

MOSFETs Silicon P-Channel MOS (U-MOSVI)

## TJ10S04M3L

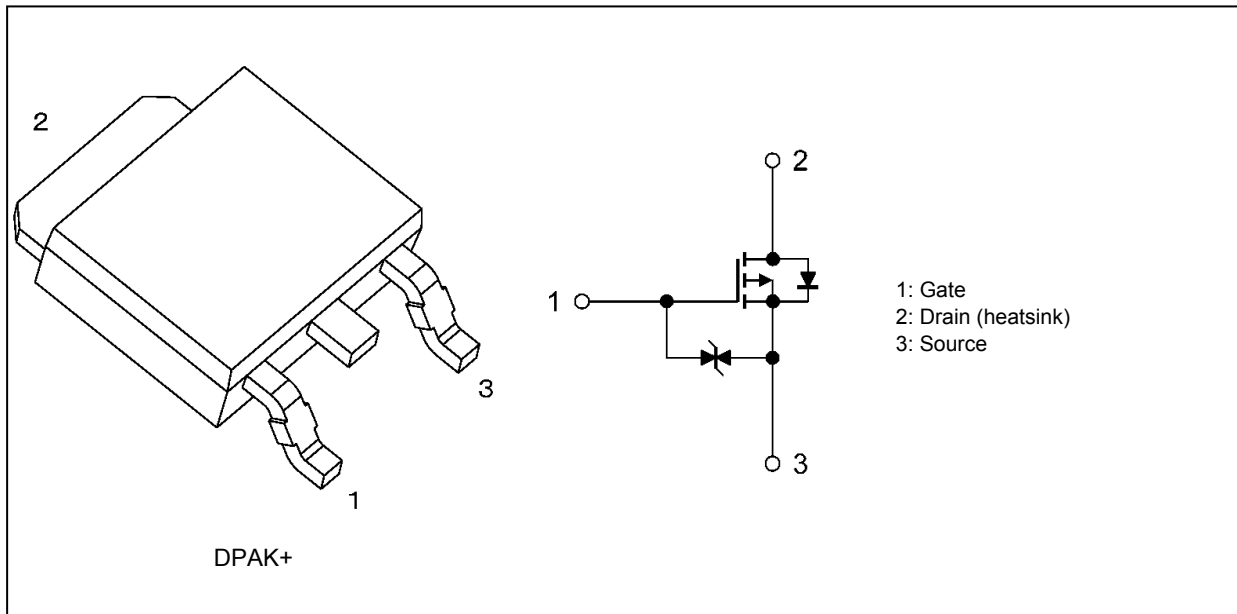
### 1. Applications

- Automotive
- Motor Drivers
- DC-DC Converters
- Switching Voltage Regulators

### 2. Features

- (1) AEC-Q101 qualified
- (2) Low drain-source on-resistance:  $R_{DS(ON)} = 33.8 \text{ m}\Omega$  (typ.) ( $V_{GS} = -10 \text{ V}$ )
- (3) Low leakage current:  $I_{DSS} = -10 \text{ }\mu\text{A}$  (max) ( $V_{DS} = -40 \text{ V}$ )
- (4) Enhancement mode:  $V_{th} = -2.0$  to  $-3.0 \text{ V}$  ( $V_{DS} = -10 \text{ V}$ ,  $I_D = -1 \text{ mA}$ )

### 3. Packaging and Internal Circuit



Start of commercial production

2011-03

## 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/+10    |                  |
| Drain current (DC) (Note 1)                    | $I_D$     | -10        | A                |
| Drain current (pulsed) (Note 1)                | $I_{DP}$  | -20        |                  |
| Power dissipation ( $T_c = 25^\circ\text{C}$ ) | $P_D$     | 27         | W                |
| Single-pulse avalanche energy (Note 2)         | $E_{AS}$  | 23         | mJ               |
| Avalanche current                              | $I_{AR}$  | -10        | A                |
| Channel temperature (Note 3)                   | $T_{ch}$  | 175        | $^\circ\text{C}$ |
| Storage temperature (Note 3)                   | $T_{stg}$ | -55 to 175 |                  |

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 | $R_{th(ch-c)}$ | 5.4 | $^\circ\text{C}/\text{W}$ |

Note 1: Ensure that the channel temperature does not exceed  $175^\circ\text{C}$ .

Note 2:  $V_{DD} = -25\text{ V}$ ,  $T_{ch} = 25^\circ\text{C}$  (initial),  $L = 243\ \mu\text{H}$ ,  $R_G = 25\ \Omega$ ,  $I_{AR} = -10\text{ A}$

Note 3: The definitions of the absolute maximum channel and storage temperatures are qualified per AEC-Q101.

