High speed and low saturation voltage 650 V TRENCHSTOP™ IGBT7 technology copacked with soft, fast recovery Emitter Controlled 7 diode

Features

- V_{CE} = 650 V
- I_C = 40 A
- Low switching losses
- Very low collector-emitter saturation voltage V_{CEsat}
- Very soft, fast recovery antiparallel diode
- Smooth switching behavior
- Humidity robustness
- Optimized for hard switching, two- and three-level topologies
- Complete product spectrum and PSpice Models: http://www.infineon.com/igbt/

Potential applications

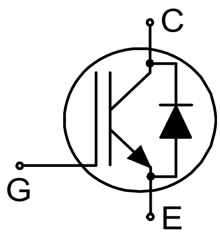
- Industrial UPS
- EV-Charging
- String inverter
- Welding

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
IKWH40N65EH7	PG-TO247-3-STD-NN4.8	K40EEH7

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 processes: 3			0.6	Nm
Thermal resistance, junction-ambient	$R_{th(j\text{-}a)}$				40	K/W
IGBT thermal resistance, junction-case	$R_{th(j\text{-}c)}$			0.54	0.71	K/W
Diode thermal resistance, junction-case	$R_{th(j\text{-}c)}$			0.72	0.94	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	limited by bondwire	$T_c = 25$ °C	80	A
			$T_c = 100$ °C	54	
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpulse}			160	A
Turn-off safe operating area		$V_{CE} \leq 650$ V, $t_p \leq 1$ µs, $T_{vj} \leq 175$ °C		160	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	208	W
			$T_c = 100$ °C	103	

Table 3 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		1.4	1.65	V
			T_{vj} = 175 °C		1.6		
Gate-emitter threshold voltage	V_{GEth}	I_C = 0.35 mA, V_{CE} = V_{GE}		2.9	3.85	4.8	V
Zero gate-voltage collector current	I_{CES}	V_{CE} = 650 V, V_{GE} = 0 V	T_{vj} = 25 °C			10	µA
			T_{vj} = 175 °C		1200		
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			56		S
Input capacitance	C_{ies}	V_{CE} = 25 V, V_{GE} = 0 V, f = 100 kHz			2016		pF
Output capacitance	C_{oes}	V_{CE} = 25 V, V_{GE} = 0 V, f = 100 kHz			70		pF
Reverse transfer capacitance	C_{res}	V_{CE} = 25 V, V_{GE} = 0 V, f = 100 kHz			8.6		pF
Gate charge	Q_G	V_{CC} = 520 V, I_C = 40 A, V_{GE} = 15 V			81		nC
Turn-on delay time	$t_{d(on)}$	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 12.5 Ω, $R_{G(off)}$ = 12.5 Ω	T_{vj} = 25 °C, I_C = 40 A		18		ns
			T_{vj} = 175 °C, I_C = 40 A		18		
Rise time (inductive load)	t_r	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 12.5 Ω, $R_{G(off)}$ = 12.5 Ω	T_{vj} = 25 °C, I_C = 40 A		25		ns
			T_{vj} = 175 °C, I_C = 40 A		28		
Turn-off delay time	$t_{d(off)}$	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 12.5 Ω, $R_{G(off)}$ = 12.5 Ω	T_{vj} = 25 °C, I_C = 40 A		141		ns
			T_{vj} = 175 °C, I_C = 40 A		167		
Fall time (inductive load)	t_f	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 12.5 Ω, $R_{G(off)}$ = 12.5 Ω	T_{vj} = 25 °C, I_C = 40 A		34		ns
			T_{vj} = 175 °C, I_C = 40 A		52		
Turn-on energy	E_{on}	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 12.5 Ω, $R_{G(off)}$ = 12.5 Ω	T_{vj} = 25 °C, I_C = 40 A		0.97		mJ
			T_{vj} = 175 °C, I_C = 40 A		1.52		

(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, $R_{G(on)}$ = 12.5 Ω, $R_{G(off)}$ = 12.5 Ω	T_{vj} = 25 °C, I_C = 40 A		0.42		mJ
			T_{vj} = 175 °C, I_C = 40 A		0.69		
Total switching energy	E_{ts}	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 12.5 Ω, $R_{G(off)}$ = 12.5 Ω	T_{vj} = 25 °C, I_C = 40 A		1.39		mJ
			T_{vj} = 25 °C, I_C = 40 A		2.19		
Operating junction temperature	T_{vj}			-40		175	°C

3 Diode

Table 4 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Diode forward current, limited by T_{vjmax}	I_F		T_c = 25 °C	76	A
			T_c = 100 °C	49	
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpulse}			160	A
Power dissipation	P_{tot}		T_c = 25 °C	158	W
			T_c = 100 °C	78	

Table 5 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode forward voltage	V_F	I_F = 40 A	T_{vj} = 25 °C		1.65	2	V
			T_{vj} = 175 °C		1.55		
Diode reverse recovery time	t_{rr}	V_R = 400 V, $R_{G(on)}$ = 12.5 Ω	T_{vj} = 25 °C, I_F = 40 A		74		ns
			T_{vj} = 175 °C, I_F = 40 A		112		
Diode reverse recovery charge	Q_{rr}	V_R = 400 V, $R_{G(on)}$ = 12.5 Ω	T_{vj} = 25 °C, I_F = 40 A		0.9		µC
			T_{vj} = 175 °C, I_F = 40 A		2.1		

(table continues...)

Table 5 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode peak reverse recovery current	I_{rrm}	V_R = 400 V, $R_{G(on)}$ = 12.5 Ω	T_{vj} = 25 °C, I_F = 40 A		19.9		A
			T_{vj} = 175 °C, I_F = 40 A		29.8		
Diode peak rate of fall of reverse recovery current	di_{rr}/dt	V_R = 400 V, $R_{G(on)}$ = 12.5 Ω	T_{vj} = 25 °C, I_F = 40 A		-1070		A/µs
			T_{vj} = 175 °C, I_F = 40 A		-719		
Reverse recovery energy	E_{rec}	V_R = 400 V, $R_{G(on)}$ = 12.5 Ω	T_{vj} = 25 °C, I_F = 40 A		0.16		mJ
			T_{vj} = 175 °C, I_F = 40 A		0.44		
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.*

