High-Power Module Silicon Carbide N-Channel MOSFET

MG400V2YMS3

1. Applications

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

2. Features

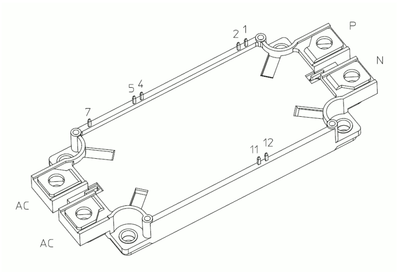
(1) V_{DSS} = 1700 V, I_D = 400 A All SiC MOSFET Module(Low loss & High speed switching)

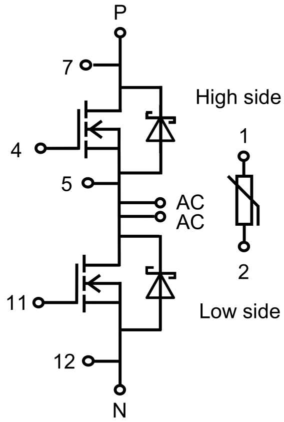
(2) Low stray inductance, low thermal resistance, maximum T_{ch}= 150 ℃, built in thermistor.

(3) Enhancement mode.

(4) Electrodes are isolated from metal base plate.

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 screws to fasten. When the thermistor is not used, pin 1 and pin 2 should be electrically connected to pin 12.

Start of commercial production

2021-11

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

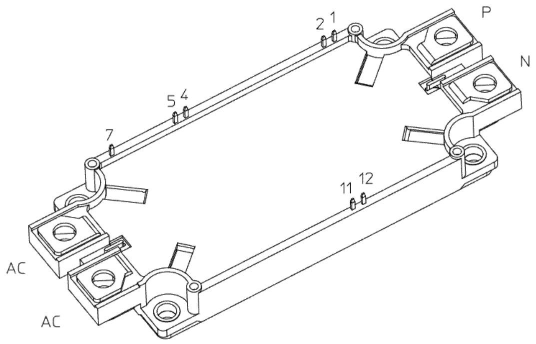


Fig. 4.1 Terminal image

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

Characteristics	Symbol	Note	Test Condition	Rating	Unit
Drain-source voltage	V_{DSS}			1700	V
Gate-source voltage	V_{GSS}			+ 25 / - 10	V
Drain current (DC)	I_D	(Note 1)		400	A
Drain current (pulsed)	I_{DP}	(Note 1)	1 ms	800	A
Drain power dissipation	P_D	(Note 1)		2000	W
Source current (DC)	I_S	(Note 1)		400	A
Source current (pulsed)	I_{SP}	(Note 1)	1 ms	800	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)	$R_{th(ch\text{-}c)}$	(Note 1)	—	—	0.060	K/W
Thermal resistance (case-to-fin)	$R_{th(c\text{-}f)}$	(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.

