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

Lead-free
Green
Halogen-free
RoHS

特性

- V_{CE} = 650 V
- I_C = 40 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/

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
- 能源生产
- 光伏优化器
- 光伏组串逆变器

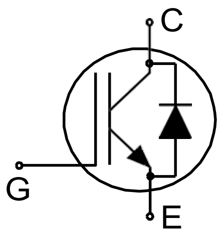
产品验证

- 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**
IKW40N65ET7	PG-TO247-3	K40EET7

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）。

目录

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	$R_{th(j-c)}$				0.65	K/W
Diode thermal resistance, junction-case	$R_{th(j-c)}$				0.9	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		$T_c = 25$ °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) 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= 120 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}	$I_C = 40$ 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, $R_{G(on)} = 10\ \Omega$, $R_{G(off)} = 10\ \Omega$, $L_\sigma = 32$ nH, $C_\sigma = 30$ 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, $R_{G(on)} = 10\ \Omega$, $R_{G(off)} = 10\ \Omega$, $L_\sigma = 32$ nH, $C_\sigma = 30$ 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		

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表 3 （续）特征值

Parameter	Symbol	Note or test condition		Values Min.	Typ.	Max.	Unit
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		

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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, $R_{G(on)}$ = 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 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	72	A
			T_c = 100 °C	43.5	
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpulse}			120	A

表 5 特征值

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		

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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}	$V_R = 650$ 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		

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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 = 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

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。

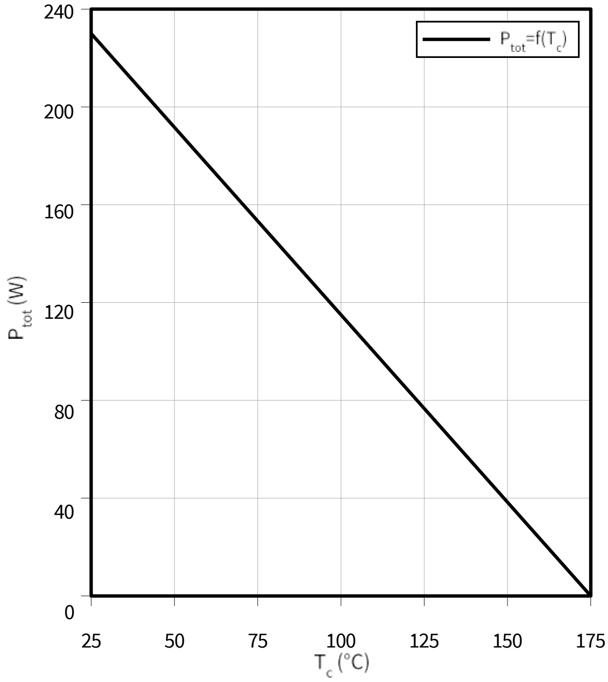
动态测试电路，L_σ、C_σ来自图E。能量损失包括“拖尾”和二极管反向恢复。

4 特性图

Power dissipation as a function of case temperature

$P_{tot} = f(T_c)$

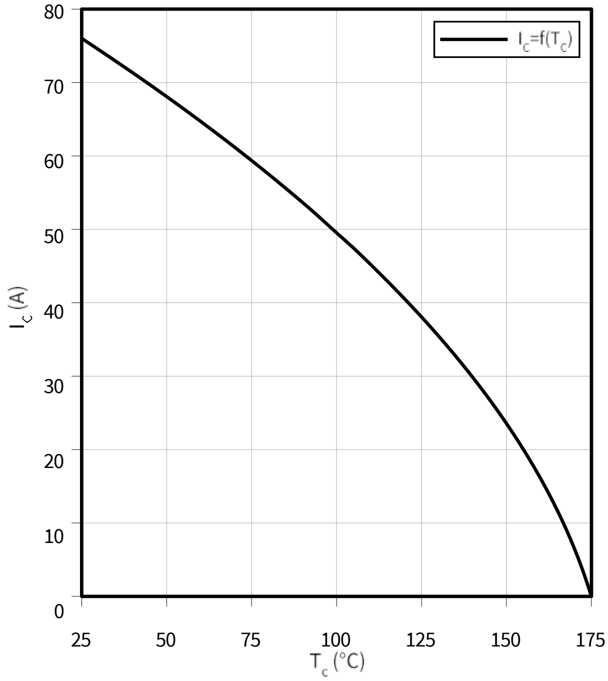
$T_{vj} \leq 175$ °C



Collector current as a function of case temperature

$I_C = f(T_c)$

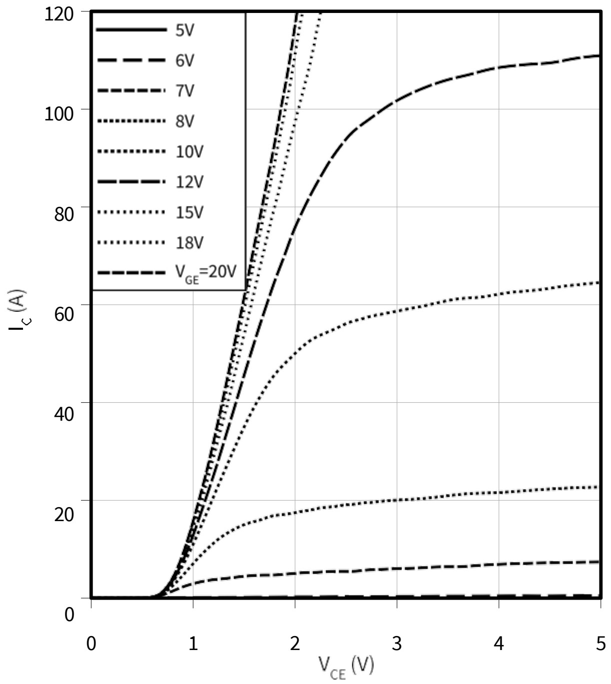
$T_{vj} \leq 175$ °C, $V_{GE} \geq 15$ V



