

TRENCHSTOP™ 高级绝缘技术

英飞凌高速开关系列第三代 IGBT，与 Rapid 1 快速软反并联二极管集成于完全隔离的封装中

特性：

英飞凌 TRENCHSTOP™ 技术提供：

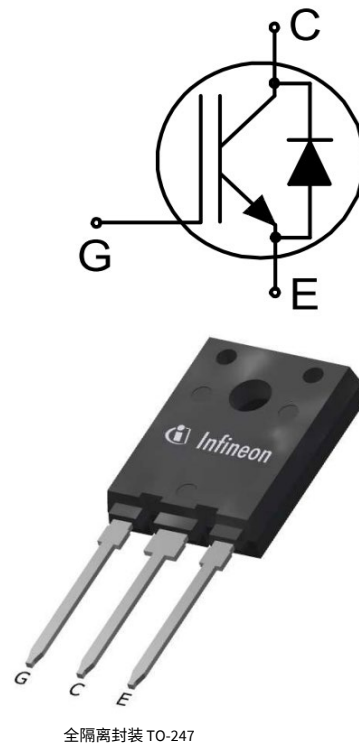
- 低 $V_{CE(sat)}$
- 在 $T_{vj} = 175^{\circ}\text{C}$ 时，短路耐受时间为 $5\mu\text{s}$
- $V_{CE(sat)}$ 正温度系数
- 低电磁干扰
- 极软快速恢复的反并联二极管
- 最高结温 175°C
- $2500 V_{RMS}$ 电气隔离，50/60 Hz， $t = 1 \text{ min}$
- 100% 经过测试的隔离安装面
- 无铅引脚镀层；符合 RoHS 标准
- 完整的产品品类和 PSpice 模型：
<http://www.infineon.com/igbt/>

潜在应用：

- 通用驱动器 (GPD)
- 伺服驱动器
- 工业开关电源
- 工业级不间断电源 (UPS)
- 充电器
- 焊接
- 太阳能组串逆变器

产品验证

符合 JEDEC47/20/22 相关测试的工业应用要求



关键性能和封装参数

Type	V_{CE}	I_C	$V_{CE(sat)}, T_{vj}=25^{\circ}\text{C}$	T_{vjmax}	Marking	Package
IKFW60N60EH3	600V	50A	1.85V	175°C	K60DEH3	PG-TO247-3-AI

本数据手册的原文使用英文撰写。为方便起见，英飞凌提供了译文；由于翻译过程中可能使用了自动化工具，英飞凌不保证译文的准确性。为确认准确性，请务必访问 [infineon.com](http://www.infineon.com) 参考最新的英文版本（控制文档）。

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最大额定值

注意：为了获得最佳的使用寿命和可靠性，英飞凌建议运行条件不超过本数据手册中所述最大额定值的 80%。

Parameter	Symbol	Value	Unit
Collector-emitter voltage, $T_{vj} \geq 25^{\circ}\text{C}$	V_{CE}	600	V
DC collector current, limited by T_{vjmax} $T_h = 25^{\circ}\text{C}$ $T_h = 65^{\circ}\text{C}$ $T_h = 65^{\circ}\text{C}$	I_C	64.0 52.0 63.0 ¹⁾	A
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpuls}	200.0	A
Turn off safe operating area $V_{CE} \leq 600\text{V}$, $T_{vj} \leq 175^{\circ}\text{C}$, $t_p = 1\mu\text{s}$	-	200.0	A
Diode forward current, limited by T_{vjmax} $T_h = 25^{\circ}\text{C}$ $T_h = 65^{\circ}\text{C}$	I_F	80.0 60.0	A
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpuls}	200.0	A
Gate-emitter voltage Transient Gate-emitter voltage ($t_p \leq 10\mu\text{s}$, $D < 0.010$)	V_{GE}	± 20 ± 30	V
Short circuit withstand time $V_{GE} = 15.0\text{V}$, $V_{CC} \leq 400\text{V}$ Allowed number of short circuits < 1000 Time between short circuits: $\geq 1.0\text{s}$ $T_{vj} = 150^{\circ}\text{C}$	t_{SC}	5	μs
Power dissipation $T_h = 25^{\circ}\text{C}$ Power dissipation $T_h = 65^{\circ}\text{C}$	P_{tot}	164.0 120.0	W
Operating junction temperature	T_{vj}	$-40...+175$	$^{\circ}\text{C}$
Storage temperature	T_{stg}	$-55...+150$	$^{\circ}\text{C}$
Soldering temperature, wave soldering 1.6mm (0.063in.) from case for 10s		260	$^{\circ}\text{C}$
Mounting torque, M3 screw Maximum of mounting processes: 3	M	0.6	Nm
Isolation voltage RMS, $f = 50/60\text{Hz}$, $t = 1\text{min}^{2)}$	V_{isol}	2500	V

热阻

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
R th Characteristics						
IGBT thermal resistance, ³⁾ junction - heatsink	R th (j-h)		-	0.77	0.91	K/W
Diode thermal resistance, ³⁾ junction - heatsink	R th (j-h)		-	1.18	1.30	K/W
Thermal resistance junction - ambient	R th (j-a)		-	-	65	K/W

¹⁾ TO-247-3 在 $T_h = 65^{\circ}\text{C}$ 时的等效额定电流，采用参考绝缘材料：152 μm 、1.3 W/mK、标准聚酰亚胺基增强载体绝缘体

²⁾ 有关在应用中正确处理和组装高级绝缘器件的信息，请参阅封装图中的注释。

³⁾ 作用于本体的力 $F = 500\text{N}$ ， $T_a = 25^{\circ}\text{C}$

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电气特性，测于 $T_{vj} = 25^{\circ}\text{C}$ 的条件下，除非另有规定

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Static Characteristic						
Collector-emitter breakdown voltage	$V_{(BR)CES}$	$V_{GE} = 0V, I_C = 0.50mA$	600	-	-	V
Collector-emitter saturation voltage	V_{CEsat}	$V_{GE} = 15.0V, I_C = 50.0A$ $T_{vj} = 25^{\circ}C$ $T_{vj} = 175^{\circ}C$	- -	1.85 2.25	2.30 -	V
Diode forward voltage	V_F	$V_{GE} = 0V, I_F = 50.0A$ $T_{vj} = 25^{\circ}C$ $T_{vj} = 175^{\circ}C$	- -	1.45 1.40	1.75 -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C = 0.80mA, V_{CE} = V_{GE}$	4.1	5.1	5.7	V
Zero gate voltage collector current	I_{CES}	$V_{CE} = 600V, V_{GE} = 0V$ $T_{vj} = 25^{\circ}C$ $T_{vj} = 175^{\circ}C$	- -	- 880	40 -	μA
Gate-emitter leakage current	I_{GES}	$V_{CE} = 0V, V_{GE} = 20V$	-	-	100	nA
Transconductance	g_{fs}	$V_{CE} = 20V, I_C = 50.0A$	-	25.0	-	S

电气特性，测于 $T_{vj} = 25^{\circ}\text{C}$ 的条件下，除非另有规定

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Dynamic Characteristic						
Input capacitance	C _{ies}	V _{CE} = 25V, V _{GE} = 0V, f= 1MHz	-	3216	-	pF
Output capacitance	C _{oes}		-	150	-	
Reverse transfer capacitance	C _{res}		-	90	-	
Gate charge	Q _G	V _{CC} = 480V, I _c = 50.0A, V _{GE} = 15V	-	290.0	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	L _E		-	13.0	-	nH
Short circuit collector current Max. 1000 short circuits Time between short circuits: ≥ 1.0s	I _{C(SC)}	V _{GE} = 15.0V, V _{CC} ≤ 400V, t _{SC} ≤ 5μs T _{vj} = 150°C	-	330	-	A

开关特性、感性负载

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic, at $T_{vj}=25^{\circ}\text{C}$						
Turn-on delay time	$t_{d(on)}$	$T_{vj}=25^{\circ}\text{C}$, $V_{CC}=400\text{V}$, $I_c=50.0\text{A}$, $V_{GE}=0.0/15.0\text{V}$, $R_{G(on)}=7.0\Omega$, $R_{G(off)}=7.0\Omega$, $L\sigma=75\text{nH}$, $C\sigma=30\text{pF}$ $L\sigma$, $C\sigma$ from Fig. E Energy losses include “tail” and diode reverse recovery.	-	27	-	ns
Rise time	t_r		-	37	-	ns
Turn-off delay time	$t_{d(off)}$		-	229	-	ns
Fall time	t_f		-	24	-	ns
Turn-on energy	E_{on}		-	1.74	-	mJ
Turn-off energy	E_{off}		-	0.93	-	mJ
Total switching energy	E_{ts}		-	2.67	-	mJ

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二极管特性，测于 $T_{vj} = 25^{\circ}\text{C}$ 的条件下

