

IGBT

IGBT with integrated diode in packages offering space saving advantage

IKD06N60RF

TRENCHSTOP™ RC-Series for hard switching applications up to 30 kHz

Data sheet

Industrial Power Control

TRENCHSTOP™ RC-Drives Fast Series

IGBT with integrated diode in packages offering space saving advantage

Features:

TRENCHSTOP™ Reverse Conducting (RC) technology for 600V applications offering

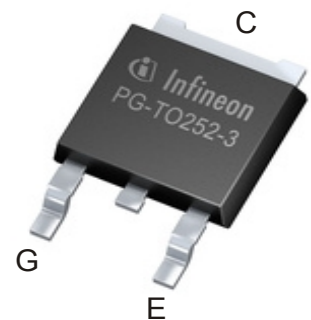
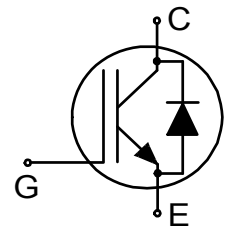
- Optimized Eon, Eoff and Qrr for low switching losses
- Operating range of 4 to 30kHz
- Smooth switching performance leading to low EMI levels
- Very tight parameter distribution
- Maximum junction temperature 175°C
- Short circuit capability of 5μs
- Best in class current versus package size performance
- Qualified according to JEDEC for target applications
- Pb-free lead plating; RoHS compliant (solder temperature 260°C, MSL1)

Complete product spectrum and PSpice Models:
<http://www.infineon.com/igbt/>

Applications:

Domestic and industrial drives:

- Compressors
- Pumps
- Fans



Key Performance and Package Parameters

Type	V_{CE}	I_C	$V_{CEsat}, T_{vj}=25^{\circ}C$	T_{vjmax}	Marking	Package
IKD06N60RF	600V	6A	2.2V	175°C	K06R60F	PG-TO252-3

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TRENCHSTOP™ RC-Drives Fast Series

Maximum Ratings

For optimum lifetime and reliability, Infineon recommends operating conditions that do not exceed 80% of the maximum ratings stated in this datasheet.

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	12.0 6.0	A
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpuls}	18.0	A
Turn off safe operating area $V_{CE} \leq 600\text{V}$, $T_{vj} \leq 175^{\circ}\text{C}$, $t_p = 1\mu\text{s}$	-	18.0	A
Diode forward current, limited by T_{vjmax} $T_c = 25^{\circ}\text{C}$ $T_c = 100^{\circ}\text{C}$	I_F	12.0 6.0	A
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpuls}	18.0	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}	100.0	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	$^{\circ}\text{C}$

Thermal Resistance

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
R _{th} Characteristics						
IGBT thermal resistance, ¹⁾ junction - case	R _{th(j-c)}		-	-	1.50	K/W
Diode thermal resistance, ²⁾ junction - case	R _{th(j-c)}		-	-	3.60	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} based on single cooling pulse. Please be aware that a correct R_{th} measurement of the IGBT, is not possible using a thermocouple.

²⁾ R_{th}/Z_{th} based on single cooling pulse. Please be aware that a correct R_{th} measurement of the Diode, is not possible using a thermocouple.

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Electrical Characteristic, at $T_{vj} = 25^{\circ}\text{C}$, unless otherwise specified

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}	$V_{GE} = 15.0V, I_C = 6.0A$ $T_{vj} = 25^{\circ}C$ $T_{vj} = 175^{\circ}C$	- -	2.20 2.30	2.50 -	V
Diode forward voltage	V_F	$V_{GE} = 0V, I_F = 6.0A$ $T_{vj} = 25^{\circ}C$ $T_{vj} = 175^{\circ}C$	- -	2.10 2.00	2.40 -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C = 0.11mA, V_{CE} = V_{GE}$	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}	$V_{CE} = 20V, I_C = 6.0A$	-	2.9	-	S
Integrated gate resistor	r_G			none		Ω

Electrical Characteristic, at $T_{vj} = 25^{\circ}\text{C}$, unless otherwise specified

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Dynamic Characteristic						
Input capacitance	C _{ies}	V _{CE} = 25V, V _{GE} = 0V, f = 1MHz	-	470	-	pF
Output capacitance	C _{oes}		-	24	-	
Reverse transfer capacitance	C _{res}		-	14	-	
Gate charge	Q _G	V _{CC} = 480V, I _C = 6.0A, V _{GE} = 15V	-	48.0	-	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	-	46	-	A

Switching Characteristic, Inductive Load

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic, at $T_{vj} = 25^{\circ}\text{C}$						
Turn-on delay time	$t_{d(on)}$	$T_{vj} = 25^{\circ}\text{C},$ $V_{CC} = 400\text{V}, I_C = 6.0\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(on)} = 23.0\Omega, R_{G(off)} = 23.0\Omega,$ $L_{\sigma} = 50\text{nH}, C_{\sigma} = 30\text{pF}$ L_{σ}, C_{σ} from Fig. E	-	7	-	ns
Rise time	t_r		-	8	-	ns
Turn-off delay time	$t_{d(off)}$		-	106	-	ns
Fall time	t_f		-	22	-	ns
Turn-on energy	E_{on}		-	0.09	-	mJ
Turn-off energy	E_{off}		-	0.09	-	mJ
Total switching energy	E_{ts}		-	0.18	-	mJ

¹⁾ Not subject to production test - verified by design/characterization

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Diode Characteristic, at $T_{vj} = 25^{\circ}\text{C}$

Diode reverse recovery time	t_{rr}	$T_{vj} = 25^{\circ}\text{C},$ $V_R = 400\text{V},$ $I_F = 6.0\text{A},$ $di_F/dt = 770\text{A}/\mu\text{s}$	-	48	-	ns
Diode reverse recovery charge	Q_{rr}		-	0.16	-	μC
Diode peak reverse recovery current	I_{rrm}		-	7.4	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-195	-	$\text{A}/\mu\text{s}$

Switching Characteristic, Inductive Load

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	

IGBT Characteristic, at $T_{vj} = 175^{\circ}\text{C}$

Turn-on delay time	$t_{d(on)}$	$T_{vj} = 175^{\circ}\text{C},$ $V_{CC} = 400\text{V}, I_C = 6.0\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(on)} = 23.0\Omega, R_{G(off)} = 23.0\Omega,$ $L\sigma = 50\text{nH}, C\sigma = 30\text{pF}$ $L\sigma, C\sigma$ from Fig. E	-	8	-	ns
Rise time	t_r		-	8	-	ns
Turn-off delay time	$t_{d(off)}$		-	115	-	ns
Fall time	t_f		-	35	-	ns
Turn-on energy	E_{on}		-	0.15	-	mJ
Turn-off energy	E_{off}		-	0.13	-	mJ
Total switching energy	E_{ts}		-	0.28	-	mJ

Diode Characteristic, at $T_{vj} = 175^{\circ}\text{C}$

Diode reverse recovery time	t_{rr}	$T_{vj} = 175^{\circ}\text{C},$ $V_R = 400\text{V},$ $I_F = 6.0\text{A},$ $di_F/dt = 770\text{A}/\mu\text{s}$	-	74	-	ns
Diode reverse recovery charge	Q_{rr}		-	0.34	-	μC
Diode peak reverse recovery current	I_{rrm}		-	10.3	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-177	-	$\text{A}/\mu\text{s}$

