

MOSFETs Silicon P-/N-Channel MOS

# SSM6L820R

## 1. Applications

- Power Management Switches

## 2. Features

- (1) AEC-Q101 qualified (Please see the orderable part number list)
- (2) Low drain-source on-resistance

Q1 N-channel:

$$R_{DS(ON)} = 39.1 \text{ m}\Omega \text{ (max) (@}V_{GS} = 4.5 \text{ V)}$$

$$R_{DS(ON)} = 53 \text{ m}\Omega \text{ (max) (@}V_{GS} = 2.5 \text{ V)}$$

$$R_{DS(ON)} = 82 \text{ m}\Omega \text{ (max) (@}V_{GS} = 1.8 \text{ V)}$$

Q2 P-channel:

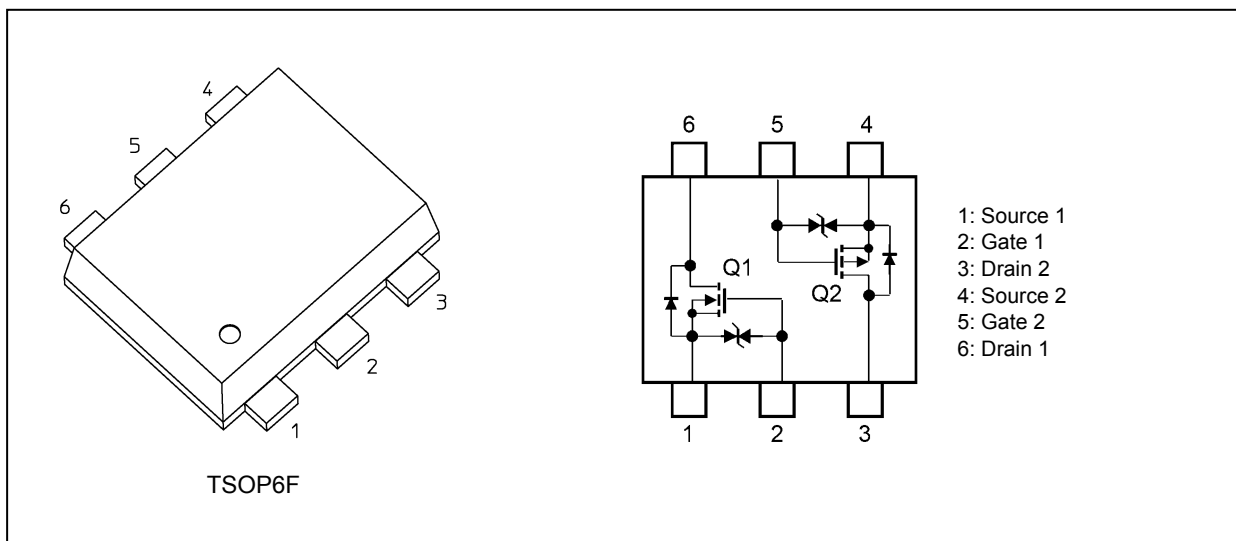
$$R_{DS(ON)} = 45 \text{ m}\Omega \text{ (max) (@}V_{GS} = -10 \text{ V)}$$

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

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

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

## 3. Packaging and Internal Circuit



## 4. Orderable part number

Orderable part number	AEC-Q101	Note
SSM6L820R,LF	—	General Use
SSM6L820R,LXGF	YES (Note 1)	Unintended Use (Note 1)
SSM6L820R,LXHF	YES	Automotive Use

Note 1: For more information, please contact our sales or use the inquiry form on our website.

Start of commercial production

2018-11

### 5. Absolute Maximum Ratings (Note)

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

Characteristics	Symbol	Rating	Unit
Drain-source voltage	$V_{DSS}$	30	V
Gate-source voltage	$V_{GSS}$	+12/-8	
Drain current (DC) (Note 1)	$I_D$	4	A
Drain current (pulsed) ( $t \leq 10\text{ ms}$ ) (Note 1), (Note 2)	$I_{DP}$	10	

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

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

#### 5.2. 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/+6	
Drain current (DC) (Note 1)	$I_D$	-4	A
Drain current (pulsed) ( $t \leq 10\text{ ms}$ ) (Note 1), (Note 2)	$I_{DP}$	-10	

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

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

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

Characteristics	Symbol	Rating	Unit
Power dissipation (Note 1)	$P_D$	1.4	W
Power dissipation ( $t \leq 10\text{ s}$ ) (Note 1)		1.8	
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: Device mounted on an FR4 board.(total rating)  
( $25.4\text{ mm} \times 25.4\text{ mm} \times 1.6\text{ mm}$ , Cu pad:  $645\text{ mm}^2$ )

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.

