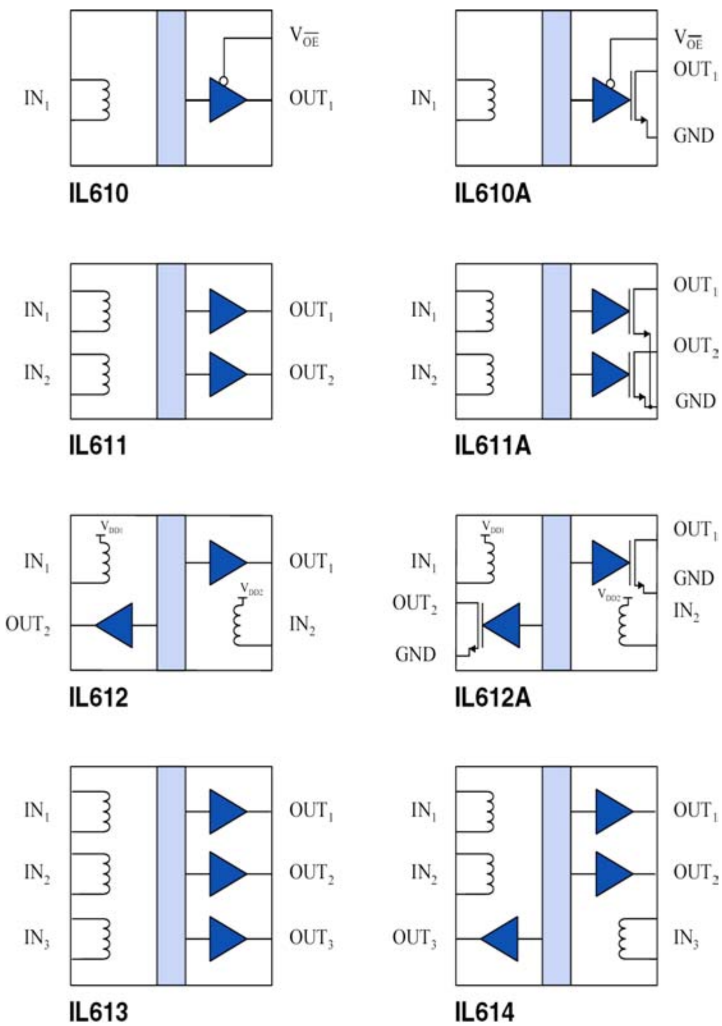
Passive Input Digital Isolators

Functional Diagram



Features

- 40 Mbps Data Rate
- Very Wide Input Voltage Range
- Open Drain or CMOS Outputs
- Failsafe Output (Logic high output for zero coil current)
- Output Enable
- 3.3 V or 5 V Power Supply
- 2500 V_{RMS} Isolation (1 Minute)
- Low Power Dissipation
- -40°C to 85°C Temperature Range
- 20 kV/µs Typical Common Mode Rejection
- UL1577 & IEC61010 Approval (pending)
- Available in MSOP, SOIC, and PDIP Packages and as Bare Die

Applications

- CAN Bus/ Device Net
- General Purpose Opto Replacement
- Wired-OR Alarms
- SPI interface
- I^2C
- RS 485, RS422, RS232
- Digital Fieldbus
- Size critical multi-channel applications

Description

The IL600 series are isolated signal couplers with CMOS or open drain transistor outputs which can be used to replace opto-couplers in many standard isolation functions. The devices are manufactured with NVE's patented IsoLoop® GMR sensor technology giving exceptionally small size and low power dissipation.

A single resistor is used to set maximum input current for input voltages above 0.5 V. The devices are available in SOIC, PDIP and MSOP packages and as bare die.

NVE Corp., 11409 Valley View Road, Eden Prairie, MN 55344-3617, U.S.A.
Telephone: 952-829-9217, Fax 952-829-9189, www.isoloop.com

Absolute Maximum Ratings[1]

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Storage Temperature	T_S	-55		150	°C	
Ambient Operating Temperature	T_A	-55		125	°C	
Supply Voltage	V_{DD}	-0.5		7	V	
Input Current	I_{IN}	-25		25	mA	
Output Voltage	V_O	-0.5		V_{CC}+0.5	V	
Maximum Output Current	I_O	-10		10	mA	
ESD			2		kV	HBM

Recommended Operating Conditions

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Ambient Operating Temperature	T_A	-40		85	°C	
Supply Voltage	V_{DD}	3.0		5.5	V	
Input Current	I_{IN}	0		10	mA	
Output Current	I_{OUT}	-4		4	mA	
Open Drain Reverse Voltage	V_{SD}	-0.5			V	
Open Drain Voltage	V_{DS}			6.5	V	
Open Drain Load Current	I_{OD}			4	mA	
Input Signal Rise and Fall Times	t_{IR}, t_{IF}			50	ms	
Common Mode Input Voltage	V_{CM}			400	$V_{AC\ RMS}$	