Diode reverse recovery time	t_{rr}	$T_{vj} = 25^{\circ}\text{C},$ $V_R = 400\text{V},$ $I_F = 50.0\text{A},$ $di_F/dt = 1000\text{A}/\mu\text{s}$	-	91	-	ns
Diode reverse recovery charge	Q_{rr}		-	1.24	-	μC
Diode peak reverse recovery current	I_{rrm}		-	27.0	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-1955	-	$\text{A}/\mu\text{s}$

开关特性、感性负载

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic, at $T_{vj}=175^{\circ}\text{C}$						
Turn-on delay time	$t_{d(\text{on})}$	$T_{vj}=175^{\circ}\text{C}$, $V_{CC}=400\text{V}$, $I_c=50.0\text{A}$, $V_{GE}=0.0/15.0\text{V}$, $R_{G(\text{on})}=7.0\Omega$, $R_{G(\text{off})}=7.0\Omega$, $L\sigma=75\text{nH}$, $C\sigma=30\text{pF}$ $L\sigma$, $C\sigma$ from Fig. E Energy losses include “tail” and diode reverse recovery.	-	26	-	ns
Rise time	t_r		-	37	-	ns
Turn-off delay time	$t_{d(\text{off})}$		-	260	-	ns
Fall time	t_f		-	22	-	ns
Turn-on energy	E_{on}		-	2.60	-	mJ
Turn-off energy	E_{off}		-	1.02	-	mJ
Total switching energy	E_{ts}		-	3.62	-	mJ

二极管特性，测于 $T_{vj} = 175^{\circ}\text{C}$ 的条件下

Diode reverse recovery time	t_{rr}	$T_{vj} = 175^{\circ}\text{C},$ $V_R = 400\text{V},$ $I_F = 50.0\text{A},$ $di_F/dt = 1000\text{A}/\mu\text{s}$	-	139	-	ns
Diode reverse recovery charge	Q_{rr}		-	3.29	-	μC
Diode peak reverse recovery current	I_{rrm}		-	34.0	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-1489	-	$\text{A}/\mu\text{s}$

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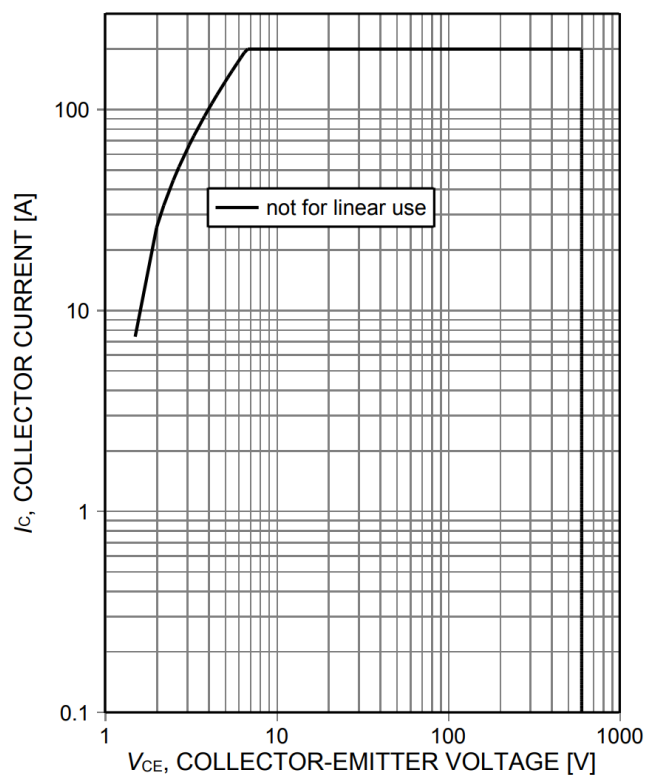


Figure 1. **Forward bias safe operating area**
($D=0$, $T_h=25^\circ\text{C}$, $T_j\leq 175^\circ\text{C}$, $V_{GE}=15\text{V}$, $t_p\leq 1\mu\text{s}$)

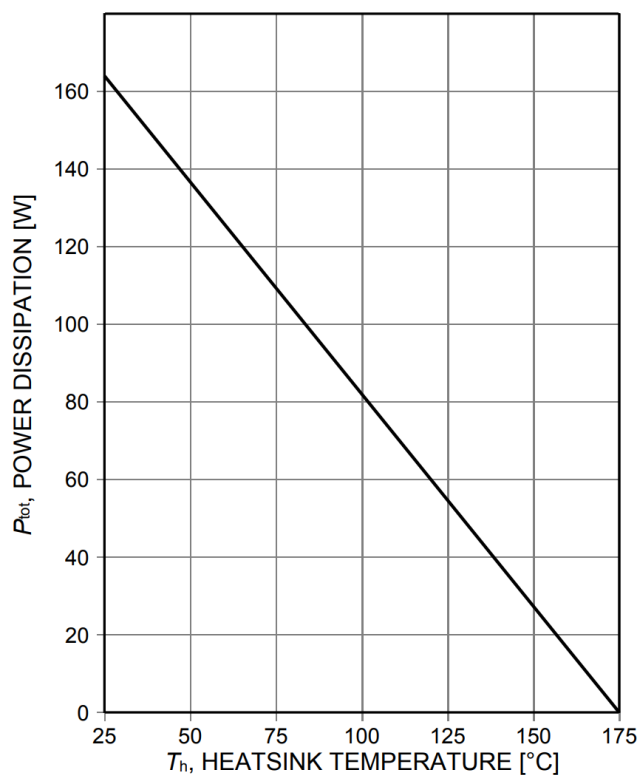


Figure 2. **Power dissipation as a function of heatsink temperature**
($T_j\leq 175^\circ\text{C}$)

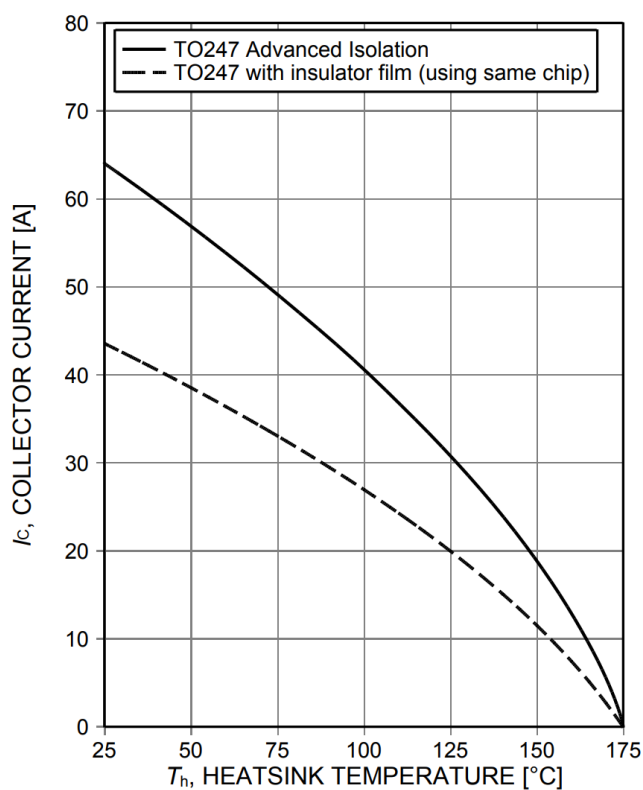


Figure 3. **Collector current as a function of heatsink temperature**
($V_{GE}\geq 15\text{V}$, $T_j\leq 175^\circ\text{C}$, insulator film: $152\mu\text{m}$, 1.3W/mK)

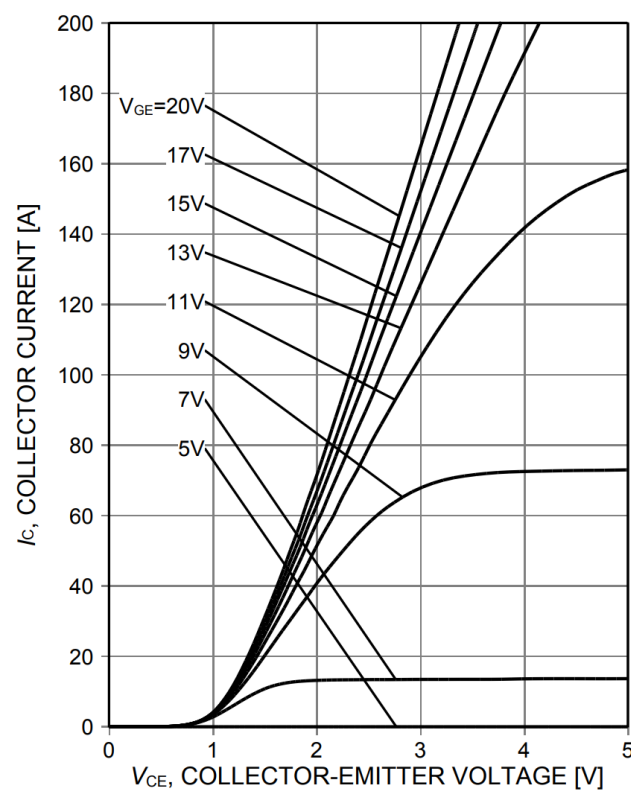


Figure 4. **Typical output characteristic**
($T_j=25^\circ\text{C}$)

