

MOSFETs Silicon Carbide N-Channel MOS

TW048N65C

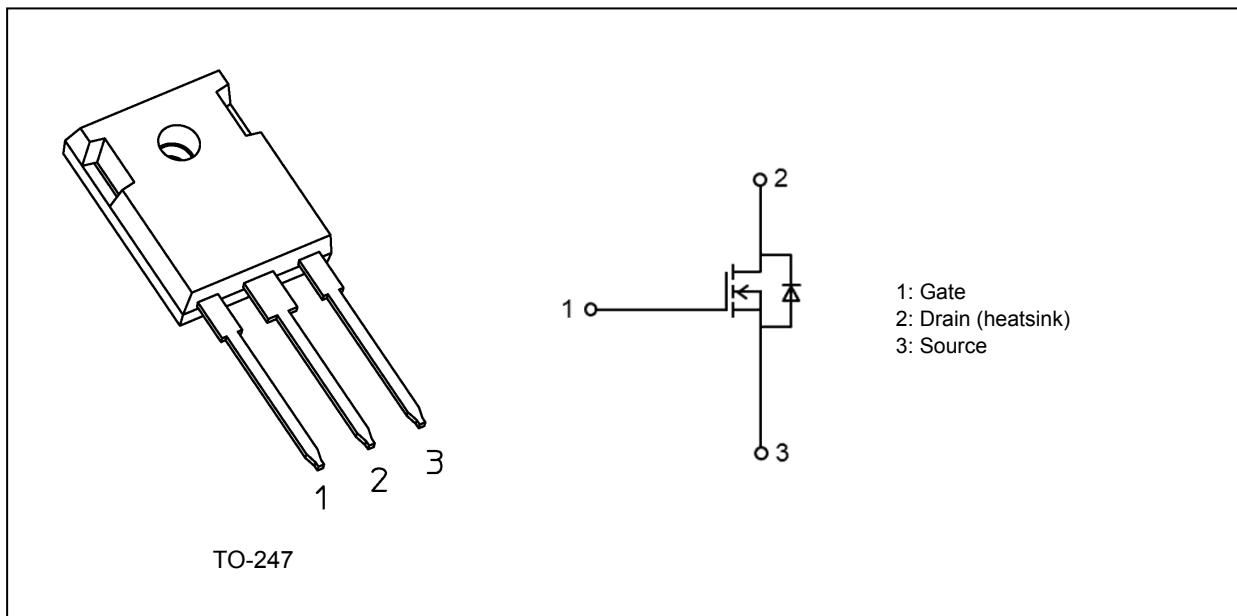
1. Applications

- Switching Voltage Regulators

2. Features

- (1) Chip design of 3rd generation (Built-in SiC schottky barrier diode)
- (2) Low diode forward voltage: $V_{DSF} = -1.35 \text{ V}$ (typ.)
- (3) High voltage: $V_{DSS} = 650 \text{ V}$
- (4) Low drain-source on-resistance: $R_{DS(ON)} = 48 \text{ m}\Omega$ (typ.)
- (5) Less susceptible to malfunction due to high threshold voltage: $V_{th} = 3.0 \text{ to } 5.0 \text{ V}$ ($V_{DS} = 10 \text{ V}$, $I_D = 1.6 \text{ mA}$)
- (6) Recommended gate - source drive voltage: $V_{GS_{on}} = 18 \text{ V}$, $V_{GS_{off}} = 0 \text{ V}$
- (7) Enhancement mode.

3. Packaging and Internal Circuit



Start of commercial production
2022-07

4. Absolute Maximum Ratings (Note) ($T_a = 25\text{ }^\circ\text{C}$ unless otherwise specified)

Characteristics	Symbol	Rating	Unit
Drain-source voltage	V_{DSS}	650	V
Gate-source voltage	V_{GSS}	+25/-10	
Drain current (DC) ($T_c = 25\text{ }^\circ\text{C}$)	I_D	40	A
Drain current (DC) ($T_c = 100\text{ }^\circ\text{C}$)	I_D	28	
Drain current (pulsed) ($T_c = 25\text{ }^\circ\text{C}$)	I_{DP}	103	
Drain current (pulsed) ($T_c = 100\text{ }^\circ\text{C}$)	I_{DP}	80	
Power dissipation ($T_c = 25\text{ }^\circ\text{C}$)	P_D	132	W
Channel temperature	T_{ch}	175	$^\circ\text{C}$
Storage temperature	T_{stg}	-55 to 175	
Mounting torque	TOR	0.8	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).

