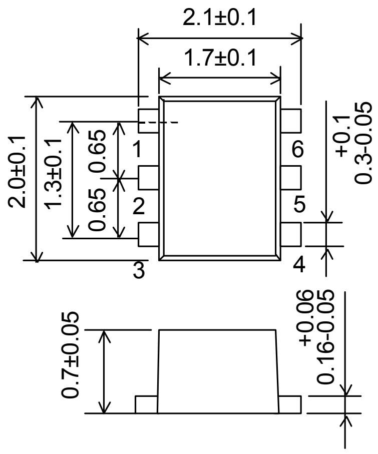
TOSHIBA Field-Effect Transistor Silicon P / N Channel MOS Type

SSM6L13TU

Power Management Switch Applications

High-Speed Switching Applications

Unit: mm



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

UF6

JEDEC	―
JEITA	―
TOSHIBA	2-2T1B

Weight: 7 mg (typ.)

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

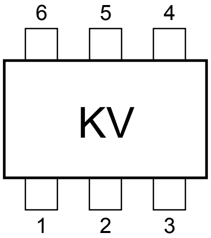
Absolute Maximum Ratings (Q1 , Q2 Common) (Ta = 25 °C)

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

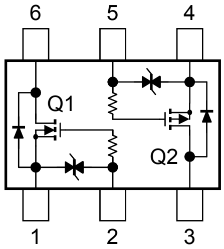
Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) 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)



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 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

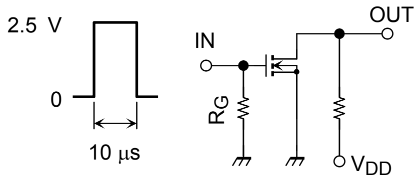
Q2 Electrical Characteristics (Ta = 25°C)

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

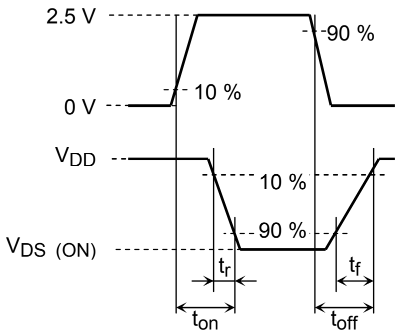
(a) Test Circuit



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

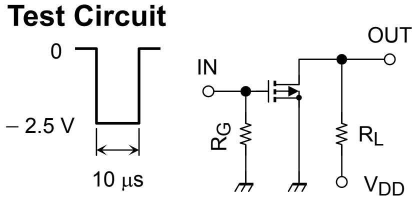
(b) V_{IN}

(c) V_{OUT}



Q2 Switching Time Test Circuit

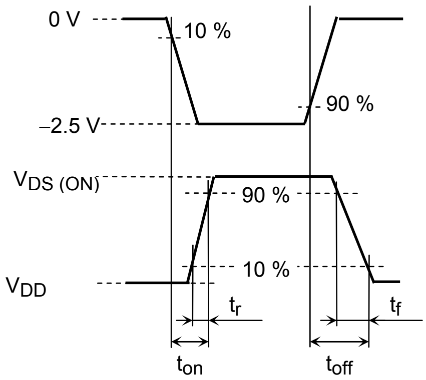
(a) Test Circuit



V_{DD} = - 10 V
R_G = 4.7 Ω
D.U. ≦ 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.

