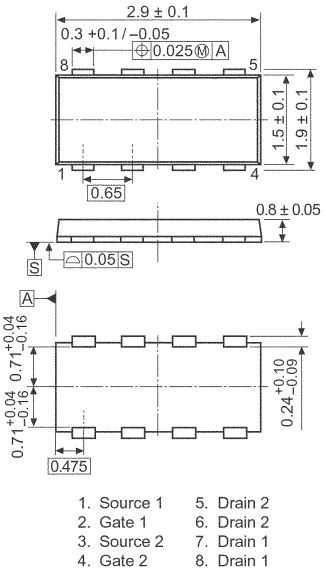
TOSHIBA Field Effect Transistor Silicon P, N Channel MOS Type (U-MOS IV / U-MOS III)

TPCF8402

Portable Equipment Applications
Motor Drive Applications
DC-DC Converter Applications

- Low drain-source ON resistance : P Channel $R_{DS\ (ON)}$ = 60 mΩ (typ.)
  N Channel $R_{DS\ (ON)}$ = 38 mΩ (typ.)
- High forward transfer admittance : P Channel $|Y_{fs}|$ = 5.9 S (typ.)
  N Channel $|Y_{fs}|$ = 6.8 S (typ.)
- Low leakage current : P Channel I_{DSS} = −10 μA (V_{DS} = −30 V)
  N Channel I_{DSS} = 10 μA (V_{DS} = 30 V)
- Enhancement-mode
  : P Channel V_{th} = −0.8 to −2.0 V (V_{DS} = −10 V, I_D = −1mA)
  N Channel V_{th} = 1.3 to 2.5 V (V_{DS} = 10 V, I_D = 1mA)

Unit: mm



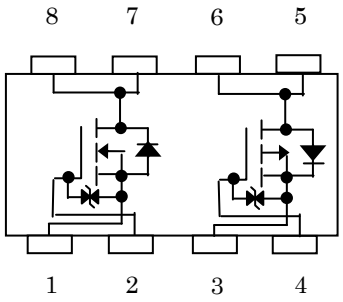
JEDEC	—
JEITA	—
TOSHIBA	2-3U1B

Weight: 0.011 g (typ.)

Absolute Maximum Ratings (Ta = 25°C)

Characteristics		Symbol	Rating		Unit
Drain-source voltage		V_{DSS}	-30	30	V
Drain-gate voltage (R_{GS} = 20 kΩ)		V_{DGR}	-30	30	V
Gate-source voltage		V_{GSS}	±20	±20	V
Drain current	DC (Note 1)	I_D	-3.2	4.0	A
	Pulse (Note 1)	I_{DP}	-12.8	16.0	
Drain power dissipation (t = 5 s) (Note 2a)	Single-device operation (Note 3a)	$P_{D\ (1)}$	1.35	1.35	W
	Single-device value at dual operation (Note 3b)	$P_{D\ (2)}$	1.12	1.12	
Drain power dissipation (t = 5 s) (Note 2b)	Single-device operation (Note 3a)	$P_{D\ (1)}$	0.53	0.53	
	Single-device value at dual operation (Note 3b)	$P_{D\ (2)}$	0.33	0.33	
Single pulse avalanche energy (Note 4)		E_{AS}	0.67	2.6	mJ
Avalanche current		I_{AR}	-1.6	2.0	A
Repetitive avalanche energy Single-device value at dual operation (Note 2a, 3b, 5)		E_{AR}	0.11		mJ
Channel temperature		T_{ch}	150		°C
Storage temperature range		T_{stg}	−55 to 150		°C

Circuit Configuration



Note: For Notes 1 to 5, refer to the next page.

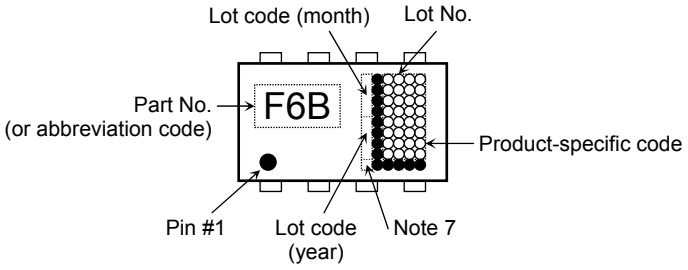
Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within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

This transistor is an electrostatic-sensitive device. Handle with caution.

Thermal Characteristics

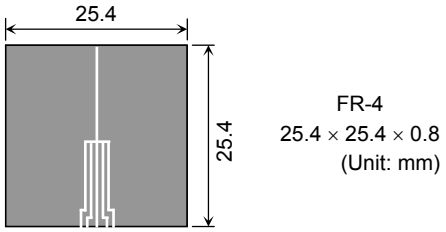
Characteristics		Symbol	Max	Unit
Thermal resistance, channel to ambient (t = 5 s) (Note 2a)	Single-device operation (Note 3a)	$R_{th\ (ch\text{-}a)\ (1)}$	92.6	°C/W
	Single-device value at dual operation (Note 3b)	$R_{th\ (ch\text{-}a)\ (2)}$	111.6	
Thermal resistance, channel to ambient (t = 5 s) (Note 2b)	Single-device operation (Note 3a)	$R_{th\ (ch\text{-}a)\ (1)}$	235.8	°C/W
	Single-device value at dual operation (Note 3b)	$R_{th\ (ch\text{-}a)\ (2)}$	378.8	

Marking (Note 6)



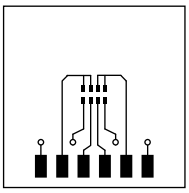
Note 1: Ensure that the channel temperature does not exceed 150°C.

