

Short circuit rugged 1200 V TRENCHSTOP™ IGBT 7 technology copacked with soft and fast recovery Emitter Controlled 7 diode

Features

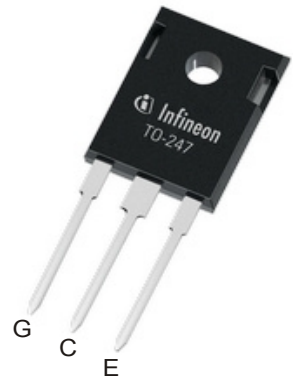
- $V_{CE}=1200\text{ V}$
- $I_C=40\text{ A}$
- IGBT co-packed with full current, soft and low Q_{rr} diode
- Low saturation voltage $V_{CE(sat)} = 2.0\text{ V}$ at $T_{vj}=175\text{ °C}$
- Optimized for hard switching topologies (2-L inverter, 3-L NPC T-type, ...)
- Short circuit ruggedness $8\text{ }\mu\text{sec}$
- Wide range of dv/dt controllability
- Complete product spectrum and PSpice Models: <http://www.infineon.com/igbt/>

Potential applications

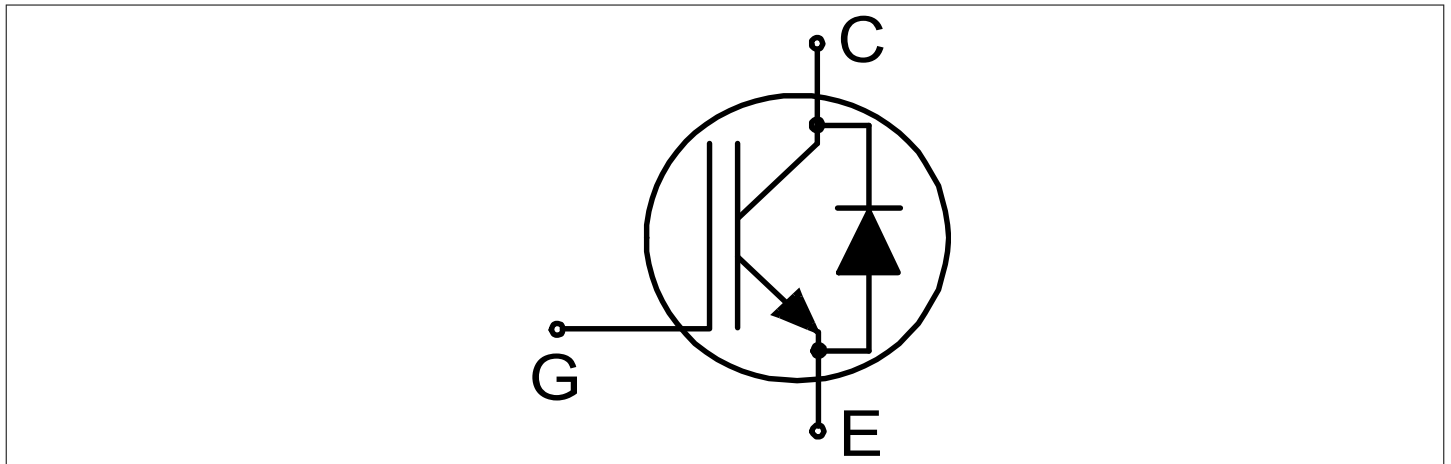
- Industrial Drives
- Industrial Power Supplies
- Solar Inverters

Product validation

- Product Validation: Qualified for industrial applications according to the relevant tests of JEDEC47/20/22



Description



Type	Package	Marking
IKW40N120CS7	PG-TO247-3	K40MCS7

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1 Package

1 Package

Table 1 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Internal emitter inductance measured 5mm. (0.197in) from case	L_E			13.0		nH
Storage temperature	T_{stg}		-55		150	°C
Soldering temperature		wave soldering 1.6mm (0.063in.) from case for 10s			260	°C
Mounting torque , M3 screw Maximum of mounting process: 3	M				0.6	Nm
Thermal resistance, junction-ambient	$R_{th(j-a)}$				40	K/W

2 IGBT

Table 2 Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit	
Collector-emitter voltage	V_{CE}	$T_{vj} \geq 25\text{ °C}$	1200	V	
DC collector current, limited by T_{vjmax}	I_C		$T_C = 25\text{ °C}$	82	A
			$T_C = 100\text{ °C}$	56	
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpuls}		120	A	
Turn-off safe operating area		$V_{CE} \leq 1200\text{ V}, T_{vj} \leq 175\text{ °C}$	120	A	
Gate-emitter voltage	V_{GE}		± 20	V	
Transient gate-emitter voltage	V_{GE}	$t_p \leq 0.5\text{ }\mu\text{s}, D < 0.001$	± 25	V	
Short circuit withstand time	t_{SC}	$V_{CC} \leq 600\text{ V}, V_{GE} = 15\text{ V}$, Allowed number of short circuits < 1000, Time between short circuits $\geq 1.0\text{ s}, T_{vj} = 150\text{ °C}$	8	μs	
Power dissipation	P_{tot}		$T_C = 25\text{ °C}$	357	W
			$T_C = 100\text{ °C}$	179	

Table 3 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Collector-emitter saturation voltage	$V_{CE\text{ sat}}$	$I_C = 40.0\text{ A}, V_{GE} = 15\text{ V}$	$T_{vj} = 25\text{ °C}$	1.65	2.00	V
			$T_{vj} = 175\text{ °C}$	2.00		

Table 3 Characteristic values (continued)

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Gate-emitter threshold voltage	V_{GEth}	$I_C = 0.78 \text{ mA}$, $V_{CE} = V_{GE}$, $T_{vj} = 25 \text{ °C}$	5.15	5.70	6.45	V
Zero gate voltage collector current	I_{CES}	$V_{CE} = 1200 \text{ V}$, $V_{GE} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$		40	μA
			$T_{vj} = 175 \text{ °C}$		3500	
Gate-emitter leakage current	I_{GES}	$V_{CE} = 0 \text{ V}$, $V_{GE} = 20 \text{ V}$			100	nA
Transconductance	g_{fs}	$I_C = 40.0 \text{ A}$, $V_{CE} = 20 \text{ V}$, $T_{vj} = 175 \text{ °C}$		17.0		S
Short circuit collector current	I_{SC}	$V_{CC} \leq 600 \text{ V}$, $V_{GE} = 15 \text{ V}$, $t_{SC} \leq 8 \mu\text{s}$, Allowed number of short circuits < 1000, Time between short circuits $\geq 1.0 \text{ s}$, $T_{vj} = 25 \text{ °C}$		240		A
Input capacitance	C_{ies}	$V_{CE} = 25 \text{ V}$, $V_{GE} = 0 \text{ V}$, $f = 100 \text{ kHz}$		5.5		nF
Output capacitance	C_{oes}	$V_{CE} = 25 \text{ V}$, $V_{GE} = 0 \text{ V}$, $f = 100 \text{ kHz}$		120		pF
Reverse transfer capacitance	C_{res}	$V_{CE} = 25 \text{ V}$, $V_{GE} = 0 \text{ V}$, $f = 100 \text{ kHz}$		27		pF
Gate charge	Q_G	$I_C = 40.0 \text{ A}$, $V_{GE} = 15 \text{ V}$, $V_{CE} = 960 \text{ V}$		230		nC
Turn-on delay time	t_{don}	$V_{CE} = 600 \text{ V}$, $V_{GE} = 15 \text{ V}$, $R_{Gon} = 4.0 \Omega$, $R_{Goff} = 4.0 \Omega$	$T_{vj} = 25 \text{ °C}$, $I_C = 40.0 \text{ A}$	27		ns
			$T_{vj} = 175 \text{ °C}$, $I_C = 40.0 \text{ A}$		23	
Rise time (inductive load)	t_r	$V_{CE} = 600 \text{ V}$, $V_{GE} = 15 \text{ V}$, $R_{Gon} = 4.0 \Omega$, $R_{Goff} = 4.0 \Omega$	$T_{vj} = 25 \text{ °C}$, $I_C = 40.0 \text{ A}$		21	ns
			$T_{vj} = 175 \text{ °C}$, $I_C = 40.0 \text{ A}$		22	
Turn-off delay time	t_{doff}	$V_{CE} = 600 \text{ V}$, $V_{GE} = 15 \text{ V}$, $R_{Gon} = 4.0 \Omega$, $R_{Goff} = 4.0 \Omega$	$T_{vj} = 25 \text{ °C}$, $I_C = 40.0 \text{ A}$		190	ns
			$T_{vj} = 175 \text{ °C}$, $I_C = 40.0 \text{ A}$		250	
Fall time (inductive load)	t_f	$V_{CE} = 600 \text{ V}$, $V_{GE} = 15 \text{ V}$, $R_{Gon} = 4.0 \Omega$, $R_{Goff} = 4.0 \Omega$	$T_{vj} = 25 \text{ °C}$, $I_C = 40.0 \text{ A}$		100	ns
			$T_{vj} = 175 \text{ °C}$, $I_C = 40.0 \text{ A}$		250	
Turn-on energy	E_{on}	$V_{CE} = 600 \text{ V}$, $V_{GE} = 15 \text{ V}$, $R_{Gon} = 4.0 \Omega$, $R_{Goff} = 4.0 \Omega$	$T_{vj} = 25 \text{ °C}$, $I_C = 40.0 \text{ A}$		2.55	mJ
			$T_{vj} = 175 \text{ °C}$, $I_C = 40.0 \text{ A}$		3.85	
Turn-off energy	E_{off}	$V_{CE} = 600 \text{ V}$, $V_{GE} = 15 \text{ V}$, $R_{Gon} = 4.0 \Omega$, $R_{Goff} = 4.0 \Omega$	$T_{vj} = 25 \text{ °C}$, $I_C = 40.0 \text{ A}$		1.75	mJ
			$T_{vj} = 175 \text{ °C}$, $I_C = 40.0 \text{ A}$		3.65	

