The 1200 V TRENCHSTOP™ IGBT7 S7 and EC7 technology, portfolio and applications

About this document

Scope and purpose

The 7th generation of discrete IGBT and diode technology with outstanding performance has been released as a flexible series to supersede Infineon's short-circuit rated TRENCHSTOP™4 based family. The scope of this application note is to walk designers through the technology and provide them with its product and application benefits, helping them to get the most out of it.

Intended audience

This document is intended for engineers who want to design an electric converter.

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1 Introduction

1.1 The 1200 V TRENCHSTOP™ IGBT7 S7 and EC7 diode technology

The 1200 V TRENCHSTOP™ IGBT7 S7 and EC7 technology are, respectively, the 7th generation of insulated gate bipolar transistor and emitter controlled diodes, the cross-sections of which are shown in Figure 1. The IGBT technology, based on micro-pattern trenches with sub-micron mesas, has been specially designed to provide strongly reduced static losses ($V_{CE(sat)}$), a high level of controllability (dV/dt), and a short-circuit withstand time capability (t_{SC}). The EC7 diode field-stop region has been designed to provide enhanced softness, without compromising the blocking voltage even at high V_{DC}, high temperature and very low current, reducing to a minimum the oscillatory behavior even under harsh conditions. Thanks to the combination of the above-mentioned technologies, the current co-packed discrete 1200 V TRENCHSTOP™ IGBT7 S7 and EC7 diode portfolio is the best fit for electric power converters requiring e.g. moderate switching frequencies (≤ 20 kHz), relatively slow switching events (≤ 10 kV/µs) and short-circuit robustness. Target applications include general purpose drives (GPD), servo drives, heating ventilation and air conditioning (HVAC), etc. in 3-phase, two- level, or 3-level NPC topologies.

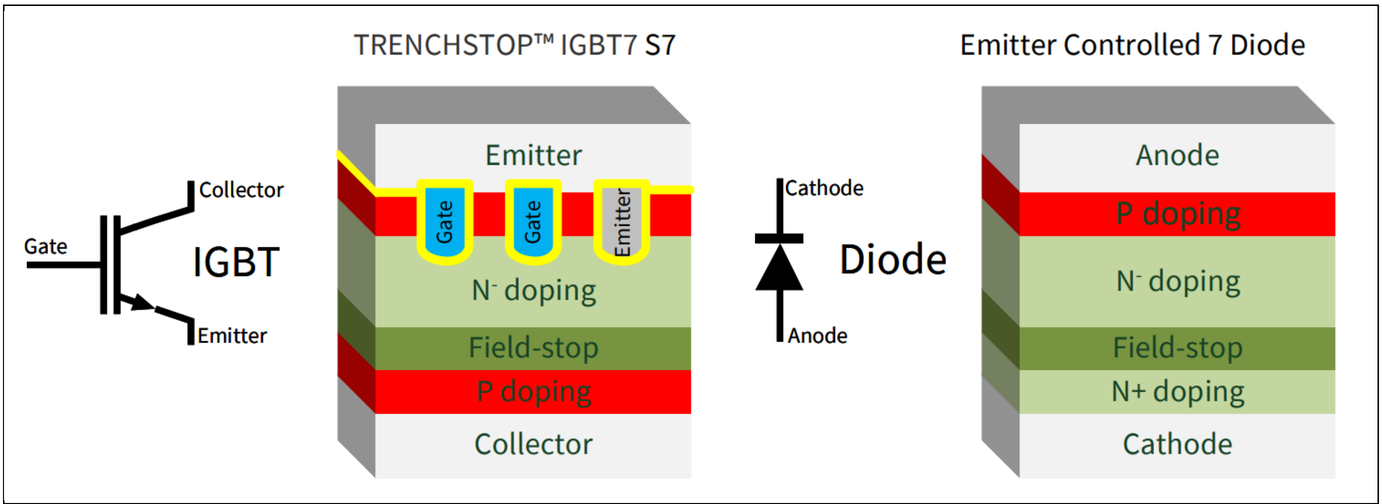

Figure 1 **1200 V TRENCHSTOP™ IGBT7 S7 and EC7 diode cross-section**

A closer look at the design in Figure 1 shows how trenches can be used as active gates (center), dummy gates (left), and emitter trenches (right). And a deeper dive into the significance of the design and tailoring of the trenches shows how they can affect the technology in terms of statics and dynamics.

- **Active gates** are responsible for channel creation. Consequently, their higher density improves static losses (steeper output characteristics), affecting the short-circuit current, and thus, a lower short-circuit withstand time. In dynamic terms, the main influence of active gates is in the C_{GE}.
- **Dummy gates** and **emitter trenches** are not responsible for channel creation (inactive trenches). Consequently, in terms of static losses, their density counteracts the effect of active gates. In dynamic terms, dummy gates mainly influence the C_{GE}, while emitter trenches affect the C_{CE}.

Therefore, the ratio of dynamic gate potential versus emitter potential trenches sets the C_{CG}, also known as Miller capacitance, which is responsible for the controllability of the device. The ability to adjust the dV/dt slope via the gate resistor is a significant feature, especially in applications sensible to load insulation aging and electromagnetic interference [1] [2].

1.2 Discrete through-hole portfolio

All components need to be assembled in packages, in this case, discrete packages. This application note describes the package, the bonding wires, and the importance of the surroundings of the chips. It explains how the 1200 V TRENCHSTOP™ IGBT7 S7 and EC7 diode can, to a certain extent, diversify its value proposition on the market owing to the assembly methods. Figure 2 shows the currently available portfolio of discrete products, highlighting the following:

- current rating segmentation, ensuring perfect system scalability within the product family
- viability of reducing turn-on losses thanks to the Kelvin-emitter pin in TO247-4 package [3] to meet the requirements of demanding applications in terms of switching frequency
- high-power density achievable with the TO247 PLUS package [4], enabling access to applications such as auxiliary and traction drives for commercial and agriculture vehicles (CAV)
- topology flexibility, e.g., drives for switched reluctance machines (SRM), and diode selection thanks to the single-die IGBT products in TO247 PLUS

Value proposition		• $3xI_{nom}$ RBSOA • Controllability • 8us Short circuit • Low $V_{ce(sat)}$ • EC7 diode softness	+ • ~30% dynamic losses reduction • ~17% more output power	+ • Up to 120% power density increase • Enabling frame size jump	+ • Usable with CoolSiC™ Schottky Diode • Switched reluctance drive topologies
Package		TO247-3 	TO247-4 	TO247-3 PLUS 	TO247-3 PLUS 
Current class [A]	8A	IKW08N120CS7			
	15A	IKW15N120CS7			
	25A	IKW25N120CS7			
	40A	IKW40N120CS7	IKZA40N120CS7		
	50A	IKW50N120CS7			
	75A			IKQ75N120CS7	IGQ75N120S7
	100A			IKQ100N120CS7	IGQ100N120S7
	120A			IKQ120N120CS7	IGQ120N120S7

Figure 2 Discrete through-hole 1200 V TRENCHSTOP™ IGBT7 S7 and copacked EC7 diode portfolio

1.3 Target applications and topologies

As mentioned above, target applications for the discrete through-hole 1200 V TRENCHSTOP™ IGBT7 S7 and EC7 diode include three-phase converters with electrical machines as loads, see Figure 3. Different machines require different variable frequency drives (VFD), each having specific requirements in terms of power, constant-power speed range (CPSR), switching frequency, controllability, overload conditions, and short-circuit withstand time. Usually, low-voltage (400 V_{RMS} to 690 V_{RMS} AC supply) induction machines (IM) and permanent magnet synchronous motors (PMSM) are driven with a standard two-level (B6) topology, however, further improvement in drive efficiency (at the same dV/dt) can be achieved via the 3-level, T-type topology. The 3-level, T-type topology, with 1200 V components in the vertical switching cells, requires 600-650 V rated devices in the horizontal switching cells, finding the perfect fit in the Infineon topology solution 650 V/ 1200 V TRENCHSTOP™ IGBT7 (IKXXXN120CS7 family + IKWXX65ET7 family). Further details and application test results of the above-mentioned solutions can be found in the “Application Test” section.
Furthermore, the 3-level, I-type topology can extend the usage up to 1500 V_{dc} of the 1200 V TRENCHSTOP™ IGBT7 S7 and EC7 diode portfolio, allowing a blocking voltage up to 2400 V. For the neutral point connected diode, Infineon offers several ultra-soft and rapid silicon diodes as well as CoolSiC™ Schottky diodes.
Figure 3 shows another potential application in a 3-phase bi-directional AC-DC converter. It is possible to replace the diode-based rectifier supply unit with a regenerative AC-DC converter in 3-phase, grid-supplied VFDs (no need to dissipate power with the braking leg – the power fed back to grid). Additionally, the bi-directional approach improves the current total harmonic distortion (THDI) absorbed from the grid (~ factor of 10 with respect to the 6-pulse diode rectifier). Last but not least, it improves the immunity of the DC voltage bus against short-term fluctuations in the mains power supply voltage.

