

IGBT

IGBT with integrated diode in packages offering space saving advantage

IKD06N60R

600V TRENCHSTOP™ RC-Series for hard switching applications

Data sheet

TRENCHSTOP™ RC-Series for hard switching applications

IGBT with integrated diode in packages offering space saving advantage

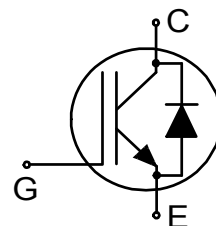
Features:

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

- Optimised V_{CEsat} and V_F for low conduction losses
- Smooth switching performance leading to low EMI levels
- Very tight parameter distribution
- Operating range of 1 to 20kHz
- 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 (for PG-TO252: solder temperature 260°C, MSL1)
- Complete product spectrum and PSpice Models:
<http://www.infineon.com/igbt/>

Applications:

- Consumer motor drives

**Key Performance and Package Parameters**

Type	V_{CE}	I_C	V_{CEsat} , $T_{vj}=25^{\circ}C$	T_{vjmax}	Marking	Package
IKD06N60R	600V	6A	1.65V	175°C	K06R60	PG-TO252-3

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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}	$V_{GE} = 15.0V, I_C = 6.0A$ $T_{vj} = 25^{\circ}C$ $T_{vj} = 175^{\circ}C$	- -	1.65 1.85	2.10 -	V
Diode forward voltage	V_F	$V_{GE} = 0V, I_F = 6.0A$ $T_{vj} = 25^{\circ}C$ $T_{vj} = 175^{\circ}C$	- -	1.70 1.70	2.10 -	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}	$V_{CE} = 20V, I_C = 6.0A$	-	3.4	-	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
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	$t_{d(\text{on})}$	$T_{vj} = 25^{\circ}\text{C},$ $V_{CC} = 400\text{V}, I_C = 6.0\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(\text{on})} = 23.0\Omega, R_{G(\text{off})} = 23.0\Omega,$ $L\sigma = 60\text{nH}, C\sigma = 40\text{pF}$ $L\sigma, C\sigma$ from Fig. E	-	12	-	ns
Rise time	t_r		-	7	-	ns
Turn-off delay time	$t_{d(\text{off})}$		-	127	-	ns
Fall time	t_f		-	152	-	ns
Turn-on energy	E_{on}		-	0.11	-	mJ
Turn-off energy	E_{off}		-	0.22	-	mJ
Total switching energy	E_{ts}		-	0.33	-	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}	$T_{vj} = 25^{\circ}\text{C},$ $V_R = 400\text{V},$ $I_F = 6.0\text{A},$ $di_F/dt = 800\text{A}/\mu\text{s}$	-	68	-	ns
Diode reverse recovery charge	Q_{rr}		-	0.37	-	μC
Diode peak reverse recovery current	I_{rrm}		-	12.0	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-211	-	$\text{A}/\mu\text{s}$

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	$t_{d(on)}$	$T_{vj} = 175^{\circ}\text{C},$ $V_{CC} = 400\text{V}, I_C = 6.0\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(on)} = 23.0\Omega, R_{G(off)} = 23.0\Omega,$ $L\sigma = 60\text{nH}, C\sigma = 40\text{pF}$ $L\sigma, C\sigma$ from Fig. E	-	12	-	ns
Rise time	t_r		-	10	-	ns
Turn-off delay time	$t_{d(off)}$		-	164	-	ns
Fall time	t_f		-	171	-	ns
Turn-on energy	E_{on}		-	0.20	-	mJ
Turn-off energy	E_{off}		-	0.36	-	mJ
Total switching energy	E_{ts}		-	0.56	-	mJ

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

Diode reverse recovery time	t_{rr}	$T_{vj} = 175^{\circ}\text{C},$ $V_R = 400\text{V},$ $I_F = 6.0\text{A},$ $di_F/dt = 800\text{A}/\mu\text{s}$	-	74	-	ns
Diode reverse recovery charge	Q_{rr}		-	0.80	-	μC
Diode peak reverse recovery current	I_{rrm}		-	17.0	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-237	-	$\text{A}/\mu\text{s}$

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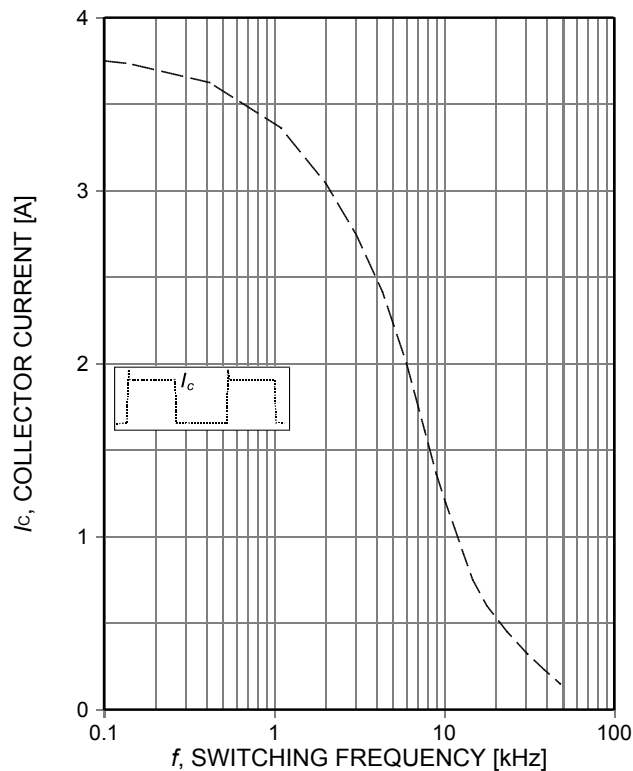


Figure 1. **Collector current as a function of switching frequency**
 ($T_{vj} \leq 175^\circ\text{C}$, $T_a = 55^\circ\text{C}$, $D = 0.5$, $V_{CE} = 400\text{V}$,
 $V_{GE} = 15/0\text{V}$, $r_G = 23\Omega$, PCB mounting, 6cm^2
 Cu, $P_{tot} = 2.4\text{W}$)

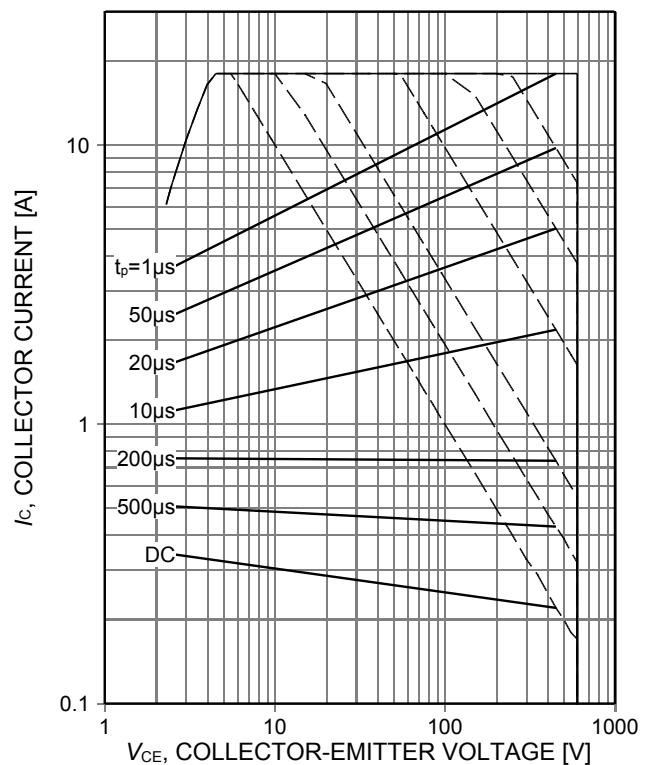


Figure 2. **Forward bias safe operating area**
 ($D = 0$, $T_C = 25^\circ\text{C}$, $T_{vj} \leq 175^\circ\text{C}$; $V_{GE} = 15\text{V}$)

