

3-Level NPC Inverter Module

1 Description

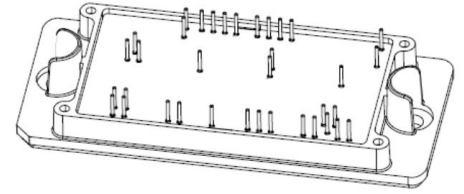
These Insulated Gate Bipolar Transistor used advanced trench and Fieldstop technology design, provided excellent V_{CEsat} and switching speed ,low gate charge. Which accords with the RoHS standard.

2 Features

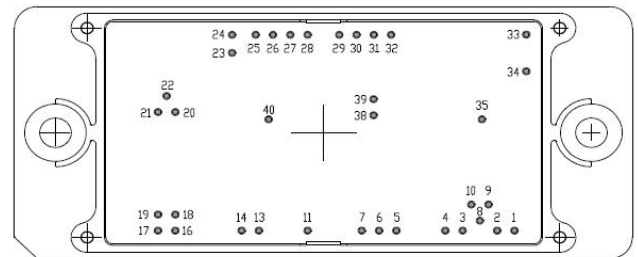
- Higher System Efficiency
- Reduced Cooling Requirements
- Low Conduction Losses Over Temperature
- Neutral Point Clamped Three-Level Inverter Module
- Low Inductive Layout
- Solderable Pins

3 Applications

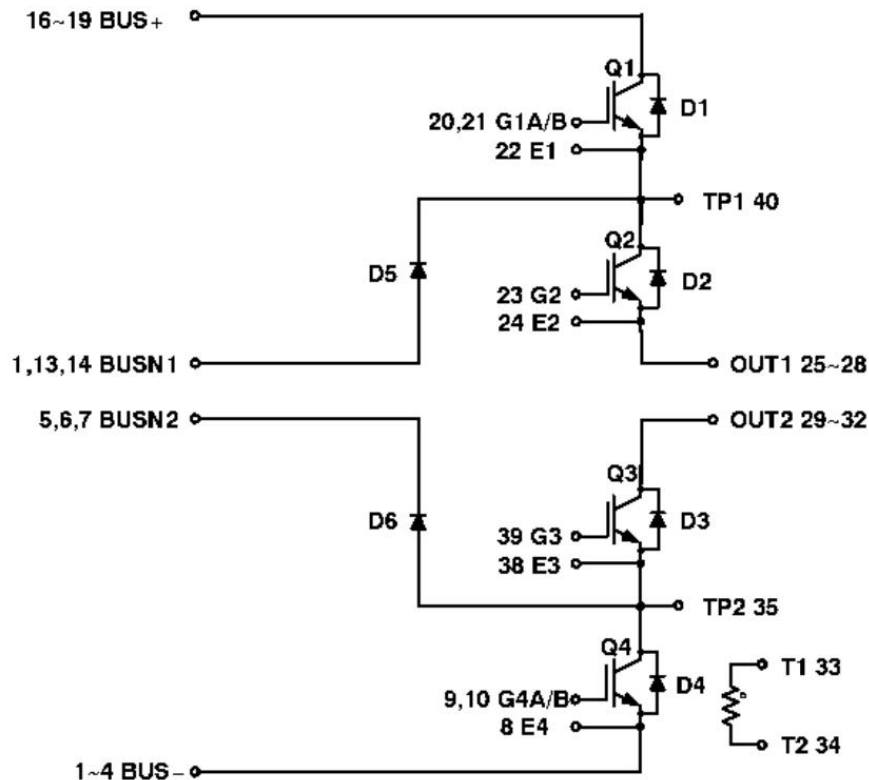
- Solar Inverters
- Uninterruptable Power Supplies Systems



PIN ASSIGNMENTS



4 Equivalent Circuit Schematic



5 Electrical Characteristics

5.1 Absolute Maximum Ratings (Q1\Q4 OUTER IGBT) (T_J=25°C, unless otherwise specified)

Parameter	Symbol	Value	Units	
Collector-to-Emitter Voltage	V _{CE}	650	V	
Gate-to-Emitter Voltage	V _{GE}	±23	V	
Gate-to-Emitter Voltage _(Pulsed) ^{#1}	V _{GE(Pulsed)}	±30	V	
DC Collector current	I _C	270	A	
Pulsed Collector Current	I _{CM}	810	A	
Junction Temperature Range	T _{jmax}	-40~175	°C	
Thermal Resistance – Chip-to-Heatsink	Thermal grease, A = 2.8 W/mK	R _{thJH}	0.24	°C/W
Thermal Resistance – Chip-to-Case		R _{thJC}	0.16	°C/W

5.2 Absolute Maximum Ratings (Q2\Q3 INNER IGBT) (T_J=25°C, unless otherwise specified)

Parameter	Symbol	Value	Units	
Collector-to-Emitter Voltage	V _{CE}	650	V	
Gate-to-Emitter Voltage	V _{GE}	±23	V	
Gate-to-Emitter Voltage _(Pulsed) ^{#1}	V _{GE(Pulsed)}	±30	V	
DC Collector current	I _C	293	A	
Pulsed Collector Current	I _{CM}	880	A	
Junction Temperature Range	T _{jmax}	-40~175	°C	
Thermal Resistance – Chip-to-Heatsink	Thermal grease, A = 2.8 W/mK	R _{thJH}	0.28	°C/W
Thermal Resistance – Chip-to-Case		R _{thJC}	0.16	°C/W

#1V_{GE(Pulsed)}, Pulse width 5uS

5.3 Absolute Maximum Ratings (D1~D4 Diode) (T_J=25°C, unless otherwise specified)

Parameter	Symbol	Value	Units	
Peak Repetitive Reverse Voltage	V _{RRM}	650	V	
Average Rectified Forward Current	I _{F(AV)}	188	A	
Repetitive Peak Forward Current	I _{FRM}	563	A	
Junction Temperature Range	T _{jmax}	-40~175	°C	
Thermal Resistance – Chip-to-Heatsink	Thermal grease, A = 2.8 W/mK	R _{thJH}	0.41	°C/W
Thermal Resistance – Chip-to-Case		R _{thJC}	0.32	°C/W

5.4 Absolute Maximum Ratings (D5~D6 Diode) (T_J=25°C, unless otherwise specified)

Parameter	Symbol	Value	Units	
Peak Repetitive Reverse Voltage	V _{RRM}	650	V	
Average Rectified Forward Current	I _{F(AV)}	230	A	
Repetitive Peak Forward Current	I _{FRM}	690	A	
I ² t-value@VR = 0 V, tP = 10 ms, Tvj = 150°C	I ² t	9800	A ² s	
Junction Temperature Range	T _{jmax}	-40~175	°C	
Thermal Resistance – Chip-to-Heatsink	Thermal grease, A = 2.8 W/mK	R _{thJH}	0.29	°C/W
Thermal Resistance – Chip-to-Case		R _{thJC}	0.19	°C/W

5.5 RECOMMENDED TEMPERATURE (IGBT Module)

Parameter	Symbol	Value	Units
Storage Temperature	T _{stg}	-40~125	°C
Operating Temperature	T _{op}	-40~150	°C

5.6 Thermal Characteristics (IGBT Module)

Parameter	Symbol	Value	Units
Isolation Test Voltage, t = 1 s, 50 Hz	V _{ISO}	4000	V
Stray Inductance	L _{CE}	17	nH
Mounting Torque(Screw:M5)	M	3~5	N.m
Flatness of base plate		0.3	mm
Weight		176.5	g
Clearance	terminal to heatsink	12.7	
Creepage distance	terminal to heatsink	12.7	
CTI		≥600	
RTI		130	°C

