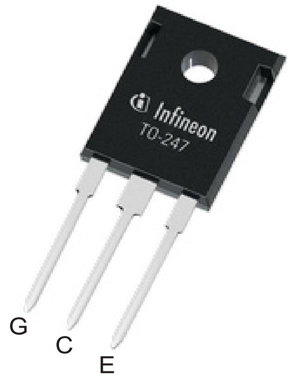
High speed DuoPack: IGBT in Trench and Fieldstop technology with soft, fast recovery antiparallel diode

Features

- V_{CE} = 1200 V
- I_C = 40 A
- Very low $V_{CE,sat}$
- Low EMI
- Very soft, fast recovery antiparallel diode
- Maximum junction temperature T_{vjmax} = 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/

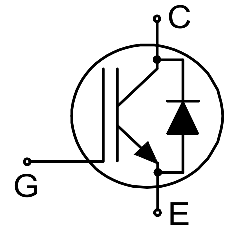


Potential applications

- Uninterruptible power supplies
- Welding converters
- Converters with high switching frequency

Lead-Free
Green
Halogen-Free
RoHS

Description



Type	Package	Marking
IKW40N120H3	PG-TO247-3	K40H1203

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1 Package

Table 1 **Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Internal emitter inductance measured 5 mm (0.197 in) from case	L_E			13.0		nH
Storage temperature	T_{stg}		-55		150	°C
Soldering temperature		wave soldering 1.6 mm (0.063 in.) from case for 10 s			260	°C
Mounting torque, M3 screw Maximum of mounting processes: 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}			1200	V
DC collector current, limited by T_{vjmax}	I_C		T_c = 25 °C	80	A
			T_c = 100 °C	40	
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpuls}			160	A
Turn-off safe operating area		$V_{CE} \leq$ 1200 V, $T_{vj} \leq$ 175 °C		160	A
Gate-emitter voltage	V_{GE}			±20	V
Short circuit withstand time	t_{SC}	$V_{CC} \leq$ 600 V, V_{GE} = 15 V, Allowed number of short circuits < 1000, Time between short circuits ≥ 1.0 s, T_{vj} = 175 °C		10	µs
Power dissipation	P_{tot}		T_c = 25 °C	483	W
			T_c = 100 °C	220	

Table 3 **Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Collector-emitter breakdown voltage	V_{BRCES}	I_C = 0.5 mA, V_{GE} = 0 V	1200			V

Table 3 Characteristic values (continued)

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Collector-emitter saturation voltage	$V_{CE\,sat}$	I_C = 40.0 A, V_{GE} = 15 V	T_{vj} = 25 °C		2.05	2.40	V
			T_{vj} = 125 °C		2.50		
			T_{vj} = 175 °C		2.70		
Gate-emitter threshold voltage	V_{GEth}	I_C = 1.00 mA, V_{CE} = V_{GE}, T_{vj} = 175 °C		5.00	5.80	6.50	V
Zero gate voltage collector current	I_{CES}	V_{CE} = 1200 V, V_{GE} = 0 V	T_{vj} = 25 °C			250	µA
			T_{vj} = 175 °C			2500	
Gate-emitter leakage current	I_{GES}	V_{CE} = 0 V, V_{GE} = 20 V				600	nA
Transconductance	g_{fs}	I_C = 40.0 A, V_{CE} = 20 V			20.0		S
Short circuit collector current	I_{SC}	V_{CC} ≤ 600 V, V_{GE} = 15 V, t_{SC} ≤ 10 µs, Allowed number of short circuits < 1000 , Time between short circuits ≥ 1.0 s, T_{vj} = 175 °C			139		A
Input capacitance	C_{ies}	V_{CE} = 25 V, V_{GE} = 0 V, f = 1000 kHz			2330		pF
Output capacitance	C_{oes}	V_{CE} = 25 V, V_{GE} = 0 V, f = 1000 kHz			185		pF
Reverse transfer capacitance	C_{res}	V_{CE} = 25 V, V_{GE} = 0 V, f = 1000 kHz			130		pF
Gate charge	Q_G	I_C = 40.0 A, V_{GE} = 15 V, V_{CE} = 960 V			185		nC
Turn-on delay time	t_{don}	V_{CE} = 600 V, V_{GE} = 15 V, R_{Gon} = 12.0 Ω, R_{Goff} = 12.0 Ω, $L_σ$ = 70 nH, $C_σ$ = 67 pF	T_{vj} = 25 °C, I_C = 40.0 A		30		ns
			T_{vj} = 175 °C, I_C = 40.0 A		29		
Rise time (inductive load)	t_r	V_{CE} = 600 V, V_{GE} = 15 V, R_{Gon} = 12.0 Ω, R_{Goff} = 12.0 Ω, $L_σ$ = 70 nH, $C_σ$ = 67 pF	T_{vj} = 25 °C, I_C = 40.0 A		57		ns
			T_{vj} = 175 °C, I_C = 40.0 A		49		
Turn-off delay time	t_{doff}	V_{CE} = 600 V, V_{GE} = 15 V, R_{Gon} = 12.0 Ω, R_{Goff} = 12.0 Ω, $L_σ$ = 70 nH, $C_σ$ = 67 pF	T_{vj} = 25 °C, I_C = 40.0 A		290		ns
			T_{vj} = 175 °C, I_C = 40.0 A		366		
Fall time (inductive load)	t_f	V_{CE} = 600 V, V_{GE} = 15 V, R_{Gon} = 12.0 Ω, R_{Goff} = 12.0 Ω, $L_σ$ = 70 nH, $C_σ$ = 67 pF	T_{vj} = 25 °C, I_C = 40.0 A		16		ns
			T_{vj} = 175 °C, I_C = 40.0 A		48		
Turn-on energy	E_{on}	V_{CE} = 600 V, V_{GE} = 15 V, R_{Gon} = 12.0 Ω, R_{Goff} = 12.0 Ω, $L_σ$ = 70 nH, $C_σ$ = 67 pF	T_{vj} = 25 °C, I_C = 40.0 A		3.20		mJ
			T_{vj} = 175 °C, I_C = 40.0 A		4.40		

Table 3 **Characteristic values (continued)**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Turn-off energy	E_{off}	V_{CE} = 600 V, V_{GE} = 15 V, R_{Gon} = 12.0 Ω, R_{Goff} = 12.0 Ω, L_{σ} = 70 nH, C_{σ} = 67 pF	T_{vj} = 25 °C, I_C = 40.0 A		1.20		mJ
			T_{vj} = 175 °C, I_C = 40.0 A		2.60		
Total switching energy	E_{ts}	V_{CE} = 600 V, V_{GE} = 15 V, R_{Gon} = 12.0 Ω, R_{Goff} = 12.0 Ω, L_{σ} = 70 nH, C_{σ} = 67 pF	T_{vj} = 25 °C, I_C = 40.0 A		4.40		mJ
			T_{vj} = 175 °C, I_C = 40.0 A		7.00		
IGBT thermal resistance, junction-case	R_{thjc}					0.31	K/W
Operating junction temperature	T_{vj}			-40		175	°C

Note: Electrical Characteristic, at T_{vj} = 25°C, unless otherwise specified.

