RUL035N02

Nch 20V 3.5A Power MOSFET

Datasheet

|	
V_{DSS}	20V
$R_{DS(on)}$ (Max.)	43mΩ
I_D	3.5A
P_D	1.0W

●**Features**

1) Low on - resistance.

2) 1.5V Drive.

3) Built-in G-S Protection Diode.

4) Small Surface Mount Package (TUMT6).

5) Pb-free lead plating ; RoHS compliant
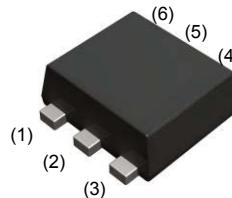
●**Application**

DC/DC converters

●**Outline**

TUMT6
SOT-363T

●**Inner circuit**

(1) Drain
(2) Drain
(3) Gate
(4) Source
(5) Drain
(6) Drain

∗1 ESD PROTECTION DIODE
∗2 BODY DIODE

●**Packaging specifications**

Type	Packaging	Taping
	Reel size (mm)	180
	Tape width (mm)	8
	Basic ordering unit (pcs)	3,000
	Taping code	TR
	Marking	XD

●**Absolute maximum ratings**(T_a = 25°C)

Parameter	Symbol	Value	Unit
Drain - Source voltage	V_{DSS}	20	V
Continuous drain current	I_D [*1]	±3.5	A
Pulsed drain current	$I_{D,pulse}$ [*2]	±7	A
Gate - Source voltage	V_{GSS}	±10	V
Power dissipation	P_D [*3]	1.0	W
	P_D [*4]	0.32	W
Junction temperature	T_j	150	°C
Range of storage temperature	T_{stg}	−55 to +150	°C

● **Thermal resistance**

Parameter	Symbol	Values			Unit
		Min.	Typ.	Max.	
Thermal resistance, junction - ambient	R_{thJA}[*3]	-	-	125	°C/W
	R_{thJA}[*4]	-	-	391	°C/W

● **Electrical characteristics**(T_a = 25°C)

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Drain - Source breakdown voltage	$V_{(BR)DSS}$	V_{GS} = 0V, I_D = 1mA	20	-	-	V
Breakdown voltage temperature coefficient	$\dfrac{\Delta V_{(BR)DSS}}{\Delta T_j}$	I_D=1mA referenced to 25°C	-	20	-	mV/°C
Zero gate voltage drain current	I_{DSS}	V_{DS} = 20V, V_{GS} = 0V	-	-	1	μA
Gate - Source leakage current	I_{GSS}	V_{GS} = ±10V, V_{DS} = 0V	-	-	±10	μA
Gate threshold voltage	$V_{GS\,(th)}$	V_{DS} = 10V, I_D = 1mA	0.3	-	1.0	V
Gate threshold voltage temperature coefficient	$\dfrac{\Delta V_{(GS)th}}{\Delta T_j}$	I_D=1mA referenced to 25°C	-	−1.9	-	mV/°C
Static drain - source on - state resistance	$R_{DS(on)}$[*5]	V_{GS}=4.5V, I_D=3.5A	-	31	43	mΩ
		V_{GS}=2.5V, I_D=3.5A	-	38	53	
		V_{GS}=1.8V, I_D=1.8A	-	50	70	
		V_{GS}=1.5V, I_D=0.7A	-	66	93	
		V_{GS}=4.5V, I_D=3.5A, T_j=125°C	-	56	80	
Gate input resistannce	R_G	f = 1MHz, open drain	-	7.5	-	Ω
Transconductance	g_{fs}[*5]	V_{DS}=10V, I_D=3.5A	3.2	8.5	-	S

*1 Limited only by maximum temperature allowed.

*2 Pw ≤ 10μs, Duty cycle ≤ 1%

*3 Mounted on a seramic board (30×30×0.8mm)

*4 Mounted on a FR4 (15×20×0.8mm)

*5 Pulsed

●**Electrical characteristics**(T_a = 25°C)

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Input capacitance	C_{iss}	V_{GS} = 0V	-	460	-	
Output capacitance	C_{oss}	V_{DS} = 10V	-	110	-	pF
Reverse transfer capacitance	C_{rss}	f = 1MHz	-	60	-	
Turn - on delay time	$t_{d(on)}$ [5]	$V_{DD} \simeq$ 10V, V_{GS} = 4.5V	-	10	-	
Rise time	t_r [5]	I_D = 1.8A	-	20	-	
Turn - off delay time	$t_{d(off)}$ [5]	R_L = 5.6Ω	-	40	-	ns
Fall time	t_f [5]	R_G = 10Ω	-	50	-	

●**Gate Charge characteristics**(T_a = 25°C)

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Total gate charge	Q_g [5]		-	5.7	-	
Gate - Source charge	Q_{gs} [5]	$V_{DD} \simeq$ 10, I_D=3.5A V_{GS} = 4.5V	-	1.1	-	nC
Gate - Drain charge	Q_{gd} [5]		-	0.9	-	

●**Body diode electrical characteristics** (Source-Drain)(T_a = 25°C)

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Inverse diode continuous, forward current	I_S [1]	T_a = 25°C	-	-	0.8	A
Forward voltage	V_{SD} [5]	V_{GS} = 0V, I_s = 0.8A	-	-	1.2	V

