

< HV MOSFET MODULE >

Preliminary

FMF800DC-66BEW

**HIGH POWER SWITCHING USE
INSULATED TYPE**

2nd 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

MAXIMUM RATINGS

Item	Symbol	Conditions	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}	$V_{DS} = 0\text{ V}$	$T_j = -40\sim 175\text{ }^\circ\text{C}$	± 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)		800	A
Reverse drain current (FWD forward current)	I_{SP}	Non repetitive pulse	$T_j = T_{op}$	1600	A
Total power dissipation	P_{tot}	$T_c = 25\text{ }^\circ\text{C}$, MOSFET part(Note 2)		6650	W
Isolation voltage	V_{isol}	Charged part to the baseplate RMS sinusoidal, 60 Hz 1 min		6000	Vrms
Partial discharge charge	Q_{pd}	Charged part to the baseplate RMS sinusoidal, 60 Hz 1 min $V_1 = 3500\text{ V}$, $V_2 = 2600\text{ V}$ (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}	$V_{DD} = 2500\text{ V}$, $V_{GS} = +17 / -7\text{ V}$, $L_s = 40\text{ nH}$, $V_{GS50\%}\text{-}V_{GS50\%}$	$T_j = T_{op}$	1.7	μs
Non-repetitive surge forward current	I_{FSM}	$t_p = 10\text{ms}$, Half sinewave	$T_j = 175\text{ }^\circ\text{C}$	5.9	kA
I ² t value	I^2t	$t_p = 10\text{ms}$, Half sinewave	$T_j = 175\text{ }^\circ\text{C}$	180	kA ² s

ELECTRICAL CHARACTERISTICS

Item	Symbol	Conditions		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	μA
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
			$T_j = 175\text{ }^\circ\text{C}$	-	0.080	3.0	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
			$T_j = 175\text{ }^\circ\text{C}$	0.90	1.45	1.90	V
Drain-source on resistance	$r_{DS(on)}$	$V_{DS} = V_{DS(on)}$, $V_{GS} = 17\text{ V}$, (Note 3)	$T_j = 25\text{ }^\circ\text{C}$	-	2.00	-	m Ω
			$T_j = 150\text{ }^\circ\text{C}$	-	4.31	-	m Ω
			$T_j = 175\text{ }^\circ\text{C}$	-	5.00	6.06	m Ω
Drain-source on-state voltage	$V_{DS(on)}$	$I_D = 800\text{ A}$, $V_{GS} = 17\text{ V}$, (Note 3)	$T_j = 25\text{ }^\circ\text{C}$	-	1.60	-	V
			$T_j = 150\text{ }^\circ\text{C}$	-	3.45	-	V
			$T_j = 175\text{ }^\circ\text{C}$	-	4.00	4.85	V
Source-drain voltage	$V_{SD(on)}$	$I_S = 800\text{ A}$, $V_{GS} = 17\text{ V}$, (Note 3, 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
Source-drain voltage	V_{SD}	$I_S = 800\text{ A}$, $V_{GS} = 0\text{ V}$, (Note 3, 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
Source-drain voltage	$V_{SD(off)}$	$I_S = 800\text{ A}$, $V_{GS} = -7\text{ V}$, (Note 3, 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

ELECTRICAL CHARACTERISTICS (continuation)