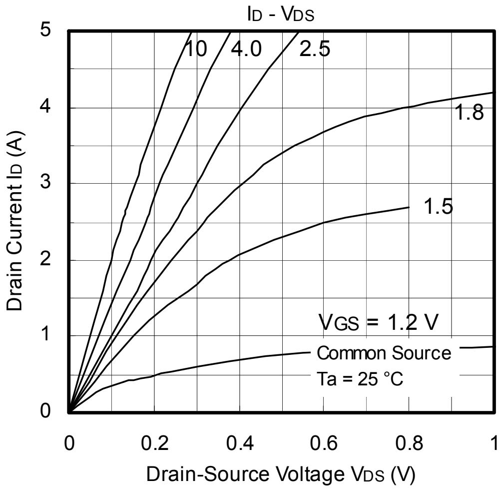
Q2 Precaution

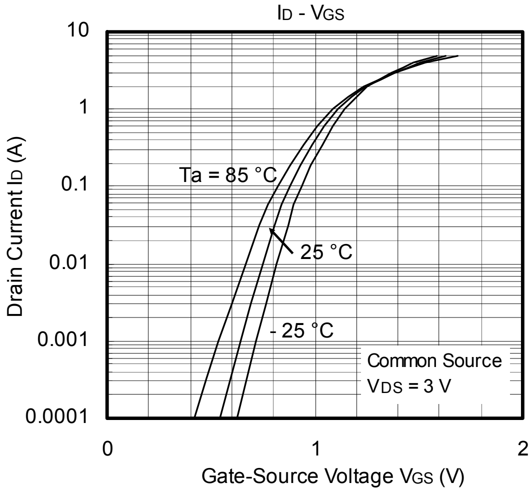
V_{th} can be expressed as the voltage between gate and source when the low operating current value is I_D= − 1 mA for this product. For normal switching operation, $V_{GS\ (on)}$ requires a higher voltage than V_{th}, and $V_{GS\ (off)}$ requires a lower voltage than V_{th}.

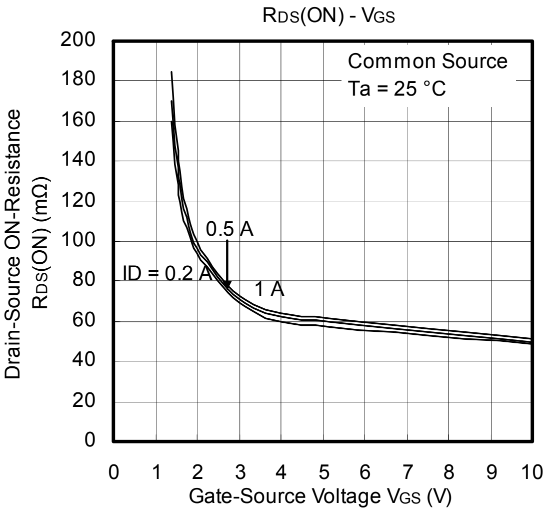
(The relationship can be established as follows: $V_{GS\ (off)} < V_{th} < V_{GS\ (on)}$.)

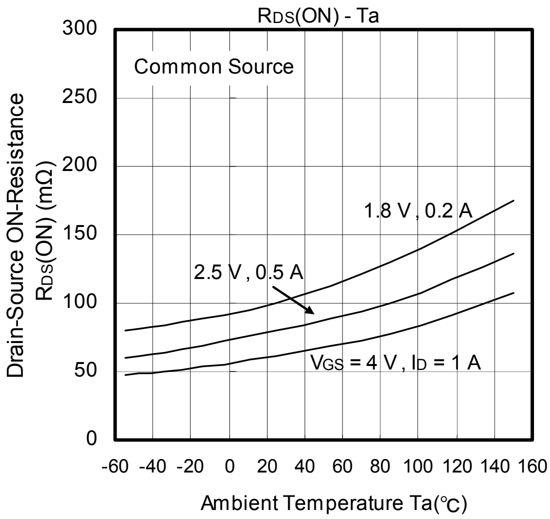
Take this into consideration when using the device.

