High-speed IGBT Power Transistor

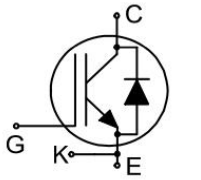
(Integrated 40A SiC SBD)

Preliminary

HKZ40N120FHRB

1. Product Features:

- Ultra-low switching losses
- Ultra-low static losses
- Internal integrated SiC Schottky Diode (SBD)
- Plug-and-play replacement of pure Si-based IGBT
- Maximum junction temperature 175℃
- Qualified according to JEDEC for target applications
- RoHS compliant



Package: TO-247-4

2. Product Applications

- Industrial Power Supplies
- Solar String Inverter
- Energy Storage Inverter
- UPS
- DC Charger for Electric Vehicles

3. Typical Performance Parameters

Tab.1. Typical Performance Parameters

Type	V_{CE}	I_C	V_{CEsat} T_{vj} = 25℃	T_{vjmax}	Marking	Package
HKZ40N120FHRB	1200V	40A	1.605V	175℃	HKZ40N120FHRB	TO-247-4

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4. Maximum Ratings

Tab.2. Maximum Ratings

Parameters	Symbol	Value	Unit
Collector-emitter voltage	V_{CE}	1200	V
DC collector current (limited by T_{vjmax})	I_C	80.0 (T_c = 25℃) 40.0 (T_c = 100℃)	A
Pulsed collector current (t_p limited by $T_{vjmax.}$)	I_{Cpuls}	160.0	A
Turn off safe operating area (V_{CE} ≤1200V, T_{vj} ≤175℃)	-	160.0	A
Diode forward current (limited by T_{vjmax})	I_F	40.0 (T_c = 80℃)	A
Diode pulse current (t_p limited by $T_{vjmax.}$)	I_{Fpuls}	160.0 (T_c = 25℃)	A
Gate-emitter voltage	V_{GE}	±20	V
Power dissipation	P_{tot}	441.0 (T_c = 25℃) 220.0 (T_c = 100℃)	W
Operating junction temperature	T_{vj}	-40 to +175	℃
Storage temperature	T_{stg}	-55 to +150	℃
Soldering temperature, (wave soldering 1.6mm from case for 10s)		260	℃
Mounting torque (M3 screw) (Maximum of mounting processes: 3)	M	0.6	Nm

5. Thermal Properties

Tab.3. Thermal Properties

Parameters	Symbol	Max. value	Unit
IGBT thermal resistance (junction - case)	$R_{th(j-c)}$	0.34	℃/W
Diode thermal resistance (junction - case)	$R_{th(j-c)}$	0.52	℃/W
Thermal resistance (junction – ambient)	$R_{th(j-a)}$	40	℃/W

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6. Electrical Characteristics

Tab.4. Static Characteristic (T_{vj} = 25℃, unless otherwise specified)

Parameters	Symbol	Conditions	Min. value	Typ. value	Max. value	Unit
Collector-emitter breakdown voltage	$V_{(BR)CES}$	V_{GE}= 0V, I_C= 1mA	1200	-	-	V
Collector-emitter saturation voltage	V_{CEsat}	V_{GE}= 15V, I_C= 40A T_{vj}= 25℃ T_{vj}= 175℃	 - -	 1.605 2.405	 2.4 -	V
Diode forward voltage	V_F	V_{GE}= 0V, I_F= 40A T_{vj} = 25℃ T_{vj}= 175℃	 - -	 2.05 3.92	 2.6 -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	I_C= 1.00mA, V_{CE}= V_{GE}	5.1	5.70	6.60	V
Zero gate voltage collector current	I_{CES}	V_{CE}= 1200V, V_{GE}= 0V T_{vj}= 25℃ T_{vj}= 175℃	 - -	 - -	 250 2500	μA
Gate-emitter leakage current	I_{GES}	V_{CE}= 0V, V_{GE}= 20V	-	-	200	nA
Transconductance	g_{fs}	V_{CE}= 20V, I_C= 15.0A	-	45.0	-	S

