MOSFETs Silicon P-/N-Channel MOS

SSM6L56FE

1. Applications

- High-Speed Switching

2. Features

(1) 1.5-V drive

(2) Low drain-source on-resistance

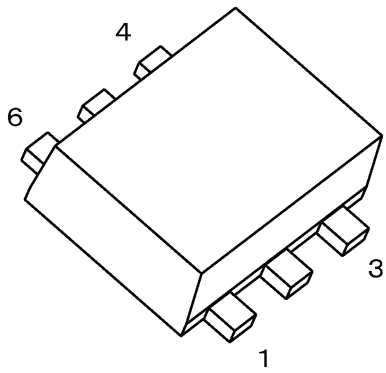
Q1 N-channel:

$R_{DS(ON)}$ = 235 mΩ (max) (@V_{GS} = 4.5 V, I_D = 800 mA)
$R_{DS(ON)}$ = 300 mΩ (max) (@V_{GS} = 2.5 V, I_D = 600 mA)
$R_{DS(ON)}$ = 480 mΩ (max) (@V_{GS} = 1.8 V, I_D = 200 mA)
$R_{DS(ON)}$ = 840 mΩ (max) (@V_{GS} = 1.5 V, I_D = 50 mA)

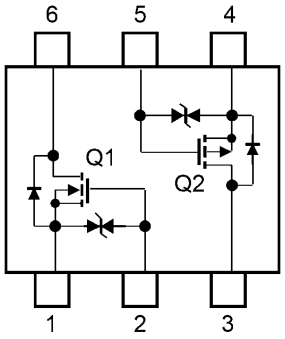
Q2 P-channel:

$R_{DS(ON)}$ = 390 mΩ (max) (@V_{GS} = -4.5 V, I_D = -800 mA)
$R_{DS(ON)}$ = 480 mΩ (max) (@V_{GS} = -2.5 V, I_D = -500 mA)
$R_{DS(ON)}$ = 660 mΩ (max) (@V_{GS} = -1.8 V, I_D = -200 mA)
$R_{DS(ON)}$ = 900 mΩ (max) (@V_{GS} = -1.5 V, I_D = -100 mA)
$R_{DS(ON)}$ = 4000 mΩ (max) (@V_{GS} = -1.2 V, I_D = -10 mA)

3. Packaging and Internal Circuit



ES6



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

Start of commercial production
2019-05

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	800	mA
Drain current (pulsed)	(Note 1)	I_{DP}	1600	

Note 1: Ensure that the channel temperature does not exceed 150 °C.

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}	±8	
Drain current (DC)	(Note 1)	I_D	-800	mA
Drain current (pulsed)	(Note 1)	I_{DP}	-1600	

Note 1: Ensure that the channel temperature does not exceed 150 °C.

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	150	mW
Power dissipation	(Note 2)		250	
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: Device mounted on an FR4 board.(total rating)
(25.4 mm × 25.4 mm × 1.6 mm, Cu pad: 0.135 mm^2 × 6)

Note 2: Device mounted on an FR4 board.(total rating)
(25.4 mm × 25.4 mm × 1.6 mm, Cu pad: 645 mm^2)

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.

Note: The channel-to-ambient thermal resistance, $R_{th(ch-a)}$, 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. 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_{DS} = 0 V, V_{GS} = ±6 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 = 800 mA, V_{GS} = 4.5 V	—	186	235	mΩ
			I_D = 600 mA, V_{GS} = 2.5 V	—	230	300	
			I_D = 200 mA, V_{GS} = 1.8 V	—	290	480	
			I_D = 50 mA, V_{GS} = 1.5 V	—	360	840	
Forward transfer admittance	(Note 3)	$\|Y_{fs}\|$	V_{DS} = 3 V, I_D = 200 mA	—	1.4	—	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.

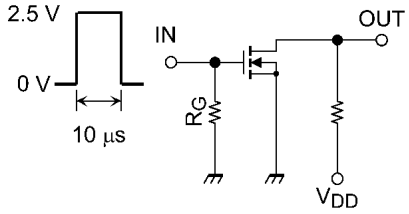
Note 2: Let V_{th} be the voltage applied between gate and source that causes the drain current (I_D) to below (1 mA for this device). Then, for normal switching operation, $V_{GS(ON)}$ must be higher than V_{th}, and $V_{GS(OFF)}$ must be lower than V_{th}. This relationship can be expressed as: $V_{GS(OFF)}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

Note 3: Pulse measurement.