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

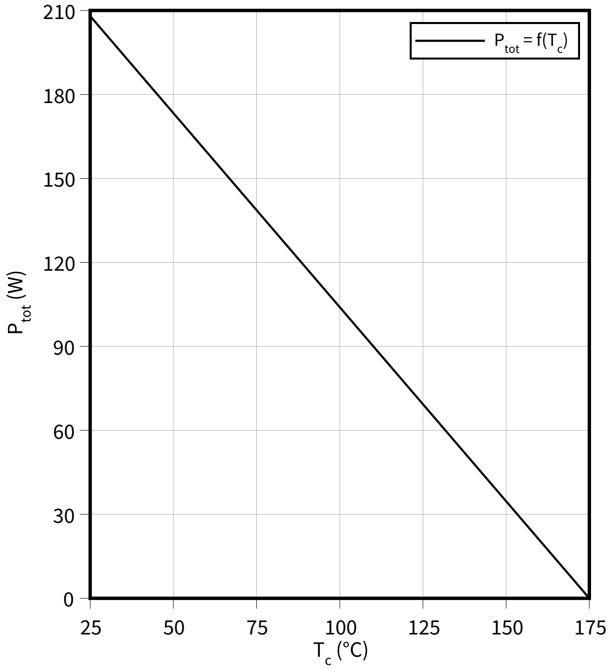
Dynamic test circuit, parasitic inductance $L_σ$ = 8 nH, parasitic capacitor $C_σ$ = 30 pF from Fig. E. Energy losses include “tail” and diode reverse recovery.

4 Characteristics diagrams

Power dissipation as a function of case temperature

$P_{tot} = f(T_c)$

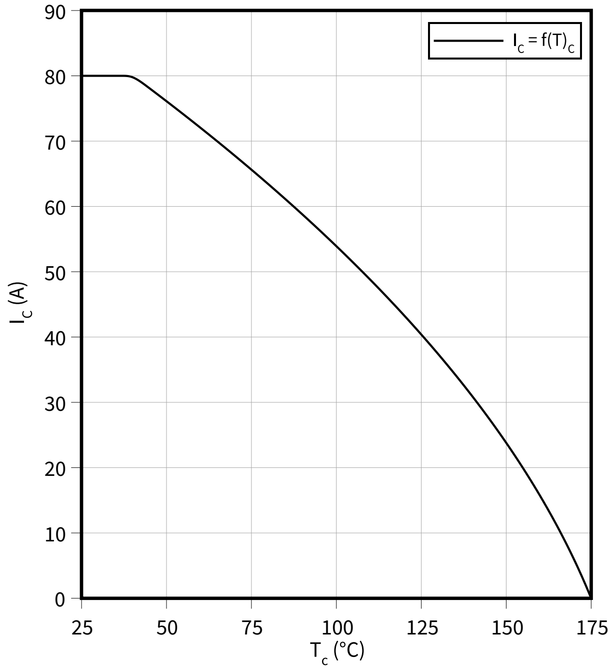
$T_{vj} \leq 175$ °C



Collector current as a function of case temperature

$I_C = f(T_c)$

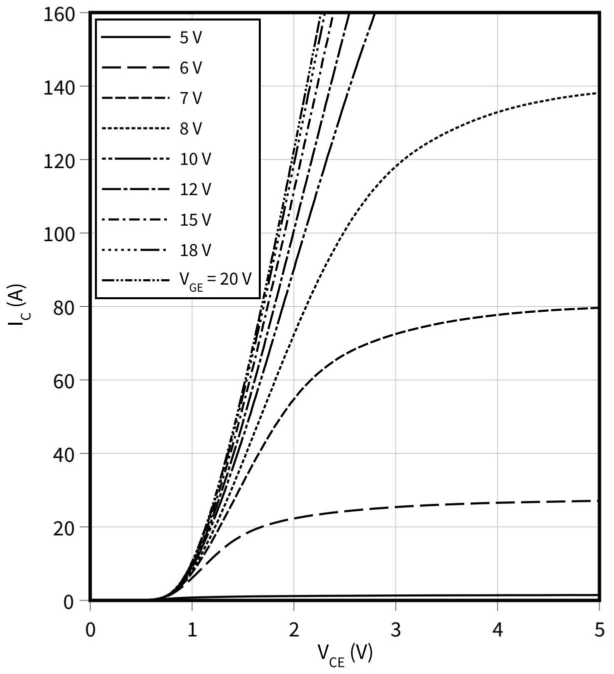
$T_{vj} \leq 175$ °C, $V_{GE} \geq 15$ V



