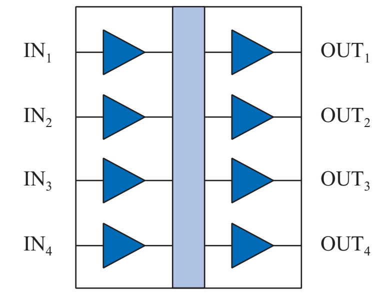
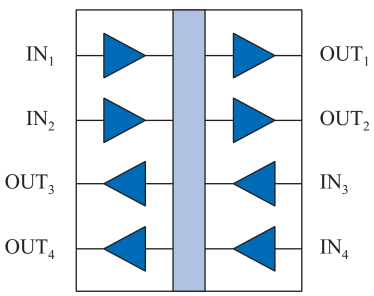
IL715/IL716/IL717

High Speed Four-Channel Digital Isolators

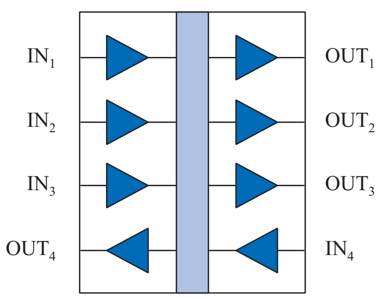
Functional Diagrams



IL715



IL716



IL717

Features

- High speed: 110 Mbps
- High temperature: −40°C to +125°C (T-Series)
- 50 kV/µs typ.; 30 kV/µs min. common mode transient immunity
- No carrier or clock for low EMI emissions and susceptibility
- 1.2 mA/channel typical quiescent current
- 100 ps typical pulse jitter
- 2 ns channel-to-channel skew
- 10 ns typical propagation delay
- 1000 V_{RMS}/1500 V_{DC} high voltage endurance
- 44000 year barrier life
- Excellent magnetic immunity
- UL 1577 recognized; IEC 60747-5-5 (VDE 0884) certified
- 0.15", 0.3", and True 8™ mm 16-pin SOIC packages

Applications

- ADCs and DACs
- Digital Fieldbus
- Multiplexed data transmission
- Board-to-board communication
- Ground loop elimination
- Parallel bus
- Logic level shifting
- Equipment covered under IEC 61010-1 Edition 3
- 5 kV_{RMS} rated IEC 60601-1 medical applications

Description

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

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

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 50 kV/µs 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°C to +100°C without derating. The IL715T, IL716T, and IL717T are specified over −40°C to +125°C; the widest temperature range digital couplers available.

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

REV. Y

Absolute Maximum Ratings

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Storage Temperature	T_S	−55		150	°C	
Ambient Operating Temperature(1) IL715T, IL716T, and IL717T	T_A	−40		100 125	°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 IL715T, IL716T, and IL717T	 T_A T_A	 −40 −40		 100 125	 °C °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 (external)	0.15" SOIC 0.3" SOIC		4.03 8.03	 8.3		mm	Per IEC 60601
Total Barrier Thickness (internal)			0.012	0.013		mm	
Leakage Current(5)				0.2		µA	240 V_{RMS}, 60 Hz
Barrier Resistance(5)				$>10^{14}$		Ω	500 V
Barrier Capacitance(5)				4		pF	f = 1 MHz
Comparative Tracking Index		CTI	≥175			V	Per IEC 60112
High Voltage Endurance (Maximum Barrier Voltage for Indefinite Life)	AC DC	V_{IO}	1000 1500			V_{RMS} V_{DC}	At maximum operating temperature
Barrier Life				44000		Years	100°C, 1000 V_{RMS}, 60% CL activation energy

Package Characteristics

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Thermal Resistance						
0.15" SOIC	θ_{JC}		41		°C/W	Thermocouple at center underside of package
0.3" SOIC	θ_{JC}		28		°C/W	
Package Power Dissipation	P_{PD}			150	mW	f = 1 MHz, V_{DD} = 5 V

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Safety and Approvals

IEC 60747-5-5 (VDE 0884) (File Number 5016933-4880-0001)

