

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

## 2SK3904

### Switching Regulator Applications

- Low drain-source ON resistance:  $R_{DS(ON)} = 0.2 \Omega$  (typ.)
- High forward transfer admittance:  $|Y_{fs}| = 9.5 S$  (typ.)
- Low leakage current:  $I_{DSS} = 100 \mu A$  (max) ( $V_{DS} = 450 V$ )
- Enhancement model:  $V_{th} = 2.0 \sim 4.0 V$  ( $V_{DS} = 10 V, I_D = 1 mA$ )

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

Characteristic		Symbol	Rating	Unit
Drain-source voltage		$V_{DSS}$	450	V
Drain-gate voltage ( $R_{GS} = 20 k\Omega$ )		$V_{DGR}$	450	V
Gate-source voltage		$V_{GSS}$	$\pm 30$	V
Drain current	DC (Note 1)	$I_D$	19	A
	Pulse (Note 1)	$I_{DP}$	76	
Drain power dissipation ( $T_c = 25^\circ C$ )		$P_D$	150	W
Single pulse avalanche energy (Note 2)		$E_{AS}$	820	mJ
Avalanche current		$I_{AR}$	19	A
Repetitive avalanche energy (Note 3)		$E_{AR}$	15	mJ
Channel temperature		$T_{ch}$	150	$^\circ C$
Storage temperature range		$T_{stg}$	$-55 \sim 150$	$^\circ C$

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	$R_{th(ch-c)}$	0.833	$^\circ C/W$
Thermal resistance, channel to ambient	$R_{th(ch-a)}$	50	$^\circ C/W$

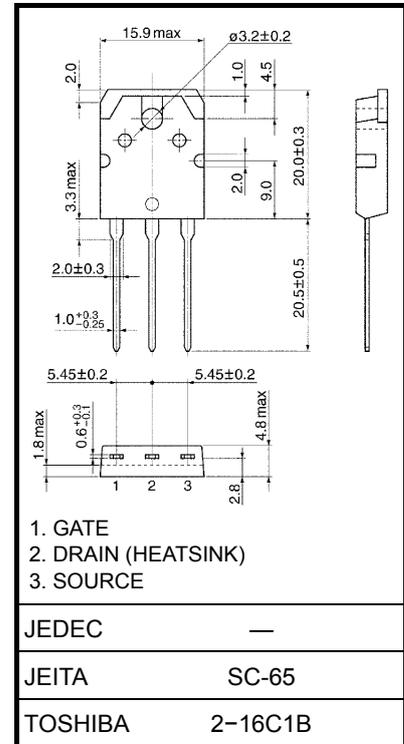
Note 1: Ensure that the channel temperature does not exceed  $150^\circ C$  during use of the device.

Note 2:  $V_{DD} = 90 V, T_{ch} = 25^\circ C, L = 3.79 mH, R_G = 25 \Omega, I_{AR} = 19 A$

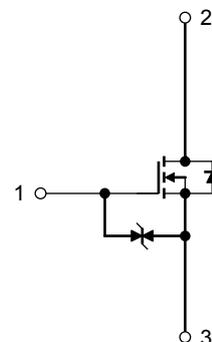
Note 3: Repetitive rating: pulse width limited by max junction temperature

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

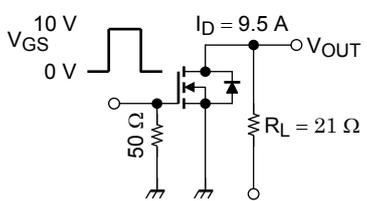
Unit: mm



Weight: 4.6 g (typ.)



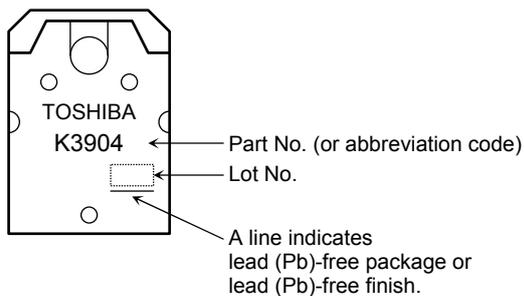
## Electrical Characteristics (Ta = 25°C)

