

MOSFETs Silicon P-Channel MOS (U-MOSVI)

# XPH13016MC

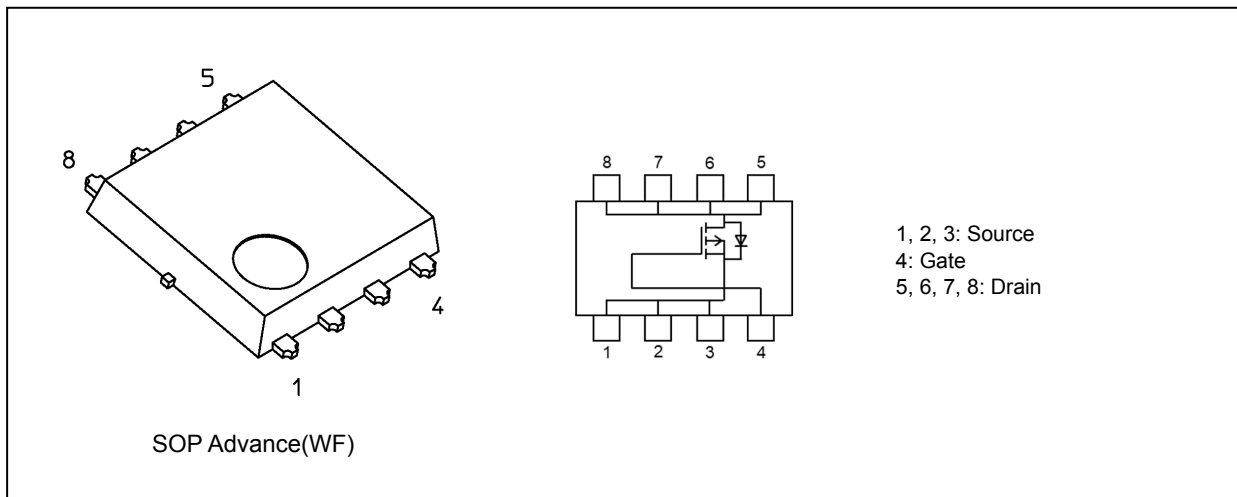
## 1. Applications

- 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  $-2.1 \text{ V}$  ( $V_{DS} = -10 \text{ V}$ ,  $I_D = -0.6 \text{ mA}$ )

## 3. Packaging and Internal Circuit



Start of commercial production

2023-05

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

Characteristics	Symbol	Rating	Unit
Drain-source voltage	$V_{DSS}$	-60	V
Gate-source voltage	$V_{GSS}$	+10/-20	
Drain current (DC) (Note 1)	$I_D$	-60	A
Drain current (pulsed) (Note 1)	$I_{DP}$	-120	
Power dissipation ( $T_c = 25\text{ °C}$ )	$P_D$	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	°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 ( $T_c = 25\text{ °C}$ )	$Z_{th(ch-c)}$	1.13	°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 °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:  $V_{DD} = -48\text{ V}$ ,  $T_{ch} = 25\text{ °C}$  (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.

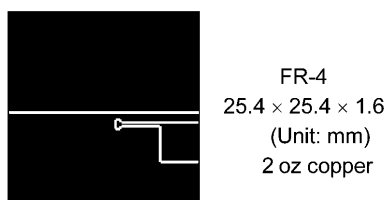


Fig. 5.1 Device Mounted on a Glass-Epoxy Board (a)

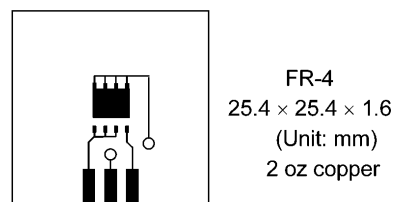


Fig. 5.2 Device Mounted on a Glass-Epoxy Board (b)

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	$I_{GSS}$	$V_{GS} = +10/-20\text{ V}, V_{DS} = 0\text{ V}$	—	—	$\pm 1$	$\mu\text{A}$
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	$\text{pF}$
Reverse transfer capacitance	$C_{rss}$		—	460	644	
Output capacitance	$C_{oss}$		—	560	—	
Gate resistance	$r_g$		—	13	26	
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	—	

