

MOSFETs Silicon P-Channel MOS (U-MOSVI)

XPH13016MC

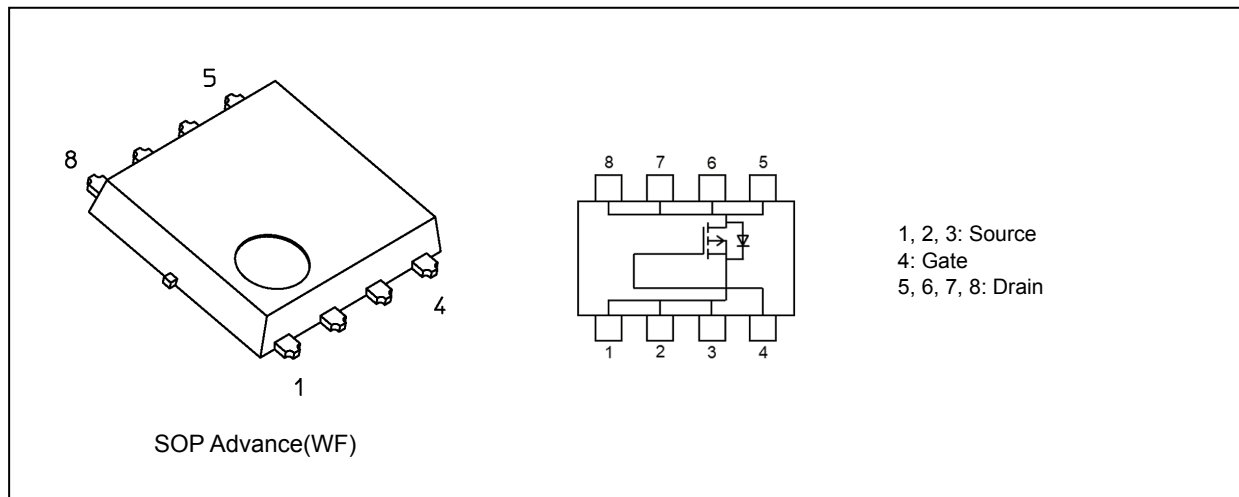
1. Applications

- 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: $R_{DS(ON)} = 9.9 \text{ m}\Omega$ (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: $V_{th} = -1.0$ to -2.1 V ($V_{DS} = -10 \text{ V}$, $I_D = -0.6 \text{ mA}$)

3. Packaging and Internal Circuit



Start of commercial production

2023-05

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

Characteristics	Symbol	Rating	Unit
Drain-source voltage	V_{DS}	-60	V
Gate-source voltage	V_{GS}	+10/-20	
Drain current (DC) (Note 1)	I_D	-60	A
Drain current (pulsed) (Note 1)	I_{DP}	-120	
Power dissipation ($T_c = 25\text{ }^{\circ}\text{C}$)	P_D	132	W
Power dissipation ($t = 10\text{ s}$) (Note 2)		3	
Power dissipation ($t = 10\text{ s}$) (Note 3)		0.96	
Single-pulse avalanche energy (Note 4)	E_{AS}	60	mJ
Single-pulse avalanche current	I_{AS}	-60	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 ($T_c = 25\text{ }^{\circ}\text{C}$)	$Z_{th(ch-c)}$	1.13	$^{\circ}\text{C/W}$
Channel-to-ambient thermal impedance ($t = 10\text{ s}$) (Note 2)	$Z_{th(ch-a)}$	50	
Channel-to-ambient thermal impedance ($t = 10\text{ s}$) (Note 3)	$Z_{th(ch-a)}$	156	

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), $L = 13\text{ }\mu\text{H}$, $R_G = 25\text{ }\Omega$, $I_{AS} = -60\text{ A}$, $V_{GS} = 0/-15\text{ V}$

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

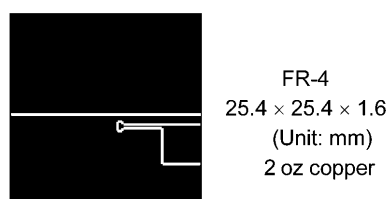


Fig. 5.1 Device Mounted on a Glass-Epoxy Board (a)

