

<Full SiC Modules>

FMF800DX2-24A

**HIGH POWER SWITCHING USE
INSULATED TYPE**



Dual switch (Half-Bridge)

Drain current I_D **8 0 0 A**
 Drain-Source voltage V_{DSX} **1 2 0 0 V**
 Maximum junction temperature T_{vjmax} **1 5 0 °C**

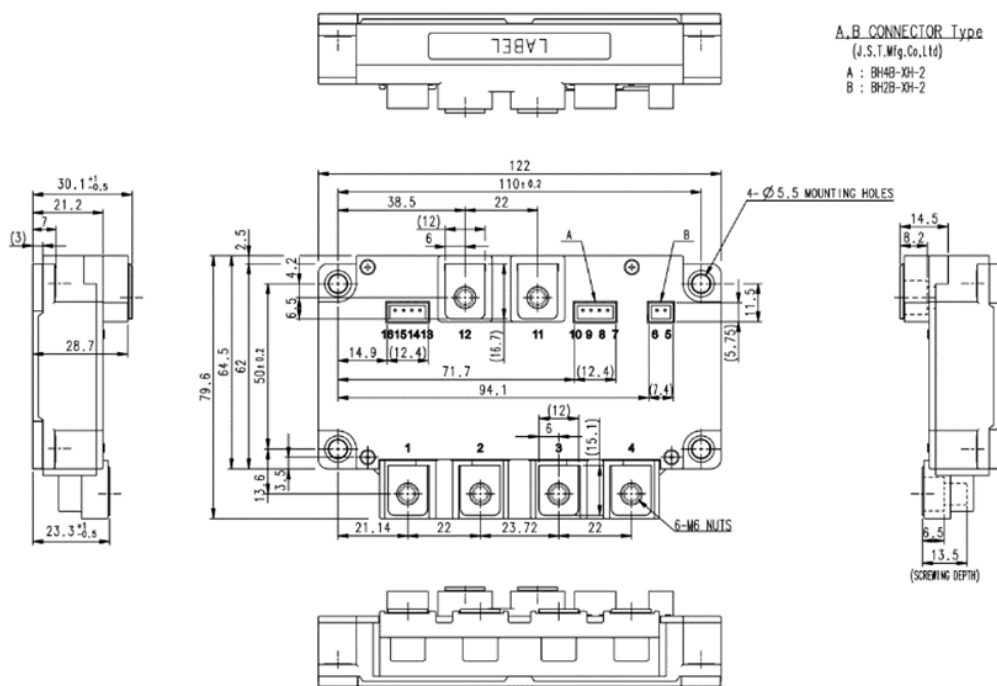
- Silicon Carbide MOSFET + Silicon Carbide Schottky Barrier Diode
- Flat base Type
- Copper base plate
- RoHS Directive compliant
- Recognized under UL1557, File E323585

APPLICATION

AC Motor Control, Motion/Servo Control, Power supply, etc.

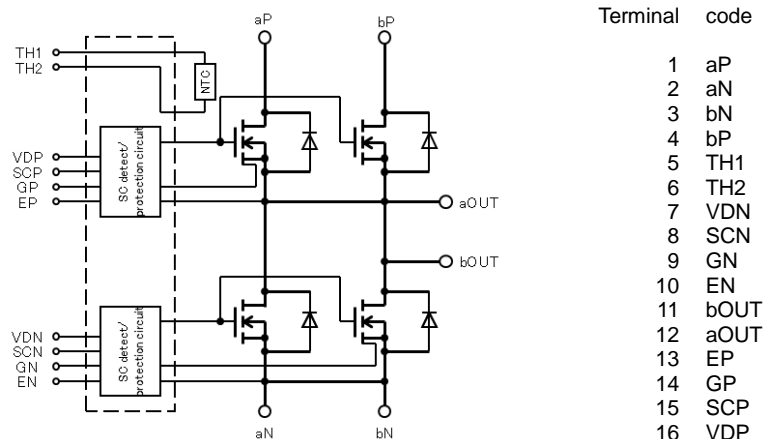
OUTLINE DRAWING & INTERNAL CONNECTION

Dimension in mm



A,B_CONNECTOR_Type
 (J.S.T.Mfg.Co.,Ltd)
 A : BH4B-XH-2
 B : BH2B-XH-2

INTERNAL CONNECTION



Terminal	code
1	aP
2	aN
3	bN
4	bP
5	TH1
6	TH2
7	VDN
8	SCN
9	GN
10	EN
11	bOUT
12	aOUT
13	EP
14	GP
15	SCP
16	VDP

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

aP and bP, aN and bN should be connected externally.

SCP, SCN are terminal for drain current sensing. The ratio of SCP/EP, SCN/EN is approximately 1:61500

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HIGH POWER SWITCHING USE

INSULATED TYPE

MAXIMUM RATINGS (T_{vj} =25 °C, unless otherwise specified)

Symbol	Item	Conditions	Rating	Unit
V _{DSX}	Drain-source voltage	V _{GS} =-15 V	1200	V
V _{GSS}	Gate-source voltage	D-S short-circuited	±20	V
I _D	Drain current	DC	800	A
I _{DRM}		Pulse, Repetitive (Note.3), T _{vj} =150°C (Note.4)	1200	
P _{tot}	Total power dissipation	T _C =25 °C (Note. 2)	2970	W
I _S (Note.1)	Source current	DC	800	A
I _{SRM} (Note.1)		Pulse, Repetitive (Note.3), T _{vj} =150°C	1200	
V _{isol}	Isolation voltage	Terminals to base plate, RMS, f=60 Hz, AC 1 min	4000	V
T _{vjmax}	Maximum junction temperature	Instantaneous event (overload)	150	°C
T _{cmax}	Maximum case temperature	(Note.2)	125	°C
T _{vjop}	Operating junction temperature	Continuous operation (under switching)	-40~+150	°C
T _{stg}	Storage temperature	-	-40~+125	°C

