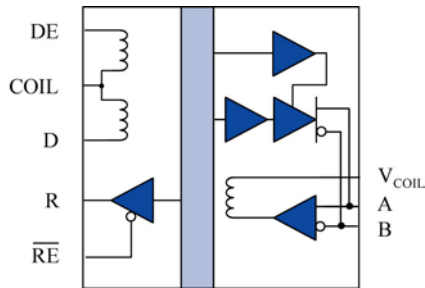
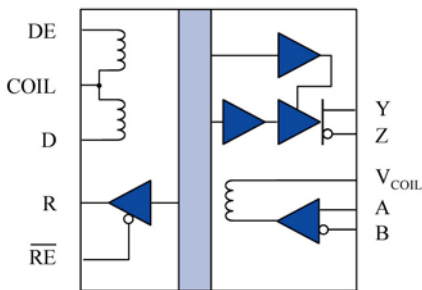


## Fractional Load RS485 and RS422 Transceivers

### Functional Diagram



**IL3285**



**IL3222**

### Truth Table.

$V_{ID}$ (A-B)	DE	RE	R	D	Mode
= 200 mV	L	L	H	C	Receive
= -200 mV	L	L	L	X	Receive
$-7 < V_{ID} < 12$	X	H	Z	X	Receive/Drive
= 1.5 V	H	L	H	H	Drive
= -1.5 V	H	L	L	L	Drive

### Selection Table.

Model	Half / Full Duplex	No. of devices allowed on bus	Data Rate Mb/s	Fail-safe
IL3285	half	256	1	yes
IL3222	full	256	1	yes

### Features

- 3.3 V Input Supply Compatible
- 2500 V<sub>RMS</sub> Isolation (1 min)
- 40 ns Propagation Delay
- 5 ns Pulse Skew
- 20 kV/ $\mu$ s Transient Immunity
- Thermal Shutdown Protection
- -40°C to +85°C Temperature Range
- 16 Pin SOIC Package
- UL1577 Approval Pending
- IEC 61010-1 Approval Pending
- $\pm 15$  kV ESD Protection

### Applications

- High Node Count Networks
- Security Networks
- Building Environmental Controls
- Industrial Control Networks
- Gaming Systems
- Factory Automation

### Description

The IL3000 series are galvanically isolated, differential bus transceivers designed for bidirectional data communication on balanced transmission lines. Isolation is achieved through patented\* Isolooop<sup>®</sup> technology. The IL3285 and IL3222 offer an exceptional 2.3 V differential output into a 54  $\Omega$  load, which allows better data integrity over longer cable lengths. These devices are also compatible with 3.3 V input supplies, allowing interface to standard microcontrollers without the need for additional level-shifting components.

The IL3000 series have current limiting and thermal shutdown features to protect against output short circuits and bus contention situations which may cause excessive power dissipation. The receivers also incorporate a “fail-safe if open” design which ensures a logic high on R if the bus lines are disconnected or “floating”.

**Absolute Maximum Ratings**

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Storage Temperature	$T_S$	-65		150	°C	
Ambient Operating Temperature	$T_A$	-40		100	°C	
Voltage Range at A or B Bus Pins		-7		12	V	
Supply Voltage <sup>(1)</sup>	$V_{DD1}, V_{DD2}$	-0.5		7	V	
Digital Input Voltage		-0.5		$V_{DD}+0.5$	V	
Digital Output Voltage		-0.5		$V_{DD}+1$	V	
ESD Protection	IL3285	$\pm 15$			kV	
	IL3222	$\pm 7$			kV	

**Recommended Operating Conditions**

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Supply Voltage	$V_{DD1}$	3.0		5.5	V	
	$V_{DD2}$	4.5		5.5	V	
Input Voltage at any Bus Terminal (separately or common mode)	$V_I$			12	V	
	$V_{IC}$			-7	V	
High-Level Digital Input Current	$I_{IH}$	10			mA	$V_{DD1} = 3.3\text{ V}$
		10			mA	$V_{DD1} = 5.0\text{ V}$
Low-Level Digital Input Current	$I_{IH}$	-10			mA	$V_{DD1} = 3.3\text{ V}$
		-10			mA	$V_{DD1} = 5.0\text{ V}$
Differential Input Voltage <sup>(2)</sup>	$V_{ID}$			+12/-7	V	
High-Level Output Current (Driver)	$I_{OH}$			-60	mA	
High-Level Digital Output Current (Receiver)	$I_{OH}$	-8		8	mA	
Low-Level Output Current (Driver)	$I_{OL}$	-60		60	mA	
Low-Level Digital Output Current (Receiver)	$I_{OL}$	-8		8	mA	
Ambient Operating Temperature	$T_A$	-40		85	°C	
Digital Input Signal Rise and Fall Times	$t_{IR}, t_{IF}$			10	µs	