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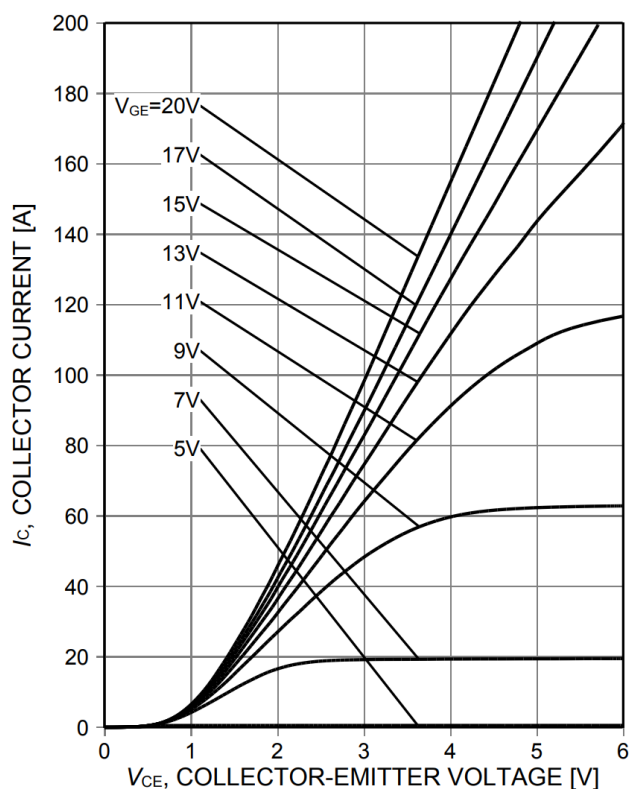


Figure 5. **Typical output characteristic**
($T_J = 175^\circ\text{C}$)

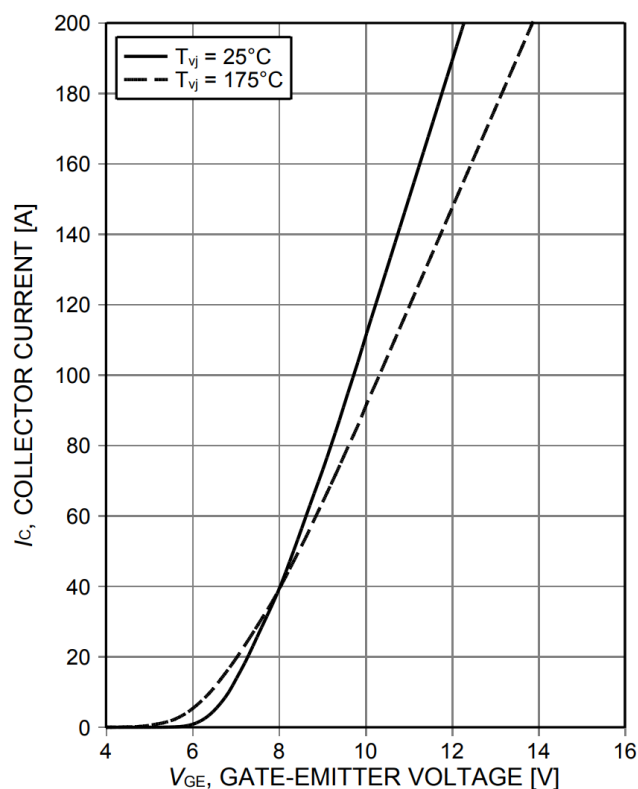


Figure 6. **Typical transfer characteristic**
($V_{CE} = 20\text{V}$)

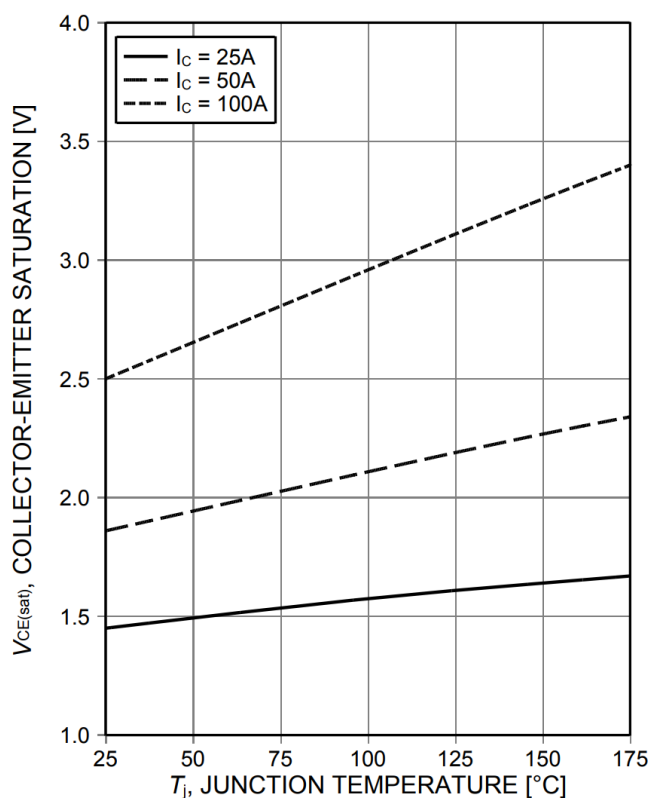


Figure 7. **Typical collector-emitter saturation voltage as a function of junction temperature**
($V_{GE} = 15\text{V}$)

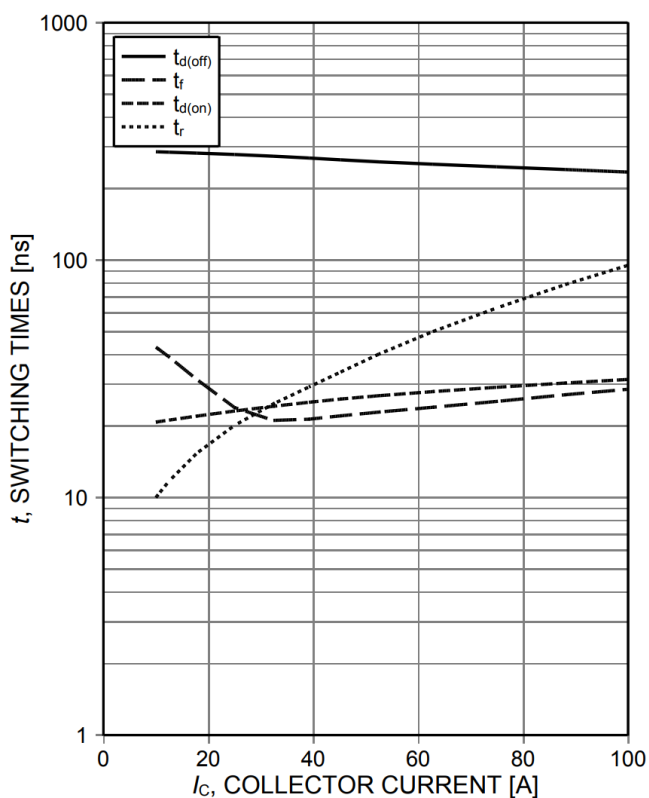


Figure 8. **Typical switching times as a function of collector current**
(ind. load, $T_J = 175^\circ\text{C}$, $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $R_G = 7\Omega$, test circuit in Fig. E)

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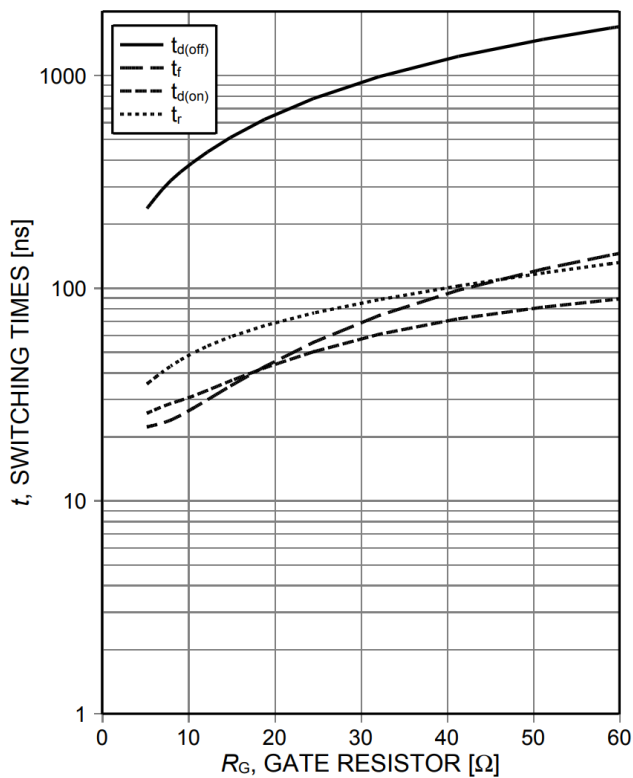


