High-Power Module　Silicon Carbide N-Channel MOSFET, Silicon Carbide SBD

MG800FXF1ZMS3

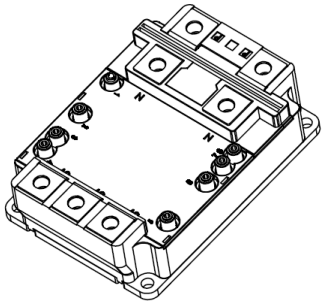
1. Applications

- High-Power Switching
- Motor Controllers (including rail traction)

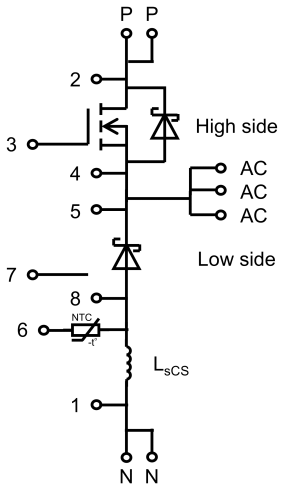
2. Features

(1) V_{DSS} = 3300 V, I_D = 800 A All SiC MOSFET Module(Low loss & High speed switching)
(2) This module is equipped with SiC MOSFET on the high side and SiC SBD on the low side.
(3) Low stray inductance, low thermal resistance, maximum T_{ch}= 175 ℃
(4) New generation standard package(Compact & easily handled by paralleling)
(5) Electrodes are isolated from metal base plate.

3. Packaging and Internal Circuit



iXPLV



Note :　P and N terminal should use two screws fastened in each and AC terminal should use three screws fastened.

Start of commercial production
2023-10

4. Terminal

Terminal No.	Connection
P	P (main terminal)
N	N (main terminal)
AC	AC (main terminal)
1	N (sense) / Current sense
2	P (sense)
3	High side gate
4	High side source sense
5	AC (sense)
6	thermistor
7	Non Conection
8	low side anode sense

Marking	High side	Low side
B	MOSFET	SBD

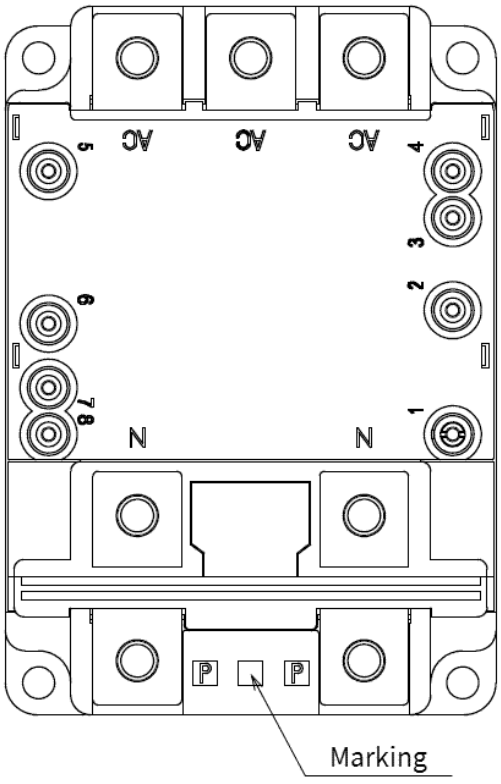


Fig. 4.1 Terminal image

5. Absolute Maximum Ratings (Note,Note 1)

5.1. MOSFET Absolute Maximum Ratings (T_c = 25℃,unless otherwise specified)

Characteristics	Symbol	Note	Test Condition	Rating	Unit
Drain-source voltage	V_{DSS}			3300	V
Gate-source voltage	V_{GSS}			+ 25 / - 10	V
Drain current (DC)	I_D	(Note 2)		800	A
Drain current (pulsed)	I_{DP}	(Note 2)		1600	A
Drain power dissipation	P_D	(Note 2)		4680	W
Source current (DC)	I_S	(Note 2)		800	A
Source current (pulsed)	I_{SP}	(Note 2)		1600	A
Channel temperature	T_{ch}			175	℃

5.2. SBD Absolute Maximum Ratings (T_c = 25℃,unless otherwise specified)

Characteristics	Symbol	Note	Test Condition	Rating	Unit
Repetitive peak reverse voltage	V_{RRM}			3300	V
Diode forward current (DC)	I_F		T_j = -40 to 175℃	800	A
Diode forward current (pulsed)	I_{FP}		T_j = -40 to 150℃	1600	A
			T_j = 150 to 175℃	800	A
Junction temperature	T_j			175	℃

5.3. Absolute Maximum Ratings (MOSFET,SBD common) (T_c = 25℃,unless otherwise specified)

Characteristics	Symbol	Note	Test Condition	Rating	Unit
Storage temperature	T_{stg}			-40 to 150	℃
Isolation voltage	V_{isol}		AC , 60 s	6000	V
Mounting torque	TOR	(Note 3)	Main terminal : M8	9.1	N · m
		(Note 4)	Signal terminal : M3	1.0	N · m
		(Note 5)	Mounting : M6	5.2	N · m

Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings.
Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Note 1: Refer to the application notes.
Note 2: Ensure tht th channel temperature does not exceed 175℃.
Note 3: The recommended tightening torque for the main terminal (M8) is 7.0 N · m.
Note 4: The recommended tightening torque for the signal terminal (M3) is 0.8 N · m.
Note 5: The recommended tightening torque for installation (M6) is 4.0 N · m.

