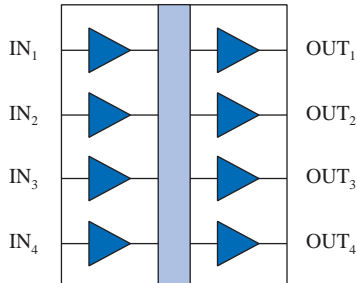
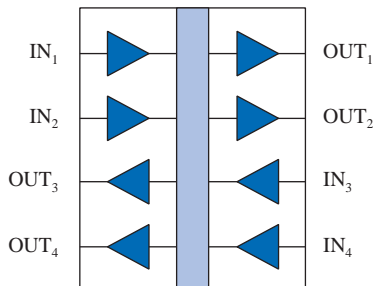


## High Speed/High Temperature Four-Channel Digital Isolators

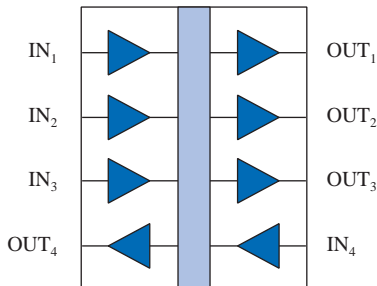
### Functional Diagrams



**IL715**



**IL716**



**IL717**

### Features

- +5 V / +3.3 V CMOS/TTL Compatible
- High Speed: 110 Mbps
- High Temperature:  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  (IL715T/IL716T/IL717T)
- 2500  $V_{\text{RMS}}$  Isolation (1 min.)
- 2 ns Typical Pulse Width Distortion
- 4 ns Typical Propagation Delay Skew
- 10 ns Typical Propagation Delay
- 30  $\text{kV}/\mu\text{s}$  Typical Common Mode Rejection
- 2 ns Channel-to-Channel Skew
- 0.3" and 0.15" 16-pin SOIC Packages
- UL1577 and IEC 61010-2001 Approval

### Applications

- ADCs and DACs
- Digital Fieldbus
- RS-485 and RS-422
- Multiplexed Data Transmission
- Data Interfaces
- Board-to-Board Communication
- Digital Noise Reduction
- Operator Interface
- Ground Loop Elimination
- Peripheral Interfaces
- Parallel Bus
- Logic Level Shifting

### Description

NVE's IL715, IL716, and IL717 four-channel high-speed digital isolators are CMOS devices manufactured with NVE's patented\* IsoLoop<sup>®</sup> spintronic Giant Magnetoresistive (GMR) technology.

All transmit and receive channels operate at 110 Mbps over the full temperature and supply voltage range. The symmetric magnetic coupling barrier provides a typical propagation delay of only 10 ns and a pulse width distortion of 2 ns, achieving the best specifications of any isolator. Typical transient immunity of 30  $\text{kV}/\mu\text{s}$  is unsurpassed. Available in 0.15" SOIC packages, the four-channel devices provide the highest channel density available.

Typical transient immunity of 30  $\text{kV}/\mu\text{s}$  is unsurpassed. High channel density makes these devices ideal for isolating ADCs and DACs, parallel buses and peripheral interfaces.

The IL715, IL716, and IL717 are available in 0.3" and 0.15" 16-pin SOIC packages and performance is specified over the temperature range of  $-40^{\circ}\text{C}$  to  $+100^{\circ}\text{C}$  without derating. The IL715T, IL716T, and IL717T are specified over  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ ; the widest temperature range digital couplers available.

## Absolute Maximum Ratings

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Storage Temperature	$T_s$	-55		150	°C	
Ambient Operating Temperature <sup>(1)</sup> IL715T, IL716T, and IL717T	$T_A$	-55		125 135	°C	
Supply Voltage	$V_{DD1}, V_{DD2}$	-0.5		7	V	
Input Voltage	$V_i$	-0.5		$V_{DD}+0.5$	V	
Output Voltage	$V_o$	-0.5		$V_{DD}+0.5$	V	
Output Current Drive	$I_o$			10	mA	
Lead Solder Temperature				260	°C	10 sec.
ESD			2		kV	HBM

## Recommended Operating Conditions

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Ambient Operating Temperature IL715, IL716, and IL717	$T_A$	-40		100	°C	
IL715T, IL716T, and IL717T	$T_A$	-40		125	°C	
Supply Voltage	$V_{DD1}, V_{DD2}$	3.0		5.5	V	
Logic High Input Voltage	$V_{IH}$	2.4		$V_{DD}$	V	
Logic Low Input Voltage	$V_{IL}$	0		0.8	V	
Input Signal Rise and Fall Times	$t_{IR}, t_{IF}$			1	µs	

## Insulation Specifications

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Creepage Distance						
0.15" SOIC		4.03			mm	
0.3" SOIC		8.08			mm	
Leakage Current			0.2		µA	240 $V_{RMS}$ , 60 Hz
Barrier Impedance			$>10^{14}  3$		$\Omega    pF$	