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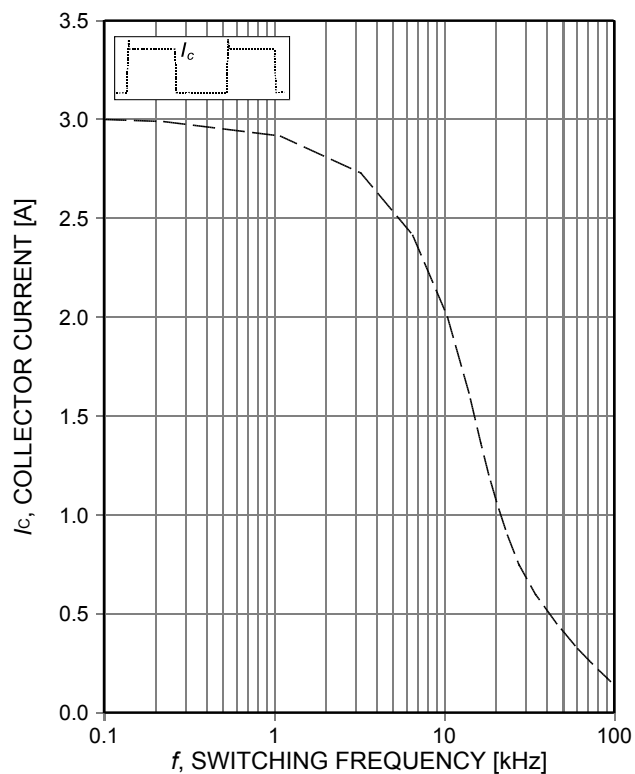


Figure 1. **Collector current as a function of switching frequency**
($T_{vj} \leq 175^\circ\text{C}$, $T_a = 55^\circ\text{C}$, $D = 0.5$, $V_{CE} = 400\text{V}$,
 $V_{GE} = 15/0\text{V}$, $r_G = 23\Omega$, PCB mounting, $6\text{cm}^2\text{Cu}$,
 $P_{tot} = 2.4\text{W}$)

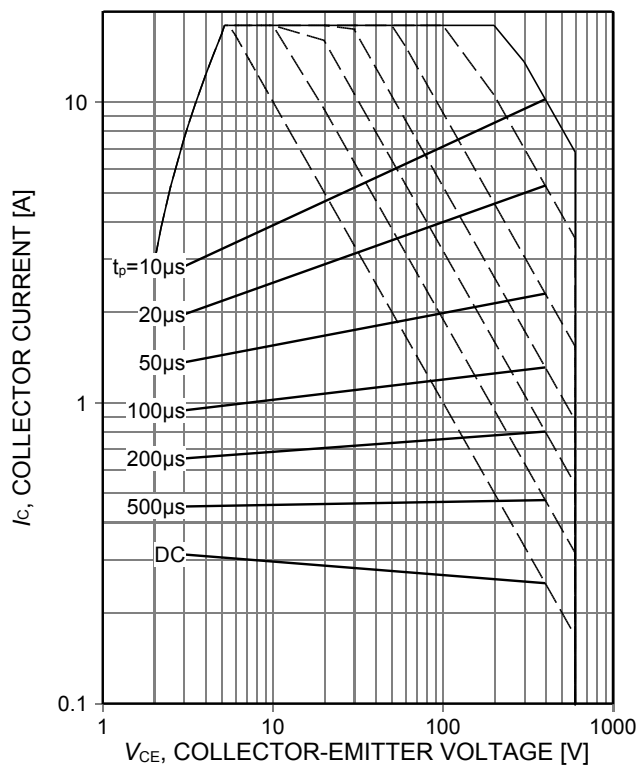


Figure 2. **Forward bias safe operating area**
($D = 0$, $T_C = 25^\circ\text{C}$, $T_{vj} \leq 175^\circ\text{C}$; $V_{GE} = 15\text{V}$)

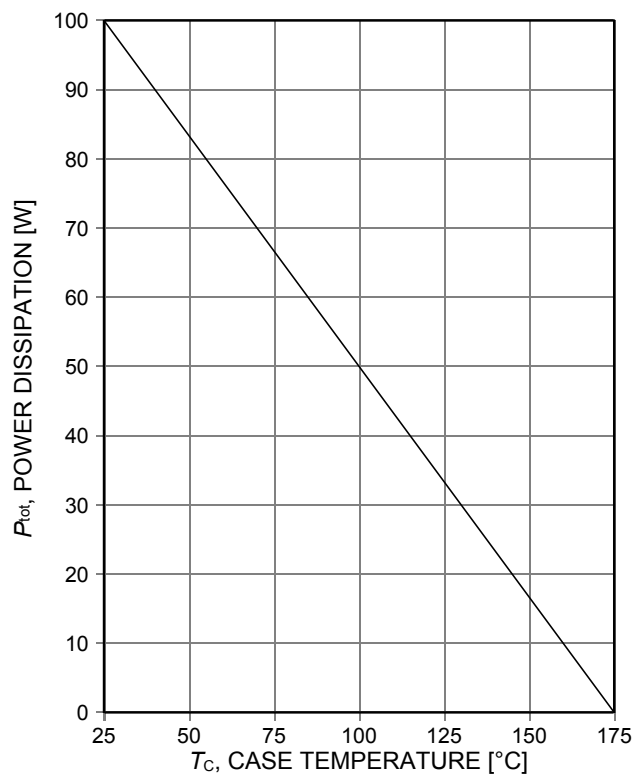


Figure 3. **Power dissipation as a function of case temperature**
($T_{vj} \leq 175^\circ\text{C}$)

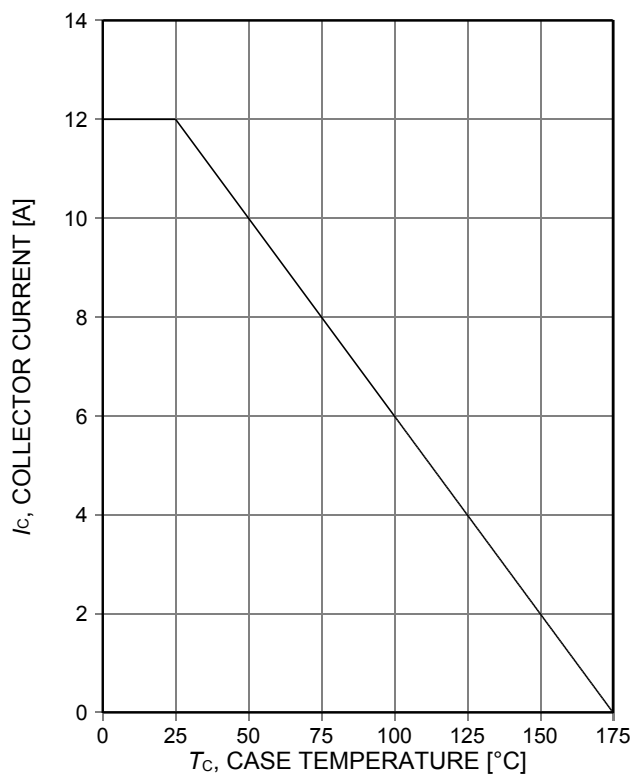


Figure 4. **Collector current as a function of case temperature**
($V_{GE} \geq 15\text{V}$, $T_{vj} \leq 175^\circ\text{C}$)

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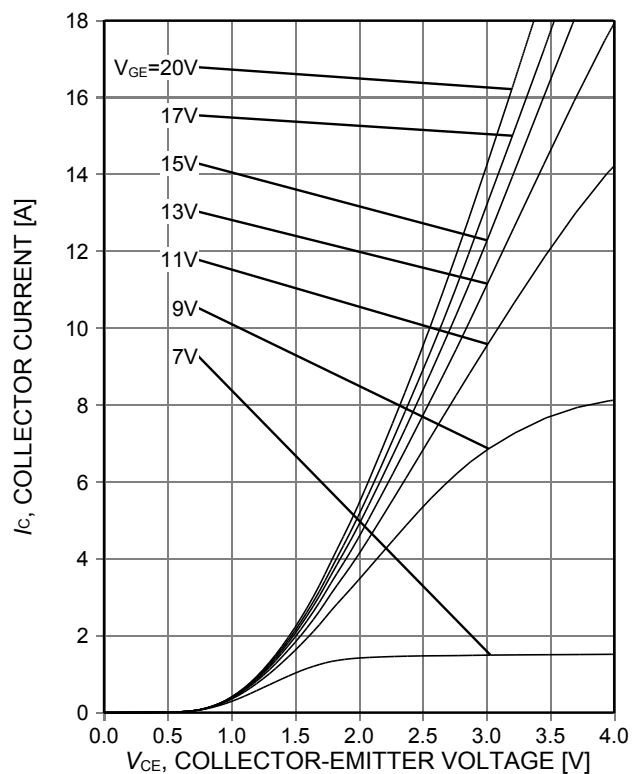


