

## IGBT

Low  $V_{CE(sat)}$  IGBT in TRENCHSTOP™ 5 technology copacked with RAPID 1 fast and soft antiparallel diode

## IKW75N65EL5

650V DuoPack IGBT and diode  
Low  $V_{CE(sat)}$  series fifth generation

Data sheet

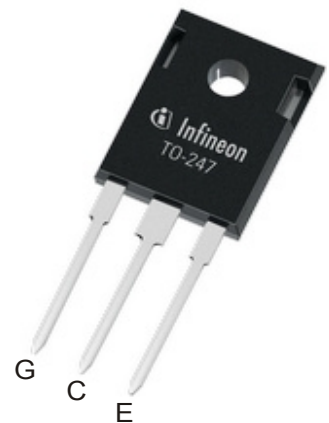
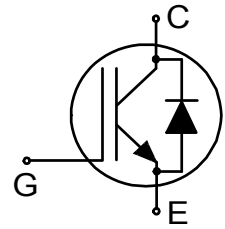
Low  $V_{CE(sat)}$  series fifth generation

## Low $V_{CE(sat)}$ IGBT in TRENCHSTOP™ 5 technology copacked with RAPID 1 fast and soft antiparallel diode

### Features and Benefits:

Low  $V_{CE(sat)}$  L5 technology offering

- Very low collector-emitter saturation voltage  $V_{CEsat}$
- Best-in-Class tradeoff between conduction and switching losses
- 650V breakdown voltage
- Low gate charge  $Q_G$
- Maximum junction temperature 175°C
- Qualified according to JEDEC for target applications
- Pb-free lead plating
- RoHS compliant
- Complete product spectrum and PSpice models:  
<http://www.infineon.com/igbt/>



### Applications:

- Uninterruptible power supplies
- Solar photovoltaic inverters
- Welding machines



### Key Performance and Package Parameters

Type	$V_{CE}$	$I_C$	$V_{CEsat}, T_{vj}=25^\circ\text{C}$	$T_{vjmax}$	Marking	Package
IKW75N65EL5	650V	75A	1.1V	175°C	K75EEL5	PG-TO247-3

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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, $T_{vj} \geq 25^{\circ}\text{C}$	$V_{CE}$	650	V
DC collector current, limited by $T_{vjmax}^{1)}$ $T_c = 25^{\circ}\text{C}$ $T_c = 100^{\circ}\text{C}$	$I_C$	80.0 80.0	A
Pulsed collector current, $t_p$ limited by $T_{vjmax}^{2)}$	$I_{Cpuls}$	300.0	A
Turn off safe operating area $V_{CE} \leq 650\text{V}$ , $T_{vj} \leq 175^{\circ}\text{C}$ , $t_p = 1\mu\text{s}^{2)}$	-	300.0	A
Diode forward current, limited by $T_{vjmax}$ $T_c = 25^{\circ}\text{C}$ value limited by bondwire $T_c = 100^{\circ}\text{C}$	$I_F$	90.0 89.0	A
Diode pulsed current, $t_p$ limited by $T_{vjmax}^{2)}$	$I_{Fpuls}$	300.0	A
Gate-emitter voltage Transient Gate-emitter voltage ( $t_p \leq 10\mu\text{s}$ , $D < 0.010$ )	$V_{GE}$	$\pm 20$ $\pm 30$	V
Power dissipation $T_c = 25^{\circ}\text{C}$ Power dissipation $T_c = 100^{\circ}\text{C}$	$P_{tot}$	536.0 268.0	W
Operating junction temperature	$T_{vj}$	-40...+175	$^{\circ}\text{C}$
Storage temperature	$T_{stg}$	-55...+150	$^{\circ}\text{C}$
Soldering temperature, <sup>3)</sup> wave soldering 1.6mm (0.063in.) from case for 10s		260	$^{\circ}\text{C}$
Mounting torque, M3 screw Maximum of mounting processes: 3	$M$	0.6	Nm

## Thermal Resistance

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
<b><math>R_{th}</math> Characteristics</b>						
IGBT thermal resistance, junction - case	$R_{th(j-c)}$		-	-	0.28	K/W
Diode thermal resistance, junction - case	$R_{th(j-c)}$		-	-	0.46	K/W
Thermal resistance junction - ambient	$R_{th(j-a)}$		-	-	40	K/W

<sup>1)</sup> Both values limited by bondwires.

<sup>2)</sup> Defined by design. Not subject to production test.

<sup>3)</sup> Package not recommended for surface mount applications.

Low  $V_{CE(sat)}$  series fifth generation**Electrical Characteristic, at  $T_{vj} = 25^{\circ}\text{C}$ , unless otherwise specified**

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
<b>Static Characteristic</b>						
Collector-emitter breakdown voltage	$V_{(BR)CES}$	$V_{GE} = 0\text{V}, I_C = 0.20\text{mA}$	650	-	-	V
Collector-emitter saturation voltage	$V_{CEsat}$	$V_{GE} = 15.0\text{V}, I_C = 75.0\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 100^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	-	1.10	1.35	V
			-	1.11	-	
			-	1.12	-	
Diode forward voltage	$V_F$	$V_{GE} = 0\text{V}, I_F = 75.0\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 100^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	-	1.40	1.70	V
			-	1.42	-	
			-	1.40	-	
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C = 1.00\text{mA}, V_{CE} = 20\text{V}$	4.2	5.0	5.8	V
Zero gate voltage collector current	$I_{CES}$	$V_{CE} = 650\text{V}, V_{GE} = 0\text{V}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	-	-	40	$\mu\text{A}$
			-	1000	-	
			-	5000	-	
Gate-emitter leakage current	$I_{GES}$	$V_{CE} = 0\text{V}, V_{GE} = 20\text{V}$	-	-	100	nA
Transconductance	$g_{fs}$	$V_{CE} = 20\text{V}, I_C = 75.0\text{A}$	-	155.0	-	S

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

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
<b>Dynamic Characteristic</b>						
Input capacitance	$C_{ies}$	$V_{CE} = 25\text{V}, V_{GE} = 0\text{V}$ $f = 1000\text{kHz}$	-	12100	-	pF
Output capacitance	$C_{oes}$		-	150	-	
Reverse transfer capacitance	$C_{res}$		-	42	-	
Gate charge	$Q_G$	$V_{CC} = 520\text{V}, I_C = 75.0\text{A},$ $V_{GE} = 15\text{V}$	-	436.0	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	$L_E$		-	13.0	-	nH

**Switching Characteristic, Inductive Load**

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
<b>IGBT Characteristic, at <math>T_{vj} = 25^{\circ}\text{C}</math></b>						
Turn-on delay time	$t_{d(on)}$	$T_{vj} = 25^{\circ}\text{C},$ $V_{CC} = 400\text{V}, I_C = 75.0\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(on)} = 4.0\Omega, R_{G(off)} = 4.0\Omega,$ $L\sigma = 40\text{nH}, C\sigma = 30\text{pF}$ $L\sigma, C\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	40	-	ns
Rise time	$t_r$		-	11	-	ns
Turn-off delay time	$t_{d(off)}$		-	275	-	ns
Fall time	$t_f$		-	50	-	ns
Turn-on energy	$E_{on}$		-	1.61	-	mJ
Turn-off energy	$E_{off}$		-	3.20	-	mJ
Total switching energy	$E_{ts}$		-	4.81	-	mJ

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

Diode reverse recovery time	$t_{rr}$	$T_{vj} = 25^{\circ}\text{C},$ $V_R = 400\text{V},$ $I_F = 75.0\text{A},$ $di_F/dt = 1500\text{A}/\mu\text{s}$	-	114	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	1.37	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$		-	29.0	-	A
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	-2170	-	$\text{A}/\mu\text{s}$

