

MOSFETs Silicon P-Channel MOS (U-MOSVI)

TJ60S04M3L

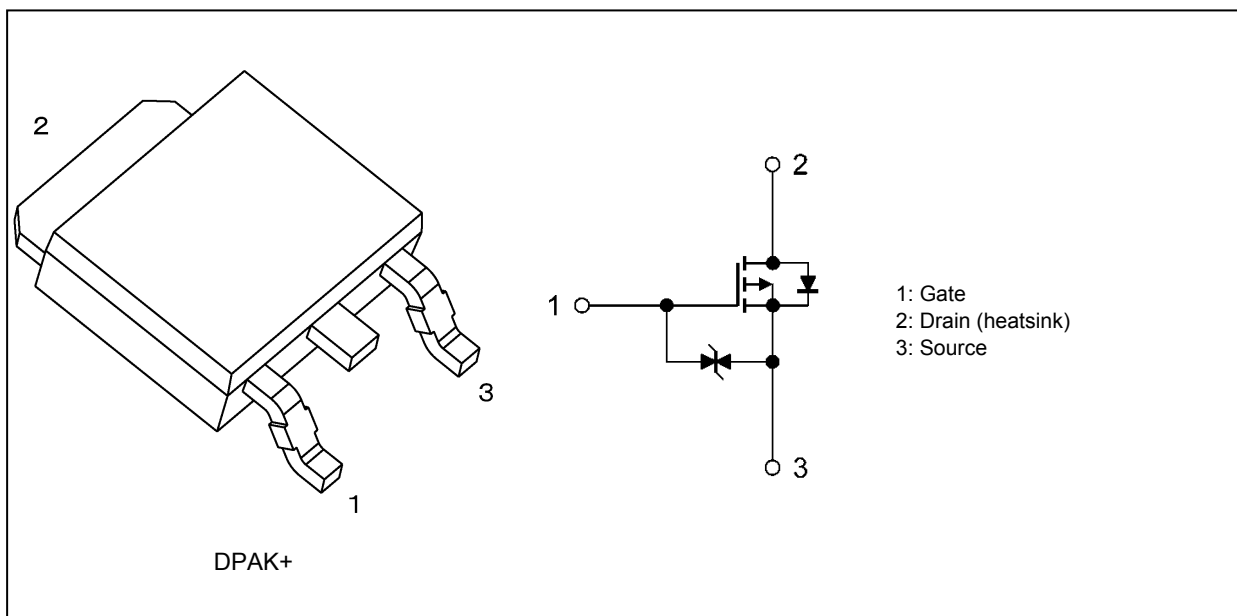
1. Applications

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

2. Features

- (1) AEC-Q101 qualified
- (2) Low drain-source on-resistance: $R_{DS(ON)} = 4.8 \text{ m}\Omega$ (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 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 | -60 | A |
| Drain current (pulsed) (Note 1) | I_{DP} | -120 | |
| Power dissipation ($T_c = 25^\circ\text{C}$) | P_D | 90 | W |
| Single-pulse avalanche energy (Note 2) | E_{AS} | 146 | mJ |
| Avalanche current | I_{AR} | -60 | 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 | $R_{th(ch-c)}$ | 1.65 | $^\circ\text{C}/\text{W}$ |

Note 1: Ensure that the channel temperature does not exceed 175°C .

Note 2: $V_{DD} = -25\text{ V}$, $T_{ch} = 25^\circ\text{C}$ (initial), $L = 42\ \mu\text{H}$, $R_G = 25\ \Omega$, $I_{AR} = -60\text{ A}$

