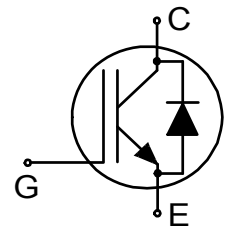


TRENCHSTOP™ IGBT6

IGBT in trench and field-stop technology with soft, fast recovery anti-parallel Rapid diode

Features and Benefits:

- Very low $V_{CE(sat)}$ 1.5V (typ.)
 - Maximum junction temperature 175°C
 - Short circuit withstand time 3μs
- Trench and field-stop technology for 650V applications offers :
- very tight parameter distribution
 - high ruggedness, temperature stable behavior
 - low V_{CEsat} and positive temperature coefficient
- Low gate charge Q_G
 - Pb-free lead plating; RoHS compliant
 - Very soft, fast recovery anti-parallel Rapid diode
 - Complete product spectrum and PLECS Models:
www.infineon.com/igbt

**Potential Applications:**

Drives

- GPD (general purpose drives)

Major home appliances

- Air conditioning
- Other major home appliances

Small home appliances

- Other small home appliances

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} , $T_{vj}=25^\circ\text{C}$	T_{vjmax}	Marking	Package
IKD06N65ET6	650V	6A	1.5V	175°C	K06EET6	PG-TO252-3

TRENCHSTOP™ IGBT6

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TRENCHSTOP™ IGBT6

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}	650	V
DC collector current, limited by T_{vjmax} $T_c = 25^{\circ}\text{C}$ $T_c = 100^{\circ}\text{C}$	I_C	9.0 6.0	A
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpuls}	18.0	A
Turn off safe operating area $V_{CE} \leq 650\text{V}$, $T_{vj} \leq 175^{\circ}\text{C}$	-	18.0	A
Diode forward current, limited by T_{vjmax} $T_c = 25^{\circ}\text{C}$ $T_c = 100^{\circ}\text{C}$	I_F	11.0 6.0	A
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpuls}	18.0	A
Gate-emitter voltage Transient Gate-emitter voltage ($t_p \leq 10\mu\text{s}$, $D < 0.010$)	V_{GE}	± 20 ± 30	V
Short circuit withstand time $V_{GE} = 15.0\text{V}$, $V_{CC} \leq 360\text{V}$ 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}	31.0 15.0	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, junction - case	$R_{th(j-c)}$		-	-	4.90	K/W
Diode thermal resistance, junction - case	$R_{th(j-c)}$		-	-	6.40	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

TRENCHSTOP™ IGBT6

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}	$V_{\text{GE}} = 15.0\text{V}$, $I_{\text{C}} = 3.0\text{A}$ $T_{\text{vj}} = 25^{\circ}\text{C}$ $T_{\text{vj}} = 125^{\circ}\text{C}$ $T_{\text{vj}} = 150^{\circ}\text{C}$	- - -	1.50 1.65 1.75	1.90 - -	V
Diode forward voltage	V_{F}	$V_{\text{GE}} = 0\text{V}$, $I_{\text{F}} = 3.0\text{A}$ $T_{\text{vj}} = 25^{\circ}\text{C}$ $T_{\text{vj}} = 125^{\circ}\text{C}$ $T_{\text{vj}} = 150^{\circ}\text{C}$	- - -	1.36 1.25 1.17	1.75 - -	V
Gate-emitter threshold voltage	$V_{\text{GE(th)}}$	$I_{\text{C}} = 0.10\text{mA}$, $V_{\text{CE}} = V_{\text{GE}}$	4.8	5.6	6.4	V
Zero gate voltage collector current	I_{CES}	$V_{\text{CE}} = 650\text{V}$, $V_{\text{GE}} = 0\text{V}$ $T_{\text{vj}} = 25^{\circ}\text{C}$ $T_{\text{vj}} = 150^{\circ}\text{C}$	- -	- 225	30 -	μA
Gate-emitter leakage current	I_{GES}	$V_{\text{CE}} = 0\text{V}$, $V_{\text{GE}} = 20\text{V}$	-	-	100	nA
Transconductance	g_{fs}	$V_{\text{CE}} = 20\text{V}$, $I_{\text{C}} = 3.0\text{A}$	-	2.1	-	S

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}	$V_{CE} = 25V, V_{GE} = 0V$ $f = 1000kHz$	-	283	-	pF
Output capacitance	C_{oes}		-	22	-	
Reverse transfer capacitance	C_{res}		-	5	-	
Gate charge	Q_G	$V_{CC} = 520V, I_C = 3.0A,$ $V_{GE} = 15V$	-	13.7	-	nC
Short circuit collector current Max. 1000 short circuits Time between short circuits: $\geq 1.0s$	$I_{C(SC)}$	$V_{GE} = 15.0V, V_{CC} \leq 360V,$ $t_{SC} \leq 3\mu s$ $T_{vj} = 150^{\circ}C$	-	35	-	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	$t_{d(\text{on})}$	$T_{vj} = 25^{\circ}\text{C}$, $V_{CC} = 400\text{V}$, $I_C = 3.0\text{A}$, $V_{GE} = 0.0/15.0\text{V}$, $R_{G(\text{on})} = 47.0\Omega$, $R_{G(\text{off})} = 47.0\Omega$, $L_{\sigma} = 30\text{nH}$, $C_{\sigma} = 30\text{pF}$ L_{σ} , C_{σ} from Fig. E Energy losses include “tail” and diode reverse recovery.	-	15	-	ns
Rise time	t_r		-	8	-	ns
Turn-off delay time	$t_{d(\text{off})}$		-	35	-	ns
Fall time	t_f		-	47	-	ns
Turn-on energy	E_{on}		-	0.06	-	mJ
Turn-off energy	E_{off}		-	0.03	-	mJ
Total switching energy	E_{ts}		-	0.09	-	mJ

TRENCHSTOP™ IGBT6

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

Diode reverse recovery time	t_{rr}	$T_{vj} = 25^{\circ}\text{C},$ $V_R = 400\text{V},$ $I_F = 3.0\text{A},$ $di_F/dt = 614\text{A}/\mu\text{s}$	-	30	-	ns
Diode reverse recovery charge	Q_{rr}		-	0.12	-	μC
Diode peak reverse recovery current	I_{rrm}		-	6.1	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-902	-	$\text{A}/\mu\text{s}$

Switching Characteristic, Inductive Load

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	

IGBT Characteristic, at $T_{vj} = 150^{\circ}\text{C}$

Turn-on delay time	$t_{d(on)}$	$T_{vj} = 150^{\circ}\text{C},$ $V_{CC} = 400\text{V}, I_C = 3.0\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(on)} = 47.0\Omega, R_{G(off)} = 47.0\Omega,$ $L\sigma = 30\text{nH}, C\sigma = 30\text{pF}$ Energy losses include "tail" and diode reverse recovery.	-	15	-	ns
Rise time	t_r		-	8	-	ns
Turn-off delay time	$t_{d(off)}$		-	37	-	ns
Fall time	t_f		-	48	-	ns
Turn-on energy	E_{on}		-	0.07	-	mJ
Turn-off energy	E_{off}		-	0.04	-	mJ
Total switching energy	E_{ts}		-	0.11	-	mJ

Diode Characteristic, at $T_{vj} = 150^{\circ}\text{C}$

Diode reverse recovery time	t_{rr}	$T_{vj} = 150^{\circ}\text{C},$ $V_R = 400\text{V},$ $I_F = 3.0\text{A},$ $di_F/dt = 516\text{A}/\mu\text{s}$	-	39	-	ns
Diode reverse recovery charge	Q_{rr}		-	0.16	-	μC
Diode peak reverse recovery current	I_{rrm}		-	6.6	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-690	-	$\text{A}/\mu\text{s}$

