TOSHIBA Field Effect Transistor Silicon P/N Channel MOS Type(π-MOSVI)

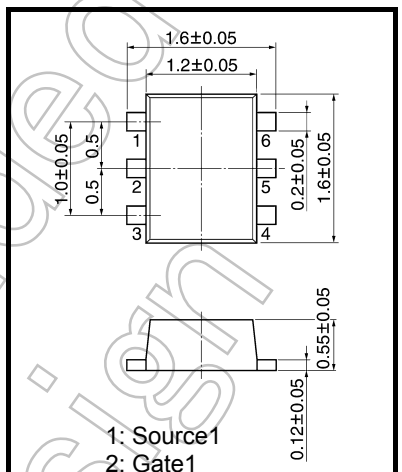
# SSM6L16FE

High Speed Switching Applications

Analog Switch Applications

- Small package
- Low on-resistance Q1: $R_{DS(ON)}$ = 4 Ω (max) (@$V_{GS}$ = 2.5 V)
  Q2: $R_{DS(ON)}$ = 12 Ω (max) (@$V_{GS}$ = −2.5 V)

Unit: mm




| | |
|---|---|
| ES6 | |
| JEDEC | — |
| JEITA | — |
| TOSHIBA | 2-2N1D |

Weight: 3 mg (typ.)

## Q1 Absolute Maximum Ratings (Ta = 25°C)

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

## Q2 Absolute Maximum Ratings (Ta = 25°C)

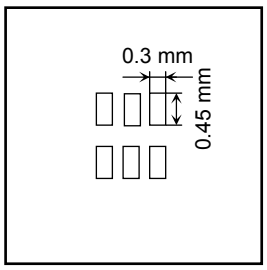
| Characteristics | | Symbol | Rating | Unit |
|---|---|---|---|---|
| Drain-Source voltage | | $V_{DSS}$ | -20 | V |
| Gate-Source voltage | | $V_{GSS}$ | ±10 | V |
| Drain current | DC | $I_D$ | -100 | mA |
| | Pulse | $I_{DP}$ | -200 | |

## Absolute Maximum Ratings (Q1, Q2 Common) (Ta = 25°C)

| Characteristics | Symbol | Rating | Unit |
|---|---|---|---|
| Power dissipation | $P_D$ (Note 1) | 150 | mW |
| Channel temperature | $T_{ch}$ | 150 | °C |
| Storage temperature range | $T_{stg}$ | −55 to 150 | °C |

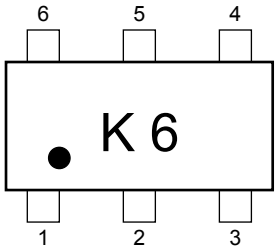
Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) 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 FR4 board
(25.4 mm × 25.4 mm × 1.6 mm, Cu Pad: 0.135 $mm^2$ × 6)

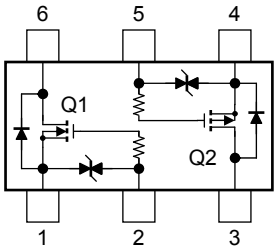



Start of commercial production
2002-03

## Marking




## Equivalent Circuit (top view)




## Handling Precaution

When handling individual devices (which are not yet mounted on a circuit board), ensure that the environment is protected against static electricity. Operators should wear anti-static clothing, and containers and other objects that come into direct contact with devices should be made of anti-static materials.

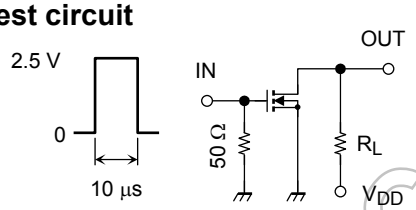
## Q1 Electrical Characteristics (Ta = 25°C)