Typical output characteristic

$I_C = f(V_{CE})$

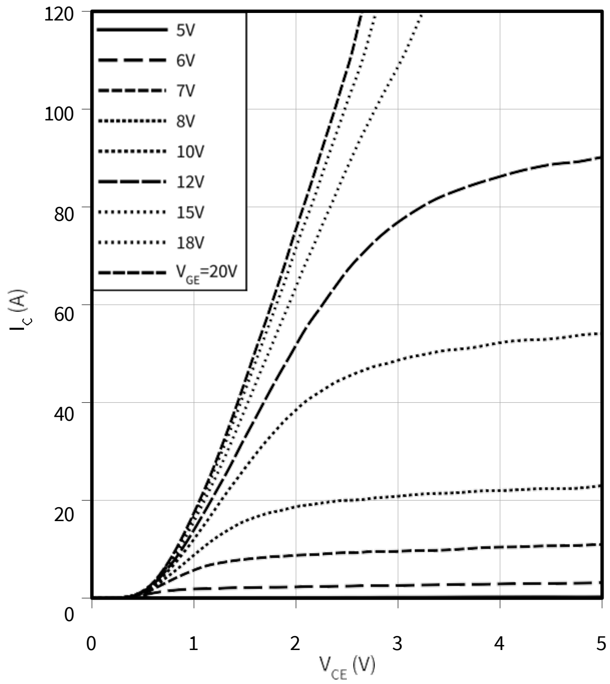
$T_{vj} = 25$ °C



Typical output characteristic

$I_C = f(V_{CE})$

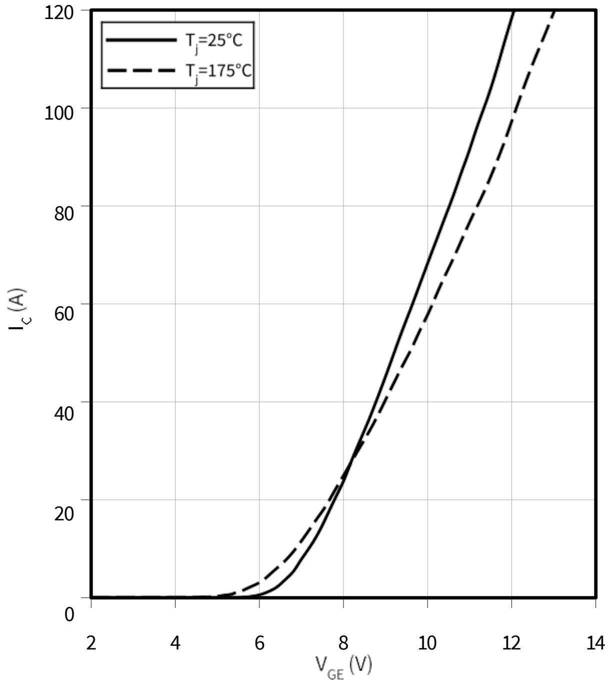
$T_{vj} = 175$ °C



Typical transfer characteristic

$I_C = f(V_{GE})$

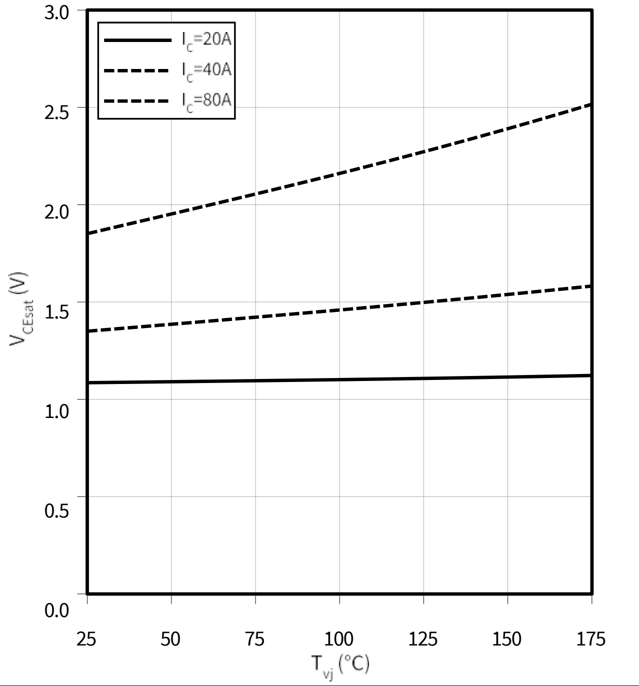
$V_{CE} = 20$ V



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

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

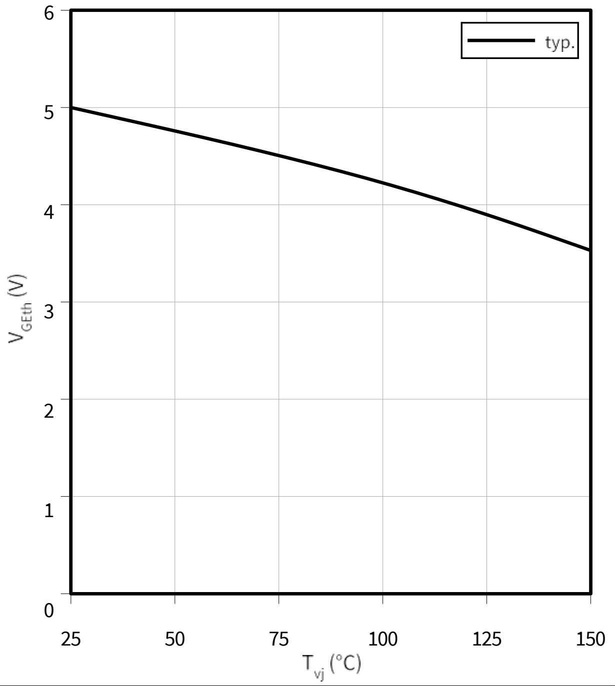
$V_{GE} = 15$ V



Gate-emitter threshold voltage as a function of junction temperature

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

