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

Welcome to another edition of the 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, a special application note we call "N***App***kin **Notes**," and a feature filled with insights and interesting facts that we call 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

The First 5-Channel Isolator with Independent Unidirectional Isolation Channels

The ADuM1510 isolator supports data rates up to 10 Mbps and operates with the supply voltage of either side ranging from 4.5 V to 5.5 V. It has a patented refresh feature that ensures DC correctness in the absence of input logic transitions and during power-up/power-down conditions. For more information on the ADuM1510, please visit www.analog.com/adum1510.

The World's Smallest DC/DC Converter

The ADuM5000 is available in a 10 x 10 mm 16-lead wide SOIC package, and is a full 40% smallest modular DC/DC converter solutions. Please visit www.analog.com/adum5000 for more information.

Dual-channel digital isolators with isoPower

The ADuM520x family are dual-channel digital isolators with *iso*Power – an integrated, isolated DC/DC converter that provides up to 500 mW of regulated, isolated power at either 5.0V from a 5.0V input supply or 3.3V from a 3.3V or 5.0V supply. For more information on the ADuM520x family, please visit www.analog.com/adum520x.

Isolated Half-Bridge Driver with Integrated Isolated High-Side Supply

The ADuM6132 is an isolated half-bridge gate driver that provides an isolated high-side driver with an integrated 275 mW high-side supply. Learn more about the part at www.analog.com/adum6132.

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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.*

N***App***kin **Note: Increasing and Decreasing Power with *iso*Power Devices**

By: Mark Cantrell, Applications Engineer

The second generation of *iso*Power devices, starting with the ADuM540x quad channel as well as upcoming ADuM520x dual channel and ADuM5000 stand alone devices offer significant improvements in power efficiency and total available power. However, just adding a relatively efficient power supply to an *i*Coupler does not provide all users the flexibility to implement real world solutions. Customers routinely require either more power than an *iso*Power device can produce or the ability to shut down the power supply when not in use. ADI has built in the ability to accomplish both of these requirements within this product family.

The *iso*Power architecture simplifies both combining power modules to increase power as well as the ability to shut down the supply. Power is transferred from primary to secondary by running a high frequency tank circuit into the transformer and rectifying it on the secondary. It is similar to a typical linear power supply but at much higher frequency. Output regulation is achieved by a PWM control signal that switches the tank circuit on and off proportionately to the power required to maintain the output voltage. The Regulation Control (RC) signal is generated on the secondary side and passed to the primary through a standard *i*Coupler data channel. Access to this digital RC signal provides great flexibility. It can be used to regulate a separate *iso*Power device, or it can be controlled by a separate *iso*Power device. It can also be used to shut off the power supply. Second generation *iso*Power ADuM5xxx series products include RC_{IN}, RC_{OUT}, and RC_{SEL} pins to achieve this flexibility.

To increase power an *iso*Power device is chosen to be the master to provide an RC signal to regulate itself as well as other modules via their RCIN pins. Since there is only one part trying to control regulation, the secondary power outputs can safely be connected together to combine their power. An example of using an ADuM540x and an ADuM5000 to generate 1W of power and 4 channels of data isolation is shown in Figure 1. All combinations of master and slave are not possible due to constraints on the availability of pins for the control functions; please refer to the data sheets for more details.

