Infineon Technologies presents the new EiceDRIVER™ Compact family, a single channel gate driver IC for general purpose. The different variants of the family are intended to support discrete IGBTs, IGBT modules and MOS transistors, but also SiC and GaN switches. Oliver Hellmund, Heiko Rettinger and Michael Wendt, Infineon Technologies, Germany

Table 1: Product overview of the new EiceDRIVER™ 1EDI Compact family
voltage will always be at \( V_{\text{IN,H}} = 0.7 \times V_{\text{VCC1}} \).

The input low threshold voltage is set at \( V_{\text{IN,L}} = 0.3 \times V_{\text{VCC1}} \) accordingly. This linear scaling allows for operations directly from a 3.3 V digital signal processor but is also capable of accepting output signals from a 12 V PFC controller to boost its signal. The maximum input voltage rating is \( V_{\text{VCC1,max}} = 17 \text{ V} \).

**Inverting and Non-Inverting Input**

The new 1EDI Compact family members provide the option to use two input signals: one inverting and one non-inverting. These inputs can be utilized in various combinations depending on the application needs. For example, the non inverting input can be used as PWM input while the inverting input can operate as kind of enable signal or vice versa.

Another example is the inverted driving of the input, \( \text{IN}^+ \) is high while \( \text{IN}^- \) is low. This can be useful for safety reasons.

If two devices are used to drive IGBTs or MOS transistors in a half bridge configuration, the \( \text{IN}^+ \) signal of the High Side Driver can be connected to the \( \text{IN}^- \) signal of the Low Side Driver and vice versa. In such a configuration a cross conduction is avoided.

The \( \text{IN}^+ \) terminal is internally pulled down to favor off state and the \( \text{IN}^- \) terminal is pulled up respectively. This setup also ensures an off state in all other configurations where an input signal might be connected to a high impedance output, a weak solder joint or a wire break.

**Various Output Configurations**

The 1EDI Compact family targets a broad range of applications. Different variants are offered to support individual requirements.

The devices with separate output for source and sink are useful to adapt the application circuit for turned on and off switching behavior. This is made possible by implementing separate gate charge and discharge resistors without the need of an additional external diode. Details are shown in Figure 1, left hand side. The supply voltage can be up to \( V_{\text{VCC}} = 35 \text{ V} \). The IC can be used with unipolar power supply for bipolar gate voltages. As a result, the driving circuit can be simplified with less PCB space and minimized parasitics in the gate loop leading to a better performance.

Another output configuration is shown in Figure 1, right hand side. Here, a common charge/discharge path is combined with an Active Miller Clamp. The advantage of this setup is that the transistor is turned off even with high \( \text{dV/dt} \). In this solution the bipolar supply can be avoided to reduce the circuit efforts and PCB space. The driver IC supports unipolar supply of up to \( V_{\text{VCC}} = 20 \text{ V} \) which is sufficient for most of the applications.

Due to the low quiescent current of the driver, a simplified supply voltage generation with bootstrap circuit can be used. The driver supports a high modulation index without the need of being equipped with a huge bootstrap capacitor.

An additional benefit of the Active Miller Clamp variant is the integrated diode which clamps the pin CLAMP to \( V_{\text{VCC}} \). Since this pin is directly connected to the gate of the power switch there is no additional resistive path compared to the body diode of the general gate output and gate resistor path — normally to be found in similar configurations. Thus, space is saved for another external diode on the PCB. The CLAMP function itself has the same current capability as the output. The 1EDI30I12MF has a minimum peak current of \( I_{\text{CLAMP}} = 3 \text{ A} \). The CLAMP circuit becomes active at turn off when the voltage at the CLAMP pin drops below \( V_{\text{VCC}} = 2 \text{ V} \). At the next turn on the CLAMP circuit is switched into a tri-state mode.

**Thermal Performance**

The dual chip design of the EiceDRIVER Compact family creates two independent sections of power loss within the package. The input section has been evaluated on its own to exclude effects from the output chip. In the second step of the evaluation the input and output operation have been combined as described in Figure 2.

The temperature increase of a 1EDI60N12AF as a function of input switching frequency of up to 5 MHz and the supply voltage of up to \( V_{\text{VCC}} = 17 \text{ V} \) was tested. The driver IC shows a temperature increase in the area of the input chip of up to 5.5 K at \( V_{\text{VCC}} = 5 \text{ V} \) and of up to 14 K at \( V_{\text{VCC}} = 17 \text{ V} \).

For the evaluation of the output section, the input was supplied with a...
constant voltage of VCC1 = 5 V. However the influence of the input chip is minor compared to the power loss in the output chip at VCC2 = 15 V and 50% duty cycle. The thermal effects of capacitive load (CLOAD) variation and different switching frequencies are recorded in Figure 3. The power loss was shared between the driver output stage and the two external gate resistors of 1.2 Ω each.

Output Current Capability
The output current is one of the most important parameters of a driver IC. The strongest driver ICs of the family, 1EDI60N12AF and 1EDI60N12AF, are rated with a minimum peak current of Ipea = 5 A at VCC = 15 V across the output device. This rating is valid over the whole temperature range, so typical values nearly double during a dynamic short circuit test without external gate resistors. Therefore, the additional booster circuit common to older designs is not needed anymore for many applications. Since the driver can deliver the output voltage up to the supply voltage in on state and down to GND in off state, the disadvantage of the reduced output voltage of a simple boost circuit can be avoided.

Switching Results
The driver 1EDI60N12AF was evaluated in a test circuit by using the CoolMOS IPZ65R095C7 as load for the driver in a boost configuration running at 50% duty cycle and switching frequency fsw = 1 MHz. The typical total gate charge of the transistor is 45 nC [3]. In this test circuit the power supply voltage was 50 V and the gate driver supply voltage was VCC2 = 12 V. The gate charge resistance and the gate discharge resistance was 1.2 Ω. The output load current was 0.5 A and the supply current of the driver was 56 mA.

With this operation conditions the maximum temperature at the CoolMOS was TCM = 81°C and at the driver with TDrv = 64°C. For this reason, the capacity of the 1EDI Compact is more than sufficient to drive the CoolMOS C7. Even at high switching frequencies the driver shows proper behavior.

Conclusion
The EiceDRIVER Compact family was developed to be operated with a wide range of discrete IGBT, MOS, modules, SiC and GaN switches. One example of the thermal performance in a test circuit and one typical application circuit were shown and discussed, both proving the outstanding performance of the new driver family. Due to its innovative design the efforts for the application circuit can be reduced. Wide input supply range and flexible input signal configurations minimize external circuit requirements, complexity and PCB space. The strong driver output and high switching frequency capability eliminates the need for booster stages which, again, saves PCB space and increases overall power density. Several output current / gate current classes and configurations of the driver family guarantee for an optimized system design in terms of layout, performance and cost. With the integrated features and the smart solution of the driver it’s easy to use. Thus, the device family matches the requirements of the applications in a cost-driven, high performance and high power density markets. Further details are available at [4].

Literature
[1] H. Rettinger, “1ED Compact – A new high performance, cost efficient, high voltage gate driver IC family”, PCIM 2014, Germany