

<Full SiC Power Modules>

FMF600DXE-34BN

HIGH POWER SWITCHING USE
INSULATED TYPE



Dual switch (Half-Bridge)

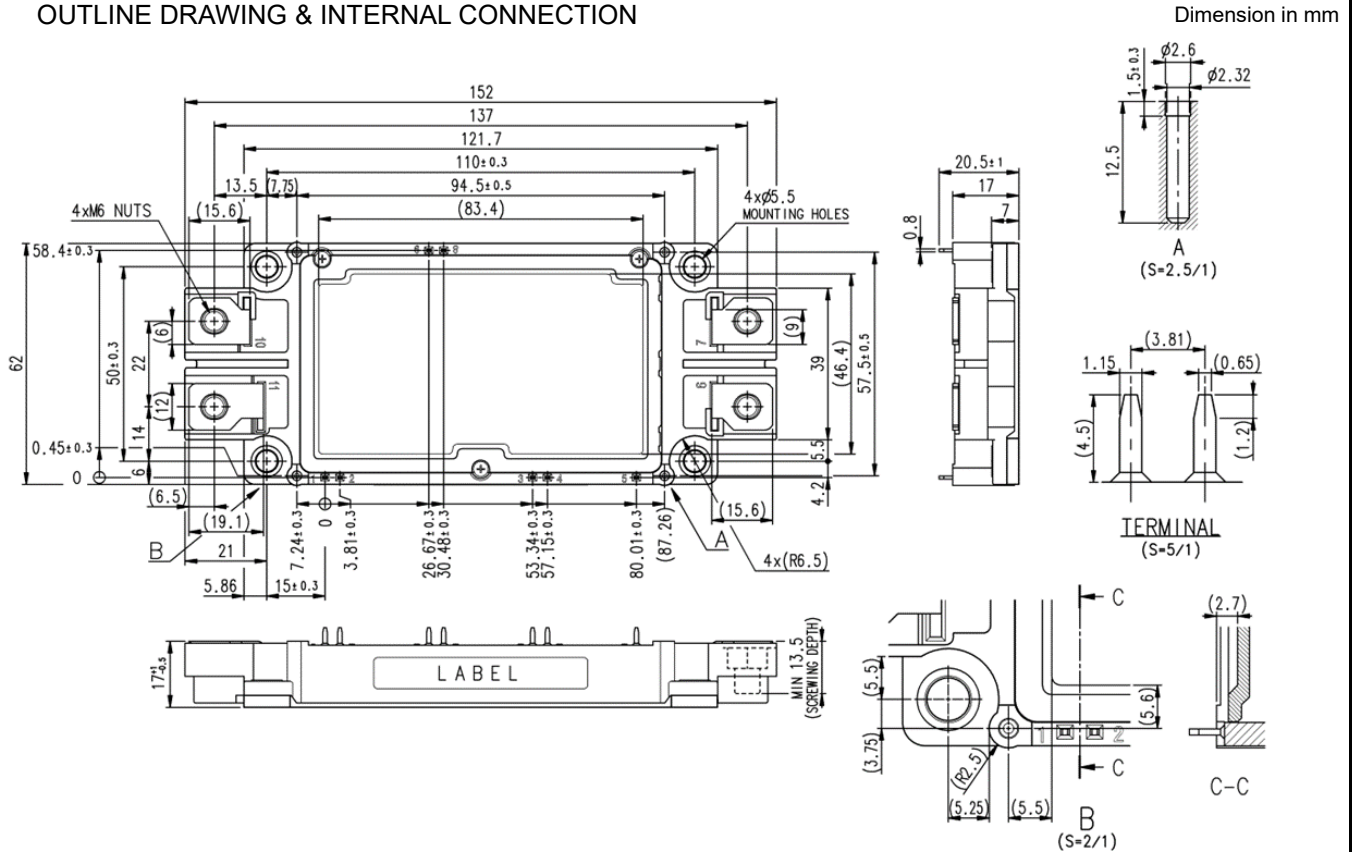
Drain current I_D **600 A**
 Drain-Source voltage V_{DSX} **1700 V**
 Maximum junction temperature T_{vjmax} **175 °C**

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

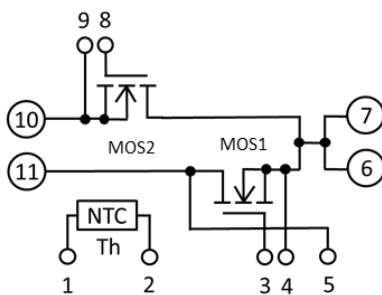
APPLICATION

HF converter, Power supply, Motor drive, etc.