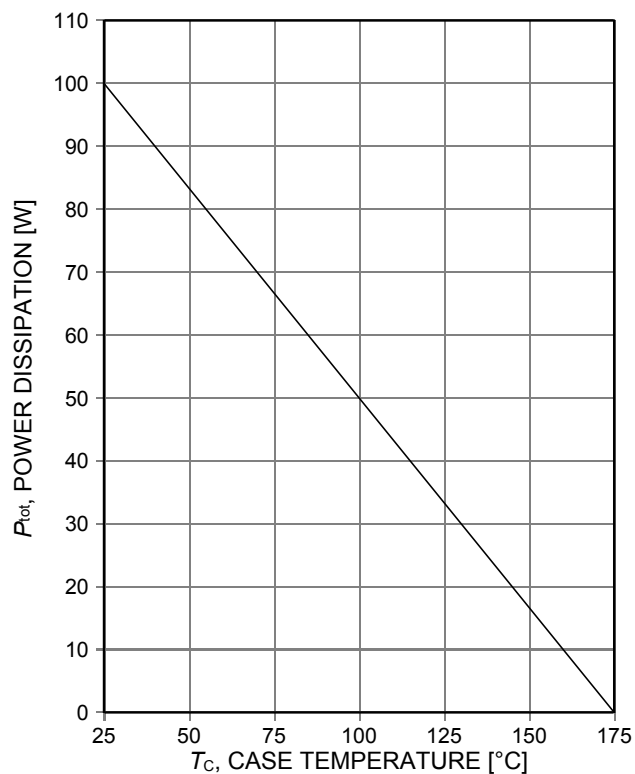


Figure 3. **Power dissipation as a function of case temperature**
 ($T_{vj} \leq 175^\circ\text{C}$)

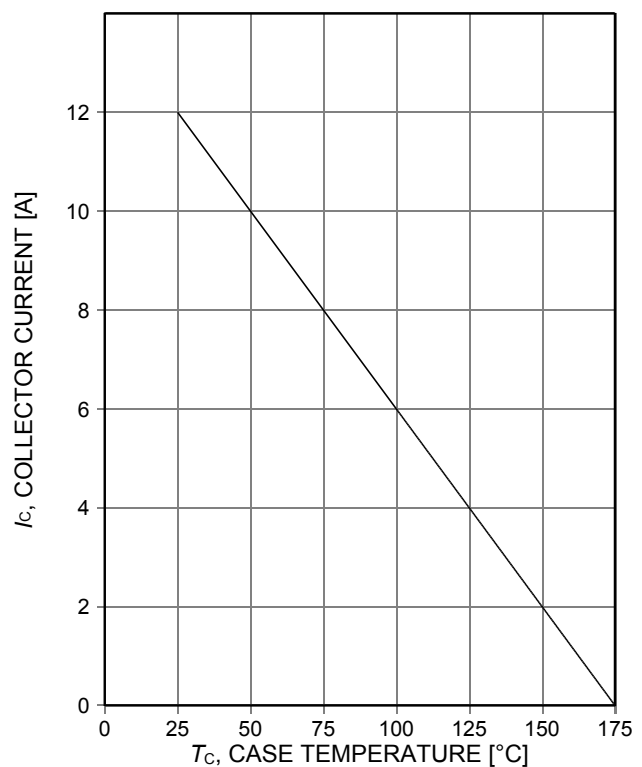


Figure 4. **Collector current as a function of case temperature**
 ($V_{GE} \geq 15\text{V}$, $T_{vj} \leq 175^\circ\text{C}$)

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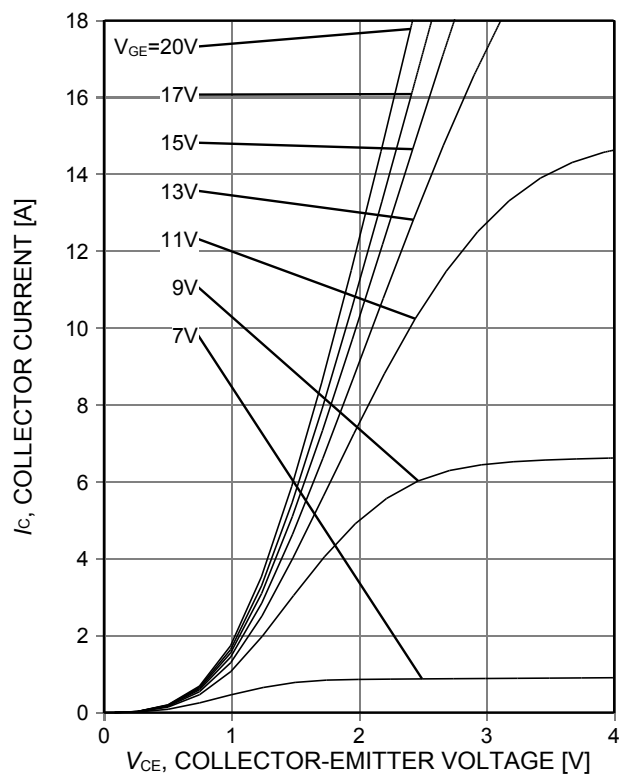


Figure 5. **Typical output characteristic**
($T_j = 25^\circ\text{C}$)

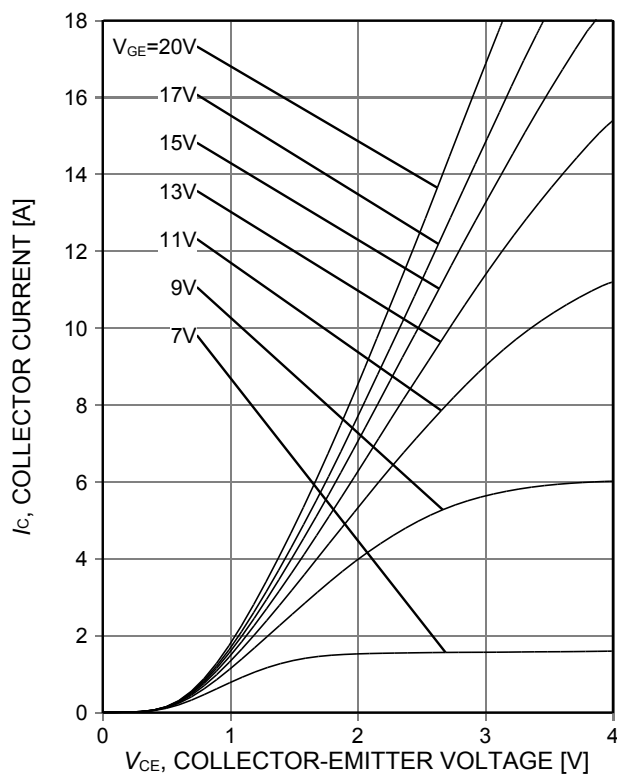


Figure 6. **Typical output characteristic**
($T_j = 175^\circ\text{C}$)

