



1200V 100A High-speed IGBT

(Integrated FRD)

Preliminary

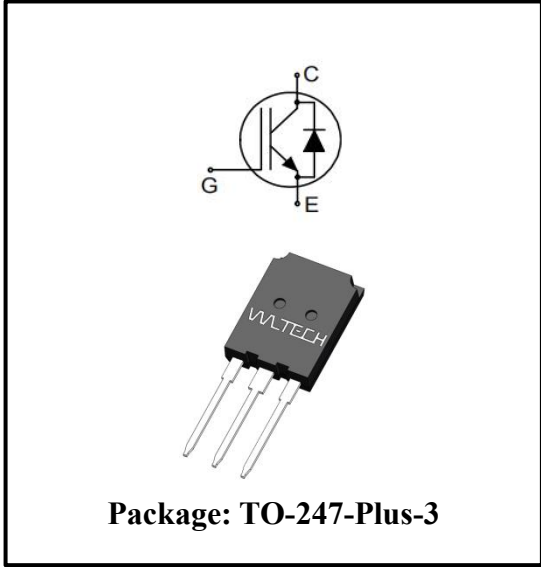
HKQ100N120SHEM

1. Product Features:

- Ultra-low switching losses
- Internal integrated fast&soft recovery anti-parallel FRD
- Maximum junction temperature 175°C
- Qualified according to JEDEC
- 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} $T_{vj} = 25^\circ\text{C}$	T_{vjmax}	Marking	Package
HKQ100N120SHEM	1200V	100A	1.55V	175°C	HKQ100N120SHEM	TO-247-Plus

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} and bond wire)	I_C	170 ($T_c = 25^\circ\text{C}$) 130 ($T_c = 100^\circ\text{C}$)	A
Pulsed collector current (t_p limited by T_{vjmax} .)	I_{Cpuls}	400	A
Turn off safe operating area ($V_{CE} \leq 1200\text{V}$, $T_{vj} \leq 175^\circ\text{C}$)	-	400	A
Diode forward current (limited by T_{vjmax})	I_F	100 ($T_c = 100^\circ\text{C}$)	A
Diode pulse current (t_p limited by T_{vjmax} .)	I_{Fpuls}	400 ($T_c = 25^\circ\text{C}$)	A
Gate-emitter voltage	V_{GE}	± 20	V
Power dissipation	P_{tot}	789.0 ($T_c = 25^\circ\text{C}$) 394.0 ($T_c = 100^\circ\text{C}$)	W
Operating junction temperature	T_{vj}	-40 to +175	$^\circ\text{C}$
Storage temperature	T_{stg}	-55 to +150	$^\circ\text{C}$
Soldering temperature, (wave soldering 1.6mm from case for 10s)		260	$^\circ\text{C}$

5. Thermal Properties

Tab.3. Thermal Properties

Parameters	Symbol	Max. value	Unit
IGBT thermal resistance (junction - case)	$R_{th(j-c)}$	0.19	$^\circ\text{C}/\text{W}$
Diode thermal resistance (junction - case)	$R_{th(j-c)}$	0.26	$^\circ\text{C}/\text{W}$
Thermal resistance (junction – ambient)	$R_{th(j-a)}$	40	$^\circ\text{C}/\text{W}$

6. Electrical Characteristics

Tab.4. Static Characteristic ($T_{vj} = 25^{\circ}\text{C}$, unless otherwise specified)

Parameters	Symbol	Conditions	Min. value	Typ. value	Max. value	Unit
Collector-emitter breakdown voltage	$V_{(BR)CES}$	$V_{GE} = 0\text{V}$	1200	-	-	V
Collector-emitter saturation voltage	V_{CEsat}	$V_{GE} = 15\text{V}, I_C = 100\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	- -	1.55 2.05	2.15 -	V
Diode forward voltage	V_F	$V_{GE} = 0\text{V}, I_F = 100\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	- -	2.64 2.14	3.1 -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C = 1.60\text{mA}, V_{CE} = V_{GE}$	4.7	5.5	6.2	V
Zero gate voltage collector current	I_{CES}	$V_{CE} = 1200\text{V}, V_{GE} = 0\text{V}$ $T_{vj} = 25^{\circ}\text{C}$	-	-	100	μA
Gate-emitter leakage current	I_{GES}	$V_{CE} = 0\text{V}, V_{GE} = 20\text{V}$	-	-	200	nA
Internal Gate Resistance	$R_{G(int)}$	$f = 1\text{MHz}, V_{ac} = 10\text{mV}$	-	8.3	-	Ω

Tab.5. Dynamic Characteristic ($T_{vj} = 25^{\circ}\text{C}$, unless otherwise specified)