OUTLINE DRAWING & INTERNAL CONNECTION



INTERNAL CONNECTION



Terminal	code
1	TH1
2	TH2
3	G1
4	S1
5	D1

Terminal	code
6	OUT
7	OUT
8	G2
9	S2
10	N
11	P

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

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

Symbol	Item	Conditions	Rating	Unit
V _{DSX}	Drain-source voltage	V _{GS} =-7 V, Measurement terminals position(P-OUT, OUT-N) Refer to Switching characteristics test circuit	1700	V
V _{GSS}	Gate-source voltage	D-S short-circuited	+20/-8.5	V
I _D	Drain current	DC, T _C =42°C (Note.2)	600	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)	2500	W
I _S (Note1)	Source current	DC	600	A
I _{SRM} (Note1)		Pulse, Repetitive (Note.3), T _{vj} =150°C(Note.4)	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) (Note.11)	175	°C
T _{vjop}	Operating junction temperature	Continuous operation (under switching) (Note.11)	-40~+150	°C
T _{Cmax}	Maximum case temperature	(Note.2, 11)	125	°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} =-7 V	-	-	1.0	mA	
		V _{DS} =1000V, V _{GS} =-7 V	-	-	1.0		
V _{GS(th)}	Gate-source threshold voltage	I _D =229 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 =600 A, V _{GS} =15V (Note.6)	T _{vj} =25 °C	-	1.62	2.75	V
			T _{vj} =125 °C	-	2.36	-	
			T _{vj} =150 °C	-	2.65	-	
V _{DS(on)} (chip)	Drain-source on-state voltage	I _D =600 A, V _{GS} =15V (Note.6)	T _{vj} =25 °C	-	1.35	-	V
			T _{vj} =125 °C	-	2.09	-	
			T _{vj} =150 °C	-	2.38	-	
r _{DS(on)} (chip)	Drain-source on-state resistance	I _D =600 A, V _{GS} =15V (Note.6)	T _{vj} =25 °C	-	2.25	-	mΩ
			T _{vj} =125 °C	-	3.48	-	
			T _{vj} =150 °C	-	3.97	-	
C _{iss}	Input capacitance	V _{DS} =10 V, V _{GS} =0V	-	55	-	nF	
C _{oss}	Output capacitance		-	23	-		
C _{rss}	Reverse transfer capacitance		-	2	-		
Q _G	Gate charge	V _{DD} =900 V, I _D =600 A, V _{GS} =0→15 V	-	1890	-	nC	
t _{d(on)}	Turn-on delay time	V _{DD} =900 V, I _D =600 A, V _{GS} =+15 / -7 V, T _{vj} =150°C, R _{G(on/off)} =1.2 / 0.75 Ω, L _{s_ext} =13.2 nH, Inductive load, per pulse	-	100	-	ns	
t _r	Rise time		-	60	-		
t _{d(off)}	Turn-off delay time		-	190	-		
t _f	Fall time		-	40	-		
t _{rr} (Note1)	Reverse recovery time		-	110	-	mJ	
E _{on}	Turn-on switching energy		-	36	-		
E _{off}	Turn-off switching energy		-	11	-		
E _{rr} (Note1)	Reverse recovery energy	-	18	-	μC		
Q _{rr} (Note1)	Reverse recovery charge	-	32	-			
V _{SD} (Note.1) (terminal)	Source-drain voltage	I _S =600 A (Note.6) V _{GS} =-7 V	T _{vj} =25 °C	-	4.47	5.50	V
			T _{vj} =125 °C	-	4.11	-	
			T _{vj} =150 °C	-	4.04	-	
V _{SD} (Note.1) (chip)	Source-drain voltage	I _S =600 A (Note.6) V _{GS} =-7 V	T _{vj} =25 °C	-	4.20	-	V
			T _{vj} =125 °C	-	3.84	-	
			T _{vj} =150 °C	-	3.77	-	

Caution: Short-circuit capability is not designed.

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HIGH 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	-	-	60	K/kW
$R_{th(c-s)}$	Contact thermal resistance ^(Note.2)	Case to heat sink, per 1 module, Thermal grease applied ^(Note.8, 11)	-	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	kΩ
$\Delta R/R$	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

MODULE

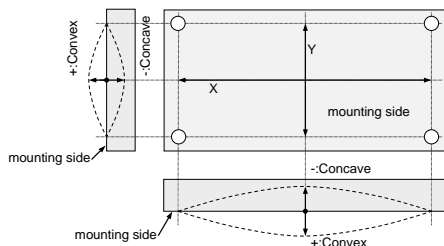
Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
M_t	Mounting torque	Main terminals M 6 screw	3.5	4.0	4.5	N·m
M_s		Mounting to heat sink M 5 screw	2.5	3.0	3.5	N·m
e_c	Flatness of base plate	On the centerline X, Y ^(Note.5)	0	-	+100	μm

Symbol	Item	Conditions	Value	Unit
m	mass	-	415	g
d_a	Clearance	Terminal to terminal	10.0	mm
		Terminal to base plate	8.2	
d_s	Creepage distance	Terminal to terminal	17.4	mm
		Terminal to base plate	16.0	
$R_{DD'+SS'}$	Internal lead resistance	P-S1, OUT-S2 terminals, per switch	0.45	mΩ
L_s	Internal stray inductance	P-N	9	nH
r_g	Internal gate resistance	Per switch	0.25	Ω

*: 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. Represent ratings and characteristics of the MOSFET body diode.

- 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.



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

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

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

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

- Reference value. Thermally conductive grease of $\lambda=0.9\text{ W/(m}\cdot\text{K)}$.

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

"φ2.6×10 or φ2.6×12, B1 tapping screw"

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

- Per switch.

- 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.

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HIGH POWER SWITCHING USE
INSULATED TYPE

