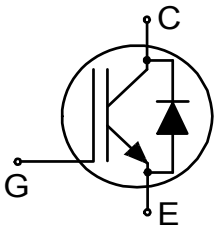
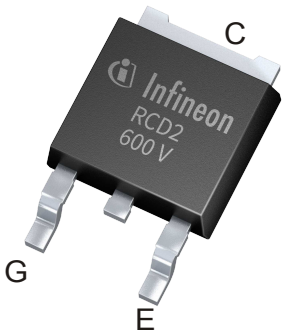
TRENCHSTOP™ RC-Series for hard switching applications

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

Green

Halogen-Free

RoHS

Key Performance and Package Parameters

Type	V_{CE}	I_C	V_{CEsat}, T_{vj}=25°C	T_{vjmax}	Marking	Package
IKD04N60RC2	600V	4A	2V	175°C	K4DRC2	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, $T_{vj} \geq 25°C$	V_{CE}	600	V
DC collector current, limited by T_{vjmax} $T_c = 25°C$ $T_c = 100°C$	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 $V_{CE} \leq 600V$, $T_{vj} \leq 175°C$, $t_p = 1µs$	-	12.0	A
Diode forward current, limited by T_{vjmax} $T_c = 25°C$ $T_c = 100°C$	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 ($t_p \leq 10µs$, $D < 0.010$)	V_{GE}	±20 ±25	V
Short circuit withstand time $V_{GE} = 15.0V$, $V_{CC} \leq 400V$ Allowed number of short circuits < 1000 Time between short circuits: ≥ 1.0s $T_{vj} = 150°C$	t_{SC}	 3	µs
Power dissipation $T_c = 25°C$ Power dissipation $T_c = 100°C$	P_{tot}	36.6 18.3	W
Operating junction temperature	T_{vj}	-40...+175	°C
Storage temperature	T_{stg}	-55...+150	°C
Soldering temperature, reflow soldering (MSL1 according to JEDEC J-STA-020)		260	°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, 6cm² Cu on PCB junction - ambient	$R_{th(j-a)}$		-	-	50	K/W

[1] Rth/Zth based on single cooling pulse. Please be aware that a correct Rth measurement of the IGBT, is not possible using a thermocouple.
[2] Rth/Zth based on single cooling pulse. Please be aware that a correct Rth measurement of the Diode, is not possible using a thermocouple.

Electrical Characteristic, at T_{vj} = 25°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°C T_{vj} = 175°C	- -	2.00 2.40	2.30 -	V
Diode forward voltage	V_F	V_{GE} = 0V, I_F = 4.0A T_{vj} = 25°C T_{vj} = 175°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°C T_{vj} = 175°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°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°C						
Turn-on delay time	$t_{d(on)}$	T_{vj} = 25°C, V_{CC} = 400V, I_C = 4.0A, V_{GE} = 0.0/15.0V, $R_{G(on)}$ = 49.0Ω, $R_{G(off)}$ = 49.0Ω, $L\sigma$ = 30nH, $C\sigma$ = 32pF $L\sigma$, $C\sigma$ from Fig. E Energy losses include “tail” and diode reverse recovery.	-	4	-	ns
Rise time	t_r		-	9	-	ns
Turn-off delay time	$t_{d(off)}$		-	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

Diode Characteristic, at T_{vj} = 25°C

Diode reverse recovery time	t_{rr}	T_{vj} = 25°C, V_R = 400V, I_F = 4.0A, di_F/dt = 681A/µs	-	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°C						
Turn-on delay time	$t_{d(on)}$	T_{vj} = 175°C, V_{CC} = 400V, I_C = 4.0A, V_{GE} = 0.0/15.0V, $R_{G(on)}$ = 49.0Ω, $R_{G(off)}$ = 49.0Ω, Lσ = 30nH, Cσ = 32pF Lσ, Cσ from Fig. E 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°C

Diode reverse recovery time	t_{rr}	T_{vj} = 175°C, V_R = 400V, I_F = 4.0A, di_F/dt = 500A/µs	-	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

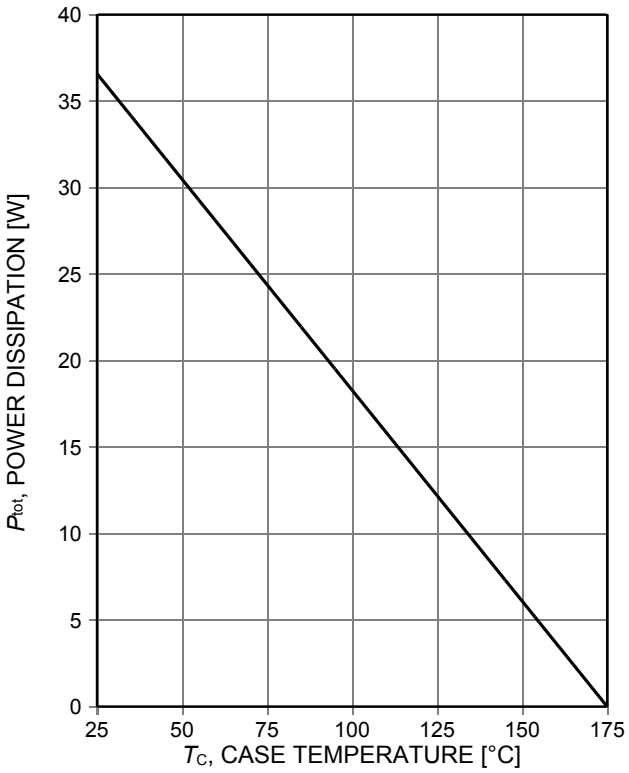


Figure 1. **Power dissipation as a function of case temperature**
(T_{vj}≤175°C)

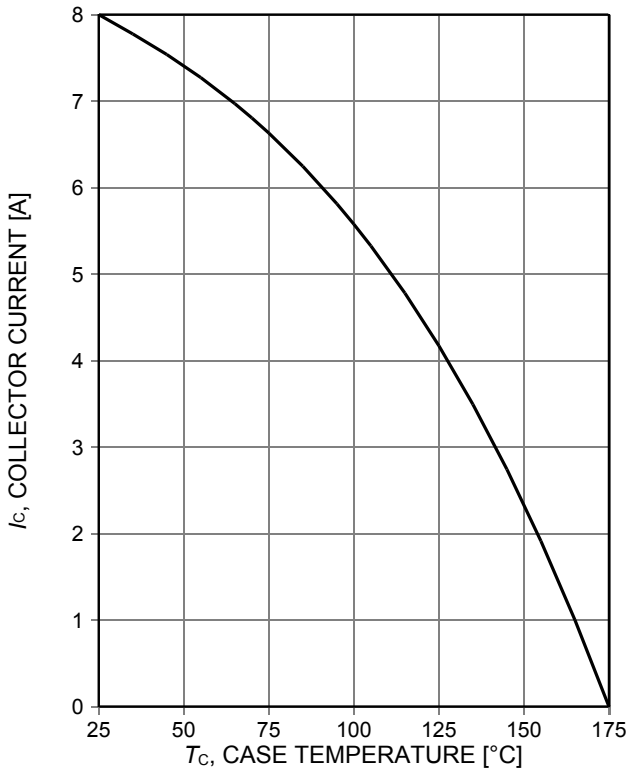


Figure 2. **Collector current as a function of case temperature**
(V_{GE}≥15V, T_{vj}≤175°C)