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

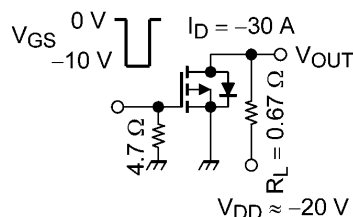
6.1. Static Characteristics ($T_a = 25^\circ\text{C}$ unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---------------|--|------|------|----------|------------------|
| Gate leakage current | I_{GSS} | $V_{GS} = -16/+10\text{ V}, V_{DS} = 0\text{ V}$ | — | — | ± 10 | 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 |
| 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 | $R_{DS(ON)}$ | $V_{GS} = -6\text{ V}, I_D = -30\text{ A}$ | — | 6.1 | 9.4 | $\text{m}\Omega$ |
| | | $V_{GS} = -10\text{ V}, I_D = -30\text{ A}$ | — | 4.8 | 6.3 | |

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} | $V_{DS} = -10\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$ | — | 6510 | — | pF |
| Reverse transfer capacitance | C_{riss} | | — | 570 | — | |
| Output capacitance | C_{oss} | | — | 780 | — | |
| Switching time (rise time) | t_r | See Figure 6.2.1. | — | 96 | — | ns |
| Switching time (turn-on time) | t_{on} | | — | 126 | — | |
| Switching time (fall time) | t_f | | — | 240 | — | |
| Switching time (turn-off time) | t_{off} | | — | 730 | — | |



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 | $V_{DD} \approx -32\text{ V}, V_{GS} = -10\text{ V}, I_D = -60\text{ A}$ | — | 125 | — | nC |
| Gate-source charge | Q_{gs} | | — | 81 | — | |
| Gate-drain charge | Q_{gd} | | — | 44 | — | |

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} | — | — | — | -60 | A |
| Reverse drain current (pulsed) (Note 5) | I_{DRP} | — | — | — | -120 | |
| Diode forward voltage | V_{DSF} | $I_{DR} = -60\text{ A}, V_{GS} = 0\text{ V}$ | — | — | 1.2 | V |
| Reverse recovery time | t_{rr} | $I_{DR} = -60\text{ A}, V_{GS} = 0\text{ V}$ $dI_{DR}/dt = 50\text{ A}/\mu\text{s}$ | — | 45 | — | ns |
| Reverse recovery charge | Q_{rr} | | — | 27 | — | nC |

Note 5: Ensure that the channel temperature does not exceed 175°C .

7. Marking (Note)

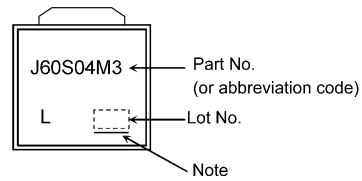


Fig. 7.1 Marking

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)

