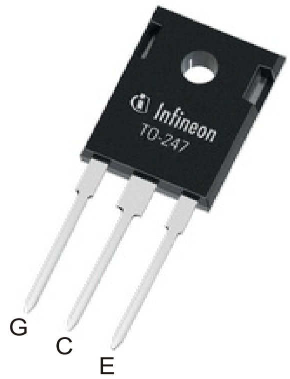
IHW40N65R6

Reverse-Conducting IGBT

Reverse-Conducting IGBT with monolithic body diode

Features



- Complete product spectrum and PSpice Models: http://www.infineon.com/igbt/
- Easy parallel switching capability due to positive temperature coefficient in V_{CEsat}
- High ruggedness and stable temperature behavior
- Low EMI
- Pb-free lead plating; RoHS compliant
- Powerful monolithic reverse-conducting diode with low forward voltage
- Very low V_{CEsat} and low E_{off}
- Very tight parameter distribution

Potential applications

- Induction Cooking
- Microwave Ovens

Product validation

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

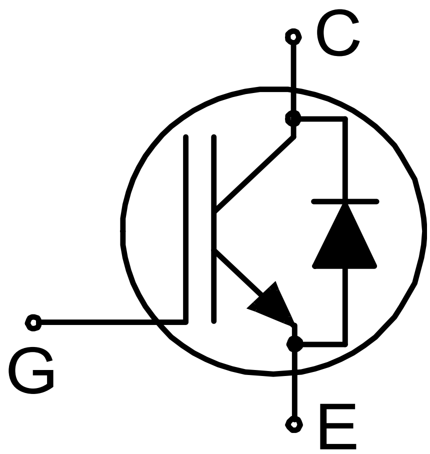
PB

Green

Halogen-Free

RoHS

Description



Type	Package	Marking
IHW40N65R6	PG-TO247-3	H40ER6

Table of contents

1 Package

Table 1 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Internal emitter inductance measured 5mm. (0.197in) from case	L_E			13.0		nH
Storage temperature	T_{stg}		-55		150	°C
Soldering temperature		wave soldering 1.6mm (0.063in.) from case for 10s			260	°C
Mounting torque , M3 screw Maximum of mounting process: 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}	$T_{vj} \geq 25$ °C		650	V
DC collector current, limited by T_{vjmax}	I_C		$T_C = 25$ °C	83	A
			$T_C = 100$ °C	54	
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpuls}			120	A
Turn-off safe operating area		$V_{CE} \leq$ 650 V, $t_P \leq$ 1 µs, $T_{vj} \leq$ 175 °C		120	A
Gate-emitter voltage	V_{GE}			±20	V
Transient gate-emitter voltage	V_{GE}	$t_p = 10$ µs, $D < 0.010$		±30	V
Power dissipation	P_{tot}		$T_C = 25$ °C	210	W
			$T_C = 100$ °C	105	

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
Collector-emitter saturation voltage	$V_{CE\,sat}$	$I_C = 40.0$ A, $V_{GE} = 15$ V	$T_{vj} = 25$ °C		1.29	1.60	V
			$T_{vj} = 175$ °C		1.50		

Table 3 Characteristic values (continued)

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Gate-emitter threshold voltage	V_{GEth}	I_C = 0.40 mA, V_{CE} = V_{GE}		3.20	4.00	4.80	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		1000		
Gate-emitter leakage current	I_{GES}	V_{CE} = 0 V, V_{GE} = 20 V				100	nA
Transconductance	g_{fs}	I_C = 40.0 A, V_{CE} = 20 V			97.0		S
Input capacitance	C_{ies}	V_{CE} = 25 V, V_{GE} = 0 V, f = 100 kHz			4029		pF
Output capacitance	C_{oes}	V_{CE} = 25 V, V_{GE} = 0 V, f = 100 kHz			42		pF
Reverse transfer capacitance	C_{res}	V_{CE} = 25 V, V_{GE} = 0 V, f = 100 kHz			16		pF
Gate charge	Q_G	I_C = 40.0 A, V_{GE} = 15 V, V_{CE} = 520 V			159		nC
Turn-on delay time	t_{don}	V_{CE} = 400 V, V_{GE} = 15 V, R_{Gon} = 10.0 Ω, R_{Goff} = 10.0 Ω, $L_σ$ = 70 nH, $C_σ$ = 30 pF	T_{vj} = 25 °C, I_C = 40.0 A		17		ns
			T_{vj} = 175 °C, I_C = 40.0 A		17		
Rise time (inductive load)	t_r	V_{CE} = 400 V, V_{GE} = 15 V, R_{Gon} = 10.0 Ω, R_{Goff} = 10.0 Ω, $L_σ$ = 70 nH, $C_σ$ = 30 pF	T_{vj} = 25 °C, I_C = 40.0 A		19		ns
			T_{vj} = 175 °C, I_C = 40.0 A		19		
Turn-off delay time	t_{doff}	V_{CE} = 400 V, V_{GE} = 15 V, R_{Gon} = 10.0 Ω, R_{Goff} = 10.0 Ω, $L_σ$ = 70 nH, $C_σ$ = 30 pF	T_{vj} = 25 °C, I_C = 40.0 A		211		ns
			T_{vj} = 175 °C, I_C = 40.0 A		236		
Fall time (inductive load)	t_f	V_{CE} = 400 V, V_{GE} = 15 V, R_{Gon} = 10.0 Ω, R_{Goff} = 10.0 Ω, $L_σ$ = 70 nH, $C_σ$ = 30 pF	T_{vj} = 25 °C, I_C = 40.0 A		15		ns
			T_{vj} = 175 °C, I_C = 40.0 A		20		
Turn-on energy	E_{on}	V_{CE} = 400 V, V_{GE} = 15 V, R_{Gon} = 10.0 Ω, R_{Goff} = 10.0 Ω, $L_σ$ = 70 nH, $C_σ$ = 30 pF	T_{vj} = 25 °C, I_C = 40.0 A		1.10		mJ
			T_{vj} = 175 °C, I_C = 40.0 A		1.27		
Turn-off energy	E_{off}	V_{CE} = 400 V, V_{GE} = 15 V, R_{Gon} = 10.0 Ω, R_{Goff} = 10.0 Ω, $L_σ$ = 70 nH, $C_σ$ = 30 pF	T_{vj} = 25 °C, I_C = 40.0 A		0.42		mJ
			T_{vj} = 175 °C, I_C = 40.0 A		0.61		

Table 3 Characteristic values (continued)

