device has IEC 61000-4-4 Level 4 EFT protection up to ±2kV and IEC 61000-4-2 Level 4 ESD protection on the bus pins, allowing this device to withstand up to ±15kV on the transceiver interface pins without latching up. This device has an extended common-mode input range of ±25V to improve data communication reliability in noisy environments. The ADM2795E is capable of operating over wide power supply ranges, with a 1.7V to 5.5V V_{DD1} power supply range, allowing interfacing to low voltage logic supplies. The ADM2795E is also fully TIA/EIA RS-485/RS-422 compliant when operated over a 3V to 5.5V V_{DD2} power supply. The device is fully characterized over an extended operating temperature range of −40°C to +125°C, and is available in a 16-lead, wide-body SOIC package.

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FUNCTIONAL BLOCK DIAGRAM

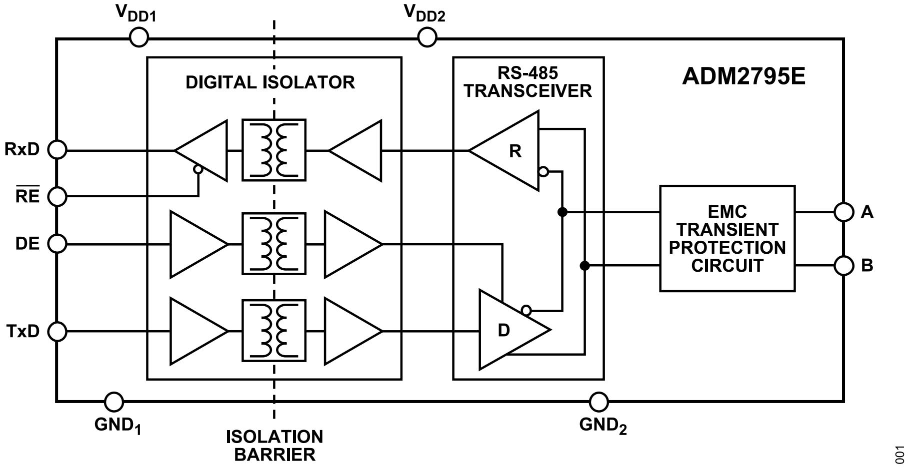


Figure 1. ADM2795E Functional Block Diagram

SPECIFICATIONS

ELECTRICAL SPECIFICATIONS

1.7V ≤ V_{DD1} ≤ 5.5V, 3V ≤ V_{DD2} ≤ 5.5V, T_A = −40°C to +125°C. All minimum/maximum specifications apply over the entire recommended operation range, unless otherwise noted. All typical specifications at T_A = 25°C, V_{DD1} = V_{DD2} = 5.0V, unless otherwise noted.

Table 1. Electrical Characteristics

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions/Comments
SUPPLY CURRENT						
Power Supply Current						
Logic Side	I_{DD1}			10	mA	Unloaded output, DE = V_{DD1}, $\overline{RE}$ = 0V
TxD/RxD Data Rate = 2.5Mbps				10	mA	Unloaded output, DE = V_{DD1}, $\overline{RE}$ = 0V
Bus Side	I_{DD2}			12	mA	Unloaded output, DE = V_{DD1}, $\overline{RE}$ = 0V
TxD/RxD Data Rate = 2.5Mbps				90	mA	Unloaded output, DE = V_{DD1}, $\overline{RE}$ = 0V
				130	mA	DE = V_{DD1}, $\overline{RE}$ = 0V, V_{DD2} = 5.5V, R = 27Ω, see Figure 27
			94		mA	DE = V_{DD1}, $\overline{RE}$ = 0V, V_{DD2} = 5.5V, R = 27Ω, see Figure 27
			46		mA	DE = V_{DD1}, $\overline{RE}$ = 0V, V_{DD2} = 3.0V, R = 27Ω, see Figure 27
Supply Current in Shutdown Mode	I_{SHDN}			10	mA	DE = 0V, $\overline{RE}$ = V_{DD1}
DRIVER						
Differential Outputs						
Differential Output Voltage	$\lvert V_{OD}\rvert$	1.5		5.0	V	V_{DD2} ≥ 3.0V, R = 27Ω or 50Ω, see Figure 27
		2.1		5.0	V	V_{DD2} ≥ 4.5V, R = 27Ω or 50Ω, see Figure 27
	$\lvert V_{OD3}\rvert$	1.5		5.0	V	V_{DD2} ≥ 3.0V, V_{CM} = −25V to +25V, see Figure 28
		2.1		5.0	V	V_{DD2} ≥ 4.5V, V_{CM} = −25V to +25V, see Figure 28
Change in Differential Output Voltage for Complementary Output States	$\Delta\lvert V_{OD}\rvert$			0.2	V	R = 27Ω or 50Ω, see Figure 27
Common-Mode Output Voltage	V_{OC}			3.0	V	R = 27Ω or 50Ω, see Figure 27
Change in Common-Mode Output Voltage for Complementary Output States	$\Delta\lvert V_{OC}\rvert$			0.2	V	R = 27Ω or 50Ω, see Figure 27
Short-Circuit Output Current						
V_{OUT} = Low	I_{OSL}	−250		+250	mA	−42V ≤ V_{SC} ≤ +42V[1]
V_{OUT} = High	I_{OSH}	−250		+250	mA	−42V ≤ V_{SC} ≤ +42V[1]
Logic Inputs (DE, $\overline{RE}$, TxD)						
Input Threshold Low	V_{IL}			0.33 × V_{DD1}	V	1.7V ≤ V_{DD1} ≤ 5.5V
Input Threshold High	V_{IH}	0.7 V_{DD1}			V	1.7V ≤ V_{DD1} ≤ 5.5V
Input Capacitance	C_I		4.0		pF	
Input Current	I_{TxD}			+1	μA	0V ≤ V_{IN} ≤ V_{DD1}
RECEIVER						
Differential Inputs						
Differential Input Threshold Voltage	V_{TH}	−200	−125	−30	mV	−25V ≤ V_{CM} ≤ +25V
Input Voltage Hysteresis	V_{HYS}		30		mV	−25V ≤ V_{CM} ≤ +25V
Input Current (A, B)	I_I	−1.0		+1.0	mA	DE = 0V, V_{DD2} = 0V/5V, V_{IN} = ±25V
		−1.0		+1.0	mA	DE = 0V, V_{DD2} = 0V/5V, V_{IN} = ±42V
Input Capacitance (A, B)	C_{AB}		150		pF	T_A = 25°C, see Figure 17
Line Input Resistance	R_{IN}	96			kΩ	−25V ≤ V_{CM} ≤ +25V, up to 256 nodes supported
Logic Outputs						
Output Voltage Low	V_{OLRxD}			0.2	V	I_{ORxD} = 3.0mA, V_A − V_B = −0.2V

SPECIFICATIONS

Table 1. Electrical Characteristics (Continued)

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions/Comments
Output Voltage High	V_{OHRxD}	V_{DD1} − 0.2			V	I_{ORxD} = −3.0mA, $V_A - V_B$ = 0.2V
Short-Circuit Current				100	mA	V_{OUT} = GND or V_{DD1}, $\overline{RE}$ = 0V
Three-State Output Leakage Current	I_{OZR}			±2	µA	$\overline{RE}$ = V_{DD1}, RxD = 0V or V_{DD1}
COMMON-MODE TRANSIENT IMMUNITY[2]		75	125		kV/µs	V_{CM} ≥1kV, transient magnitude ≥800V

[1] V_{SC} is the short-circuit voltage at the RS-485 A or B bus pin.

[2] Common-mode transient immunity is the maximum common-mode voltage slew rate that can be sustained while maintaining specification-compliant operation. V_{CM} is the common-mode potential difference between the logic and bus sides. The transient magnitude is the range over which the common mode is slewed. The common-mode voltage slew rates apply to both rising and falling common-mode voltage edges.

TIMING SPECIFICATIONS

V_{DD1} = 1.7V to 5.5V, V_{DD2} = 3.0V to 5.5V, T_A = T_{MIN} to T_{MAX} (−40°C to +125°C), unless otherwise noted.

Table 2. Timing Characteristics

Parameter	Min	Typ	Max	Unit	Test Conditions/Comments
DRIVER[1]					
Maximum Data Rate	2.5			Mbps	
Propagation Delay, t_{DPLH}, t_{DPHL}		30	500	ns	R_{LDIFF} = 54Ω, C_{L1} = C_{L2} = 100pF, see Figure 29 and Figure 33
Differential Skew, t_{SKEW}		10	50	ns	R_{LDIFF} = 54Ω, C_{L1} = C_{L2} = 100pF, see Figure 29 and Figure 33
Rise/Fall Times, t_R, t_F		40	130	ns	R_{LDIFF} = 54Ω, C_{L1} = C_{L2} = 100pF, see Figure 29 and Figure 33
Enable Time, t_{ZH}, t_{ZL}		500	2500	ns	R_L = 110Ω, C_L = 50pF, see Figure 30 and Figure 35
Disable Time, t_{HZ}, t_{LZ}		500	2500	ns	R_L = 110Ω, C_L = 50pF, see Figure 30 and Figure 35
RECEIVER[2]					
Propagation Delay, t_{PLH}, t_{PHL}		120	200	ns	C_L = 15pF, see Figure 31 and Figure 34, 10, V_{ID} ≥ ±1.5V
		140	220	ns	C_L = 15pF, see Figure 31 and Figure 34, V_{ID} ≥ ±600mV
Skew, t_{SKEW}		4	40	ns	C_L = 15pF, see Figure 31 and Figure 34, V_{ID} ≥ ±1.5V
Enable Time		10	50	ns	R_L = 1kΩ, C_L = 15pF, see Figure 32 and Figure 36
Disable Time		10	50	ns	R_L = 1kΩ, C_L = 15pF, see Figure 32 and Figure 36
RxD Pulse Width Distortion			40	ns	C_L = 15pF, see Figure 31 and Figure 34, V_{ID} ≥ ±1.5V

[1] See Figure 29 for the definition of R_{LDIFF}.

[2] Receiver propagation delay, skew, and pulse width distortion specifications are tested with a receiver differential input voltage (V_{ID}) of ≥±600mV or ≥±1.5V, as noted.

INSULATION SPECIFICATIONS

The ADM2795E is suitable for "safe electrical insulation" only within the safety limiting ratings. Compliance with the safety limiting ratings shall be ensured by means of suitable protective circuits.

Table 3. ADM2795E 16-Lead Standard Small Outline Package [SOIC_W] (RW-16) Insulation Characteristics

Parameter	Symbol	Value	Unit	Test Conditions/Comments
GENERAL				
Minimum External Clearance Distance	CLR	7.8	mm	Measured from input terminals to output terminals, shortest distance through air per IEC 60664-1
Minimum External Creepage Distance	CRP	7.8	mm	Measured from input terminals to output terminals, shortest distance along body per IEC 60664-1
Distance Through Insulation	DTI	29.0	µm	Minimum internal
Comparative Tracking Index	CTI	>400	V	Per IEC 60112
Material Group		II		Per IEC 60664-1
Overvoltage Category per IEC 60664-1		I to IV		Rated mains voltage ≤ 300V rms

SPECIFICATIONS

Table 3. ADM2795E 16-Lead Standard Small Outline Package [SOIC_W] (RW-16) Insulation Characteristics (Continued)

Parameter	Symbol	Value	Unit	Test Conditions/Comments
		I to III		Rated mains voltage ≤ 400V rms
SAFETY LIMITING VALUES				
Maximum Ambient Safety Temperature	T_S	150	°C	
Maximum Total Power Dissipation	P_{TOT}	1.8	W	$T_A \leq 25°C$, $P_{TOT} = P_{SI} = P_{SO}$
Derating Above Ambient (T_A)		14.4	mW/°C	$T_A > 25°C$, see Figure 2
Junction-to-Air Thermal Impedance	θ_{JA}	59.7	°C/W	See the Thermal Resistance section
IEC 60747-17 (REINFORCED INSULATION)				
Maximum Repetitive Peak Isolation Voltage	V_{IORM}	849	V peak	
Maximum Isolation Working Voltage	V_{IOWM}	600	V rms	AC voltage, end of life test, f = 60Hz
		849	V peak	DC voltage
Maximum Transient Isolation Voltage	V_{IOTM}	7000	V peak	$V_{TEST} \geq 1.2 \times V_{IOTM}$, t = 1s (100% production)
Maximum Impulse Voltage	V_{IMP}	7000	V peak	Surge voltage in air, waveform per IEC 61000-4-5
Maximum Surge Isolation Voltage	V_{IOSM}	12800	V peak	$V_{TEST} \geq 1.3 \times V_{IMP}$ minimum 10kV (type test), tested in oil, waveform per IEC 61000-4-5
Apparent Charge	q_{pd}	≤5	pC	Method a (sample test), $V_{ini} = V_{IOTM}$, t_{ini} = 60s, $V_{pd(m)} = 1.6 \times V_{IORM}$, t_m = 10s Method b1 (100% production), $V_{ini} \geq 1.2 \times V_{IOTM}$, t_{ini} = 1s, $V_{pd(m)} = 1.875 \times V_{IORM}$, t_m = 1s
Resistance (Input to Output)[1]	R_{IO}	$>10^{13}$	Ω	T_A = 25°C, V_{TEST} = 500V DC, t = 60 s
	R_{IO_S}	$>10^{9}$	Ω	$T_A = T_S$, V_{TEST} = 500V DC, t = 60s
Capacitance (Input to Output)[1]	C_{IO}	2.2	pF	f_{TEST} = 1MHz
Climatic Category		40/125/21		
Pollution Degree		2		Per IEC 60664-1
UL 1577				
Maximum Withstanding Isolation Voltage	V_{ISO}	5000	V rms	$V_{TEST} = 1.2 \times V_{ISO}$, t = 1s (100% production)

[1] Device measured as a 2-terminal device with Pin 1 to Pin 8 connected and Pin 9 to Pin 16 connected.

