DFH10AL12EZC1

1200V 3-Level Hybrid Power Module

Description

The DFH10AL12EZC1 is a 3-level Power Module. It integrates 1200V SiC MOSFET chips and 1200V IGBT chips designed for the applications such as Solar Inverter, High frequency switching, Energy storage Systems etc.

Features

- Blocking voltage:1200V
- $R_{ds(on)}$: 9.5mΩ (V_{GS}=15V)/8.3mΩ (V_{GS}=18V)
- Low Switching Losses
- High current density
- Press FIT Contact Technology
- 175°C maximum junction temperature
- Thermistor inside

Applications

- Solar inverter Systems
- Three-level applications
- Energy Storage Systems
- High Frequency Switching application

Circuit diagram

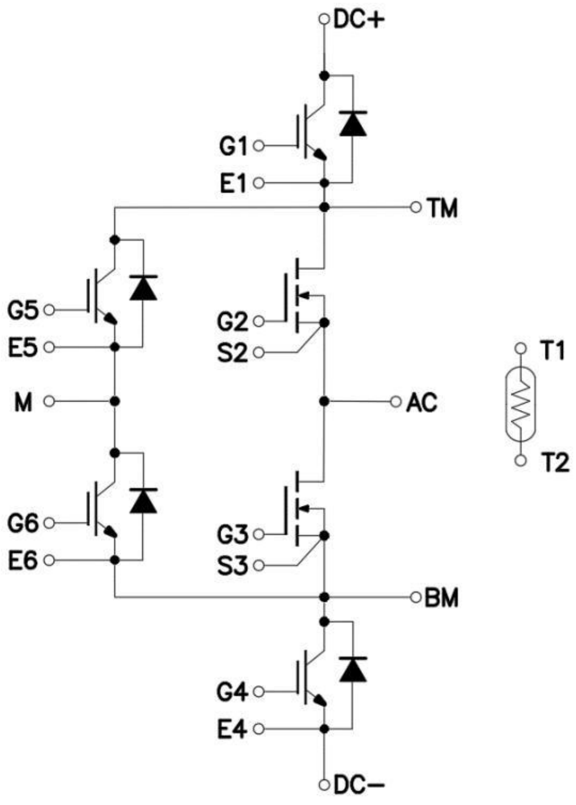

Figure 1. Out drawing & circuit diagram for DFH10AL12EZC1

Pin Configuration

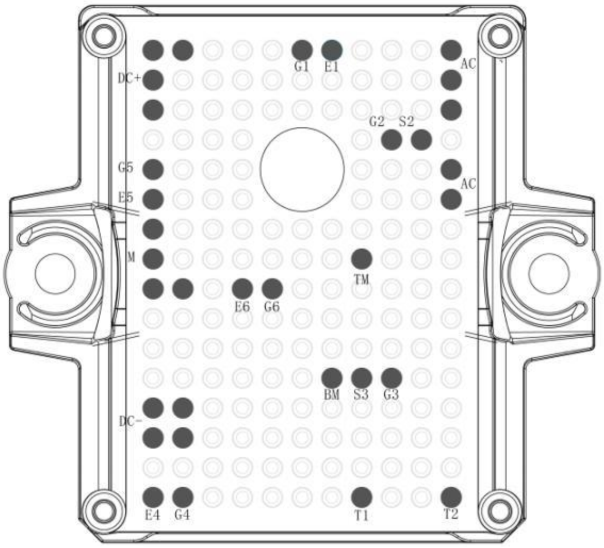

Figure 2. Pin configuration

Module

Parameter	Conditions	Value	Unit
Isolation voltage	Main terminal to base plate, RMS, f =50Hz, t =1min	3.0	kV
Creepage distance	terminal to heatsink	11.5	mm
	terminal to terminal	6.3	
Clearance	terminal to heatsink	10.0	
	terminal to terminal	5.0	
Comparative tracking index	-	> 400	
Mounting torque for module mounting	Screw M4 baseplate to heatsink	1.8 to 2.2	Nm
Storage temperature	-	-40 to 125	°C
Weight	-	40	g

NTC characteristics

Symbol	Parameter	Condition	Value			Unit
			Min.	Typ.	Max.	
R_{25}	Resistance	T_C =25°C	-	5	-	kΩ
ΔR/R	Deviation of R100	T_C =100°C, R_{100} =493Ω	-5	-	5	%
P_{25}	Power dissipation	T_C =25°C	-	-	20	mW
$B_{25/50}$	B-value	R2 =R25 exp [$B_{25/50}$(1/T2 - 1/(298,15 K))]	-	3375	-	K
$B_{25/80}$	B-value	R2 =R25 exp [$B_{25/80}$(1/T2 - 1/(298,15 K))]	-	3411	-	K
$B_{25/100}$	B-value	R2 =R25 exp [$B_{25/100}$(1/T2 - 1/(298,15 K))]	-	3433	-	K

Maximum Ratings (SiC MOSFET，T_j=25°C unless otherwise specified)

Symbol	Parameter	Conditions	Ratings	Unit
V_{DSS}	Drain-Source Voltage	G-S Short	1200	V
V_{GSS}	G-S Voltage	D-S Short, Note1	-10 to 22	V
I_{DS}	DC Continuous Drain Current	T_C=125°C	100	A
I_{SD}	Source (Body diode) Current	T_C=125°C	32	A
I_{DP}	Drain Pulse Current, Peak	Less than 1ms, Note2	200	A
T_j	junction temperature	-	-40 to 175	°C

Note1: Recommended Operating Value, +18V/-5V, +15V/-4V, +15V/-5V

Note2: Pulse width limited by maximum junction temperature

Maximum Ratings (IGBT and FRD，T_j=25°C unless otherwise specified)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CES}	Collector-Emitter Voltage	G-E Short	1200	V
V_{GES}	Gate-Emitter Voltage	C-E Short	±20	V
I_{CN}	DC Continuous Collector Current	T_C=135°C	100	A
I_{CM}	Pulse Collector Current	t_p=1ms, Note1	200	A
I_F	Diode forward Current	T_C=100°C	100	A
I_{FRM}	Repetitive peak forward Current	t_p=1ms, Note1	200	A
T_j	junction temperature	-	-40 to 175	°C
T_{stg}	Storage temperature	-	-40 to 125	°C

Note1: Pulse width limited by maximum junction temperature

MOSFET Electrical characteristics (T_j=25°C unless otherwise specified, chip)

