

<Full SiC Power Modules>

FMF300E3XZ-34B

HIGH POWER SWITCHING USE
INSULATED TYPE



Chopper

Drain current I_D **300 A**
 Drain-Source voltage V_{DSX} **1700 V**
 Maximum junction temperature T_{vjmax} **175 °C**

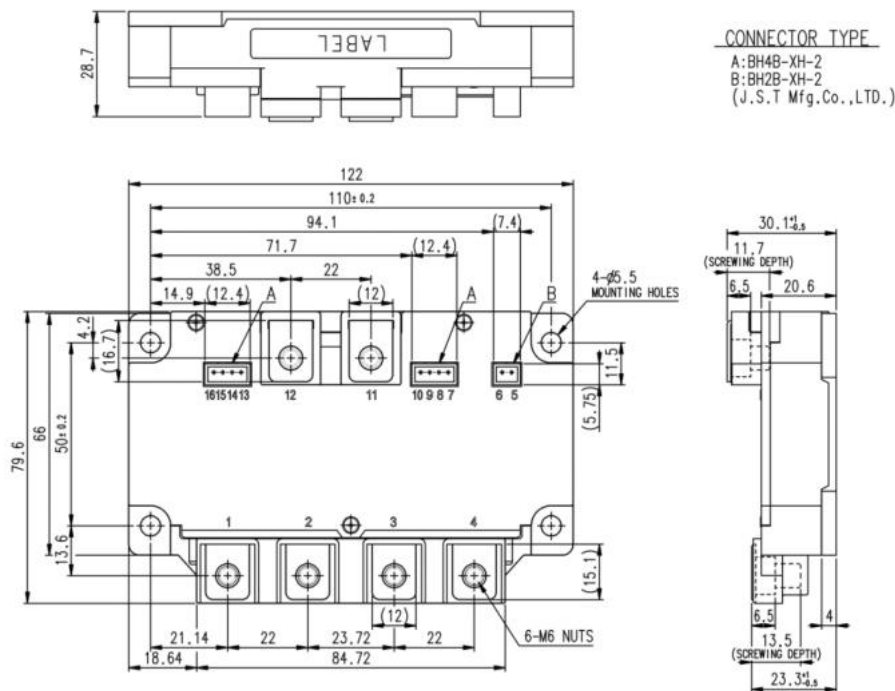
- Silicon Carbide MOSFET + Silicon Carbide Schottky Barrier Diode
- Flat base Type
- Copper base plate
- RoHS Directive compliant
- Recognized under UL1557, File E323585

APPLICATION

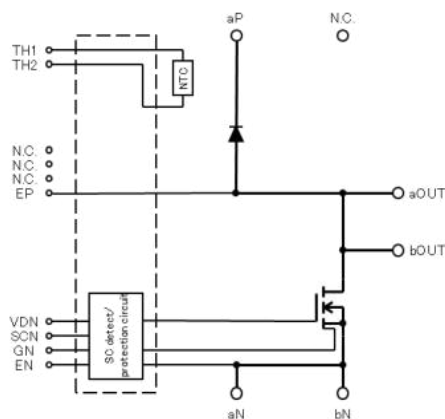
Power supply

OUTLINE DRAWING & INTERNAL CONNECTION

Dimension in mm



INTERNAL CONNECTION



Terminal code

- | | |
|----|------|
| 1 | aP |
| 2 | aN |
| 3 | bN |
| 4 | N.C. |
| 5 | TH1 |
| 6 | TH2 |
| 7 | VDN |
| 8 | SCN |
| 9 | GN |
| 10 | EN |
| 11 | bOUT |
| 12 | aOUT |
| 13 | EP |
| 14 | N.C. |
| 15 | N.C. |
| 16 | N.C. |

Tolerance otherwise specified

Division of Dimension	Tolerance
0.5 to 3	±0.2
over 3 to 6	±0.3
over 6 to 30	±0.5
over 30 to 120	±0.8
over 120 to 400	±1.2

aN and bN, aOUT-bOUT must be connected externally.

FMF300E3XZ-34BHIGH POWER SWITCHING USE
INSULATED TYPE**MAXIMUM RATINGS (T_{vj} =25 °C, unless otherwise specified)****MOSFET**

Symbol	Item	Conditions	Rating	Unit
V _{DSX}	Drain-source voltage	V _{GS} =-15 V	1700	V
V _{GSS}	Gate-source voltage	D-S short-circuited	±20	V
I _D	Drain current	DC, T _C =48°C (Note.1)	300	A
I _{DRM}		Pulse, Repetitive (Note.2), T _{vj} =150°C	450	
P _{tot}	Total power dissipation	T _C =25 °C (Note. 1)	1230	W

SBD

Symbol	Item	Conditions	Rating	Unit
V _{RRM}	Repetitive peak reverse voltage	-	1700	V
I _F	Forward current	DC	300	A
I _{FRM}		Pulse, Repetitive (Note.2)	450	

MODULE

Symbol	Item	Conditions	Rating	Unit
V _{isol}	Isolation voltage	Terminals to base plate, RMS, f=60 Hz, AC 1 min	5000	V
T _{vjmax}	Maximum junction temperature	Instantaneous event (overload) (Note.9)	175	°C
T _{vjop}	Operating junction temperature	Continuous operation (under switching) (Note.9)	-40~+150	°C
T _{cmax}	Maximum case temperature	(Note.1, 9)	125	°C
T _{stg}	Storage temperature	-	-40~+125	°C

