

TRENCHSTOP™ RC-Drives Fast 系列

英飞凌集成二极管 IGBT，具有节省空间的封装优势

特性：

英飞凌 TRENCHSTOP™ 反向导电（RC）技术适用于 600V 应用，提供

- 针对低开关损耗优化的 E_{on} 、 E_{off} 和 Q_{rr}
- 工作频率范围为 4 至 30 kHz
- 平滑的开关性能，从而实现低电磁干扰（EMI）水平
- 参数分布紧密
- 最高结温 175°C
- 5 μ s 的短路耐受能力
- 行业领先的电流与封装尺寸性能
- 符合 JEDEC 目标应用要求
- 无铅电镀；符合 RoHS 要求（焊接温度 260°C，MSL1）

完整的产品品类和 PSpice 模型：<http://www.infineon.com/igbt/>

应用：

家用和工业用驱动器：

- 压缩机
- 水泵
- 风扇



关键性能和封装参数

Type	V_{CE}	I_C	$V_{CEsat}, T_{vj}=25^{\circ}C$	T_{vjmax}	Marking	Package
IKD10N60RF	600V	10A	2.2V	175°C	K10R60F	PG-TO252-3

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 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} $T_c = 25^{\circ}\text{C}$ $T_c = 100^{\circ}\text{C}$	I_C	20.0 10.0	A
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpuls}	30.0	A
Turn off safe operating area $V_{CE} \leq 600\text{V}$, $T_{vj} \leq 175^{\circ}\text{C}$, $t_p = 1\mu\text{s}$	-	30.0	A
Diode forward current, limited by T_{vjmax} $T_c = 25^{\circ}\text{C}$ $T_c = 100^{\circ}\text{C}$	I_F	20.0 10.0	A
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpuls}	30.0	A
Gate-emitter voltage	V_{GE}	± 20	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 $T_c = 25^{\circ}\text{C}$	P_{tot}	150.0	W
Operating junction temperature	T_{vj}	$-40\dots+175$	$^{\circ}\text{C}$
Storage temperature	T_{stg}	$-55\dots+150$	$^{\circ}\text{C}$
Soldering temperature, reflow soldering (MSL1 according to JEDEC J-STA-020)		260	$^{\circ}\text{C}$

热阻

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
R th Characteristics						
IGBT thermal resistance, ¹⁾ junction - case	R _{th(j-c)}		-	-	1.00	K/W
Diode thermal resistance, ²⁾ junction - case	R _{th(j-c)}		-	-	2.60	K/W
Thermal resistance, min. footprint junction - ambient	R _{th(j-a)}		-	-	75	K/W
Thermal resistance, 6cm ² Cu on PCB junction - ambient	R _{th(j-a)}		-	-	50	K/W

¹⁾ R_{th} / Z_{th} 基于单次冷却脉冲。请注意，使用热电偶无法正确测量 IGBT 的 R_{th}。

²⁾ R_{th} / Z_{th} 基于单次冷却脉冲。请注意，使用热电偶无法正确测量二极管的 R_{th}。

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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	$V_{(BR)CES}$	$V_{GE} = 0V, I_C = 0.20mA$	600	-	-	V
Collector-emitter saturation voltage	V_{CEsat}	$V_{GE} = 15.0V, I_C = 10.0A$ $T_{vj} = 25^{\circ}C$ $T_{vj} = 175^{\circ}C$	- -	2.20 2.30	2.50 -	V
Diode forward voltage	V_F	$V_{GE} = 0V, I_F = 10.0A$ $T_{vj} = 25^{\circ}C$ $T_{vj} = 175^{\circ}C$	- -	2.10 2.00	2.40 -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C = 0.17mA, V_{CE} = V_{GE}$	4.3	5.0	5.7	V
Zero gate voltage collector current ¹⁾	I_{CES}	$V_{CE} = 600V, V_{GE} = 0V$ $T_{vj} = 25^{\circ}C$ $T_{vj} = 175^{\circ}C$	- -	- -	40 1000	μA
Gate-emitter leakage current	I_{GES}	$V_{CE} = 0V, V_{GE} = 20V$	-	-	100	nA
Transconductance	g_{fs}	$V_{CE} = 20V, I_C = 10.0A$	-	4.6	-	S
Integrated gate resistor	r_G			none		Ω

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	-	655	-	pF
Output capacitance	C _{oes}		-	37	-	
Reverse transfer capacitance	C _{res}		-	22	-	
Gate charge	Q _G	V _{CC} = 480V, I _c = 10.0A, V _{GE} = 15V	-	64.0	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	L _E		-	7.0	-	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} = 25°C	-	74	-	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	$t_{d(on)}$	$T_{vj} = 25^{\circ}\text{C},$ $V_{CC} = 400\text{V}, I_c = 10.0\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(on)} = 26.0\Omega, R_{G(off)} = 26.0\Omega,$ $L\sigma = 50\text{nH}, C\sigma = 30\text{pF}$ $L\sigma, C\sigma$ from Fig. E	-	12	-	ns
Rise time	t_r		-	15	-	ns
Turn-off delay time	$t_{d(off)}$		-	168	-	ns
Fall time	t_f		-	18	-	ns
Turn-on energy	E_{on}		-	0.19	-	mJ
Turn-off energy	E_{off}		-	0.16	-	mJ
Total switching energy	E_{ts}		-	0.35	-	mJ

¹⁾ 无需经过生产测试 - 经过设计/特性验证

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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}	$T_{vj} = 25^{\circ}\text{C},$ $V_R = 400\text{V},$ $I_F = 10.0\text{A},$ $di_F/dt = 750\text{A}/\mu\text{s}$	-	72	-	ns
Diode reverse recovery charge	Q_{rr}		-	0.27	-	μC
Diode peak reverse recovery current	I_{rrm}		-	9.1	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-146	-	A/ μs

开关特性、感性负载

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	

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

Turn-on delay time	$t_{d(on)}$	$T_{vj} = 175^{\circ}\text{C},$ $V_{CC} = 400\text{V}, I_C = 10.0\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(on)} = 26.0\Omega, R_{G(off)} = 26.0\Omega,$ $L\sigma = 50\text{nH}, C\sigma = 30\text{pF}$ $L\sigma, C\sigma$ from Fig. E	-	12	-	ns
Rise time	t_r		-	15	-	ns
Turn-off delay time	$t_{d(off)}$		-	178	-	ns
Fall time	t_f		-	20	-	ns
Turn-on energy	E_{on}		-	0.31	-	mJ
Turn-off energy	E_{off}		-	0.21	-	mJ
Total switching energy	E_{ts}		-	0.52	-	mJ

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

Diode reverse recovery time	t_{rr}	$T_{vj} = 175^{\circ}\text{C},$ $V_R = 400\text{V},$ $I_F = 10.0\text{A},$ $di_F/dt = 720\text{A}/\mu\text{s}$	-	112	-	ns
Diode reverse recovery charge	Q_{rr}		-	0.62	-	μC
Diode peak reverse recovery current	I_{rrm}		-	12.9	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-136	-	A/ μs

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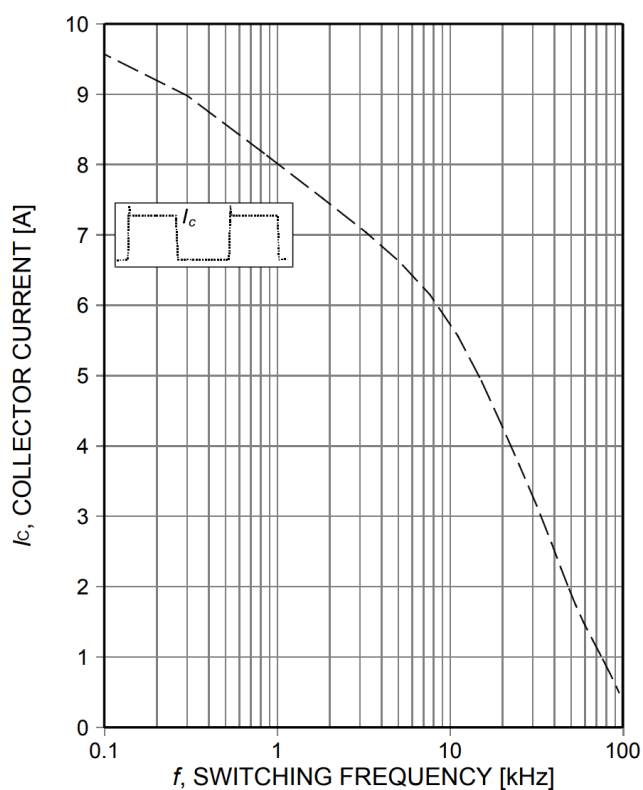


