

# 4V+2.5V Drive Nch+Nch MOSFET

## US6M1

### ●Structure

Silicon N-channel / P-channel MOSFET

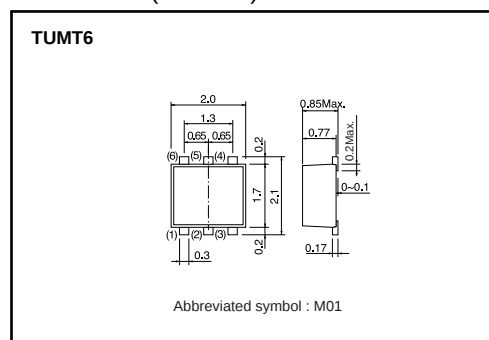
### ●Features

- 1) Low on-resistance.
- 2) Built-in G-S Protection Diode.
- 3) Small Surface Mount Package (TUMT6).

### ●Application

Power switching, DC / DC converter.

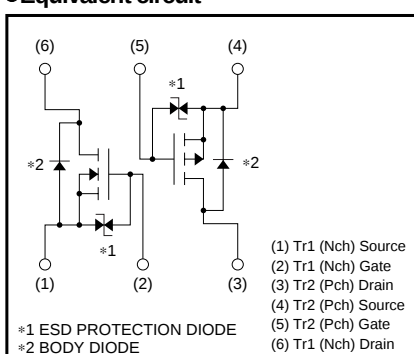
### ●Dimensions (Unit : mm)



### ●Packaging specifications

| Type  | Package                      | Taping |
|-------|------------------------------|--------|
|       | Code                         | TR     |
|       | Basic ordering unit (pieces) | 3000   |
| US6M1 |                              | ○      |

### ●Equivalent circuit



### ●Absolute maximum ratings (Ta=25°C)

| Parameter                   | Symbol            | Limits             |                | Unit        |
|-----------------------------|-------------------|--------------------|----------------|-------------|
|                             |                   | Tr1 : Nchannel     | Tr2 : Pchannel |             |
| Drain-source voltage        | V <sub>DS</sub>   | 30                 | -20            | V           |
| Gate-source voltage         | V <sub>GS</sub>   | 20                 | -12            | V           |
| Drain current               | Continuous        | I <sub>D</sub>     | ±1.4           | A           |
|                             | Pulsed            | I <sub>DP</sub> *1 | ±5.6           | A           |
| Source current (Body diode) | Continuous        | I <sub>S</sub>     | 0.6            | A           |
|                             | Pulsed            | I <sub>SP</sub> *1 | 5.6            | A           |
| Total power dissipation     | P <sub>D</sub> *2 | 1                  |                | W / TOTAL   |
|                             |                   | 0.7                |                | W / ELEMENT |
| Channel temperature         | T <sub>ch</sub>   | 150                |                | °C          |
| Storage temperature         | T <sub>stg</sub>  | -55 to +150        |                | °C          |

\*1 Pw≤10μs, Duty cycle≤1%

\*2 Mounted on a ceramic board.

### ●Thermal resistance

| Parameter          | Symbol                  | Limits | Unit             |
|--------------------|-------------------------|--------|------------------|
| Channel to ambient | R <sub>th</sub> (ch-a)* | 125    | °C / W / TOTAL   |
|                    |                         | 179    | °C / W / ELEMENT |

\*2 Mounted on a ceramic board.