Note 2: (a) Device mounted on a glass-epoxy board (a) (b) Device mounted on a glass-epoxy board (b)



FR-4
25.4 × 25.4 × 0.8
(Unit: mm)

(a)



FR-4
25.4 × 25.4 × 0.8
(Unit: mm)

(b)

Note 3: a) The power dissipation and thermal resistance values are shown for a single device.
(During single-device operation, power is only applied to one device.)
b) The power dissipation and thermal resistance values are shown for a single device.
(During dual operation, power is evenly applied to both devices.)

Note 4: P Channel: V_{DD} = −24 V, T_{ch} = 25°C (initial), L = 0.2 mH, R_G = 25 Ω, I_{AR} = −1.6 A
N Channel: V_{DD} = 24 V, T_{ch} = 25°C (initial), L = 0.5 mH, R_G = 25 Ω, I_{AR} = 2.0 A

Note 5: Repetitive rating: Pulse width limited by maximum channel temperature.

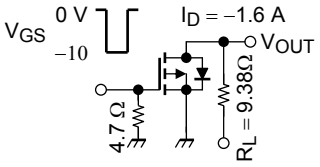
Note 6: "●" on the lower left of the marking indicates Pin 1.

Note 7 A dot marking identifies the indication of product Labels.
Without a dot: [[Pb]]/INCLUDES > MCV
With a dot: [[G]]/RoHS COMPATIBLE or [[G]]/RoHS [[Pb]]

Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product. The RoHS is the Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

P-channel

Electrical Characteristics (Ta = 25°C)

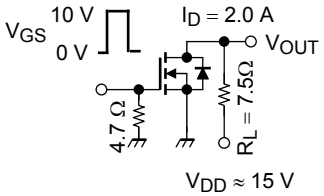
Characteristics		Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current		I_{GSS}	V_{GS} = ±16 V, V_{DS} = 0 V	—	—	±10	μA
Drain cut-off current		I_{DSS}	V_{DS} = −30 V, V_{GS} = 0 V	—	—	−10	μA
Drain-source breakdown voltage		$V_{(BR)\ DSS}$	I_D = −10 mA, V_{GS} = 0 V	−30	—	—	V
		$V_{(BR)\ DSX}$	I_D = −10 mA, V_{GS} = 20 V	−15	—	—	
Gate threshold voltage		V_{th}	V_{DS} = −10 V, I_D = −1 mA	−0.8	—	−2.0	V
Drain-source ON resistance		$R_{DS\ (ON)}$	V_{GS} = −4.5 V, I_D = −1.6A	—	80	105	mΩ
			V_{GS} = −10 V, I_D = −1.6 A	—	60	72	
Forward transfer admittance		$\|Y_{fs}\|$	V_{DS} = −10 V, I_D = −1.6 A	2.9	5.9	—	S
Input capacitance		C_{iss}	V_{DS} = −10 V, V_{GS} = 0 V, f = 1 MHz	—	600	—	pF
Reverse transfer capacitance		C_{rss}		—	60	—	
Output capacitance		C_{oss}		—	70	—	
Switching time	Rise time	t_r	 Duty ≤ 1%, t_w = 10 μs	—	5.3	—	ns
	Turn-on time	t_{on}		—	12	—	
	Fall time	t_f		—	8.4	—	
	Turn-off time	t_{off}		—	34	—	
Total gate charge (gate-source plus gate-drain)		Q_g	V_{DD} ≈ −24 V, V_{GS} = −10 V, I_D = −3.2 A	—	14	—	nC
Gate-source charge 1		Q_{gs1}		—	1.4	—	
Gate-drain (“miller”) charge		Q_{gd}		—	2.7	—	

Source-Drain Ratings and Characteristics (Ta = 25°C)

Characteristics		Symbol	Test Condition	Min	Typ.	Max	Unit
Drain reverse current	Pulse (Note 1)	I_{DRP}	—	—	—	−12.8	A
Forward voltage (diode)		V_{DSF}	I_{DR} = −3.2 A, V_{GS} = 0 V	—	—	1.2	V

