TOSHIBA Field Effect Transistor Silicon P/N-Channel MOS Type
(P-Channel／N-Channel Ultra-High-Speed U-MOSIII)

TPC8406-H

High Efficiency DC／DC Converter Applications

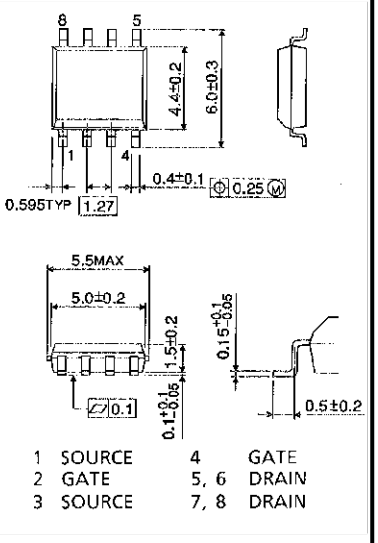
Notebook PC Applications

Portable Equipment Applications

CCFL Inverter Applications

- Small footprint due to a small and thin package
- High speed switching
- Low drain-source ON-resistance: P-Channel $R_{DS\ (ON)}$ = 24 mΩ (typ.)
  N-Channel $R_{DS\ (ON)}$ = 22 mΩ (typ.)
- Small gate charge: P-Channel Q_{SW} = 9.7 nC (typ.)
  N-Channel Q_{SW} = 3.5 nC (typ.)
- High forward transfer admittance: P-Channel $|Y_{fs}|$ = 13 S (typ.)
  N-Channel $|Y_{fs}|$ = 14 S (typ.)
- Low leakage current: P-Channel I_{DSS} = −10 μA (V_{DS} = −40 V)
  N-Channel I_{DSS} = 10 μA (V_{DS} = 40 V)
- Enhancement mode
  : P-Channel V_{th} = −0.8 to −2.0 V (V_{DS} = −10 V, I_D = −1 mA)
  : N-Channel V_{th} = 1.1 to 2.3 V (V_{DS} = 10 V, I_D = 1 mA)

Unit: mm



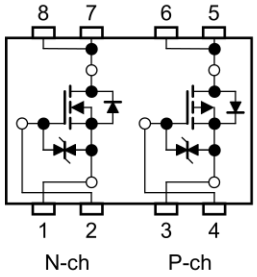
JEDEC	—
JEITA	—
TOSHIBA	2-6J1E

Weight: 0.085 g (typ.)

Absolute Maximum Ratings (Ta = 25°C)

Characteristic		Symbol	Rating		Unit
			P-Channel	N-Channel	
Drain-source voltage		V_{DSS}	−40	40	V
Drain-gate voltage (R_{GS} = 20 kΩ)		V_{DGR}	−40	40	V
Gate-source voltage		V_{GSS}	±20	±20	V
Drain current	DC (Note 1)	I_D	−6.5	6.5	A
	Pulse (Note 1)	I_{DP}	−26	26	
Drain power dissipation (t = 10s) (Note 2a)	Single-device operation (Note 3a)	$P_{D(1)}$	1.5	1.5	W
	Single-device value at dual operation (Note 3b)	$P_{D(2)}$	1.1	1.1	
Drain power dissipation (t = 10s) (Note 2b)	Single-device operation (Note 3a)	$P_{D(1)}$	0.75	0.75	
	Single-device value at dual operation (Note 3b)	$P_{D(2)}$	0.45	0.45	
Single-pulse avalanche energy		E_{AS}	19 (Note 4a)	19 (Note 4b)	mJ
Avalanche current		I_{AR}	−6.5	6.5	A
Repetitive avalanche energy Single-device value at operation (Note 2a, 3b, 5)		E_{AR}	0.08		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.

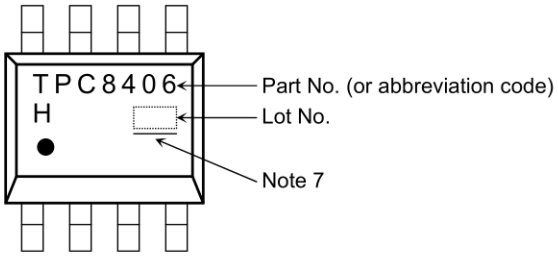
Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within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

Thermal Characteristics

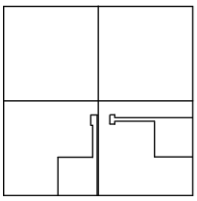
Characteristic		Symbol	Max	Unit
Thermal resistance, channel to ambient (t = 10s) (Note 2a)	Single-device operation (Note 3a)	$R_{th\ (ch\text{-}a)\ (1)}$	83.3	°C/W
	Single-device value at dual operation (Note 3b)	$R_{th\ (ch\text{-}a)\ (2)}$	114	
Thermal resistance, channel to ambient (t = 10s) (Note 2b)	Single-device operation (Note 2a)	$R_{th\ (ch\text{-}a)\ (1)}$	167	
	Single-device value at dual operation (Note 2b)	$R_{th\ (ch\text{-}a)\ (2)}$	278	

Marking (Note 6)



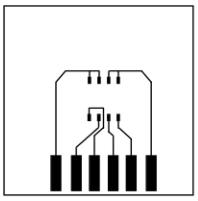
Note 1: The channel temperature should not exceed 150°C during use.

