High-Power Module Silicon Carbide N-Channel MOSFET

MG250YD2YMS3

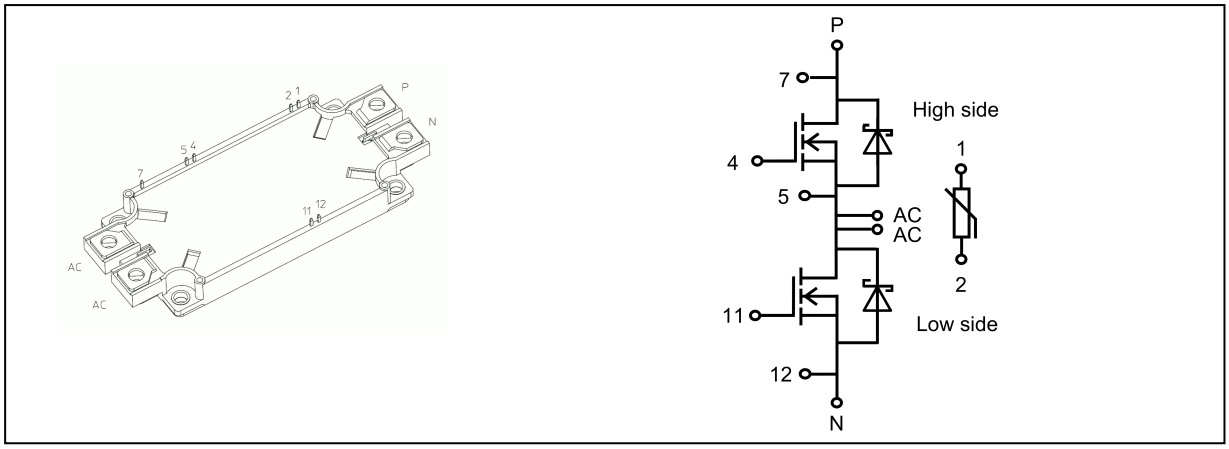
1. Applications

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

2. Features

(1) V_{DSS} = 2200 V, I_D = 250 A All SiC MOSFET Module(Low loss & High speed switching)
(2) Low stray inductance, low thermal resistance, maximum T_{ch}= 150 ℃, built in thermistor.
(3) Enhancement mode.
(4) Electrodes are isolated from metal base plate.
(5) UL-recognized: UL 1557, File No.E552353

3. Packaging and Internal Circuit (Note)



Note: P and N terminal should use one screw to fasten in each and AC terminal should use two screw to fasten.
When the thermistor is not used, pin 1 and 2 should be electrically connected to pin 12.

Start of commercial production
2023-07

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4. Terminal

Symbol & No.	Terminal name
P	P(main terminal)
N	N(main terminal)
AC	AC(main terminals)
1	Thermistor
2	Thermistor
4	High side gate
5	High side source sense / Low side drain sense
7	High side drain sense
11	Low side gate
12	Low side source sense

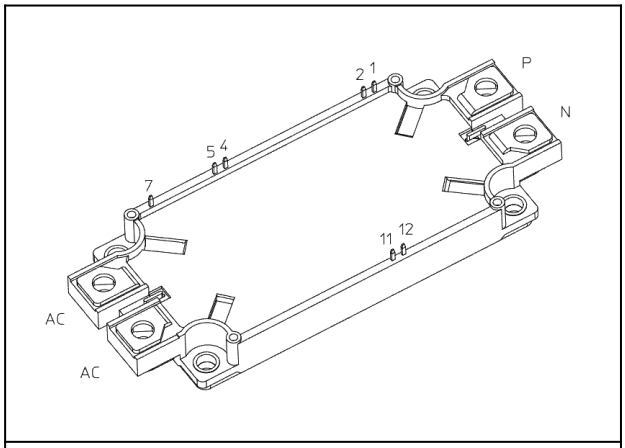


Fig. 4.1 Terminal image

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5. Absolute Maximum Ratings (Note)(T_C = 25 °C unless otherwise specified)

Characteristics	Symbol	Note	Test Condition	Rating	Unit
Drain-source voltage	V_{DSS}			2200	V
Gate-source voltage	V_{GSS}			+ 25 / - 10	V
Drain current (DC)	I_D	(Note 1)		250	A
Drain current (pulsed)	I_{DP}	(Note 1)	1 ms	500	A
Drain power dissipation	P_D	(Note 1)		2000	W
Source current (DC)	I_S	(Note 1)		250	A
Source current (pulsed)	I_{SP}	(Note 1)	1 ms	500	A
Channel temperature	T_{ch}			150	°C
Storage temperature	T_{stg}			-40 to 150	°C
Isolation voltage	V_{isol}		AC , 60 s	4000	Vrms
Isolation voltage (thermistor terminal-other terminals)	V_{isol}(therm)		AC , 60 s	4000	Vrms
Mounting torque	TOR	(Note 2)	Main terminal: M6	4.5	N · m
		(Note 3)	Mounting: M5	3.5	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: Refer to the application notes.