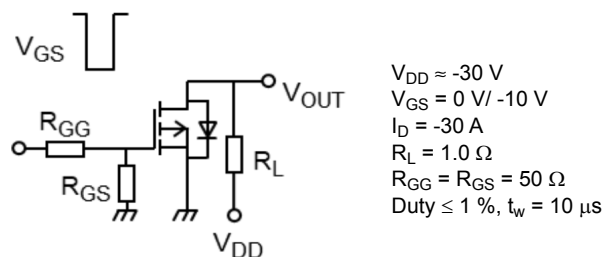


Fig. 6.2.1 Switching Time Test Circuit

#### 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

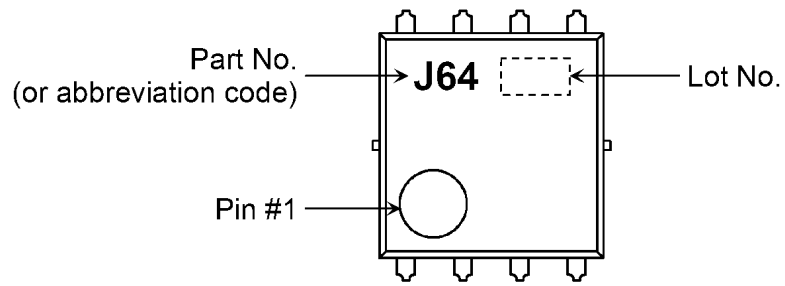
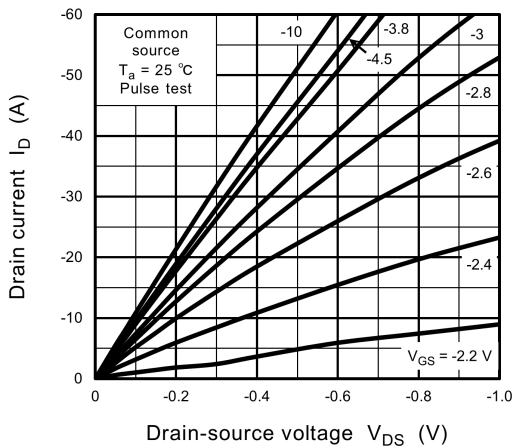
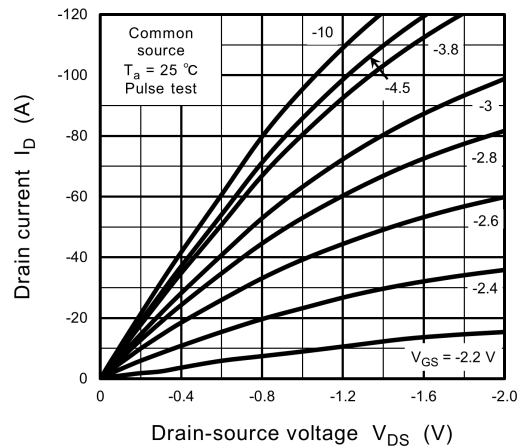


Fig. 7.1 Marking

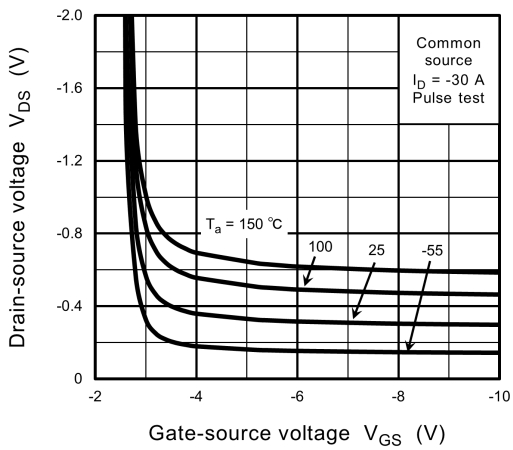
### 8. Characteristics Curves (Note)



