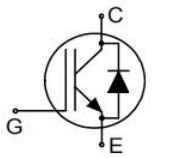
RoHS

High-speed IGBT Power Transistor

(Integrated FRD)

HKW40N120FHEQ



Package: TO-247-3

1. Product Features:

- Ultra-low switching losses
- Ultra-low static losses
- Internal integrated fast&soft recovery anti-parallel FRD
- Maximum junction temperature 175℃
- Qualified according to JEDEC and AEC Q101
- RoHS compliant

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
HKW40N120FHEQ	1200V	40A	1.67V	175℃	HKW40N120FHEQ	TO-247-3

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 = 110℃)	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)	$R_{th(j-c)}$	0.30	℃/W
Diode thermal resistance (junction - case)	$R_{th(j-c)}$	0.64	℃/W
Thermal resistance (junction – ambient)	$R_{th(j-a)}$	40	℃/W

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℃	 - -	 1.67 2.52	 2.4	V
Diode forward voltage	V_F	V_{GE}= 0V, I_F= 40A T_{vj} = 25℃ T_{vj}= 175℃	 - -	 2.2 1.86	 2.6 -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	I_C= 1.00mA, V_{CE}= V_{GE}	5.5	6.1	6.50	V
Zero gate voltage collector current	I_{CES}	V_{CE}= 1200V, V_{GE}= 0V T_{vj}= 25℃ T_{vj}= 175℃	 - -	 - 300	 250 -	uA
Gate-emitter leakage current	I_{GES}	V_{CE}= 0V, V_{GE}= 20V	-	-	200	nA
Transconductance	g_{fs}	V_{CE}= 20V, I_C= 15.0A	-	33.0	-	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	-	8342	-	pF
Output capacitance	C_{oes}		-	193	-	
Reverse transfer capacitance	C_{res}		-	63	-	
Gate-charge	Q_g	V_{CE}= 960V, I_C= 40.0A, V_{GE}= 15V	-	307	-	nC

Tab.6. Switching Characteristic (Inductive load)

Parameters	Symbol	Conditions	Min. value	Typ. value	Max. value	Unit
IGBT Characteristic， at T_{vj} = 25°C						
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	-	75	-	ns
Rise time	t_r		-	44	-	
Turn-off delay time	$t_{d(off)}$		-	320	-	
Fall time	t_f		-	90	-	
Turn-on energy	E_{on}	Energy losses include “tail” and diode reverse recovery.	-	2.48	-	mJ
Turn-off energy	E_{off}		-	1.31	-	
Total switching energy	E_{ts}		-	3.79	-	
Diode Characteristic， at T_{vj} = 25°C						
Diode reverse recovery time	t_{rr}	T_{vj} = 25°C, V_R =600V, I_F =40.0A, di_F/dt = 500A/μs	-	153	-	ns
Diode reverse recovery charge	Q_{rr}		-	1.28	-	μC
Diode peak reverse recovery current	I_{rrm}		-	16	-	A
Diode peak rate of fall of reverse Recovery current during tb	di_{rr}/dt		-	-164	-	A/μs

Tab.7. Switching Characteristic (Inductive load)

Parameters	Symbol	Conditions	Min. value	Typ. value	Max. value	Unit
IGBT Characteristic， at T_{vj} = 175°C						
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	-	67	-	ns
Rise time	t_r		-	49	-	
Turn-off delay time	$t_{d(off)}$		-	347	-	
Fall time	t_f		-	79	-	
Turn-on energy	E_{on}	Energy losses include “tail” and diode reverse recovery.	-	3.12	-	mJ
Turn-off energy	E_{off}		-	1.41	-	
Total switching energy	E_{ts}		-	4.53	-	
Diode Characteristic， at T_{vj} = 175°C						
Diode reverse recovery time	t_{rr}	T_{vj} = 175°C, V_R =600V, I_F =40.0A, di_F/dt = 500A/μs	-	288	-	ns
Diode reverse recovery charge	Q_{rr}		-	4.47	-	μC
Diode peak reverse recovery current	I_{rrm}		-	32	-	A
Diode peak rate of fall of reverse Recovery current during tb	di_{rr}/dt		-	-150	-	A/μs