#### 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	$t_{d(on)}$	$T_{vj} = 150^{\circ}\text{C},$ $V_{CC} = 400\text{V}, I_C = 75.0\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(on)} = 4.0\Omega, R_{G(off)} = 4.0\Omega,$ $L\sigma = 40\text{nH}, C\sigma = 30\text{pF}$ $L\sigma, C\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	39	-	ns
Rise time	$t_r$		-	14	-	ns
Turn-off delay time	$t_{d(off)}$		-	330	-	ns
Fall time	$t_f$		-	144	-	ns
Turn-on energy	$E_{on}$		-	2.12	-	mJ
Turn-off energy	$E_{off}$		-	5.10	-	mJ
Total switching energy	$E_{ts}$		-	7.22	-	mJ

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

Diode reverse recovery time	$t_{rr}$	$T_{vj} = 150^{\circ}\text{C},$ $V_R = 400\text{V},$ $I_F = 75.0\text{A},$ $di_F/dt = 1500\text{A}/\mu\text{s}$	-	95	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	2.43	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$		-	40.0	-	A
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	-2900	-	$\text{A}/\mu\text{s}$

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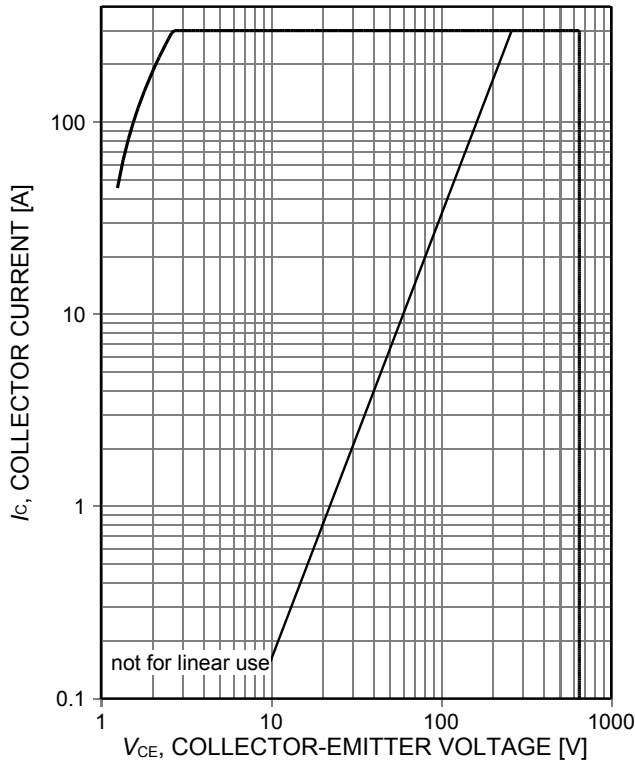


Figure 1. **Forward bias safe operating area**  
 ( $D=0$ ,  $T_C=25^\circ\text{C}$ ,  $T_{vj}\leq 175^\circ\text{C}$ ,  $V_{GE}=15\text{V}$ ,  $t_p=1\mu\text{s}$ ,  
 $I_{Cmax}$  defined by design - not subject to production test)

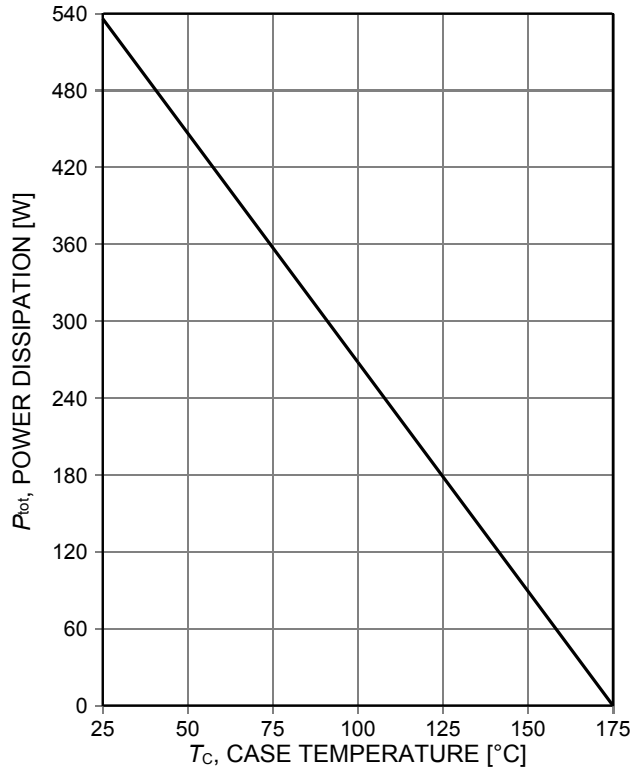


Figure 2. **Power dissipation as a function of case temperature**  
 ( $T_{vj}\leq 175^\circ\text{C}$ )

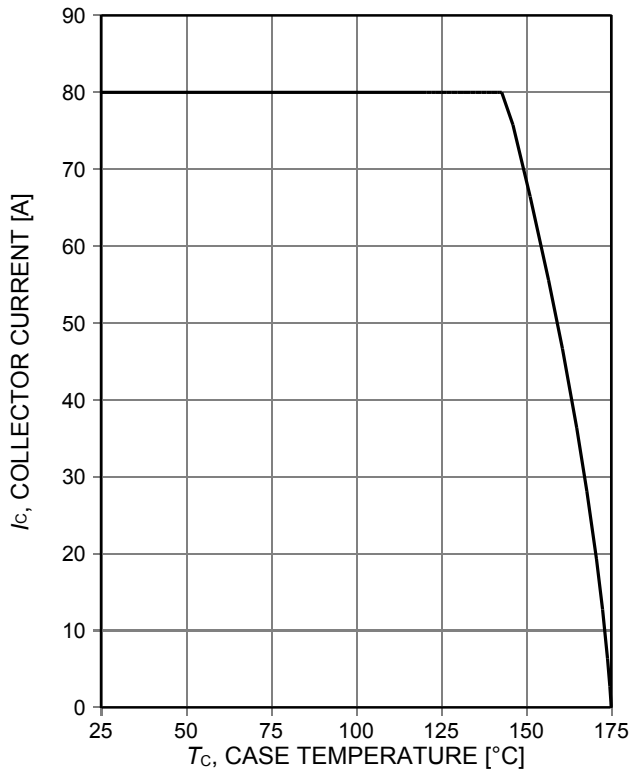


Figure 3. **Collector current as a function of case temperature**  
 ( $V_{GE}\geq 15\text{V}$ ,  $T_{vj}\leq 175^\circ\text{C}$ )

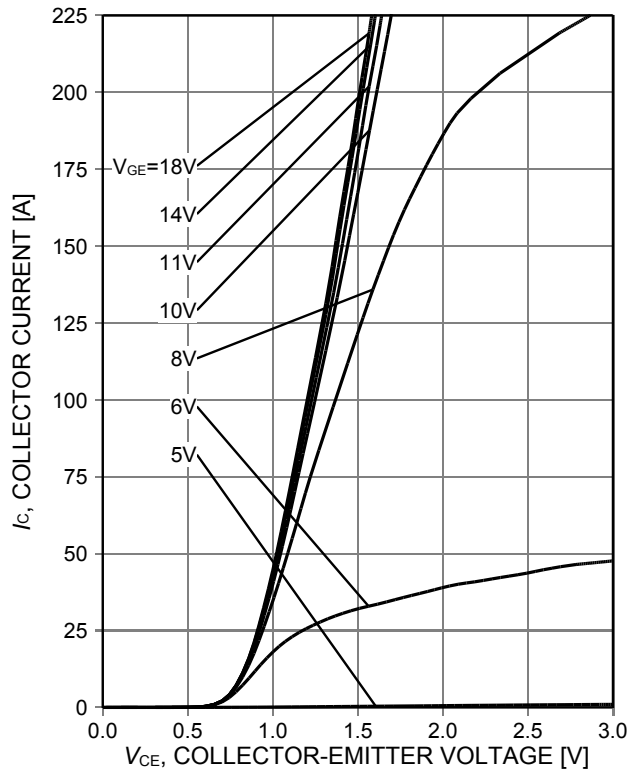


Figure 4. **Typical output characteristic**  
 ( $T_{vj}=25^\circ\text{C}$ )