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Total switching energy	E_{ts}	V_{CE} = 400 V, V_{GE} = 15 V, R_{Gon} = 10.0 Ω, R_{Goff} = 10.0 Ω, $L_σ$ = 70 nH, $C_σ$ = 30 pF	T_{vj} = 25 °C, I_C = 40.0 A		1.52		mJ
			T_{vj} = 175 °C, I_C = 40.0 A		1.88		
Soft turn-off energy	E_{off}	V_{CE} = 162 V, V_{GE} = 15 V, R_{Gon} = 10.0 Ω, R_{Goff} = 10.0 Ω, C_r = 30 nF, $L_σ$ = 70 nH, $C_σ$ = 30 pF	T_{vj} = 25 °C, I_C = 40.0 A		0.11		mJ
			T_{vj} = 175 °C, I_C = 40.0 A		0.22		
IGBT thermal resistance, junction-case	R_{thjc}					0.71	K/W
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		T_C = 25 °C	35	A
			T_C = 100 °C	21	
Diode pulsed current, limited by T_{vjmax}	I_{Fpuls}			120	A
Power dissipation	P_{tot}		T_C = 25 °C	54	W
			T_C = 100 °C	27	

Table 5 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode forward voltage	V_F	I_F = 40.0 A	T_{vj} = 25 °C		1.50	1.90	V
			T_{vj} = 175 °C		1.66		
Reverse leakage current	I_R	V_R = 650 V	T_{vj} = 25 °C			40	µA
			T_{vj} = 175 °C		1000		

Table 5 Characteristic values (continued)

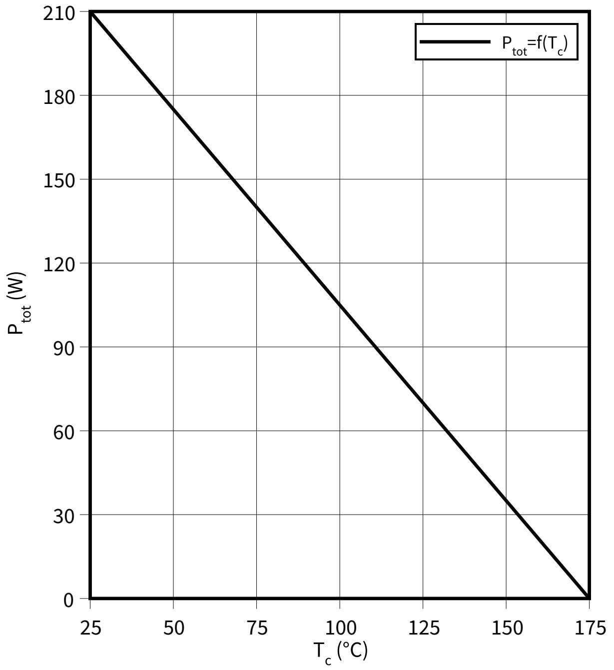
Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode reverse recovery time	t_{rr}	V_R = 400 V	T_{vj} = 25 °C, I_F = 40.0 A, $-di_F/dt$ = 1000 A/µs		99		ns
			T_{vj} = 175 °C, I_F = 40.0 A, $-di_F/dt$ = 1000 A/µs		133		
Diode reverse recovery charge	Q_{rr}	V_R = 400 V	T_{vj} = 25 °C, I_F = 40.0 A, $-di_F/dt$ = 1000 A/µs		2.16		µC
			T_{vj} = 175 °C, I_F = 40.0 A, $-di_F/dt$ = 1000 A/µs		3.77		
Diode peak reverse recovery current	I_{rrm}	V_R = 400 V	T_{vj} = 25 °C, I_F = 40.0 A, $-di_F/dt$ = 1000 A/µs		35.0		A
			T_{vj} = 175 °C, I_F = 40.0 A, $-di_F/dt$ = 1000 A/µs		46.0		
Diode peak rate off fall of reverse recovery current	dI_{rr}/dt	V_R = 400 V	T_{vj} = 25 °C, I_F = 40.0 A, $-di_F/dt$ = 1000 A/µs		-926		A/µs
			T_{vj} = 175 °C, I_F = 40.0 A, $-di_F/dt$ = 1000 A/µs		-901		
Diode thermal resistance, junction-case	R_{thjc}					2.77	K/W
Operating junction temperature	T_{vj}			-40		175	°C

