

MOSFETs Silicon N-channel MOS (U-MOS^{VI}-H)

XPN12006NC

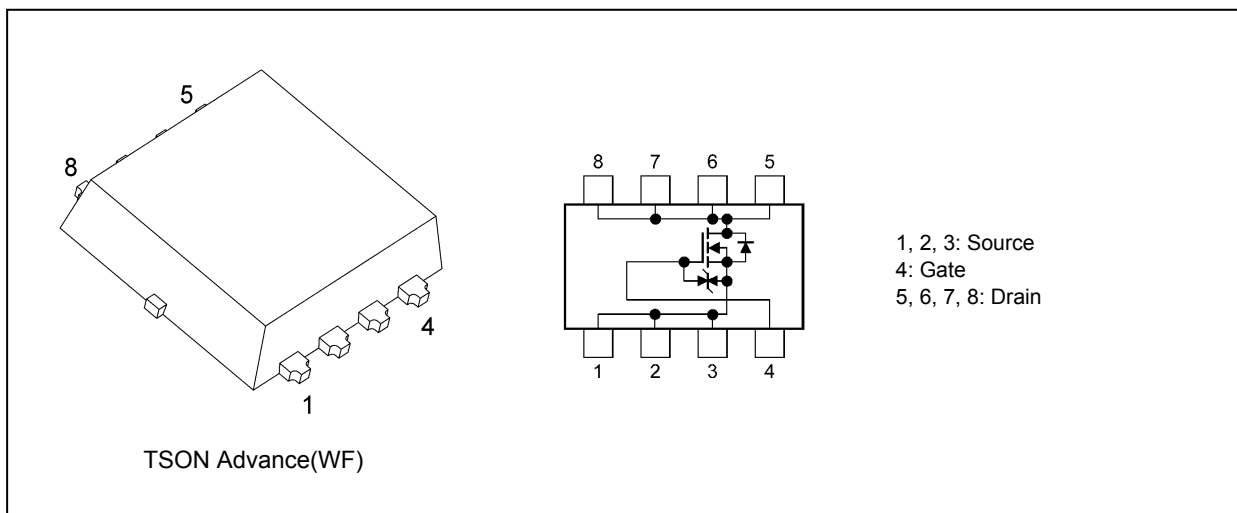
1. Applications

- Automotive
- Switching Voltage Regulators
- DC-DC Converters
- Motor Drivers

2. Features

- (1) AEC-Q101 qualified
- (2) Small, thin package
- (3) Low drain-source on-resistance: $R_{DS(ON)} = 9.8 \text{ m}\Omega$ (typ.) ($V_{GS} = 10 \text{ V}$)
- (4) Low leakage current: $I_{DSS} = 10 \text{ }\mu\text{A}$ (max) ($V_{DS} = 60 \text{ V}$)
- (5) Enhancement mode: $V_{th} = 1.5 \text{ to } 2.5 \text{ V}$ ($V_{DS} = 10 \text{ V}$, $I_D = 0.2 \text{ mA}$)

3. Packaging and Internal Circuit



Start of commercial production

2019-12

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

Characteristics	Symbol	Rating	Unit
Drain-source voltage	V_{DSS}	60	V
Gate-source voltage	V_{GSS}	± 20	
Drain current (DC) (Note 1)	I_D	20	A
Drain current (pulsed) (Note 1)	I_{DP}	60	
Power dissipation ($T_c = 25\text{ }^\circ\text{C}$)	P_D	65	W
Power dissipation ($t = 10\text{ s}$) (Note 2)		2.27	
Power dissipation ($t = 10\text{ s}$) (Note 3)		0.84	
Single-pulse avalanche energy (Note 4)	E_{AS}	41	mJ
Single-pulse avalanche current	I_{AS}	20	A
Channel temperature (Note 5)	T_{ch}	175	$^\circ\text{C}$
Storage temperature (Note 5)	T_{stg}	-55 to 175	

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 impedance ($T_c = 25\text{ }^\circ\text{C}$)	$Z_{th(ch-c)}$	2.3	$^\circ\text{C/W}$
Channel-to-ambient thermal impedance ($t = 10\text{ s}$) (Note 2)	$Z_{th(ch-a)}$	66	
Channel-to-ambient thermal impedance ($t = 10\text{ s}$) (Note 3)	$Z_{th(ch-a)}$	178	

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

Note 2: Device mounted on a glass-epoxy board (a), Figure 5.1

Note 3: Device mounted on a glass-epoxy board (b), Figure 5.2

Note 4: $V_{DD} = 48\text{ V}$, $T_{ch} = 25\text{ }^\circ\text{C}$ (initial), $L = 79.1\text{ }\mu\text{H}$, $R_G = 25\Omega$, $I_{AS} = 20\text{ A}$

Note 5: The definitions of the absolute maximum channel and storage temperatures are qualified per AEC-Q101.

