High-speed IGBT Power Transistor

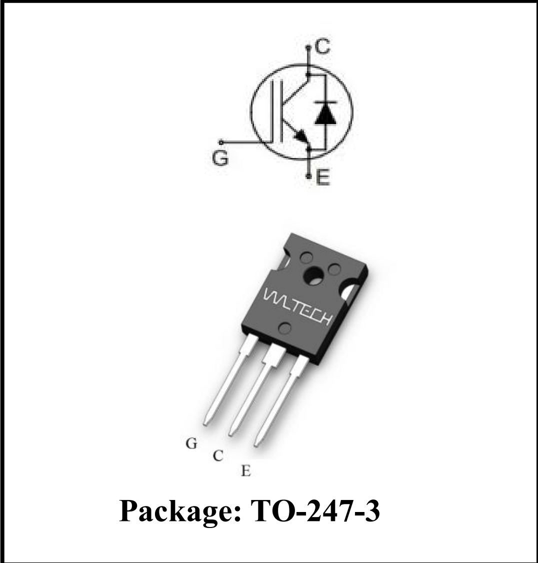
(Integrated FRD)

Preliminary

AHKW75N65SHEL

1. Product Features:

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



Package: TO-247-3

2. Product Applications

- Automotive HEV−EV Onboard Chargers
- Automotive HEV−EV DC−DC Converters
- Totem Pole Bridgeless PFC

3. Typical Performance Parameters

Tab.1. Typical Performance Parameters

Type	V_{CE}	I_C	V_{CEsat} T_{vj} = 25°C	T_{vjmax}	Marking	Package
AHKW75N65SHEL	650V	75A	1.65V	175°C	AHKW75N65SHEL	TO-247-3

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4. Maximum Ratings

Tab.2. Maximum Ratings

Parameters	Symbol	Value	Unit
Collector-emitter voltage, $Tvj \geq 25°C$	V_{CE}	650	V
DC collector current (limited by T_{vjmax})	I_C	90(T_c = 25°C） 75(T_c = 100°C）	A
Pulsed collector current (t_p limited by $T_{vjmax.}$)	I_{Cpuls}	300	A
Diode forward current (limited by T_{vjmax})	I_F	75(T_c = 100°C）	A
Diode pulse current (t_p limited by $T_{vjmax.}$）	I_{Fpuls}	300(T_c = 25°C)	A
Gate-emitter voltage	V_{GE}	±20	V
Transient Gate-emitter voltage (tp ≤ 10μs，D < 0.0100)		±30	V
Power dissipation	P_{tot}	484(T_c = 25°C） 242(T_c = 100°C）	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)	$R_{th(j-c)}$	0.31	°C/W
Diode thermal resistance (junction - case)	$R_{th(j-c)}$	0.38	°C/W
Thermal resistance (junction – ambient)	$R_{th(j-a)}$	40	°C/W

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6. Electrical Characteristics

Tab.4. Static Characteristic (T_{vj} = 25°C, 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	650	-	-	V
Collector-emitter saturation voltage	V_{CEsat}	V_{GE}= 15V, I_C= 75A T_{vj}= 25°C T_{vj}= 175°C	- -	1.65 2.2	2.1 -	V
Diode forward voltage	V_F	V_{GE}= 0V, I_F= 75A T_c = 25°C T_c= 175°C	- -	1.49 1.32	2.1 -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	I_C=0.75mA, V_{CE}= V_{GE}	3.4	5.45	6.4	V
Zero gate voltage collector current	I_{CES}	V_{CE}= 1200V, V_{GE}= 0V T_{vj}= 25°C	-	-	250	µA
Gate-emitter leakage current	I_{GES}	V_{CE}= 0V, V_{GE}= 20V	-	-	400	nA

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

Parameters	Symbol	Conditions	Min. value	Typ. value	Max. value	Unit
Input capacitance	C_{ies}	V_{CE}= 30V, V_{GE}= 0V f = 1MHz	-	2886	-	pF
Output capacitance	C_{oes}		-	233	-	
Reverse transfer capacitance	C_{res}		-	44	-	
Gate-charge	Q_g	V_{CE}= 400V, I_C= 75.0A, V_{GE}= 15V	-	112	-	nC
Gate−to−emitter charge	Qge		-	23	-	nC
Gate−to−collector charge	Qgc		-	47	-	nC

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Tab.6. Switching Characteristic (Inductive load)