4 Characteristics diagrams

Power dissipation as a function of case temperature, IGBT

$P_{tot} = f(T_c)$

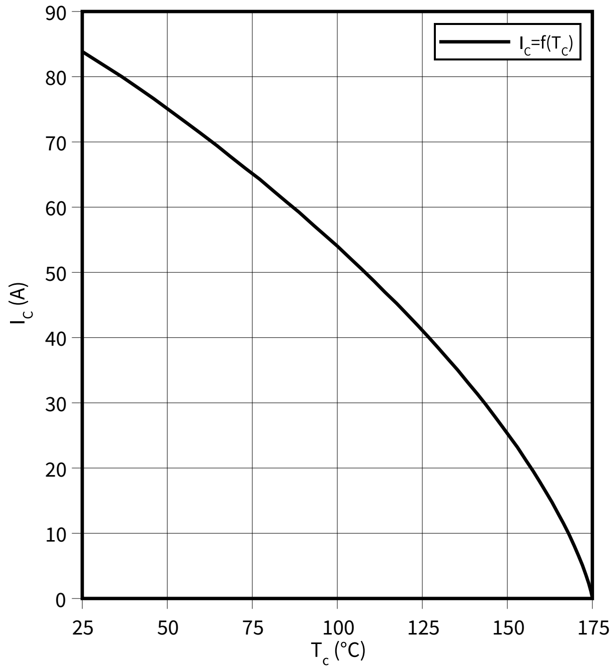
$T_{vj} \leq 175$ °C



Collector current as a function of case temperature, IGBT

$I_C = f(T_c)$

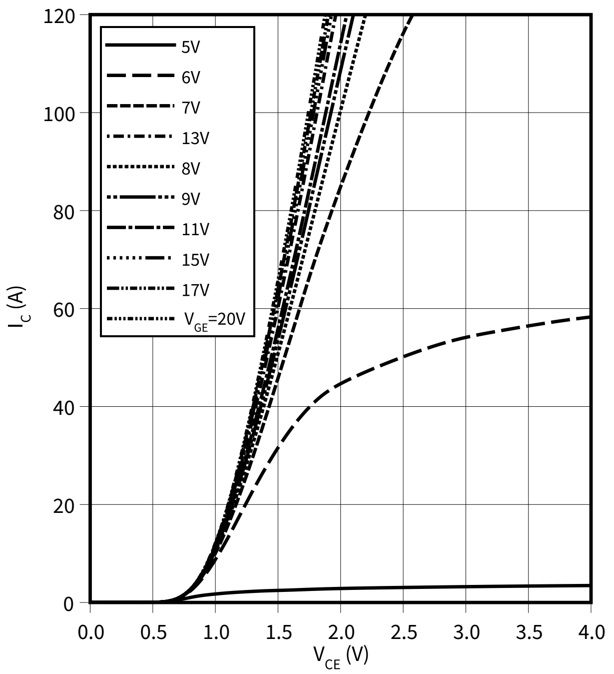
$T_{vj} \leq 175$ °C, $V_{GE} = 15$ V



Typical output characteristic, IGBT

$I_C = f(V_{CE})$

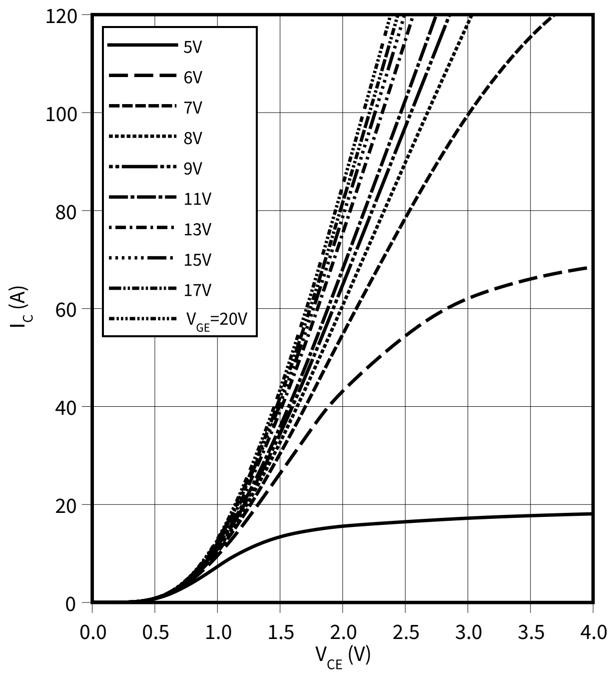
$T_{vj} = 25$ °C



Typical output characteristic, IGBT

$I_C = f(V_{CE})$

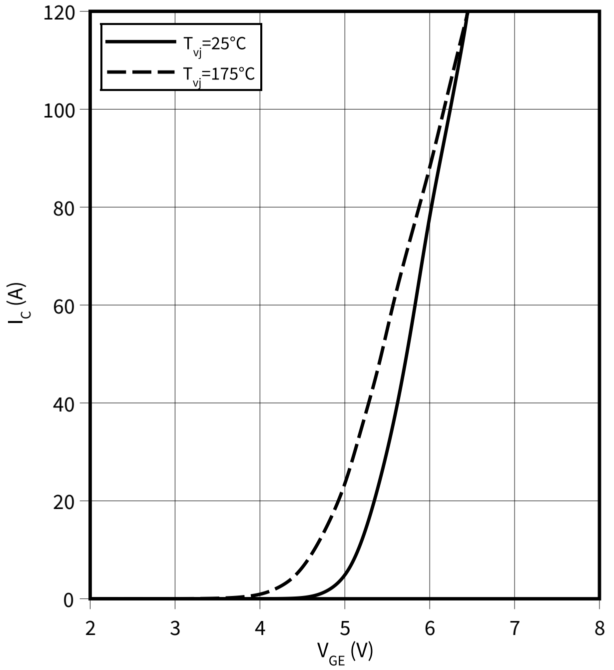
$T_{vj} = 175$ °C



Typical transfer characteristic, IGBT

$I_C = f(V_{GE})$

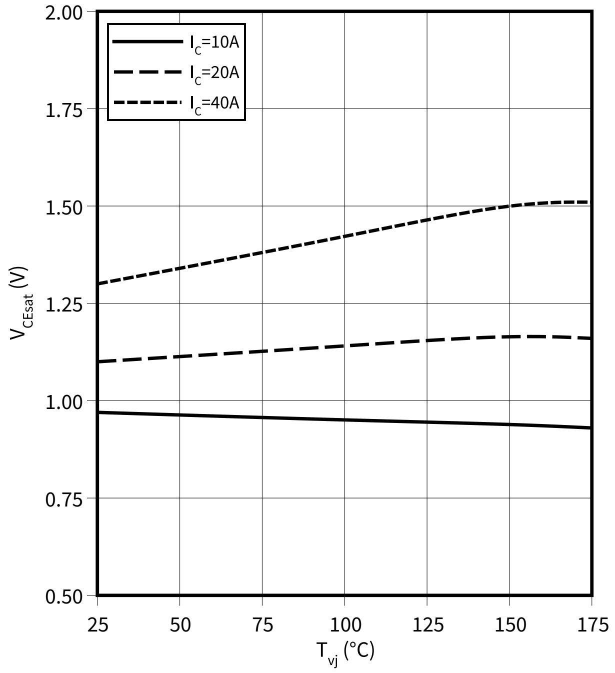
$V_{CE} = 20\ V$



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

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

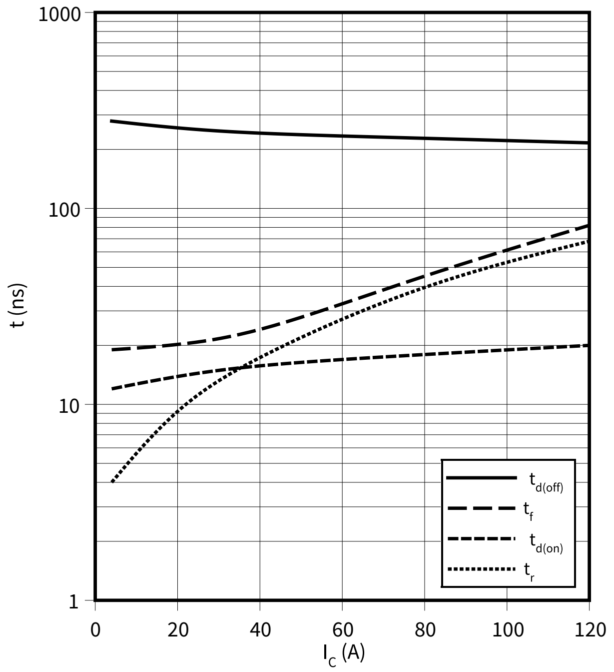
$V_{GE} = 15\ V$



Typical switching times as a function of collector current, IGBT

$t = f(I_C)$

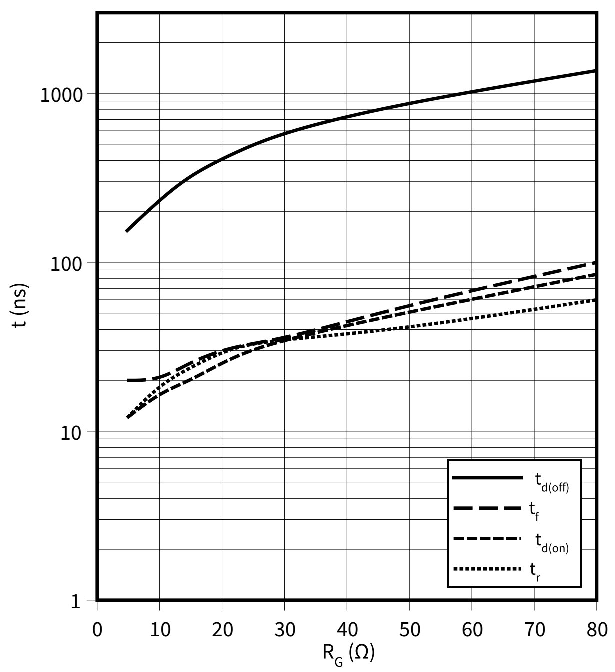
$R_{Goff} = 10.0\ \Omega$, $V_{CE} = 400\ V$, $T_{vj} = 175\ °C$, $V_{GE} = 0/15\ V$, $R_{Gon} = 10.0\ \Omega$

