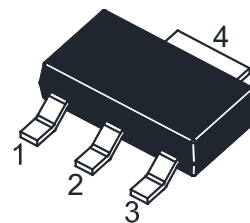
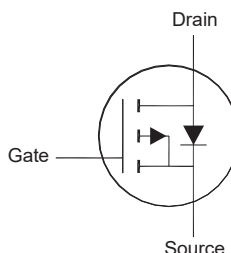


## P-Channel Enhancement Mode MOSFET

### Features

- AEC-Q101 Qualified
- Surface-mounted package
- Halogen and Antimony Free(HAF), RoHS compliant



1.Gate 2.Drain 3.Source 4.Dr.  
SOT-223 Plastic Package

### Key Parameters

| Parameter         | Value                   | Unit |
|-------------------|-------------------------|------|
| $-V_{(BR)DSS}$    | 60                      | V    |
| $R_{DS(ON)}$ Max  | 170 @ $-V_{GS} = 10$ V  | mΩ   |
|                   | 220 @ $-V_{GS} = 4.5$ V |      |
| $-V_{GS(th)}$ typ | 1.6                     | V    |
| $Q_g$ typ         | 7 @ $-V_{GS} = 10$ V    | nC   |

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

| Parameter                                        | Symbol                    | Value         | Unit             |
|--------------------------------------------------|---------------------------|---------------|------------------|
| Drain-Source Voltage                             | $-V_{DS}$                 | 60            | V                |
| Gate-Source Voltage                              | $V_{GS}$                  | $\pm 20$      | V                |
| Drain Current                                    | $-I_D$                    | 7             | A                |
|                                                  |                           | 4.4           |                  |
|                                                  | $T_c = 25^\circ\text{C}$  |               |                  |
|                                                  | $T_c = 100^\circ\text{C}$ |               |                  |
| Peak Drain Current <sup>1)</sup>                 | $-I_{DM}$                 | 15            | A                |
| Avalanche Current                                | $-I_{AS}$                 | 9.3           | A                |
| Avalanche Energy <sup>2)</sup>                   | $E_{AS}$                  | 4.3           | mJ               |
| Power Dissipation                                | $P_D$                     | 18.6          | W                |
|                                                  | $T_c = 25^\circ\text{C}$  |               |                  |
| Operating Junction and Storage Temperature Range | $T_J, T_{stg}$            | - 55 to + 150 | $^\circ\text{C}$ |

### Thermal Characteristics

| Parameter                                                 | Symbol          | Max. | Unit               |
|-----------------------------------------------------------|-----------------|------|--------------------|
| Thermal Resistance from Junction to Case                  | $R_{\theta JC}$ | 6.7  | $^\circ\text{C/W}$ |
| Thermal Resistance from Junction to Ambient <sup>3)</sup> | $R_{\theta JA}$ | 65   | $^\circ\text{C/W}$ |

<sup>1)</sup> Pulse Test: Pulse Width  $\leq 100$   $\mu\text{s}$ , Duty Cycle  $\leq 2\%$ , Repetitive rating, pulse width limited by junction temperature  $T_{J(MAX)} = 150^\circ\text{C}$ .

<sup>2)</sup> Limited by  $T_{J(MAX)}$ , starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.1$  mH,  $R_g = 25$   $\Omega$ ,  $-I_{AS} = 9.3$  A,  $V_{GS} = 10$  V.

<sup>3)</sup> Device mounted on FR-4 substrate PC board, 2oz copper, with 1-inch square copper plate in still air.

