New IsolationTechnology Improves Reliability and Safety

To ensure safe and reliable operation for industrial and automotive electrical systems, isolation is required between the high voltage, high power elements in a circuit and the low voltage sensing, processing and control elements. Power Integrations' FluxLink™ magneto-inductive coupling technology uses a coreless transformer built-into the lead frame of the device. This unique technology not only affords complete galvanic isolation between the low voltage and high voltage sides of the device but also provides a high speed isolated two-way communications link. **Michael Hornkamp, Senior Director Marketing, Gate Drivers, Power Integrations GmbH, Ense, Germany**

Incorporating FluxLink into the lead frame ensures the mechanical tolerances can be maintained to a high level, providing a stable, low coupling capacitance, high speed, bi-directional link which can maintain its isolation integrity even after IC destruction. The low capacitive coupling between the primary side and secondary of the transformer and its reduced loop area improve primary side immunity to magnetic field interference and current and voltage transients developed on the secondary side to achieve reliable robust operation.

High isolation capability

FluxLink provides reinforced Isolation up to 1200 V, basic isolation to 1700 V, transient isolation voltage of 8 kV maximum for 1 minute and is certified to VDE0884-10. This internal reinforced isolation is supported by the external creepage and clearance distances of 9.5 mm provided by Power Integrations' eSOP™ package (Figure 1) which meets or exceeds TUV/IEC60950 requirements.

FluxLink provides the galvanic and reinforced isolation required to meet VDE0884-11 and IEC60747-17 requirements along with very high electromagnetic interference (EMI) and magnetic field immunity, allowing manufacturers to easily comply with IEC61000-4-8 and IEC61000-4-9 standards. All parts in the family operate up to 125°C and are 100 % tested during production using both hi-pot and partial discharge techniques along with functionality testing designed to ensure safe reliable operation throughout the device lifetime.

Additionally, FluxLink technology delivers full safety isolation in the event of a system failure on the high voltage side, caused for example, by an IGBT Collector Gate short. Alternative isolation technologies such as optocouplers offer similar voltage isolation but suffer from temperature stability and long-term reliability issues, thereby reducing system reliability and increasing maintenance costs. Other isolation techniques may not offer the safety isolation provided by FluxLink in the event of a failure on the high voltage secondary side, compromising protection and safety on the primary side.

Simplified power semiconductor drivers

FluxLink technology has been integrated into many products including AC/DC convertors and SCALE-iDriver IGBT / Power MOSFET drivers. The high speed, low latency, low jitter, of the FluxLink enables precise control and timing signals to be transferred from the low voltage primary interface and controller side to the high voltage secondary power switching side. The high voltage secondary side is also able to return feedback and fault information back to the primary interface and control side to ensure correct and safe

Figure 1: FluxLink™ magneto-inductive coupling technology uses a coreless transformer built-into the lead frame of the device

