< HVMOSFET MODULE >

FMF200DC-66BE

HIGH POWER SWITCHING USE

INSULATED TYPE 2nd gen. HVMOSFET (High Voltage Metal Oxide Semiconductor Field Effect Transistor) Modules

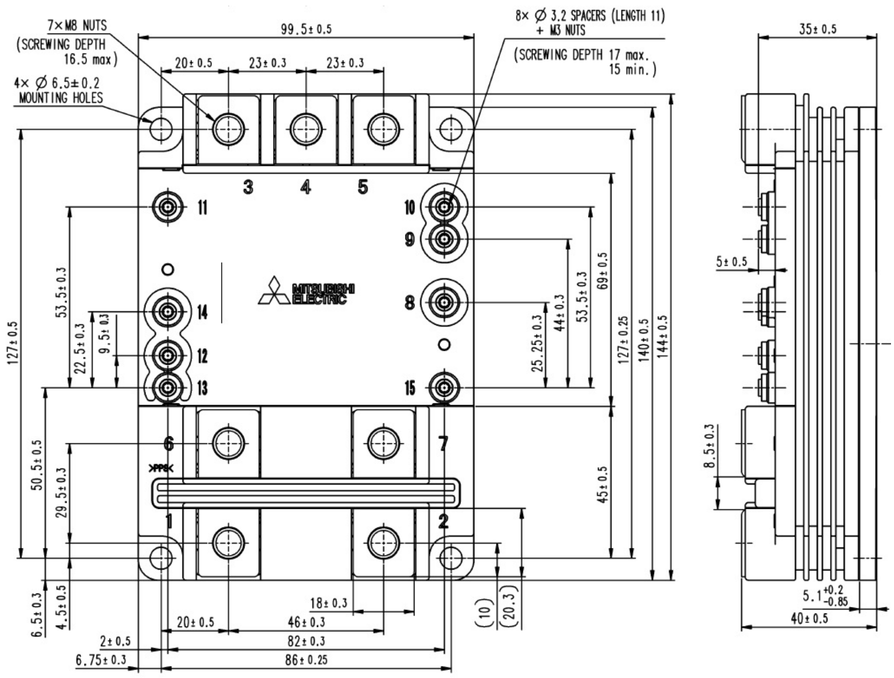
FMF200DC-66BE

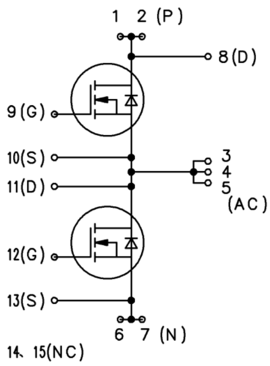
- I_D 200A
- V_{DSX} 3300V
- 2-element in a Pack
- Insulated Type
- SiC SBD embedded MOSFET

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	D(N)
12	G(N)
13	S(N)
14, 15	NC

MAXIMUM RATINGS

Item	Symbol	Condition		Ratings	Unit
Drain-Source voltage, specified gate-source voltage	V_{DSX}	V_{GS} = -7 V	T_j = -40~175 °C	3300	V
Gate-Source voltage	V_{GSS}	V_{DS} = 0 V	T_j = -40~175 °C	±20	V
Drain current	I_D	V_{GS} = 17 V , T_c = 105 °C , AC terminal output current (Note 1)		200	A
Drain current	I_{DP}	Non repetitive pulse	T_j = T_{op}	400	A
Reverse drain current (FWD forward current)	I_S	V_{GS} = -7 V , T_c = 103 °C , AC terminal output current(Note 1)(Note 2)		200	A
Reverse drain current (FWD forward current)	I_{SP}	Non repetitive pulse(Note 2)	T_j = T_{op}	400	A
Total power dissipation	P_{tot}	T_c = 25 °C , MOSFET part(Note 3)		2080	W
Isolation voltage	V_{isol}	Charge part to the baseplate RMS sinusoidal, 60Hz 1min		6000	Vrms
Partial discharge charge	Q_{pd}	Charged part to the baseplate RMS sinusoidal, 60 Hz 1min V1 = 3500 V, V2 = 2600 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	°C
Case temperature	T_c	Maximum case temperature range in on-state		-40~150	°C
Storage temperature	T_{stg}	Maximum case temperature range in off-state		-50~175	°C
Operating junction temperature	T_{jop}	Maximum junction temperature range for switching operation		-40~175	°C
Short-circuit withstand pulse duration	t_{pSC}	V_{DD} = 2500 V , V_{GS} = +17 / -7 V , L_s = 40 nH , V_{GS}50%-V_{GS}50%	T_j = T_{op}	1.7	μs
Short circuit energy	E_{SC}	V_{DD} = 2500 V , F(t)weibull=1%	T_j = T_{op}	8.7	J
Non-repetitive surge forward current	I_{FSM}	t_p = 10ms, F(t)weibull=1%, Half sinewave	T_j = 175 °C	1.4	kA
I2t value	I^2t	t_p = 10ms, F(t)weibull=1%, Half sinewave	T_j = 175 °C	10	kA^2s