5.7 Electrical Characteristics (Q1\Q4 IGBT) (T_j=25°C, unless otherwise specified)

Parameter	Symbol	Conditions	Value			Units
			Min	Typ	Max	
Static Characteristics						
Collector-to-Emitter Breakdown Voltage	V _{(BR)CES}	I _C =250μA, V _{GE} =0V, T _J =25°C	650	--	--	V
Collector-to-Emitter Leakage	I _{CES}	V _{CE} =650V, V _{GE} =0V, T _J =25°C	--	--	100	μA
Gate-to-Emitter Leakage Current	I _{GES}	V _{GE} =±23V, V _{CE} =0V, T _J =25°C	--	--	±100	nA
Gate Threshold Voltage	V _{GE(th)}	V _{CE} =V _{GE} , I _C =4.0mA	3.2	3.8	4.4	V
Collector-emitter saturation voltage	V _{CEsat}	V _{GE} =15V, I _C =450A, T _J =25°C	--	1.6	2.2	V
		V _{GE} =15V, I _C =450A, T _J =150°C	--	1.85	-	V
Dynamic Characteristics						
Input Capacitance	C _{iss}	V _{CE} =20V, V _{GE} =0V, f=10KHz, T _a =25°C	--	24054	--	pF
Output Capacitance	C _{oss}		--	1942	--	
Reverse Transfer Capacitance	C _{rss}		--	140	--	
IGBT Characteristics						
Turn-on delay time	t _{d(on)}	V _{GE} = -7 V / +15 V	--	75	--	nS
Rise time	t _r		V _{CE} = 400 V	--	33	--
Turn-off delay time	t _{d(off)}	I _C = 150 A	--	757	--	nS
Fall time	t _f		R _{Gon} = 9.4 Ω	--	44	--
Turn-on energy	E _{on}	R _{Goff} = 15.7 Ω	--	4.7	--	mJ
Turn-off energy	E _{off}		T _J = 25°C	--	2.6	--
Total switching energy	E _{ts}		--	7.3	--	mJ
Turn-on delay time	t _{d(on)}	V _{GE} = -7 V / +15 V	--	58	--	nS
Rise time	t _r		V _{CE} = 400 V	--	38	--
Turn-off delay time	t _{d(off)}	I _C = 150 A	--	804	--	nS
Fall time	t _f		R _{Gon} = 9.4 Ω	--	54	--
Turn-on energy	E _{on}	R _{Goff} = 15.7 Ω	--	7.2	--	mJ
Turn-off energy	E _{off}		T _J = 150°C	--	3.3	--
Total switching energy	E _{ts}		--	10.5	--	mJ
Gate charge	Q _g	V _{CE} =480V, V _{GE} =±15V	--	1.6	--	uC

5.8 Electrical Characteristics (D5/D6 Diode)(Tc=25°C, unless otherwise specified)

Parameter	Symbol	Conditions	Value			Units
			Min	Typ	Max	
Diode forward voltage	V _F	I _F =450A, T _J =25°C	--	1.65	2.05	V
		I _F =450A, T _J =150°C	--	1.75	--	V
Diode reverse recovery time	t _{rr}	V _{GE} = -7 V / +15 V	--	173	--	ns
Diode peak reverse recovery current	I _{rrm}	V _{CE} = 400 V, I _C = 150 A	--	120	--	A
Diode reverse recovery charge	Q _{rr}	R _{Gon} = 9.4 Ω, R _{Goff} = 15.7 Ω	--	8.68	--	uC
Reverse Recovery Energy	E _{RR}	T _J = 25°C	--	1.94	--	mJ
Diode reverse recovery time	t _{rr}	V _{GE} = -7 V / +15 V	--	215	--	ns
Diode peak reverse recovery current	I _{rrm}	V _{CE} = 400 V, I _C = 150 A	--	184	--	A
Diode reverse recovery charge	Q _{rr}	R _{Gon} = 9.4 Ω, R _{Goff} = 15.7 Ω	--	20.4	--	uC
Reverse Recovery Energy	E _{RR}	T _J = 150°C	--	4.55	--	mJ

5.9 Electrical Characteristics (Q2/Q3 IGBT) (Tj=25°C, unless otherwise specified)

Parameter	Symbol	Conditions	Value			Units
			Min	Typ	Max	
Static Characteristics						
Collector-to-Emitter Breakdown Voltage	V _{(BR)CES}	I _C =250μA, V _{GE} =0V, T _J =25°C	650	--	--	V
Collector-to-Emitter Leakage	I _{CES}	V _{CE} =650V, V _{GE} =0V, T _J =25°C	--	--	100	μA
Gate-to-Emitter Leakage Current	I _{GES}	V _{GE} =±23V, V _{CE} =0V, T _J =25°C	--	--	±100	nA
Gate Threshold Voltage	V _{GE(th)}	V _{CE} =V _{GE} , I _C =4.0mA	4.2	4.85	5.4	V
Collector-emitter saturation voltage	V _{CEsat}	V _{GE} =15V, I _C =450A, T _J =25°C	--	1.28	1.8	V
		V _{GE} =15V, I _C =450A, T _J =150°C	--	1.45	-	V
Dynamic Characteristics						
Input Capacitance	C _{iss}	V _{CE} =20V, V _{GE} =0V, f=10KHz, T _a =25°C	--	46942	--	pF
Output Capacitance	C _{oss}		--	982	--	
Reverse Transfer Capacitance	C _{rss}		--	263	--	
IGBT Characteristics						
Turn-on delay time	t _{d(on)}	V _{GE} = -7 V / +15 V	--	826	--	nS
Rise time	t _r		V _{CE} = 400 V	--	149	--
Turn-off delay time	t _{d(off)}	I _C = 150 A	--	3790	--	nS
Fall time	t _f		R _{Gon} = 40 Ω	--	118	--
Turn-on energy	E _{on}	R _{Goff} = 40 Ω	--	15.9	--	mJ
Turn-off energy	E _{off}		T _J = 25°C	--	8.8	--
Total switching energy	E _{ts}		--	24.7	--	mJ
Turn-on delay time	t _{d(on)}	V _{GE} = -7 V / +15 V	--	689	--	nS
Rise time	t _r		V _{CE} = 400 V	--	180	--
Turn-off delay time	t _{d(off)}	I _C = 150 A	--	4167	--	nS
Fall time	t _f		R _{Gon} = 40 Ω	--	108	--
Turn-on energy	E _{on}	R _{Goff} = 40 Ω	--	18.75	--	mJ
Turn-off energy	E _{off}		T _J = 150°C	--	9.3	--
Total switching energy	E _{ts}		--	28.05	--	mJ
Gate charge	Q _g	V _{CE} =480V, V _{GE} =±15V	--	3.7	--	uC

