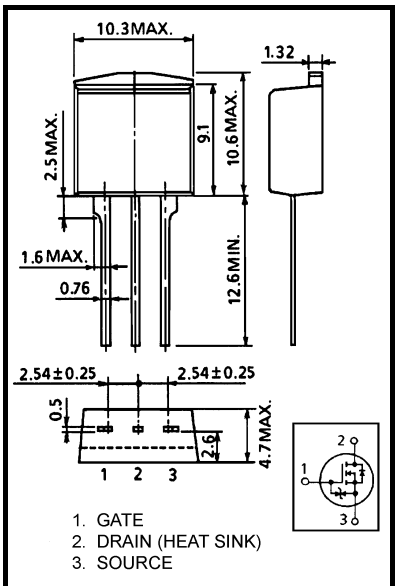
TOSHIBA Field Effect Transistor Silicon N Channel MOS Type (π−MOSV)

# 2SK2401

## Chopper Regulator, DC−DC Converter and Motor Drive Applications

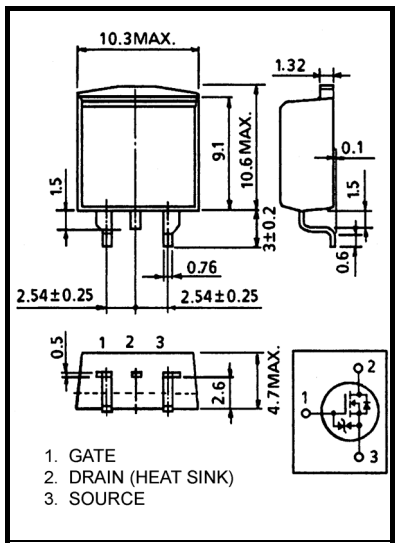
- Low drain−source ON resistance : $R_{DS\ (ON)}$ = 0.13 Ω (typ.)
- High forward transfer admittance : $|Y_{fs}|$ = 17 S (typ.)
- Low leakage current : $I_{DSS}$ = 100 μA (max) ($V_{DS}$ = 200 V)
- Enhancement mode : $V_{th}$ = 1.5~3.5 V ($V_{DS}$ = 10 V, $I_D$ = 1 mA)

Unit: mm




| | |
|---|---|
| JEDEC | — |
| JEITA | — |
| TOSHIBA | 2-10S1B |

Weight: 1.5 g (typ.)




| | |
|---|---|
| JEDEC | — |
| JEITA | — |
| TOSHIBA | 2-10S2B |

Weight: 1.5 g (typ.)

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

| Characteristics | | Symbol | Rating | Unit |
|---|---|---|---|---|
| Drain−source voltage | | $V_{DSS}$ | 200 | V |
| Drain−gate voltage ($R_{GS}$ = 20 kΩ) | | $V_{DGR}$ | 200 | V |
| Gate−source voltage | | $V_{GSS}$ | ±20 | V |
| Drain current | DC (Note 1) | $I_D$ | 15 | A |
| | Pulse (Note 1) | $I_{DP}$ | 45 | A |
| Drain power dissipation (Tc = 25°C) | | $P_D$ | 75 | W |
| Single pulse avalanche energy (Note 2) | | $E_{AS}$ | 166 | mJ |
| Avalanche current | | $I_{AR}$ | 15 | A |
| Repetitive avalanche energy (Note 3) | | $E_{AR}$ | 7.5 | 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 | $R_{th\ (ch-c)}$ | 1.67 | °C / W |
| Thermal resistance, channel to ambient | $R_{th\ (ch-a)}$ | 83.3 | °C / W |

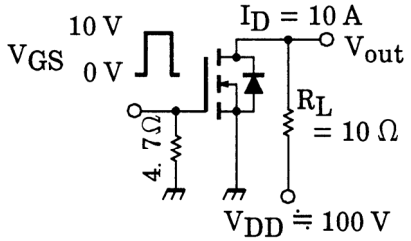
Note 1: Ensure that the channel temperature does not exceed 150°C.

