

# 4V+2.5V Drive Nch+Nch MOSFET

## US6M1

### ●Structure

Silicon N-channel / P-channel MOSFET

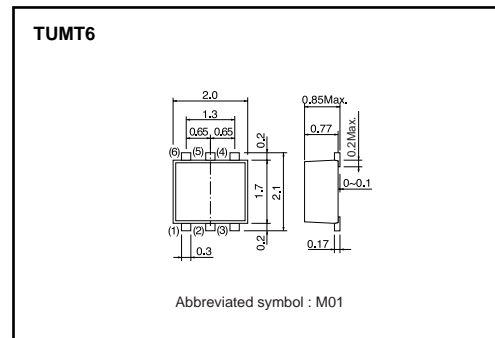
### ●Features

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

### ●Application

Power switching, DC / DC converter.

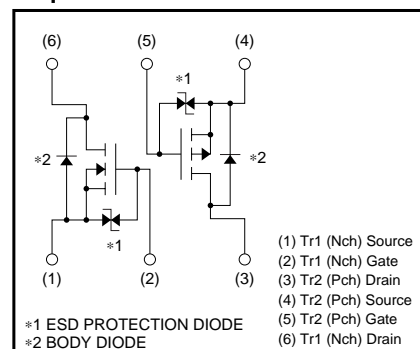
### ●Dimensions (Unit : mm)



### ●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>BSS</sub>	30	-20	V	
Gate-source voltage	V <sub>GSS</sub>	20	-12	V	
Drain current	Continuous	I <sub>D</sub>	±1.4	±1	A
	Pulsed	I <sub>DP</sub> *1	±5.6	±4	A
Source current (Body diode)	Continuous	I <sub>S</sub>	0.6	-0.4	A
	Pulsed	I <sub>SP</sub> *1	5.6	-4	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 cycles≤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> <sup>*</sup>	–	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>   <sup>*</sup>	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> <sup>*</sup>	–	6	–	ns	I <sub>D</sub> =0.7A, V <sub>DD</sub> ≐15V
Rise time	t <sub>r</sub> <sup>*</sup>	–	6	–	ns	V <sub>GS</sub> =10V
Turn-off delay time	t <sub>d(off)</sub> <sup>*</sup>	–	13	–	ns	R <sub>L</sub> =21Ω
Fall time	t <sub>f</sub> <sup>*</sup>	–	8	–	ns	R <sub>G</sub> =10Ω
Total gate charge	Q <sub>g</sub> <sup>*</sup>	–	1.4	2.0	nC	V <sub>DD</sub> ≐15V R <sub>L</sub> =11Ω
Gate-source charge	Q <sub>gs</sub> <sup>*</sup>	–	0.6	–	nC	V <sub>GS</sub> =5V R <sub>G</sub> =10Ω
Gate-drain charge	Q <sub>gd</sub> <sup>*</sup>	–	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 <sub>gss</sub>	–	–	–10	μA	V <sub>GS</sub> =12V, V <sub>DS</sub> =0V
Drain-source breakdown voltage	V <sub>(BR) DSS</sub>	–20	–	–	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> = –20V, V <sub>GS</sub> =0V
Gate threshold voltage	V <sub>GS(th)</sub>	–0.7	–	–2.0	V	V <sub>DS</sub> = –10V, I <sub>D</sub> = –1mA
Static drain-source on-state resistance	R <sub>DS(on)</sub> *	–	280	390	mΩ	I <sub>D</sub> = –1A, V <sub>GS</sub> = –4.5V
		–	310	430		I <sub>D</sub> = –1A, V <sub>GS</sub> = –4V
		–	570	800		I <sub>D</sub> = –0.5A, V <sub>GS</sub> = –2.5V
Forward transfer admittance	Y <sub>fs</sub>   *	0.7	–	–	S	I <sub>D</sub> = –0.5A, V <sub>DS</sub> = –10V
Input capacitance	C <sub>iss</sub>	–	150	–	pF	V <sub>DS</sub> = –10V
Output capacitance	C <sub>oss</sub>	–	20	–	pF	V <sub>GS</sub> =0V
Reverse transfer capacitance	C <sub>rss</sub>	–	20	–	pF	f=1MHz
Turn-on delay time	t <sub>d(on)</sub> *	–	9	–	ns	I <sub>D</sub> = –0.5A, V <sub>DD</sub> ≐ –15V
Rise time	t <sub>r</sub> *	–	8	–	ns	V <sub>GS</sub> = –4.5V
Turn-off delay time	t <sub>d(off)</sub> *	–	25	–	ns	R <sub>L</sub> =30Ω
Fall time	t <sub>f</sub> *	–	10	–	ns	R <sub>G</sub> =10Ω
Total gate charge	Q <sub>g</sub> *	–	2.1	–	nC	V <sub>DD</sub> ≐ –15V R <sub>L</sub> =15Ω
Gate-source charge	Q <sub>gs</sub> *	–	0.5	–	nC	V <sub>GS</sub> = –4.5V R <sub>G</sub> =10Ω
Gate-drain charge	Q <sub>gd</sub> *	–	0.5	–	nC	I <sub>D</sub> = –1A

