

<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**

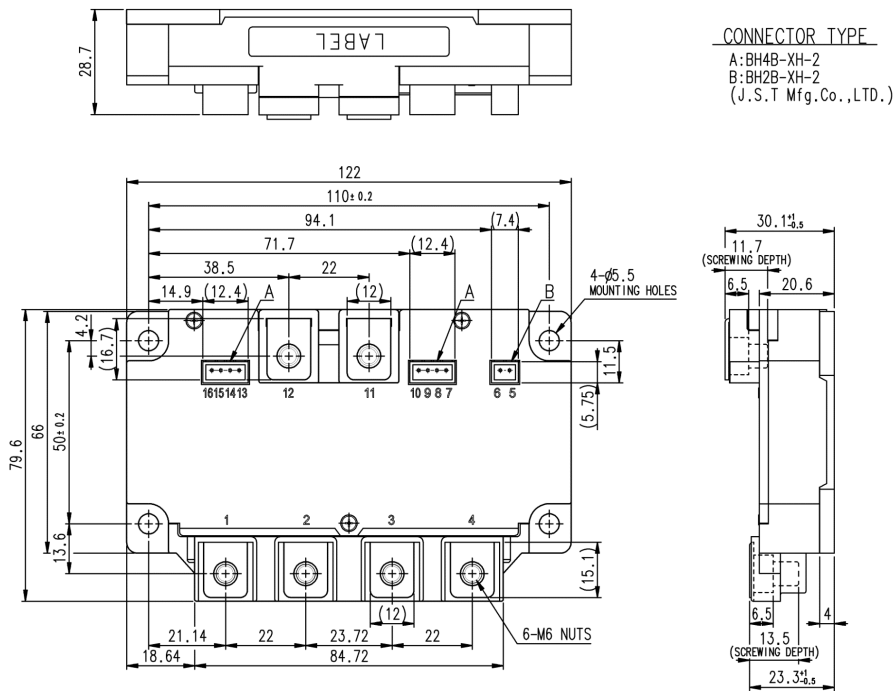
- Silicon Carbide MOSFET + Silicon Carbide Schottky Barrier Diode
- Flat base Type
- Copper base plate
- RoHS Directive compliant
- Recognized under UL1557, File E323585

## APPLICATION

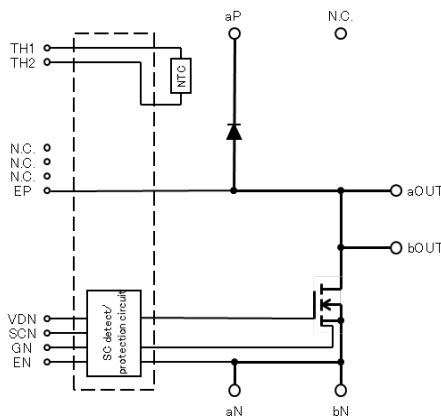
Power supply

### 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-34B**HIGH POWER SWITCHING USE  
INSULATED TYPE**MAXIMUM RATINGS (T<sub>vj</sub> =25 °C, unless otherwise specified)****MOSFET**

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

**SBD**

Symbol	Item	Conditions	Rating	Unit
V <sub>R RM</sub>	Repetitive peak reverse voltage	-	1700	V
I <sub>F</sub>	Forward current	DC	300	A
I <sub>FRM</sub>		Pulse, Repetitive (Note.2)	450	

**MODULE**

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

# FMF300E3XZ-34B

HIGH POWER SWITCHING USE  
INSULATED TYPE

## ELECTRICAL CHARACTERISTICS (T<sub>vj</sub>=25 °C, unless otherwise specified)]

### MOSFET

Symbol	Item	Conditions (note.8)	Limits			Unit	
			Min.	Typ.	Max.		
I <sub>DSX</sub>	Drain-source cut-off current	V <sub>DS</sub> =V <sub>DSX</sub> , V <sub>GS</sub> =-15 V	-	-	0.1	mA	
V <sub>GS(th)</sub>	Gate-source threshold voltage	I <sub>D</sub> =113 mA, V <sub>DS</sub> =10 V	1.8	2.5	3.2	V	
I <sub>GSS</sub>	Gate-source leakage current	V <sub>GS</sub> =V <sub>GSS</sub> , D-S short-circuited	-	-	0.5	μA	
V <sub>DS(on)</sub> (terminal)	Drain-source on-state voltage	I <sub>D</sub> =300 A, V <sub>GS</sub> =15V (Note.5)	T <sub>vj</sub> =25 °C	-	1.65	2.60	V
			T <sub>vj</sub> =125 °C	-	2.19	-	
			T <sub>vj</sub> =150 °C	-	2.33	-	
V <sub>DS(on)</sub> (chip)	Drain-source on-state voltage	I <sub>D</sub> =300 A, V <sub>GS</sub> =15V (Note.5)	T <sub>vj</sub> =25 °C	-	1.47	-	V
			T <sub>vj</sub> =125 °C	-	2.01	-	
			T <sub>vj</sub> =150 °C	-	2.15	-	
r <sub>DS(on)</sub> (chip)	Drain-source on-state resistance	I <sub>D</sub> =300 A, V <sub>GS</sub> =15V (Note.5)	T <sub>vj</sub> =25 °C	-	4.90	-	mΩ
			T <sub>vj</sub> =125 °C	-	6.70	-	
			T <sub>vj</sub> =150 °C	-	7.16	-	
C <sub>iss</sub>	Input capacitance	V <sub>DS</sub> =10 V, V <sub>GS</sub> =0V	-	27.4	-	nF	
C <sub>oss</sub>	Output capacitance		-	11.5	-		
C <sub>rss</sub>	Reverse transfer capacitance		-	0.98	-		
Q <sub>G</sub>	Gate charge	V <sub>DD</sub> =900 V, I <sub>D</sub> =300 A, V <sub>GS</sub> =0→15 V	-	800	-	nC	
t <sub>d(on)</sub>	Turn-on delay time	V <sub>DD</sub> =900 V, I <sub>D</sub> =300 A, V <sub>GS</sub> =±15 V, T <sub>vj</sub> =150°C, R <sub>G</sub> =1.5Ω, L <sub>s_ext</sub> =16nH, Inductive load, per pulse	-	200	-	ns	
t <sub>r</sub>	Rise time		-	50	-		
t <sub>d(off)</sub>	Turn-off delay time		-	220	-		
t <sub>f</sub>	Fall time		-	30	-		
E <sub>on</sub>	Turn-on switching energy		-	16	-		mJ
E <sub>off</sub>	Turn-off switching energy	-	5	-			
Q <sub>C</sub>	Drain-source charge	-	2	-	μC		
r <sub>g</sub>	Internal gate resistance	Per switch	-	0.5	-	Ω	