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

### 6. Electrical Characteristics

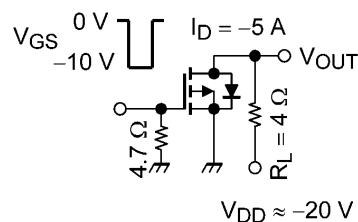
#### 6.1. Static Characteristics ( $T_a = 25^\circ\text{C}$ unless otherwise specified)

| Characteristics                         | Symbol        | Test Condition                                   | Min  | Typ. | Max      | Unit             |
|---|---------------|--|------|------|----------|------------------|
| Gate leakage current                    | $I_{GSS}$     | $V_{GS} = -16/+10\text{ V}, V_{DS} = 0\text{ V}$ | —    | —    | $\pm 10$ | $\mu\text{A}$    |
| 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                |
| Drain-source breakdown voltage (Note 4) | $V_{(BR)DSX}$ | $I_D = -10\text{ mA}, V_{GS} = 10\text{ V}$      | -30  | —    | —        |                  |
| Gate threshold voltage                  | $V_{th}$      | $V_{DS} = -10\text{ V}, I_D = -1\text{ mA}$      | -2.0 | —    | -3.0     |                  |
| Drain-source on-resistance              | $R_{DS(ON)}$  | $V_{GS} = -6\text{ V}, I_D = -5\text{ A}$        | —    | 42   | 62       | $\text{m}\Omega$ |
|   |               | $V_{GS} = -10\text{ V}, I_D = -5\text{ A}$       | —    | 33.8 | 44       |                  |

Note 4: If a forward bias is applied between gate and source, this device enters  $V_{(BR)DSX}$  mode. Note that the drain-source breakdown voltage is lowered in this mode.

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

| Characteristics                | Symbol    | Test Condition   | Min | Typ. | Max | Unit |
|--------------------------------|-----------|--|-----|------|-----|------|
| Input capacitance              | $C_{iss}$ | $V_{DS} = -10\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$ | —   | 930  | —   | pF   |
| Reverse transfer capacitance   | $C_{rss}$ |  | —   | 90   | —   |      |
| Output capacitance             | $C_{oss}$ |  | —   | 140  | —   |      |
| Switching time (rise time)     | $t_r$     | See Figure 6.2.1.  | —   | 7    | —   | ns   |
| Switching time (turn-on time)  | $t_{on}$  |  | —   | 15   | —   |      |
| Switching time (fall time)     | $t_f$     |  | —   | 40   | —   |      |
| Switching time (turn-off time) | $t_{off}$ |  | —   | 145  | —   |      |



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)

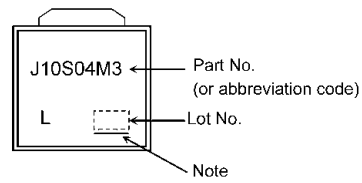
| Characteristics                                 | Symbol   | Test Condition   | Min | Typ. | Max | Unit |
|---|----------|--|-----|------|-----|------|
| Total gate charge (gate-source plus gate-drain) | $Q_g$    | $V_{DD} \approx -32\text{ V}, V_{GS} = -10\text{ V}, I_D = -10\text{ A}$ | —   | 19   | —   | nC   |
| Gate-source charge                              | $Q_{gs}$ |  | —   | 13.5 | —   |      |
| Gate-drain charge                               | $Q_{gd}$ |  | —   | 5.5  | —   |      |

#### 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 (DC) (Note 5)     | $I_{DR}$  | —  | —   | —    | -10 | A    |
| Reverse drain current (pulsed) (Note 5) | $I_{DRP}$ | —  | —   | —    | -20 |      |
| Diode forward voltage                   | $V_{DSF}$ | $I_{DR} = -10\text{ A}, V_{GS} = 0\text{ V}$ | —   | —    | 1.2 | V    |
| Reverse recovery time                   | $t_{rr}$  | $I_{DR} = -10\text{ A}, V_{GS} = 0\text{ V}$ | —   | 28   | —   | ns   |
| Reverse recovery charge                 | $Q_{rr}$  | $dI_{DR}/dt = 50\text{ A}/\mu\text{s}$       | —   | 11   | —   |      |

Note 5: Ensure that the channel temperature does not exceed  $175^\circ\text{C}$ .

## 7. Marking (Note)



**Fig. 7.1 Marking**

Note: A line under a Lot No. identifies the indication of product Labels.