Figure 9. **Typical switching times as a function of gate resistor**
(ind. load, $T_J=175^\circ\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=0/15\text{V}$, $I_C=50\text{A}$, test circuit in Fig. E)

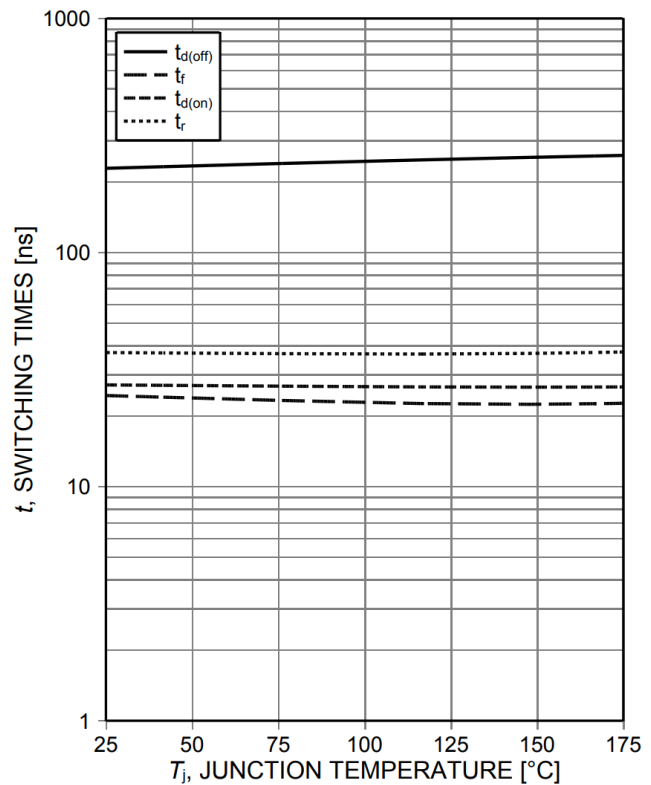


Figure 10. **Typical switching times as a function of junction temperature**
(ind. load, $V_{CE}=400\text{V}$, $V_{GE}=0/15\text{V}$, $I_C=50\text{A}$, $r_G=7\Omega$, test circuit in Fig. E)

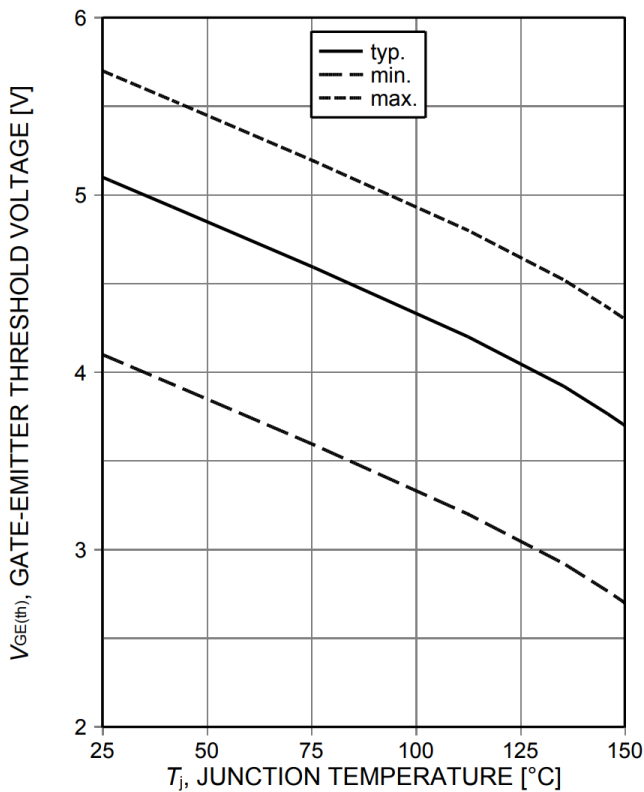


Figure 11. **Gate-emitter threshold voltage as a function of junction temperature**
($I_C=0.43\text{mA}$)

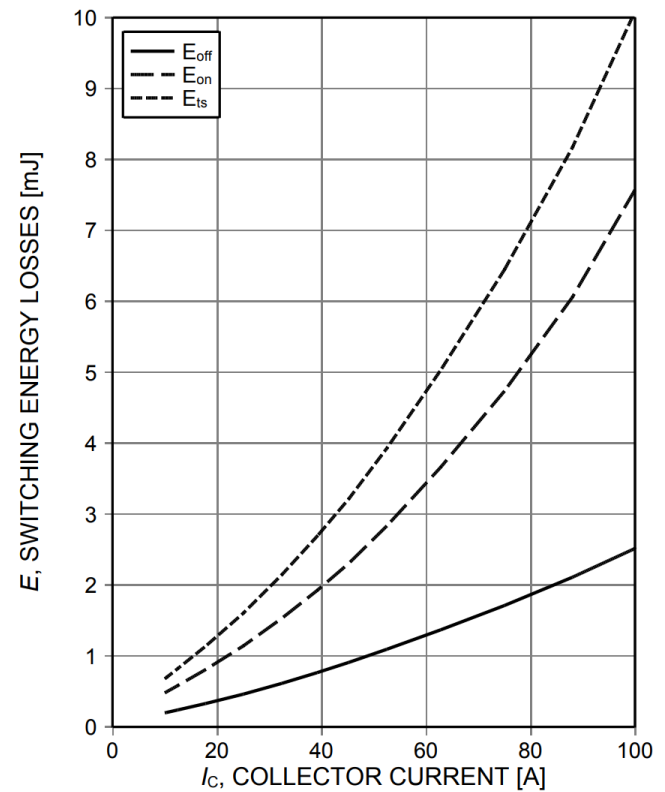


Figure 12. **Typical switching energy losses as a function of collector current**
(ind. load, $T_J=175^\circ\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=0/15\text{V}$, $R_G=7\Omega$, test circuit in Fig. E)

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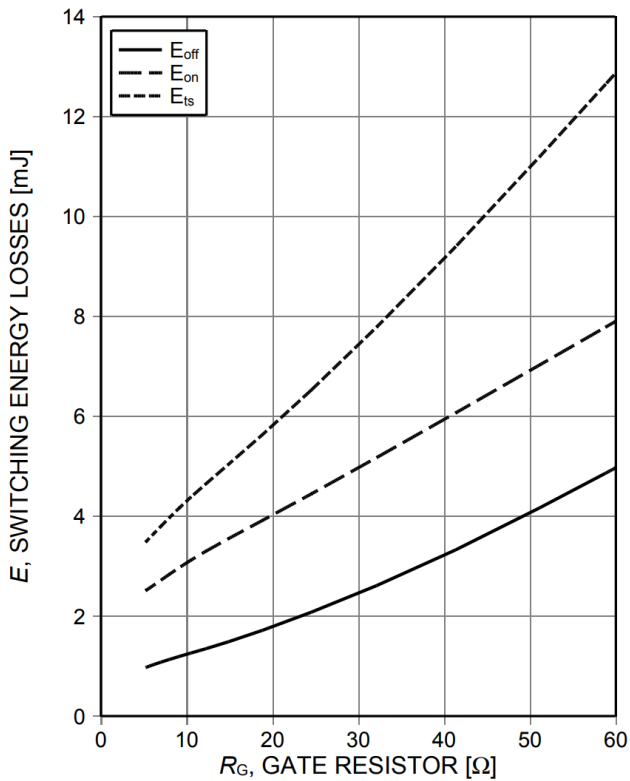


Figure 13. **Typical switching energy losses as a function of gate resistor**
(ind. load, $T_j=175^\circ\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=0/15\text{V}$, $I_C=50\text{A}$, test circuit in Fig. E)