N-channel

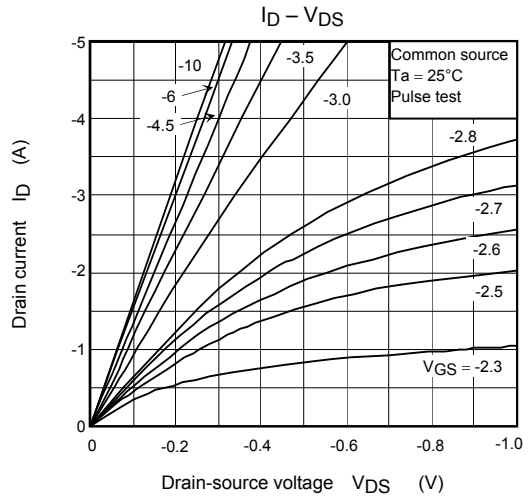
Electrical Characteristics (Ta = 25°C)

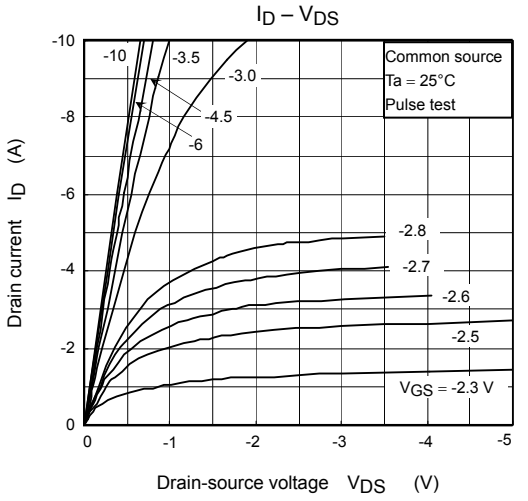
Characteristics		Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current		I_{GSS}	V_{GS} = ±16 V, V_{DS} = 0 V	—	—	±10	μA
Drain cut-off current		I_{DSS}	V_{DS} = 30 V, V_{GS} = 0 V	—	—	10	μA
Drain-source breakdown voltage		$V_{(BR)\ DSS}$	I_D = 10 mA, V_{GS} = 0 V	30	—	—	V
		$V_{(BR)\ DSX}$	I_D = 10 mA, V_{GS} = −20 V	15	—	—	
Gate threshold voltage		V_{th}	V_{DS} = 10 V, I_D = 1 mA	1.3	—	2.5	V
Drain-source ON resistance		$R_{DS\ (ON)}$	V_{GS} = 4.5 V, I_D = 2.0 A	—	58	77	mΩ
			V_{GS} = 10 V, I_D = 2.0 A	—	38	50	
Forward transfer admittance		$\|Y_{fs}\|$	V_{DS} = 10 V, I_D = 2.0 A	3.4	6.8	—	S
Input capacitance		C_{iss}	V_{DS} = 10 V, V_{GS} = 0 V, f = 1 MHz	—	470	—	pF
Reverse transfer capacitance		C_{rss}		—	60	—	
Output capacitance		C_{oss}		—	80	—	
Switching time	Rise time	t_r	 Duty ≤ 1%, t_w = 10 μs	—	5.2	—	ns
	Turn-on time	t_{on}		—	8.3	—	
	Fall time	t_f		—	4.0	—	
	Turn-off time	t_{off}		—	22	—	
Total gate charge (gate-source plus gate-drain)		Q_g	V_{DD} ≈ 24 V, V_{GS} = 10 V, I_D = 4 A	—	10	—	nC
Gate-source charge 1		Q_{gs1}		—	1.7	—	
Gate-drain (“miller”) charge		Q_{gd}		—	2.4	—	

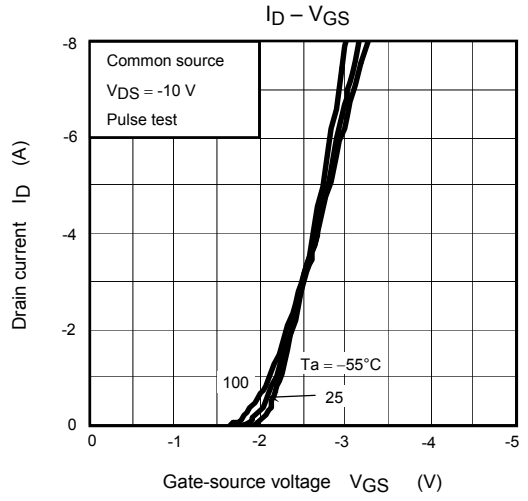
Source−Drain Ratings and Characteristics (Ta = 25°C)

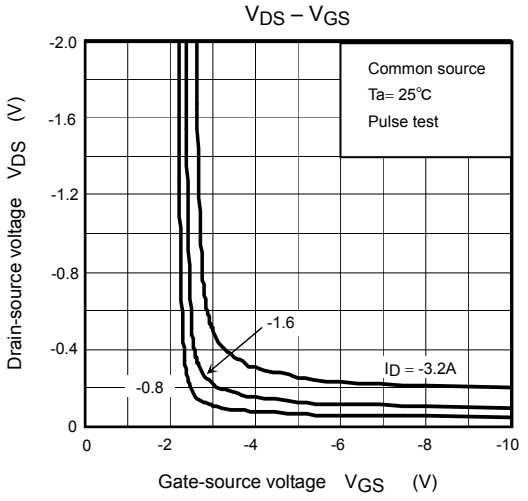
Characteristics		Symbol	Test Condition	Min	Typ.	Max	Unit
Drain reverse current	Pulse (Note 1)	I_{DRP}	—	—	—	16.0	A
Forward voltage (diode)		V_{DSF}	I_{DR} = 4.0 A, V_{GS} = 0 V	—	—	−1.2	V