Note 2: $V_{DD}$ = 50 V, $T_{ch}$ = 25°C (initial), L = 1.2 mH, $R_G$ = 25 Ω, $I_{AR}$ = 15 A

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

This transistor is an electrostatic-sensitive device.
Please handle with caution.

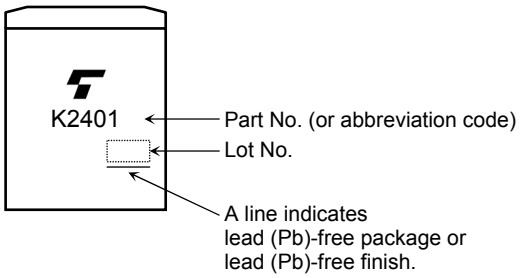
## Electrical Characteristics (Ta = 25°C)

| 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 | | $I_{DSS}$ | $V_{DS}$ = 200 V, $V_{GS}$ = 0 V | — | — | 100 | μA |
| Drain−source breakdown voltage | | $V_{(BR)\ DSS}$ | $I_D$ = 10 mA, $V_{GS}$ = 0 V | 200 | — | — | V |
| Gate threshold voltage | | $V_{th}$ | $V_{DS}$ = 10 V, $I_D$ = 1 mA | 1.5 | — | 3.5 | V |
| Drain−source ON resistance | | $R_{DS\ (ON)}$ | $V_{GS}$ = 10 V, $I_D$ = 10 A | — | 0.13 | 0.18 | Ω |
| Forward transfer admittance | | $\|Y_{fs}\|$ | $V_{DS}$ = 10 V, $I_D$ = 10 A | 10 | 17 | — | S |
| Input capacitance | | $C_{iss}$ | $V_{DS}$ = 10 V, $V_{GS}$ = 0 V, f = 1 MHz | — | 2000 | — | pF |
| Reverse transfer capacitance | | $C_{rss}$ | | — | 200 | — | |
| Output capacitance | | $C_{oss}$ | | — | 600 | — | |
| Switching time | Rise time | $t_r$ |  | — | 35 | — | ns |
| | Turn−on time | $t_{on}$ | | — | 50 | — | |
| | Fall time | $t_f$ | | — | 10 | — | |
| | Turn−off time | $t_{off}$ | Duty ≦ 1%, $t_w$ = 10 μs | — | 66 | — | |
| Total gate charge (Gate−source plus gate−drain) | | $Q_g$ | $V_{DD}$ ≈ 100 V, $V_{GS}$ = 10 V, $I_D$ = 15 A | — | 40 | — | nC |
| Gate−source charge | | $Q_{gs}$ | | — | 25 | — | |
| Gate−drain (“miller”) charge | | $Q_{gd}$ | | — | 15 | — | |

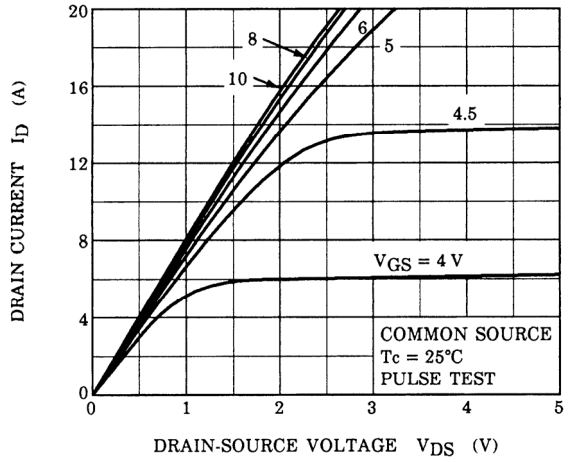
## Source−Drain Ratings and Characteristics (Ta = 25°C)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Continuous drain reverse current (Note 1) | $I_{DR}$ | — | — | — | 15 | A |
| Pulse drain reverse current (Note 1) | $I_{DRP}$ | — | — | — | 45 | A |
| Forward voltage (diode) | $V_{DSF}$ | $I_{DR}$ = 15 A, $V_{GS}$ = 0 V | — | — | −2.0 | V |
| Reverse recovery time | $t_{rr}$ | $I_{DR}$ = 15 A, $V_{GS}$ = 0 V<br>$dI_{DR}$ / dt = 100 A / μs | — | 180 | — | ns |
| Reverse recovery charge | $Q_{rr}$ | | — | 1.13 | — | μC |

