Low loss Duopack: IGBT 7 with Trench and Fieldstop technology

Features

- V_{CE} = 650 V
- I_C = 40 A
- Very low $V_{CE,sat}$
- Low turn-off losses
- Short tail current
- Reduced 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/igbt7/

Lead-free
Green
Halogen-free
RoHS

Potential applications

- Servo drives
- General purpose drives (GPD)
- Industrial UPS
- Industrial SMPS
- Energy generation
- Solar optimizer
- Solar string inverter

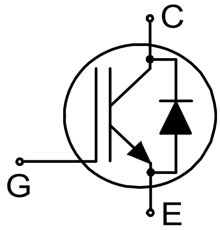
Product validation

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

Description

Package pin definition:

• Pin C & backside - Collector
• Pin E - Emitter
• Pin G - Gate



Type	Package	Marking
IKW40N65ET7	PG-TO247-3	K40EET7

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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 processes: 3			0.6	Nm
Thermal resistance, junction-ambient	$R_{th(j-a)}$				40	K/W
IGBT thermal resistance, junction-case	$R_{th(j-c)}$				0.65	K/W
Diode thermal resistance, junction-case	$R_{th(j-c)}$				0.9	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	76	A
			$T_c = 100$ °C	49.5	
Pulsed collector current, t_p limited by T_{vjmax} [1]	I_{Cpulse}			120	A
Turn-off safe operating area[2]		$V_{CE} \leq 650$ V, $t_p = 1$ µs, $T_{vj} \leq 175$ °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
Short-circuit withstand time	t_{SC}	$V_{GE} = 15$ V, Allowed number of short circuits < 1000, Time between short circuits ≥ 1.0 s	$V_{CC} \leq 330$ V, $T_{vj} = 100$ °C	5	µs
			$V_{CC} \leq 400$ V, $T_{vj} = 150$ °C	3	
Power dissipation	P_{tot}		$T_c = 25$ °C	230.8	W
			$T_c = 100$ °C	115.4	

1) Defined by design. Not subject to production test.
2) Clamped inductive load current test for each device, $I_C = 120$ A, $V_{CC} = 400$ V, $T_c = 25$°C, $V_{GE} = 20$ V, L = 80 µH, $R_G = 10$ Ω

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		1.35	1.65	V
			T_{vj} = 125 °C		1.5		
			T_{vj} = 175 °C		1.6		
Gate-emitter threshold voltage	V_{GEth}	I_C = 0.4 mA, $V_{CE} = V_{GE}$		4.3	5	5.7	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		900		
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			20.5		S
Short-circuit collector current	I_{SC}	$V_{CC} \leq$ 400 V, V_{GE} = 15 V, $t_{SC} \leq$ 3 µs, Allowed number of short circuits < 1000, Time between short circuits ≥ 1.0 s, T_{vj} = 150 °C			205		A
Input capacitance	C_{ies}	V_{CE} = 25 V, V_{GE} = 0 V, f = 1000 kHz			2475		pF
Output capacitance	C_{oes}	V_{CE} = 25 V, V_{GE} = 0 V, f = 1000 kHz			77		pF
Reverse transfer capacitance	C_{res}	V_{CE} = 25 V, V_{GE} = 0 V, f = 1000 kHz			25		pF
Gate charge	Q_G	I_C = 40 A, V_{GE} = 15 V, V_{CC} = 520 V			235		nC
Turn-on delay time	$t_{d(on)}$	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 10 Ω, $R_{G(off)}$ = 10 Ω, L_σ = 32 nH, C_σ = 30 pF	T_{vj} = 25 °C, I_C = 40 A		20		ns
			T_{vj} = 25 °C, I_C = 20 A		19		
			T_{vj} = 175 °C, I_C = 40 A		23		
			T_{vj} = 175 °C, I_C = 20 A		21		
Rise time (inductive load)	t_r	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 10 Ω, $R_{G(off)}$ = 10 Ω, L_σ = 32 nH, C_σ = 30 pF	T_{vj} = 25 °C, I_C = 40 A		15		ns
			T_{vj} = 25 °C, I_C = 20 A		9		
			T_{vj} = 175 °C, I_C = 40 A		20		
			T_{vj} = 175 °C, I_C = 20 A		12		

(table continues...)

Table 3 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Turn-off delay time	$t_{d(off)}$	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 10 Ω, $R_{G(off)}$ = 10 Ω, L_σ = 32 nH, C_σ = 30 pF	T_{vj} = 25 °C, I_C = 40 A		310		ns
			T_{vj} = 25 °C, I_C = 20 A		330		
			T_{vj} = 175 °C, I_C = 40 A		380		
			T_{vj} = 175 °C, I_C = 20 A		430		
Fall time (inductive load)	t_f	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 10 Ω, $R_{G(off)}$ = 10 Ω, L_σ = 32 nH, C_σ = 30 pF	T_{vj} = 25 °C, I_C = 40 A		13		ns
			T_{vj} = 25 °C, I_C = 20 A		17		
			T_{vj} = 175 °C, I_C = 40 A		57		
			T_{vj} = 175 °C, I_C = 20 A		70		
Turn-on energy	E_{on}	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 10 Ω, $R_{G(off)}$ = 10 Ω, L_σ = 32 nH, C_σ = 30 pF	T_{vj} = 25 °C, I_C = 40 A		1.05		mJ
			T_{vj} = 25 °C, I_C = 20 A		0.45		
			T_{vj} = 175 °C, I_C = 40 A		1.65		
			T_{vj} = 175 °C, I_C = 20 A		0.84		
Turn-off energy	E_{off}	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 10 Ω, $R_{G(off)}$ = 10 Ω, L_σ = 32 nH, C_σ = 30 pF	T_{vj} = 25 °C, I_C = 40 A		0.59		mJ
			T_{vj} = 25 °C, I_C = 20 A		0.26		
			T_{vj} = 175 °C, I_C = 40 A		1.13		
			T_{vj} = 175 °C, I_C = 20 A		0.59		

(table continues...)

Table 3 **(continued) Characteristic values**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Total switching energy	E_{ts}	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 10 Ω, $R_{G(off)}$ = 10 Ω, L_σ = 32 nH, C_σ = 30 pF	T_{vj} = 25 °C, I_C = 40 A		1.64		mJ
			T_{vj} = 25 °C, I_C = 20 A		0.71		
			T_{vj} = 175 °C, I_C = 40 A		2.78		
			T_{vj} = 175 °C, I_C = 20 A		1.43		
Operating junction temperature	T_{vj}			-40		175	°C

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	limited by bondwire	T_c = 25 °C	72	A
			T_c = 100 °C	43.5	
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpulse}			120	A

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} = 125 °C		1.6		
			T_{vj} = 175 °C		1.55		

(table continues...)