Note 1: Ensure that the channel temperature does not exceed 150 °C.

Note 2: The recommended tightening torque for the main terminal (M6) is 4.0 N · m.

Note 3: The recommended tightening torque for mounting (M5) is 3.0 N · m.

6. Thermal-resistance

Characteristics	Symbol	Note	Min	Typ.	Max	Unit
Thermal resistance (channel-to-case)	$R_{th(ch-c)}$	(Note 1)	—	—	0.060	K/W
Thermal resistance (case-to-fin)	$R_{th(c-f)}$	(Note 2)	—	0.013	—	K/W

Note 1: The value per half a module.

Note 2: 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.

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7. 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} = 2200 V, V_{GS} = 0 V	—	—	250	μA	—
Gate threshold voltage	V_{th}	(Note 4)	I_D = 250 mA, V_{DS} = 10 V	3.5	4.5	5.5	V	—
Drain-source on-voltage (sense)	$V_{DS(on)}$ sense	(Note 3)	I_D = 250 A, V_{GS} = + 20 V, T_{ch} = 25 °C	—	0.7	—	V	—
			I_D = 250 A, V_{GS} = + 20 V, T_{ch} = 150 °C	—	1.5	2.1	V	—
Drain-source on-voltage (terminal)	$V_{DS(on)}$ terminal	(Note 2)	I_D = 250 A, V_{GS} = + 20 V, T_{ch} = 25 °C	—	0.9	—	V	—
Input capacitance	C_{iss}		V_{DS} = 1100 V, V_{GS} = 0 V, f = 10 kHz	—	55	—	nF	—
Internal gate resistance	r_{ig}		V_{DS} = 10 V, V_{GS} = 0 V, f = 1 MHz	—	2.7	—	Ω	—
Switching time (turn-on delay time)	$t_{d(on)}$	(Note 1)	Inductive load, V_{DD} = 1100 V, I_D = 250 A, V_{GS} = + 20 V / - 6 V, $R_{G(on)}$ = 0.5 Ω, $R_{G(off)}$ = 3.0 Ω, T_{ch} = 150 °C, L_S ≈ 45 nH	—	0.16	—	μs	7.1 7.2 7.3
Switching time (rise time)	t_r	(Note 1)	Inductive load, V_{DD} = 1100 V, I_D = 250 A, V_{GS} = + 20 V / - 6 V, $R_{G(on)}$ = 0.5 Ω, $R_{G(off)}$ = 3.0 Ω, T_{ch} = 150 °C, L_S ≈ 45 nH	—	0.04	—	μs	7.1 7.2 7.3
Switching time (turn-on time)	t_{on}			—	0.20	—	μs	
Switching time (turn-off delay time)	$t_{d(off)}$			—	0.40	—	μs	
Switching time (fall time)	t_f			—	0.08	—	μs	
Switching time (turn-off time)	t_{off}			—	0.48	—	μs	
Turn-on switching loss	E_{on}			—	14	26	mJ	
Turn-off switching loss	E_{off}			—	11	22	mJ	
Source-drain on-voltage (sense)	$V_{SD(on)}$ sense	(Note 3)	I_S = 250 A, V_{GS} = + 20 V, T_{ch} = 25 °C	—	0.7	—	V	—
			I_S = 250 A, V_{GS} = + 20 V, T_{ch} = 150 °C	—	1.5	2.1	V	—
Source-drain on-voltage (terminal)	$V_{SD(on)}$ terminal	(Note 2)	I_S = 250 A, V_{GS} = + 20 V, T_{ch} = 25 °C	—	0.9	—	V	—
Source-drain off-voltage (sense)	$V_{SD(off)}$ sense	(Note 3)	I_S = 250 A, V_{GS} = - 6 V, T_{ch} = 25 °C	—	1.6	—	V	—
			I_S = 250 A, V_{GS} = - 6 V, T_{ch} = 150 °C	—	2.4	3.2	V	—
Source-drain off-voltage (terminal)	$V_{SD(off)}$ terminal	(Note 2)	I_S = 250 A, V_{GS} = - 6 V, T_{ch} = 25 °C	—	1.8	—	V	—
Reverse recovery time	t_{rr}	(Note 1)	Inductive load, V_{DD} = 1100 V, I_S = 250 A, V_{GS} = - 6 V, Drive side $R_{G(on)}$ = 0.5 Ω, T_{ch} = 150 °C, L_S ≈ 45 nH	—	40	—	ns	7.4 7.5 7.6
Reverse recovery loss	E_{rr}			—	1.5	—	mJ	
Stray inductance	L_{sPN}		P terminal-N terminal	—	12	—	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: L_s is a sum of the stray inductance between the P and N terminals (L_{sPN}) and the stray inductance of external circuitry (L_{ext}). (L_{ext} is shown in Fig. 7.1,7.2,7.4,7.5)