Parameters	Symbol	Conditions	Min. value	Typ. value	Max. value	Unit
IGBT Characteristic， at T_c= 25°C						
Turn-on delay time	$t_{d(on)}$	T_c = 25°C, V_{CC} = 400V, I_C = 37.5A, V_{GE} = 0.0/15.0V, *Rgon=4.7 Ω， Rgoff=4.7 Ω* Inductive load	-	26	-	ns
Rise time	t_r		-	24	-	
Turn-off delay time	$t_{d(off)}$		-	155	-	
Fall time	t_f		-	60	-	
Turn-on energy	E_{on}		-	1.104	-	mJ
Turn-off energy	E_{off}		-	0.333	-	
Total switching energy	E_{ts}		-	1.437	-	
Turn-on delay time	$t_{d(on)}$	T_c = 25°C, V_{CC} = 400V, I_C = 75.0A, V_{GE} = 0.0/15.0V, *Rgon=4.7 Ω， Rgoff=4.7 Ω* Inductive load	-	31	-	ns
Rise time	t_r		-	52	-	
Turn-off delay time	$t_{d(off)}$		-	147	-	
Fall time	t_f		-	38	-	
Turn-on energy	E_{on}		-	2.751	-	mJ
Turn-off energy	E_{off}		-	0.842	-	
Total switching energy	E_{ts}		-	3.59	-	
Diode Characteristic， at T_c= 25°C						
Diode reverse recovery time	t_{rr}	T_c = 25°C, I_F =75.0A, di_F/dt = 1000A/us	-	108	-	ns
Diode reverse recovery charge	Q_{rr}		-	1521	-	nC

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Tab.7. Switching Characteristic (Inductive load)

Parameters	Symbol	Conditions	Min. value	Typ. value	Max. value	Unit
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	T_c = 175°C, V_{CC} = 400V, I_C = 37.5A, V_{GE} = 0.0/15.0V, *Rgon=4.7 Ω， Rgoff=4.7 Ω* Inductive load	-	28	-	ns
Rise time	t_r		-	28	-	
Turn-off delay time	$t_{d(off)}$		-	215	-	
Fall time	t_f		-	81	-	
Turn-on energy	E_{on}		-	1.365	-	mJ
Turn-off energy	E_{off}		-	0.584	-	
Total switching energy	E_{ts}		-	1.949	-	
Turn-on delay time	$t_{d(on)}$	T_c = 175°C, V_{CC} = 400V, I_C = 75.0A, V_{GE} = 0.0/15.0V, *Rgon=4.7 Ω， Rgoff=4.7 Ω* Inductive load	-	33	-	ns
Rise time	t_r		-	55	-	
Turn-off delay time	$t_{d(off)}$		-	190	-	
Fall time	t_f		-	57	-	
Turn-on energy	E_{on}		-	3.433	-	mJ
Turn-off energy	E_{off}		-	1.263	-	
Total switching energy	E_{ts}		-	4.696	-	
Diode Characteristic						
Diode reverse recovery time	t_{rr}	T_c = 175°C, I_F=75.0A, di_F/dt = 1000A/s	-	195	-	ns
Diode reverse recovery charge	Q_{rr}		-	7169	-	nC
Reverse Recovery Energy	*Erec*		-	1.36	-	mJ

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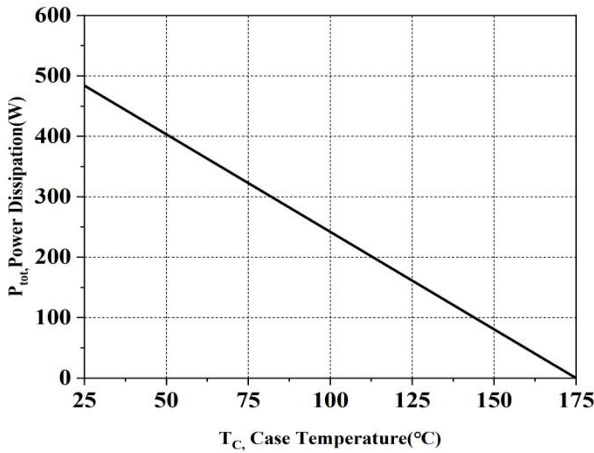

Fig.1. Power dissipation as a function of case temperature (T_j≤ 175°C)

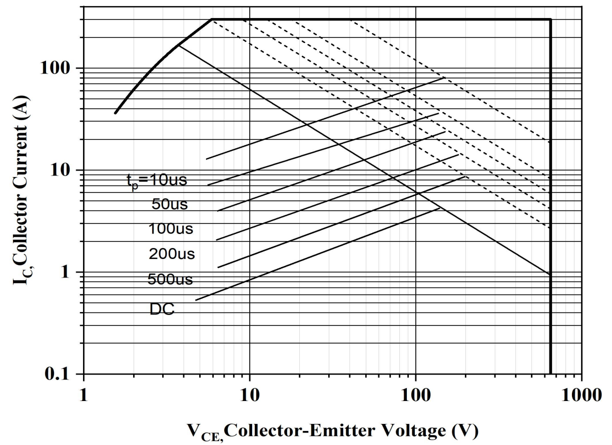

Fig.2. Forward bias safe operating area (D = 0, T_C= 25°C, T_j≤ 175°C, V_{GE}= 15V)