Figure 1. **Collector current as a function of switching frequency**
 ($T_{vj} \leq 175^\circ\text{C}$, $T_a = 55^\circ\text{C}$, $D = 0.5$, $V_{CE} = 400\text{V}$,
 $V_{GE} = 15/0\text{V}$, $r_G = 26\Omega$, PCB mounting with thermal vias and heatsink, see Appnote:
www.infineon.com/igbt)

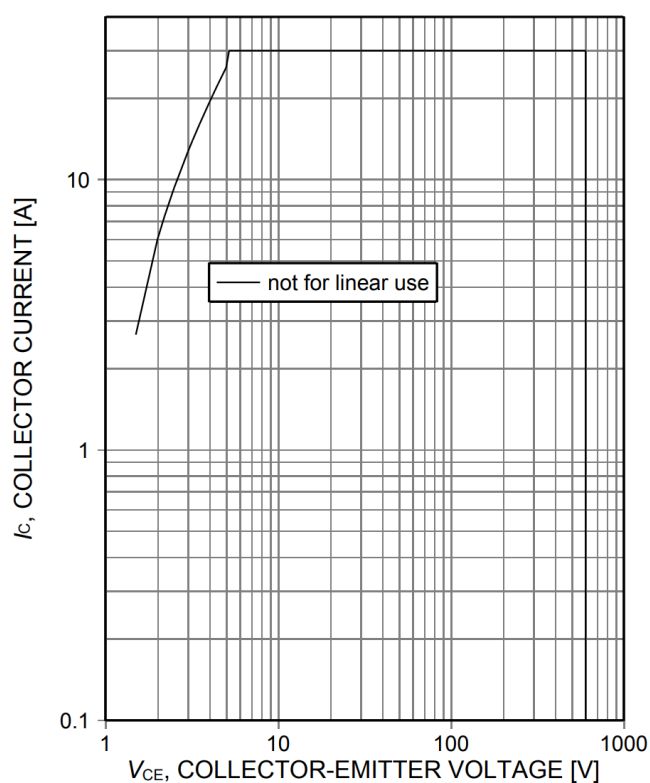


Figure 2. **Forward bias safe operating area**
 ($D = 0$, $T_C = 25^\circ\text{C}$, $T_{vj} \leq 175^\circ\text{C}$; $V_{GE} = 15\text{V}$)

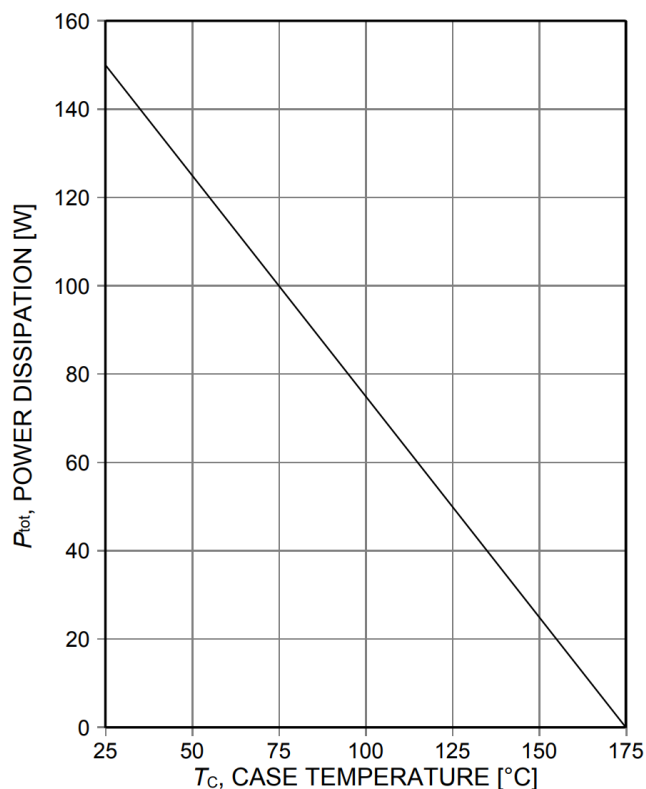


Figure 3. **Power dissipation as a function of case temperature**
 ($T_{vj} \leq 175^\circ\text{C}$)

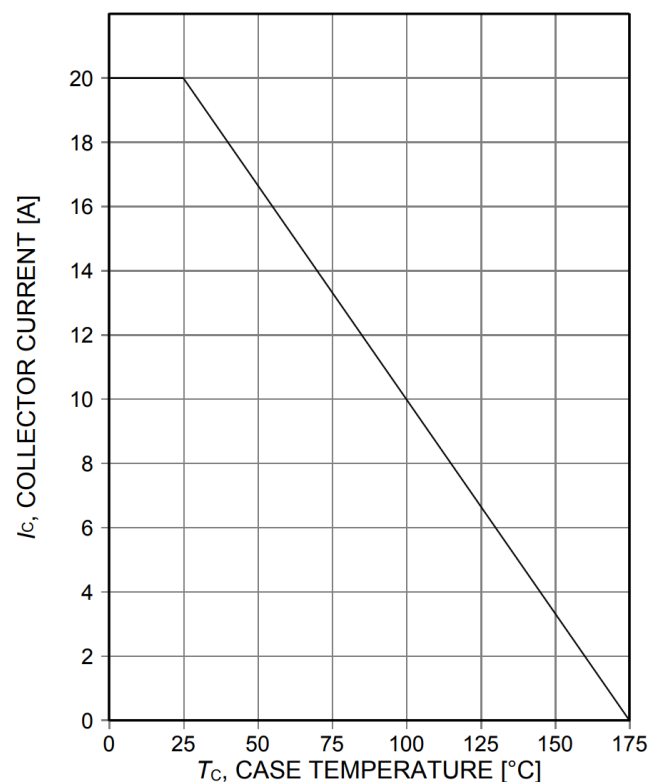


Figure 4. **Collector current as a function of case temperature**
 ($V_{GE} \geq 15\text{V}$, $T_{vj} \leq 175^\circ\text{C}$)

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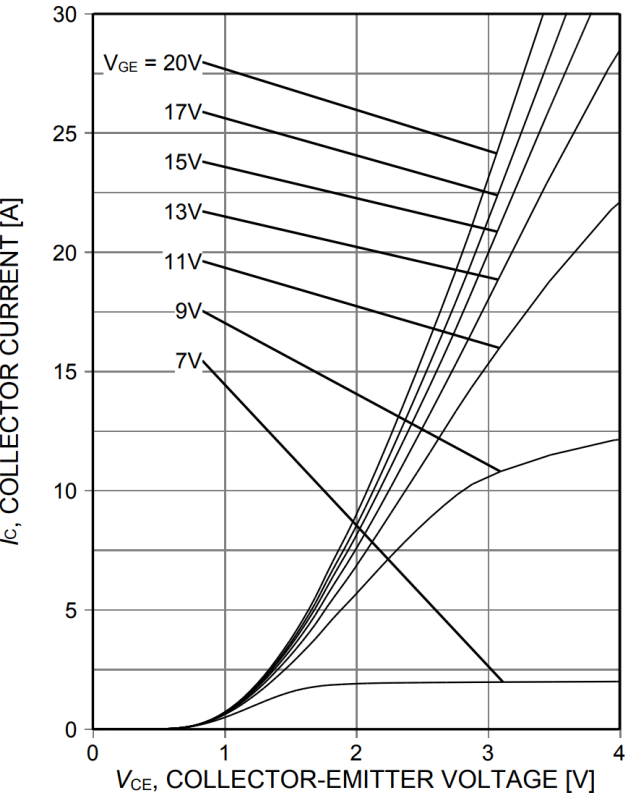


Figure 5. **Typical output characteristic**
($T_{vj}=25^{\circ}\text{C}$)

