

MOSFETs Silicon P-/N-Channel MOS

SSM6L36TU

1. Applications

- High-Speed Switching

2. Features

- (1) 1.5-V drive
- (2) Low drain-source on-resistance

Q1 N-channel:

$$R_{DS(ON)} = 1.52 \text{ m}\Omega \text{ (max) (@}V_{GS} = 1.5 \text{ V)}$$

$$R_{DS(ON)} = 1.14 \text{ m}\Omega \text{ (max) (@}V_{GS} = 1.8 \text{ V)}$$

$$R_{DS(ON)} = 0.85 \text{ m}\Omega \text{ (max) (@}V_{GS} = 2.5 \text{ V)}$$

$$R_{DS(ON)} = 0.66 \text{ m}\Omega \text{ (max) (@}V_{GS} = 4.5 \text{ V)}$$

$$R_{DS(ON)} = 0.63 \text{ m}\Omega \text{ (max) (@}V_{GS} = 5.0 \text{ V)}$$

Q2 P-channel:

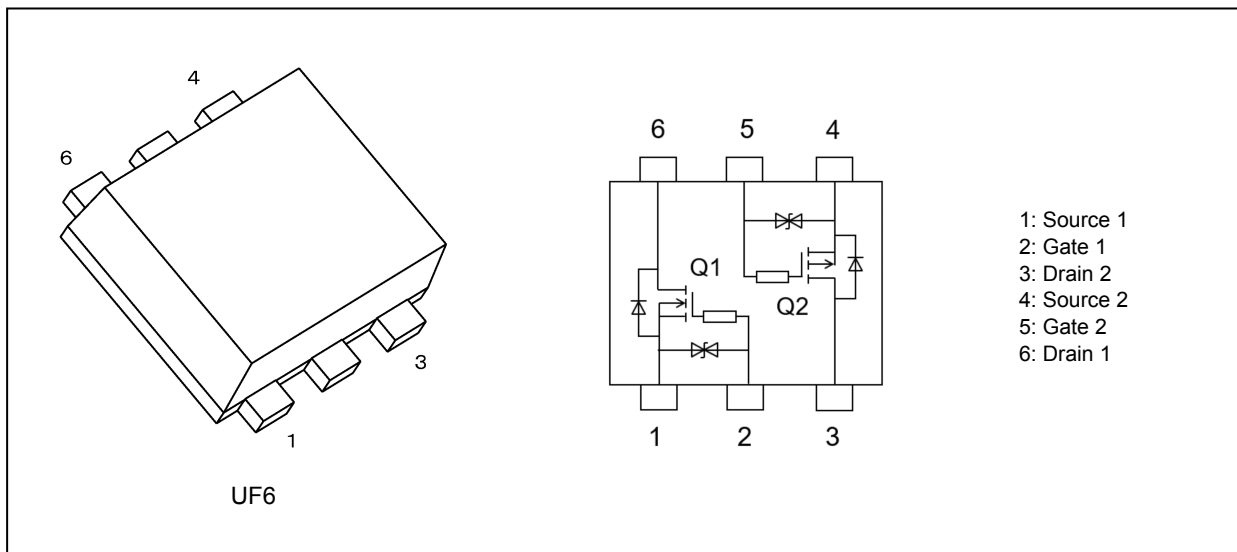
$$R_{DS(ON)} = 3.60 \text{ m}\Omega \text{ (max) (@}V_{GS} = -1.5 \text{ V)}$$

$$R_{DS(ON)} = 2.70 \text{ m}\Omega \text{ (max) (@}V_{GS} = -1.8 \text{ V)}$$

$$R_{DS(ON)} = 1.60 \text{ m}\Omega \text{ (max) (@}V_{GS} = -2.8 \text{ V)}$$

$$R_{DS(ON)} = 1.31 \text{ m}\Omega \text{ (max) (@}V_{GS} = -4.5 \text{ V)}$$

3. Packaging and Internal Circuit



Start of commercial production

2008-06

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}	± 10	V
Drain current (DC)	I_D	500	mA
Drain current (pulsed)	I_{DP}	1000	