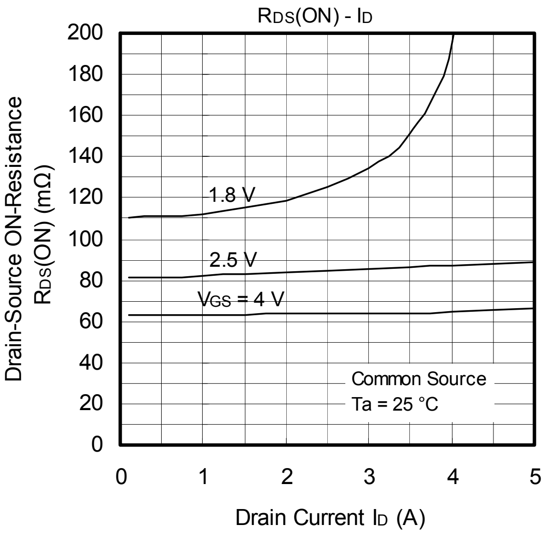
Q1 Data

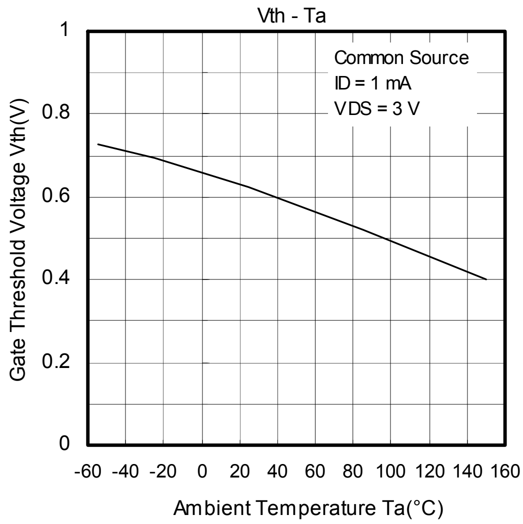

ID - VDS
10
4.0
2.5
1.8
1.5
VGS = 1.2 V
Common Source
Ta = 25 °C
Drain Current ID (A)
Drain-Source Voltage VDS (V)
0
0.2
0.4
0.6
0.8
1
1
2
3
4
5

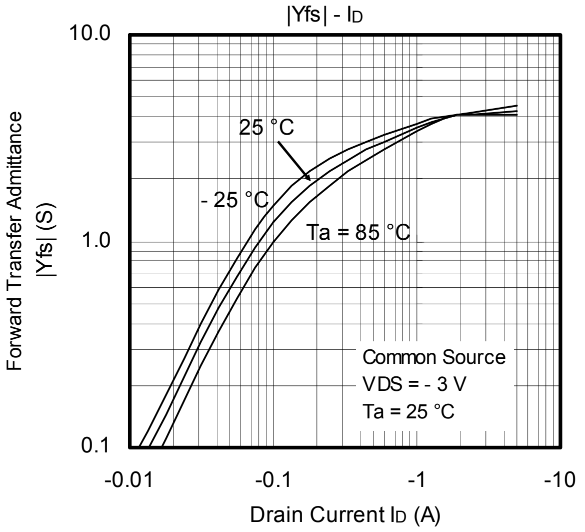

ID - VGS
Ta = 85 °C
25 °C
- 25 °C
Common Source
VDS = 3 V
Drain Current ID (A)
Gate-Source Voltage VGS (V)
10
1
0.1
0.01
0.001
0.0001
0
1
2

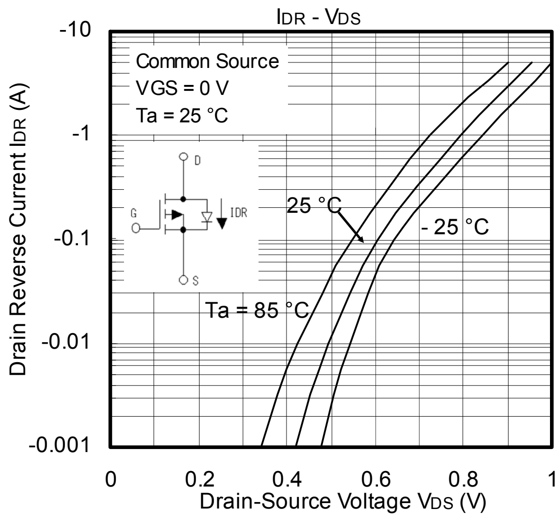

RDS(ON) - VGS
Common Source
Ta = 25 °C
0.5 A
ID = 0.2 A
1 A
Drain-Source ON-Resistance RDS(ON) (mΩ)
Gate-Source Voltage VGS (V)
0
20
40
60
80
100
120
140
160
180
200
1
2
3
4
5
6
7
8
9
10

