MOSFETs Silicon P-/N-Channel MOS

SSM6L61NU

1. Applications

- Power Management Switches
- DC-DC Converters

2. Features

(1) Low drain-source on-resistance

Q1 N-channel:

$R_{DS(ON)}$ = 33 mΩ (max) (@V_{GS} = 4.5 V)

$R_{DS(ON)}$ = 45 mΩ (max) (@V_{GS} = 2.5 V)

$R_{DS(ON)}$ = 74 mΩ (max) (@V_{GS} = 1.8 V)

$R_{DS(ON)}$ = 108 mΩ (max) (@V_{GS} = 1.5 V)

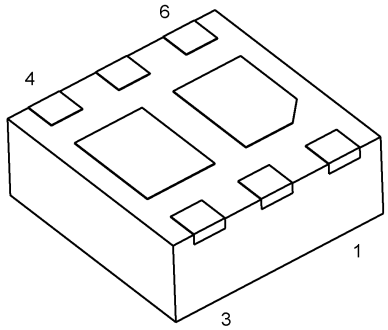
Q2 P-channel:

$R_{DS(ON)}$ = 56 mΩ (max) (@V_{GS} = -4.5 V)

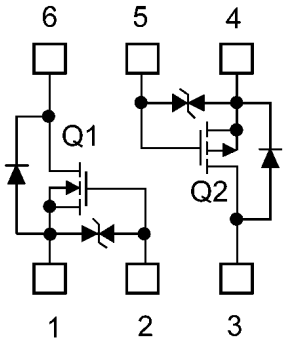
$R_{DS(ON)}$ = 76 mΩ (max) (@V_{GS} = -2.5 V)

$R_{DS(ON)}$ = 157 mΩ (max) (@V_{GS} = -1.8 V)

3. Packaging and Internal Circuit



UDFN6



1: Source 1
2: Gate 1
3: Drain 2
4: Source 2
5: Gate 2
6: Drain 1

Start of commercial production
2015-12

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4. Absolute Maximum Ratings (Note)

4.1. Q1 Absolute Maximum Ratings (Unless otherwise specified, T_a = 25 °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 °C.
Note 2: Pulse width (PW) ≤ 10 s, duty ≤ 1 %

4.2. Q2 Absolute Maximum Ratings (Unless otherwise specified, T_a = 25 °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 °C.
Note 2: Pulse width (PW) ≤ 10 s, duty ≤ 1 %

4.3. Absolute Maximum Ratings (Unless otherwise specified, T_a = 25 °C) (Q1, Q2 Common)

Characteristics			Symbol	Rating	Unit
Power dissipation		(Note 1)	P_D	1	W
Power dissipation	(t ≤ 10 s)	(Note 1)	P_D	2	
Channel temperature			T_{ch}	150	°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 × 25.4 mm × 1.6 mm, Cu pad: 645 mm^2)

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

Note: The junction-to-ambient thermal resistance, $R_{th(j\text{-}a)}$, 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.

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5. Electrical Characteristics

5.1. Q1 Static Characteristics (Unless otherwise specified, T_a = 25 °C)

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

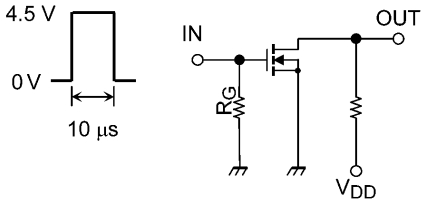
Note 2: Let V_{th} be the voltage applied between gate and source that causes the drain current (I_D) to below (1 mA for this device). Then, for normal switching operation, $V_{GS(ON)}$ must be higher than V_{th}, and $V_{GS(OFF)}$ must be lower than V_{th}. This relationship can be expressed as: $V_{GS(OFF)}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

Note 3: Pulse measurement.

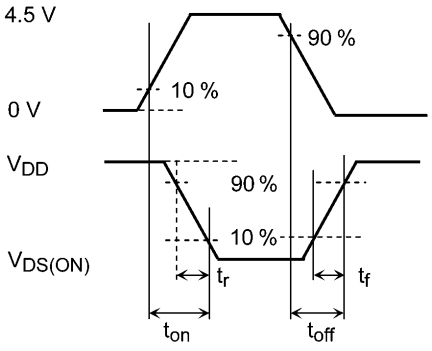
5.2. Q1 Dynamic Characteristics (Unless otherwise specified, T_a = 25 °C)

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

5.3. Q1 Switching Time Test Circuit



Switching Time Test Circuit



Input Waveform/Output Waveform

5.4. Q1 Gate Charge Characteristics (Unless otherwise specified, T_a = 25 °C)

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

5.5. Q1 Source-Drain Characteristics (Unless otherwise specified, T_a = 25 °C)

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

Note 1: Pulse measurement.