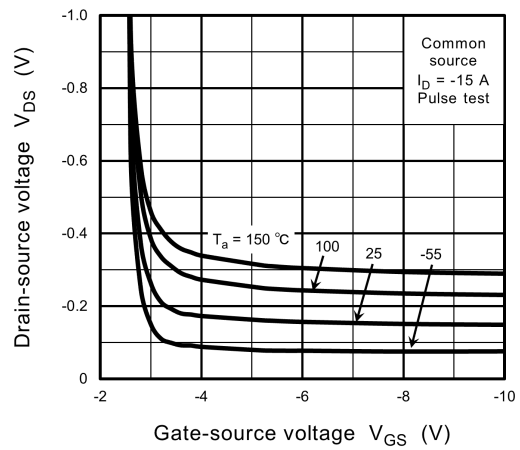
**Fig. 8.1  $I_D - V_{DS}$**



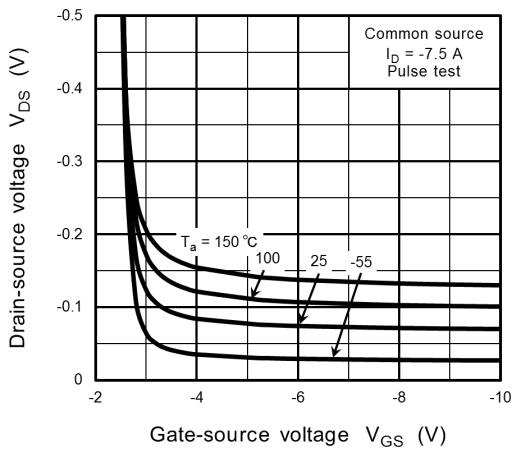
**Fig. 8.2  $I_D - V_{DS}$**



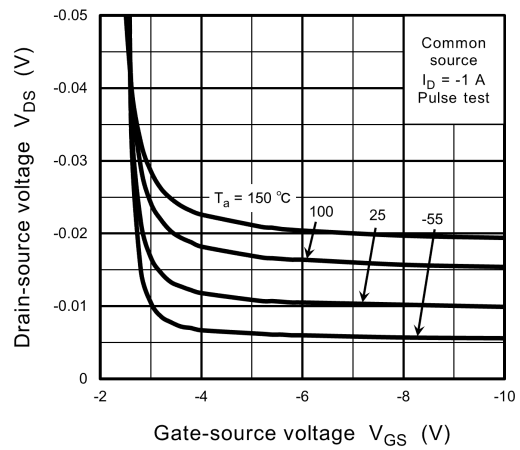
**Fig. 8.3  $V_{DS} - V_{GS}$**



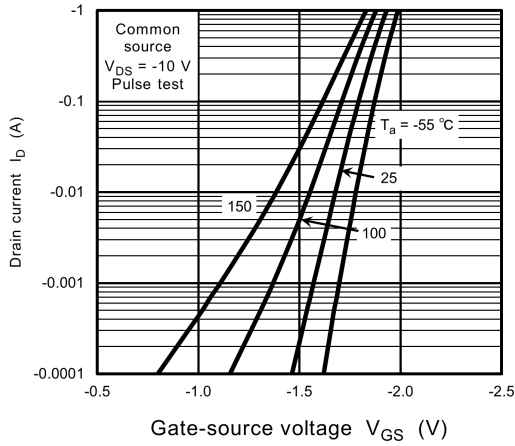
**Fig. 8.4  $V_{DS} - V_{GS}$**



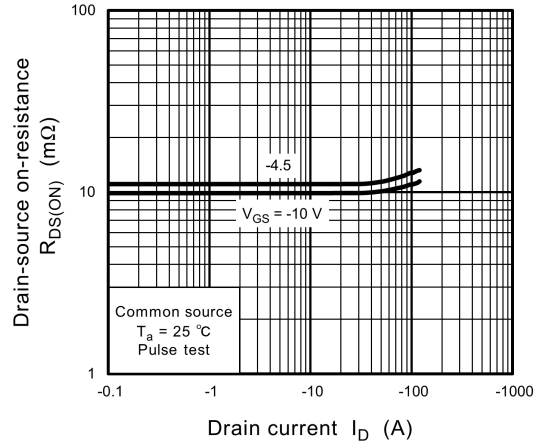
