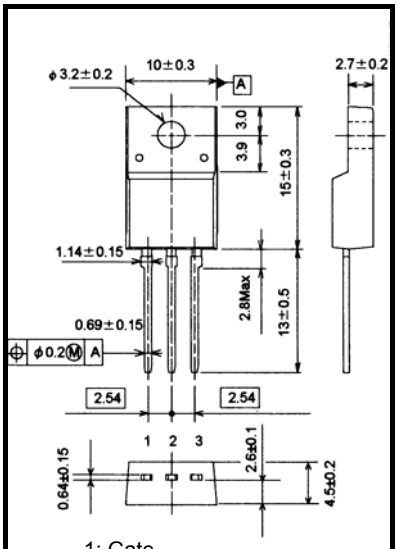
TOSHIBA Field Effect Transistor Silicon N-Channel MOS Type ($\pi$-MOSVI)

# 2SK4012

Switching Regulator Applications

- Low drain−source ON-resistance : $R_{DS\ (ON)}$ = 0.33 Ω (typ.)
- High forward transfer admittance : $|Y_{fs}|$ = 8.5 S (typ.)
- Low leakage current : $I_{DSS}$ = 100 μA (max) ($V_{DS}$ = 500 V)
- Enhancement mode : $V_{th}$ = 2.0 to 4.0 V ($V_{DS}$ = 10 V, $I_D$ = 1 mA)

Unit: mm




1: Gate
2: Drain
3: Source

| | |
|---|---|
| JEDEC | — |
| JEITA | SC-67 |
| TOSHIBA | 2-10U1B |

Weight: 1.7 (typ.)

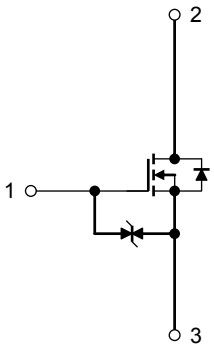
## Absolute Maximum Ratings (Ta = 25°C)

| Characteristic | | Symbol | Rating | Unit |
|---|---|---|---|---|
| Drain−source voltage | | $V_{DSS}$ | 500 | V |
| Drain−gate voltage ($R_{GS}$ = 20 kΩ) | | $V_{DGR}$ | 500 | V |
| Gate−source voltage | | $V_{GSS}$ | ±30 | V |
| Drain current | DC (Note 1) | $I_D$ | 13 | A |
| | Pulse (Note 1) | $I_{DP}$ | 52 | A |
| Drain power dissipation (Tc = 25°C) | | $P_D$ | 45 | W |
| Single-pulse avalanche energy (Note 2) | | $E_{AS}$ | 1170 | mJ |
| Avalanche current | | $I_{AR}$ | 13 | A |
| Repetitive avalanche energy (Note 3) | | $E_{AR}$ | 4.5 | mJ |
| Channel temperature | | $T_{ch}$ | 150 | °C |
| Storage temperature range | | $T_{stg}$ | −55 to 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

| Characteristic | Symbol | Max | Unit |
|---|---|---|---|
| Thermal resistance, channel to case | $R_{th\ (ch-c)}$ | 2.78 | °C / W |
| Thermal resistance, channel to ambient | $R_{th\ (ch-a)}$ | 62.5 | °C / W |



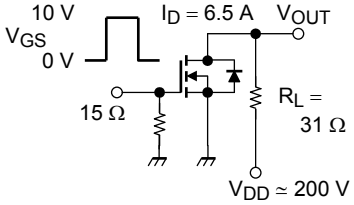

Note 1: Ensure that the channel temperature does not exceed 150°C.

Note 2: $V_{DD}$ = 90 V, $T_{ch}$ = 25°C (initial), L = 11.8 mH, $R_G$ = 25 Ω, $I_{AR}$ = 13 A

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)

