TOSHIBA Field Effect Transistor Silicon N, P Channel MOS Type (π−MOSVI/U−MOSII)

TPC8402

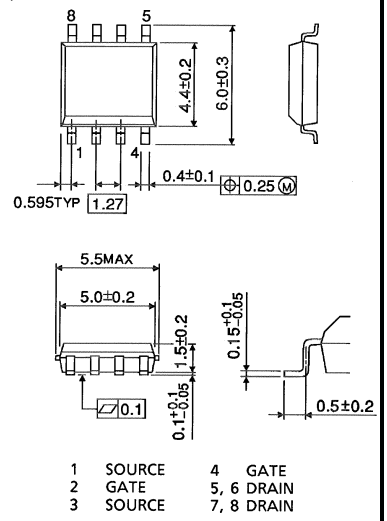
Lithium Ion Secondary Battery Applications

Notebook PCs

Portable Equipment Applications

- Low drain−source ON resistance
  : P Channel $R_{DS\ (ON)}$ = 27 mΩ (typ.)
  N Channel $R_{DS\ (ON)}$ = 37 mΩ (typ.)
- High forward transfer admittance
  : P Channel $|Y_{fs}|$ = 7 S (typ.)
  N Channel $|Y_{fs}|$ = 6 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~ −2.0 V (V_{DS} = −10 V, I_D = −1mA)
  N Channel V_{th} = 0.8~2.0 V (V_{DS} = 10 V, I_D = 1mA)

Unit: mm



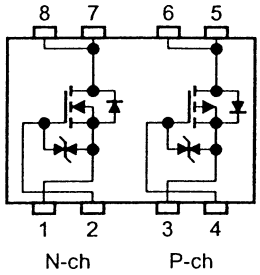
JEDEC	—
JEITA	—
TOSHIBA	2-6J1E

Weight: 0.080 g (typ.)

Maximum Ratings (Ta = 25°C)

Characteristics		Symbol	Rating		Unit
			P Channel	N Channel	
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	−4.5	5	A
	Pulse (Note 1)	I_{DP}	−18	20	
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)	$P_{D\ (2)}$	1.0	1.0	
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}	26.3 (Note 4a)	32.5 (Note 4b)	mJ
Avalanche current		I_{AR}	−4.5	5	A
Repetitive avalanche energy Single-device value at operation (Note 2a, Note 3b, Note 5)		E_{AR}	0.10		mJ
Channel temperature		T_{ch}	150		°C
Storage temperature range		T_{stg}	−55~150		°C

Circuit Configuration



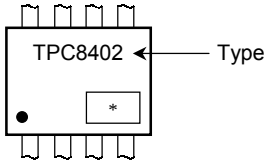
Note: For (Note 1), (Note 2a), (Note 2b), (Note 3a), (Note 3b), (Note 4a), (Note 4b) and (Note 5), please refer to the next page.

This transistor is an electrostatic sensitive device. Please handle with caution.

Thermal Characteristics

Characteristics		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)	$R_{th\ (ch\text{-}a)\ (2)}$	125	
Thermal resistance, channel to ambient (t = 10s) (Note 2b)	Single-device operation (Note 3a)	$R_{th\ (ch\text{-}a)\ (1)}$	167	
	Single-device value at dual operation (Note 3b)	$R_{th\ (ch\text{-}a)\ (2)}$	278	

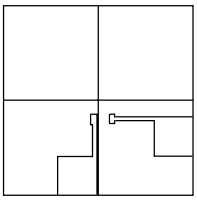
Marking



Note 1: Please use devices on condition that the channel temperature is below 150°C.

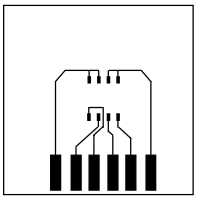
Note 2:

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:

a) V_{DD} = −24 V, T_{ch} = 25°C (Initial), L = 1.0 mH, R_G = 25 Ω, I_{AR} = −4.5 A

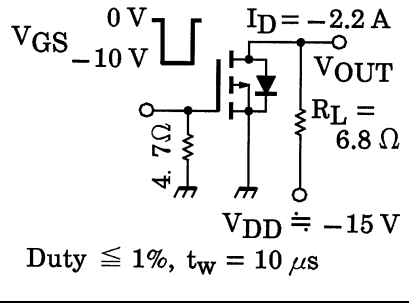
b) V_{DD} = 24 V, T_{ch} = 25°C (Initial), L = 1.0 mH, R_G = 25 Ω, I_{AR} = 5.0 A

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

Note 6: • on lower left of the marking indicates Pin 1.
* shows lot number. (year of manufacture: last decimal digit of the year of manufacture, month of manufacture: January to December are denoted by letters A to L respectively.)

P-0ch

Electrical Characteristics (Ta = 25°C)

