

www.ti.com

DIFFERENTIAL BUS TRANSCEIVER

FEATURES

- FULL-/HALF-DUPLEX OPERATION
- 1500Vrms ISOLATION (cont)
- 2500Vrms ISOLATION (1 min)
- 2.5Mbps PERFORMANCE
- LOOP-TEST FACILITY

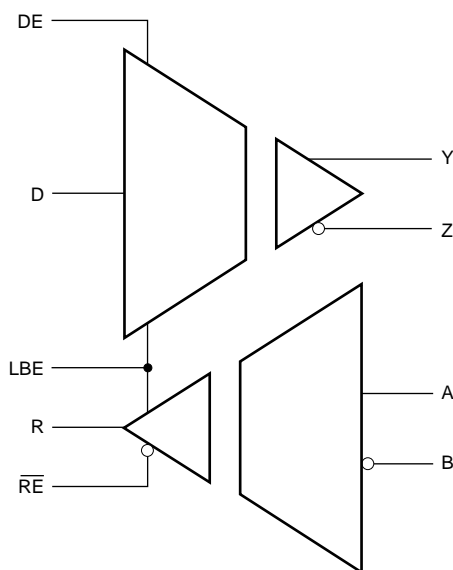
APPLICATIONS

- BUS TRANSMISSION SYSTEMS
- GROUND LOOP ISOLATION

DESCRIPTION

ISO422 provides 1500Vrms isolation for industrial bus transmission systems. ISO422 may be configured in full or half duplex modes providing the user with best flexibility for the application. Transmission rates of 2.5Mbps can be obtained covering most requirements. A loop-back test facility is included. LBE allows data on the D input to be routed to the R output for test purposes.

ISO422 is available in 24-pin PDIP and 24-pin Gull Wing packages and is specified over the temperature range -40°C to $+85^{\circ}\text{C}$.



SPECIFICATIONS

At $T_A = +25^\circ\text{C}$, and $V_S = +5\text{V}$, unless otherwise noted.

PARAMETER	CONDITIONS	ISO422P, P-U			UNITS
		MIN	TYP	MAX	
ISOLATION					
Rated Continuous Isolation	V_{ISO} 50Hz, 60Hz	1500			V
Partial Discharge Voltage	1s, 5 x 5pC/per cycle ⁽¹⁾	2500			V
Barrier Impedance			$> 10^{14} \parallel 10$		$\Omega \parallel \text{pF}$
Leakage Current	240V, 60Hz 2500V, 50Hz		1	16	μA
Creepage Distance			8.6		mm
Internal Isolation Distance			0.1		mm
Transient Recovery Time	5kV/ μs Edge			1	μs
DRIVER DC CHARACTERISTICS					
High Level Input Voltage	V_{IH} D and DE Inputs ⁽²⁾	2			V
Low Level Input Voltage	V_{IL} D and DE Inputs ⁽²⁾			0.8	V
Input Leakage Current	I_L D and DE Inputs ⁽²⁾		5		nA
Input Capacitance	C_{IN} D and DE Inputs ⁽²⁾		5		pF
Output Voltage	V_O V_Y or V_Z	0		5	V
Differential Output Voltage	V_{OD} I_{OY} or $I_{OZ} = 0$	1.5		5	V
	$R_L = 100\Omega$	2	3.6	5	V
	$R_L = 54\Omega$	1.5	2.8	5	V
Change in Mag Diff Out Voltage	$\Delta V_{OD} $ $R_L = 100\Omega$ or 54Ω ⁽³⁾		± 40	± 200	mV
Common-Mode Output Voltage	V_{OC} $R_L = 100\Omega$ or 54Ω			3	V
Change in Mag CM Out Voltage	$\Delta V_{OC} $ $R_L = 100\Omega$ or 54Ω ⁽³⁾		± 40	± 200	mV
Output Current	I_O $V_O = V_{CC2}$, Output Disabled		± 10	± 1000	nA
	$V_O = 0\text{V}$, Output Disabled		± 10	± 1000	nA
Short-Circuit Output Current	$V_O = V_{CC2}$, Continuous		100		mA
	$V_O = 0\text{V}$, Continuous		-110		mA
DRIVER SWITCHING CHARACTERISTICS (Figure 6)					
Differential Output Delay Time	t_{DD} $R_L = 54\Omega$		120	150	ns
Skew $ t_{DDH} - t_{DDL} $	$R_L = 54\Omega$		25	50	ns
Differential Output Transition Time	t_{DT} $R_L = 54\Omega$			100	ns
Output Enable Time to HIGH	t_{DZH} $R_L = 100\Omega$		120	150	ns
Output Enable Time to LOW	t_{DZL} $R_L = 100\Omega$		120	150	ns
Output Disable Time from HIGH	t_{DZH} $R_L = 100\Omega$		120	150	ns
Output Disable Time from LOW	t_{DLZ} $R_L = 100\Omega$		120	150	ns
RECEIVER DC CHARACTERISTICS					
High Level Output Voltage	V_{OH} $I_{OH} = 6\text{mA}$	$V_{CC} - 1$			V
Low Level Output Voltage	V_{OL} $I_{OL} = 6\text{mA}$			0.4	V
Output Short-Circuit Current	I_{OS} 1s max		30		mA
Output HI-Z Leakage	I_{OZ} $V_{OUT} = 0\text{V}$ to V_{CC1}		± 10	± 1000	nA
Enable Input HIGH Threshold	V_{IH} \overline{RE} Input ⁽²⁾	2			V
Enable Input LOW Threshold	V_{IL} \overline{RE} Input ⁽²⁾			0.8	V
Input Leakage Current	I_L \overline{RE} Input ⁽²⁾		5		nA
Input Capacitance	C_{IN} \overline{RE} Input ⁽²⁾		5		pF
Differential Input HIGH Threshold	V_{TH} $V_O = 2.8\text{V}$		100	200	mV
Differential Input LOW Threshold	V_{TL} $V_O = 0.4\text{V}$	-200	-100		mV
Input Hysteresis	See Note 4		60		mV
Line Input Current	I_{BI} Power On ($GND_B < V_{BI} < V_{SB}$)		± 10	± 1000	nA
Line Voltage	V_{BI} Power Off ($I_{BI} \pm 10\text{mA}$ max)		± 12		V
Input Resistance	R_{IN}	1			M Ω
RECEIVER SWITCHING CHARACTERISTICS (Figure 7)					
Propagation Delay L to H	t_{RLH} $V_{ID} = -1.5\text{V}$ to 1.5V , $C_L = 10\text{pF}$		120	150	ns
Propagation Delay H to L	t_{RHL} $V_{ID} = 1.5\text{V}$ to -1.5V , $C_L = 10\text{pF}$		120	150	ns
Skew $ t_{RLH} - t_{RHL} $			40		ns
Output Rise Time	t_R $C_L = 10\text{pF}$		10		ns
Output Fall Time	t_F $C_L = 10\text{pF}$		10		ns
Output Enable Time to HIGH	t_{RZH} $C_L = 10\text{pF}$		15	25	ns
Output Enable Time to LOW	t_{RZL} $C_L = 10\text{pF}$		15	25	ns
Output Disable Time from HIGH	t_{RHZ} $C_L = 10\text{pF}$		15	25	ns
Output Disable Time from LOW	t_{RLZ} $C_L = 10\text{pF}$		15	25	ns