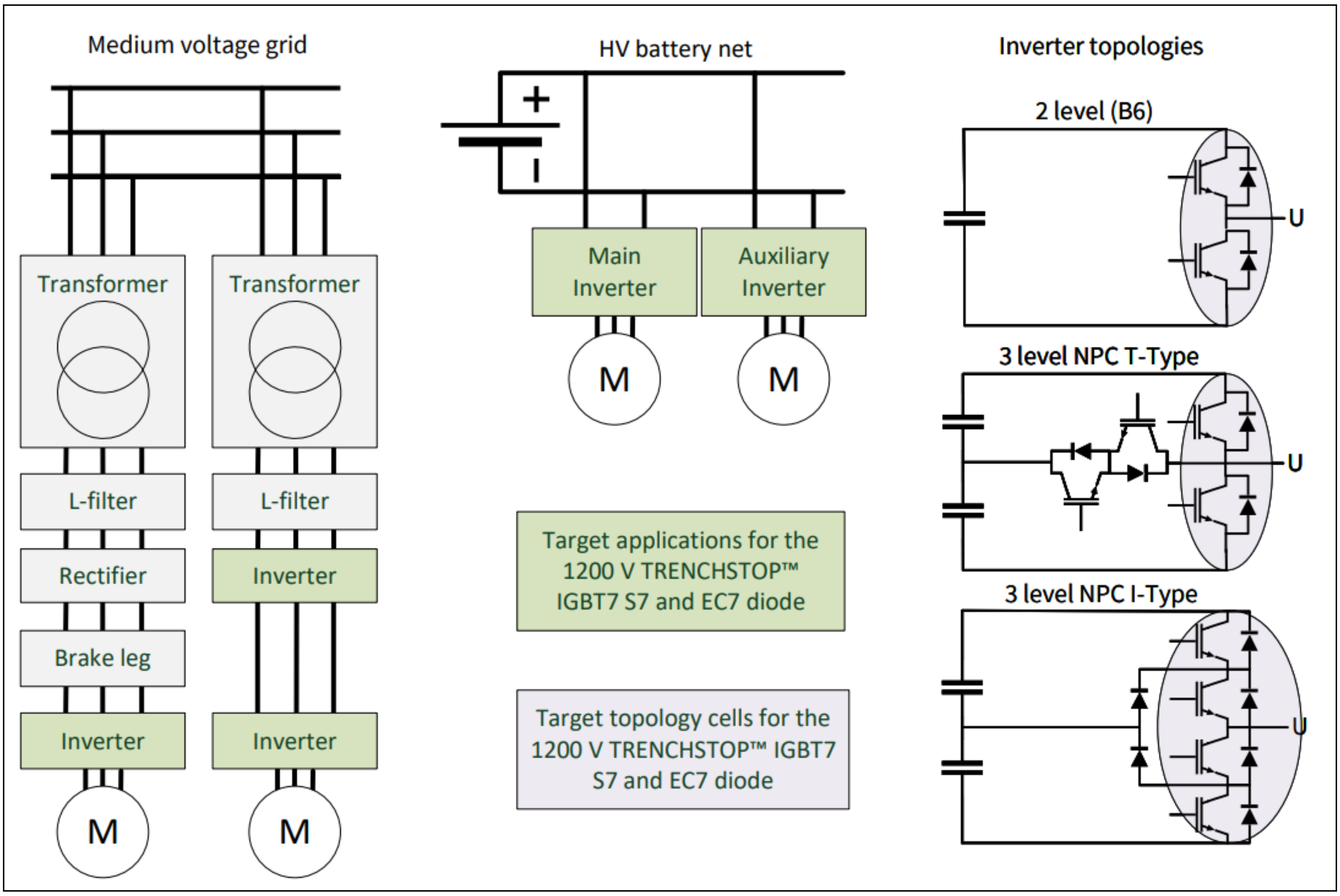

Figure 3 Target applications and topologies in grid and battery supplied nets

2 Static performance

2.1 IGBT collector-emitter saturation voltage ($V_{ce(sat)}$) and DC current (I_c), diode forward voltage (V_F) and diode forward current (I_F)

The on-state voltage drop across the collector-emitter pin represents the static performance of the device. This voltage drop is a function of the collector current, the gate-emitter voltage and temperature. Infineon rates by current density the discrete 1200 V TRENCHSTOP™ IGBT7 S7 and EC7 diode family. In fact, $V_{ce(sat)\ 25°C}$ = 1.65 V and $V_{F\ 25°C}$ = 1.65 V are constant across all current classes of the product family. However, Infineon DC collector current and diode forward current at T_C = 100 °C is well above the nominal current defined for $V_{ce(sat)\ 25°C}$ = 1.65 V and $V_{F\ 25°C}$ = 1.65 V. This brings additional value to the market for our 1200 V TRENCHSTOP™ IGBT7 S7 and EC7 diode family, e.g., a 40 A rated IGBT and diode (IKW/IKZA-40N120CS7) can withstand 56 A DC collector current and 46 A diode forward current at T_C = 100 °C, before the T_{vj}=175 °C. Figure 4 highlights the benefits of the discrete 1200 V TRENCHSTOP™ IGBT7 S7 and EC7 diode family compared to other short-circuit rated 1200 V discrete products from competitors. The IKQXXXN120CS7 (TO247-PLUS) products DC collector current and diode forward current at T_C = 100 °C are limited by the bonding wire capability and not by a T_{vj} of 175 °C. Therefore, Infineon strongly recommends that the datasheet values not be exceeded to avoid overheating of the bonding wires (or T_{vj}>175 °C in other products). It is important to note that the DC collector current and diode forward current do not represent the real maximum output current during operation under a certain switching frequency (for the derating factor, refer to the "Application Test" section).

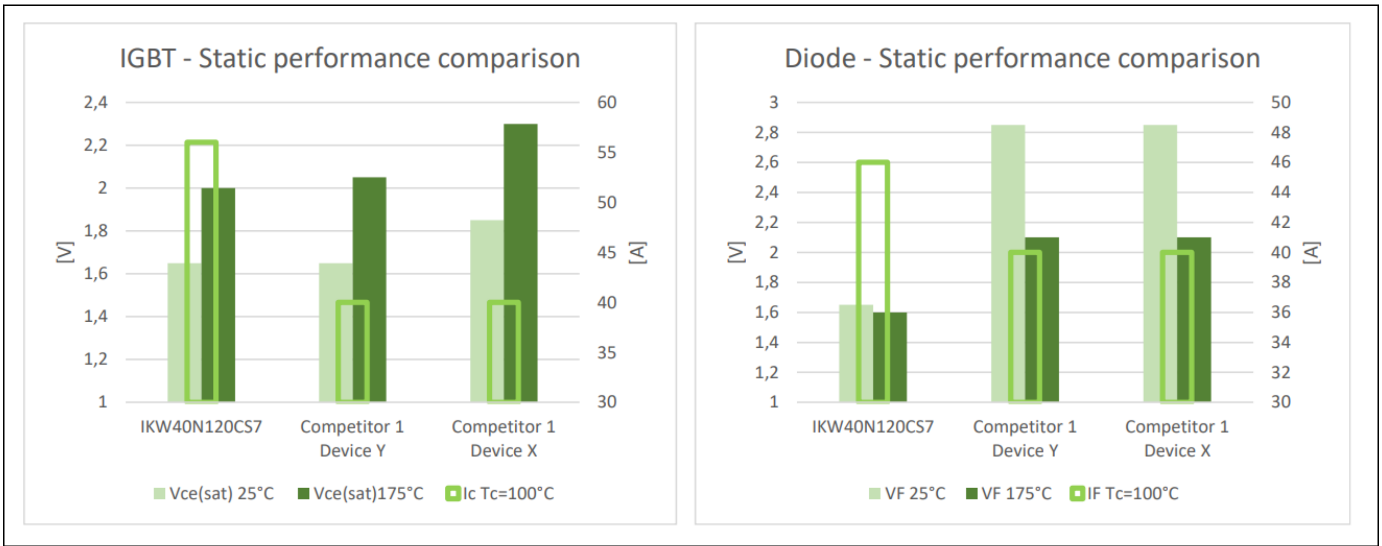

Figure 4 **IGBT and diode static performance comparison**

2.2 Short circuit collector current (I_{sc}) and short circuit withstand time (t_{sc})

One of the main consequences of short-circuit requirements is that the short-circuit collector current must be limited to a value that the chip and the package can withstand for a certain time (short-circuit withstand time t_{sc}). Therefore, given a short-circuit withstand time requirement, the transconductance of the FET is decreased to limit the power delivered to the IGBT die during the event. The decrease in transconductance negatively affects the output characteristics of the designed IGBT technology, decreasing its steepness. Consequently, the on-state voltage drops increase across the collector-emitter pin (static losses). In a nutshell, the system's efficiency is sacrificed proportionally to the required short-circuit withstand time. Infineon's goal is thus to educate converter designers, helping them to identify short-circuit events and react to them as quickly as possible by providing easy and inexpensive system solutions for short-circuit detection within 1 µs, either with the DESAT 1ED-F2 family [5] or the DC bus shunt [6]. Focusing again on the robustness of the 1200 V