Parameters	Symbol	Conditions	Min. value	Typ. value	Max. value	Unit
Input capacitance	C_{ies}	$V_{CE} = 25\text{V}, V_{GE} = 0\text{V}$ $f = 100\text{kHz}$	-	8736	-	pF
Output capacitance	C_{oes}		-	331	-	
Reverse transfer capacitance	C_{res}		-	45	-	
Gate-charge	Q_g	$V_{CE} = 960\text{V}, I_C = 100\text{A},$ $V_{GE} = 15\text{V}$	-	335	-	nC

Tab.6. Switching Characteristic (Inductive load)

Parameters	Symbol	Conditions	Min. value	Typ. value	Max. value	Unit
IGBT Characteristic, at $T_{vj} = 25^{\circ}\text{C}$						
Turn-on delay time	$t_{d(on)}$	$T_{vj} = 25^{\circ}\text{C}$, $V_{CC} = 600\text{V}$, $I_C = 100\text{A}$, $V_{GE} = 0.0/15.0\text{V}$, $R_{G(on)} = 2.0\Omega$ $R_{G(off)} = 2.0\Omega$ Inductive load	-	63	-	ns
Rise time	t_r		-	28	-	
Turn-off delay time	$t_{d(off)}$		-	409	-	
Fall time	t_f		-	42	-	
Turn-on energy	E_{on}	Energy losses include "tail" and diode reverse recovery.	-	4.44	-	mJ
Turn-off energy	E_{off}		-	3.32	-	
Total switching energy	E_{ts}		-	7.75	-	
IGBT Characteristic, at $T_{vj} = 25^{\circ}\text{C}$						
Turn-on delay time	$t_{d(on)}$	$T_{vj} = 25^{\circ}\text{C}$, $V_{CC} = 600\text{V}$, $I_C = 50\text{A}$, $V_{GE} = 0.0/15.0\text{V}$, $R_{G(on)} = 2.0\Omega$ $R_{G(off)} = 2.0\Omega$ Inductive load	-	57	-	ns
Rise time	t_r		-	23	-	
Turn-off delay time	$t_{d(off)}$		-	420	-	
Fall time	t_f		-	30	-	
Turn-on energy	E_{on}	Energy losses include "tail" and diode reverse recovery.	-	1.4	-	mJ
Turn-off energy	E_{off}		-	1.38	-	
Total switching energy	E_{ts}		-	2.78	-	
Diode Characteristic, at $T_{vj} = 25^{\circ}\text{C}$						
Diode reverse recovery time	t_{rr}	$T_{vj} = 25^{\circ}\text{C}$, $V_R = 600\text{V}$, $I_F = 100\text{A}$, $R_{G(on)} = 2.0\Omega$	-	230	-	ns
Diode reverse recovery charge	Q_{rr}		-	3.46	-	μC
Diode peak reverse recovery current	I_{rrm}		-	38	-	A
Diode peak rate of fall of reverse Recovery current during tb	di_{rr}/dt		-	-2200	-	A/ μs

Diode reverse recovery time	t_{rr}	$T_{vj} = 25^{\circ}\text{C},$ $V_R = 600\text{V},$ $I_F = 50\text{A},$ $R_{G(on)} = 2.0\Omega$	-	29	-	ns
Diode reverse recovery charge	Q_{rr}		-	1.09	-	μC
Diode peak reverse recovery current	I_{rrm}		-	62	-	A
Diode peak rate of fall of reverse Recovery current during tb	di_{rr}/dt		-	-5000	-	A/ μs

Tab.7. Switching Characteristic (Inductive load)

Parameters	Symbol	Conditions	Min. value	Typ. value	Max. value	Unit
IGBT Characteristic, at $T_{vj} = 175^{\circ}\text{C}$						
Turn-on delay time	$t_{d(on)}$	$T_{vj} = 175^{\circ}\text{C},$ $V_{CC} = 600\text{V}, I_C = 100\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(on)} = 2.0\Omega$ $R_{G(off)} = 2.0\Omega$ Inductive load	-	63	-	ns
Rise time	t_r		-	34	-	
Turn-off delay time	$t_{d(off)}$		-	532	-	
Fall time	t_f		-	87	-	
Turn-on energy	E_{on}	Energy losses include “tail” and diode reverse recovery.	-	6.6	-	mJ
Turn-off energy	E_{off}		-	4.75	-	
Total switching energy	E_{ts}		-	11.35	-	
Diode Characteristic, at $T_{vj} = 175^{\circ}\text{C}$						
Turn-on delay time	$t_{d(on)}$	$T_{vj} = 175^{\circ}\text{C},$ $V_{CC} = 600\text{V}, I_C = 50\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(on)} = 2.0\Omega$ $R_{G(off)} = 2.0\Omega$ Inductive load	-	57	-	ns
Rise time	t_r		-	26	-	
Turn-off delay time	$t_{d(off)}$		-	546	-	
Fall time	t_f		-	72	-	
Turn-on energy	E_{on}	Energy losses include “tail” and diode reverse recovery.	-	2.52	-	mJ
Turn-off energy	E_{off}		-	2.13	-	
Total switching energy	E_{ts}		-	4.65	-	