Tab.5. Dynamic Characteristic (T_{vj} = 25℃, unless otherwise specified)

Parameters	Symbol	Conditions	Min. value	Typ. value	Max. value	Unit
Input capacitance	C_{ies}	V_{CE}= 25V, V_{GE}= 0V f = 1MHz	-	8716	-	pF
Output capacitance	C_{oes}		-	448	-	
Reverse transfer capacitance	C_{res}		-	43	-	
Gate-charge	Q_g	V_{CE}= 960V, I_C= 40.0A, V_{GE}= 15V	-	311	-	nC

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Tab.6. Switching Characteristic (Inductive load)

Parameters	Symbol	Conditions	Min. value	Typ. value	Max. value	Unit
Turn-on delay time	$t_{d(on)}$	T_{vj} = 25°C, V_{CC} = 600V, I_C = 40.0A, V_{GE} = 0.0/15.0V, $R_{G(on)}$ = $R_{G(off)}$ = 12.0Ω, Inductive load	-	73	-	ns
Rise time	t_r		-	28	-	
Turn-off delay time	$t_{d(off)}$		-	375	-	
Fall time	t_f		-	120	-	
Turn-on energy	E_{on}	Energy losses include "tail" and diode reverse recovery.	-	1.11	-	mJ
Turn-off energy	E_{off}		-	1.73	-	
Total switching energy	E_{ts}		-	2.64	-	
Turn-on delay time	$t_{d(on)}$	T_{vj} = 175°C, V_{CC} = 600V, I_C = 40.0A, V_{GE} = 0.0/15.0V, $R_{G(on)}$ = $R_{G(off)}$ = 12.0Ω Inductive load	-	65	-	ns
Rise time	t_r		-	33	-	
Turn-off delay time	$t_{d(off)}$		-	428	-	
Fall time	t_f		-	131	-	
Turn-on energy	E_{on}	Energy losses include "tail" and diode reverse recovery.	-	1.41	-	mJ
Turn-off energy	E_{off}		-	2.09	-	
Total switching energy	E_{ts}		-	3.50	-	

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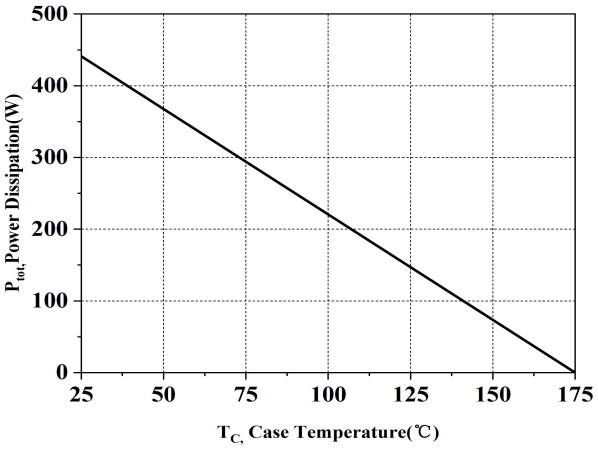

Fig.1. Power dissipation as a function of case temperature ($T_j \leq 175°C$)

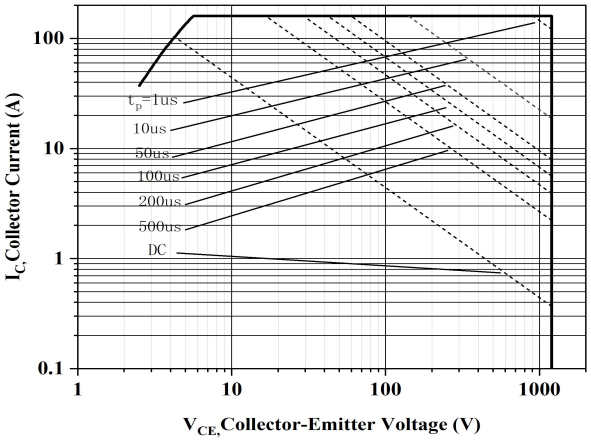

Fig.2. Forward bias safe operating area ($D = 0$, $T_C = 25°C$, $T_j \leq 175°C$, $V_{GE} = 15V$)

