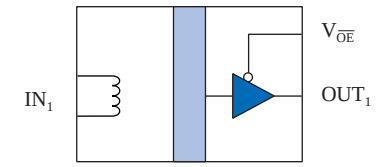
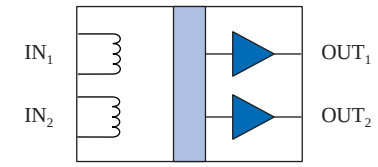
Passive-Input Digital Isolators – CMOS Outputs

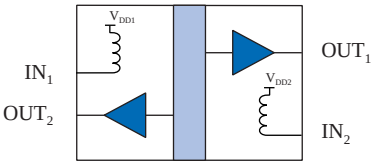
Functional Diagrams



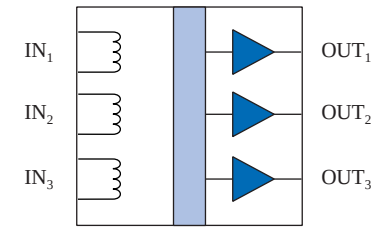
IL610



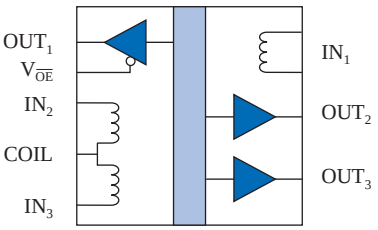
IL611



IL612



IL613



IL614

Features

- Up to 100 Mbps Data Rate
- Single-ended or Differential Input Operation
- Flexible Inputs with Very Wide Input Voltage Range
- Failsafe Output (logic high output for zero coil current)
- Output Enable (IL610)
- 3.3 V or 5 V Operation / Level Translation
- 2500 V_{RMS} Isolation (1 minute)
- Low Power Dissipation
- −40°C to 85°C Temperature Range
- 20 kV/µs Transient Immunity
- Low EMC Footprint
- UL1577 and IEC61010-2001 Approved
- 8-Pin MSOP, SOIC, and PDIP Packages
- Bare Die Available (IL610)

Applications

- CAN Bus / Device Net
- Differential Line Receiver
- Optocoupler Replacement
- SPI Interface
- RS-485, RS-422, or RS-232
- Digital Fieldbus
- Space-critical multi-channel applications

Description

The IL600 Series are passive input digital signal isolators with CMOS outputs. They have a similar interface but better performance and higher package density than optocouplers.

The devices are manufactured with NVE's patented* IsoLoop® spintronic Giant Magnetoresistive (GMR) technology for small size, high speed, and low power.

A single resistor sets the maximum input current for voltages above 0.5 V. A capacitor in parallel with the current-limit resistor provides improved dynamic performance.

These versatile components simplify inventory requirements by replacing a variety of optocouplers and functioning over a wide range of data rates, edge speeds, and power supply levels. The devices are available in MSOP, SOIC, and PDIP packages, as well as bare die.

NVE Corporation 11409 Valley View Road, Eden Prairie, MN 55344-3617 Phone: (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	
DC Input Current	I_{IN}	−25		25	mA	
AC Input Current (Single-Ended Input)	I_{IN}	−35		35	mA	
AC Input Current (Differential Input)	I_{IN}	−75		75	mA	
Output Voltage	V_O	−0.5		V_{DD}+1.5	V	
Maximum Output Current	I_O	−10		10	mA	
ESD			2		kV	HBM

Note 1: Operating at absolute maximum ratings will not damage the device. Parametric performance is not guaranteed at absolute maximum ratings.

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 Low	$I_{IN\ LOW}$	5		10	mA	Current flow direction defined as positive when flowing into the Coil− terminal and out Coil+
Input Current High	$I_{IN\ HIGH}$	−10		0.5	mA	
Differential Input Current Low	$I_{IN\ LOW}$	5		60	mA	
Differential Input Current High	$I_{IN\ HIGH}$	−60		−5	mA	
Output Current	I_{OUT}	−4		4	mA	
Common Mode Input Voltage	V_{CM}			400	V_{RMS}	

Insulation Specifications

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Creepage Distance (mm)						
MSOP		3.01			mm	
0.15" SOIC		4.03			mm	
0.3" SOIC		8.08			mm	
0.3" PDIP		7.08			mm	
Internal Isolation Distance			9		µm	
Leakage Current			0.2		µA	240 V_{RMS}, 60 Hz
Barrier Impedance			$>10^{14}\|\|7$		Ω || pF	
Rated Voltage (1 minute; MSOP)	V_{ISO}	1,000			V_{AC}	50 Hz to 60 Hz
Rated Voltage (1 min.; SOIC & PDIP)	V_{ISO}	2,500			V_{AC}	50 Hz to 60 Hz

Safety and Approvals

IEC61010-2001

TUV Certificate Numbers: N1502812, N1502812-101

Classification: Reinforced Insulation

Model	Package	Pollution Degree	Material Group	Max. Working Voltage
IL610-2E, IL611-2E, IL612-2E	PDIP	II	III	300 V_{RMS}
IL613E, IL614E	SOIC (0.3")	II	III	300 V_{RMS}
IL610-3E, IL611-3E, IL612-3E, IL613-3E, IL614-3E	SOIC (0.15")	II	III	150 V_{RMS}

UL 1577

Component Recognition Program File Number: E207481
Rated 2,500V_{RMS} for 1 minute (SOIC, PDIP)

Soldering Profile

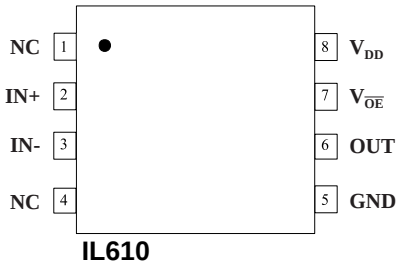
Per JEDEC J-STD-020C

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 Pin Connections

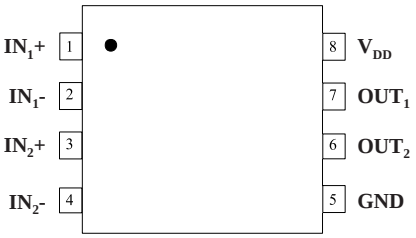
1	NC	No internal connection
2	IN+	Coil connection
3	IN−	Coil connection
4	NC	No internal connection
5	GND	Ground return for V_{DD}
6	OUT	Data out
7	$V_{\overline{OE}}$	Output enable. Internally held low with 100 kΩ
8	V_{DD}	Supply Voltage



IL610

IL611 Pin Connections

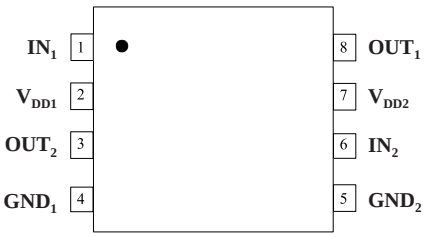
1	IN_1+	Channel 1 coil connection
2	IN_1-	Channel 1 coil connection
3	IN_2+	Channel 2 coil connection
4	IN_2-	Channel 2 coil connection
5	GND	Ground return for V_{DD}
6	OUT_2	Data out, channel 2
7	OUT_1	Data out, channel 1
8	V_{DD}	Supply Voltage



IL611

IL612 Pin Connections

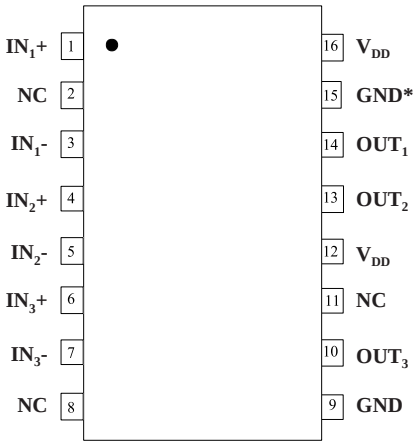
1	IN_1	Data in, channel 1
2	V_{DD1}	Supply Voltage 1
3	OUT_2	Data out, channel 2
4	GND_1	Ground return for V_{DD1}
5	GND_2	Ground return for V_{DD2}
6	IN_2	Data in, channel 2
7	V_{DD2}	Supply Voltage 2
8	OUT_1	Data out, channel 1