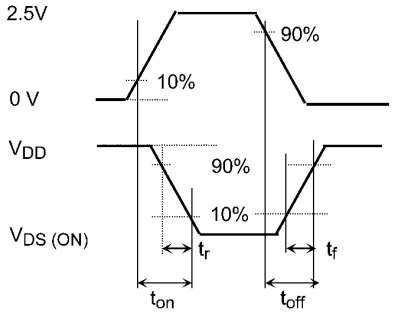
5.2. Q1 Dynamic Characteristics (Unless otherwise specified, T_a = 25 °C)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Input capacitance	C_{iss}	V_{DS} = 10 V , V_{GS} = 0 V, f = 1 MHz	—	55	—	pF
Reverse transfer capacitance	C_{rss}		—	6	—	
Output capacitance	C_{oss}		—	16	—	
Switching time (turn-on time)	t_{on}	V_{DD} = 10 V, I_D = 200 mA, V_{GS} = 0 to 2.5 V, R_G = 50 Ω	—	5.5	—	ns
Switching time (turn-off time)	t_{off}		—	8.5	—	

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} = 10 V, I_D = 800 mA, V_{GS} = 4.5 V	—	1.0	—	nC
Gate-source charge 1	Q_{gs1}		—	0.12	—	
Gate-drain charge	Q_{gd}		—	0.4	—	

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 = -800 mA, V_{GS} = 0 V	—	-0.82	-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_{DS} = 0 V, V_{GS} = ±8 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} = 5 V	-15	—	—	
Gate threshold voltage	(Note 2)	V_{th}	V_{DS} = -3 V, I_D = -1 mA	-0.3	—	-1.0	
Drain-source on-resistance	(Note 3)	$R_{DS(ON)}$	I_D = -800 mA, V_{GS} = -4.5 V	—	310	390	mΩ
			I_D = -500 mA, V_{GS} = -2.5 V	—	380	480	
			I_D = -200 mA, V_{GS} = -1.8 V	—	470	660	
			I_D = -100 mA, V_{GS} = -1.5 V	—	560	900	
			I_D = -10 mA, V_{GS} = -1.2 V	—	770	4000	
Forward transfer admittance	(Note 3)	$\|Y_{fs}\|$	V_{DS} = -3 V, I_D = -100 mA	0.5	1.0	—	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.

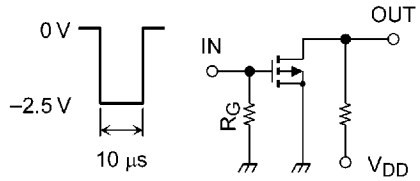
Note 2: Let V_{th} be the voltage applied between gate and source that causes the drain current (I_D) to below (-1 mA for this device). Then, for normal switching operation, $V_{GS(ON)}$ must be higher than V_{th}, and $V_{GS(OFF)}$ must be lower than V_{th}. This relationship can be expressed as: $V_{GS(OFF)}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

Note 3: Pulse measurement.

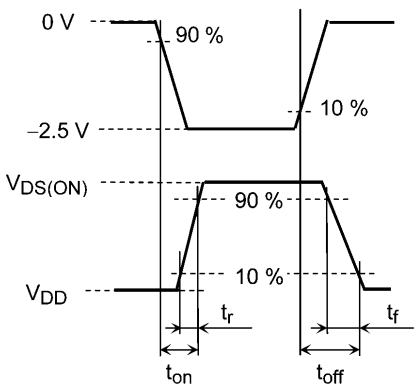
5.7. Q2 Dynamic Characteristics (Unless otherwise specified, T_a = 25 °C)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Input capacitance	C_{iss}	V_{DS} = -10 V , V_{GS} = 0 V, f = 1 MHz	—	100	—	pF
Reverse transfer capacitance	C_{rss}		—	10	—	
Output capacitance	C_{oss}		—	16	—	
Switching time (turn-on time)	t_{on}	V_{DD} = -10 V, I_D = -200 mA, V_{GS} = 0 to -2.5 V, R_G = 50 Ω	—	8	—	ns
Switching time (turn-off time)	t_{off}		—	26	—	