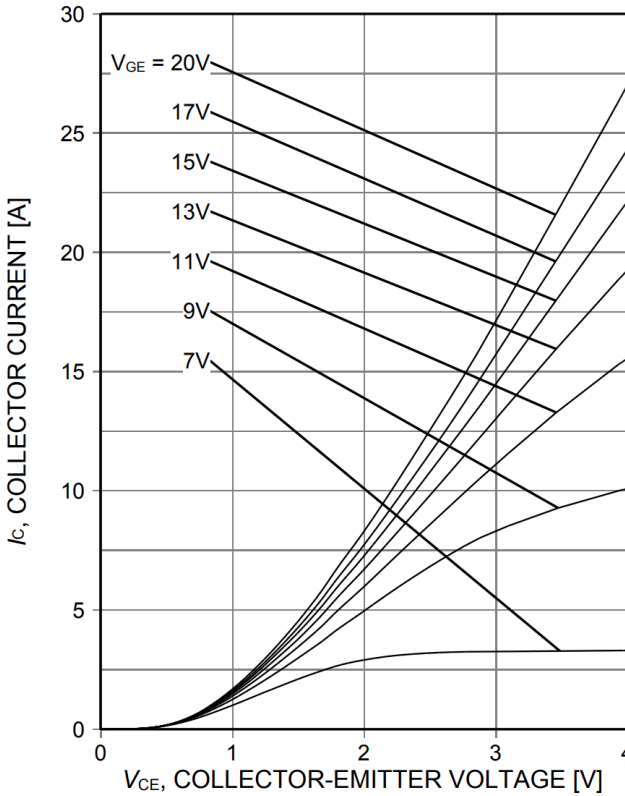


Figure 6. **Typical output characteristic**
($T_{vj}=175^{\circ}\text{C}$)

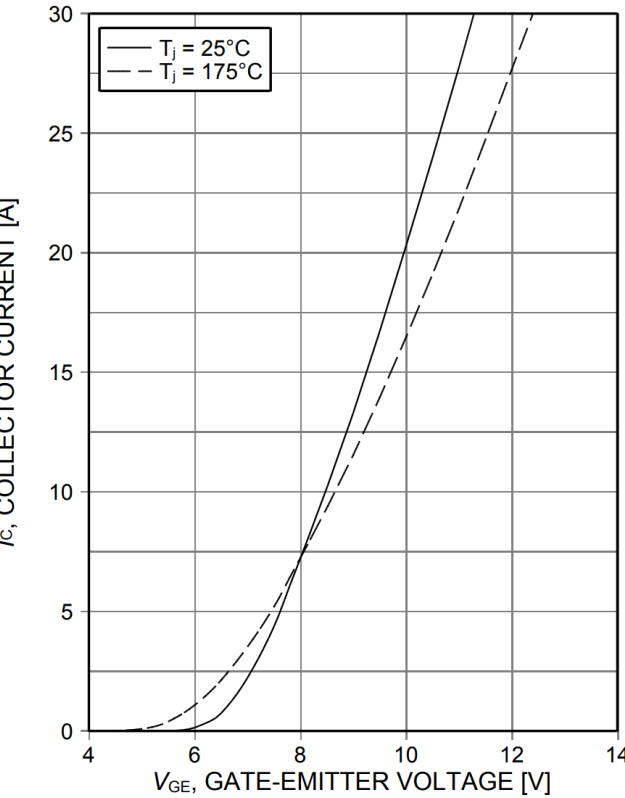


Figure 7. **Typical transfer characteristic**
($V_{ce}=10\text{V}$)

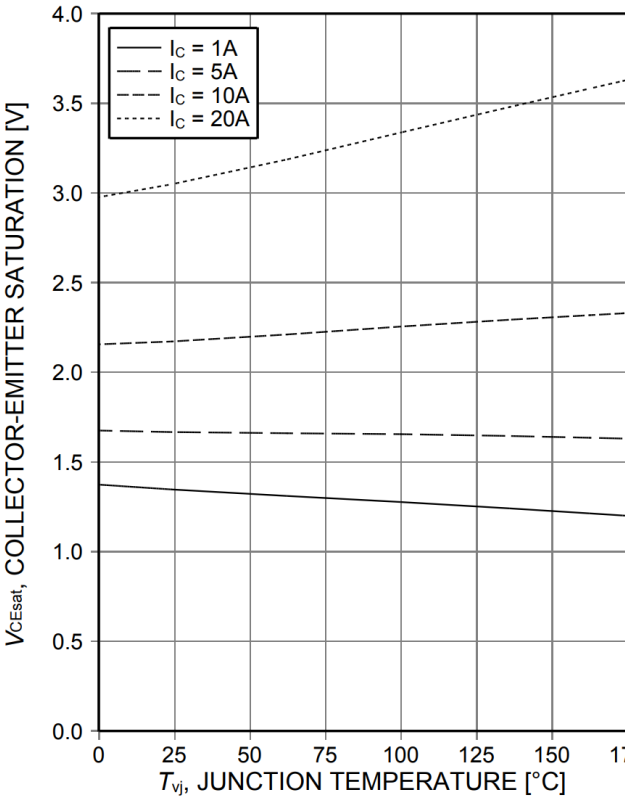


Figure 8. **Typical collector-emitter saturation voltage as a function of junction temperature**
($V_{ge}=15\text{V}$)

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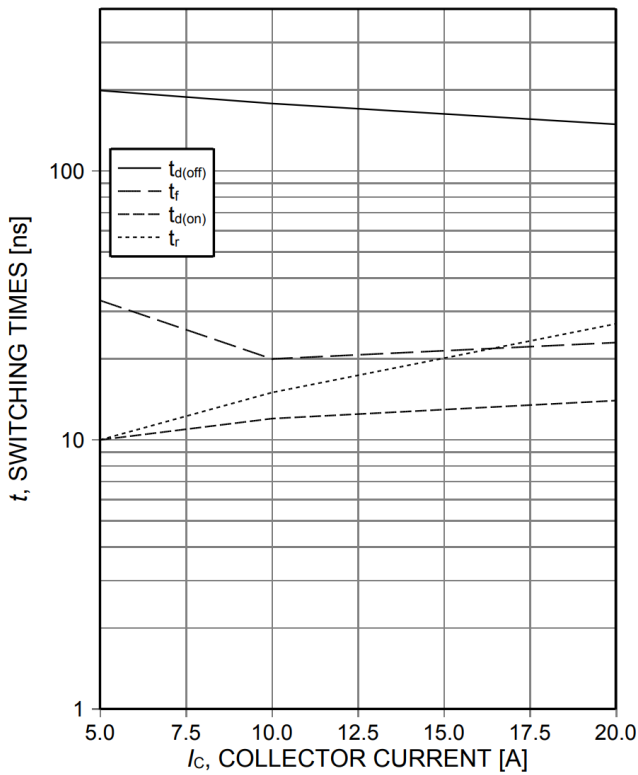


Figure 9. **Typical switching times as a function of collector current**

(inductive load, $T_{vj}=175^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $r_G=26\Omega$, Dynamic test circuit in Figure E)

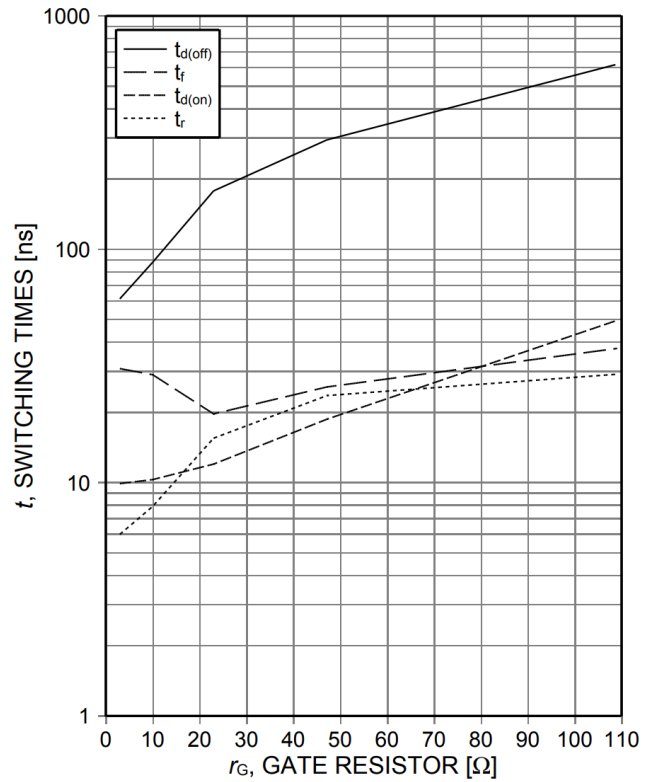


Figure 10. **Typical switching times as a function of gate resistor**

(inductive load, $T_{vj}=175^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=10\text{A}$, Dynamic test circuit in Figure E)

