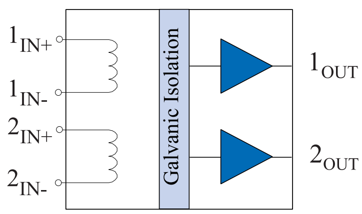
Dual Passive Input Digital Isolator

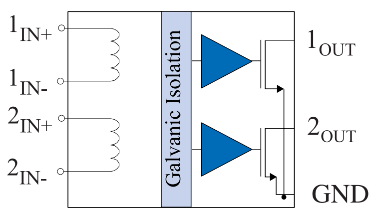
Functional Diagram

Each device in the dual channel IL611 consists of a coil, vertically isolated from a GMR Wheatstone bridge by a polymer dielectric layer. A magnetic shield reduces interference from external magnetic field sources. The GMR bridge outputs are fed to a comparator, which in turn feeds a CMOS output stage, or an open drain transistor output.

IL611



IL611A



Features

- MSOP, SOIC, PDIP Packages
- -40°C to 85°C Temperature Range
- 5 V or 3.3 V Power Supply
- 40 MBd Data Rate
- Open Drain or CMOS Outputs
- Very Wide Input Voltage Range
- 20 kV/ms Minimum Common Mode Rejection
- Low Power Dissipation
- UL1577 & IEC061010 Approval (pending)
- Failsafe Output (Logic high when zero current flows in coil)

Applications

- General Purpose Opto Replacement
- Line Voltage Window Comparator
- Isolated RS422 Reciever
- Isolated Relay Driver
- Isolated Wired-OR Alarms

Description

The IL611 and the IL611A 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 IsoLoop® GMR sensor technology giving exceptionally small size and low power dissipation. The passive input structure allows direct interface to a very wide range of voltage inputs. A single resistor is used to set maximum input current for input voltages above 0.5 V.   The devices are available in the 8 Pin SOIC, PDIP and MSOP packages.

Absolute Maximum Ratings

Parameters	Symbol	Min.	Max.	Units
Storage Temperature	T_S	-55	150	°C
Ambient Operating Temperature[1]	T_A	-55	150	°C
Supply Voltage	V_{DD}	-0.5	7	V
Common Mode Input Voltage	V_{IN}		800	$V_{AC\ RMS}$
Input Current	I_{IN}	-30	30	mA
Output Voltage (IL611)	V_O	-0.5	V_{CC}+0.5	V
Maximum Output Current	I_O	-10	10	mA
Magnetic Field Immunity			100	Gauss
ESD		2kV Human Body Model		

Recommended Operating Conditions

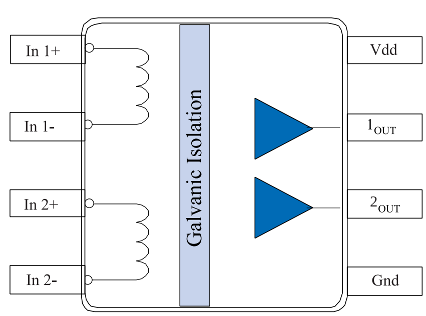
Parameters	Symbol	Min.	Max.	Units
Ambient Operating Temperature	T_A	-40	85	°C
Supply Voltage	V_{CC}	3.0	5.5	V
Input Current	I_{IN}	0	10	mA
Output Current	I_{OUT}	-4	4	mA
Open Drain Reverse Voltage	V_{SD}	-0.5		V
Open Drain Maximum Drain Voltage	V_{DS}		6.5	V
Open Drain Load Current	I_{OD}		4	mA
Input Signal Rise and Fall Times	t_{IR}, t_{IF}		50	msec
Differential Input Voltage	V_{IN+} -V_{IN-}	-400	400	$mV_{AC\ RMS}$
		-500	500	mV_{DC}
Common Mode Input Voltage	V_{CM}		400	$V_{AC\ RMS}$

Insulation Specifications

Parameter	Condition	Min.	Typ.	Max.	Units
Rated Voltage, 1min					V_{RMS}
MSOP	60 Hz	1000			
SOIC	60 Hz	2500			
PDIP	60 Hz	2500			
Creepage Distance (External)					mm
MSOP		3.01			
0.15" SOIC		4.026			
0.30" PDIP		7.077			
Internal Isolation Distance			9		µm
Leakage Current	240 V_{RMS} 60 Hz		0.2		μA_{RMS}

Pin Configuration

Pin #	Pin Name	Description
1	In1 +	Channel 1 Coil+
2	In 1-	Channel 1 Coil -
3	In 2+	Channel 2 Coil+
4	In 2-	Channel 2 Coil -
5	GND	Isolated Ground
6	Output 2	CMOS (IL611) or Open Drain Output (IL611A)
7	Output 1	CMOS (IL611) or Open Drain Output (IL611A)
8	V_{DD}	Logic Supply Voltage (3.0 to 5.5 V)



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Electrical Specifications

All specifications valid over full temperature and supply range unless otherwise stated.

