MOSFETs Silicon N-Channel MOS (U-MOSⅥ-H)

TK40P04M1

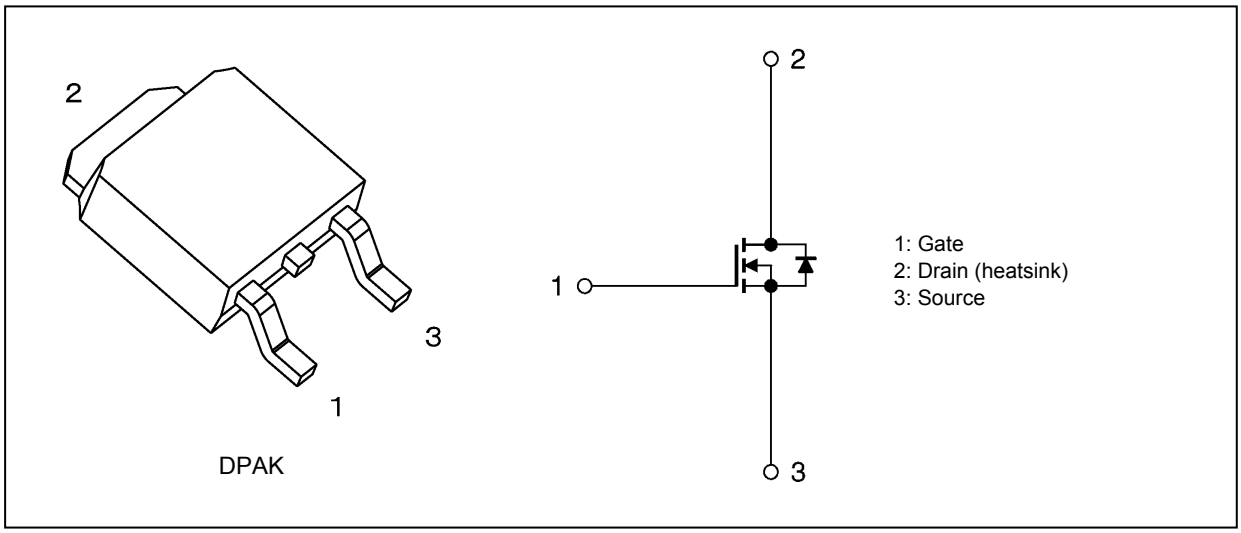
1. Applications

- Switching Voltage Regulators
- Motor Drivers

2. Features

(1) High-speed switching
(2) Low gate charge: Q_{SW} = 7.4 nC (typ.)
(3) Low drain-source on-resistance: $R_{DS(ON)}$ = 8.5 mΩ (typ.) (V_{GS} = 10 V)
(4) Low leakage current: I_{DSS} = 10 μA (max) (V_{DS} = 40 V)
(5) Enhancement mode: V_{th} = 1.3 to 2.3 V (V_{DS} = 10 V, I_D = 0.2 mA)

3. Packaging and Internal Circuit



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

Characteristics		Symbol	Rating	Unit
Drain-source voltage		V_{DSS}	40	V
Gate-source voltage		V_{GSS}	±20	
Drain current (DC)	(Note 1)	I_D	40	A
Drain current (pulsed)	(Note 1)	I_{DP}	120	
Power dissipation	(T_c = 25°C)	P_D	47	W
Single-pulse avalanche energy	(Note 2)	E_{AS}	41	mJ
Avalanche current		I_{AR}	40	A
Channel temperature		T_{ch}	150	°C
Storage temperature		T_{stg}	-55 to 150	

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	$R_{th(ch-c)}$	2.65	°C/W
Channel-to-ambient thermal resistance	$R_{th(ch-a)}$	125	

Note 1: Ensure that the channel temperature does not exceed 150°C.
Note 2: V_{DD} = 32 V, T_{ch} = 25°C (initial), L = 20 μH, R_G = 25 Ω, I_{AR} = 40 A