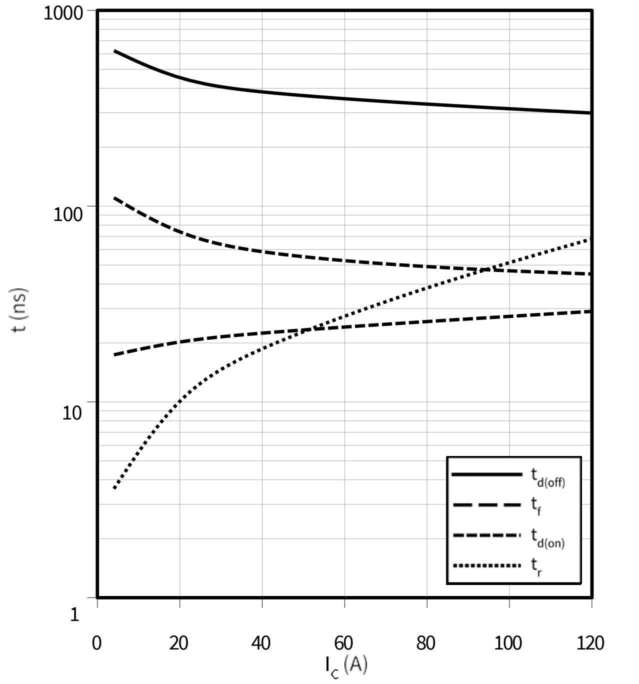
$I_C = 0.4$ mA



Typical switching times as a function of collector current

$t = f(I_C)$

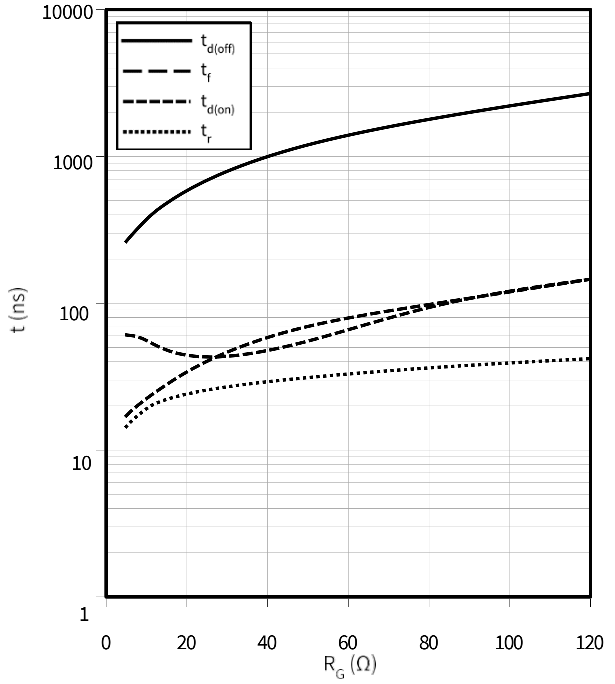
$V_{CC} = 400$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V, $R_G = 10\ \Omega$



Typical switching times as a function of gate resistor

$t = f(R_G)$

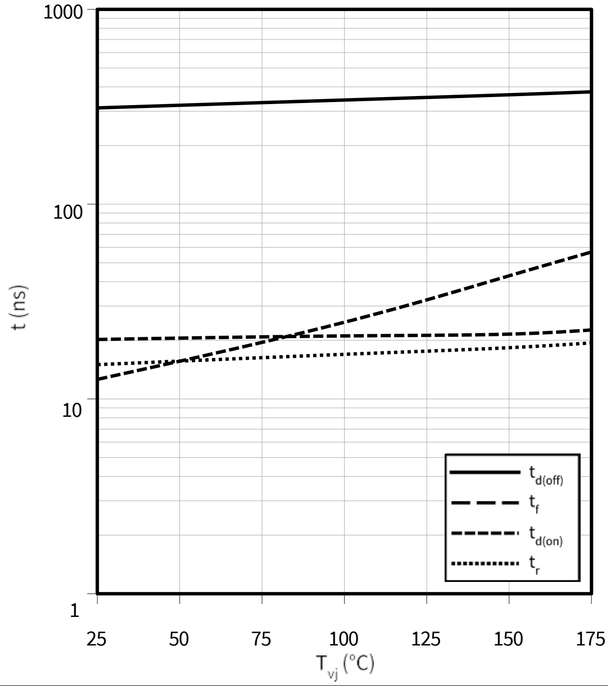
$I_C = 40$ A, $V_{CC} = 400$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V



Typical switching times as a function of junction temperature

$t = f(T_{vj})$

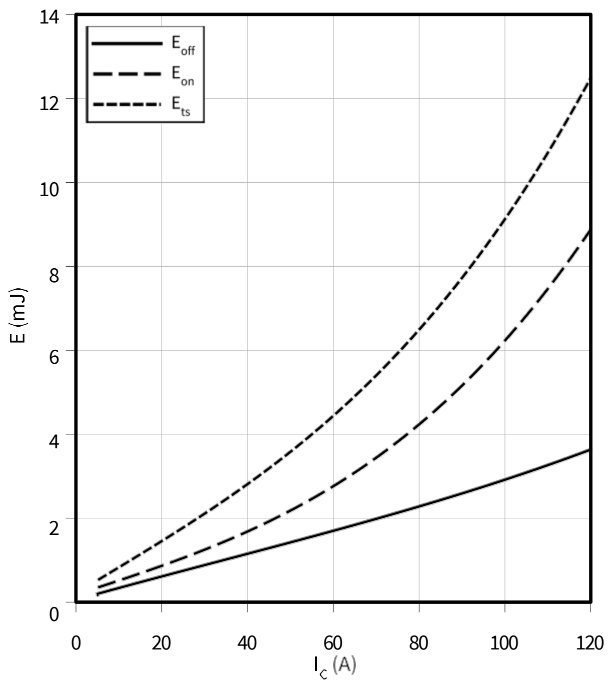
$I_C = 40$ A, $V_{CC} = 400$ V, $V_{GE} = 0/15$ V, $R_G = 10$ Ω



