MITSUBISHI ELECTRIC

< HVMOSFET MODULE >

FMF375DC-66A

HIGH POWER SWITCHING USE
INSULATED TYPE HVMOSFET (High Voltage Metal Oxide Semiconductor Field Effect Transistor) Module

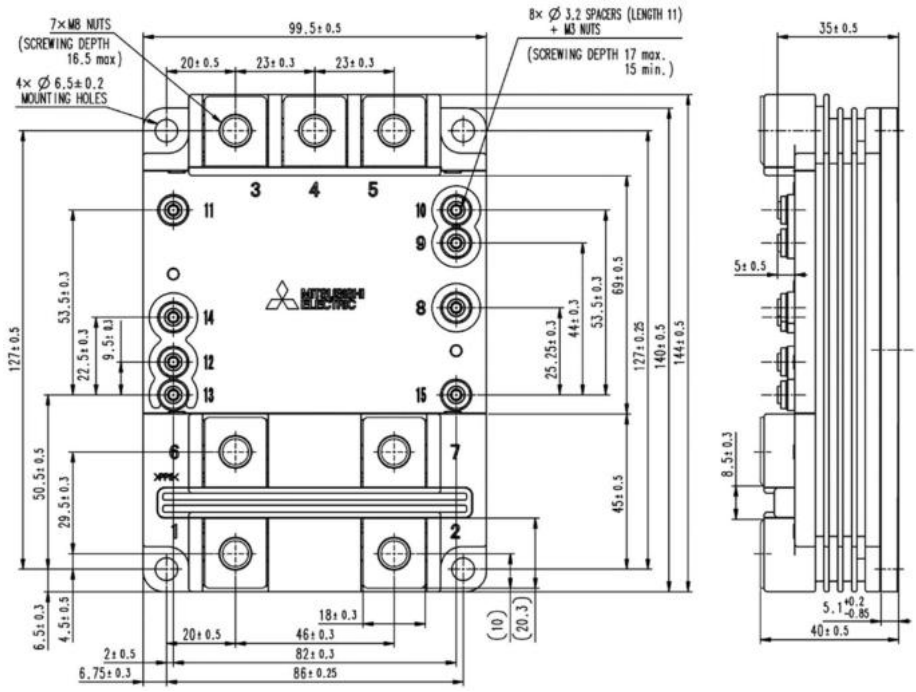
FMF375DC-66A

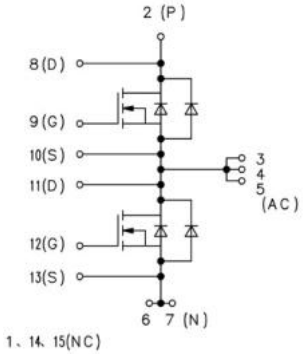
- I_D ..... 375 A
- V_{DSX} ..... 3300 V
- 2-element in a Pack
- Insulated Type
- SiC MOSFET
- JBS(Junction Barrier Schottky)

APPLICATION

Traction drives, High Reliability Converters / Inverters, DC choppers

OUTLINE DRAWING & CIRCUIT DIAGRAM **Dimensions in mm**





CIRCUIT DIAGRAM

No.	Terminals
1	NC
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) / S(P)
12	G(N)
13	S(N)
14, 15	NC

Note 1. Terminal 1 is not connected to the circuit, but must be shorted to terminal 2 when using the module.