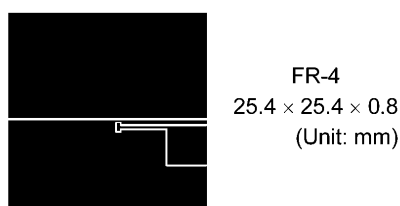


Fig. 5.1 Device Mounted on a Glass-Epoxy Board (a)

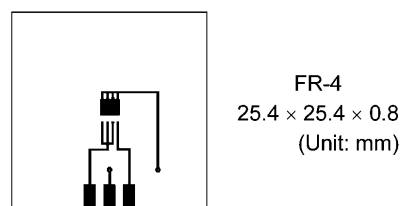


Fig. 5.2 Device Mounted on a Glass-Epoxy Board (b)

Note: This transistor is sensitive to electrostatic discharge and should be handled with care.

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}	$V_{GS} = \pm 16\text{ V}, V_{DS} = 0\text{ V}$	—	—	± 10	μA
Drain cut-off current	I_{DSS}	$V_{DS} = 60\text{ V}, V_{GS} = 0\text{ V}$	—	—	10	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$I_D = 10\text{ mA}, V_{GS} = 0\text{ V}$	60	—	—	V
	$V_{(BR)DSX}$	$I_D = 10\text{ mA}, V_{GS} = -20\text{ V}$	40	—	—	
Gate threshold voltage	V_{th}	$V_{DS} = 10\text{ V}, I_D = 0.2\text{ mA}$	1.5	—	2.5	
Drain-source on-resistance	$R_{DS(ON)}$	$V_{GS} = 4.5\text{ V}, I_D = 10\text{ A}$	—	14.8	23.7	$\text{m}\Omega$
		$V_{GS} = 10\text{ V}, I_D = 10\text{ A}$	—	9.8	12.0	

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}	$V_{DS} = 10\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$	—	1100	—	pF
Reverse transfer capacitance	C_{rss}		—	70	—	
Output capacitance	C_{oss}		—	600	—	
Gate resistance	r_g		—	2.0	4.0	Ω
Switching time (rise time)	t_r	See Fig. 6.2.1	—	5	—	ns
Switching time (turn-on time)	t_{on}		—	15	—	
Switching time (fall time)	t_f		—	8	—	
Switching time (turn-off time)	t_{off}		—	33	—	

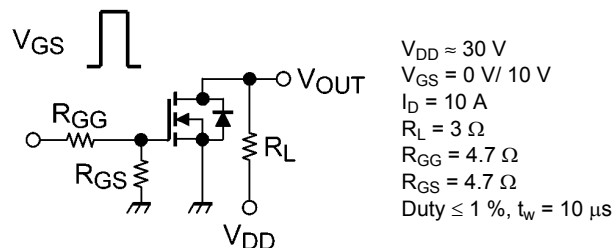


Fig. 6.2.1 Switching Time Test Circuit

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	$V_{DD} \approx 48\text{ V}, V_{GS} = 10\text{ V}, I_D = 20\text{ A}$	—	23	—	nC
Gate-source charge 1	Q_{gs1}		—	6	—	
Gate-drain charge	Q_{gd}		—	4	—	

6.4. Source-Drain Characteristics ($T_a = 25\text{ }^\circ\text{C}$ unless otherwise specified)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Reverse drain current (pulsed) (Note 6)	I_{DRP}	—	—	—	60	A
Diode forward voltage	V_{DSF}	$I_{DR} = 20\text{ A}, V_{GS} = 0\text{ V}$	—	—	-1.2	V

Note 6: Ensure that the channel temperature does not exceed $175\text{ }^\circ\text{C}$.