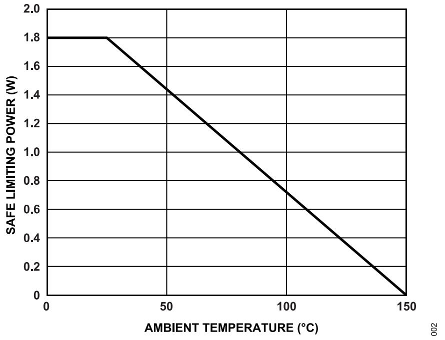


Figure 2. Thermal Derating Curve for 16-Lead Standard Small Outline Package [SOIC_W] (RW-16) Package, Dependence of Safety Limiting Power with Ambient Temperature per IEC 60747-17

SPECIFICATIONS

REGULATORY INFORMATION

The ADM2795E has been approved by the organizations listed in Table 4. Copies of the relevant certificates are available at Safety and Regulatory Certifications for Digital Isolation.

Table 4. ADM2795E 16-Lead Standard Small Outline Package [SOIC_W] (RW-16) Package Certifications

Regulatory Agency	Safety Standard/Rating	File or Certificate Number
UL	UL 1577 Single protection, 5000V rms isolation voltage	File E214100
CSA[1]	CSA/EN/IEC 60950-1 Basic insulation at 780V rms Reinforced insulation at 390V rms CSA/IEC 60601-1 2 MOPP at 237.5V rms CSA/IEC 61010-1 Basic insulation at 600V rms[2]	File 205078
VDE	DIN EN IEC 60747-17 (VDE 0884-17) Reinforced insulation at 849V peak	Certificate 40051926
CQC	GB 4943.1 Basic insulation at 780V rms Reinforced insulation at 390V rms	Certificate CQC18001204896

[1] Working voltages are quoted for Pollution Degree 2, Material Group III and Overvoltage Category II except where otherwise specified. The ADM2795E case material has been evaluated by CSA as Material Group II.

[2] Overvoltage Category III.

ABSOLUTE MAXIMUM RATINGS

T_A = 25°C, unless otherwise noted.

Table 5.

Parameter	Rating
V_{DD1}	−0.5V to +7V
V_{DD2}	−0.5V to +7V
Digital Input/Output Voltage (DE, $\overline{RE}$, TxD, RxD)	−0.3V to V_{DD1} + 0.3V
Driver Output/Receiver Input Voltage	±48V
Operating Temperature Range	−40°C to +125°C
Storage Temperature Range	−65°C to +150°C
Maximum Junction Temperature	150°C
Continuous Total Power Dissipation	405mW
Lead Temperature	
Soldering (10 sec)	300°C
Vapor Phase (60 sec)	215°C
Infrared (15 sec)	220°C

Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the product. This is a stress rating only; functional operation of the product at these or any other conditions above those indicated in the operational section of this specification is not implied. Operation beyond the maximum operating conditions for extended periods may affect product reliability.

THERMAL RESISTANCE

Thermal performance is directly linked to PCB design and operating environment. Careful attention to PCB thermal design is required.

θ_{JA} is the natural convection junction to ambient thermal resistance measured in a one cubic foot sealed enclosure. θ_{JC} is the junction to case thermal resistance.

Table 6. Thermal Resistance

Package Type	θ_{JA}[1]	θ_{JC}[1]	Unit
RW-16	59.7	28.3	°C/W

[1] Thermal impedance simulated values are based on a JEDEC 2S2P thermal test board with no vias. See JEDEC JESD51.

ELECTROSTATIC DISCHARGE (ESD) RATINGS

The following ESD information is provided for handling of ESD-sensitive devices in an ESD-protected area only.

Human body model (HBM) per ANSI/ESDA/JEDEC JS-001.

Charged device model (CDM) per ANSI/ESDA/JEDEC JS-002.

International Electrotechnical Commission (IEC) electromagnetic compatibility: Part 4-2 (IEC) per IEC 61000-4-2.

Air Discharge (DO-160G) per DO-160G Section 25 ESD Protection

Table 7. ADM2795E, 16-Lead Standard Small Outline Package [SOIC_W] (RW-16) ESD Characteristics

Table 7. ADM2795E, 16-Lead Standard Small Outline Package [SOIC_W] (RW-16) ESD Characteristics (Continued)

ESD Model	Withstand Threshold (kV)	Class
HBM	≥±6	3A[1]
	>±30	3B[2]
CDM	1.25	C5[1]
IEC	±8 (contact) to GND_2	Level 4[2]
	±15 (air) to GND_2	Level 4[2]
	±9 (contact) to GND_1	Level 4[2, 3]
	±8 (air) to GND_1	Level 3[2, 3]
DO-160G	±15 (air)[2]	

[1] All pins.

[2] Pin A and Pin B only.

[3] Limited by clearance across isolation barrier.

ELECTRICAL FAST TRANSIENTS (EFT) AND SURGE RATINGS

International Electrotechnical Commission (IEC) electromagnetic compatibility: Part 4-4 (IEC) per IEC 61000-4-4.

Table 8. ADM2795E, 16-Lead Standard Small Outline Package [SOIC_W] (RW-16) EFT Characteristics

Model	Withstand Threshold (kV)	Repetition Frequency (kHz)	Class
IEC	±2 to GND_2	5 or 100	Level 4[1]
	±2 to GND_1	5 or 100	Level 4[1]

[1] Pin A and Pin B only.

International Electrotechnical Commission (IEC) electromagnetic compatibility: Part 4-5 (IEC) per IEC 61000-4-5

Table 9. ADM2795E, 16-Lead Standard Small Outline Package [SOIC_W] (RW-16) Surge Characteristics

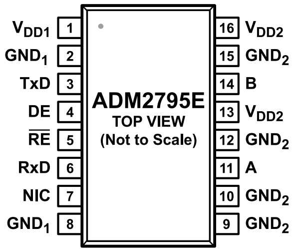
Model	Withstand Threshold (kV)	Class
IEC	±4 to GND_2	Level 4[1]
	±4 to GND_1	Level 4[1]

[1] Pin A and Pin B only.

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.

PIN CONFIGURATION AND FUNCTION DESCRIPTIONS



NOTES
1. NIC = NOT INTERNALLY CONNECTED.

Figure 3. Pin Configuration

Table 10. Pin Function Descriptions

Pin No.	Mnemonic	Description
1	V_{DD1}	1.7V to 5.5V Flexible Logic Interface Supply.
2	GND_1	Ground 1, Logic Side.
3	TxD	Transmit Data Input. Data to be transmitted by the driver is applied to this input.
4	DE	Driver Output Enable. A high level on this pin enables the driver differential outputs, A and B. A low level places them into a high impedance state.
5	$\overline{RE}$	Receiver Enable Input. This pin is an active low input. Driving this input low enables the receiver, and driving it high disables the receiver.
6	RxD	Receiver Output Data. This output is high when (A – B) > −30mV and low when (A – B) < −200mV.
7	NIC	Not Internally Connected. This pin is not internally connected.
8	GND_1	Ground 1, Logic Side.
9	GND_2	Isolated Ground 2, Bus Side.
10	GND_2	Isolated Ground 2, Bus Side.
11	A	Noninverting Driver Output/Receiver Input. When the driver is disabled, or when V_{DD1} or V_{DD2} is powered down, Pin A is put into a high impedance state to avoid overloading the bus.
12	GND_2	Isolated Ground 2, Bus Side.
13	V_{DD2}	3V to 5.5V Power Supply. Pin 13 must be connected externally to Pin 16.
14	B	Inverting Driver Output/Receiver Input. When the driver is disabled, or when V_{DD1} or V_{DD2} is powered down, Pin B is put into a high impedance state to avoid overloading the bus.
15	GND_2	Isolated Ground 2, Bus Side.
16	V_{DD2}	3V to 5.5V Power Supply. Pin 16 must be connected externally to Pin 13.

TYPICAL PERFORMANCE CHARACTERISTICS

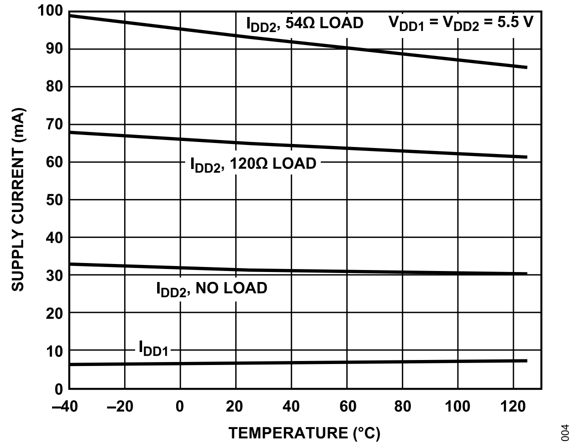


Figure 4. Supply Current (I_{CC}) vs. Temperature at R_L = 54Ω, 120Ω, and No Load; Data Rate = 2.5Mbps, V_{DD1} = 5.5V, V_{DD2} = 5.5V

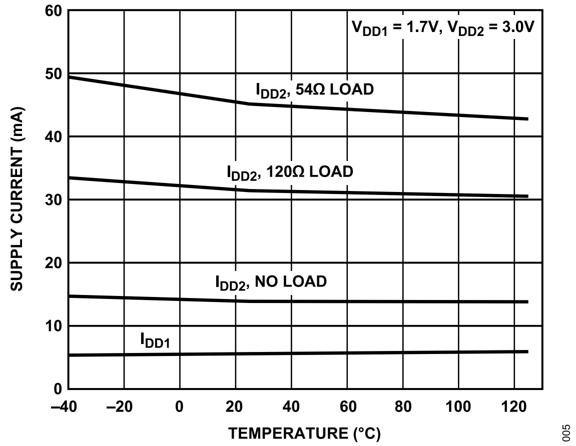


Figure 5. Supply Current (I_{CC}) vs. Temperature at R_L = 54Ω, 120Ω, and No Load; Data Rate = 2.5Mbps, V_{DD1} = 1.7V, V_{DD2} = 3.0V