Insulation Specifications

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Creepage Distance (external)						
MSOP		3.010			mm	
0.15'' SOIC		4.026			mm	
0.30'' SOIC		8.077			mm	
0.30'' PDIP		7.077			mm	
Internal Isolation Distance			9		μm	
Leakage Current			0.2		μA_{RMS}	240 V_{RMS}, 60 Hz
Barrier Impedance			$>10^{14}\|\|7$		Ω || pF	

Safety & Approvals

IEC61010-1

TUV Certificate Numbers: *Approval Pending*

Classification

Model	Package	Pollution Degree	Material Group	Max. Working Voltage
IL610-1, IL610A-1, IL611-1, IL611A-1	MSOP	II	III	100 V_{RMS}
IL610-2, IL610A-2, IL611-2, IL611A-2, IL612-2, IL612A-2	PDIP	II	III	300 V_{RMS}
IL613, IL614	SOIC (0.3")	II	III	300 V_{RMS}
IL610-3, IL610A-3, IL611-3, IL611A-3, IL612-3, IL612A-3 IL613-3, IL614-3	SOIC (0.15")	II	III	150 V_{RMS}

UL 1577

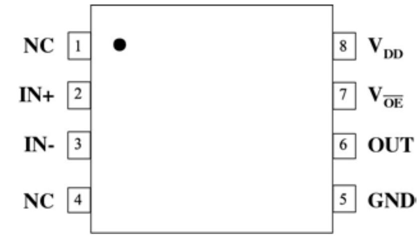
Component Recognition program. File #: *Approval Pending*
Rated 2500V_{RMS} for 1 minute (SOIC, PDIP), 1000V_{RMS} for 1 minute (MSOP)

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.

IL610 and IL610A Pin Connections

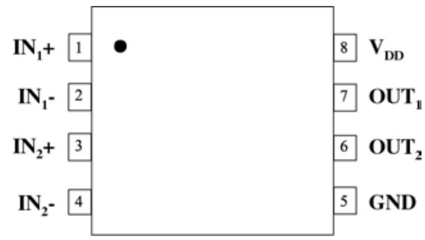
1	NC	No internal connection
2	IN+	Coil connection
3	IN-	Coil connection
4	NC	No internal connection
5	GND	Ground return for V_{DD}
6	OUT	Data out
7	$V_{\overline{OE}}$	Output enable. Internally held low with 100 kΩ
8	V_{DD}	Supply Voltage



IL610
IL610A

IL611 and IL611A Pin Connections

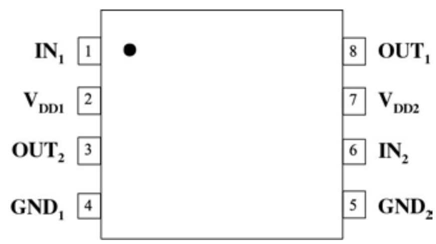
1	IN_1+	Channel 1 coil connection
2	IN_1-	Channel 1 coil connection
3	IN_2+	Channel 2 coil connection
4	IN_2-	Channel 2 coil connection
5	GND	Ground return for V_{DD}
6	OUT_2	Data out channel 2
7	OUT_1	Data out channel 1
8	V_{DD}	Supply Voltage



IL611
IL611A

IL612 and IL612A Pin Connections

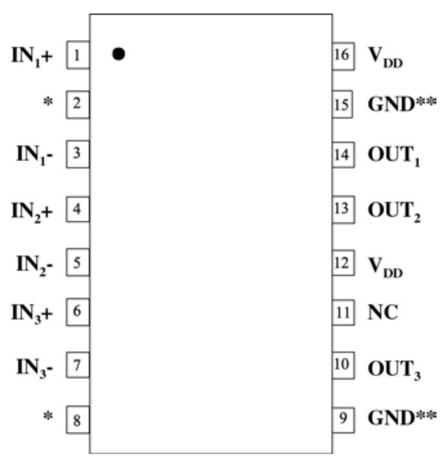
1	IN_1	Data in, channel 1
2	$V_{DD\,1}$	Supply Voltage 1
3	OUT_2	Data out, channel 2
4	GND_1	Ground return for V_{DD1}
5	GND_2	Ground return for V_{DD2}
6	IN_2	Data in, channel 2
7	$V_{DD\,2}$	Supply Voltage 2
8	OUT_1	Data out, channel 1