Table 5 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode reverse recovery time	t_{rr}	V_R = 650 V	T_{vj} = 25 °C, I_F = 40 A, $-di_F/dt$ = 1779 A/µs		85		ns
			T_{vj} = 25 °C, I_F = 20 A, $-di_F/dt$ = 2381 A/µs		59		
			T_{vj} = 175 °C, I_F = 40 A, $-di_F/dt$ = 1660 A/µs		145		
			T_{vj} = 175 °C, I_F = 20 A, $-di_F/dt$ = 1881 A/µs		105		
Diode reverse recovery charge	Q_{rr}	V_R = 650 V	T_{vj} = 25 °C, I_F = 40 A, $-di_F/dt$ = 1779 A/µs		0.95		µC
			T_{vj} = 25 °C, I_F = 20 A, $-di_F/dt$ = 2381 A/µs		0.7		
			T_{vj} = 175 °C, I_F = 40 A, $-di_F/dt$ = 1660 A/µs		2.8		
			T_{vj} = 175 °C, I_F = 20 A, $-di_F/dt$ = 1881 A/µs		2.02		
Diode peak reverse recovery current	I_{rrm}	V_R = 650 V	T_{vj} = 25 °C, I_F = 40 A, $-di_F/dt$ = 1779 A/µs		22		A
			T_{vj} = 25 °C, I_F = 20 A, $-di_F/dt$ = 2381 A/µs		24.5		
			T_{vj} = 175 °C, I_F = 40 A, $-di_F/dt$ = 1660 A/µs		35		
			T_{vj} = 175 °C, I_F = 20 A, $-di_F/dt$ = 1881 A/µs		35		

(table continues...)

Table 5 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode peak rate of fall of reverse recovery current	di_{rr}/dt	V_R = 650 V	T_{vj} = 25 °C, I_F = 40 A, $-di_F/dt$ = 1779 A/µs		380		A/µs
			T_{vj} = 25 °C, I_F = 20 A, $-di_F/dt$ = 2381 A/µs		520		
			T_{vj} = 175 °C, I_F = 40 A, $-di_F/dt$ = 1660 A/µs		290		
			T_{vj} = 175 °C, I_F = 20 A, $-di_F/dt$ = 1881 A/µs		425		
Operating junction temperature	T_{vj}			-40		175	°C

Note: *Maximum rated values: 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.

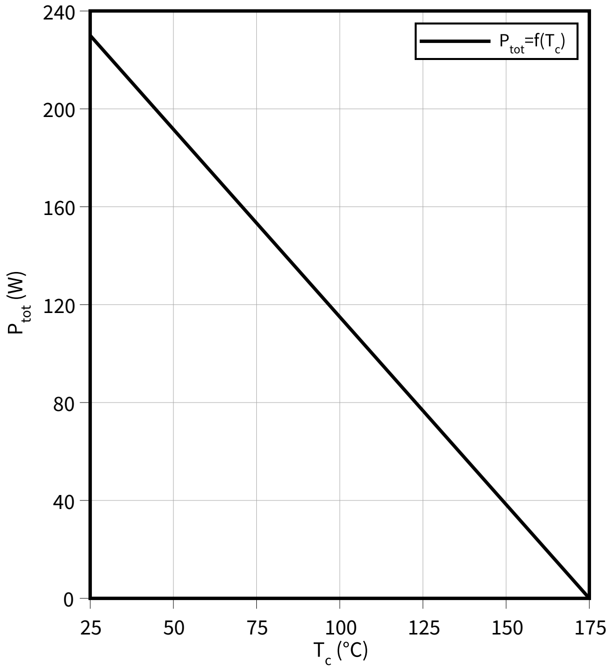
Dynamic test circuit, L_σ, C_σ from Fig. E. Energy losses include “tail” and diode reverse recovery.

4 Characteristics diagrams

Power dissipation as a function of case temperature

$P_{tot} = f(T_c)$

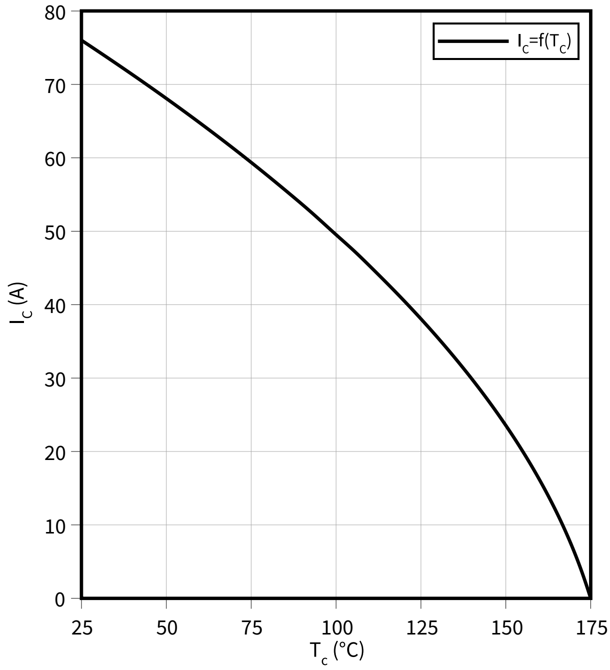
$T_{vj} \leq 175$ °C



Collector current as a function of case temperature

$I_C = f(T_c)$

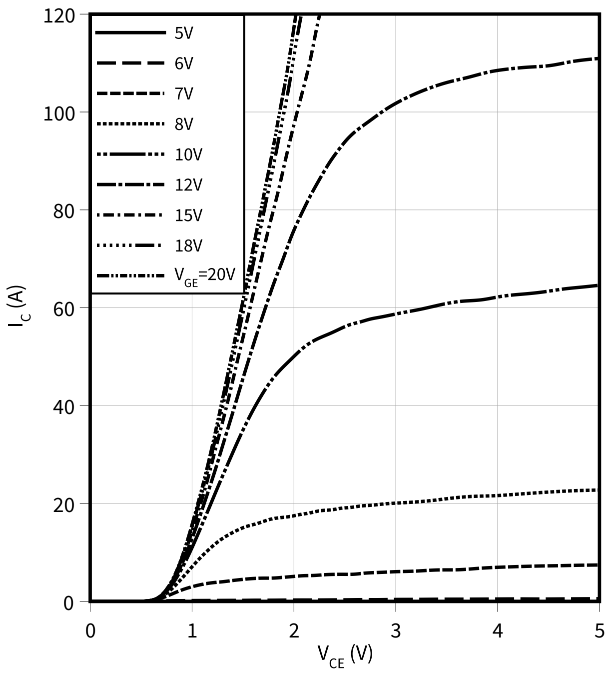
$T_{vj} \leq 175$ °C, $V_{GE} \geq 15$ V