Table 3 Characteristic values (continued)

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Total switching energy	E_{ts}	$V_{CE} = 600\text{ V}, V_{GE} = 15\text{ V}, R_{Gon} = 4.0\ \Omega, R_{Goff} = 4.0\ \Omega$	$T_{vj} = 25\text{ }^\circ\text{C}, I_C = 40.0\text{ A}$		4.30		mJ
			$T_{vj} = 175\text{ }^\circ\text{C}, I_C = 40.0\text{ A}$		7.50		
IGBT thermal resistance, junction-case	R_{thjc}			0.30	0.42	K/W	
Operating junction temperature	T_{vj}		-40		175	$^\circ\text{C}$	

3 Diode

Table 4 Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit	
Repetitive peak reverse voltage	V_{RRM}	$T_{vj} \geq 25\text{ }^\circ\text{C}$	1200	V	
Diode forward current, limited by T_{vjmax}	I_F		$T_C = 25\text{ }^\circ\text{C}$	69	A
			$T_C = 100\text{ }^\circ\text{C}$	46	
Diode pulsed current, limited by T_{vjmax}	I_{Fpuls}		120	A	
Power dissipation	P_{tot}		$T_C = 25\text{ }^\circ\text{C}$	208	W
			$T_C = 100\text{ }^\circ\text{C}$	104	

Table 5 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Diode forward voltage	V_F	$I_F = 40.0\text{ A}$	$T_{vj} = 25\text{ }^\circ\text{C}$	1.65	2.15	V
			$T_{vj} = 175\text{ }^\circ\text{C}$	1.60		
Reverse leakage current	I_R	$V_R = 1200\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$		40	μA
			$T_{vj} = 175\text{ }^\circ\text{C}$	3500		
Diode reverse recovery time	t_{rr}	$V_R = 600\text{ V}, R_{Gon} = 4.0\ \Omega$	$T_{vj} = 25\text{ }^\circ\text{C}, I_F = 40.0\text{ A}$	175		ns
			$T_{vj} = 175\text{ }^\circ\text{C}, I_F = 40.0\text{ A}$	315		
Diode reverse recovery charge	Q_{rr}	$V_R = 600\text{ V}, R_{Gon} = 4.0\ \Omega$	$T_{vj} = 25\text{ }^\circ\text{C}, I_F = 40.0\text{ A}$	2.45		μC
			$T_{vj} = 175\text{ }^\circ\text{C}, I_F = 40.0\text{ A}$	6.60		

Table 5 Characteristic values (continued)

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Diode peak reverse recovery current	I_{rrm}	$V_R = 600 \text{ V}, R_{Gon} = 4.0 \text{ } \Omega$	$T_{vj} = 25 \text{ } ^\circ\text{C}, I_F = 40.0 \text{ A}$		28.0		A
			$T_{vj} = 175 \text{ } ^\circ\text{C}, I_F = 40.0 \text{ A}$		42.0		
Diode peak rate off fall of reverse recovery current	di_{rr}/dt	$V_R = 600 \text{ V}, R_{Gon} = 4.0 \text{ } \Omega$	$T_{vj} = 25 \text{ } ^\circ\text{C}, I_F = 40.0 \text{ A}$		-190		A/ μs
			$T_{vj} = 150 \text{ } ^\circ\text{C}, I_F = 40.0 \text{ A}$		-145		
Reverse recovery energy	E_{rec}	$V_R = 600 \text{ V}, R_{Gon} = 4.0 \text{ } \Omega$	$T_{vj} = 25 \text{ } ^\circ\text{C}, I_F = 40.0 \text{ A}$		0.75		mJ
			$T_{vj} = 175 \text{ } ^\circ\text{C}, I_F = 40.0 \text{ A}$		2.40		
Diode thermal resistance, junction-case	R_{thjc}			0.55	0.75		K/W
Operating junction temperature	T_{vj}		-40		175		$^\circ\text{C}$

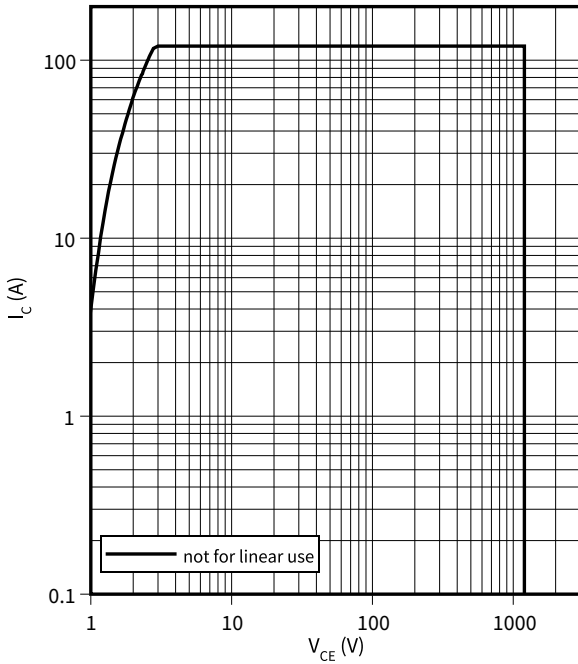
Note: For optimum lifetime and reliability, Infineon recommends operating conditions that do not exceed 80% of the maximum ratings stated in this datasheet.