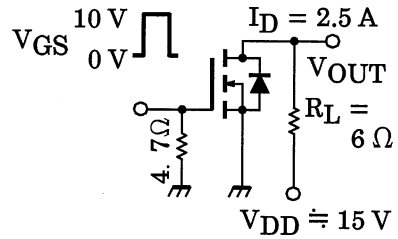
Characteristics		Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current		I_{GSS}	V_{GS} = ±16 V, V_{DS} = 0 V	—	—	±10	μA
Drain cut−OFF current		I_{DSS}	V_{DS} = −30 V, V_{GS} = 0 V	—	—	−10	μA
Drain−source breakdown voltage		$V_{(BR)\ DSS}$	I_D = −10 mA, V_{GS} = 0 V	−30	—	—	V
		$V_{(BR)\ DSX}$	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 V, I_D = −2.2 A	—	55	65	mΩ
		$R_{DS\ (ON)}$	V_{GS} = −10 V, I_D = −2.2 A	—	27	35	
Forward transfer admittance		$\|Y_{fs}\|$	V_{DS} = −10 V, I_D = −2.2 A	3.5	7	—	S
Input capacitance		C_{iss}	V_{DS} = −10 V, V_{GS} = 0 V, f = 1 MHz	—	970	—	pF
Reverse transfer capacitance		C_{rss}		—	180	—	
Output capacitance		C_{oss}		—	370	—	
Switching time	Rise time	t_r		—	17	—	ns
	Turn−ON time	t_{on}		—	20	—	
	Fall time	t_f		—	75	—	
	Turn−OFF time	t_{off}		—	160	—	
Total gate charge (Gate−source plus gate−drain)		Q_g	V_{DD} ≈ −24 V, V_{GS} = −10 V, I_D = −4.5 A	—	28	—	nC
Gate−source charge 1		Q_{gs1}		—	6	—	
Gate−drain (“miller”) charge		Q_{gd}		—	12	—	

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

Characteristics		Symbol	Test Condition	Min	Typ.	Max	Unit
Drain reverse current	Pulse (Note 1)	I_{DRP}	—	—	—	−18	A
Forward voltage (diode)		V_{DSF}	I_{DR} = −4.5 A, V_{GS} = 0 V	—	—	1.2	V

N-ch

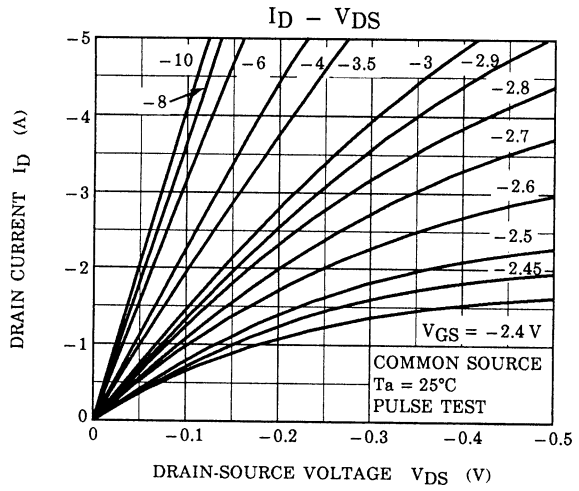
Electrical Characteristics (Ta = 25°C)

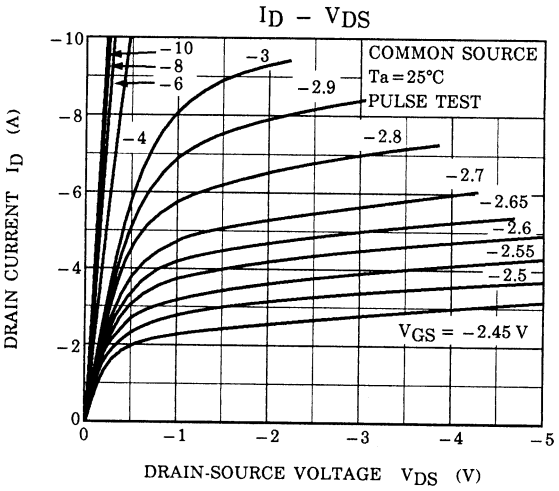
Characteristics		Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current		I_{GSS}	V_{GS} = ±16 V, V_{DS} = 0 V	—	—	±10	μA
Drain cut−OFF current		I_{DSS}	V_{DS} = 30 V, V_{GS} = 0 V	—	—	10	μA
Drain−source breakdown voltage		$V_{(BR)\ DSS}$	I_D = 10 mA, V_{GS} = 0 V	30	—	—	V
Gate threshold voltage		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 V, I_D = 2.5 A	—	58	80	mΩ
		$R_{DS\ (ON)}$	V_{GS} = 10 V, I_D = 2.5 A	—	37	50	mΩ
Forward transfer admittance		$\|Y_{fs}\|$	V_{DS} = 10 V, I_D = 2.5 A	3	6	—	S
Input capacitance		C_{iss}	V_{DS} = 10 V, V_{GS} = 0 V, f = 1 MHz	—	475	—	pF
Reverse transfer capacitance		C_{rss}		—	85	—	
Output capacitance		C_{oss}		—	270	—	
Switching time	Rise time	t_r		—	10	—	ns
	Turn−ON time	t_{on}		—	16	—	
	Fall time	t_f		—	13	—	
	Turn−OFF time	t_{off}		—	70	—	
Total gate charge (Gate−source plus gate−drain)		Q_g	V_{DD} ≈ 24 V, V_{GS} = 10 V, I_D = 5 A	—	16	—	nC
Gate−source charge 1		Q_{gs1}		—	11	—	
Gate−drain (“miller”) charge		Q_{gd}		—	5	—	

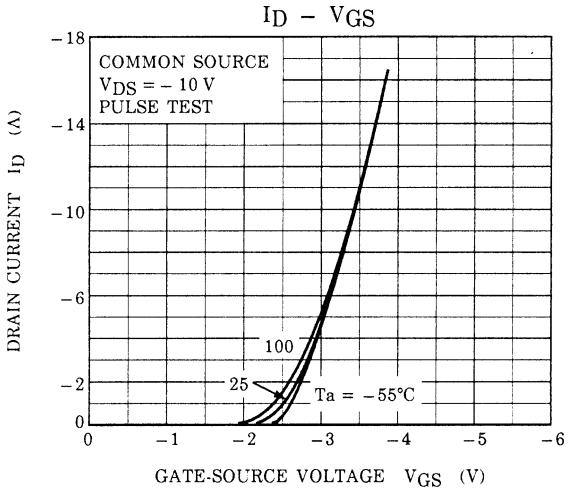
Source−Drain Ratings and Characteristics (Ta = 25°C)

