

TOSHIBA Field Effect Transistor Silicon N-Channel MOS Type (MACH II  $\pi$ -MOS VI)

## 2SK3936

### Switching Regulator Applications

- Small gate charge:  $Q_g = 60 \text{ nC}$  (typ.)
- Fast reverse recovery time:  $t_{rr} = 380 \text{ ns}$  (typ.)
- Low drain-source ON-resistance:  $R_{DS(ON)} = 0.2 \Omega$  (typ.)
- High forward transfer admittance:  $|Y_{fs}| = 16.5 \text{ S}$  (typ.)
- Low leakage current:  $I_{DSS} = 500 \mu\text{A}$  ( $V_{DS} = 500 \text{ V}$ )
- Enhancement mode:  $V_{th} = 2.0 \text{ to } 4.0 \text{ V}$  ( $V_{DS} = 10 \text{ V}$ ,  $I_D = 1 \text{ mA}$ )

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

Characteristic	Symbol	Rating	Unit
Drain-source voltage	$V_{DSS}$	500	V
Drain-gate voltage ( $R_{GS} = 20 \text{ k}\Omega$ )	$V_{DGR}$	500	V
Gate-source voltage	$V_{GSS}$	$\pm 30$	V
Drain current	DC (Note 1)	$I_D$	23
	Pulse (Note 1)	$I_{DP}$	92
Drain power dissipation ( $T_c = 25^\circ\text{C}$ )	$P_D$	150	W
Single-pulse avalanche energy (Note 2)	$E_{AS}$	759	mJ
Avalanche current	$I_{AR}$	23	A
Repetitive avalanche energy (Note 3)	$E_{AR}$	15	mJ
Channel temperature	$T_{ch}$	150	$^\circ\text{C}$
Storage temperature range	$T_{stg}$	-55 to 150	$^\circ\text{C}$

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

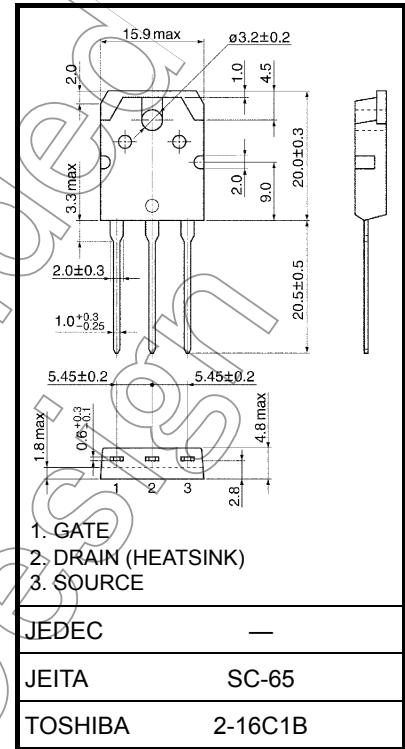
Note 1: Ensure that the channel temperature does not exceed  $150^\circ\text{C}$ .

Note 2:  $V_{DD} = 90 \text{ V}$ ,  $T_{ch} = 25^\circ\text{C}$  (initial),  $L = 2.44 \text{ mH}$ ,  $I_{AR} = 23 \text{ A}$ ,  $R_G = 25 \Omega$

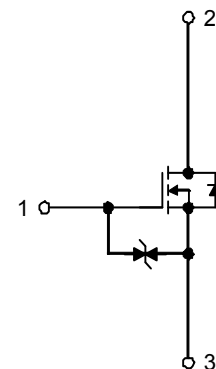
Note 3: Repetitive rating: pulse width limited by maximum channel temperature

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

Unit: mm



Weight: 4.6 g (typ.)



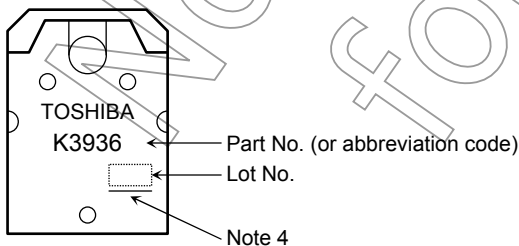
## Electrical Characteristics (Ta = 25°C)