Figure 5. **Typical output characteristic**
($T_j=25^{\circ}\text{C}$)

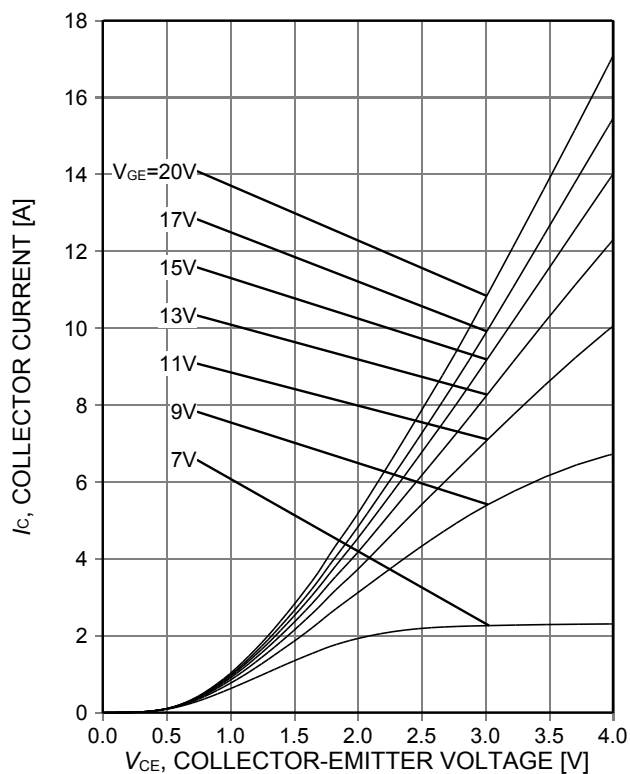


Figure 6. **Typical output characteristic**
($T_j=175^{\circ}\text{C}$)

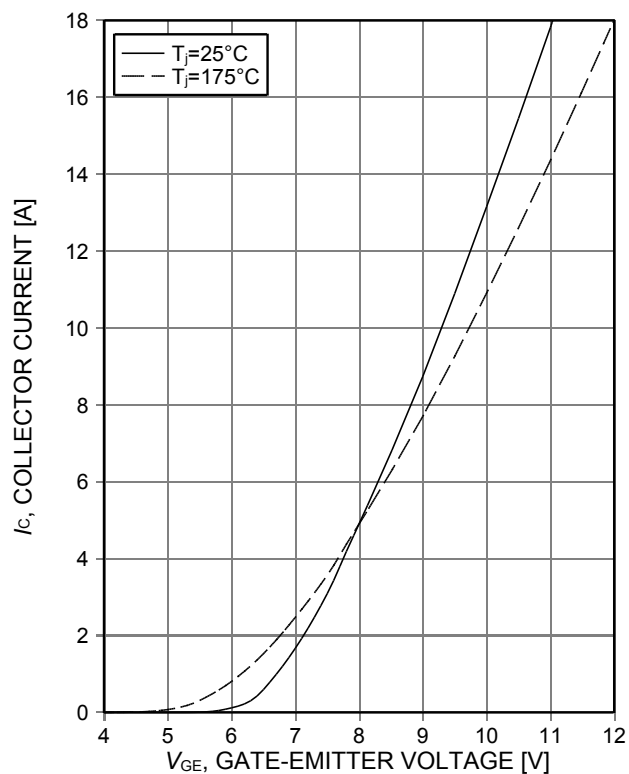


Figure 7. **Typical transfer characteristic**
($V_{ce}=10\text{V}$)

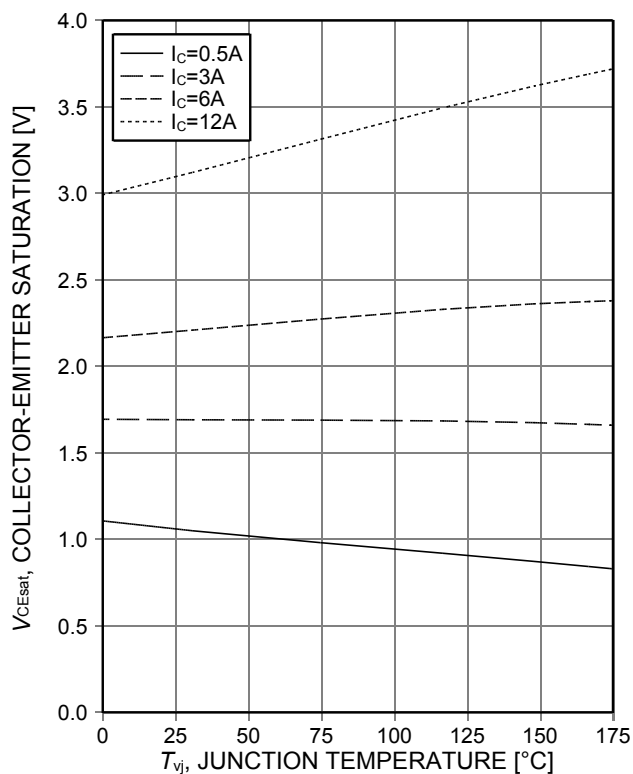


Figure 8. **Typical collector-emitter saturation voltage as a function of junction temperature**
($V_{ge}=15\text{V}$)

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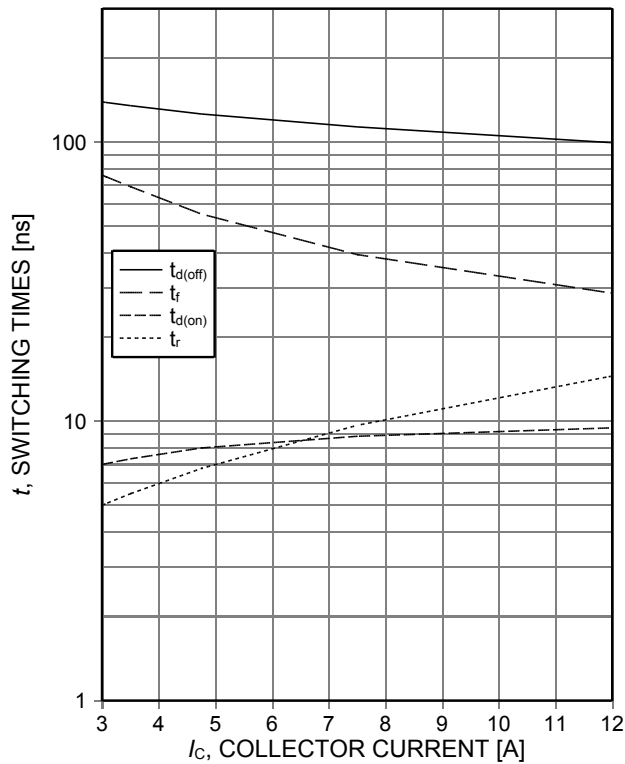


Figure 9. **Typical switching times as a function of collector current**
(inductive load, $T_{vj}=175^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $r_G=23\Omega$, Dynamic test circuit in Figure E)