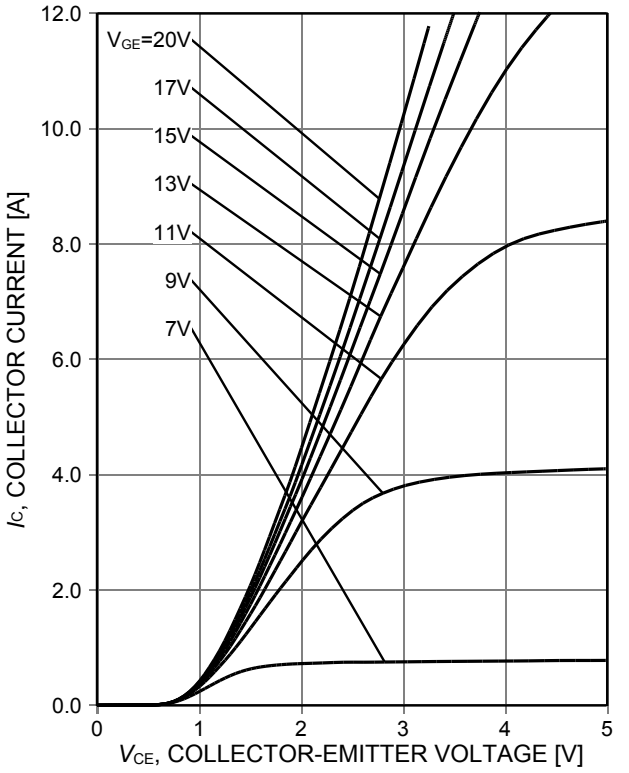


Figure 3. **Typical output characteristic**
(T_{vj}=25°C)

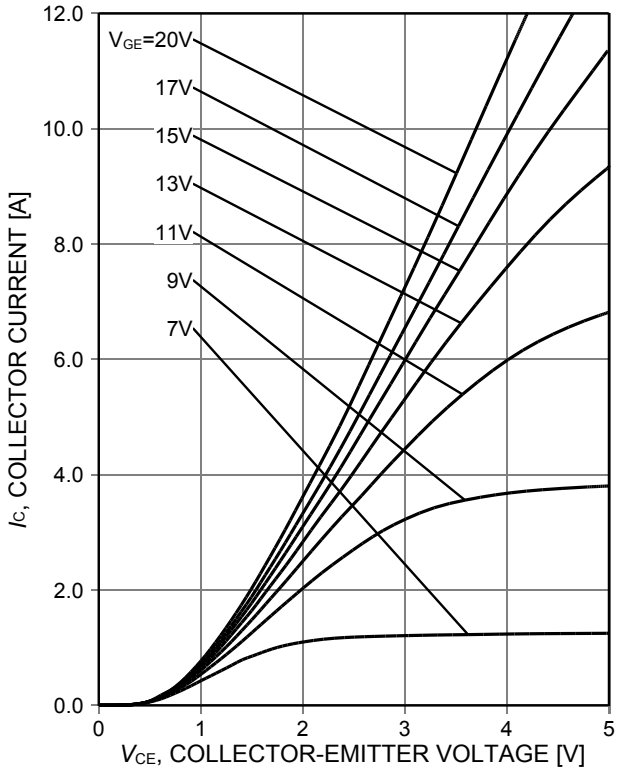


Figure 4. **Typical output characteristic**
(T_{vj}=175°C)

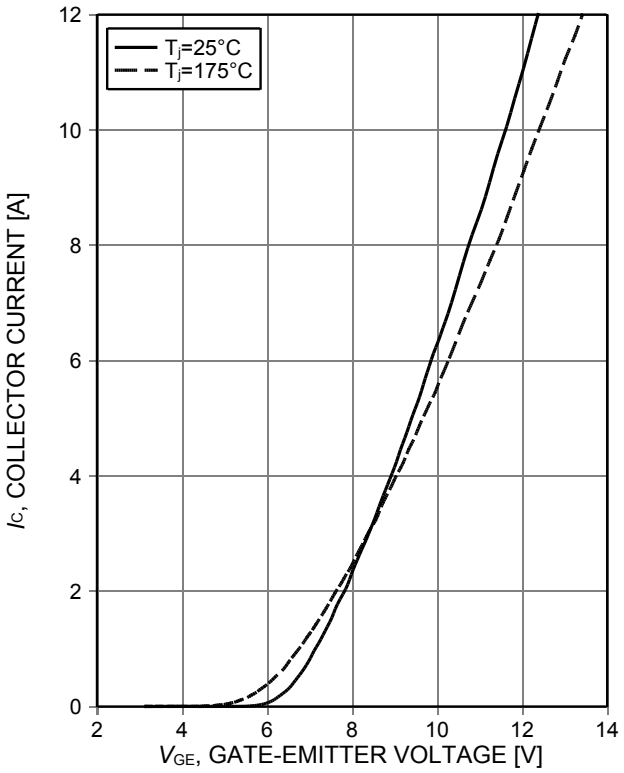


Figure 5. **Typical transfer characteristic**
(V_{CE}=20V)

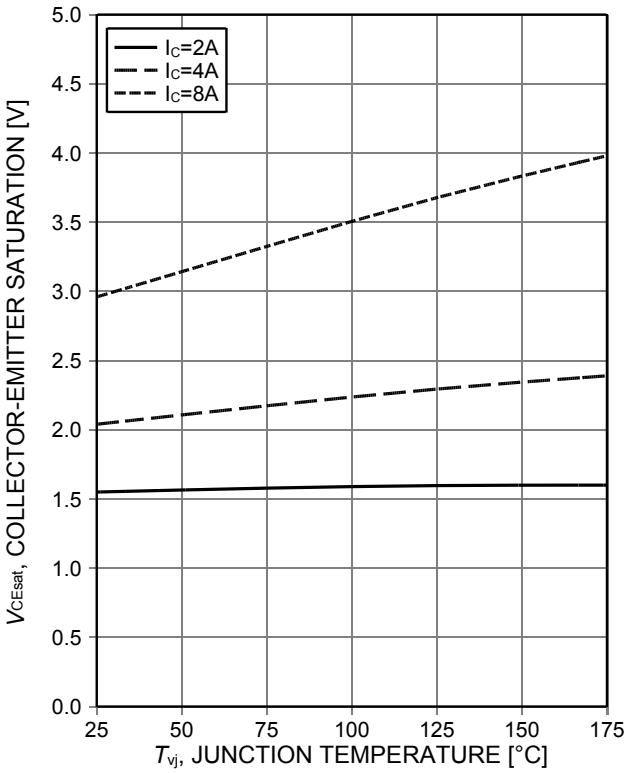


Figure 6. **Typical collector-emitter saturation voltage as a function of junction temperature**
(V_{GE}=15V)