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

Symbol	Item	Conditions (note10)	Limits			Unit	
			Min.	Typ.	Max.		
I _{DSX}	Drain-source cut-off current	V _{DS} =V _{DSX} , V _{GS} =-15 V	-	-	44	mA	
		V _{DS} =800V, V _{GS} =-15 V	-	-	1.0		
I _{GSS}	Gate-source leakage current	V _{GS} =V _{GSS} , D-S short-circuited	-	-	0.5	μA	
V _{GS(th)}	Gate-source threshold voltage	I _D =271 mA, V _{DS} =10 V	0.5	1	1.6	V	
r _{DS(on)} (Chip)	Static drain-source On-state resistance	I _D =800 A, V _{GS} =15V (Note.6)	T _{vj} =25 °C	-	1.6	-	mΩ
			T _{vj} =150 °C	-	2.8	-	
V _{DS(on)} (chip)	Static drain-source On-state voltage	I _D =800 A, V _{GS} =15V (Note.6)	T _{vj} =25 °C	-	1.31	-	V
			T _{vj} =125 °C	-	2.02	-	
			T _{vj} =150 °C	-	2.21	-	
V _{DS(on)} (terminal)	Static drain-source On-state voltage	I _D =800 A, V _{GS} =15V (Note.6)	T _{vj} =25 °C	-	1.66	2.30	V
			T _{vj} =125 °C	-	2.38	-	
			T _{vj} =150 °C	-	2.56	-	
C _{iss}	Input capacitance	V _{DS} =10 V, V _{GS} =0V	-	70	-	nF	
C _{oss}	Output capacitance		-	25	-		
C _{rss}	Reverse transfer capacitance		-	2	-		
Q _G	Gate charge	V _{DD} =600 V, I _D =800 A, V _{GS} =15 V	-	2800	-	nC	
t _{d(on)}	Turn-on delay time	V _{DD} =600 V, I _D =800 A, V _{GS} =±15 V, R _G =1.6Ω, Inductive load	-	100	-	ns	
t _r	Rise time		-	60	-		
t _{d(off)}	Turn-off delay time		-	350	-		
t _f	Fall time		-	60	-		
Q _C	Drain-source charge		-	4	-	μC	
V _{SD} (Note.1) (chip)	Source-drain voltage	I _S =800 A (Note.6) V _{GS} =-15 V	T _{vj} =25 °C	-	1.7	-	V
			T _{vj} =125 °C	-	2.2	-	
			T _{vj} =150 °C	-	2.4	-	
V _{SD} (Note.1) (terminal)	Source-drain voltage	I _S =800 A (Note.6) V _{GS} =-15 V	T _{vj} =25 °C	-	2.05	2.45	V
			T _{vj} =125 °C	-	2.55	-	
			T _{vj} =150 °C	-	2.75	-	
E _{on}	Turn-on switching energy per pulse	V _{DD} =600 V, I _D /I _S =800 A,	-	14.2	-	mJ	
E _{off}	Turn-off switching energy per pulse	V _{GS} =±15 V, R _G =1.6Ω, T _{vj} =125°C	-	35.5	-		
E _{rec} (Note.1)	Diode switching energy per pulse	Inductive load	-	1.1	-		
R _{DD+SS}	Internal lead resistance	P-N, T _C =25°C (Note.2)	-	0.5	-	mΩ	
r _g	Internal gate resistance	Per switch	-	0.54	-	Ω	
L _s	Internal stray inductance	P-N	-	10	-	nH	

Caution; No short-circuit capability is designed.

FMF800DX2-24AHIGH POWER SWITCHING USE
INSULATED TYPE**THERMAL RESISTANCE CHARACTERISTICS**

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$R_{th(j-c)Q}$	Thermal resistance ^(Note. 2)	Junction to case, per inverter switch	-	-	42	K/kW
$R_{th(j-c)D}$		Junction to case, per inverter FWD	-	-	61	
$R_{th(c-s)}$	Contact thermal resistance ^(Note.2)	Case to heat sink, per 1 module, Thermal grease applied ^(Note.8)	-	15	-	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.2)	4.85	5.00	5.15	k Ω
$\Delta R/R$	Deviation of resistance	$T_C=100\text{ }^\circ\text{C}$ ^(Note.2) , $R_{100}=493\text{ }\Omega$	-7.3	-	+7.8	%
$B_{(25/50)}$	B-constant	Approximate by equation ^(Note.7)	-	3375	-	K
P_{25}	Power dissipation	$T_C=25\text{ }^\circ\text{C}$ ^(Note.2)	-	-	10	mW

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HIGH POWER SWITCHING USE
INSULATED TYPE

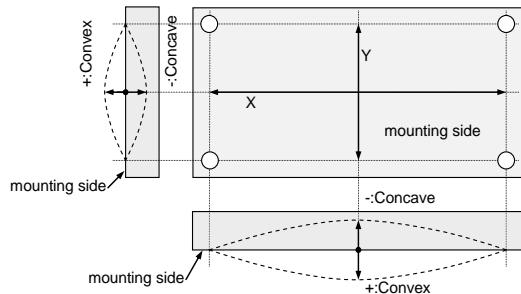
MECHANICAL CHARACTERISTICS

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	3.5	
d_s	Creepage distance		17	-	-	mm
d_a	Clearance		10	-	-	mm
m	mass	-	-	454	-	g
e_c	Flatness of base plate	On the centerline X, Y (Note.5)	± 0	-	+100	μm

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

Note1. Represent ratings and characteristics of the anti-parallel, source-drain free wheeling diode (FWD).

- 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_{vjmax} rating.
- Junction temperature (T_{vj}) should not increase beyond T_{vjmax} rating.
- The base plate (mounting side) flatness measurement points (X, Y) are as follows of the following figure.



6 Pulse width and repetition rate should be such as to cause negligible temperature rise. Refer to the figure of test circuit.

$$7. B_{(25/50)} = \ln\left(\frac{R_{25}}{R_{50}}\right) / \left(\frac{1}{T_{25}} - \frac{1}{T_{50}}\right)$$

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]

8. Typical value is measured by using thermally conductive grease of $\lambda=0.9$ W/(m·K).

9. Use the following screws when mounting the printed circuit board (PCB) on the standoffs.

" $\varnothing 2.6 \times 10$ or $\varnothing 2.6 \times 12$, B1 tapping screw"

The length of the screw depends on the thickness (t1.6) of the PCB.

10. Per switch (ex. Tr1 chips total in page.6)

RECOMMENDED OPERATING CONDITIONS

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
V_{DD}	(DC) Supply voltage	Applied across aP -aN/ bP-bN terminals	-	600	850	V
V_D	DC supply voltage(control)	Applied across VDP-EP/VDN-EN terminals	13.5	15	16.5	V
$V_{GS(+)}$	Gate-Source positive drive voltage	Applied across GP-EP,GN-EN terminals	13.5	15	16.5	V
$V_{GS(-)}$	Gate-Source negative drive voltage	Applied across GP-EP/GN-EN terminals	-16.5	-15.0	-9	V
R_G	External gate resistance (Note.11)	Per switch	1.6	-	10	Ω
$t_{d(SCoff)}$	Gate cutoff delay time after SC output	$V_{GS}=15\text{V}$, $R_G=1.6\Omega$, $T_{vj}=150^\circ\text{C}$	-	-	3	μs
f_c	Switching frequency	$V_{GS}=\pm 15\text{V}$, $R_G=1.6\Omega$, $V_{DD}=600\text{V}$, $T_{vj}=150^\circ\text{C}$	-	-	100	kHz