**Insulation Specifications**

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Creepage Distance (external)		8.077				
Barrier Impedance $\Omega    \text{pC}$			$>10^{14}    7$			
Leakage Current	$\mu\text{A}_{RMS}$		0.2			240 $V_{RMS}$ , 60 Hz

**Safety & Approvals**

**IEC61010-1**

TUV Certificate Numbers: *Approval Pending*

**Classification as Table 1.**

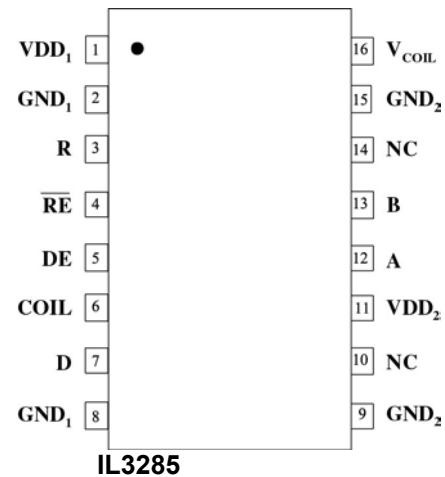
Model	Pollution Degree	Material Group	Max. Working Voltage	Package Type	
				16-SOIC (0.3")	
IL3285, IL3222	II	III	300 $V_{RMS}$		

**UL 1577**

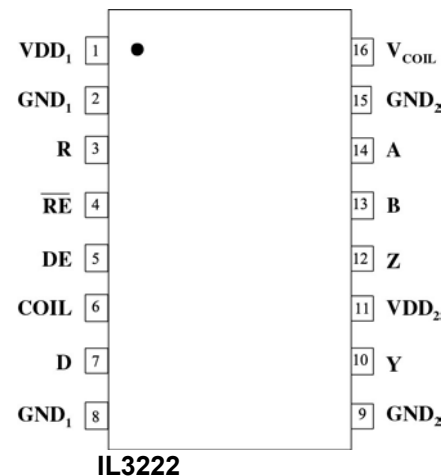
Rated 2500  $V_{RMS}$  for 1 minute  
 Component Recognition program. File #: *Approval Pending*

## Pin Connections

1	V <sub>DD1</sub>	Input Power Supply
2	GND <sub>1</sub>	Input Power Supply Ground Return
3	R	Output Data from Bus
4	$\overline{RE}$	Read Data Enable (if RE is high, R= high impedance)
5	DE	Drive Enable
6	COIL	Supply voltage side of coils for DE and D
7	D	Data Input to Bus
8	GND <sub>1</sub>	Input Power Supply Ground Return
9	GND <sub>2</sub>	Output Power Supply Ground Return
10	NC	No Internal Connection
11	V <sub>DD2</sub>	Output Power Supply
12	A	Noninverting bus line
13	B	Inverting bus line
14	NC	No Internal Connection
15	GND <sub>2</sub>	Output Power Supply Ground Return
16	V <sub>COIL</sub>	Supply voltage side of coil for R



1	V <sub>DD1</sub>	Input Power Supply
2	GND <sub>1</sub>	Input Power Supply Ground Return
3	R	Output Data from Bus
4	$\overline{RE}$	Read Data Enable (if RE is high, R= high impedance)
5	DE	Drive Enable
6	COIL	Supply voltage side of coils for DE and D
7	D	Data Input to Bus
8	GND <sub>1</sub>	Input Power Supply Ground Return
9	GND <sub>2</sub>	Output Power Supply Ground Return
10	Y	Noninverting driver bus line
11	V <sub>DD2</sub>	Output Power Supply
12	Z	Inverting driver bus line
13	B	Inverting receiver bus line
14	A	Noninverting receiver bus line
15	GND <sub>2</sub>	Output Power Supply Ground Return
16	V <sub>COIL</sub>	Supply voltage side of coil for R



## Electrostatic Discharge Sensitivity

This product has been tested for electrostatic sensitivity to the limits stated in the specifications. However, NVE recommends that all integrated circuits be handled with appropriate care to avoid damage. Damage caused by inappropriate handling or storage could range from performance degradation to complete failure.