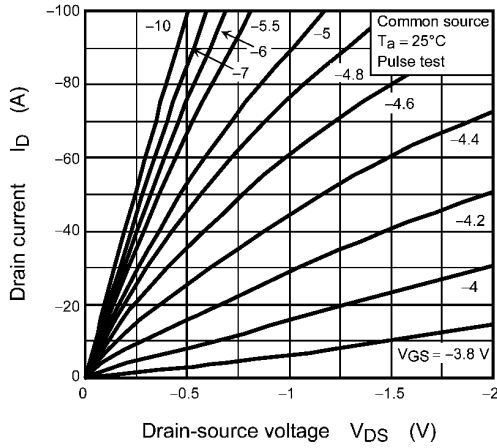


Fig. 8.1 $I_D - V_{DS}$

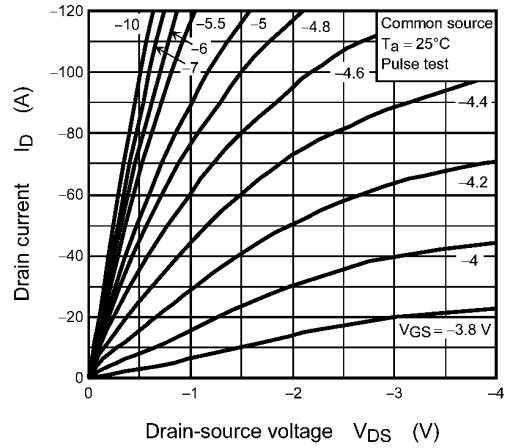


Fig. 8.2 $I_D - V_{DS}$

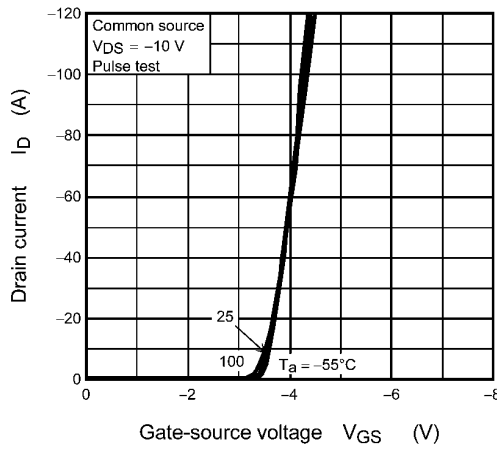


Fig. 8.3 $I_D - V_{GS}$

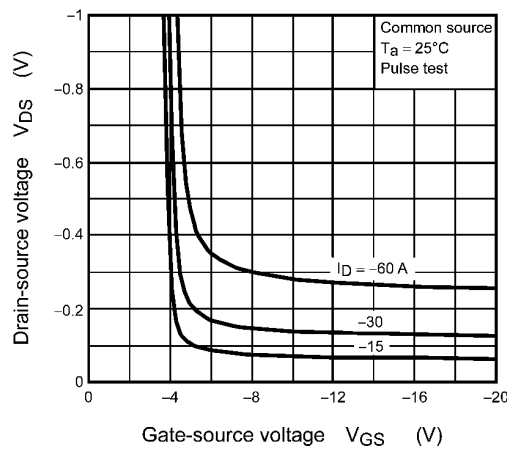


Fig. 8.4 $V_{DS} - V_{GS}$

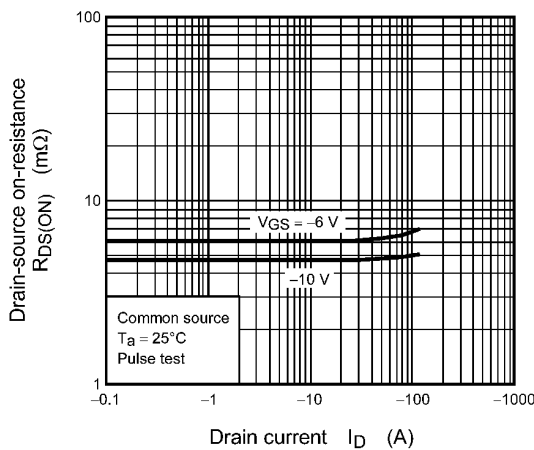


Fig. 8.5 $R_{DS(ON)} - I_D$

