

TOSHIBA Field-Effect Transistor Silicon N / P Channel MOS Type

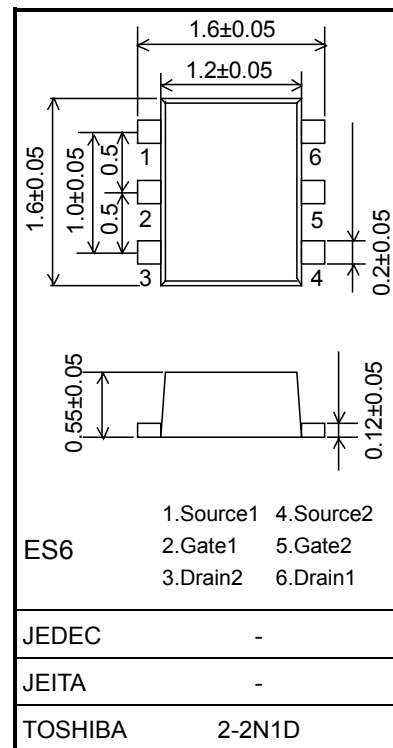
## SSM6L35FE

○ High-Speed Switching Applications

○ Analog Switch Applications

- N-ch: 1.2-V drive  
P-ch: 1.2-V drive
- N-ch, P-ch, 2-in-1
- Low ON-resistance
  - Q1 N-ch:  $R_{ON} = 20\ \Omega$  (max) (@ $V_{GS} = 1.2\text{ V}$ )  
 $R_{ON} = 8\ \Omega$  (max) (@ $V_{GS} = 1.5\text{ V}$ )  
 $R_{ON} = 4\ \Omega$  (max) (@ $V_{GS} = 2.5\text{ V}$ )  
 $R_{ON} = 3\ \Omega$  (max) (@ $V_{GS} = 4.0\text{ V}$ )
  - Q2 P-ch:  $R_{ON} = 44\ \Omega$  (max) (@ $V_{GS} = -1.2\text{ V}$ )  
 $R_{ON} = 22\ \Omega$  (max) (@ $V_{GS} = -1.5\text{ V}$ )  
 $R_{ON} = 11\ \Omega$  (max) (@ $V_{GS} = -2.5\text{ V}$ )  
 $R_{ON} = 8\ \Omega$  (max) (@ $V_{GS} = -4.0\text{ V}$ )

Unit: mm



Weight: 3.0 mg (typ.)

Q1 Absolute Maximum Ratings ( $T_a = 25^\circ\text{C}$ )

Characteristics		Symbol	Rating	Unit
Drain-source voltage		$V_{DSS}$	20	V
Gate-source voltage		$V_{GSS}$	$\pm 10$	V
Drain current	DC	$I_D$	180	mA
	Pulse	$I_{DP}$	360	

Q2 Absolute Maximum Ratings ( $T_a = 25^\circ\text{C}$ )

Characteristics		Symbol	Rating	Unit
Drain-source voltage		$V_{DSS}$	-20	V
Gate-source voltage		$V_{GSS}$	$\pm 10$	V
Drain current	DC	$I_D$	-100	mA
	Pulse	$I_{DP}$	-200	

Absolute Maximum Ratings ( $T_a = 25^\circ\text{C}$ ) (Common to the Q1, Q2)

Characteristic	Symbol	Rating	Unit
Drain power dissipation	$P_D$ (Note 1)	150	mW
Channel temperature	$T_{ch}$	150	$^\circ\text{C}$
Storage temperature range	$T_{stg}$	-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: Total rating

Mounted on an FR4 board  
 (25.4 mm  $\times$  25.4 mm  $\times$  1.6 mm, Cu Pad: 0.135 mm<sup>2</sup>  $\times$  6)

