

TK35S04K3L

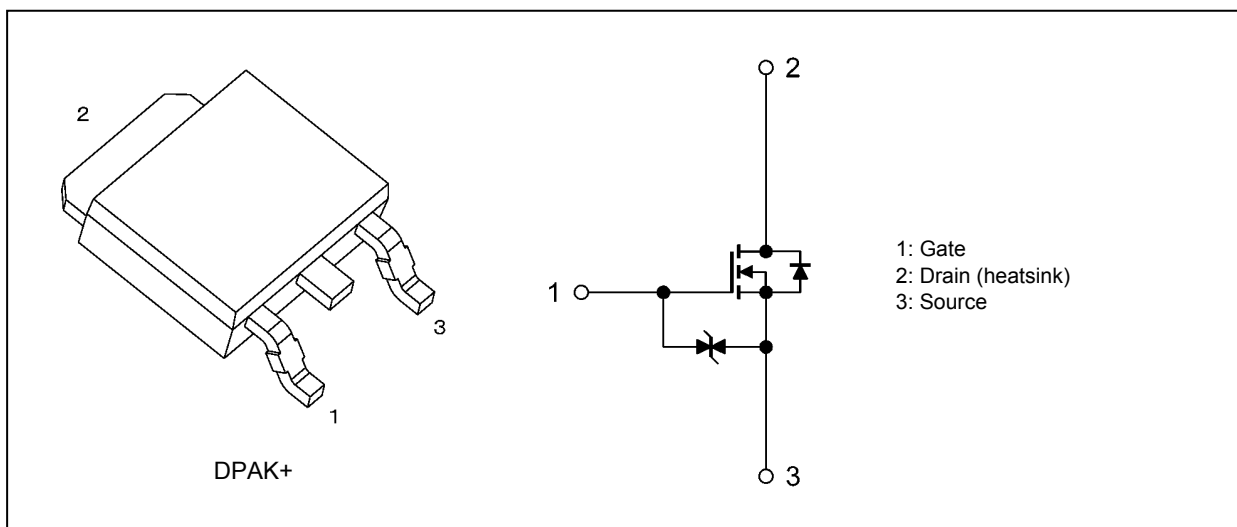
1. Applications

- Automotive
- Motor Drivers
- DC-DC Converters
- Switching Voltage Regulators

2. Features

- (1) AEC-Q101 qualified
- (2) Low drain-source on-resistance: $R_{DS(ON)} = 8.2 \text{ m}\Omega$ (typ.) ($V_{GS} = 10 \text{ V}$)
- (3) Low leakage current: $I_{DSS} = 10 \text{ }\mu\text{A}$ (max) ($V_{DS} = 40 \text{ V}$)
- (4) Enhancement mode: $V_{th} = 2.0 \text{ to } 3.0 \text{ V}$ ($V_{DS} = 10 \text{ V}$, $I_D = 1 \text{ mA}$)

3. Packaging and Internal Circuit



Start of commercial production

2011-04

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

Characteristics	Symbol	Rating	Unit
Drain-source voltage	V_{DSS}	40	V
Gate-source voltage	V_{GSS}	± 20	
Drain current (DC) (Note 1)	I_D	35	A
Drain current (pulsed) (Note 1)	I_{DP}	70	
Power dissipation ($T_c = 25^\circ\text{C}$)	P_D	58	W
Single-pulse avalanche energy (Note 2)	E_{AS}	42	mJ
Avalanche current	I_{AR}	35	A
Channel temperature (Note 3)	T_{ch}	175	$^\circ\text{C}$
Storage temperature (Note 3)	T_{stg}	-55 to 175	

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	$R_{th(ch-c)}$	2.6	$^\circ\text{C}/\text{W}$

Note 1: Ensure that the channel temperature does not exceed 175°C .

Note 2: $V_{DD} = 25\text{ V}$, $T_{ch} = 25^\circ\text{C}$ (initial), $L = 36\ \mu\text{H}$, $R_G = 1\ \Omega$, $I_{AR} = 35\text{ A}$

Note 3: The definitions of the absolute maximum channel and storage temperatures are qualified per AEC-Q101.

