

TOSHIBA Field Effect Transistor Silicon N-Channel MOS Type (U-MOSVI-H)

# TK50P04M1

High-Efficiency DC-DC Converter Applications  
Switching Regulator

- High-speed switching
- Small gate charge:  $Q_{SW} = 9.4 \text{ nC (typ.)}$
- Low drain-source ON-resistance:  $R_{DS(ON)} = 6.7 \text{ m}\Omega \text{ (typ.)}$
- High forward transfer admittance:  $|Y_{fs}| = 105 \text{ S (typ.)}$
- Low leakage current:  $I_{DSS} = 10 \text{ }\mu\text{A (max)}$  ( $V_{DS} = 40 \text{ V}$ )
- Enhancement mode:  $V_{th} = 1.3 \text{ to } 2.3 \text{ V}$  ( $V_{DS} = 10 \text{ V}$ ,  $I_D = 0.5 \text{ mA}$ )

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

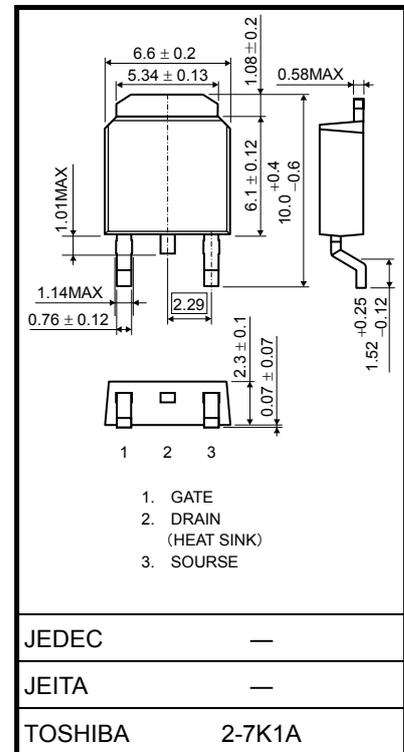
Characteristic		Symbol	Rating	Unit
Drain-source voltage		$V_{DSS}$	40	V
Drain-gate voltage ( $R_{GS} = 20 \text{ k}\Omega$ )		$V_{DGR}$	40	V
Gate-source voltage		$V_{GSS}$	$\pm 20$	V
Drain current	DC (Note 1)	$I_D$	50	A
	Pulsed (Note 1)	$I_{DP}$	150	
Drain power dissipation ( $T_c = 25^\circ\text{C}$ )		$P_D$	60	W
Single-pulse avalanche energy (Note 2)		$E_{AS}$	65	mJ
Avalanche current		$I_{AR}$	50	A
Repetitive avalanche energy ( $T_c=25^\circ\text{C}$ ) (Note 3)		$E_{AR}$	4.4	mJ
Channel temperature		$T_{ch}$	150	°C
Storage temperature range		$T_{stg}$	-55 to 150	°C

Note: For Notes 1 to 3, refer to the next page.

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).

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

Unit: mm

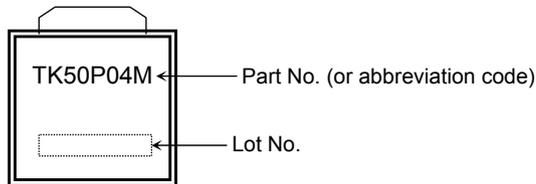


Weight: 0.36 g (typ.)

## Thermal Characteristics

Characteristic	Symbol	Max	Unit
Thermal resistance, channel to case	$R_{th(ch-c)}$	2.08	°C / W
Thermal resistance, channel to ambient	$R_{th(ch-a)}$	125	°C / W

## Marking (Note 4)

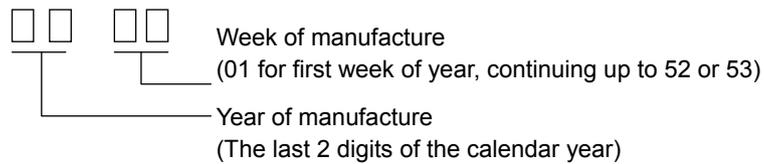


Note 1: The channel temperature should not exceed 150°C during use.