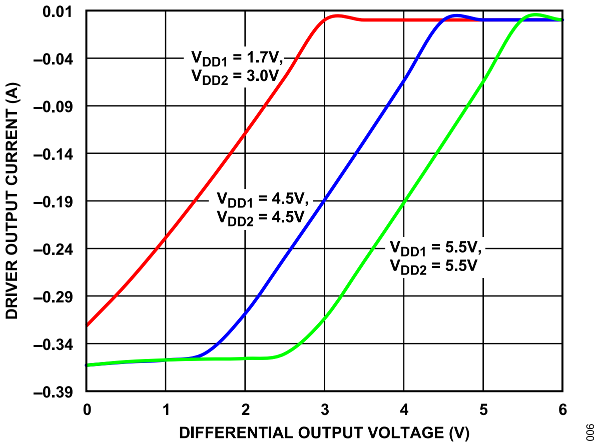


Figure 6. Driver Output Current vs. Differential Output Voltage

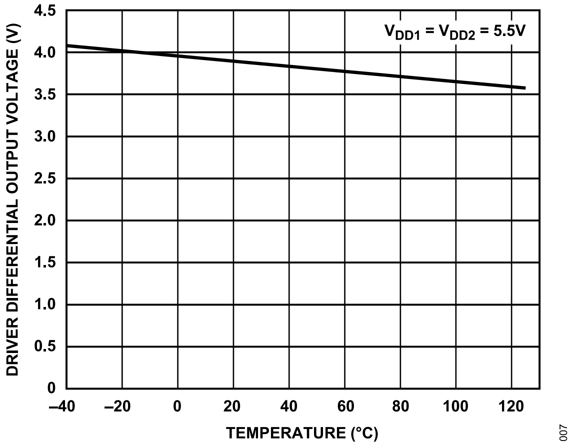


Figure 7. Driver Differential Output Voltage vs. Temperature

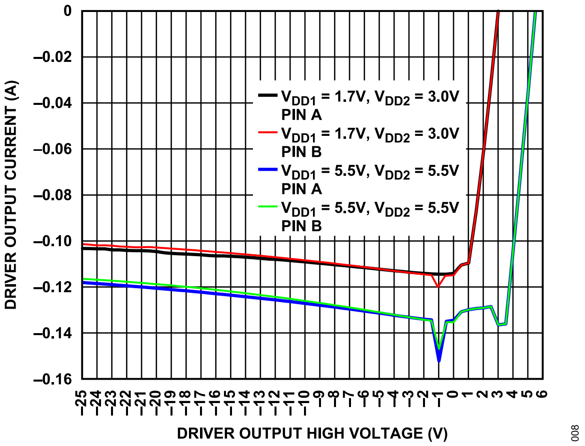


Figure 8. Driver Output Current vs. Driver Output High Voltage

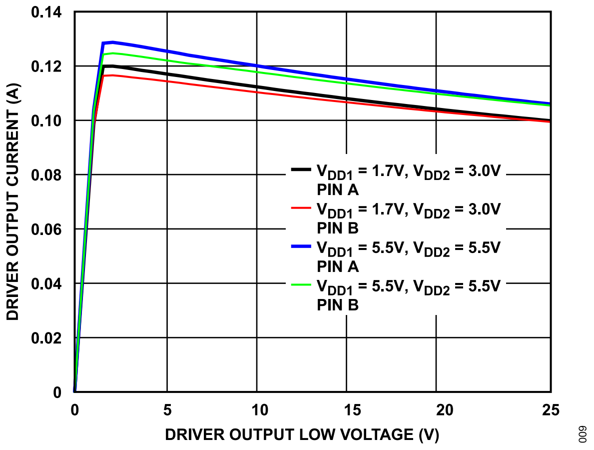


Figure 9. Driver Output Current vs. Driver Output Low Voltage

TYPICAL PERFORMANCE CHARACTERISTICS

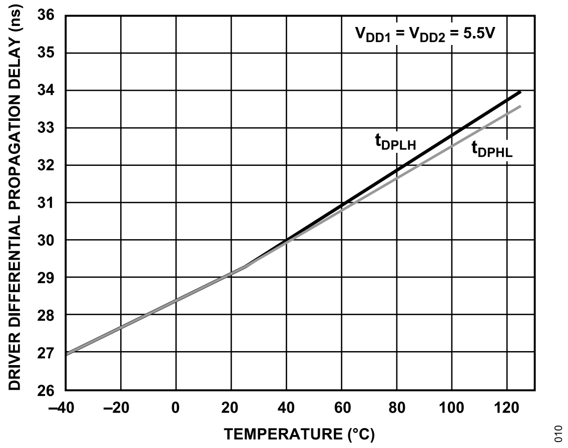


Figure 10. Driver Differential Propagation Delay vs. Temperature

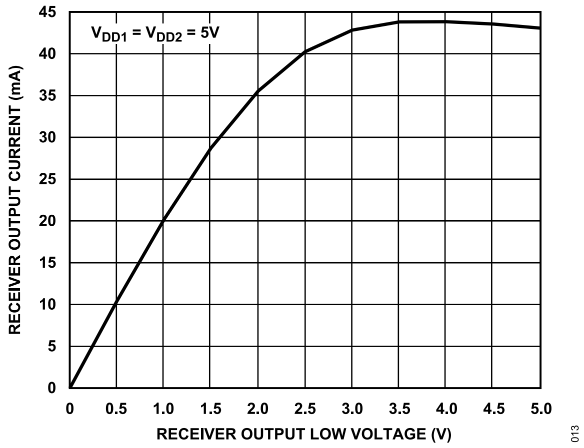


Figure 13. Receiver Output Current vs. Receiver Output Low Voltage

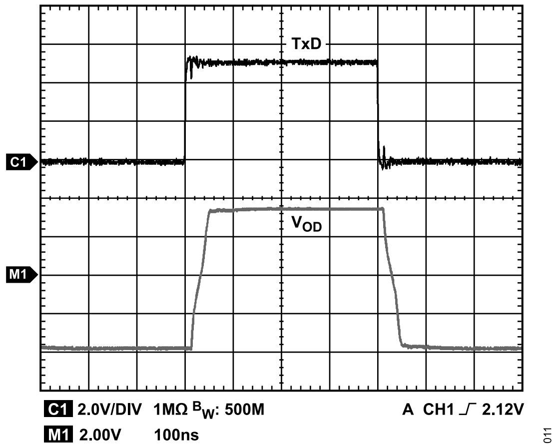


Figure 11. Driver Propagation Delay (Oscilloscope)

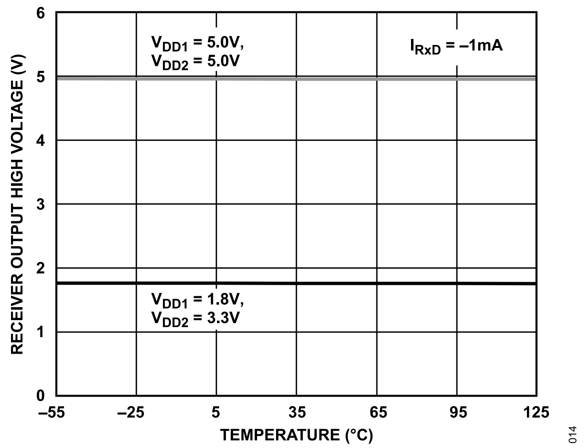


Figure 14. Receiver Output High Voltage vs. Temperature

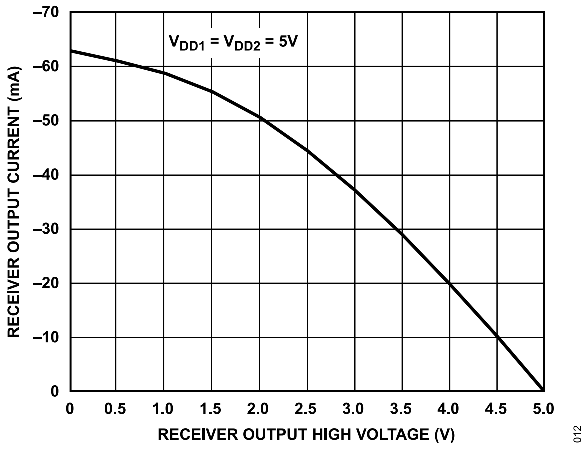


Figure 12. Receiver Output Current vs. Receiver Output High Voltage

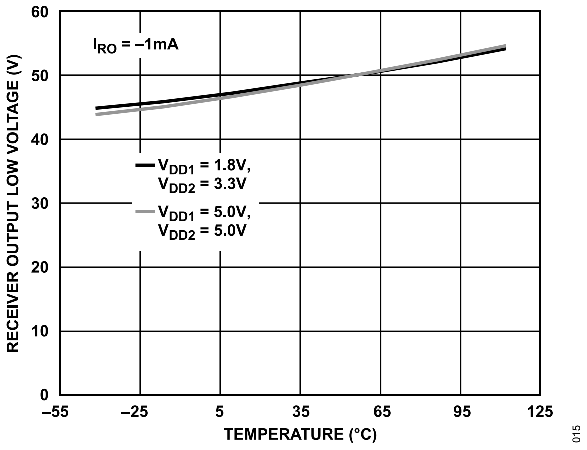


Figure 15. Receiver Output Low Voltage vs. Temperature

TYPICAL PERFORMANCE CHARACTERISTICS

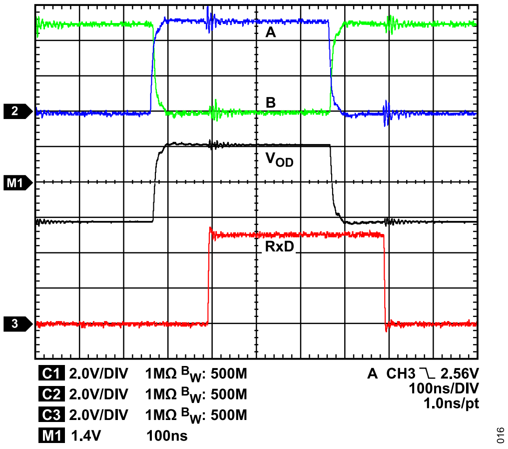


Figure 16. Receiver Propagation Delay (Oscilloscope)

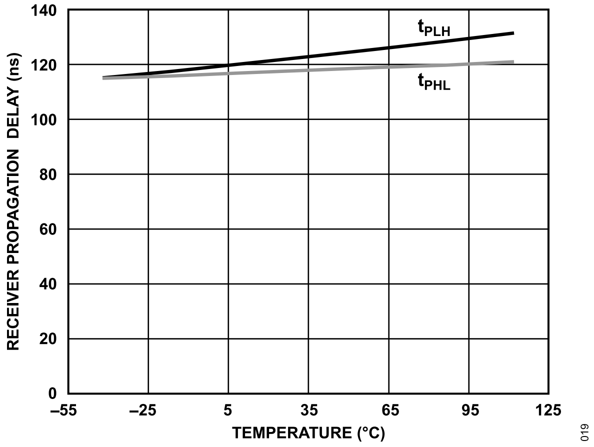


Figure 19. Receiver Propagation Delay vs. Temperature

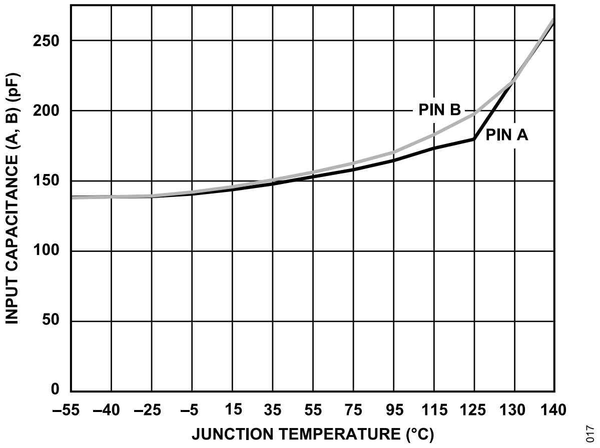


Figure 17. Input Capacitance (A, B) vs. Junction Temperature

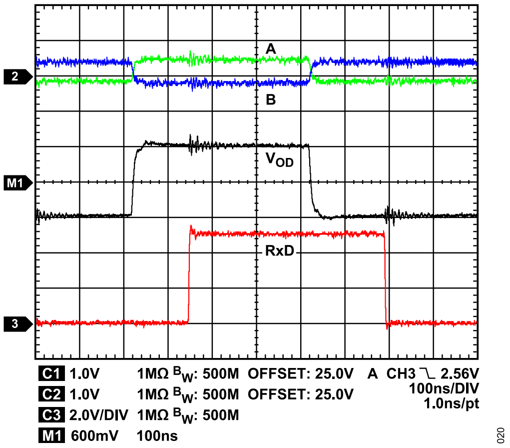


Figure 20. Receiver Performance with Input Common-Mode Voltage of 25V

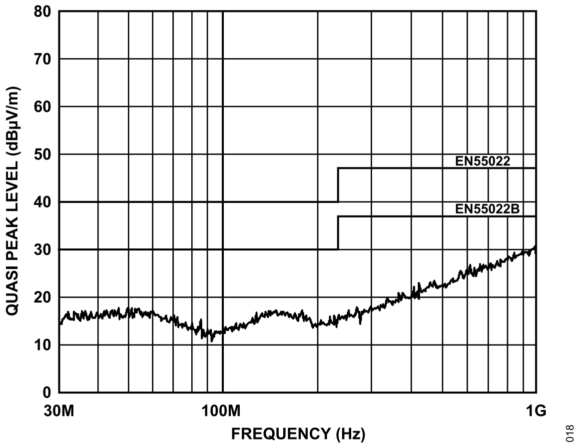


Figure 18. Radiated Emissions Profile with 120pF Capacitor to GND_1 on the RxD Pin (Horizontal Scan, Data Rate = 2.5Mbps, V_{DD1} = V_{DD2} = 5.0V)

