MITSUBISHI ELECTRIC

< HVMOSFET MODULE >

FMF800E1C-66BEW

HIGH POWER SWITCHING USE
INSULATED TYPE

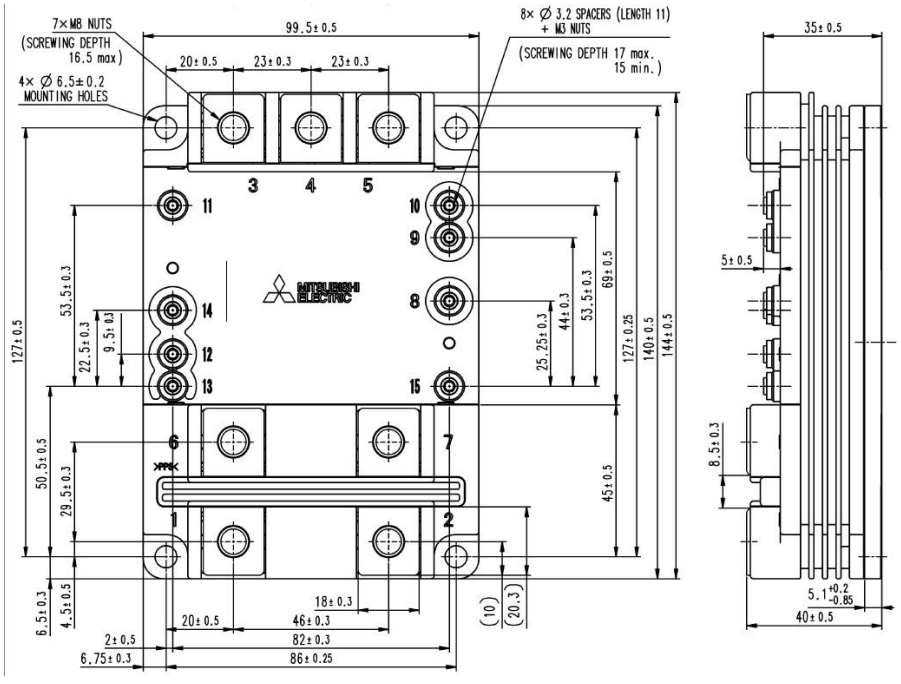
FMF800E1C-66BEW

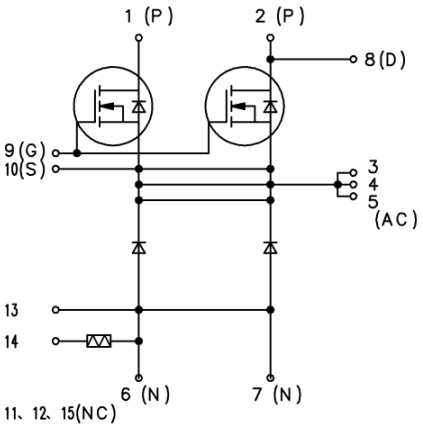
- I_D 800A
- V_{DSX} 3300V
- 2-element in a Pack
- Insulated Type
- SiC SBD embedded MOSFET (P-side)
- SiC SBD (N-side, Clamp-Diode)

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), K(N)
6, 7	DC-, A(N)
8	D(P)
9	G(P)
10	S(P)
11	NC
12	NC
13	A(N)
14	NTC
15	NC

MAXIMUM RATINGS

Item	Symbol	Conditions		Ratings	Unit
Drain-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 = 87 °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 V , T_c = 85 °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 °C , MOSFET part, Clamp-Diode(SBD) part (Note 3.)		6650	W
Isolation voltage	V_{isol}	Charged part to the baseplate RMS sinusoidal AC 60Hz 1min		6000	V_{rms}
Partial discharge charge	Q_{pd}	Charged part to the baseplate RMS sinusoidal AC 60Hz V1=3500V、V2=2600V(IEC61287-1 Ed.3.0:2014)		10	pC
Junction temperature	T_j	-		-40~175	°C
Case temperature	T_c	-		-40~150	°C
Storage temperature	T_{stg}	-		-50~175	°C
Operating junction temperature	T_{jop}	-		-40~175	°C
Short-circuit withstand pulse duration	t_{pSC}	V_{DD} = 2500 V , V_{GS} = +17 / -7 V , L_s = 40 nH ,	T_j = T_{op}	1.7	µs
Short circuit energy	E_{SC}	V_{DD} = 2500 V , F(t)weibull=1%	T_j = T_{op}	35	J
Non-repetitive surge forward current	I_{FSM}	t_p = 10ms, F(t)weibull=1%, Half sine wave 1 cycle	T_j = 175 °C	5.9	kA
I^2t value	I^2t	t_p = 10ms, F(t)weibull=1%, Half sine wave 1 cycle	T_j = 175 °C	180	kA^2s