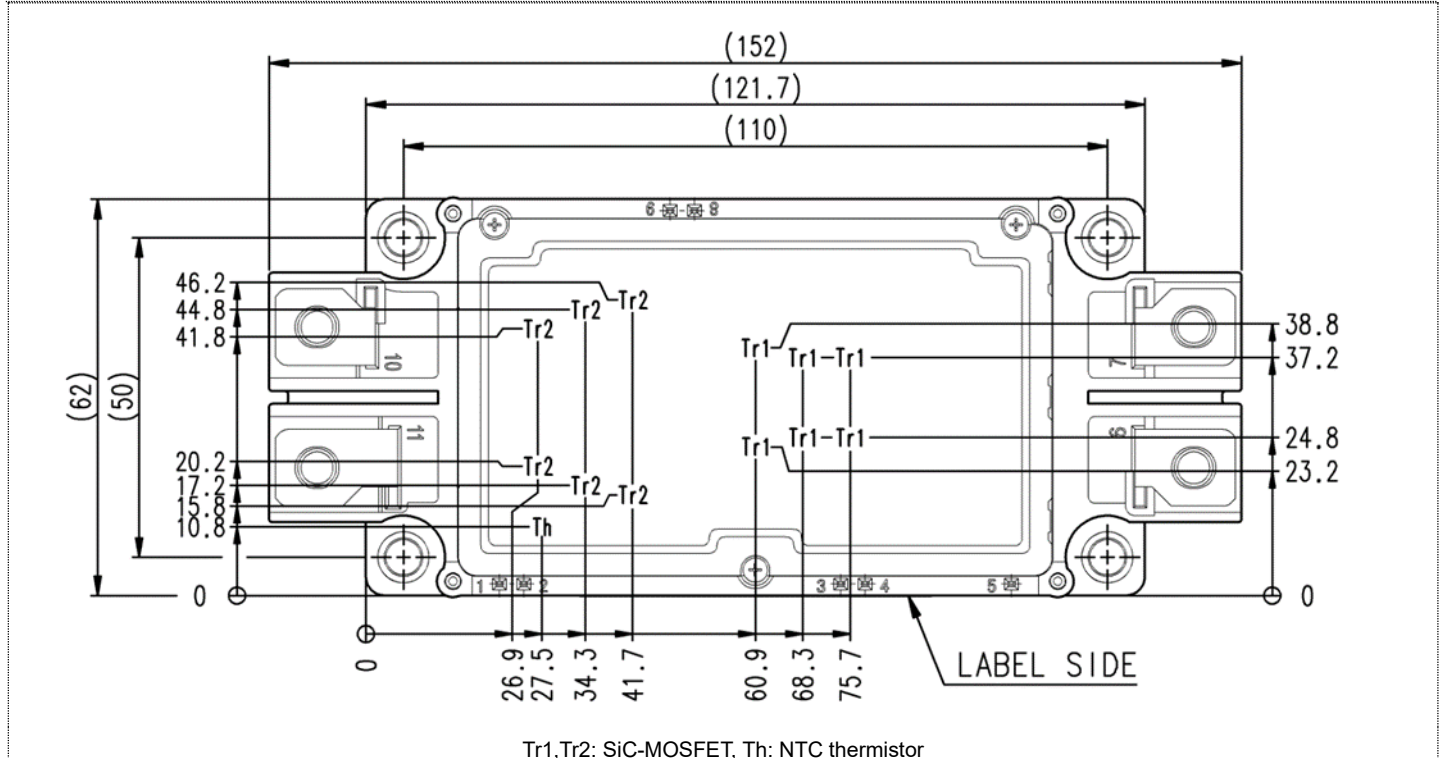
RECOMMENDED OPERATING CONDITIONS

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
V_{DD}	(DC) Supply voltage	Applied across P-N terminals	-	900	1200	V
$V_{GS(+)}$	Gate-Source drive positive voltage	Applied across G1-S1, G2-S2 terminals	13.5	15	16.5	V
$V_{GS(-)}$	Gate-Source drive negative voltage	Applied across G1-S1, G2-S2 terminals	-8.5	-7	-5.5	V
$R_{G(on)}$	External gate turn-on resistance (Note.12)	Per switch	1.2	-	6.0	Ω
$R_{G(off)}$	External gate turn-off resistance (Note.12)		0.75	-	6.0	

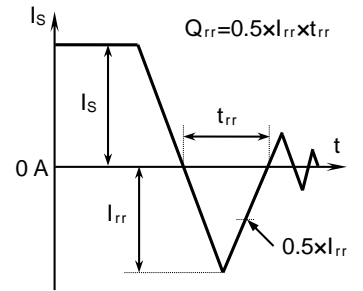
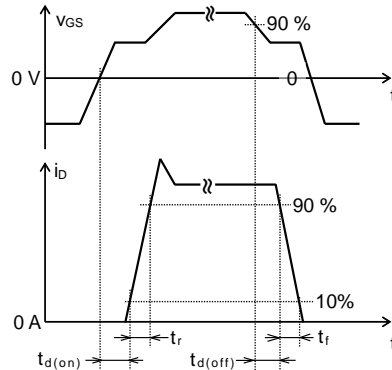
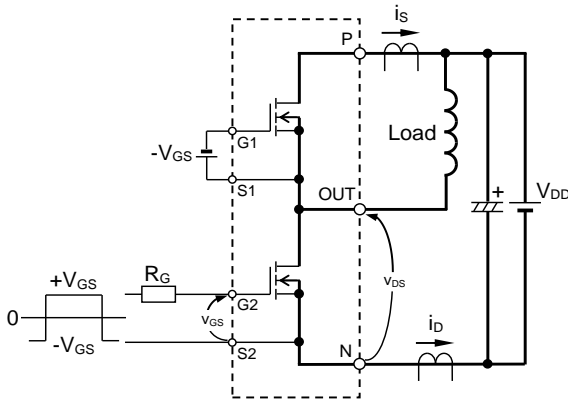
Note 12. The value of external gate resistance should be considered the surge voltage not to exceed the rating voltage in the worst system condition.

