

Application Bulletin AB-15

IL600-Series Isolators Provide Unique Channel-to-Channel Isolation

Traditionally, optocouplers had been used to provide channel-to-channel isolation of digital signals when required in applications such as PLCs. Unfortunately, optocouplers reduced performance by increasing timing parameters such as PWD, propagation delay and skew. The IsoLoop[®] IL600/IL600A Digital Isolators provide excellent channel-to-channel isolation with little or no timing degradation.

Other high-speed multi-channel isolators require power supplies on both sides of the isolation barrier, and require that all channels are referenced to the same ground. Those designs cannot be used in applications where a differential voltage greater than the supply maximum (typically 7 V) may be present across one or more channels.

Channel-to-channel isolators in the IL600-Series Isolators are available in two-channel (the IL611) and three-channel (IL613) versions. The maximum allowed voltage between channels is dependent on the spacing between package pins. The IL611 is available in an 8-pin PDIP, 8-pin SOIC, or a unique 8-pin MSOP. The IL613 is available in a 16-pin SOIC.

PLC Isolation

PLCs are an excellent example of the value of channel-to-channel isolation. An illustrative circuit is shown in Figure 1:

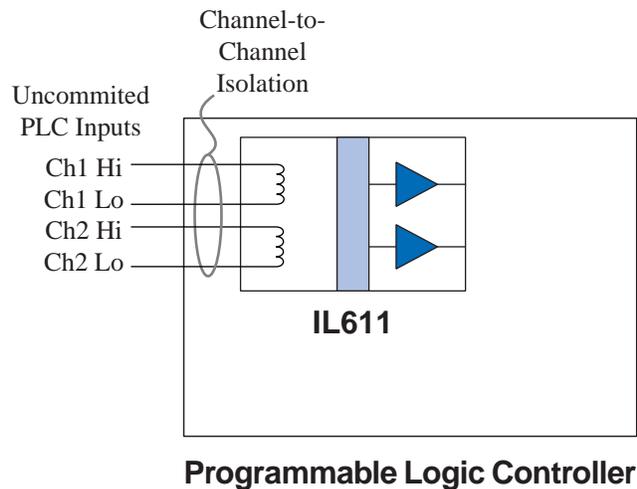


Figure 1. Isolated PLC

Input-to-Output Isolation Voltage

In any isolator, the maximum allowed input-to-output isolation voltage is governed by the internal spacing between metals at different potentials and the materials inserted into the space. Safety standards covering IsoLoop isolators (UL1577 and IEC61010-2000), allow a maximum of 2300 V_{RMS} across the MSOP package, and 2500 V_{RMS} across PDIP and SOIC packages. For safety standard qualification, the device must withstand these voltages for at least 1 minute. Continuous voltage standoff across the package is limited by the safety standards to 150 V_{RMS} for the MSOP and 0.15-inch SOIC packages, and 300 V_{RMS} in the 0.3-inch SOIC case.

Channel-to-Channel Isolation Voltage

Channel-to-channel isolation voltage is not mandated by safety standards, but is clearly limited by the spacing between exposed pins on the input channels and whether these are exposed to air or coated with an insulator (varnish, etc.). For parallel electrodes (in this case, IC pins), Paschen's Law states the breakdown field strength (E_b) in air is approximately 3×10^6 V/m. The following calculations show the maximum DC voltage values that can be expected between channels on the IL611 and IL613 devices. A DC analysis was chosen for easy reference to Paschen's curve shown on the following page.

Paschen's Law states if we know the distance between pins for each type of package, we can calculate the breakdown voltage in air as follows:

$$V_b = E_b \times d$$

Where V_b = breakdown voltage, and
 d = distance between IC pins.

For IsoLoop packages, we get:

MSOP ($d = 0.1$ mm)

$$\begin{aligned} V_b &= E_b \times d \\ &= 3 \times 10^6 \times 10^{-4} \\ &= 300 \text{ V (see Note 1)} \end{aligned}$$

SOIC ($d = 0.5$ mm)

$$\begin{aligned} V_b &= E_b \times d \\ &= (3 \times 10^6) \times (5 \times 10^{-4}) \\ &= 1500 \text{ V} \end{aligned}$$

PDIP ($d = 0.65$ mm)

$$\begin{aligned} V_b &= E_b \times d \\ &= (3 \times 10^6) \times (6.5 \times 10^{-4}) \\ &= 1950 \text{ V} \end{aligned}$$

Note 1. As d becomes less than 0.1 mm, breakdown becomes non-linear with spacing. From Paschen's curve (Figure 2) the minimum V_b in atmospheric air for parallel electrodes is approximately 370 V. Breakdown is not possible between parallel electrodes in air below 300 V because of the activation energy required to ionize air.