6. Thermal Chracteristics

Characteristics	Symbol	Note	Min	Typ.	Max	Unit
Thermal resistance (channel-to-case)	$R_{th(ch-c)}$		—	—	0.032	K/W
Thermal resistance (junction-to-case)	$R_{th(j-c)}$		—	—	0.04	K/W
Thermal resistance (case-to-fin)	$R_{th(c-f)}$	(Note)	—	0.0026	—	K/W

Note: The value per module.
Apply 50 μm of 3 W/m · K grease between the case and fin while taking care not to create a void, and tighten to the recommended torque before use.

7. Electrical Characteristics

7.1. MOSFET Electrical Characteristics (T_c = 25°C,unless otherwise specified)

Characteristics	Symbol	Note	Test Condition	Min	Typ.	Max	Unit	Fig.
Gate-source leakage current	I_{GSS}		V_{GS} = +25 V / -10 V, V_{DS} = 0 V	—	—	±100	nA	—
Drain-source cut-off current	I_{DSS}		V_{DS} = 3300V, V_{GS} = 0 V	—	—	1	mA	—
Gate threshold voltage	V_{th}	(Note 1)	I_D = 0.8 A, V_{DS} = 10 V	—	4.8	—	V	—
Drain-source on-voltage (sense)	$V_{DS(on)}$ sense		I_D = 800 A, V_{GS} = + 20 V, T_{ch} = 25 °C	—	1.3	—	V	—
			I_D = 800 A, V_{GS} = + 20 V, T_{ch} = 175 °C	—	3.6	5.2	V	—
Drain-source on-voltage (terminal)	$V_{DS(on)}$ terminal		I_D = 800 A, V_{GS} = + 20 V, T_{ch} = 25 °C	—	1.4	—	V	—
Input capacitance	C_{iss}		V_{DS} = 1800 V, V_{GS} = 0 V, f = 100 kHz	—	173	—	nF	—
Internal gate resistance	r_{ig}		f = 1 MHz	—	2.75	—	Ω	—
Switching time (turn-on delay time)	$t_{d(on)}$	(Note 2)	Inductive load, V_{DD} = 1800 V, I_D = 800 A, V_{GS} = + 20 V / - 6 V, $R_{G(on)}$ = 1.5 Ω, $R_{G(off)}$ = 3.6 Ω, C_{GS} = 100nF, T_{ch} = 175 °C, L_S ≈ 70 nH	—	0.58	—	μs	7.1 7.2
Switching time (rise time)	t_r			—	0.17	—	μs	
Switching time (turn-on time)	t_{on}			—	0.75	—	μs	
Switching time (turn-off delay time)	$t_{d(off)}$			—	1.80	—	μs	
Switching time (fall time)	t_f			—	0.15	—	μs	
Switching time (turn-off time)	t_{off}			—	1.95	—	μs	
Turn-on switching loss	E_{on}			—	230	—	mJ	
Turn-off switching loss	E_{off}			—	230	—	mJ	
Source-drain on-voltage (sense)	$V_{SD(on)}$ sense		I_S = 800 A, V_{GS} = + 20 V, T_{ch} = 25 °C	—	1.3	—	V	—
	$V_{SD(on)}$ sense		I_S = 800 A, V_{GS} = + 20 V, T_{ch} = 175 °C	—	3.5	5.1	V	—
Source-drain on-voltage (terminal)	$V_{SD(on)}$ terminal		I_S = 800 A, V_{GS} = + 20 V, T_{ch} = 25 °C	—	1.4	—	V	—
Source-drain off-voltage (sense)	$V_{SD(off)}$ sense		I_S = 800 A, V_{GS} = - 6 V, T_{ch} = 25 °C	—	2.1	—	V	—
	$V_{SD(off)}$ sense		I_S = 800 A, V_{GS} = - 6 V, T_{ch} = 175 °C	—	4.3	6.3	V	—
Source-drain off-voltage (terminal)	$V_{SD(off)}$ terminal		I_S = 800 A, V_{GS} = - 6 V, T_{ch} = 25 °C	—	2.2	—	V	—
Reverse recovery time	t_{rr}	(Note 2)	Inductive Load, V_{DD} = 1800 V,I_S = 800 A, V_{GS} = - 6 V, Drive side $R_{G(on)}$ = 2.2 Ω, C_{GS} = 100nF, T_{ch} = 175 °C, L_S ≈ 110 nH	—	0.09	—	μs	7.3 7.5
Reverse recovery loss	E_{rr}			—	18	—	mJ	
Stray inductance	L_{sPN}		P terminal — N terminal	—	12	—	nH	—
Current sensing inductance	L_{sCS}		1 terminal — 8 terminal	—	2.7	—	nH	—
Rated NTC resistance	R		T_c = 25 °C	3.5	5.0	6.5	kΩ	—
	R		T_c = 150 °C	125	165	205	Ω	—
NTC B value	B		T_{NTC} = 25 to 150 °C	—	3375	—	K	—

Note 1: Gate-Source Voltage (-10V) is applied 5ms before measurement.