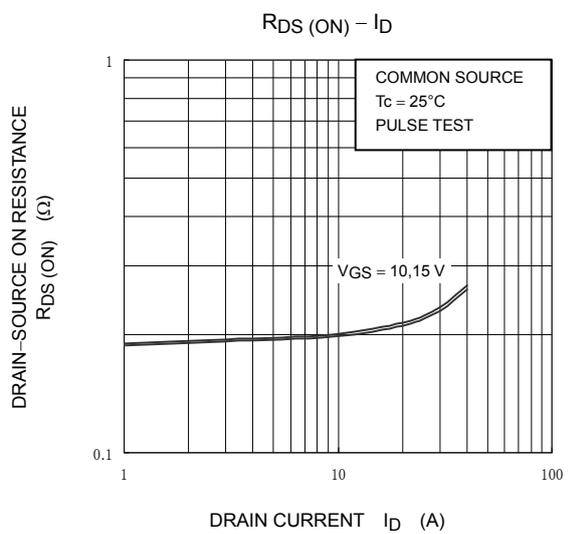
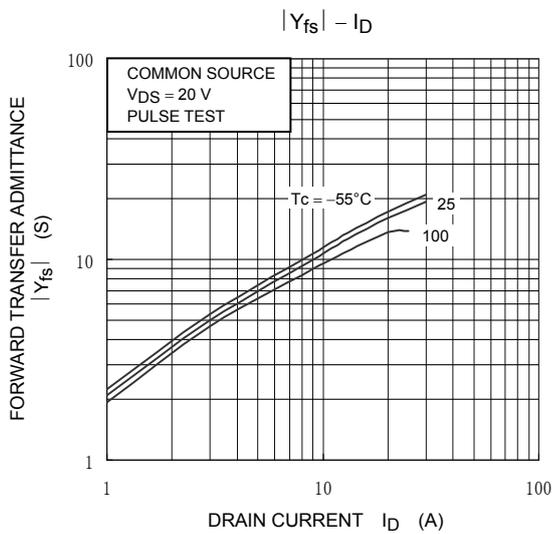
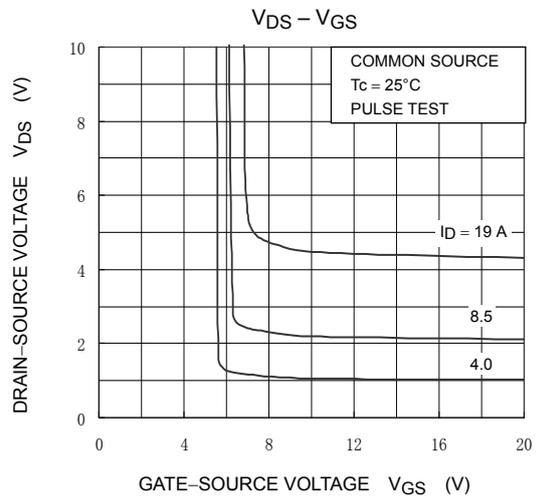
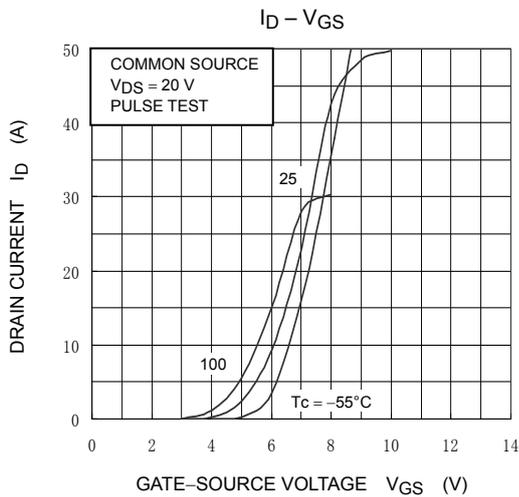
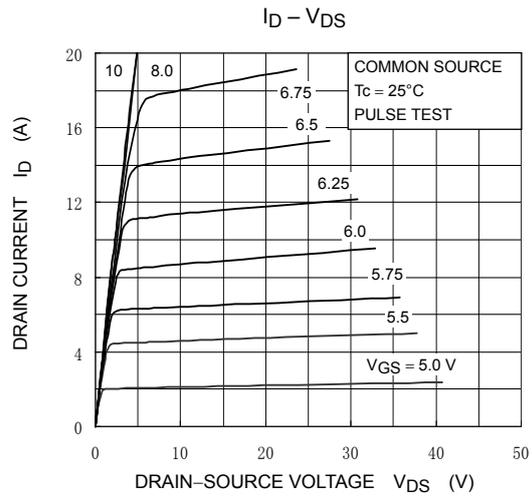
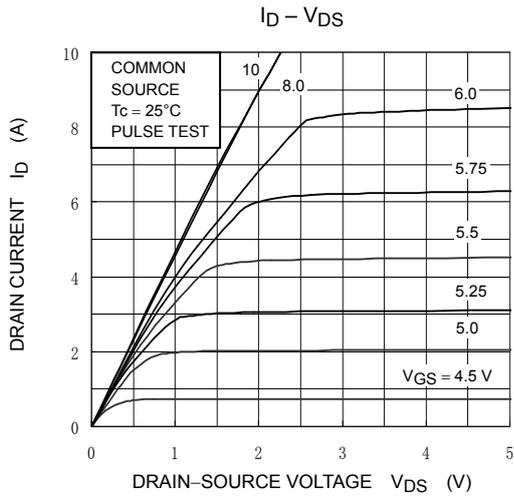
Characteristic		Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current		$I_{GSS}$	$V_{GS} = \pm 25\text{ V}, V_{DS} = 0\text{ V}$	—	—	$\pm 10$	$\mu\text{A}$
Drain-source breakdown voltage		$V_{(BR)GSS}$	$I_G = \pm 10\ \mu\text{A}, V_{DS} = 0\text{ V}$	$\pm 30$	—	—	V
Drain cut-off current		$I_{DSS}$	$V_{DS} = 450\text{ V}, V_{GS} = 0\text{ V}$	—	—	100	$\mu\text{A}$
Drain-source breakdown voltage		$V_{(BR)DSS}$	$I_D = 10\text{ mA}, V_{GS} = 0\text{ V}$	450	—	—	V
Gate threshold voltage		$V_{th}$	$V_{DS} = 10\text{ V}, I_D = 1\text{ mA}$	2.0	—	4.0	V
Drain-source ON resistance		$R_{DS(ON)}$	$V_{GS} = 10\text{ V}, I_D = 9.5\text{ A}$	—	0.2	0.26	$\Omega$
Forward transfer admittance		$ Y_{fs} $	$V_{DS} = 10\text{ V}, I_D = 9.5\text{ A}$	2.6	9.5	—	S
Input capacitance		$C_{iss}$	$V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$	—	3100	—	pF
Reverse transfer capacitance		$C_{rss}$		—	20	—	
Output capacitance		$C_{oss}$		—	270	—	
Switching time	Rise time	$t_r$	 <p>Duty <math>\leq 1\%</math>, <math>t_w = 10\ \mu\text{s}</math></p>	—	70	—	ns
	Turn-on time	$t_{on}$		—	130	—	
	Fall time	$t_f$		—	70	—	
	Turn-off time	$t_{off}$		—	280	—	
Total gate charge (gate-source plus gate-drain)		$Q_g$	$V_{DD} \approx 360\text{ V}, V_{GS} = 10\text{ V}, I_D = 19\text{ A}$	—	62	—	nC
Gate-source charge		$Q_{gs}$		—	40	—	
Gate-drain ("Miller") charge		$Q_{gd}$		—	22	—	

