TRENCHSTOP™ 5 WR6 technology in enhanced creepage and clearance package offers improved reliability against package contamination

Features

- V_{CE} = 650 V
- I_C = 40 A
- Pin-to-pin creepage distance > 4.8 mm
- Pin-to-pin clearance distance > 3.4 mm
- Monolithic diode optimized for PFC and welding applications
- Stable temperature behavior
- Very low V_{CEsat} and low E_{off}
- Easy parallel switching capability based on positive temperature coefficient of V_{CEsat}
- Low temperature dependence of V_{CEsat} and E_{sw}
- Product spectrum and PSpice Models: http://www.infineon.com/igbt/

Potential applications

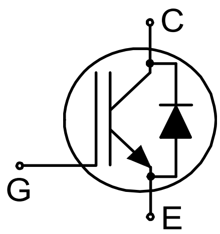
- PFC
- Welding
- ZCS applications

Product validation

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

Lead-free
Green
Halogen-free
RoHS

Description



Type	Package	Marking
IKWH40N65WR6	PG-TO247-3-STD-NN4.8	H40EWR6

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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		nH
Storage temperature	T_{stg}		-55		150	°C
Soldering temperature	T_{sold}	wave soldering 1.6 mm (0.063 in.) from case for 10 s			260	°C
Mounting torque	M	M3 screw, Maximum of mounting process: 3			0.6	Nm
Thermal resistance, junction-ambient	$R_{th(j-a)}$				40	K/W
IGBT thermal resistance, junction-case	$R_{th(j-c)}$				0.9	K/W
Diode thermal resistance, junction-case	$R_{th(j-c)}$				4.2	K/W

2 IGBT

Table 2 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Collector-emitter voltage	V_{CE}	$T_{vj} \geq 25$ °C		650	V
DC collector current, limited by T_{vjmax}	I_C		$T_c = 25$ °C	70	A
			$T_c = 100$ °C	45	
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpulse}			120	A
Turn-off safe operating area		$V_{CE} \leq 650$ V, $T_{vj} \leq 175$ °C		120	A
Gate-emitter voltage	V_{GE}			±20	V
Transient gate-emitter voltage	V_{GE}	$t_p \leq 10$ µs, $D < 0.01$		±30	V
Power dissipation	P_{tot}		$T_c = 25$ °C	175	W
			$T_c = 100$ °C	78	

Table 3 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Collector-emitter breakdown voltage	V_{BRCES}	$I_C = 0.2$ mA, V_{GE}=0 V	650			V

(table continues...)

Table 3 **(continued) Characteristic values**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Collector-emitter saturation voltage	V_{CEsat}	I_C = 40 A, V_{GE} = 15 V	T_{vj} = 25 °C		1.55	1.85	V
			T_{vj} = 175 °C		1.8		
Gate-emitter threshold voltage	V_{GEth}	I_C = 0.4 mA, V_{CE} = V_{GE}		3.2	4	4.8	V
Zero gate-voltage collector current	I_{CES}	V_{CE} = 650 V, V_{GE}=0 V	T_{vj} = 25 °C			40	µA
			T_{vj} = 175 °C		0.5		mA
Gate-emitter leakage current	I_{GES}	V_{CE}=0 V, V_{GE} = 20 V				100	nA
Transconductance	g_{fs}	I_C = 40 A, V_{CE} = 20 V			89		S
Input capacitance	C_{ies}	V_{CE} = 25 V, V_{GE}=0 V, f = 100 kHz			2890		pF
Output capacitance	C_{oes}	V_{CE} = 25 V, V_{GE}=0 V, f = 100 kHz			28		pF
Reverse transfer capacitance	C_{res}	V_{CE} = 25 V, V_{GE}=0 V, f = 100 kHz			11		pF
Gate charge	Q_G	I_C = 40 A, V_{GE} = 15 V, V_{CC} = 520 V			117		nC
Turn-on delay time	$t_{d(on)}$	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 27 Ω, $R_{G(off)}$ = 27 Ω, L_σ = 30 nH, C_σ = 26 pF	T_{vj} = 25 °C, I_C = 40 A		37		ns
			T_{vj} = 175 °C, I_C = 40 A		34		
Rise time (inductive load)	t_r	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 27 Ω, $R_{G(off)}$ = 27 Ω, L_σ = 30 nH, C_σ = 26 pF	T_{vj} = 25 °C, I_C = 40 A		24		ns
			T_{vj} = 175 °C, I_C = 40 A		25		
Turn-off delay time	$t_{d(off)}$	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 27 Ω, $R_{G(off)}$ = 27 Ω, L_σ = 30 nH, C_σ = 26 pF	T_{vj} = 25 °C, I_C = 40 A		353		ns
			T_{vj} = 175 °C, I_C = 40 A		401		
Fall time (inductive load)	t_f	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 27 Ω, $R_{G(off)}$ = 27 Ω, L_σ = 30 nH, C_σ = 26 pF	T_{vj} = 25 °C, I_C = 40 A		23		ns
			T_{vj} = 175 °C, I_C = 40 A		18		
Turn-on energy	E_{on}	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 27 Ω, $R_{G(off)}$ = 27 Ω, L_σ = 30 nH, C_σ = 26 pF	T_{vj} = 25 °C, I_C = 40 A		1.09		mJ
			T_{vj} = 175 °C, I_C = 40 A		1.23		

(table continues...)

Table 3 **(continued) Characteristic values**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Turn-off energy	E_{off}	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 27 Ω, $R_{G(off)}$ = 27 Ω, L_σ = 30 nH, C_σ = 26 pF	T_{vj} = 25 °C, I_C = 40 A		0.57		mJ
			T_{vj} = 175 °C, I_C = 40 A		0.89		
Total switching energy	E_{ts}	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 27 Ω, $R_{G(off)}$ = 27 Ω, L_σ = 30 nH, C_σ = 26 pF	T_{vj} = 25 °C, I_C = 40 A		1.66		mJ
			T_{vj} = 175 °C, I_C = 40 A		2.12		
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		650	V
Diode forward current, limited by T_{vjmax}	I_F		T_c = 25 °C	20	A
			T_c = 100 °C	11	
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpulse}			40	A

Table 5 **Characteristic values**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode forward voltage	V_F	I_F = 10 A	T_{vj} = 25 °C		1.3	1.6	V
			T_{vj} = 175 °C		1.3		
Diode reverse recovery time	t_{rr}	V_R = 400 V	T_{vj} = 25 °C, I_F = 20 A, $-di_F/dt$ = 1460 A/µs		79		ns
			T_{vj} = 175 °C, I_F = 20 A, $-di_F/dt$ = 1350 A/µs		104		

(table continues...)