Note 2: L_s is the sum of the stray inductance between the P and N terminals (L_{sPN}) and the stray inductance of external circuitry (L_{ext}) .

7.2. SBD Electrical Characteristics (T_c = 25°C,unless otherwise specified)

Characteristics	Symbol	Note	Test Condition	Min	Typ.	Max	Unit	Fig.
Repetitive peak reverse current	I_{RRM}		V_R = 3300 V	—	—	60	μA	—
Forward voltage (sense)	$V_{F\ sense}$		I_F = 800 A, T_j = 25 °C	—	2.0	—	V	—
			I_F = 800 A, T_j = 175 °C	—	3.9	5.0	V	—
Forward voltage (terminal)	$V_{F\ terminal}$		I_F = 800 A, T_j = 25 °C	—	2.2	—	V	—
Reverse recovery charge	Q_{rr}	(Note)	V_R = 1800 V, I_F = 800 A, Drive side $R_{G(on)}$ = 1.5 Ω, T_j = 175 °C,L_s ≈ 70 nH	—	10	—	μC	7.4 7.5
Reverse recovery time	t_{rr}			—	0.08	—	μs	
Reverse recovery loss	E_{rr}			—	10	—	mJ	

Note: L_s is the sum of the stray inductance between the P and N terminals (L_{sPN}) and the stray inductance of external circuitry (L_{ext}) .

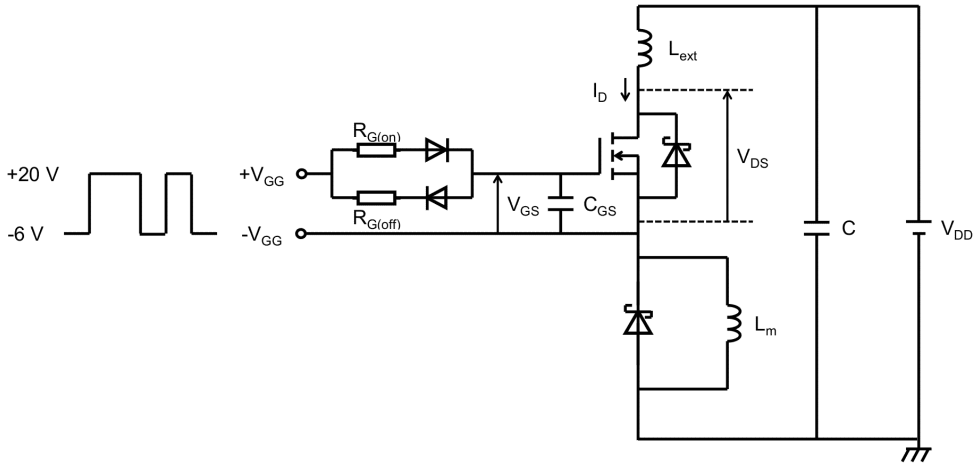


Fig. 7.1 Inductive Load Switching Test Circuit

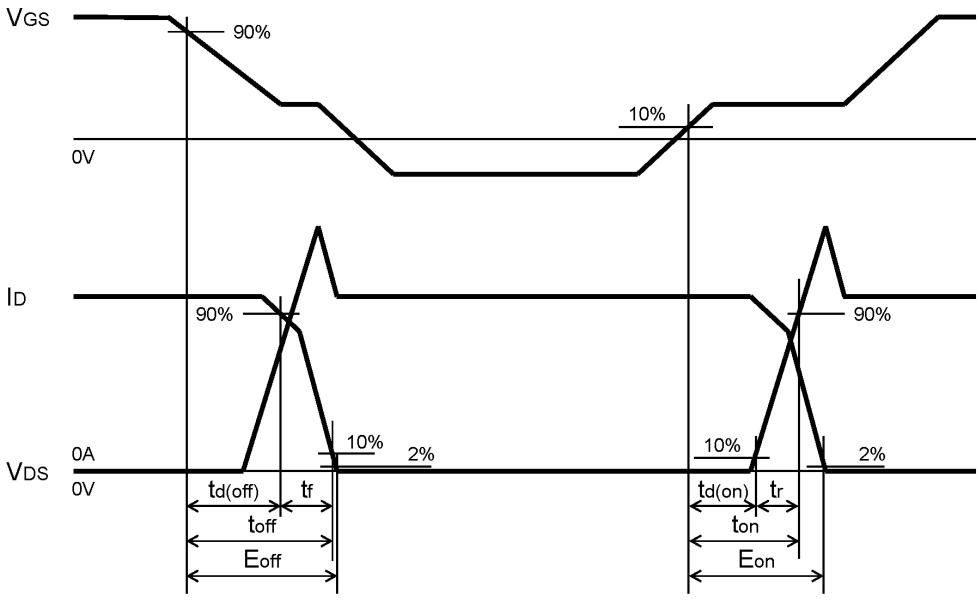


Fig. 7.2 Timing Chart (MOSFET part)