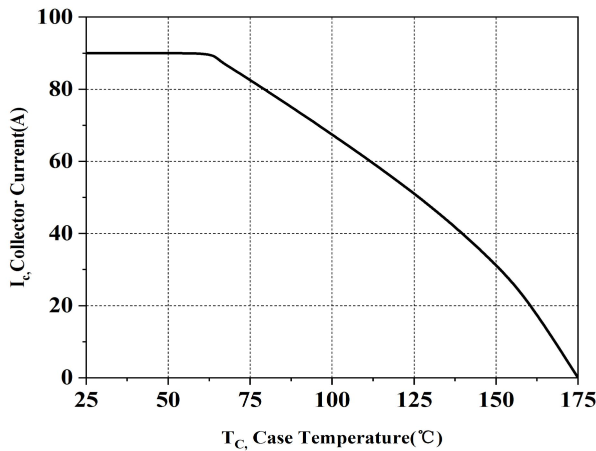

Fig.3. Collector current as a function of case temperature (V_{GE}≥ 15V,T_j≤ 175°C)

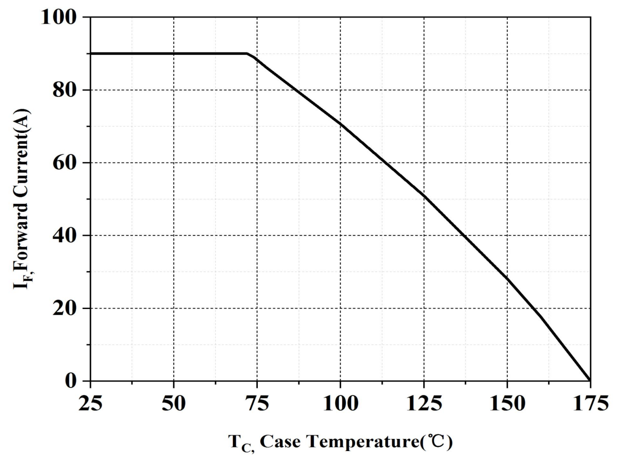

Fig.4. Diode Forward current as a function of case temperature

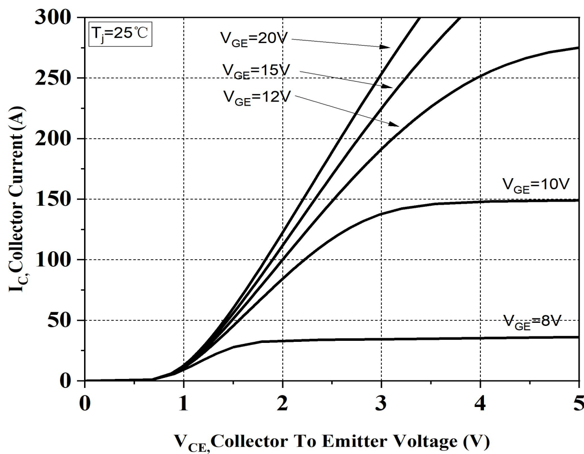

Fig.5. Typical output characteristics (T_j= 25°C)

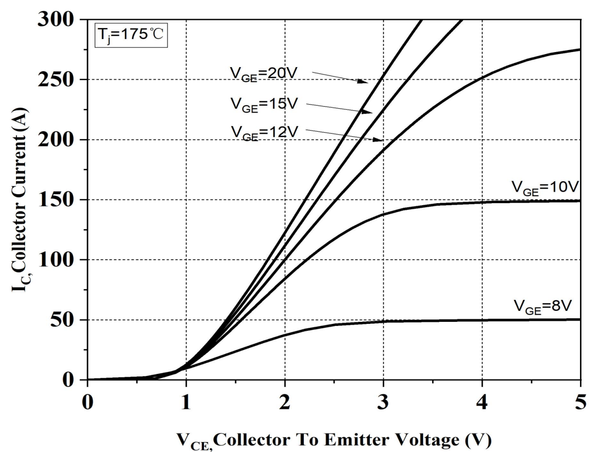

Fig.6. Typical output characteristics (T_j= 175°C)