ELECTRICAL CHARACTERISTICS

Item	Symbol	Conditions		Limits			Unit
				Min.	Typ.	Max.	
Gate-source leakage current	I_{GSS}	V_{DS} = 0 V , V_{GS} = V_{GSS}	T_j = 25 °C	-0.5	-	0.5	μA
Drain-source cut-off current	I_{DSX}	V_{DS} = V_{DSX} , V_{GS} = -7 V	T_j = 25 °C	-	0.8	-	μA
			T_j = 150 °C	-	12.5	-	μA
			T_j = 175 °C	-	20.0	750	μA
Gate-source threshold voltage	$V_{GS(th)}$	V_{DS} = 10 V , I_D = 20mA	T_j = 25 °C	1.60	2.10	2.60	V
			T_j = 150 °C	-	1.50	-	V
			T_j = 175 °C	0.90	1.45	1.90	V
Drain-source on resistance	$r_{DS(on)}$	V_{DS} = $V_{DS(on)}$, V_{GS} = 17 V	T_j = 25 °C	-	8.00	-	mΩ
			T_j = 150 °C	-	17.25	-	mΩ
			T_j = 175 °C	-	20.00	24.25	mΩ
Drain-source on-state voltage	$V_{DS(on)}$	I_D = 200 A , V_{GS} = 17 V (Note 4)	T_j = 25 °C	-	1.60	-	V
			T_j = 150 °C	-	3.45	-	V
			T_j = 175 °C	-	4.00	4.85	V
Source-drain voltage	$V_{SD(on)}$	I_S = 200 A , V_{GS} = 17 V (Note 4)	T_j = 25 °C	-	1.45	-	V
			T_j = 150 °C	-	3.25	-	V
			T_j = 175 °C	-	3.80	4.40	V
Source-drain voltage	V_{SD}	I_S = 200 A , V_{GS} = 0 V (Note 4)	T_j = 25 °C	-	2.00	-	V
			T_j = 150 °C	-	3.85	-	V
			T_j = 175 °C	-	4.35	5.00	V
Source-drain voltage	$V_{SD(off)}$	I_S = 200 A , V_{GS} = -7 V (Note 4)	T_j = 25 °C	-	2.00	-	V
			T_j = 150 °C	-	3.85	-	V
			T_j = 175 °C	-	4.35	5.00	V
Input capacitance	C_{iss}	V_{DS} = 10 V , V_{GS} = 0 V , f = 100kHz , 1/2 module	T_j = 25 °C	-	27.6	-	nF
Output capacitance	C_{oss}	V_{DS} = 10 V , V_{GS} = 0 V , f = 100kHz , 1/2 module	T_j = 25 °C	-	17.6	-	nF
Reverse transfer capacitance	C_{rss}	V_{DS} = 10 V , V_{GS} = 0 V , f = 100kHz , 1/2 module	T_j = 25 °C	-	0.7	-	nF
Gate charge	Q_G	V_{DD} = 1800 V , I_D = 200 A , V_{GS} = +17 / -7 V , 1/2 module	T_j = 25 °C	-	0.8	-	μC

