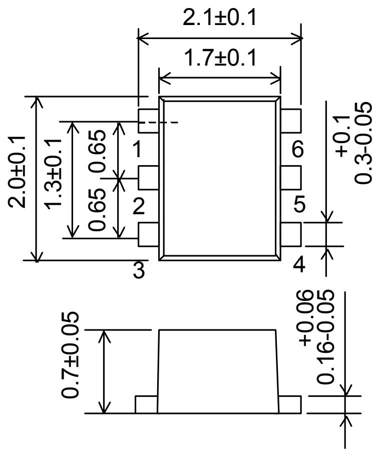
TOSHIBA Field-Effect Transistor Silicon P / N Channel MOS Type

SSM6L13TU

Power Management Switch Applications

High-Speed Switching Applications

Unit: mm



1.Source1 4.Source2
2.Gate1 5.Gate2
UF6 3.Drain2 6.Drain1

JEDEC	―
JEITA	―
TOSHIBA	2-2T1B

Weight: 7 mg (typ.)

- 1.8-V drive
- N–ch , P–ch 2–in–1
- Low ON–resistance: Nch $R_{DS(ON)}$ = 235 mΩ (max) (@V_{GS} = 1.8 V)
- $R_{DS(ON)}$ = 178 mΩ (max) (@V_{GS} = 2.5 V)
- : Pch $R_{DS(ON)}$ = 460 mΩ (max) (@V_{GS} = −1.8 V)
- $R_{DS(ON)}$ = 306 mΩ (max) (@V_{GS} = −2.5 V)

Q1 Absolute Maximum Ratings (Ta = 25 °C)

Characteristic		Symbol	Rating	Unit
Drain-source voltage		V_{DS}	20	V
Gate-source voltage		V_{GSS}	±12	V
Drain current	DC	I_D	0.8	A
	Pulse	I_{DP}	1.6	

Q2 Absolute Maximum Ratings (Ta = 25 °C)

Characteristic		Symbol	Rating	Unit
Drain-source voltage		V_{DS}	−20	V
Gate-source voltage		V_{GSS}	± 8	V
Drain current	DC	I_D	−0.8	A
	Pulse	I_{DP}	−1.6	

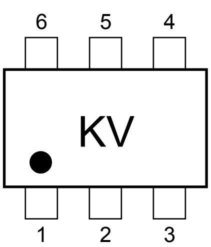
Absolute Maximum Ratings (Q1 , Q2 Common) (Ta = 25 °C)

Characteristic	Symbol	Rating	Unit
Power dissipation	P_D (Note 1)	500	mW
Channel temperature	T_{ch}	150	°C
Storage temperature range	T_{stg}	−55 to 150	°C

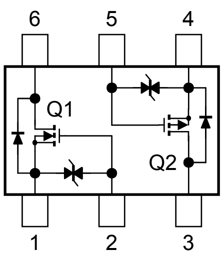
Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) 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: Mounted on an FR4 board (total dissipation)
(25.4 mm × 25.4 mm × 1.6 mm, Cu Pad: 645 mm^2)

Marking



Equivalent Circuit (top view)



Q1 Electrical Characteristics (Ta = 25°C)

Characteristic		Symbol	Test Conditions	Min	Typ.	Max	Unit
Drain-source breakdown voltage		$V_{(BR)DSS}$	I_D = 1 mA, V_{GS} = 0	20	—	—	V
		$V_{(BR)DSX}$	I_D = 1 mA, V_{GS} = − 12 V	10	—	—	
Drain cutoff current		I_{DSS}	V_{DS} = 20 V, V_{GS} = 0	—	—	1	μA
Gate leakage current		I_{GSS}	V_{GS} = ± 12 V, V_{DS} = 0	—	—	± 1	μA
Gate threshold voltage		V_{th}	V_{DS} = 3 V, I_D = 1 mA	0.4	—	1.0	V
Forward transfer admittance		$\|Y_{fs}\|$	V_{DS} = 3 V, I_D = 0.6 A (Note 2)	2.3	3.75	—	S
Drain-source ON-resistance		$R_{DS(ON)}$	I_D = 0.6 A, V_{GS} = 4.0 V (Note 2)	—	116	143	mΩ
			I_D = 0.4 A, V_{GS} = 2.5 V (Note 2)	—	134	178	
			I_D = 0.2 A, V_{GS} = 1.8 V (Note 2)	—	160	235	
Input capacitance		C_{iss}	V_{DS} = 10 V, V_{GS} = 0, f = 1 MHz	—	268	—	pF
Output capacitance		C_{oss}	V_{DS} = 10 V, V_{GS} = 0, f = 1 MHz	—	44	—	pF
Reverse transfer capacitance		C_{rss}	V_{DS} = 10 V, V_{GS} = 0, f = 1 MHz	—	34	—	pF
Switching time	Turn-on time	t_{on}	V_{DD} = 10 V, I_D = 0.25 A,	—	9	—	ns
	Turn-off time	t_{off}	V_{GS} = 0 to 2.5 V, R_G = 4.7 Ω	—	16	—	
Drain-source forward voltage		V_{DSF}	I_D = − 0.8 A, V_{GS} = 0 V (Note 2)	—	− 0.8	− 1.15	V