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions
DC Specifications						
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	
Logic High Input Threshold	$I\ In_H$		$I\ In_H$-2	$I\ In_H$-1	mA	
Logic Low Input Threshold	$I\ In_L$		7	10	mA	
Quiescent Current	I_q		4	6	mA	V_{DD} = 5 V
			2.8	4		V_{DD} = 3.3 V
Logic High Output Voltage	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 (IL611)						
Data Rate		40			MBd	50% Duty Cycle
Minimum Pulse Width	PW	25			ns	50% Points, V_O
Propagation Delay Input to Output (High to Low)	t_{PHL}		20	25	ns	C_L = 15 p, 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 Prop. Delay Drift to t_{PLH}	t_{PLH}		50			ps / °C
Pulse Width Distortion[2] $\|t_{PHL}-t_{PLH}\|$	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	|CMH|,|CML|	15	20		kV/µs	V_T = 300 V peak
Switching Specifications (IL611A)						
Data Rate		10			MBd	50% Duty Cycle, R_L= 1kΩ
Minimum Pulse Width	PW	100			ns	50% Points, V_O, R_L= 1kΩ
Propagation Delay Input to Output (High to Low)	t_{PHL}		20	25	ns	C_L = 2kΩ/15 pF
Propagation Delay Input to Output (Low to High)	t_{PLH}		50	75	ns	C_L = 2kΩ/15 pF
Common Mode Transient Immunity	|CMH|,|CML|	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.

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.

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Operation

The IL611 is a current mode device. 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. Only a single resistor is required to limit the input coil to the recommended 10mA. This allows large input voltages to be used since there is no semiconductor structure on the input.

The graph of Figure 1 also shows the typical response of the IL611. The GMR bridge structure is designed such that the output of the isolator is a logic high when there is no field signal present. Figure 1 also shows that switching to the low state will occur at typically 7mA of coil current. Switching back to the high state occurs when the input current falls 2mA below the level required for the low state. This allows glitch free interface with low slew rate signals.

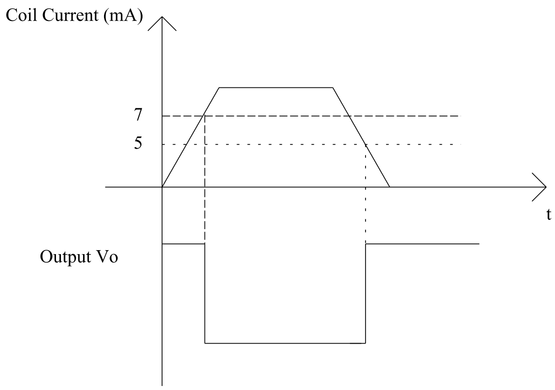


Figure 1 IL611 Transfer Function

Configuration

The IL611 family can be configured to transmit true or inverted data. The internal GMR sensor switches the output to Logic Low if current flows from pin 3 (In-) to pin 2 (In+). The zero field state (no signal present) is logic high. Figure 2 shows an example of an input scheme for both inverting and non-inverting data. A logic input has been used for clarity, but it should be noted that the input signal voltage can be up to 400V in magnitude provided a suitable resistor is used in series with the coil for overcurrent protection.

In +	In-	Vo	Circuit
L	L	H	A
L	H	L	A
H	H	H	B
L	H	L	B

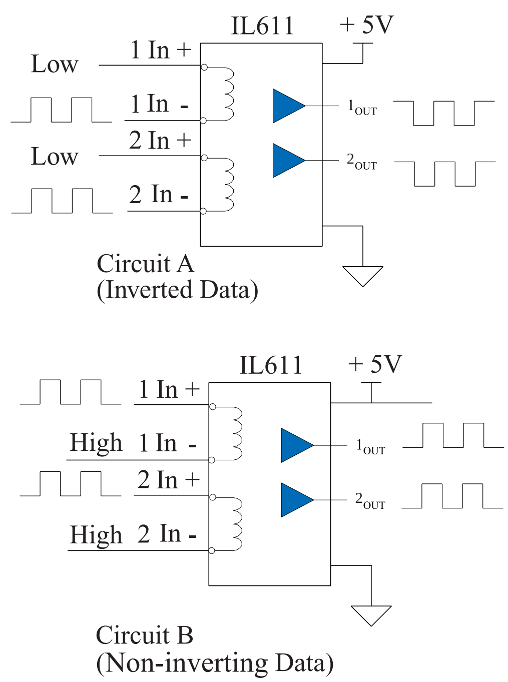


Figure 2 Input Coding Scheme

Input Current Limiting

The absolute maximum current through the coil of the IL611 is 30mA DC. However, it is important to limit input current to levels well below this in all applications. The worst case logic threshold current is 10mA. While typical threshold currents are substantially less than this, NVE recommends designing a 10mA 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. Logic high is the zero current state.*

To calculate the value of the protection resistor (R1) required, use Ohm's law as shown in the example 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.

