

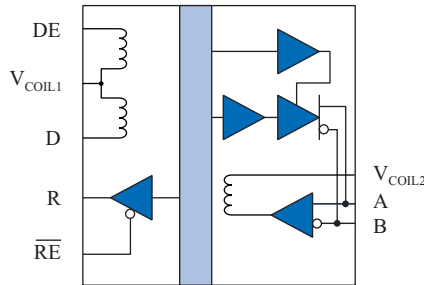


**THE DATASHEET OF  
IL 322E**

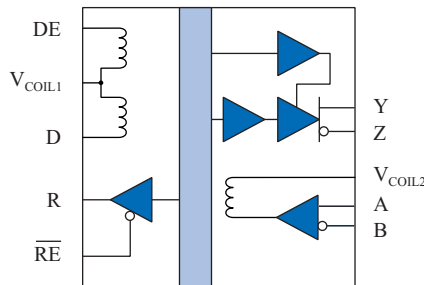


## Fractional Load Passive Input RS-485 and RS-422 Isolated Transceivers

### Functional Diagrams



**IL3285**



**IL3222**

### IL3285 Truth Table

V <sub>ID</sub> (A-B)	DE	RE	R	D	Mode	Notes
≥ 200 mV	L	L	H	X	Receive	
≤ -200mV	L	L	L	X		
Open	L	L	H	X		A/B failsafe
≥ 1.5 V	H	L	H	H	Drive	R reads back D information
≤ -1.5 V	H	L	L	L		
≥ 1.5 V	H	H	Z	H		R tri-state (no output)
≤ -1.5 V	H	H	Z	L		
X	L	H	Z	X	Disabled	R tri-state; A/B failsafe

Z = High Impedance X = Irrelevant

\* "H"=no coil-current flowing; "L"=coil current.

### IL3222 Receiver

RE	R	V <sub>(A-B)</sub>
H	Z	X
L	H	≥ 200 mV
L	L	≤ -200 mV
L	H	Open

### IL3222 Driver

DE	D	V <sub>(Y-Z)</sub>
L	X	Z
H	H	≥ 2 V
H	L	≤ -2 V

### Selection Table

Model	Full/Half Duplex	No. of Devices Allowed on Bus	Data Rate Mbps	Fail-Safe
IL3285	half	256	5	yes
IL3222	full	256	5	yes

IsoLoop® is a registered trademark of NVE Corporation.

\*U.S. Patent numbers 5,831,426; 6,300,617 and others.

### Features

- 3 V to 5 V power supplies
- 5 Mbps data rate
- 1/8 unit load
- 15 kV bus ESD protection
- 20 kV/μs typical common mode rejection
- No carrier or clock for low EMI emissions and susceptibility
- -40 °C to +85 °C temperature range
- Thermal shutdown protection
- 2500 V<sub>RMS</sub> isolation
- IEC 60747-17 (VDE 0884-17):2021-10; UL 1577
- 0.15" or 0.3" True 8™ mm 16-pin SOIC packages

### Applications

- High node-count networks
- Security networks
- Building environmental controls
- Industrial control networks
- Gaming systems

### Description

The IL3285 and IL3222 are galvanically isolated, differential bus transceivers designed for bidirectional data communication over balanced transmission lines. The devices use NVE's patented\* IsoLoop spintronic Giant Magnetoresistance (GMR) technology. The IL3285 delivers at least 1.5 V into a 54 Ω load, and the IL3222 at least 2 V into a 100 Ω load for excellent data integrity over long cables. These devices are also compatible with 3.3 V input supplies, allowing interface to standard microcontrollers without additional level shifting.

A unique ceramic/polymer composite barrier provides excellent isolation and virtually unlimited barrier life.

Both the IL3285 and IL3222 have current limiting and thermal shutdown features to protect against output short circuits and bus contentions that may cause excessive power dissipation. The receivers also incorporate a "fail-safe if open" design, ensuring a logic high on R if the bus lines are disconnected or "floating."

Receiver input resistance of 96 kΩ is eight times the RS-485 "Unit Load" (UL) minimum of 12 kΩ. Thus these products are known as "one-eighth UL" transceivers. There can be up to 256 on a network while still complying with the RS-485 loading specification.

### Absolute Maximum Ratings

Operating at absolute maximum ratings will not damage the device. However, extended periods of operation at the absolute maximum ratings may affect performance and reliability.

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Storage Temperature	$T_S$	-55		150	°C	
Junction Temperature	$T_J$	-55		150	°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		±15			kV	
Input Current	$I_{IN}$	-25		+25	mA	
ESD (all bus nodes)		15			kV	HBM

Note 1. All voltage values are with respect to network ground except differential I/O bus voltages.

### 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	
Ambient Operating Temperature	$T_A$	-40		85	°C	
Junction Temperature	$T_J$	-40		100	°C	
Input Voltage at any Bus Terminal (separately or common mode)	$V_I$ $V_{IC}$			12 -7	V	
Input Threshold for Output Logic High	$I_{INH}$		1.5	0.8	mA	
Input Threshold for Output Logic Low	$I_{INL}$	5	3.5		mA	
Differential Input Voltage	$V_{ID}$			+12/-7	V	
High-Level Output Current (Driver)	$I_{OH}$	-60		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	
Digital Input Signal Rise, Fall Times	$t_{IR}, t_{IF}$			1	µs	

**Safety Approvals**

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**IEC 60747-17 (VDE 0884-17):2021-10** (Basic Isolation; VDE File Number 5016933-4880-0001):

- Isolation voltage ( $V_{ISO}$ ): 2500  $V_{RMS}$
- Transient overvoltage ( $V_{IOTM}$ ): 4000  $V_{PK}$
- Surge rating 4000 V
- Each part tested at 1590  $V_{PK}$  for 1 second, 5 pC partial discharge limit
- Samples tested at 4000  $V_{PK}$  for 60 sec.; then 1358  $V_{PK}$  for 10 sec. with 5 pC partial discharge limit
  
- Working Voltage ( $V_{IORM}$ ; pollution degree 2):

Package	Part No. Suffix	Working Voltage
Narrow-body SOIC16	-3	700 $V_{RMS}$
Wide-body SOIC16/True 8™	None	600 $V_{RMS}$

Safety-Limiting Values	Symbol	Value	Units
Safety rating ambient temperature	$T_S$	180	°C
Safety rating power (180 °C)	$P_S$	270	mW
Supply current safety rating (total of supplies)	$I_S$	54	mA

**UL 1577** (Component Recognition Program File Number E207481)

- 2500 V rating
- Each part tested at 3000  $V_{RMS}$  (4243  $V_{PK}$ ) for 1 second
- Each lot sample tested at 2500  $V_{RMS}$  (3536  $V_{PK}$ ) for 1 minute

**Soldering Profile**

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Per JEDEC J-STD-020C, MSL 1

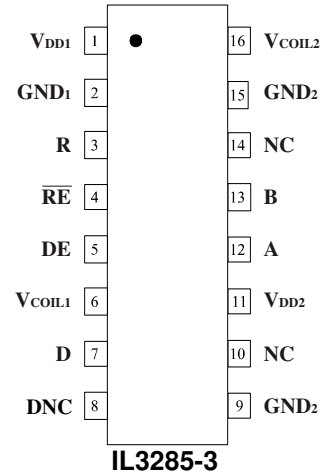
**Electrostatic Discharge Sensitivity**

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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.