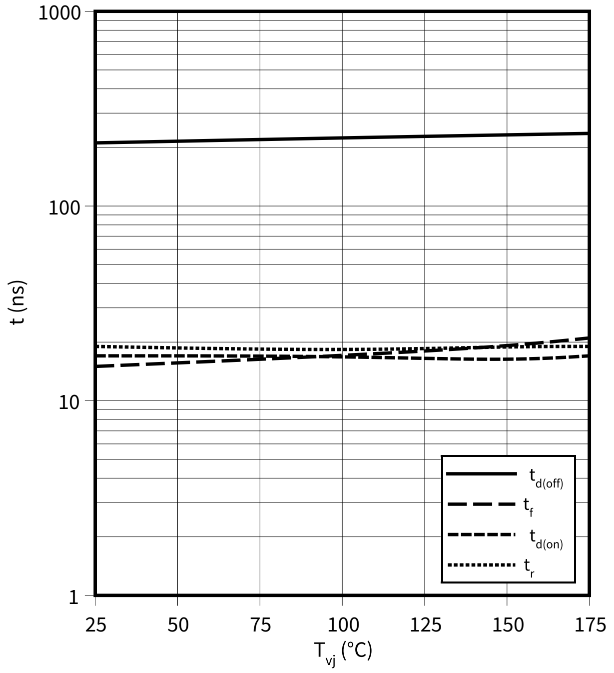
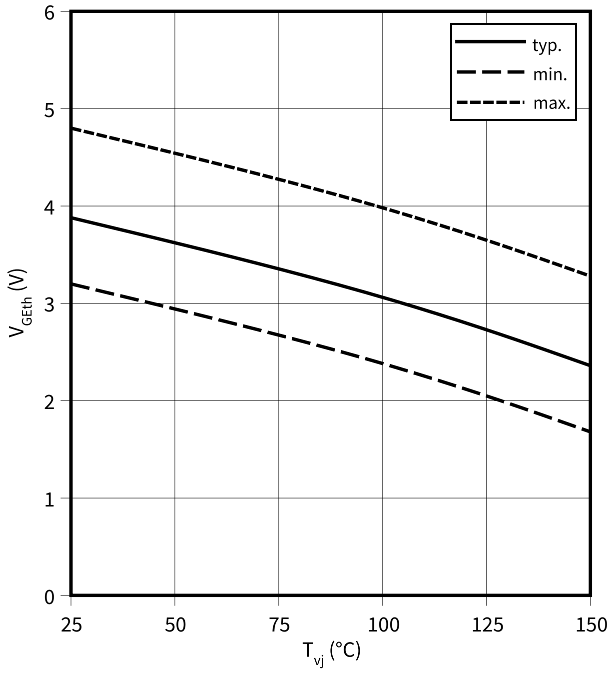
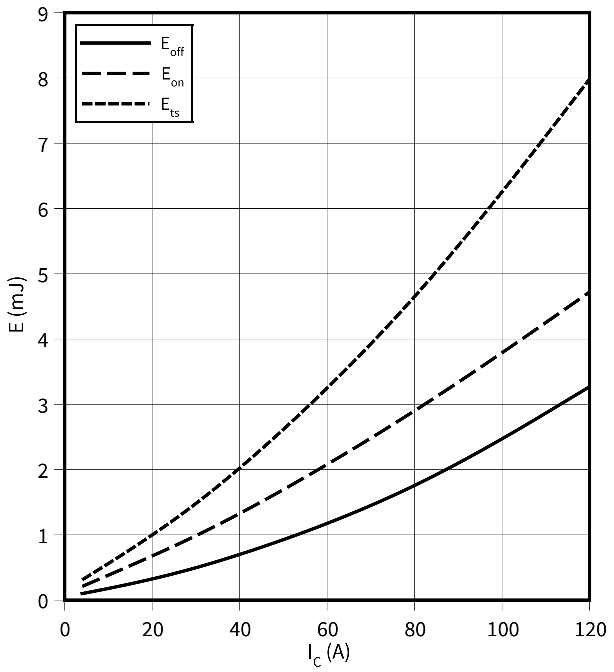
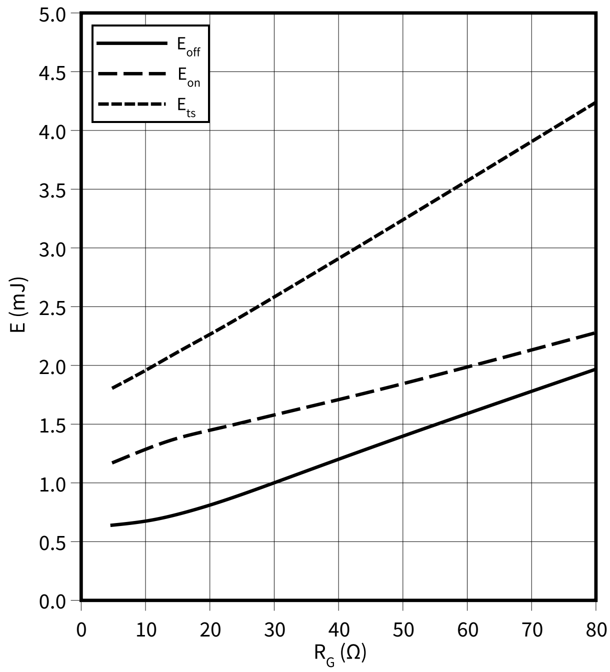


