

TOSHIBA Field-Effect Transistor Silicon N-Channel MOS Type ( $\pi$ -MOS V)

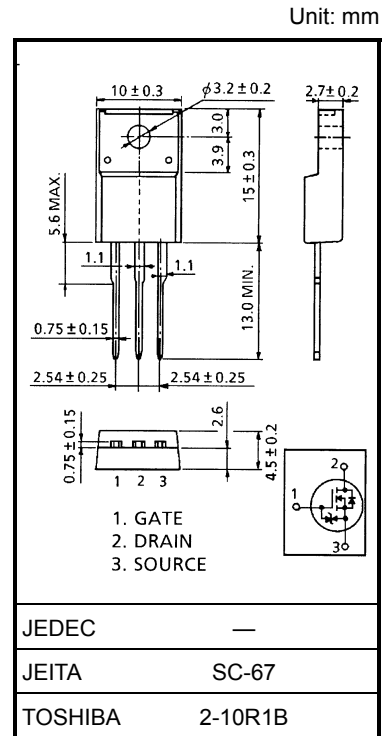
# 2SK3994

Switching Regulator, DC/DC Converter Applications  
Motor Drive Applications

- Low drain-source ON-resistance :  $R_{DS(ON)} = 90 \text{ m}\Omega$  (typ.)
- High forward transfer admittance :  $|Y_{fs}| = 10 \text{ S}$  (typ.)
- Low leakage current :  $I_{DSS} = 100 \mu\text{A}$  (max) ( $V_{DS} = 250 \text{ V}$ )
- Enhancement mode :  $V_{th} = 3.0 \text{ to } 5.0 \text{ V}$  ( $V_{DS} = 10 \text{ V}$ ,  $I_D = 1 \text{ mA}$ )

### Absolute Maximum Ratings ( $T_a = 25^\circ\text{C}$ )

Characteristics		Symbol	Rating	Unit
Drain-source voltage		$V_{DSS}$	250	V
Drain-gate voltage ( $R_{GS} = 20 \text{ k}\Omega$ )		$V_{DGR}$	250	V
Gate-source voltage		$V_{GSS}$	$\pm 30$	V
Drain current	DC (Note 1)	$I_D$	20	A
	Pulse (Note 1)	$I_{DP}$	80	A
Drain power dissipation ( $T_c = 25^\circ\text{C}$ )		$P_D$	45	W
Single-pulse avalanche energy (Note 2)		$E_{AS}$	487	mJ
Avalanche current		$I_{AR}$	20	A
Repetitive avalanche energy (Note 3)		$E_{AR}$	4.5	mJ
Channel temperature		$T_{ch}$	150	$^\circ\text{C}$
Storage temperature range		$T_{stg}$	-55~150	$^\circ\text{C}$



Weight: 1.9 g (typ.)

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

Characteristics	Symbol	Max	Unit
Thermal resistance, channel to case	$R_{th(ch-c)}$	2.78	$^\circ\text{C} / \text{W}$
Thermal resistance, channel to ambient	$R_{th(ch-a)}$	62.5	$^\circ\text{C} / \text{W}$

Note 1: Ensure that the channel temperature does not exceed  $150^\circ\text{C}$ .

Note 2:  $V_{DD} = 90 \text{ V}$ ,  $T_{ch} = 25^\circ\text{C}$  (initial),  $L = 2.06 \text{ mH}$ ,  $R_G = 25 \Omega$ ,  $I_{AR} = 20 \text{ A}$