| Characteristic | | Symbol | Test Condition | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|---|
| Gate leakage current | | $I_{GSS}$ | $V_{GS}$ = ±10 V, $V_{DS}$ = 0 | — | — | ±1 | μA |
| Drain-Source breakdown voltage | | $V_{(BR)\ DSS}$ | $I_D$ = 0.1 mA, $V_{GS}$ = 0 | 20 | — | — | V |
| Drain cut-off current | | $I_{DSS}$ | $V_{DS}$ = 20 V, $V_{GS}$ = 0 | — | — | 1 | μA |
| Gate threshold voltage | | $V_{th}$ | $V_{DS}$ = 3 V, $I_D$ = 0.1 mA | 0.6 | — | 1.1 | V |
| Forward transfer admittance | | $\|Y_{fs}\|$ | $V_{DS}$ = 3 V, $I_D$ = 10 mA (Note2) | 40 | — | — | mS |
| Drain-Source on-resistance | | $R_{DS\ (ON)}$ | $I_D$ = 10 mA, $V_{GS}$ = 4 V (Note2) | — | 1.5 | 3.0 | Ω |
| | | | $I_D$ = 10 mA, $V_{GS}$ = 2.5 V (Note2) | — | 2.2 | 4.0 | |
| | | | $I_D$ = 1 mA, $V_{GS}$ = 1.5 V (Note2) | — | 5.2 | 15 | |
| Input capacitance | | $C_{iss}$ | $V_{DS}$ = 3 V, $V_{GS}$ = 0, f = 1 MHz | — | 9.3 | — | pF |
| Reverse transfer capacitance | | $C_{rss}$ | | — | 4.5 | — | pF |
| Output capacitance | | $C_{oss}$ | | — | 9.8 | — | pF |
| Switching time | Turn-on time | $t_{on}$ | $V_{DD}$ = 3 V, $I_D$ = 10 mA, $V_{GS}$ = 0 to 2.5 V | — | 70 | — | ns |
| | Turn-off time | $t_{off}$ | | — | 125 | — | |

Note2: Pulse test

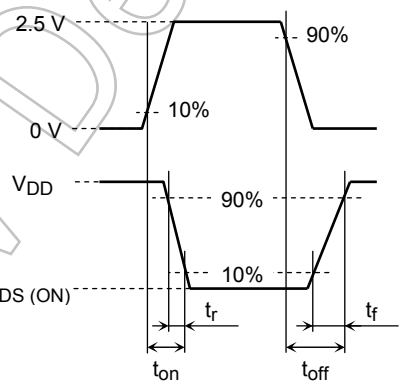
## Switching Time Test Circuit

### (a) Test circuit




$V_{DD}$ = 3 V
Duty ≤ 1%
$V_{IN}$: $t_r$, $t_f$ < 5 ns
($Z_{out}$ = 50 Ω)
Common Source
Ta = 25°C

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




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




## Precaution

$V_{th}$ can be expressed as the voltage between the gate and source when the low operating current value is $I_D$ = 0.1 mA for this product. For normal switching operation, $V_{GS\ (on)}$ requires a higher voltage than $V_{th}$ and $V_{GS\ (off)}$ requires a lower voltage than $V_{th}$. (The relationship can be established as follows: $V_{GS\ (off)} < V_{th} < V_{GS\ (on)}$.)

Be sure to take this into consideration when using the device.

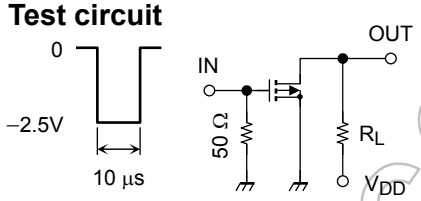
## Q2 Electrical Characteristics (Ta = 25°C)

| Characteristic | | Symbol | Test Condition | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|---|
| Gate leakage current | | $I_{GSS}$ | $V_{GS}$ = ±10 V, $V_{DS}$ = 0 | — | — | ±1 | μA |
| Drain-Source breakdown voltage | | $V_{(BR)\ DSS}$ | $I_D$ = −0.1 mA, $V_{GS}$ = 0 | −20 | — | — | V |
| Drain cut-off current | | $I_{DSS}$ | $V_{DS}$ = −20 V, $V_{GS}$ = 0 | — | — | −1 | μA |
| Gate threshold voltage | | $V_{th}$ | $V_{DS}$ = −3 V, $I_D$ = −0.1 mA | −0.6 | — | −1.1 | V |
| Forward transfer admittance | | $\|Y_{fs}\|$ | $V_{DS}$ = −3 V, $I_D$ = −10 mA (Note3) | 25 | — | — | mS |
| Drain-Source on-resistance | | $R_{DS\ (ON)}$ | $I_D$ = −10 mA, $V_{GS}$ = −4 V (Note3) | — | 6 | 8 | Ω |
| | | | $I_D$ = −10 mA, $V_{GS}$ = −2.5 V (Note3) | — | 8 | 12 | |
| | | | $I_D$ = −1 mA, $V_{GS}$ = −1.5 V (Note3) | — | 18 | 45 | |
| Input capacitance | | $C_{iss}$ | $V_{DS}$ = −3 V, $V_{GS}$ = 0, f = 1 MHz | — | 11 | — | pF |
| Reverse transfer capacitance | | $C_{rss}$ | | — | 3.7 | — | pF |
| Output capacitance | | $C_{oss}$ | | — | 10 | — | pF |
| Switching time | Turn-on time | $t_{on}$ | $V_{DD}$ = −3 V, $I_D$ = −10 mA, $V_{GS}$ = 0 to −2.5 V | — | 130 | — | ns |
| | Turn-off time | $t_{off}$ | | — | 190 | — | |