Start of commercial production  
 2008-03

## Q1 Electrical Characteristics (Ta = 25°C)

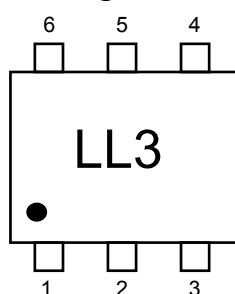
Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current	$I_{GSS}$	$V_{GS} = \pm 10\text{ V}$ , $V_{DS} = 0\text{ V}$	—	—	$\pm 10$	$\mu\text{A}$
Drain-source breakdown voltage	$V_{(BR)DSS}$	$I_D = 0.1\text{ mA}$ , $V_{GS} = 0\text{ V}$	20	—	—	V
Drain cutoff current	$I_{DSS}$	$V_{DS} = 20\text{ V}$ , $V_{GS} = 0\text{ V}$	—	—	1	$\mu\text{A}$
Gate threshold voltage	$V_{th}$	$V_{DS} = 3\text{ V}$ , $I_D = 1\text{ mA}$	0.4	—	1.0	V
Forward transfer admittance	$ Y_{fs} $	$V_{DS} = 3\text{ V}$ , $I_D = 50\text{ mA}$ (Note 2)	115	—	—	mS
Drain-source ON-resistance	$R_{DS(ON)}$	$I_D = 50\text{ mA}$ , $V_{GS} = 4\text{ V}$ (Note 2)	—	1.5	3	$\Omega$
		$I_D = 50\text{ mA}$ , $V_{GS} = 2.5\text{ V}$ (Note 2)	—	2	4	
		$I_D = 5\text{ mA}$ , $V_{GS} = 1.5\text{ V}$ (Note 2)	—	3	8	
		$I_D = 5\text{ mA}$ , $V_{GS} = 1.2\text{ V}$ (Note 2)	—	5	20	
Input capacitance	$C_{iss}$	$V_{DS} = 3\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 1\text{ MHz}$	—	9.5	—	pF
Reverse transfer capacitance	$C_{rss}$		—	4.1	—	
Output capacitance	$C_{oss}$		—	9.5	—	
Switching time	Turn-on time	$V_{DD} = 3\text{ V}$ , $I_D = 50\text{ mA}$ , $V_{GS} = 0\text{ to }2.5\text{ V}$	—	115	—	ns
	Turn-off time		—	300	—	
Drain-source forward voltage	$V_{DSF}$	$I_D = -180\text{ mA}$ , $V_{GS} = 0\text{ V}$ (Note 2)	—	-0.9	-1.2	V

## Q2 Electrical Characteristics (Ta = 25°C)

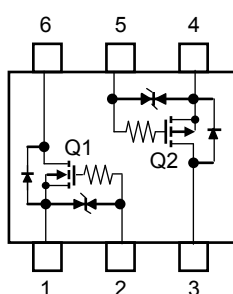
Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current	$I_{GSS}$	$V_{GS} = \pm 10\text{ V}$ , $V_{DS} = 0\text{ V}$	—	—	$\pm 10$	$\mu\text{A}$
Drain-source breakdown voltage	$V_{(BR)DSS}$	$I_D = -0.1\text{ mA}$ , $V_{GS} = 0\text{ V}$	-20	—	—	V
Drain cutoff current	$I_{DSS}$	$V_{DS} = -20\text{ V}$ , $V_{GS} = 0\text{ V}$	—	—	-1	$\mu\text{A}$
Gate threshold voltage	$V_{th}$	$V_{DS} = -3\text{ V}$ , $I_D = -1\text{ mA}$	-0.4	—	-1.0	V
Forward transfer admittance	$ Y_{fs} $	$V_{DS} = -3\text{ V}$ , $I_D = -50\text{ mA}$ (Note 2)	77	—	—	mS
Drain-source ON-resistance	$R_{DS(ON)}$	$I_D = -50\text{ mA}$ , $V_{GS} = -4\text{ V}$ (Note 2)	—	4.3	8	$\Omega$
		$I_D = -50\text{ mA}$ , $V_{GS} = -2.5\text{ V}$ (Note 2)	—	5.6	11	
		$I_D = -5\text{ mA}$ , $V_{GS} = -1.5\text{ V}$ (Note 2)	—	8.2	22	
		$I_D = -2\text{ mA}$ , $V_{GS} = -1.2\text{ V}$ (Note 2)	—	11	44	
Input capacitance	$C_{iss}$	$V_{DS} = -3\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 1\text{ MHz}$	—	12.2	—	pF
Reverse transfer capacitance	$C_{rss}$		—	6.5	—	
Output capacitance	$C_{oss}$		—	10.4	—	
Switching time	Turn-on time	$V_{DD} = -3\text{ V}$ , $I_D = -50\text{ mA}$ , $V_{GS} = 0\text{ to }-2.5\text{ V}$	—	175	—	ns
	Turn-off time		—	251	—	
Drain-source forward voltage	$V_{DSF}$	$I_D = 100\text{ mA}$ , $V_{GS} = 0\text{ V}$ (Note 2)	—	0.83	1.2	V