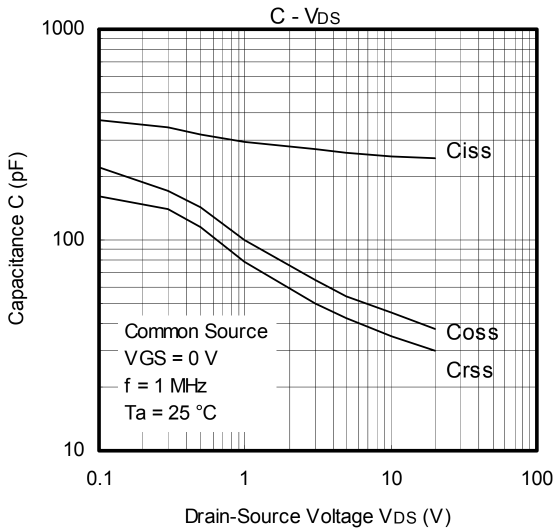

RDS(ON) - Ta
Common Source
1.8 V , 0.2 A
2.5 V , 0.5 A
VGS = 4 V , ID = 1 A
Drain-Source ON-Resistance RDS(ON) (mΩ)
Ambient Temperature Ta(°C)
0
50
100
150
200
250
300
-60
-40
-20
0
20
40
60
80
100
120
140
160

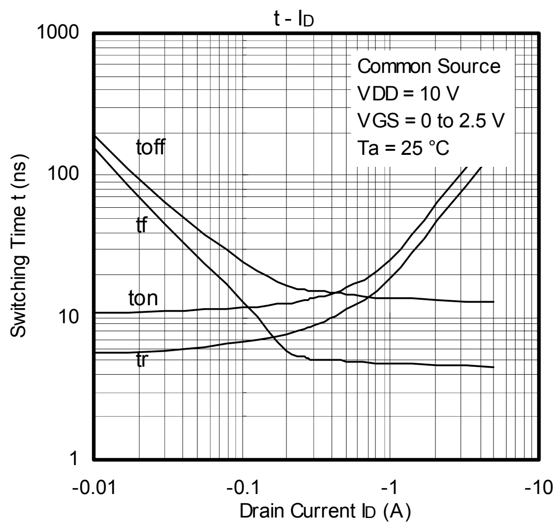

RDS(ON) - ID
1.8 V
2.5 V
VGS = 4 V
Common Source
Ta = 25 °C
Drain-Source ON-Resistance RDS(ON) (mΩ)
Drain Current ID (A)
0
20
40
60
80
100
120
140
160
180
200
1
2
3
4
5


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

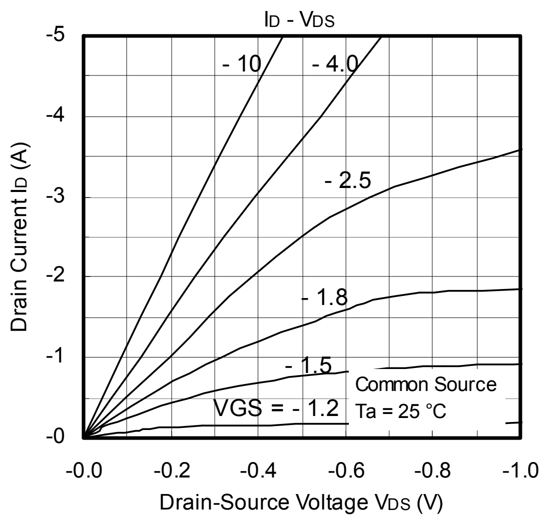

|Yfs| - ID
Forward Transfer Admittance |Yfs| (S)
10.0
1.0
0.1
-0.01
-0.1
-1
-10
Drain Current ID (A)
25 °C
- 25 °C
Ta = 85 °C
Common Source
VDS = - 3 V
Ta = 25 °C

