

TRENCHSTOP™ 2 low $V_{CE(sat)}$ second generation IGBT

Low $V_{CE(sat)}$ IGBT in TRENCHSTOP™ 2 technology copacked with soft, fast recovery full current rated anti-parallel Emitter Controlled Diode

Features:

TRENCHSTOP™ 2 technology offers:

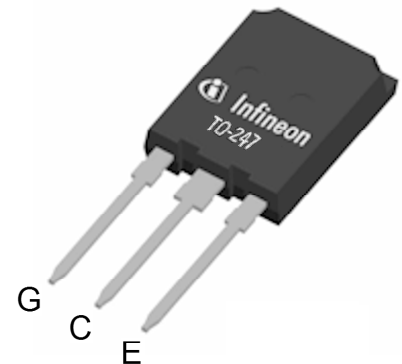
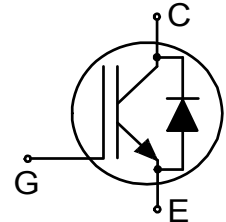
- Very low $V_{CE(sat)}$, 1.75V at nominal current
- 10µsec short circuit withstand time at $T_{vj}=175^{\circ}\text{C}$
- Easy paralleling capability due to positive temperature coefficient in $V_{CE(sat)}$
- Low EMI
- Very soft, fast recovery full current anti-parallel diode
- Maximum junction temperature 175°C
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models:
<http://www.infineon.com/igbt>

Applications:

- GPD (General Purpose Drives)
- Servo Drives
- Commercial Vehicles
- Agricultural Vehicles
- Three-level Solar String Inverter
- Welding

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
IKQ40N120CT2	1200V	40A	1.75V	175°C	K40MCT2	PG-TO247-3-46



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TRENCHSTOP™ 2 low $V_{ce(sat)}$ second generation IGBT

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}	1200	V
DC collector current, limited by T_{vjmax} $T_c = 25^{\circ}\text{C}$ value limited by bondwire $T_c = 135^{\circ}\text{C}$	I_C	80.0 40.0	A
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpuls}	160.0	A
Turn off safe operating area $V_{CE} \leq 1200\text{V}$, $T_{vj} \leq 175^{\circ}\text{C}$, $t_p = 1\mu\text{s}$	-	160.0	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	80.0 40.0	A
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpuls}	160.0	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 $V_{GE} = 15.0\text{V}$, $V_{CC} \leq 600\text{V}$ Allowed number of short circuits < 1000 Time between short circuits: $\geq 1.0\text{s}$ $T_{vj} = 175^{\circ}\text{C}$	t_{SC}	10	μs
Power dissipation $T_c = 25^{\circ}\text{C}$ Power dissipation $T_c = 135^{\circ}\text{C}$	P_{tot}	500.0 133.0	W
Operating junction temperature	T_{vj}	$-40 \dots +175$	$^{\circ}\text{C}$
Storage temperature	T_{stg}	$-55 \dots +150$	$^{\circ}\text{C}$
Soldering temperature, wave soldering 1.6mm (0.063in.) from case for 10s		260	$^{\circ}\text{C}$

Thermal Resistance

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	

 R_{th} Characteristics

IGBT thermal resistance, junction - case	$R_{th(j-c)}$		-	-	0.30	K/W
Diode thermal resistance, junction - case	$R_{th(j-c)}$		-	-	0.50	K/W
Thermal resistance junction - ambient	$R_{th(j-a)}$		-	-	40	K/W

TRENCHSTOP™ 2 low $V_{ce(sat)}$ second generation IGBTElectrical 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	$V_{(BR)CES}$	$V_{GE} = 0V, I_C = 0.50mA$	1200	-	-	V
Collector-emitter saturation voltage	V_{CEsat}	$V_{GE} = 15.0V, I_C = 40.0A$ $T_{vj} = 25^{\circ}C$ $T_{vj} = 175^{\circ}C$	- -	1.75 2.30	2.15 -	V
Diode forward voltage	V_F	$V_{GE} = 0V, I_F = 40.0A$ $T_{vj} = 25^{\circ}C$ $T_{vj} = 175^{\circ}C$	- -	1.90 1.85	2.30 -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C = 1.50mA, V_{CE} = V_{GE}$	5.1	5.8	6.5	V
Zero gate voltage collector current	I_{CES}	$V_{CE} = 1200V, V_{GE} = 0V$ $T_{vj} = 25^{\circ}C$ $T_{vj} = 175^{\circ}C$	- -	- 3000	250 -	μA
Gate-emitter leakage current	I_{GES}	$V_{CE} = 0V, V_{GE} = 20V$	-	-	100	nA
Transconductance	g_{fs}	$V_{CE} = 20V, I_C = 40.0A$	-	15.0	-	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 = 1MHz	-	2385	-	pF
Output capacitance	C _{oes}		-	235	-	
Reverse transfer capacitance	C _{res}		-	132	-	
Gate charge	Q _G	V _{CC} = 960V, I _C = 40.0A, V _{GE} = 15V	-	190.0	-	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.	
IGBT Characteristic, at $T_{vj} = 25^{\circ}\text{C}$						
Turn-on delay time	$t_{d(\text{on})}$	$T_{vj} = 25^{\circ}\text{C},$ $V_{CC} = 600\text{V}, I_C = 40.0\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(\text{on})} = 12.0\Omega, R_{G(\text{off})} = 12.0\Omega,$ $L\sigma = 90\text{nH}, C\sigma = 67\text{pF}$ $L\sigma, C\sigma$ from Fig. E Energy losses include “tail” and diode reverse recovery.	-	32	-	ns
Rise time	t_r		-	43	-	ns
Turn-off delay time	$t_{d(\text{off})}$		-	328	-	ns
Fall time	t_f		-	51	-	ns
Turn-on energy	E_{on}		-	3.10	-	mJ
Turn-off energy	E_{off}		-	2.90	-	mJ
Total switching energy	E_{ts}		-	6.00	-	mJ

TRENCHSTOP™ 2 low $V_{ce(sat)}$ second generation IGBTDiode Characteristic, at $T_{vj} = 25^{\circ}\text{C}$

Diode reverse recovery time	t_{rr}	$T_{vj} = 25^{\circ}\text{C},$ $V_R = 600\text{V},$ $I_F = 40.0\text{A},$ $di_F/dt = 1000\text{A}/\mu\text{s}$	-	298	-	ns
Diode reverse recovery charge	Q_{rr}		-	3.10	-	μC
Diode peak reverse recovery current	I_{rrm}		-	18.0	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-120	-	$\text{A}/\mu\text{s}$

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	$t_{d(on)}$	$T_{vj} = 175^{\circ}\text{C},$ $V_{CC} = 600\text{V}, I_C = 40.0\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(on)} = 12.0\Omega, R_{G(off)} = 12.0\Omega,$ $L\sigma = 90\text{nH}, C\sigma = 67\text{pF}$ Energy losses include "tail" and diode reverse recovery.	-	30	-	ns
Rise time	t_r		-	44	-	ns
Turn-off delay time	$t_{d(off)}$		-	420	-	ns
Fall time	t_f		-	110	-	ns
Turn-on energy	E_{on}		-	5.10	-	mJ
Turn-off energy	E_{off}		-	4.70	-	mJ
Total switching energy	E_{ts}		-	9.80	-	mJ

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

Diode reverse recovery time	t_{rr}	$T_{vj} = 175^{\circ}\text{C},$ $V_R = 600\text{V},$ $I_F = 40.0\text{A},$ $di_F/dt = 1000\text{A}/\mu\text{s}$	-	488	-	ns
Diode reverse recovery charge	Q_{rr}		-	7.40	-	μC
Diode peak reverse recovery current	I_{rrm}		-	27.0	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-103	-	$\text{A}/\mu\text{s}$