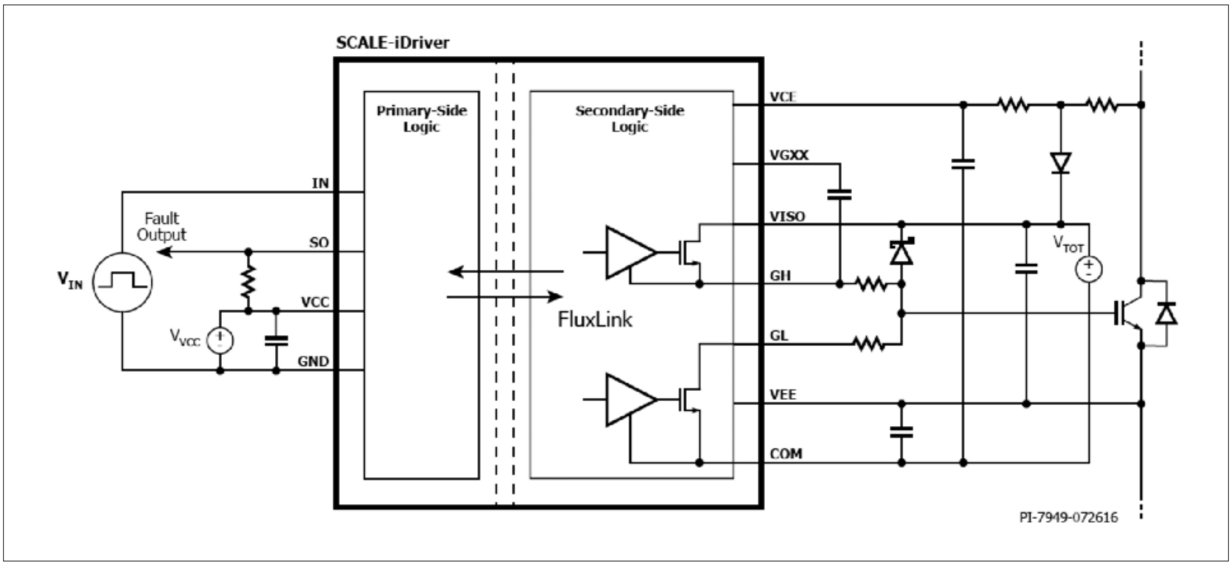

Figure 2: Typical single channel IGBT with SCALE-iDriver

operation of the power stage. Enhanced safety features, previously performed by additional external components, can now be integrated into the SCALE-iDriver IC, simplifying board design, reducing the bill of materials cost and improving reliability.

The SCALE-iDriver family has a working voltage of up to 900 V. Devices are available with four peak output-current ratings - 1 A (SID1112K) 2.5 A (SID1132K), 5.0 A (SID1152K) and 8.0 A (SID1182K), and three voltage ratings - 650 V, 1200 V and 1700 V. This high peak drive current allows the SCALE-iDriver to directly drive IGBTs with collector currents up to 800 A.

For gate drive requirements in excess of sink/source peak current of ±8.0 A, the SID1182K gate driver IC may be used with an external amplifier (current booster) to achieve 15 A or more with full safety functionality. Safety features include short-circuit detection (DESAT), Advanced Soft Shut Down (ASSD) to reduce turn off di/dt and limit turn-off overvoltage, primary side and secondary side Under Voltage Lockout (UVLO) and temperature compensated output impedance.

IGBT driver example

If we examine a typical SCALE-iDriver design, we can see how FluxLink is able to improve safety and reliability whilst reducing overall build cost. Figure 2 illustrates the number of external component required for a typical single channel IGBT SCALE-iDriver circuit.

The SCALE-iDriver power supply requirements have been simplified. Only two power rails are required, +5 V (VCC Pin) Vin to power the primary side, and a single unregulated +25 V (VISO Pin) to power the secondary side. The secondary side power supply should provide the same level of isolation that the SCALE-iDriver provides and have minimal capacitive coupling between primary and secondary or to any other secondary channel; typically this could be provided by a flyback converter with primary side regulation. Internal power supply monitoring and auxiliary power supply generation blocks on both the primary and secondary sides are integrated within the SCALE-iDriver. The secondary side +25 V supply is internally regulated to +15 V to generate the positive gate emitter voltage and then a negative -10 V rail is generated to provide the negative gate emitter voltage.

On the primary side the interface is designed to work with microcontrollers using 5 V I/O logic. Only two pins are required, the Input (IN Pin) and an open drain Fault Output (SO Pin). The input gate driver commands are transferred from the input across the FluxLink isolation barrier to the secondary side logic driving the Gate High (GH0 turn-on Pin and Gate Low (GL) turn-off pins.

During normal operation the SO output stays in the high impedance state, pulled high by an external pull up resistor. In the event of a fault condition, either on the primary side or secondary side, the SO output will be connected to ground and the input switching commands will be ignored. Primary and secondary fault detection and reporting enhances system reliability and safety. The primary side will indicate a fault when the V_{CC} supply drops below the primary side under voltage limit, UVLO V_{CC} and the SO output will remain grounded as long as V_{CC} stays below the threshold.

The secondary side features under voltage detection and output short circuit detection with advanced soft shut down. When a fault is detected the information is transferred back across the isolation barrier to drive the fault output low. During either of these conditions the fault output is driven low after a delay of typically 190 ns. To manage IGBT and SiC-MOSFET behavior, the ASSD can turn off the IGBT or SiC-MOSFET typically in 1.8 µs with a programmable delay time, the SO output SO fault signal has a period of 10 µs. Once the fault has been removed, the SCALE-iDriver IC will need a new 'turn-on' command transition on the input before the driver will enter the on-state again.

A short-circuit of the connected power device is detected using the semiconductor desaturation effect which then triggers the ASSD routine protecting the power switch by controlling the collector current slope, limiting the V_{CE} over voltage excursions which could damage the IGBT or MOSFET. The primary and secondary side under voltage detection also enables safe power on and power off even in the event of slow supply voltage ramp rate. The driver will also correct any short drive pulses, caused by input noise, by internally extending the duration of the output drive signals GH and GL.