- Working Voltage (V_{IORM}) 600 V_{RMS} (848 V_{PK}); basic insulation; pollution degree 2
- Transient overvoltage (V_{IOTM}) and surge voltage (V_{IOSM}) 4000 V_{PK}
- 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

IEC 61010-1 (Edition 2; TUV Certificate Numbers N1502812; N1502812-101)
Reinforced Insulation; Pollution Degree II; Material Group III

Part No. Suffix	Package	Working Voltage
-3	SOIC	150 V_{RMS}
None	Wide-body SOIC/True 8™	300 V_{RMS}

UL 1577 (Component Recognition Program File Number E207481)
Each part tested at 3000 V_{RMS} (4240 V_{PK}) for 1 second; each lot sample tested at 2500 V_{RMS} (3530 V_{PK}) for 1 minute

Soldering Profile

Per JEDEC J-STD-020C, MSL 1

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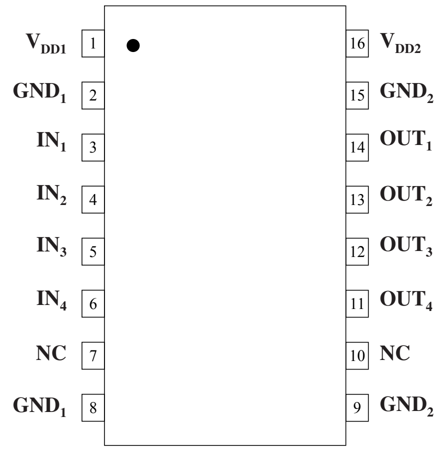
IL715 Pin Connections

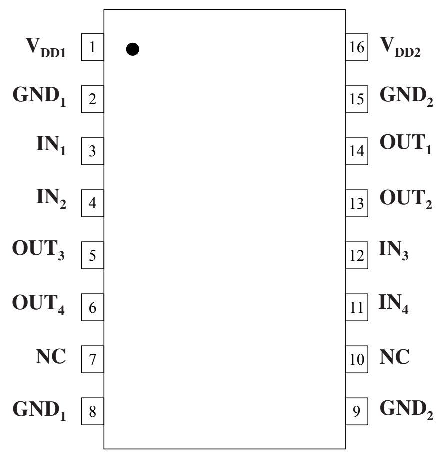
1	V_{DD1}	Supply voltage
2	GND_1	Ground return for V_{DD1}*
3	IN_1	Data in, channel 1
4	IN_2	Data in, channel 2
5	IN_3	Data in, channel 3
6	IN_4	Data in, channel 4
7	NC	No connection
8	GND_1	Ground return for V_{DD1}*
9	GND_2	Ground return for V_{DD2}*
10	NC	No connection
11	OUT_4	Data out, channel 4
12	OUT_3	Data out, channel 3
13	OUT_2	Data out, channel 2
14	OUT_1	Data out, channel 1
15	GND_2	Ground return for V_{DD2}*
16	V_{DD2}	Supply voltage



IL715

IL716 Pin Connections

1	V_{DD1}	Supply voltage
2	GND_1	Ground Return for V_{DD1}*
3	IN_1	Data in, channel 1
4	IN_2	Data in, channel 2
5	OUT_3	Data out, channel 3
6	OUT_4	Data out, channel 4
7	NC	No connection
8	GND_1	Ground Return for V_{DD1}*
9	GND_2	Ground Return for V_{DD2}*
10	NC	No connection
11	IN_4	Data in, channel 4
12	IN_3	Data in, channel 3
13	OUT_2	Data out, channel 2
14	OUT_1	Data out, channel 1
15	GND_2	Ground Return for V_{DD2}*
16	V_{DD2}	Supply voltage