Diode reverse recovery time	t_{rr}	$T_{vj} = 175^{\circ}\text{C},$ $V_R = 600\text{V},$ $I_F = 100\text{A},$ $R_{G(on)} = 2.0\Omega$	-	420	-	ns
Diode reverse recovery charge	Q_{rr}		-	13.3	-	μC
Diode peak reverse recovery current	I_{rrm}		-	80	-	A
Diode peak rate of fall of reverse Recovery current during tb	di_{rr}/dt		-	-800	-	A/ μs
Diode reverse recovery time	t_{rr}	$T_{vj} = 175^{\circ}\text{C},$ $V_R = 600\text{V},$ $I_F = 50\text{A},$ $R_{G(on)} = 2.0\Omega$	-	274	-	ns
Diode reverse recovery charge	Q_{rr}		-	9.3	-	μC
Diode peak reverse recovery current	I_{rrm}		-	84	-	A
Diode peak rate of fall of reverse Recovery current during tb	di_{rr}/dt		-	-915	-	A/ μs

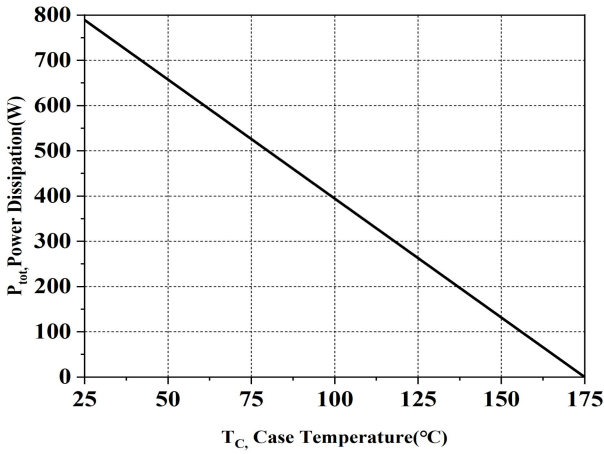


Fig.1. Power dissipation as a function of case temperature ($T_j \leq 175^\circ\text{C}$)

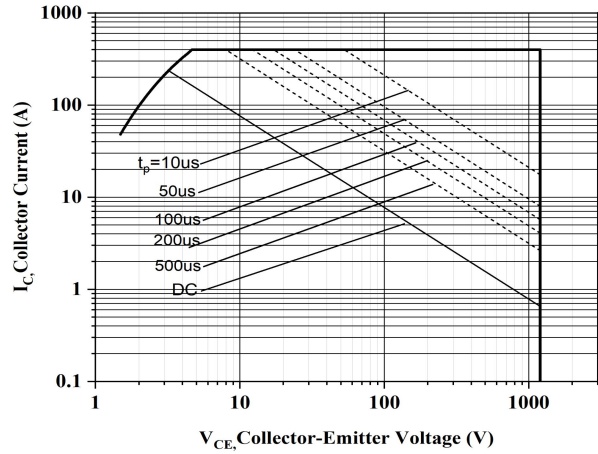


Fig.2. Forward bias safe operating area ($D = 0, T_C = 25^\circ\text{C}, T_j \leq 175^\circ\text{C}, V_{GE} = 15\text{V}$)

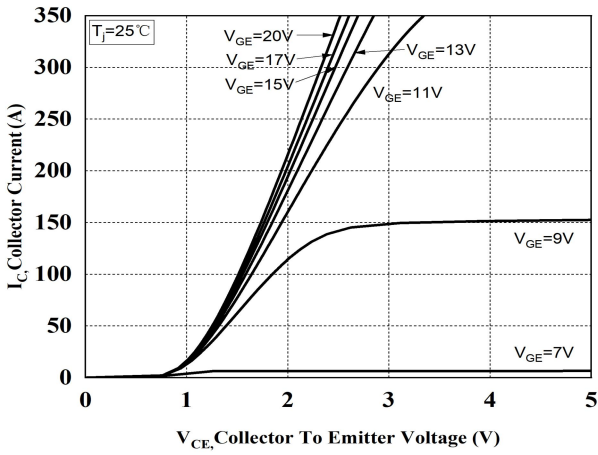


Fig.3. Typical output characteristics ($T_j = 25^\circ\text{C}$)