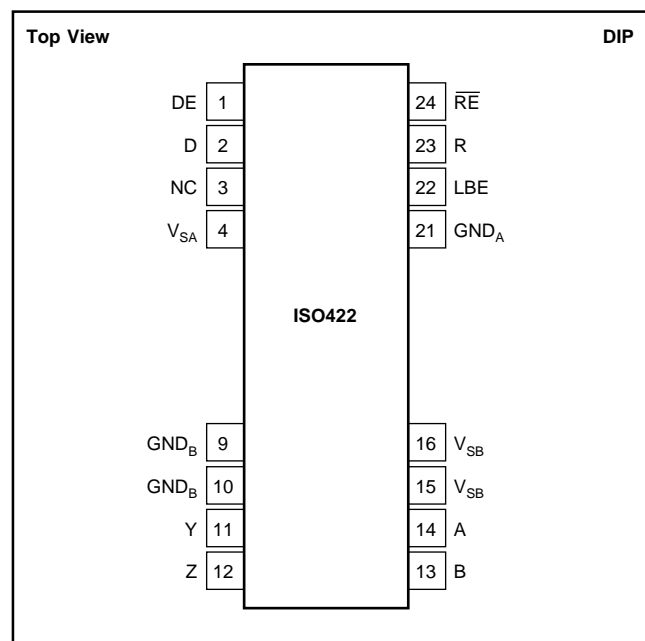
SPECIFICATIONS (CONT)

At $T_A = +25^\circ\text{C}$, and $V_S = +5\text{V}$, unless otherwise noted.

PARAMETER	CONDITIONS	ISO422P, P-U			UNITS
		MIN	TYP	MAX	
POWER					
Supply Voltage—Data Side	V_{SA}	4.5		5.5	V
Supply Current—Data Side	I_{SA}		10	13	mA
Supply Current—Data Side	I_{SA}		20		mA
Supply Voltage—Bus Side	V_{SB}	4.5		5.5	V
Supply Voltage—Bus Side	I_{SB}		12	20	mA
			20		mA
BUS LIMITS					
Input Current				± 10	mA
Maximum Differential Input				± 5	V
Maximum Data Rate			2.5		Mbps
TEMPERATURE RANGE					
Operating		-40		+85	$^\circ\text{C}$
Storage		-40		+125	$^\circ\text{C}$
Thermal Resistance	θ_{JA}		75		$^\circ\text{C/W}$

NOTES: (1) All devices receive a 1s test. Failure criterion is > 5 pulses of $> 5\text{pC}$ per cycle. (2) Logic inputs are HCT-type and thresholds are a function of power supply voltage with approximately 100mV hysteresis. (3) Change in magnitude when the input is changed from HIGH to LOW. (4) The difference between the differential low to high and high to low transition points.

