# Agilent/NVE GMR Isolators–Performance Comparison to Analog Devices *i*Coupler® Products

Two new optocoupler alternative isolation technologies have been introduced in recent years. Analog Devices' *i*Coupler technology uses chip scale transformers to transmit data across an isolation barrier. NVE's IsoLoop® technology uses a coil and GMR* (giant magnetoresistive) structure to do the same. The IsoLoop technology is also offered by Agilent Technologies in the form of NVE manufactured components sold under the Agilent brand.

While both technologies provide substantial performance improvements relative to optocouplers, there are significant differences between the two. These differences contribute to several Agilent/NVE performance problems that are not apparent in the relevant data sheets but are critical in many applications. These problem areas include the occurrence of incorrect or unstable outputs in situations such as power-up, input noise spikes, or slow input edges. Additionally, the Agilent/NVE parts were found to exhibit excessive ringing on their outputs, potentially causing board or system level electromagnetic interference problems. Below is an overview of the *i*Coupler and IsoLoop technologies, followed by a summary of measurement data that uncovered these issues.

TECHNOLOGY OVERVIEWS

Both the IsoLoop and *i*Coupler technologies use magnetic rather than optical means to transmit data across an isolation barrier. The *i*Coupler technology does this using a transformer structure, while the IsoLoop technology uses a GMR structure.
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Analog Devices *i*Coupler Technology

NVE IsoLoop Technology
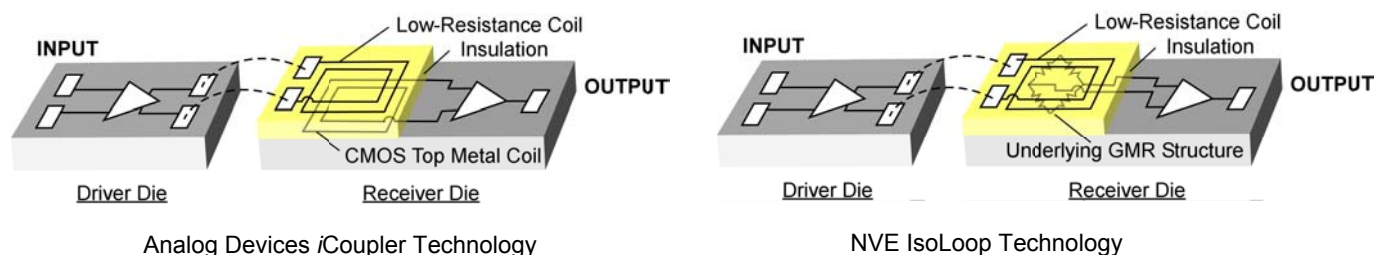
Key Differentiating Features

- Data transmission triggered by input logic transitions
- Driver refresh function ensures dc correctness in absence of input logic transitions
- Correct output upon start-up guaranteed within 1 µs
- Input filter prevents false triggering due to input noise
- Fail-safe output state upon loss of input power
- Insensitive to external dc magnetic field

Key Differentiating Features

- Data transmission triggered by input logic transitions
- dc correctness not ensured
- Correct output upon start-up not guaranteed
- Susceptible to false triggering by input noise
- Retains last state upon loss of input power
- Sensitive to external dc magnetic field

PERFORMANCE CHARACTERISTICS

Below is a summary of the key performance characteristics for the two technologies. The performance characteristics of a popular Agilent high speed optocoupler are also included for comparison .

Parameter[1]	Unit	ADI ADuM1100	Agilent HCPL-0900/ NVE IL710	Agilent HCPL-0710
Maximum Data Rate	MBd	100 min	100 min	12.5 min
Total Supply Current, Quescient Total Supply Current, 25 MBd Data Rate Total Supply Current, 100 MBd Data Rate	mA	0.9 max 4.5 max 17 max	6.0 max 10 (note 2) 26 (note 2)	23 max
Transient Immunity	kV/µs	25 min	20 min	10 min
Propagation Delay	ns	18 max	15 max	40 max
Pulsewidth Distortion	ns	2 max	3 max	8 max

Notes
[1] Values are 5 V operation data and are from the ADI ADuM1100 data sheet (Rev. C), NVE IL710 data sheet (7/02), Agilent HCPL-0900 data sheet (10/02), Agilent HCPL-0710 data sheet (1999), and ADI measurements of IL710 supply current versus data rate.
[2] Agilent/NVE do not specify maximum supply current values at nonquiescent conditions. The 25 MBd and 100 MBd values are obtained from ADI measurements of five NVE IL710 units.