### Driver Section

Electrical Specifications are  $T_{min}$  to  $T_{max}$  unless otherwise stated.

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Output voltage				$V_{DD}$	V	$I_O = 0$
Differential Output Voltage	$ V_{OD1} $			$V_{DD}$	V	$I_O = 0$
Differential Output Voltage <sup>(6)</sup>	$V_{OD3}$	1.5	2.3	5	V	$R_L = 54 \Omega$ , $V_{DD} = 5 V$
Change in Magnitude of <sup>(7)</sup> Differential Output Voltage	$\Delta V_{OD} $			$\pm 0.2$	V	$R_L = 54 \Omega$ or $100 \Omega$
	$V_{OC}$					
Common Mode Output Voltage	$V_{OC}$			3	V	$R_L = 54 \Omega$ or $100 \Omega$
Change in Magnitude of <sup>(7)</sup> Common Mode Output Voltage	$\Delta V_{OC} $			$\pm 0.2$	V	$R_L = 54 \Omega$ or $100 \Omega$
Output Current <sup>(4)</sup>				1 -0.8	mA	Output Disabled, $V_O = 12$
High Level Input Current	$I_{IH}$			2	mA	
Low Level Input Current	$I_{IL}$			10	mA	
Short-circuit Output Current	$I_{OS}$	60		250	mA	$-7 V < V_O < 12 V$
Supply Current ( $V_{DD2} = +5V$ )	$I_{DD2}$		4	7	mA	No Load (Outputs Enabled)
Supply Current ( $V_{DD1} = +5V$ )	$I_{DD1}$		2	3	mA	
Supply Current ( $V_{DD2} = +3.3V$ )	$I_{DD1}$		1.4	2	mA	

### Switching Specifications

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Maximum Data Rate		5			Mbps	$R_L = 54 \Omega$ , $C_L = 50 pF$
Differential Output Prop Delay	$t_D(OD)$		40	65	ns	$R_L = 54 \Omega$ , $C_L = 50 pF$
Pulse Skew <sup>(10)</sup>	$t_{SK}(P)$		6	20	ns	$R_L = 54 \Omega$ , $C_L = 50 pF$
Differential Output Rise & Fall Time	$t_T(OD)$		12	25	ns	$R_L = 54 \Omega$ , $C_L = 50 pF$
Output Enable Time To High Level	$t_{PZH}$		25	80	ns	$R_L = 54 \Omega$ , $C_L = 50 pF$
Output Enable Time To Low Level	$t_{PZL}$		25	80	ns	$R_L = 54 \Omega$ , $C_L = 50 pF$
Output Disable Time From High Level	$t_{PHZ}$		25	80	ns	$R_L = 54 \Omega$ , $C_L = 50 pF$
Output Disable Time From Low Level	$t_{PLZ}$		25	80	ns	$R_L = 54 \Omega$ , $C_L = 50 pF$
Skew Limit <sup>(5)</sup>	$t_{SK}(LIM)$		12	40	ns	$R_L = 54 \Omega$ , $C_L = 50 pF$

Notes: These notes apply to both driver and receiver sections.

- All Voltage values are with respect to network ground except differential I/O bus voltages.
- Differential input/output voltage is measured at the noninverting terminal A with respect to the inverting terminal B.
- Skew limit is the maximum difference in any two channels in one device.
- The power-off measurement in ANSI Standard EIA/TIA-422-B applies to disabled outputs only and is not applied to combined inputs and outputs.
- All typical values are at  $V_{DD1}, V_{DD2} = 5 V$  or  $V_{DD1} = 3.3 V$  and  $T_A = 25^\circ C$ .
- While  $-7 V < V_{CM} < 12 V$ , the minimum  $V_{OD2}$  with a  $54 \Omega$  load is either  $\frac{1}{2} V_{OD1}$  or  $2.3 V$ , whichever is greater.
- $D|V_{OD}|$  and  $D|V_{OC}|$  are the changes in magnitude of  $V_{OD}$  and  $V_{OC}$ , respectively, that occur when the input is changed from one logic state to the other.
- This applies for both power on and power off, refer to ANSI standard RS-485 for exact condition. The EIA/TIA-422-B limit does not apply for a combined driver and receiver terminal.
- Includes 10 ns read enable time. Maximum propagation delay is 25 ns after read assertion.
- Pulse skew is defined as the  $|t_{PLH} - t_{PHL}|$  of each channel.

