

< HV MOSFET MODULE >

# FMF800DC-66BEW

HIGH POWER SWITCHING USE

INSULATED TYPE

2<sup>nd</sup> gen. HV MOSFET (High Voltage Metal Oxide Semiconductor Field Effect Transistor) Modules

## FMF800DC-66BEW



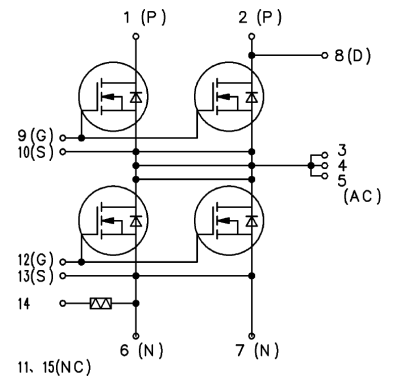
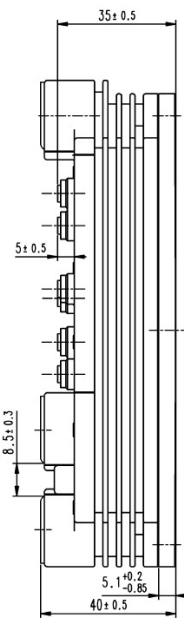
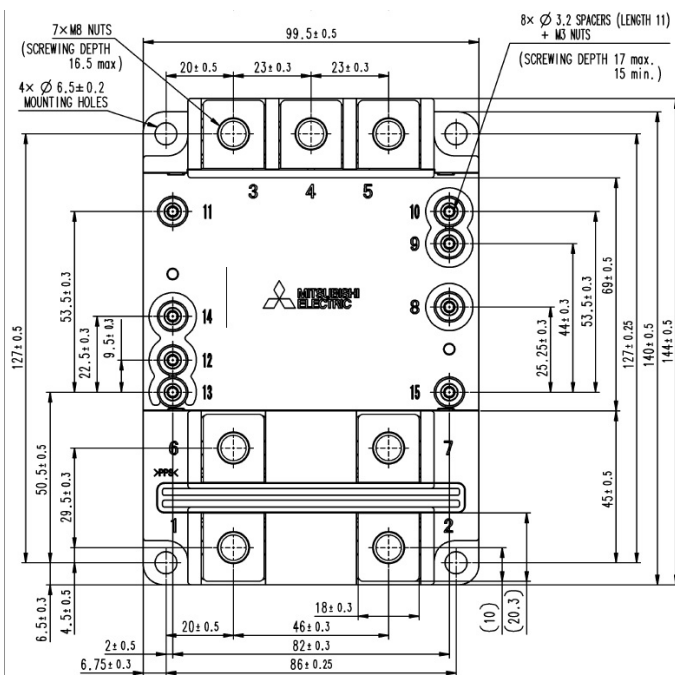
- $I_D$ .....800A
- $V_{DSX}$ .....3300V
- 2-element in a Pack
- Insulated Type
- SiC SBD embedded MOSFET

## APPLICATION

Traction drives, High Reliability Converters / Inverters, DC choppers

## OUTLINE DRAWING & CIRCUIT DIAGRAM

Dimensions in mm



## CIRCUIT DIAGRAM

No.	Terminals
1, 2	DC+, D(P)
3, 4, 5	AC, S(P), D(N)
6, 7	DC-, S(N)
8	D(P)
9	G(P)
10	S(P)
11	NC
12	G(N)
13	S(N)
14	NTC
15	NC

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**MAXIMUM RATINGS**

Item	Symbol	Condition	Ratings	Unit	
Drain-Source voltage, specified gate-source voltage	$V_{DSX}$	$V_{GS} = -7\text{ V}$	$T_J = -40\sim 175\text{ }^\circ\text{C}$	3300	V
Gate-Source voltage	$V_{GSS}$	$V_{DS} = 0\text{ V}$	$T_J = -40\sim 175\text{ }^\circ\text{C}$	$\pm 20$	V
Drain current	$I_D$	$V_{GS} = 17\text{ V}$ , $T_c = 87\text{ }^\circ\text{C}$ , AC terminal output current (Note 1)		800	A
Drain current	$I_{DP}$	Non repetitive pulse	$T_J = T_{op}$	1600	A
Reverse drain current (FWD forward current)	$I_S$	$V_{GS} = -7\text{ V}$ , $T_c = 85\text{ }^\circ\text{C}$ , AC terminal output current(Note 1)(Note 2)		800	A
Reverse drain current (FWD forward current)	$I_{SP}$	Non repetitive pulse(Note 2)	$T_J = T_{op}$	1600	A
Total power dissipation	$P_{tot}$	$T_c = 25\text{ }^\circ\text{C}$ , MOSFET part(Note 3)		6650	W
Isolation voltage	$V_{isol}$	Charge part to the baseplate RMS sinusoidal, 60Hz 1min		6000	$V_{rms}$
Partial discharge charge	$Q_{pd}$	Charged part to the baseplate RMS sinusoidal, 60 Hz 1min $V_1 = 3500\text{ V}$ , $V_2 = 2600\text{ V}$ (acc. to IEC 61287-1)		10	pC
Junction temperature	$T_J$	Maximum temperature range in off-state or on-state(non-switching)		-40~175	$^\circ\text{C}$
Case temperature	$T_c$	Maximum case temperature range in on-state		-40~150	$^\circ\text{C}$
Storage temperature	$T_{stg}$	Maximum case temperature range in off-state		-50~175	$^\circ\text{C}$
Operating junction temperature	$T_{jop}$	Maximum junction temperature range for switching operation		-40~175	$^\circ\text{C}$
Short-circuit withstand pulse duration	$t_{pSC}$	$V_{DD} = 2500\text{ V}$ , $V_{GS} = +17 / -7\text{ V}$ , $L_s = 40\text{ nH}$ , $V_{GS50\%}-V_{GS50\%}$	$T_J = T_{op}$	1.7	$\mu\text{s}$
Short circuit energy	$E_{SC}$	$V_{DD} = 2500\text{ V}$ , $F(t)$ weibull=1%	$T_J = T_{op}$	35	J
Non-repetitive surge forward current	$I_{FSM}$	$t_p = 10\text{ms}$ , $F(t)$ weibull=1%, Half sinewave	$T_J = 175\text{ }^\circ\text{C}$	5.9	kA
I <sup>2</sup> t value	$I^2t$	$t_p = 10\text{ms}$ , $F(t)$ weibull=1%, Half sinewave	$T_J = 175\text{ }^\circ\text{C}$	180	$\text{kA}^2\text{s}$