## Package Characteristics

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Capacitance (Input–Output) <sup>(5)</sup>	$C_{I-O}$		4		pF	f = 1 MHz
Thermal Resistance						
0.15" SOIC	$\theta_{JC}$		41		°C/W	Thermocouple at center underside of package
0.3" SOIC	$\theta_{JC}$		28		°C/W	
Package Power Dissipation	$P_{PD}$			150	mW	f = 1 MHz, $V_{DD} = 5 V$

## Safety and Approvals

### IEC61010-1

TUV Certificate Numbers: **N1502812, N1502812-101**

### Classification as Reinforced Insulation

Model	Package	Pollution Degree	Material Group	Max. Working Voltage
IL715, IL716, and IL717	0.3" SOIC	II	III	300 $V_{RMS}$
IL715-3, IL716-3, and IL717-3	0.15" SOIC	II	III	150 $V_{RMS}$

### UL 1577

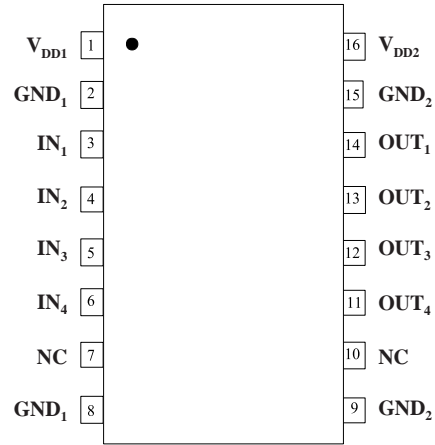
Component Recognition Program File Number: E207481  
Rated 2500 $V_{RMS}$  for 1 minute

### Soldering Profile

Per JEDEC J-STD-020C, MSL=2

**IL715 Pin Connections**

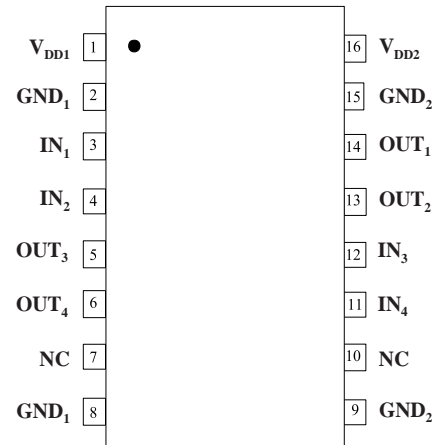
1	V <sub>DD1</sub>	Supply voltage
2	GND <sub>1</sub>	Ground return for V <sub>DD1</sub>
3	IN <sub>1</sub>	Data in, channel 1
4	IN <sub>2</sub>	Data in, channel 2
5	IN <sub>3</sub>	Data in, channel 3
6	IN <sub>4</sub>	Data in, channel 4
7	NC	No connection
8	GND <sub>1</sub>	Ground return for V <sub>DD1</sub>
9	GND <sub>2</sub>	Ground return for V <sub>DD2</sub>
10	NC	No connection
11	OUT <sub>4</sub>	Data out, channel 4
12	OUT <sub>3</sub>	Data out, channel 3
13	OUT <sub>2</sub>	Data out, channel 2
14	OUT <sub>1</sub>	Data out, channel 1
15	GND <sub>2</sub>	Ground return for V <sub>DD2</sub>
16	V <sub>DD2</sub>	Supply voltage



**IL715**

**IL716 Pin Connections**

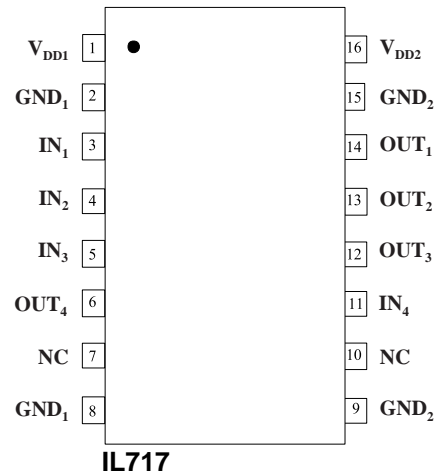
1	V <sub>DD1</sub>	Supply voltage
2	GND <sub>1</sub>	Ground Return for V <sub>DD1</sub>
3	IN <sub>1</sub>	Data in, channel 1
4	IN <sub>2</sub>	Data in, channel 2
5	OUT <sub>3</sub>	Data out, channel 3
6	OUT <sub>4</sub>	Data out, channel 4
7	NC	No connection
8	GND <sub>1</sub>	Ground Return for V <sub>DD1</sub>
9	GND <sub>2</sub>	Ground Return for V <sub>DD2</sub>
10	NC	No connection
11	IN <sub>4</sub>	Data in, channel 4
12	IN <sub>3</sub>	Data in, channel 3
13	OUT <sub>2</sub>	Data out, channel 2
14	OUT <sub>1</sub>	Data out, channel 1
15	GND <sub>2</sub>	Ground Return for V <sub>DD2</sub>
16	V <sub>DD2</sub>	Supply voltage



