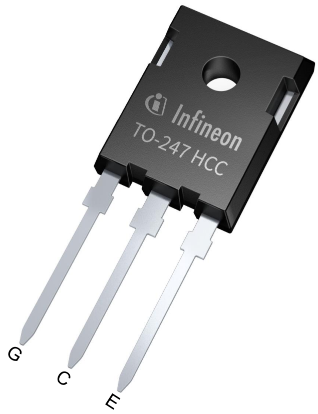
TRENCHSTOP™ 5 WR6 technology in enhanced creepage and clearance package offers improved reliability against package contamination



Features

- V_{CE} = 650 V
- I_C = 60 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 paralleling capability due to positive temperature coefficient in V_{CEsat}
- Low temperature dependence of V_{CEsat} and E_{sw}
- Product spectrum and PSpice Models: http://www.infineon.com/igbt/

Potential applications

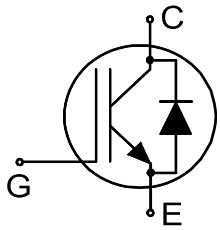
- PFC
- Welding
- ZCS applications

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
IKWH60N65WR6	PG-TO247-3-STD-NN4.8	H60EWR6

Table of contents

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	$R_{th(j-c)}$				0.6	K/W
Diode thermal resistance, junction-case	$R_{th(j-c)}$				2.3	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	100	A
			$T_c = 100$ °C	63	
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpulse}			180	A
Turn-off safe operating area		$V_{CE} \leq 650$ V, $T_{vj} \leq 175$ °C		180	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	240	W
			$T_c = 100$ °C	120	

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 = 60 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 = 0.6 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 = 60 A, V_{CE} = 20 V			150		S
Input capacitance	C_{ies}	V_{CE} = 25 V, V_{GE}=0 V, f = 100 kHz			4270		pF
Output capacitance	C_{oes}	V_{CE} = 25 V, V_{GE}=0 V, f = 100 kHz			44		pF
Reverse transfer capacitance	C_{res}	V_{CE} = 25 V, V_{GE}=0 V, f = 100 kHz			19		pF
Gate charge	Q_G	I_C = 60 A, V_{GE} = 15 V, V_{CC} = 520 V			174		nC
Turn-on delay time	$t_{d(on)}$	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 15 Ω, $R_{G(off)}$ = 15 Ω, $L_σ$ = 30 nH, $C_σ$ = 31 pF	T_{vj} = 25 °C, I_C = 60 A		35		ns
			T_{vj} = 175 °C, I_C = 60 A		32		
Rise time (inductive load)	t_r	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 15 Ω, $R_{G(off)}$ = 15 Ω, $L_σ$ = 30 nH, $C_σ$ = 31 pF	T_{vj} = 25 °C, I_C = 60 A		28		ns
			T_{vj} = 175 °C, I_C = 60 A		30		
Turn-off delay time	$t_{d(off)}$	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 15 Ω, $R_{G(off)}$ = 15 Ω, $L_σ$ = 30 nH, $C_σ$ = 31 pF	T_{vj} = 25 °C, I_C = 60 A		311		ns
			T_{vj} = 175 °C, I_C = 60 A		344		
Fall time (inductive load)	t_f	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 15 Ω, $R_{G(off)}$ = 15 Ω, $L_σ$ = 30 nH, $C_σ$ = 31 pF	T_{vj} = 25 °C, I_C = 60 A		23		ns
			T_{vj} = 175 °C, I_C = 60 A		20		
Turn-on energy	E_{on}	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 15 Ω, $R_{G(off)}$ = 15 Ω, $L_σ$ = 30 nH, $C_σ$ = 31 pF	T_{vj} = 25 °C, I_C = 60 A		1.82		mJ
			T_{vj} = 175 °C, I_C = 60 A		2.04		

(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, $R_{G(on)}$ = 15 Ω, $R_{G(off)}$ = 15 Ω, L_{σ} = 30 nH, C_{σ} = 31 pF	T_{vj} = 25 °C, I_C = 60 A		0.85		mJ
			T_{vj} = 175 °C, I_C = 60 A		1.17		
Total switching energy	E_{ts}	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 15 Ω, $R_{G(off)}$ = 15 Ω, L_{σ} = 30 nH, C_{σ} = 31 pF	T_{vj} = 25 °C, I_C = 60 A		2.67		mJ
			T_{vj} = 175 °C, I_C = 60 A		3.21		
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	32	A
			T_c = 100 °C	19	
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpulse}			60	A

Table 5 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode forward voltage	V_F	I_F = 16 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, $R_{G(on)}$ = 15 Ω	T_{vj} = 25 °C, I_F = 30 A, $-di_F/dt$ = 1700 A/µs		92		ns
			T_{vj} = 175 °C, I_F = 30 A, $-di_F/dt$ = 1600 A/µs		121		

