

SSM6L61NU

1. Applications

- Power Management Switches
- DC-DC Converters

2. Features

- (1) Low drain-source on-resistance

Q1 N-channel:

$$R_{DS(ON)} = 33 \text{ m}\Omega \text{ (max) (@}V_{GS} = 4.5 \text{ V)}$$

$$R_{DS(ON)} = 45 \text{ m}\Omega \text{ (max) (@}V_{GS} = 2.5 \text{ V)}$$

$$R_{DS(ON)} = 74 \text{ m}\Omega \text{ (max) (@}V_{GS} = 1.8 \text{ V)}$$

$$R_{DS(ON)} = 108 \text{ m}\Omega \text{ (max) (@}V_{GS} = 1.5 \text{ V)}$$

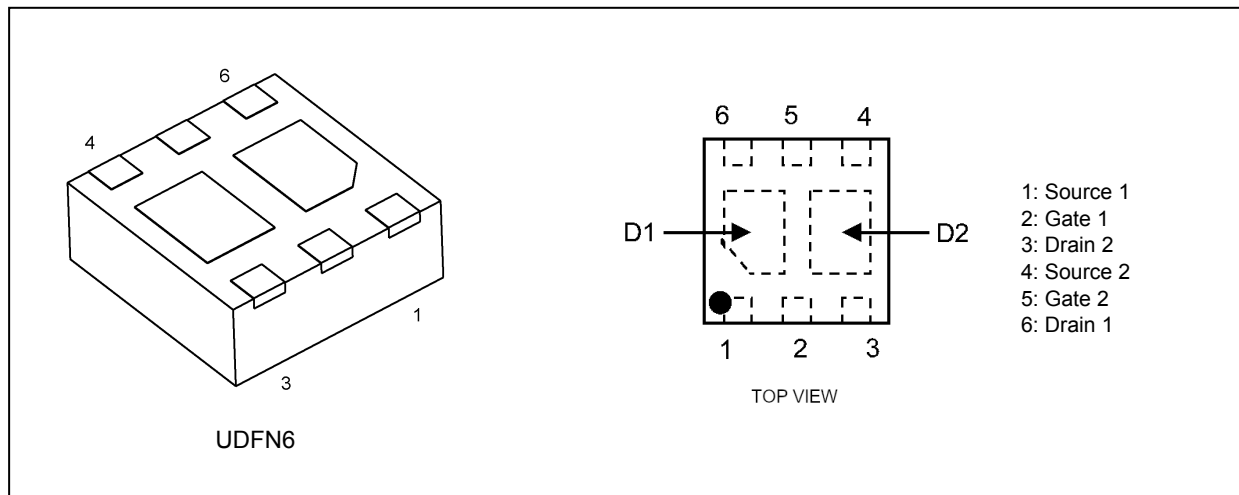
Q2 P-channel:

$$R_{DS(ON)} = 56 \text{ m}\Omega \text{ (max) (@}V_{GS} = -4.5 \text{ V)}$$

$$R_{DS(ON)} = 76 \text{ m}\Omega \text{ (max) (@}V_{GS} = -2.5 \text{ V)}$$

$$R_{DS(ON)} = 157 \text{ m}\Omega \text{ (max) (@}V_{GS} = -1.8 \text{ V)}$$

3. Packaging and Pin Assignment



Start of commercial production
2015-12

4. Absolute Maximum Ratings (Note)

4.1. Q1 Absolute Maximum Ratings (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

Characteristics	Symbol	Rating	Unit
Drain-source voltage	V_{DSS}	20	V
Gate-source voltage	V_{GSS}	± 8	
Drain current (DC) (Note 1)	I_D	4	A
Drain current (pulsed) (Note 1), (Note 2)	I_{DP}	16	

Note 1: Ensure that the channel temperature does not exceed $150\text{ }^\circ\text{C}$.

Note 2: Pulse width (PW) $\leq 10\text{ }^\mu\text{s}$, duty $\leq 1\%$

4.2. Q2 Absolute Maximum Ratings (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

Characteristics	Symbol	Rating	Unit
Drain-source voltage	V_{DSS}	-20	V
Gate-source voltage	V_{GSS}	± 12	
Drain current (DC) (Note 1)	I_D	-4	A
Drain current (pulsed) (Note 1), (Note 2)	I_{DP}	-16	

Note 1: Ensure that the channel temperature does not exceed $150\text{ }^\circ\text{C}$.

Note 2: Pulse width (PW) $\leq 10\text{ }^\mu\text{s}$, duty $\leq 1\%$

4.3. Absolute Maximum Ratings (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$) (Q1, Q2 Common)

Characteristics	Symbol	Rating	Unit
Power dissipation (Note 1)	P_D	1	W
Power dissipation ($t \leq 10\text{ s}$) (Note 1)	P_D	2	
Channel temperature	T_{ch}	150	$^\circ\text{C}$
Storage temperature	T_{stg}	-55 to 150	

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).