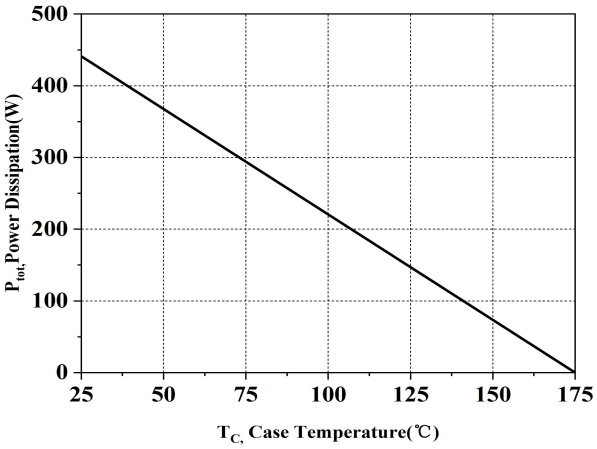


Fig.1. Power dissipation as a function of case temperature ($T_j \leq 175°C$)

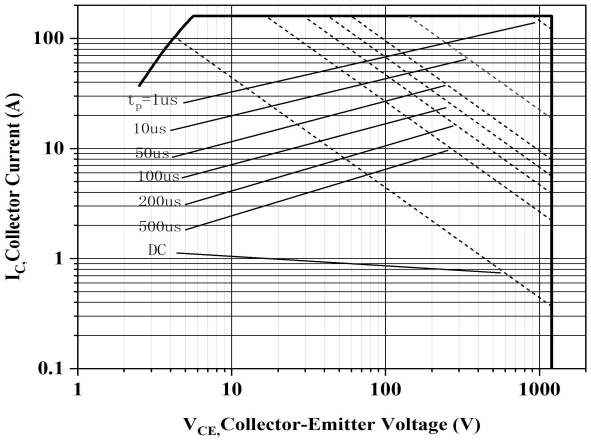


Fig.2. Forward bias safe operating area
($D = 0$, $T_C = 25°C$, $T_j \leq 175°C$, $V_{GE} = 15V$)

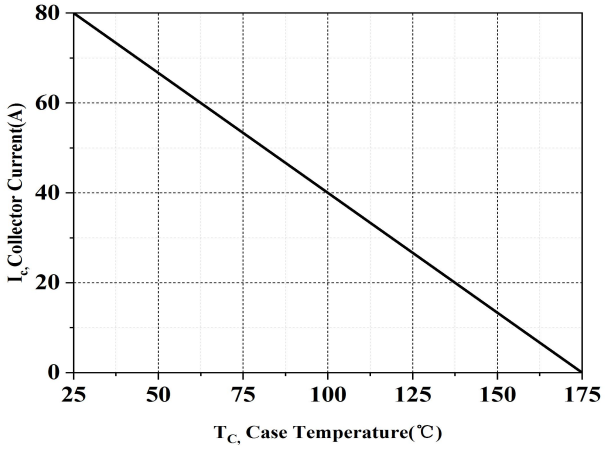


Fig.3. Collector current as a function of case temperature ($V_{GE} \geq 15V, T_j \leq 175°C$)