Dynamic test circuit, parasitic inductance $L_\sigma = 30 \text{ nH}$, $C_\sigma = 18 \text{ pF}$

4 Characteristics diagrams

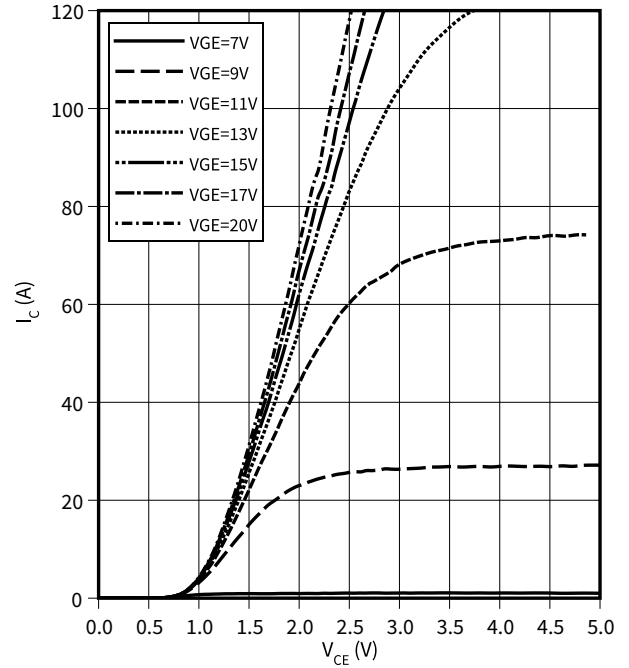
Reverse bias safe operating area, IGBT

$I_C = f(V_{CE})$
 $T_{vj} \leq 175\text{ °C}$, $V_{GE} = 15\text{ V}$



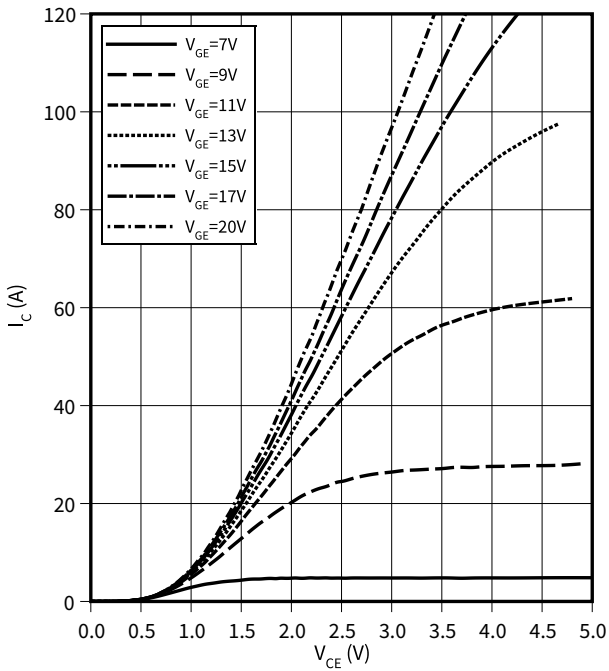
Typical output characteristic, IGBT

$I_C = f(V_{CE})$
 $T_{vj} = 25\text{ °C}$



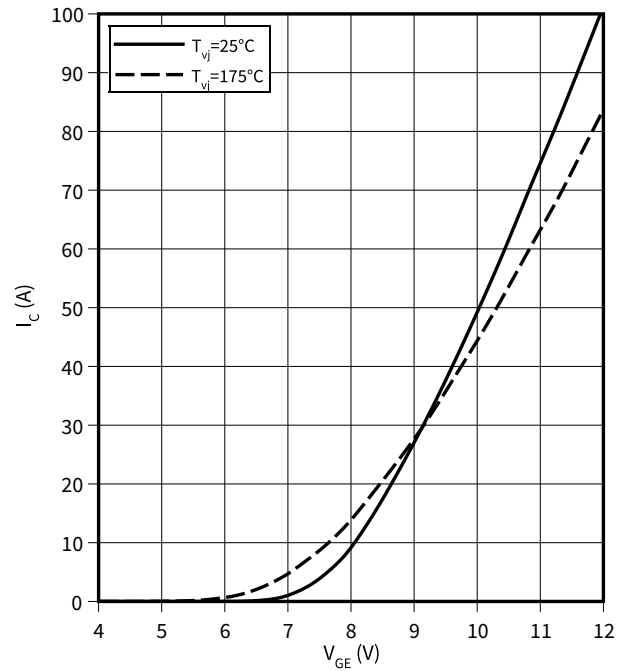
Typical output characteristic, IGBT

$I_C = f(V_{CE})$
 $T_{vj} = 175\text{ °C}$



Typical transfer characteristic, IGBT

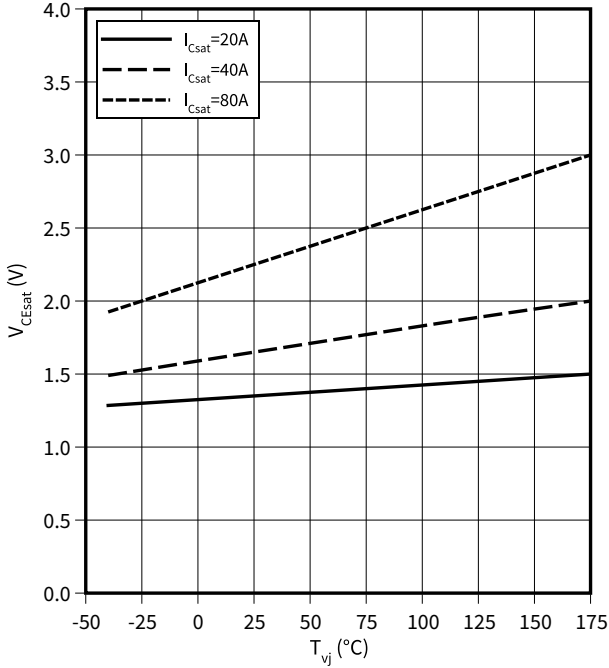
$I_C = f(V_{GE})$
 $V_{CE} = 20\text{ V}$



4 Characteristics diagrams

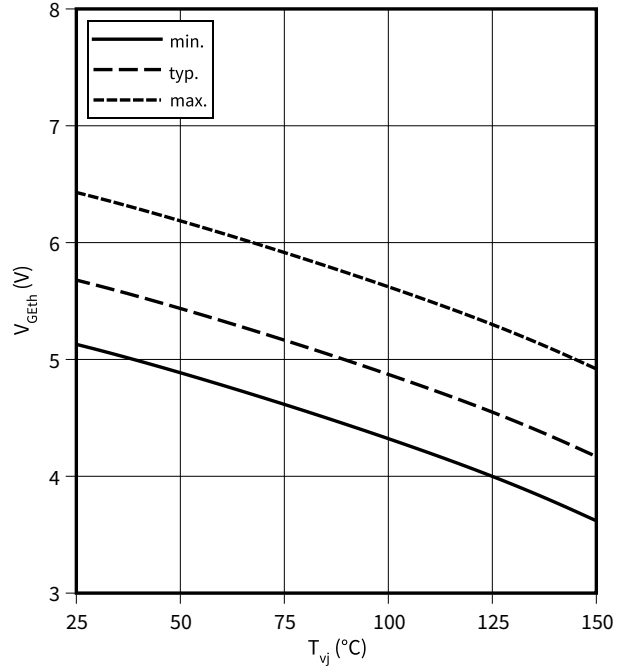
Typical collector-emitter saturation voltage as a function of junction temperature, IGBT

$V_{CEsat} = f(T_{vj})$
 $V_{GE} = 15 \text{ V}$



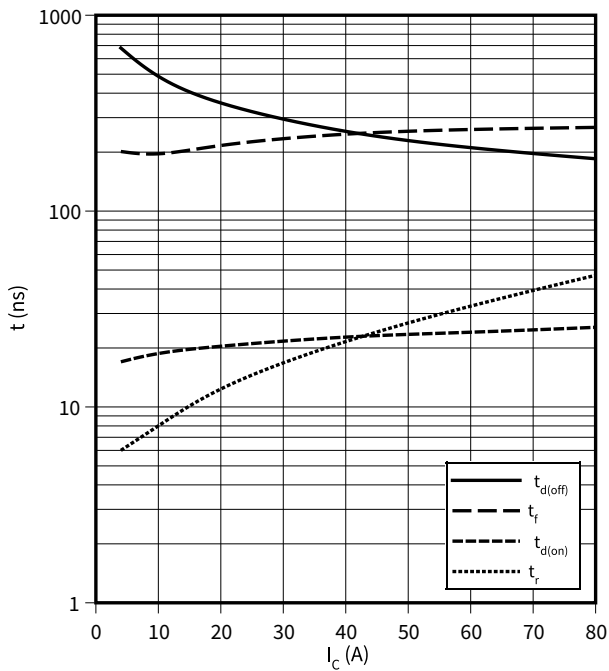
Gate-emitter threshold voltage as a function of junction temperature, IGBT