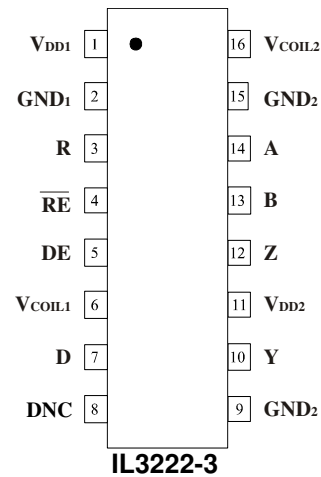
## IL3285-3 Pin Connections (0.15" SOIC Package)

1	V <sub>DD1</sub>	Input power supply
2	GND <sub>1</sub>	Ground return for V <sub>DD1</sub>
3	R	Output data from bus
4	$\overline{RE}$	Read enable (if RE is high, R is high impedance)
5	DE	Drive enable
6	V <sub>COIL1</sub>	Coils for DE and D (connect to V <sub>DD1</sub> )
7	D	Data input to bus
8	DNC	Do not connect
9	GND <sub>2</sub>	Ground return for V <sub>DD2</sub> (internally connected to pin 15)
10	NC	No internal connection
11	V <sub>DD2</sub>	Output power supply
12	A	Non-inverting bus line
13	B	Inverting bus line
14	NC	No internal connection
15	GND <sub>2</sub>	Ground return for V <sub>DD2</sub> (internally connected to pin 9)
16	V <sub>COIL2</sub>	Coil for R



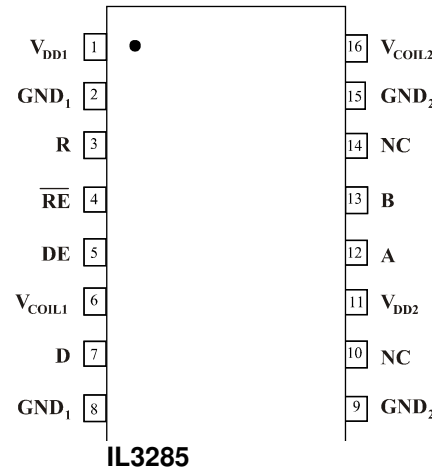
## IL3222-3 Pin Connections (0.15" SOIC Package)

1	V <sub>DD1</sub>	Input power supply
2	GND <sub>1</sub>	Ground return for V <sub>DD1</sub>
3	R	Output data from bus
4	$\overline{RE}$	Read enable (if RE is high, R is high impedance)
5	DE	Drive enable
6	V <sub>COIL1</sub>	Coils for DE and D (connect to V <sub>DD1</sub> )
7	D	Data input to bus
8	DNC	Do not connect
9	GND <sub>2</sub>	Ground return for V <sub>DD2</sub> (internally connected to pin 15)
10	Y	Non-inverting 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	Non-inverting receiver bus line
15	GND <sub>2</sub>	Ground return for V <sub>DD2</sub> (internally connected to pin 9)
16	V <sub>COIL2</sub>	Coil for R



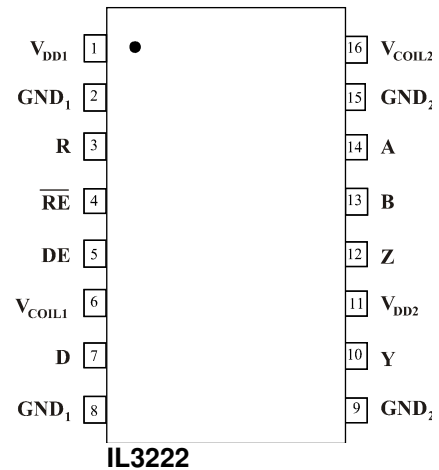
## IL3285 Pin Connections (0.3" SOIC Package)

1	V <sub>DD1</sub>	Input power supply
2	GND <sub>1</sub>	Ground return for V <sub>DD1</sub>
3	R	Output data from bus
4	$\overline{\text{RE}}$	Read enable (if RE is high, R is high impedance)
5	DE	Drive enable
6	V <sub>COIL1</sub>	Coils for DE and D (connect to V <sub>DD1</sub> )
7	D	Data input to bus
8	GND <sub>1</sub>	Internally connected to pin 2 for 0.3" package; no internal connection on 0.15" IL3285-3
9	GND <sub>2</sub>	Ground return for V <sub>DD2</sub> (internally connected to pin 15)
10	NC	No internal connection
11	V <sub>DD2</sub>	Output power supply
12	A	Non-inverting bus line
13	B	Inverting bus line
14	NC	No internal connection
15	GND <sub>2</sub>	Ground return for V <sub>DD2</sub> (internally connected to pin 9)
16	V <sub>COIL2</sub>	Coil for R



## IL3222 Pin Connections (0.3" SOIC Package)

1	V <sub>DD1</sub>	Input power supply
2	GND <sub>1</sub>	Ground return for V <sub>DD1</sub>
3	R	Output data from bus
4	$\overline{\text{RE}}$	Read enable (if RE is high, R is high impedance)
5	DE	Drive enable
6	V <sub>COIL1</sub>	Coils for DE and D (connect to V <sub>DD1</sub> )
7	D	Data input to bus
8	GND <sub>1</sub>	Internally connected to pin 2 for 0.3" package; no internal connection on 0.15" IL3222-3
9	GND <sub>2</sub>	Ground return for V <sub>DD2</sub> (internally connected to pin 15)
10	Y	Non-inverting 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	Non-inverting receiver bus line
15	GND <sub>2</sub>	Ground return for V <sub>DD2</sub> (internally connected to pin 9)
16	V <sub>COIL2</sub>	Coil for R



