MOSFETs Silicon P-/N-Channel MOS (U-MOS Ⅵ/U-MOS Ⅳ)

TPCP8407

1. Applications

- Motor Drivers
- Mobile Equipment

2. Features

(1) AEC-Q101 qualified

(2) Small, thin package

(3) Low gate charge

N-channel MOSFET: Q_{SW} = 4.7 nC (typ.)

P-channel MOSFET: Q_{SW} = 5.5 nC (typ.)

(4) Low drain-source on-resistance

N-channel MOSFET: $R_{DS(ON)}$ = 29.1 mΩ (typ.) (V_{GS} = 10 V)

P-channel MOSFET: $R_{DS(ON)}$ = 43.7 mΩ (typ.) (V_{GS} = -10V)

(5) Low leakage current

N-channel MOSFET: I_{DSS} = 10 μA (max) (V_{DS} = 40 V)

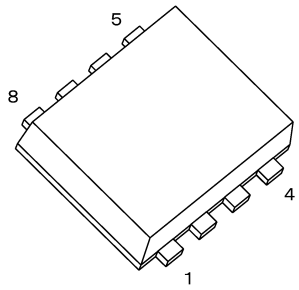
P-channel MOSFET: I_{DSS} = -10 μA (max) (V_{DS} = -40 V)

(6) Enhancement mode

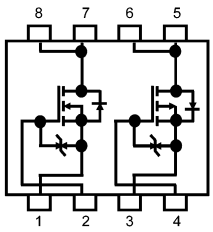
N-channel MOSFET: V_{th} = 2 to 3 V (V_{DS} = 10 V, I_D = 1 mA)

P-channel MOSFET: V_{th} = -2 to -3 V (V_{DS} = -10 V, I_D = -1 mA)

3. Packaging and Internal Circuit



PS-8



1: Source (N-channel)
2: Gate (N-channel)
3: Source (P-channel)
4: Gate (P-channel)
5, 6: Drain (P-channel)
7, 8: Drain (N-channel)

Start of commercial production
2013-05

4. Absolute Maximum Ratings (Note) (T_a = 25 °C unless otherwise specified)

4.1. N-Channel MOSFET

Characteristics			Symbol	Rating	Unit
Drain-source voltage			V_{DSS}	40	V
Gate-source voltage			V_{GSS}	±20	
Drain current (DC)		(Note 1)	I_D	5	A
Drain current (pulsed)		(Note 1)	I_{DP}	20	
Power dissipation (single operation)	(t = 5 s)	(Note 2), (Note 4)	$P_{D(1)}$	1.77	W
Power dissipation (per device for dual operation)	(t = 5 s)	(Note 2), (Note 5)	$P_{D(2)}$	1.47	
Power dissipation (single operation)	(t = 5 s)	(Note 3), (Note 4)	$P_{D(1)}$	0.69	
Power dissipation (per device for dual operation)	(t = 5 s)	(Note 3), (Note 5)	$P_{D(2)}$	0.43	
Single-pulse avalanche energy		(Note 6)	E_{AS}	33.2	mJ
Avalanche current			I_{AR}	5	A
Channel temperature		(Note 7)	T_{ch}	175	°C
Storage temperature		(Note 7)	T_{stg}	-55 to 175	

4.2. P-Channel MOSFET

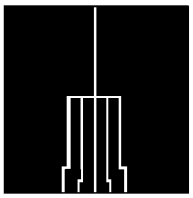
Characteristics			Symbol	Rating	Unit
Drain-source voltage			V_{DSS}	-40	V
Gate-source voltage			V_{GSS}	-20/+10	
Drain current (DC)		(Note 1)	I_D	-4	A
Drain current (pulsed)		(Note 1)	I_{DP}	-16	
Power dissipation (single operation)	(t = 5 s)	(Note 2), (Note 4)	$P_{D(1)}$	1.77	W
Power dissipation (per device for dual operation)	(t = 5 s)	(Note 2), (Note 5)	$P_{D(2)}$	1.47	
Power dissipation (single operation)	(t = 5 s)	(Note 3), (Note 4)	$P_{D(1)}$	0.69	
Power dissipation (per device for dual operation)	(t = 5 s)	(Note 3), (Note 5)	$P_{D(2)}$	0.43	
Single-pulse avalanche energy		(Note 6)	E_{AS}	46.2	mJ
Avalanche current			I_{AR}	-4	A
Channel temperature		(Note 7)	T_{ch}	175	°C
Storage temperature		(Note 7)	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

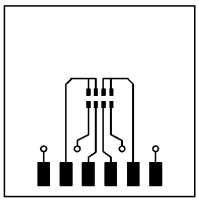
Characteristics			Symbol	Max	Unit
Channel-to-ambient thermal resistance (single operation)	(t = 5 s)	(Note 2), (Note 4)	$R_{th(ch\text{-}a)(1)}$	84.7	°C/W
Channel-to-ambient thermal resistance (per device for dual operation)	(t = 5 s)	(Note 2), (Note 5)	$R_{th(ch\text{-}a)(2)}$	102	
Channel-to-ambient thermal resistance (single operation)	(t = 5 s)	(Note 3), (Note 4)	$R_{th(ch\text{-}a)(1)}$	217.3	
Channel-to-ambient thermal resistance (per device for dual operation)	(t = 5 s)	(Note 3), (Note 5)	$R_{th(ch\text{-}a)(2)}$	348.8	