**ELECTRICAL CHARACTERISTICS**

Item	Symbol	Condition	Limits			Unit	
			Min.	Typ.	Max.		
Gate-source leakage current	$I_{GSS}$	$V_{DS} = 0\text{ V}$ , $V_{GS} = V_{GSS}$	$T_J = 25\text{ }^\circ\text{C}$	-2.0	-	2.0	$\mu\text{A}$
Drain-source cut-off current	$I_{DSX}$	$V_{DS} = V_{DSX}$ , $V_{GS} = -7\text{ V}$	$T_J = 25\text{ }^\circ\text{C}$	-	0.003	-	mA
			$T_J = 150\text{ }^\circ\text{C}$	-	0.050	-	mA
Gate-source threshold voltage	$V_{GS(th)}$	$V_{DS} = 10\text{ V}$ , $I_D = 80\text{mA}$	$T_J = 25\text{ }^\circ\text{C}$	1.60	2.10	2.60	V
			$T_J = 150\text{ }^\circ\text{C}$	-	1.50	-	V
Drain-source on resistance	$r_{DS(on)}$	$V_{DS} = V_{DS(on)}$ , $V_{GS} = 17\text{ V}$ , P-side(Terminal 8-10)	$T_J = 175\text{ }^\circ\text{C}$	0.90	1.45	1.90	V
			$T_J = 25\text{ }^\circ\text{C}$	-	2.00	-	$\text{m}\Omega$
			$T_J = 150\text{ }^\circ\text{C}$	-	4.31	-	$\text{m}\Omega$
Drain-source on resistance	$r_{DS(on)}$	$V_{DS} = V_{DS(on)}$ , $V_{GS} = 17\text{ V}$ , N-side(Terminal 10-13),(Note 5)	$T_J = 175\text{ }^\circ\text{C}$	-	5.00	6.06	$\text{m}\Omega$
			$T_J = 25\text{ }^\circ\text{C}$	-	2.25	-	$\text{m}\Omega$
			$T_J = 150\text{ }^\circ\text{C}$	-	4.63	-	$\text{m}\Omega$
Drain-source on-state voltage	$V_{DS(on)}$	$I_D = 800\text{ A}$ , $V_{GS} = 17\text{ V}$ , P-side(Terminal 8-10)(Note 4)	$T_J = 175\text{ }^\circ\text{C}$	-	5.38	6.44	$\text{m}\Omega$
			$T_J = 25\text{ }^\circ\text{C}$	-	1.60	-	V
			$T_J = 150\text{ }^\circ\text{C}$	-	3.45	-	V
Drain-source on-state voltage	$V_{DS(on)}$	$I_D = 800\text{ A}$ , $V_{GS} = 17\text{ V}$ , N-side(Terminal 10-13),(Note 4))(Note 5)	$T_J = 175\text{ }^\circ\text{C}$	-	4.00	4.85	V
			$T_J = 25\text{ }^\circ\text{C}$	-	1.80	-	V
			$T_J = 150\text{ }^\circ\text{C}$	-	3.70	-	V
			$T_J = 175\text{ }^\circ\text{C}$	-	4.30	5.15	V

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**ELECTRICAL CHARACTERISTICS (continuation)**