Note 1: Total rating. Device mounted on a FR4 board.(25.4 mm \times 25.4 mm \times 1.6 mm, Cu pad: 645 mm²)

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

Note: The junction-to-ambient thermal resistance, $R_{th(j-a)}$, and the drain power dissipation, P_D , vary according to the board material, board area, board thickness and pad area. When using this device, be sure to take heat dissipation fully into account.

5. Thermal Characteristics

Characteristics	Symbol	Max	Unit
Channel-to-ambient thermal resistance (Note 1)	$R_{th(ch-a)}$	125	$^\circ\text{C/W}$

Note 1: Device mounted on an 25.4 mm \times 25.4 mm \times 1.6 mm FR4 glass epoxy board (Cu pad: 645 mm²)

6. Electrical Characteristics

6.1. Q1 Static Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current	I_{GSS}	$V_{GS} = \pm 6\text{ V}, V_{DS} = 0\text{ V}$	—	—	± 1	μA
Drain cut-off current	I_{DSS}	$V_{DS} = 16\text{ V}, V_{GS} = 0\text{ V}$	—	—	1	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$I_D = 1\text{ mA}, V_{GS} = 0\text{ V}$	20	—	—	V
Drain-source breakdown voltage (Note 1)	$V_{(BR)DSX}$	$I_D = 1\text{ mA}, V_{GS} = -5\text{ V}$	15	—	—	
Gate threshold voltage (Note 2)	V_{th}	$V_{DS} = 3\text{ V}, I_D = 1\text{ mA}$	0.4	—	1.0	
Drain-source on-resistance (Note 3)	$R_{DS(ON)}$	$I_D = 4.0\text{ A}, V_{GS} = 4.5\text{ V}$	—	25	33	$\text{m}\Omega$
		$I_D = 1.0\text{ A}, V_{GS} = 2.5\text{ V}$	—	31	45	
		$I_D = 0.5\text{ A}, V_{GS} = 1.8\text{ V}$	—	40	74	
		$I_D = 0.5\text{ A}, V_{GS} = 1.5\text{ V}$	—	54	108	
Forward transfer admittance (Note 3)	$ Y_{fs} $	$V_{DS} = 3\text{ V}, I_D = 2\text{ A}$	—	12	—	S

Note 1: If a reverse 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.

Note 2: Let V_{th} be the voltage applied between gate and source that causes the drain current (I_D) to be below (1 mA for this device). Then, for normal switching operation, $V_{GS(ON)}$ must be higher than V_{th} , and $V_{GS(OFF)}$ must be lower than V_{th} . This relationship can be expressed as: $V_{GS(OFF)} < V_{th} < V_{GS(ON)}$.

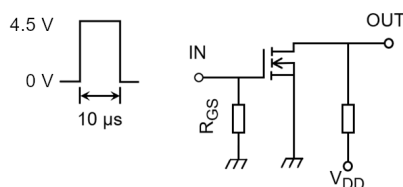
Take this into consideration when using the device.

Note 3: Pulse measurement.

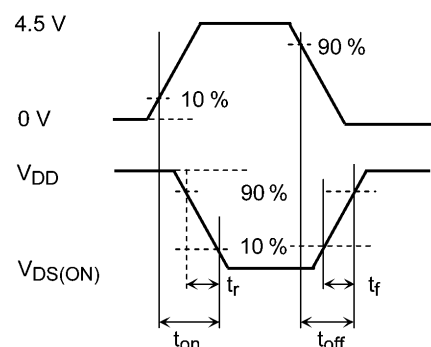
6.2. Q1 Dynamic Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Input capacitance	C_{iss}	$V_{DS} = 10\text{ V}, V_{GS} = 0\text{ V},$ $f = 1\text{ MHz}$	—	410	—	pF
Reverse transfer capacitance	C_{rss}		—	40	—	
Output capacitance	C_{oss}		—	85	—	
Switching time (turn-on time)	t_{on}	$V_{DD} = 10\text{ V}, I_D = 0.5\text{ A}$ $V_{GS} = 0\text{ to }4.5\text{ V}, R_{GS} = 10\text{ }\Omega$	—	25	—	ns
Switching time (turn-off time)	t_{off}		—	45	—	

6.3. Q1 Switching Time Test Circuit



Switching Time Test Circuit



Input Waveform/Output Waveform

6.4. Q1 Gate Charge Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Total gate charge (gate-source plus gate-drain)	Q_g	$V_{DD} = 8\text{ V}, I_D = 4\text{ A},$ $V_{GS} = 4.5\text{ V}$	—	3.6	—	nC
Gate-source charge 1	Q_{gs1}		—	0.62	—	
Gate-drain charge	Q_{gd}		—	0.79	—	

6.5. Q1 Source-Drain Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Diode forward voltage (Note 1)	V_{DSF}	$I_{DR} = 4.0\text{ A}$, $V_{GS} = 0\text{ V}$	—	0.8	1.2	V

Note 1: Pulse measurement.