Note 2 : Pulse test

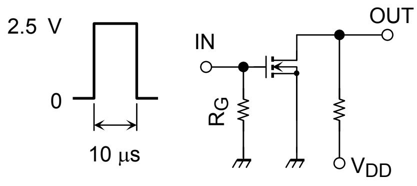
Q2 Electrical Characteristics (Ta = 25°C)

Characteristic		Symbol	Test Conditions	Min	Typ.	Max	Unit
Drain-source breakdown voltage		$V_{(BR)DSS}$	I_D = − 1 mA, V_{GS} = 0	− 20	—	—	V
		$V_{(BR)DSX}$	I_D = − 1 mA, V_{GS} = + 8 V	− 12	—	—	
Drain cutoff current		I_{DSS}	V_{DS} = − 20 V, V_{GS} = 0	—	—	− 10	μA
Gate leakage current		I_{GSS}	V_{GS} = ± 8 V, V_{DS} = 0	—	—	± 1	μA
Gate threshold voltage		V_{th}	V_{DS} = − 3 V, I_D = − 1 mA	− 0.3	—	− 1.0	V
Forward transfer admittance		$\|Y_{fs}\|$	V_{DS} = − 3 V, I_D = − 0.6 A (Note 2)	1.5	2.5	—	S
Drain-source ON-resistance		$R_{DS(ON)}$	I_D = − 0.6 A, V_{GS} = − 4.0 V (Note 2)	—	175	234	mΩ
			I_D = − 0.4 A, V_{GS} = − 2.5 V (Note 2)	—	230	306	
			I_D = − 0.1 A, V_{GS} = − 1.8 V (Note 2)	—	300	460	
Input capacitance		C_{iss}	V_{DS} = − 10 V, V_{GS} = 0, f = 1 MHz	—	250	—	pF
Output capacitance		C_{oss}	V_{DS} = − 10 V, V_{GS} = 0, f = 1 MHz	—	45	—	pF
Reverse transfer capacitance		C_{rss}	V_{DS} = − 10 V, V_{GS} = 0, f = 1 MHz	—	35	—	pF
Switching time	Turn-on time	t_{on}	V_{DD} = − 10 V, I_D = − 0.25 A,	—	12	—	ns
	Turn-off time	t_{off}	V_{GS} = 0 to − 2.5 V, R_G = 4.7 Ω	—	18	—	
Drain-source forward voltage		V_{DSF}	I_D = 0.8 A, V_{GS} = 0 V (Note 2)	—	0.85	1.2	V

Note 2: Pulse test

Q1 Switching Time Test Circuit

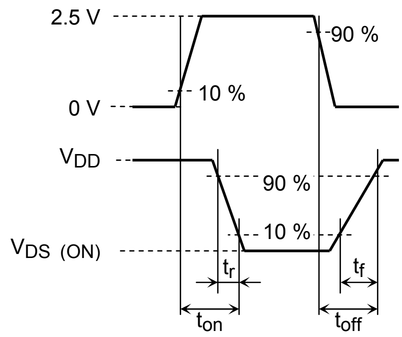
(a) Test Circuit



V_{DD} = 10 V
R_G = 4.7 Ω
Duty ≤ 1%
V_{IN}: t_r, t_f < 5 ns
Common Source
Ta = 25 °C

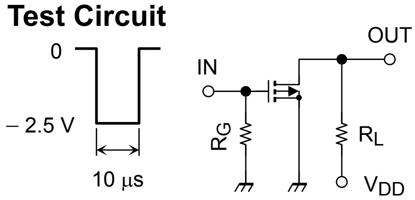
(b) V_{IN}

(c) V_{OUT}



Q2 Switching Time Test Circuit

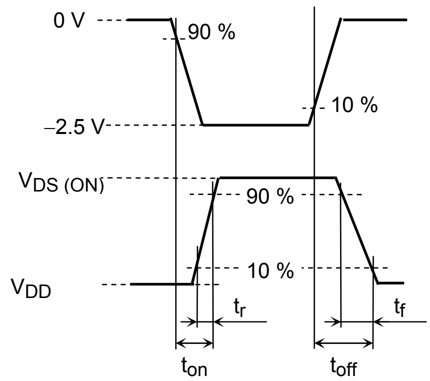
(a) Test Circuit



V_{DD} = - 10 V
R_G = 4.7 Ω
Duty ≤ 1 %
V_{IN}: t_r, t_f < 5 ns
Common Source
Ta = 25 °C

(b) V_{IN}

(c) V_{OUT}



Q1 Precaution

V_{th} can be expressed as the voltage between gate and source when the low operating current value is I_D= 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: $V_{GS\ (off)} < V_{th} < V_{GS\ (on)}$.)

Take this into consideration when using the device.

Q2 Precaution

V_{th} can be expressed as the voltage between gate and source when the low operating current value is I_D= − 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: $V_{GS\ (off)} < V_{th} < V_{GS\ (on)}$.)