Characteristic		Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current		$I_{GSS}$	$V_{GS} = \pm 25\text{ V}, V_{DS} = 0\text{ V}$	—	—	$\pm 10$	$\mu\text{A}$
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		$I_{DSS}$	$V_{DS} = 500\text{ V}, V_{GS} = 0\text{ V}$	—	—	500	$\mu\text{A}$
Drain-source breakdown voltage		$V_{(BR)DSS}$	$I_D = 10\text{ mA}, V_{GS} = 0\text{ V}$	500	—	—	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		$R_{DS(ON)}$	$V_{GS} = 10\text{ V}, I_D = 11.5\text{ A}$	—	0.2	0.25	$\Omega$
Forward transfer admittance		$ Y_{fs} $	$V_{DS} = 10\text{ V}, I_D = 11.5\text{ A}$	8	16.5	—	S
Input capacitance		$C_{iss}$	$V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$	—	4250	—	pF
Reverse transfer capacitance		$C_{rss}$		—	10	—	
Output capacitance		$C_{oss}$		—	420	—	
Switching time	Rise time	$t_r$	<p><math>I_D = 11.5\text{ A}, V_{OUT}</math>  <math>V_{GS} = 10\text{ V}, 0\text{ V}</math>  <math>4.7\ \Omega, 17.4\ \Omega</math>  <math>V_{DD} \approx 200\text{ V}</math></p>	—	12	—	ns
	Turn-on time	$t_{on}$		—	45	—	
	Fall time	$t_f$		—	10	—	
	Turn-off time	$t_{off}$		Duty $\leq 1\%$ , $t_w = 10\ \mu\text{s}$	—	80	
Total gate charge		$Q_g$	$V_{DD} \approx 400\text{ V}, V_{GS} = 10\text{ V}, I_D = 23\text{ A}$	—	60	—	nC
Gate-source charge		$Q_{gs}$		—	50	—	
Gate-drain charge		$Q_{gd}$		—	10	—	

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

Characteristic	Symbol	Test Condition	Min	Typ.	Max	Unit
Continuous drain reverse current (Note 1)	$I_{DR}$	—	—	—	23	A
Pulse drain reverse current (Note 1)	$I_{DRP}$	—	—	—	92	A
Forward voltage (diode)	$V_{DSF}$	$I_{DR} = 23\text{ A}, V_{GS} = 0\text{ V}$	—	—	-1.7	V
Reverse recovery time	$t_{rr}$	$I_{DR} = 23\text{ A}, V_{GS} = 0\text{ V},$	—	380	—	ns
Reverse recovery charge	$Q_{rr}$	$dI_{DR}/dt = 100\text{ A}/\mu\text{s}$	—	2.4	—	$\mu\text{C}$