## Transistors

## N-ch

## ●Electrical characteristics (Ta=25°C)

| Parameter                               | Symbol                | Min. | Typ. | Max. | Unit | Conditions                                  |
|-----------------------------------------|-----------------------|------|------|------|------|---------------------------------------------|
| Gate-source leakage                     | I <sub>gss</sub>      | —    | —    | 10   | μA   | V <sub>GS</sub> =20V, V <sub>DS</sub> =0V   |
| Drain-source breakdown voltage          | V <sub>(BR) DSS</sub> | 30   | —    | —    | V    | I <sub>D</sub> =1mA, V <sub>GS</sub> =0V    |
| Zero gate voltage drain current         | I <sub>DSS</sub>      | —    | —    | 1    | μA   | V <sub>DS</sub> =30V, V <sub>GS</sub> =0V   |
| Gate threshold voltage                  | V <sub>GS(th)</sub>   | 1.0  | —    | 2.5  | V    | V <sub>DS</sub> =10V, I <sub>D</sub> =1mA   |
| Static drain-source on-state resistance | R <sub>DS(on)</sub> * | —    | 170  | 240  | mΩ   | I <sub>D</sub> =1.4A, V <sub>GS</sub> =10V  |
|                                         |                       | —    | 250  | 350  |      | I <sub>D</sub> =1.4A, V <sub>GS</sub> =4.5V |
|                                         |                       | —    | 270  | 380  |      | I <sub>D</sub> =1.4A, V <sub>GS</sub> =4V   |
| Forward transfer admittance             | Y <sub>fs</sub>   *   | 1.0  | —    | —    | S    | I <sub>D</sub> =1.4A, V <sub>DS</sub> =10V  |
| Input capacitance                       | C <sub>iss</sub>      | —    | 70   | —    | pF   | V <sub>DS</sub> =10V                        |
| Output capacitance                      | C <sub>oss</sub>      | —    | 15   | —    | pF   | V <sub>GS</sub> =0V                         |
| Reverse transfer capacitance            | C <sub>rss</sub>      | —    | 12   | —    | pF   | f=1MHz                                      |
| Turn-on delay time                      | t <sub>d(on)</sub> *  | —    | 6    | —    | ns   | I <sub>D</sub> =0.7A, V <sub>DD</sub> ≐15V  |
| Rise time                               | t <sub>r</sub> *      | —    | 6    | —    | ns   | V <sub>GS</sub> =10V                        |
| Turn-off delay time                     | t <sub>d(off)</sub> * | —    | 13   | —    | ns   | R <sub>L</sub> =21Ω                         |
| Fall time                               | t <sub>f</sub> *      | —    | 8    | —    | ns   | R <sub>G</sub> =10Ω                         |
| Total gate charge                       | Q <sub>g</sub> *      | —    | 1.4  | 2.0  | nC   | V <sub>DD</sub> ≐15V R <sub>L</sub> =11Ω    |
| Gate-source charge                      | Q <sub>gs</sub> *     | —    | 0.6  | —    | nC   | V <sub>GS</sub> =5V R <sub>G</sub> =10Ω     |
| Gate-drain charge                       | Q <sub>gd</sub> *     | —    | 0.3  | —    | nC   | I <sub>D</sub> =1.4A                        |

\*Pulsed

## ●Body diode characteristics (Source-Drain) (Ta=25°C)

| Parameter       | Symbol          | Min. | Typ. | Max. | Unit | Test Conditions                           |
|-----------------|-----------------|------|------|------|------|-------------------------------------------|
| Forward voltage | V <sub>SD</sub> | —    | —    | 1.2  | V    | I <sub>S</sub> =0.6A, V <sub>GS</sub> =0V |

## Transistors

## P-ch

## ●Electrical characteristics (Ta=25°C)

| Parameter                               | Symbol         | Min. | Typ. | Max. | Unit | Conditions                              |
|-----------------------------------------|----------------|------|------|------|------|-----------------------------------------|
| Gate-source leakage                     | $I_{GSS}$      | —    | —    | −10  | μA   | $V_{GS}=12V, V_{DS}=0V$                 |
| Drain-source breakdown voltage          | $V_{(BR) DSS}$ | −20  | —    | —    | V    | $I_D = -1mA, V_{GS}=0V$                 |
| Zero gate voltage drain current         | $I_{DSS}$      | —    | —    | −1   | μA   | $V_{DS} = -20V, V_{GS}=0V$              |
| Gate threshold voltage                  | $V_{GS(th)}$   | −0.7 | —    | −2.0 | V    | $V_{DS} = -10V, I_D = -1mA$             |
| Static drain-source on-state resistance | $R_{DS(on)}$ * | —    | 280  | 390  | mΩ   | $I_D = -1A, V_{GS} = -4.5V$             |
|                                         |                | —    | 310  | 430  |      | $I_D = -1A, V_{GS} = -4V$               |
|                                         |                | —    | 570  | 800  |      | $I_D = -0.5A, V_{GS} = -2.5V$           |
| Forward transfer admittance             | $ Y_{fs} $ *   | 0.7  | —    | —    | S    | $I_D = -0.5A, V_{DS} = -10V$            |
| Input capacitance                       | $C_{iss}$      | —    | 150  | —    | pF   | $V_{DS} = -10V$                         |
| Output capacitance                      | $C_{oss}$      | —    | 20   | —    | pF   | $V_{GS}=0V$                             |
| Reverse transfer capacitance            | $C_{rss}$      | —    | 20   | —    | pF   | $f=1MHz$                                |
| Turn-on delay time                      | $t_{d(on)}$ *  | —    | 9    | —    | ns   | $I_D = -0.5A, V_{DD} \doteq -15V$       |
| Rise time                               | $t_r$ *        | —    | 8    | —    | ns   | $V_{GS} = -4.5V$                        |
| Turn-off delay time                     | $t_{d(off)}$ * | —    | 25   | —    | ns   | $R_L=30\Omega$                          |
| Fall time                               | $t_f$ *        | —    | 10   | —    | ns   | $R_G=10\Omega$                          |
| Total gate charge                       | $Q_g$ *        | —    | 2.1  | —    | nC   | $V_{DD} \doteq -15V \quad R_L=15\Omega$ |
| Gate-source charge                      | $Q_{gs}$ *     | —    | 0.5  | —    | nC   | $V_{GS} = -4.5V \quad R_G=10\Omega$     |
| Gate-drain charge                       | $Q_{gd}$ *     | —    | 0.5  | —    | nC   | $I_D = -1A$                             |