Note 2: Pulse test

## Marking

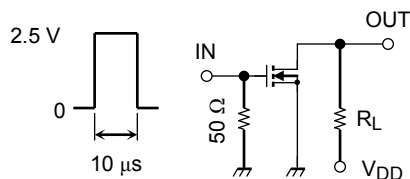


## Equivalent Circuit (top view)



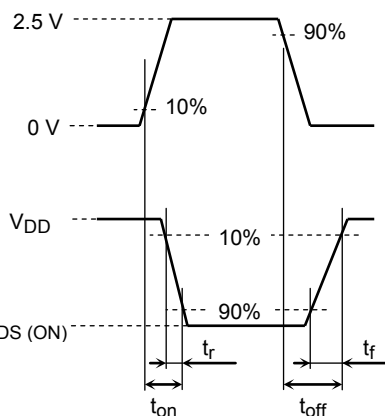
## Q1 Switching Time Test Circuit

### (a) Test Circuit

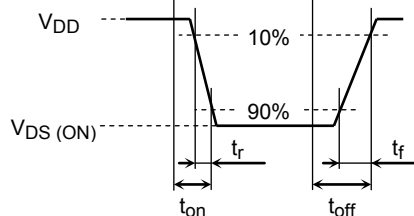


$V_{DD} = 3 \text{ V}$   
 Duty  $\leq 1\%$   
 $V_{IN}$ :  $t_r, t_f < 5 \text{ ns}$   
 $(Z_{out} = 50 \Omega)$   
 Common Source  
 $T_a = 25^\circ\text{C}$

### (b) $V_{IN}$

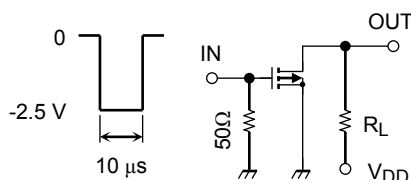


### (c) $V_{OUT}$



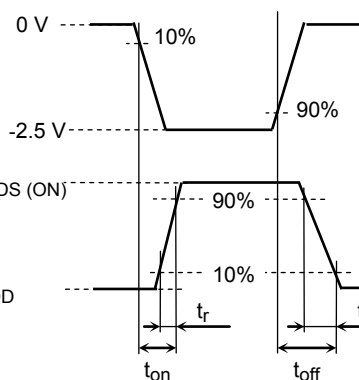
## Q2 Switching Time Test Circuit

### (a) Test Circuit

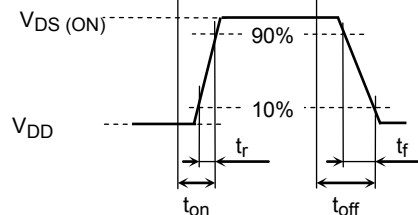


$V_{DD} = -3 \text{ V}$   
 Duty  $\leq 1\%$   
 $V_{IN}$ :  $t_r, t_f < 5 \text{ ns}$   
 $(Z_{out} = 50 \Omega)$   
 Common Source  
 $T_a = 25^\circ\text{C}$

### (b) $V_{IN}$



### (c) $V_{OUT}$



## Q1 Usage Considerations

Let  $V_{th}$  be the voltage applied between gate and source that causes the drain current ( $I_D$ ) to below (1 mA for the Q1 of the SSM6L35FE). 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.