5.6. Q2 Static Characteristics (Unless otherwise specified, T_a = 25 °C)

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

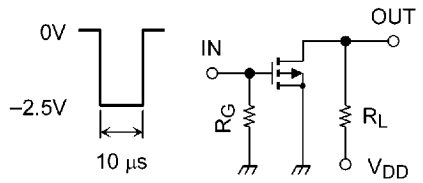
Note 2: Let V_{th} be the voltage applied between gate and source that causes the drain current (I_D) to below (-1 mA for this device). Then, for normal switching operation, $V_{GS(ON)}$ must be higher than V_{th}, and $V_{GS(OFF)}$ must be lower than V_{th}. This relationship can be expressed as: $V_{GS(OFF)}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

Note 3: Pulse measurement.

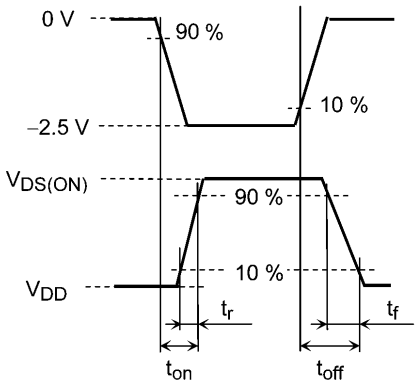
5.7. Q2 Dynamic Characteristics (Unless otherwise specified, T_a = 25 °C)

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

5.8. Q2 Switching Time Test Circuit



Switching Time Test Circuit



Input Waveform/Output Waveform

5.9. Q2 Gate Charge Characteristics (Unless otherwise specified, T_a = 25 °C)

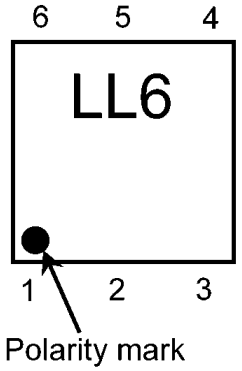
Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Total gate charge (gate-source plus gate-drain)	Q_g	V_{DD} = -10 V, I_D = -4 A, V_{GS} = -4.5 V	—	6.74	—	nC
Gate-source charge 1	Q_{gs1}		—	0.95	—	
Gate-drain charge	Q_{gd}		—	1.50	—	

5.10. Q2 Source-Drain Characteristics (Unless otherwise specified, T_a = 25 °C)

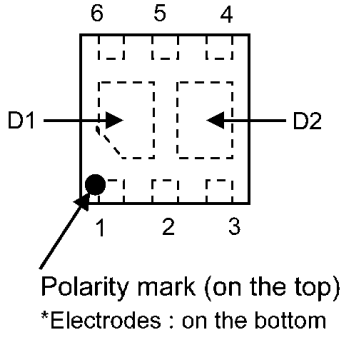
Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Diode forward voltage (Note 1)	V_{DSF}	I_D = 4.0 A, V_{GS} = 0 V	—	0.87	1.2	V

Note 1: Pulse measurement.

6. Marking and Pin Assignment



Marking



Pin Assignment (Top view)