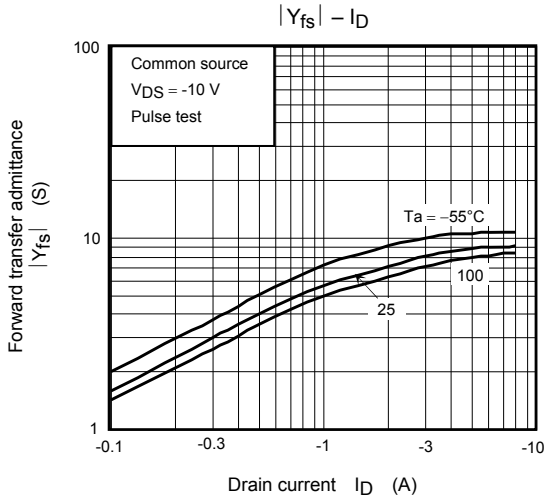
P-channel

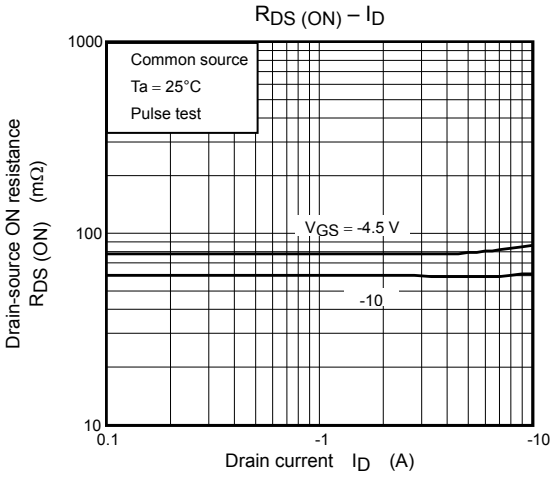

$I_D - V_{DS}$
Common source
Ta = 25°C
Pulse test
-10
-6
-4.5
-3.5
-3.0
-2.8
-2.7
-2.6
-2.5
V_{GS} = -2.3
Drain current I_D (A)
Drain-source voltage V_{DS} (V)


$I_D - V_{DS}$
Common source
Ta = 25°C
Pulse test
-10
-3.5
-3.0
-4.5
-6
-2.8
-2.7
-2.6
-2.5
V_{GS} = -2.3 V
Drain current I_D (A)
Drain-source voltage V_{DS} (V)


$I_D - V_{GS}$
Common source
V_{DS} = -10 V
Pulse test
Ta = −55°C
100
25
Drain current I_D (A)
Gate-source voltage V_{GS} (V)

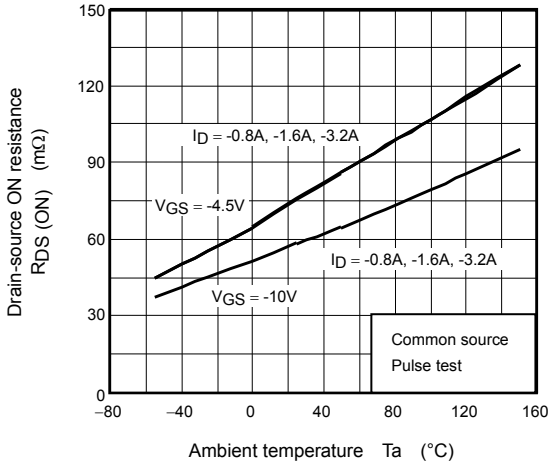

$V_{DS} - V_{GS}$
Common source
Ta= 25°C
Pulse test
-1.6
-0.8
I_D = -3.2A
Drain-source voltage V_{DS} (V)
Gate-source voltage V_{GS} (V)


$|Y_{fs}| - I_D$
Common source
V_{DS} = -10 V
Pulse test
Ta = −55°C
100
25
Forward transfer admittance $|Y_{fs}|$ (S)
Drain current I_D (A)

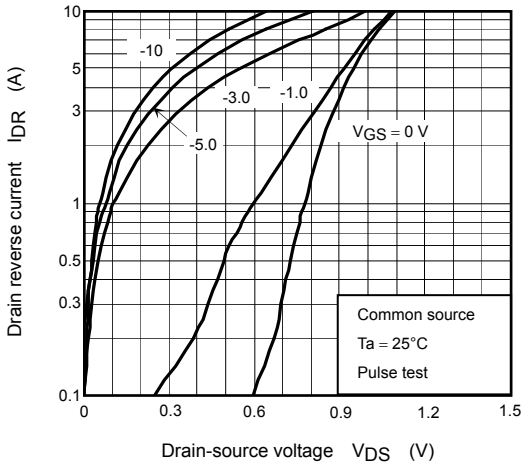

$R_{DS\ (ON)} - I_D$
Common source
Ta = 25°C
Pulse test
V_{GS} = -4.5 V
-10
Drain-source ON resistance $R_{DS\ (ON)}$ (mΩ)
Drain current I_D (A)