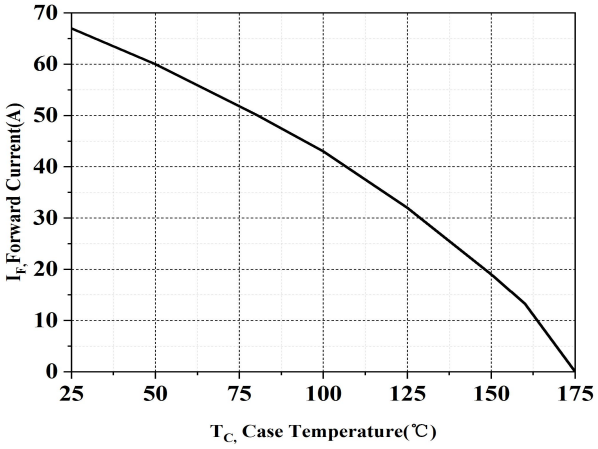


Fig.4. Diode Forward current as a function of case temperature

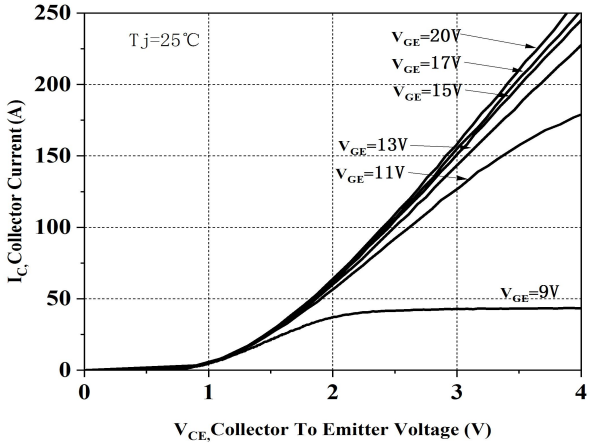


Fig.5. Typical output characteristics
($T_j = 25°C$)

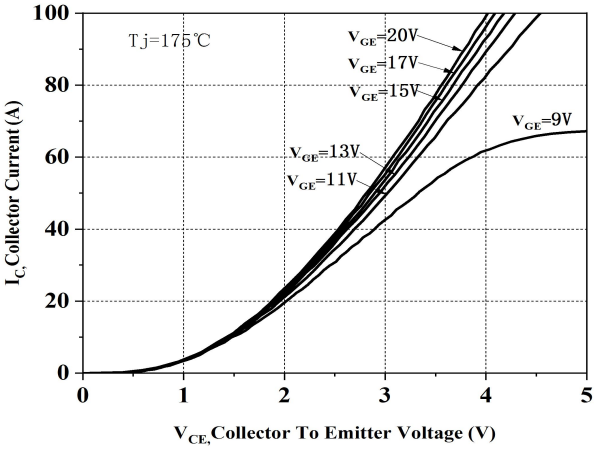


Fig.6. Typical output characteristics
($T_j = 175°C$)

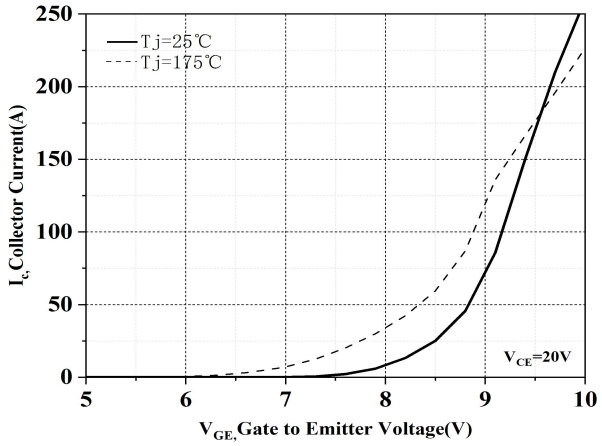


Fig.7. Typical transfer characteristic

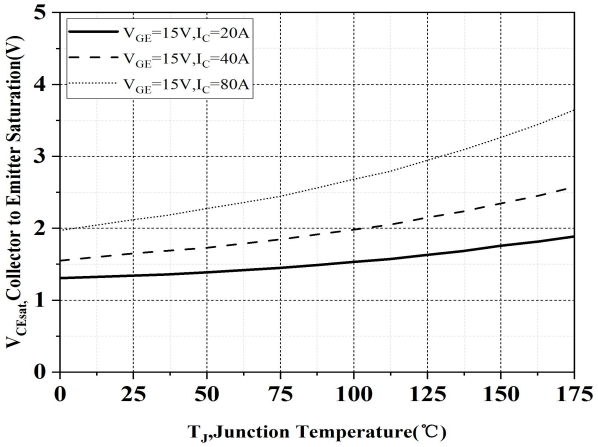


Fig.8. Typical collector-emitter saturation voltage vs junction temperature

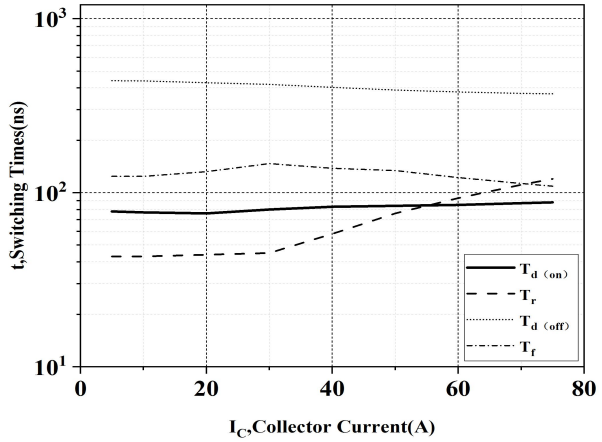


Fig.9. Typical switching times vs collector current (T_j= 175°C, V_{CE}= 600V, V_{GE}= 15/0V)