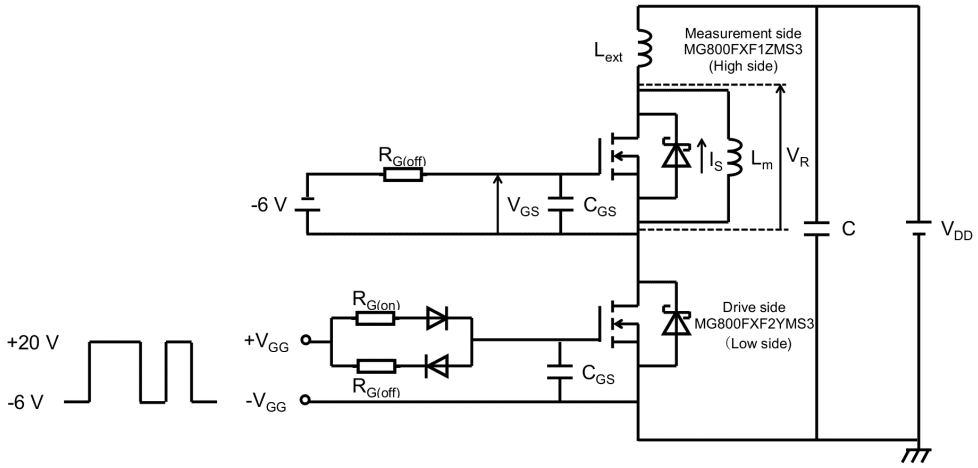


Fig. 7.3 MOSFET Reverse Inductive Load Switching Test Circuit

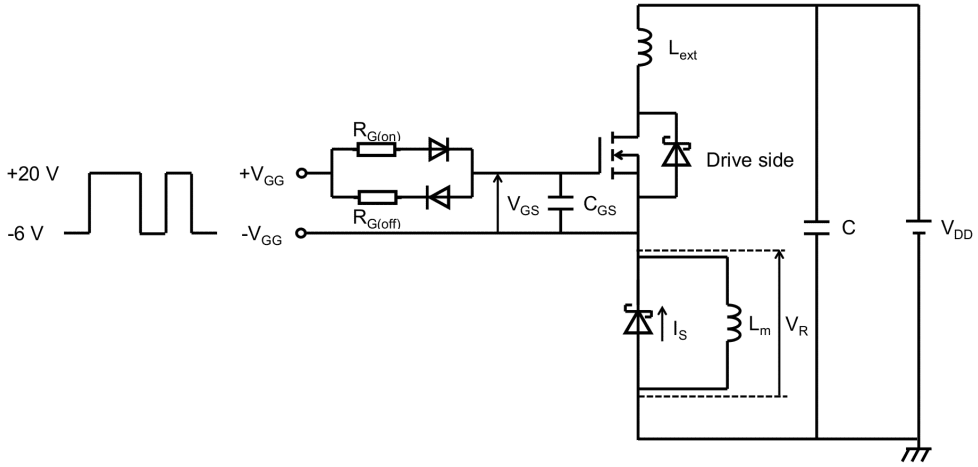


Fig. 7.4 SBD Reverse Inductive Load Switching Test Circuit

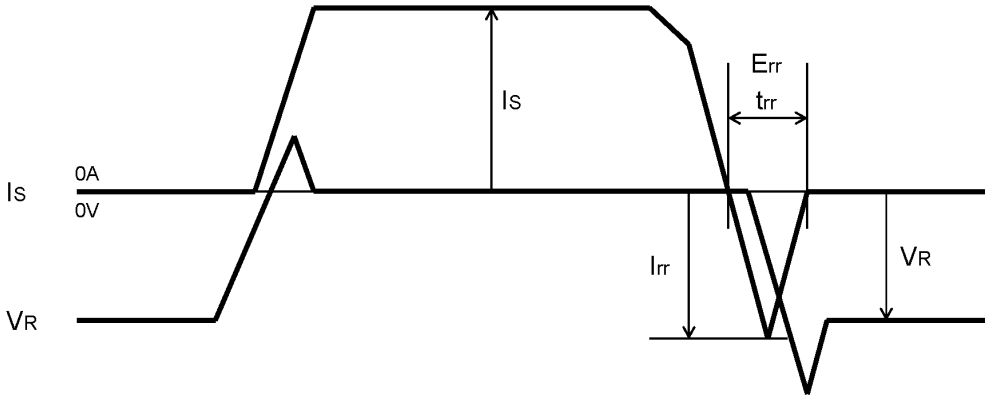


Fig. 7.5 Timing Chart (Diode part)