PIN CONFIGURATION



ABSOLUTE MAXIMUM RATINGS

Supply Voltage: V_{SA}	-0.5V to +6V
V_{SB}	-0.5V to +6V
Continuous Isolation Voltage	1500Vrms
Storage Temperature	-40 $^\circ\text{C}$ to +125 $^\circ\text{C}$
Lead Temperature (soldering, 10s)	+300 $^\circ\text{C}$



ELECTROSTATIC DISCHARGE SENSITIVITY

Electrostatic discharge can cause damage ranging from performance degradation to complete device failure. Burr-Brown Corporation recommends that all integrated circuits be handled and stored using appropriate ESD protection methods.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet published specifications.

PACKAGE/ORDERING INFORMATION

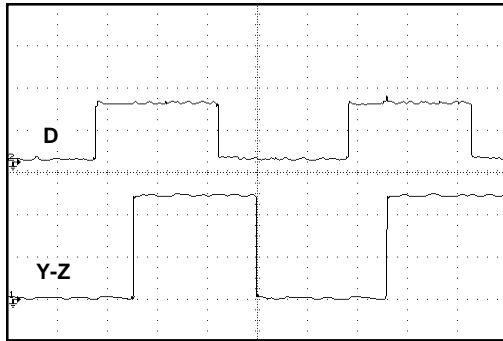
PRODUCT	PACKAGE	PACKAGE DRAWING NUMBER ⁽¹⁾	SPECIFIED TEMPERATURE RANGE	PACKAGE MARKING	ORDERING NUMBER	TRANSPORT MEDIA
ISO422P	24-Pin Plastic DIP	249-4	-40 $^\circ\text{C}$ to +85 $^\circ\text{C}$	ISO422P	ISO422P	Rails
ISO422P-U	24-Pin Gull Wing Surface Mount	243-5	-40 $^\circ\text{C}$ to +85 $^\circ\text{C}$	ISO422P-U	ISO422P-U	Rails

NOTES: (1) For detailed drawing and dimension table, please see end of data sheet, or Appendix C of Burr-Brown IC Data Book.

TYPICAL PERFORMANCE CURVES

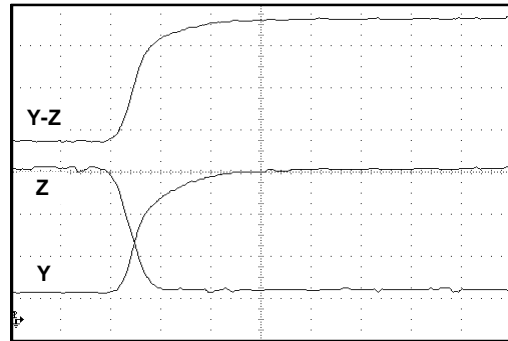
At $T_A = +25^\circ\text{C}$, and $V_S = +5\text{V}$, unless otherwise noted.