3 Diode

Table 4 **Maximum rated values**

Parameter	Symbol	Note or test condition		Values	Unit
Repetitive peak reverse voltage	V_{RRM}	T_{vj} ≥ 25 °C		1200	V
Diode forward current, limited by T_{vjmax}	I_F		T_c = 25 °C	40	A
			T_c = 100 °C	20	
Diode pulsed current, limited by T_{vjmax}	I_{Fpuls}			160	A

Table 5 **Characteristic values**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode forward voltage	V_F	I_F = 20.0 A	T_{vj} = 25 °C		1.80	2.35	V
			T_{vj} = 175 °C		1.85		
Diode forward voltage	V_F	I_F = 40.0 A	T_{vj} = 25 °C		2.40	3.05	V
			T_{vj} = 125 °C		2.60		
			T_{vj} = 175 °C		2.60		
Reverse leakage current	I_R	V_R = 1200 V	T_{vj} = 25 °C			250	µA
			T_{vj} = 175 °C			2500	

Table 5 Characteristic values (continued)

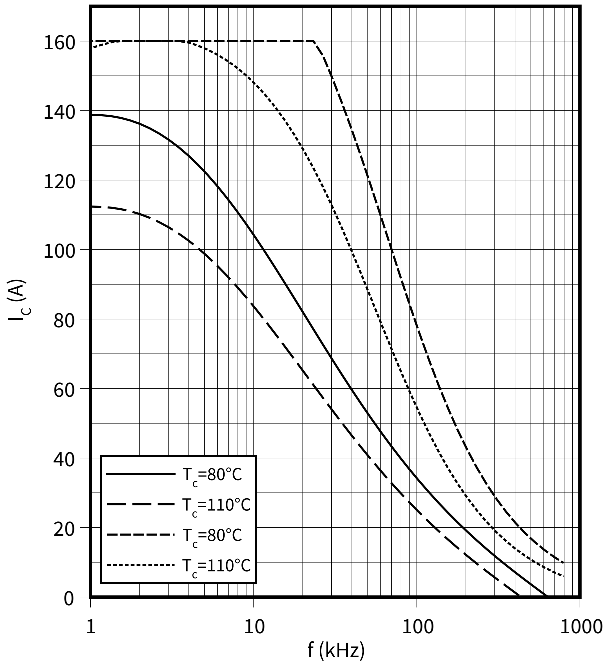
Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode reverse recovery time	t_{rr}	$V_R = 600$ V	$T_{vj} = 25$ °C, $I_F = 40.0$ A, $-di_F/dt = 500$ A/µs		355		ns
			$T_{vj} = 175$ °C, $I_F = 40.0$ A, $-di_F/dt = 500$ A/µs		639		
Diode reverse recovery charge	Q_{rr}	$V_R = 600$ V	$T_{vj} = 25$ °C, $I_F = 40.0$ A, $-di_F/dt = 500$ A/µs		1.90		µC
			$T_{vj} = 175$ °C, $I_F = 40.0$ A, $-di_F/dt = 500$ A/µs		4.30		
Diode peak reverse recovery current	I_{rrm}	$V_R = 600$ V	$T_{vj} = 25$ °C, $I_F = 40.0$ A, $-di_F/dt = 500$ A/µs		12.8		A
			$T_{vj} = 175$ °C, $I_F = 40.0$ A, $-di_F/dt = 500$ A/µs		16.0		
Diode peak rate off fall of reverse recovery current	dI_{rr}/dt	$V_R = 600$ V	$T_{vj} = 25$ °C, $I_F = 40.0$ A, $-di_F/dt = 500$ A/µs		-105		A/µs
			$T_{vj} = 175$ °C, $I_F = 40.0$ A, $-di_F/dt = 500$ A/µs		-84		
Diode thermal resistance, junction-case	R_{thjc}					1.11	K/W
Operating junction temperature	T_{vj}			-40		175	°C

4 Characteristics diagrams

Collector current as a function of switching frequency, IGBT

$I_C = f(f)$

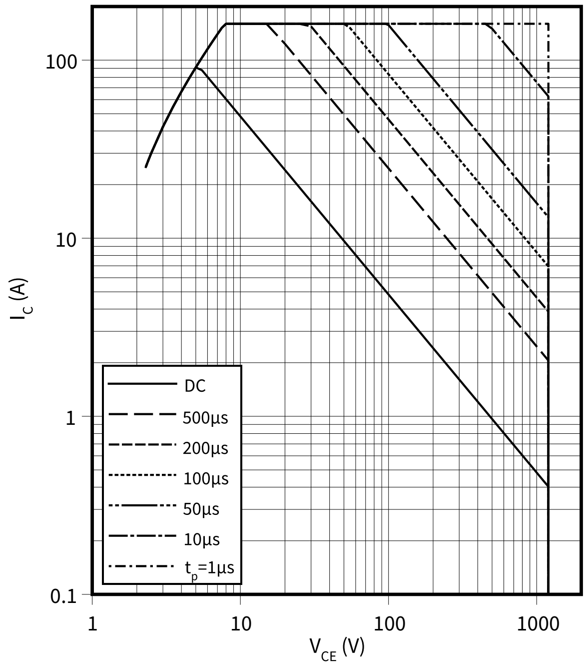
$D = 0.5$, $V_{CE} = 600$ V, $T_{vj} \leq 175$ °C, $V_{GE} = 0/15$ V, $R_G = 12\ \Omega$



Forward bias safe operating area, IGBT

$I_C = f(V_{CE})$

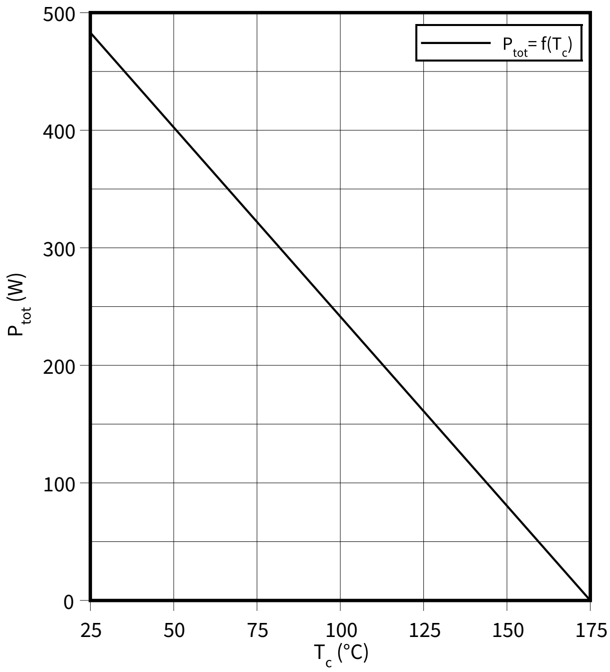
$D = 0$, $T_{vj} \leq 175$ °C, $V_{GE} = 15$ V, $T_c = 25$ °C



