英飞凌低损耗 Duopack：采用 Trench 和 Fieldstop 技术的 IGBT 7

特性



- V_{CE} = 650 V
- I_C = 20 A
- 非常低的 $V_{CE,sat}$
- 低关断损耗
- 低拖尾电流
- EMI 降低
- 非常柔软、快速恢复的反并联二极管
- 最高结温 T_{vjmax} = 175°C
- 符合 JEDEC 目标应用要求
- 无铅镀层；符合RoHS标准
- 完整的产品范围和 PSpice 模型： http://www.infineon.com/igbt7/

Lead-free

Green

Halogen-free

RoHS

潜在应用

- 伺服驱动器
- 通用驱动器（GPD）
- 工业级不间断电源（UPS）
- 工业开关电源
- 光伏优化器
- 光伏组串逆变器

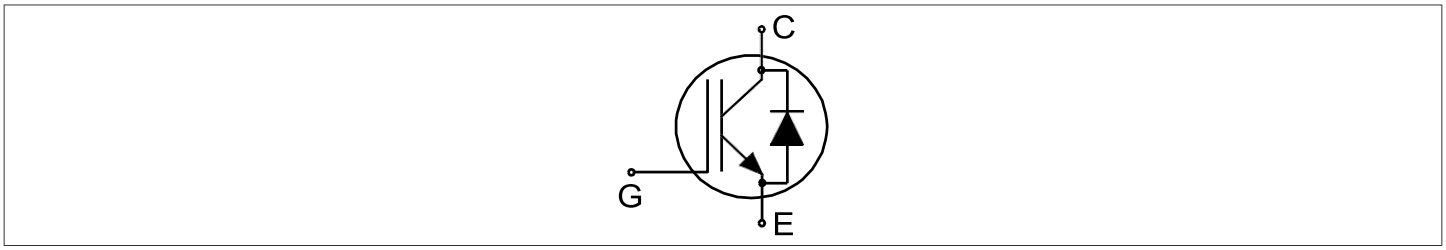
产品验证

- 符合JEDEC47/20/22相关测试的工业应用要求

描述

封装引脚定义：

- 引脚 C & 背面 - 集电极
- 引脚 E - 发射极
- 引脚 G - 栅极



Type	Package	Marking
IKW20N65ET7	PG-TO247-3	K20EET7

本数据手册的原文使用英文撰写。为方便起见，英飞凌提供了译文；由于翻译过程中可能使用了自动化工具，英飞凌不保证译文的准确性。 为确认准确性，请务必访问 infineon.com 参考最新的英文版本（控制文档）。

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1 封装

表 1 特征值

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	$R_{th(j-c)}$				1.1	K/W
Diode thermal resistance, junction-case	$R_{th(j-c)}$				1.4	K/W

2 IGBT

表 2 最大额定值

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	40	A
			$T_c = 100$ °C	27.5	
Pulsed collector current, t_p limited by T_{vjmax} [1)]	I_{Cpulse}			60	A
Turn-off safe operating area[2)]		$V_{CE} \leq 650$ V, t_p=1 µs, $T_{vj} \leq 175$ °C		60	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	136	W
			$T_c = 100$ °C	68	

1) 由设计标定，不受制于生产测试。
2) 对每个器件进行钳位电感负载电流测试，I_C= 60 A，V_{CC}= 400 V，T_c= 25°C，V_{GE}= 20 V，L = 80 µH，R_G= 10 Ω

表 3　　特征值

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Collector-emitter saturation voltage	V_{CEsat}	I_C = 20 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 = 0.2 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		700		
Gate-emitter leakage current	I_{GES}	V_{CE} = 0 V, V_{GE} = 20 V				100	nA
Transconductance	g_{fs}	I_C = 20 A, V_{CE} = 20 V			10		S
Short-circuit collector current	I_{SC}	V_{CC} ≤ 400 V, V_{GE} = 15 V, t_{SC} ≤ 3 µs, Allowed number of short circuits < 1000, Time between short circuits ≥ 1.0 s, T_{vj} = 150 °C			110		A
Input capacitance	C_{ies}	V_{CE} = 25 V, V_{GE} = 0 V, f = 1000 kHz			1310		pF
Output capacitance	C_{oes}	V_{CE} = 25 V, V_{GE} = 0 V, f = 1000 kHz			42		pF
Reverse transfer capacitance	C_{res}	V_{CE} = 25 V, V_{GE} = 0 V, f = 1000 kHz			13		pF
Gate charge	Q_G	V_{CC} = 520 V, I_C = 20 A, V_{GE} = 15 V			128		nC
Turn-on delay time	$t_{d(on)}$	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 12 Ω, $R_{G(off)}$ = 12 Ω, L_σ = 32 nH, C_σ = 30 pF	T_{vj} = 25 °C, I_C = 20 A		16		ns
			T_{vj} = 25 °C, I_C = 10 A		15		
			T_{vj} = 175 °C, I_C = 20 A		17		
			T_{vj} = 175 °C, I_C = 10 A		15		
Rise time (inductive load)	t_r	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 12 Ω, $R_{G(off)}$ = 12 Ω, L_σ = 32 nH, C_σ = 30 pF	T_{vj} = 25 °C, I_C = 20 A		10		ns
			T_{vj} = 25 °C, I_C = 10 A		6		
			T_{vj} = 175 °C, I_C = 20 A		12		
			T_{vj} = 175 °C, I_C = 10 A		7		

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表 3　　（续）特征值

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, $R_{G(on)}$ = 12 Ω, $R_{G(off)}$ = 12 Ω, L_σ = 32 nH, C_σ = 30 pF	T_{vj} = 25 °C, I_C = 20 A		210		ns
			T_{vj} = 25 °C, I_C = 10 A		235		
			T_{vj} = 175 °C, I_C = 20 A		255		
			T_{vj} = 175 °C, I_C = 10 A		310		
Fall time (inductive load)	t_f	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 12 Ω, $R_{G(off)}$ = 12 Ω, L_σ = 32 nH, C_σ = 30 pF	T_{vj} = 25 °C, I_C = 20 A		20		ns
			T_{vj} = 25 °C, I_C = 10 A		18		
			T_{vj} = 175 °C, I_C = 20 A		75		
			T_{vj} = 175 °C, I_C = 10 A		80		
Turn-on energy	E_{on}	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 12 Ω, $R_{G(off)}$ = 12 Ω, L_σ = 32 nH, C_σ = 30 pF	T_{vj} = 25 °C, I_C = 20 A		0.36		mJ
			T_{vj} = 25 °C, I_C = 10 A		0.16		
			T_{vj} = 175 °C, I_C = 20 A		0.58		
			T_{vj} = 175 °C, I_C = 10 A		0.3		
Turn-off energy	E_{off}	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 12 Ω, $R_{G(off)}$ = 12 Ω, L_σ = 32 nH, C_σ = 30 pF	T_{vj} = 25 °C, I_C = 20 A		0.36		mJ
			T_{vj} = 25 °C, I_C = 10 A		0.21		
			T_{vj} = 175 °C, I_C = 20 A		0.61		
			T_{vj} = 175 °C, I_C = 10 A		0.34		