IL716

***NOTE:** Pins 2 and 8 are internally connected, as are pins 9 and 15.

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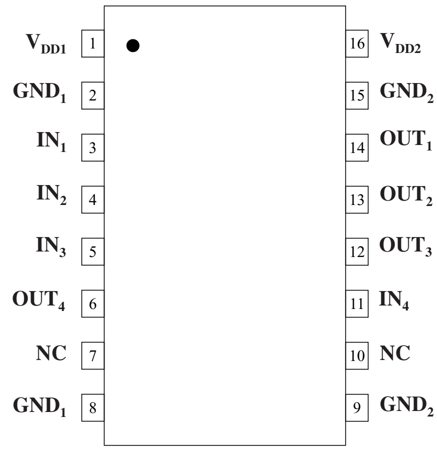
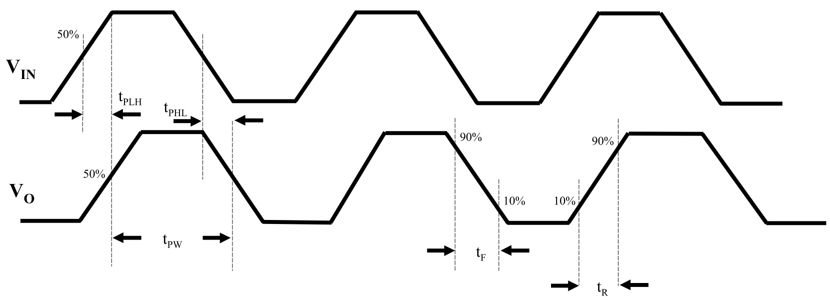
IL717 Pin Connections

1	V_{DD1}	Supply voltage
2	GND_1	Ground return for V_{DD1}*
3	IN_1	Data in, channel 1
4	IN_2	Data in, channel 2
5	IN_3	Data in, channel 3
6	OUT_4	Data out, channel 4
7	NC	No connection
8	GND_1	Ground return for V_{DD1}*
9	GND_2	Ground return for V_{DD2}*
10	NC	No connection
11	IN_4	Data in, channel 4
12	OUT_3	Data out, channel 3
13	OUT_2	Data out, channel 2
14	OUT_1	Data out, channel 1
15	GND_2	Ground return for V_{DD2}*
16	V_{DD2}	Supply voltage



***NOTE:** Pins 2 and 8 are internally connected, as are pins 9 and 15.

Timing Diagram



Legend

t_{PLH}	Propagation Delay, Low to High
t_{PHL}	Propagation Delay, High to Low
t_{PW}	Minimum Pulse Width
t_R	Rise Time
t_F	Fall Time

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3.3 Volt Electrical Specifications (T_{min} to T_{max} unless otherwise stated)						
Parameters	**Symbol**	**Min.**	**Typ.**	**Max.**	**Units**	**Test Conditions**
Input Quiescent Supply Current						
IL715	I_{DD1}		16	20	μA	
IL716			2.4	3.5	mA	
IL717			1.2	1.75	mA	
Output Quiescent Supply Current						
IL715	I_{DD2}		4.8	7	mA	
IL716			2.4	3.5	mA	
IL717			3.6	5.25	mA	
Logic Input Current	I_I	−10		10	μA	
Logic High Output Voltage	V_{OH}	$V_{DD} - 0.1$	V_{DD}		V	$I_O = -20$ μA, $V_I = V_{IH}$
		0.8 x V_{DD}	0.9 x V_{DD}			$I_O = -4$ mA, $V_I = V_{IH}$
Logic Low Output Voltage	V_{OL}		0	0.1	V	$I_O = 20$ μA, $V_I = V_{IL}$
			0.5	0.8		$I_O = 4$ mA, $V_I = V_{IL}$

Switching Specifications ($V_{DD} = 3.3$ V)						
Maximum Data Rate		100	110		Mbps	$C_L = 15$ pF
Pulse Width(7)	PW	10			ns	50% Points, V_O
Propagation Delay Input to Output (High to Low)	t_{PHL}		12	18	ns	$C_L = 15$ pF
Propagation Delay Input to Output (Low to High)	t_{PLH}		12	18	ns	$C_L = 15$ pF
Pulse Width Distortion (2)	PWD		2	3	ns	$C_L = 15$ pF
Propagation Delay Skew (3)	t_{PSK}		4	6	ns	$C_L = 15$ pF
Output Rise Time (10%–90%)	t_R		2	4	ns	$C_L = 15$ pF
Output Fall Time (10%–90%)	t_F		2	4	ns	$C_L = 15$ pF
Common Mode Transient Immunity (Output Logic High or Logic Low)(4)	$\|CM_H\|,\|CM_L\|$	30	50		kV/μs	$V_{CM} = 1500$ V_{DC} $t_{TRANSIENT} = 25$ ns
Channel-to-Channel Skew	t_{CSK}		2	3	ns	$C_L = 15$ pF
Dynamic Power Consumption(6)			140	240	μA/Mbps	per channel

