

MOSFETs Silicon N-Channel MOS ( $\pi$ -MOS $\text{V}_{III}$ )

# TK9A90E

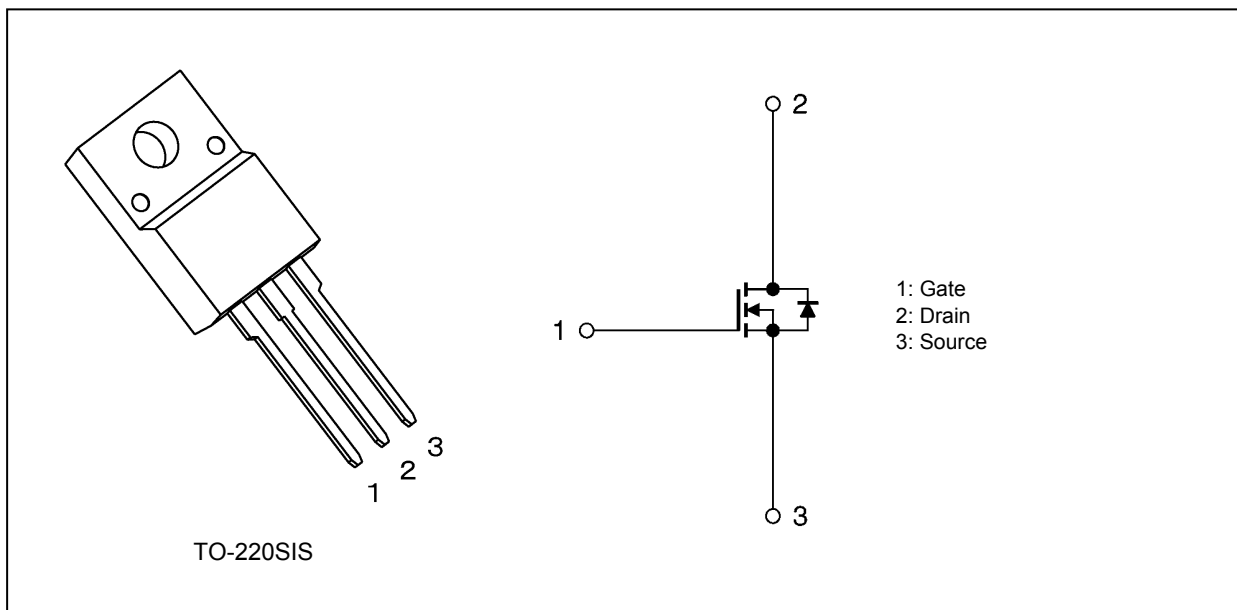
## 1. Applications

- Switching Voltage Regulators

## 2. Features

- (1) Low drain-source on-resistance:  $R_{DS(ON)} = 1.0 \Omega$  (typ.)
- (2) Low leakage current :  $I_{DSS} = 10 \mu\text{A}$  (max) ( $V_{DS} = 720 \text{ V}$ )
- (3) Enhancement mode:  $V_{th} = 2.5$  to  $4.0 \text{ V}$  ( $V_{DS} = 10 \text{ V}$ ,  $I_D = 0.9 \text{ mA}$ )

## 3. Packaging and Internal Circuit



Start of commercial production

2013-10

**4. Absolute Maximum Ratings (Note) ( $T_a = 25\text{ }^\circ\text{C}$  unless otherwise specified)**

Characteristics	Symbol	Rating	Unit
Drain-source voltage	$V_{DSS}$	900	V
Gate-source voltage	$V_{GSS}$	$\pm 30$	
Drain current (DC) (Note 1)	$I_D$	9	A
Drain current (pulsed) (Note 1)	$I_{DP}$	27	
Power dissipation ( $T_c = 25^\circ\text{C}$ )	$P_D$	50	W
Single-pulse avalanche energy (Note 2)	$E_{AS}$	454	mJ
Avalanche current	$I_{AR}$	9	A
Reverse drain current (DC) (Note 1)	$I_{DR}$	9	
Reverse drain current (pulsed) (Note 1)	$I_{DRP}$	27	
Channel temperature	$T_{ch}$	150	$^\circ\text{C}$
Storage temperature	$T_{stg}$	-55 to 150	
Isolation voltage (RMS)	$V_{ISO(RMS)}$	2000	V
Mounting torque	TOR	0.6	N · m

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).