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}	± 8	V
Drain current (DC)	I_D	-330	mA
Drain current (pulsed)	I_{DP}	-660	

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

Characteristics	Note	Symbol	Rating	Unit
Power dissipation	(Note 1)	P_D	500	mW
Channel temperature		T_{ch}	150	$^\circ\text{C}$
Storage temperature		T_{stg}	-55 to 150	$^\circ\text{C}$

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: Device mounted on an FR4 board.(total rating)(25.4 mm × 25.4 mm × 1.6 mm, Cu pad: 645 mm²)

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

Note: The MOSFETs in this device are sensitive to electrostatic discharge. When handling this device, the worktables, operators, soldering irons and other objects should be protected against anti-static discharge.

5. Electrical Characteristics

5.1. 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}	$V_{GS} = \pm 10\text{ V}, V_{DS} = 0\text{ V}$	—	—	± 1	μA
Drain cut-off current	I_{DSS}	$V_{DS} = 20\text{ V}, V_{GS} = 0\text{ V}$	—	—	1	μA
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)	$V_{(BR)DSX}$	$I_D = 1\text{ mA}, V_{GS} = -10\text{ V}$	12	—	—	
Gate threshold voltage (Note 2)	V_{th}	$V_{DS} = 3\text{ V}, I_D = 1\text{ mA}$	0.35	—	1.0	V
Drain-source on-resistance (Note 3)	$R_{DS(ON)}$	$I_D = 200\text{ mA}, V_{GS} = 5.0\text{ V}$	—	0.46	0.63	Ω
		$I_D = 200\text{ mA}, V_{GS} = 4.5\text{ V}$	—	0.51	0.66	
		$I_D = 200\text{ mA}, V_{GS} = 2.5\text{ V}$	—	0.66	0.85	
		$I_D = 100\text{ mA}, V_{GS} = 1.8\text{ V}$	—	0.81	1.14	
		$I_D = 50\text{ mA}, V_{GS} = 1.5\text{ V}$	—	0.95	1.52	
Forward transfer admittance (Note 3)	$ Y_{fs} $	$V_{DS} = 3\text{ V}, I_D = 200\text{ mA}$	420	840	—	mS

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: $V_{GS(OFF)} < V_{th} < V_{GS(ON)}$.

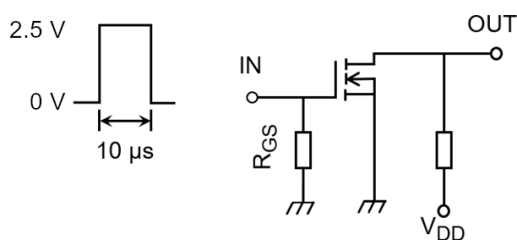
Take this into consideration when using the device.

Note 3: Pulse measurement.

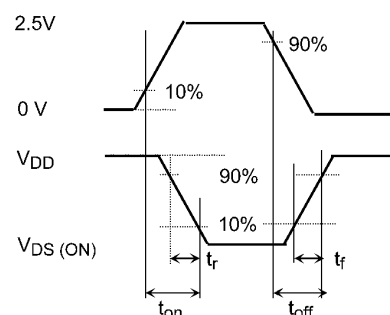
5.2. Q1 Dynamic Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Input capacitance	C_{iss}	$V_{DS} = 10\text{ V}, V_{GS} = 0\text{ V},$ $f = 1\text{ MHz}$	—	46	—	pF
Reverse transfer capacitance	C_{rss}		—	7.3	—	
Output capacitance	C_{oss}		—	10.8	—	
Switching time (turn-on time)	t_{on}	$V_{DD} = 10\text{ V}, I_D = 200\text{ mA}$ $V_{GS} = 0\text{ to }2.5\text{ V}, R_{GS} = 50\ \Omega$ Duty $\leq 1\%$, Input: $t_r, t_f < 5\text{ ns}$, Common source, See Chapter 5.3.	—	30	—	ns
Switching time (turn-off time)	t_{off}		—	75	—	