CHIP LOCATION (Top view)

Dimension in mm, tolerance: ± 1 mm

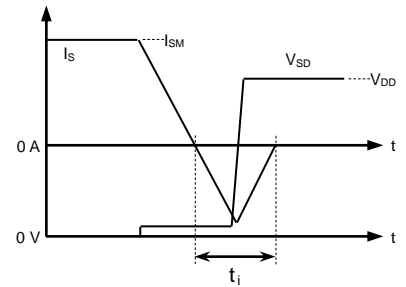
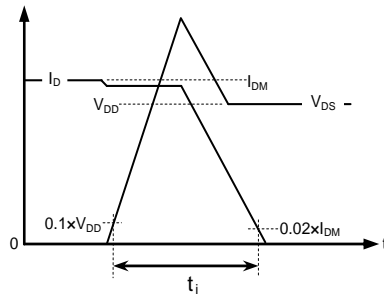
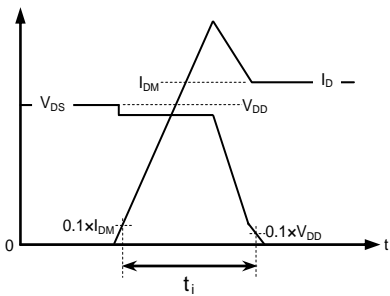


TEST CIRCUIT AND WAVEFORMS



Switching characteristics test circuit and waveforms

t_{rr} , Q_{rr} test waveform



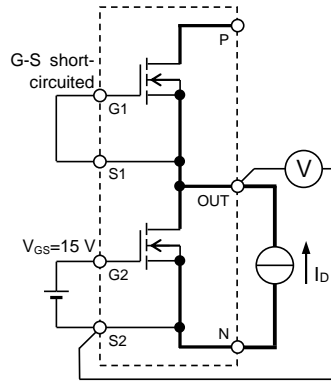
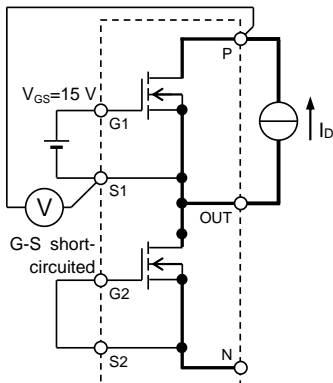
MOSFET Turn-on switching energy

MOSFET Turn-off switching energy

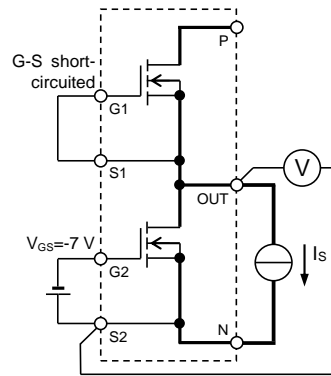
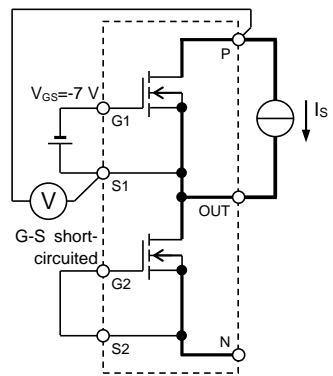
MOSFET body diode Reverse recovery energy

Switching energy and Reverse recovery energy test waveforms (Integral time instruction drawing)

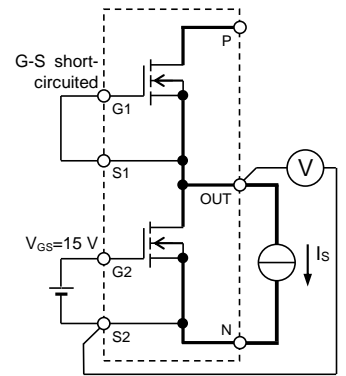
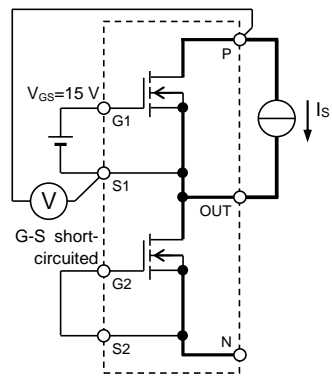
TEST CIRCUIT