\*Pulsed

## ●Body diode characteristics (Source-Drain) (Ta=25°C)

| Parameter       | Symbol   | Min. | Typ. | Max. | Unit | Test Conditions          |
|-----------------|----------|------|------|------|------|--------------------------|
| Forward voltage | $V_{SD}$ | —    | —    | −1.2 | V    | $I_S = -0.4A, V_{GS}=0V$ |

## Transistors

## N-ch

## ●Electrical characteristic curves

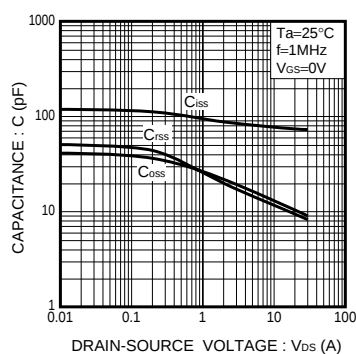


Fig.1 Typical Capacitance vs. Drain-Source Voltage

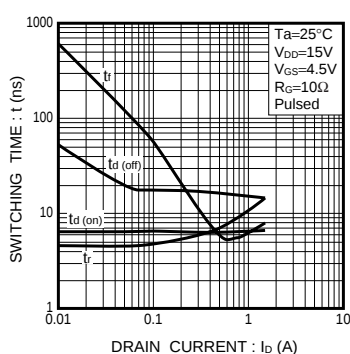


Fig.2 Switching Characteristics

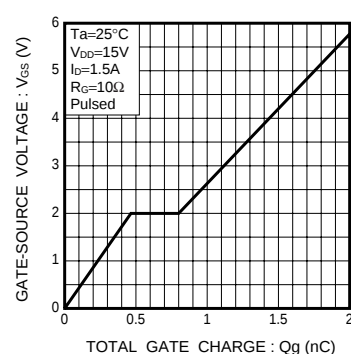


Fig.3 Dynamic Input Characteristics

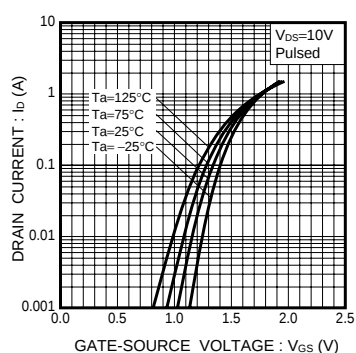


Fig.4 Typical Transfer Characteristics

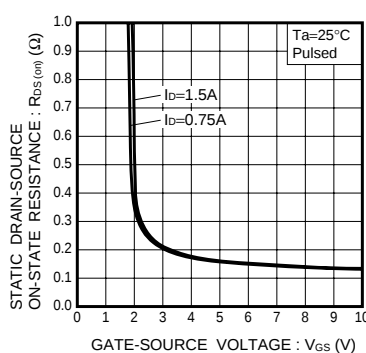


Fig.5 Static Drain-Source On-State Resistance vs. Gate-Source Voltage

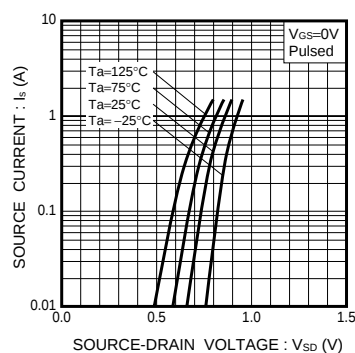


Fig.6 Source Current vs. Source-Drain Voltage

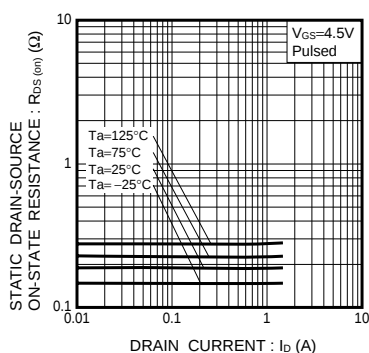


Fig.7 Static Drain-Source On-State Resistance vs. Drain Current (I)