## Q2 Usage Considerations

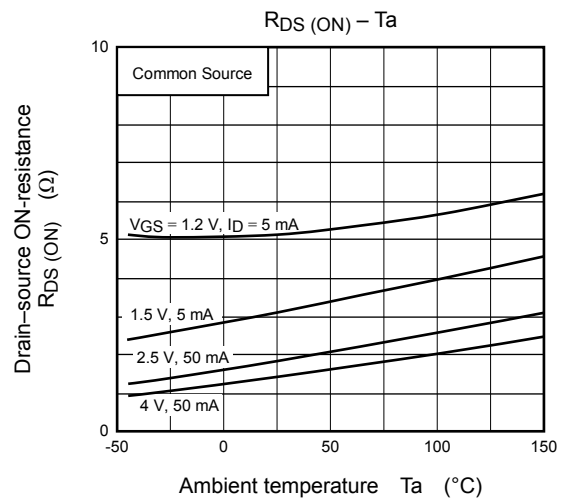
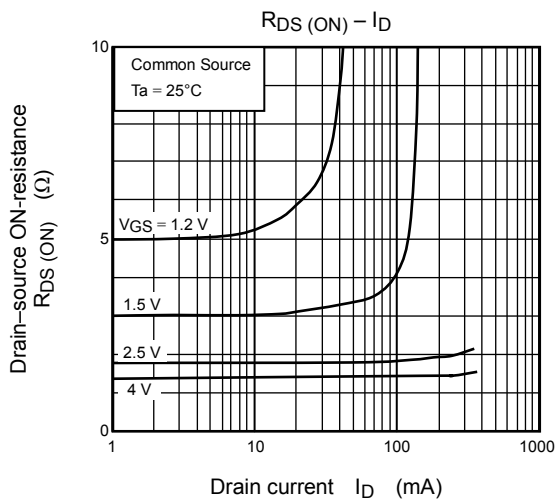
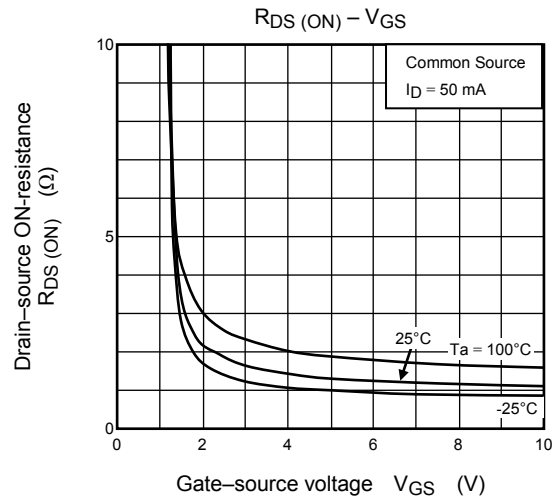
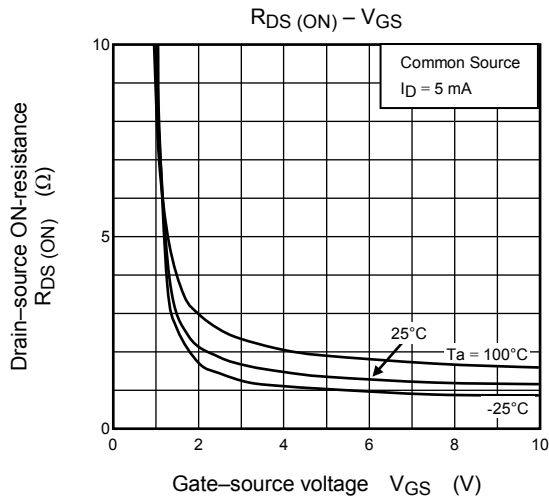
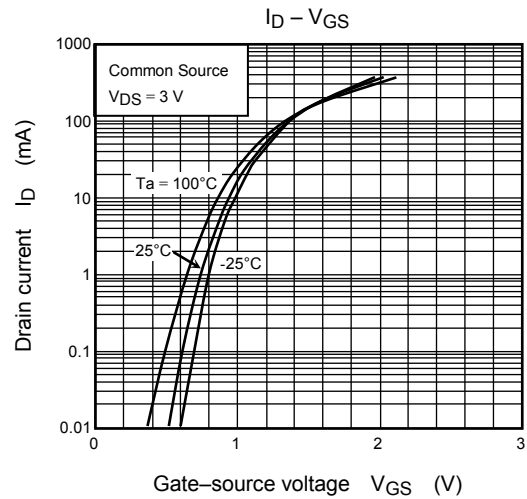
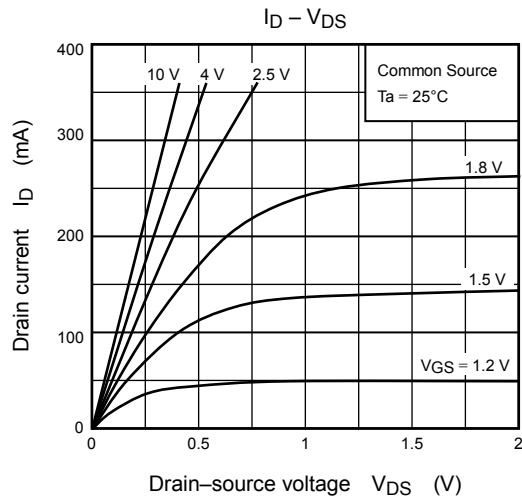
Let  $V_{th}$  be the voltage applied between gate and source that causes the drain current ( $I_D$ ) to below (-1 mA for the Q2 of the SSM6L35FE). Then, for normal switching operation,  $V_{GS(on)}$  must be higher than  $V_{th}$ , and  $V_{GS(off)}$  must be lower than  $V_{th}$ . This relationship can be expressed as:  $V_{GS(off)} < V_{th} < V_{GS(on)}$ .

