IGBT/MOSFET Applications based on Coreless Transformer Driver IC2EDF2012-F

A. Volke [1], M. Herkap [1], B. Strzalkowski [2]

[1] ept GmbH, Max-Planck-Str. 5, D-59581 Warstein, Germany, info@ept.com, Tel.: +49-(0)2902-764-0
[2] Infineon Technologies AG, Balanstr. 59, D-81609 München, Germany

Driver IC's either for IGBTs or MOSFETs are commonly used in several power electronics applications. Here the problem of isolating the high and low side driver stages occurs. Currently almost all of these applications are based on optocouplers, discrete transformers or level-

Driver EMI r uggedness

Besides the insulation capability, a further key point necessa ry for the usage as a driver in an industrial environment is importat: The ruggedness against high dV/dt disturbance and an overall immunity against the change of external magnetic fields. Concerning the 2ED020I12 -F the critical compoent in terms of EMI seems to be the coreless transformer and associated receiver circuitry. Tests conducted have proved that the 2ED020I12 -F is immune against dV/dt of at least 50kV/µs as well as dI/dt

greater than 100

medium to high power applications, but negligible for low to medium power applications.

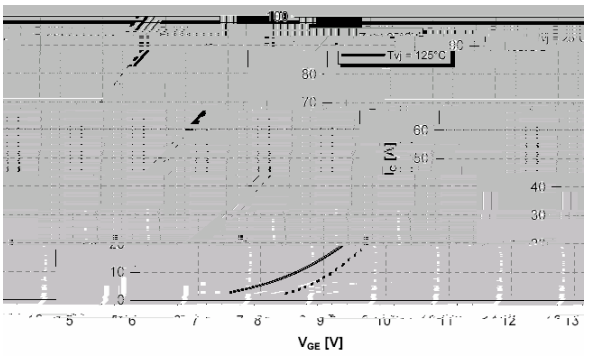

Figure 6: Transfer characteristic

Comparing the turn-on delay times with 0V to +15V and -15V to 15V switching the IGBT has in general lower delay times as shown in a measurement for several values of R_G in Figure 7.

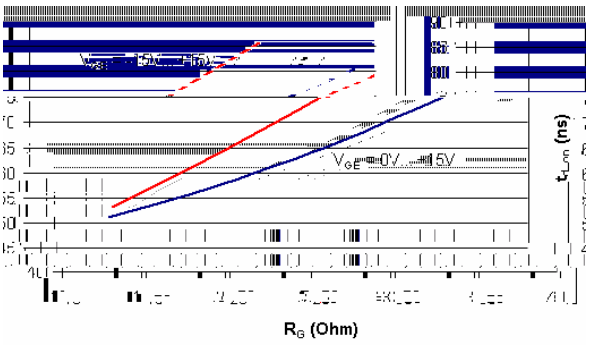

Figure 7: Comparison $t_{d\_on} = f(R_G)$

On the other hand concerning the turn-off delay times with 0V to +15V gate voltage the IGBT has larger delay times than with a -15V to +15V driver stage as shown in Figure 8.

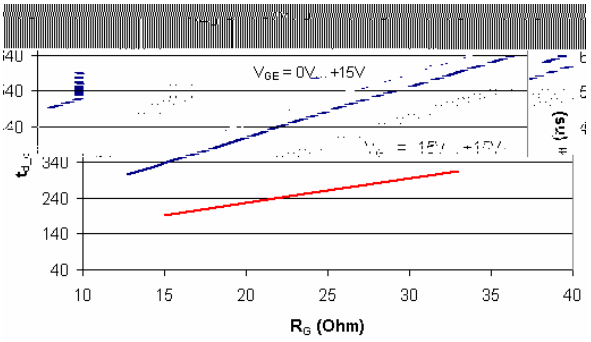

Figure 8: Comparison $t_{d\_off} = f(R_G)$

Applications

The 2ED020I12-F is a driver IC not only for IGBTs, but due to the rated maximum switching frequency of up to 60kHz without degradation also suitable for MOSFETs. This opens the way for applications like