5.10 Electrical Characteristics (D1~D4 Diode)(Tc=25°C, unless otherwise specified)

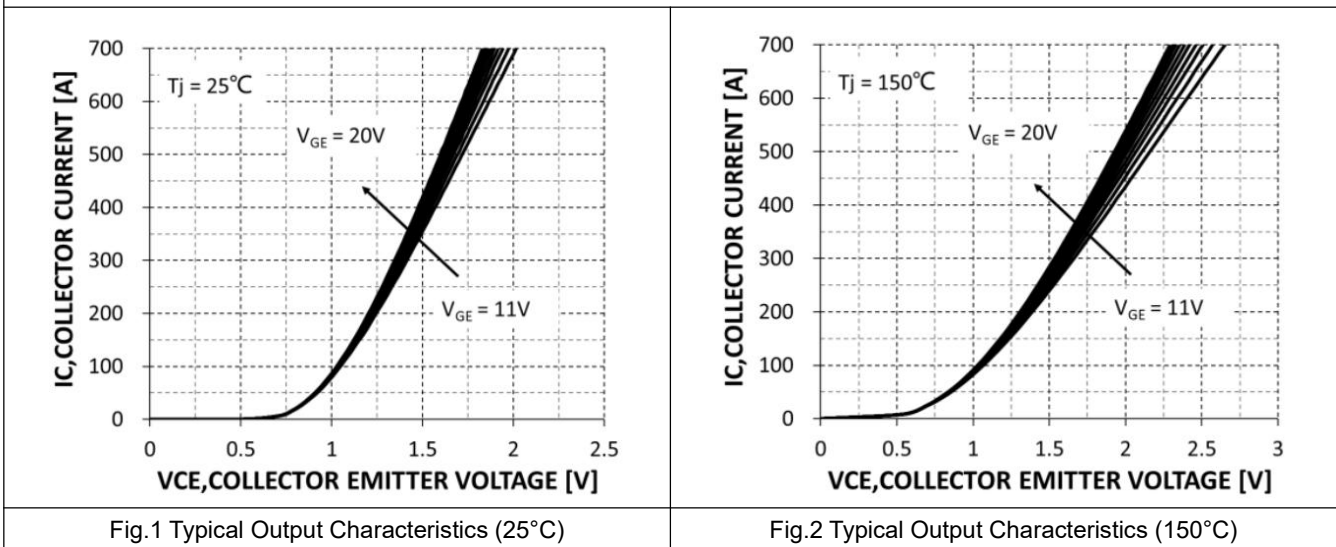
Parameter	Symbol	Conditions	Value			Units
			Min	Typ	Max	
Diode forward voltage	V _F	I _F =100A, T _J =25°C	--	1.23	1.65	V
		I _F =100A, T _J =150°C	--	1.18	--	V
Diode reverse recovery time	t _{rr}	V _{GE} = -7 V / +15 V	--	363	--	ns
Diode peak reverse recovery current	I _{rrm}	V _{CE} = 400 V, I _C = 150 A	--	43.3	--	A
Diode reverse recovery charge	Q _{rr}	R _{Gon} = 40 Ω, R _{Goff} = 40 Ω	--	6.48	--	uC
Reverse Recovery Energy	E _{RR}	T _J = 25°C	--	1.1	--	mJ
Diode reverse recovery time	t _{rr}	V _{GE} = -7 V / +15 V	--	436	--	ns
Diode peak reverse recovery current	I _{rrm}	V _{CE} = 400 V, I _C = 150 A	--	48.1	--	A
Diode reverse recovery charge	Q _{rr}	R _{Gon} = 40 Ω, R _{Goff} = 40 Ω	--	10.6	--	uC
Reverse Recovery Energy	E _{RR}	T _J = 150°C	--	1.78	--	mJ

5.11 Electrical Characteristics (NTC)(Tc=25°C, unless otherwise specified)

Parameter	Symbol	Conditions	Value			Units
			Min	Typ	Max	
Rated Resistance	R ₂₅	T _C =25°C	--	22	--	kΩ
B-value	B _{25/50}	B (25/50), tolerance ±3%	--	3950	--	k
B-value	B _{25/100}	B (25/100), tolerance ±3%	--	3998	--	k
Deviation of R100	ΔR/R	T _C = 100°C, R100 = 493 Ω	-5	--	+5	%
Power Dissipation	P ₂₅	TNTC = 25°C	--	--	20	mW

6 Typical Characteristic Curves

IGBT Q1, Q4 And DIODE D1, D4



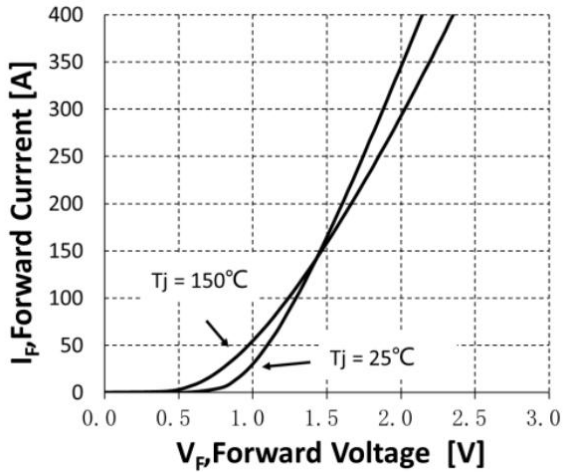


Fig.3 Body Diode Characteristics

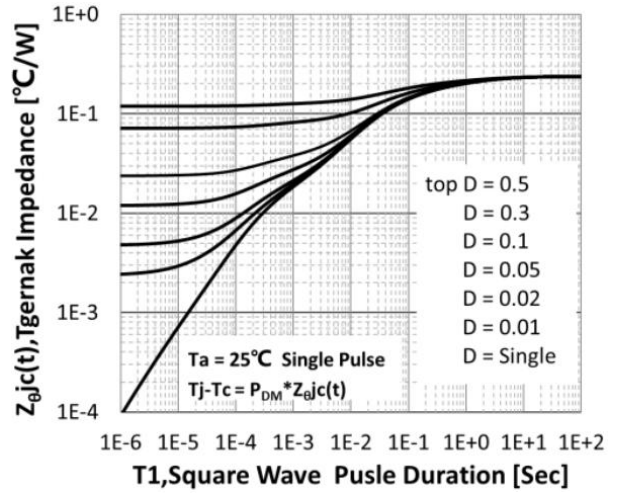


Fig.4 Transient Thermal Impedance(Q1,Q4)

IGBT Q2, Q3 And DIODE D2, D3

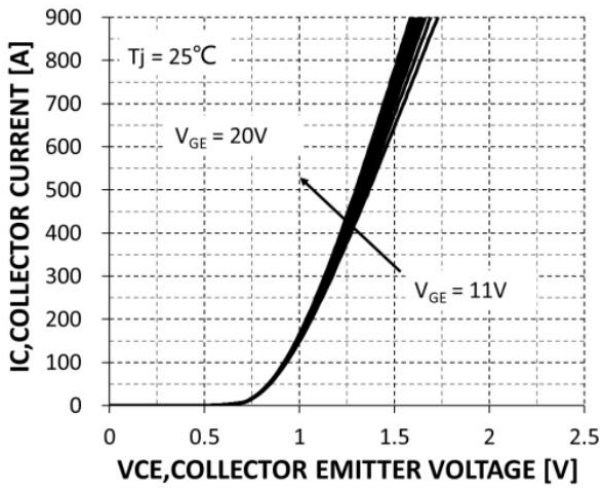


Fig.5 Typical Output Characteristics (25°C)

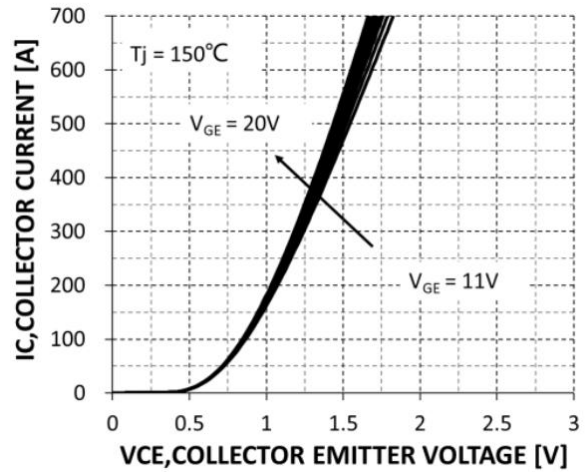


Fig.6 Typical Output Characteristics (150°C)