IL612

IL613 Pin Connections

1	IN_1+	Channel 1 coil connection
2	NC	No connection (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	NC	No connection (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

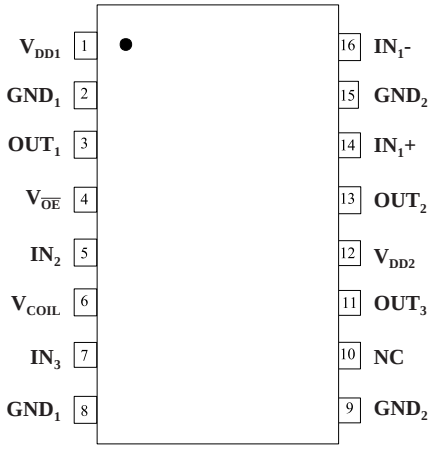


IL613

Note: Pins 12 and 16 must be connected externally.

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	$V_{\overline{OE}}$	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	NC	No Connection
11	OUT_3	Data out, channel 3
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

Electrical Specifications

Electrical specifications are T_{min} to T_{max} and 4.5 V to 5.5 V unless otherwise stated.

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Coil Input Impedance	Z_{COIL}		85||9		Ω||nH	T_{AMB} = 25°C V_{DD} = 3.0 V to 5.5 V
Temperature Coefficient of Coil Resistance	TC R_{COIL}		0.2	0.25	Ω/°C	V_{DD} = 3.0 V to 5.5 V
Input Threshold for Output Logic High	I_{INH}	0.5	1		mA	Single or Differential V_{DD} = 3.0 V to 5.5 V
Input Threshold for Output Logic Low	I_{INL}	5	3.5		mA	Single or Differential V_{DD} = 3.0 V to 5.5 V
Quiescent Current	IL610, I_{DD} IL611, I_{DD} IL612, I_{DD1} IL612, I_{DD2} IL613, I_{DD} IL614, I_{DD1} IL614, I_{DD2}		2 4 2 2 6 2 4	3 6 3 3 9 3 6	mA mA mA mA mA mA mA	V_{DD} = 5 V, I_{IN} = 0
Logic High Output Voltage	V_{OH}	4.9	5		V	V_{DD} = 5 V, I_O = 20 µA
		4.0	4.8			V_{DD} = 5 V, I_O = 4 mA
Logic Low Output Voltage	V_{OL}		0	0.1	V	V_{DD} = 5 V, I_O = −20 µA
			0.2	0.8		V_{DD} = 5 V, I_O = −4 mA
Logic Output Drive Current	$\|I_O\|$	7	10		mA	
Failsafe Operation Input Current[1]	$I_{FS-HIGH}$	−25		0.5	mA	See Test Circuit 1
	I_{FS-LOW}	5		25	mA	
Switching Specifications at 5V						
Input Signal Rise and Fall Times	t_{IR}, t_{IF}			1	µs	See Test Circuit 1
Data Rate		100			Mbps	See Test Circuit 1
Minimum Pulse Width[2]	PW	10			ns	See Test Circuit 1
Propagation Delay Input to Output (High-to-Low)	t_{PHL}		8	15	ns	See Test Circuit 1
Propagation Delay Input to Output (Low to High)	t_{PLH}		8	15	ns	See Test Circuit 1
Average Propagation Delay Drift	t_{PLH}		10		ps/°C	
Pulse Width Distortion $\|t_{PHL} - t_{PLH}\|$[3]	PWD		3	5	ns	See Test Circuit 1
Pulse Jitter[4]	t_J			100	ps	See Test Circuit 1
Propagation Delay Skew[5]	t_{PSK}	−2		2	ns	See Test Circuit 1
Output Rise Time (10–90%)	t_R		2	4	ns	See Test Circuit 1
Output Fall Time (10–90%)	t_F		2	4	ns	See Test Circuit 1
Common Mode Transient Immunity	$\|CM_H\|$,$\|CM_L\|$	15	20		kV/µs	V_T = 300 V_{peak}

Notes:

1. Failsafe Operation is defined as the guaranteed output state which will be achieved if the DC input current falls between the input levels specified (see Test Circuit for details).
2. Minimum Pulse Width is the shortest pulse width at which the specified PWD is guaranteed.
3. PWD is defined as $|t_{PHL} - t_{PLH}|$.
4. 66,535-bit pseudo-random binary signal (PRBS) NRZ bit pattern with no more than five consecutive 1s or 0s; 800 ps transition time.
5. 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.

Electrical specifications are T_{min} to T_{max} and 3.0V to 3.6V unless otherwise stated.

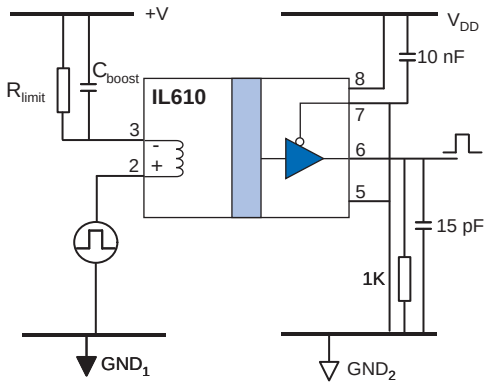
Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Quiescent Current	IL610, I_{DD}		1.3	2	mA	V_{DD} = 3.3 V, I_{IN} = 0
	IL611, I_{DD}		2.6	4	mA	
	IL612, I_{DD1}		1.3	2	mA	
	IL612, I_{DD2}		1.3	2	mA	
	IL613, I_{DD}		4	6	mA	
	IL614, I_{DD1}		1.3	2	mA	
	IL614, I_{DD2}		2.6	4	mA	
Logic High Output Voltage	V_{OH}	3.2	3.3		V	V_{DD} = 3.3 V, I_O = 20 µA
		3.0	3.1			V_{DD} = 3.3 V, I_O = 4 mA
Logic Low Output Voltage	V_{OL}		0	0.1	V	V_{DD} = 3.3 V, I_O = −20 µA
			0.2	0.8		V_{DD} = 3.3 V, I_O = −4 mA
Logic Output Drive Current	$\|I_O\|$	7	10		mA	
Failsafe Operation Input Current[4]	$I_{FS-HIGH}$	−25		0.3	mA	See Test Circuit 1
	I_{FS-LOW}	8		25	mA	
Switching Specifications at 3.3V						
Input Signal Rise and Fall Times	t_{IR}, t_{IF}			1	µs	See Test Circuit 1
Data Rate		100			Mbps	See Test Circuit 1
Minimum Pulse Width[1]	PW	10			ns	See Test Circuit 1
Propagation Delay Input to Output (High to Low)	t_{PHL}		12	18	ns	See Test Circuit 1
Propagation Delay Input to Output (Low to High)	t_{PLH}		12	18	ns	See Test Circuit 1
Average Propagation Delay Drift	t_{PLH}		10		ps/°C	
Pulse Width Distortion $\|t_{PHL} - t_{PLH}\|$ [2]	PWD		3	5	ns	See Test Circuit 1
Propagation Delay Skew[3]	t_{PSK}	−2		2	ns	See Test Circuit 1
Output Rise Time (10–90%)	t_R		3	5	ns	See Test Circuit 1
Output Fall Time (10–90%)	t_F		3	5	ns	See Test Circuit 1
Common Mode Transient Immunity	$\|CM_H\|$,$\|CM_L\|$	15	20		kV/µs	V_T = 300 V_{peak}

Notes:

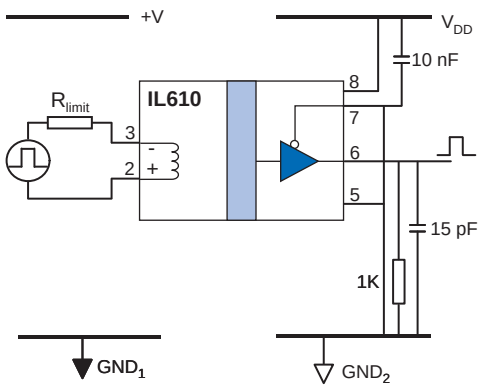
1. The Minimum Pulse Width is the shortest pulse width at which the specified PWD is guaranteed.
2. PWD is defined as $| t_{PHL} - t_{PLH} |$.
3. t_{PSK} is equal to the magnitude of the worst case difference in t_{PHL} and/or t_{PLH} that will be seen between units at 25°C.
4. Failsafe Operation is defined as the guaranteed output state which will be achieved if the DC input current falls between the input levels specified (see Test Circuit 1 for details). Note if Failsafe to Logic Low is required, the DC current supplied to the coil must be at least 8 mA using 3.3 V supplies versus 5 mA for 5 V supplies. Select the value of limit resistor appropriately.

Test Circuits

The test circuits below were used to obtain the specifications on the previous pages. In differential mode, the boost capacitor is generally not required, but it may be used to increase external magnetic field immunity or improve PWD performance as required.



Test Circuit 1 (Single-Ended)



Test Circuit 2 (Differential)

Operation

IL600-Series Isolators are current mode devices. Changes in current flow into the input coil result in logic state changes at the output. One of the significant advantages of the passive coil input is that both single ended and differential inputs can be handled without reverse bias protection. The GMR sensor switches the output to logic low if current flows from (In−) to (In+). Resistors set the coil input current to the 5 mA minimum. There is no limit to input voltages because there are no semiconductor input structures.

The absolute maximum current through the coil of the IL600-Series is 25 mA DC, or ±75 mA in differential mode. The worst-case logic low threshold current is 5 mA. While typical threshold currents are actually less, NVE recommends 5 mA logic low thresholds as a minimum design value. In all cases, the current must flow from In− to In+ in the coil to switch the output low. This is the case for true or inverted data, in single-ended or differential configurations. Output logic high is the zero input current state. Note that current flowing from Coil+ to Coil- (negative current in the specifications) will push the GMR sensor further into the high state.

Figure 1 shows the response of the IL600-Series. The GMR bridge structure is designed so the output of the isolator is logic high with no signal present. The output will switch to the low state with approximately 3.5 mA of coil current, and switch back to the high state when the input current falls below 1.5 mA. This allows glitch-free interface with low slew rate signals.

To calculate the value of the protection resistor (R1), use Ohm's law as shown in the examples below. Note that only the magnitude of the voltage across the coil is important; the absolute values of V_{INH} and V_{INL} are arbitrary.

Calculating Limiting Resistor Value

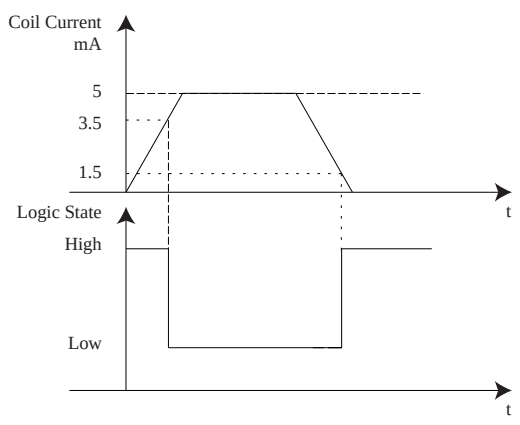


Figure 1. IL600-Series Transfer Function

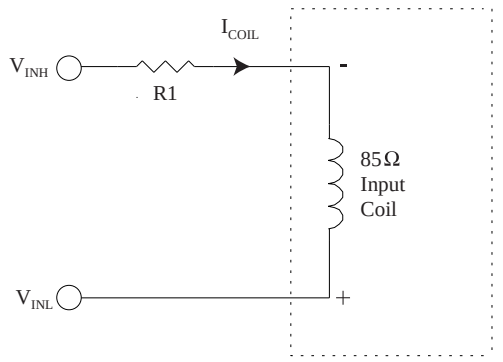


Figure 2. Limiting Resistor Calculation Equivalent Circuit

Example 1. In this case, T_{NOM} = 25ºC, V_{IN} High = 24V, V_{IN} Low = 1.8V, R_{COIL} =85 Ω and I_{COIL} minimum is specified as 5 mA. Total loop resistance is:

$$(R1+R_{COIL}) = \frac{(V_{INH} - V_{INL})}{I_{COIL}} = \frac{22.2\ \Omega}{0.005} = 4440\ \Omega$$

Therefore:
R1 = 4440 Ω − 85 Ω = 4355 Ω

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} = 85 Ω.

At T_{MAX} = 85ºC:

$$R_{COIL} = 85 + (T_{MAX} - T_{NOM}) \times TCR_{COIL}$$
$$= 85 + (85 - 25) \times 0.2 = 85 + 12 = 97\ \Omega$$

Therefore, the recommended series resistor is:

$$R1 = \frac{(V_{INH} - V_{INL})}{I_{COIL}} - R_{COIL}$$

$$R1 = \frac{(5-0)}{0.005} - 97 = 903\ \Omega$$

Allowance should also be made for the temperature coefficient of the current limiting resistor to ensure that I_{COIL} is at least 5 mA at the maximum operating temperature.

Failsafe Operation

Internal failsafe biasing ensures the output will always switch to the high state if the input coil is open-circuit. This is true for either 5 V or 3.3 V output supplies. The specifications on pages 5 and 6 show the enhanced failsafe conditions available with the IL600-Series Isolators that cover the non-open circuit condition. The output will remain in the state specified, or will switch to that state, if the specified current is flowing in the coil. Note that positive values of current mean current flow into the In− input (pin 3 in Test Circuit 1).

Single-Ended or Differential Input

The IL610, IL611, IL613, and channel 1 of the IL614 can be run with single-ended or differential inputs. In differential mode, coil current reverses each cycle. In single-ended mode, a "boost capacitor" placed across the current limit resistor provides pulsed current reversal for correct operation. In the differential mode, current will naturally flow through the coil in both directions without the boost cap, although the cap can still be used if application factors such as increased external field immunity or improved PWD performance mandate. Absolute Maximum recommended coil current in single-ended mode is 25 mA while differential mode allows up to ±75 mA to flow. The difference in specifications is due to the risk of electromigration of coil metals under constant current flow. In single ended mode, long-term DC current flow above 25 mA can cause erosion of the coil metal (rather like river flow does to its banks). In differential mode, erosion takes place in both directions as each current cycle reverses and has a net effect of zero up to the fuse current. A current of more than 100 mA will cause the coil to irreparably fuse open.

There are many applications where the differential option can be very useful. One advantage over optocouplers and other high-speed couplers is that no reverse bias protection for the input structure is required for a differential signal. This reduces cost and complexity. One of the more common applications is for an isolated Differential Line Receiver. For example, RS-485 can drive an IL610 directly for a fraction of the cost of an isolated RS-485 node (see *Illustrative Applications* section).

Typical Resistor Values

V_{COIL}	0.125W, 10% Resistor
3.3 V	560 Ω
5 V	910 Ω

The table shows typical values for the external resistor in 5 V and 3 V logic systems. As always, these values as approximate and should be adjusted for temperature or other application specifics If the expected temperature range is large, 5% or even 1% tolerance resistors may provide additional design margin. Alternatively, see the *Applications Information* section for circuit ideas allowing more generalized resistor selection.