Typical switching times as a function of gate resistor, IGBT

$t = f(R_G)$

$I_C = 40.0\ A$, $V_{CE} = 400\ V$, $T_{vj} = 175\ °C$, $V_{GE} = 0/15\ V$

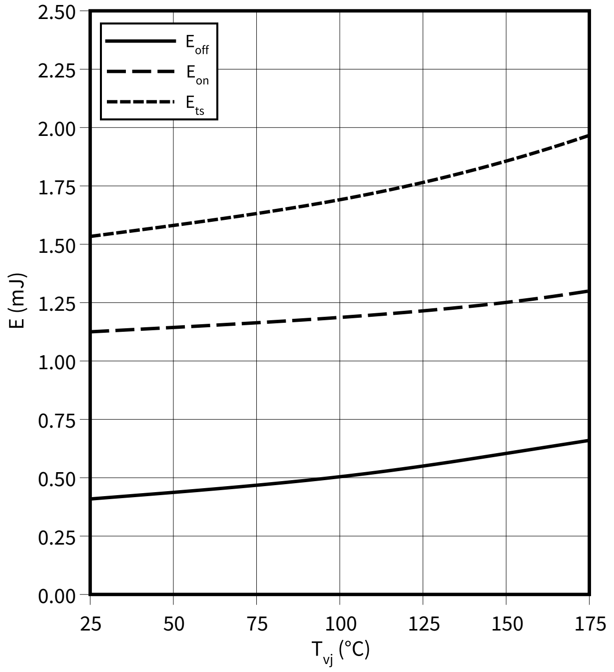


Typical switching times as a function of junction temperature, IGBT $t = f(T_{vj})$ I_C = 40.0 A, R_{Goff} = 10.0 Ω, V_{CE} = 400 V, V_{GE} = 0/15 V, R_{Gon} = 10.0 Ω	**Gate-emitter threshold voltage as a function of junction temperature, IGBT** $V_{GEth} = f(T_{vj})$ I_C = 0.40 mA
	
Typical switching energy losses as a function of collector current, IGBT $E = f(I_C)$ R_{Goff} = 10.0 Ω, V_{CE} = 400 V, T_{vj} = 175 °C, V_{GE} = 0/15 V, R_{Gon} = 10.0 Ω	**Typical switching energy losses as a function of gate resistor, IGBT** $E = f(R_G)$ I_C = 40.0 A, V_{CE} = 400 V, T_{vj} = 175 °C, V_{GE} = 0/15 V
	

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

$E = f(T_{vj})$

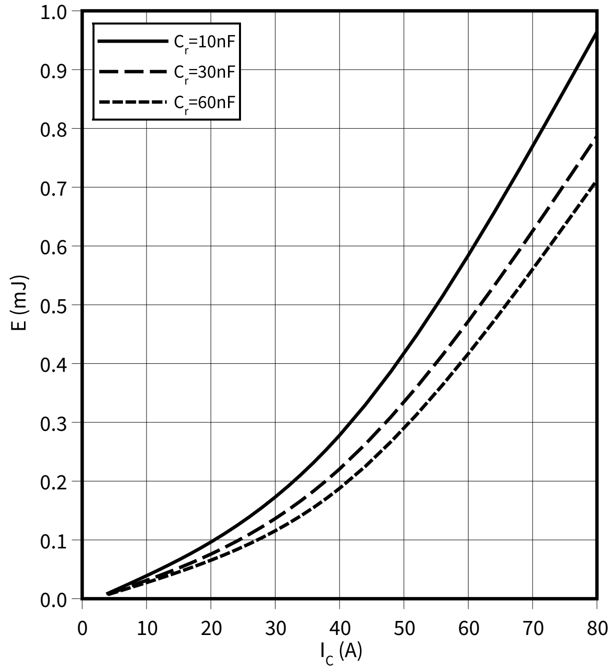
$I_C = 40.0$ A, $R_{Goff} = 10.0\ \Omega$, $V_{CE} = 400$ V, $V_{GE} = 0/15$ V, $R_{Gon} = 10.0\ \Omega$



Typical soft-switching turn-off energy loss as a function of collector current, IGBT

$E = f(I_C)$

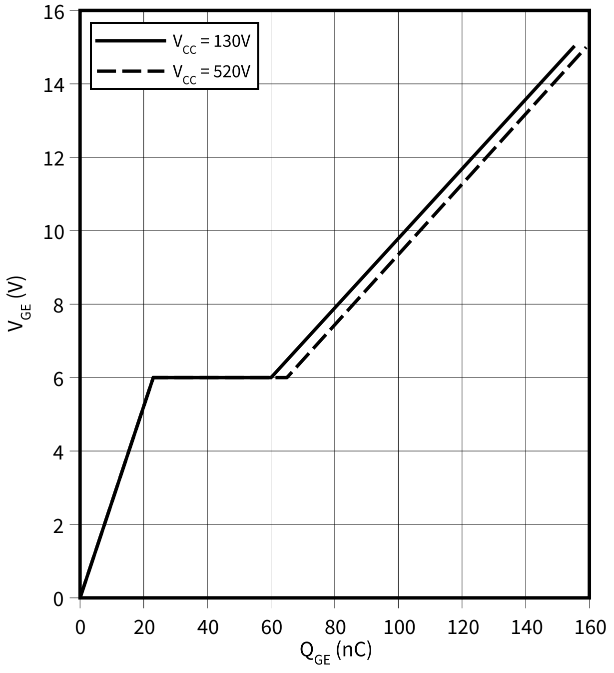
$R_{Goff} = 10.0\ \Omega$, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V