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: Power dissipation and thermal resistance values per device with the other device being off (During single operation, power is supplied to only one of the two devices.)
Note 5: Power dissipation and thermal resistance values per device for dual operation (During dual operation, power is evenly supplied to both devices.)
Note 6: N channel: V_{DD} = 25 V, T_{ch} = 25 °C (initial), L = 1.379 mH, R_G = 1 Ω, I_{AR} = 5 A
P channel: V_{DD} = -25 V, T_{ch} = 25 °C (initial), L = 2.999 mH, R_G = 25 Ω, I_{AR} = -4 A
Note 7: The definitions of the absolute maximum channel and storage temperatures are qualified per AEC-Q101.



FR-4
25.4 × 25.4 × 0.8
(Unit: mm)

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



FR-4
25.4 × 25.4 × 0.8
(Unit: mm)

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 °C unless otherwise specified)

6.1.1. N-Channel MOSFET

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current	I_{GSS}	V_{GS} = ±16 V, V_{DS} = 0 V	—	—	±10	μA
Drain cut-off current	I_{DSS}	V_{DS} = 40 V, V_{GS} = 0 V	—	—	10	
Drain-source breakdown voltage	$V_{(BR)DSS}$	I_D = 10 mA, V_{GS} = 0 V	40	—	—	V
Drain-source breakdown voltage (Note 8)	$V_{(BR)DSX}$	I_D = 10 mA, V_{GS} = -20 V	20	—	—	
Gate threshold voltage	V_{th}	V_{DS} = 10 V, I_D = 1 mA	2	2.5	3	
Drain-source on-resistance	$R_{DS(ON)}$	V_{GS} = 6 V, I_D = 2.5 A	—	39.3	62.8	mΩ
		V_{GS} = 10 V, I_D = 2.5 A	—	29.1	36.3	

6.1.2. P-Channel MOSFET

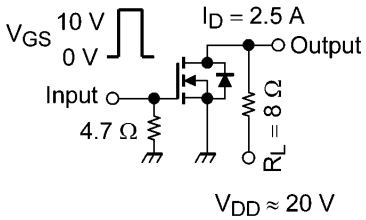
Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current	I_{GSS}	V_{GS} = -16/+10 V, V_{DS} = 0 V	—	—	±10	μA
Drain cut-off current	I_{DSS}	V_{DS} = -40 V, V_{GS} = 0 V	—	—	-10	
Drain-source breakdown voltage	$V_{(BR)DSS}$	I_D = -10 mA, V_{GS} = 0 V	-40	—	—	V
Drain-source breakdown voltage (Note 8)	$V_{(BR)DSX}$	I_D = -10 mA, V_{GS} = 10 V	-30	—	—	
Gate threshold voltage	V_{th}	V_{DS} = -10 V, I_D = -1 mA	-2	-2.5	-3	
Drain-source on-resistance	$R_{DS(ON)}$	V_{GS} = -6 V, I_D = -2 A	—	51.4	82.2	mΩ
		V_{GS} = -10 V, I_D = -2 A	—	43.7	56.8	

Note 8: If a reverse bias is applied between gate and source, this device enters $V_{(BR)DSX}$ mode. Note that the drain-source breakdown voltage is lowered in this mode.

6.2. Dynamic Characteristics (T_a = 25 °C unless otherwise specified)

6.2.1. N-Channel MOSFET

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Input capacitance	C_{iss}	V_{DS} = 10 V, V_{GS} = 0 V, f = 1 MHz	—	505	—	pF
Reverse transfer capacitance	C_{rss}		—	66	—	
Output capacitance	C_{oss}		—	115	—	
Switching time (rise time)	t_r	See Fig. 6.2.1.1.	—	5	—	ns
Switching time (turn-on time)	t_{on}		—	12	—	
Switching time (fall time)	t_f		—	4	—	
Switching time (turn-off time)	t_{off}		—	17	—	

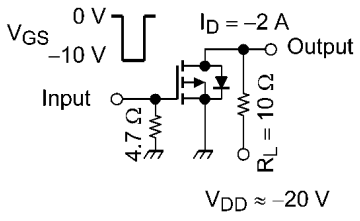


Duty ≤ 1%, t_w = 10 μs

Fig. 6.2.1.1 Switching Time Test Circuit

6.2.2. P-Channel MOSFET

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Input capacitance	C_{iss}	V_{DS} = -10 V, V_{GS} = 0 V, f = 1 MHz	—	810	—	pF
Reverse transfer capacitance	C_{rss}		—	85	—	
Output capacitance	C_{oss}		—	130	—	
Switching time (rise time)	t_r	See Fig. 6.2.2.1.	—	8	—	ns
Switching time (turn-on time)	t_{on}		—	25	—	
Switching time (fall time)	t_f		—	33	—	
Switching time (turn-off time)	t_{off}		—	126	—	