● **Electrical characteristic curves**

Fig.1 Power Dissipation Derating Curve
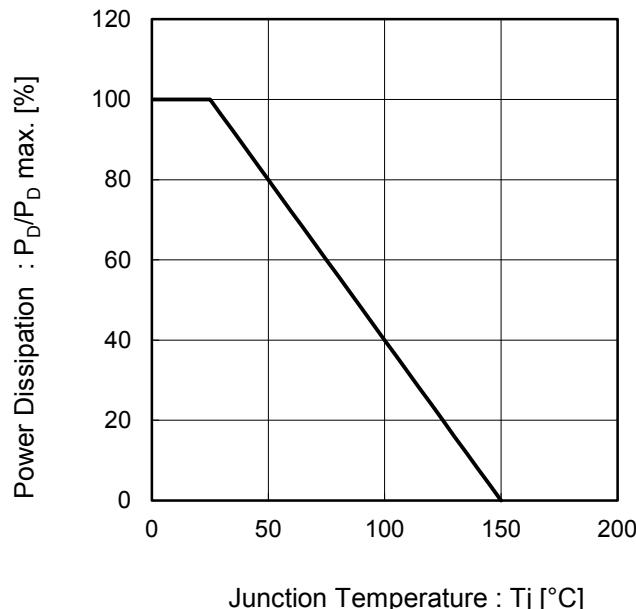
Fig.2 Maximum Safe Operating Area
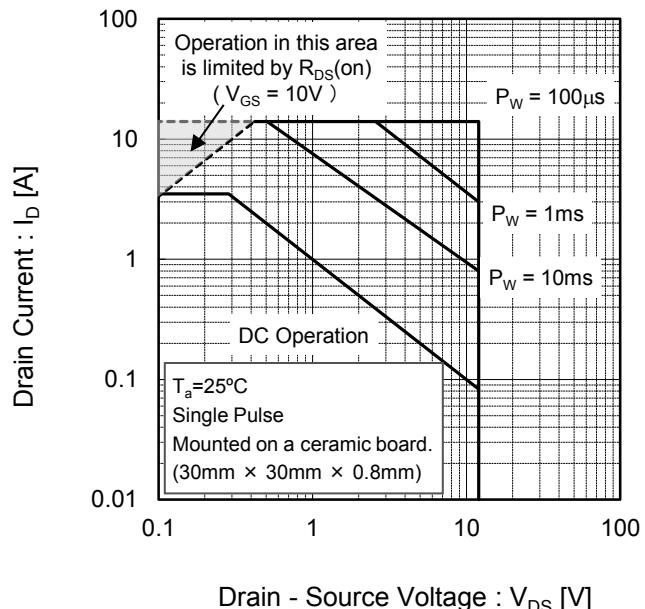
Fig.3 Normalized Transient Thermal Resistance vs. Pulse Width
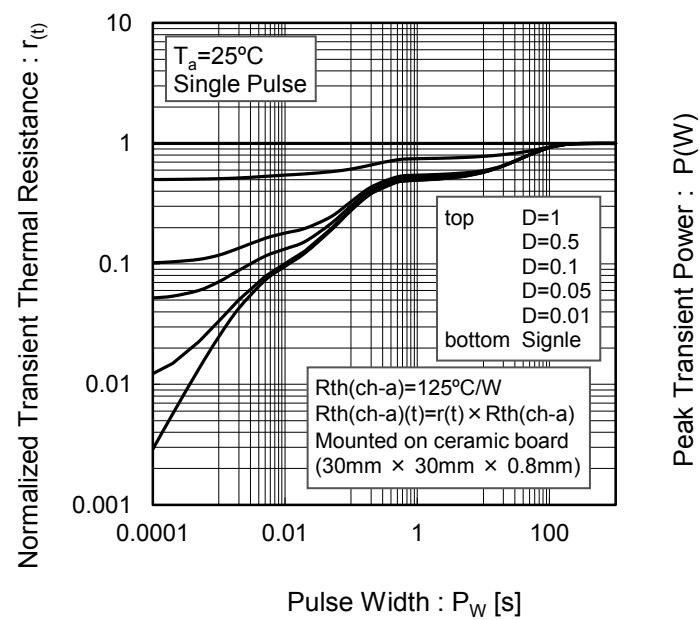
Fig.4 Single Pulse Maxmum Power dissipation
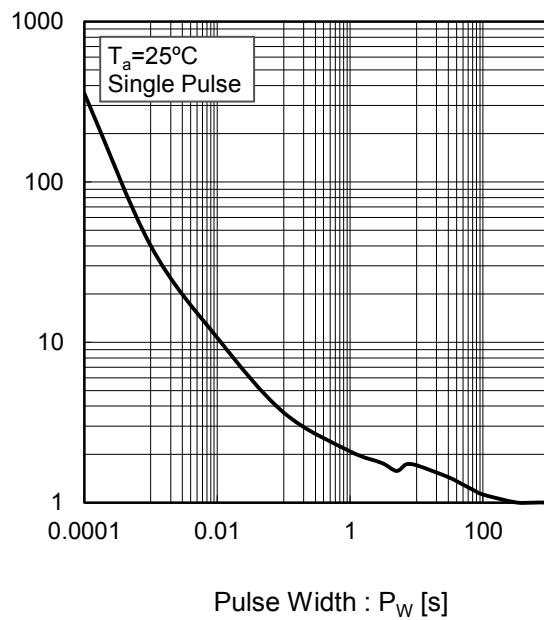
● **Electrical characteristic curves**

Fig.5 Typical Output Characteristics(I)

T_a=25ºC Pulsed

V_{GS}=4.5V
V_{GS}=2.5V
V_{GS}=1.8V
V_{GS}=1.5V
V_{GS}=1.3V
V_{GS}=1.1V

Drain Current : I_D [A]