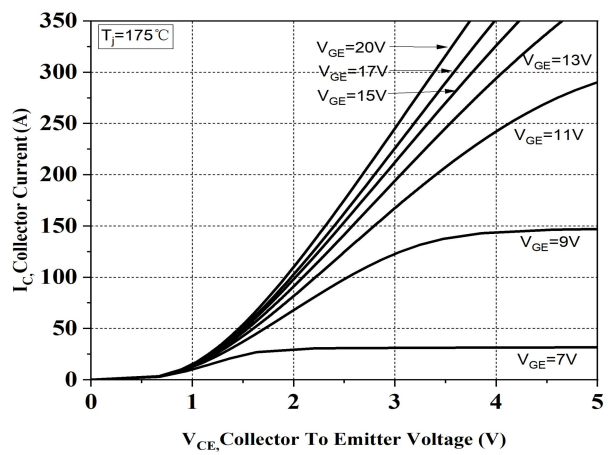


Fig.4. Typical output characteristics ($T_j = 175^\circ\text{C}$)

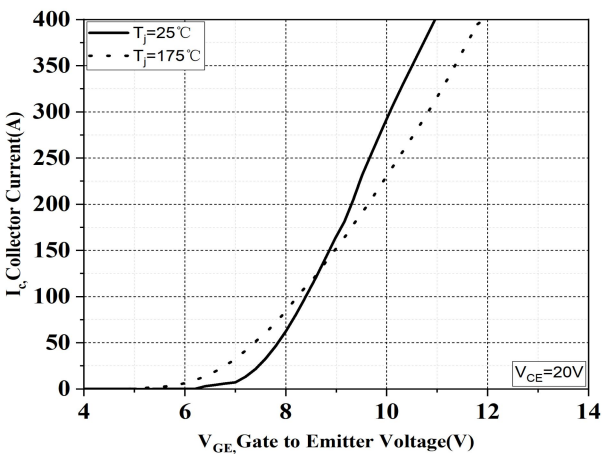


Fig.5. Typical transfer characteristic

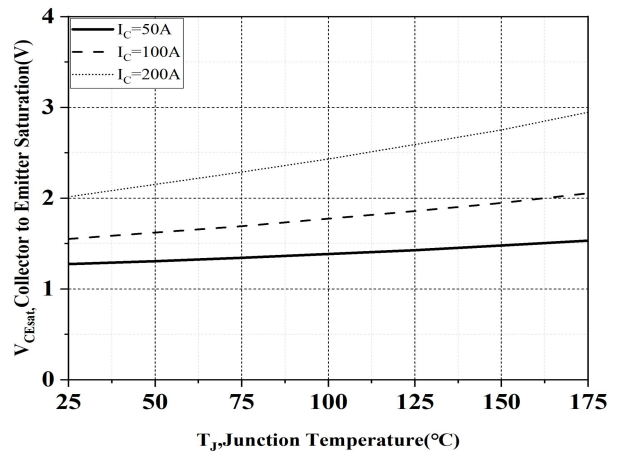


Fig.6. Typical collector-emitter saturation voltage vs. junction temperature ($V_{GE} = 15\text{V}$)

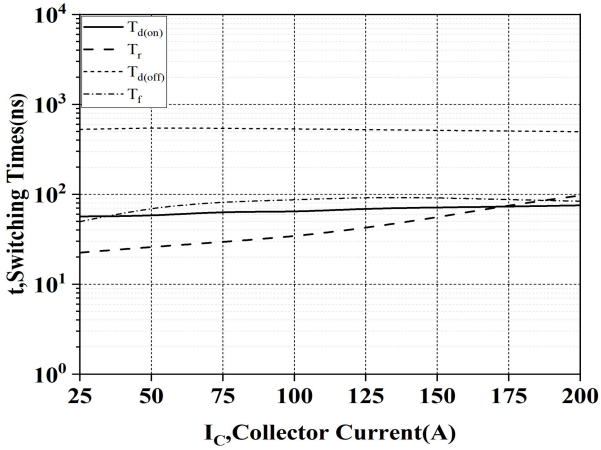


Fig.7. Typical switching times vs. collector current
($T_j = 175^\circ\text{C}$, $V_{CE} = 600\text{V}$, $V_{GE} = 15/0\text{V}$)

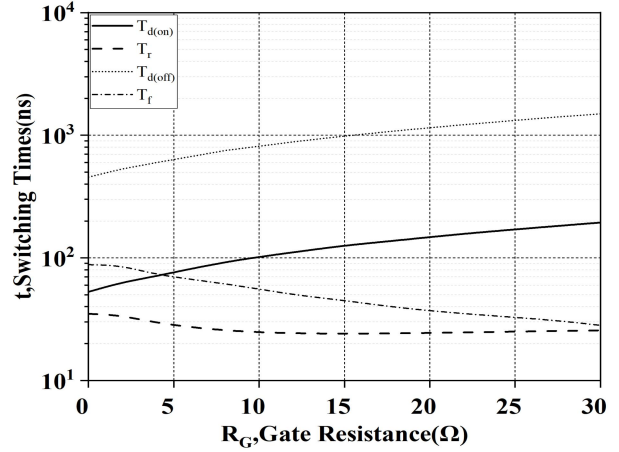


Fig.8. Typical switching times vs. gate Resistor

($T_j = 175^\circ\text{C}$, $V_{CE} = 600\text{V}$, $V_{GE} = 15/0\text{V}$, $I_C = 100\text{A}$)