### Receiver Section

Electrical Specifications are  $T_{min}$  to  $T_{max}$  unless otherwise stated.

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Positive-going Input Threshold Voltage	$V_{IT+}$			0.2	V	$-7\text{ V} < V_{CM} < 12\text{ V}$
Negative-going Input Threshold Voltage	$V_{IT-}$	-0.2			V	$-7\text{ V} < V_{CM} < 12\text{ V}$
Hysteresis Voltage ( $V_{it+} - V_{it-}$ )	$V_{HYS}$		70		mV	$V_{CM} = 0\text{V}$ , $T = 25^{\circ}\text{C}$
High Level Digital Output Voltage	$V_{OH}$	$V_{DD} - 0.2$	$V_{DD}$		V	$V_{ID} = 200\text{ mV}$ $I_{OH} = -20\text{ mA}$
Low Level Digital Output Voltage	$V_{OL}$			0.2	V	$V_{ID} = -200\text{ mV}$ $I_{OL} = 20\text{ mA}$
High-impedance-state output current	$I_{OZ}$			1	$\mu\text{A}$	$0.4 \leq V_O \leq (V_{DD2} - 0.5)\text{ V}$
Line Input Current(8)	$I_I$			1	mA	$V_I = 12\text{ V}$
				-0.8		$V_I = -7\text{ V}$
Input Resistance	$r_I$	96			k $\Omega$	
Supply Current ( $V_{DD2} = +5\text{V}$ )	$I_{DD2}$		4	7	mA	
Supply Current ( $V_{DD1} = +5\text{V}$ )	$I_{DD1}$		2	3	mA	
Supply Current ( $V_{DD1} = +3.3\text{V}$ )	$I_{DD1}$		1.4	2	mA	

#### Switching Characteristics @ 5 V

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Maximum Data Rate		1			Mbps	$R_L = 54\ \Omega$ , $C_L = 50\text{ pF}$
Propagation Delay <sup>(9)</sup>	$t_{PD}$		100	165	ns	$-1.5 \leq V_O \leq 1.5\text{ V}$ , $C_L = 15\text{ pF}$
Pulse Skew <sup>(10)</sup>	$t_{SK(P)}$		4	16	ns	$-1.5 \leq V_O \leq 1.5\text{ V}$ , $C_L = 15\text{ pF}$
Skew Limit <sup>(3)</sup>	$t_{SK(LIM)}$		8	32	ns	$R_L = 54\ \Omega$ , $C_L = 50\text{ pF}$
Output Enable Time To High Level	$t_{PZH}$		15	60	ns	$C_L = 15\text{ pF}$
Output Enable Time To Low Level	$t_{PZL}$		15	60	ns	$C_L = 15\text{ pF}$
Output Disable Time From High Level	$t_{PHZ}$		15	60	ns	$C_L = 15\text{ pF}$
Output Disable Time From Low Level	$t_{PLZ}$		15	60	ns	$C_L = 15\text{ pF}$

#### Switching Characteristics @ 3.3 V

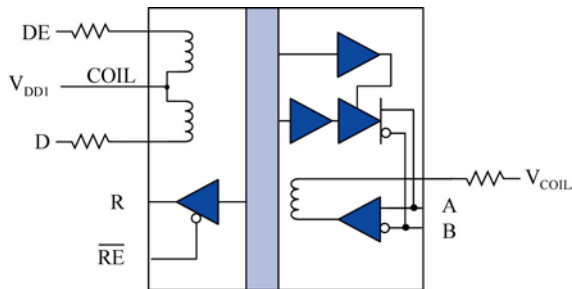
Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Maximum Data Rate		5			Mbps	$R_L = 54\ \Omega$ , $C_L = 50\text{ pF}$
Propagation Delay <sup>(9)</sup>	$t_{PD}$		105	170	ns	$-1.5 \leq V_O \leq 1.5\text{ V}$ , $C_L = 15\text{ pF}$
Pulse Skew <sup>(10)</sup>	$t_{SK(P)}$		4	16	ns	$-1.5 \leq V_O \leq 1.5\text{ V}$ , $C_L = 15\text{ pF}$
Skew Limit <sup>(3)</sup>	$t_{SK(LIM)}$		8	16	ns	$R_L = 54\ \Omega$ , $C_L = 50\text{ pF}$
Output Enable Time To High Level	$t_{PZH}$		17	27	ns	$C_L = 15\text{ pF}$
Output Enable Time To Low Level	$t_{PZL}$		17	27	ns	$C_L = 15\text{ pF}$
Output Disable Time From High Level	$t_{PHZ}$		17	27	ns	$C_L = 15\text{ pF}$
Output Disable Time From Low Level	$t_{PLZ}$		17	27	ns	$C_L = 15\text{ pF}$