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)

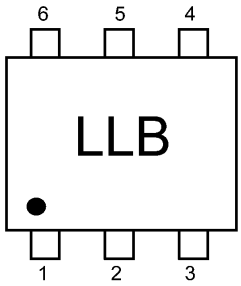
Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Total gate charge (gate-source plus gate-drain)	Q_g	V_{DD} = -10 V, I_D = -800 mA, V_{GS} = -4.5 V	—	1.6	—	nC
Gate-source charge 1	Q_{gs1}		—	0.2	—	
Gate-drain charge	Q_{gd}		—	0.4	—	

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 = 800 mA, V_{GS} = 0 V	—	0.9	1.2	V

Note 1: Pulse measurement.

6. Marking



Marking

7. Characteristics Curves (Note)

7.1. Q1 Characteristics Curves

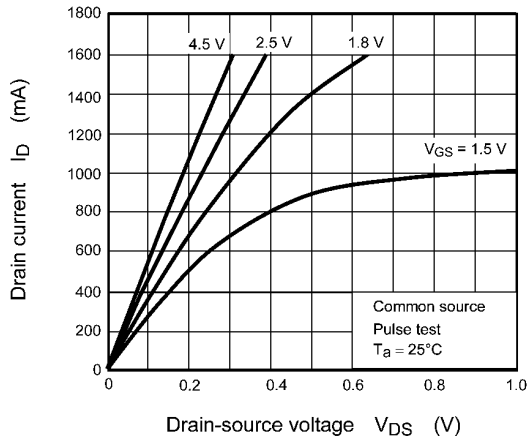


Fig. 7.1.1 I_D - V_{DS}

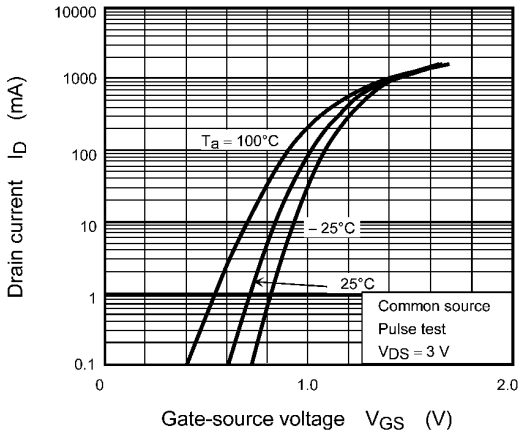


Fig. 7.1.2 I_D - V_{GS}

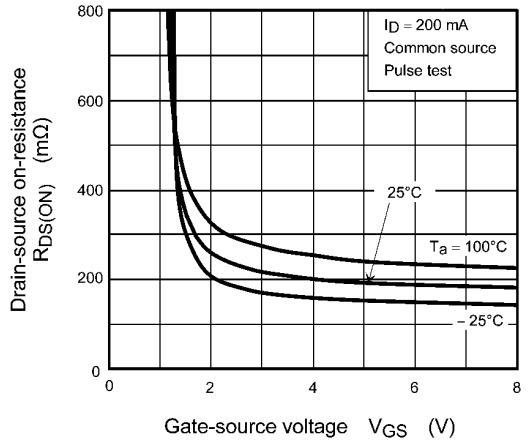


Fig. 7.1.3 $R_{DS(ON)}$ - V_{GS}

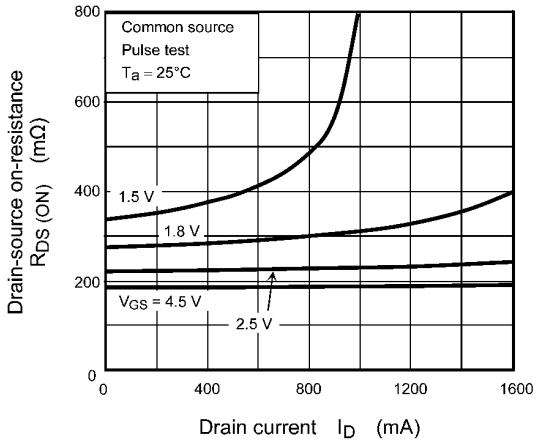


Fig. 7.1.4 $R_{DS(ON)}$ - I_D

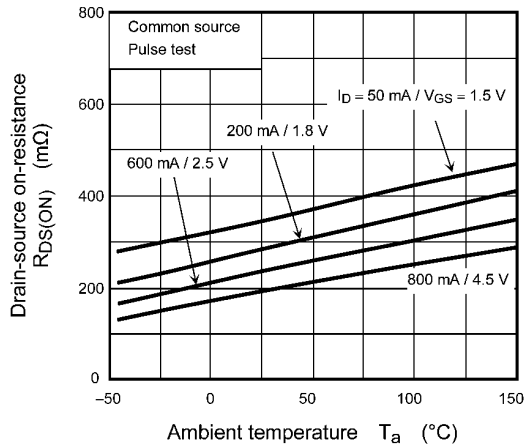