IL612
IL612A

IL613 Pin Connections

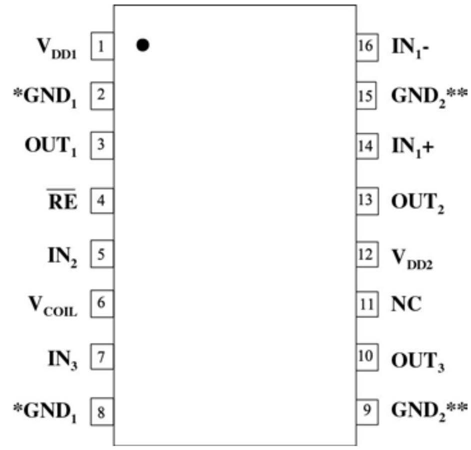
1	IN_1+	Channel 1 coil connection
2	*	Internally connected to pin 8
3	IN_1-	Channel 1 coil connection
4	IN_2+	Channel 2 coil connection
5	IN_2-	Channel 2 coil connection
6	IN_3+	Channel 3 coil connection
7	IN_3-	Channel 3 coil connection
8	*	Internally connected to pin 2
9	GND	Ground return for V_{DD} (Internally connected to pin 15)
10	OUT_3	Data out channel 3
11	NC	No connection
12	V_{DD}	Supply Voltage. Pin 12 and pin 16 must be connected externally
13	OUT_2	Data out channel 2
14	OUT_1	Data out channel 1
15	GND	Ground return for V_{DD} (Internally connected to pin 9)
16	V_{DD}	Supply Voltage. Pin 12 and pin 16 must be connected externally



IL613
* Pins 2 and 8 internally connected
** Pins 9 and 15 internally connected

IL614 Pin Connections

1	V_{DD1}	Supply Voltage 1
2	GND_1	Ground return for V_{DD1} (Internally connected to pin 8)
3	OUT_1	Data out channel 1
4	$\overline{RE}$	Channel 1 data output enable. Internally held low with 100 kΩ
5	IN_2	Data in channel 2
6	V_{coil}	Supply connection for channel 2 and channel 3 coils
7	IN_3	Data in channel 3
8	GND_1	Ground return for V_{DD1} (Internally connected to pin 2)
9	GND_2	Ground return for V_{DD2} (Internally connected to pin 15)
10	OUT_3	Data out channel 3
11	NC	No connection
12	V_{DD2}	Supply Voltage 2
13	OUT_2	Data out channel 2
14	IN_1+	Coil connection
15	GND_2	Ground return for V_{DD2} (Internally connected to pin 9)
16	IN_1-	Coil connection



IL614
* Pins 2 and 8 internally connected
** Pins 9 and 15 internally connected

Electrical Specifications

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

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Coil Input Impedance	Z_{COIL}	47‖8	55‖9	67‖10	Ω‖nH	T_{AMB} = 25°C
Temperature Coeff of Coil Resistance	TC R_{COIL}		0.16	0.165	Ω/°C	
Input Threshold for Logic High	I IN_H			2	mA	
Input Threshold for Logic Low	I IN_L	10			mA	
Quiescent Current	IL610, I_{DD1} IL610, I_{DD2} IL611, I_{DD1} IL611, I_{DD2} IL612, I_{DD1} IL612, I_{DD2} IL613, I_{DD1} IL613, I_{DD2} IL614, I_{DD1} IL614, I_{DD2}		 2 4 2 2 6 2 4	0 3 0 6 3 3 0 9 3 6	μA mA μA mA mA mA μA mA mA mA	V_{DD}= 5 V, I_{IN}=0
Quiescent Current	IL610, I_{DD1} IL610, I_{DD2} IL611, I_{DD1} IL611, I_{DD2} IL612, I_{DD1} IL612, I_{DD2} IL613, I_{DD1} IL613, I_{DD2} IL614, I_{DD1} IL614, I_{DD2}		 1.3 2.6 1.3 1.3 4 1.3 2.6	0 2 0 4 2 2 0 6 2 4	μA mA μA mA mA mA μA mA mA mA	V_{DD}= 3.3 V, I_{IN}=0
Logic High Output Voltage[4]	V_{OH}	V_{DD}-0.1	V_{DD}		V	I_O = -20 μA
		V_{DD}	V_{DD}-0.5			I_O = -4 mA
Logic Low Output Voltage	V_{OL}		0	0.1	V	I_O = 20 μA
			0.5	0.8		I_O = 4 mA
Logic Output Current	I_O	4	7		mA	
Switching Specifications CMOS Outputs						
Data Rate		40			Mbps	50% Duty Cycle
Minimum Pulse Width	PW	25			ns	50% Points, Vo
Propagation Delay Input to Output (High to Low)	t_{PHL}		20	25	ns	C_L = 15 pF, I_{COIL} = 10 mA
Propagation Delay Input to Output (Low to High)	t_{PLH}		20	25	ns	C_L = 15 pF, I_{COIL} = 10 mA
Average Propagation Delay Drift			50			ps/°C
Pulse Width Distortion $\|t_{PHL}-t_{PLH}\|$ [2]	PWD		7	10	ns	C_L = 15 pF
Propagation Delay Skew [3]	t_{PSK}		10	20	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	$\|CM_H\|,\|CM_L\|$	15	20		kV/μs	V_T = 300 V_{peak}
Switching Specifications Open Drain Outputs						
Parameters	**Symbol**	**Min.**	**Typ.**	**Max.**	**Units**	**Test Conditions**
Data Rate		10			Mbps	50% Duty Cycle, R_{pullup} = 1 kΩ
Minimum Pulse Width	PW	100			ns	50% Duty Cycle, R_{pullup} = 1 kΩ
Propagation Delay Input to Output (High to Low)	t_{PHL}		20	25	ns	C_L = 2 kΩ ‖15 pF
Propagation Delay Input to Output (Low to High)	t_{PLH}		50	75	ns	C_L = 2 kΩ ‖15 pF
Common Mode Transient Immunity	$\|CM_H\|,\|CM_L\|$	15	20		kV/μs	V_T = 300 V_{peak}