Power dissipation as a function of case temperature, IGBT

$P_{tot} = f(T_c)$

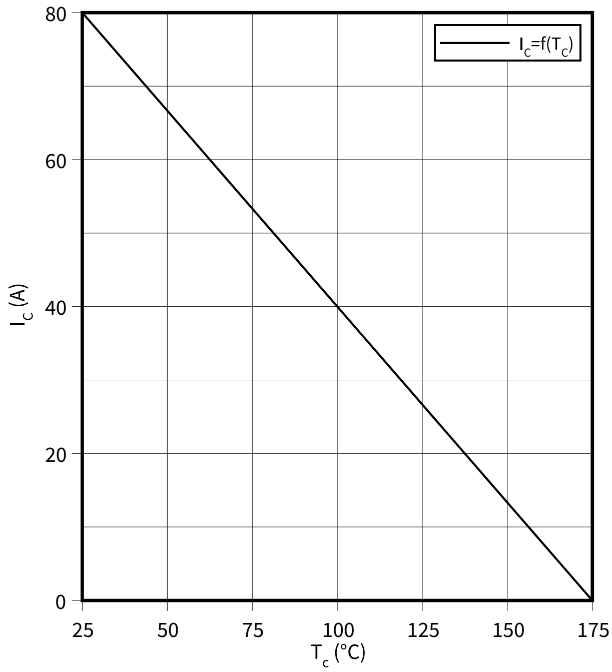
$T_{vj} \leq 175$ °C



Collector current as a function of case temperature, IGBT

$I_C = f(T_c)$

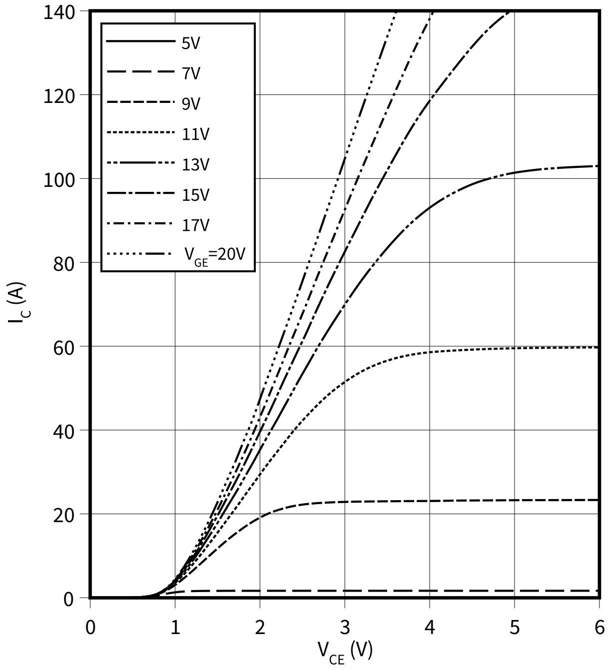
$T_{vj} \leq 175$ °C, $V_{GE} \geq 15$ V