Table 5 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode reverse recovery charge	Q_{rr}	V_R = 400 V	T_{vj} = 25 °C, I_F = 20 A, $-di_F/dt$ = 1460 A/µs		1.4		µC
			T_{vj} = 175 °C, I_F = 20 A, $-di_F/dt$ = 1350 A/µs		2.5		
Diode peak reverse recovery current	I_{rrm}	V_R = 400 V	T_{vj} = 25 °C, I_F = 20 A, $-di_F/dt$ = 1460 A/µs		24.7		A
			T_{vj} = 175 °C, I_F = 20 A, $-di_F/dt$ = 1350 A/µs		38.3		
Diode peak rate of fall of reverse recovery current	di_{rr}/dt	V_R = 400 V	T_{vj} = 25 °C, I_F = 20 A, $-di_F/dt$ = 1460 A/µs		383		A/µs
			T_{vj} = 175 °C, I_F = 20 A, $-di_F/dt$ = 1350 A/µs		821		
Operating junction temperature	T_{vj}			-40		175	°C

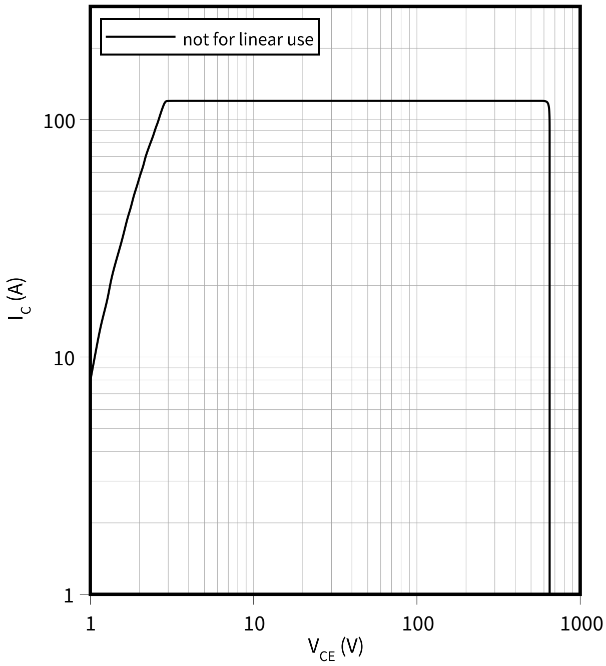
Note: For optimum lifetime and reliability, Infineon recommends operating conditions that do not exceed 80% of the maximum ratings stated in this datasheet.

4 Characteristics diagrams

Reverse bias safe operating area

$I_C = f(V_{CE})$

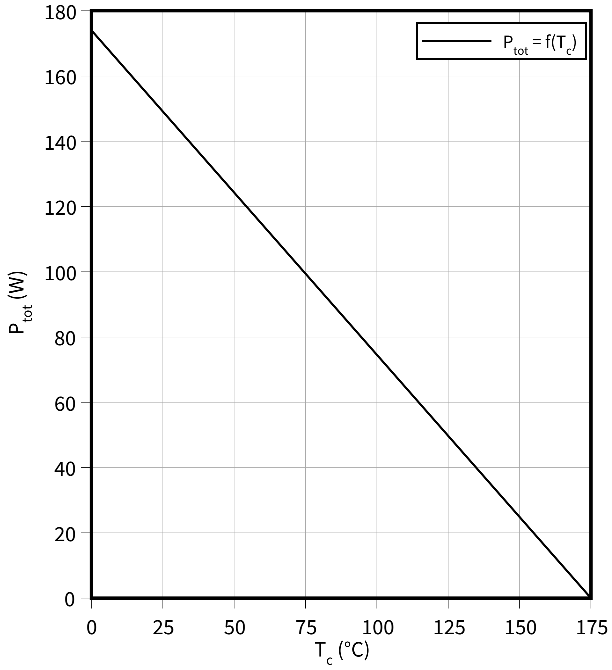
$T_{vj} \leq 175\ °C$, $T_c = 25\ °C$, $V_{GE} = 15\ V$



Power dissipation as a function of case temperature

$P_{tot} = f(T_c)$

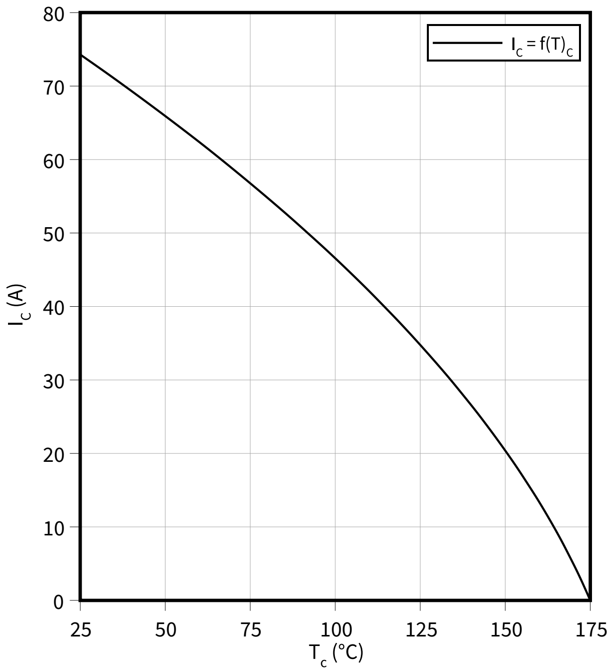
$T_{vj} \leq 175\ °C$



Collector current as a function of case temperature

$I_C = f(T_c)$

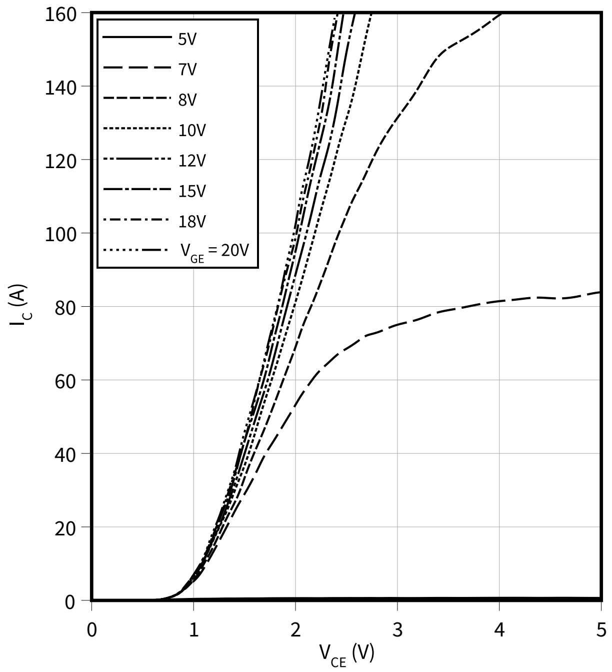
$T_{vj} \leq 175\ °C$, $V_{GE} \geq 15\ V$