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 applied to one device only.).

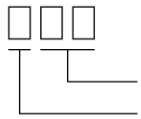
b) The power dissipation and thermal resistance values are shown for a single device (During dual operation, power is evenly applied to both devices.).

Note 4: a) V_{DD} = 24 V, T_{ch} = 25°C (initial), L = 0.5 mH, R_G = 25 Ω, I_{AR} = 6.5 A
b) V_{DD} = 24 V, T_{ch} = 25°C (initial), L = 0.5 mH, R_G = 25 Ω, I_{AR} = 6.5 A

Note 5: Repetitive rating: pulse width limited by maximum channel temperature

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

* Weekly code: (Three digits)



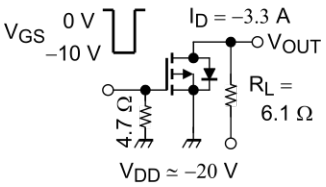
Week of manufacture
(01 for first week of year, continuing up to 52 or 53)

Year of manufacture
(The last digit of the calendar year)

Note 7: A line under a Lot No. identifies the indication of product Labels.
Not underlined: [[Pb]]/INCLUDES > MCV
Underlined: [[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.

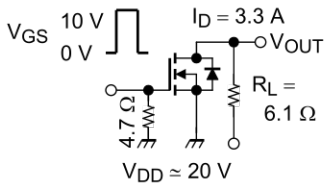
P-Channel Electrical Characteristics (Ta = 25°C)

Characteristic		Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current		I_{GSS}	V_{GS} = ±16 V, V_{DS} = 0 V	—	—	±10	μA
Drain cutoff current		I_{DSS}	V_{DS} = −40 V, V_{GS} = 0 V	—	—	−10	μA
Drain-source breakdown voltage		$V_{(BR)\ DSS}$	I_D = −10 mA, V_{GS} = 0 V	−40	—	—	V
		$V_{(BR)\ DSX}$	I_D = −10 mA, V_{GS} = 20 V	−20	—	—	
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 = − 3.3 A	—	29	37	mΩ
			V_{GS} = −10 V, I_D = − 3.3 A	—	24	30	
Forward transfer admittance		$\|Y_{fs}\|$	V_{DS} = −10 V, I_D = − 3.3 A	6.5	13	—	S
Input capacitance		C_{iss}	V_{DS} = −10 V, V_{GS} = 0 V, f = 1 MHz	—	1190	—	pF
Reverse transfer capacitance		C_{rss}		—	170	—	
Output capacitance		C_{oss}		—	250	—	
Switching time	Rise time	t_r	 Duty ≦ 1%, t_w = 10 μs	—	5	—	ns
	Turn-on time	t_{on}		—	12	—	
	Fall time	t_f		—	12	—	
	Turn-off time	t_{off}		—	43	—	
Total gate charge (gate-source plus gate-drain)		Q_g	V_{DD} ≃ −32 V, V_{GS} =−10V I_D = −6.5 A	—	27	—	nC
			V_{DD} ≃ −32 V, V_{GS} = −5 V I_D = − 6.5 A	—	15	—	
Gate-source charge 1		Q_{gs1}	V_{DD} ≃ −32 V, V_{GS} = −10 V I_D = − 6.5 A	—	3.2	—	
Gate-drain (“Miller”) charge		Q_{gd}		—	8.1	—	
Gate switch charge		Q_{SW}		—	9.7	—	

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

Characteristic		Symbol	Test Condition	Min	Typ.	Max	Unit
Drain reverse current	Pulse (Note 1)	I_{DRP}	—	—	—	−26	A
Forward voltage (diode)		V_{DSF}	I_{DR} = −6.5 A, V_{GS} = 0 V	—	—	1.2	V

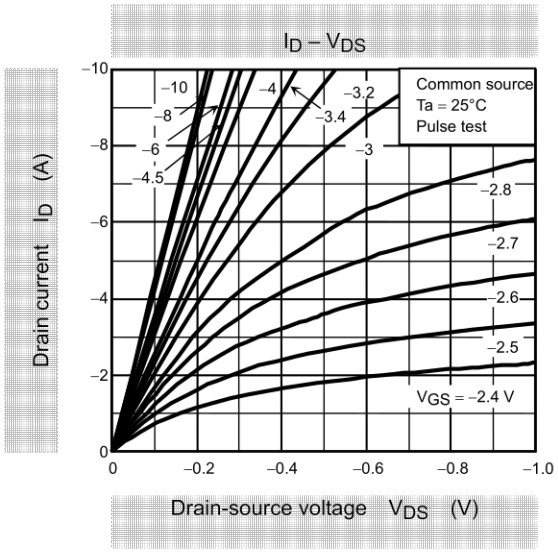
N-channel Electrical Characteristics (Ta = 25°C)