Take this into consideration when using the device.

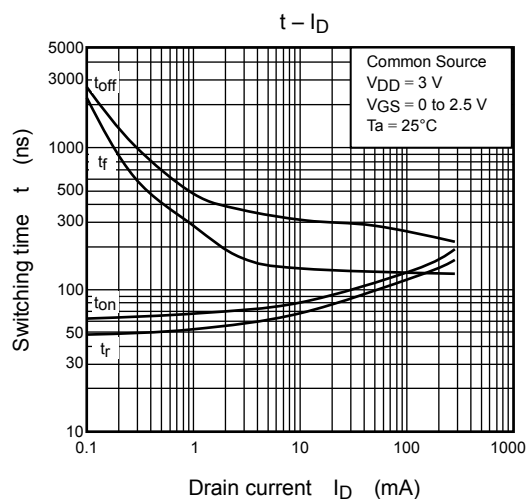
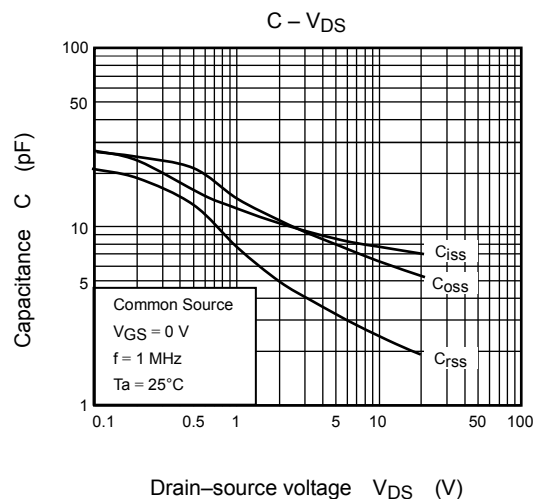
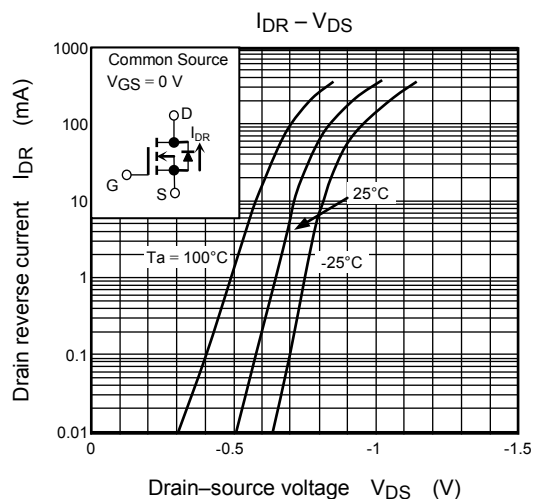
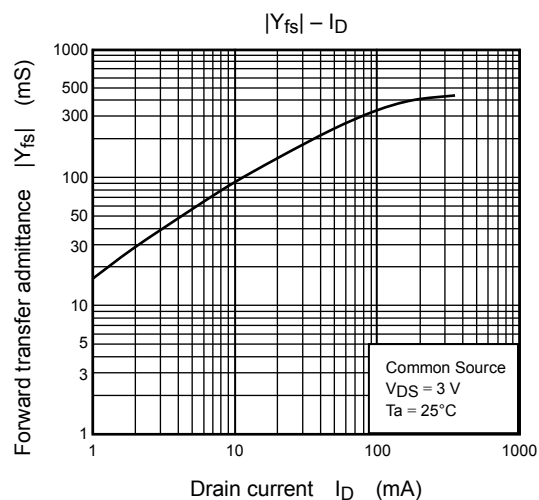
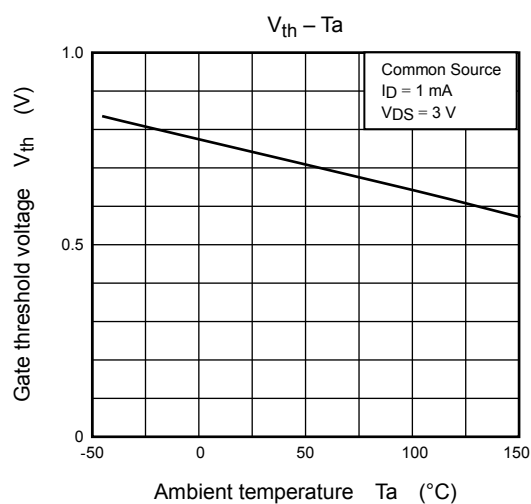
## Handling Precaution