**Introduction**

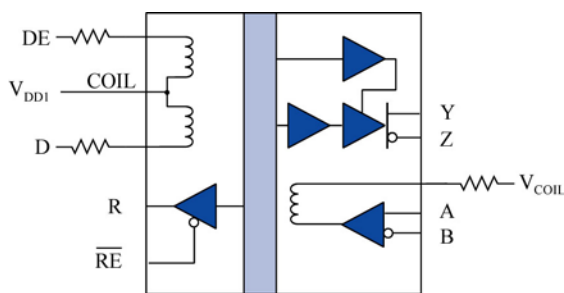
The IL3000 family of isolated RS485 and RS422 transceivers are based on the revolutionary IL600 family of digital isolators. A single external resistor is used to set each input channel's maximum current for input voltages above 0.5 V. For additional information, view the IL600 Series data sheet.

**Operation**

The IL3000 series are current mode devices and utilize NVE's IL600 Series of digital isolators configured for non-inverting outputs. The default state of each isolator output is the logic high state for zero coil current. Therefore, to switch the digital isolator output low, a logic low input signal voltage is applied to the input coil via a current limiting resistor. The resulting coil current switches the isolator output low which in turn is sent to the transceiver. See Figure 1 and Figure 2 below for typical coil connections.



**Figure 1. Typical coil Connections for IL3285**

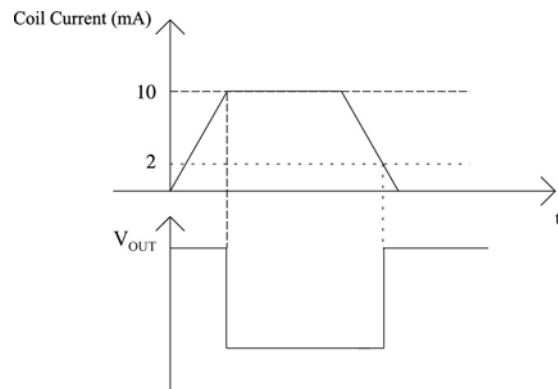


**Figure 2. Typical coil Connections for IL3222**

Only a single resistor is required to limit the input coil to the recommended 10 mA. This allows a wide range of input voltages to be used since there is no semiconductor structure on the input.

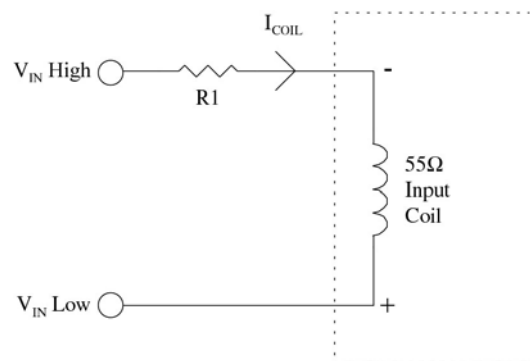
The absolute maximum current through the coil of the IL3000 series is 25 mA DC. However, it is important to limit input current to levels well below this in all applications. The worst case logic threshold current is 10 mA. While typical threshold currents are substantially less than this, NVE recommends designing a 10 mA logic threshold current in each application.

Figure 3 shows the response of the IL3000 Series. The GMR bridge structure is designed such that the output of the isolator is logic high when no field signal is present. The output will switch to the low state with 10 mA of coil current and the output will switch back to the high state when the input current falls below 2 mA. This allows glitch-free interface with low slew rate signals.



**Figure 3. IL3000 Series Transfer Function**

To calculate the value of the protection resistor (R1) required, use Ohm's law as shown in the examples below. It should be noted that we are concerned only with the magnitude of the voltage across the coil. The absolute values of  $V_{in\ High}$  and  $V_{in\ Low}$  are arbitrary.