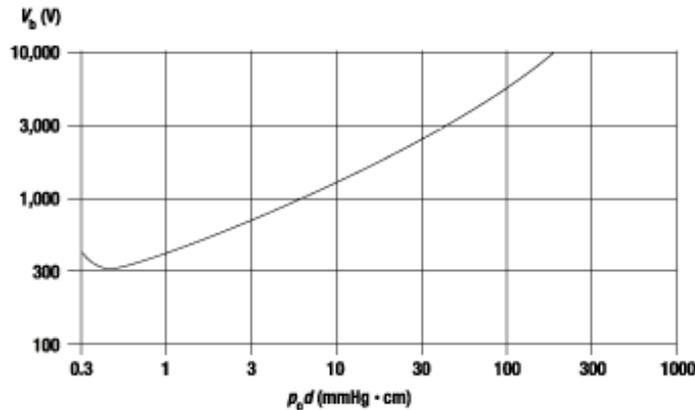


Figure 2. Paschen's Curve

Table 1 summarizes isolation parameters for several Isolator part types. Operation at or near breakdown voltage is not recommended, of course. The maximum recommended continuous voltage between adjacent channels is V_{cmax} .

	IL611-1E	IL611-2E	IL611-3E	IL613E	IL613-3E
Package	MSOP-8	PDIP-8	SOIC-8	SOIC-16	SOIC-16
V_{WI-O}	2300 V_{RMS}	2500 V_{RMS}	2500 V_{RMS}	2500 V_{RMS}	2500 V_{RMS}
V_{bc-C}	~350 V_{DC}	1950 V_{DC}	1500 V_{DC}	1500 V_{DC}	1500 V_{DC}
V_{cmax}	120 V_{RMS}	400 V_{RMS}	400 V_{RMS}	400 V_{RMS}	400 V_{RMS}

Table 1. Summary of isolator high-voltage parameters

Definitions for the parameters are as follows:

V_{WI-O} \equiv Input-to-output withstand voltage
(see IL600-Series data sheet for complete information on qualifying standards).

V_{bc-C} \equiv Channel-to-channel breakdown voltage (not recommended for operation).

V_{cmax} \equiv Maximum recommended continuous voltage between adjacent channels.

The parameters are shown graphically in Figure 3:

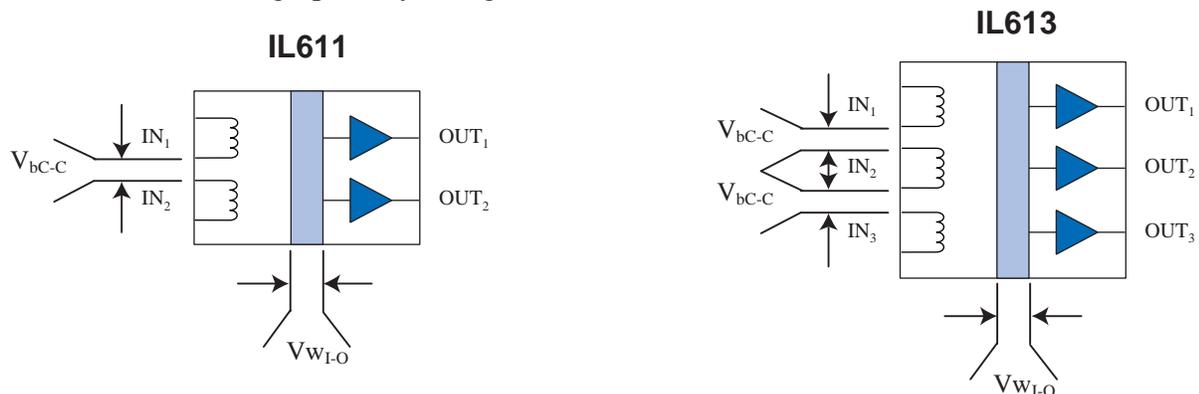


Figure 3. Isolation parameters