Item	Symbol	Conditions		Limits			Unit
				Min.	Typ.	Max.	
Input capacitance	C_{iss}	$V_{DS} = 10\text{ V}$, $V_{GS} = 0\text{ V}$, $f = 100\text{ kHz}$, 1/2 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 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 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 module	$T_j = 25\text{ }^\circ\text{C}$	-	3.3	-	μC
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 1800\text{ V}$, $I_D = 800\text{ A}$, $V_{GS} = +17 / -7\text{ V}$, $L_s = 40\text{ nH}$, $R_{G(on)} = 1.5\ \Omega$, $R_{G(off)} = 1.5\ \Omega$, Inductive load	$T_j = 25\text{ }^\circ\text{C}$	-	0.36	-	μs
			$T_j = 150\text{ }^\circ\text{C}$	-	0.32	-	μs
			$T_j = 175\text{ }^\circ\text{C}$	-	0.32	0.50	μs
Rise time	t_r	$V_{DD} = 1800\text{ V}$, $I_D = 800\text{ A}$, $V_{GS} = +17 / -7\text{ V}$, $L_s = 40\text{ nH}$, $R_{G(on)} = 1.5\ \Omega$, $R_{G(off)} = 1.5\ \Omega$, Inductive load	$T_j = 25\text{ }^\circ\text{C}$	-	0.18	-	μs
			$T_j = 150\text{ }^\circ\text{C}$	-	0.15	-	μs
			$T_j = 175\text{ }^\circ\text{C}$	-	0.15	0.30	μs
Turn-on (switching) energy per pulse 10% integral	$E_{on(10\%)}$	$V_{DD} = 1800\text{ V}$, $I_D = 800\text{ A}$, $V_{GS} = +17 / -7\text{ V}$, $L_s = 40\text{ nH}$, $R_{G(on)} = 1.5\ \Omega$, $R_{G(off)} = 1.5\ \Omega$, Inductive load	$T_j = 25\text{ }^\circ\text{C}$	-	0.24	-	J/P
			$T_j = 150\text{ }^\circ\text{C}$	-	0.20	-	J/P
			$T_j = 175\text{ }^\circ\text{C}$	-	0.20	-	J/P
Turn-off delay time	$t_{d(off)}$	$V_{DD} = 1800\text{ V}$, $I_D = 800\text{ A}$, $V_{GS} = +17 / -7\text{ V}$, $L_s = 40\text{ nH}$, $R_{G(on)} = 1.5\ \Omega$, $R_{G(off)} = 1.5\ \Omega$, Inductive load	$T_j = 25\text{ }^\circ\text{C}$	-	0.50	-	μs
			$T_j = 150\text{ }^\circ\text{C}$	-	0.61	-	μs
			$T_j = 175\text{ }^\circ\text{C}$	-	0.64	-	μs
Fall time	t_{f1}	$V_{DD} = 1800\text{ V}$, $I_D = 800\text{ A}$, $V_{GS} = +17 / -7\text{ V}$, $L_s = 40\text{ nH}$, $R_{G(on)} = 1.5\ \Omega$, $R_{G(off)} = 1.5\ \Omega$, Inductive load	$T_j = 25\text{ }^\circ\text{C}$	-	0.17	-	μs
			$T_j = 150\text{ }^\circ\text{C}$	-	0.19	-	μs
			$T_j = 175\text{ }^\circ\text{C}$	-	0.19	-	μs
Turn-off (switching) energy per pulse 10% integral	$E_{off(10\%)}$	$V_{DD} = 1800\text{ V}$, $I_D = 800\text{ A}$, $V_{GS} = +17 / -7\text{ V}$, $L_s = 40\text{ nH}$, $R_{G(on)} = 1.5\ \Omega$, $R_{G(off)} = 1.5\ \Omega$, Inductive load	$T_j = 25\text{ }^\circ\text{C}$	-	0.11	-	J/P
			$T_j = 150\text{ }^\circ\text{C}$	-	0.13	-	J/P
			$T_j = 175\text{ }^\circ\text{C}$	-	0.13	-	J/P

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 $\lambda_{grease} = 1\text{ W/m}\cdot\text{K}$, $D(c-s) = 70\ \mu\text{m}$, 1/2 module	-	22.5	-	K/kW

MECHANICAL CHARACTERISTICS

Item	Symbol	Conditions	Limits			Unit
			Min.	Typ.	Max.	
Mounting torque	M _t	Main terminals 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, Mass(IEC)	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 _{P DS}	Between DC+ and DC- (terminal 1,2-6,7)	-	14	-	nH
	L _{P DS}	Between DC+ and AC (terminal 1,2-3,4,5)	-	40	-	nH
	L _{P DS}	Between AC and DC- (terminal 3,4,5-6,7)	-	40	-	nH
Internal lead resistance, DD'-SS'	R _{DD'+SS'}	T _c =25°C, Between DC+ and DC- (terminal 1,2-6,7)	-	0.46	-	mΩ
	R _{DD'+SS'}	T _c =25°C, Between DC+ and AC (terminal 1,2-3,4,5)	-	0.22	-	mΩ
	R _{DD'+SS'}	T _c =25°C, Between AC and DC- (terminal 3,4,5-6,7)	-	0.33	-	mΩ
Zero-power resistance	R ₂₅	T _c =25°C	4.65	5.00	5.35	kΩ
B-constant	B _(25/50)	-	-	3375	-	K
Screw hole depth for auxiliary electrode	l	M3	15	-	17	mm

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

Note 2. Junction temperature (T_j) should not exceed T_{jmax} rating.

Note 3. Pulse width and repetition rate should be such as to cause negligible temperature rise.

Note 4. The symbols represent characteristics of the anti-parallel, source to drain free-wheel diode (FWDi).