**Figure 4. Series Resistor Calculation Equivalent Circuit.**

**Example 1.** In this case,  $T_{nom} = 25^{\circ}\text{C}$ ,  $V_{in\ High}$  is 5 V,  $V_{in\ Low}$  is 0 V, and  $I_{coil}$  minimum is specified as 10 mA. Total loop resistance is

$$(R1 + R_{coil}) = \frac{(V_{in\ High} - V_{in\ Low})}{I_{coil}} = \frac{5.0}{0.01} \Omega = 500 \Omega$$

Therefore,

$$R1 = (500 - 55) \Omega = 445 \Omega$$

**Example 2.** At a maximum operating temperature of  $85^{\circ}\text{C}$ ,  $T_{max} = 85^{\circ}\text{C}$ ,  $T_{nom} = 25^{\circ}\text{C}$ ,  $V_{in\ High} = 5\text{ V}$ ,  $V_{in\ Low} = 0\text{ V}$ , and nominal  $R_{coil} = 55 \Omega$ . At  $T_{max} = 85^{\circ}\text{C}$

$$R_{coil} = 55 + (T_{max} - T_{min}) \times TCR_{coil}$$

$$= 55 + (85 - 25) \times 0.165 = 55 + 9.9 = 65 \Omega$$

Therefore, the recommended series resistor is

$$R1 = \frac{(V_{in\ High} - V_{in\ Low})}{I_{coil}} - R_{coil}$$

$$= \frac{5 - 0}{0.01} - 65 = 435 \Omega$$

Allowance should also be made for the temperature coefficient of the current limiting resistor to ensure that  $I_{coil}$  is 10 mA at maximum operating temperature.

### Power Supplies

It is recommended that 47 nF ceramic capacitors be used to decouple the power supplies. The capacitors must be placed as close as possible to  $V_{DD}$  for proper operation.

### DC Correctness

The IL3000 Series of isolated transceivers are inherently DC stable which effectively maintains the correct output state with respect to data input. At power up, the bus outputs will follow the Function Table shown on Page 1. It is recommended that the DE input is always held low during power up to eliminate false drive data pulses from the bus. The use of an external power supply monitor to minimize glitches caused by slow power-up and power-down transients is not required.

### Application Information

#### Receiver Features

The receiver in these devices feature a “fail-safe if open” function that guarantees a high level receiver output if the receiver inputs are unconnected (floating). IL3285 receiver outputs have tri-state capability via the active low RE input.