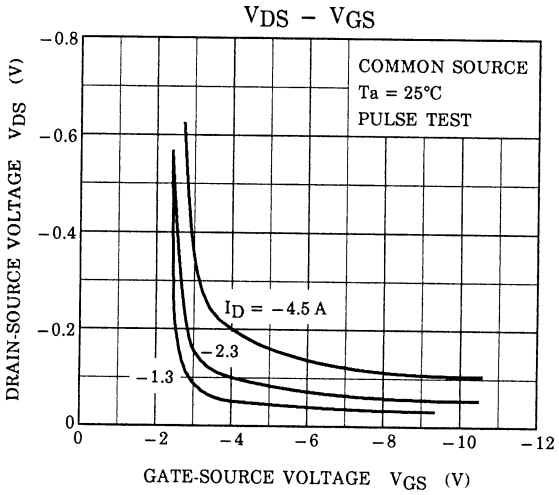
Characteristics		Symbol	Test Condition	Min	Typ.	Max	Unit
Drain reverse current	Pulse (Note 1)	I_{DRP}	—	—	—	20	A
Forward voltage (diode)		V_{DSF}	I_{DR} = 6 A, V_{GS} = 0 V	—	—	−1.2	V

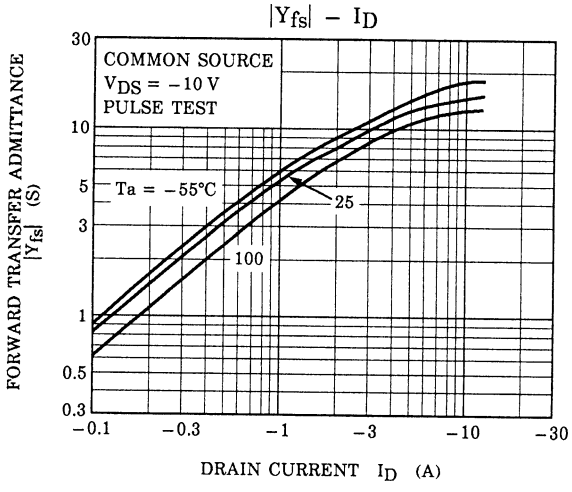
P-ch

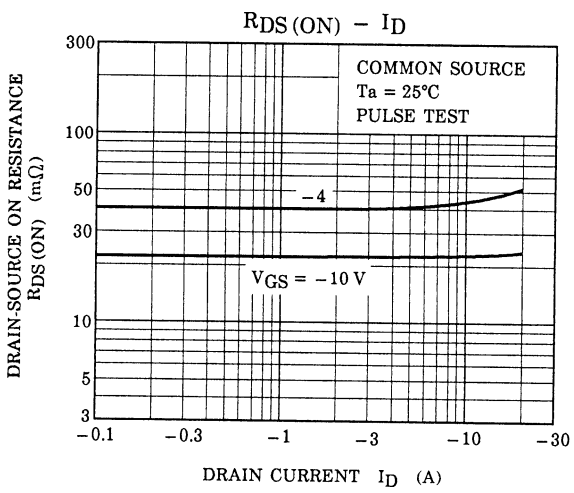

I_D – V_{DS}
DRAIN CURRENT I_D (A)
DRAIN-SOURCE VOLTAGE V_{DS} (V)
−10
−8
−6
−4
−3.5
−3
−2.9
−2.8
−2.7
−2.6
−2.5
−2.45
V_{GS} = −2.4 V
COMMON SOURCE
Ta = 25°C
PULSE TEST


I_D – V_{DS}
DRAIN CURRENT I_D (A)
DRAIN-SOURCE VOLTAGE V_{DS} (V)
COMMON SOURCE
Ta = 25°C
PULSE TEST
−10
−8
−6
−4
−3
−2.9
−2.8
−2.7
−2.65
−2.6
−2.55
−2.5
V_{GS} = −2.45 V


I_D – V_{GS}
DRAIN CURRENT I_D (A)
GATE-SOURCE VOLTAGE V_{GS} (V)
COMMON SOURCE
V_{DS} = − 10 V
PULSE TEST
100
25
Ta = −55°C

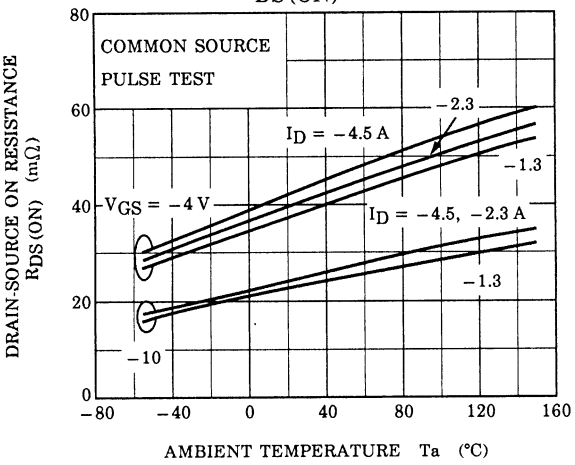

V_{DS} – V_{GS}
DRAIN-SOURCE VOLTAGE V_{DS} (V)
GATE-SOURCE VOLTAGE V_{GS} (V)
COMMON SOURCE
Ta = 25°C
PULSE TEST
I_D = −4.5 A
−2.3
−1.3


$|Y_{fs}|$ – I_D
FORWARD TRANSFER ADMITTANCE $|Y_{fs}|$ (S)
DRAIN CURRENT I_D (A)
COMMON SOURCE
V_{DS} = −10 V
PULSE TEST
Ta = −55°C
25
100

