

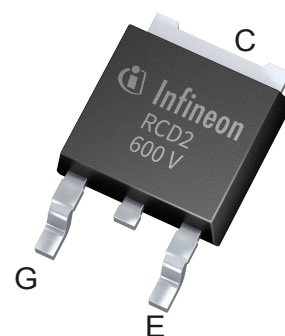
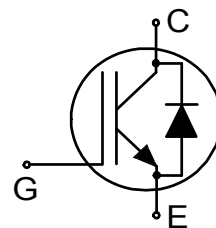
TRENCHSTOP™ RC-Series for hard switching applications

Cost effective monolithically integrated IGBT with Diode

Features:

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

- Very tight parameter distribution
- Operating range up to 20kHz
- Maximum junction temperature 175°C
- Short circuit capability of 3μs
- Humidity robust design
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models:
<http://www.infineon.com/rc-d2>

**Potential Applications:**

- Major Home Appliances
 - Air Conditioning
 - Refrigerators
- Drives
 - GPD (General Purpose Drives)

Product Validation:

Qualified for industrial applications according to the relevant tests of JEDEC47/20/22

**Key Performance and Package Parameters**

Type	V_{CE}	I_C	$V_{CEsat}, T_{vj}=25^{\circ}C$	T_{vjmax}	Marking	Package
IKD04N60RC2	600V	4A	2V	175°C	K4DRC2	PG-TO252-3

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TRENCHSTOP™ RC-Series for hard switching applications

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	8.0 5.6	A
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpuls}	12.0	A
Turn off safe operating area $V_{CE} \leq 600\text{V}$, $T_{vj} \leq 175^{\circ}\text{C}$, $t_p = 1\mu\text{s}$	-	12.0	A
Diode forward current, limited by T_{vjmax} $T_c = 25^{\circ}\text{C}$ $T_c = 100^{\circ}\text{C}$	I_F	4.6 2.4	A
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpuls}	12.0	A
Gate-emitter voltage Transient Gate-emitter voltage ($t_p \leq 10\mu\text{s}$, $D < 0.010$)	V_{GE}	± 20 ± 25	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}	3	μs
Power dissipation $T_c = 25^{\circ}\text{C}$ Power dissipation $T_c = 100^{\circ}\text{C}$	P_{tot}	36.6 18.3	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	$R_{th(j-c)}$		-	-	4.10	K/W
Diode thermal resistance, ²⁾ junction - case	$R_{th(j-c)}$		-	-	10.10	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 saturation voltage	V_{CEsat}	$V_{GE} = 15.0V, I_C = 4.0A$ $T_{vj} = 25^{\circ}C$ $T_{vj} = 175^{\circ}C$	- -	2.00 2.40	2.30 -	V
Diode forward voltage	V_F	$V_{GE} = 0V, I_F = 4.0A$ $T_{vj} = 25^{\circ}C$ $T_{vj} = 175^{\circ}C$	- -	1.90 1.95	2.20 -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C = 0.45mA, V_{CE} = V_{GE}$	4.3	5.0	5.7	V
Zero gate voltage collector current	I_{CES}	$V_{CE} = 600V, V_{GE} = 0V$ $T_{vj} = 25^{\circ}C$ $T_{vj} = 175^{\circ}C$	- -	- -	25 2500	μA
Gate-emitter leakage current	I_{GES}	$V_{CE} = 0V, V_{GE} = 20V$	-	-	100	nA
Transconductance	g_{fs}	$V_{CE} = 20V, I_C = 4.0A$	-	2.0	-	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 = 1000kHz	-	180	-	pF
Output capacitance	C _{oes}		-	10	-	
Reverse transfer capacitance	C _{res}		-	7	-	
Gate charge	Q _G	V _{CC} = 480V, I _C = 4.0A, V _{GE} = 15V	-	24.0	-	nC

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	$t_{d(\text{on})}$	$T_{vj} = 25^{\circ}\text{C}$, $V_{CC} = 400\text{V}$, $I_C = 4.0\text{A}$, $V_{GE} = 0.0/15.0\text{V}$, $R_{G(\text{on})} = 49.0\Omega$, $R_{G(\text{off})} = 49.0\Omega$, $L_{\sigma} = 30\text{nH}$, $C_{\sigma} = 32\text{pF}$ L_{σ} , C_{σ} from Fig. E Energy losses include “tail” and diode reverse recovery.	-	4	-	ns
Rise time	t_r		-	9	-	ns
Turn-off delay time	$t_{d(\text{off})}$		-	90	-	ns
Fall time	t_f		-	41	-	ns
Turn-on energy	E_{on}		-	0.10	-	mJ
Turn-off energy	E_{off}		-	0.04	-	mJ
Total switching energy	E_{ts}		-	0.14	-	mJ

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

Diode reverse recovery time	t_{rr}	$T_{vj} = 25^{\circ}\text{C},$ $V_R = 400\text{V},$ $I_F = 4.0\text{A},$ $di_F/dt = 681\text{A}/\mu\text{s}$	-	80	-	ns
Diode reverse recovery charge	Q_{rr}		-	148.00	-	nC
Diode peak reverse recovery current	I_{rrm}		-	5.7	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-110	-	A/ μs

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	$t_{d(on)}$	$T_{vj} = 175^{\circ}\text{C},$ $V_{CC} = 400\text{V}, I_C = 4.0\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(on)} = 49.0\Omega, R_{G(off)} = 49.0\Omega,$ $L\sigma = 30\text{nH}, C\sigma = 32\text{pF}$ Energy losses include "tail" and diode reverse recovery.	-	4	-	ns
Rise time	t_r		-	10	-	ns
Turn-off delay time	$t_{d(off)}$		-	98	-	ns
Fall time	t_f		-	47	-	ns
Turn-on energy	E_{on}		-	0.13	-	mJ
Turn-off energy	E_{off}		-	0.05	-	mJ
Total switching energy	E_{ts}		-	0.18	-	mJ

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

Diode reverse recovery time	t_{rr}	$T_{vj} = 175^{\circ}\text{C},$ $V_R = 400\text{V},$ $I_F = 4.0\text{A},$ $di_F/dt = 500\text{A}/\mu\text{s}$	-	108	-	ns
Diode reverse recovery charge	Q_{rr}		-	254.00	-	nC
Diode peak reverse recovery current	I_{rrm}		-	6.4	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-87	-	A/ μs

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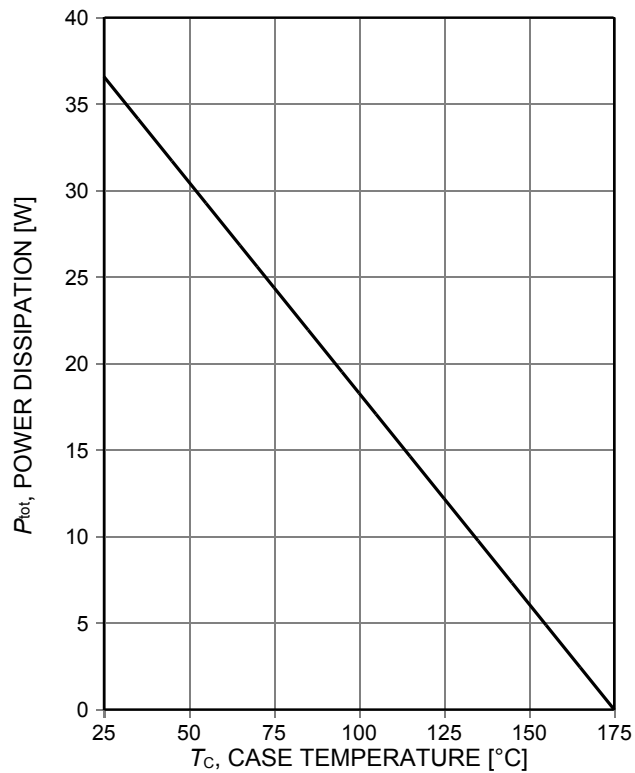