$V_{DS(on)}$ test circuit



V_{SD} test circuit, $V_{GS} = -7V$



V_{SD} test circuit, $V_{GS} = 15V$

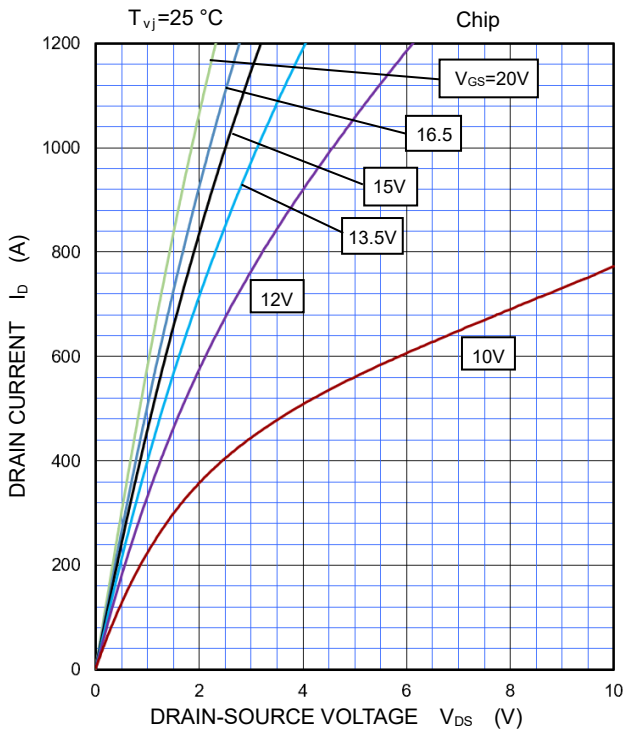
FMF600DXE-34BN

HIGH POWER SWITCHING USE

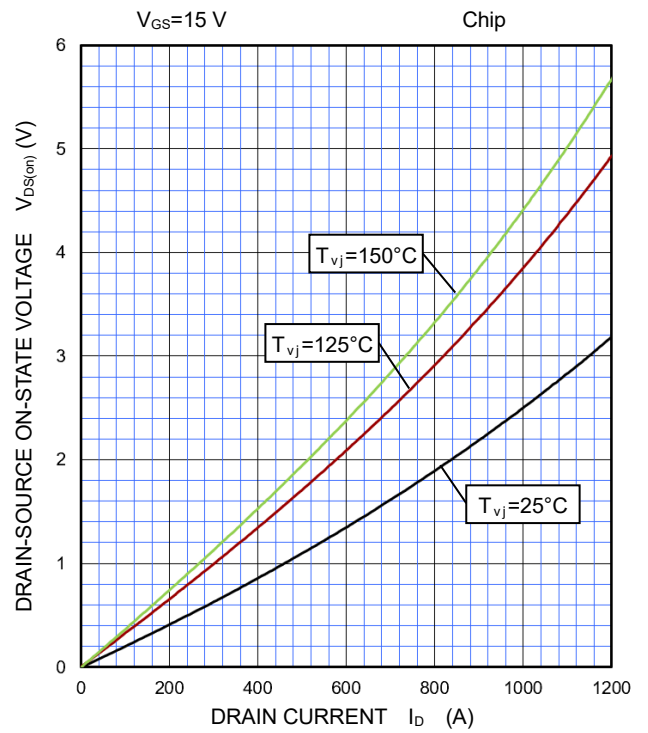
INSULATED TYPE

PERFORMANCE CURVES

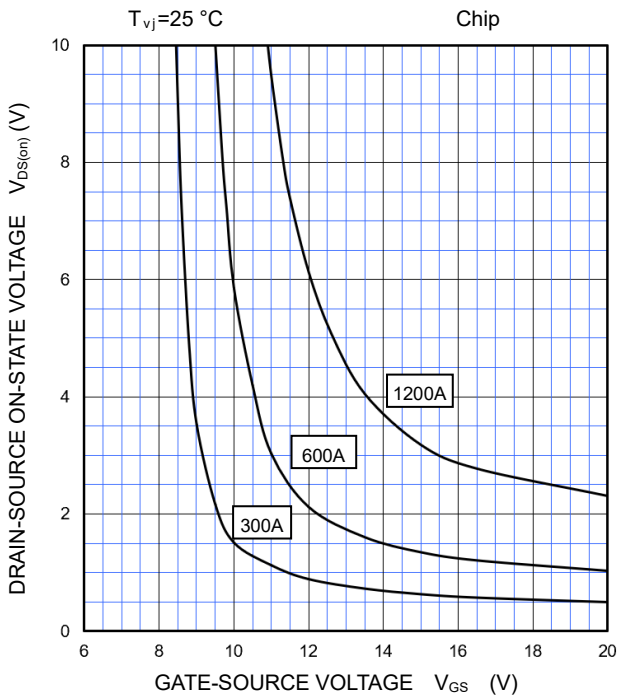
OUTPUT CHARACTERISTICS (TYPICAL)



DRAIN-SOURCE ON STATE VOLTAGE CHARACTERISTICS (TYPICAL)



DRAIN-SOURCE ON STATE VOLTAGE CHARACTERISTICS (TYPICAL)