Typical output characteristic

$I_C = f(V_{CE})$

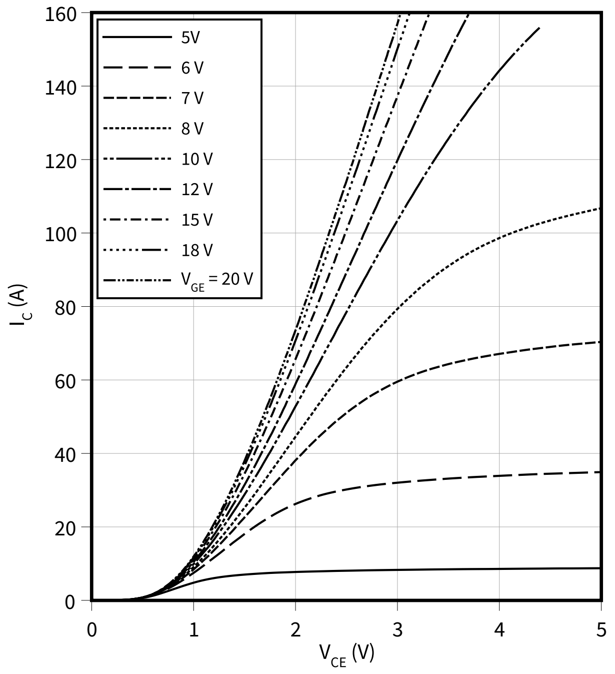
$T_{vj} = 25$ °C



Typical output characteristic

$I_C = f(V_{CE})$

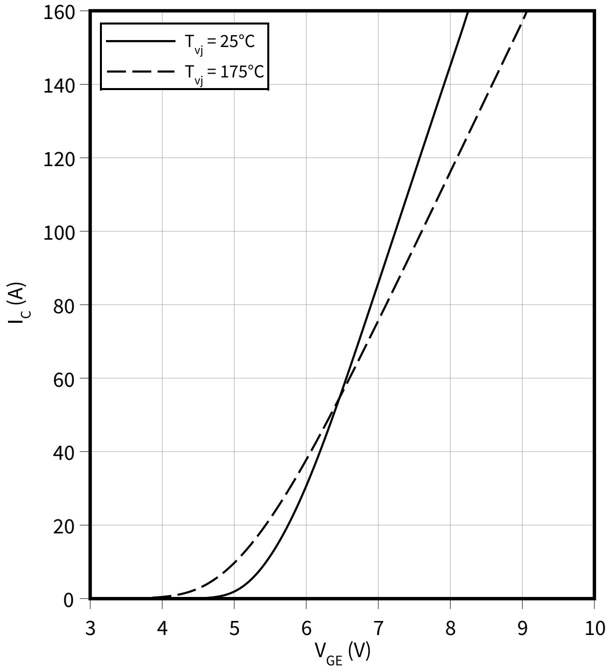
$T_{vj} = 175$ °C



Typical transfer characteristic

$I_C = f(V_{GE})$

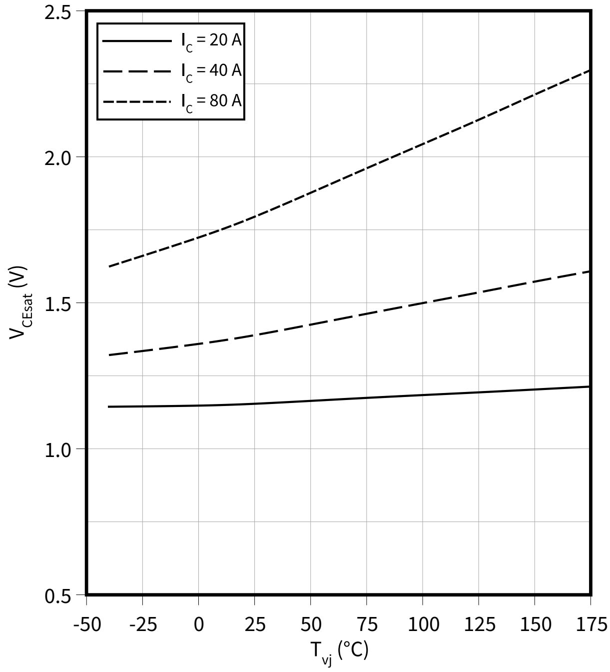
$V_{CE} = 20$ V



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

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

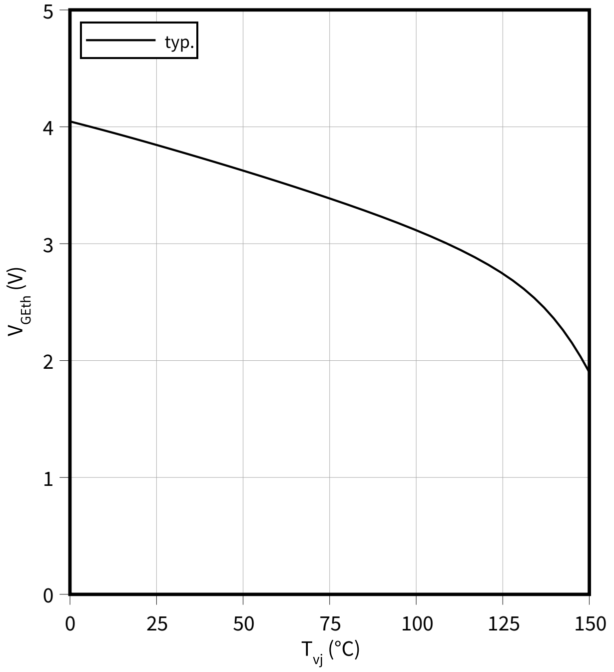
$V_{GE} = 15$ V



Gate-emitter threshold voltage as a function of junction temperature

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

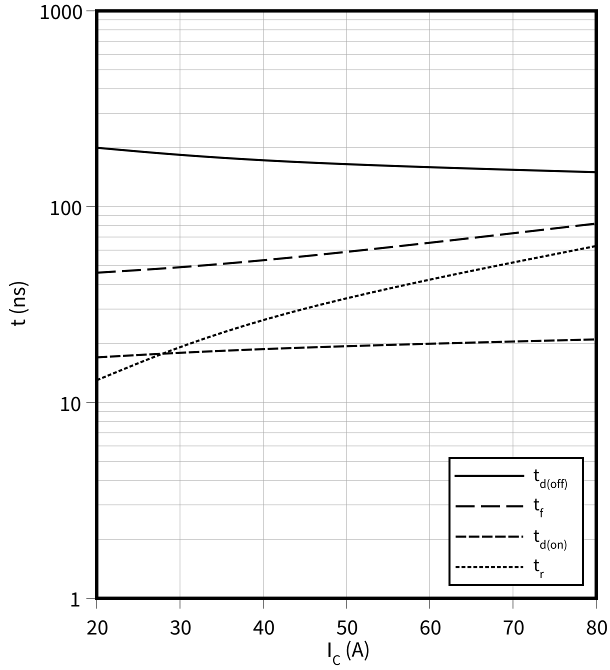
$I_C = 0.35$ mA



Typical switching times as a function of collector current

$t = f(I_C)$

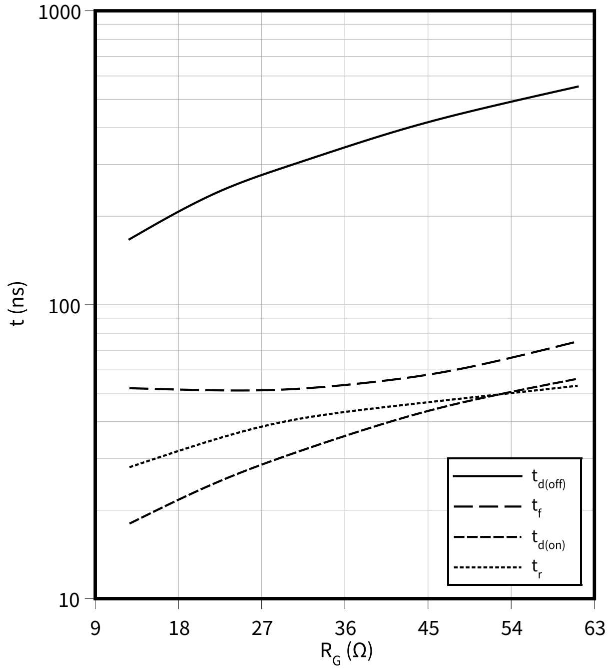
$V_{CC} = 400$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V, $R_G = 12.5\ \Omega$