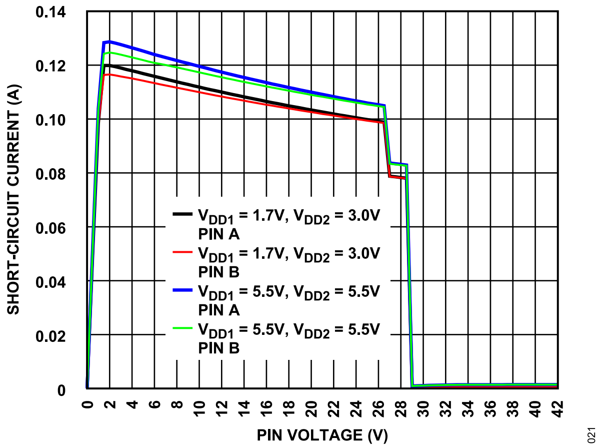


Figure 21. Short-Circuit Current over Fault Voltage Range

TYPICAL PERFORMANCE CHARACTERISTICS

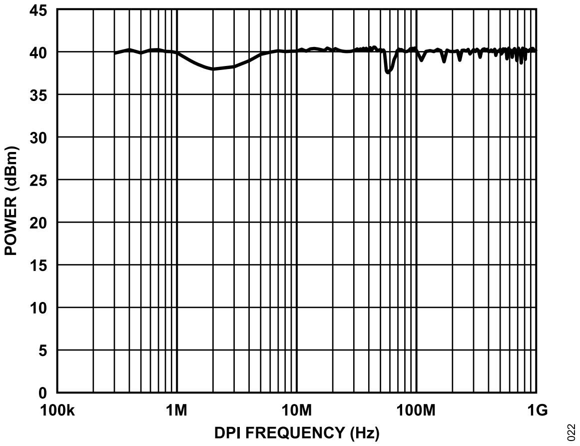


Figure 22. DPI IEC 62132-4 Noise Immunity with 100nF and 10µF Decoupling on V_{DD1}

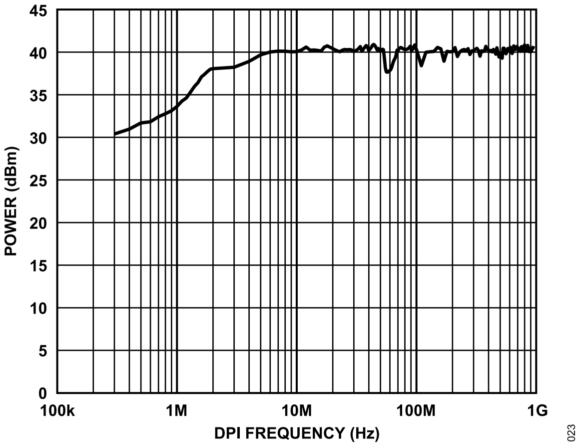


Figure 23. DPI IEC 62132-4 Noise Immunity with 100nF Decoupling on V_{DD1}

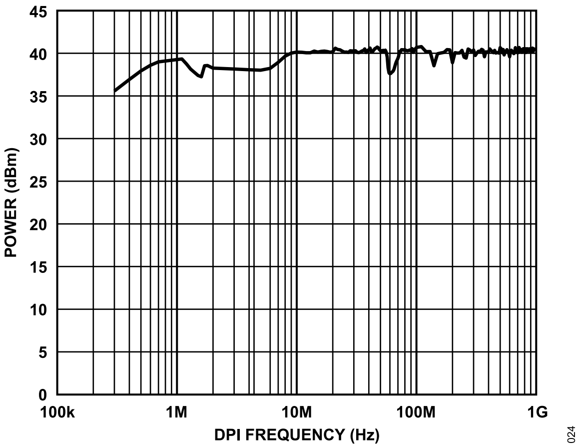


Figure 24. DPI IEC 62132-4 Noise Immunity with 100nF and Decoupling on V_{DD2}

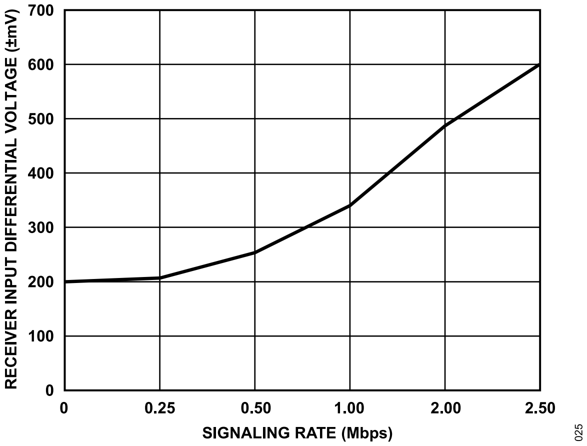


Figure 25. Receiver Input Differential Voltage (V_{ID}) vs. Signaling Rate

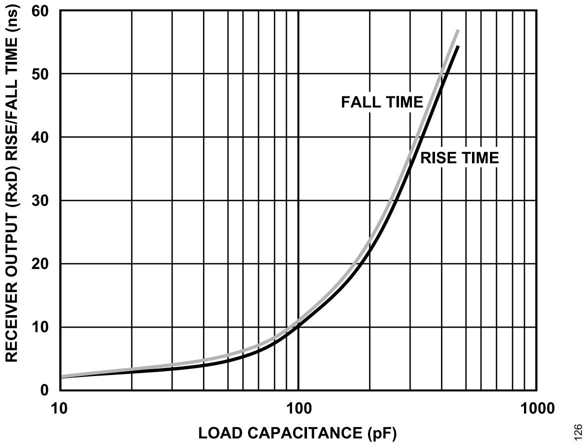


Figure 26. Receiver Output (RxD) Rise/Fall Time vs. Load Capacitance

TEST CIRCUITS

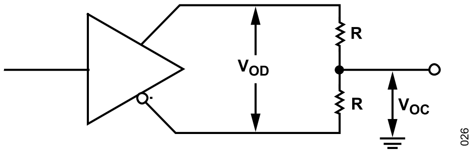


Figure 27. Driver Voltage Measurement

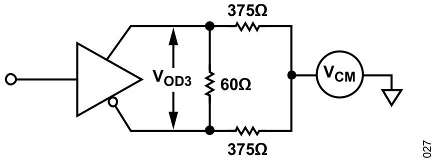


Figure 28. Driver Voltage Measurement over Common-Mode Voltage Range

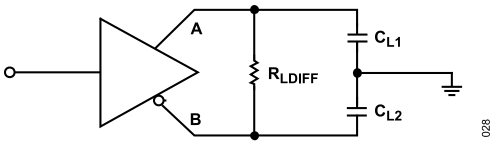


Figure 29. Driver Propagation Delay

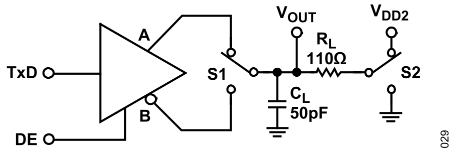


Figure 30. Driver Enable/Disable

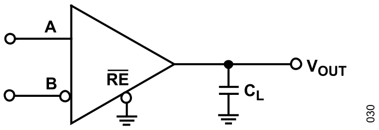


Figure 31. Receiver Propagation Delay

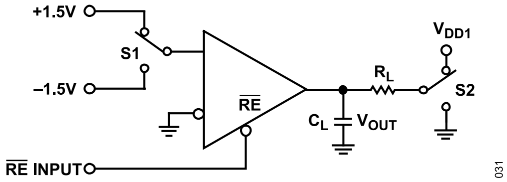


Figure 32. Receiver Enable/Disable

TEST CIRCUITS

SWITCHING CHARACTERISTICS

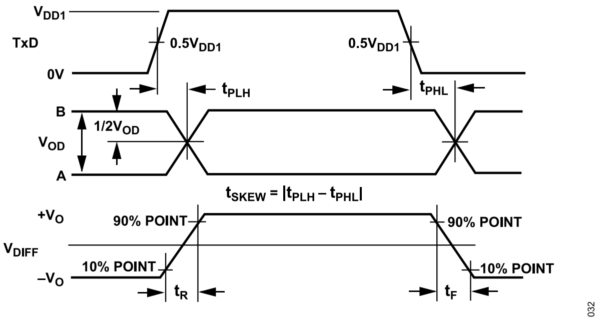


Figure 33. Driver Propagation Delay, Rise/Fall Timing

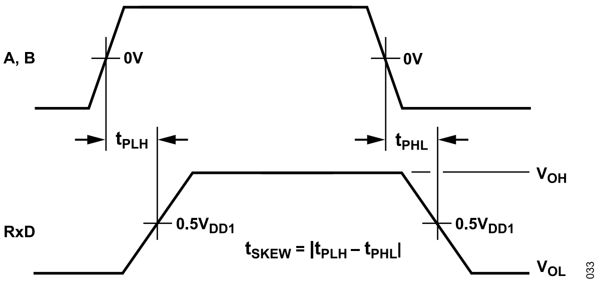


Figure 34. Receiver Propagation Delay

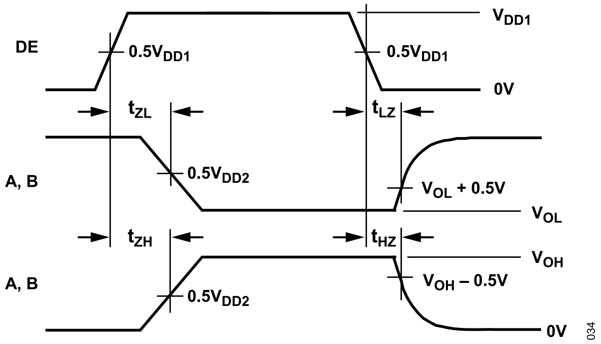


Figure 35. Driver Enable/Disable Timing

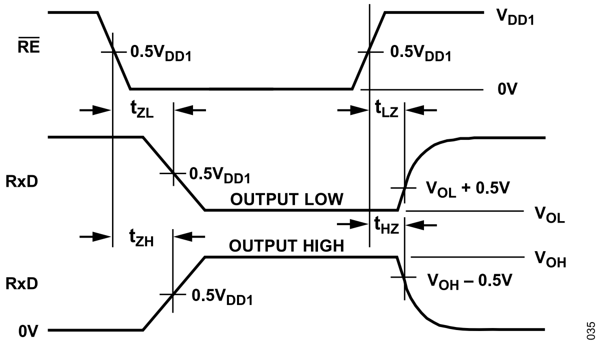


Figure 36. Receiver Enable/Disable Timing

THEORY OF OPERATION

RS-485 WITH ROBUSTNESS

The ADM2795E is a 3V to 5.5V RS-485/RS-422 transceiver with robustness that reduces system failures when operating in harsh application environments.

The ADM2795E is an RS-485/RS-422 transceiver that integrates IEC 61000-4-5 Level 4 surge protection, allowing up to ±4kV of protection on the RS-485 bus pins without the need for external protection components such as transient voltage suppressors (TVS) or TISP® surge protectors. The ADM2795E has IEC 61000-4-4 Level 4 EFT protection up to ±2kV and IEC 61000-4-2 Level 4 ESD protection on the bus pins.

The ADM2795E is an RS-485 transceiver that offers a defined level of overvoltage fault protection in addition to IEC 61000-4-2 ESD, IEC 61000-4-4 EFT, and IEC 61000-4-5 surge protection for the RS-485 bus pins.

INTEGRATED AND CERTIFIED IEC EMC SOLUTION

The driver outputs/receiver inputs of RS-485 devices often experience high voltage faults resulting from short circuits to power supplies that exceed the −7V to +12V range specified in the TIA/EIA-485-A standard. Typically, RS-485 applications require costly external protection devices, such as positive temperature coefficient (PTC) fuses, for operation in these harsh electrical environments. In harsh electrical environments, system designers also must consider common EMC problems, choosing components to provide IEC 61000-4-2 ESD, IEC 61000-4-4 EFT, and IEC 61000-4-5 surge protection for the RS-485 bus pins.

In choosing suitable EMC protection components, the system designer is faced with two challenges: complying with EMC regulations, and matching the dynamic breakdown characteristics of the EMC protection to the RS-485 transceiver. To overcome these challenges, the designer may need to run multiple design, test, and printed circuit board (PCB) board iterations, leading to a slower time to market and project budget overruns.

To reduce system cost and design complexity, the ADM2795E provides certified integrated EMC protection and overvoltage fault protection on the RS-485 bus pins. The ADM2795E integrated EMC and overvoltage fault protection circuits are optimally performance matched, saving the circuit designer significant design and testing time.

Figure 37 shows an isolated EMC protected RS-485 circuit layout example, which targets IEC 61000-4-2 ESD Level 4, IEC 61000-4-4 EFT Level 4, and IEC 61000-4-5 surge protection to Level 4 for the RS-485 bus pins. This circuit uses several discrete components, including two TISP surge protectors, two transient blocking units (TBUs), and one dual TVS. Due to the integrated protection components of the ADM2795E, the PCB area is significantly reduced when compared to a solution with discrete EMC protection components.