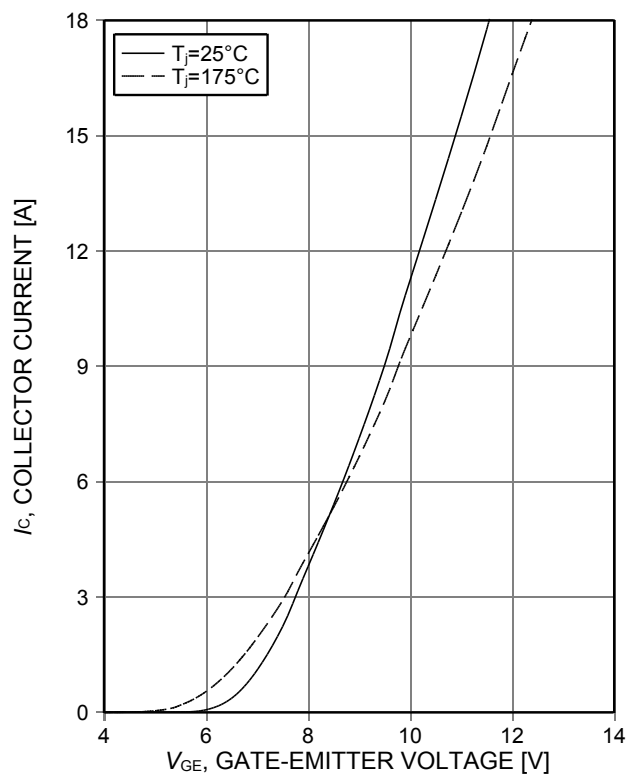


Figure 7. **Typical transfer characteristic**
($V_{CE} = 10\text{V}$)

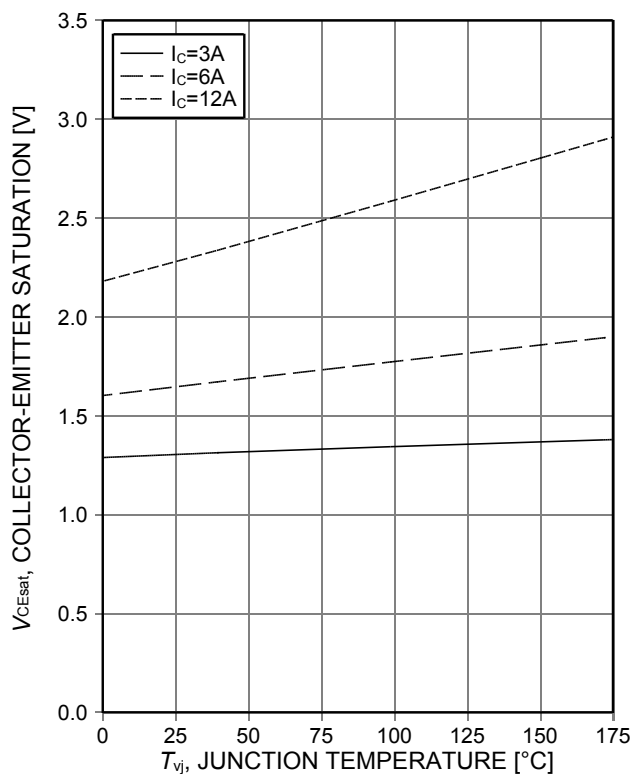


Figure 8. **Typical collector-emitter saturation voltage as a function of junction temperature**
($V_{GE} = 15\text{V}$)

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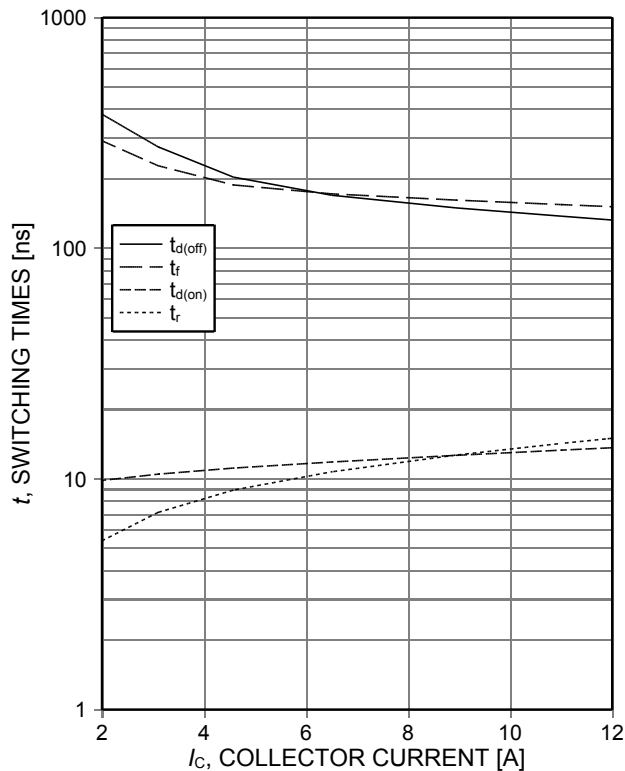


Figure 9. **Typical switching times as a function of collector current**
(inductive load, $T_{vj}=175^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $r_G=23\Omega$, Dynamic test circuit in Figure E)

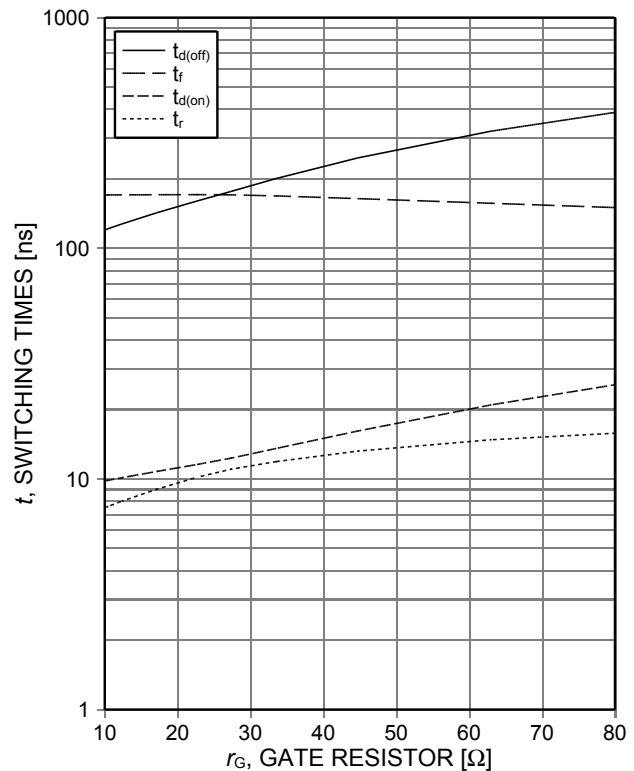


Figure 10. **Typical switching times as a function of gate resistor**
(inductive load, $T_{vj}=175^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=6\text{A}$, Dynamic test circuit in Figure E)