8. MOSFET Characteristics Curves (Note)

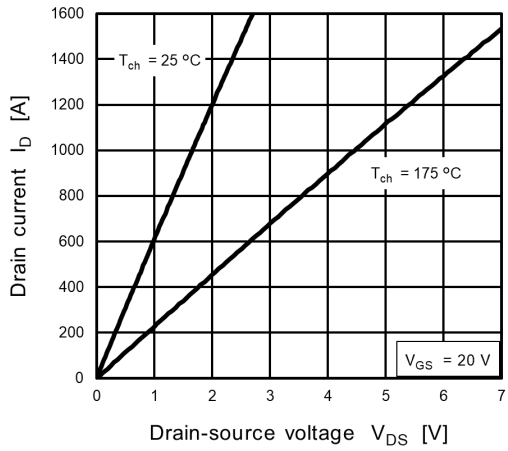


Fig. 8.1 I_D - V_{DS} (Note 1)

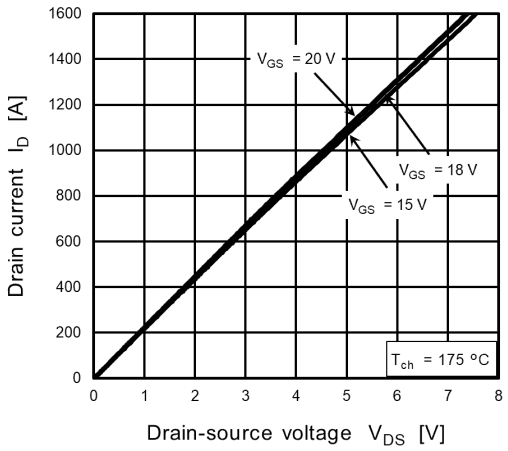


Fig. 8.2 I_D - V_{DS} (Note 1)

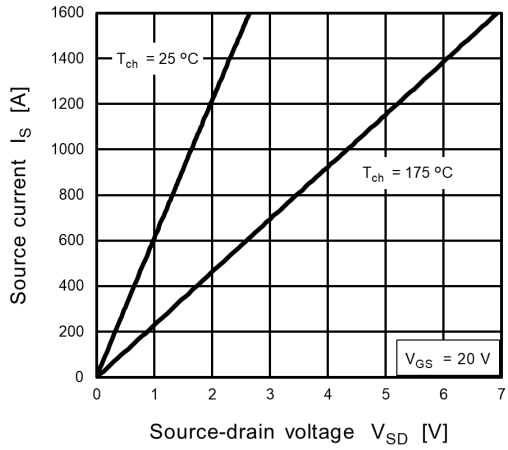


Fig. 8.3 I_S - V_{SD} (Note 1)

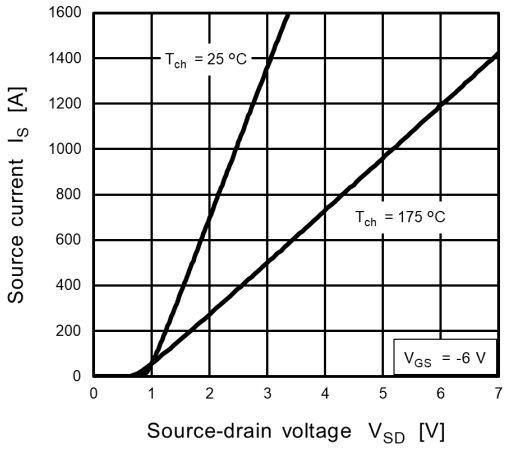


Fig. 8.4 I_S - V_{SD} (Note 1)