Typical output characteristic, IGBT

$I_C = f(V_{CE})$

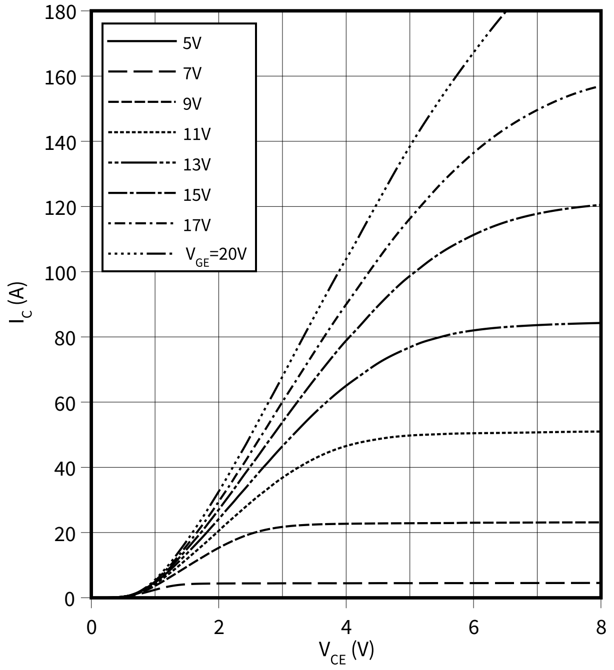
$T_{vj} = 25\ °C$



Typical output characteristic, IGBT

$I_C = f(V_{CE})$

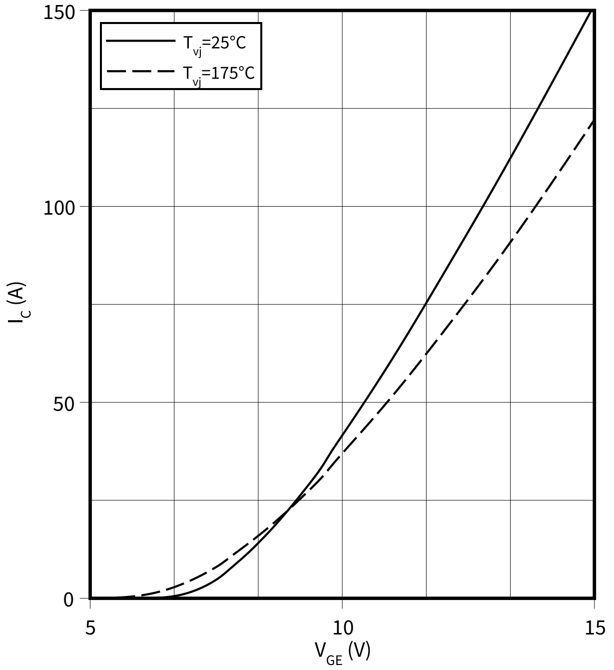
$T_{vj} = 175\ °C$



Typical transfer characteristic, IGBT

$I_C = f(V_{GE})$

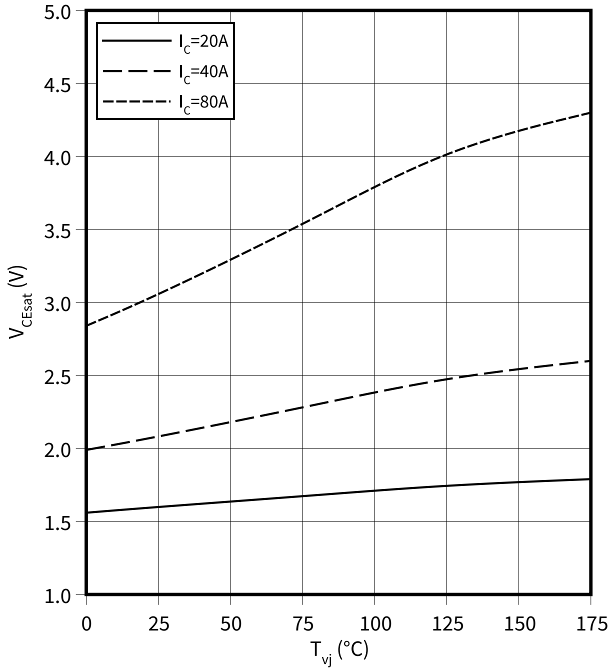
$V_{CE} = 20\ V$



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

$V_{CEsat} = f(T_{vj})$

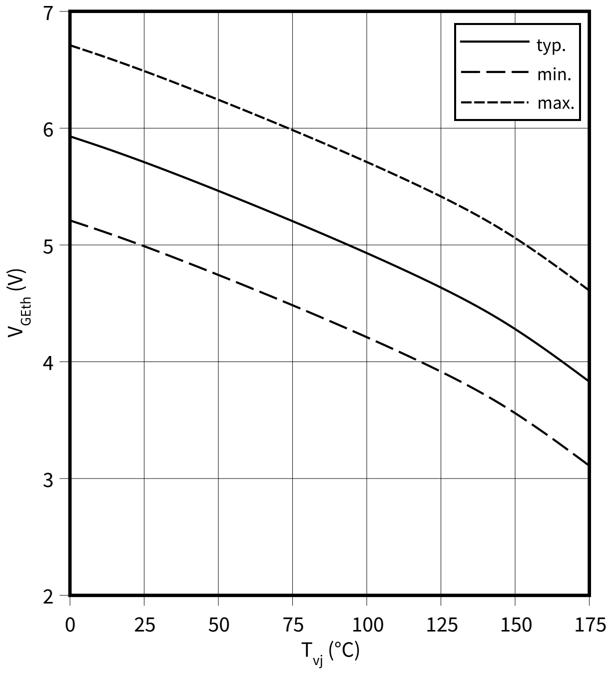
$V_{GE} = 15\ V$



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

$V_{GEth} = f(T_{vj})$

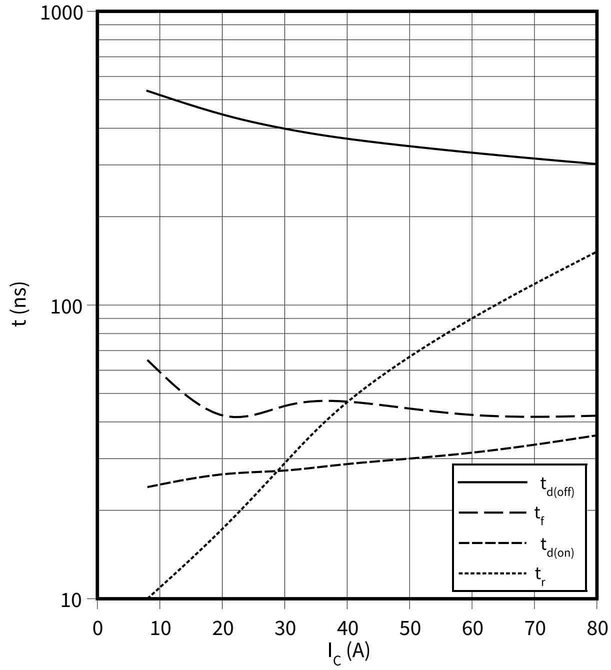
$I_C = 1.00$ mA



Typical switching times as a function of collector current, IGBT

$t = f(I_C)$

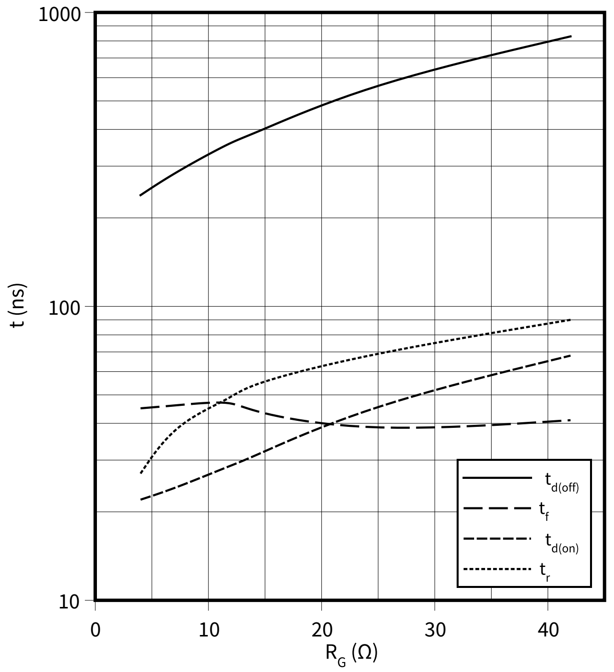
$V_{CE} = 600$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V, $R_G = 12\ \Omega$



Typical switching times as a function of gate resistance, IGBT

$t = f(R_G)$

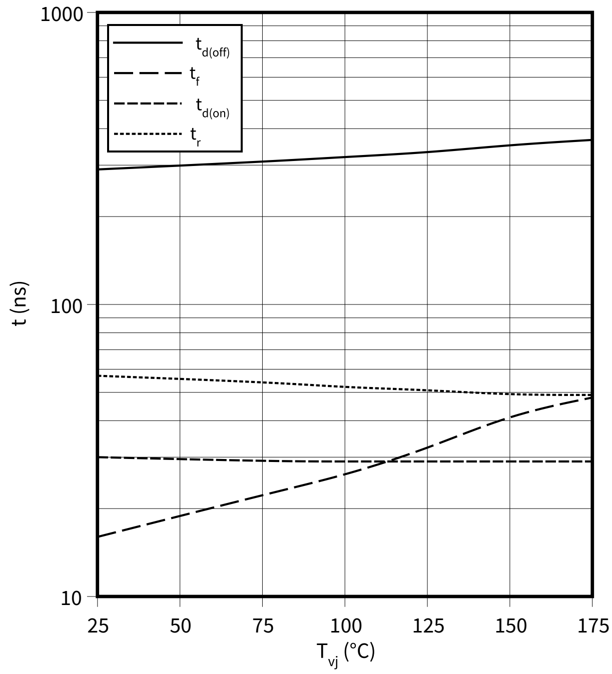
$I_C = 40.0$ A, $V_{CE} = 600$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V



Typical switching times as a function of junction temperature, IGBT

$t = f(T_{vj})$

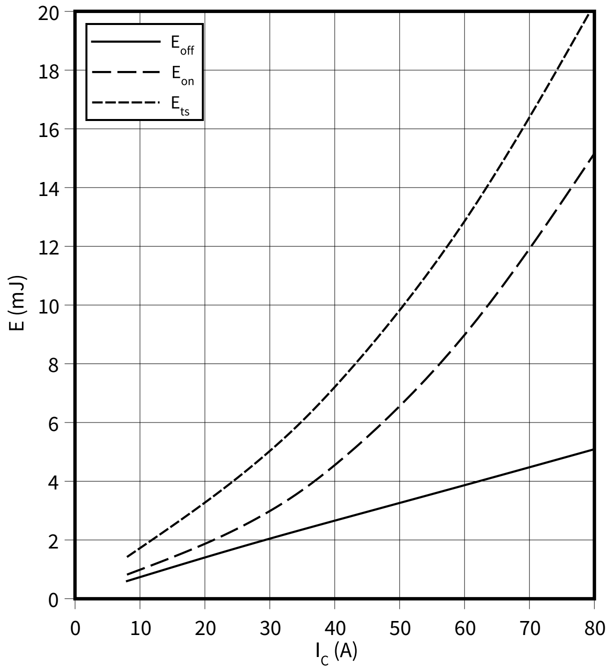
$I_C = 40.0$ A, $V_{CE} = 600$ V, $V_{GE} = 0/15$ V, $R_G = 12\ \Omega$



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

$E = f(I_C)$

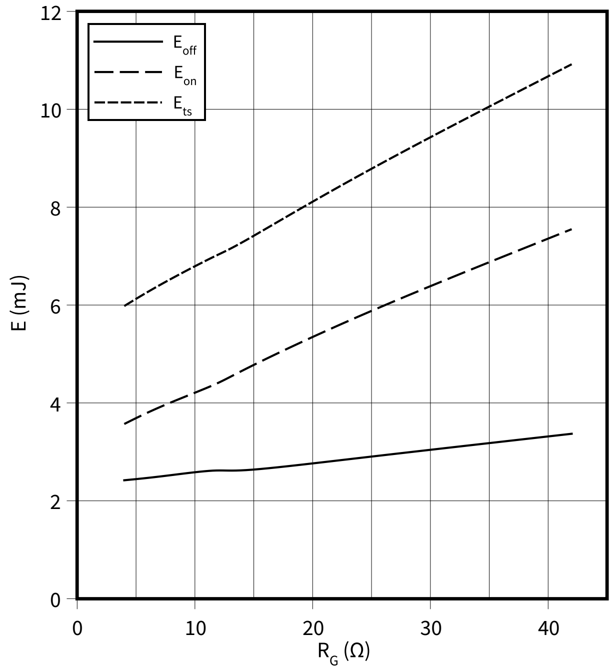
$V_{CE} = 600$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V, $R_G = 12\ \Omega$