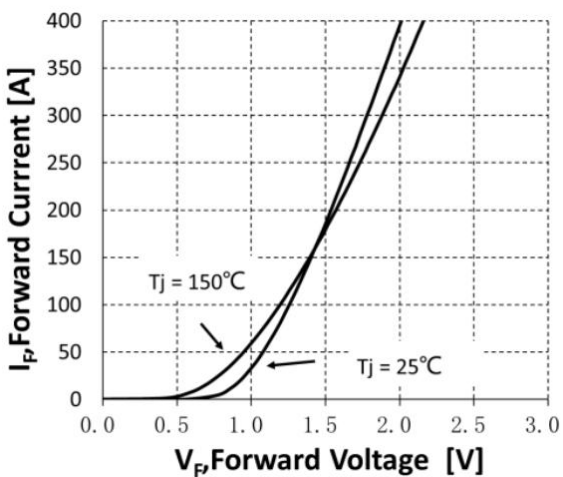


Fig.7 Body Diode Characteristics

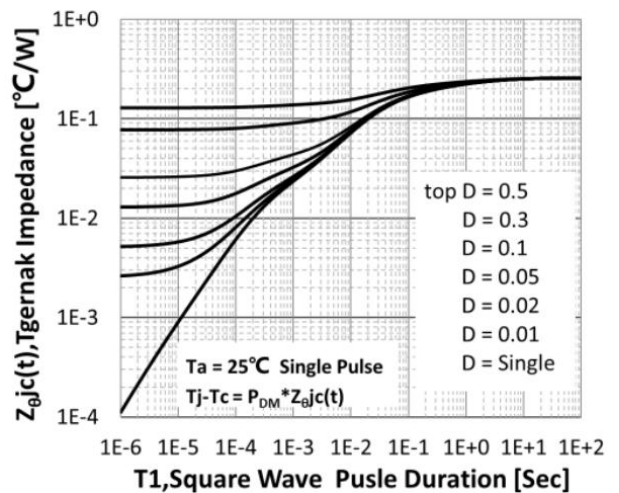


Fig.8 Transient Thermal Impedance(Q2,Q3)

DIODE D5, D6

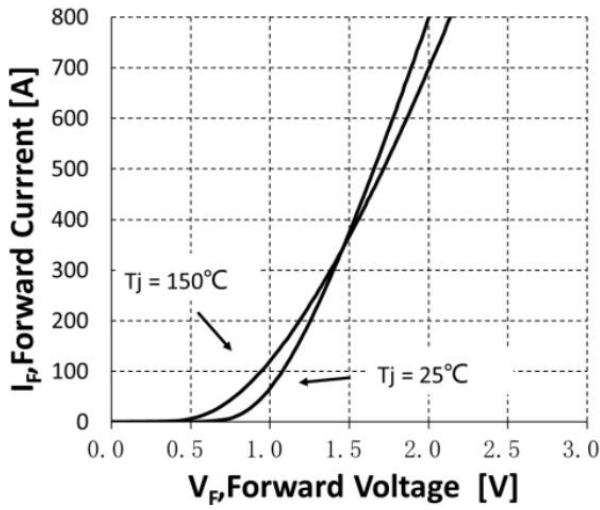


Fig.9 Diode Forward Characteristics

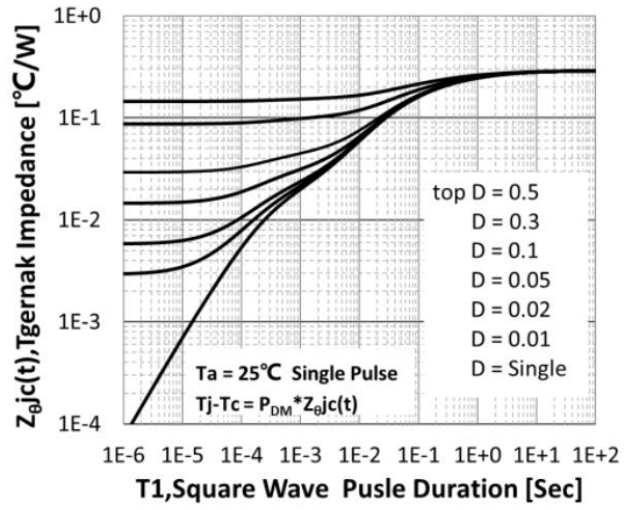


Fig.10 Transient Thermal Impedance(D5,D6)

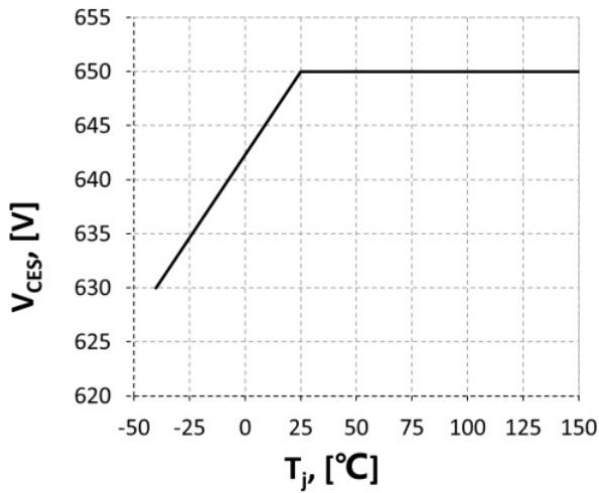


Fig.11 maximum allowed collector-emitter voltage(D5,D6)