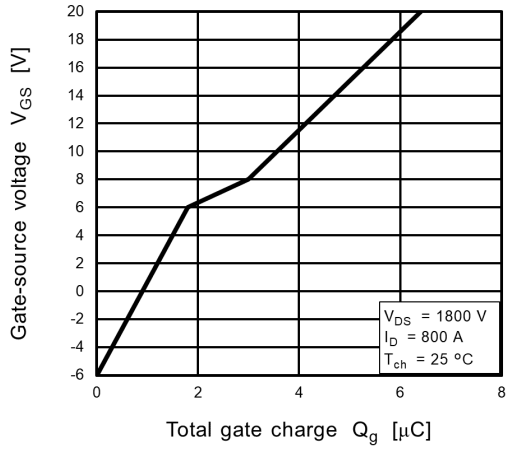


Fig. 8.5 V_{GS} -Q_g

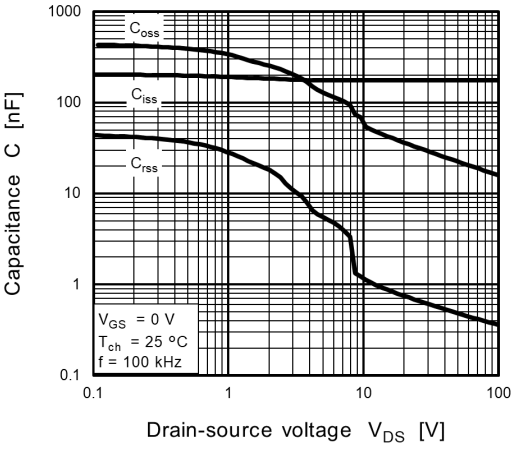


Fig. 8.6 C_{iss}, C_{oss}, C_{rss} - V_{DS}

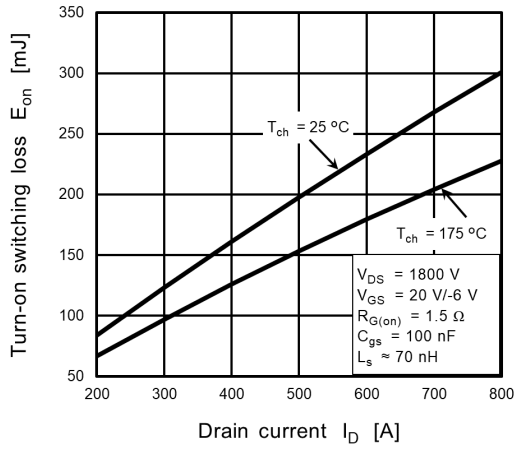


Fig. 8.7 E_{on} - I_D

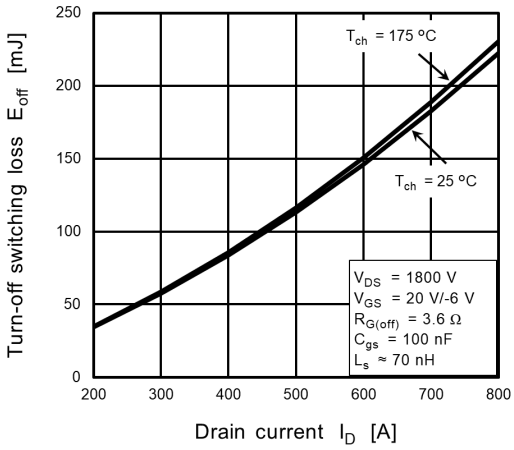


Fig. 8.8 E_{off} - I_D

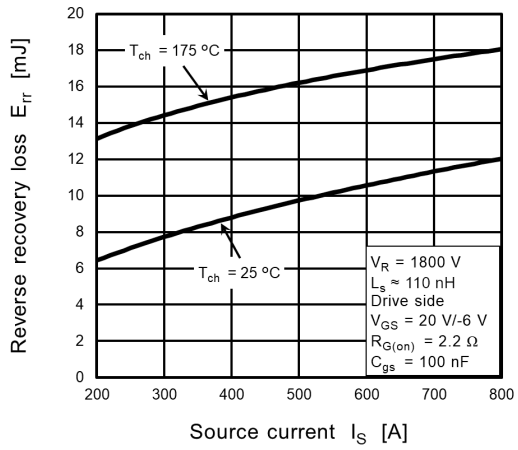


Fig. 8.9 E_{rr} - I_S

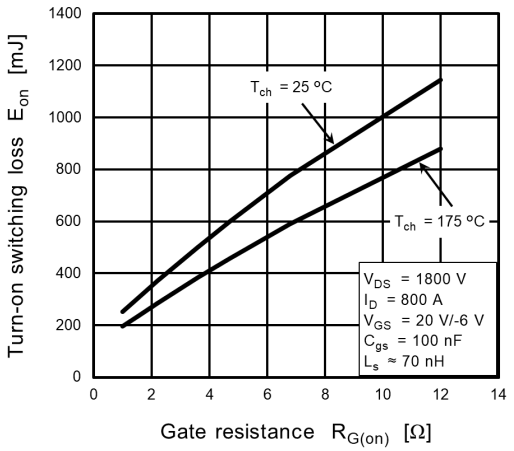


Fig. 8.10 E_{on} -$R_{G(on)}$

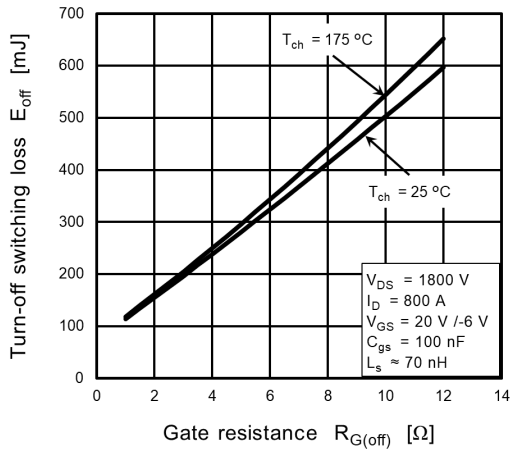


Fig. 8.11 E_{off} - $R_{G(off)}$

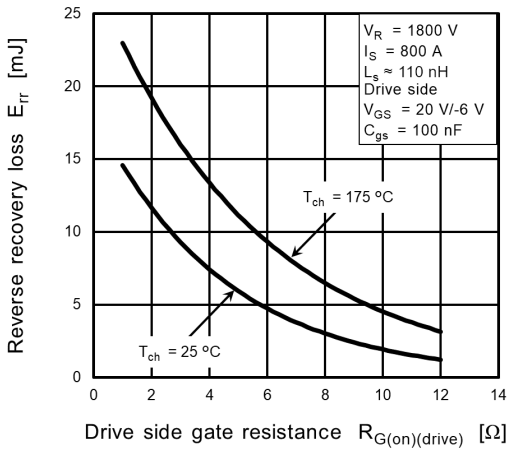