MAXIMUM RATINGS (Clamp-Diode part)

Item	Symbol	Conditions		Ratings	Unit
Repetitive peak reverse voltage	V_{RRM}	-	T_j = -40~175 °C	3300	V
Forward current	I_F	T_c = 96 °C , DC, (Note 1.)		800	A
	I_{FRM}	-	T_j = T_{op}	1600	A
Non-repetitive surge forward current	I_{FSM}	t_p = 10ms, F(t)weibull=1%, Half sine wave 1 cycle	T_j = 175 °C	3.5	kA
I^2t value	I^2t	t_p = 10ms, F(t)weibull=1%, Half sine wave 1 cycle	T_j = 175 °C	64	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	-2.0	-	2.0	µA
			T_j = 150 °C	-2.0	-	2.0	µA
			T_j = 175 °C	-2.0	-	2.0	µA
Drain-source cut-off current	I_{DSX}	V_{DS} = V_{DSX} , V_{GS} = -7 V	T_j = 25 °C	0.0	0.003	2.0	mA
			T_j = 150 °C	-	0.050	-	mA
			T_j = 175 °C	0.0	0.080	3.0	mA
Gate-source threshold voltage	$V_{GS(th)}$	V_{DS} = 10 V , I_D = 80mA	T_j = 25 °C	-	2.10	-	V
			T_j = 150 °C	-	1.50	-	V
			T_j = 175 °C	-	1.45	1.90	V
Drain-source on resistance	$r_{DS(on)}$	V_{DS} = $V_{DS(on)}$, V_{GS} = 17 V , P-side(Terminal 8-10)	T_j = 25 °C	-	2.00	-	mΩ
			T_j = 150 °C	-	4.31	-	mΩ
			T_j = 175 °C	-	5.00	6.06	mΩ
Drain-source on-state voltage	$V_{DS(on)}$	I_D = 800 A , V_{GS} = 17 V , P-side(Terminal 8-10), (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 = 800 A , V_{GS} = 17 V , P-side(Terminal 8-10), (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 = 800 A , V_{GS} = 0 V , P-side(Terminal 8-10), (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 = 800 A , V_{GS} = -7 V , P-side(Terminal 8-10), (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 , per 1/2 module	T_j = 25 °C	-	110	-	nF
Output capacitance	C_{oss}	V_{DS} = 10 V , V_{GS} = 0 V , f = 100kHz , per 1/2 module	T_j = 25 °C	-	70	-	nF
Reverse transfer capacitance	C_{rss}	V_{DS} = 10 V , V_{GS} = 0 V , f = 100kHz , per 1/2 module	T_j = 25 °C	-	2.7	-	nF
Gate charge	Q_G	V_{DD} = 1800 V , I_D = 800 A , V_{GS} = +17 / -7 V, per 1/2 module	T_j = 25 °C	-	3.3	-	µC
Turn-on delay time	$t_{d(on)}$	V_{DD} = 1800 V , I_D = 800 A , V_{GS} = +17 / -7 V , L_s = 40 nH , $R_{G(on)}$ = 1.5 Ω , $R_{G(off)}$ = 1.5 Ω , Inductive Load	T_j = 25 °C	-	0.36	-	µs
			T_j = 150 °C	-	0.32	-	µs
			T_j = 175 °C	-	0.32	0.50	µs
Rise time	t_r		T_j = 25 °C	-	0.18	-	µs
			T_j = 150 °C	-	0.15	-	µs
			T_j = 175 °C	-	0.15	0.30	µs
Turn-on switching energy per pulse (Note 5)	$E_{on(10\%)}$		T_j = 25 °C	-	0.26	-	J
			T_j = 150 °C	-	0.22	-	J
			T_j = 175 °C	-	0.22	-	J
Turn-on switching energy per pulse	E_{on}		T_j = 25 °C	-	0.27	-	J
			T_j = 150 °C	-	0.23	-	J
			T_j = 175 °C	-	0.23	-	J
Total capacitive charge (Note 2,6)	Q_C	V_{DD} = 1800 V , I_D = 800 A , V_{GS} = +17 / -7 V , L_s = 40 nH , $R_{G(on)}$ = 1.5 Ω , $R_{G(off)}$ = 1.5 Ω , Inductive Load	T_j = 25 °C	-	10.7	-	µC
			T_j = 150 °C	-	12.5	-	µC
			T_j = 175 °C	-	12.5	-	µC
Diode turn-off energy per pulse (Note 2,5)	$E_{off\_Diode(10\%)}$		T_j = 25 °C	-	0.004	-	J
			T_j = 150 °C	-	0.005	-	J
			T_j = 175 °C	-	0.005	-	J
Diode turn-off energy per pulse (Note 2)	E_{off_Diode}		T_j = 25 °C	-	0.004	-	J
			T_j = 150 °C	-	0.006	-	J
			T_j = 175 °C	-	0.006	-	J

