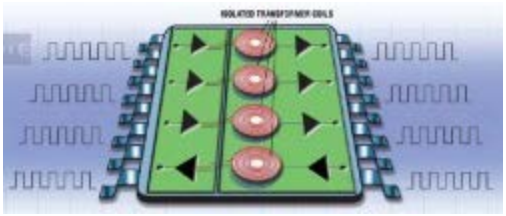
Analog Devices' Digital Isolation Update
*i*Coupler® News

Welcome to the third edition of Analog Devices' Digital Isolation Update. Whether you are already using *i*Coupler technology or still designing with optocouplers, this Digital Isolation Update will keep you posted as we continue to introduce a wide array of new isolation products, including gate drivers, transceivers, and multi-channel digital isolators with *iso*Power™ isolated, integrated DC/DC converters.

Each Digital Isolation Update includes a look at New Products, General News, a special application note we call "N***App***kin **Notes**," and it will also present insights and interesting facts in Inside *i*Coupler Technology.

We are always looking for feedback, so please feel free to e-mail us at: *i*Coupler_Isolation@analog.com.

New *i*Coupler Products



ADuM2200 / ADuM2201

The ADuM220x are dual channel isolators which have similar performance and features to *i*Coupler family members ADuM120x and ADuM320x, but the ADuM220x is 100% tested at 5kV rms and has reinforced insulation ideal for medical applications. For more information on the ADuM220x family, please visit www.analog.com/adum220x.

ADuM1420

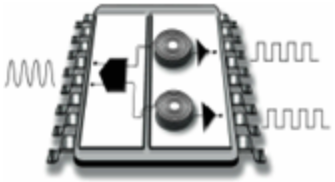
The ADuM1420 is a quad isolated gate driver that provides independent and isolated high-side and low-side outputs. The ADuM1420 offers the benefit of true, galvanic isolation between the input and each of the four outputs. For more information on the ADuM1420 please visit www.analog.com/adum1420.

ADM2491E

The ADM2491E is a 16 Mbps 5kV rms isolated data transceiver with ±8 kV ESD protection and is suitable for high speed, half- or full-duplex communication on multipoint transmission lines. The ADM2491E employs *i*Coupler technology to combine a three-channel isolator, a three-state differential line driver and a differential input receiver into a single package. For more information on the ADM2491E please visit www.analog.com/rs485.

AD7400A / AD7401A

The AD7400A and AD7401A are isolated Σ-Δ ADCs that are ideal for current monitoring in motor control applications where a direct connection to current shunts is required. Similar to the AD7400 and AD7401, these products meet safety standards from UL, CSA, and VDE with up to 3.75 kV rms of reinforced isolation. Compared to the AD7400 and AD7401, the AD7400A (internal clock) and the AD7401A (external clock) offer superior INL and DNL and a wider temperature range (-40°C to 125°C). Both parts are available in a 16-lead SOIC package, while the AD7400A is also available in an 8-lead gull-wing surface mount DIP. The AD7400A and AD7401A are now sampling. Please visit www.analog.com/AD7400A or www.analog.com/AD7401A for more information.



iCoupler digital isolation technology integrates chip scale transformer technology with an analog front end.

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General News

iCoupler Products Featured in Latest Medical ICs Ad

The ADuM240x family of *i*Coupler products is currently being featured in Analog Devices' latest Medical ICs ad. The ADuM240x, as well as the ADuM225x and the newly released ADuM220x families all have 5kV reinforced insulation ratings and meet the IEC 60601-1 medical safety approvals. For more information on these products or other featured Medical ICs, please visit www.analog.com/medical-ad1.

iCoupler Team is Now Hiring

The *i*Coupler team is growing and is looking for two individuals with marketing or applications engineering backgrounds.

If you have experience with isolation solutions and/or applications involving isolation in a previous marketing or applications position, we invite you to learn more about these opportunities. Please visit www.analog.com/jobs and search the corresponding Boston area reference numbers below.

Marketing Engineer - Req. Number 105646

Applications Engineer - Req. Number 106160

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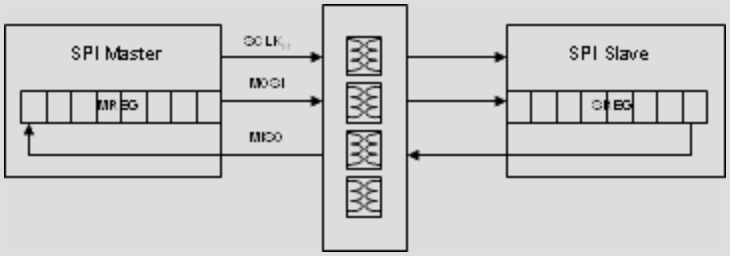
*N**App**kin **Notes** – written expressly for the* Digital Isolation Update *– are ideas, hints, and tips for building with iCoupler technology.*

This Issue, **Clocking Options for SPI**
By Mark Cantrell, Applications Engineer

Isolating high-speed SPI isn't always as obvious as choosing a digital isolator based on guaranteed data rate. It turns out that propagation delay can also limit SPI speed. Fortunately, as this note explains, there is a straightforward way to eliminate propagation delay as a bottleneck.