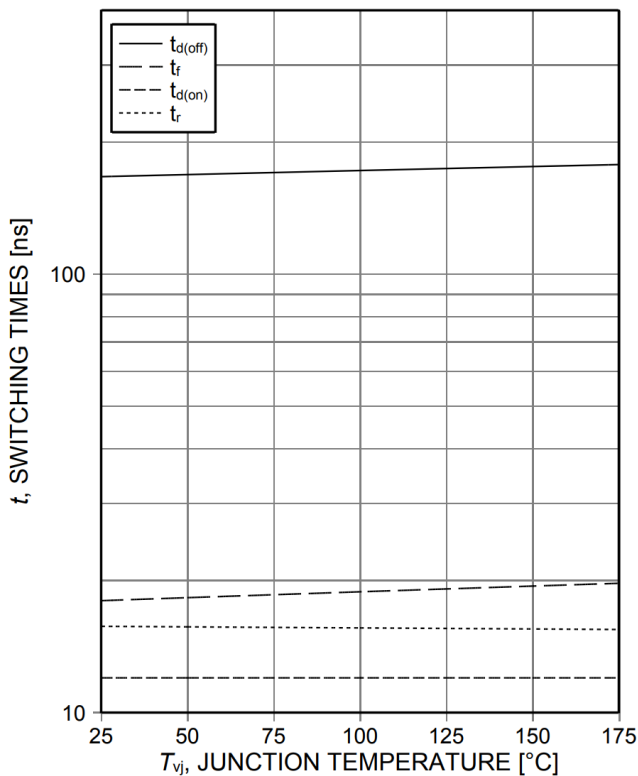


Figure 11. **Typical switching times as a function of junction temperature**

(inductive load, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=10\text{A}$, $r_G=26\Omega$, Dynamic test circuit in Figure E)

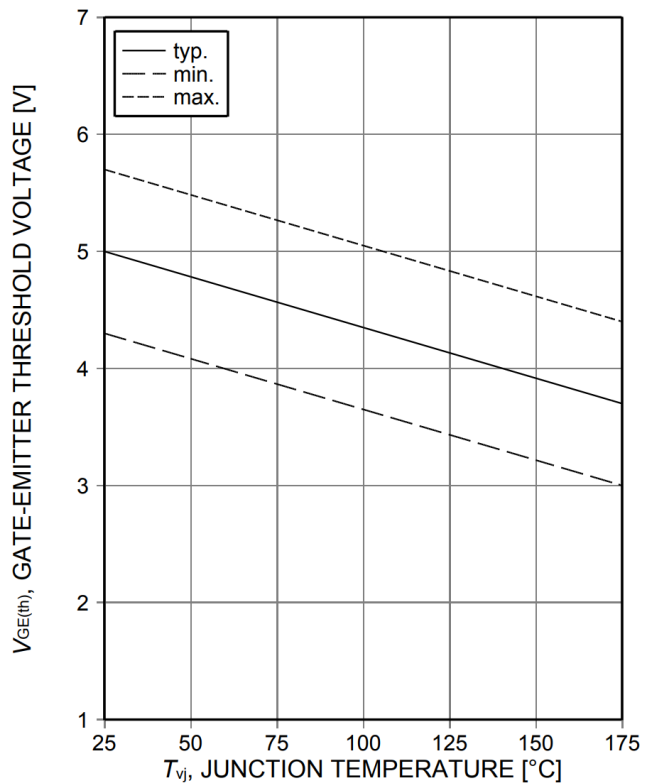


Figure 12. **Gate-emitter threshold voltage as a function of junction temperature**

($I_C=0,17\text{mA}$)

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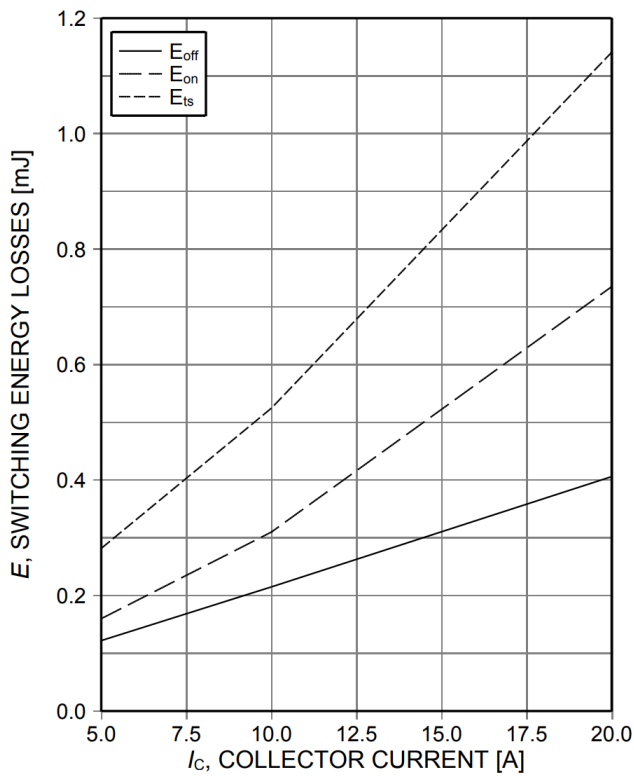


Figure 13. **Typical switching energy losses as a function of collector current** (inductive load, $T_{vj}=175^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $r_c=26\Omega$, Dynamic test circuit in Figure E)

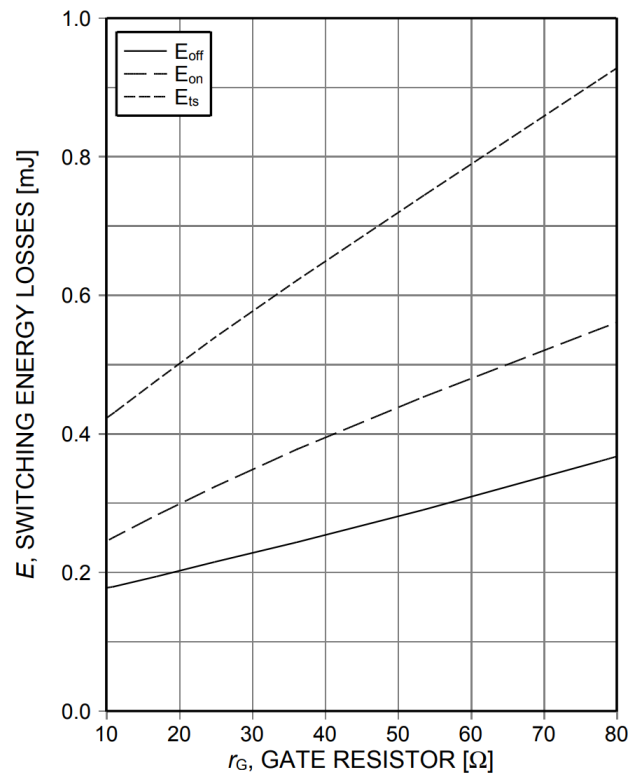


Figure 14. **Typical switching energy losses as a function of gate resistor** (inductive load, $T_{vj}=175^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=10\text{A}$, Dynamic test circuit in Figure E)

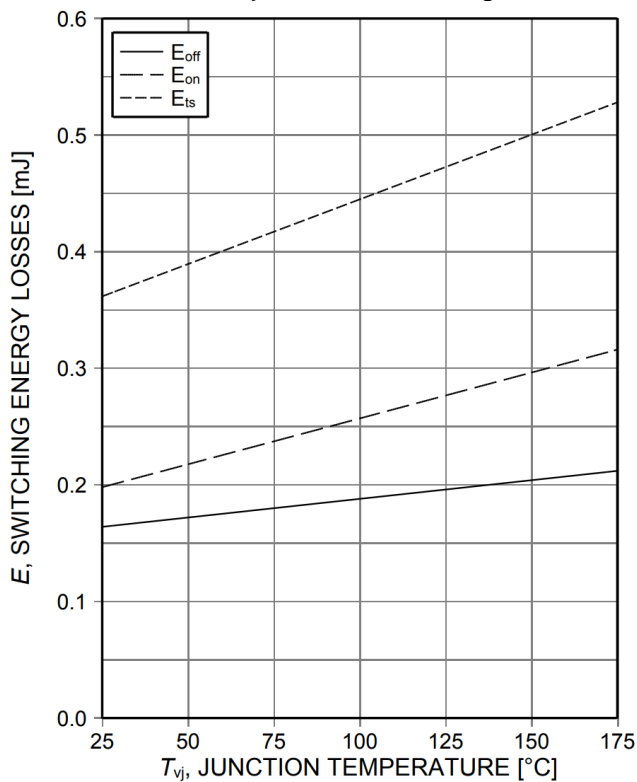


Figure 15. **Typical switching energy losses as a function of junction temperature** (inductive load, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=10\text{A}$, $r_G=26\Omega$, Dynamic test circuit in Figure E)