**5. Thermal Characteristics**

Characteristics	Symbol	Max	Unit
Channel-to-case thermal resistance	$R_{th(ch-c)}$	2.5	$^\circ\text{C/W}$
Channel-to-ambient thermal resistance	$R_{th(ch-a)}$	62.5	

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),  $L = 10.3\text{ mH}$ ,  $R_G = 25\ \Omega$ ,  $I_{AR} = 9\text{ A}$

Note: This transistor is sensitive to electrostatic discharge and should be handled with care.

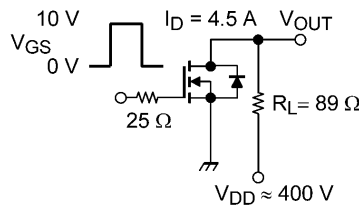
**6. Electrical Characteristics**

**6.1. Static Characteristics ( $T_a = 25\text{ }^\circ\text{C}$  unless otherwise specified)**

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current	$I_{GSS}$	$V_{GS} = \pm 30\text{ V}, V_{DS} = 0\text{ V}$	—	—	$\pm 1$	$\mu\text{A}$
Drain cut-off current	$I_{DSS}$	$V_{DS} = 720\text{ V}, V_{GS} = 0\text{ V}$	—	—	10	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$I_D = 10\text{ mA}, V_{GS} = 0\text{ V}$	900	—	—	V
Gate threshold voltage	$V_{th}$	$V_{DS} = 10\text{ V}, I_D = 0.9\text{ mA}$	2.5	—	4.0	
Drain-source on-resistance	$R_{DS(ON)}$	$V_{GS} = 10\text{ V}, I_D = 4.5\text{ A}$	—	1.0	1.3	$\Omega$

**6.2. Dynamic Characteristics ( $T_a = 25\text{ }^\circ\text{C}$  unless otherwise specified)**

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Input capacitance	$C_{iss}$	$V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$	—	2000	—	$\mu\text{F}$
Reverse transfer capacitance	$C_{rss}$		—	15	—	
Output capacitance	$C_{oss}$		—	150	—	
Gate resistance	$r_g$	$V_{DS} = \text{OPEN}, f = 1\text{ MHz}$	—	3.5	—	$\Omega$
Switching time (rise time)	$t_r$	See Fig. 6.2.1.	—	40	—	ns
Switching time (turn-on time)	$t_{on}$		—	80	—	
Switching time (fall time)	$t_f$		—	35	—	
Switching time (turn-off time)	$t_{off}$		—	140	—	
MOSFET dv/dt ruggedness	dv/dt	$V_{DD} = 0\text{ to }400\text{ V}, I_D = 9\text{ A}$	20	—	—	V/ns



Duty  $\leq 1\%$ ,  $t_w = 10\text{ }\mu\text{s}$

**Fig. 6.2.1 Switching Time Test Circuit**

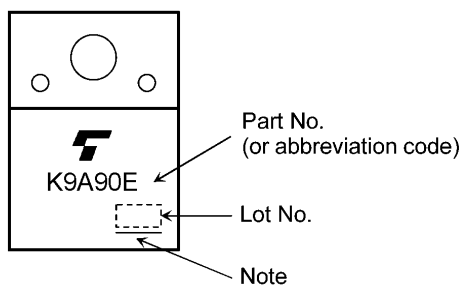
**6.3. Gate Charge Characteristics ( $T_a = 25\text{ }^\circ\text{C}$  unless otherwise specified)**