5.3. Q1 Switching Time Test Circuit



Switching Time Test Circuit



Input Waveform/Output Waveform

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

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Total gate charge (gate-source plus gate-drain)	Q_g	$V_{DS} = 10\text{ V}$, $I_D = 0.5\text{ A}$, $V_{GS} = 4.0\text{ V}$	—	1.23	—	nC
Gate-source charge	Q_{gs}		—	0.60	—	
Gate-drain charge	Q_{gd}		—	0.63	—	

5.5. 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}	$I_{DR} = 0.5\text{ A}$, $V_{GS} = 0\text{ V}$	—	0.88	1.2	V

Note 1: Pulse measurement.

5.6. 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}	$V_{GS} = \pm 8\text{ V}$, $V_{DS} = 0\text{ V}$	—	—	± 1	μA
Drain cut-off current	I_{DSS}	$V_{DS} = -16\text{ V}$, $V_{GS} = 0\text{ V}$	—	—	-10	
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}	$V_{DS} = -3\text{ V}$, $I_D = -1\text{ mA}$	-0.3	—	-1.0	V
Drain-source on-resistance (Note 3)	$R_{DS(ON)}$	$I_D = -1000\text{ mA}$, $V_{GS} = -4.5\text{ V}$	—	0.95	1.31	Ω
		$I_D = -80\text{ mA}$, $V_{GS} = -2.8\text{ V}$	—	1.22	1.60	
		$I_D = -40\text{ mA}$, $V_{GS} = -1.8\text{ V}$	—	1.80	2.70	
		$I_D = -0.5\text{ A}$, $V_{GS} = -1.8\text{ V}$	—	2.23	3.60	
Forward transfer admittance (Note 3)	$ Y_{fs} $	$V_{DS} = -3\text{ V}$, $I_D = -100\text{ mA}$	190	—	—	mS

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: $V_{GS(OFF)} < V_{th} < V_{GS(ON)}$.

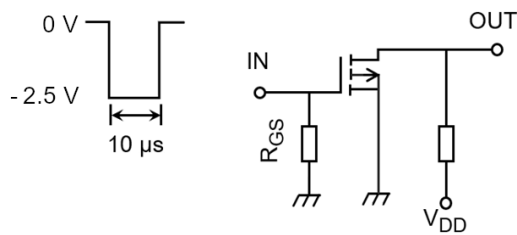
Take this into consideration when using the device.

Note 3: Pulse measurement.

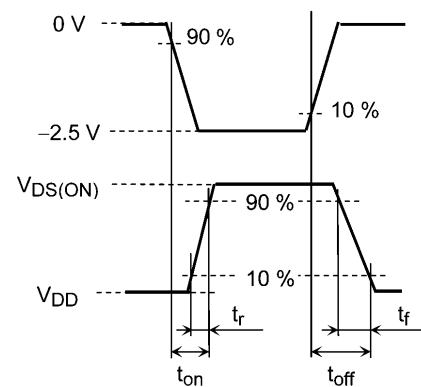
5.7. Q2 Dynamic Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Input capacitance	C_{iss}	$V_{DS} = -10\text{ V}$, $V_{GS} = 0\text{ V}$, $f = 1\text{ MHz}$	—	43	—	μF
Reverse transfer capacitance	C_{rss}		—	6.1	—	
Output capacitance	C_{oss}		—	10.3	—	
Switching time (turn-on time)	t_{on}	$V_{DD} = -10\text{ V}$, $I_D = -100\text{ mA}$ $V_{GS} = 0\text{ V}$ to -2.5 V , $R_{GS} = 50\text{ }\Omega$ Duty $\leq 1\%$, Input: $t_r, t_f < 5\text{ ns}$, Common source, See Chapter 5.3.	—	90	—	ns
Switching time (turn-off time)	t_{off}		—	200	—	

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)

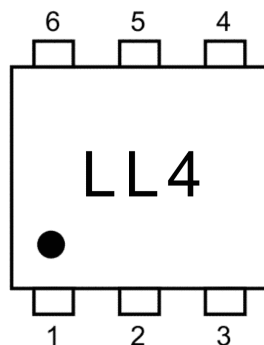
Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Total gate charge (gate-source plus gate-drain)	Q _g	V _{DS} = -10 V, I _{DS} = -330 mA, V _{GS} = -4.0 V	—	1.2	—	nC
Gate-source charge	Q _{gs}		—	0.85	—	
Gate-drain charge	Q _{gd}		—	0.35	—	

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 _{DR} = 330 mA, V _{GS} = 0 V	—	0.88	1.2	V

Note 1: Pulse measurement.