### 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	$I_{GSS}$	$V_{DD} = 0\text{ V}, V_{GS} = 10\text{-}8\text{ V}$	—	—	$\pm 10$	$\mu\text{A}$
Drain cut-off current	$I_{DSS}$	$V_{DS} = 24\text{ V}, V_{GS} = 0\text{ V}$	—	—	1	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$I_D = 1\text{ mA}, V_{GS} = 0\text{ V}$	30	—	—	V
Drain-source breakdown voltage (Note 1)	$V_{(BR)DSX}$	$I_D = 1\text{ mA}, V_{GS} = -12\text{ V}$	18	—	—	
Gate threshold voltage (Note 2)	$V_{th}$	$V_{DS} = 3\text{ V}, I_D = 1\text{ mA}$	0.4	—	1	
Drain-source on-resistance (Note 3)	$R_{DS(ON)}$	$I_D = 2.0\text{ A}, V_{GS} = 4.5\text{ V}$	—	30	39.1	$\text{m}\Omega$
		$I_D = 1.0\text{ A}, V_{GS} = 2.5\text{ V}$	—	37	53	
		$I_D = 0.5\text{ A}, V_{GS} = 1.8\text{ V}$	—	46	82	

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.

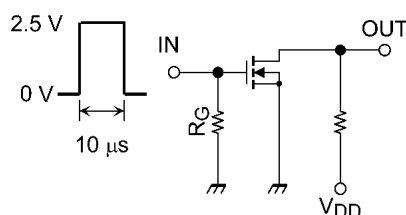
Note 2: Let  $V_{th}$  be the voltage applied between gate and source that causes the drain current ( $I_D$ ) to below (1 mA for this device). Then, for normal switching operation,  $V_{GS(ON)}$  must be higher than  $V_{th}$ , and  $V_{GS(OFF)}$  must be lower than  $V_{th}$ . This relationship can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

Note 3: Pulse measurement.

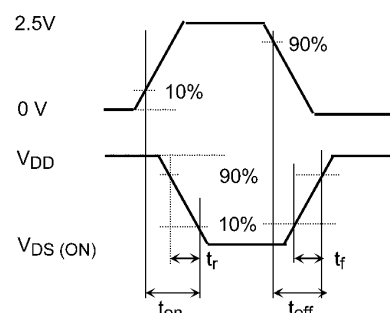
#### 6.2. Q1 Dynamic Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$ )

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Input capacitance	$C_{iss}$	$V_{DS} = 15\text{ V}, V_{GS} = 0\text{ V},$ $f = 1\text{ MHz}$	—	310	—	$\text{pF}$
Reverse transfer capacitance	$C_{rss}$		—	20	—	
Output capacitance	$C_{oss}$		—	52	—	
Switching time (turn-on time)	$t_{on}$	$V_{DD} = 15\text{ V}, I_D = 1\text{ A},$ $V_{GS} = 0\text{ to }2.5\text{ V}, R_G = 4.7\text{ }\Omega$ Duty $\leq 1\%$ , $V_{IN}$ : tr, tf < 5 ns Common source	—	26	—	ns
Switching time (turn-off time)	$t_{off}$		—	17.0	—	

#### 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)	$Q_g$	$V_{DD} = 15\text{ V}, I_D = 4.0\text{ A},$ $V_{GS} = 4.5\text{ V}$	—	3.2	—	nC
Gate-source charge 1	$Q_{gs1}$		—	0.5	—	
Gate-drain charge	$Q_{gd}$		—	0.7	—	

### 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)	$V_{DSF}$	$I_D = -4\text{ A}$ , $V_{GS} = 0\text{ V}$	—	-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	$I_{GSS}$	$V_{DS} = 0\text{ V}$ , $V_{GS} = +6/-10\text{ V}$	—	—	$\pm 1$	$\mu\text{A}$
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	$\text{m}\Omega$
		$I_D = -3.0\text{ A}$ , $V_{GS} = -4.5\text{ V}$	—	44	56	$\text{m}\Omega$
		$I_D = -2.0\text{ A}$ , $V_{GS} = -2.5\text{ V}$	—	60	76	
		$I_D = -0.5\text{ A}$ , $V_{GS} = -1.8\text{ V}$	—	83	157	

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

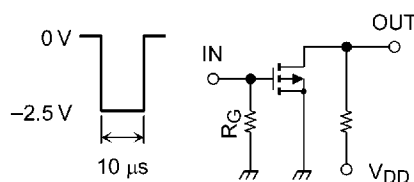
Take this into consideration when using the device.

Note 3: Pulse measurement.