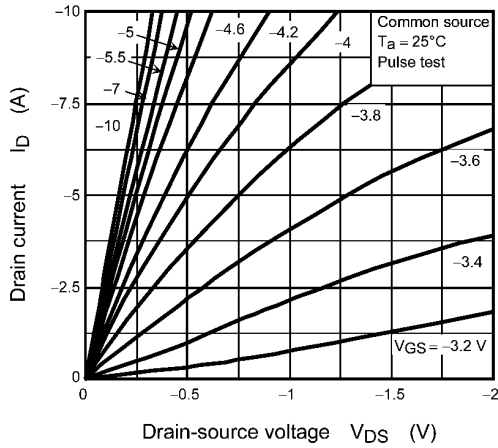
Not underlined: [[Pb]]/INCLUDES > MCV

Underlined: [[G]]/RoHS COMPATIBLE or [[G]]/RoHS [[Pb]]

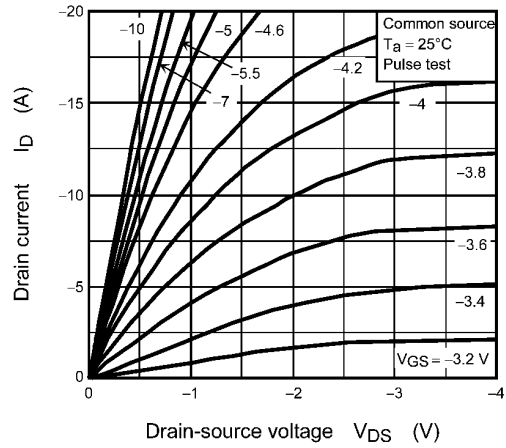
Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product.

The RoHS is the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

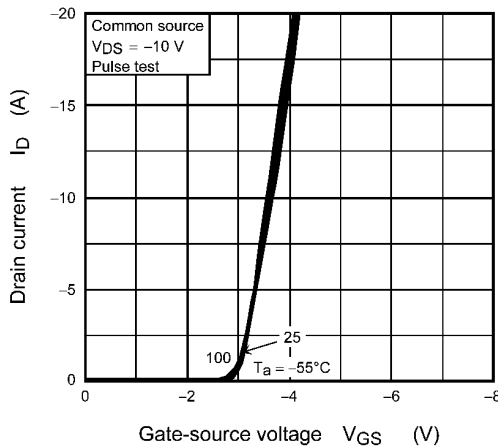
## 8. Characteristics Curves (Note)