Note 2:  $V_{DD} = 32\text{ V}$ ,  $T_{ch} = 25^\circ\text{C}$  (initial),  $L = 20\ \mu\text{H}$ ,  $R_G = 25\ \Omega$ ,  $I_{AR} = 50\ \text{A}$

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

Note 4: \* Weekly code: (Four digits)

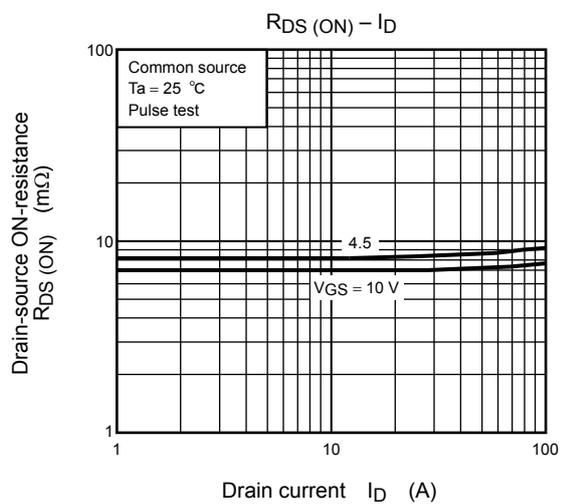
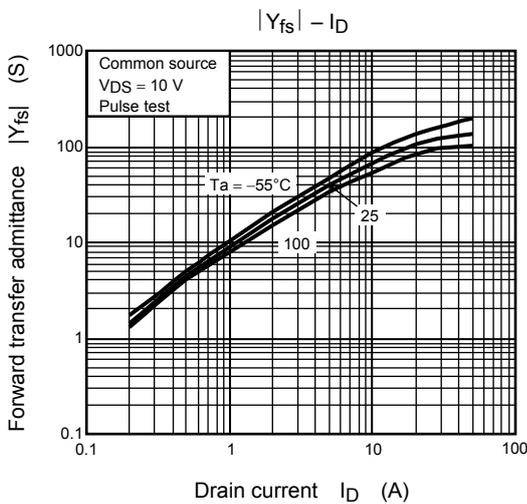
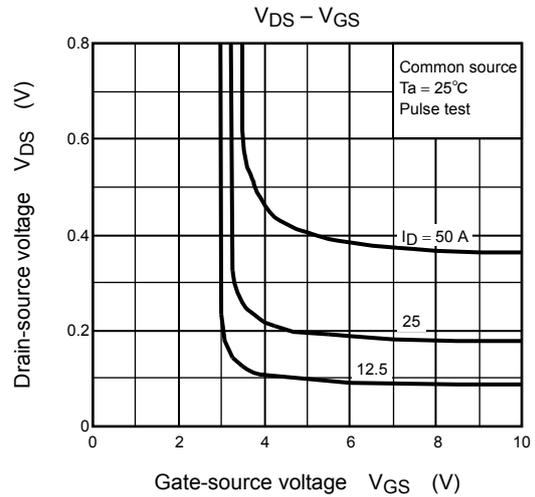
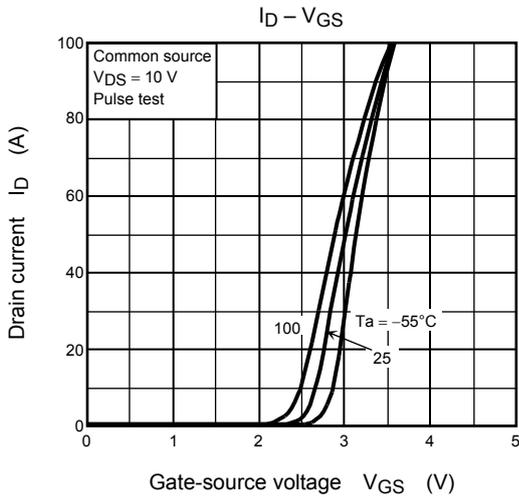
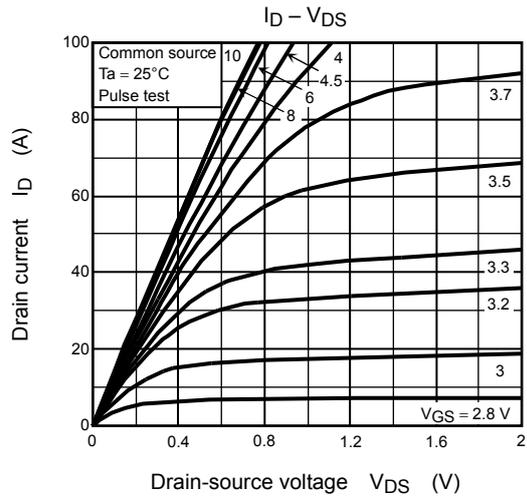
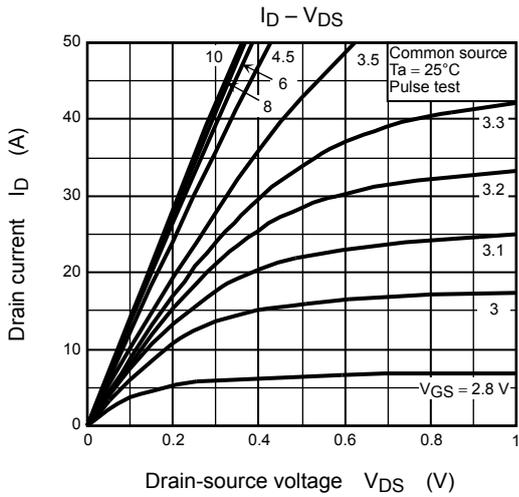