7. Electrical Characteristics (Tc = 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	—	—	±30	nA	—
Drain-source cut-off current	I_{DSS}		V_{DS} = 1700 V, V_{GS} = 0 V	—	—	250	μA	—
Gate threshold voltage	V_{th}	(Note 4)	I_D = 400 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 = 400 A, V_{GS} = + 20 V, T_{ch} = 25 °C	—	0.8	—	V	—
			I_D = 400 A, V_{GS} = + 20 V, T_{ch} = 150 °C	—	1.6	2.4	V	—
Drain-source on-voltage (terminal)	$V_{DS(on)}$ terminal	(Note 2)	I_D = 400 A, V_{GS} = + 20 V, T_{ch} = 25 °C	—	1.1	—	V	—
Input capacitance	C_{iss}		V_{DS} = 900 V, V_{GS} = 0 V, f = 10 kHz	—	53	—	nF	—
Internal gate resistance	r_{ig}		V_{DS} = 10 V, V_{GS} = 0 V, f = 1 MHz	—	3.5	—	Ω	—
Switching time (turn-on delay time)	$t_{d(on)}$	(Note 1)	Inductive load, V_{DD} = 900 V, I_D = 400 A, V_{GS} = + 20 V / - 6 V, $R_{G(on)}$ = 2.4 Ω, $R_{G(off)}$ = 5.1 Ω, T_{ch} = 150 °C, $L_S \approx$ 40 nH	—	0.22	—	μs	7.1 7.2 7.3
Switching time (rise time)	t_r			—	0.07	—	μs	
Switching time (turn-on time)	t_{on}			—	0.29	—	μs	
Switching time (turn-off delay time)	$t_{d(off)}$			—	0.61	—	μs	
Switching time (fall time)	t_f			—	0.07	—	μs	
Switching time (turn-off time)	t_{off}			—	0.68	—	μs	
Turn-on switching loss	E_{on}			—	28	41	mJ	
Turn-off switching loss	E_{off}			—	27	40	mJ	
Source-drain on-voltage (sense)	$V_{SD(on)}$ sense	(Note 3)	I_S = 400 A, V_{GS} = + 20 V, T_{ch} = 25 °C	—	0.8	—	V	—
			I_S = 400 A, V_{GS} = + 20 V, T_{ch} = 150 °C	—	1.5	2.2	V	—
Source-drain on-voltage (terminal)	$V_{SD(on)}$ terminal	(Note 2)	I_S = 400 A, V_{GS} = + 20 V, T_{ch} = 25 °C	—	1.1	—	V	—
Source-drain off-voltage (sense)	$V_{SD(off)}$ sense	(Note 3)	I_S = 400 A, V_{GS} = - 6 V, T_{ch} = 25 °C	—	1.6	—	V	—
			I_S = 400 A, V_{GS} = - 6 V, T_{ch} = 150 °C	—	2.4	3.5	V	—
Source-drain off-voltage (terminal)	$V_{SD(off)}$ terminal	(Note 2)	I_S = 400 A, V_{GS} = - 6 V, T_{ch} = 25 °C	—	1.9	—	V	—
Reverse recovery time	t_{rr}	(Note 1)	Inductive load, V_{DD} = 900 V, I_S = 400 A, V_{GS} = -6 V, Drive side $R_{G(on)}$ = 2.4 Ω, T_{ch} = 150 °C, $L_S \approx$ 40 nH	—	50	—	ns	7.4 7.5 7.6
Reverse recovery loss	E_{rr}			—	0.7	—	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	—
			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.

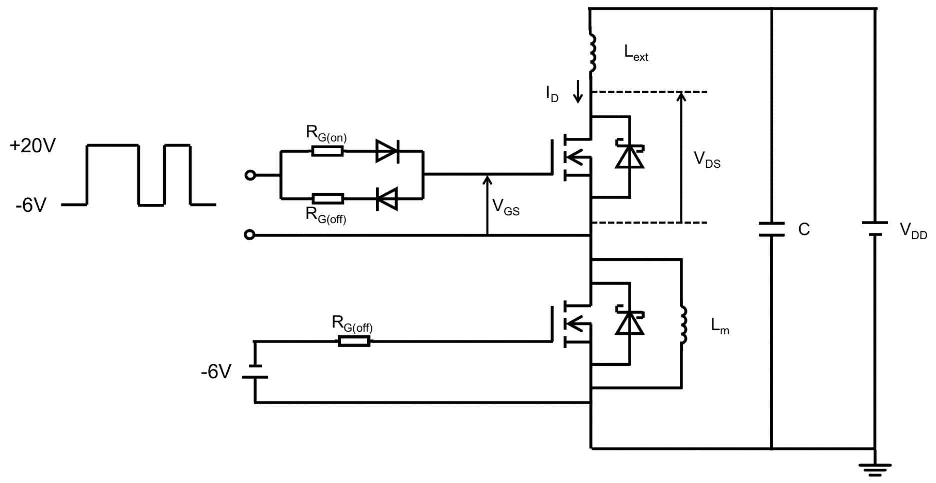


Fig. 7.1 Inductive Load Switching Test Circuit (High side Switching)