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表 3　　（续）特征值

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, $R_{G(on)}$ = 12 Ω, $R_{G(off)}$ = 12 Ω, L_σ = 32 nH, C_σ = 30 pF	T_{vj} = 25 °C, I_C = 20 A		0.72		mJ
			T_{vj} = 25 °C, I_C = 10 A		0.37		
			T_{vj} = 175 °C, I_C = 20 A		1.19		
			T_{vj} = 175 °C, I_C = 10 A		0.64		
Operating junction temperature	T_{vj}			-40		175	°C

3　　二极管

表 4　　最大额定值

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	40	A
			T_c = 100 °C	27.5	
Diode pulsed current, t_p limited by T_{vjmax} [1)]	I_{Fpulse}			60	A

1)　由设计标定，不受制于生产测试。

表 5　　特征值

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode forward voltage	V_F	I_F = 20 A	T_{vj} = 25 °C		1.65	2	V
			T_{vj} = 125 °C		1.6		
			T_{vj} = 175 °C		1.55		

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表 5　　（续）特征值

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 = 20 A, $-di_F/dt$ = 1420 A/µs		70		ns
			T_{vj} = 25 °C, I_F = 10 A, $-di_F/dt$ = 1800 A/µs		42		
			T_{vj} = 175 °C, I_F = 20 A, $-di_F/dt$ = 1420 A/µs		120		
			T_{vj} = 175 °C, I_F = 10 A, $-di_F/dt$ = 1450 A/µs		88		
Diode reverse recovery charge	Q_{rr}	V_R = 400 V	T_{vj} = 25 °C, I_F = 20 A, $-di_F/dt$ = 1420 A/µs		0.44		µC
			T_{vj} = 25 °C, I_F = 10 A, $-di_F/dt$ = 1800 A/µs		0.28		
			T_{vj} = 175 °C, I_F = 20 A, $-di_F/dt$ = 1420 A/µs		1.18		
			T_{vj} = 175 °C, I_F = 10 A, $-di_F/dt$ = 1450 A/µs		0.85		
Diode peak reverse recovery current	I_{rrm}	V_R = 400 V	T_{vj} = 25 °C, I_F = 20 A, $-di_F/dt$ = 1420 A/µs		13		A
			T_{vj} = 25 °C, I_F = 10 A, $-di_F/dt$ = 1800 A/µs		14		
			T_{vj} = 175 °C, I_F = 20 A, $-di_F/dt$ = 1420 A/µs		19		
			T_{vj} = 175 °C, I_F = 10 A, $-di_F/dt$ = 1450 A/µs		20		

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表 5　　（续）特征值

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 = 400 V	T_{vj} = 25 °C, I_F = 20 A, $-di_F/dt$ = 1420 A/µs		210		A/µs
			T_{vj} = 25 °C, I_F = 10 A, $-di_F/dt$ = 1800 A/µs		420		
			T_{vj} = 175 °C, I_F = 20 A, $-di_F/dt$ = 1420 A/µs		180		
			T_{vj} = 175 °C, I_F = 10 A, $-di_F/dt$ = 1450 A/µs		265		
Operating junction temperature	T_{vj}			-40		175	°C

注意： *为了获得最佳的使用寿命和可靠性，英飞凌建议工作条件不超过本数据手册中所述最大额定值的 80%。*

电气特性，T_{vj} = 25°C，除非另有说明。

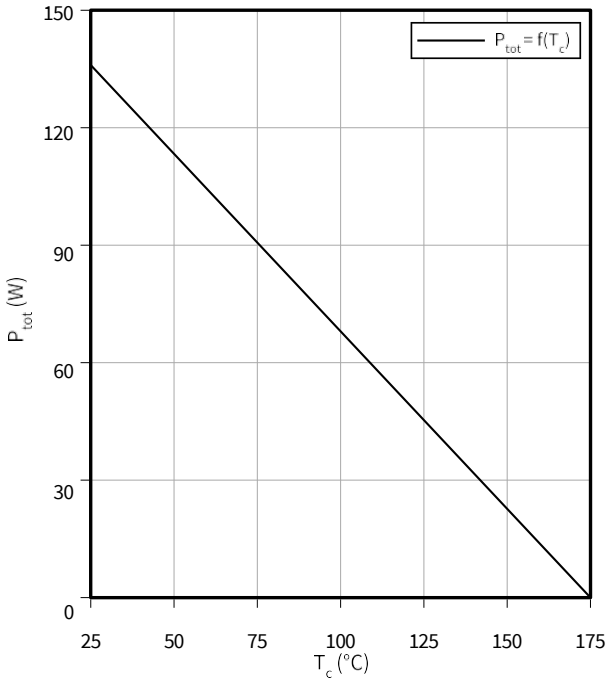
动态测试电路，L_σ 、C_σ来自图E。能量损失包括“拖尾”和二极管反向恢复。

4 特性图

Power dissipation as a function of case temperature

$P_{tot} = f(T_c)$

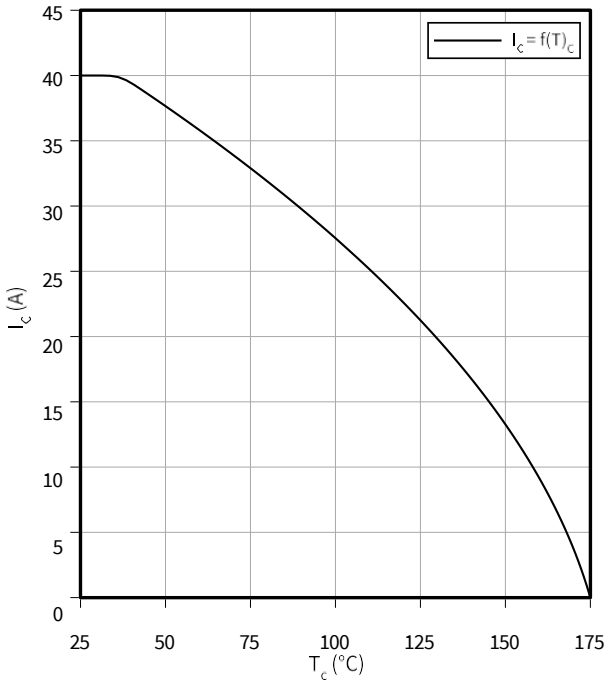
$T_{vj} \leq 175\ °C$



Collector current as a function of case temperature

$I_C = f(T_c)$

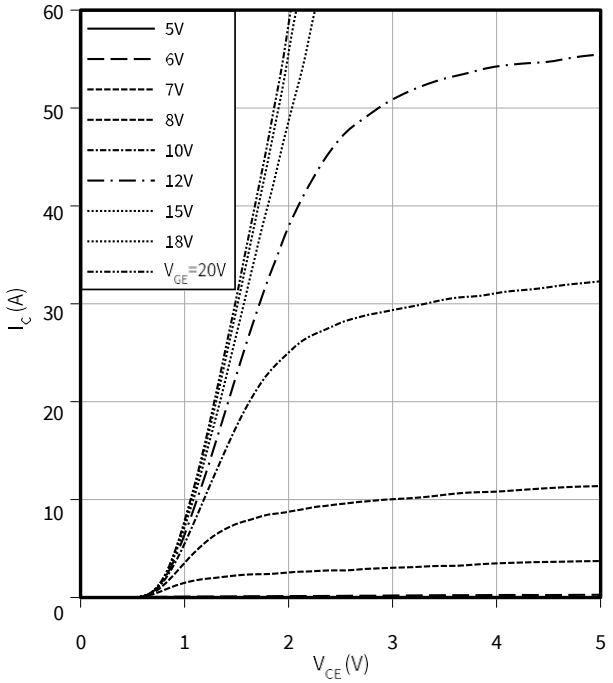
$T_{vj} \leq 175\ °C, V_{GE} \geq 15\ V$