TRENCHSTOP™ IGBT7 S7, Figure 5 illustrates the derating function against T_{vj} and V_{cc}. Furthermore, the short-circuit collector current increases with V_{ge}, therefore, the short-circuit withstand time is affected by the V_{ge}. The $I_{sc}(V_{ge})$ and $t_{sc}(V_{ge})$ functions are plotted in the "Characteristics diagrams" section of each datasheet so that designers can choose the worst-case $t_{sc}(V_{ge}, T_{vj}, V_{cc})$ according to their boundary conditions. Whenever the datasheet graphs do not cover the boundary conditions of the design, linear interpolation can be applied (see Figure 5). For the sake of completeness, Infineon applies margins in the t_{sc} datasheet. In fact, the IGBT short-circuit withstand time before destruction (without a margin) is higher than the datasheet value, see Figure 5 (150°C without a margin). However, Infineon does not recommend that datasheet value and conditions be exceeded.

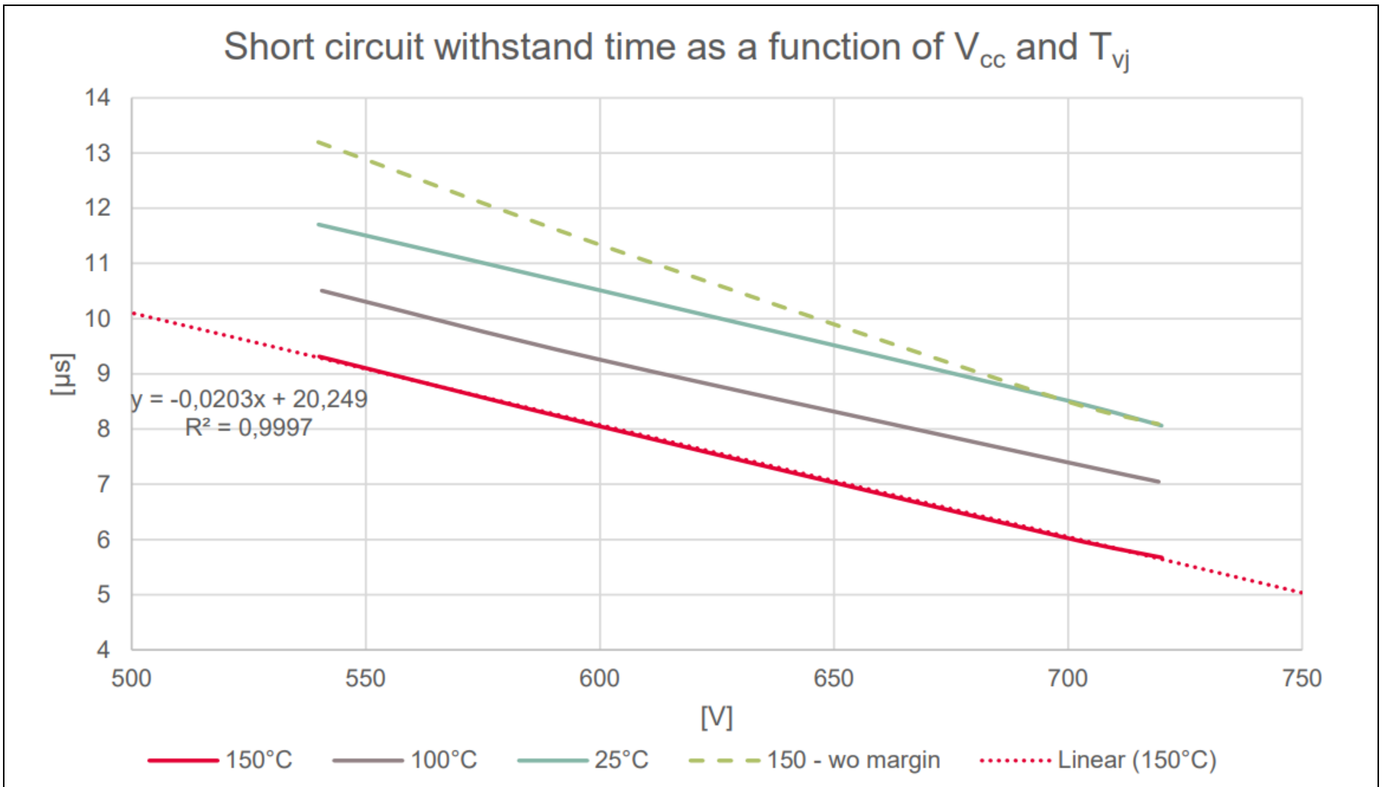

Figure 5 **IGBT short circuit withstand time derating function – $t_{sc}(T_{vj},V_{cc})$**

2.3 Maximum collector-emitter voltage (V_{ce}) and repetitive peak reverse voltage (V_{rrm})

The discrete 1200 V TRENCHSTOP™ IGBT7 S7 and EC7 diode family datasheets clearly define the voltage class of the device by the collector-emitter voltage (V_{ce}) and the repetitive peak reverse voltage (V_{RRM}). These parameters represent the blocking voltage capability of the IGBT and diode, while respecting the zero-gate voltage collector current (I_{CES}) and reverse leakage current ($I_{R,}$) values, both T_{vj}=25°C and 175°C, in the datasheet. The reverse bias safe operating area (RBSOA) graph further specifies the operability conditions of the device, excluding the linear usage of the 1200 V TRENCHSTOP™ IGBT7 S7 and EC7 diode family. Although Infineon 1200 V TRENCHSTOP™ IGBT7 S7 and EC7 diodes have higher breakdown voltage than the maximum blocking voltage specified in the datasheet, see Figure 6. In previous technologies, e.g., IGBT in 2nd generation TRENCHSTOP™, the parameter collector-emitter breakdown voltage ($V_{(BR)CES}$ at Vge=0 V, Ic=500 µA) defined the voltage class of the device. Although shown in Figure 6 breakdown voltage measurements should be avoided as this endangers the devices and the resulting values may show fluctuating behavior.

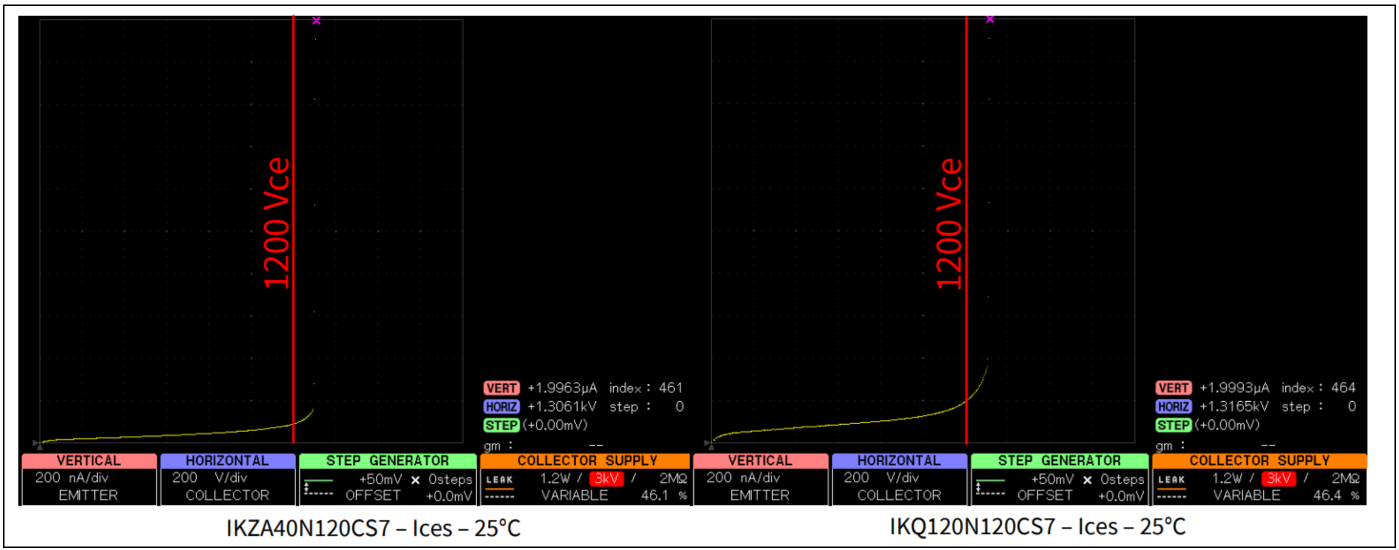

Figure 6 **1200 V TRENCHSTOP™ IGBT7 S7 I_{CES} at 25°C**

2.3.1 High temperature high humidity reverse bias (HV-H3TRB)

Nowadays, reliable and durable power converters are clearly a must. Environmentally demanding applications, e.g., solar converters, are widely increasing, together with challenges presented by harsh environmental conditions, in particular temperature and humidity. That is why Infineon has applied new qualification strategies to their latest semiconductor technologies. To see the qualification tests, please refer to the QPAC of the device. The HV-H3TRB is a test with three stress factors: temperature, humidity, and high voltage. The HV-H3TRB test represents a holistic approach to reliability in demanding environmental conditions. The 1200 V TRENCHSTOP™ IGBT7 S7 and EC7 diode family qualification includes 1000-hour testing of the high temperature high humidity reverse bias (HV-H3TRB) at an ambient temperature of 85°C, relative humidity of 85 %, and V_{CE} of 80% (V_{CE_max}=960V). The pass or fail criteria are determined by the datasheet values reached after 1000 hours of monitoring zero-gate voltage collector current (I_{CES}) and reverse-leakage current (I_R).