Duty≤1%, t_w = 10 μs

Fig. 6.2.2.1 Switching Time Test Circuit

6.3. Gate Charge Characteristics (T_a = 25 °C unless otherwise specified)

6.3.1. N-Channel MOSFET

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Total gate charge (gate-source plus gate-drain)	Q_g	V_{DD} ≈ 32 V, V_{GS} = 10 V, I_D = 5 A	—	11.8	—	nC
Gate-source charge 1	Q_{gs1}		—	2.1	—	
Gate-drain charge	Q_{gd}		—	3.9	—	
Gate switch charge	Q_{SW}		—	4.7	—	

6.3.2. P-Channel MOSFET

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Total gate charge (gate-source plus gate-drain)	Q_g	V_{DD} ≈ -32 V, V_{GS} = -10 V, I_D = -4 A	—	18	—	nC
Gate-source charge 1	Q_{gs1}		—	2.6	—	
Gate-drain charge	Q_{gd}		—	4.6	—	
Gate switch charge	Q_{SW}		—	5.5	—	

6.4. Source-Drain Characteristics (T_a = 25 °C unless otherwise specified)

6.4.1. N-Channel MOSFET

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Reverse drain current (pulsed) (Note 9)	I_{DRP}	—	—	—	20	A
Diode forward voltage	V_{DSF}	I_{DR} = 5 A, V_{GS} = 0 V	—	—	-1.2	V

6.4.2. P-Channel MOSFET

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Reverse drain current (pulsed) (Note 9)	I_{DRP}	—	—	—	-16	A
Diode forward voltage	V_{DSF}	I_{DR} = -4 A, V_{GS} = 0 V	—	—	1.2	V

Note 9: Ensure that the channel temperature does not exceed 175 °C.