Typical output characteristic

$I_C = f(V_{CE})$

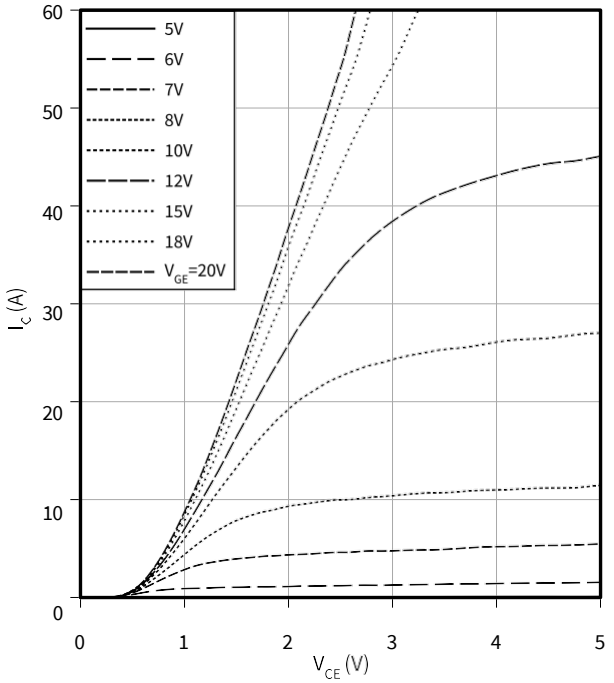
$T_{vj} = 25\ °C$



Typical output characteristic

$I_C = f(V_{CE})$

$T_{vj} = 175\ °C$

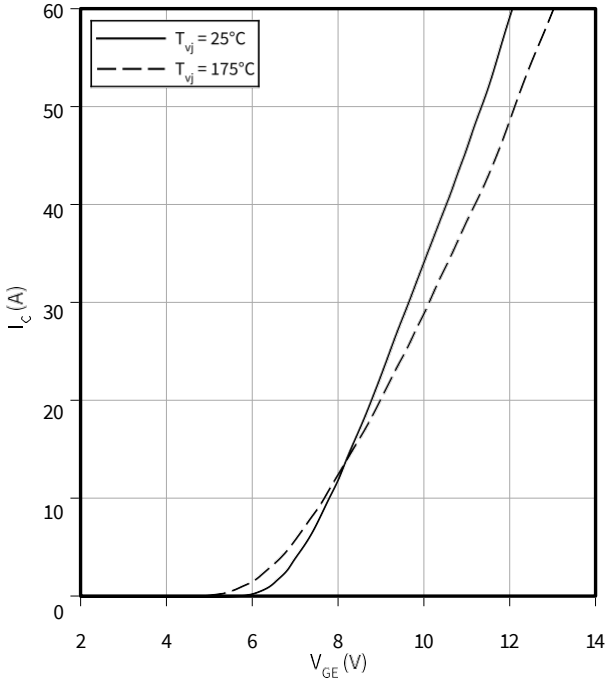


4 特征图

Typical transfer characteristic

$I_C = f(V_{GE})$

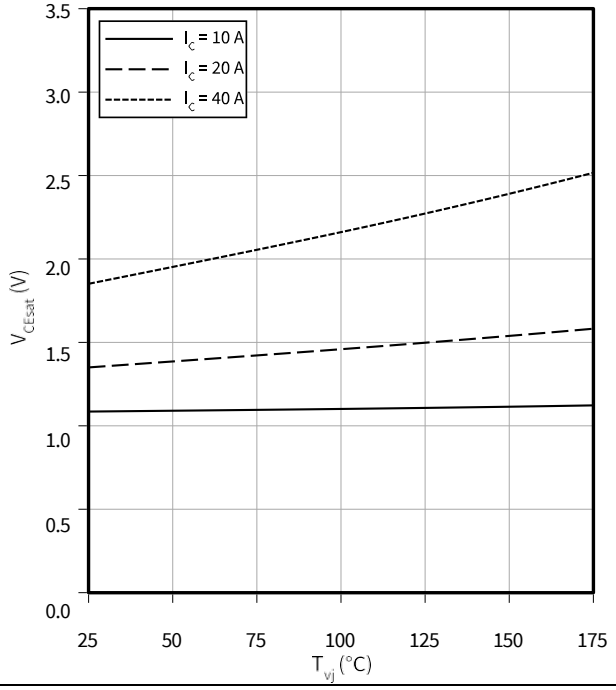
$V_{CE} = 20$ V



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

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

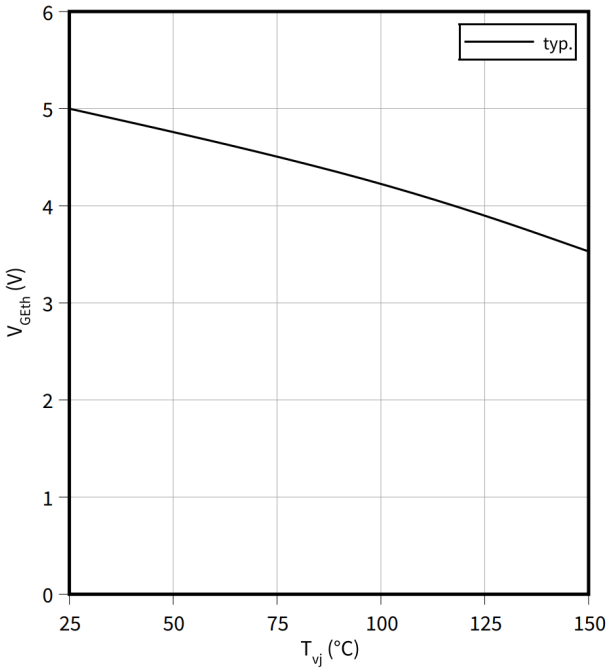
$V_{GE} = 15$ V



Gate-emitter threshold voltage as a function of junction temperature

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

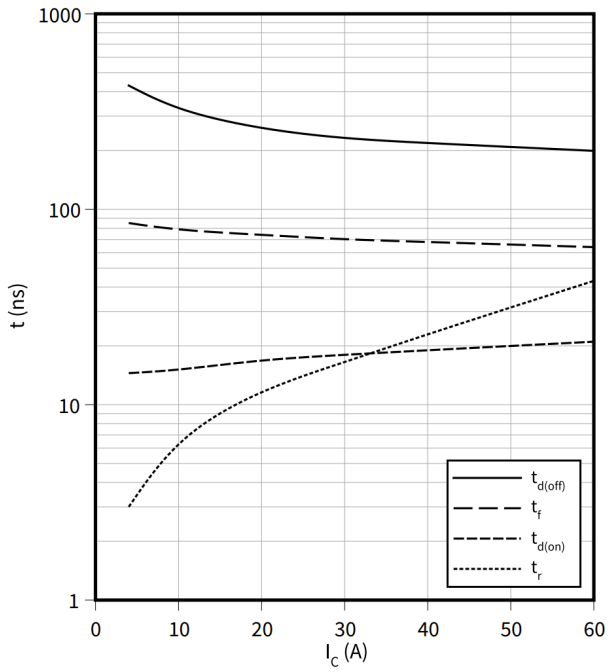
$I_C = 0.2$ mA



Typical switching times as a function of collector current

