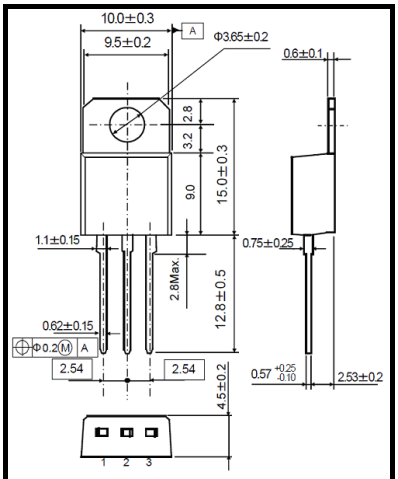
TOSHIBA Field Effect Transistor Silicon N Channel MOS Type (Ultra-High-Speed U-MOSⅢ)

# TK70D06J1

## Switching Regulator Application

- High-Speed switching
- Small gate charge: $Q_g$ = 87 nC (typ.)
- Low drain-source ON resistance: $R_{DS\ (ON)}$ = 5.1 mΩ (typ.)
- High forward transfer admittance: $|Y_{fs}|$ = 80 S (typ.)
- Low leakage current: $I_{DSS}$ = 10 μA (max) ($V_{DS}$ = 60 V)
- Enhancement-mode: $V_{th}$ = 1.1 to 2.3 V ($V_{DS}$ = 10 V, $I_D$ = 1 mA)

Unit: mm




| | |
|---|---|
| JEDEC | - |
| JEITA | - |
| TOSHIBA | 2-10V1A |

Weight: 1.35 g (typ.)

## Absolute Maximum Ratings (Ta = 25°C)

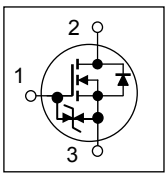
| Characteristics | | Symbol | Rating | Unit |
|---|---|---|---|---|
| Drain-source voltage | | $V_{DSS}$ | 60 | V |
| Drain-gate voltage ($R_{GS}$ = 20 kΩ) | | $V_{DGR}$ | 60 | V |
| Gate-source voltage | | $V_{GSS}$ | ±20 | V |
| Drain current | DC (Note 1) | $I_D$ | 70 | A |
| | Pulse (Note 1) | $I_{DP}$ | 280 | |
| Drain power dissipation (Tc = 25°C) | | $P_D$ | 140 | W |
| Single pulse avalanche energy (Note 2) | | $E_{AS}$ | 751 | mJ |
| Avalanche current | | $I_{AR}$ | 70 | A |
| Repetitive avalanche energy (Note 3) | | $E_{AR}$ | 10.3 | mJ |
| Channel temperature | | $T_{ch}$ | 150 | °C |
| Storage temperature range | | $T_{stg}$ | −55~150 | °C |

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).

## Thermal Characteristics

| Characteristics | Symbol | Max | Unit |
|---|---|---|---|
| Thermal resistance, channel to case | $R_{th\ (ch-c)}$ | 0.89 | °C/W |
| Thermal resistance, channel to ambient | $R_{th\ (ch-a)}$ | 83.3 | °C/W |

Internal Connection



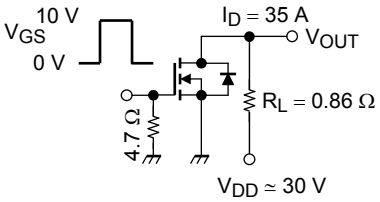

Note 1: Ensure that the channel & lead temperature does not exceed 150°C.

Note 2: $V_{DD}$ = 25 V, $T_{ch}$ = 25°C, L = 200 μH, $I_{AR}$ = 70 A, $R_G$ = 1 Ω

Note 3: Repetitive rating: pulse width limited by maximum channel temperature.

This transistor is an electrostatic-sensitive device. Handle with care.