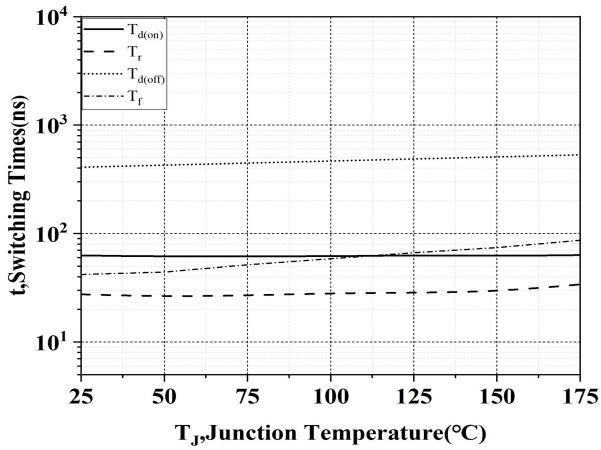


Fig.9. Typical switching times vs. junction temperature

($V_{CE} = 600\text{V}$, $V_{GE} = 15/0\text{V}$, $I_C = 100\text{A}$)

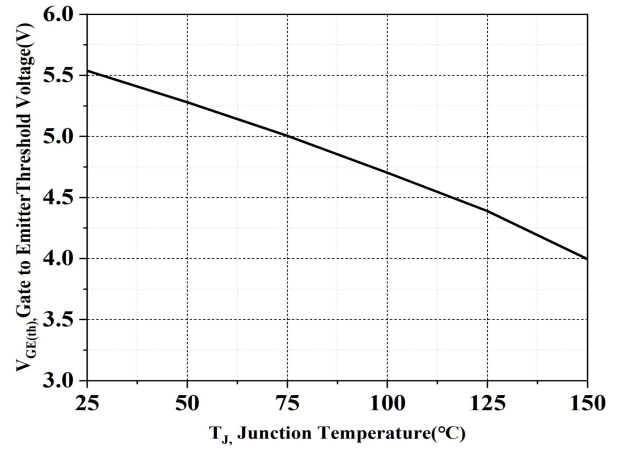


Fig.10. Gate-emitter threshold voltage vs. junction temperature

($I_C = 1.6\text{mA}$)

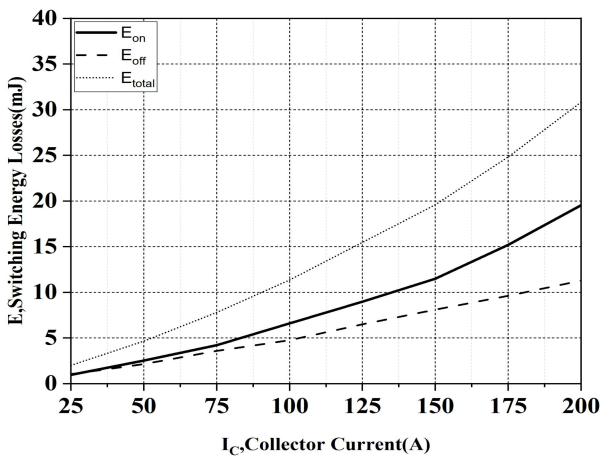


Fig.11. Typical switching energy losses as a function of collector current

($T_j = 175^\circ\text{C}$, $V_{CE} = 600\text{V}$, $V_{GE} = 15/0\text{V}$)

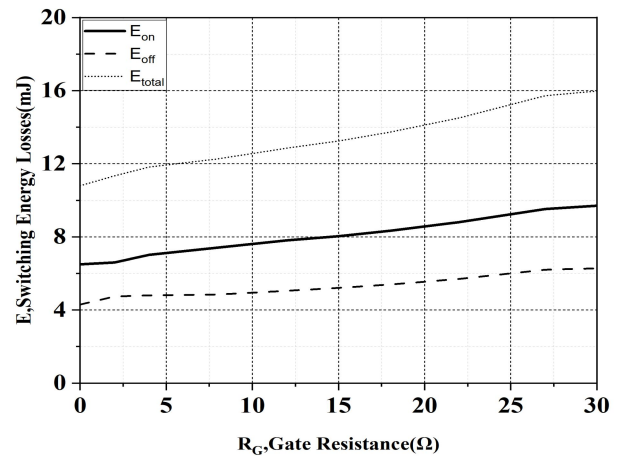


Fig.12. Typical switching energy losses as a function of gate resistor

($T_j = 175^\circ\text{C}$, $V_{CE} = 600\text{V}$, $V_{GE} = 15/0\text{V}$, $I_C = 100\text{A}$)