$t = f(I_C)$

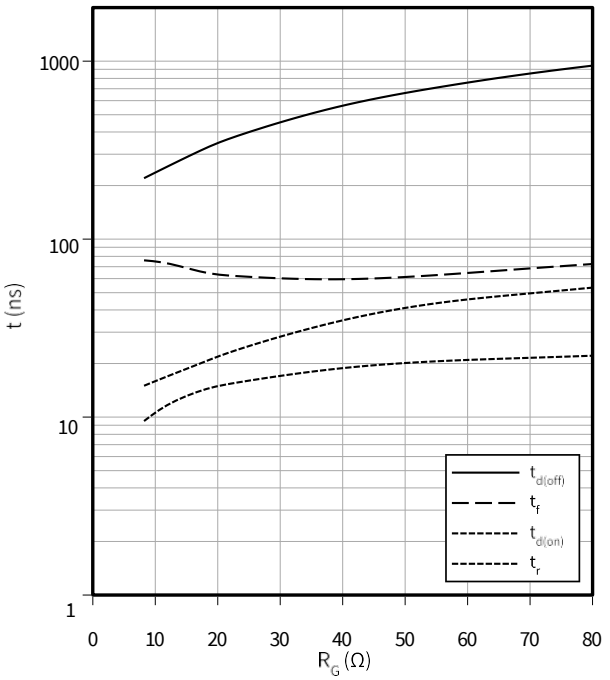
$V_{CC} = 400$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V, $R_G = 12$ Ω



Typical switching times as a function of gate resistor

$t = f(R_G)$

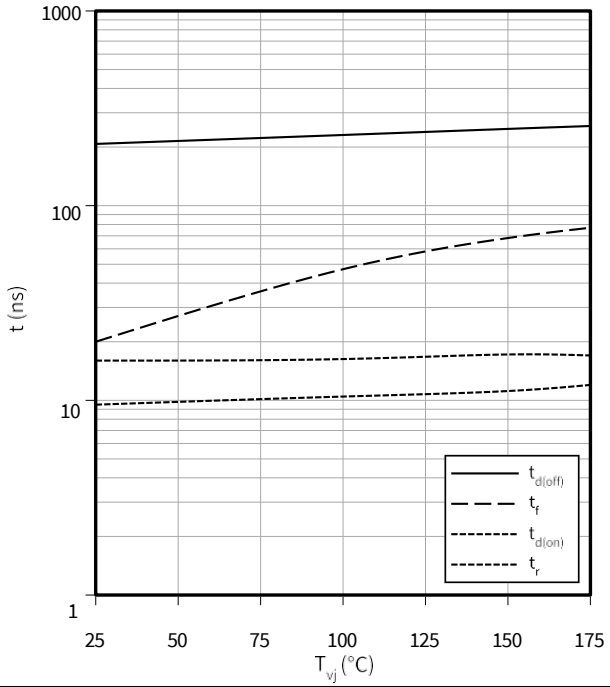
$I_C = 20\ A$, $V_{CC} = 400\ V$, $T_{vj} = 175\ °C$, $V_{GE} = 0/15\ V$



Typical switching times as a function of junction temperature

$t = f(T_{vj})$

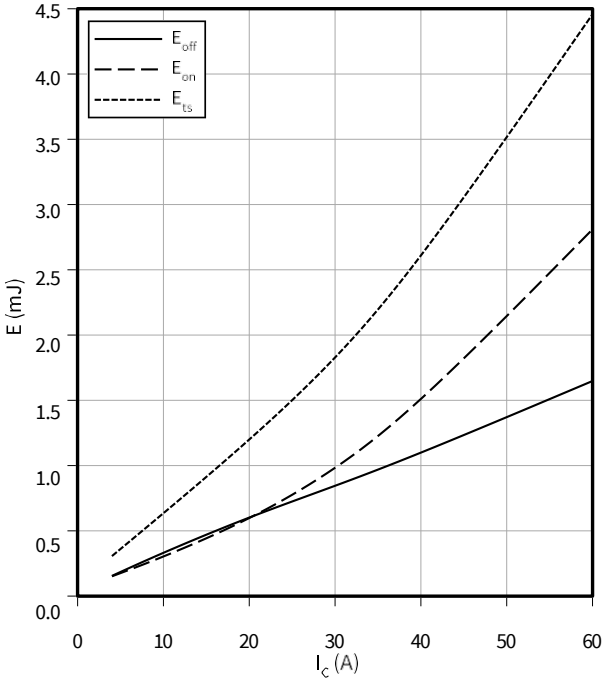
$I_C = 20\ A$, $V_{CC} = 400\ V$, $V_{GE} = 0/15\ V$, $R_G = 12\ \Omega$



Typical switching energy losses as a function of collector current

$E = f(I_C)$

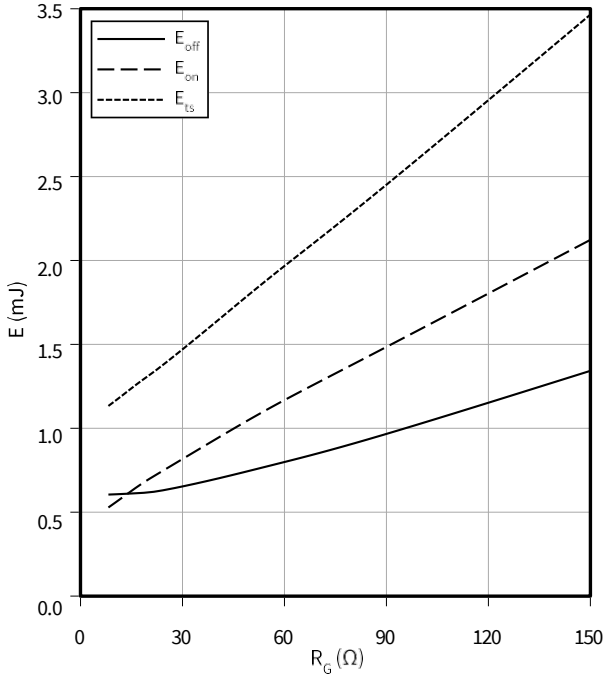
$V_{CC} = 400\ V$, $T_{vj} = 175\ °C$, $V_{GE} = 0/15\ V$, $R_G = 12\ \Omega$