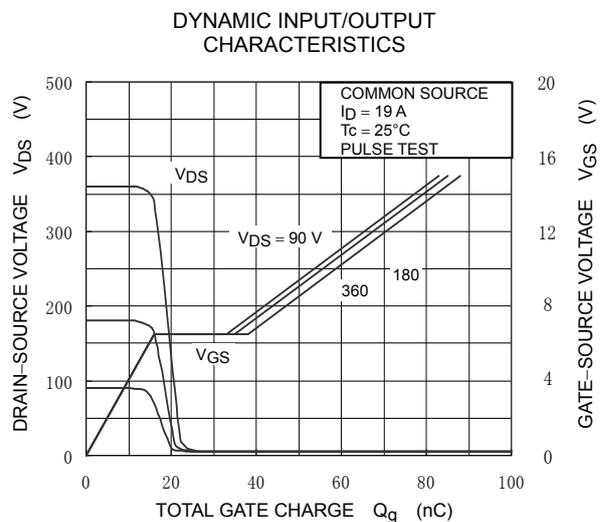
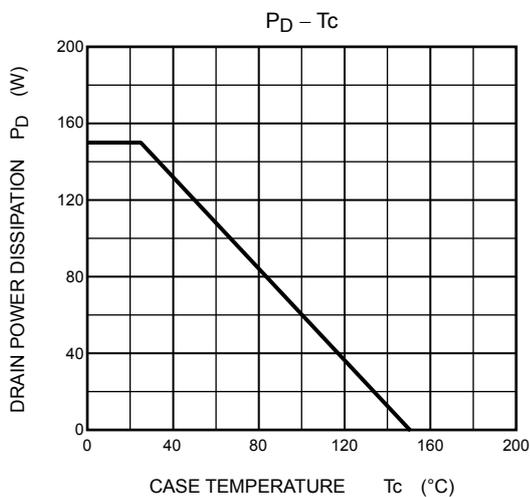
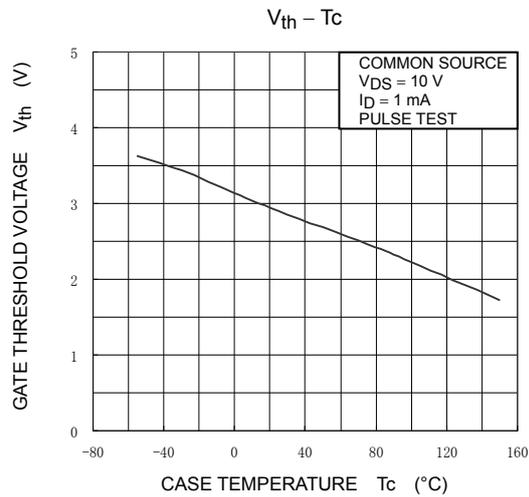
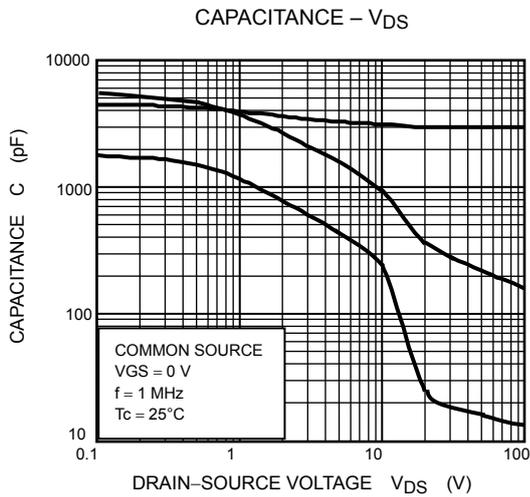
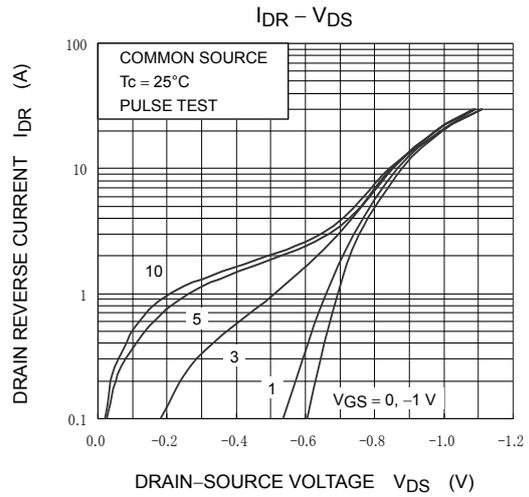
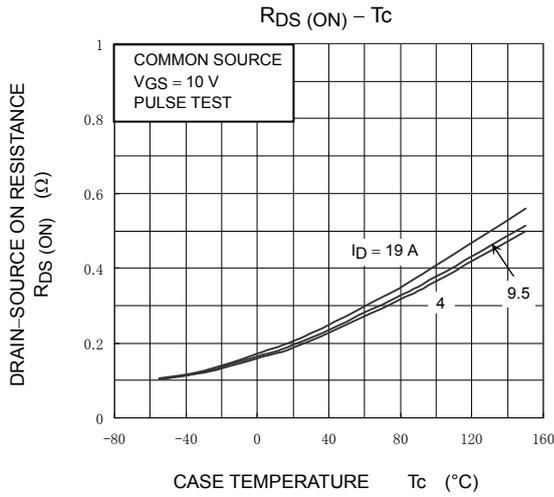
## Source-Drain Ratings and Characteristics (Ta = 25°C)

