

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

SSM6L36FE

○ High-Speed Switching Applications

- 1.5-V drive
- Low ON-resistance Q1 Nch: $R_{on} = 1.52\Omega$ (max) (@ $V_{GS} = 1.5\text{ V}$)
 $R_{on} = 1.14\Omega$ (max) (@ $V_{GS} = 1.8\text{ V}$)
 $R_{on} = 0.85\Omega$ (max) (@ $V_{GS} = 2.5\text{ V}$)
 $R_{on} = 0.66\Omega$ (max) (@ $V_{GS} = 4.5\text{ V}$)
 $R_{on} = 0.63\Omega$ (max) (@ $V_{GS} = 5.0\text{ V}$)
- Q2 Pch: $R_{on} = 3.60\Omega$ (max) (@ $V_{GS} = -1.5\text{ V}$)
 $R_{on} = 2.70\Omega$ (max) (@ $V_{GS} = -1.8\text{ V}$)
 $R_{on} = 1.60\Omega$ (max) (@ $V_{GS} = -2.8\text{ V}$)
 $R_{on} = 1.31\Omega$ (max) (@ $V_{GS} = -4.5\text{ V}$)

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}	± 10	V
Drain current	DC	I_D	500	mA
	Pulse	I_{DP}	1000	

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}	± 8	V
Drain current	DC	I_D	-330	mA
	Pulse	I_{DP}	-660	

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

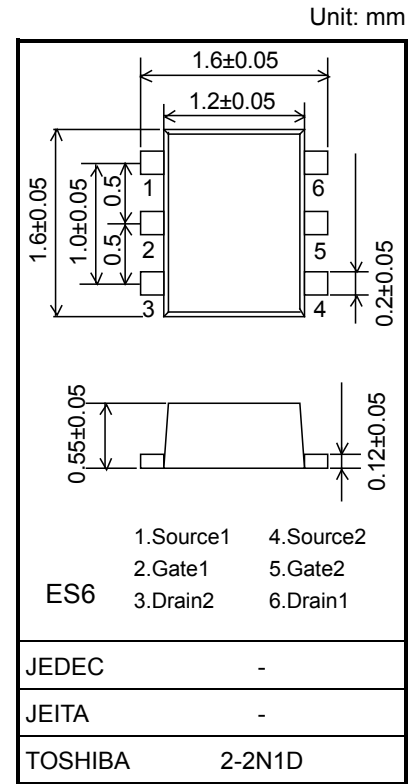
Characteristics	Symbol	Rating	Unit
Drain power dissipation	P_D (Note 1)	150	mW
Channel temperature	T_{ch}	150	$^\circ\text{C}$
Storage temperature range	T_{stg}	-55 to 150	$^\circ\text{C}$

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 mm² \times 6)



Weight: 3.0 mg (typ.)

Start of commercial production
 2008-06

Q1 Electrical Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$I_D = 1 \text{ mA}, V_{GS} = 0 \text{ V}$	20	—	—	V	
	$V_{(BR)DSX}$	$I_D = 1 \text{ mA}, V_{GS} = -10 \text{ V}$	12	—	—		
Drain cutoff current	I_{DSS}	$V_{DS} = 20 \text{ V}, V_{GS} = 0 \text{ V}$	—	—	1	μA	
Gate leakage current	I_{GSS}	$V_{GS} = \pm 10 \text{ V}, V_{DS} = 0 \text{ V}$	—	—	± 1	μA	
Gate threshold voltage	V_{th}	$V_{DS} = 3 \text{ V}, I_D = 1 \text{ mA}$	0.35	—	1.0	V	
Forward transfer admittance	$ Y_{fs} $	$V_{DS} = 3 \text{ V}, I_D = 200 \text{ mA}$ (Note2)	420	840	—	mS	
Drain-source ON-resistance	$R_{DS(ON)}$	$I_D = 200 \text{ mA}, V_{GS} = 5.0 \text{ V}$ (Note2)	—	0.46	0.63	Ω	
		$I_D = 200 \text{ mA}, V_{GS} = 4.5 \text{ V}$ (Note2)	—	0.51	0.66		
		$I_D = 200 \text{ mA}, V_{GS} = 2.5 \text{ V}$ (Note2)	—	0.66	0.85		
		$I_D = 100 \text{ mA}, V_{GS} = 1.8 \text{ V}$ (Note2)	—	0.81	1.14		
		$I_D = 50 \text{ mA}, V_{GS} = 1.5 \text{ V}$ (Note2)	—	0.95	1.52		
Input capacitance	C_{iss}	$V_{DS} = 10 \text{ V}, V_{GS} = 0 \text{ V}, f = 1 \text{ MHz}$	—	46	—	pF	
Output capacitance	C_{oss}		—	10.8	—		
Reverse transfer capacitance	C_{rss}		—	7.3	—		
Total Gate Charge	Q_g		—	1.23	—		
Gate-Source Charge	Q_{gs}	$V_{DS} = 10 \text{ V}, I_D = 0.5 \text{ A}, V_{GS} = 4.0 \text{ V}$	—	0.60	—	nC	
Gate-Drain Charge	Q_{gd}		—	0.63	—		
Switching time	Turn-on time	t_{on}	$V_{DD} = 10 \text{ V}, I_D = 200 \text{ mA}$ $V_{GS} = 0 \text{ to } 2.5 \text{ V}, R_G = 50 \Omega$	—	30	—	ns
	Turn-off time	t_{off}		—	75	—	
Drain-source forward voltage	V_{DSF}	$I_D = -0.5 \text{ A}, V_{GS} = 0 \text{ V}$ (Note2)	—	-0.88	-1.2	V	