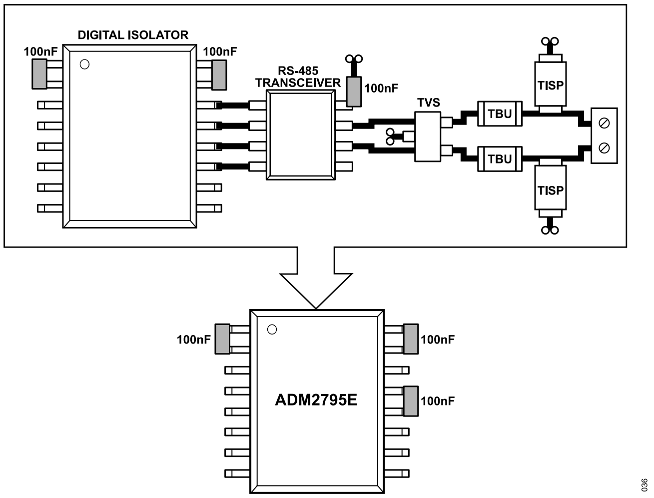


Figure 37. ADM2795E Certified Integrated IEC 61000-4-5 Surge Solution, Saving the Designer Significant PCB Area

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OVERVOLTAGE FAULT PROTECTION

The ADM2795E is an RS-485 transceiver that offers fault protection over a 3V to 5.5V V_{DD2} operating range without the need for close examination of the logic pin state (TxD input and the DE and $\overline{RE}$ enable pins) of the RS-485 transceiver. The transceiver is also fault protected over the entire extended common-mode operating range of ±25V.

The ADM2795E RS-485 driver outputs/receiver inputs are protected from short circuits to any voltage within the range of –42V to +42V AC/DC peak. The maximum short-circuit output current in a fault condition is ±250mA. The RS-485 driver includes a foldback current limiting circuit that reduces the driver current at voltages above the ±25V common-mode range limit of the transceiver (see Figure 21 in the Typical Performance Characteristics section). This current reduction due to the foldback feature allows better management of power dissipation and heating effects.

±42 V MISWIRE PROTECTION

The ADM2795E is protected against high voltage miswire events when it operates on a bus that does not have RS-485 termination or bus biasing resistors installed. A typical miswire event is where a high voltage 24V AC/DC power supply is connected directly to RS-485 bus pin connectors. The ADM2795E can withstand miswiring faults of up to ±42V peak on the RS-485 bus pins with respect to GND_2 without damage. Miswiring protection is guaranteed on the ADM2795E RS-485 A and B bus pins, and is guaranteed in the case of a hot swap of connectors to the bus pins. Table 11 and Table 12 provide a summary of the high voltage miswire protection offered by the ADM2795E. The ADM2795E is tested with ±42V DC and with ±24V ± 20% rms, 50Hz/60Hz, with both a hot plug and DC ramp test waveforms. The test is performed in both powered and unpowered/floating power supply cases, and at a range of different states for the RS-485 TxD input and the DE and $\overline{RE}$ enable pins. The RS-485 bus pins survive a high voltage miswire from Pin A to GND_2, from Pin B to GND_2, and between Pin A and Pin B.

Table 11. Miswire Protection Table Abbreviations

Letter	Description
H	High level for logic pin
L	Low level for logic pin
X	On or off power supply state

Table 12. High Voltage Miswire Protection

Supply		Inputs			Miswire Protection at RS-485 Outputs Pins[1, 2]
V_{DD1}	V_{DD2}	DE	$\overline{RE}$	TxD	
X	X	H/L	H/L	H/L	$-42V\ DC \le V_A \le +42V\ DC$
X	X	H/L	H/L	H/L	$-42V\ DC \le V_B \le +42V\ DC$
X	X	H/L	H/L	H/L	$-42V\ AC \le V_A \le +42V\ AC$
X	X	H/L	H/L	H/L	$-42V\ AC \le V_B \le +42V\ AC$

[1] This is the AC/DC peak miswire voltage between Pin A and GND_2, or Pin B and GND_2, or between Pin A and Pin B.

[2] V_A refers to the voltage on Pin A, and V_B refers to the voltage on Pin B.

RS-485 NETWORK BIASING AND TERMINATION

For a high voltage miswire on the RS-485 A and B bus pins with biasing and termination resistors installed, there is a current path through the biasing network to the ADM2795E power supply pin, V_{DD2}. To protect the ADM2795E in this scenario, the device has an integrated V_{DD2} protection circuit.

The ADM2795E is a fault protected RS-485 device that also features protection for its power supply pin. This means that the current path through the R1 pull-up resistor does not cause damage to the V_{DD2} pin, although the pull-up resistor itself can be damaged if not appropriately power rated (see Figure 38). The R1 pull-up resistor power rating depends on the miswire voltage and the resistance value.

If there is a miswire between the A and B pins in the Figure 38 bus setup, the ADM2795E is protected, but the RT bus termination resistor can be damaged if not appropriately power rated. The RT termination resistor power rating depends on the miswire voltage and the resistance value.

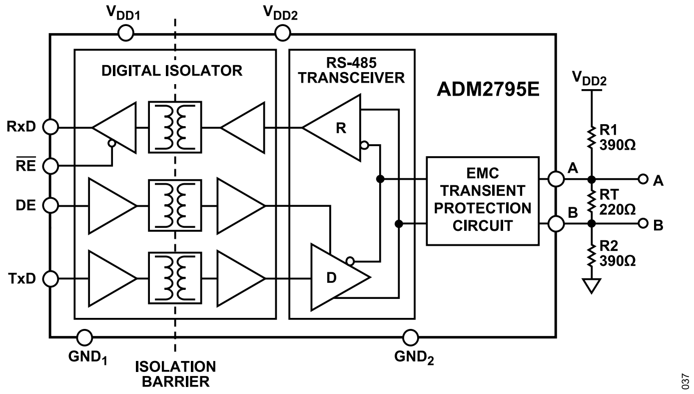

Figure 38. High Voltage Miswiring Protection for the ADM2795E with Bus Termination and Biasing Resistor

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IEC ESD, EFT, AND SURGE PROTECTION

Electrical and electronic equipment must be designed to meet system level IEC standards. The following are example system level IEC standards:

- Process control and automation: IEC 61131-2
- Motor control: IEC 61800-3
- Building automation: IEC 60730-1

For data communication lines, these system level standards specify varying levels of protection against the following three types of high voltage transients:

- IEC 61000-4-2 ESD
- IEC 61000-4-4 EFT
- IEC 61000-4-5 surge

Each of these specifications defines a test method to assess the immunity of electronic and electrical equipment against the defined phenomenon. The following sections summarize each of these tests. The ADM2795E is fully tested in accordance with these IEC EMC specifications, and is certified IEC EMC compliant.

Electrostatic Discharge (ESD)

ESD is the sudden transfer of electrostatic charge between bodies at different potentials caused by near contact or induced by an electric field. ESD has the characteristics of high current in a short time period. The primary purpose of the IEC 61000-4-2 test is to determine the immunity of systems to external ESD events outside the system during operation. IEC 61000-4-2 describes testing using the following two coupling methods: contact discharge and air gap discharge. Contact discharge implies a direct contact between the discharge gun and the unit under test. During air discharge testing, the charged electrode of the discharge gun is moved toward the unit under test until a discharge occurs as an arc across the air gap. The discharge gun does not make direct contact with the unit under test. A number of factors affect the results and repeatability of the air discharge test, including humidity, temperature, barometric pressure, distance, and rate of approach to the unit under test. This method is a better representation of an actual ESD event but is not as repeatable. Therefore, contact discharge is the preferred test method.

During testing, the data port is subjected to at least 10 positive and 10 negative single discharges with a minimum 1 sec interval between each pulse. Selection of the test voltage is dependent on the system end environment.

Figure 39 shows the 8kV contact discharge current waveform as described in the IEC 61000-4-2 specification. Some of the key waveform parameters are rise times of less than 1ns and pulse widths of approximately 60ns.

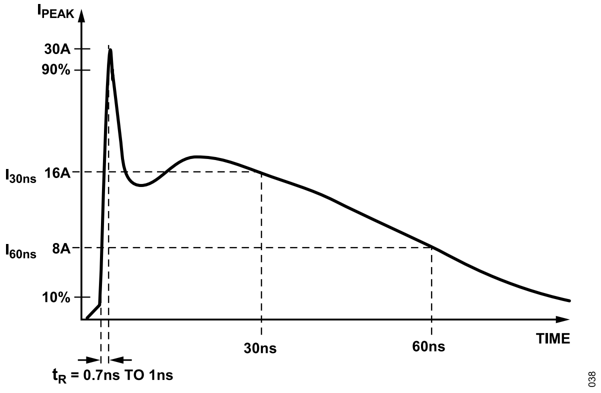

Figure 39. IEC 61000-4-2 ESD Waveform (8kV)

Figure 40 shows an example test setup where the ADM2795E evaluation board is tested to both contact discharge and air discharge for the IEC 61000-4-2 ESD standard.

Testing was performed with the IEC ESD gun connected to the local bus, GND_2. In testing to GND_2, the ADM2795E is robust to IEC 61000-4-2 events and passes the highest level recognized in the standard, Level 4, which defines a contact discharge voltage of ±8kV and an air discharge voltage of ±15kV.

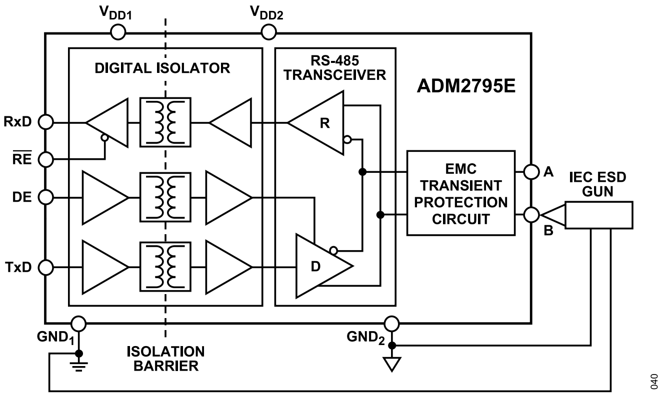

Figure 40. IEC 61000-4-2 ESD Testing to GND_1 or GND_2

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Testing was also performed with the IEC ESD gun connected to the logic side GND_1. Testing to GND_1 demonstrates the robustness of the ADM2795E isolation barrier. The isolation barrier is capable of withstanding IEC 61000-4-2 ESD to ±9kV contact and to ±8kV air. Testing was performed in normal transceiver operation, with the ADM2795E clocking data at 2.5Mbps. Table 13 and Table 16 summarize the certified test results.

Table 13. IEC 61000-4-2 Certified Test Results

ESD Gun Connected to	IEC 61000-4-2 Test Result	Certified Result
GND_2	±15kV (air), ±8kV (contact), Level 4 protection	Yes
GND_1	Withstands ±8kV (air), ±9kV (contact)	Yes

Figure 41 shows the 8kV contact discharge current waveform from the IEC 61000-4-2 standard compared to the HBM ESD 8kV waveform. Figure 41 shows that the two standards each specify a very different waveform shape and peak current. The peak current associated with a IEC 61000-4-2 8 kV pulse is 30A, while the corresponding peak current for HBM ESD is more than five times less, at 5.33A. The other difference is the rise time of the initial voltage spike, with IEC 61000-4-2 ESD having a much faster rise time of 1ns, compared to the 10ns associated with the HBM ESD waveform. The amount of power associated with an IEC ESD waveform is much greater than that of an HBM ESD waveform. The ADM2795E with IEC 61000-4-2 ESD ratings is better suited for operation in harsh environments compared to other RS-485 transceivers that state varying levels of HBM ESD protection.

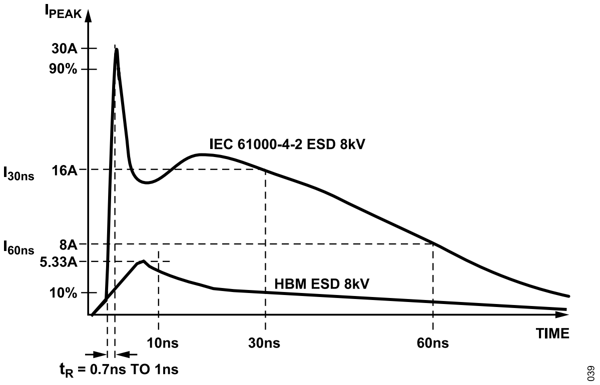

Figure 41. IEC 61000-4-2 ESD Waveform (8kV) Compared to HBM ESD Waveform (8kV)

Electrical Fast Transients (EFTs)

EFT testing involves coupling a number of extremely fast transient impulses onto the signal lines to represent transient disturbances (associated with external switching circuits that are capacitively coupled onto the communication ports), which may include relay and switch contact bounce or transients originating from the switching of inductive or capacitive loads—all of which are very common in industrial environments. The EFT test defined in IEC 61000-4-4 attempts to simulate the interference resulting from these types of events.

Figure 42 shows the EFT 50Ω load waveforms. The EFT waveform is described in terms of a voltage across a 50Ω impedance from a generator with a 50Ω output impedance. The output waveform consists of a 15ms burst of 5kHz high voltage transients repeated at 300ms intervals. The EFT test is also performed with a 750μs burst at a higher 100kHz frequency. Each individual pulse has a rise time of 5ns and a pulse duration of 50ns, measured between the 50% point on the rising and falling edges of the waveform. The total energy in a single EFT pulse is similar to that in an ESD pulse.