MAXIMUM RATINGS

Symbol	Item	Conditions	Ratings	Unit
V_{DSX}	Drain-source voltage	V_{GS} = -5 V, T_j = -40 ~ 175 °C	3300	V
V_{GSS}	Gate-source voltage	V_{DS} = 0V, T_j = 25 °C	±20	V
I_D (Note 2)	Drain current	DC, V_{GS} = +17 V	375	A
I_{DM}		Pulse (Note 3), T_j = 175 °C	750	A
I_S (Note 2)	Source current (Note 4)	DC, V_{GS} = -5 V	375	A
I_{SM}		Pulse (Note 3), T_j = 175 °C	750	A
P_{tot}	Maximum power dissipation (Note 5)	T_c = 25 °C, MOSFET part	2300	W
V_{iso}	Isolation voltage	RMS, sinusoidal, f = 60Hz, t = 1 min.	6000	V
V_e	Partial discharge extinction voltage	RMS, sinusoidal, f = 60 Hz, Q_{PD} ≤ 10 pC T_c = 25 °C	2600	V
T_j	Channel temperature	—	−40 ~ +175	°C
T_{op}	Operating channel temperature	—	−40 ~ +175	°C
T_{stg}	Storage temperature	—	−40 ~ +175	°C
t_{SC}	Short circuit capability (Maximum pulse width)	T_j = 175°C, V_{DD} = 2500V, V_{GS} = +17V / -5V $R_{G(on)}$ = 1.0 Ω, $R_{G(off)}$ = 1.0 Ω, L_S = 60 nH	4	µs

ELECTRICAL CHARACTERISTICS

Symbol	Item	Conditions		Limits			Unit
				Min	Typ	Max	
I_{GSS}	Gate leakage current	V_{GS} = V_{GSS}, V_{DS} = 0 V, T_j = 25 °C		—	—	1.0	µA
I_{DSX}	Drain-source cut-off current	V_{DS} = V_{DSX}, V_{GS} = −5 V	T_j = 25 °C	—	—	1.3	mA
			T_j = 150 °C	—	0.8	—	
			T_j = 175 °C	—	1.5	—	
$V_{GS(th)}$	Gate-source threshold voltage	V_{DS} = 10V, I_C = 37.5 mA	T_j = 25 °C	—	2.10	—	V
			T_j = 150 °C	—	1.40	—	
			T_j = 175 °C	—	1.30	—	
$r_{DS(on)}$	Drain-source resistance	V_{DS} = $V_{DS(on)}$ V_{GS} = +17 V	T_j = 25 °C	—	4.7	—	mΩ
			T_j = 150 °C	—	9.1	—	
			T_j = 175 °C	—	10.4	—	
$V_{DS(on)}$	Drain-source on voltage	V_{GS} = 17 V I_D = 375 A (Note 6)	T_j = 25 °C	—	1.75	—	V
			T_j = 150 °C	—	3.40	—	
			T_j = 175 °C	—	3.90	—	
C_{iss}	Input capacitance	V_{DS} = 10 V, V_{GS} = 0 V f = 100 kHz, T_j = 25 °C		—	105	—	nF
C_{oss}	Output capacitance			—	17.0	—	nF
C_{rss}	Reverse transfer capacitance			—	0.4	—	nF
Q_G	Total gate charge	V_{DD} = 1800 V, I_D = 375 A, V_{GS} = +17V / -5V		—	3.35	—	µC
$t_{d(on)}$	Turn-on delay time	V_{DD} = 1800 V I_D = 375 A V_{GS} = +17 V / -5 V $R_{G(on)}$ = 1.0 Ω L_s = 60 nH Inductive load	T_j = 175 °C	—	—	1.20	µs
t_r	Rise time		T_j = 175 °C	—	—	0.80	µs
E_{on}	Turn-on switching energy per pulse		T_j = 150 °C	—	250	—	mJ
			T_j = 175 °C	—	260	—	
$t_{d(off)}$	Turn-off delay time	V_{DD} = 1800 V I_D = 375 A V_{GS} = +17 V / -5 V $R_{G(off)}$ = 1.0 Ω L_s = 60 nH Inductive load	T_j = 150 °C	—	0.85	—	µs
			T_j = 175 °C	—	0.90	—	
t_f	Fall time		T_j = 150 °C	—	0.23	—	µs
			T_j = 175 °C	—	0.24	—	
E_{off}	Turn-off switching energy per pulse		T_j = 150 °C	—	90	—	mJ
			T_j = 175 °C	—	90	—	
V_{SD}	Source-drain voltage (Note 4)	V_{GS} = 0 V I_S = 375 A (Note 6)	T_j = 25 °C	—	2.50	—	V
			T_j = 150 °C	—	3.35	—	
			T_j = 175 °C	—	3.50	—	
V_{SD}	Source-drain voltage (Note 4)	V_{GS} = +17 V I_S = 375 A (Note 6)	T_j = 25 °C	—	1.20	—	V
			T_j = 150 °C	—	2.10	—	
			T_j = 175 °C	—	2.40	—	