P-channel

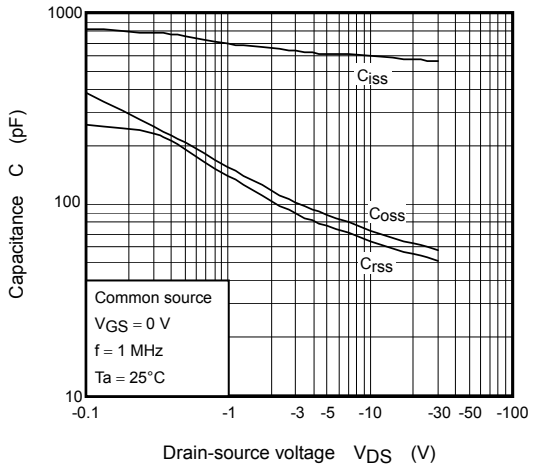
$R_{DS\ (ON)}$ – Ta



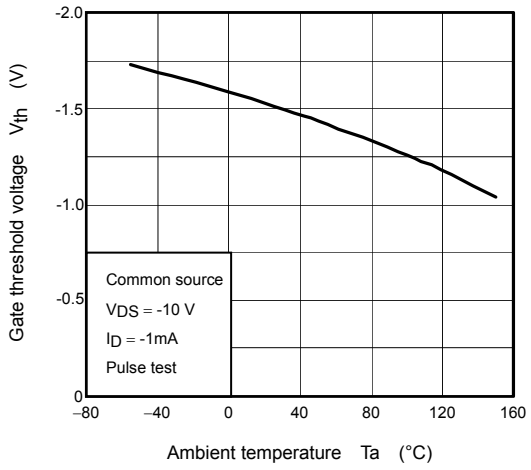
I_{DR} – V_{DS}



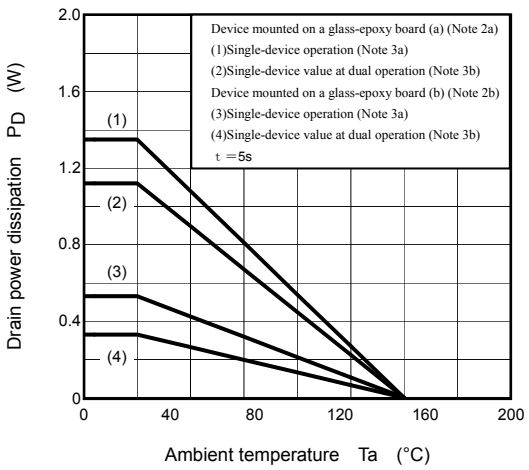
Capacitance – V_{DS}



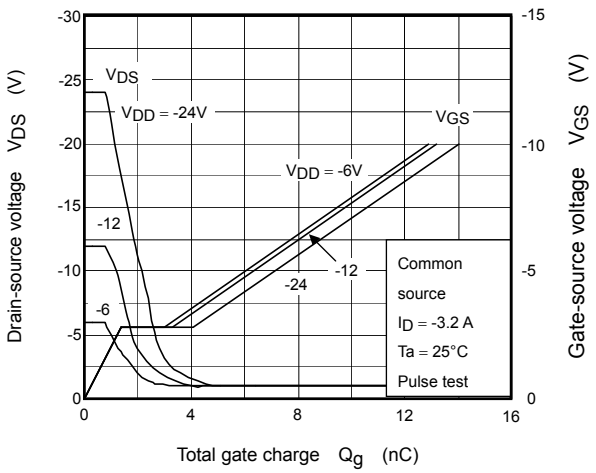
V_{th} – Ta



P_D – Ta

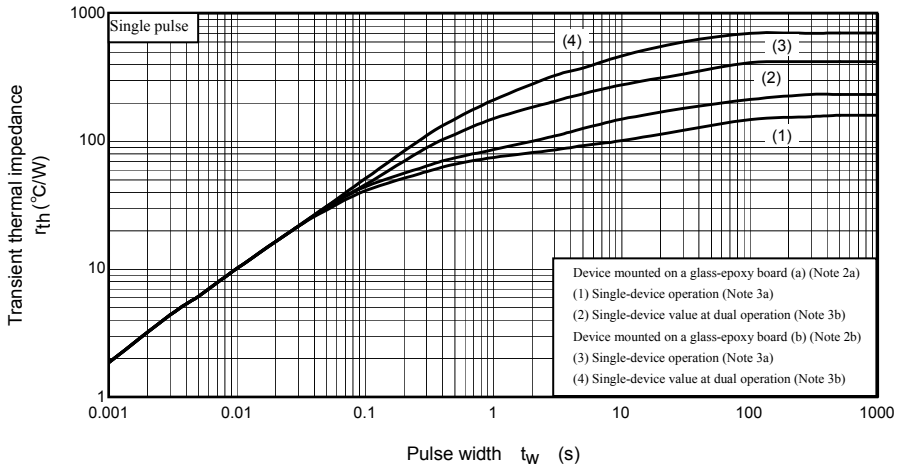


Dynamic input/output characteristics

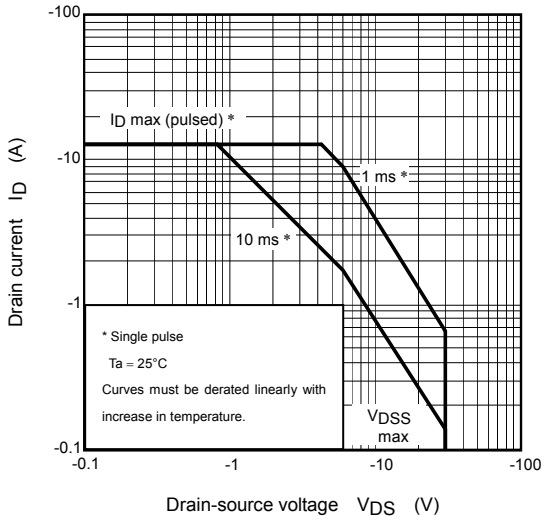


P-channel

$r_{th} - t_w$

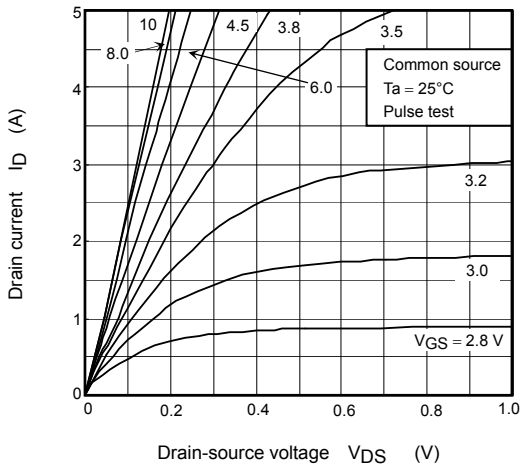


Safe operating area

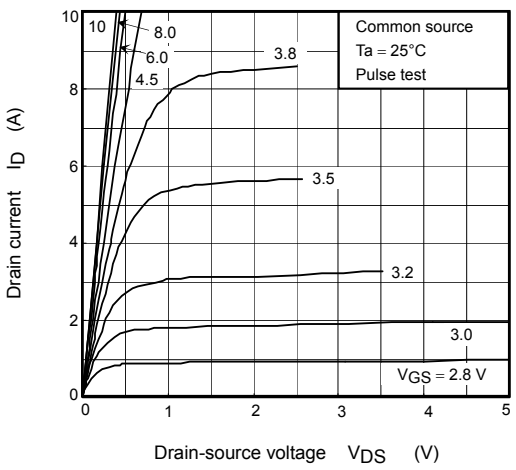