Note3: Pulse test

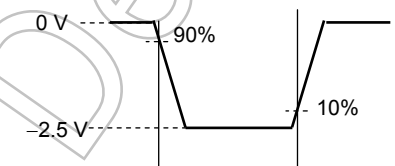
## Switching Time Test Circuit

**(a) Test circuit**

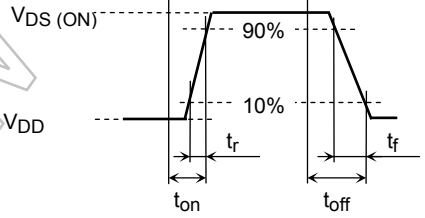



$V_{DD}$ = −3 V
Duty ≤ 1%
$V_{IN}$: $t_r$, $t_f$ < 5 ns
($Z_{out}$ = 50 Ω)
Common Source
Ta = 25°C

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




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



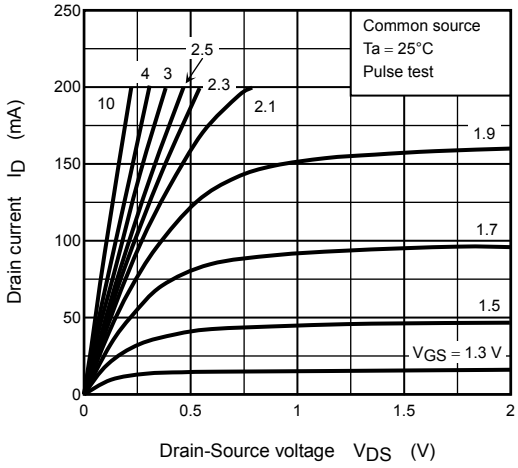

## Precaution

$V_{th}$ can be expressed as the voltage between the gate and source when the low operating current value is $I_D$ = - 0.1 mA for this product. For normal switching operation, $V_{GS\ (on)}$ requires a higher voltage than $V_{th}$ and $V_{GS\ (off)}$ requires a lower voltage than $V_{th}$. (The relationship can be established as follows: $V_{GS\ (off)} < V_{th} < V_{GS\ (on)}$.)

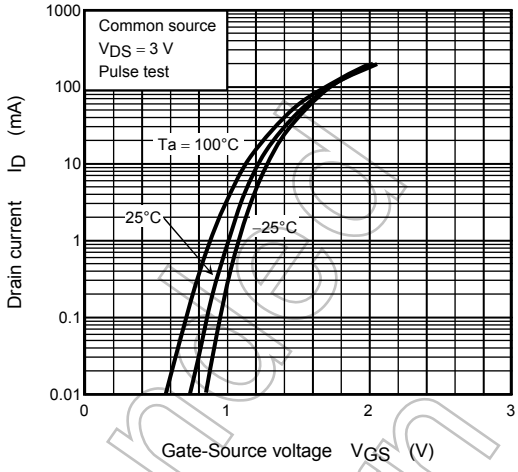
Be sure to take this into consideration when using the device.

