

TK40P04M1

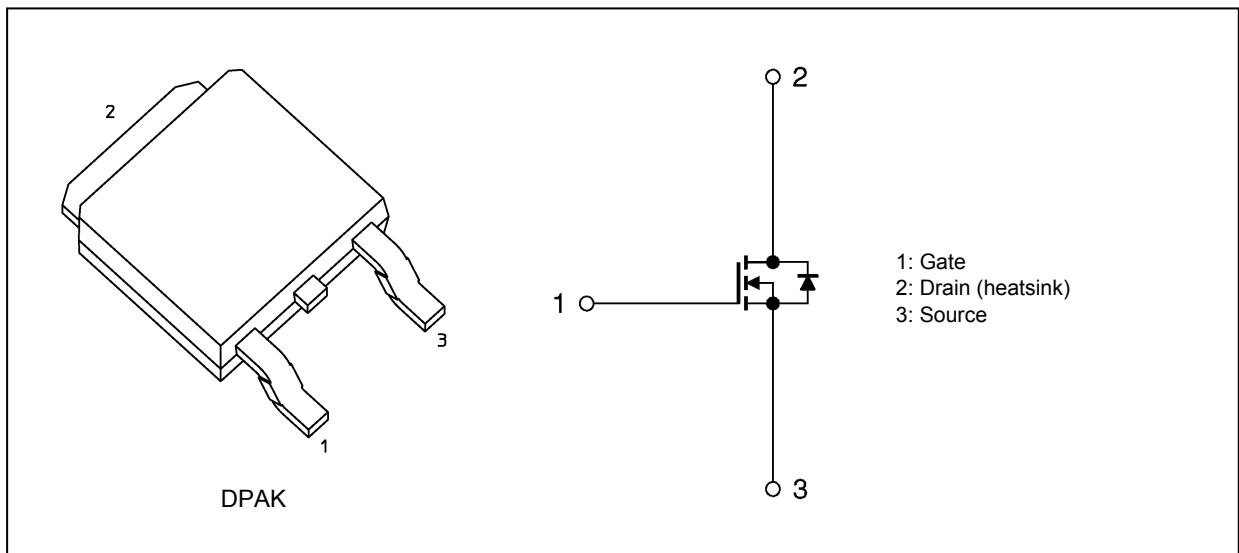
1. Applications

- Switching Voltage Regulators
- Motor Drivers
- Power Management Switches

2. Features

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

3. Packaging and Internal Circuit



Start of commercial production

2008-12

4. Absolute Maximum Ratings (Note) ($T_a = 25^\circ\text{C}$ 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 ($T_c = 25^\circ\text{C}$) | P_D | 47 | W |
| Single-pulse avalanche energy (Note 2) | E_{AS} | 41 | mJ |
| Single-pulse avalanche current | I_{AS} | 40 | A |
| Channel temperature | T_{ch} | 150 | $^\circ\text{C}$ |
| 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 | $^\circ\text{C}/\text{W}$ |
| Channel-to-ambient thermal resistance | $R_{th(ch-a)}$ | 125 | |

Note 1: Ensure that the channel temperature does not exceed 150°C .

Note 2: $V_{DD} = 32\text{ V}$, $T_{ch} = 25^\circ\text{C}$ (initial), $L = 20\ \mu\text{H}$, $R_G = 25\ \Omega$, $I_{AS} = 40\text{ A}$