Symbol	Item	Condition	Value			Unit
			Min.	Typ.	Max	

$V_{(BR)DSS}$	Drain-Source Breakdown Voltage	V_{GS} =0V, I_D =200uA		1200	-	-	V
I_{DSS}	Zero gate voltage drain Current	V_{DS}=1200V, V_{GS}=0V		-	2	-	μA
$V_{GS(th)}$	Gate-source threshold Voltage	I_D =70mA, V_{DS}=V_{GS}, T_j=25°C		1.8	2.7	-	V
		I_D =70mA, V_{DS}=V_{GS}, T_j=175°C		-	2.05	-	V
I_{GSS}	Gate-Source Leakage Current	V_{GS} =20V, V_{DS} =0V, T_j=25°C		-	200	-	nA
$R_{DS(on)}$ (Chip)	Static drain-source On-state resistance	I_D=100A V_{GS}=15V	T_j=25°C	-	9.5	-	mΩ
			T_j=175°C	-	14.3	-	mΩ
		I_D=100A V_{GS}=+18V	T_j=25°C	-	8.3	12.5	mΩ
			T_j=175°C	-	12.6	-	mΩ
$V_{DS(on)}$ (Chip)	Static drain-source On-state Voltage	I_D=100A V_{GS}=15V	T_j=25°C	-	0.95	-	V
			T_j=175°C	-	1.43	-	V
		I_D=100A V_{GS}=+18V	T_j=25°C	-	0.83	1.25	V
			T_j=175°C	-	1.26	-	V
C_{iss}	Input Capacitance	V_D=800V, V_{GS}=0V f=1MHz, V_{AC}=25mV		-	11.6	-	nF
C_{oss}	Output Capacitance			-	0.352	-	nF
C_{rss}	Reverse transfer Capacitance			-	0.028	-	nF

Q_G	Total gate charge	V_{DD}=800V, I_D=120A, V_{GS}=-5/+15V		-	360	-	nC
R_{Gint}	Internal Gate Resistance	f=1Mhz, V_{AC}=25mV		-	0.65	-	Ω
$t_{d(on)}$	Turn-on delay time	V_{DD}=600V I_D=100A V_{GS}=+15V/-4V R_g=5.1Ω Inductive load switching operation	T_j=25°C	-	43	-	ns
			T_j=150°C	-	40	-	
t_r	Rise time		T_j=25°C	-	23	-	ns
			T_j=150°C	-	19	-	
$t_{d(off)}$	Turn-off delay time		T_j=25°C	-	112	-	ns
			T_j=150°C	-	120	-	
t_f	Fall time		T_j=25°C	-	15	-	ns
			T_j=150°C	-	40	-	
E_{on}	Turn-on power dissipation		T_j=25°C	-	2.22	-	mJ
			T_j=150°C	-	2.31	-	
E_{off}	Turn-off power dissipation		T_j=25°C	-	1.50	-	mJ
			T_j=150°C	-	1.59	-	
$R_{th(j-c)}$	FET Thermal Resistance	Junction to Case/MOSFET		-	0.32	-	K/W
$R_{th(c-s)}$	Thermal Resistance, Case to sink (Conductive Grease applied) , Note1			-	0.12	-	K/W

Note1: Assumes Thermal Conductivity of grease is 2.8W/m·K and thickness is 50um.

Body Diode Electrical characteristics (T_j=25°C unless otherwise specified, chip: Target)

Symbol	Item	Condition		Value			Unit
				Min.	Typ.	Max	
V_{SD}	Body Diode Forward Voltage	V_{GS}=-5V I_{SD}=100A	T_j=25°C	-	5.1	-	V
			T_j=175°C	-	4.6	-	
T_{rr}	Reverse recovery time	V_{DD}=600V I_D=100A V_{GS}=+15/-4V R_g=5.1Ω Inductive load switching operation	T_j=25°C	-	26	-	ns
			T_j=150°C	-	50	-	
Q_{rr}	Reverse recovery charge		T_j=25°C	-	0.75	-	µC
			T_j=150°C	-	3.20	-	
E_{rr}	Diode switching power		T_j=25°C	-	0.12	-	mJ

	dissipation		T_j =150°C	-	0.79	-	

IGBT Electrical characteristics (T_j =25°C unless otherwise specified, chip)

Symbol	Item	Condition		Value			Unit
				Min.	Typ.	Max	
$V_{CE(sat)}$ (Chip)	Collector-Emitter Saturation Voltage	I_C =100A V_{GE} =15V	T_j =25°C	-	1.56	-	V
			T_j =175°C	-	1.81	-	V
$V_{GE(th)}$	Gate-Emitter threshold Voltage	I_C =2.6mA, V_{CE} =10V		-	5.9	-	V
Q_G	Gate charge	V_{GE} =-15V to +15V		-	2.0	-	uC
R_{Gint}	Internal gate resistor	-	T_j =25°C	-	13	-	Ω
C_{ies}	Input Capacitance	V_{CE} =25V, V_{GE} =0V f=1MHz	T_j =25°C	-	3.56	-	nF
C_{res}	Reverse transfer Capacitance			-	0.04	-	nF
I_{CES}	Collector- Emitter Cut off Current	V_{CE} =1200V, V_{GE} =0V	T_j =25°C	-	-	0.01	mA
I_{GES}	Gate-Emitter Leakage Current	V_{GE} =20V, V_{CE} =0V	T_j =25°C	-	-	0.1	uA

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$t_{d(on)}$	Turn-on delay time	V_{CC} =600V I_C= 100A V_{GE} =+15V/-15V R_g =1.5Ω Inductive load	T_j =25°C	-	100	-	ns
			T_j =125°C	-	108	-	
			T_j =175°C	-	114	-	
t_r	Rise time		T_j =25°C	-	31	-	ns
			T_j =125°C	-	34	-	
			T_j =175°C	-	37	-	
$t_{d(off)}$	Turn-off delay time		T_j =25°C	-	228	-	ns
			T_j =125°C	-	299	-	
			T_j =175°C	-	342	-	
t_f	Fall time		T_j =25°C	-	210	-	ns
			T_j=125°C	-	308	-	
			T_j =175°C	-	384	-	
E_{on}	Turn-on power dissipation		T_j =25°C	-	1.24	-	mJ
			T_j =125°C	-	1.80	-	
			T_j =175°C	-	2.01	-	
E_{off}	Turn-off power dissipation		T_j =25°C	-	6.7	-	mJ
			T_j =125°C	-	12.2	-	
			T_j =175°C	-	15.1	-	
$R_{th(j-c)}$	Thermal Resistance, Junction to Case (IGBT)			-	0.16	-	K/W
$R_{th(c-s)}$	Thermal Resistance, Case to sink (Conductive Grease applied) , Note1			-	0.12	-	K/W

Note1: Assumes Thermal Conductivity of grease is 2.8W/m·K and thickness is 50um.