ELECTRICAL CHARACTERISTICS

Item	Symbol	Conditions		Limits			Unit
				Min.	Typ.	Max.	
Turn-on delay time	$t_{d(on)}$	V_{DD} = 1800 V , I_D = 200 A , V_{GS} = +17 / -7 V , L_s = 40 nH	T_j = 175 °C	-	-	0.37	μs
Rise time	t_r	V_{DD} = 1800 V , I_D = 200 A , V_{GS} = +17 / -7 V , L_s = 40 nH	T_j = 175 °C	-	-	0.23	μs
Turn-on (switching) energy per pulse 10% integral	$E_{on(10\%)}$	V_{DD} = 1800 V , I_D = 200 A , V_{GS} = +17 / -7 V , L_s = 40 nH $R_{G(on)}$ = 1.5 Ω , $R_{G(off)}$ = 6.0 Ω, Inductive load	T_j = 25 °C	-	0.07	-	J
			T_j = 150 °C	-	0.06	-	J
			T_j = 175 °C	-	0.06	-	J
Turn-on (switching) energy per pulse	E_{on}	V_{DD} = 1800 V , I_D = 200 A , V_{GS} = +17 / -7 V , L_s = 40 nH $R_{G(on)}$ = 1.5 Ω , $R_{G(off)}$ = 6.0 Ω, Inductive load	T_j = 25 °C	-	0.07	-	J
			T_j = 150 °C	-	0.06	-	J
			T_j = 175 °C	-	0.06	-	J
Total capacitive charge	Q_C	V_{DD} = 1800 V , I_D = 200 A , V_{GS} = +17 / -7 V , L_s = 40 nH $R_{G(on)}$ = 1.5 Ω , $R_{G(off)}$ = 6.0 Ω, Inductive load	T_j = 25 °C	-	2.7	-	μC
			T_j = 150 °C	-	3.1	-	μC
			T_j = 175 °C	-	3.1	-	μC
Diode turn-off energy (per pulse)	$E_{off\_Diode(10\%)}$	V_{DD} = 1800 V , I_D = 200 A , V_{GS} = +17 / -7 V , L_s = 40 nH $R_{G(on)}$ = 1.5 Ω , $R_{G(off)}$ = 6.0 Ω, Inductive load	T_j = 25 °C	-	0.24	-	mJ
			T_j = 150 °C	-	-	-	mJ
			T_j = 175 °C	-	0.54	-	mJ
Diode switching off energy of diode	E_{off_Diode}	V_{DD} = 1800 V , I_D = 200 A , V_{GS} = +17 / -7 V , L_s = 40 nH $R_{G(on)}$ = 1.5 Ω , $R_{G(off)}$ = 6.0 Ω, Inductive load	T_j = 25 °C	-	0.34	-	mJ
			T_j = 150 °C	-	-	-	mJ
			T_j = 175 °C	-	0.65	-	mJ
Turn-off delay time	$t_{d(off)}$	V_{DD} = 1800 V , I_D = 200 A , V_{GS} = +17 / -7 V , L_s = 40 nH	T_j = 175 °C	-	-	0.94	μs
Fall time	t_f	V_{DD} = 1800 V , I_D = 200 A , V_{GS} = +17 / -7 V , L_s = 40 nH	T_j = 175 °C	-	-	0.40	μs
Turn-off (switching) energy per pulse 10% integral	$E_{off(10\%)}$	V_{DD} = 1800 V , I_D = 200 A , V_{GS} = +17 / -7 V , L_s = 40 nH $R_{G(on)}$ = 1.5 Ω , $R_{G(off)}$ = 6.0 Ω, Inductive load	T_j = 25 °C	-	0.03	-	J
			T_j = 150 °C	-	0.03	-	J
			T_j = 175 °C	-	0.03	-	J
Turn-off (switching) energy per pulse	E_{off}	V_{DD} = 1800 V , I_D = 200 A , V_{GS} = +17 / -7 V , L_s = 40 nH $R_{G(on)}$ = 1.5 Ω , $R_{G(off)}$ = 6.0 Ω, Inductive load	T_j = 25 °C	-	0.03	-	J
			T_j = 150 °C	-	0.03	-	J
			T_j = 175 °C	-	0.03	-	J

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	-	-	72.0	K/kW
Contact thermal resistance case to heatsink	$R_{th(c-s)}$	Case to heat sink, λ_{grease} = 1W/m·K, $D_{(c-s)}$ = 70μm, 1/2 module	-	57.0	-	K/kW