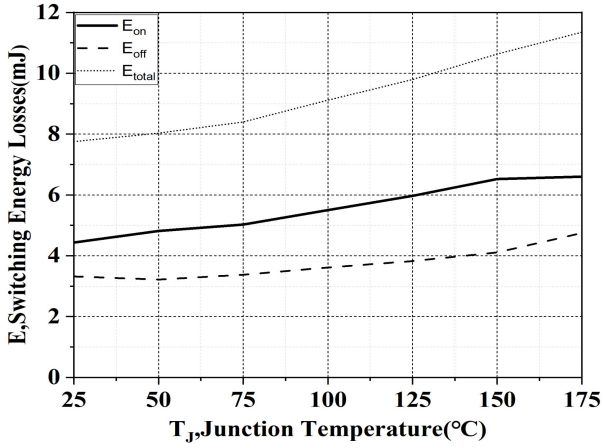


Fig.13. Typical switching energy losses as a function of junction temperature

(Inductive load, $V_{CE} = 600V$, $V_{GE} = 15/0V$, $I_C = 100A$)

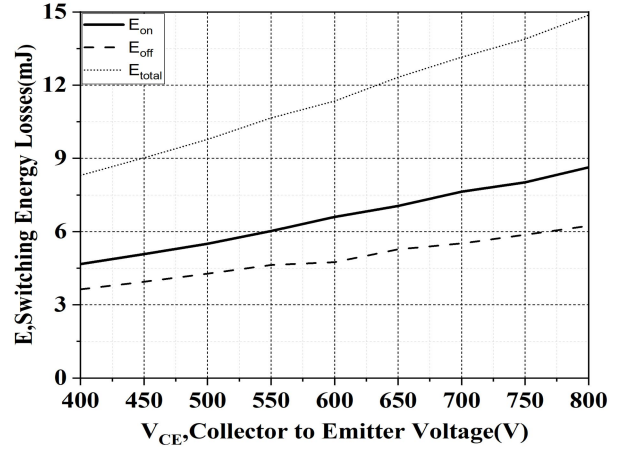


Fig.14. Typical switching energy losses as a function of collector emitter voltage

(Inductive load, $T_j = 175^\circ C$, $V_{GE} = 15/0V$, $I_C = 100A$)

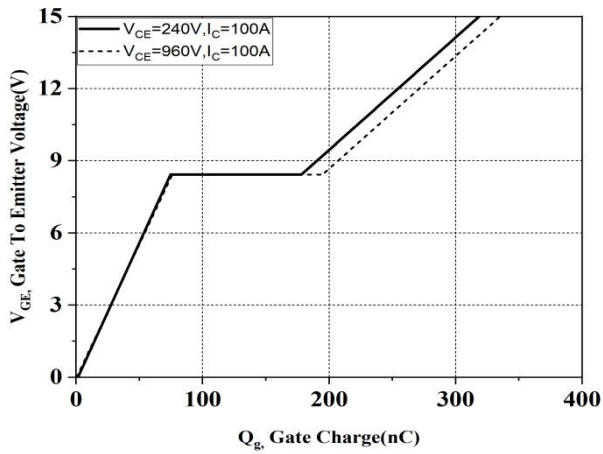


Fig.15. Typical gate charge

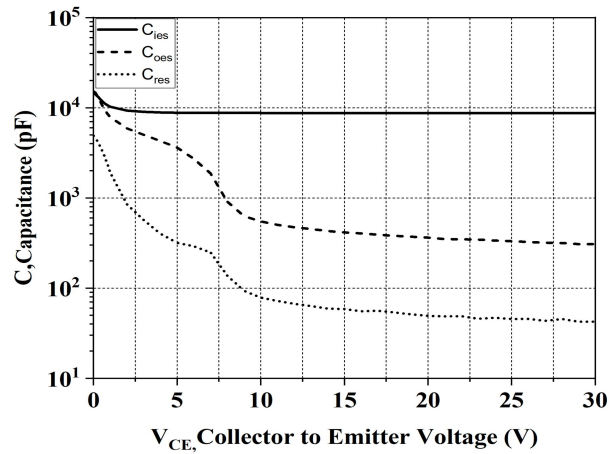


Fig.16. Typical capacitance as a function of collector-emitter voltage
($V_{GE} = 0V, f = 100KHz$)

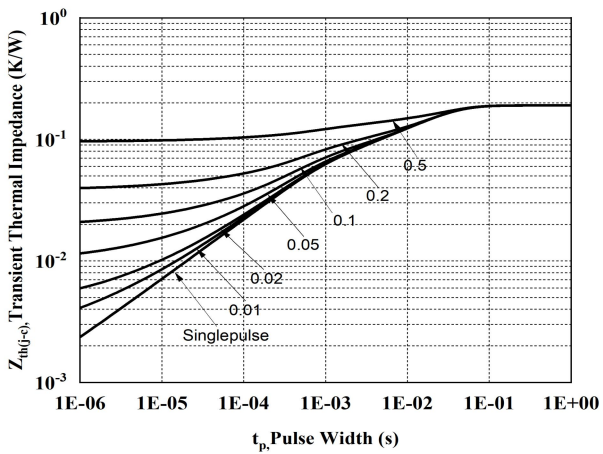


Fig.17. IGBT transient thermal impedance
($D = t_p/T$)