Fig. 8.12 E_{rr} -$R_{G(on)}$

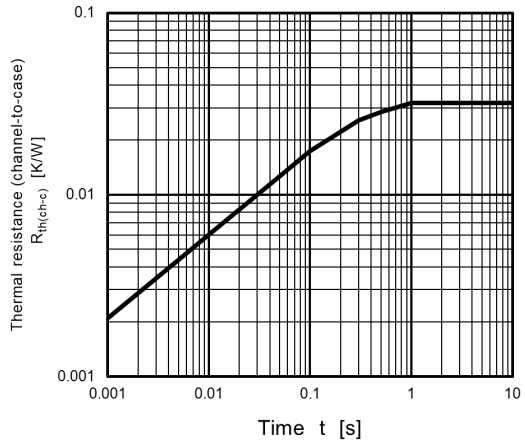


Fig. 8.13 $R_{th(ch-c)}$ - t (Guarnteed Maximum)

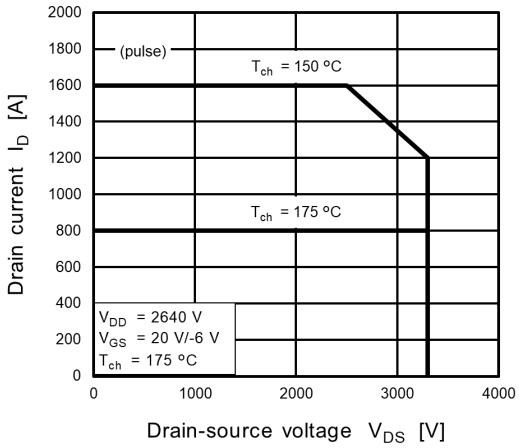


Fig. 8.14 Reverse bias safe operating area (RBSOA)(Guaranteed Maximum)

Note: The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

Note 1: Source - drain voltage and Drain - source voltage are measured at sense terminals.

9. SBD Characteristics Curves (note)

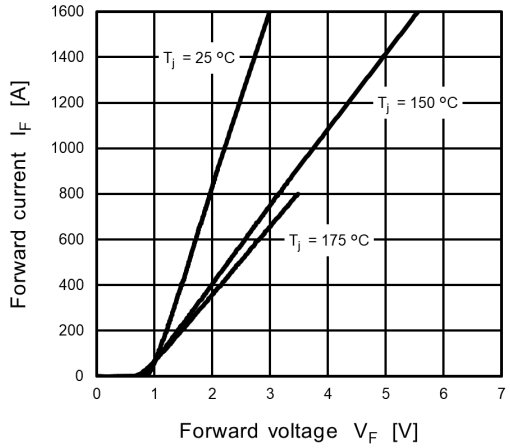


Fig. 9.1 I_F - V_F (Note 1)