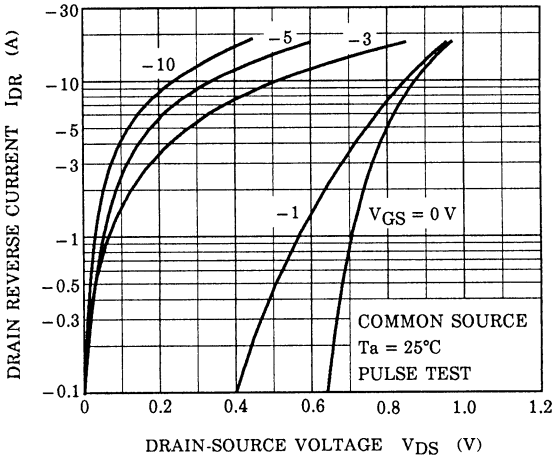

$R_{DS\,(ON)}$ – I_D
DRAIN-SOURCE ON RESISTANCE $R_{DS\,(ON)}$ (mΩ)
DRAIN CURRENT I_D (A)
COMMON SOURCE
Ta = 25°C
PULSE TEST
−4
V_{GS} = −10 V

P-ch

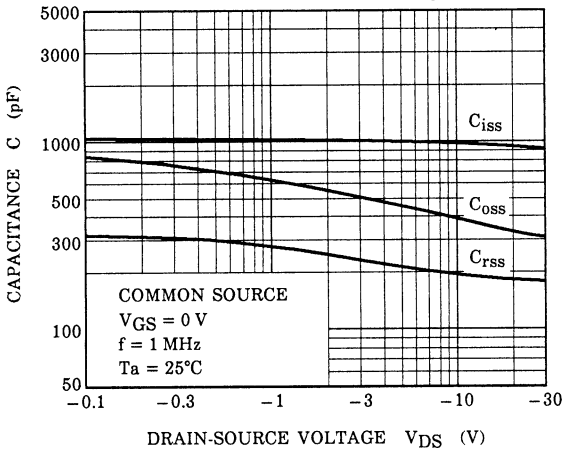
$R_{DS\,(ON)}$ – Ta



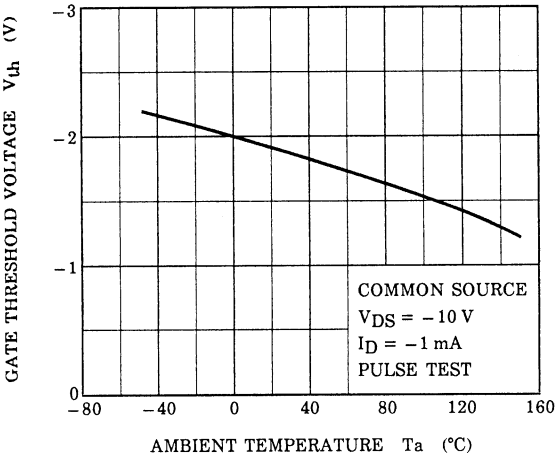
I_{DR} – V_{DS}



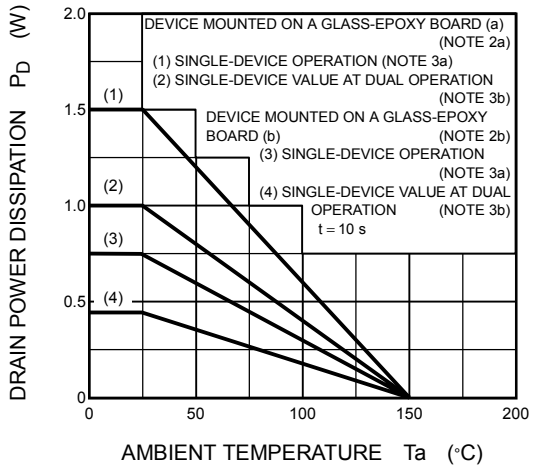
CAPACITANCE – V_{DS}



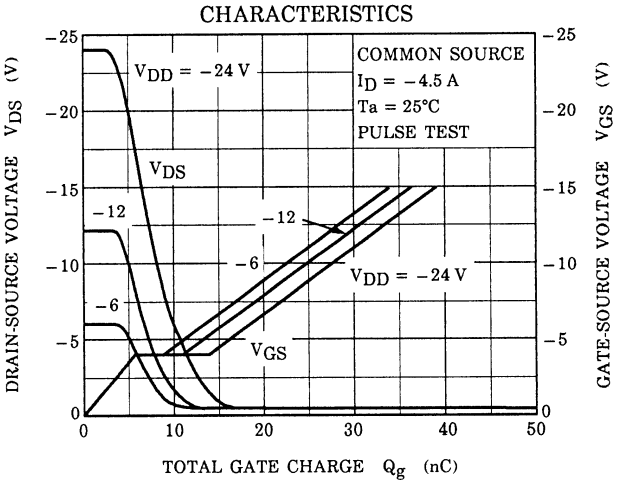
V_{th} – Ta



P_D – Ta

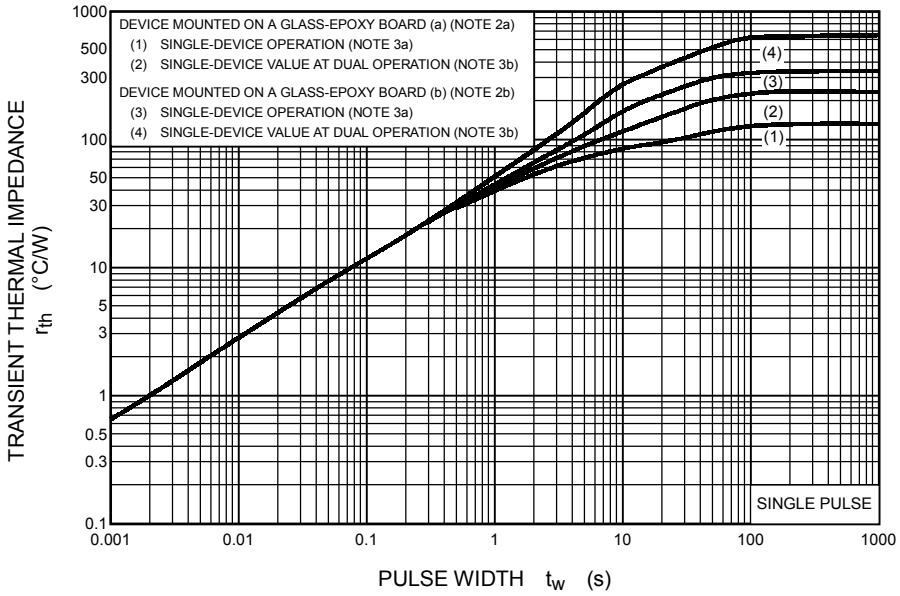


DYNAMIC INPUT / OUTPUT CHARACTERISTICS