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

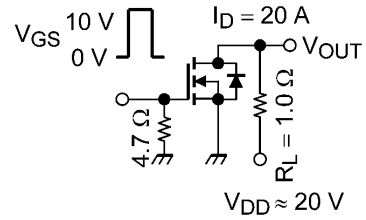
6. Electrical Characteristics

6.1. Static Characteristics (T_a = 25°C unless otherwise specified)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current	I_{GSS}	V_{GS} = ±20 V, V_{DS} = 0 V	—	—	±0.1	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
	$V_{(BR)DSX}$	I_D = 10 mA, V_{GS} = -20 V	25	—	—	
Gate threshold voltage	V_{th}	V_{DS} = 10 V, I_D = 0.2 mA	1.3	—	2.3	
Drain-source on-resistance	$R_{DS(ON)}$	V_{GS} = 4.5 V, I_D = 20 A	—	10.3	13.4	mΩ
		V_{GS} = 10 V, I_D = 20 A	—	8.5	11	

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

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Input capacitance	C_{iss}	V_{DS} = 10 V, V_{GS} = 0 V, f = 1 MHz	—	1920	—	pF
Reverse transfer capacitance	C_{rss}		—	90	—	
Output capacitance	C_{oss}		—	310	—	
Gate resistance	r_g	V_{DS} = 10 V, V_{GS} = 0 V, f = 5 MHz	—	1.6	3.5	Ω
Switching time (rise time)	t_r	See Figure 6.2.1.	—	20	—	ns
Switching time (turn-on time)	t_{on}		—	27	—	
Switching time (fall time)	t_f		—	18	—	
Switching time (turn-off time)	t_{off}		—	63	—	



Duty ≤ 1%, t_w = 10 μs

Fig. 6.2.1 Switching Time Test Circuit

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

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 = 40 A	—	29	—	nC
		V_{DD} ≈ 32 V, V_{GS} = 5 V, I_D = 40 A	—	15	—	
Gate-source charge 1	Q_{gs1}	V_{DD} ≈ 32 V, V_{GS} = 10 V, I_D = 40 A	—	6.0	—	
Gate-drain charge	Q_{gd}		—	4.7	—	
Gate switch charge	Q_{SW}		—	7.4	—	

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

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Reverse drain current (pulsed) (Note 3)	I_{DRP}	—	—	—	120	A
Diode forward voltage	V_{DSF}	I_{DR} = 40 A, V_{GS} = 0 V	—	—	-1.2	V

Note 3: Ensure that the channel temperature does not exceed 150°C.