### SBD

Symbol	Item	Conditions (note.8)	Limits			Unit	
			Min.	Typ.	Max.		
I <sub>R<sub>RM</sub></sub>	Reverse current	V <sub>RM</sub> =V <sub>RRM</sub>	-	-	5	mA	
		V <sub>DS</sub> =1000V, V <sub>GS</sub> =-15 V	-	-	0.5		
V <sub>F</sub> (terminal)	Forward voltage	I <sub>F</sub> =300 A (Note.5)	T <sub>vj</sub> =25 °C	-	1.80	2.40	V
			T <sub>vj</sub> =125 °C	-	2.45	-	
			T <sub>vj</sub> =150 °C	-	2.69	-	
V <sub>F</sub> (chip)	Forward voltage	I <sub>F</sub> =300 A (Note.5)	T <sub>vj</sub> =25 °C	-	1.64	-	V
			T <sub>vj</sub> =125 °C	-	2.28	-	
			T <sub>vj</sub> =150 °C	-	2.52	-	

### MODULE

Symbol	Item	Conditions (note.8)	Limits			Unit
			Min.	Typ.	Max.	
R <sub>DD+SS'</sub>	Internal lead resistance	P-N	-	0.6	-	mΩ
L <sub>s</sub>	Internal stray inductance	P-N	-	25	-	nH

# FMF300E3XZ-34B

HIGH POWER SWITCHING USE  
INSULATED TYPE

## THERMAL RESISTANCE CHARACTERISTICS

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$R_{th(j-c)Q}$	Thermal resistance <sup>(Note. 1)</sup>	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 <sup>(Note.1)</sup>	Case to heat sink, per 1 module, Thermal grease applied <sup>(Note.7, 9)</sup>	-	12	-	K/kW

## NTC THERMISTOR PART

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

## MECHANICAL CHARACTERISTICS

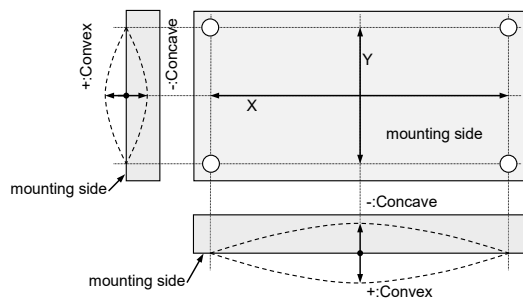
Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$M_t$	Mounting torque	Main terminals M 6 screw	3.5	4.0	4.5	N·m
$M_s$		Mounting to heat sink M 5 screw	2.5	3.0	6.0	
$m$	mass	-	-	500	-	g
$d_a$	Clearance	-	10	-	-	mm
$d_s$	Creepage distance	-	17	-	-	mm
$e_c$	Flatness of base plate	On the centerline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

\*: 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.

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



5. 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]

7. Typical value is measured by using thermally conductive grease of  $\lambda=0.9\text{ W/(m}\cdot\text{K)}$ / $D_{(c-s)}=100\text{ }\mu\text{m}$ .
8. Per switch (ex. Tr1 chips total in page.7)
9. 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 ( $T_{vjmax}$ ,  $T_{vjop}$ ,  $T_{Cmax}$ ) must be maintained below the maximum rated temperature throughout consideration of the temperature rise even for long term usage.

# 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 <sup>(Note.10)</sup>	Per switch	1.5	-	7.5	$\Omega$	
$f_c$	Switching frequency	$V_{GS(+)}=15V, R_G=1.5\Omega, V_{DD}=900V, T_{vj}=150^\circ C$	$V_{GS(-)} < -10V$	-	-	50	kHz
			$V_{GS(-)} \geq -10V$	-	-	100	kHz
$t_{d(SCoff)}$	Gate cutoff delay time after SC output	$V_{GS}=15V, R_G=1.5\Omega, V_{DD} \leq 1200V, T_{vj}=150^\circ C$	-	-	3	$\mu s$	