5. Thermal Characteristics

Characteristics	Symbol	Max	Unit
Channel-to-case thermal resistance	$R_{th(ch-c)}$	1.133	$^\circ\text{C/W}$
Channel-to-ambient thermal resistance	$R_{th(ch-a)}$	50	

Note 1: Ensure that the channel temperature does not exceed $175\text{ }^\circ\text{C}$.

Note: This transistor is sensitive to electrostatic discharge and should be handled with care. It should be used for switching applications.

6. Electrical Characteristics

6.1. Static Characteristics ($T_a = 25\text{ }^\circ\text{C}$ unless otherwise specified)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current	I_{GSS}	$V_{GS} = +25/-10\text{ V}, V_{DS} = 0\text{ V}$	—	—	± 0.1	μA
Drain cut-off current	I_{DSS}	$V_{DS} = 650\text{ V}, V_{GS} = 0\text{ V}$	—	3	58	
		$T_a = 150\text{ }^\circ\text{C}, V_{DS} = 650\text{ V}, V_{GS} = 0\text{ V}$	—	17	—	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$I_D = 4\text{ mA}, V_{GS} = 0\text{ V}$	650	—	—	V
Gate threshold voltage (Note 2)	V_{th}	$V_{DS} = 10\text{ V}, I_D = 1.6\text{ mA}$	3.0	—	5.0	
Drain-source on-resistance	$R_{DS(ON)}$	$V_{GS} = 18\text{ V}, I_D = 20\text{ A}$	—	48	65	$\text{m}\Omega$
		$T_a = 150\text{ }^\circ\text{C}, V_{GS} = 18\text{ V}, I_D = 20\text{ A}$	—	53	—	

Note 2: Please be sure to apply I_{GSS} ($V_{GS} = 25\text{ V}$) before the V_{th} test.

6.2. Dynamic Characteristics ($T_a = 25\text{ }^\circ\text{C}$ unless otherwise specified)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Input capacitance	C_{ISS}	$V_{DS} = 400\text{ V}, V_{GS} = 0\text{ V}, f = 100\text{ kHz}$	—	1362	—	pF
Reverse transfer capacitance	C_{RSS}		—	4.4	—	
Output capacitance	C_{OSS}		—	156	—	
Effective output capacitance (energy related)	$C_{o(er)}$		—	175	—	
Effective output capacitance (time related)	$C_{o(tr)}$		—	258	—	
Output charge	Q_{OSS}		—	103	—	
C_{OSS} stored energy	E_{OSS}	—	14	—	μJ	
Gate resistance	r_g	$V_{DS} = \text{OPEN}, f = 1\text{ MHz}$	—	3.6	—	Ω
Switching time (rise time)	t_r	See Fig. 6.2.1	—	43	—	ns
Switching time (turn-on time)	t_{on}		—	69	—	
Switching time (fall time)	t_f		—	32	—	
Switching time (turn-off time)	t_{off}		—	68	—	

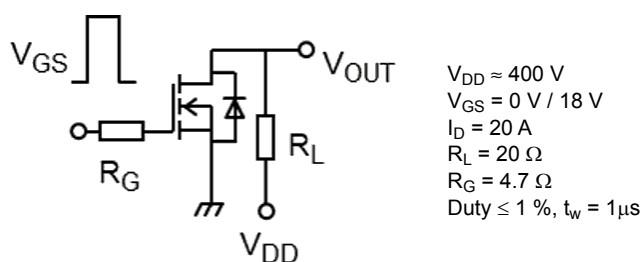


Fig. 6.2.1 Switching Time Test Circuit

6.3. Gate Charge Characteristics ($T_a = 25\text{ }^\circ\text{C}$ unless otherwise specified)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Total gate charge (gate-source plus gate-drain)	Q_g	$V_{DD} \approx 400\text{ V}, V_{GS} = 18\text{ V}, I_D = 20\text{ A}$	—	41	—	nC
Gate-source charge 1	Q_{gs1}		—	17	—	
Gate-drain charge	Q_{gd}		—	6.2	—	