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

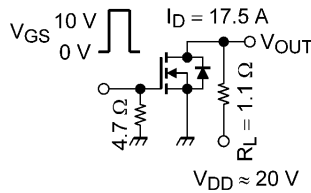
6. Electrical Characteristics

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

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current	I_{GSS}	$V_{GS} = \pm 16\text{ V}, V_{DS} = 0\text{ V}$	—	—	± 10	μA
Drain cut-off current	I_{DSS}	$V_{DS} = 40\text{ V}, V_{GS} = 0\text{ V}$	—	—	10	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$I_D = 10\text{ mA}, V_{GS} = 0\text{ V}$	40	—	—	V
	$V_{(BR)DSX}$	$I_D = 10\text{ mA}, V_{GS} = -20\text{ V}$	20	—	—	
Gate threshold voltage	V_{th}	$V_{DS} = 10\text{ V}, I_D = 1\text{ mA}$	2.0	—	3.0	
Drain-source on-resistance	$R_{DS(ON)}$	$V_{GS} = 6\text{ V}, I_D = 17.5\text{ A}$	—	11.0	15.0	$\text{m}\Omega$
		$V_{GS} = 10\text{ V}, I_D = 17.5\text{ A}$	—	8.2	10.3	

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

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Input capacitance	C_{iss}	$V_{DS} = 10\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$	—	1370	—	pF
Reverse transfer capacitance	C_{rss}		—	180	—	
Output capacitance	C_{oss}		—	320	—	
Switching time (rise time)	t_r	See Figure 6.2.1.	—	9	—	ns
Switching time (turn-on time)	t_{on}		—	19	—	
Switching time (fall time)	t_f		—	12	—	
Switching time (turn-off time)	t_{off}		—	35	—	



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

Fig. 6.2.1 Switching Time Test Circuit

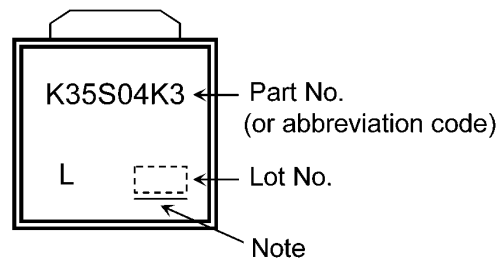
6.3. Gate Charge Characteristics ($T_a = 25^\circ\text{C}$ unless otherwise specified)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Total gate charge (gate-source plus gate-drain)	Q_g	$V_{DD} \approx 32\text{ V}, V_{GS} = 10\text{ V}, I_D = 35\text{ A}$	—	28	—	nC
Gate-source charge	Q_{gs}		—	18	—	
Gate-drain charge	Q_{gd}		—	10	—	

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

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Reverse drain current (DC)	I_{DR}	—	—	—	35	A
Reverse drain current (pulsed)	I_{DRP}	—	—	—	70	
Diode forward voltage	V_{DSF}	$I_{DR} = 35\text{ A}, V_{GS} = 0\text{ V}$	—	—	-1.2	V
Reverse recovery time	t_{rr}	$I_{DR} = 35\text{ A}, V_{GS} = 0\text{ V}$ $-di_{DR}/dt = 50\text{ A}/\mu\text{s}$	—	35	—	ns
Reverse recovery charge	Q_{rr}		—	17	—	nC

Note 4: Ensure that the channel temperature does not exceed 175°C .

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)