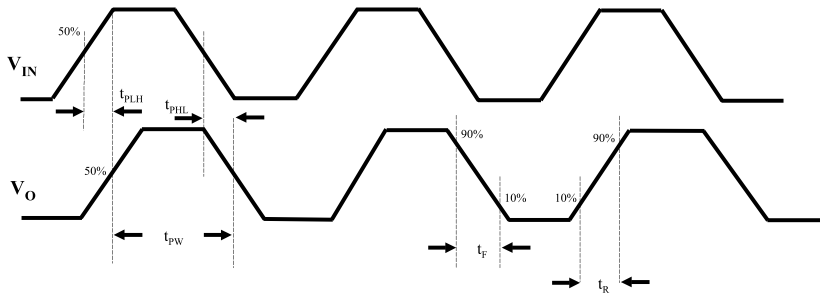
**IL716**

**IL717 Pin Connections**

1	V <sub>DD1</sub>	Supply voltage
2	GND <sub>1</sub>	Ground return for V <sub>DD1</sub>
3	IN <sub>1</sub>	Data in, channel 1
4	IN <sub>2</sub>	Data in, channel 2
5	IN <sub>3</sub>	Data in, channel 3
6	OUT <sub>4</sub>	Data out, channel 4
7	NC	No connection
8	GND <sub>1</sub>	Ground return for V <sub>DD1</sub>
9	GND <sub>2</sub>	Ground return for V <sub>DD2</sub>
10	NC	No connection
11	IN <sub>4</sub>	Data in, channel 4
12	OUT <sub>3</sub>	Data out, channel 3
13	OUT <sub>2</sub>	Data out, channel 2
14	OUT <sub>1</sub>	Data out, channel 1
15	GND <sub>2</sub>	Ground return for V <sub>DD2</sub>
16	V <sub>DD2</sub>	Supply voltage



**Timing Diagram**



**Legend**

t <sub>PLH</sub>	Propagation Delay, Low to High
t <sub>PHL</sub>	Propagation Delay, High to Low
t <sub>PW</sub>	Minimum Pulse Width
t <sub>R</sub>	Rise Time
t <sub>F</sub>	Fall Time

## 3.3 Volt Electrical Specifications

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

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
<b>DC Specifications</b>						
Input Quiescent Supply Current						
IL715	$I_{DD1}$		16	20	$\mu\text{A}$	
IL716			3.3	4	$\text{mA}$	
IL717			1.5	2	$\text{mA}$	
Output Quiescent Supply Current						
IL715	$I_{DD2}$		5.5	8	$\text{mA}$	
IL716			3.3	4	$\text{mA}$	
IL717			3	6	$\text{mA}$	
Logic Input Current	$I_I$	-10		10	$\mu\text{A}$	
Logic High Output Voltage	$V_{OH}$	$V_{DD} - 0.1$	$V_{DD}$		V	$I_O = -20 \mu\text{A}, V_I = V_{IH}$
		$0.8 \times V_{DD}$	$0.9 \times V_{DD}$			$I_O = -4 \text{mA}, V_I = V_{IH}$
Logic Low Output Voltage	$V_{OL}$		0	0.1	V	$I_O = 20 \mu\text{A}, V_I = V_{IL}$
			0.5	0.8		$I_O = 4 \text{mA}, V_I = V_{IL}$
<b>Switching Specifications</b>						
Maximum Data Rate		100	110		Mbps	$C_L = 15 \text{pF}$
Pulse Width <sup>(7)</sup>	PW	10			ns	50% Points, $V_O$
Propagation Delay Input to Output (High to Low)	$t_{PHL}$		12	18	ns	$C_L = 15 \text{pF}$
Propagation Delay Input to Output (Low to High)	$t_{PLH}$		12	18	ns	$C_L = 15 \text{pF}$
Pulse Width Distortion <sup>(2)</sup>	PWD		2	3	ns	$C_L = 15 \text{pF}$
Propagation Delay Skew <sup>(3)</sup>	$t_{PSK}$		4	6	ns	$C_L = 15 \text{pF}$
Output Rise Time (10%–90%)	$t_R$		2	4	ns	$C_L = 15 \text{pF}$
Output Fall Time (10%–90%)	$t_F$		2	4	ns	$C_L = 15 \text{pF}$
Common Mode Transient Immunity (Output Logic High or Logic Low) <sup>(4)</sup>	$ CM_H ,  CM_L $	20	30		$\text{kV}/\mu\text{s}$	$V_{CM} = 300 \text{V}$
Channel-to-Channel Skew	$t_{CSK}$		2	3	ns	$C_L = 15 \text{pF}$
Dynamic Power Consumption <sup>(6)</sup>			140	240	$\mu\text{A}/\text{MHz}$	per channel
<b>Magnetic Field Immunity<sup>(8)</sup> (<math>V_{DD2} = 3\text{V}, 3\text{V} &lt; V_{DD1} &lt; 5.5\text{V}</math>)</b>						
Power Frequency Magnetic Immunity	$H_{PF}$	1000	1500		A/m	50Hz/60Hz
Pulse Magnetic Field Immunity	$H_{PM}$	1800	2000		A/m	$t_p = 8\mu\text{s}$
Damped Oscillatory Magnetic Field	$H_{OSC}$	1800	2000		A/m	0.1Hz – 1MHz
Cross-axis Immunity Multiplier <sup>(9)</sup>	$K_X$		2.5			