6. Marking



7. Characteristics Curves (Note)

7.1. Q1 (N-ch MOSFET) Characteristics Curves

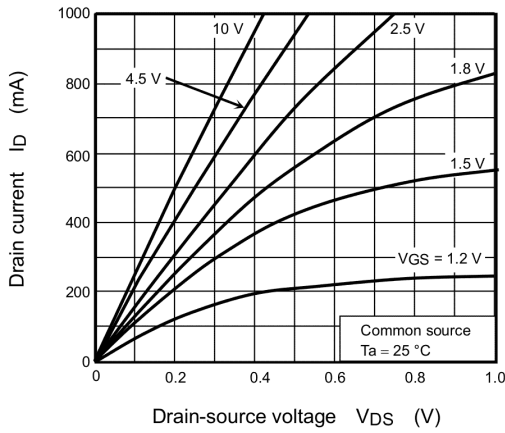


Fig. 7.1.1 $I_D - V_{DS}$

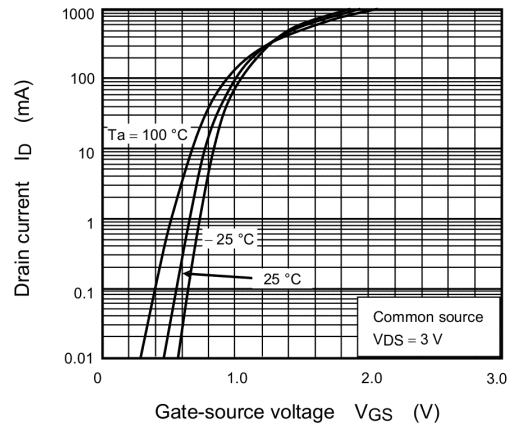


Fig. 7.1.2 $I_D - V_{GS}$

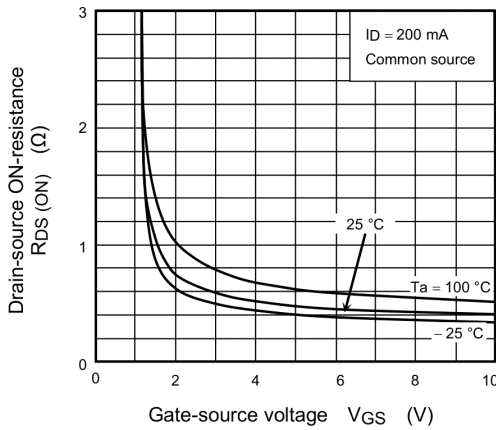


Fig. 7.1.3 $R_{DS(ON)} - V_{GS}$

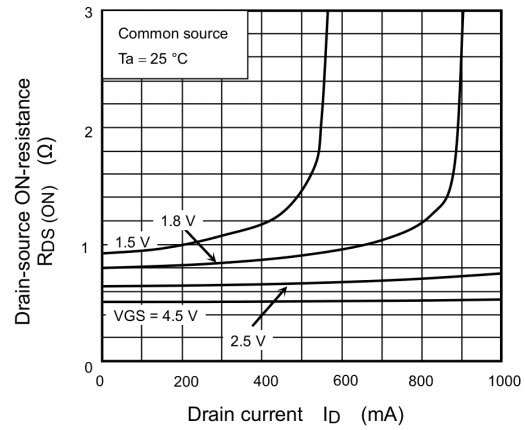


Fig. 7.1.4 $R_{DS(ON)} - I_D$