7. Characteristics Curves (Note)

7.1. Q1 Characteristics Curves

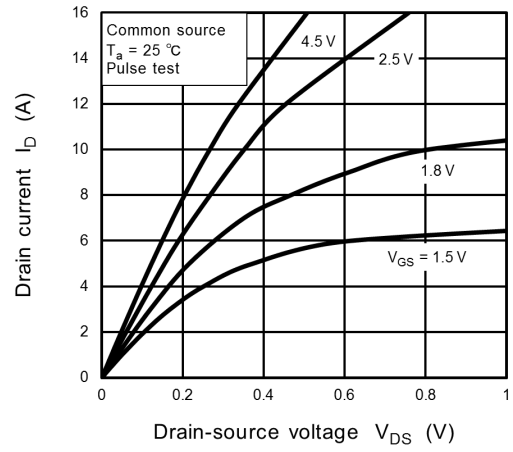


Fig. 7.1.1 I_D - V_{DS}

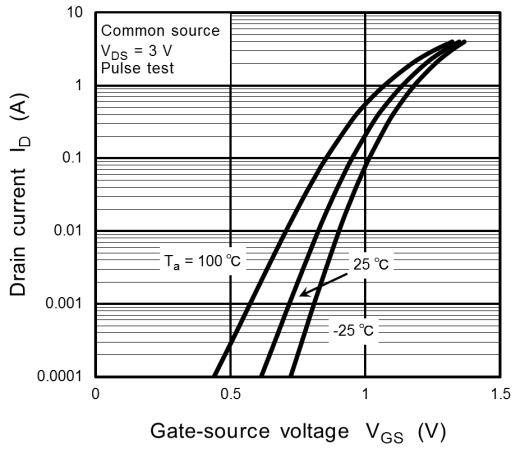


Fig. 7.1.2 I_D - V_{GS}

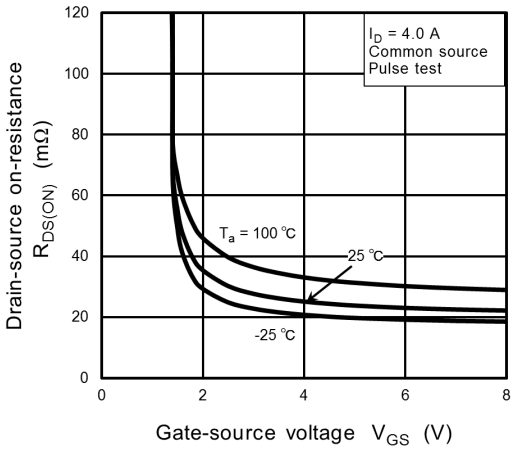


Fig. 7.1.3 $R_{DS(ON)}$ - V_{GS}

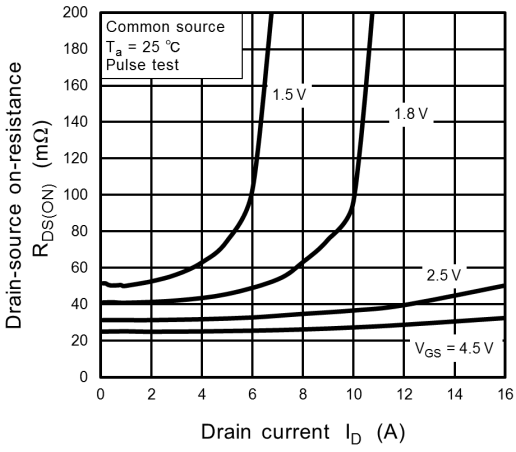


Fig. 7.1.4 $R_{DS(ON)}$ - I_D