Figure 1. **Power dissipation as a function of case temperature**
($T_{vj} \leq 175^\circ\text{C}$)

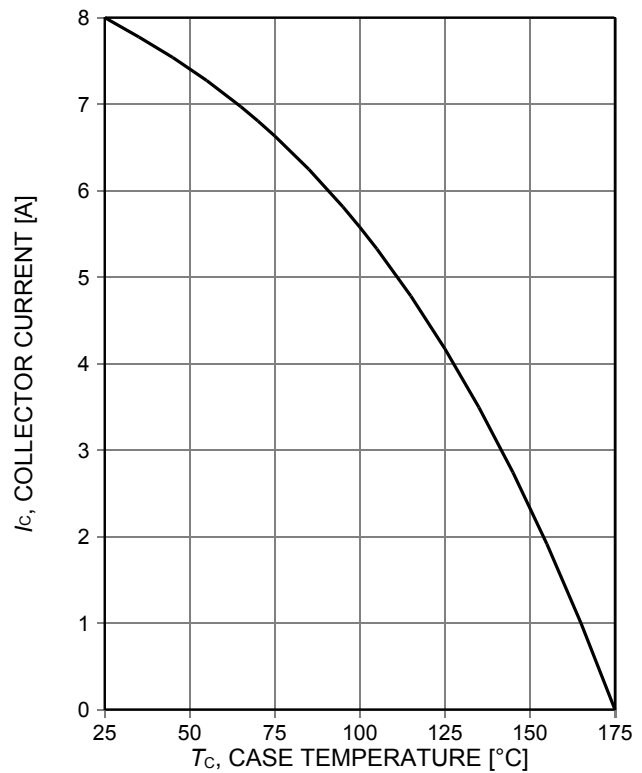


Figure 2. **Collector current as a function of case temperature**
($V_{GE} \geq 15\text{V}$, $T_{vj} \leq 175^\circ\text{C}$)

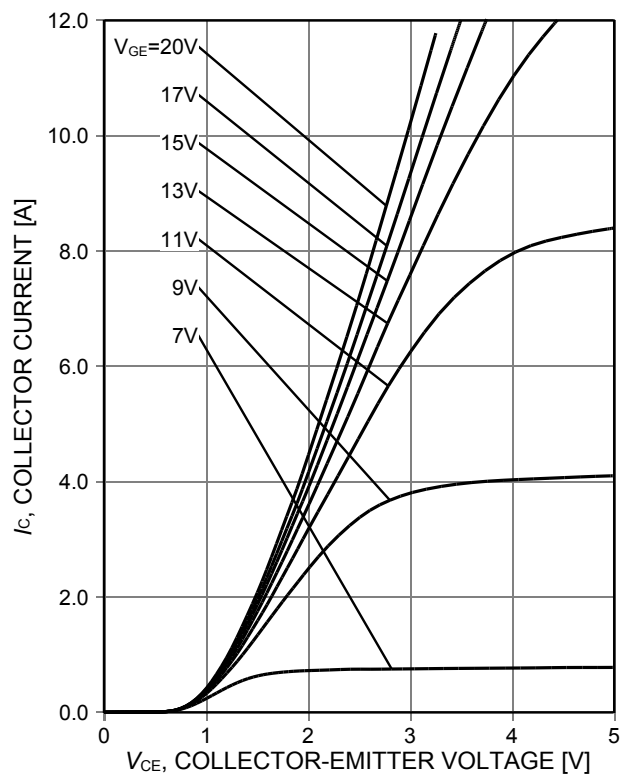


Figure 3. **Typical output characteristic**
($T_{vj} = 25^\circ\text{C}$)

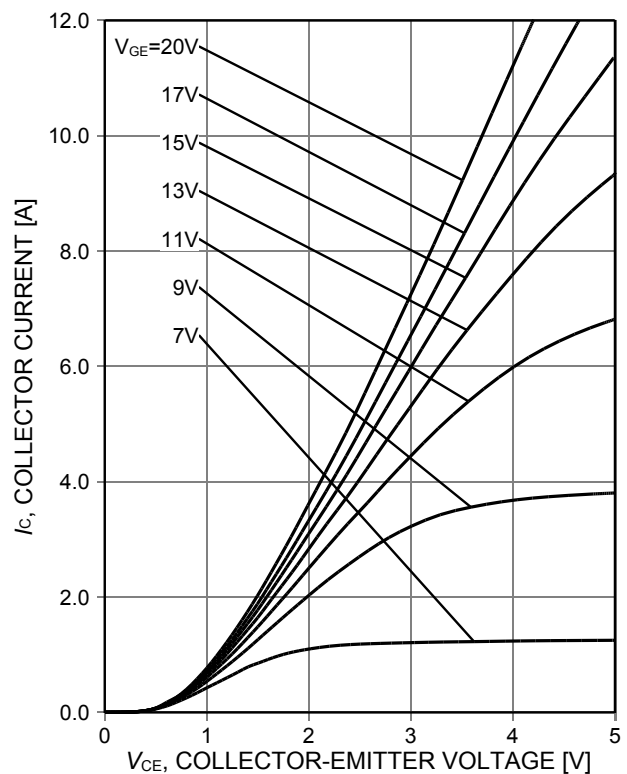


Figure 4. **Typical output characteristic**
($T_{vj} = 175^\circ\text{C}$)

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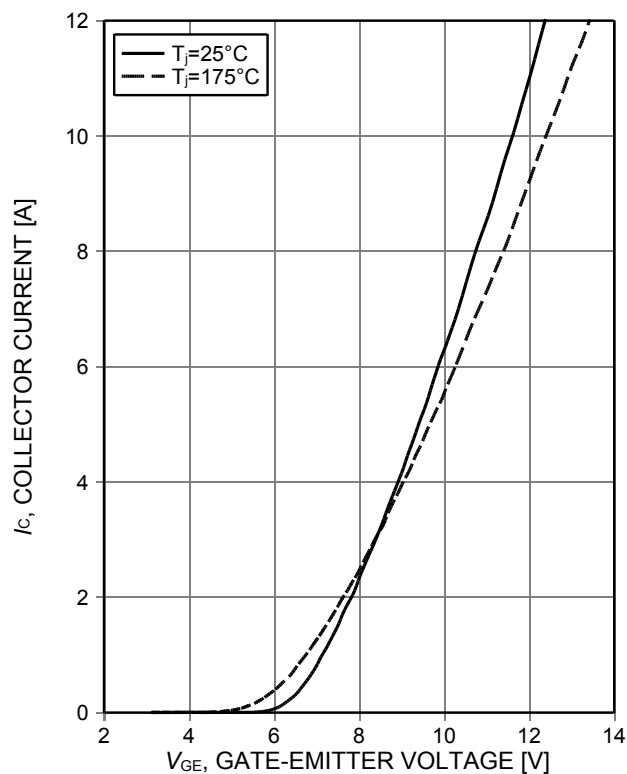