### Marking

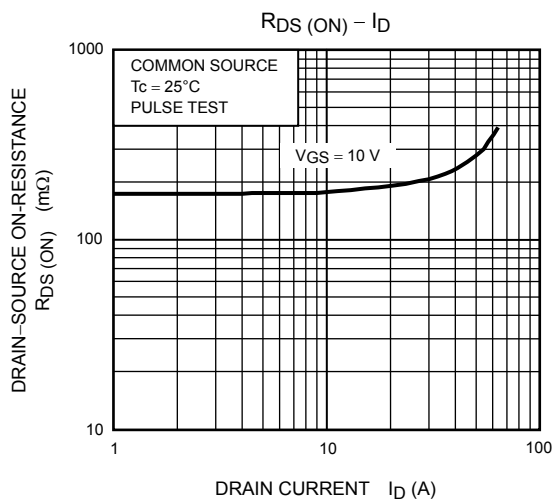
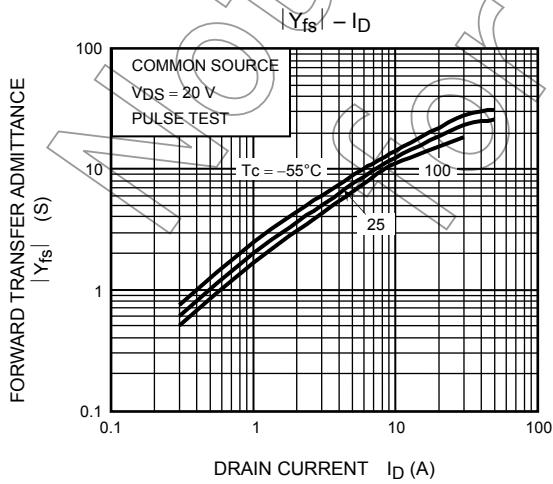
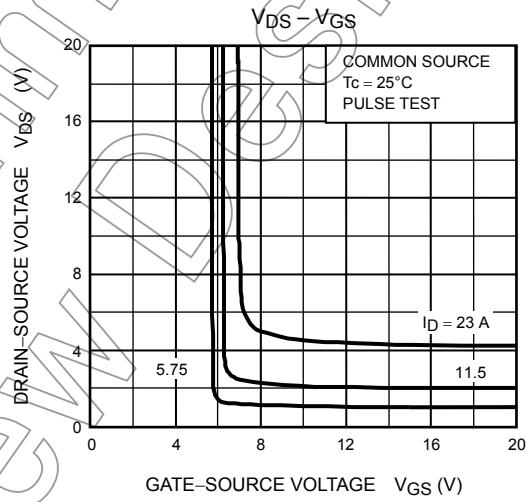
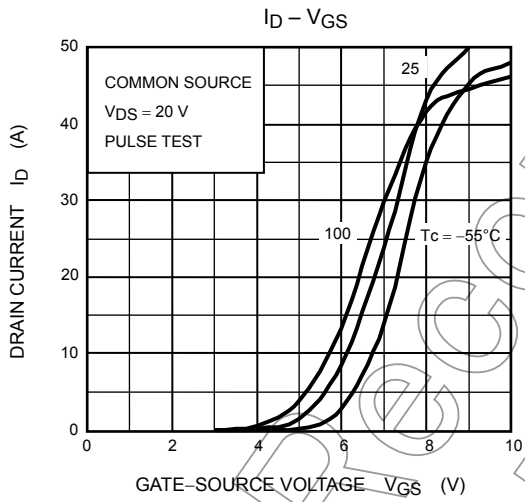
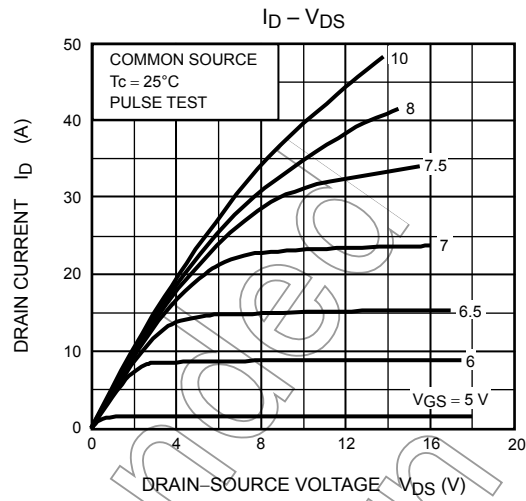
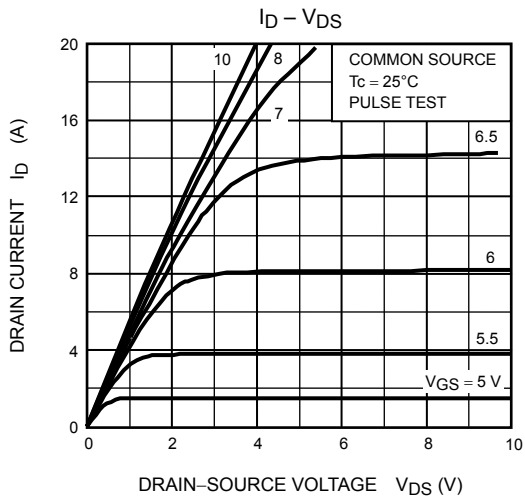