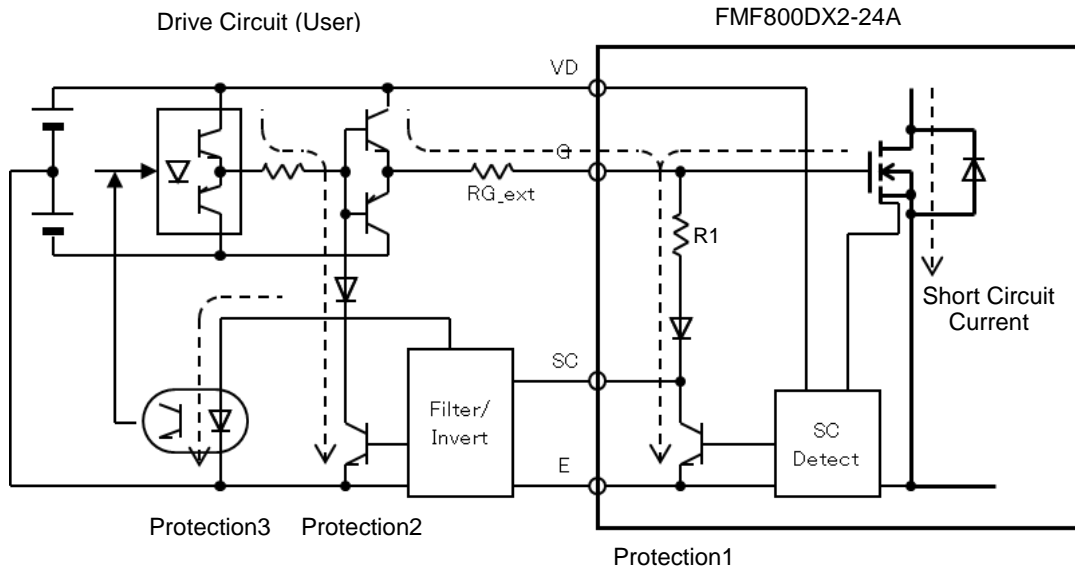
Note 11. The value of external gate resistance should be considered the surge voltage not to exceed the rating voltage in the worst system condition.

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HIGH POWER SWITCHING USE

INSULATED TYPE

SC DETECTION & PROTECTION



Example of application (SC detection & protection)