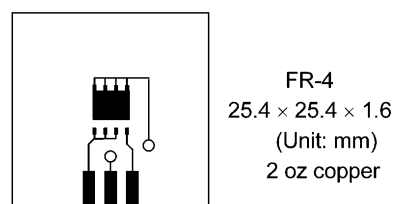


Fig. 5.2 Device Mounted on a Glass-Epoxy Board (b)

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}	$V_{GS} = +10/-20\text{ V}$, $V_{DS} = 0\text{ V}$	—	—	± 1	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
	$V_{(BR)DSX}$	$I_D = -10\text{ mA}$, $V_{GS} = 10\text{ V}$	-50	—	—	
Gate threshold voltage	V_{th}	$V_{DS} = -10\text{ V}$, $I_D = -0.6\text{ mA}$	-1.0	—	-2.1	
Drain-source on-resistance	$R_{DS(ON)}$	$V_{GS} = -4.5\text{ V}$, $I_D = -30\text{ A}$	—	11.1	16.6	$\text{m}\Omega$
		$V_{GS} = -10\text{ V}$, $I_D = -30\text{ A}$	—	9.9	12.9	

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}	$V_{DS} = -10\text{ V}$, $V_{GS} = 0\text{ V}$, $f = 1\text{ MHz}$	—	6820	9548	pF
Reverse transfer capacitance	C_{rss}		—	460	644	
Output capacitance	C_{oss}		—	560	—	
Gate resistance	r_g		—	13	26	Ω
Switching time (rise time)	t_r	See Fig. 6.2.1	—	95	—	ns
Switching time (turn-on time)	t_{on}		—	105	—	
Switching time (fall time)	t_f		—	277	—	
Switching time (turn-off time)	t_{off}		—	1165	—	

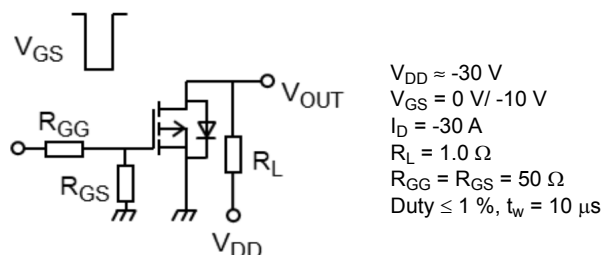


Fig. 6.2.1 Switching Time Test Circuit

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	$V_{DD} \approx -48\text{ V}$, $V_{GS} = -10\text{ V}$, $I_D = -60\text{ A}$	—	148	—	nC
Gate-source charge 1	Q_{gs1}		—	13	—	
Gate-drain charge	Q_{gd}		—	39	—	

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 (DC) (Note 6)	I_{DR}	—	—	—	-60	A
Reverse drain current (pulsed) (Note 6)	I_{DRP}	—	—	—	-120	A
Diode forward voltage	V_{DSF}	$I_{DR} = -60\text{ A}$, $V_{GS} = 0\text{ V}$	—	—	1.2	V
Reverse recovery time	t_{rr}	$I_{DR} = -60\text{ A}$, $V_{GS} = 0\text{ V}$ $-dI_{DR}/dt = -50\text{ A}/\mu\text{s}$	—	73	—	ns
Reverse recovery charge	Q_{rr}		—	51	—	nC