7. Marking

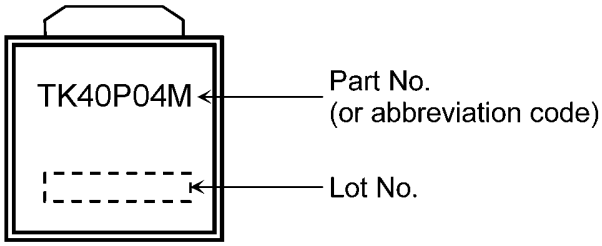


Fig. 7.1 Marking

8. Characteristics Curves (Note)

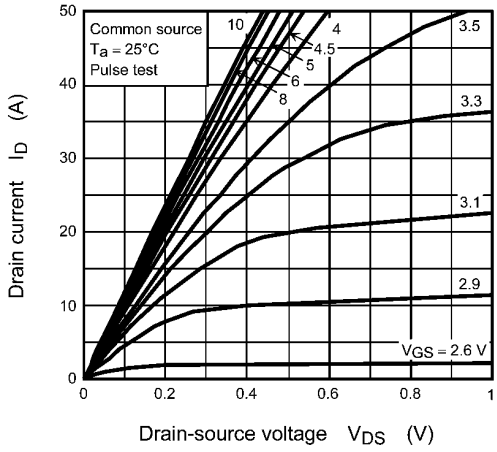


Fig. 8.1 I_D - V_{DS}

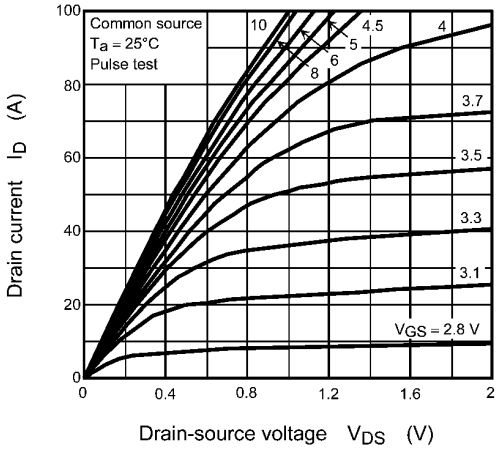


Fig. 8.2 I_D - V_{DS}

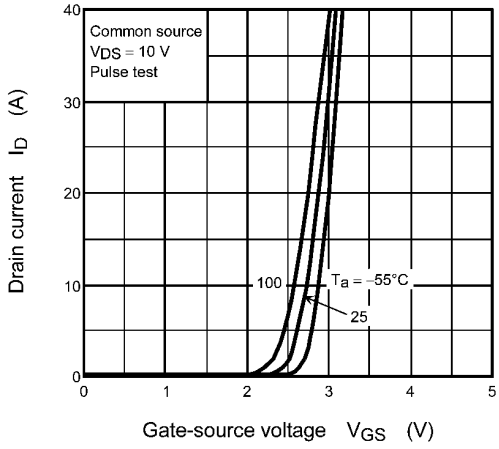


Fig. 8.3 I_D - V_{GS}

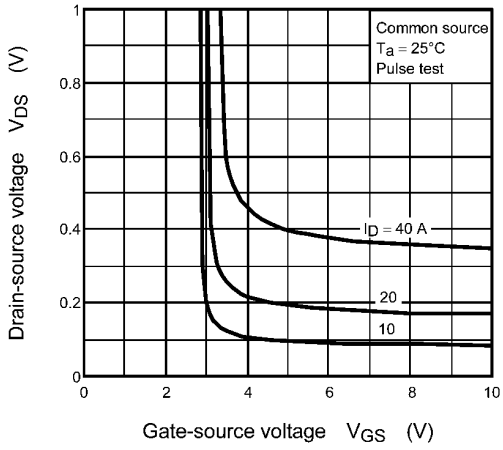


Fig. 8.4 V_{DS} - V_{GS}

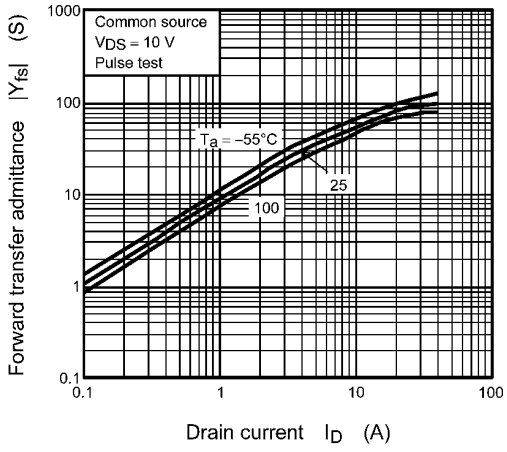


Fig. 8.5 $|Y_{fs}|$ - I_D