Magnetic Field Immunity(8) ($V_{DD2} = 3V$, $3V < V_{DD1} < 5.5V$)						
Power Frequency Magnetic Immunity	H_{PF}	1000	1500		A/m	50Hz/60Hz
Pulse Magnetic Field Immunity	H_{PM}	1800	2000		A/m	$t_p = 8$μs
Damped Oscillatory Magnetic Field	H_{OSC}	1800	2000		A/m	0.1Hz – 1MHz
Cross-axis Immunity Multiplier(9)	K_X		2.5			

5 Volt Electrical Specifications (T_{min} to T_{max} unless otherwise stated)						
Parameters	**Symbol**	**Min.**	**Typ.**	**Max.**	**Units**	**Test Conditions**
Input Quiescent Supply Current						
IL715	I_{DD1}		24	30	µA	
IL716			3.6	5	mA	
IL717			1.8	2.5	mA	
Output Quiescent Supply Current						
IL715	I_{DD2}		7.2	10	mA	
IL716			3.6	5	mA	
IL717			5.4	7.5	mA	
Logic Input Current	I_I	−10		10	µA	
Logic High Output Voltage	V_{OH}	$V_{DD} - 0.1$	V_{DD}		V	$I_O = -20$ µA, $V_I = V_{IH}$
		0.8 x V_{DD}	0.9 x V_{DD}			$I_O = -4$ mA, $V_I = V_{IH}$
Logic Low Output Voltage	V_{OL}		0	0.1	V	$I_O = 20$ µA, $V_I = V_{IL}$
			0.5	0.8		$I_O = 4$ mA, $V_I = V_{IL}$

Switching Specifications ($V_{DD} = 5V$)						
Maximum Data Rate		100	110		Mbps	$C_L = 15$ pF
Pulse Width(7)	PW	10			ns	50% Points, V_O
Propagation Delay Input to Output (High to Low)	t_{PHL}		10	15	ns	$C_L = 15$ pF
Propagation Delay Input to Output (Low to High)	t_{PLH}		10	15	ns	$C_L = 15$ pF
Pulse Width Distortion(2)	PWD		2	3		$C_L = 15$ pF
Pulse Jitter(10)	t_J		100		ps	$C_L = 15$ pF
Propagation Delay Skew(3)	t_{PSK}		4	6	ns	$C_L = 15$ pF
Output Rise Time (10%–90%)	t_R		1	3	ns	$C_L = 15$ pF
Output Fall Time (10%–90%)	t_F		1	3	ns	$C_L = 15$ pF
Common Mode Transient Immunity (Output Logic High or Logic Low)(4)	$\|CM_H\|,\|CM_L\|$	30	50		kV/µs	$V_{CM} = 1500$ V_{DC} $t_{TRANSIENT} = 25$ ns
Channel-to-Channel Skew	t_{CSK}		2	3	ns	$C_L = 15$ pF
Dynamic Power Consumption(6)			200	340	µA/Mbps	per channel

Magnetic Field Immunity(8) (V_{DD2}= 5V, 3V<V_{DD1}<5.5V)						
Power Frequency Magnetic Immunity	H_{PF}	2800	3500		A/m	50Hz/60Hz
Pulse Magnetic Field Immunity	H_{PM}	4000	4500		A/m	$t_p = 8$µs
Damped Oscillatory Magnetic Field	H_{OSC}	4000	4500		A/m	0.1Hz – 1MHz
Cross-axis Immunity Multiplier(9)	K_X		2.5			