\*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> = –0.4A, V <sub>GS</sub> =0V

Transistors

N-ch

●Electrical characteristic curves

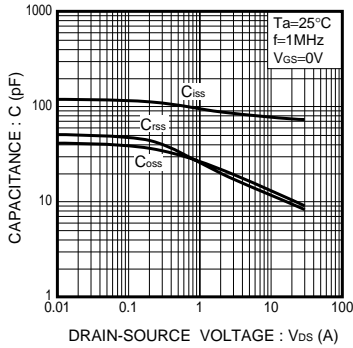


Fig.1 Typical Capacitance vs. Drain-Source Voltage

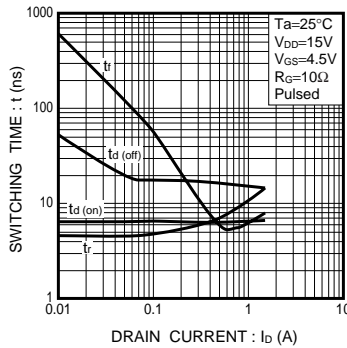


Fig.2 Switching Characteristics

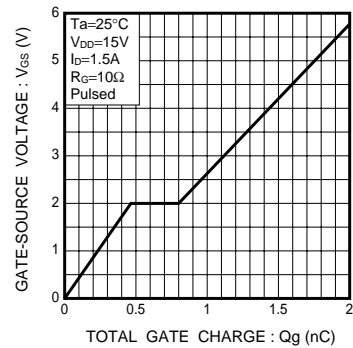


Fig.3 Dynamic Input Characteristics

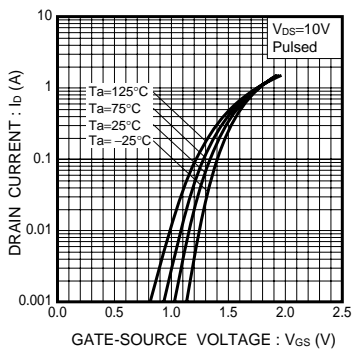


Fig.4 Typical Transfer Characteristics

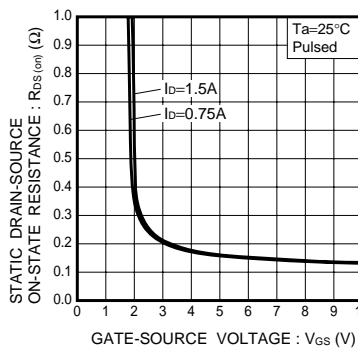


Fig.5 Static Drain-Source On-State Resistance vs. Gate-Source Voltage

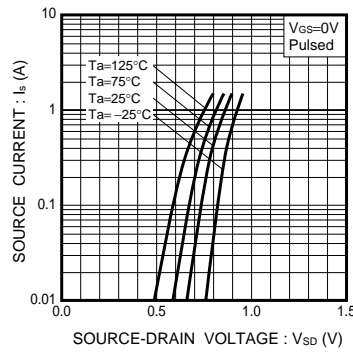


Fig.6 Source Current vs. Source-Drain Voltage

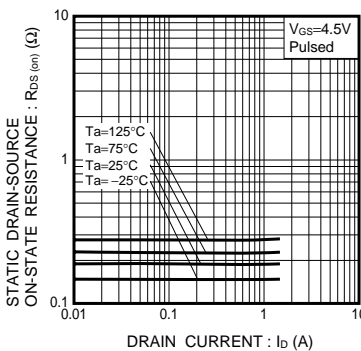


Fig.7 Static Drain-Source On-State Resistance vs. Drain Current (I)