Figure 5. **Typical transfer characteristic**
($V_{CE}=20V$)

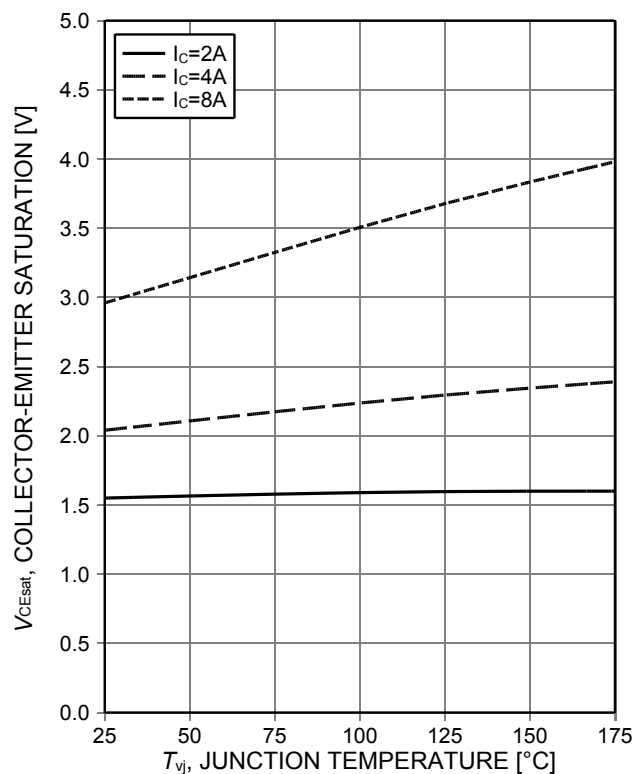


Figure 6. **Typical collector-emitter saturation voltage as a function of junction temperature**
($V_{GE}=15V$)

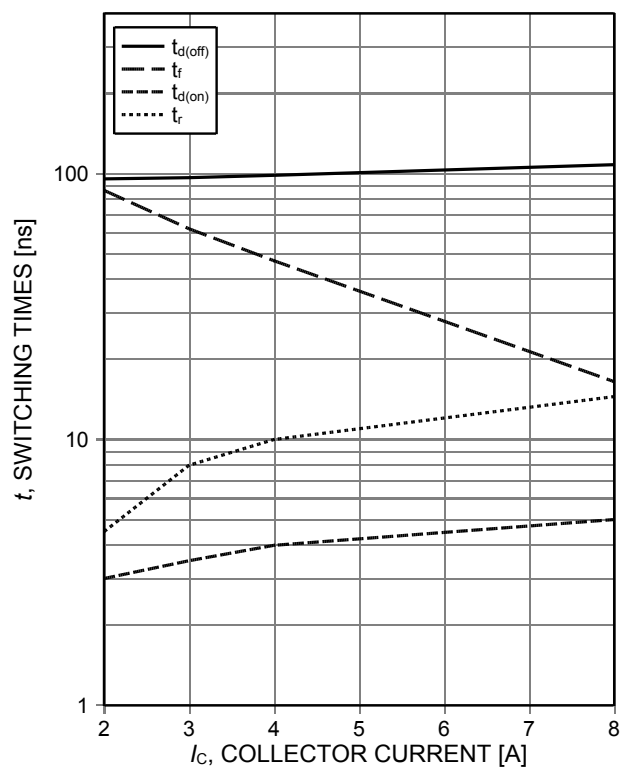


Figure 7. **Typical switching times as a function of collector current**
(inductive load, $T_{J1}=175^{\circ}C$, $V_{CE}=400V$, $V_{GE}=15/0V$, $R_G=49\Omega$, Dynamic test circuit in Figure E)

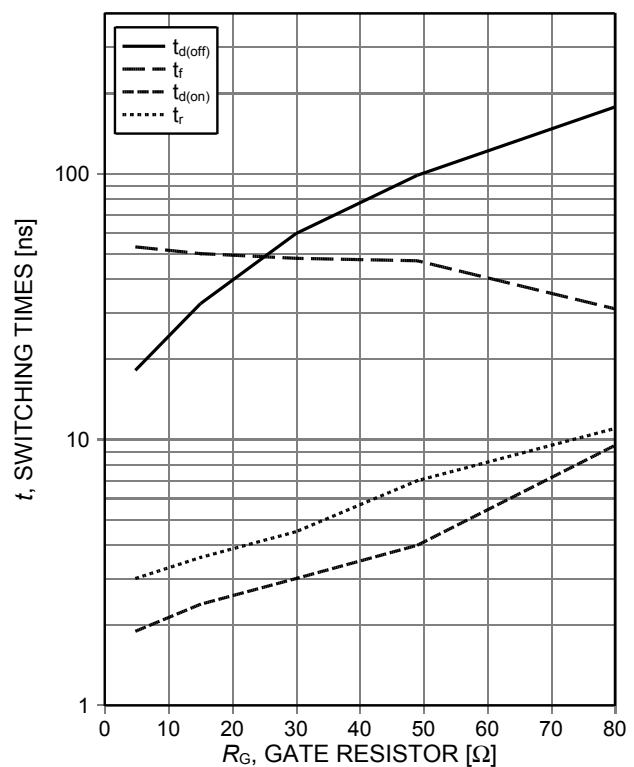


Figure 8. **Typical switching times as a function of gate resistor**
(inductive load, $T_{J1}=175^{\circ}C$, $V_{CE}=400V$, $V_{GE}=15/0V$, $I_C=4A$, Dynamic test circuit in Figure E)

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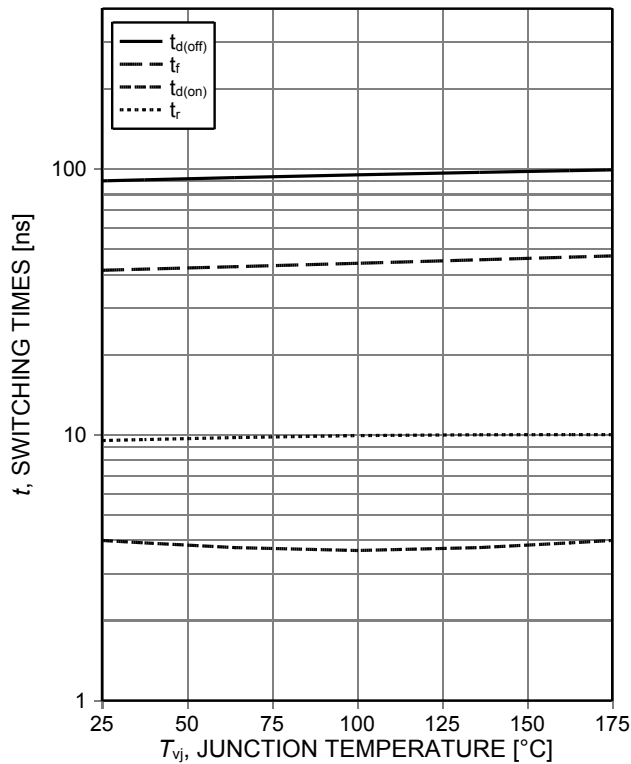


Figure 9. **Typical switching times as a function of junction temperature**
(inductive load, $V_{CE}=400V$, $V_{GE}=15/0V$, $I_C=4A$, $R_G=49\Omega$, Dynamic test circuit in Figure E)