Typical gate charge, IGBT

$V_{GE} = f(Q_{GE})$

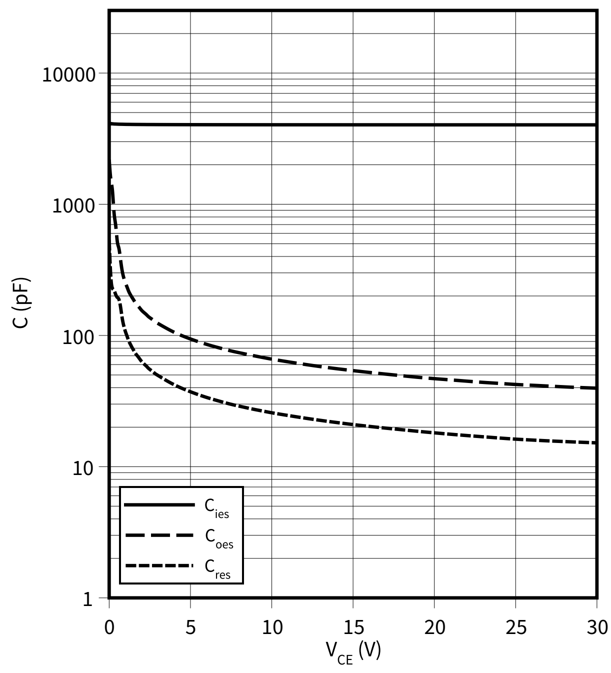
$I_C = 40.0$ A



Typical capacitance as a function of collector-emitter voltage, IGBT

$C = f(V_{CE})$

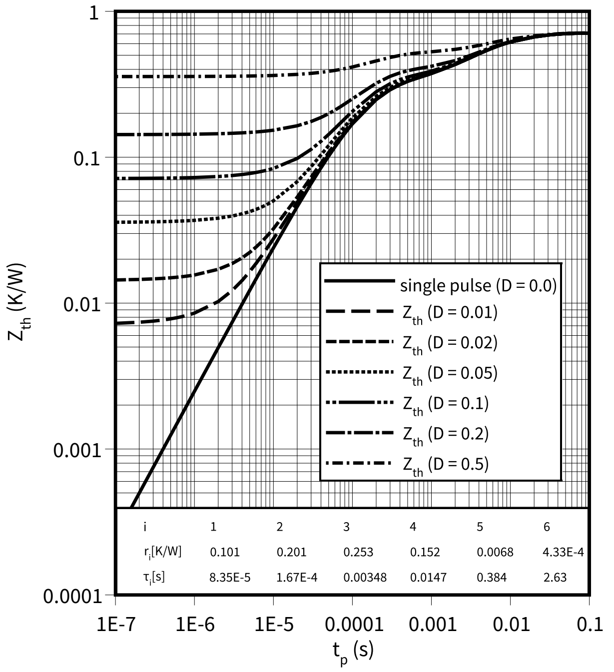
f = 100 kHz, $V_{GE} = 0$ V



IGBT transient thermal resistance, IGBT

$Z_{th} = f(t_p)$

$D = t_p/T$

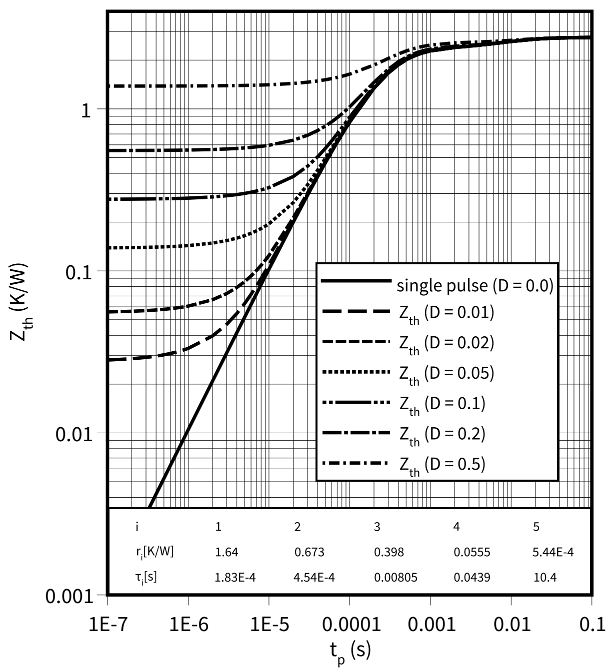


i	1	2	3	4	5	6
r_i[K/W]	0.101	0.201	0.253	0.152	0.0068	4.33E-4
τ_i[s]	8.35E-5	1.67E-4	0.00348	0.0147	0.384	2.63

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

$Z_{th} = f(t_p)$

$D = t_p/T$

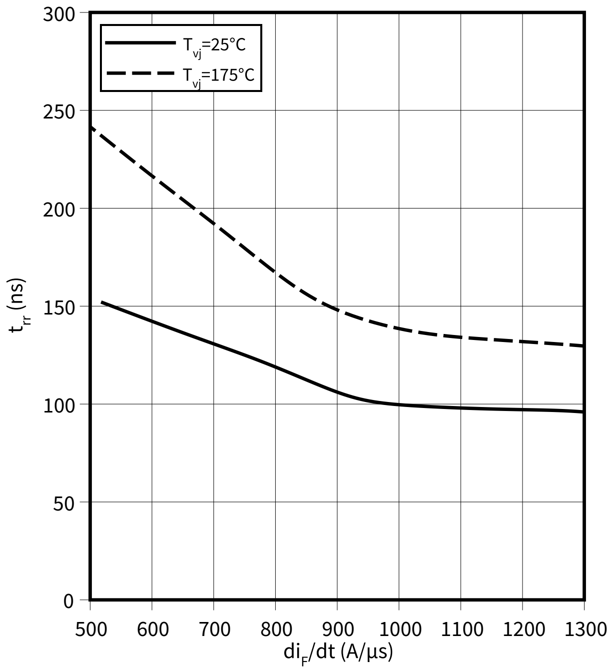


i	1	2	3	4	5
r_i[K/W]	1.64	0.673	0.398	0.0555	5.44E-4
τ_i[s]	1.83E-4	4.54E-4	0.00805	0.0439	10.4