Typical switching times as a function of gate resistor

$t = f(R_G)$

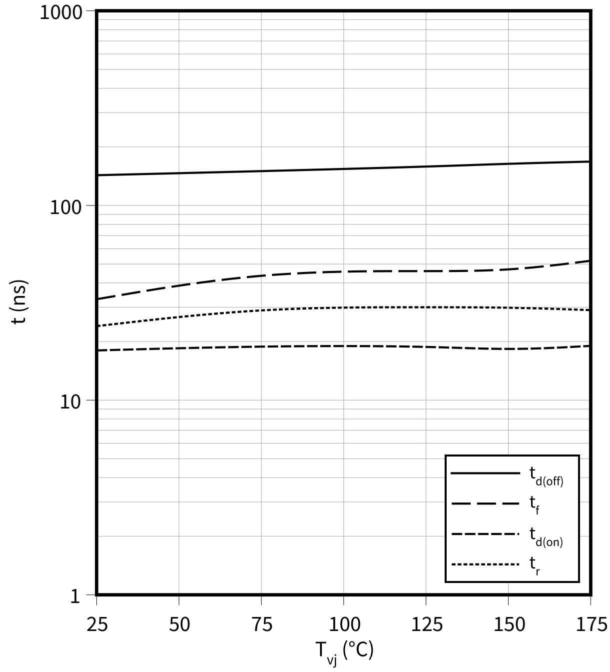
$I_C = 40$ A, $V_{CC} = 400$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V



Typical switching times as a function of junction temperature

$t = f(T_{vj})$

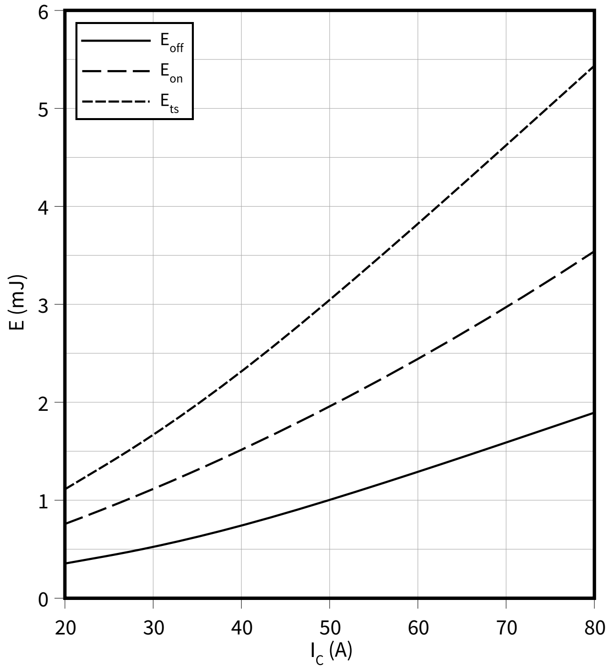
$I_C = 40$ A, $V_{CC} = 400$ V, $V_{GE} = 0/15$ V, $R_G = 12.5$ Ω



Typical switching energy losses as a function of collector current

$E = f(I_C)$

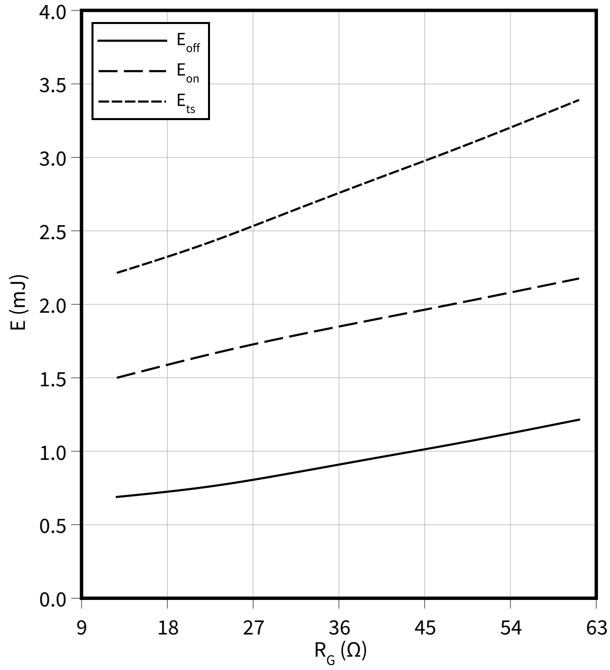
$V_{CC} = 400$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V, $R_G = 12.5$ Ω



Typical switching energy losses as a function of gate resistor

$E = f(R_G)$

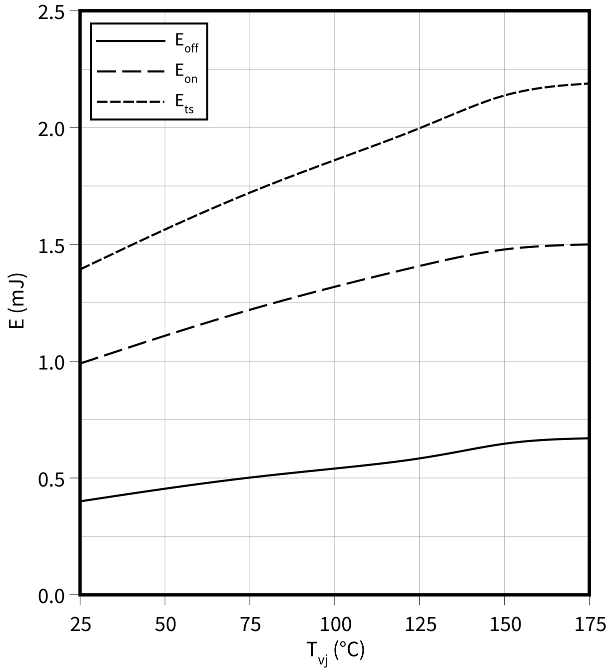
$I_C = 40$ A, $V_{CC} = 400$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V



Typical switching energy losses as a function of junction temperature

$E = f(T_{vj})$

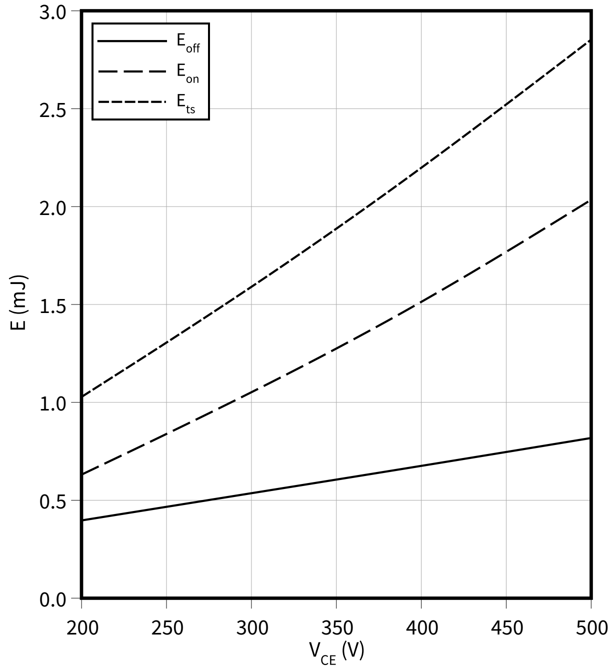
$I_C = 40$ A, $V_{CC} = 400$ V, $V_{GE} = 0/15$ V, $R_G = 12.5\ \Omega$