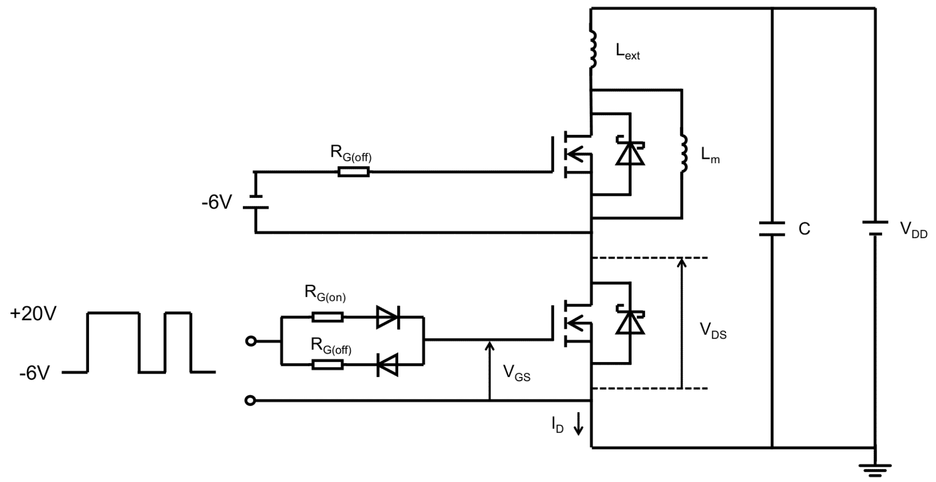


Fig. 7.2 Inductive Load Switching Test Circuit (Low side Switching)

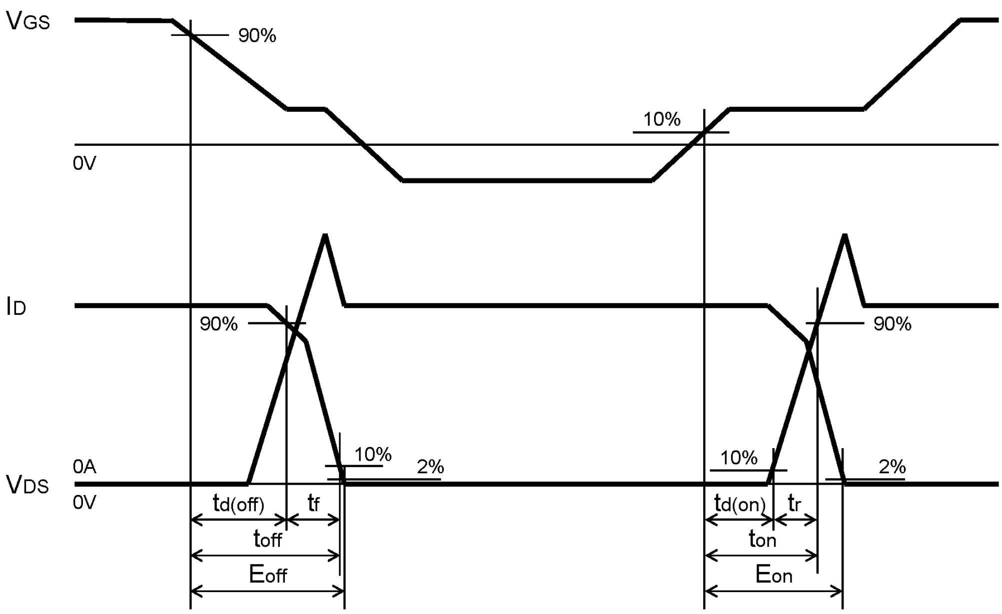


Fig. 7.3 Timing Chart (MOSFET part)

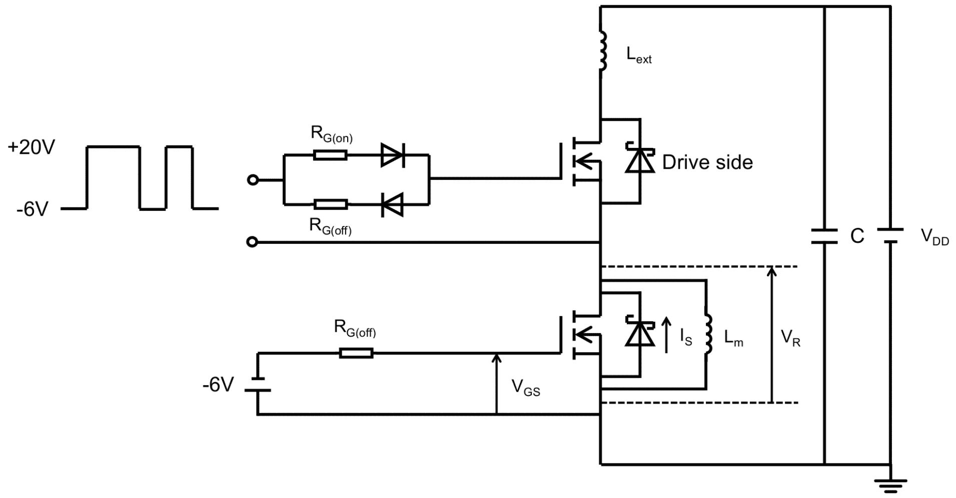


Fig. 7.4 Inductive Load Reverse Recovery Test Circuit (High side Switching)