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

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

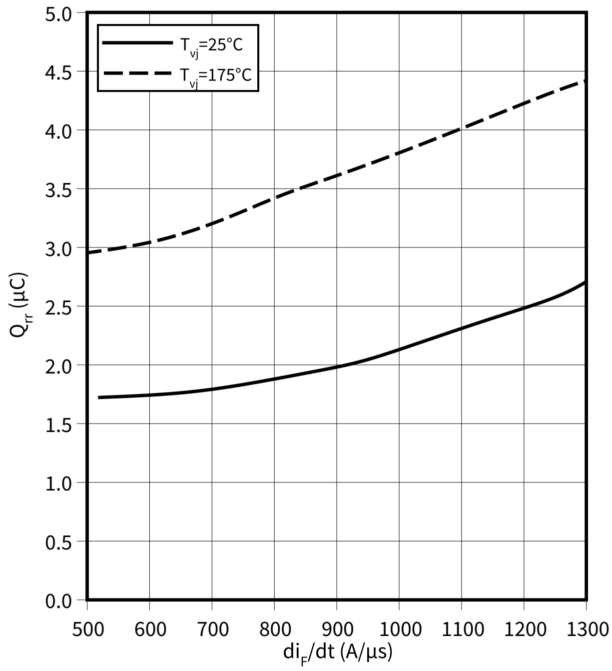
$V_R = 400$ V, $I_F = 40.0$ A



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

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

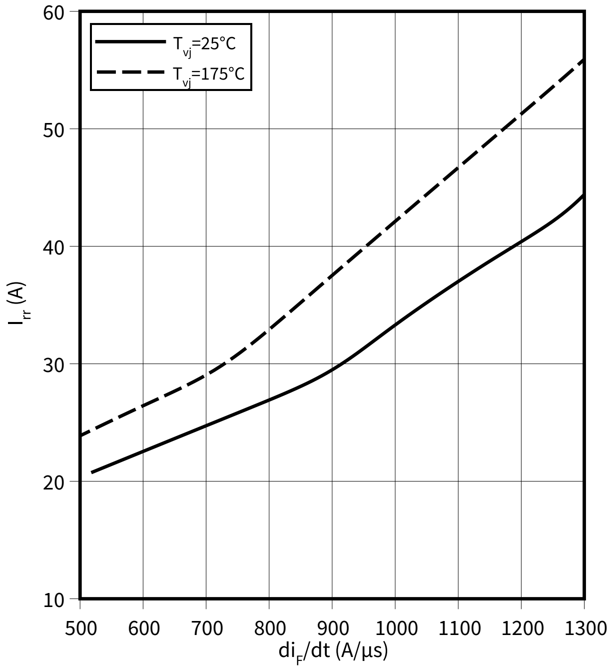
$V_R = 400$ V, $I_F = 40.0$ A



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

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

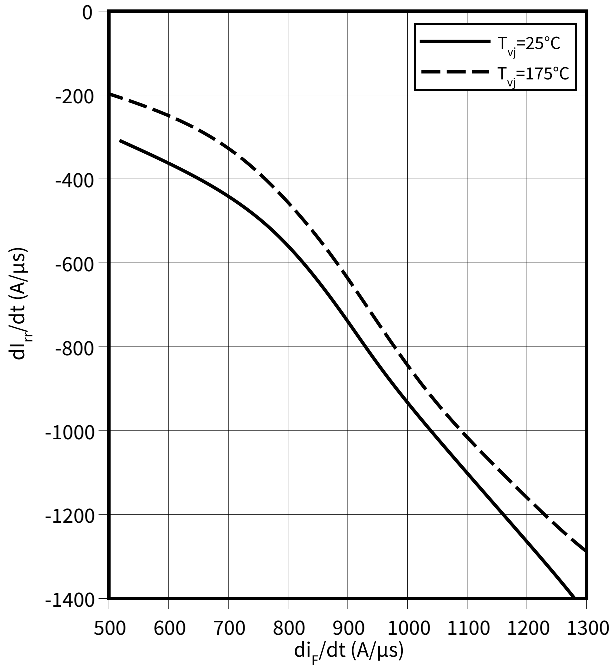
$V_R = 400$ V, $I_F = 40.0$ A



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

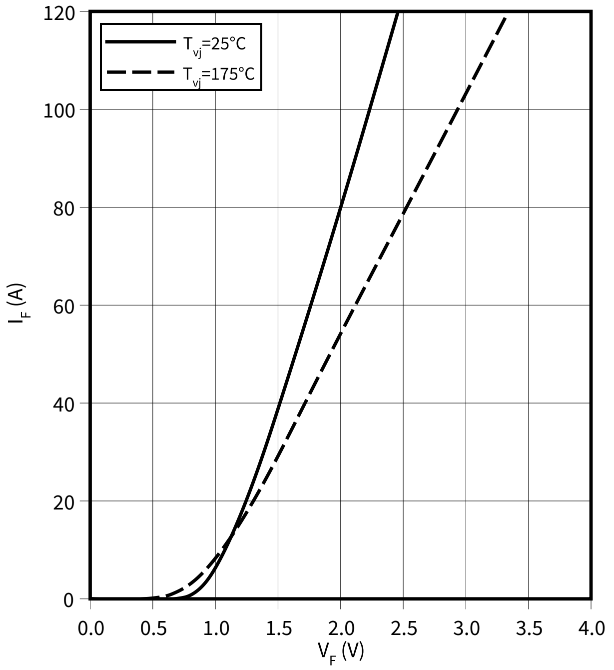
$dI_{rr}/dt = f(di_F/dt)$

$I_F = 40.0$ A, $V_R = 400$ V



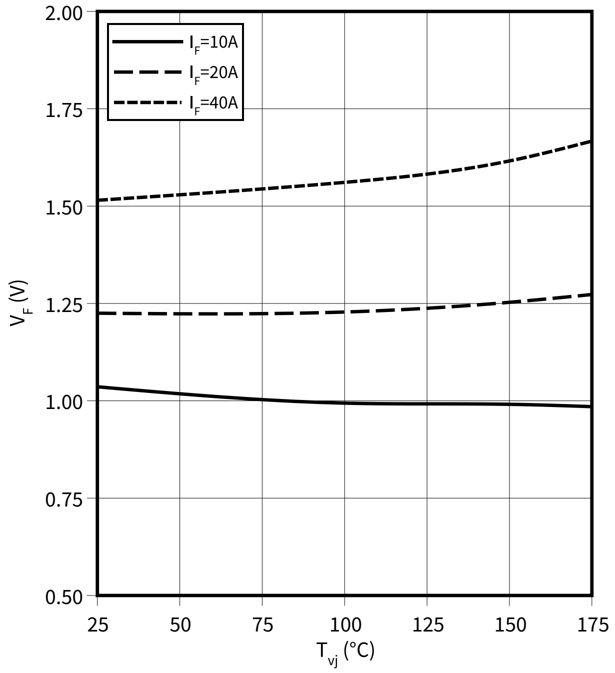
Typical diode forward current as a function of forward voltage, Diode

$I_F = f(V_F)$



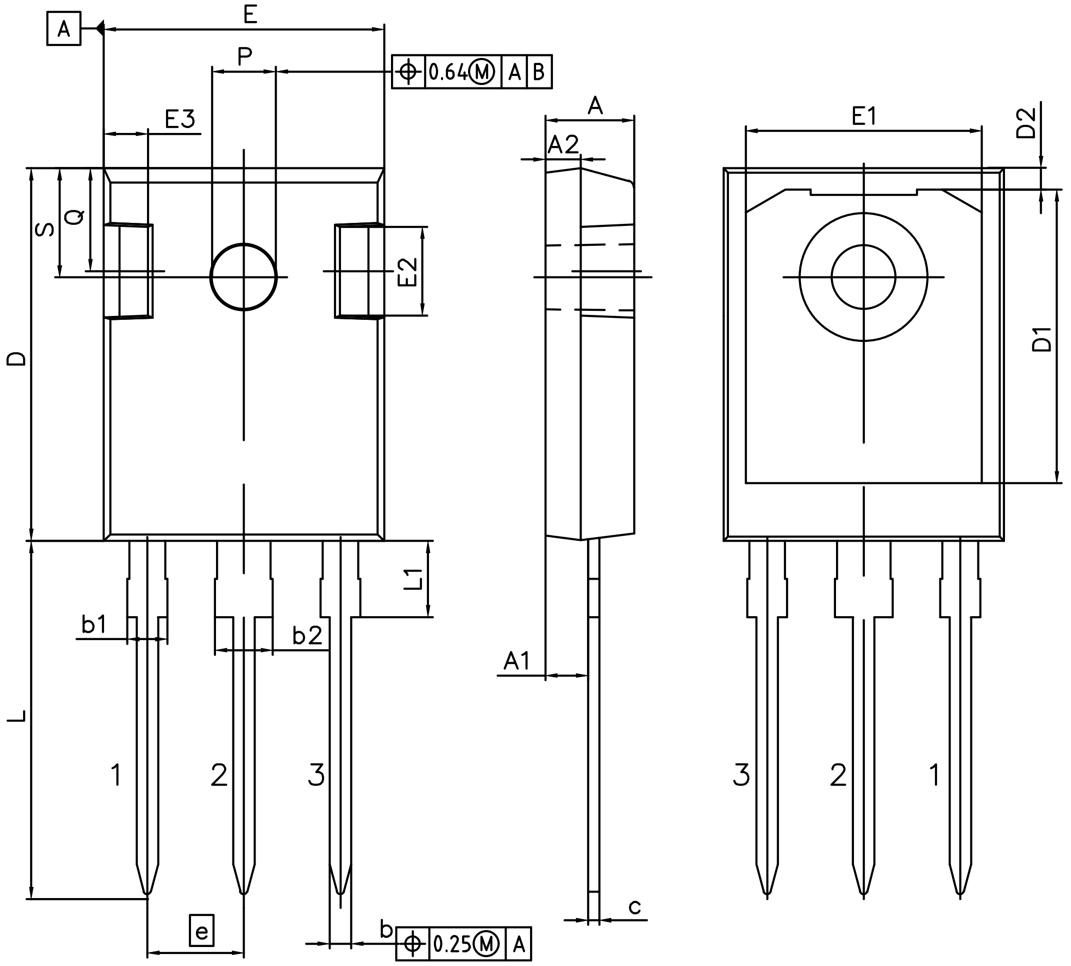
Typical diode forward voltage as a function of junction temperature, Diode