Freewheeling Diode Electrical characteristics (T_j =25°C unless otherwise specified, chip)

Symbol	Item	Condition		Value			Unit
				Min.	Typ.	Max	
V_F	Diode Forward Voltage	I_F =100A, V_{GE} =0V	T_j =25°C	-	1.9	-	V
			T_j =175°C	-	1.75	-	
			T_j =25°C	-	0.36	-	

t_{rr}	Reverse recovery time	(Switch side) V_{CC}=600V I_C=100A V_{GE}= +15V/-15V R_g=1.5Ω (FRD side) V_{rr}=600V I_F=100A V_{GE}= +15V/-15V Inductive load switching operation	T_j=125°C	-	0.53	-	us
			T_j=175°C	-	0.71	-	
I_{RM}	Peak reverse recovery Current		T_j=25°C	-	103	-	A
			T_j=125°C	-	131	-	
			T_j=175°C	-	154	-	
Q_{rr}	Recovered charge		T_j=25°C	-	9.32	-	uC
			T_j=125°C	-	16.7	-	
			T_j=175°C	-	27.2	-	
E_{rr}	Reverse recovered energy		T_j=25°C	-	3.74	-	mJ
			T_j=125°C	-	6.90	-	
			T_j=175°C	-	8.77	-	
$R_{th(j-c)}$	Thermal Resistance, Junction to Case (Diode)			-	0.28	-	K/W
$R_{th(c-s)}$	Thermal Resistance, Case to sink (Conductive Grease applied) , Note1			-	0.12	-	K/W

Note1: Assumes Thermal Conductivity of grease is 2.8W/m·K and thickness is 50um.