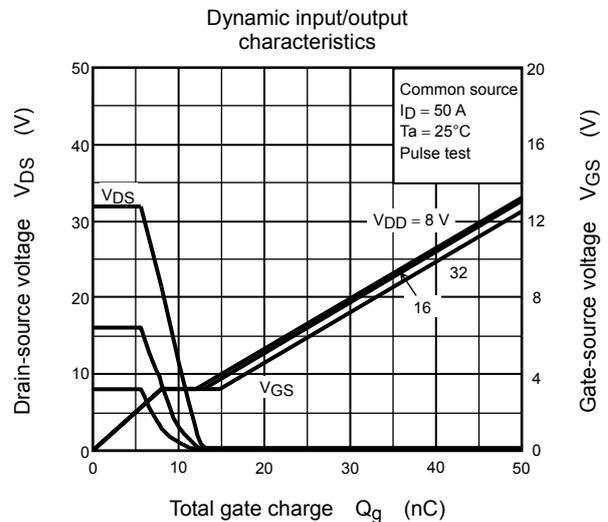
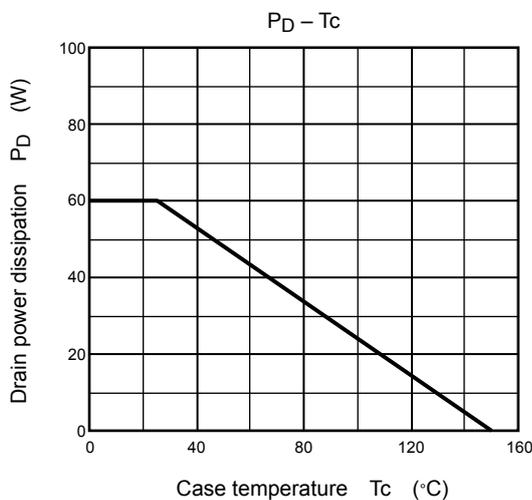
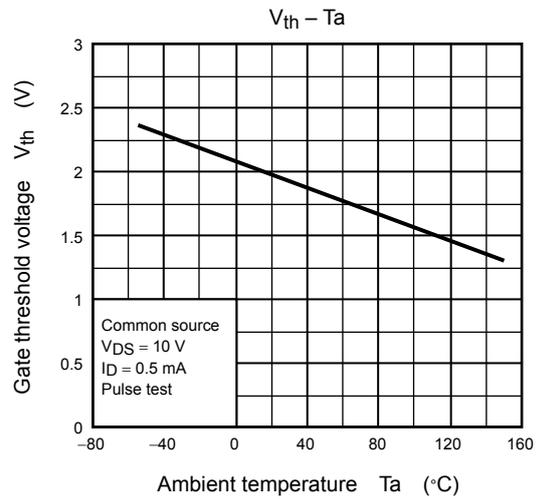
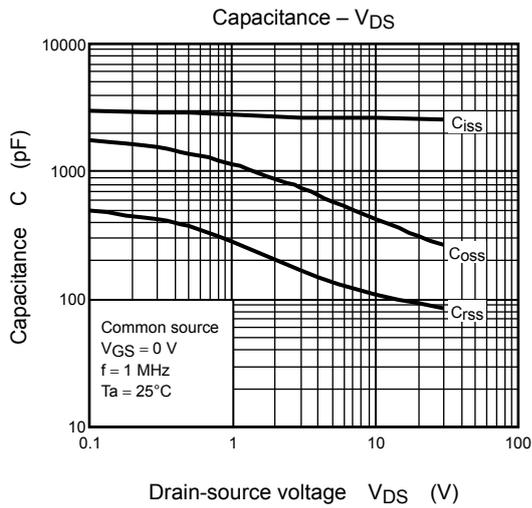
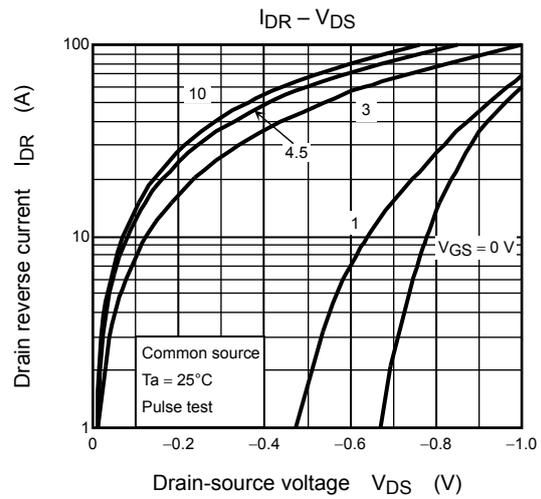
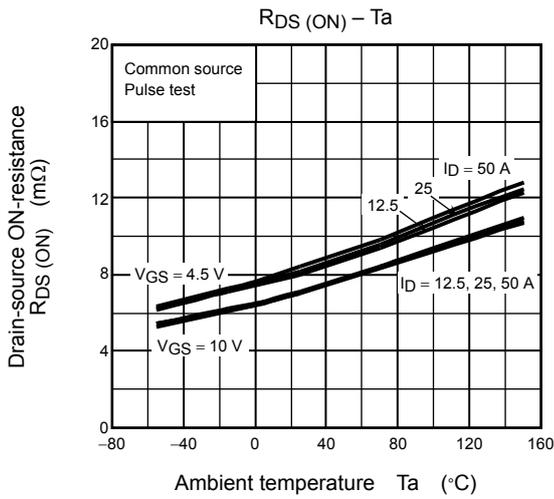
## Electrical Characteristics (Ta = 25°C)