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

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

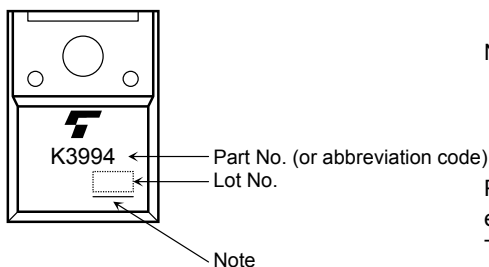
## Electrical Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit	
Gate leakage current	$I_{GSS}$	$V_{GS} = \pm 25 \text{ V}, V_{DS} = 0 \text{ V}$	—	—	$\pm 10$	$\mu\text{A}$	
Gate-source breakdown voltage	$V_{(BR)GSS}$	$I_G = \pm 10 \mu\text{A}, V_{DS} = 0 \text{ V}$	$\pm 30$	—	—	V	
Drain cutoff current	$I_{DSS}$	$V_{DS} = 250 \text{ V}, V_{GS} = 0 \text{ V}$	—	—	100	$\mu\text{A}$	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$I_D = 10 \text{ mA}, V_{GS} = 0 \text{ V}$	250	—	—	V	
Gate threshold voltage	$V_{th}$	$V_{DS} = 10 \text{ V}, I_D = 1 \text{ mA}$	3.0	—	5.0	V	
Drain-source ON-resistance	$R_{DS(ON)}$	$V_{GS} = 10 \text{ V}, I_D = 10 \text{ A}$	—	90	105	m $\Omega$	
Forward transfer admittance	$ Y_{fs} $	$V_{DS} = 10 \text{ V}, I_D = 10 \text{ A}$	5	10	—	S	
Input capacitance	$C_{iss}$	$V_{DS} = 10 \text{ V}, V_{GS} = 0 \text{ V}, f = 1 \text{ MHz}$	—	2090	—	pF	
Reverse transfer capacitance	$C_{rss}$		—	280	—		
Output capacitance	$C_{oss}$		—	1000	—		
Switching time	Rise time	$t_r$		—	20	—	ns
	Turn-on time	$t_{on}$		—	40	—	
	Fall time	$t_f$		—	10	—	
	Turn-off time	$t_{off}$		Duty $\leq 1\%$ , $t_w = 10 \mu\text{s}$	—	40	
Total gate charge (gate-source plus gate-drain)	$Q_g$	$V_{DD} \approx 200 \text{ V}, V_{GS} = 10 \text{ V}, I_D = 20 \text{ A}$	—	45	—	nC	
Gate-source charge	$Q_{gs}$		—	22	—		
Gate-drain ("Miller") charge	$Q_{gd}$		—	23	—		

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

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Continuous drain reverse current (Note 1)	$I_{DR}$	—	—	—	20	A
Pulse drain reverse current (Note 1)	$I_{DRP}$	—	—	—	80	A
Forward voltage (diode)	$V_{DSF}$	$I_{DR} = 20 \text{ A}, V_{GS} = 0 \text{ V}$	—	—	-1.5	V
Reverse recovery time	$t_{rr}$	$I_{DR} = 20 \text{ A}, V_{GS} = 0 \text{ V}$	—	320	—	ns
Reverse recovery charge	$Q_{rr}$	$dI_{DR} / dt = 100 \text{ A} / \mu\text{s}$	—	2.8	—	$\mu\text{C}$