Typical output characteristic

$I_C = f(V_{CE})$

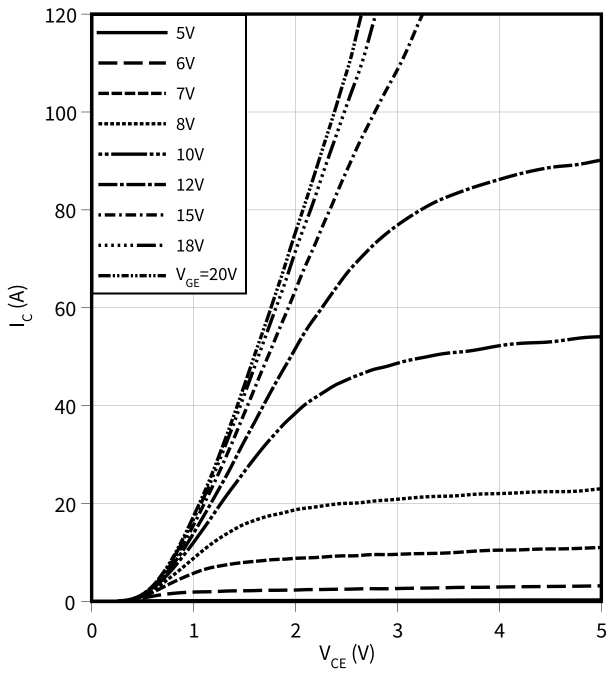
$T_{vj} = 25$ °C



Typical output characteristic

$I_C = f(V_{CE})$

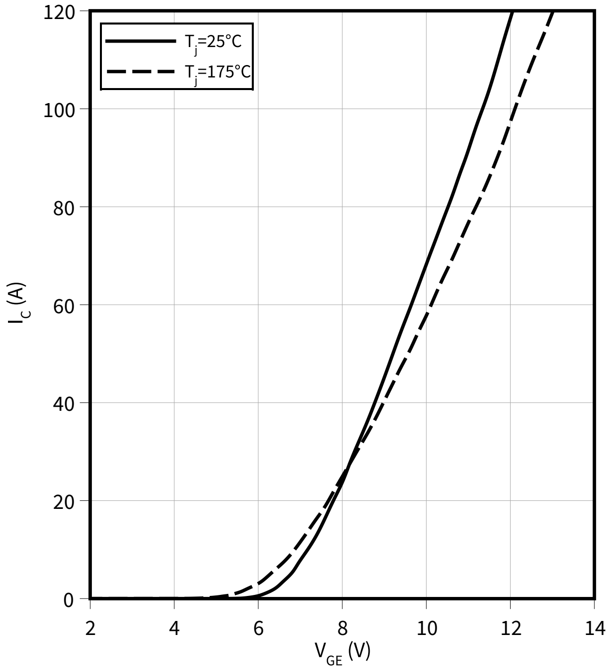
$T_{vj} = 175$ °C



Typical transfer characteristic

$I_C = f(V_{GE})$

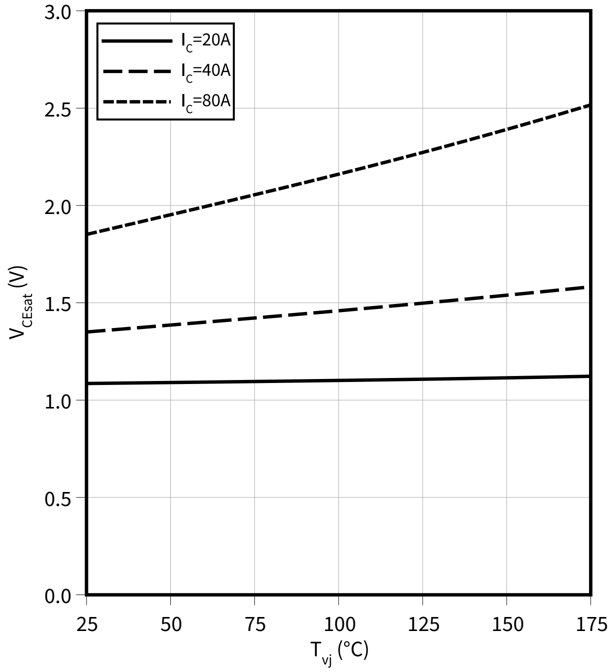
$V_{CE} = 20$ V



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

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

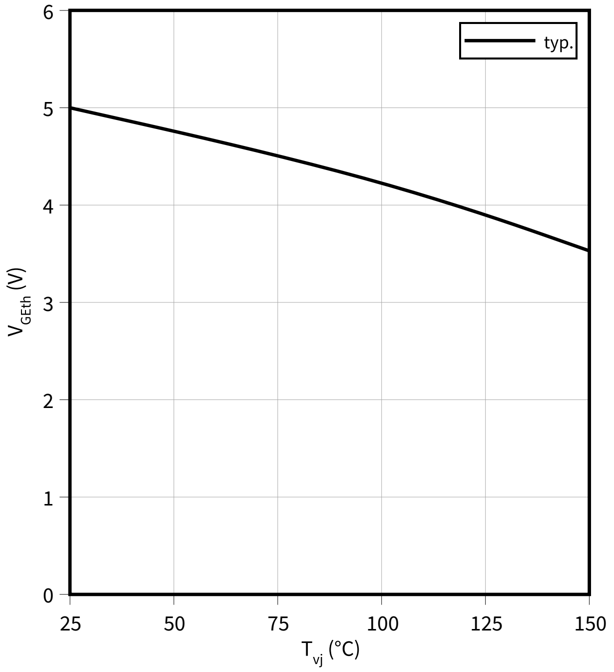
$V_{GE} = 15$ V



Gate-emitter threshold voltage as a function of junction temperature

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

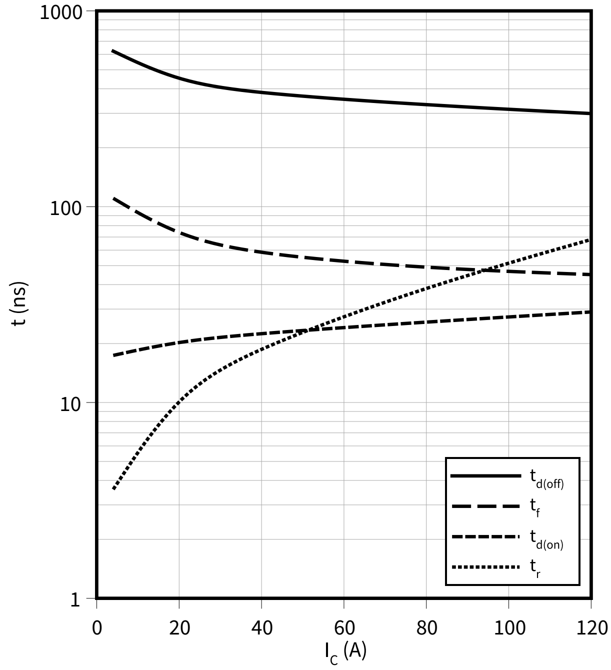
$I_C = 0.4$ mA



Typical switching times as a function of collector current

$t = f(I_C)$

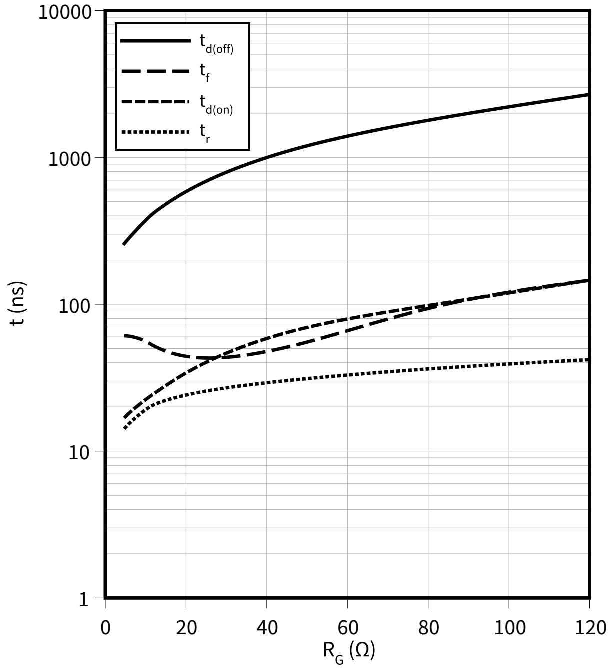