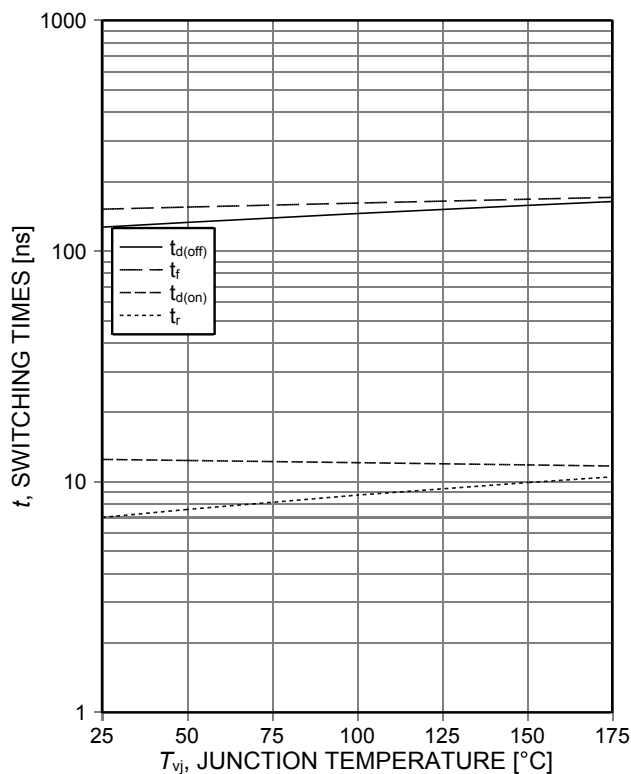


Figure 11. **Typical switching times as a function of junction temperature**
(inductive load, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=6\text{A}$, $r_G=23\Omega$, Dynamic test circuit in Figure E)

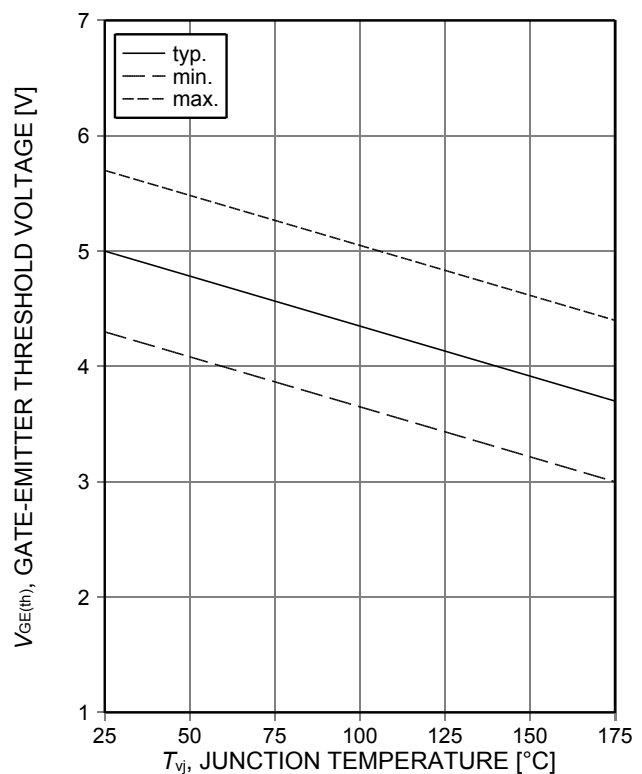


Figure 12. **Gate-emitter threshold voltage as a function of junction temperature**
($I_C=0.11\text{mA}$)

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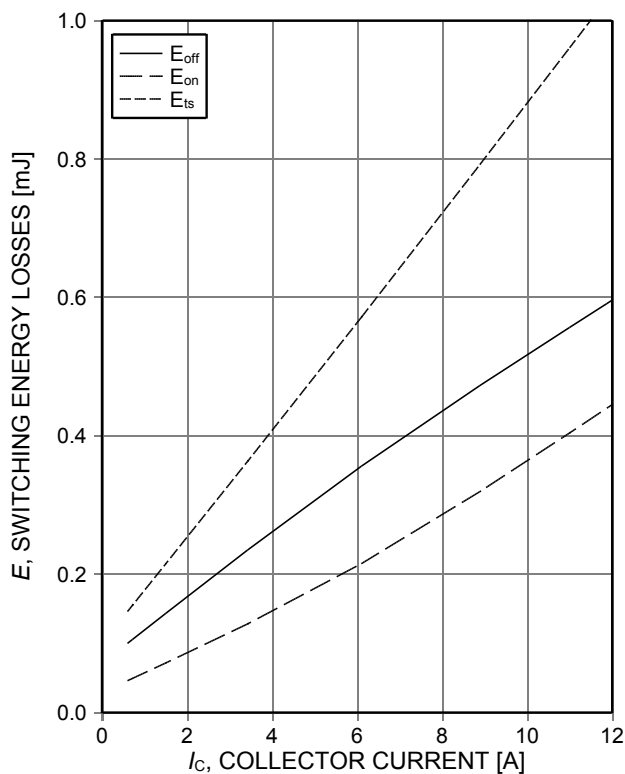


Figure 13. **Typical switching energy losses as a function of collector current**
(inductive load, $T_{vj}=175^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $r_G=23\Omega$, Dynamic test circuit in Figure E)

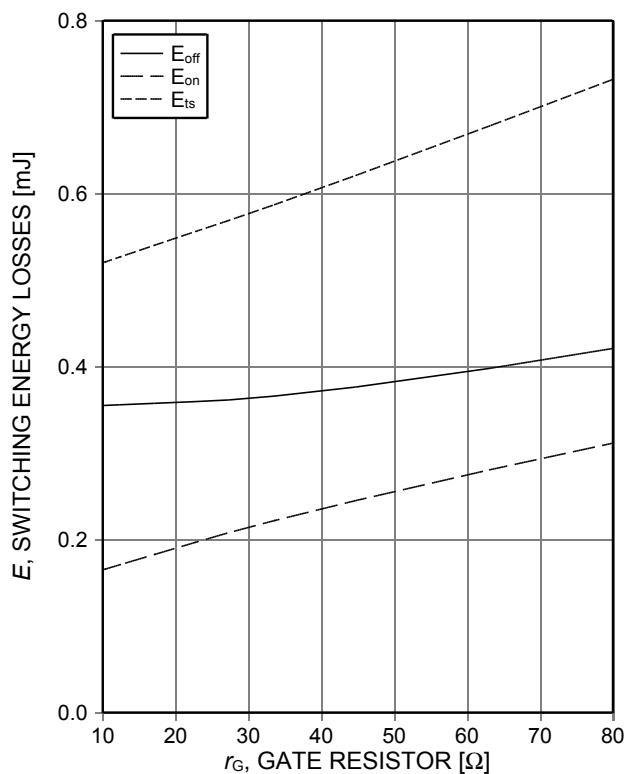


Figure 14. **Typical switching energy losses as a function of gate resistor**
(inductive load, $T_{vj}=175^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=6\text{A}$, Dynamic test circuit in Figure E)