Notes:

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 the PWD divided by the pulse width.
3. t_{PSK} is equal to the magnitude of the worst case difference in t_{PHL} and/or t_{PLH} that will be seen between units at 25°C.
4. The term V_{DD} refers to the supply voltage on the output side of the isolated channel.

Operation

The IL600 series are current mode devices. Changes in current flow into the input coil result in logic state changes at the output. One of the great advantages of the passive coil input is that both single ended and differential inputs can be handled without the need for reverse bias protection. The internal GMR sensor switches the output to logic low if current flows from (In-) to (In+). Only a single resistor is required to limit the input coil to the recommended 10 mA. This allows large input voltages to be used since there is no semiconductor structure on the input.

The absolute maximum current through the coil of the IL600 series is 25 mA DC. However, it is important to limit input current to levels well below this in all applications. The worst case logic threshold current is 10 mA. While typical threshold currents are substantially less than this, NVE recommends designing a 10 mA logic threshold current in each application. In all cases, the current must flow from In- to In+ in the coil to switch the output low. This is true regardless of true or inverted data configurations. Output logic high is the zero input current state.

Figure 1 shows the response of the IL600 series. The GMR bridge structure is designed such that the output of the isolator is logic high when no field signal is present. The output will switch to the low state with 10 mA of coil current and the output will switch back to the high state when the input current falls below 2 mA. This allows glitch-free interface with low slew rate signals.

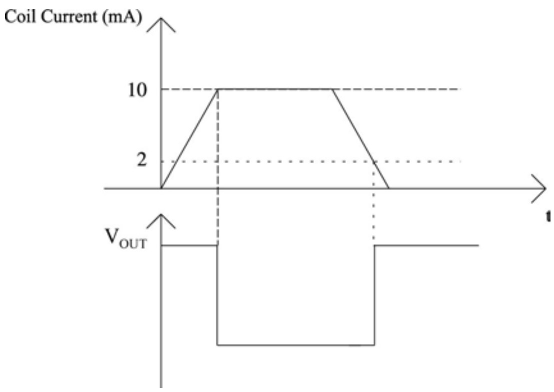


Figure 1. IL600 Series Transfer Function

To calculate the value of the protection resistor (R1) required, use Ohm's law as shown in the examples below. It should be noted that we are concerned only with the magnitude of the voltage across the coil. The absolute values of V_{in} High and V_{in} Low are arbitrary.

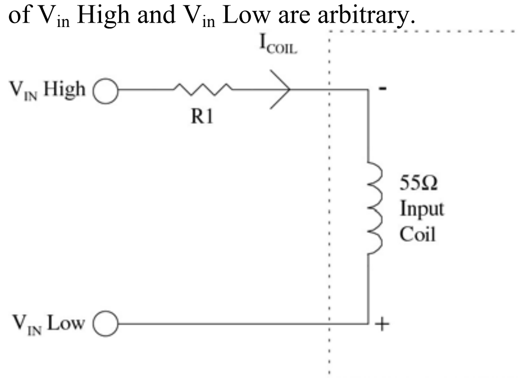


Figure 2. Series Resistor Calculation Equivalent Circuit.

Example 1. In this case, T_{nom} = 25ºC, V_{in} High is 24 V, V_{in} Low is 1.8 V, and I_{coil} minimum is specified as 10 mA. Total loop resistance is

$$(R1 + R_{coil}) = \frac{(V_{in}\,High - V_{in}\,Low)}{I_{coil}} = \frac{22.2}{0.01}\,\Omega = 2220\,\Omega$$

Therefore,

$$R1 = (2220 - 55)\,\Omega = 2145\,\Omega$$

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

$$R_{coil} = 55 + (T_{max} - T_{min}) \times TCR_{coil}$$
$$= 55 + (85 - 25) \times 0.165 = 55 + 9.9 = 65\,\Omega$$

Therefore, the recommended series resistor is

$$R1 = \frac{(V_{in}High - V_{in}Low)}{I_{coil}} - R_{coil}$$
$$= \frac{5 - 0}{0.01} - 65 = 435\,\Omega$$

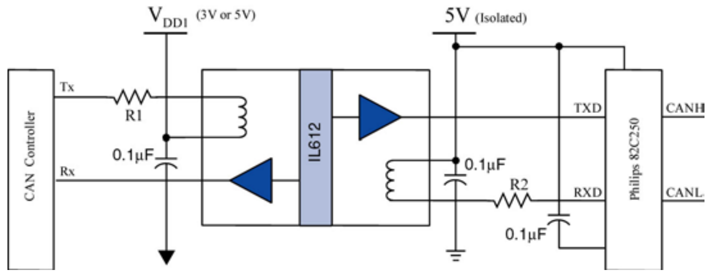
Allowance should also be made for the temperature coefficient of the current limiting resistor to ensure that I_{coil} is 10 mA at maximum operating temperature.