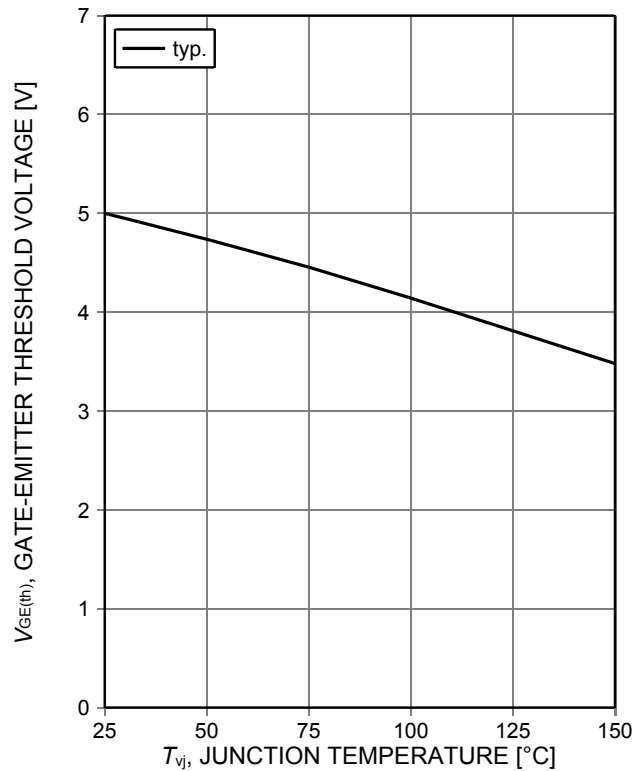


Figure 10. **Gate-emitter threshold voltage as a function of junction temperature**
($I_C=0.45mA$)

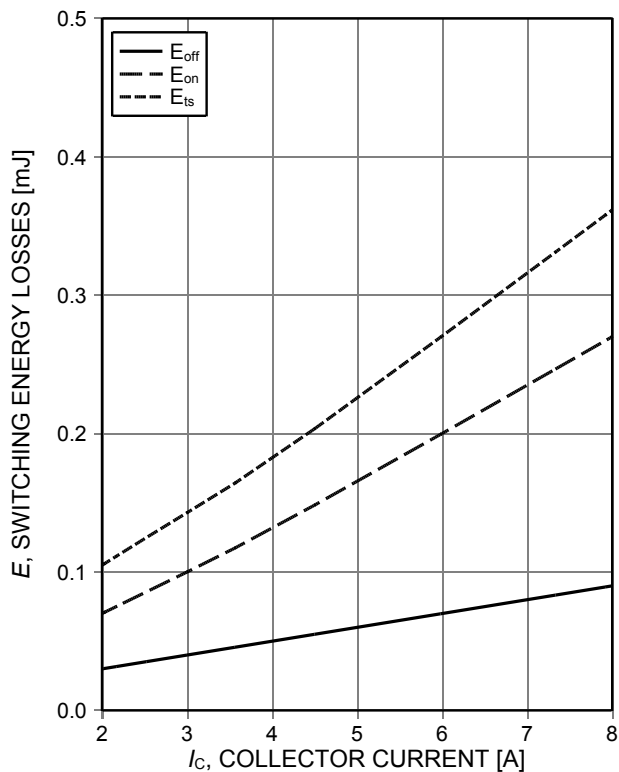


Figure 11. **Typical switching energy losses as a function of collector current**
(inductive load, $T_{vj}=175^{\circ}C$, $V_{CE}=400V$, $V_{GE}=15/0V$, $R_G=49\Omega$, Dynamic test circuit in Figure E)

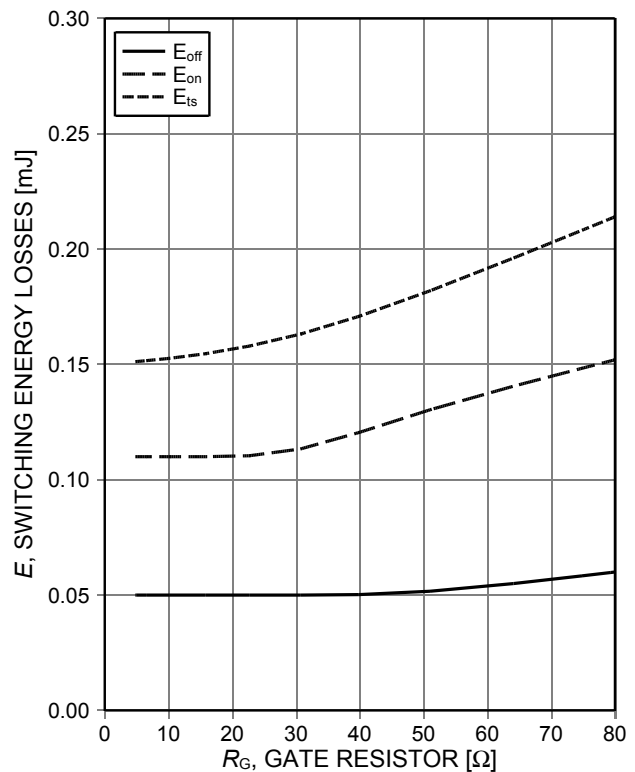


Figure 12. **Typical switching energy losses as a function of gate resistor**
(inductive load, $T_{vj}=175^{\circ}C$, $V_{CE}=400V$, $V_{GE}=15/0V$, $I_C=4A$, Dynamic test circuit in Figure E)

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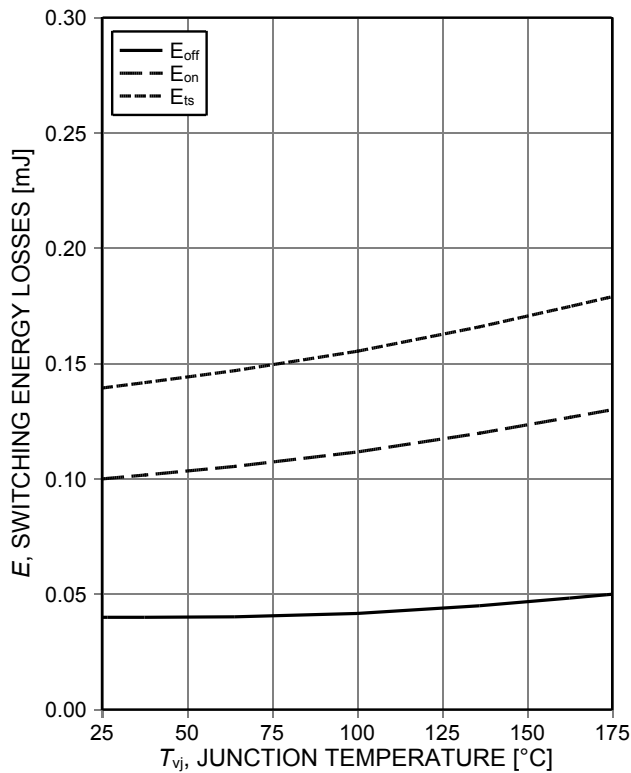


Figure 13. **Typical switching energy losses as a function of junction temperature**
(inductive load, $V_{CE}=400V$, $V_{GE}=15/0V$, $I_C=4A$, $R_G=49\Omega$, Dynamic test circuit in Figure E)