Note 2: The value shown are when two AC terminals are connected.

Note 3: The values are measured between drain sense and source sense.

Note 4: Gate-source voltage (-10V) is applied 5ms before measurement.

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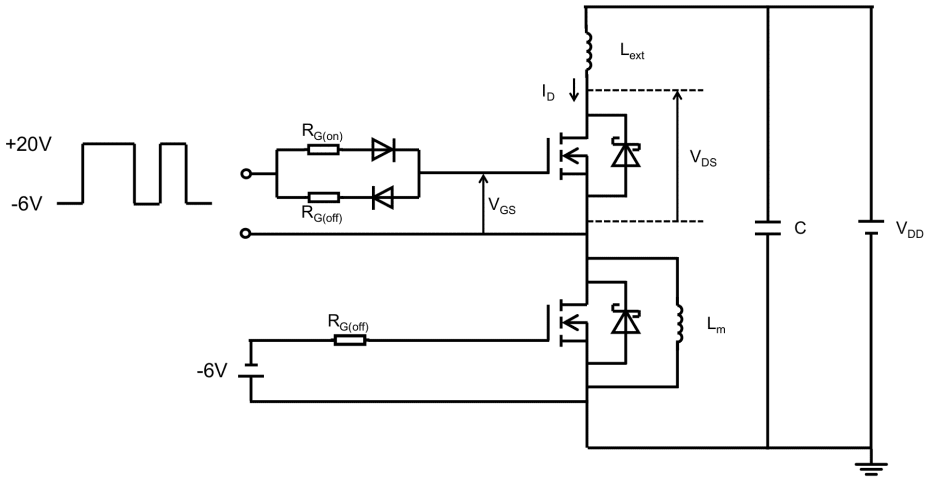


Fig. 7.1 Inductive Load Switching Test Circuit(High side Switching)

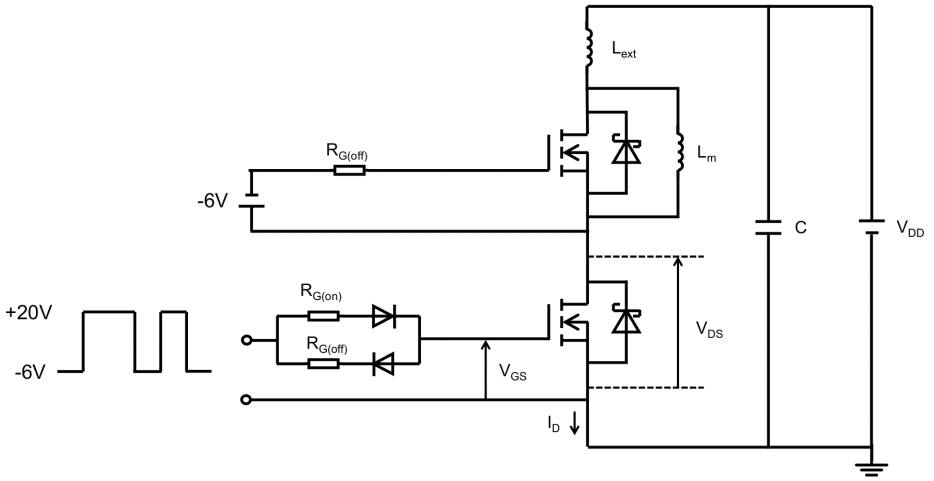


Fig. 7.2 Inductive Load Switching Test Circuit(Low side Switching)