ELECTRICAL CHARACTERISTICS (T_{vj}=25 °C, unless otherwise specified)]**MOSFET**

Symbol	Item	Conditions (note.8)	Limits			Unit
			Min.	Typ.	Max.	
I _{DSX}	Drain-source cut-off current	V _{DS} =V _{DSX} , V _{GS} =-15 V	-	-	0.1	mA
V _{GS(th)}	Gate-source threshold voltage	I _D =113 mA, V _{DS} =10 V	1.8	2.5	3.2	V
I _{GSS}	Gate-source leakage current	V _{GS} =V _{GSS} , D-S short-circuited	-	-	0.5	μA
V _{DS(on)} (terminal)	Drain-source on-state voltage	I _D =300 A, V _{GS} =15V (Note.5)	T _{vj} =25 °C	-	1.65	V
			T _{vj} =125 °C	-	2.19	
			T _{vj} =150 °C	-	2.33	
V _{DS(on)} (chip)	Drain-source on-state voltage	I _D =300 A, V _{GS} =15V (Note.5)	T _{vj} =25 °C	-	1.47	V
			T _{vj} =125 °C	-	2.01	
			T _{vj} =150 °C	-	2.15	
r _{DS(on)} (chip)	Drain-source on-state resistance	I _D =300 A, V _{GS} =15V (Note.5)	T _{vj} =25 °C	-	4.90	mΩ
			T _{vj} =125 °C	-	6.70	
			T _{vj} =150 °C	-	7.16	
C _{iss}	Input capacitance	V _{DS} =10 V, V _{GS} =0V	-	27.4	-	nF
C _{oss}	Output capacitance		-	11.5	-	
C _{rss}	Reverse transfer capacitance		-	0.98	-	
Q _G	Gate charge	V _{DD} =900 V, I _D =300 A, V _{GS} =0→15 V	-	800	-	nC
t _{d(on)}	Turn-on delay time	V _{DD} =900 V, I _D =300 A, V _{GS} =±15 V, T _{vj} =150°C, R _G =1.5Ω, L _{s_ext} =16nH, Inductive load, per pulse	-	200	-	ns
t _r	Rise time		-	50	-	
t _{d(off)}	Turn-off delay time		-	220	-	
t _f	Fall time		-	30	-	
E _{on}	Turn-on switching energy		-	16	-	mJ
E _{off}	Turn-off switching energy		-	5	-	
Q _C	Drain-source charge		-	2	-	μC
r _g	Internal gate resistance	Per switch	-	0.5	-	Ω

SBD

Symbol	Item	Conditions (note.8)	Limits			Unit
			Min.	Typ.	Max.	
I _{RRM}	Reverse current	V _{RM} =V _{RRM}	-	-	5	mA
		V _{DS} =1000V, V _{GS} =-15 V	-	-	0.5	
V _F (terminal)	Forward voltage	I _F =300 A (Note.5)	T _{vj} =25 °C	-	1.80	V
			T _{vj} =125 °C	-	2.45	
			T _{vj} =150 °C	-	2.69	
V _F (chip)	Forward voltage	I _F =300 A (Note.5)	T _{vj} =25 °C	-	1.64	V
			T _{vj} =125 °C	-	2.28	
			T _{vj} =150 °C	-	2.52	

MODULE

Symbol	Item	Conditions (note.8)	Limits			Unit
			Min.	Typ.	Max.	
R _{DD'+SS'}	Internal lead resistance	aP-EP, OUT-EN terminals, per switch	-	0.6	-	mΩ
L _s	Internal stray inductance	P-N	-	25	-	nH

THERMAL RESISTANCE CHARACTERISTICS

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$R_{th(j-c)Q}$	Thermal resistance ^(Note. 1)	Junction to case, per inverter switch	-	-	121	K/kW
$R_{th(j-c)D}$		Junction to case, per inverter FWD	-	-	131	
$R_{th(c-s)}$	Contact thermal resistance ^(Note. 1)	Case to heat sink, per 1 module, Thermal grease applied ^(Note. 7, 9)	-	12	-	K/kW

NTC THERMISTOR PART

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
R_{25}	Zero-power resistance	$T_C=25\text{ }^{\circ}\text{C}$ ^(Note. 1)	4.85	5.00	5.15	kΩ
$\Delta R/R$	Deviation of resistance	$T_C=100\text{ }^{\circ}\text{C}$ ^(Note. 1) , $R_{100}=493\text{ }\Omega$	-7.3	-	+7.8	%
$B_{(25/50)}$	B-constant	Approximate by equation ^(Note. 6)	-	3375	-	K
P_{25}	Power dissipation	$T_C=25\text{ }^{\circ}\text{C}$ ^(Note. 1)	-	-	10	mW

MECHANICAL CHARACTERISTICS

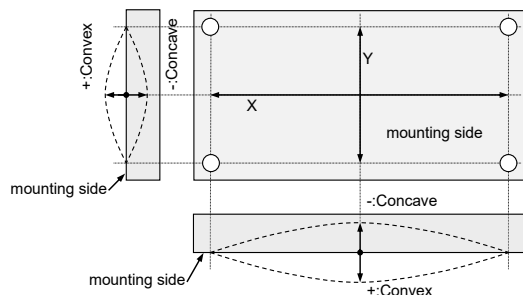
Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
M_t	Mounting torque	Main terminals M 6 screw	3.5	4.0	4.5	N·m
M_s		Mounting to heat sink M 5 screw	2.5	3.0	6.0	
m	mass	-	-	500	-	g
d_a	Clearance	-	10	-	-	mm
d_s	Creepage distance	-	17	-	-	mm
e_c	Flatness of base plate	On the centerline X, Y ^(Note. 4)	-100	-	+100	μm
-	Connector insertion force	2 pin type	0	-	25	N
		4 pin type	0	-	35	

*: This product is compliant with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) directive 2011/65/EU and (EU)2015/863.

Note1. Case temperature (T_C) and heat sink temperature (T_s) are defined on the each surface (mounting side) of base plate and heat sink just under the chips.

Refer to the figure of chip location.

- Pulse width and repetition rate should be such that the device junction temperature (T_{vj}) does not exceed $T_{vj\max}$ rating.
- Junction temperature (T_{vj}) should not increase beyond $T_{vj\max}$ rating.
- The base plate (mounting side) flatness measurement points (X, Y) are as follows of the following figure.