Driver Section

Electrical Specifications (V <sub>DD1</sub> = 3 V – 5.5 V; V <sub>DD2</sub> = 4.5 V – 5.5 V; T = –40°C – 85°C unless otherwise stated)						
Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Coil Input Resistance	R <sub>COIL</sub>	47	85	112	Ω	T = 25°C
Coil Input Resistance	R <sub>COIL</sub>	31	85	128	Ω	T = –40°C – 85°C
Coil Resistance Temperature Coefficient	TC R <sub>COIL</sub>		0.2	0.25	Ω/°C	
Coil Inductance	L <sub>COIL</sub>		9		nH	
High Level Input Current	I <sub>INH</sub>	0.5	1		mA	t <sub>IR</sub> = t <sub>IF</sub> = 3 ns;
Low Level Input Current	I <sub>INL</sub>		3.5	5	mA	C <sub>BOOST</sub> = 16 pF
Output voltage				V <sub>DD</sub>	V	I <sub>O</sub> = 0
Differential Output Voltage	V <sub>OD1</sub>			V <sub>DD</sub>	V	I <sub>O</sub> = 0
Differential Output Voltage	V <sub>OD2</sub>	2	3		V	R <sub>L</sub> = 100 Ω, V <sub>DD</sub> = 5 V
Differential Output Voltage <sup>(6)</sup>	V <sub>OD3</sub>	1.5	2.3		V	R <sub>L</sub> = 54 Ω, V <sub>DD</sub> = 5 V
Change in Magnitude <sup>(7)</sup> of Differential Output Voltage	Δ V <sub>OD</sub>			±0.2	V	R <sub>L</sub> = 54 Ω or 100 Ω
Common Mode Output Voltage	V <sub>OC</sub>			3	V	R <sub>L</sub> = 54 Ω or 100 Ω
Change in Magnitude <sup>(7)</sup> of Common Mode Output Voltage	Δ V <sub>OC</sub>			0.2	V	R <sub>L</sub> = 54 Ω or 100 Ω
Output Current <sup>(4)</sup>				1 –0.8	mA mA	Output disabled, V <sub>O</sub> = 12 V V <sub>O</sub> = –7 V
Short-circuit Output Current	I <sub>OS</sub>	60		250	mA	–7 V < V <sub>O</sub> < 12 V
Supply Current (V <sub>DD2</sub> = +5 V)	I <sub>DD2</sub>		6	7	mA	No Load
(V <sub>DD1</sub> = +5 V)	I <sub>DD1</sub>		2.5	3	mA	(Outputs Enabled)
Supply Current (V <sub>DD1</sub> = +3.3 V)	I <sub>DD2</sub>		1.3	2	mA	No Load (Outputs Enabled)
Common Mode Rejection	CM <sub>H</sub>  ,  CM <sub>L</sub>	15	20		kV/μs	V <sub>T</sub> = 300 V <sub>peak</sub>

Switching Specifications (V <sub>DD1</sub> = 5 V; V <sub>DD2</sub> = 5 V; T = –40°C – 85°C)						
Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Data Rate		5			Mbps	R <sub>L</sub> = 54 Ω; C <sub>L</sub> = 50 pF; C <sub>boost</sub> = 16pF
Differential Output Prop Delay	t <sub>D</sub> (OD)		40	65	ns	
Pulse Skew <sup>(10)</sup>	t <sub>SK</sub> (P)		6	20	ns	
Differential Output Rise and Fall Time	t <sub>T</sub> (OD)	3	12	25	ns	
Drive Enable Time to High Level	t <sub>PZH</sub>		25	80	ns	
Drive Enable Time to Low Level	t <sub>PZL</sub>		25	80	ns	
Drive Disable Time from High Level	t <sub>PHZ</sub>		25	80	ns	
Drive Disable Time from Low Level	t <sub>PLZ</sub>		25	80	ns	
Skew Limit <sup>(3)</sup>	t <sub>SK</sub> (LIM)			8	ns	

Switching Specifications (V <sub>DD1</sub> = 3.3 V; V <sub>DD2</sub> = 5 V; T = –40°C – 85°C)						
Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Data Rate		5			Mbps	R <sub>L</sub> = 54 Ω; C <sub>L</sub> = 50 pF; C <sub>boost</sub> = 16pF
Differential Output Prop Delay	t <sub>D</sub> (OD)		40	65	ns	
Pulse Skew <sup>(10)</sup>	t <sub>SK</sub> (P)		6	20	ns	
Differential Output Rise and Fall Time	t <sub>T</sub> (OD)	3	12	25	ns	
Drive Enable Time to High Level	t <sub>PZH</sub>		25	80	ns	
Drive Enable Time to Low Level	t <sub>PZL</sub>		25	80	ns	
Drive Disable Time from High Level	t <sub>PHZ</sub>		25	80	ns	
Drive Disable Time from Low Level	t <sub>PLZ</sub>		25	80	ns	
Skew Limit <sup>(3)</sup>	t <sub>SK</sub> (LIM)			8	ns	

## Receiver Section

Electrical Specifications ( $V_{DD1} = 3\text{ V} - 5.5\text{ V}$ ; $V_{DD2} = 4.5\text{ V} - 5.5\text{ V}$ ; $T = -40^{\circ}\text{C} - 85^{\circ}\text{C}$ unless otherwise stated)						
Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Coil Resistance	$R_{COIL}$	47	85	112	$\Omega$	$T = 25^{\circ}\text{C}$
		31	85	128	$\Omega$	$T = -40^{\circ}\text{C} - 85^{\circ}\text{C}$
Coil Resistance Temperature Coefficient	$TC R_{COIL}$		0.2	0.25	$\Omega/^{\circ}\text{C}$	
Positive-going Input Threshold	$V_{IT+}$			0.2	V	$-7\text{ V} < V_{CM} < 12\text{ V}$
Negative-going Input Threshold	$V_{IT-}$	-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	$V_{OH}$	$V_{DD} - 0.2$	$V_{DD} - 0.2$		V	$V_{ID} = 200\text{ mV}$
						$I_{OH} = 4\text{ mA}$
Low Level Digital Output Voltage	$V_{OL}$			0.8	V	$V_{ID} = -200\text{ mV}$
						$I_{OL} = 4\text{ mA}$
High impedance state output current	$I_{OZ}$			10	$\mu\text{A}$	$0.4 \leq V_{O} \leq (V_{DD2} - 0.5)\text{ V}$
Line Input Current <sup>(8)</sup>	$I_I$			1	mA	$V_I = 12\text{ V}$
				-0.8		$V_I = -7\text{ V}$
Input Resistance	$r_I$	96			k $\Omega$	

Switching Characteristics ( $V_{DD1} = 5\text{ V}$ ; $V_{DD2} = 5\text{ V}$ ; $C_{boost} = 16\text{ pF}$ ; $T = -40^{\circ}\text{C} - 85^{\circ}\text{C}$ )						
Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Data Rate		5			Mbps	$R_L = 54\ \Omega$ , $C_L = 50\text{ pF}$
Propagation Delay <sup>(9)</sup>	$t_{PD}$		90	150	ns	$-1.5 \leq V_O \leq 1.5\text{ V}$ , $C_L = 15\text{ pF}$
Pulse Skew <sup>(10)</sup>	$t_{SK}(P)$		6	20	ns	$-1.5 \leq V_O \leq 1.5\text{ V}$ , $C_L = 15\text{ pF}$
Skew Limit <sup>(3)</sup>	$t_{SK}(LIM)$		2	8	ns	$R_L = 54\ \Omega$ , $C_L = 50\text{ pF}$
Read Enable Time to High Level	$t_{PZH}$		4	10	ns	$C_L = 15\text{ pF}$
Read Enable Time to Low Level	$t_{PZL}$		4	10	ns	
Read Disable Time from High Level	$t_{PHZ}$		4	10	ns	
Read Disable Time from Low Level	$t_{PLZ}$		4	10	ns	

