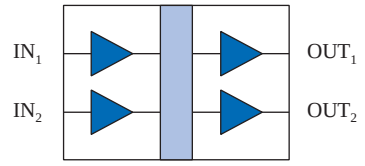
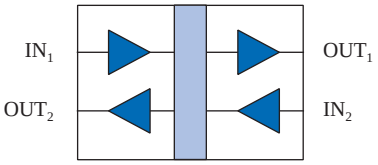
High Speed/High Temperature Dual Digital Isolators

Functional Diagrams



IL711



IL712

Features

- +5 V/+3.3 V CMOS / TTL Compatible
- High Speed: 150 Mbps Typical (IL711S/IL712S)
- High Temperature: −40°C to +125°C (IL711T/IL712T)
- 2500 V_{RMS} Isolation (1 min.)
- 300 ps Typical Pulse Width Distortion (IL711S/IL712S)
- 100 ps Typical Pulse Jitter
- 4 ns Typical Propagation Delay Skew
- 10 ns Typical Propagation Delay
- 30 kV/µs Typical Common Mode Transient Immunity
- Low EMC Footprint
- 2 ns Channel-to-Channel Skew
- 8-pin MSOP, SOIC, and PDIP Packages
- UL1577 and IEC 61010-2001 Approved

Applications

- PROFIBUS
- DeviceNet
- CAN
- RS-485 and RS-422
- Board-to-Board Communication
- Peripheral Interfaces
- Logic Level Shifting

Description

NVE's IL700 family of high-speed digital isolators are CMOS devices manufactured with NVE's patented* IsoLoop® spintronic Giant Magnetoresistive (GMR) technology. The IL711S and IL712S are the world's fastest two-channel isolators, with a 150 Mbps typical data rate for both channels.

The symmetric magnetic coupling barrier provides a typical propagation delay of only 10 ns and a pulse width distortion as low as 300 ps (0.3 ns), achieving the best specifications of any isolator. Typical transient immunity of 30 kV/µs is unsurpassed. The IL711 has two transmit channels; the IL712 has one transmit and one receive channel. The IL712 operates full duplex, making it ideal for many fieldbus applications, including PROFIBUS.

The IL711 and IL712 are available in 8-pin MSOP, SOIC, and PDIP packages. Standard and S-Grade parts are specified over a temperature range of −40°C to +100°C; T-Grade parts have a maximum operating temperature of +125°C.

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Absolute Maximum Ratings

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Storage Temperature	T_S	−55		150	°C	
Ambient Operating Temperature[1] IL711T/IL712T	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 IL711/IL712 and IL711S/IL712S IL711T/IL712T	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						
MSOP		3.01			mm	
SOIC		4.03			mm	
PDIP		7.04			mm	
Leakage Current[5]			0.2		µA	240 V_{RMS}, 60 Hz
Barrier Impedance[5]			$>10^{14}\|\|3$		Ω || pF	

Package Characteristics

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Capacitance (Input–Output)[5]	C_{I-O}		2		pF	f = 1 MHz
Thermal Resistance						
MSOP	θ_{JC}		168		°C/W	Thermocouple at center underside of package
SOIC	θ_{JC}		144		°C/W	
PDIP	θ_{JC}		54		°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
IL711-1; IL712-1	MSOP	II	III	150 V_{RMS}
IL711-2; IL712-2	PDIP	II	III	300 V_{RMS}
IL711-3; IL712-3	SOIC	II	III	150 V_{RMS}

UL 1577

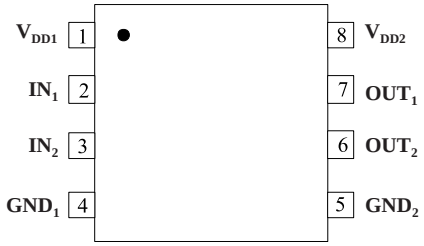
Component Recognition Program File Number: E207481
Rated 2500V_{RMS} for 1 minute