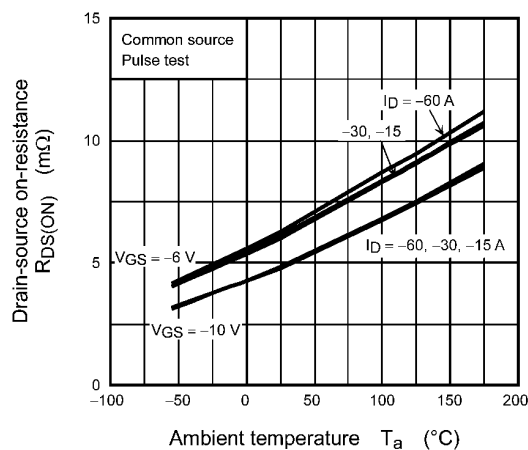


Fig. 8.6 $R_{DS(ON)} - T_a$

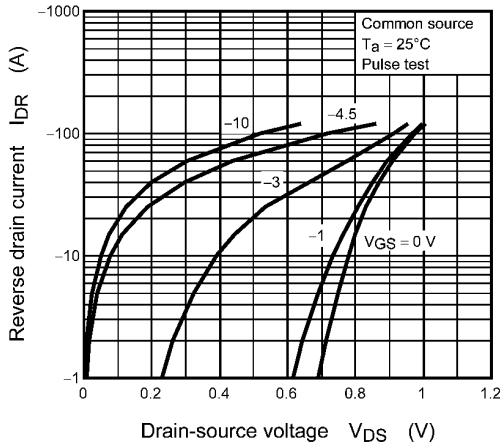


Fig. 8.7 $I_{DR} - V_{DS}$

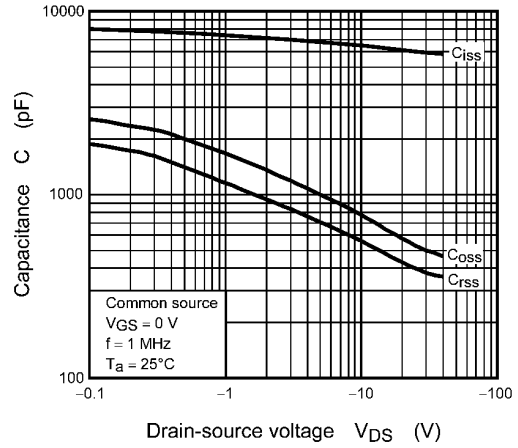


Fig. 8.8 Capacitance - V_{DS}

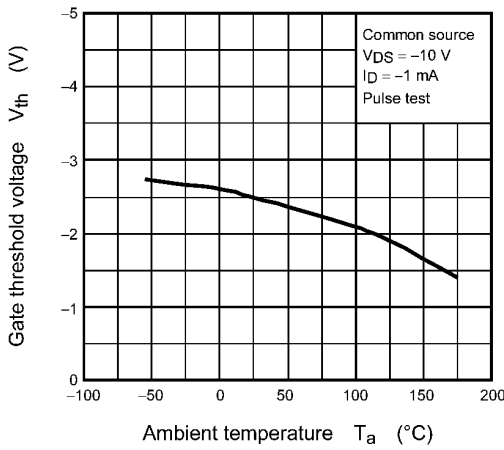


Fig. 8.9 $V_{th} - T_a$

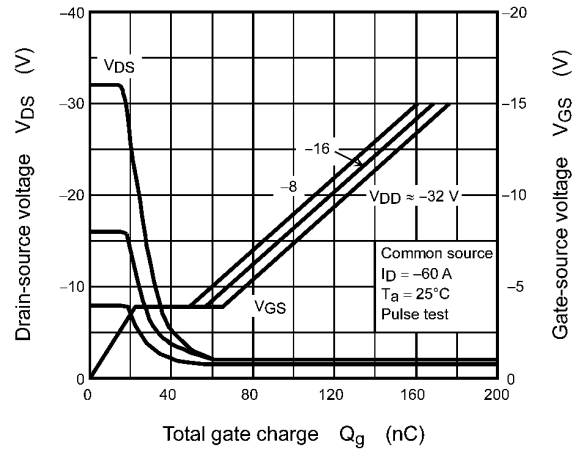
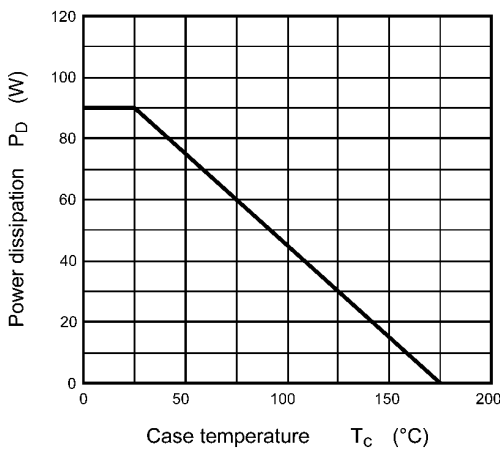