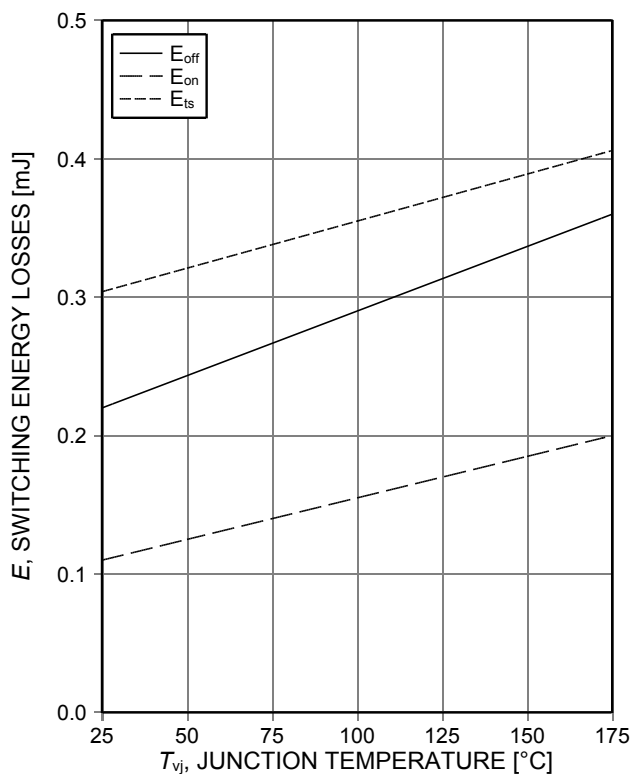


Figure 15. **Typical switching energy losses as a function of junction temperature**
(inductive load, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=6\text{A}$, $r_G=23\Omega$, Dynamic test circuit in Figure E)

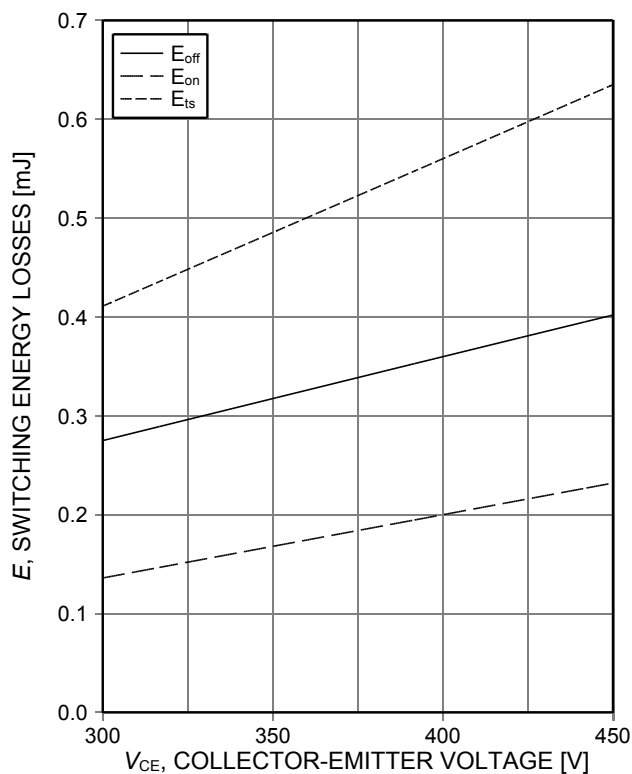


Figure 16. **Typical switching energy losses as a function of collector emitter voltage**
(inductive load, $T_{vj}=175^{\circ}\text{C}$, $V_{GE}=15/0\text{V}$, $I_C=6\text{A}$, $r_G=23\Omega$, Dynamic test circuit in Figure E)

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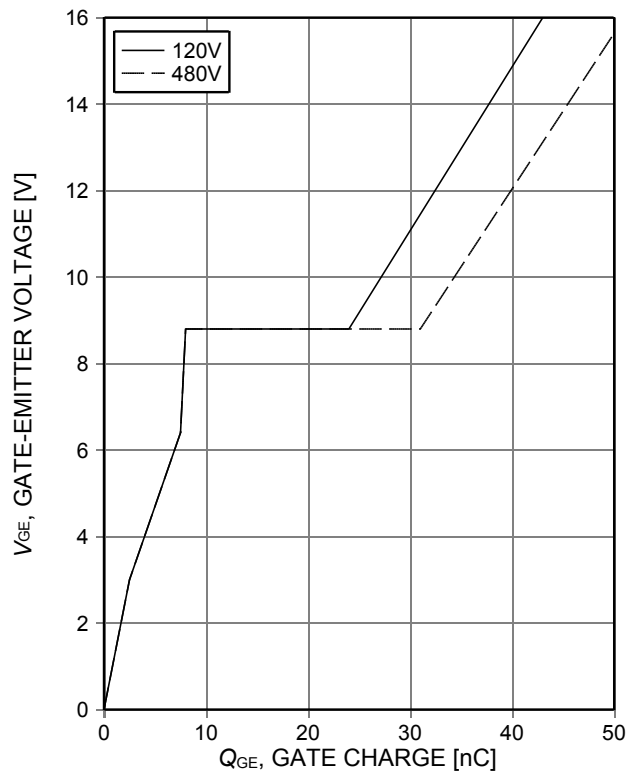


Figure 17. **Typical gate charge**
($I_C=6A$)

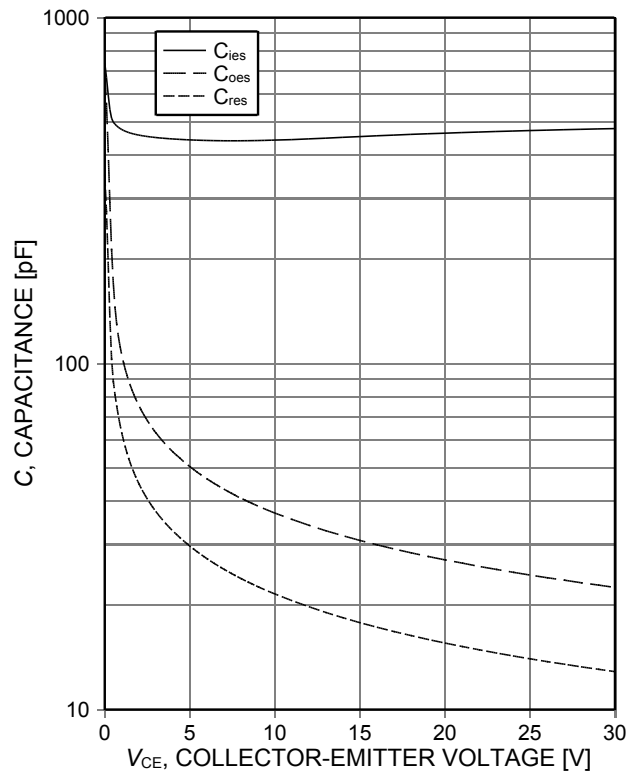


Figure 18. **Typical capacitance as a function of collector-emitter voltage**
($V_{GE}=0V$, $f=1MHz$)