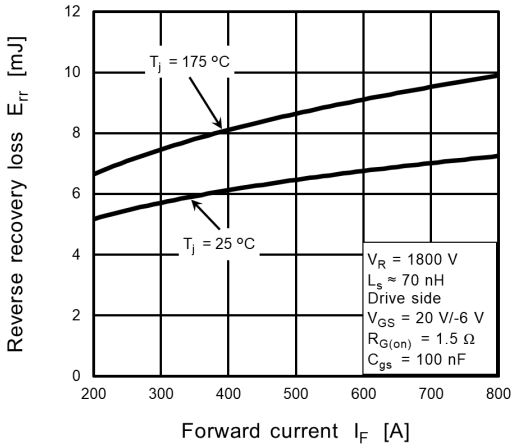


Fig. 9.2 E_{rr} - I_F

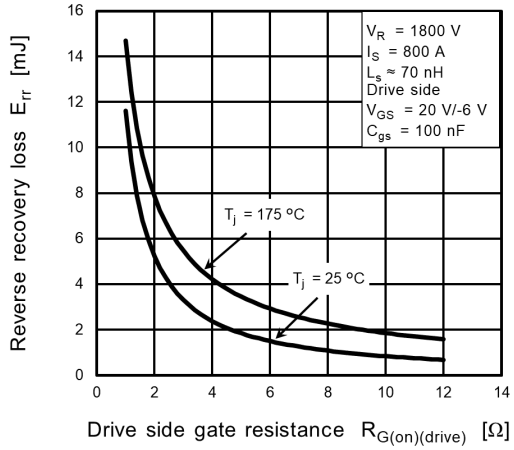


Fig. 9.3 E_{rr} - $R_{G(on)}$

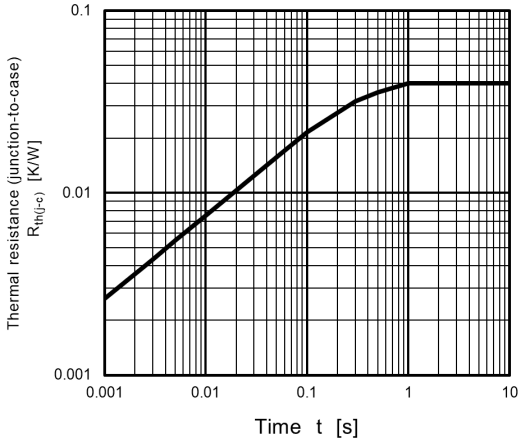


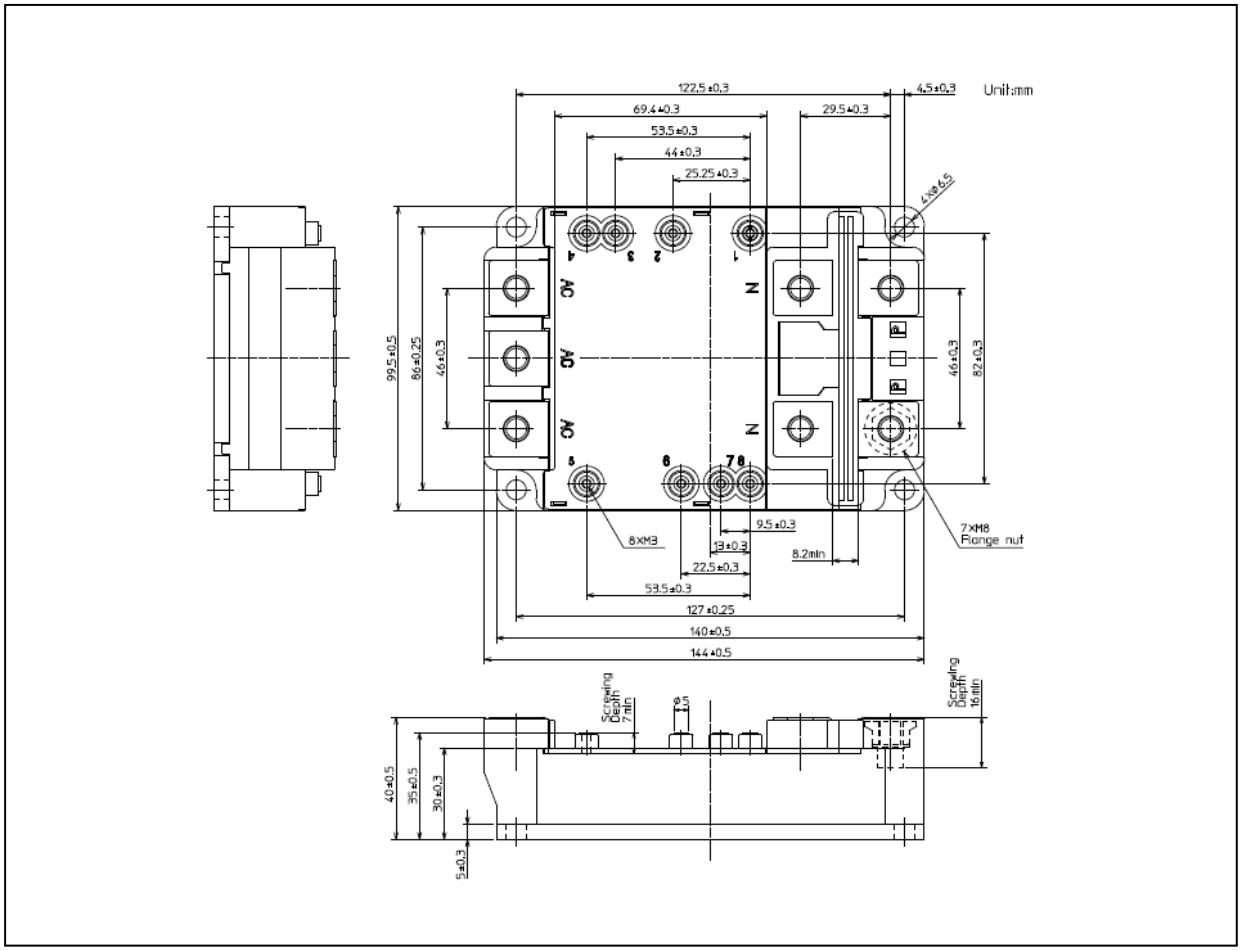
Fig. 9.4 $R_{th(j-c)}$ - t (Guaranteed Maximum)

note: The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

Note 1: Forward voltage is measured at sense terminals.

Package Dimensions

Unit: mm



Weight: 840 g (typ.)

Package Name(s)
TOSHIBA: 2-144A1A
Nickname: iXPLV

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