Characteristics at  $T_a = 25^\circ\text{C}$  unless otherwise specified

| Parameter                                                                                                                                                                            | Symbol         | Min.   | Typ.     | Max.       | Unit          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|--------|----------|------------|---------------|
| <b>STATIC PARAMETERS</b>                                                                                                                                                             |                |        |          |            |               |
| Drain-Source Breakdown Voltage<br>at $-I_D = 250\ \mu\text{A}$                                                                                                                       | $-V_{(BR)DSS}$ | 60     | -        | -          | V             |
| Drain-Source On-State Current<br>at $-V_{DS} = 60\ \text{V}$                                                                                                                         | $-I_{DSS}$     | -      | -        | 1          | $\mu\text{A}$ |
| Gate-Source Leakage Current<br>at $V_{GS} = \pm 20\ \text{V}$                                                                                                                        | $I_{GSS}$      | -      | -        | $\pm 100$  | nA            |
| Gate-Source Threshold Voltage<br>at $V_{DS} = V_{GS}$ , $-I_D = 250\ \mu\text{A}$                                                                                                    | $-V_{GS(th)}$  | 1.2    | -        | 2.5        | V             |
| Drain-Source On-State Resistance<br>at $-V_{GS} = 10\ \text{V}$ , $-I_D = 5\ \text{A}$<br>at $-V_{GS} = 4.5\ \text{V}$ , $-I_D = 4\ \text{A}$                                        | $R_{DS(ON)}$   | -<br>- | 150<br>- | 170<br>220 | m $\Omega$    |
| <b>DYNAMIC PARAMETERS</b>                                                                                                                                                            |                |        |          |            |               |
| Forward Transconductance<br>at $-V_{DS} = 5\ \text{V}$ , $-I_D = 4\ \text{A}$                                                                                                        | $g_{fs}$       | -      | 5.5      | -          | S             |
| Gate resistance<br>at $V_{GS} = 0\ \text{V}$ , $V_{DS} = 0\ \text{V}$ , $f = 1\ \text{MHz}$                                                                                          | $R_g$          | -      | 9.2      | -          | $\Omega$      |
| Input Capacitance<br>at $V_{GS} = 0\ \text{V}$ , $-V_{DS} = 30\ \text{V}$ , $f = 1\ \text{MHz}$                                                                                      | $C_{iss}$      | -      | 361      | -          | pF            |
| Output Capacitance<br>at $V_{GS} = 0\ \text{V}$ , $-V_{DS} = 30\ \text{V}$ , $f = 1\ \text{MHz}$                                                                                     | $C_{oss}$      | -      | 25       | -          | pF            |
| Reverse Transfer Capacitance<br>at $V_{GS} = 0\ \text{V}$ , $-V_{DS} = 30\ \text{V}$ , $f = 1\ \text{MHz}$                                                                           | $C_{rss}$      | -      | 20       | -          | pF            |
| Total Gate Charge<br>at $-V_{GS} = 10\ \text{V}$ , $-V_{DS} = 30\ \text{V}$ , $-I_D = 5\ \text{A}$<br>at $-V_{GS} = 4.5\ \text{V}$ , $-V_{DS} = 30\ \text{V}$ , $-I_D = 5\ \text{A}$ | $Q_g$          | -<br>- | 7<br>3.2 | -<br>-     | nC            |
| Gate-Source Charge<br>at $-V_{GS} = 10\ \text{V}$ , $-V_{DS} = 30\ \text{V}$ , $-I_D = 5\ \text{A}$                                                                                  | $Q_{gs}$       | -      | 1.6      | -          | nC            |
| Gate-Drain Charge<br>at $-V_{GS} = 10\ \text{V}$ , $-V_{DS} = 30\ \text{V}$ , $-I_D = 5\ \text{A}$                                                                                   | $Q_{gd}$       | -      | 1.3      | -          | nC            |
| Turn-On Delay Time<br>at $-V_{GS} = 10\ \text{V}$ , $-V_{DD} = 30\ \text{V}$ , $-I_D = 5\ \text{A}$ , $R_g = 3.3\ \Omega$                                                            | $t_{d(on)}$    | -      | 5        | -          | ns            |
| Turn-On Rise Time<br>at $-V_{GS} = 10\ \text{V}$ , $-V_{DD} = 30\ \text{V}$ , $-I_D = 5\ \text{A}$ , $R_g = 3.3\ \Omega$                                                             | $t_r$          | -      | 3        | -          | ns            |
| Turn-Off Delay Time<br>at $-V_{GS} = 10\ \text{V}$ , $-V_{DD} = 30\ \text{V}$ , $-I_D = 5\ \text{A}$ , $R_g = 3.3\ \Omega$                                                           | $t_{d(off)}$   | -      | 7.5      | -          | ns            |
| Turn-Off Fall Time<br>at $-V_{GS} = 10\ \text{V}$ , $-V_{DD} = 30\ \text{V}$ , $-I_D = 5\ \text{A}$ , $R_g = 3.3\ \Omega$                                                            | $t_f$          | -      | 1        | -          | ns            |
| <b>Body-Diode PARAMETERS</b>                                                                                                                                                         |                |        |          |            |               |
| Drain-Source Diode Forward Voltage<br>at $-I_S = 1\ \text{A}$ , $V_{GS} = 0\ \text{V}$                                                                                               | $-V_{SD}$      | -      | -        | 1.2        | V             |
| Body-Diode Continuous Current                                                                                                                                                        | $-I_S$         | -      | -        | 7          | A             |
| Body-Diode Continuous Current, Pulsed                                                                                                                                                | $-I_{SM}$      | -      | -        | 15         | A             |
| Body Diode Reverse Recovery Time<br>at $-I_S = 5\ \text{A}$ , $di/dt = 100\ \text{A}/\mu\text{s}$                                                                                    | $t_{rr}$       | -      | 8        | -          | ns            |
| Body Diode Reverse Recovery Charge<br>at $-I_S = 5\ \text{A}$ , $di/dt = 100\ \text{A}/\mu\text{s}$                                                                                  | $Q_{rr}$       | -      | 3.6      | -          | nC            |