3 Dynamic performance

3.1 Gate charge and Gate capacitances

To assess the dynamic performance of an IGBT as mentioned in Section 1.1, the first parameters to look at are the Q_{GE} (C_{GE}) and Q_{GC} (C_{GC} Miller capacitance), the sum of which is the gate charge (Q_G). Specifically, Q_G represents the charge that must be injected into or removed from the gate to take the IGBT from the “cut-off” region to the “saturation” region, and vice versa. This is basically the essence of its dynamic performance, since the gate charge also strictly affects the gate driver selection, the secondary side supply, and in general, the gate driver board design. A rule of thumb for the gate driver design is:

$$I_{GATE(AVG)} = Q_G * f_{sw} \rightarrow P_{GATE(AVG)} = I_{GATE(AVG)} * \left(V_{G(ON)} - V_{G(OFF)}\right)$$

The 1200 V TRENCHSTOP™ IGBT7 S7 MPT technology has a significantly higher (~20%) gate charge compared to Infineon’s previous technology targeting the same applications, e.g., IGBT TRENCHSTOP™ 2nd generation. Hence, when replacing components, designers should check the capability of the gate driver and circuitry to deliver +20% average power. On the other hand, the higher $C_{GE} / \sum C_{TOT}$ (S7 ~0.98 versus T2 ~0.90) in combination with the still high $C_{GC} / \sum C_{TOT}$ are two factors in favor of the IGBT7 S7 MPT technology, which enables high controllability (Figure 7) and robustness with respect to re-turn on phenomena.

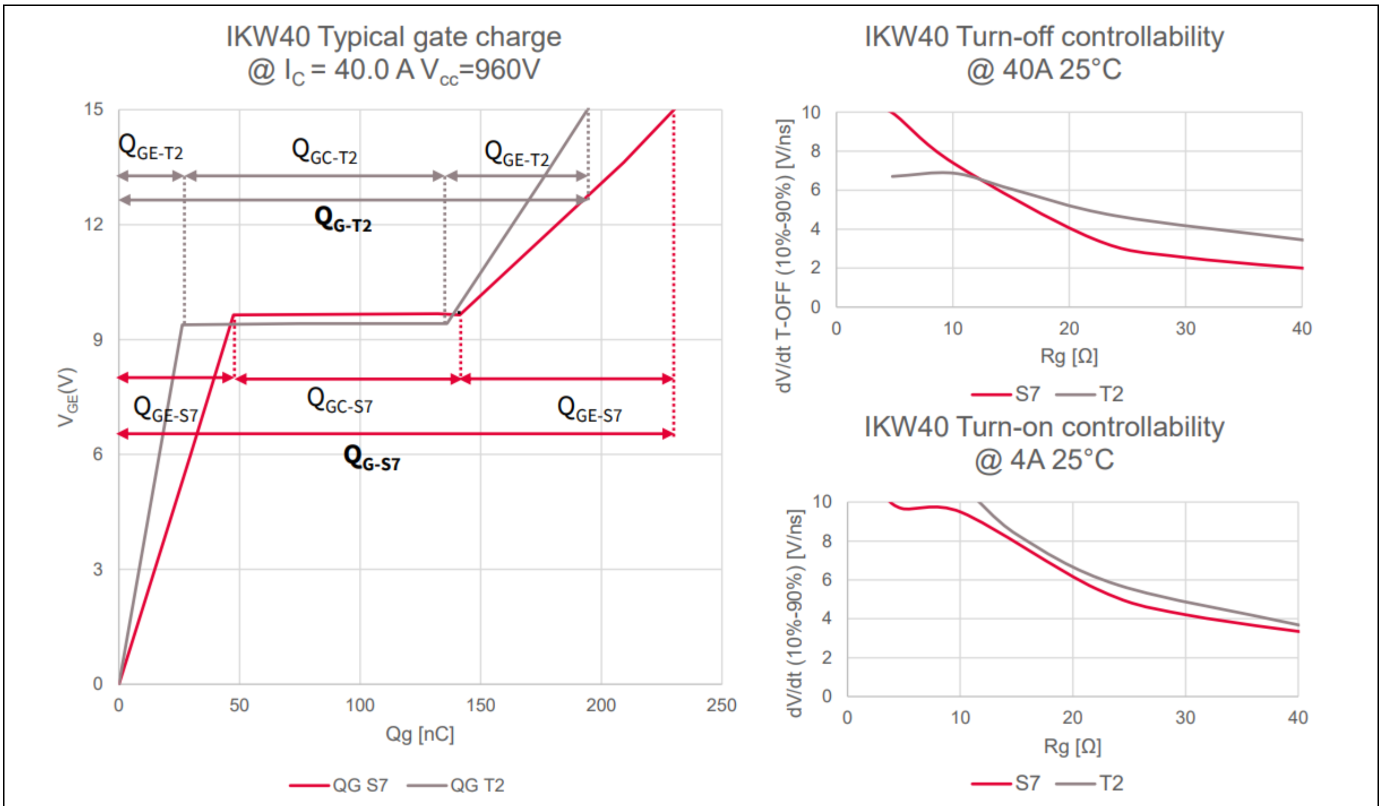

Figure 7 **The 1200 V TRENCHSTOP™ IGBT7 S7 versus T2 gate charge ratio and controllability**

3.2 Turn-on event

Before the real IGBT turn-on occurs, the gate current charges the C_{GE} capacitance until the $V_{GE(th)}$ value (timeframe 1 in Figure 9). After that threshold, the collector current starts to flow across the IGBT and the V_{CE} slowly decreases (timeframe 2 in Figure 9). One important effect of this timeframe, affected by the reverse recovery of the diode (trade-off of softness versus losses), is the current overshoot, as well as the dI_c/dt defined by the gate resistor. After the peak overshoot, the V_{CE} starts decreasing drastically; the dV_{CE}/dt is proportional to the gate resistor, since the V_{GE} is settle to the Miller plateau value and it is constant, until the C_{CG} is fully charged (see timeframe 3 in Figure 9). Then the V_{GE} increases, logarithmically, up to the $V_{GE(ON)}$ value, while the V_{CE} follows in saturation mode $V_{CE(sat)}(V_{GE})$ (see timeframe 4 in Figure 9).

