

TOSHIBA Field Effect Transistor Silicon N-Channel MOS Type (L<sup>2</sup>-π-MOSV)

# 2SK2399

Chopper Regulator, DC/DC Converter and Motor Drive Applications

- 4 V gate drive
- Low drain-source ON-resistance :  $R_{DS(ON)} = 0.17 \Omega$  (typ.)
- High forward transfer admittance :  $|Y_{fs}| = 4.5 \text{ S}$  (typ.)
- Low leakage current :  $I_{DSS} = 100 \mu\text{A}$  (max) ( $V_{DS} = 100 \text{ V}$ )
- Enhancement mode :  $V_{th} = 0.8 \text{ to } 2.0 \text{ V}$  ( $V_{DS} = 10 \text{ V}$ ,  $I_D = 1 \text{ mA}$ )

## Absolute Maximum Ratings (Ta = 25°C)

Characteristic		Symbol	Rating	Unit
Drain-source voltage		$V_{DSS}$	100	V
Drain-gate voltage ( $R_{GS} = 20 \text{ k}\Omega$ )		$V_{DGR}$	100	V
Gate-source voltage		$V_{GSS}$	$\pm 20$	V
Drain current	DC (Note 1)	$I_D$	5	A
	Pulse (Note 1)	$I_{DP}$	20	A
Drain power dissipation ( $T_c = 25^\circ\text{C}$ )		$P_D$	20	W
Single-pulse avalanche energy (Note 2)		$E_{AS}$	180	mJ
Avalanche current		$I_{AR}$	5	A
Repetitive avalanche energy (Note 3)		$E_{AR}$	2	mJ
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).

## Thermal Characteristics

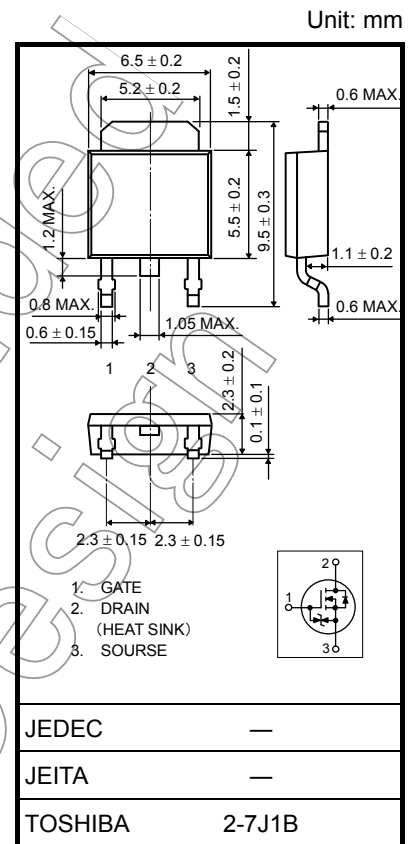
Characteristic	Symbol	Max	Unit
Thermal resistance, channel to case	$R_{th(ch-c)}$	6.25	°C / W
Thermal resistance, channel to ambient	$R_{th(ch-a)}$	125	°C / W

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

Note 2:  $V_{DD} = 25 \text{ V}$ ,  $T_{ch} = 25^\circ\text{C}$  (initial),  $L = 11.6 \text{ mH}$ ,  $R_G = 25 \Omega$ ,  $I_{AR} = 5 \text{ A}$

Note 3: Repetitive rating: pulse width limited by maximum channel temperature

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



Weight: 0.36 g (typ.)

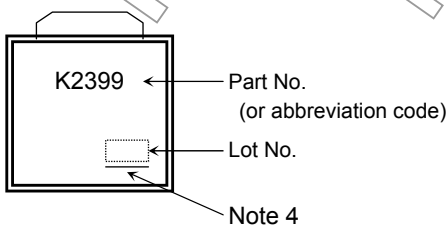
## Electrical Characteristics (Ta = 25°C)