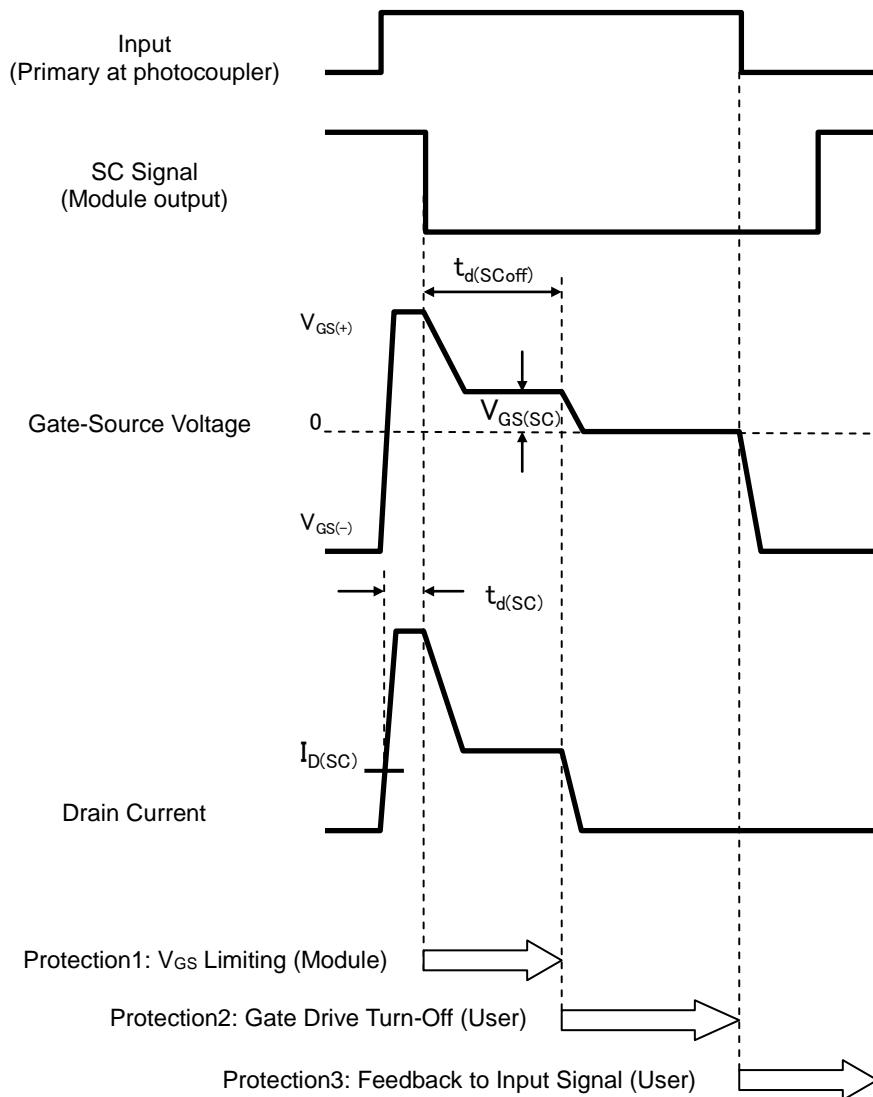


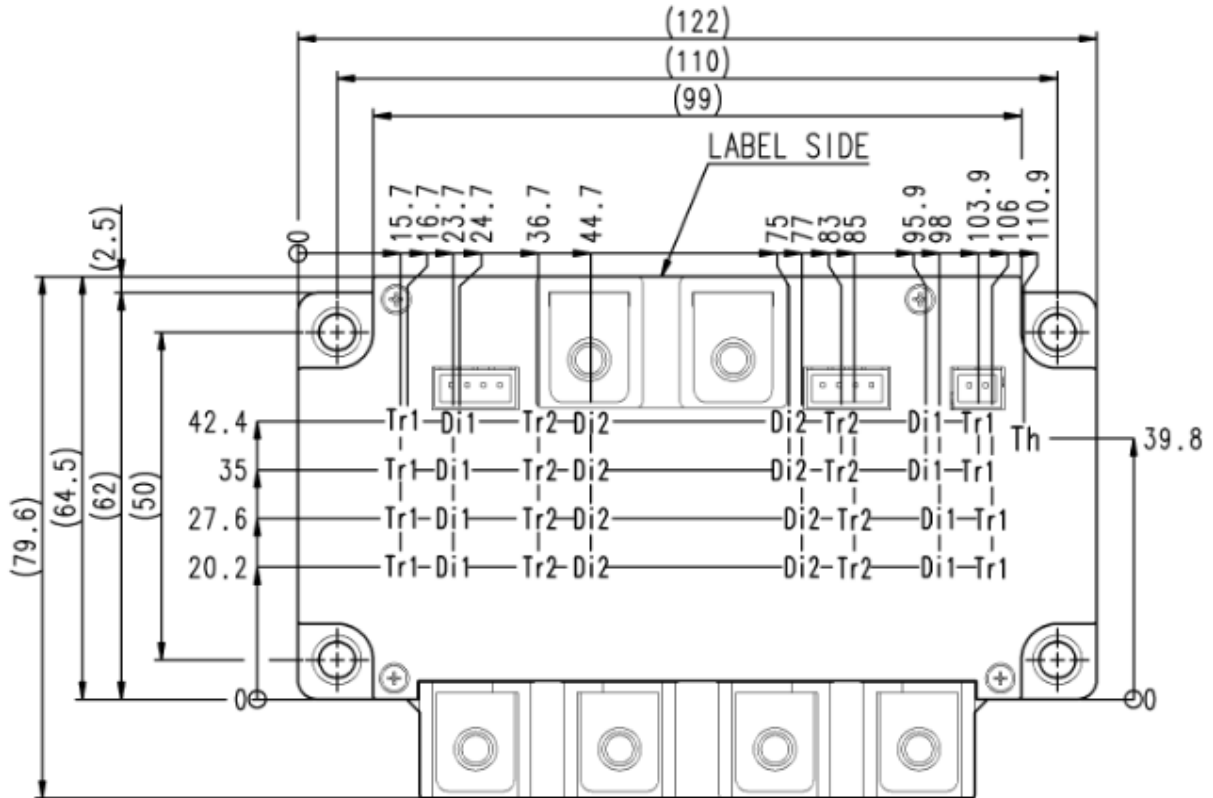
Diagram of SC detection & protection

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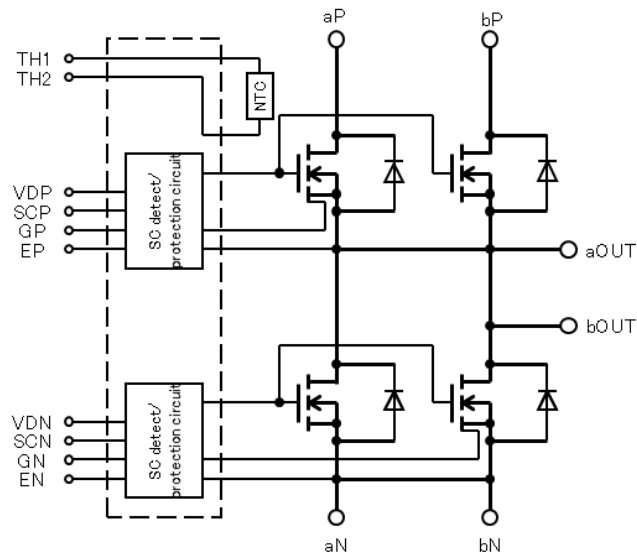
HIGH POWER SWITCHING USE
INSULATED TYPE

CHIP LOCATION (Top view)

Dimension in mm, tolerance: ± 1 mm



Tr1,Tr2: MOSFET, Di1,Di2: SBD, TH: NTC thermistor



- The terminal aP-bP, aN-bN, aOUT-bOUT must be connected with each other.
- When the current sensor is not used, SCP-EP, SCN-EN must be short-circuited.

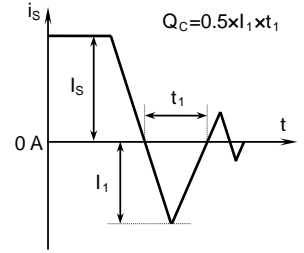
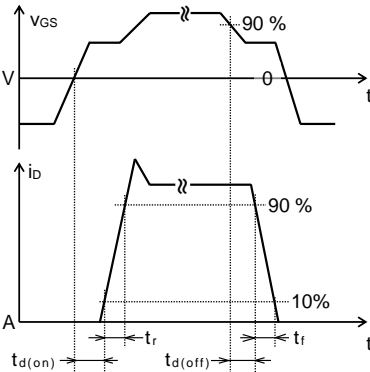
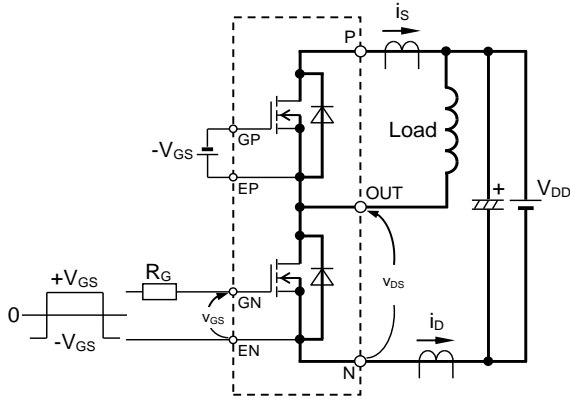
Internal connection