Fig. 7.1.5 $R_{DS(ON)}$ - T_a

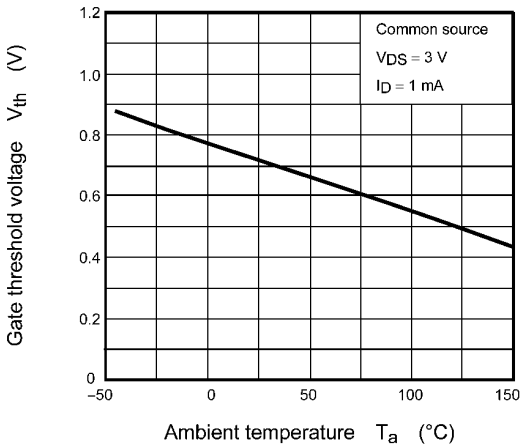


Fig. 7.1.6 V_{th} - T_a

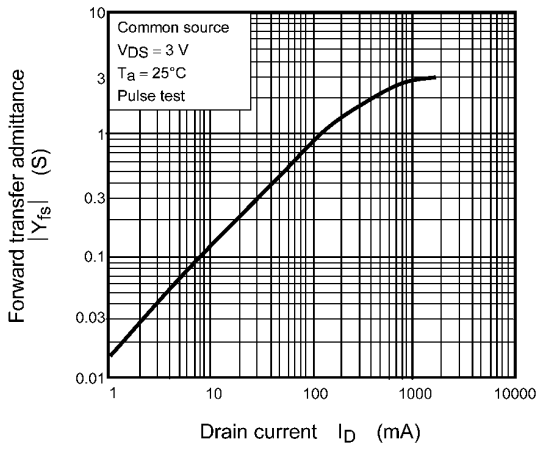


Fig. 7.1.7 $|Y_{fs}|$ - I_D

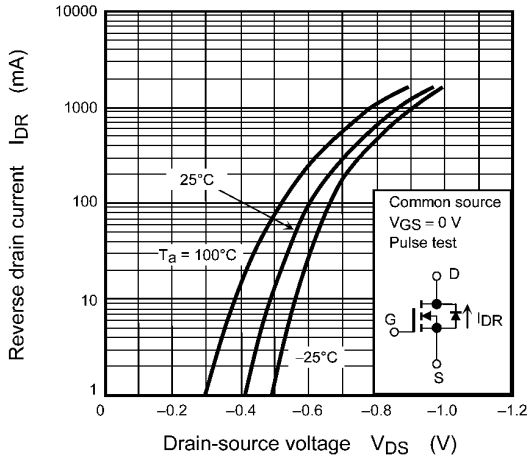


Fig. 7.1.8 I_{DR} - V_{DS}

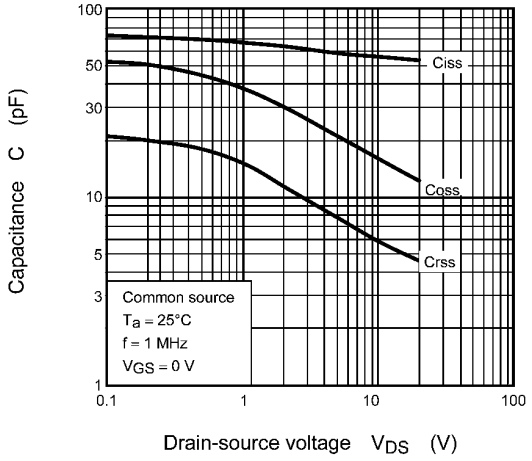


Fig. 7.1.9 C - V_{DS}

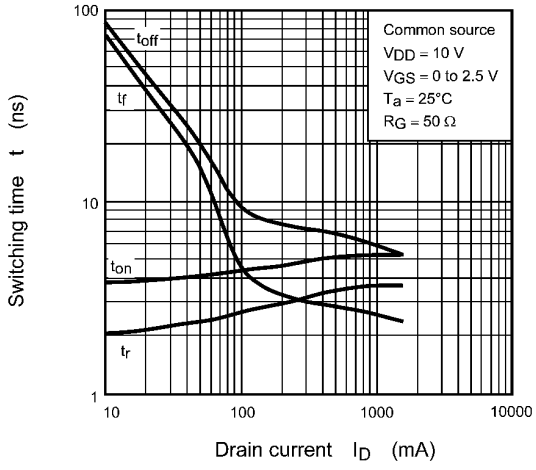


Fig. 7.1.10 t - I_D

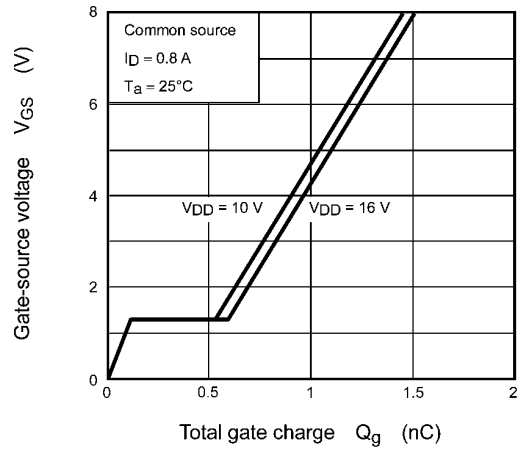