Typical switching energy losses as a function of collector current

$E = f(I_C)$

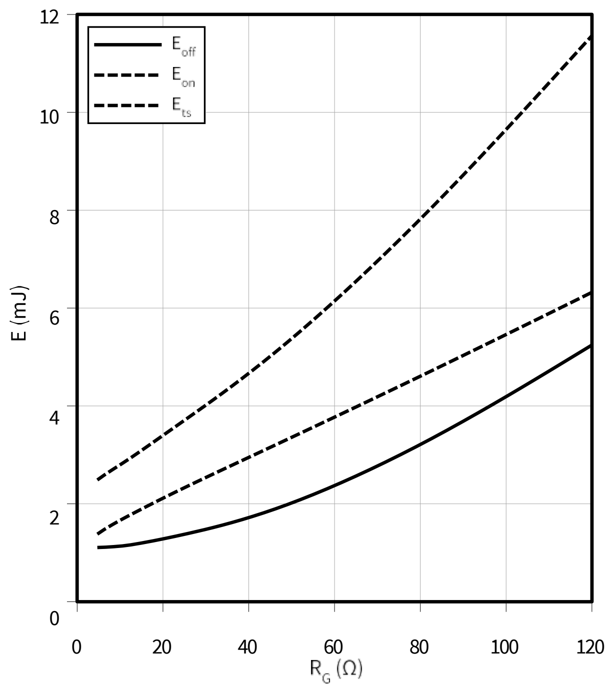
$V_{CC} = 400$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V, $R_G = 10$ Ω



Typical switching energy losses as a function of gate resistor

$E = f(R_G)$

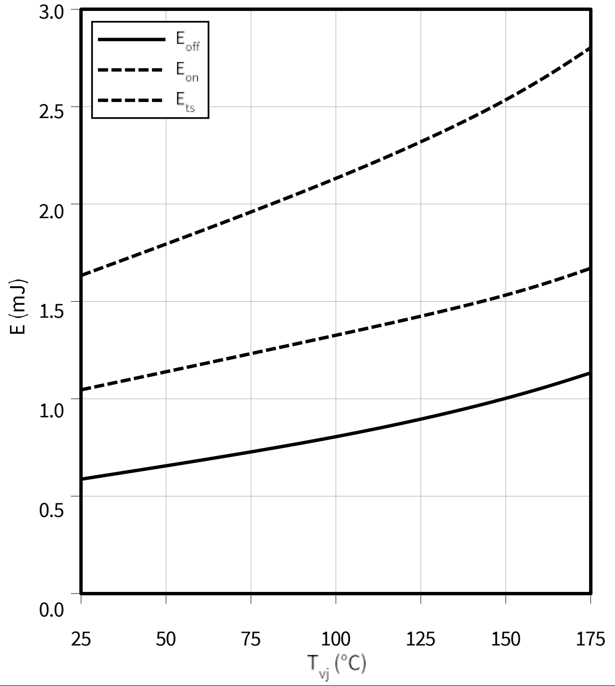
$I_C = 40$ A, $V_{CC} = 400$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V



Typical switching energy losses as a function of junction temperature

$E = f(T_{vj})$

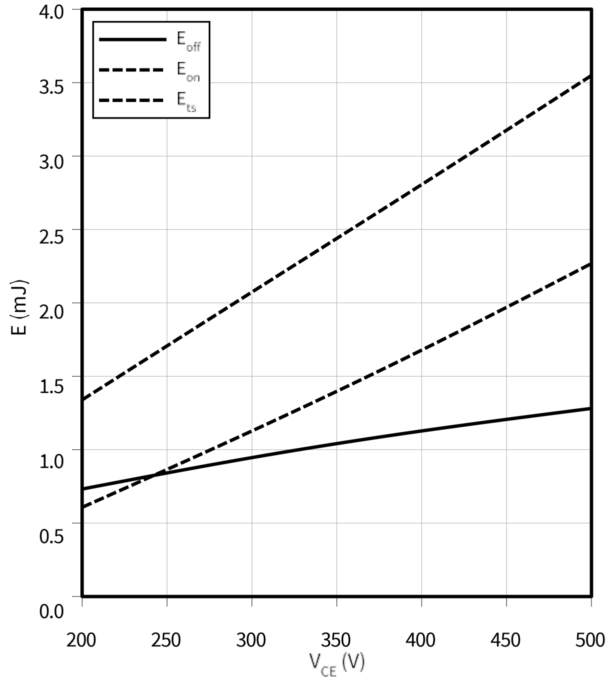
$I_C = 40$ A, $V_{CC} = 400$ V, $V_{GE} = 0/15$ V, $R_G = 10\ \Omega$



Typical switching energy losses as a function of collector emitter voltage

$E = f(V_{CE})$

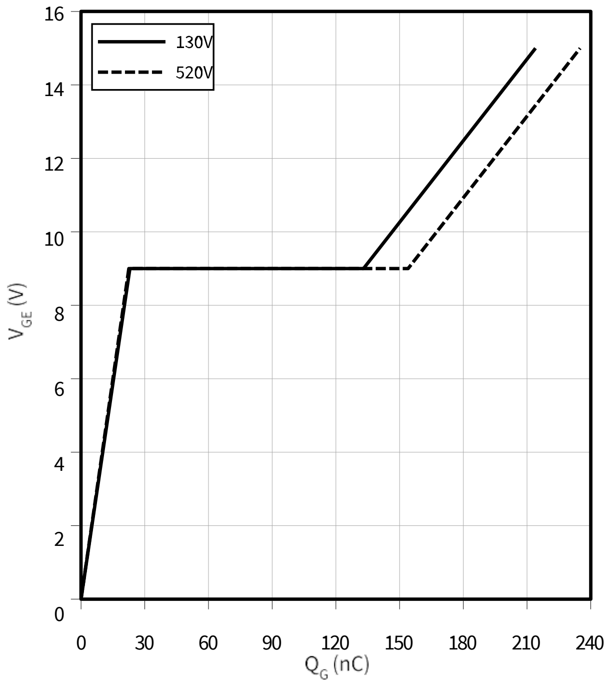
$I_C = 40$ A, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V, $R_G = 10\ \Omega$