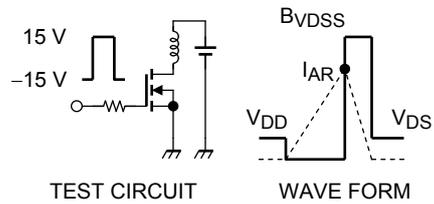
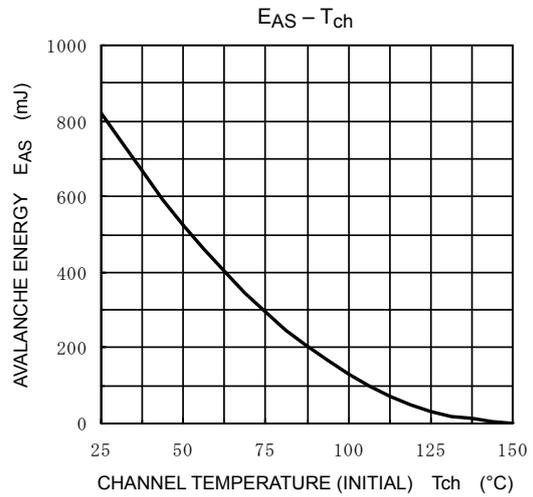
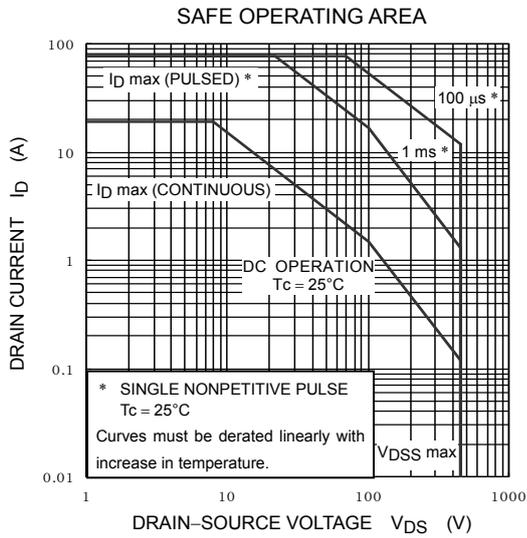
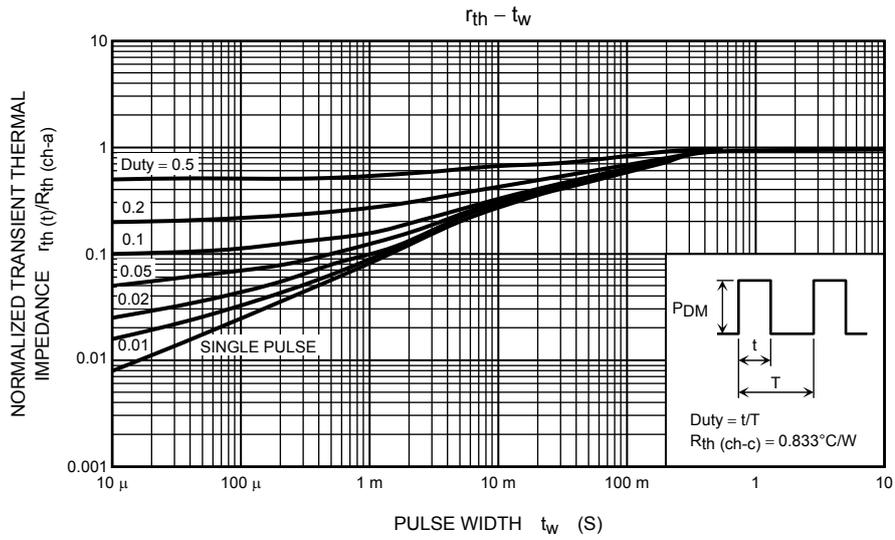
Characteristic	Symbol	Test Condition	Min	Typ.	Max	Unit
Continuous drain reverse current (Note 1)	$I_{DR}$	—	—	—	19	A
Pulse drain reverse current (Note 1)	$I_{DRP}$	—	—	—	76	A
Forward voltage (diode)	$V_{DSF}$	$I_{DR} = 19\text{ A}, V_{GS} = 0\text{ V}$	—	—	-1.7	V
Reverse recovery time	$t_{rr}$	$I_{DR} = 19\text{ A}, V_{GS} = 0\text{ V},$	—	1300	—	$\mu\text{s}$
Reverse recovery charge	$Q_{rr}$	$dI_{DR}/dt = 100\text{ A}/\mu\text{s}$	—	18	—	$\mu\text{C}$

## Marking









$R_G = 25 \Omega$   
 $V_{DD} = 90 \text{ V}, L = 3.79 \text{ mH}$

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

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