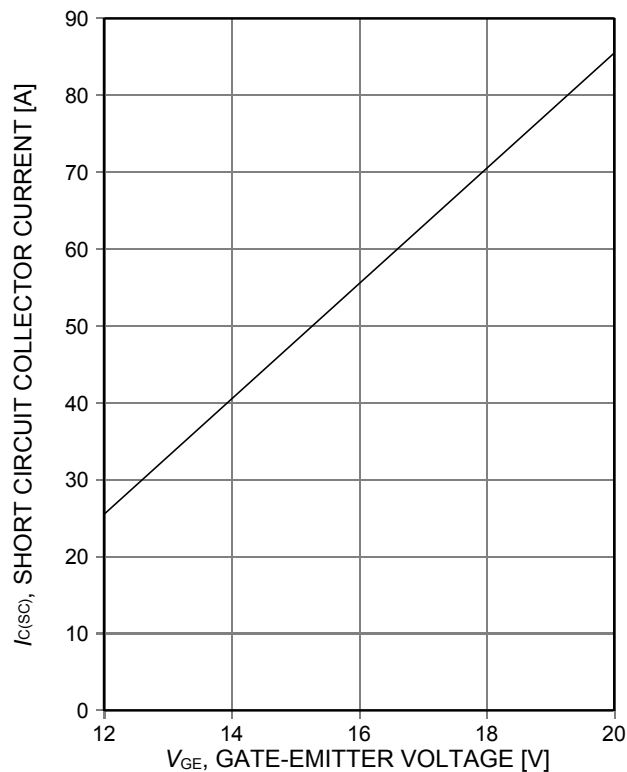


Figure 19. **Typical short circuit collector current as a function of gate-emitter voltage**
($V_{CE}\leq 400V$, start at $T_{vj}=25^\circ C$)

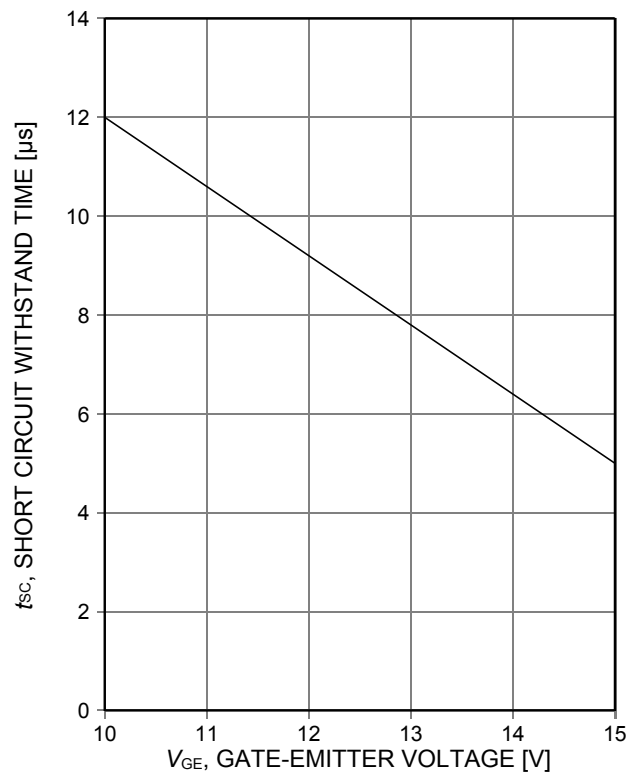


Figure 20. **Short circuit withstand time as a function of gate-emitter voltage**
($V_{CE}\leq 400V$, start at $T_{vj}\leq 150^\circ C$)

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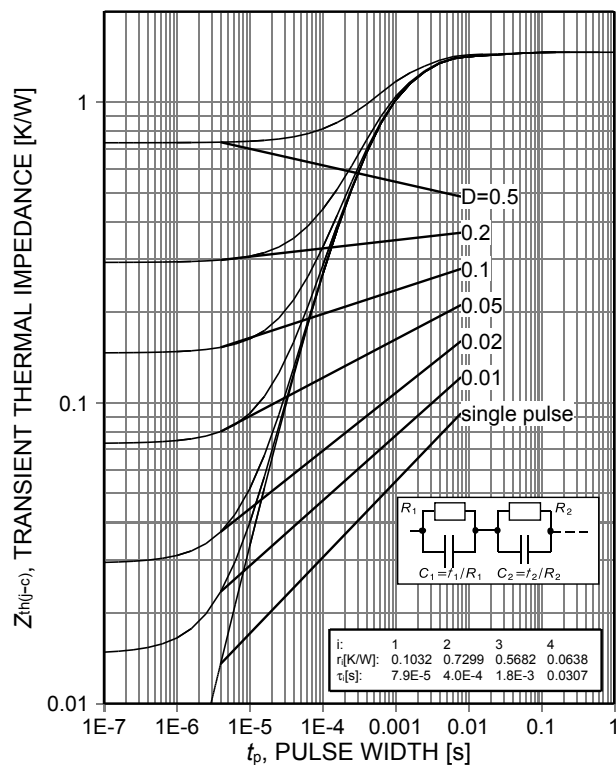


Figure 21. IGBT transient thermal impedance as a function of pulse width ¹⁾ (see page 4)
($D = t_p/T$)

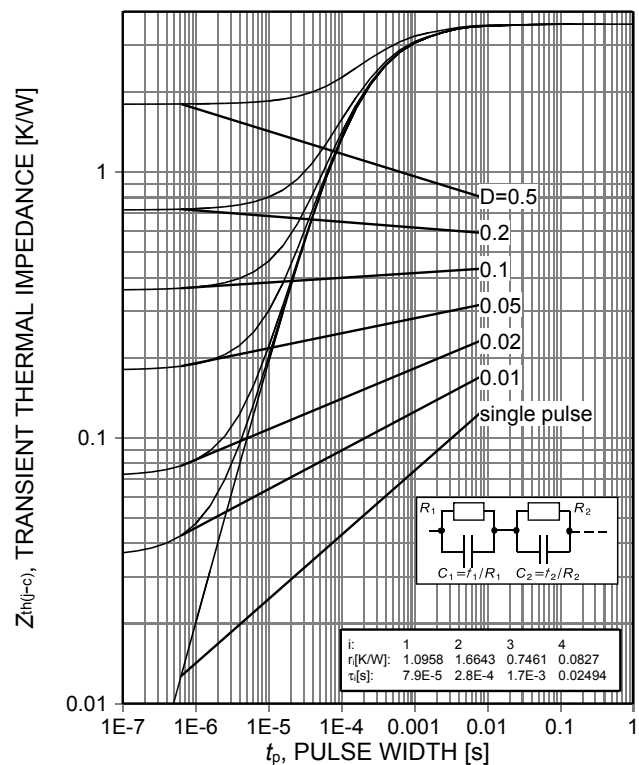


Figure 22. Diode transient thermal impedance as a function of pulse width ²⁾ (see page 4)
($D = t_p/T$)