PROPAGATION DELAY



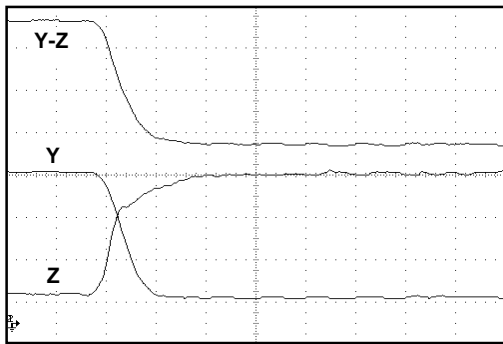
2 $\mu\text{s}/\text{div}$

BUS 0 TO 1 TRANSITION



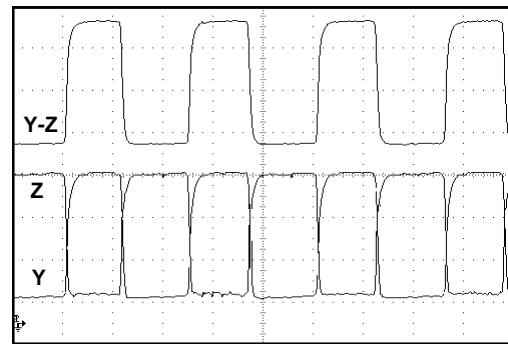
20ns/div

BUS 1 TO 0 TRANSITION



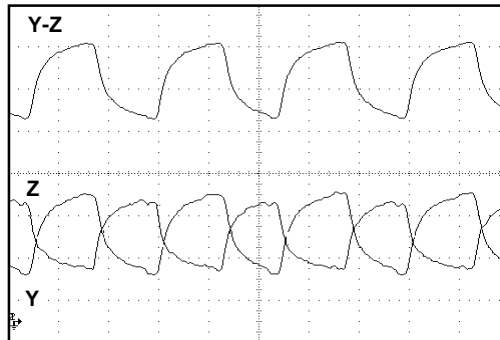
20ns/div

TERMINATED 200m CABLE



50ns/div

2k Ω RESISTORS INSERTED IN TERMINATED CABLE



200ns/div

OPERATION

ISO422 is an isolated, full-duplex bus transceiver which is compatible with three-wire data bus systems using EIA standards RS-422-A and RS-485. It is based on Burr-Brown's capacitive barrier technology. The data bus input is designed to present a very high impedance to the data bus, thus allowing a virtually unlimited number of receivers on any data bus section. To allow this feature, the data bus input is limited to a common-mode range within the magnitude of the supplies. This limitation requires that all nodes on the bus are referenced to a common ground. However, systems attached to the bus through ISO422, are isolated up to 1500Vrms and may, therefore, have local floating ground potentials up to this isolation voltage. The circuit encodes all data passed across the barrier to ensure that the input values and control signals are correctly passed across the barrier under all power up conditions. The ISO422 also allows data recovery to the current input state, after any transient upset.

TRANSMIT

Data is passed from the D input to the data bus outputs after a barrier transmission delay (t_{DD}) when the DE input is HIGH. When DE is LOW, the data bus drivers are switched off, and assume the high impedance state. When enabling the data bus output, i.e., switching DE from LOW to HIGH, the enable signal is passed directly across the barrier and enables the output, after a barrier transmission delay and output enable time (t_{DLZ}/t_{DZH}). Similarly, when disabling the data bus output, i.e., switching DE from HIGH to LOW, the disable signal is passed directly across the barrier and disables the output after a barrier transmission delay and output disable time (t_{DLZ}/t_{DZH}).

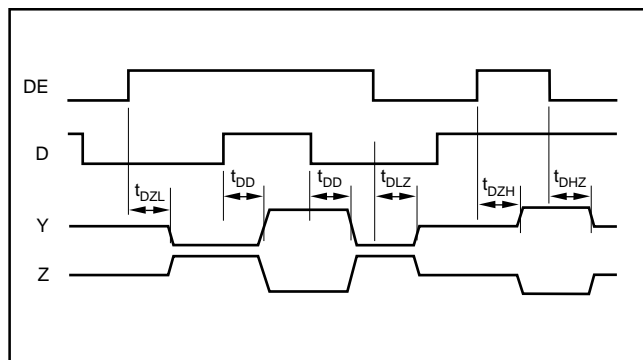


FIGURE 1. ISO422 Data Transmit.

RECEIVE

The receive data is determined by the data bus differential signal after a barrier transmission delay (t_{RZL}). When the difference between the A input and the B input (A-B) is greater than +200mV, the R output will be HIGH. If A-B is more negative than -200mV, the R output is undefined. Since the receiver has a high impedance input, no disable signal is required for the data bus input, which is always

active. The receive enable/disable time is simply the time to enable/disable the R output (t_{RLZ}) and does not require any additional barrier transmission time.

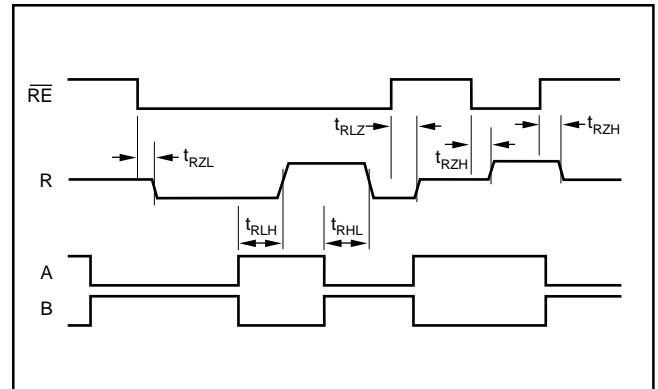


FIGURE 2. ISO422 Data Receive.

DATA CORRUPTION

If, due to transient upset, the data passed across the barrier is corrupted, the data will be restored within 100ns from the end of the corrupting signal.

SYNCHRONIZATION

The data transmitted across the barrier is coded using an internal clock. This clock also captures the incoming asynchronous data and synchronizes it to the clock edges. This will give rise to an rms propagation delay jitter of approximately 50ns.

LOOPBACK

A loopback function is provided by the LBE input. If this input is HIGH, then enabling both the transmitter and the receiver will cause the device to route the D input to the R output, in addition to the data bus outputs. Data on the incoming bus is ignored. This feature allows a simple connection test to be performed during any application. When LBE is LOW, transmit and receive will operate in the normal full-duplex mode.

DATA BUS CONNECTION

ISO422 can be used in half duplex, or full duplex data communication bus systems. It is capable of continuously driving a 54Ω load, equivalent to a double-terminated transmission line, at the fully specified data rate. When connecting to the data bus, the voltage on the A and B input lines must remain between V_{SB} and GND_B . This can be achieved by using a common bus ground connection, such as GND_B , as shown in Figures 5 and 6.