- Pulse width and repetition rate should be such as to cause negligible temperature rise.

$$6. B_{(25/50)} = \ln\left(\frac{R_{25}}{R_{50}}\right) / \left(\frac{1}{T_{25}} - \frac{1}{T_{50}}\right)$$

R_{25} : resistance at absolute temperature T_{25} [K]; $T_{25}=25\text{ }^{\circ}\text{C}+273.15=298.15$ [K]

R_{50} : resistance at absolute temperature T_{50} [K]; $T_{50}=50\text{ }^{\circ}\text{C}+273.15=323.15$ [K]

- Typical value is measured by using thermally conductive grease of $\lambda=0.9\text{ W/(m}\cdot\text{K)}/D_{(C-S)}=100\mu\text{m}$.

- Per switch (ex. Tr1 chips total in page.7)

- Long term performance related to thermal conductive grease (including but not limited to aspects such as the increase of thermal resistance due to pumping out, etc.) should be verified under your specific application conditions. Each temperature condition ($T_{vj\max}$, $T_{vj\text{op}}$, $T_{C\max}$) must be maintained below the maximum rated temperature throughout consideration of the temperature rise even for long term usage.

<Full SiC Power Modules>

FMF300E3XZ-34B

HIGH POWER SWITCHING USE
INSULATED TYPE

RECOMMENDED OPERATING CONDITIONS

Symbol	Item	Conditions	Limits			Unit	
			Min.	Typ.	Max.		
V _{DD}	(DC) Supply voltage	Applied across aP -aN+bN terminals	-	900	1200	V	
V _D	DC supply voltage (control)	Applied across VDN-EN terminals	13.5	15.0	16.5	V	
V _{GS(+)}	Gate-Source positive drive voltage	Applied across GN-EN terminals	13.5	15.0	16.5	V	
V _{GS(-)}	Gate-Source negative drive voltage	Applied across GN-EN terminals	-16.5	-15.0	-7.0	V	
R _G	External gate resistance ^(Note.10)	Per switch	1.5	-	7.5	Ω	
f _c	Switching frequency	V _{GS(+)} =15V, R _G =1.5Ω, V _{DD} =900V, T _{vj} =150°C	V _{GS(-)} <-10V	-	-	50	kHz
			V _{GS(-)} ≥-10V	-	-	100	kHz
t _{d(SCoff)}	Gate cutoff delay time after SC output	V _{GS} =15V, R _G =1.5Ω, V _{DD} ≤1200V, T _{vj} =150°C	-	-	3	μs	

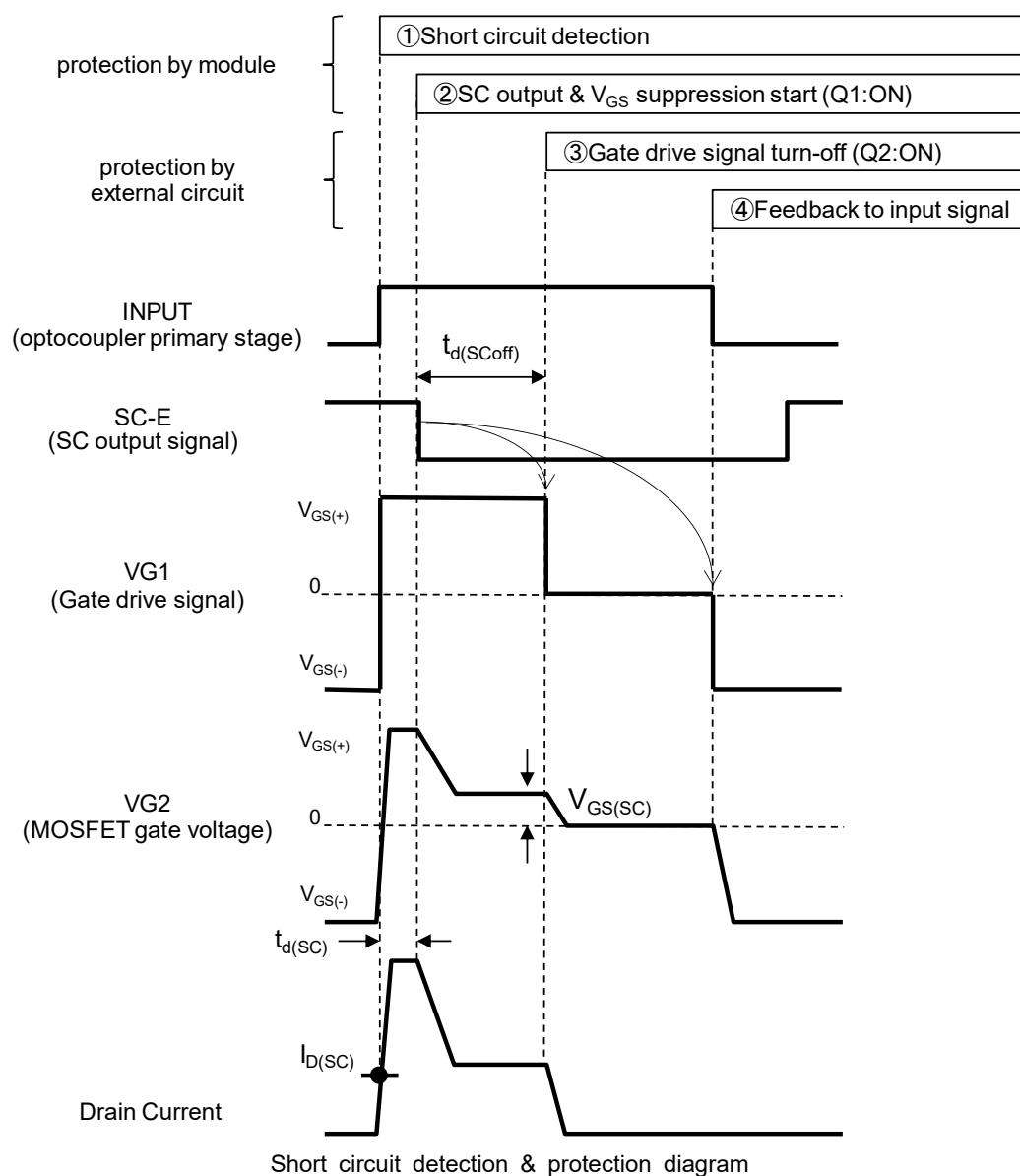
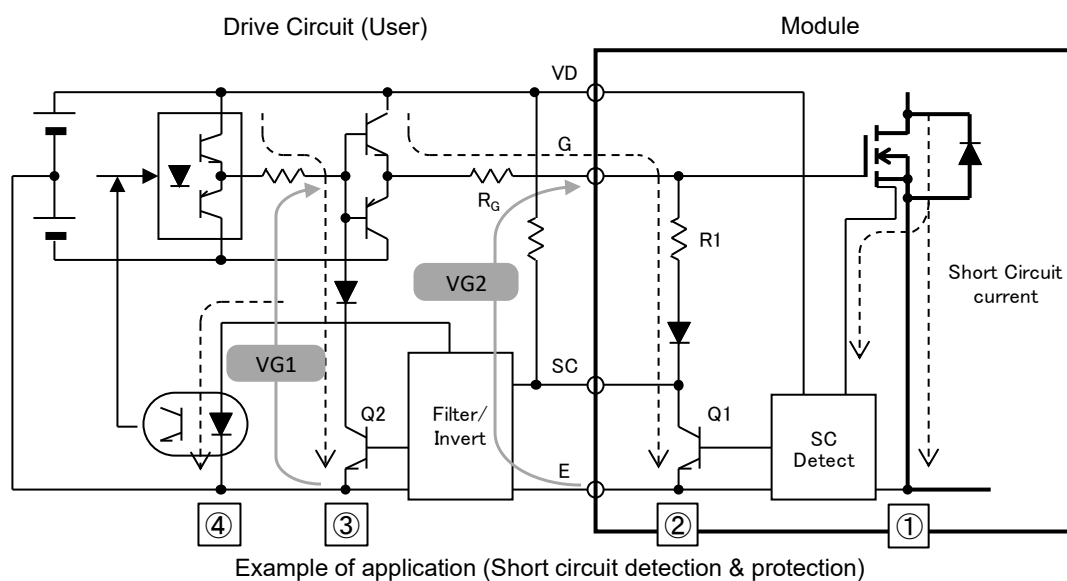
Note 10. The value of external gate resistance should be considered the surge voltage not to exceed the rating voltage in the worst system condition.