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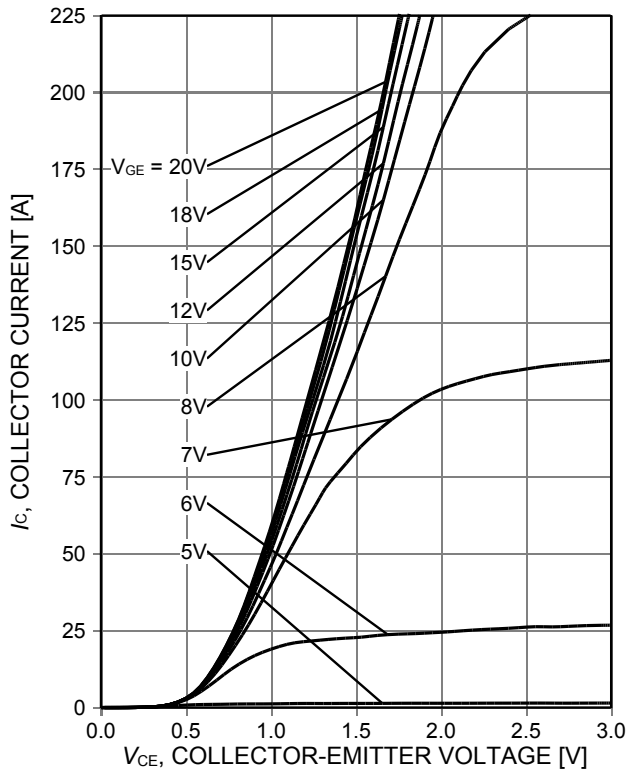


Figure 5. Typical output characteristic ( $T_{vj}=175^{\circ}\text{C}$ )

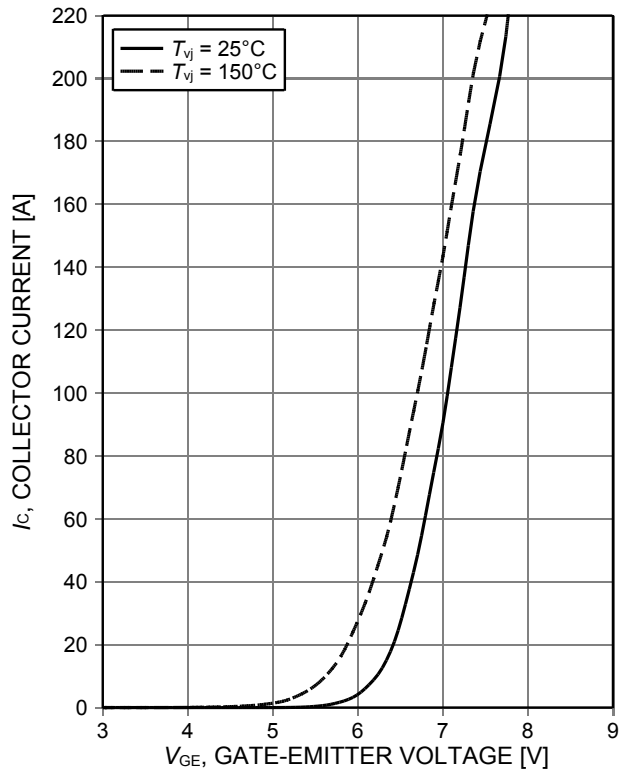


Figure 6. Typical transfer characteristic ( $V_{CE}=20\text{V}$ )

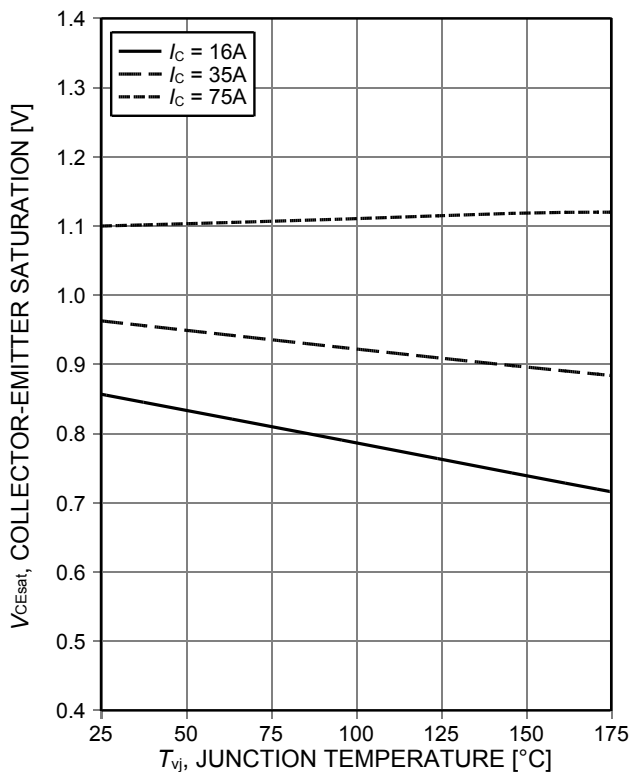


Figure 7. Typical collector-emitter saturation voltage as a function of junction temperature ( $V_{GE}=15\text{V}$ )

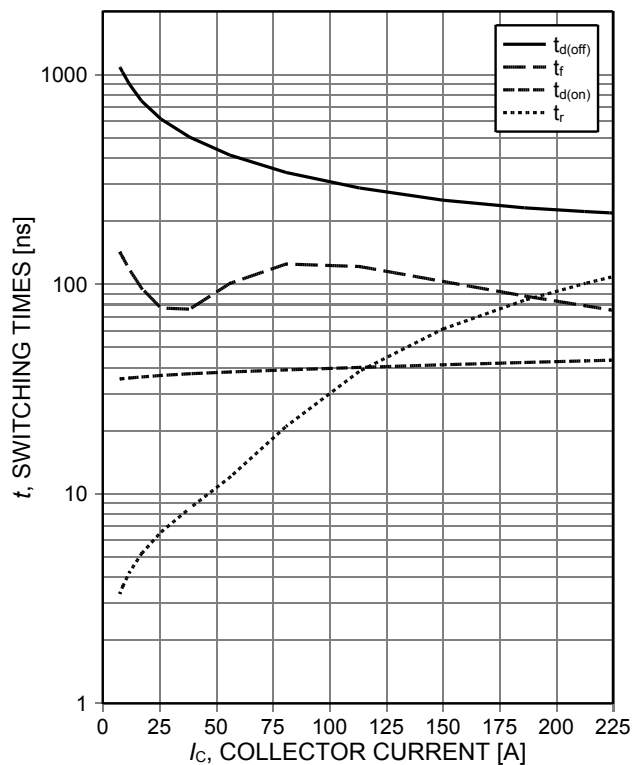


Figure 8. Typical switching times as a function of collector current (inductive load,  $T_{vj}=150^{\circ}\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $R_{G(on)}=4\Omega$ ,  $R_{G(off)}=4\Omega$ , dynamic test circuit in Figure E)