$V_{CC} = 400$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V, $R_G = 10\ \Omega$



Typical switching times as a function of gate resistor

$t = f(R_G)$

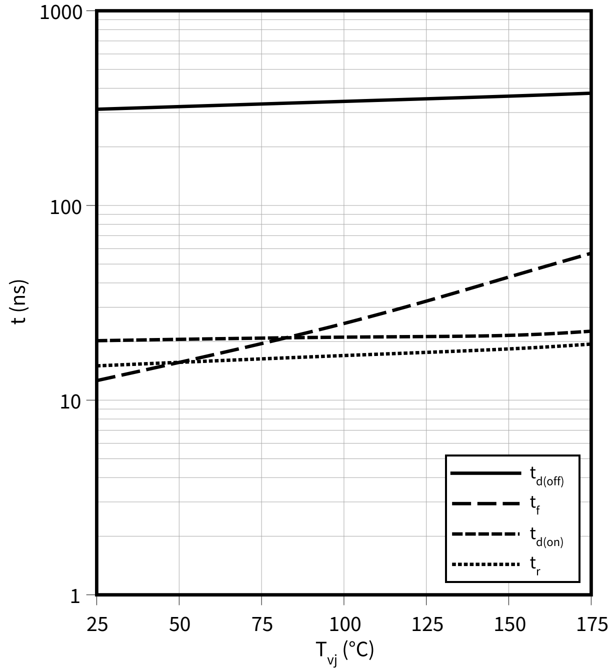
$I_C = 40$ A, $V_{CC} = 400$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V



Typical switching times as a function of junction temperature

$t = f(T_{vj})$

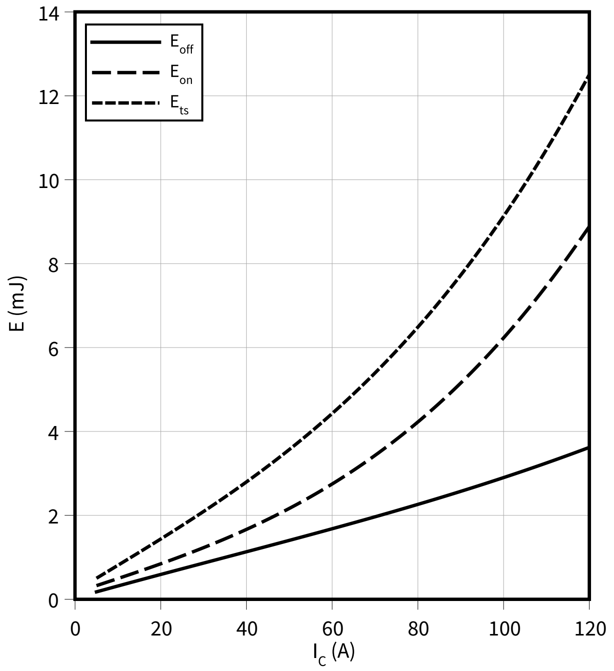
$I_C = 40$ A, $V_{CC} = 400$ V, $V_{GE} = 0/15$ V, $R_G = 10$ Ω



Typical switching energy losses as a function of collector current

$E = f(I_C)$

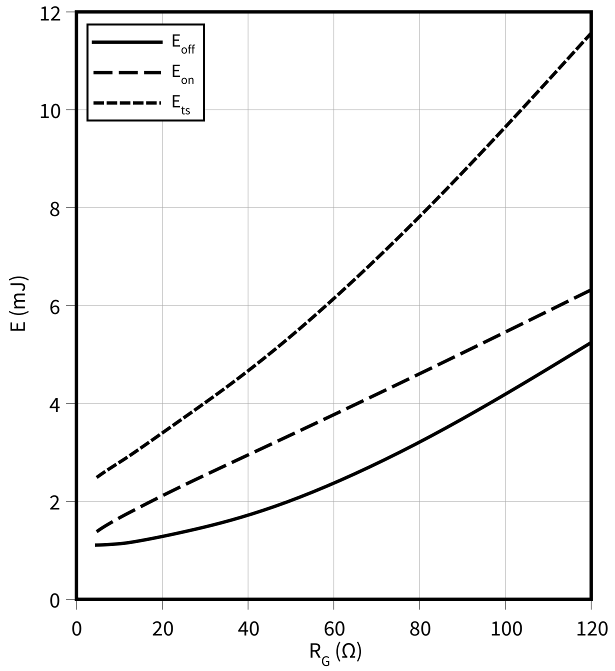
$V_{CC} = 400$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V, $R_G = 10$ Ω



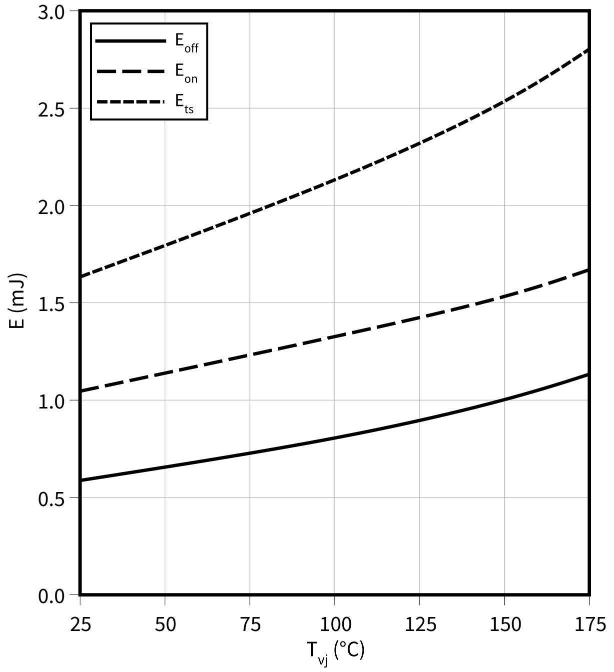
Typical switching energy losses as a function of gate resistor