Typical switching energy losses as a function of gate resistor

$E = f(R_G)$

$I_C = 20\ A$, $V_{CC} = 400\ V$, $T_{vj} = 175\ °C$, $V_{GE} = 0/15\ V$

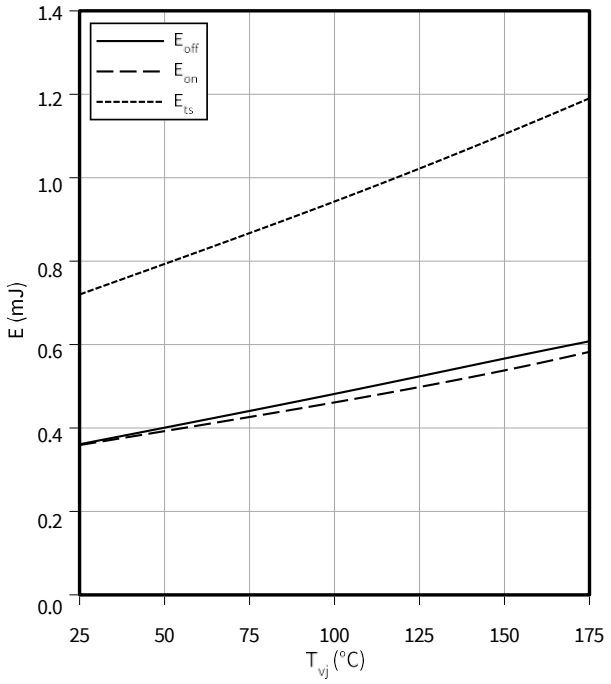


4 特征图

Typical switching energy losses as a function of junction temperature

$E = f(T_{vj})$

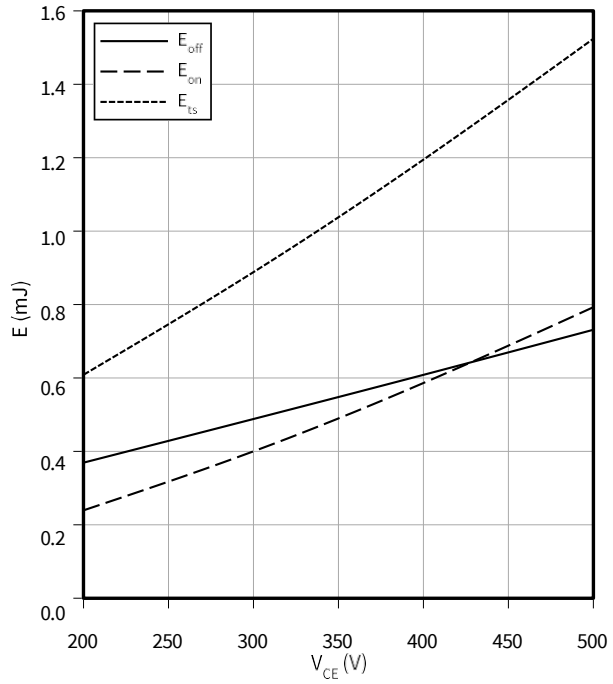
$I_C = 20\ A$, $V_{CC} = 400\ V$, $V_{GE} = 0/15\ V$, $R_G = 12\ \Omega$



Typical switching energy losses as a function of collector emitter voltage

$E = f(V_{CE})$

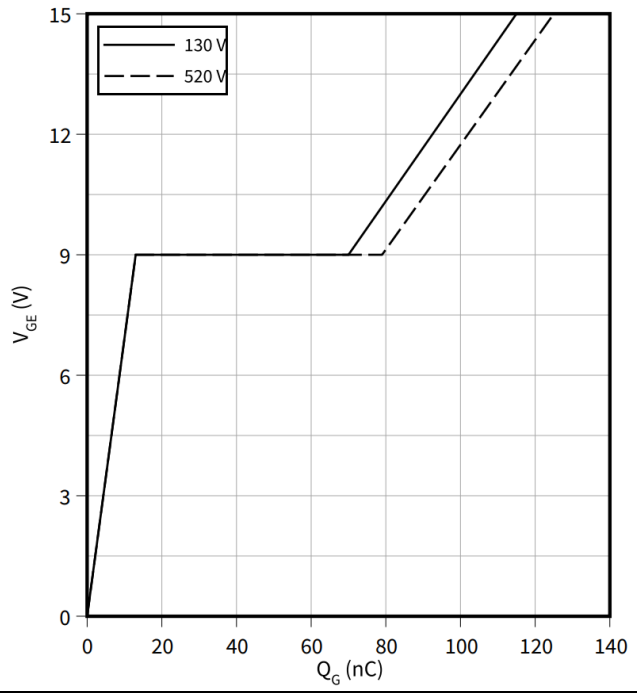
$I_C = 20\ A$, $T_{vj} = 175\ °C$, $V_{GE} = 0/15\ V$, $R_G = 12\ \Omega$