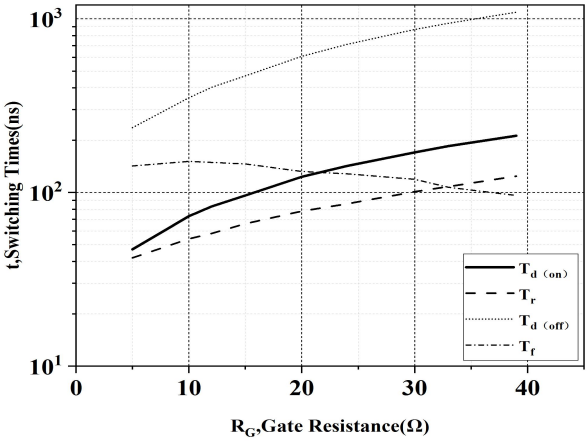


Fig.10. Typical switching times vs gate Resistor (Tj= 175°C, VCE= 600V, VGE= 15/0V, IC = 40A)

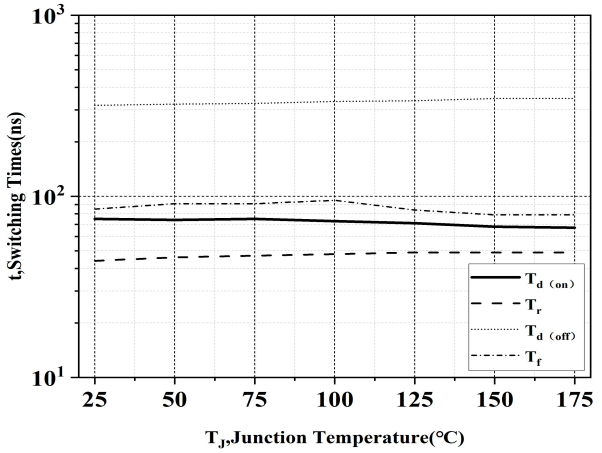


Fig.11. Typical switching times vs junction temperature

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

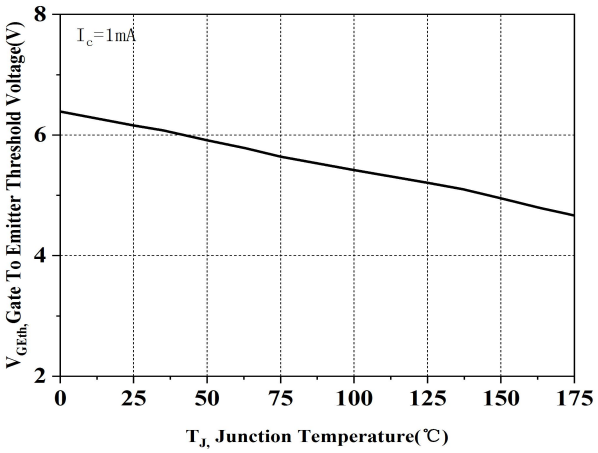


Fig.12. Gate-emitter threshold voltage vs junction temperature

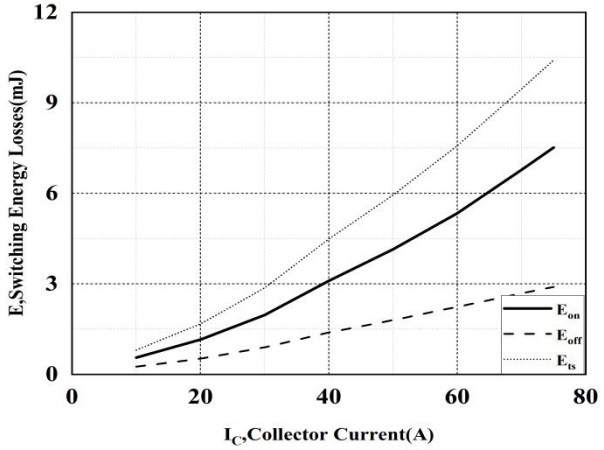


Fig.13. Typical switching energy losses as a function of collector current