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

1. Absolute maximum ambient operating temperature means the device will not be damaged if operated under these conditions. It does not guarantee performance.
2. PWD is defined as $|t_{PHL} - t_{PLH}|$. %PWD is equal to PWD divided by pulse width.
3. t_{PSK} is the magnitude of the worst-case difference in t_{PHL} and/or t_{PLH} between devices at 25°C.
4. 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 $V_O < 0.8$ V. The common mode voltage slew rates apply to both rising and falling common mode voltage edges.
5. Device is considered a two terminal device: pins 1–8 shorted and pins 9–16 shorted.
6. Dynamic power consumption is calculated per channel and is supplied by the channel's input side power supply.
7. Minimum pulse width is the minimum value at which specified PWD is guaranteed.
8. The relevant test and measurement methods are given in the Electromagnetic Compatibility section on p. 7.
9. 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).
10. 66,535-bit pseudo-random binary signal (PRBS) NRZ bit pattern with no more than five consecutive 1s or 0s; 800 ps transition time.

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Application Information

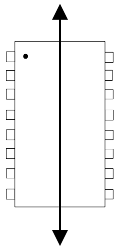
Electrostatic Discharge Sensitivity
This product has been tested for electrostatic sensitivity to the limits stated in the specifications. However, NVE recommends that all integrated circuits be handled with appropriate care to avoid damage. Damage caused by inappropriate handling or storage could range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

Electromagnetic Compatibility
IsoLoop Isolators have the lowest EMC footprint of any isolation technology. IsoLoop Isolators' Wheatstone bridge configuration and differential magnetic field signaling ensure excellent EMC performance against all relevant standards.

These isolators are fully compliant with generic EMC standards EN50081, EN50082-1 and the umbrella line-voltage standard for Information Technology Equipment (ITE) EN61000. NVE has completed 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:



Cross-axis Field Direction

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_1 and GND_2 are highly recommended for data rates above 10 Mbps. Capacitors must be located 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.

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:

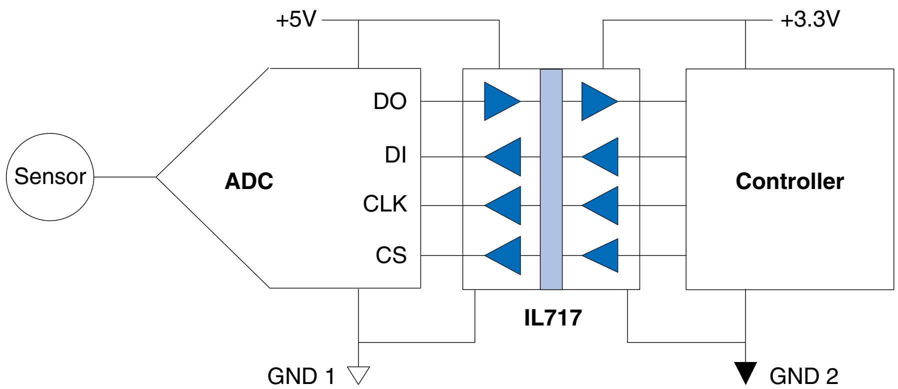
$$\text{PWD\%} = \frac{3\text{ ns}}{80\text{ ns}} \times 100\% = 3.75\%$$

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.