6.6. Q2 Static Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current	I_{GSS}	$V_{GS} = \pm 10\text{ V}$, $V_{DS} = 0\text{ V}$	—	—	± 1	μA
Drain cut-off current	I_{DSS}	$V_{DS} = -20\text{ V}$, $V_{GS} = 0\text{ V}$	—	—	-1	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$I_D = -1\text{ mA}$, $V_{GS} = 0\text{ V}$	-20	—	—	V
Drain-source breakdown voltage (Note 1)	$V_{(BR)DSX}$	$I_D = -1\text{ mA}$, $V_{GS} = 8\text{ V}$	-12	—	—	
Gate threshold voltage (Note 2)	V_{th}	$V_{DS} = -3\text{ V}$, $I_D = -1\text{ mA}$	-0.5	—	-1.2	
Drain-source on-resistance (Note 3)	$R_{DS(ON)}$	$I_D = -3.5\text{ A}$, $V_{GS} = -10\text{ V}$	—	36	45	m Ω
		$I_D = -3.0\text{ A}$, $V_{GS} = -4.5\text{ V}$	—	44	56	
		$I_D = -2.0\text{ A}$, $V_{GS} = -2.5\text{ V}$	—	60	76	
		$I_D = -0.5\text{ A}$, $V_{GS} = -1.8\text{ V}$	—	83	157	
Forward transfer admittance (Note 3)	$ Y_{fs} $	$V_{DS} = -3\text{ V}$, $I_D = -2.0\text{ A}$	—	9.5	—	S

Note 1: If a reverse 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.

Note 2: Let V_{th} be the voltage applied between gate and source that causes the drain current (I_D) to below (-1 mA for this device). Then, for normal switching operation, $V_{GS(ON)}$ must be higher than V_{th} , and $V_{GS(OFF)}$ must be lower than V_{th} . This relationship can be expressed as: $V_{GS(OFF)} < V_{th} < V_{GS(ON)}$.

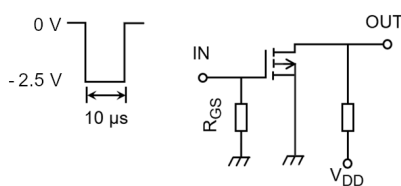
Take this into consideration when using the device.

Note 3: Pulse measurement.

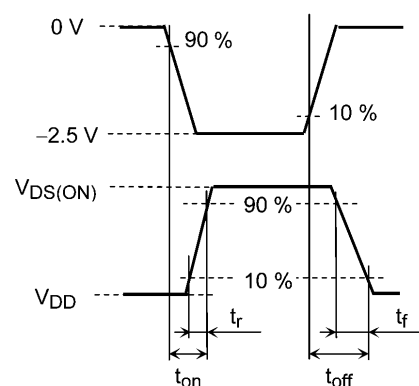
6.7. Q2 Dynamic Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Input capacitance	C_{iss}	$V_{DS} = -10\text{ V}$, $V_{GS} = 0\text{ V}$, $f = 1\text{ MHz}$	—	480	—	pF
Reverse transfer capacitance	C_{rss}		—	76	—	
Output capacitance	C_{oss}		—	90	—	
Switching time (turn-on time)	t_{on}	$V_{DD} = -10\text{ V}$, $I_D = -0.5\text{ A}$ $V_{GS} = 0\text{ V}$ to -2.5 V , $R_{GS} = 4.7\text{ }\Omega$	—	21	—	ns
Switching time (turn-off time)	t_{off}		—	54	—	

6.8. Q2 Switching Time Test Circuit



Switching Time Test Circuit



Input Waveform/Output Waveform

6.9. Q2 Gate Charge Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

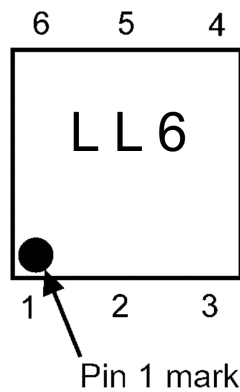
Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Total gate charge (gate-source plus gate-drain)	Q_g	$V_{DD} = -10\text{ V}$, $I_D = -4\text{ A}$, $V_{GS} = -4.5\text{ V}$	—	6.74	—	nC
Gate-source charge 1	Q_{gs1}		—	0.95	—	
Gate-drain charge	Q_{gd}		—	1.50	—	

6.10. Q2 Source-Drain Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

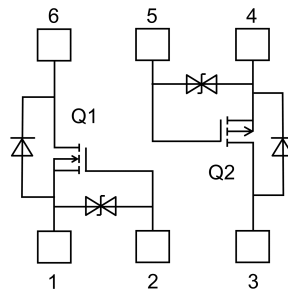
Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Diode forward voltage (Note 1)	V_{DSF}	$I_{DR} = 4.0\text{ A}$, $V_{GS} = 0\text{ V}$	—	0.87	1.2	V

Note 1: Pulse measurement.