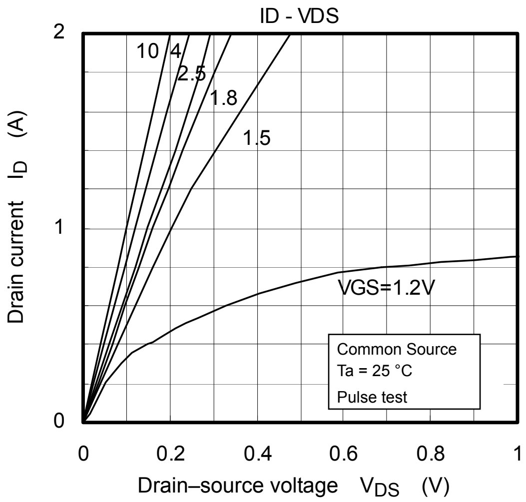
Take this into consideration when using the device.

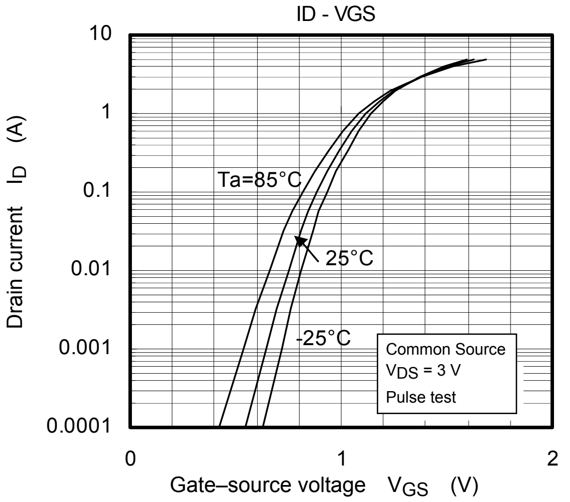
Handling Precaution

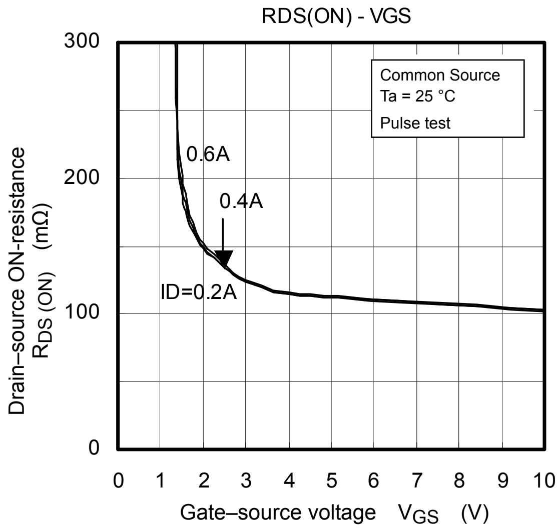
When handling individual devices that are not yet mounted on a circuit board, make sure that the environment is protected against electrostatic discharge. Operators should wear antistatic clothing, and containers and other objects that come into direct contact with devices should be made of antistatic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

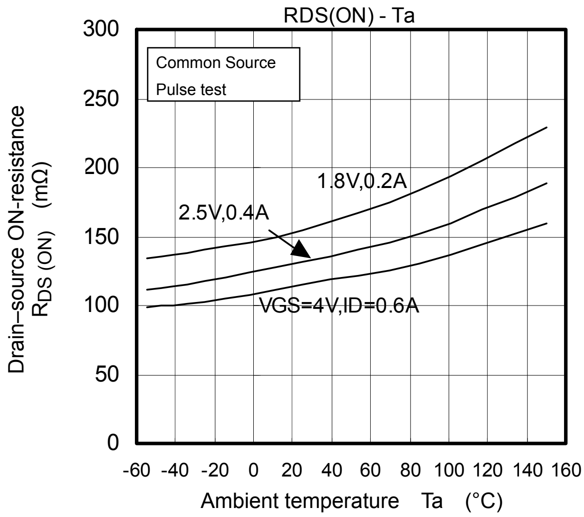
Thermal resistance $R_{th\ (ch\text{-}a)}$ and Power dissipation P_D vary depending on board material, board area, board thickness and pad area. When using this device, please take heat dissipation into consideration.