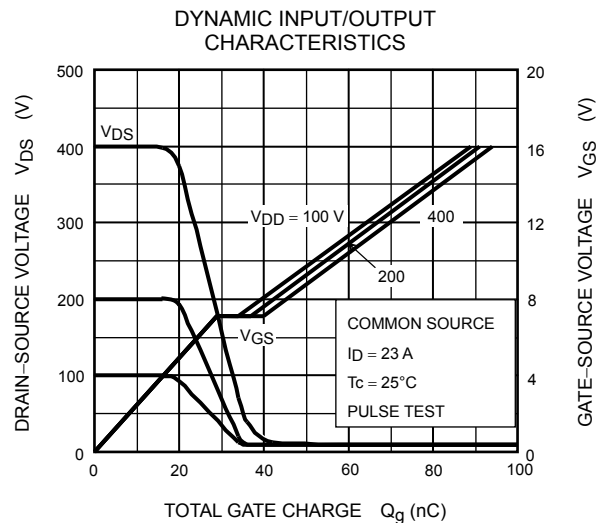
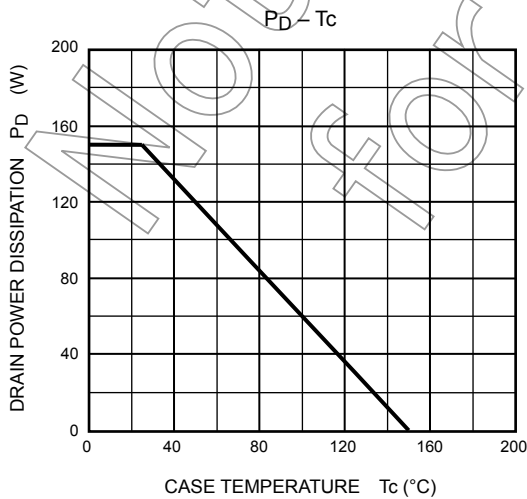
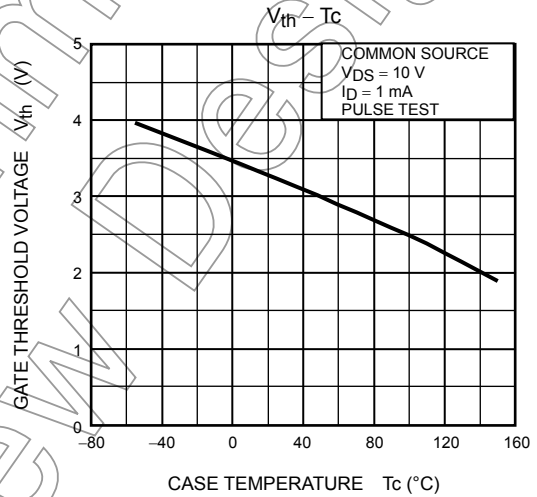
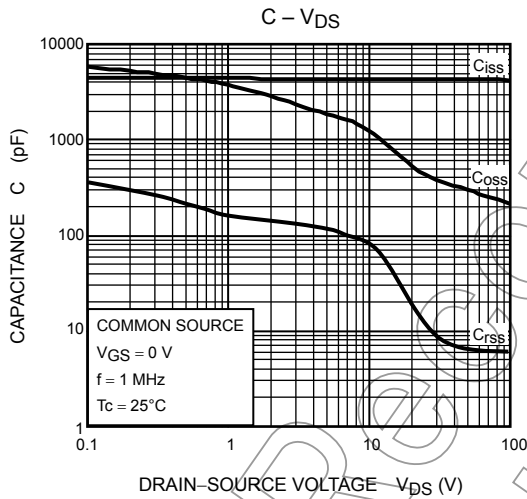
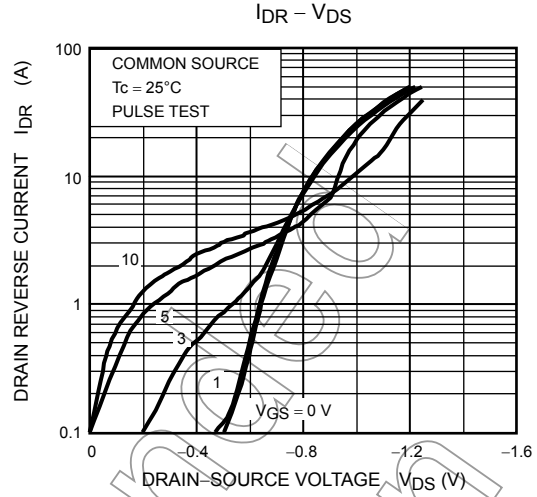
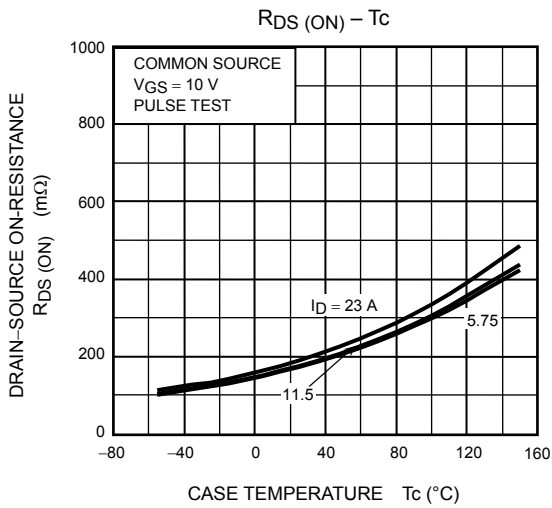
Note 4: A line under a Lot No. identifies the indication of product Labels.