Typical gate charge

$V_{GE} = f(Q_G)$

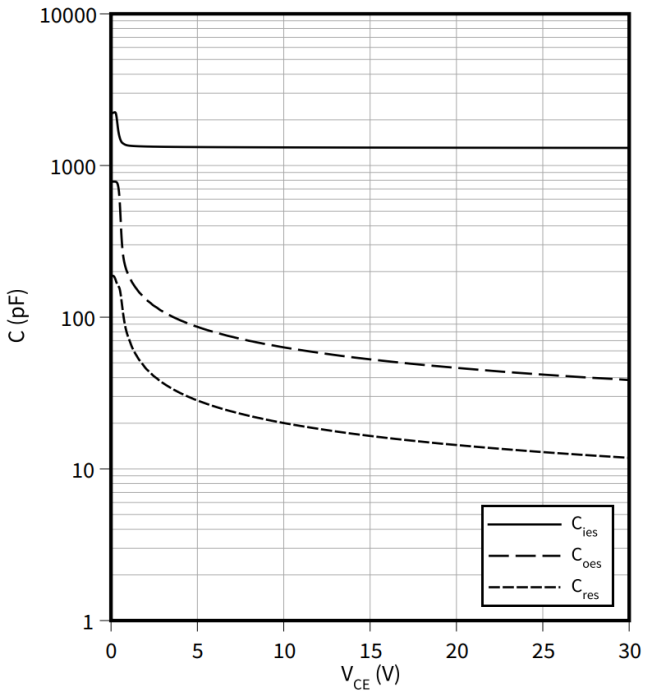
$I_C = 20\ A$



Typical capacitance as a function of collector-emitter voltage

$C = f(V_{CE})$

$f = 1000\ kHz$, $V_{GE} = 0\ V$

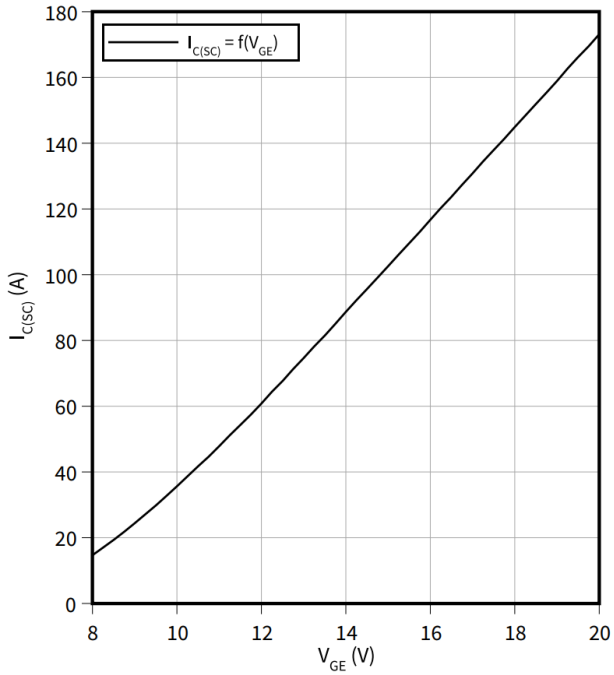


4 特征图

Typical short circuit collector current as a function of gate-emitter voltage

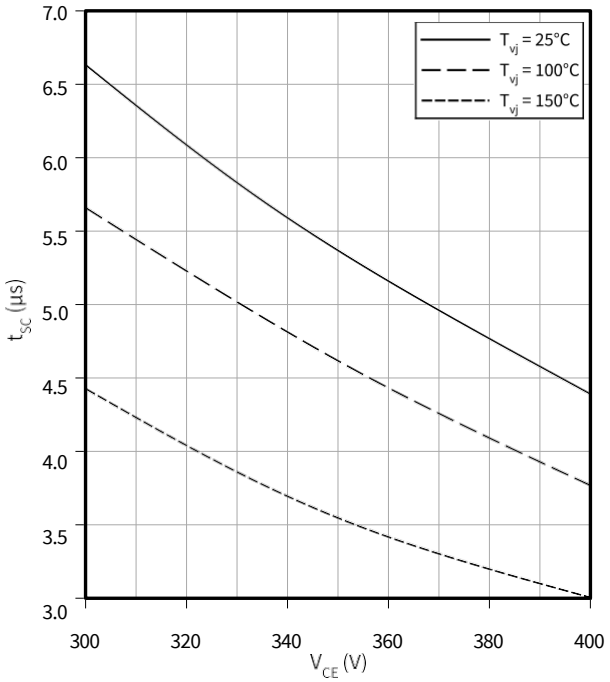
$I_{C(SC)} = f(V_{GE})$

$T_{vj} = 150\ °C$, $V_{CC} \leq 400\ V$



Typical short circuit safe operating range as a function of collector-emitter voltage

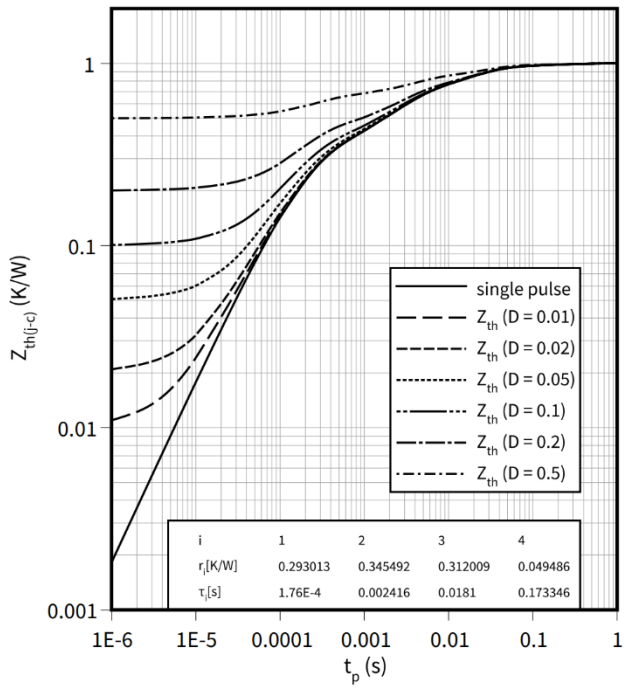
$t_{SC} = f(V_{CE})$



IGBT transient thermal impedance as a function of pulse width

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

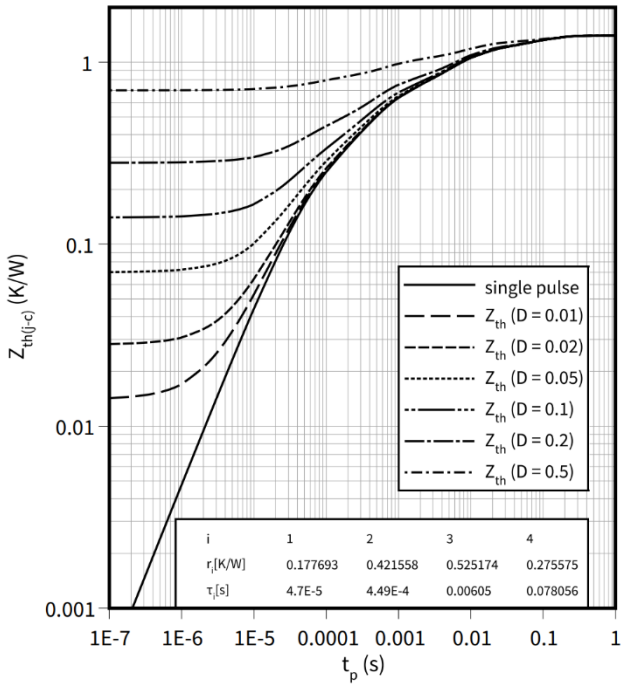
$D = t_p/T$



Diode transient thermal impedance as a function of pulse width

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

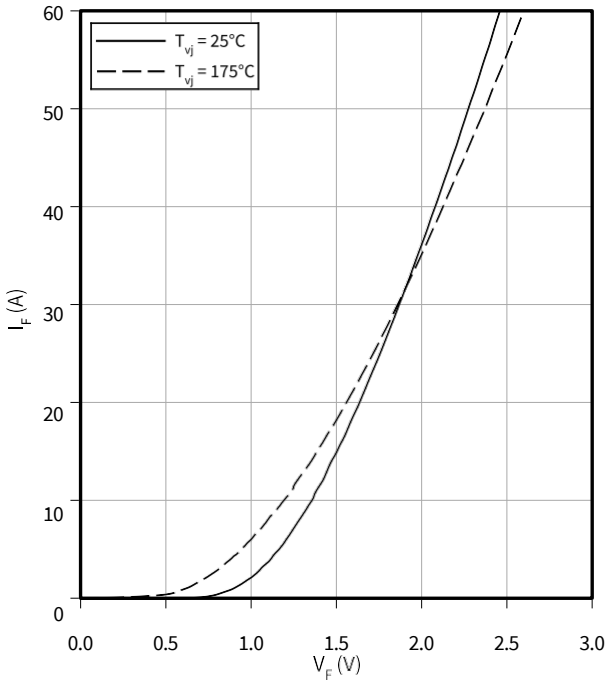
$D = t_p/T$



4 特征图

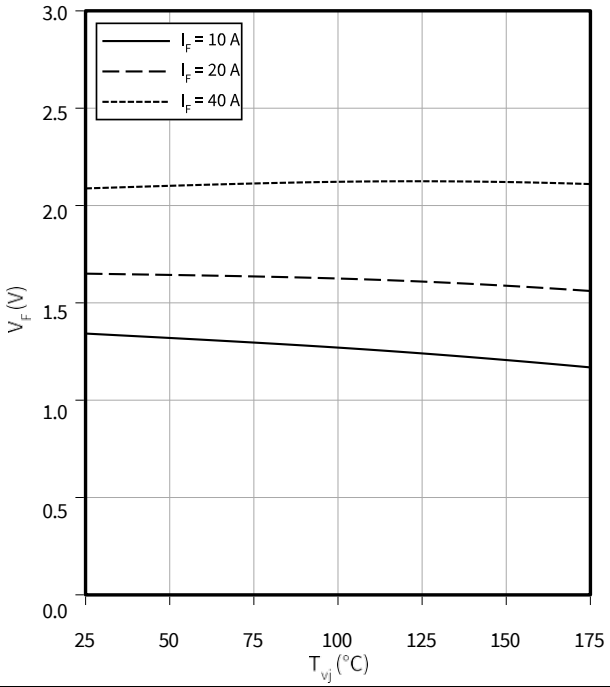
Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