For any system connected to the bus, the isolation provided by ISO422 allows the independent local ground potential to be as high as 1500Vrms with respect to the data bus ground reference. This feature replaces the limited +12V to -7V range of the RS-485 standard with the full-isolation voltage capability of the ISO422.

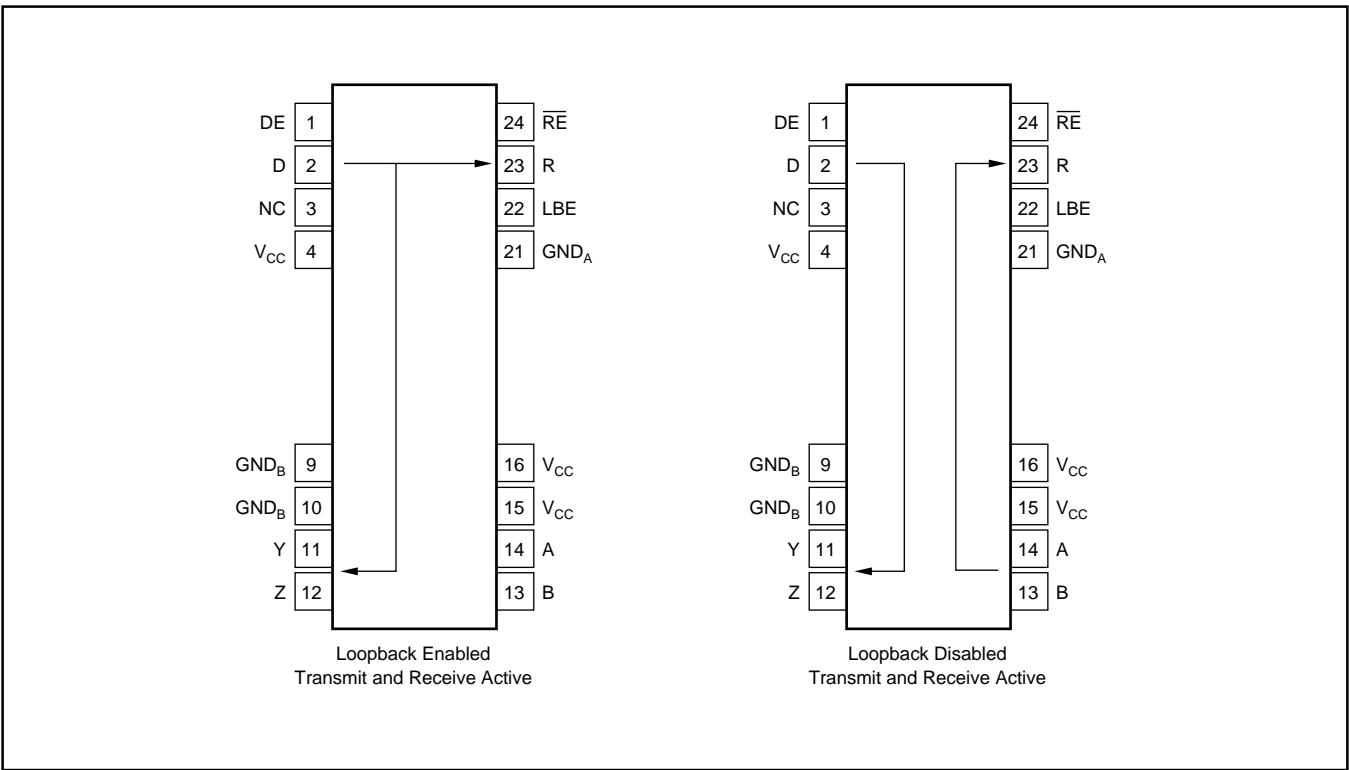


FIGURE 3. Loopback.

CONNECTION TO CAN BUS

Since the bus can be enabled and disabled at the same rate as the data (2.5MHz), it is possible to use ISO422 as an isolated bus driver in CAN systems. Again, the ISO422 bus line must be constrained within the supply voltages.

Figure 4 shows the connections which allow ISO422 to be used in CANbus systems. The DE input of the ISO422 is used as the CAN TX0 input and is used to transmit the data by enabling and disabling the Y and Z outputs. The D and RE inputs of the ISO422 are tied to GND_A. This ensures that the Y output can only pull down, and the Z output can only pull up. With D tied to GND_A, the DE input of ISO422 (TX0 of CAN) activates the Y output as an open drain pull-down driver, and activates the Z output as an open drain pull-up driver. Therefore, the Y line acts as CANL and the Z line acts as CANH. When DE (TX0) is HIGH, ISO422 makes the bus state dominant i.e., Y pulls LOW and Z pulls HIGH. With DE (TX0) LOW, Y and Z are high impedance and the bus state is recessive. Data is received in the normal manner which is half duplex. Line A is connected to CANH, and line B is connected to CANL. The R output becomes RX0. RE is tied to GND_A to keep R (RX0) enabled. If required, RE may be used to disable the RX0 output.