7. Marking

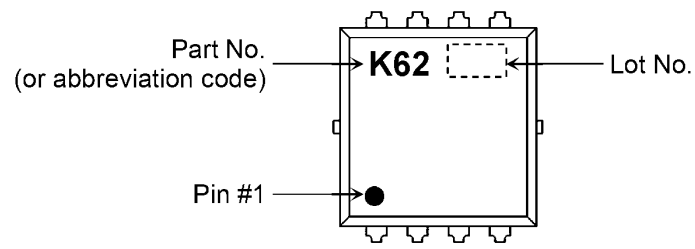


Fig. 7.1 Marking

8. Characteristics Curves (Note)

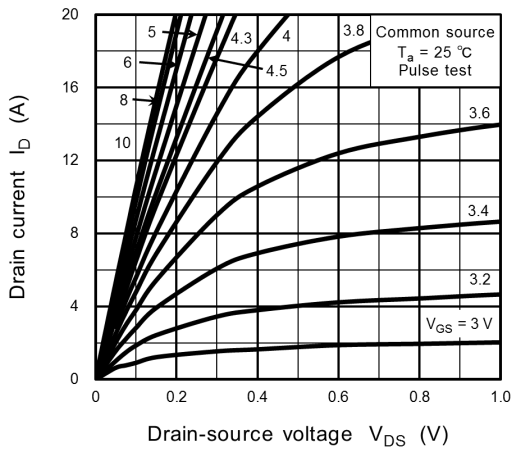


Fig. 8.1 $I_D - V_{DS}$

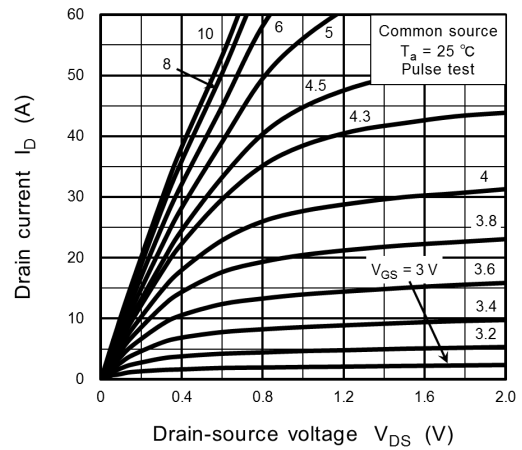


Fig. 8.2 $I_D - V_{DS}$

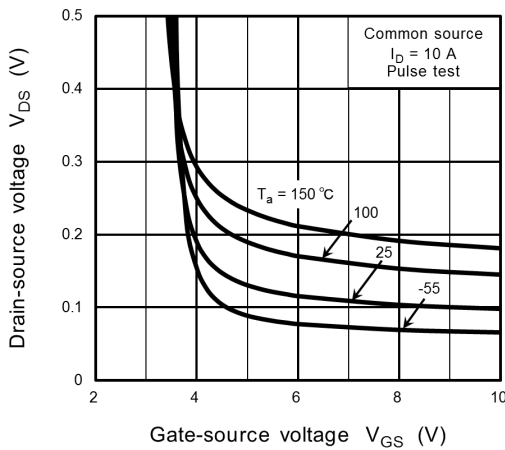


Fig. 8.3 $V_{DS} - V_{GS}$

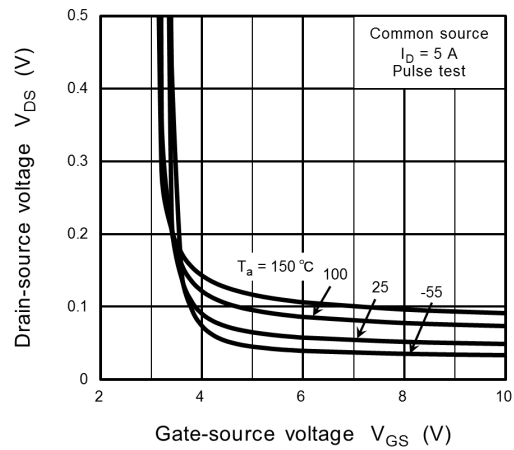


Fig. 8.4 $V_{DS} - V_{GS}$

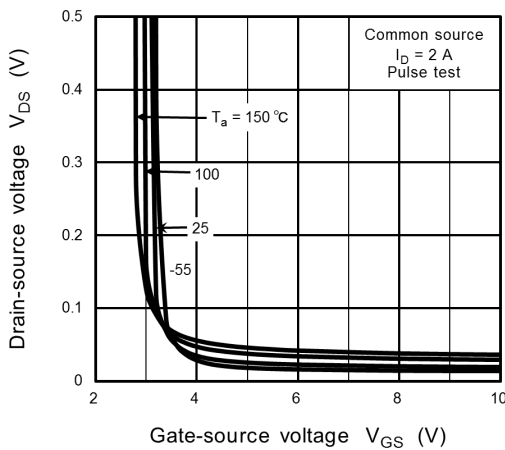