Switching Characteristics ( $V_{DD1} = 3.3\text{ V}$ ; $V_{DD2} = 5\text{ V}$ ; $C_{boost} = 16\text{ pF}$ ; $T = -40^{\circ}\text{C} - 85^{\circ}\text{C}$ )						
Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Data Rate		5			Mbps	$R_L = 54\ \Omega$ , $C_L = 50\text{ pF}$
Propagation Delay <sup>(9)</sup>	$t_{PD}$		100	150	ns	$-1.5 \leq V_O \leq 1.5\text{ V}$ , $C_L = 15\text{ pF}$
Pulse Skew <sup>(10)</sup>	$t_{SK}(P)$		10	20	ns	$-1.5 \leq V_O \leq 1.5\text{ V}$ , $C_L = 15\text{ pF}$
Skew Limit <sup>(3)</sup>	$t_{SK}(LIM)$		4	10	ns	$R_L = 54\ \Omega$ , $C_L = 50\text{ pF}$
Read Enable Time to High Level	$t_{PZH}$		5	10	ns	$C_L = 15\text{ pF}$
Read Enable Time to Low Level	$t_{PZL}$		5	10	ns	
Read Disable Time from High Level	$t_{PHZ}$		5	10	ns	
Read Disable Time from Low Level	$t_{PLZ}$		17	10	ns	

## Insulation Specifications

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Comparative Tracking Index	CTI	$\geq 175$			V	Per IEC 60112
Endurance Voltage (Maximum Working Voltage for Indefinite Life)	AC	1000			$V_{RMS}$	At maximum operating temperature
	DC	1500			$V_{DC}$	
Creepage Distance (external)	0.15" SOIC	4.03			mm	Per IEC 60601
	0.3" SOIC	8.03	8.3			
Total Barrier Thickness (internal)		0.012	0.013		mm	
Barrier Resistance	$R_{IO}$		$>10^{14}$		$\Omega$	500 V
Barrier Capacitance	$C_{IO}$		7		pF	$f = 1\text{ MHz}$
Leakage Current			0.2		$\mu\text{A}$	240 $V_{RMS}$ , 60 Hz

### Thermal Characteristics

Parameter		Symbol	Min.	Typ.	Max.	Units	Test Conditions	
Junction–Ambient Thermal Resistance	0.15" SOIC	$\theta_{JA}$		82		$^{\circ}\text{C}/\text{W}$	Double-sided PCB in free air	
	0.3" SOIC			67				
Junction–Case (Top) Thermal Resistance	0.15" SOIC	$\theta_{JC}$		8				
	0.3" SOIC			12				
Junction–Ambient Thermal Resistance	0.3" SOIC	$\theta_{JA}$		46			2s2p PCB in free air per JESD51	
Junction–Case (Top) Thermal Resistance		$\theta_{JC}$		9				
Power Dissipation	0.15" SOIC	$P_D$		700				mW
	0.3" SOIC			1500				

**Notes** (apply to both driver and receiver sections):

1. All voltages are with respect to network ground except differential I/O bus voltages.
2. Differential input/output voltage is measured at the non-inverting 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  $V_{DD1}$ ,  $V_{DD2} = 5\text{ V}$  or  $V_{DD1} = 3.3\text{ V}$  and  $T_A = 25^{\circ}\text{C}$ .
6. While  $-7\text{ V} < V_{CM} < 12\text{ V}$ , the minimum  $V_{OD2}$  with a  $54\ \Omega$  load is either  $\frac{1}{2} V_{OD1}$  or  $1.5\text{ V}$ , whichever is greater.
7.  $\Delta|V_{OD}|$  and  $\Delta|V_{OC}|$  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.
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  $|t_{PLH} - t_{PHL}|$  of each channel.

## Applications Information

### Input Resistor Values

The IL3222 and IL3285 are current-mode devices. Changes in input coil current switch internal spintronic GMR sensors. Inputs are logically high when the coil voltage is high, that is when there is no coil current.

A single resistor is required to limit the input coil current to the 5 mA threshold current. The absolute maximum current through any coil is 25 mA.

### Typical Input Resistor Values

V <sub>COIL</sub>	Coil Resistor
3.3 V	510 Ω
5 V	820 Ω

The table shows typical values for the external coil resistors in 5 V and 3 V logic systems. As always, these values are approximate and should be adjusted for temperature or other application specifics.

### Boost Capacitor

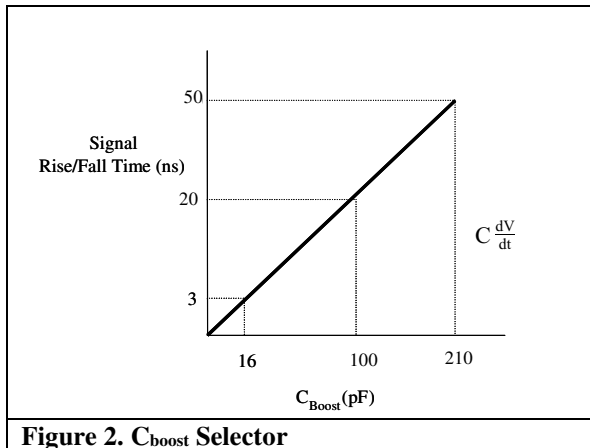


Figure 2. C<sub>boost</sub> Selector

The boost capacitor in parallel with the current-limiting resistor boosts the instantaneous coil current at the signal transition. This ensures switching and reduces propagation delay and reduces pulse-width distortion.

**Select the value of the boost capacitor based on the rise and fall times of the signal driving the inputs.** The instantaneous boost capacitor current is proportional to input edge speeds ( ). Select a capacitor value based on the rise and fall times of the input signal to be isolated that provides approximately 20 mA of additional “boost” current. Figure 2 is a guide to boost capacitor selection. For high-speed logic signals ( $t_r, t_f < 10$  ns), a 16 pF capacitor is recommended. The capacitor value is generally not critical; if in doubt, choose a higher value up to a maximum of 470 pF.

### RS-485 and RS-422 Busses

RS-485 and RS-422 are differential (balanced) data transmission standards for use over long distances or in noisy environments. RS-422 is an RS-485 subset, so RS-485 transceivers are also RS-422-compliant. RS-422 is a multi-drop standard allowing only one driver and up to 10 receivers on each bus (assuming unit load receivers). RS-485 is a true multipoint standard which allows up to 32 unit load devices (any combination of drivers and receivers) on each bus. To allow for multipoint operation, RS-485 requires drivers to handle bus contention without damage. Another important advantage of RS-485 is the extended common-mode range (CMR), which requires driver outputs and receiver inputs withstand +12 V to -7 V. RS-422 and RS-485 are intended for runs as long as 4,000 feet (1,200 m), so the wide CMR is necessary for ground potential differences, as well as voltages induced in the cable by external fields.