Soldering Profile

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

IL711 Pin Connections

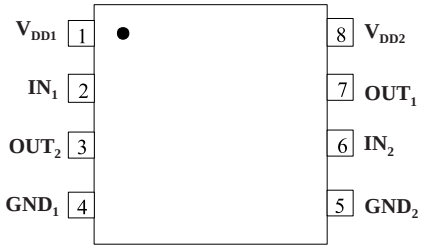
1	V_{DD1}	Supply voltage
2	IN_1	Data in, channel 1
3	IN_2	Data in, channel 2
4	GND_1	Ground return for V_{DD1}
5	GND_2	Ground return for V_{DD2}
6	OUT_2	Data out, channel 2
7	OUT_1	Data out, channel 1
8	V_{DD2}	Supply voltage



IL711

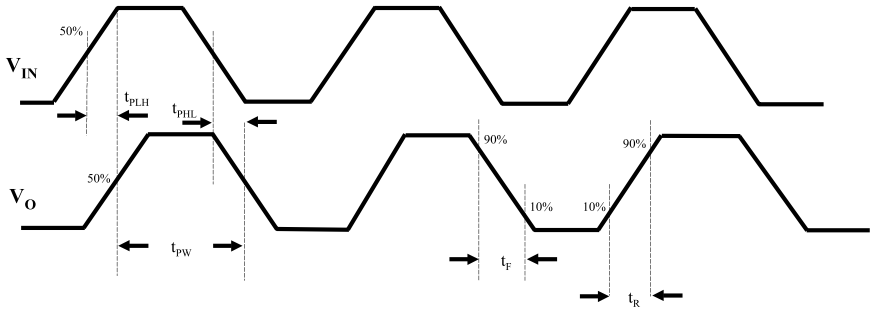
IL712 Pin Connections

1	V_{DD1}	Supply voltage
2	IN_1	Data in, channel 1
3	OUT_2	Data out, channel 2
4	GND_1	Ground return for V_{DD1}
5	GND_2	Ground return for V_{DD2}
6	IN_2	Data in, channel 2
7	OUT_1	Data out, channel 1
8	V_{DD2}	Supply voltage



IL712

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

3.3 Volt Electrical Specifications

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

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
DC Specifications						
Input Quiescent Supply Current						
IL711	I_{DD1}		8	10	µA	
IL712			1.5	2	mA	
Output Quiescent Supply Current						
IL711	I_{DD2}		3.3	4	mA	
IL712			1.5	2	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						
Maximum Data Rate IL711/IL712 and IL711T/IL712T IL711S and IL712S		 100 130	 110 140		 Mbps Mbps	 C_L = 15 pF C_L = 15 pF
Pulse Width[7]	PW	10	7.5		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] IL711/IL712 and IL711T/IL712T IL711S and IL712S	PWD		 2 1	 3 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]	$\|CM_H\|$,$\|CM_L\|$	20	30		kV/µs	V_{CM} = 300 V
Channel-to-Channel Skew	t_{CSK}		2	3	ns	C_L = 15 pF
Dynamic Power Consumption[6]			140	240	µA/MHz	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 = 8µs
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

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

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
DC Specifications						
Input Quiescent Supply Current						
IL711	I_{DD1}		10	15	µA	
IL712			2.5	3	mA	
Output Quiescent Supply Current						
IL711	I_{DD2}		5	6	mA	
IL712			2.5	3	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						
Maximum Data Rate IL711/IL712 and IL711T/IL712T IL711S and IL712S		 100 130	 110 150		 Mbps Mbps	 C_L = 15 pF C_L = 15 pF
Pulse Width[7]	PW	10	7.5		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] IL711/IL712 and IL711T/IL712T IL711S and IL712S	PWD		 2 0.3	 3 3	ns	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]	$\|CM_H\|$,$\|CM_L\|$	20	30		kV/µs	V_{cm} = 300 V
Channel to Channel Skew	t_{CSK}		2	3	ns	C_L = 15 pF
Dynamic Power Consumption[6]			200	340	µA/MHz	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 = 8µs
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 1–4 shorted and pins 5–8 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. 6.
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. 6).
10. 64k-bit pseudo-random binary signal (PRBS) NRZ bit pattern with no more than five consecutive 1s or 0s; 800 ps transition time.