7. Marking



8. Internal Circuit



9. Characteristics Curves (Note)

9.1. Q1 Characteristics Curves

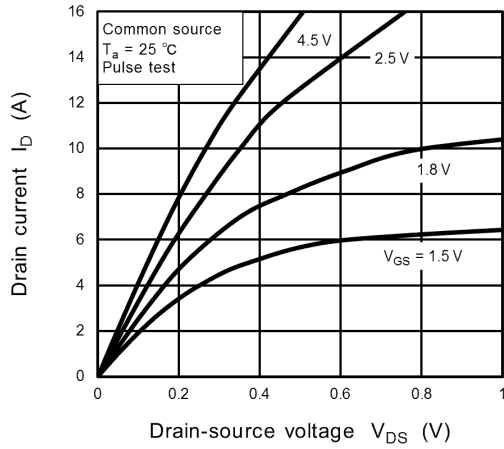


Fig. 9.1.1 $I_D - V_{DS}$

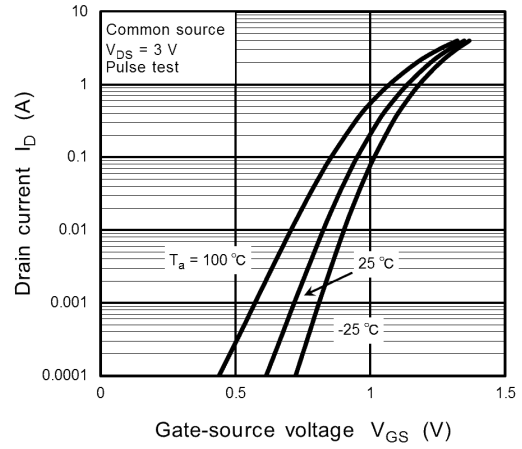


Fig. 9.1.2 $I_D - V_{GS}$

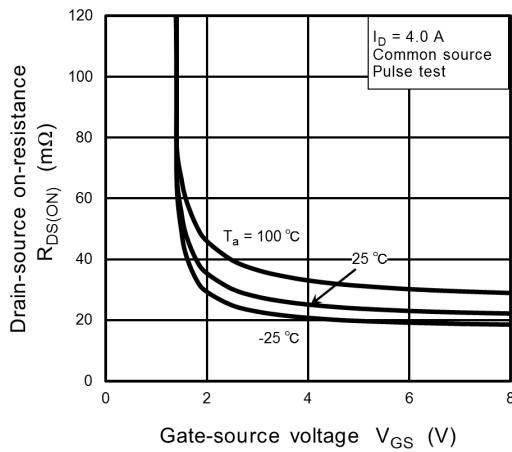


Fig. 9.1.3 $R_{DS(ON)} - V_{GS}$

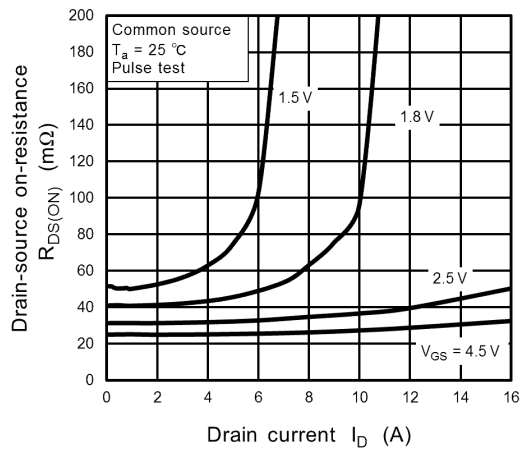


Fig. 9.1.4 $R_{DS(ON)} - I_D$