## Electrical Characteristics (Ta = 25°C)

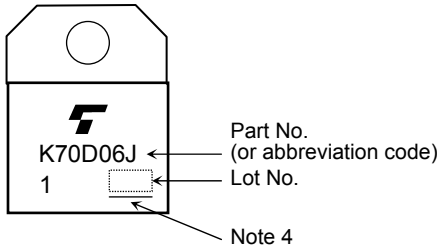
| Characteristics | | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|
| Gate leakage current | | $I_{GSS}$ | $V_{GS}$ = ±16 V, $V_{DS}$ = 0 V | — | — | ±10 | μA |
| Drain cut-OFF current | | $I_{DSS}$ | $V_{DS}$ = 60 V, $V_{GS}$ = 0 V | — | — | 10 | μA |
| Drain-source breakdown voltage | | $V_{(BR)\ DSS}$ | $I_D$ = 10 mA, $V_{GS}$ = 0 V | 60 | — | — | V |
| | | $V_{(BR)\ DSX}$ | $I_D$ = 10 mA, $V_{GS}$ = -20 V | 45 | — | — | |
| Gate threshold voltage | | $V_{th}$ | $V_{DS}$ = 10 V, $I_D$ = 1 mA | 1.1 | — | 2.3 | V |
| Drain-source ON resistance | | $R_{DS\ (ON)}$ | $V_{GS}$ = 4.5 V, $I_D$ = 35A | — | 5.8 | 7.6 | mΩ |
| | | | $V_{GS}$ = 10 V, $I_D$ = 35A | — | 5.1 | 6.4 | |
| Forward transfer admittance | | $\|Y_{fs}\|$ | $V_{DS}$ = 10 V, $I_D$ = 35 A | 40 | 80 | — | S |
| Input capacitance | | $C_{iss}$ | $V_{DS}$ = 10V, $V_{GS}$ = 0 V, f = 1 MHz | — | 5450 | — | pF |
| Reverse transfer capacitance | | $C_{rss}$ | | — | 320 | — | |
| Output capacitance | | $C_{oss}$ | | — | 1420 | — | |
| Switching time | Rise time | $t_r$ |  | — | 9 | — | ns |
| | Turn-ON time | $t_{on}$ | | — | 24 | — | |
| | Fall time | $t_f$ | | — | 21 | — | |
| | Turn-OFF time | $t_{off}$ | | — | 106 | — | |
| Total gate charge (gate-source plus gate-drain) | | Qg | $V_{DD}$ ≃ 48 V, $V_{GS}$ = 5 V, $I_D$ = 70A | — | 47 | — | nC |
| | | | $V_{DD}$ ≃ 48 V, $V_{GS}$ = 10 V, $I_D$ = 70A | — | 87 | — | |
| Gate-source charge 1 | | $Q_{gs1}$ | $V_{DD}$ ≃ 48 V, $V_{GS}$ = 10 V, $I_D$ = 70A | — | 16 | — | |
| Gate-drain (“miller”) charge | | $Q_{gd}$ | | — | 19 | — | |
| Gate switch charge | | $Q_{sw}$ | | — | 30 | — | |



## Source-Drain Ratings and Characteristics (Ta = 25°C)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Continuous drain reverse current (Note 1) | $I_{DR}$ | — | — | — | 70 | A |
| Pulse drain reverse current (Note 1) | $I_{DRP}$ | — | — | — | 280 | A |
| Forward voltage (diode) | $V_{DSF}$ | $I_{DR}$ = 70 A, $V_{GS}$ = 0 V | — | −1.0 | −1.2 | V |
| Reverse recovery time | $t_{rr}$ | $I_{DR}$ = 70 A, $V_{GS}$ = 0 V, | — | 60 | — | ns |
| Reverse recovery charge | $Q_{rr}$ | $dI_{DR}/dt$ = 50 A/μs | — | 51 | — | nC |

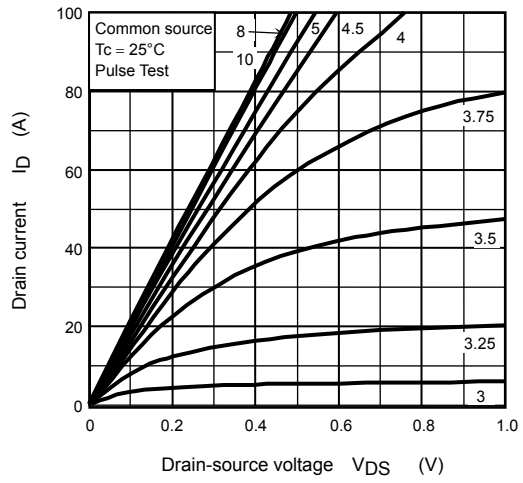
## Marking



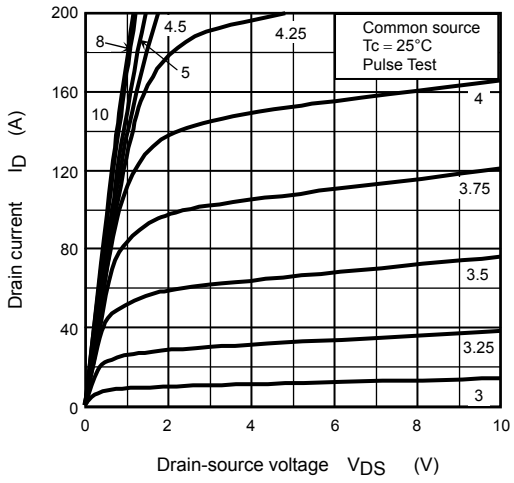

Note 4: A line under a Lot No. identifies the indication of product Labels.
Not underlined: [[Pb]]/INCLUDES > MCV
Underlined: [[G]]/RoHS COMPATIBLE or [[G]]/RoHS [[Pb]]

Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product. The RoHS is the Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

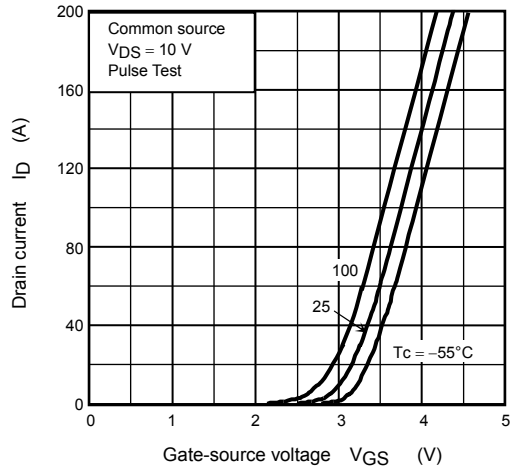
$I_D - V_{DS}$



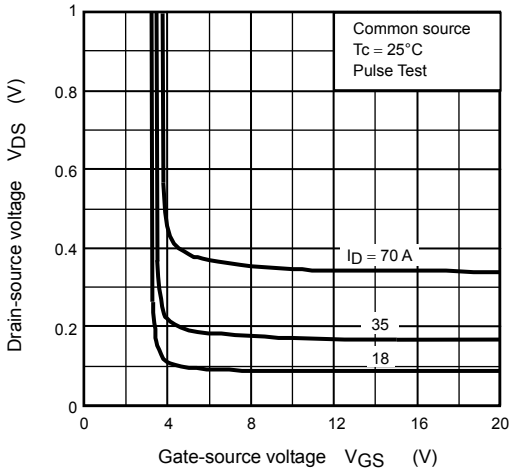

$I_D - V_{DS}$



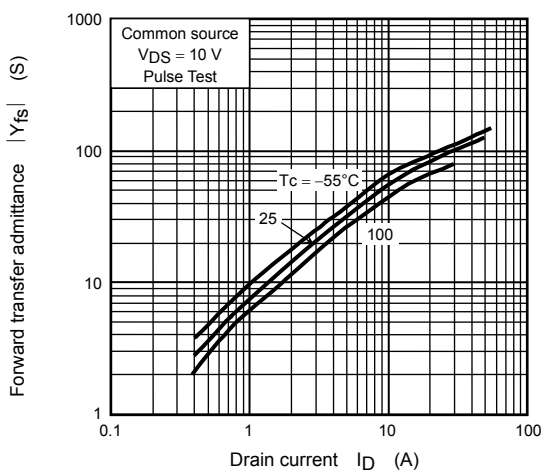

$I_D - V_{GS}$



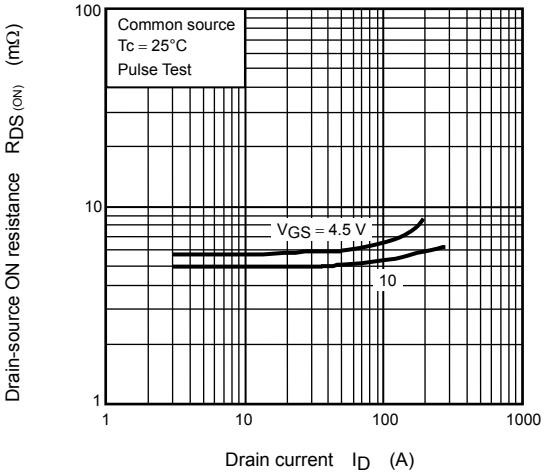

$V_{DS} - V_{GS}$



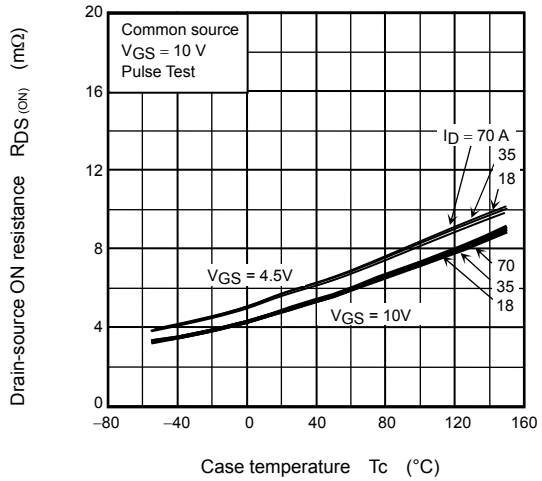