## Q1 (N-ch MOSFET)

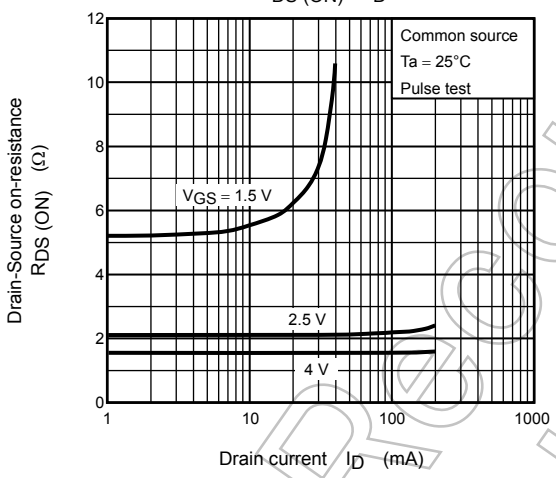
$I_D - V_{DS}$



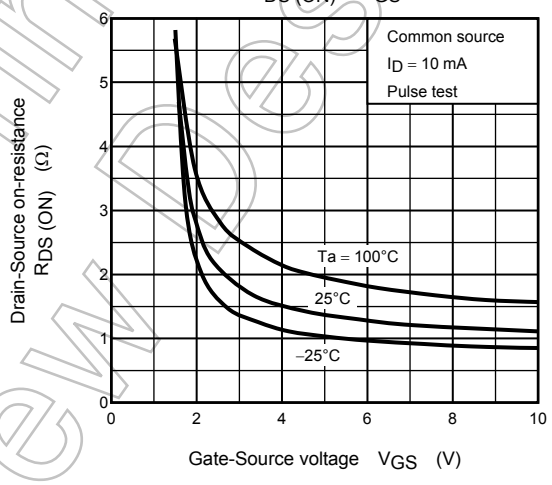

$I_D - V_{GS}$



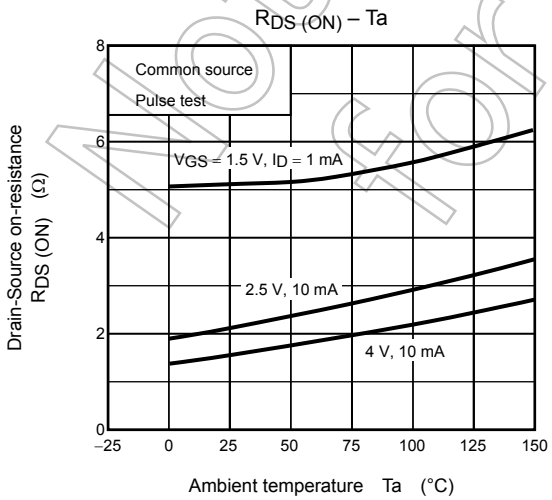

$R_{DS\ (ON)} - I_D$



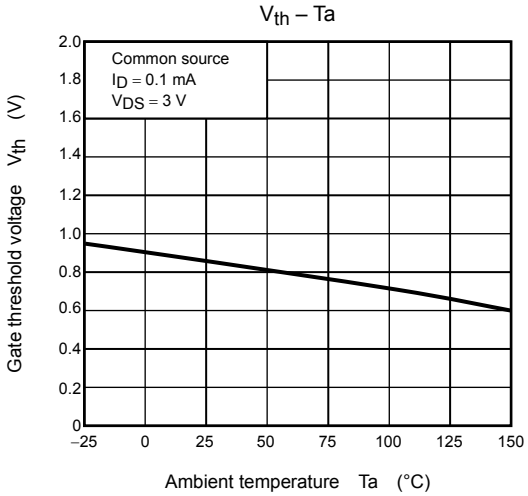

$R_{DS\ (ON)} - V_{GS}$




$R_{DS\ (ON)} - Ta$

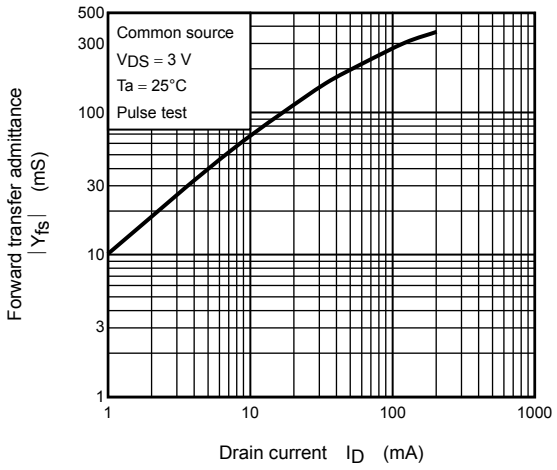