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

7. Marking

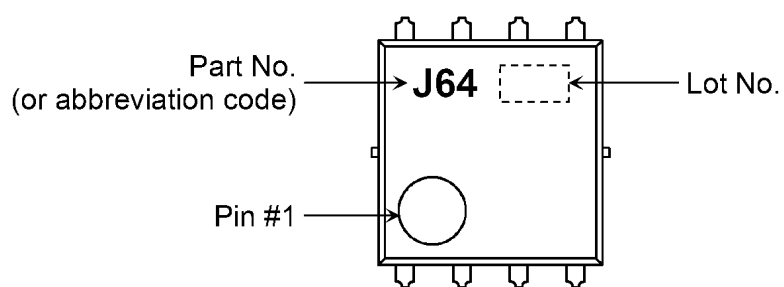


Fig. 7.1 Marking

8. Characteristics Curves (Note)

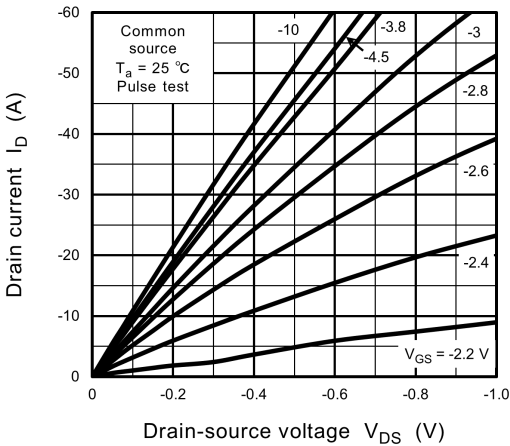


Fig. 8.1 ID - VDS

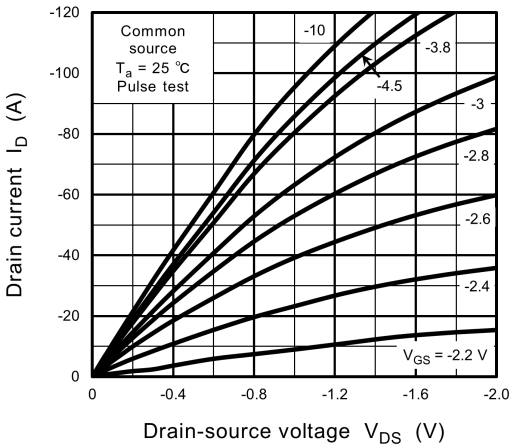


Fig. 8.2 ID - VDS

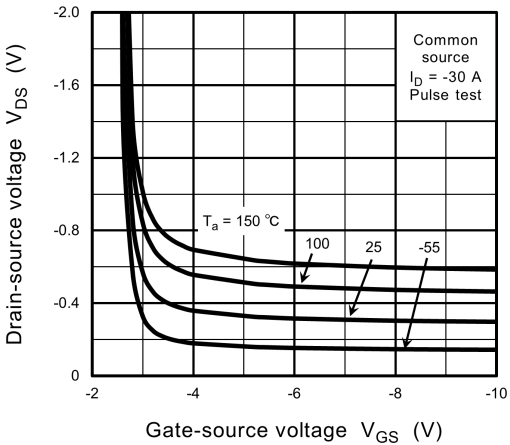


Fig. 8.3 VDS - VGS

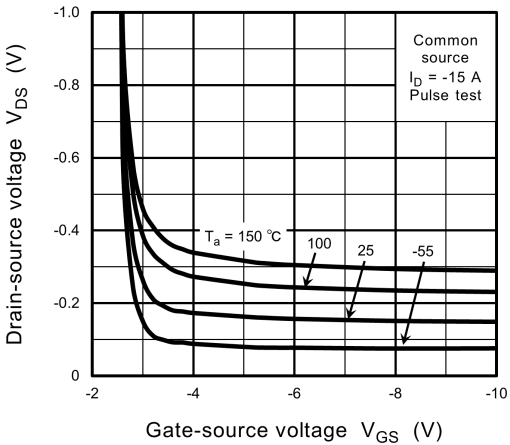


Fig. 8.4 VDS - VGS