SHORT CIRCUIT DETECTION & PROTECTION CHARACTERISTICS

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$I_{D(SC)}$	SC detect drain current	$T_{vj}=150^\circ C$, $V_{GS}=15V$	450	600	-	A
$t_{d(SC)}$	SC detect delay time	$T_{vj}=150^\circ C$, $V_{DD} \leq 1200V$, $V_{GS}=15V$, $R_G=1.5\Omega$	-	1	-	μs
$V_{GS(SC)}$	SC protection gate limit voltage	$T_{vj}=150^\circ C$, $V_{GS}=15V$, $R_G=1.5\Omega$	-	0	-	V
$R1$	SC protection gate limit resistance	-	-	0	-	Ω

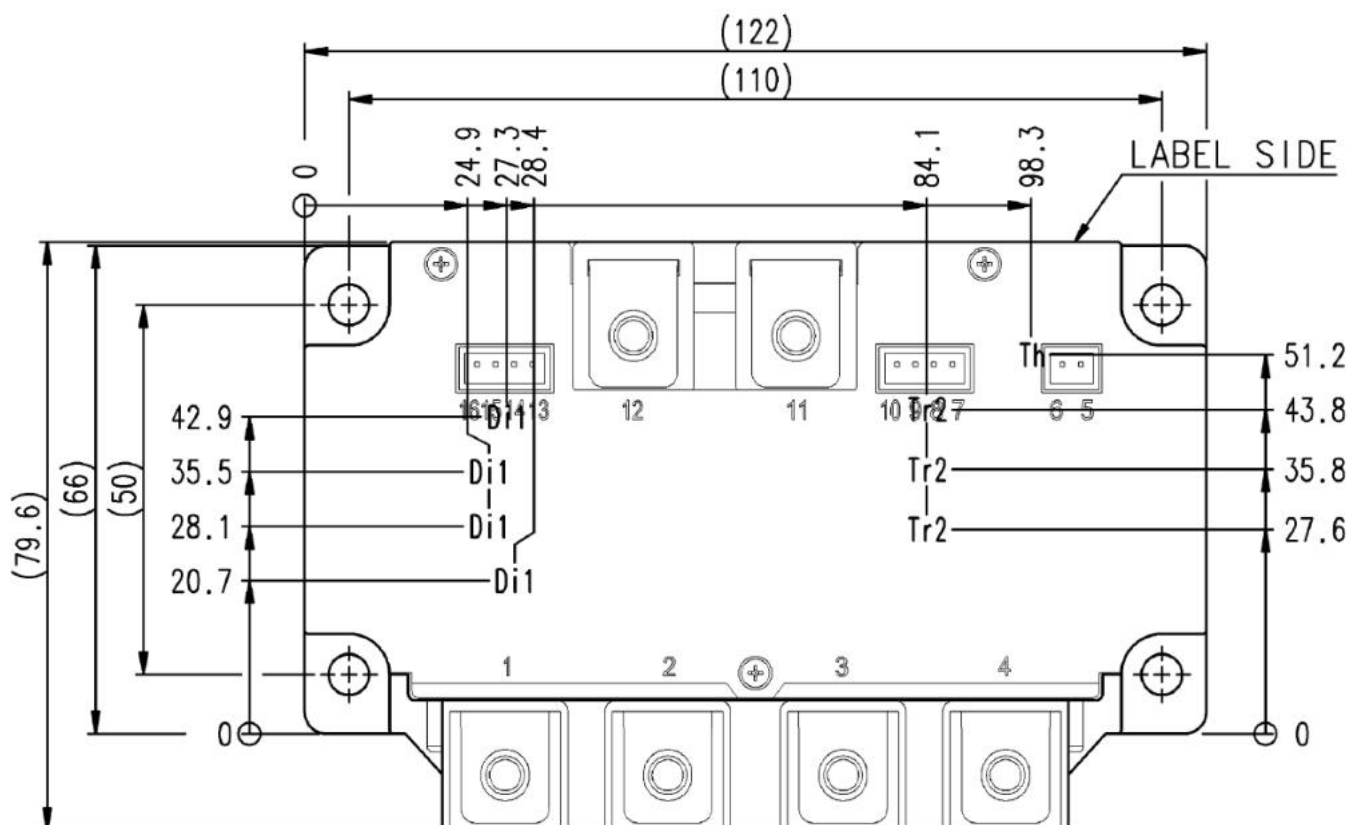
Refer to the circuit in page.6

SHORT CIRCUIT DETECTION & PROTECTION



CHIP LOCATION (Top view)

Dimension in mm, tolerance: ± 1 mm

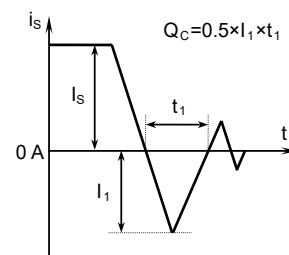
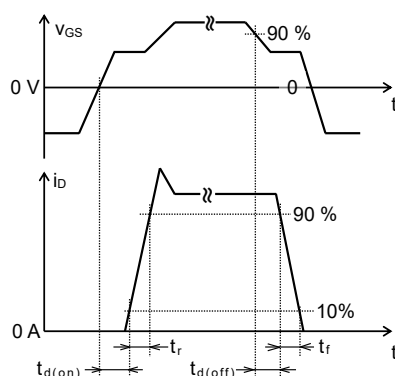