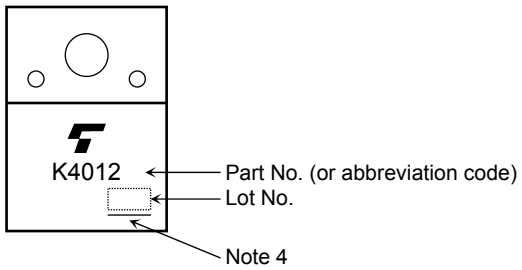
| Characteristic | | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|
| Gate leakage current | | $I_{GSS}$ | $V_{GS}$ = ±25 V, $V_{DS}$ = 0 V | — | — | ±10 | μA |
| Gate−source breakdown voltage | | $V_{(BR)\ GSS}$ | $I_G$ = ±10 μA, $V_{DS}$ = 0 V | ±30 | — | — | V |
| Drain cutoff current | | $I_{DSS}$ | $V_{DS}$ = 500 V, $V_{GS}$ = 0 V | — | — | 100 | μA |
| Drain−source breakdown voltage | | $V_{(BR)\ DSS}$ | $I_D$ = 10 mA, $V_{GS}$ = 0 V | 500 | — | — | V |
| Gate threshold voltage | | $V_{th}$ | $V_{DS}$ = 10 V, $I_D$ = 1 mA | 2.0 | — | 4.0 | V |
| Drain−source ON-resistance | | $R_{DS\ (ON)}$ | $V_{GS}$ = 10 V, $I_D$ = 6.5 A | — | 0.33 | 0.4 | Ω |
| Forward transfer admittance | | $\|Y_{fs}\|$ | $V_{DS}$ = 10 V, $I_D$ = 6.5 A | 4.0 | 8.5 | — | S |
| Input capacitance | | $C_{iss}$ | $V_{DS}$ = 25 V, $V_{GS}$ = 0 V, f = 1 MHz | — | 2400 | — | pF |
| Reverse transfer capacitance | | $C_{rss}$ | | — | 18 | — | |
| Output capacitance | | $C_{oss}$ | | — | 220 | — | |
| Switching time | Rise time | $t_r$ |  | — | 25 | — | ns |
| | Turn−on time | $t_{on}$ | | — | 70 | — | |
| | Fall time | $t_f$ | | — | 10 | — | |
| | Turn−off time | $t_{off}$ | Duty ≤ 1%, $t_w$ = 10 μs | — | 95 | — | |
| Total gate charge (gate−source plus gate−drain) | | $Q_g$ | $V_{DD}$ ≈ 400 V, $V_{GS}$ = 10 V, $I_D$ = 13 A | — | 50 | — | nC |
| Gate−source charge | | $Q_{gs}$ | | — | 30 | — | |
| Gate−drain (“Miller”) charge | | $Q_{gd}$ | | — | 20 | — | |



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

| Characteristic | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Continuous drain reverse current (Note 1) | $I_{DR}$ | — | — | — | 13 | A |
| Pulse drain reverse current (Note 1) | $I_{DRP}$ | — | — | — | 52 | A |
| Forward voltage (diode) | $V_{DSF}$ | $I_{DR}$ = 13 A, $V_{GS}$ = 0 V | — | — | −1.7 | V |
| Reverse recovery time | $t_{rr}$ | $I_{DR}$ = 13 A, $V_{GS}$ = 0 V<br>$dI_{DR}$ / dt = 100 A / μs | — | 1000 | — | ns |
| Reverse recovery charge | $Q_{rr}$ | | — | 11 | — | μC |

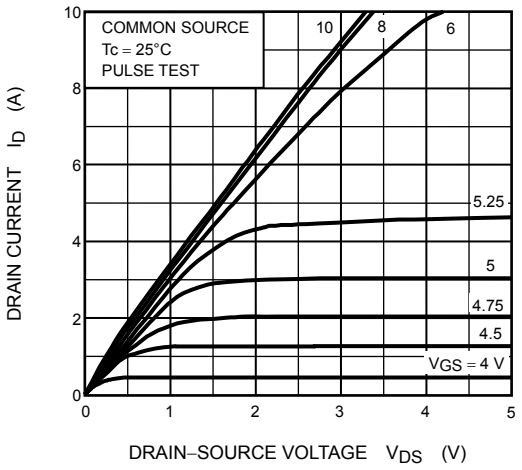
## Marking



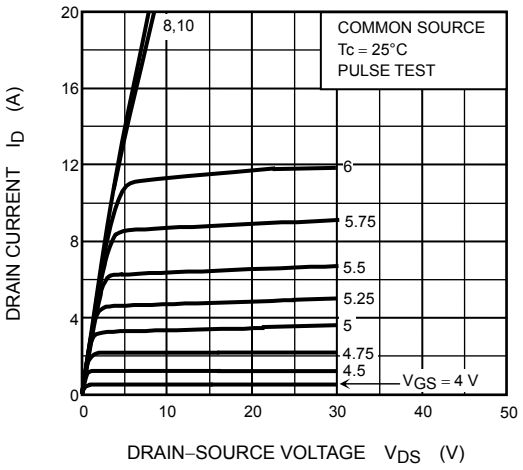

Note 4: A line under a Lot No. identifies the indication of product Labels.
Not underlined: [[Pb]]/INCLUDES > MCV
Underlined: [[G]]/RoHS COMPATIBLE or [[G]]/RoHS [[Pb]]

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.