Test Conditions

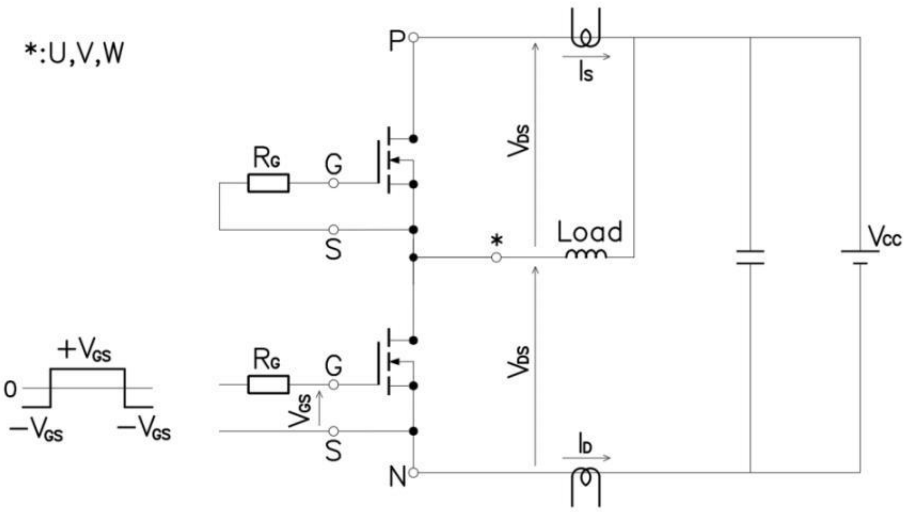


Figure 3. Switching time measure circuit

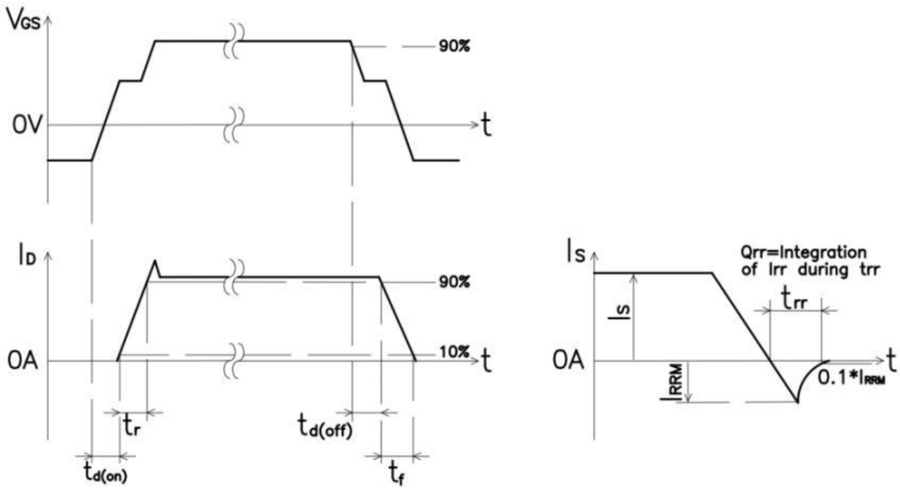


Figure 4. Switching time definition

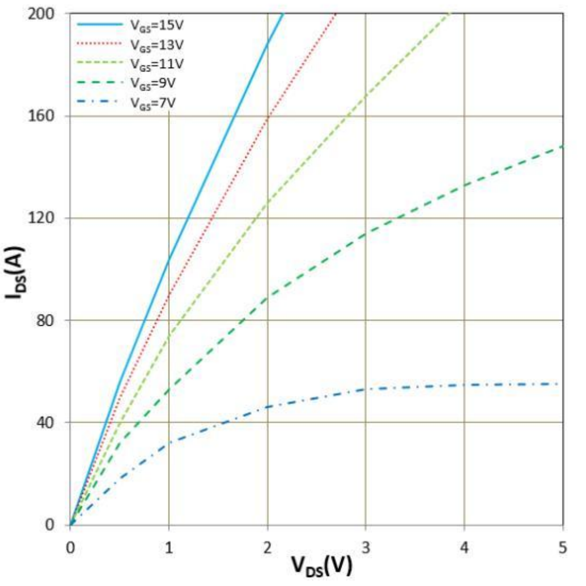


Figure 5. I_{DS} vs V_{DS}, SiC MOSFET

T_j =25°C, V_{GS} parameter

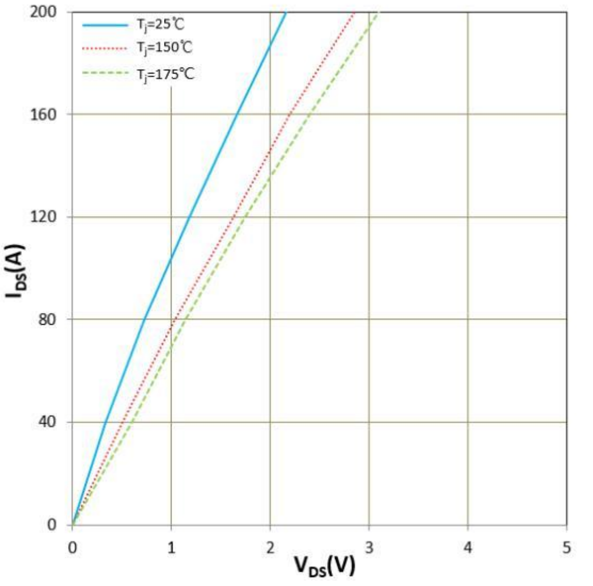


Figure 6. I_{DS} vs V_{DS}, SiC MOSFET

V_{GS} =+15V

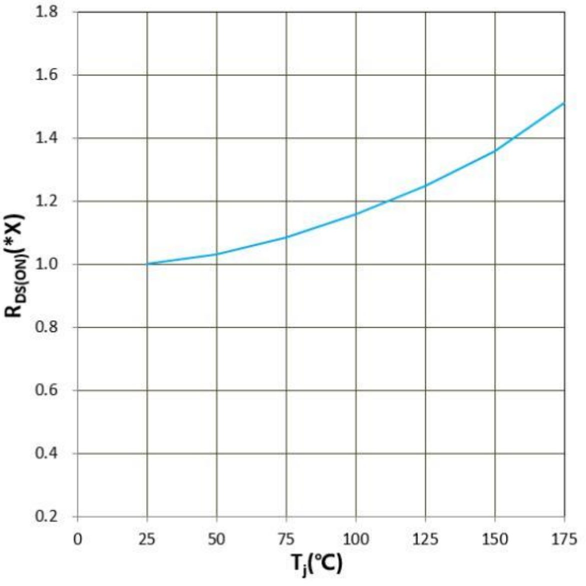


Figure 7. $R_{DS(ON)}$ vs T_j, SiC MOSFET

V_{GS} =+15V, I_D =100A, 1.0X =9.5mΩ