$V_{GETh} = f(T_{vj})$
 $I_C = 0.85 \text{ mA}$



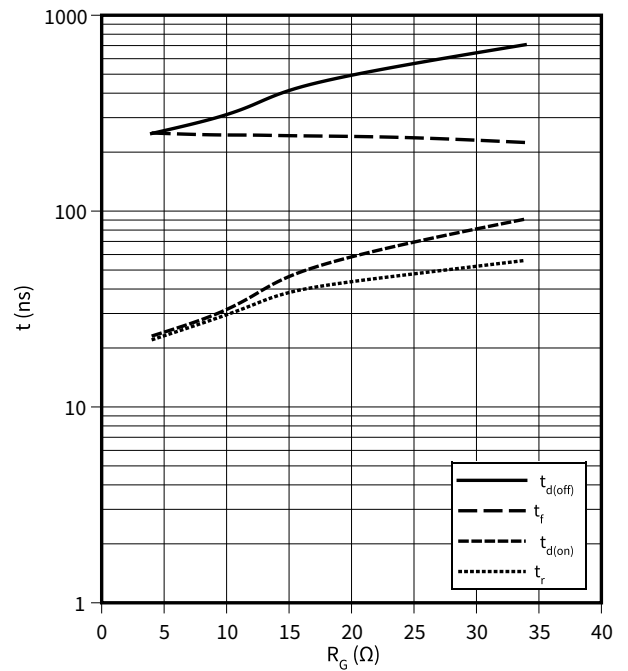
Typical switching times as a function of collector current, IGBT

$t = f(I_C)$
 $T_{vj} = 175 \text{ °C}, V_{GE} = 0/15 \text{ V}, R_G = 4.0 \text{ } \Omega, V_{CE} = 600 \text{ V}$



Typical switching times as a function of gate resistor, IGBT

$t = f(R_G)$
 $I_C = 40.0 \text{ A}, V_{CE} = 600 \text{ V}, T_{vj} = 175 \text{ °C}, V_{GE} = 0/15 \text{ V}$

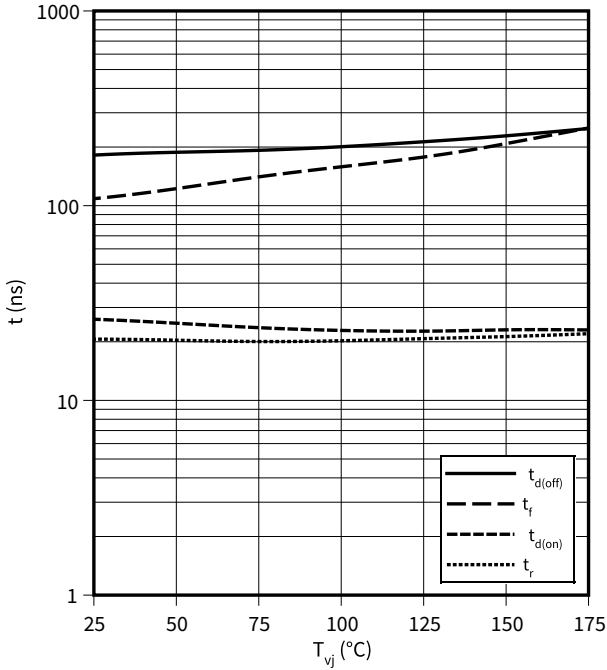


4 Characteristics diagrams

Typical switching times as a function of junction temperature, IGBT

$t = f(T_{vj})$

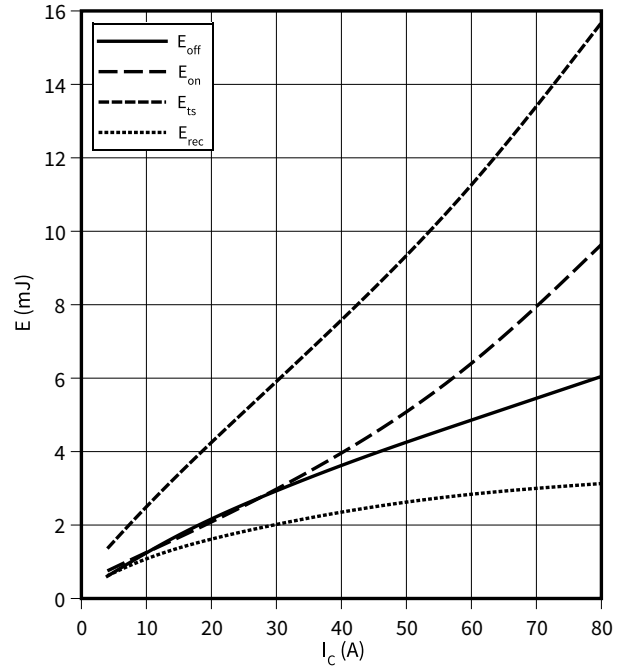
$I_C = 40.0 \text{ A}, V_{CE} = 600 \text{ V}, V_{GE} = 0/15 \text{ V}, R_G = 4.0 \text{ } \Omega$



Typical switching energy losses as a function of collector current, IGBT

$E = f(I_C)$

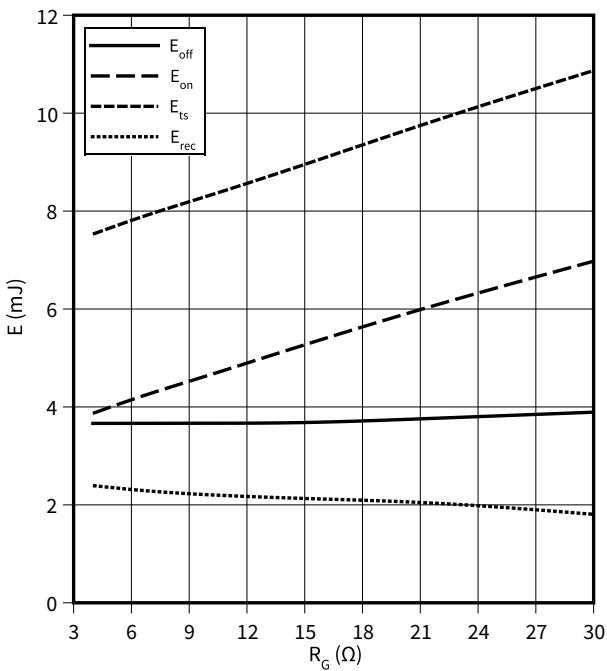
$V_{CE} = 600 \text{ V}, T_{vj} = 175 \text{ } ^\circ\text{C}, V_{GE} = 0/15 \text{ V}, R_G = 4.0 \text{ } \Omega$



Typical switching energy losses as a function of gate resistor, IGBT

$E = f(R_G)$

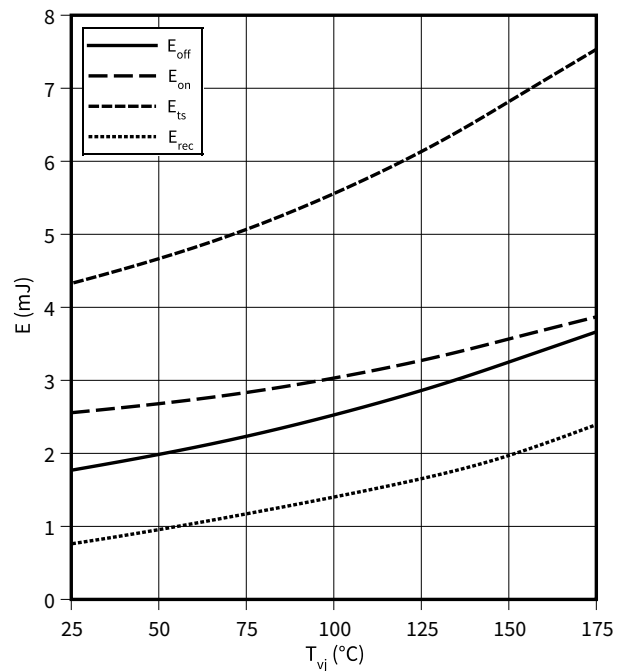
$I_C = 40.0 \text{ A}, V_{CE} = 600 \text{ V}, T_{vj} = 175 \text{ } ^\circ\text{C}, V_{GE} = 0/15 \text{ V}$