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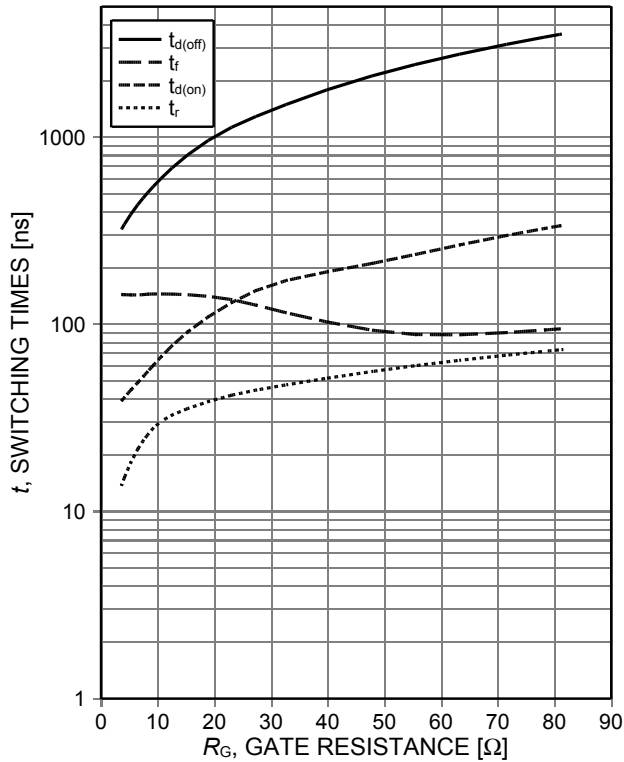


Figure 9. **Typical switching times as a function of gate resistance**  
 (inductive load,  $T_{vj}=150^{\circ}\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=75\text{A}$ , dynamic test circuit in Figure E)

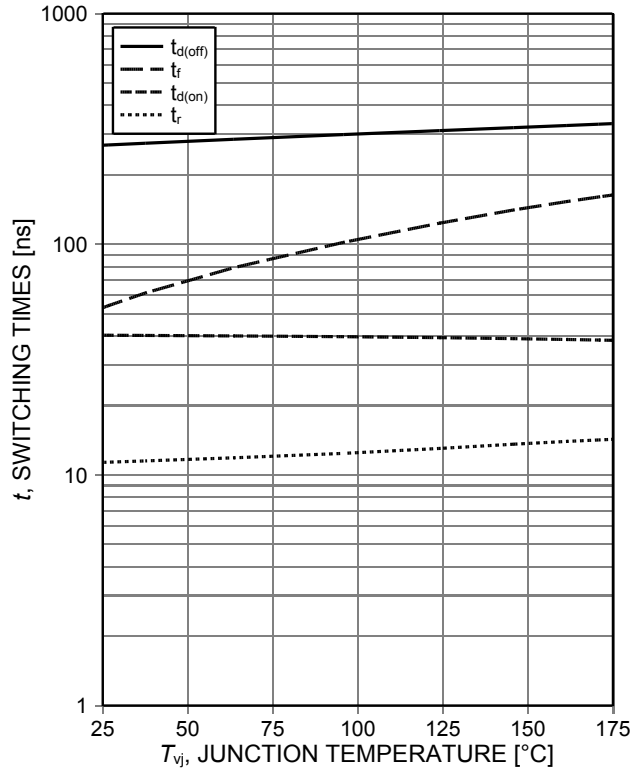


Figure 10. **Typical switching times as a function of junction temperature**  
 (inductive load,  $V_{CE}=400\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=75\text{A}$ ,  $R_{G(on)}=4\Omega$ ,  $R_{G(off)}=4\Omega$ , dynamic test circuit in Figure E)

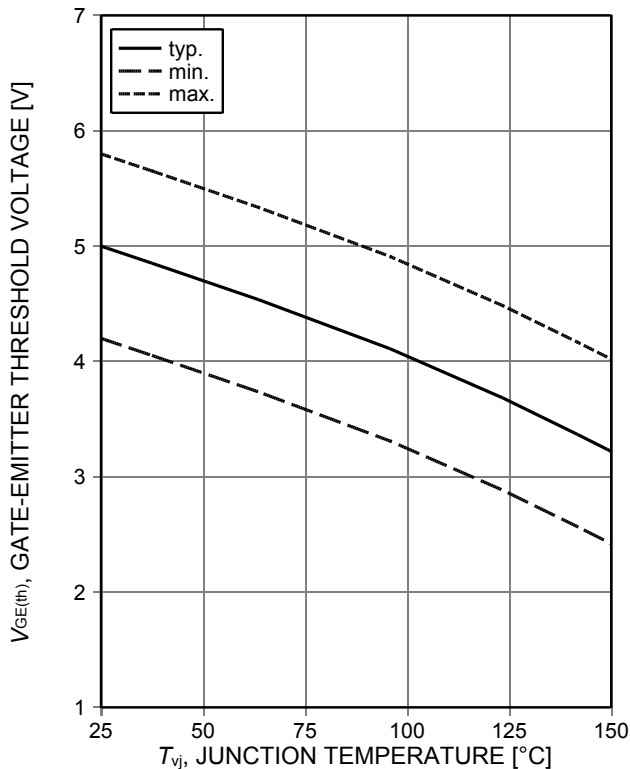


Figure 11. **Gate-emitter threshold voltage as a function of junction temperature**  
 ( $I_C=1\text{mA}$ )

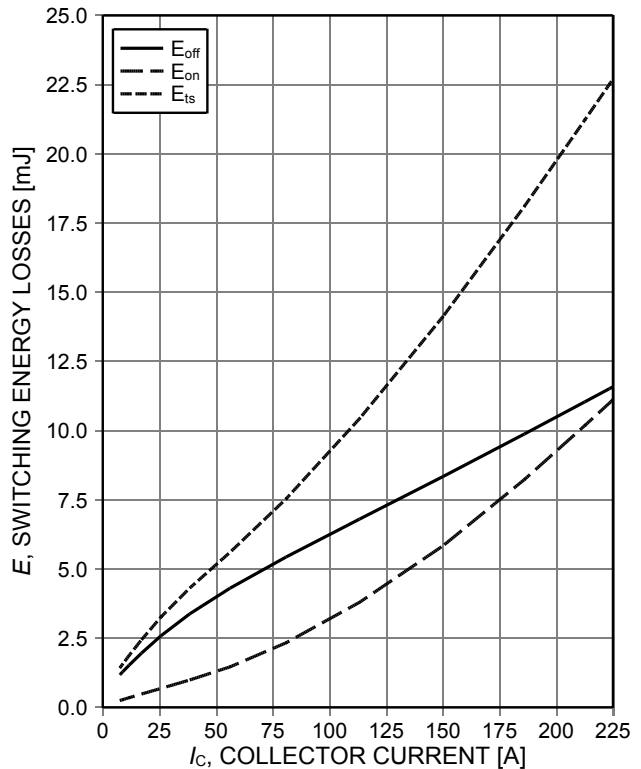


Figure 12. **Typical switching energy losses as a function of collector current**  
 (inductive load,  $T_{vj}=150^{\circ}\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $R_{G(on)}=4\Omega$ ,  $R_{G(off)}=4\Omega$ , dynamic test circuit in Figure E)

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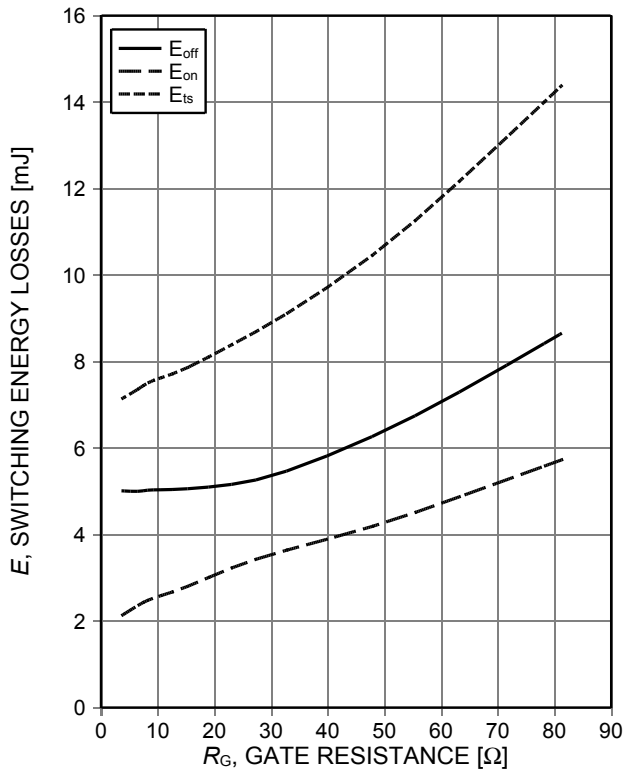