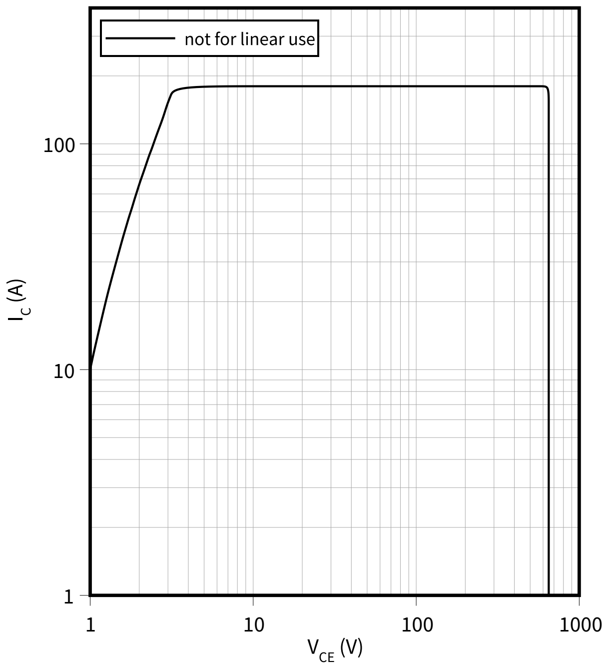
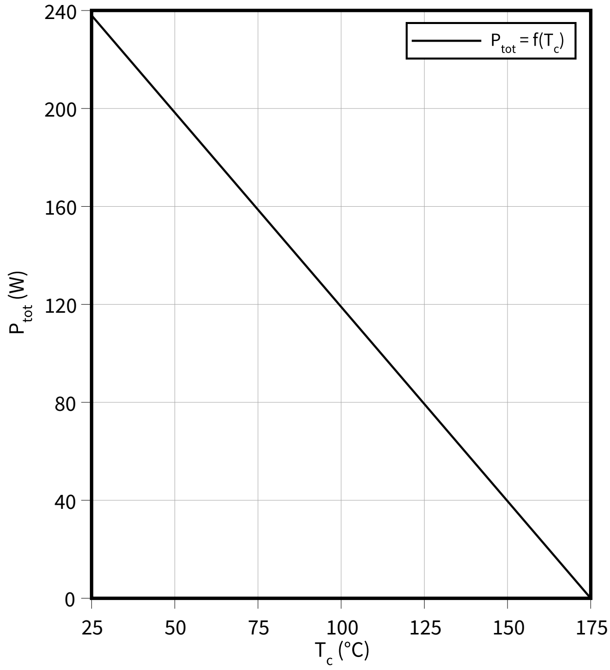
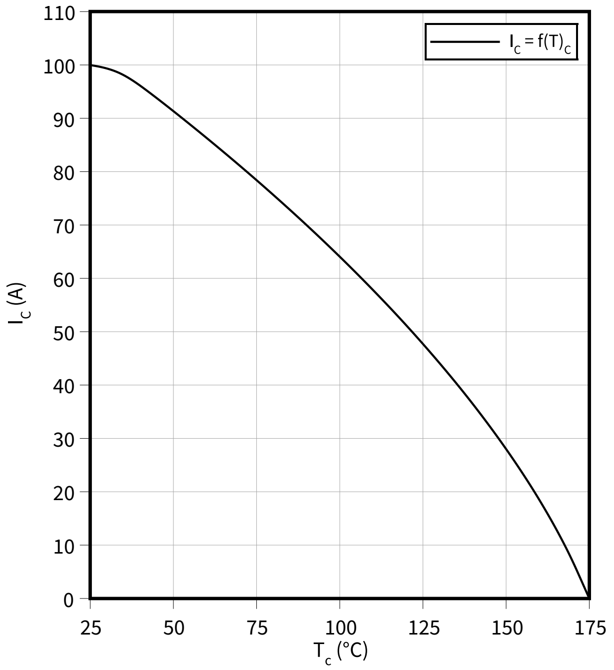
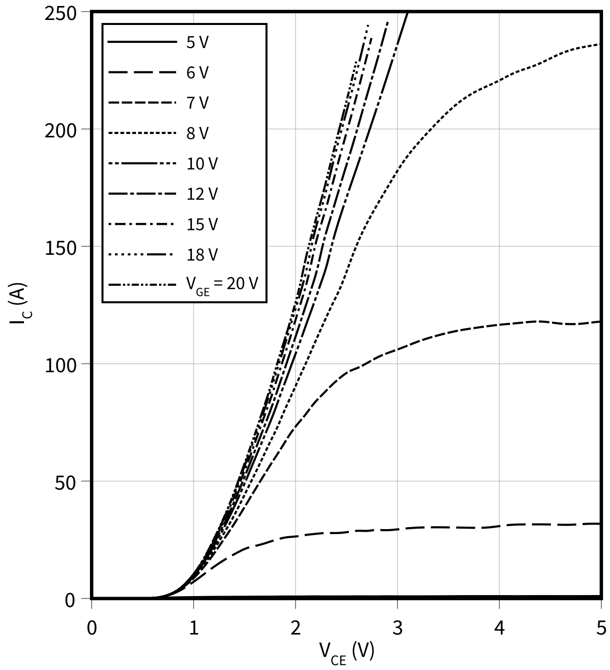
(table continues...)

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, $R_{G(on)}$ = 15 Ω	T_{vj} = 25 °C, I_F = 30 A, $-di_F/dt$ = 1700 A/µs		2.3		µC
			T_{vj} = 175 °C, I_F = 30 A, $-di_F/dt$ = 1600 A/µs		3.8		
Diode peak reverse recovery current	I_{rrm}	V_R = 400 V, $R_{G(on)}$ = 15 Ω	T_{vj} = 25 °C, I_F = 30 A, $-di_F/dt$ = 1700 A/µs		34		A
			T_{vj} = 175 °C, I_F = 30 A, $-di_F/dt$ = 1600 A/µs		48.3		
Diode peak rate of fall of reverse recovery current	di_{rr}/dt	V_R = 400 V, $R_{G(on)}$ = 15 Ω	T_{vj} = 25 °C, I_F = 30 A, $-di_F/dt$ = 1700 A/µs		450		A/µs
			T_{vj} = 175 °C, I_F = 30 A, $-di_F/dt$ = 1600 A/µs		900		
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.*