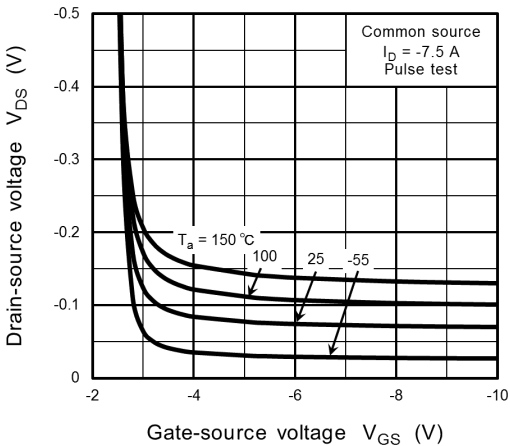


Fig. 8.5 VDS - VGS

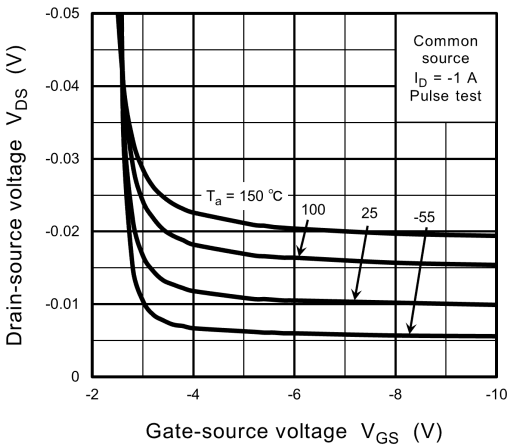


Fig. 8.6 VDS - VGS

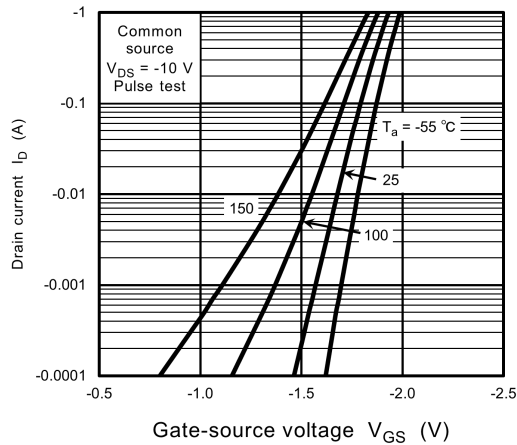


Fig. 8.7 $I_D - V_{GS}$

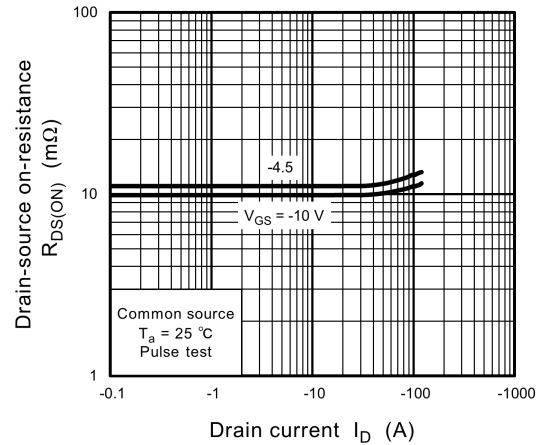


Fig. 8.8 $R_{DS(ON)} - I_D$

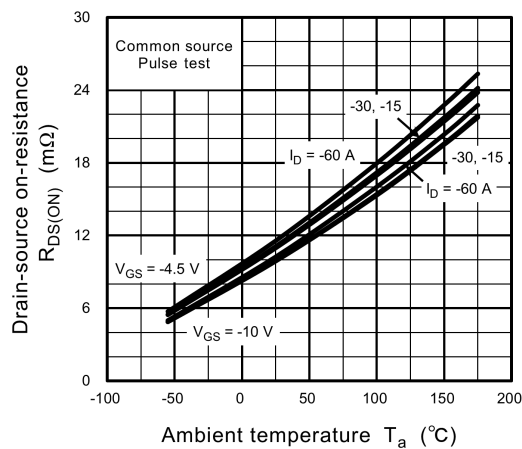


Fig. 8.9 $R_{DS(ON)} - T_a$

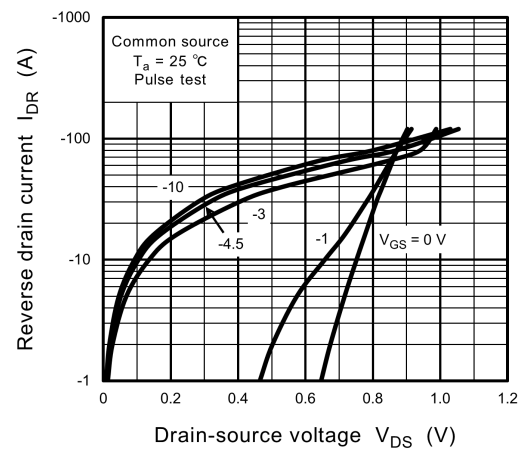


Fig. 8.10 $I_{DR} - V_{DS}$