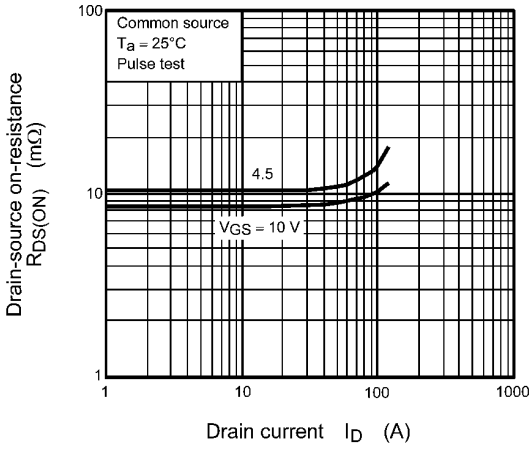


Fig. 8.6 $R_{DS(ON)}$ - I_D

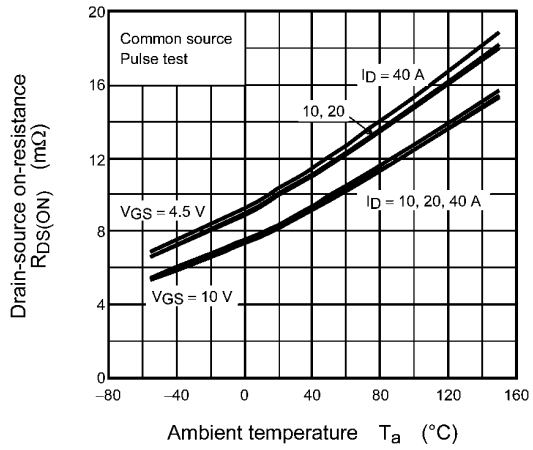


Fig. 8.7 $R_{DS(ON)}$ - T_a

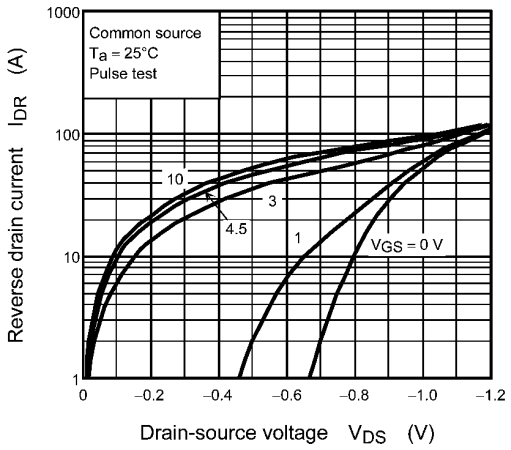


Fig. 8.8 I_{DR} - V_{DS}

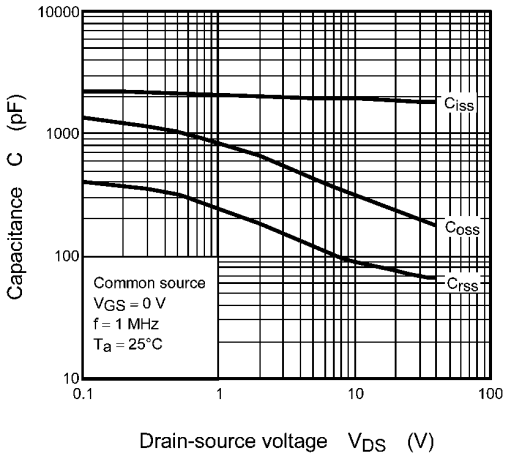


Fig. 8.9 Capacitance - V_{DS}

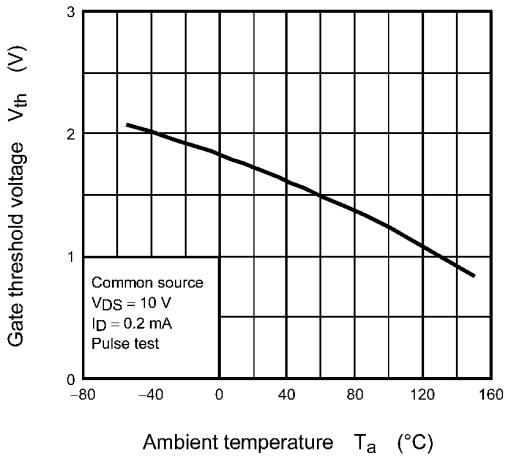


Fig. 8.10 V_{th} - T_a

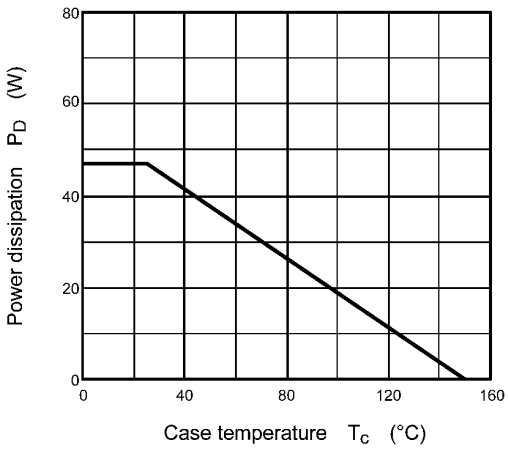


Fig. 8.11 P_D - T_c
(Guaranteed Maximum)