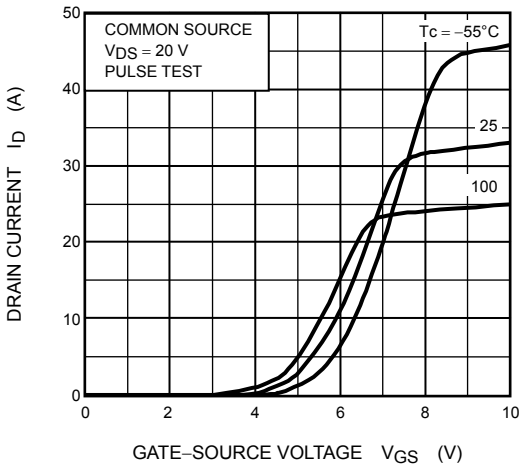
$I_D - V_{DS}$



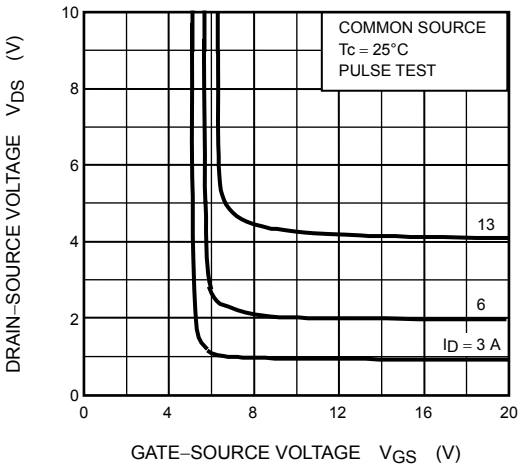

$I_D - V_{DS}$



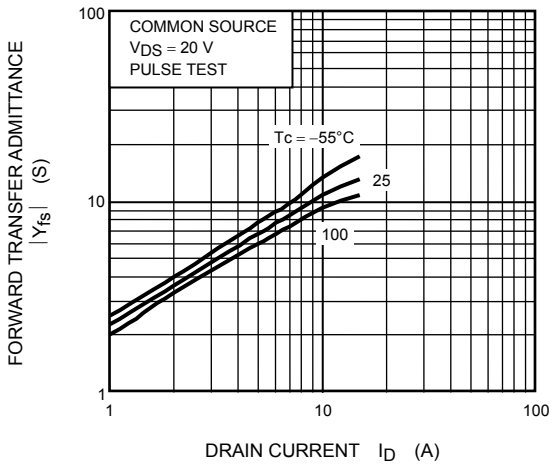

$I_D - V_{GS}$



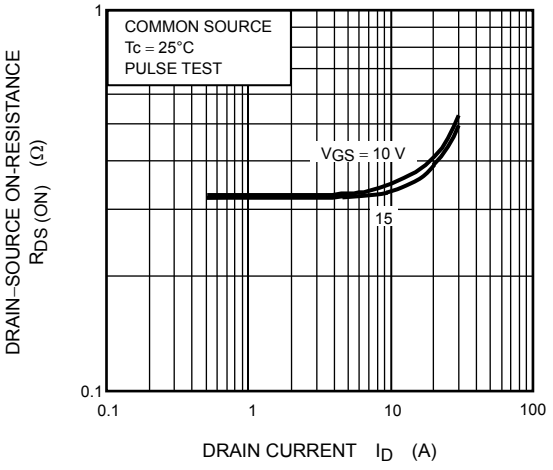

$V_{DS} - V_{GS}$



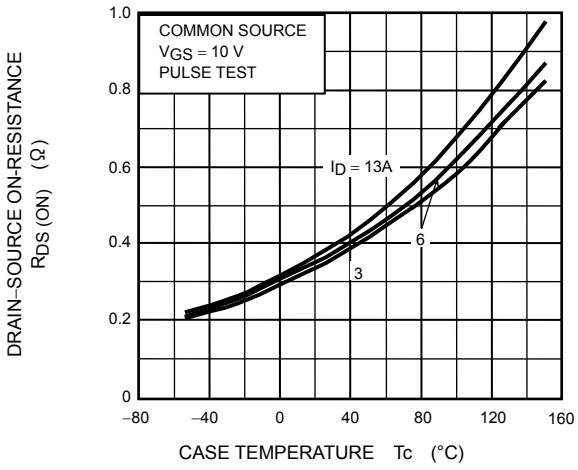

$|Y_{fs}| - I_D$



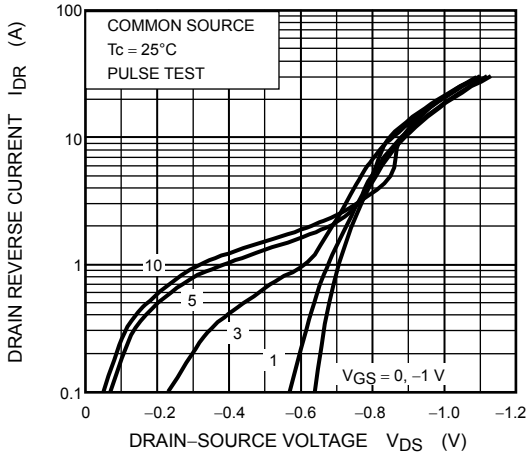