Drain - Source Voltage : V_{DS} [V]

Fig.6 Typical Output Characteristics(II)

V_{GS}=4.5V
V_{GS}=2.5V
V_{GS}=1.8V
V_{GS}=1.5V
V_{GS}=1.3V
V_{GS}=1.2V
V_{GS}=1.1V

T_a=25ºC Pulsed

Drain Current : I_D [A]

Drain - Source Voltage : V_{DS} [V]
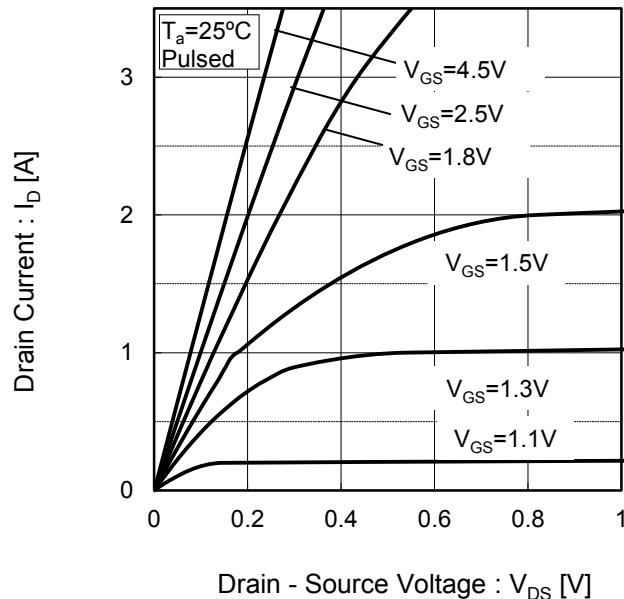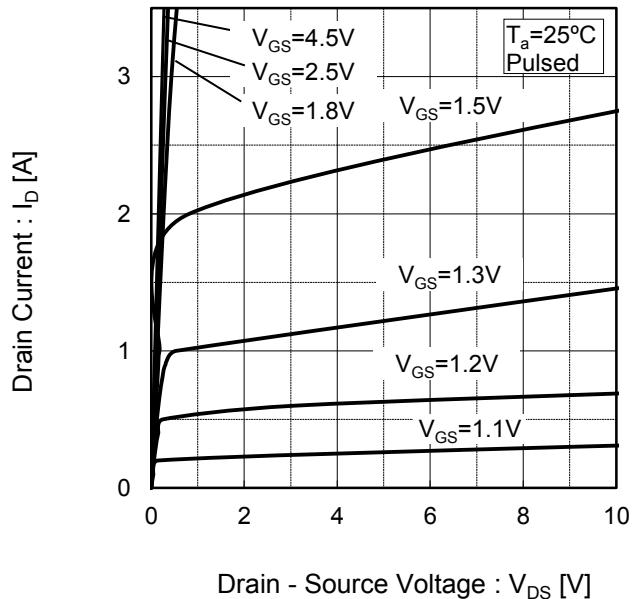
Fig.7 Breakdown Voltage
vs. Junction Temperature

V_{GS} = 0V
I_D = 1mA
pulsed

Drain - Source Breakdown Voltage : $V_{(BR)DSS}$ [V]

Junction Temperature : T_j [°C]
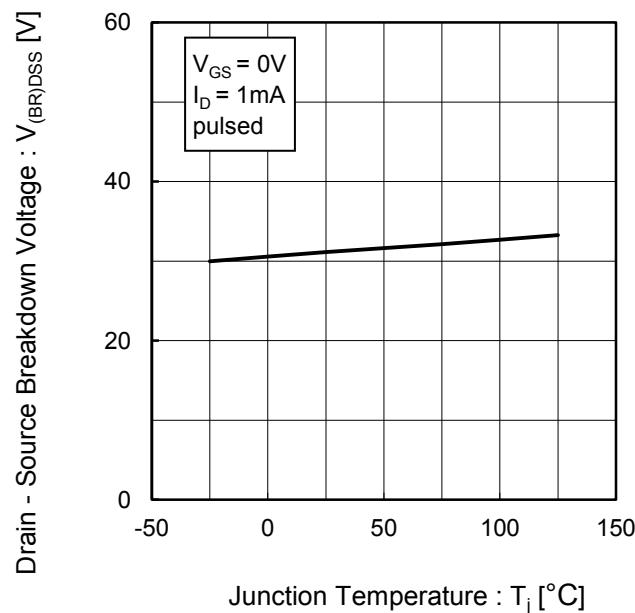
Fig.8 Typical Transfer Characteristics

V_{DS}=10V
Pulsed

T_a=125°C
T_a=75°C
T_a=25°C
T_a= −25°C

Drain Current : I_D [A]

Gate - Source Voltage : V_{GS} [V]
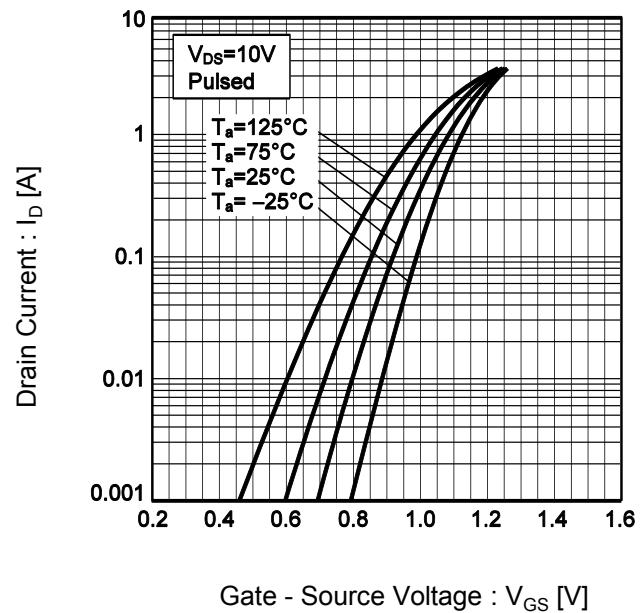
● **Electrical characteristic curves**