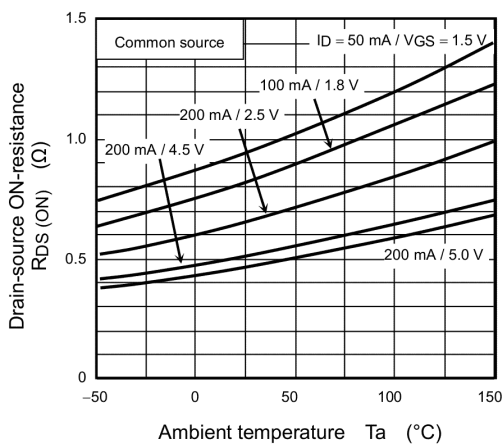


Fig. 7.1.5 $R_{DS(ON)} - T_a$

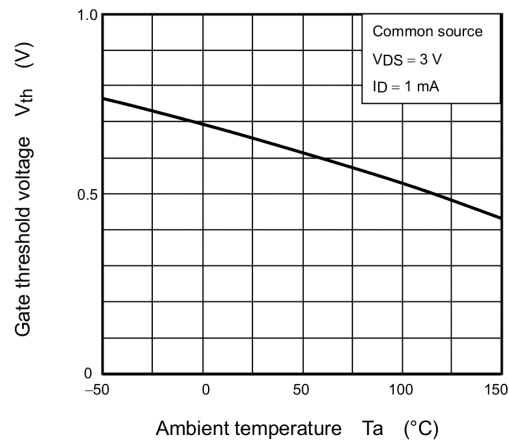


Fig. 7.1.6 $V_{th} - T_a$

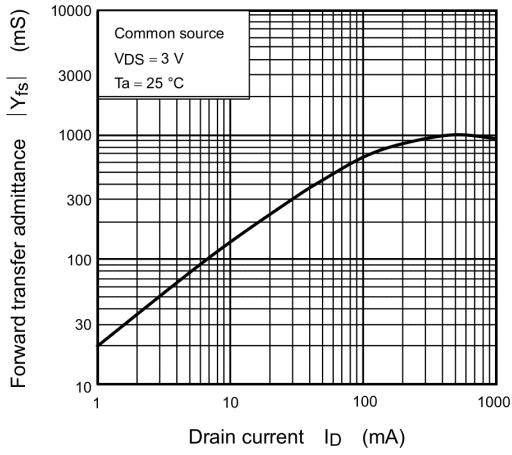


Fig. 7.1.7 $|Y_{fs}| - I_D$

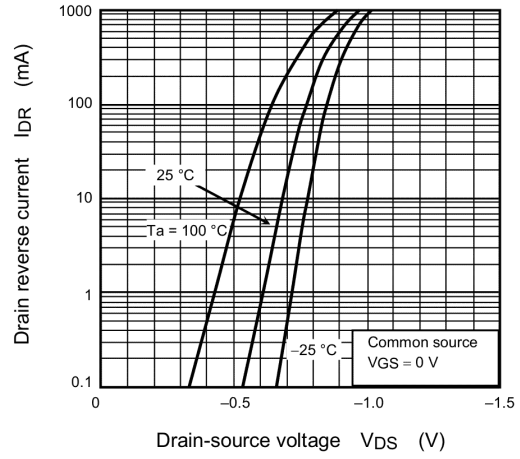


Fig. 7.1.8 $I_{DR} - V_{DS}$

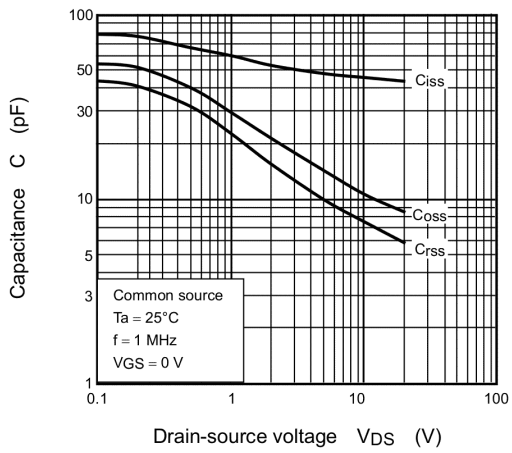


Fig. 7.1.9 $C - V_{DS}$

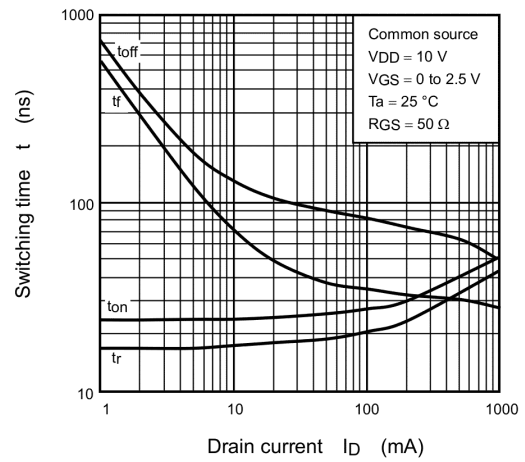


Fig. 7.1.10 $t - I_D$

