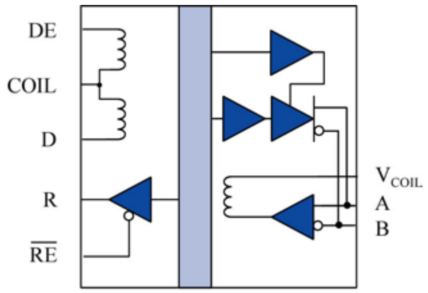
NVE CORPORATION

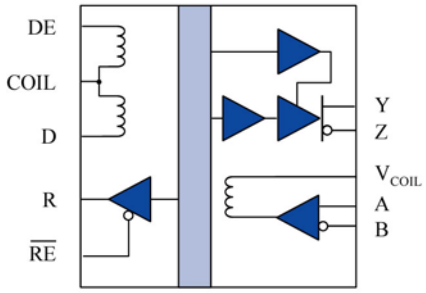
IL3285 IL3222

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_{RMS} Isolation (1 min)
- 40 ns Propagation Delay
- 5 ns Pulse Skew
- 20 kV/µs Transient Immunity
- Thermal Shutdown Protection
- -40°C to +85°C Temperature Range
- 16 Pin SOIC Package
- UL1577 Approval Pending
- IEC 61010-1 Approval Pending
- ±15 kV ESD Protection

Applications

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

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Description

The IL3000 series are galvanically isolated, differential bus transceivers designed for bidirectional data communication on balanced transmission lines. Isolation is achieved through patented* Isoloop® technology. The IL3285 and IL3222 offer an exceptional 2.3 V differential output into a 54 Ω 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 "sail-safe if open" design which ensures a logic high on R if the bus lines are disconnected or "floating".

Isoloop® is a registered trademark of NVE Corporation.
*U.S. Patent number 5,831,426; 6,300,617 and others.

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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 (1)	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 IL3222		±15 ±7			kV kV	

Recommended Operating Conditions

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Supply Voltage	V_{DD1} V_{DD2}	3.0 4.5		5.5 5.5	V	
Input Voltage at any Bus Terminal (separately or common mode)	V_I V_{IC}			12 -7	V	
High-Level Digital Input Current	I_{IH}	10 10			mA mA	V_{DD1}= 3.3 V V_{DD1}= 5.0 V
Low-Level Digital Input Current	I_{IH}	-10 -10			mA mA	V_{DD1}= 3.3 V V_{DD1}= 5.0 V
Differential Input Voltage (2)	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 Ω || pC			$>10^{14}\|\|7$			
Leakage Current	μA_{RMS}		0.2			240 V_{RMS}, 60 Hz

Safety & Approvals

IEC61010-1

TUV Certificate Numbers: *Approval Pending*

Classification as Table 1.

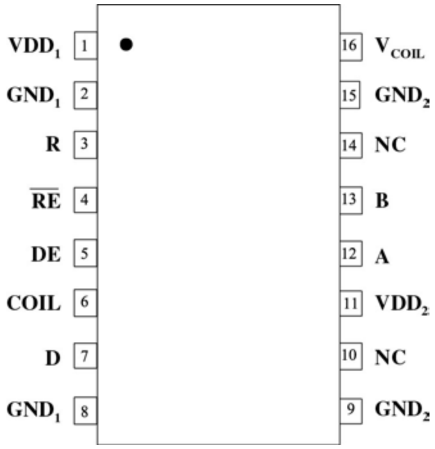
Model	Pollution Degree	Material Group	Max. Working Voltage	Package Type	
				16-SOIC (0.3")	
IL3285, IL3222	II	III	300 V_{RMS}		

UL 1577

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

Pin Connections

1	V_{DD1}	Input Power Supply
2	GND_1	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_1	Input Power Supply Ground Return
9	GND_2	Output Power Supply Ground Return
10	NC	No Internal Connection
11	V_{DD2}	Output Power Supply
12	A	Noninverting bus line
13	B	Inverting bus line
14	NC	No Internal Connection
15	GND_2	Output Power Supply Ground Return
16	V_{COIL}	Supply voltage side of coil for R