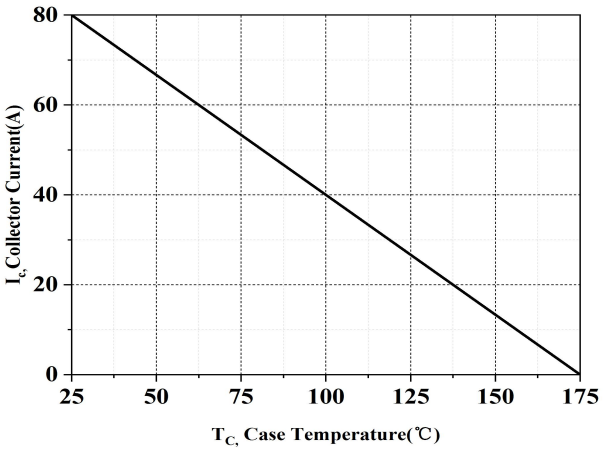

Fig.3. Collector current as a function of case temperature ($V_{GE} \geq 15V, T_j \leq 175°C$)

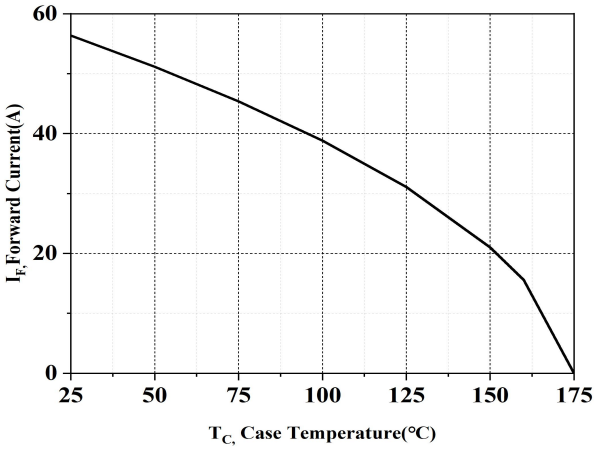

Fig.4. Diode Forward current as a function of case temperature

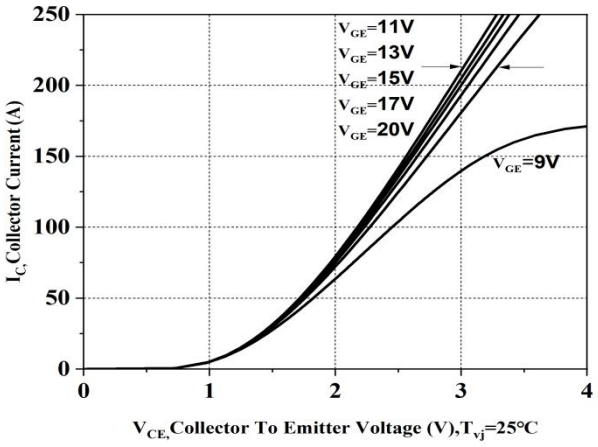

Fig.5. Typical output characteristics
($T_j = 25°C$)

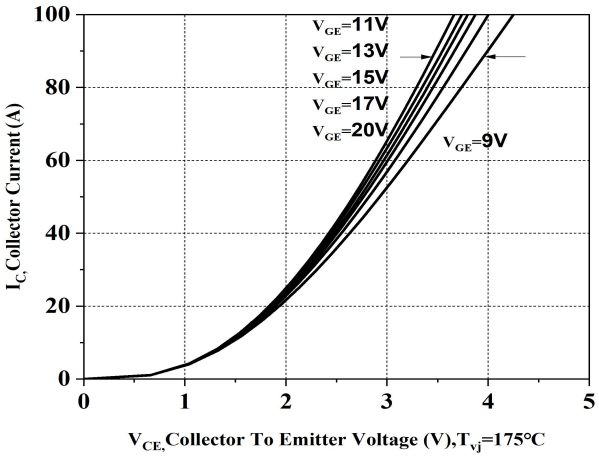

Fig.6. Typical output characteristics
($T_j = 175°C$)