## Electrical Characteristics Curves

Fig. 1 Typical Output Characteristics

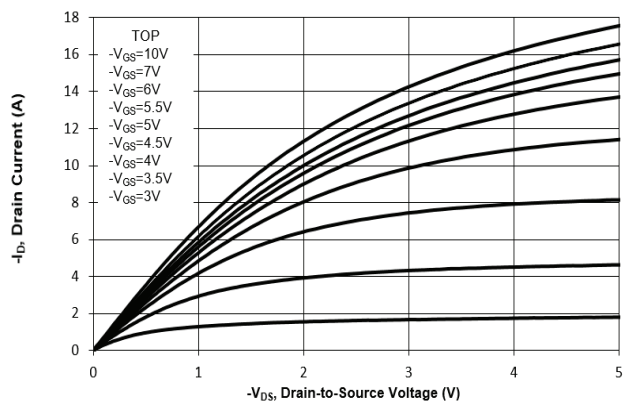


Fig. 2 Typical Transfer Characteristics

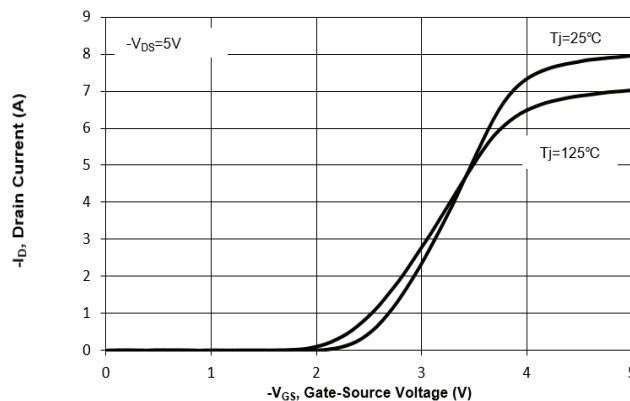


Fig. 3 on-Resistance vs. Drain Current

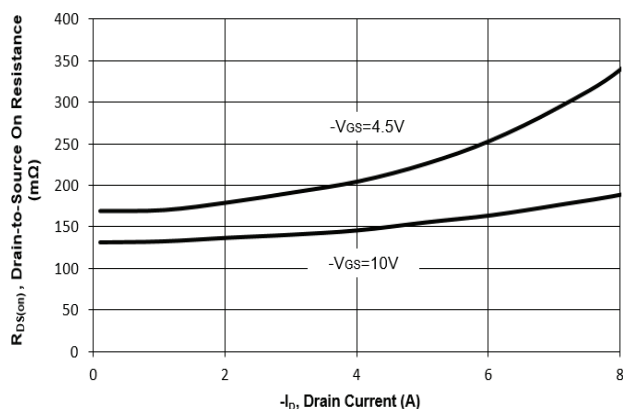


Fig. 4 on-Resistance vs. Gate to Source Voltage