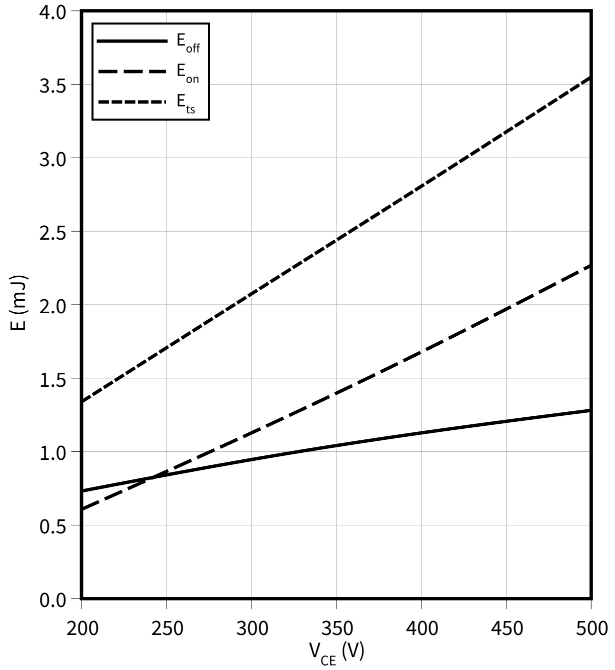
$E = f(R_G)$

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

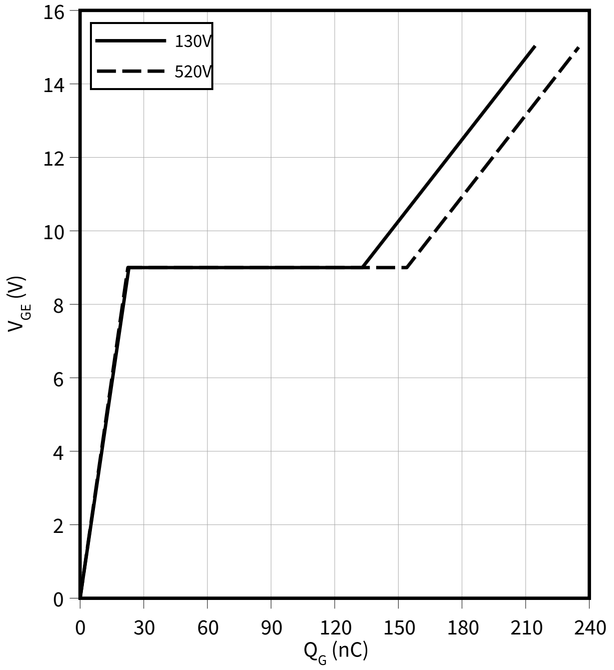


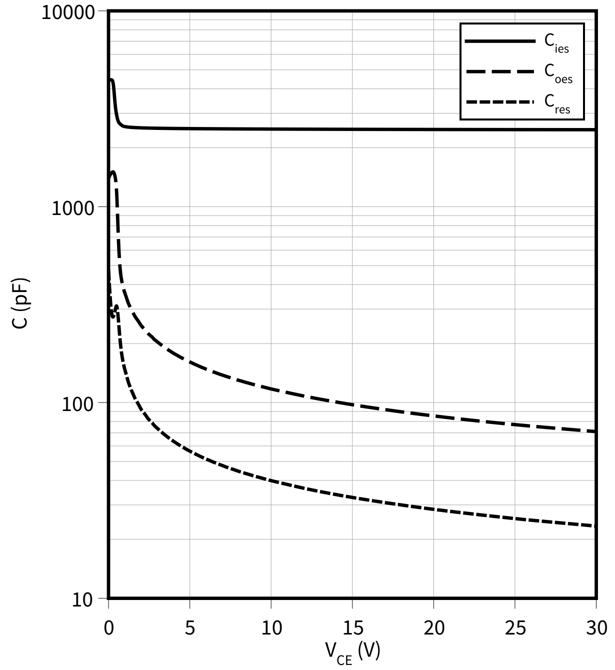
Typical switching energy losses as a function of junction temperature $E = f(T_{vj})$ $I_C = 40$ A, $V_{CC} = 400$ V, $V_{GE} = 0/15$ V, $R_G = 10\ \Omega$	**Typical switching energy losses as a function of collector emitter voltage** $E = f(V_{CE})$ $I_C = 40$ A, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V, $R_G = 10\ \Omega$