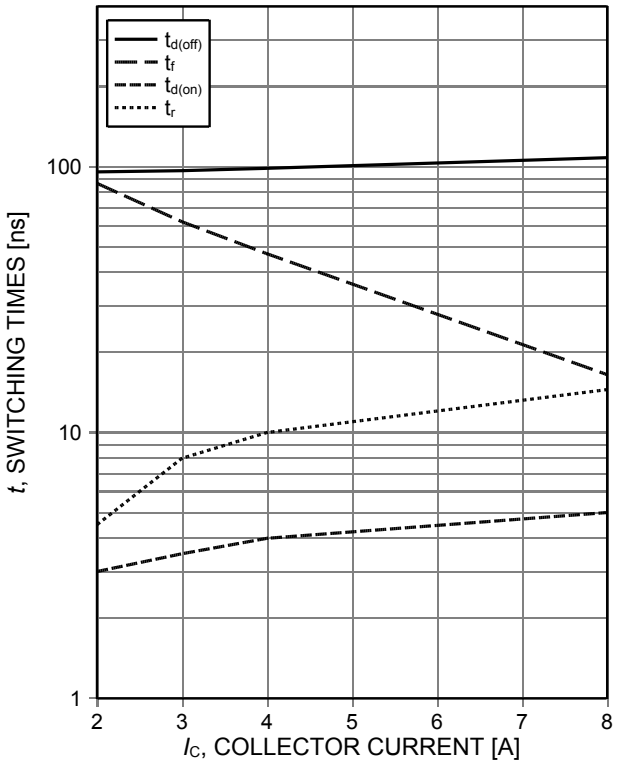


Figure 7. **Typical switching times as a function of collector current**
(inductive load, T_{vj}=175°C, V_{CE}=400V, V_{GE}=15/0V, R_G=49Ω, Dynamic test circuit in Figure E)

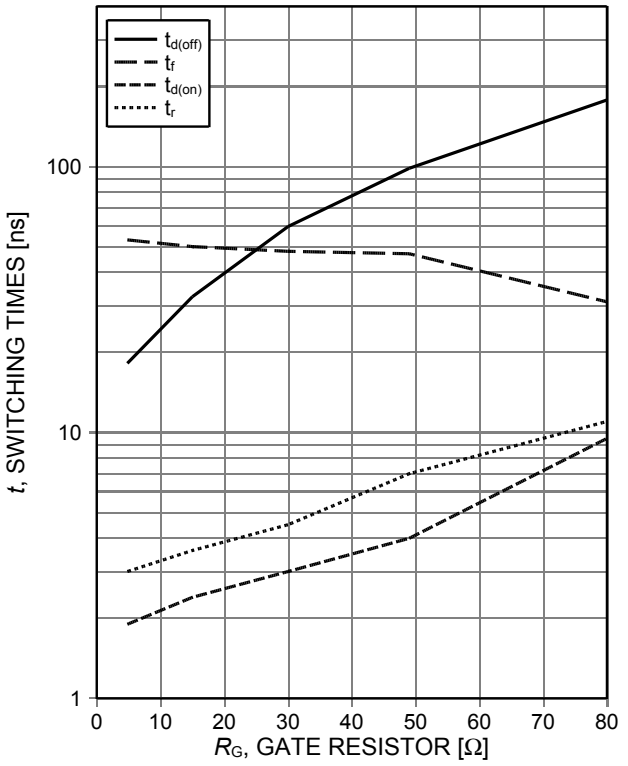


Figure 8. **Typical switching times as a function of gate resistor**
(inductive load, T_{vj}=175°C, V_{CE}=400V, V_{GE}=15/0V, I_C=4A, Dynamic test circuit in Figure E)

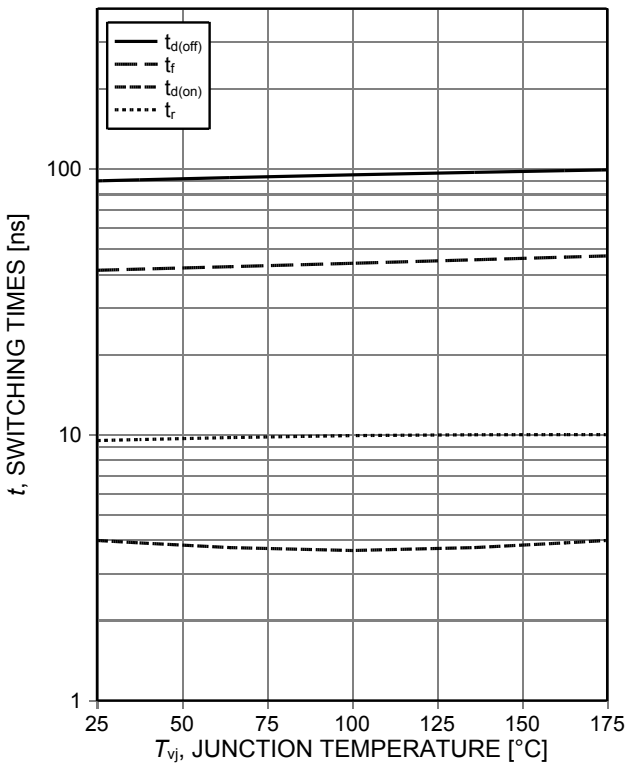


Figure 9. **Typical switching times as a function of junction temperature**
(inductive load, V_{CE}=400V, V_{GE}=15/0V, I_C=4A, R_G=49Ω, Dynamic test circuit in Figure E)

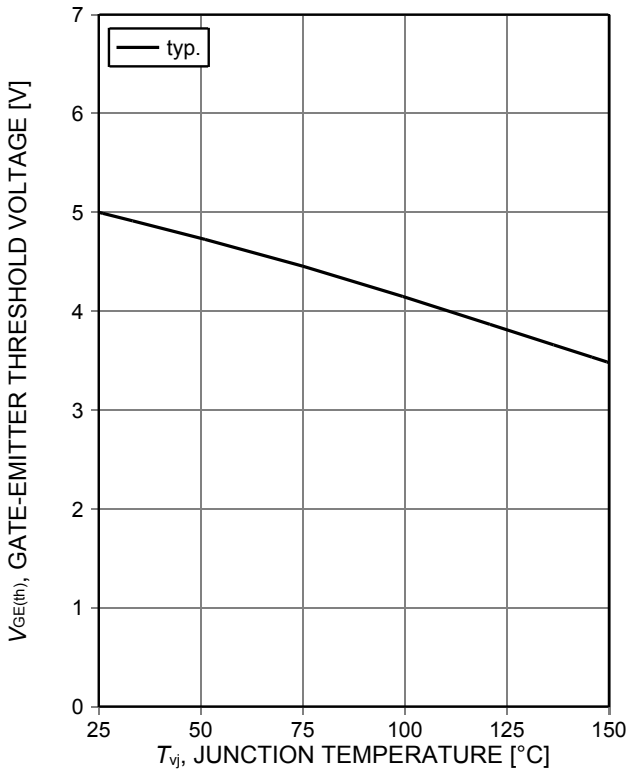


Figure 10. **Gate-emitter threshold voltage as a function of junction temperature**
(I_C=0.45mA)