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* GMR structures have the property of magnetic field-dependent resistance. The IsoLoop technology transmits data across an isolation barrier by configuring a receiver that is sensitive to magnetic field changes caused by the driver circuitry and primary coil.

AGILENT/NVE PERFORMANCE PROBLEMS

A series of measurements was performed using ADI ADuM1100, NVE IL710 (Agilent HCPL-0900), and NVE IL716 (Agilent HCPL-901J) units to evaluate their performance characteristics. These measurements revealed certain performance difficulties with the Agilent/NVE parts. These related to incorrect or unstable outputs in situations such as power-up, input noise spikes, or slow input edges, as well as excessive output ringing. While most of the IsoLoop data shown below was obtained from a single-channel part, similar performance problems were also observed in the quad IsoLoop component. The impact of any of these characteristics on a particular system design is highly dependent on the application specifics and should be assessed by the designer. With the exception of the power-up issue, these characteristics are not documented in the NVE/Agilent data sheets.

POWER-UP/INITIALIZATION PERFORMANCE

A major difference between the *i*Coupler and IsoLoop technologies relates to the concept of dc correctness. This refers to the ability of an isolator to output the correct logic state when the input is a dc signal. The *i*Coupler technology includes a refresh driver circuit that ensures a correct output state in the absence of input transitions. The IsoLoop technology lacks this feature and consequently depends solely on input logic transitions to trigger correct output states.

In fact, the Agilent/NVE data sheets state that the IsoLoop parts could enter an "ambiguous output state depending on power-up, shutdown and power loss sequencing." To examine this, samples of ADI ADuM1100 and NVE IL710 (Agilent HCPL-0900) products were subjected to a power-up situation involving a logic low input as shown below. In this situation, the V_{DD2} output supply was on and the V_{DD1} input supply was being brought up. Prior to the application of input power, the outputs of both isolators were at logic highs. As input power was brought up, the ADuM1100 output correctly transitioned to a logic low state, while the IL710 output remained at the incorrect output state despite the presence of supply voltage at the input.
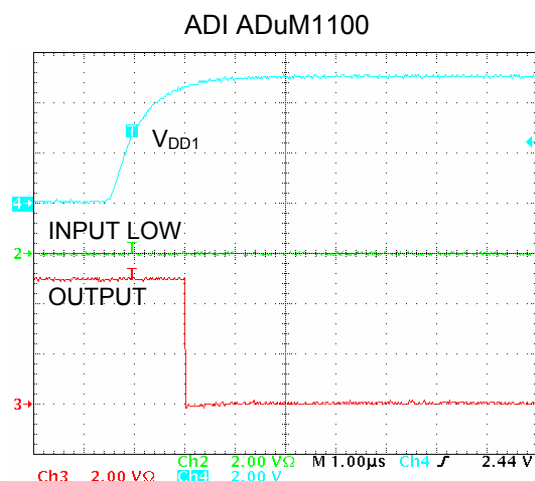
ADI ADuM1100

NVE IL710

Figure 1. ADuM1100 Power-Up Performance
Ch. 2: Input (low)
Ch. 4: V_{DD1} power-up
Ch. 3: Output (high prior to power-up, correctly transitions to low during power-up)
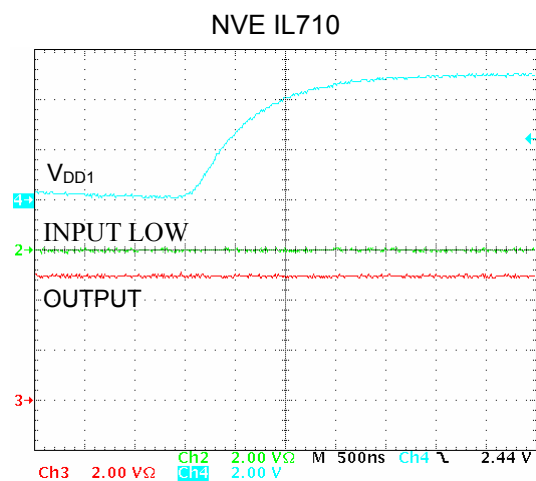
Figure 2. IL710 Power-Up Performance
Ch. 2: Input (low)
Ch. 4: V_{DD1} power-up
Ch. 3: Output (high prior to power-up, incorrectly remains high after power-up)