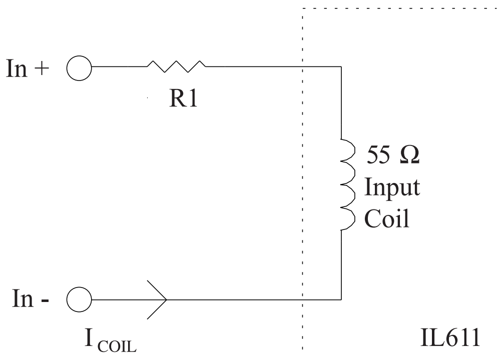


Figure 3 Input Current Limiting

In this case, $V_{IN\ HIGH}$ is 24V, $V_{IN\ LOW}$ is 1.8V.

I_{COIL} maximum is specified as 10mA. Total loop resistance must therefore be:

$$(R1 + R_{COIL}) = \frac{(V_{IN}\ High - V_{IN}\ Low)}{I_{COIL}\ MAX} = \frac{22.2}{0.010} = 2220\ \Omega$$

$$\Rightarrow R1 = 2220 - R_{COIL} = 2165\Omega$$

At lower voltages TC R_{COIL} should also be taken into consideration and R1 specified to give 10 mA I_{COIL} at maximum application temperature.

* Note that current flow from In- to In+ will also give a logic high at the output. In this case, the off state is merely reinforced by the magnetic field generated pushing the GMR sensor further into the logical off state.

For example, for maximum operating temperature of 85°C;

T_{OP} MAX = 85ºC, T_{NOM} = 25ºC, V_{IN} High = 5V, V_{IN} Low = 0V,

At T_{NOM}:

$$R_{COIL} = 55\ \Omega \text{ and}$$

$$R1 = \frac{(V_{IN}\ High - V_{IN}\ Low)}{0.010} - R_{COIL} = \frac{(5.0 - 0)}{0.010} - 55 = 445\ \Omega$$

However, at T_{OP} MAX,

$$R_{COIL} = 55 + (T_{OP}\ MAX - T_{NOM}) \cdot TC\ R_{COIL}MAX = 55 + (85 - 25) \cdot 0.165 = 55 + 9.9 = 65\ \Omega$$

Therefore, taking into account the effects of TC R_{COIL} T_{OP} MAX

$$R1 = \frac{(V_{IN}\ High - V_{IN}\ Low)}{0.010} - R_{COIL} = \frac{(5.0 - 0)}{0.010} - 65 = 435\ \Omega$$

Applications

The IL611 has many uses, and can be used in the same general applications as the standard diode input optocoupler. Unlike the opto, there are fewer limitations on bandwidth, current consumption, temperature range and wear-out. The transfer mechanism across the isolation barrier is field based, not particle based, so there is no intrinsic wear-out mechanism. The field based transfer function also means that applications where radiation may be encountered, such as aerospace and nuclear applications, now have a standard device for many isolation functions.

The IL611's passive input structure makes it a truly unique isolation device, enabling it to operate without expensive protection in applications where an optocoupler input might be reverse biased or subject to over and under error voltages. The device can also be subjected to a wide temperature range without harm or wear-out, making it an excellent choice for many automotive applications.

The IL611 is ideal in differential line receiver applications, such as isolated RS422, RS485 and RS232 receiver nodes. The current mode nature of the isolator allows up to two isolated RS422 receiver nodes to be implemented. These are usually slow speed applications where signal bounce and reflection at the termination are not critical parts of the transmission specification. See Figure 4 for details.

Non-Inverting Configuration

The non-inverting mode of operation is shown in Figure 5. A signal is applied to the In+ and a voltage equal to the highest signal level is applied to In-. In 5V CMOS logic systems, pin 3 would be connected to +5V, while in 24V logic systems, pin 3 would be forced to 24V. Protection resistor R1 is determined by the process outlined in "Input Current Limiting."

Resistors R3 and R4 (2kΩ pull up) are only required for the Open Drain output IL611A version of the device. The 10nF decoupling capacitor is not essential for operation, but is recommended in all circuits for wave shaping purposes.