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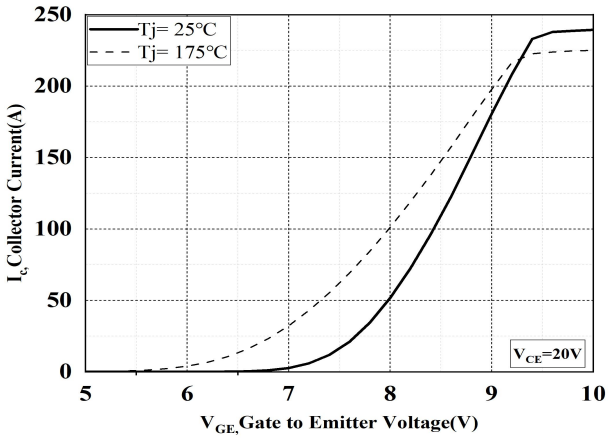

Fig.7. Typical transfer characteristic

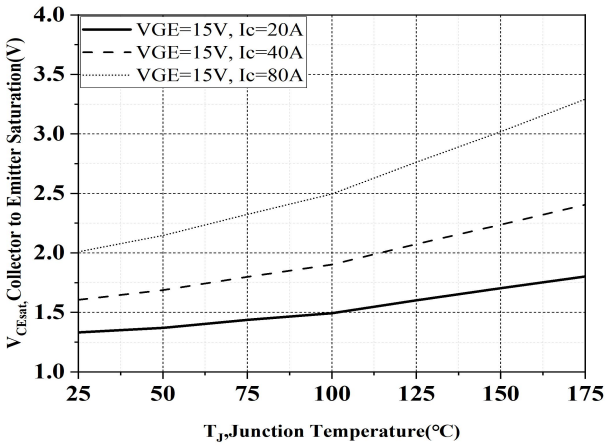

Fig.8. Typical collector-emitter saturation voltage vs. junction temperature

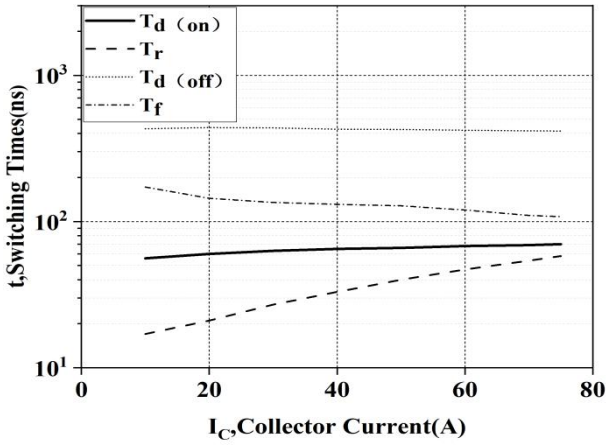

Fig.9. Typical switching times vs. collector current (T_j= 175°C, V_{CE}= 600V, V_{GE}= 15/0V, R_G= 12Ω)