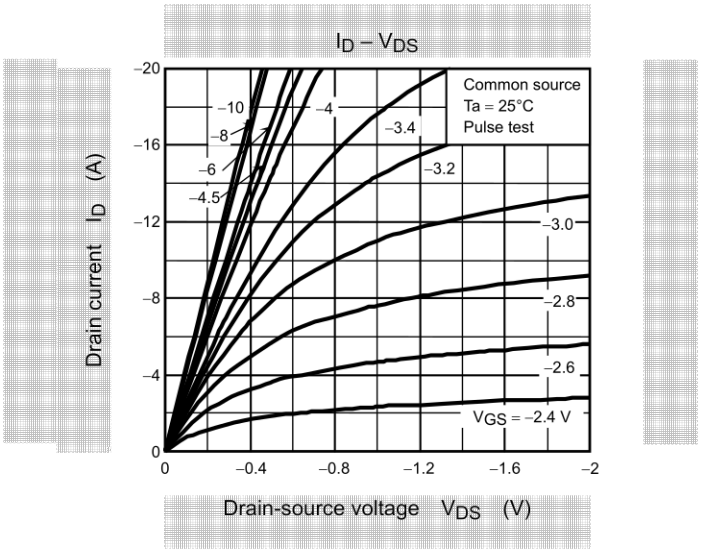
Characteristic		Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current		I_{GSS}	V_{GS} = ±16 V, V_{DS} = 0 V	—	—	±10	μA
Drain cutoff current		I_{DSS}	V_{DS} = 40 V, V_{GS} = 0 V	—	—	10	μA
Drain-source breakdown voltage		$V_{(BR)\ DSS}$	I_D = 10 mA, V_{GS} = 0 V	40	—	—	V
		$V_{(BR)\ DSX}$	I_D = 10 mA, V_{GS} = −20 V	25	—	—	
Gate threshold voltage		V_{th}	V_{DS} = 10 V, I_D = 1 mA	1.1	—	2.3	V
Drain-source ON-resistance		$R_{DS\ (ON)}$	V_{GS} = 4.5 V, I_D = 3.3 A	—	27	35	mΩ
			V_{GS} = 10 V, I_D = 3.3 A	—	22	27	
Forward transfer admittance		$\|Y_{fs}\|$	V_{DS} = 10 V, I_D = 3.3 A	7	14	—	S
Input capacitance		C_{iss}	V_{DS} = 10 V, V_{GS} = 0 V, f = 1 MHz	—	650	—	pF
Reverse transfer capacitance		C_{rss}		—	55	—	
Output capacitance		C_{oss}		—	240	—	
Switching time	Rise time	t_r		—	3	—	ns
	Turn-on time	t_{on}		—	9	—	
	Fall time	t_f		—	2	—	
	Turn-off time	t_{off}	Duty ≦ 1%, t_w = 10 μs	—	18	—	
Total gate charge (gate-source plus gate-drain)		Q_g	V_{DD} ≃ 32 V, V_{GS} =10V, I_D = 6.5A	—	11	—	nC
			V_{DD} ≃ 32 V, V_{GS} = 5 V,I_D = 6.5A	—	6.2	—	
Gate-source charge 1		Q_{gs1}	V_{DD} ≃ 32 V, V_{GS} = 10 V, I_D = 6.5A	—	2.1	—	
Gate-drain (“Miller”) charge		Q_{gd}		—	2.7	—	
Gate switch charge		Q_{SW}		—	3.5	—	

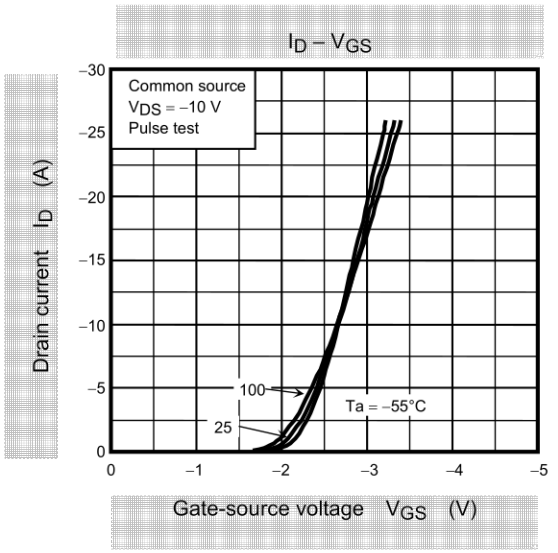
Source-Drain Ratings and Characteristics (Ta = 25°C)

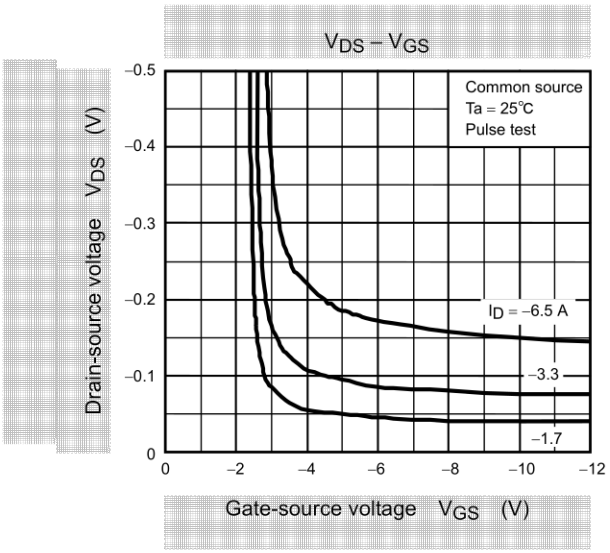
Characteristic		Symbol	Test Condition	Min	Typ.	Max	Unit
Drain reverse current	Pulse (Note 1)	I_{DRP}	—	—	—	26	A
Forward voltage (diode)		V_{DSF}	I_{DR} = 6.5 A, V_{GS} = 0 V	—	—	−1.2	V