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.

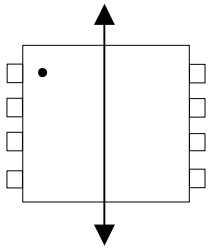
Electromagnetic Compatibility

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.

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. Unless the circuit connected to the isolator performs its own power-on reset (POR), 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.
In CAN applications, the IL712 should be used with CAN transceivers with Dominant Timeout functions for seamless POR. Most CAN transceiver manufacturers offer Dominant Timeout options. Examples include NXP's TJA 1050 and TJA 1040 transceivers.

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:

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

For example, with data rates of 12.5 Mbps:

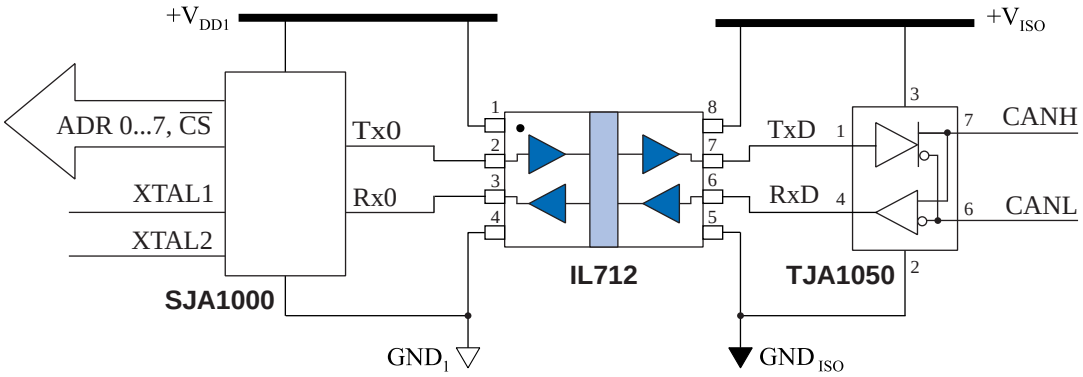
$$PWD\% = \frac{3\text{ ns}}{80\text{ ns}} \times 100\% = 3.75\%$$

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.