Boost Capacitor

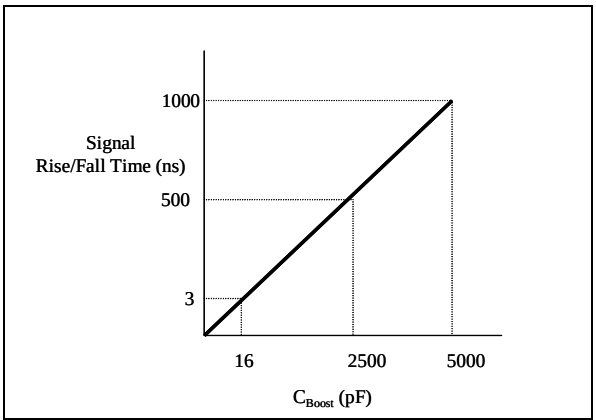


Figure 3. C_{boost} Selector

The boost capacitor in parallel with the current-limiting resistor boosts the instantaneous coil current at the signal transition. The boost pushes the GMR bridge output through the comparator threshold voltage with less propagation delay and pulse width distortion.

The instantaneous boost capacitor current is proportional to input edge speeds ($C\frac{dV}{dt}$). 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 3 is a guide to boost capacitor selection. For standard logic signals (t_r,t_f < 10 ns), a 16 pF capacitor is recommended. The capacitor value is generally not critical, and can often vary ±50% with little noticeable difference in device performance.

Dynamic Power Consumption

Power consumption is proportional to duty cycle, not data rate. The use of NRZ coding minimizes power dissipation since no additional power is consumed when the output is in the high state. In differential mode, where the logic high condition may still require a current to be forced through the coil, power consumption will be higher than a typical NRZ single ended configuration.

Power Supply Decoupling

47 nF ceramic capacitors are recommended to decouple the power supplies. The capacitors should be placed as close as possible to the appropriate V_{DD} pin for optimal output wave shaping.

Applications Information

IL600-Series Isolators are current mode devices. This means that a current of a certain magnitude and direction must flow in the input coil to change the output logic state. Figure 4 shows a simplified transfer curve for a typical IL600-Series data channel.

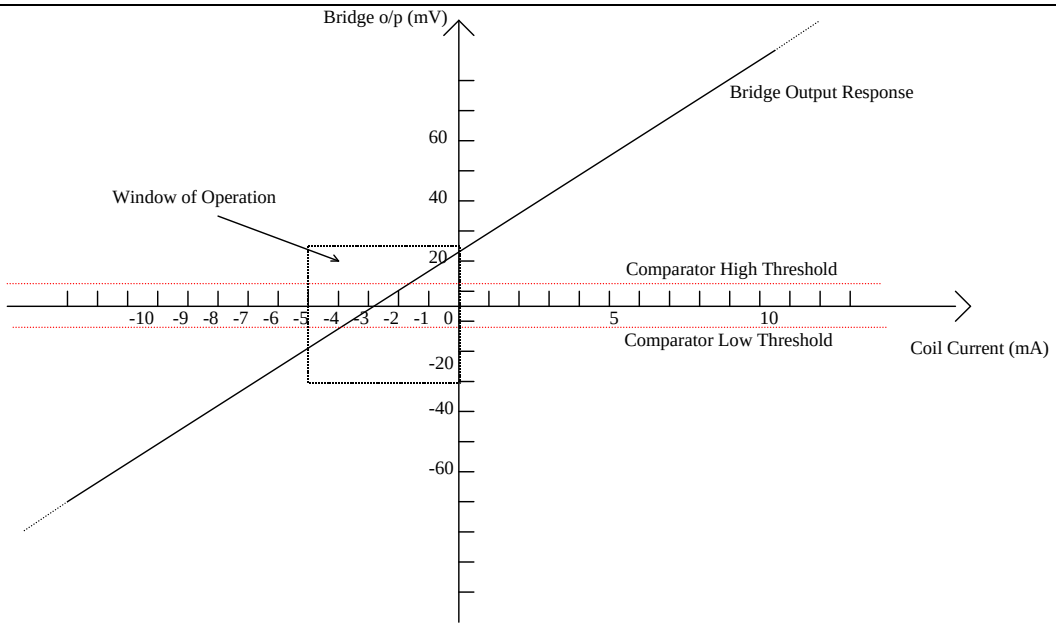


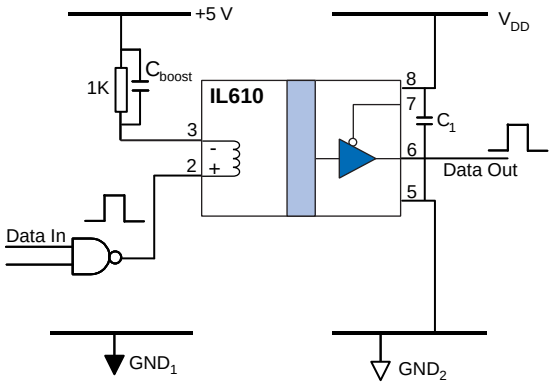
Figure 4. IL600-Series Transfer Function

The transfer function for this device is approximately linear. An applied coil input current creates a magnetic field that causes the GMR bridge output to change in proportion to the applied field. The GMR bridge is connected to a comparator. When the bridge output is greater than the comparator high threshold level, the output will go high. Similarly, when the bridge output is less than the comparator low threshold, the output will go low. The “Window of Operation” shown in Figure 4 highlights the specified corners of device operation. An input current of approximately −3.5 mA or −1.5 mA will cause the device to hover around the comparator switching thresholds producing an unstable output. For single-ended operation across the entire temperature range and power supply range, the magnitude of the coil current for a logic low should be at least −5 mA, and the magnitude of the coil current for a logic high should be between −0.5 mA and 0 mA. The stated direction of the current is negative in Figure 4 because the magnetic field is negative with respect to Earth Field. Current is always fed into the In− terminal of an IL600-Series device. Since these currents are actually sourced, not sunk by the user, the specified currents are quoted as positive values in the *Electrical Specifications* section of this data sheet.

When designing circuits using digital logic, most designers are aware that the input to a logic gate is differential with respect to ground. Separate ground layers, star points or planes usually need to be designed into circuit boards with fast switching currents to reduce ground voltage bounce caused by inductance in ground returns. Ground error voltages can cause data errors in high-speed circuits due to their impact on the effective logic threshold voltage at any given instant. Similarly, when using IL600-Series devices, the designer should be aware that it is the voltage magnitude across the coil that creates the current, not just the value of the input voltage. To illustrate this point, consider the single-ended non-inverting and inverting cases.

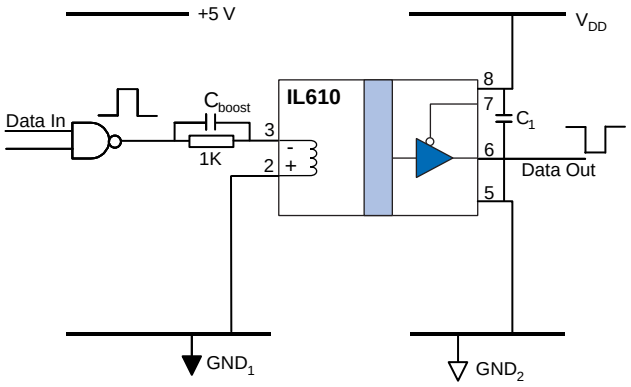
In the non-inverting circuit, the In− terminal is connected via a 1 kΩ current-limiting resistor to the supply rail, and the input is connected to the In+ terminal. Assume the supply voltage is +5 V and the input signal is a 5 V CMOS signal. A 1 kΩ resistance is selected to limit the coil current to 5 mA. For the purpose of this illustration we will ignore the coil resistance. When a logic high (+5 V) is applied to the input, the current through the coil is zero. When the input is a logic low (0 V), approximately 5 mA flows through the coil from the In− side to the In+ side. Figure 4 shows that the device will transition to both logic states easily under these conditions. Now assume that the 5 V rail is at 5.5 V and the CMOS input signal is loaded so that its high level is only 4.5 V. When a logic high (4.5 V) appears on the input, there is still a current of −1mA flowing through the coil. Figure 4 shows that the device is getting close to the off-state threshold of −1.5 mA, and now exceeds the specification of −0.5 mA for this logic level. Some intermittent operation or complete non-function should be expected in this case. The designer must ensure that the difference between the logic high voltage and the power supply voltage is such that the residual current in the coil is lower than 0.5 mA.