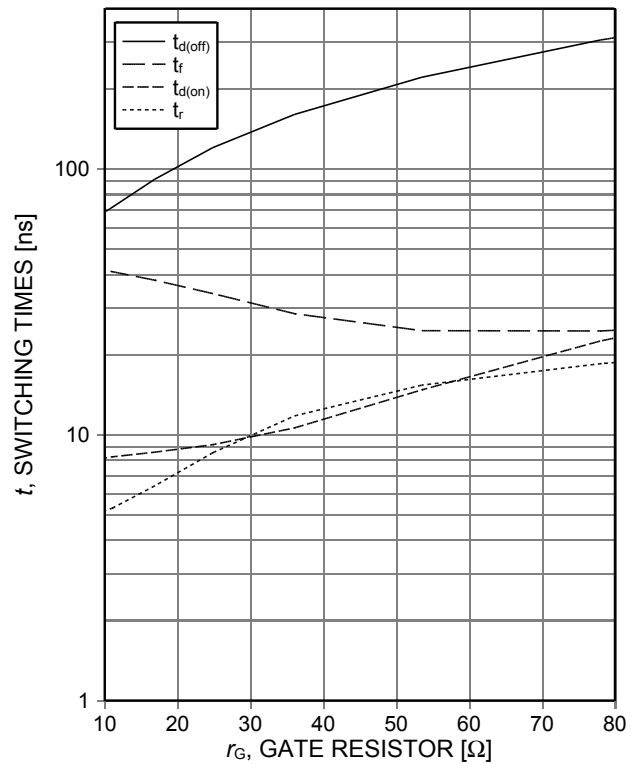


Figure 10. **Typical switching times as a function of gate resistor**
(inductive load, $T_{vj}=175^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=6\text{A}$, Dynamic test circuit in Figure E)

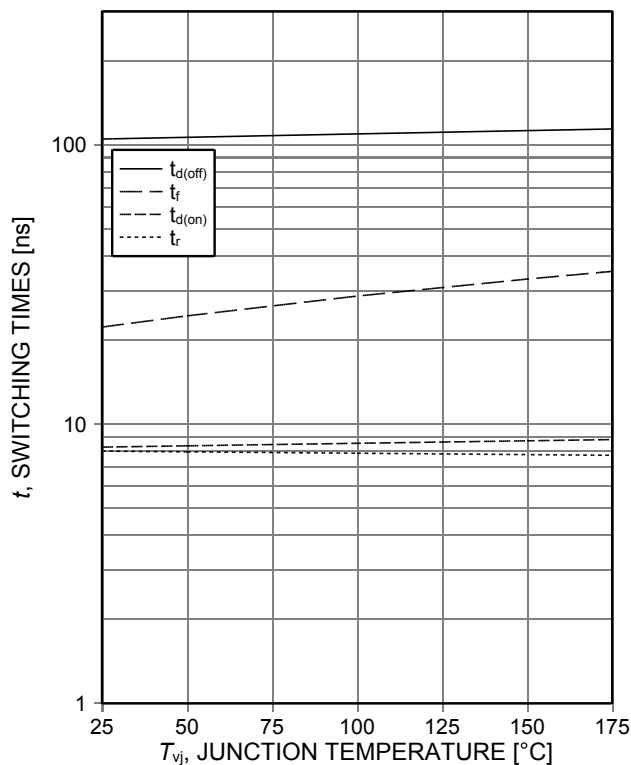


Figure 11. **Typical switching times as a function of junction temperature**
(inductive load, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=6\text{A}$, $r_G=23\Omega$, Dynamic test circuit in Figure E)

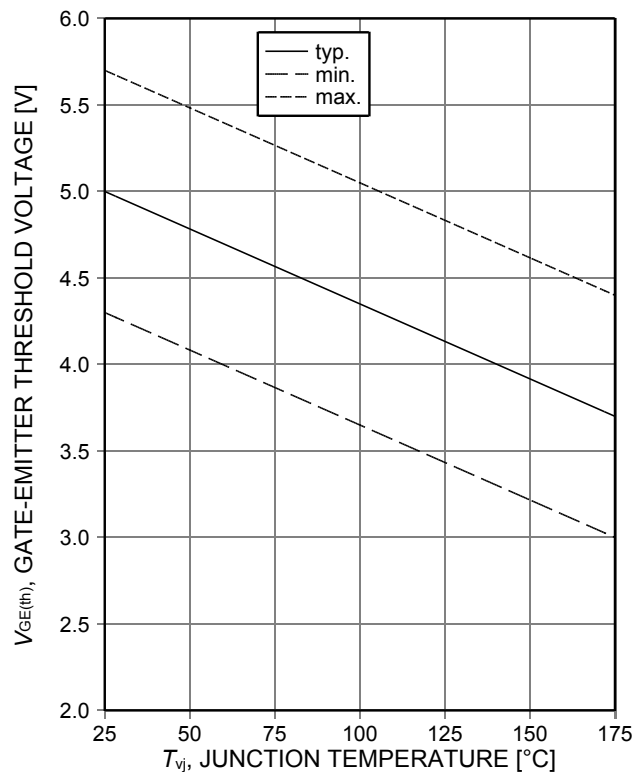


Figure 12. **Gate-emitter threshold voltage as a function of junction temperature**
($I_C=0,11\text{mA}$)

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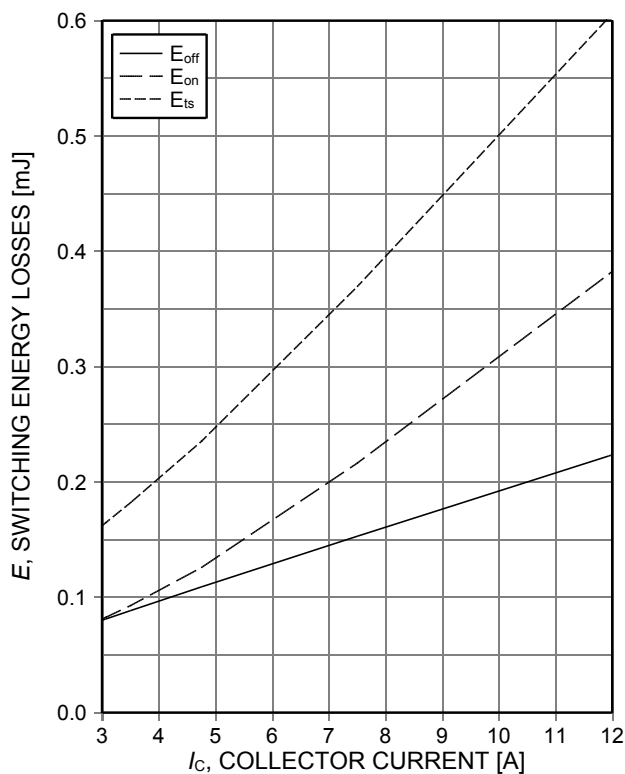


Figure 13. **Typical switching energy losses as a function of collector current**
(inductive load, $T_{vj}=175^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $r_G=23\Omega$, Dynamic test circuit in Figure E)