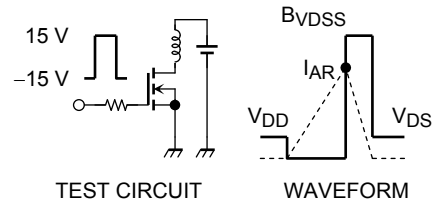
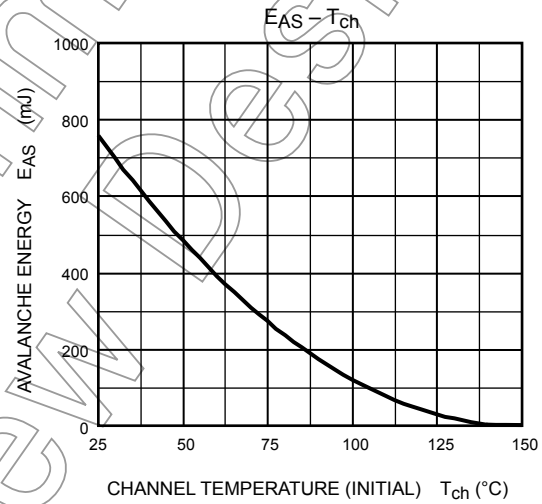
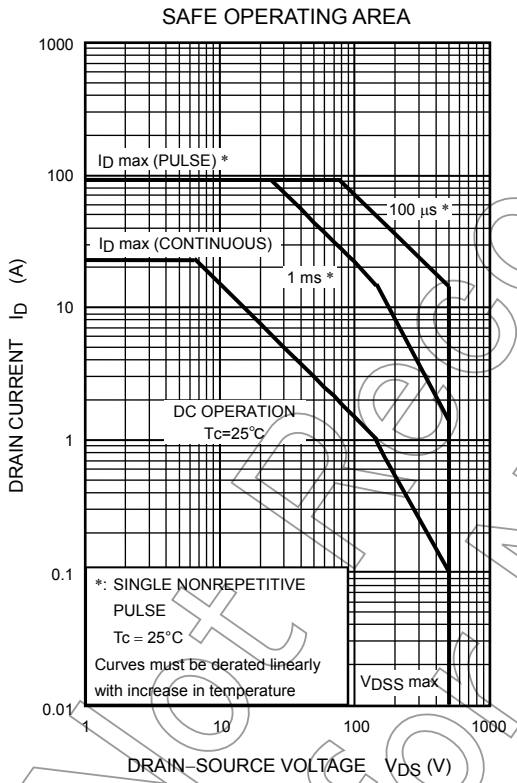
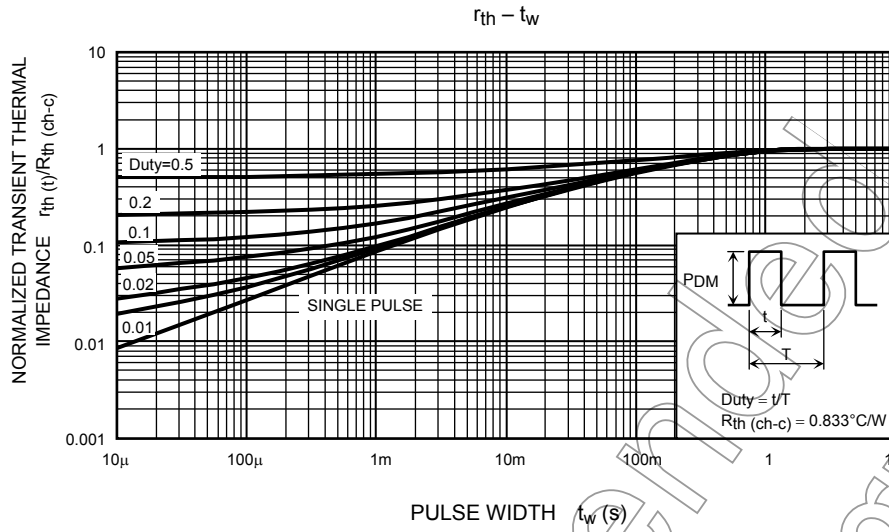
Not underlined: [[Pb]]/INCLUDES > MCV

Underlined: [[G]]/RoHS COMPATIBLE or [[G]]/RoHS [[Pb]]

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$R_G = 25 \Omega$   
 $V_{DD} = 90 V, L = 2.44 mH$

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

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