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

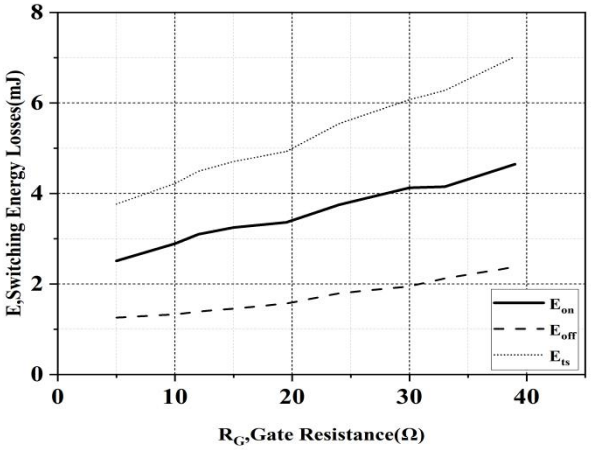


Fig.14. Typical switching energy losses as a function of gate resistor

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

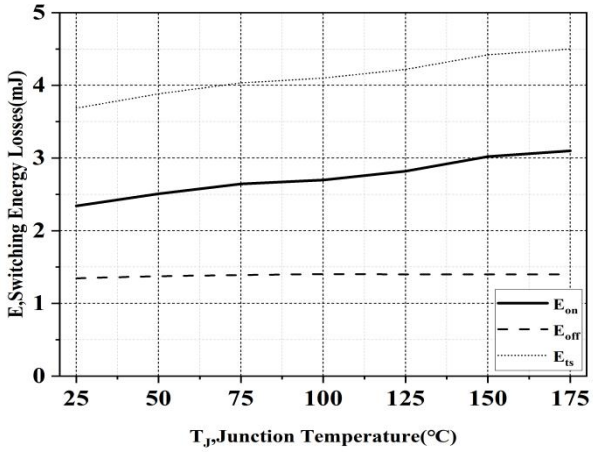


Fig.15. Typical switching energy losses as a function of junction temperature

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

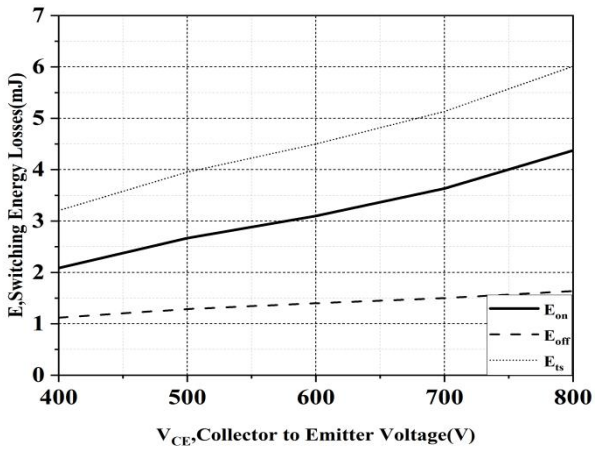


Fig.16. Typical switching energy losses as a function of collector emitter voltage