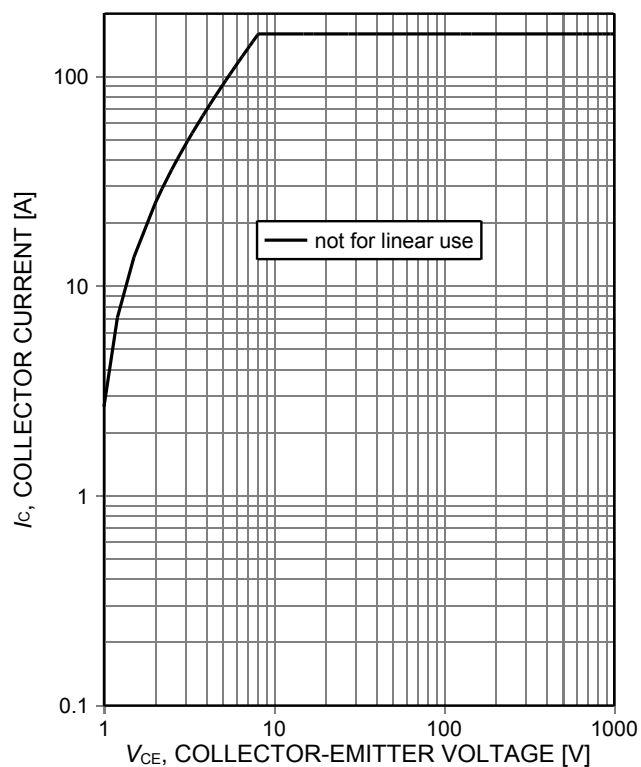
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Figure 1. **Forward bias safe operating area**
($D=0$, $T_C=25^\circ\text{C}$, $T_{vj}\leq 175^\circ\text{C}$; $V_{GE}=15\text{V}$)

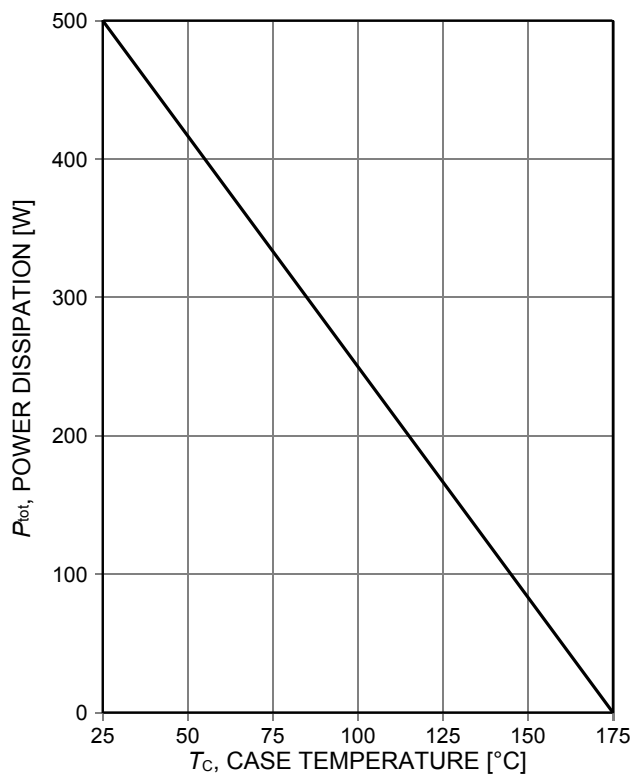


Figure 2. **Power dissipation as a function of case temperature**
($T_{vj}\leq 175^\circ\text{C}$)

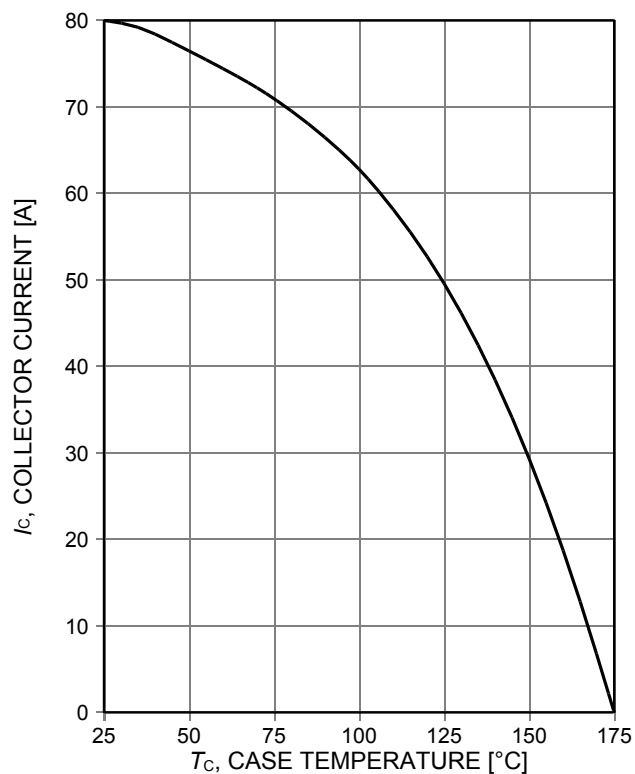


Figure 3. **Collector current as a function of case temperature**
($V_{GE}\geq 15\text{V}$, $T_{vj}\leq 175^\circ\text{C}$)

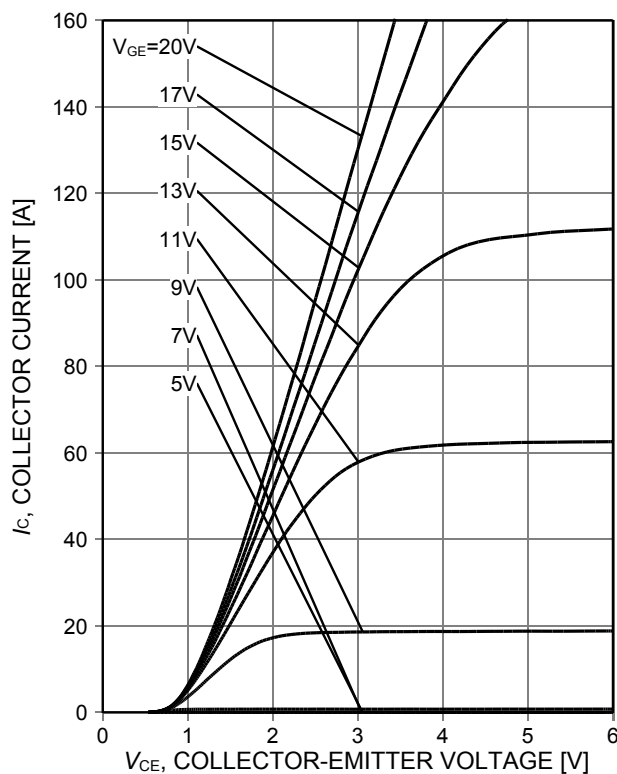


Figure 4. **Typical output characteristic**
($T_{vj}=25^\circ\text{C}$)

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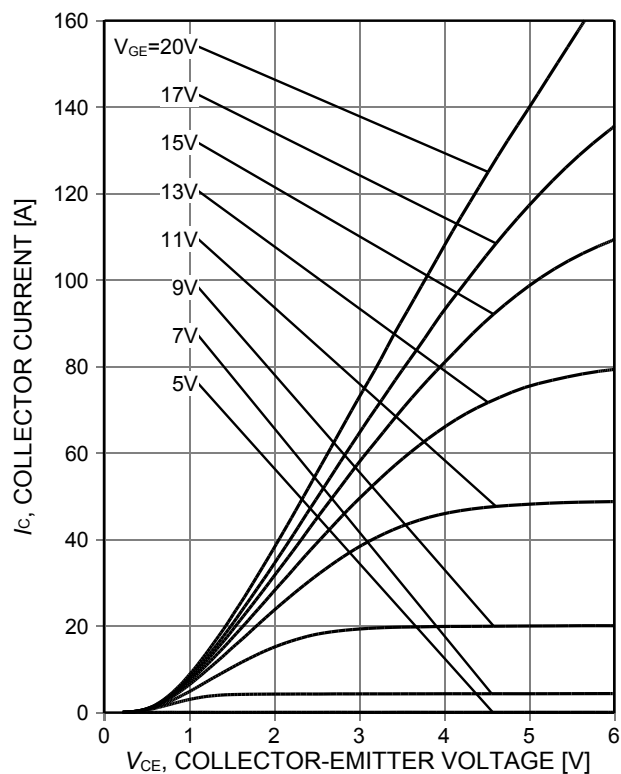