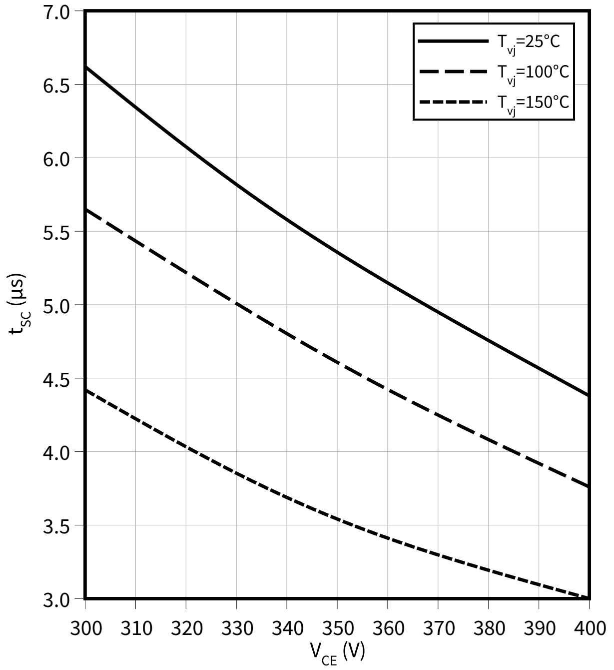
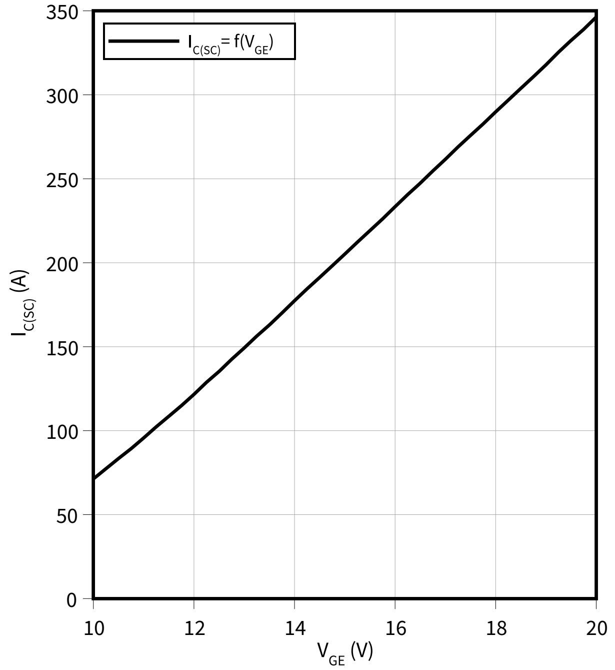
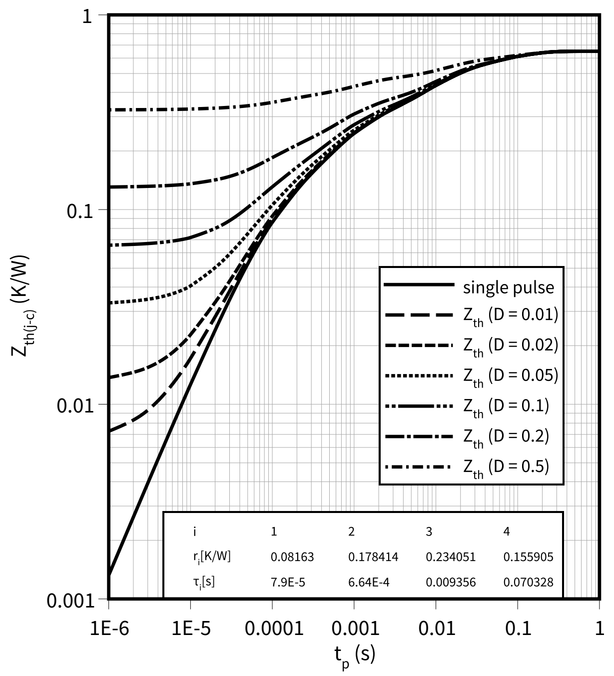
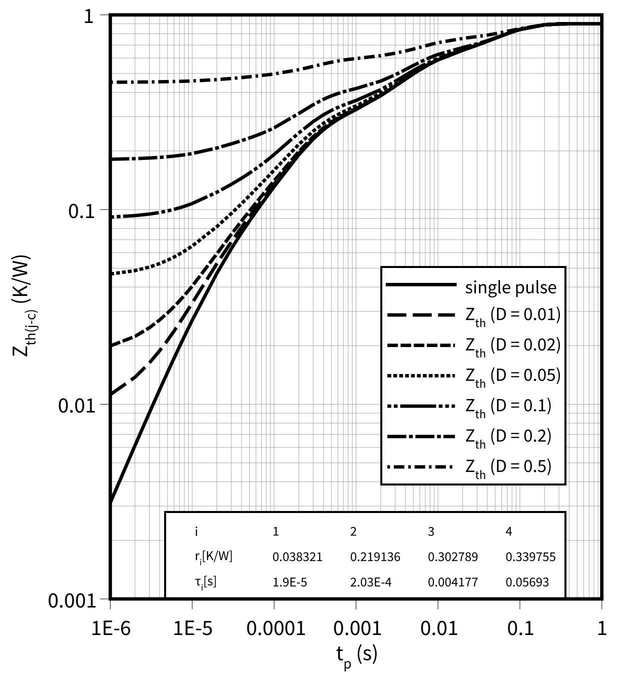




Typical gate charge $V_{GE} = f(Q_G)$ $I_C = 40$ A	**Typical capacitance as a function of collector-emitter voltage** $C = f(V_{CE})$ f = 1000 kHz, $V_{GE} = 0$ V

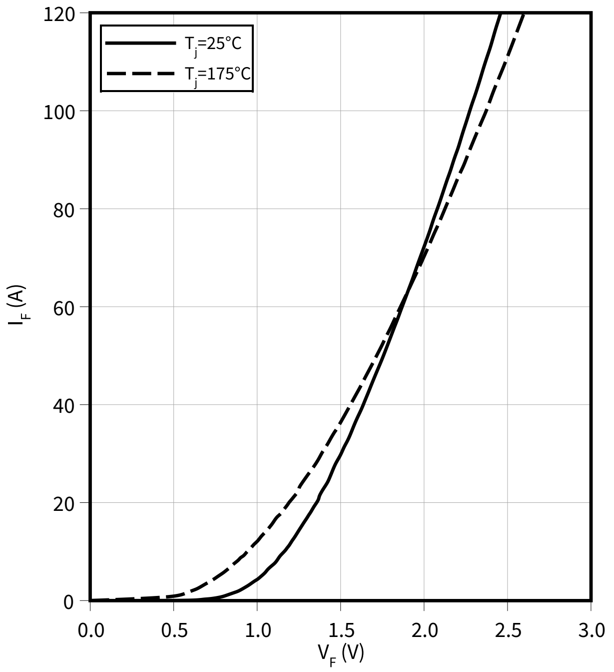




Typical short circuit safe operating range as a function of collector-emitter voltage $t_{SC} = f(V_{CE})$	**Typical short circuit collector current as a function of gate-emitter voltage** $I_{C(SC)} = f(V_{GE})$ $T_{vj} = 150\ °C, V_{CC} \le 400\ V$
	
IGBT transient thermal impedance as a function of pulse width $Z_{th(j-c)} = f(t_p)$ $D = t_p/T$	**Diode transient thermal impedance as a function of pulse width** $Z_{th(j-c)} = f(t_p)$ $D = t_p/T$
	

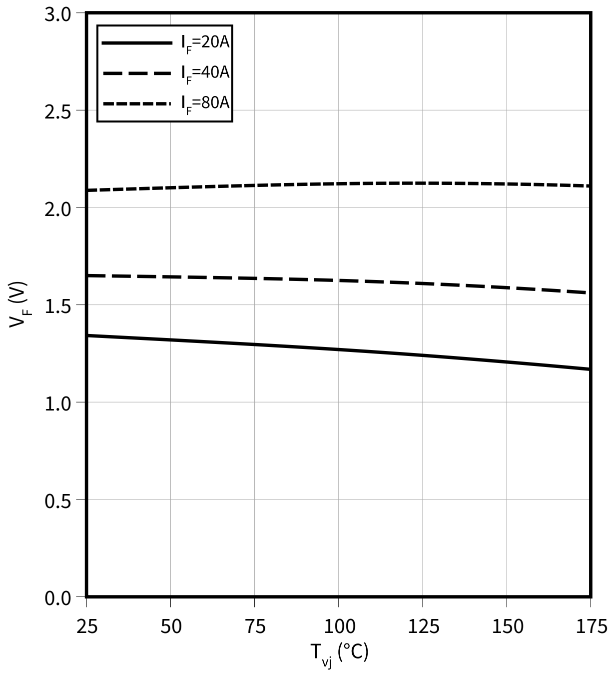
Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