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

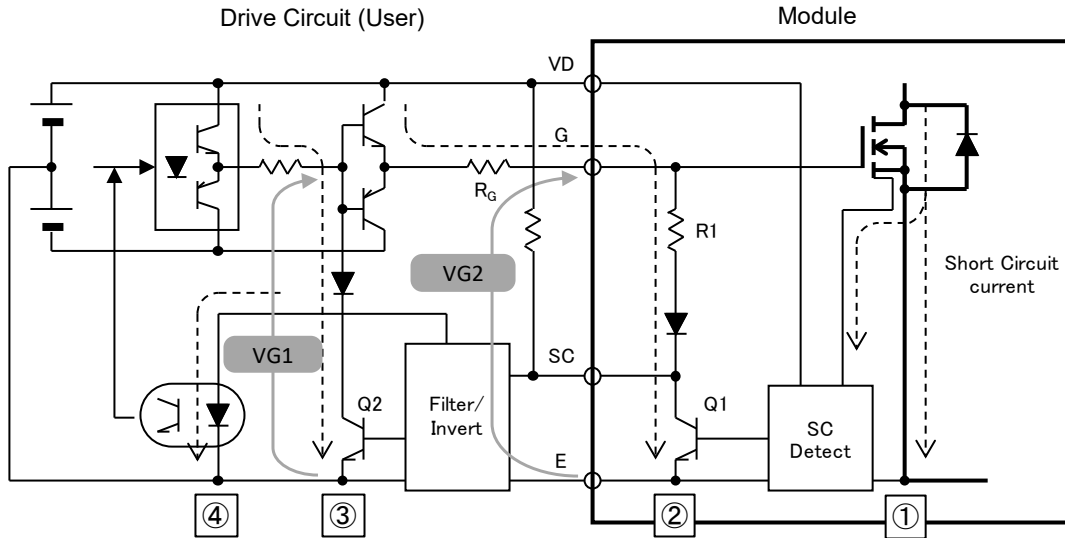
Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$I_{D(SC)}$	SC detect drain current	$T_{vj}=150^\circ C, V_{GS}=15V$	450	600	-	A
$t_{d(SC)}$	SC detect delay time	$T_{vj}=150^\circ C, V_{DD} \leq 1200V, V_{GS}=15V, R_G=1.5\Omega$	-	1	-	$\mu s$
$V_{GS(SC)}$	SC protection gate limit voltage	$T_{vj}=150^\circ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

Refer to the circuit in page.6

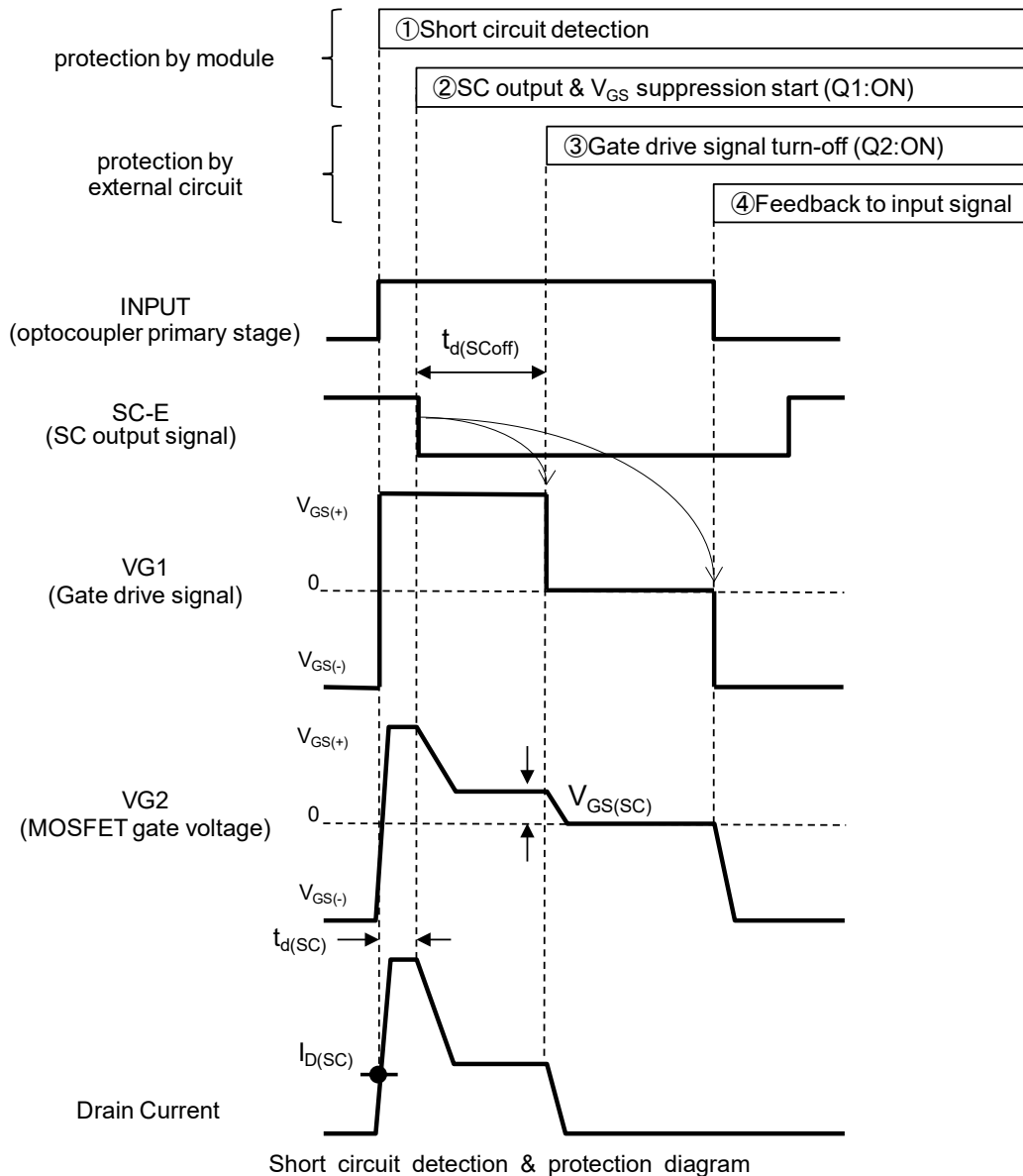
# FMF300E3XZ-34B

HIGH POWER SWITCHING USE  
INSULATED TYPE

## SHORT CIRCUIT DETECTION & PROTECTION



Example of application (Short circuit detection & protection)