## 5 Volt Electrical Specifications

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

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
<b>DC Specifications</b>						
Input Quiescent Supply Current						
IL715	$I_{DD1}$		24	30	$\mu\text{A}$	
IL716			5	6	$\text{mA}$	
IL717			2	3	$\text{mA}$	
Output Quiescent Supply Current						
IL715	$I_{DD2}$		8	12	$\text{mA}$	
IL716			5	6	$\text{mA}$	
IL717			6	9	$\text{mA}$	
Logic Input Current	$I_I$	-10		10	$\mu\text{A}$	
Logic High Output Voltage	$V_{OH}$	$V_{DD} - 0.1$	$V_{DD}$		V	$I_O = -20 \mu\text{A}, V_I = V_{IH}$
		$0.8 \times V_{DD}$	$0.9 \times V_{DD}$			$I_O = -4 \text{mA}, V_I = V_{IH}$
Logic Low Output Voltage	$V_{OL}$		0	0.1	V	$I_O = 20 \mu\text{A}, V_I = V_{IL}$
			0.5	0.8		$I_O = 4 \text{mA}, V_I = V_{IL}$
<b>Switching Specifications</b>						
Maximum Data Rate		100	110		Mbps	$C_L = 15 \text{pF}$
Pulse Width <sup>(7)</sup>	PW	10			ns	50% Points, $V_o$
Propagation Delay Input to Output (High to Low)	$t_{PHL}$		10	15	ns	$C_L = 15 \text{pF}$
Propagation Delay Input to Output (Low to High)	$t_{PLH}$		10	15	ns	$C_L = 15 \text{pF}$
Pulse Width Distortion <sup>(2)</sup>	PWD		2	3		$C_L = 15 \text{pF}$
Propagation Delay Skew <sup>(3)</sup>	$t_{PSK}$		4	6	ns	$C_L = 15 \text{pF}$
Output Rise Time (10%–90%)	$t_R$		1	3	ns	$C_L = 15 \text{pF}$
Output Fall Time (10%–90%)	$t_F$		1	3	ns	$C_L = 15 \text{pF}$
Common Mode Transient Immunity (Output Logic High or Logic Low) <sup>(4)</sup>	$ CM_H ,  CM_L $	20	30		$\text{kV}/\mu\text{s}$	$V_{cm} = 300 \text{V}$
Channel-to-Channel Skew	$t_{CSK}$		2	3	ns	$C_L = 15 \text{pF}$
Dynamic Power Consumption <sup>(6)</sup>			200	340	$\mu\text{A}/\text{MHz}$	per channel
<b>Magnetic Field Immunity<sup>(8)</sup> (<math>V_{DD2} = 5\text{V}, 3\text{V} &lt; V_{DD1} &lt; 5.5\text{V}</math>)</b>						
Power Frequency Magnetic Immunity	$H_{PF}$	2800	3500		A/m	50Hz/60Hz
Pulse Magnetic Field Immunity	$H_{PM}$	4000	4500		A/m	$t_p = 8 \mu\text{s}$
Damped Oscillatory Magnetic Field	$H_{OSC}$	4000	4500		A/m	0.1Hz – 1MHz
Cross-axis Immunity Multiplier <sup>(9)</sup>	$K_X$		2.5			

### Notes (apply to both 3.3 V and 5 V specifications):

- Absolute maximum ambient operating temperature means the device will not be damaged if operated under these conditions. It does not guarantee performance.
- PWD is defined as  $|t_{PHL} - t_{PLH}|$ . %PWD is equal to PWD divided by pulse width.
- $t_{PSK}$  is the magnitude of the worst-case difference in  $t_{PHL}$  and/or  $t_{PLH}$  between devices at 25°C.
- $CM_H$  is the maximum common mode voltage slew rate that can be sustained while maintaining  $V_o > 0.8 V_{DD2}$ .  $CM_L$  is the maximum common mode input voltage that can be sustained while maintaining  $V_o < 0.8 \text{V}$ . The common mode voltage slew rates apply to both rising and falling common mode voltage edges.
- Device is considered a two terminal device: pins 1–8 shorted and pins 9–16 shorted.
- Dynamic power consumption is calculated per channel and is supplied by the channel's input side power supply.
- Minimum pulse width is the minimum value at which specified PWD is guaranteed.
- The relevant test and measurement methods are given in the Electromagnetic Compatibility section on p. 7.
- External magnetic field immunity is improved by this factor if the field direction is "end-to-end" rather than to "pin-to-pin" (see diagram on p. 7).