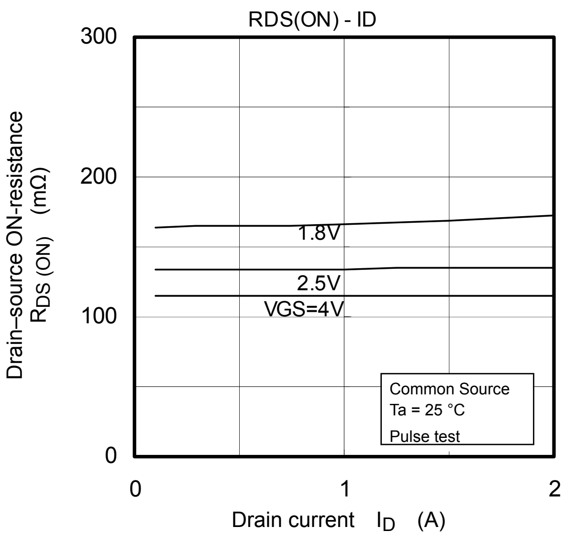
Q1 Data

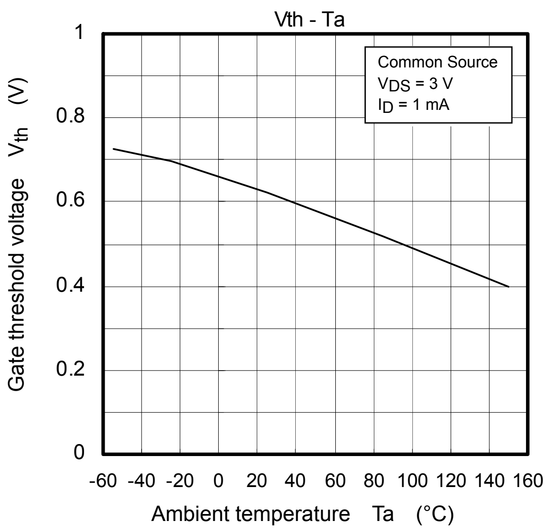

ID - VDS
10
4
2.5
1.8
1.5
VGS=1.2V
Common Source
Ta = 25 °C
Pulse test
Drain current I_D (A)
Drain–source voltage V_{DS} (V)
0
1
2
0
0.2
0.4
0.6
0.8
1


ID - VGS
Ta=85°C
25°C
-25°C
Common Source
V_{DS} = 3 V
Pulse test
Drain current I_D (A)
Gate–source voltage V_{GS} (V)
10
1
0.1
0.01
0.001
0.0001
0
1
2

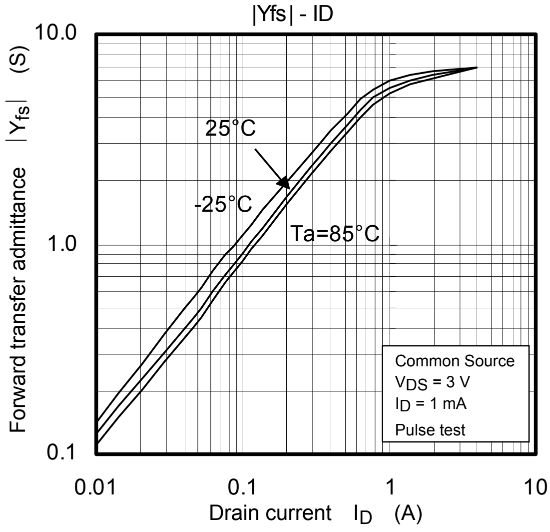

RDS(ON) - VGS
Common Source
Ta = 25 °C
Pulse test
0.6A
0.4A
ID=0.2A
Drain–source ON-resistance $R_{DS\ (ON)}$ (mΩ)
Gate–source voltage V_{GS} (V)
300
200
100
0
0
1
2
3
4
5
6
7
8
9
10

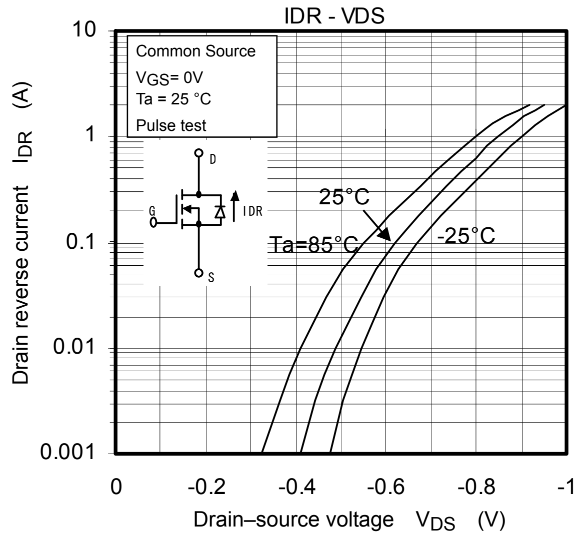

RDS(ON) - Ta
Common Source
Pulse test
1.8V,0.2A
2.5V,0.4A
VGS=4V,ID=0.6A
Drain–source ON-resistance $R_{DS\ (ON)}$ (mΩ)
Ambient temperature Ta (°C)
300
250
200
150
100
50
0
-60
-40
-20
0
20
40
60
80
100
120
140
160