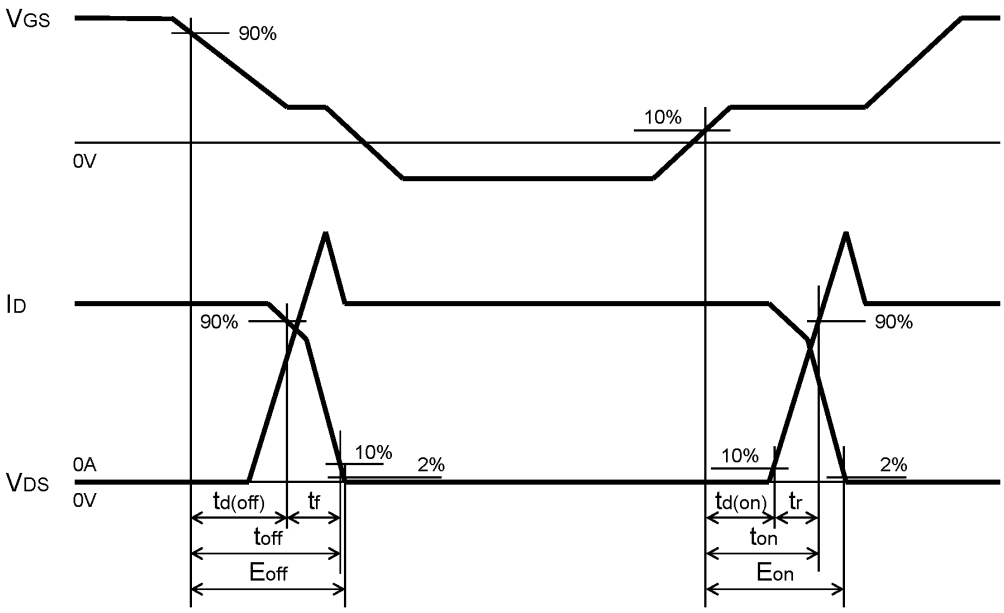


Fig. 7.3 Timing Chart(MOSFET part)

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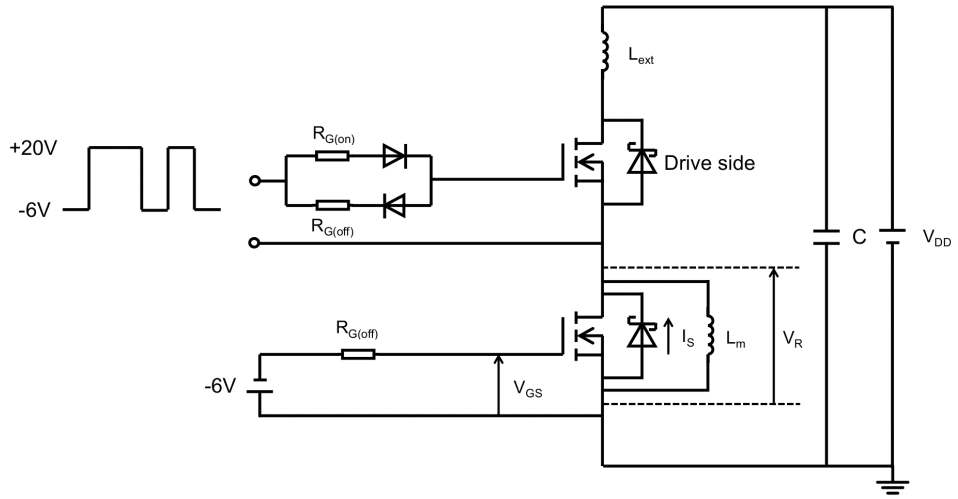


Fig. 7.4 Inductive Load Reverse Recovery Test Circuit(High side Switching)