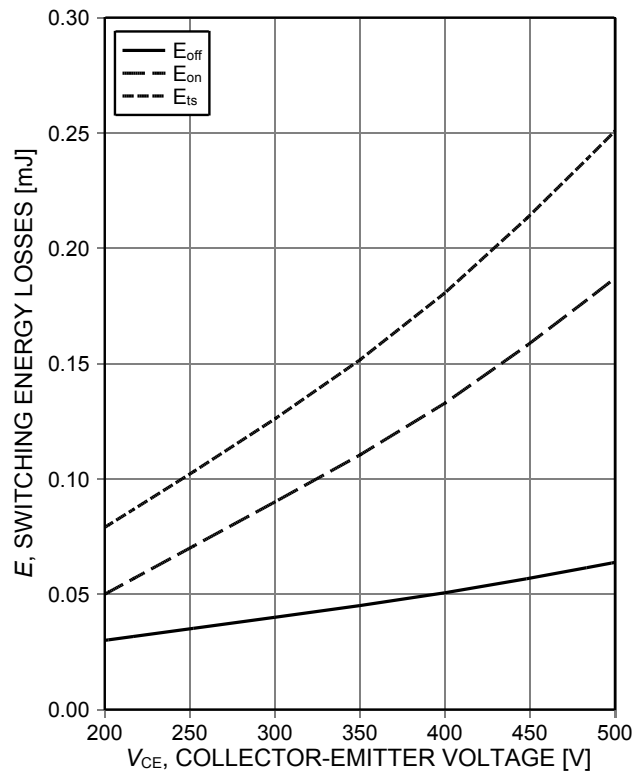


Figure 14. **Typical switching energy losses as a function of collector-emitter voltage**
(inductive load, $T_{vj}=175^\circ C$, $V_{GE}=15/0V$, $I_C=4A$, $R_G=49\Omega$, Dynamic test circuit in Figure E)

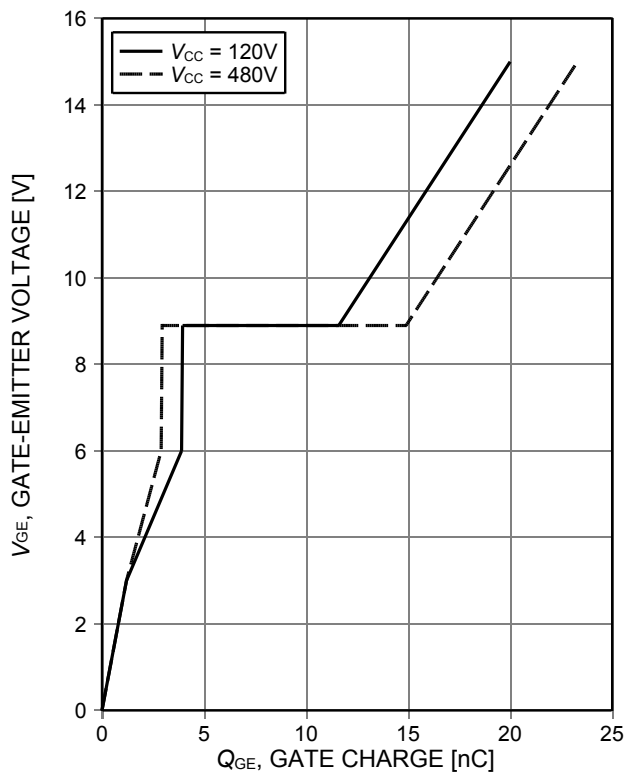


Figure 15. **Typical gate charge**
($I_C=4A$)

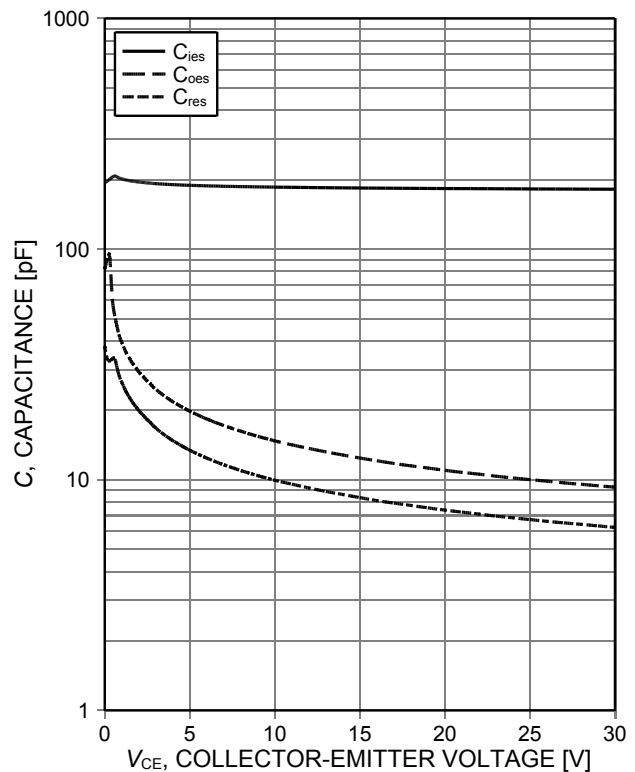


Figure 16. **Typical capacitance as a function of collector-emitter voltage**
($V_{GE}=0V$, $f=1MHz$)

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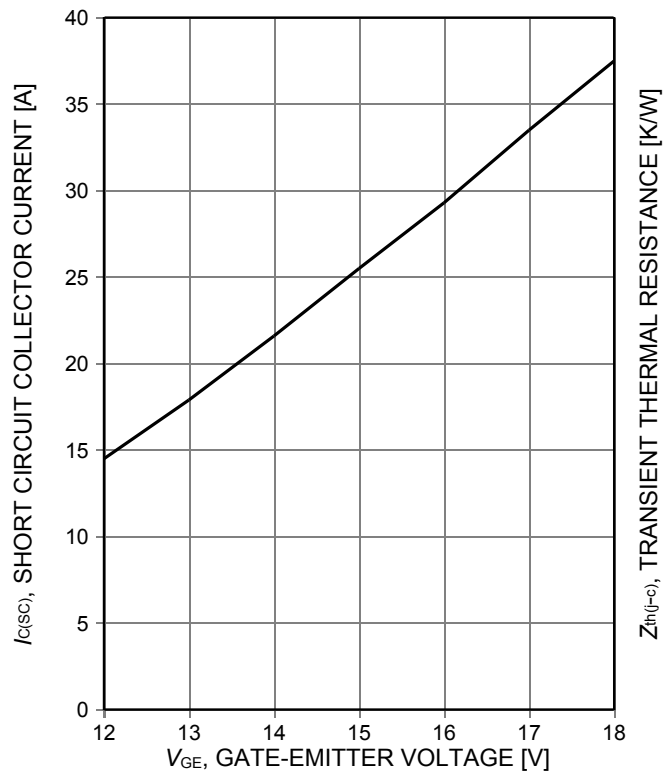


Figure 17. Typical short circuit collector current as a function of gate-emitter voltage ($V_{CE} \leq 400V$, $T_{vj} \leq 150^\circ C$)