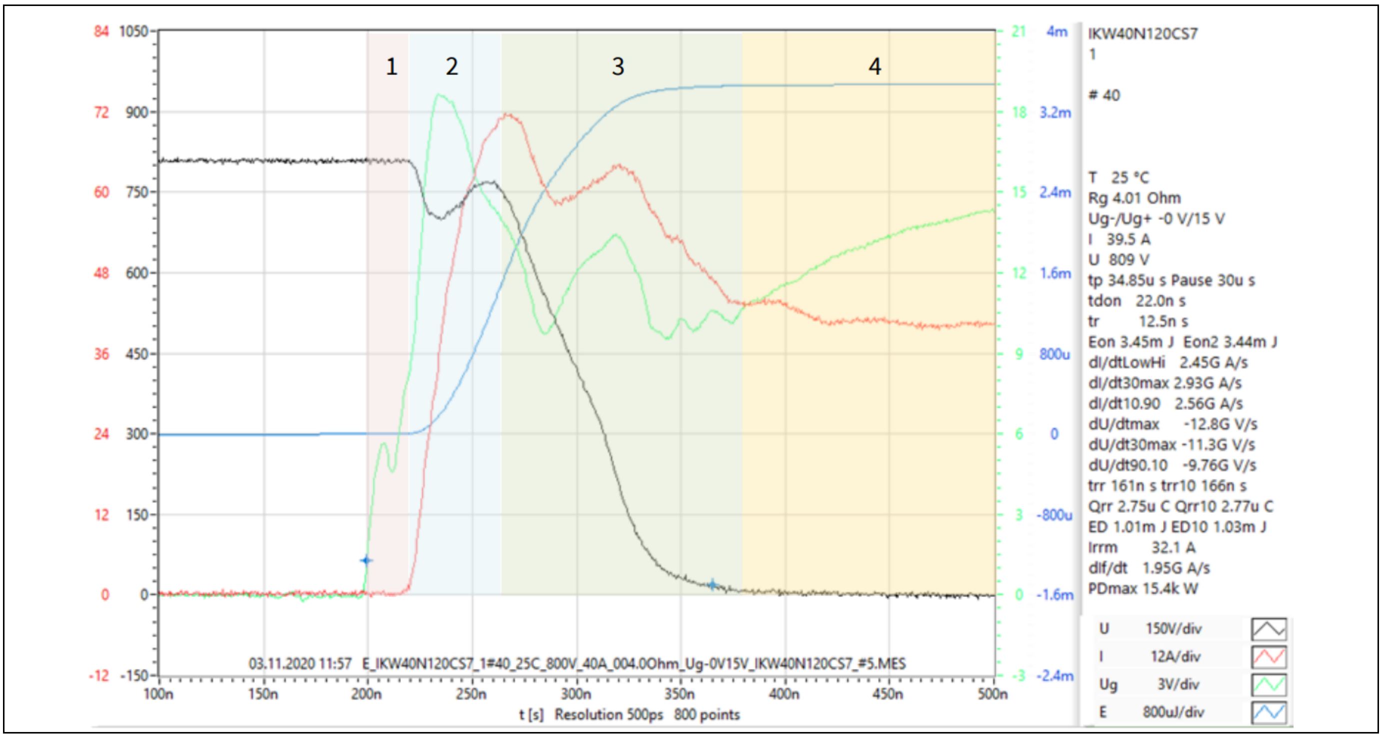

Figure 8 IKW40N120CS7 turn-on event description by timeframe

As stated previously, the gate resistor is the main influencer of the IGBT turn-on event. However, other conditions also affect turn-on performance, such as T_{vj}, I_C, V_{CE}, V_{GE}, and board parasitics. Designers should therefore consider all the effects of the boundary conditions to collect the worst-case conditions for their design. Ideally, the R_{GON} should be as low as possible to reduce energy to a minimum during turn-on events. But besides efficiency, some application requirements, such as insulation stress, electromagnetic compatibility, and interference demand a higher R_{GON}. As an example, a non-integrated, general-purpose drive (VFD, machine cable-connected) application requires a maximum dV/dt of 5 kV/µs. We see in Figure 9 how to design the turn-on gate resistor R_{GON}= ~25 Ω (worst-case conditions with 10% I_{nom}, 25°C and L_{σ}=70 nH). In terms of parasitic interference, the impact of a lower parasitic inductance (L_{σ}=35 nH) is emphasized. Infineon usually tests dynamic performance in a specific double pulse test (DPT), the board for which is designed to minimize the L_{σ}, reducing its impact on dynamic losses as much as possible. Nevertheless, real application boards often differ from the optimized DPT board (usually having higher L_{σ}). Infineon therefore suggests that designers test the dynamic performance under real board conditions so that the R_G values selected are not exceeded in favor of a worst-case design that is too conservative. Another Infineon solution for meeting the afore-mentioned requirements without compromising efficiency is the combination of the 1200 V TRENCHSTOP™ IGBT7 S7 with the EiceDRIVER™ 1ED32xxMC12H family. The two-level, slew-rate control (2L-SRC) enables on-the-fly gate resistor changes, and further improves dynamic performance, preventing useless additional turn-on losses at high load [7].

3.2.1 The turn on benefits of the Kelvin-Emitter pin

Often the fourth pin is associated with products targeting applications with mid-to-high switching frequencies, without limiting the speed of dynamic events. Certainly, those circumstances are the ones you can gain most from, however, the Kelvin-emitter pin enhances dynamic performance also at moderate speed of the turn-on event. Figure 10 shows a clear example of IKZA40N120CS7 effectiveness in improving dynamic performance during turn-on, enabling ~30% reduction at nominal current in E_{ON} compared to the 3-pin version (IKW40N120NCS7).

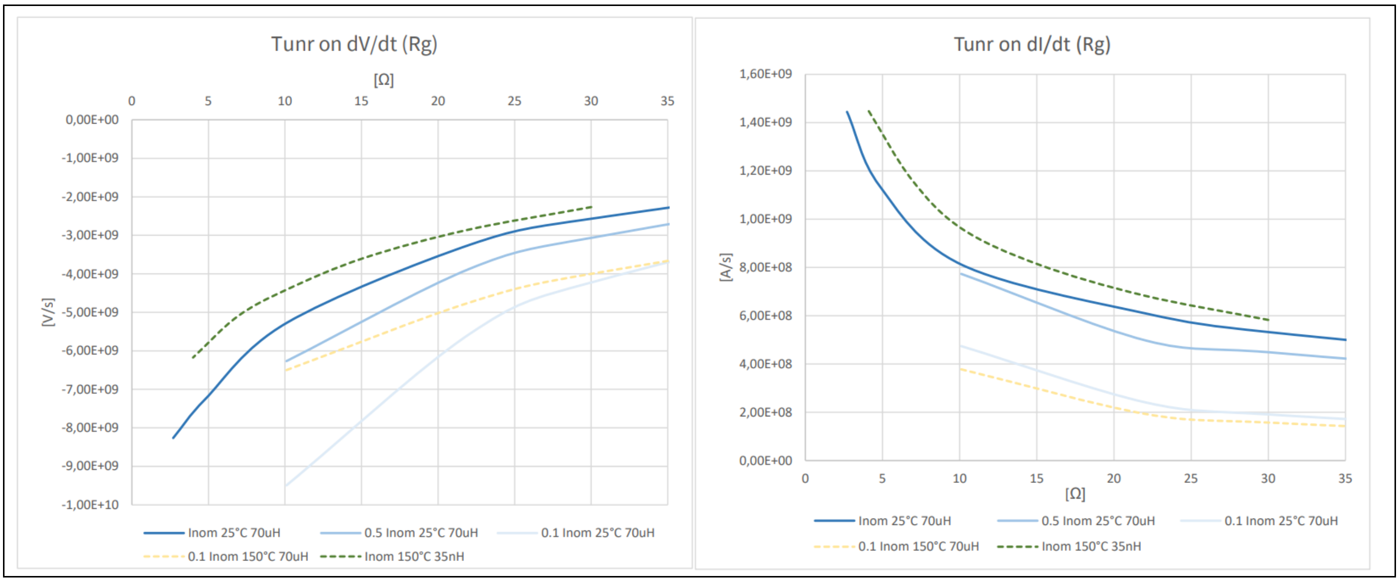

Figure 9 **IKW40N120CS7 turn-on at 600 V V_{GE-}=0 V_{GE+}=15 V, dV/dt (R_g) and dI/dt (R_g) with parasitic inductance, current and temperature influences**