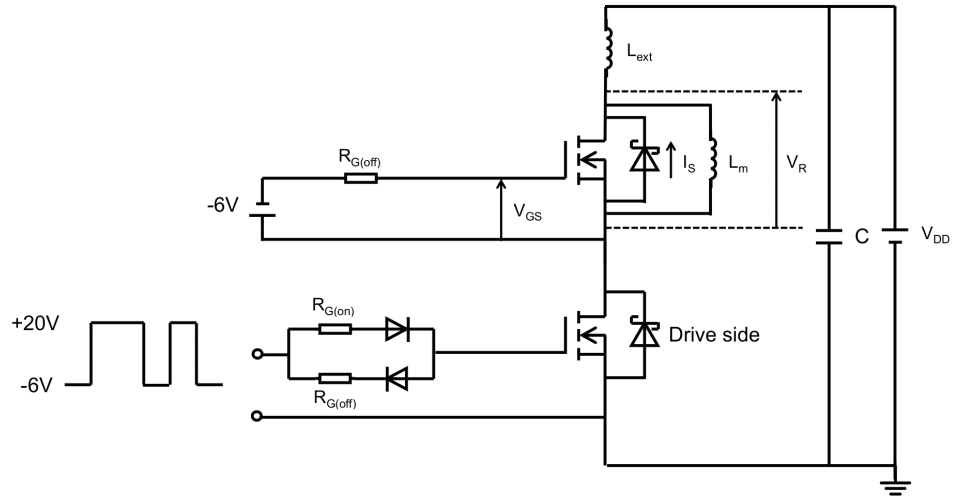


Fig. 7.5 Inductive Load Reverse Recovery Test Circuit(Low side Switching)

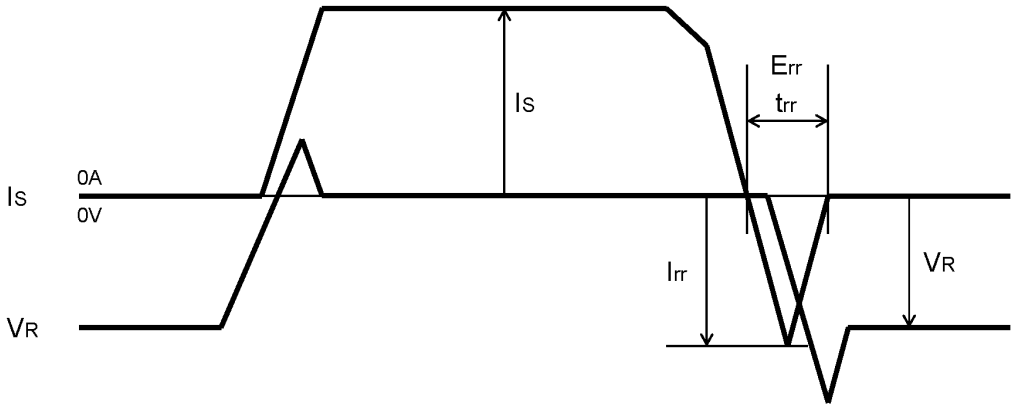


Fig. 7.6 Timing Chart(Diode part)

8. Characteristics Curves (Note)

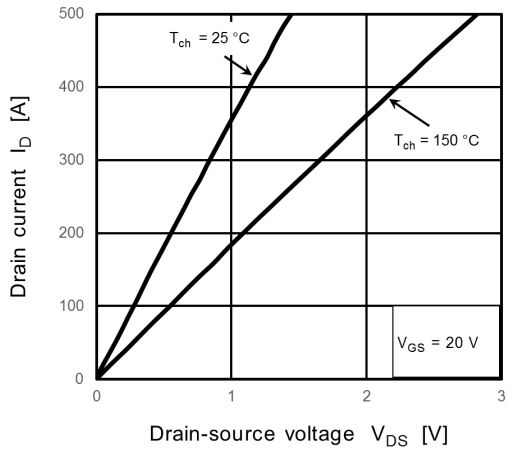


Fig. 8.1 I_D - V_{DS}(Note 1)

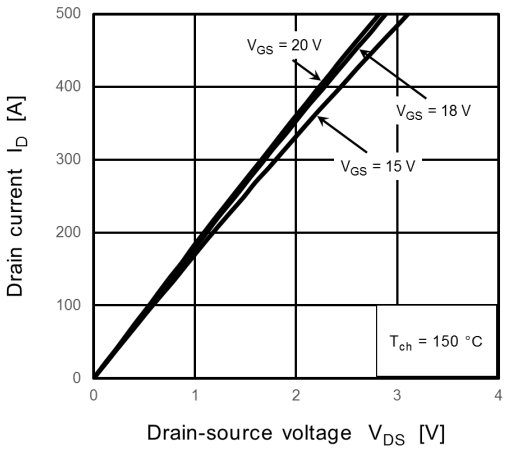


Fig. 8.2 I_D - V_{DS}(Note 1)