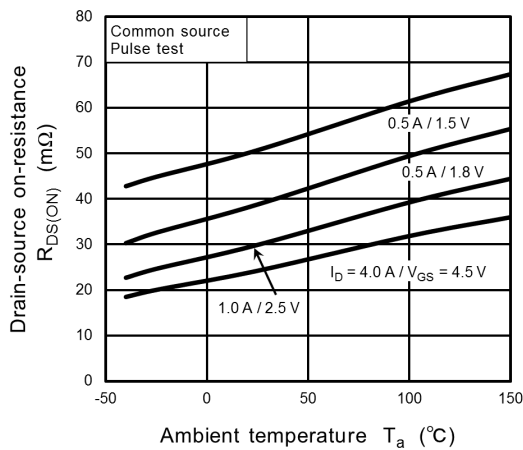


Fig. 9.1.5 $R_{DS(ON)} - T_a$

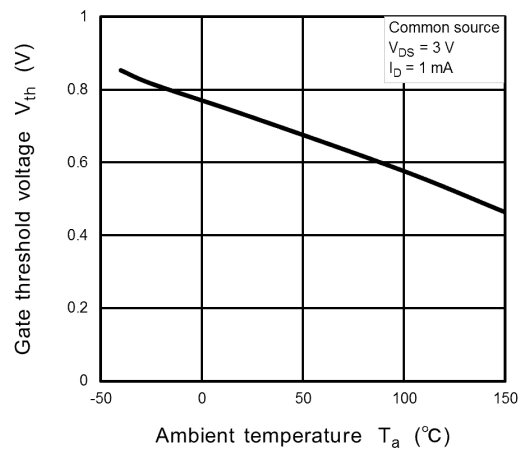


Fig. 9.1.6 $V_{th} - T_a$

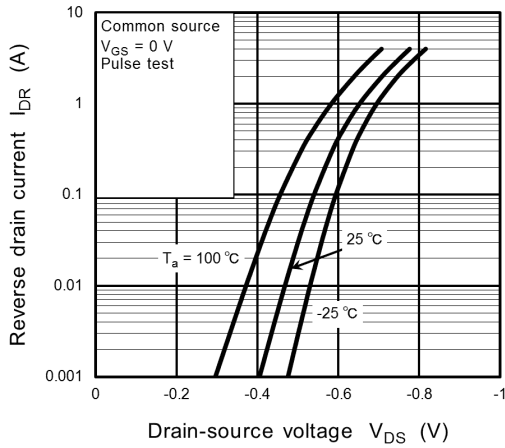


Fig. 9.1.7 $I_{DR} - V_{DS}$

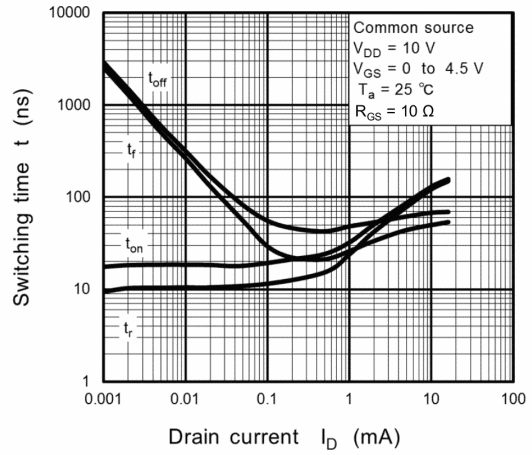


Fig. 9.1.8 $t - I_D$

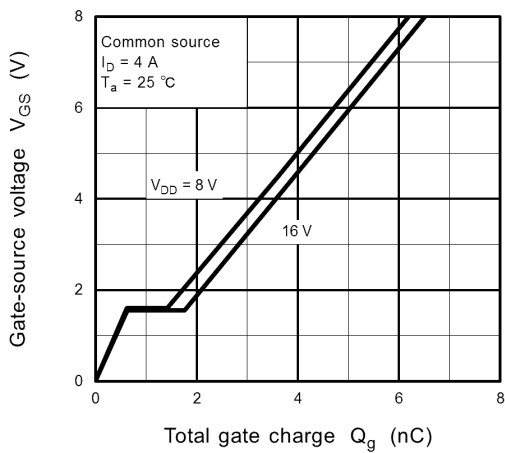


Fig. 9.1.9 Dynamic Input Characteristics

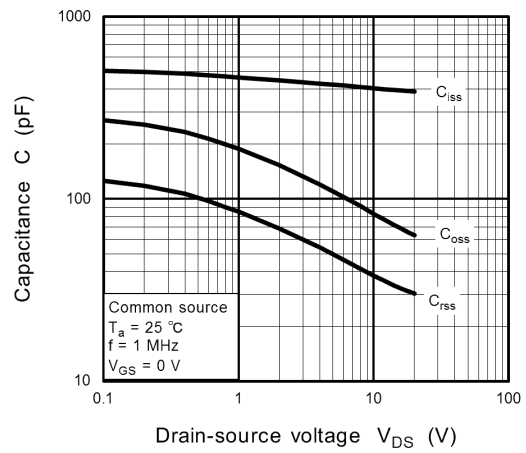