Figure 13. **Typical switching energy losses as a function of gate resistance**  
 (inductive load,  $T_{vj}=150^{\circ}\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=75\text{A}$ , dynamic test circuit in Figure E)

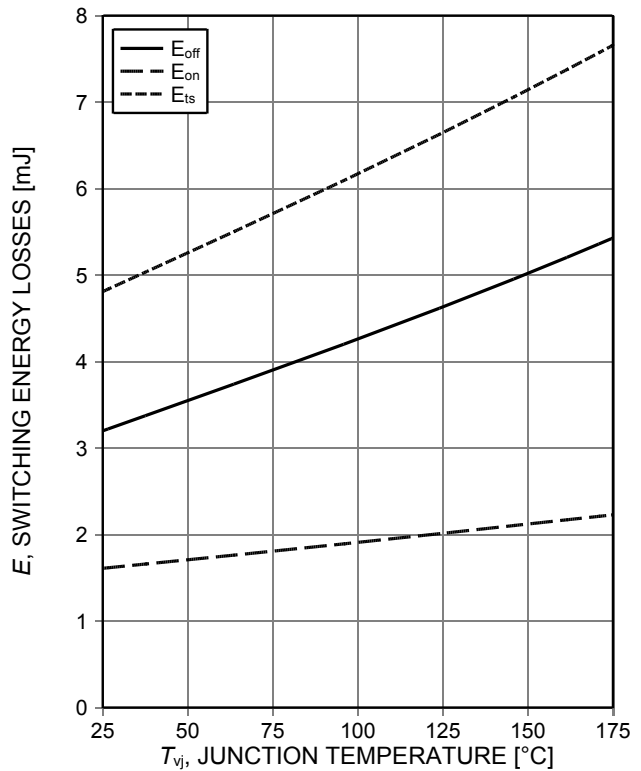


Figure 14. **Typical switching energy losses as a function of junction temperature**  
 (inductive load,  $V_{CE}=400\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=75\text{A}$ ,  $R_{G(on)}=4\Omega$ ,  $R_{G(off)}=4\Omega$ , dynamic test circuit in Figure E)

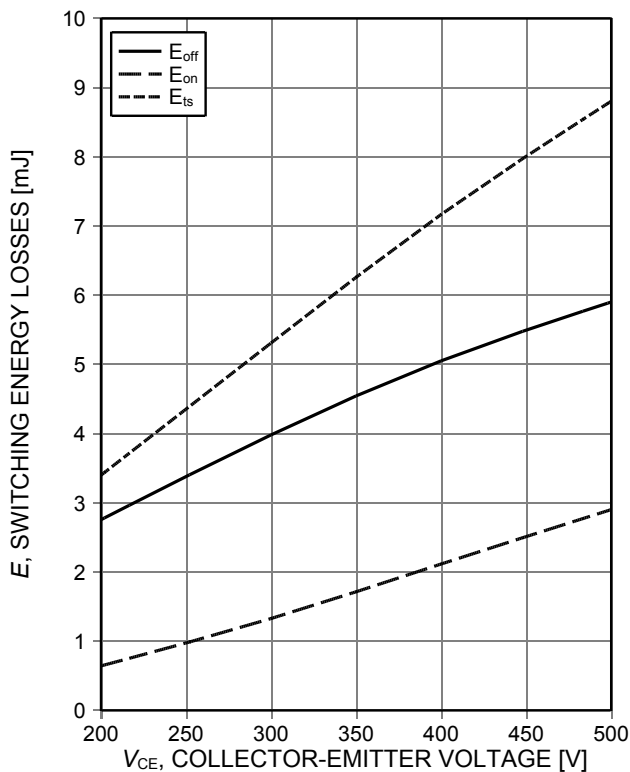


Figure 15. **Typical switching energy losses as a function of collector emitter voltage**  
 (inductive load,  $T_{vj}=150^{\circ}\text{C}$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=75\text{A}$ ,  $R_{G(on)}=4\Omega$ ,  $R_{G(off)}=4\Omega$ , dynamic test circuit in Figure E)

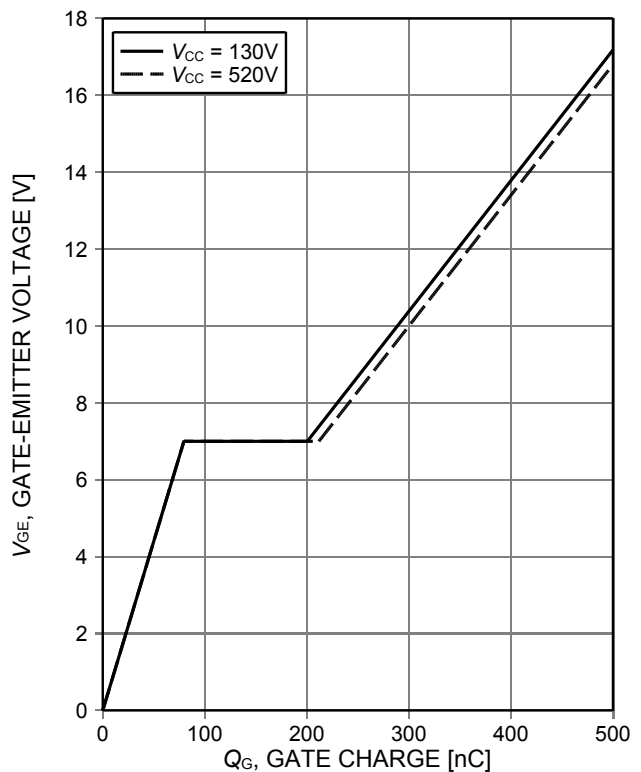


Figure 16. **Typical gate charge**  
 ( $I_C=75\text{A}$ )

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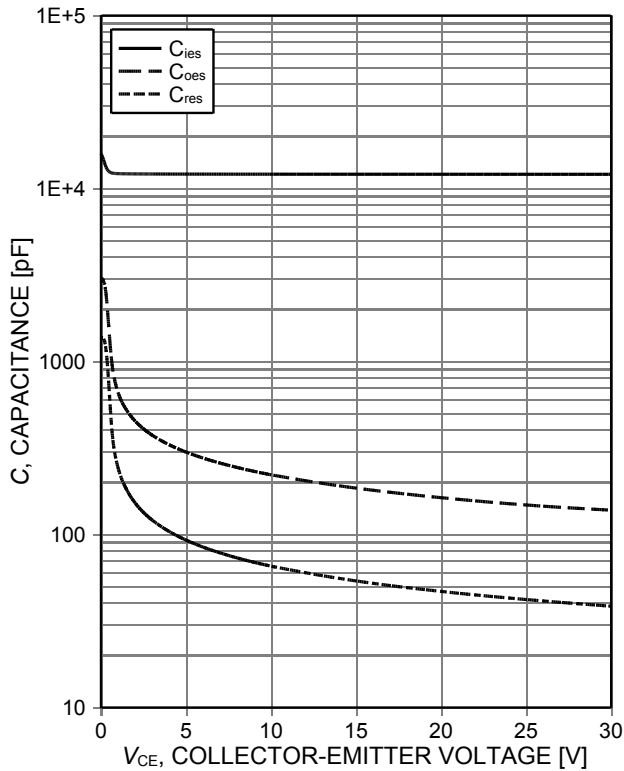


Figure 17. Typical capacitance as a function of collector-emitter voltage ( $V_{GE}=0V$ ,  $f=1MHz$ )