Typical switching energy losses as a function of junction temperature, IGBT

$E = f(T_{vj})$

$I_C = 40.0 \text{ A}, V_{CE} = 600 \text{ V}, V_{GE} = 0/15 \text{ V}, R_G = 4.0 \text{ } \Omega$

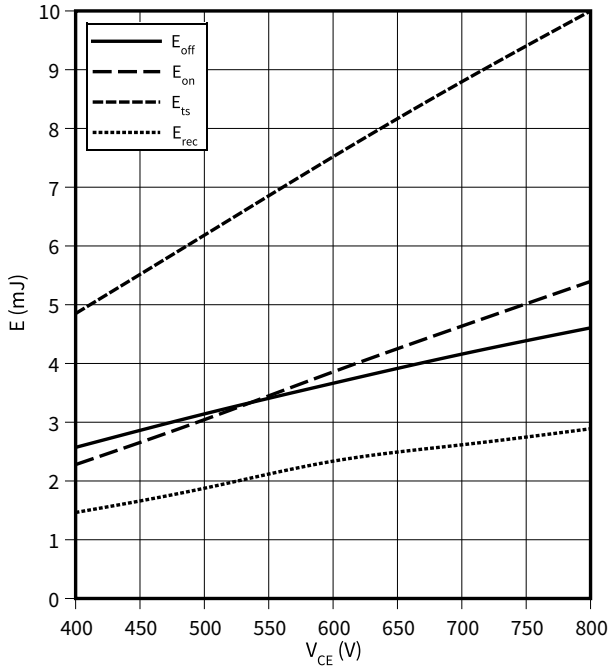


4 Characteristics diagrams

Typical switching energy losses as a function of collector emitter voltage, IGBT

$E = f(V_{CE})$

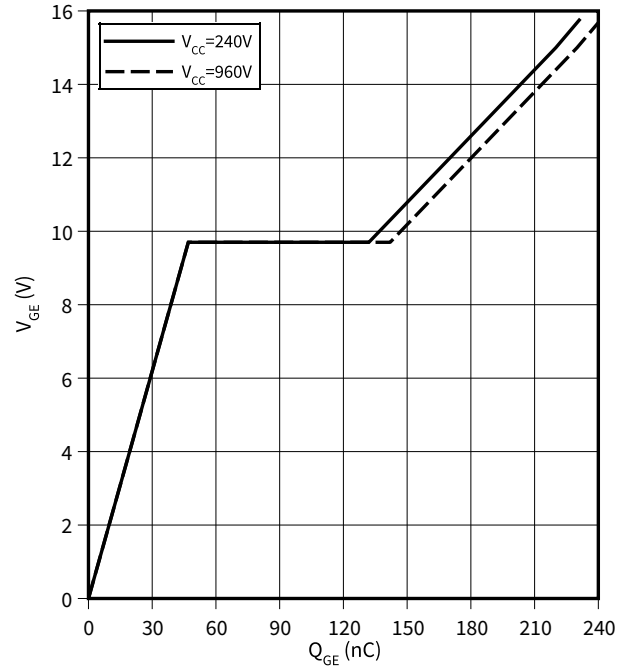
$I_C = 40.0 \text{ A}$, $T_{vj} = 175 \text{ }^\circ\text{C}$, $V_{GE} = 0/15 \text{ V}$, $R_G = 4.0 \text{ } \Omega$



Typical gate charge, IGBT

$V_{GE} = f(Q_{GE})$

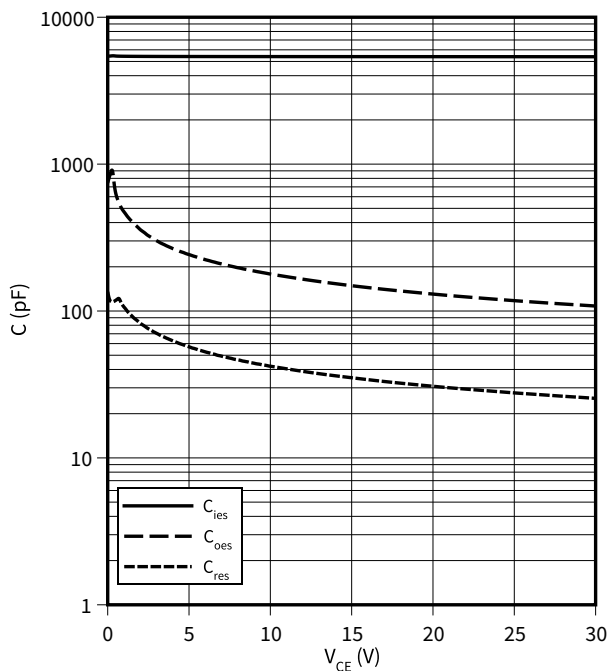
$I_C = 40.0 \text{ A}$



Typical capacitance as a function of collector-emitter voltage, IGBT

$C = f(V_{CE})$

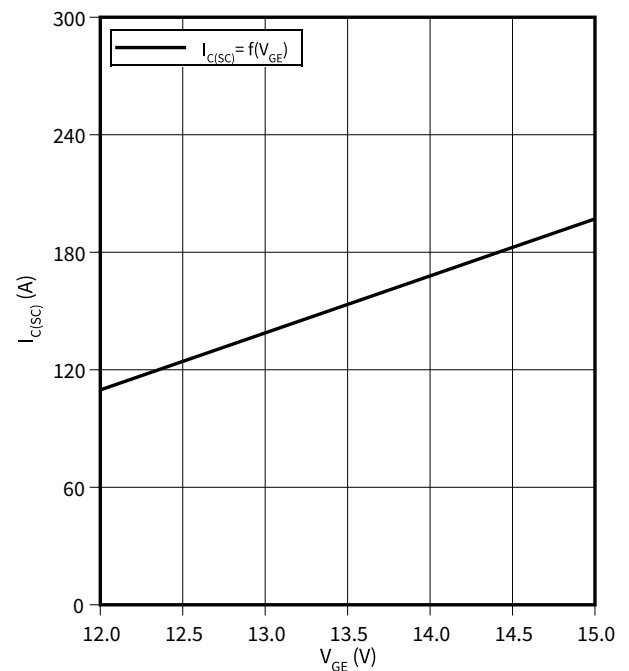
$f = 100 \text{ kHz}$, $V_{GE} = 0 \text{ V}$



Typical short circuit collector current as a function of gate-emitter voltage, IGBT

$I_{C(SC)} = f(V_{GE})$

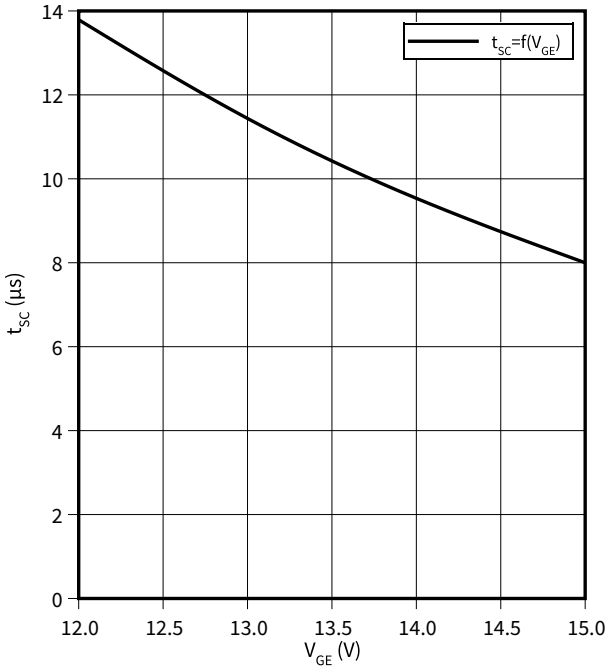
$T_{vj} = 150 \text{ }^\circ\text{C}$, $V_{CC} = 600 \text{ V}$