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HIGH POWER SWITCHING USE

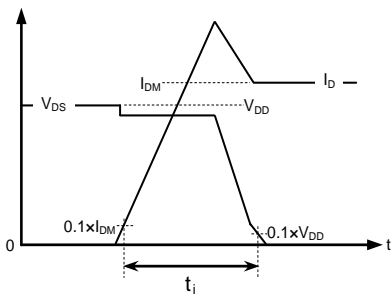
INSULATED TYPE

TEST CIRCUIT AND WAVEFORMS

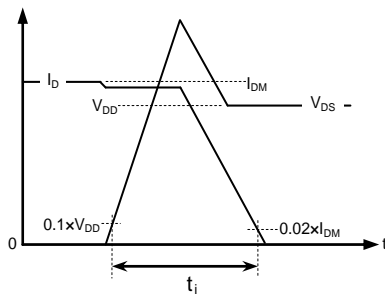


Switching characteristics test circuit and waveforms

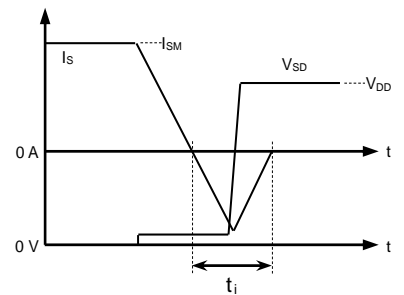
Qc test waveform



MOSFET Turn-on switching energy



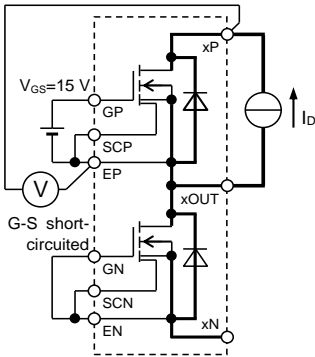
MOSFET Turn-off switching energy



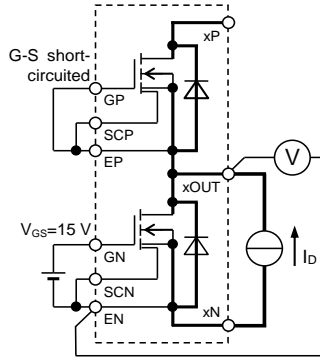
Diode switching energy

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

TEST CIRCUIT

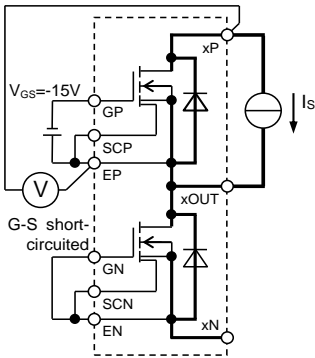


Tr1

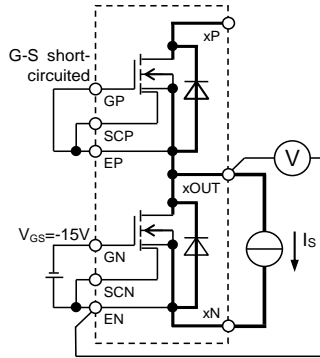


Tr2

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

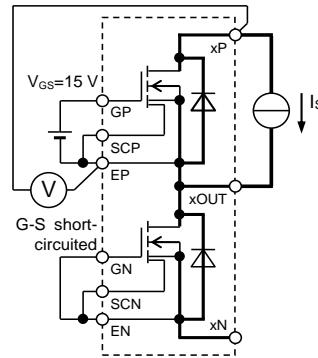


Di1

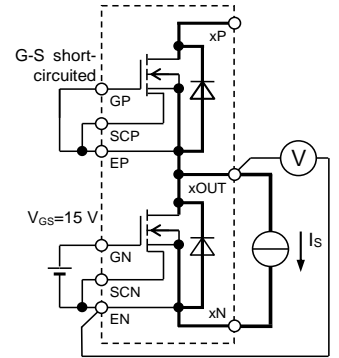


Di2

V_{SD} test circuit (x: Connected *a and *b)



Tr1 & Di1



Tr2 & Di2

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

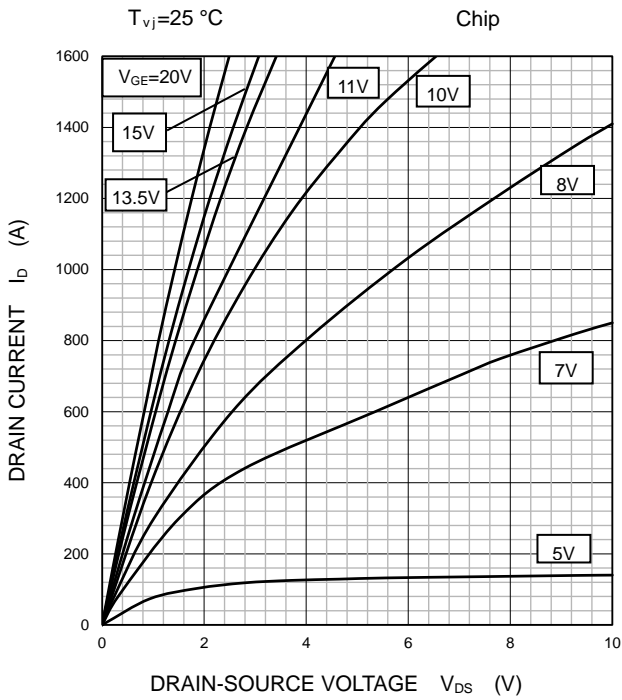
FMF800DX2-24A

HIGH POWER SWITCHING USE

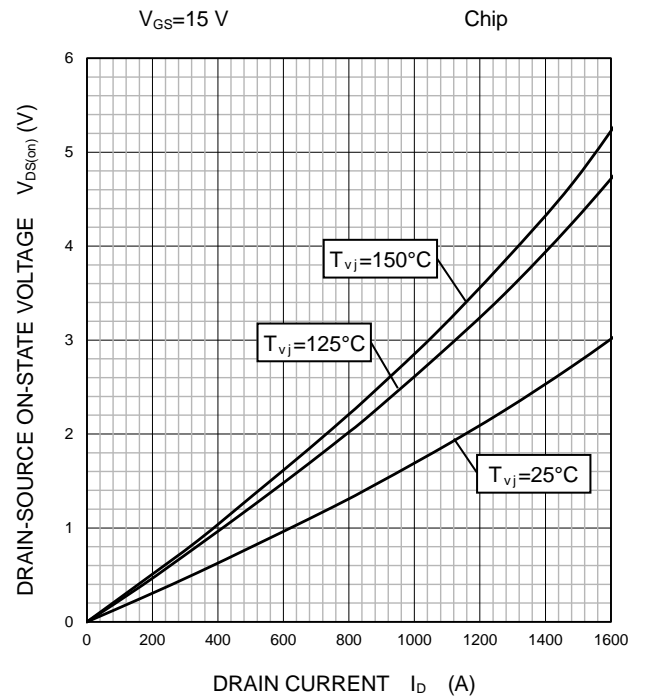
INSULATED TYPE

PERFORMANCE CURVES

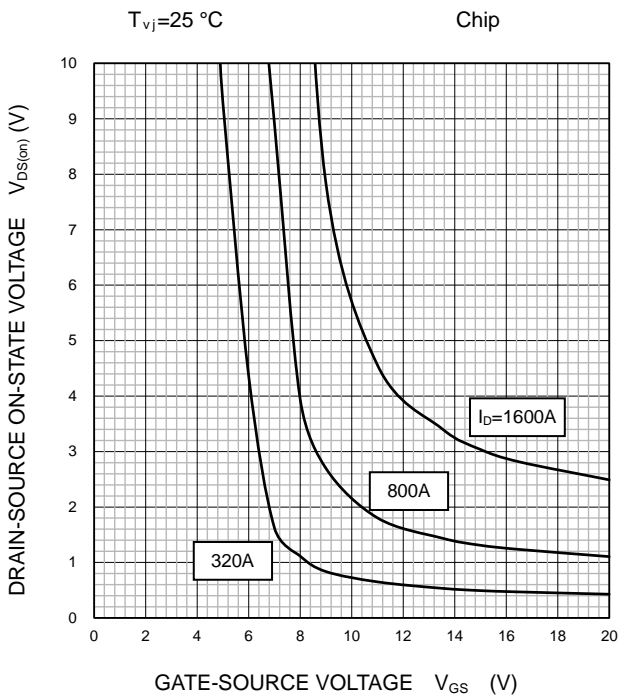
OUTPUT CHARACTERISTICS (TYPICAL)



DRAIN-SOURCE ON STATE VOLTAGE CHARACTERISTICS (TYPICAL)



DRAIN-SOURCE ON STATE VOLTAGE CHARACTERISTICS (TYPICAL)