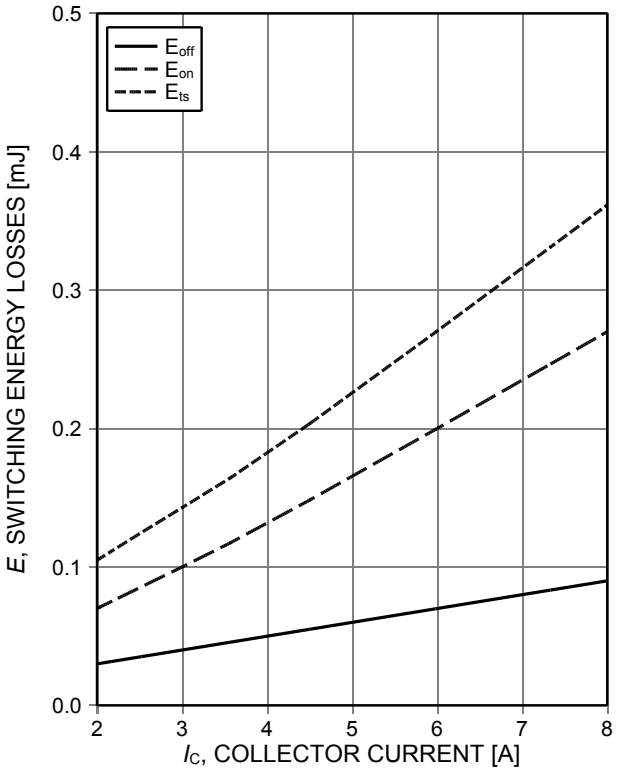


Figure 11. **Typical switching energy losses as a function of collector current**
(inductive load, T_{vj}=175°C, V_{CE}=400V, V_{GE}=15/0V, R_G=49Ω, Dynamic test circuit in Figure E)

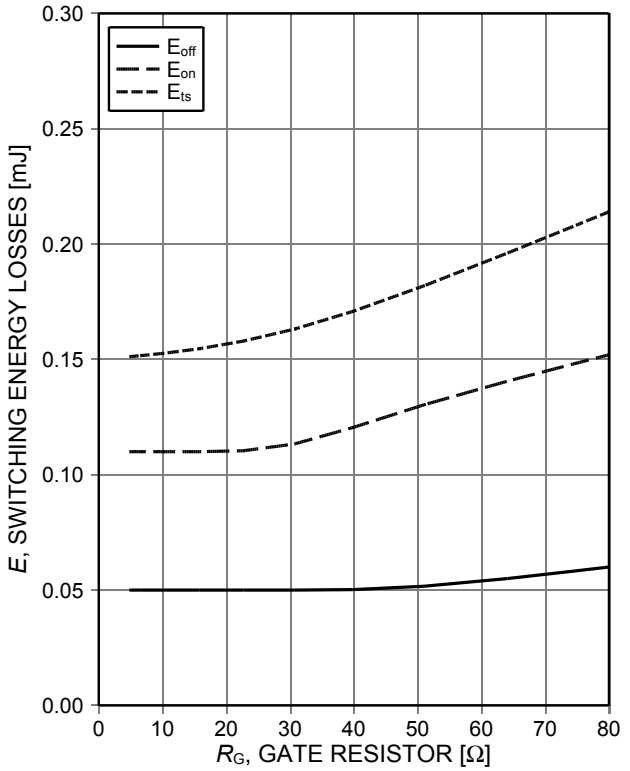


Figure 12. **Typical switching energy losses as a function of gate resistor**
(inductive load, T_{vj}=175°C, V_{CE}=400V, V_{GE}=15/0V, I_C=4A, Dynamic test circuit in Figure E)

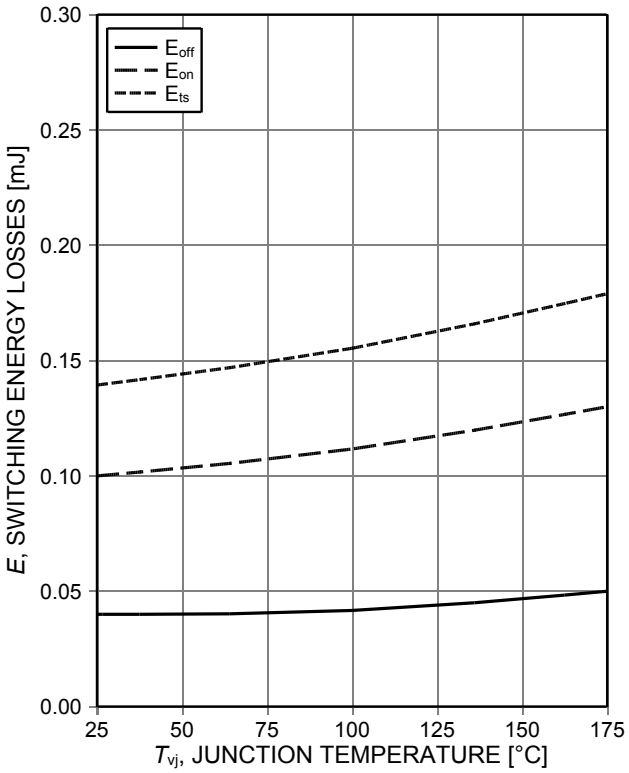


Figure 13. **Typical switching energy losses as a function of junction temperature** (inductive load, V_{CE}=400V, V_{GE}=15/0V, I_C=4A, R_G=49Ω, Dynamic test circuit in Figure E)

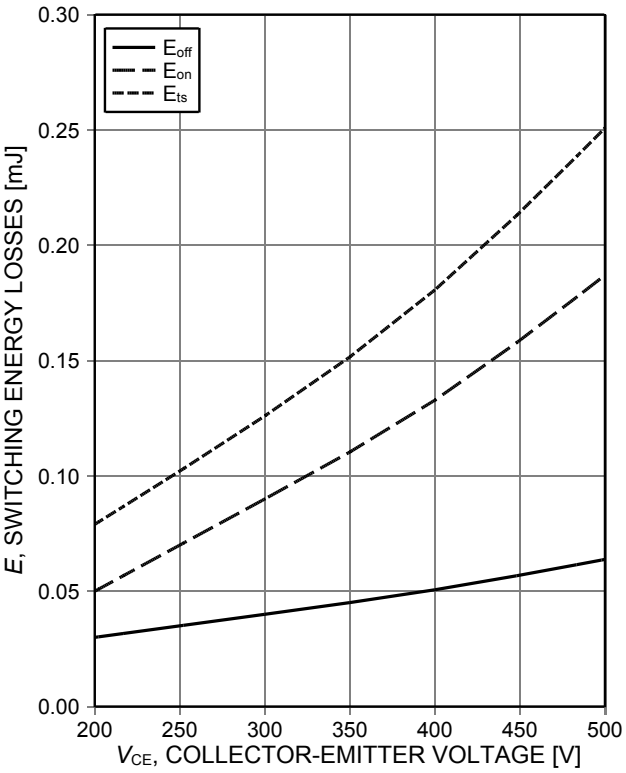


Figure 14. **Typical switching energy losses as a function of collector emitter voltage** (inductive load, T_{vj}=175°C, V_{GE}=15/0V, I_C=4A, R_G=49Ω, Dynamic test circuit in Figure E)