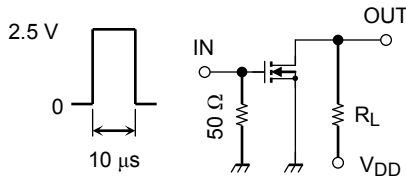
Q2 Electrical Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Conditions	Min	Typ.	Max	Unit	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$I_D = -1 \text{ mA}, V_{GS} = 0 \text{ V}$	-20	—	—	V	
	$V_{(BR)DSX}$	$I_D = -1 \text{ mA}, V_{GS} = 8 \text{ V}$	-12	—	—		
Drain cutoff current	I_{DSS}	$V_{DS} = -16 \text{ V}, V_{GS} = 0 \text{ V}$	—	—	-10	μA	
Gate leakage current	I_{GSS}	$V_{GS} = \pm 8 \text{ V}, V_{DS} = 0 \text{ V}$	—	—	± 1	μA	
Gate threshold voltage	V_{th}	$V_{DS} = -3 \text{ V}, I_D = -1 \text{ mA}$	-0.3	—	-1.0	V	
Forward transfer admittance	$ Y_{fs} $	$V_{DS} = -3 \text{ V}, I_D = -100 \text{ mA}$ (Note2)	190	—	—	mS	
Drain-source ON-resistance	$R_{DS(ON)}$	$I_D = -100 \text{ mA}, V_{GS} = -4.5 \text{ V}$ (Note2)	—	0.95	1.31	Ω	
		$I_D = -80 \text{ mA}, V_{GS} = -2.8 \text{ V}$ (Note2)	—	1.22	1.60		
		$I_D = -40 \text{ mA}, V_{GS} = -1.8 \text{ V}$ (Note2)	—	1.80	2.70		
		$I_D = -30 \text{ mA}, V_{GS} = -1.5 \text{ V}$ (Note2)	—	2.23	3.60		
Input capacitance	C_{iss}	$V_{DS} = -10 \text{ V}, V_{GS} = 0 \text{ V}, f = 1 \text{ MHz}$	—	43	—	pF	
Output capacitance	C_{oss}		—	10.3	—		
Reverse transfer capacitance	C_{rss}		—	6.1	—		
Total Gate Charge	Q_g	$V_{DS} = -10 \text{ V}, I_{DS} = -330 \text{ mA}, V_{GS} = -4 \text{ V}$	—	1.2	—	nC	
Gate-Source Charge	Q_{gs}		—	0.85	—		
Gate-Drain Charge	Q_{gd}		—	0.35	—		
Switching time	Turn-on time	t_{on}	$V_{DD} = -10 \text{ V}, I_D = -100 \text{ mA}$ $V_{GS} = 0 \text{ to } -2.5 \text{ V}, R_G = 50 \Omega$	—	90	—	ns
	Turn-off time	t_{off}		—	200	—	
Drain-source forward voltage	V_{DSF}	$I_D = 330 \text{ mA}, V_{GS} = 0 \text{ V}$ (Note2)	—	0.88	1.2	V	