$V_F = f(T_{vj})$



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

DOCUMENT NO.
Z8B00003327

REVISION
06

SCALE 3:1
0 1 2 3 4 5mm

EUROPEAN PROJECTION

ISSUE DATE
25.07.2018

Figure 6

6 Testing conditions

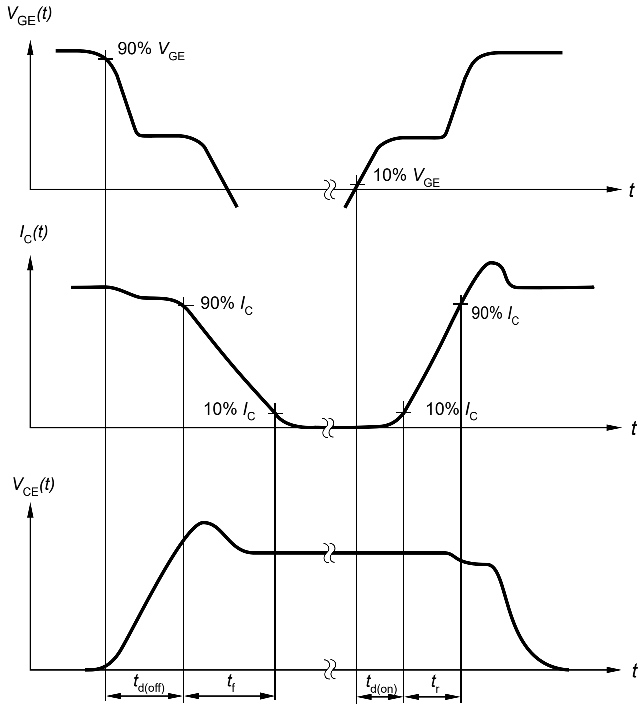


Figure A. **Definition of switching times**

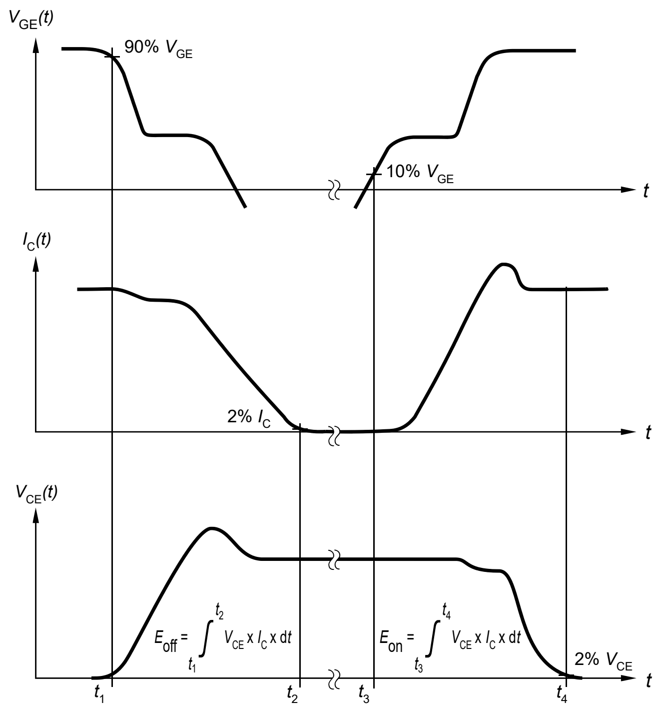


Figure B. **Definition of switching losses**

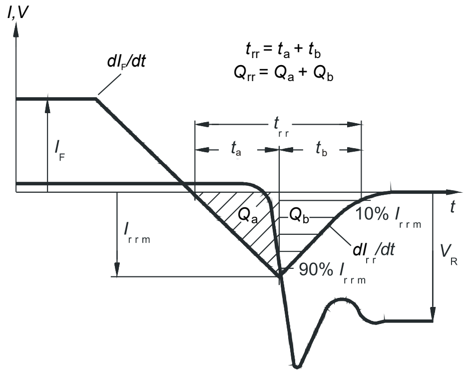


Figure C. **Definition of diode switching characteristics**

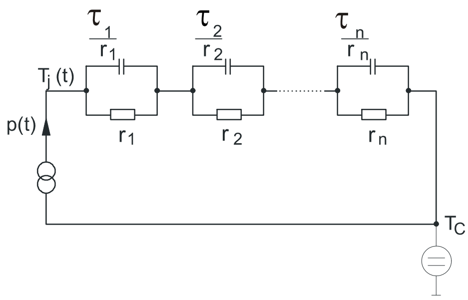


Figure D. **Thermal equivalent circuit**

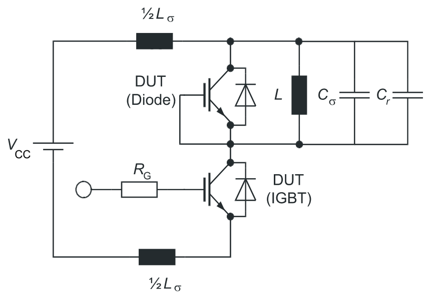


Figure E. **Dynamic test circuit**
Parasitic inductance L_σ,
parasitic capacitor C_σ,
relief capacitor C_r,
(only for ZVT switching)

Figure 7

Revision history

Revision	Date of release	Description of changes
1.00	2020.12.21	Final datasheet
1.10	2021.02.22	Soft turn-off energy data changed. Editorial changes in graph.
1.20	2021.03.21	Dynamic characteristic change from 1000 kHz to 100 kHz