$|Y_{fs}| - I_D$



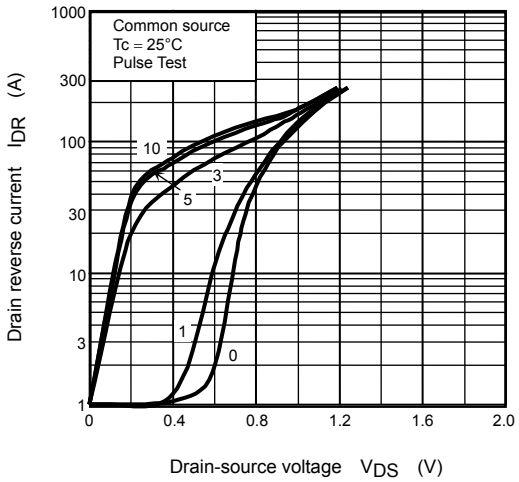

$R_{DS\ (ON)} - I_D$



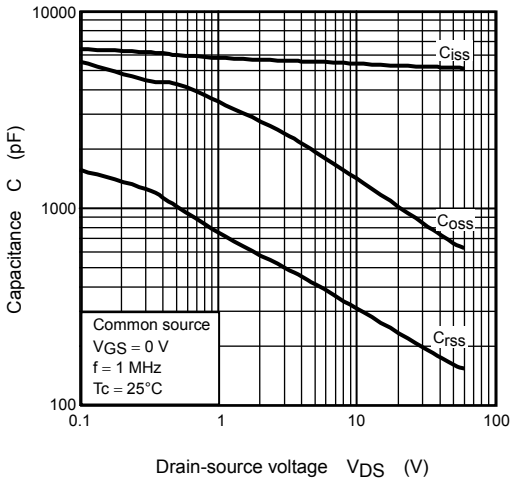
$R_{DS\ (ON)}$ – Tc



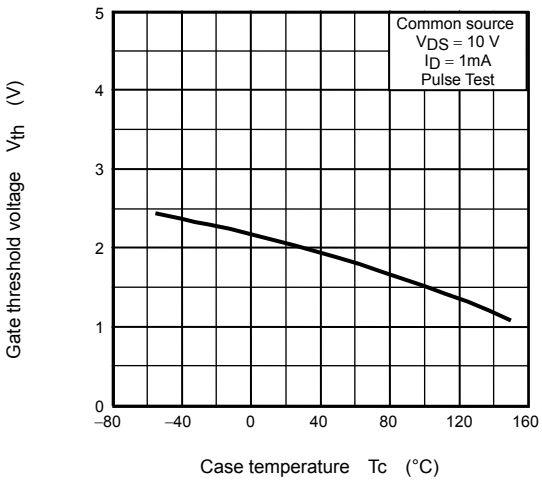

$I_{DR}$ – $V_{DS}$



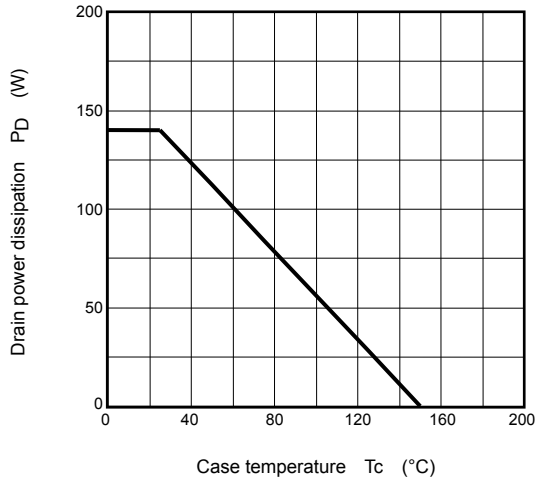

Capacitance – $V_{DS}$



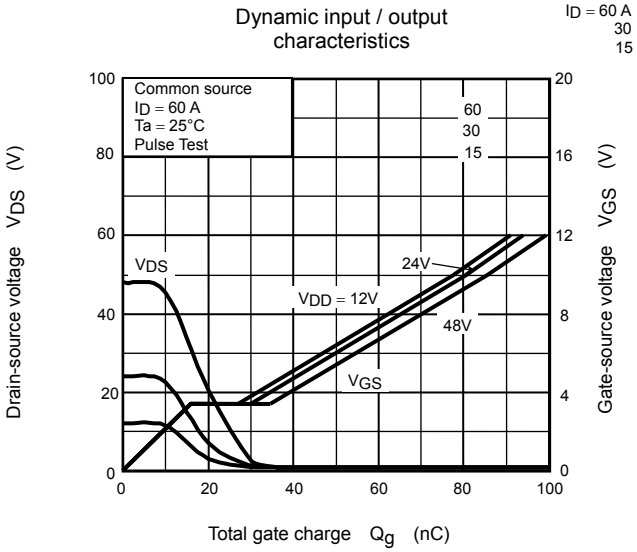

$V_{th}$ – Tc



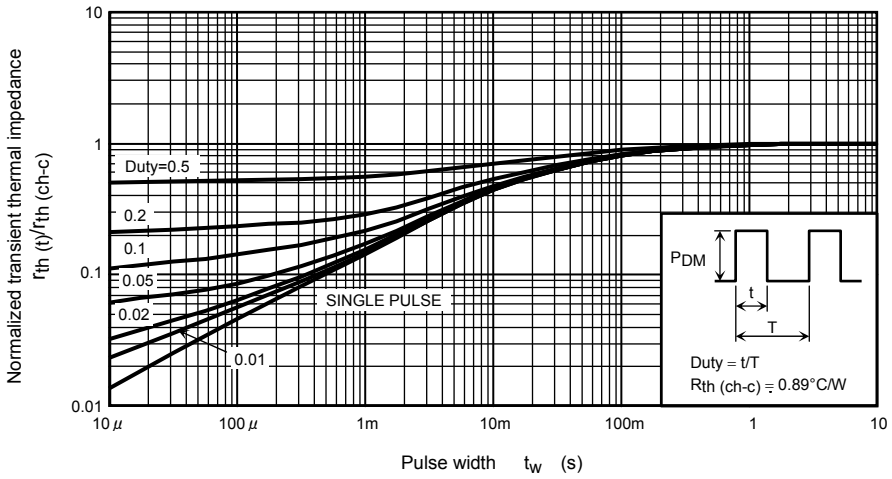