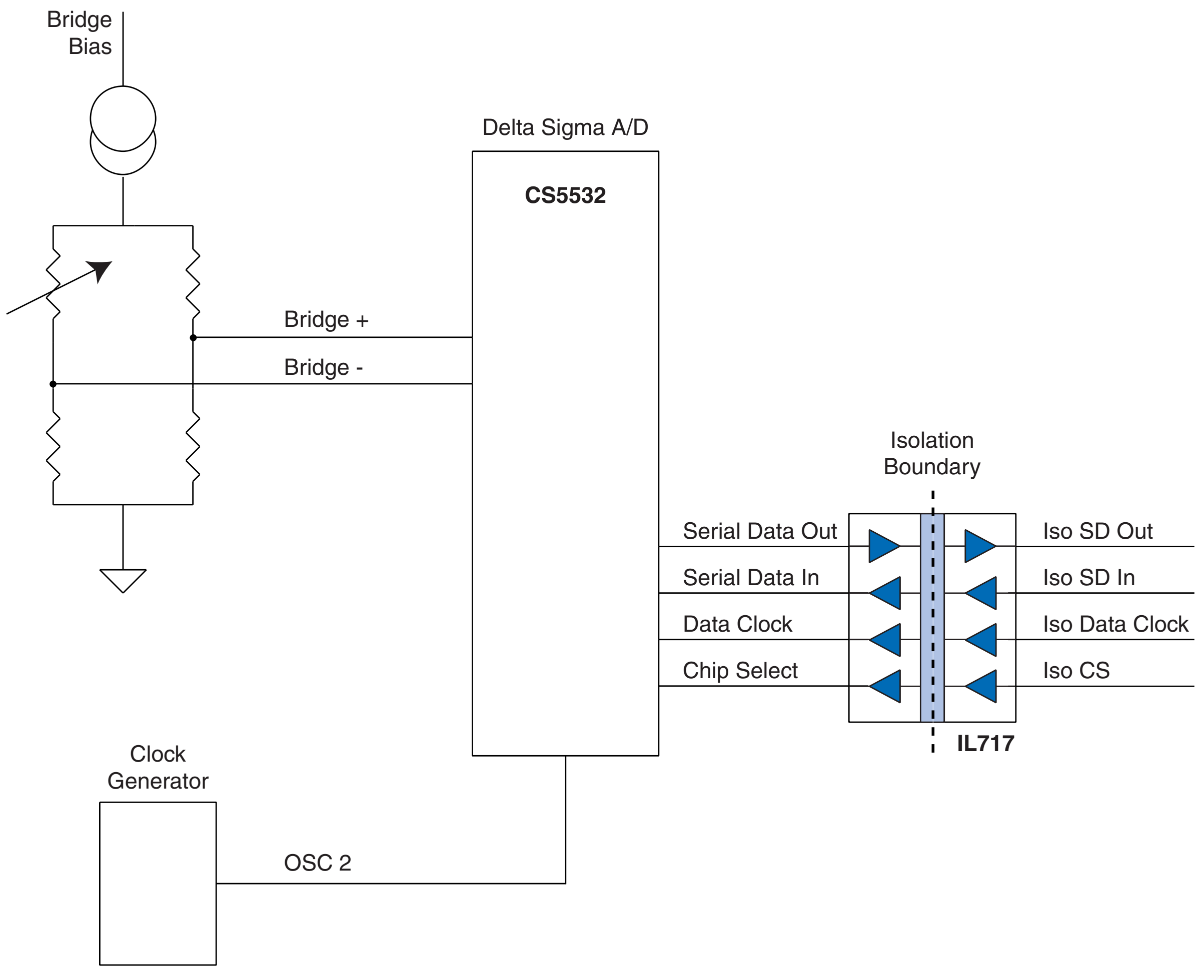
Propagation delay skew is the signal propagation difference between two or more channels. This becomes significant in clocked systems because it is undesirable for the clock pulse to arrive before the data has settled. Short propagation delay skew is therefore especially critical in high data rate parallel 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.