IGBT Q1, Q4 And DIODE D5, D6

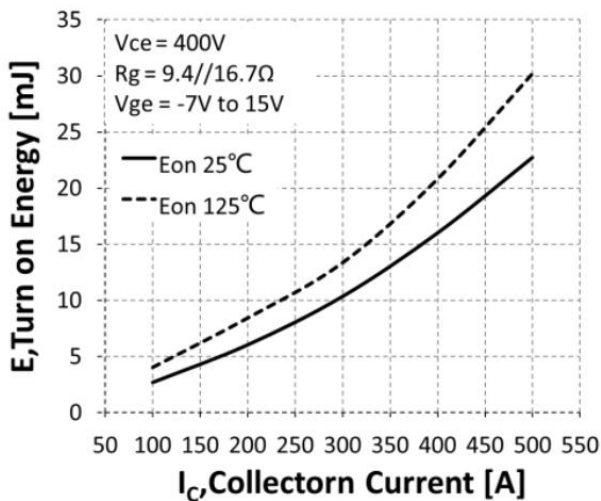


Fig.12 Typical Switching Loss Eon vs. IC

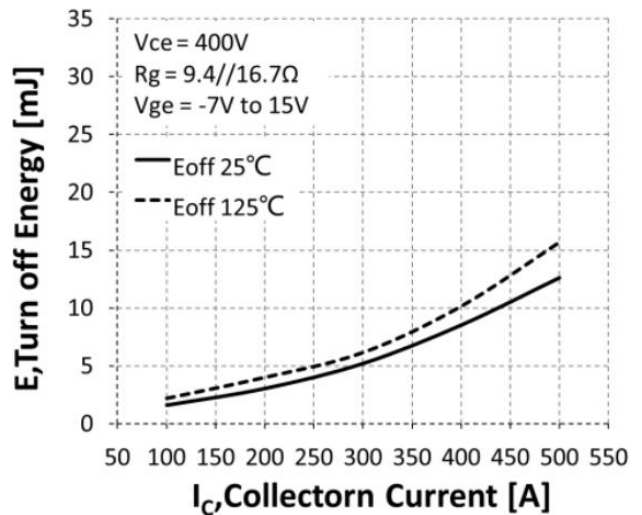


Fig.13 Typical Switching Loss Eoff vs. IC

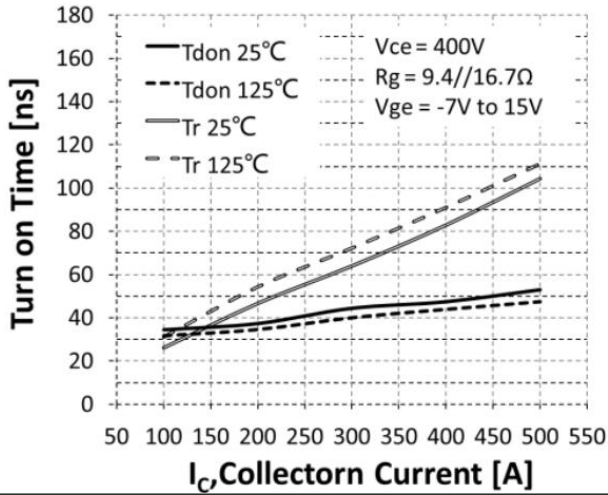


Fig.14 Typical Switching Time T_{on} vs. I_C

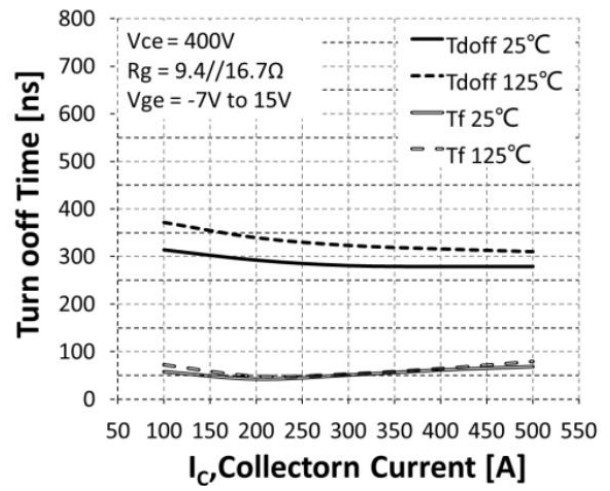


Fig.15 Typical Switching Time T_{off} vs. I_C

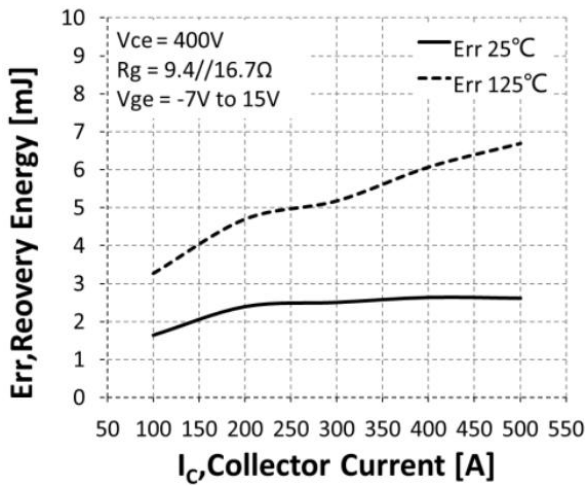


Fig.16 Typical Recovery Energy vs. I_C

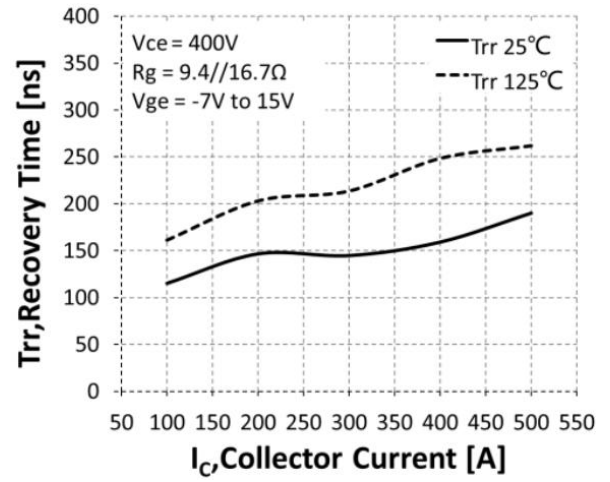


Fig.17 Typical Recovery Time vs. I_C

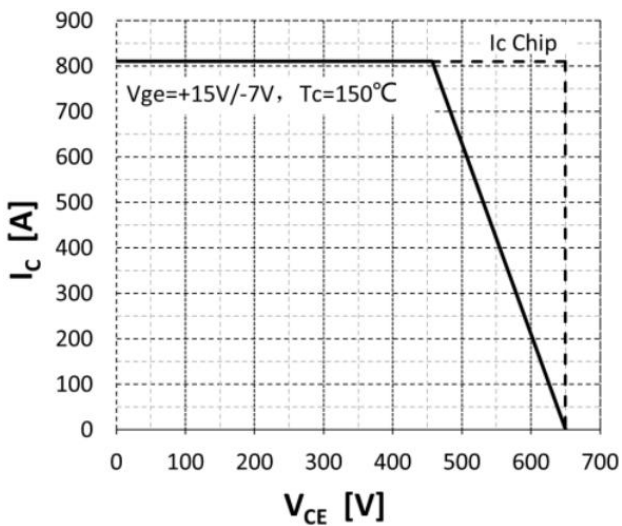


Fig.18 RBSOA(Q1,Q4)

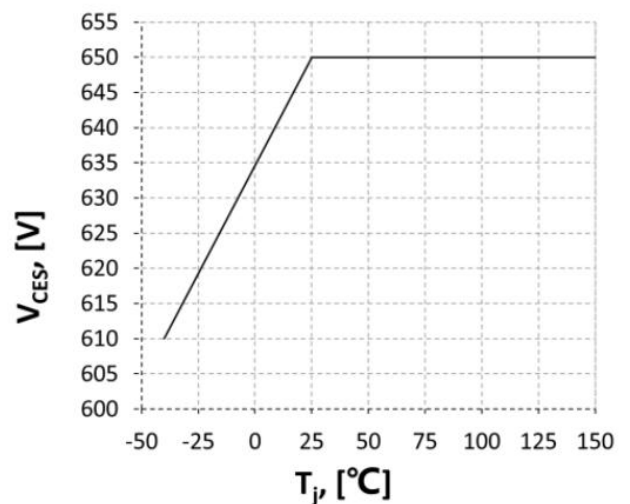


Fig.19 maximum allowed collector-emitter voltage (Q1,Q4)

IGBT Q1, Q4 And DIODE D5, D6 (continued)