6.4. Source · Drain Characteristics ($T_a = 25\text{ °C}$ unless otherwise specified)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Reverse drain current (DC) (Note 3)	I_{DR}	$T_c = 25\text{ °C}, V_{GS} = -5\text{ V}$	—	—	35	A
		$T_c = 100\text{ °C}, V_{GS} = -5\text{ V}$	—	—	23	
		$T_c = 25\text{ °C}, V_{GS} = 18\text{ V}$	—	—	40	
		$T_c = 100\text{ °C}, V_{GS} = 18\text{ V}$	—	—	28	
Reverse drain current (pulsed) (Note 3)	I_{DRP}	$T_c = 25\text{ °C}, V_{GS} = -5\text{ V}$	—	—	103	
		$T_c = 100\text{ °C}, V_{GS} = -5\text{ V}$	—	—	41	
		$T_c = 25\text{ °C}, V_{GS} = 18\text{ V}$	—	—	103	
		$T_c = 100\text{ °C}, V_{GS} = 18\text{ V}$	—	—	80	
Diode forward voltage	V_{DSF}	$I_{DR} = 12\text{ A}, V_{GS} = -5\text{ V}$	—	-1.35	-1.80	V
		$T_a = 150\text{ °C}, I_{DR} = 12\text{ A}, V_{GS} = -5\text{ V}$	—	-1.60	—	
Reverse recovery time	t_{rr}	$I_{DR} = 13\text{ A}, V_{GS} = 0\text{ V}, V_{DD} = 400\text{ V}, -dI_{DR}/dt = 1000\text{ A}/\mu\text{s}$	—	50	—	ns
Reverse recovery charge	Q_{rr}		—	250	—	nC
Peak reverse recovery current	I_{rr}		—	10	—	A

Note 3: Ensure that the channel temperature does not exceed 175 °C.

7. Marking (Note)

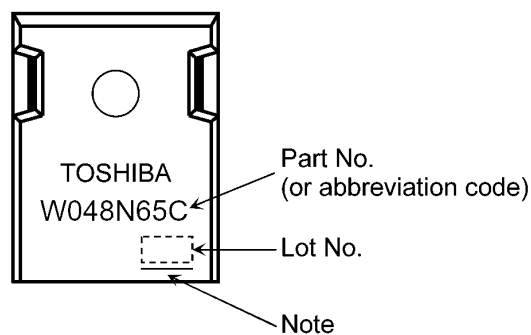


Fig. 7.1 Marking

Note: A line under a Lot No. identifies the indication of product Labels.

Not underlined: [[Pb]]/INCLUDES > MCV

Underlined: [[G]]/RoHS COMPATIBLE or [[G]]/RoHS [[Pb]]

Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product.