TRENCHSTOP™ IGBT6

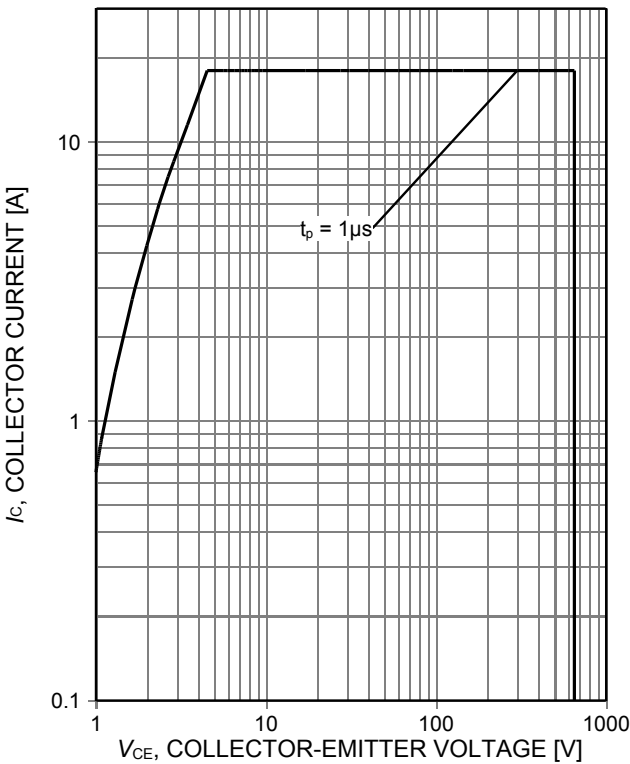


Figure 1. **Forward bias safe operating area**
($D=0$, $T_C=25^\circ\text{C}$, $T_{vj}\leq 175^\circ\text{C}$; $V_{GE}=15\text{V}$.
Recommended use at $V_{GE}\geq 15\text{V}$)

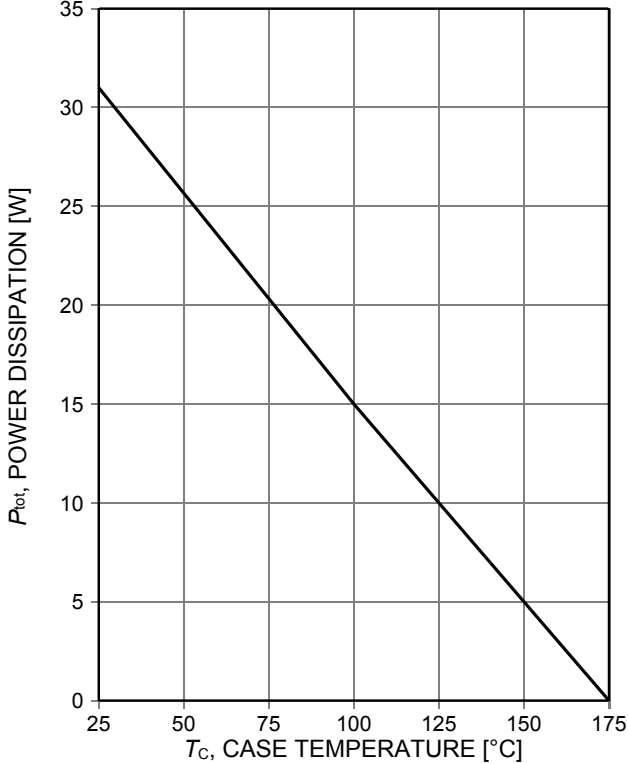


Figure 2. **Power dissipation as a function of case temperature**
($T_{vj}\leq 175^\circ\text{C}$)

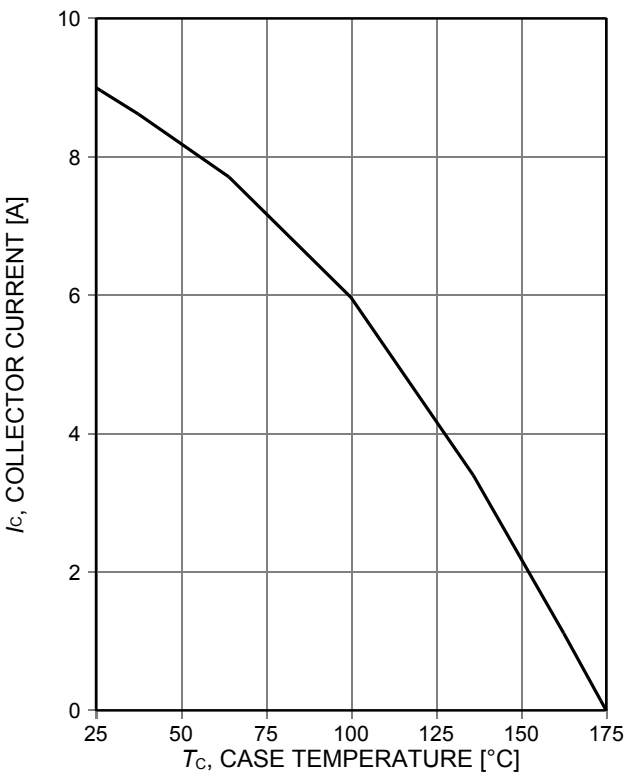


Figure 3. **Collector current as a function of case temperature**
($V_{GE}\geq 15\text{V}$, $T_{vj}\leq 175^\circ\text{C}$)

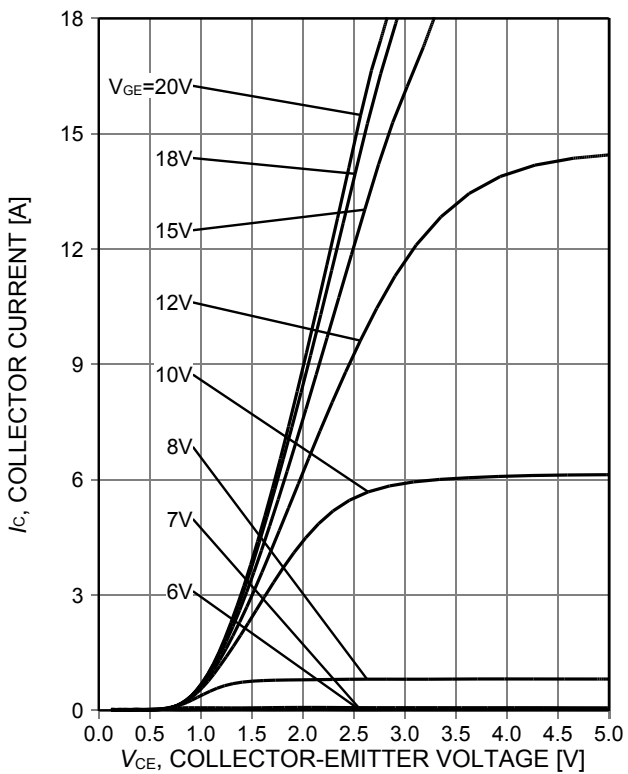


Figure 4. **Typical output characteristic**
($T_{vj}=25^\circ\text{C}$)