$R_{DS\ (ON)} - I_D$



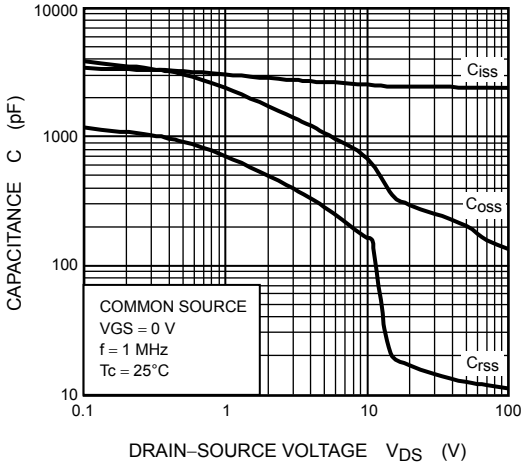
$R_{DS\ (ON)}$ – Tc



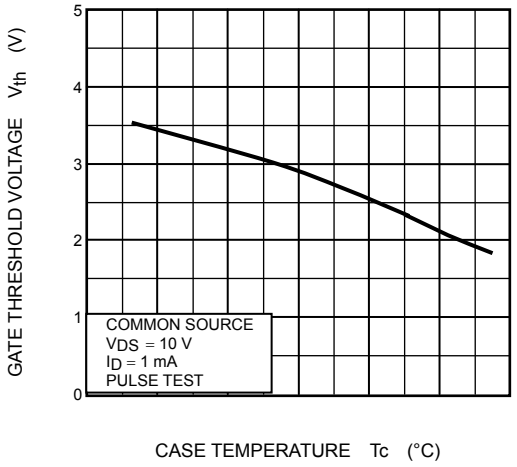

$I_{DR}$ – $V_{DS}$



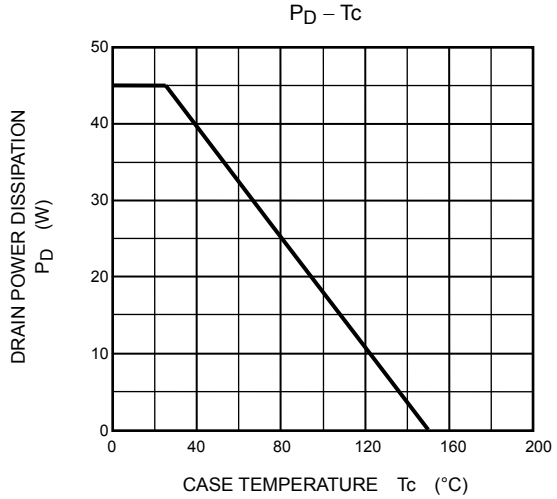

C – $V_{DS}$



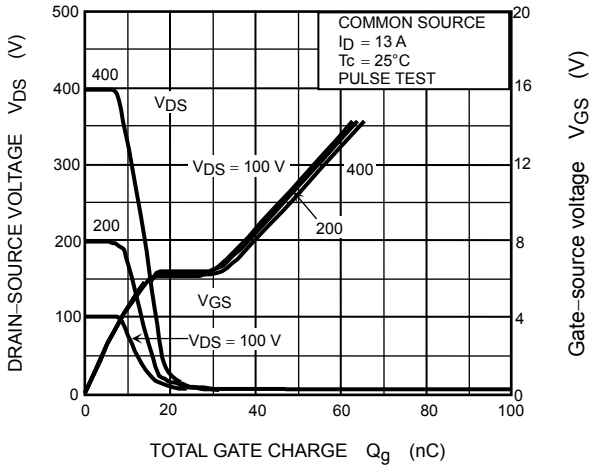

$V_{th}$ – Tc



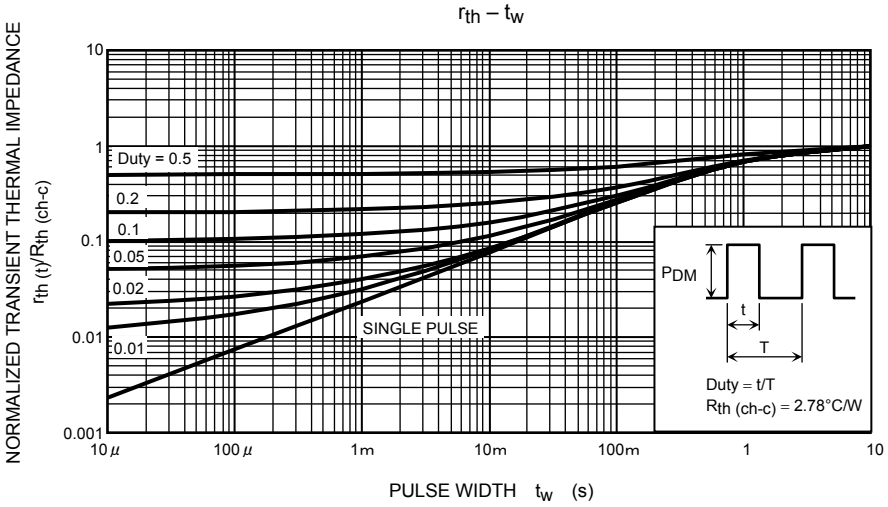

$P_D$ – Tc



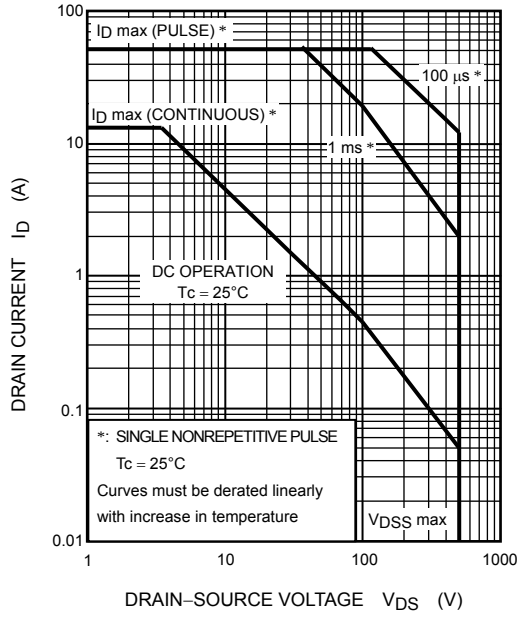