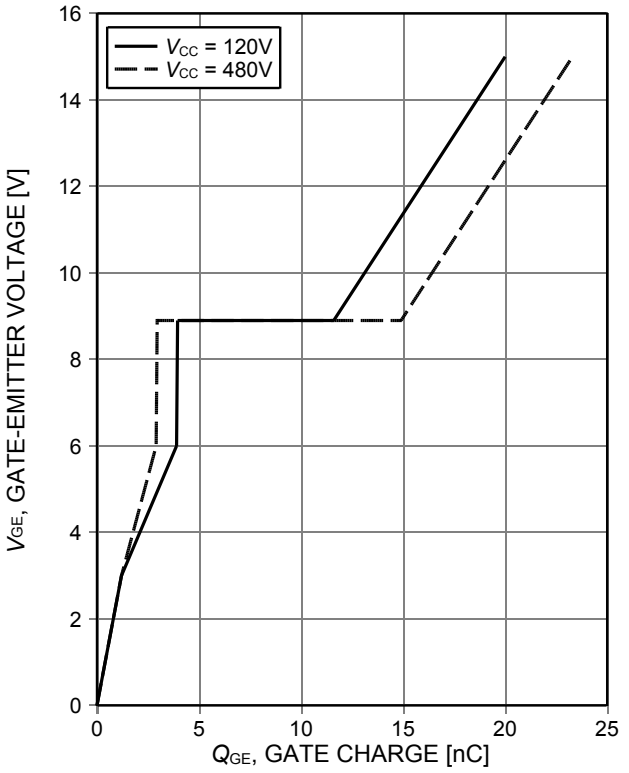


Figure 15. **Typical gate charge** (I_C=4A)

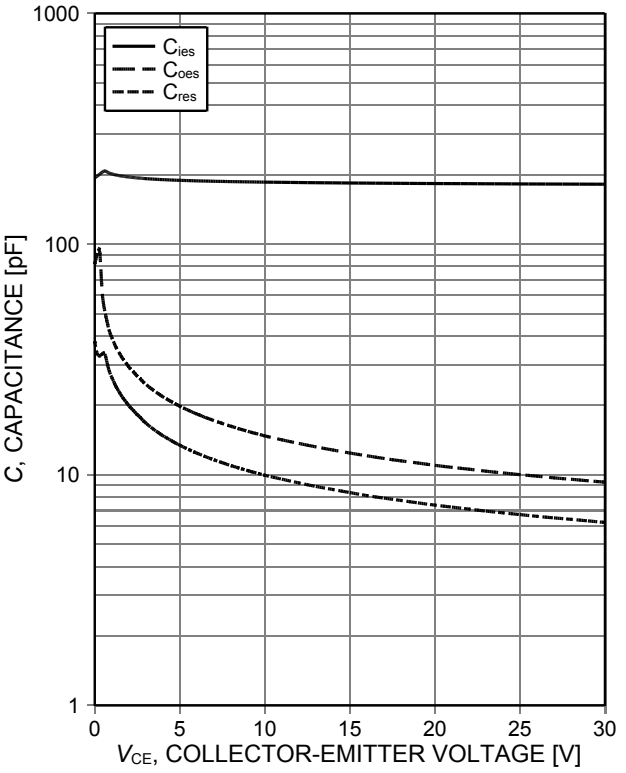


Figure 16. **Typical capacitance as a function of collector-emitter voltage** (V_{GE}=0V, f=1MHz)

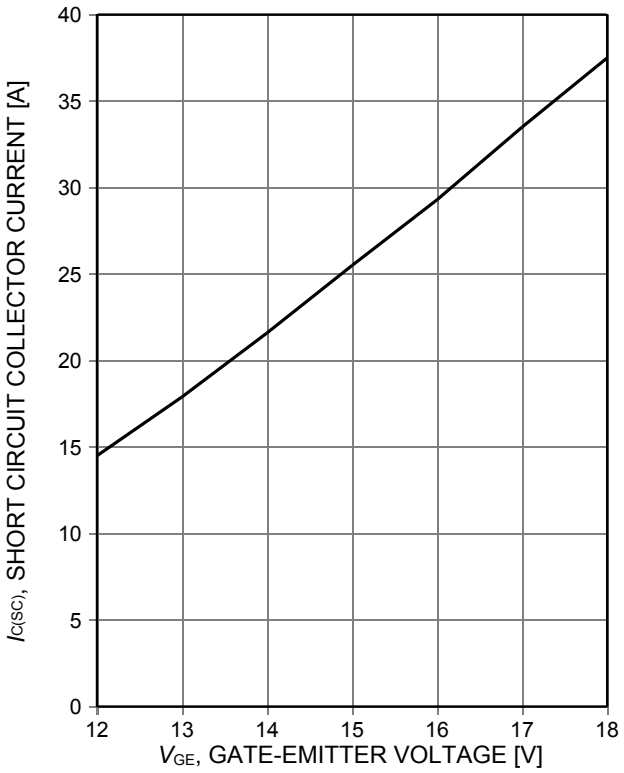


Figure 17. **Typical short circuit collector current as a function of gate-emitter voltage**
(V_{CE}≤400V, T_{vj}≤150°C)

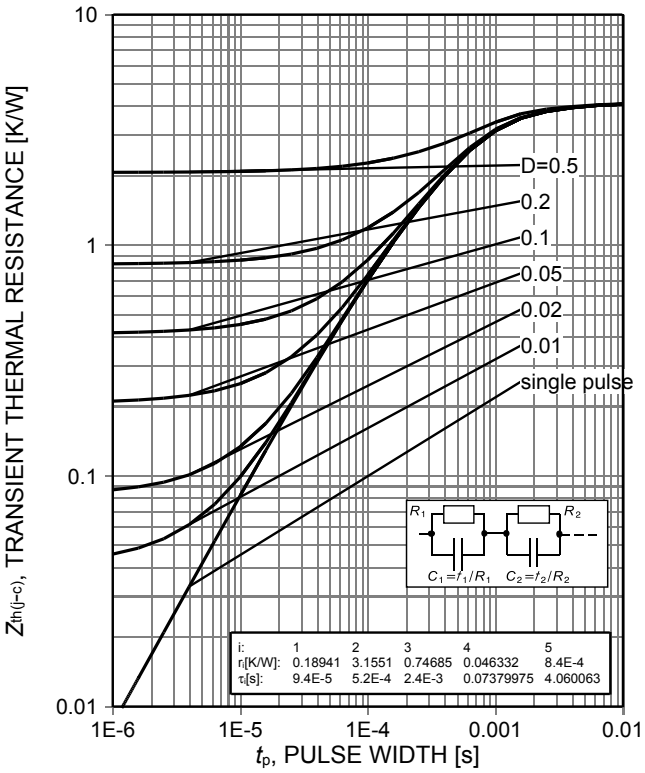


Figure 18. **IGBT transient thermal resistance**
($D=t_p/T$)