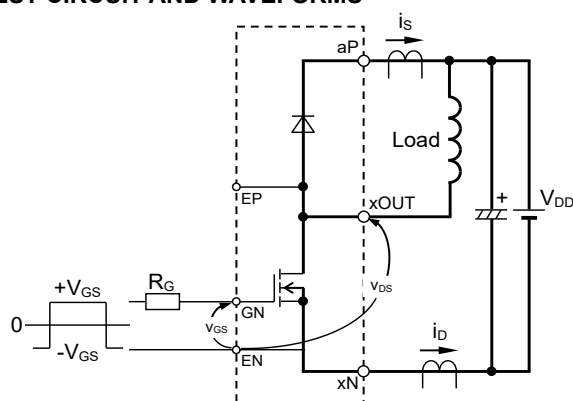


Tr2: SiC-MOSFET, Di1: SiC-SBD, Th: NTC thermistor

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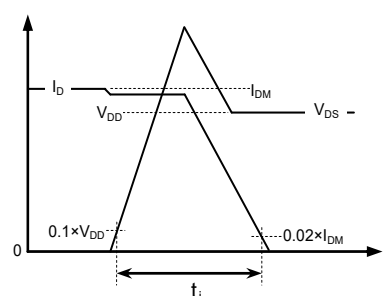
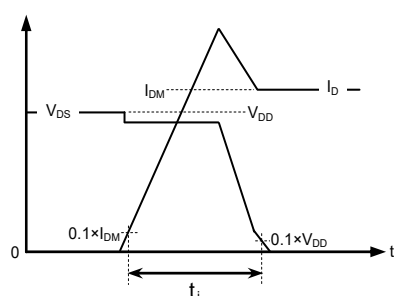
HIGH POWER SWITCHING USE
INSULATED TYPE

TEST CIRCUIT AND WAVEFORMS



Switching characteristics test circuit and waveforms(x: connected a* and b*)

Q_C test waveform

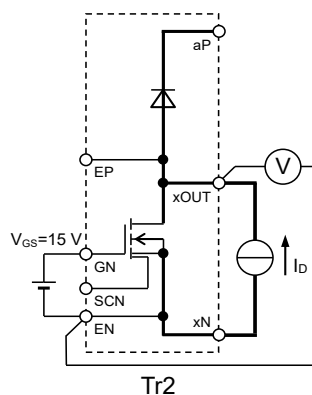


MOSFET Turn-on switching energy

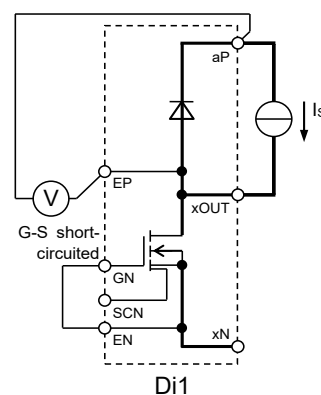
MOSFET Turn-off switching energy

Turn-on / Turn-off switching energy test waveforms (Integral time instruction drawing)

TEST CIRCUIT



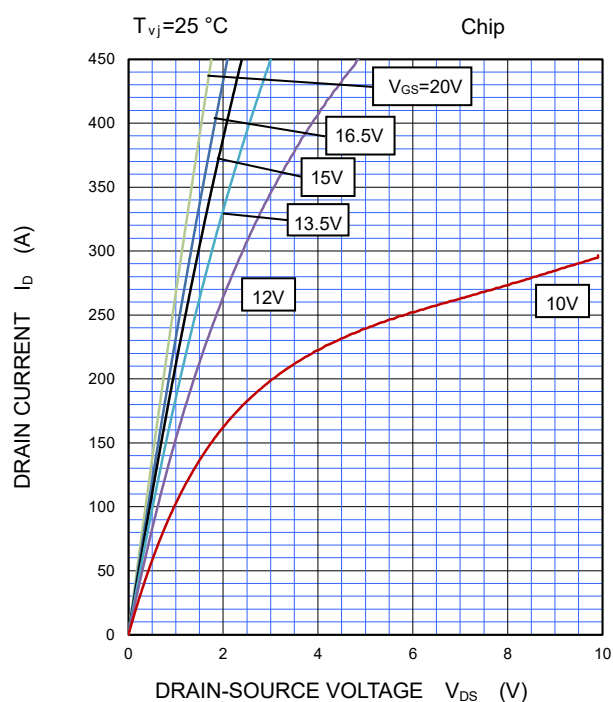
$V_{DS(on)}$ test circuit (x: Connected a* and b*)