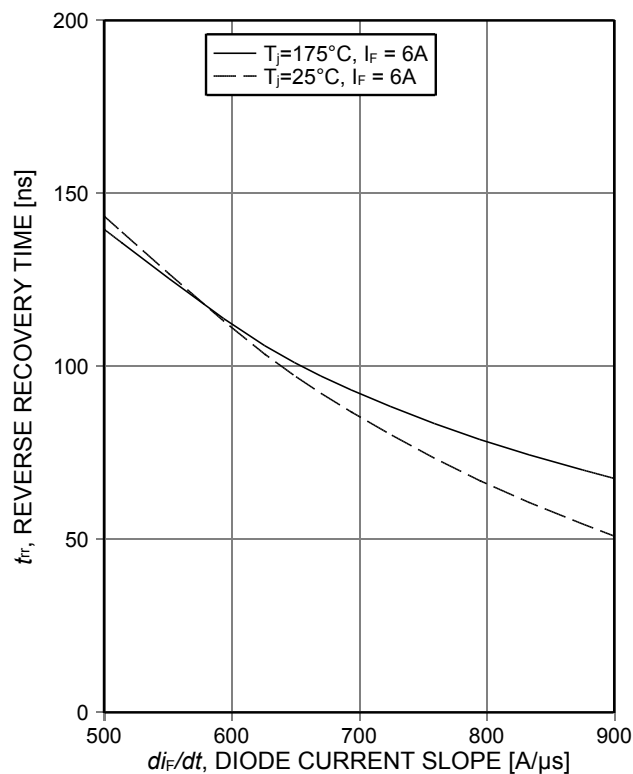


Figure 23. Typical reverse recovery time as a function of diode current slope
($V_R = 400V$)

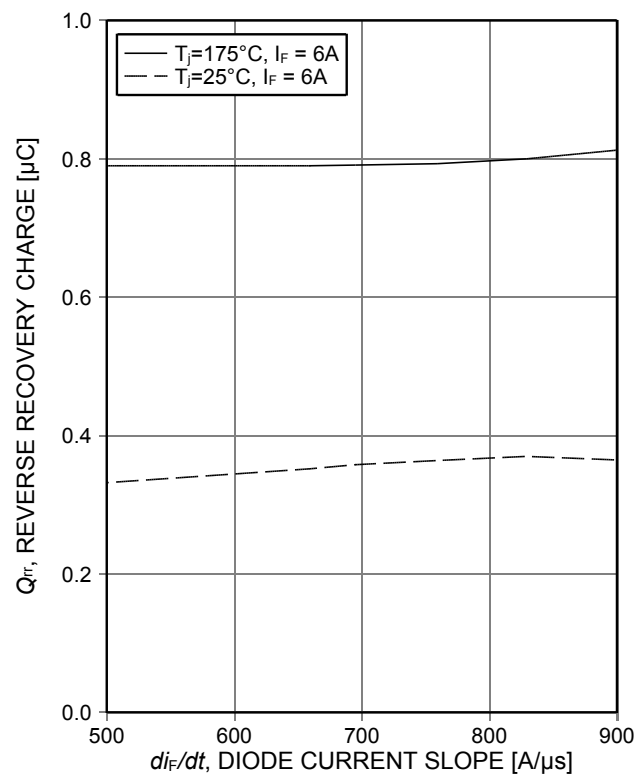


Figure 24. Typical reverse recovery charge as a function of diode current slope
($V_R = 400V$)

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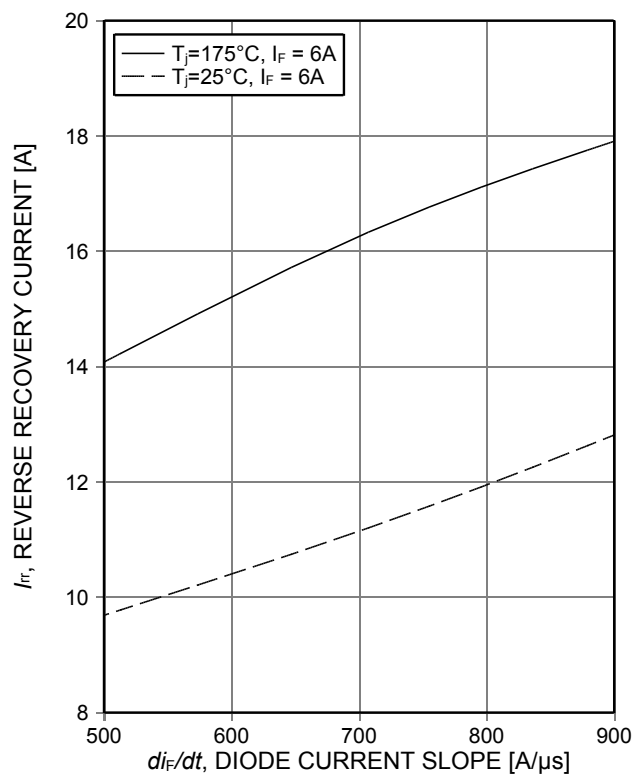


Figure 25. **Typical reverse recovery current as a function of diode current slope**
($V_R=400V$)

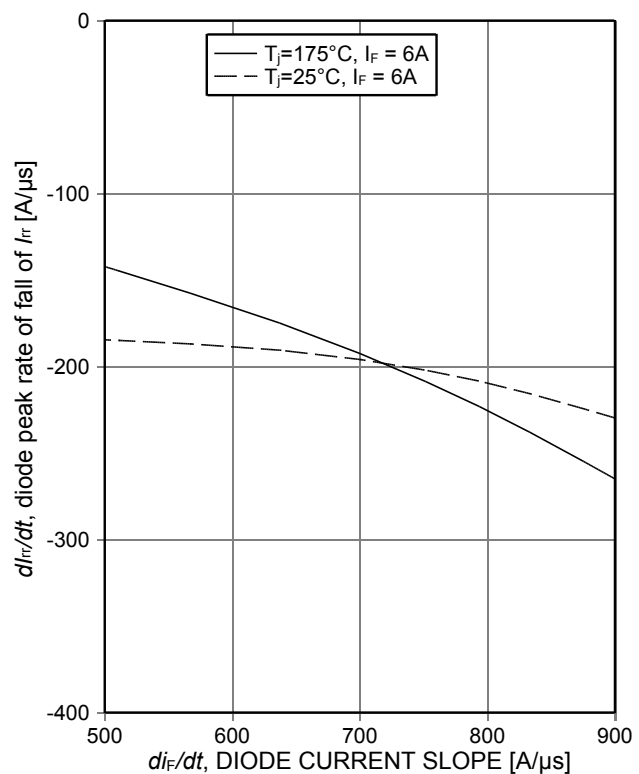


Figure 26. **Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**
($V_R=400V$)