Figure 5. **Typical output characteristic**
($T_{vj}=175^{\circ}\text{C}$)

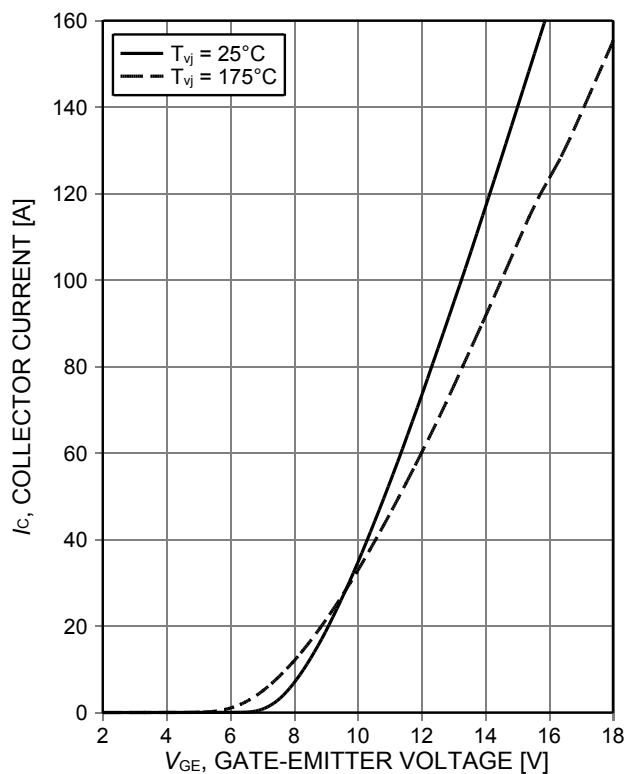


Figure 6. **Typical transfer characteristic**
($V_{CE}=20\text{V}$)

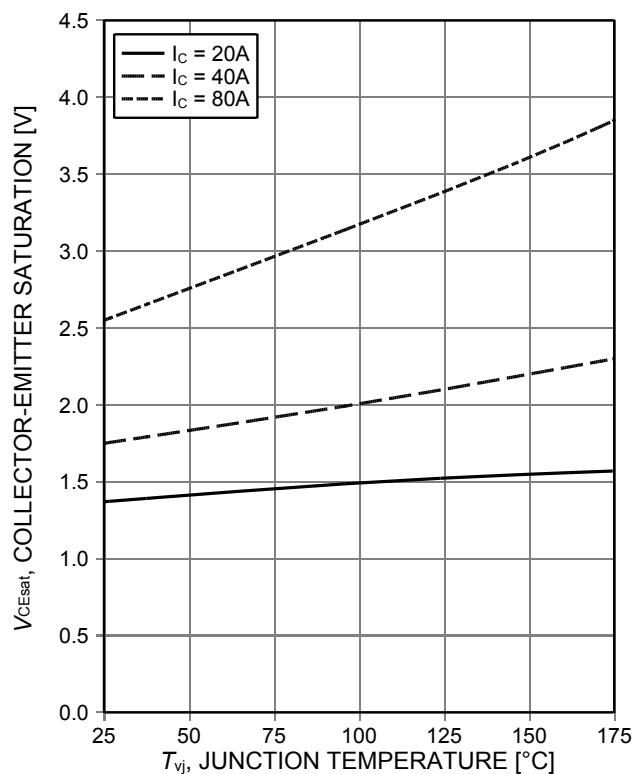


Figure 7. **Typical collector-emitter saturation voltage as a function of junction temperature**
($V_{GE}=15\text{V}$)

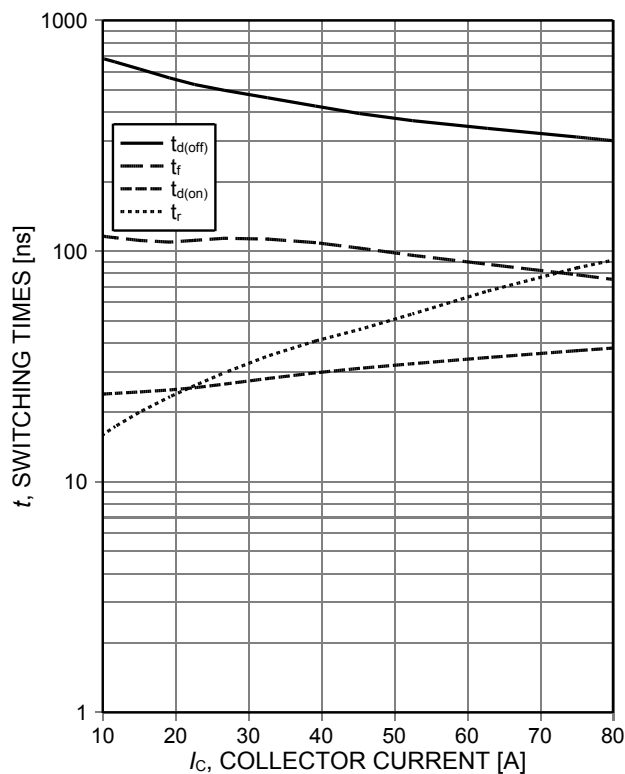


Figure 8. **Typical switching times as a function of collector current**
(inductive load, $T_{vj}=175^{\circ}\text{C}$, $V_{CE}=600\text{V}$, $V_{GE}=15/0\text{V}$, $r_G=12\Omega$, Dynamic test circuit in Figure E)

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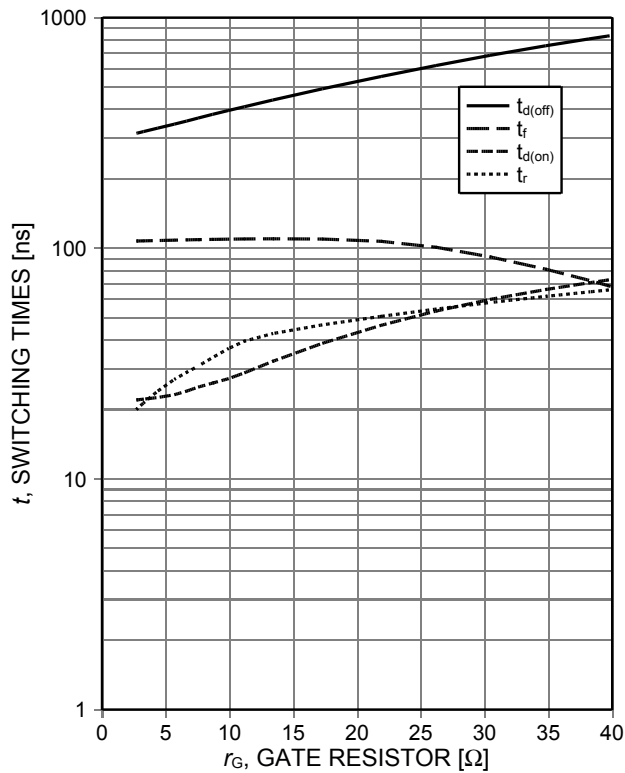


Figure 9. **Typical switching times as a function of gate resistor**
(inductive load, $T_{vj}=175^\circ\text{C}$, $V_{CE}=600\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=40\text{A}$, Dynamic test circuit in Figure E)