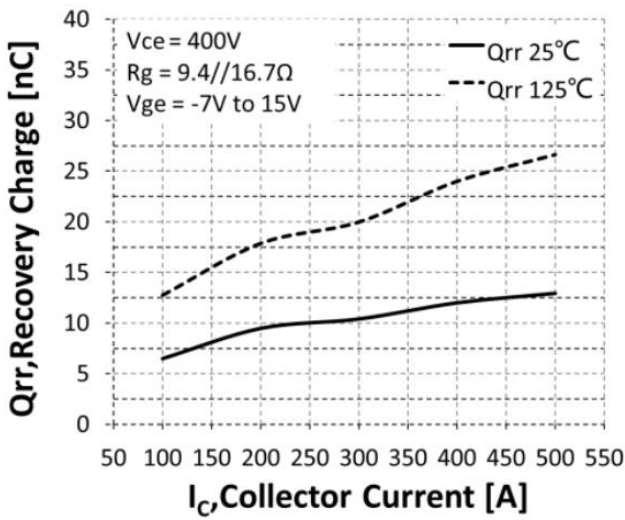


Fig.20 Typical Recovery Charge vs. IC

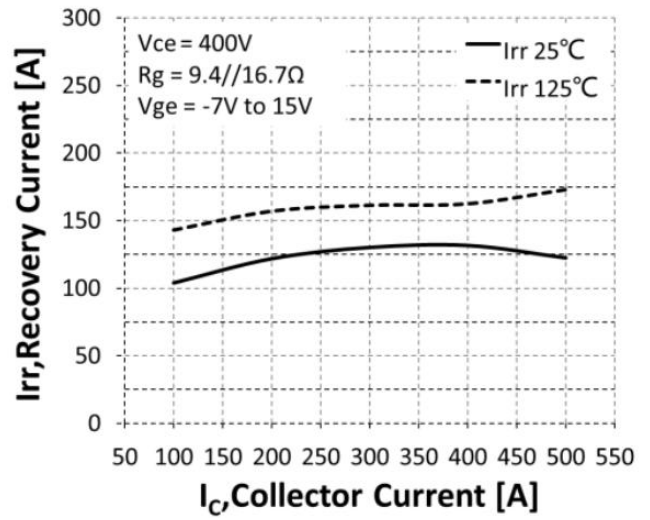


Fig.21 Typical Recovery Current vs. IC

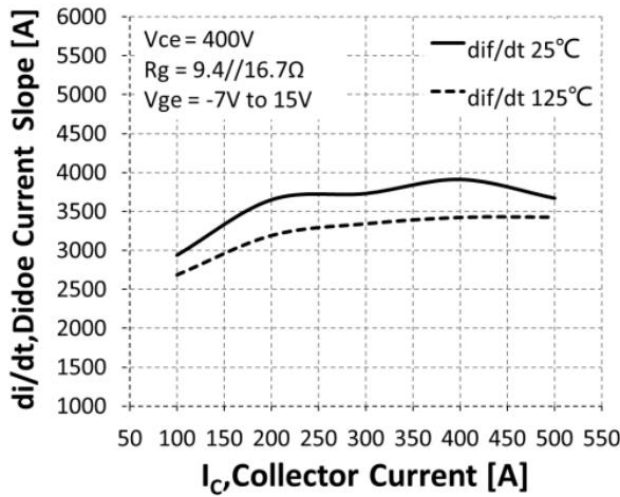
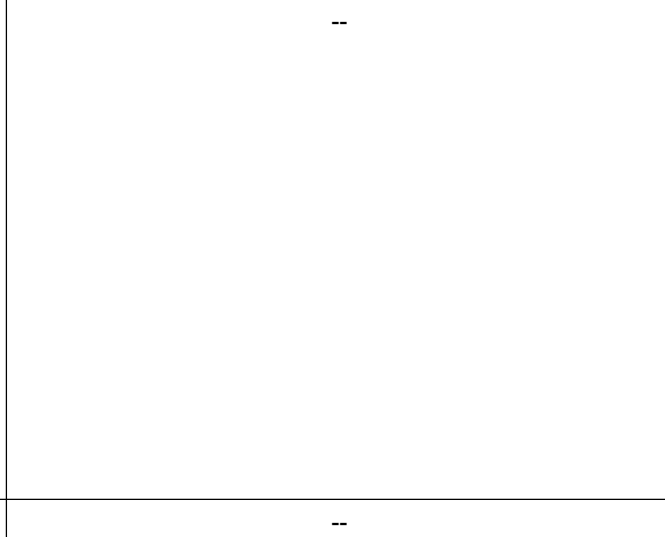