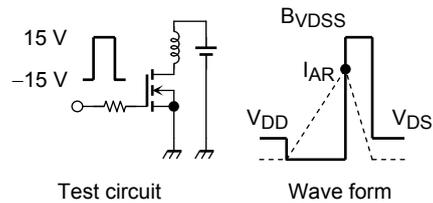
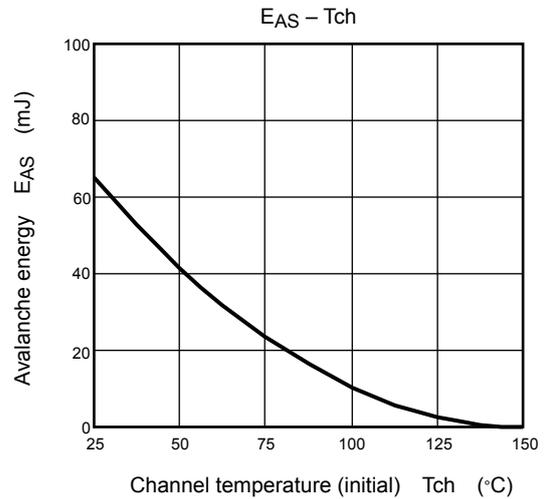
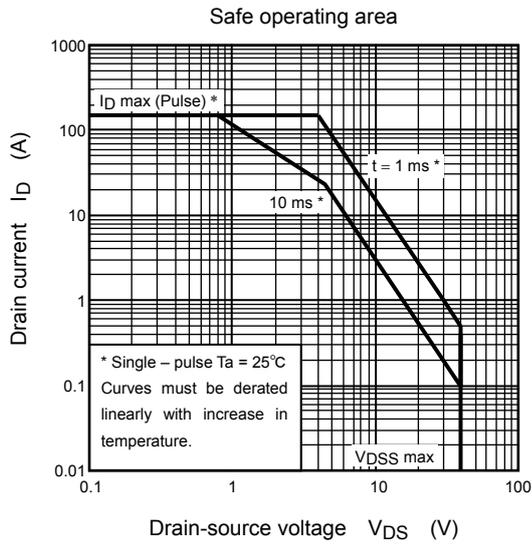
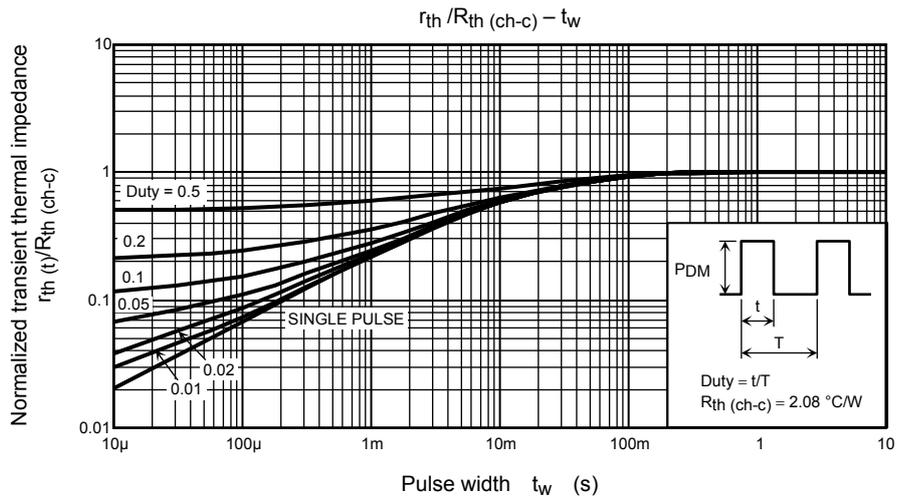
Characteristic		Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current		$I_{GSS}$	$V_{GS} = \pm 20\text{ V}, V_{DS} = 0\text{ V}$	—	—	$\pm 100$	nA
Drain cutoff current		$I_{DSS}$	$V_{DS} = 40\text{ V}, V_{GS} = 0\text{ V}$	—	—	10	$\mu\text{A}$
Drain-source breakdown voltage		$V_{(BR)DSS}$	$I_D = 10\text{ mA}, V_{GS} = 0\text{ V}$	40	—	—	V
		$V_{(BR)DSX}$	$I_D = 10\text{ mA}, V_{GS} = -20\text{ V}$	25	—	—	
Gate threshold voltage		$V_{th}$	$V_{DS} = 10\text{ V}, I_D = 0.5\text{ mA}$	1.3	—	2.3	V
Drain-source ON-resistance		$R_{DS(ON)}$	$V_{GS} = 4.5\text{ V}, I_D = 25\text{ A}$	—	7.8	10.2	m $\Omega$
			$V_{GS} = 10\text{ V}, I_D = 25\text{ A}$	—	6.7	8.7	
Forward transfer admittance		$ Y_{fs} $	$V_{DS} = 10\text{ V}, I_D = 25\text{ A}$	52.5	105	—	S
Input capacitance		$C_{iss}$	$V_{DS} = 10\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$	—	2600	—	pF
Reverse transfer capacitance		$C_{rss}$		—	110	—	
Output capacitance		$C_{oss}$		—	420	—	
Gate resistance		$r_g$	$V_{DS} = 10\text{ V}, V_{GS} = 0\text{ V}, f = 5\text{ MHz}$	—	2.5	—	$\Omega$