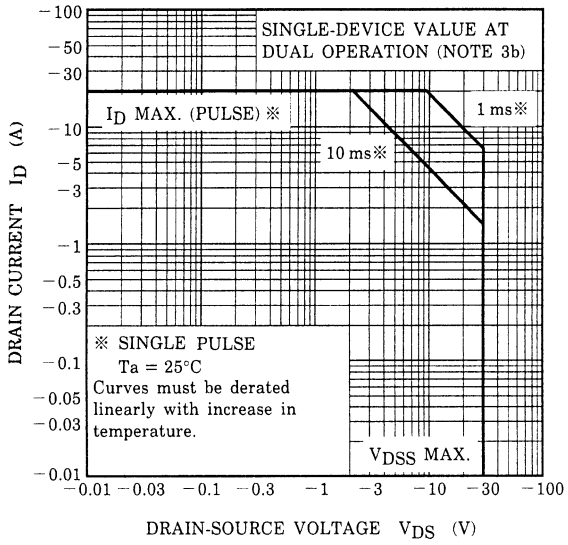


P-ch

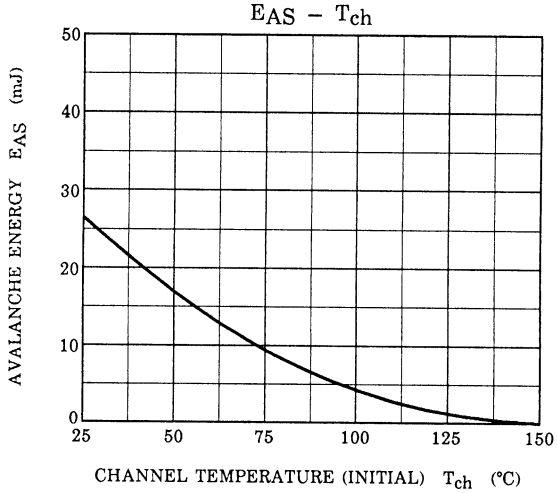
$r_{th} - t_w$

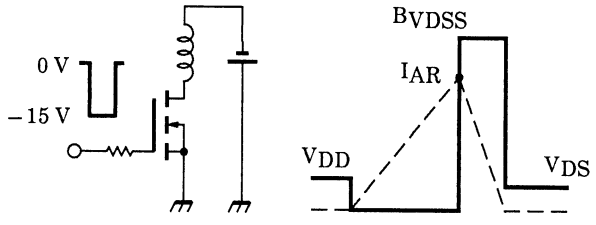


SAFE OPERATING AREA



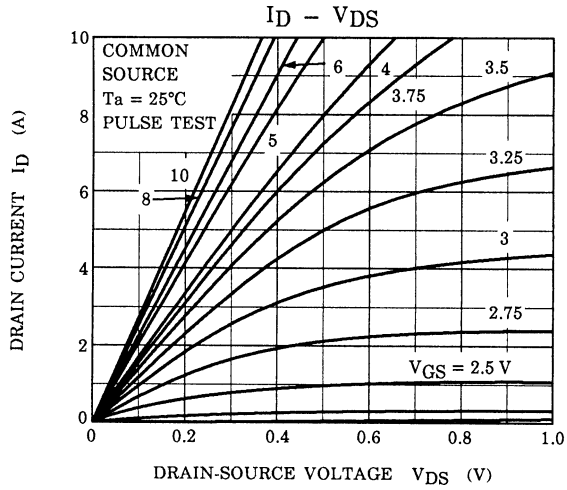
$E_{AS} - T_{ch}$

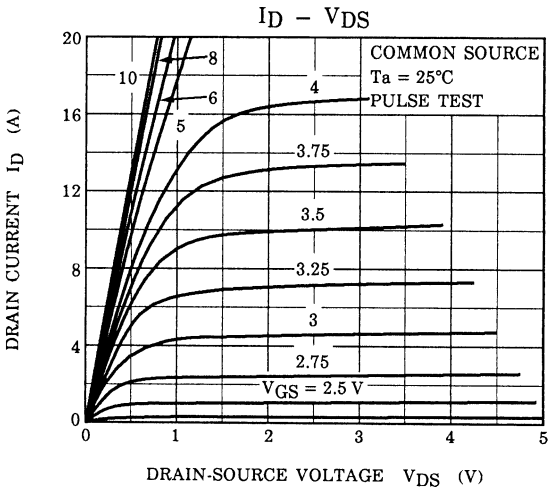


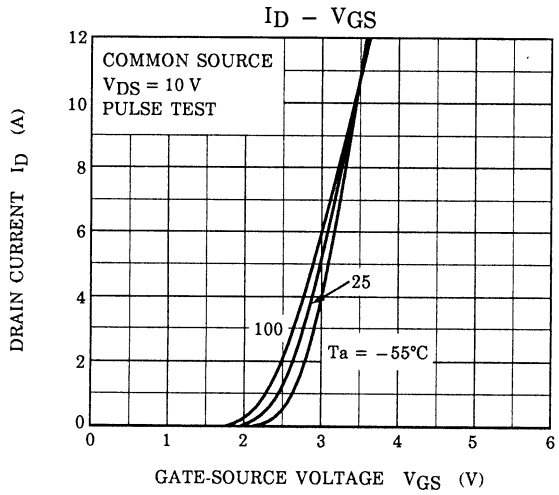


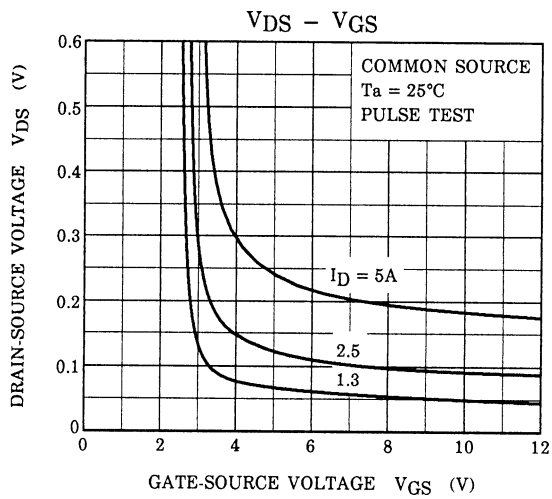
T_{ch} = 25°C (Initial)
Peak I_{AR} = −4.5 A, R_G = 25 Ω $E_{AS} = \frac{1}{2} \cdot L \cdot I^2 \cdot \left(\frac{B_{VDSS}}{B_{VDSS} - V_{DD}} \right)$
V_{DD} = −24 V, L = 1.0 mH