Fig. 9.1.10 $C - V_{DS}$

9.2. Q2 Characteristics Curves

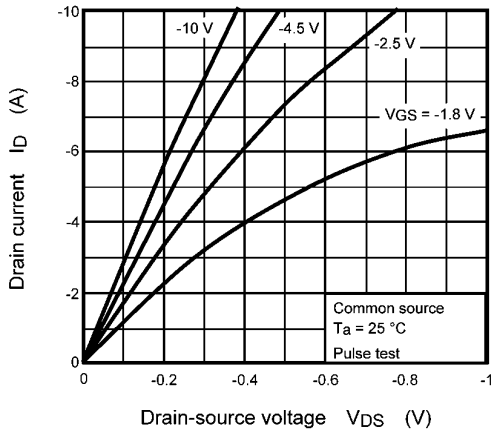


Fig. 9.2.1 $I_D - V_{DS}$

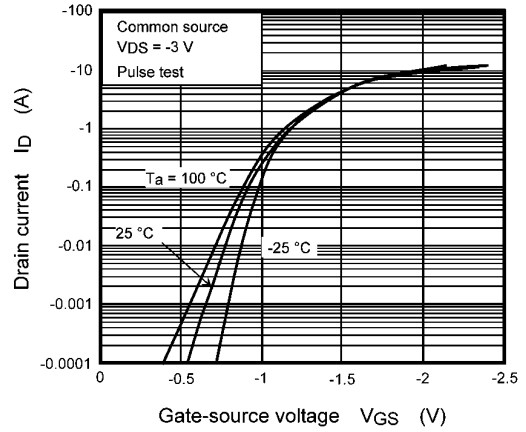


Fig. 9.2.2 $I_D - V_{GS}$

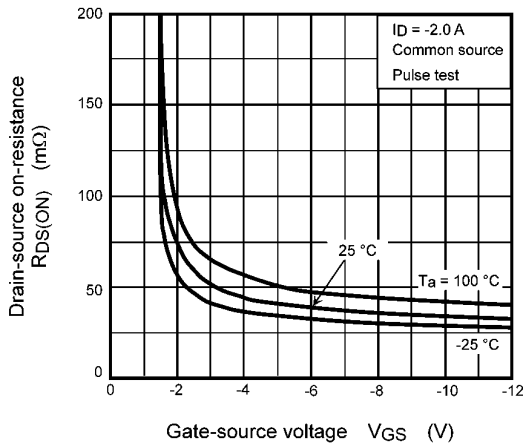


Fig. 9.2.3 $R_{DS(ON)} - V_{GS}$

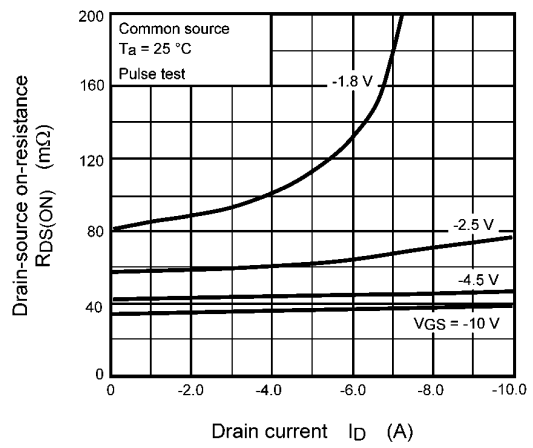


Fig. 9.2.4 $R_{DS(ON)} - I_D$

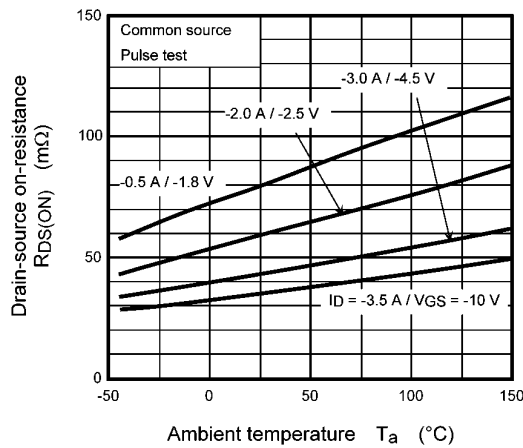