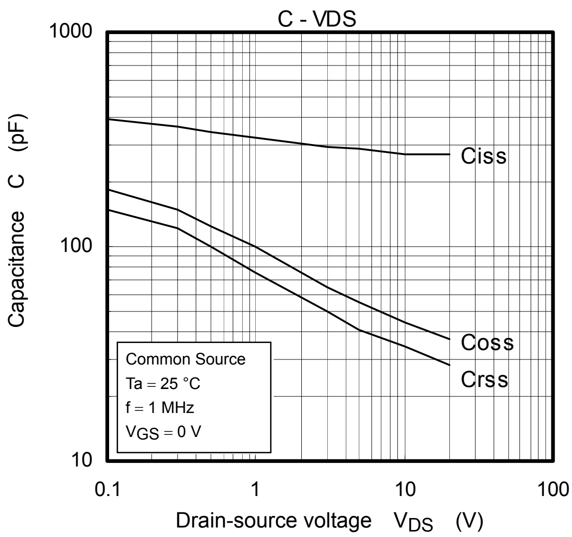

RDS(ON) - ID
1.8V
2.5V
VGS=4V
Common Source
Ta = 25 °C
Pulse test
Drain–source ON-resistance $R_{DS\ (ON)}$ (mΩ)
Drain current I_D (A)
300
200
100
0
0
1
2

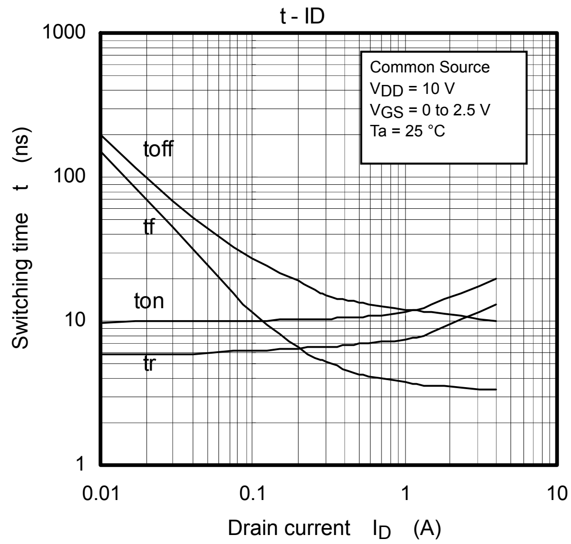

Vth - Ta
Common Source
V_{DS} = 3 V
I_D = 1 mA
Gate threshold voltage V_{th} (V)
Ambient temperature Ta (°C)
1
0.8
0.6
0.4
0.2
0
-60
-40
-20
0
20
40
60
80
100
120
140
160

Q1 Data

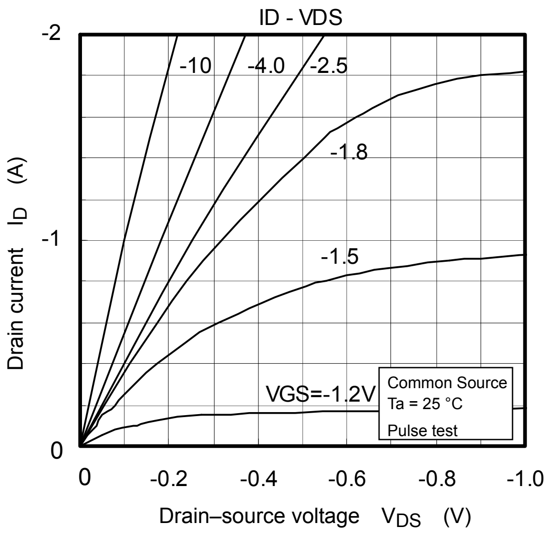

|Yfs| - ID
Forward transfer admittance |Yfs| (S)
10.0
1.0
0.1
25°C
-25°C
Ta=85°C
Common Source
VDS = 3 V
ID = 1 mA
Pulse test
0.01
0.1
1
10
Drain current ID (A)

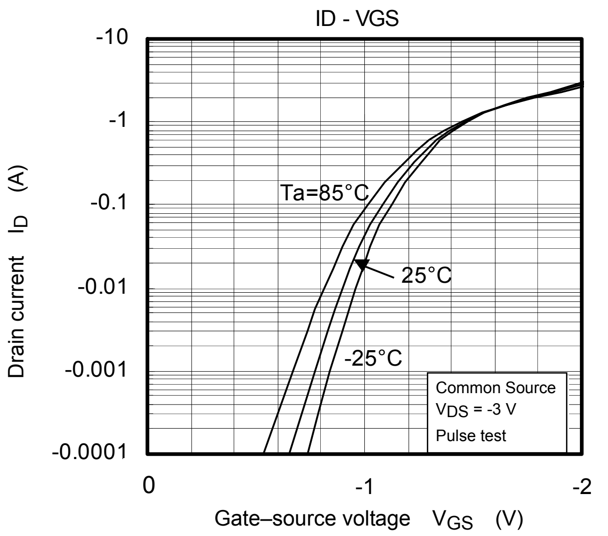

IDR - VDS
Drain reverse current IDR (A)
10
1
0.1
0.01
0.001
Common Source
VGS= 0V
Ta = 25 °C
Pulse test
D
G
S
IDR
25°C
Ta=85°C
-25°C
0
-0.2
-0.4
-0.6
-0.8
-1
Drain–source voltage VDS (V)