### Receiver Features

IL3000 transceivers have differential input receivers for maximum noise immunity and common-mode rejection. Input sensitivity is  $\pm 200$  mV as required by the RS-422 and RS-485 specifications. The receivers include a “fail-safe if open” function that guarantees a high level receiver output if the receiver inputs are unconnected (floating). Receivers easily meet the data rates supported by the corresponding driver. IL3000-Series receiver outputs have tri-state capabilities with active low RE inputs.

### Driver Features

The RS485/422 driver is a differential output device that delivers at least 1.5 V across a 54 Ω load (RS-485), and at least 2 V across a 100 Ω load (RS-422). The driver features low propagation delay skew to maximize bit width and minimize EMI. IL3222 and IL3285 drivers have tri-state capability with an active high DE input.

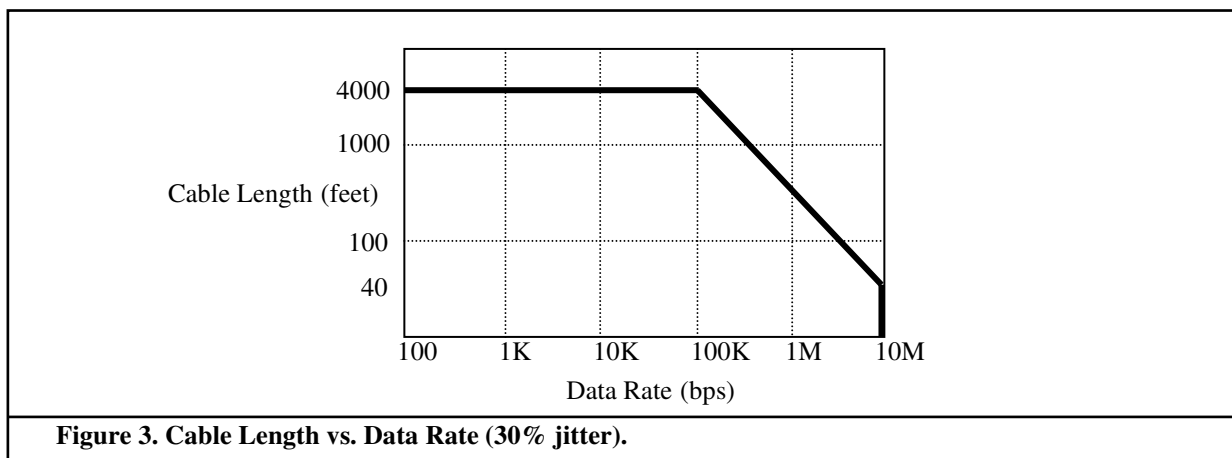
**Cabling, Data Rate and Terminations**

**Cabling**

Use twisted-pair cable. The cable can be unshielded if it is short (less than 10 meters) and the data rate is slow (less than 100 Kbps). Otherwise, use screened cable with the shield tied to earth ground at one end only. Do not tie the shield to digital ground. The other end of the shield may be tied to earth ground through an RC network. This prevents a DC ground loop in the shield. Shielded cable minimizes EMI emissions and external noise coupling to the bus.

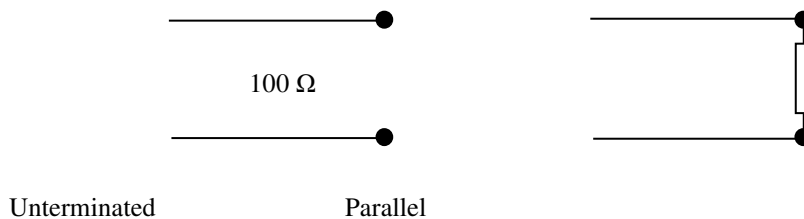
**Data Rate**

The longer the cable, the slower the data rate. The RS-485 bus can transmit ground over 4,000 feet (1,200 meters) or at 10 Mbps, but not both at the same time. Transducer and cable characteristics combine to act as a filter with the general response shown in Figure 3. Other parameters such as acceptable jitter affect the final cable length versus data rate tradeoff. Less jitter means better signal quality but shorter cable lengths or slower data rates. Figure 4 shows a generally accepted 30% jitter and a corresponding data rate versus cable length.



**Terminations**

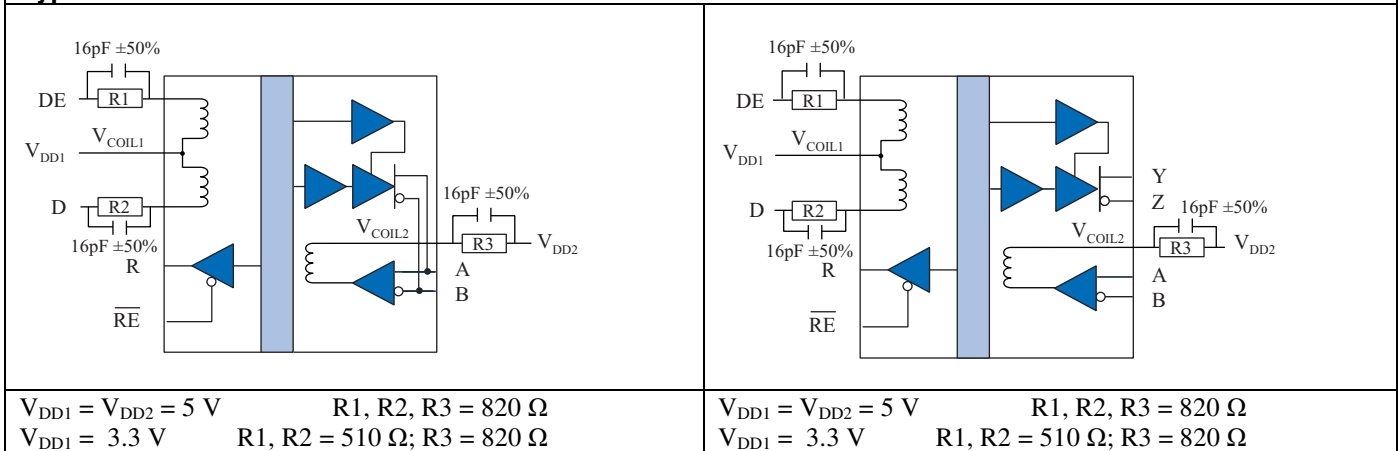
Transmission lines should be terminated to avoid reflections that cause data errors. In RS-485 systems both ends of the bus, not every node, should be terminated. In RS-422 systems only the receiver end should be terminated.



Proper termination is imperative when using IL3285 and IL3222 to minimize reflections. Unterminated lines are only suitable for very low data rates and very short cable runs, otherwise line reflections cause problems. Parallel terminations are the most popular. They allow high data rates and excellent signal quality.