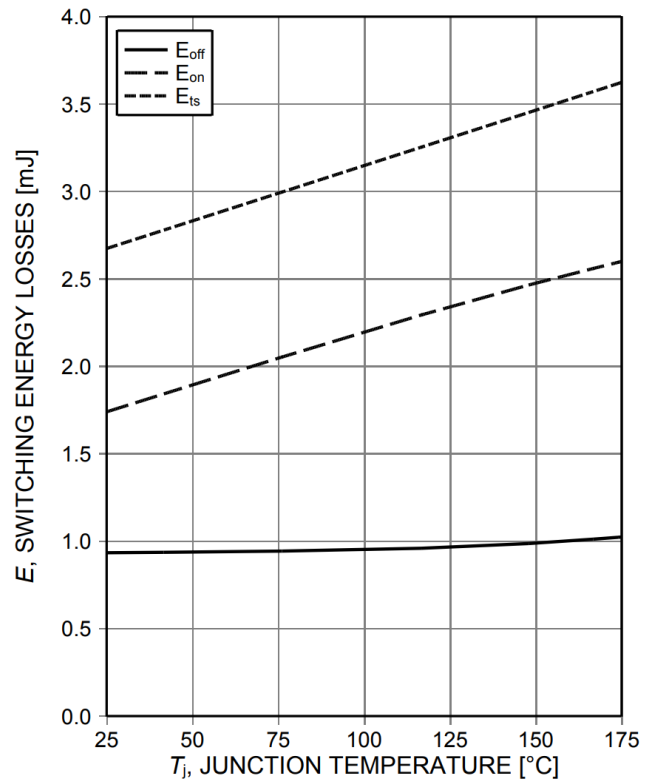


Figure 14. **Typical switching energy losses as a function of junction temperature**
(ind load, $V_{CE}=400\text{V}$, $V_{GE}=0/15\text{V}$, $I_C=50\text{A}$, $R_G=7\Omega$, test circuit in Fig. E)

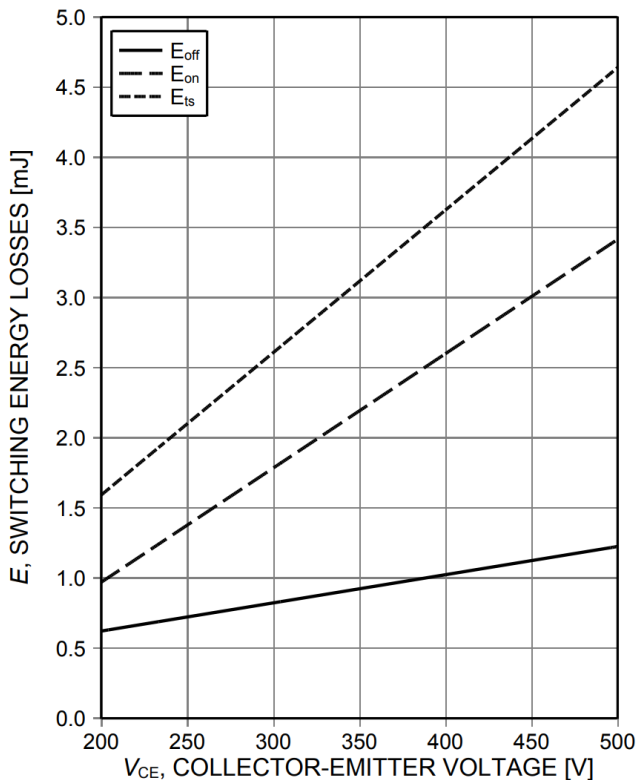


Figure 15. **Typical switching energy losses as a function of collector emitter voltage** (ind. load, $T_j=175^\circ\text{C}$, $V_{GE}=0/15\text{V}$, $I_C=50\text{A}$, $R_G=7\Omega$, test circuit in Fig. E)

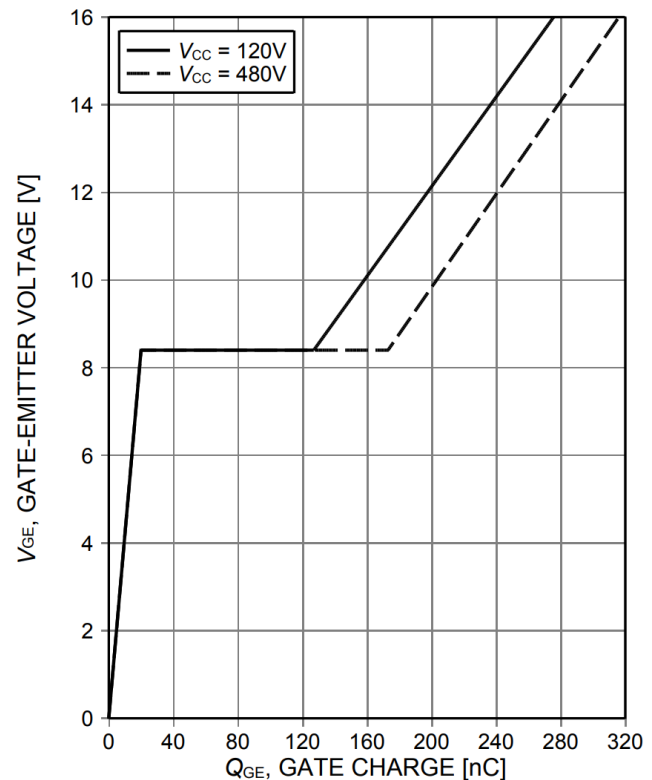


Figure 16. **Typical gate charge**
($I_C=50\text{A}$)

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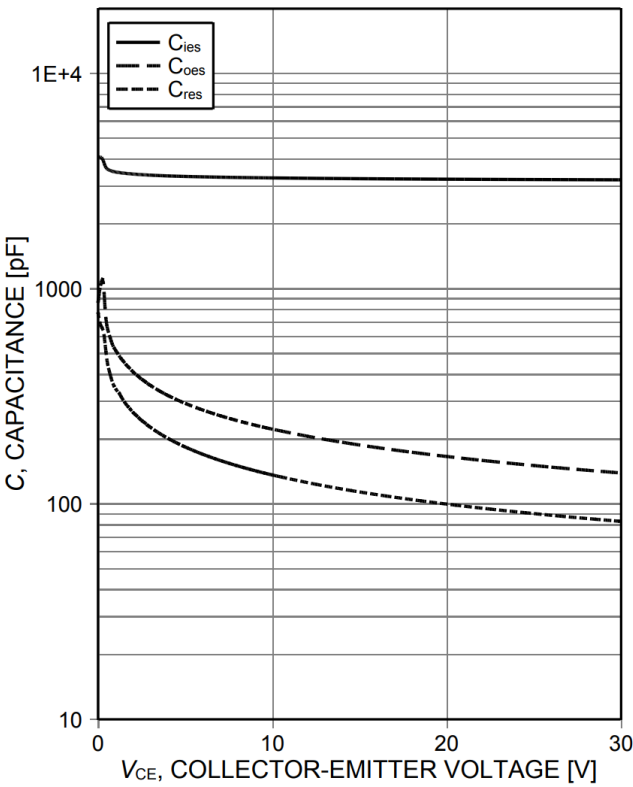


Figure 17. **Typical capacitance as a function of collector-emitter voltage**
($V_{GE}=0$ V, $f=1$ MHz)

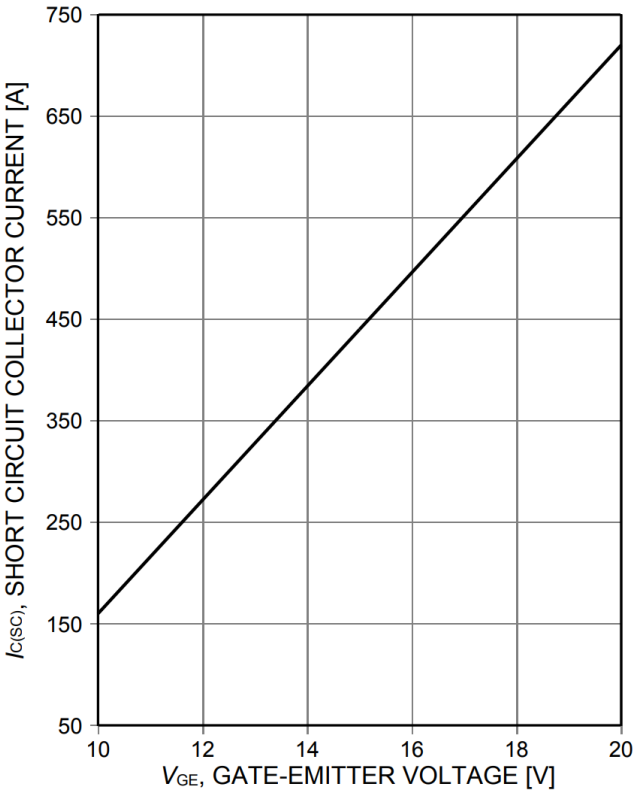


Figure 18. **Typical short circuit collector current as a function of gate-emitter voltage** ($V_{CE}\leq 400$ V, start at $T_J=25^\circ\text{C}$)