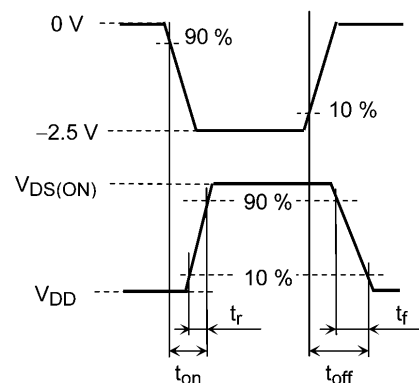
### 6.7. Q2 Dynamic Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$ )

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	—	$\text{pF}$
Reverse transfer capacitance	$C_{rss}$		—	76	—	
Output capacitance	$C_{oss}$		—	90	—	
Switching time (turn-on time)	$t_{on}$	$V_{DD} = -10\text{ V}$ , $I_D = -0.5\text{ A}$ , $V_{GS} = 0$ to $-2.5\text{ V}$ , $R_G = 4.7\text{ }\Omega$ Duty $\leq 1\%$ , $V_{IN}$ : $t_r, t_f < 5\text{ ns}$ , Common source	—	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, $T_a = 25\text{ }^\circ\text{C}$ )

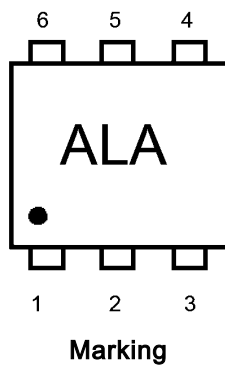
Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Total gate charge (gate-source plus gate-drain)	$Q_g$	$V_{DD} = -10\text{ V}$ , $I_D = -4.0\text{ A}$ , $V_{GS} = -4.5\text{ V}$	—	6.7	—	nC
Gate-source charge 1	$Q_{gs1}$		—	0.95	—	
Gate-drain charge	$Q_{gd}$		—	1.50	—	

### 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)	$V_{DSF}$	$I_D = 4\text{ A}$ , $V_{GS} = 0\text{ V}$	—	0.87	1.2	V

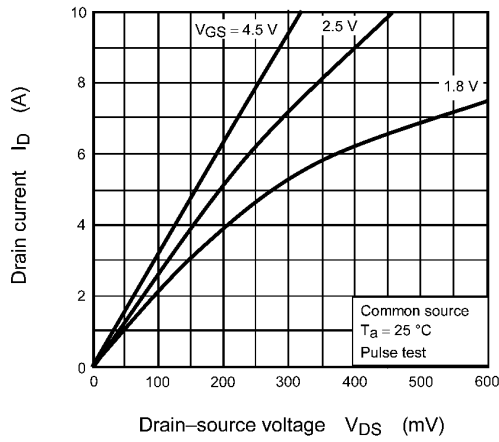
Note 1: Pulse measurement.