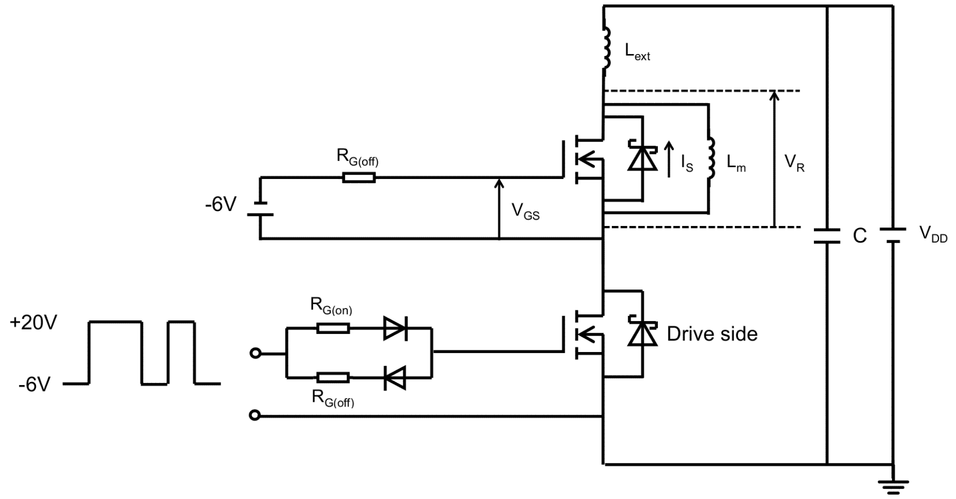


Fig. 7.5 Inductive Load Reverse Recovery Test Circuit (Low side Switching)

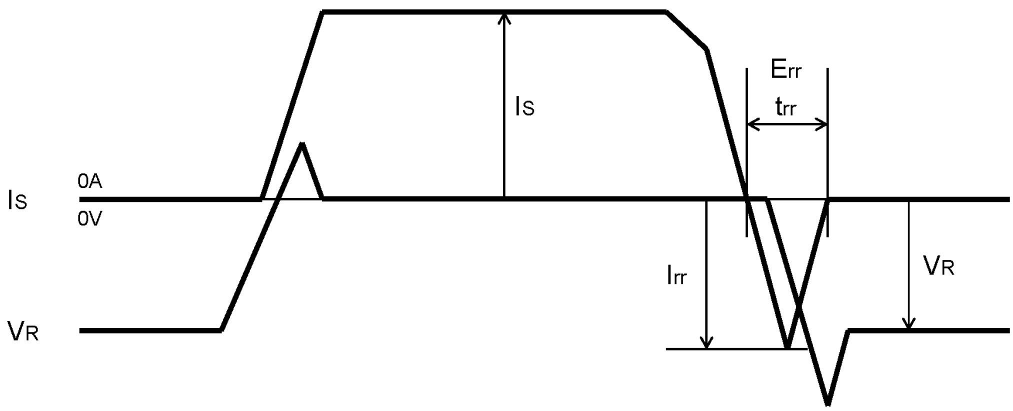


Fig. 7.6 Timing Chart (Diode part)

8. Characteristics Curves (Note)

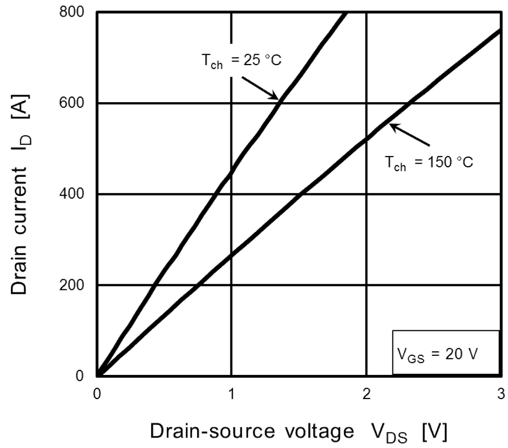


Fig. 8.1 I_D - V_{DS}(Note 1)