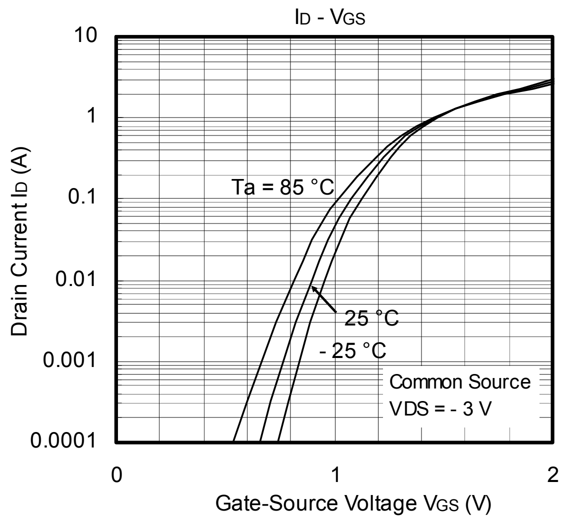

IDR - VDS
Drain Reverse Current IDR (A)
-10
-1
-0.1
-0.01
-0.001
0
0.2
0.4
0.6
0.8
1
Drain-Source Voltage VDS (V)
Common Source
VGS = 0 V
Ta = 25 °C
D
G
S
IDR
25 °C
- 25 °C
Ta = 85 °C

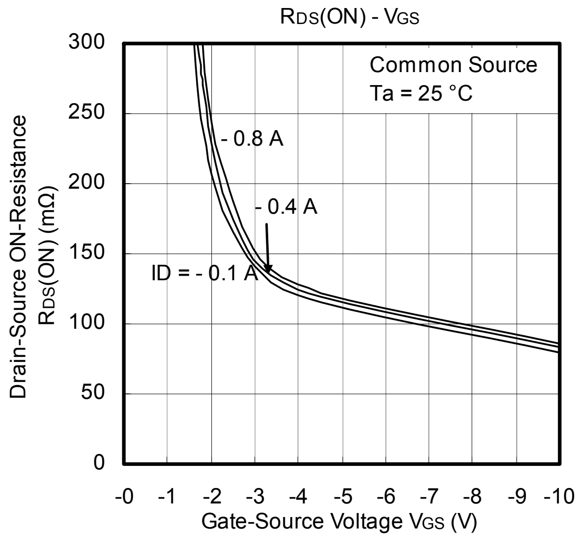

C - VDS
Capacitance C (pF)
1000
100
10
0.1
1
10
100
Drain-Source Voltage VDS (V)
Ciss
Coss
Crss
Common Source
VGS = 0 V
f = 1 MHz
Ta = 25 °C

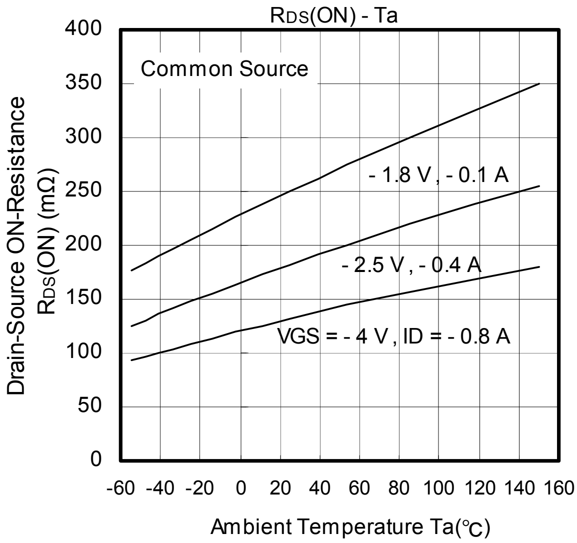

t - ID
Switching Time t (ns)
1000
100
10
1
-0.01
-0.1
-1
-10
Drain Current ID (A)
Common Source
VDD = 10 V
VGS = 0 to 2.5 V
Ta = 25 °C
toff
tf
ton
tr