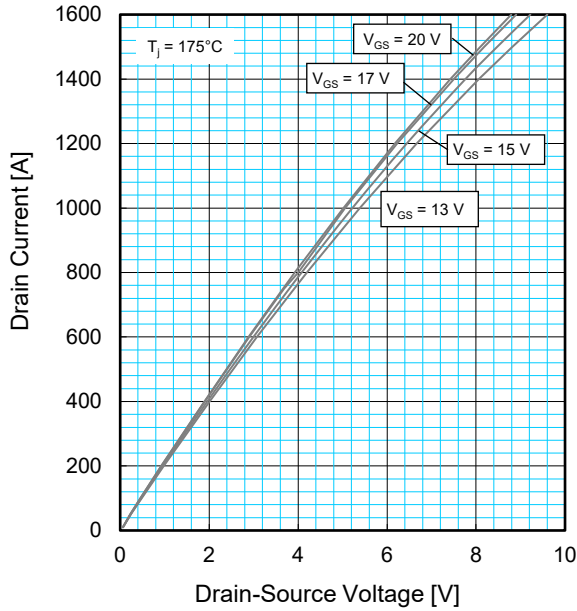
Note 5. $B_{(25/50)} = \ln \left(\frac{R_{25}}{R_{50}} \right) / \left(\frac{1}{T_{25}} - \frac{1}{T_{50}} \right)$

R₂₅: resistance at absolute temperature T₂₅ [K]; T₂₅ = 25[°C] + 273.15 = 298.15[K]

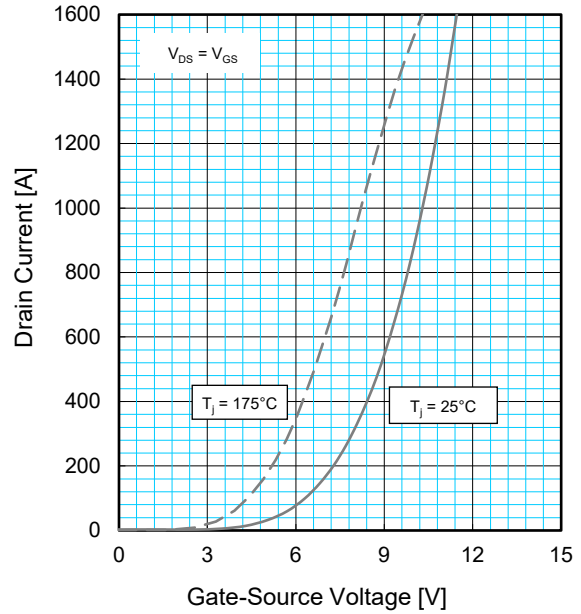
R₅₀: resistance at absolute temperature T₅₀ [K]; T₅₀ = 50[°C] + 273.15 = 323.15[K]

PERFORMANCE CURVES

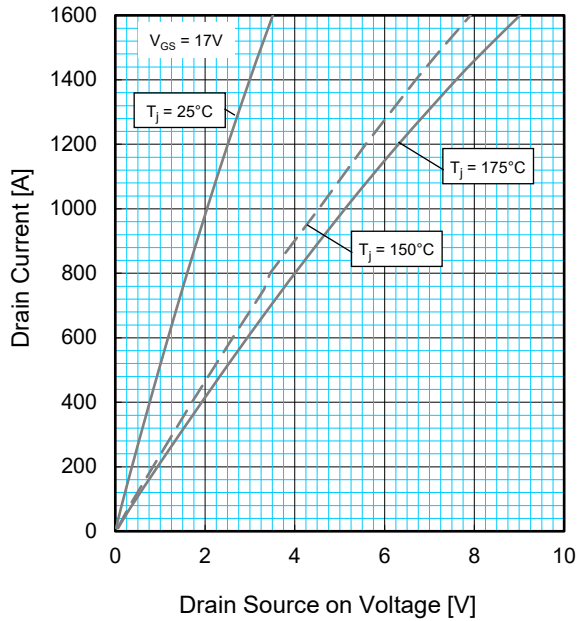
OUTPUT CHARACTERISTICS (TYPICAL)



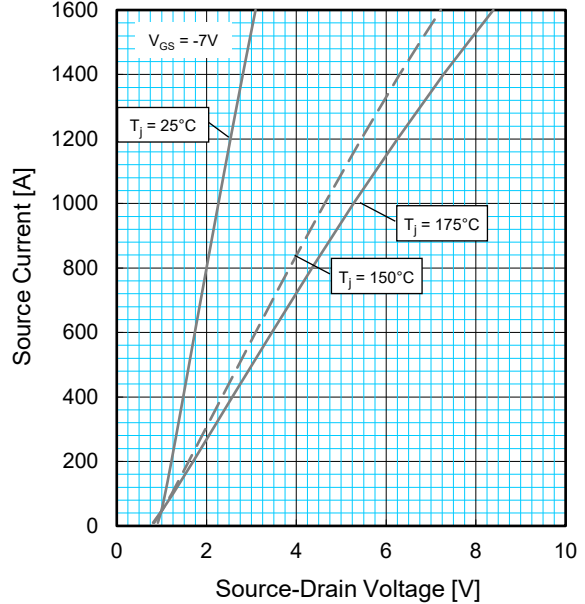
TRANSFER CHARACTERISTICS (TYPICAL)