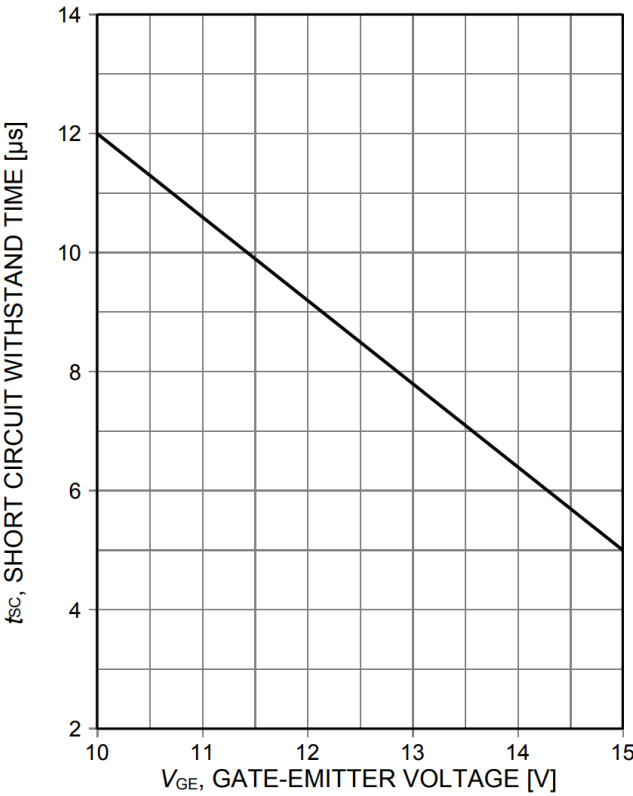


Figure 19. **Short circuit withstand time as a function of gate-emitter voltage**
($V_{CE}\leq 400$ V, start at $T_J\leq 150^\circ\text{C}$)

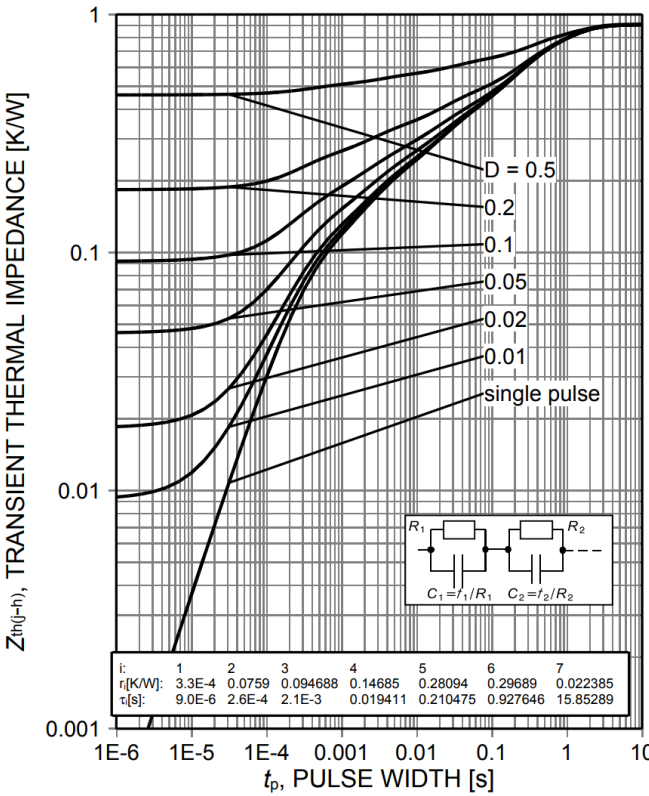


Figure 20. **IGBT transient thermal impedance as a function of pulse width**
($D=t_p/T$)

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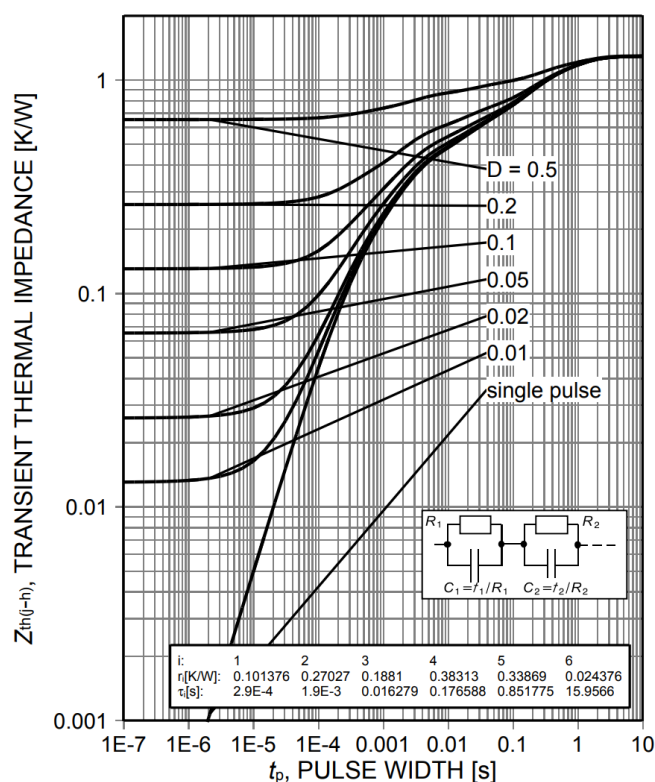


Figure 21. Diode transient thermal impedance as a function of pulse width
($D=t_p/T$)

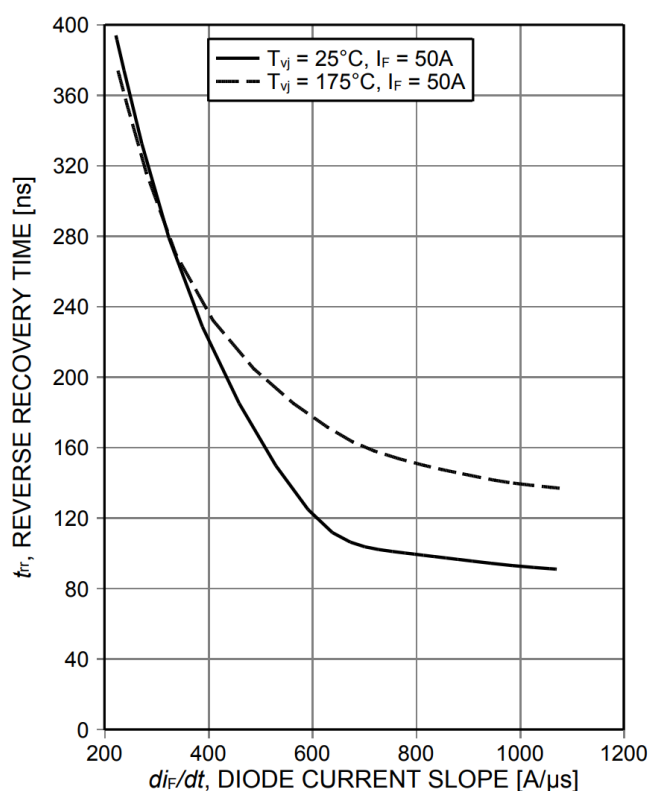


Figure 22. Typical reverse recovery time as a function of diode current slope
($V_R=400V$)

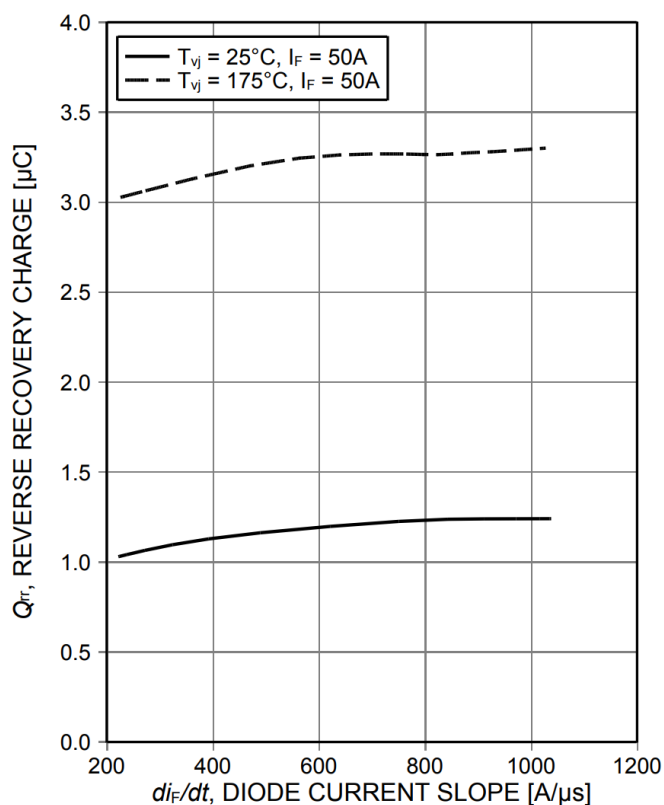


Figure 23. Typical reverse recovery charge as a function of diode current slope ($V_R=400V$)