Typical diode forward voltage as a function of junction temperature

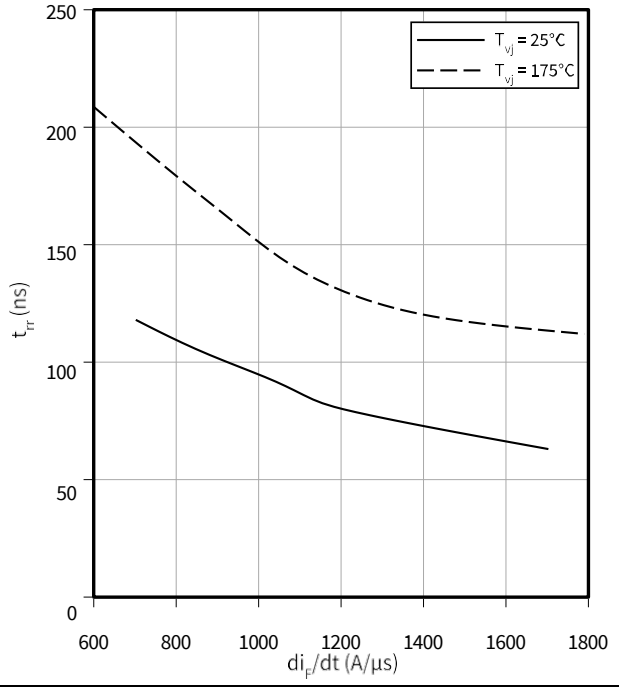
$V_F = f(T_{vj})$



Typical reverse recovery time as a function of diode current slope

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

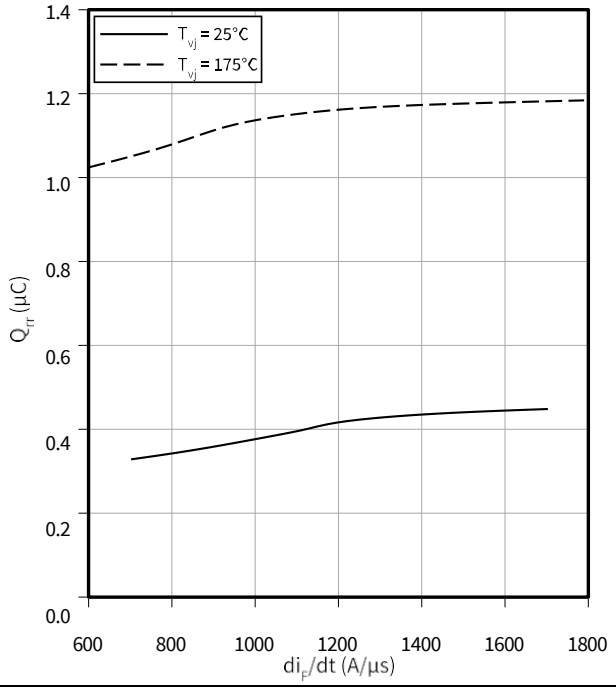
$V_R = 400$ V, $I_F = 20$ A



Typical reverse recovery charge as a function of diode current slope

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

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

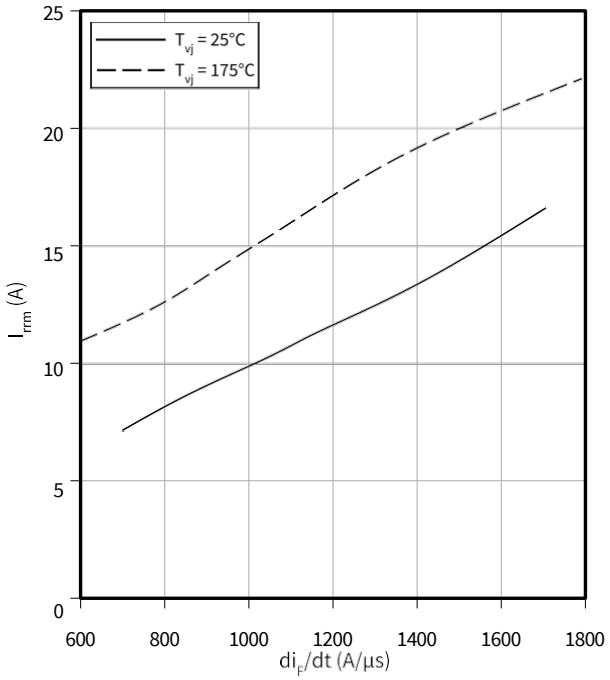


4 特征图

Typical reverse recovery current as a function of diode current slope

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

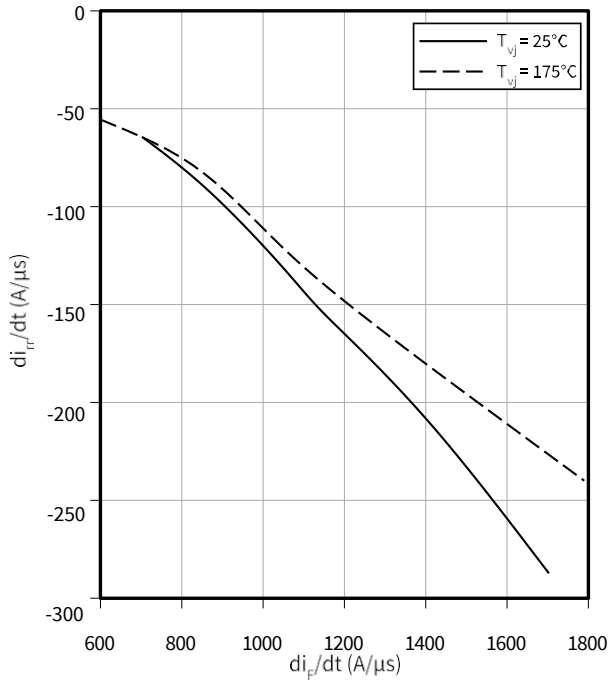
$V_R = 400\ V$, $I_F = 20\ A$



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

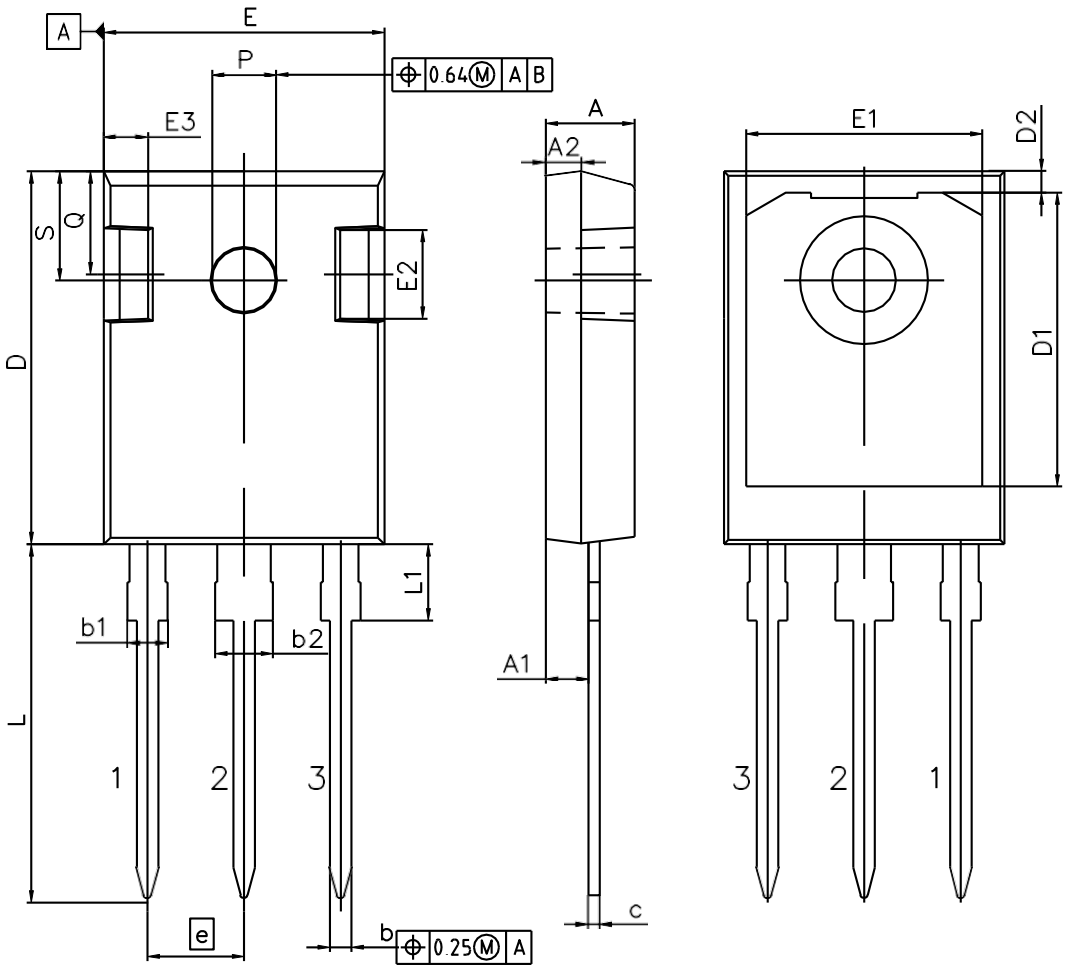
$di_{rr}/dt = f(di_F/dt)$

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



5 封装外形