Typical output characteristic

$I_C = f(V_{CE})$

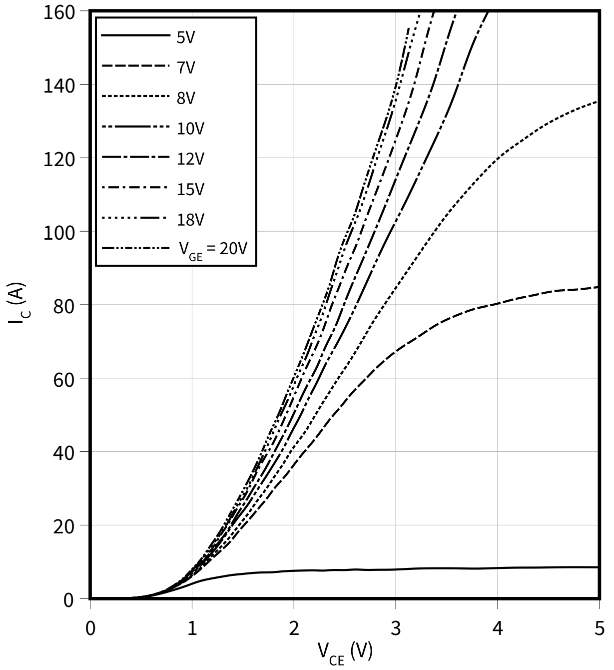
$T_{vj} = 25\ °C$



Typical output characteristic

$I_C = f(V_{CE})$

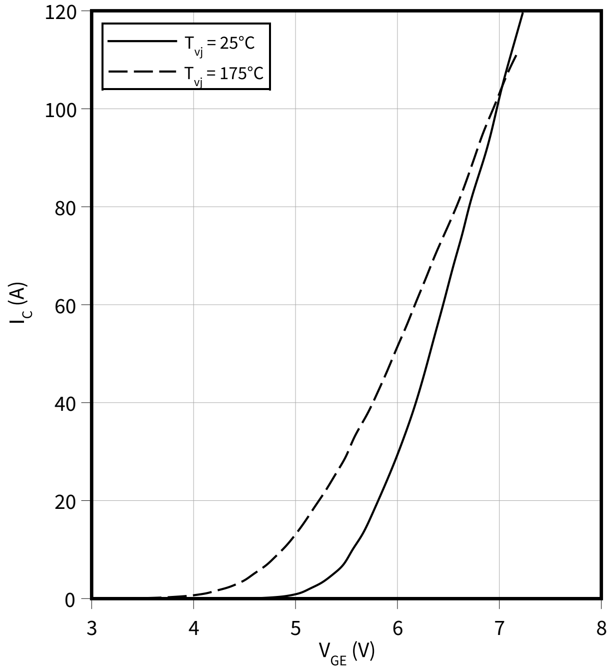
$T_{vj} = 175\ °C$



Typical transfer characteristic

$I_C = f(V_{GE})$

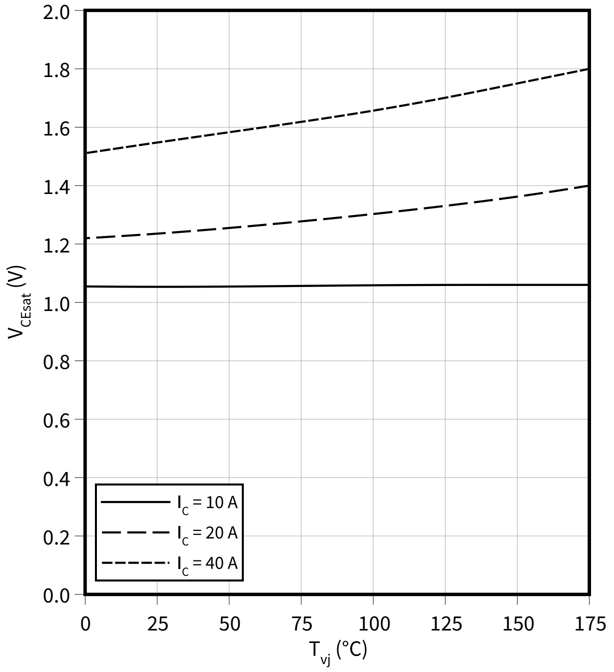
$V_{CE} = 20\ V$



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

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

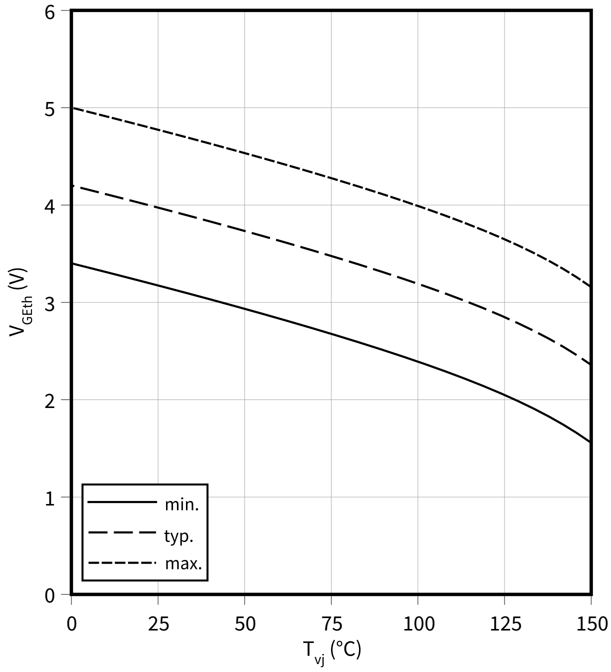
$V_{GE} = 15\ V$



Gate-emitter threshold voltage as a function of junction temperature

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

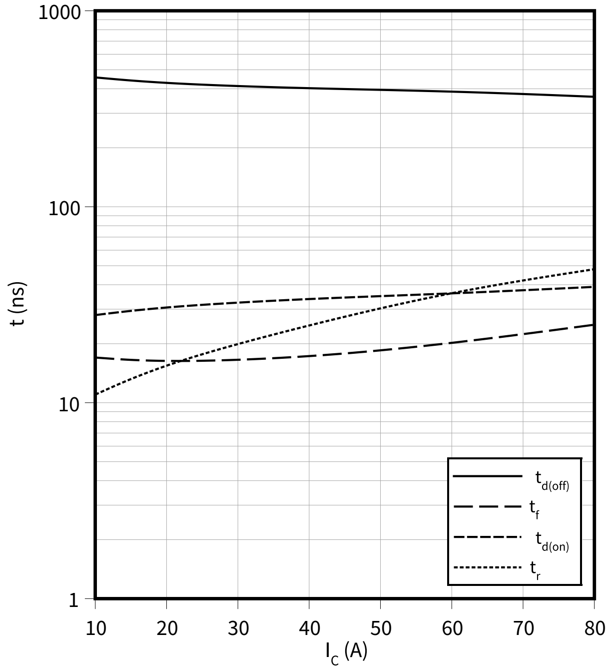
$I_C = 0.4\ mA$



Typical switching times as a function of collector current

$t = f(I_C)$

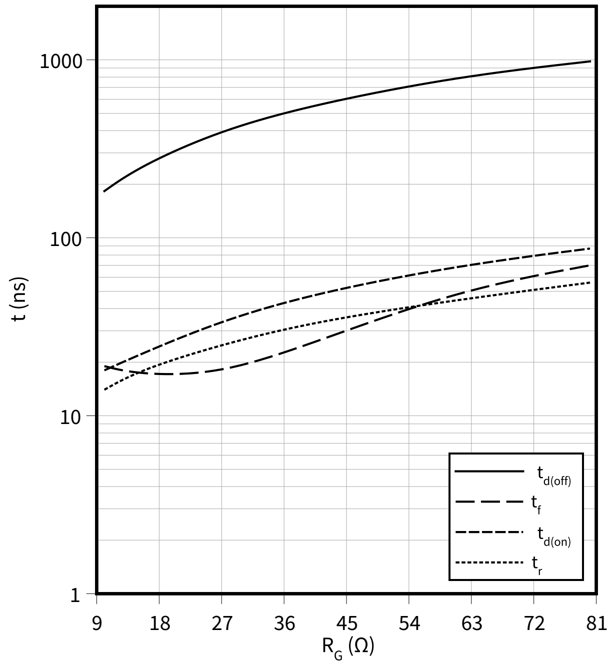
$V_{CC} = 400$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V, $R_G = 27$ Ω