INPUT NOISE SUSCEPTIBILITY

A second area in which IsoLoop devices were found to have difficulties involves their ability to perform in the presence of glitches or noise spikes on the input data signal. Both *i*Coupler and IsoLoop devices specify a minimum pulsewidth of 10 ns. Measurements were taken to determine how the parts behave when subjected to input pulses of *less* than the minimum duration. While it is acceptable for an isolator not to respond to a pulse shorter than the specified minimum pulsewidth, it is not acceptable for such a pulse to induce an enduring incorrect output. *i*Coupler products have an input filter and a corrective refresh circuit to protect against this possibility. The observed characteristics of IsoLoop devices are consistent with the lack of such protective features.

Below is a comparison of the ADuM1100 and the IL710 (HCPL-0900) when subjected to an input noise pulse with a duration of about 8 ns. The ADuM1100 successfully tracked the input and ended up at the correct output low condition. The IL710 responded to the noise pulse but got stuck in an incorrect output high condition. The IL710 remained in this incorrect state until another transition was applied to the input.
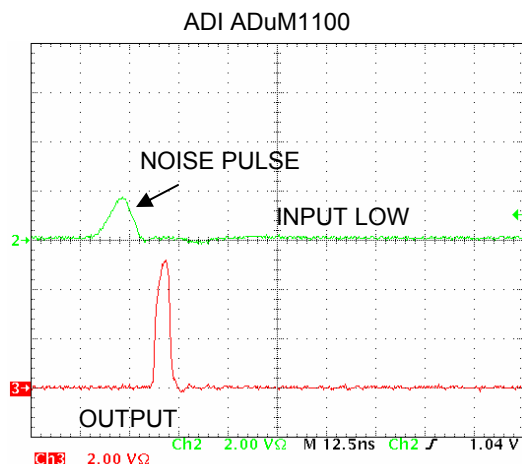
ADI ADuM1100

NVE IL710

Figure 3. ADuM1100 Performance with ~8 ns Input Noise Pulse
Ch. 2:   Input (low with noise pulse imposed)
Ch. 3:   Output (transitions to high and immediately returns to correct low state)
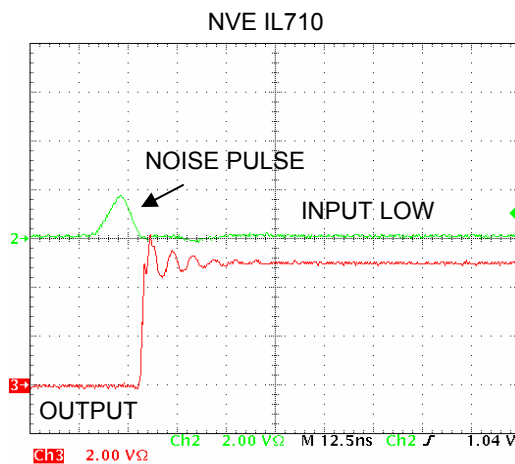
Figure 4. IL710 Performance with ~8 ns Input Noise Pulse
Ch. 2:   Input (low with noise pulse imposed)
Ch. 3:   Output (triggers to incorrect high state with no recovery)

Additional measurements were performed with even shorter input noise pulses. In this case, the NVE IL716 (HCPL-901J) was evaluated. Below is a comparison of the ADuM1100 and the IL716 when subjected to an input noise pulse having a duration of about 2 7 ns. In this case, the ADuM1100 ignored the input and maintained a correct output low condition throughout the test. The IL716 responded to the noise pulse and entered an unstable condition. Due to the IL710's lack of dc correctness, it remained in an oscillatory condition until another transition was applied to the input.
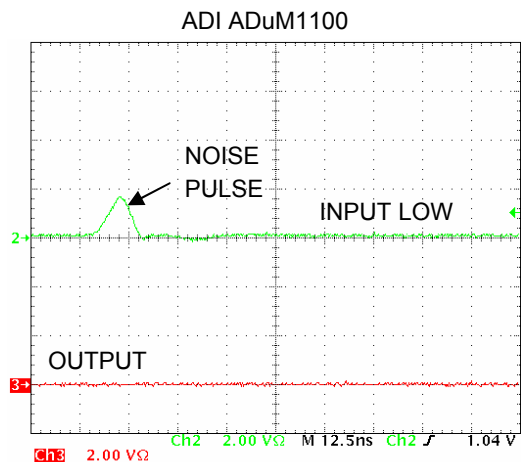
ADI ADuM1100