## 7. Marking

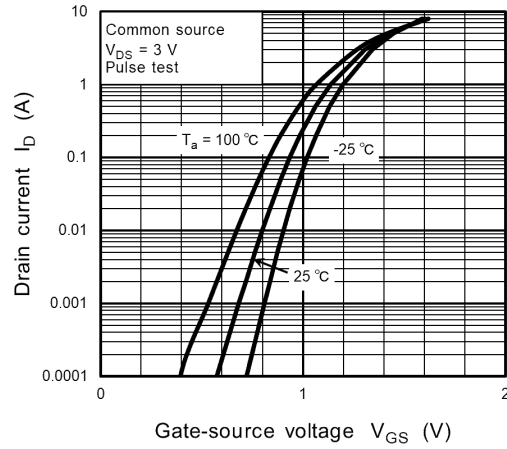


### 8. Characteristics Curves (Note)

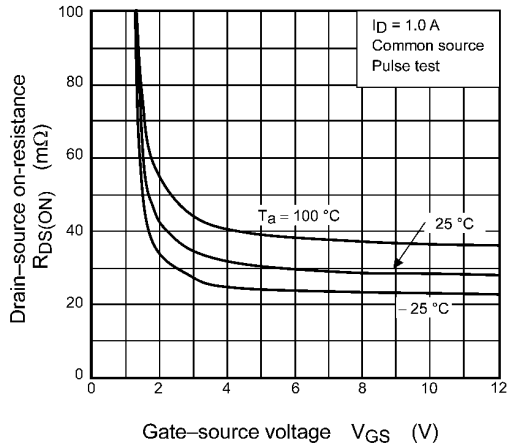
#### 8.1. Q1 Characteristics Curves



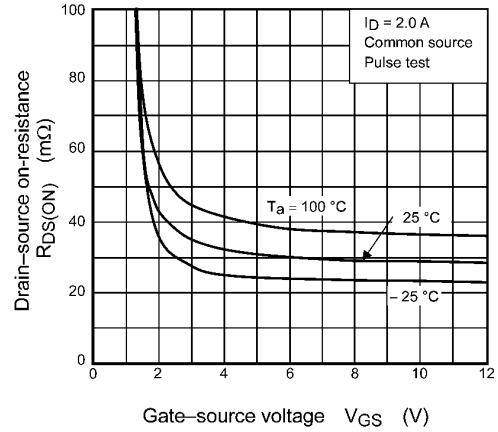
**Fig. 8.1.1**  $I_D - V_{DS}$



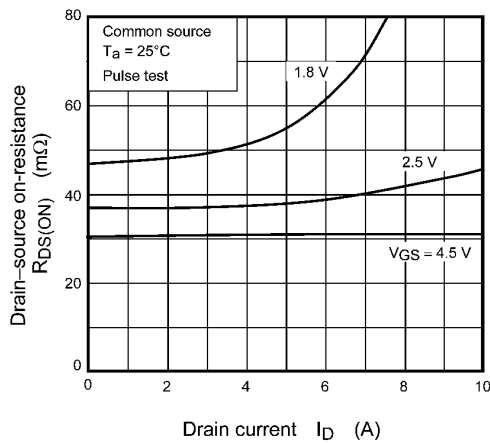
**Fig. 8.1.2**  $I_D - V_{GS}$



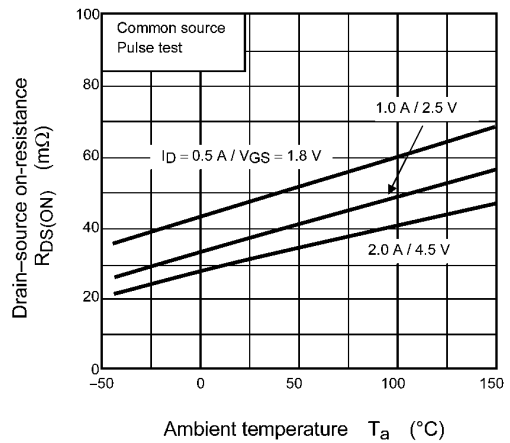
**Fig. 8.1.3**  $R_{DS(ON)} - V_{GS}$



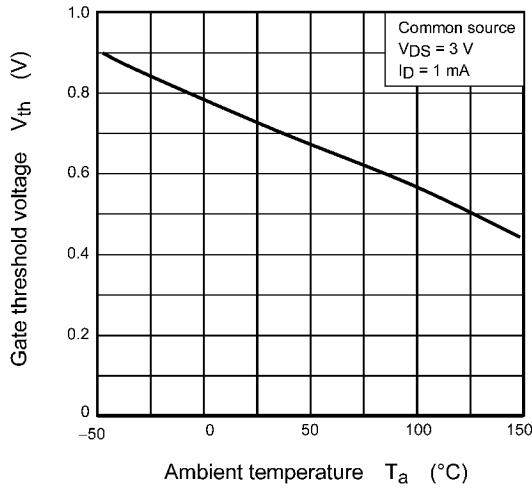