## Application Information

### 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.

### Electromagnetic Compatibility

IL700-Series isolators are fully compliant with generic EMC standards EN50081, EN50082-1 and the umbrella line-voltage standard for Information Technology Equipment (ITE) EN61000. The IsoLoop Isolator's Wheatstone bridge configuration and differential magnetic field signaling ensure excellent EMC performance against all relevant standards. NVE conducted compliance tests in the categories below:

#### EN50081-1

Residential, Commercial & Light Industrial  
Methods EN55022, EN55014

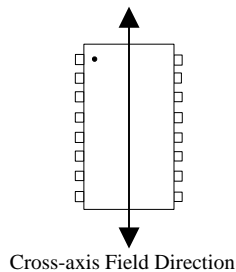
#### EN50082-2: Industrial Environment

Methods EN61000-4-2 (ESD), EN61000-4-3 (Electromagnetic Field Immunity), EN61000-4-4 (Electrical Transient Immunity), EN61000-4-6 (RFI Immunity), EN61000-4-8 (Power Frequency Magnetic Field Immunity), EN61000-4-9 (Pulsed Magnetic Field), EN61000-4-10 (Damped Oscillatory Magnetic Field)

#### ENV50204

Radiated Field from Digital Telephones (Immunity Test)

Immunity to external magnetic fields is even higher if the field direction is "end-to-end" rather than to "pin-to-pin" as shown in the diagram below:



### Dynamic Power Consumption

IsoLoop Isolators achieve their low power consumption from the way they transmit data across the isolation barrier. By detecting the edge transitions of the input logic signal and converting these to narrow current pulses, a magnetic field is created around the GMR Wheatstone bridge. Depending on the direction of the magnetic field, the bridge causes the output comparator to switch following the input logic signal. Since the current pulses are narrow, about 2.5 ns, the power consumption is independent of mark-to-space ratio and solely dependent on frequency. This has obvious advantages over optocouplers, which have power consumption heavily dependent on mark-to-space ratio.

### Power Supply Decoupling

Both power supplies to these devices should be decoupled with low ESR 47 nF ceramic capacitors. Ground planes for both GND<sub>1</sub> and GND<sub>2</sub> are highly recommended for data rates above 10 Mbps. Capacitors must be located as close as possible to the V<sub>DD</sub> pins.

### Signal Status on Start-up and Shut Down

To minimize power dissipation, input signals are differentiated and then latched on the output side of the isolation barrier to reconstruct the signal. This could result in an ambiguous output state depending on power up, shutdown and power loss sequencing. Therefore, the designer should consider including an initialization signal in the start-up circuit. Initialization consists of toggling the input either high then low, or low then high.

### Data Transmission Rates

The reliability of a transmission system is directly related to the accuracy and quality of the transmitted digital information. For a digital system, those parameters which determine the limits of the data transmission are pulse width distortion and propagation delay skew.

Propagation delay is the time taken for the signal to travel through the device. This is usually different when sending a low-to-high than when sending a high-to-low signal. This difference, or error, is called pulse width distortion (PWD) and is usually in nanoseconds. It may also be expressed as a percentage:

$$\text{PWD}\% = \frac{\text{Maximum Pulse Width Distortion (ns)}}{\text{Signal Pulse Width (ns)}} \times 100\%$$

For example, with data rates of 12.5 Mbps:

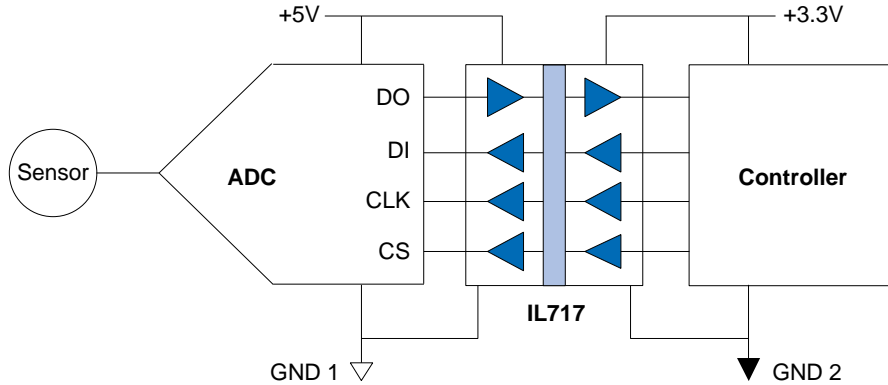
$$\text{PWD}\% = \frac{3 \text{ ns}}{80 \text{ ns}} \times 100\% = 3.75\%$$

This figure is almost **three times** better than any available optocoupler with the same temperature range, and **two times** better than any optocoupler regardless of published temperature range. IsoLoop isolators exceed the 10% maximum PWD recommended by PROFIBUS, and will run to nearly 35 Mb within the 10% limit.