The inverting configuration design problem is similar to the problems associated with standard logic. In the inverting configuration, the signal into the coil is differential with respect to ground. The designer must ensure that the difference between the logic low voltage and the coil ground is such that the residual coil current is less than 0.5 mA. Conventional ground bounce design precautions apply.



Non-Inverting Circuit

Note. C_1 is 47 nF ceramic.



Inverting Circuit

Note. C_1 is 47 nF ceramic.

Figure 5. Inverting and non-inverting circuits

The IL612 and IL614 devices have some inputs that do not offer inverting operation. The IL612 coil In− input is hardwired internally to the device power supply; therefore it is important to ensure the isolator power supply is at the same voltage as the power supply to the source of the input logic signal. The IL614 has a common coil In− for two inputs. This pin should be connected to the power supply for the logic driving channels 2 and 3, and the channels run should be run in non-inverting mode.

IL600 devices are simple to use as long as it is remembered that there must be enough coil current (5 mA) to ensure logic low output, and close to zero current (0.5 mA to 0 mA) to ensure logic high output.

Electromagnetic Compatibility and Magnetic Field Immunity

Because IL600-Series Isolators are completely static, they have the lowest emitted noise of any non-optical isolators.

IsoLoop devices operate by imposing a magnetic field on a GMR sensor, which translates the change in field into a change in logic state. There are several ways of enhancing magnetic field immunity. The devices are manufactured with a magnetic shield above the sensor. The shield acts as a flux concentrator to boost the magnetic signal from the internal coil, and as a shield against external magnetic fields. The shield absorbs surrounding stray flux until it becomes saturated. At saturation the shield is transparent to external applied fields, and the GMR sensor may react to the field. To compensate for this effect, IsoLoop Isolators use Wheatstone Bridge structures that are only sensitive to differential magnetic fields.

Providing a larger internal field will reduce the effect of an external field on the GMR sensor.

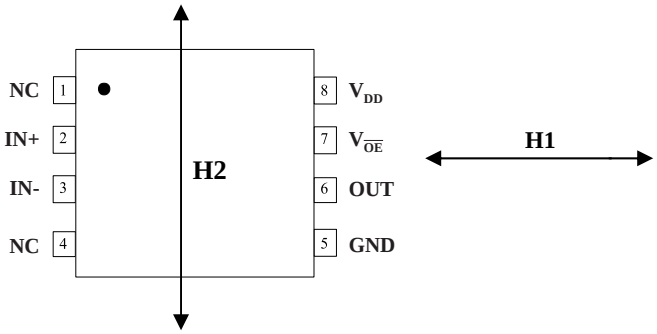
Immunity to external magnetic fields can also be enhanced by proper orientation of the device with respect to the field direction, the use of differential signaling, and field boosting capacitors.

Two ways to enhance immunity to external magnetic field are summarized below.

1. Orientation of the device with respect to the field direction

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 direction "H2" has considerably less effect and results in higher magnetic immunity.



2. Differential Signaling and Boost Capacitors

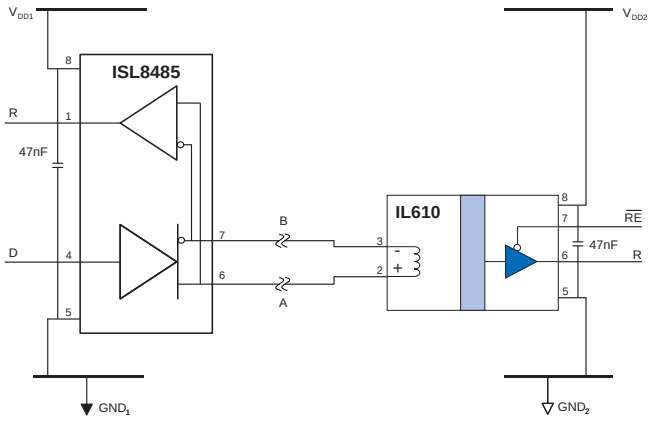
Regardless of orientation, driving the coil differentially improves magnetic immunity. This is because the logic high state is driven by an applied field instead of zero field, as is the case with single-ended operation. The higher the coil current, the higher the internal field, and the higher the immunity to external fields. Optimal magnetic immunity is achieved by adding the boost capacitor.

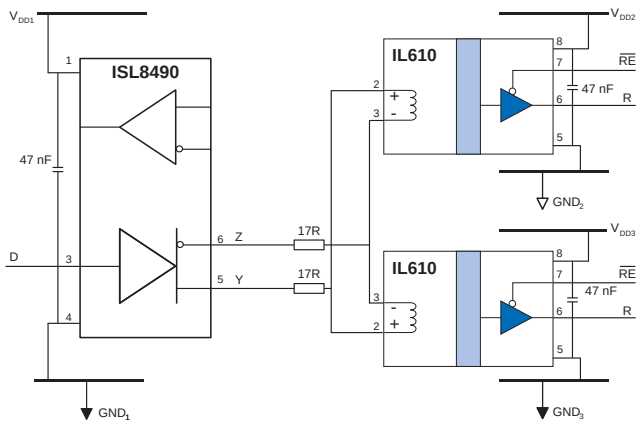
Method	Approximate Immunity	Immunity Description
Field applied in H1 direction	±20 Gauss	A DC current of 16 A flowing in a conductor 1 cm from the device could cause disturbance.
Field applied in H2 direction	±70 Gauss	A DC current of 56 A flowing in a conductor 1 cm from the device could cause disturbance.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

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 greater than 100 µs long are more susceptible to magnetic fields than shorter pulse widths.