Switching time	Rise time	$t_r$	<p><math>V_{GS} = 10\text{ V}, 0\text{ V}</math>  <math>I_D = 25\text{ A}</math>  <math>R_L = 0.8\ \Omega</math>  <math>V_{DD} \approx 20\text{ V}</math>  <math>Duty \leq 1\%, t_w = 10\ \mu\text{s}</math></p>	—	22	—	ns
	Turn-on time	$t_{on}$		—	29	—	
	Fall time	$t_f$		—	10	—	
	Turn-off time	$t_{off}$		—	77	—	
Total gate charge (gate-source plus gate-drain)		$Q_g$	$V_{DD} \approx 32\text{ V}, V_{GS} = 10\text{ V}, I_D = 50\text{ A}$	—	38	—	nC
			$V_{DD} \approx 32\text{ V}, V_{GS} = 5\text{ V}, I_D = 50\text{ A}$	—	20	—	
Gate-source charge 1		$Q_{gs1}$	$V_{DD} \approx 32\text{ V}, V_{GS} = 10\text{ V}, I_D = 50\text{ A}$	—	8.0	—	
Gate-drain ("Miller") charge		$Q_{gd}$	$V_{DD} \approx 32\text{ V}, V_{GS} = 10\text{ V}, I_D = 50\text{ A}$	—	5.7	—	
Gate switch charge		$Q_{sw}$	$V_{DD} \approx 32\text{ V}, V_{GS} = 10\text{ V}, I_D = 50\text{ A}$	—	9.4	—	

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

Characteristic		Symbol	Test Condition	Min	Typ.	Max	Unit
Drain reverse current	Pulse (Note 1)	$I_{DRP}$	—	—	—	150	A
Forward voltage (diode)		$V_{DSF}$	$I_{DR} = 50\text{ A}, V_{GS} = 0\text{ V}$	—	—	-1.2	V







$R_G = 25 \Omega$   
 $V_{DD} = 32 \text{ V}, L = 20 \mu\text{H}$

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

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