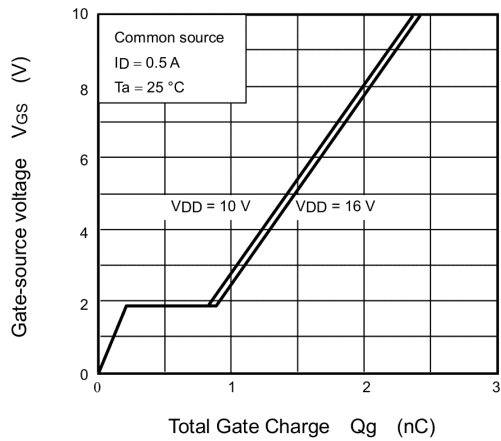


Fig. 7.1.11 Dynamic Input Characteristics

7.2. Q2 (P-ch MOSFET) Characteristics Curves

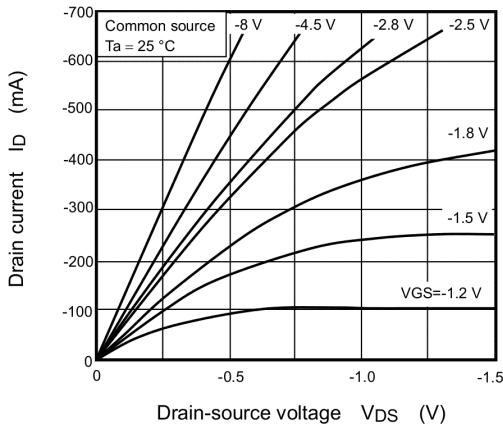


Fig. 7.2.1 $I_D - V_{DS}$

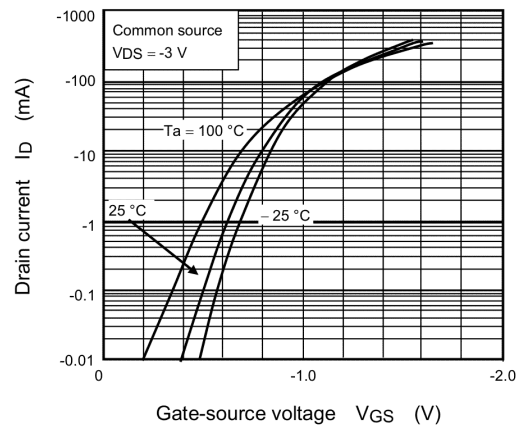


Fig. 7.2.2 $I_D - V_{GS}$

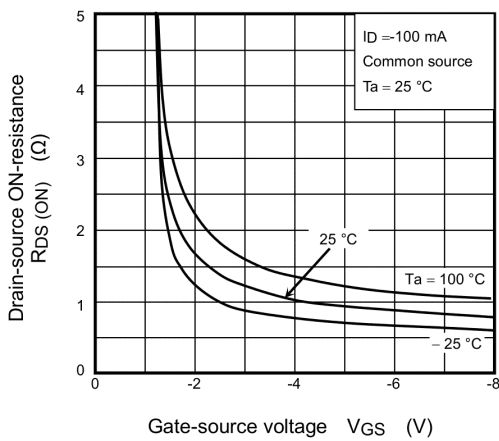


Fig. 7.2.3 $R_{DS(ON)} - V_{GS}$

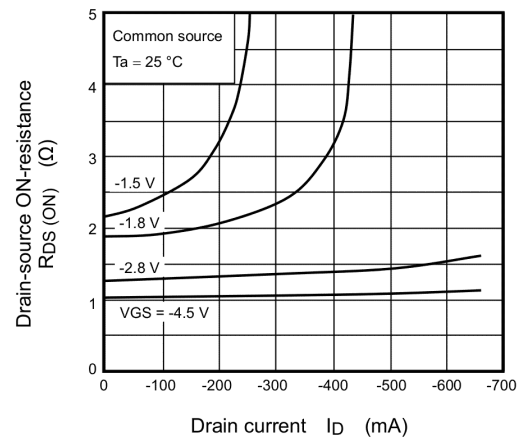