ELECTRICAL CHARACTERISTICS (continuation)

Item	Symbol	Conditions		Limits			Unit
				Min.	Typ.	Max.	
Turn-off delay time	$t_{d(off)}$	V_{DD} = 1800 V , I_D = 800 A , V_{GS} = +17 / -7 V , L_s = 40 nH , $R_{G(on)}$ = 1.5 Ω , $R_{G(off)}$ = 1.5 Ω , Inductive Load	T_j = 25 °C	-	0.43	-	µs
			T_j = 150 °C	-	0.52	-	µs
			T_j = 175 °C	-	0.54	-	µs
Fall time	t_{f1}		T_j = 25 °C	-	0.17	-	µs
			T_j = 150 °C	-	0.19	-	µs
			T_j = 175 °C	-	0.19	-	µs
Turn-off switching energy per pulse (Note 5)	$E_{off(10\%)}$		T_j = 25 °C	-	0.10	-	J
			T_j = 150 °C	-	0.11	-	J
			T_j = 175 °C	-	0.11	-	J
Turn-off switching energy per pulse	E_{off}		T_j = 25 °C	-	0.10	-	J
			T_j = 150 °C	-	0.11	-	J
			T_j = 175 °C	-	0.11	-	J

ELECTRICAL CHARACTERISTICS (Clamp-Diode part)

Item	Symbol	Conditions		Limits			Unit
				Min.	Typ.	Max.	
Peak reverse recovery current	I_{RRM}	V_{KA} = 3300 V	T_j = 25 °C	0.0	0.03	1.6	mA
			T_j = 150 °C	-	0.4	-	mA
			T_j = 175 °C	0.0	0.8	32	mA
Forward voltage	V_F	I_F = 800 A , N-side(Terminal 10-13) , (Note 7)	T_j = 25 °C	-	2.0	-	V
			T_j = 150 °C	-	3.7	-	V
			T_j = 175 °C	-	4.1	4.7	V
		I_F = 800 A , N-side	T_j = 25 °C	-	1.8	-	V
			T_j = 150 °C	-	3.4	-	V
			T_j = 175 °C	-	3.8	4.4	V
Diode turn-off energy per pulse (Note 5)	$E_{off\_Diode(10\%)}$	V_{GS} = +17 / -7 V , L_s = 40 nH , $R_{G(on)}$ = 1.5 Ω , $R_{G(off)}$ = 1.5 Ω , V_{KK} = 1800 V , I_F = 800 A , Inductive Load	T_j = 25 °C	-	0.002	-	J
			T_j = 150 °C	-	0.004	-	J
			T_j = 175 °C	-	0.004	-	J
Diode turn-off energy per pulse	E_{off_Diode}		T_j = 25 °C	-	0.003	-	J
			T_j = 150 °C	-	0.005	-	J
			T_j = 175 °C	-	0.005	-	J