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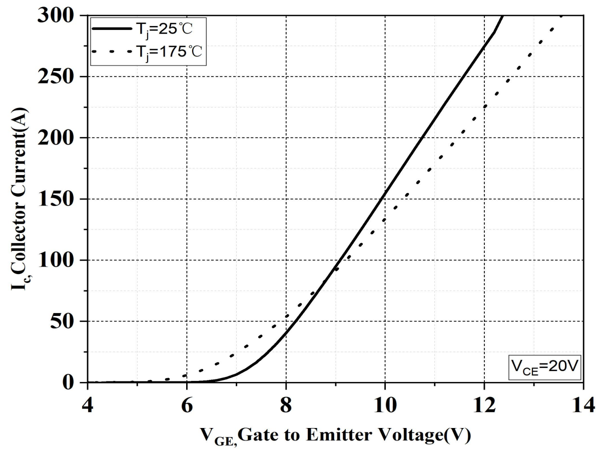

Fig.7. Typical transfer characteristic

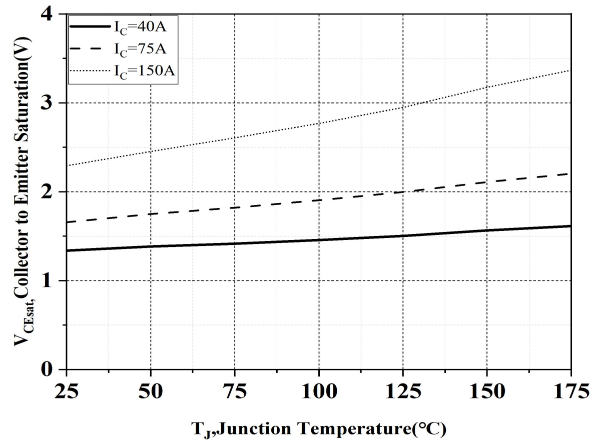

Fig.8. Typical collector-emitter saturation voltage vs. junction temperature (V_{GE}=15V)

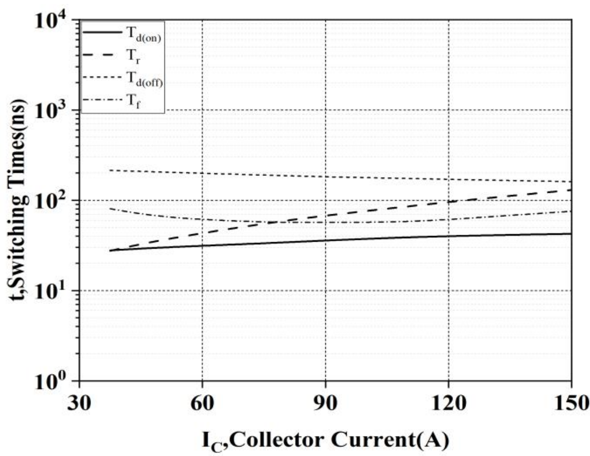

Fig.9. Typical switching times vs. collector current

(T_j= 175°C, V_{CE}= 400V, V_{GE}= 15/0V)

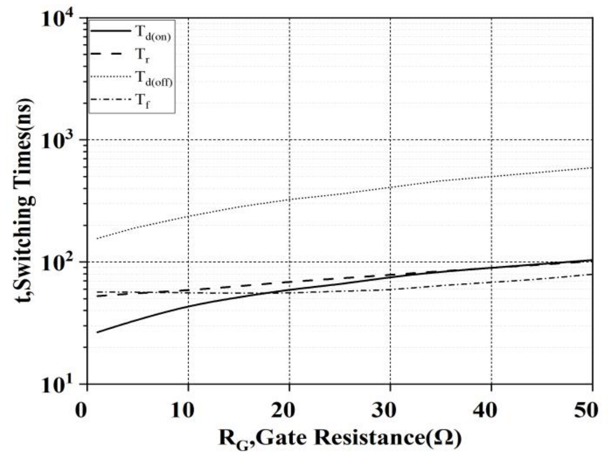

Fig.10. Typical switching times vs. gate Resistor

(Tj= 175°C, VCE=400V, VGE= 15/0V, IC = 75A)

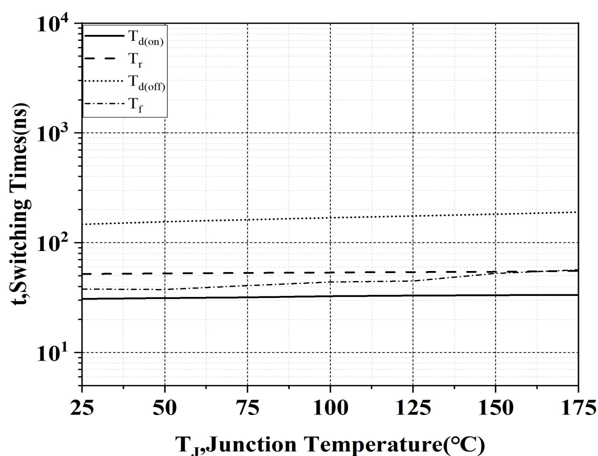

Fig.11. Typical switching times vs. junction temperature

(V_{CE}= 400V, V_{GE}= 15/0V, I_C = 75A)