TRENCHSTOP™ IGBT6

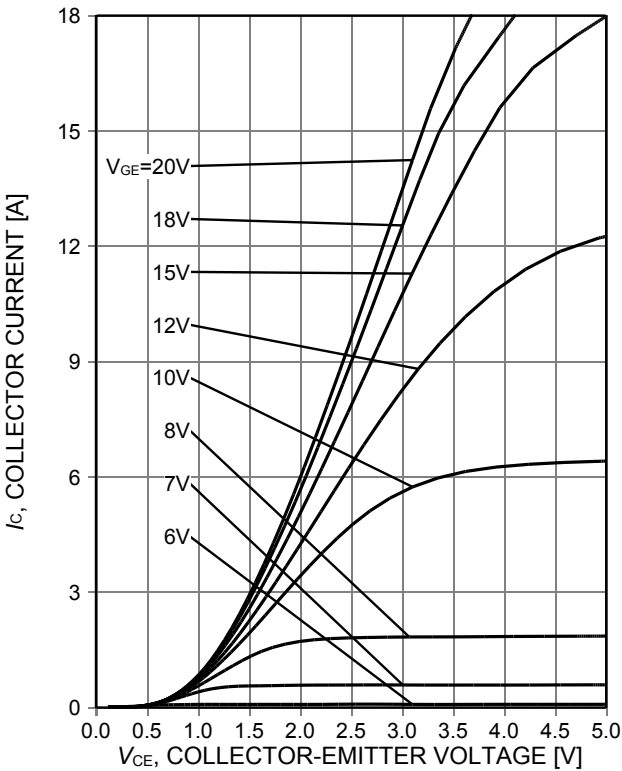


Figure 5. Typical output characteristic
($T_{vj}=150^{\circ}\text{C}$)

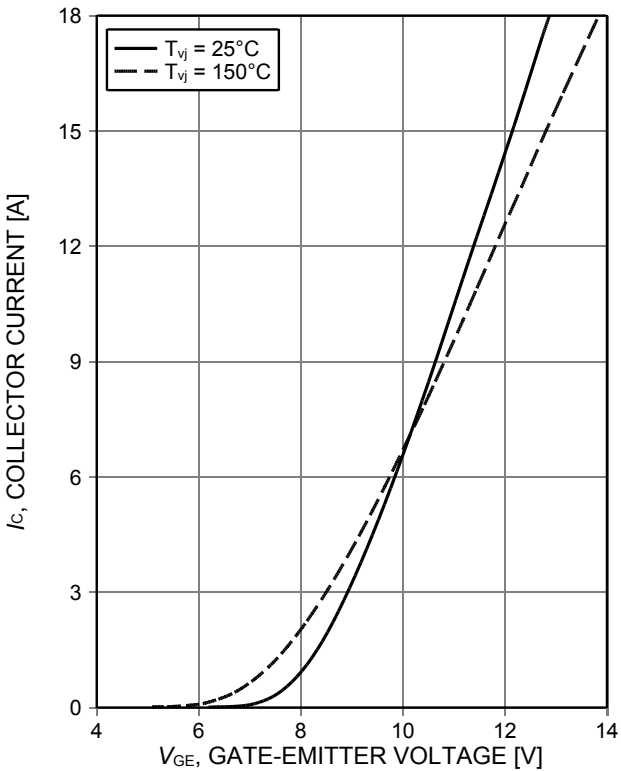


Figure 6. Typical transfer characteristic
($V_{ce}=50\text{V}$)

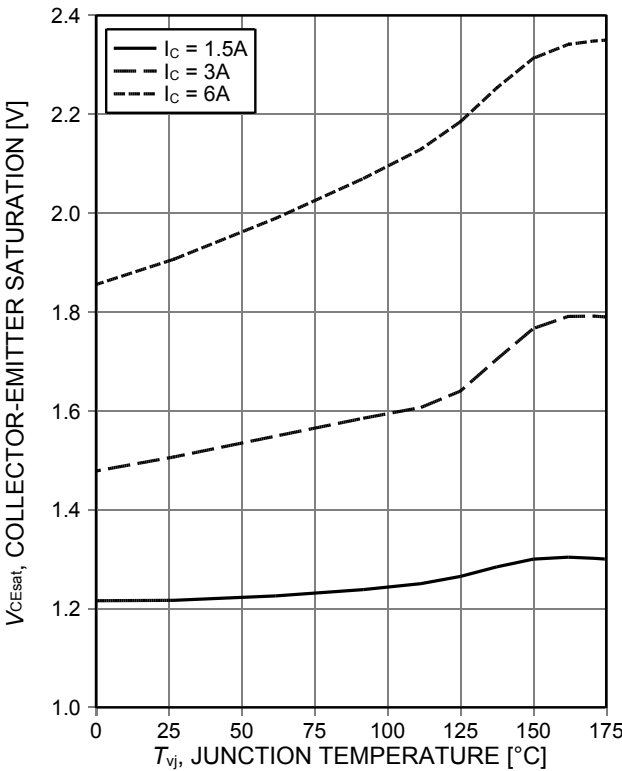


Figure 7. Typical collector-emitter saturation voltage as
a function of junction temperature
($V_{ge}=15\text{V}$)

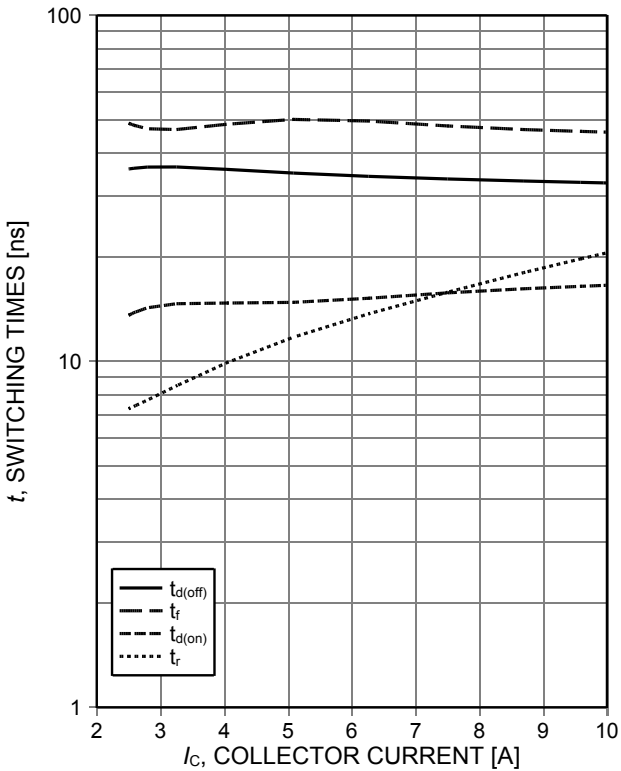


Figure 8. Typical switching times as a function of
collector current
(inductive load, $T_{vj}=150^{\circ}\text{C}$, $V_{ce}=400\text{V}$,
 $V_{ge}=0/15\text{V}$, $R_G=47\Omega$, Dynamic test circuit in
Figure E)

TRENCHSTOP™ IGBT6

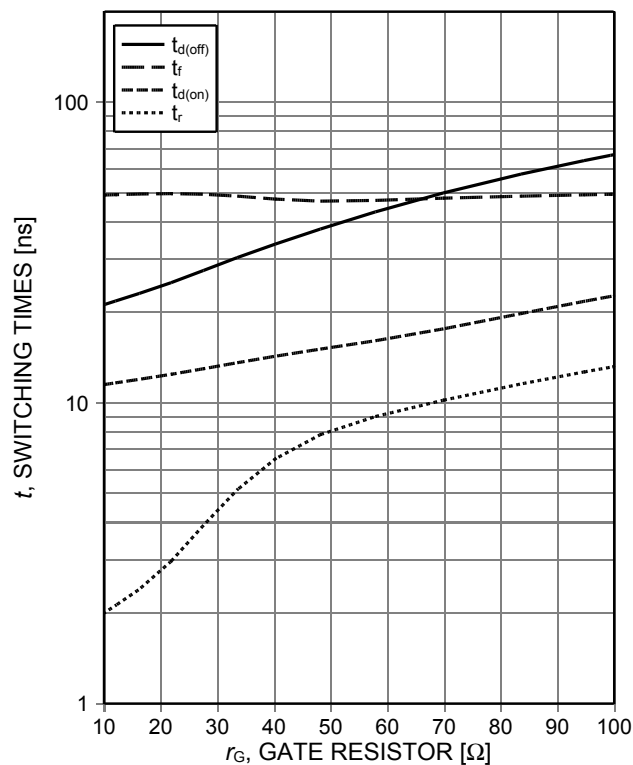


Figure 9. **Typical switching times as a function of gate resistor**
(inductive load, $T_{vj}=150^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=0/15\text{V}$, $I_C=3\text{A}$, Dynamic test circuit in Figure E)