NVE IL710

Figure 5. ADuM1100 Performance with ~7 ns Input Noise Pulse
Ch. 2:   Input (low with noise pulse imposed)
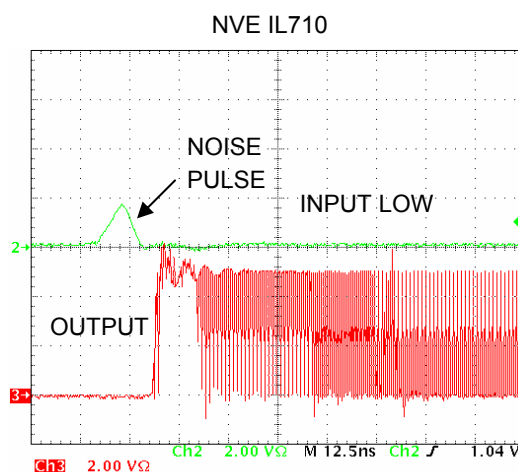Ch. 3:   Output (maintains correct low state)

Figure 6. IL710 Performance with ~7 ns Input Noise Pulse
Ch. 2:   Input (low with noise pulse imposed)
Ch. 3:   Output (unstable)

SLOW INPUT SIGNAL PERFORMANCE

A third area in which IsoLoop devices were observed to have difficulty was with slow input edges. *i*Coupler product data sheets cite a maximum input rise time of 1 ms in their recommended operating conditions. In contrast, IsoLoop product data sheets cite a maximum input rise time of only 1 µs. Measurements performed with the IL716 (HCPL-901J) indicated that even the specified 1 µs maximum rise time could not be accommodated in a trouble-free manner. Phenomena such as output glitches, incorrect states, and oscillations were observed with the IL716. This is indicative of an input stage having insufficient noise margin. Below are comparisons of ADuM1100 and IL716 behavior when subjected to rise times of 100 ns and 500 ns duration.
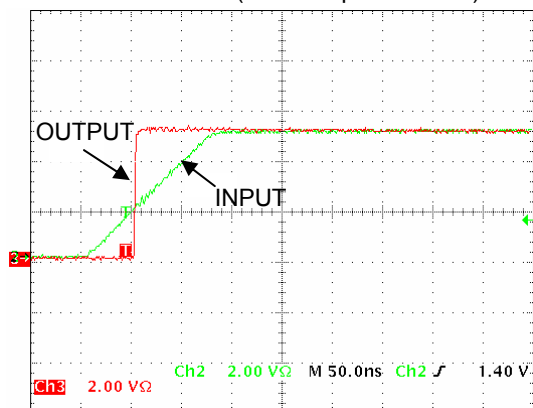

Figure 7. ADuM1100 Performance with 100 ns Input Rise Time
Ch. 2: Input
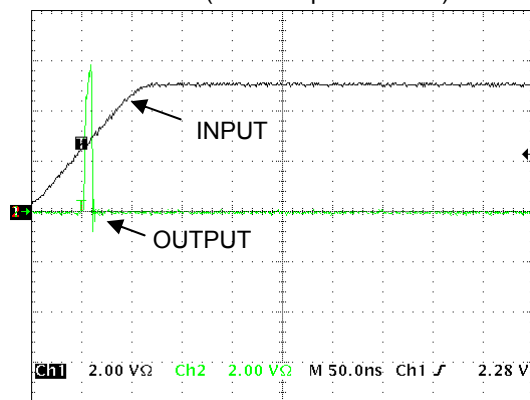Ch. 3: Output (cleanly transitions to correct state)

Figure 8. IL716 Performance with 100 ns Input Rise Time
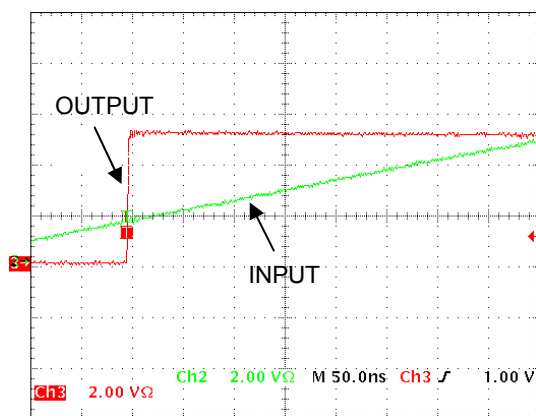Ch. 1: Input
Ch. 2: Output (glitches and remains in incorrect state)