Illustrative Applications

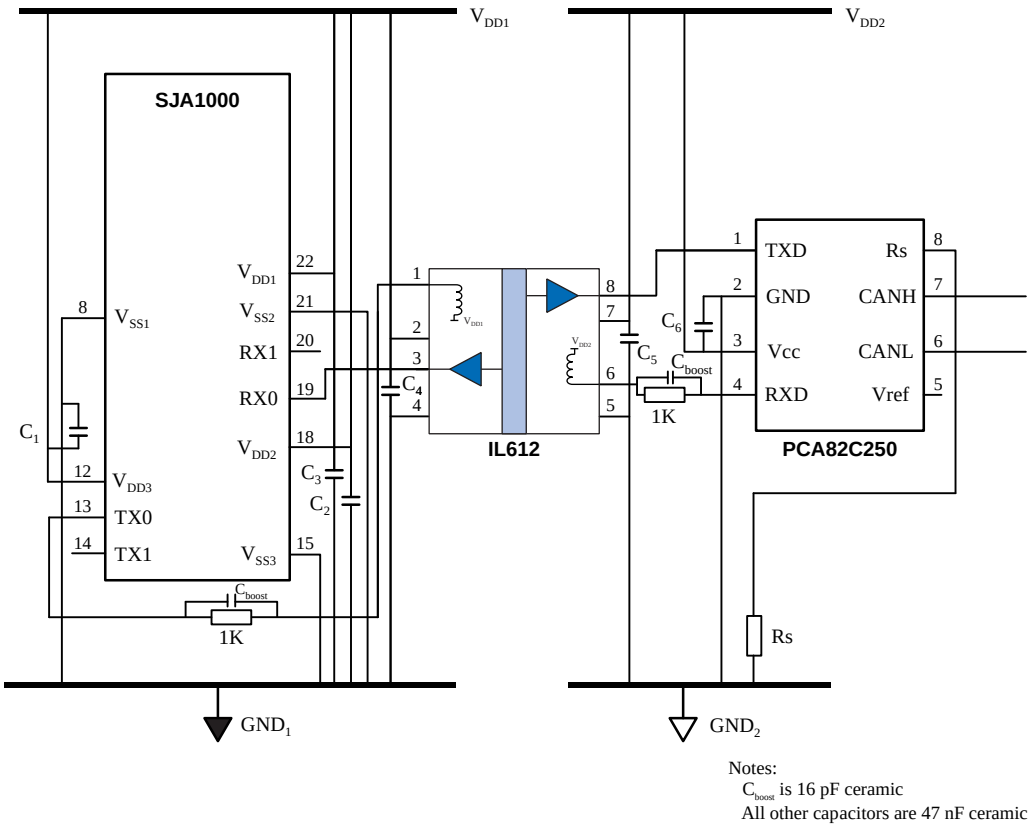




Isolated RS-485 and RS-422 Receivers Using IL610s

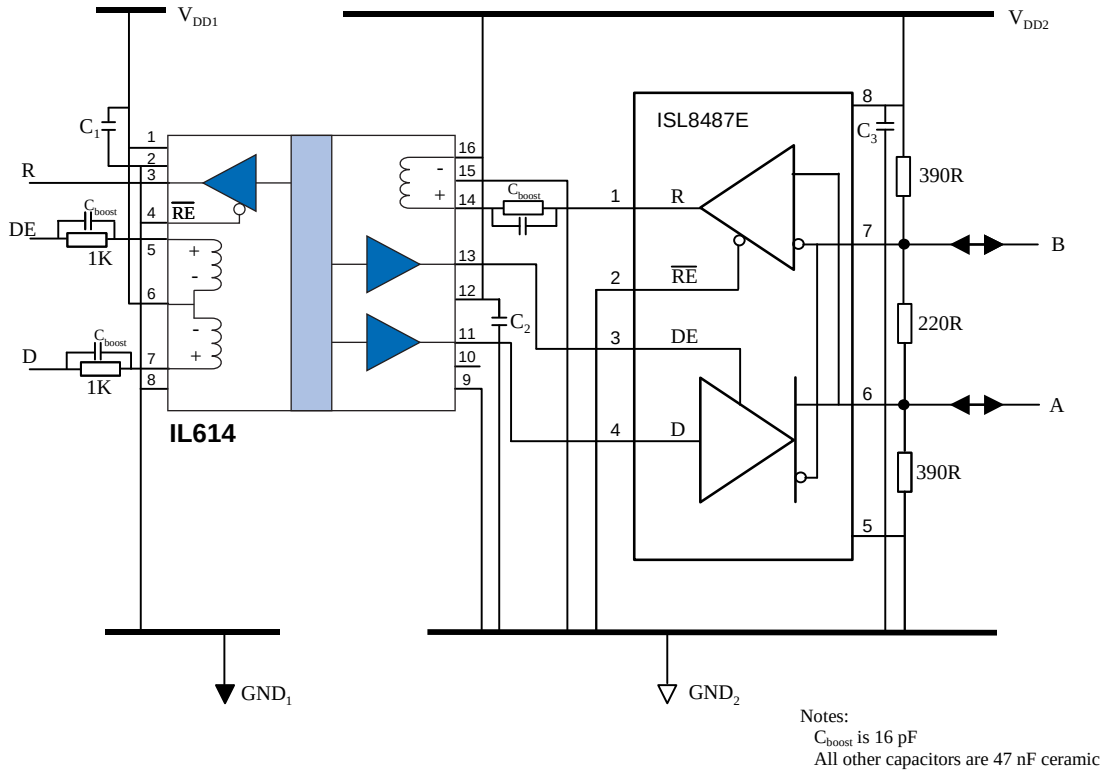
IL610s can be used as simple isolated RS-485 or RS-422 receivers, terminating signals at the IL610 for a fraction of the cost of an isolated node. Cabling is greatly simplified by eliminating the need to power the input side of the receiving board. No current-limiting resistor is needed for a single receiver because it will draw less current than the driver maximum. Current limiting resistors allow at least eight nodes without exceeding the maximum load of the transceiver chip. Placement of the current-limiting resistors on both lines provides better dynamic signal balance. There is generally no need for line termination resistors below data rates of approximately 10 Mbps because the IL610 coil resistance of approximately 85 Ω is close to the characteristic impedance of most cables. The circuit is intrinsically open circuit failsafe because the IL610 is guaranteed to switch to the high state when the coil input current is less than 500 µA.

Number of Nodes	Current Limit Resistors (Ω)
1	None
2	17
3	22
4	27
5	27
6	27
7	30
8	30



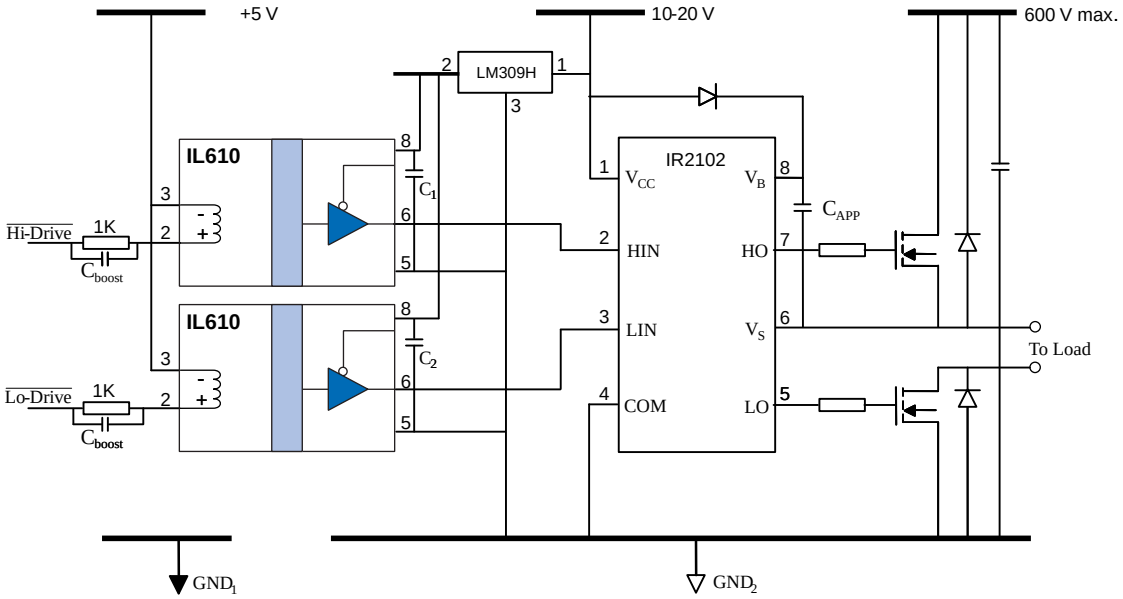
Isolated CAN Bus

Low pulse width distortion is critical for CAN bus, and IL600 Isolators are specified for just 3 ns typical pulse width distortion. Their fail-safe output (logic high output for zero coil current) ensures proper power-on. The speed of IL600 isolators easily supports the maximum CAN bus transfer speed of 1 Mbps.



Isolated RS-485 – Fractional Load

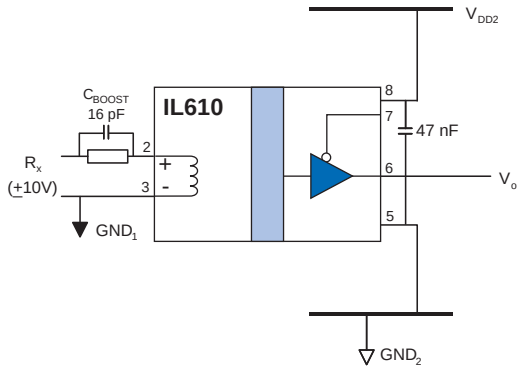
The unique IL614 three-channel isolator can be used as part of a multi-chip design with a variety of non-isolated transceivers. The IL614 provides 2.5 kV_{RMS} isolation (1 minute) and 20 kV/µs transient immunity. The IL614-3 is in a narrow-body (0.15 inch-wide) package when board space is critical.