**Fig. 8.5  $V_{DS} - V_{GS}$**



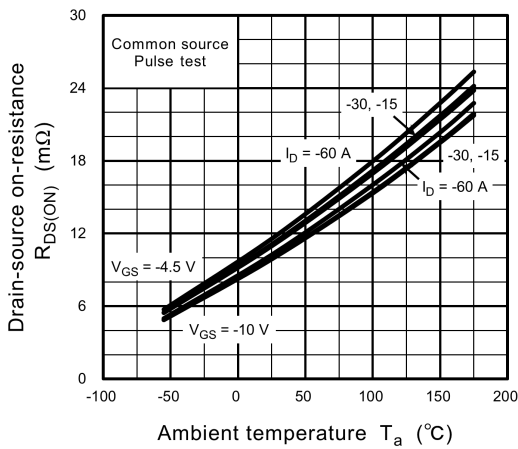
**Fig. 8.6  $V_{DS} - V_{GS}$**



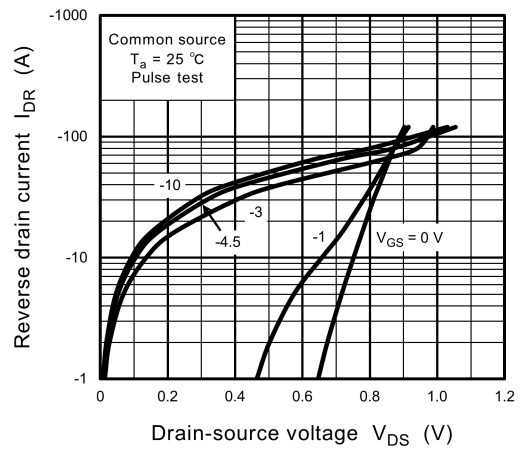
**Fig. 8.7  $I_D - V_{GS}$**



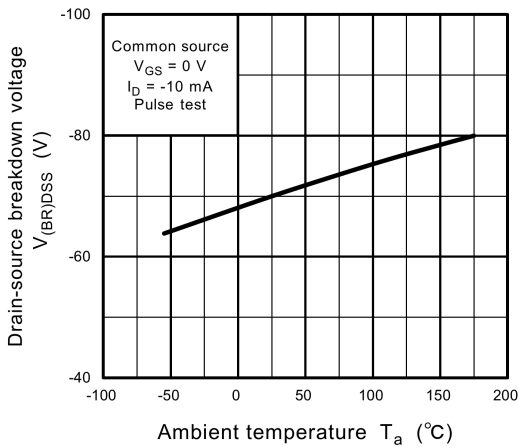
**Fig. 8.8  $R_{DS(ON)} - I_D$**



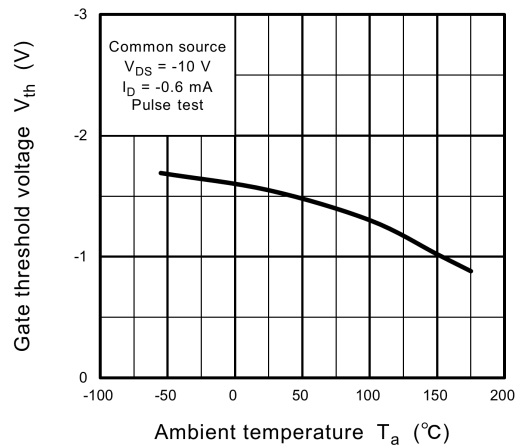
**Fig. 8.9  $R_{DS(ON)} - T_a$**



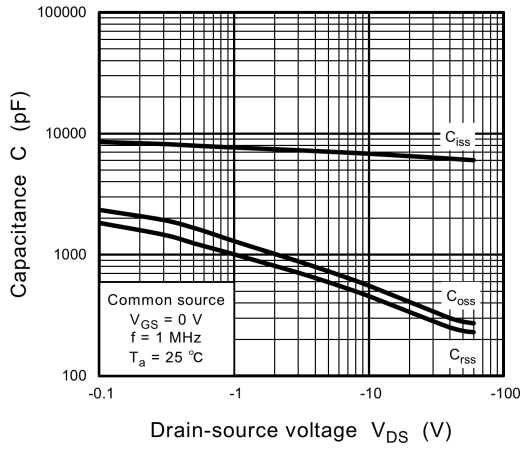