Characteristics		Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current		$I_{GSS}$	$V_{GS} = \pm 16\text{ V}, V_{DS} = 0\text{ V}$	—	—	$\pm 10$	$\mu\text{A}$
Drain cutoff current		$I_{DSS}$	$V_{DS} = 100\text{ V}, V_{GS} = 0\text{ V}$	—	—	100	$\mu\text{A}$
Drain-source breakdown voltage		$V_{(BR)DSS}$	$I_D = 10\text{ mA}, V_{GS} = 0\text{ V}$	100	—	—	V
Gate threshold voltage		$V_{th}$	$V_{DS} = 10\text{ V}, I_D = 1\text{ mA}$	0.8	—	2.0	V
Drain-source ON-resistance		$R_{DS(ON)}$	$V_{GS} = 4\text{ V}, I_D = 2.5\text{ A}$	—	0.22	0.30	$\Omega$
			$V_{GS} = 10\text{ V}, I_D = 2.5\text{ A}$	—	0.17	0.23	
Forward transfer admittance		$ Y_{fs} $	$V_{DS} = 10\text{ V}, I_D = 2.5\text{ A}$	2.0	4.5	—	S
Input capacitance		$C_{iss}$	$V_{DS} = 10\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$	—	500	—	pF
Reverse transfer capacitance		$C_{rss}$		—	80	—	
Output capacitance		$C_{oss}$		—	190	—	
Switching time	Rise time	$t_r$	<p><math>I_D = 2.5\text{ A}</math>  <math>V_{GS} = 10\text{ V}, 0\text{ V}</math>  <math>50\Omega</math>  <math>R_L = 20\Omega</math>  <math>V_{DD} \approx 50\text{ V}</math>                      Duty <math>\leq 1\%</math>, <math>t_W = 10\mu\text{s}</math></p>	—	17	—	ns
	Turn-on time	$t_{on}$		—	25	—	
	Fall time	$t_f$		—	50	—	
	Turn-off time	$t_{off}$		—	195	—	
Total gate charge (gate-source plus gate-drain)		$Q_g$	$V_{DD} \approx 80\text{ V}, V_{GS} = 10\text{ V}, I_D = 5\text{ A}$	—	22	—	nC
Gate-source charge		$Q_{gs}$		—	15	—	
Gate-drain ("Miller") charge		$Q_{gd}$		—	7	—	