ELECTRICAL CHARACTERISTICS

Symbol	Item	Conditions		Limits			Unit
				Min	Typ	Max	
I_{FSM}	Surge forward current (Note 4)	V_{SD} = 0 V, t_p = 10 ms, T_j = 125 °C start		—	—	—	kA
I^2t	Surge current load integral (Note 4)			—	—	—	kA^2s
Q_C	Total capacitive charge (Note 4)	V_{DD} = 1800 V, I_D = 375 A di_S/dt ≈ 1200 A/μs L_s = 60 nH	T_j = 25 °C	—	8	—	μC
			T_j = 150 °C	—	15	—	
			T_j = 175 °C	—	20	—	
E_{off_diode}	Diode turn-off energy (Note 4) per pulse		T_j = 25 °C	—	5	—	mJ
			T_j = 150 °C	—	11	—	
			T_j = 175 °C	—	15	—	

THERMAL CHARACTERISTICS

Symbol	Item	Conditions	Limits			Unit
			Min	Typ	Max	
$R_{th(j-c)Q}$	Thermal resistance	Junction to Case, MOSFET part 1/2 module	—	—	64.0	K/kW
$R_{th(j-c)D}$		Junction to Case, FWDi part 1/2 module	—	—	109.0	K/kW
$R_{th(c-s)}$	Contact thermal resistance	Case to heat sink, 1/2 module λ_{grease} = 1 W/m·K, $D_{(c-s)}$ = 100 μm	—	45.0	—	K/kW

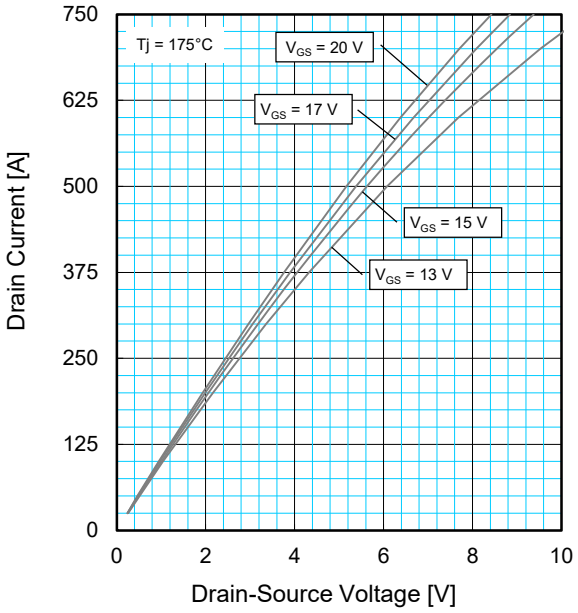
MECHANICAL CHARACTERISTICS

Symbol	Item	Conditions	Limits			Unit
			Min	Typ	Max	
M_t	Mounting torque	Main terminals screw M8 (Note 7)	7.0	—	14.0	N·m
M_s		Mounting screw M6	3.0	—	6.0	N·m
M_t		Auxiliary terminals screw M3	0.4	—	0.6	N·m
m	Mass	—	—	0.80	—	kg
CTI	Comparative tracking index	—	600	—	—	—
d_a	Clearance	Between terminals and baseplate	19.2	—	—	mm
d_s	Creepage distance	Between terminals and baseplate	32	—	—	mm
$L_{P\ P-N}$	Parasitic stray inductance	Between terminal 2 and terminal 6,7	—	28.0	—	nH
$L_{p\ s-ss}$	Internal inductance	Between Auxiliary terminals (terminal 10-11)	—	t.b.d.	—	nH
		Between Auxiliary terminals and DC- (terminal 13-6,7)	—	t.b.d.	—	
$R_{DD'+SS'}$	Internal lead resistance	Between DC+ and DC- (terminal 2-6,7)	—	0.92	—	mΩ
		Between DC+ and AC (terminal 2-3,4,5)	—	0.44	—	
		Between AC and DC- (terminal 3,4,5-6,7)	—	0.66	—	