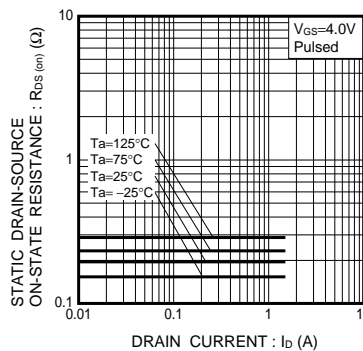


Fig.8 Static Drain-Source On-State Resistance vs. Drain Current (II)

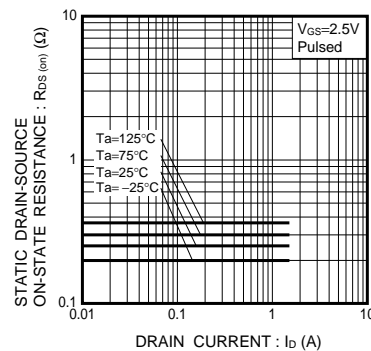


Fig.9 Static Drain-Source On-State Resistance vs. Drain Current (III)

Transistors

P-ch

●Electrical characteristic curves

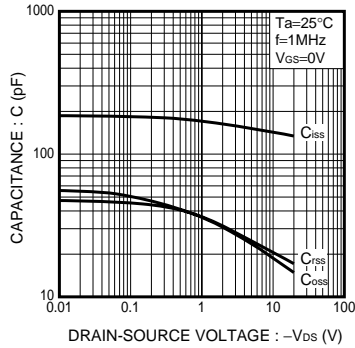


Fig.1 Typical Capacitance vs. Drain-Source Voltage

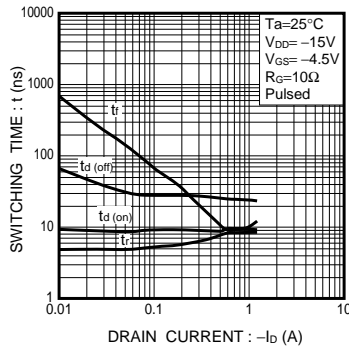


Fig.2 Switching Characteristics

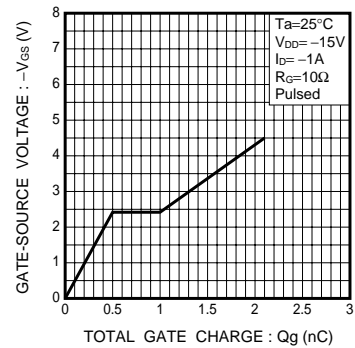


Fig.3 Dynamic Input Characteristics

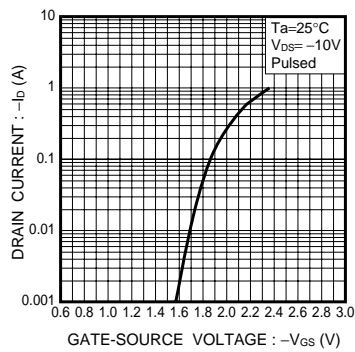


Fig.4 Typical Transfer Characteristics

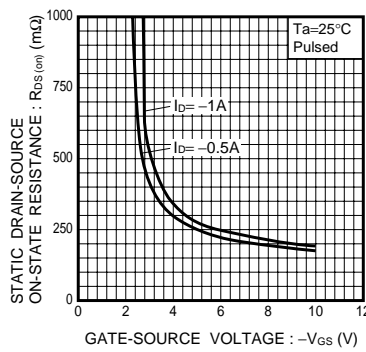


Fig.5 Static Drain-Source On-State Resistance vs. Gate-Source Voltage

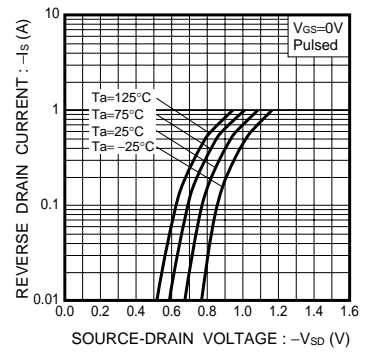


Fig.6 Source Current vs. Source-Drain Voltage

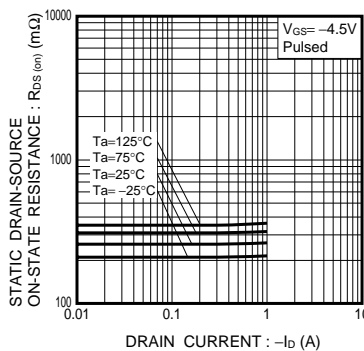


Fig.7 Static Drain-Source On-State Resistance vs. Drain Current (I)