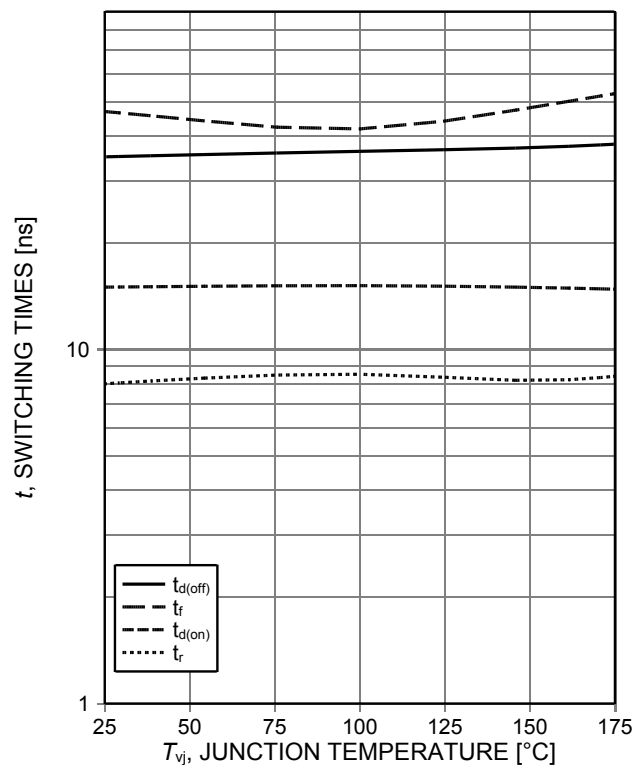


Figure 10. **Typical switching times as a function of junction temperature**
(inductive load, $V_{CE}=400\text{V}$, $V_{GE}=0/15\text{V}$, $I_C=3\text{A}$, $R_G=47\Omega$, Dynamic test circuit in Figure E)

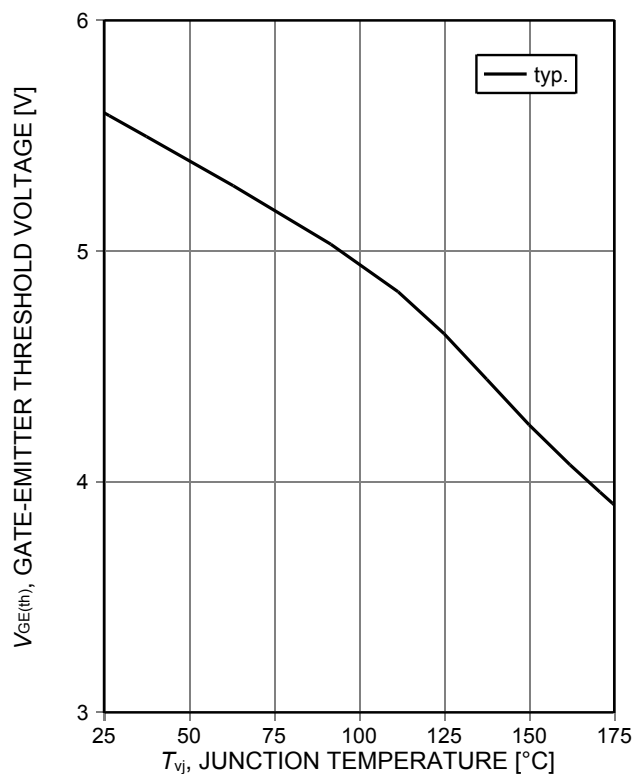


Figure 11. **Gate-emitter threshold voltage as a function of junction temperature**
($I_C=0.10\text{mA}$)

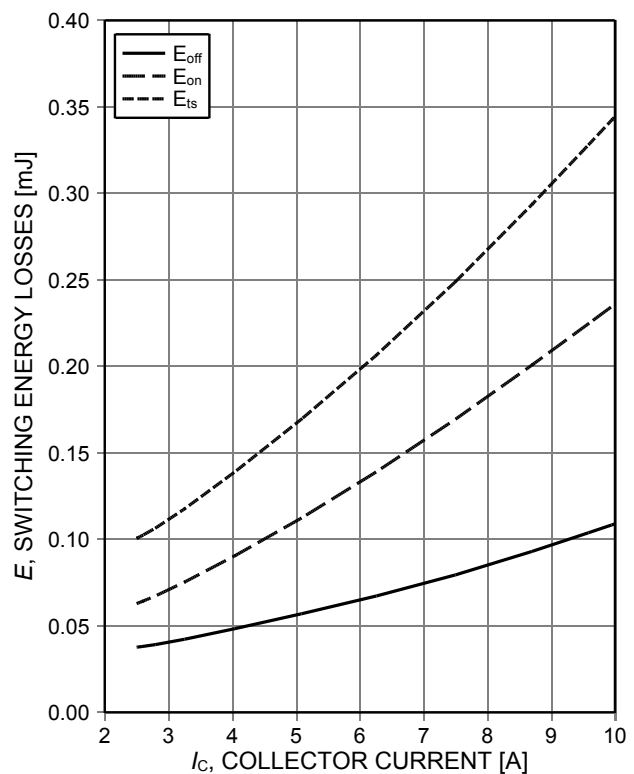


Figure 12. **Typical switching energy losses as a function of collector current**
(inductive load, $T_{vj}=150^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=0/15\text{V}$, $R_G=47\Omega$, Dynamic test circuit in Figure E)

TRENCHSTOP™ IGBT6

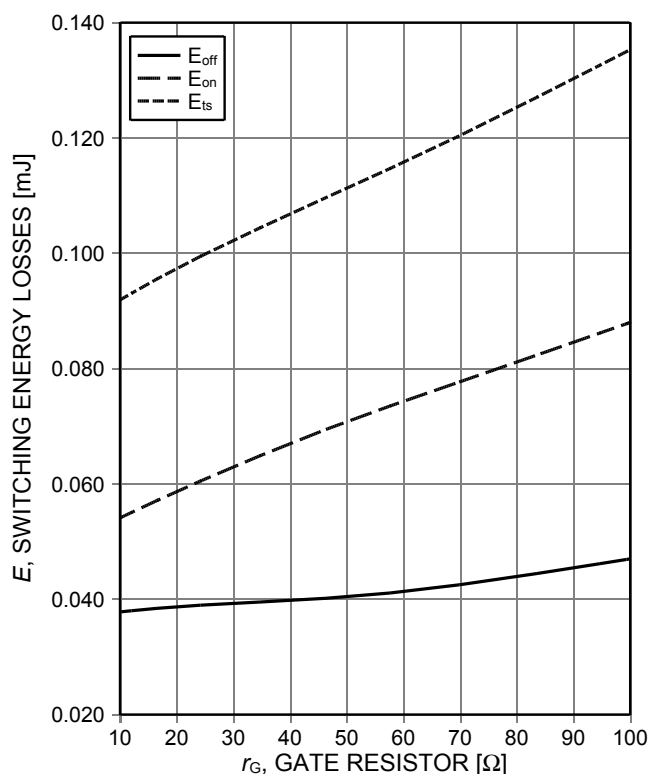


Figure 13. **Typical switching energy losses as a function of gate resistor**
(inductive load, $T_{vj}=150^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=0/15\text{V}$, $I_C=3\text{A}$, Dynamic test circuit in Figure E)