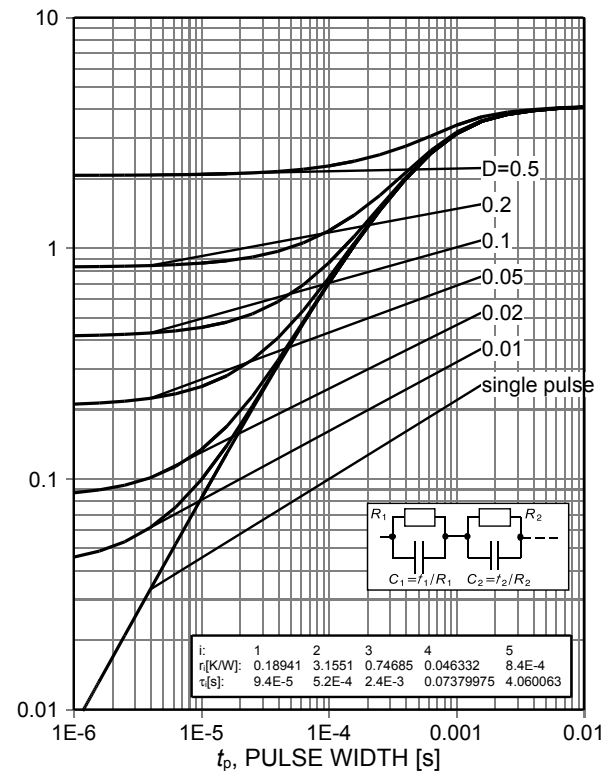


Figure 18. IGBT transient thermal resistance ($D = t_p/T$)

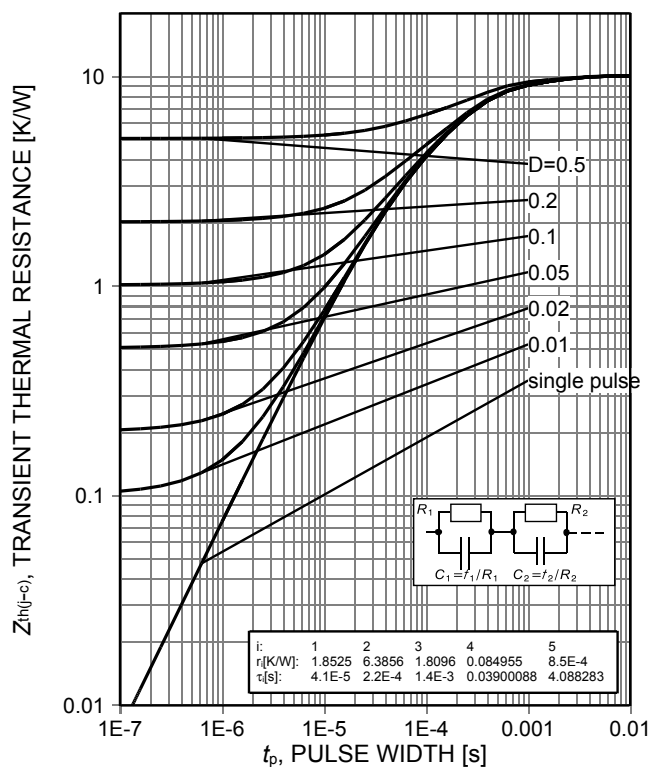


Figure 19. Diode transient thermal impedance as a function of pulse width ($D = t_p/T$)

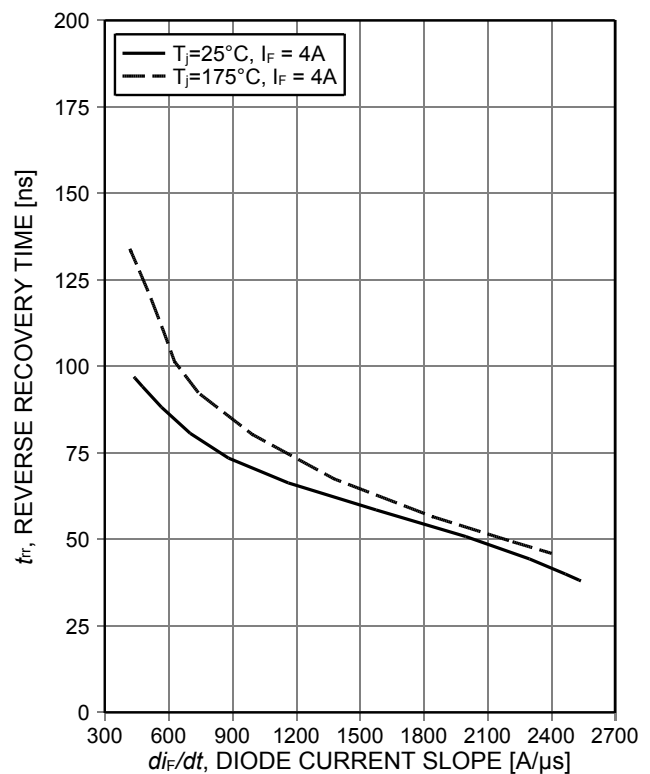


Figure 20. Typical reverse recovery time as a function of diode current slope ($V_R = 400V$)

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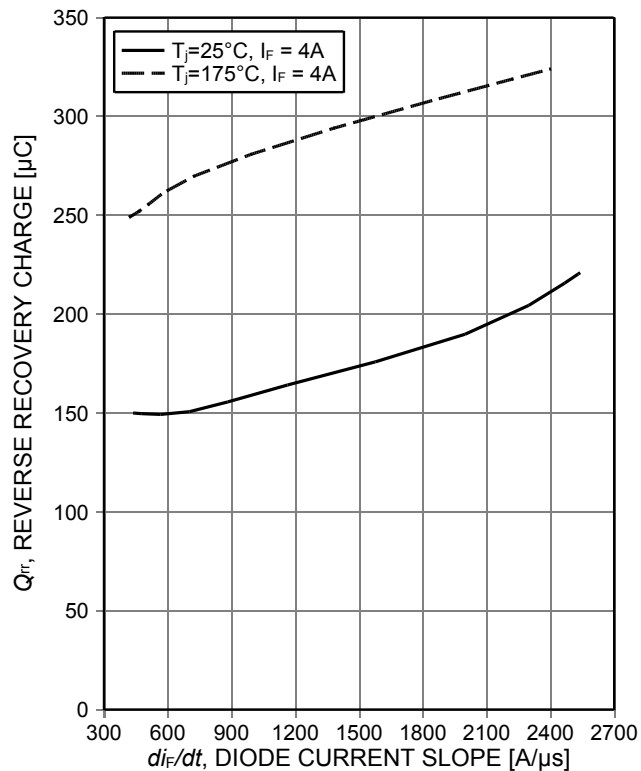


Figure 21. Typical reverse recovery charge as a function of diode current slope
($V_R=400V$)