Note 2: Pulse test

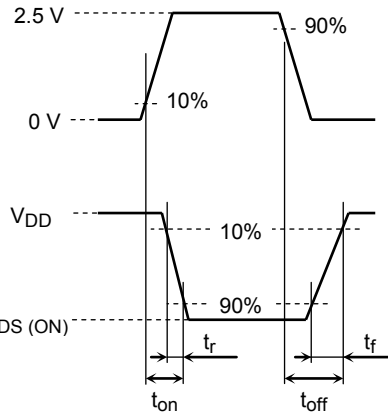
Q1 Switching Time Test Circuit

(a) Test Circuit

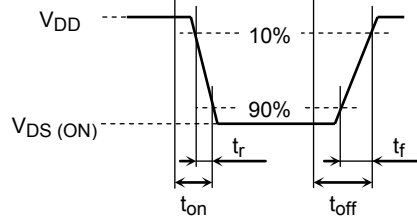


$V_{DD} = 10\text{ V}$
 Duty $\leq 1\%$
 V_{IN} : $t_r, t_f < 5\text{ ns}$
 ($Z_{out} = 50\ \Omega$)
 Common Source
 $T_a = 25^\circ\text{C}$

(b) V_{IN}

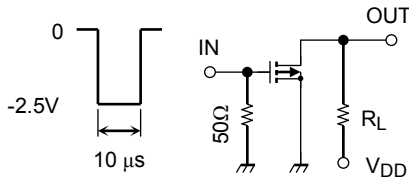


(c) V_{OUT}



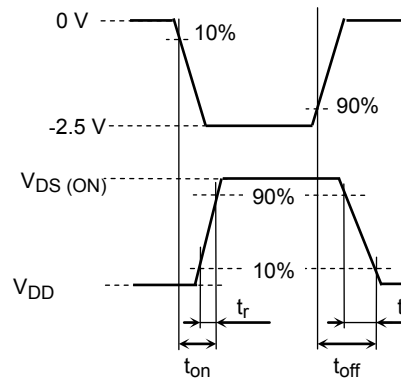
Q2 Switching Time Test Circuit

(a) Test Circuit

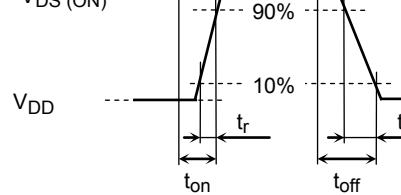


$V_{DD} = -10\text{ V}$
 Duty $\leq 1\%$
 V_{IN} : $t_r, t_f < 5\text{ ns}$
 ($Z_{out} = 50\ \Omega$)
 Common Source
 $T_a = 25^\circ\text{C}$

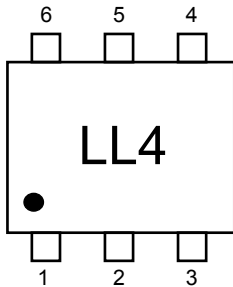
(b) V_{IN}



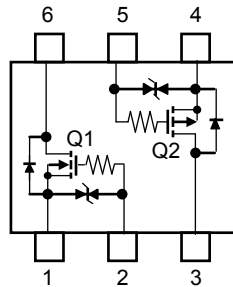
(c) V_{OUT}



Marking



Equivalent Circuit (top view)



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 SSM6L36FE). 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