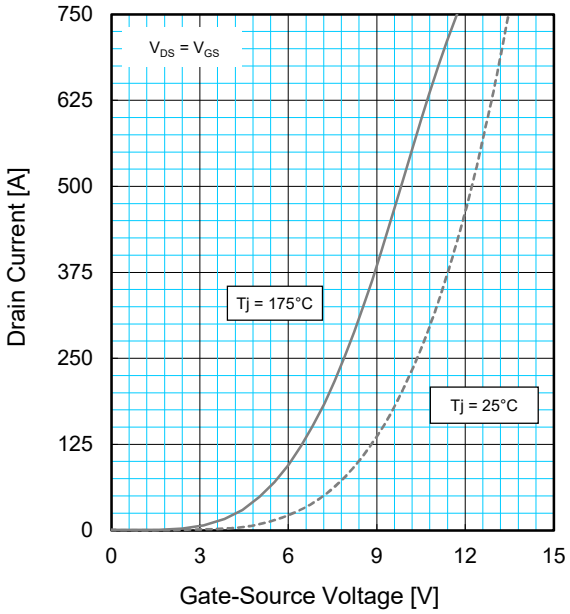
Note 2. The energization time is a short time in which the internal electrode does not generate heat.
Note 3. Pulse width and repetition rate should be such that junction temperature (T_j) does not exceed T_{jmax} rating.
Note 4. The symbols represent characteristics of the anti-parallel, source to drain free-wheel diode (FWD_i).
Note 5. Junction temperature (T_j) should not exceed T_{jmax} rating.
Note 6. Pulse width and repetition rate should be such as to cause negligible temperature rise.
Note 7. This is the case when installing the product on the bus-bar.

PERFORMANCE CURVES

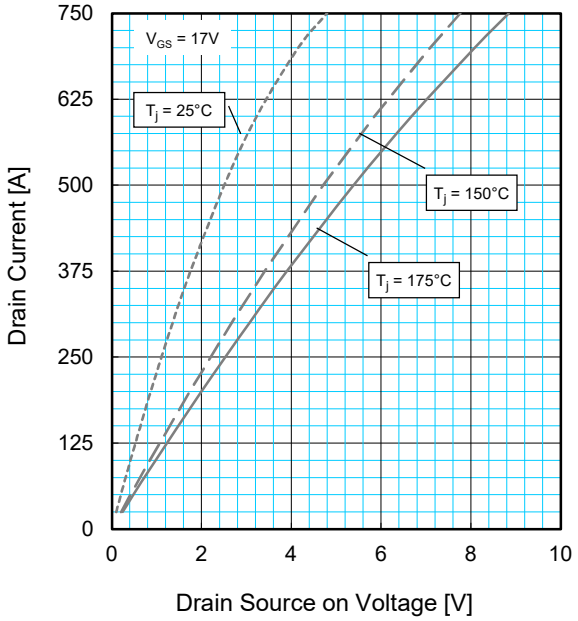
OUTPUT CHARACTERISTICS (TYPICAL)



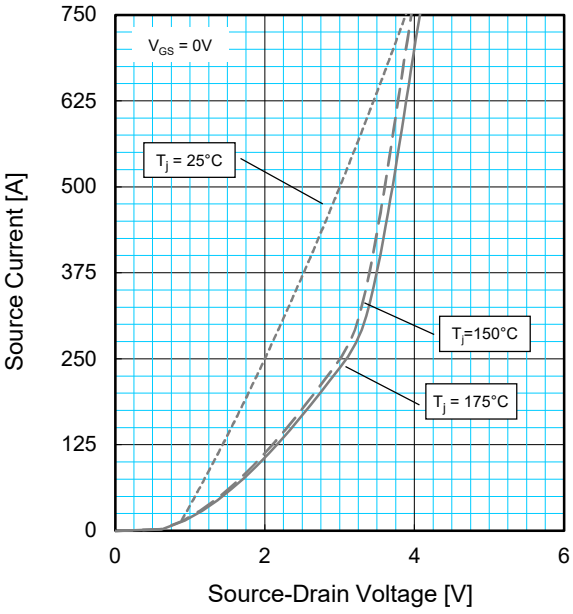
TRANSFER CHARACTERISTICS (TYPICAL)