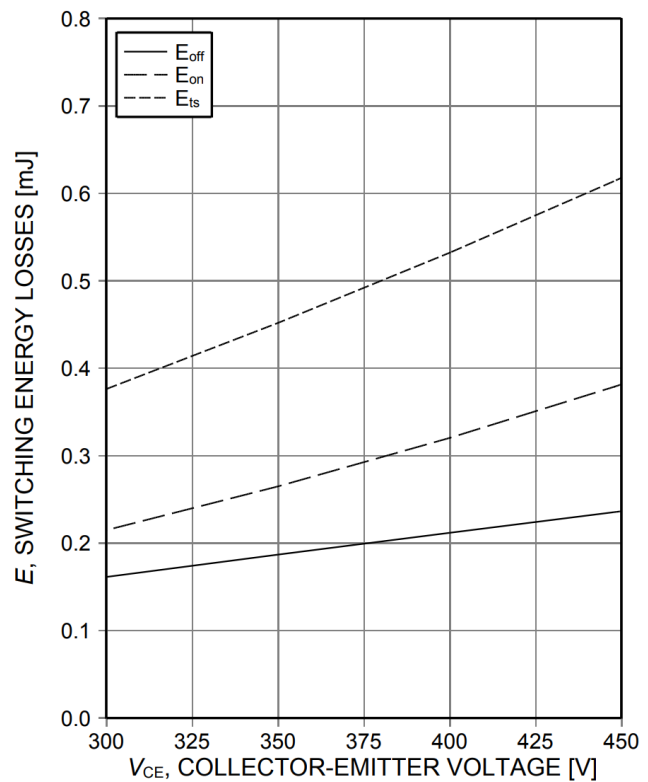


Figure 16. **Typical switching energy losses as a function of collector emitter voltage** (inductive load, $T_{vj}=175^{\circ}\text{C}$, $V_{GE}=15/0\text{V}$, $I_C=10\text{A}$, $r_G=26\Omega$, Dynamic test circuit in Figure E)

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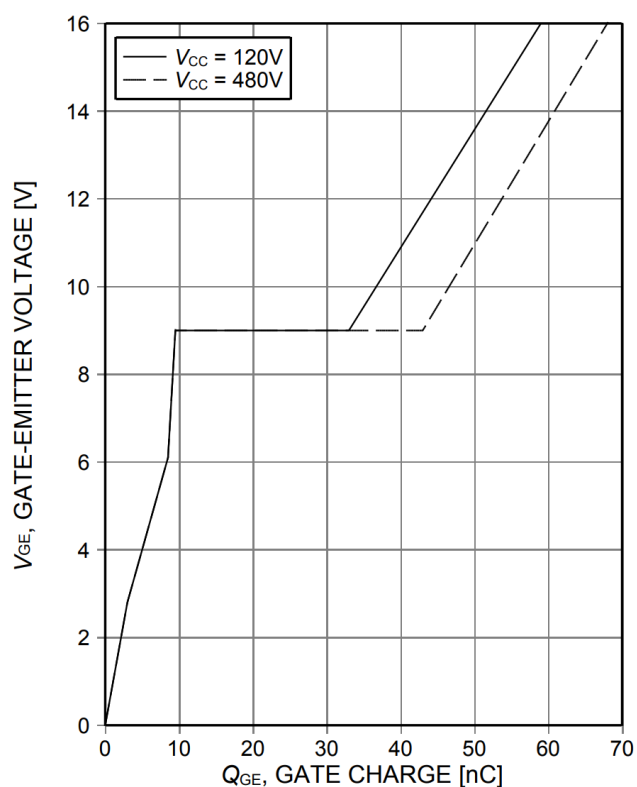


Figure 17. **Typical gate charge**
($I_C=10A$)

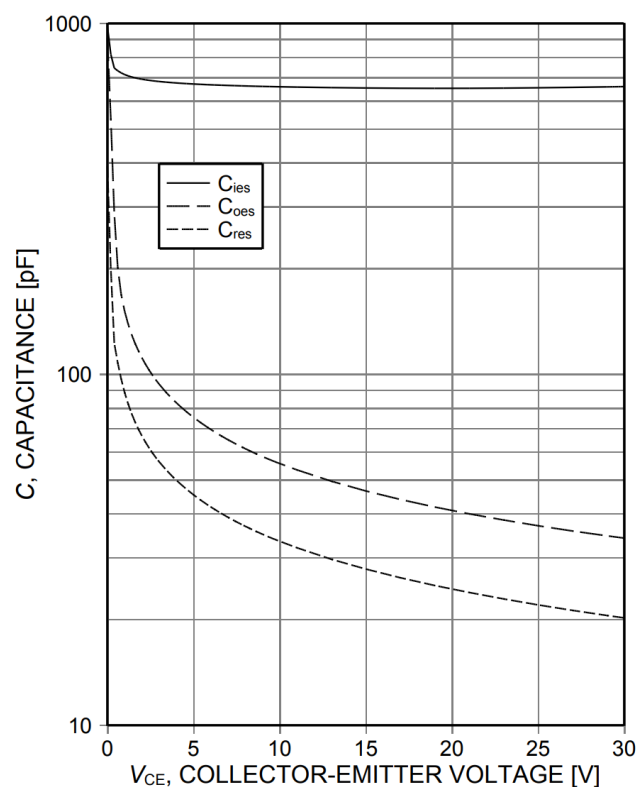


Figure 18. **Typical capacitance as a function of collector-emitter voltage**
($V_{GE}=0V$, $f=1MHz$)

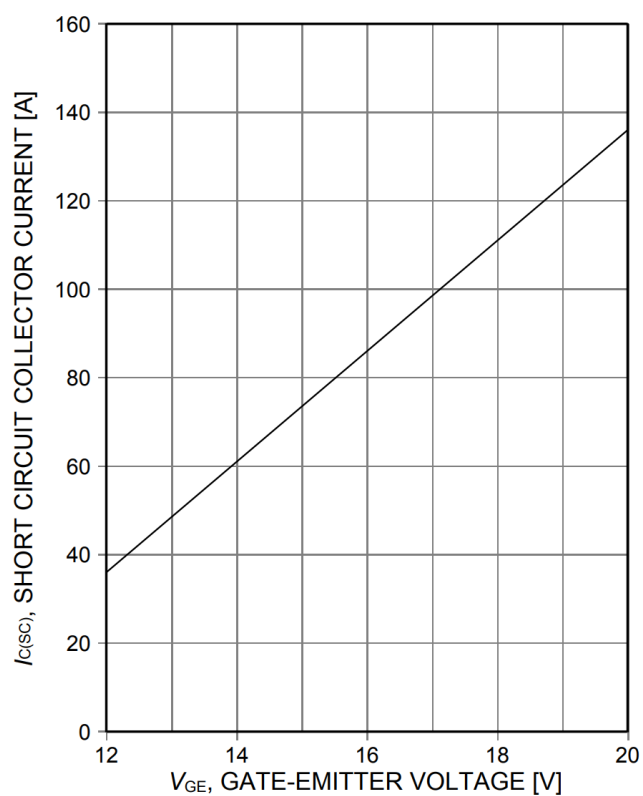


Figure 19. **Typical short circuit collector current as a function of gate-emitter voltage** ($V_{CE} \leq 400V$, start at $T_{vj}=25^\circ C$)