Power Supplies

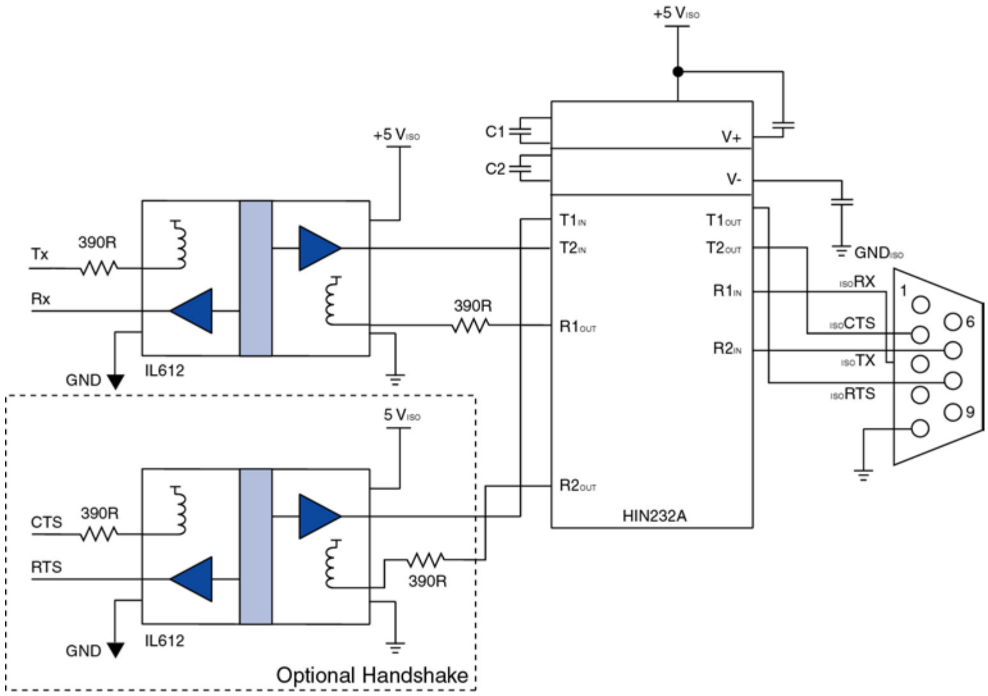
It is recommended that 47 nF ceramic capacitors be used to decouple the power supplies. The capacitors must be placed as close as possible to V_{DD} for proper operation.