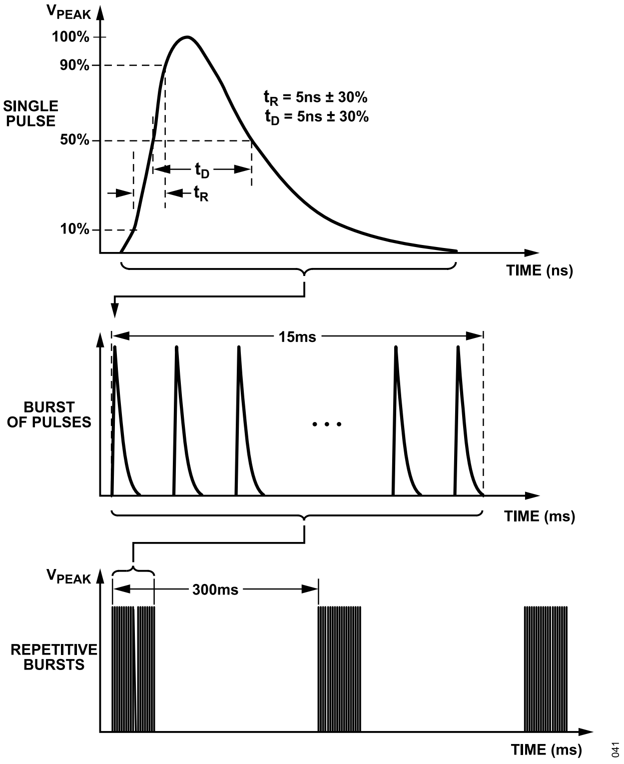

Figure 42. IEC 61000-4-4 EFT 50Ω Load Waveforms

During testing, these EFT fast burst transients are coupled onto the communication lines using a capacitive clamp, as shown in Figure 43. The EFT is capacitively coupled onto the communication lines by the clamp rather than direct contact. This clamp also reduces the loading caused by the low output impedance of the EFT generator. The coupling capacitance between the clamp and cable depends on cable diameter, shielding, and insulation on the cable. The EFT clamp edge is placed 50cm from the equipment under test (EUT) (ADM2795E evaluation board). The EFT generator is set up for either 5kHz or 100kHz repetitive EFT bursts. The ADM2795E was tested in both 5kHz and 100kHz test setups.

With the EFT clamp connected to GND_2, the ADM2795E is robust to IEC 61000-4-4 EFT transients and protects against the highest level recognized in the standard, Level 4, which defines a voltage level of ±2kV. With the IEC 61000-4-4 EFT clamp connected to

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GND_1, the ADM2795E is robust to IEC 61000-4-4 EFT transients and withstands up to ±2kV. Testing was performed in normal transceiver operation, with the ADM2795E clocking data at 2.5Mbps. The results shown in Table 14 are valid for a setup with or without an RS-485 cable shield connection to GND_2. The ADM2795E withstands up to ±2kV IEC 61000-4-4 EFT without damage. Table 14 and Table 16 summarize the certified test results.

Table 14. IEC 61000-4-4 Certified Test Results

EFT Clamp Connected to	IEC 61000-4-4 Test Result	Certified Result
GND_2	±2kV Level 4 protection	Yes
GND_1	Withstands ±2kV	Yes

Surge

Surge transients are caused by overvoltage from switching or lightning transients. Switching transients can result from power system switching, load changes in power distribution systems, or various system faults such as short circuits. Lightning transients can be a result of high currents and voltages injected into the circuit from nearby lightning strikes. IEC 61000-4-5 defines waveforms, test methods, and test levels for evaluating immunity against these destructive surges.

The waveforms are specified as the outputs of a waveform generator in terms of open circuit voltage and short-circuit current. Two waveforms are described. The 10µs/700µs combination waveform is used to test ports intended for connection to symmetrical communication lines: for example, telephone exchange lines. The 1.2µs/50µs combination waveform generator is used in all other cases, in particular short distance signal connections. For RS-485 ports, the 1.2µs/50µs waveform is predominantly used and is described in this section. The waveform generator has an effective output impedance of 2Ω; therefore, the surge transient has high currents associated with it.

Figure 44 shows the 1.2µs and 50µs surge transient waveform. ESD and EFT have similar rise times, pulse widths, and energy levels; however, the surge pulse has a rise time of 1.25µs and the pulse width is 50µs. Additionally, the surge pulse energy is three to four orders of magnitude larger than the energy in an ESD or EFT pulse. Therefore, the surge transient is considered the most severe of the EMC transients.

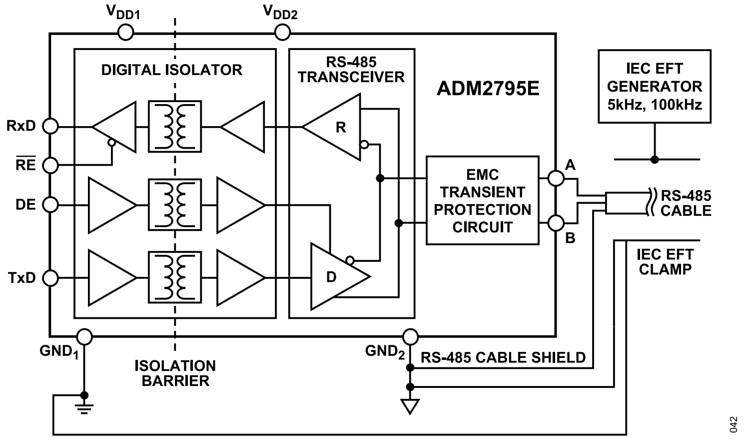

Figure 43. IEC 61000-4-4 EFT Testing to GND_1 or GND_2

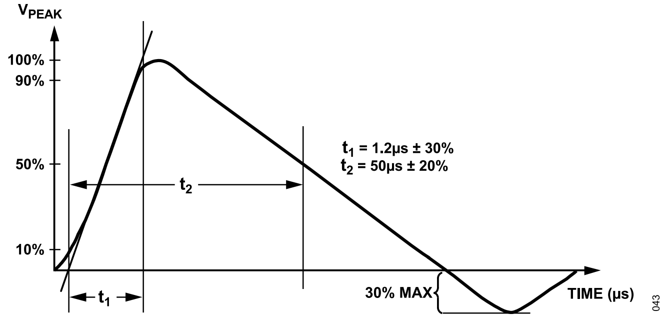

Figure 44. IEC 61000-4-5 Surge 1.2µs/50µs Waveform

THEORY OF OPERATION

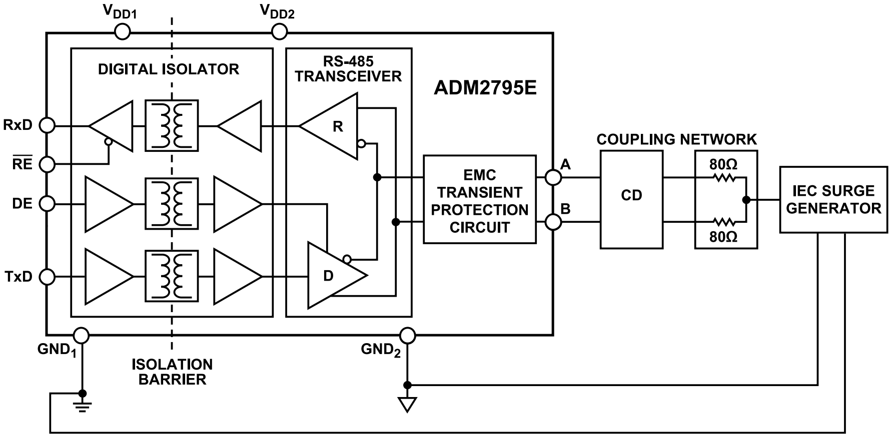

Figure 45. IEC 61000-4-5 Surge Testing to GND$_1$ or GND$_2$

IEC 61000-4-5 surge testing involves using a coupling/decoupling network (CDN) to couple the surge transient into the RS-485 A and B bus pins. The coupling network for a half-duplex RS-485 device consists of an 80Ω resistor on both the A and B lines and a coupling device. The total parallel sum of the resistance is 40Ω. The coupling device can be capacitors, gas arrestors, clamping devices, or any method that allows the EUT to function correctly during the applied test. During the surge test, five positive and five negative pulses are applied to the data ports with a maximum time interval of one minute between each pulse. The standard states that the device must be set up in normal operating conditions for the duration of the test. Figure 45 shows the test setup for surge testing. Testing is performed in normal transceiver operation, with the ADM2795E clocking data at 2.5Mbps.

With the IEC surge generator connected to GND$_2$, the ADM2795E is robust to IEC 61000-4-5 events and protects against the highest level recognized in the standard, Level 4, which defines a peak voltage of ±4kV.

With the IEC surge generator connected to GND$_1$, the ADM2795E is robust to IEC 61000-4-5 events and withstands up to ±4kV surge. The ADM2795E withstands up to ±4kV IEC 61000-4-5 surge without damage and with no bit errors in data communications. Testing to GND$_1$ demonstrates the robustness of the ADM2795E isolation barrier. Table 15 and Table 16 summarize the certified test results.

Table 15. IEC 61000-4-5 Certified Test Results

Surge Generator Connected to	IEC 61000-4-5 Test Result	Certified Result
GND$_2$	±4kV Level 4 protection	Yes
GND$_1$	Withstands ±4kV	Yes

Table 16 summarizes the ADM2795E performance and classification achieved for the noted IEC system level EMC standards.

The performance corresponds to each classification as follows:

- Class A—normal operation
- Class B—temporary loss of performance (bit errors)
- Class C—system needs reset
- Class D—permanent loss of function

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Table 16. Summary of Certified EMC System Level Classifications for the ADM2795E

Test	Ground Connection	Classification	Highest Pass Level
IEC 61000-4-5 Surge	GND_1	Class A	±4kV
	GND_2	Class B	±4kV
IEC 61000-4-4 Electrical Fast Transient (EFT)	GND_1	Class B	±2kV
	GND_2	Class B	±2kV
IEC 61000-4-2 Electrostatic Discharge (ESD)	GND_1	Class B	±8kV (air), ±9kV (contact)
	GND_2	Class B	±15kV (air), ±8kV (contact)
IEC 61000-4-6 Conducted RF Immunity	GND_1	Class A	10V/m rms
	GND_2	Class A	10V/m rms
IEC 61000-4-3 Radiated RF Immunity	GND_2	Class A	30V/m
IEC 61000-4-8 Magnetic Immunity	GND_2	Class A	100A/m

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IEC CONDUCTED, RADIATED, AND MAGNETIC IMMUNITY

IEC 61000-4-6 Conducted RF Immunity

The IEC 61000-4-6 conducted immunity test is applicable to products that operate in environments where RF fields are present and that are connected to mains supplies or other networks (signal or control lines). The source of conducted disturbances are electromagnetic fields, emanating from RF transmitters that may act on the whole length of cables connected to installed equipment.

In the IEC 61000-4-6 test, an RF voltage is swept/stepped from 150kHz to 80MHz or 100MHz. The RF voltage is amplitude modulated 80% at 1kHz. One ADM2795E evaluation board is tested to Level 3, which is the highest test level of 10V. For IEC 61000-4-6 testing, the stress signal is applied by using the clamp detailed in Table 17. The clamp is placed on the communications cable between two ADM2795E transceivers. For all testing, the equipment and EUT setup are as described in Table 17 and Figure 46.

Table 17 shows the test results where the EUT pass IEC 61000-4-6 to Level 3. For all of the tests, the IEC 61000-4-6 clamp is placed at the EVAL-ADM2795EEBZ EUT, and the cable shield is either floating or Earth grounded. The second EVAL-ADM2795EEBZ (auxiliary equipment) was placed on the network to terminate the communications bus. The IEC 61000-4-6 generator clamp was either connected to GND_1 or GND_2 of the ADM2795E EUT to provide a return current path for the IEC 61000-4-6 transient current.

The ADM2795E evaluation board is tested and certified to pass IEC 61000-4-6 conducted RF immunity testing to Level 3 at 10V/m rms, in a variety of configurations as described in Table 16 and Table 17.