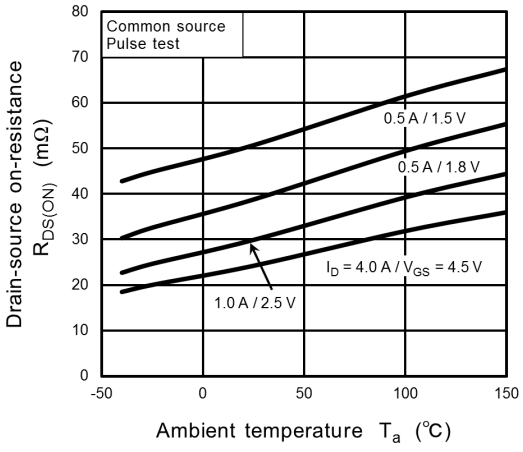


Fig. 7.1.5 $R_{DS(ON)}$ - T_a

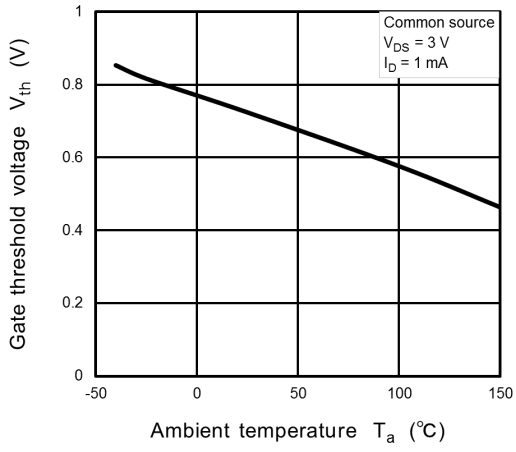


Fig. 7.1.6 V_{th} - T_a

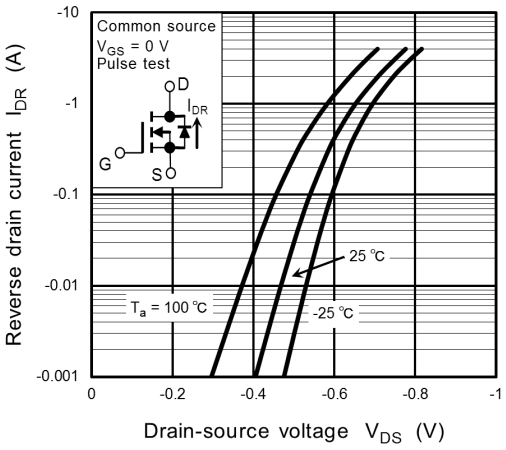


Fig. 7.1.7 I_{DR} - V_{DS}

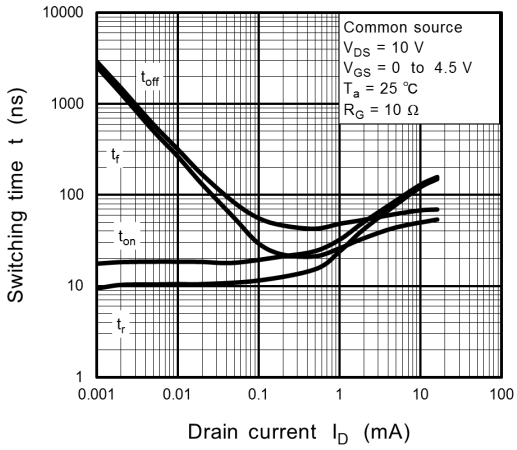


Fig. 7.1.8 t - I_D

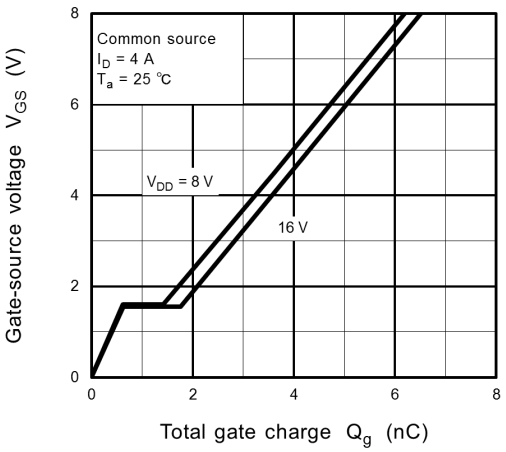


Fig. 7.1.9 Dynamic Input Characteristics

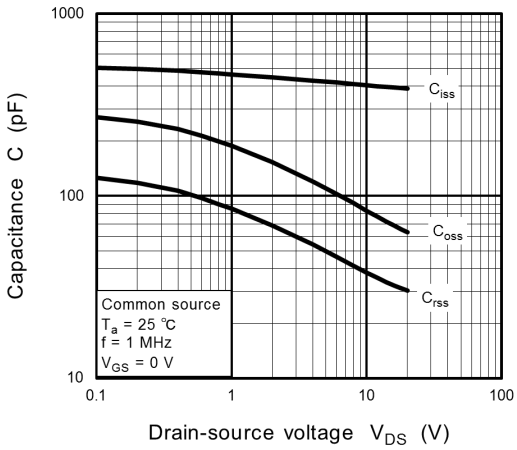