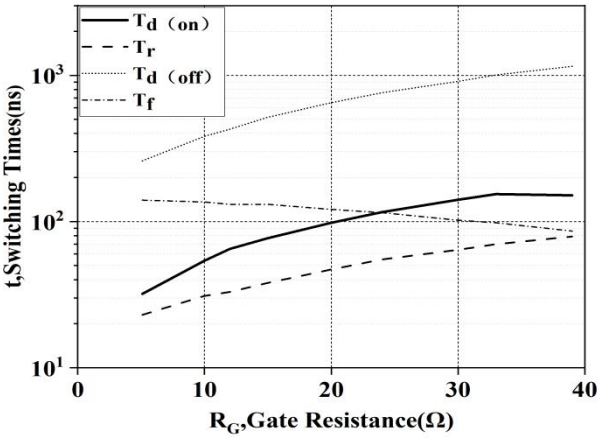

Fig.10. Typical switching times vs. gate Resistor (Tj= 175°C, VCE= 600V, VGE= 15/0V, IC = 40A)

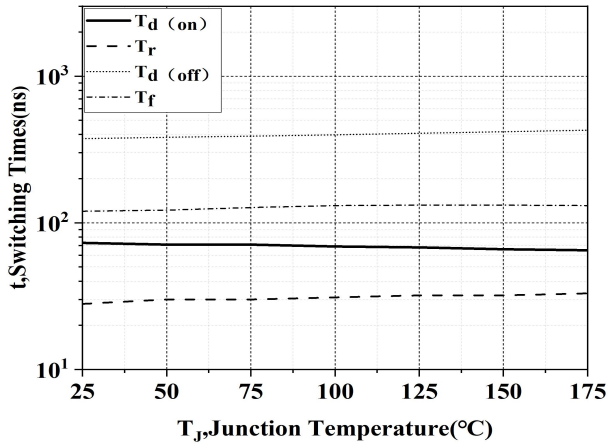

Fig.11. Typical switching times vs. junction temperature

(V_{CE}= 600V, V_{GE}= 15/0V, I_C = 40A,R_G= 12Ω）

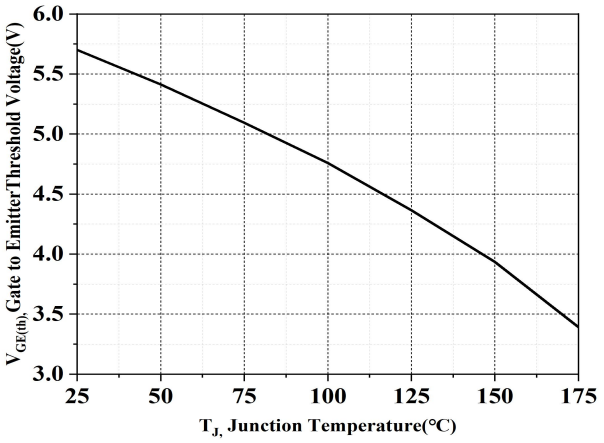

Fig.12. Gate-emitter threshold voltage vs. junction temperature

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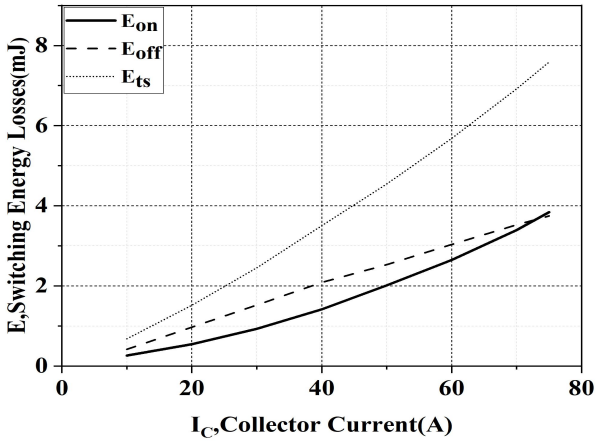