THERMAL CHARACTERISTICS

Item	Symbol	Conditions	Limits			Unit
			Min.	Typ.	Max.	
Thermal resistance junction to case	$R_{th(j-c)}$	MOSFET + embedded SBD part, per 1/2 module	-	-	22.5	K/kW
Thermal resistance junction to case	$R_{th(j-c)D}$	Clamp-Diode part, per 1/2 module	-	-	22.5	K/kW
Contact thermal resistance case to heatsink	$R_{th(c-s)}$	Case to heat sink, λgrease = 1W/m·K, D(c-s) = 70μm per 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
		Main terminal screw : M8	7.0	-	10.0	N·m
Mounting torque	M_t	Mounting screw : M6	3.0	-	6.0	N·m
Mounting torque	M_t	Auxiliary terminal 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	8.5	-	mm
Creepage distance along surface	d_s	-	32.0	32.5	-	mm
Internal inductance, D-S	$L_{P\ DS}$	Between DC+ and DC-(terminal1,2-6,7)	-	15	-	nH
	$L_{P\ DS}$	Between DC+ and AC (terminal1,2-3,4,5)	-	43	-	nH
	$L_{P\ DS}$	Between AC and DC-(terminal3,4,5-6,7)	-	43	-	nH
Internal lead resistance, DD'-SS'	$R_{DD'+SS'}$	T_C=25°C, Between DC+ and DC-(terminal1,2-6,7)	-	0.46	-	mΩ
	$R_{DD'+SS'}$	T_C=25°C, Between DC+ and AC (terminal1,2-3,4,5)	-	0.22	-	mΩ
	$R_{DD'+SS'}$	T_C=25°C, Between AC and DC-(terminal3,4,5-6,7)	-	0.33	-	mΩ
Zero-power resistance	R_{25}	T_C=25°C	4.65	5.00	5.35	kΩ
B-constant	$B_{(25/50)}$	Approximate by equation,(Note 8)	-	3375	-	K

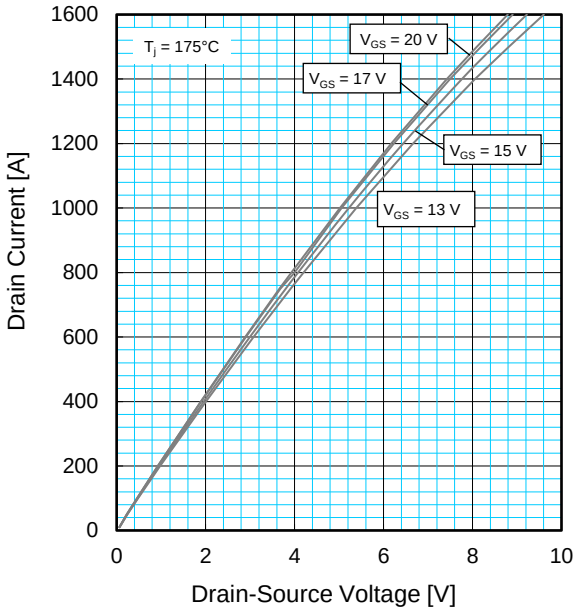
Note 1. Control Case Temperature (T_c) so that the junction temperature (T_j) does not exceed the maximum rating.
Note 2. The symbols represent characteristics of the anti-parallel, source to drain free-wheel diode (FWDi).
Note 3. Junction temperature (T_j) should not exceed T_{j_max} rating.
Note 4. Pulse width and repetition rate should be such as to cause negligible temperature rise.
Note 5. The integration range of switching energies is from 10%V_{DS} to 10%I_D(I_S).
Note 6. The integration range of total capacitive charge (Q_c) is from I_S=0A to 2%I_S.
Note 7. N-side characteristic value includes wiring resistance between P-side source potential and N-side drain potential.
Note 8. $B_{(25/50)} = \ln\left(\frac{R_{25}}{R_{50}}\right) / \left(\frac{1}{T_{25}} - \frac{1}{T_{50}}\right)$

R_{25}: resistance at absolute temperature T_{25} [K]; T_{25} = 25[ºC] + 273.15 = 298.15[K]
R_{50}: resistance at absolute temperature T_{50} [K]; T_{50} = 50[ºC] + 273.15 = 323.15[K]

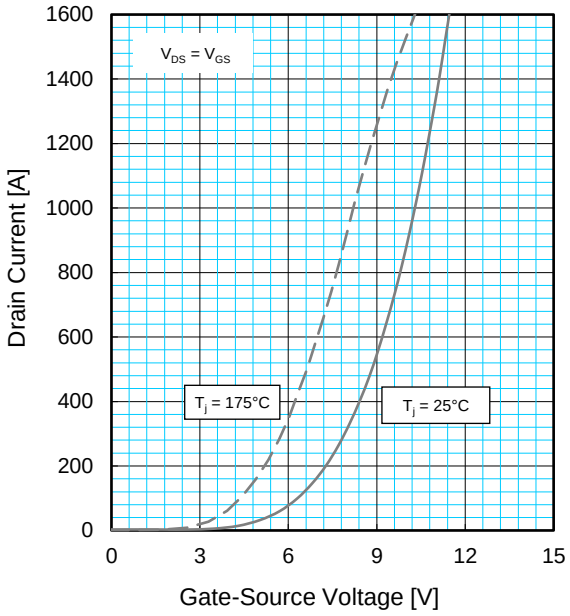
Products falling under the subject item No. 2 (41) 3 of Appended Table 1 of the Export Trade Control Order.