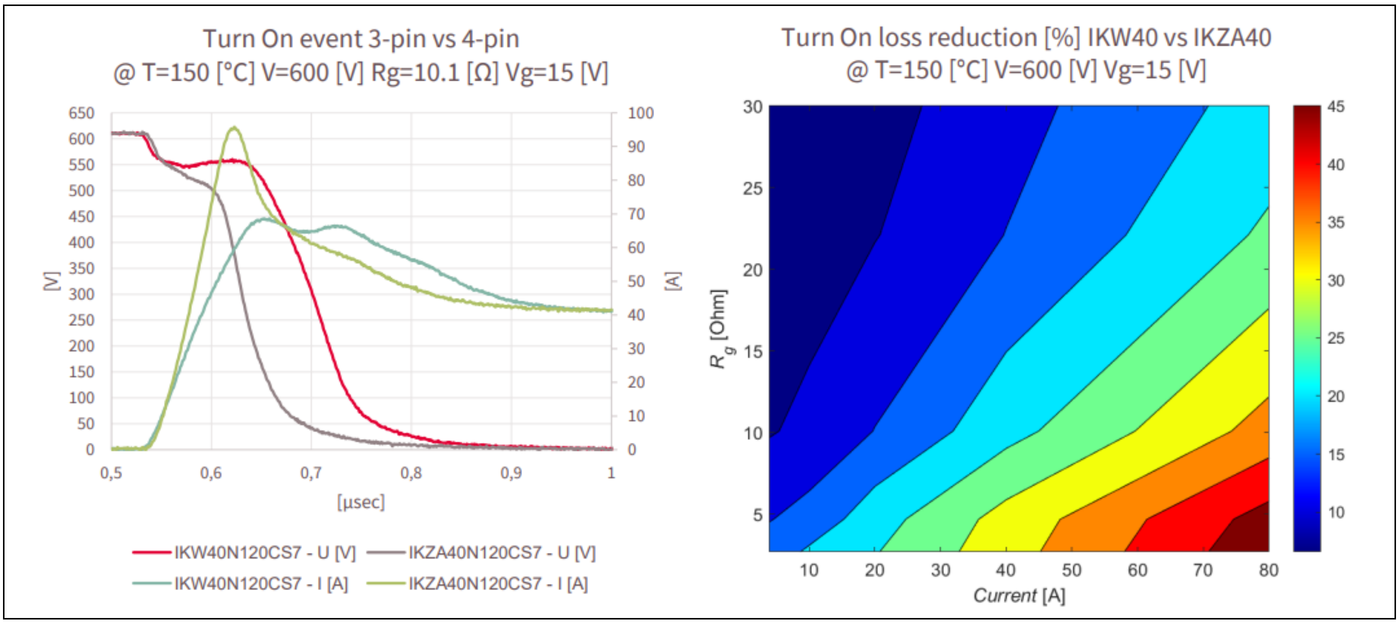

Figure 10 **IKW40N120CS7 vs IKZA40N120CS7 Kelvin emitter pin influences**

3.3 Turn-off event

As with the turn-on process, the IGBT turn-off event starts with the discharge of C_{GE}, proportionally to the value of the R_{GOFF} (see Figure 11, timeframe 1). Then, the V_{GE} settles to the Miller plateau value to discharge C_{CG} with a slight and slow increase of V_{CE} (see Figure 11, timeframe 2). Afterwards, once the remaining Q_{GE} is discharged so that the $V_{GE} < V_{GE(th)}$, the collector current decreases with a steepness that is proportional to its magnitude, thus influencing the speed of the dV_{CE}/dt (see Figure 11, timeframe 3). Finally, the V_{CE} settles to the DC-bus voltage, and the collector current slowly settles to zero (tail current phenomena) due to the minority carrier recombination (see Figure 11, timeframe 4). In hard switching conversion, the last timeframe of the tail current phenomena causes most of the dynamic losses. In fact, this remains the main critique of IGBT technologies compared to Si MOSFETs or WBG devices. The only way to reduce tail current, and fall time t_f, is to “pay” with higher static losses ($V_{CE(SAT)}$). In each datasheet it is visible that R_{GOFF} higher values increases the $t_{d(OFF)}$, defined as the time from the 90% V_{GE} to the 90% I_C (see Figure 11, timeframes 1, 2, and partially 3), but not impacting the current slope significantly. Consequently, increasing R_{GOFF} does not result in any additional energy losses during turn-off (no influence in fall time t_f). Figure 12 also shows that the 1200 V TRENCHSTOP™ IGBT7 S7 dV/dt is slightly influenced by temperature, crossing 5 kV/us (GPD requirement application) with R_{GOFF} between 16 and 18 Ω for the whole temperature operation range. With these values also the dI/dt stays below the limit that could harm the electromagnetic compatibility and interference.

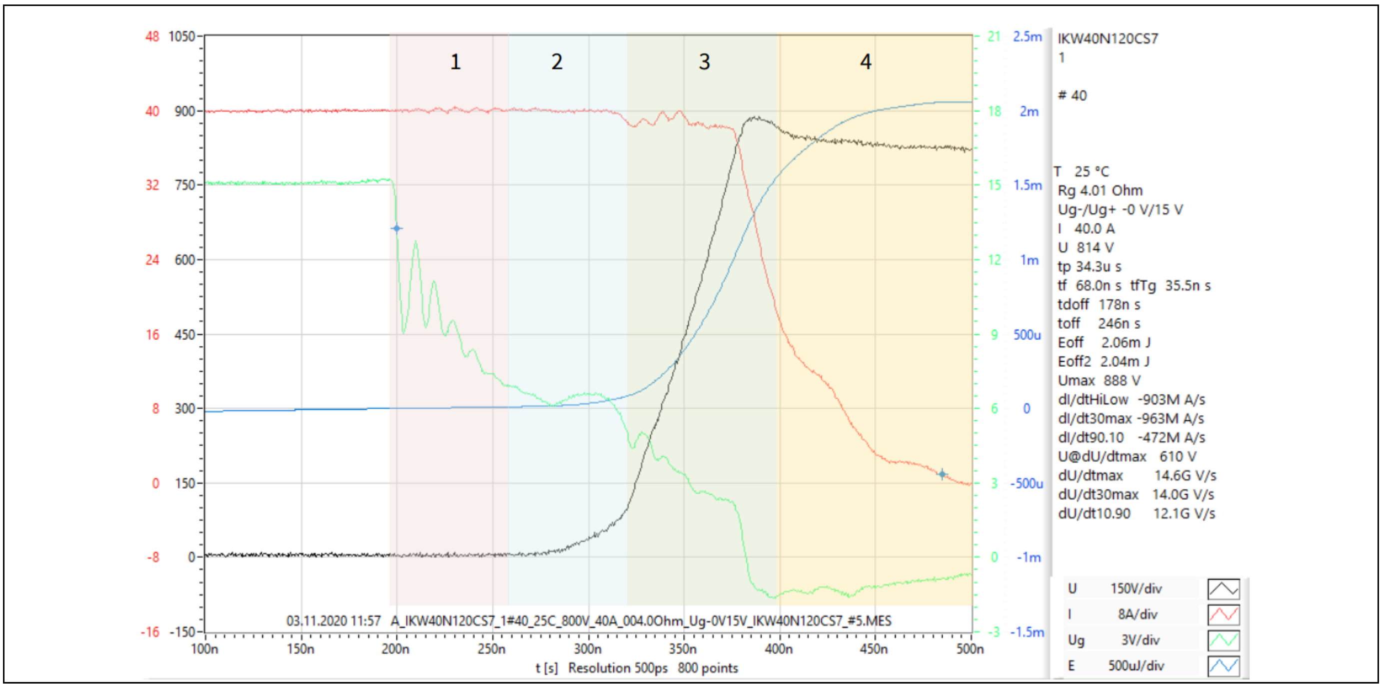

Figure 11 **IKW40N120CS7 turn-off event description by timeframe**

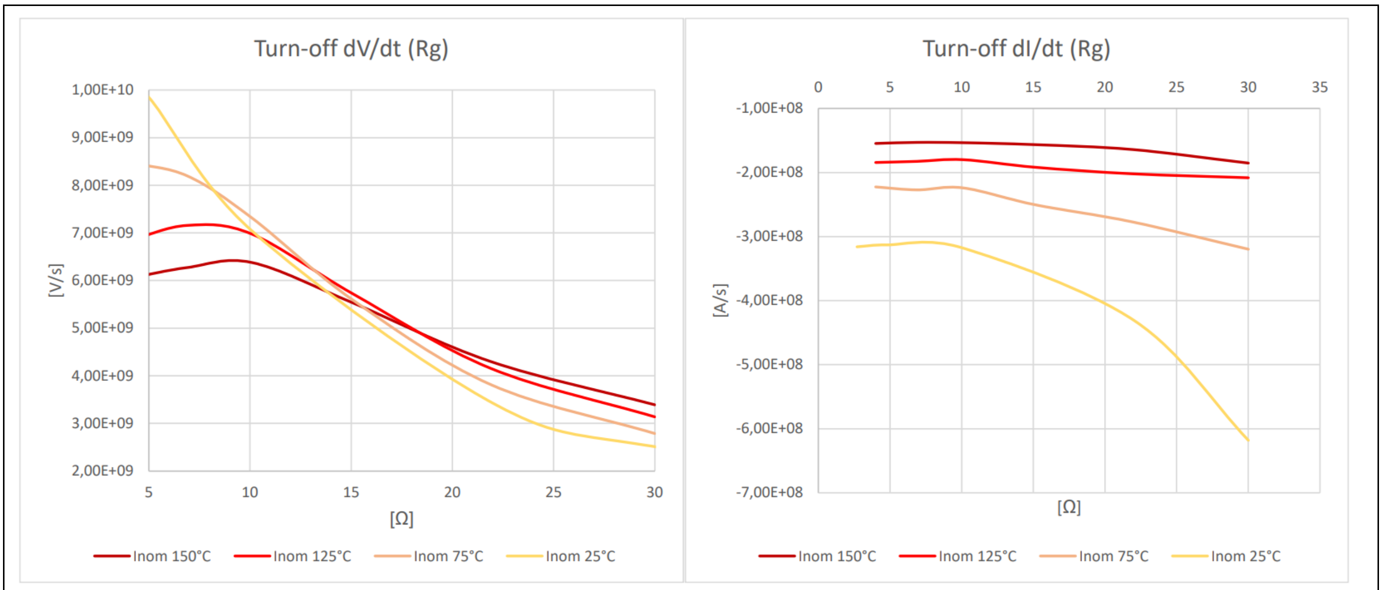

Figure 12 **IKW40N120CS7 turn-off at 600 V V_{GE-}=0 V_{GE+}=15 V, dV/dt (Rg) and dI/dt (Rg) with temperature influences**

4 Application performance

In general, the real application performance of the devices is influenced by several factors, which more or less compromise the full potential output current, I_F and I_{DC}(T_C = 100 °C), of the product. Since we cannot list all the influences here, we will focus on the main derating factors, including switching frequency, the thermal interface between case and heat sink, heat sink cooling, mounting and torque, topology, the type of conversion, the gate voltage level and R_G selection. For one main factor, switching frequency, a rough derating curve based on a PLECS simulation of a DC-AC 2-level converter is depicted in Figure 13.