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

$E = f(R_G)$

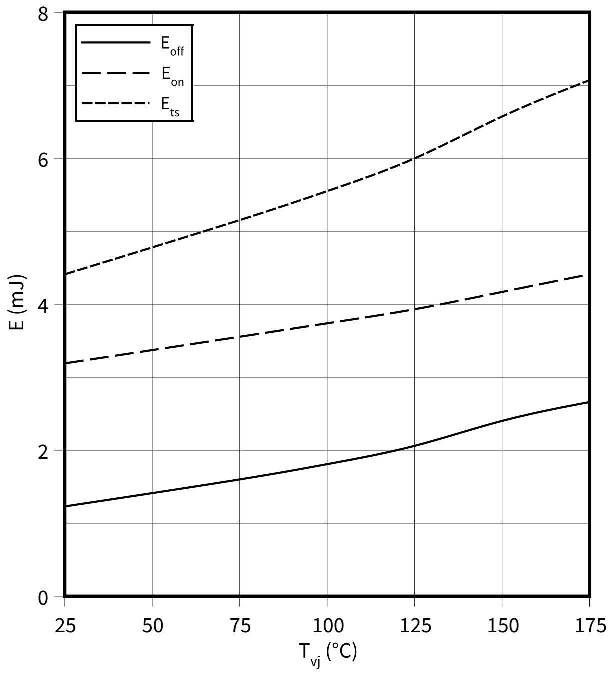
$I_C = 40.0$ A, $V_{CE} = 600$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V



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

$E = f(T_{vj})$

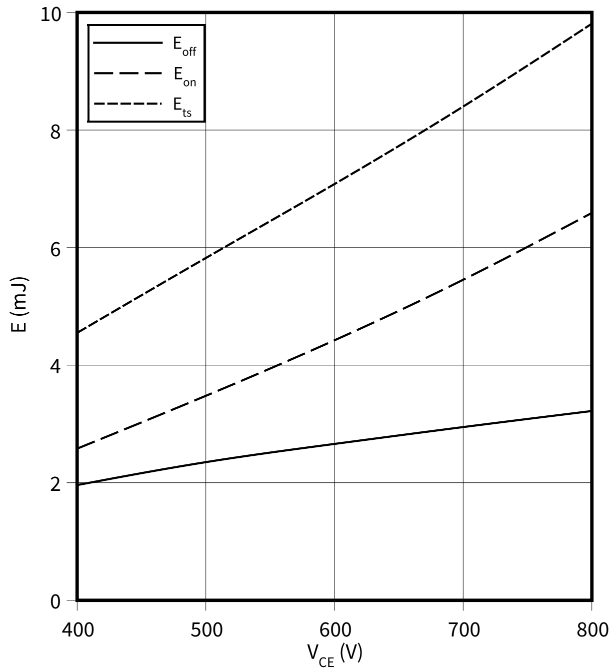
$I_C = 40.0$ A, $V_{CE} = 600$ V, $V_{GE} = 0/15$ V, $R_G = 12\ \Omega$



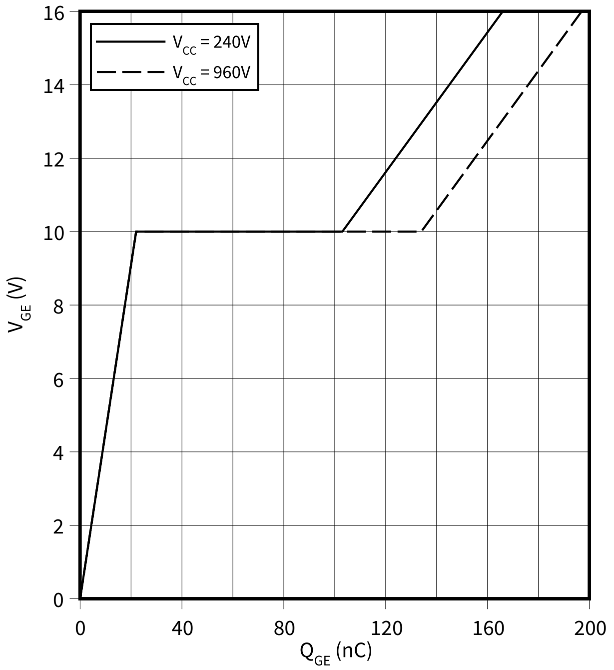
Typical switching energy losses as a function of collector emitter voltage, IGBT

$E = f(V_{CE})$

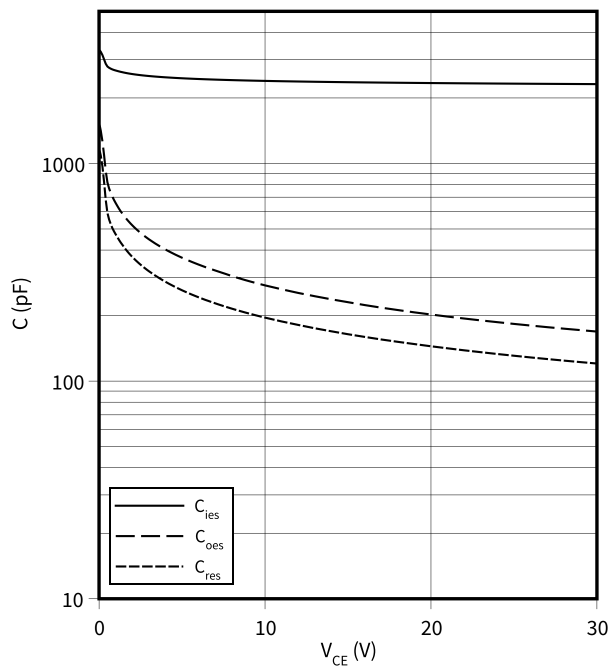
$I_C = 40.0$ A, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V, $R_G = 12\ \Omega$



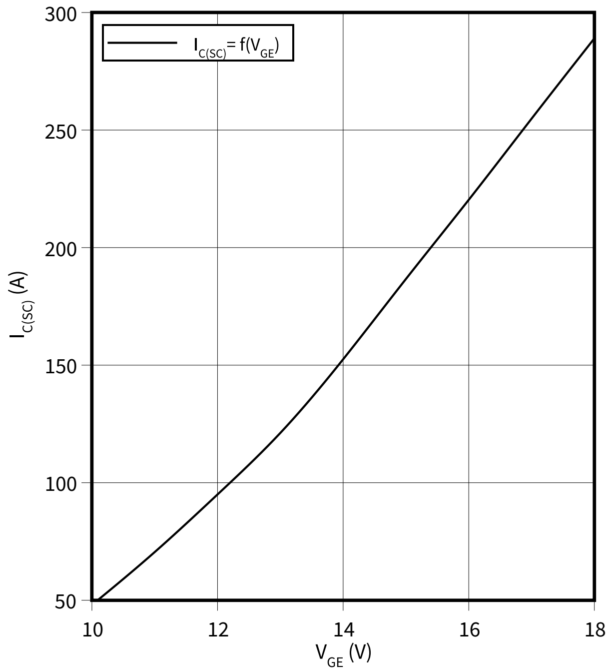
Typical gate charge, IGBT
$V_{GE} = f(Q_{GE})$
$I_C = 40.0$ A