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

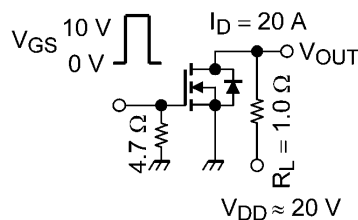
6. Electrical Characteristics

6.1. Static Characteristics ($T_a = 25^\circ\text{C}$ unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|--------------------------------|---------------|-------------------------------------------------|-----|------|-----------|------------------|
| Gate leakage current | I_{GSS} | $V_{GS} = \pm 20\text{ V}, V_{DS} = 0\text{ V}$ | — | — | ± 0.1 | μA |
| Drain cut-off current | I_{DSS} | $V_{DS} = 40\text{ V}, V_{GS} = 0\text{ V}$ | — | — | 10 | |
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | $I_D = 10\text{ mA}, V_{GS} = 0\text{ V}$ | 40 | — | — | V |
| | $V_{(BR)DSX}$ | $I_D = 10\text{ mA}, V_{GS} = -20\text{ V}$ | 25 | — | — | |
| Gate threshold voltage | V_{th} | $V_{DS} = 10\text{ V}, I_D = 0.2\text{ mA}$ | 1.3 | — | 2.3 | |
| Drain-source on-resistance | $R_{DS(ON)}$ | $V_{GS} = 4.5\text{ V}, I_D = 20\text{ A}$ | — | 10.3 | 13.4 | $\text{m}\Omega$ |
| | | $V_{GS} = 10\text{ V}, I_D = 20\text{ A}$ | — | 8.5 | 11 | |

6.2. Dynamic Characteristics ($T_a = 25^\circ\text{C}$ unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|--------------------------------|-----------|---------------------------------------------------------------|-----|------|-----|-------------|
| Input capacitance | C_{iss} | $V_{DS} = 10\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$ | — | 1920 | — | pF |
| Reverse transfer capacitance | C_{rss} | | — | 90 | — | |
| Output capacitance | C_{oss} | | — | 310 | — | |
| Gate resistance | r_g | $V_{DS} = 10\text{ V}, V_{GS} = 0\text{ V}, f = 5\text{ MHz}$ | — | 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 $\leq 1\%$, $t_w = 10\ \mu\text{s}$
Fig. 6.2.1 Switching Time Test Circuit

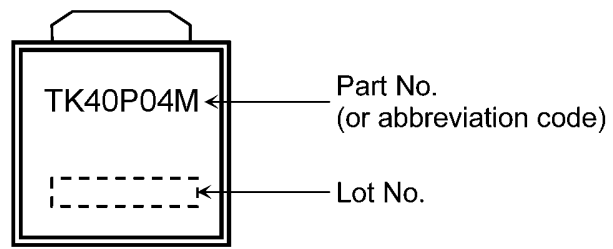
6.3. Gate Charge Characteristics ($T_a = 25^\circ\text{C}$ unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|-------------------------------------------------|-----------|-----------------------------------------------------------------------|-----|------|-----|------|
| Total gate charge (gate-source plus gate-drain) | Q_g | $V_{DD} \approx 32\text{ V}, V_{GS} = 10\text{ V}, I_D = 40\text{ A}$ | — | 29 | — | nC |
| | | $V_{DD} \approx 32\text{ V}, V_{GS} = 5\text{ V}, I_D = 40\text{ A}$ | — | 15 | — | |
| Gate-source charge 1 | Q_{gs1} | $V_{DD} \approx 32\text{ V}, V_{GS} = 10\text{ V}, I_D = 40\text{ A}$ | — | 6.0 | — | |
| Gate-drain charge | Q_{gd} | | — | 4.7 | — | |
| Gate switch charge | Q_{sw} | | — | 7.4 | — | |

6.4. Source-Drain Characteristics ($T_a = 25^\circ\text{C}$ 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} | $I_{DR} = 40\text{ A}, V_{GS} = 0\text{ V}$ | — | — | -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)