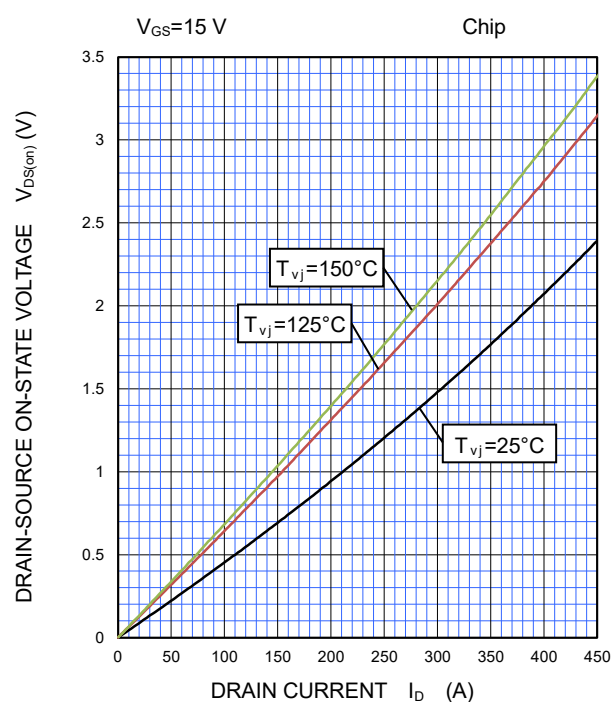
V_{SD} test circuit, $V_{GS}=-15V$ (x: Connected a* and b*)

PERFORMANCE CURVES

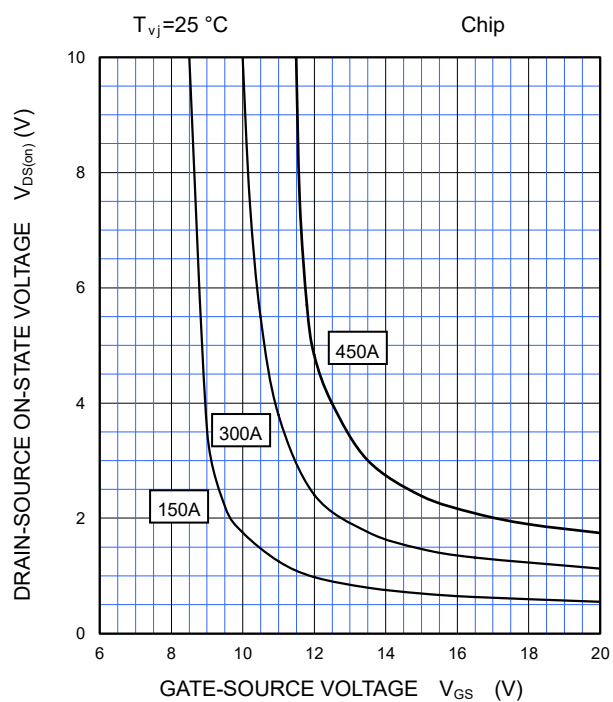
OUTPUT
CHARACTERISTICS
(TYPICAL)



MOSFET ON STATE VOLTAGE
CHARACTERISTICS
(TYPICAL)



MOSFET ON STATE VOLTAGE
CHARACTERISTICS
(TYPICAL)

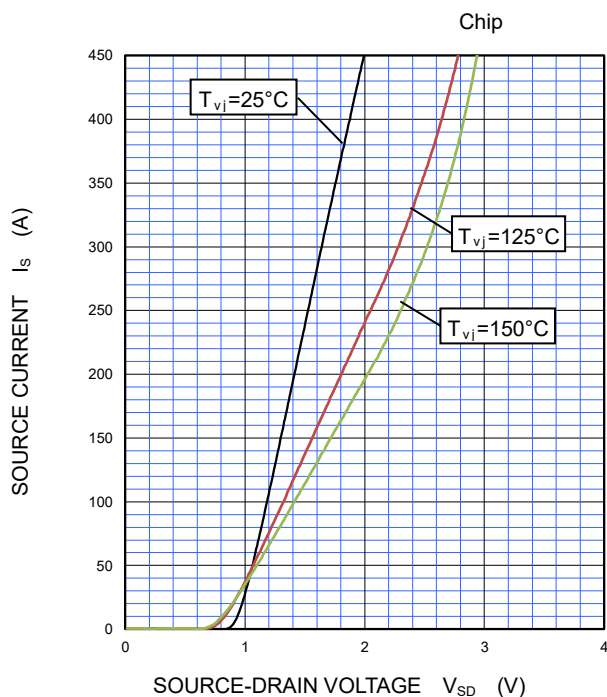


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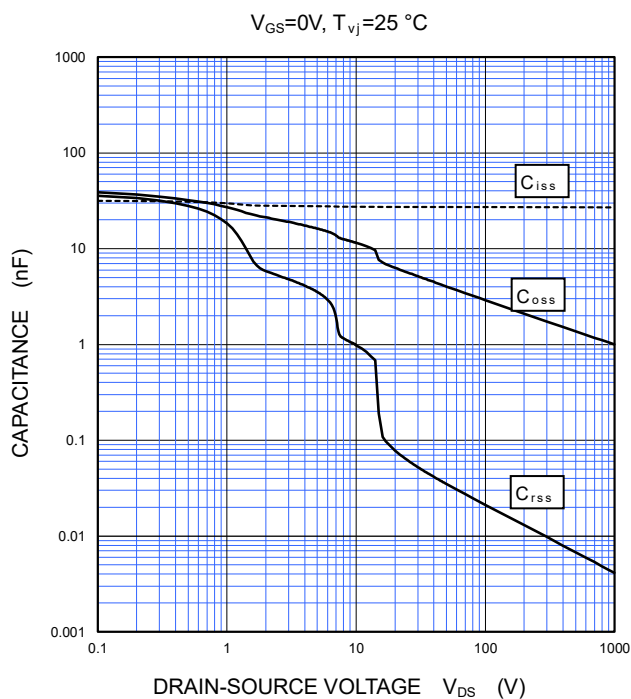
HIGH POWER SWITCHING USE
INSULATED TYPE