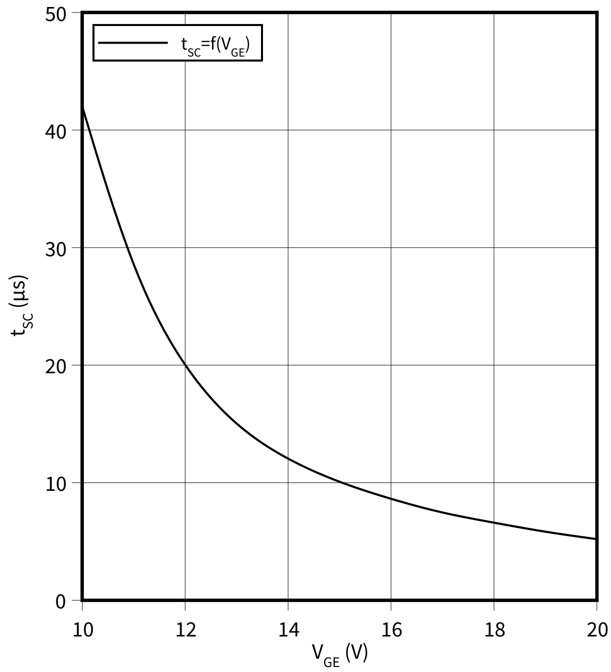
Typical capacitance as a function of collector-emitter voltage, IGBT
$C = f(V_{CE})$
f = 1000 kHz, $V_{GE} = 0$ V



Typical short circuit collector current as a function of gate-emitter voltage, IGBT
$I_{C(SC)} = f(V_{GE})$
$V_{CE} \leq 600$ V, $T_{vj,\ start} = 25$ °C

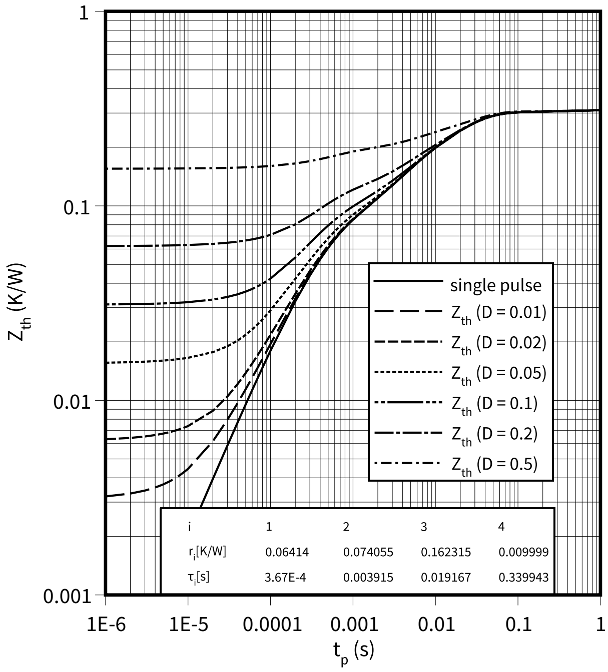


Short circuit withstand time as a function of gate-emitter voltage, IGBT
$t_{SC} = f(V_{GE})$
$T_{vj} \leq 175$ °C, $V_{CC} \leq 600$ V



IGBT transient thermal impedance, IGBT

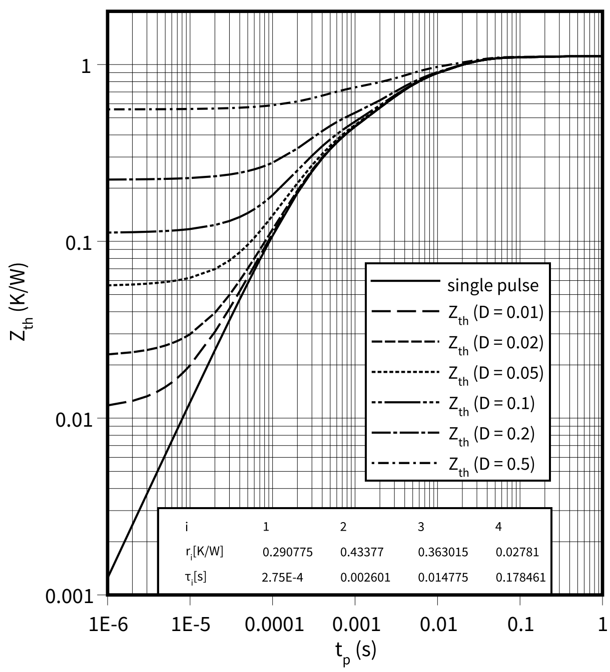
$Z_{th} = f(t_p)$
$D = t_p/T$



i	1	2	3	4
r_i[K/W]	0.06414	0.074055	0.162315	0.009999
τ_i[s]	3.67E-4	0.003915	0.019167	0.339943

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

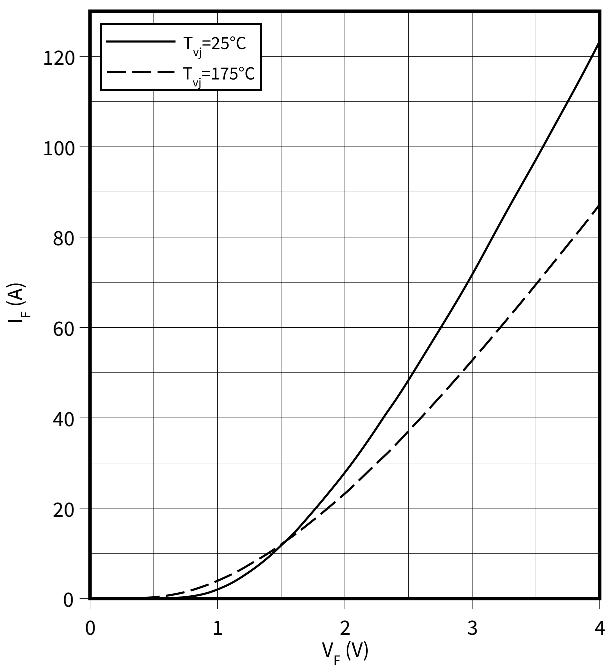
$Z_{th} = f(t_p)$
$D = t_p/T$



i	1	2	3	4
r_i[K/W]	0.290775	0.43377	0.363015	0.02781
τ_i[s]	2.75E-4	0.002601	0.014775	0.178461

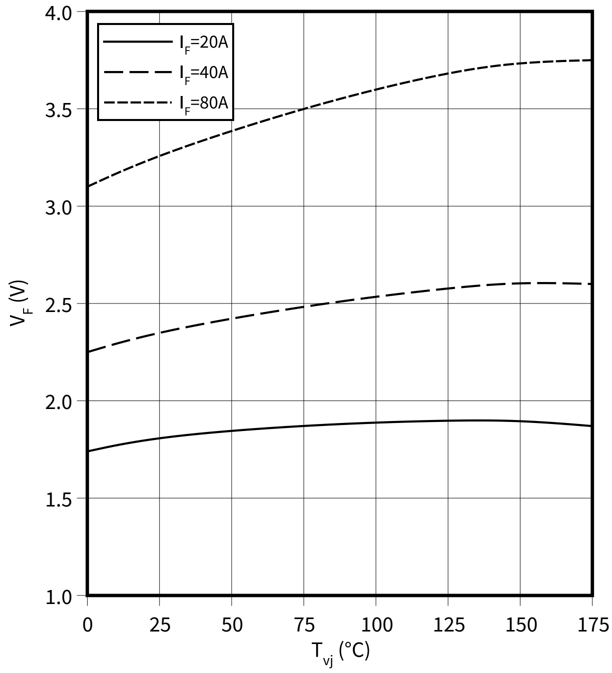
Typical diode forward current as a function of forward voltage, Diode