IL3285

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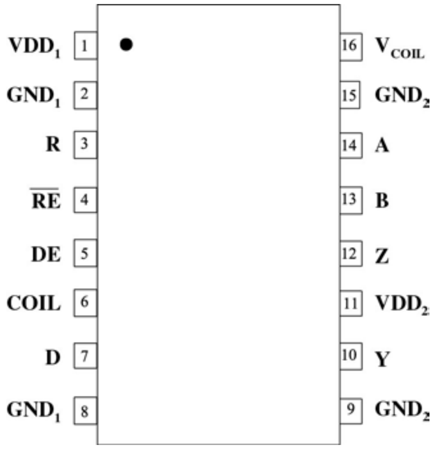
1	V_{DD1}	Input Power Supply
2	GND_1	Input Power Supply Ground Return
3	R	Output Data from Bus
4	$\overline{RE}$	Read Data Enable (if RE is high, R= high impedance)
5	DE	Drive Enable
6	COIL	Supply voltage side of coils for DE and D
7	D	Data Input to Bus
8	GND_1	Input Power Supply Ground Return
9	GND_2	Output Power Supply Ground Return
10	Y	Noninverting driver bus line
11	V_{DD2}	Output Power Supply
12	Z	Inverting driver bus line
13	B	Inverting receiver bus line
14	A	Noninverting receiver bus line
15	GND_2	Output Power Supply Ground Return
16	V_{COIL}	Supply voltage side of coil for R



IL3222

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	Io = 0
Differential Output Voltage	$\lvert V_{OD1}\rvert$			V_{DD}	V	$I_O = 0$
Differential Output Voltage$^{(6)}$	V_{OD3}	1.5	2.3	5	V	$R_L = 54\ \Omega$, $V_{DD} = 5$ V
Change in Magnitude of $^{(7)}$ Differential Output Voltage	$\Delta\lvert V_{OD}\rvert$			±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 $^{(7)}$ Common Mode Output Voltage	$\Delta\lvert V_{OC}\rvert$			±0.2	V	$R_L = 54\ \Omega$ or $100\ \Omega$
Output Current$^{(4)}$				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	$-7\text{ V} < V_O < 12\text{ V}$
Supply Current ($V_{DD2} = +5V$)	I_{DD2}		4	7	mA	No Load (Outputs Enabled)
Supply Current ($V_{DD1} = +5V$)	I_{DD1}		2	3	mA	
($V_{DD2} = +3.3V$)	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$^{(10)}$	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$^{(3)}$	t_{SK}(LIM)		12	40	ns	$R_L = 54\ \Omega$, $C_L = 50$pF

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

1. All Voltage values are with respect to network ground except differential I/O bus voltages.
2. Differential input/output voltage is measured at the noninverting terminal A with respect to the inverting terminal B.
3. Skew limit is the maximum difference in any two channels in one device.
4. 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.
5. All typical values are at $V_{DD!}$,V_{DD2} = 5 V or $V_{DD!}$= 3.3 V and T_A = 25°C.
6. While –7 V<VCM>12 V, the minimum V_{OD2} with a 54 Ω load is either ½ V_{OD1} or 2.3 V, whichever is greater.
7. 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 form one logic state to the other.
8. 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.
9. Includes 10 ns read enable time. Maximum propagation delay is 25 ns after read assertion.
10. Pulse skew is defined as the |t_{PLH} -t_{PHL}l| 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 V < VCM < 12 V
Negative-going Input Threshold Voltage	V_{IT-}	–0.2			V	-7 V < VCM < 12 V
Hysteresis Voltage (Vit+ - Vit-)	V_{HYS}		70		mV	VCM =0V, T=25°C
High Level Digital Output Voltage	V_{OH}	$V_{DD} – 0.2$	V_{DD}		V	$V_{ID} = 200$ mV
						$I_{OH} = -20$ mA
Low Level Digital Output Voltage	V_{OL}			0.2	V	$V_{ID} = -200$ mV
						$I_{OL} = 20$mA
High-impedance-state output current	I_{OZ}			1	μA	$0.4 \le V_O \le (V_{DD2} - 0.5)$ V
Line Input Current(8)	I_I			1	mA	$V_I = 12$ V
				-0.8		$V_I = -7$ V
Input Resistance	r_I	96			kΩ	
Supply Current ($V_{DD2} = +5$V)	I_{DD2}		4	7	mA	
Supply Current ($V_{DD1} = +5$V)	I_{DD1}		2	3	mA	
Supply Current ($V_{DD1} = +3.3$V)	I_{DD1}		1.4	2	mA	
Switching Characteristics @ 5 V						
Parameters	**Symbol**	**Min.**	**Typ.**	**Max.**	**Units**	**Test Conditions**
Maximum Data Rate		1			Mbps	$R_L = 54\ \Omega$, $C_L = 50$ pF
Propagation Delay[9]	t_{PD}		100	165	ns	$-1.5 \le V_O \le 1.5$ V, $C_L = 15$ pF
Pulse Skew[10]	$t_{SK}(P)$		4	16	ns	$-1.5 \le V_O \le 1.5$ V, $C_L = 15$ pF
Skew Limit[3]	$t_{SK}(LIM)$		8	32	ns	$R_L = 54\ \Omega$, $C_L = 50$ pF
Output Enable Time To High Level	t_{PZH}		15	60	ns	$C_L = 15$ pF
Output Enable Time To Low Level	t_{PZL}		15	60	ns	$C_L = 15$ pF
Output Disable Time From High Level	t_{PHZ}		15	60	ns	$C_L = 15$ pF
Output Disable Time From Low Level	t_{PLZ}		15	60	ns	$C_L = 15$ pF
Switching Characteristics @ 3.3 V						
Parameters	**Symbol**	**Min.**	**Typ.**	**Max.**	**Units**	**Test Conditions**
Maximum Data Rate		5			Mbps	$R_L = 54\ \Omega$, $C_L = 50$ pF
Propagation Delay[9]	t_{PD}		105	170	ns	$-1.5 \le V_O \le 1.5$ V, $C_L = 15$ pF
Pulse Skew[10]	$t_{SK}(P)$		4	16	ns	$-1.5 \le V_O \le 1.5$ V, $C_L = 15$ pF
Skew Limit[3]	$t_{SK}(LIM)$		8	16	ns	$R_L = 54\ \Omega$, $C_L = 50$ pF
Output Enable Time To High Level	t_{PZH}		17	27	ns	$C_L = 15$ pF
Output Enable Time To Low Level	t_{PZL}		17	27	ns	$C_L = 15$ pF
Output Disable Time From High Level	t_{PHZ}		17	27	ns	$C_L = 15$ pF
Output Disable Time From Low Level	t_{PLZ}		17	27	ns	$C_L = 15$ pF