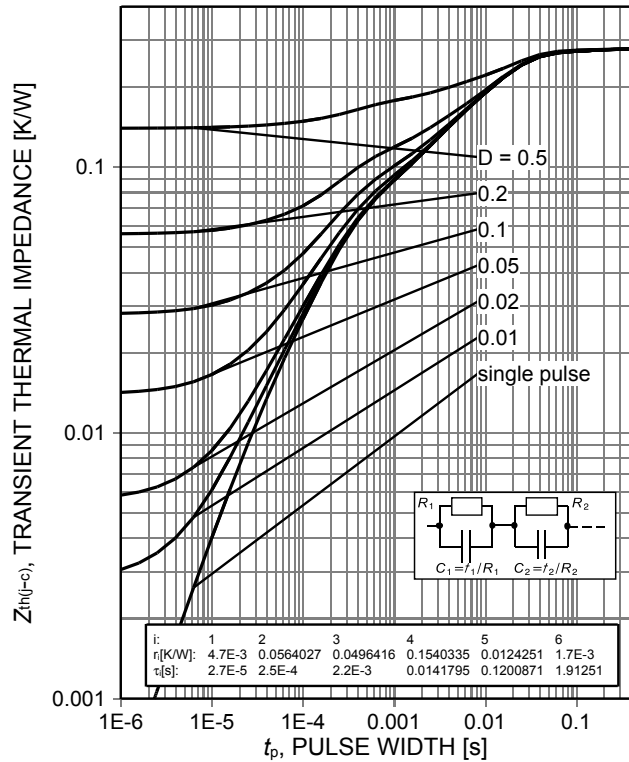


Figure 18. IGBT transient thermal impedance ( $D=t_p/T$ )

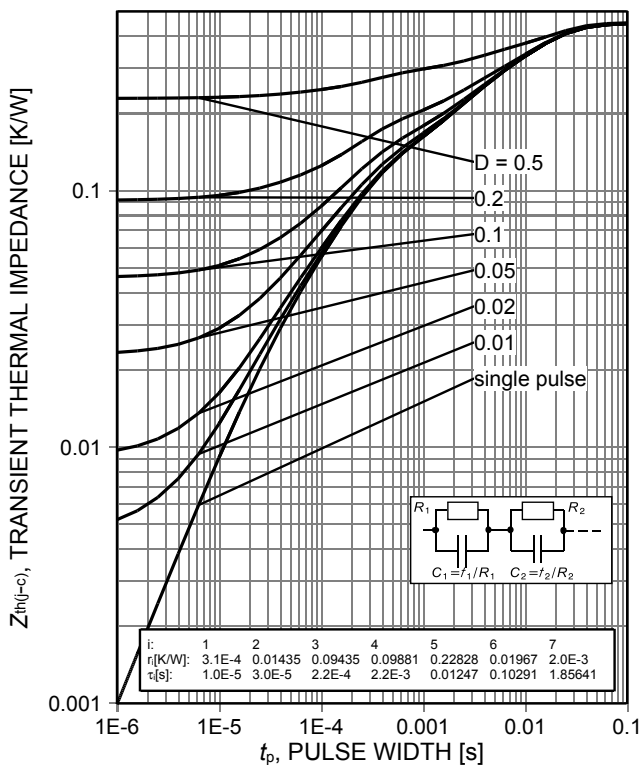


Figure 19. Diode transient thermal impedance as a function of pulse width ( $D=t_p/T$ )

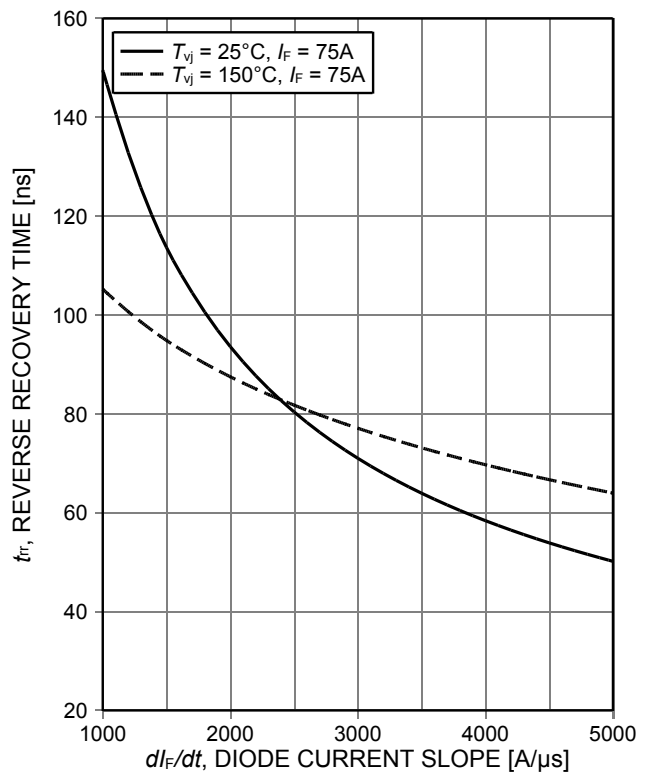


Figure 20. Typical reverse recovery time as a function of diode current slope ( $V_R=400V$ )

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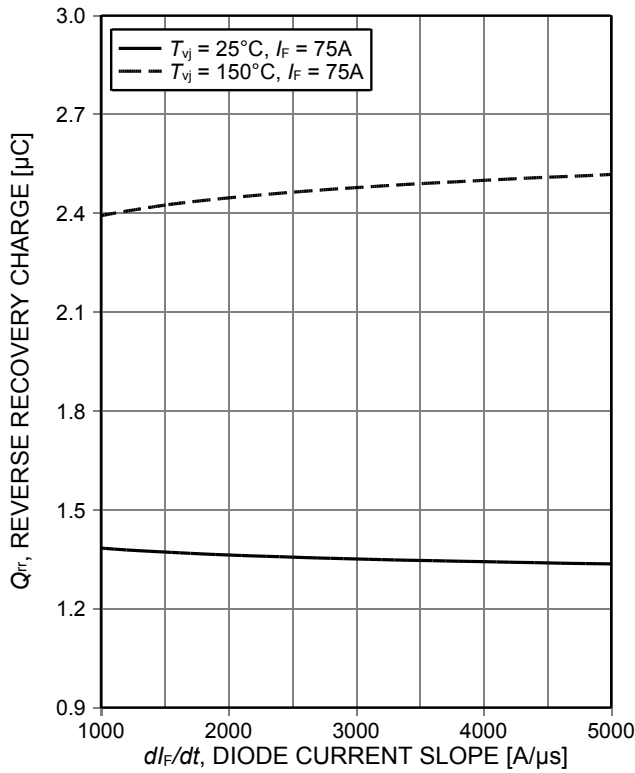


Figure 21. Typical reverse recovery charge as a function of diode current slope ( $V_R=400V$ )

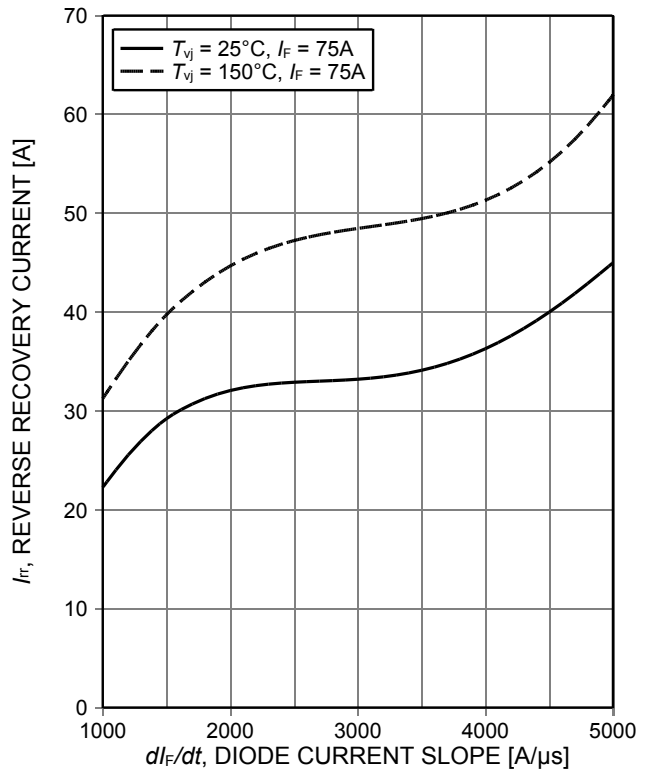


Figure 22. Typical reverse recovery current as a function of diode current slope ( $V_R=400V$ )