Typical switching times as a function of gate resistor

$t = f(R_G)$

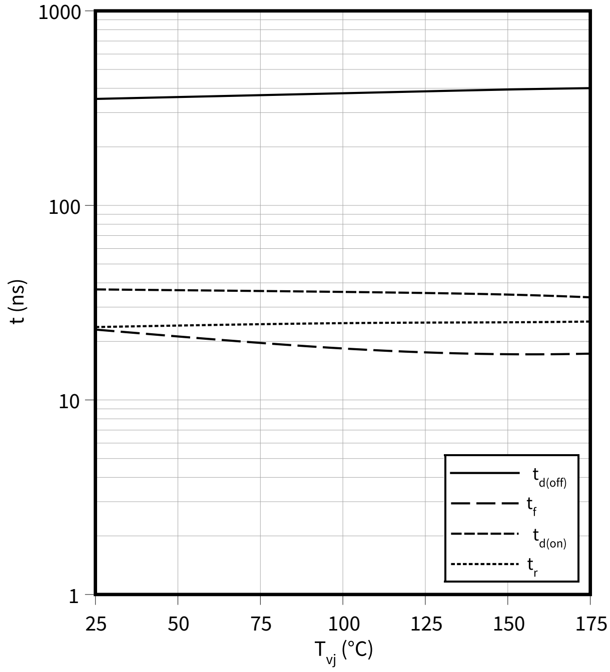
$I_C = 40$ A, $V_{CC} = 400$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V



Typical switching times as a function of junction temperature

$t = f(T_{vj})$

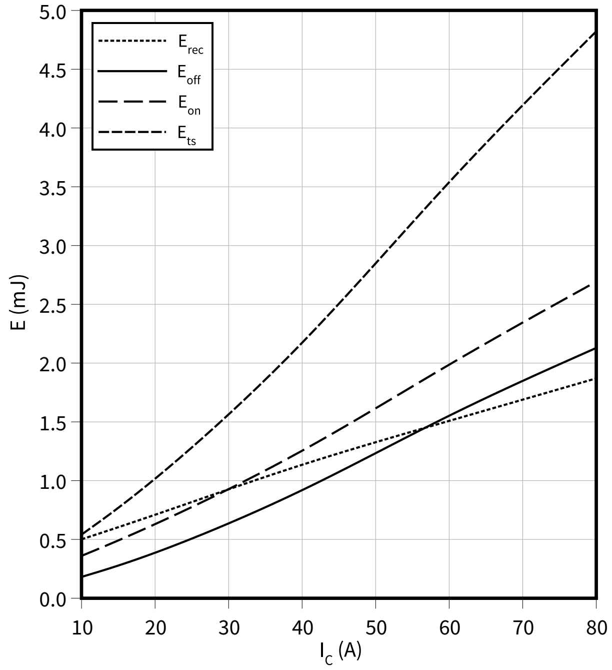
$I_C = 40$ A, $V_{CC} = 400$ V, $V_{GE} = 0/15$ V, $R_G = 27$ Ω



Typical switching energy losses as a function of collector current

$E = f(I_C)$

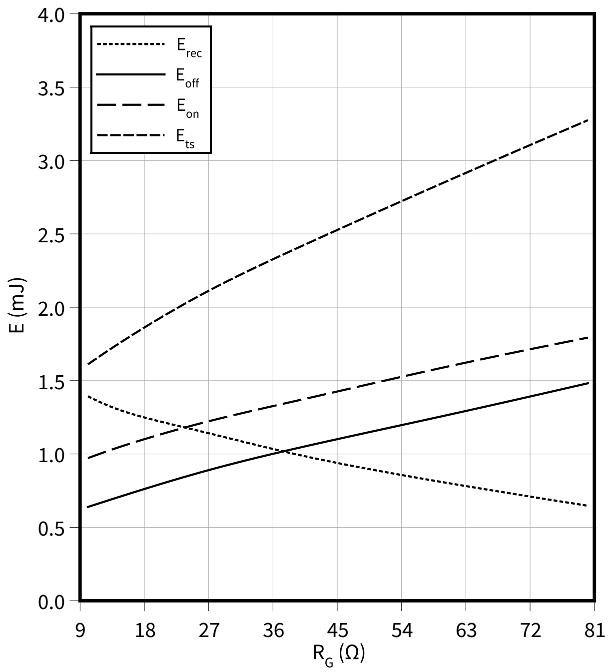
$V_{CC} = 400$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V, $R_G = 27$ Ω



Typical switching energy losses as a function of gate resistor

$E = f(R_G)$

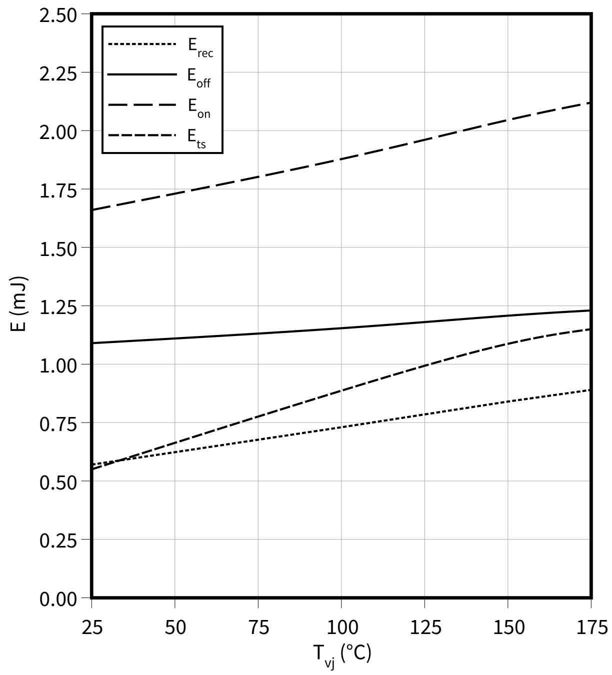
$I_C = 40$ A, $V_{CC} = 400$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V