Fig. 8.10 Dynamic Input/Output Characteristics



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

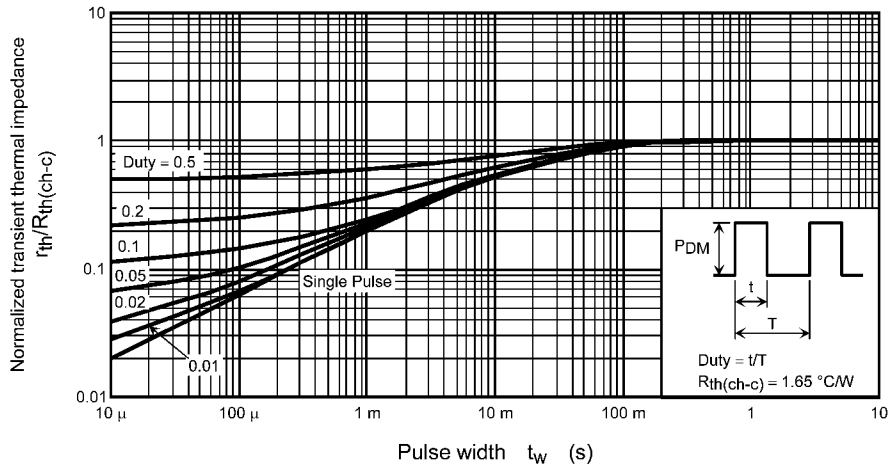


Fig. 8.12 $r_{th}/R_{th(ch-c)} - t_w$
(Guaranteed Maximum)

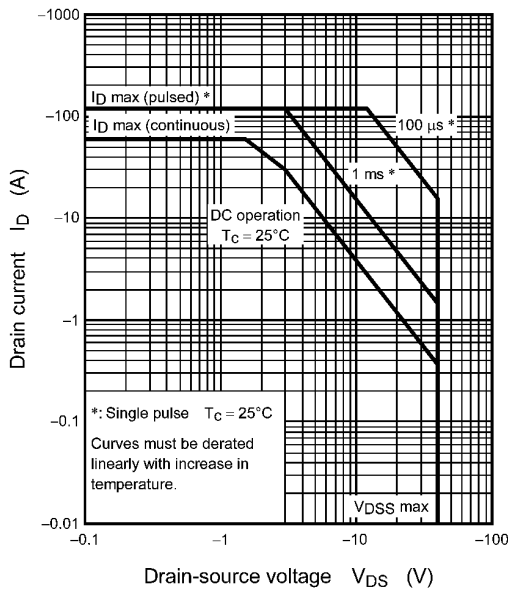


Fig. 8.13 Safe Operating Area
(Guaranteed Maximum)

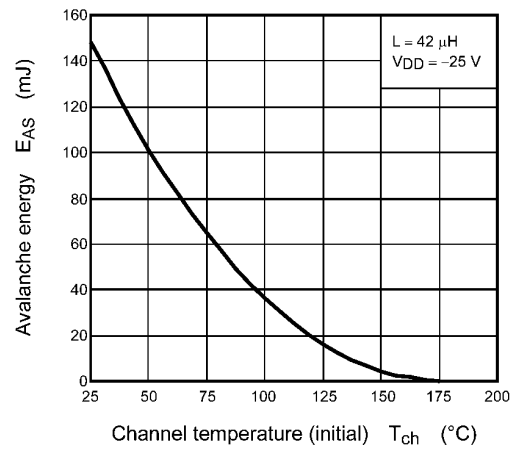
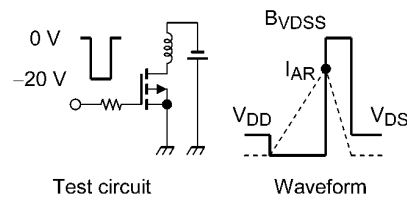


Fig. 8.14 $E_{AS} - T_{ch}$
(Guaranteed Maximum)



$$R_G = 25 \Omega, V_{DD} = -25 \text{ V}, L = 42 \mu\text{H} \quad E_{AS} = \frac{1}{2} \cdot L \cdot I_{AR}^2 \cdot \left(\frac{BV_{DSS}}{BV_{DSS} - V_{DD}} \right)$$

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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