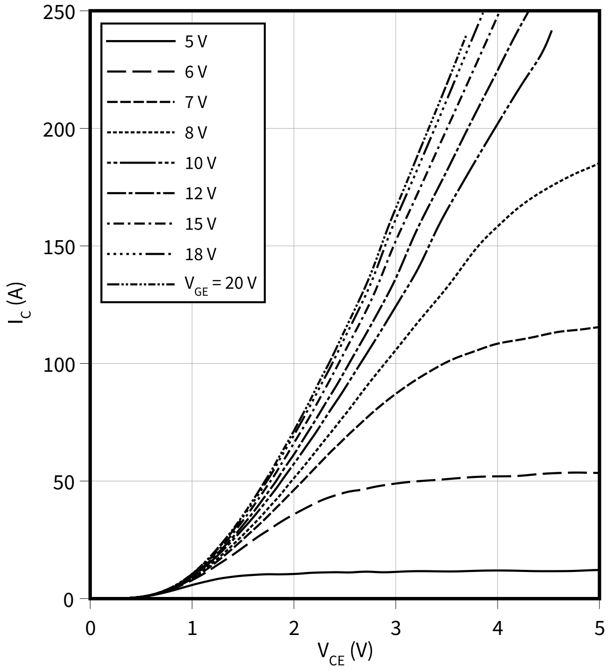
4 Characteristics diagrams

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

$I_C = f(V_{CE})$

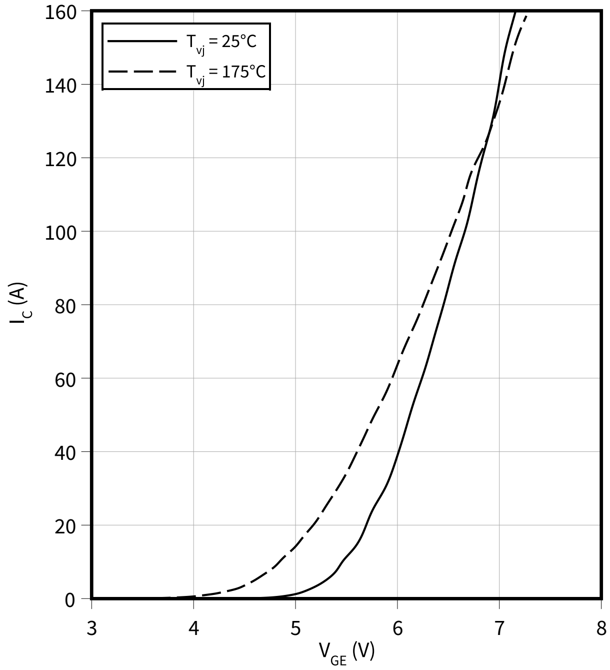
$T_{vj} = 175\ °C$



Typical transfer characteristic

$I_C = f(V_{GE})$

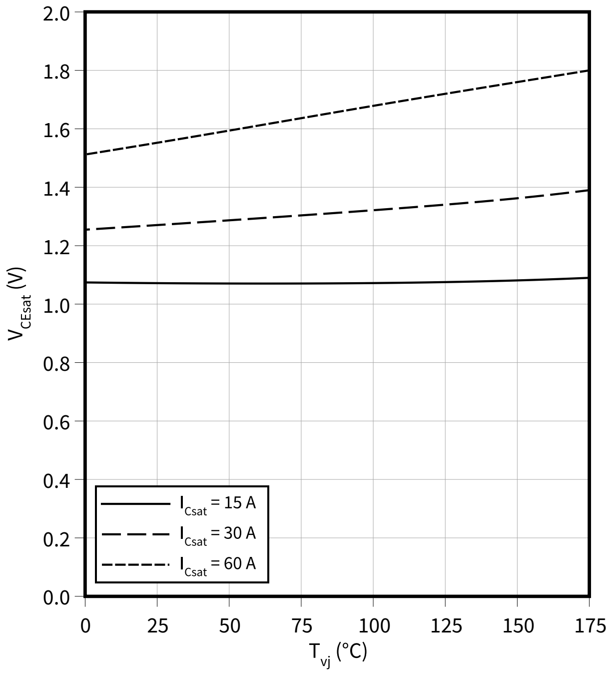
$V_{CE} = 20\ V$



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

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

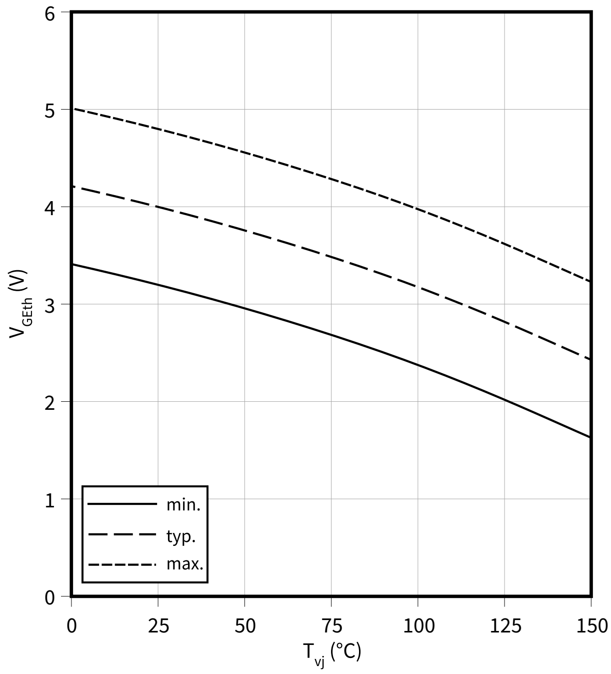
$V_{GE} = 15\ V$



Gate-emitter threshold voltage as a function of junction temperature

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

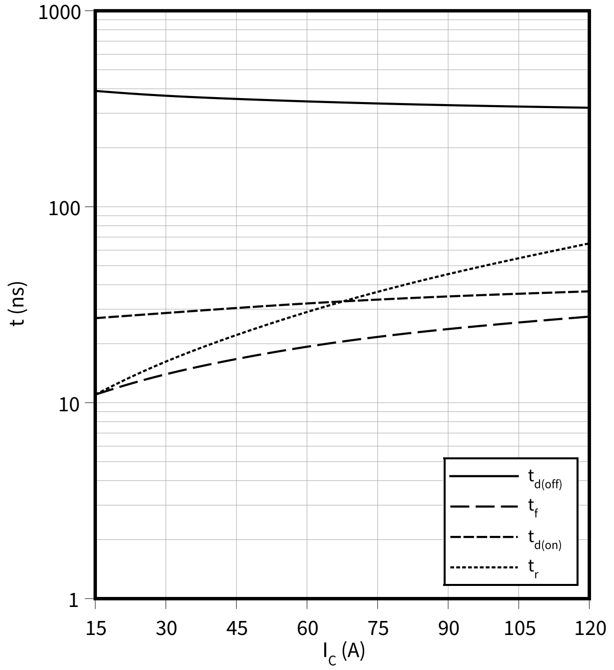
$I_C = 0.2\ mA$



Typical switching times as a function of collector current

$t = f(I_C)$

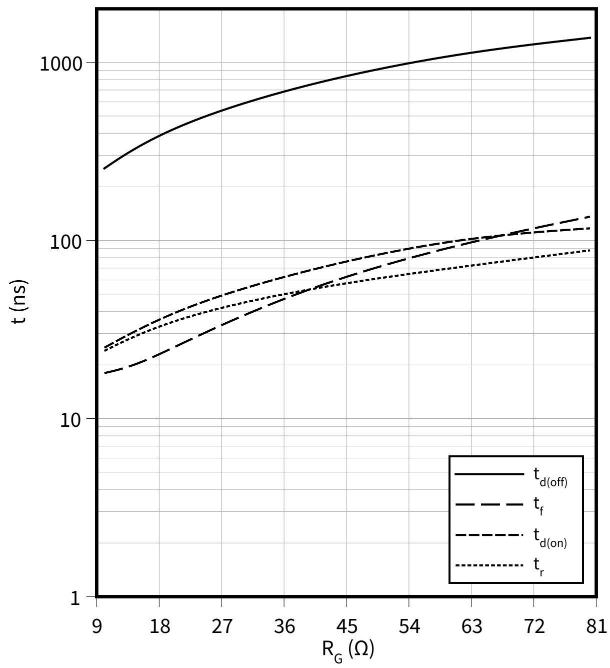
$V_{CC} = 400$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V, $R_G = 15\ \Omega$