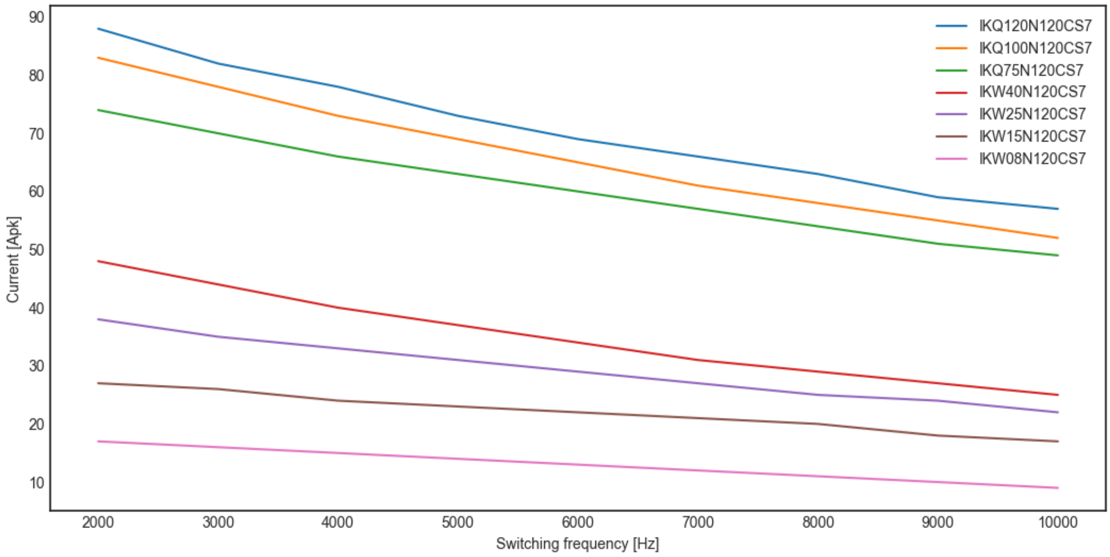

Figure 13 Derating curve of the discrete 1200 V TRENCHSTOP™ IGBT7 family, condition: 600 V_{DC}, Rth_{CH}=1 K/W, heat sink temperature=100°C, cos(ϕ)=1, m_{index}=1, f_{ele}=50 Hz, R_G as per datasheet value

4.1 3 phase 2-level general purpose drive < 12 kW

Targeting 3 phase 2-level general purpose drive under 12 kW, the IKW-IKZAXXN120CS7 family is a perfect match. A 10 kW GPD application using IKW40N120CS7 is demonstrated [2], emphasizing the significance of controllability in applications such as GPD. Compared to competitor parts selected among 1200 V 40 A short-circuit (SC-) rated devices in 3-pin TO-247 packages, the 1200 V TRENCHSTOP™ IGBT7 S7 proved to be the best in class. The study led to the following conclusions concerning IKW40N120CS7 (see also Figure 14):

- IKW40N120CS7 improves the output current of the drives up to 25% at T_{case}=130°C compared to similar devices available in the market.
- IKW40N120CS7 increases the reliability of the drives by lowering the T_{case} at Ic=18 A by up to 35% compared to similar devices available in the market.

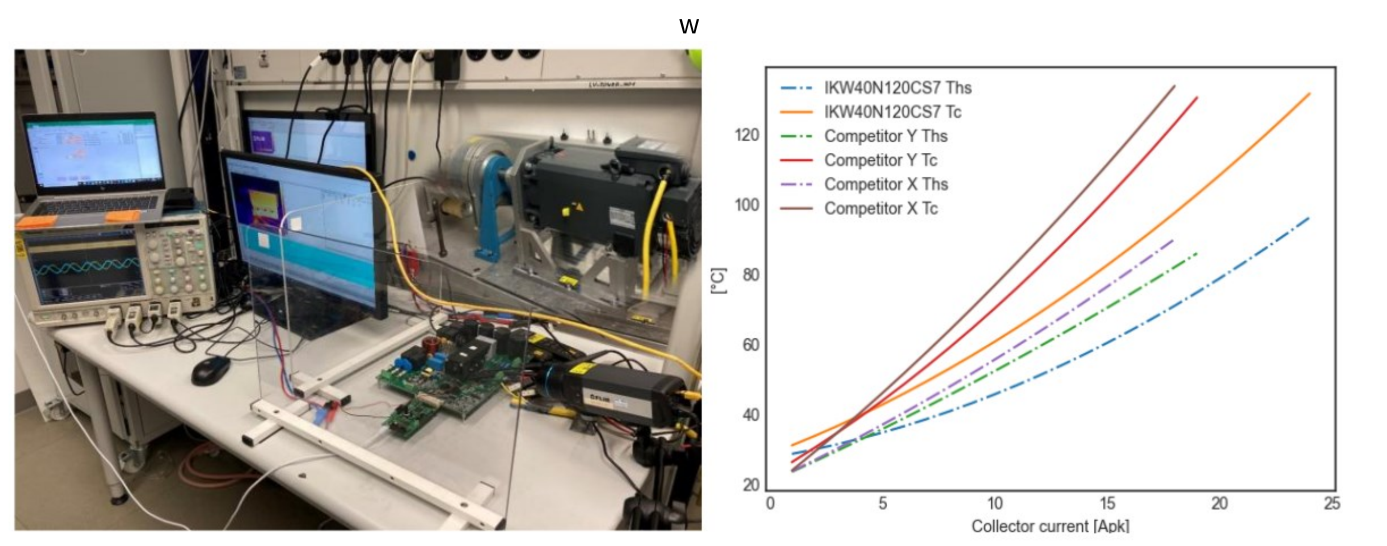

Figure 14 **3 phase 2-level general purpose drive application test set up, case and heatsink temperature function of the collector current**

4.2 3 phase 3-Level T-Type DC-AC converter < 12kW.

Several applications require an interface to the grid, e.g. active front end, which focuses particularly on the current total harmonic distortion (THD_I). These applications generally use different filters (passive component-based) to meet the increasing demands for drawing power from the grid or feeding power into it. Often filters are bulky inductors, so the need for compact, power electronic-based converters is pushing the limits of switching frequency to reduce the size of the filters. Another way to meet the challenge of passive size reduction is to use multilevel converters, such as the neutral-point-clamped T-type (see Figure 3). Moreover, 3-level converters are beneficial for VFD, since they offer the possibility of gaining dynamic performance at the same dV/dt, and reducing the current ripple by half at the same switching frequency, i.e., increased machine efficiency. The 1200 V TRENCHSTOP™ IGBT7 S7, especially the 4-pin version IKZA40N120CS7 combined with the 650 V TRENCHSTOP™ IGBT7 T7, is a good choice for short-circuit rated devices. Moreover, further improvements in dynamic turn-on can be achieved using the CoolSiC™ hybrid discrete, the TRENCHSTOP™ 5 S5 IGBT. Figure 15 shows the waveforms and results in efficiency, compared to the non-short-circuit rated fast IGBTs, such as the 1200 V and 650 TRENCHSTOP™ IGBT7 H7.