Table 17. IEC 61000-4-6 EUT and Equipment

Parameter	Details
IEC 61000-4-6 Clamp	Schaffner KEMZ 801, placed at 30cm from the EUT
IEC 61000-4-6 Test Level	Level 3, 0.15MHz to 80MHz, 10V/m rms, 80% amplitude modulated (AM) by a 1kHz sinusoidal
EUT	EVAL-ADM2795EEBZ
EUT Data Rate	2.5Mbps
EUT Power	9V battery at V_{DD1} and V_{DD2}, regulated on EUT to 5V
Cable Between EUT	5m, Unitronic® Profibus, 22 American wire gauge (AWG)
Cable Termination	120Ω resistor at both cable ends
Pass/Fail Criteria	Pass: data at receiver with a pulse width distortion within 10% of mean

Table 18. IEC 61000-4-6 Certified Test Results

Clamp Location from EUT (cm)	Cable Shield	Current Return Path	IEC 61000-4-6 Test Frequency (MHz)	Certified Result
30	Floating	GND_1	0.15 to 80	Pass
30	Earthed	GND_1	0.15 to 80	Pass
30	Floating	GND_2	0.15 to 80	Pass
30	Earthed	GND_2	0.15 to 80	Pass

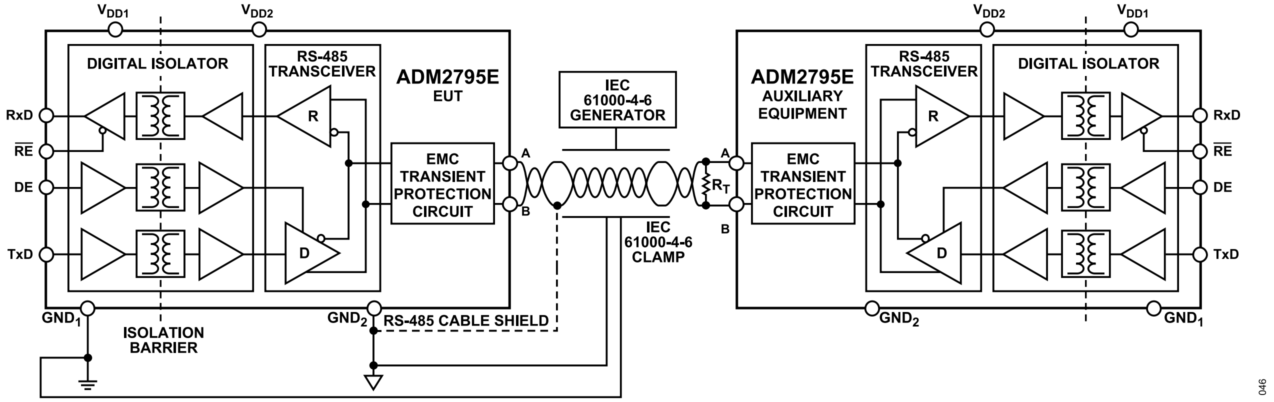

Figure 46. IEC 61000-4-6 Conducted RF Immunity Example Test Setup Testing to GND_1 or GND_2

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IEC 61000-4-3 Radiated RF Immunity

Testing to IEC 61000-4-3 ensures that electronic equipment is immune to commonly occurring radiated RF fields. Some commonly occurring unintentional RF emitting devices in an industrial application are electric motors and welders.

In the IEC 61000-4-3 test, a radiated RF field is generated by an antenna in a shielded anechoic chamber using a precalibrated field, swept from 80MHz to 2.7GHz. The RF voltage is amplitude modulated 80% at 1kHz. Each face of the EUT is subjected to vertical and horizontal polarizations.

Figure 47 shows the test setup with the EVAL-ADM2795EEBZ, the EUT, placed in an anechoic chamber, powered with two 9 V batteries. The EVAL-ADM2795EEBZ on board regulators power V_{DD1} at 5.0V and V_{DD2} at 5.0V. The EVAL-ADM2795EEBZ is loaded with a 120Ω termination resistor for the duration of the test. A pattern generator provides a 2.5Mbps data input to the ADM2795E TxD pin. The ADM2795E receiver output (RxD) is monitored with an oscilloscope.

The pass criteria chosen is less than a 10% change in the bit width of the RxD signal in the presence of the IEC 61000-4-3 radiated RF field.

The ADM2795E evaluation board is tested and certified to pass IEC 61000-4-3 radiated RF immunity testing to Level 4 (30V/m). Level 4 is the highest level specified in the IEC 61000-4-3 standard.

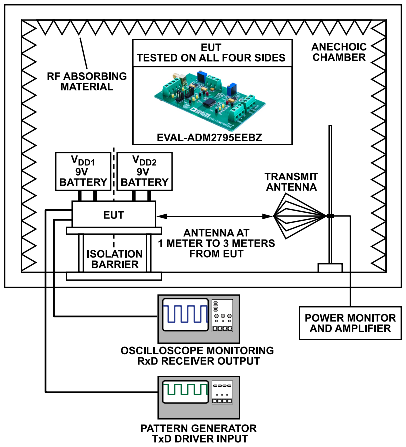

Figure 47. Testing for IEC 61000-4-3 Radiated RF Immunity

IEC 61000-4-8 Magnetic Immunity

Testing to IEC 61000-4-8 ensures that electronic equipment is immune to commonly occurring magnetic fields. The source of magnetic fields in typical industrial communication applications is power line current or 50Hz/60Hz transformers in close proximity to the equipment.

In the IEC 61000-4-8 test, a controlled magnetic field of defined field strength is produced by driving a large coil (induction coil) with a test current generator. The EUT is placed at the center of the induction coil, subjecting the EUT to a magnetic field.

Figure 48 shows the test setup with the EVAL-ADM2795EEBZ, the EUT, placed in an anechoic chamber, powered with two 9V batteries. The EVAL-ADM2795EEBZ on board regulators power V_{DD1} at 5.0V and V_{DD2} at 5.0V. The EVAL-ADM2795EEBZ is loaded with a 120Ω termination resistor for the duration of the test. A pattern generator provides a 2.5Mbps data input to the ADM2795E TxD pin. The ADM2795E receiver output (RxD) is monitored with an oscilloscope.

The pass criteria chosen is less than a 10% change in the bit width of the RxD signal in the presence of the IEC 61000-4-8 magnetic field.

The ADM2795E evaluation board is tested and certified to pass IEC 61000-4-8 magnetic immunity testing to Level 5 (100A/m). Level 5 is the highest level specified in the IEC 61000-4-8 standard.

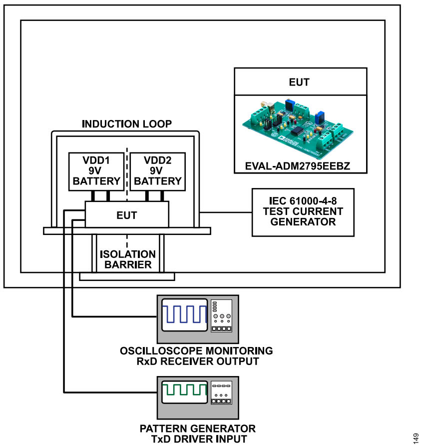

Figure 48. Testing for IEC 61000-4-8 Magnetic Immunity

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RADIATED EMISSIONS AND PCB LAYOUT

The ADM2795E meets stringent electromagnetic interference (EMI) emissions targets (EN55022 Class B) with minimal PCB layout considerations. To achieve a 6dBµV/m margin from EN55022 Class B limits, add a 120pF, 0603 body size capacitor on the PCB trace connected to the RxD pin and GND$_1$ (see Figure 49). Place the capacitor at 5mm from the RxD pin for optimal performance. The ADM2795E evaluation board user guide provides an example PCB layout. Figure 18 shows a typical performance plot of the ADM2795E EN55022 radiated emissions profile (with a 120pF capacitor to GND$_1$ on the RxD pin).The effect of adding load capacitance on the RxD pin is shown in the typical waveform rise and fall times in Figure 26.

NOISE IMMUNITY

Direct power injection (DPI) measures the ability of a component to reject noise injected onto the power supply or input pins. The ADM2795E was tested to the DPI IEC 62132-4 standard, with a high power noise source capacitively coupled into either the V_{DD1} or V_{DD2} power supply pin. The noise source was swept through a 300kHz to 1GHz frequency band. During DPI IEC 62132-4 testing, the ADM2795E TxD pin was clocked at 2.5Mbps, and the clock data output on the RxD pin was monitored for errors (loopback test mode). The fail criteria was defined as greater than ±10% change in the bit width of the RxD signal.

Figure 50 shows a test setup, with the DPI noise source injected through a 6.8nF capacitor on the ADM2795E V_{DD1} power supply pin. Figure 22 to Figure 24 in the Typical Performance Characteristics section show the fail point for the ADM2795E across the noise power (dBm) vs. DPI frequency (Hz). Figure 21 shows that the addition of a 10µF decoupling capacitor, in addition to the standard 100nF decoupling capacitor, improves low frequency noise immunity.

Performance to the IEC 62132-4 standard was evaluated for the ADM2795E and compared to other isolators/transceivers available in the market. The ADM2795E noise immunity performance exceeds that of other similar products. The ADM2795E maintains excellent performance over frequency, but other isolation products exhibit bit errors in the 200MHz to 700MHz frequency band.

FULLY RS-485 COMPLIANT OVER AN EXTENDED ±25 V COMMON-MODE VOLTAGE RANGE

The ADM2795E is an RS-485 transceiver that offers an extended common-mode input range of ±25V across an operating voltage range of 3V to 5.5V, while still meeting or exceeding compliance with TIA/EIA RS-485/RS-422 standards. The TIA/EIA RS-485/RS-422 standards specify a bus differential voltage of at least 1.5V across the common-mode voltage range. In addition, when powered at greater than 4.5V V_{DD2}, the ADM2795E driver output is a minimum 2.1V $|V_{OD}|$, meeting the requirements for a Profibus compliant RS-485 driver. The extended common-mode input voltage range of ±25V improves system robustness over long cable lengths, where large differences in ground potential between RS-485 transceivers are possible. The extended common-mode input voltage range of ±25V improves data communication reliability in noisy environments over long cable lengths where ground loop voltages are possible.

1.7V TO 5.5V V_{DD1} LOGIC SUPPLY

The ADM2795E features a logic supply pin, V_{DD1}, for flexible digital interface operational to voltages as low as 1.7V. The V_{DD1} pin powers the logic inputs (TxD input, and DE and $\overline{RE}$ control pins) and the RxD output. These pins interface with logic devices such as universal asynchronous receiver/transmitters (UARTs), application specific integrated circuits (ASICs), and microcontrollers. Many of these devices use power supplies significantly lower than 5V.

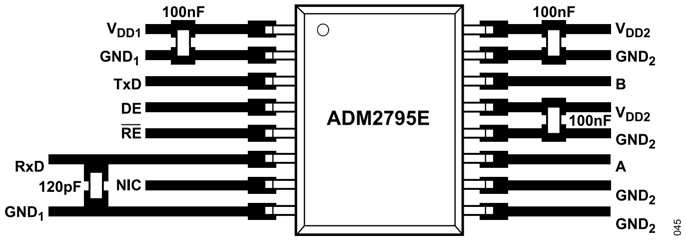

Figure 49. Recommended PCB Layout to Meet EN55022 Class B Radiated Emissions

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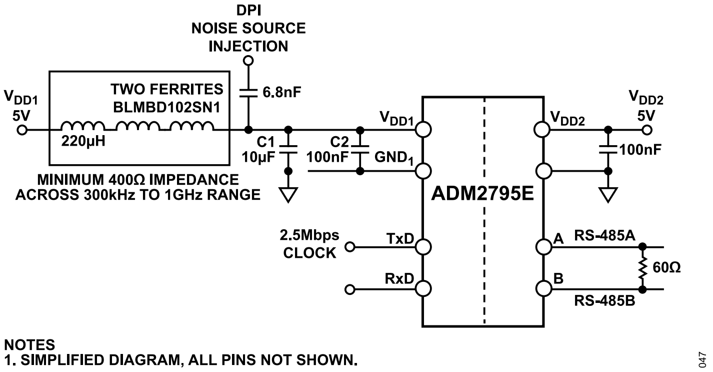

Figure 50. Typical Setup for DPI IEC 62132-4 Noise Immunity Test

TRUTH TABLES

Table 20 and Table 21 use the abbreviations shown in Table 19. V_{DD1} supplies the DE, TxD, $\overline{RE}$, and RxD pins only.

Table 19. Truth Table Abbreviations

Letter	Description
H	High level
I	Indeterminate
L	Low level
X	Any state
Z	High impedance (off)
NC	Disconnected

Table 20. Transmitting Truth Table

Supply Status		Inputs		Outputs	
V_{DD2}	V_{DD1}	DE	TxD	A	B
On	On	H	H	H	L
On	On	H	L	L	H
On	On	L	X	Z	Z
On	Off	H	H	I	I
On	Off	H	L	I	I
On	Off	L	X	I	I
Off	On	X	X	Z	Z
Off	Off	X	X	Z	Z

Table 21. Receiving Truth Table

Supply Status		Inputs		Outputs
V_{DD2}	V_{DD1}	A − B	$\overline{RE}$	RxD
On	On	>−0.03V	L	H
On	On	<−0.2V	L	L
On	Off	>−0.03V	L	I
On	Off	<−0.2V	L	I
On	On	−0.2V < A − B < −0.03V	L	I
On	Off	−0.2V < A − B < −0.03V	L	I
On	On	Inputs open/shorted	L	H
On	Off	Inputs open/shorted	L	I
On	On	X	H	Z
On	Off	X	H	I
Off	Off	X	H	I
Off	Off	X	L or NC	I

RECEIVER FAIL-SAFE

The receiver input includes a fail-safe feature that guarantees a logic high RxD output when the A and B inputs are floating, open circuit, or short circuit. A logic high RxD output is guaranteed in a terminated transmission line with all drivers disabled. This fail-safe RxD guaranteed output logic high is implemented by setting the receiver input threshold between −30mV and −200mV. If the differential receiver input voltage (A − B) is greater than or equal to −30mV, RxD is logic high. If A − B is less than or equal to −200mV, RxD is logic low. In the case of a terminated bus with all transmitters disabled, the receiver differential input voltage is pulled to 0V by the termination. With the receiver thresholds of the ADM2795E, this results in a RxD output logic high with a 30mV minimum noise margin.