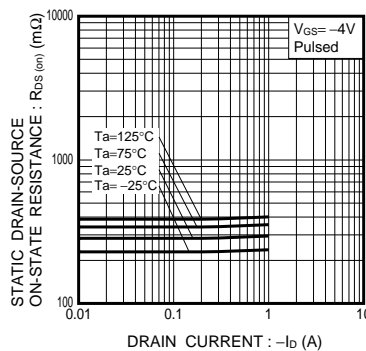


Fig.8 Static Drain-Source On-State Resistance vs. Drain Current (II)

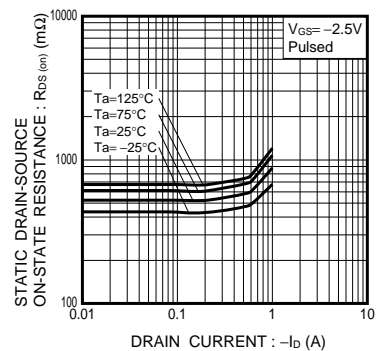


Fig.9 Static Drain-Source On-State Resistance vs. Drain Current (III)

Transistors

N-ch

●Measurement circuit

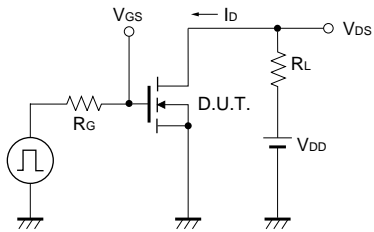


Fig.1-1 Switching Time Measurement Circuit

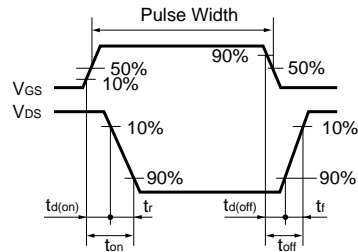


Fig.1-2 Switching Waveforms

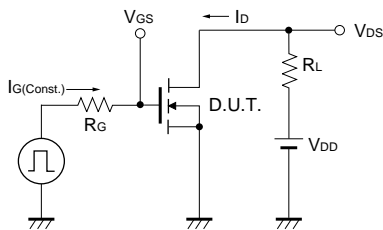


Fig.2-1 Gate Charge Measurement Circuit

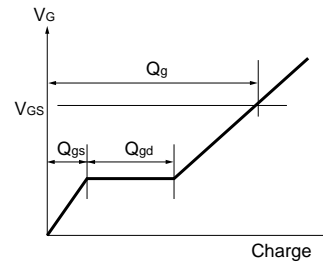


Fig.2-2 Gate Charge Waveform

Transistors

P-ch

●Measurement circuit

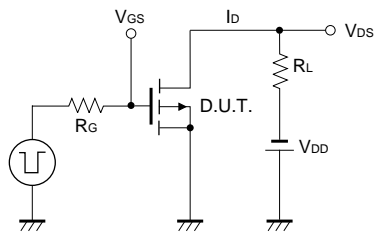


Fig.3-1 Switching Time Measurement Circuit

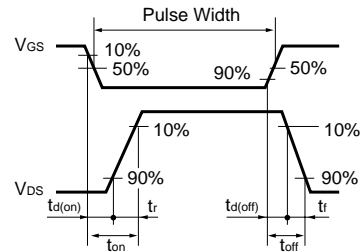


Fig.3-2 Switching Waveforms

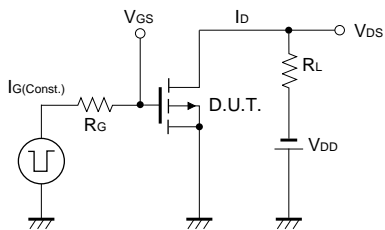


Fig.4-1 Gate Charge Measurement Circuit

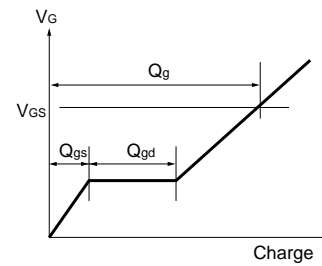


Fig.4-2 Gate Charge Waveform

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