$I_F = f(V_F)$



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

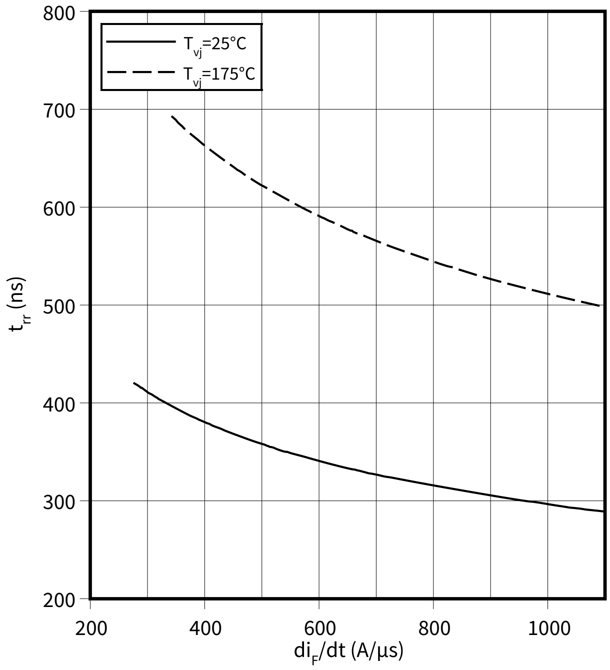
$V_F = f(T_{vj})$



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

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

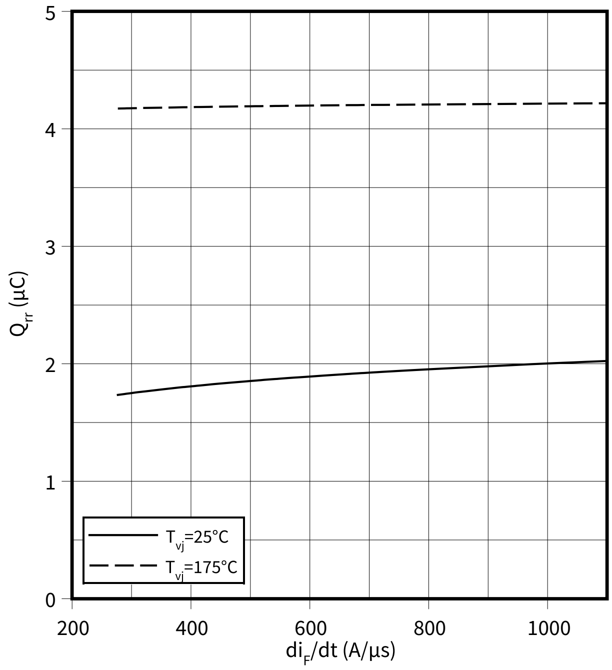
$V_R = 600\ V$, $I_F = 40\ A$



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

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

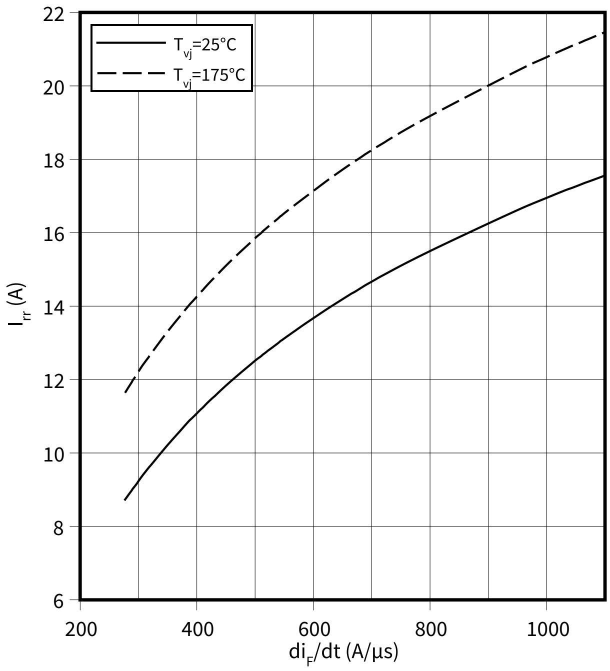
$V_R = 600\ V$, $I_F = 40\ A$



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

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

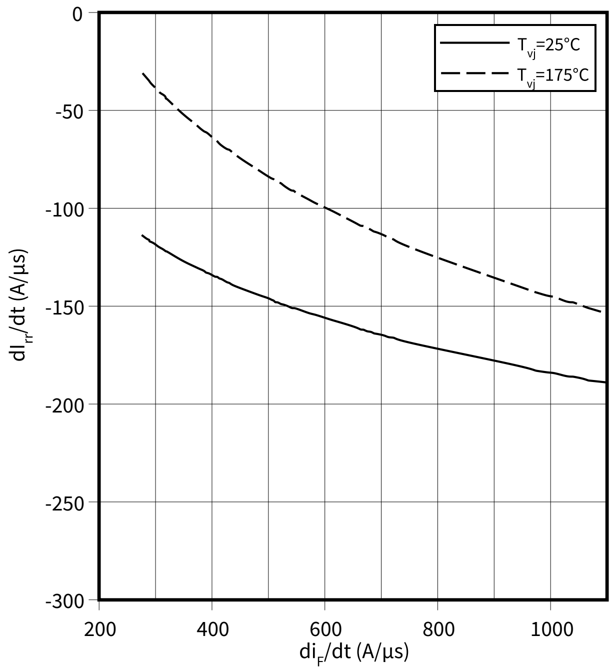
$V_R = 600\ V$, $I_F = 40\ A$



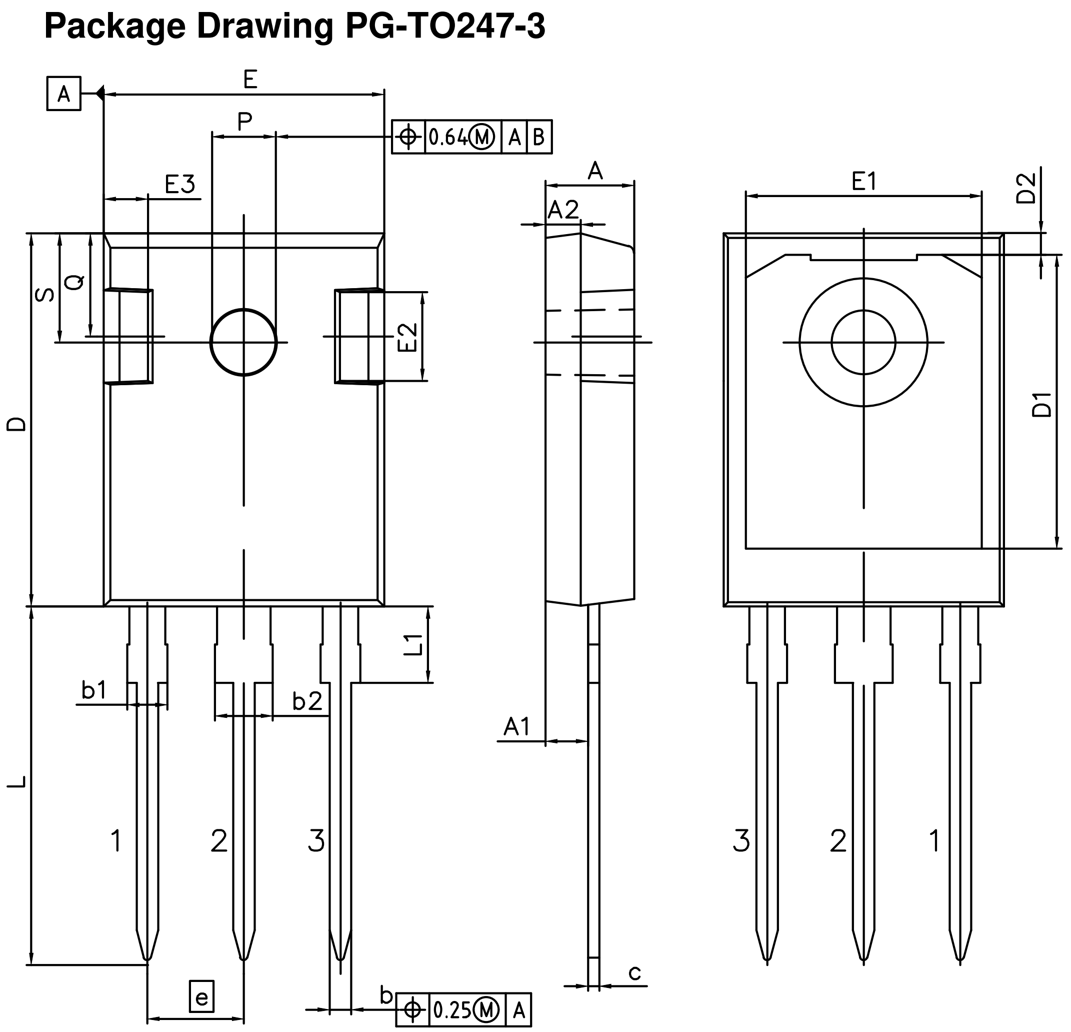
Typical diode peak rate of fall of reverse recovery current as a function of diode current slope, Diode

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

$V_R = 600\ V$, $I_F = 40\ A$



5 Package outlines