DRAIN-SOURCE ON VOLTAGE CHARACTERISTICS (TYPICAL)

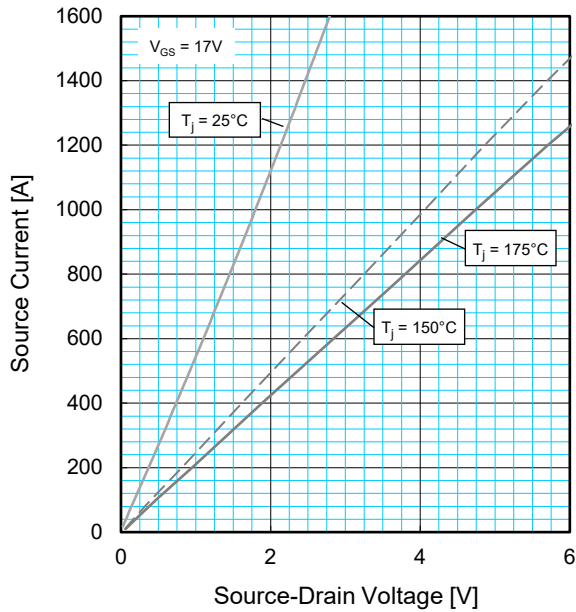


FREE-WHEEL DIODE FORWARD CHARACTERISTICS (TYPICAL)

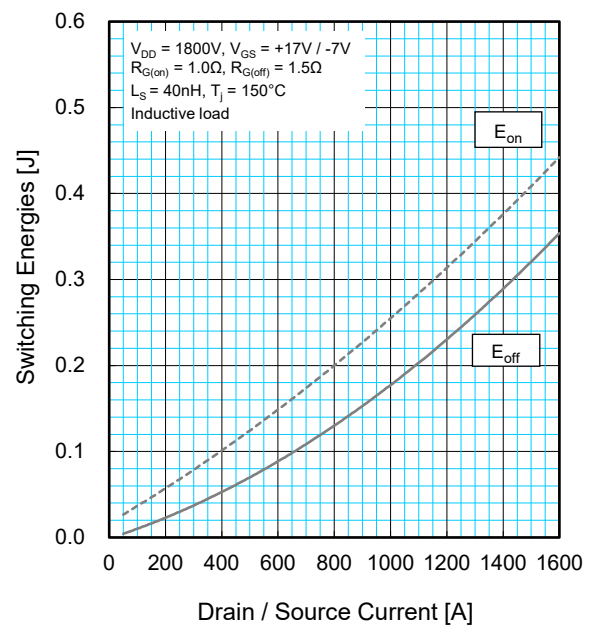


PERFORMANCE CURVES

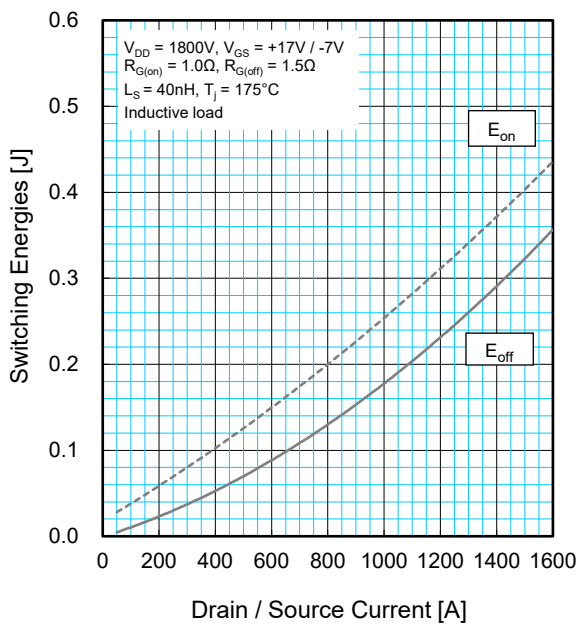
FREE-WHEEL DIODE FORWARD CHARACTERISTICS (TYPICAL)



HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)



HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)



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