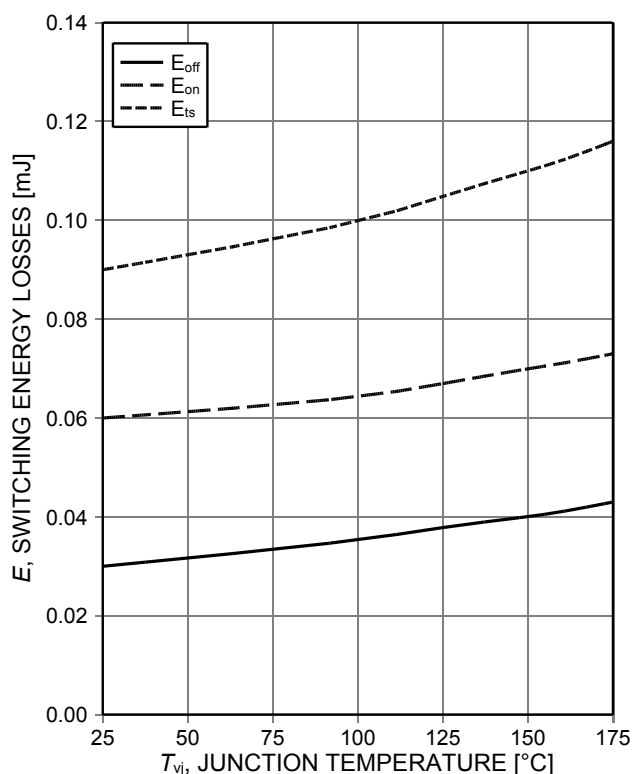


Figure 14. **Typical switching energy losses as a function of junction temperature**
(inductive load, $V_{CE}=400\text{V}$, $V_{GE}=0/15\text{V}$, $I_C=3\text{A}$, $R_G=47\Omega$, Dynamic test circuit in Figure E)

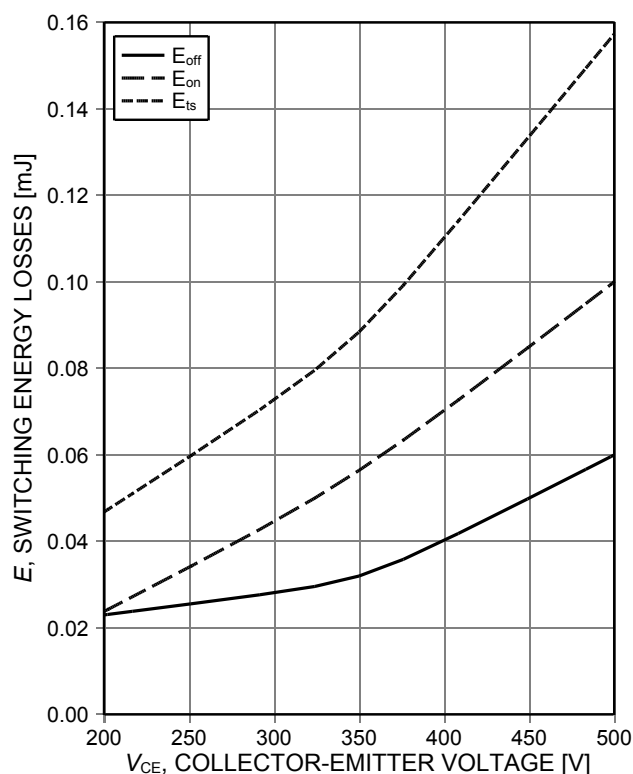


Figure 15. **Typical switching energy losses as a function of collector emitter voltage**
(inductive load, $T_{vj}=150^{\circ}\text{C}$, $V_{GE}=0/15\text{V}$, $I_C=3\text{A}$, $R_G=47\Omega$, Dynamic test circuit in Figure E)

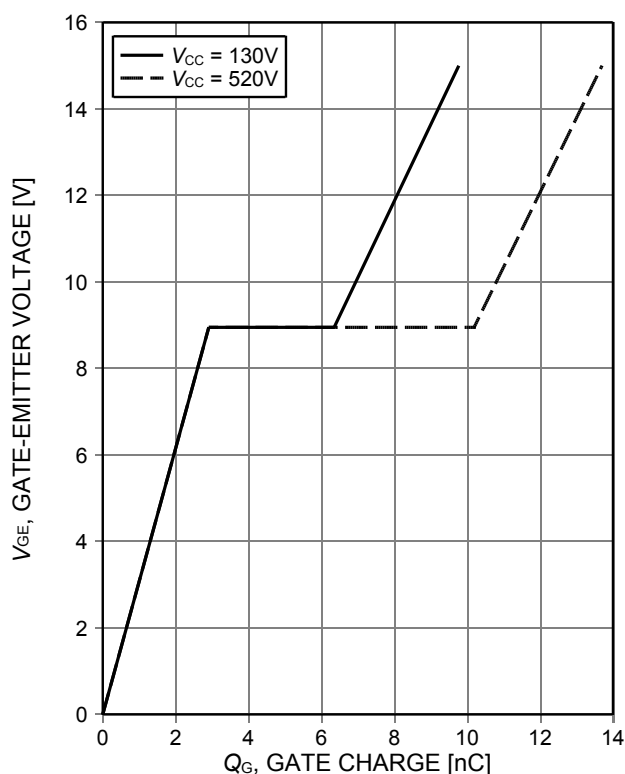


Figure 16. **Typical gate charge**
($I_C=3\text{A}$)

TRENCHSTOP™ IGBT6

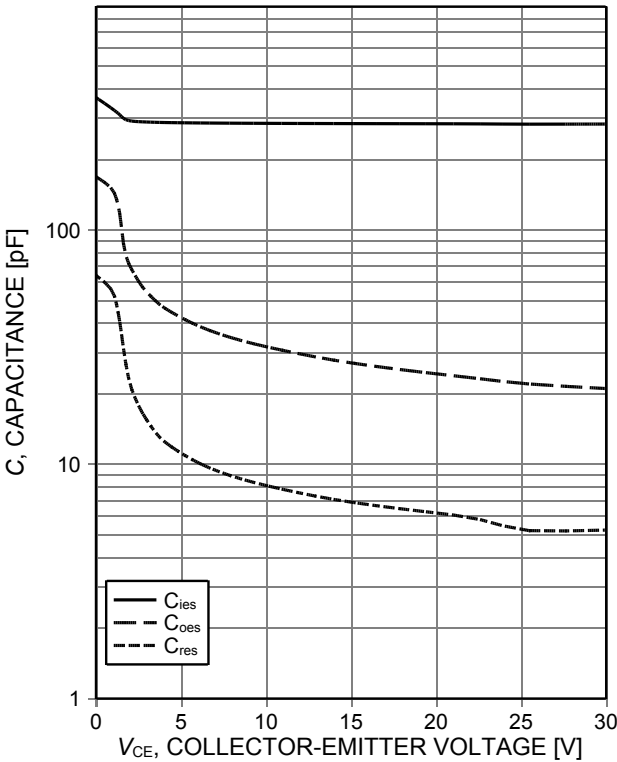


Figure 17. Typical capacitance as a function of collector-emitter voltage (V_{GE}=0V, f=1MHz)