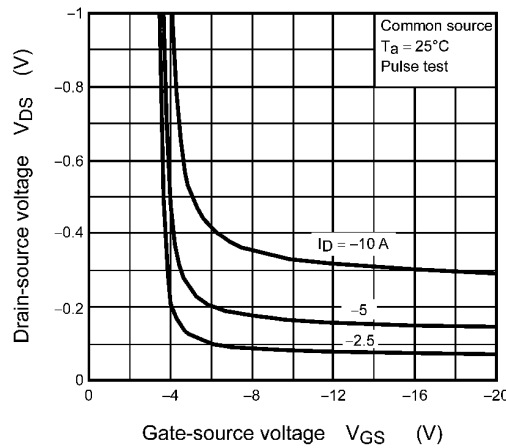
**Fig. 8.1  $I_D - V_{DS}$**



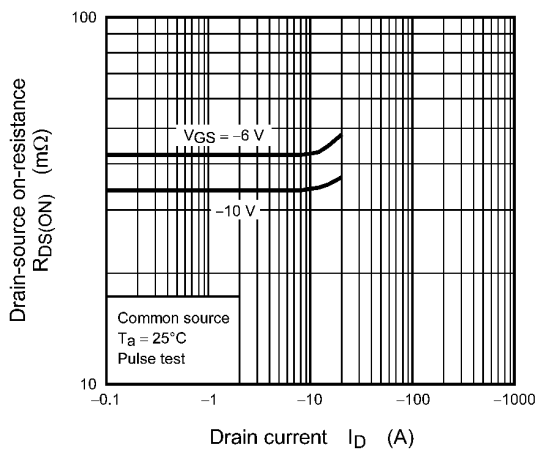
**Fig. 8.2  $I_D - V_{DS}$**



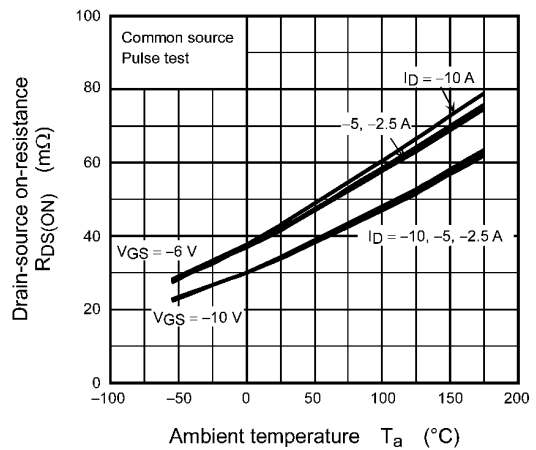
**Fig. 8.3  $I_D - V_{GS}$**



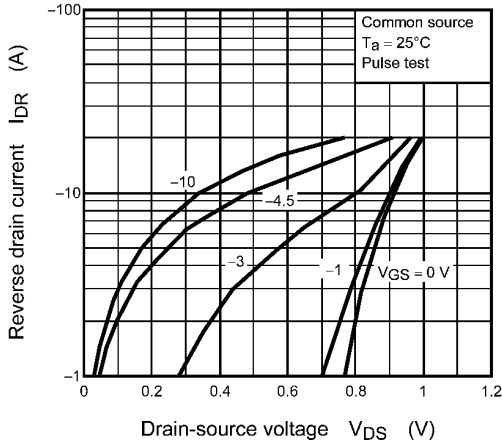
**Fig. 8.4  $V_{DS} - V_{GS}$**



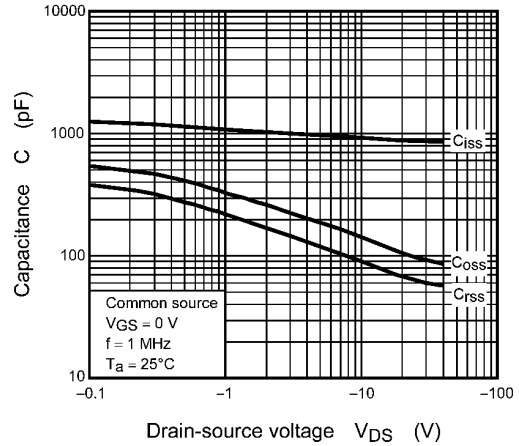
**Fig. 8.5  $R_{DS(ON)} - I_D$**



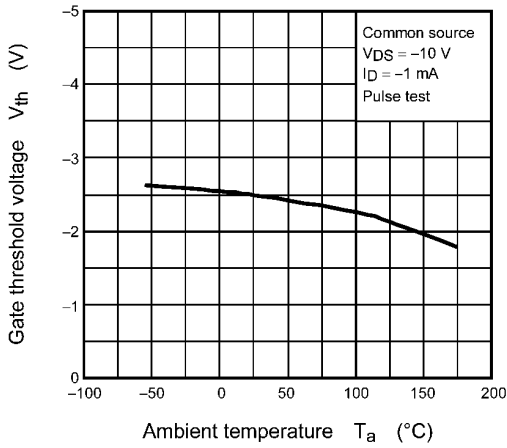
**Fig. 8.6  $R_{DS(ON)} - T_a$**



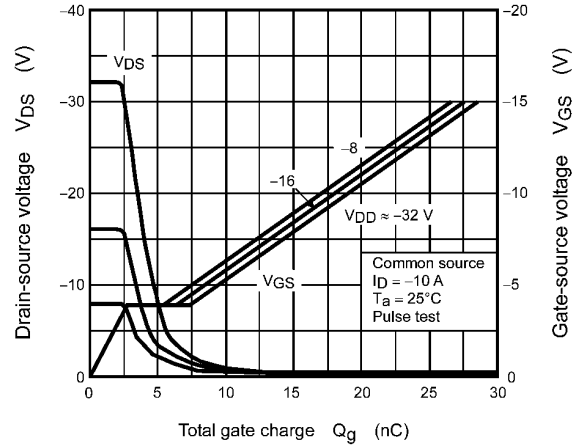
**Fig. 8.7  $I_{DR} - V_{DS}$**



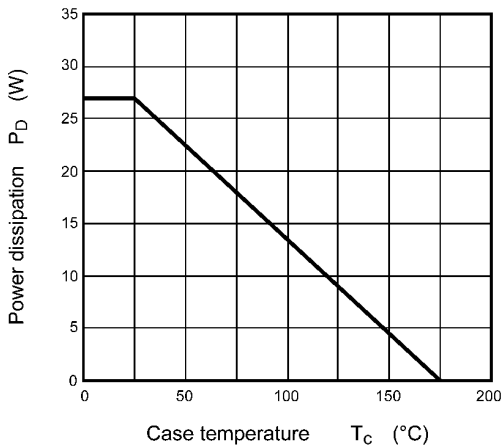
**Fig. 8.8 Capacitance -  $V_{DS}$**



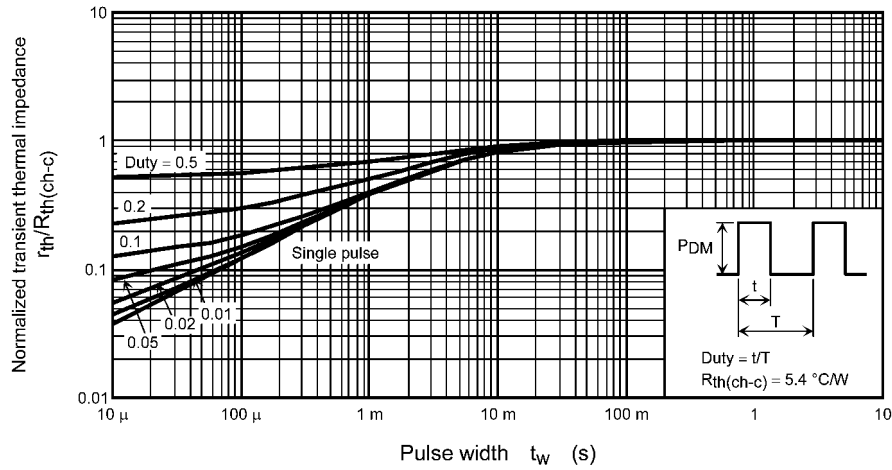
**Fig. 8.9  $V_{th} - T_a$**



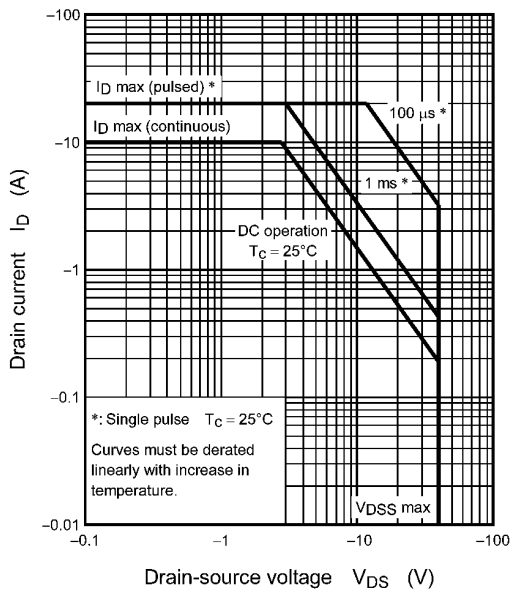