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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Figure 6

6 Testing conditions

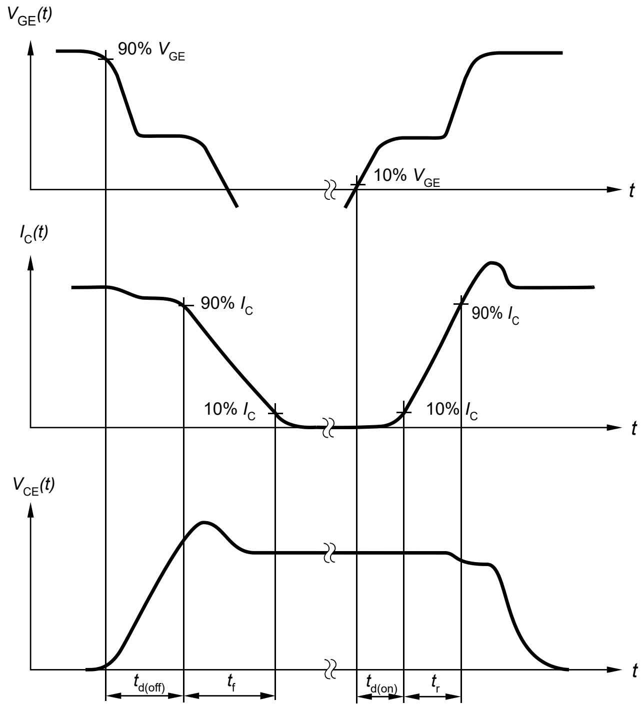

Figure A. **Definition of switching times**

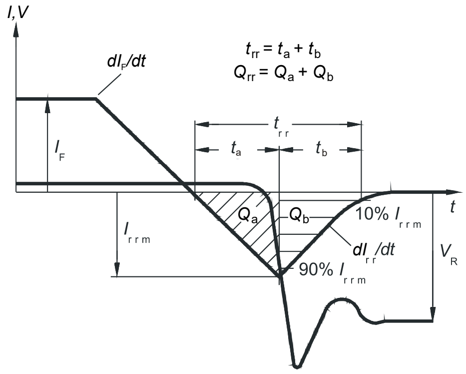

Figure C. **Definition of diode switching characteristics**

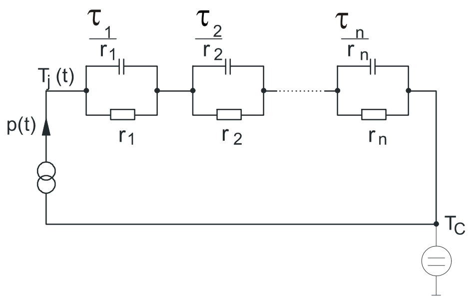

Figure D. **Thermal equivalent circuit**

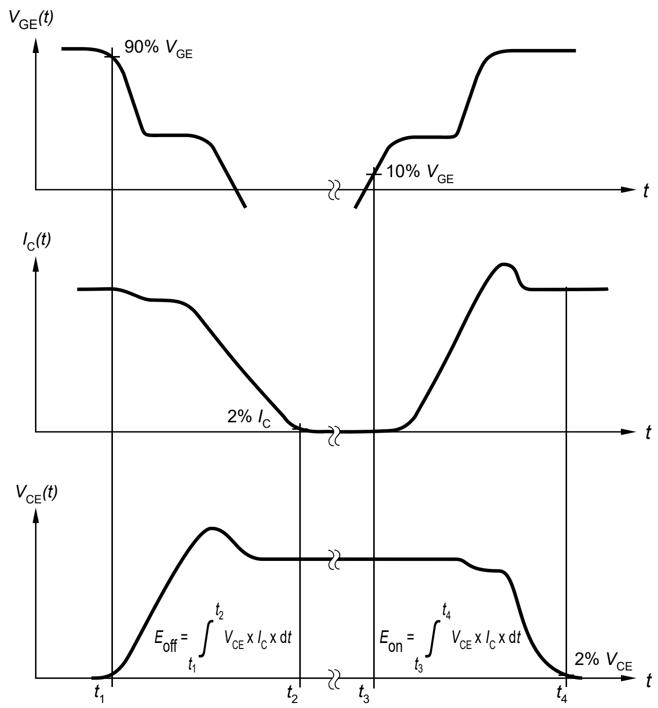

Figure B. **Definition of switching losses**

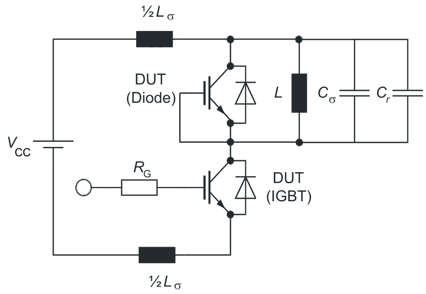

Figure E. **Dynamic test circuit**
Parasitic inductance L_{σ},
parasitic capacitor C_{σ},
relief capacitor C_r,
(only for ZVT switching)

Figure 7

Revision history

Document revision	Date of release	Description of changes
V1.1	2009-12-03	
V1.2	2010-02-10	
V2.1	2014-11-26	Final data sheet
V2.2		Minor change figure 28
1.10	2021-09-08	Update of legend at the diagram $V_F = f(T_{vj})$

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