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Total gate charge (gate-source plus gate-drain)	$Q_g$	$V_{DD} \approx 400\text{ V}, V_{GS} = 10\text{ V}, I_D = 9\text{ A}$	—	46	—	nC
Gate-source charge 1	$Q_{gs1}$		—	13	—	
Gate-drain charge	$Q_{gd}$		—	18	—	

**6.4. Source-Drain Characteristics ( $T_a = 25\text{ }^\circ\text{C}$  unless otherwise specified)**

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Diode forward voltage	$V_{DSF}$	$I_{DR} = 9\text{ A}, V_{GS} = 0\text{ V}$	—	—	-1.7	V
Reverse recovery time	$t_{rr}$	$I_{DR} = 9\text{ A}, V_{GS} = 0\text{ V}$ $-dI_{DR}/dt = 100\text{ A}/\mu\text{s}$	—	1200	—	ns
Reverse recovery charge	$Q_{rr}$		—	12	—	$\mu\text{C}$
Peak reverse recovery current	$I_{rr}$		—	24	—	A

**7. Marking (Note)**



**Fig. 7.1 Marking**

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

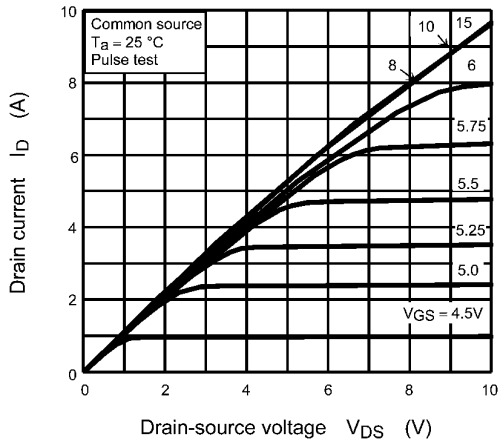
Not underlined: [[Pb]]/INCLUDES > MCV

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

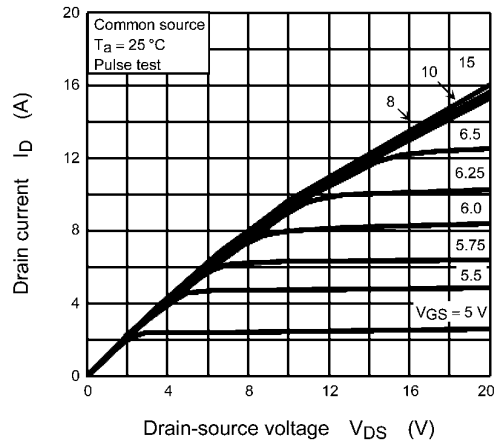
Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product.