Application Diagrams

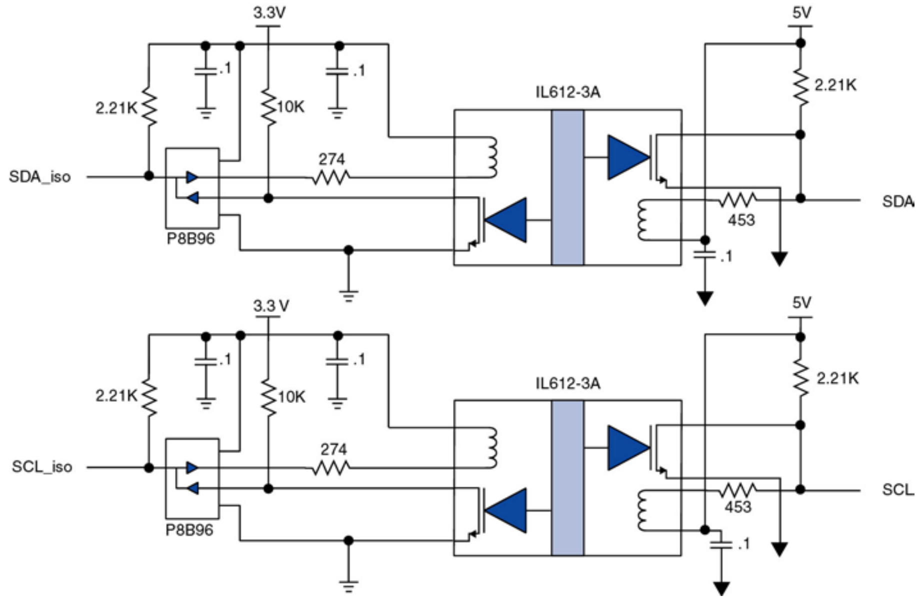
CAN Bus



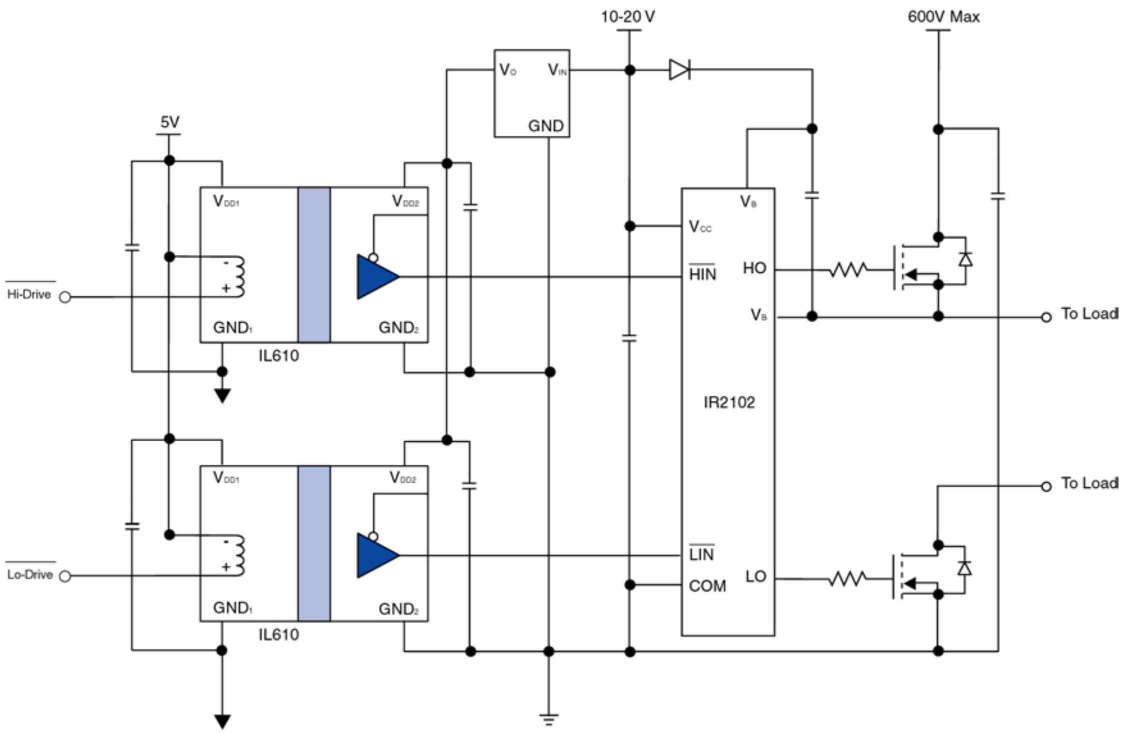
RS232



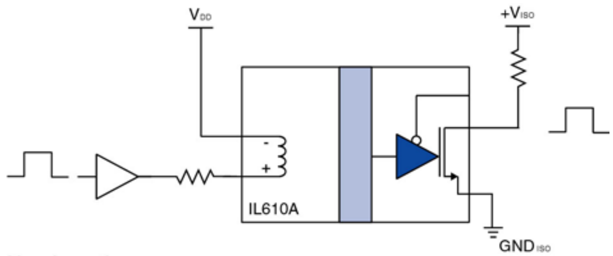
I²C



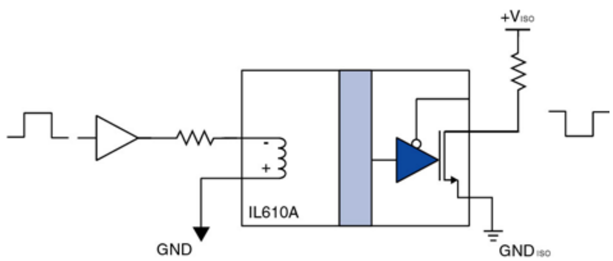
Single Phase Power Control



Inverting and Non-Inverting Circuits

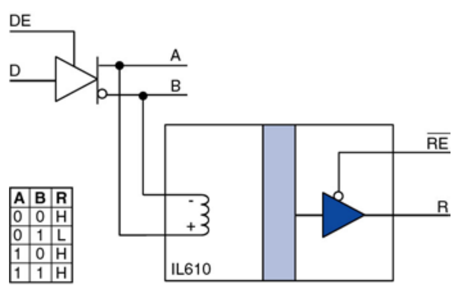


Non-inverting



Inverting

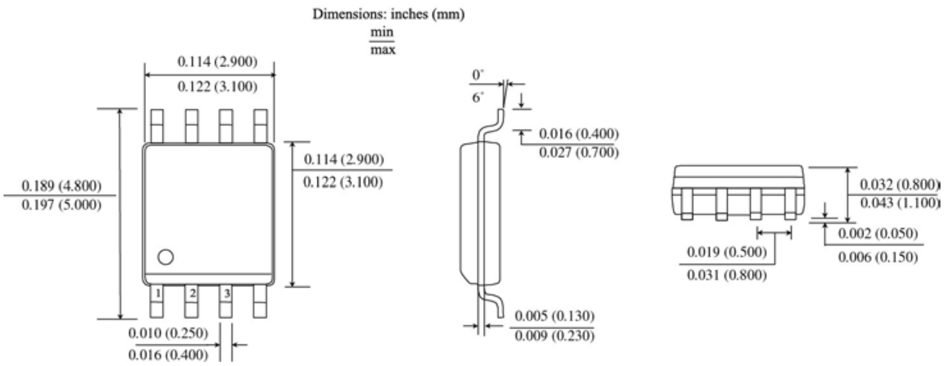
Differential to Single Ended Conversion



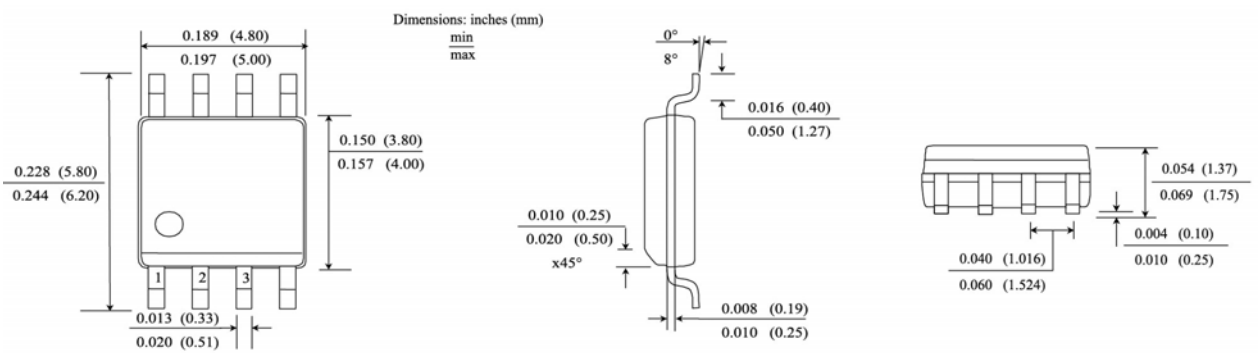
A	B	R
0	0	H
0	1	L
1	0	H
1	1	H

Package drawings, dimensions and specifications

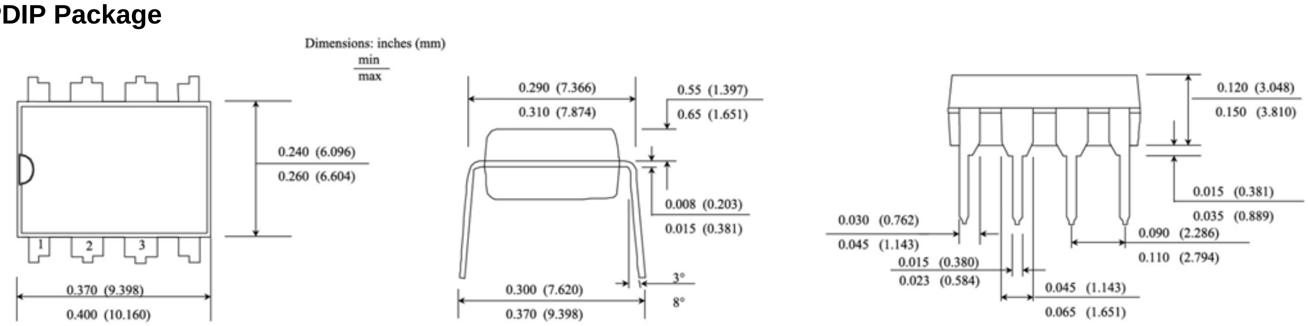
8-pin MSOP Package



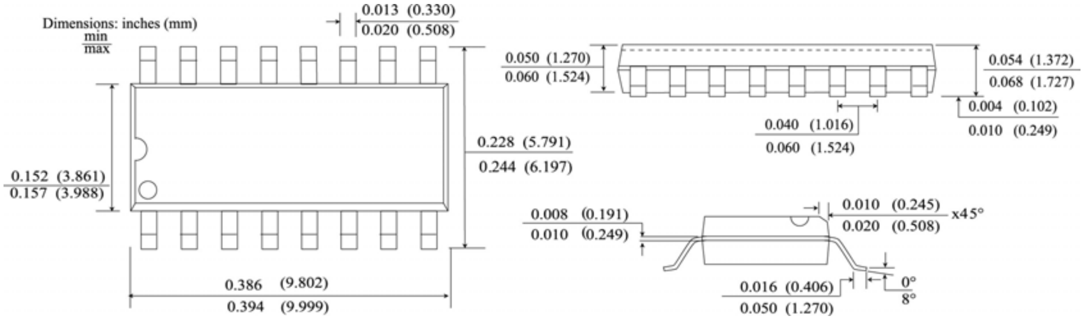
8-pin SOIC Package



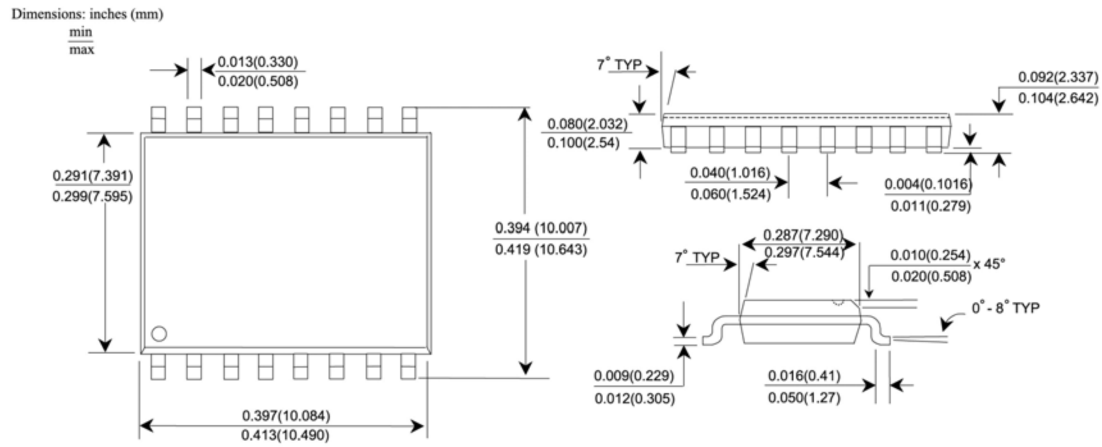
8-pin PDIP Package



0.15" 16-pin SOIC



0.30" 16-pin SOIC



Ordering information and valid part numbers.

IL 610 A -1 E TR13

Bulk Package
- Blank = Tube
- TR7 = 7" Tape and Reel
- TR13 = 13" Tape and Reel

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

Package Type
- Blank = 0.3" SOIC
- -1 = MSOP
- -2 = PDIP