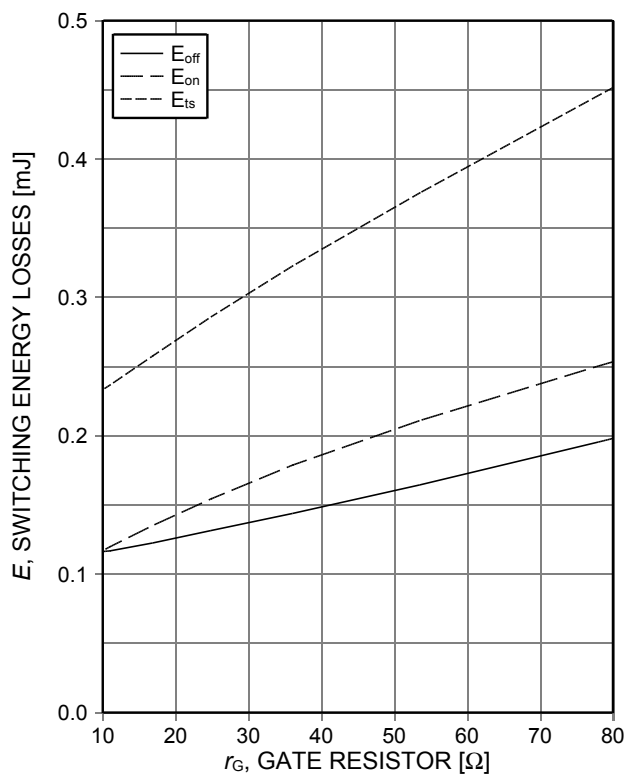


Figure 14. **Typical switching energy losses as a function of gate resistor**
(inductive load, $T_{vj}=175^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=6\text{A}$, Dynamic test circuit in Figure E)

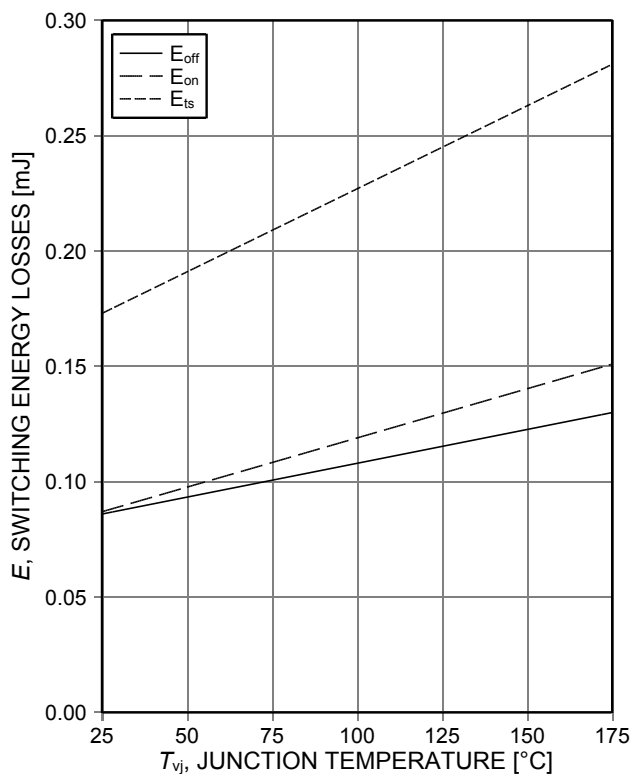


Figure 15. **Typical switching energy losses as a function of junction temperature**
(inductive load, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=6\text{A}$, $r_G=23\Omega$, Dynamic test circuit in Figure E)

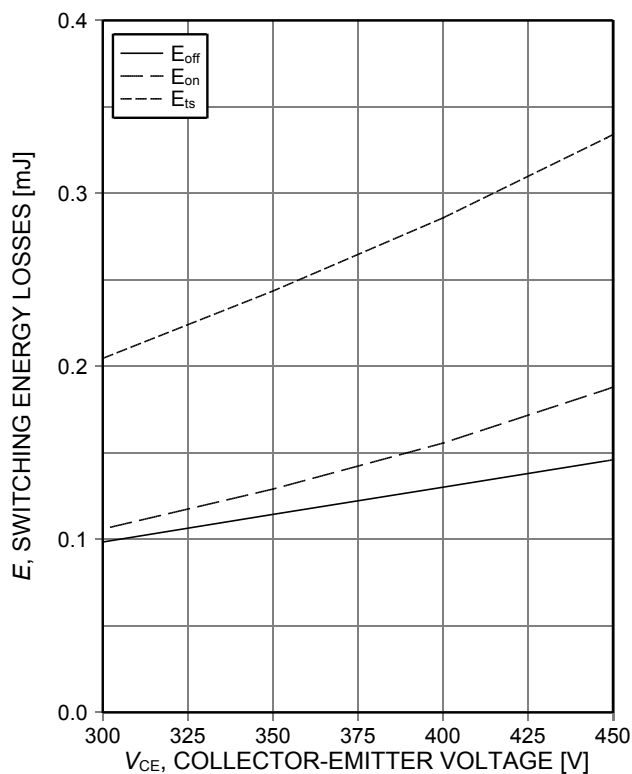


Figure 16. **Typical switching energy losses as a function of collector emitter voltage**
(inductive load, $T_{vj}=175^{\circ}\text{C}$, $V_{GE}=15/0\text{V}$, $I_C=6\text{A}$, $r_G=23\Omega$, Dynamic test circuit in Figure E)

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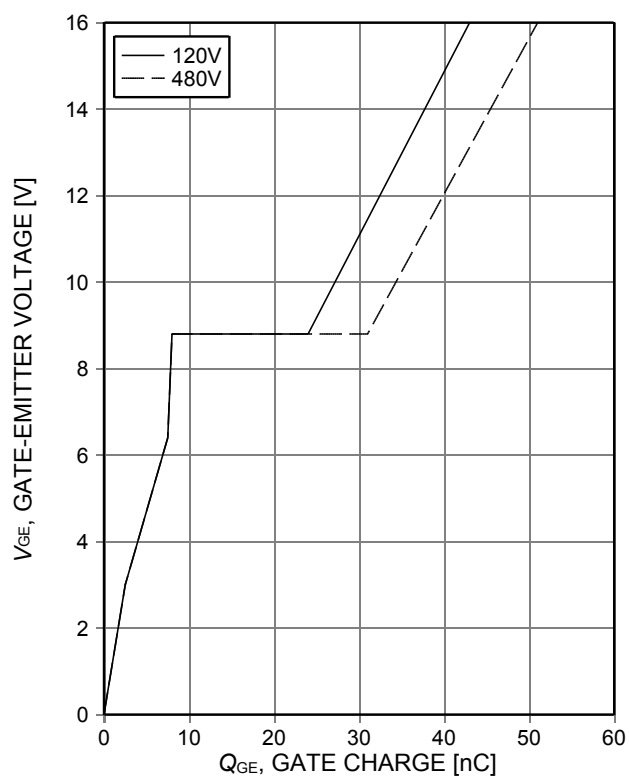


Figure 17. **Typical gate charge**
($I_C=6A$)

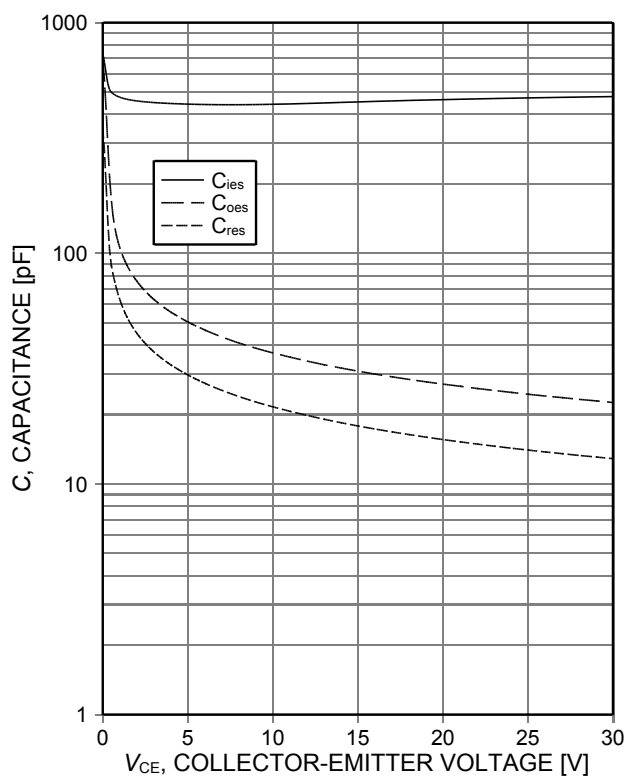


Figure 18. **Typical capacitance as a function of collector-emitter voltage**
($V_{GE}=0V$, $f=1MHz$)