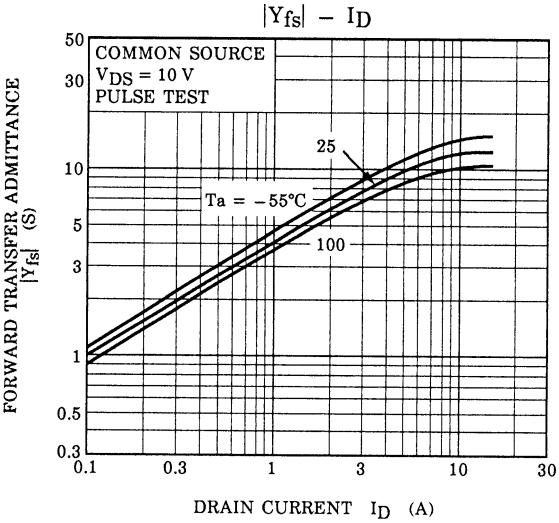
N-ch

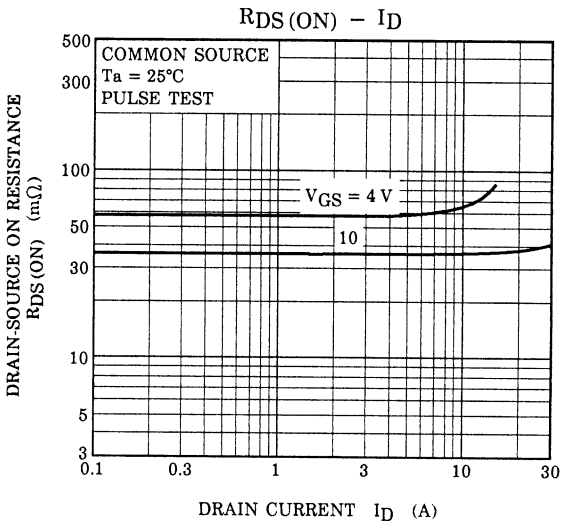

I_D – V_{DS}
COMMON SOURCE
Ta = 25°C
PULSE TEST
10
8
6
5
4
3.5
3.75
3.25
3
2.75
V_{GS} = 2.5 V
DRAIN CURRENT I_D (A)
DRAIN-SOURCE VOLTAGE V_{DS} (V)


I_D – V_{DS}
COMMON SOURCE
Ta = 25°C
PULSE TEST
10
8
6
5
4
3.75
3.5
3.25
3
2.75
V_{GS} = 2.5 V
DRAIN CURRENT I_D (A)
DRAIN-SOURCE VOLTAGE V_{DS} (V)


I_D – V_{GS}
COMMON SOURCE
V_{DS} = 10 V
PULSE TEST
25
100
Ta = −55°C
DRAIN CURRENT I_D (A)
GATE-SOURCE VOLTAGE V_{GS} (V)