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

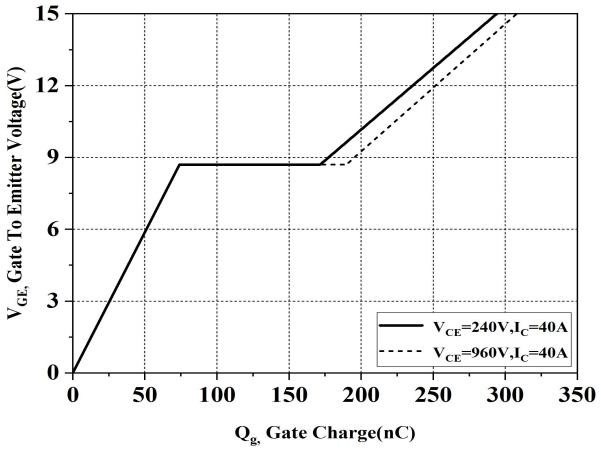


Fig.17. Typical gate charge

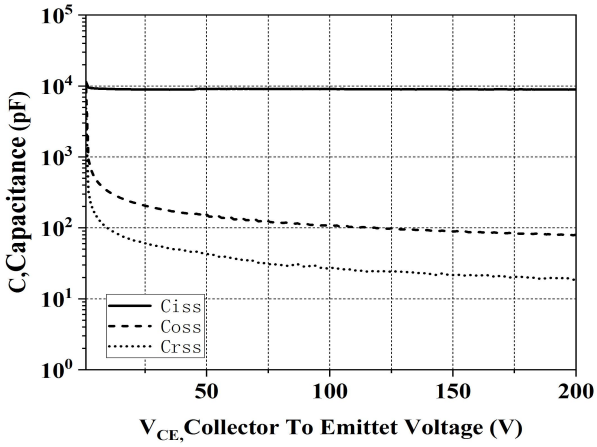


Fig.18. Typical capacitance as a function of collector-emitter voltage

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

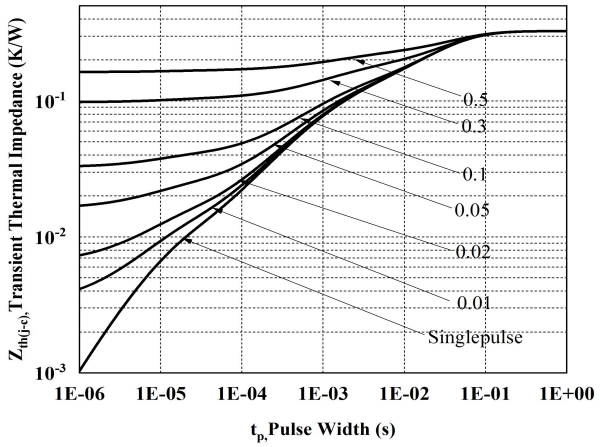


Fig.19. IGBT transient thermal impedance
(D = t_p/T)

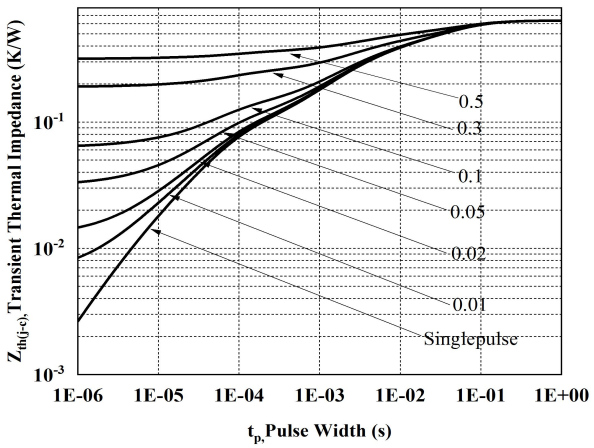


Fig.20. Transient thermal impedance of diode
(D = t_p/T)