7. Marking

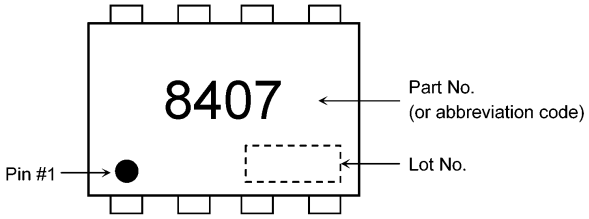


Fig. 7.1 Marking

8. Characteristics Curves (Note)

8.1. N-Channel MOSFET

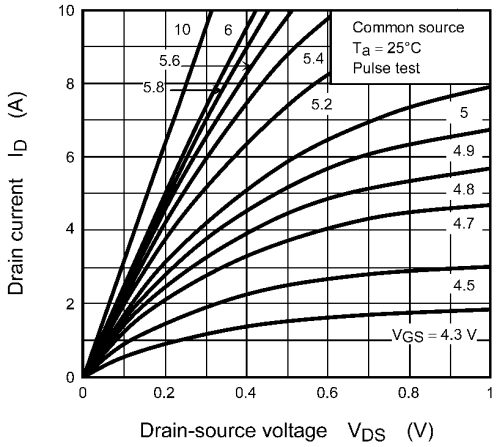


Fig. 8.1.1 I_D - V_{DS}

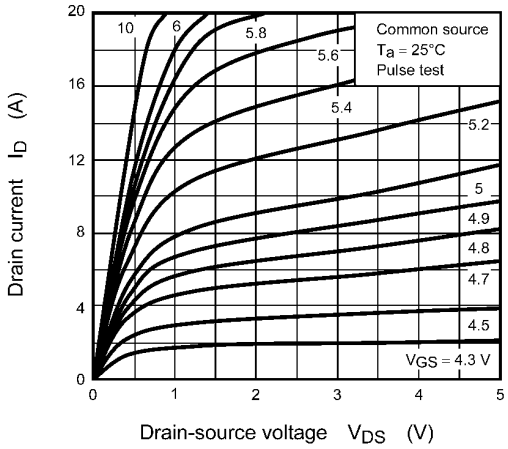


Fig. 8.1.2 I_D - V_{DS}

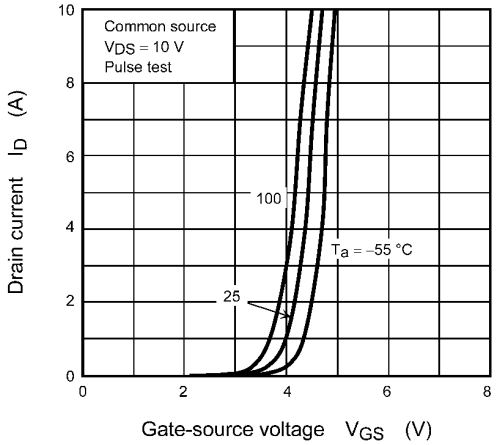


Fig. 8.1.3 I_D - V_{GS}

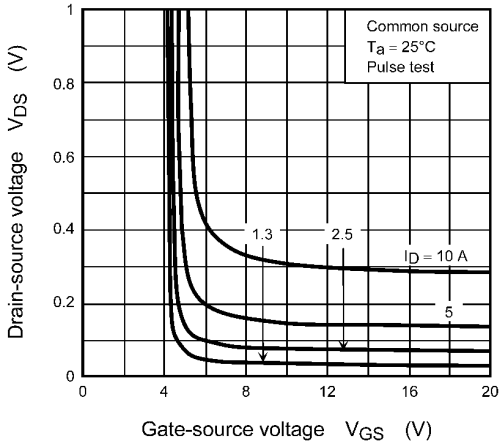


Fig. 8.1.4 V_{DS} - V_{GS}

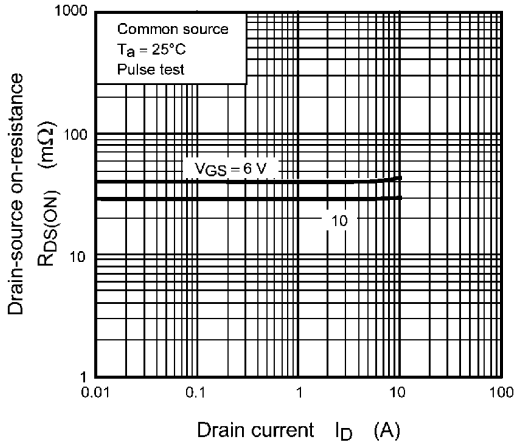


Fig. 8.1.5 $R_{DS(ON)}$ - I_D

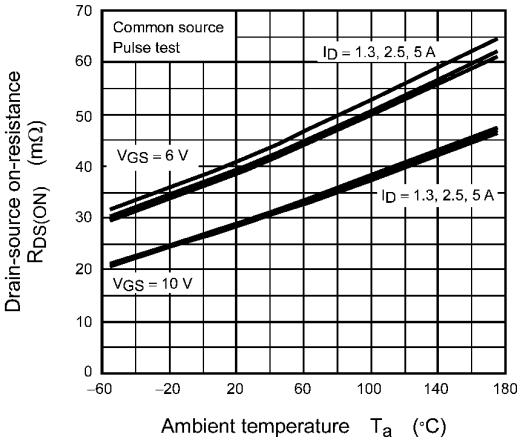


Fig. 8.1.6 $R_{DS(ON)}$ - T_a (Note 10)

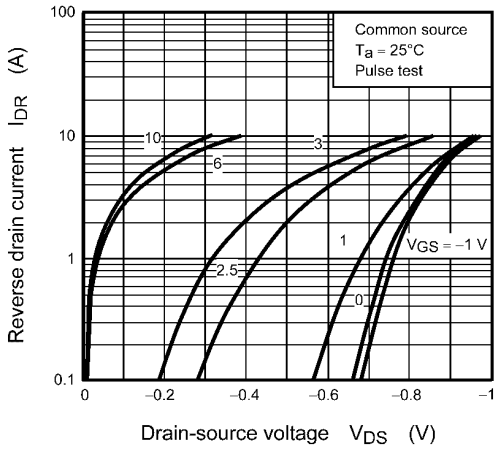


Fig. 8.1.7 I_{DR} - V_{DS}

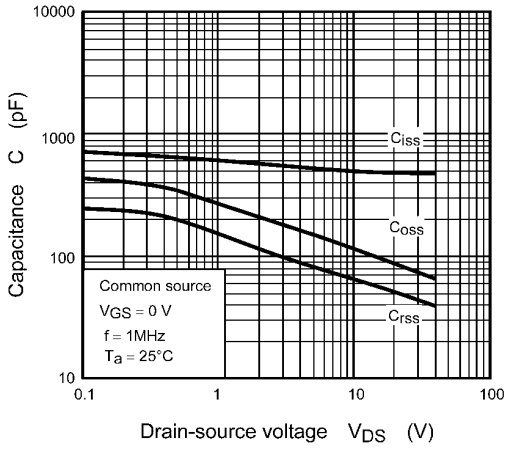


Fig. 8.1.8 Capacitance - V_{DS}

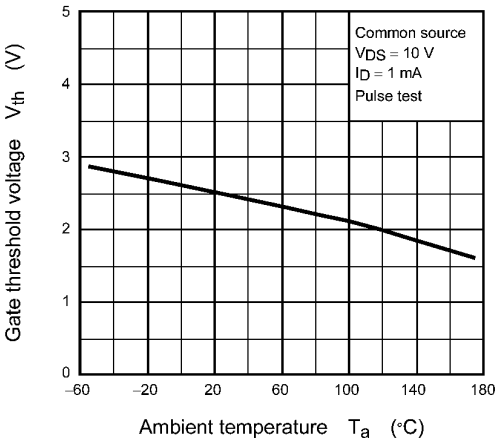


Fig. 8.1.9 V_{th} - T_a (Note 10)