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

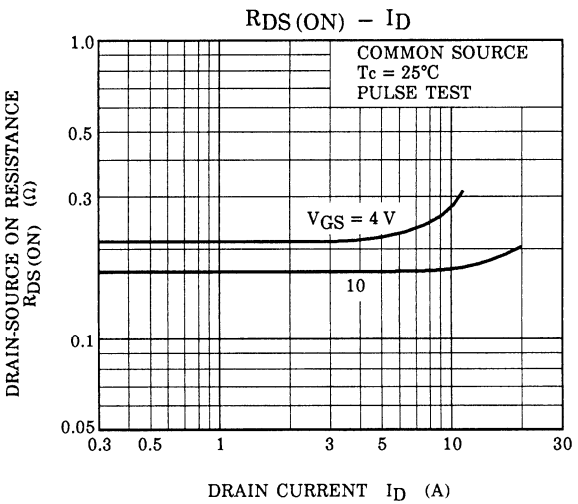
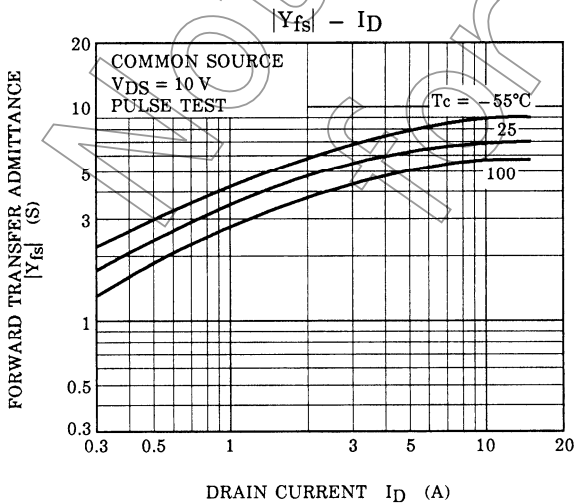
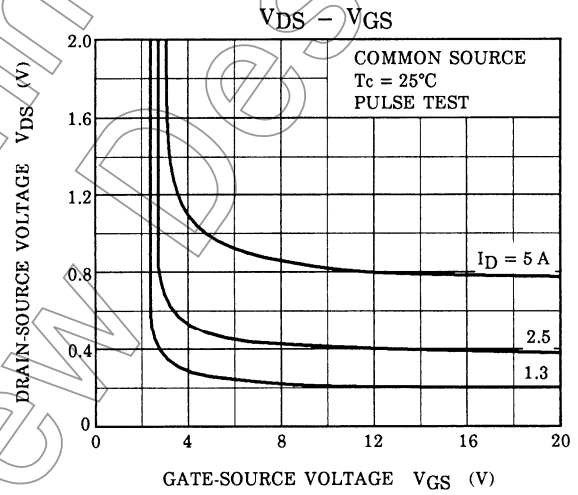
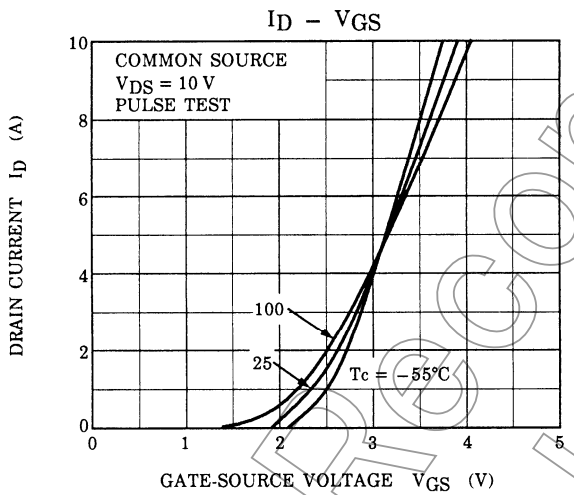
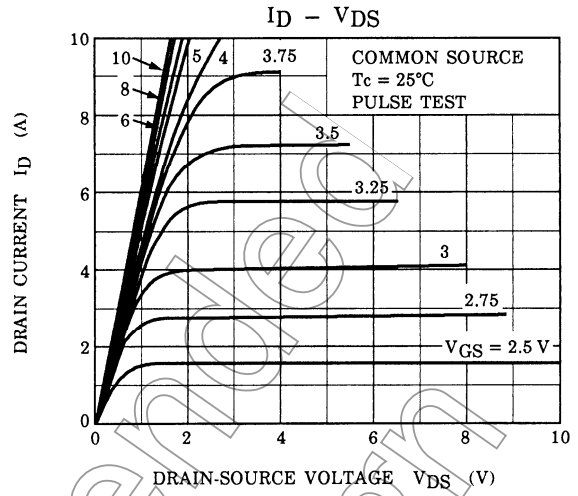
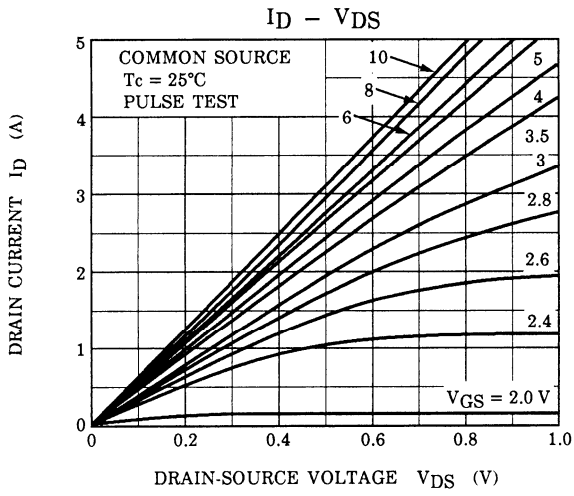
Characteristic	Symbol	Test Condition	Min	Typ.	Max	Unit
Continuous drain reverse current (Note 1)	$I_{DR}$	—	—	—	5	A
Pulse drain reverse current (Note 1)	$I_{DRP}$	—	—	—	20	A
Forward voltage (diode)	$V_{DSF}$	$I_{DR} = 5\text{ A}, V_{GS} = 0\text{ V}$	—	—	-1.7	V
Reverse recovery time	$t_{rr}$	$I_{DR} = 5\text{ A}, V_{GS} = 0\text{ V}, dI_{DR} / dt = 50\text{ A} / \mu\text{s}$	—	160	—	ns
Reverse recovery charge	$Q_{rr}$		—	0.28	—	$\mu\text{C}$