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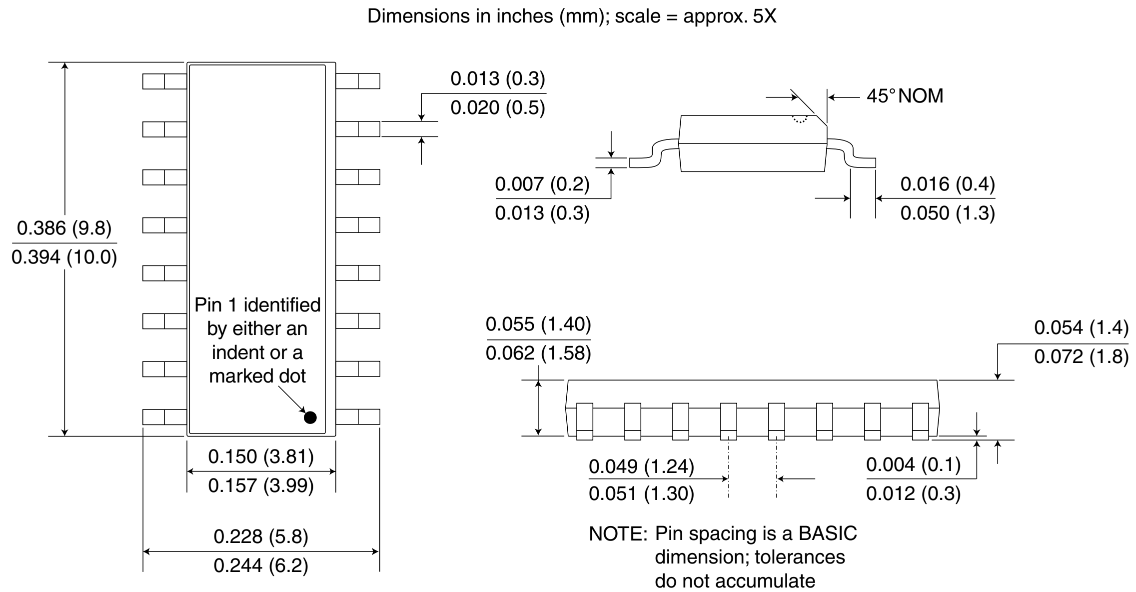
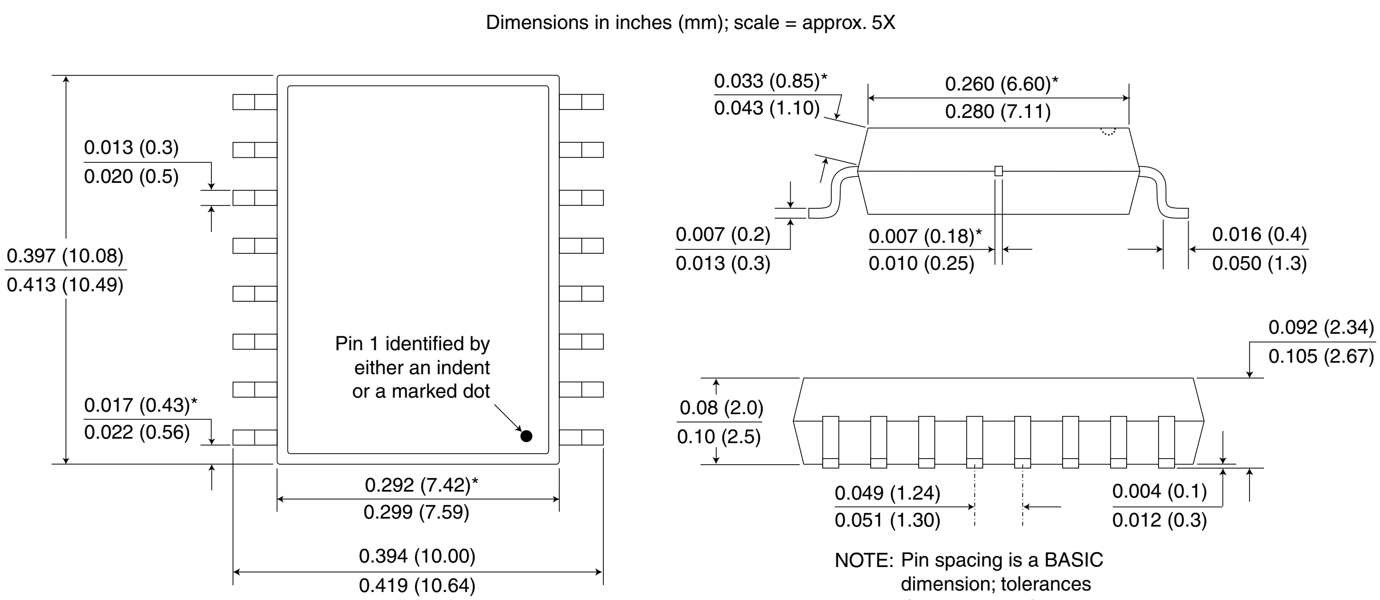
Package Drawings

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



0.3" 16-pin SOIC Package (no suffix)