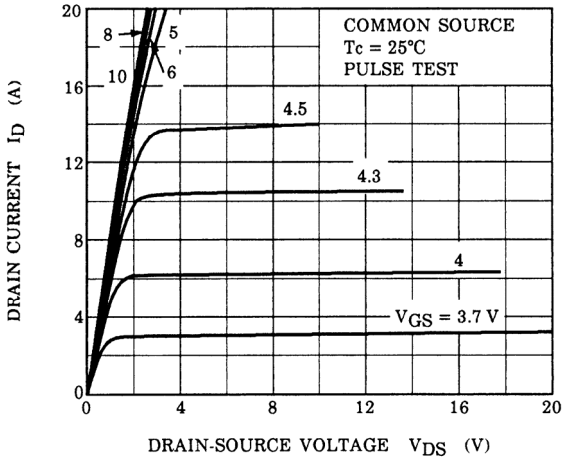
## Marking



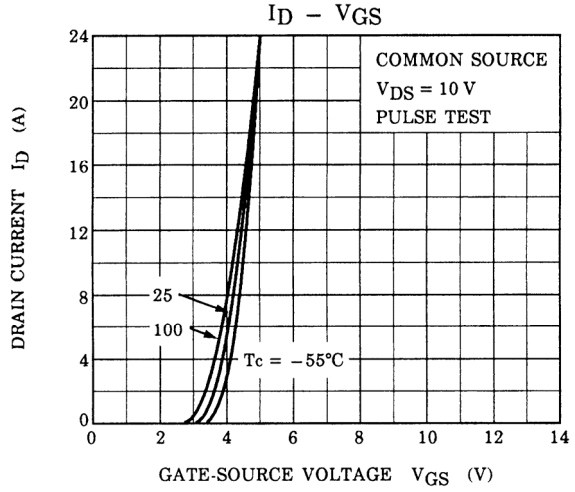
$I_D - V_{DS}$



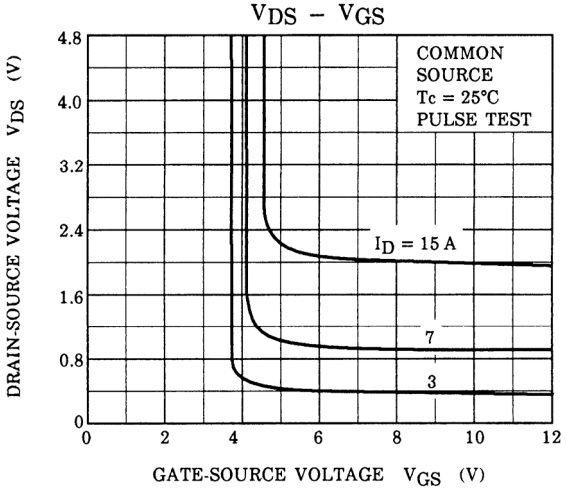

$I_D - V_{DS}$



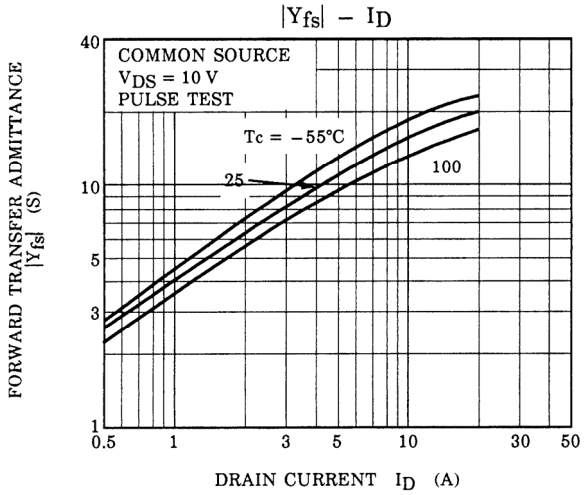

$I_D - V_{GS}$



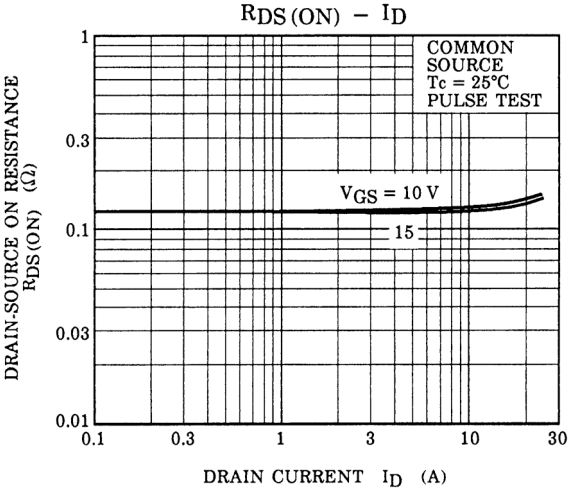

$V_{DS} - V_{GS}$