Typical switching times as a function of gate resistor

$t = f(R_G)$

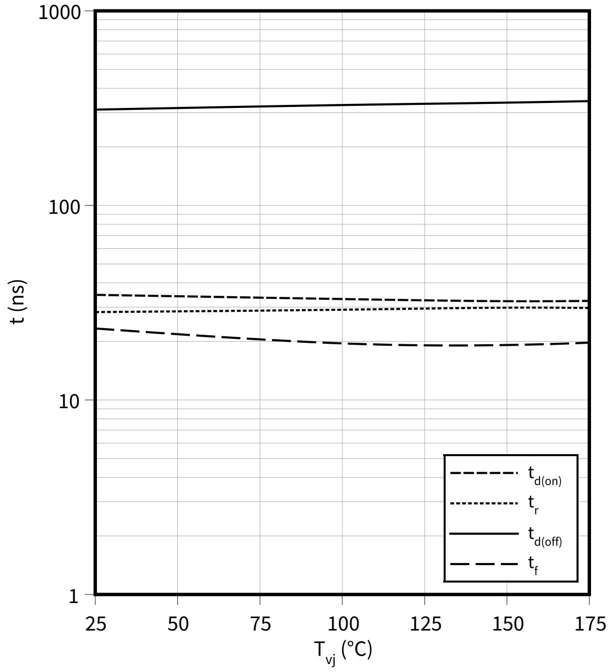
$I_C = 60$ A, $V_{CC} = 400$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V



Typical switching times as a function of junction temperature

$t = f(T_{vj})$

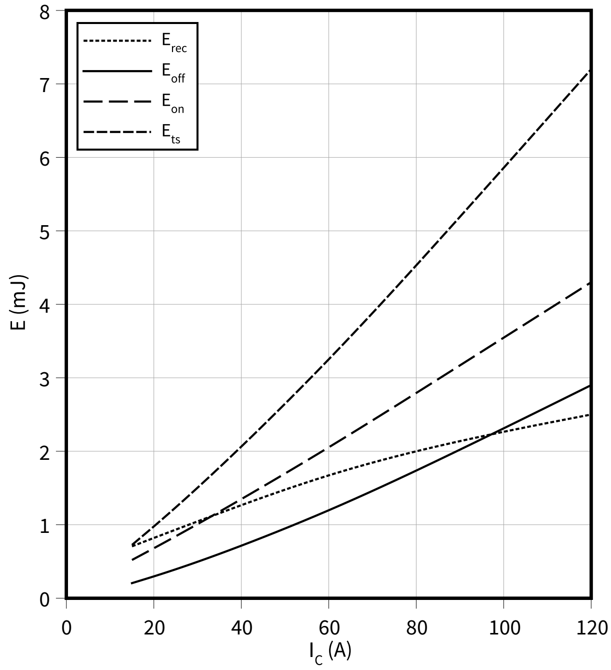
$I_C = 60$ A, $V_{CC} = 400$ V, $V_{GE} = 0/15$ V, $R_G = 15\ \Omega$



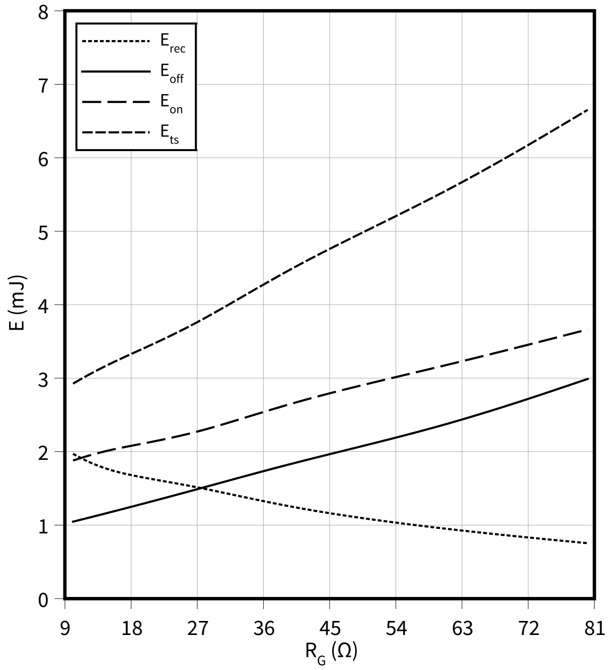
Typical switching energy losses as a function of collector current