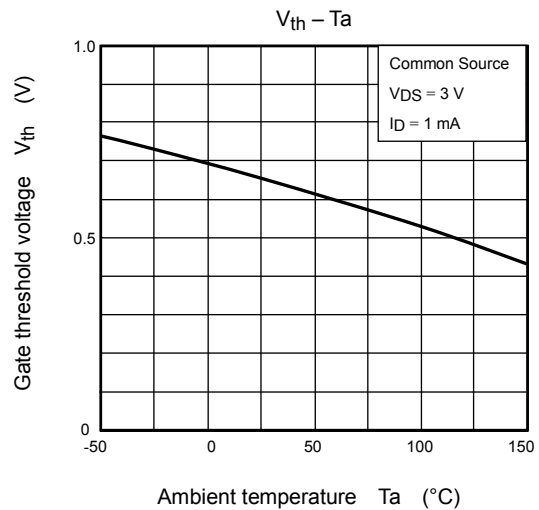
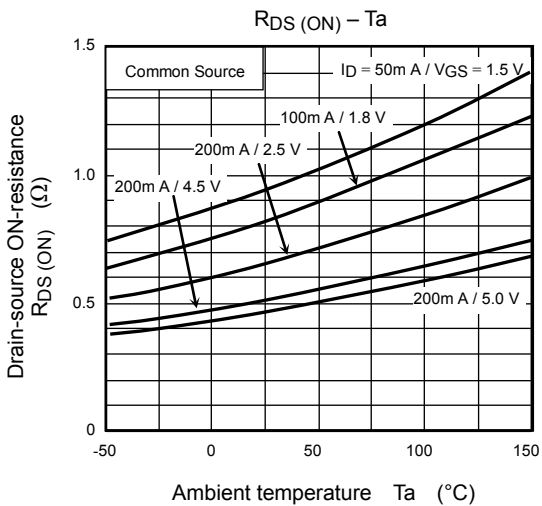
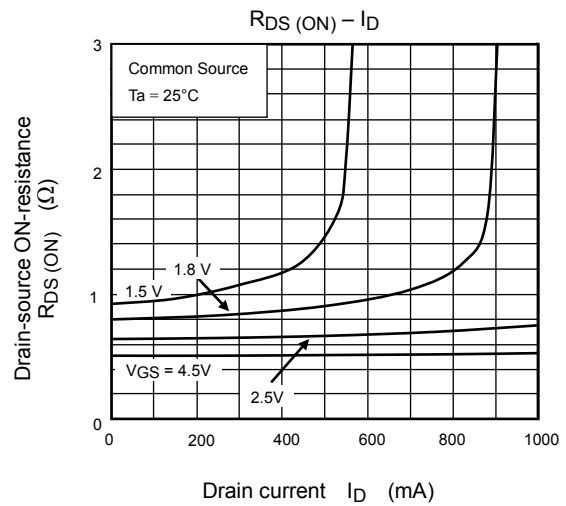
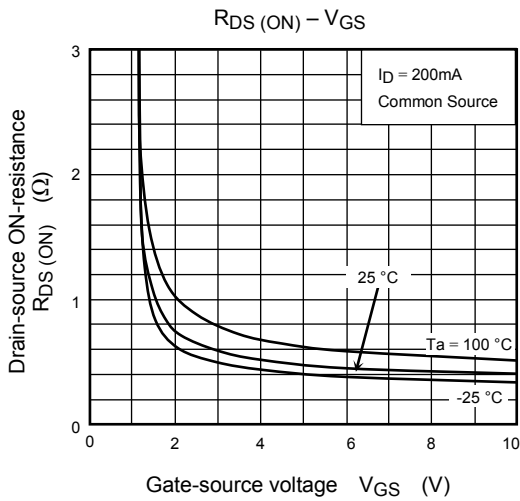
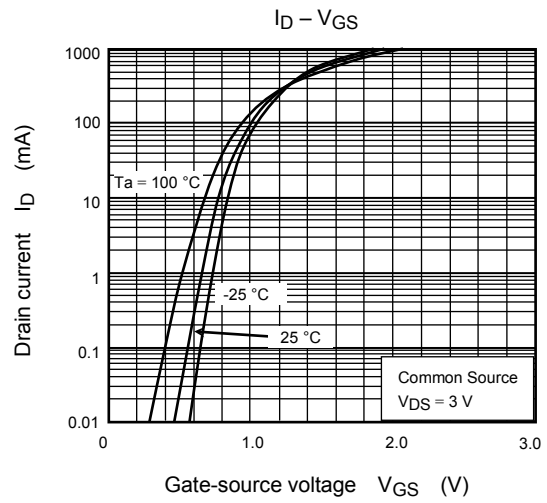
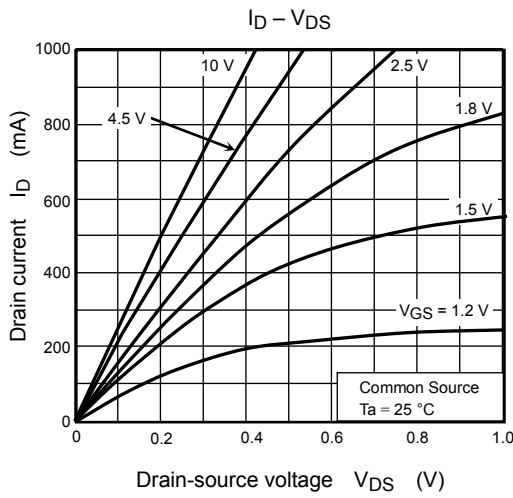
Let V_{th} be the voltage applied between gate and source that causes the drain current (I_D) to below (-1 mA for the Q2 of the SSM6L36FE). Then, for normal switching operation, $V_{GS(on)}$ must be higher than V_{th} , and $V_{GS(off)}$ must be lower than V_{th} . This relationship can be expressed as: $V_{GS(off)} < V_{th} < V_{GS(on)}$.