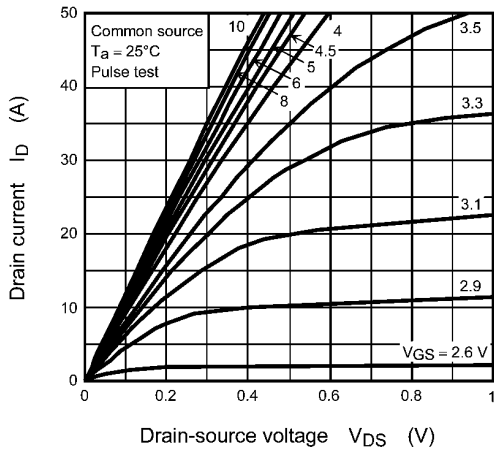


Fig. 8.1 $I_D - V_{DS}$

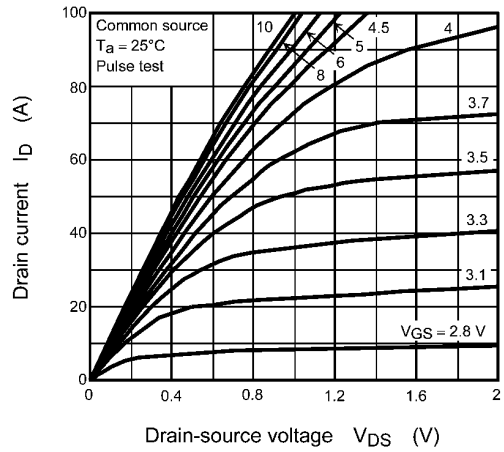


Fig. 8.2 $I_D - V_{DS}$

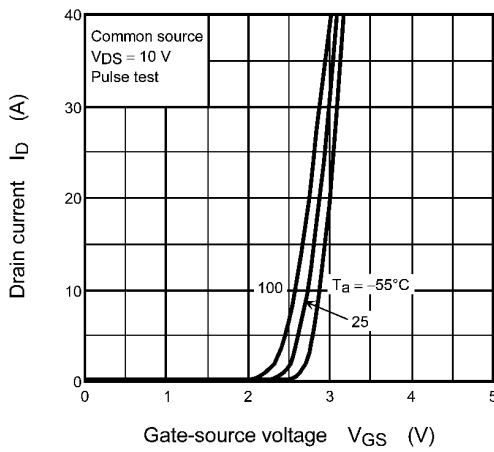


Fig. 8.3 $I_D - V_{GS}$

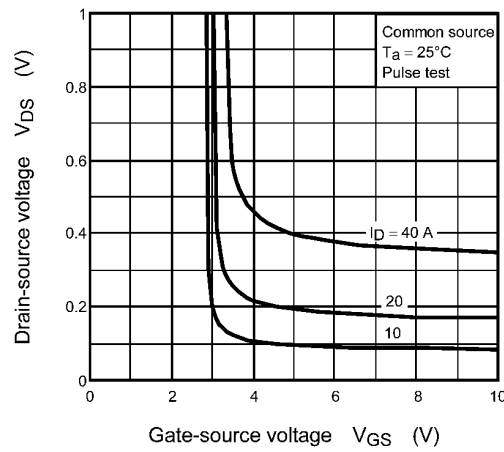


Fig. 8.4 $V_{DS} - V_{GS}$

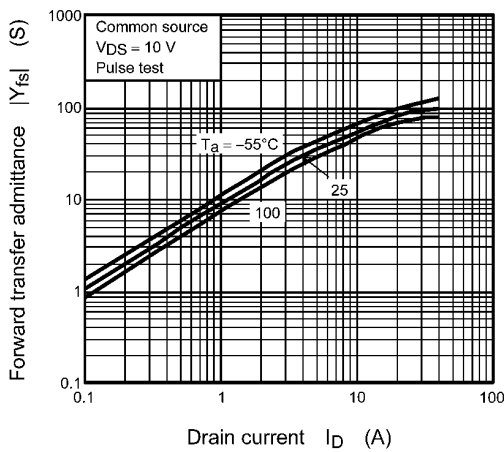


Fig. 8.5 $|Y_{fs}| - I_D$

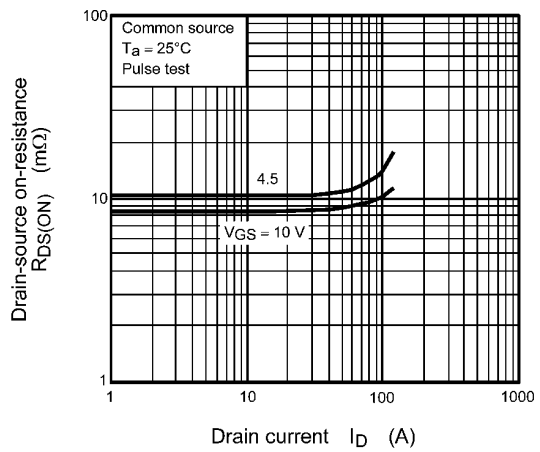