Item	Symbol	Condition	Limits			Unit	
			Min.	Typ.	Max.		
Source-drain voltage	$V_{SD(on)}$	$I_S = 800\text{ A}, V_{GS} = 17\text{ V}, \text{P-side(Terminal 8-10)}(\text{Note 4})$	$T_J = 25\text{ }^\circ\text{C}$	-	1.45	-	V
			$T_J = 150\text{ }^\circ\text{C}$	-	3.25	-	V
			$T_J = 175\text{ }^\circ\text{C}$	-	3.80	4.40	V
		$I_S = 800\text{ A}, V_{GS} = 17\text{ V}, \text{N-side(Terminal 10-13)},(\text{Note 4)}(\text{Note 5})$	$T_J = 25\text{ }^\circ\text{C}$	-	1.65	-	V
			$T_J = 150\text{ }^\circ\text{C}$	-	3.50	-	V
			$T_J = 175\text{ }^\circ\text{C}$	-	4.10	4.70	V
Source-drain voltage	$V_{SD}$	$I_S = 800\text{ A}, V_{GS} = 0\text{ V}, \text{P-side(Terminal 8-10)}(\text{Note 4})$	$T_J = 25\text{ }^\circ\text{C}$	-	2.00	-	V
			$T_J = 150\text{ }^\circ\text{C}$	-	3.85	-	V
			$T_J = 175\text{ }^\circ\text{C}$	-	4.35	5.00	V
		$I_S = 800\text{ A}, V_{GS} = 0\text{ V}, \text{N-side(Terminal 10-13)},(\text{Note 4)}(\text{Note 5})$	$T_J = 25\text{ }^\circ\text{C}$	-	2.20	-	V
			$T_J = 150\text{ }^\circ\text{C}$	-	4.10	-	V
			$T_J = 175\text{ }^\circ\text{C}$	-	4.65	5.30	V
Source-drain voltage	$V_{SD(off)}$	$I_S = 800\text{ A}, V_{GS} = -7\text{ V}, \text{P-side(Terminal 8-10)}(\text{Note 4})$	$T_J = 25\text{ }^\circ\text{C}$	-	2.00	-	V
			$T_J = 150\text{ }^\circ\text{C}$	-	3.85	-	V
			$T_J = 175\text{ }^\circ\text{C}$	-	4.35	5.00	V
		$I_S = 800\text{ A}, V_{GS} = -7\text{ V}, \text{N-side(Terminal 10-13)},(\text{Note 4)}(\text{Note 5})$	$T_J = 25\text{ }^\circ\text{C}$	-	2.20	-	V
			$T_J = 150\text{ }^\circ\text{C}$	-	4.10	-	V
			$T_J = 175\text{ }^\circ\text{C}$	-	4.65	5.30	V
Input capacitance	$C_{iss}$	$V_{DS} = 10\text{ V}, V_{GS} = 0\text{ V}, f = 100\text{ kHz}, 1/2\text{ module}$	$T_J = 25\text{ }^\circ\text{C}$	-	110	-	nF
Output capacitance	$C_{oss}$	$V_{DS} = 10\text{ V}, V_{GS} = 0\text{ V}, f = 100\text{ kHz}, 1/2\text{ module}$	$T_J = 25\text{ }^\circ\text{C}$	-	70	-	nF
Reverse transfer capacitance	$C_{rss}$	$V_{DS} = 10\text{ V}, V_{GS} = 0\text{ V}, f = 100\text{ kHz}, 1/2\text{ module}$	$T_J = 25\text{ }^\circ\text{C}$	-	2.7	-	nF
Gate charge	$Q_G$	$V_{DD} = 1800\text{ V}, I_D = 800\text{ A}, V_{GS} = +17 / -7\text{ V}, 1/2\text{ module}$	$T_J = 25\text{ }^\circ\text{C}$	-	3.3	-	$\mu\text{C}$
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 1800\text{ V}, I_D = 800\text{ A}, V_{GS} = +17 / -7\text{ V}, L_s = 40\text{ nH}$	$T_J = 175\text{ }^\circ\text{C}$	-	-	0.50	$\mu\text{s}$
Rise time	$t_r$	$V_{DD} = 1800\text{ V}, I_D = 800\text{ A}, V_{GS} = +17 / -7\text{ V}, L_s = 40\text{ nH}$	$T_J = 175\text{ }^\circ\text{C}$	-	-	0.30	$\mu\text{s}$
Turn-on (switching) energy per pulse 10% integral	$E_{on(10\%)}$	$V_{DD} = 1800\text{ V}, I_D = 800\text{ A}, V_{GS} = +17 / -7\text{ V}, L_s = 40\text{ nH}$ $R_{G(on)} = 1.5\ \Omega, R_{G(off)} = 1.5\ \Omega, \text{Inductive load}$	$T_J = 25\text{ }^\circ\text{C}$	-	0.26	-	J