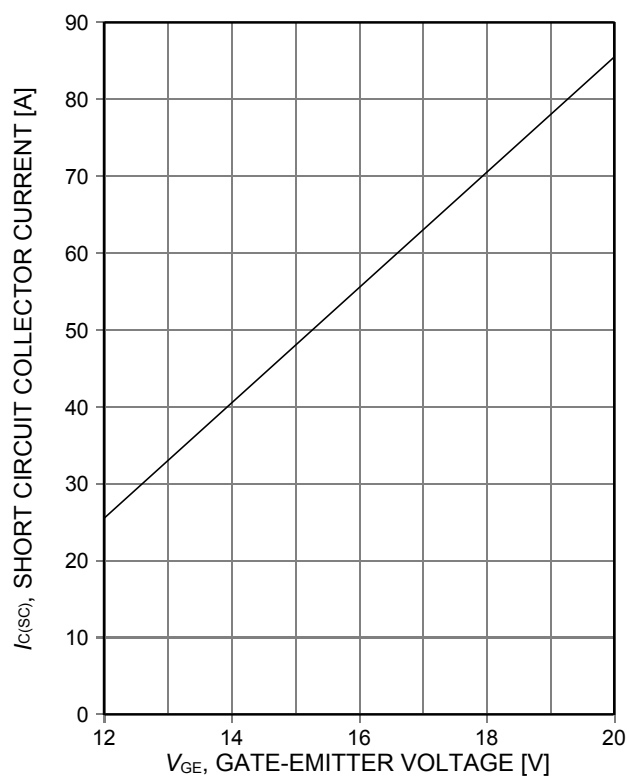


Figure 19. **Typical short circuit collector current as a function of gate-emitter voltage**
($V_{CE} \leq 400V$, start at $T_{vj}=25^\circ C$)

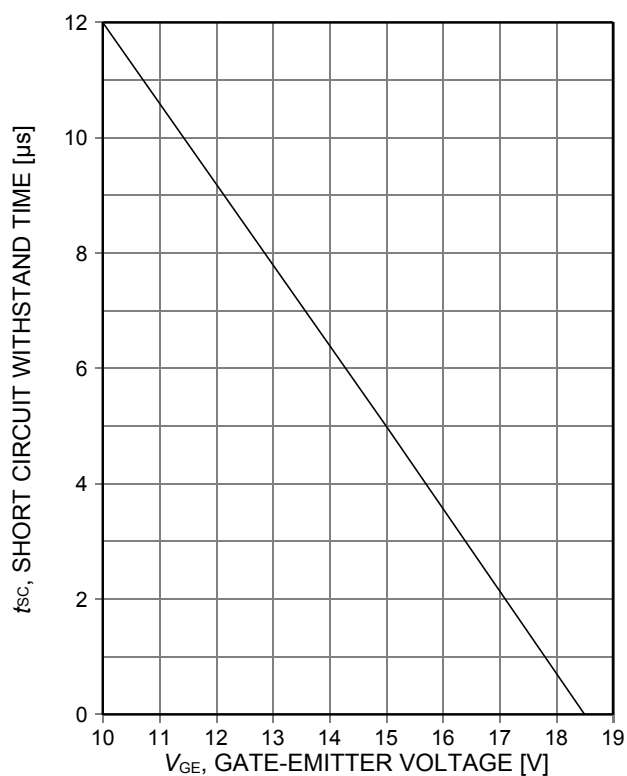


Figure 20. **Short circuit withstand time as a function of gate-emitter voltage**
($V_{CE} \leq 400V$, start at $T_{vj}=150^\circ C$)

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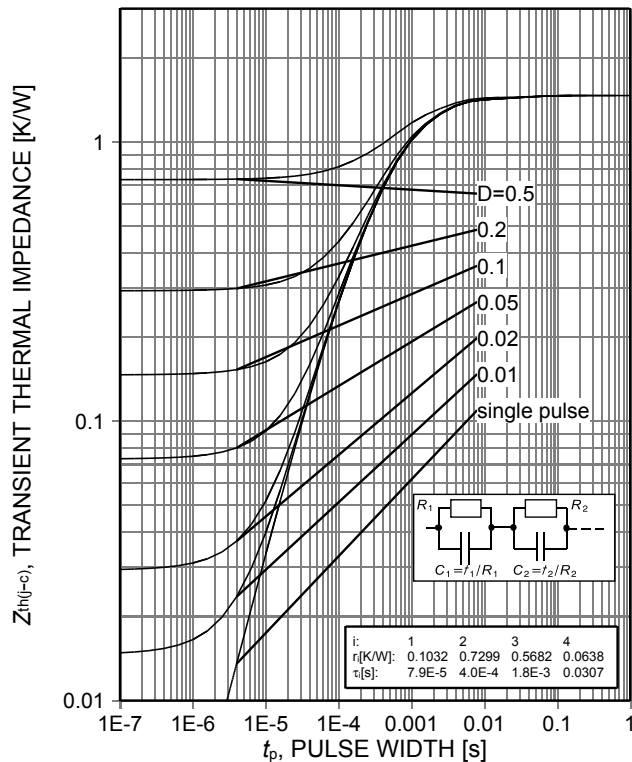


Figure 21. IGBT transient thermal impedance as a function of pulse width ¹⁾ (see page 4)
($D=t_p/T$)

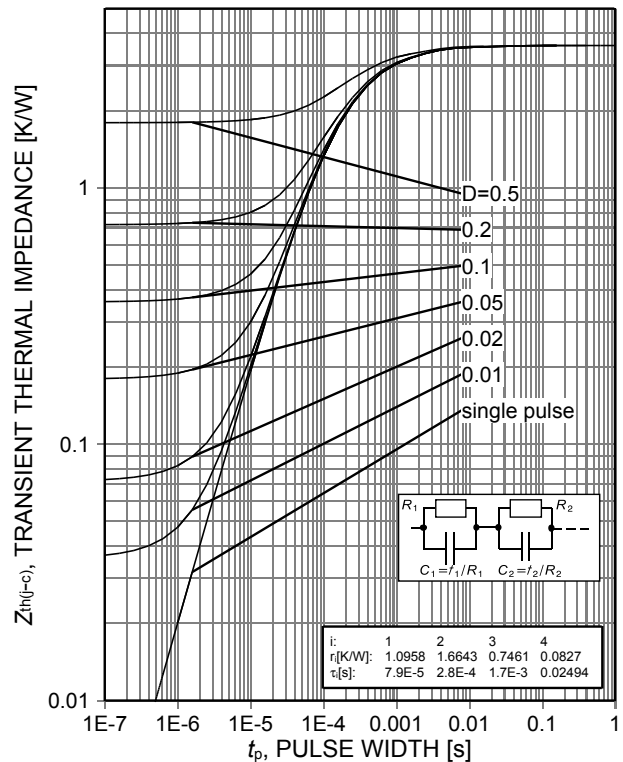


Figure 22. Diode transient thermal impedance as a function of pulse width ²⁾ (see page 4)
($D=t_p/T$)