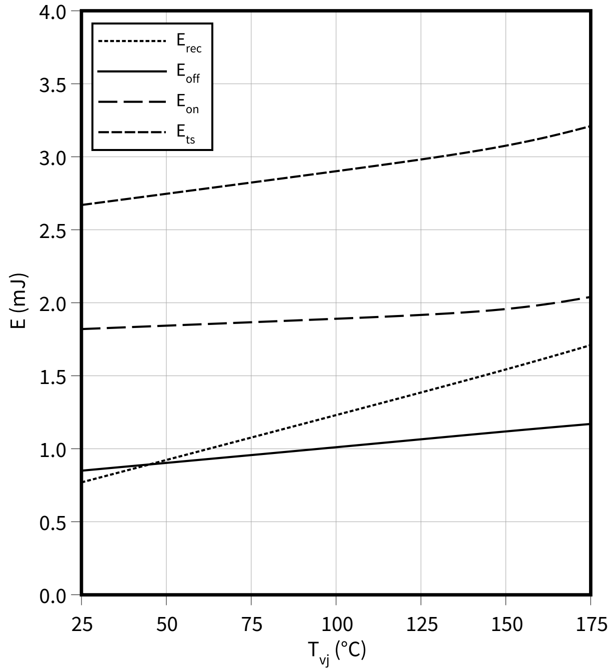
$E = f(I_C)$

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

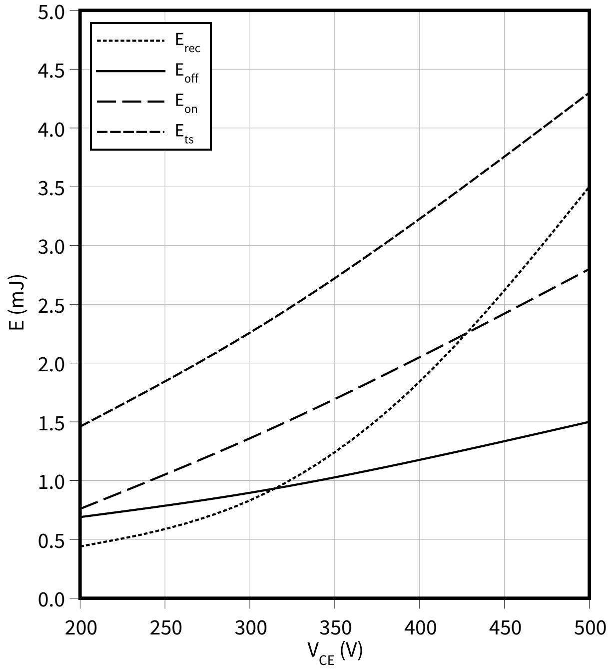


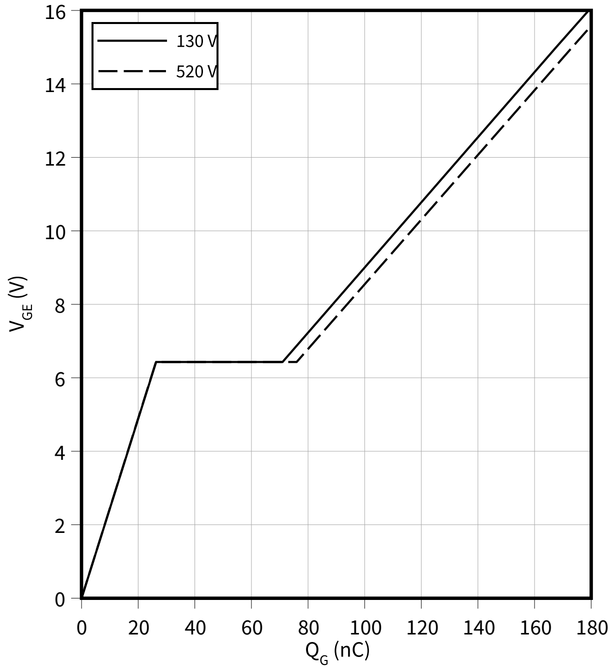
Typical switching energy losses as a function of gate resistor	**Typical switching energy losses as a function of junction temperature**
$E = f(R_G)$	$E = f(T_{vj})$
I_C = 60 A, V_{CC} = 400 V, T_{vj} = 175 °C, V_{GE} = 0/15 V	I_C = 60 A, V_{CC} = 400 V, V_{GE} = 0/15 V, R_G = 15 Ω





Typical switching energy losses as a function of collector emitter voltage	**Typical gate charge**
$E = f(V_{CE})$	$V_{GE} = f(Q_G)$
I_C = 60 A, T_{vj} = 175 °C, V_{GE} = 0/15 V, R_G = 15 Ω	I_C = 60 A