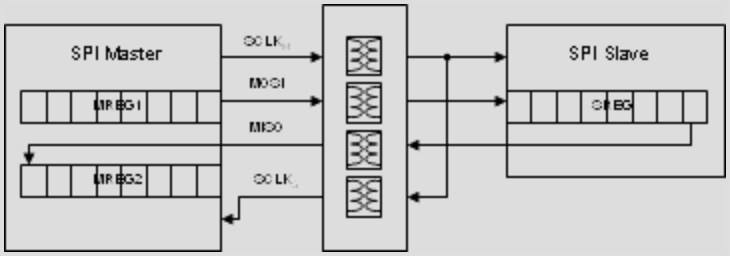


Standard implementations of SPI use the clock signal, SCLKM, generated by the Master device to control all movement of data on the bus. Data moves between the Master and Slave as if they were two interconnected shift registers. The Master and Slave present data to the bus on one phase of the clock and read the data into their shift register on the opposite phase. This system works fine as long as the round trip propagation delay through the bus is less than half of the clock period, because the data must be back to the master by the next clock edge, half a clock period later.

Incorporating isolation into an SPI bus constrains the SCLKM rate because data from the Slave device must arrive at the Master before the next clock edge. Since the minimum time required for this to happen is 2x the maximum propagation delay, this sets a maximum limit on the clock rate.

For example, the ADuM1401CRWZ has a guaranteed speed of 45 MHz with a maximum propagation delay of 32 ns. When used to isolate SPI, the clock half period must be greater than 2 propagation delays, or a maximum SCLKM rate of 7.8MHz. This is a severe limitation on the data rate. In fact, a digital isolator would need a maximum guaranteed propagation delay less than 5.5 ns to support 45 MHz SPI.

Luckily the straightforward solution shown below eliminates this bottleneck. If the SCLKM signal is wrapped back through the coupler along with the data from the Slave device, the timing between the new signal, SCLKS, and the data is the same to within the propagation delay skew of the coupler. SCLKS can be used to clock data back into the Master at rates which are again set by guaranteed data rate of the coupler. In this example, that raises the SPI clock rate to the full 45MHZ, a 5x improvement. The cost of this solution is the additional coupler channel to wrap the Master clock.



The recommended *i*Coupler devices for SPI applications are the ADuM1401CRWZ and ADuM3441CRWZ. Data rates of up to 50 MHz can be achieved with these devices.

For more information on *i*Coupler products with please visit www.analog.com/*i*coupler or send an email to *i*Coupler_Isolation@analog.com.

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Inside *i*Coupler Technology

by Baoxing Chen, Design Engineer

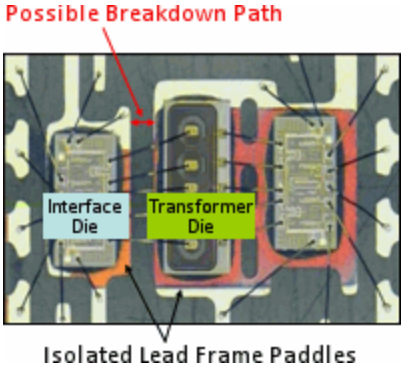
In a previous Digital Isolation Update, we described how *i*Coupler products' isolation characteristics are dependent on the polyimide insulation material between the top and bottom transformer coils. In this Update we explain how package design and materials are also crucial elements for ensuring the isolation characteristics of our products. With *i*Coupler products, we take great care designing the package and lead frames and also selecting the molding compound in order to achieve isolation ratings up to 5kV rms reinforced insulation.

With regards to the external package dimensions, certain minimum spacings are required in order to satisfy applicable safety standards. Creepage and clearance distances are defined as the shortest distance between conductors on either side of the isolation barrier either along the package surface (creepage) or in a line-of-sight through the air (clearance). The packages used for *i*Coupler products have been approved by CSA, VDE, TUV, and UL for distances of clearance/creepage distances of at least 4mm or 8mm. These spacings are adequate to meet

safety requirements of the most common applications involving isolation.

Within the package, to guarantee isolation ratings of up to 5kV rms, we make sure that there is adequate separation through the package molding compound between conductors on either side of the isolation barrier.

The figure to the right shows an example of one possible breakdown path. This path is between two paddles on which different die are attached - *i*Coupler products use multiple die in the package to encode and decode signals transferred across the transformer isolation barrier. Each paddle can be at a separate voltage potential differing by thousands of volts. The breakdown characteristics of this path are dependent on the distance through the molding compound between the two paddles.



This distance must be long enough to achieve the specified 1 minute isolation rating associated with a given *i*Coupler product (2.5kV rms or 5kV rms for most *i*Coupler products). In production the isolation barrier on each *i*Coupler product is tested at either 3kV rms or 6kV rms. We selected a package molding compound with a breakdown strength of at least 20V peak / µm. This translates to a paddle separation requirement of at least 210 µm separation for 2.5kV rms products and 420 µm for 5kV rms products. *i*Coupler packages are designed to meet these separation distances.

A common question with *i*Coupler products relates to a distance-through-insulation requirement that is often perceived to apply. In actuality, current versions of the most commonly applicable safety standards do not have distance-through-insulation requirements for semiconductor-type devices with casings completely filled with an insulating compound. Some safety standards require additional testing involving temperature cycling and elevate voltages to ensure the integrity of internal insulating materials. See, for example, IEC 60950-1 (2nd edition) or IEC 61010-1 (2nd edition).

In summary, while *i*Coupler isolators use industry standard packaging, the package, lead frame and molding compound have been optimized to ensure that *i*Coupler products meet up to 5kV rms isolation ratings and comply with various safety standards. For more information on *i*Coupler safety approvals, please visit www.analog.com/*i*couplersafety.

Visit our website, www.analog.com/*i*coupler to learn more about our latest, award winning *i*Coupler technology, download data sheets and order free samples, or email us directly at *i*Coupler_Isolation@analog.com.

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Postal Address: Analog Devices, Inc. | Three Technology Way | Norwood, MA 02062 USA