Typical switching energy losses as a function of junction temperature

$E = f(T_{vj})$

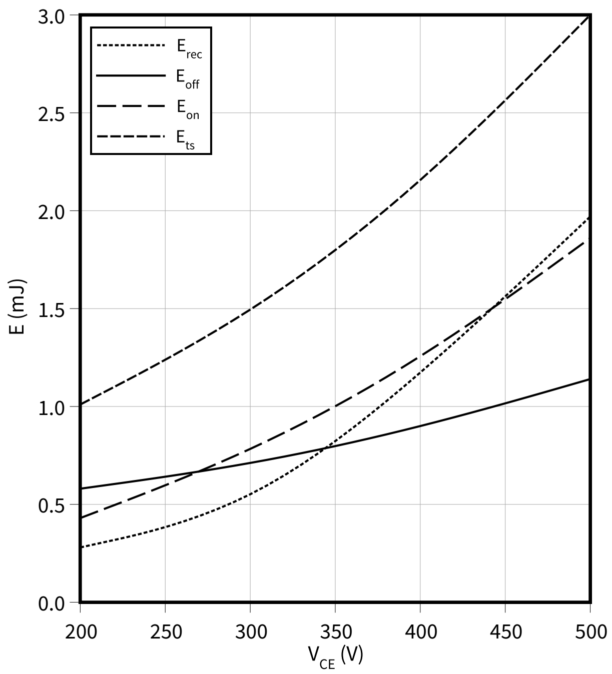
$I_C = 40$ A, $V_{CC} = 400$ V, $V_{GE} = 0/15$ V, $R_G = 27$ Ω



Typical switching energy losses as a function of collector emitter voltage

$E = f(V_{CE})$

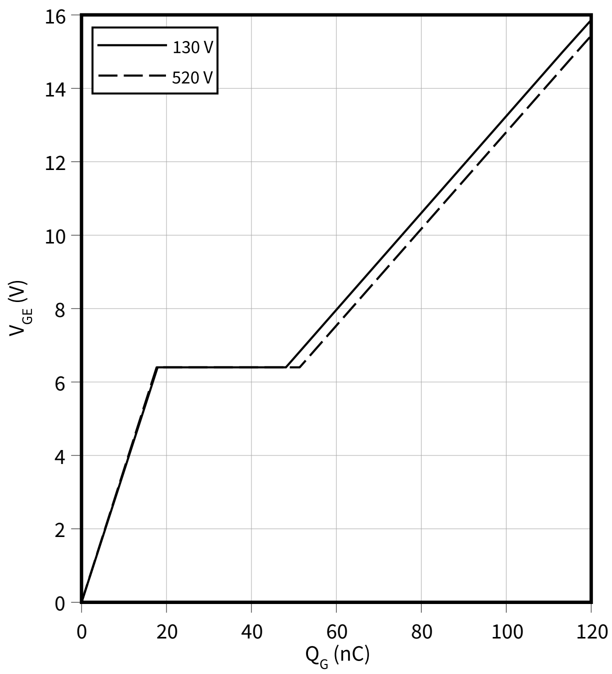
$I_C = 40$ A, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V, $R_G = 27$ Ω



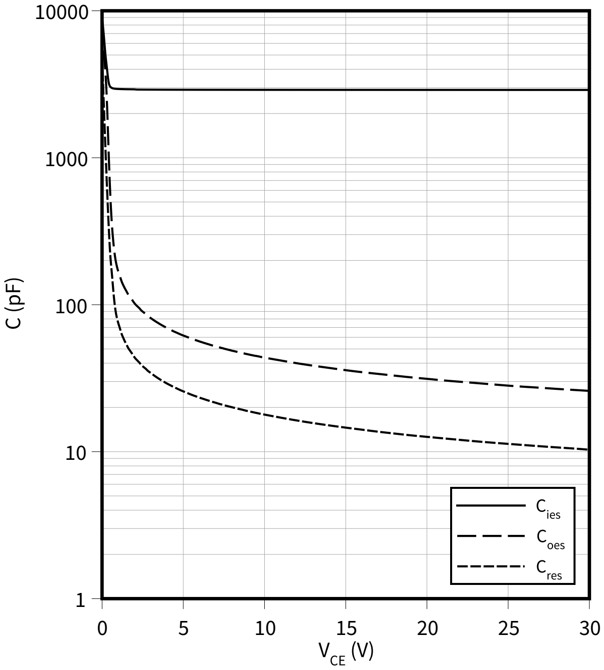
Typical gate charge

$V_{GE} = f(Q_G)$

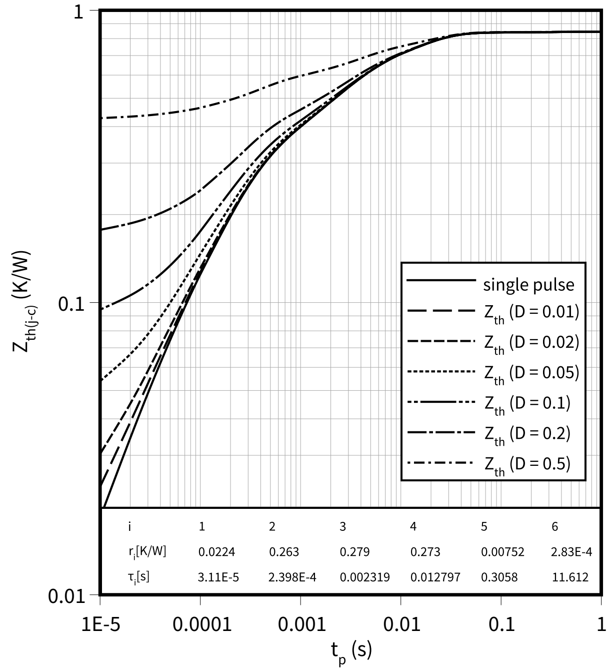
$I_C = 40$ A



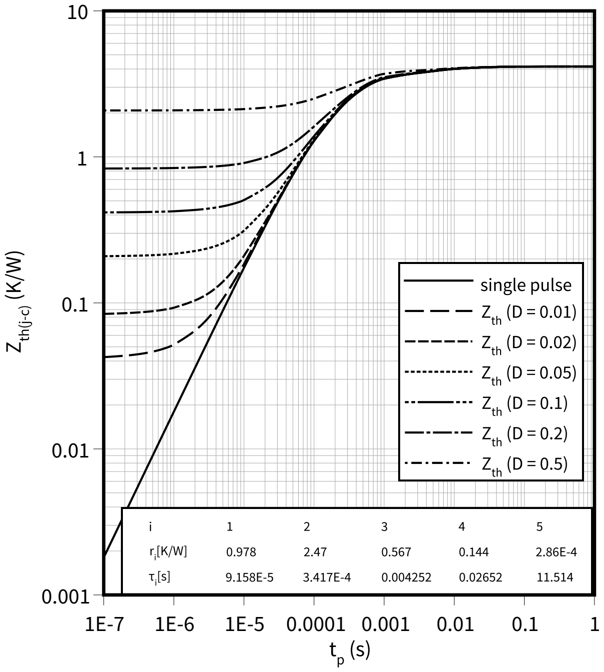
Typical capacitance as a function of collector-emitter voltage
$C = f(V_{CE})$
$f = 100$ kHz, $V_{GE} = 0$ V