Typical gate charge

$V_{GE} = f(Q_G)$

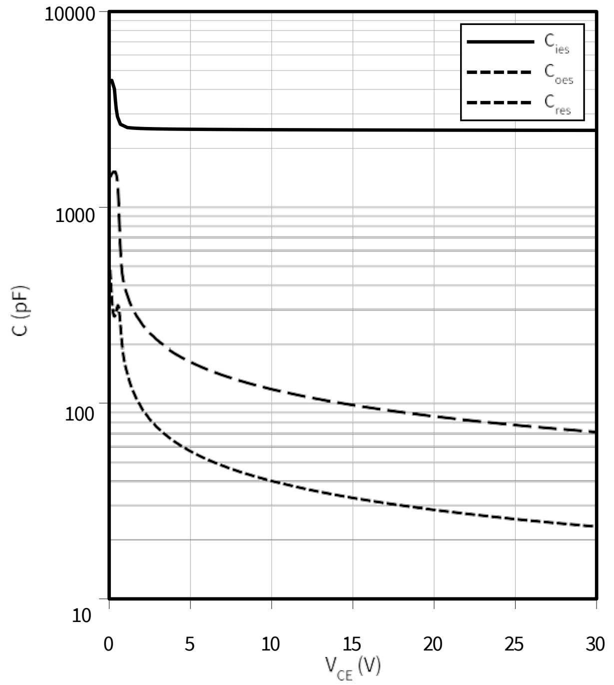
$I_C = 40$ A



Typical capacitance as a function of collector-emitter voltage

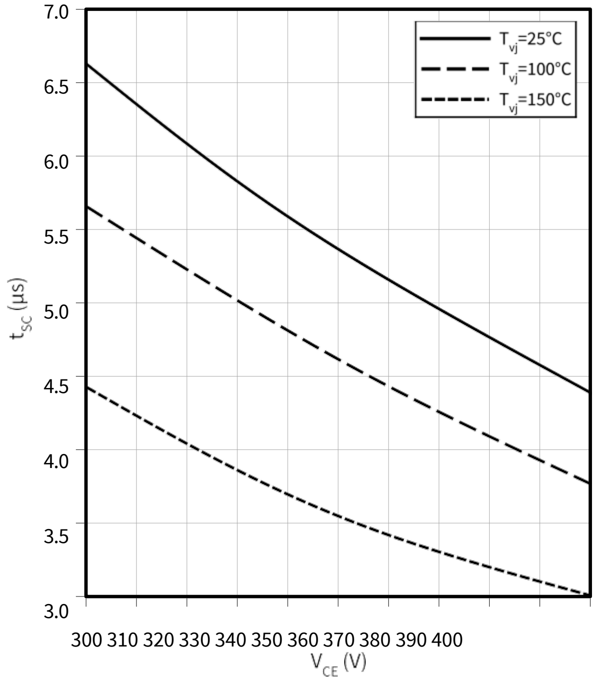
$C = f(V_{CE})$

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



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

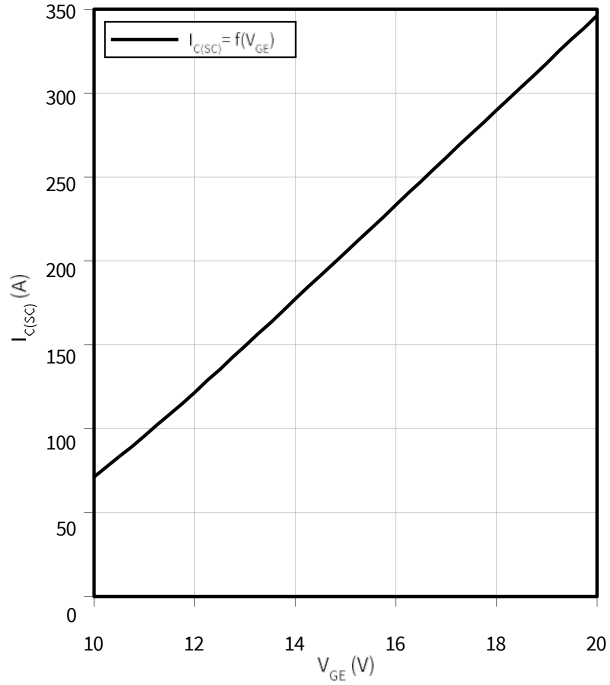
$t_{SC} = f(V_{CE})$



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

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