The RoHS is the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

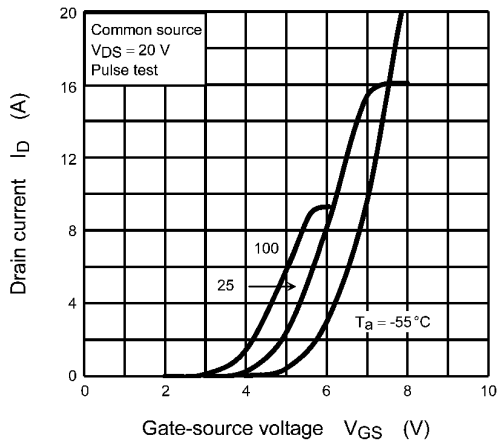
**8. Characteristics Curves (Note)**



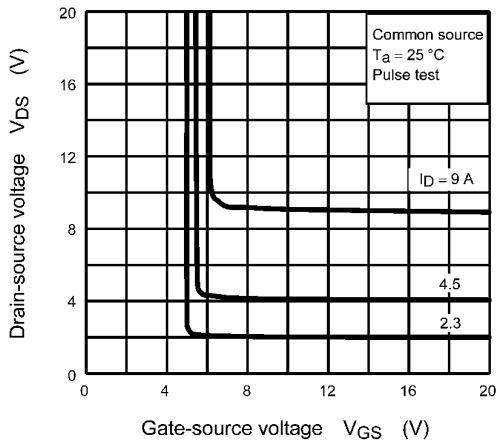
**Fig. 8.1  $I_D - V_{DS}$**



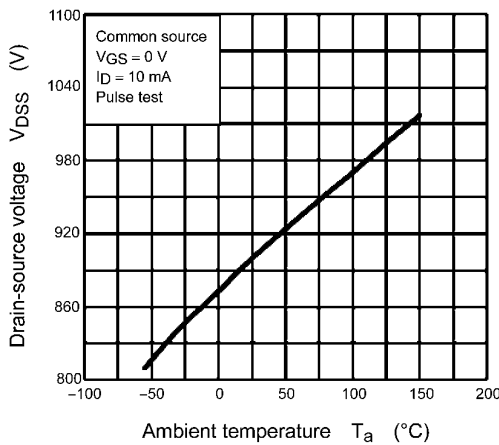
**Fig. 8.2  $I_D - V_{DS}$**



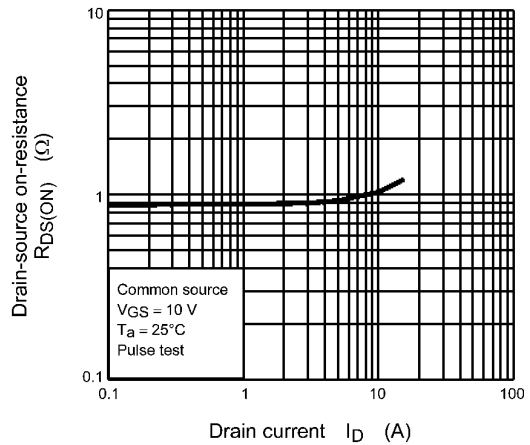
**Fig. 8.3  $I_D - V_{GS}$**



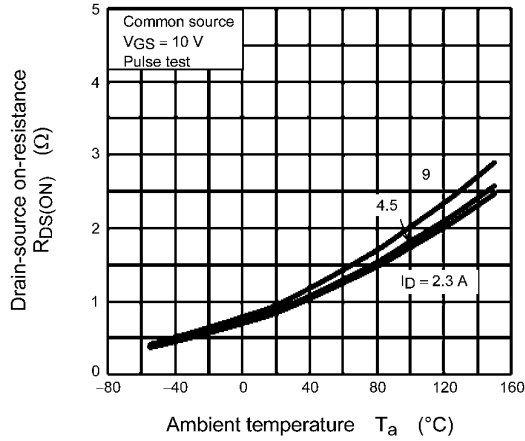