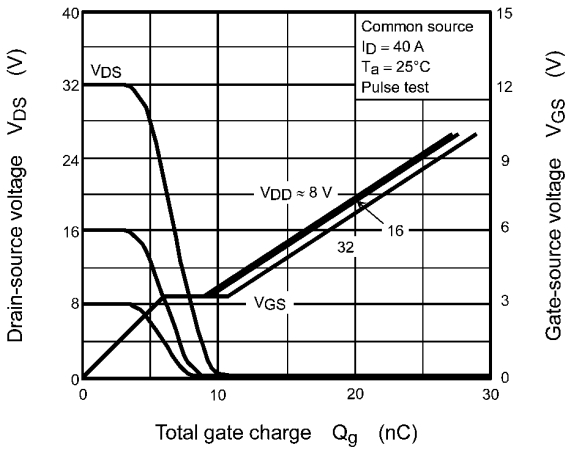


Fig. 8.12 Dynamic Input/Output Characteristics

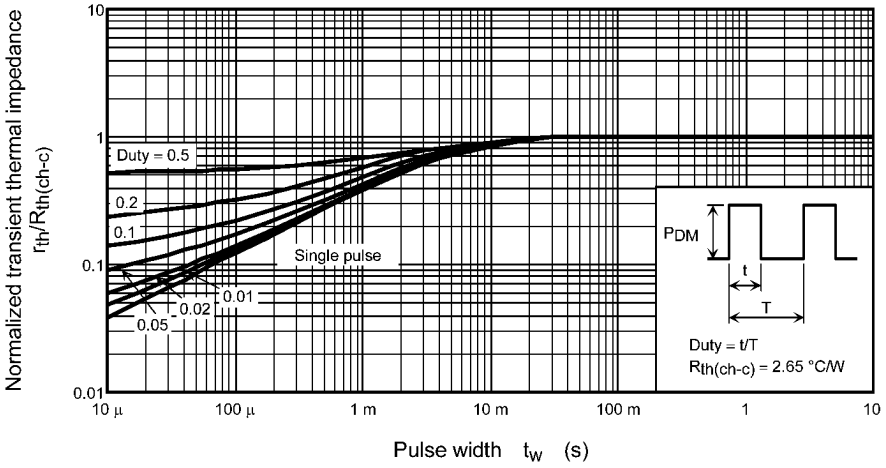


Fig. 8.13 $r_{th}/R_{th(ch-c)}$ - t_w (Guaranteed Maximum)

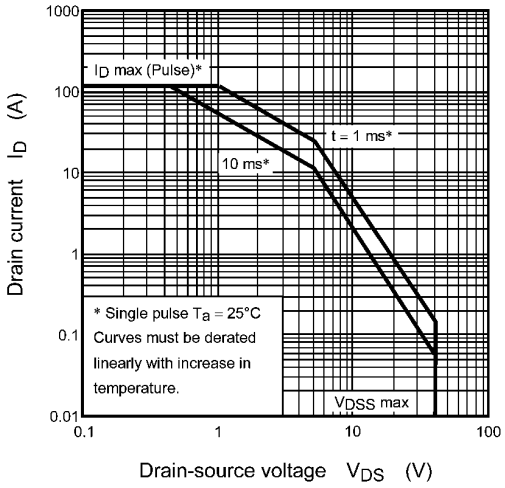


Fig. 8.14 Safe Operating Area (Guaranteed Maximum)

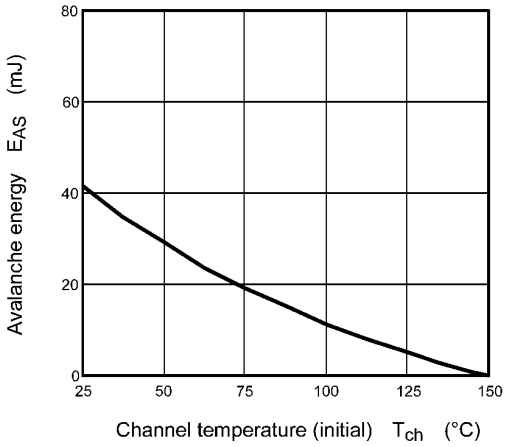
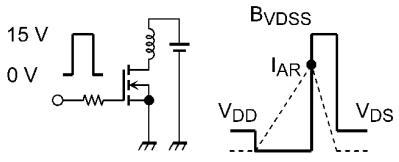


Fig. 8.15 E_{AS} - T_{ch} (Guaranteed Maximum)