4 Characteristics diagrams

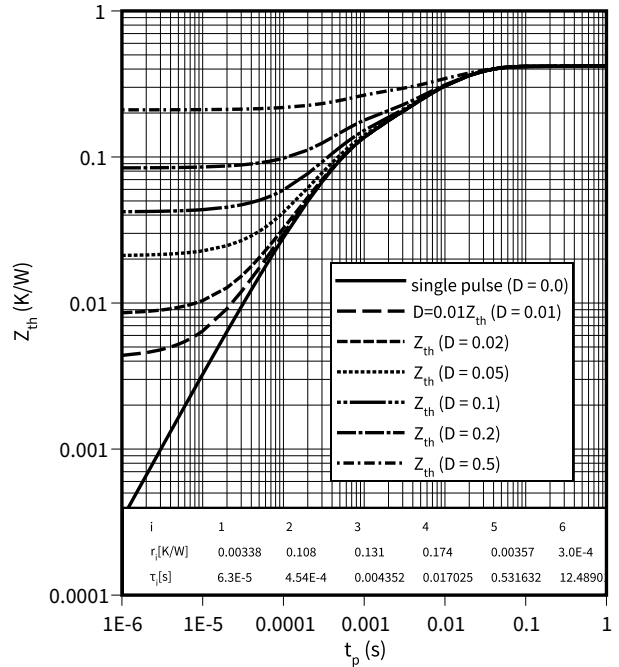
Short circuit withstand time as a function of gate-emitter voltage, IGBT

$t_{SC} = f(V_{GE})$
 $T_{vj} \leq 150\text{ °C}$, $V_{CC} = 600\text{ V}$



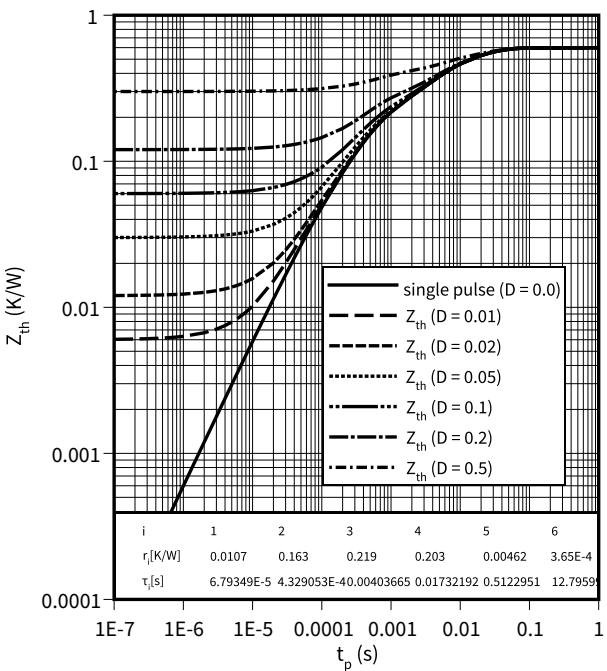
IGBT transient thermal impedance, IGBT

$Z_{th} = f(t_p)$
 $D = t_p/T$



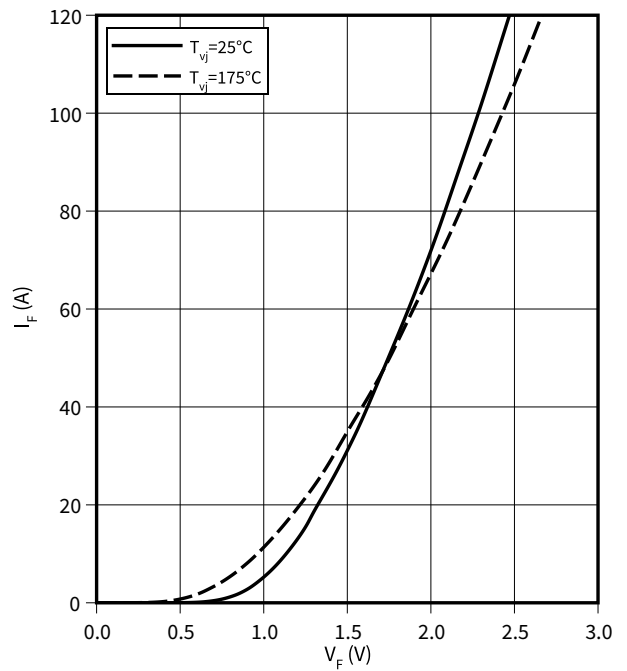
Diode transient thermal impedance as a function of pulse width, Diode

$Z_{th} = f(t_p)$
 $D = t_p/T$



Typical diode forward current as a function of forward voltage, Diode

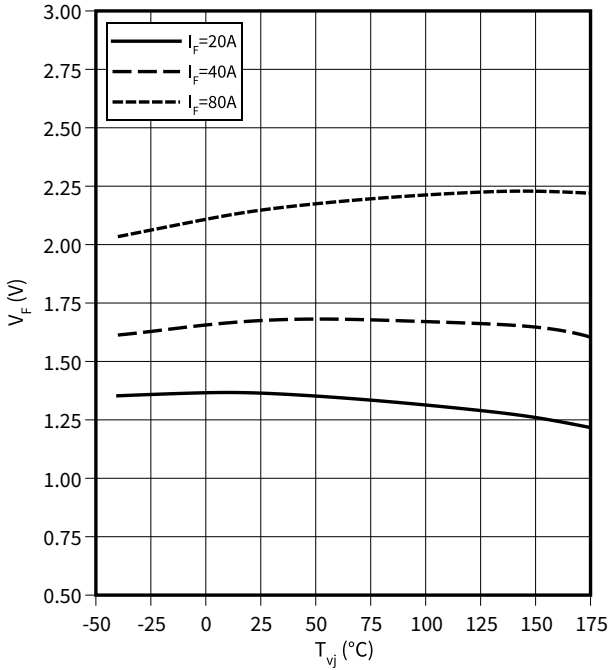
$I_F = f(V_F)$



4 Characteristics diagrams

Typical diode forward voltage as a function of junction temperature, Diode

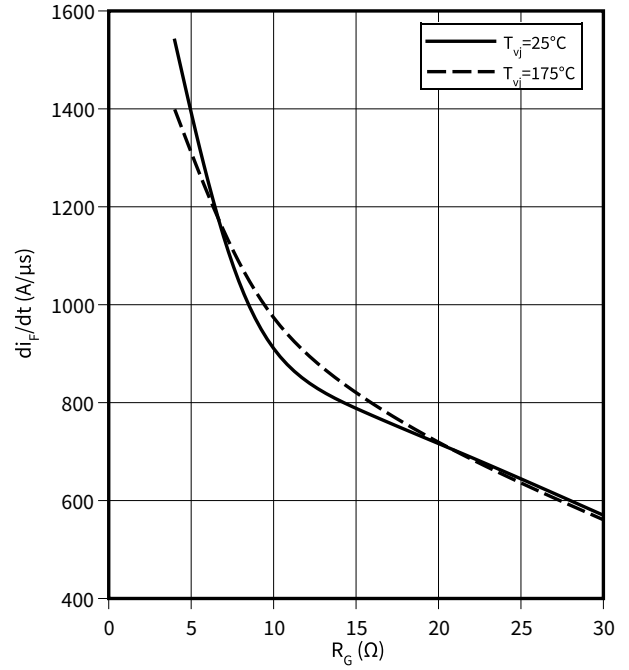
$V_F = f(T_{vj})$



Typical diode current slope as a function of gate resistor, Diode

$di_F/dt = f(R_G)$

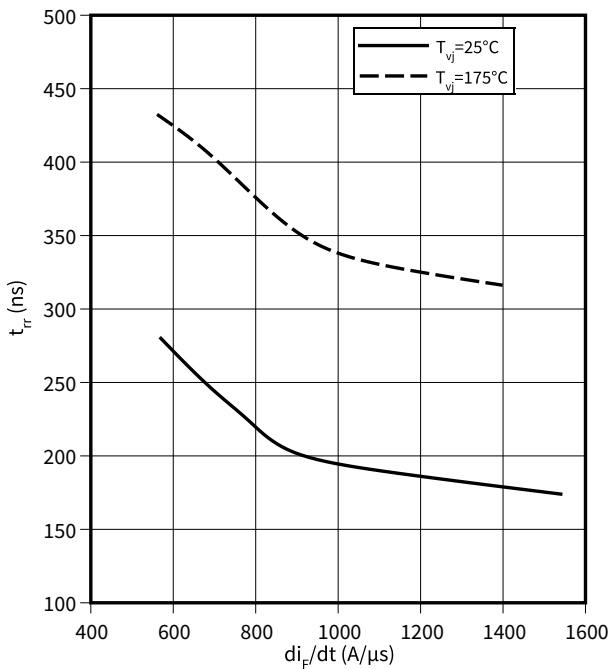
$I_C = 40.0 A, V_{CE} = 600 V, V_{GE} = 0/15 V$