$V_{th} - Ta$

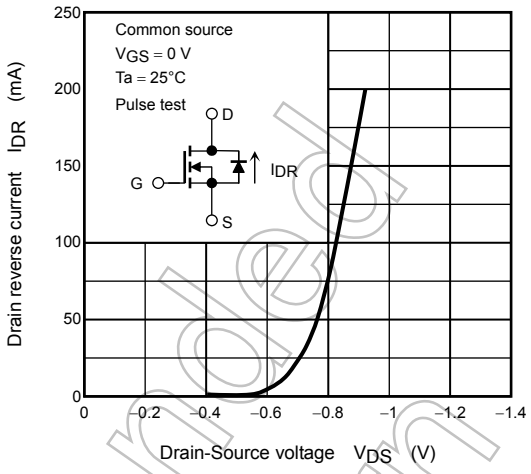


## Q1 (N-ch MOSFET)

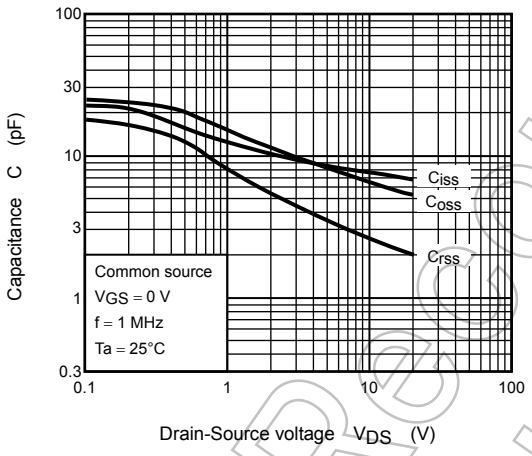
$|Y_{fs}| - I_D$



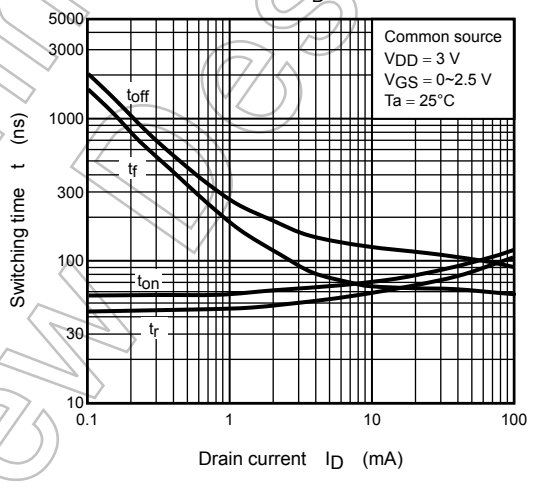

$I_{DR} - V_{DS}$




$C - V_{DS}$

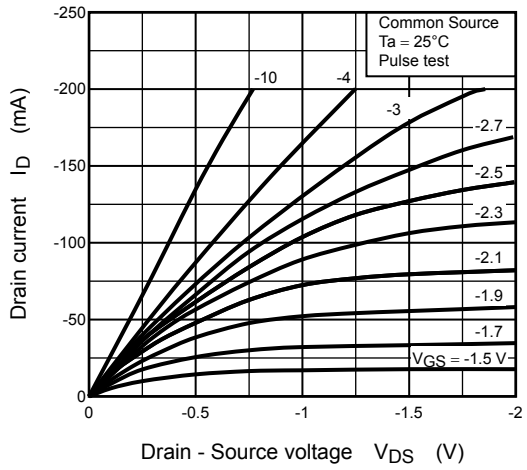



$t - I_D$

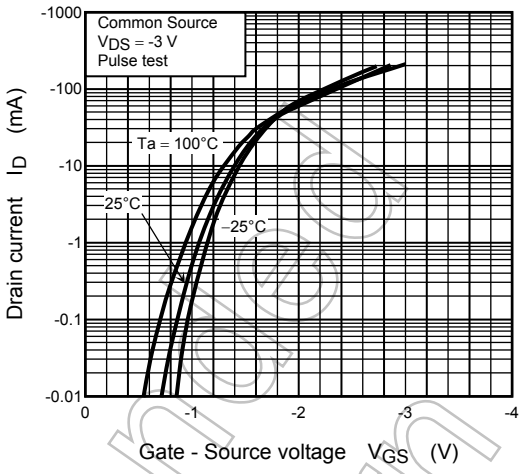


## Q2 (P-ch MOSFET)

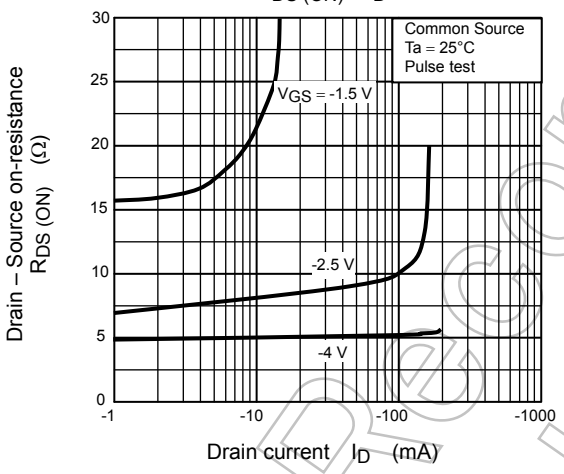