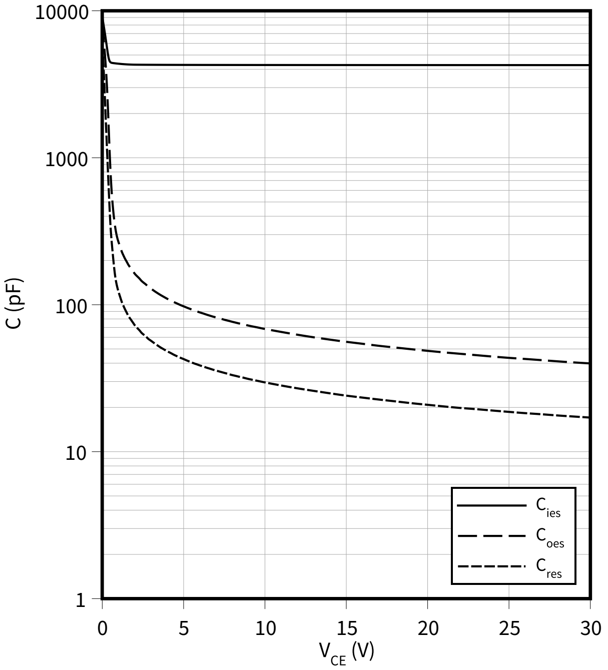




Typical capacitance as a function of collector-emitter voltage

$C = f(V_{CE})$

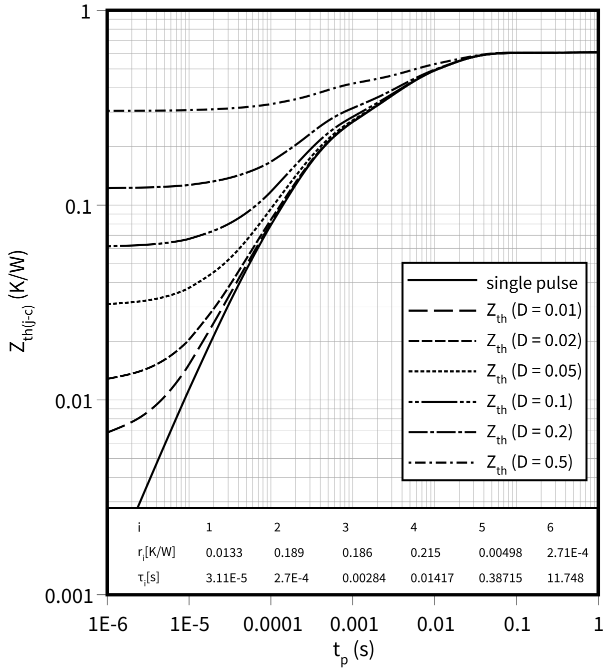
$f = 100\ kHz,\ V_{GE} = 0\ V$



IGBT transient thermal impedance as a function of pulse width

$Z_{th(j-c)} = f(t_p)$

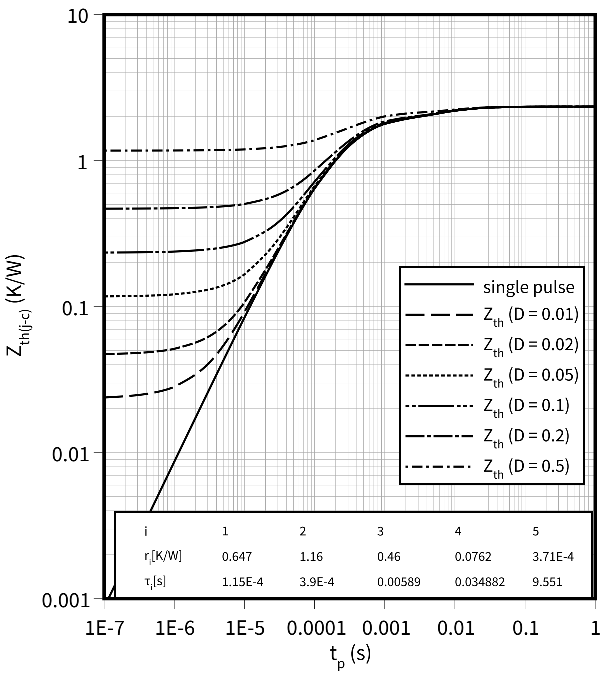
$D = t_p/T$



Diode transient thermal impedance as a function of pulse width

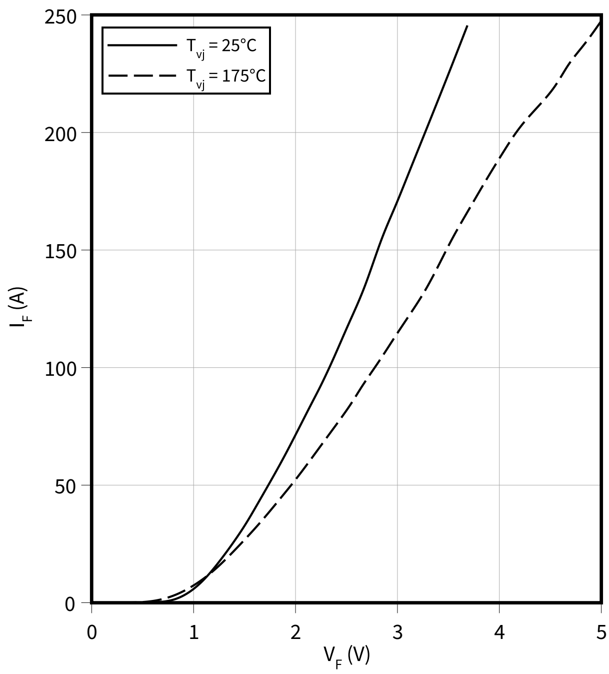
$Z_{th(j-c)} = f(t_p)$

$D = t_p/T$



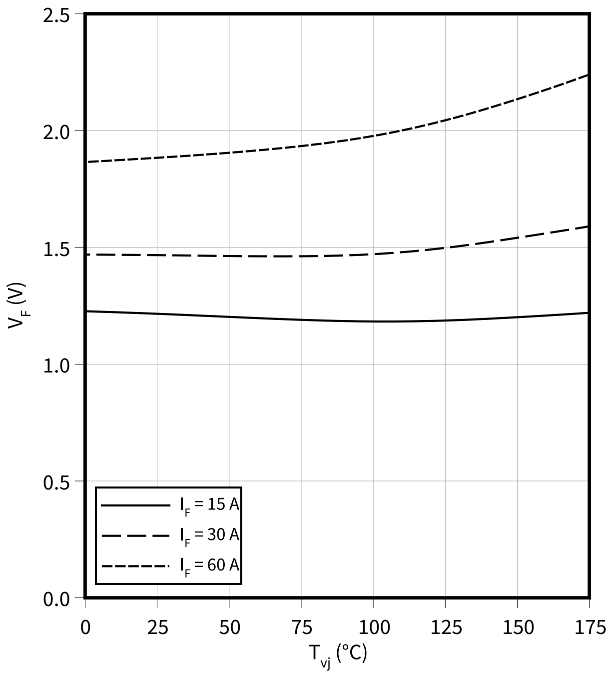
Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