**Fig. 8.4  $V_{DS} - V_{GS}$**



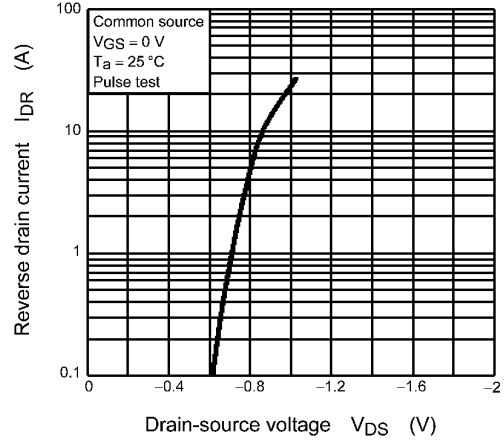
**Fig. 8.5  $V_{DSS} - T_a$**



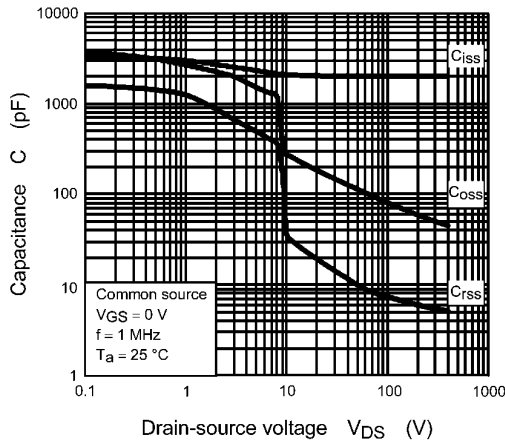
**Fig. 8.6  $R_{DS(ON)} - I_D$**



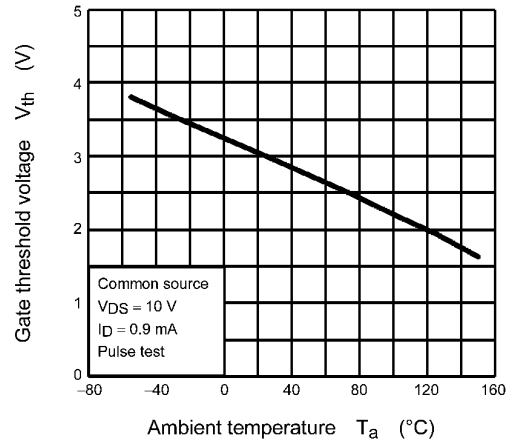
**Fig. 8.7 R<sub>DS(ON)</sub> - T<sub>a</sub>**



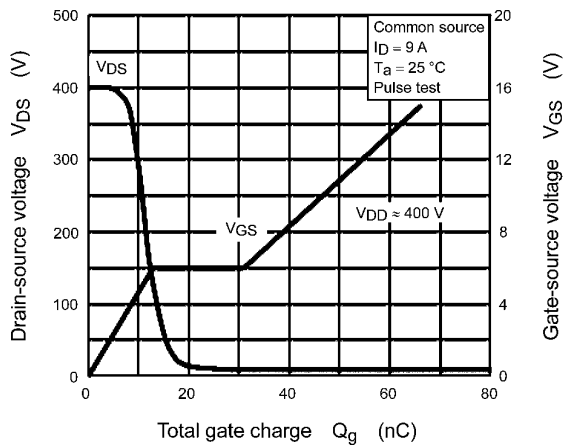
**Fig. 8.8 I<sub>DR</sub> - V<sub>DS</sub>**