The RoHS is the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

8. Characteristics Curves (Note)

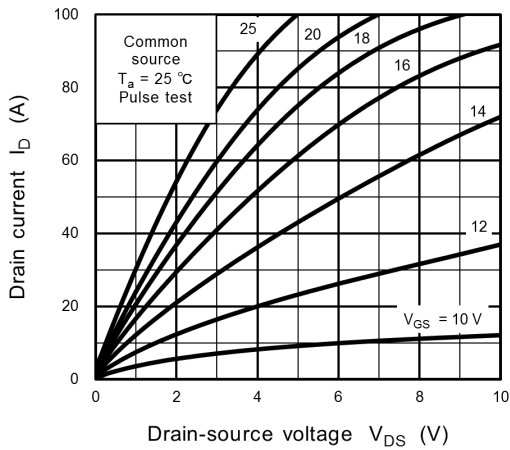


Fig. 8.1 $I_D - V_{DS}$

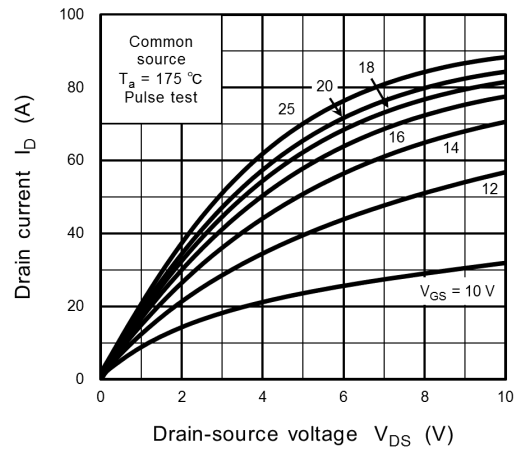


Fig. 8.2 $I_D - V_{DS}$

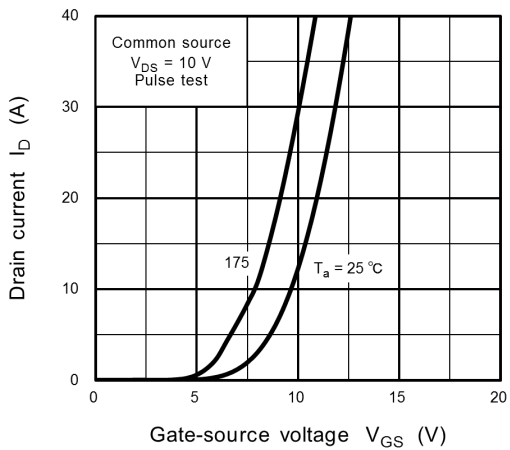


Fig. 8.3 $I_D - V_{GS}$

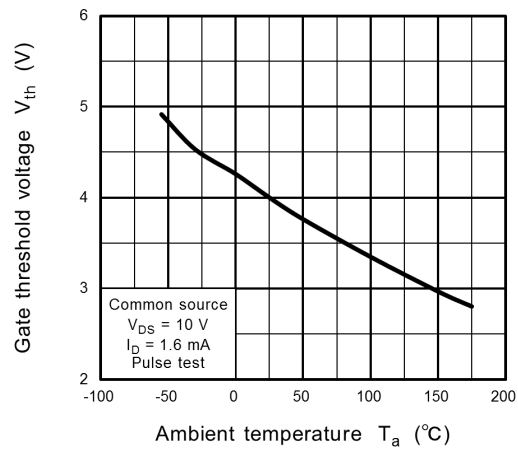


Fig. 8.4 $V_{th} - T_a$

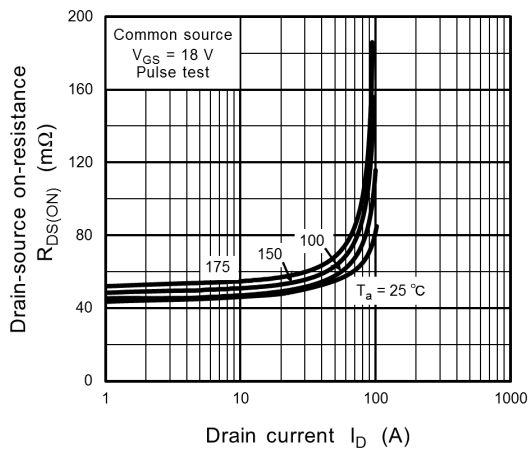


Fig. 8.5 $R_{DS(ON)} - I_D$

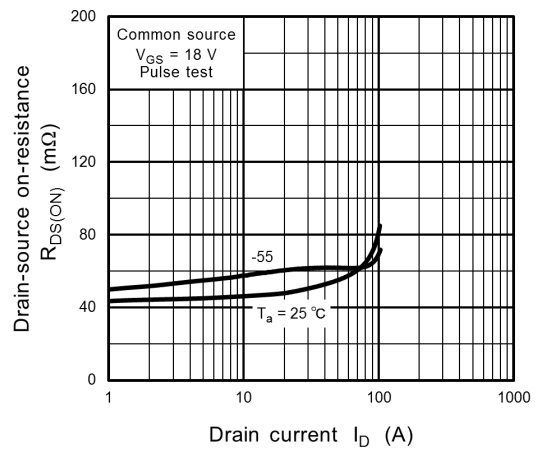