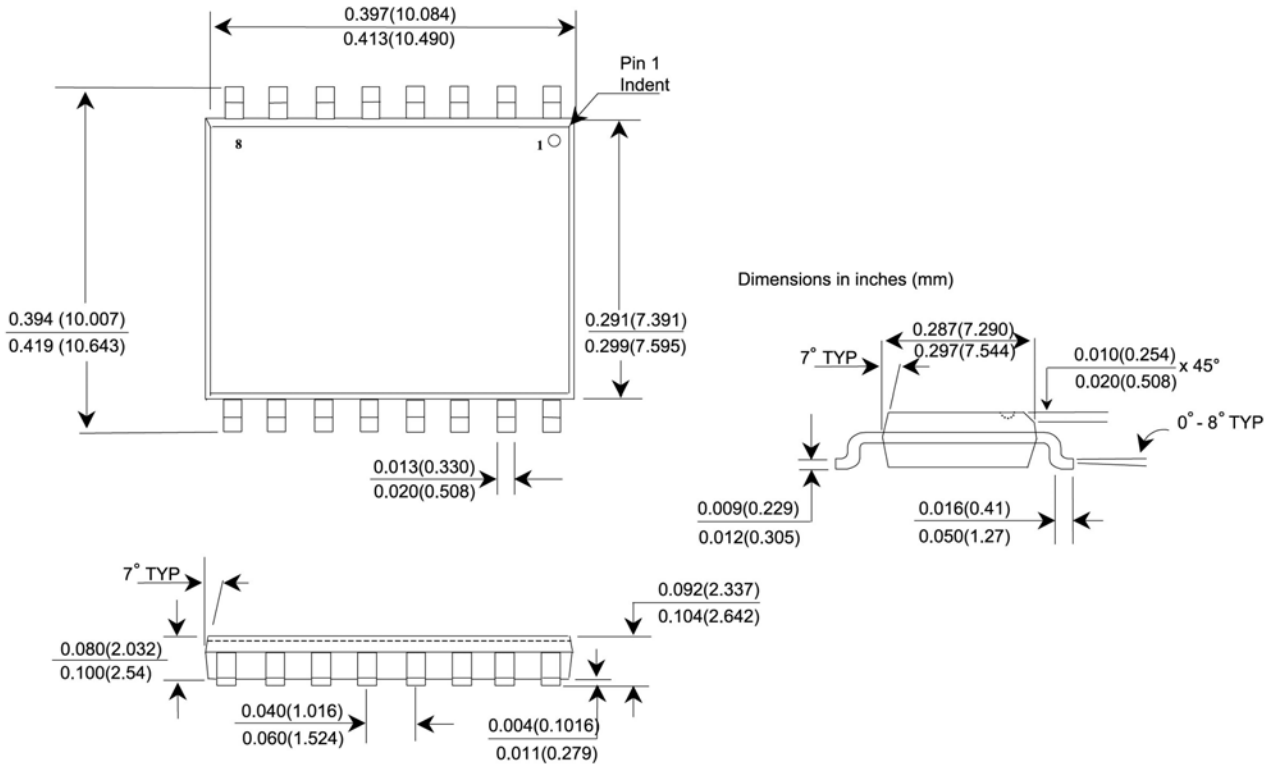
#### Driver Features

The driver in these devices delivers at least 1.5 V across a 54  $\Omega$  load and features low propagation delay skew to maximize bit width and to minimize EMI. The drivers have tri-state capability via the active high DE input.

#### Receiver Data Rate, Cables and Terminations

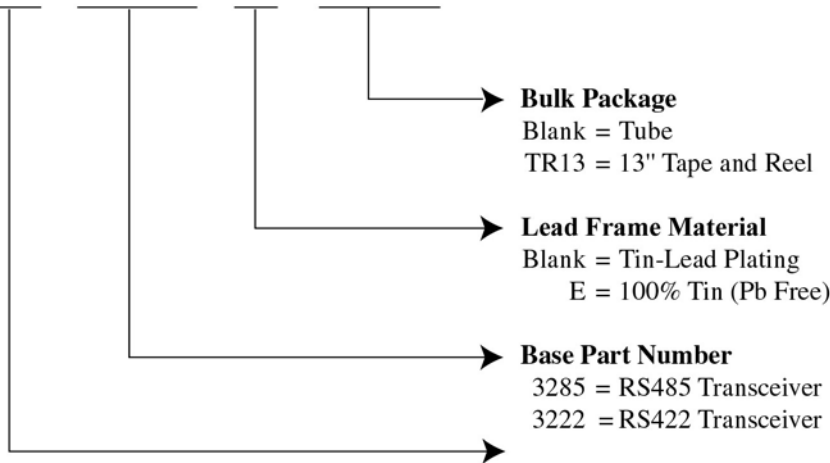
This devices are intended for network lengths up to 4000', but the maximum system data rate decreases as the transmission line length increases. Twisted pair cable should be used in all networks since they tend to pick up noise and other electromagnetically induced voltages as common mode signals, which are effectively rejected by the differential receivers in these ICs.

**Package Dimensions: 0.3" 16- in SOIC**



**Ordering Information and Valid part Numbers**

**IL 3285 E TR13**



**Valid Part Numbers**

- IL3285
- IL3285E
- IL3285TR13
- IL3285E TR13
- IL3222
- IL3222E
- IL3222TR13
- IL3222ETR13

**Product Family**  
IL = Isolators



## **About NVE**

An ISO 9001 Certified Company

NVE Corporation is a high technology components manufacturer having the unique capability to combine leading edge Giant Magnetoresistive (GMR) materials with integrated circuits to make high performance electronic components. Products include Magnetic Field Sensors, Magnetic Field Gradient Sensors (Gradiometer), Digital Magnetic Field Sensors, Digital Signal Isolators and Isolated Bus Transceivers.

NVE is a leader in GMR research and in 1994 introduced the world's first products using GMR material, a line of GMR magnetic field sensors that can be used for position, magnetic media, wheel speed and current sensing.

NVE is located in Eden Prairie, Minnesota, a suburb of Minneapolis. Please visit our Web site at [www.nve.com](http://www.nve.com) or call 952-829-9217 for information on products, sales or distribution.

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***Specifications shown are subject to change without notice.***

ISB-DS-001-IL3285/22-A  
January 26, 2005