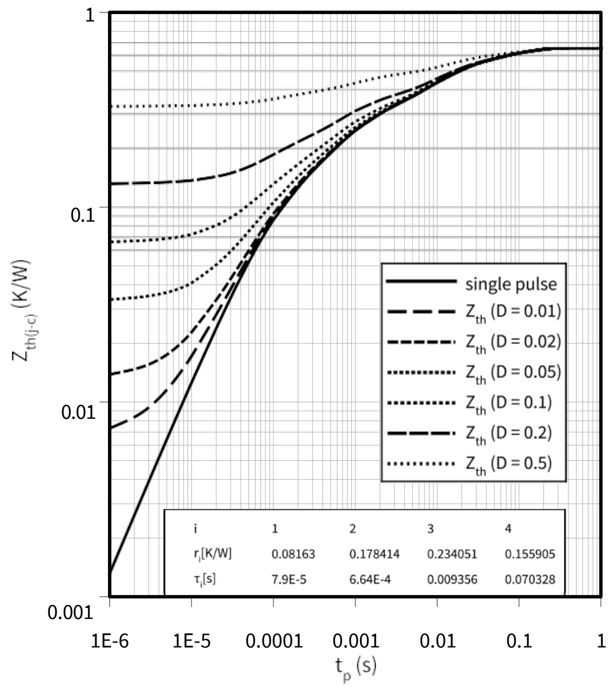
$T_{vj} = 150$ °C, $V_{CC} \leq 400$ V



IGBT transient thermal impedance as a function of pulse width

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

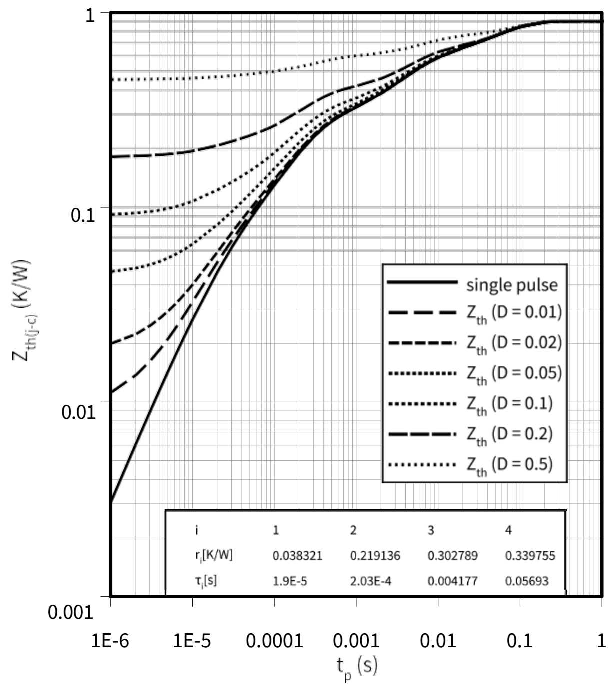
$D = t_p/T$



Diode transient thermal impedance as a function of pulse width

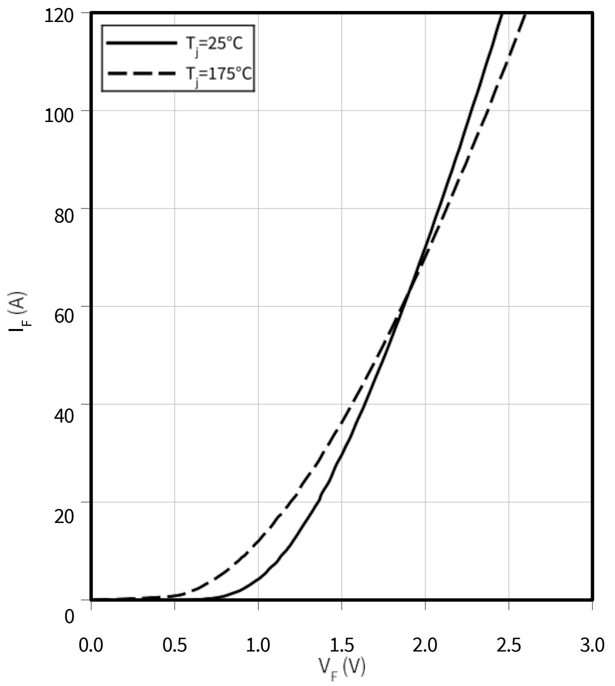
$Z_{th(j-c)} = f(t_p)$

$D = t_p/T$



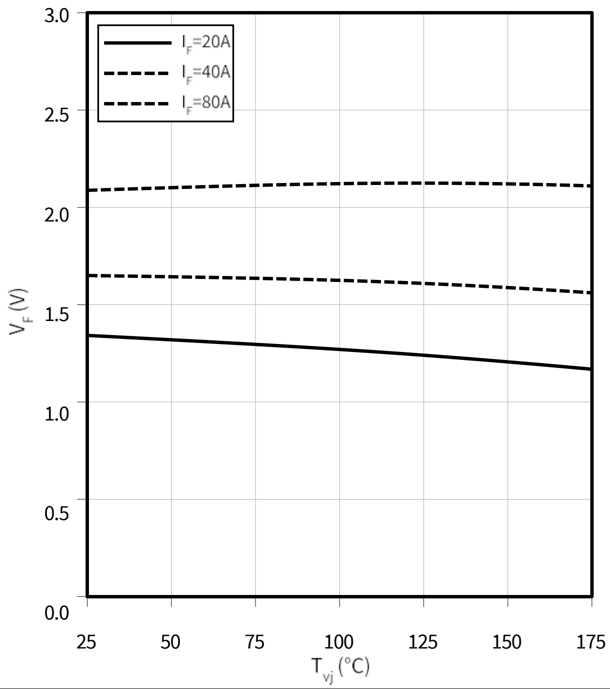
Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