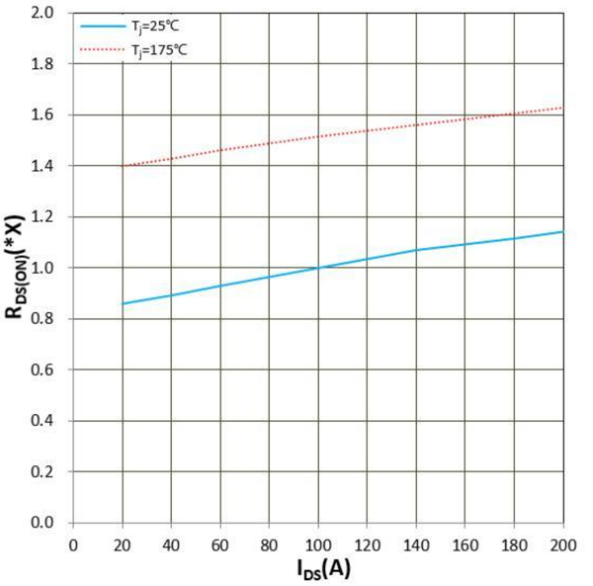


Figure 8. $R_{DS(ON)}$ vs I_{DS}, SiC MOSFET

V_{GS} =+15V, 1.0X =9.5mΩ

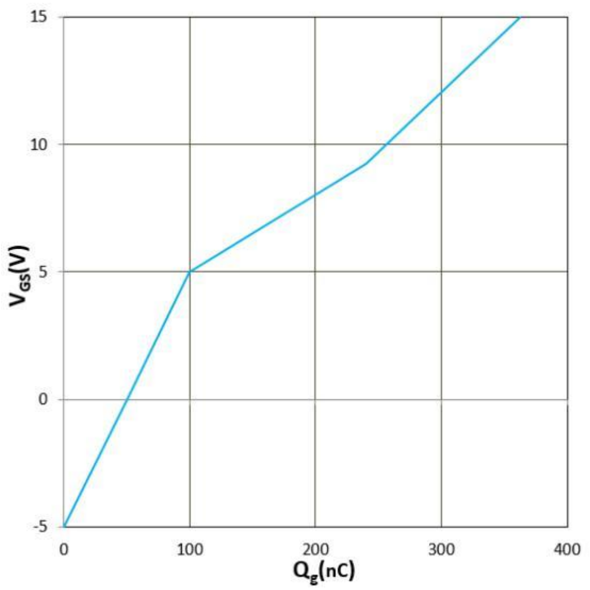


Figure 9. V_{GS} vs Q_g, SiC MOSFET

V_{DS} =800V, I_D =120A , T_j =25°C

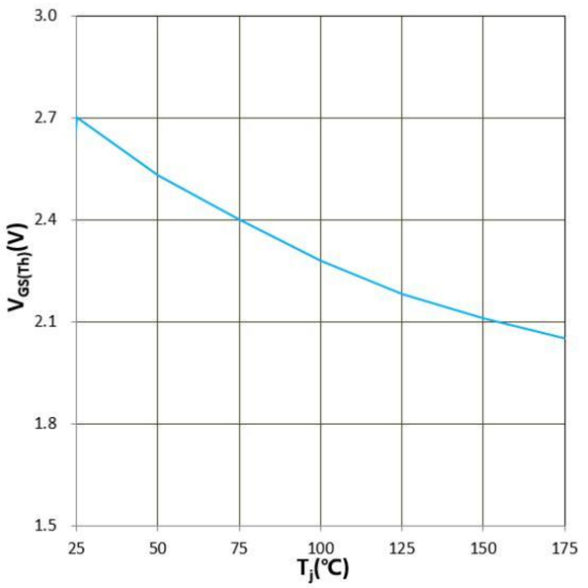


Figure 10. $V_{GS(TH)}$ vs T_j, SiC MOSFET

V_{GS} =V_{DS}, I_D =70mA

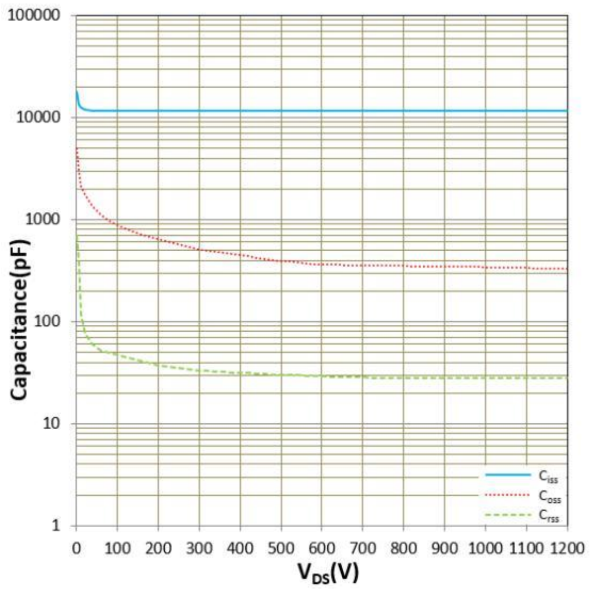


Figure 11. C_{iss}, C_{oss}, C_{rss} vs V_{DS}, SiC MOSFET

T_j =25°C, V_{GS} =0V, f=1MHz