Occasionally in noisy environments, fast pulses or noise appearing on the bus lines cause errors. One way of alleviating such errors without adding circuit delays is to place a series resistor in the bus line. Depending on the power supply, the resistor should be between 300  $\Omega$  (3 V supply) and 500  $\Omega$  (5 V supply).

**Typical Coil Connections**



**Fail-Safe Operation**

“Fail-safe operation” is defined here as the forcing of a logic high state on the “R” output in response to an open-circuit condition between the “A” and “B” lines of the bus, or when no drivers are active on the bus.

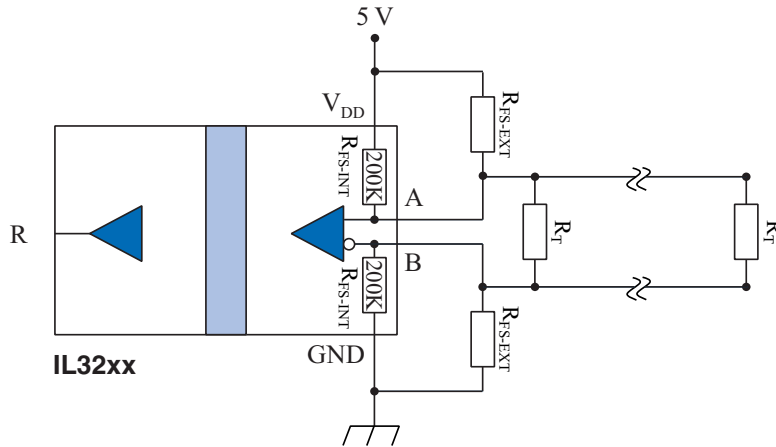
Proper biasing can ensure fail-safe operation, that is a known state when there are no active drivers on the bus. IL3285 and IL3222 Isolated Transceivers include internal pull-up and pull-down resistors of approximately 200 k $\Omega$  in the receiver section ( $R_{FS-INT}$ ; see figure on following page). These internal resistors are designed to ensure failsafe operation but only if there are no termination resistors. The entire  $V_{DD}$  will appear between inputs “A” and “B” if there is no loading and no termination resistors, and there will be more than the required 200 mV with up to four RS-485/RS-422 worst-case one-eighth unit loads of 96 k $\Omega$ . Many designs operating below 1 Mbps or less than 1,000 feet are unterminated. Termination resistors may not be necessary for very low data rates and very short cable runs because reflections have time to settle before data sampling, which occurs at the middle of the bit interval.

In busses with low-impedance termination resistors, however, the differential voltage across the conductor pair will be close to zero with no active drivers. In this case the state of the bus is indeterminate, and the idle bus will be susceptible to noise. For example, with 120  $\Omega$  termination resistors ( $R_T$ ) on each end of the cable, and four eighth unit loads (96 k $\Omega$  each), without external fail-safe biasing resistors the internal pull-up and pull-down resistors will produce a voltage between inputs “A” and “B” of only about one millivolt. This is not nearly enough to ensure a known state. External fail-safe biasing resistors ( $R_{FS-EXT}$ ) at one end of the bus can ensure fail-safe operation with a terminated bus. Resistors should be selected so that under worst-case power supply and resistor tolerances there is at least 200 mV across the conductor pair with no active drivers to meet the input sensitivity specification of the RS-422 and RS-485 standards.

Using the same value for pull-up and pull-down biasing resistors maintains balance for positive- and negative going transitions. Lower-value resistors increase inactive noise immunity at the expense of quiescent power consumption. Note that each Unit Load on the bus adds a worst-case loading of 12 k $\Omega$  across the conductor pair, and 256 one-eighth unit loads add 375  $\Omega$  worst-case loading. The more loads on the bus, the lower the required values of the biasing resistors.

In the example with two 120  $\Omega$  termination resistors and four eighth unit loads, 560  $\Omega$  external biasing resistors provide more than 200 mV between “A” and “B” with adequate margin for power supply variations and resistor tolerances. This ensures a known state when there are no active drivers. Other illustrative examples are shown in the following table:

**Fail-Safe Biasing**



$R_{FS-EXT}$	$R_T$	Loading	Nominal $V_{A-B}$ (inactive)	Fail-Safe Operation?
Internal Only	None	Four eighth-unit loads (96 k $\Omega$ ea.)	283 mV	Yes
Internal Only	120 $\Omega$	Four eighth-unit loads (96 k $\Omega$ ea.)	1 mV	No
560 $\Omega$	120 $\Omega$	Four eighth-unit loads (96 k $\Omega$ ea.)	254 mV	Yes
510 $\Omega$	120 $\Omega$	256 eighth-unit loads (96 k $\Omega$ ea.)	243 mV	Yes

**Power Supply Decoupling**

Both  $V_{DD1}$  and  $V_{DD2}$  should be bypassed with 0.1  $\mu$ F typical (0.047  $\mu$ F minimum) capacitors placed as close as possible to the  $V_{DD}$  pins.

**Maintaining Creepage**

Creepage distances are often critical in isolated circuits. In addition to meeting JEDEC standards, NVE isolator packages have unique creepage specifications. Standard pad libraries often extend under the package, compromising creepage and clearance. Similarly, ground planes, if used, should be spaced to avoid compromising clearance. Package drawings and recommended pad layouts are included in this datasheet.

**Magnetic Field Immunity**

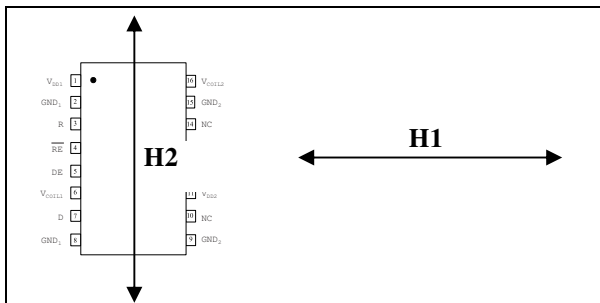
IsoLoop Isolators operate by imposing a magnetic field on a GMR sensor, which translates the change in field into a change in logic state. A magnetic shield and a Wheatstone Bridge configuration provide good immunity to external magnetic fields. Immunity to external magnetic fields can be enhanced by proper orientation of the device with respect to the field direction and larger boost capacitors.

An applied field in the “H1” direction is the worst case for magnetic immunity. In this case the external field is in the same

direction as the applied internal field. In one direction it will tend to help switching; in the other it will hinder switching. This can cause unpredictable operation.

An applied field in the direction of “H2” has considerably less effect on the sensor and will result in significantly higher immunity levels as shown in Table 1.

The greatest magnetic immunity is achieved by adding a larger boost capacitor across the input resistor. Very high immunity can be achieved with this method.