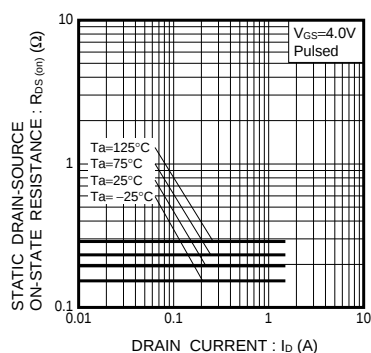


Fig.8 Static Drain-Source On-State Resistance vs. Drain Current (II)

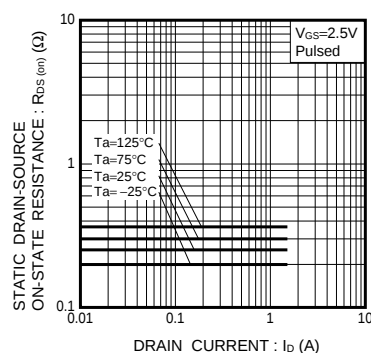


Fig.9 Static Drain-Source On-State Resistance vs. Drain Current (III)

## Transistors

## P-ch

## ●Electrical characteristic curves

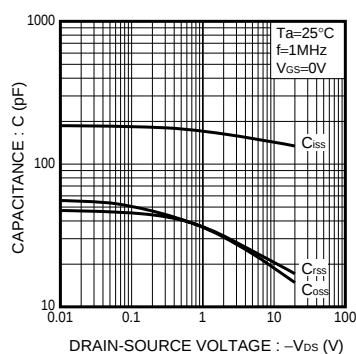


Fig.1 Typical Capacitance vs. Drain-Source Voltage

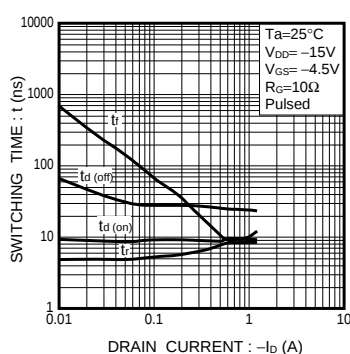


Fig.2 Switching Characteristics

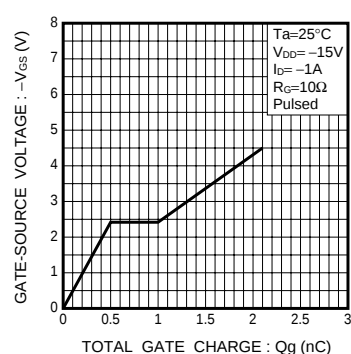


Fig.3 Dynamic Input Characteristics

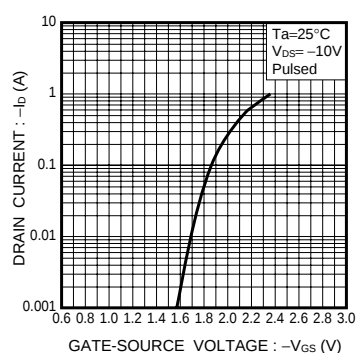


Fig.4 Typical Transfer Characteristics

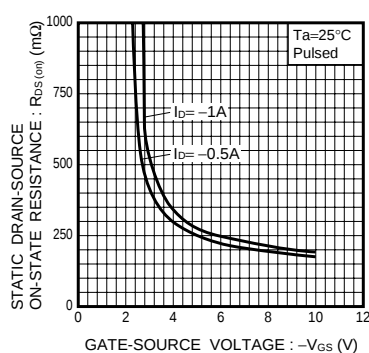


Fig.5 Static Drain-Source On-State Resistance vs. Gate-Source Voltage

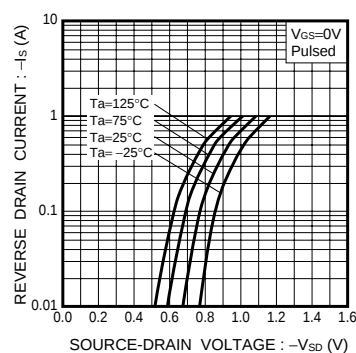


Fig.6 Source Current vs. Source-Drain Voltage

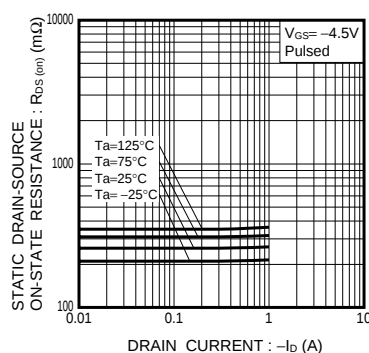


Fig.7 Static Drain-Source On-State Resistance vs. Drain Current (I)