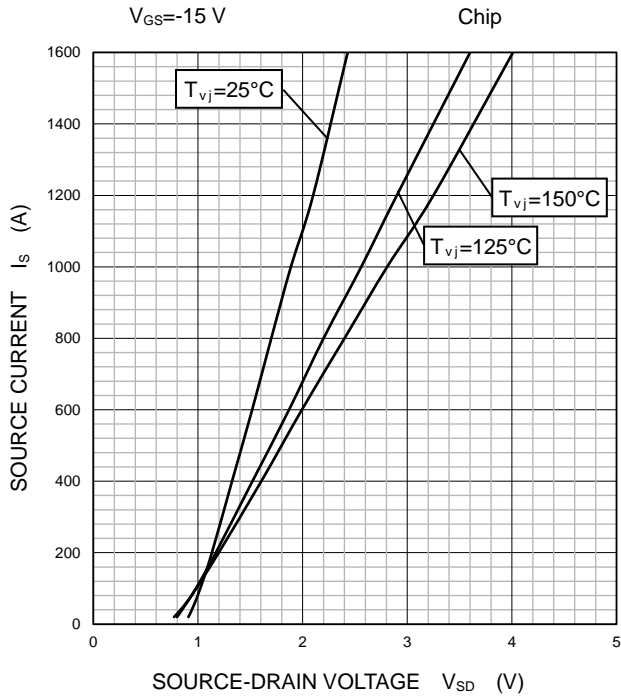
FMF800DX2-24A

HIGH POWER SWITCHING USE

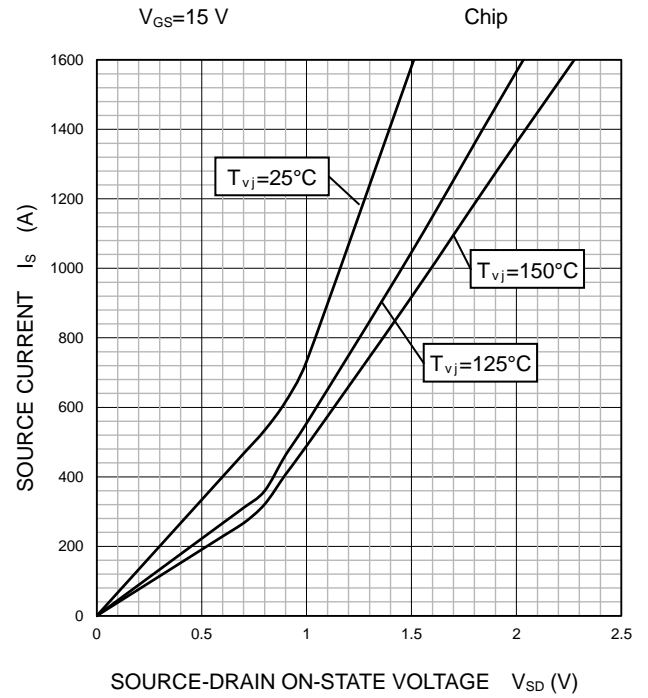
INSULATED TYPE

PERFORMANCE CURVES

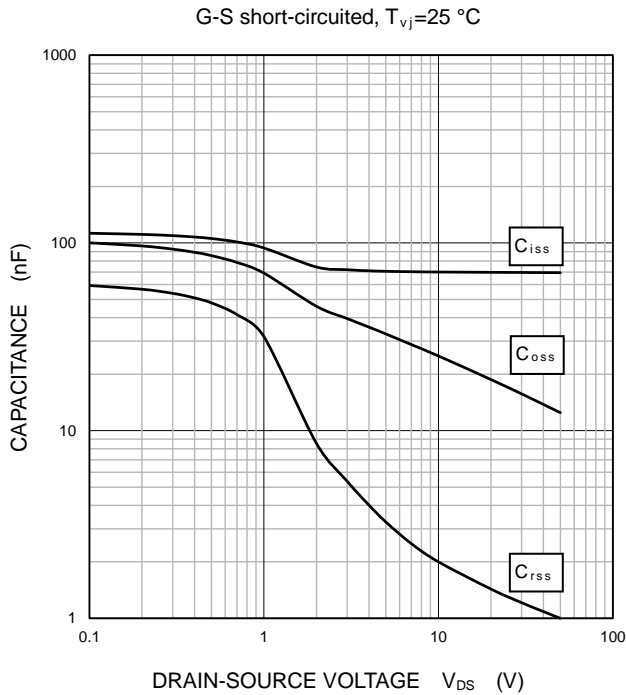
FREE WHEELING DIODE
FORWARD CHARACTERISTICS
(TYPICAL)



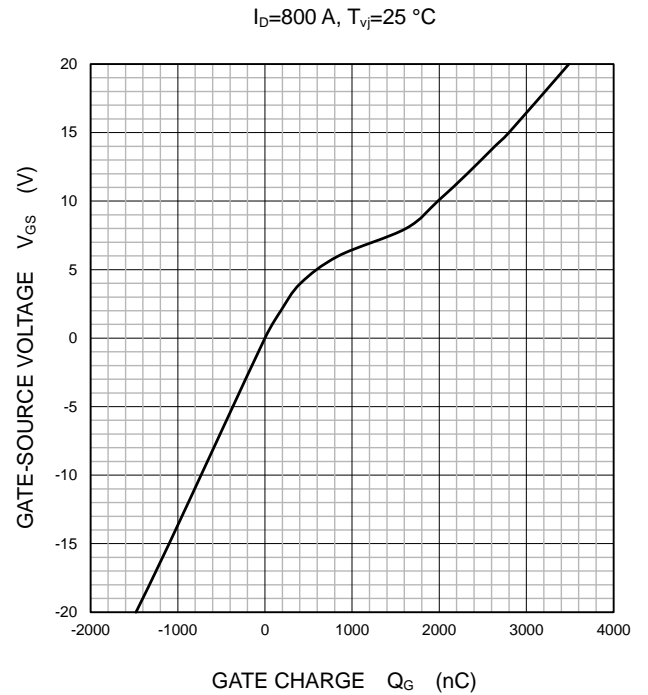
SOURCE-DRAIN ON STATE VOLTAGE
CHARACTERISTICS
(TYPICAL)



CAPACITANCE
CHARACTERISTICS
(TYPICAL)



GATE CHARGE
CHARACTERISTICS
(TYPICAL)