Typical switching energy losses as a function of collector emitter voltage

$E = f(V_{CE})$

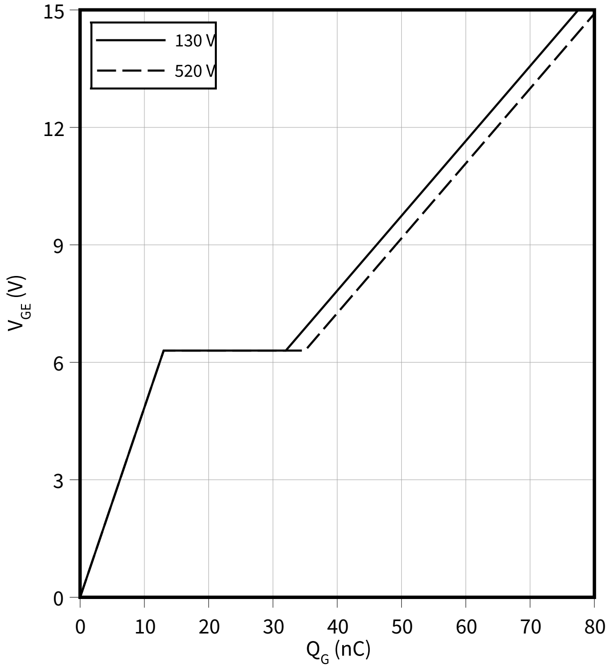
$I_C = 40$ A, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V, $R_G = 12.5\ \Omega$



Typical gate charge

$V_{GE} = f(Q_G)$

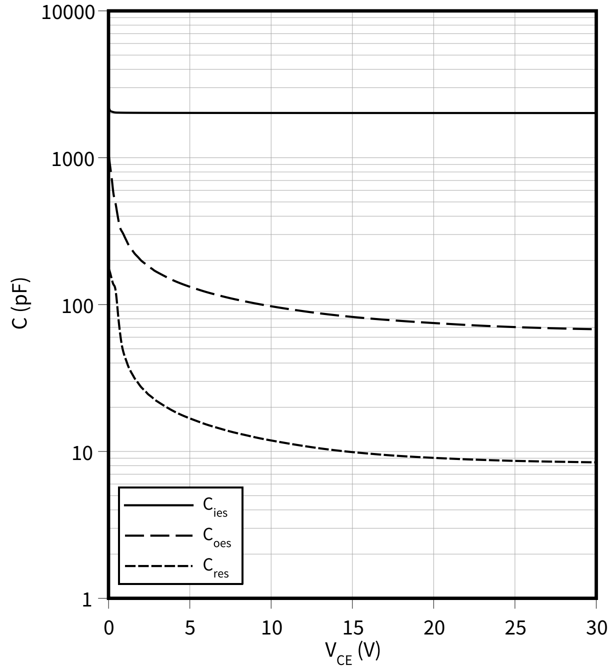
$I_C = 40$ A



Typical capacitance as a function of collector-emitter voltage

$C = f(V_{CE})$

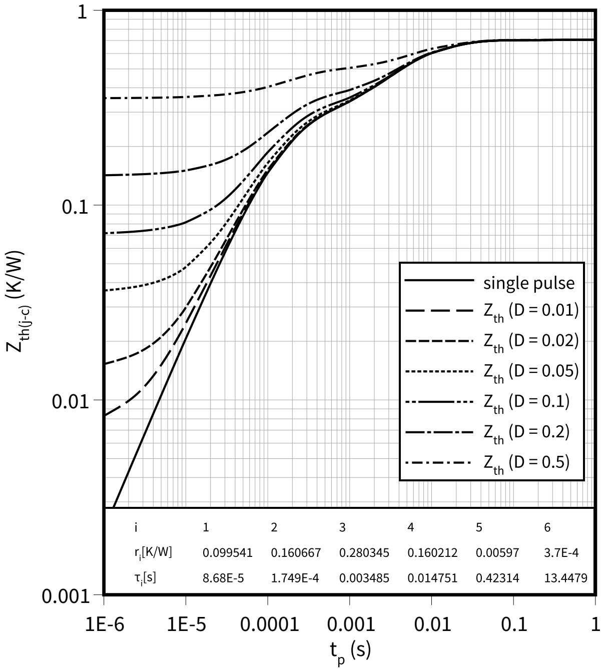
$f = 100$ kHz, $V_{GE} = 0$ V



IGBT transient thermal impedance as a function of pulse width

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

$D = t_p/T$

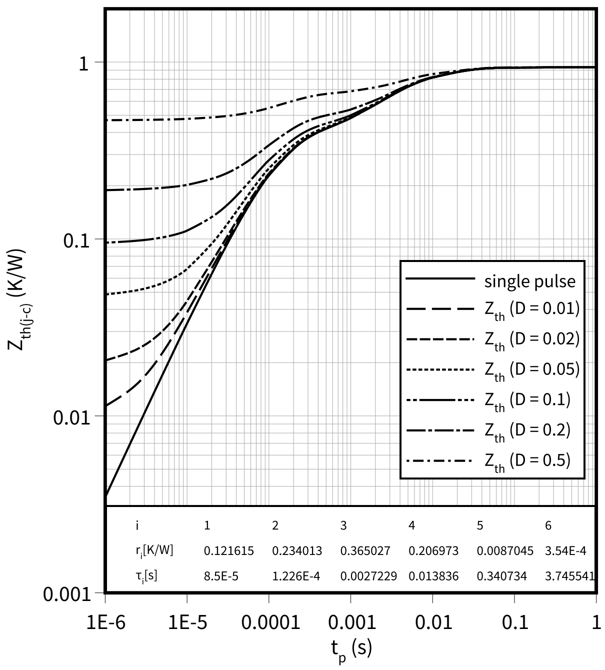


i	1	2	3	4	5	6
r_i[K/W]	0.099541	0.160667	0.280345	0.160212	0.00597	3.7E-4
τ_i[s]	8.68E-5	1.749E-4	0.003485	0.014751	0.42314	13.4479