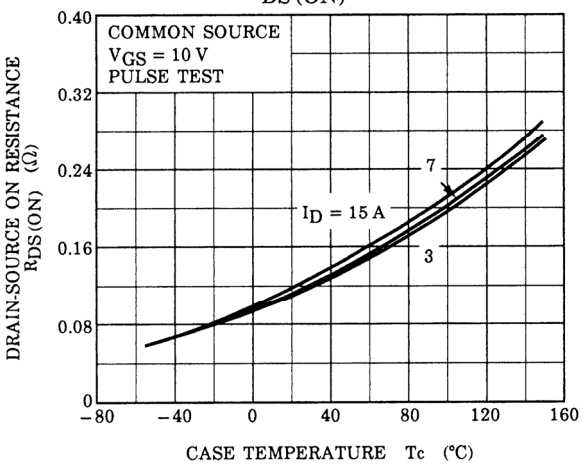

$|Y_{fs}| - I_D$



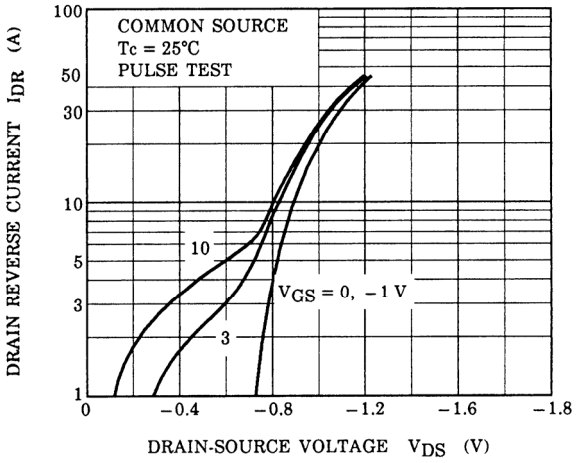

$R_{DS\,(ON)} - I_D$



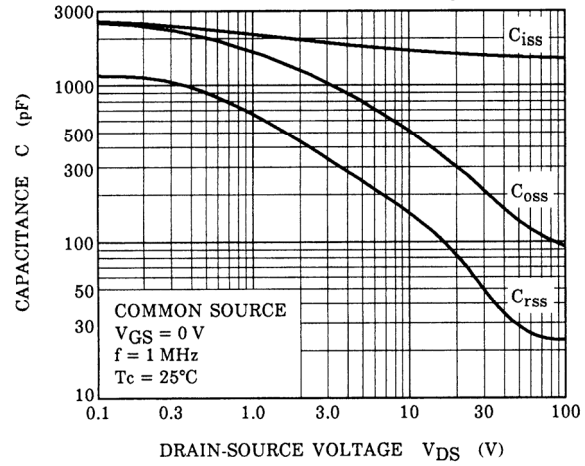
$R_{DS\,(ON)}$ – Tc



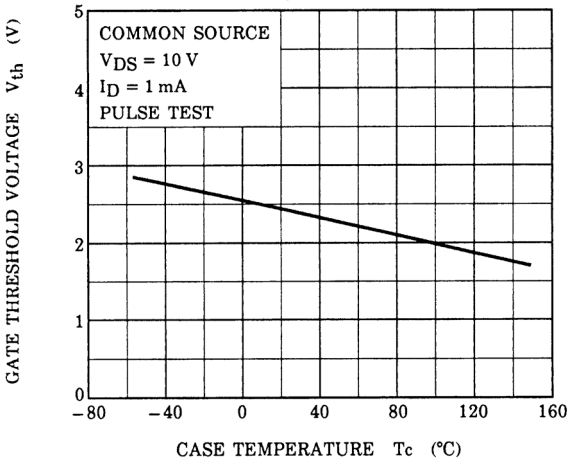

$I_{DR}$ – $V_{DS}$



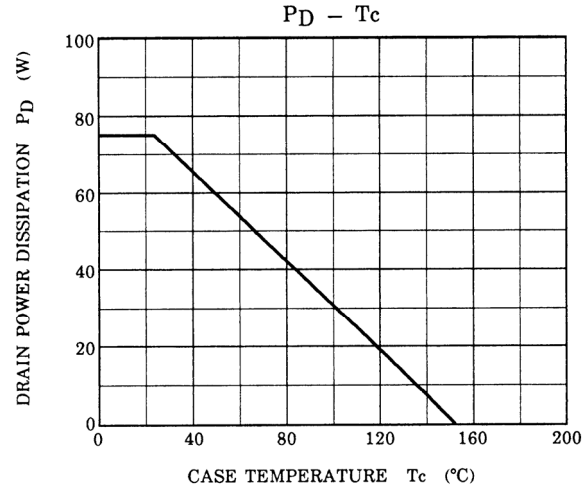