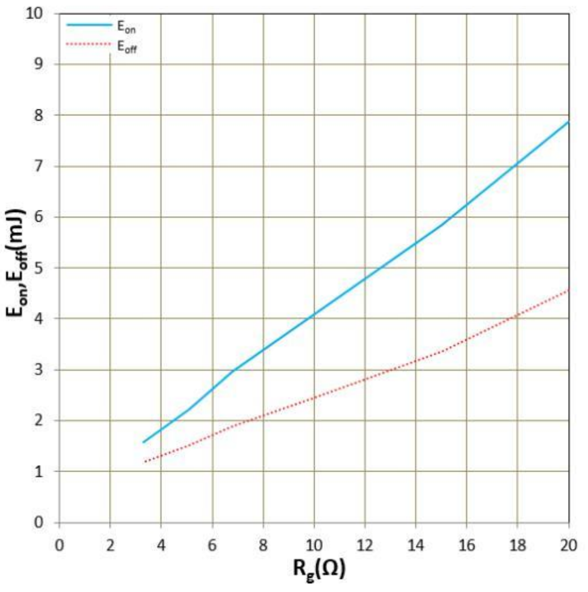


Figure 12. E_{on}, E_{off} vs R_g, SiC MOSFET

T_j =25°C, V_{CC} =600V, I_D =100A, V_{GS} =+15V/-4V

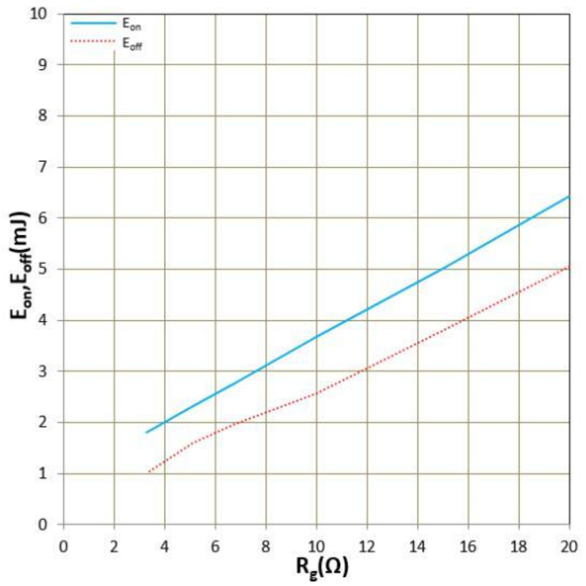


Figure 13. E_{on}, E_{off} vs R_g, SiC MOSFET

T_j =150°C, V_{CC} =600V, I_D =100A , V_{GS} =+15V/-4V

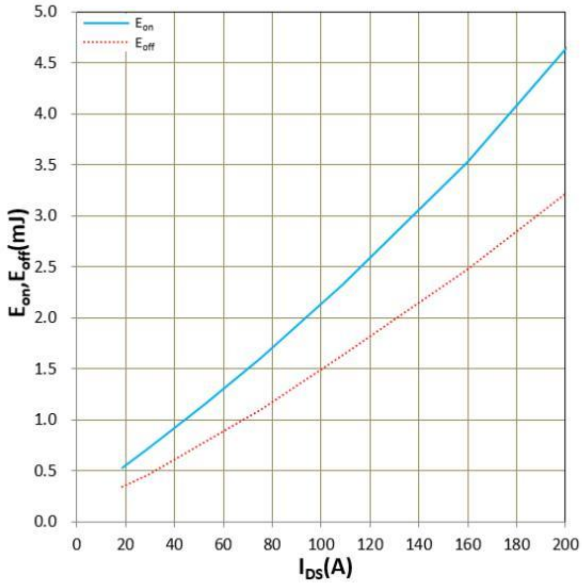


Figure 14. E_{on}, E_{off} vs I_{DS}, SiC MOSFET

T_j =25°C, V_{CC} =600V, R_g =5.1Ω, V_{GS} =+15V/-4V

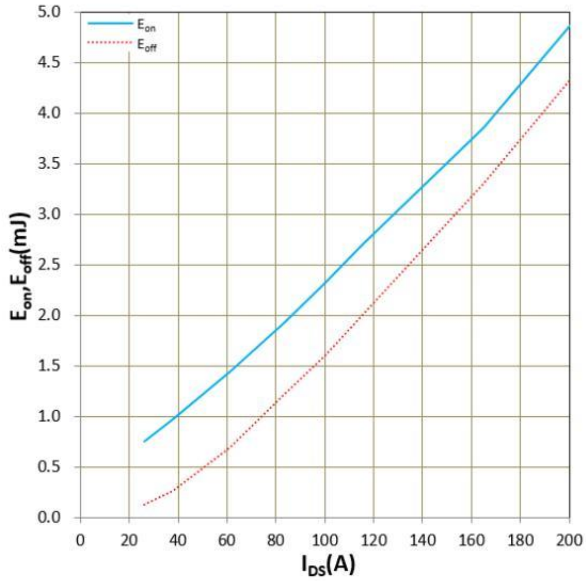
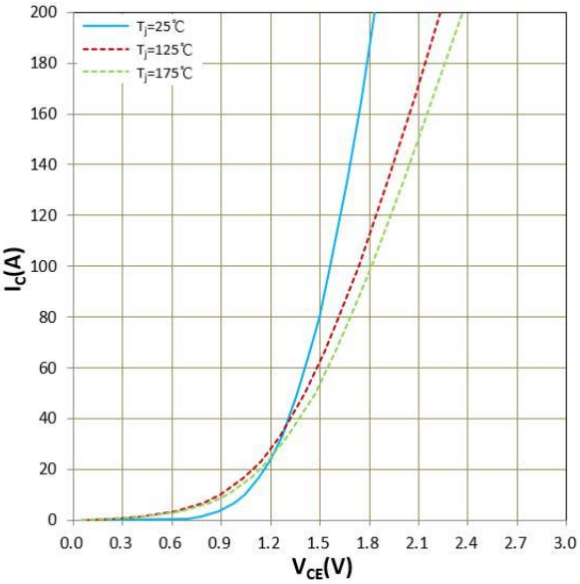