- 3-phase low and medium power converters for AC and BLDC drives
- H-Bridges for DC drives or SMPS

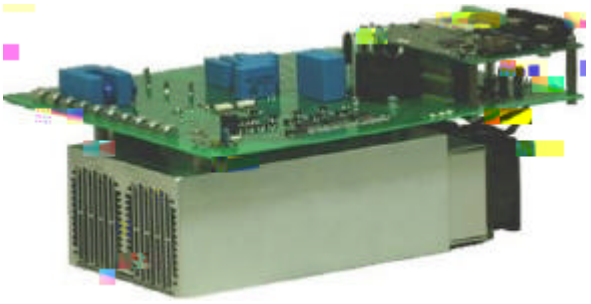

Figure 9: 15kVA converter with 2ED020I12-F

External circuitry

A convenient solution for the power supply of the high side of the driver is realized by a bootstrap circuit. As an alternative a separate floating power supply provided by an SMPS might be used. The simple bootstrap circuit contains a suitable diode and capacitor. The selection of these devices is determined by several factors:

- The blocking voltage of the diode must withstand the DC-Link voltage. Thus, for 800V systems a 1200V diode is the proper choice.
- The voltage provided by the capacitor has to be maintained at a value greater than the UVLO threshold of the driver. The value of the bootstrap capacitor can

work as an additional common lowside emitter or source resistor.

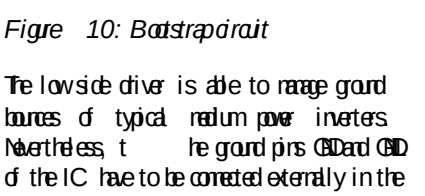

Figure 10: Bootstrap circuit

The lowside driver is able to manage ground bounces of typical medium power inverters. Nevertheless, the ground pins GND and GND of the IC have to be connected externally in the

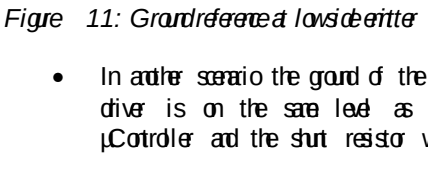

Figure 11: Ground reference at lowside emitter

- In another scenario the ground of the driver is on the same level as the µController and the shunt resistor will

threshold – set by R7 and R8 – of the comparator is reached. The benefit of this circuit is that one driver IC handles one half-bridge not only for switching the power semiconductors, but also for measurement tasks. No further discrete OpAmps or comparators are needed.

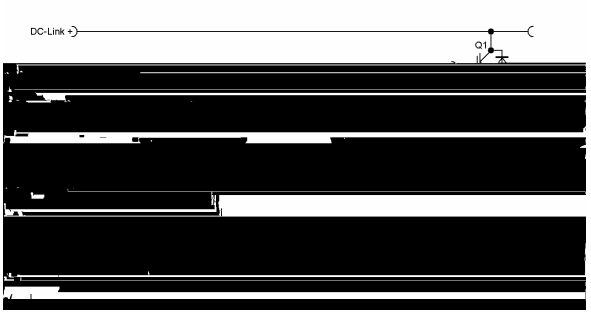

Figure 14: Positive OC/SC detection

Another, more complex possibility would be combining the OpAmps and comparators of several driver IC's (for example in 3-phase converters with a shunt resistor placed in the negative DC-Link).

isolation of up to 1200V. Furthermore, the demand for the combination of safety isolation, high reliability, and low production costs for analog-to-digital converters (ADC) leads to the development of a sigma-delta ADC with coreless transformer. Target applications will be shunt current measurements for instance in individual phases of 3-phase converters, potential free measurement of PTC/NTC resistors, and DC-link voltages. Figure 18 shows an application with six CLT single driver IC's and six CLT ADC. All of them with safety isolation to drive and control a 3 phase motor.

Figure 18: Application with ADC's and driver IC's of eupec EiceDRIVER™ family

Conclusion

The potential of the coreless transformer technology implemented in the driver IC 2ED020I12-F – and soon also in driver and analog-digital-converters [illegible]