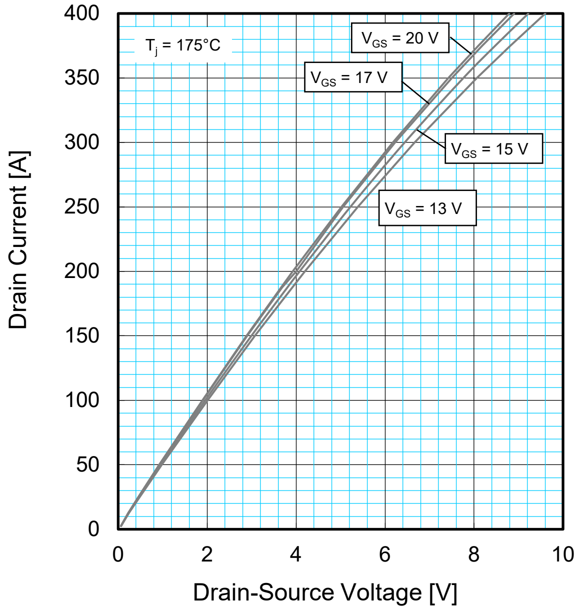
MECHANICAL CHARACTERISTICS

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	$L_{P\,DS}$	Between DC+ and DC-(terminal1,2-6,7)	-	28	-	nH
	$L_{P\,DS}$	Between DC+ and AC, (terminal1,2-3,4,5)	-	50	-	nH
	$L_{P\,DS}$	Between AC and DC-(terminal3,4,5-6,7)	-	50	-	nH

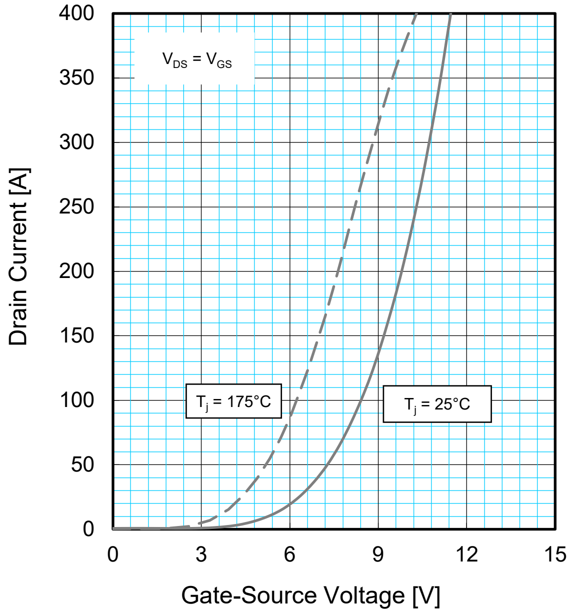
Note 1. Control Case Temperature (T_C) so that the junction temperature (T_j) does not exceed the maximum rating.
Note 2. The symbols represent characteristics of the anti-parallel, source to drain free-wheel diode (FWDi).
Note 3. Junction temperature (T_j) should not exceed T_{jmax} rating.
Note 4. Pulse width and repetition rate should be such as to cause negligible temperature rise.

PERFPRMANCE CURVES

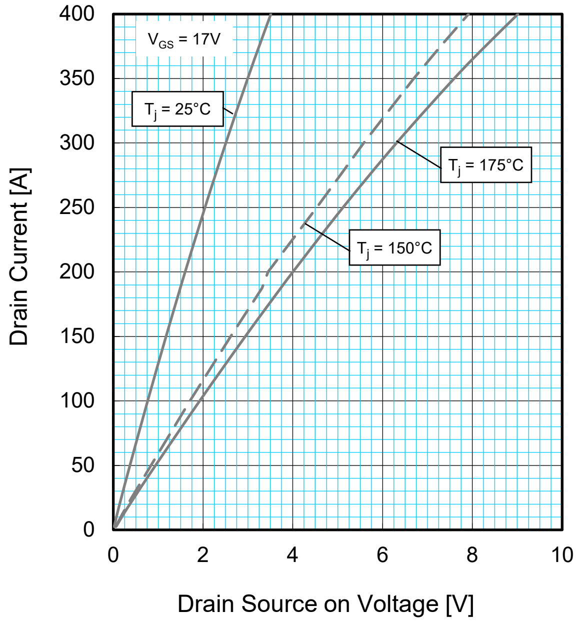
OUTPUT CHARACTERISTICS (TYPICAL)