			$T_J = 150\text{ }^\circ\text{C}$	-	0.22	-	J
			$T_J = 175\text{ }^\circ\text{C}$	-	0.22	-	J
Turn-on (switching) energy per pulse	$E_{on}$	$V_{DD} = 1800\text{ V}, I_D = 800\text{ A}, V_{GS} = +17 / -7\text{ V}, L_s = 40\text{ nH}$ $R_{G(on)} = 1.5\ \Omega, R_{G(off)} = 1.5\ \Omega, \text{Inductive load}$	$T_J = 25\text{ }^\circ\text{C}$	-	0.27	-	J
			$T_J = 150\text{ }^\circ\text{C}$	-	0.23	-	J
			$T_J = 175\text{ }^\circ\text{C}$	-	0.23	-	J
Total capacitive charge	$Q_C$	$V_{DD} = 1800\text{ V}, I_D = 800\text{ A}, V_{GS} = +17 / -7\text{ V}, L_s = 40\text{ nH}$ $R_{G(on)} = 1.5\ \Omega, R_{G(off)} = 1.5\ \Omega, \text{Inductive load}$	$T_J = 25\text{ }^\circ\text{C}$	-	10.7	-	$\mu\text{C}$
			$T_J = 150\text{ }^\circ\text{C}$	-	12.5	-	$\mu\text{C}$
			$T_J = 175\text{ }^\circ\text{C}$	-	12.5	-	$\mu\text{C}$
Diode turn-off energy (per pulse)	$E_{off\_Diode(10\%)}$	$V_{DD} = 1800\text{ V}, I_D = 800\text{ A}, V_{GS} = +17 / -7\text{ V}, L_s = 40\text{ nH}$ $R_{G(on)} = 1.5\ \Omega, R_{G(off)} = 1.5\ \Omega, \text{Inductive load}$	$T_J = 25\text{ }^\circ\text{C}$	-	0.004	-	J
			$T_J = 150\text{ }^\circ\text{C}$	-	0.005	-	J
			$T_J = 175\text{ }^\circ\text{C}$	-	0.005	-	J
Diode switching off energy of diode	$E_{off\_Diode}$	$V_{DD} = 1800\text{ V}, I_D = 800\text{ A}, V_{GS} = +17 / -7\text{ V}, L_s = 40\text{ nH}$ $R_{G(on)} = 1.5\ \Omega, R_{G(off)} = 1.5\ \Omega, \text{Inductive load}$	$T_J = 25\text{ }^\circ\text{C}$	-	0.004	-	J
			$T_J = 150\text{ }^\circ\text{C}$	-	0.006	-	J
			$T_J = 175\text{ }^\circ\text{C}$	-	0.006	-	J
Turn-off delay time	$t_{d(off)}$	$V_{DD} = 1800\text{ V}, I_D = 800\text{ A}, V_{GS} = +17 / -7\text{ V}, L_s = 40\text{ nH}$	$T_J = 175\text{ }^\circ\text{C}$	-	-	0.94	$\mu\text{s}$
Fall time	$t_f$	$V_{DD} = 1800\text{ V}, I_D = 800\text{ A}, V_{GS} = +17 / -7\text{ V}, L_s = 40\text{ nH}$	$T_J = 175\text{ }^\circ\text{C}$	-	-	0.40	$\mu\text{s}$
Turn-off (switching) energy per pulse 10% integral	$E_{off(10\%)}$	$V_{DD} = 1800\text{ V}, I_D = 800\text{ A}, V_{GS} = +17 / -7\text{ V}, L_s = 40\text{ nH}$ $R_{G(on)} = 1.5\ \Omega, R_{G(off)} = 1.5\ \Omega, \text{Inductive load}$	$T_J = 25\text{ }^\circ\text{C}$	-	0.10	-	J
			$T_J = 150\text{ }^\circ\text{C}$	-	0.11	-	J
			$T_J = 175\text{ }^\circ\text{C}$	-	0.11	-	J
Turn-off (switching) energy per pulse	$E_{off}$	$V_{DD} = 1800\text{ V}, I_D = 800\text{ A}, V_{GS} = +17 / -7\text{ V}, L_s = 40\text{ nH}$ $R_{G(on)} = 1.5\ \Omega, R_{G(off)} = 1.5\ \Omega, \text{Inductive load}$	$T_J = 25\text{ }^\circ\text{C}$	-	0.10	-	J
			$T_J = 150\text{ }^\circ\text{C}$	-	0.11	-	J
			$T_J = 175\text{ }^\circ\text{C}$	-	0.11	-	J