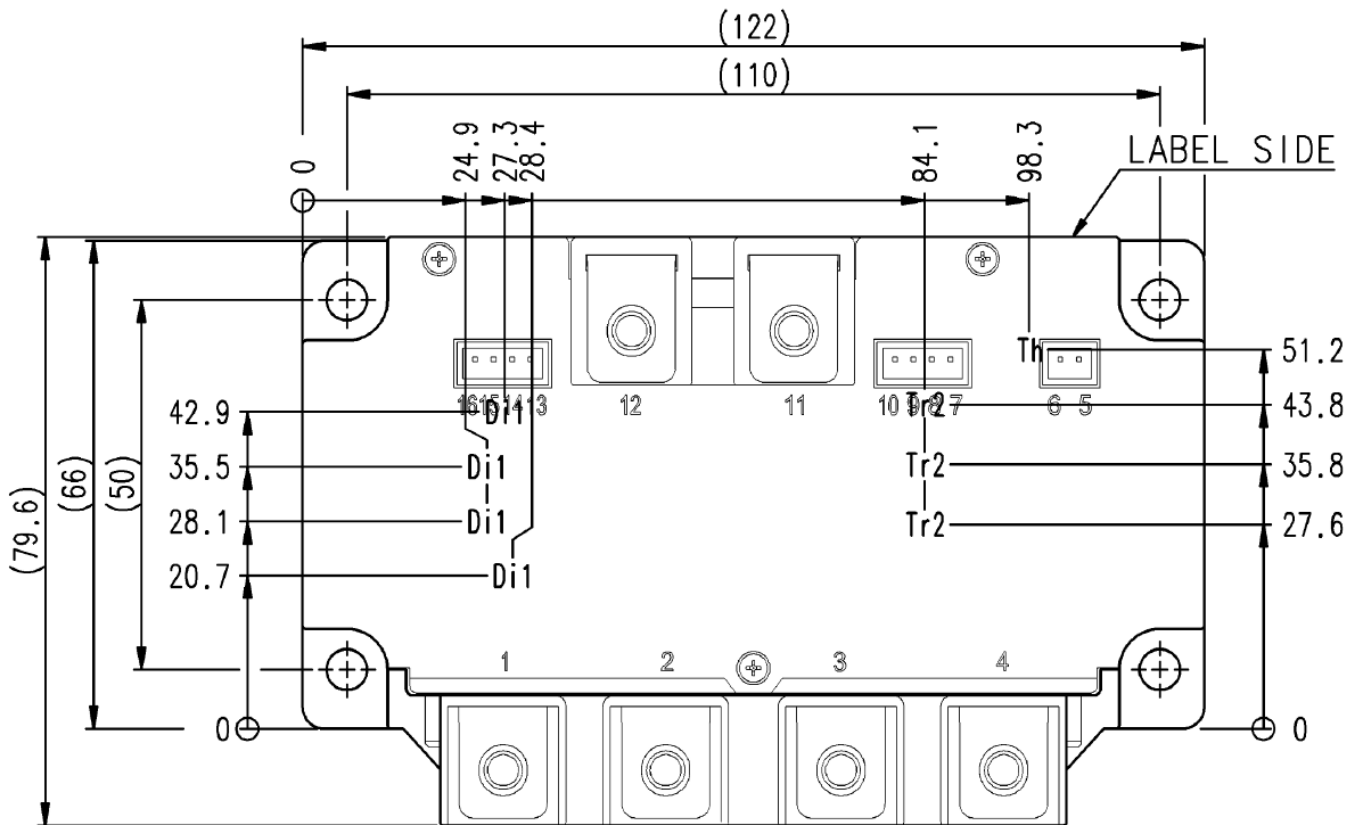
Short circuit detection & protection diagram

# FMF300E3XZ-34B

HIGH POWER SWITCHING USE  
INSULATED TYPE

## CHIP LOCATION (Top view)

Dimension in mm, tolerance:  $\pm 1$  mm

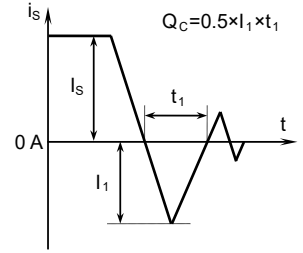
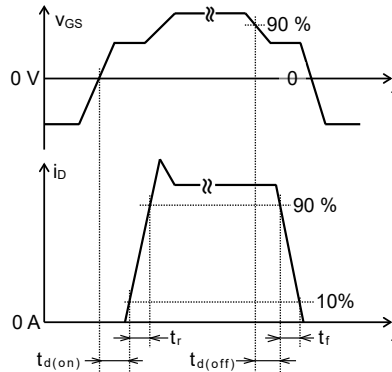
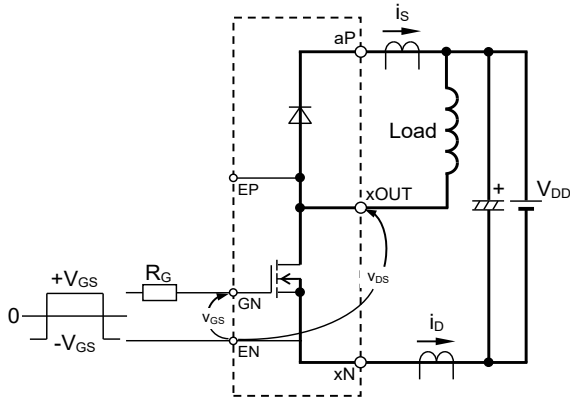