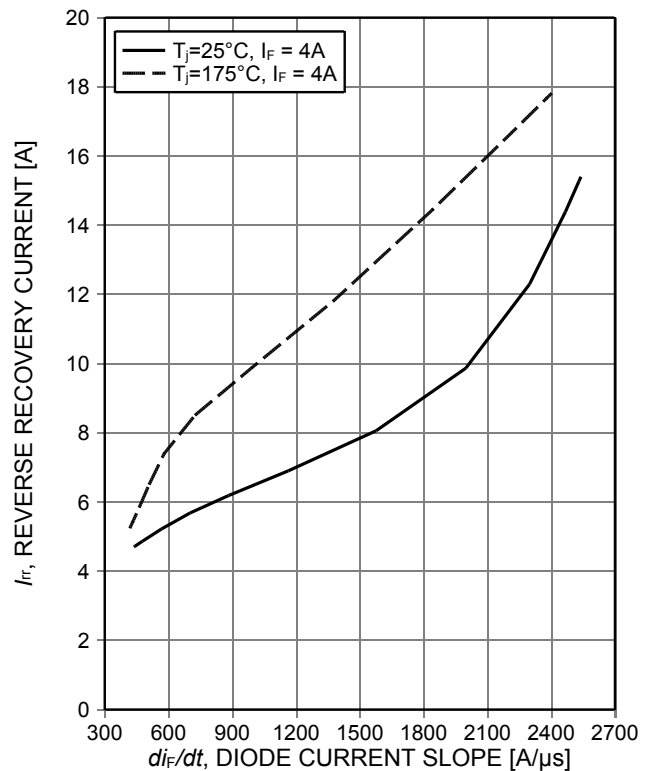


Figure 22. Typical reverse recovery current as a function of diode current slope
($V_R=400V$)

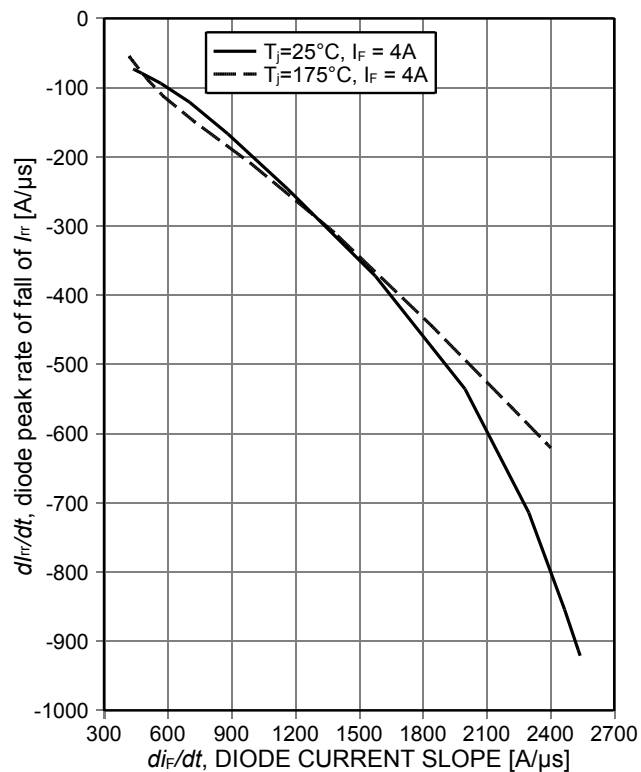


Figure 23. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope
($V_R=400V$)

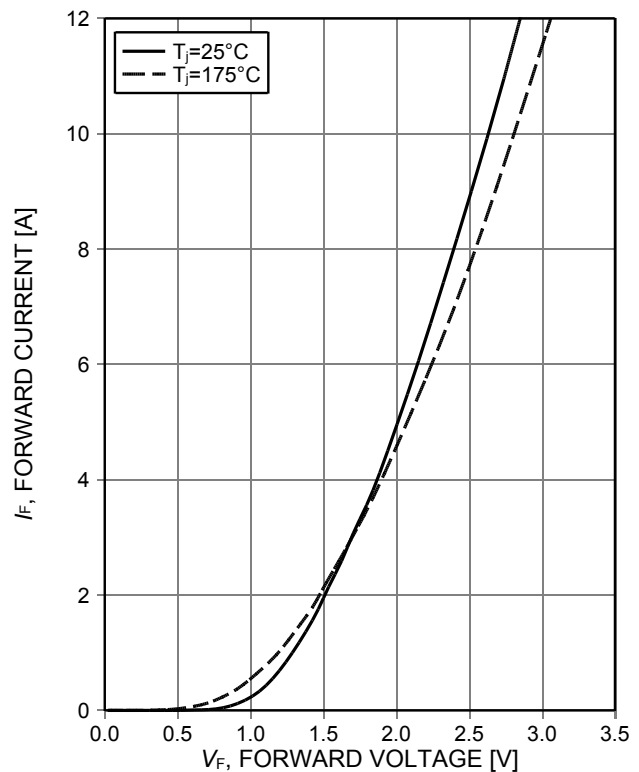


Figure 24. Typical diode forward current as a function of forward voltage

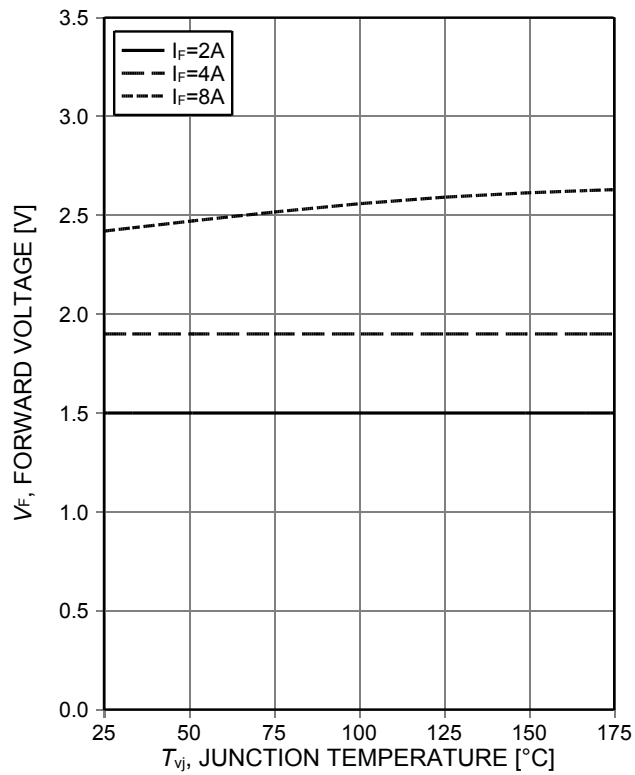
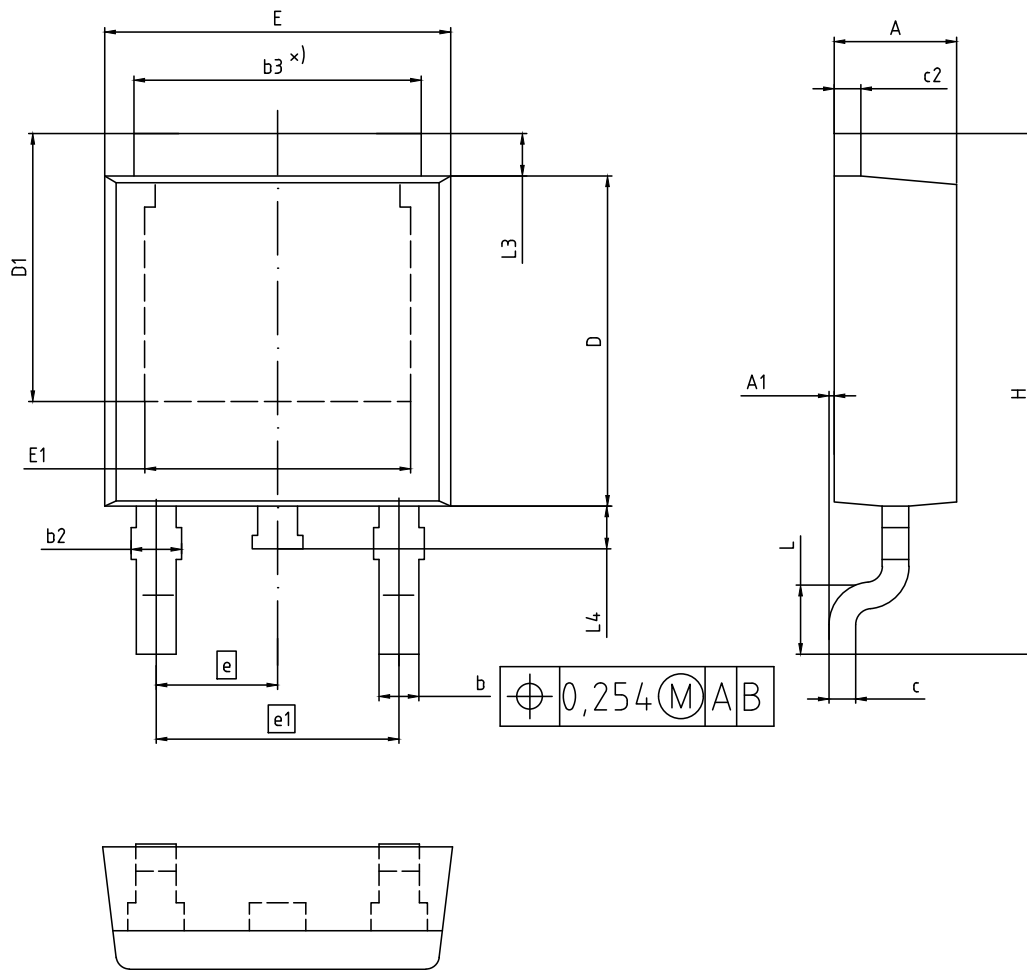