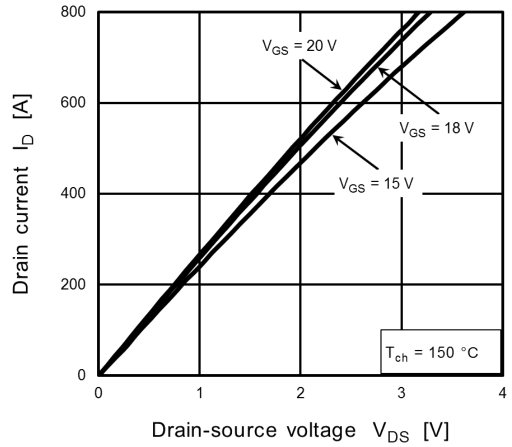


Fig. 8.2 I_D - V_{DS}(Note 1)

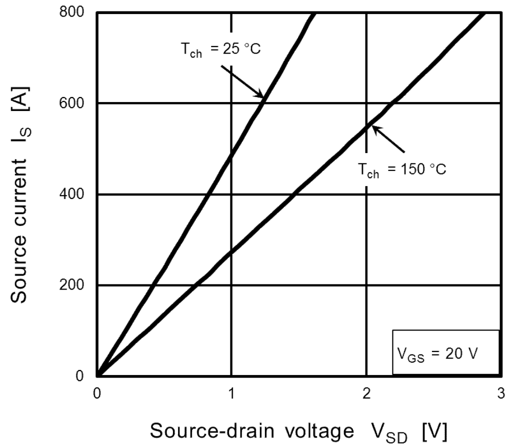


Fig. 8.3 I_S - V_{SD}(Note 1)

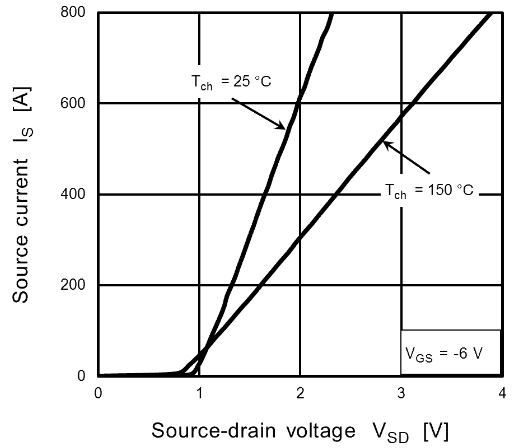


Fig. 8.4 I_S - V_{SD}(Note 1)