Tr2: SiC-MOSFET, Di1: SiC-SBD, Th: NTC thermistor

# FMF300E3XZ-34B

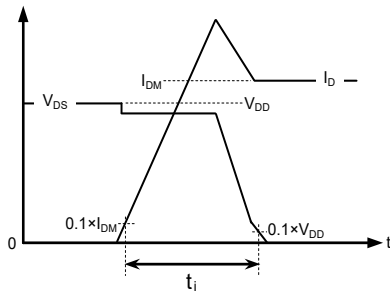
HIGH POWER SWITCHING USE  
INSULATED TYPE

## TEST CIRCUIT AND WAVEFORMS

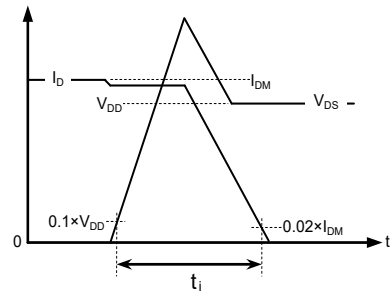


Switching characteristics test circuit and waveforms(x: connected a\* and b\*)

Q<sub>c</sub> test waveform



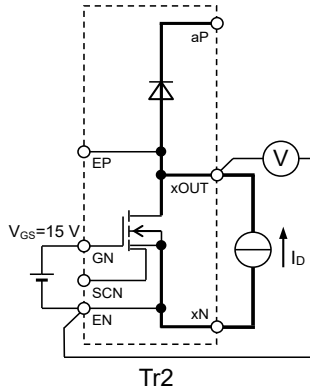
MOSFET Turn-on switching energy



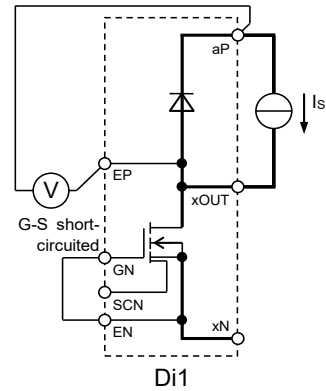
MOSFET Turn-off switching energy

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

## TEST CIRCUIT



V<sub>DS(on)</sub> test circuit (x: Connected a\* and b\*)



V<sub>SD</sub> test circuit, V<sub>GS</sub>=-15V (x: Connected a\* and b\*)