Fig. 7.1.10 C - V_{DS}

7.2. Q2 Characteristics Curves

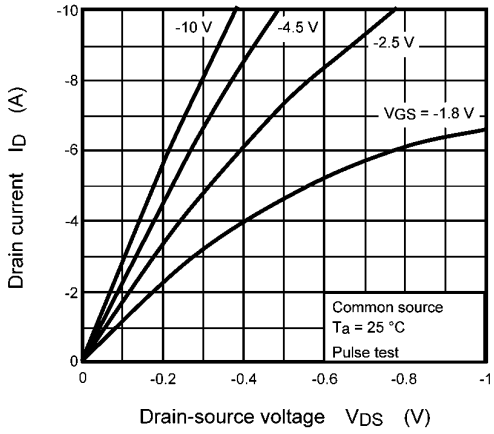


Fig. 7.2.1 I_D - V_{DS}

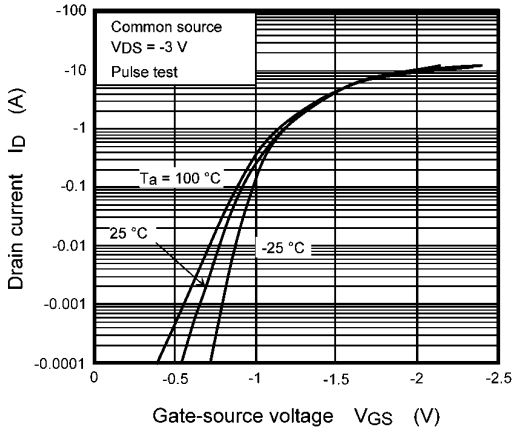


Fig. 7.2.2 I_D - V_{GS}

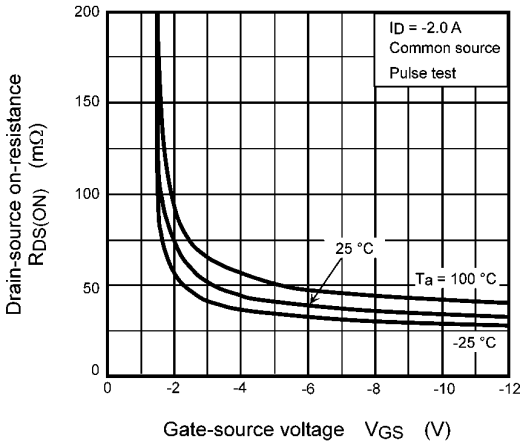


Fig. 7.2.3 $R_{DS(ON)}$ - V_{GS}

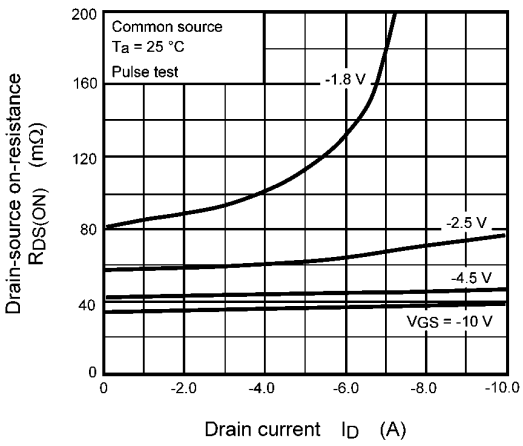


Fig. 7.2.4 $R_{DS(ON)}$ - I_D