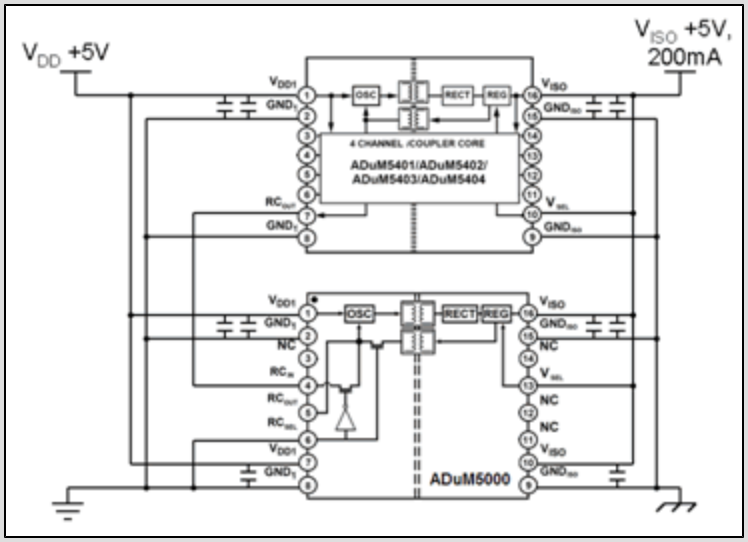

Figure 1 - 1W power configuration

The RC_{IN} pins can also be used to place the part in low current power down state. The RC_{SEL} pin chooses whether the RC signal is coming from the devices secondary side regulator, or an external source. If the RC_{IN} signal is tied to ground, then switching RCSEL will change the source of regulation between the secondary side controller and a logic zero forcing the tank circuit off. This turns the DC/DC converter from full regulation to a low power state. An example using the ADuM520x is shown in Figure 2.

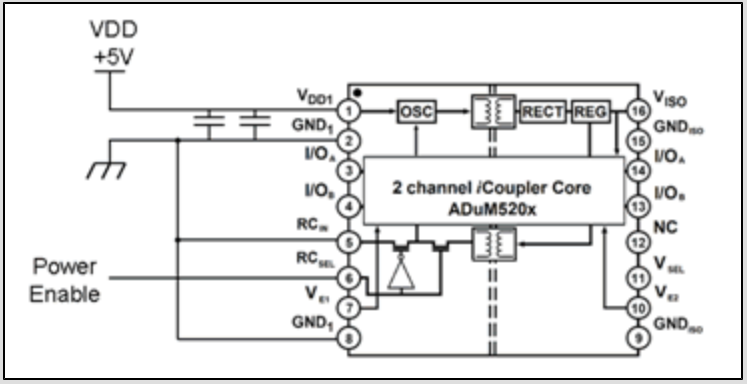

Figure 2 - Power Shut Down

These power control techniques improve the flexibility of the *iso*Power system allowing higher power as well as very low power, widening the range of potential applications significantly. High power sensors, and controls as well as battery power applications are within reach of this innovative technology.

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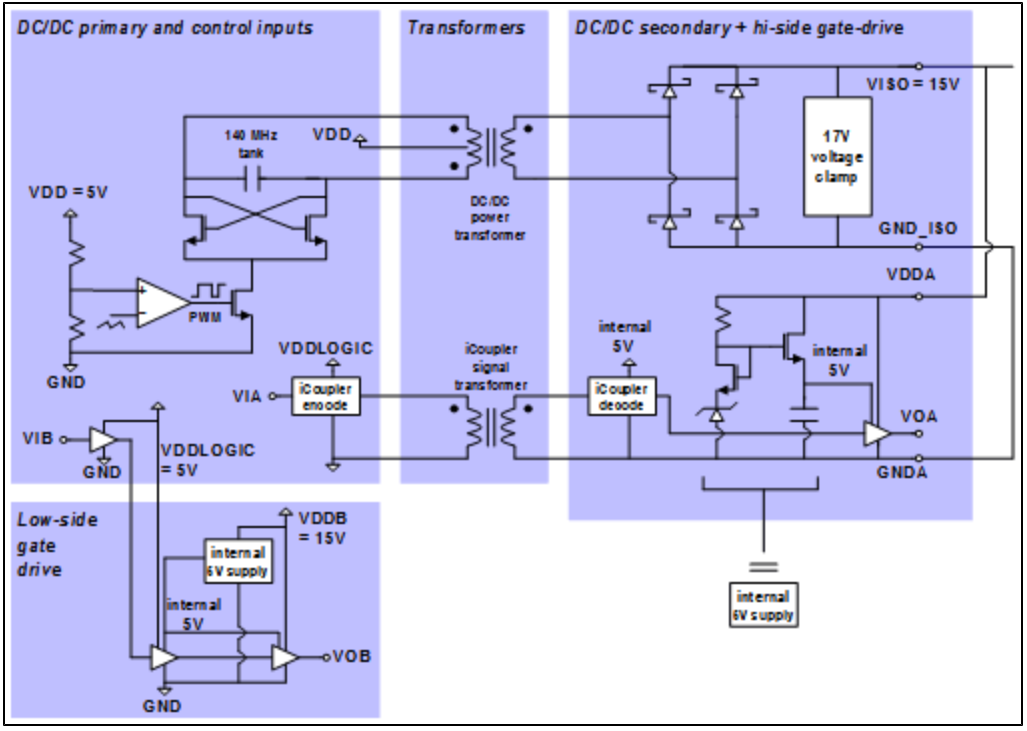
Inside *i*Coupler Technology