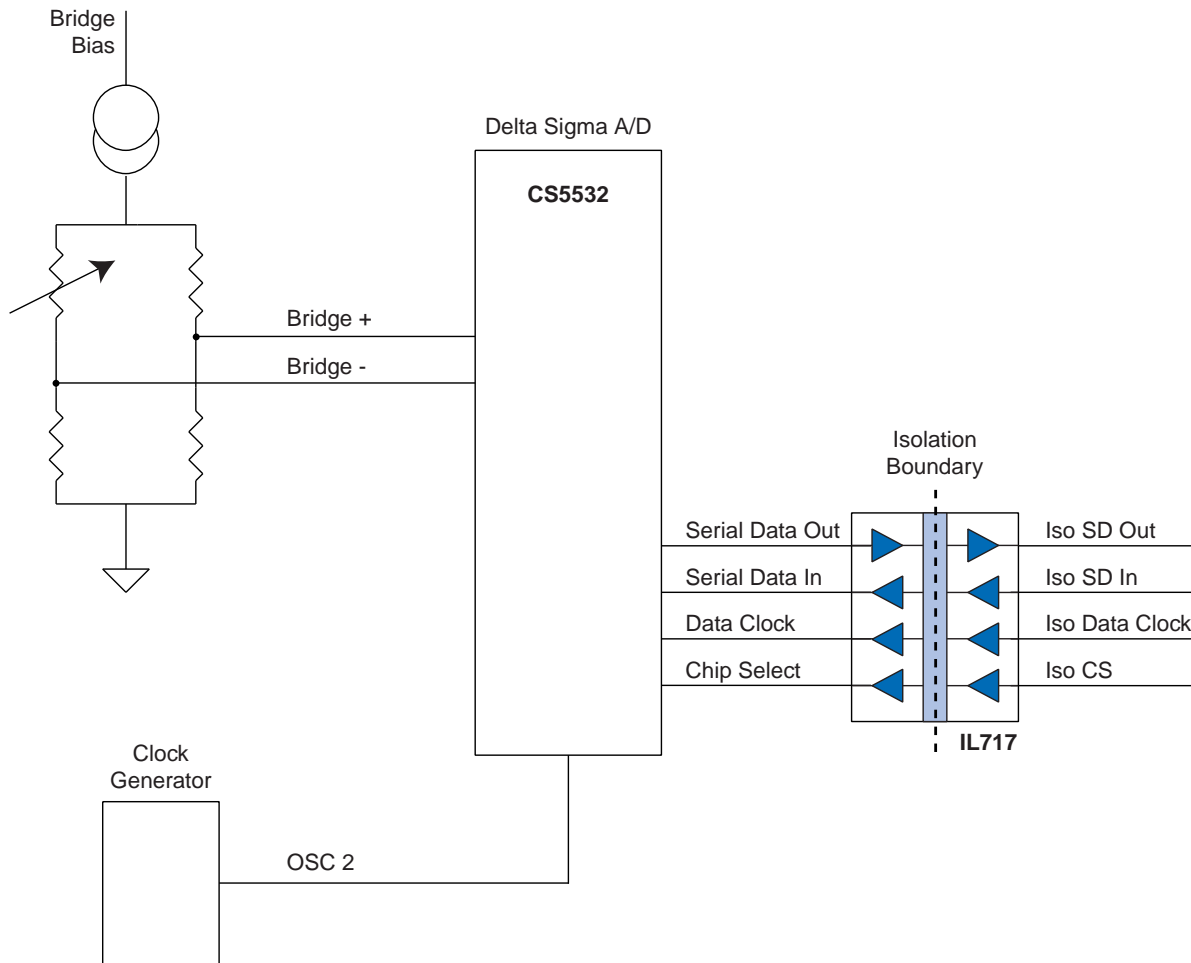
Propagation delay skew is the signal propagation difference between two or more channels. This becomes significant in clocked systems because it is undesirable for the clock pulse to arrive before the data has settled. Short propagation delay skew is therefore especially critical in high data rate parallel systems for establishing and maintaining accuracy and repeatability. Worst-case channel-to-channel skew in an IL700 Isolator is only 3 ns, which is **ten times** better than any optocoupler. IL700 Isolators have a maximum propagation delay skew of 6 ns, which is **five times** better than any optocoupler.