$R_G = 25\ \Omega$
V_{DD} = 32 V, L = 20 μH

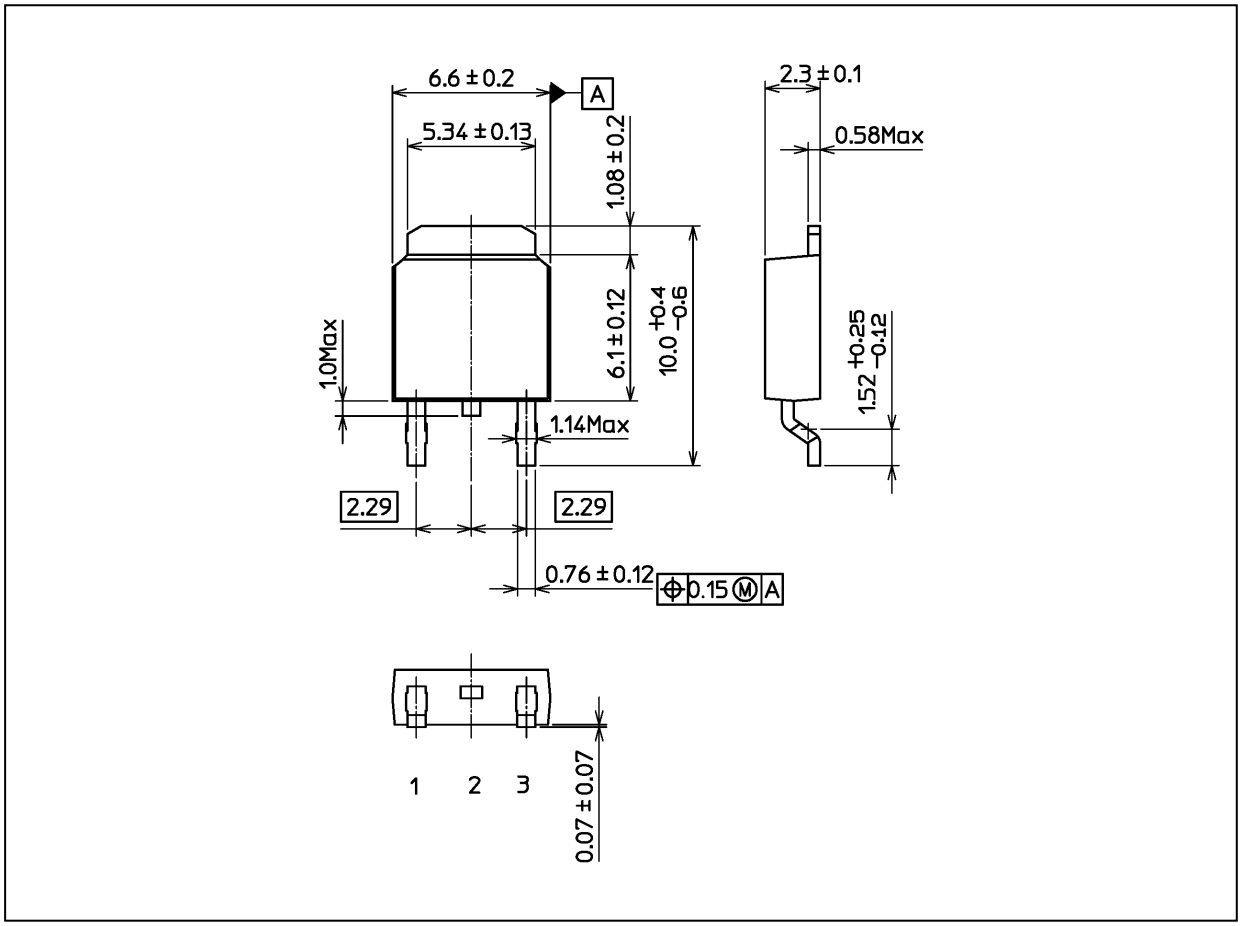
$$E_{AS} = \frac{1}{2} \cdot L \cdot I_{AR}^2 \cdot \left(\frac{B_{VDSS}}{B_{VDSS} - V_{DD}} \right)$$

Fig. 8.16 Test Circuit/Waveform

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

Package Dimensions

Unit: mm



Weight: 0.36 g (typ.)

Package Name(s)
TOSHIBA: 2-7K1S
Nickname: DPAK

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