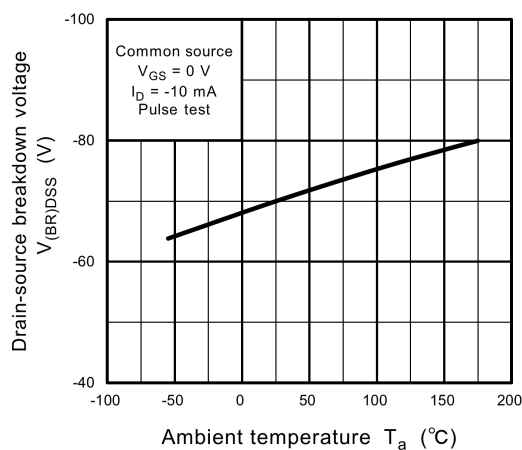


Fig. 8.11 $V_{(BR)DSS} - T_a$

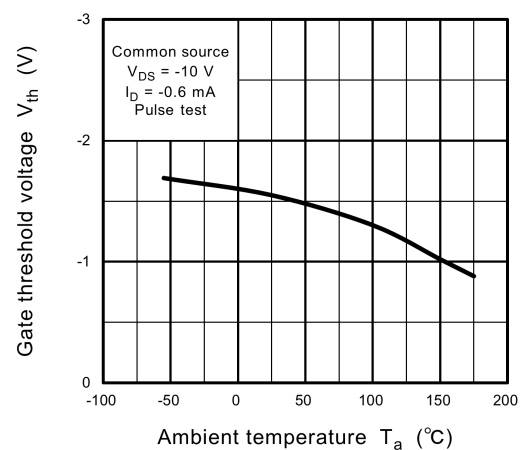


Fig. 8.12 $V_{th} - T_a$

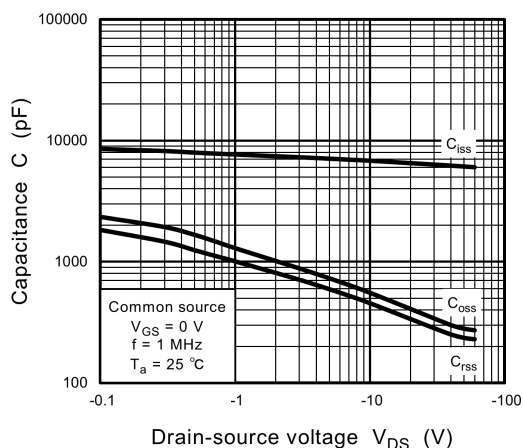


Fig. 8.13 Capacitance - V_{DS}

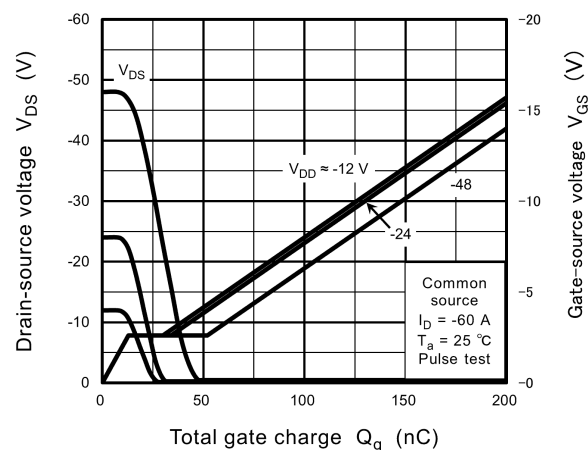


Fig. 8.14 Dynamic Input/Output Characteristics

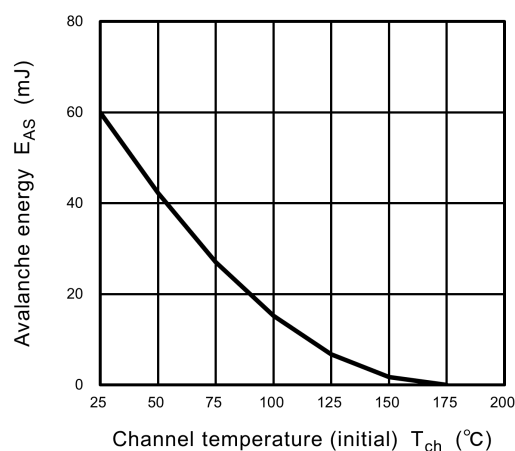


Fig. 8.15 E_{AS} - T_{ch} (Guaranteed Maximum)