Take this into consideration when using the device.

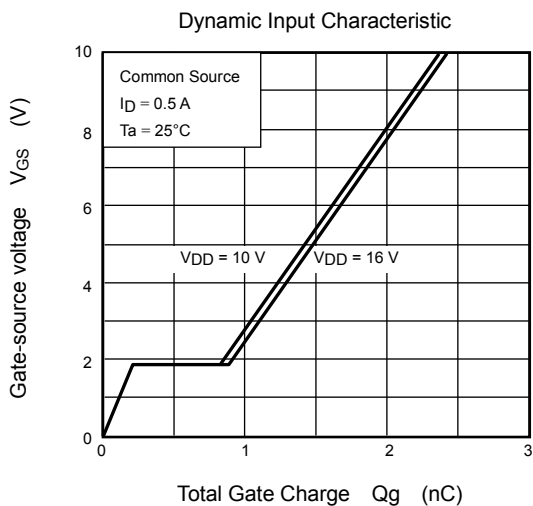
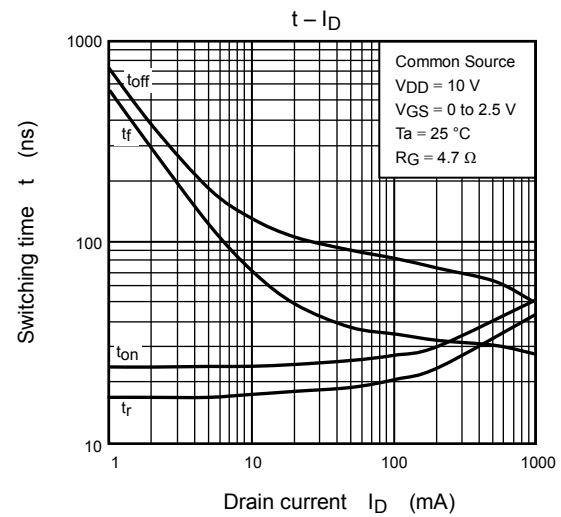
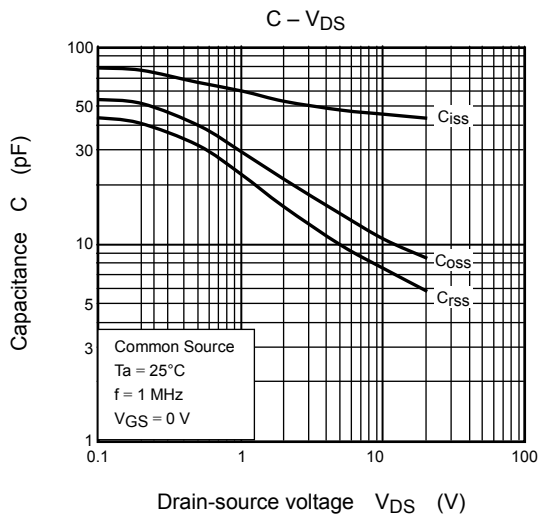
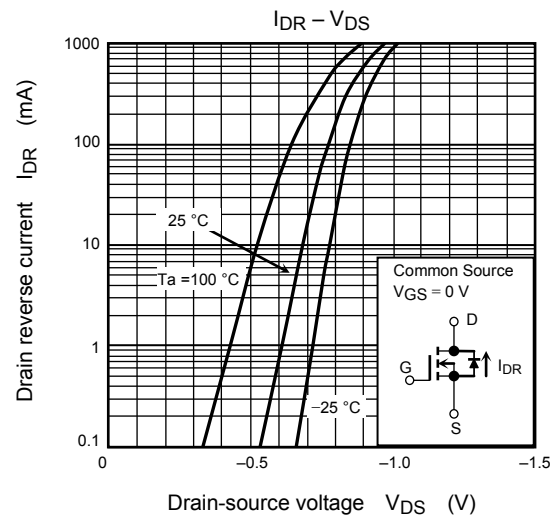
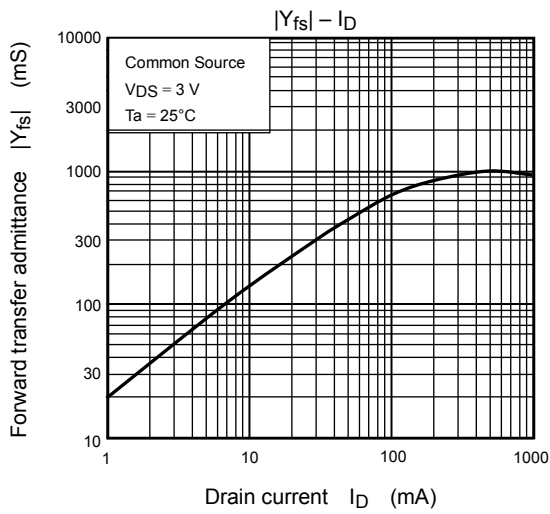
Handling Precaution