DRAIN-SOURCE ON VOLTAGE CHARACTERISTICS (TYPICAL)

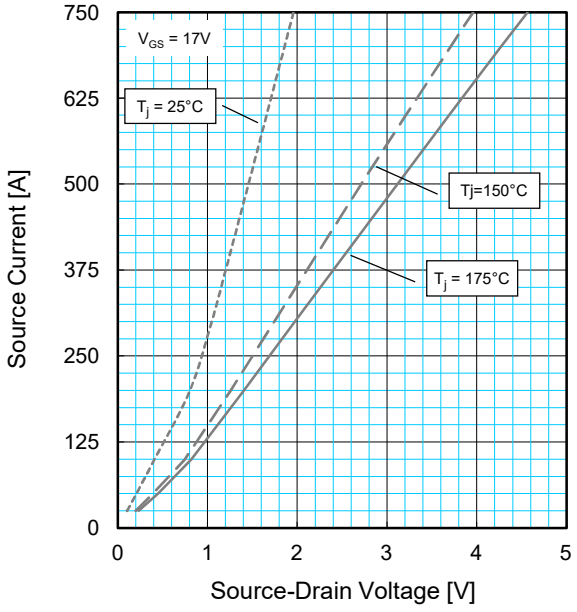


FREE-WHEEL DIODE FORWARD CHARACTERISTICS (TYPICAL)

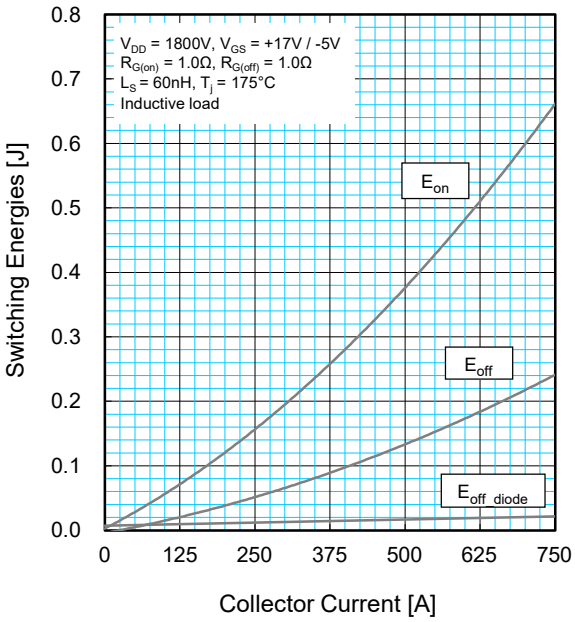


PERFORMANCE CURVES

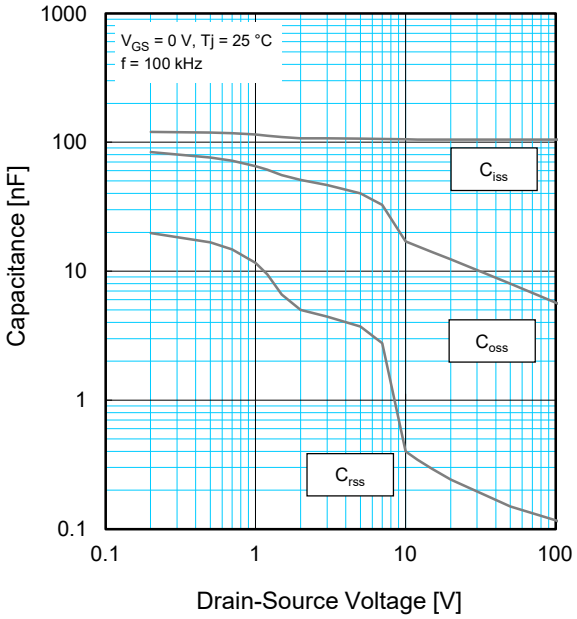
FREE-WHEEL DIODE FORWARD CHARACTERISTICS (TYPICAL)