When handling individual devices that are not yet mounted on a circuit board, make sure that the environment is protected against electrostatic discharge. Operators should wear antistatic clothing, and containers and other objects that come into direct contact with devices should be made of antistatic materials.

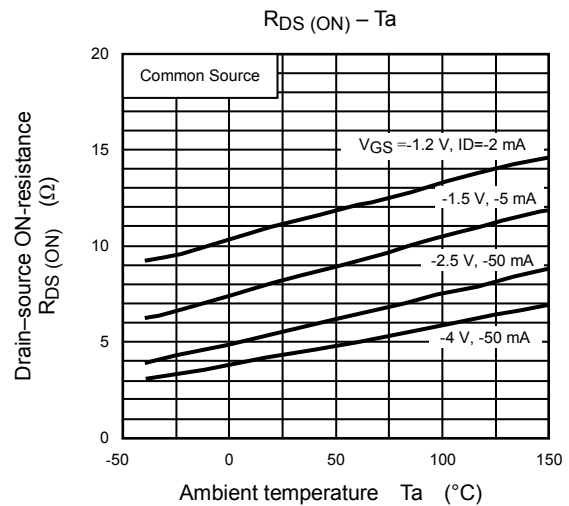
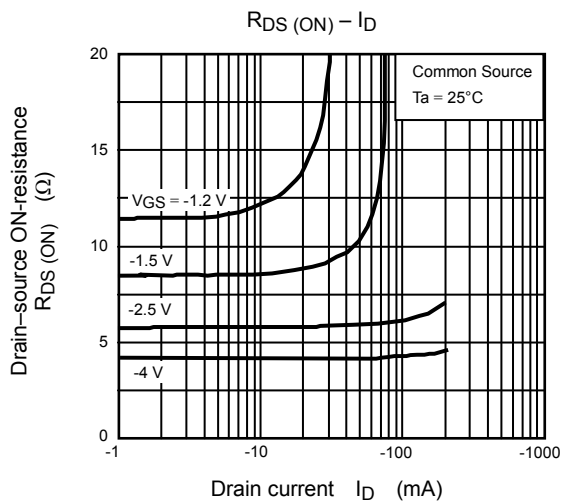
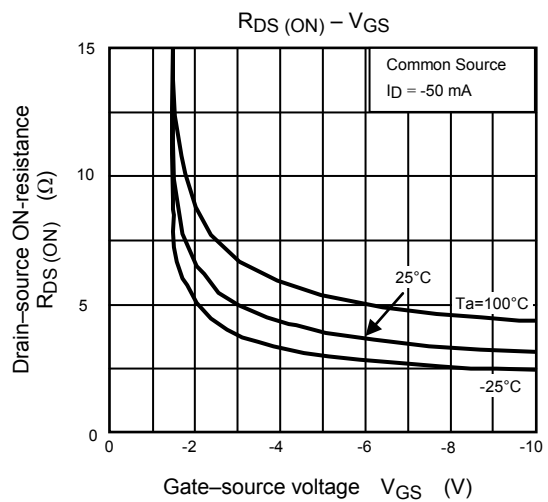
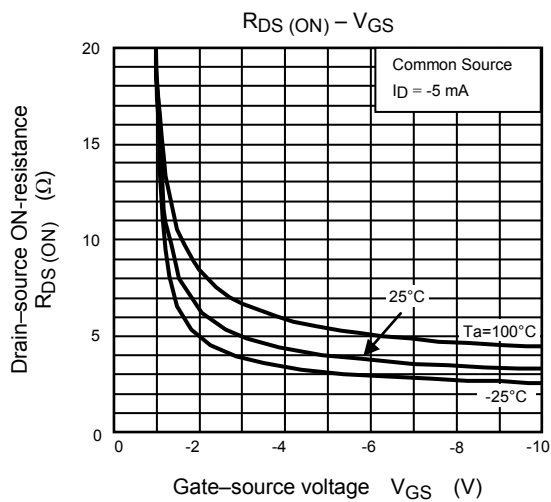
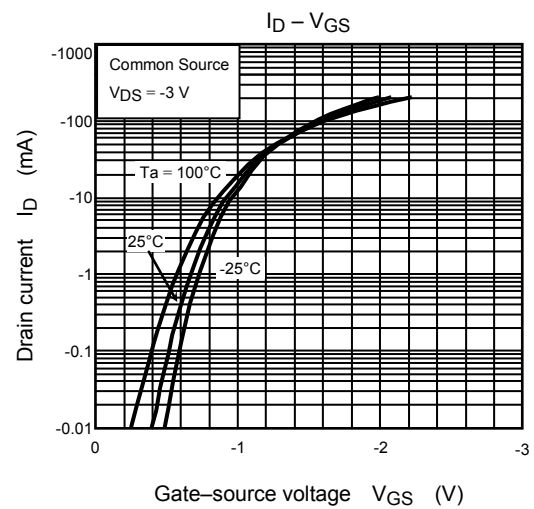
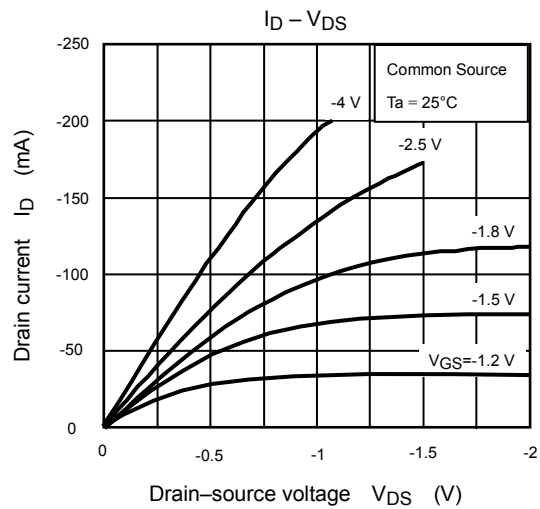
## Q1 (N-ch MOSFET)