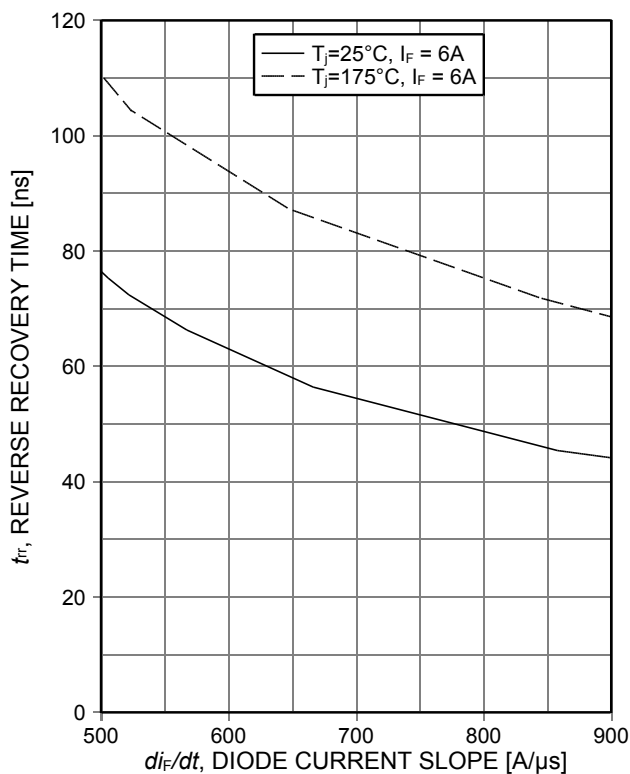


Figure 23. Typical reverse recovery time as a function of diode current slope
($V_R=400V$)

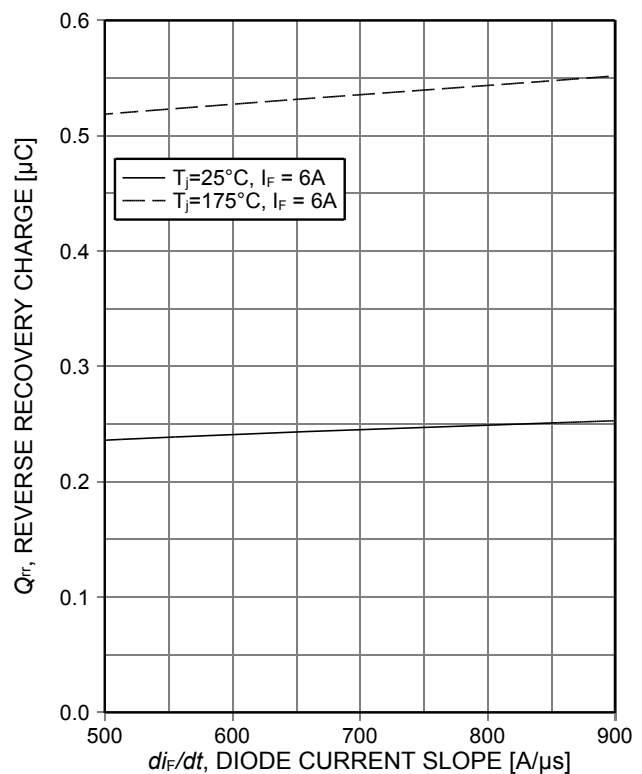


Figure 24. Typical reverse recovery charge as a function of diode current slope
($V_R=400V$)

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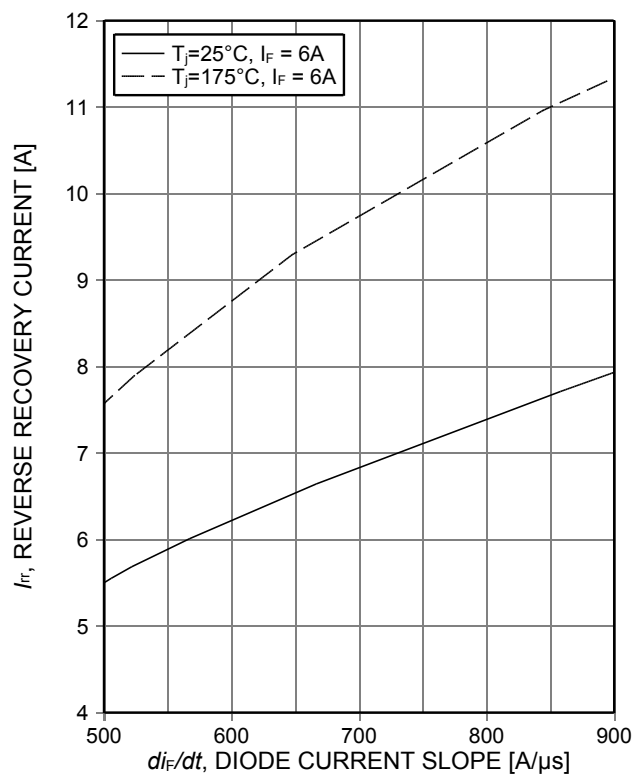


Figure 25. Typical reverse recovery current as a function of diode current slope ($V_R=400V$)

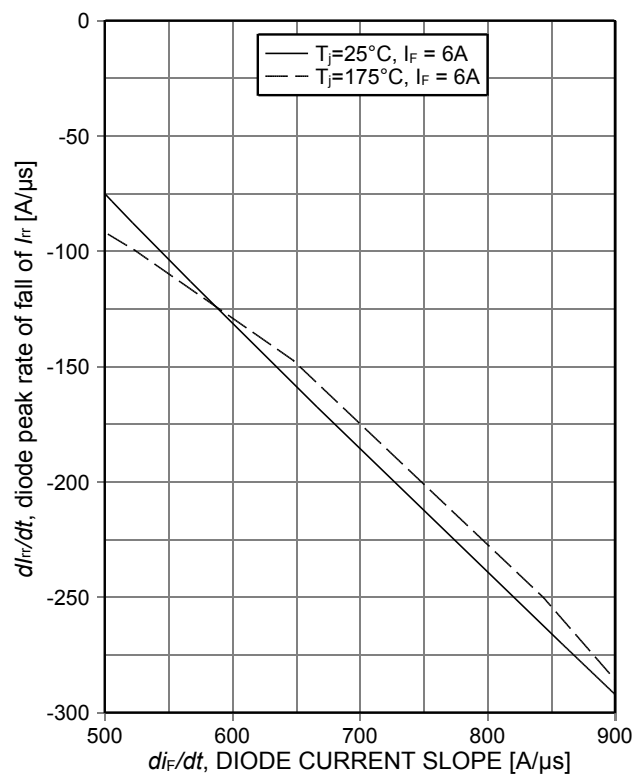


Figure 26. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope ($V_R=400V$)