Fig. 8.6 $R_{DS(ON)} - I_D$

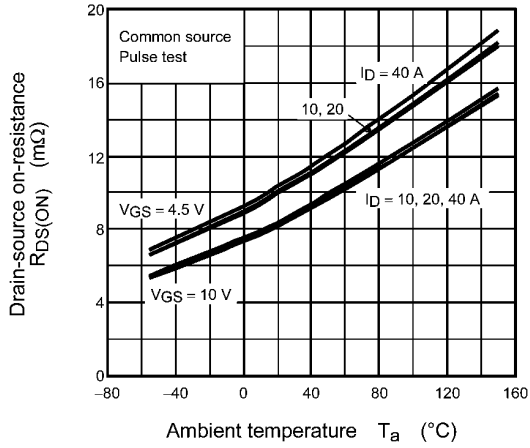


Fig. 8.7 $R_{DS(ON)} - T_a$

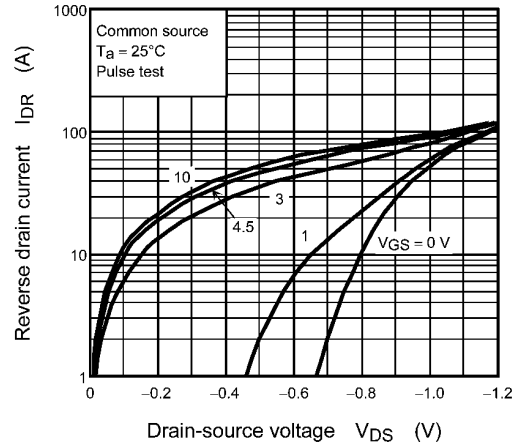


Fig. 8.8 $I_{DR} - V_{DS}$

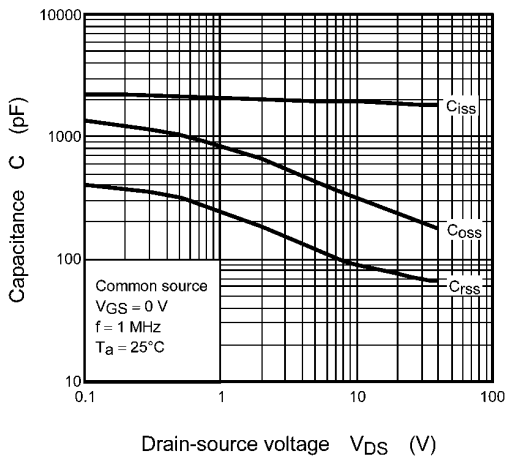


Fig. 8.9 Capacitance - V_{DS}

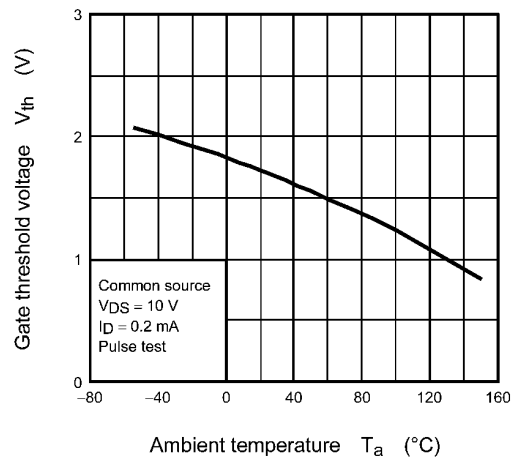


Fig. 8.10 $V_{th} - T_a$

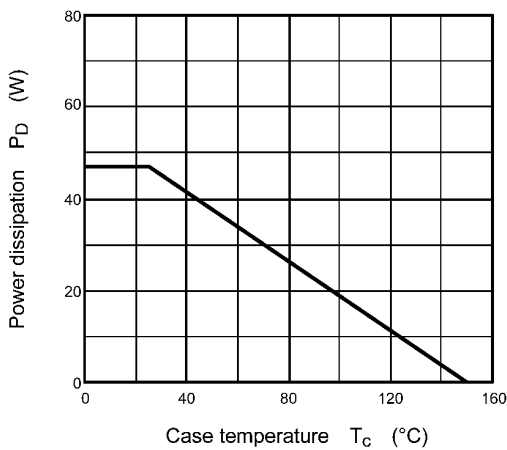


Fig. 8.11 $P_D - T_c$
(Guaranteed Maximum)