PERFORMANCE CURVES

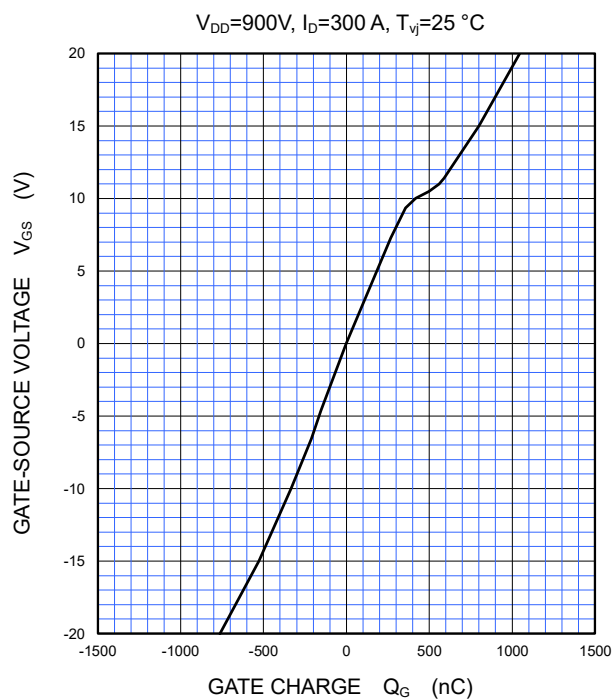
**DIODE
FORWARD CHARACTERISTICS
(TYPICAL)**



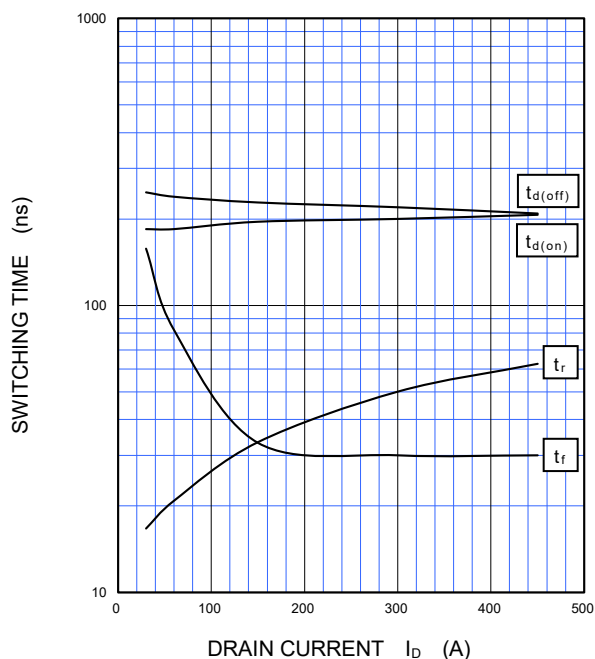
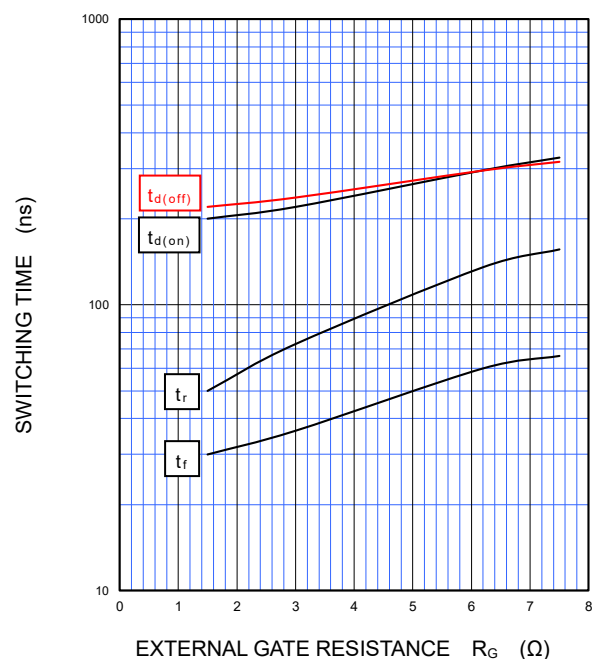
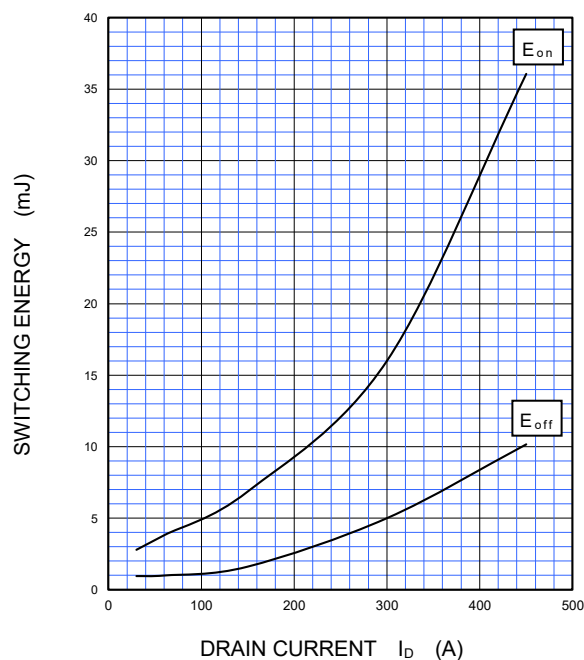
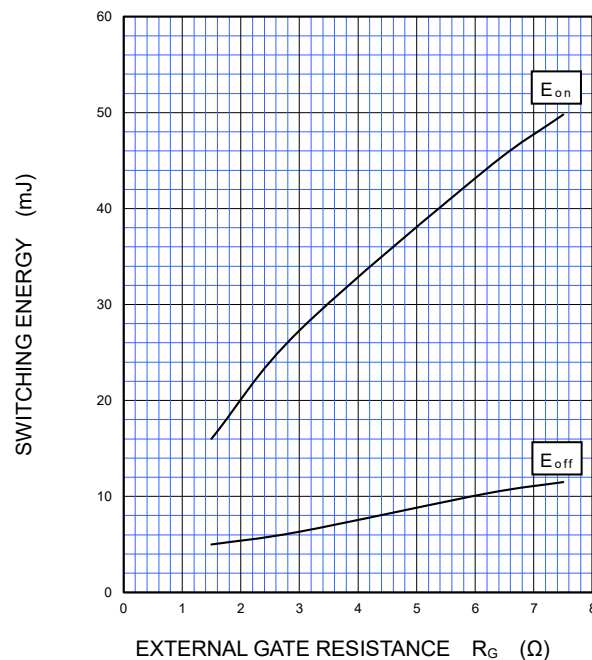
**MOSFET CAPACITANCE
CHARACTERISTICS
(TYPICAL)**