Fig. 8.6 $R_{DS(ON)} - I_D$

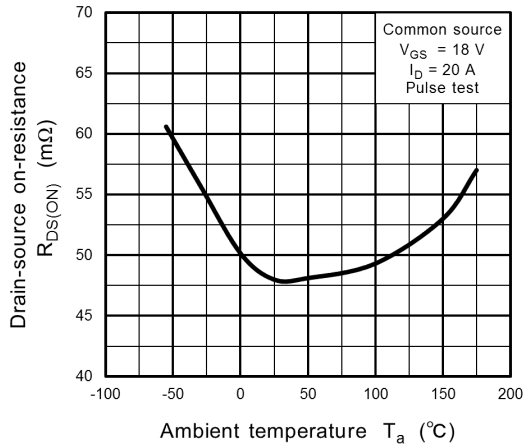


Fig. 8.7 $R_{DS(ON)} - T_a$

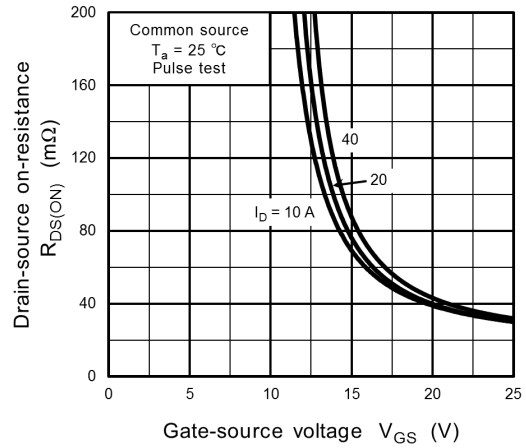


Fig. 8.8 $R_{DS(ON)} - V_{GS}$

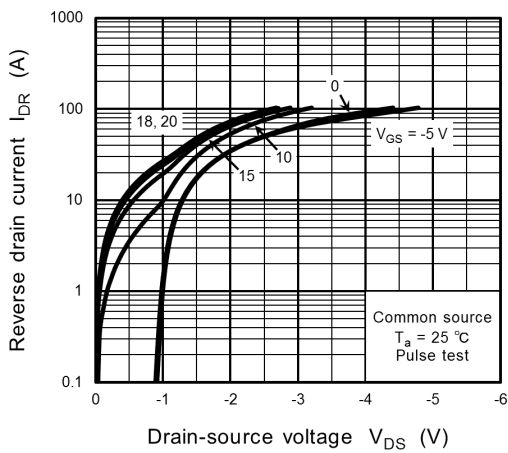


Fig. 8.9 $I_{DR} - V_{DS}$

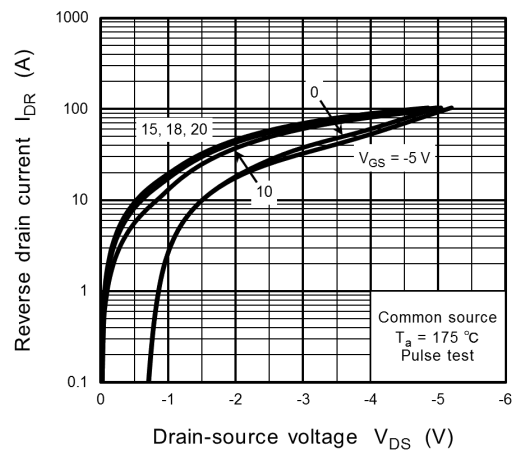


Fig. 8.10 $I_{DR} - V_{DS}$

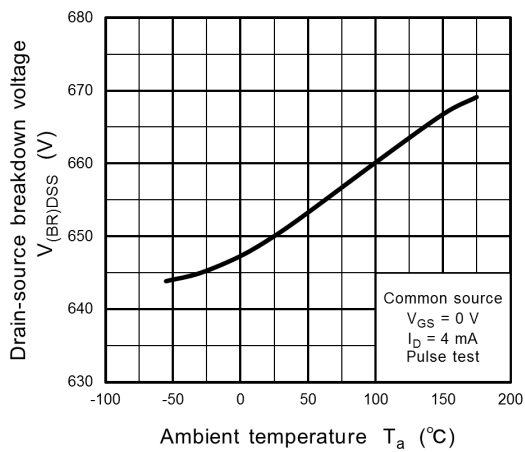


Fig. 8.11 $V_{DSS} - T_a$

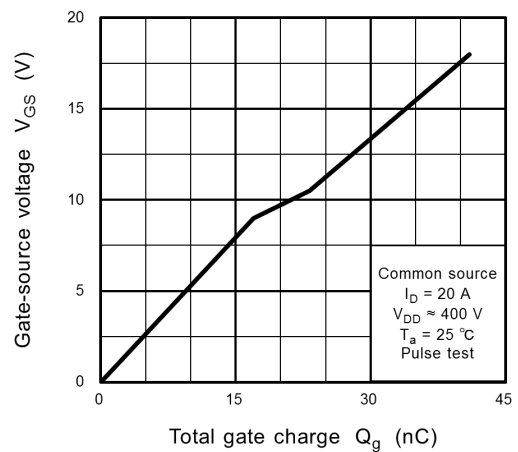


Fig. 8.12 Dynamic Input Characteristics

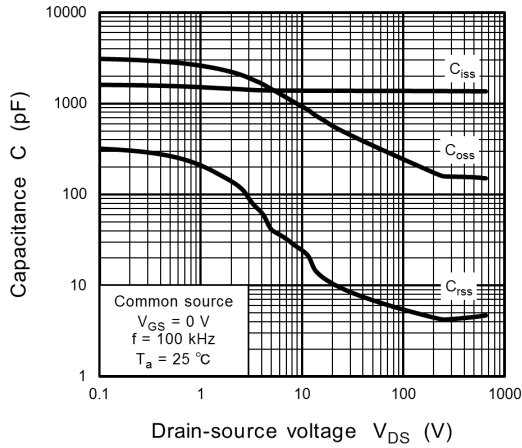