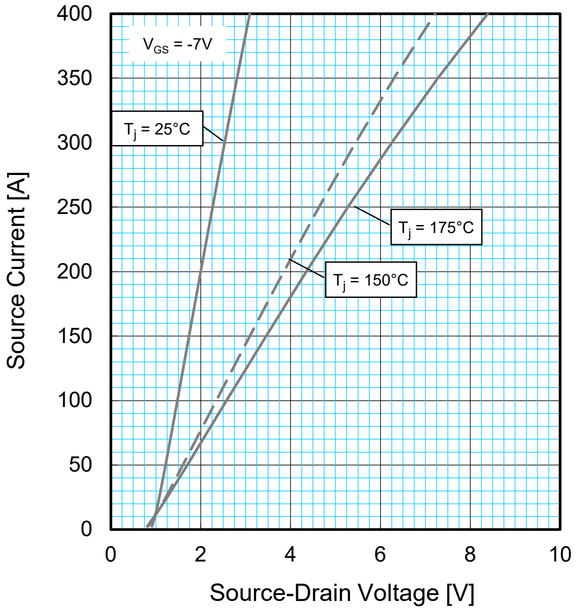
TRANSFER CHARACTERISTICS (TYPICAL)



DRAIN-SOURCE ON VOLTAGE CHARACTERISTICS (TYPICAL)

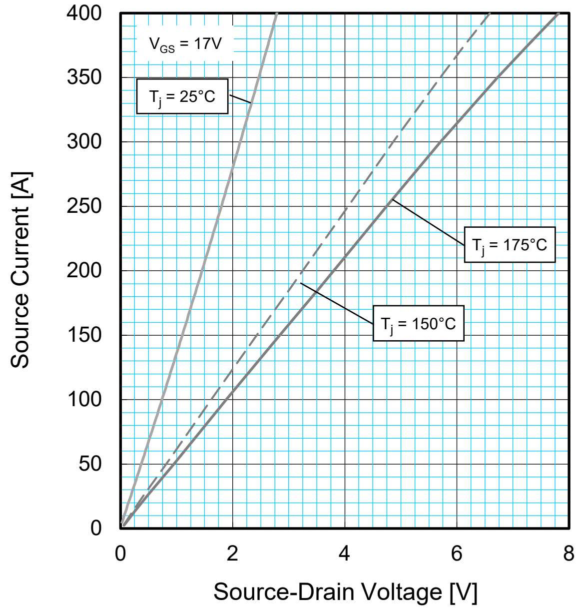


FREE-WHEEL DIODE FORWARD CHARACTERISTICS (TYPICAL)