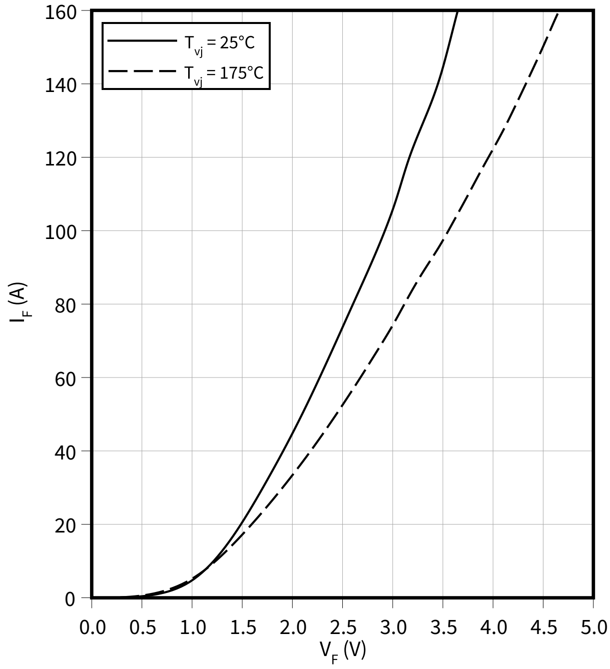
IGBT transient thermal impedance as a function of pulse width
$Z_{th(j-c)} = f(t_p)$
$D = t_p/T$



Diode transient thermal impedance as a function of pulse width
$Z_{th(j-c)} = f(t_p)$
$D = t_p/T$