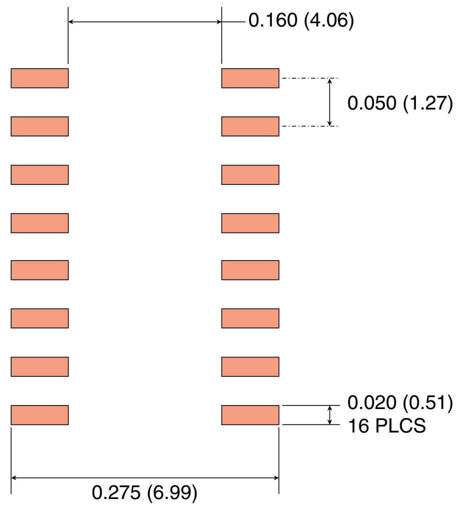


*Specified for True 8™ package to guarantee 8 mm creepage per IEC 60601.

Recommended Pad Layouts

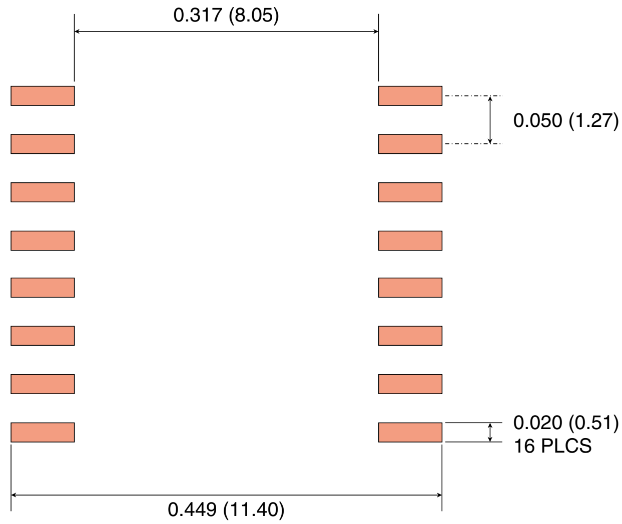
0.15" 16-pin SOIC Pad Layout

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 716 T - 3 E TR13

Bulk Packaging (TR13)
Blank = Tube
TR7 = 7" Tape and Reel
TR13 = 13" Tape and Reel

Package (E)
Blank = 80/20 Tin/Lead Plating
E = RoHS Compliant

Package Type (3)
Blank = 0.30" 16-pin SOIC
-3 = 0.15" 16-pin SOIC

Grade (T)
Blank = Standard Temp.
T = High Temperature

Base Part Number (716)
715 = 4 Transmit Channels
716 = 2 Transmit Channels
2 Receive Channels
717 = 3 Transmit Channels
1 Receive Channel

Product Family (IL)
IL = Isolators

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.

RoHS COMPLIANT

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ISB-DS-001-IL715/6/7-Y
November 2013

Changes

- IEC 60747-5-5 (VDE 0884) certification.

ISB-DS-001-IL715/6/7-X

Changes

- Tighter quiescent current specifications.
- Upgraded from MSL 2 to MSL 1.

ISB-DS-001-IL715/6/7-W

Changes

- Increased transient immunity specifications based on additional data.
- Added VDE 0884 pending.
- Added high voltage endurance specification.
- Increased magnetic immunity specifications.
- Updated package drawings.
- Added recommended solder pad layouts.

ISB-DS-001-IL715/6/7-V

Changes

- Detailed isolation and barrier specifications.
- Cosmetic changes.

ISB-DS-001-IL715/6/7-U

Changes

- Tightened typical output quiescent supply spec. to 1.5 mA/channel at 3.3V.

ISB-DS-001-IL715/6/7-T

Changes

- Updates to terms and conditions.

ISB-DS-001-IL715/6/7-S

Changes

- Added clarification of internal ground connections (pp. 3-4).

ISB-DS-001-IL715/6/7-R

Changes

- Added typical jitter specification at 5V.

ISB-DS-001-IL715/6/7-Q

Changes

- Added EMC details.

ISB-DS-001-IL715/6/7-P

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

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November 2013