Fig.9 Gate Threshold Voltage
vs. Junction Temperature

V_{DS} = 10V
I_D = 1mA
pulsed

Gate Threshold Voltage : $V_{GS(th)}$ [V]

Junction Temperature : T_j [°C]
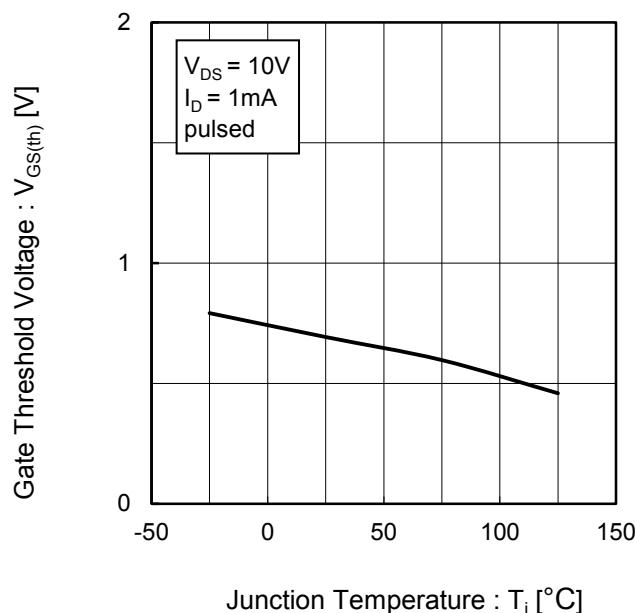
Fig.10 Transconductance vs. Drain Current

V_{DS}= 10V
Pulsed

T_a= −25°C
T_a=25°C
T_a=75°C
T_a=125°C

Transconductance : g_{fs} [S]
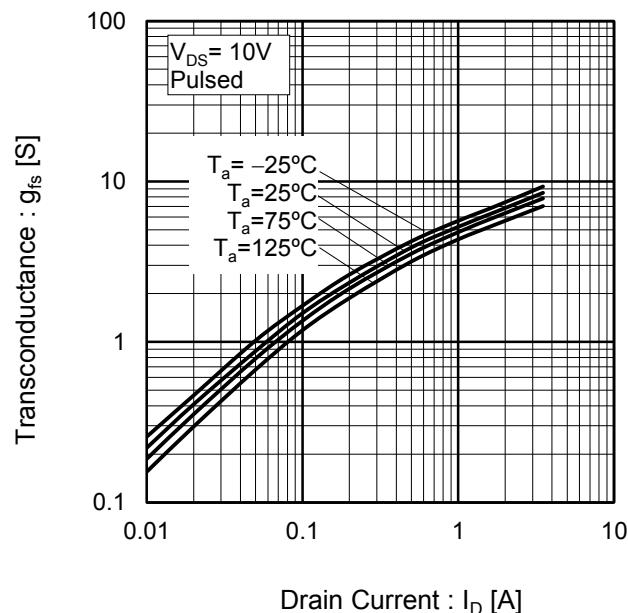
Drain Current : I_D [A]

Fig.11 Drain CurrentDerating Curve

Drain Current Dissipation : I_D/I_D max. (%)

Junction Temperature : T_j [°C]
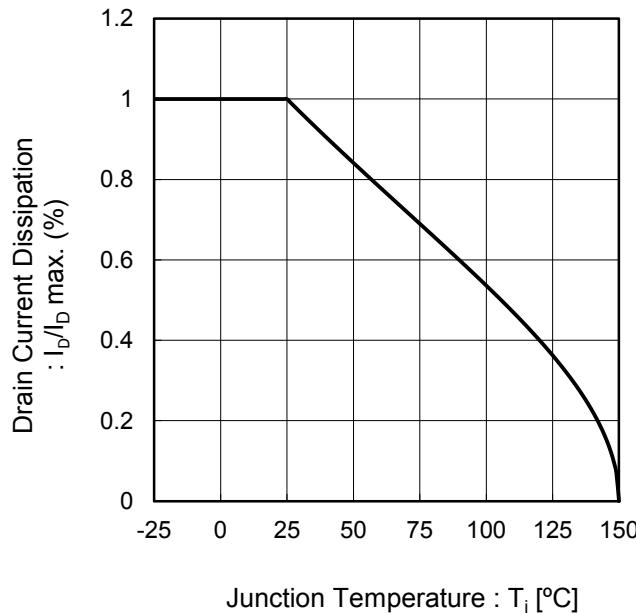
Fig.12 Static Drain - Source On - State
Resistance vs. Gate Source Voltage

I_D=3.5A

I_D=1.8A

T_a=25°C
Pulsed

Static Drain - Source On-State Resistance : $R_{DS(on)}$ [mΩ]

Gate - Source Voltage : V_{GS} [V]