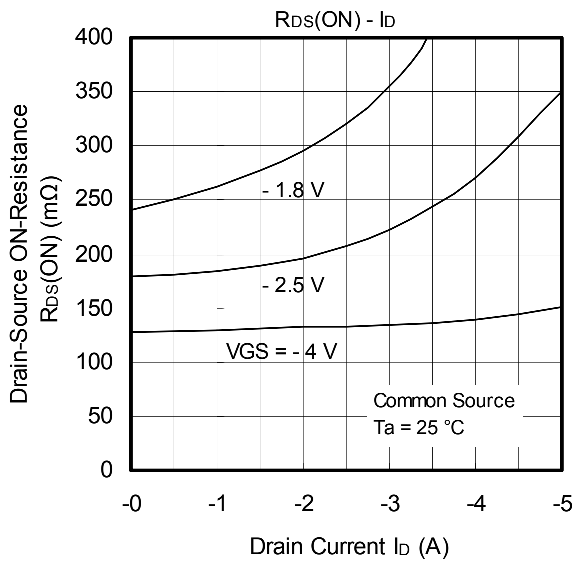
Q2 Data

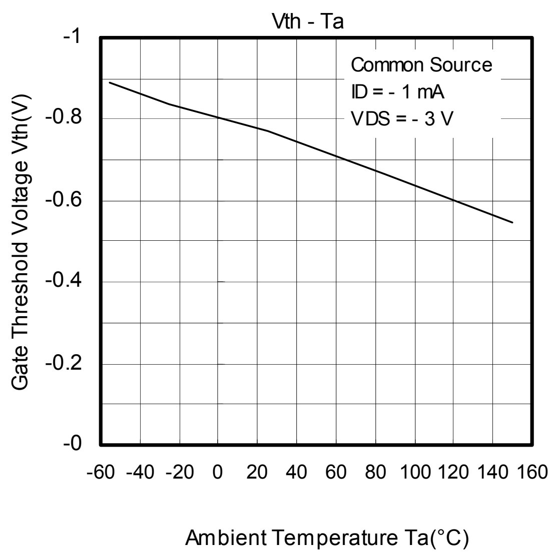

ID - VDS
Drain Current ID (A)
Drain-Source Voltage VDS (V)
- 10
- 4.0
- 2.5
- 1.8
- 1.5
VGS = - 1.2
Common Source
Ta = 25 °C
-5
-4
-3
-2
-1
-0
-0.0
-0.2
-0.4
-0.6
-0.8
-1.0

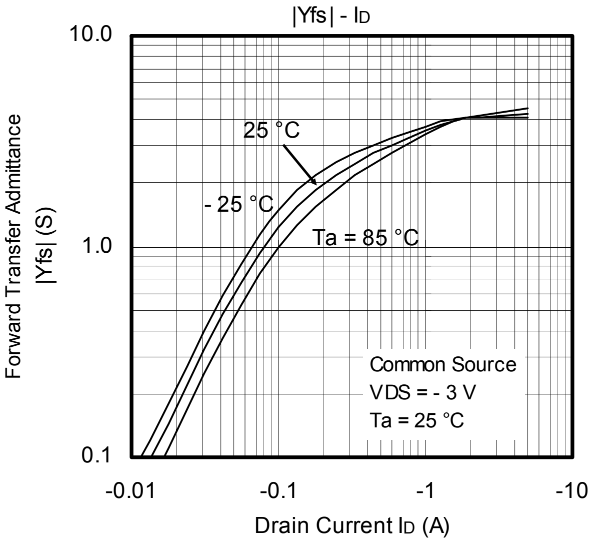

ID - VGS
Drain Current ID (A)
Gate-Source Voltage VGS (V)
Ta = 85 °C
25 °C
- 25 °C
Common Source
VDS = - 3 V
10
1
0.1
0.01
0.001
0.0001
0
1
2