- -3 = 0.15" SOIC
- -5 = Bare die

Output Type
- Blank = CMOS Output
- A = Open Drain Output

Base Part Number
- 610 = Single Channel
- 611 = 2 Drive Channel
- 612 = 1 Drive Channel, 1 Receive Channel
- 613 = 3 Drive Channel
- 614 = 1 Drive Channel, 2 Receive Channel

Product Family
- IL = Isolators

IL610 Valid Part Numbers

IL610-1
IL610A-1
IL610-2
IL610A-2
IL610-3
IL610A-3
IL610-5
IL610A-5
IL610-1TR7
IL610A-1TR7
IL610-3TR7
IL610A-3TR7
IL610-1TR13
IL610A-1TR13
IL610-3TR13
IL610A-3TR13

IL611 Valid Part Numbers

IL611-1
IL611A-1
IL611-2
IL611A-2
IL611-3
IL611A-3
IL611-5
IL611A-5
IL611-1TR7
IL611A-1TR7
IL611-3TR7
IL611A-3TR7
IL611-1TR13
IL611A-1TR13
IL611-3TR13
IL611A-3TR13

IL612 Valid Part Numbers

IL612-2
IL612A-2
IL612-3
IL612A-3
IL612-3TR7
IL612A-3TR7
IL612-3TR13
IL612A-3TR13

IL613 Valid Part Numbers

IL613
IL613TR13
IL613-3
IL613-3TR7
IL613-3TR13

IL614 Valid Part Numbers

IL614
IL614TR13
IL614-3
IL614-3TR7
IL614-3TR13

Lead Free Part Numbers

All part numbers listed above are available in the Lead Free (E) packages.

About NVE

An ISO 9001 Certified Company

NVE Corporation is a high technology components manufacturer having the unique capability to combine leading edge Giant Magnetoresistive (GMR) materials with integrated circuits to make high performance electronic components. Products include Magnetic Field Sensors, Magnetic Field Gradient Sensors (Gradiometer), Digital Magnetic Field Sensors, Digital Signal Isolators and Isolated Bus Transceivers.

NVE is a leader in GMR research and in 1994 introduced the world's first products using GMR material, a line of GMR magnetic field sensors that can be used for position, magnetic media, wheel speed and current sensing.

NVE is located in Eden Prairie, Minnesota, a suburb of Minneapolis. Please visit our Web site at www.nve.com or call 952-829-9217 for information on products, sales or distribution.

NVE Corporation
11409 Valley View Road
Eden Prairie, MN 55344-3617 USA
Telephone: (952) 829-9217
Fax: (952) 829-9189
Internet: www.nve.com
e-mail: isoinfo@nve.com

ISB-DS-001-IL600-A
January 28, 2005