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.

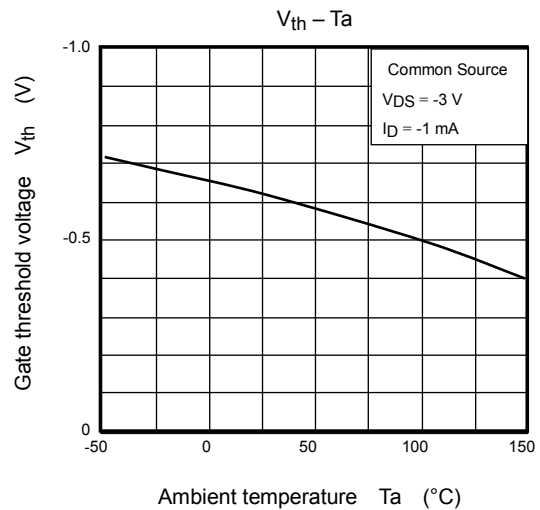
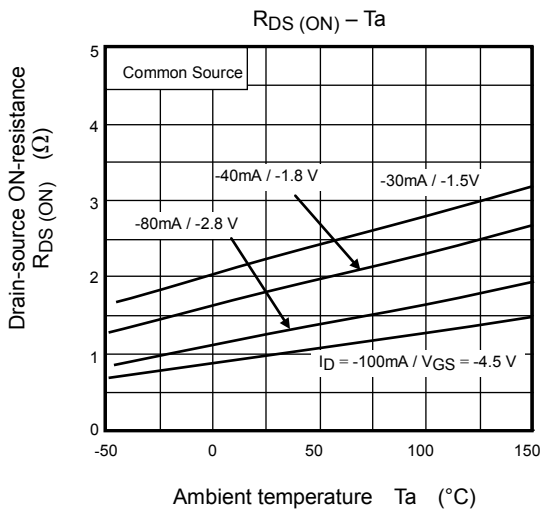
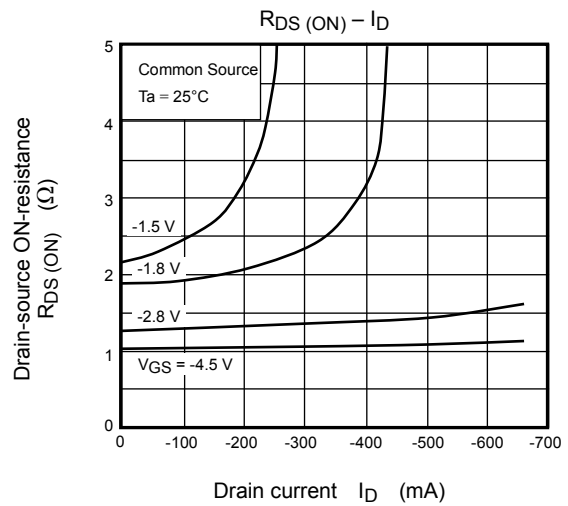
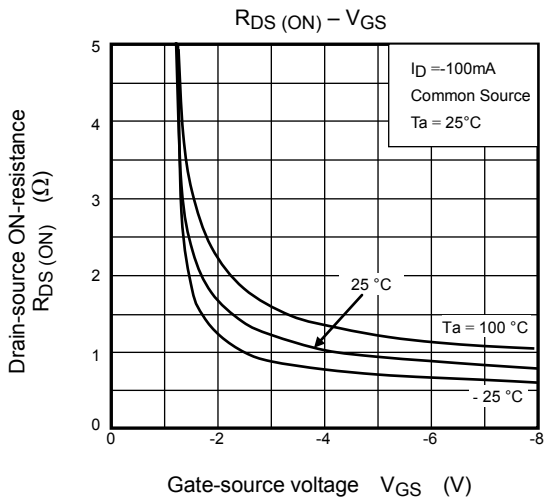
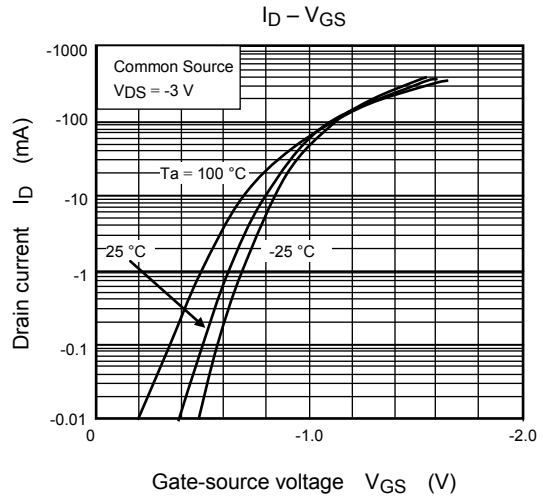
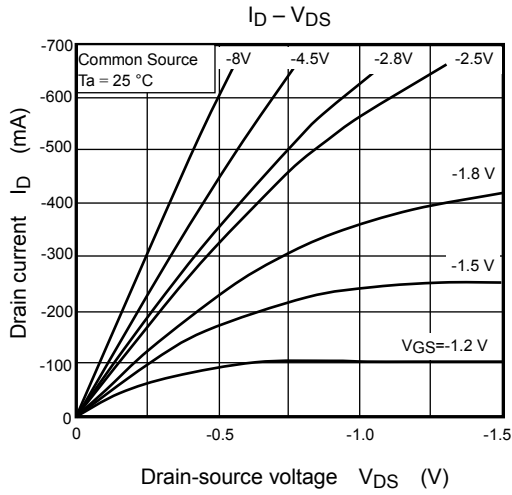
Q1 (N-ch MOSFET)