PERFPRMANCE CURVES

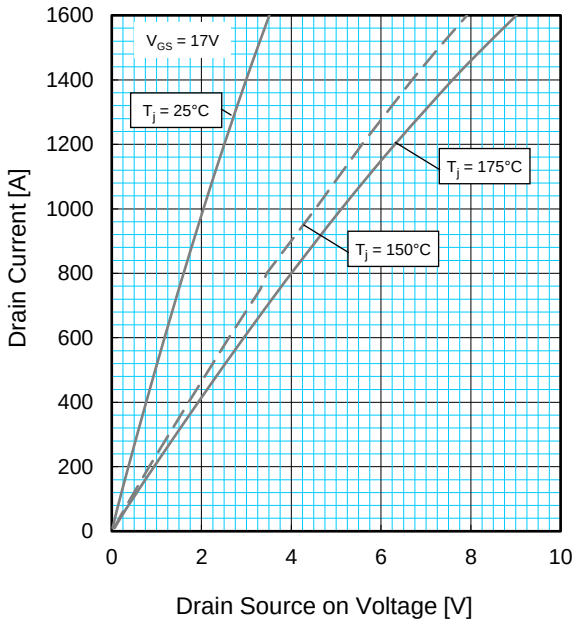
OUTPUT CHARACTERISTICS (TYPICAL)



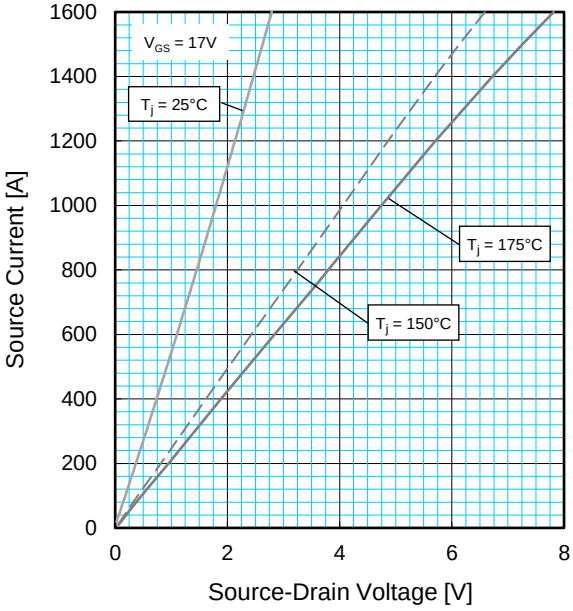
TRANSFER CHARACTERISTICS (TYPICAL)



DRAIN-SOURCE ON VOLTAGE CHARACTERISTICS (TYPICAL)

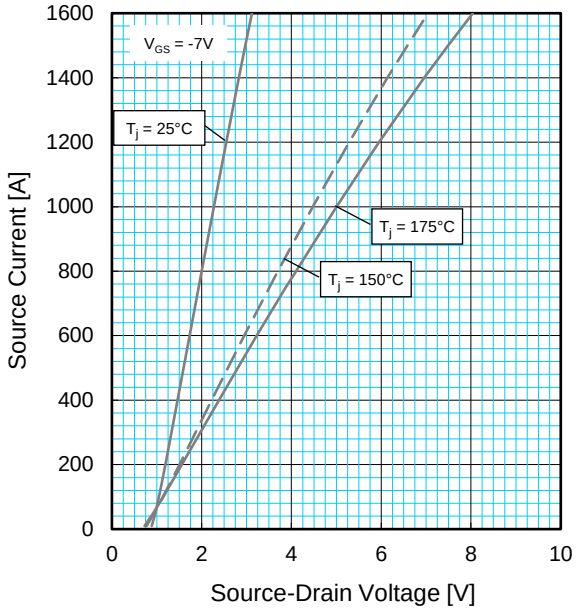


FREE-WHEEL DIODE FORWARD CHARACTERISTICS (TYPICAL)