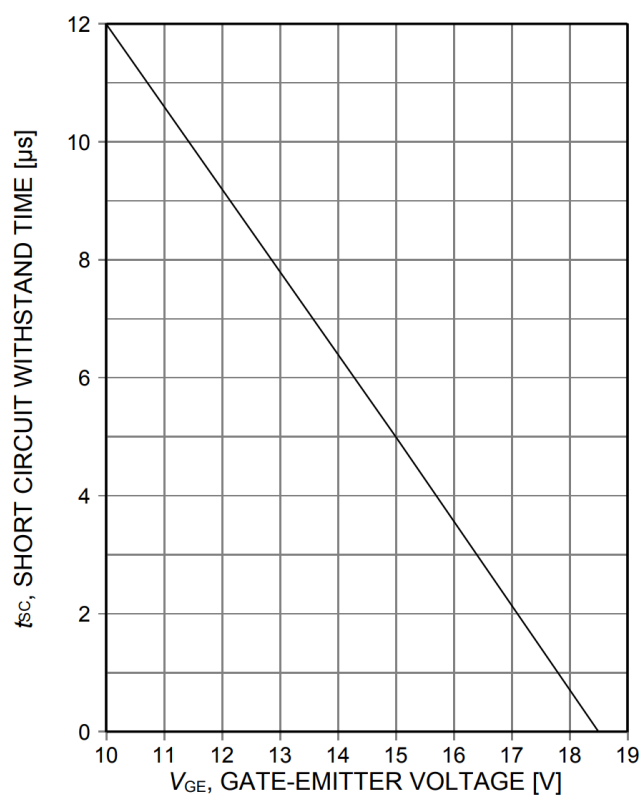
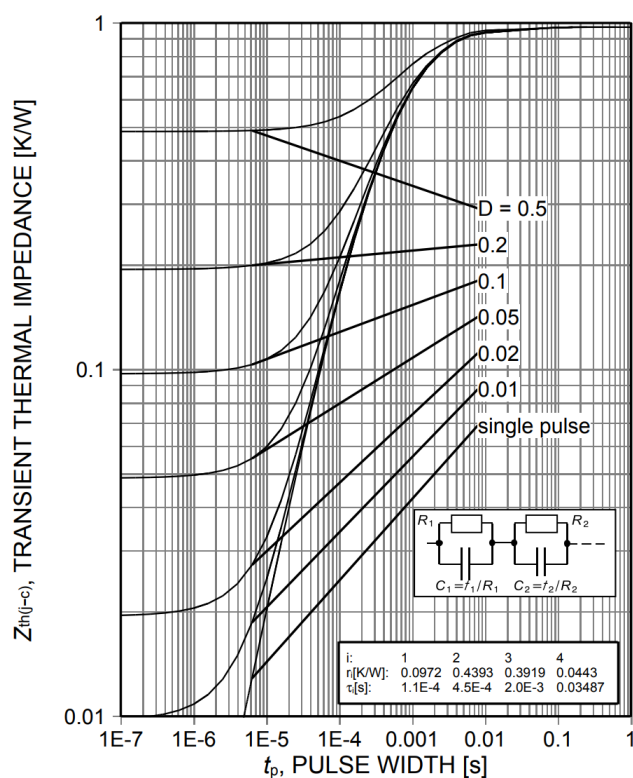
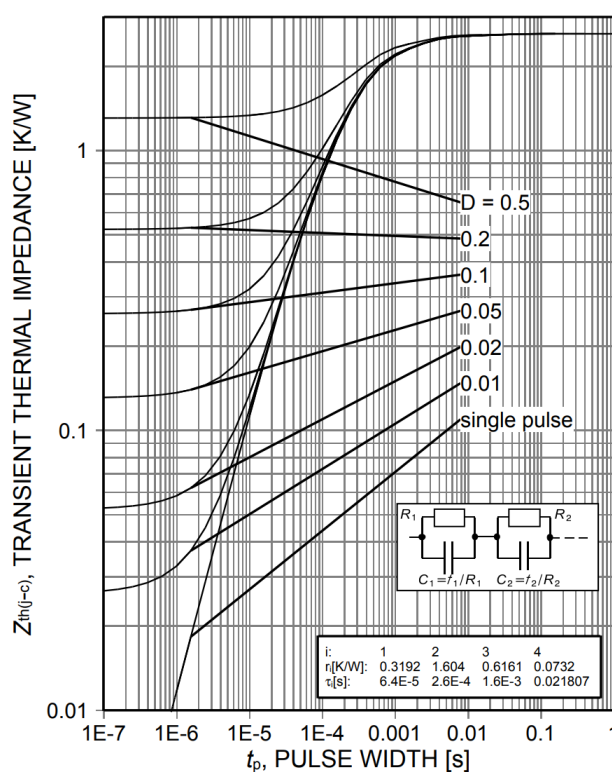
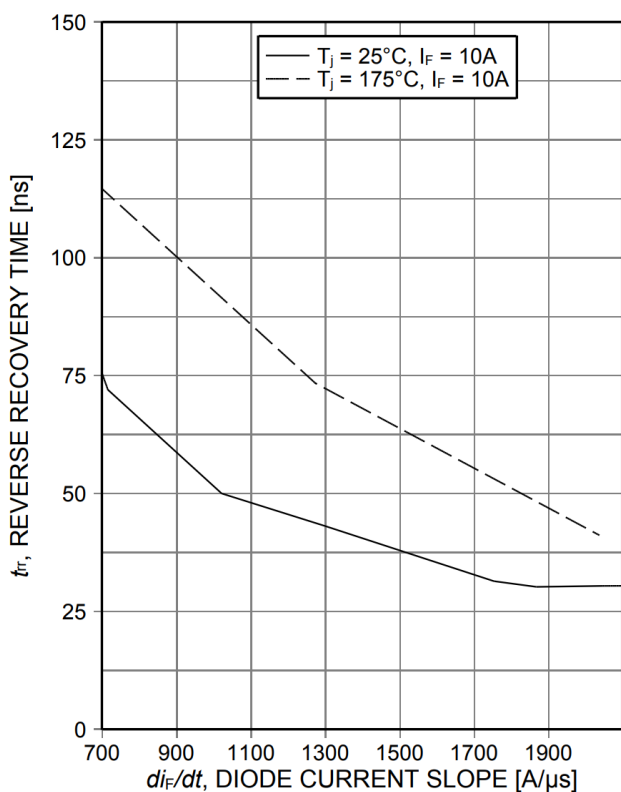
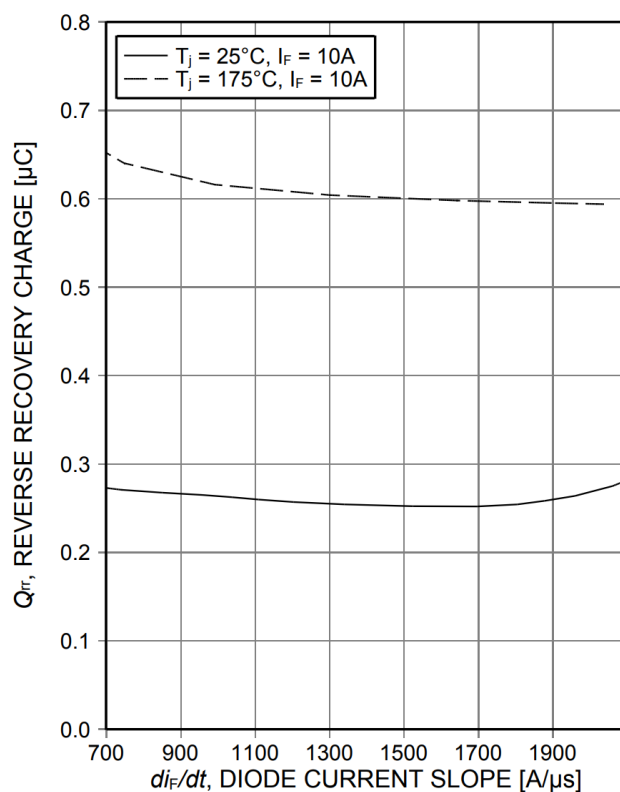


Figure 20. **Short circuit withstand time as a function of gate-emitter voltage**
($V_{CE} \leq 400V$, start at $T_{vj}=150^\circ C$)

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Figure 21. IGBT transient thermal impedance as a function of pulse width ¹⁾ (see page 4) ($D=t_p/T$)Figure 22. Diode transient thermal impedance as a function of pulse width ²⁾ (see page 4) ($D=t_p/T$)Figure 23. Typical reverse recovery time as a function of diode current slope ($V_R=400V$)Figure 24. Typical reverse recovery charge as a function of diode current slope ($V_R=400V$)