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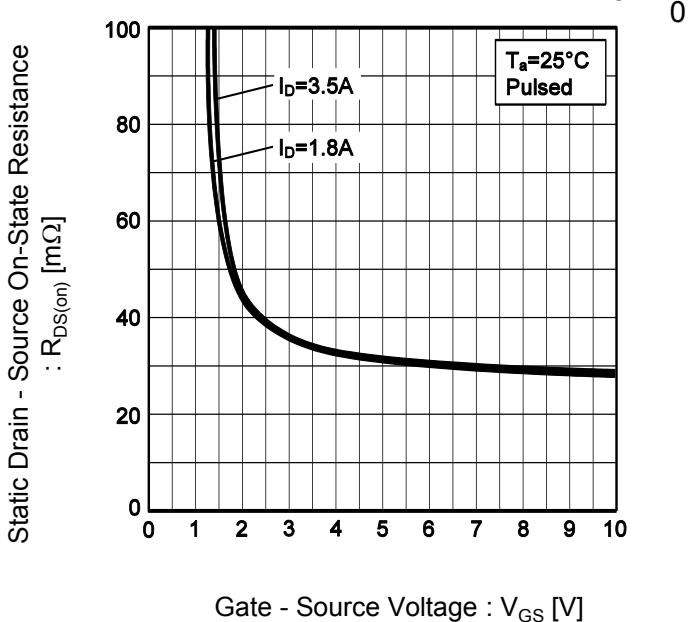
●**Electrical characteristic curves**

Fig.13 Static Drain - Source On - State
Resistance vs. Drain Current(I)

Static Drain - Source On-State Resistance : $R_{DS(on)}$ [mΩ]

V_{GS}=4.5V
Pulsed

T_a=125°C
T_a=75°C
T_a=25°C
T_a= −25°C
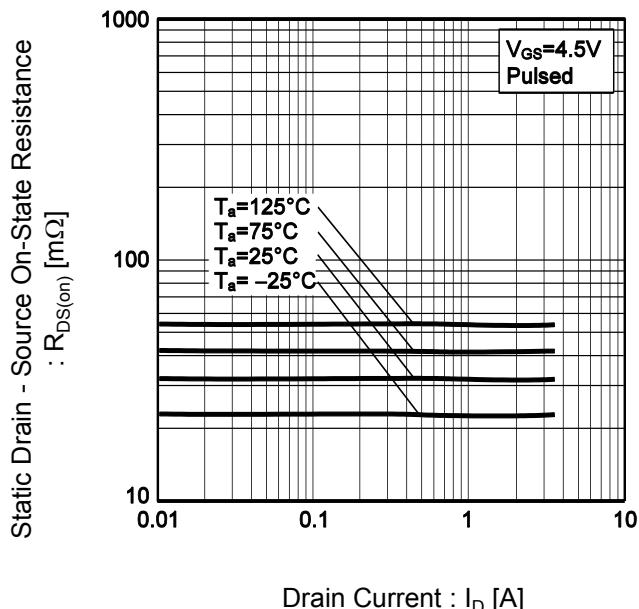
Drain Current : I_D [A]

Fig.14 Static Drain - Source On - State
Resistance vs. Junction Temperature

Static Drain - Source On-State Resistance : $R_{DS(on)}$ [mΩ]

V_{GS} = 10V
I_D=3.5A
pulsed

Junction Temperature : T_j [°C]
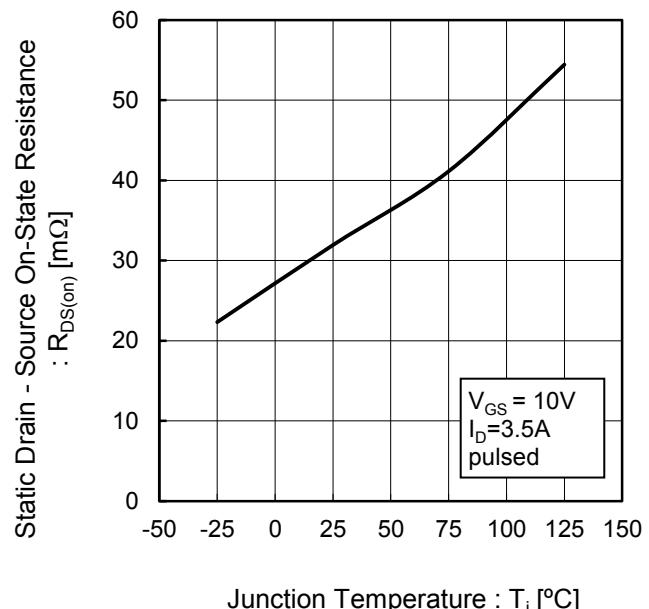
●**Electrical characteristic curves**