**Figure 3. Orientation of External Magnetic Field**

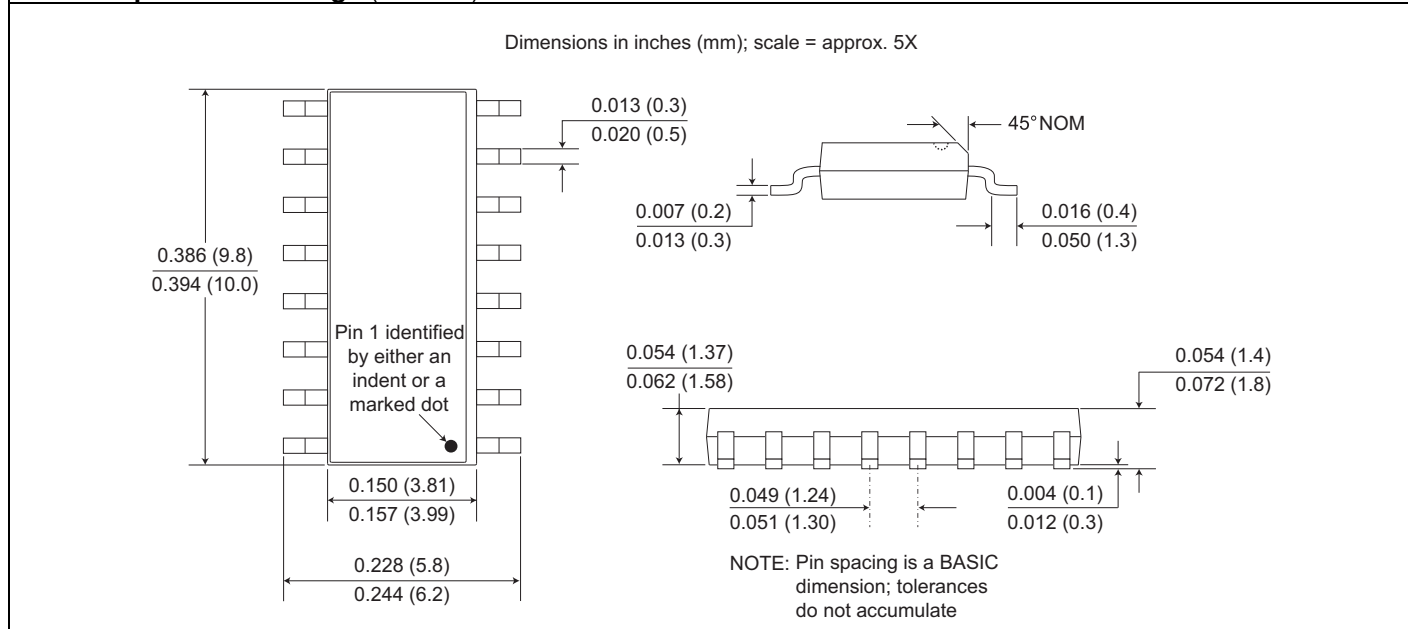
<b>Method</b>	<b>Approximate Immunity</b>	<b>Immunity Description</b>
Field applied in direction H1	±20 Gauss	A DC current of 16 A flowing in a conductor 1 cm from the device could cause disturbance
Field applied in direction H2	±70 Gauss	A DC current of 56 A flowing in a conductor 1 cm from the device could cause disturbance
Field applied in any direction but with boost capacitor (470 pF) in circuit	±250 Gauss	A DC current of 200 A flowing in a conductor 1 cm from the device could cause disturbance
<b>Table 1. Magnetic Immunity</b>		

#### **Data Rate and Magnetic Field Immunity**

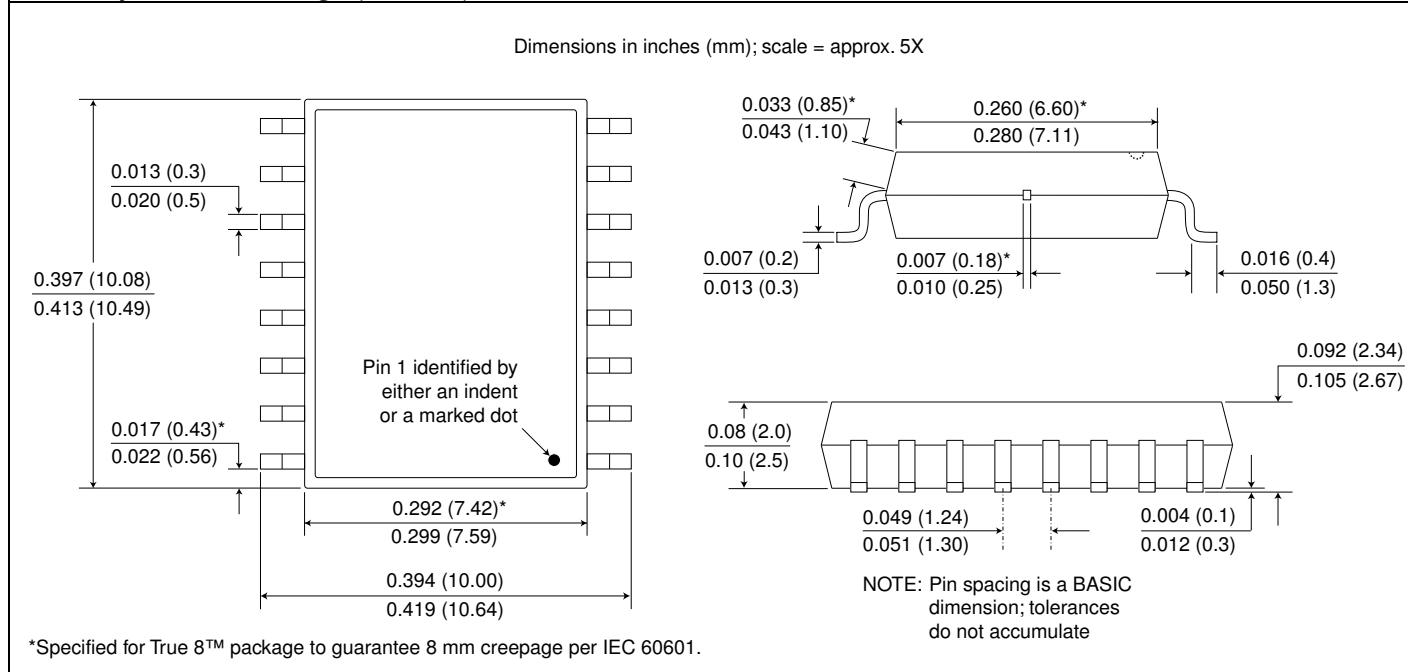
It is easier to disrupt an isolated DC signal with an external magnetic field than it is to disrupt an isolated AC signal. Similarly, a DC magnetic field will have a greater effect on the device than an AC magnetic field of the same effective magnitude. For example, signals with pulses longer than 100  $\mu$ s are more susceptible to magnetic fields than shorter pulse widths. For input signals faster than 1 MHz, rising in less than 3 ns, a 470 pF field-boost capacitor provides as much as 400 Gauss immunity, while the same input capacitor might provide just 70 Gauss immunity at 50 kHz.