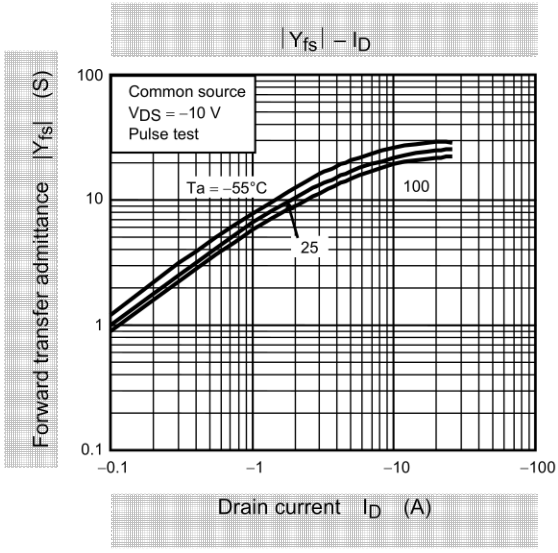
P-Channel

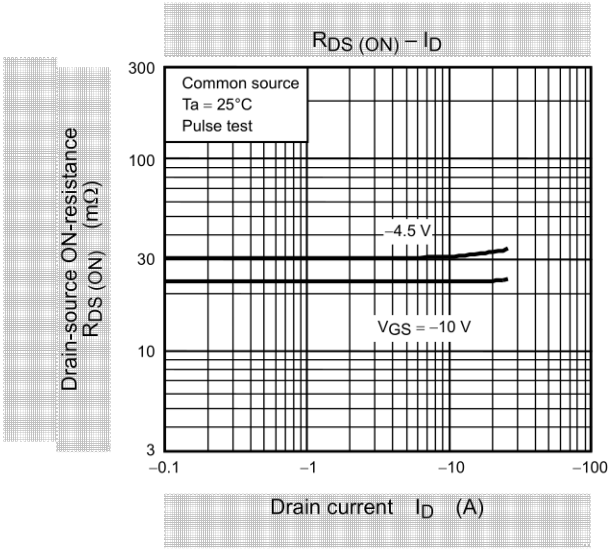

$I_D - V_{DS}$
Common source
Ta = 25°C
Pulse test
−10
−8
−6
−4.5
−4
−3.4
−3.2
−3
−2.8
−2.7
−2.6
−2.5
V_{GS} = −2.4 V
Drain current I_D (A)
Drain-source voltage V_{DS} (V)


$I_D - V_{DS}$
Common source
Ta = 25°C
Pulse test
−10
−8
−6
−4.5
−4
−3.4
−3.2
−3.0
−2.8
−2.6
V_{GS} = −2.4 V
Drain current I_D (A)
Drain-source voltage V_{DS} (V)


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

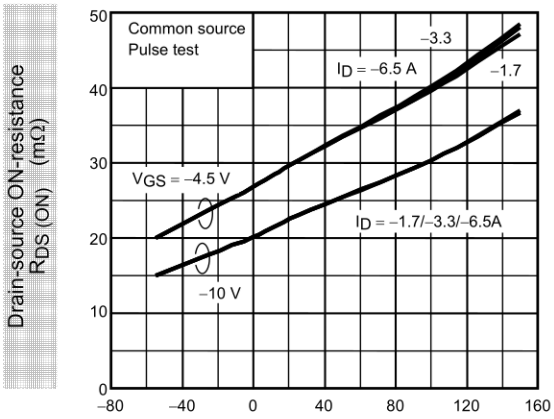

$V_{DS} - V_{GS}$
Common source
Ta = 25°C
Pulse test
I_D = −6.5 A
−3.3
−1.7
Drain-source voltage V_{DS} (V)
Gate-source voltage V_{GS} (V)


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

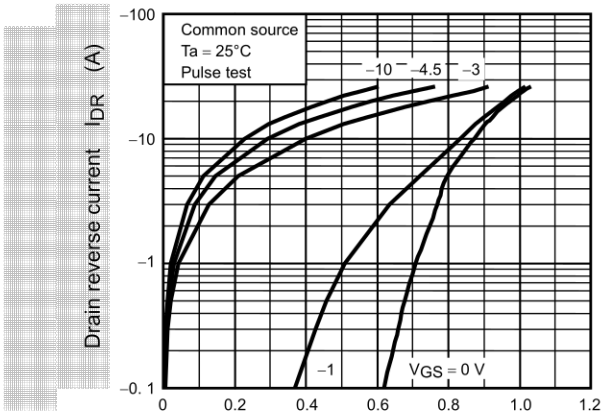

$R_{DS\ (ON)} - I_D$
Common source
Ta = 25°C
Pulse test
−4.5 V
V_{GS} = −10 V
Drain-source ON-resistance $R_{DS\ (ON)}$ (mΩ)
Drain current I_D (A)