Fig.22 Typical di/dt vs. IC



IGBT Q2, Q3 And DIODE D1, D4

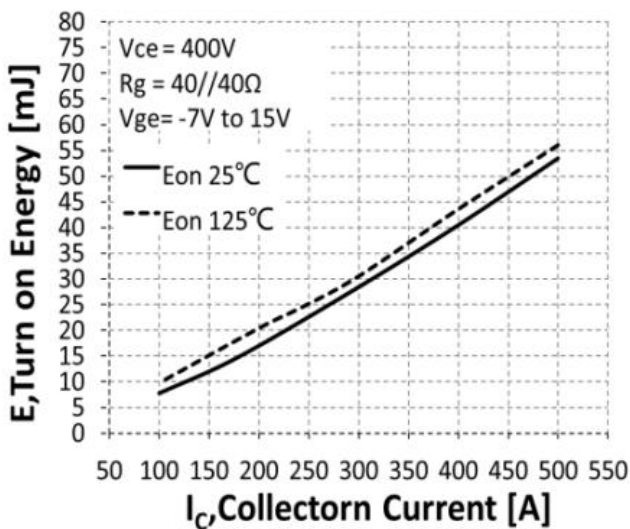


Fig.23 Typical Switching Loss Eon vs. IC

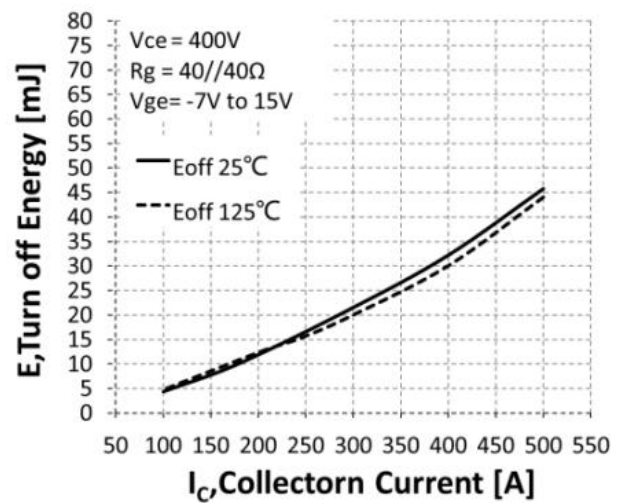


Fig.24 Typical Switching Loss Eoff vs. IC

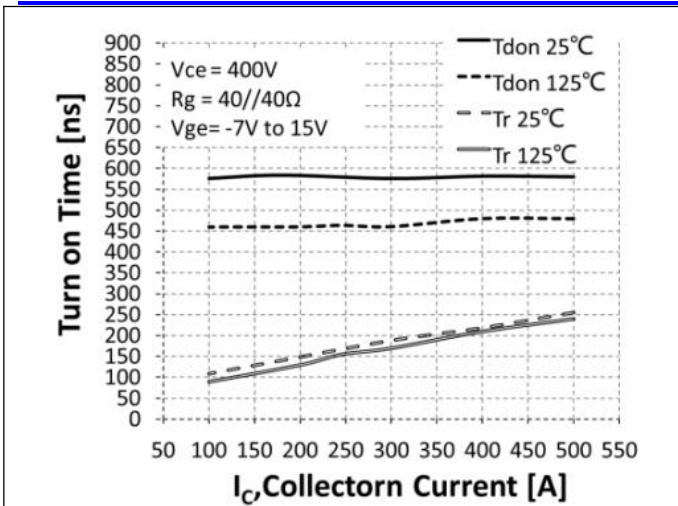


Fig.25 Typical Switching Time T_{on} vs. I_C

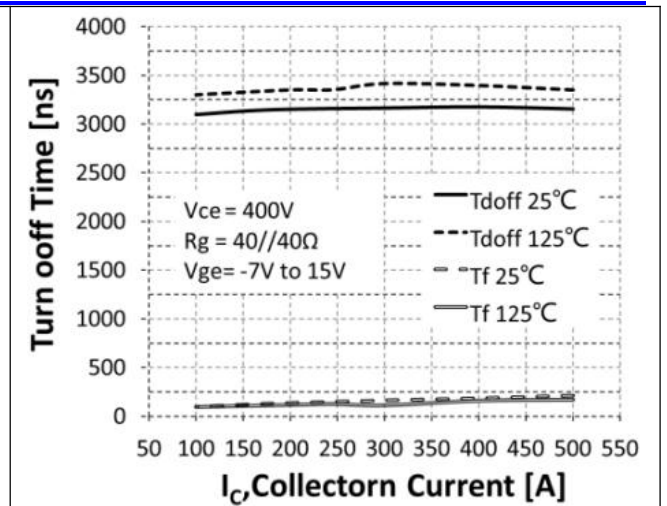


Fig.26 Typical Switching Time T_{off} vs. I_C

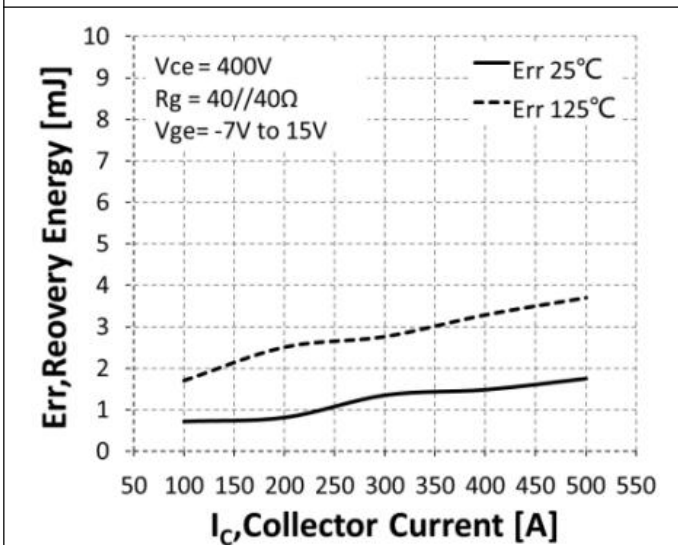


Fig.27 Typical Recovery Energy vs. I_C

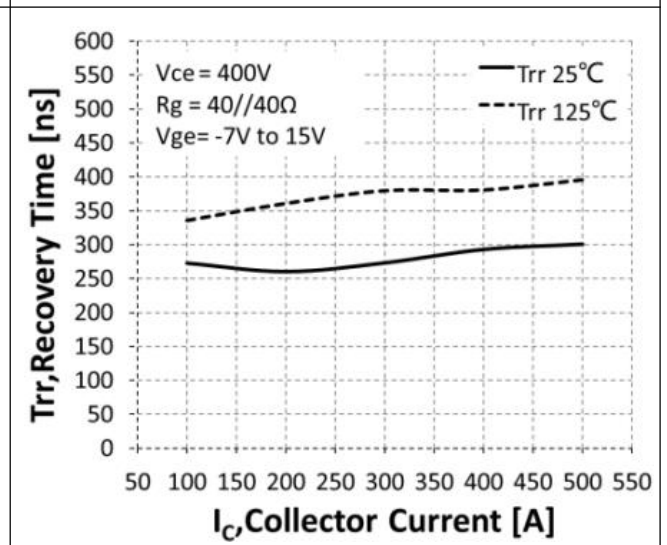


Fig.28 Typical Recovery Time vs. I_C

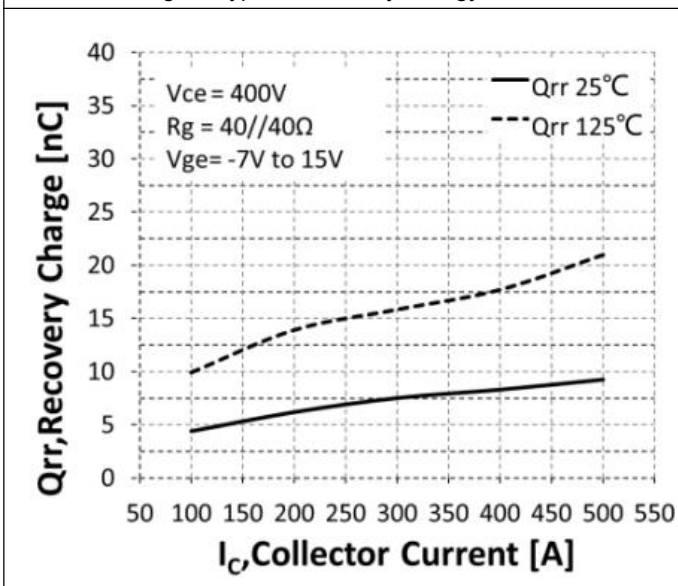


Fig.29 Typical Recovery Charge vs. I_C

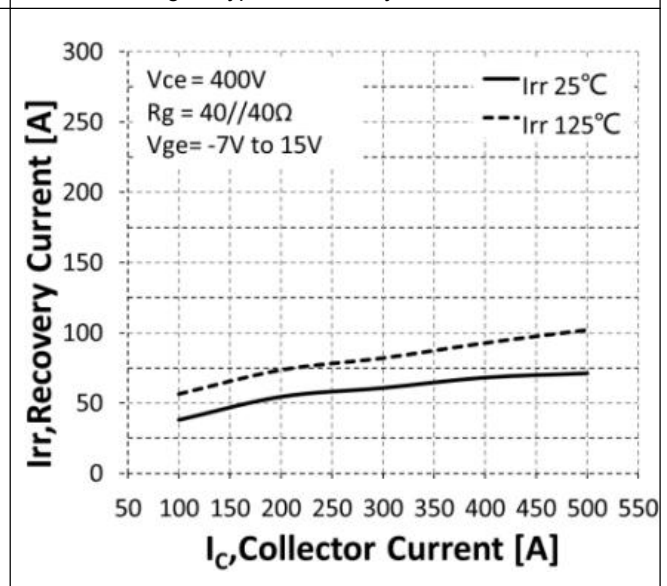


Fig.30 Typical Recovery Current vs. I_C

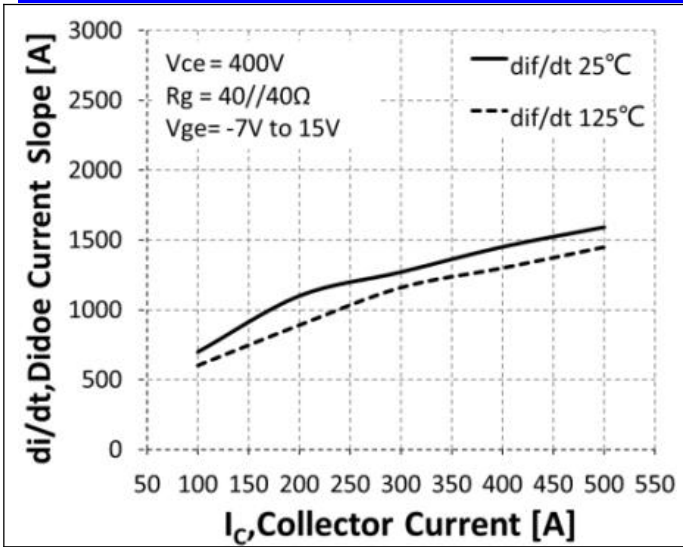


Fig.31 Typical di/dt vs. IC

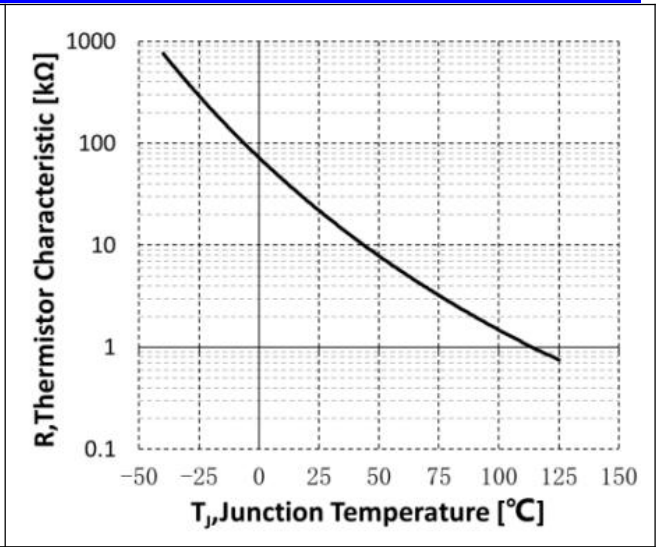


Fig.32 Typical Thermistor vs. Tj

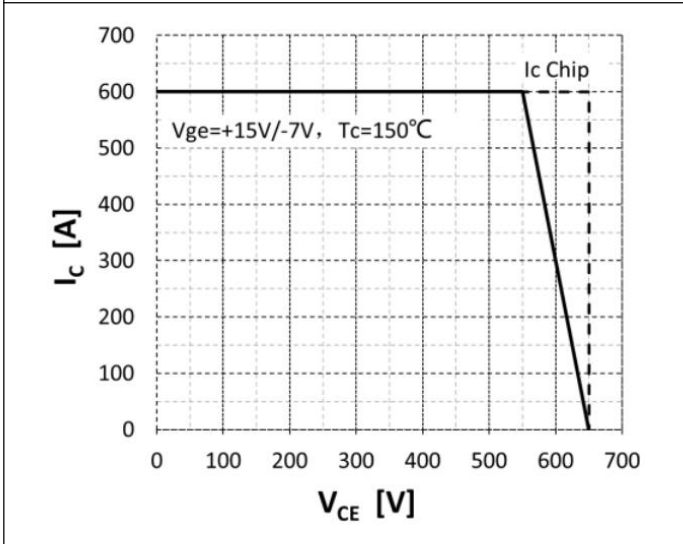


Fig.33 RBSOA(Q2,Q3)

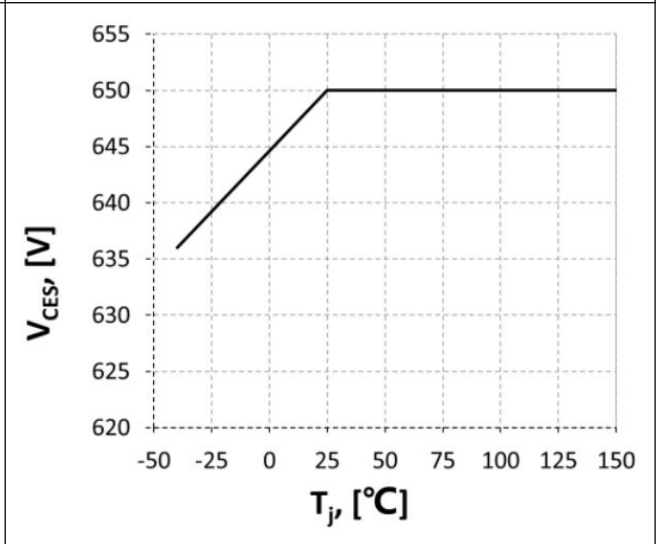
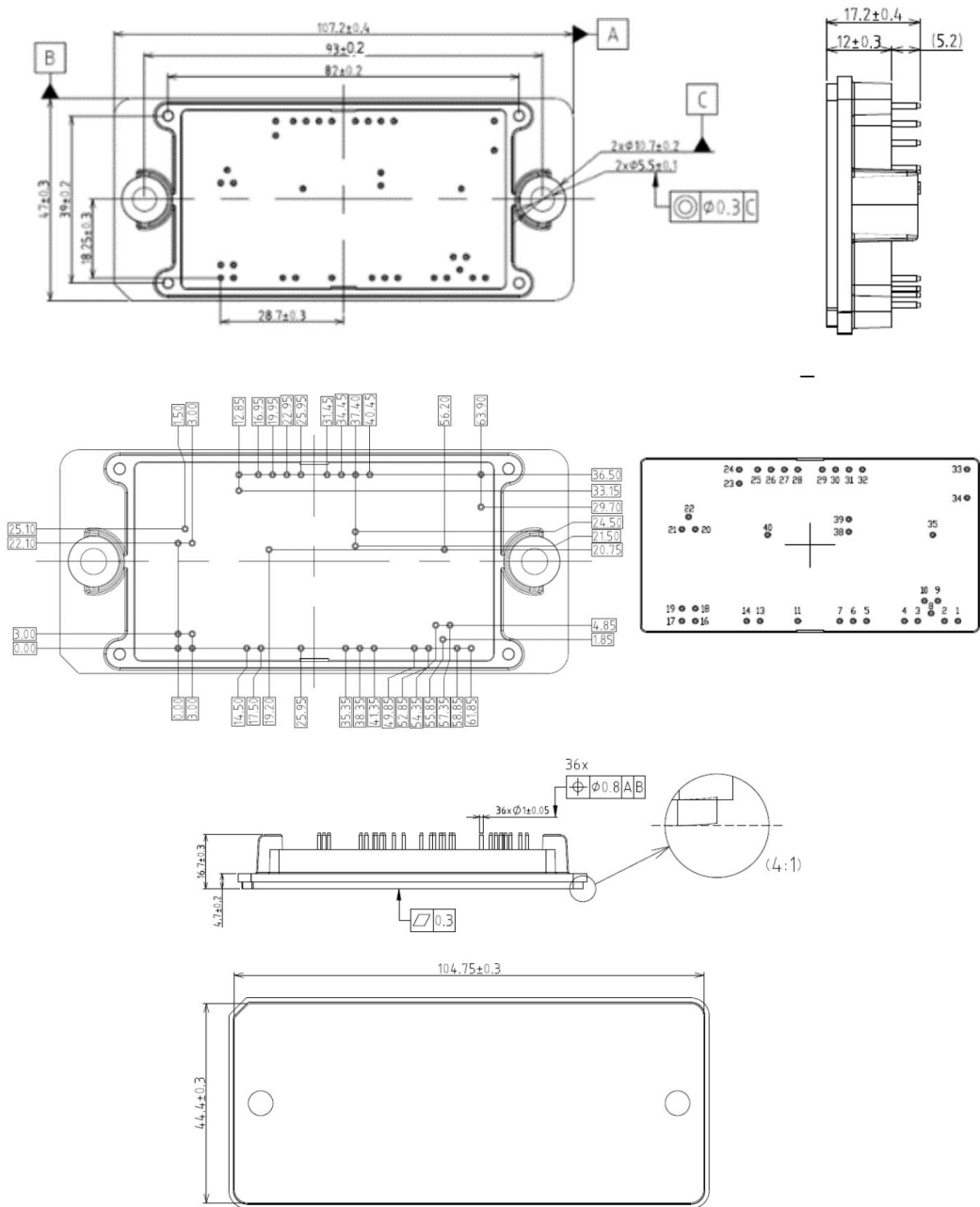


Fig.34 maximum allowed collector-emitter voltage(Q2,Q3)

7 Dimensions



8 Attentions

- Jiangsu Donghai Semiconductor Technology CO.,LTD. reserves the right to change the specification without prior notice! The customer should obtain the latest version of the information before making the order and verify that the information is complete and up to date.
- It is the responsibility of the purchaser for any failure or failure of any semiconductor product under certain conditions. It is the responsibility of the purchaser to comply with safety standards and to take safety measures in the system design and machine manufacturing of Donghai products in order to avoid potential risk of failure. Injury or property damage.
- Product promotion is endless, our company will be dedicated to provide customers with better products.

9 Appendix

Revision history:

Date	REV.	Description	Page
2023.3.1	1.0	Original	
2023.3.22	1.1	Add product name	All
		Add PIN Assignments	1 Page
2023.3.23	1.2	Adding Curves	5~10 Page
		Modify some parameters	All
		Revise Dimensions	10Page
2023.5.8	1.3	Add DIODE (D5,D6) I^2t value parameter	2 Page
		Adjust RECOMMENDED TEMPERATURE sequence	2 Page
		Add Thermal Characteristics parameter	3 Page
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