Fig. 7.2.4 $R_{DS(ON)} - I_D$

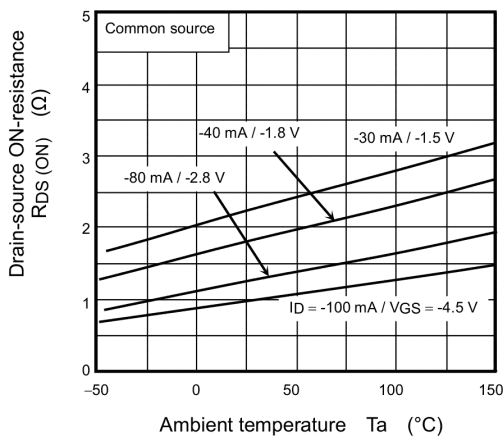


Fig. 7.2.5 $R_{DS(ON)} - T_a$

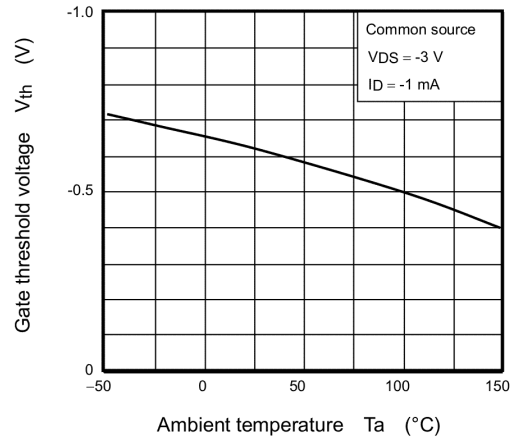


Fig. 7.2.6 $V_{th} - T_a$

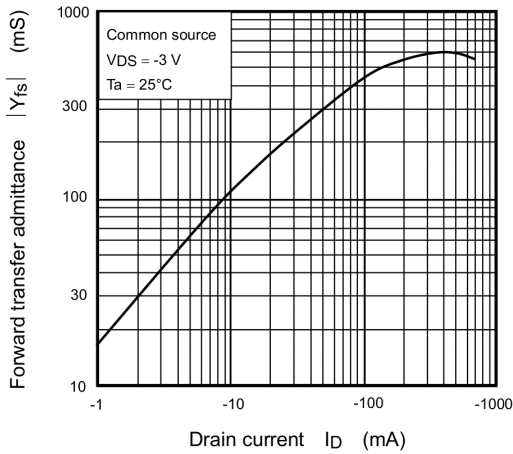


Fig. 7.2.7 $|Y_{fs}| - I_D$

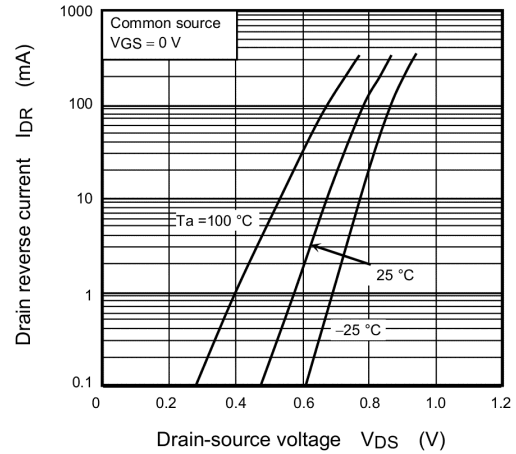


Fig. 7.2.8 $I_{DR} - V_{DS}$

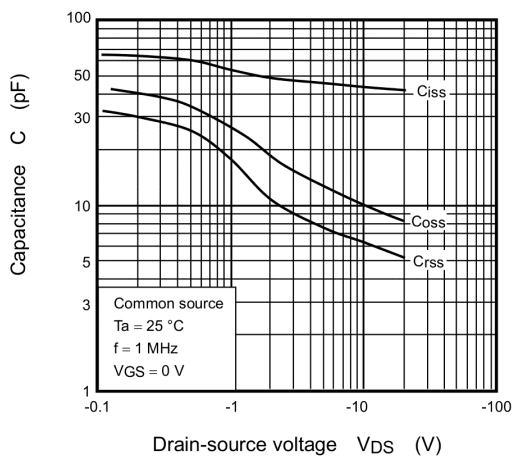


Fig. 7.2.9 $C - V_{DS}$