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**THERMAL CHARACTERISTICS**

Item	Symbol	Conditions	Limits			Unit
			Min.	Typ.	Max.	
Thermal resistance junction to case	$R_{th(j-c)}$	Junction to Case, MOSFET + embeded SBD part, 1/2 module	-	-	22.5	K/kW
Contact thermal resistance case to heatsink	$R_{th(c-s)}$	Case to heat sink, $\lambda_{grease} = 1W/m^2K$ , $D_{(c-s)} = 70\mu m$ , 1/2 module	-	22.5	-	K/kW

**MECHANICAL CHARACTERISTICS**

Item	Symbol	Conditions	Limits			Unit
			Min.	Typ.	Max.	
Mounting torque	$M_t$	Main terminal screw M8 This is the case when installing the product on the bus bar	7.0	-	22.0	N·m
Mounting torque	$M_t$	Mounting screw M6	3.0	-	6.0	N·m
Mounting torque	$M_t$	Auxiliary terminals screw M3	0.4	-	0.8	N·m
Mass	m	-	-	0.8	-	kg
Comparative tracking index	CTI	-	600	-	-	-
Clearance distance in air	$d_a$	Between main terminal	8.0	-	-	mm
Creepage distance along surface	$d_s$	-	32.0	-	-	mm
Internal inductance, D-S	$L_{PDS}$	Between DC+ and DC-(terminal1,2-6,7)	-	15	-	nH
	$L_{PDS}$	Between DC+ and AC (terminal1,2-3,4,5)	-	43	-	nH
	$L_{PDS}$	Between AC and DC-(terminal3,4,5-6,7)	-	43	-	nH
Internal lead resistance, DD'-SS'	$R_{DD+SS'}$	$T_C=25^\circ C$ , Between DC+ and DC-(terminal1,2-6,7)	-	0.46	-	mΩ
	$R_{DD+SS'}$	$T_C=25^\circ C$ , Between DC+ and AC(terminal1,2-3,4,5)	-	0.22	-	mΩ
	$R_{DD+SS'}$	$T_C=25^\circ C$ , Between AC and DC-(terminal3,4,5-6,7)	-	0.33	-	mΩ
Zero-power resistance	$R_{25}$	$T_C=25^\circ C$	4.65	5.00	5.35	kΩ
B-constant	$B_{(25/50)}$	Approximate by equation,(Note 6)	-	3375	-	K

Note 1. Control Case Temperature ( $T_c$ ) so that the junction temperature ( $T_j$ ) does not exceed the maximum rating.

Note 2. The symbols represent characteristics of the anti-parallel, source to drain free-wheel diode (FWDi).

Note 3. Junction temperature ( $T_j$ ) should not exceed  $T_{jmax}$  rating.

Note 4. Pulse width and repetition rate should be such as to cause negligible temperature rise.

Note 5. N-side characteristic value includes wiring resistance between P-side source potential and N-side drain potential.

(P-side characteristic value corresponds to chip characteristics).

Note 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];  $T_{25} = 25[^\circ C] + 273.15 = 298.15[K]$

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

Products falling under the subject item No. 2 (41) 3 of Appended Table 1 of the Export Trade Control Order.

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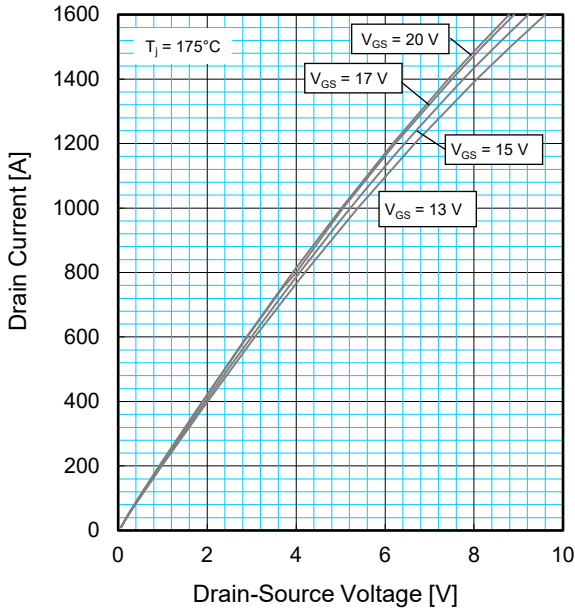
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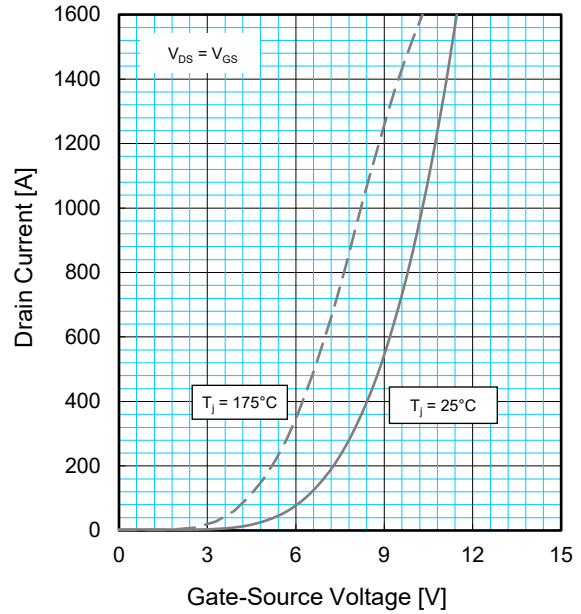
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## PERFORMANCE CURVES