Typical diode forward voltage as a function of junction temperature

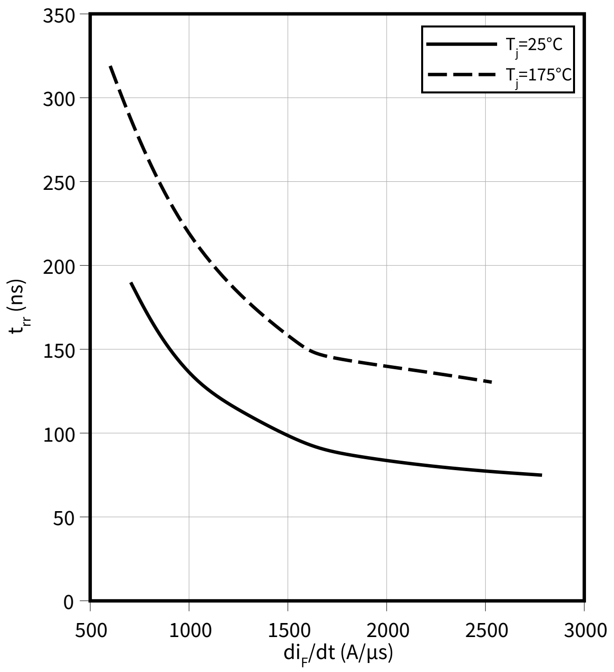
$V_F = f(T_{vj})$



Typical reverse recovery time as a function of diode current slope

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

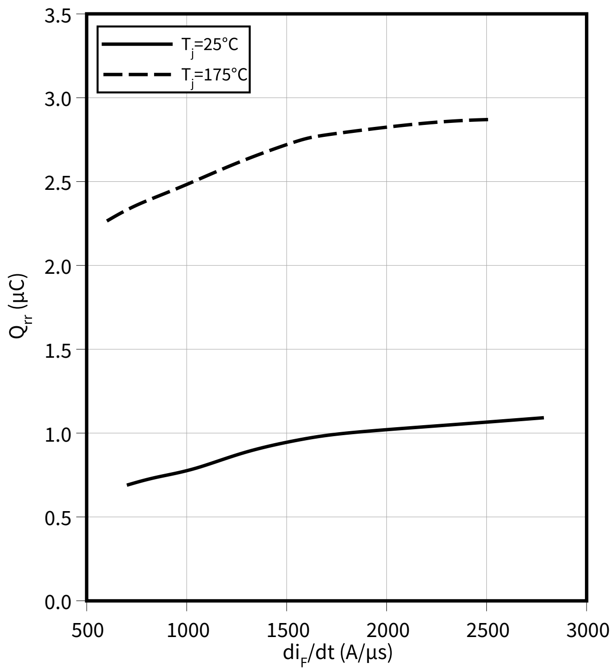
$V_R = 400$ V, $I_F = 40$ A

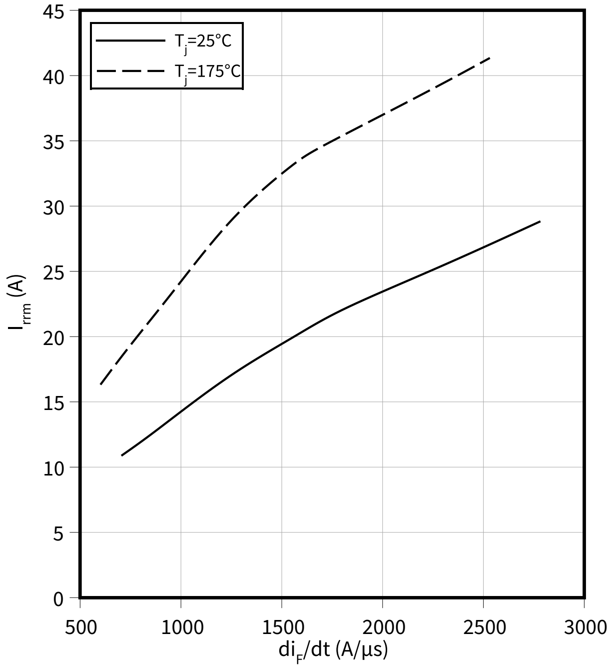
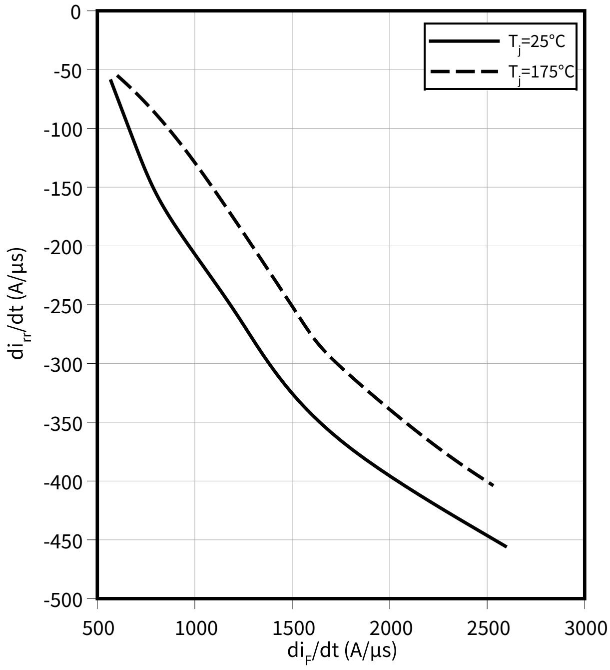