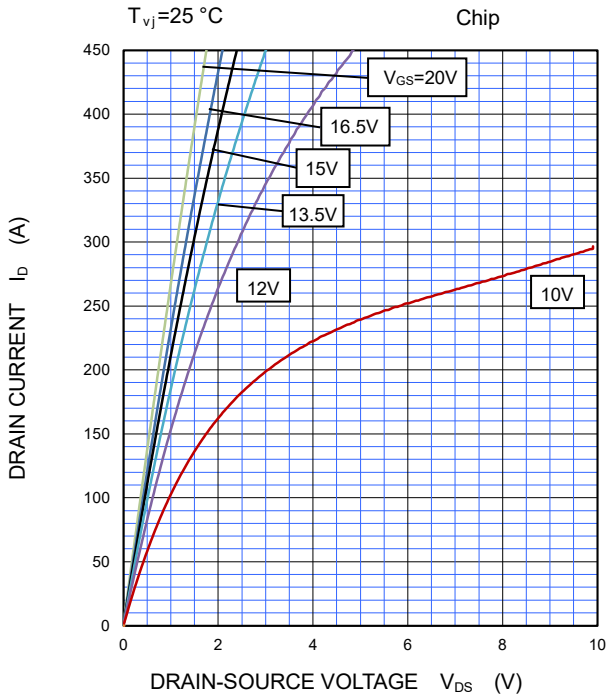


# FMF300E3XZ-34B

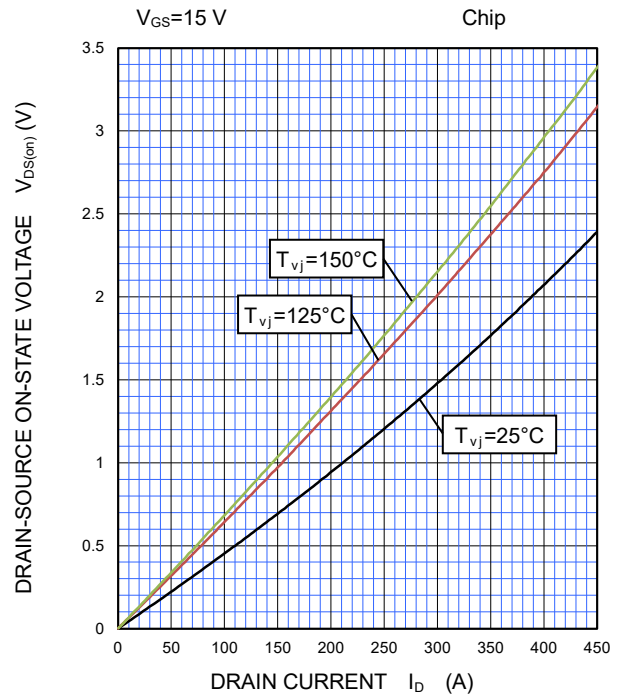
HIGH POWER SWITCHING USE  
INSULATED TYPE

## PERFORMANCE CURVES

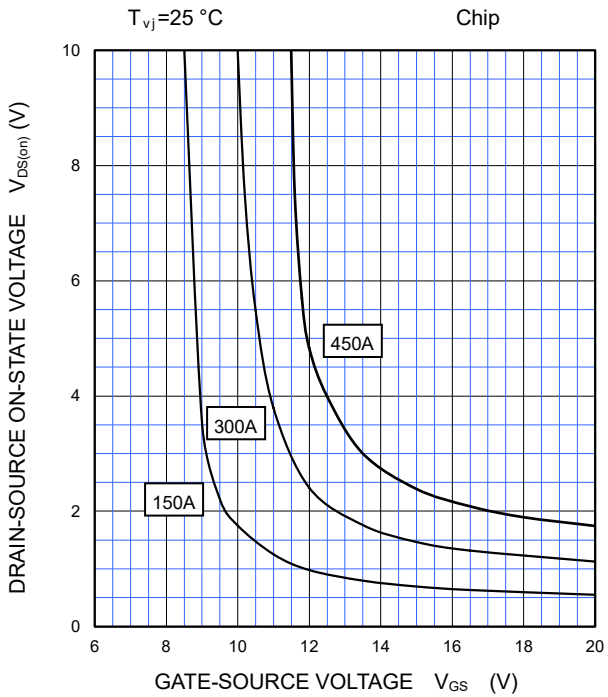
**OUTPUT CHARACTERISTICS (TYPICAL)**



**MOSFET ON STATE VOLTAGE CHARACTERISTICS (TYPICAL)**



**MOSFET ON STATE VOLTAGE CHARACTERISTICS (TYPICAL)**

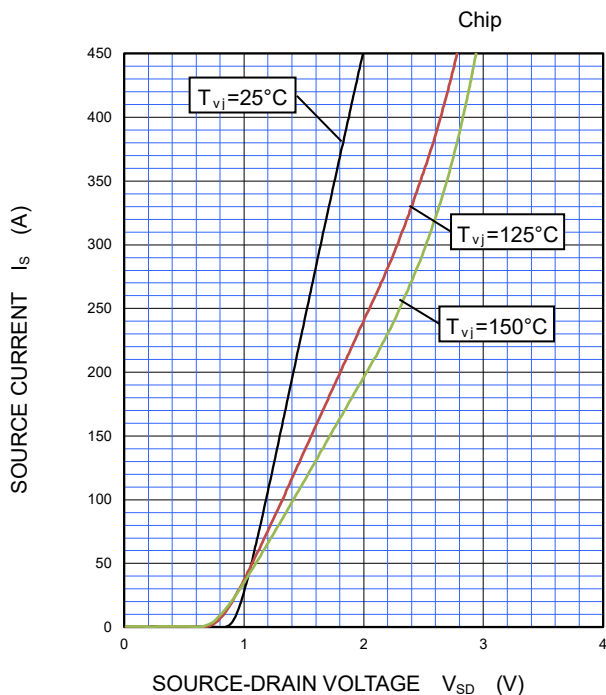


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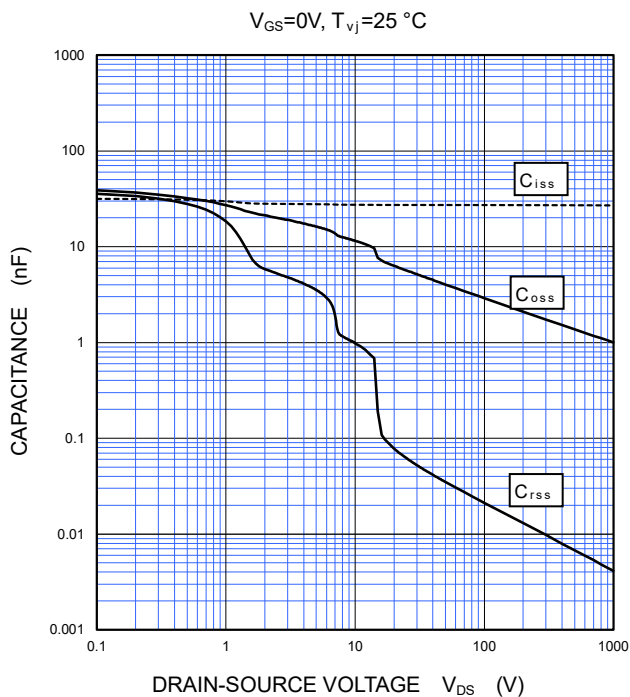
HIGH POWER SWITCHING USE  
INSULATED TYPE