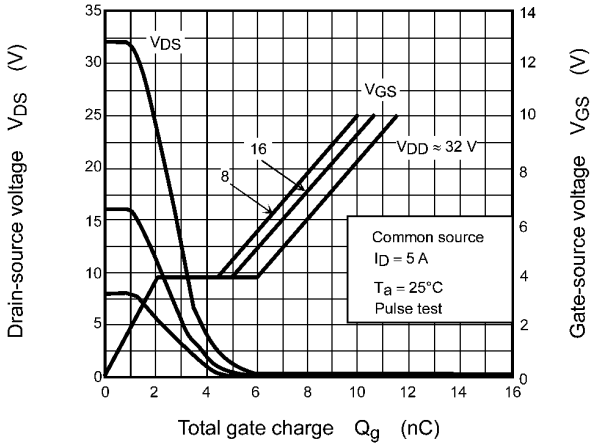


Fig. 8.1.10 Dynamic Input/Output Characteristics

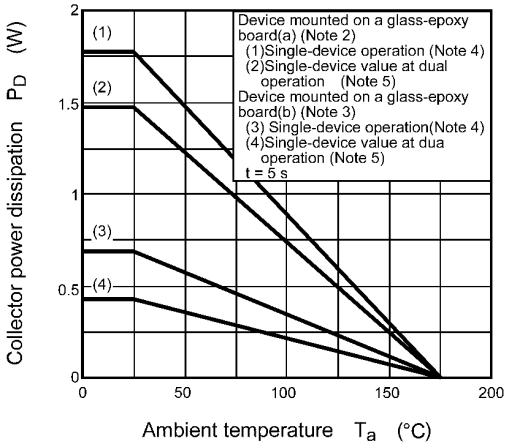


Fig. 8.1.11 P_D - T_a
(Guaranteed Maximum) (Note 10)

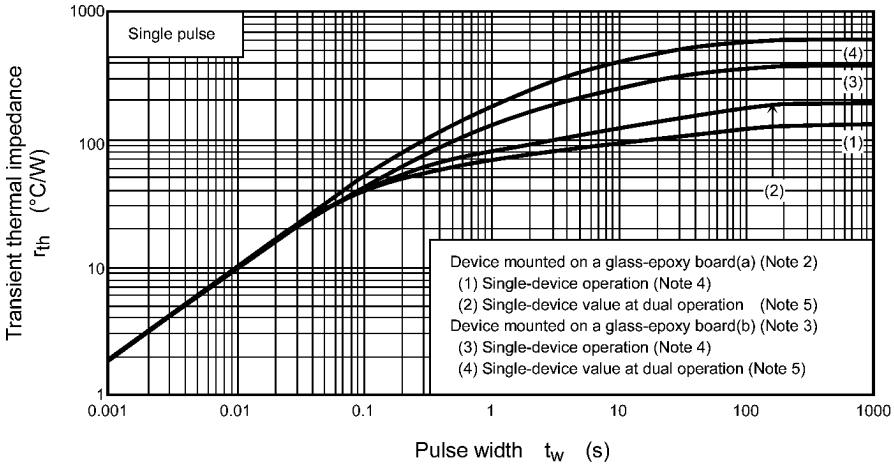


Fig. 8.1.12 r_{th} - t_w (Guaranteed Maximum)

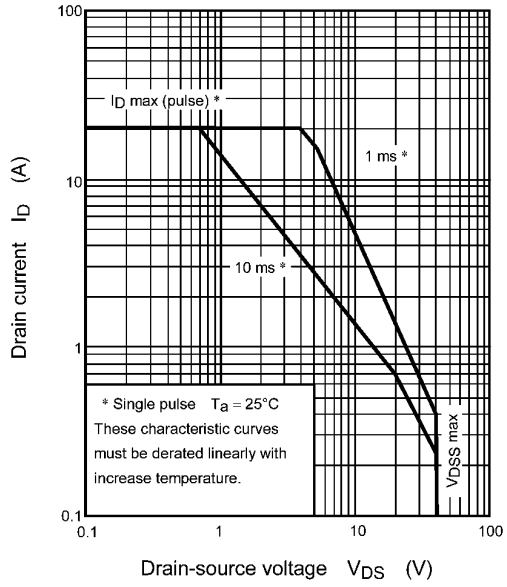


Fig. 8.1.13 Safe Operating Area (Guaranteed Maximum)