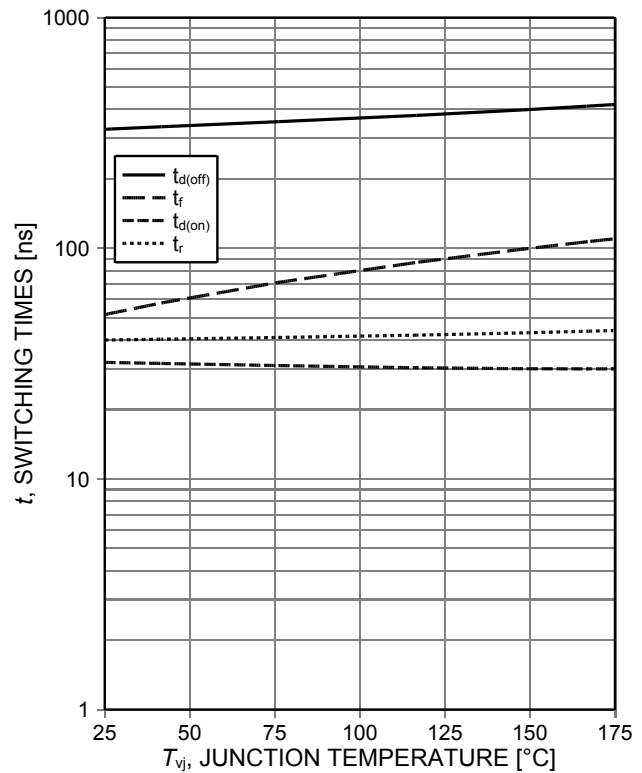


Figure 10. **Typical switching times as a function of junction temperature**
(inductive load, $V_{CE}=600\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=40\text{A}$, $r_G=12\Omega$, Dynamic test circuit in Figure E)

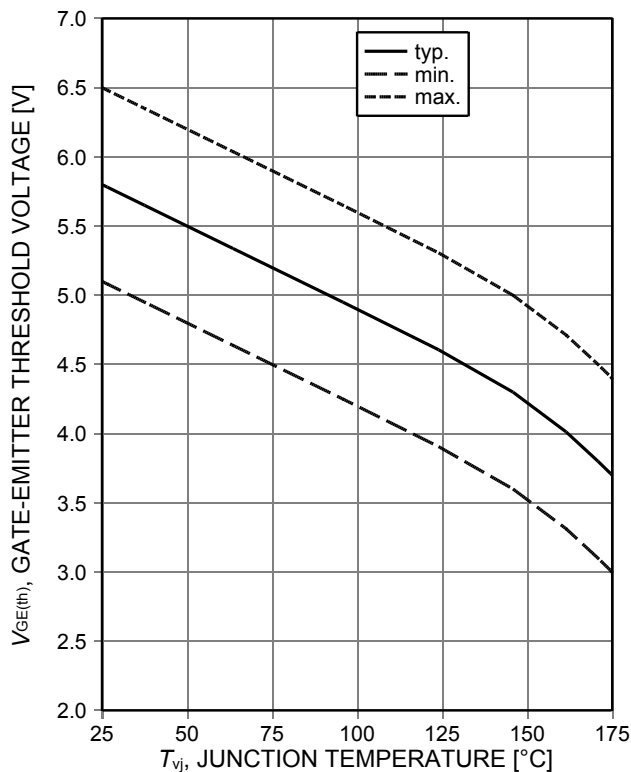


Figure 11. **Gate-emitter threshold voltage as a function of junction temperature**
($I_C=1.5\text{mA}$)

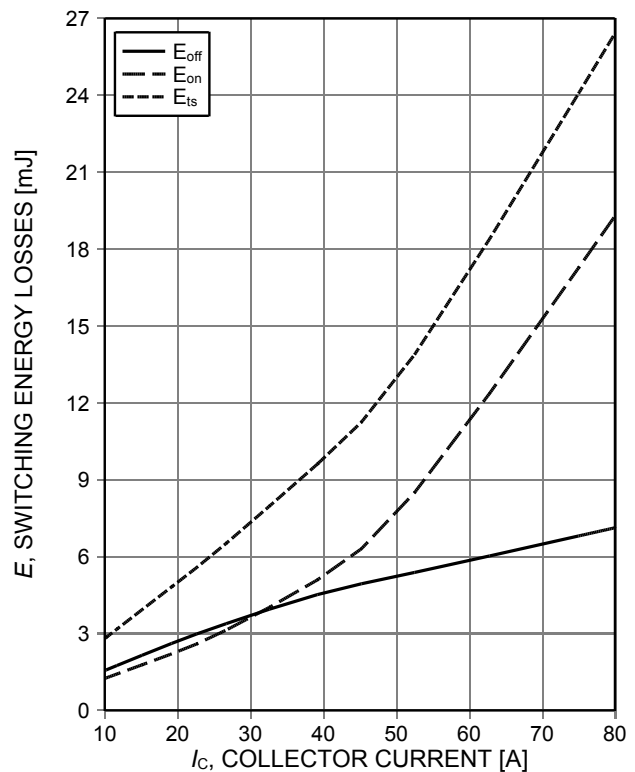


Figure 12. **Typical switching energy losses as a function of collector current**
(inductive load, $T_{vj}=175^\circ\text{C}$, $V_{CE}=600\text{V}$, $V_{GE}=15/0\text{V}$, $r_G=12\Omega$, Dynamic test circuit in Figure E)

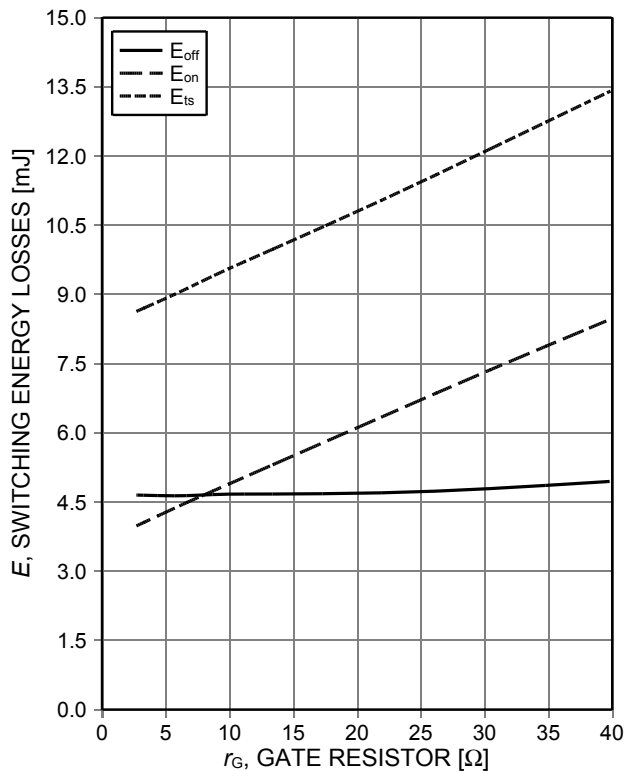
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Figure 13. **Typical switching energy losses as a function of gate resistor**
(inductive load, $T_{vj}=175^\circ\text{C}$, $V_{CE}=600\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=40\text{A}$, Dynamic test circuit in Figure E)

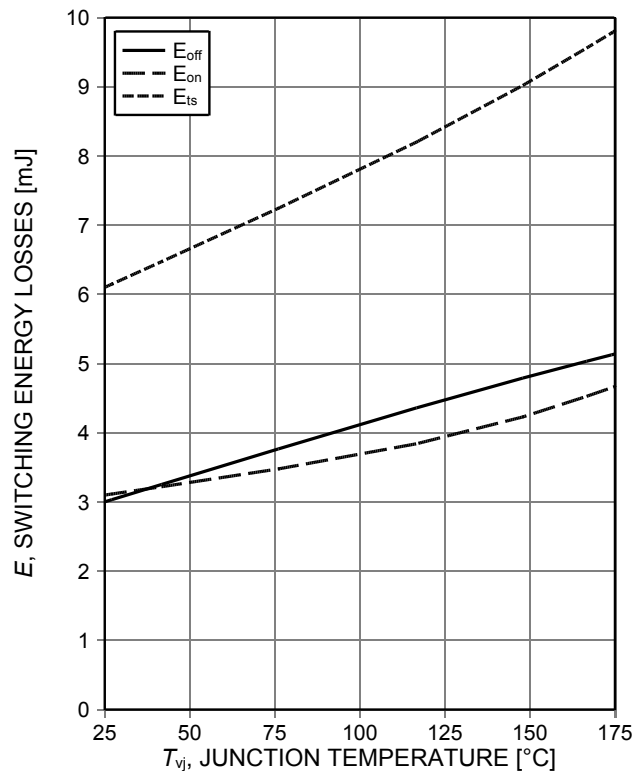


Figure 14. **Typical switching energy losses as a function of junction temperature**
(inductive load, $V_{CE}=600\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=40\text{A}$, $r_G=12\Omega$, Dynamic test circuit in Figure E)