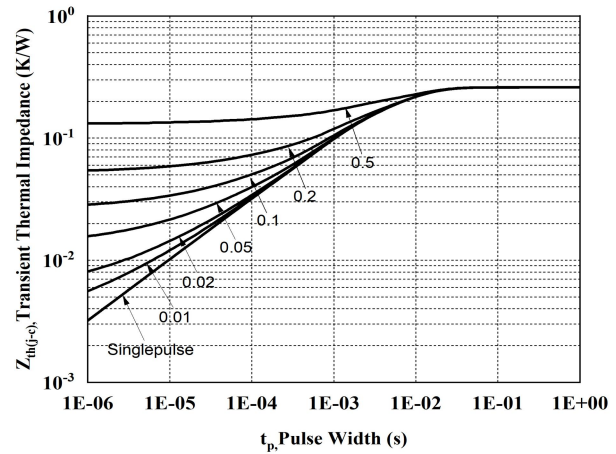


Fig.18. Transient thermal impedance of diode
($D = t_p/T$)

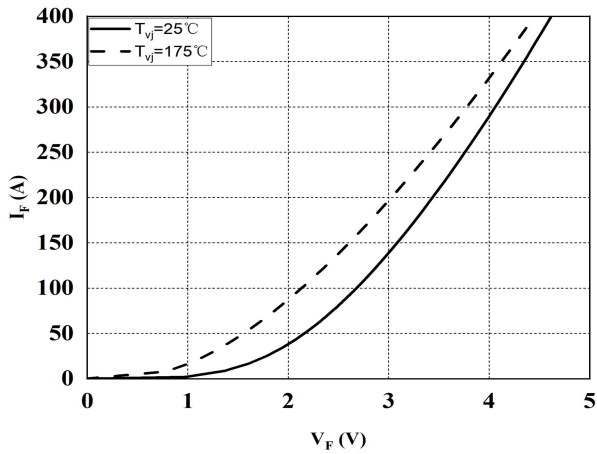


Fig.19. Typical diode forward current as a function of forward voltage

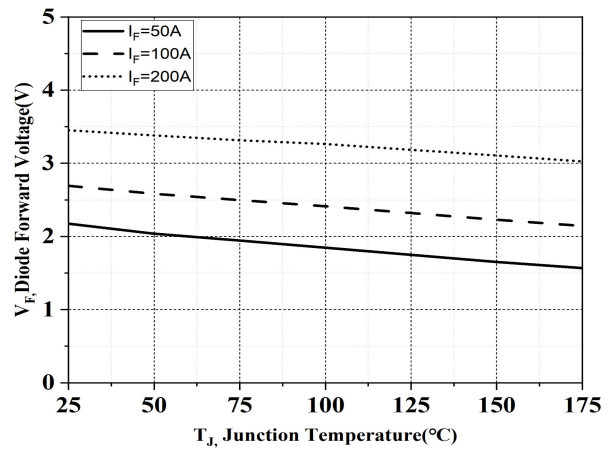


Fig.20. Typical diode forward voltage as a function of junction temperature

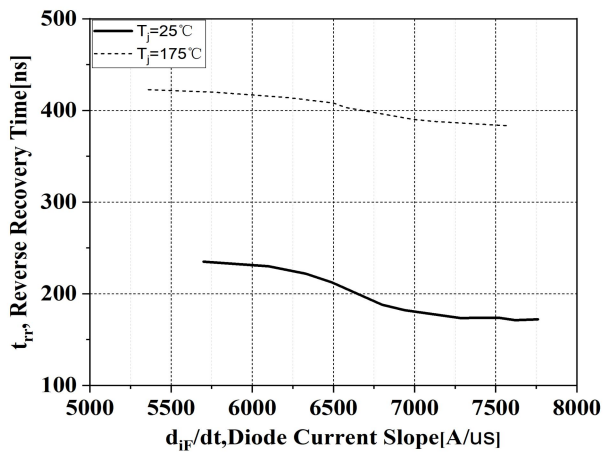


Fig.21. Typical reverse recovery time as a function of diode current slope (VR=600V)