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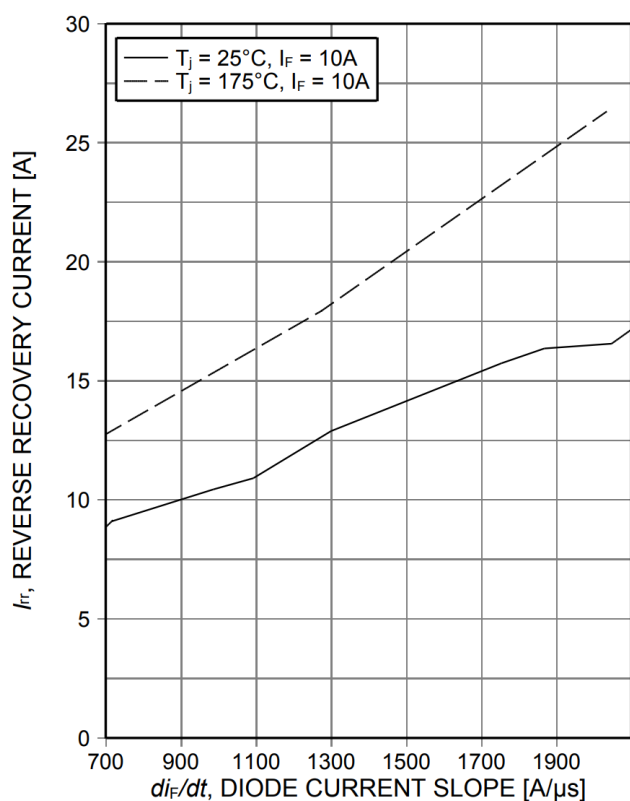


Figure 25. **Typical reverse recovery current as a function of diode current slope** ($V_R=400V$)

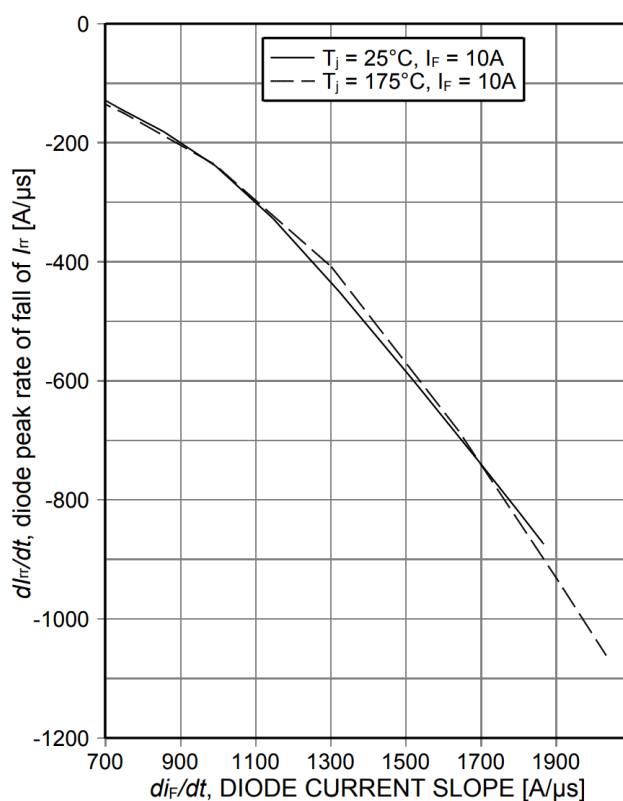


Figure 26. **Typical diode peak rate of fall of reverse recovery current as a function of diode current slope** ($V_R=400V$)

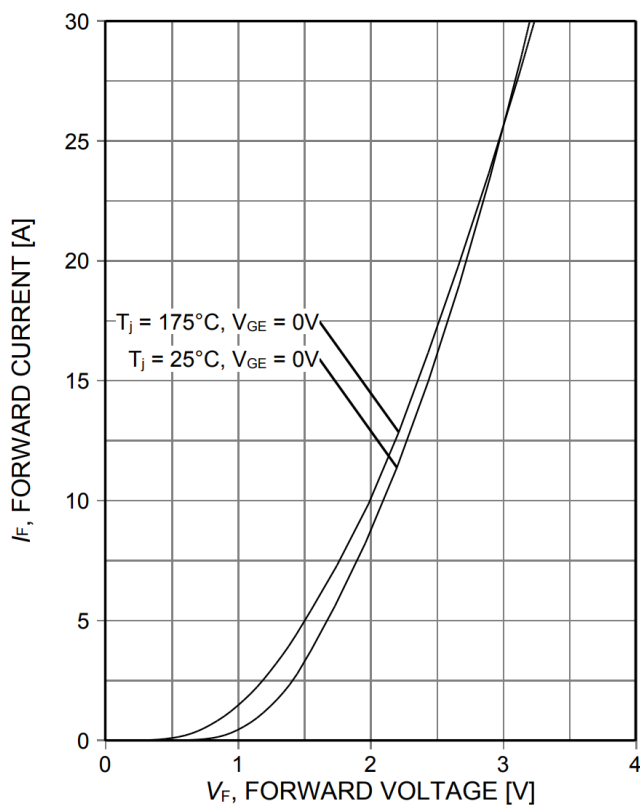


Figure 27. **Typical diode forward current as a function of forward voltage**

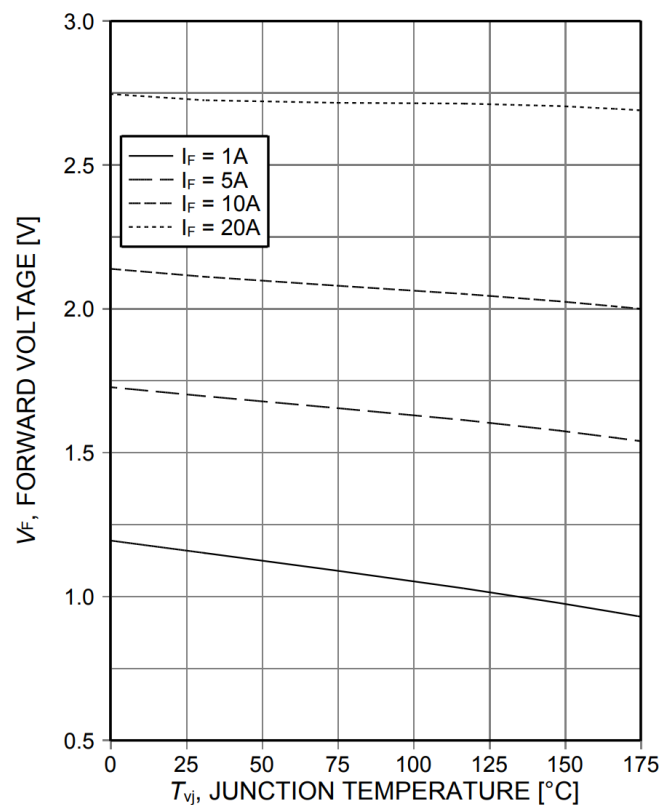
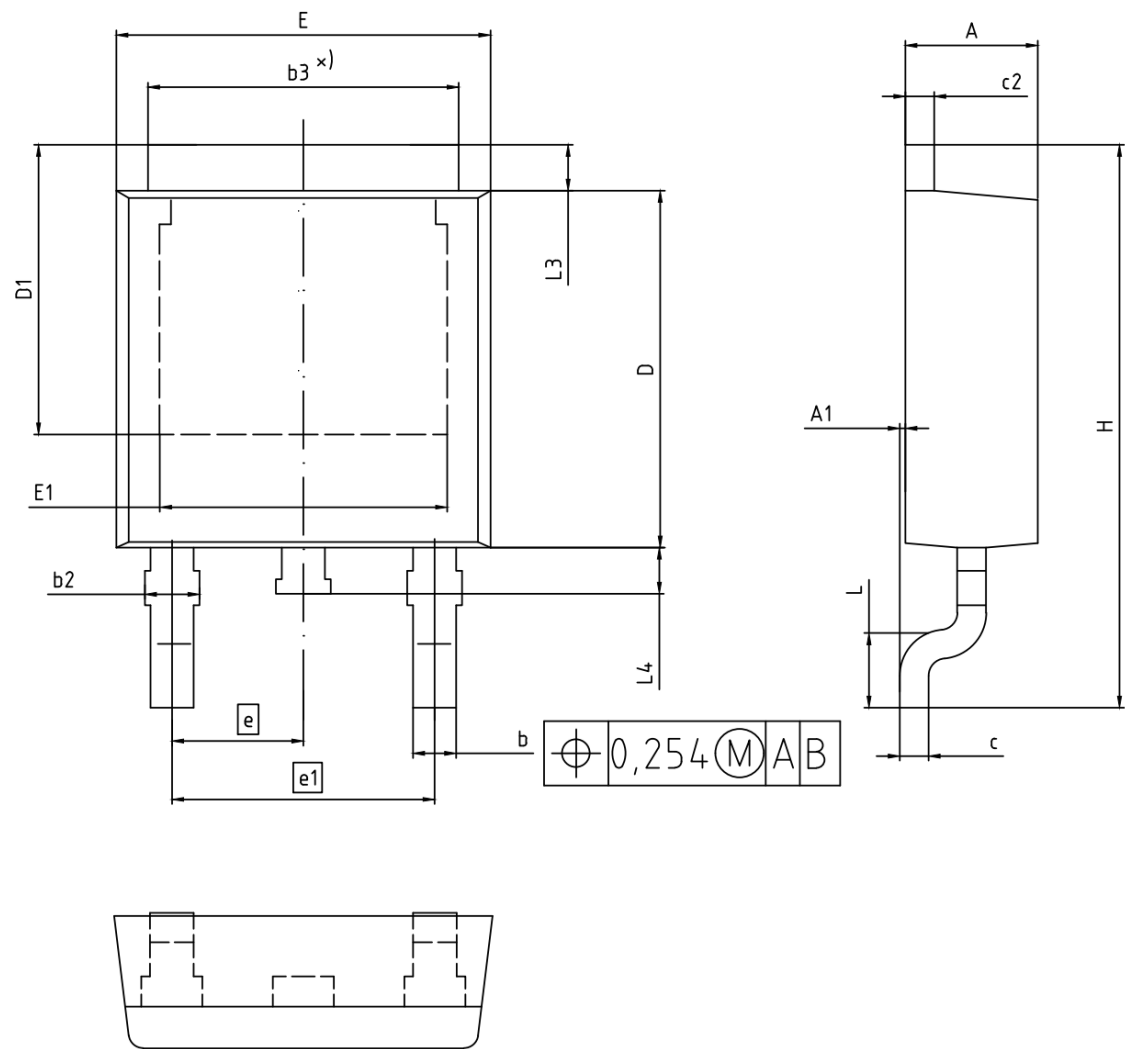