**Fig. 8.10  $I_{DR} - V_{DS}$**



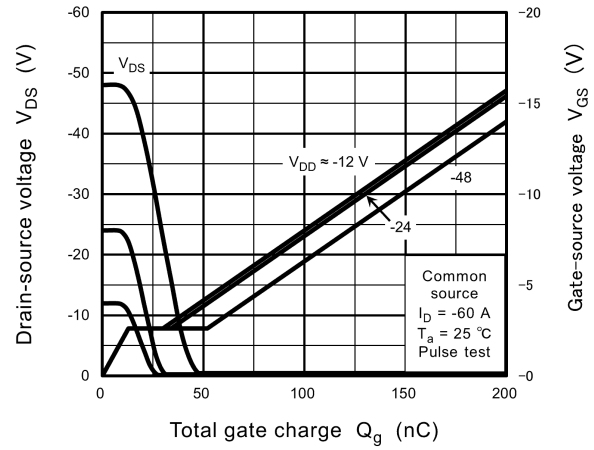
**Fig. 8.11  $V_{(BR)DSS} - T_a$**



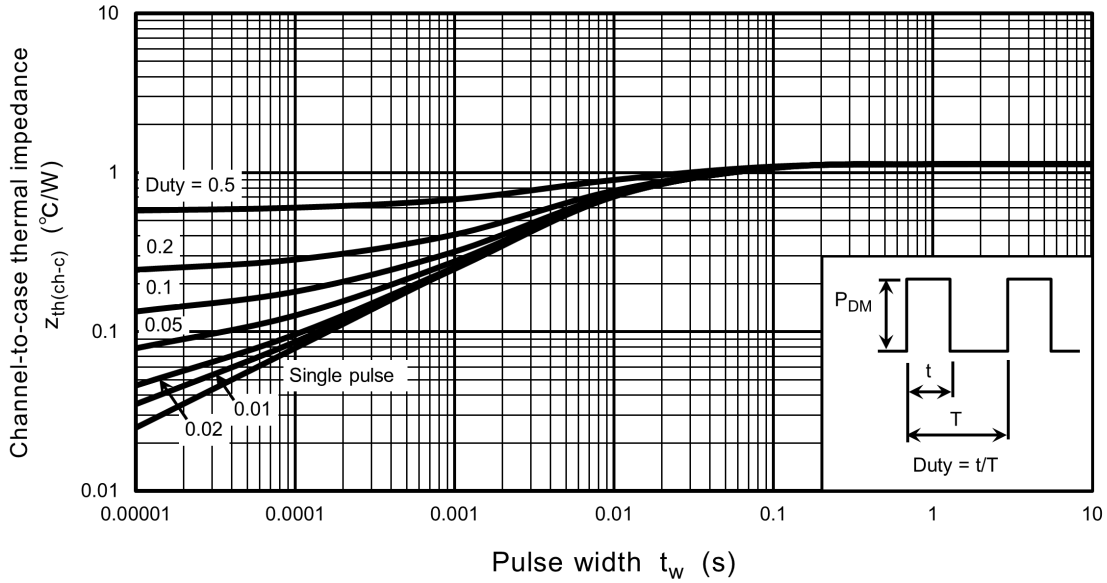
**Fig. 8.12  $V_{th} - T_a$**



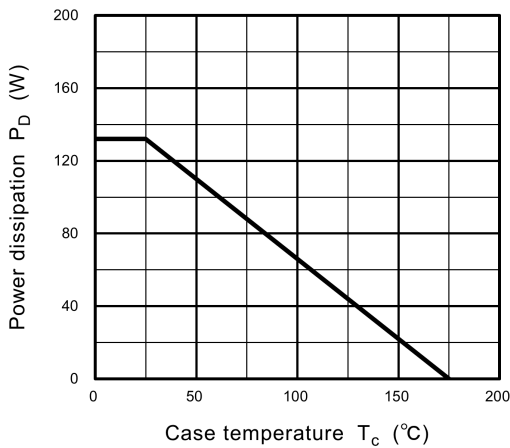
**Fig. 8.13 Capacitance -  $V_{DS}$**



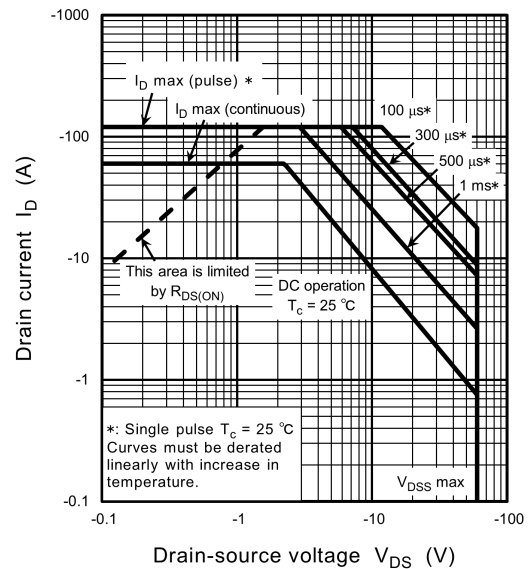
**Fig. 8.14 Dynamic Input/Output Characteristics**