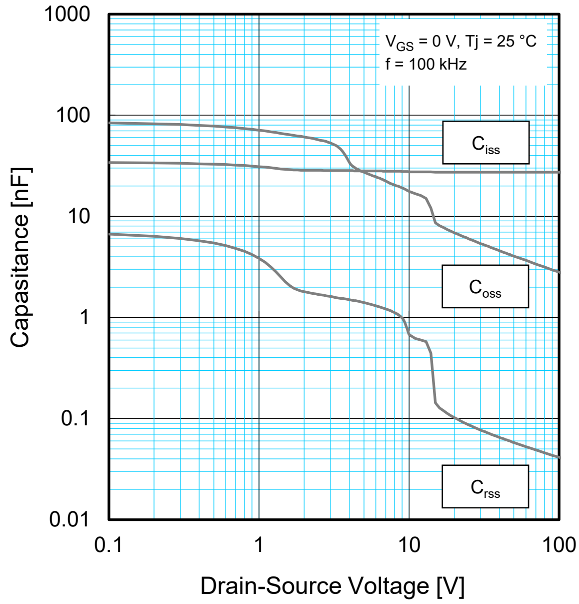


PERFORMANCE CURVES

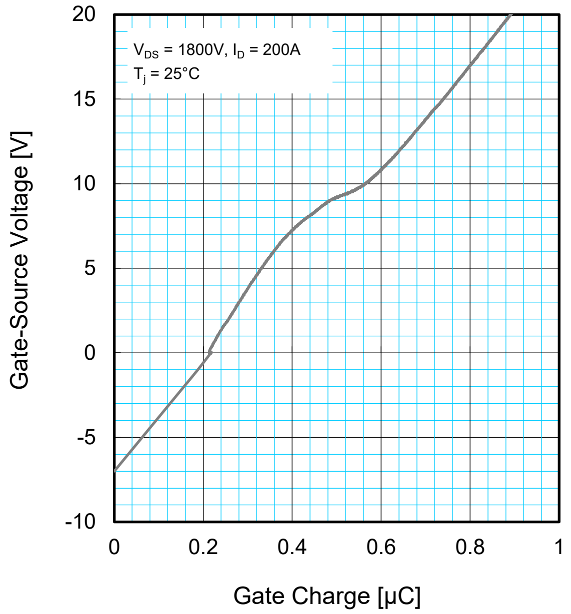
FREE-WHEEL DIODE FORWARD CHARACTERISTICS (TYPICAL)



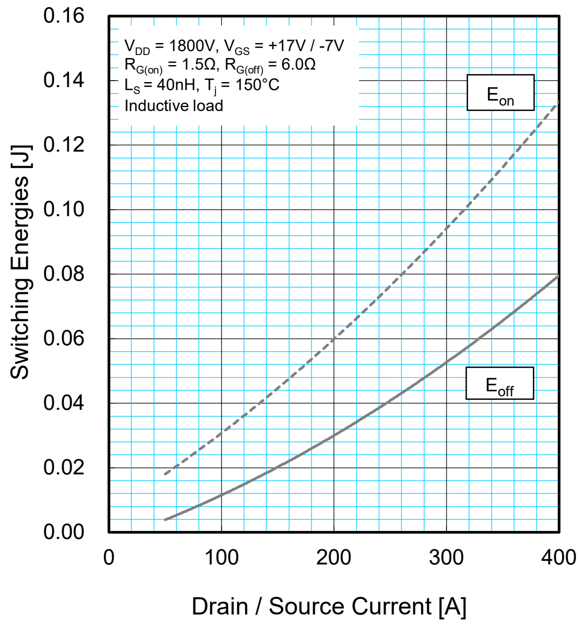
CAPACITANCE CHARACTERISTICS (TYPICAL)



GATE CHARGE CHARACTERISTICS (TYPICAL)

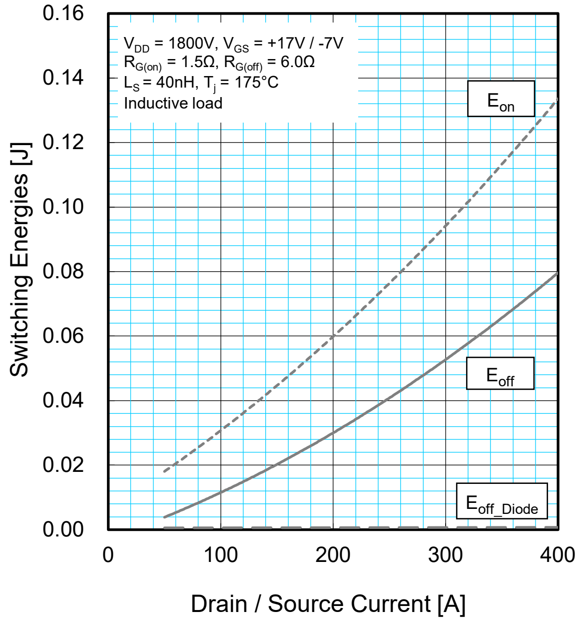


HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)