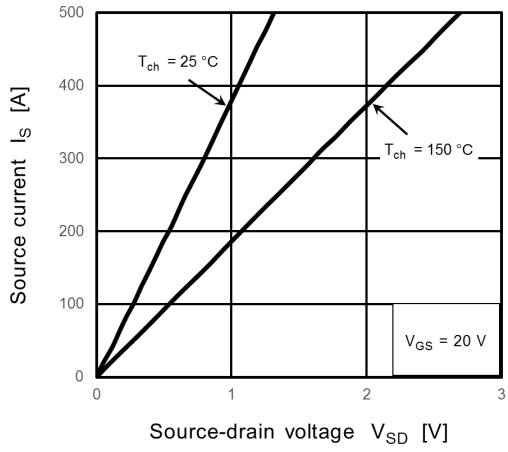


Fig. 8.3 I_S - V_{SD}(Note 1)

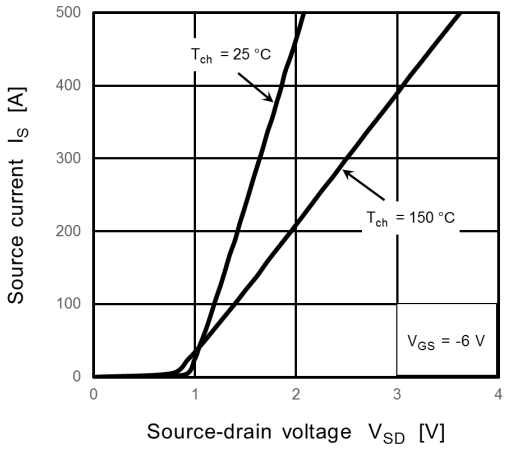


Fig. 8.4 I_S - V_{SD}(Note 1)

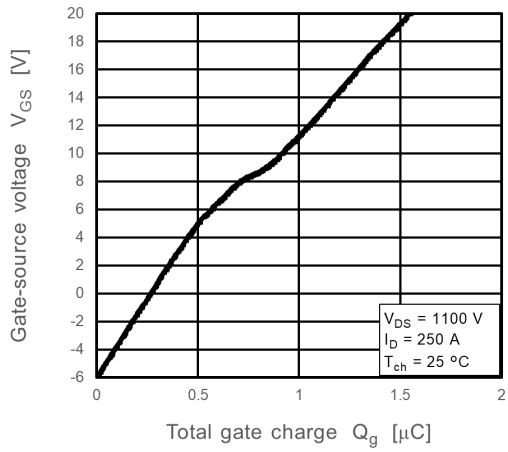


Fig. 8.5 V_{GS} -Q_g

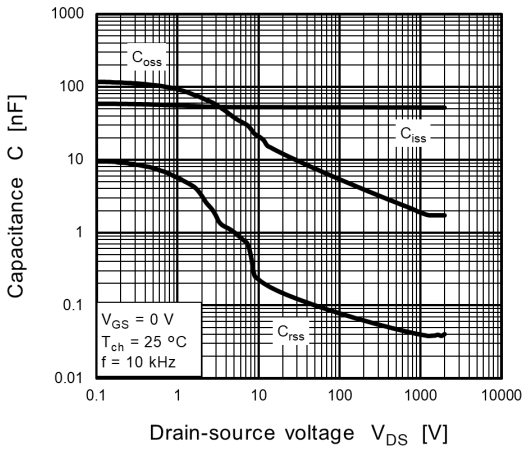


Fig. 8.6 C_{iss}, C_{oss}, C_{rss} - V_{DS}

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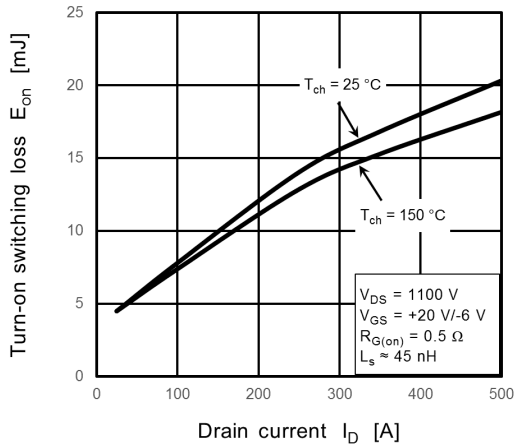