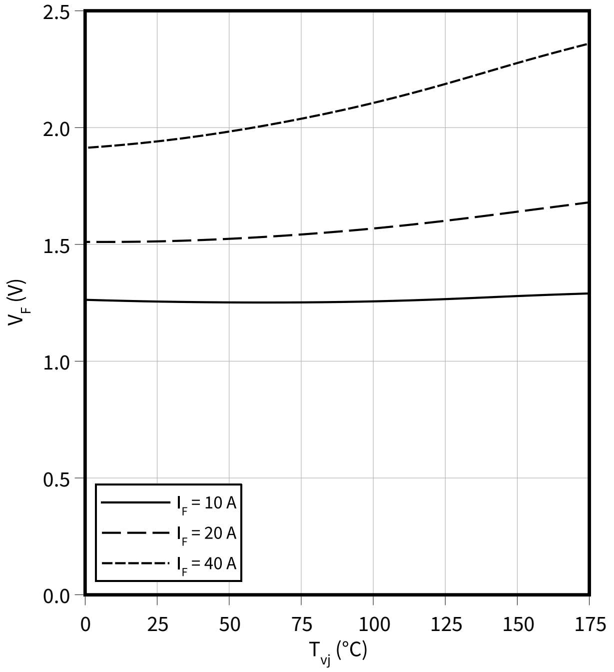


Typical diode forward current as a function of forward voltage
$I_F = f(V_F)$



Typical diode forward voltage as a function of junction temperature

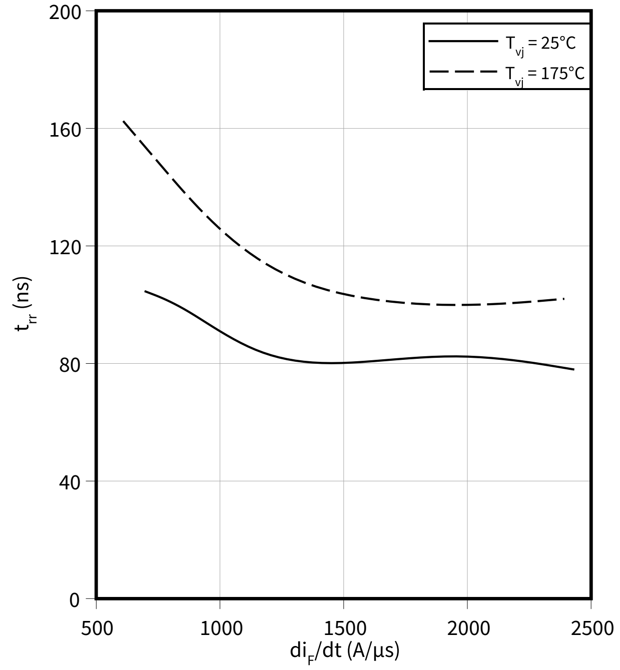
$V_F = f(T_{vj})$



Typical reverse recovery time as a function of diode current slope

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

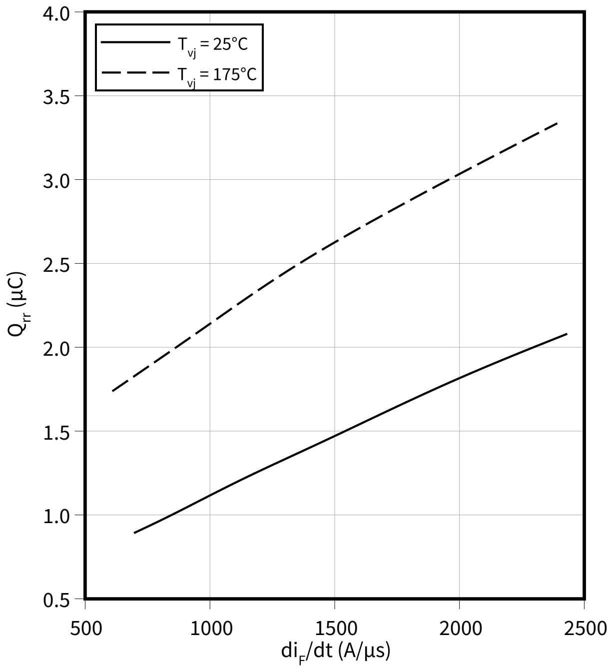
$V_R = 400$ V, $I_F = 20$ A



Typical reverse recovery charge as a function of diode current slope

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

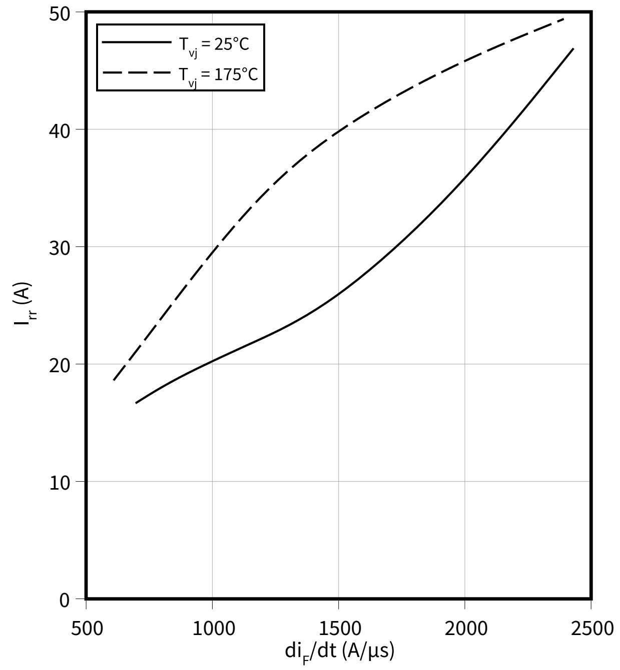
$I_F = 20$ A, $V_R = 400$ V



Typical reverse recovery current as a function of diode current slope

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

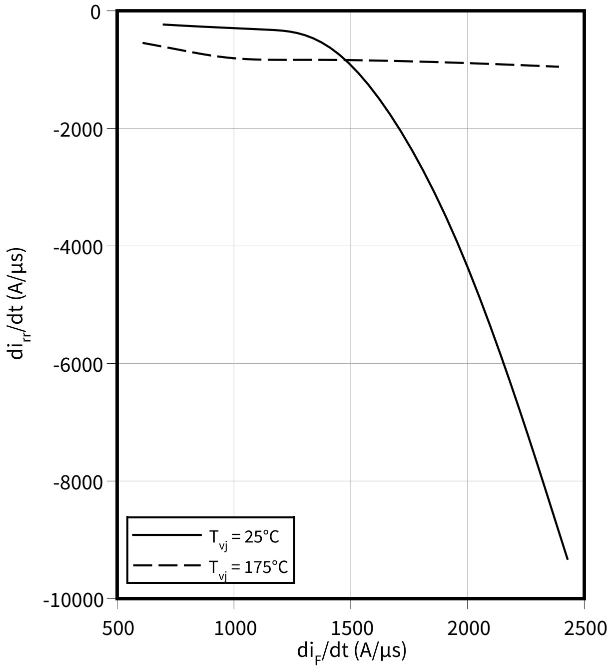
$I_F = 20$ A, $V_R = 400$ V



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

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

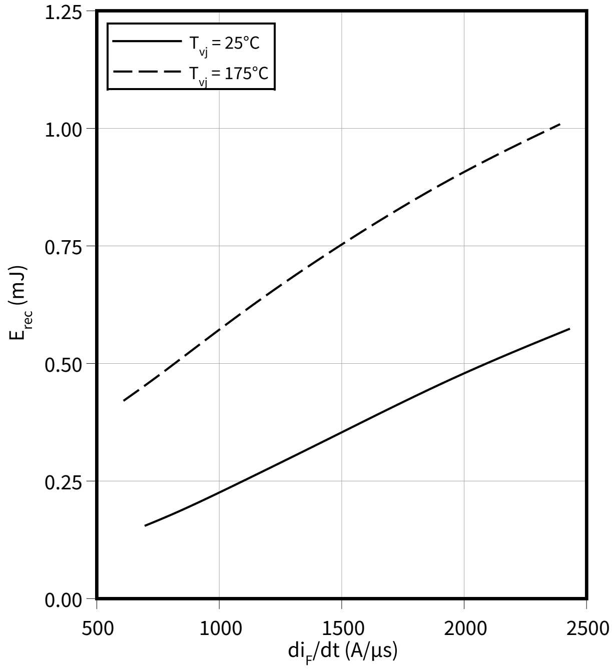
$V_R = 400\ V$, $I_F = 20\ A$



Typical reverse energy losses as a function of diode current slope

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

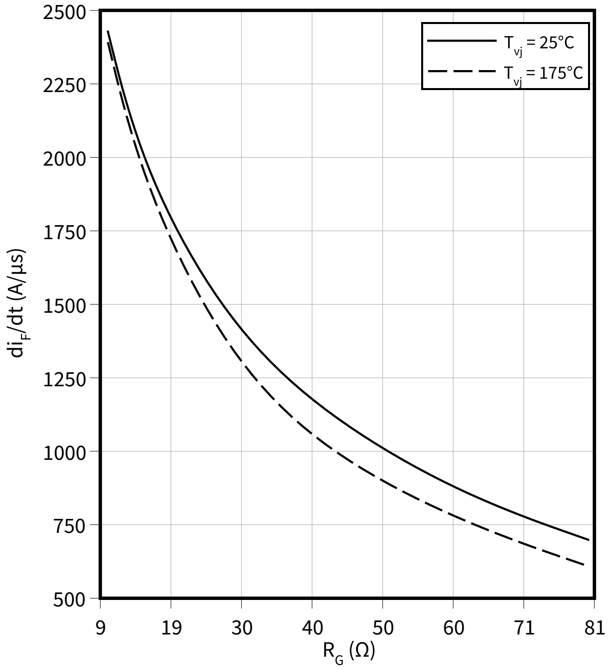
$V_R = 400\ V$, $I_F = 20\ A$



Typical diode current slope as a function of gate resistor

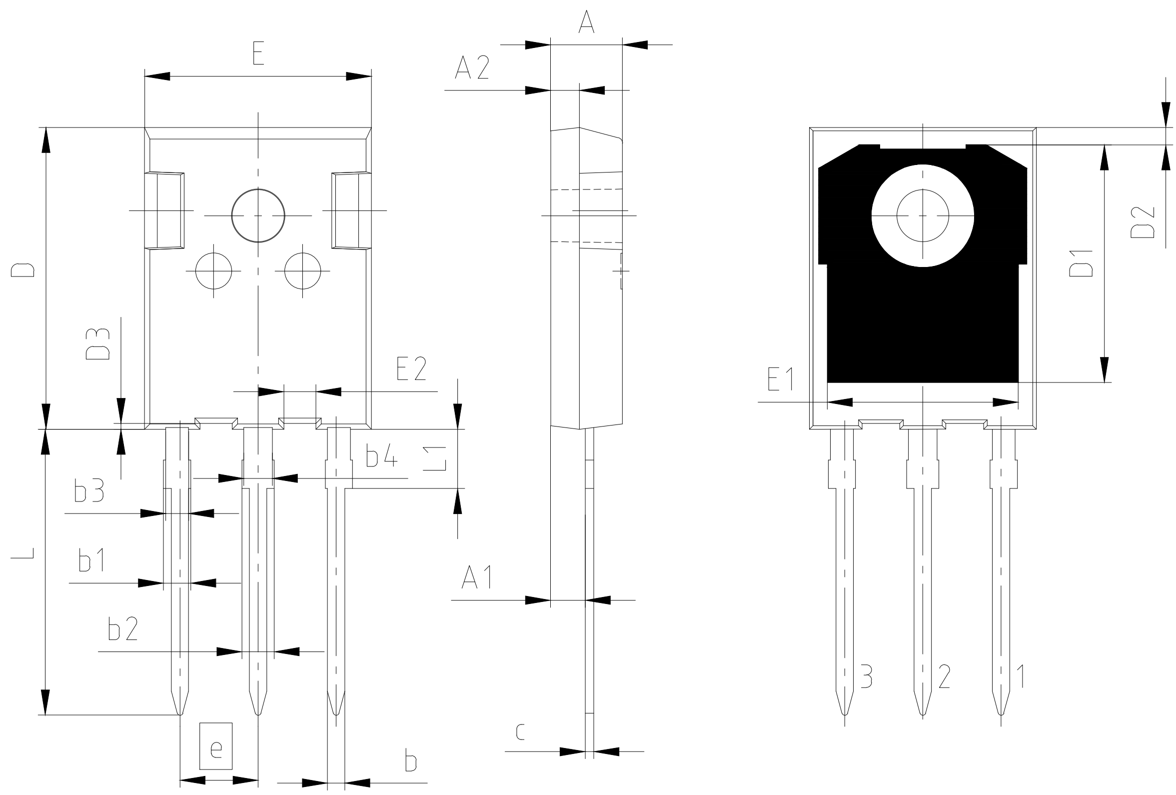
$di_F/dt = f(R_G)$

$V_R = 400\ V$, $I_F = 20\ A$



5 Package outlines

PG-TO247-3-STD-NN4.8



PACKAGE - GROUP NUMBER:	PG-TO247-3-U04	
DIMENSIONS	**MILLIMETERS**	
	MIN.	MAX.
A	4.90	5.10
A1	2.31	2.51
A2	1.90	2.10
b	1.16	1.26
b1		1.90
b2		2.30
b3	1.55	1.65
b4	1.96	2.06
c	0.59	0.66
D	20.90	21.10
D1	16.25	16.85
D2	1.05	1.35
D3	0.55	0.65
E	15.70	15.90
E1	13.10	13.50
E2	2.14	2.34
e	5.44	
N	3	
L	19.80	20.10
L1	3.95	4.30