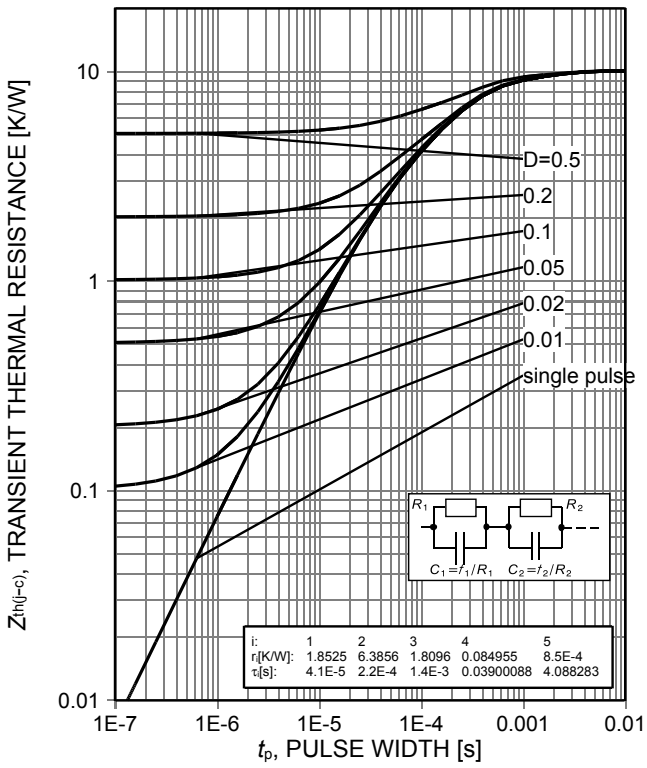


Figure 19. **Diode transient thermal impedance as a function of pulse width**
($D=t_p/T$)

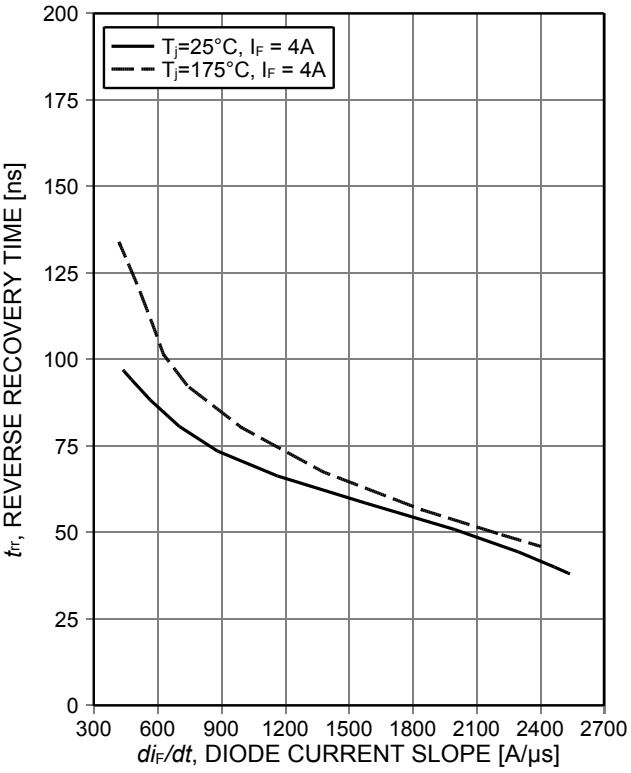


Figure 20. **Typical reverse recovery time as a function of diode current slope**
(V_R=400V)

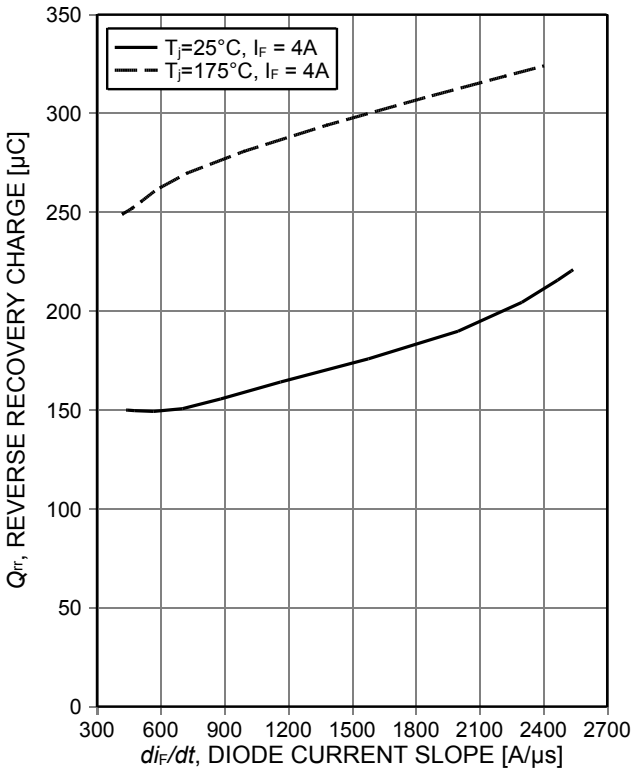


Figure 21. **Typical reverse recovery charge as a function of diode current slope** (V_R=400V)

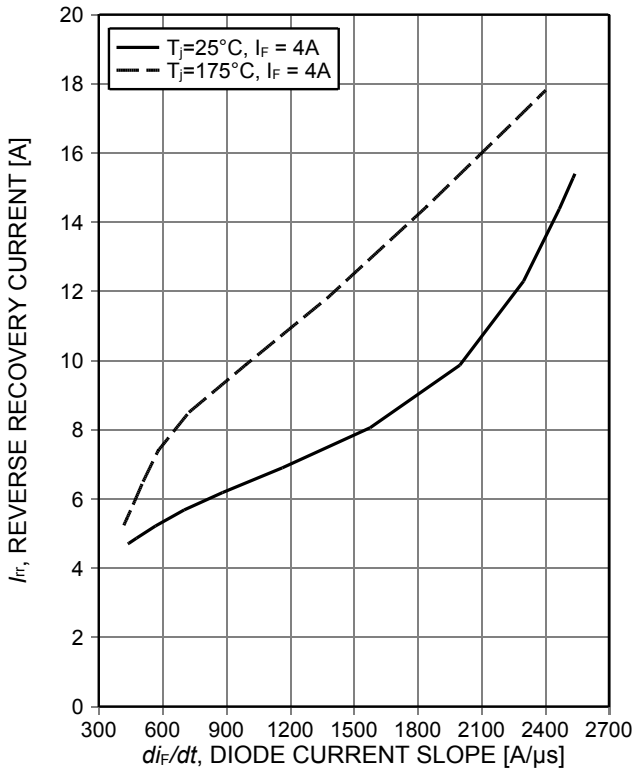


Figure 22. **Typical reverse recovery current as a function of diode current slope** (V_R=400V)