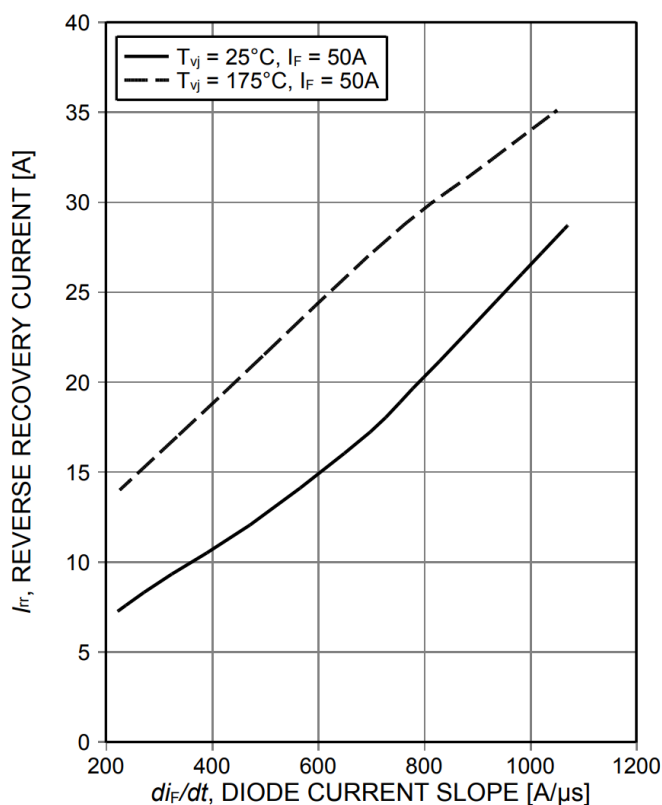


Figure 24. Typical reverse recovery current as a function of diode current slope ($V_R=400V$)

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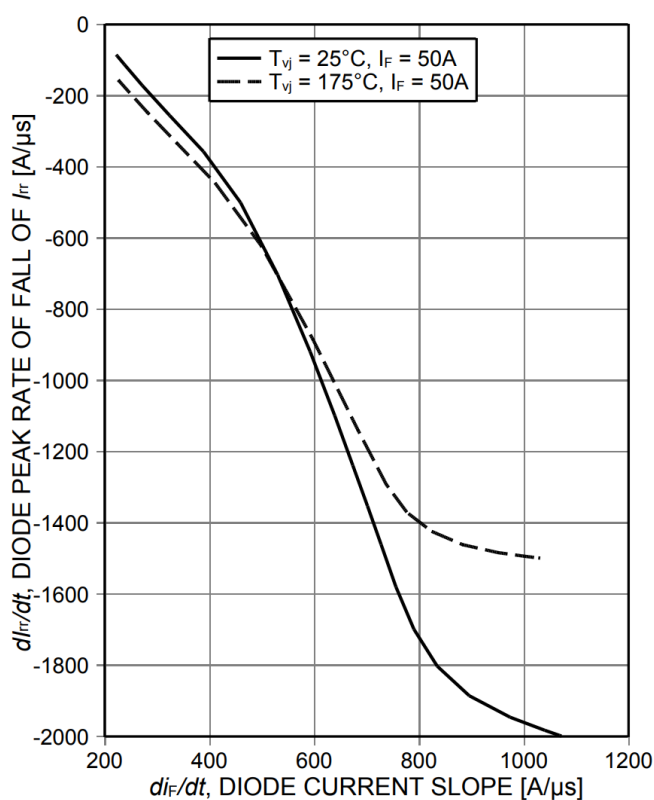


Figure 25. **Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**
($V_R=400V$)

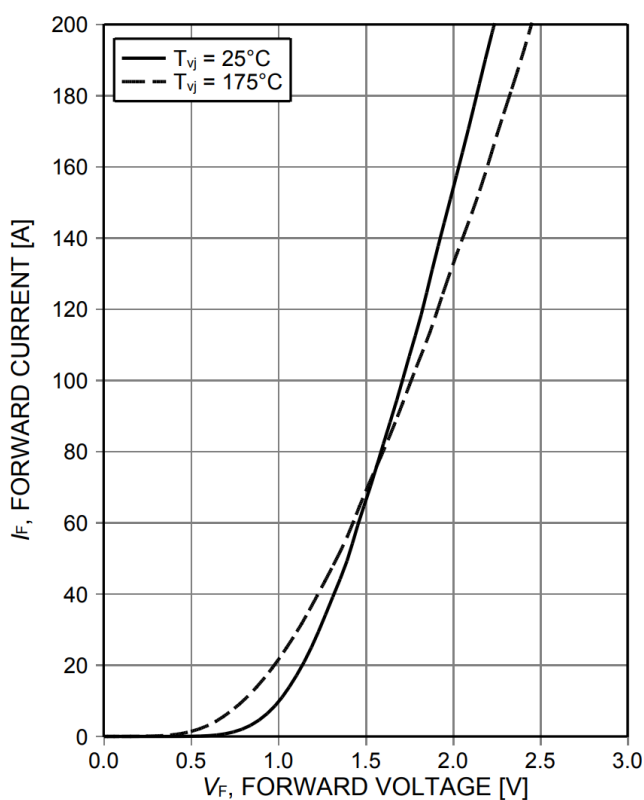


Figure 26. **Typical diode forward current as a function of forward voltage**

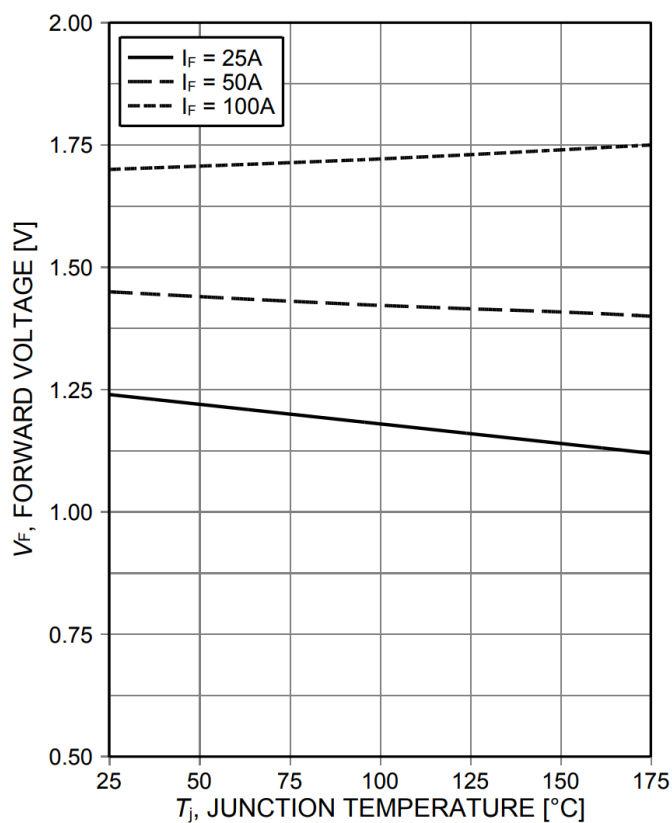
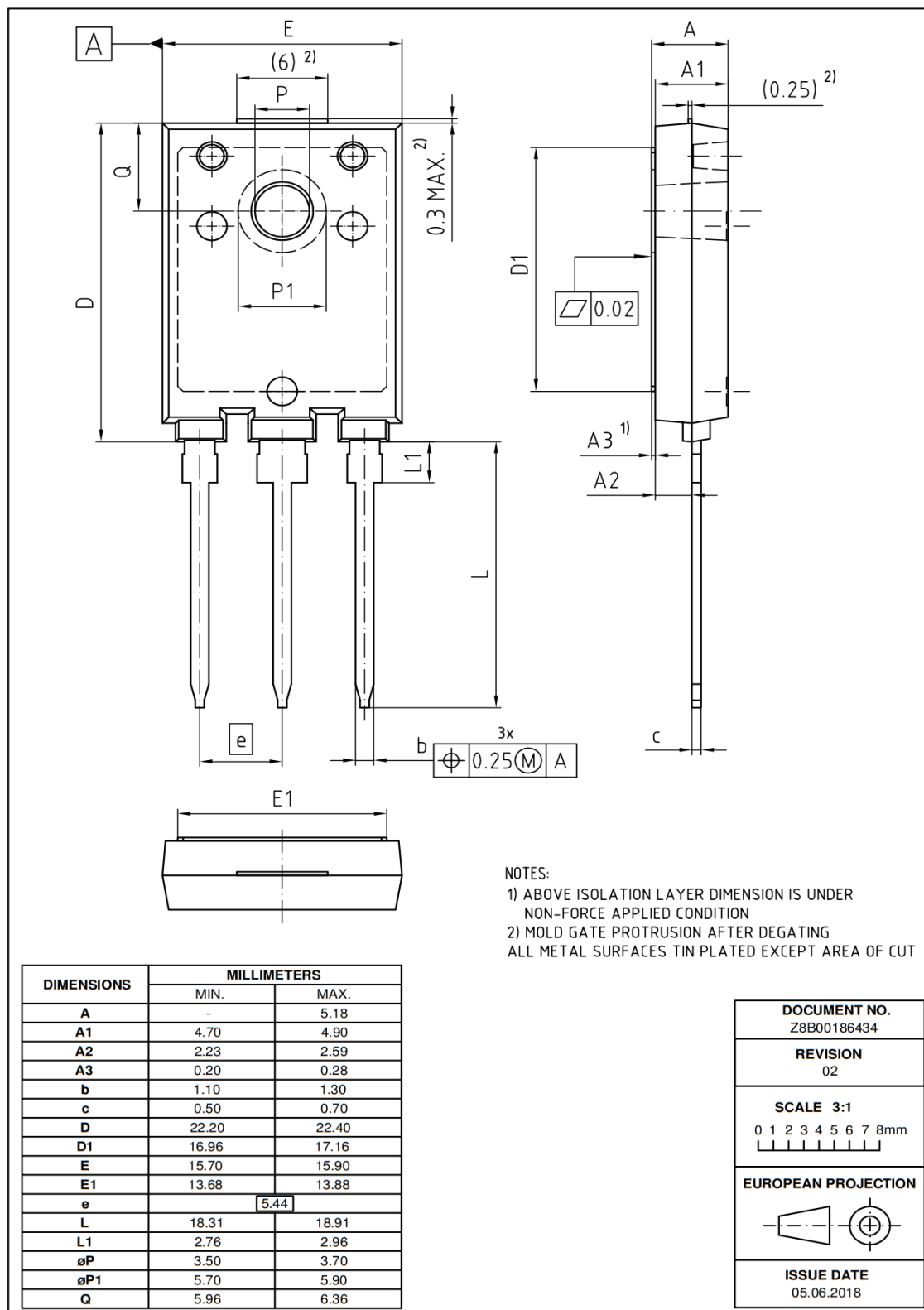