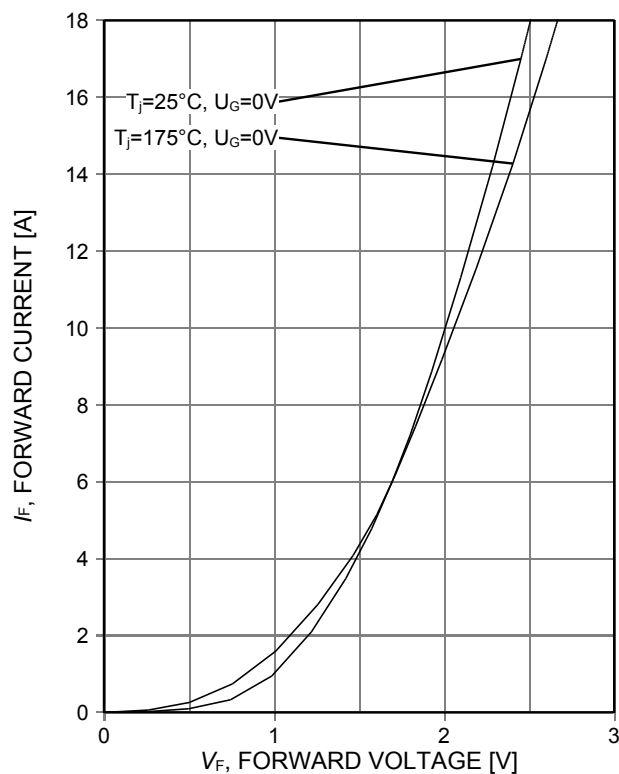


Figure 27. **Typical diode forward current as a function of forward voltage**

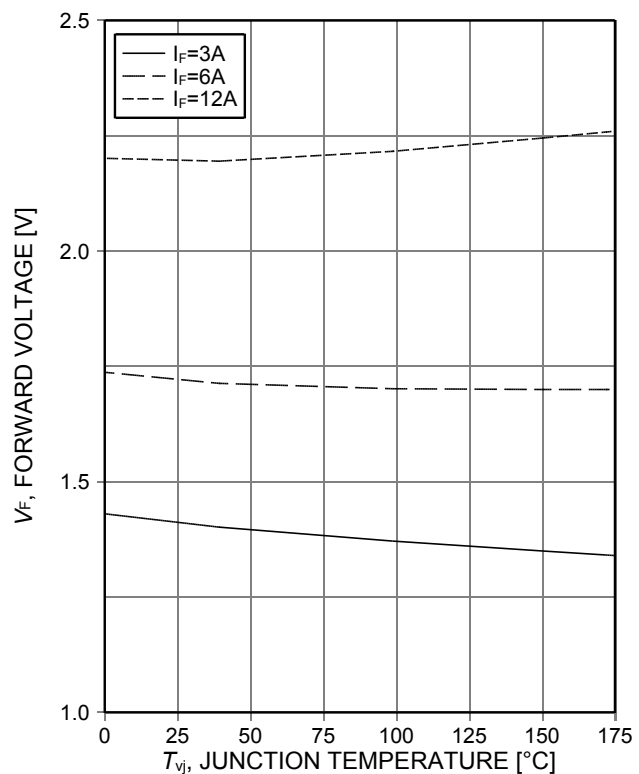
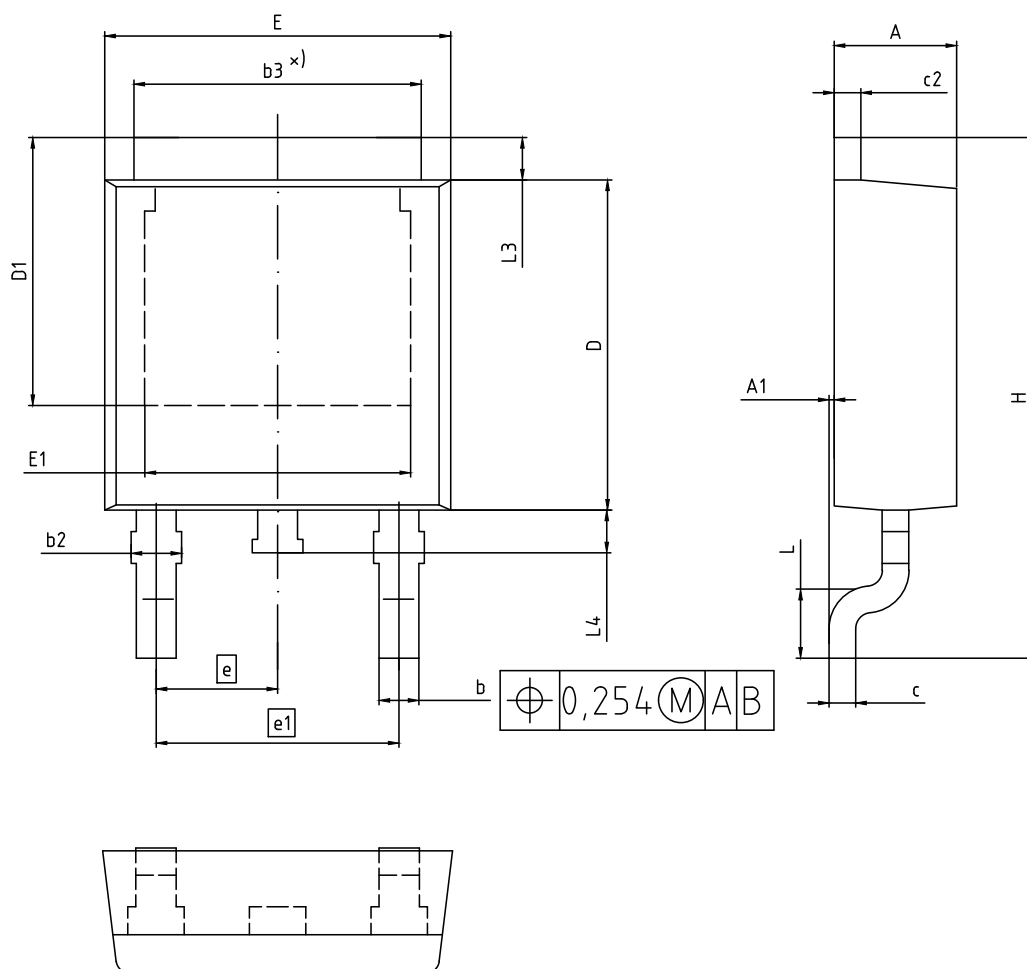


Figure 28. **Typical diode forward voltage as a function of junction temperature**

TRENCHSTOP™ RC-Series for hard switching applications

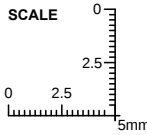
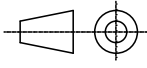
Package Drawing PG-TO252-3

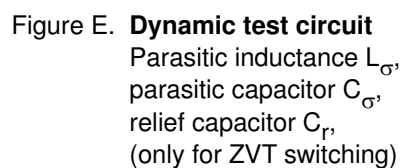


NOTES:

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



TRENCHSTOP™ RC-Series for hard switching applications

Revision History

IKD06N60R

Revision: 2014-03-12, Rev. 2.5

Previous Revision

Revision	Date	Subjects (major changes since last revision)
1.2	2010-01-12	-
2.1	2011-01-17	Release of final datasheet
2.2	2013-02-19	Change package
2.3	2013-12-10	Neu value ICES max limit at 175°C
2.4	2014-02-26	Without PB free logo
2.5	2014-03-12	Storage temp -55...+150°C

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Please note that this product is not qualified according to the AEC Q100 or AEC Q101 documents of the Automotive Electronics Council.

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