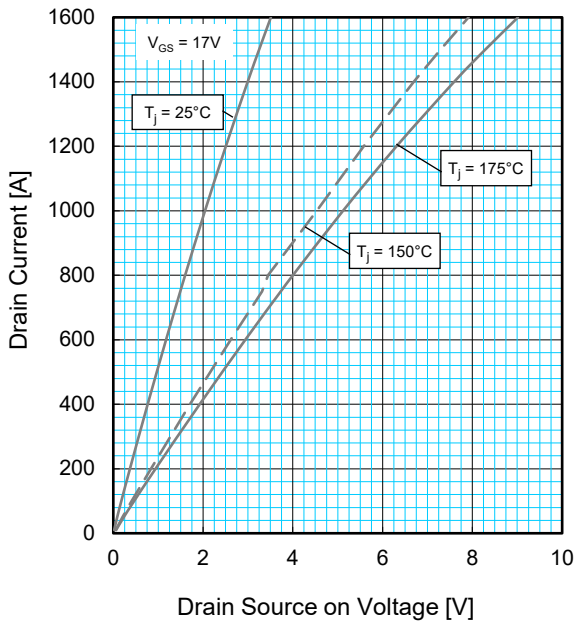
**OUTPUT CHARACTERISTICS (TYPICAL)**



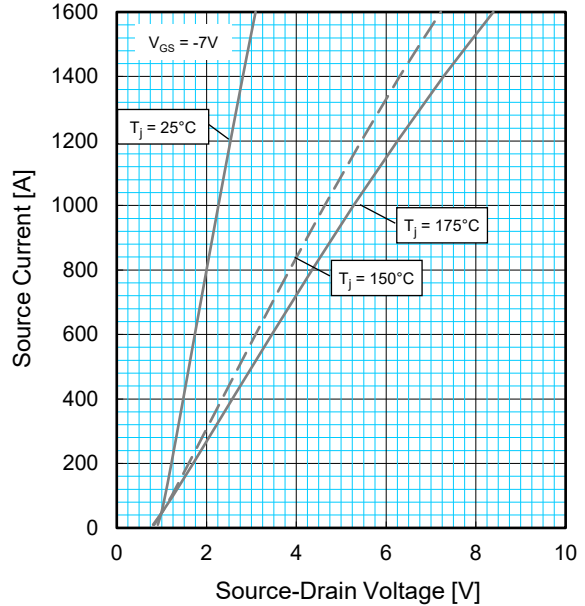
**TRANSFER CHARACTERISTICS (TYPICAL)**



**DRAIN-SOURCE ON VOLTAGE CHARACTERISTICS (TYPICAL)**



**FREE-WHEEL DIODE FORWARD CHARACTERISTICS (TYPICAL)**



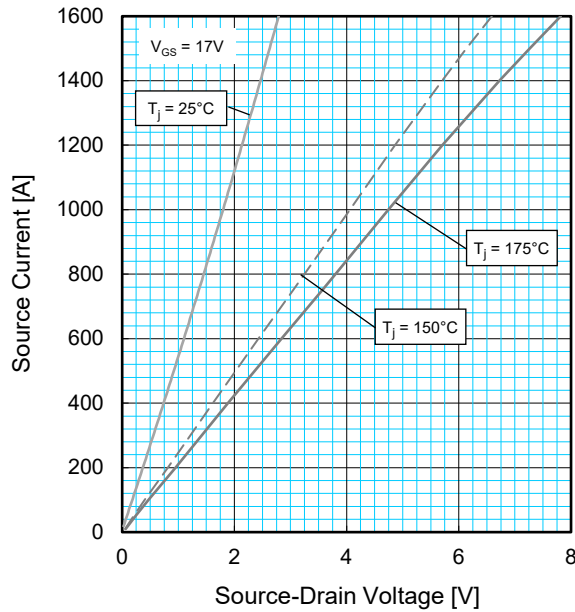
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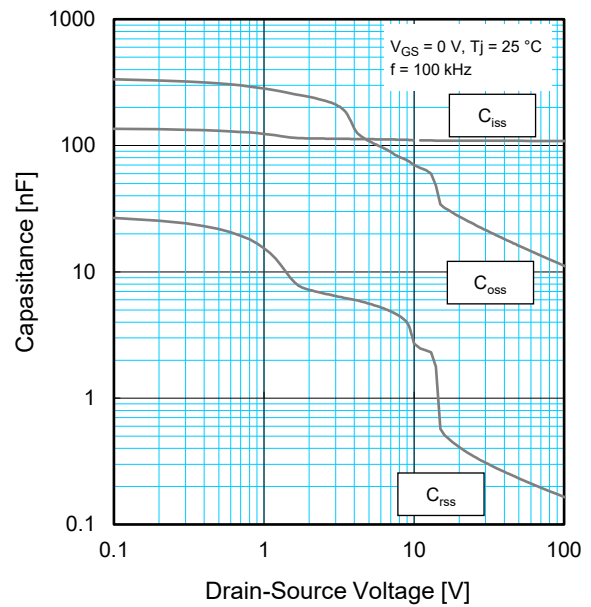
INSULATED TYPE 2<sup>nd</sup> gen. HV MOSFET (High Voltage Metal Oxide Semiconductor Field Effect Transistor) Modules