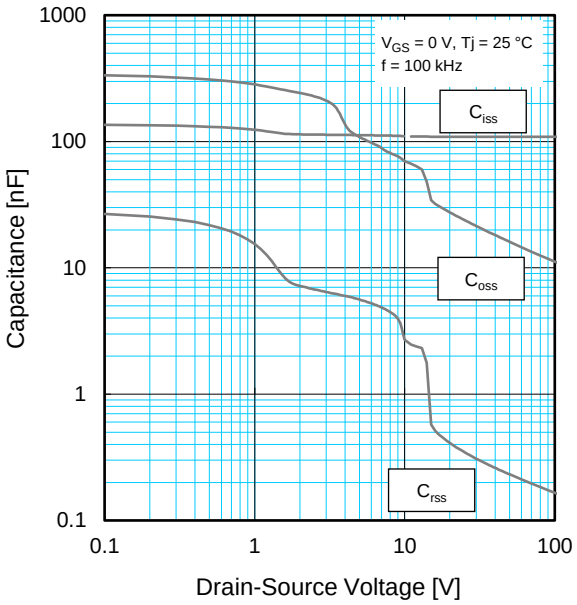


PERFORMANCE CURVES

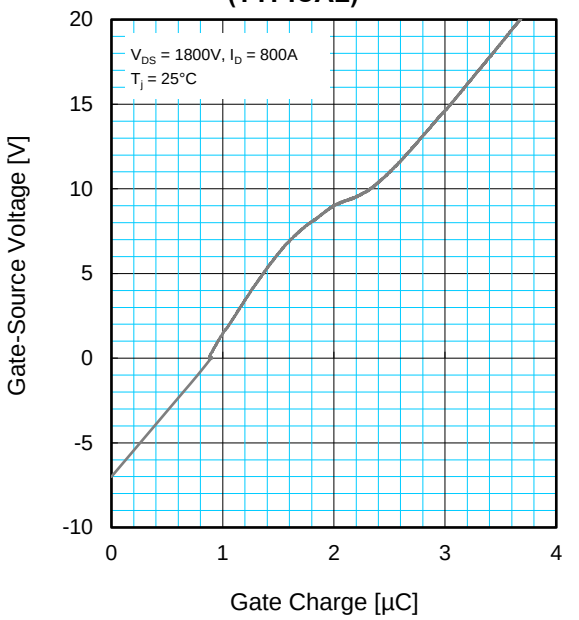
CLAMP-DIODE FORWARD CHARACTERISTICS (TYPICAL)



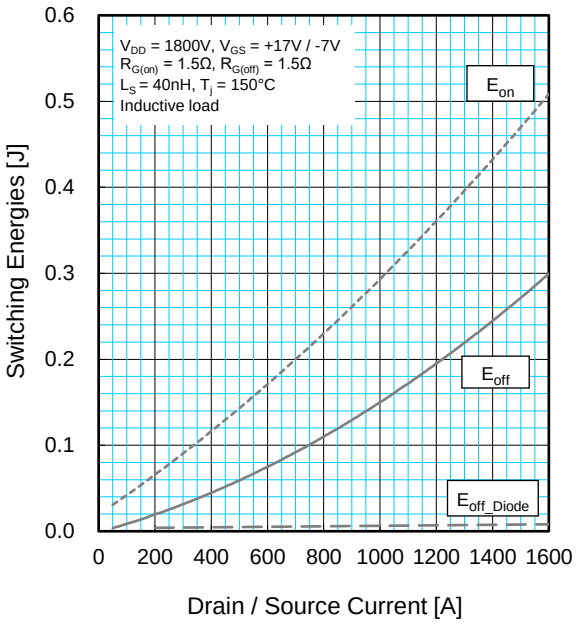
CAPACITANCE CHARACTERISTICS (TYPICAL)



GATE CHARGE CHARACTERISTICS (TYPICAL)

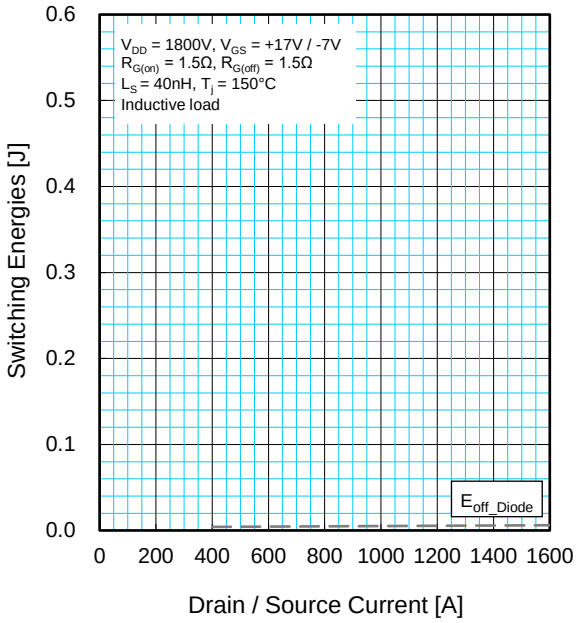


HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)