Figure 27. **Typical diode forward voltage as a function of junction temperature**

PG-TO247-3-AI (PG-HSIP247-3)



注： 为确保在应用中正确处理和组装该高级绝缘装置，绝缘层不得因尖锐工具的刺穿或超过国际标准（IEC 60068-2-6 和 IEC 60068-2-27）规定水平的机械冲击/震动而导致绝缘层受损。该先进绝缘装置仅适用于安装在合适的散热器上，该散热器的推荐平整度应小于每 100 mm 20 μm，粗糙度应小于 10 μm。

测试条件

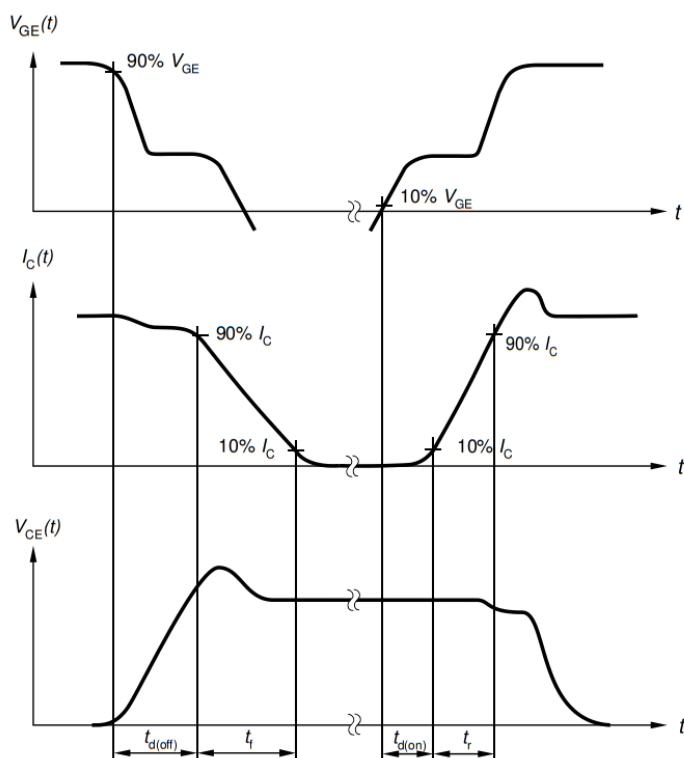


Figure A. Definition of switching times

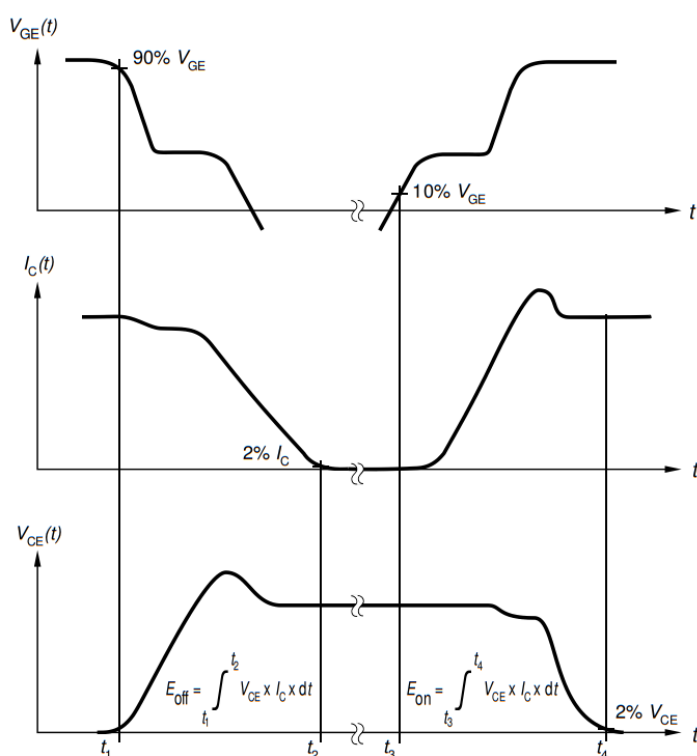


Figure B. Definition of switching losses

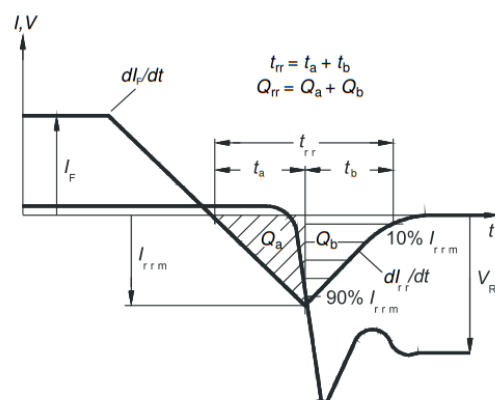


Figure C. Definition of diode switching characteristics

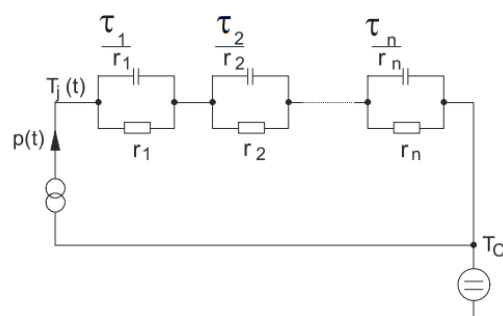


Figure D. Thermal equivalent circuit

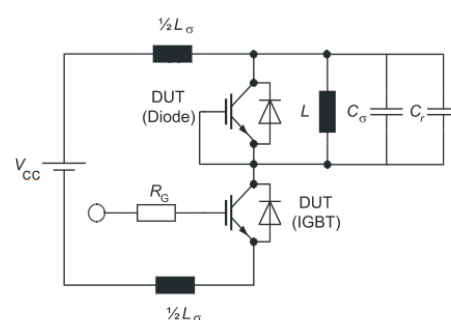


Figure E. **Dynamic test circuit**
 Parasitic inductance L_{σ} ,
 parasitic capacitor C_{σ} ,
 relief capacitor C_r ,
 (only for ZVT switching)

TRENCHSTOP™ 5 高级绝缘技术

修订记录

IKFW60N60EH3

Revision: 2017-09-21, Rev. 2.1

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.1	2017-09-21	Final data sheet

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