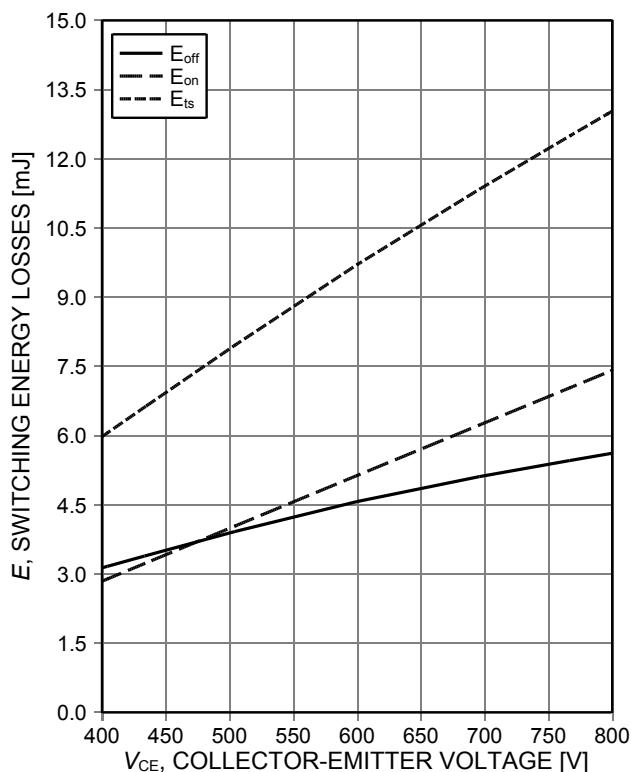


Figure 15. **Typical switching energy losses as a function of collector emitter voltage**
(inductive load, $T_{vj}=175^\circ\text{C}$, $V_{GE}=15/0\text{V}$, $I_C=40\text{A}$, $r_G=12\Omega$, Dynamic test circuit in Figure E)

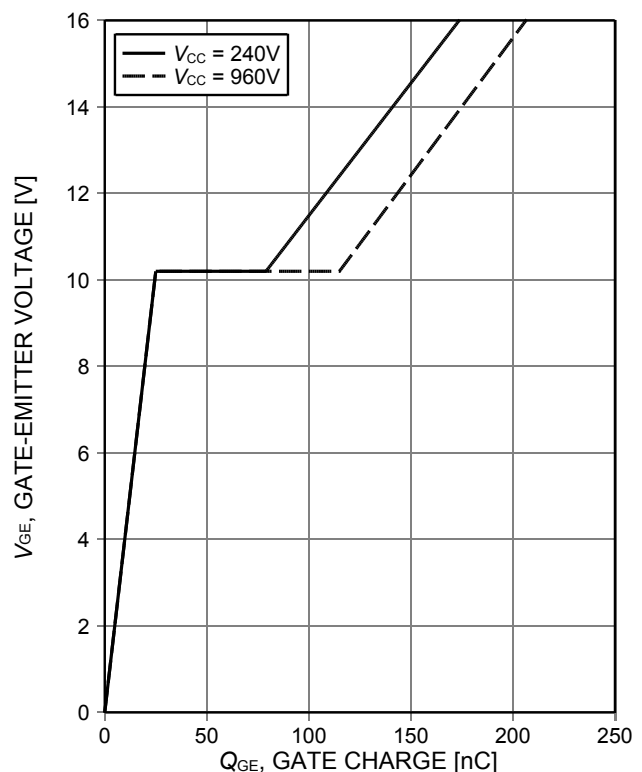


Figure 16. **Typical gate charge**
($I_C=40\text{A}$)

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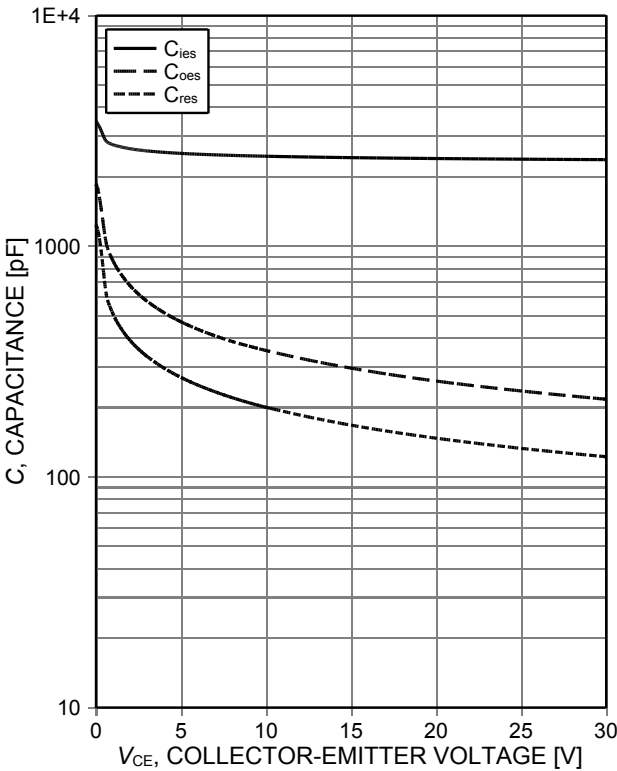


Figure 17. Typical capacitance as a function of collector-emitter voltage ($V_{GE}=0V$, $f=1MHz$)

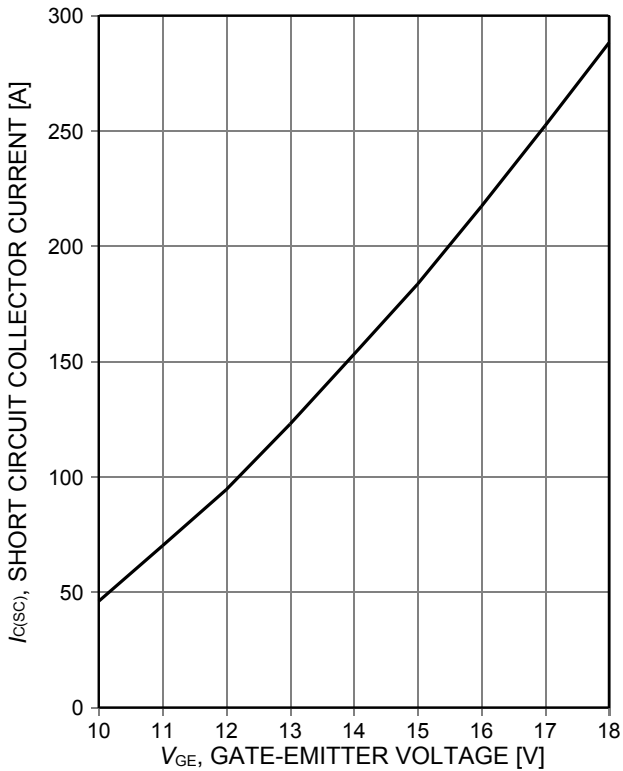


Figure 18. Typical short circuit collector current as a function of gate-emitter voltage ($V_{CE}\leq 600V$, $T_{vj}\leq 175^{\circ}C$)