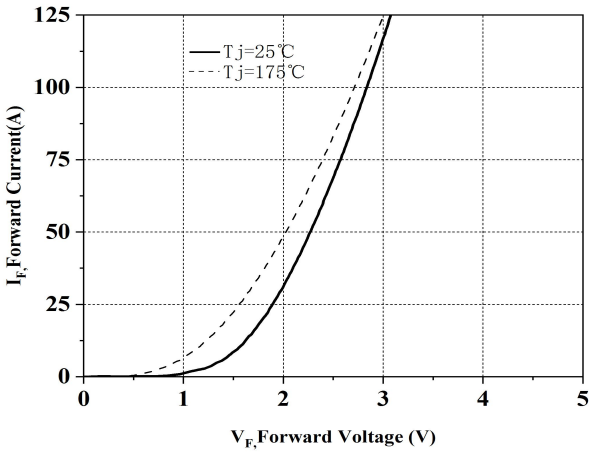


Fig.21. Typical diode forward current as a function of forward voltage

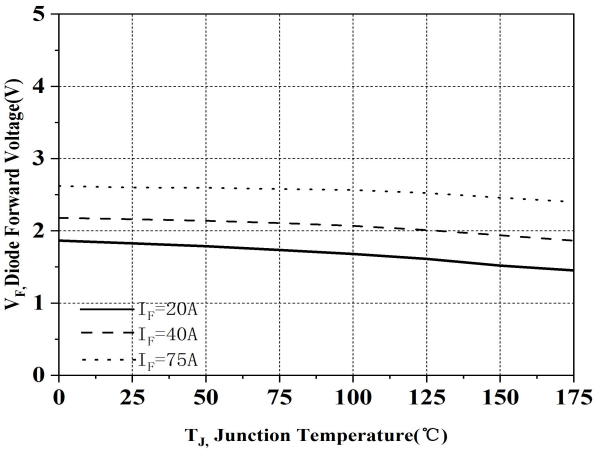


Fig.22. Typical diode forward voltage as a function of junction temperature

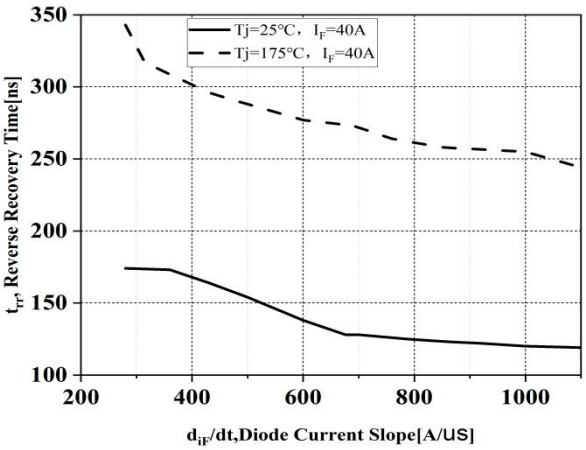


Fig.23.Typical reverse recovery time as a function of diode current slope
(VR=600V)

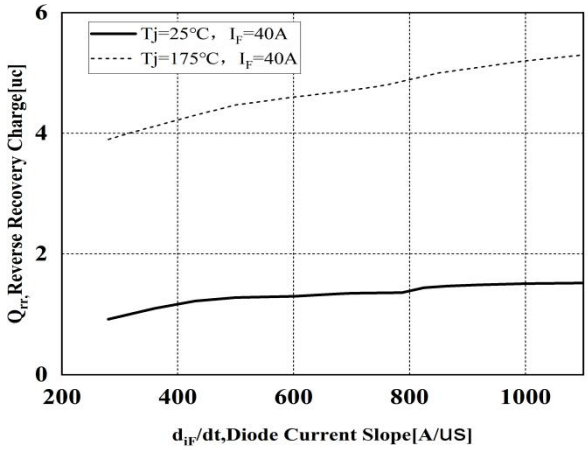


Fig.24. Typical reverse recovery charge as a function of diode current slope
(VR=600V)

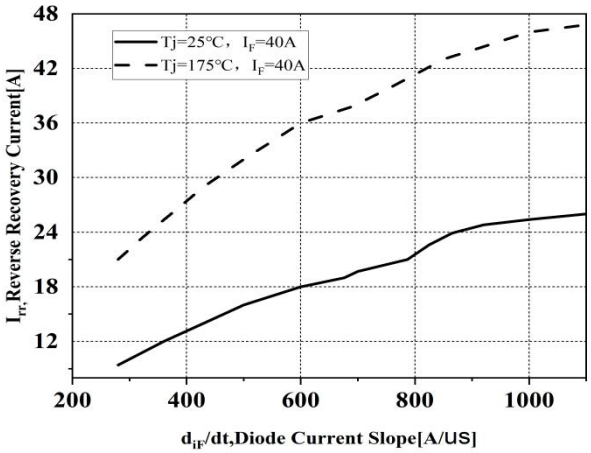


Fig.25.Typical reverse recovery current as a function of diode current slope

(VR=600V)