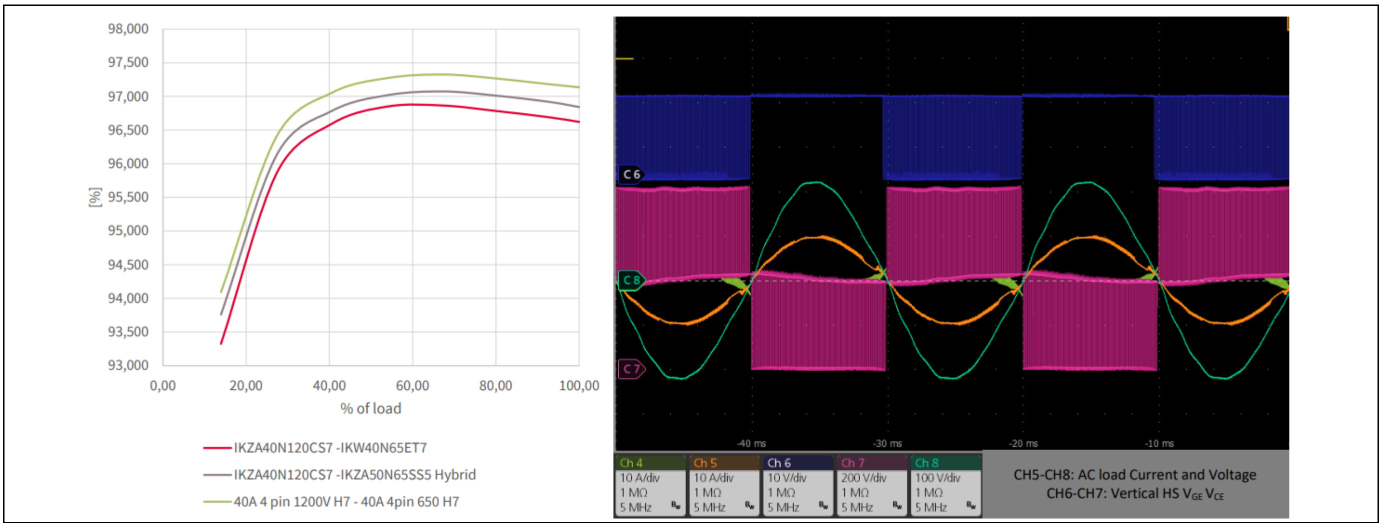

Figure 15 **3-phase, 3-level T-type DC-AC converter operation and efficiency, at 800 V_{DC} cos(ϕ)=1, m_{index}=1, f_{ele}=50 Hz**

4.3 3 phase 2-Level DC-AC / AC-DC converter >12 kW

This subchapter introduces the TO-247 PLUS package, which hosts the newly released chip current classes 75 A, 100 A, 120 A of the 1200 V TRENCHSTOP™ IGBT7 S7 and EC7 diode. The clear value proposition of these products is the enhanced power density of the converter (see Figure 16). Previously, the TO-247 PLUS allowed only up to 75 A, fully rated, co-packed chips of previous Infineon technologies. Nowadays, thanks to the outstanding performance and loss reduction of the 1200 V TRENCHSTOP™ IGBT7 S7and EC7 diode, the PLUS package can host up to 120 A, fully rated, co-packed chips. The benefits include:

- A boost of power density up to ~75% in the same thermal design, and up to ~120% in the improved thermal design (ceramic + thermal grease as thermal interface material).
- A frame-size jump, changing one component in the designer bill of materials (BOM).

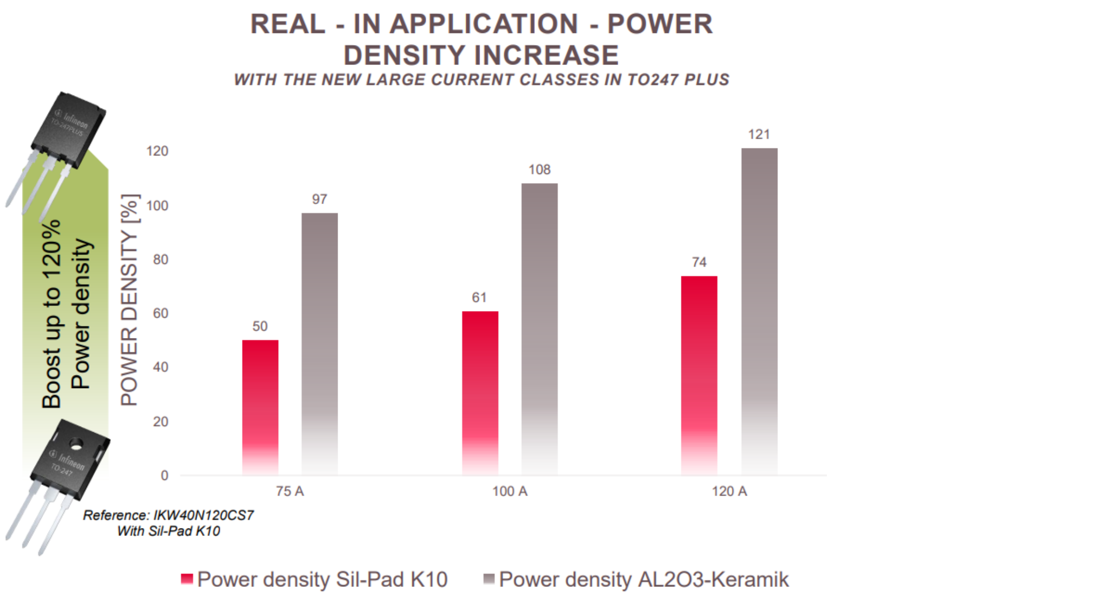

Figure 16 1200 V TRENCHSTOP™ IGBT7 S7and EC7 diode 75 A, 100 A, 120 A in TO-247 PLUS power density improvement. Condition: 800 V_{DC}, heat sink temperature=100°C, cos(ϕ)=1, m_{index}=1, f_{ele}=50 Hz, R_G as per datasheet value

Continuous chip shrinking and current density increases have long been a concern within the power-converter design community. The results of a comparison illustrated in Figure 17 aim to demystify the concern that because of reduced thermal performance, the new-generation chip with higher current density cannot deliver the same output power in the tests as in real application conditions. As clearly shown in Figure 17, the new IKW75N120CS7 delivers extraordinary output current performance, compared to previous generations. In conclusion, decreased thermal performance caused by higher current density is offset by the loss reduction in the new 1200 V TRENCHSTOP™ IGBT7 S7and EC7 diode. Additionally, the test results demonstrate that IKW75N120CS7, with its better performance in terms of output current, can easily replace two, 40 A-rated competitor parts, a feature that would not apply to previous Infineon products, e.g., IKQ75N120CT2.

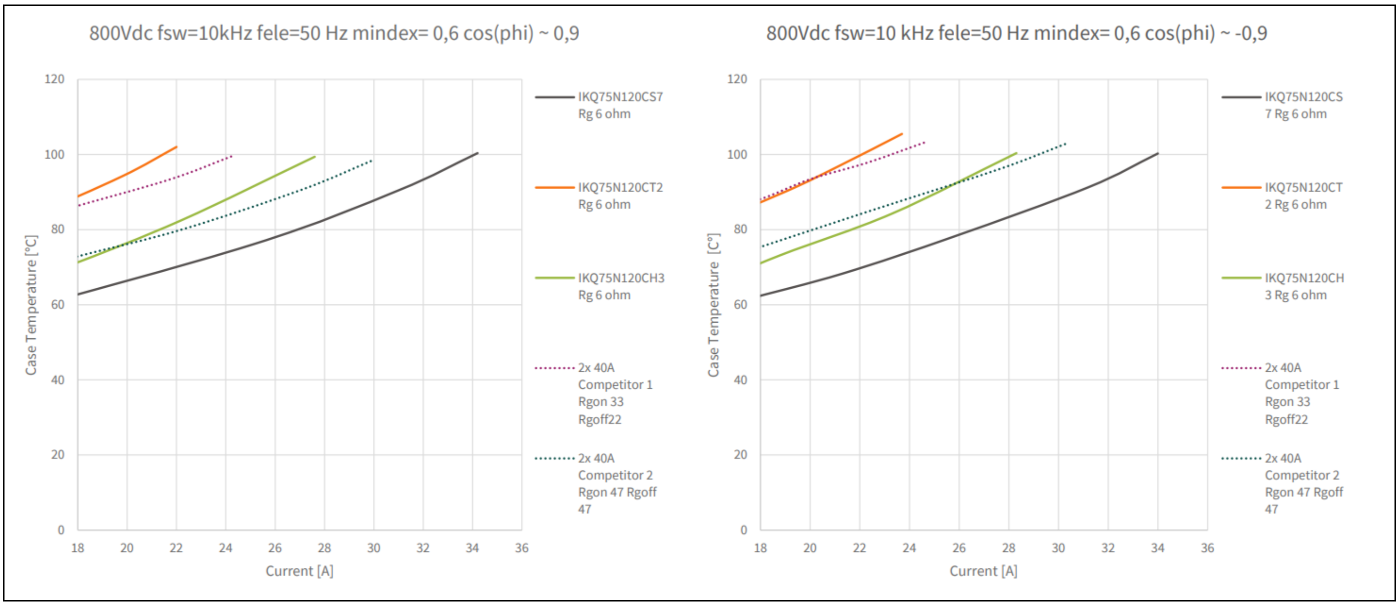

Figure 17 **3-phase, 2-level DC-AC converter IGBT and diode application comparison with Infineon devices and competitors.**

5 Summary and conclusion

The application note describes Infineon's 7th generation of discrete IGBT and diode technology, highlighting the benefits of the product and system level via static, dynamic, and application tests. Furthermore, a comparison with other Infineon technologies and competitors is performed, emphasizing the superior performance of the latest Infineon technology. Finally, the value propositions of the extended discrete portfolio: flexibility, power density, and enhanced dynamic performance are successfully demonstrated via application test benches.

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