Fig. 7.1.11 Dynamic Input Characteristics

7.2. Q2 Characteristics Curves

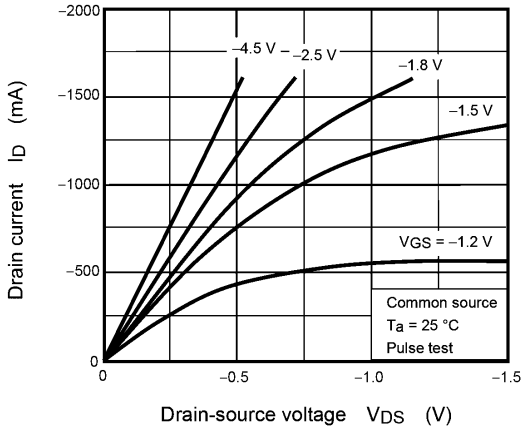


Fig. 7.2.1 I_D - V_{DS}

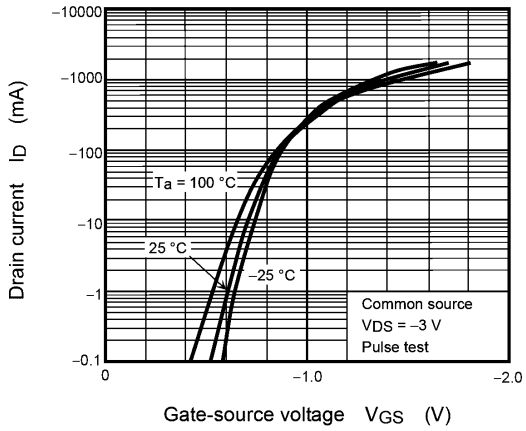


Fig. 7.2.2 I_D - V_{GS}

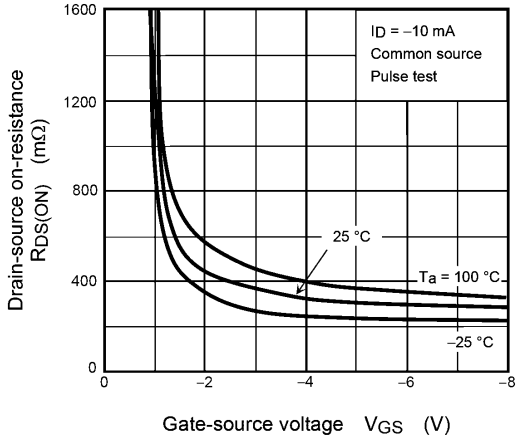


Fig. 7.2.3 $R_{DS(ON)}$ - V_{GS}

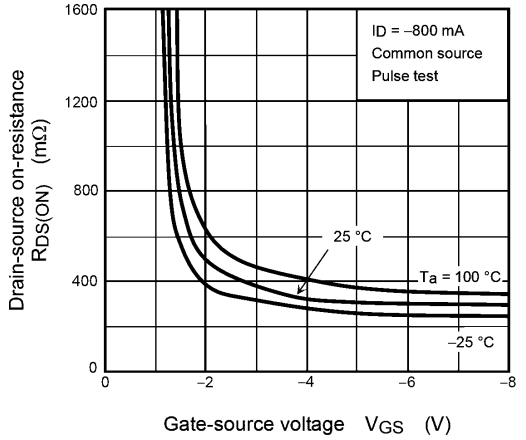


Fig. 7.2.4 $R_{DS(ON)}$ - V_{GS}

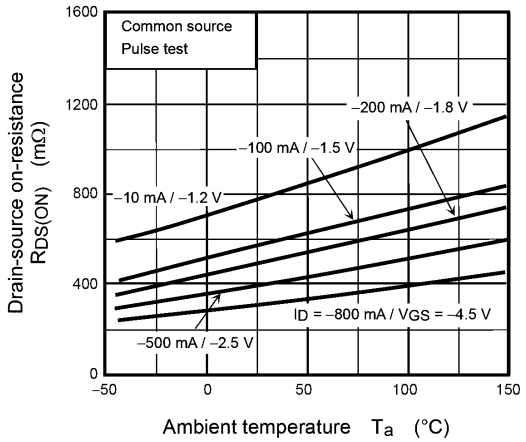


Fig. 7.2.5 $R_{DS(ON)}$ - T_a