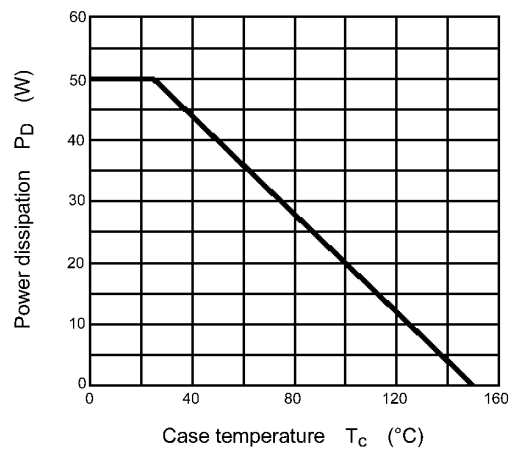
**Fig. 8.9 C - V<sub>DS</sub>**



**Fig. 8.10 V<sub>th</sub> - T<sub>a</sub>**



**Fig. 8.11 Dynamic Input/Output Characteristics**



**Fig. 8.12 P<sub>D</sub> - T<sub>c</sub>  
(Guaranteed Maximum)**

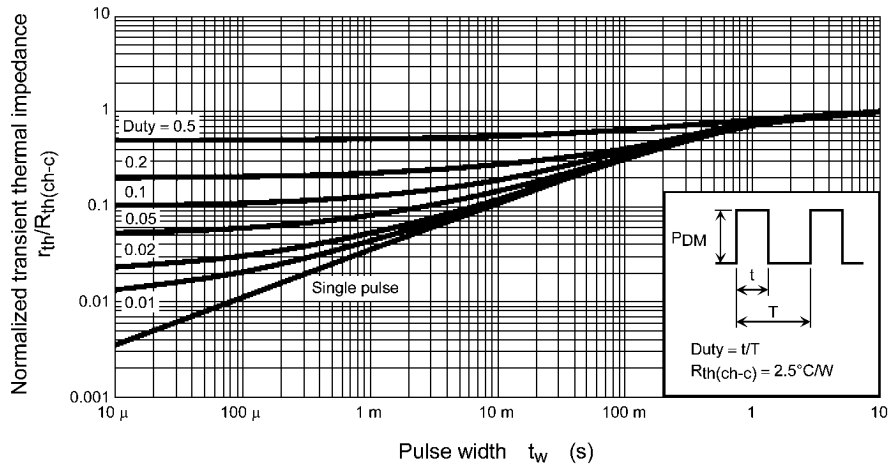


Fig. 8.13  $r_{th} - t_w$   
(Guaranteed Maximum)

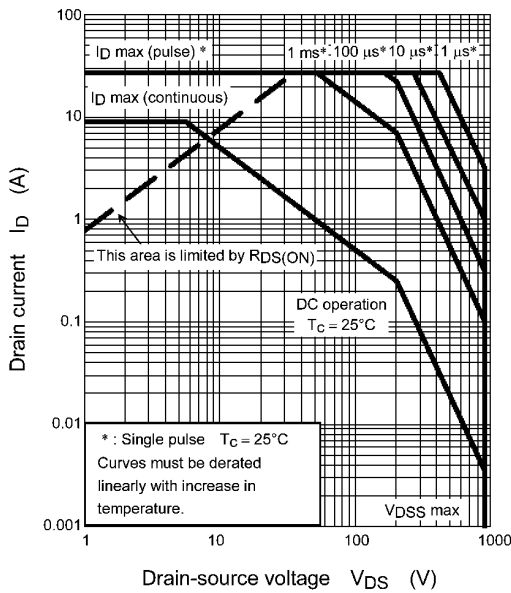


Fig. 8.14 Safe Operating Area  
(Guaranteed Maximum)

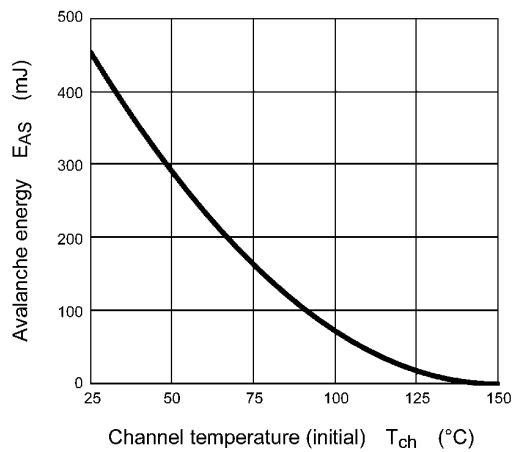
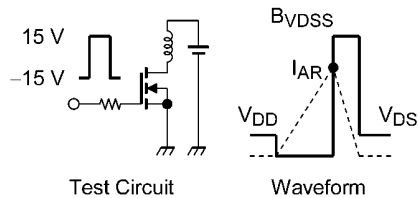


Fig. 8.15  $E_{AS} - T_{ch}$   
(Guaranteed Maximum)



$$R_G = 25 \Omega, V_{DD} = 90 \text{ V } E_{AS} = \frac{1}{2} \cdot L \cdot I_{AR}^2 \cdot \left( \frac{B_{VDSS}}{B_{VDSS} - V_{DD}} \right)$$

Fig. 8.16 Test Circuit/Waveform

Note: The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

**Package Dimensions**

Unit: mm



Weight: 1.7 g (typ.)

Package Name(s)
JEITA: SC-67
TOSHIBA: 2-10U1S
Nickname: TO-220SIS



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