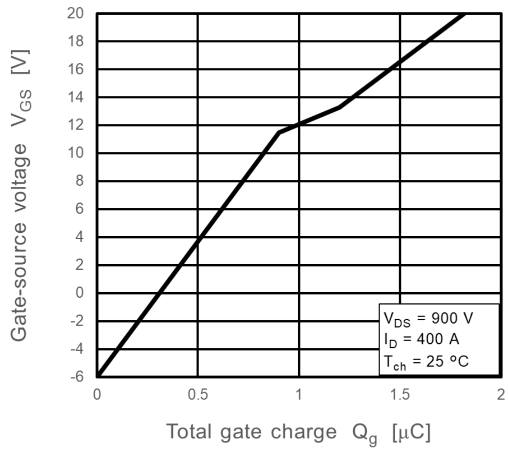


Fig. 8.5 V_{GS} -Q_g

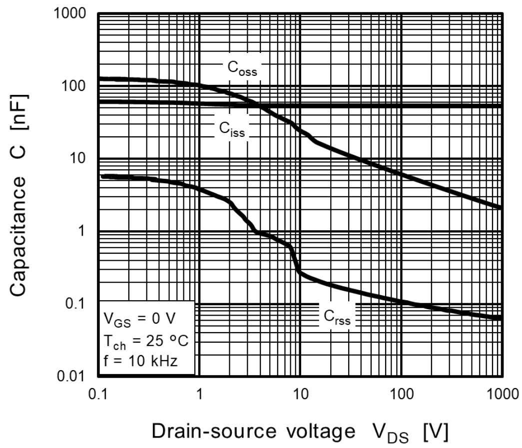


Fig. 8.6 C_{iss}, C_{oss}, C_{rss} - V_{DS}

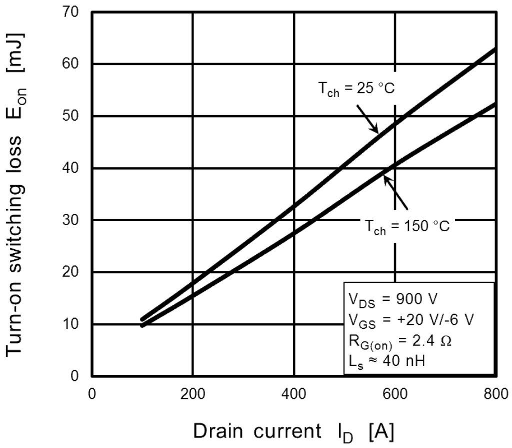


Fig. 8.7 E_{on} - I_D

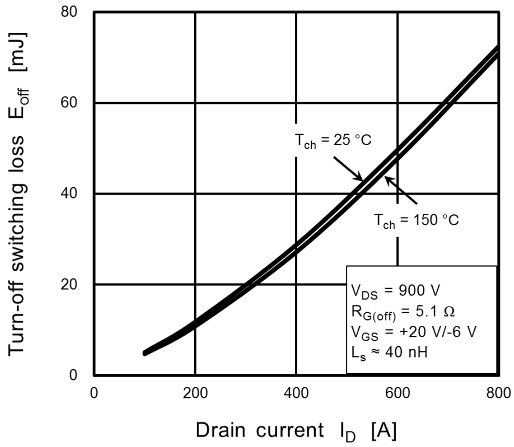


Fig. 8.8 E_{off} - I_D

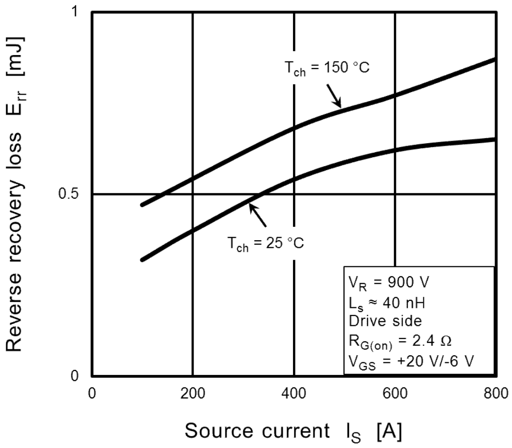


Fig. 8.9 E_{rr} - I_S

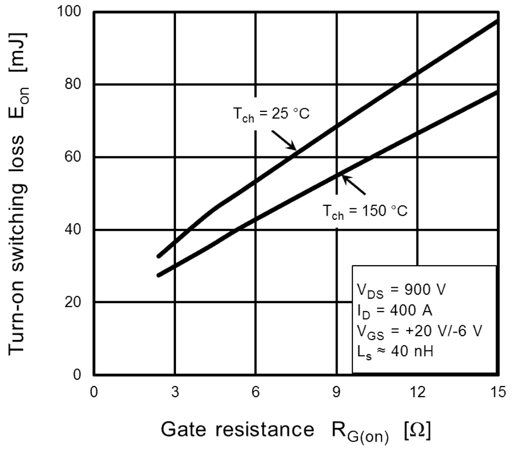


Fig. 8.10 E_{on} -$R_{G(on)}$

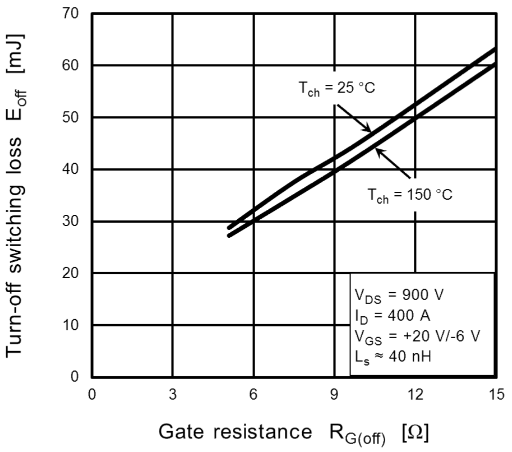


Fig. 8.11 E_{off} - $R_{G(off)}$