Fig. 9.2.5 $R_{DS(ON)} - T_a$

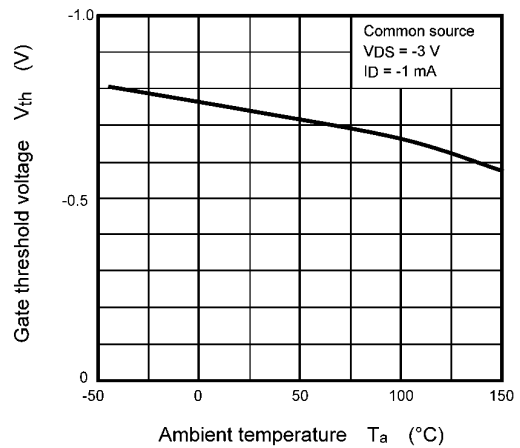


Fig. 9.2.6 $V_{th} - T_a$

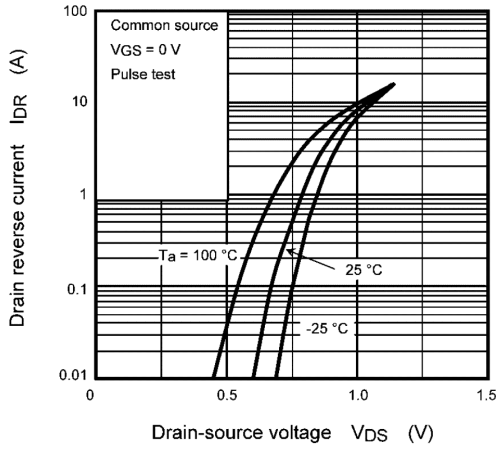


Fig. 9.2.7 $I_{DR} - V_{DS}$

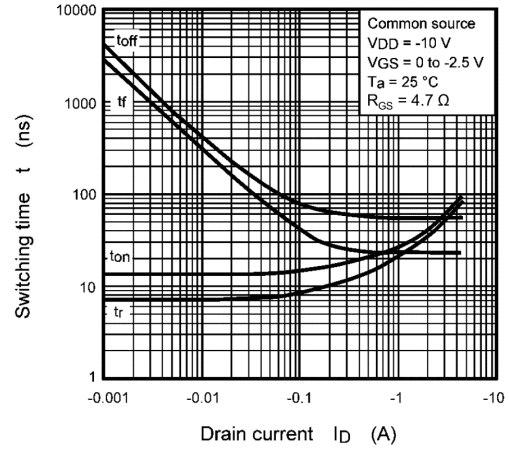


Fig. 9.2.8 $t - I_D$

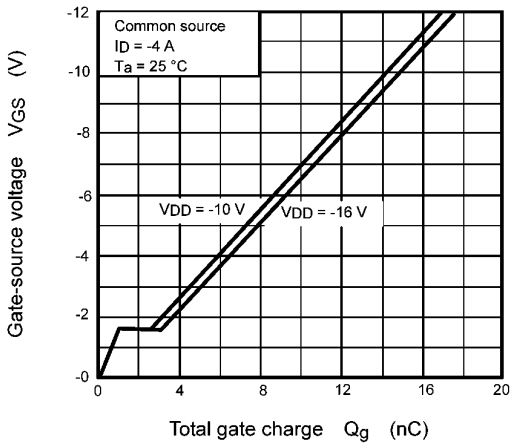


Fig. 9.2.9 Dynamic Input Characteristics

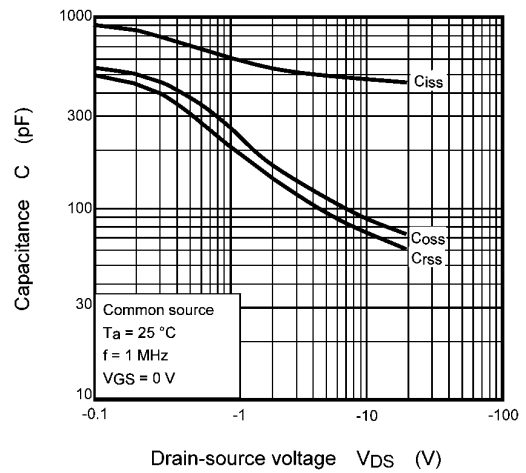


Fig. 9.2.10 $C - V_{DS}$

9.3. Characteristics Curves (Q1, Q2 Common)