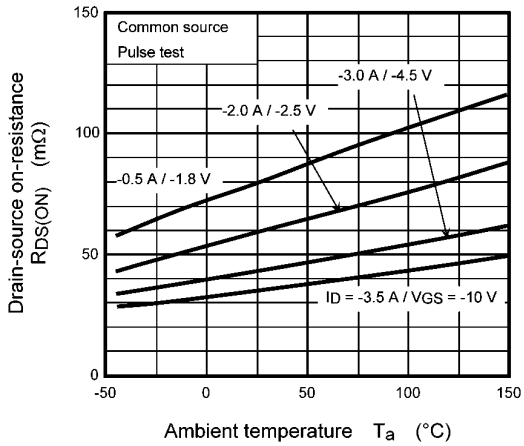


Fig. 7.2.5 $R_{DS(ON)}$ - T_a

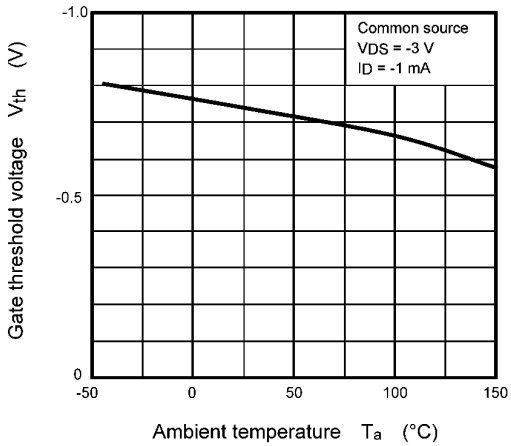


Fig. 7.2.6 V_{th} - T_a

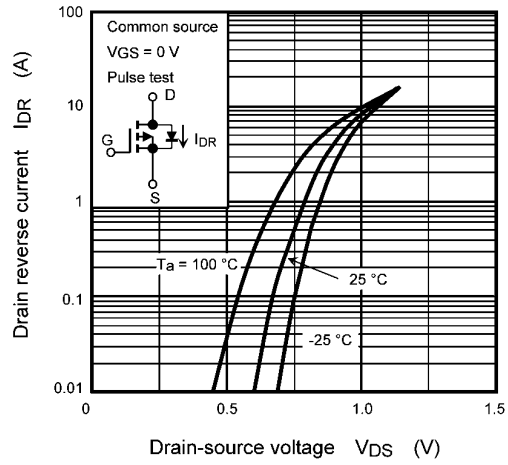


Fig. 7.2.7 I_{DR} - V_{DS}

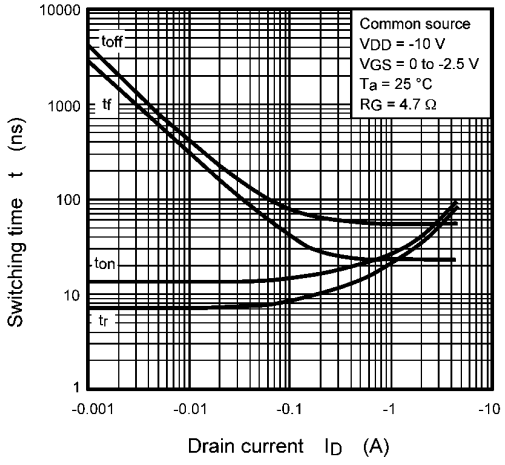


Fig. 7.2.8 t - I_D

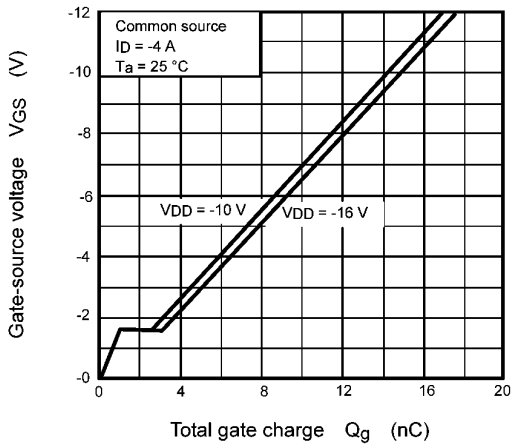


Fig. 7.2.9 Dynamic Input Characteristics