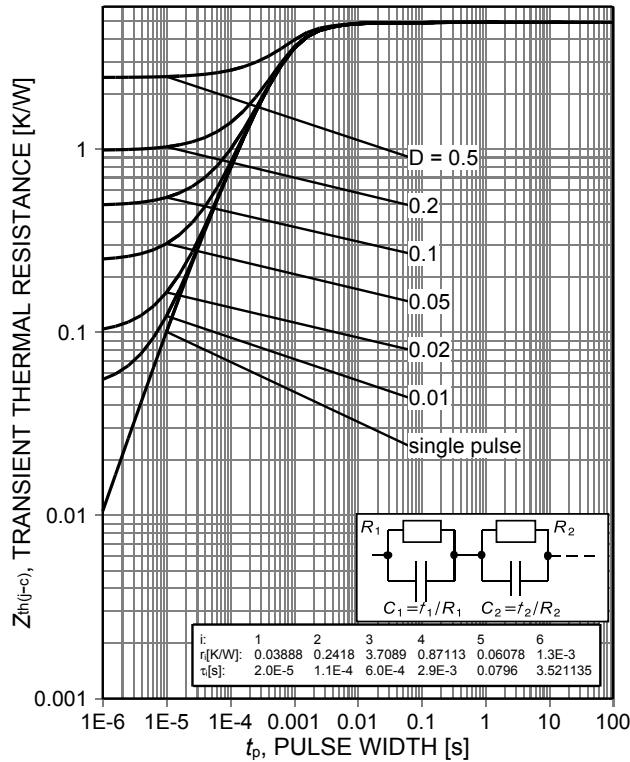


Figure 18. IGBT transient thermal impedance (D=t_p/T)

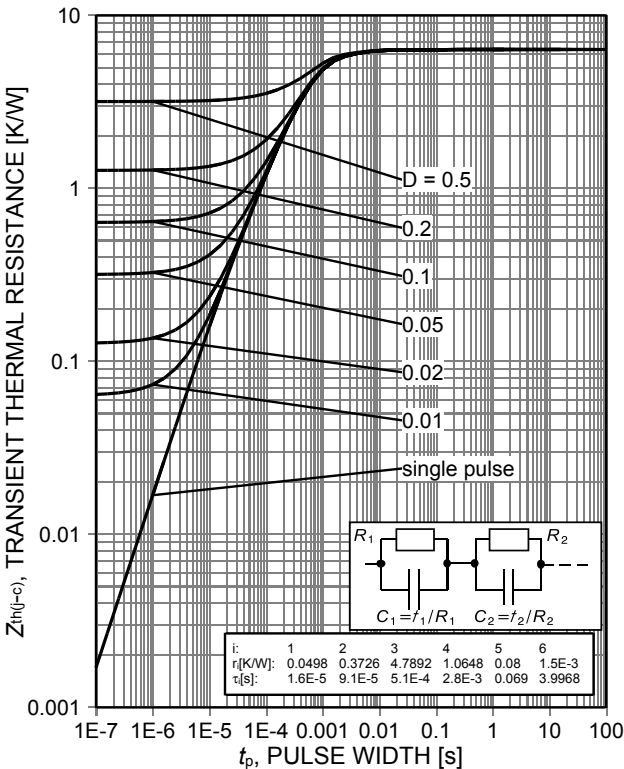


Figure 19. Diode transient thermal impedance as a function of pulse width (D=t_p/T)

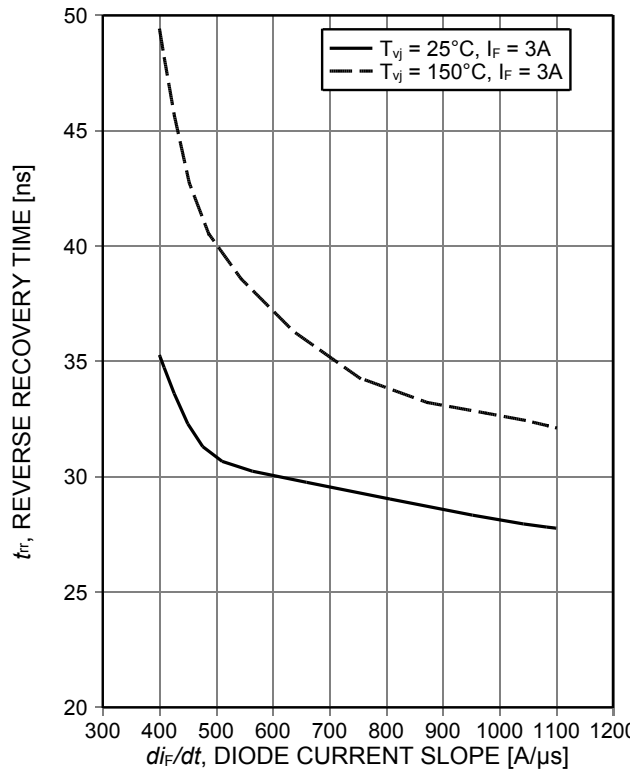


Figure 20. Typical reverse recovery time as a function of diode current slope (V_R=400V)

TRENCHSTOP™ IGBT6

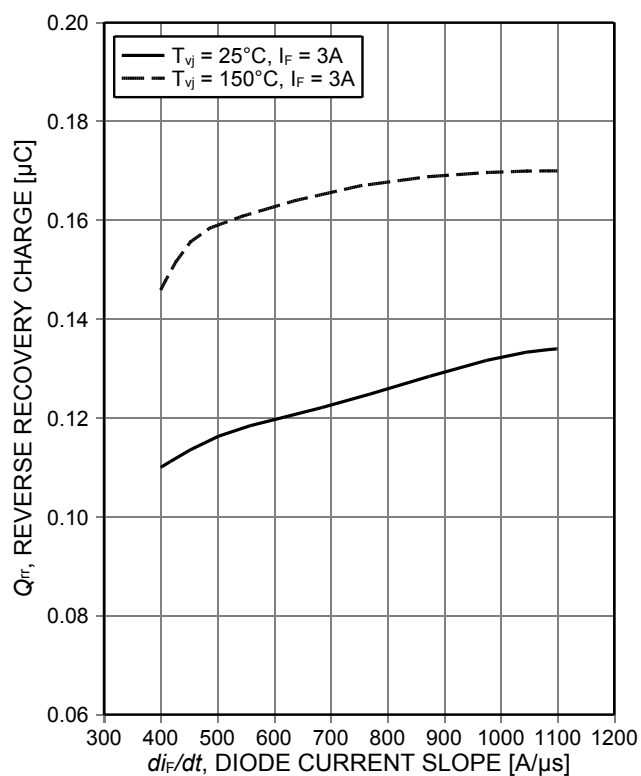


Figure 21. Typical reverse recovery charge as a function of diode current slope ($V_R=400V$)