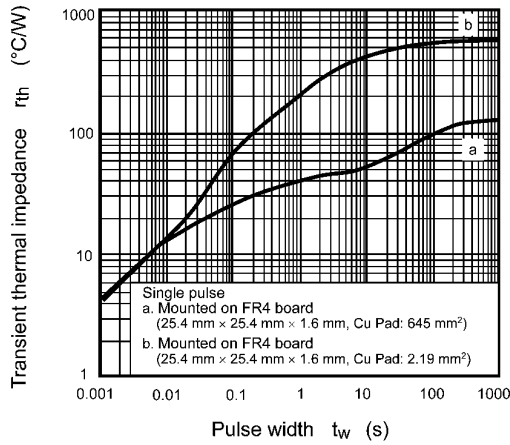


Fig. 9.3.1 $r_{th} - t_w$

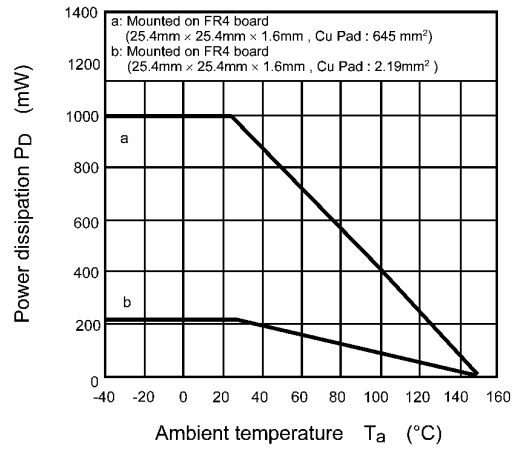
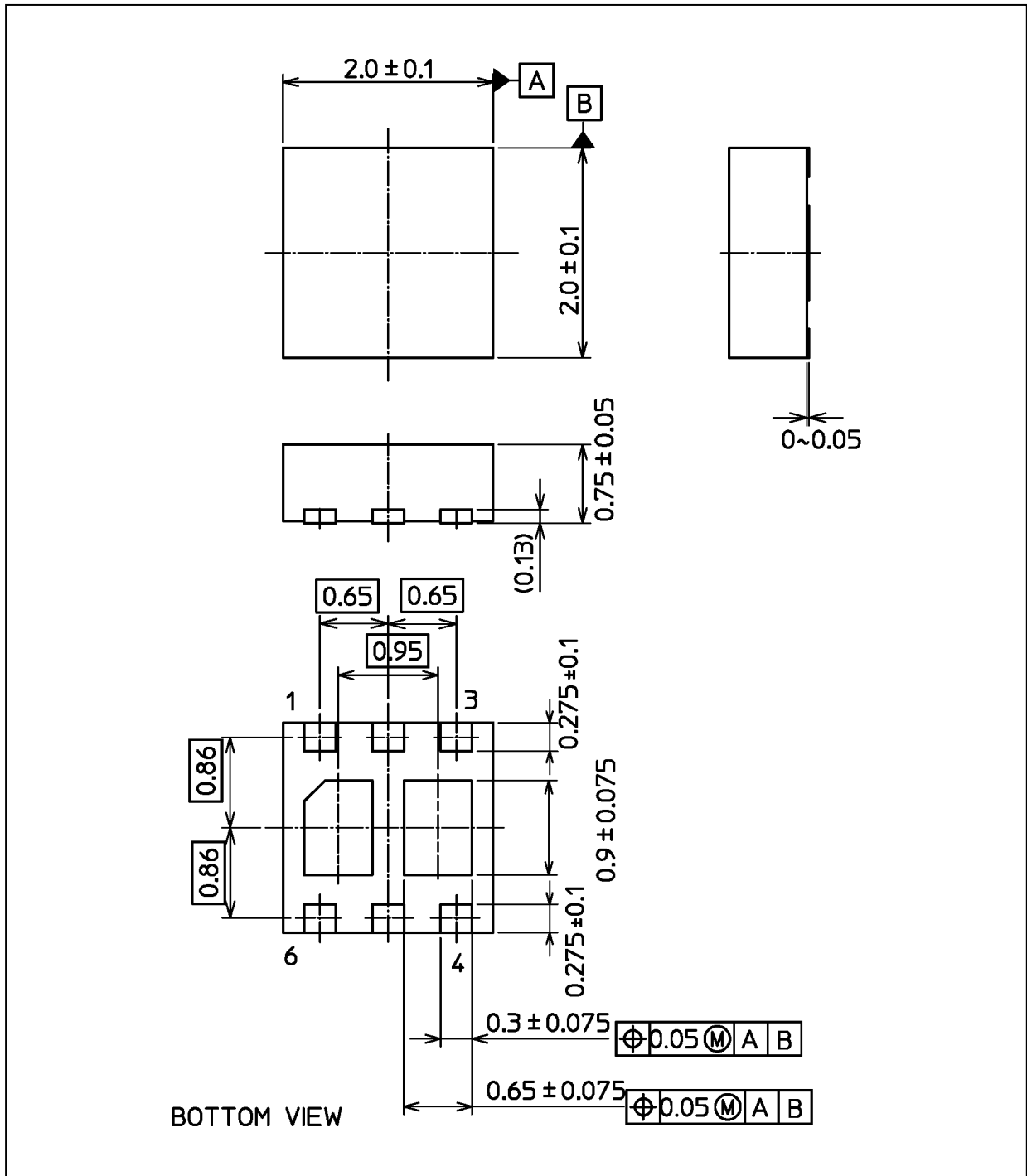


Fig. 9.3.2 $P_D - T_a$

Note: The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

Package Dimensions

Unit: mm



Weight: 8.5 mg (typ.)

Package Name(s)
Nickname: UDFN6

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