Typical reverse recovery charge as a function of diode current slope

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

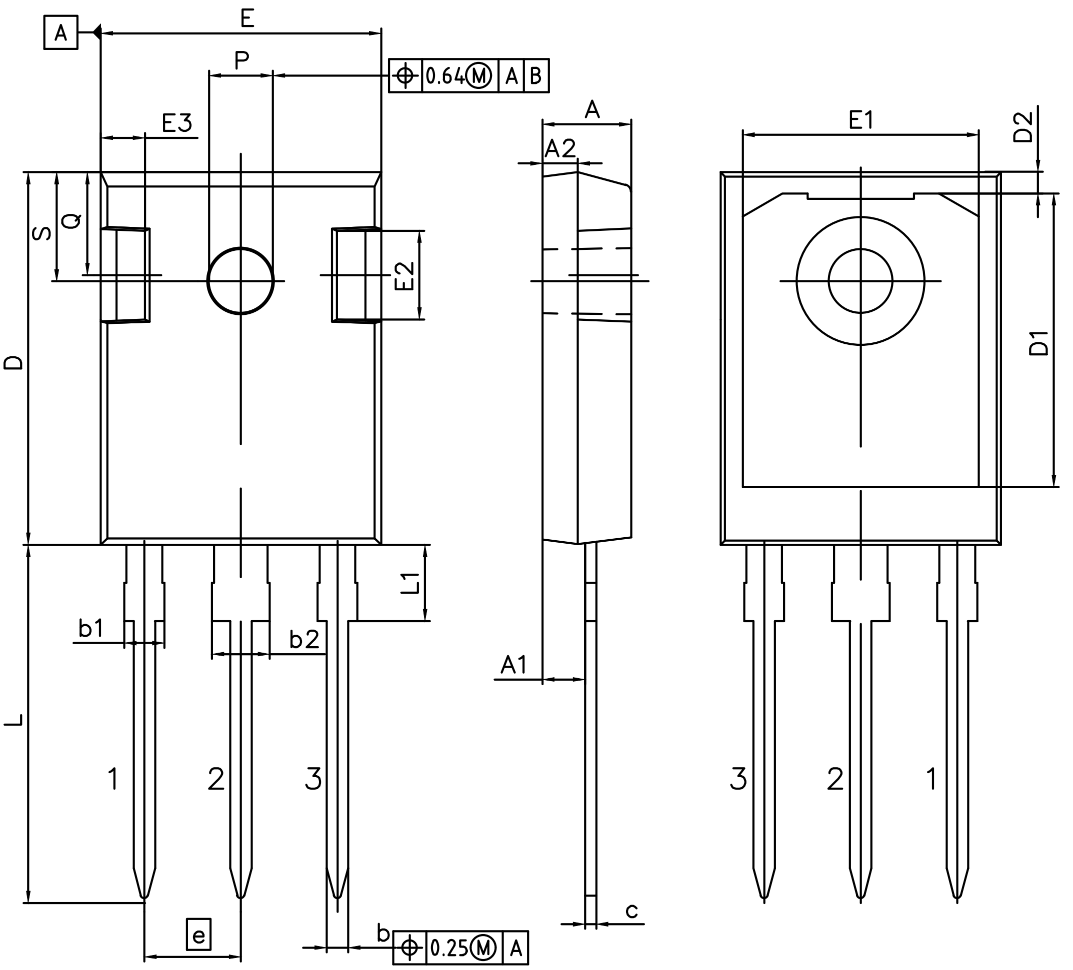
$V_R = 400$ V, $I_F = 40$ A



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
	

5 Package outlines

Package Drawing PG-TO247-3



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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REVISION 06
SCALE 3:1 0 1 2 3 4 5mm
EUROPEAN PROJECTION
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Figure 1

6 Testing conditions

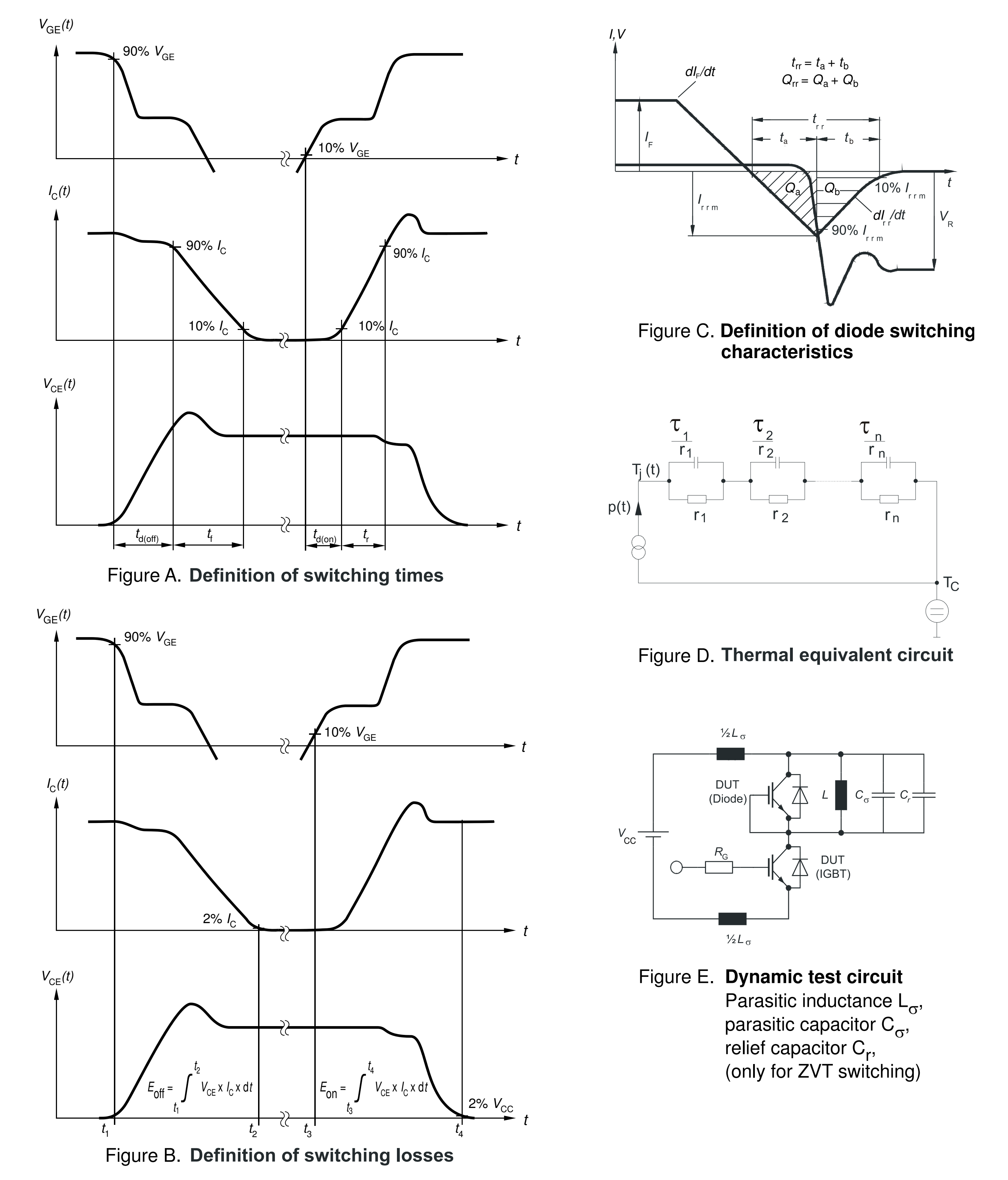

Figure 2

Revision history

Document revision	Date of release	Description of changes
V1.1	2020-04-28	Preliminary data sheet
V2.1	2020-05-12	Final data sheet
n/a	2020-11-30	Datasheet migrated to a new system with a new layout and new revision number schema: target or preliminary datasheet = 0.xy; final datasheet = 1.xy
1.00	2021-06-29	Change of potential applications and new diagram added (t_{SC} as function of V_{CE})
1.10	2023-01-26	Feature list corrections Editorial changes

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