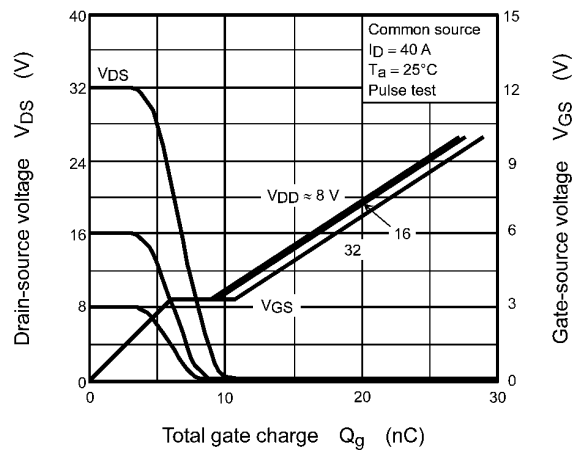


Fig. 8.12 Dynamic Input/Output Characteristics

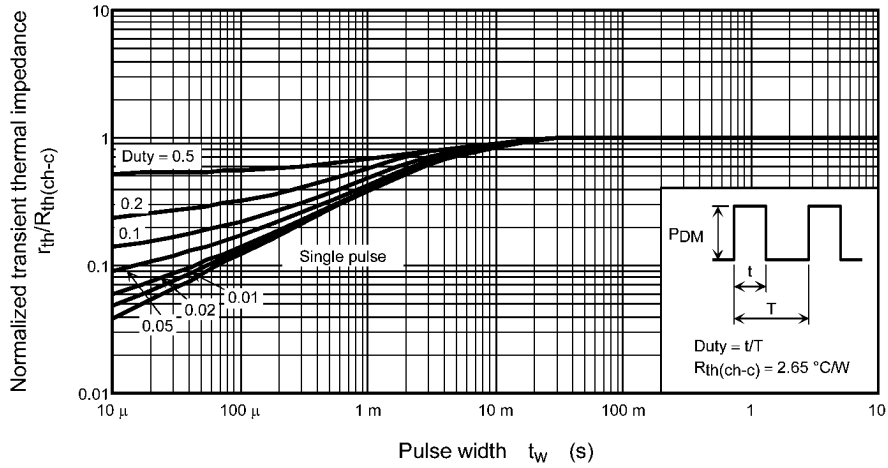


Fig. 8.13 $r_{th}/R_{th(ch-c)} - t_w$
(Guaranteed Maximum)

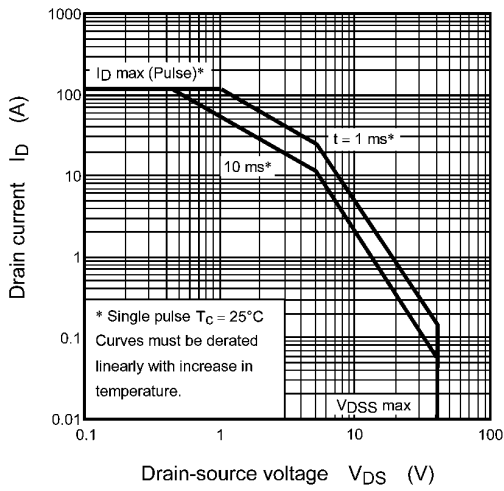


Fig. 8.14 Safe Operating Area
(Guaranteed Maximum)

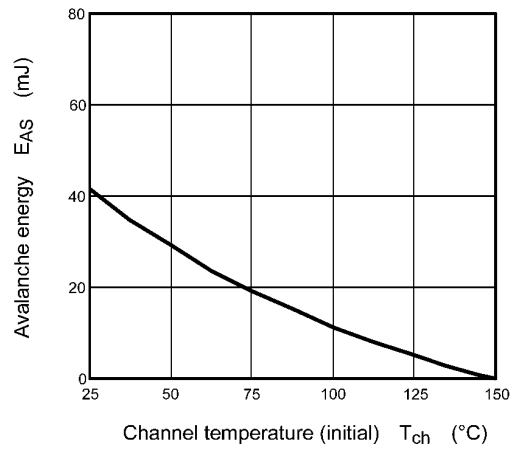


Fig. 8.15 $E_{AS} - T_{ch}$
(Guaranteed Maximum)