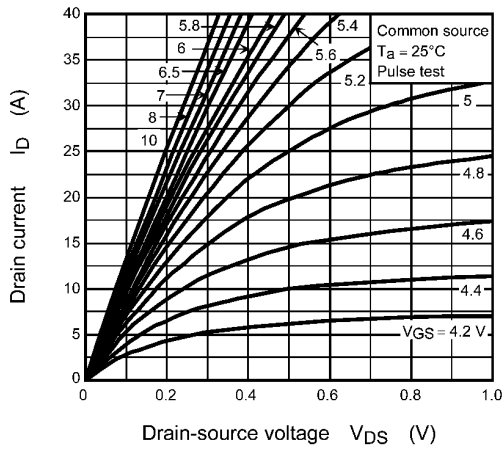


Fig. 8.1 $I_D - V_{DS}$

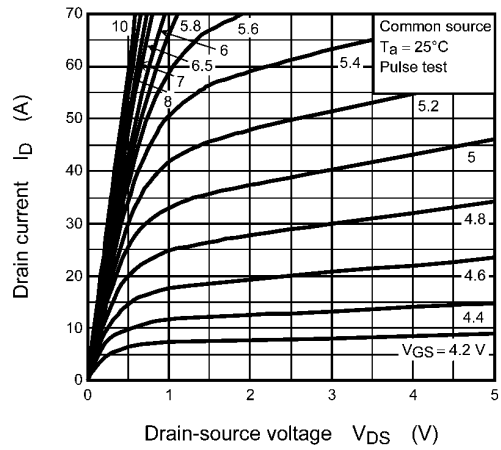


Fig. 8.2 $I_D - V_{DS}$

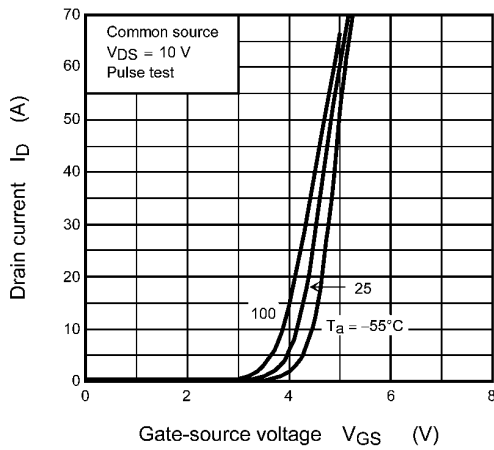


Fig. 8.3 $I_D - V_{GS}$

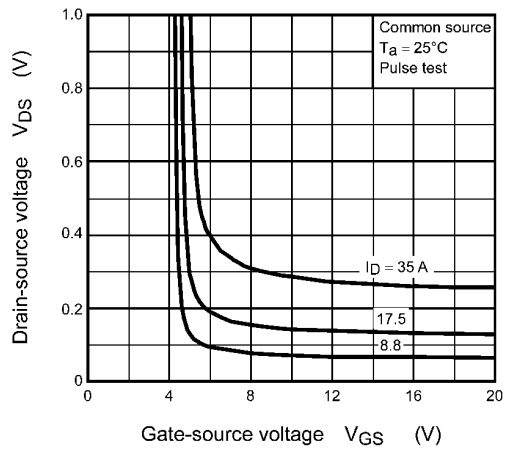


Fig. 8.4 $V_{DS} - V_{GS}$

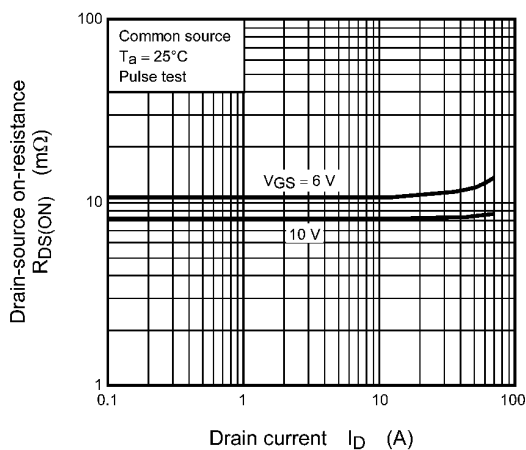


Fig. 8.5 $R_{DS(ON)} - I_D$