DYNAMIC INPUT/OUTPUT CHARACTERISTICS



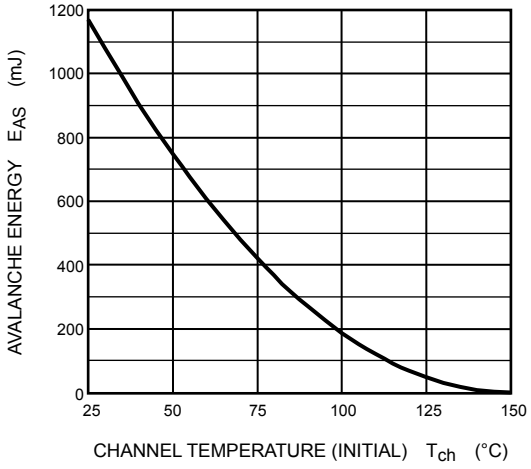
$r_{th} - t_w$

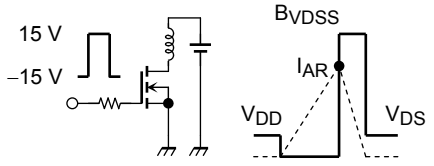



SAFE OPERATING AREA




$E_{AS} - T_{ch}$




$R_G = 25\ \Omega$
$V_{DD} = 90$ V, L = 11.8 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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