Figure 25. Typical diode forward voltage as a function of junction temperature

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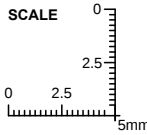
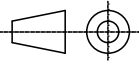
Package Drawing PG-TO252-3



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

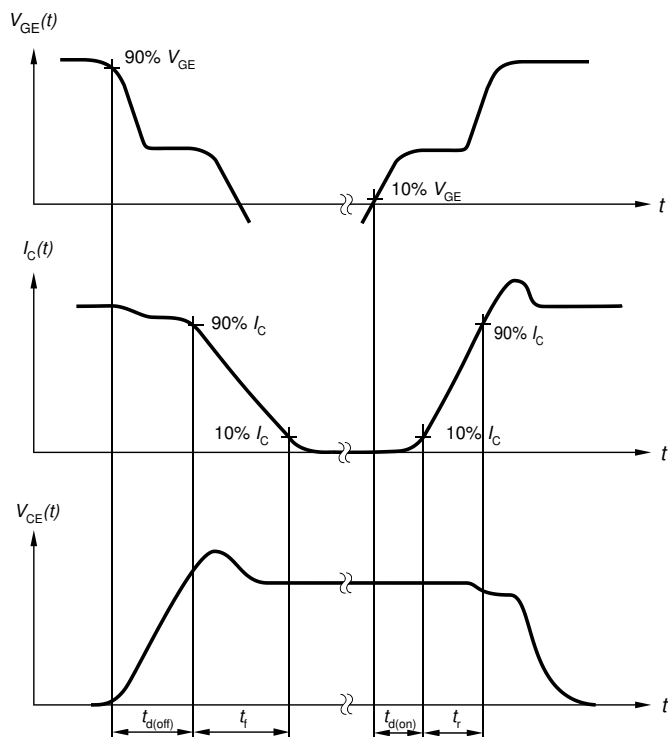


Figure A. Definition of switching times

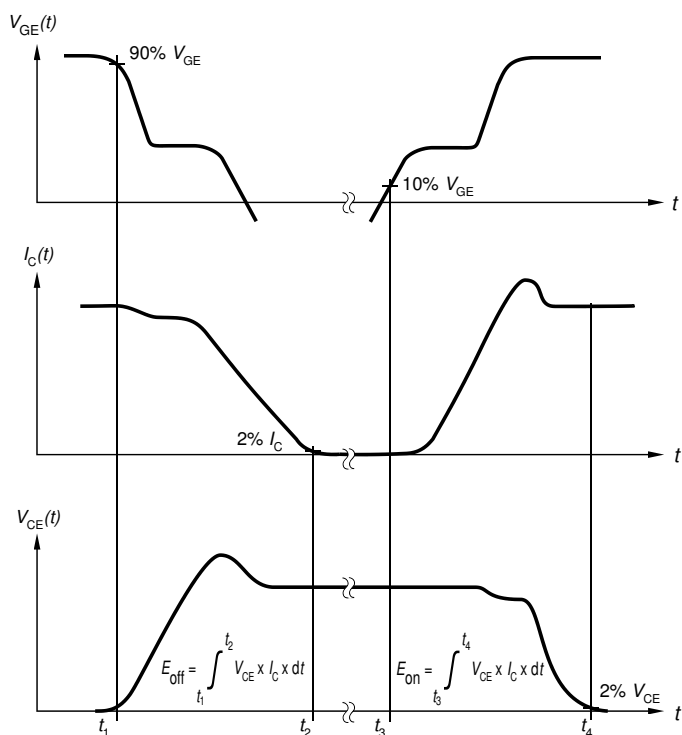


Figure B. Definition of switching losses

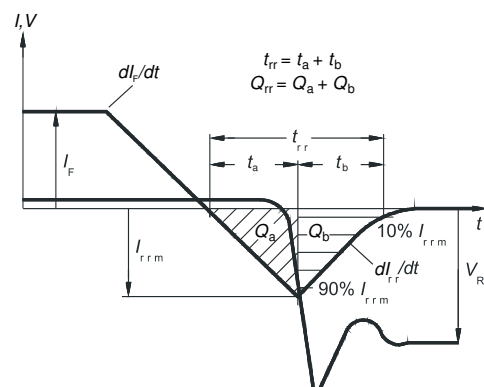


Figure C. Definition of diode switching characteristics

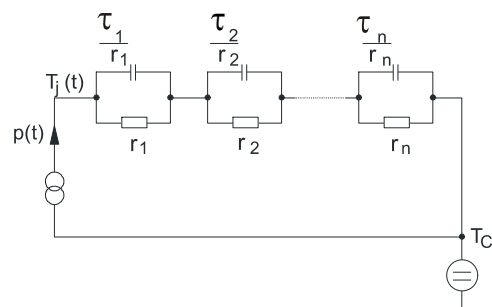


Figure D. Thermal equivalent circuit

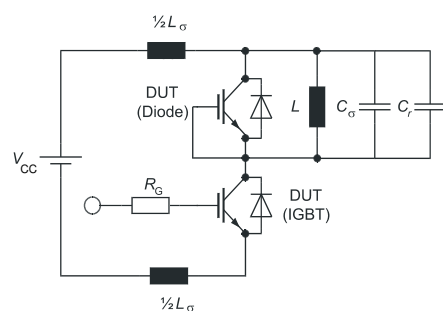


Figure E. **Dynamic test circuit**
Parasitic inductance L_σ ,
parasitic capacitor C_σ ,
relief capacitor C_r ,
(only for ZVT switching)

TRENCHSTOP™ RC-Series for hard switching applications**Revision History**

IKD04N60RC2**Revision: 2020-09-28, Rev. 2.1**

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.1	2020-09-28	Final data sheet

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