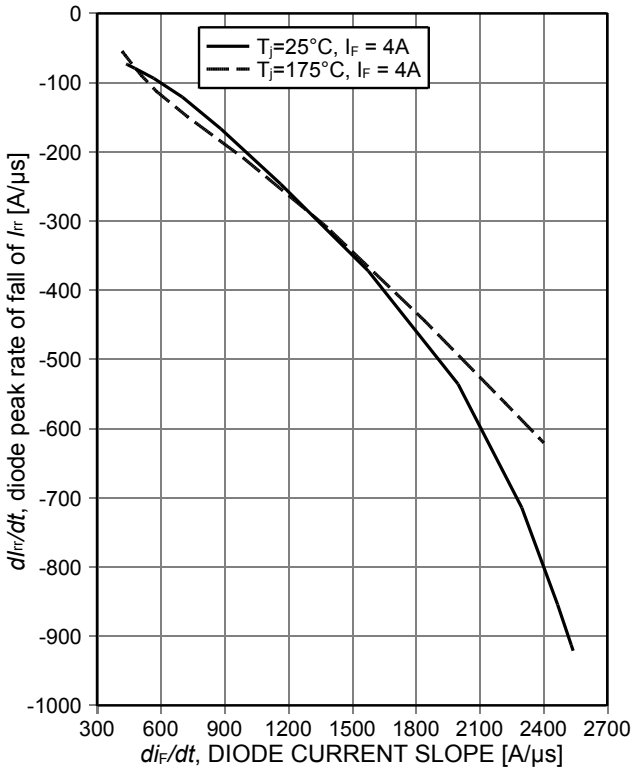


Figure 23. **Typical diode peak rate of fall of reverse recovery current as a function of diode current slope** (V_R=400V)

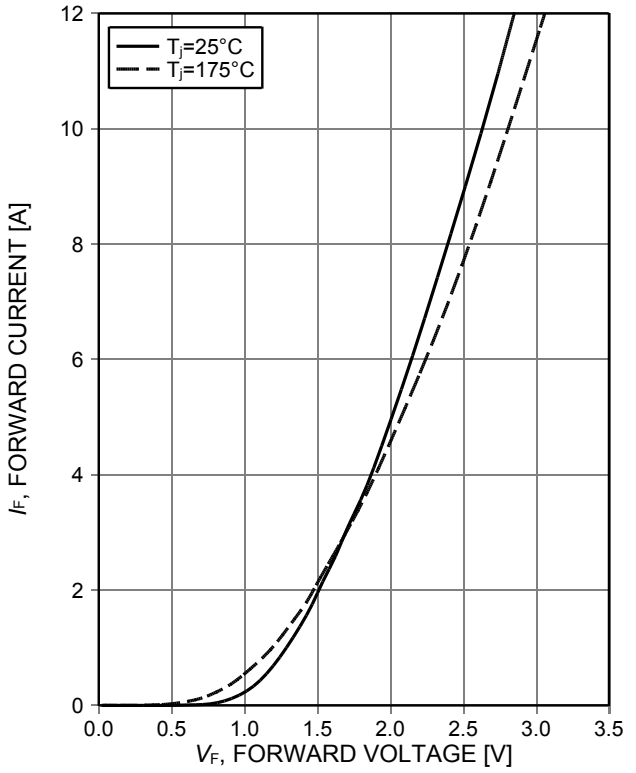


Figure 24. **Typical diode forward current as a function of forward voltage**

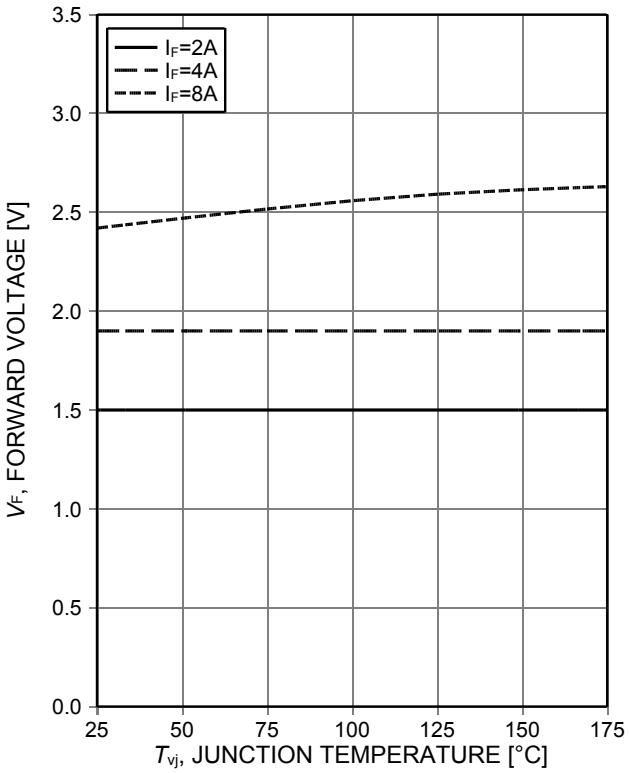
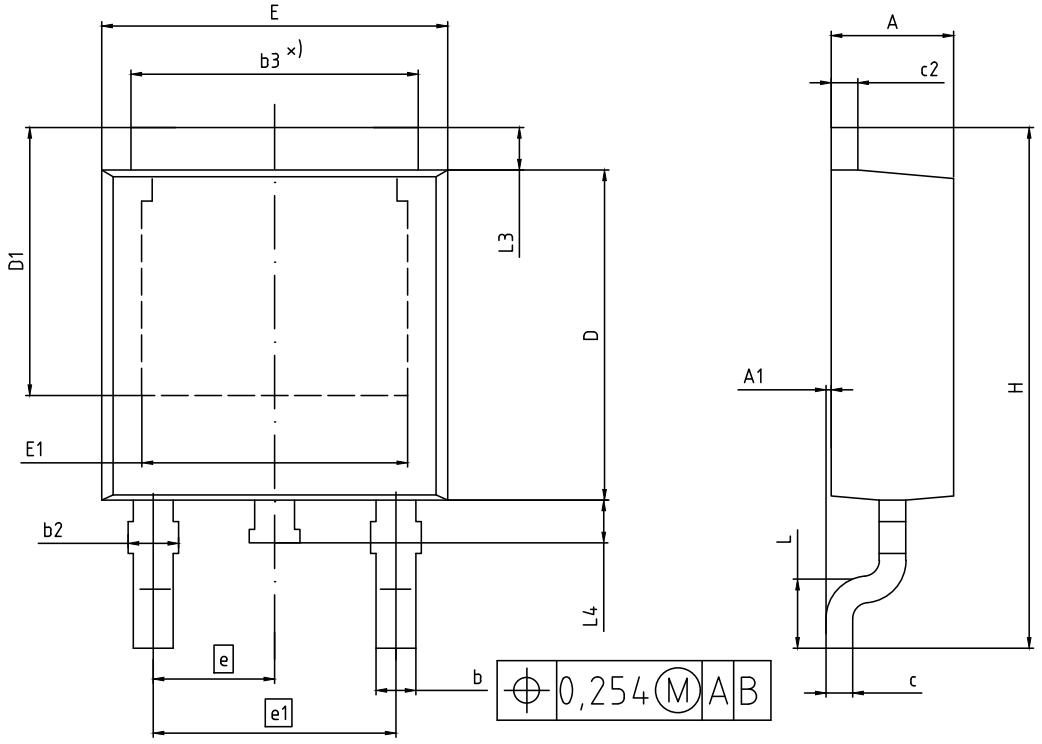
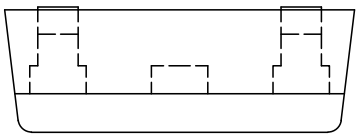