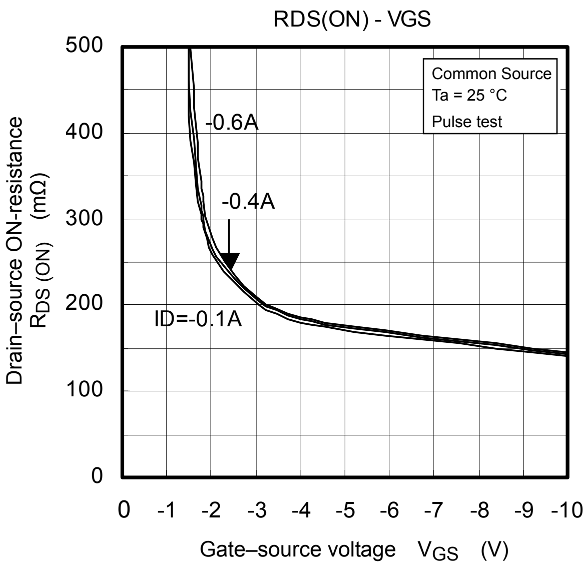

C - VDS
Capacitance C (pF)
1000
100
10
Ciss
Coss
Crss
Common Source
Ta = 25 °C
f = 1 MHz
VGS = 0 V
0.1
1
10
100
Drain-source voltage VDS (V)

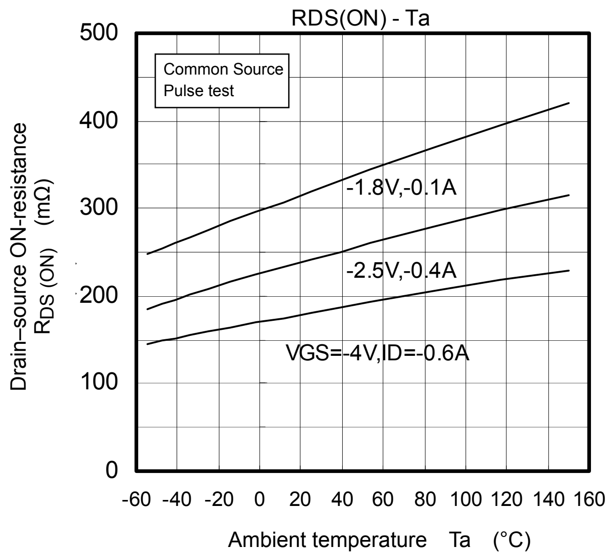

t - ID
Switching time t (ns)
1000
100
10
1
Common Source
VDD = 10 V
VGS = 0 to 2.5 V
Ta = 25 °C
toff
tf
ton
tr
0.01
0.1
1
10
Drain current ID (A)

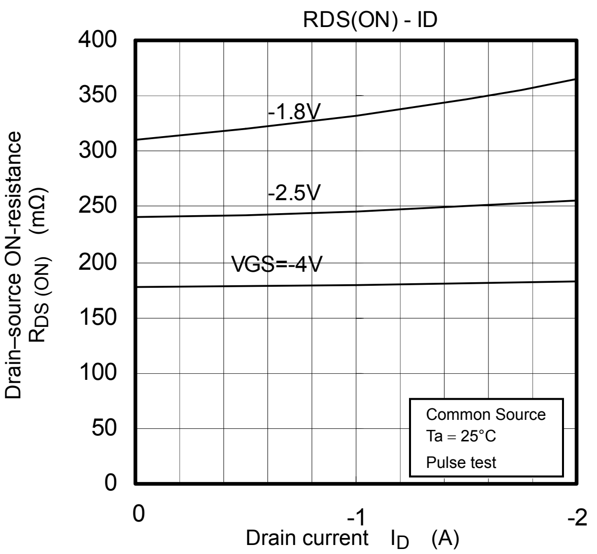
Q2 Data

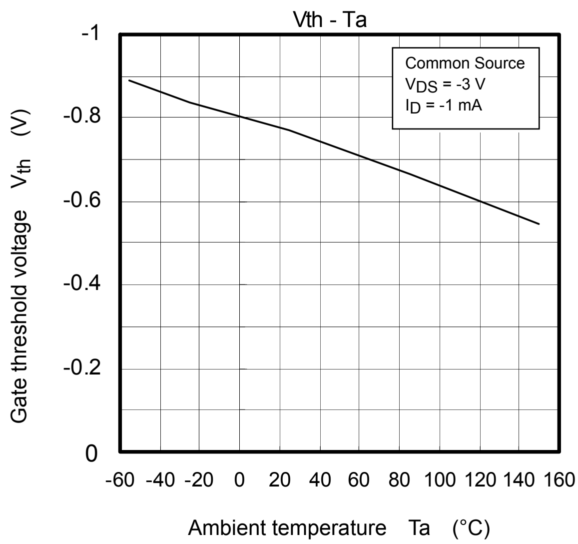

ID - VDS
-10
-4.0
-2.5
-1.8
-1.5
VGS=-1.2V
Common Source
Ta = 25 °C
Pulse test
-2
-1
0
0
-0.2
-0.4
-0.6
-0.8
-1.0
Drain current ID (A)
Drain–source voltage VDS (V)