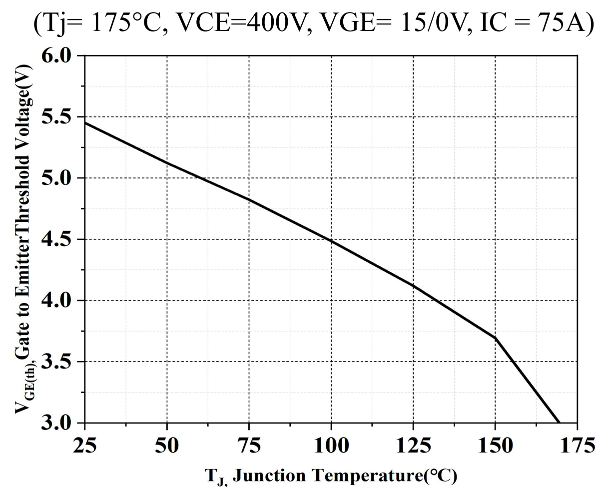

Fig.12. Gate-emitter threshold voltage vs. junction temperature

(I_C=0.75mA)

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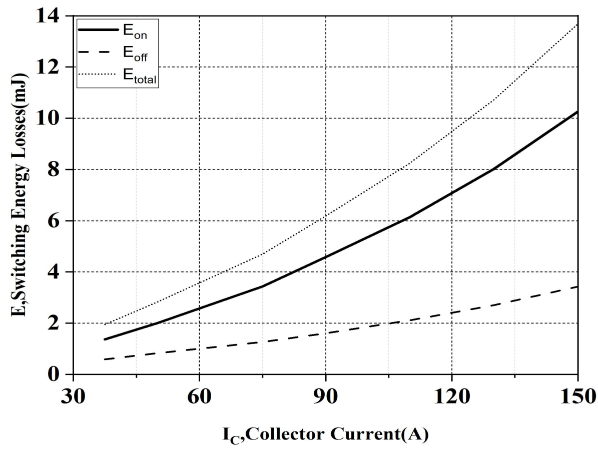

Fig.13. Typical switching energy losses as a function of collector current

(T_j= 175°C, V_{CE}= 400V, V_{GE}= 15/0V)

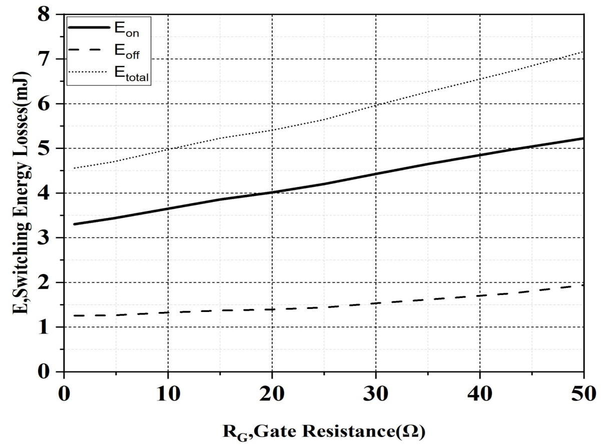

Fig.14. Typical switching energy losses as a function of gate resistor

(T_j= 175°C, V_{CE}= 400V, V_{GE}= 15/0V, I_C = 75A)

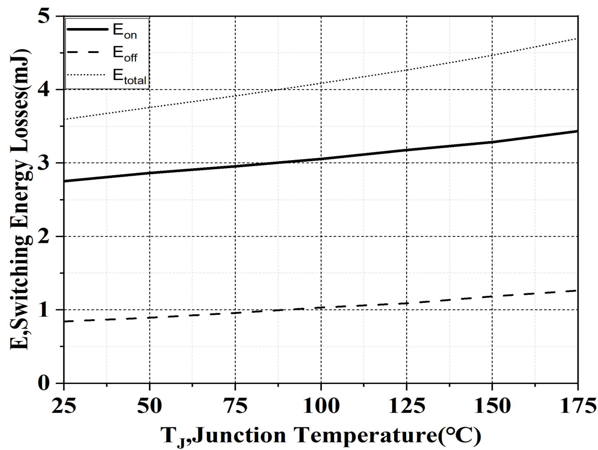

Fig.15. Typical switching energy losses as a function of junction temperature

(Inductive load, V_{CE}= 400V, V_{GE}= 15/0V, I_C = 75A)