$I_D - V_{DS}$



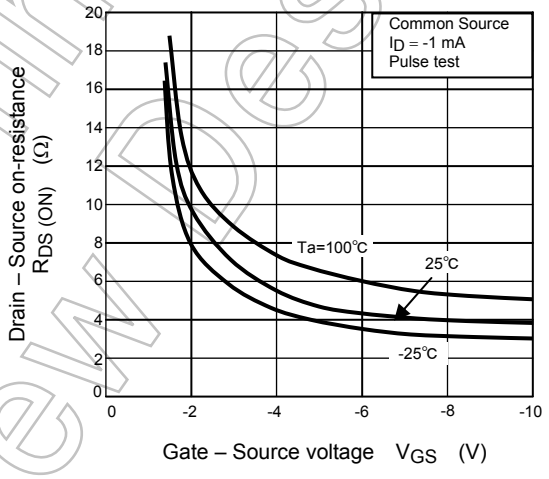

$I_D - V_{GS}$



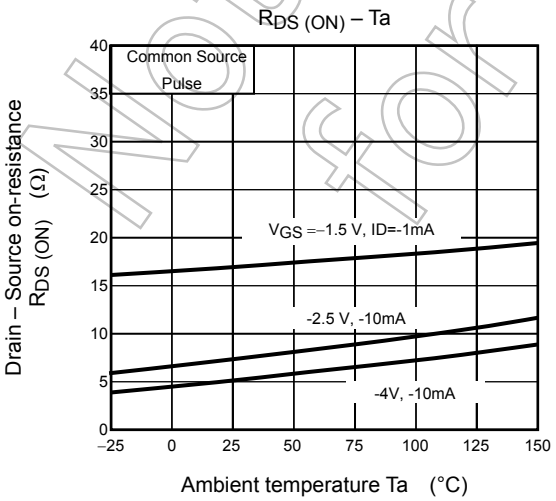

$R_{DS\ (ON)} - I_D$



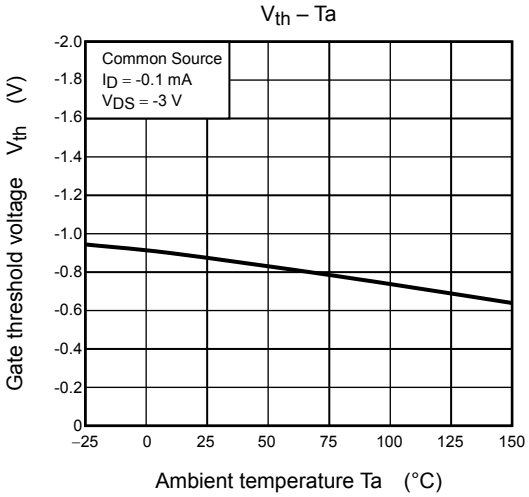

$R_{DS\ (ON)} - V_{GS}$




$R_{DS\ (ON)} - Ta$

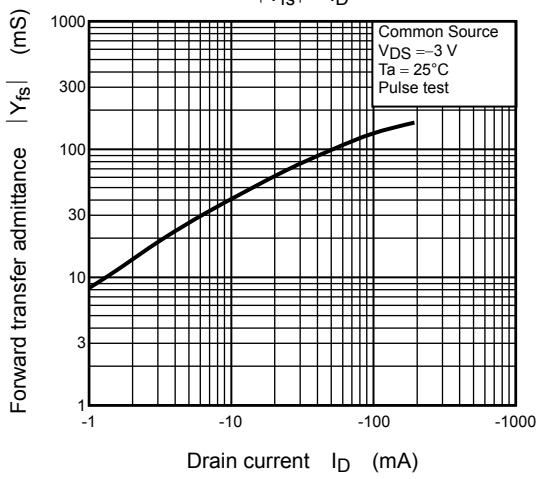



$V_{th} - Ta$

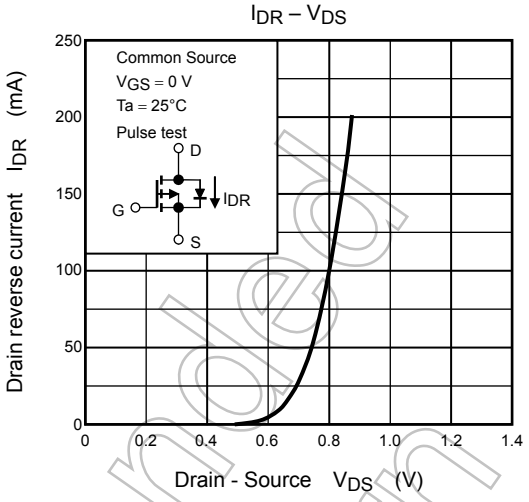