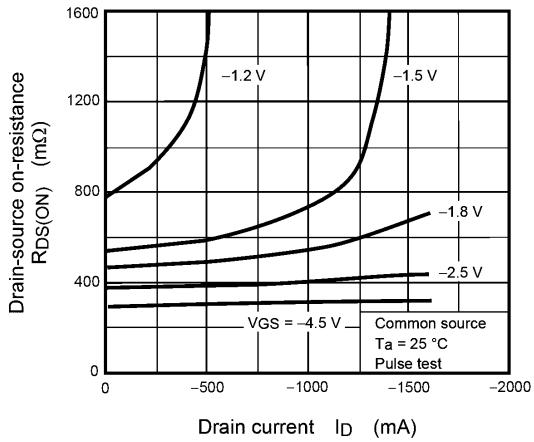


Fig. 7.2.6 $R_{DS(ON)}$ - I_D

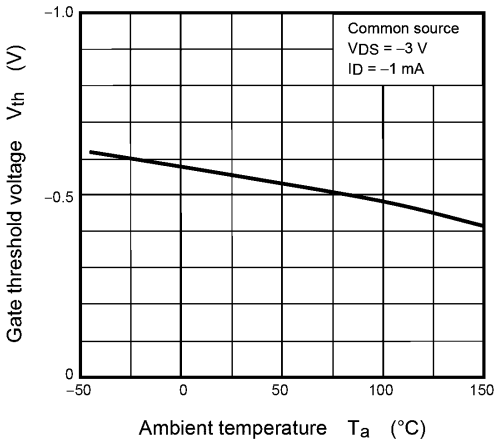


Fig. 7.2.7 V_{th} - T_a

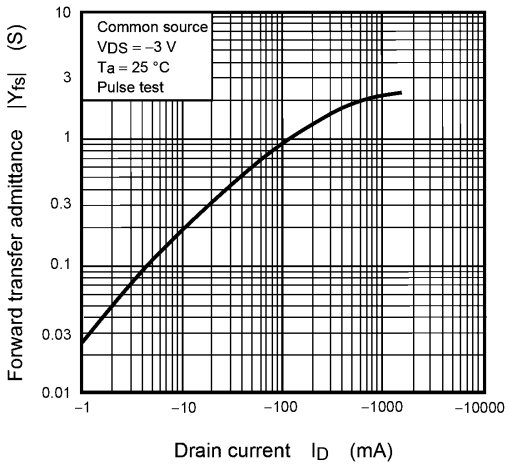


Fig. 7.2.8 $|Y_{fs}|$ - I_D

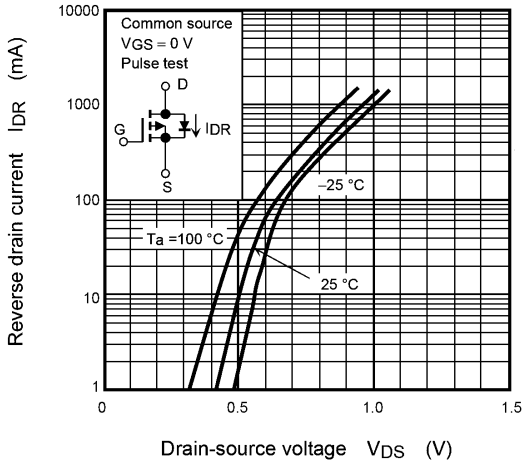


Fig. 7.2.9 I_{DR} - V_{DS}

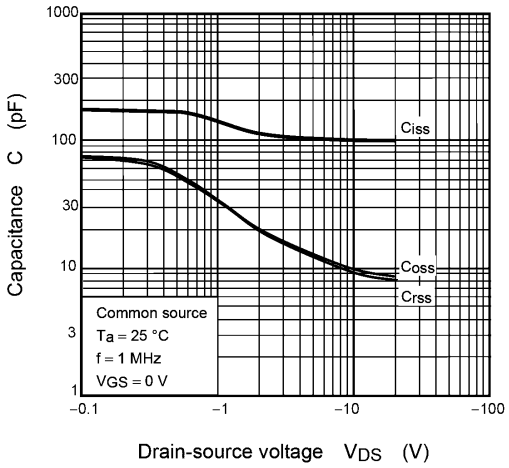


Fig. 7.2.10 C - V_{DS}

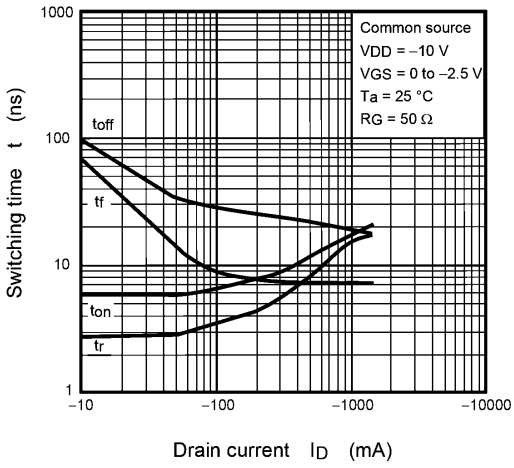


Fig. 7.2.11 t - I_D