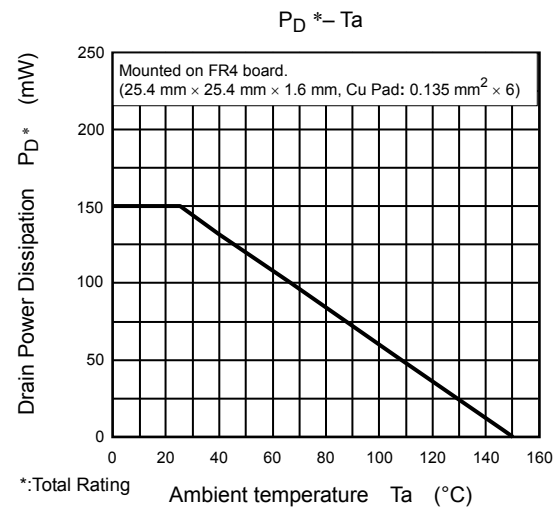
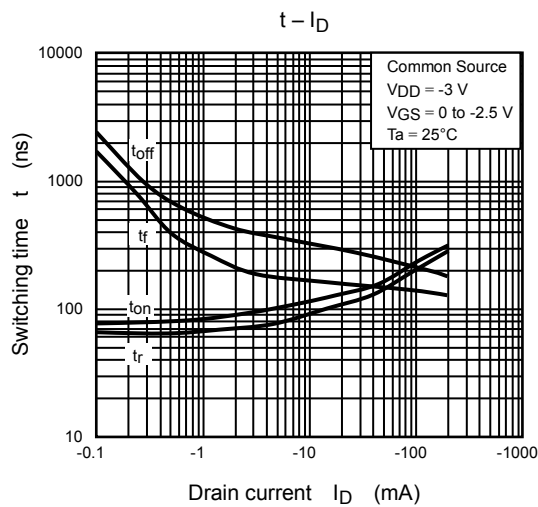
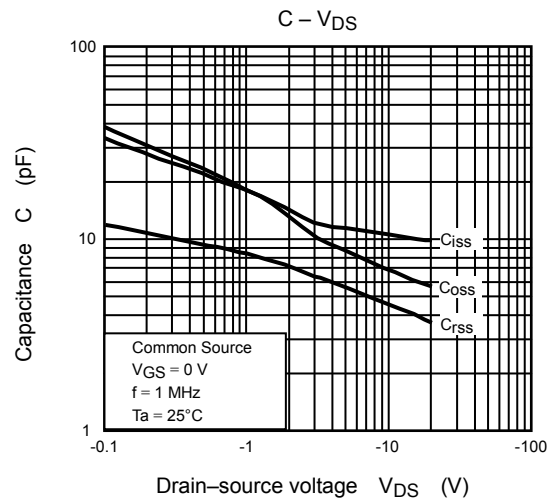
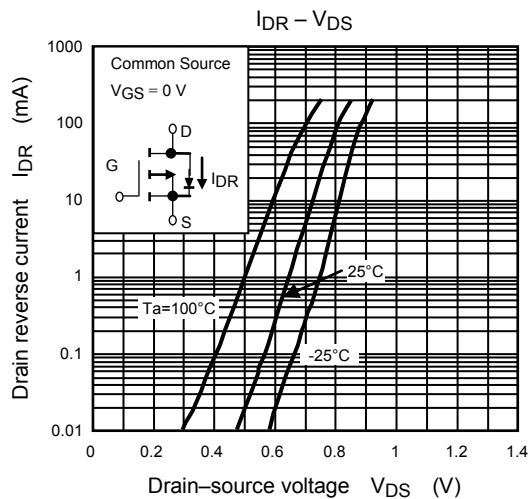
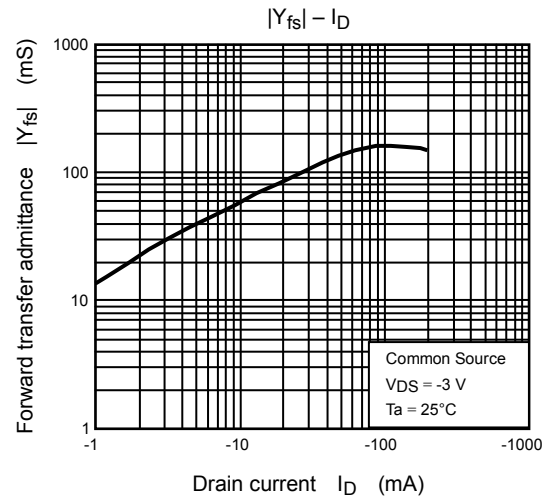
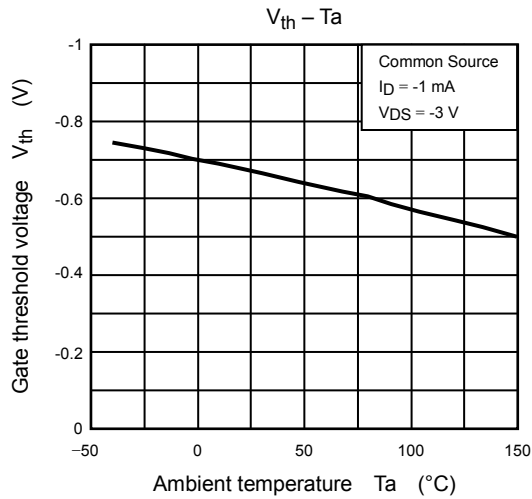
## Q1 (N-ch MOSFET)



## Q2 (P-ch MOSFET)



## Q2 (P-ch MOSFET)



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