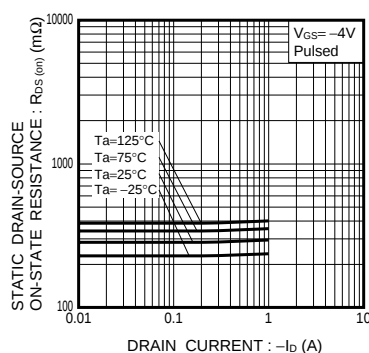


Fig.8 Static Drain-Source On-State Resistance vs. Drain Current (II)

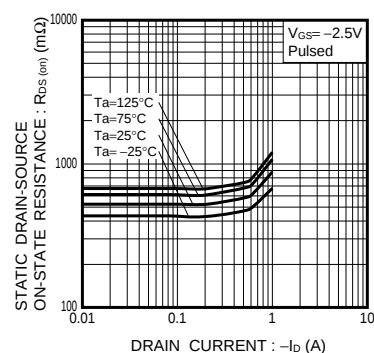


Fig.9 Static Drain-Source On-State Resistance vs. Drain Current (III)

## Transistors

## N-ch

## ●Measurement circuit

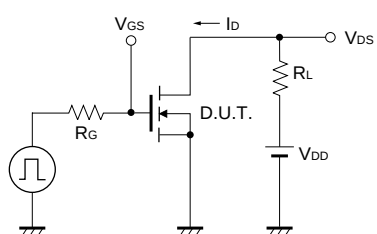


Fig.1-1 Switching Time Measurement Circuit

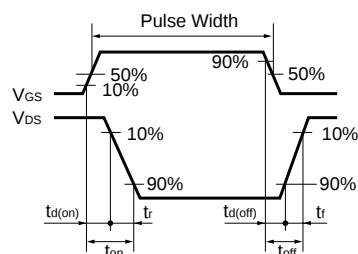


Fig.1-2 Switching Waveforms

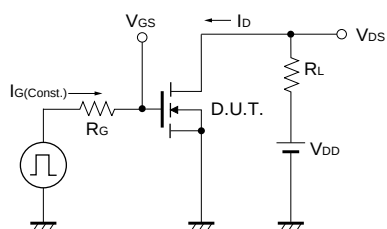


Fig.2-1 Gate Charge Measurement Circuit

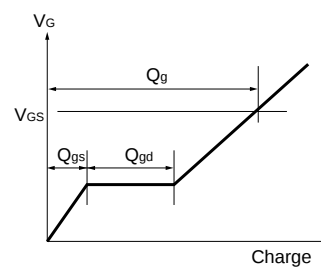


Fig.2-2 Gate Charge Waveform

## Transistors

## P-ch

## ●Measurement circuit

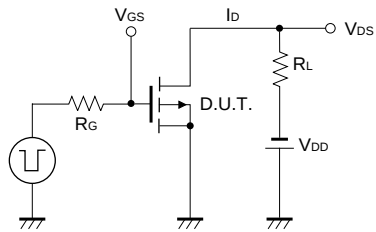


Fig.3-1 Switching Time Measurement Circuit

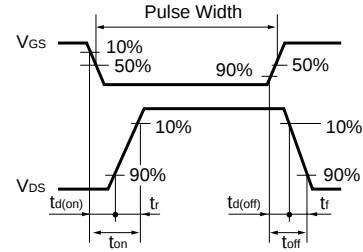


Fig.3-2 Switching Waveforms

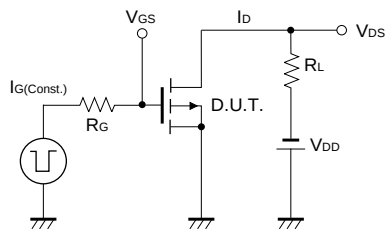


Fig.4-1 Gate Charge Measurement Circuit

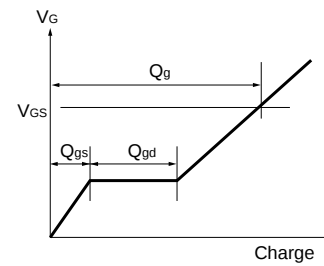


Fig.4-2 Gate Charge Waveform

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