**GATE CHARGE
CHARACTERISTICS
(TYPICAL)**



PERFORMANCE CURVES

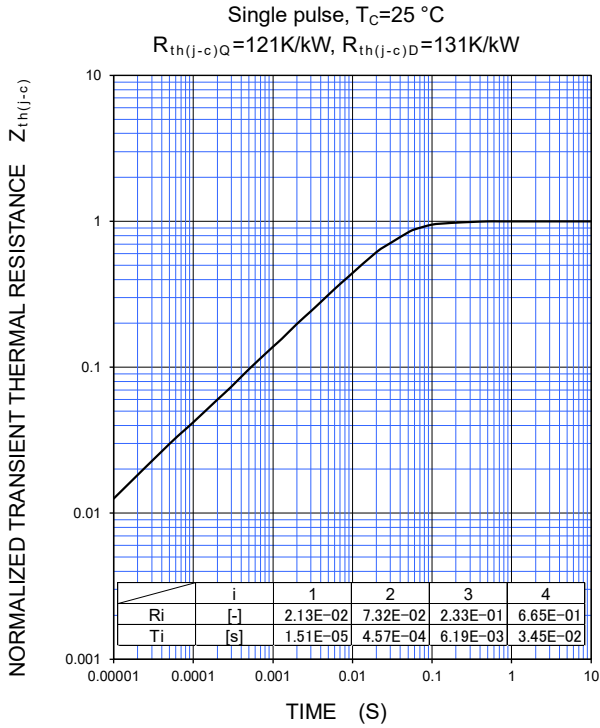
HALF-BRIDGE SWITCHING CHARACTERISTICS
(TYPICAL) $V_{DD}=900\text{ V}$, $V_{GS}=\pm 15\text{ V}$, $R_G=1.5\ \Omega$, $T_{vj}=150\text{ }^\circ\text{C}$, $L_{s_ext}=16\text{ nH}$
INDUCTIVE LOAD, PER PULSEHALF-BRIDGE SWITCHING CHARACTERISTICS
(TYPICAL) $V_{DD}=900\text{ V}$, $V_{GS}=\pm 15\text{ V}$, $I_D=300\text{ A}$, $T_{vj}=150\text{ }^\circ\text{C}$, $L_{s_ext}=16\text{ nH}$
INDUCTIVE LOAD, PER PULSEHALF-BRIDGE SWITCHING CHARACTERISTICS
(TYPICAL) $V_{DD}=900\text{ V}$, $V_{GS}=\pm 15\text{ V}$, $R_G=1.5\ \Omega$, $T_{vj}=150\text{ }^\circ\text{C}$, $L_{s_ext}=16\text{ nH}$
INDUCTIVE LOAD, PER PULSEHALF-BRIDGE SWITCHING CHARACTERISTICS
(TYPICAL) $V_{DD}=900\text{ V}$, $V_{GS}=\pm 15\text{ V}$, $I_D=300\text{ A}$, $T_{vj}=150\text{ }^\circ\text{C}$, $L_{s_ext}=16\text{ nH}$
INDUCTIVE LOAD, PER PULSE

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HIGH POWER SWITCHING USE
INSULATED TYPE

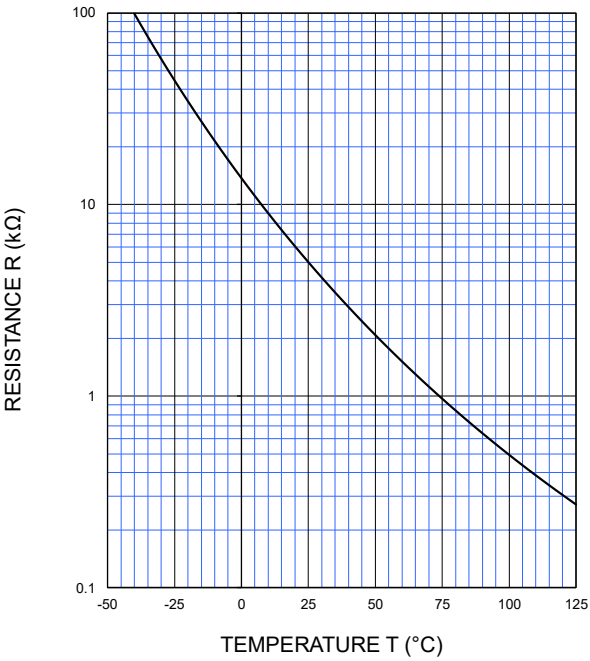
PERFORMANCE CURVES

TRANSIENT THERMAL IMPEDANCE
CHARACTERISTICS
(MAXIMUM)



NTC thermistor part

TEMPERATURE
CHARACTERISTICS
(TYPICAL)



Note: The characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

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