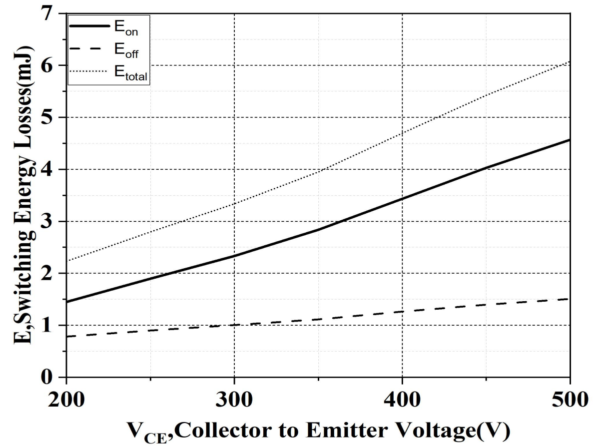

Fig.16. Typical switching energy losses as a function of collector emitter voltage

(Inductive load, T_j= 175°C, V_{GE}= 15/0V, I_C = 75A)

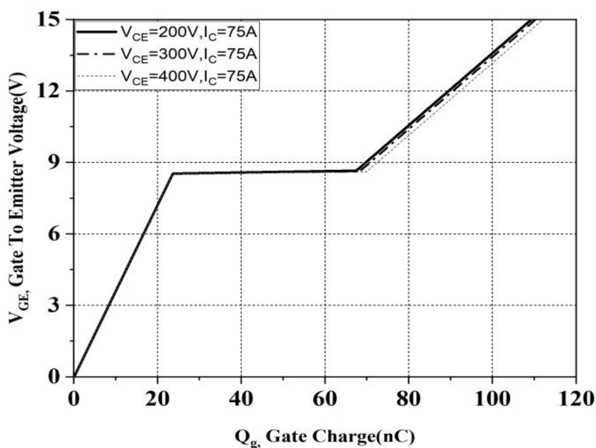

Fig.17. Typical gate charge

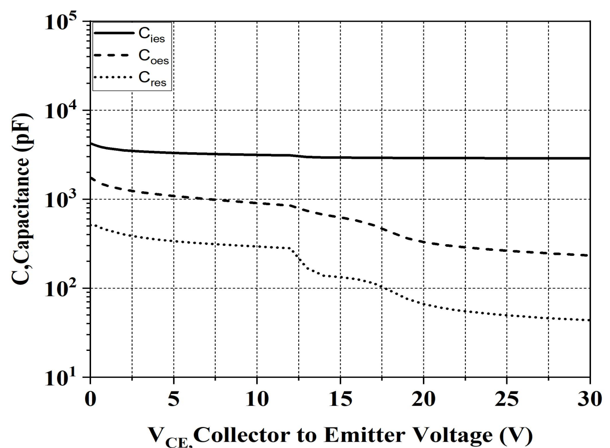

Fig.18. Typical capacitance as a function of collector-emitter voltage

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

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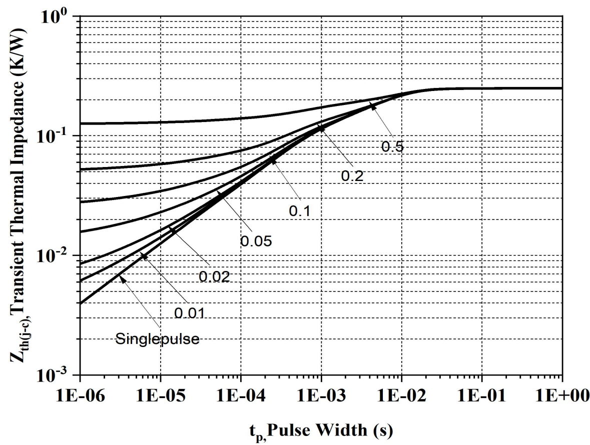

Fig.19. IGBT transient thermal impedance

(D = t_p/T)

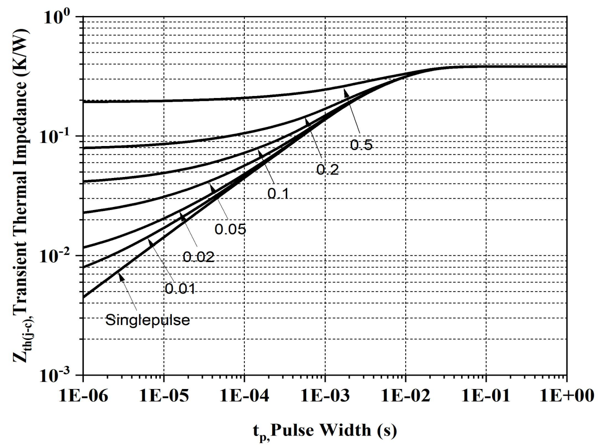

Fig.20. Transient thermal impedance of diode

(D = t_p/T)