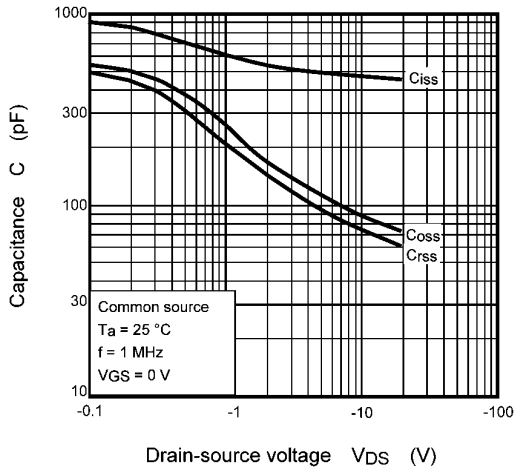


Fig. 7.2.10 C - V_{DS}

7.3. Characteristics Curves (Q1, Q2 Common)

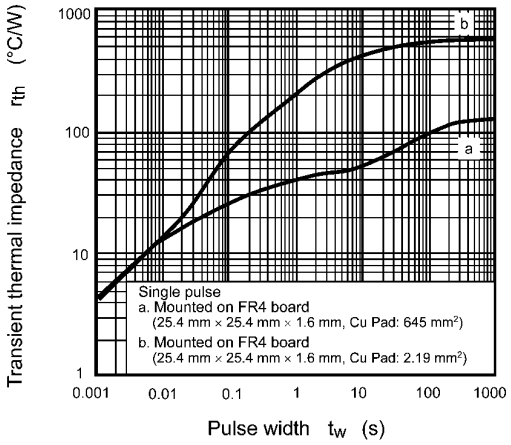


Fig. 7.3.1 r_{th} - t_w

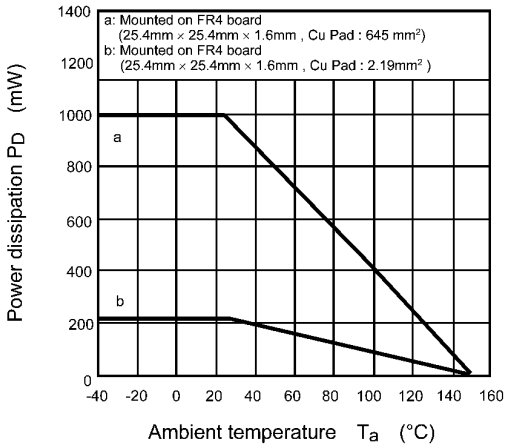
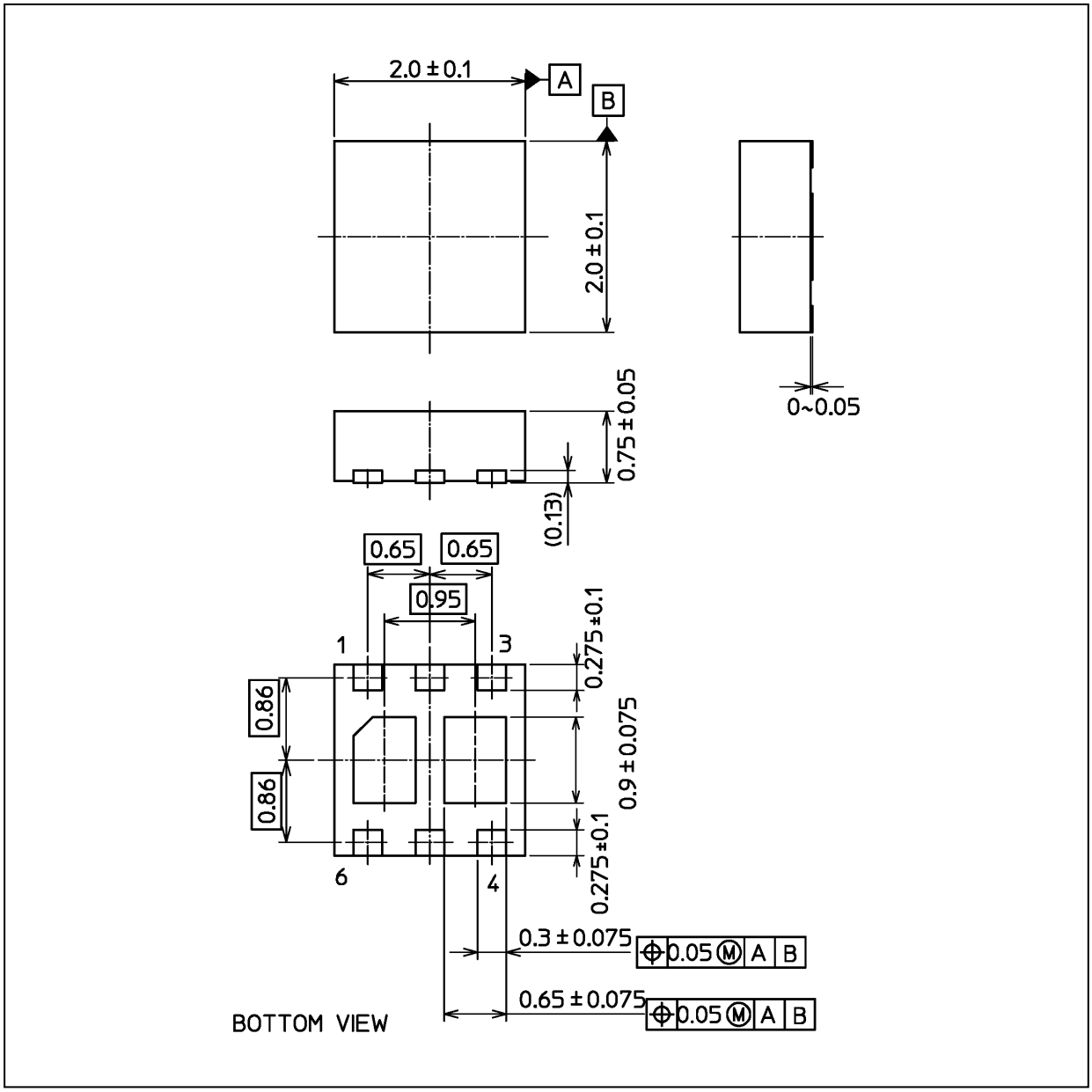


Fig. 7.3.2 P_D - T_a

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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