Notes:
C_{boost} is 16 pF
C_{APP} is application specific
All other capacitors are 47 nF ceramic

Single-Phase Power Control

The fail-safe output (logic high output for zero coil current) of IL600 Isolators ensures power FETs will be off on power-up. The IL600 inputs can be configured for inverting or non-inverting operation (see Applications Information).



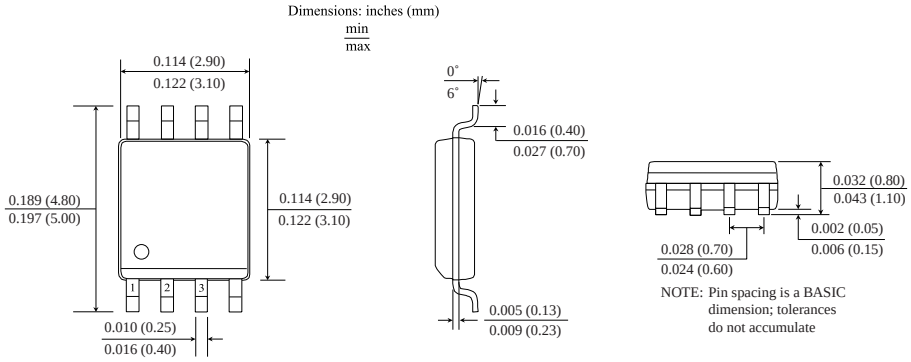
Notes:
C_{BOOST} is 16pF ceramic
C1 and C2 are 47 nF ceramic

Isolated RS-232 Receiver Using IL610

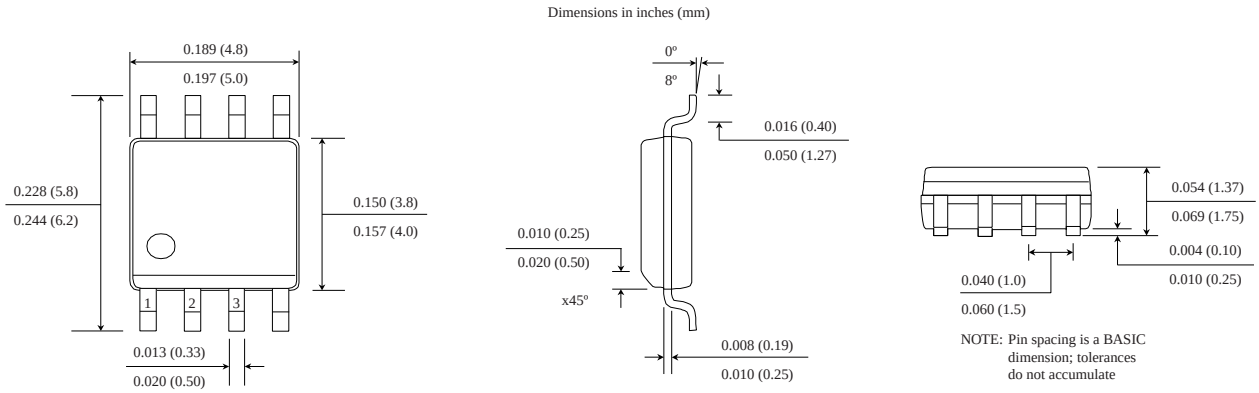
An IL610 can be used as a simple isolated RS-232 receiver. Cabling is greatly simplified by eliminating the need to power the input side of the receiving board. A similar circuit can be used for RS-422/RS-485, LVDS, or other differential networks. The IL610-1 is a unique MSOP isolator when board space is critical. Older RS-232 nodes may not have the required 5 mA drive capability required by the IL610.