Fig. 8.7 E_{on} - I_D

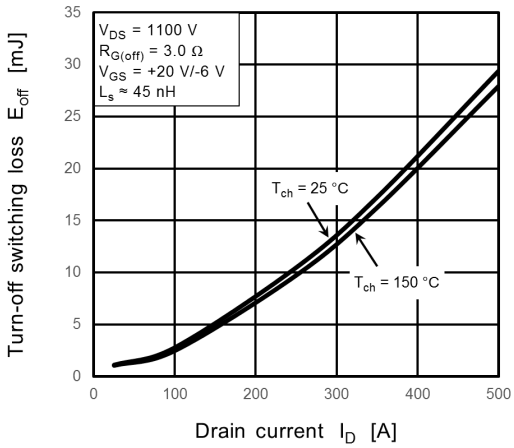


Fig. 8.8 E_{off} - I_D

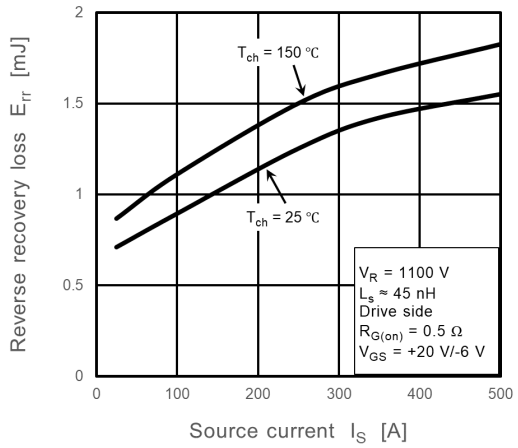


Fig. 8.9 E_{rr} - I_S

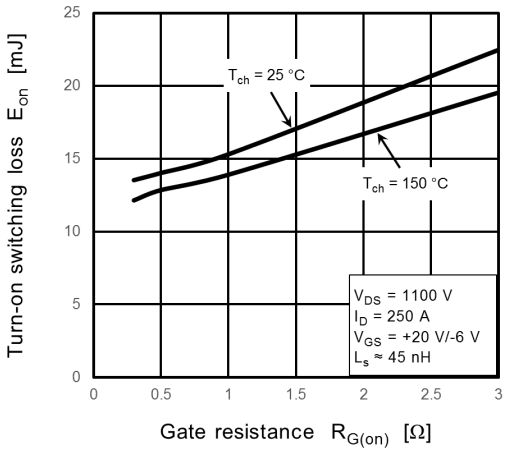


Fig. 8.10 E_{on} -$R_{G(on)}$

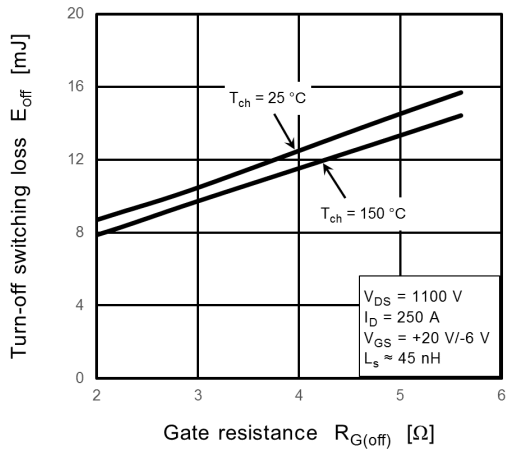


Fig. 8.11 E_{off} - $R_{G(off)}$

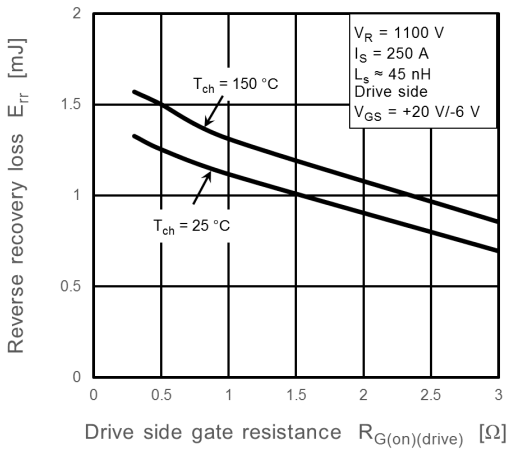


Fig. 8.12 E_{rr} -$R_{G(on)}$

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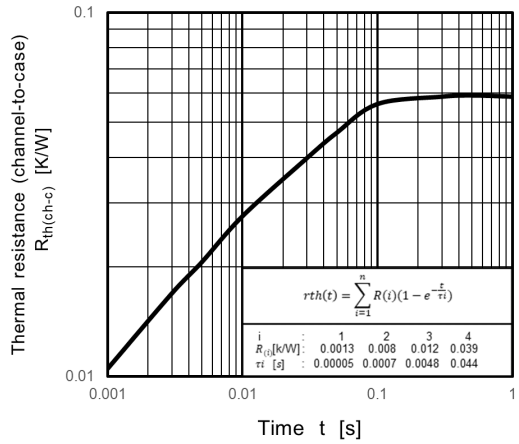