N-channel

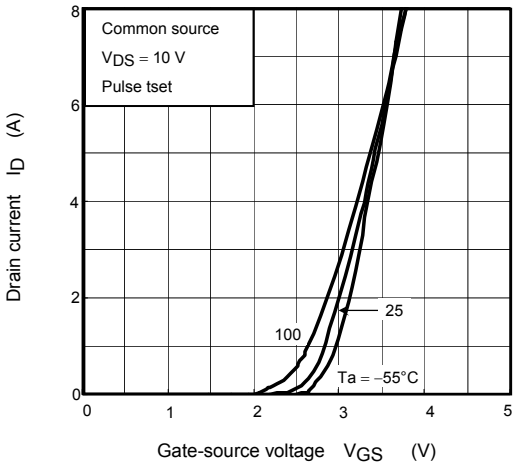
$I_D - V_{DS}$



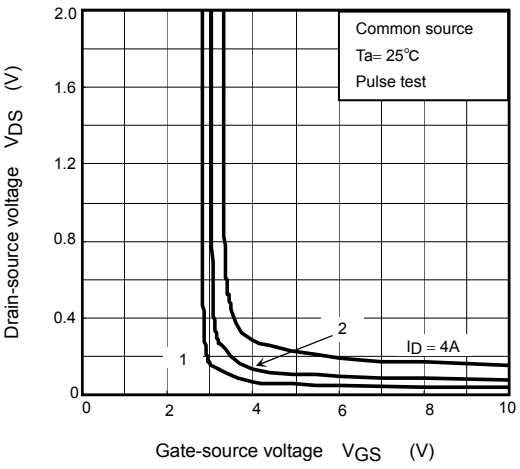
$I_D - V_{DS}$



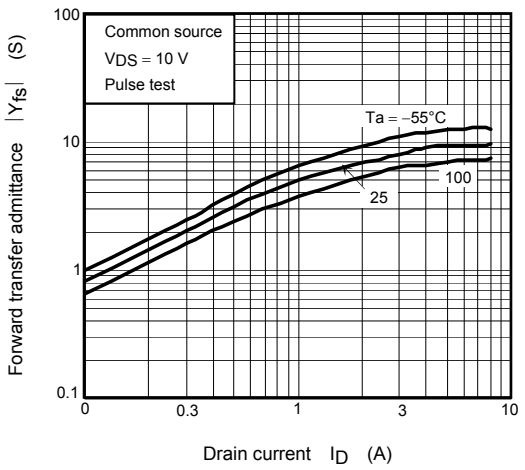
$I_D - V_{GS}$



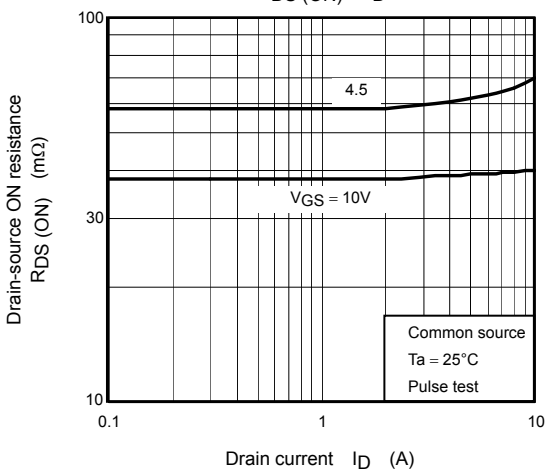
$V_{DS} - V_{GS}$



$|Y_{fs}| - I_D$

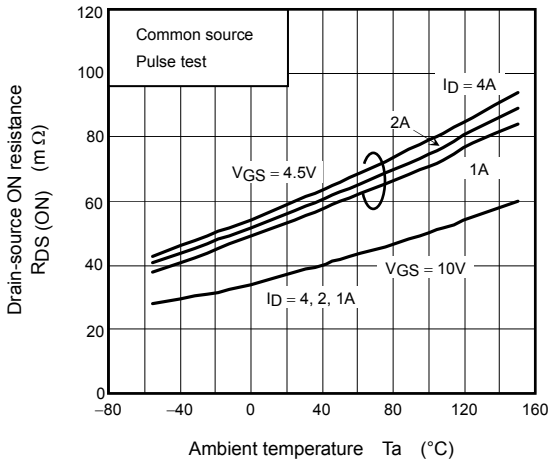


$R_{DS\ (ON)} - I_D$

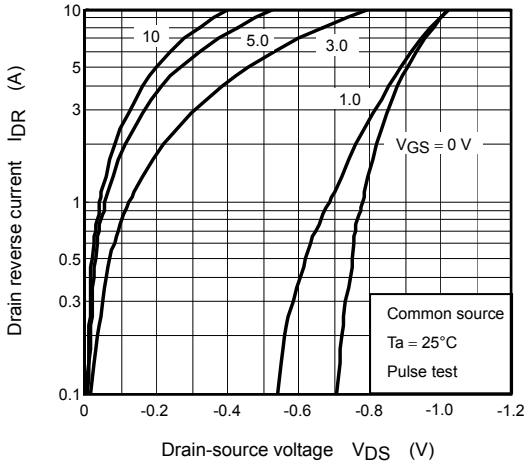


N-channel

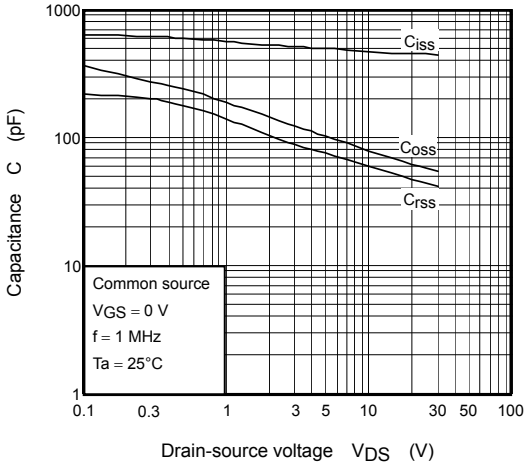
$R_{DS\ (ON)}$ – Ta



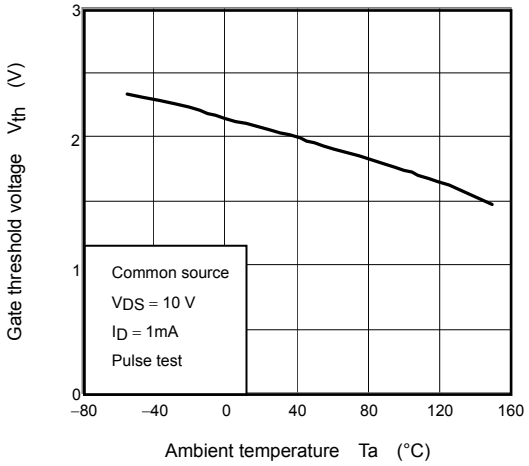