**Application Diagrams**

**Isolated Logic Level Shifters**



**Single-Channel Isolated Delta-Sigma A/D Converter**

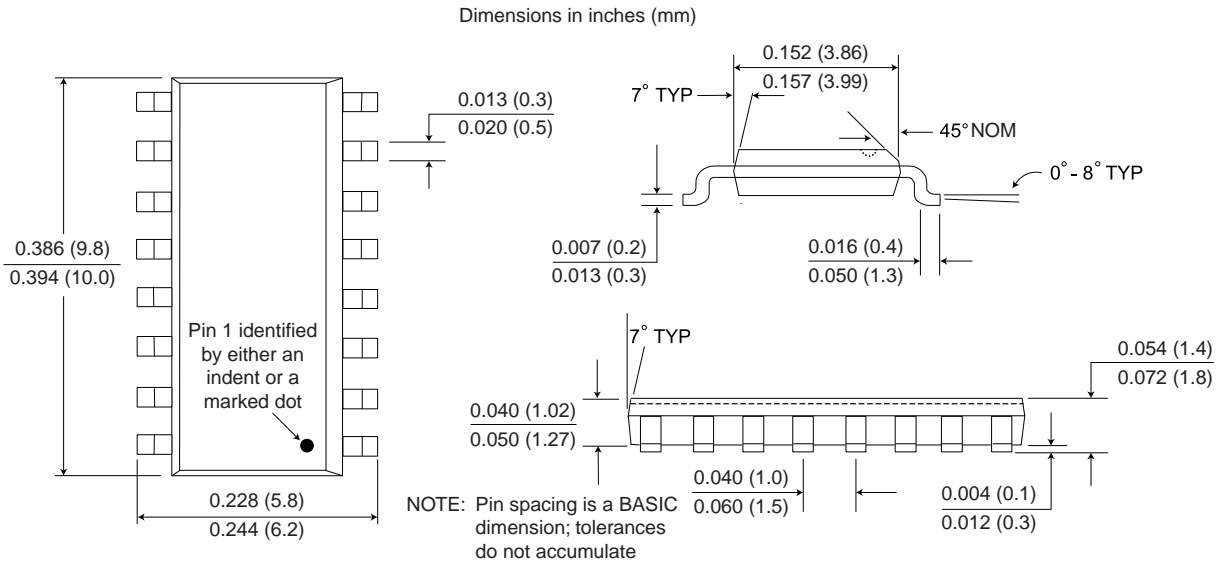


This circuit illustrates a typical single-channel delta-sigma ADC. The A/D is located on the bridge with no signal conditioning electronics between the bridge sensor and the ADC. In this case, the IL717 is the best choice for isolation. It isolates the control bus from the microcontroller. The system clock is located on the isolated side of the system.