By Eric Gaalaas, Design Engineer

Analog Devices' isolated gate-drive products with integrated high-side supply provide two 15 V outputs with hundreds of volts of isolation between the high-side and low-side channels. This is accomplished by integrating an isolated DC/DC converter with *i*Coupler technology. The recently released ADuM6132, for example, provides an isolated supply for the high-side gate-drive channel, V_{ISO}, that supplies up to 20 mA to external high-side circuitry. The gate drive capability, at 15V, is several hundred mA. This article summarizes how these gate drivers transfer isolated power and data.

The DC/DC converter works as shown in the figure, by inverting the 5 V DC input V_{DD} voltage into high-frequency AC, driving the AC through a power transformer to achieve DC isolation between the primary and secondary windings, and then rectifying the secondary-side AC waveform to create the desired V_{ISO} DC output. A transformer-coupled resonator combines the inverting and transformer functions into a single circuit. On the primary side of the resonator, the cross-coupled transistor connection establishes positive feedback which amplifies disturbances. The LC tank formed by the inductance looking into the transformer primary and the tank transistor drain capacitance sustains oscillations at approximately 140 MHz.

Energy is supplied to the converter via the center-tap in the primary winding, which is connected to the V_{DD} input power supply. At resonance, the Q of the LC tank is sufficiently high to provide voltage gain, so that 5 V DC input is converted into 18 V AC at the tank output. Fast Schottky diodes in the full-bridge rectifier convert the AC at the transformer secondary into the V_{ISO} DC output, in a manner that minimizes diode losses.



To maintain an equilibrium value for V_{ISO}, the average power provided by the converter must equal the average power consumed by the off-chip load plus on-chip secondary-side circuits. In the converter, the V_{DD} voltage and load characteristics determine the amount of energy provided to the transformer primary per AC oscillation cycle. Average power transfer from V_{DD} to V_{ISO} is therefore regulated by controlling the average number of AC oscillation cycles per unit time. A PWM circuit does this, by turning the resonator on and off through the bottom-most of the 3 primary-side transistors shown in the figure. In some *iso*Power products, such as the ADuM6132 shown in the figure, the PWM duty cycle is controlled 'open-loop' by the V_{DD} voltage, which weakens the dependence of V_{ISO} on V_{DD}, but not the load dependence. In other *iso*Power products, the PWM duty cycle is set by voltage feedback from the secondary side of the converter, enabling fully regulated V_{ISO}. A voltage clamp at the rectifier output shunts energy between V_{ISO} and GND_{ISO} to prevent overvoltage at V_{ISO} during light load conditions.

The ADuM6132 accepts non-isolated 5 V control inputs for both gate-drive channels. *i*Coupler transformer-coupled level-shifting circuits translate the control inputs between voltage domains as needed. In all gate driver products, an *i*Coupler translates the high-side control input to the V_{ISO} high-side voltage domain. In some products, such as the ADuM5230, the low-side output is isolated from both the high-side output and control inputs, requiring an additional *i*Coupler isolated channel. In other products, such as the ADuM6132 shown here, the low-side output and control inputs share a common ground reference, so that no low-side *i*Coupler is needed. In this case, where the high-side channel includes *i*Coupler isolation and the low-side channel does not, delay-matching circuitry is used in the low-side channel to get best possible matching of propagation delays between channels. Overall propagation delay from control input to gate drive output is typically 50 ns, and delay mismatch between channels is 10 ns or less.

SPECIAL APPLICATION NOTE

Controlling Radiated Emissions with *iso*Power Devices

Abstract: *iso*Power devices use high frequency switching elements to transfer power through its transformer. Special care must be taken during printed circuitry board (PCB) layout to meet emissions standards. This special application note identifies the radiated mechanisms and offers specific guidance on addressing them. This application note is extremely useful when designing in members of the ADuM5xxx and/or ADuM6xxx families. The app note is available here: www.analog.com/an-0971.

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