Inverting Configuration

In Inverting mode, the data is coupled to In- and In+ is grounded. If large voltages are being used at the input, this mode is often more convenient than the non-inverting data mode above. Voltage levels up to 400V can be accommodated easily without the need to find a high voltage source to bias the In+ terminal as required in the non-inverting data mode.

Wired-OR Connections

The Open Drain IL611A option allows easy wired-OR connections of isolated functions. This can be especially useful in Industrial Process Control applications where several sensors can indicate Alarm conditions. If the resultant alarms have a common end function, such as shutdown or reset, it is very convenient to wire-OR these outputs, eliminating the need for additional logic. The decoupling capacitor is not required in this type of application.

Figure 4 Isolated RS422 Receiver

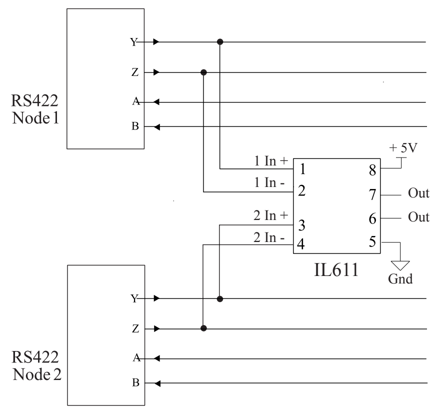


Figure 5 Non-Inverting Configuration

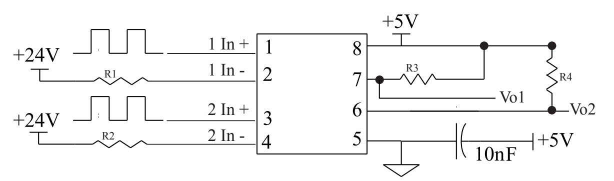


Figure 6 Inverting Configuration

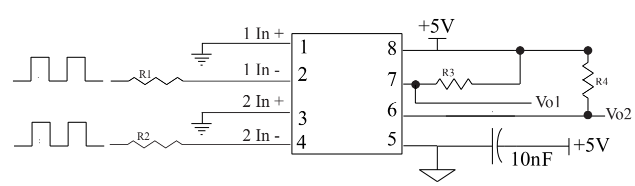
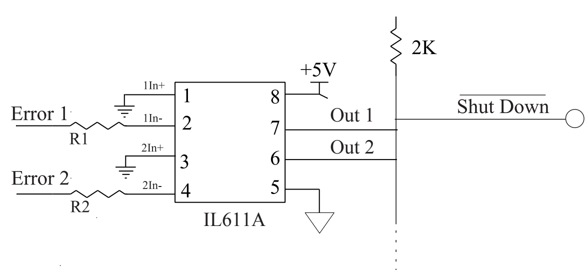


Figure 7 Wired-OR Connections



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Line Voltage Monitor

The passive input structure of the IL611 makes it highly suited to line voltage monitoring applications. No diodes or diode bridges are required to protect the device. Instead, a single resistor is used to both protect the device and set the voltage threshold of the monitor.

Using the inverting and non-inverting configurations, it is possible to set a trigger level on both halves of the supply cycle. The circuit below shows the IL611 configured to trigger at +/-70V on a 110 volt line.

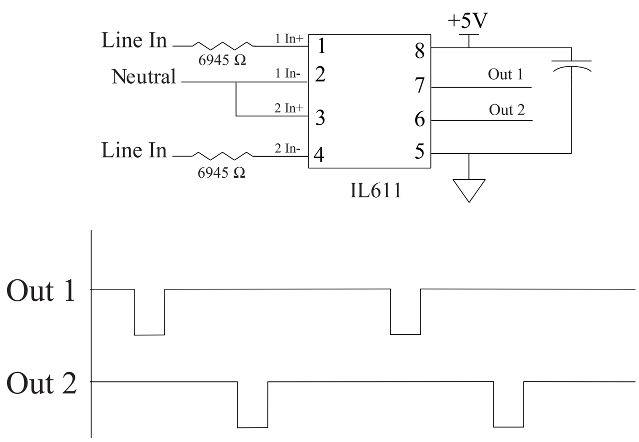

Figure 8 Line Voltage Monitor

Part Numbering Guide

IL 611 A - 1

- **Bulk Package**
  - 1 = 8 pin MSOP
  - 2 = 8 pin PDIP
  - 3 = 8 pin SOIC
  - 5 = Bare Die (full wafers)
- **Output Type**
  - Blank = CMOS Output
  - A = Open Drain Output
- **Base Part Number**
  - 611 = Dual Channel
- **Product Family**
  - IL = Isolators

Valid Part Numbers

IL611-1
IL611-2
IL611-3
IL611-5

IL611A-1
IL611A-2
IL611A-3
IL611A-5

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