**Package Drawings**

**0.15" 16-pin SOIC Package (-3 suffix)**



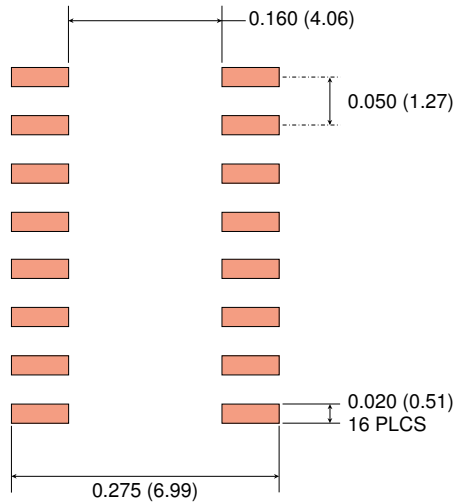
**0.3" 16-pin SOIC Package (no suffix)**



**Recommended Pad Layouts**

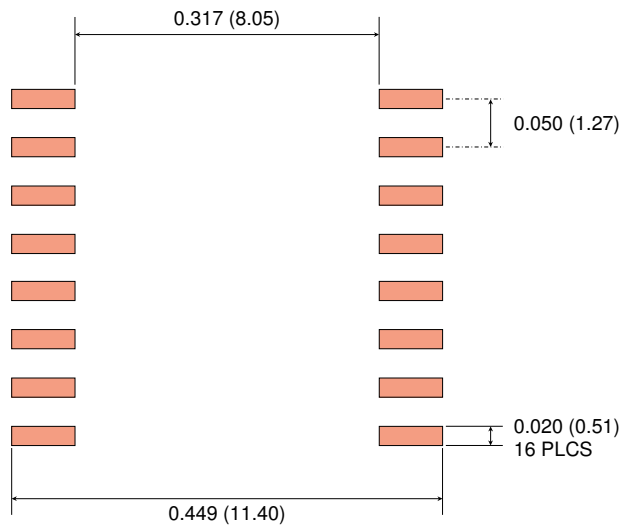
**0.15" 16-pin SOIC Pad Layout**

Dimensions in inches (mm); scale = approx. 5X



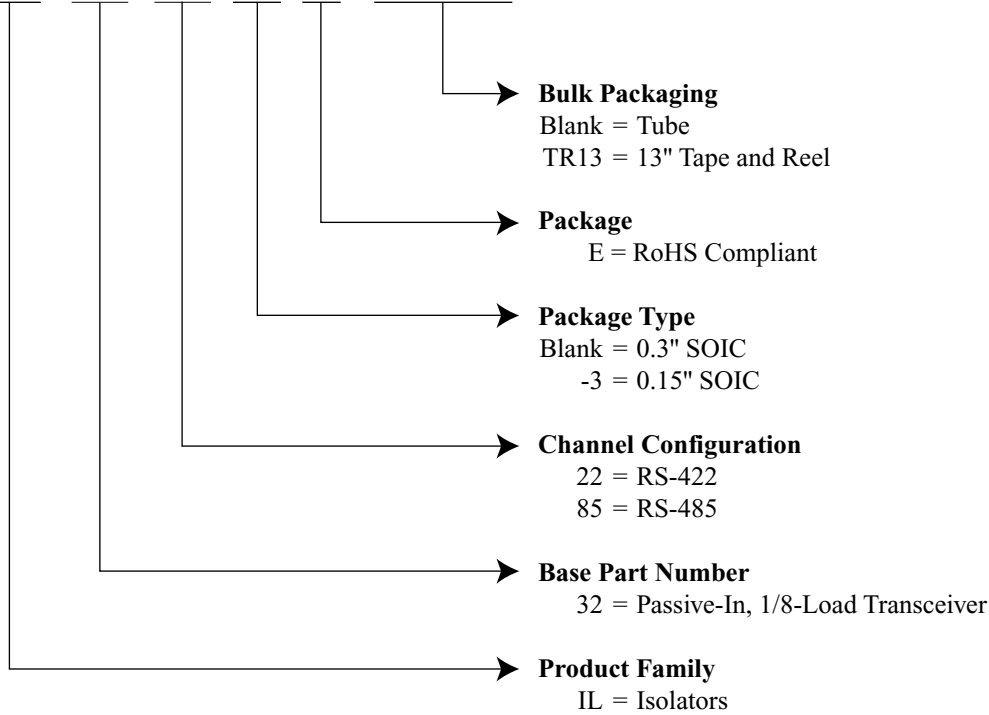
**0.3" 16-pin SOIC Pad Layout**

Dimensions in inches (mm); scale = approx. 5X



**Ordering Information and Valid Part Numbers**

**IL 32 85 -3 E TR13**



**Valid Part Numbers**

- IL3285E
- IL3285E TR13
- IL3285-3E
- IL3285-3E TR13
- IL3222E
- IL3222E TR13
- IL3222-3E
- IL3222-3E TR13



## Revision History

**ISB-DS-001-IL3285/22-S**  
**October 2022**

**Changes**

- Changed output drive table to 2 V output voltage (p. 1).
- Footnote that HIGH is no coil-current flowing and LOW is coil-current flowing (p. 1).
- Upgraded to VDE 0884-17 (p. 3).
- Increased Working Voltage ratings based on latest VDE testing (p. 3).

**ISB-DS-001-IL3285/22-R**

**Changes**

- Clarified RS-485 truth table (p. 1).
- Increased Working Voltage ( $V_{IORM}$ ) to 600  $V_{RMS}$  (p.3).
- Upgraded from VDE V 0884-10 to VDE V 0884-11 / IEC 60747-17 (p. 3).
- Clarified IL3185-3E and IL3122-3E pin 8 should not be connected (p. 4).
- Added thermal characteristics (p. 8).

**ISB-DS-001-IL3285/22-Q**

**Changes**

- IEC 60747-5-5 (VDE 0884) certification.
- Upgraded from MSL 2 to MSL 1.
- Rearranged low level input current specification so maximum is more than minimum.

**ISB-DS-001-IL3285/22-P**

**Changes**

- Added VDE 0884 pending.
- Clarified switching specifications.
- Updated package drawings.
- Added recommended solder pad layouts.

**ISB-DS-001-IL3285/22-O**

**Changes**

- Detailed isolation and barrier specifications.
- Cosmetic changes.

**ISB-DC-001-IL3285/22-N**

**Changes**

- Added minimum/maximum coil resistance specifications.
- Misc. cosmetic changes.

**ISB-DS-001-IL3285/22-M**

**Change**

- Update terms and conditions.

**ISB-DS-001-IL3285/22-L**

**Change**

- Clarified ground pin connections (pp. 3-4).

**ISB-DS-001-IL3285/22-K**

**Changes**

- Changes to current-limiting resistor values (pp. 7 and 10).
- Details for boost capacitor selection (p. 7).

**ISB-DS-001-IL3285/22-J**

**Change**

- Noted UL1577 Approval.

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*October 2022*

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