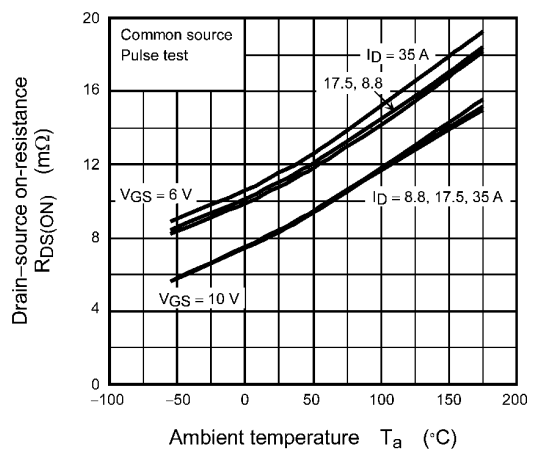


Fig. 8.6 $R_{DS(ON)} - T_a$

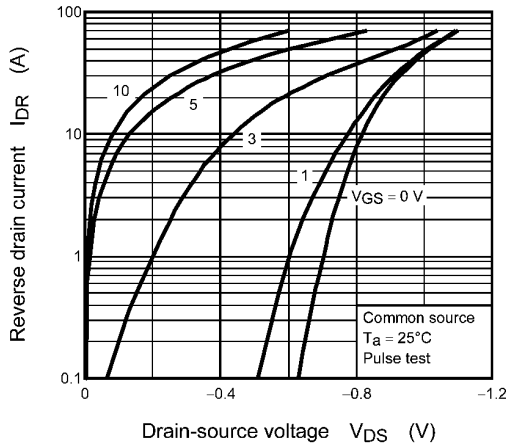


Fig. 8.7 $I_{DR} - V_{DS}$

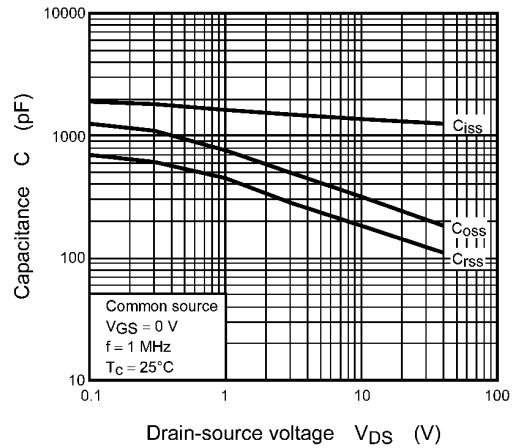


Fig. 8.8 Capacitance - V_{DS}

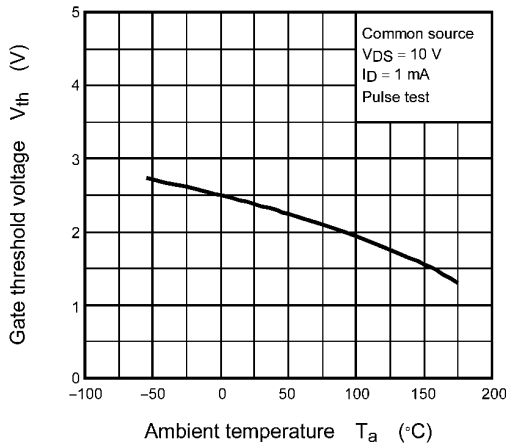


Fig. 8.9 $V_{th} - T_a$

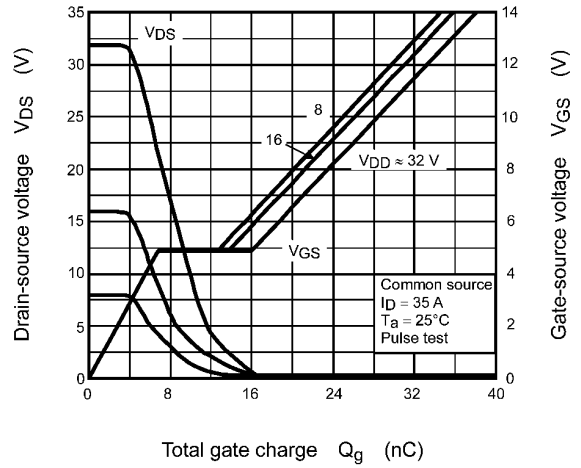
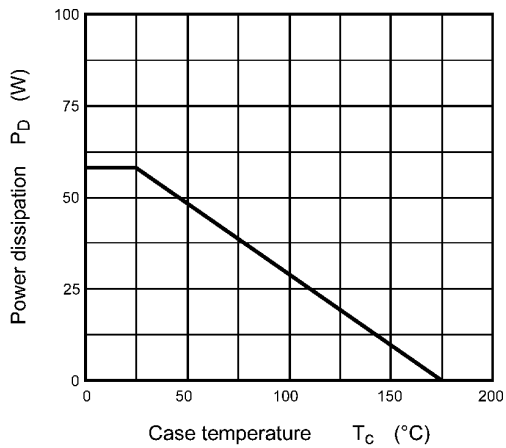