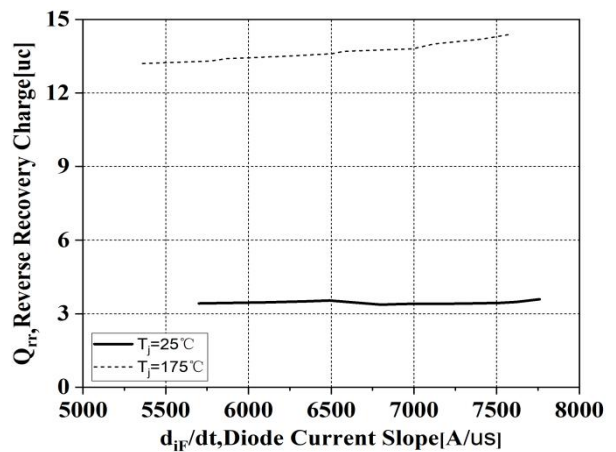


Fig.22. Typical reverse recovery charge as a function of diode current slope (VR=600V)

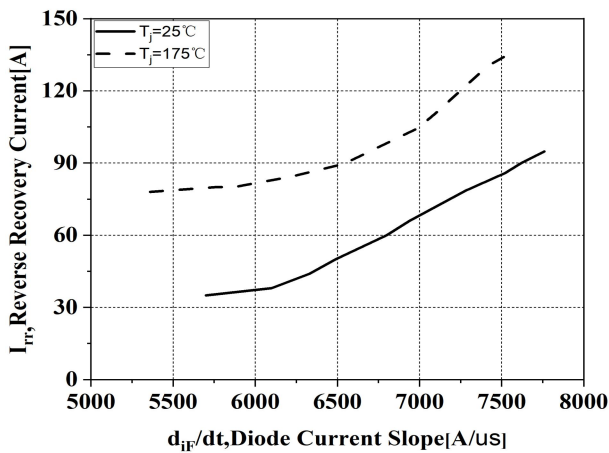


Fig.23. Typical reverse recovery current as a function of diode current slope (VR=600V)

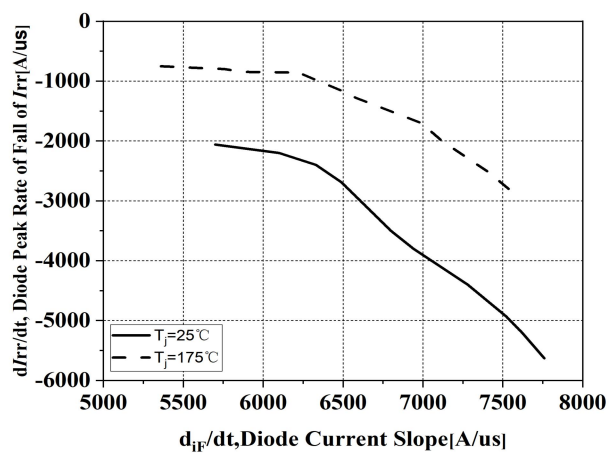
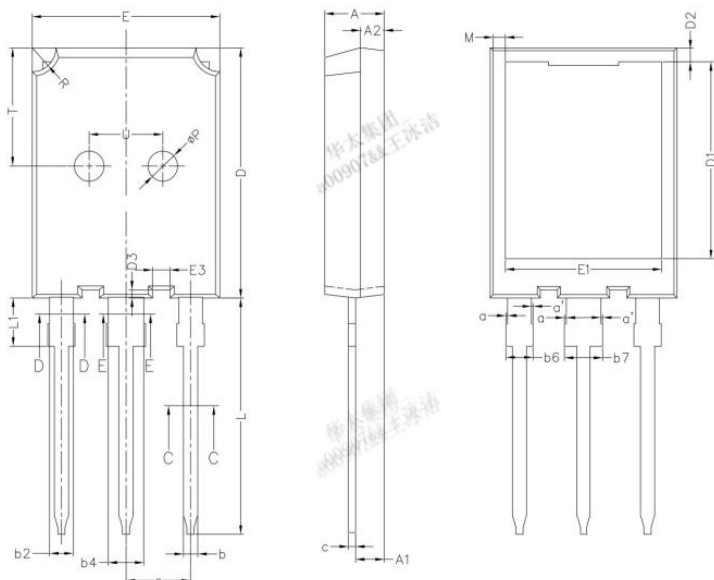


Fig.24. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope (VR=600V)

7. Package Dimensions



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
a	0	-	0.15
a'	0	-	0.15
b	1.16	-	1.26
b1	1.15	1.2	1.22
b2	1.96	-	2.06
b3	1.95	2.00	2.02
b4	2.96	-	3.06
b5	2.95	3.00	3.02
b6	-	-	2.25
b7	-	-	3.25
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	1.17	1.35
D3	0.58	0.68	0.78
E	15.70	15.80	15.90
E1	13.10	13.26	13.50
E3	1.35	1.45	1.55
e	5.34	5.44	5.54
L	19.80	19.92	20.10
L1	3.90	-	4.30
M	0.70	-	1.30
P	2.40	2.50	2.60
R	1.90	2.00	2.10
T	9.80	-	10.20
U	6.00	-	6.40

8. Version Information

Version No.	Date changed	Version revision record
V1.0	2024/04	Preliminary version