Application Bulletin AB-16

Applications for IL800, IL700, IL200, IL500, and IL600 Series Digital Isolators

One of the most frequently asked questions at the isolator applications desk is "what's the difference between NVE's digital isolator families?" This application note sheds some light on the design differences between the various model families, why those differences are important, and where the individual products are best used. There are naturally some applications for digital isolators that overlap the families offered, but in general, some products are better used in some categories than others. By the time you've read this bulletin, you'll know why.

GMR Isolator Design

The design of every GMR isolator offered by NVE is very similar: an analog or digital input signal creates a differential magnetic field that is sensed by a GMR resistor bridge and translated to a digital output signal by a comparator. The application requirements addressed by the various families are shown in Table 1 below.

Application Requirement	Isolator Design Feature	Products
High data rate	High bandwidth GMR sensor	IL8xx, IL7xx, IL2xx
Smallest packages	MSOP8 or narrow-body SOIC16	All
Analog or differential inputs	Passive input (field coil)	IL6xx
Low PWD, 50 ps jitter	High slew rate inputs to coil	IL8xx, IL7xx, IL2xx
Low EMC footprint	Data driven transfer function	IL7xx, IL2xx
Low quiescent power	Pulsed magnetic field (2.5 ns)	IL7xx, IL2xx, IL5xx
Low dynamic power	Passive inputs	IL6xx
Excellent transient immunity	Low capacitance Wheatstone bridge configuration	All
Known initial output	Internal refresh or passive input	IL8xx, IL5xx, IL6xx
Channel-to-channel isolation	Isolated inputs	IL611, IL613
Wired-OR outputs	Open-drain outputs	IL6xxA ("A" types)
Failsafe operation	Known zero-input state	IL6xx
DC correct	Linear transfer function or refresh	IL6xx (linear), IL5xx
Optocoupler emulation	Passive input	IL6xx
Cost sensitive	Lower-speed interface	IL5xx

Table 1. Application Requirements.

Let's split the application requirements still further and take a look at some strengths of the different families.

Low power consumption is achieved by pulsing the magnetic field generated by the input signal, rather than applying a DC signal across the field coil. The field coil is the major current path through the device, and the current pulses are on the order 50 mA with duration of 2.5 ns. The magnitude and duration of the pulse are independent of signal mark-to-space ratio, although average power consumption obviously increases proportionally with increasing data rate.

The IL600 Series has a linear magnetic transfer function. It is designed so a coil current of 5 mA flowing from the –In to +In terminal will cause the output to go low. When the input current falls to less than 0.5 mA, the output will always go back to the high state. The IL600 Series behaves exactly like an optocoupler in that regard and while its switching current requirement of 5 mA may appear high when compared to the other families at low frequencies (200 µA at 1 MHz), there is a crossover at approximately 15 MHz when the IL6xx becomes the lowest average power user in the group. See Table 2 for an overview of "per channel" power consumption with 3.3 V supplies.

Data Rate (Mbps)	**IL2xx**	**IL6xx**	**IL5xx**	**IL7xx**	**IL8xx**
2	0.7	8	0.8	0.7	1.3
40	14	11	N/A	14	15
100	40	15	N/A	40	40

Table 2. No-Load Power Consumption in mW per channel at 3.3V.

High Data Rate comes free with GMR circuits due to the 2 GHz bandwidth of the sensor. The speed-limiting factor in NVE isolators is the CMOS interface circuitry. IL8xx, IL7xx, and IL2xx have the fastest electronics. Slower electronics in the IL500 Series reduce their cost. With data rates ranging from 2 Mbps to as high as 150 Mbps, there's an NVE isolator for every speed requirement.

Low PWD and jitter are again a function of the GMR switching element's bandwidth, but with the additional consideration of perfect symmetry. Unlike transistors, it is as easy to switch a GMR element "on" as it is to switch it "off." In the on state, the resistance of the GMR element is approximately 5% greater than the off state. GMR switching symmetry is largely independent of bandwidth. NVE uses precision laser trimming of the thin film GMR pattern to null the GMR bridge offset voltage. The process produces isolators with typically less than 1 ns PWD and only 50 ps jitter.

NVE Isolators have a **low EMC footprint** because the input data is transferred directly across the isolation barrier with no RF carriers or refresh clocks. Transformer, capacitive, and RF isolation techniques require internal, asynchronous data clocks in the transfer function, resulting in much higher EMI emissions.

The excellent **transient immunity** specification of 30 kV/µs minimum (50 kV/µs typical) for digital input NVE Isolators results from their symmetrical, cross-coupled Wheatstone bridge configuration.

Analog, differential analog and differential digital signals can all be isolated directly with IL600-Series Isolators. These devices provide access to the internal field coil, meaning the user can steer current into the device to isolate many different signal types. For instance, RS-422, RS-485 and RS-232 differential signals can all be isolated directly without a separate RS-xxx receiver. An external resistor in the coil path limits current to 5 mA.

In addition, low-voltage digital signals (1.2 V to 2.8 V) can be input on the coil side and translated to 3 V or 5 V levels with ease. The fact that IL600-Series devices are current, not voltage, driven means any signal at any voltage level (specified up to 400 V_{rms}) can be connected to the coil input, limited to 5 mA with a resistor and transferred to the output as an isolated digital signal. The **channel-to-channel** isolation feature of this family makes it easy to isolate multiple signals from different grounds and present the isolated outputs to a common controller such as a PLC in the industrial environment, or a supply alarm monitor in a telecom base station. The ultra-miniature MSOPs enable space savings not available in any other isolator format. If

wired-OR functionality is needed in an alarm application, the open-drain options available in the IL600 Series allow outputs to be tied to a single pull-up resistor, eliminating the open collector logic gate normally required with other isolators.

Failsafe operation, the requirement that isolator outputs must be in a defined state if input power is lost, is available in the IL600 Series. This function, along with **DC correct** operation, is usually required in applications where an incorrect output level after input supply failure could result in contentious circuit operation. For example, a CAN control node could be stuck in the dominant mode (logic low), effectively halting the system. Similarly, the **DC-correct** function allows users who need to know output states at power-up to confidently design their systems knowing the output will always follow the input. NVE's IL800 and IL500 Series have internal refresh clocks, meaning outputs can be guaranteed after the first clock pulse has been issued. Some part types also have external SYNC lines that can be connected to a standard Power-On Reset pulse to ensure output conditions immediately after reset is asserted.

True optocoupler emulation can be achieved using the IL600 Series. The venerable opto has been used in so many applications it's impossible to list them all. Most opto replacement products, however, are digital input devices, meaning only opto applications with digital inputs can be replaced without redesign of the input signal network. The IL6xx has direct optocoupler connectivity, so any input format used by optocouplers can also be used by the IL6xx without redesign. Don't forget the additional advantage in the passive input structure of the IL6xx versus a typical opto diode input—unlike the diode, there's no need to protect the coil against reverse bias. Any reverse voltage on the coil pins simply serves to push the isolator further into the off state. The differential signaling technique mentioned above uses this unique feature.

For **cost-sensitive** applications, you can't beat the IL500 Series. It represents the lowest possible cost for GMR isolators and is great for those sub-megahertz applications previously served by low-end optocouplers. In addition, multi-channel configurations and small packages make it a natural for reducing PCB size and cost while retaining opto functionality.