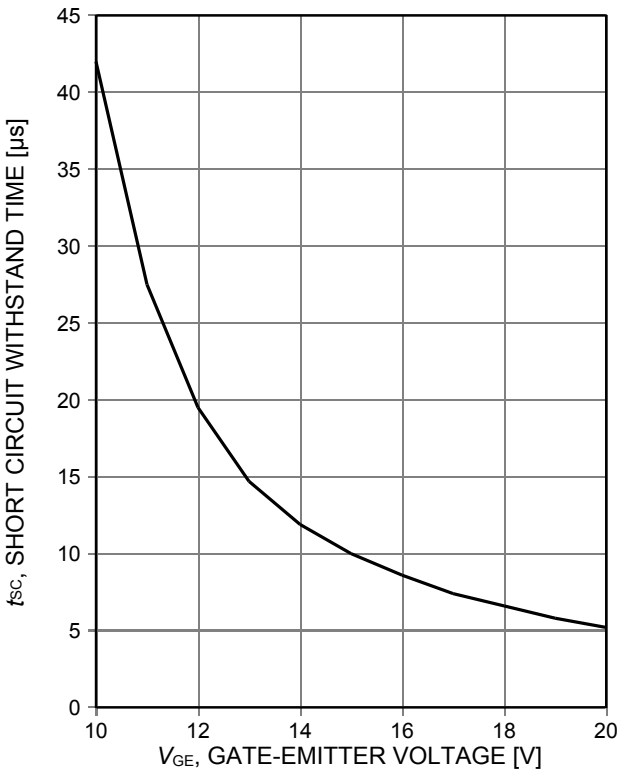


Figure 19. Short circuit withstand time as a function of gate-emitter voltage ($V_{CE}\leq 600V$, start at $T_{vj}\leq 175^{\circ}C$)

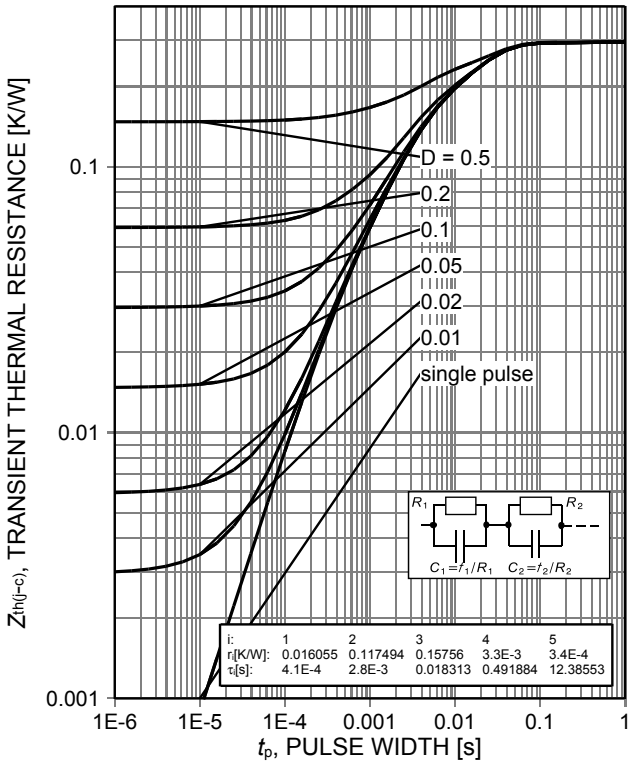


Figure 20. IGBT transient thermal resistance ($D=t_p/T$)

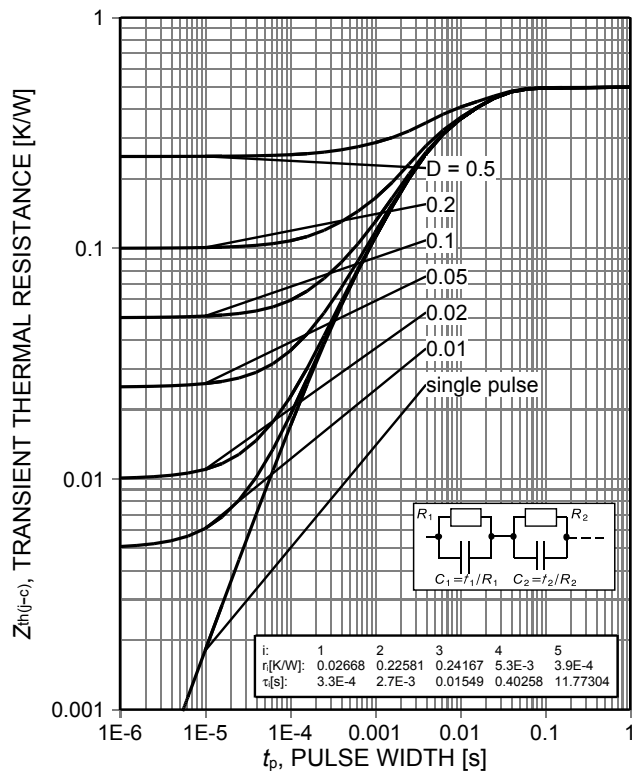
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Figure 21. Diode transient thermal impedance as a function of pulse width ($D = t_p/T$)

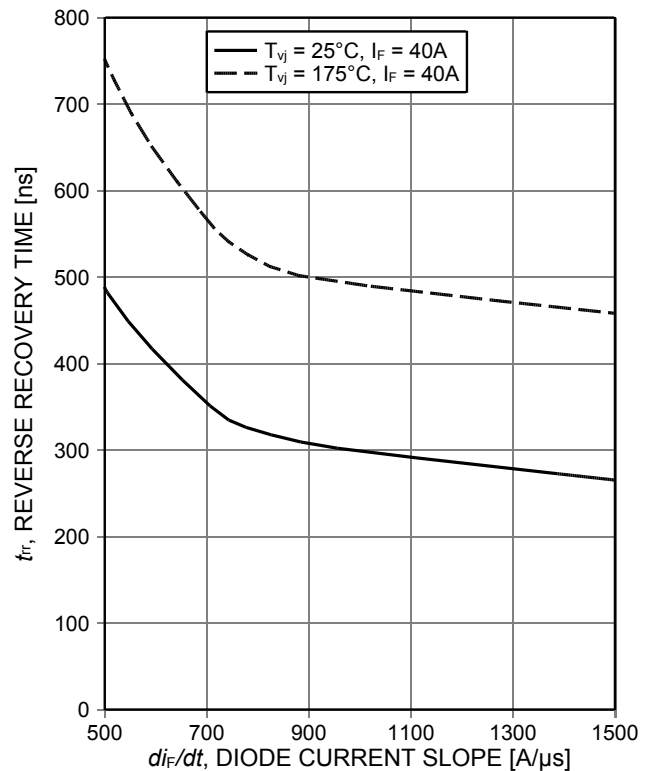


Figure 22. Typical reverse recovery time as a function of diode current slope ($V_R = 600V$)

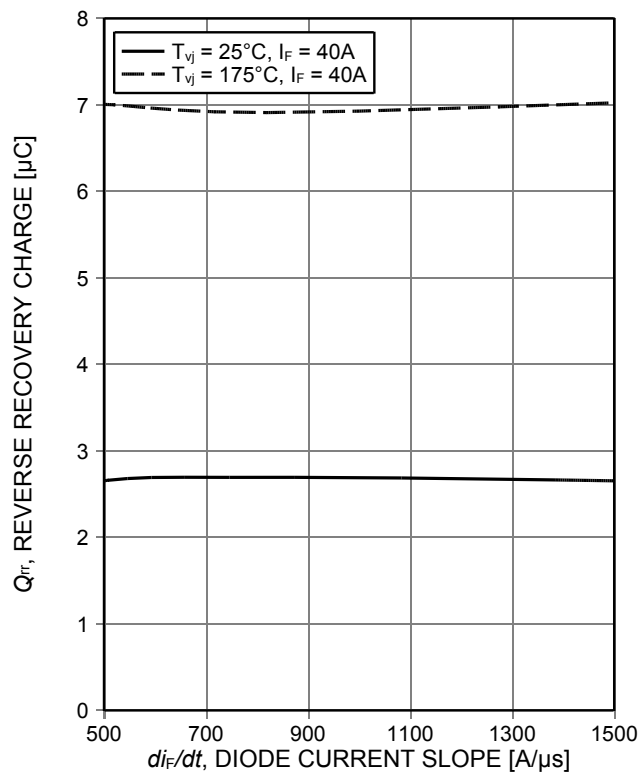


Figure 23. Typical reverse recovery charge as a function of diode current slope ($V_R = 600V$)