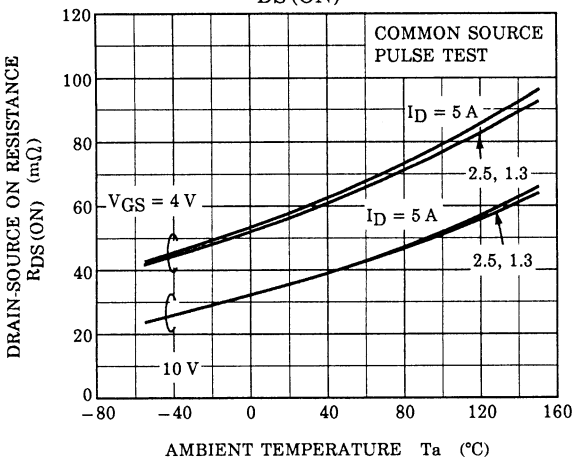

V_{DS} – V_{GS}
COMMON SOURCE
Ta = 25°C
PULSE TEST
I_D = 5A
2.5
1.3
DRAIN-SOURCE VOLTAGE V_{DS} (V)
GATE-SOURCE VOLTAGE V_{GS} (V)


$|Y_{fs}|$ – I_D
COMMON SOURCE
V_{DS} = 10 V
PULSE TEST
25
Ta = −55°C
100
FORWARD TRANSFER ADMITTANCE $|Y_{fs}|$ (S)
DRAIN CURRENT I_D (A)

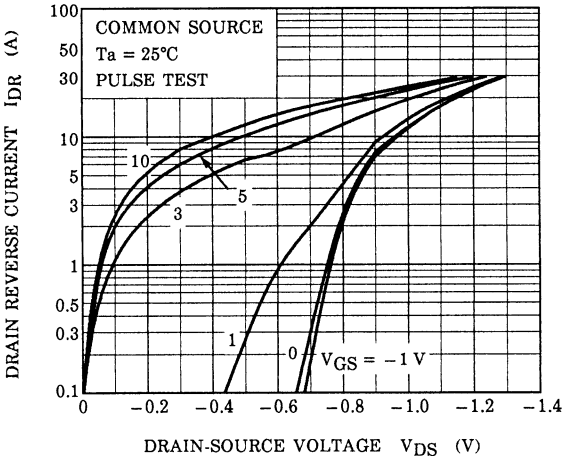

$R_{DS\,(ON)}$ – I_D
COMMON SOURCE
Ta = 25°C
PULSE TEST
V_{GS} = 4 V
10
DRAIN-SOURCE ON RESISTANCE $R_{DS\,(ON)}$ (mΩ)
DRAIN CURRENT I_D (A)