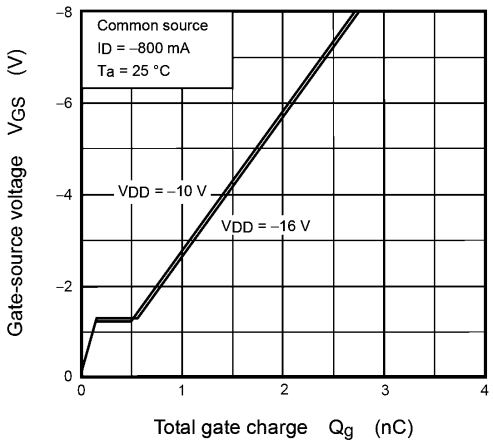


Fig. 7.2.12 Dynamic Input Characteristics

7.3. Characteristics Curves (Q1, Q2 Common)

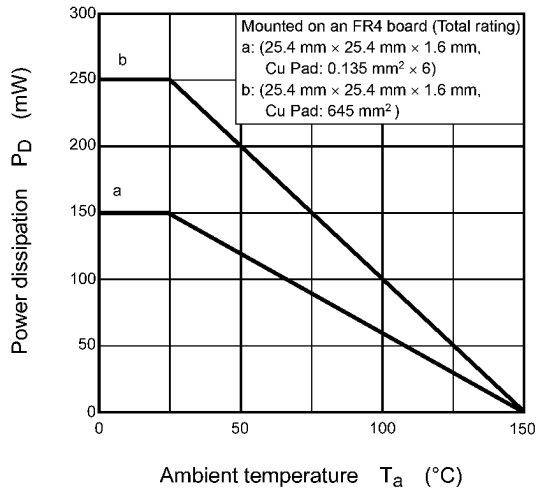
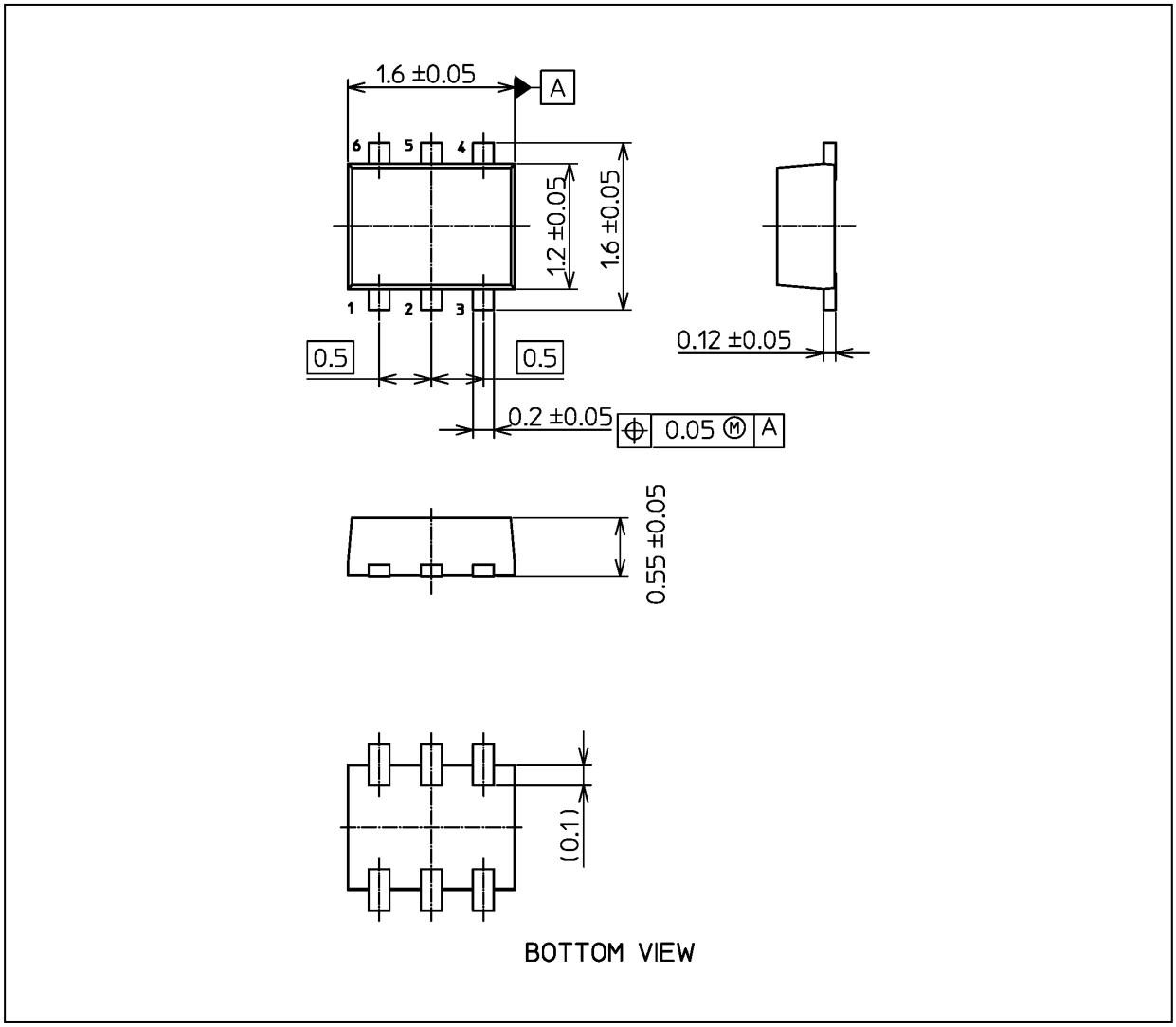


Fig. 7.3.1 P_D - T_a

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

Package Dimensions

Unit: mm



Weight: 3.0 mg (typ.)

Package Name(s)
Nickname: ES6

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