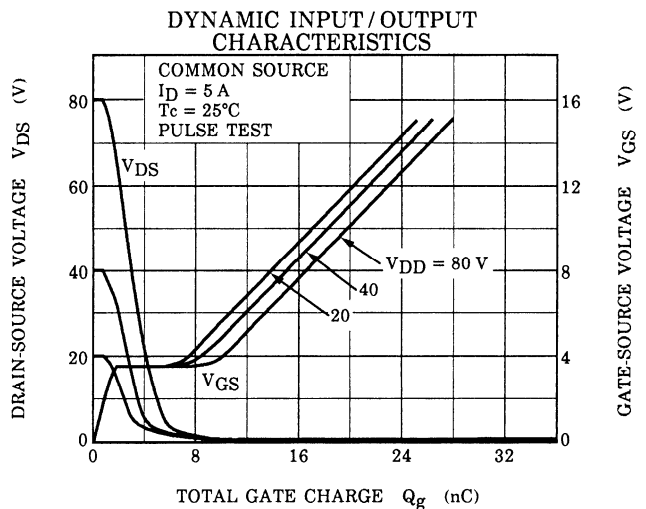
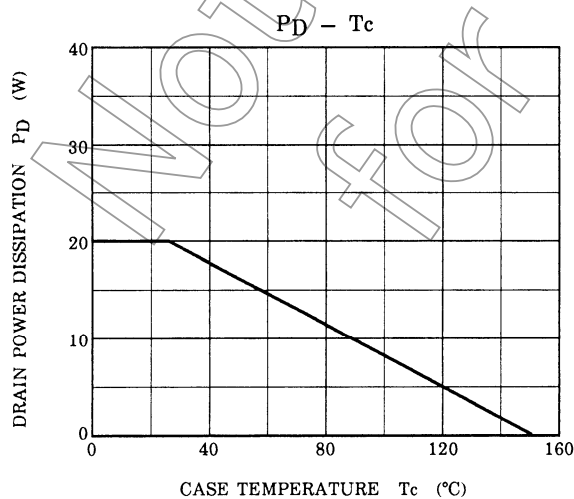
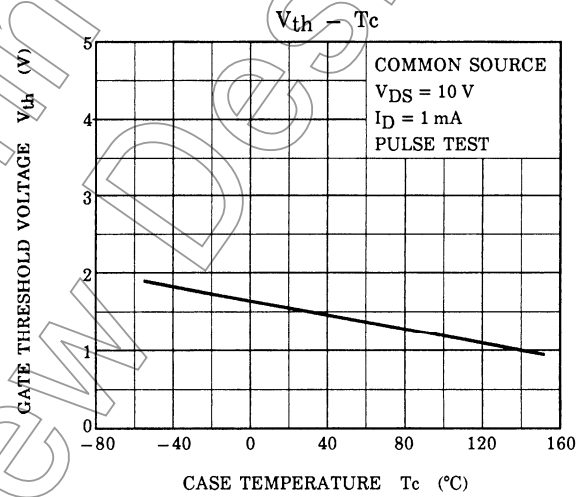
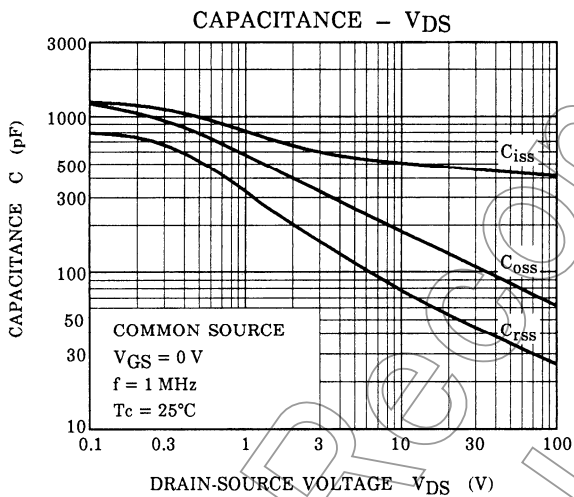
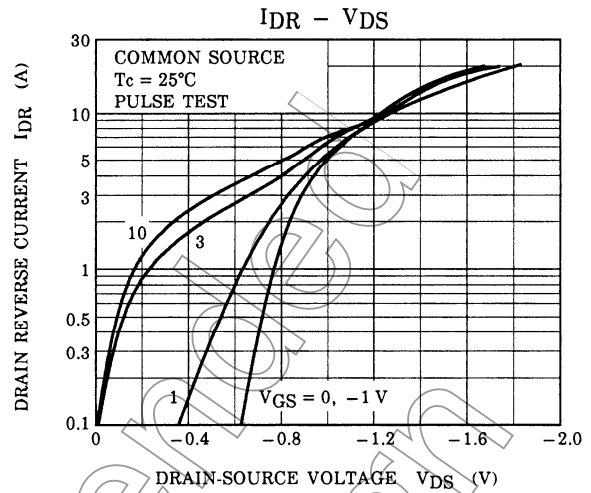
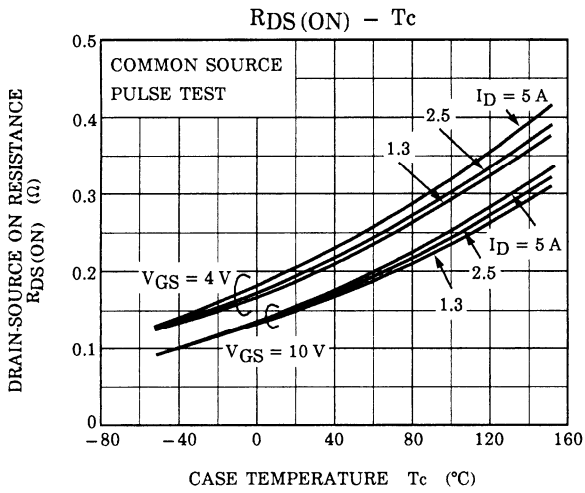
## Marking