ID - VGS
Ta=85°C
25°C
-25°C
Common Source
VDS = -3 V
Pulse test
-10
-1
-0.1
-0.01
-0.001
-0.0001
0
-1
-2
Drain current ID (A)
Gate–source voltage VGS (V)

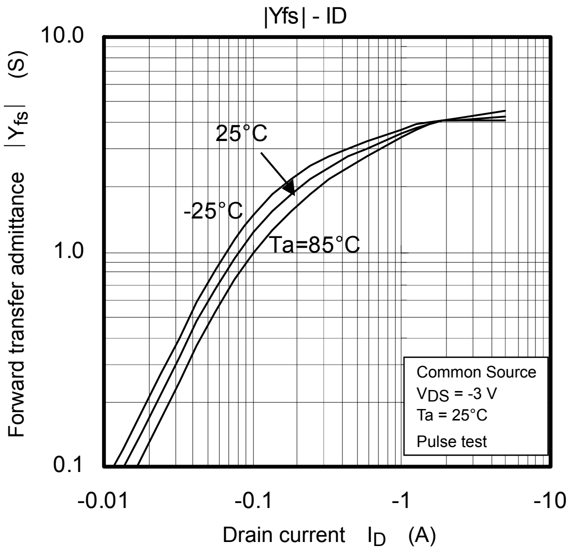

RDS(ON) - VGS
Common Source
Ta = 25 °C
Pulse test
-0.6A
-0.4A
ID=-0.1A
500
400
300
200
100
0
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
Drain–source ON-resistance RDS (ON) (mΩ)
Gate–source voltage VGS (V)

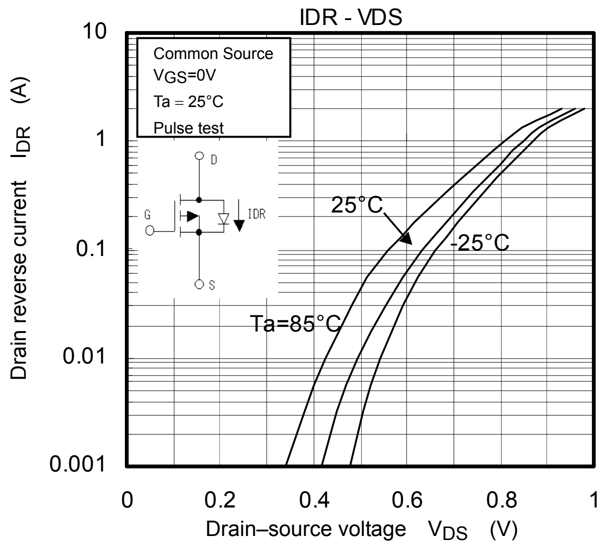

RDS(ON) - Ta
Common Source
Pulse test
-1.8V,-0.1A
-2.5V,-0.4A
VGS=-4V,ID=-0.6A
500
400
300
200
100
0
-60
-40
-20
0
20
40
60
80
100
120
140
160
Drain–source ON-resistance RDS (ON) (mΩ)
Ambient temperature Ta (°C)

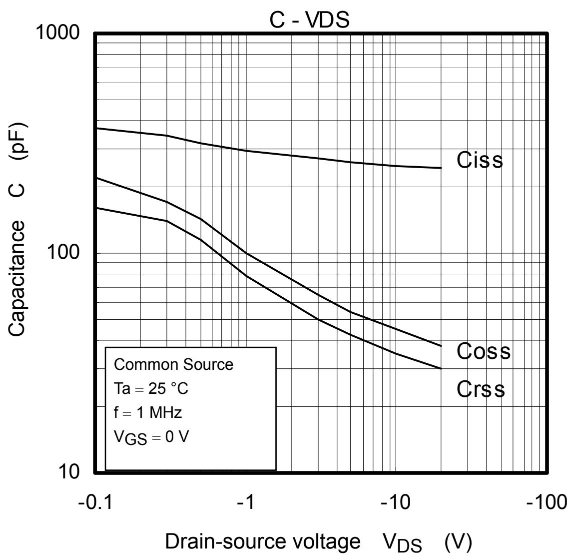

RDS(ON) - ID
-1.8V
-2.5V
VGS=-4V
Common Source
Ta = 25°C
Pulse test
400
350
300
250
200
150
100
50
0
0
-1
-2
Drain–source ON-resistance RDS (ON) (mΩ)
Drain current ID (A)

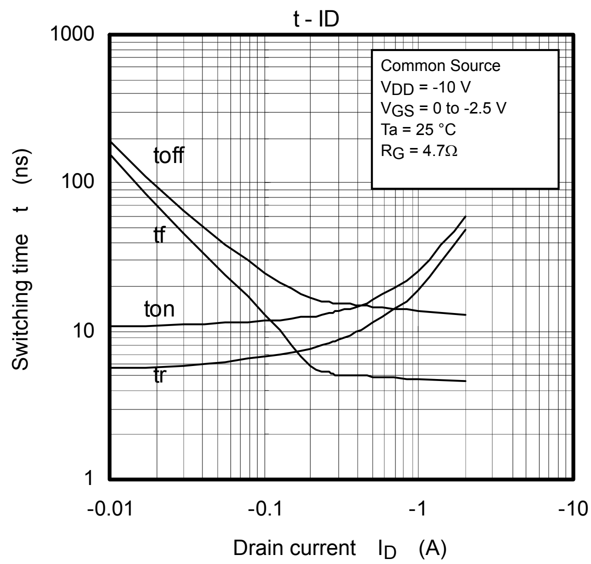

Vth - Ta
Common Source
VDS = -3 V
ID = -1 mA
-1
-0.8
-0.6
-0.4
-0.2
0
-60
-40
-20
0
20
40
60
80
100
120
140
160
Gate threshold voltage Vth (V)
Ambient temperature Ta (°C)