Fig. 8.13 $R_{th(ch-c)}$ - t
(Guaranteed Maximum)

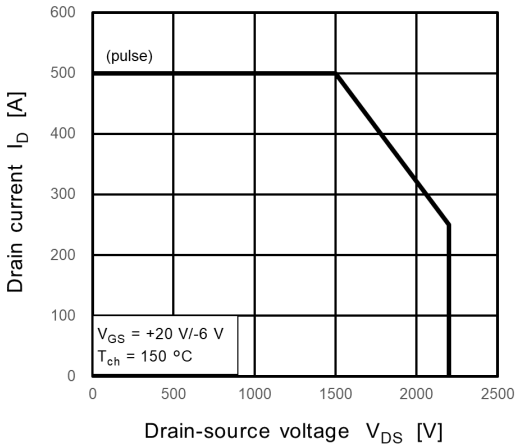


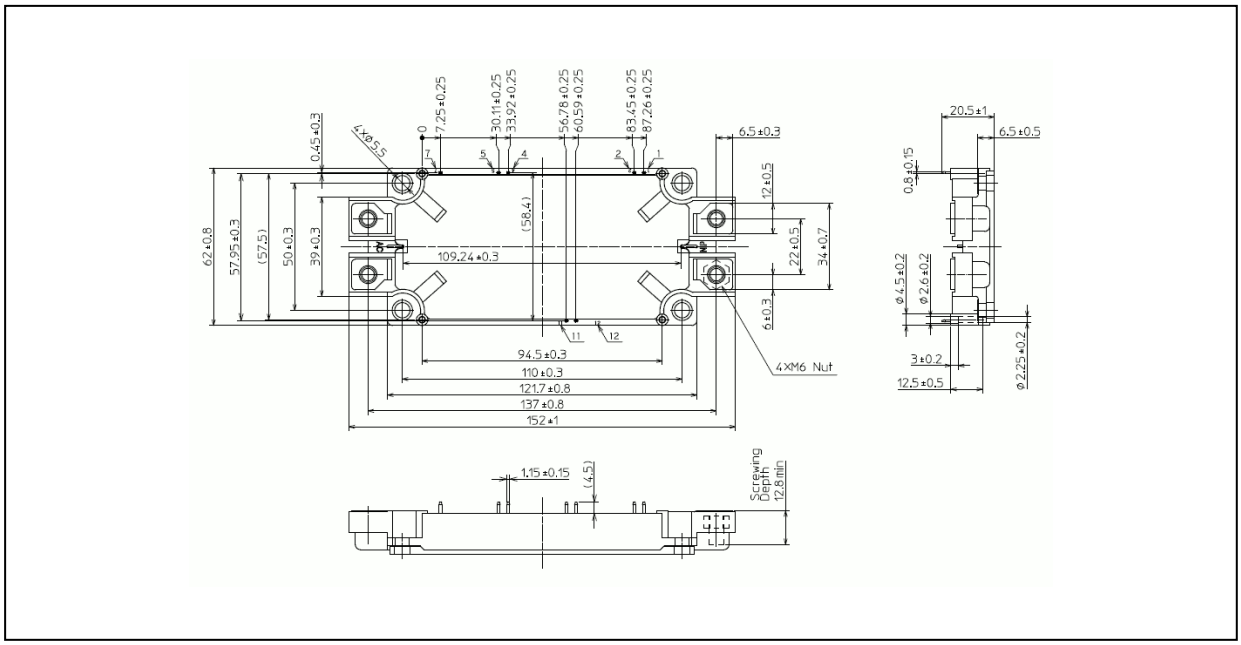
Fig. 8.14 Reverse bias safe operating area
(RBSOA)
(Guaranteed Maximum)

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.

Package Dimensions

Unit: mm



Weight: 350 g (typ.)

Package Name(s)
TOSHIBA: 2-153A1A

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