Fig. 8.5 $V_{DS} - V_{GS}$

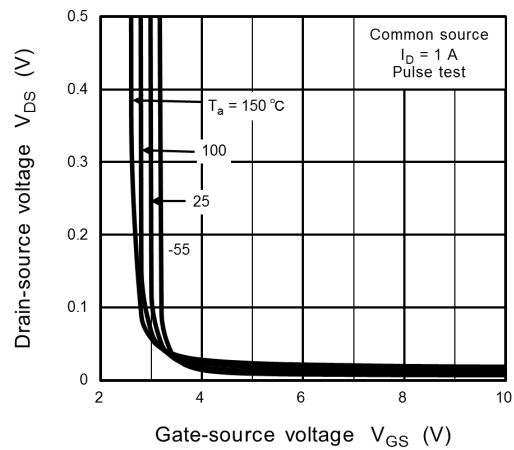


Fig. 8.6 $V_{DS} - V_{GS}$

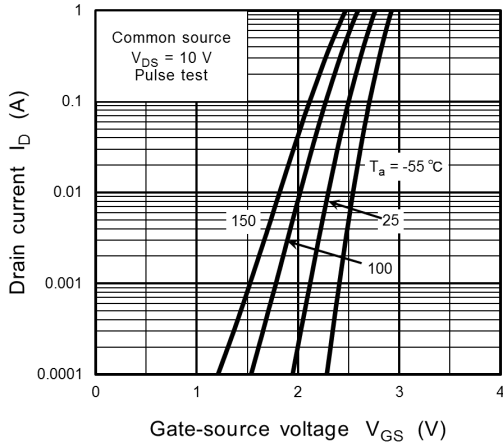


Fig. 8.7 $I_D - V_{GS}$

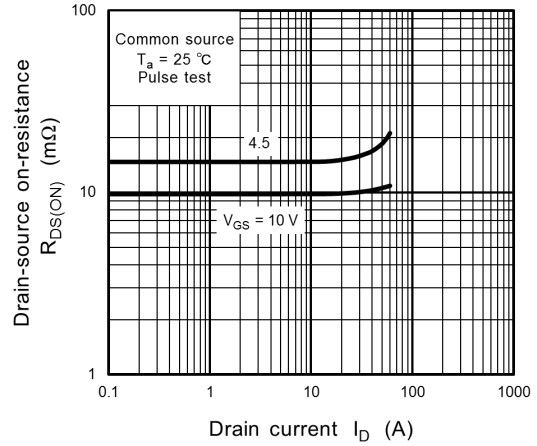


Fig. 8.8 $R_{DS(ON)} - I_D$

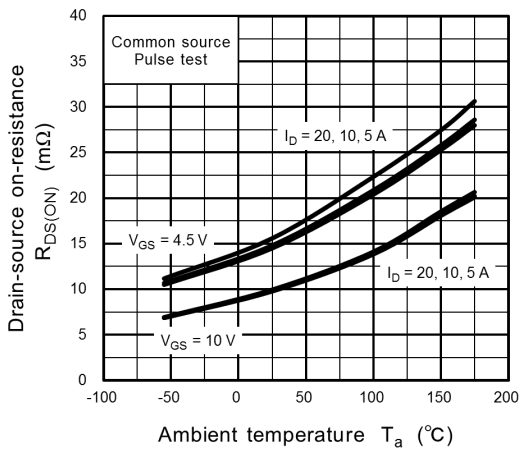


Fig. 8.9 $R_{DS(ON)} - T_a$

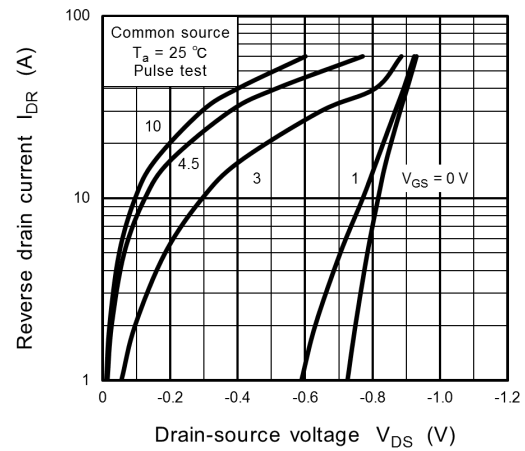


Fig. 8.10 $I_{DR} - V_{DS}$