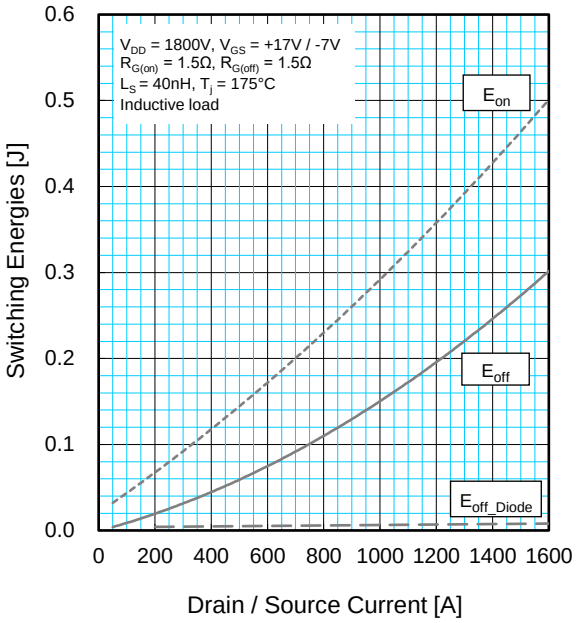


PERFORMANCE CURVES

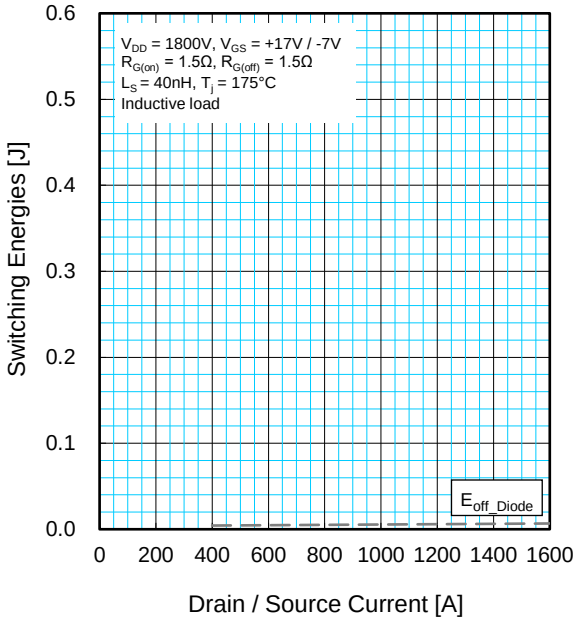
HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL, CLAMP-DIODE)



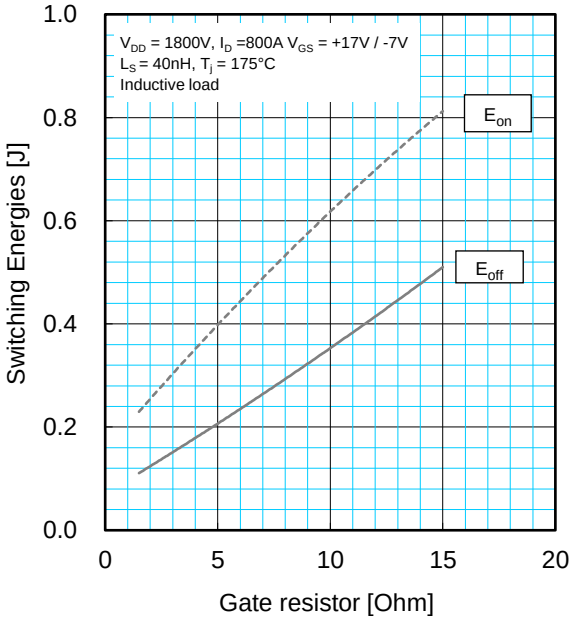
HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)



HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL, CLAMP-DIODE)

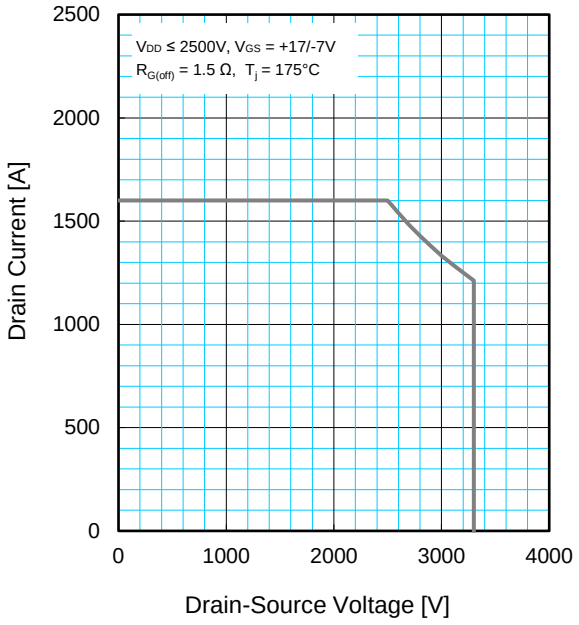


HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)