Fig. 8.13 C - V_{DS}

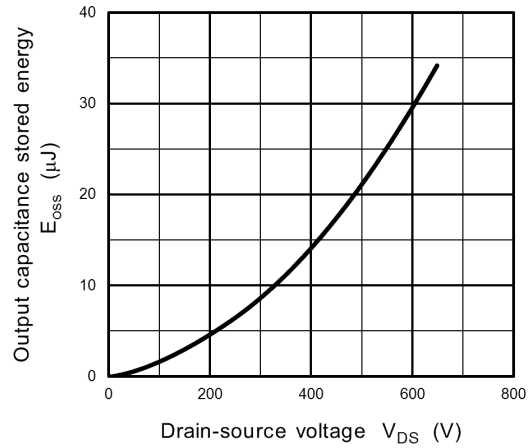
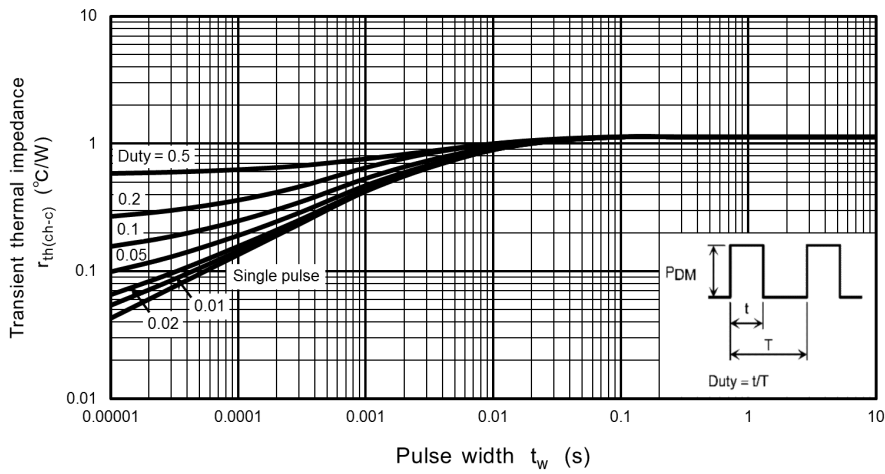
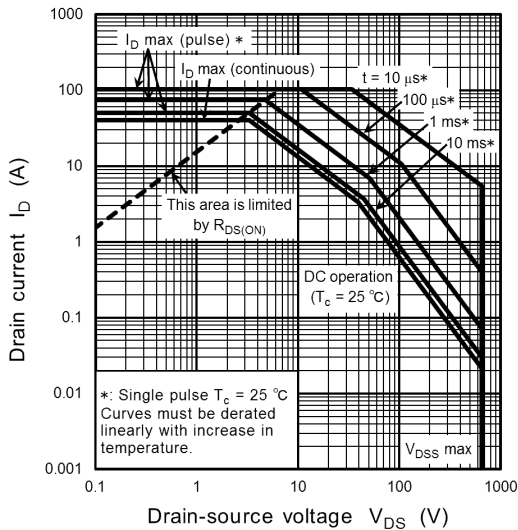


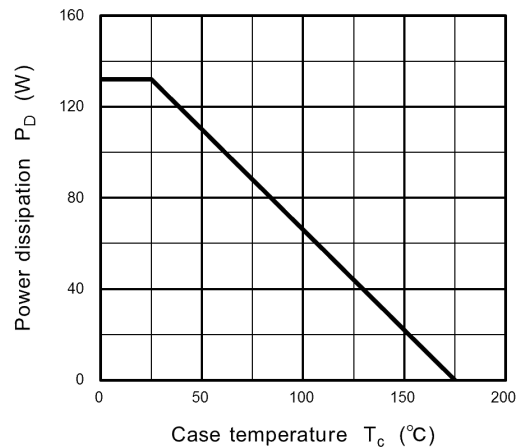
Fig. 8.14 E_{oss} - V_{DS}



**Fig. 8.15 $r_{th(ch-c)}$ - t_w
(Guaranteed Maximum)**



**Fig. 8.16 Safe Operating Area
(Guaranteed Maximum)**



**Fig. 8.17 P_D - T_c
(Guaranteed Maximum)**

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

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