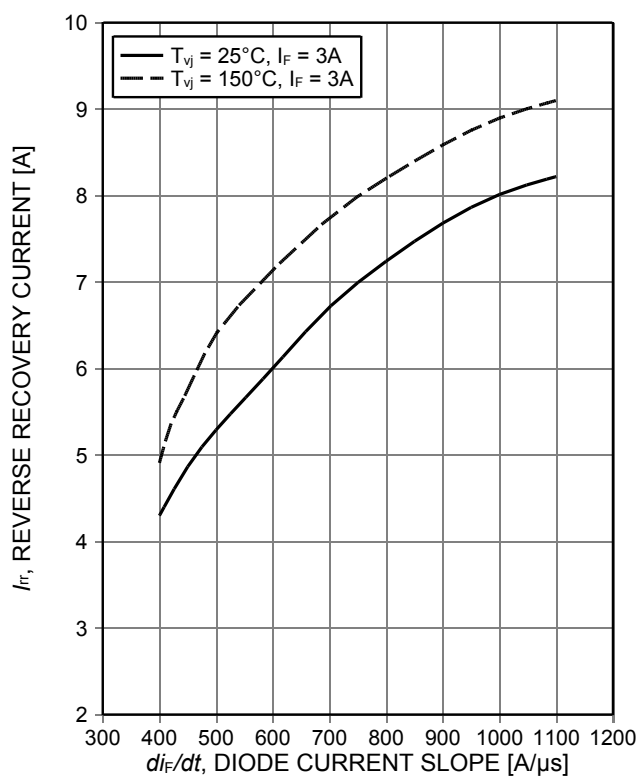


Figure 22. Typical reverse recovery current as a function of diode current slope ($V_R=400V$)

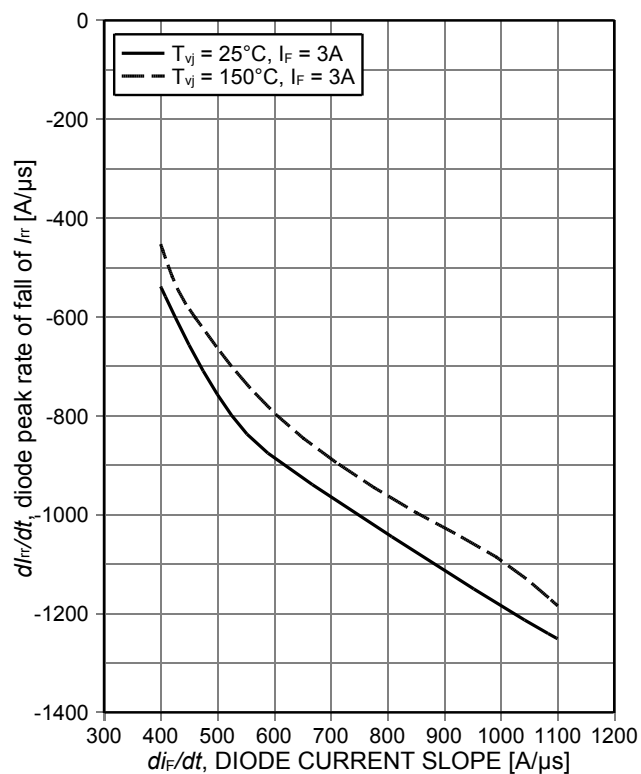


Figure 23. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope ($V_R=400V$)

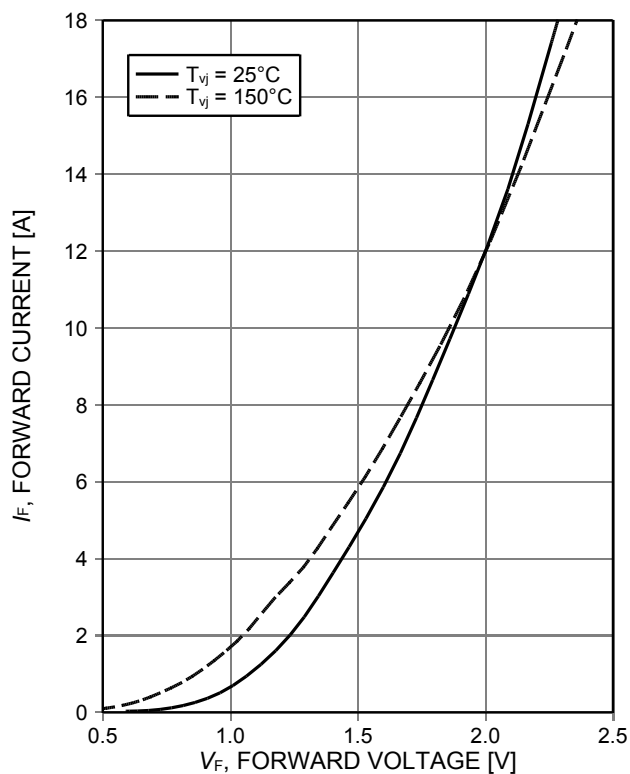


Figure 24. Typical diode forward current as a function of forward voltage

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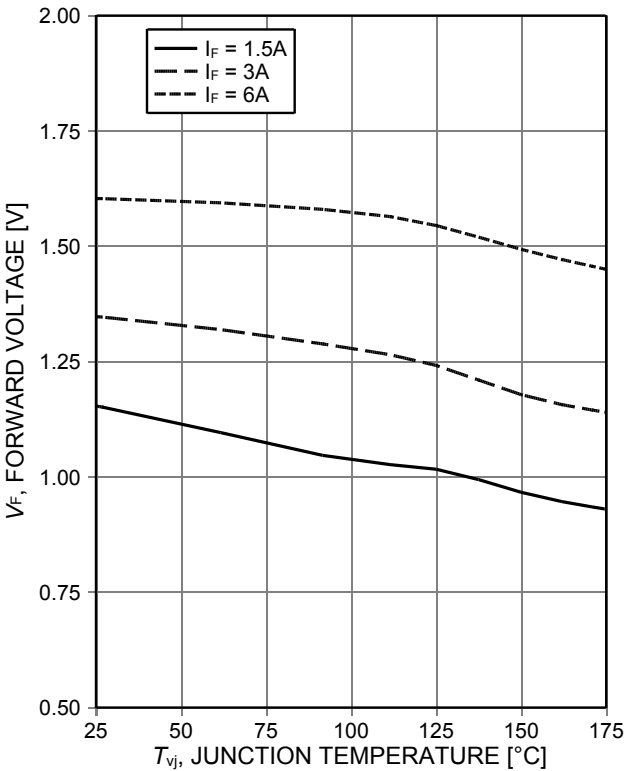
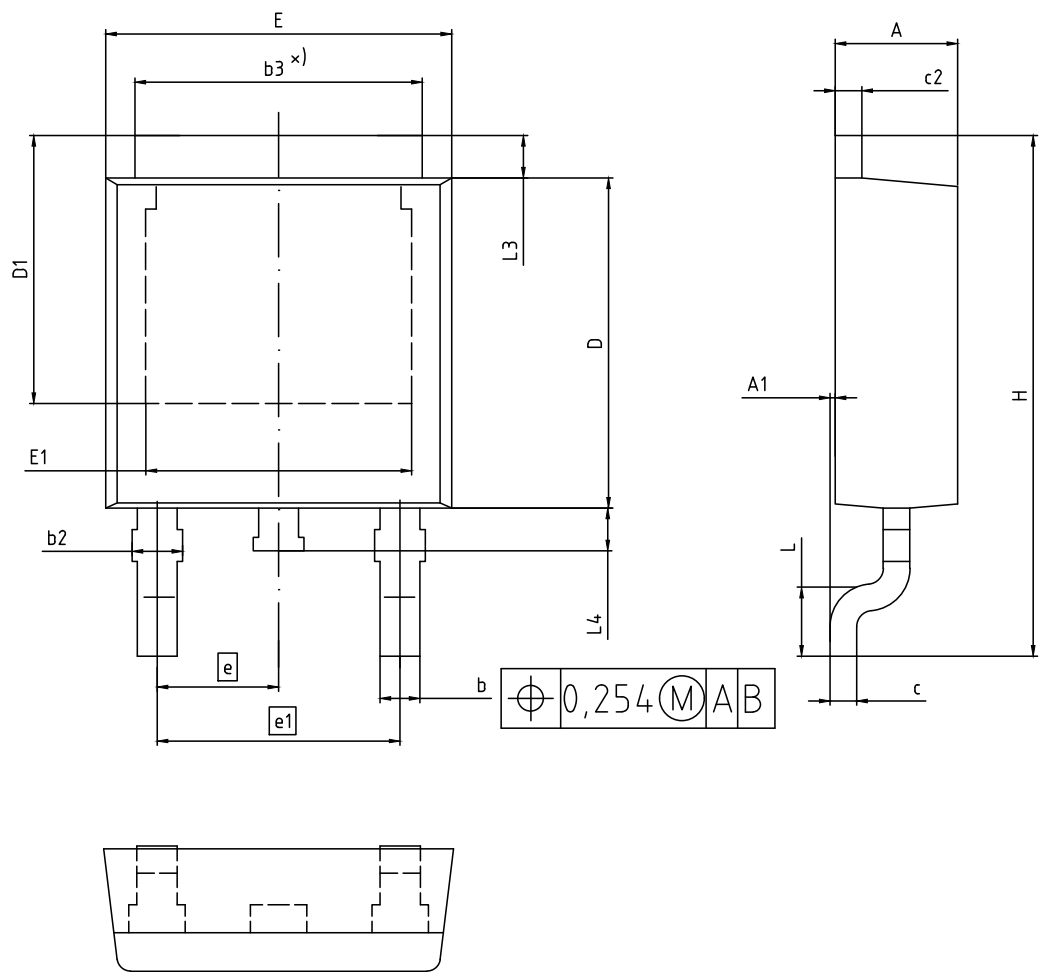