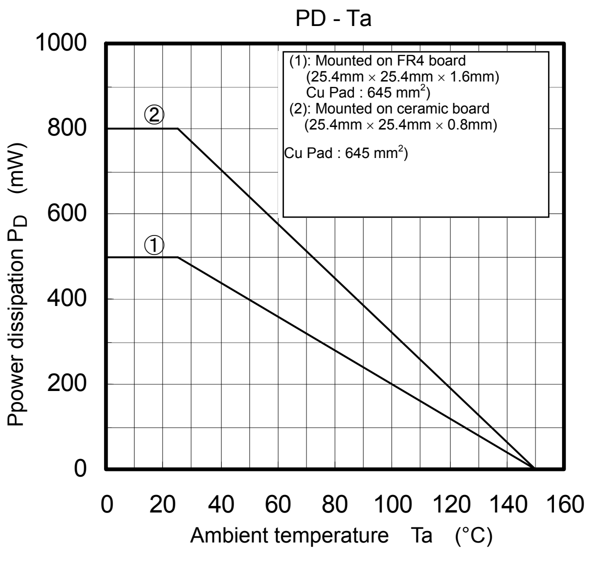
Q2 Data

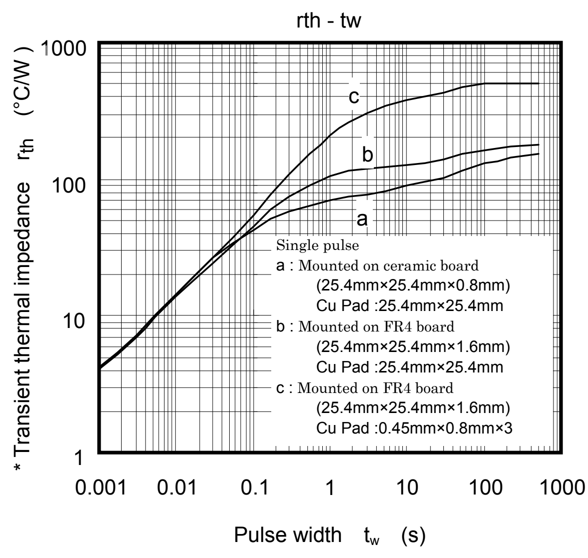

|Yfs| - ID
Forward transfer admittance |Yfs| (S)
10.0
1.0
0.1
25°C
-25°C
Ta=85°C
Common Source
VDS = -3 V
Ta = 25°C
Pulse test
-0.01
-0.1
-1
-10
Drain current ID (A)


IDR - VDS
Drain reverse current IDR (A)
10
1
0.1
0.01
0.001
Common Source
VGS=0V
Ta = 25°C
Pulse test
D
G
IDR
S
25°C
-25°C
Ta=85°C
0
0.2
0.4
0.6
0.8
1
Drain–source voltage VDS (V)


C - VDS
Capacitance C (pF)
1000
100
10
Ciss
Coss
Crss
Common Source
Ta = 25 °C
f = 1 MHz
VGS = 0 V
-0.1
-1
-10
-100
Drain-source voltage VDS (V)


t - ID
Switching time t (ns)
1000
100
10
1
Common Source
VDD = -10 V
VGS = 0 to -2.5 V
Ta = 25 °C
RG = 4.7Ω
toff
tf
ton
tr
-0.01
-0.1
-1
-10
Drain current ID (A)


PD - Ta
Ppower dissipation PD (mW)
1000
800
600
400
200
0
(1): Mounted on FR4 board
(25.4mm × 25.4mm × 1.6mm)
Cu Pad : 645 mm2)
(2): Mounted on ceramic board
(25.4mm × 25.4mm × 0.8mm)
Cu Pad : 645 mm2)
②
①
0
20
40
60
80
100
120
140
160
Ambient temperature Ta (°C)


rth - tw
* Transient thermal impedance rth (°C/W)
1000
100
10
1
c
b
a
Single pulse
a : Mounted on ceramic board
(25.4mm×25.4mm×0.8mm)
Cu Pad :25.4mm×25.4mm
b : Mounted on FR4 board
(25.4mm×25.4mm×1.6mm)
Cu Pad :25.4mm×25.4mm
c : Mounted on FR4 board
(25.4mm×25.4mm×1.6mm)
Cu Pad :0.45mm×0.8mm×3
0.001
0.01
0.1
1
10
100
1000
Pulse width tw (s)

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