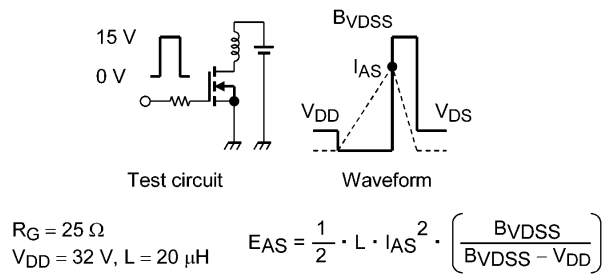


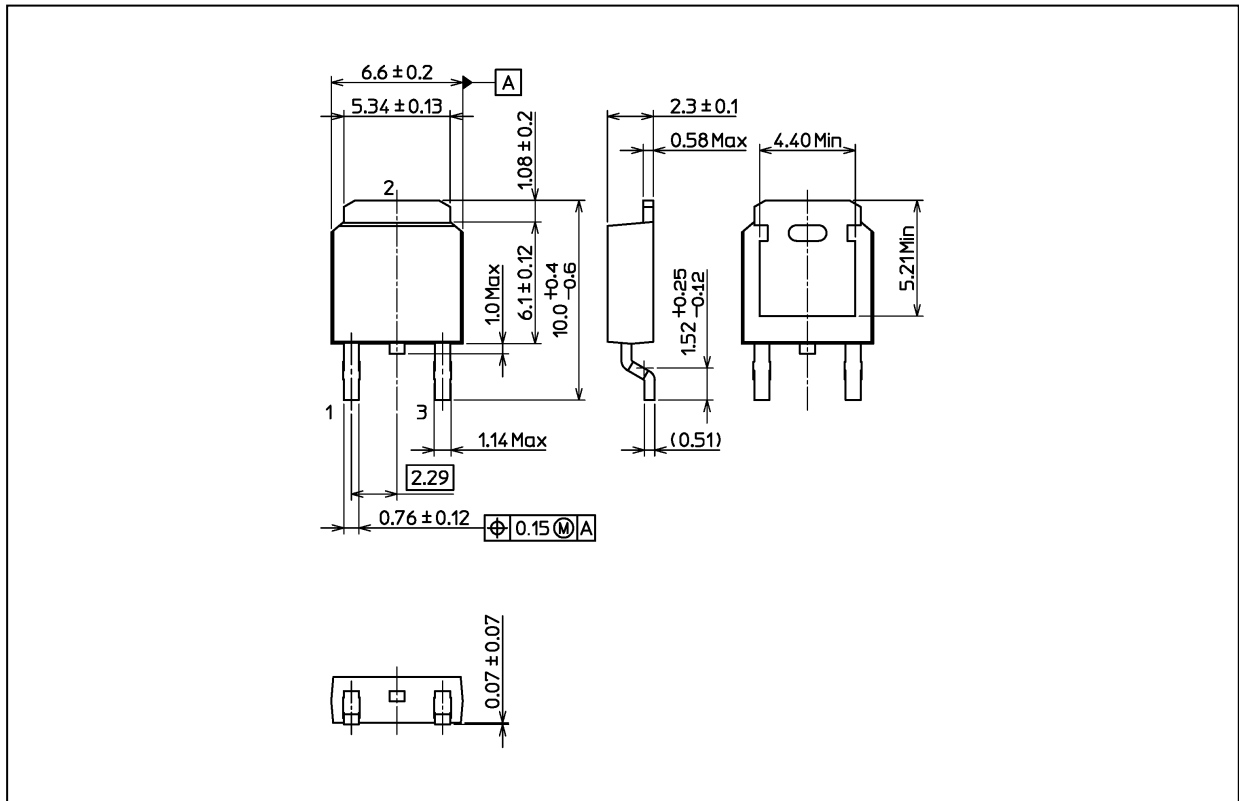
Fig. 8.16 Test Circuit/Waveform

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

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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