RS-485 DATA RATE AND BUS CAPACITANCE

The data rate and bus node capability of the ADM2795E are dependent on the operating temperature of the device. As the operating temperature of the ADM2795E is increased, the capacitance of the ADM2795E integrated EMC protection circuitry is also increased. The driver output structures of the ADM2795E can be simplified as low-pass filter structures, with a given resistance and capacitance. As the operating temperature increases, the capacitance increases. The low-pass filter effectively works to decrease the maximum data rate that can be driven on the RS-485 bus pins.

HOT SWAP CAPABILITY

When a PCB is inserted into a hot (or powered) backplane, differential disturbances to the data bus can lead to data errors. The ADM2795E was lab tested to ensure that the RS-485 A and B bus pins did not output spurious data during a power-up/power-down event, which simulated a PCB hot insertion. The power supply ramp test rates were 0V to 5V in 300µs (fast ramp rate), and 0V to 5V in

APPLICATIONS INFORMATION

9.5ms (slow ramp rate). For these ramp rates, the RS-485 A and B outputs were monitored and with no output glitches were observed.

ROBUST HALF-DUPLEX RS-485 NETWORK

Figure 51 shows a robust isolated RS-485 communications network, with bus communications running over 1000 feet of cabling. Over long cable runs with multiple RS-485 nodes, a number of hazards can either corrupt data communication or even cause permanent damage to the RS-485 interface. The ADM2795E provides robust protection against high voltage faults to bus power supplies and EMC transients, such as an IEC 61000-4-5 surge. In addition, the ADM2795E has an extended common-mode input range of ±25V, which allows ±25V of ground potential difference between the isolated GND_2 pins of two or more ADM2795E devices.

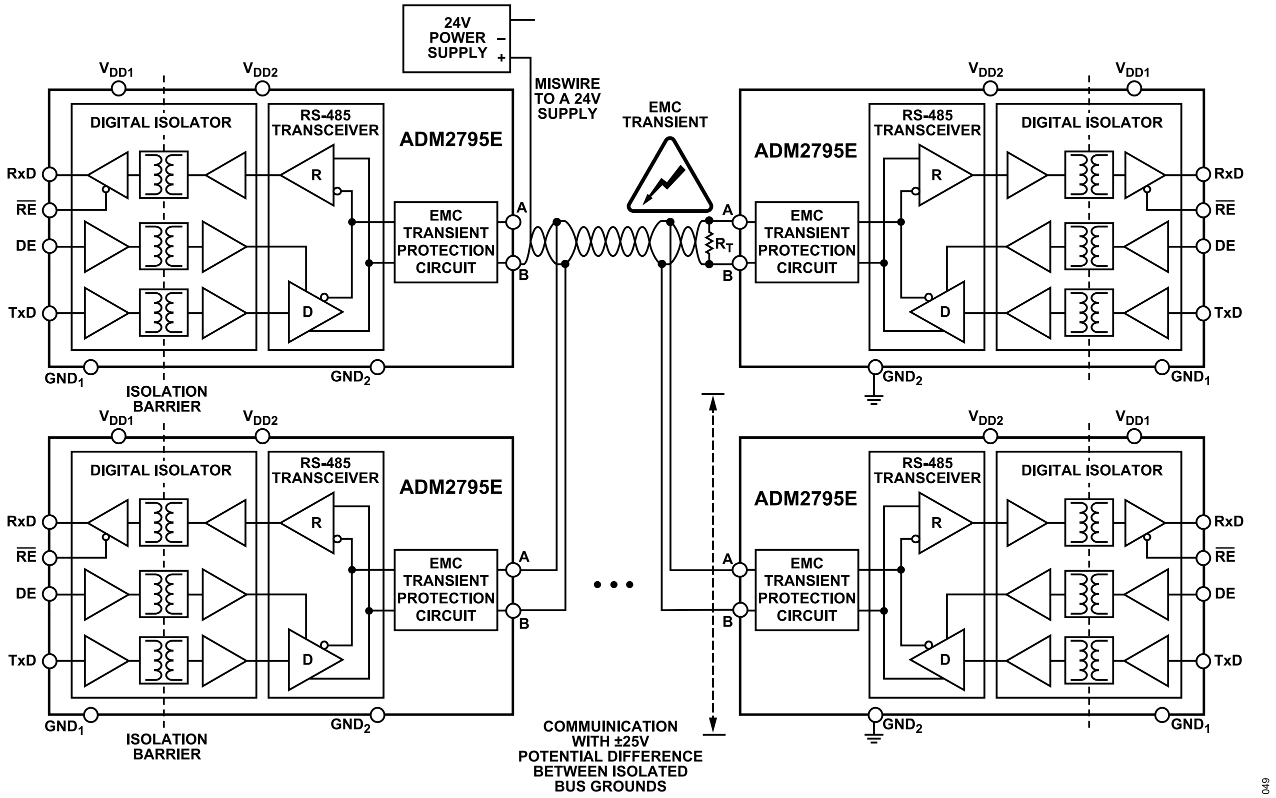

Figure 51. Robust Half-Duplex Isolated RS-485 Communication Network

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EMC COMPLIANT AND FAULT PROTECTED SIGNAL AND POWER ISOLATED RS-485 NODE

The circuit shown in Figure 52 demonstrates a fully isolated RS-485 node using the ADM2795E and the ADuM6028 isolated DC-DC converter. The small form factor and low radiated emissions of the ADuM6028 make the combination of the two devices ideal for space constrained applications that require high voltage ±42V fault protection on the bus pins as well as integrated Level 4 EMC protection to IEC standards against ESD, EFT, and surge.

The ADuM6028 can deliver a minimum of 60mA of current at the 3.3V output supply in a compact 5.85mm × 10.31mm low profile footprint. When the ADM2795E is fully loaded and switching at 2.5Mbps, the device consumes up to 50mA at 3.3V, which can be supplied from the ADuM6028.

The ADuM6028 can be powered from either a 3.3V or 5V supply, depending on the selected model. The V_{DD1} pin of the ADM2795E can be powered from the same rail as the isolated DC-DC converter, or the device can alternatively be connected to the low voltage supply rail of a microcontroller or logic device that operates with an input supply voltage between 1.7V and 5.5V.

In applications where 5kV of isolation is not required, the ADuM5028 can be used in place of the ADuM6028. See Table 22 for device selection and the maximum allowed ambient temperature.

Two surface-mount ferrite beads are used to meet EN 55022 Class B radiated emissions requirements on a standard 2-layer PCB. See the ADuM6028 data sheet for implementation details.

In applications where a 5V V_{DD2} supply voltage is preferred on the ADM2795E, users can replace the ADuM6028 with the ADuM6020, which can provide the necessary 100mA for up to 105°C operation in a compact 16-lead wide body SOIC package.

Table 22. Isolated DC-DC Converter Selection Table

Isolation Rating (kV)	V_{DDP} Supply Voltage (V)	Maximum Operating Temperature (°C)	Isolated DC-DC Converter
5	5	85	ADuM6028-5BRIZ
5	3.3	105	ADuM6028-3BRIZ
2.5	5	85	ADuM5028-5BRIZ
2.5	3.3	105	ADuM5028-3BRIZ

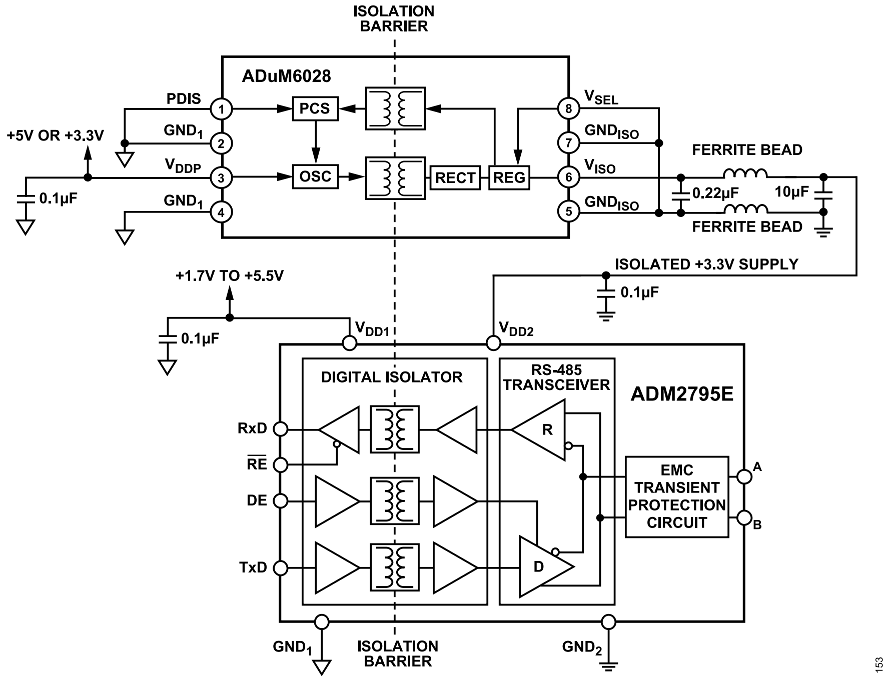
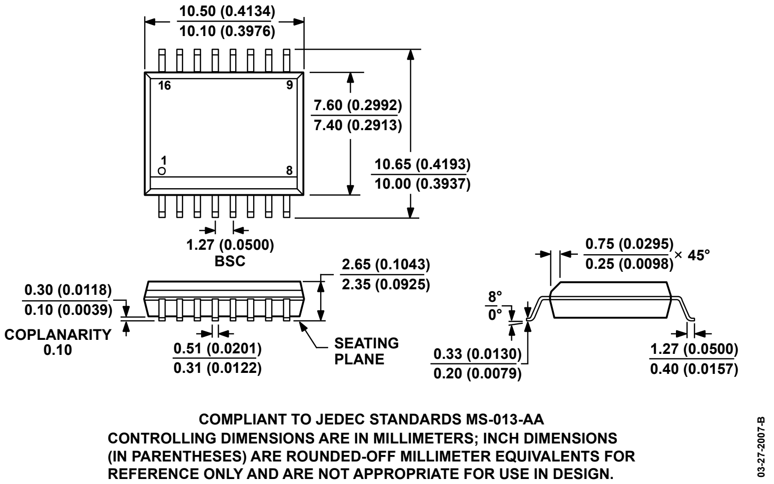


Figure 52. 2.5Mbps, 5kV Signal and Power Isolated RS-485 Node with ±42V Fault Protection and Level 4 EMC Protection (3.3V Transceiver)

OUTLINE DIMENSIONS



COMPLIANT TO JEDEC STANDARDS MS-013-AA
CONTROLLING DIMENSIONS ARE IN MILLIMETERS; INCH DIMENSIONS (IN PARENTHESES) ARE ROUNDED-OFF MILLIMETER EQUIVALENTS FOR REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN.

Figure 53. 16-Lead Standard Small Outline Package [SOIC_W]
Wide Body
(RW-16)
Dimensions shown in millimeters and (inches)

ORDERING GUIDE

Model[1]	Temperature Range	Package Description	Packing Quantity	Package Option
ADM2795EBRWZ	−40°C to +125°C	16-Lead Standard Small Outline Package [SOIC_W]	Tube, 47	RW-16
ADM2795EBRWZ-RL7	−40°C to +125°C	16-Lead Standard Small Outline Package [SOIC_W], 7” Reel	Reel, 400	RW-16
ADM2795EARWZ	−40°C to +85°C	16-Lead Standard Small Outline Package [SOIC_W]	Tube, 47	RW-16
ADM2795EARWZ-RL7	−40°C to +85°C	16-Lead Standard Small Outline Package [SOIC_W], 7” Reel	Reel, 400	RW-16

[1] Z = RoHS Compliant Part.

EVALUATION BOARDS

Model[1]	Package Description
EVAL-ADM2795EEBZ	Evaluation Board
EVAL-ADM2795EARDZ	Arduino Shield

[1] Z = RoHS Compliant Part.