Diode transient thermal impedance as a function of pulse width

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

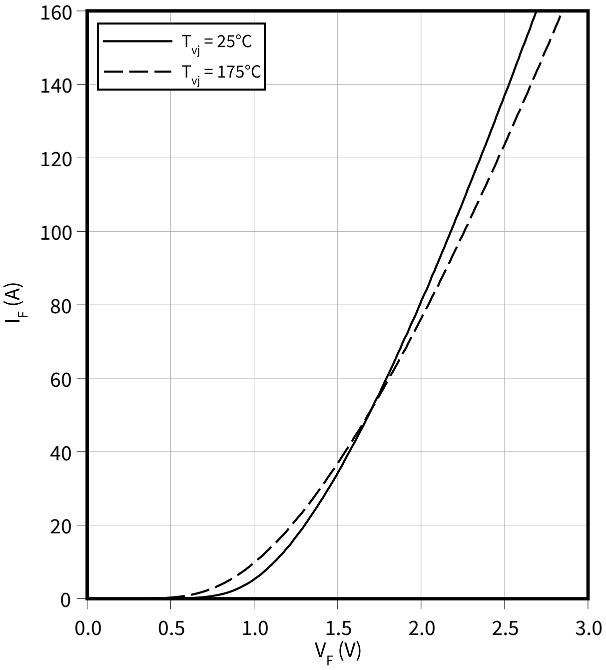
$D = t_p/T$



i	1	2	3	4	5	6
r_i[K/W]	0.121615	0.234013	0.365027	0.206973	0.0087045	3.54E-4
τ_i[s]	8.5E-5	1.226E-4	0.0027229	0.013836	0.340734	3.745541

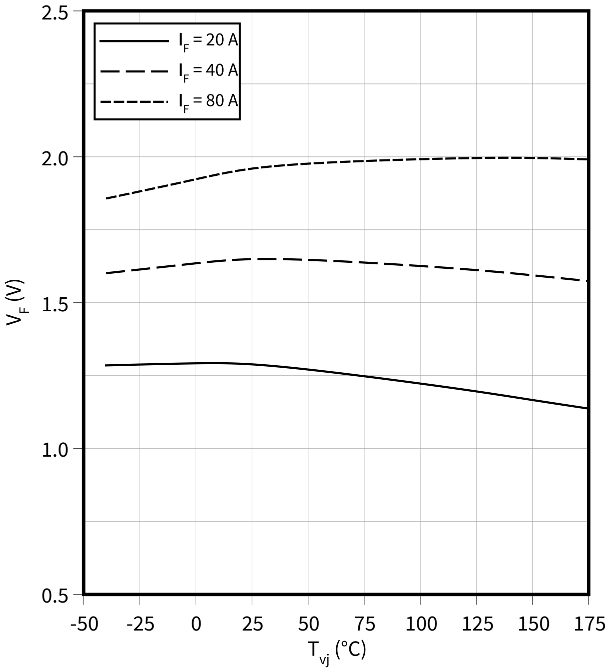
Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