Fig. 8.10 Dynamic Input/Output Characteristics



**Fig. 8.11 $P_D - T_c$
(Guaranteed Maximum)**

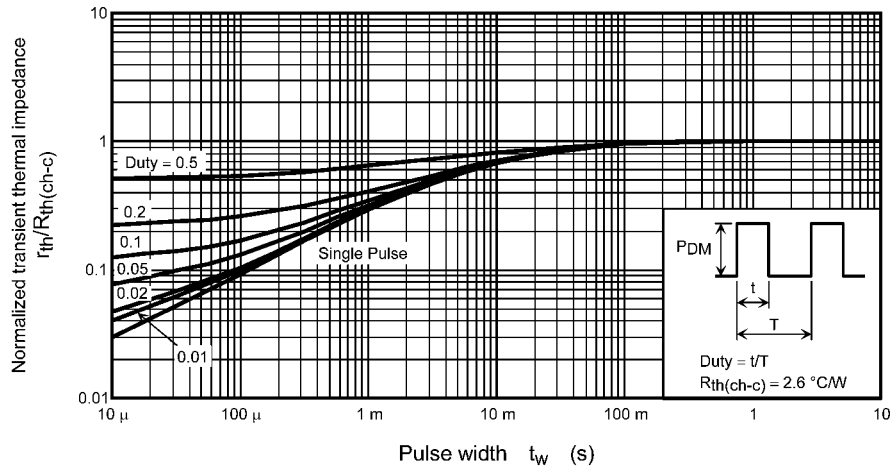


Fig. 8.12 $r_{th}/R_{th(ch-c)} - t_w$
(Guaranteed Maximum)

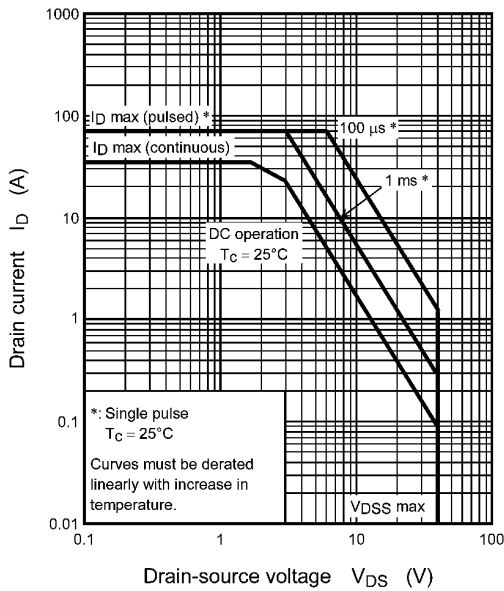


Fig. 8.13 Safe Operating Area
(Guaranteed Maximum)

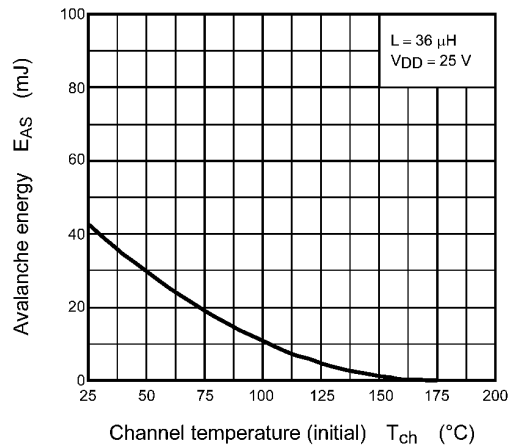
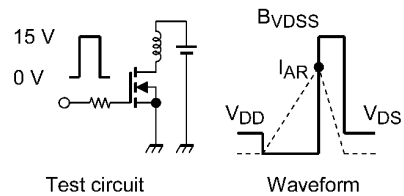


Fig. 8.14 $E_{AS} - T_{ch}$
(Guaranteed Maximum)



$$R_G = 1 \Omega, V_{DD} = 25 \text{ V}, L = 36 \mu\text{H} \quad E_{AS} = \frac{1}{2} \cdot L \cdot I_{AR}^2 \cdot \left(\frac{B_{VDS}}{B_{VDS} - V_{DD}} \right)$$

Fig. 8.15 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: 0.36 g (typ.)

Package Name(s)
TOSHIBA: 2-7M1A
Nickname: DPAK+

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