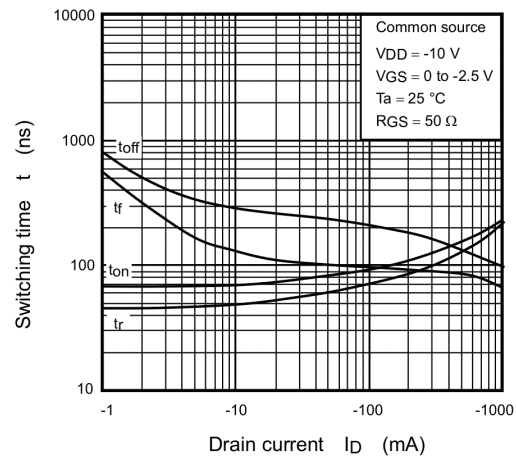


Fig. 7.2.10 $t - I_D$

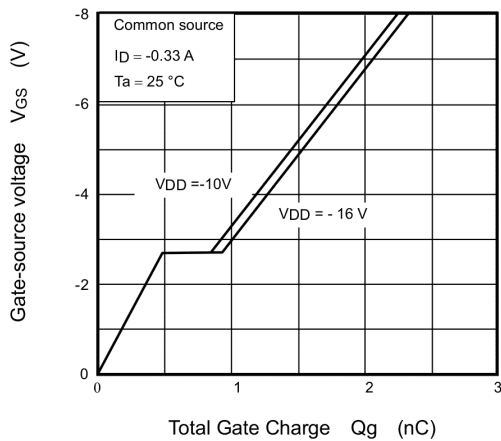
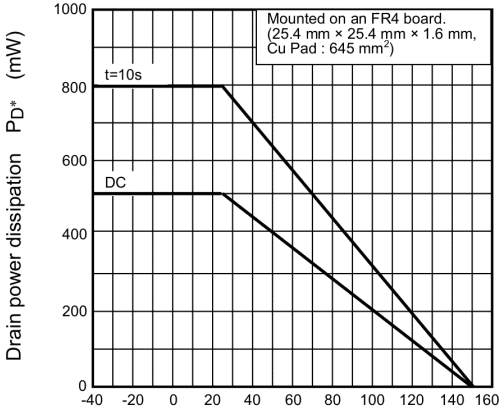


Fig. 7.2.11 Dynamic Input Characteristics

7.3. Characteristics Curves (Q1, Q2 Common)



*: Total Rating Ambient temperature Ta (°C)

Fig. 7.3.1 PD - Ta

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

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