**Fig. 8.1.4**  $R_{DS(ON)} - V_{GS}$



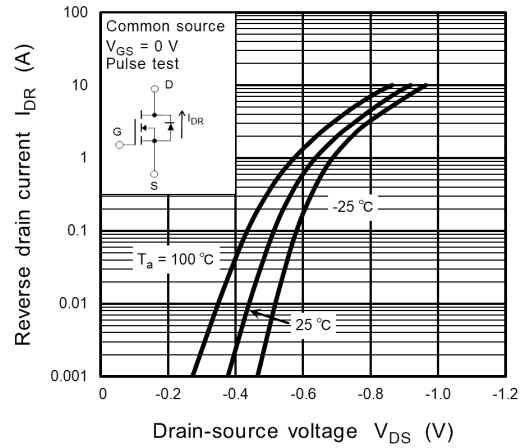
**Fig. 8.1.5**  $R_{DS(ON)} - I_D$



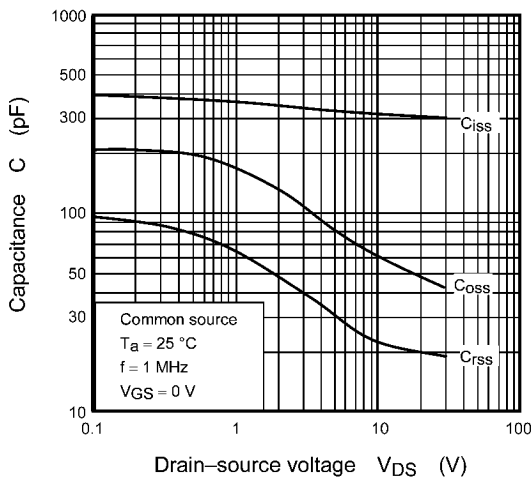
**Fig. 8.1.6**  $R_{DS(ON)} - T_a$



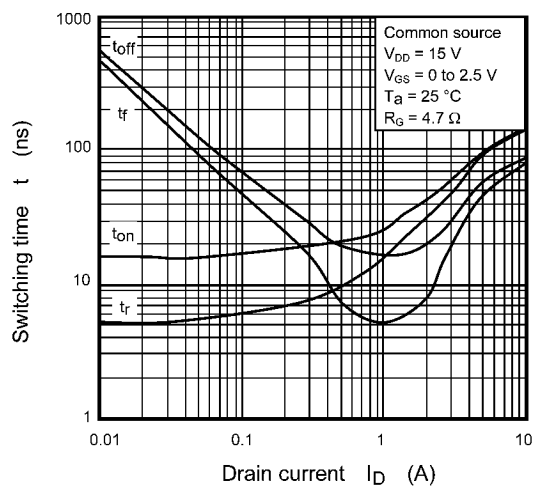
**Fig. 8.1.7  $V_{th} - T_a$**



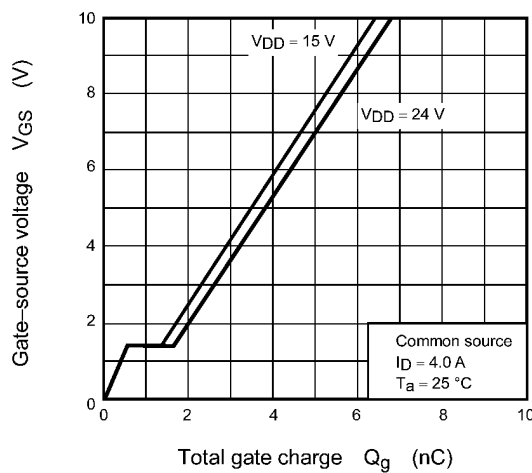
**Fig. 8.1.8  $I_{DR} - V_{DS}$**



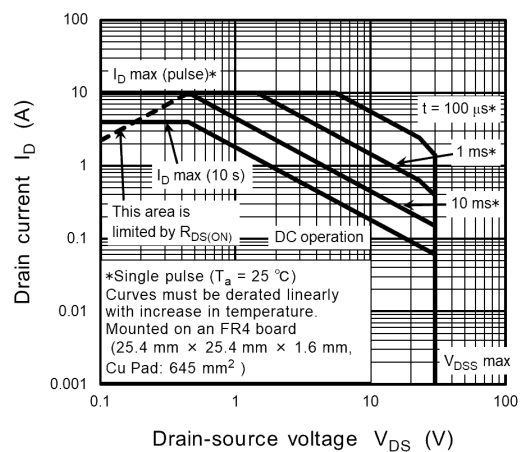
**Fig. 8.1.9  $C - V_{DS}$**



**Fig. 8.1.10  $t - I_D$**

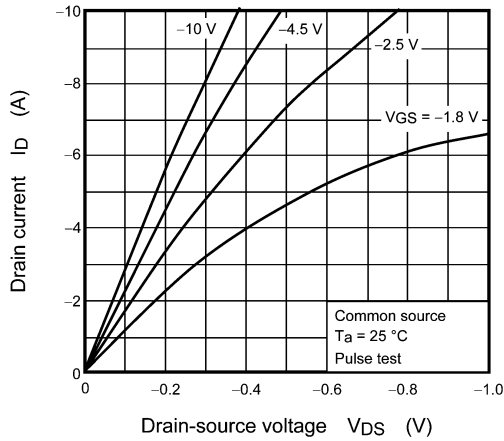