## Marking

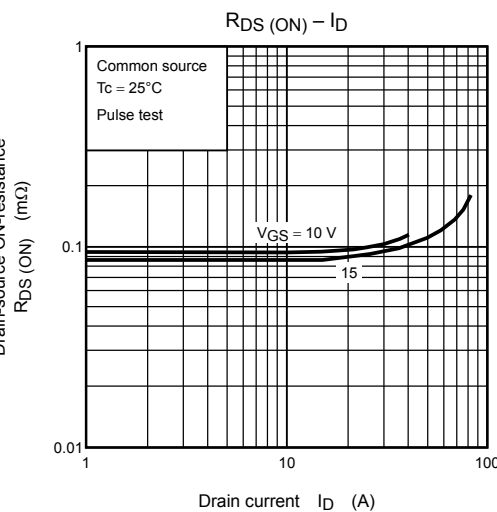
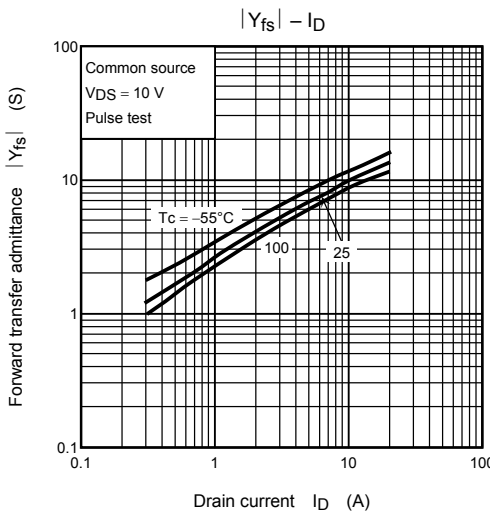
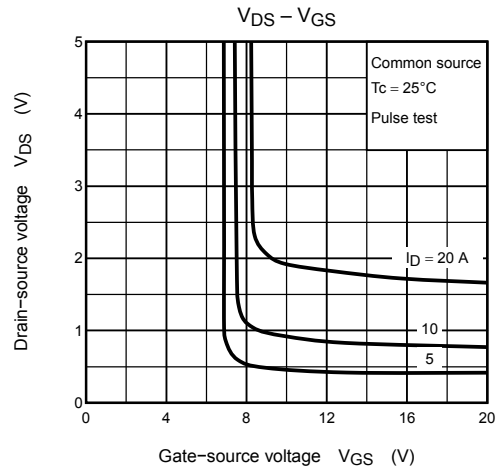
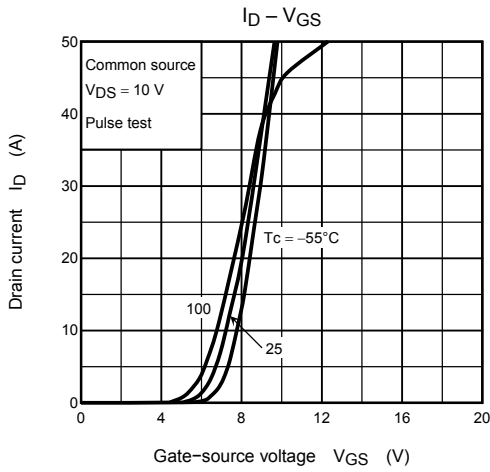
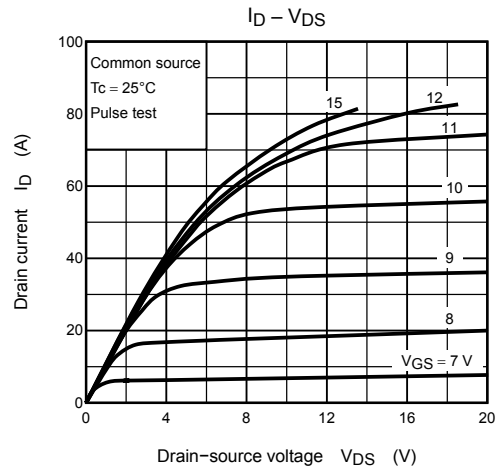
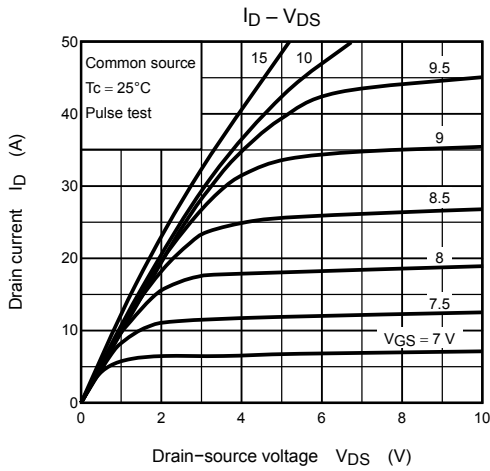