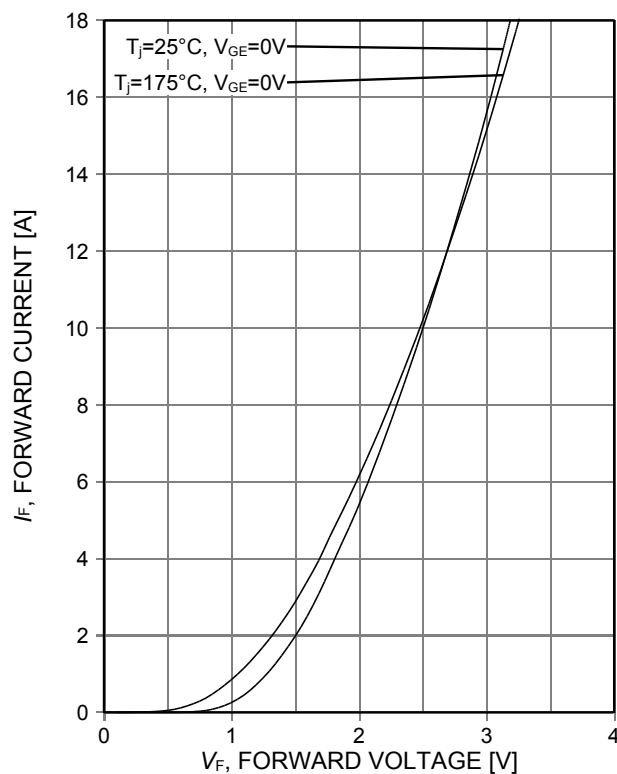


Figure 27. Typical diode forward current as a function of forward voltage

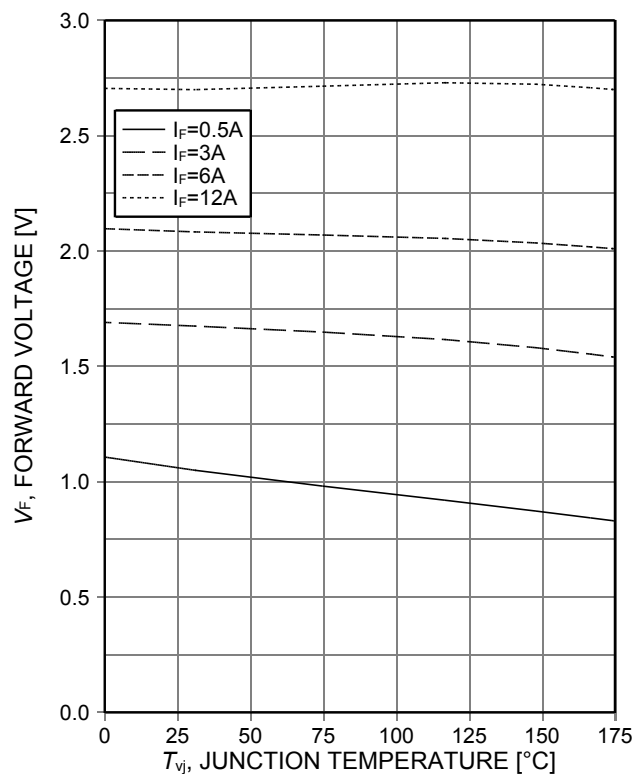


Figure 28. Typical diode forward voltage as a function of junction temperature

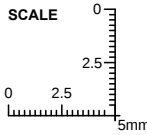
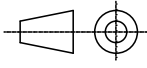
Package Drawing PG-TO252-3



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

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REVISION 06

Testing Conditions

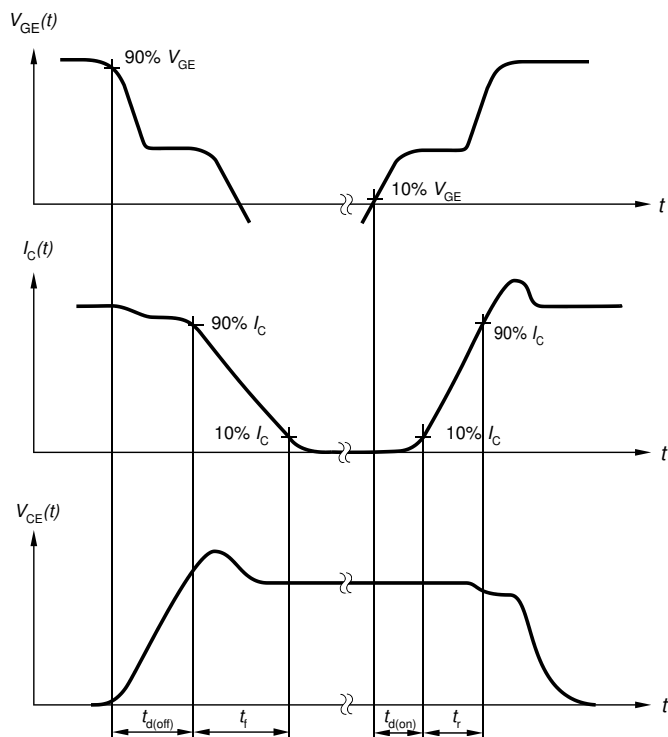


Figure A. Definition of switching times

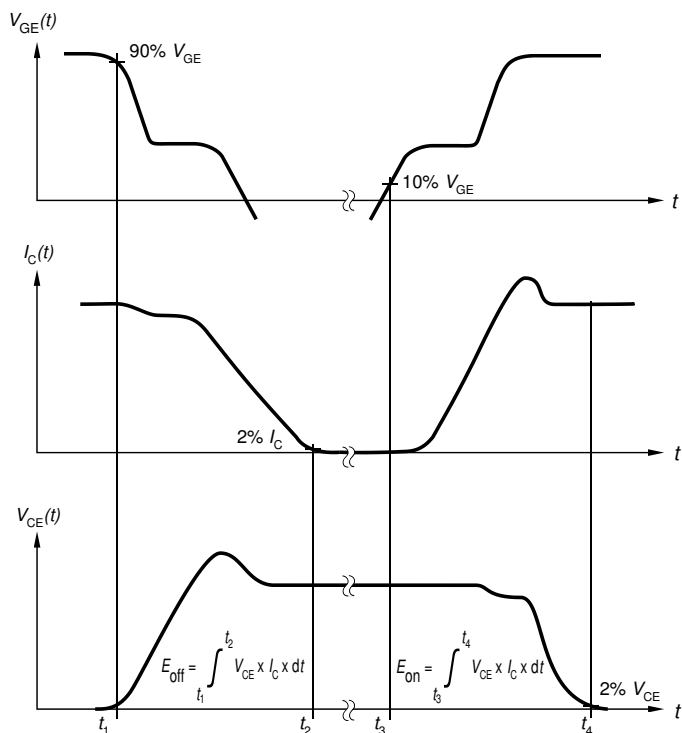


Figure B. Definition of switching losses

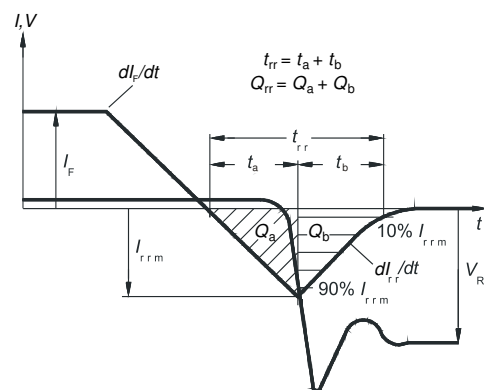


Figure C. Definition of diode switching characteristics

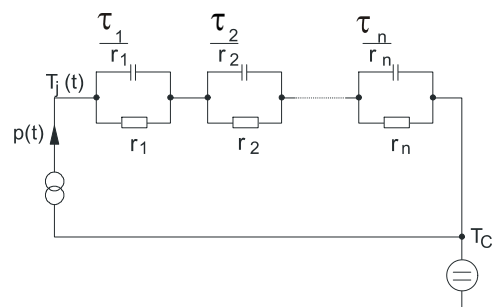


Figure D. Thermal equivalent circuit

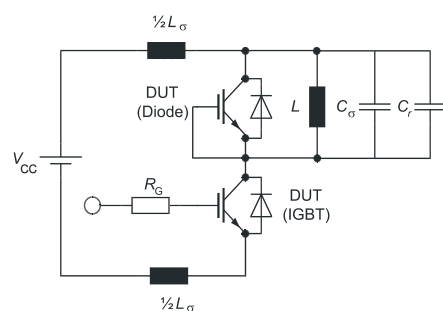


Figure E. **Dynamic test circuit**
Parasitic inductance L_σ ,
parasitic capacitor C_σ ,
relief capacitor C_r ,
(only for ZVT switching)

TRENCHSTOP™ RC-Drives Fast Series**Revision History**

IKD06N60RF**Revision: 2014-03-12, Rev. 2.4**

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

Trademarks

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