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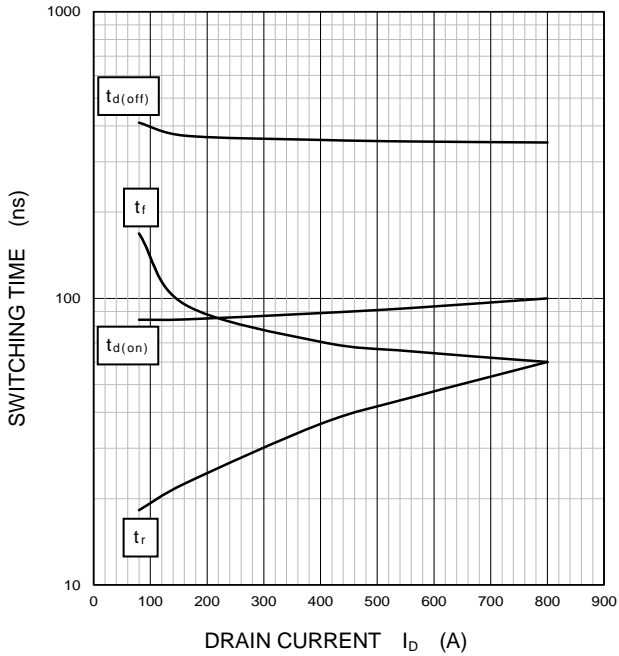
HIGH POWER SWITCHING USE

INSULATED TYPE

PERFORMANCE CURVES

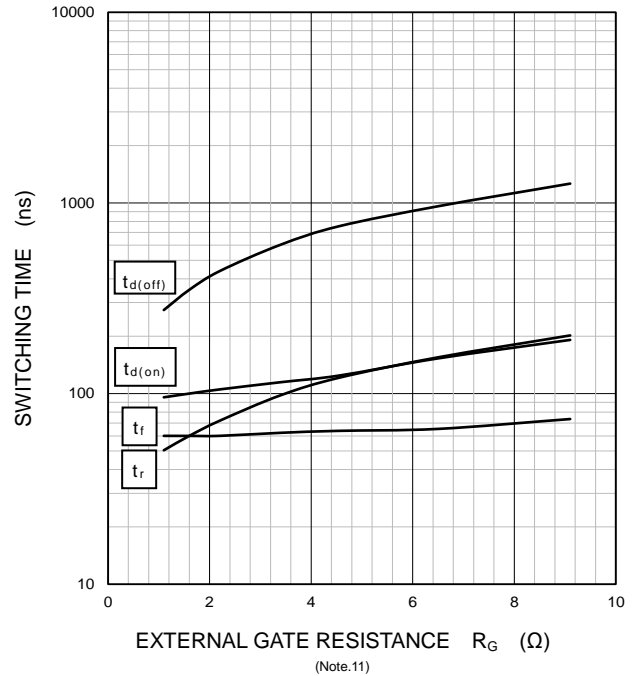
HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)

$V_{DD}=600\text{ V}$, $V_{GS}=\pm 15\text{ V}$, $R_G=1.6\ \Omega$,
 $T_{vj}=125\text{ }^\circ\text{C}$, INDUCTIVE LOAD



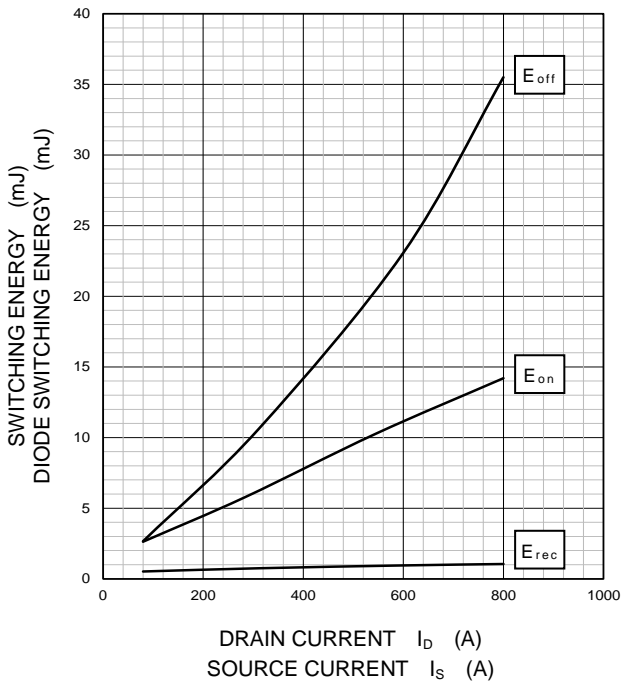
HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)

$V_{DD}=600\text{ V}$, $V_{GS}=\pm 15\text{ V}$, $I_D=800\text{ A}$,
 $T_{vj}=125\text{ }^\circ\text{C}$, INDUCTIVE LOAD



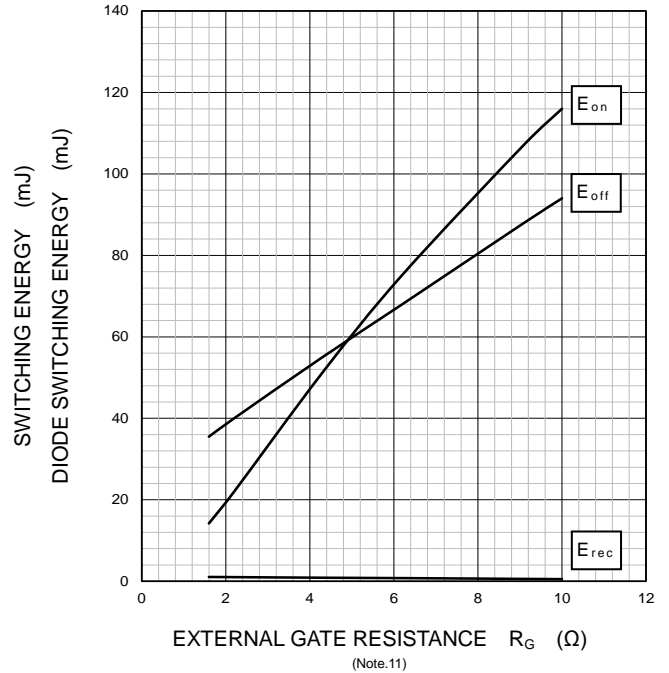
HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)

$V_{DD}=600\text{ V}$, $V_{GS}=\pm 15\text{ V}$, $R_G=1.6\ \Omega$, $T_{vj}=125\text{ }^\circ\text{C}$,
INDUCTIVE LOAD, PER PULSE



HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)

$V_{DD}=600\text{ V}$, $V_{GS}=\pm 15\text{ V}$, $I_D/I_S=800\text{ A}$, $T_{vj}=125\text{ }^\circ\text{C}$,
INDUCTIVE LOAD, PER PULSE