Figure 15. E_{on}, E_{off} vs I_{DS}, SiC MOSFET

T_j =150°C, V_{CC} =600V, R_g =5.1Ω, V_{GS} =+15V/-4V



igure 16. Ic vs V_{GE}, IGBT

V_{GE} =15V

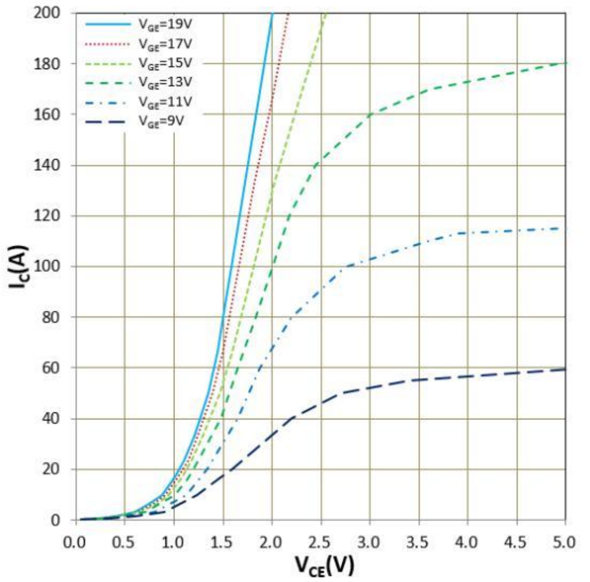


Figure 17. Ic vs V_{CE}, IGBT

T_j =175°C

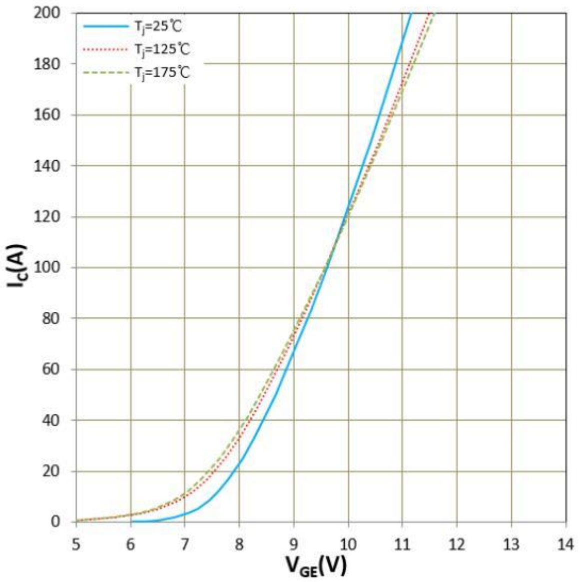


Figure 18. Ic vs V_{GE}, IGBT

V_{CE} =20V

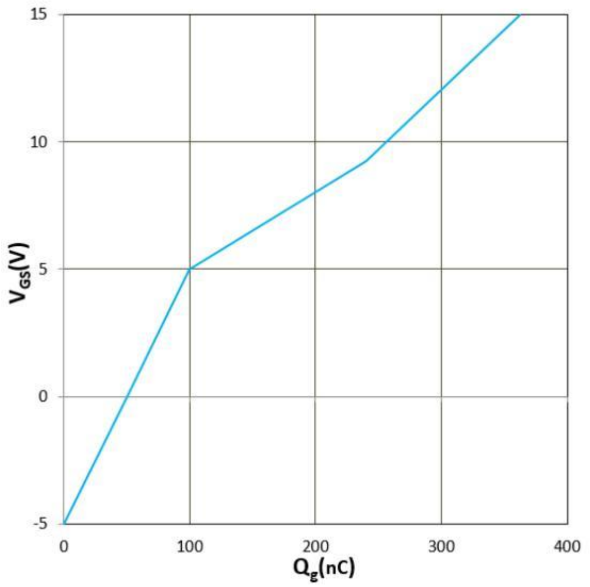


Figure 19. V_{GE} vs Q_g, IGBT

V_{CC} =600V, I_D =100A , T_j =25°C

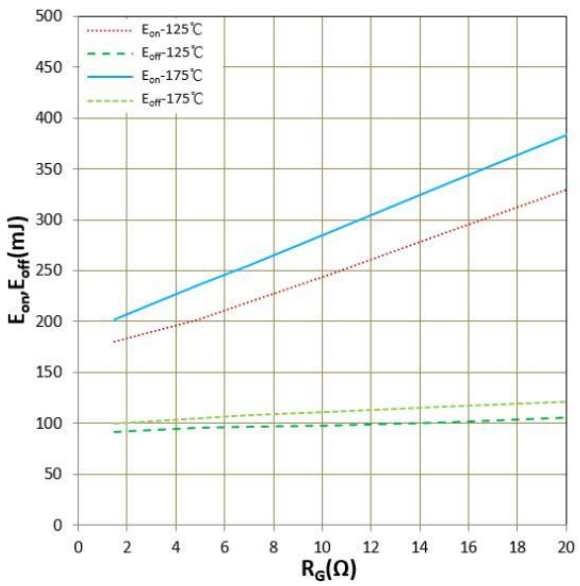


Figure 20. E_{on}, E_{off} vs I_C, IGBT

V_{CC}=600V, V_{GE}=±15V, R_g=1.5Ω

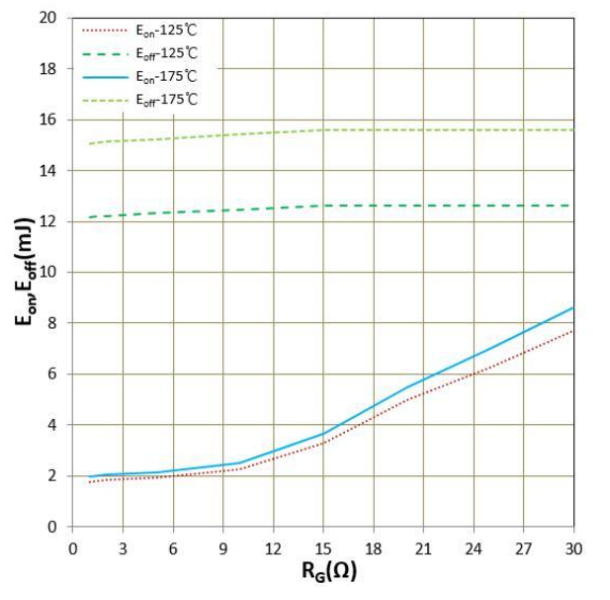


Figure 21. E_{on}, E_{off} vs R_g, IGBT

V_{CC}=600V, V_{GE}=±15V, I_C=100A

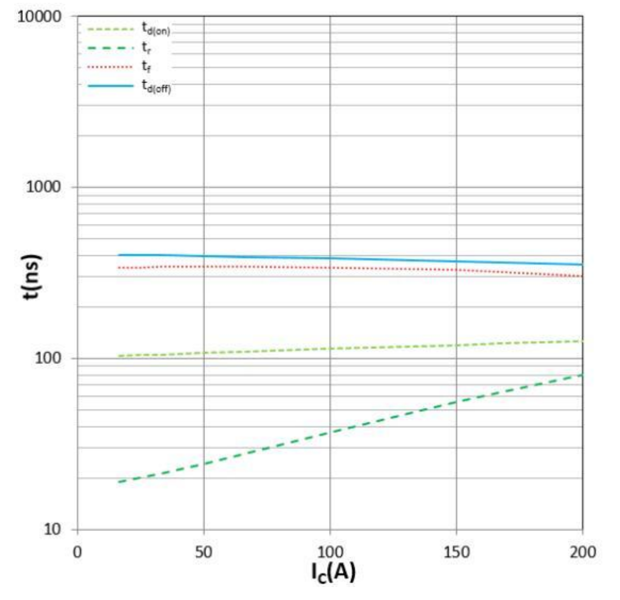


Figure 22. Switching time vs I_C, IGBT