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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.

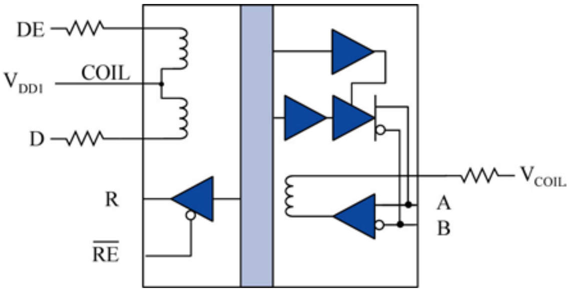

Figure 1. Typical coil Connections for IL3285

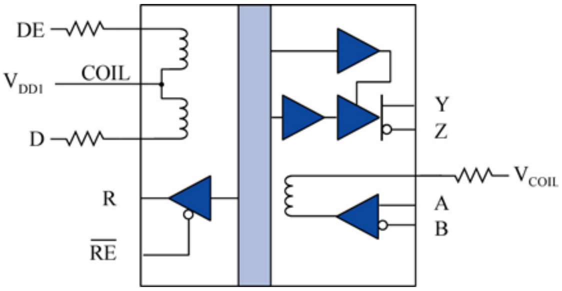

Figure 2. Typical coil Connections for IL3222

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.

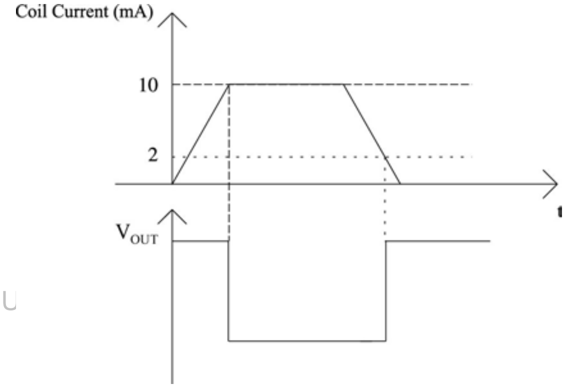

Figure 3. IL3000 Series Transfer Function

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.

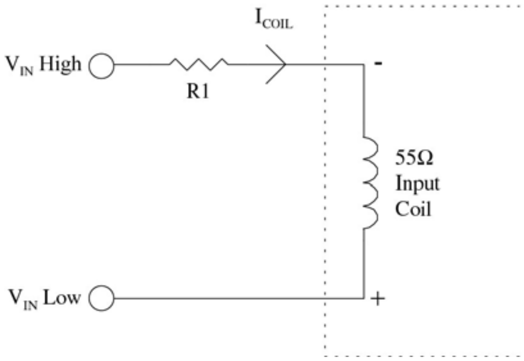

Figure 4. Series Resistor Calculation Equivalent Circuit.

Example 1. In this case, T_{nom} = 25ºC, 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

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

Therefore,

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

Example 2. At a maximum operating temperature of 85°C, T_{max} = 85ºC, T_{nom} = 25ºC, V_{in} High = 5 V, V_{in} Low = 0 V, and nominal R_{coil} = 55 Ω. At T_{max} = 85ºC

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

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

Therefore, the recommended series resistor is

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

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

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.

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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 $\overline{RE}$ input.