Figure 28. **Typical diode forward voltage as a function of junction temperature**

封装图 PG-T0252-3



NOTES:
1. ALL DIMENSIONS REFER TO JEDEC
STANDARD TO-252 DO NOT INCLUDE MOLD
FLASH OR PROTRUSIONS.

DIM	MILLIMETERS	
	MIN	MAX
A	2.16	2.41
A1	0.00	0.15
b	0.64	0.89
b2	0.65	1.15
b3	4.95	5.50
c	0.46	0.61
c2	0.40	0.98
D	5.97	6.22
D1	5.02	5.84
E	6.35	6.73
E1	4.32	5.21
e	2.29 (BSC)	
e1	4.57 (BSC)	
N	3	
H	9.40	10.48
L	1.18	1.78
L3	0.89	1.27
L4	0.51	1.02

DOCUMENT NO.
Z8B00003328

SCALE
0 2.5 5mm

EUROPEAN PROJECTION

ISSUE DATE
05-02-2016

REVISION
06

测试条件

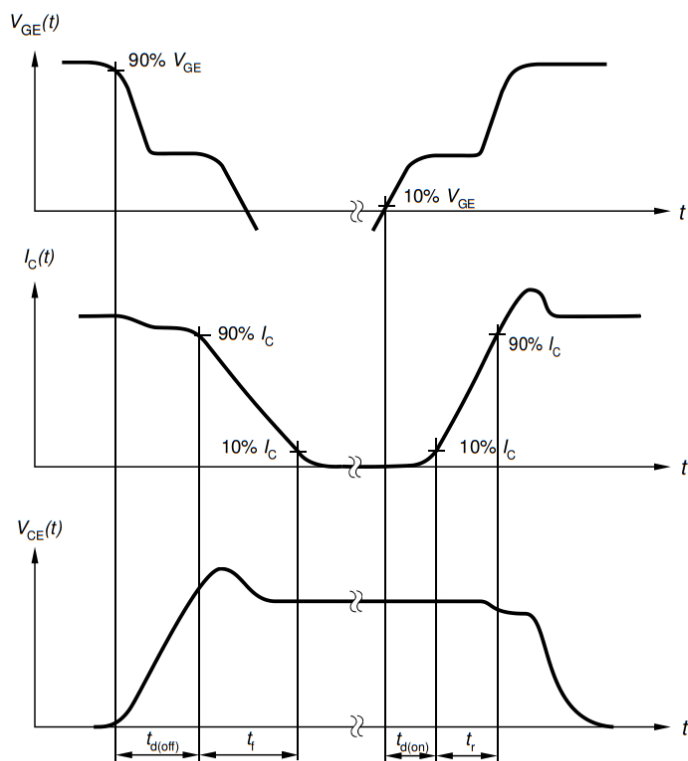


Figure A. Definition of switching times

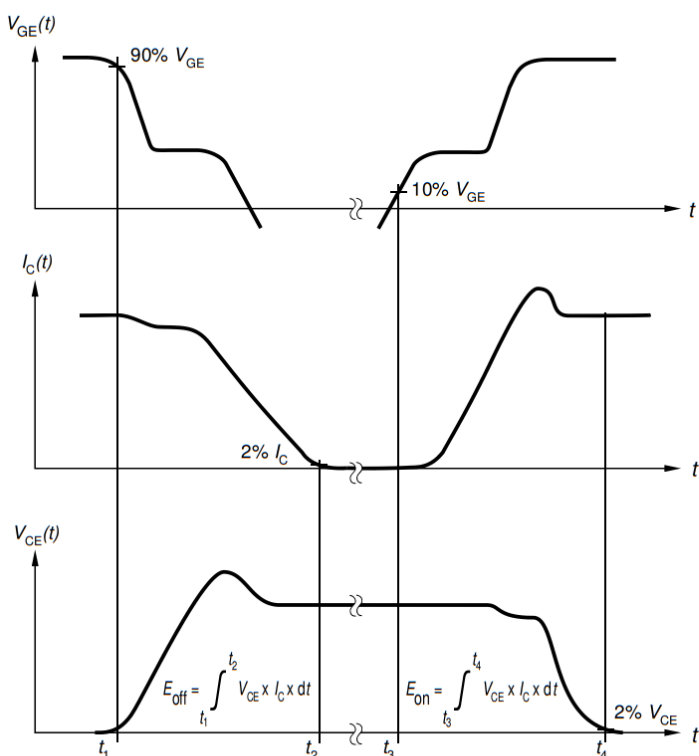


Figure B. Definition of switching losses

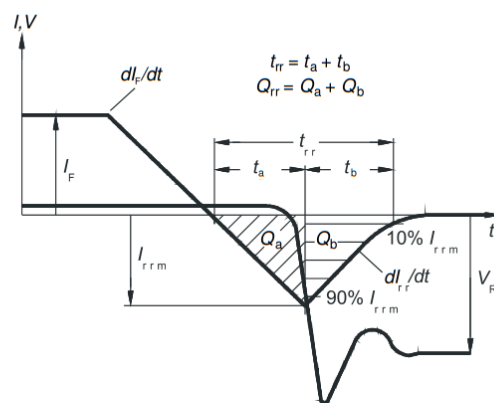


Figure C. Definition of diode switching characteristics

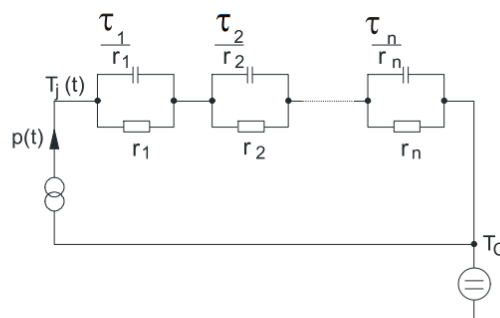


Figure D. Thermal equivalent circuit

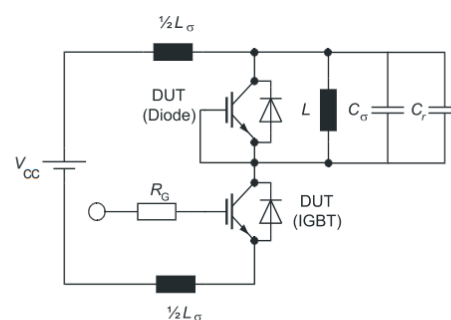


Figure E. Dynamic test circuit
Parasitic inductance L_{σ} ,
parasitic capacitor C_{σ} ,
relief capacitor C_r ,
(only for ZVT switching)

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修订记录

IKD10N60RF

Revision: 2017-09-26, Rev. 2.5

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.1	2012-02-24	Final data sheet
2.2	2013-12-10	New value ICES max limit at 175°C
2.3	2014-02-26	Without PB free logo
2.4	2014-03-12	Storage temp -55...+150°C
2.5	2017-09-26	Update Fig. 13 E(Ic)

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Infineon Technologies AG
81726 München, Germany
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版本 2026-09-24

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