Figure 25. Typical diode forward voltage as a function of junction temperature

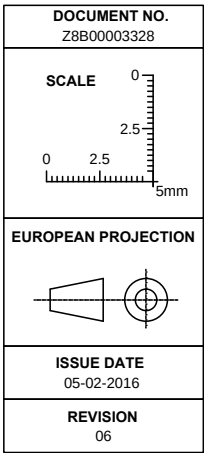
TRENCHSTOP™ IGBT6

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



Testing Conditions

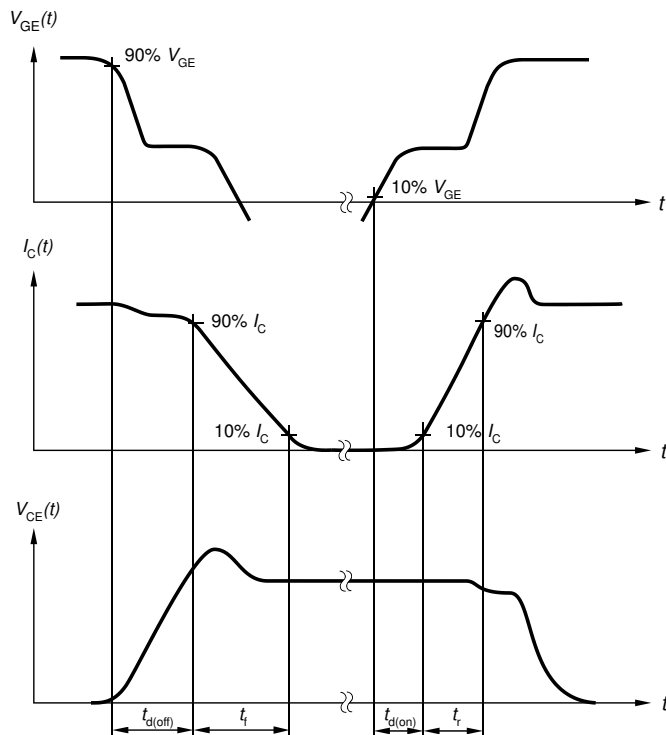


Figure A. Definition of switching times

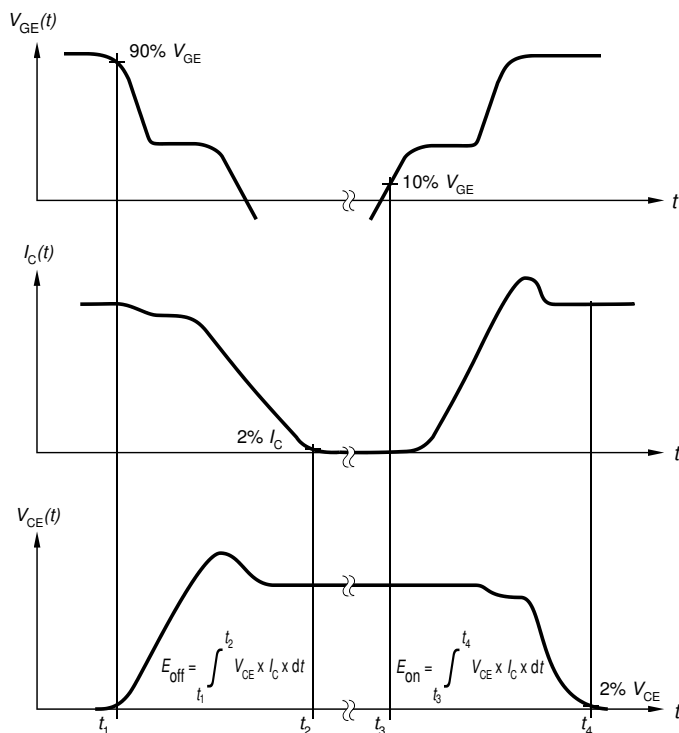


Figure B. Definition of switching losses

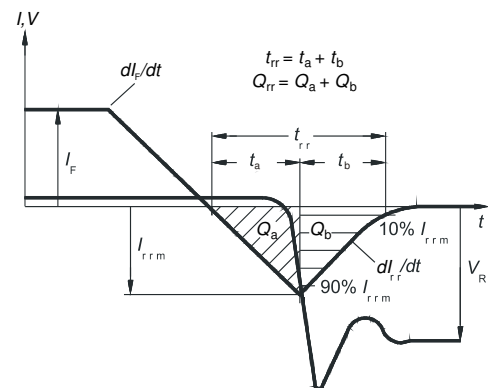


Figure C. Definition of diode switching characteristics

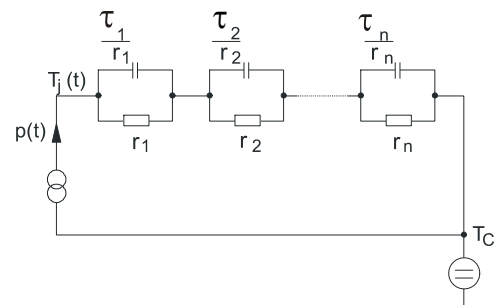


Figure D. Thermal equivalent circuit

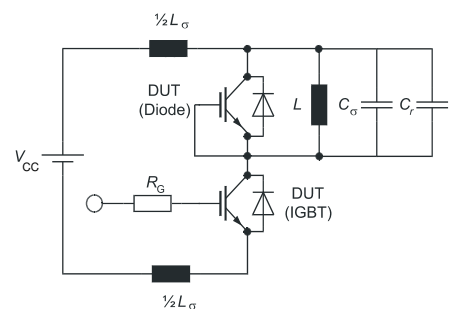


Figure E. **Dynamic test circuit**
Parasitic inductance L_σ ,
parasitic capacitor C_σ ,
relief capacitor C_r ,
(only for ZVT switching)

TRENCHSTOP™ IGBT6**Revision History**

IKD06N65ET6**Revision: 2020-04-20, Rev. 2.2**

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.1	2020-03-16	Final
2.2	2020-04-20	Final

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