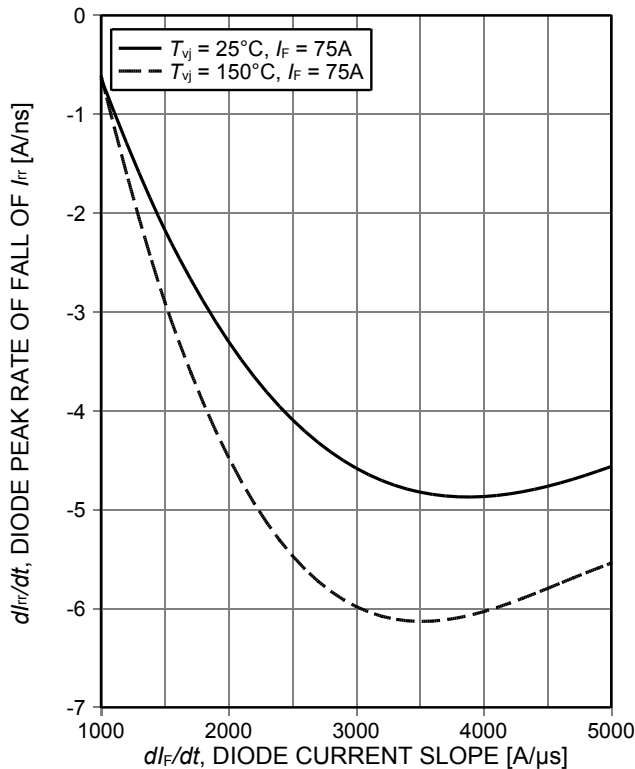


Figure 23. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope ( $V_R=400V$ )

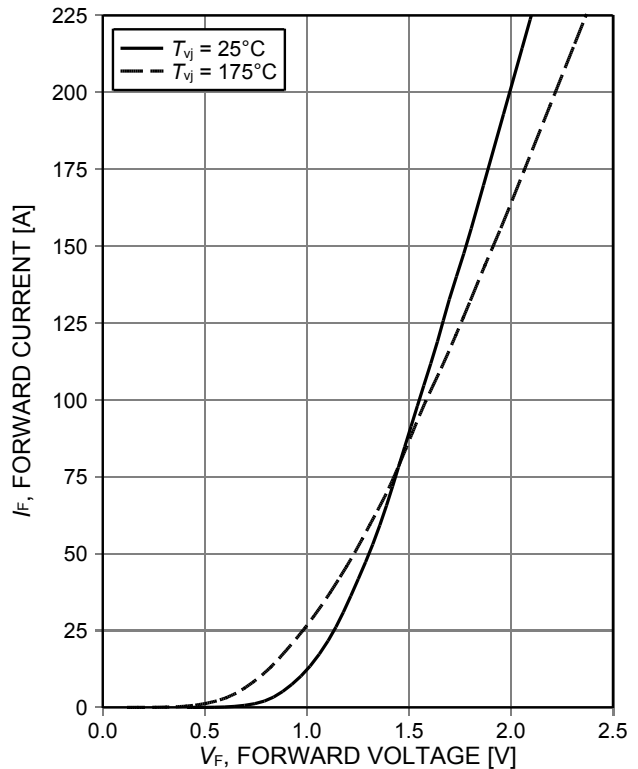


Figure 24. Typical diode forward current as a function of forward voltage

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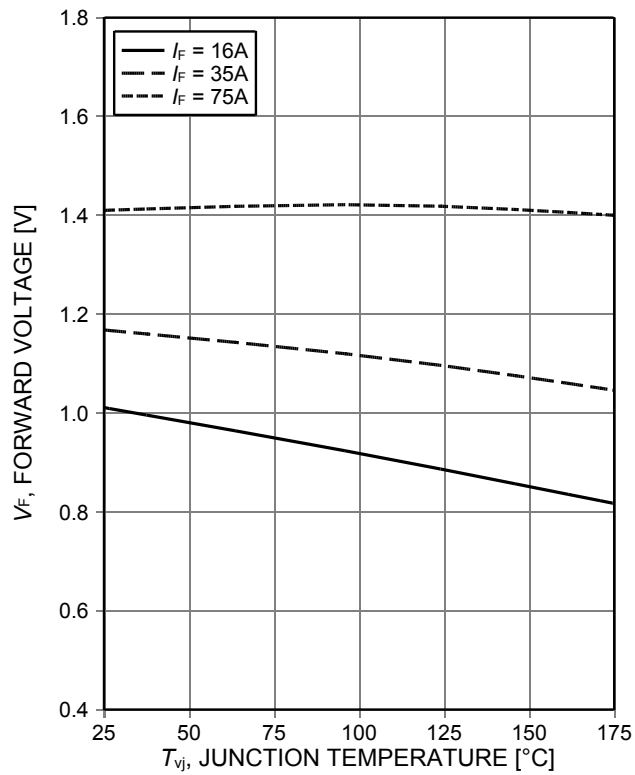
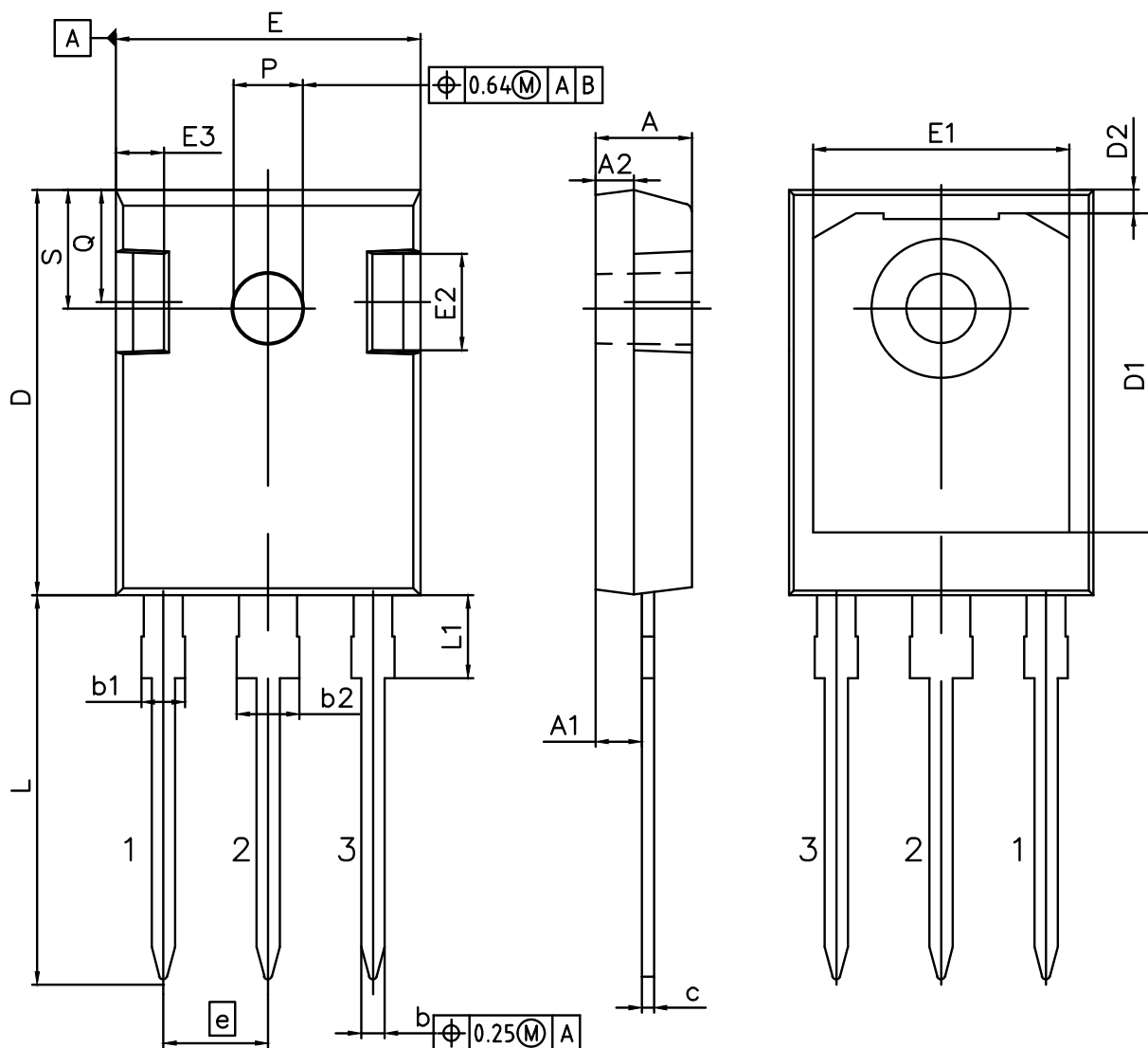