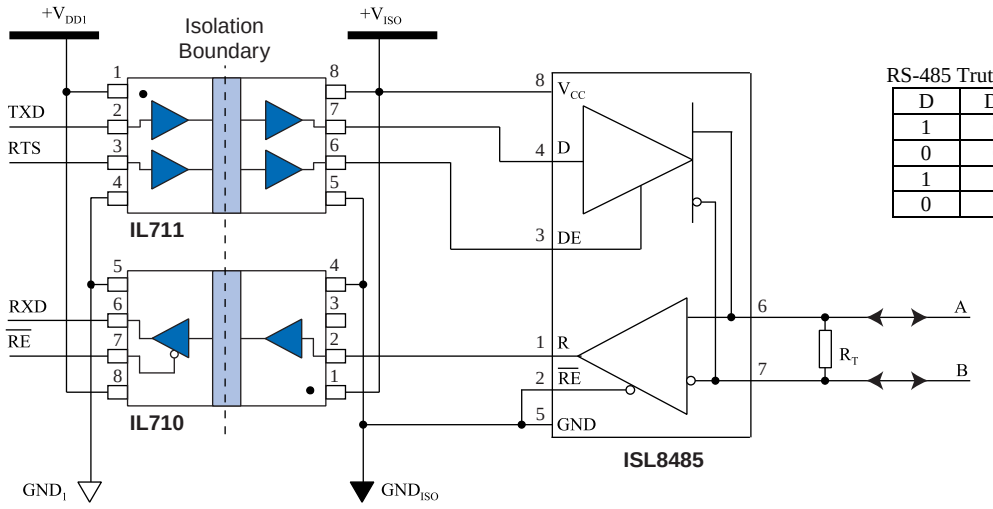
Illustrative Applications

Isolated CAN



In today's CAN networks, node-to-node isolation is increasingly recommended by designers to reduce EMI susceptibility, especially in high-speed applications and in hybrid and electrical vehicle networks, where the 12 V battery has been replaced with one of several hundred volts. Operator and equipment safety becomes critical when a high voltage source, such as the battery, needs to be connected to diagnosis systems during routine maintenance procedures. In the application shown above, the microcontroller is isolated from the CAN transceiver by an IL712, allowing higher speed and more reliable bus operation by eliminating ground loops and reducing susceptibility to noise and EMI events. The IL712's best-in-class 10 ns typical propagation delay minimizes CAN loop delay and maximizes data rate over any given bus length. The simple circuit works with any CAN transceiver with a TxD dominant timeout, which includes all of the current-generation transceivers.

Isolated PROFIBUS / RS-485



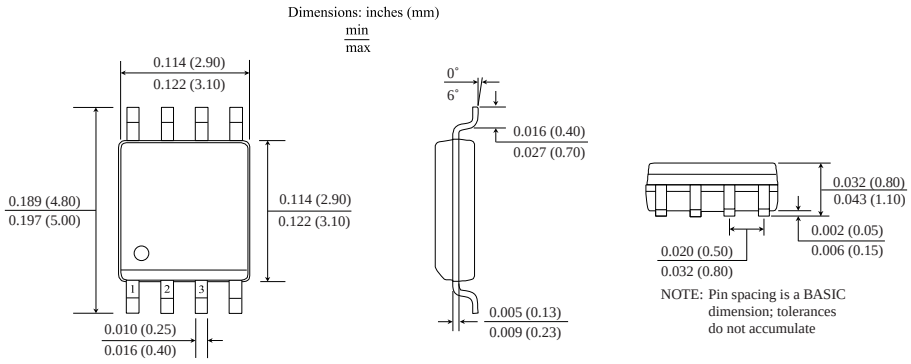
RS-485 Truth Table

D	DE	A	B	R
1	0	Z	Z	X
0	0	Z	Z	X
1	1	1	0	1
0	1	0	1	0

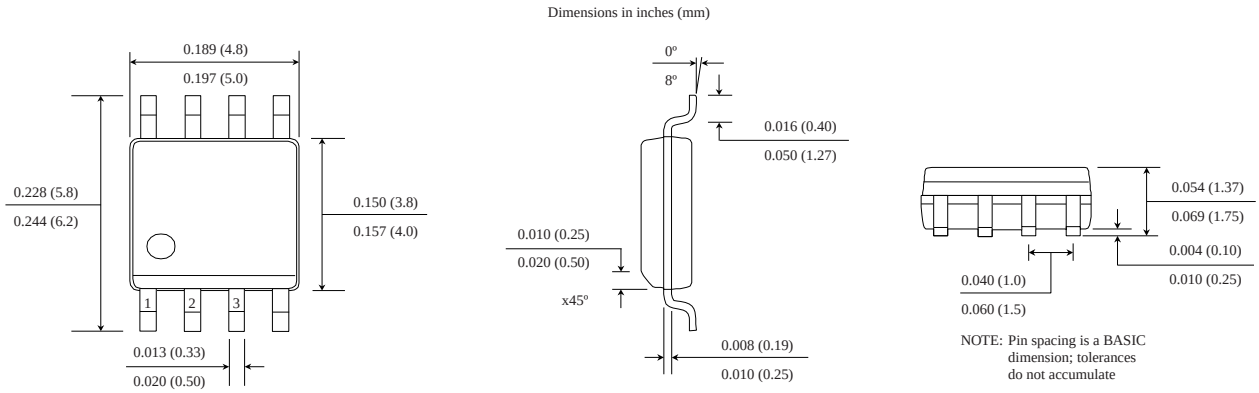
NVE offers a unique line of PROFIBUS / RS-485 transceivers, but IL700 high-speed digital signal isolators can also be used as part of multi-chip designs with non-isolated PROFIBUS transceivers.