I_{DR} – V_{DS}



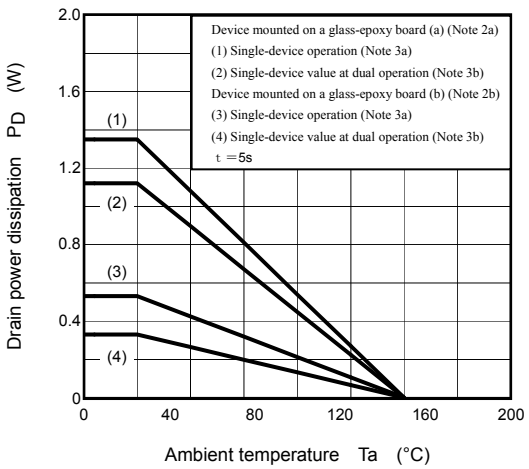
Capacitance – V_{DS}



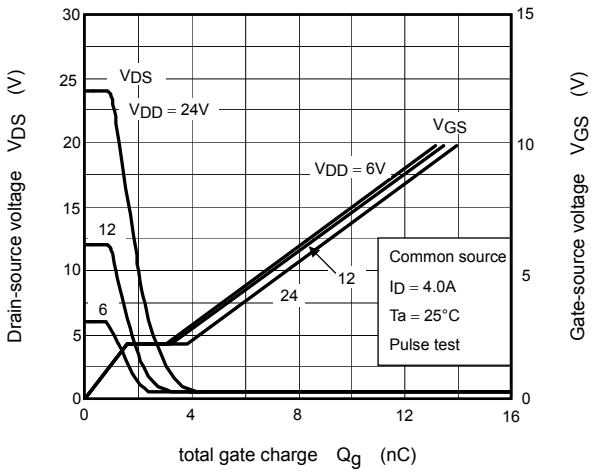
V_{th} – Ta



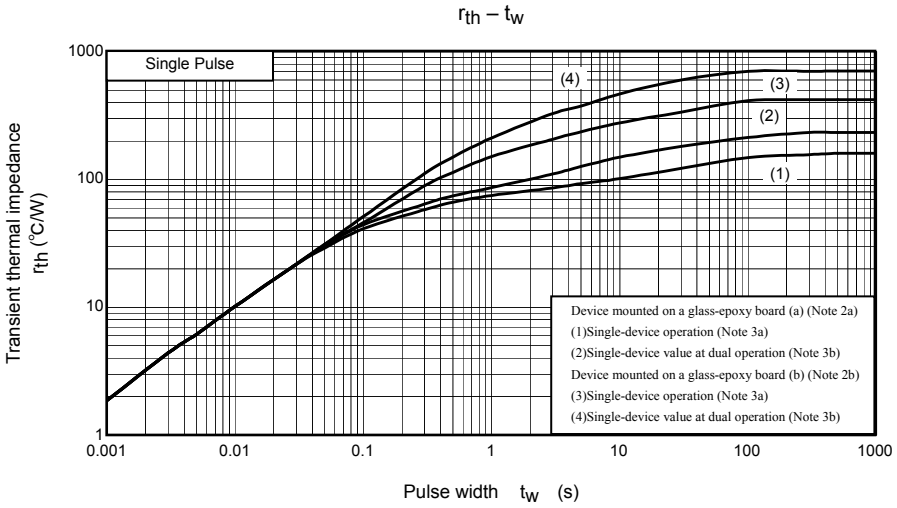
P_D – Ta

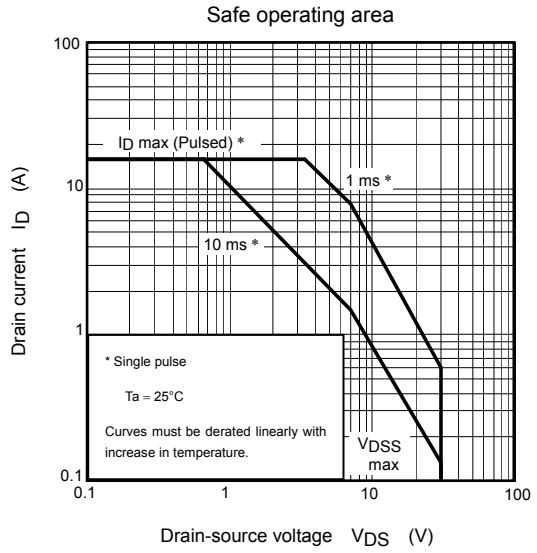


Dynamic input/output characteristics



N-channel


$r_{th} - t_w$
Single Pulse
(4)
(3)
(2)
(1)
Transient thermal impedance r_{th} (°C/W)
1000
100
10
1
0.001
0.01
0.1
1
10
100
1000
Pulse width t_w (s)
Device mounted on a glass-epoxy board (a) (Note 2a)
(1)Single-device operation (Note 3a)
(2)Single-device value at dual operation (Note 3b)
Device mounted on a glass-epoxy board (b) (Note 2b)
(3)Single-device operation (Note 3a)
(4)Single-device value at dual operation (Note 3b)


Safe operating area
I_D max (Pulsed) *
1 ms *
10 ms *
Drain current I_D (A)
100
10
1
0.1
* Single pulse
Ta = 25°C
Curves must be derated linearly with increase in temperature.
V_{DSS} max
0.1
1
10
100
Drain-source voltage V_{DS} (V)

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