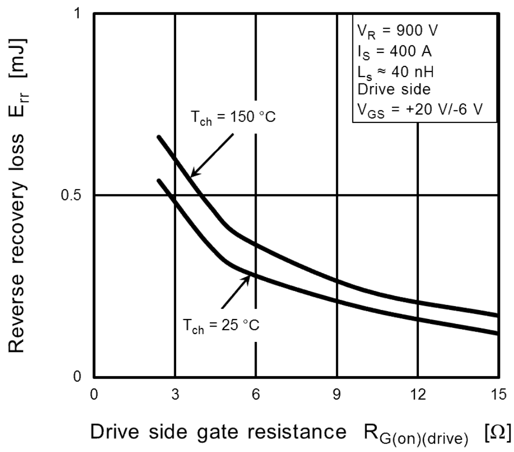


Fig. 8.12 E_{rr} -$R_{G(on)}$

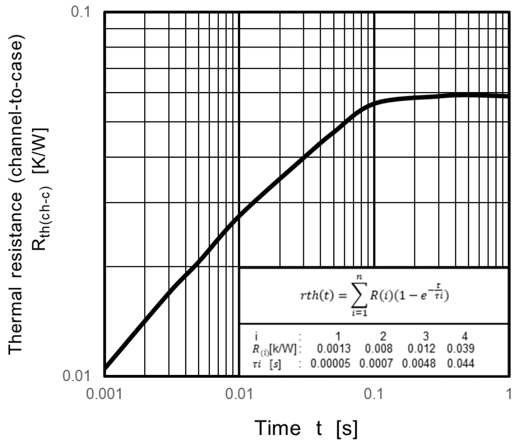


Fig. 8.13 $R_{th(ch-c)}$ - t
(Guaranteed Maximum)

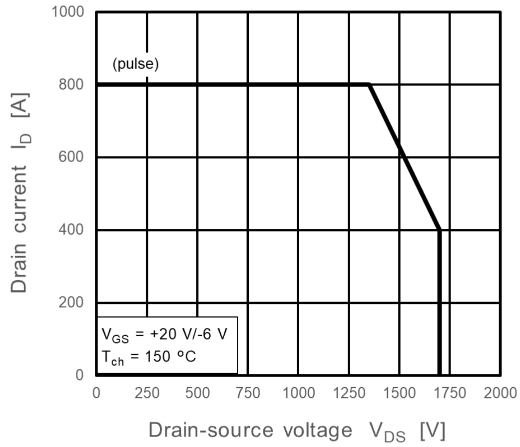


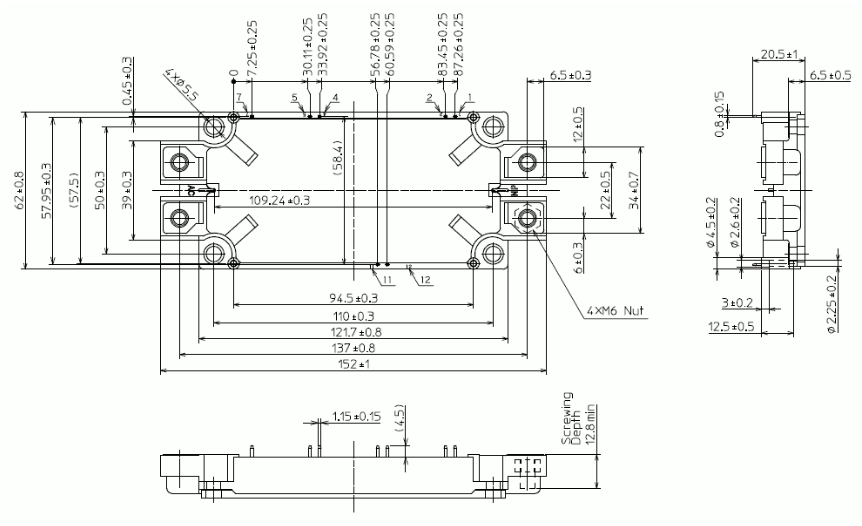
Fig. 8.14 Reverse bias safe operating area
(RBSOA)
(Guaranteed Maximum)

Note: The above characteristics curves are presented for reference only and not guaranteed by production tests, 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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