V_{CC}=600V, V_{GE}=±15V, R_g =1.5Ω, T_j=175°C

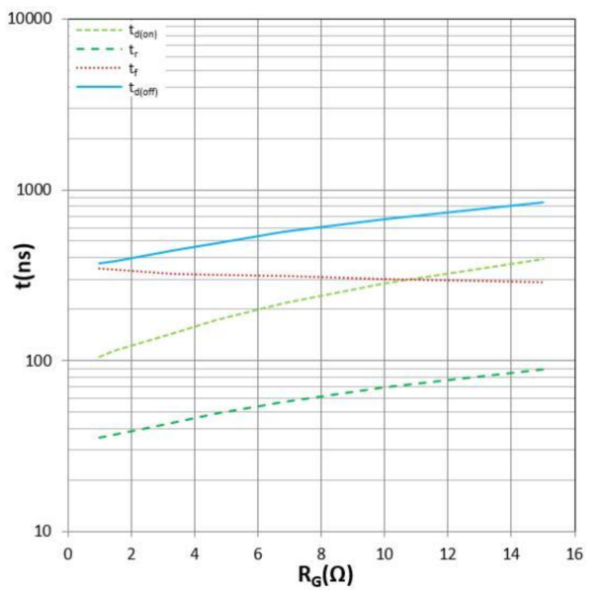


Figure 23. Switching time vs R_g, IGBT

V_{CC}=600V, V_{GE}=±15V, I_C =100A, T_j=175°C

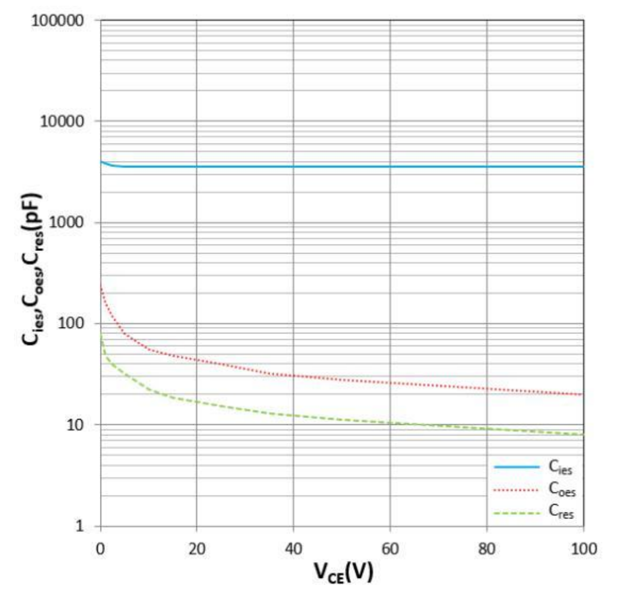


Figure 24. C_{ies}, C_{oss}, C_{res} vs V_{CE}, IGBT

T_j =25°C, V_{GE} =0V, f=1MHz

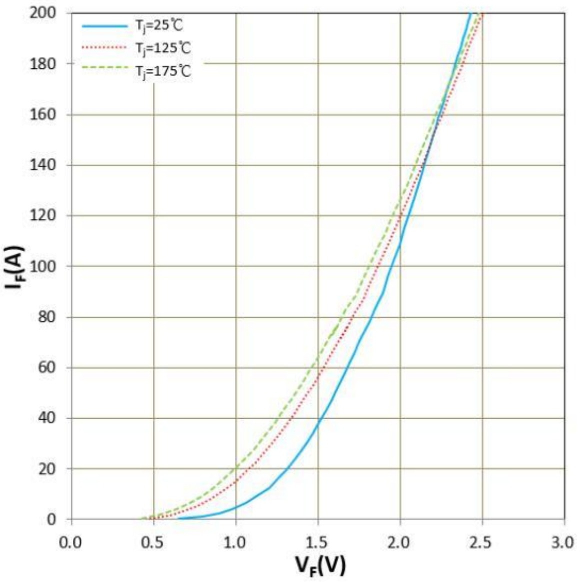


Figure 25. I_F vs V_F, Freewheeling Diode

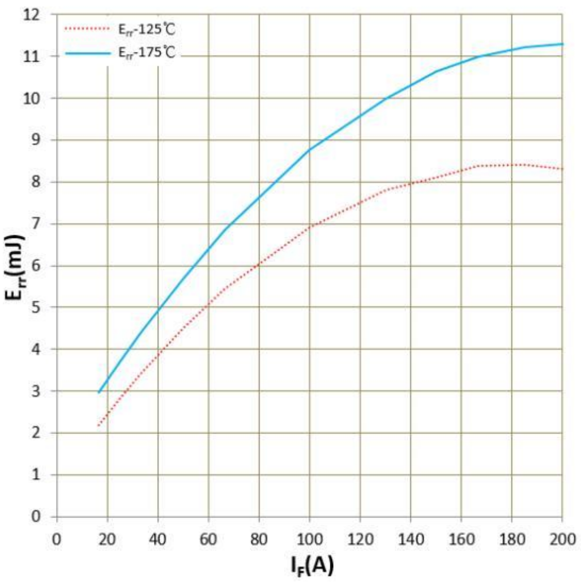


Figure 26. E_{rr} vs I_F, Freewheeling Diode

V_{CC}=600V, R_g=1.5Ω

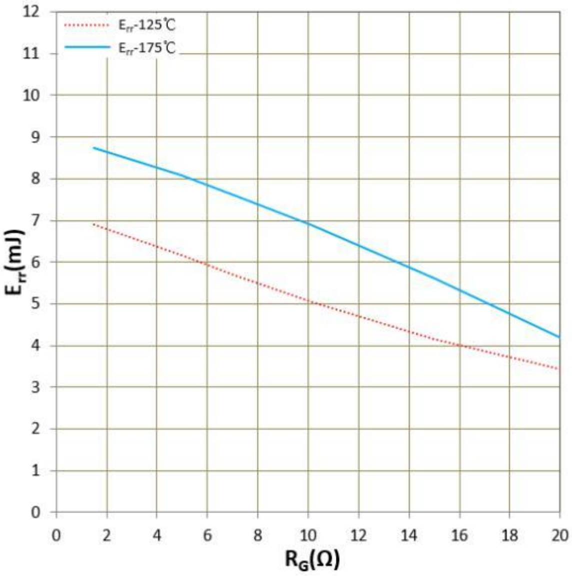
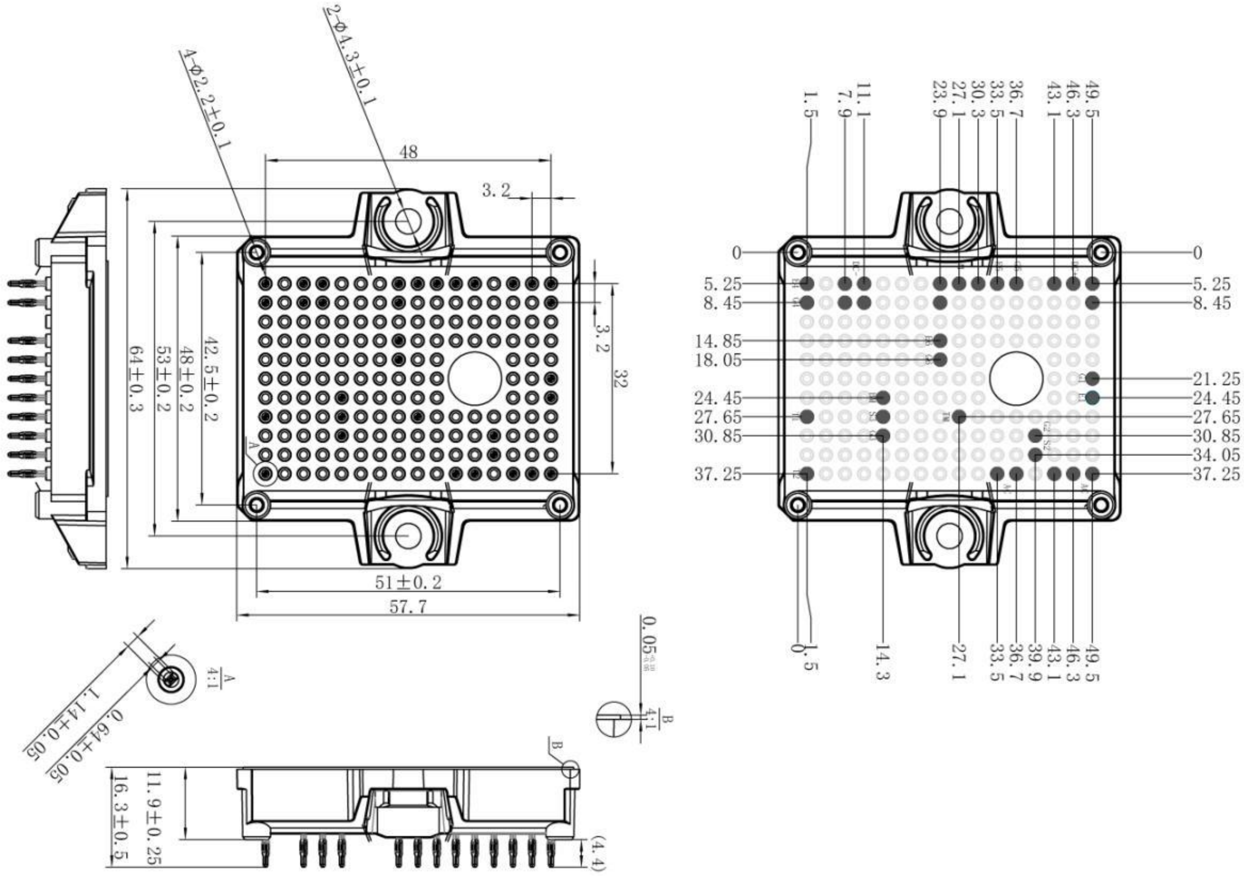


Figure 27. E_{rr} vs R_g, Freewheeling Diode

V_{CC}=600V, I_C=100A

Package dimensions



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