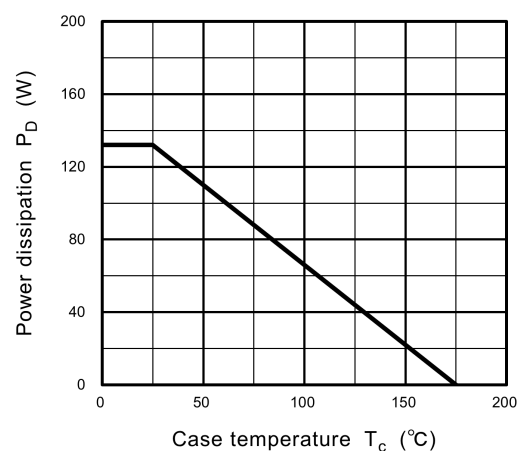


Fig. 8.16 P_D - T_c (Guaranteed Maximum)

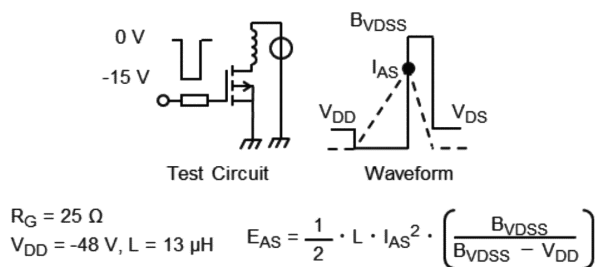


Fig. 8.17 Test Circuit/Waveform

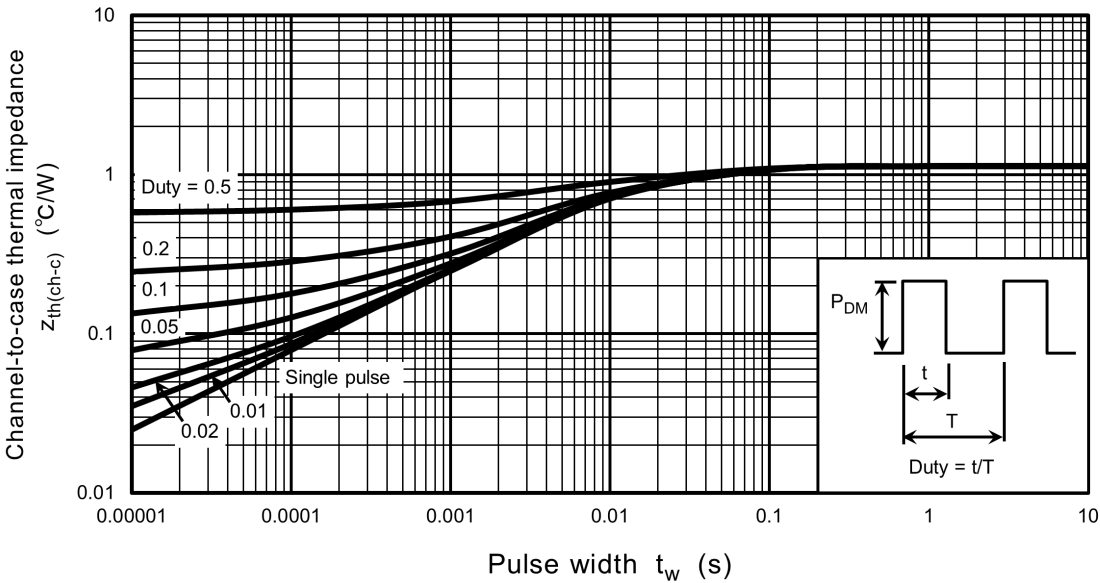


Fig. 8.18 $z_{th(ch-c)} - t_w$ (Guaranteed Maximum)