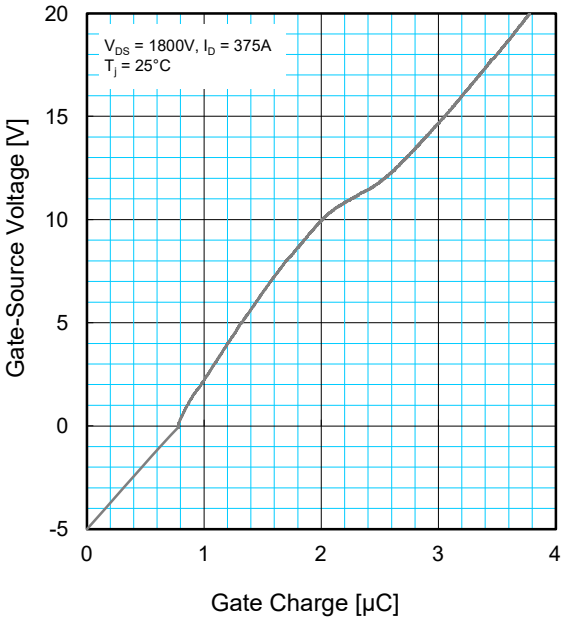
HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)



CAPACITANCE CHARACTERISTICS (TYPICAL)

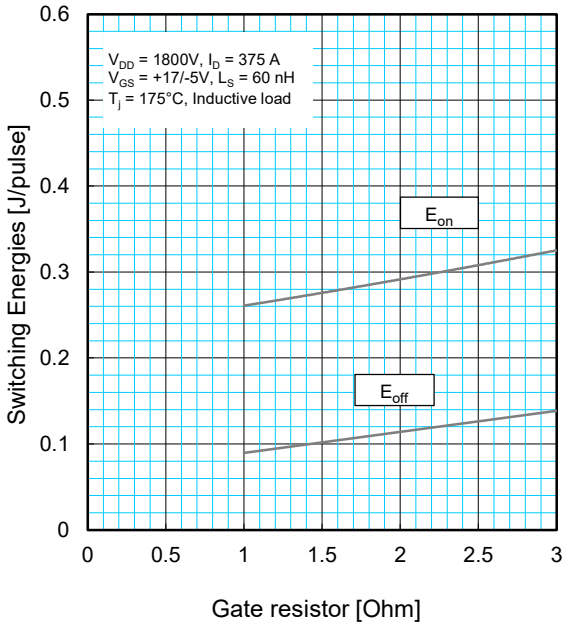


GATE CHARGE CHARACTERISTICS (TYPICAL)