Figure 25. Typical diode forward voltage as a function of junction temperature

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### Package Drawing PG-TO247-3



DIMENSIONS	MILLIMETERS	
	MIN.	MAX.
A	4.70	5.30
A1	2.20	2.60
A2	1.50	2.50
b	1.00	1.40
b1	1.60	2.41
b2	2.57	3.43
c	0.38	0.89
D	20.70	21.50
D1	13.08	17.65
D2	0.51	1.35
E	15.50	16.30
E1	12.38	14.15
E2	3.40	5.10
E3	1.00	2.60
e	5.44	
L	19.80	20.40
L1	3.85	4.50
P	3.50	3.70
Q	5.35	6.25
S	6.04	6.30

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Testing Conditions

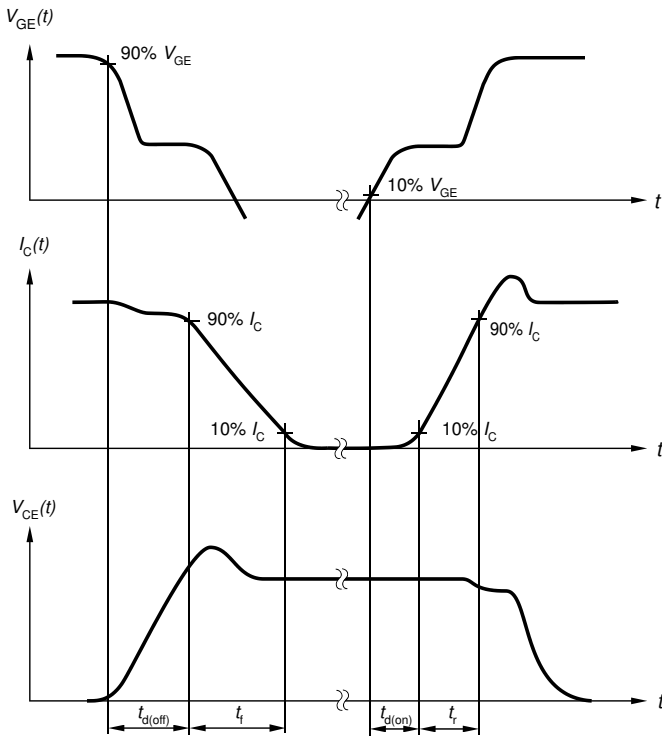


Figure A. Definition of switching times

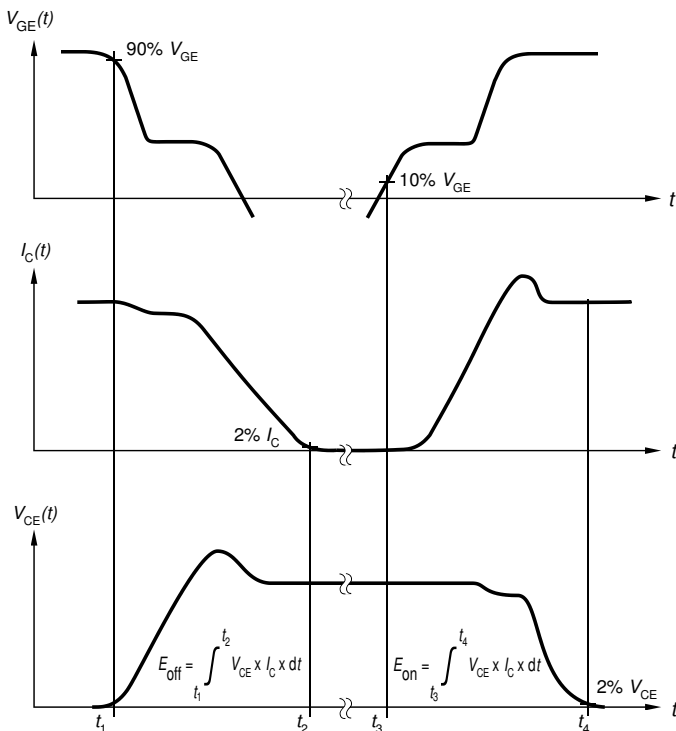


Figure B. Definition of switching losses

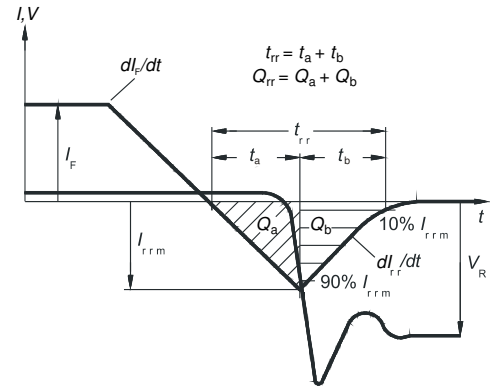


Figure C. Definition of diode switching characteristics

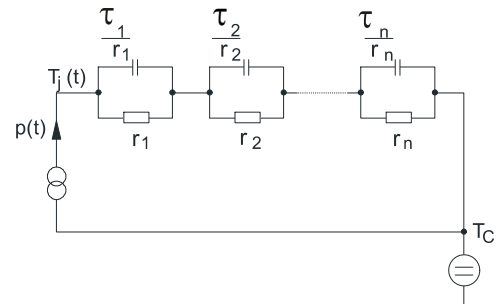


Figure D. Thermal equivalent circuit

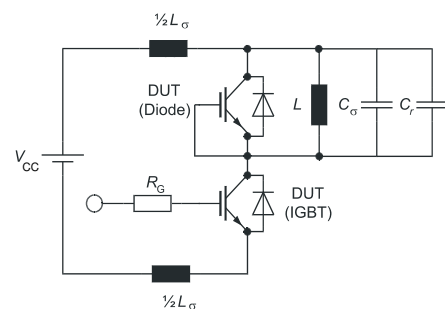


Figure E. **Dynamic test circuit**  
Parasitic inductance  $L_{\sigma}$ ,  
parasitic capacitor  $C_{\sigma}$ ,  
relief capacitor  $C_r$ ,  
(only for ZVT switching)

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Low  $V_{CE(sat)}$  series fifth generation

### Revision History

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IKW75N65EL5

**Revision: 2020-10-07, Rev. 2.2**

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Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.1	2014-12-10	Final data sheet
2.2	2020-10-07	VGE(th): test condition update



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