Driver Features

The driver is device delivers at least 1.5 V across a 54 Ω 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.

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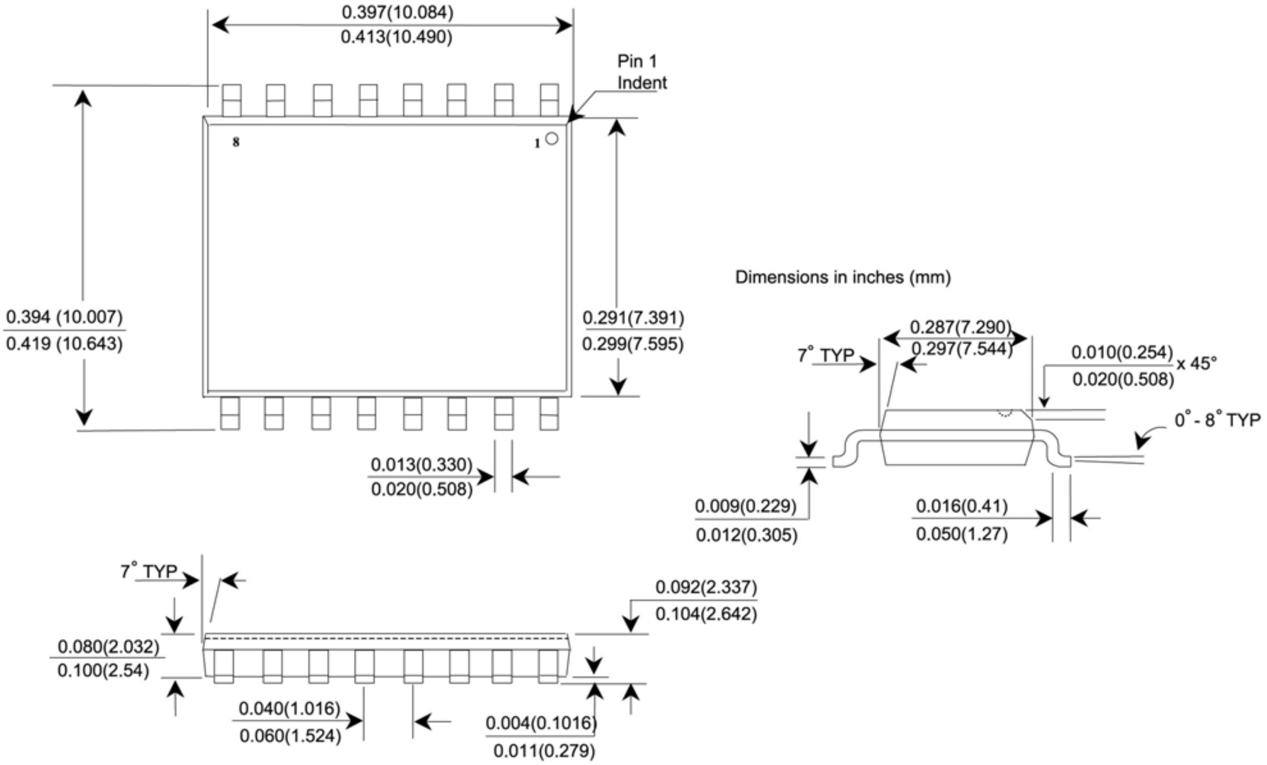
Receiver Data Rate, Cables and Terminations

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


0.397(10.084)
0.413(10.490)
Pin 1
Indent
8
1
0.394 (10.007)
0.419 (10.643)
0.291(7.391)
0.299(7.595)
0.013(0.330)
0.020(0.508)
Dimensions in inches (mm)
7° TYP
0.287(7.290)
0.297(7.544)
0.010(0.254)
0.020(0.508)
x 45°
0° - 8° TYP
0.009(0.229)
0.012(0.305)
0.016(0.41)
0.050(1.27)
7° TYP
0.092(2.337)
0.104(2.642)
0.080(2.032)
0.100(2.54)
0.040(1.016)
0.060(1.524)
0.004(0.1016)
0.011(0.279)

Ordering Information and Valid part Numbers

IL 3285 E TR13

Bulk Package
Blank = Tube
TR13 = 13" Tape and Reel

Lead Frame Material
Blank = Tin-Lead Plating
E = 100% Tin (Pb Free)

Base Part Number
3285 = RS485 Transceiver
3222 = RS422 Transceiver

Product Family
IL = Isolators

Valid Part Numbers

IL3285
IL3285E
IL3285TR13
IL3285E TR13

IL3222
IL3222E
IL3222TR13
IL3222ETR13

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 or call 952-829-9217 for information on products, sales or distribution.

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Specifications shown are subject to change without notice.

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January 26, 2005