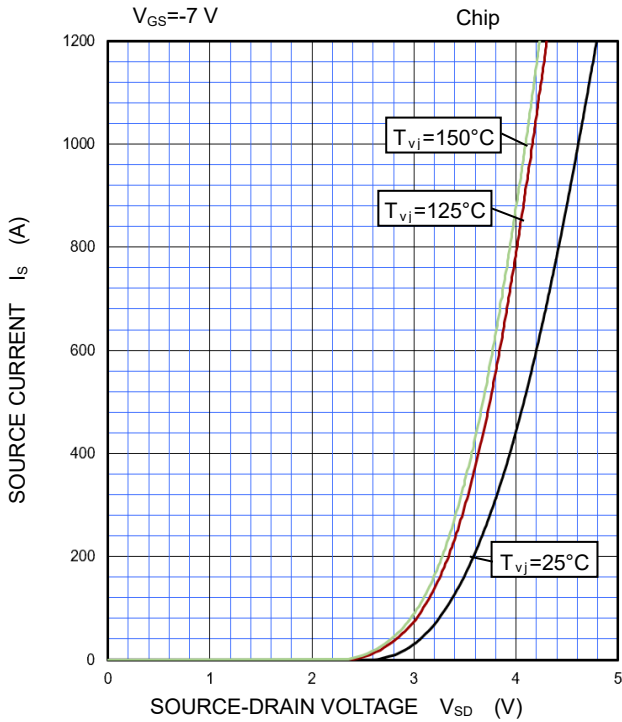


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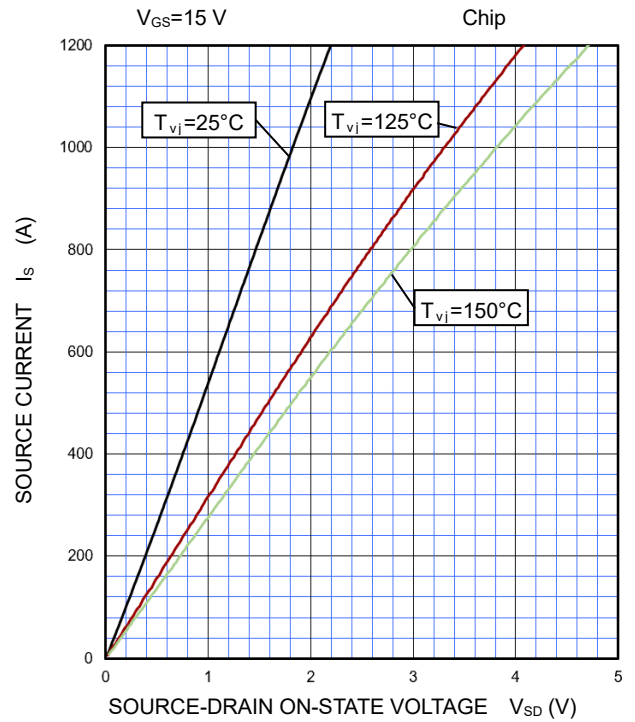
HIGH POWER SWITCHING USE
INSULATED TYPE

PERFORMANCE CURVES

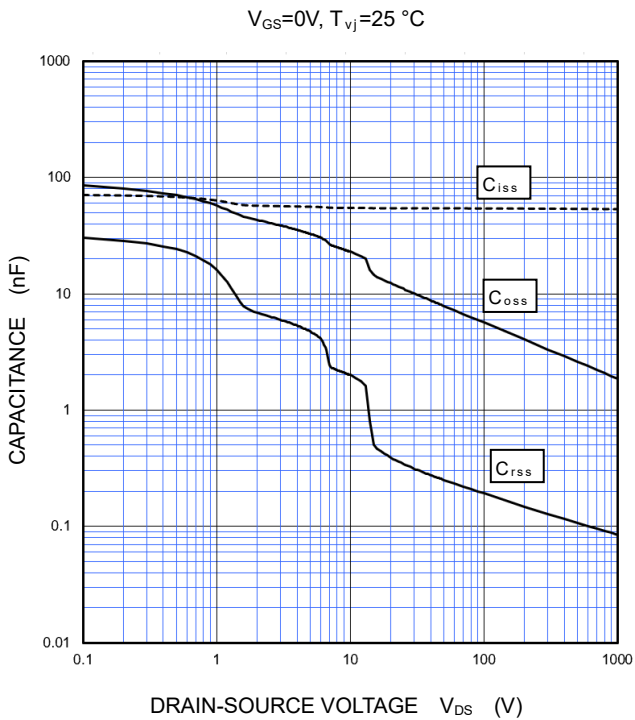
MOSFET BODY DIODE
FORWARD CHARACTERISTICS
(TYPICAL)



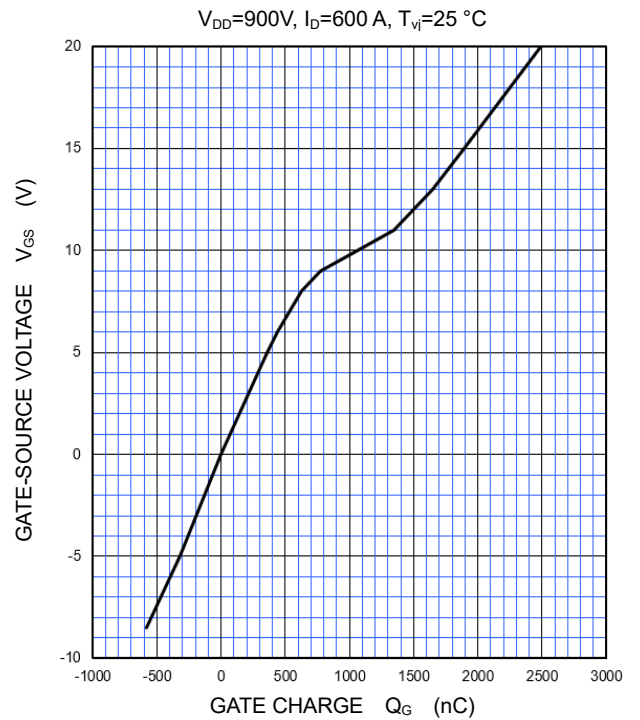
SOURCE-DRAIN ON STATE VOLTAGE
CHARACTERISTICS
(TYPICAL)



CAPACITANCE
CHARACTERISTICS
(TYPICAL)



GATE CHARGE
CHARACTERISTICS
(TYPICAL)



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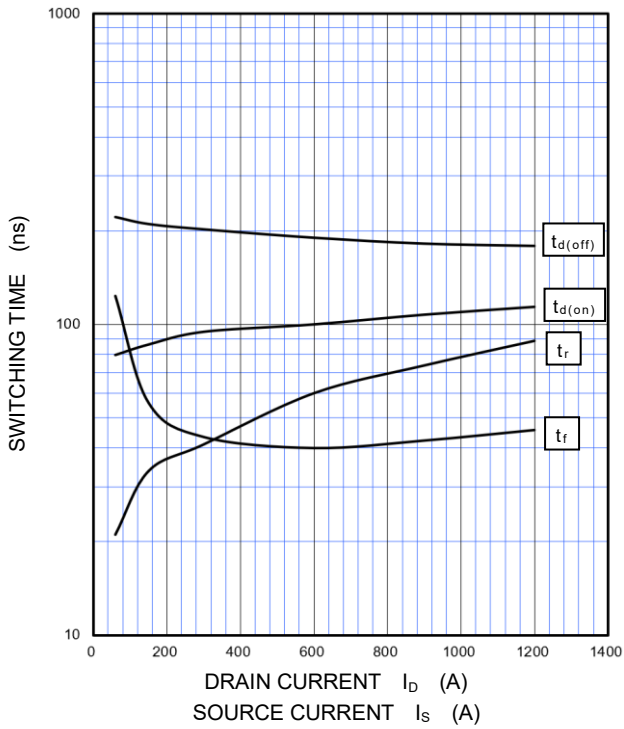
HIGH POWER SWITCHING USE