Fig.15 Static Drain - Source On - State
Resistance vs. Drain Current(II)
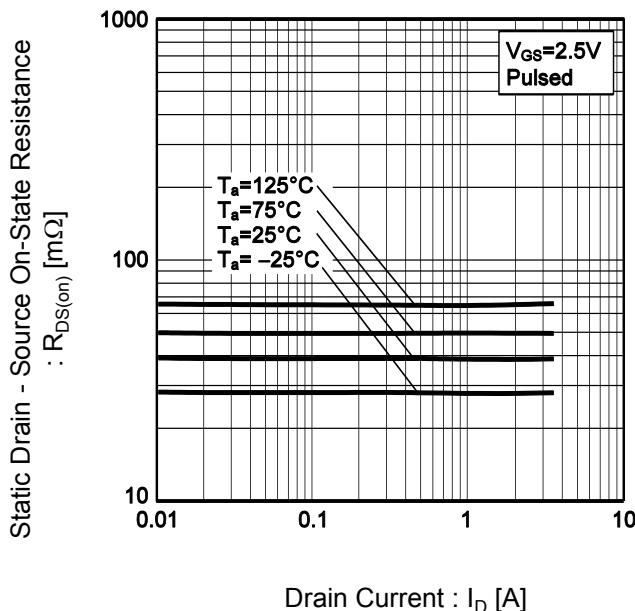
Fig.16 Static Drain-Source On-State
Resistance vs. Drain Current(III)
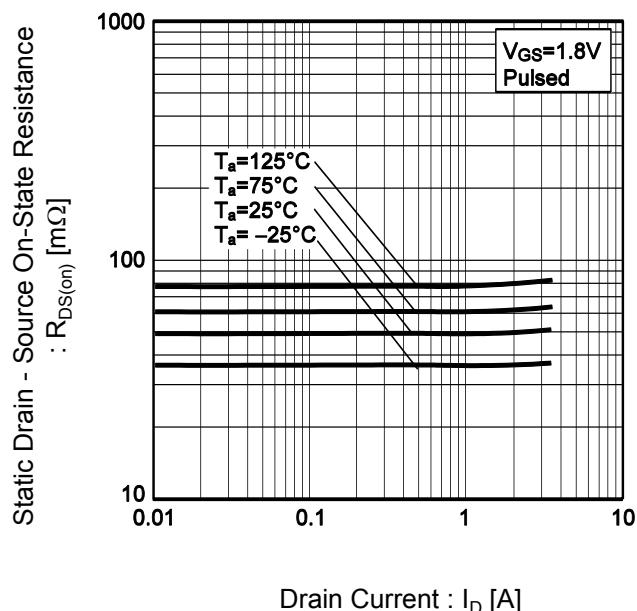
Fig.17 Static Drain - Source On - State
Resistance vs. Drain Current(IV)
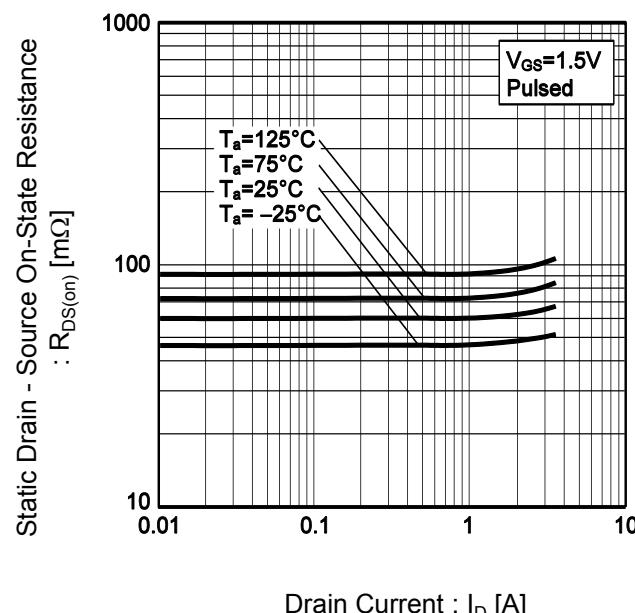
Fig.18 Static Drain - Source On - State
Resistance vs. Drain Current(V)

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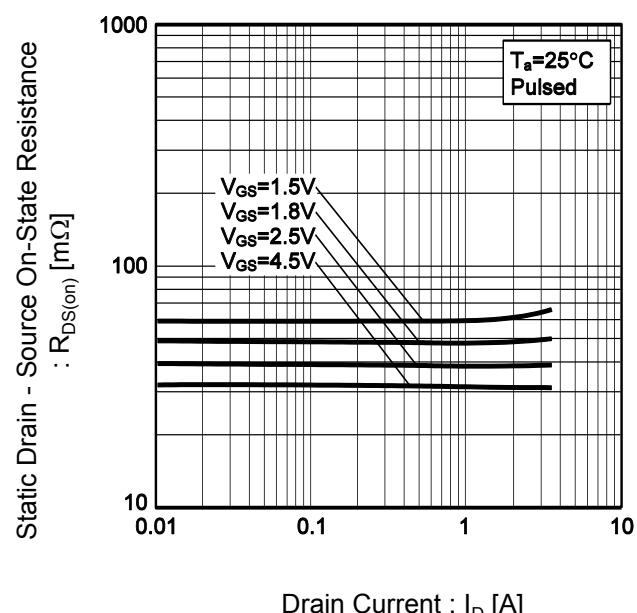
● **Electrical characteristic curves**

Fig.19 Typical Capacitance
        vs. Drain - Source Voltage

$T_a=25°C$
$f=1MHz$
$V_{GS}=4.5V$

Capacitance : C [pF]

C_{iss}

C_{oss}

C_{rss}

Drain - Source Voltage : V_{DS} [V]
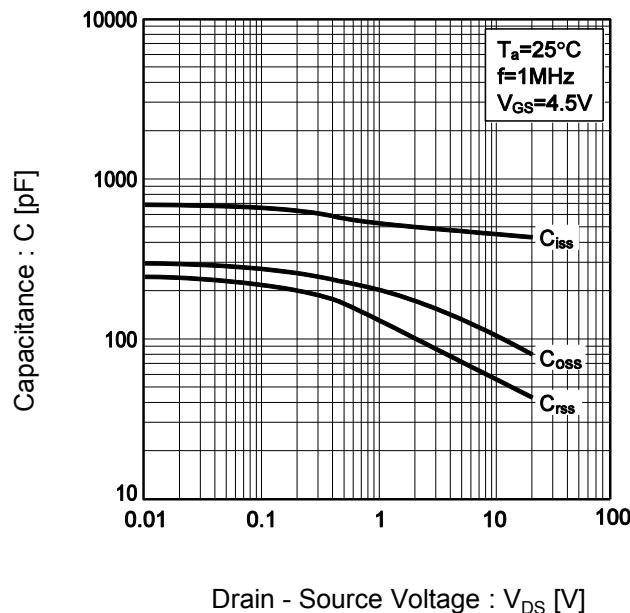
Fig.20 Switching Characteristics