N-ch

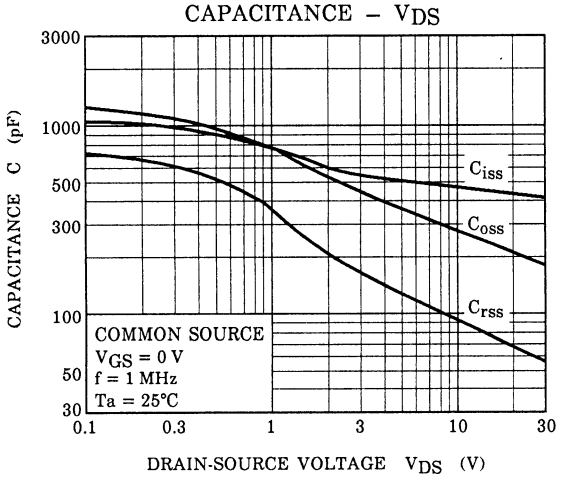
$R_{DS\,(ON)}$ – Ta



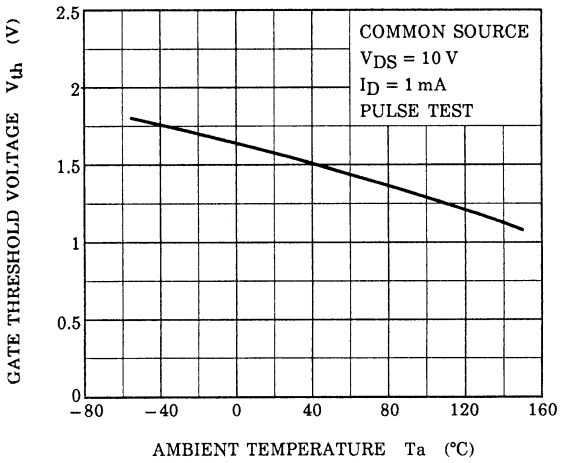
I_{DR} – V_{DS}



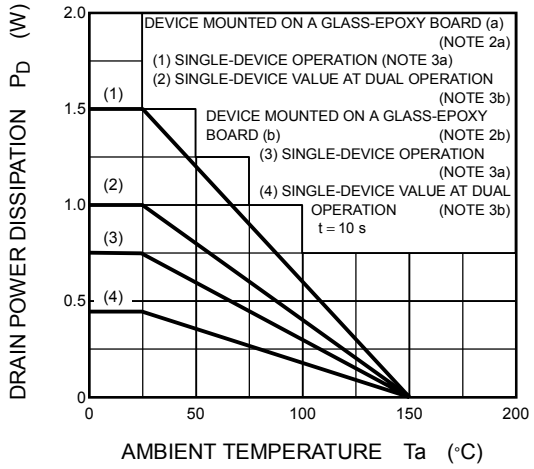
CAPACITANCE – V_{DS}



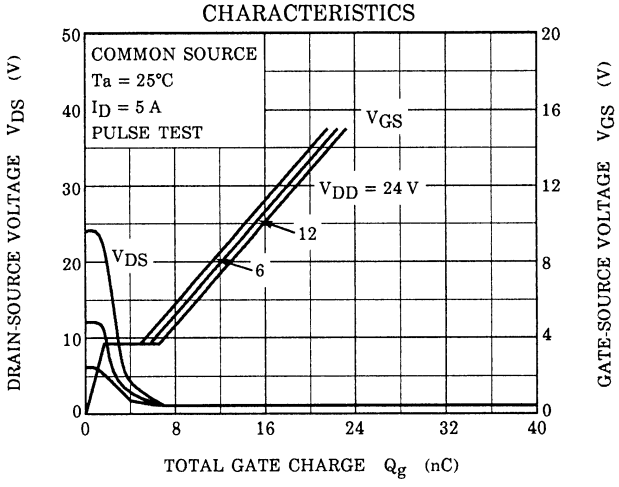
V_{th} – Ta



P_D – Ta

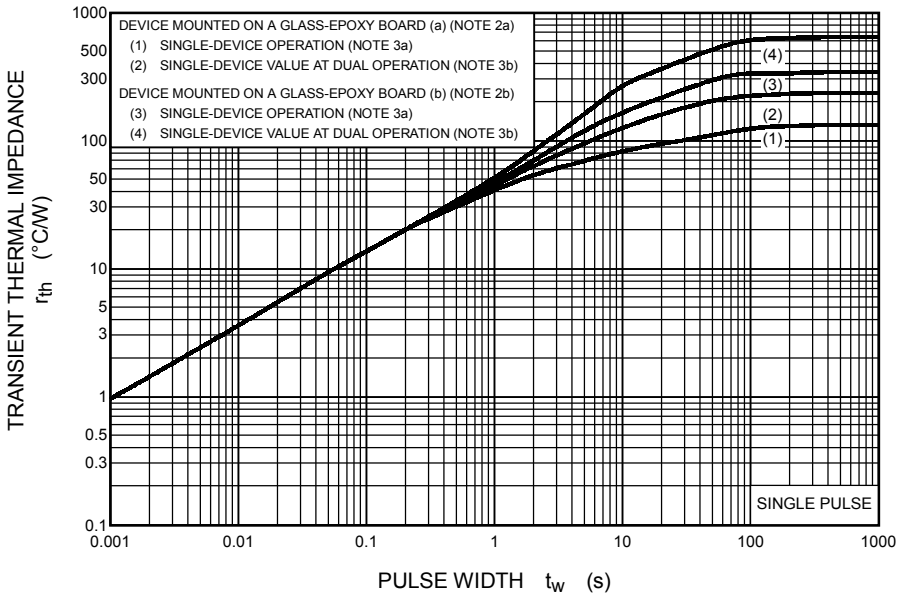


DYNAMIC INPUT / OUTPUT CHARACTERISTICS

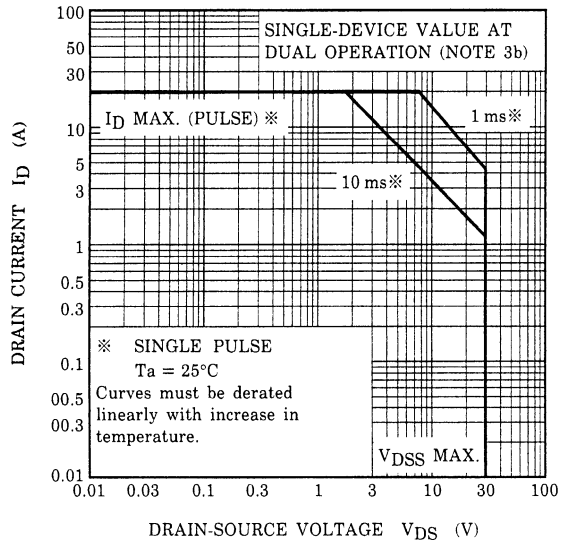


N-ch

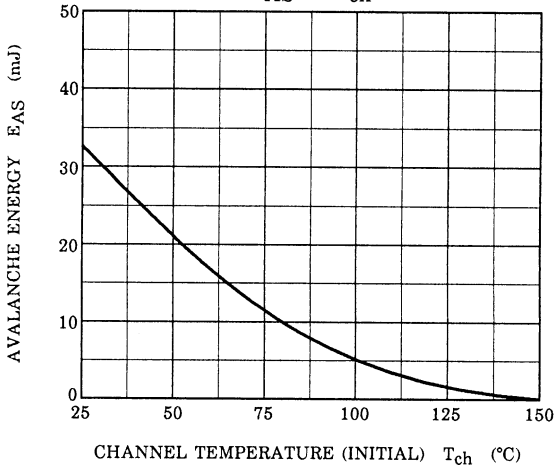
$r_{th} - t_w$

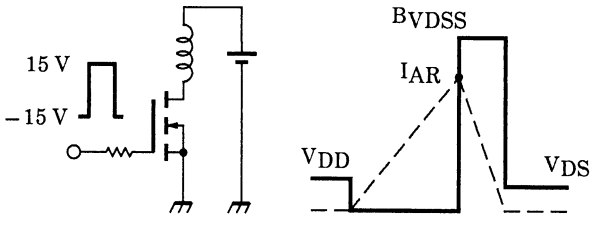


SAFE OPERATING AREA



$E_{AS} - T_{ch}$





T_{ch} = 25°C (Initial)
Peak I_{AR} = 5 A, R_G = 25 Ω
V_{DD} = 24 V, L = 1.0 mH

$$E_{AS} = \frac{1}{2} \cdot L \cdot I^2 \cdot \left(\frac{B_{VDSS}}{B_{VDSS} - V_{DD}}\right)$$

RESTRICTIONS ON PRODUCT USE

000707EAA

- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property.
  In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the “Handling Guide for Semiconductor Devices,” or “TOSHIBA Semiconductor Reliability Handbook” etc..
- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury (“Unintended Usage”). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer’s own risk.
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA CORPORATION for any infringements of intellectual property or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any intellectual property or other rights of TOSHIBA CORPORATION or others.
- The information contained herein is subject to change without notice.