Package Drawings, Dimensions and Specifications

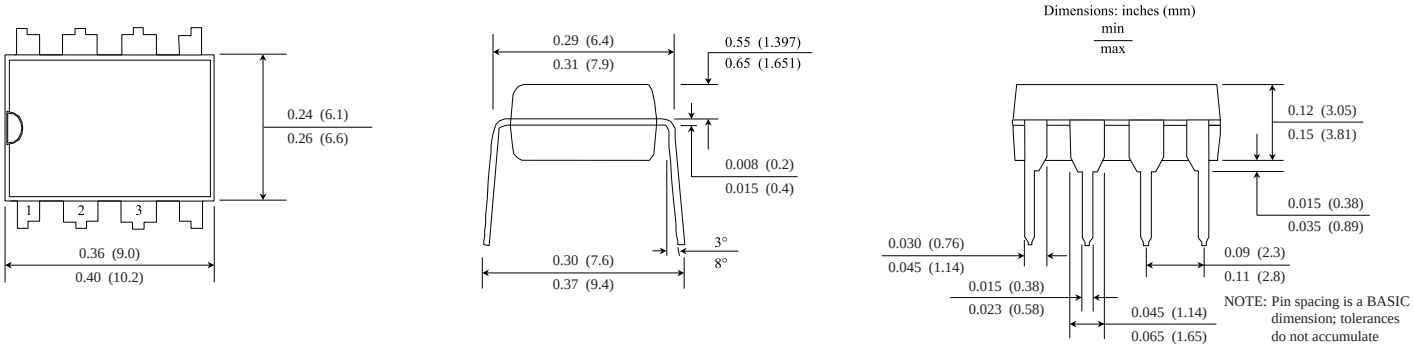
8-pin MSOP



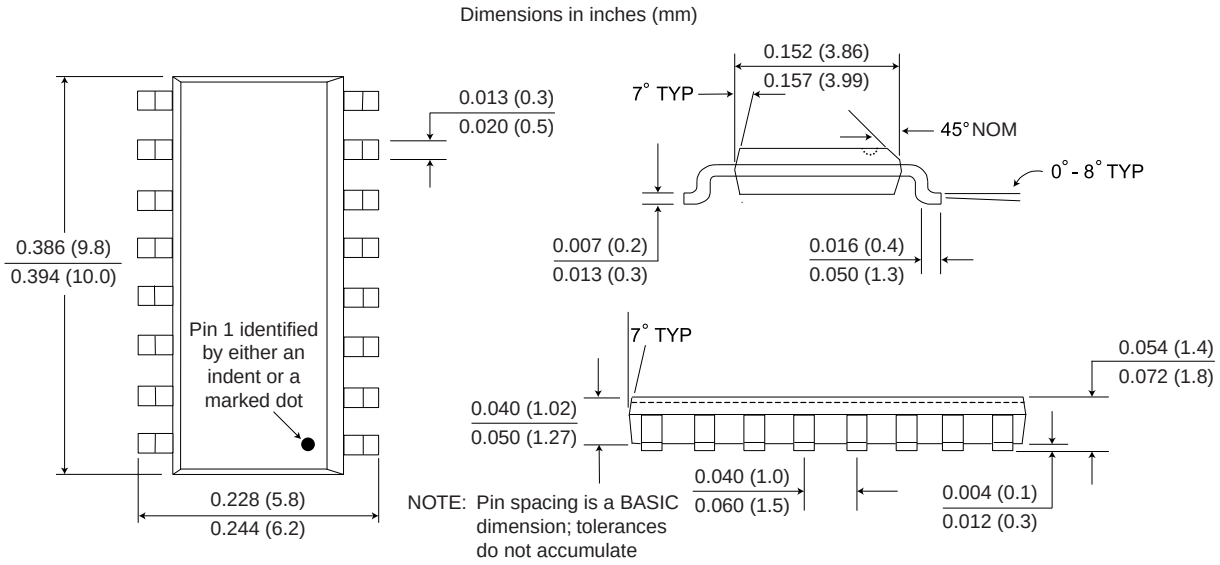
8-pin SOIC Package



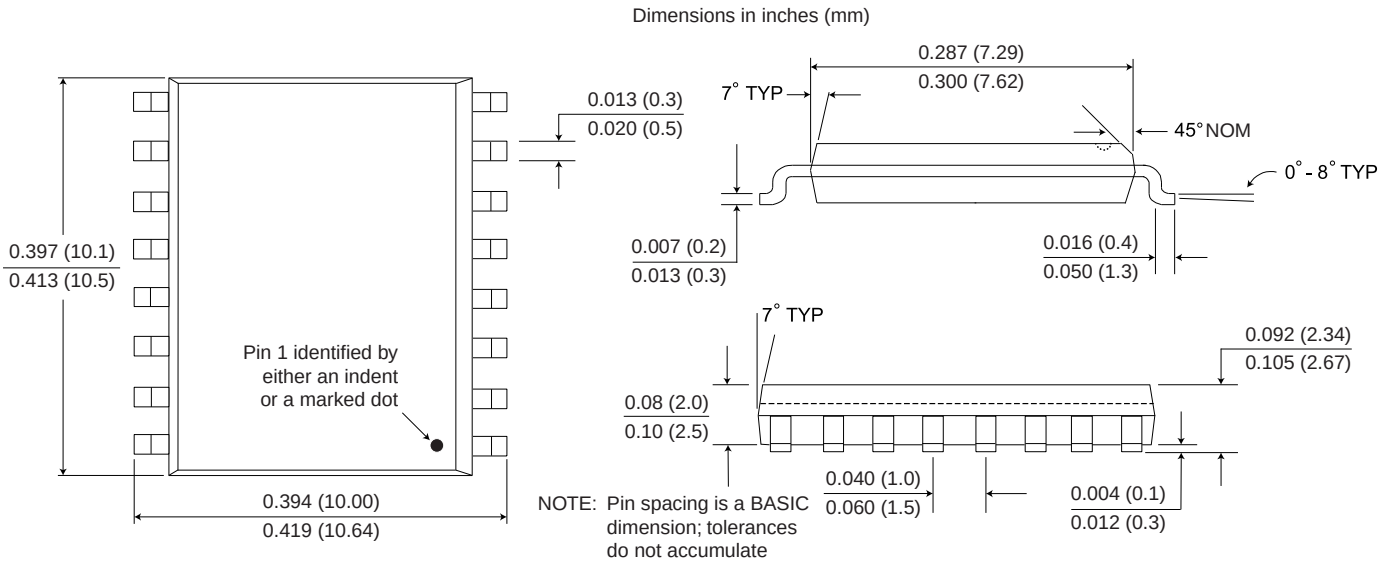
8-pin PDIP



0.15" 16-pin SOIC Package



0.3" 16-pin SOIC Package



Ordering Information and Valid Part Numbers

IL 610 - 1 E TR13

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

Package
E = RoHS Compliant

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

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

Product Family
IL = Isolators

IL610 Valid Part Numbers

IL610-1E
IL610-2E
IL610-3E
IL610-5

IL611 Valid Part Numbers

IL611-1E
IL611-2E
IL611-3E

IL612 Valid Part Numbers

IL612-2E
IL612-3E

IL613 Valid Part Numbers

IL613E
IL613-3E

IL614 Valid Part Numbers

IL614E
IL614-3E

All MSOP and SOIC part types are available on tape and reel.

RoHS COMPLIANT

Revision History

ISB-DS-001-IL600-W **February 2012**	**Changes** • Update terms and conditions.
ISB-DS-001-IL600-V	**Changes** • Additional changes to pin spacing specification on MSOP drawing.
ISB-DS-001-IL600-U	**Changes** • Changed pin spacing specification on MSOP drawing.
ISB-DS-001-IL600-T	**Changes** • Added typical jitter specification at 5V.
ISB-DS-001-IL600-S	**Changes** • P. 2—Deleted MSOP IEC61010 approval.
ISB-DS-001-IL600-R	**Changes** • Added EMC details.
ISB-DS-001-IL600-Q	**Changes** • IEC 61010 approval for MSOP versions.
ISB-DS-001-IL600-P	**Changes** • Specified coil resistance as typical only. • Revised section on calculating limiting resistors.
ISB-DS-001-IL600-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-IL600-N	**Changes** • Changed lower limit of length on PDIP package drawing.
ISB-DS-001-IL600-M	**Changes** • Changed ordering information to reflect that devices are now fully RoHS compliant with no exemptions.
ISB-DS-001-IL600-L	**Changes** • Added differential drive specifications • Eliminated soldering profile chart
ISB-DS-001-IL600-K	**Changes** • Changed IL485 transceiver
ISB-DS-001-IL600-J	**Changes** • Added enhanced failsafe specification • Repaginated

Datasheet Limitations
The information and data provided in datasheets shall define the specification of the product as agreed between NVE and its customer, unless NVE and customer have explicitly agreed otherwise in writing. All specifications are based on NVE test protocols. In no event however, shall an agreement be valid in which the NVE product is deemed to offer functions and qualities beyond those described in the datasheet.

Limited Warranty and Liability
Information in this document is believed to be accurate and reliable. However, NVE does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information.

In no event shall NVE be liable for any indirect, incidental, punitive, special or consequential damages (including, without limitation, lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Right to Make Changes
NVE reserves the right to make changes to information published in this document including, without limitation, specifications and product descriptions at any time and without notice. This document supersedes and replaces all information supplied prior to its publication.

Use in Life-Critical or Safety-Critical Applications
Unless NVE and a customer explicitly agree otherwise in writing, NVE products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical devices or equipment. NVE accepts no liability for inclusion or use of NVE products in such applications and such inclusion or use is at the customer's own risk. Should the customer use NVE products for such application whether authorized by NVE or not, the customer shall indemnify and hold NVE harmless against all claims and damages.

Applications
Applications described in this datasheet are illustrative only. NVE makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using NVE products, and NVE accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the NVE product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customers. Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

NVE does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customers. The customer is responsible for all necessary testing for the customer's applications and products using NVE products in order to avoid a default of the applications and the products or of the application or use by customer's third party customers. NVE accepts no liability in this respect.

Limiting Values
Stress above one or more limiting values (as defined in the Absolute Maximum Ratings System of IEC 60134) will cause permanent damage to the device. Limiting values are stress ratings only and operation of the device at these or any other conditions above those given in the recommended operating conditions of the datasheet is not warranted. Constant or repeated exposure to limiting values will permanently and irreversibly affect the quality and reliability of the device.

Terms and Conditions of Sale
In case an individual agreement is concluded only the terms and conditions of the respective agreement shall apply. NVE hereby expressly objects to applying the customer's general terms and conditions with regard to the purchase of NVE products by customer.

No Offer to Sell or License
Nothing in this document may be interpreted or construed as an offer to sell products that is open for acceptance or the grant, conveyance or implication of any license under any copyrights, patents or other industrial or intellectual property rights.

Export Control
This document as well as the items described herein may be subject to export control regulations. Export might require a prior authorization from national authorities.

Automotive Qualified Products
Unless the datasheet expressly states that a specific NVE product is automotive qualified, the product is not suitable for automotive use. It is neither qualified nor tested in accordance with automotive testing or application requirements. NVE accepts no liability for inclusion or use of non-automotive qualified products in automotive equipment or applications.

In the event that customer uses the product for design-in and use in automotive applications to automotive specifications and standards, customer (a) shall use the product without NVE's warranty of the product for such automotive applications, use and specifications, and (b) whenever customer uses the product for automotive applications beyond NVE's specifications such use shall be solely at customer's own risk, and (c) customer fully indemnifies NVE for any liability, damages or failed product claims resulting from customer design and use of the product for automotive applications beyond NVE's standard warranty and NVE's product specifications.

An ISO 9001 Certified Company

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

ISB-DS-001-IL600-W

February 2012