$T_a=25°C$
$V_{DD}=10V$
$V_{GS}=4.5V$
$R_G=10Ω$
Pulsed

Switching Time : t [ns]

t_f

$t_{d(off)}$

$t_{d(on)}$

t_r

Drain Current : I_D [A]
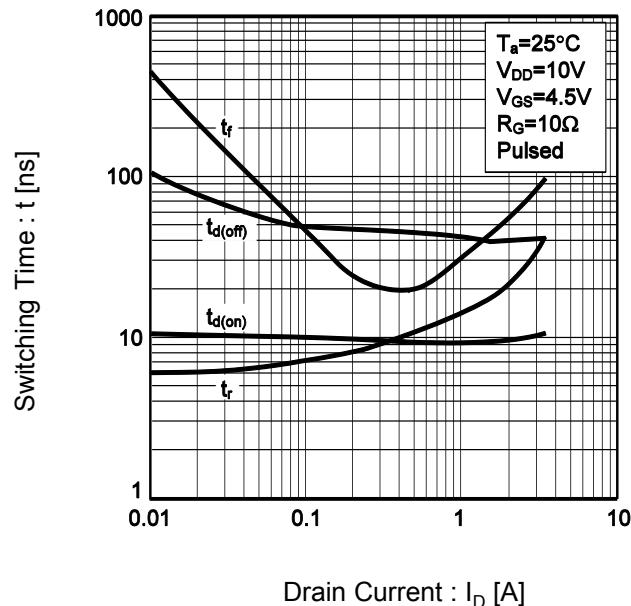
Fig.21 Dynamic Input Characteristics

$T_a=25°C$
$V_{DD}=10V$
$I_D=3.5A$
$R_G=10Ω$
Pulsed

Gate - Source Voltage : V_{GS} [V]

Total Gate Charge : Q_g [nC]
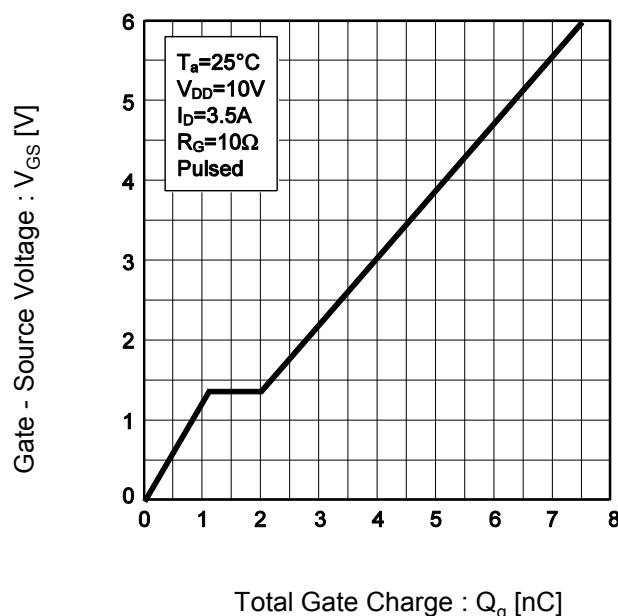
Fig.22 Source Current
        vs. Source Drain Voltage

$V_{GS}=0V$
Pulsed

$T_a=125°C$
$T_a=75°C$
$T_a=25°C$
$T_a=-25°C$

Source Current : I_S [A]

Source-Drain Voltage : V_{SD} [V]
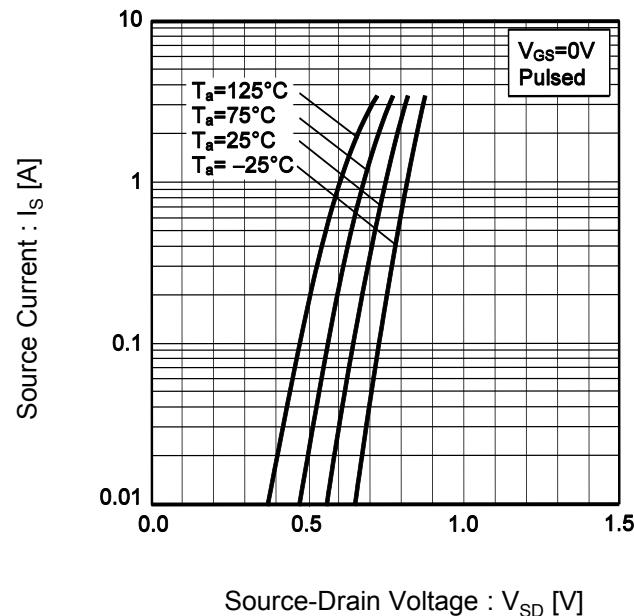
● **Measurement circuits**

Fig.1-1 Switching Time Measurement Circuit
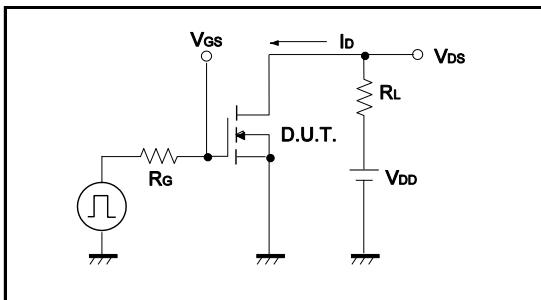