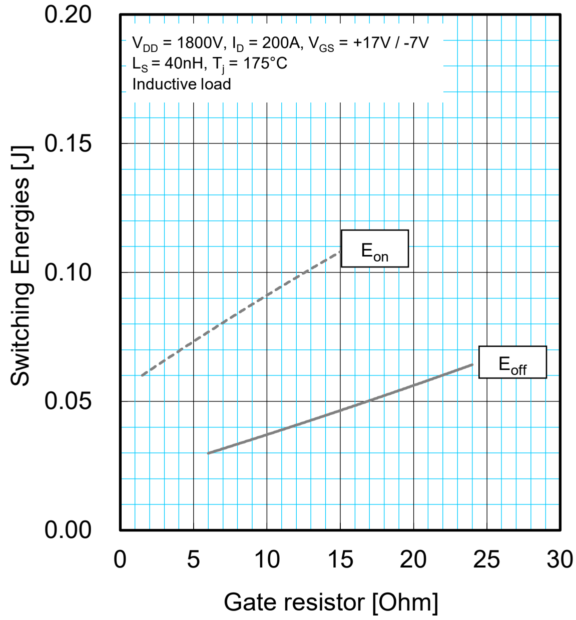


PERFORMANCE CURVES

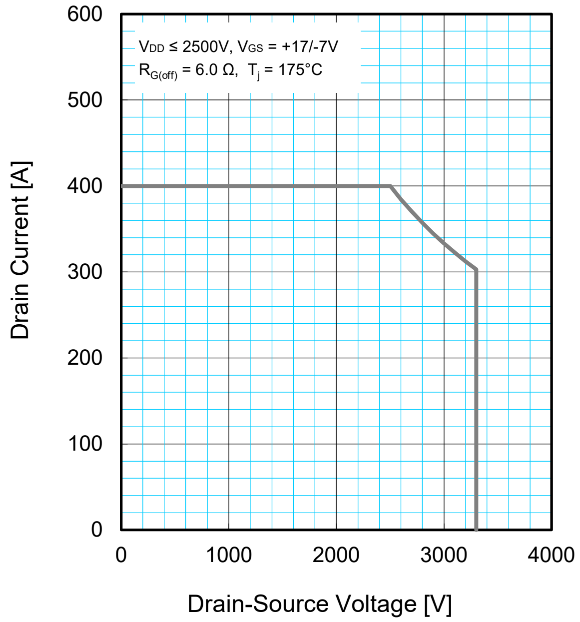
HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)



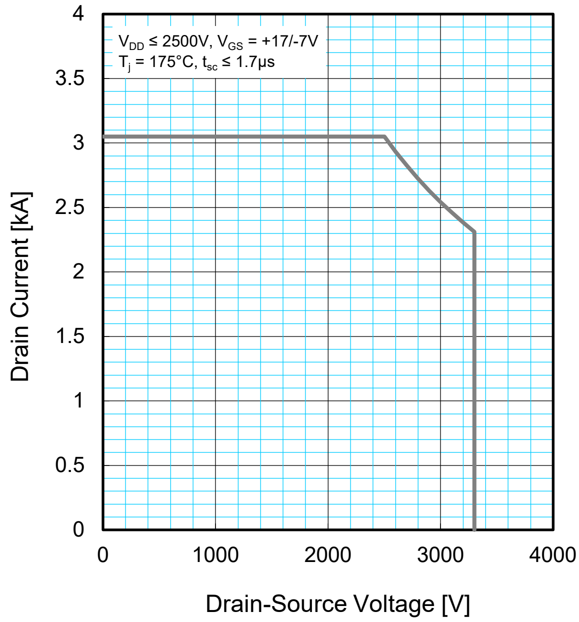
HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)



REVERSE BIAS SAFE OPERATING AREA (RBSOA)

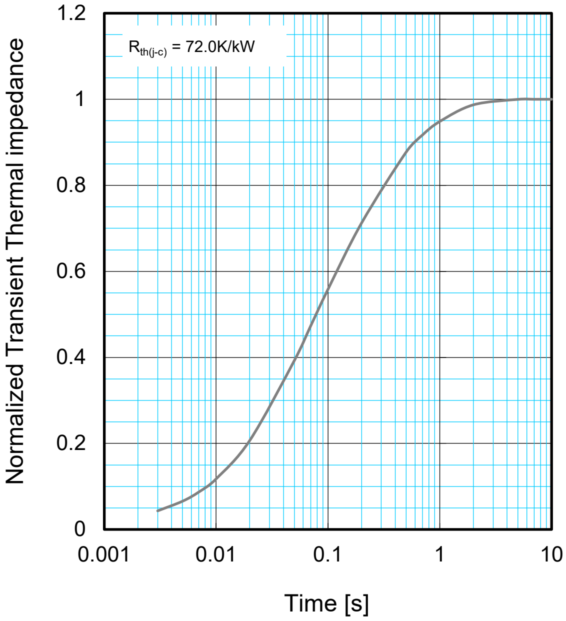


SHORT CIRCUIT SAFE OPERATING AREA (SCSOA)



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
τ_i [sec.] :	0.0001	0.7324	0.0381	0.1698

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