Typical reverse recovery time as a function of diode current slope, Diode

$t_{rr} = f(di_F/dt)$

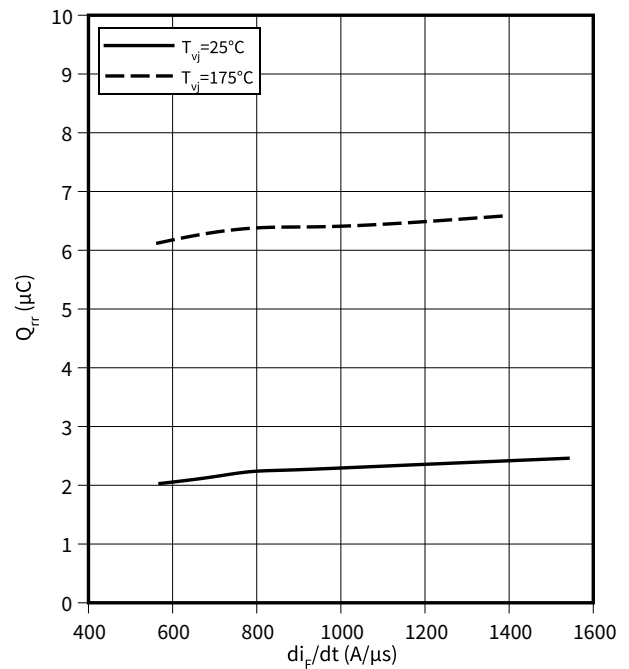
$V_R = 600 V, I_F = 40.0 A$



Typical reverse recovery charge as a function of diode current slope, Diode

$Q_{rr} = f(di_F/dt)$

$V_R = 600 V, I_F = 40.0 A$

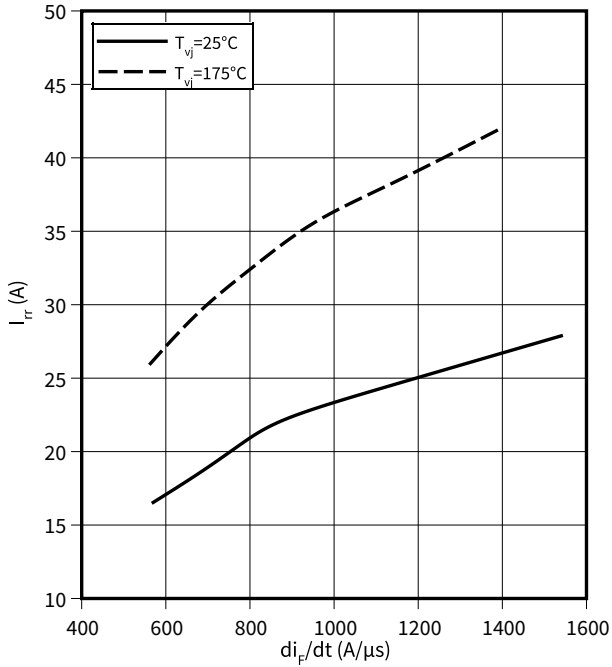


4 Characteristics diagrams

Typical reverse recovery current as a function of diode current slope, Diode

$I_{rr} = f(di_F/dt)$

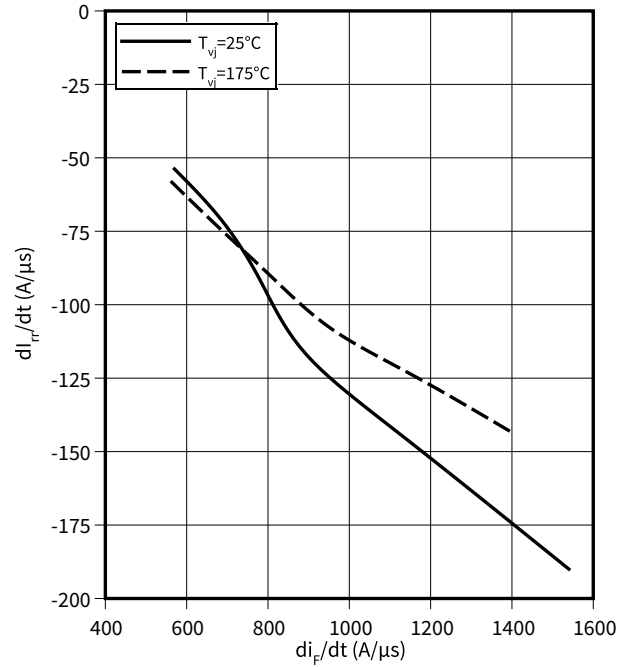
$V_R = 600\text{ V}, I_F = 40.0\text{ A}$



Typical diode peak rate of fall of reverse recovery current as a function of diode current slope, Diode

$dI_{rr}/dt = f(di_F/dt)$

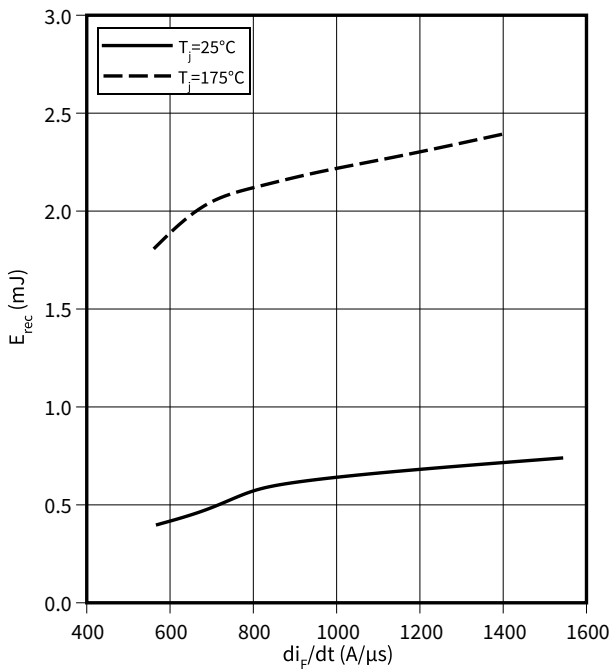
$V_R = 600\text{ V}, I_F = 40.0\text{ A}$