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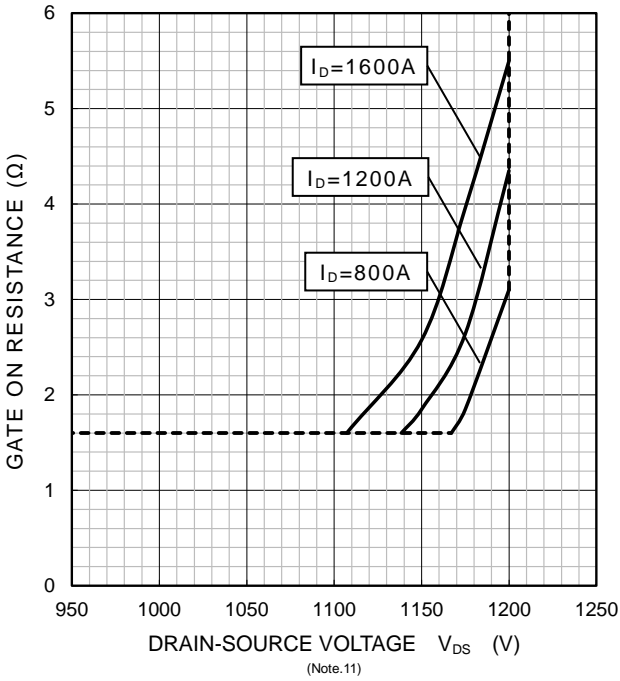
HIGH POWER SWITCHING USE

INSULATED TYPE

PERFORMANCE CURVES

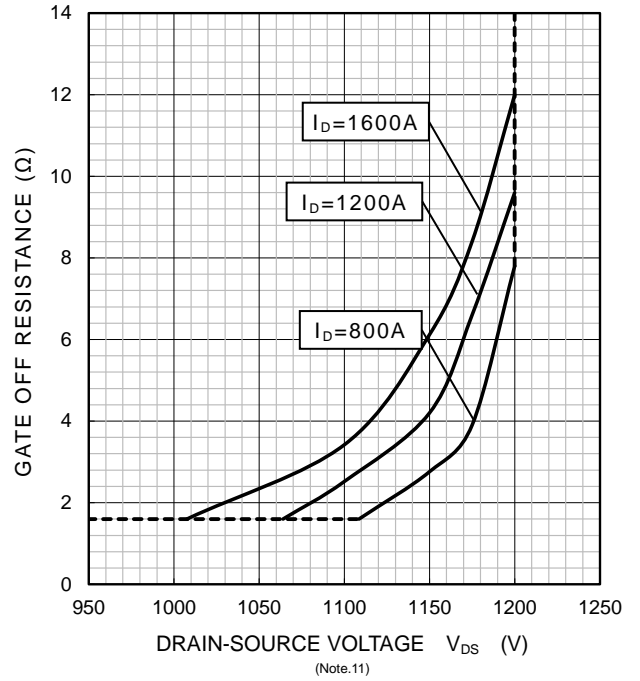
RECOMMENDED GATE RESISTANCE
(MINIMUM)

TURN ON, $V_{GS} = \pm 15\text{ V}$



RECOMMENDED GATE RESISTANCE
(MINIMUM)

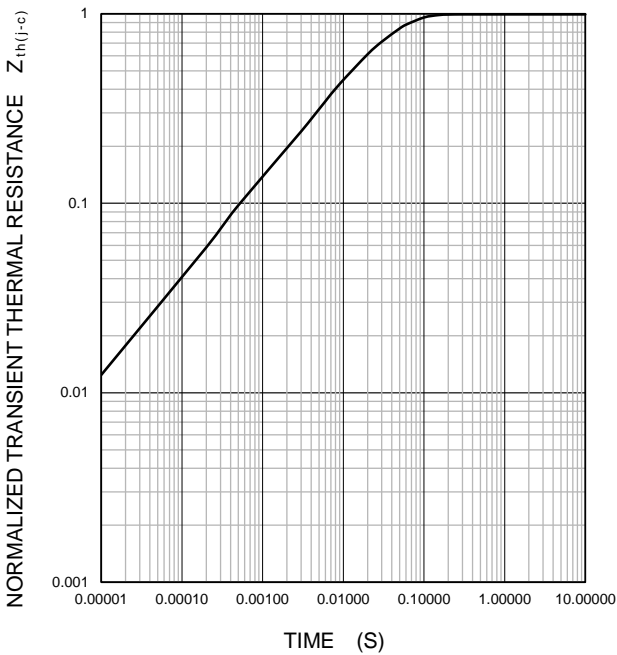
TURN OFF, $V_{GS} = \pm 15\text{ V}$



TRANSIENT THERMAL IMPEDANCE
CHARACTERISTICS
(MAXIMUM)

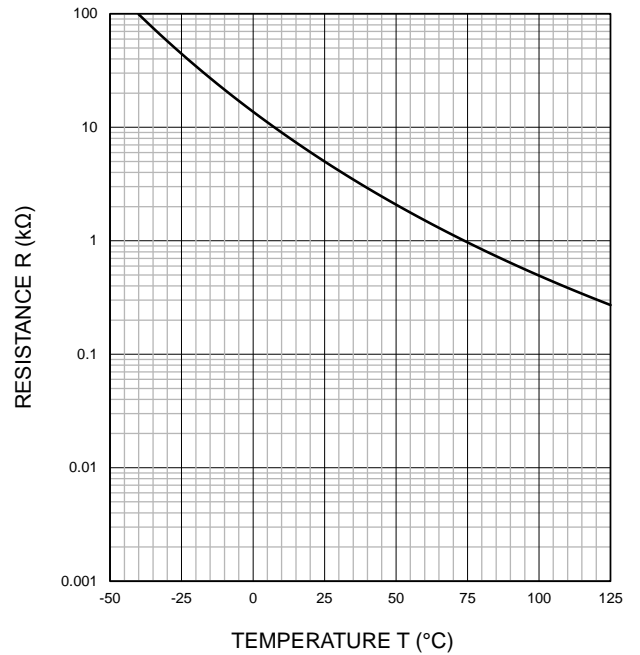
Single pulse, $T_C = 25\text{ °C}$

$R_{th(j-c)Q} = 42\text{ K/kW}$, $R_{th(j-c)D} = 61\text{ K/kW}$



NTC thermistor part

TEMPERATURE
CHARACTERISTICS
(TYPICAL)



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

FMF800DX2-24A

HIGH POWER SWITCHING USE
INSULATED TYPE

Keep safety first in your circuit designs!

This product is designed for industrial application purpose. The performance, the quality and support level of the product is guaranteed by "Customer's Std. Spec."

Mitsubishi Electric Corporation puts its reasonable effort into making semiconductor products better and more reliable, but there is always the possibility that trouble may occur with them by the reliability lifetime such as Power Cycle, Thermal Cycle or others, or to be used under special circumstances(e.g. high humidity, dusty, salty, highlands, environment with lots of organic matter / corrosive gas / explosive gas, or situation which terminal of semiconductor products is received strong mechanical stress).

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. Furthermore, trouble with semiconductors may lead to personal injury, fire or property damage. Remember to give due consideration to safety when making your circuit designs, with appropriate measures such as (i) placement of substitutive, auxiliary circuits (e.g. appropriate fuse or circuit breaker between a power supply and semiconductor products), (ii) use of non-flammable material or (iii) prevention against any malfunction or mishap.

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