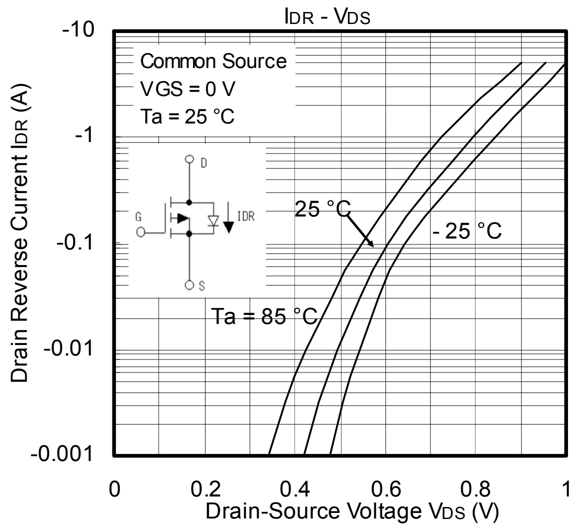

RDS(ON) - VGS
Drain-Source ON-Resistance RDS(ON) (mΩ)
Gate-Source Voltage VGS (V)
Common Source
Ta = 25 °C
- 0.8 A
- 0.4 A
ID = - 0.1 A
300
250
200
150
100
50
0
-0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10

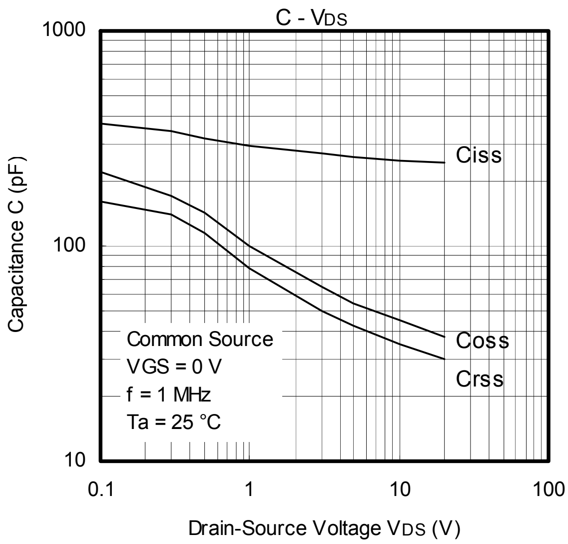

RDS(ON) - Ta
Drain-Source ON-Resistance RDS(ON) (mΩ)
Ambient Temperature Ta(°C)
Common Source
- 1.8 V , - 0.1 A
- 2.5 V , - 0.4 A
VGS = - 4 V , ID = - 0.8 A
400
350
300
250
200
150
100
50
0
-60
-40
-20
0
20
40
60
80
100
120
140
160

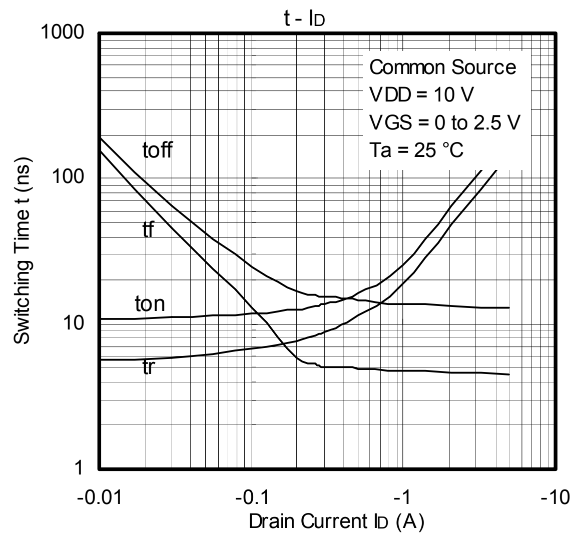

RDS(ON) - ID
Drain-Source ON-Resistance RDS(ON) (mΩ)
Drain Current ID (A)
- 1.8 V
- 2.5 V
VGS = - 4 V
Common Source
Ta = 25 °C
400
350
300
250
200
150
100
50
0
-0
-1
-2
-3
-4
-5