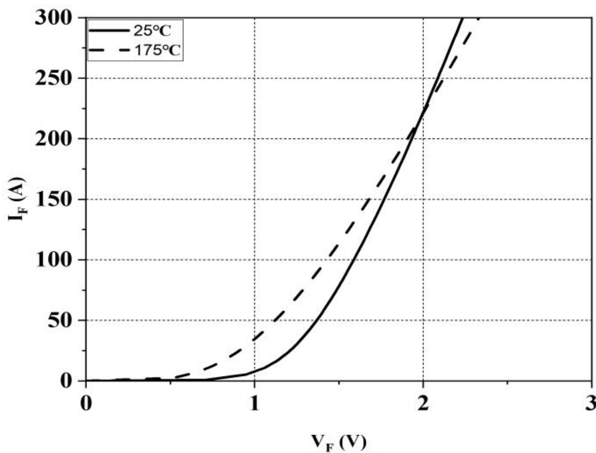

Fig.21. Typical diode forward current as a function of forward voltage

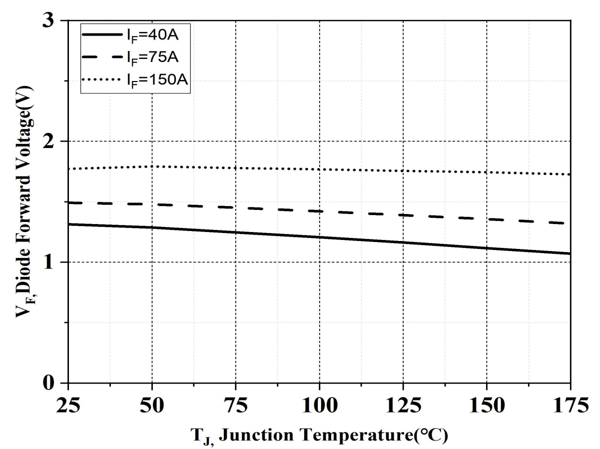

Fig.22. Typical diode forward voltage as a function of junction temperature

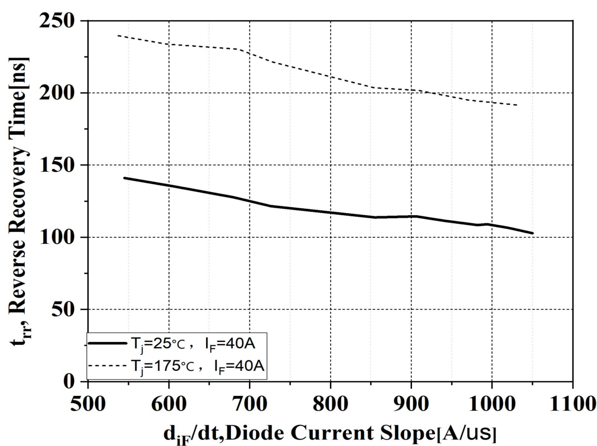

Fig.23.Typical reverse recovery time as a function of diode current slope

(VR=400V)

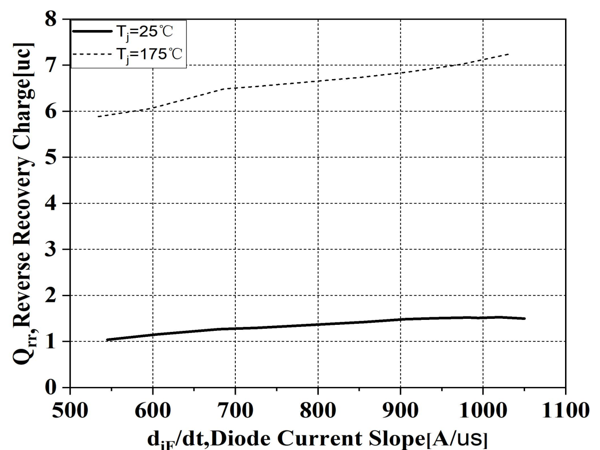

Fig.24. Typical reverse recovery charge as a function of diode current slope

(VR=400V)