P-Channel

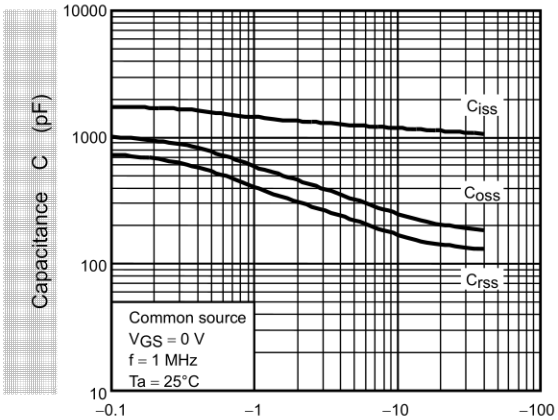
$R_{DS\ (ON)}$ – Ta



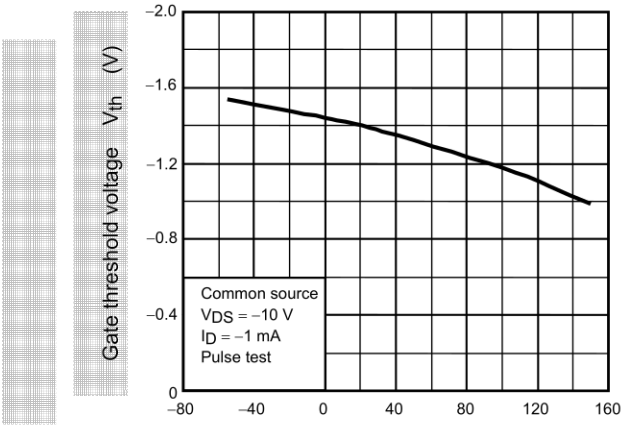
I_{DR} – V_{DS}



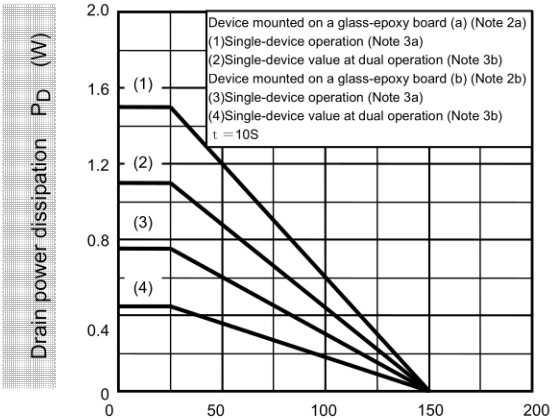
Capacitance – V_{DS}



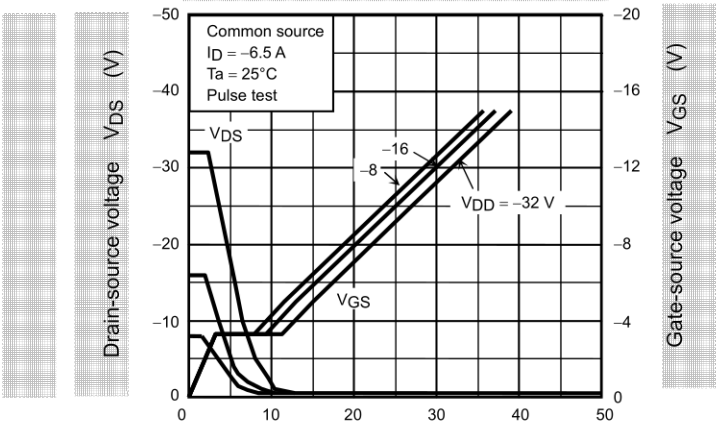
V_{th} – Ta



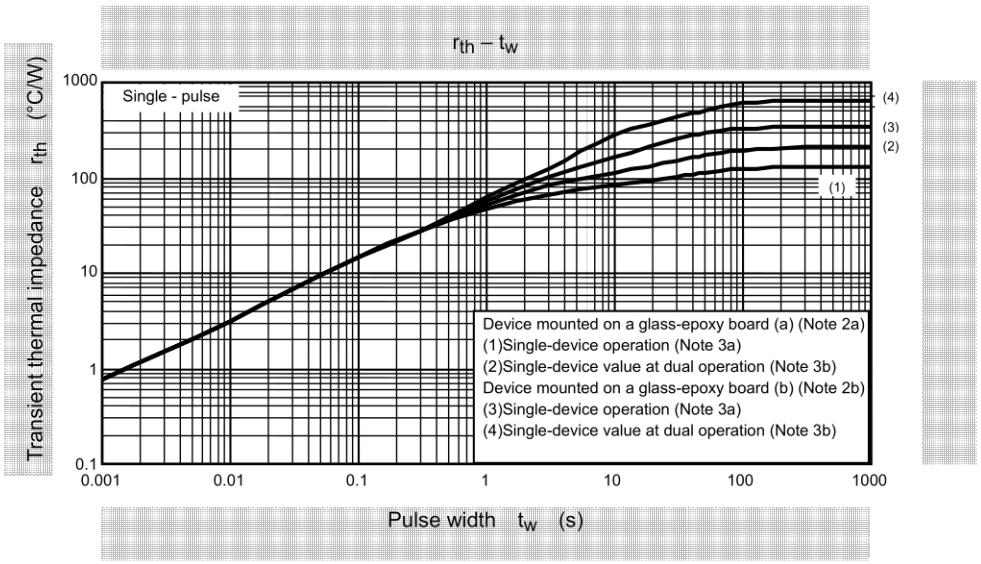
P_D – Ta

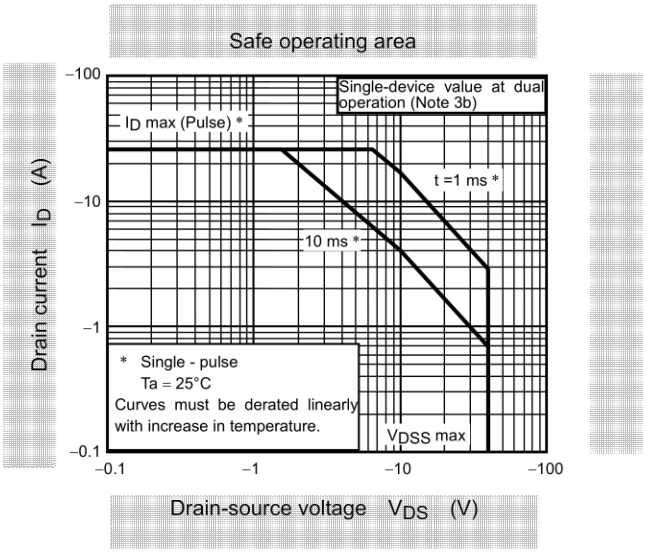


Dynamic input/output characteristics



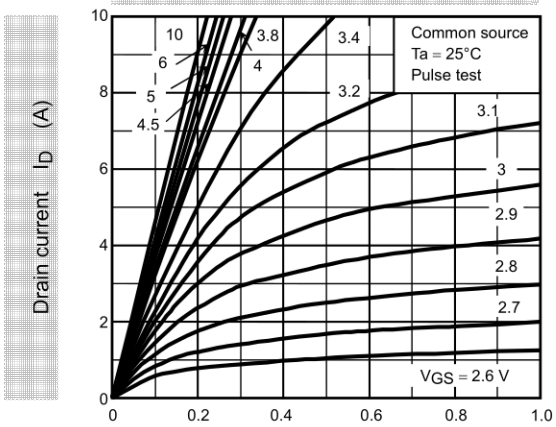
P-Channel


$r_{th} - t_w$
Transient thermal impedance r_{th} (°C/W)