Figure 9. ADuM1100 Performance with 500 ns Rise Time
Ch. 2: Input
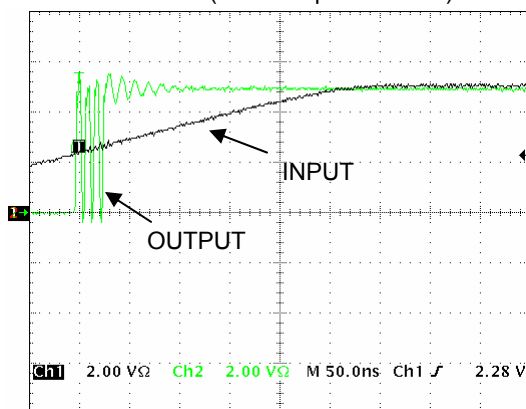Ch. 3: Output (cleanly transitions to correct state)

Figure 10. IL716 Performance with 500 ns Input Rise Time
Ch. 2: Input
Ch. 3: Output (oscillates and eventually achieves correct state)

EXCESSIVE OUTPUT RINGING

Lastly, IsoLoop devices were found to exhibit a large degree of overshoot or ringing at their output. Below is a comparison of ADuM1100 and NVE IL710 (HCPL-0900) output characteristics. The excessive ringing on the NVE output has the potential to cause difficulties with system-level electromagnetic interference (EMI) testing.
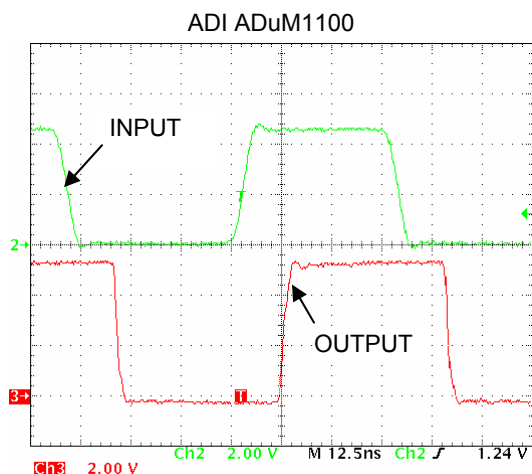

Figure 11. ADuM1100 Output Waveform
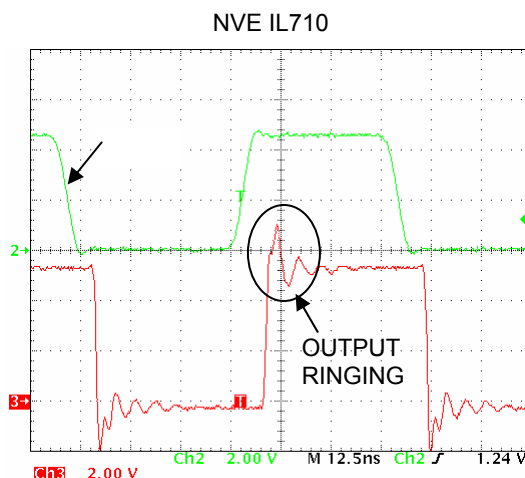Ch. 2: Input
Ch. 3: Output

Figure12. IL710 Output Waveform
Ch. 2: Input
Ch. 3: Output

CONCLUSIONS

While both the *i*Coupler and IsoLoop technologies offer many improvements over optocoupler technology, there are some important differences in their behavior characteristics.

Condition	*i*Coupler (Analog Devices)	IsoLoop (NVE or Agilent)
Power-up/initialization	Output always matches the input	Output may or may not match the input
Input noise susceptibility	Following a noise spike, output always matches the input	Following a noise spike, output may match the input, may not match the input, or may oscillate
Slow input rise time	Output always transitions to correct state	Output may transition to correct state, may remain in incorrect state, or may oscillate
Output ringing/overshoot	Minimal Overshoot (<200 mV)	Excessive overshoot (~1.8 V measured) with 2-3 oscillations

The ideal isolation product provides a deterministic, correct output not just under benign data sheet conditions but also under real world conditions that involve power-ups, input noise, and a wide range of input slew rates. The designer should consider the impact of the differences listed in the table when selecting an isolation component. Based on the measurements summarized above, Analog Devices' *i*Coupler products are much better suited to ensuring correct outputs under all conditions than are the IsoLoop products offered by NVE and Agilent Technologies.