## Q2 (P-ch MOSFET)

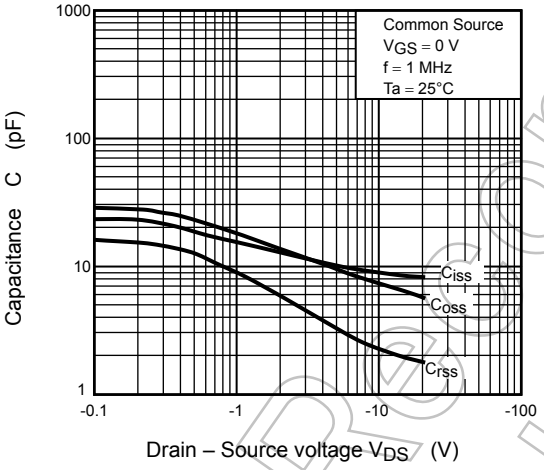
$|Y_{fs}| - I_D$



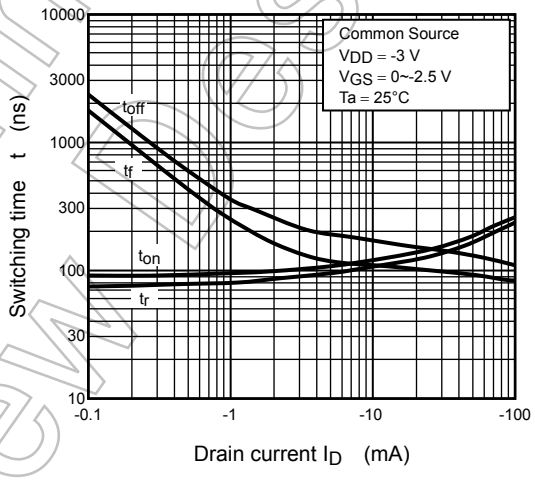

$I_{DR} - V_{DS}$




$C - V_{DS}$

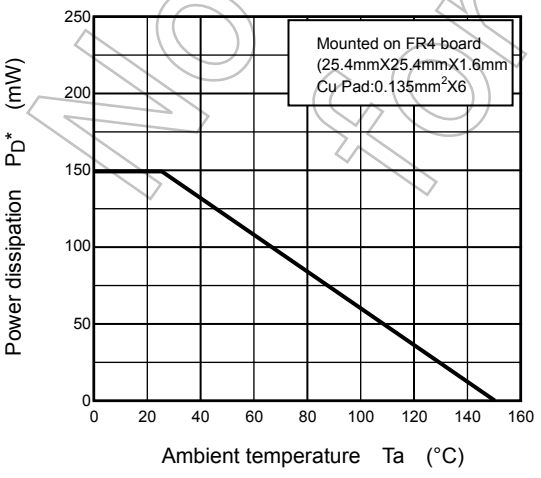



$t - I_D$




## Common Characteristics

$P_D^* - Ta$




*:Total rating

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