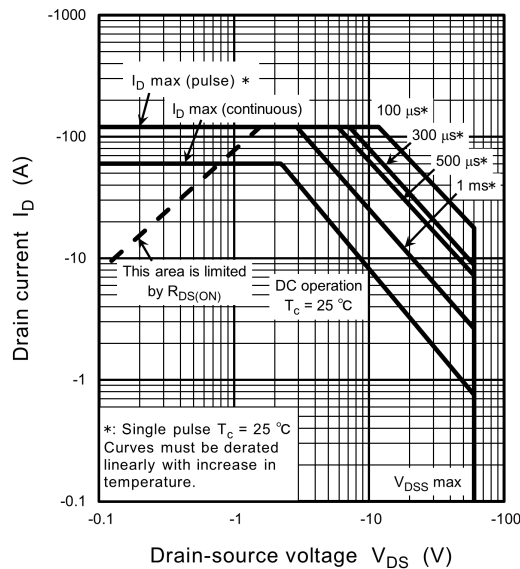
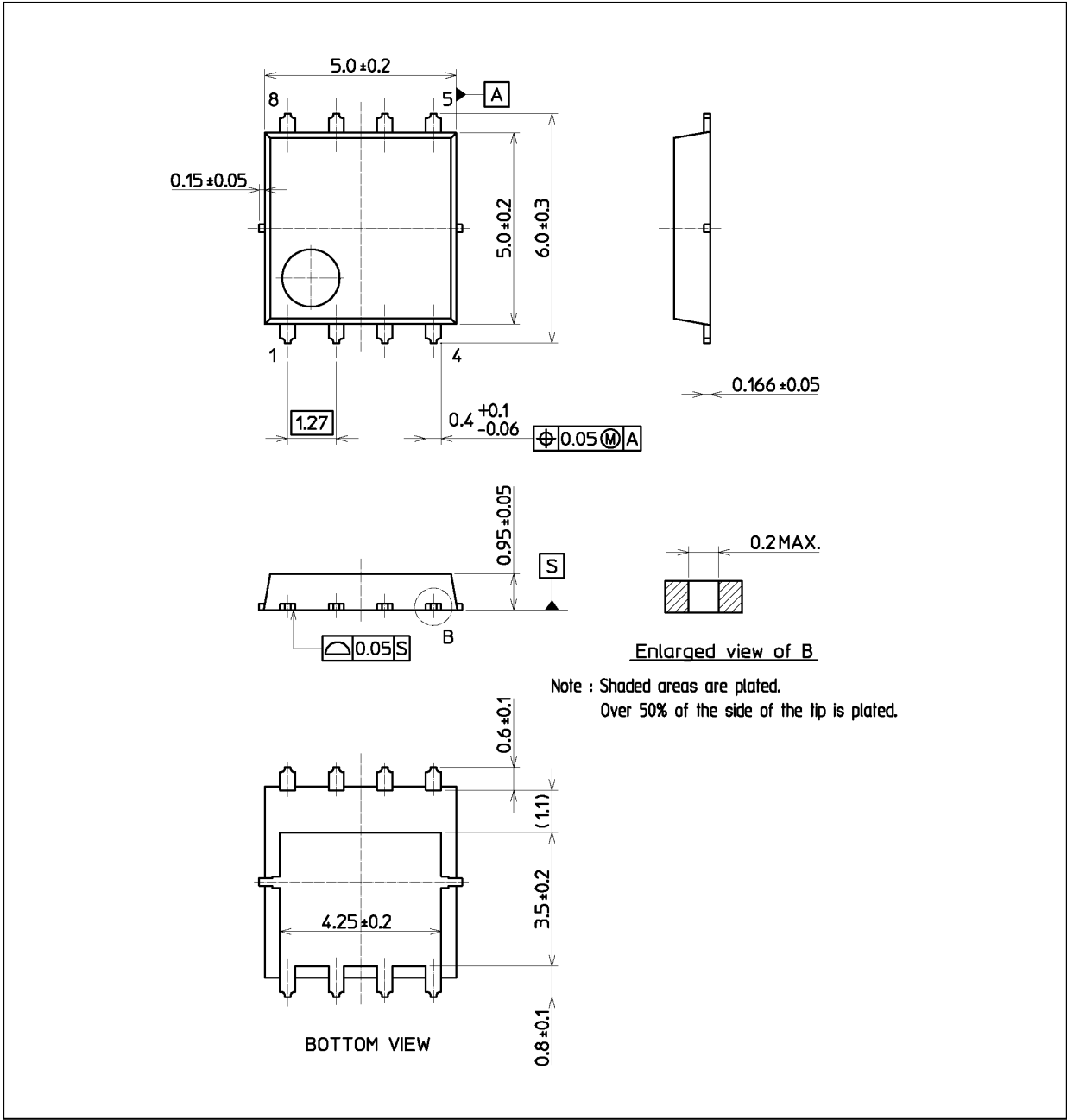


Fig. 8.19 Safe Operating Area (Guaranteed Maximum)

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

Package Dimensions

Unit: mm



Weight: 0.080 g (typ.)

Package Name(s)
TOSHIBA: 2-5Q4A
Nickname: SOP Advance(WF)

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