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

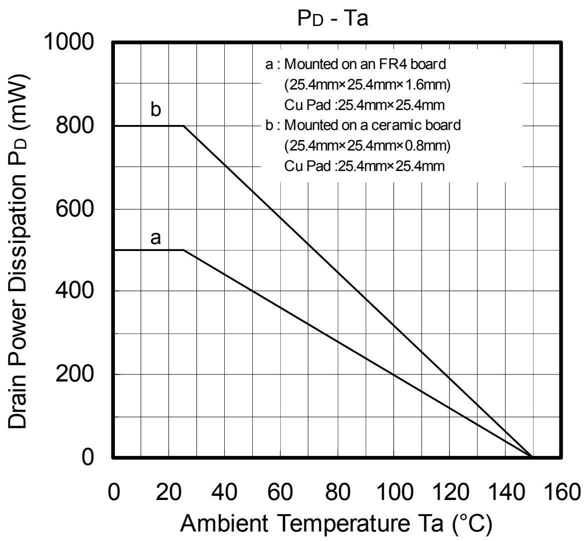

|Yfs| - ID
Forward Transfer Admittance |Yfs| (S)
Drain Current ID (A)
10.0
1.0
0.1
-0.01
-0.1
-1
-10
25 °C
- 25 °C
Ta = 85 °C
Common Source
VDS = - 3 V
Ta = 25 °C

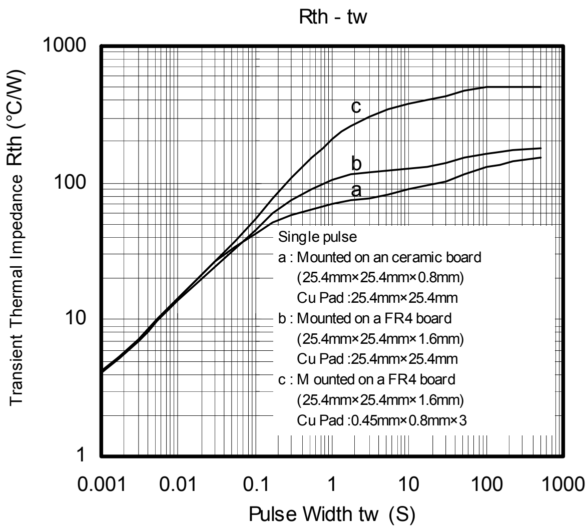

IDR - VDS
Drain Reverse Current IDR (A)
Drain-Source Voltage VDS (V)
-10
-1
-0.1
-0.01
-0.001
0
0.2
0.4
0.6
0.8
1
Common Source
VGS = 0 V
Ta = 25 °C
D
G
S
IDR
25 °C
- 25 °C
Ta = 85 °C


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


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

Q1 , Q2 Data


PD - Ta
Drain Power Dissipation PD (mW)
Ambient Temperature Ta (°C)
1000
800
600
400
200
0
0
20
40
60
80
100
120
140
160
a : Mounted on an FR4 board
(25.4mm×25.4mm×1.6mm)
Cu Pad :25.4mm×25.4mm
b : Mounted on a ceramic board
(25.4mm×25.4mm×0.8mm)
Cu Pad :25.4mm×25.4mm
b
a


Rth - tw
Transient Thermal Impedance Rth (°C/W)
Pulse Width tw (S)
1000
100
10
1
0.001
0.01
0.1
1
10
100
1000
c
b
a
Single pulse
a : Mounted on an ceramic board
(25.4mm×25.4mm×0.8mm)
Cu Pad :25.4mm×25.4mm
b : Mounted on a FR4 board
(25.4mm×25.4mm×1.6mm)
Cu Pad :25.4mm×25.4mm
c : M ounted on a FR4 board
(25.4mm×25.4mm×1.6mm)
Cu Pad :0.45mm×0.8mm×3