INSULATED TYPE

PERFORMANCE CURVES

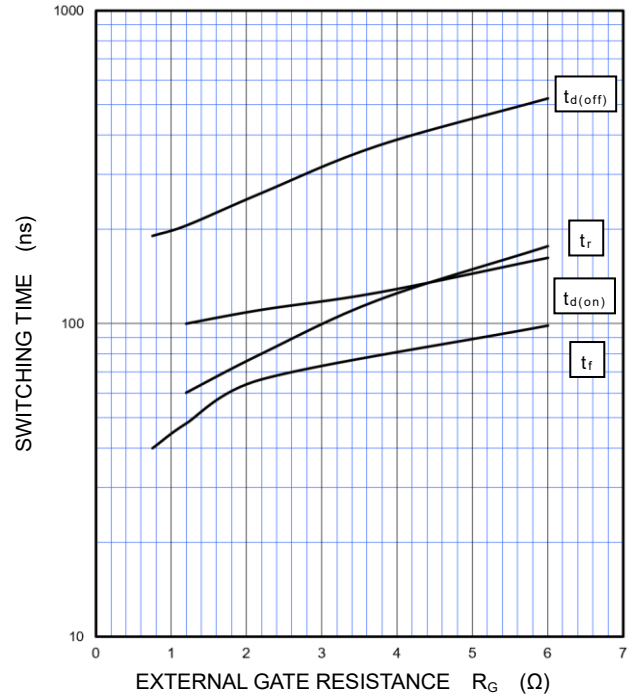
HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)

$V_{DD}=900\text{ V}$, $V_{GS}=15 / -7\text{ V}$, $R_{G(on/off)}=1.2 / 0.75\Omega$,
 $T_{vj}=150\text{ }^\circ\text{C}$, $L_{s_ext}=13.2\text{ nH}$
INDUCTIVE LOAD



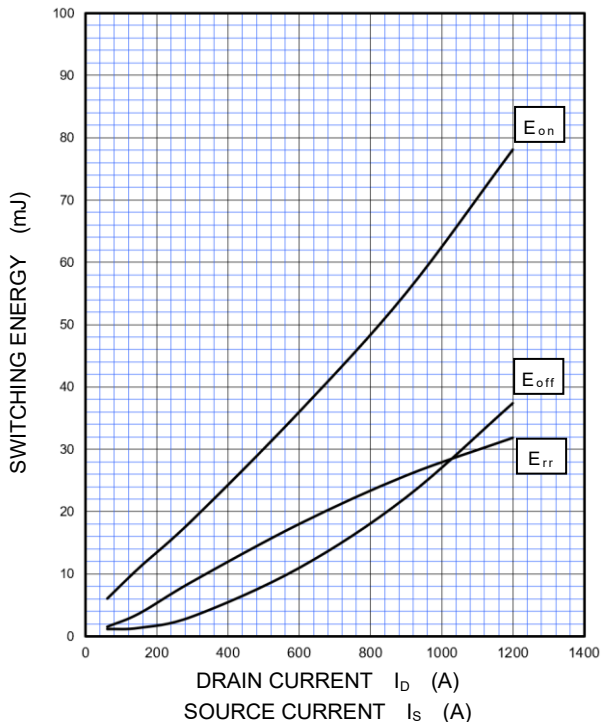
HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)

$V_{DD}=900\text{ V}$, $V_{GS}=15 / -7\text{ V}$, $I_D=600\text{ A}$,
 $T_{vj}=150\text{ }^\circ\text{C}$, $L_{s_ext}=13.2\text{ nH}$
INDUCTIVE LOAD



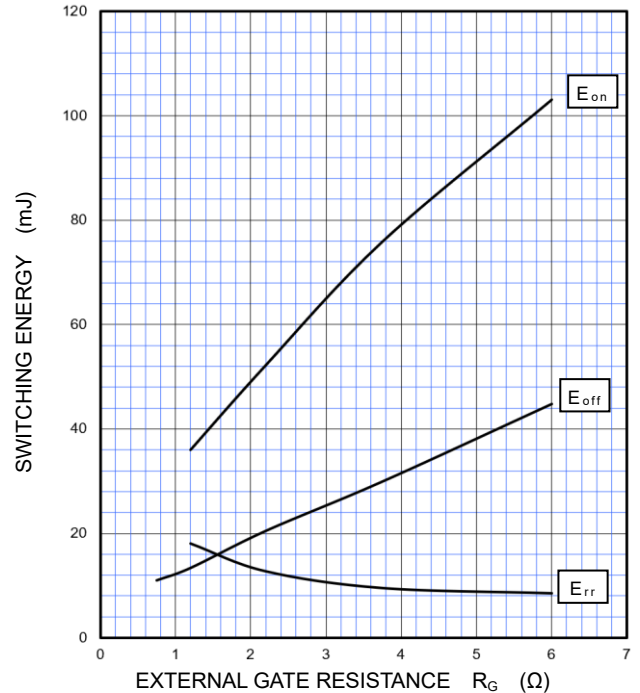
HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)

$V_{DD}=900\text{ V}$, $V_{GS}=15 / -7\text{ V}$, $R_{G(on/off)}=1.2 / 0.75\Omega$,
 $T_{vj}=150\text{ }^\circ\text{C}$, $L_{s_ext}=13.2\text{ nH}$
INDUCTIVE LOAD, PER PULSE



HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)

$V_{DD}=900\text{ V}$, $V_{GS}=15 / -7\text{ V}$, $I_D=600\text{ A}$,
 $T_{vj}=150\text{ }^\circ\text{C}$, $L_{s_ext}=13.2\text{ nH}$
INDUCTIVE LOAD, PER PULSE



FMF600DXE-34BN

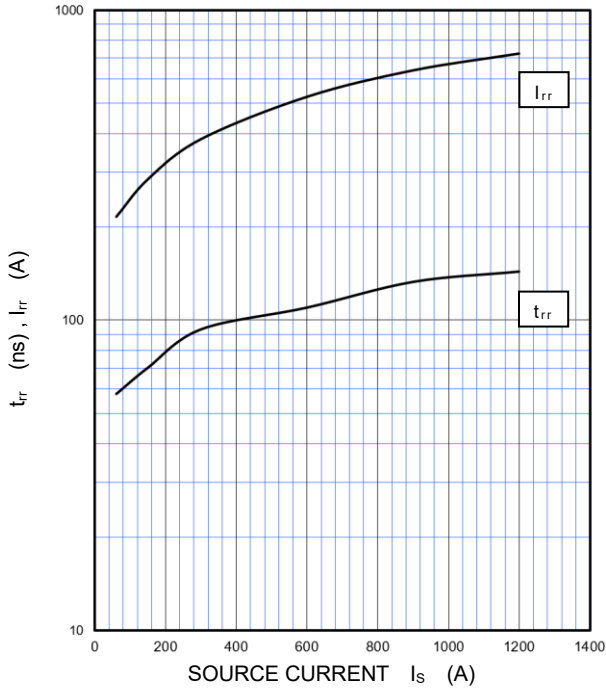
HIGH POWER SWITCHING USE

INSULATED TYPE

PERFORMANCE CURVES

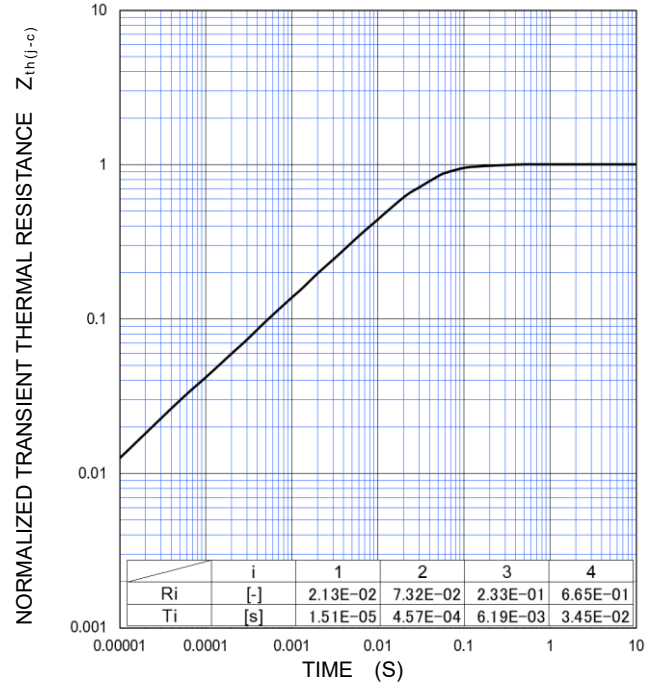
MOSFET BODY DIODE
REVERSE RECOVERY CHARACTERISTICS
(TYPICAL)

$V_{DD}=900\text{ V}$, $V_{GS}=15 / -7\text{ V}$, $R_{G(on/off)}=1.2 / 0.75\Omega$,
 $T_{vj}=150\text{ }^\circ\text{C}$, $L_{s_ext}=13.2\text{ nH}$
INDUCTIVE LOAD, PER PULSE



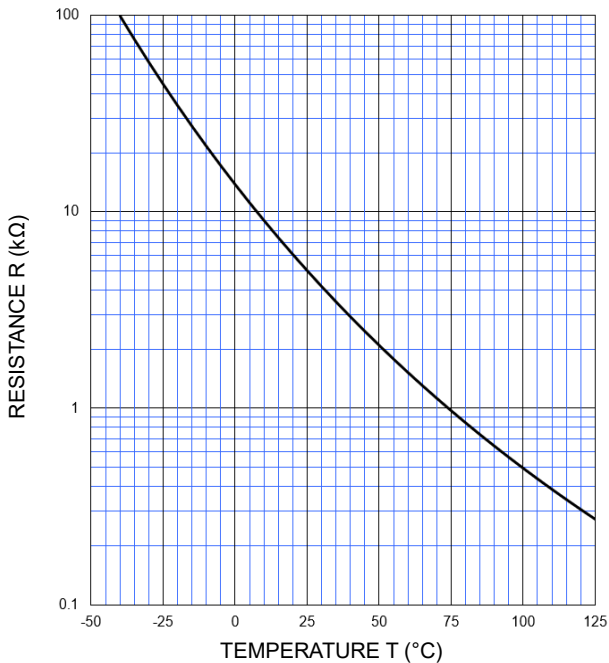
TRANSIENT THERMAL IMPEDANCE
CHARACTERISTICS
(MAXIMUM)

Single pulse, $T_c=25\text{ }^\circ\text{C}$
 $R_{th(j-c)Q}=60\text{K/kW}$



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.

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HIGH POWER SWITCHING USE
INSULATED TYPE

Keep safety first in your circuit designs!

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