Package Drawings, Dimensions and Specifications

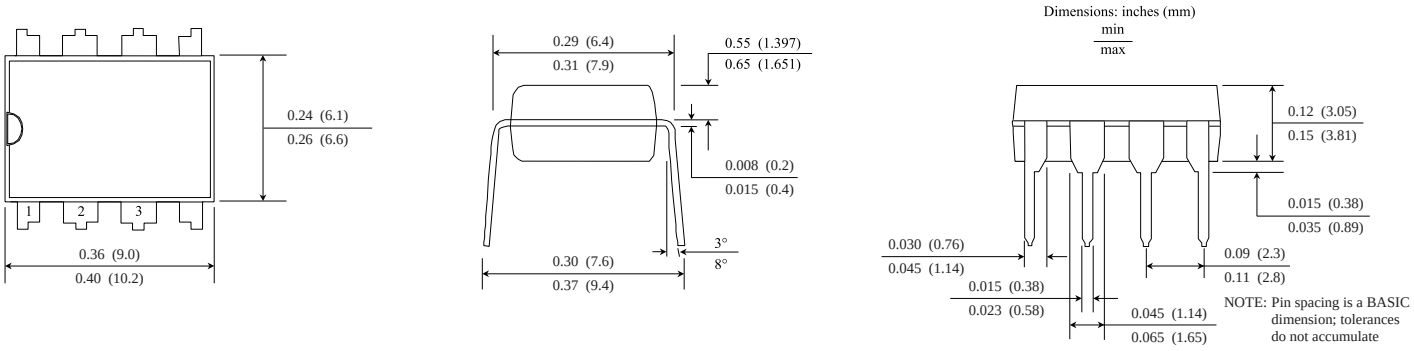
8-pin MSOP



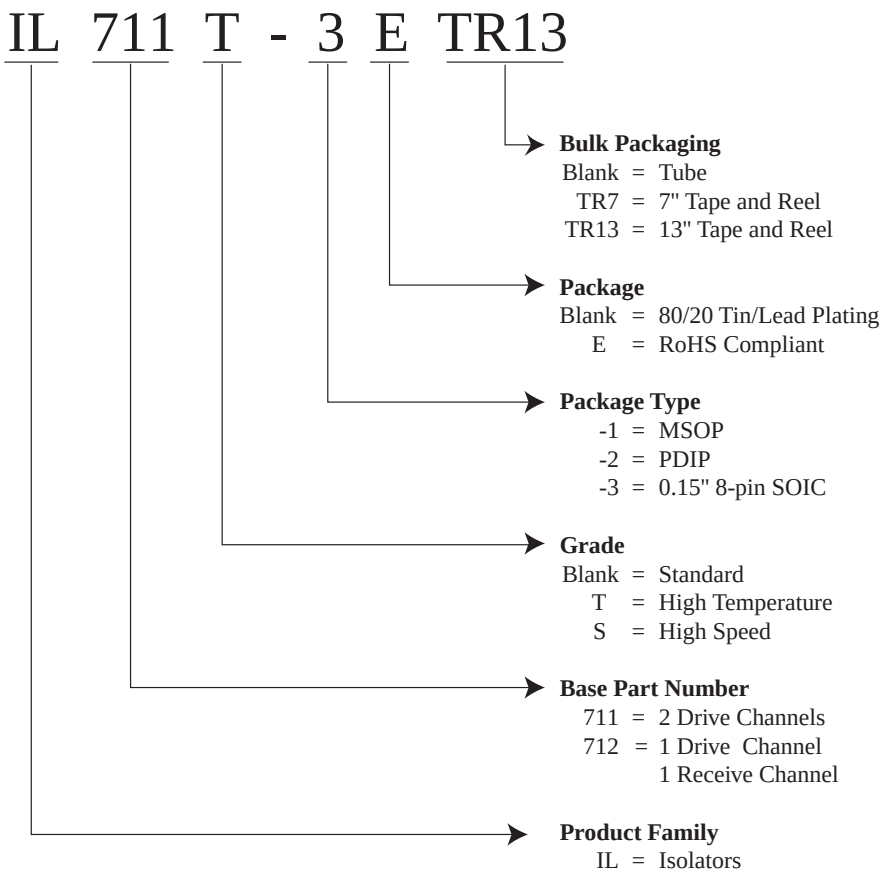
8-pin SOIC Package



8-pin PDIP



Ordering Information and Valid Part Numbers



Valid Part Numbers

IL711-1	IL712-1
IL711-1E	IL712-1E
IL711S-1	IL712S-1
IL711S-1E	IL712S-1E
IL711T-1	IL712T-1
IL711T-1E	IL712T-1E
IL711-2	IL712-2
IL711-2E	IL712-2E
IL711T-2	IL712T-2
IL711T-2E	IL712T-2E
IL711-3	IL712-3
IL711S-3	IL712S-3
IL711T-3	IL712T-3
IL711-3E	IL712-3E
IL711S-3E	IL712S-3E
IL711T-3E	IL712T-3E

All MSOP and SOIC parts are available on tape and reel.

RoHS COMPLIANT

ISB-DS-001-IL711/12-U **December 2009**	**Changes** • Added CAN application diagram (p. 7).
ISB-DS-001-IL711/12-T	**Changes** • Added typical jitter specification at 5V.
ISB-DS-001-IL711/12-S	**Changes** • Added EMC details.
ISB-DS-001-IL711/12-R	**Changes** • IEC 61010 approval for MSOP versions.
ISB-DS-001-IL711/12-Q	**Changes** • Added magnetic field immunity and electromagnetic compatibility specifications.
ISB-DS-001-IL711/12-P	**Changes** • Correct SOIC package drawing.
ISB-DS-001-IL711/12-O	**Changes** • Note on all package drawings that pin-spacing tolerances are non-accumulating; change MSOP pin-spacing dimensions and tolerance accordingly.
ISB-DS-001-IL711/12-N	**Changes** • Changed lower limit of length on PDIP package drawing. • Tightened pin-spacing tolerance on MSOP package drawing.
ISB-DS-001-IL711/12-M	**Changes** • Changed ordering information to reflect that devices are now fully RoHS compliant with no exemptions.
ISB-DS-001-IL711/12-L	**Changes** • Eliminated soldering profile chart
ISB-DS-001-IL711/12-K	**Changes** • Added RS-485 application circuit
ISB-DS-001-IL711/12-J	**Changes** • MSOP packages, S- and T-Grades added • Order information updated
ISB-DS-001-IL711/12-I	**Changes** Added MSOP Specifications Updated IEC and UL Approval Numbers

About NVE

An ISO 9001 Certified Company

NVE Corporation manufactures innovative products based on unique spintronic Giant Magnetoresistive (GMR) technology. Products include Magnetic Field Sensors, Magnetic Field Gradient Sensors (Gradiometers), Digital Magnetic Field Sensors, Digital Signal Isolators, and Isolated Bus Transceivers.

NVE pioneered spintronics and in 1994 introduced the world's first products using GMR material, a line of ultra-precise magnetic sensors for position, magnetic media, gear speed and current sensing.

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