Typical diode forward voltage as a function of junction temperature

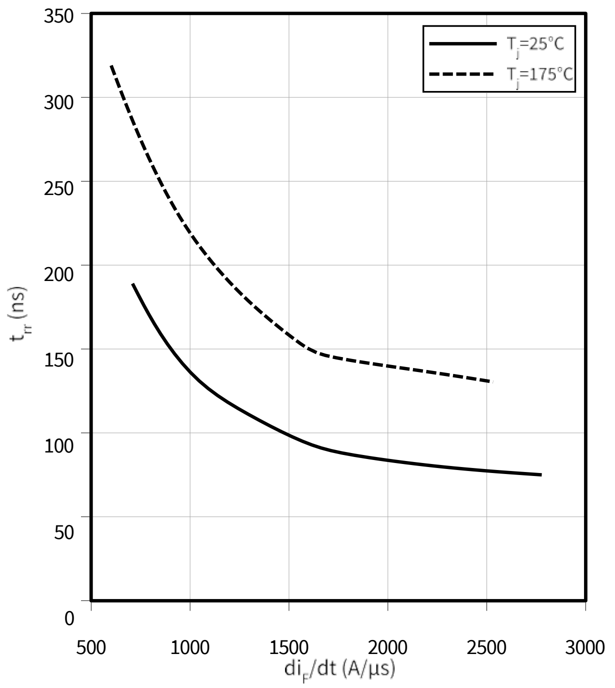
$V_F = f(T_{vj})$



Typical reverse recovery time as a function of diode current slope

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

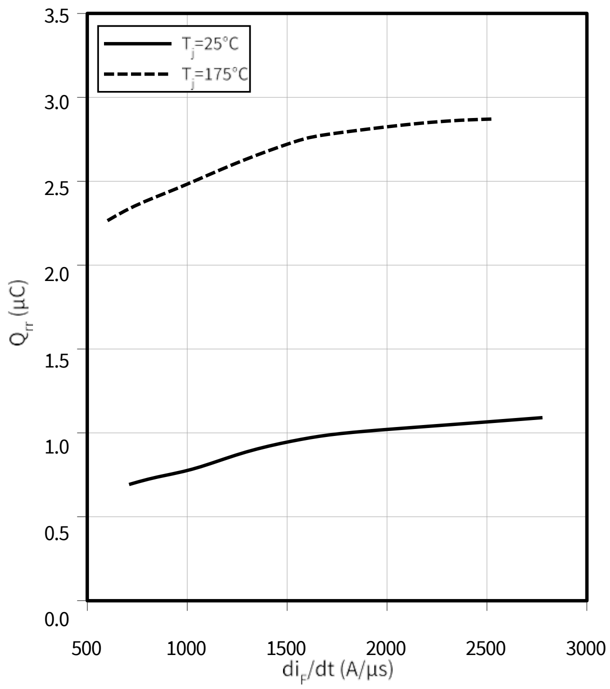
$V_R = 400$ V, $I_F = 40$ A

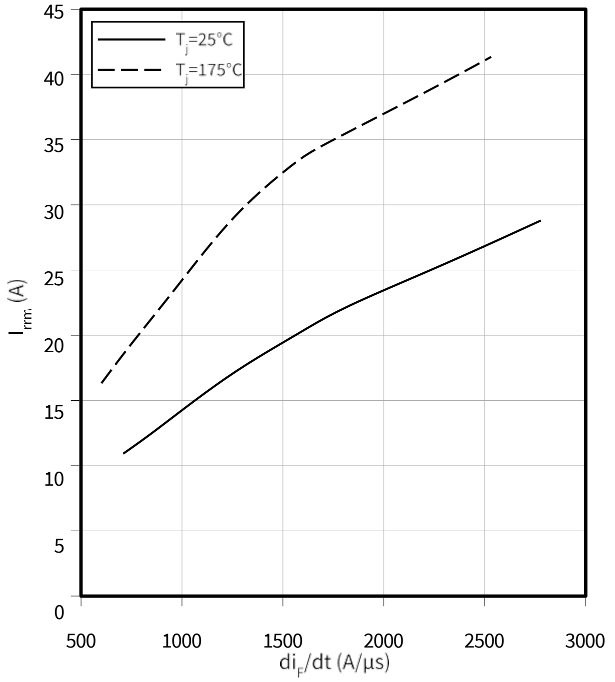
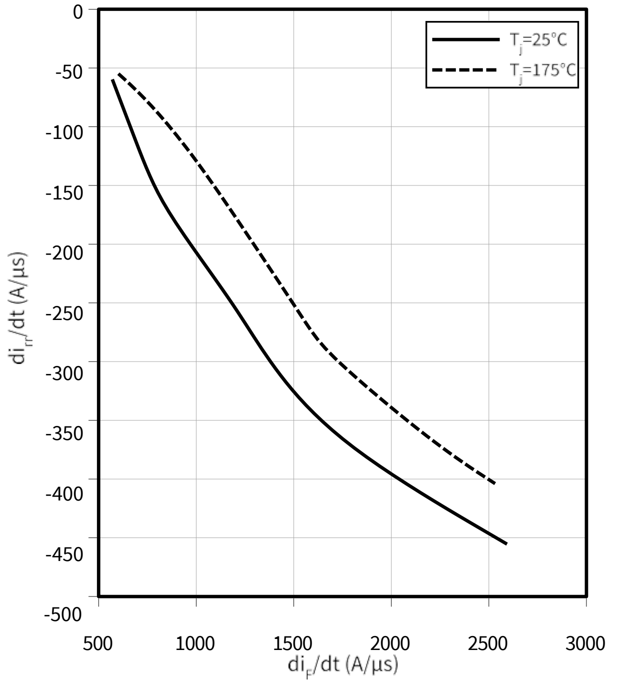