**Fig. 8.10 Dynamic Input/Output Characteristics**



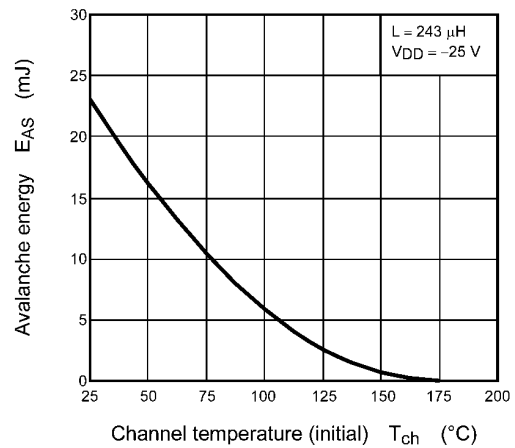
**Fig. 8.11  $P_D - T_c$   
(Guaranteed Maximum)**



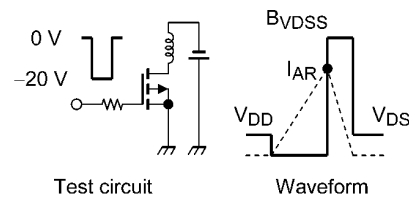
**Fig. 8.12**  $r_{th}/R_{th(ch-c)} - t_w$   
(Guaranteed Maximum)



**Fig. 8.13** Safe Operating Area  
(Guaranteed Maximum)



**Fig. 8.14**  $E_{AS} - T_{ch}$   
(Guaranteed Maximum)



$$R_G = 25 \Omega, V_{DD} = -25 \text{ V}, L = 243 \mu\text{H} \quad E_{AS} = \frac{1}{2} \cdot L \cdot I_{AR}^2 \cdot \left( \frac{B_{VDSS}}{B_{VDSS} - V_{DD}} \right)$$

**Fig. 8.15** 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: 2-7M1A |
| Nickname: DPAK+ |



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