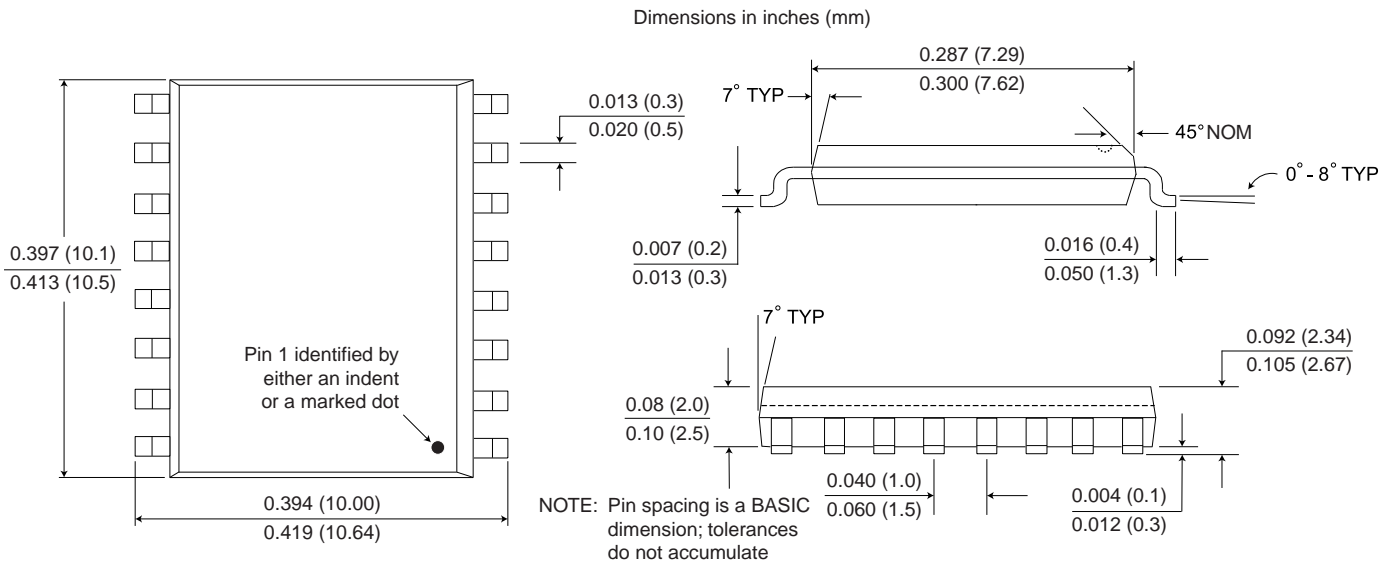


**Package Drawings, Dimensions and Specifications**

**0.15" SOIC Package**

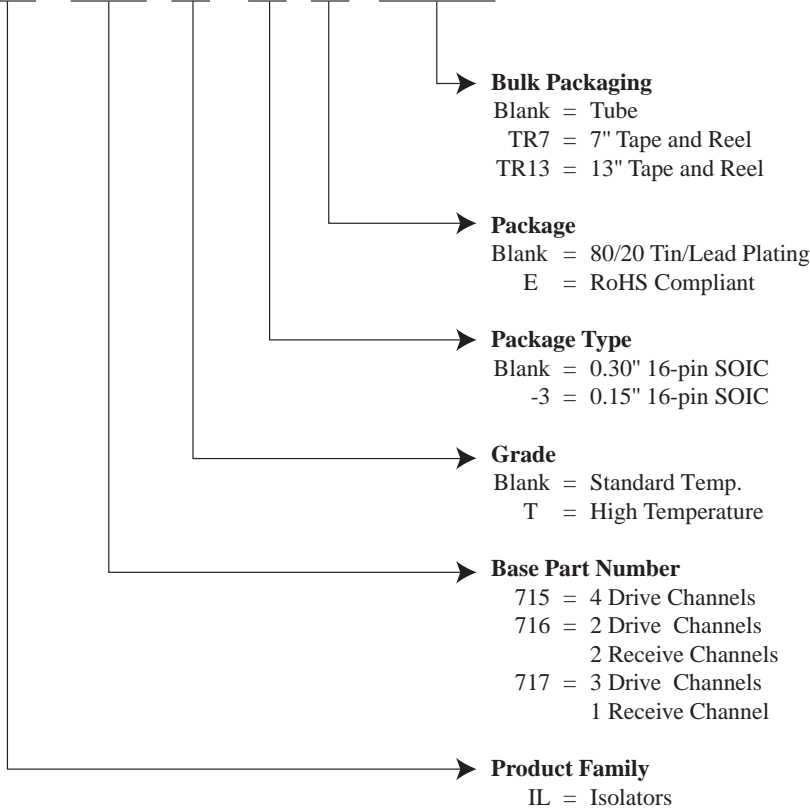


**0.3" SOIC Package**



## Ordering Information and Valid Part Numbers

### IL 716 T - 3 E TR13



### Valid Part Numbers

IL715	IL716	IL717
IL715E	IL716E	IL717E
IL715-3	IL716-3	IL717-3
IL715-3E	IL716-3E	IL717-3E
IL715T	IL716T	IL717T
IL715TE	IL716TE	IL717TE
IL715T-3	IL716T-3	IL717T-3
IL715T-3E	IL716T-3E	IL717T-3E

All IL715, IL716, and IL717 part types are available on tape and reel.



**ISB-DS-001-IL715/6/7-P**  
**March 2008**

**Changes**

- Added magnetic field immunity and electromagnetic compatibility specifications.
- Added notes on package drawings that pin-spacing tolerances are non-accumulating.

**ISB-DS-001-IL715/6/7-O**

**Changes**

- Changed ordering information to reflect that devices are now fully RoHS compliant with no exemptions.

**ISB-DS-001-IL715/6/7-N**

**Changes**

- Eliminated soldering profile chart

**ISB-DS-001-IL715/6/7-M**

**Changes**

- Package drawings updated

**ISB-DS-001-IL715/6/7-L**

**Changes**

- T-Grades added
- Package drawings updated
- Order information updated

**ISB-DS-001-IL715/6/7-K**

**Changes**

- Update UL and IEC approvals
- Package characteristics added

**ISB-DS-001-IL715/6/7-J**

**Changes**

- Revision letter added.
- Storage temperature changed from 175°C max. to 150°C max.
- Lead soldering temperature changed from 180°C max. to 260°C max.
- IEC 61010-1 Classification: “Reinforced Insulation” added.
- Dynamic Power Consumption: units corrected from mA/mHz to mA/MHz.
- Ordering Information. 5 Volt only option removed.  
The following valid part numbers removed.  
IL715B, IL715-3B, IL715BE, IL715-3BE  
IL716B, IL716-3B, IL716BE, IL716-3BE  
IL717B, IL717-3B, IL717BE, IL717-3BE

## **About NVE**

An ISO 9001 Certified Company

NVE Corporation is a high technology components manufacturer having the unique capability to combine spintronic 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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