1000
100
10
1
0.1
0.001
0.01
0.1
1
10
100
1000
Single - pulse
(4)
(3)
(2)
(1)
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)
Pulse width t_w (s)

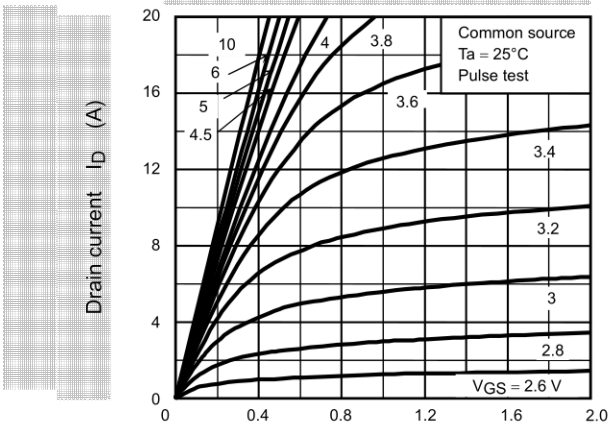

Safe operating area
Drain current I_D (A)
−100
−10
−1
−0.1
−0.1
−1
−10
−100
Single-device value at dual operation (Note 3b)
I_D max (Pulse) *
t =1 ms *
10 ms *
* Single - pulse
Ta = 25°C
Curves must be derated linearly with increase in temperature.
V_{DSS} max
Drain-source voltage V_{DS} (V)