Fig.13. Typical switching energy losses as a function of collector current

(T_j= 175°C, V_{CE}= 600V, V_{GE}= 15/0V, R_G= 12Ω）

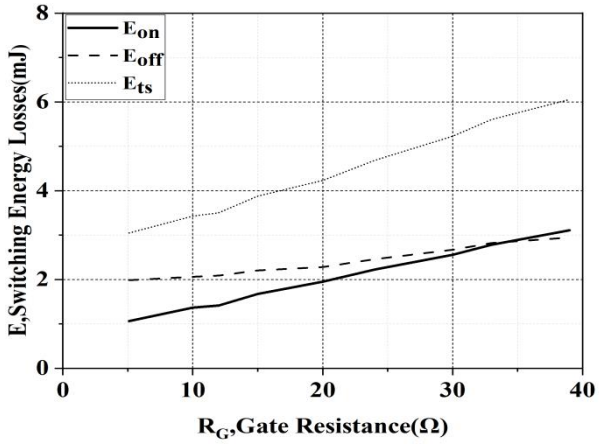

Fig.14. Typical switching energy losses as a function of gate resistor

(T_j= 175°C, V_{CE}= 600V, V_{GE}= 15/0V, I_C = 40A）

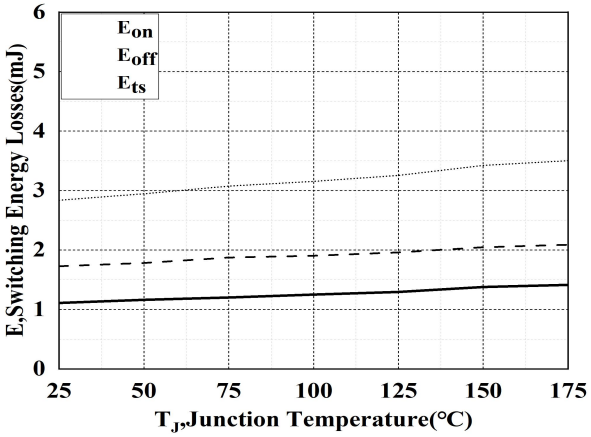

Fig.15. Typical switching energy losses as a function of junction temperature

(Inductive load, V_{CE}= 600V, V_{GE}= 15/0V, R_G= 12Ω, I_C = 40A）

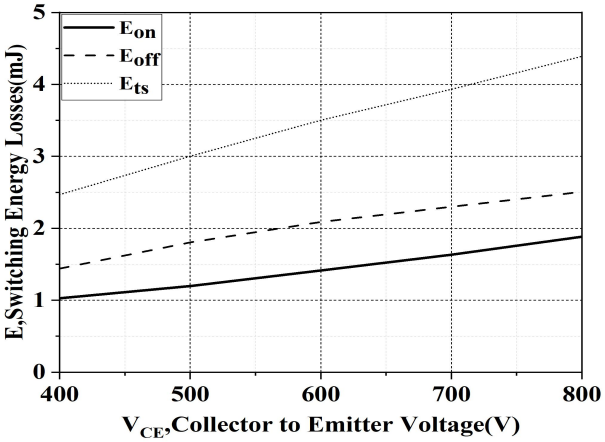

Fig.16. Typical switching energy losses as a function of collector emitter voltage

(Inductive load, T_j= 175°C, V_{GE}= 15/0V, R_G= 12Ω, I_C = 40A）

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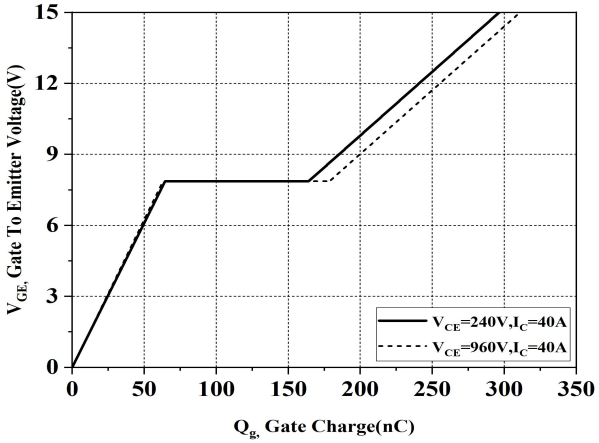