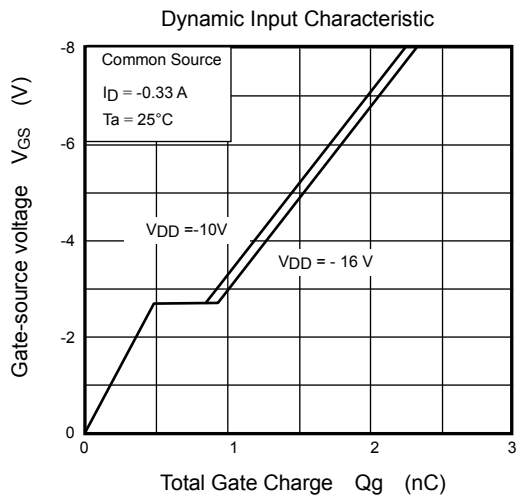
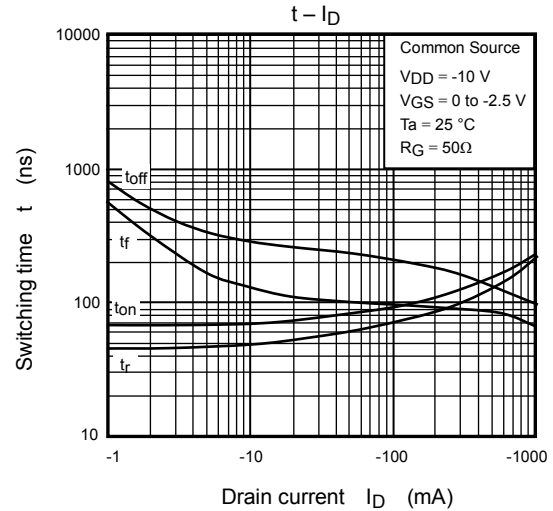
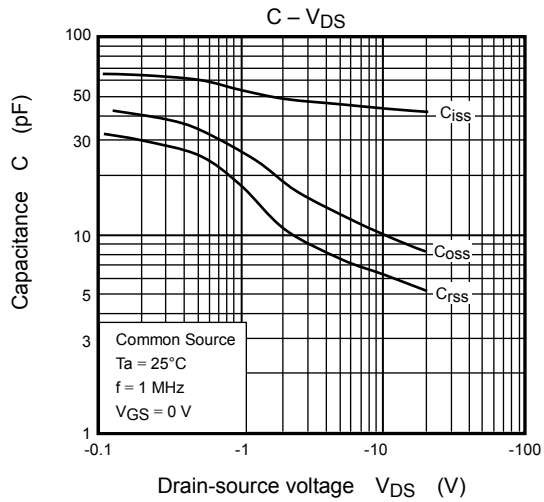
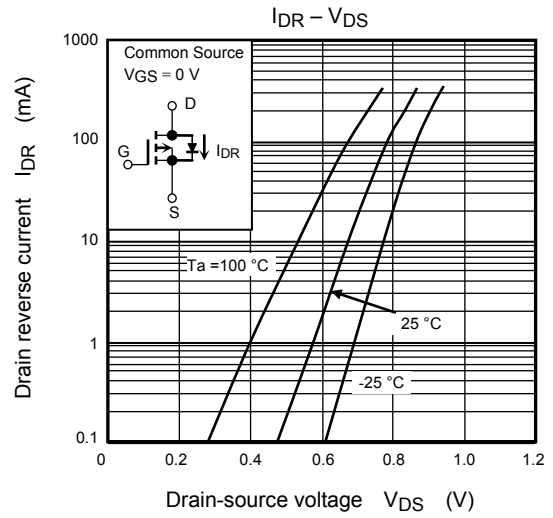
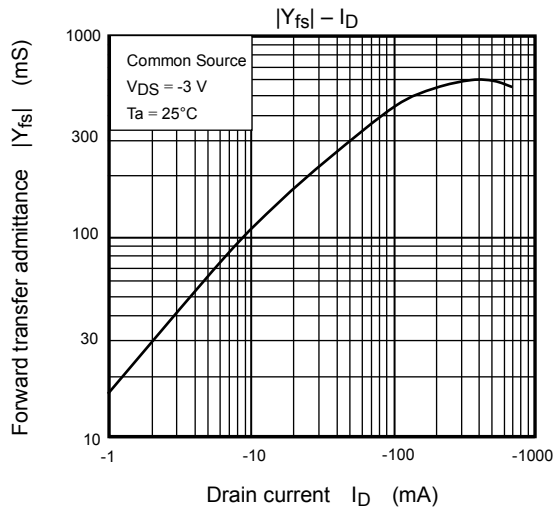
Q1 (N-ch MOSFET)



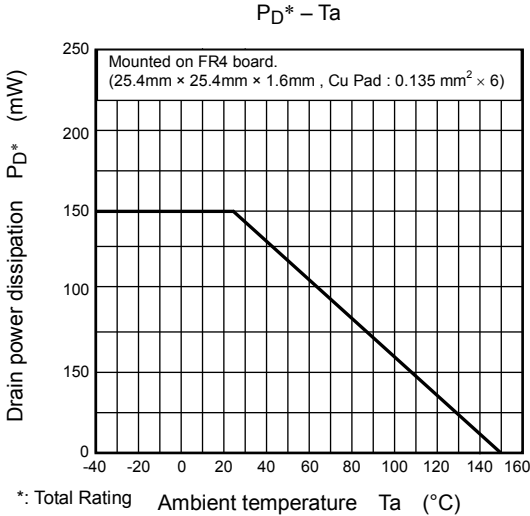
Q2 (P-ch MOSFET)



Q2 (P-ch MOSFET)



Q1, Q2 Common



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