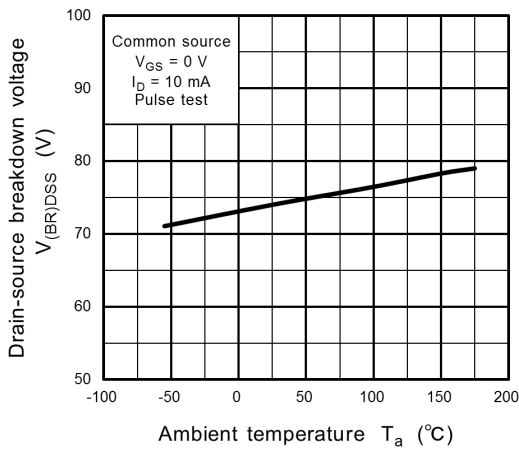


Fig. 8.11 $V_{(BR)DSS} - T_a$

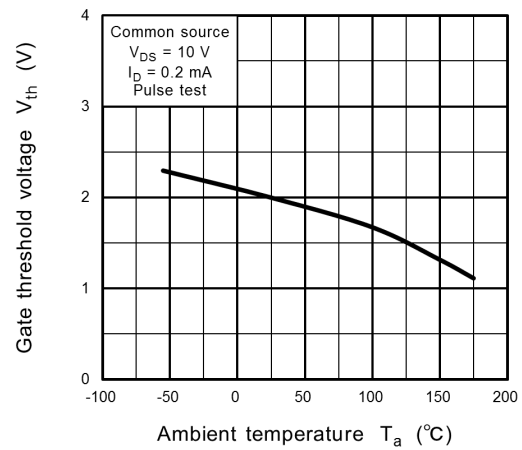


Fig. 8.12 $V_{th} - T_a$

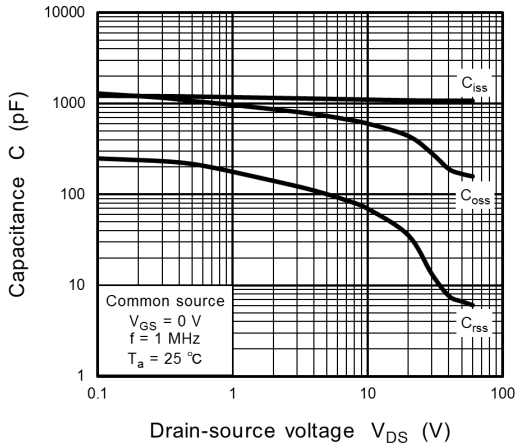


Fig. 8.13 Capacitance - V_{DS}

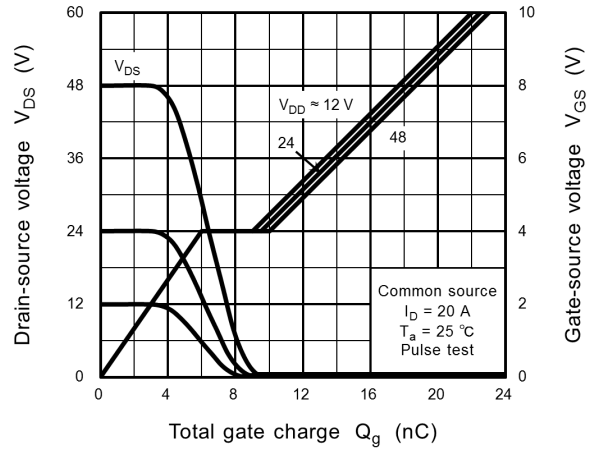


Fig. 8.14 Dynamic Input/Output Characteristics

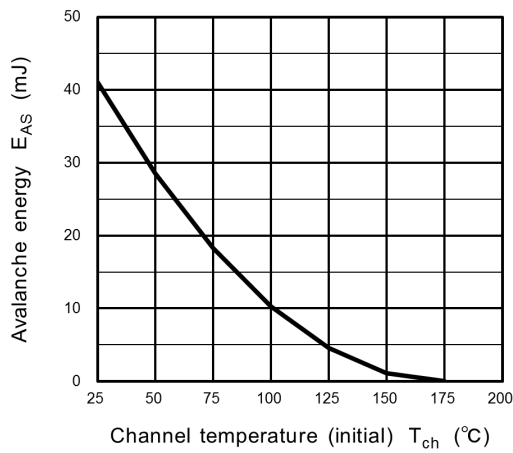


Fig. 8.15 $E_{AS} - T_{ch}$

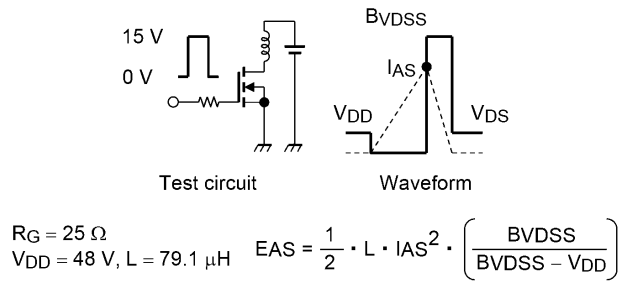