Typical diode forward voltage as a function of junction temperature

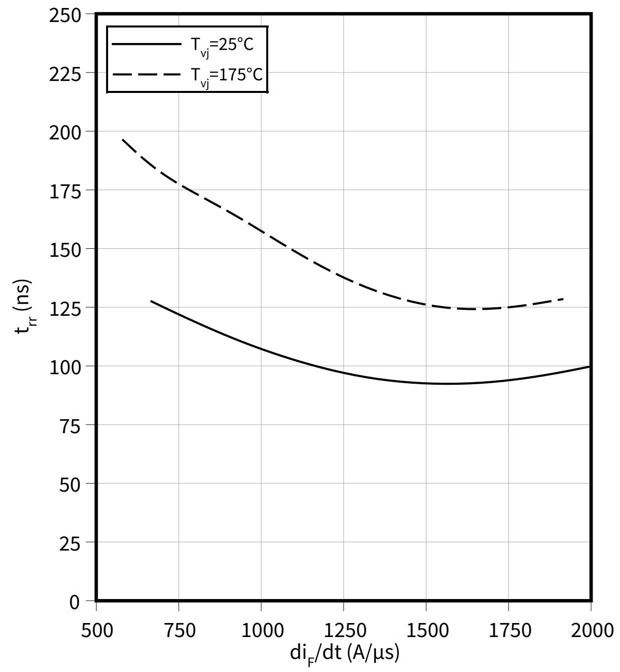
$V_F = f(T_{vj})$



Typical reverse recovery time as a function of diode current slope

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

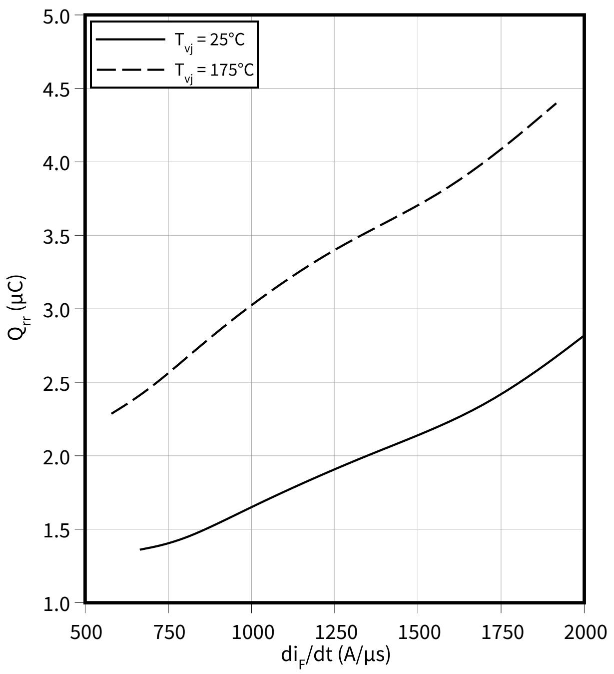
$V_R = 400$ V, $I_F = 30$ A



Typical reverse recovery charge as a function of diode current slope

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

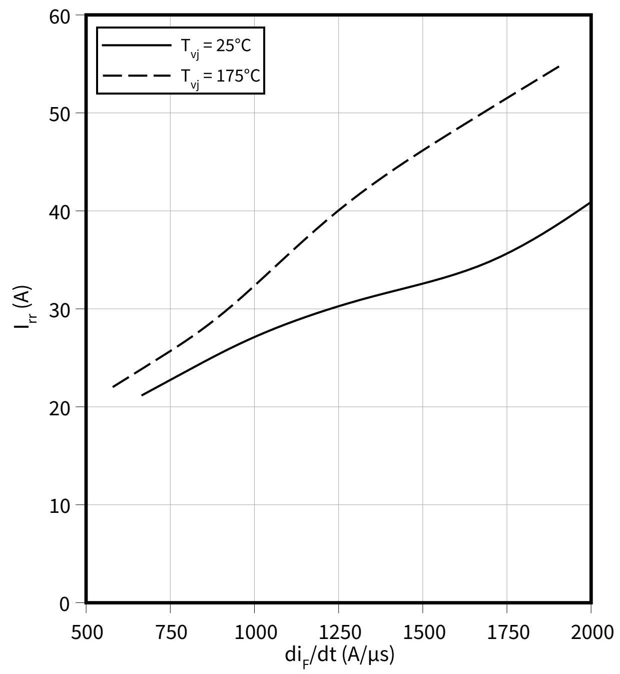
$V_R = 400$ V, $I_F = 30$ A



Typical reverse recovery current as a function of diode current slope

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

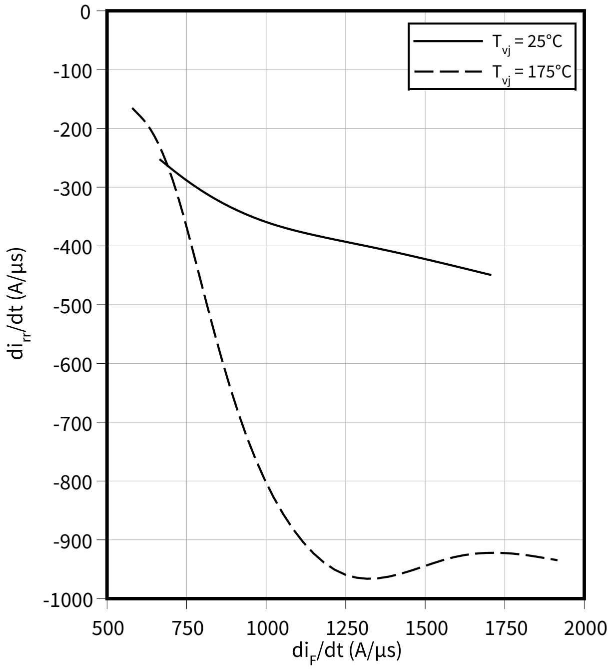
$V_R = 400$ V, $I_F = 30$ A



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

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

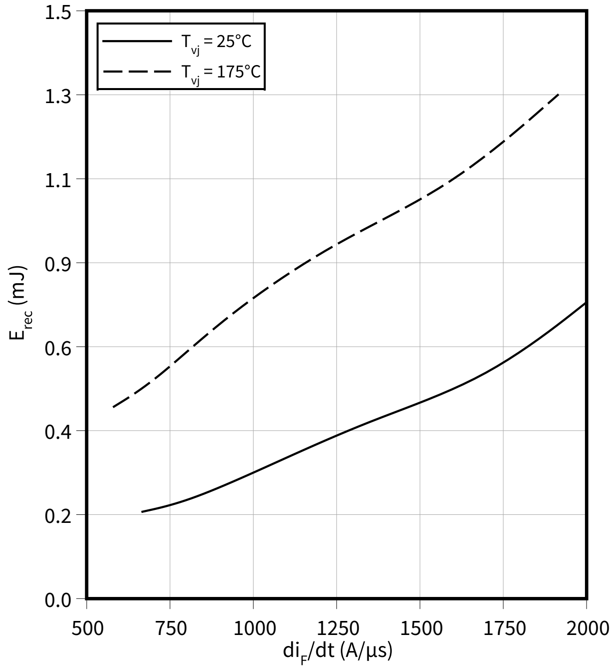
$V_R = 400$ V, $I_F = 30$ A



Typical reverse energy losses as a function of diode current slope

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