N-Channel

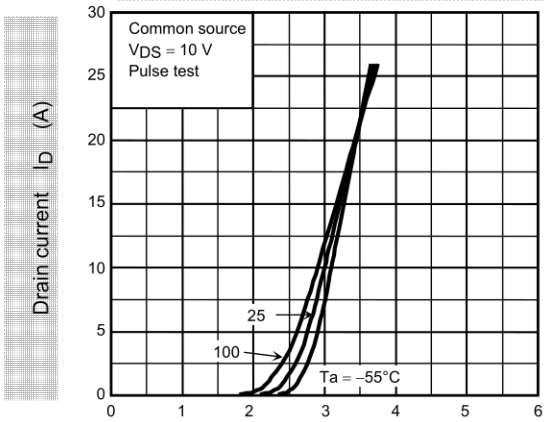
$I_D - V_{DS}$



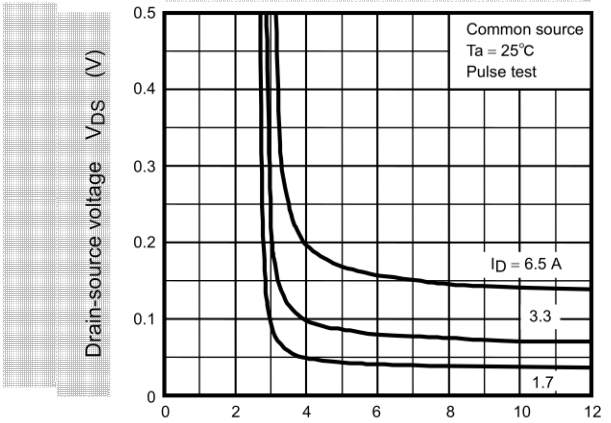
$I_D - V_{DS}$



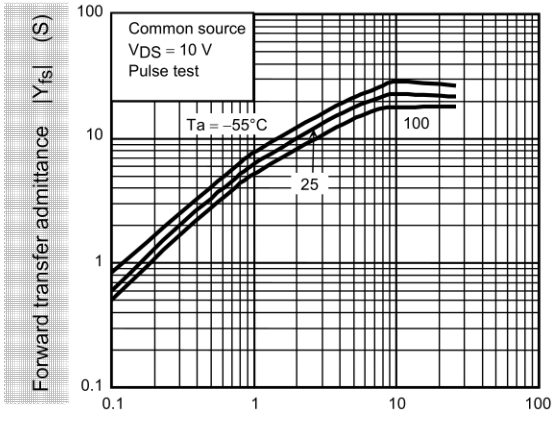
$I_D - V_{GS}$



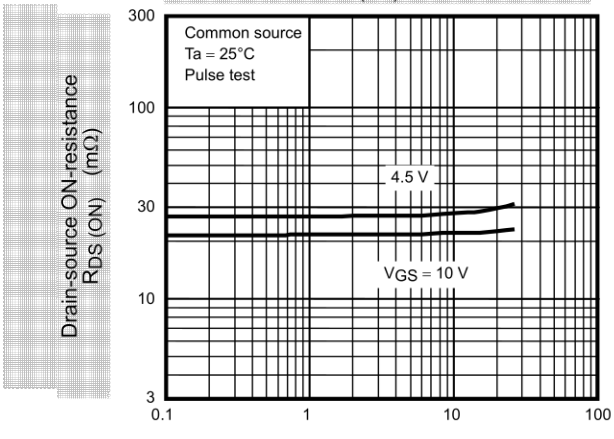
$V_{DS} - V_{GS}$



$|Y_{fs}| - I_D$

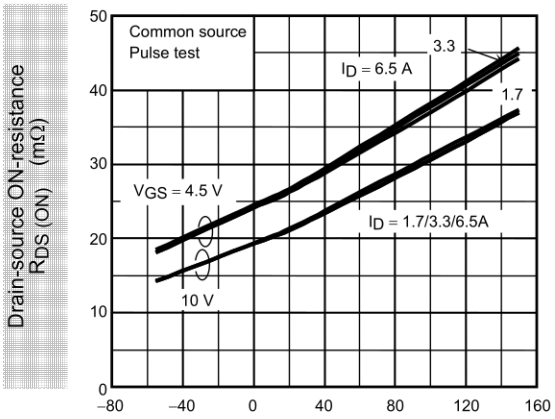


$R_{DS\ (ON)} - I_D$

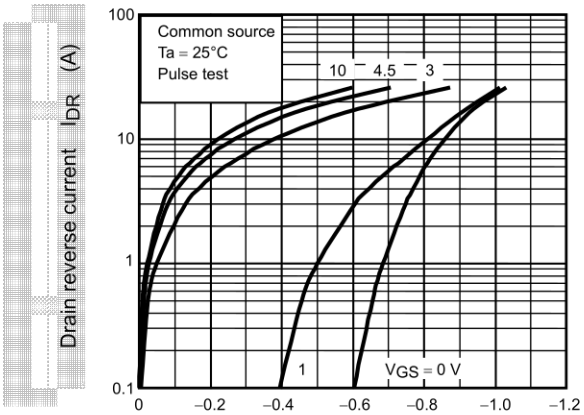


N-Channel

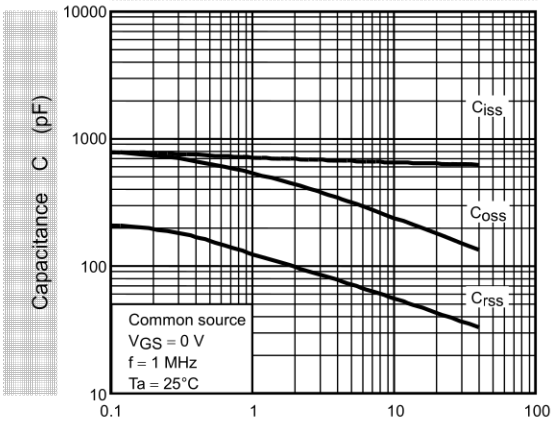
$R_{DS\ (ON)}$ – Ta



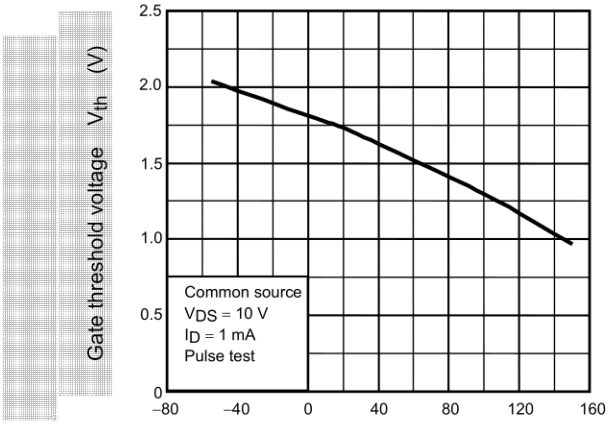
I_{DR} – V_{DS}



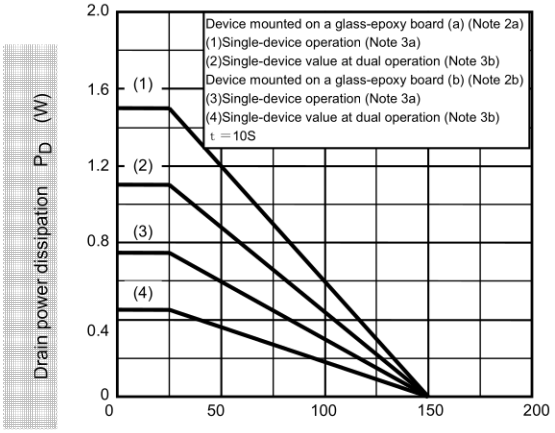
Capacitance – V_{DS}



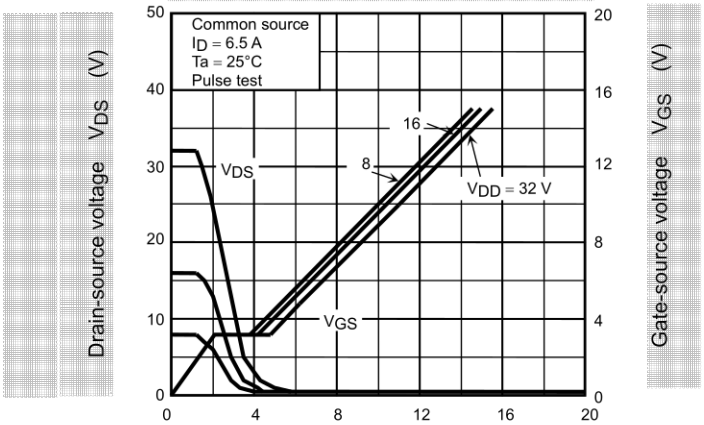
V_{th} – Ta



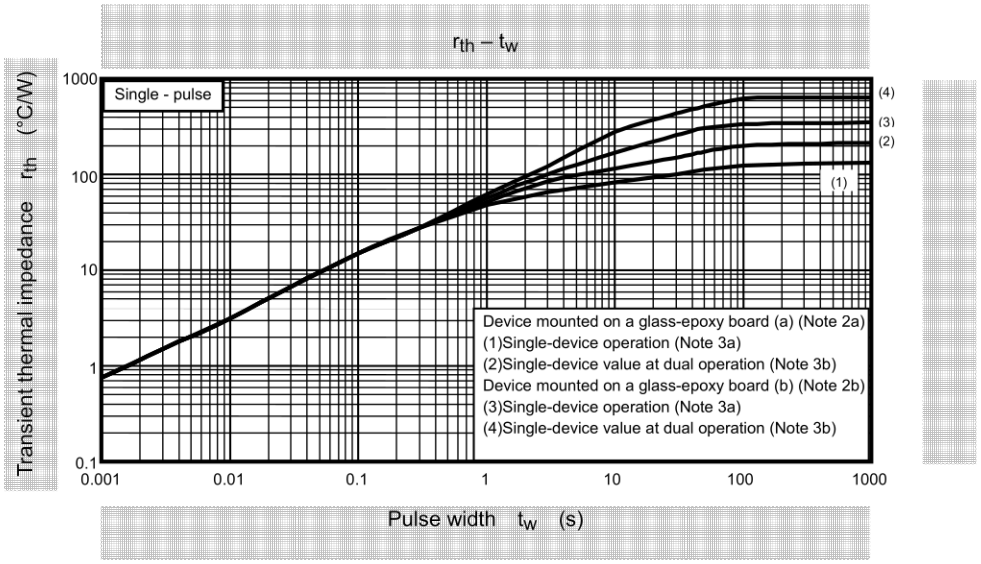