## PERFORMANCE CURVES

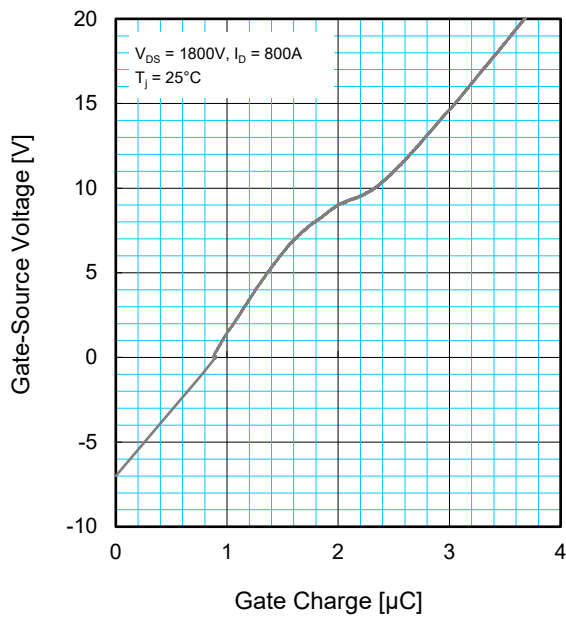
**FREE-WHEEL DIODE FORWARD CHARACTERISTICS (TYPICAL)**



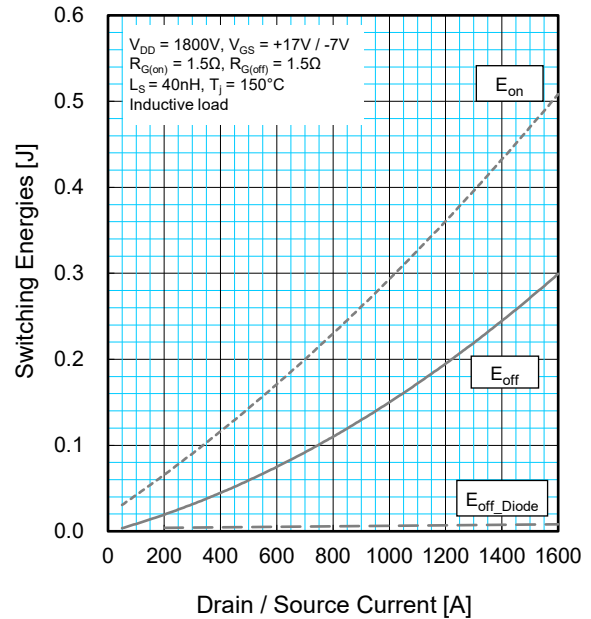
**CAPACITANCE CHARACTERISTICS (TYPICAL)**



**GATE CHARGE CHARACTERISTICS (TYPICAL)**



**HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)**



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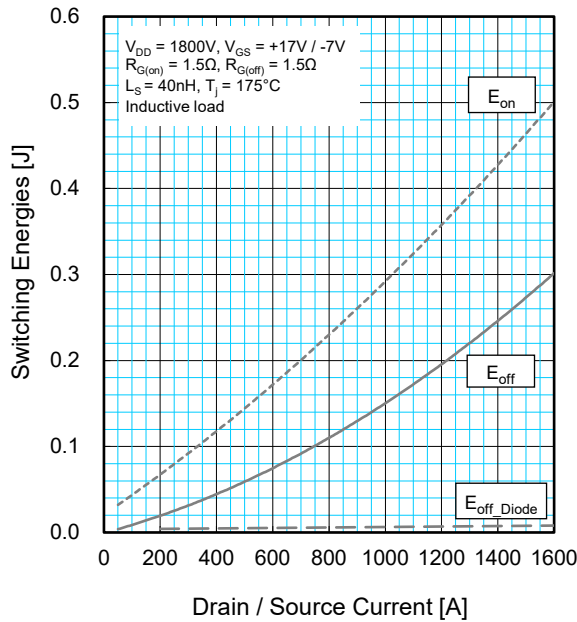
HIGH POWER SWITCHING USE

INSULATED TYPE

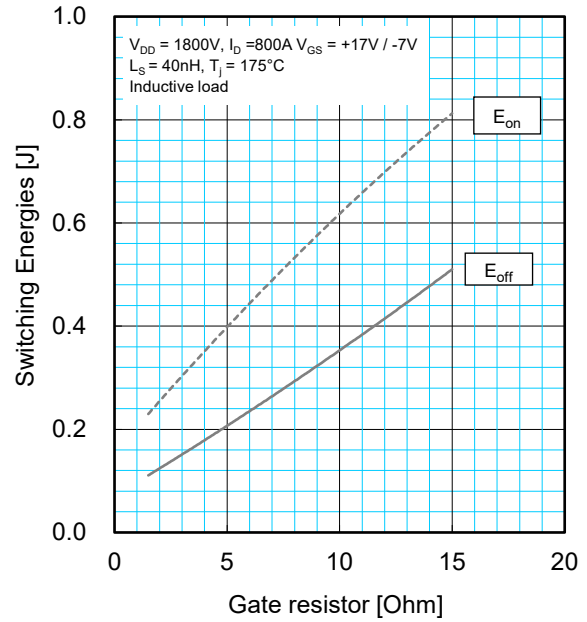
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## PERFORMANCE CURVES

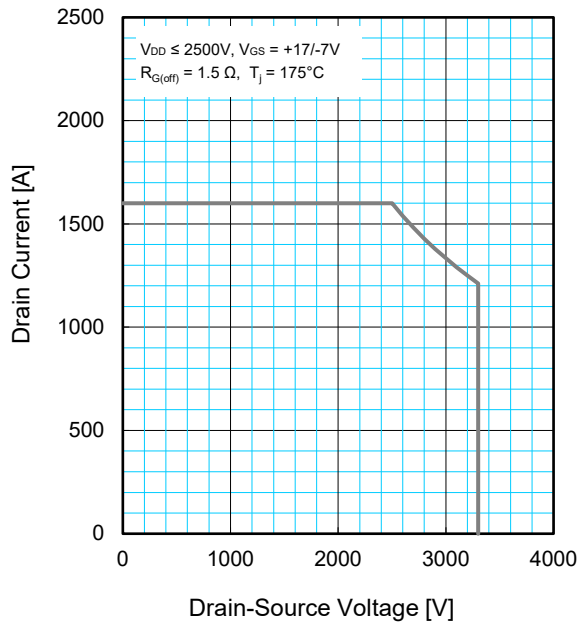
**HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)**