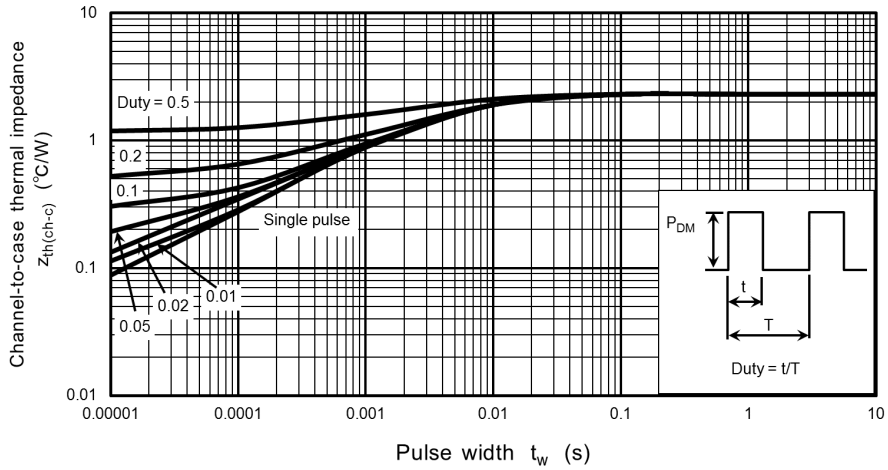
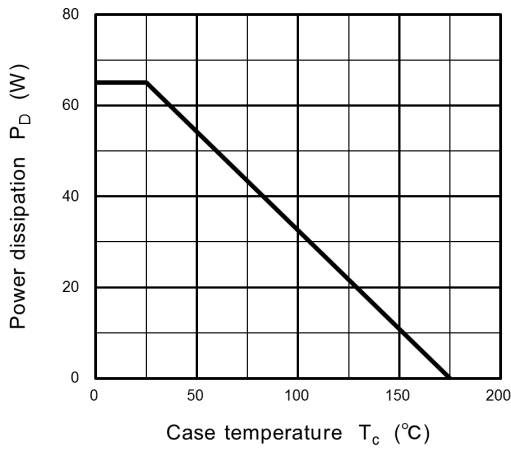


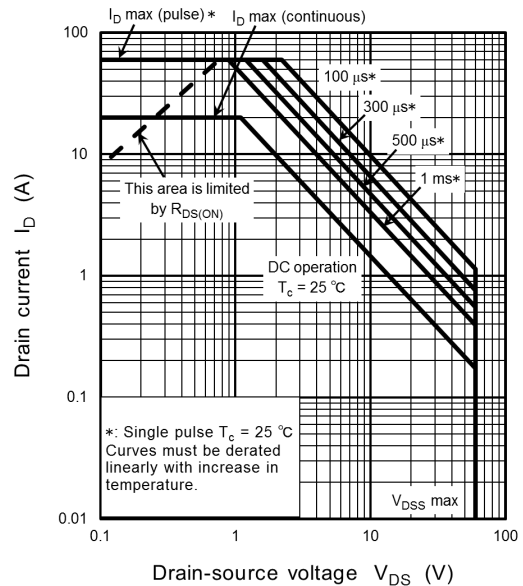
Fig. 8.16 Test Circuit/Waveform



**Fig. 8.17 $Z_{th(ch-c)} - t_w$
(Guaranteed Maximum)**



**Fig. 8.18 $P_D - T_c$
(Guaranteed Maximum)**



**Fig. 8.19 Safe Operating Area
(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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