8.2. P-Channel MOSFET

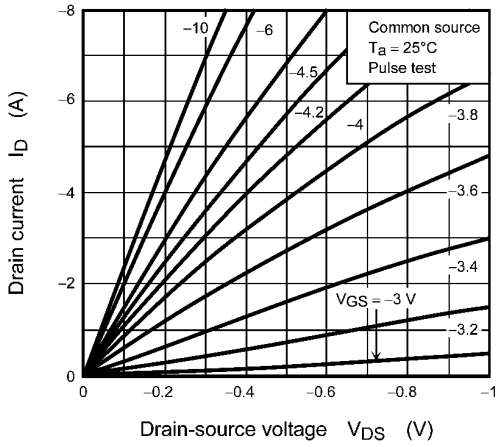


Fig. 8.2.1 I_D - V_{DS}

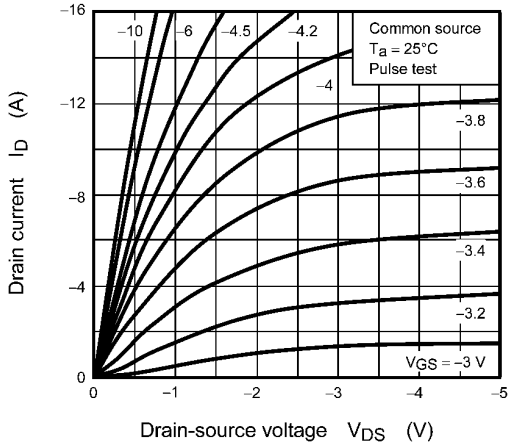


Fig. 8.2.2 I_D - V_{DS}

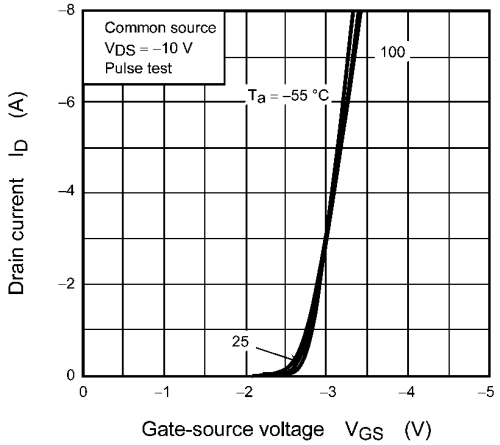


Fig. 8.2.3 I_D - V_{GS}

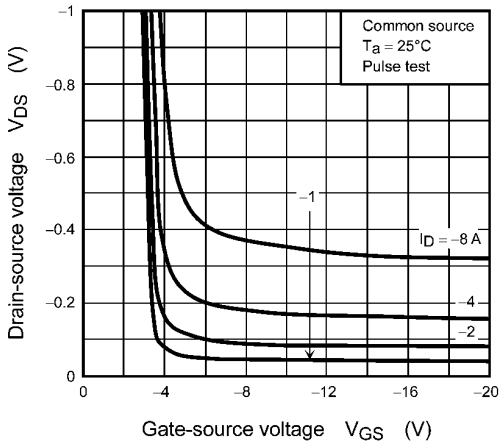


Fig. 8.2.4 V_{DS} - V_{GS}

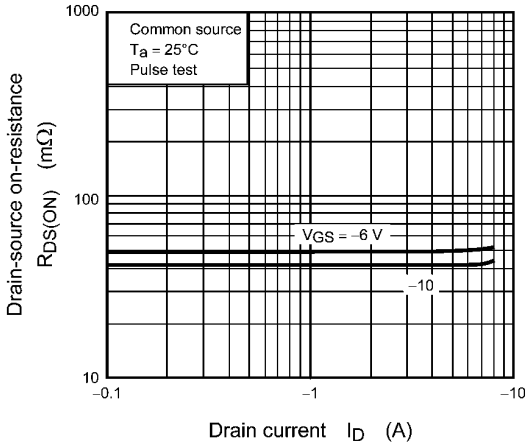


Fig. 8.2.5 $R_{DS(ON)}$ - I_D

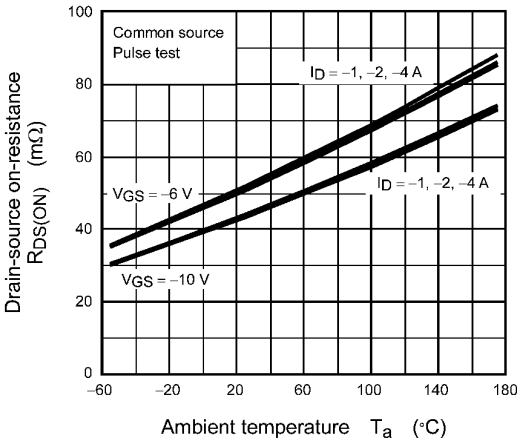


Fig. 8.2.6 $R_{DS(ON)}$ - T_a (Note 10)