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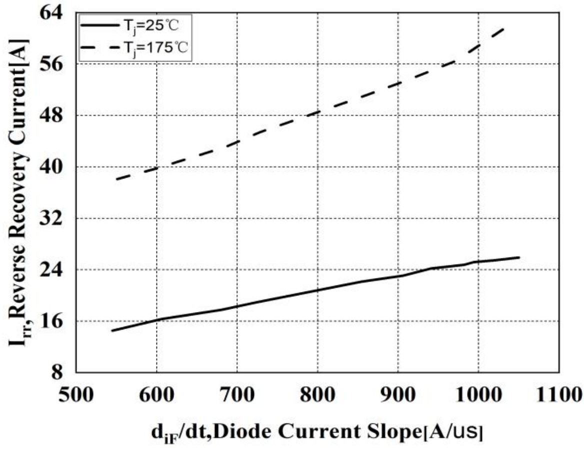

Fig.25.Typical reverse recovery current as a function of diode current slope
(VR=400V)

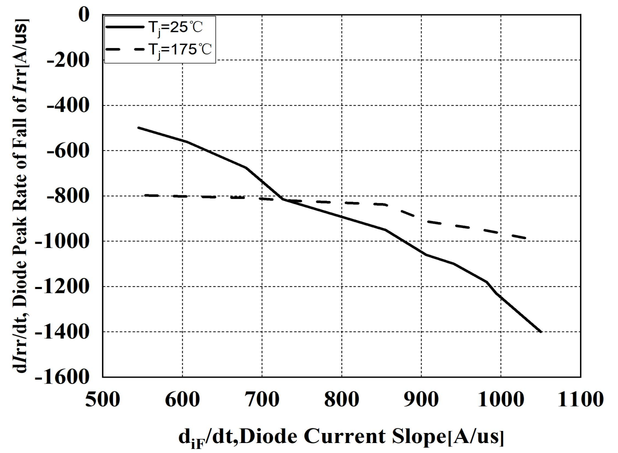

Fig.26.Typical diode peak rate of fall of reverse recovery current as a function of diode current slope
(VR=400V)

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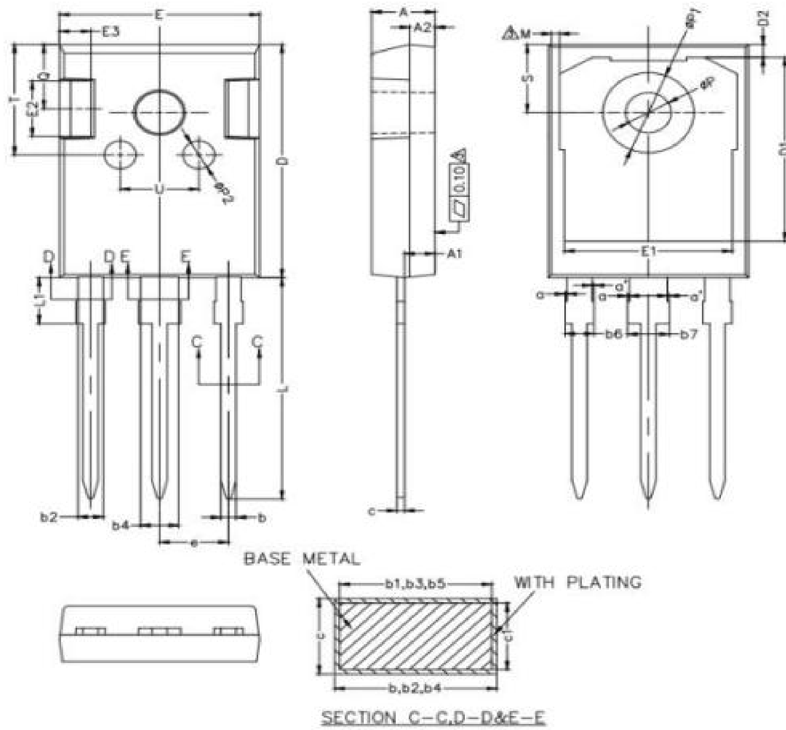
7. Package Dimensions



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
⚠	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	1.20	1.35
	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	5.34	5.44	5.54
	L	19.80	19.92	20.10
⚠	L1	3.95	4.13	4.30
⚠	M	0.35	–	0.95
	P	3.50	3.60	3.70
⚠	P1	7.00	–	7.40
	P2	2.40	2.50	2.60
	Q	5.60	–	6.00
⚠	S	6.05	6.15	6.25
	T	9.80	–	10.20
	U	6.00	–	6.40

NOTES:
1. ALL DIMENSIONS REFER TO JEDEC STANDARD TO-247 AD DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
2. EJECTION MARK DEPTH $0.10^{+0.15}_{-0.05}$

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8. Version Information

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

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