P_D – Ta

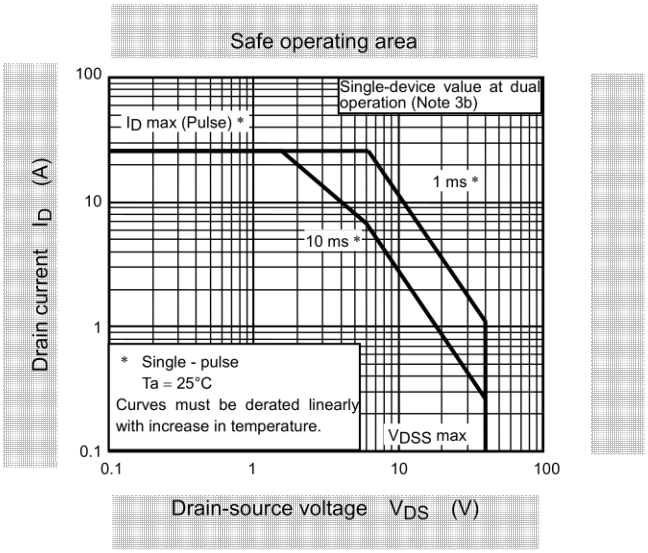


Dynamic input/output characteristics



N-Channel


$r_{th} - t_w$
Transient thermal impedance r_{th} (°C/W)
1000
100
10
1
0.1
0.001
0.01
0.1
1
10
100
1000
Single - pulse
(4)
(3)
(2)
(1)
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)
Pulse width t_w (s)


Safe operating area
Drain current I_D (A)
100
10
1
0.1
0.1
1
10
100
Single-device value at dual operation (Note 3b)
I_D max (Pulse) *
1 ms *
10 ms *
* Single - pulse
Ta = 25°C
Curves must be derated linearly with increase in temperature.
V_{DSS} max
Drain-source voltage V_{DS} (V)

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