Typical reverse energy losses as a function of diode current slope, Diode

$E_{rec} = f(di_F/dt)$

$V_R = 600\text{ V}, I_F = 40.0\text{ A}$



5 Package outlines

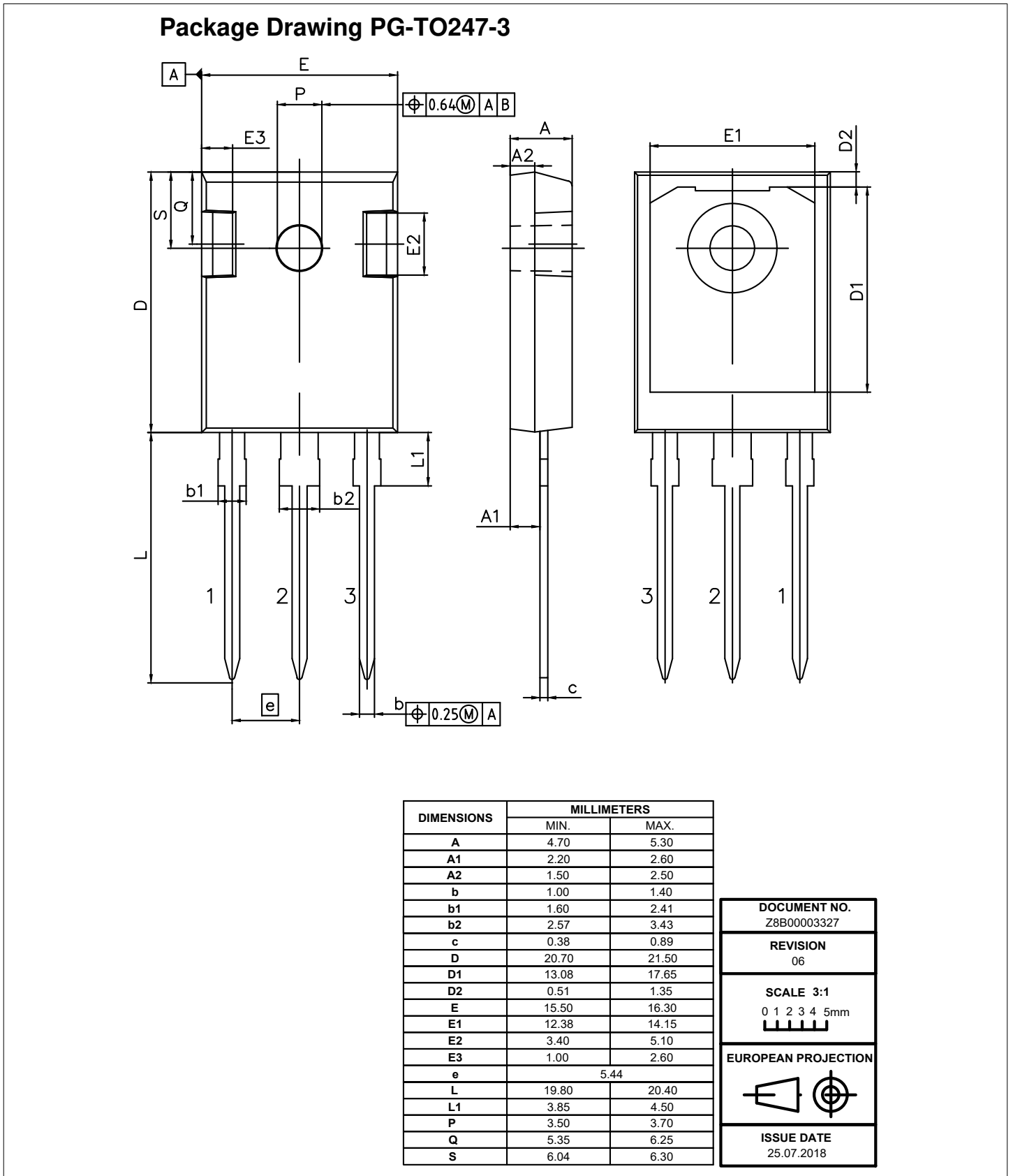


Figure 6

6 Testing conditions

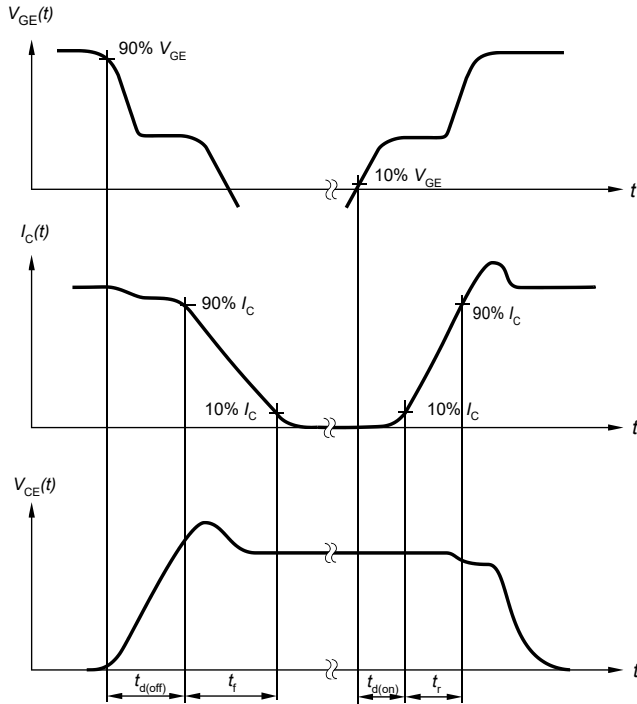


Figure A. Definition of switching times

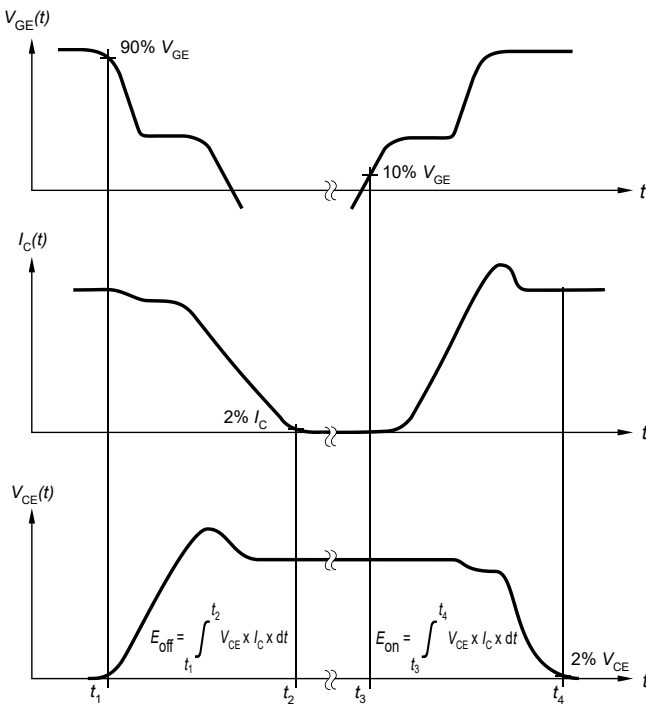


Figure B. Definition of switching losses

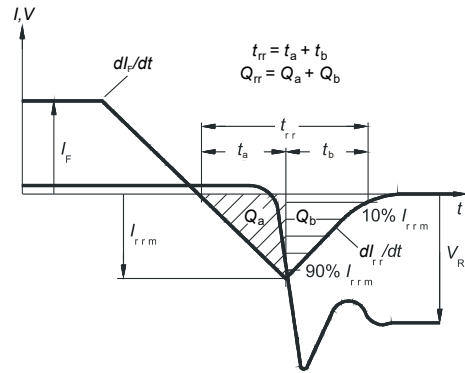


Figure C. Definition of diode switching characteristics

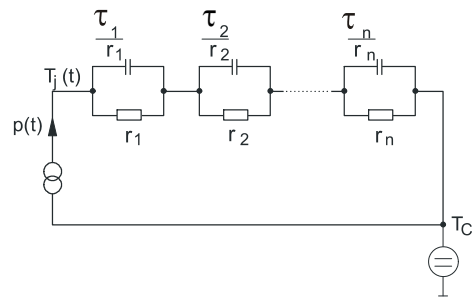


Figure D. Thermal equivalent circuit

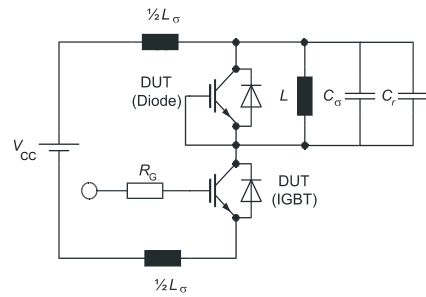


Figure E. **Dynamic test circuit**
 Parasitic inductance L_σ ,
 parasitic capacitor C_σ ,
 relief capacitor C_r ,
 (only for ZVT switching)

Figure 7

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