Figure 25. **Typical diode forward voltage as a function of junction temperature**

Package Drawing PG-TO252-3





NOTES:

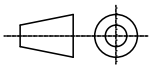
1. ALL DIMENSIONS REFER TO JEDEC STANDARD TO-252 DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.

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

DOCUMENT NO.
Z8B00003328

SCALE
0 2.5 0 2.5 5mm

EUROPEAN PROJECTION



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05-02-2016

REVISION
06

Testing Conditions

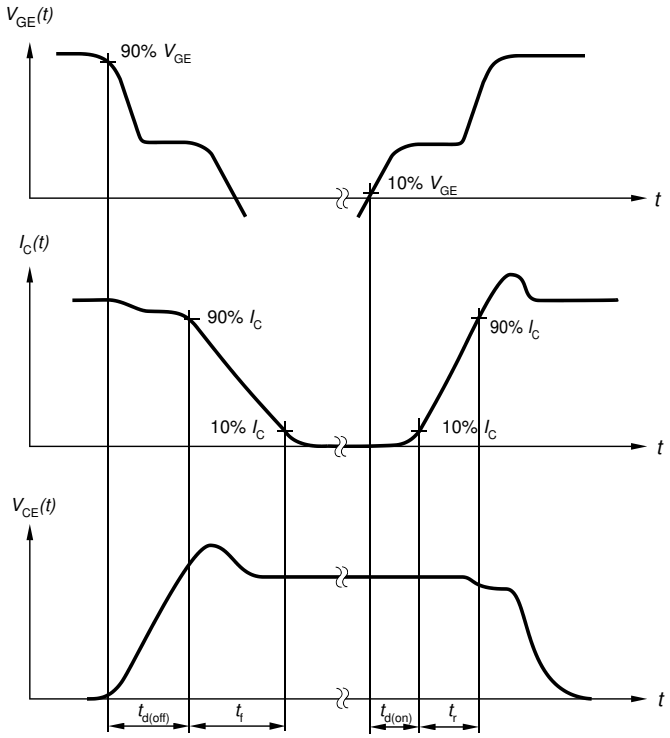

Figure A. **Definition of switching times**

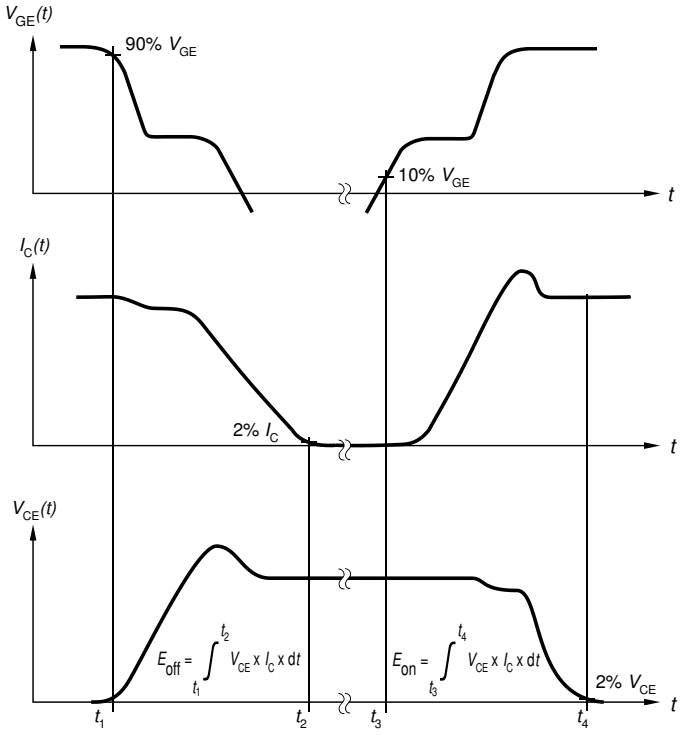

Figure B. **Definition of switching losses**

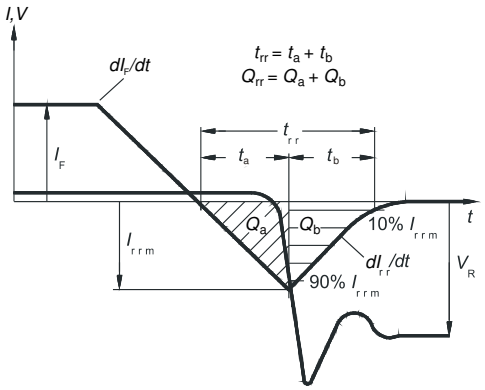

Figure C. **Definition of diode switching characteristics**

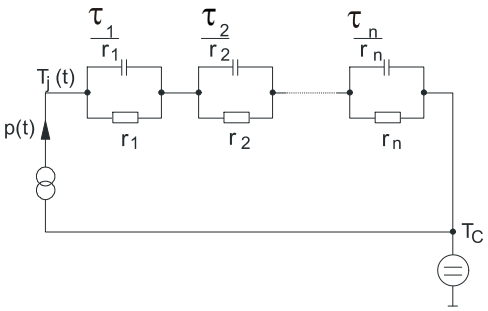

Figure D. **Thermal equivalent circuit**

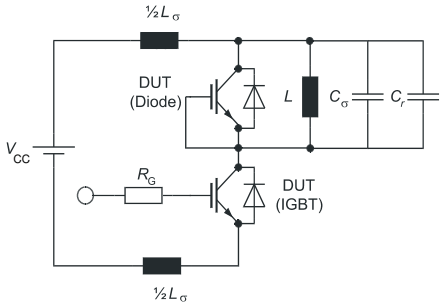

Figure E. **Dynamic test circuit**
Parasitic inductance L_σ,
parasitic capacitor C_σ,
relief capacitor C_r,
(only for ZVT switching)

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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