**Fig. 8.1.11 Dynamic Input Characteristics**

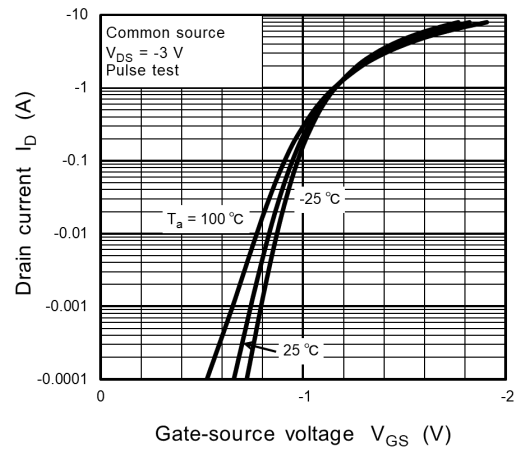


**Fig. 8.1.12 Safe Operating Area**

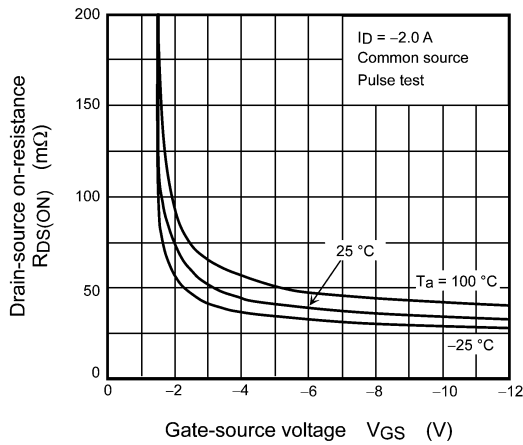
### 8.2. Q2 Characteristics Curves



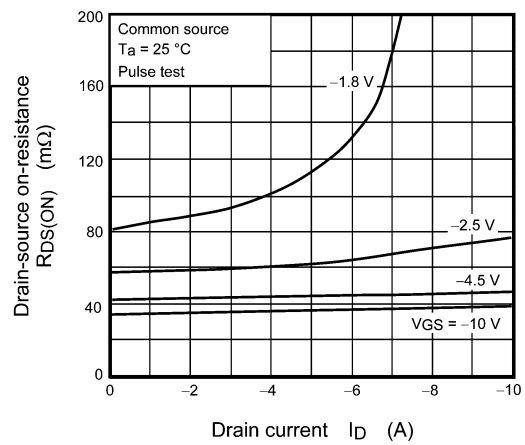
**Fig. 8.2.1  $I_D - V_{DS}$**



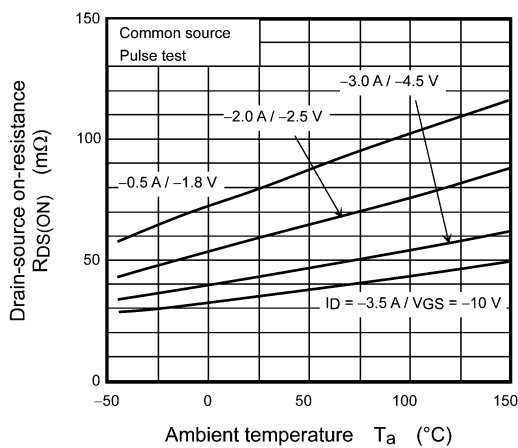
**Fig. 8.2.2  $I_D - V_{GS}$**



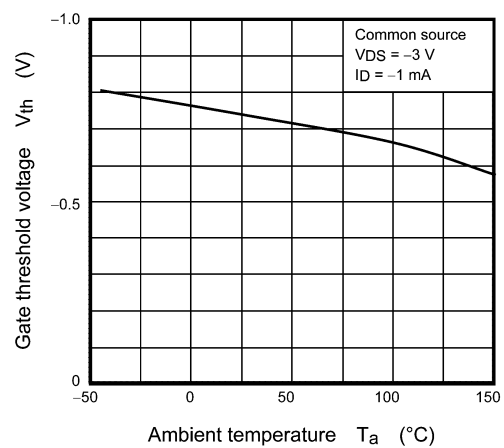