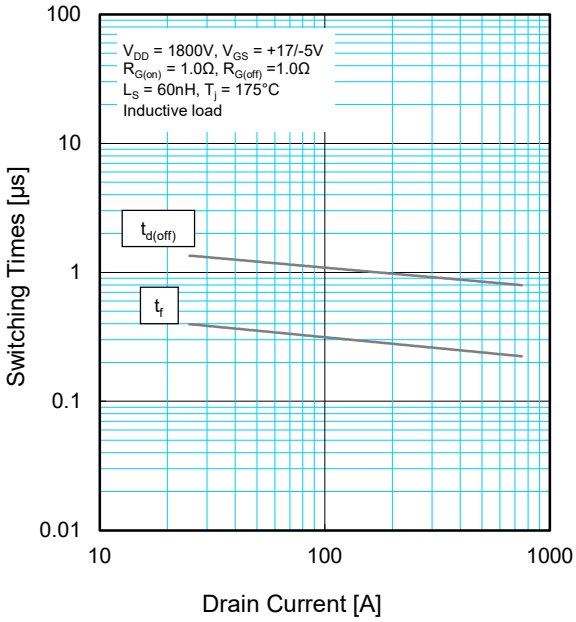


PERFORMANCE CURVES

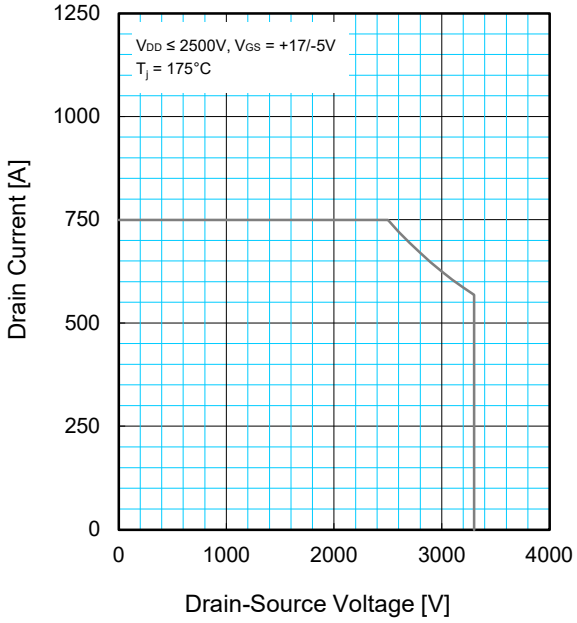
HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)



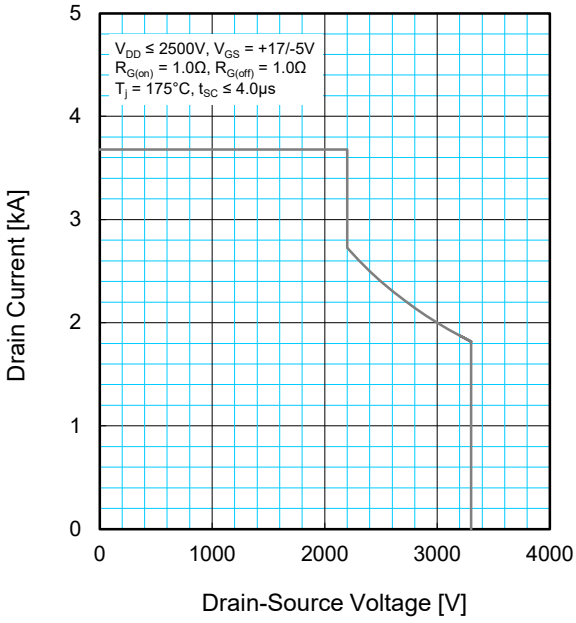
HALF-BRIDGE SWITCHING TIME CHARACTERISTICS (TYPICAL)



REVERSE BIAS SAFE OPERATING AREA (RBSOA)

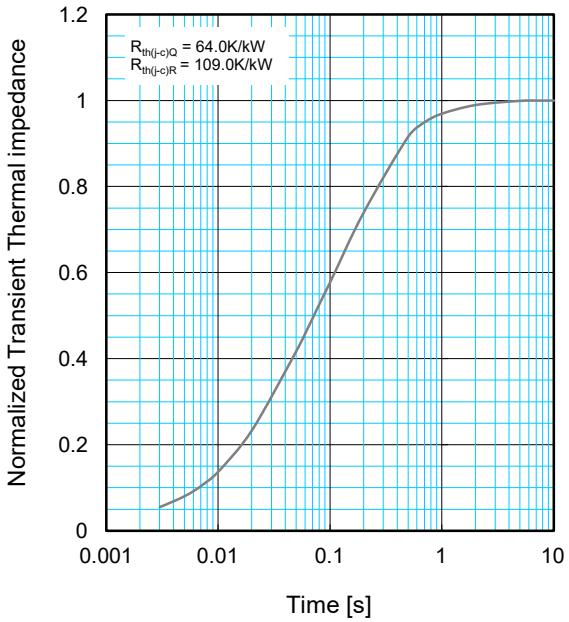


SHORT CIRCUIT SAFE OPERATING AREA (SCSOA)



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
$R_i / R_{th(j-c)}$	0.0145	0.3107	0.5977	0.0772
τ_i [s]	0.0001	0.0291	0.1797	1.0024

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