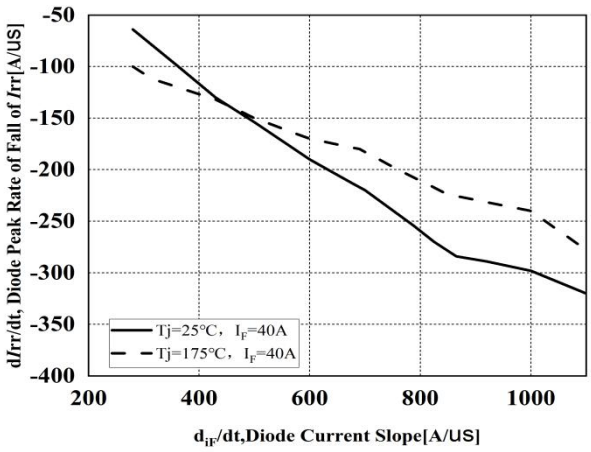
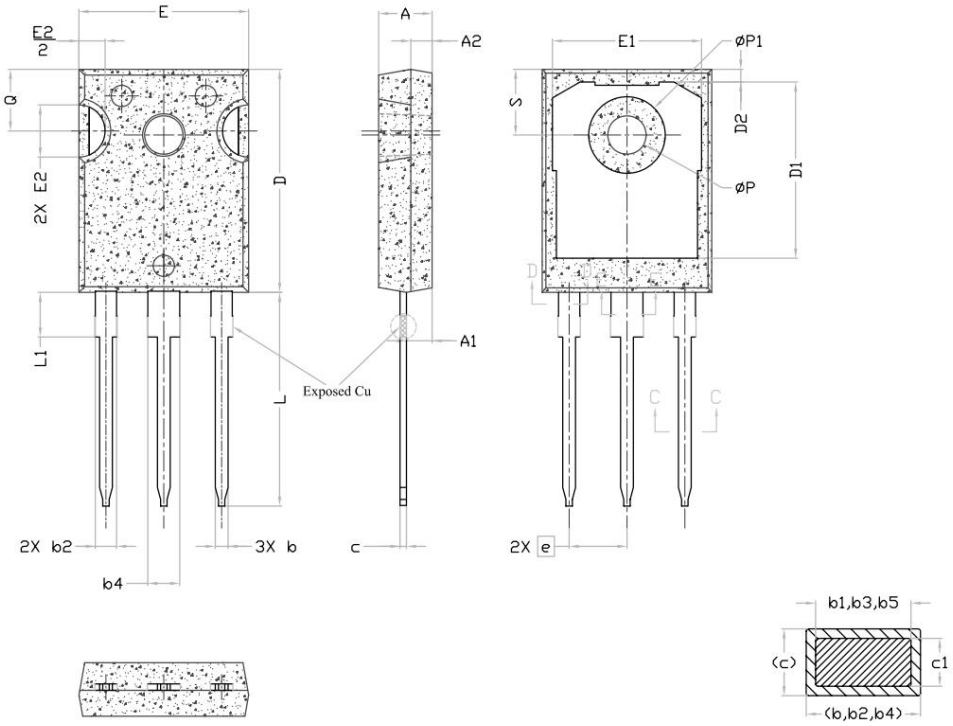


Fig.26.Typical diode peak rate of fall of reverse recovery current as a function of diode current slope

(VR=600V)

7. Package Dimensions



SYMBOL	DIMENSIONS			NOTES
	MIN.	NOM.	MAX.	
A	4.83	5.02	5.21	
A1	2.29	2.41	2.55	
A2	1.50	2.00	2.49	
b	1.12	1.20	1.33	
b1	1.12	1.20	1.28	
b2	1.91	2.00	2.39	6
b3	1.91	2.00	2.34	
b4	2.87	3.00	3.22	6, 8
b5	2.87	3.00	3.18	
c	0.55	0.60	0.69	6
c1	0.55	0.60	0.65	
D	20.80	20.95	21.10	4
D1	16.25	16.55	17.65	5
D2	0.51	1.19	1.35	
E	15.75	15.94	16.13	4
E1	13.46	14.02	14.16	5
E2	4.32	4.91	5.49	3
e	5.44BSC			
L	19.81	20.07	20.32	
L1	4.10	4.19	4.40	6
ØP	3.56	3.61	3.65	7
ØP1	7.19REF.			
Q	5.39	5.79	6.20	
S	6.04	6.17	6.30	

8. Version Information

Version No.	Date changed	Version revision record
V1.0	2023/04	Initial release