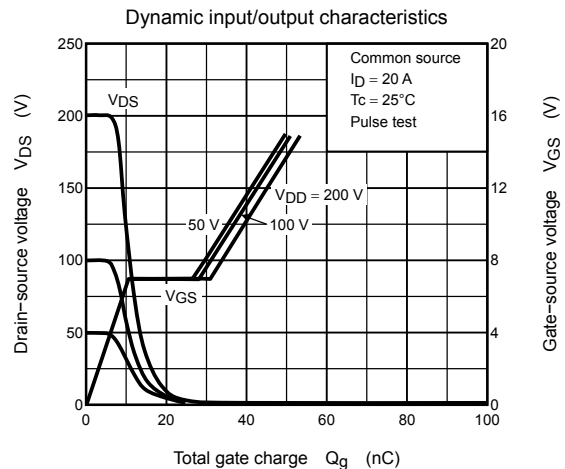
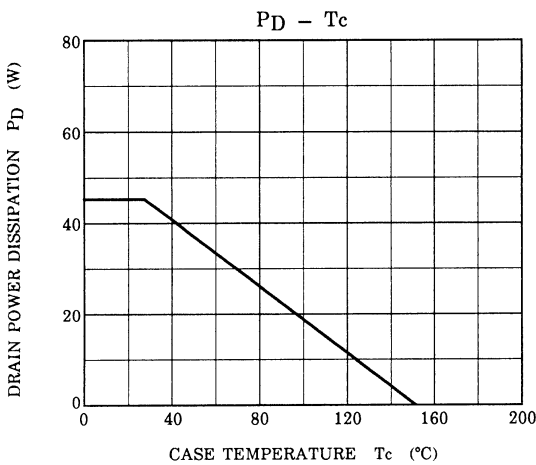
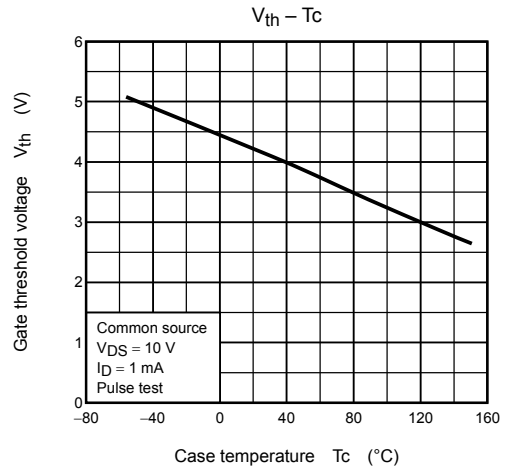
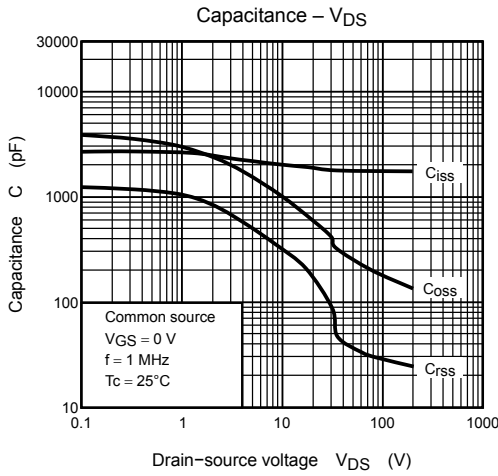
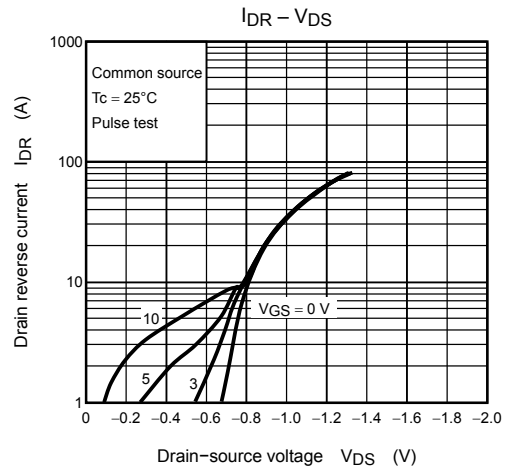
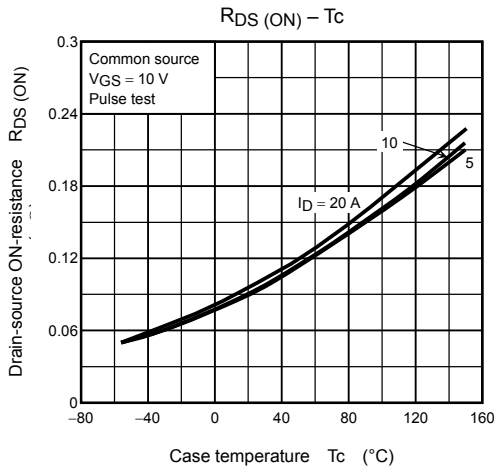
Note: A line under a Lot No. identifies the indication of product Labels.

