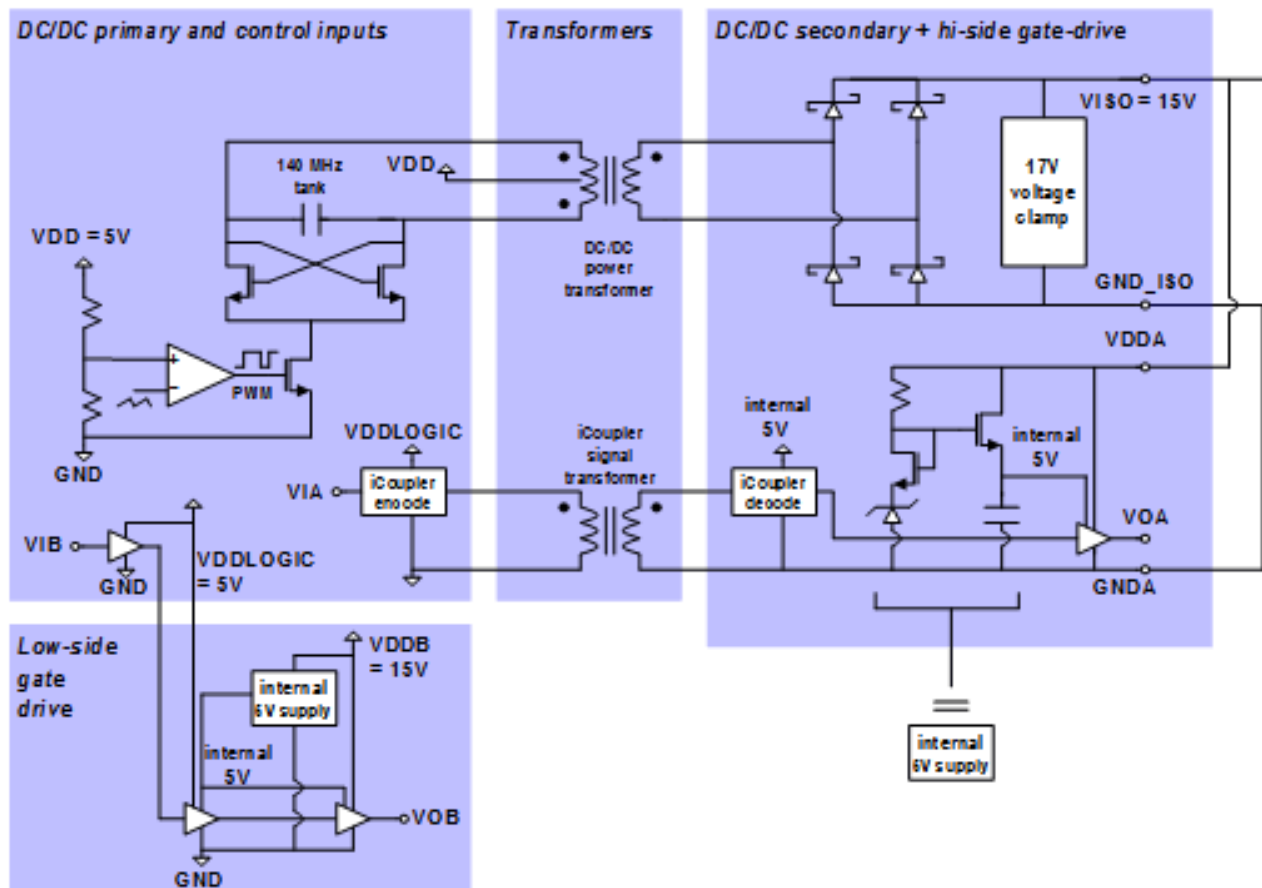


Inside *iCoupler*[®] Technology: Gate Drivers Transferring Isolated Data Power

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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-to-dc converter with *iCoupler* 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-to-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 *iSoPower*[®] 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 *iSoPower* 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. *iCoupler* transformer-coupled level-shifting circuits translate the control inputs between voltage domains as needed. In all gate driver products, an *iCoupler* 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 *iCoupler* 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 *iCoupler* is needed. In this case, where the high-side channel includes *iCoupler* 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.

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