Typical diode forward voltage as a function of junction temperature

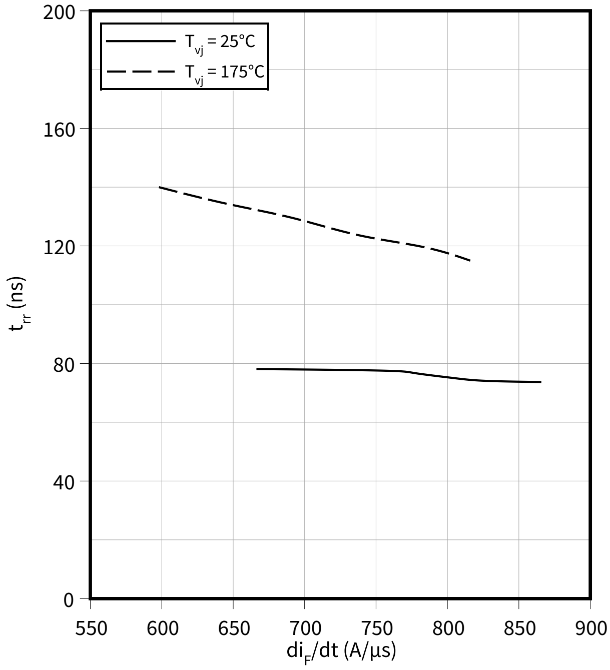
$V_F = f(T_{vj})$



Typical reverse recovery time as a function of diode current slope

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

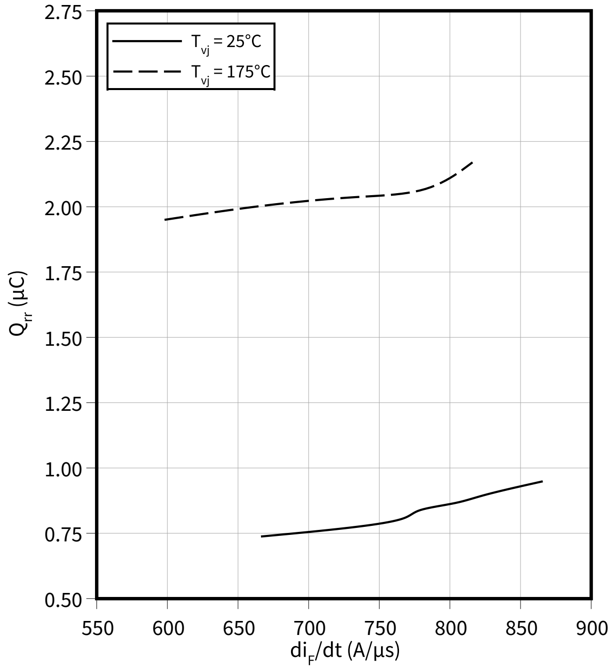
$I_F = 40$ A, $V_R = 400$ V



Typical reverse recovery charge as a function of diode current slope

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

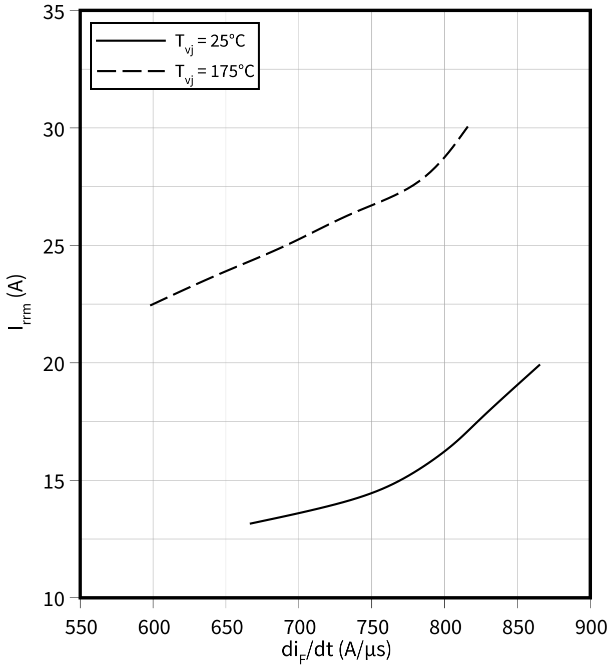
$V_R = 400$ V, $I_F = 40$ A



Typical reverse recovery current as a function of diode current slope

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

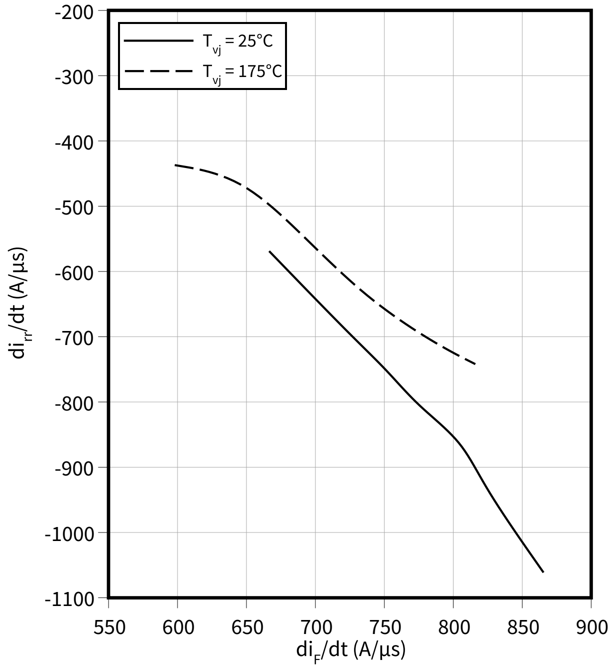
$V_R = 400$ V, $I_F = 40$ A



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

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

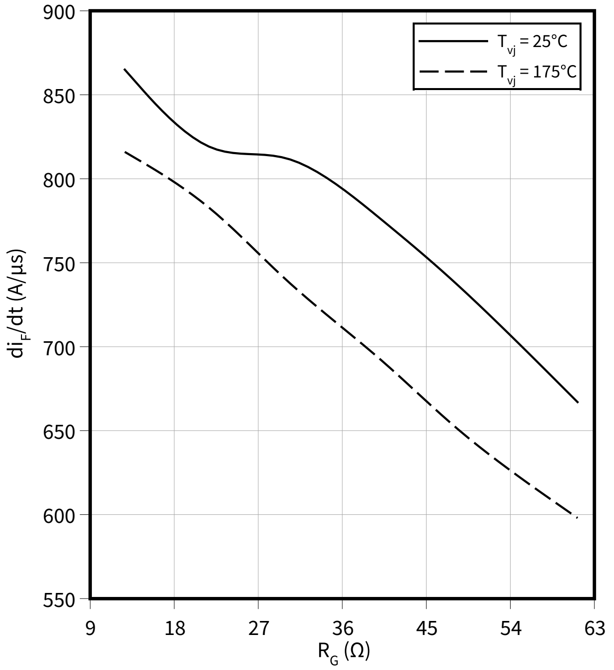
$V_R = 400$ V, $I_F = 40$ A



Typical diode current slope as a function of gate resistor

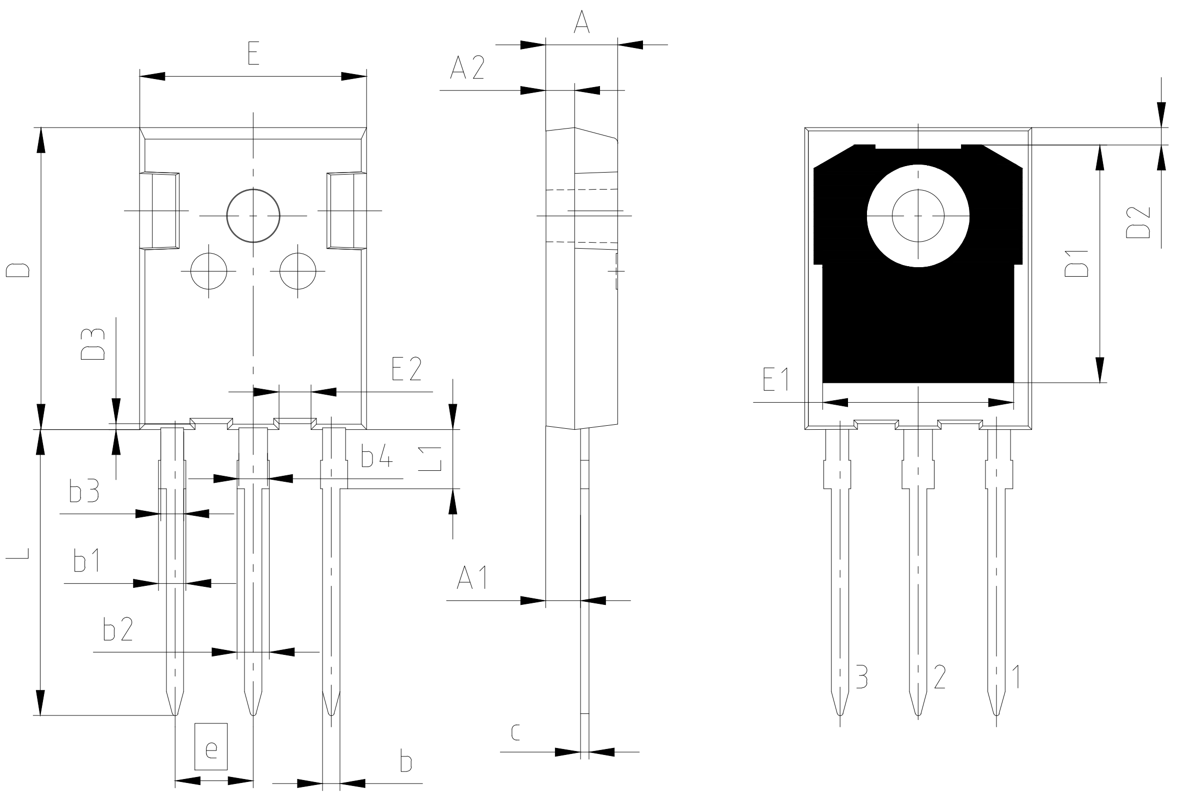
$di_F/dt = f(R_G)$

$V_R = 400$ V, $I_F = 40$ 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