Typical reverse recovery charge as a function of diode current slope

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

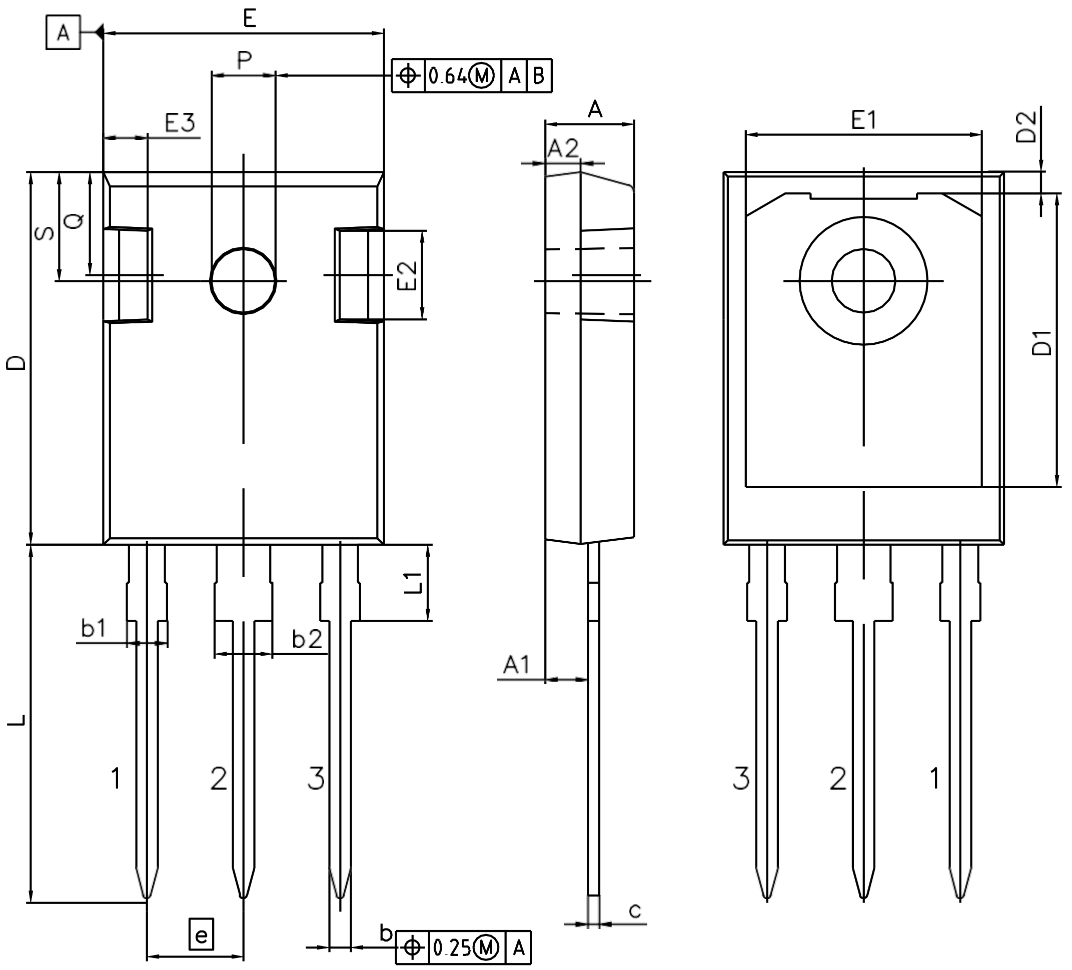
$V_R = 400$ V, $I_F = 40$ A



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 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

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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

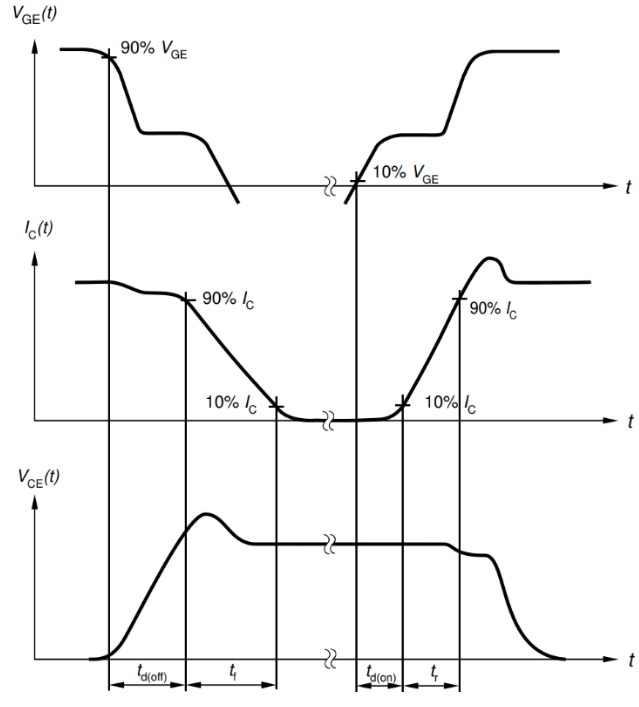

Figure A. **Definition of switching times**

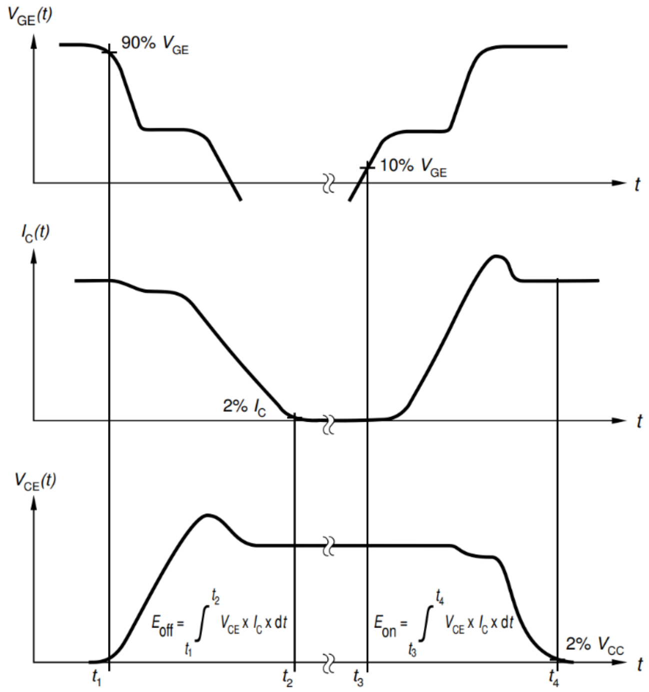

Figure B. **Definition of switching losses**

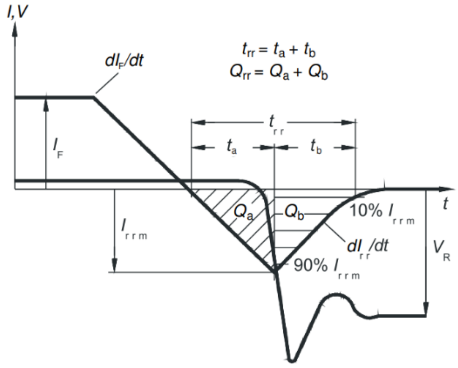

Figure C. **Definition of diode switching characteristics**

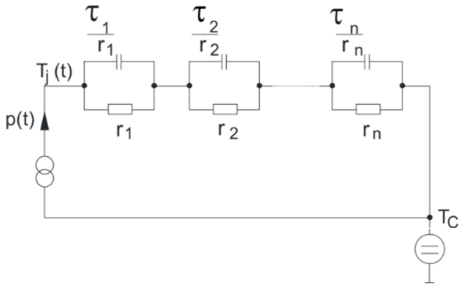

Figure D. **Thermal equivalent circuit**

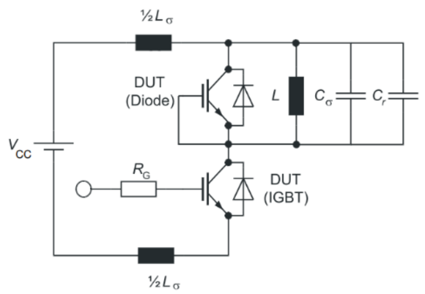

Figure E. **Dynamic test circuit**
Parasitic inductance L_σ,
parasitic capacitor C_σ,
relief capacitor C_r,
(only for ZVT switching)

图 2

修订记录

Document revision	Date of release	Description of changes
V1.1	2020-04-28	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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Infineon Technologies AG 出版，
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Do you have a question about this document?

Email:

erratum@infineon.com