CAPACITANCE – $V_{DS}$



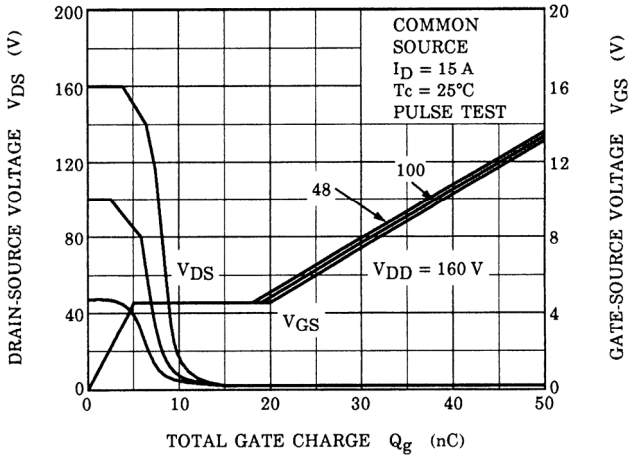

$V_{th}$ – Tc



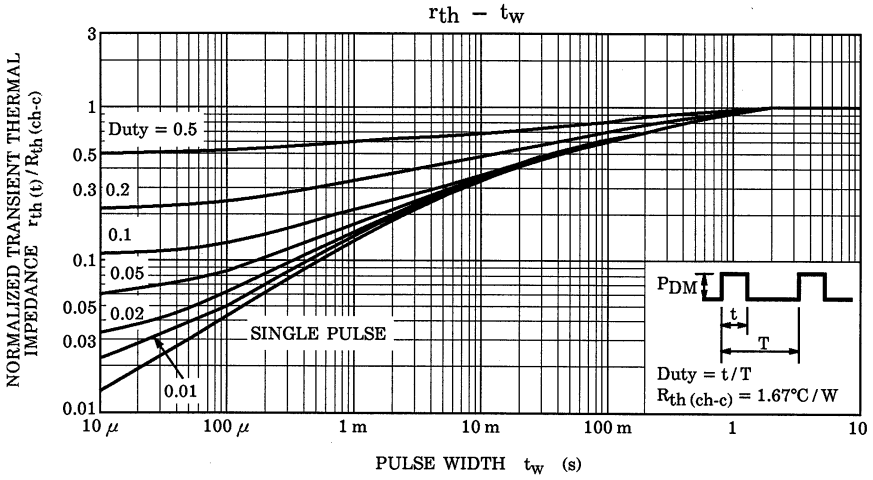

$P_D$ – Tc



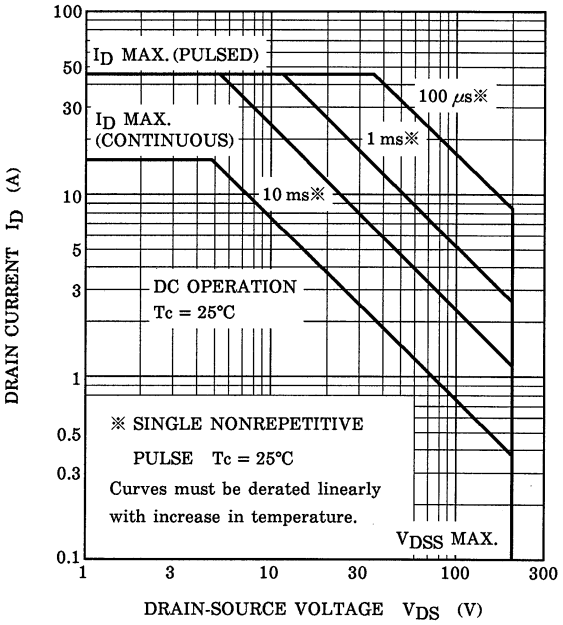

DYNAMIC INPUT / OUTPUT CHARACTERISTICS



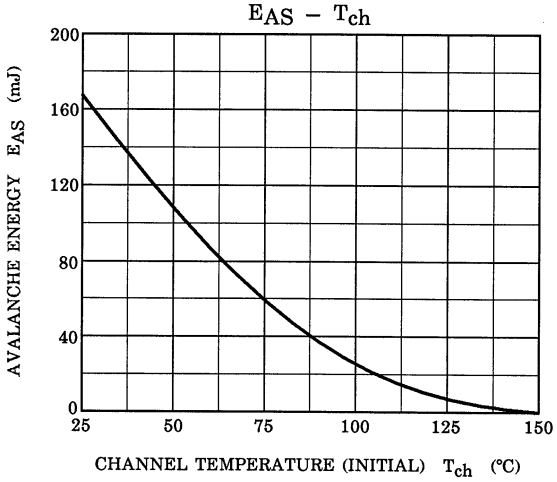
$r_{th} - t_w$

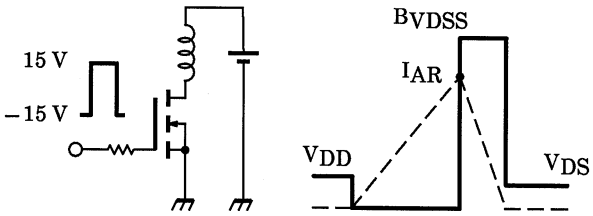



SAFE OPERATING AREA




$E_{AS} - T_{ch}$




TEST CIRCUIT WAVE FORM

$R_G = 25\ \Omega$
$V_{DD} = 50$ V, L = 1.2 mH

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

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20070701-EN

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