Fig.17. Typical gate charge

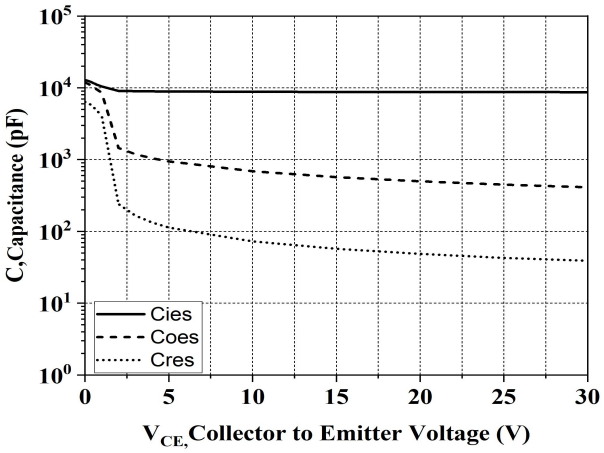

Fig.18. Typical capacitance as a function of collector-emitter voltage

(V_{GE} = 0V,f = 1MHz)

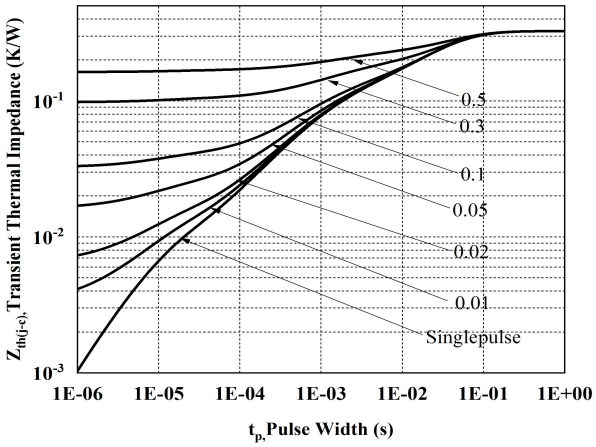

Fig.19. IGBT transient thermal impedance

(D = t_p/T)

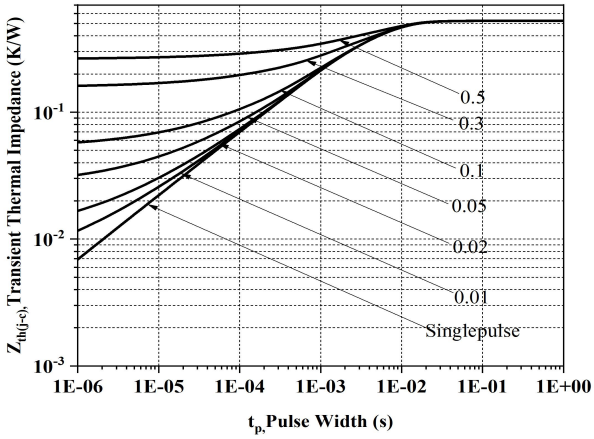

Fig.20. Transient thermal impedance of diode

(D = t_p/T)