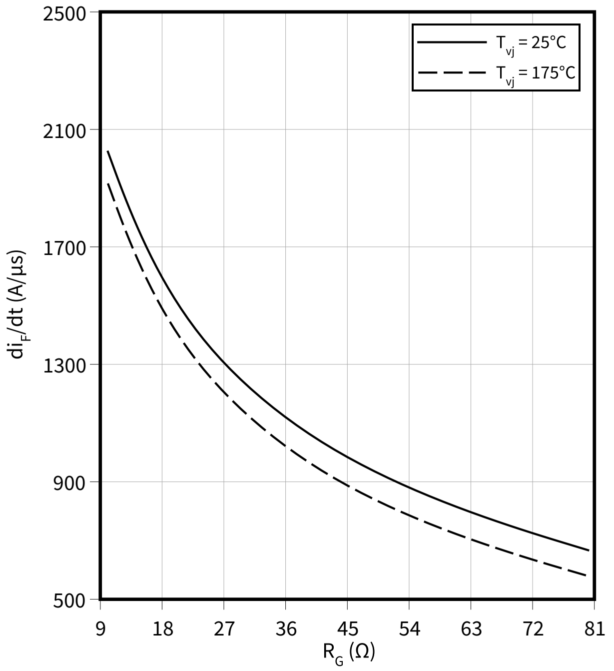
$V_R = 400$ V, $I_F = 30$ A



Typical diode current slope as a function of gate resistor

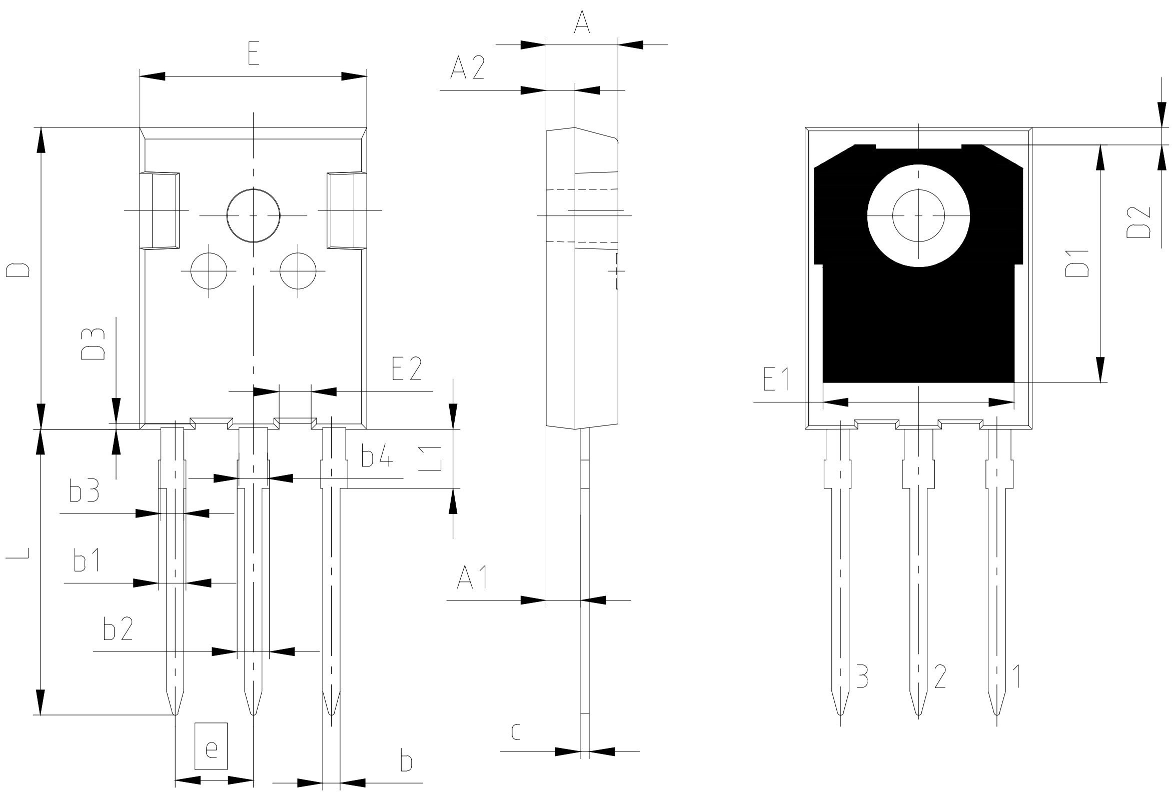
$di_F/dt = f(R_G)$

$V_R = 400$ V, $I_F = 30$ 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

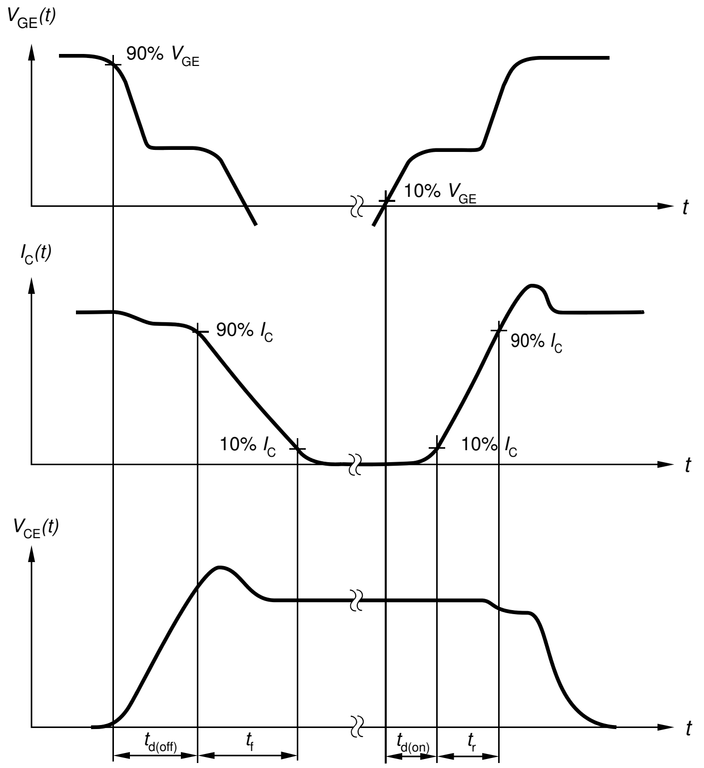


Figure A. **Definition of switching times**

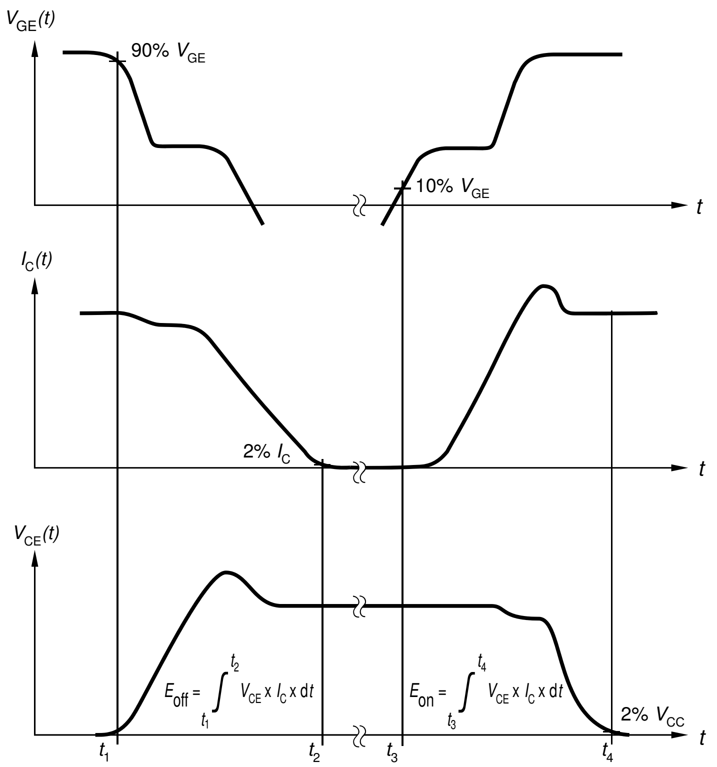


Figure B. **Definition of switching losses**

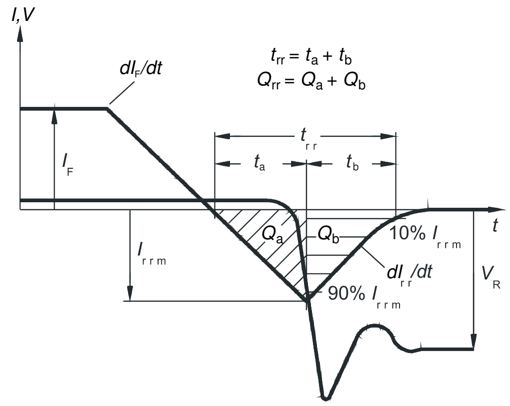


Figure C. **Definition of diode switching characteristics**

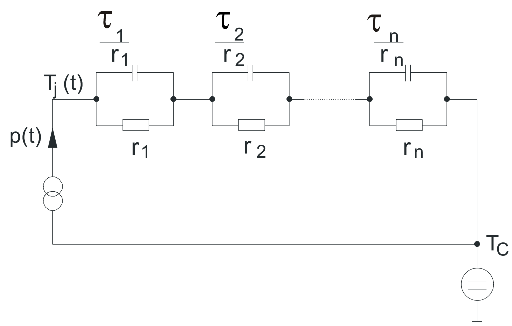


Figure D. **Thermal equivalent circuit**

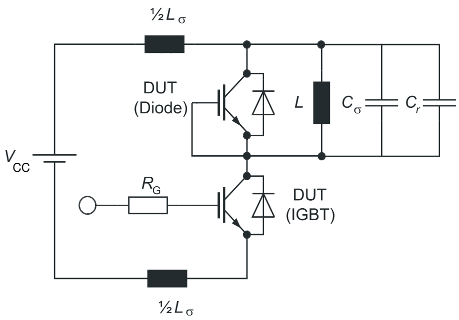


Figure E. **Dynamic test circuit**
Parasitic inductance L_σ,
parasitic capacitor C_σ,
relief capacitor C_r,
(only for ZVT switching)

Figure 2

Revision history

Document revision	Date of release	Description of changes
1.00	2021-05-21	Final datasheet
1.10	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