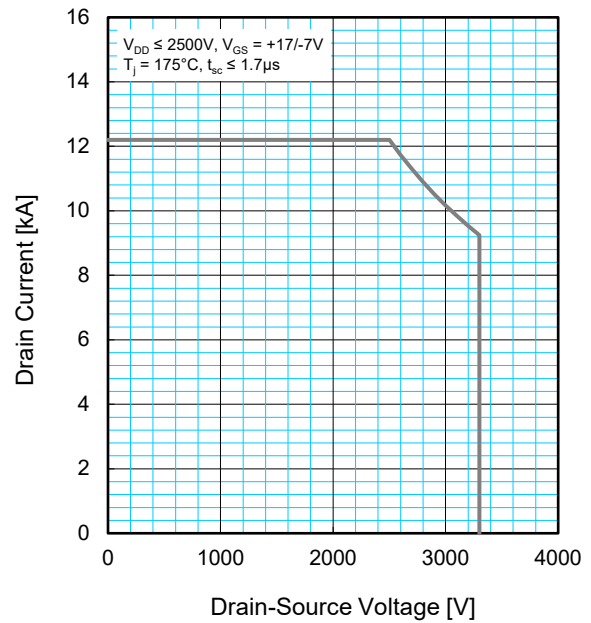
**HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)**



**REVERSE BIAS SAFE OPERATING AREA (RBSOA)**



**SHORT CIRCUIT SAFE OPERATING AREA (SCSOA)**



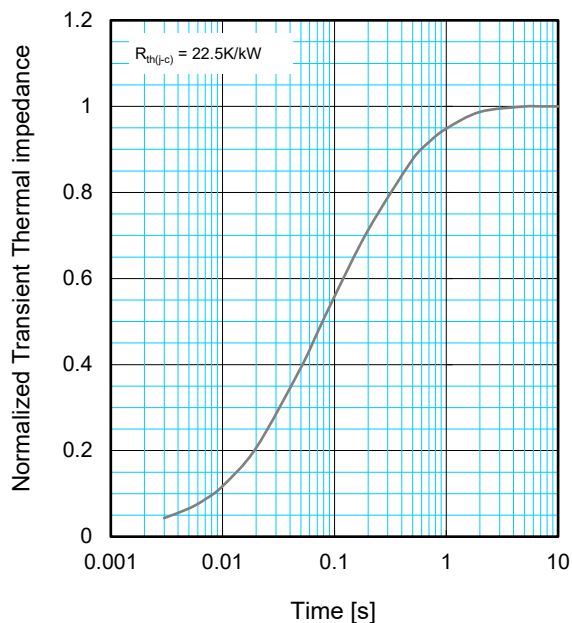
# FMF800DC-66BEW

HIGH POWER SWITCHING USE

INSULATED TYPE 2<sup>nd</sup> gen. HV MOSFET (High Voltage Metal Oxide Semiconductor Field Effect Transistor) Modules

## PERFORMANCE CURVES

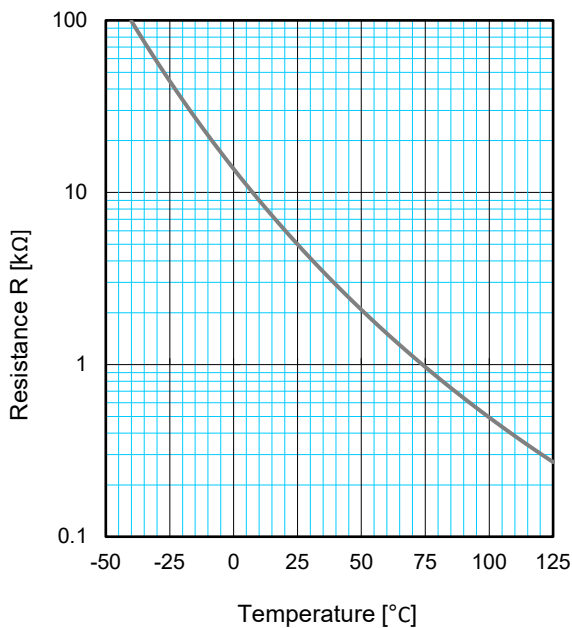
### TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS



$$Z_{th(j-c)}(t) = \sum_{i=1}^n R_i \left\{ 1 - \exp\left(-\frac{t}{\tau_i}\right) \right\}$$

	1	2	3	4
$R_i / R_{th}$ :	0.0078	0.1975	0.3553	0.4393
$\tau_i$ [sec.] :	0.0001	0.7324	0.0381	0.1698

### NTC THERMISTOR TEMPERATURE CHARACTERISTICS (TYPICAL)





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