封装图 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

图 1

6 测试条件

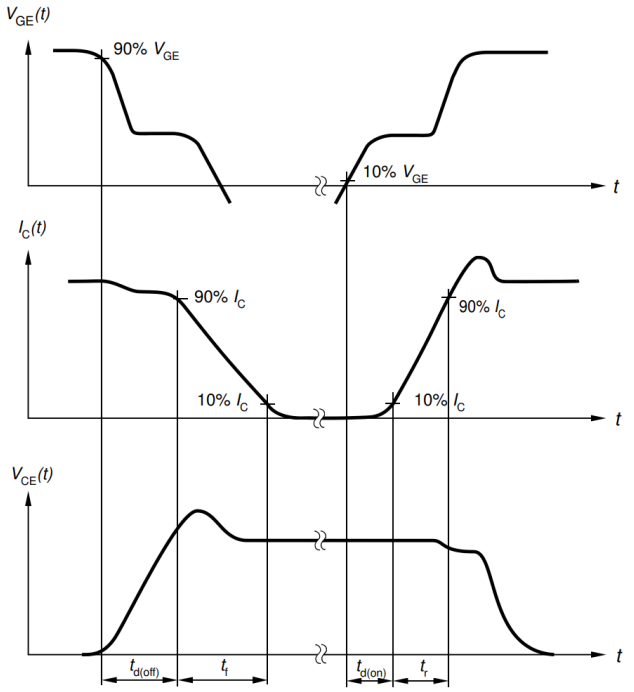


Figure A. **Definition of switching times**

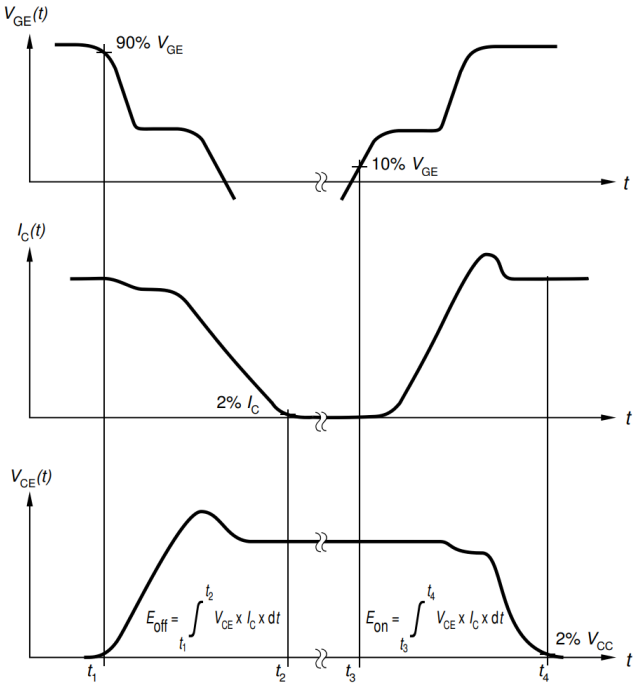


Figure B. **Definition of switching losses**

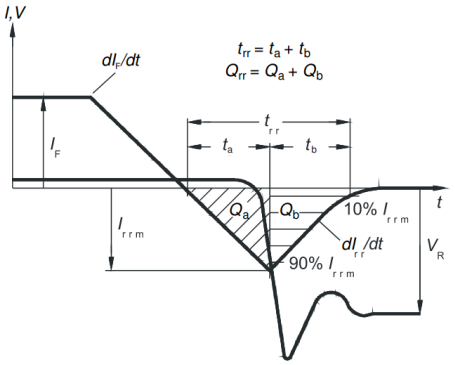


Figure C. **Definition of diode switching characteristics**

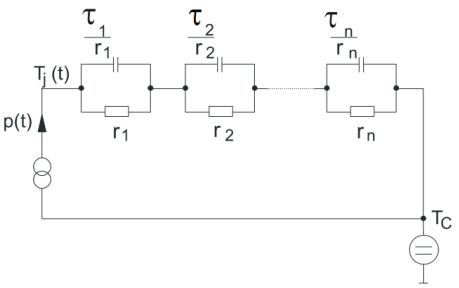


Figure D. **Thermal equivalent circuit**

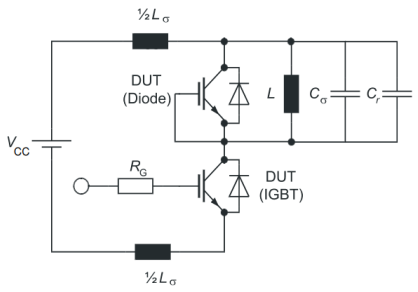


Figure E. **Dynamic test circuit**
Parasitic inductance L_σ,
parasitic capacitor C_σ,
relief capacitor C_r,
(only for ZVT switching)

图 2

修订记录

Document revision	Date of release	Description of changes
V1.1	2020-04-20	Preliminary Data Sheet
V2.1	2020-05-12	Final data sheet
V2.2	2020-06-29	Increase of forward current rating at Tc=100°C to 27.5A
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
1.20	2023-12-12	Updating E_{off} losses Editorial changes

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