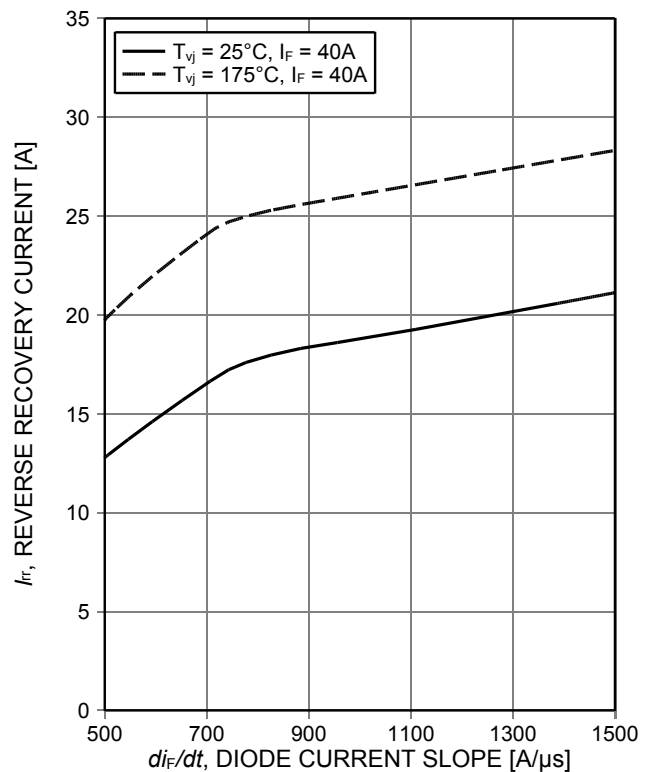


Figure 24. Typical reverse recovery current as a function of diode current slope ($V_R = 600V$)

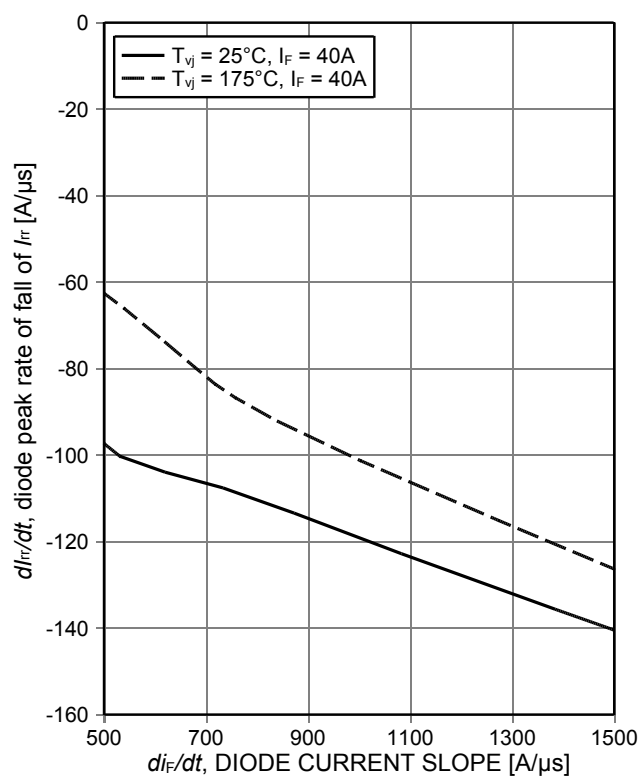
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Figure 25. **Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**
($V_R=600V$)

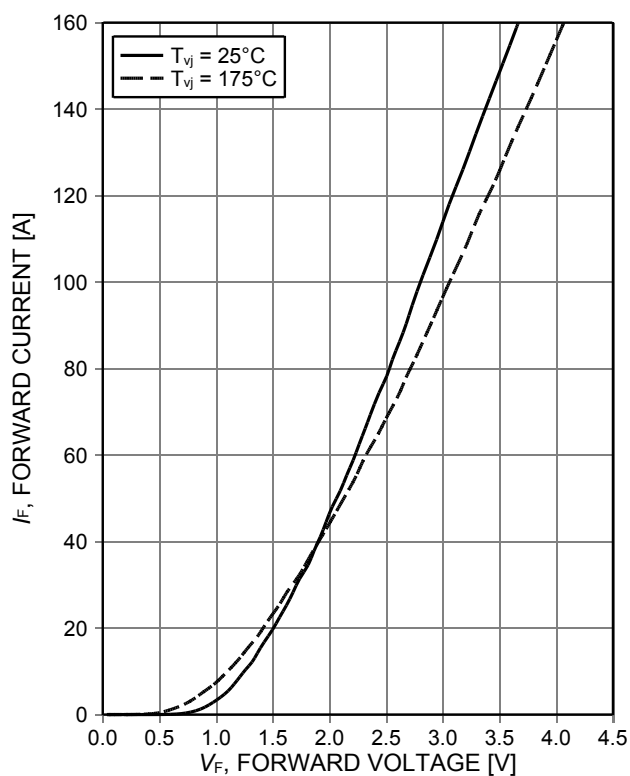


Figure 26. **Typical diode forward current as a function of forward voltage**

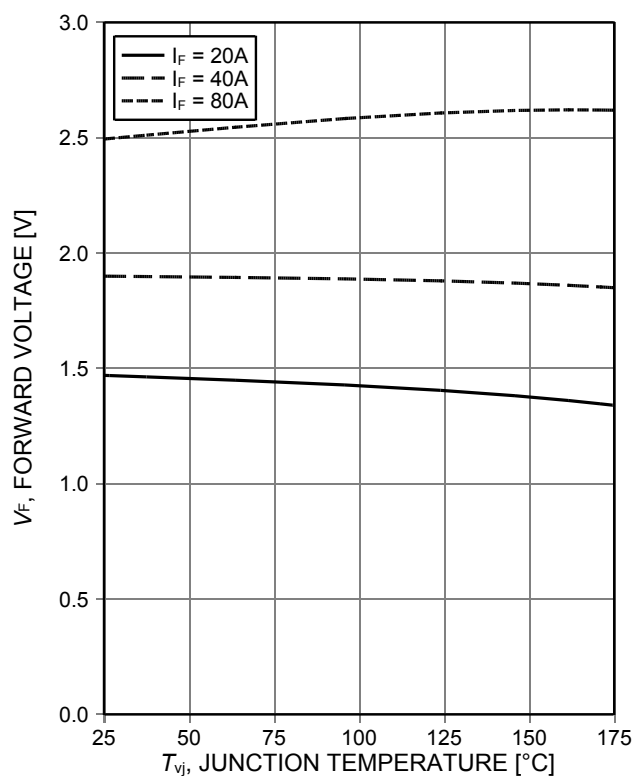
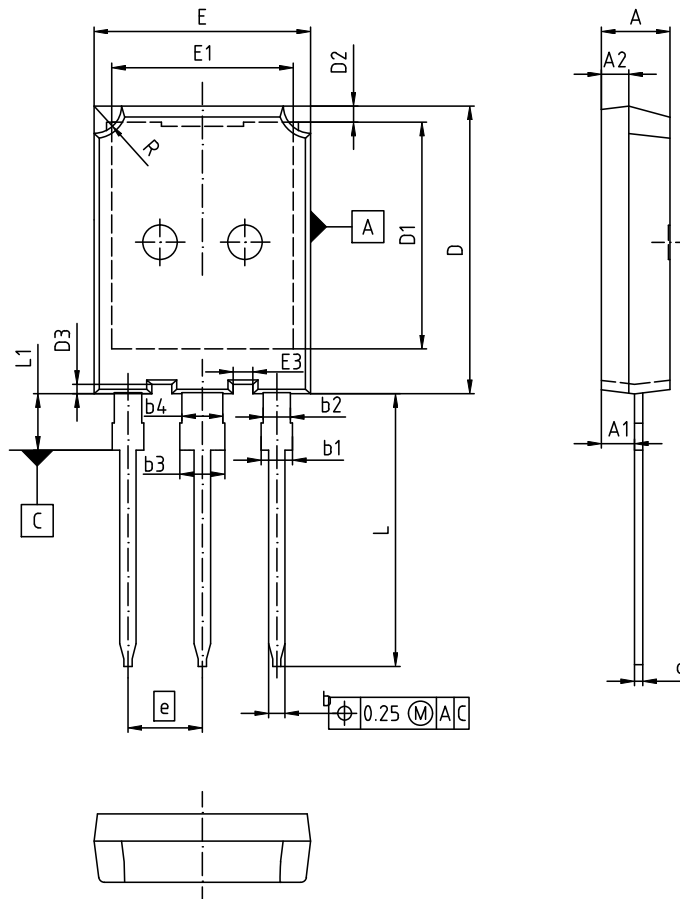