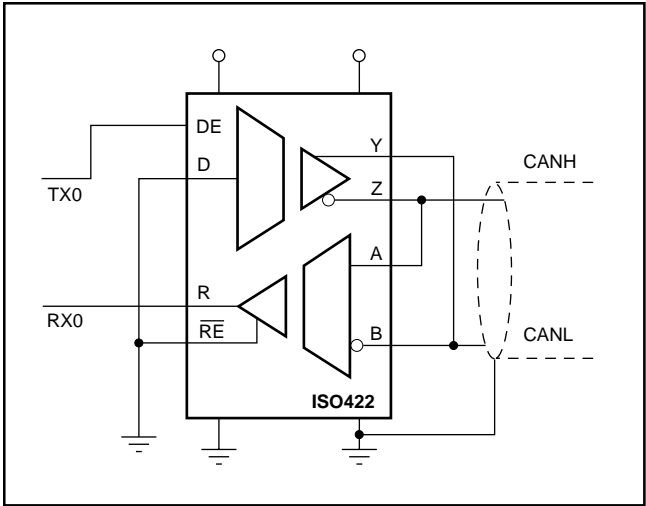


FIGURE 4. CANBus Connection.

TX0	CANH	CANL	BUS	RX0
H	H	L	Dominant	L
L	Hi-Z	Hi-Z	Recessive	H

TABLE I. CAN.

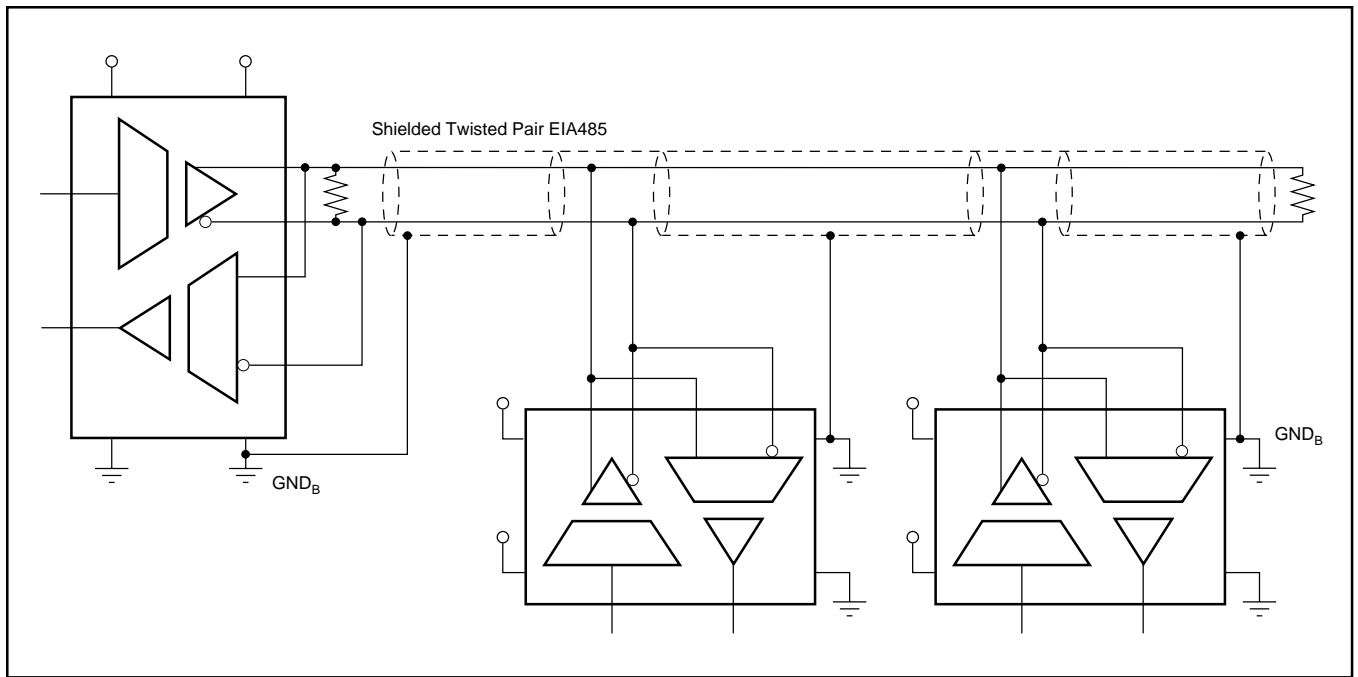


FIGURE 5. Half-Duplex Connection.