Figure 1

6 Testing conditions

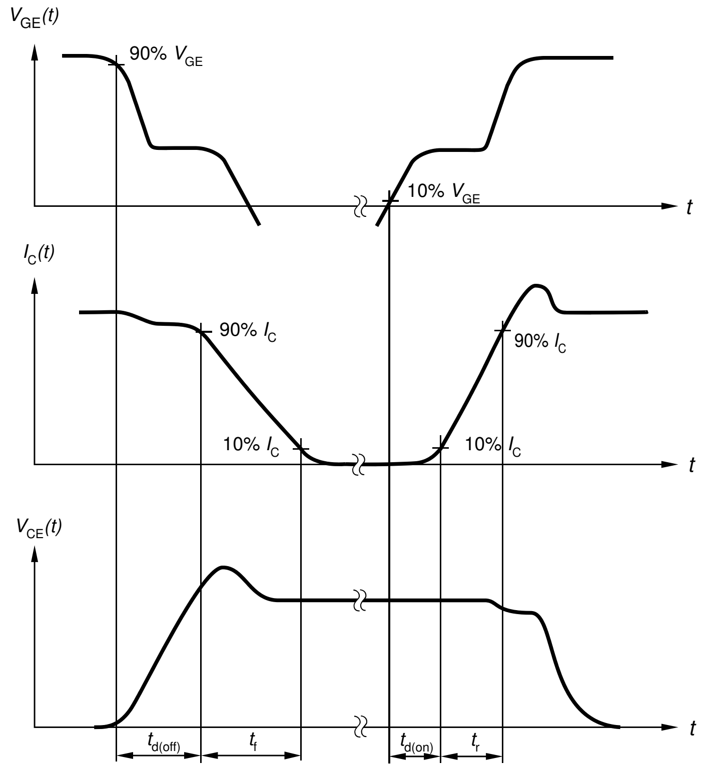


Figure A. **Definition of switching times**

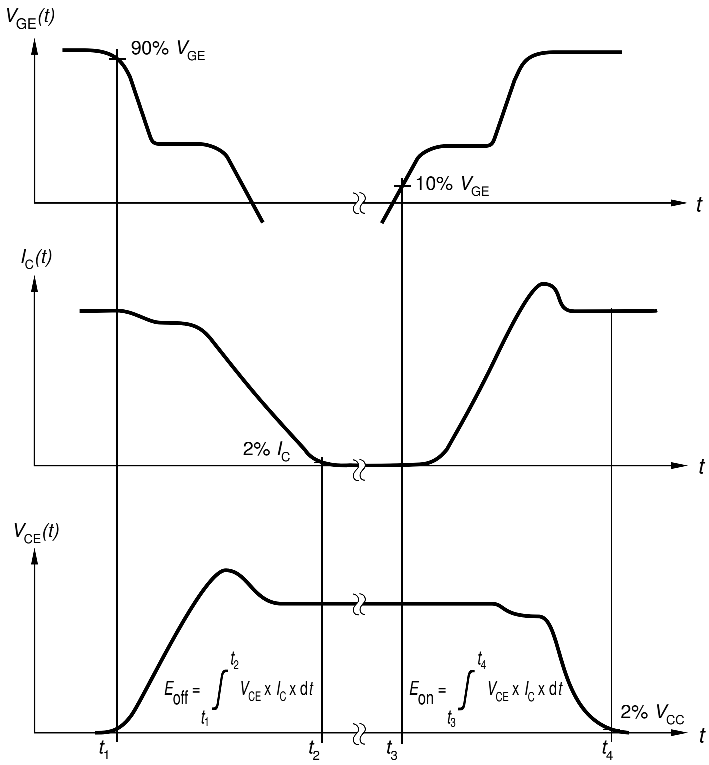


Figure B. **Definition of switching losses**

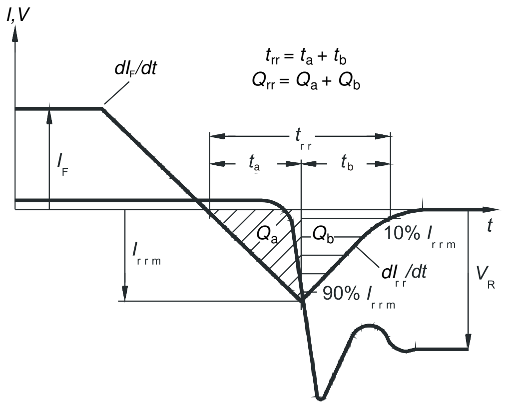


Figure C. **Definition of diode switching characteristics**

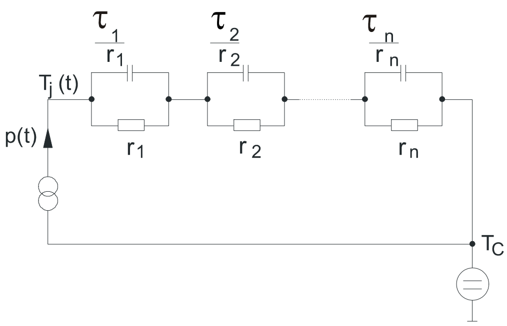


Figure D. **Thermal equivalent circuit**

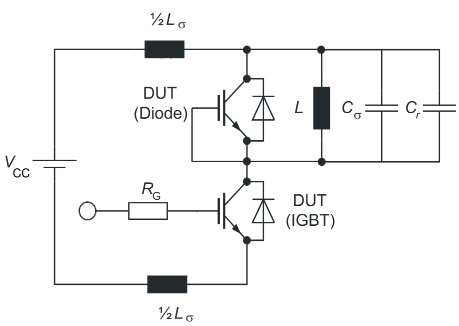


Figure E. **Dynamic test circuit**
Parasitic inductance L_σ,
parasitic capacitor C_σ,
relief capacitor C_r,
(only for ZVT switching)

Figure 2

Revision history

Document revision	Date of release	Description of changes
1.00	2021-05-17	Final datasheet
1.10	2021-05-18	Update of diagram E = f(Tvj)
1.20	2021-06-29	Update of diagram $E = f(T_{vj})$
1.30	2022-12-06	Update of “DC collector current, limited by T_{vjmax}” in table “Maximum rated values”, for 25°C and 100°C Transient gate-emitter voltage V_{GE} in table “Maximum rated values” of IGBT changed to ±30V Update of diagram “Collector current as a function of case temperature”, $I_C = f(T_c)$ "Forward bias safe operating area” diagram renamed to “Reverse bias safe operating area” Correction of package outline dimensions Change package name to marketing name Editorial changes

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