Figure 27. **Typical diode forward voltage as a function of junction temperature**

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Package Drawing PG-TO247-3-46



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.90	5.10	0.193	0.201
A1	2.31	2.51	0.091	0.099
A2	1.90	2.10	0.075	0.083
b	1.16	1.26	0.046	0.050
b1	1.96	2.25	0.077	0.089
b2	1.96	2.06	0.077	0.081
c	0.59	0.66	0.023	0.026
D	20.90	21.10	0.823	0.831
D1	16.25	16.85	0.640	0.663
D2	1.05	1.35	0.041	0.053
D3	0.58	0.78	0.023	0.031
E	15.70	15.90	0.618	0.626
E1	13.10	13.50	0.516	0.531
E3	1.35	1.55	0.053	0.061
e	5.44 (BSC)		0.214 (BSC)	
N	3		3	
L	19.80	20.10	0.780	0.791
L1	-	4.30	-	0.169
R	1.90	2.10	0.075	0.083

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SCALE	
EUROPEAN PROJECTION	
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REVISION 01	

Testing Conditions

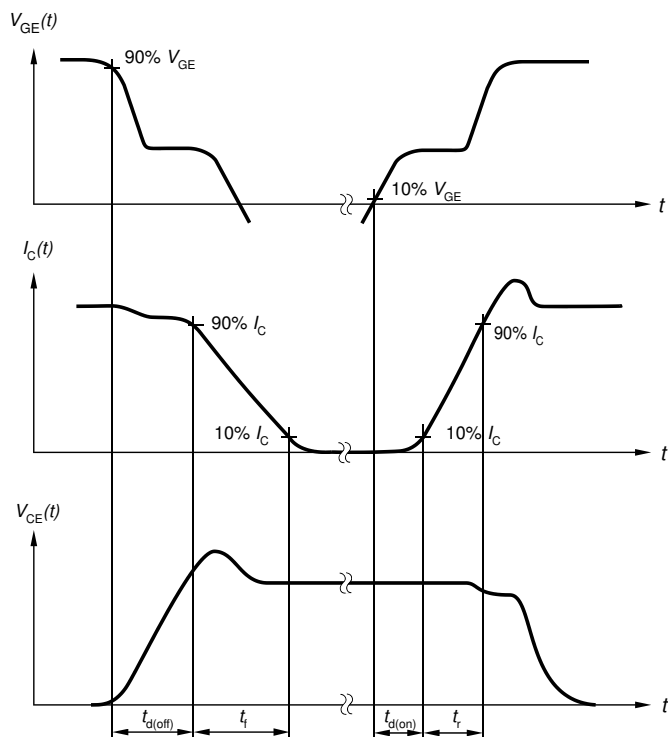


Figure A. Definition of switching times

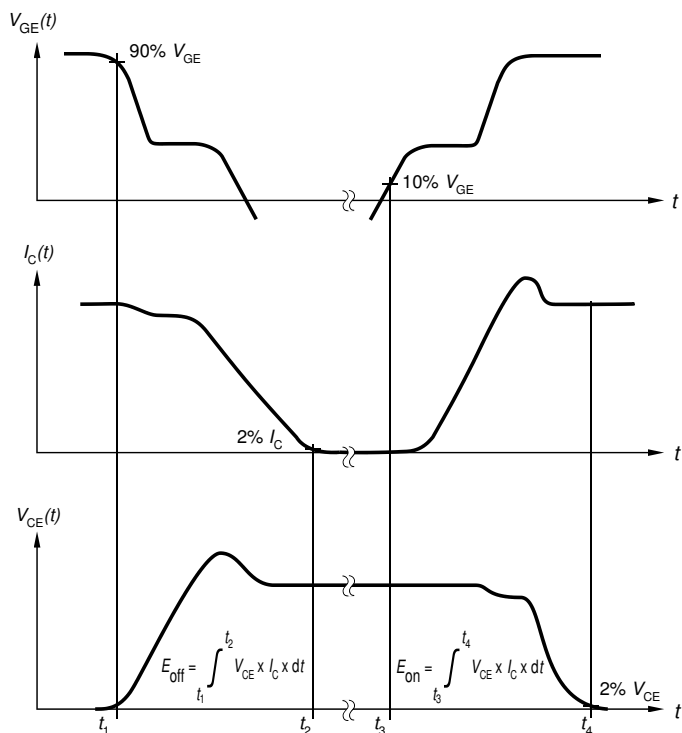


Figure B. Definition of switching losses

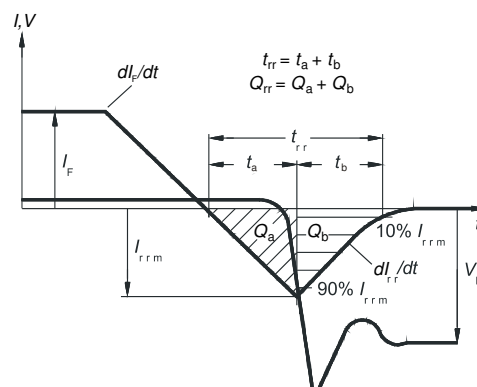


Figure C. Definition of diode switching characteristics

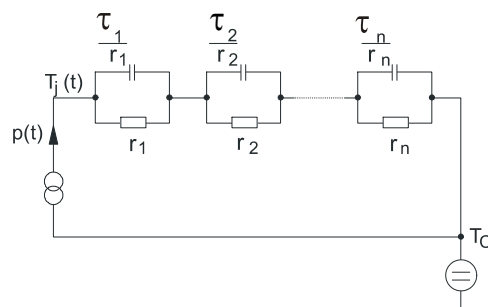


Figure D. Thermal equivalent circuit

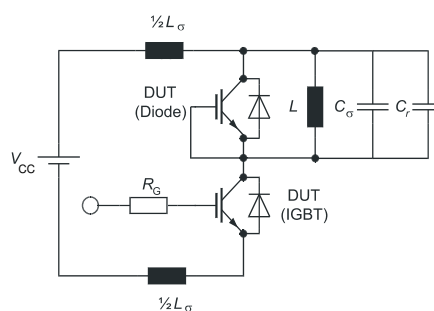


Figure E. **Dynamic test circuit**
Parasitic inductance L_σ ,
parasitic capacitor C_σ ,
relief capacitor C_r ,
(only for ZVT switching)

Revision HistoryIKQ40N120CT2

Revision: 2019-04-15, Rev. 2.3

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.1	2017-05-12	Final data sheet
2.2	2017-06-09	Update Figure 26
2.3	2019-04-15	Update condition for V_{geth} page 4 and Fig. 11

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