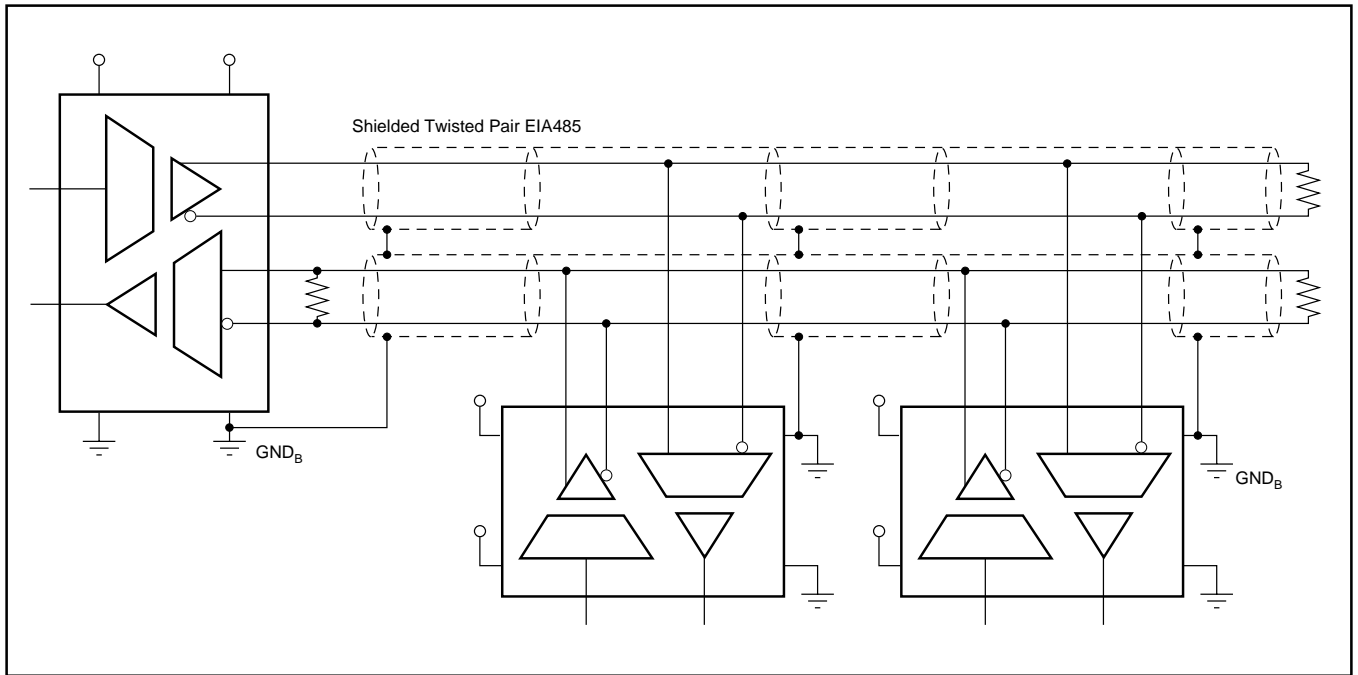


FIGURE 6. Full-Duplex Connection.

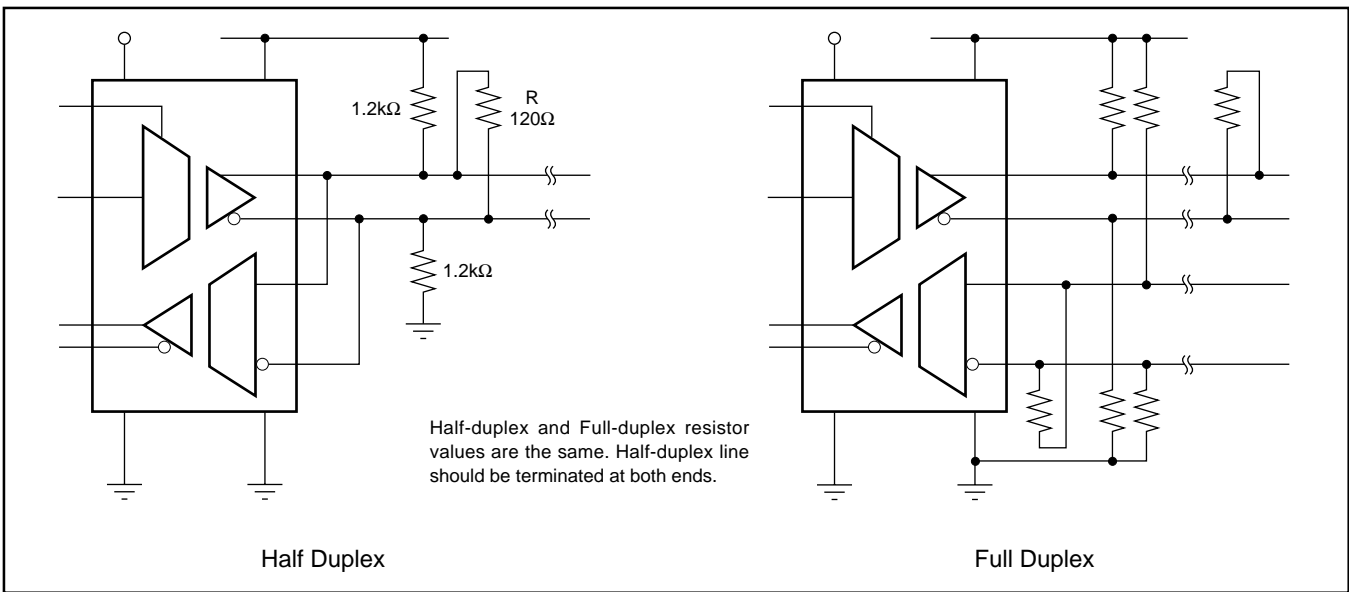


FIGURE 7. Suggested Bus Termination Methods.