**Fig. 8.2.3  $R_{DS(ON)} - V_{GS}$**



**Fig. 8.2.4  $R_{DS(ON)} - I_D$**

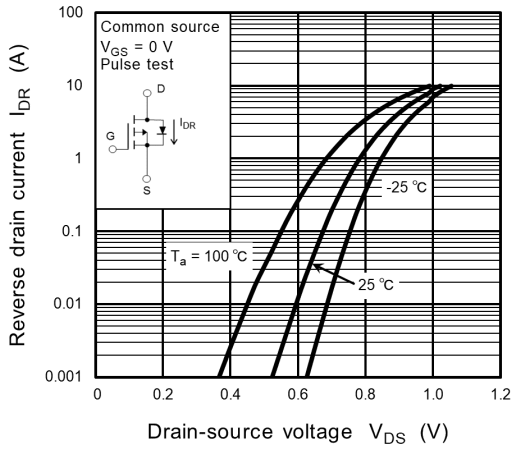


**Fig. 8.2.5  $R_{DS(ON)} - T_a$**

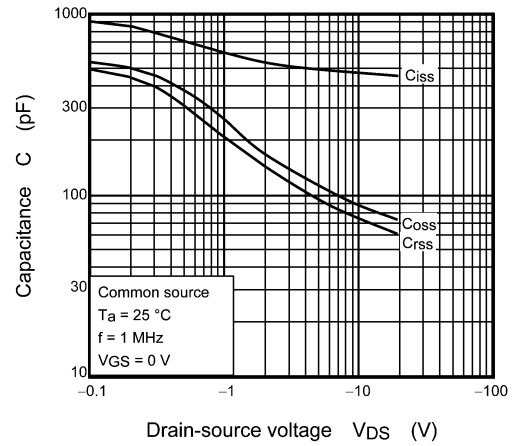


**Fig. 8.2.6  $V_{th} - T_a$**

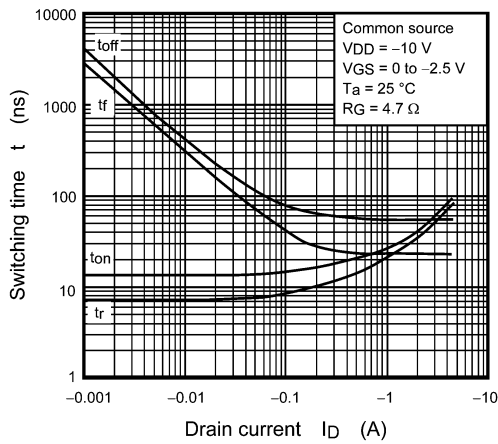




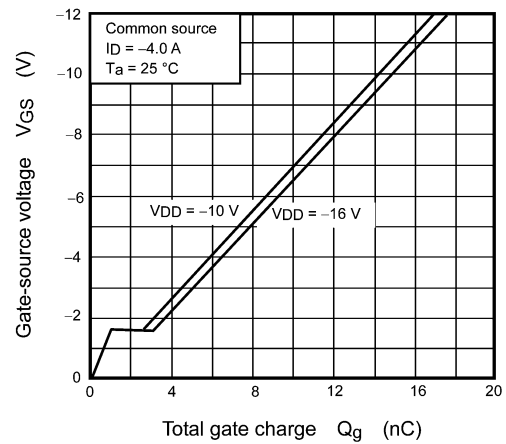
**Fig. 8.2.7  $I_{DR} - V_{DS}$**



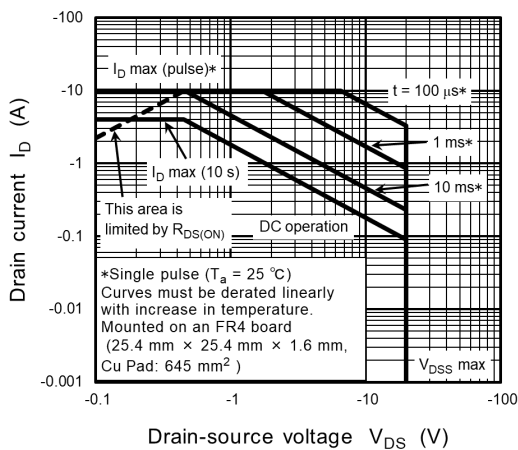
**Fig. 8.2.8  $C - V_{DS}$**



**Fig. 8.2.9  $t - I_D$**



**Fig. 8.2.10 Dynamic Input Characteristics**



**Fig. 