## PERFORMANCE CURVES

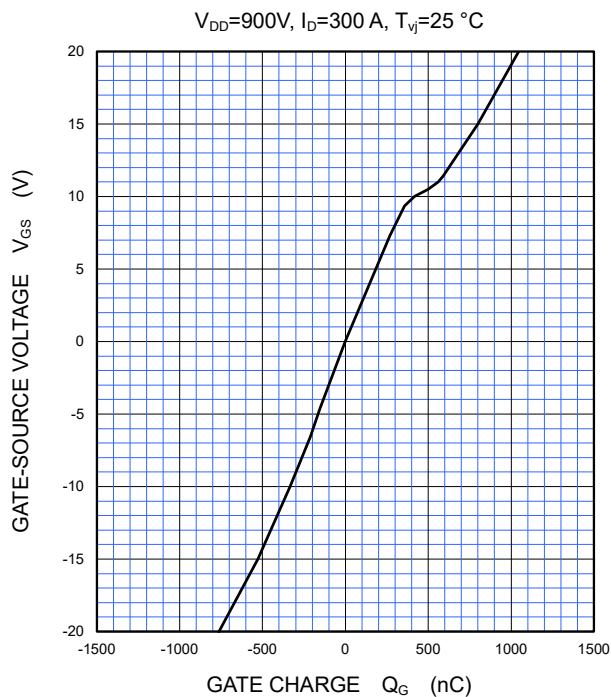
**DIODE  
FORWARD CHARACTERISTICS  
(TYPICAL)**



**MOSFET CAPACITANCE  
CHARACTERISTICS  
(TYPICAL)**



**GATE CHARGE  
CHARACTERISTICS  
(TYPICAL)**



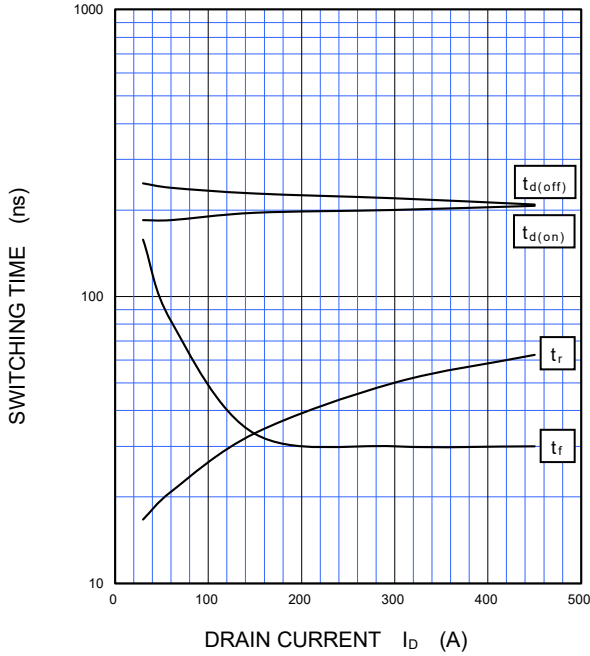
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HIGH POWER SWITCHING USE  
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## PERFORMANCE CURVES

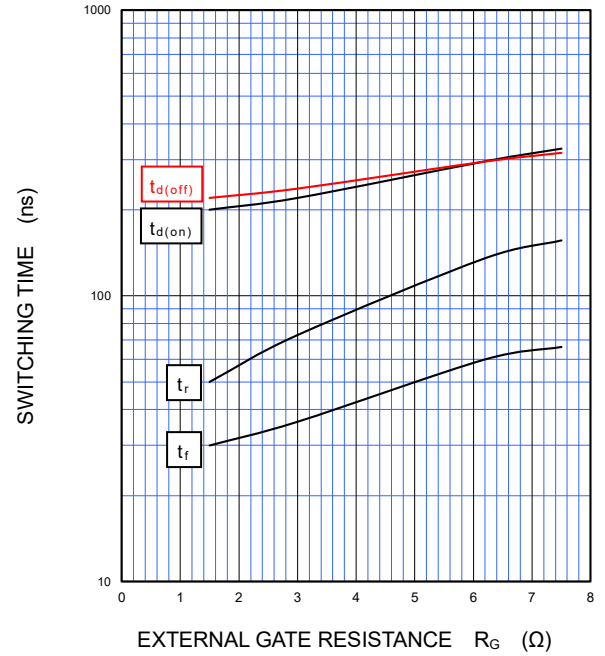
HALF-BRIDGE SWITCHING CHARACTERISTICS  
(TYPICAL)

$V_{DD}=900\text{ V}$ ,  $V_{GS}=\pm 15\text{ V}$ ,  $R_G=1.5\ \Omega$ ,  $T_{vj}=150\text{ }^\circ\text{C}$ ,  $L_{s\_ext}=16\text{ nH}$   
INDUCTIVE LOAD, PER PULSE



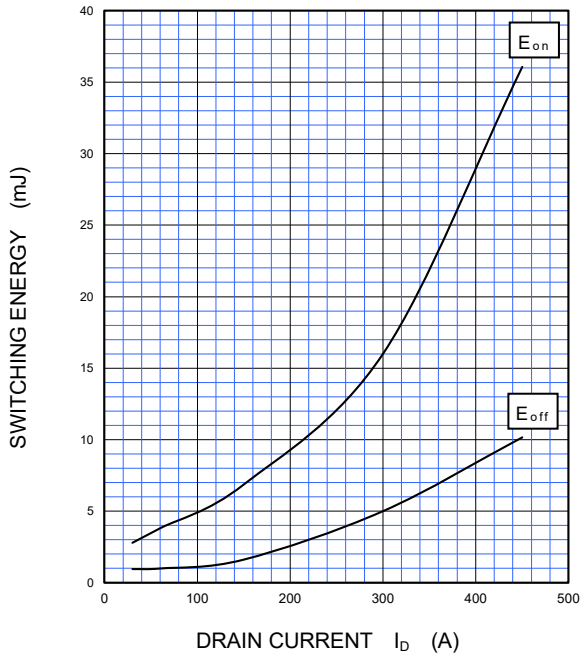
HALF-BRIDGE SWITCHING CHARACTERISTICS  
(TYPICAL)

$V_{DD}=900\text{ V}$ ,  $V_{GS}=\pm 15\text{ V}$ ,  $I_D=300\text{ A}$ ,  $T_{vj}=150\text{ }^\circ\text{C}$ ,  $L_{s\_ext}=16\text{ nH}$   
INDUCTIVE LOAD, PER PULSE



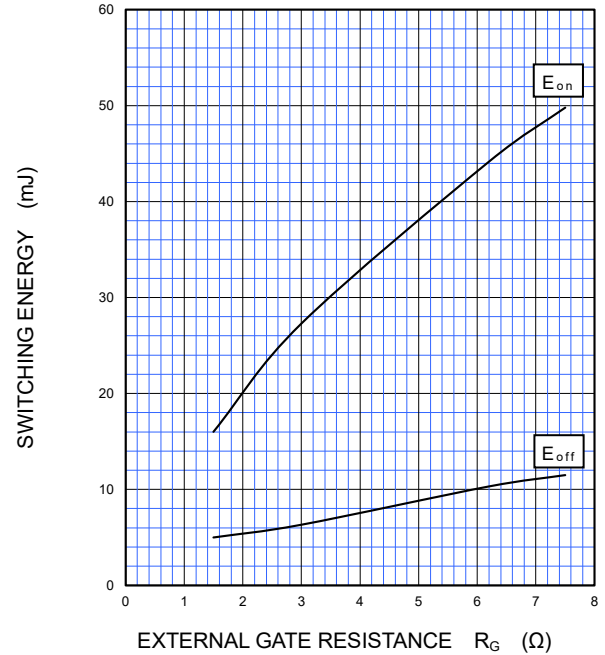
HALF-BRIDGE SWITCHING CHARACTERISTICS  
(TYPICAL)