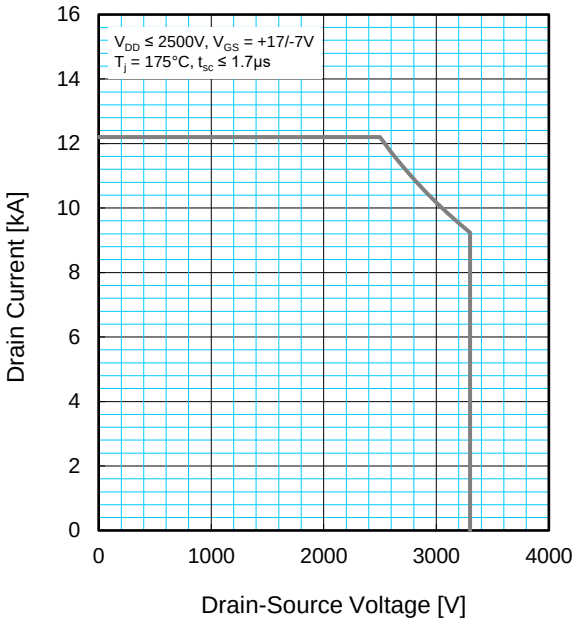


PERFORMANCE CURVES

REVERSE BIAS SAFE OPERATING AREA (RBSOA)

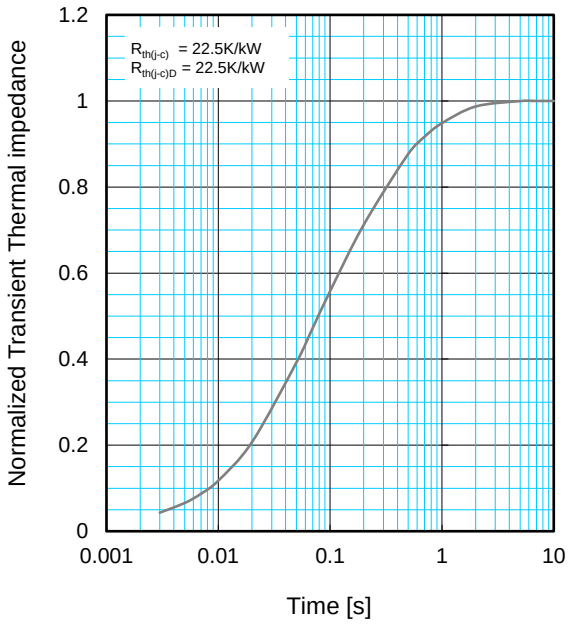


SHORT CIRCUIT SAFE OPERATING AREA (SCSOA)



PERFORMANCE CURVES

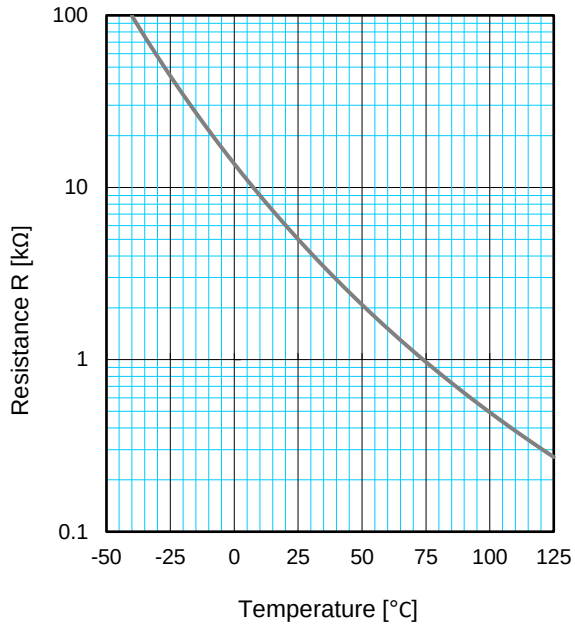
TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS



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

	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

NTC THERMISTOR TEMPERATURE CHARACTERISTICS (TYPICAL)



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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