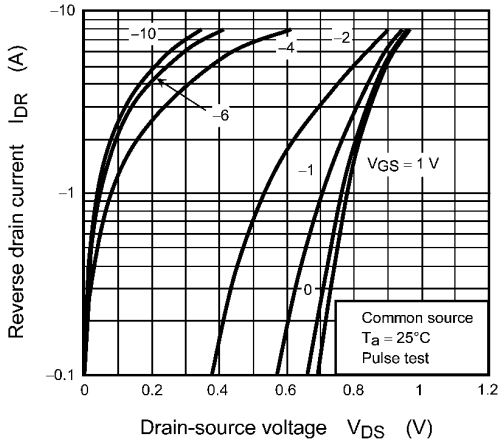


Fig. 8.2.7 I_{DR} - V_{DS}

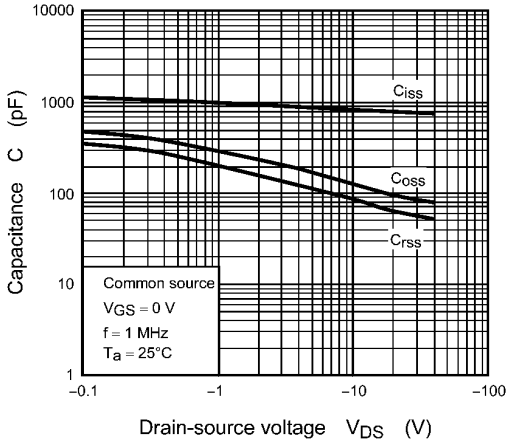


Fig. 8.2.8 Capacitance - V_{DS}

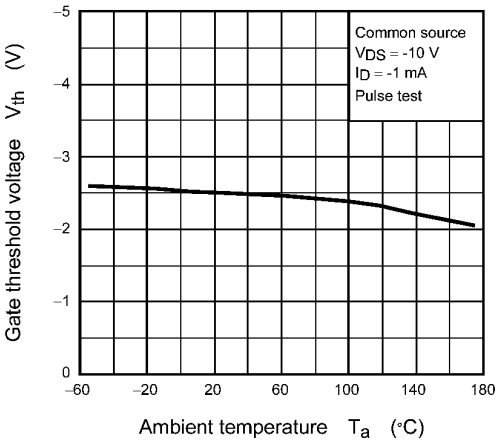


Fig. 8.2.9 V_{th} - T_a (Note 10)

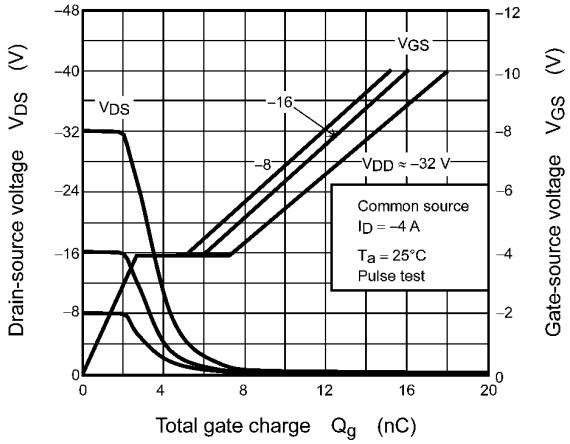


Fig. 8.2.10 Dynamic Input/Output Characteristics

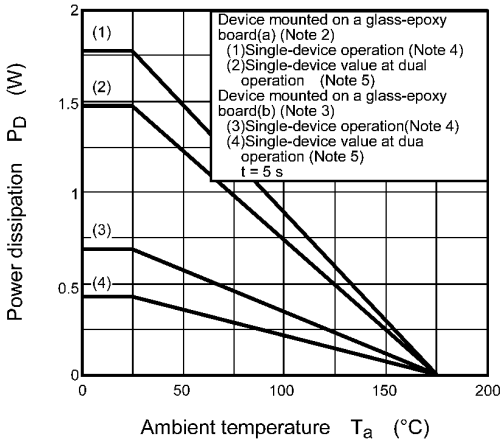


Fig. 8.2.11 P_D - T_a (Guaranteed Maximum) (Note 10)

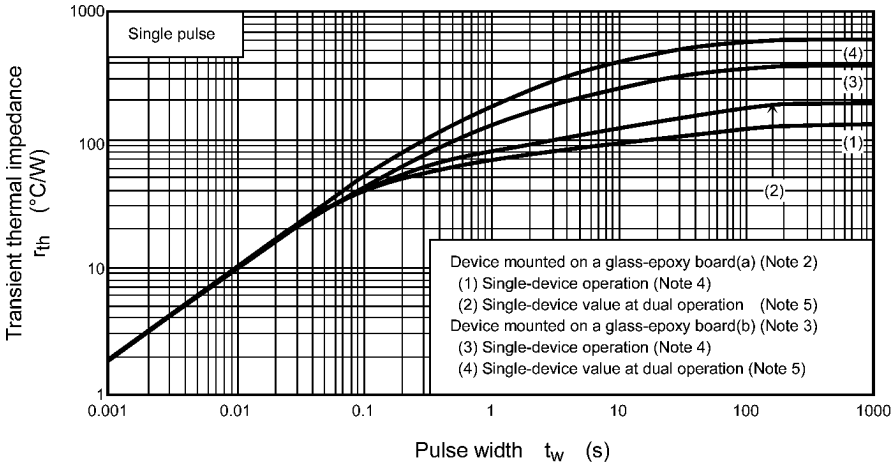


Fig. 8.2.12 r_{th} - t_w (Guaranteed Maximum)