$V_{DD}=900\text{ V}$ ,  $V_{GS}=\pm 15\text{ V}$ ,  $R_G=1.5\ \Omega$ ,  $T_{vj}=150\text{ }^\circ\text{C}$ ,  $L_{s\_ext}=16\text{ nH}$   
INDUCTIVE LOAD, PER PULSE



HALF-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



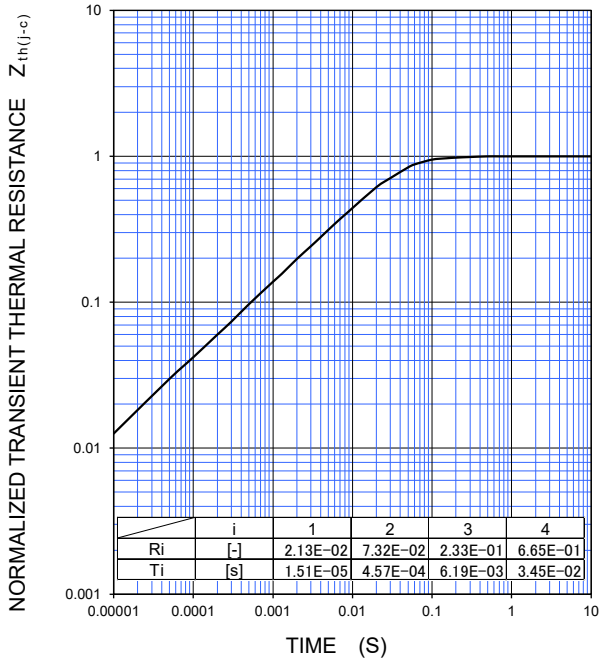
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## PERFORMANCE CURVES

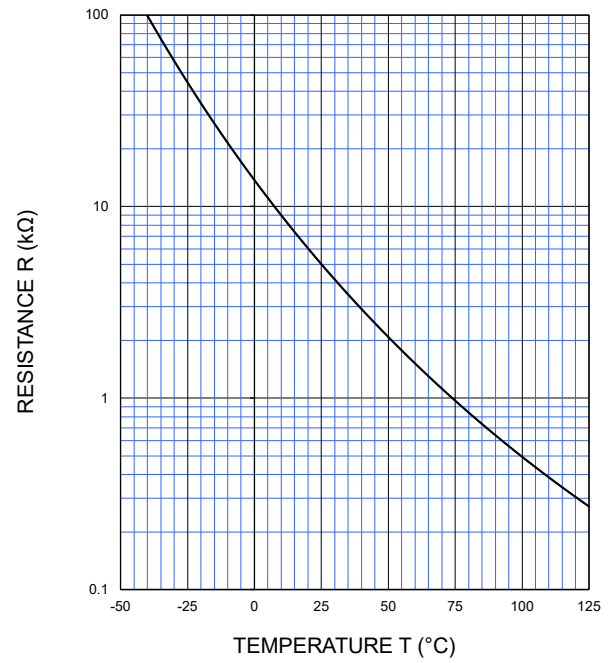
**TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (MAXIMUM)**

Single pulse,  $T_c=25\text{ }^\circ\text{C}$   
 $R_{th(j-c)Q}=121\text{K/kW}$ ,  $R_{th(j-c)D}=131\text{K/kW}$



**NTC thermistor part**

**TEMPERATURE CHARACTERISTICS (TYPICAL)**



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

### **Important Notice**

The information contained in this datasheet shall in no event be regarded as a guarantee of conditions or characteristics. This product has to be used within its specified maximum ratings, and is subject to customer's compliance with any applicable legal requirement, norms and standards.

Except as otherwise explicitly approved by Mitsubishi Electric Corporation in a written document signed by authorized representatives of Mitsubishi Electric Corporation, our products may not be used in any applications where a failure of the product or any consequences of the use thereof can reasonably be expected to result in personal injury.

In usage of power semiconductor, there is always the possibility that trouble may occur with them by the reliability lifetime such as Power Cycle, Thermal Cycle or others, or when used under special circumstances (e.g. condensation, high humidity, dusty, salty, highlands, environment with lots of organic matter / corrosive gas / explosive gas, or situations which terminals of semiconductor products receive strong mechanical stress). Therefore, please pay sufficient attention to such circumstances. Further, depending on the technical requirements, our semiconductor products may contain environmental regulation substances, etc. If there is necessity of detailed confirmation, please contact our nearest sales branch or distributor.

The contents or data contained in this datasheet are exclusively intended for technically trained staff. Customer's technical departments should take responsibility to evaluate the suitability of Mitsubishi Electric Corporation product for the intended application and the completeness of the product data with respect to such application. In the customer's research and development, please evaluate it not only with a single semiconductor product but also in the entire system, and judge whether it's applicable. As required, pay close attention to the safety design by installing appropriate fuse or circuit breaker between a power supply and semiconductor products to prevent secondary damage. Please also pay attention to the application note and the related technical information.

## **Keep safety first in your circuit designs!**

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