Fig.1-2 Switching Waveforms
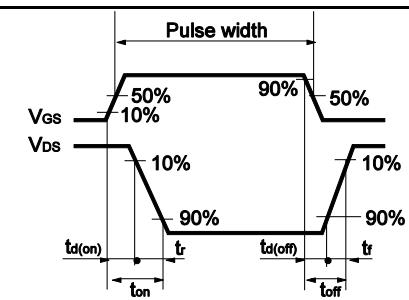
Fig.2-1 Gate Charge Measurement Circuit
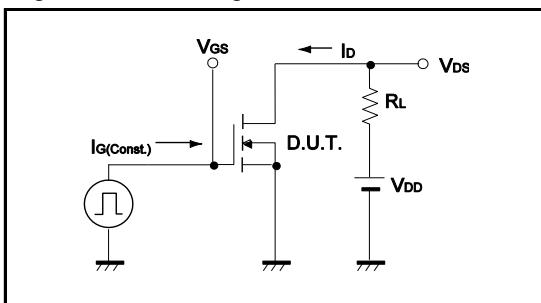

Fig.2-2 Gate Charge Waveform
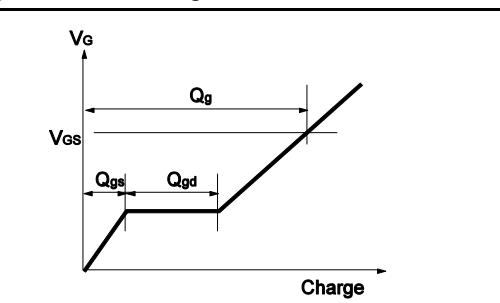
● **Dimensions** (Unit : mm)

TUMT6
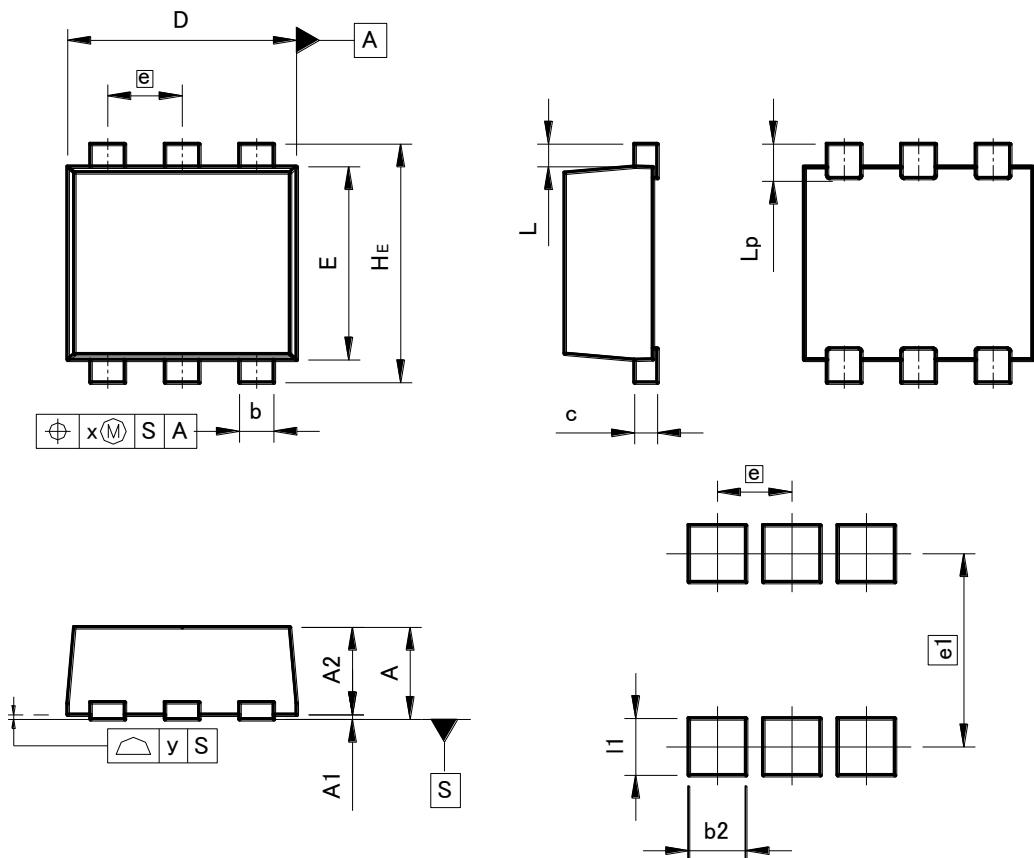
Pattern of terminal position areas

DIM	MILIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	–	0.85	–	0.033
A1	0.00	0.10	0	0.004
A2	0.72	0.82	0.028	0.032
b	0.25	0.40	0.01	0.016
c	0.12	0.22	0.005	0.009
D	1.90	2.10	0.075	0.083
E	1.60	1.80	0.063	0.071
e	0.65		0.03	
HE	2.00	2.20	0.079	0.087
L	0.20		0.01	
Lp	–	0.40	–	0.016
x	–	0.10	–	0.004
y	–	0.10	–	0.004

DIM	MILIMETERS		INCHES	
	MIN	MAX	MIN	MAX
e1	1.70		0.067	
b2	–	0.50	–	0.02
l1	–	0.50	–	0.02

Dimension in mm/inches

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