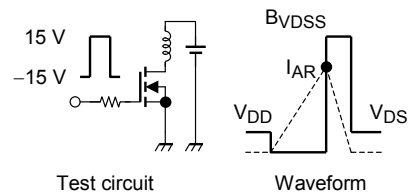
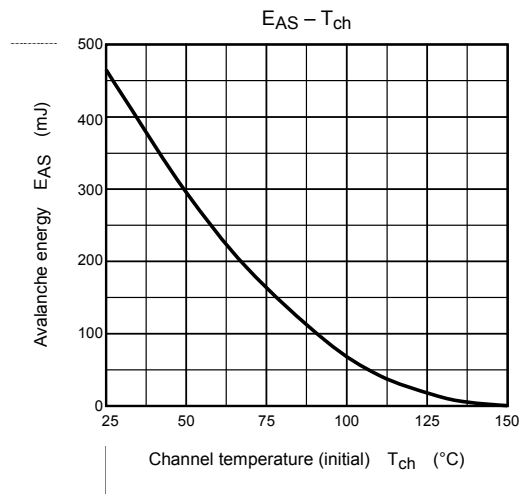
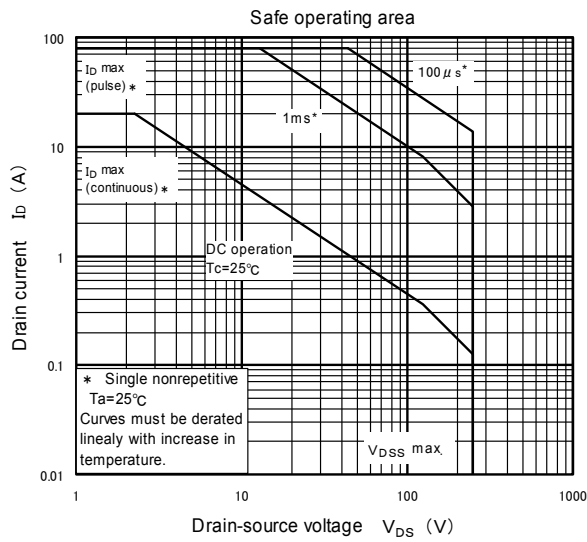
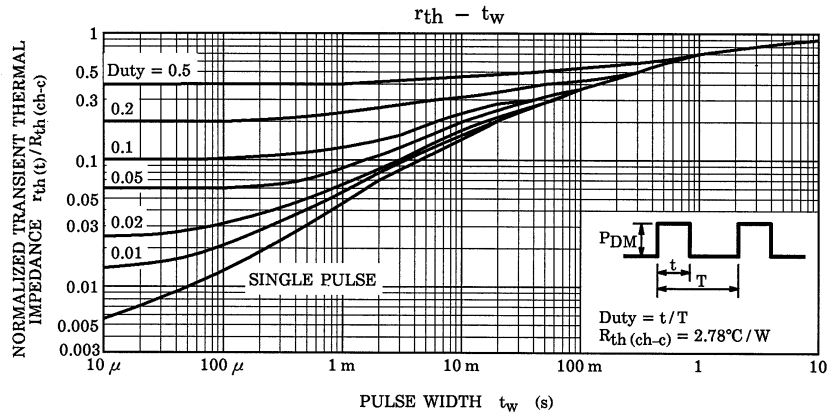
Not underlined:  $[[\text{Pb}]]/\text{INCLUDES} > \text{MCV}$

Underlined:  $[[\text{G}]]/\text{RoHS COMPATIBLE}$  or  $[[\text{G}]]/\text{RoHS} [[\text{Pb}]]$

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$R_G = 25\ \Omega$   
 $V_{DD} = 50\ V, L = 2.06\ mH$

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

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