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



**Fig. 8.16**  $P_D - T_c$  (Guaranteed Maximum)



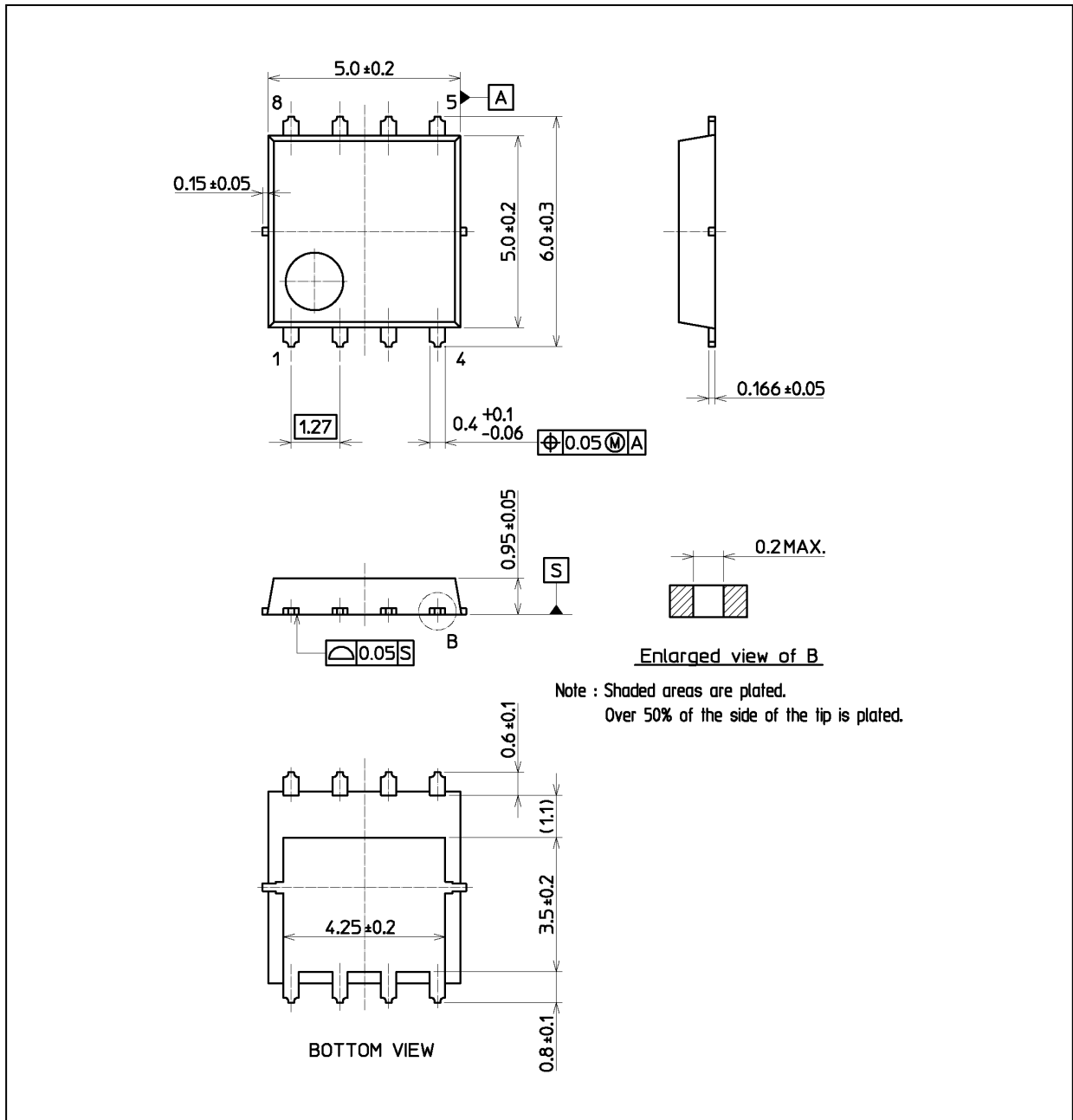
**Fig. 8.17** Safe Operating Area (Guaranteed Maximum)

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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