$P_D$ – Tc



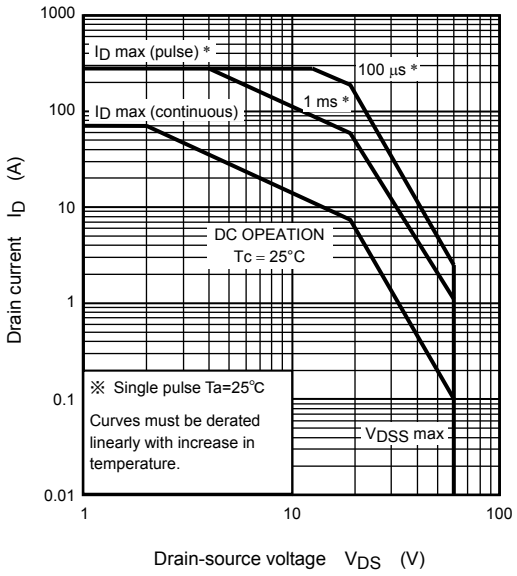

Dynamic input / output characteristics



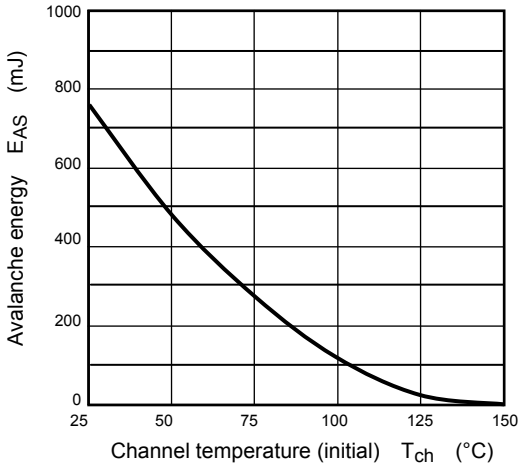
$r_{th} - t_w$

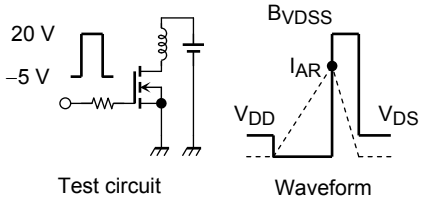



SAFE OPERATING AREA




$E_{AS} - T_{ch}$




$R_G = 1\ \Omega$
$V_{DD} = 25$ V, L = 200 μH

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

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