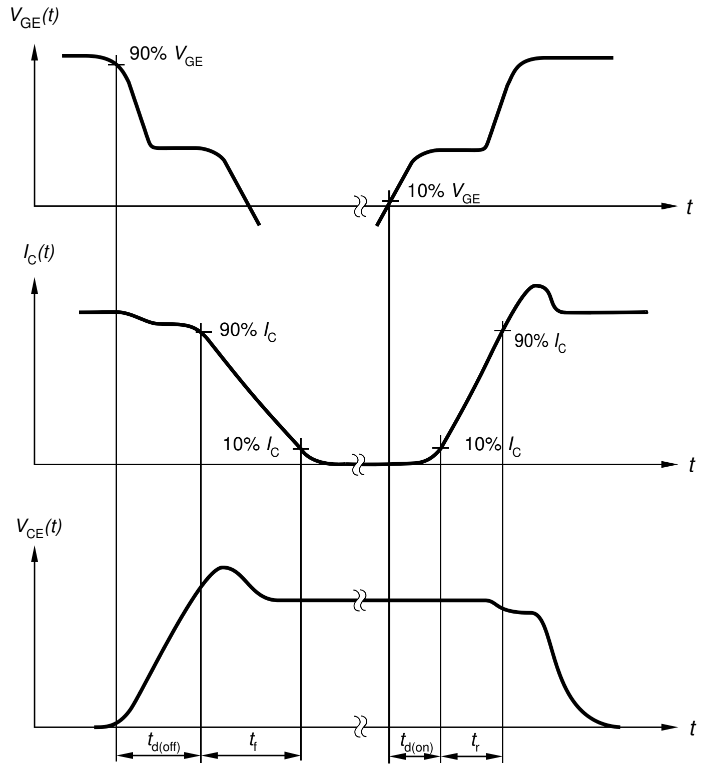


Figure A. **Definition of switching times**

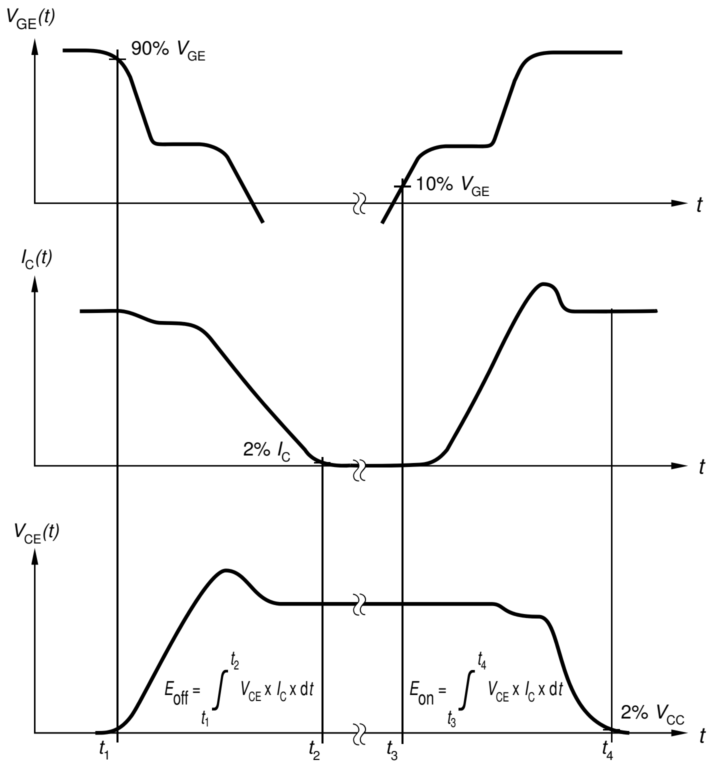


Figure B. **Definition of switching losses**

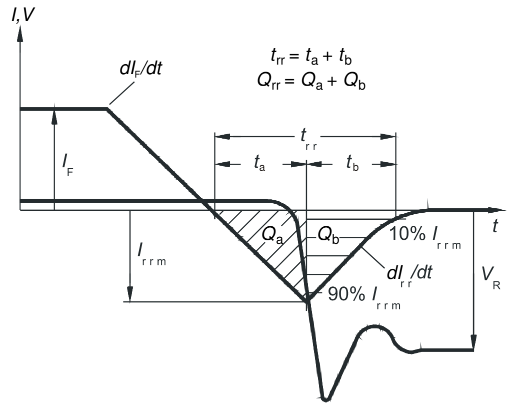


Figure C. **Definition of diode switching characteristics**

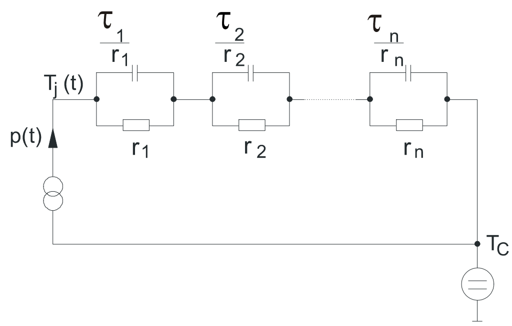


Figure D. **Thermal equivalent circuit**

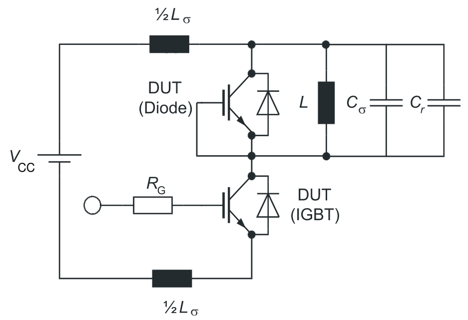


Figure E. **Dynamic test circuit**
Parasitic inductance L_σ,
parasitic capacitor C_σ,
relief capacitor C_r,
(only for ZVT switching)

Figure 2

Revision history

Document revision	Date of release	Description of changes
1.00	2023-02-09	Final datasheet
1.10	2023-04-25	Correction of switching values in Table 3 Correction of diagram $V_{GE} = f(Q_G)$

Trademarks

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Edition 2023-04-25

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81726 Munich, Germany

Do you have a question about any aspect of this document?

Email: erratum@infineon.com

Document reference
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