8.2.11 Safe Operating Area**

### 8.3. Characteristics Curves (Q1, Q2 Common)

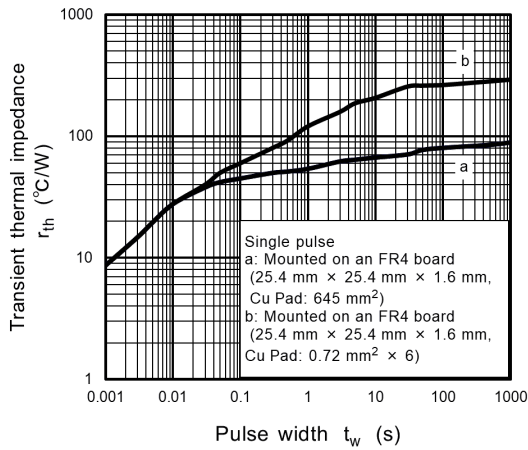


Fig. 8.3.1  $r_{th} - t_w$

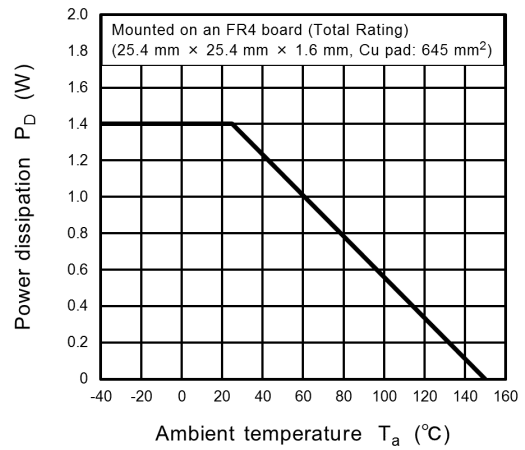
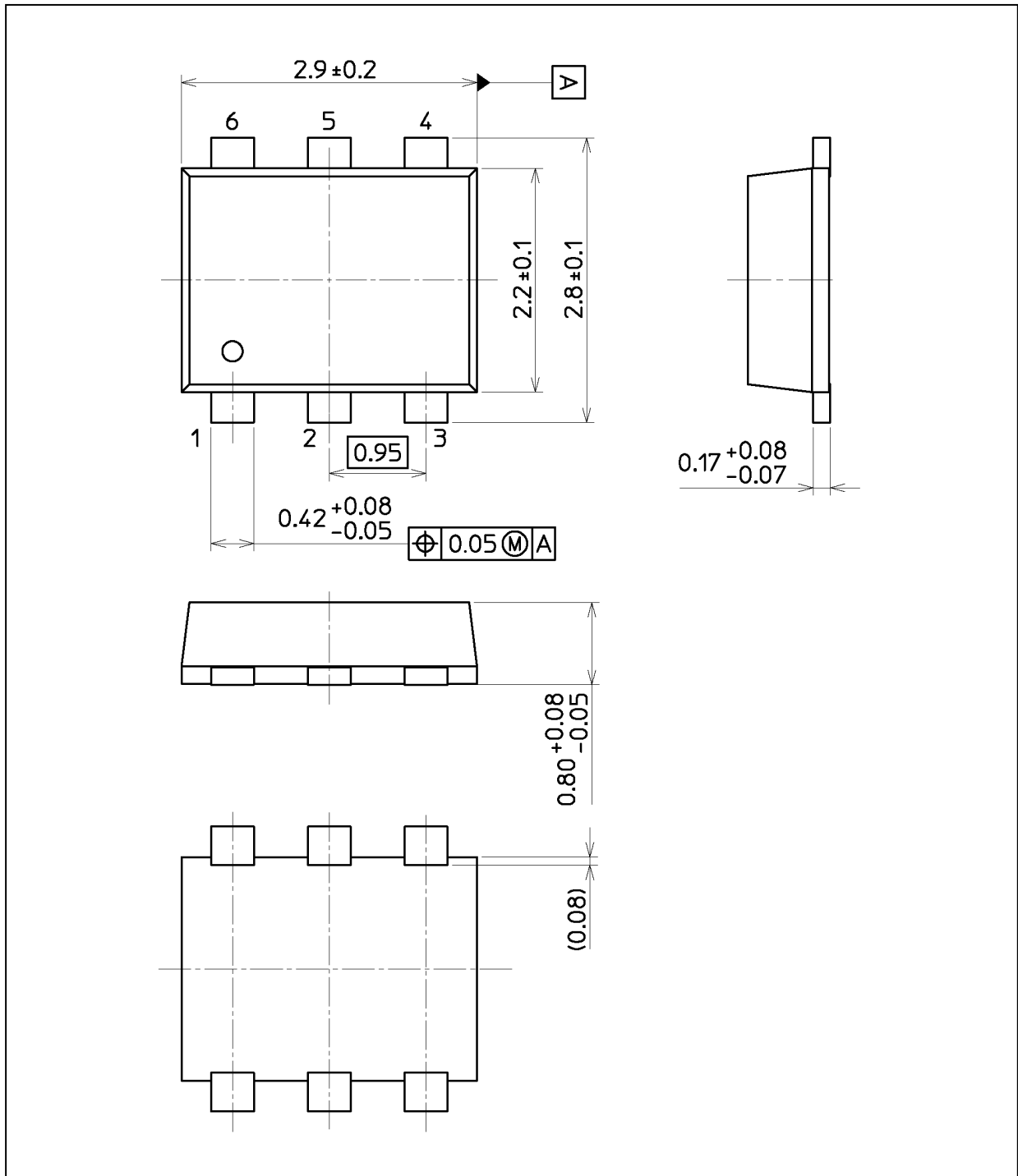


Fig. 8.3.2  $P_D - T_a$

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

## Package Dimensions

Unit: mm



Weight: 0.016 g (typ.)

Package Name(s)
Nickname: TSOP6F

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