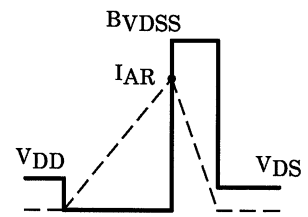
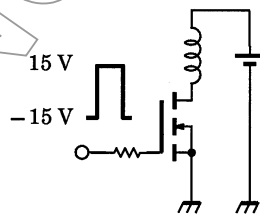
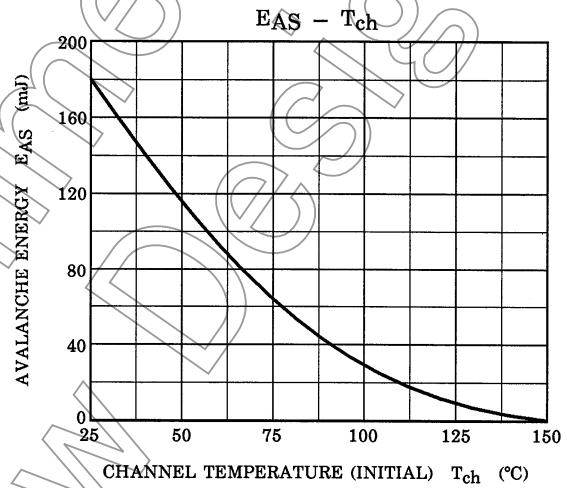
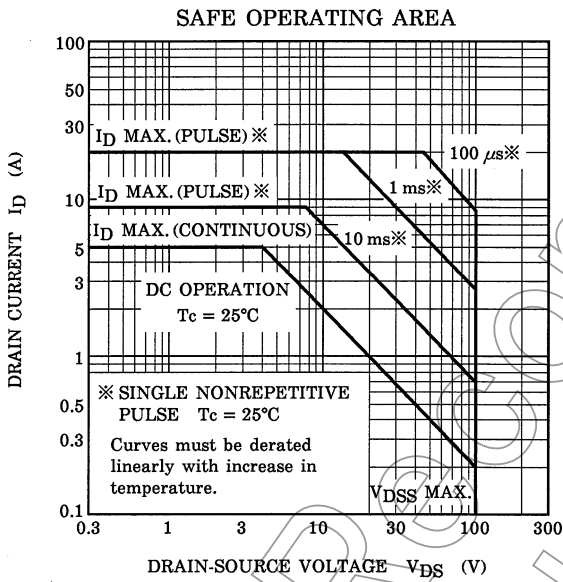
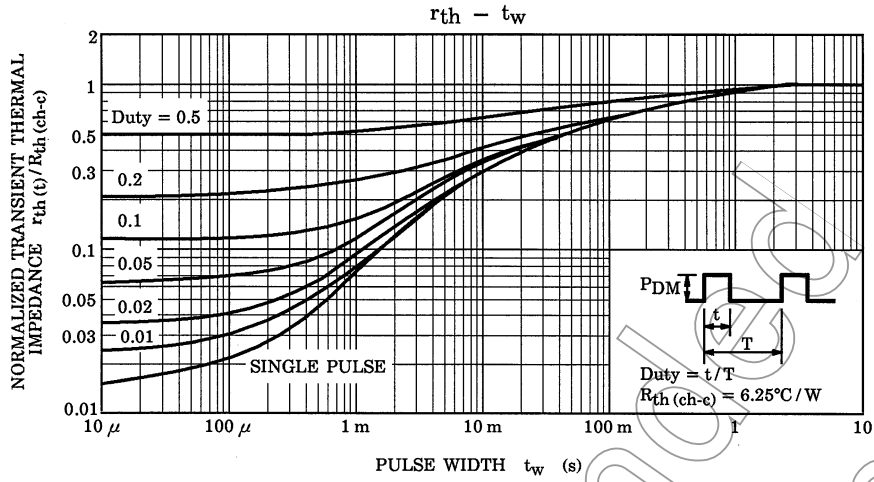


Note 4 : A line under a Lot No. identifies the indication of product Labels [[G]]/RoHS COMPATIBLE or [[G]]/RoHS [[Pb]]

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TEST CIRCUIT

WAVE FORM

$R_G = 25 \Omega$   
 $V_{DD} = 25 \text{ V}, L = 11.6 \text{ mH}$

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

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