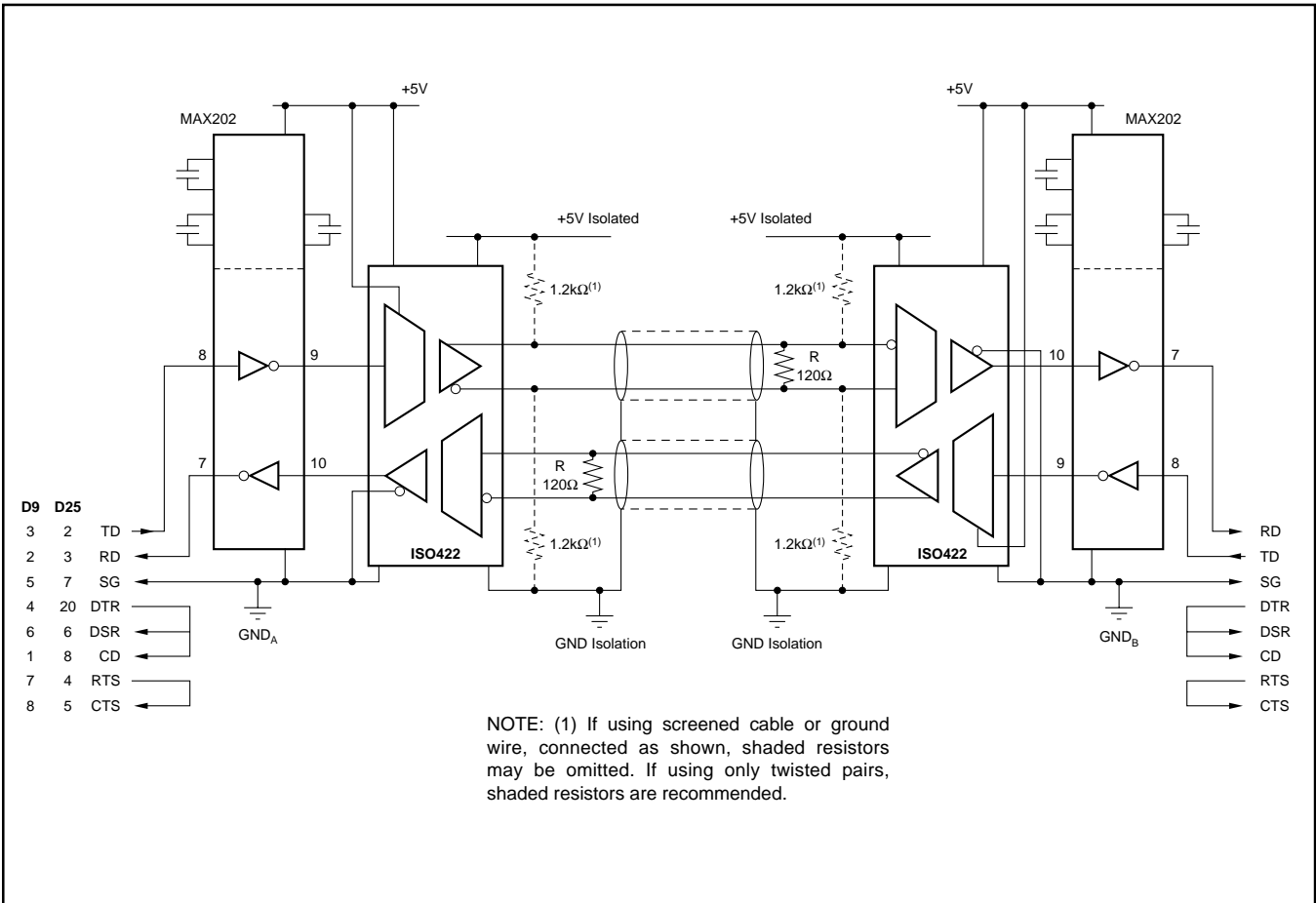


FIGURE 8. Isolated RS232 to RS422. Null Modem Configuration.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products

Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
RF/IF and ZigBee® Solutions	www.ti.com/lprf

Applications

Audio	www.ti.com/audio
Automotive	www.ti.com/automotive
Broadband	www.ti.com/broadband
Digital Control	www.ti.com/digitalcontrol
Medical	www.ti.com/medical
Military	www.ti.com/military
Optical Networking	www.ti.com/opticalnetwork
Security	www.ti.com/security
Telephony	www.ti.com/telephony
Video & Imaging	www.ti.com/video
Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2008, Texas Instruments Incorporated