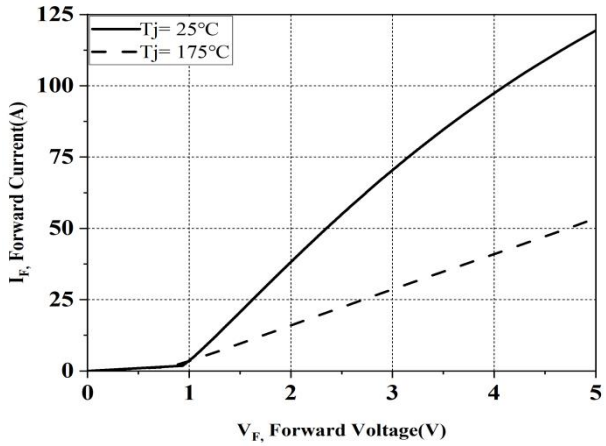

Fig.21. Typical diode forward current as a function of forward voltage

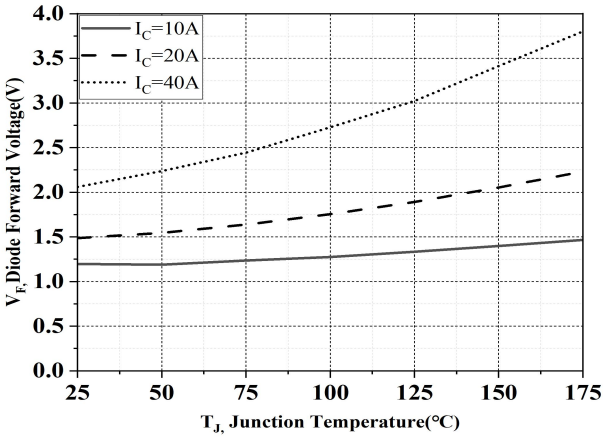

Fig.22. Typical diode forward voltage as a function of junction temperature

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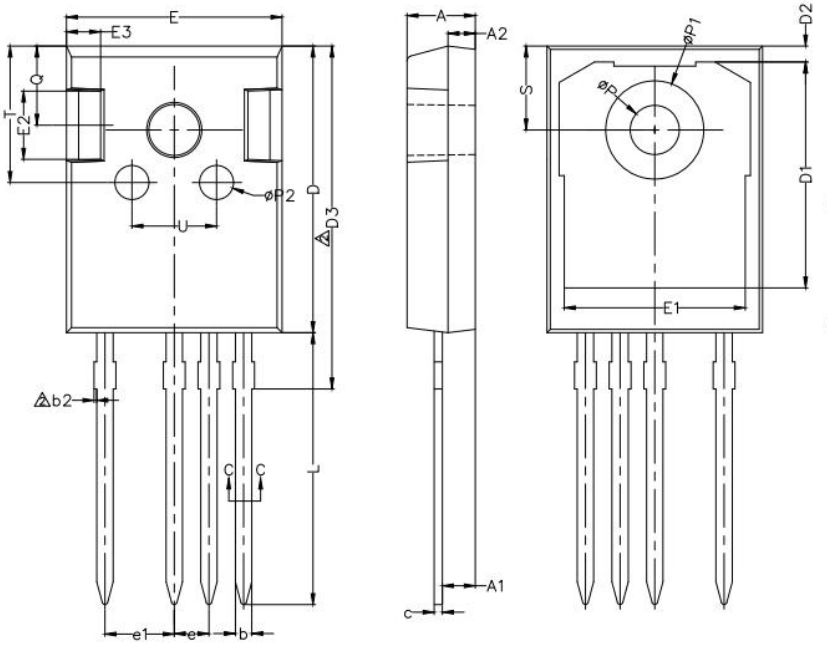
7. Package Dimensions



COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	4.90	5.00	5.10
A1	2.31	2.41	2.51
A2	1.90	2.00	2.10
b	1.16	–	1.29
b1	1.15	1.20	1.25
⚠ b2	0	–	0.20
c	0.59	–	0.66
c1	0.58	0.60	0.62
D	20.90	21.00	21.10
D1	16.25	16.55	16.85
D2	1.05	1.20	1.35
⚠ D3	24.97	25.12	25.27
E	15.70	15.80	15.90
E1	13.10	13.30	13.50
E2	4.90	5.00	5.10
E3	2.40	2.50	2.60
e	2.44	2.54	2.64
e1	4.98	5.08	5.18
L	19.80	19.92	20.10
P	3.50	3.60	3.70
P1	–	–	7.40
P2	2.40	2.50	2.60
Q	5.60	–	6.00
S		6.15BSC	
T	9.80	–	10.20
U	6.00	–	6.40

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8. Version Information

Version No.	Status	Date changed	Version revision record
V1.0	Preliminary version	2023/09	

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