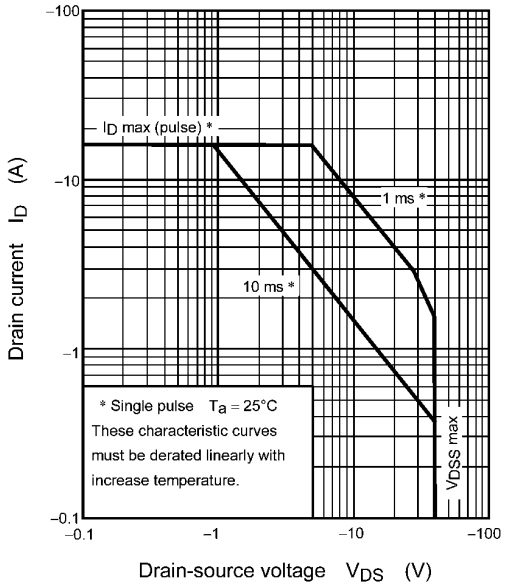


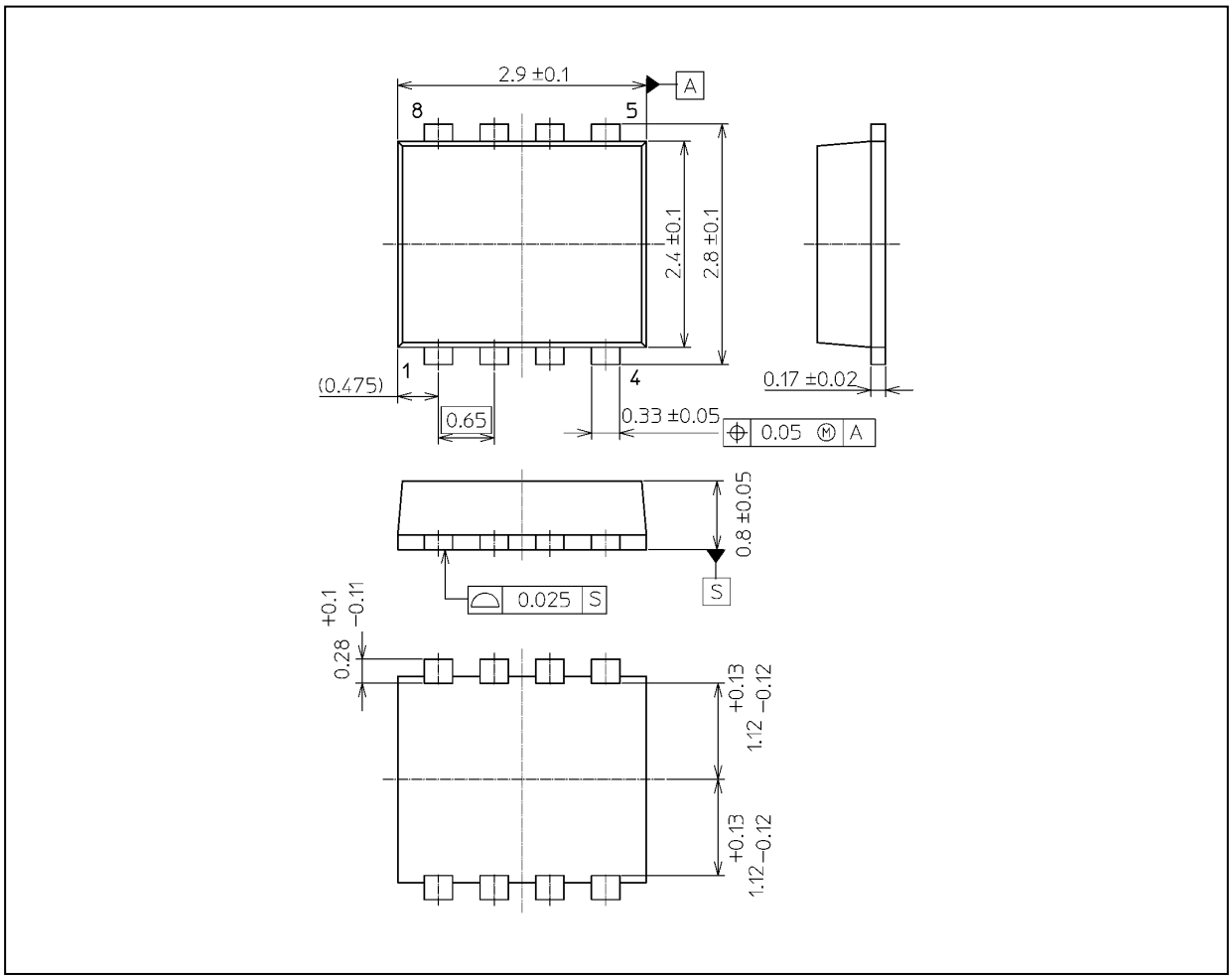
Fig. 8.2.13 Safe Operating Area (Guaranteed Maximum)

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

Note 10: The definitions of the absolute maximum channel and storage temperatures are qualified per AEC-Q101.

Package Dimensions

Unit: mm



Weight: 0.017 g (typ.)

Package Name(s)
TOSHIBA: 2-3V1S
Nickname: PS-8

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