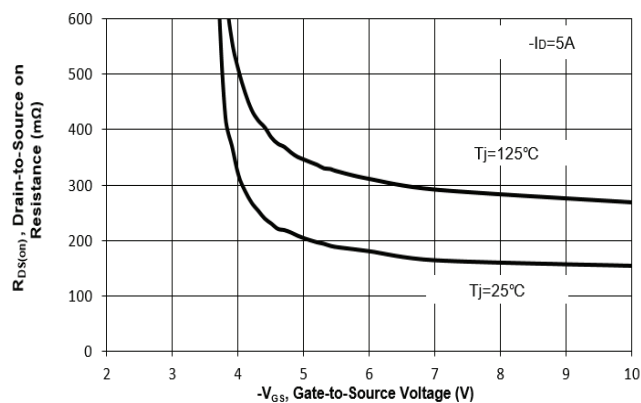


Fig. 5 on-Resistance vs. Tj

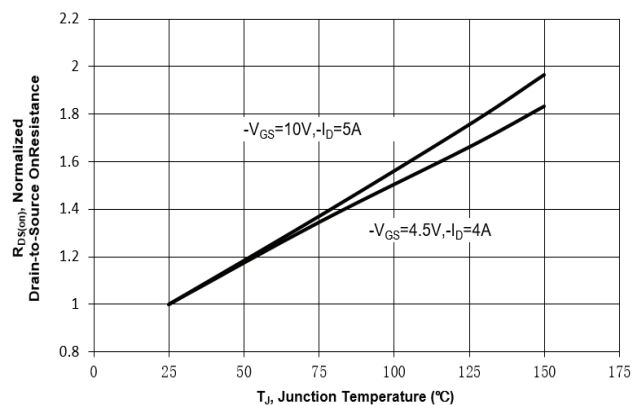
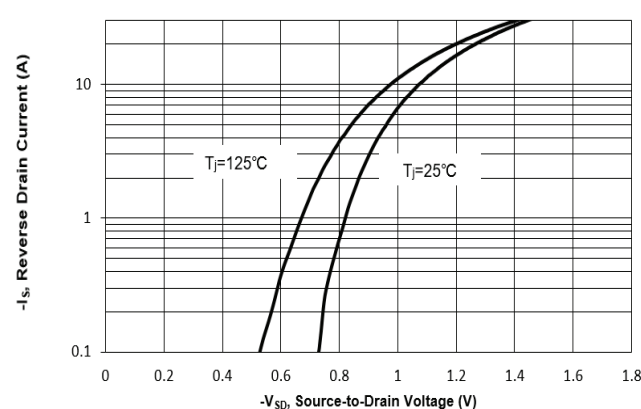


Fig. 6 Typical Body-Diode Forward Characteristics



## Electrical Characteristics Curves

Fig. 7 Typical Junction Capacitance

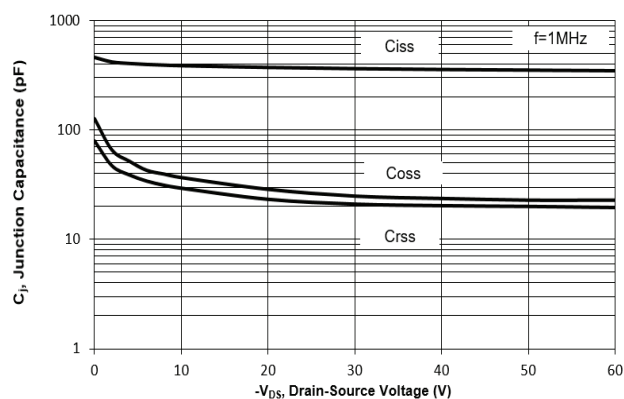


Fig. 8 Drain-Source Leakage Current vs.  $T_j$

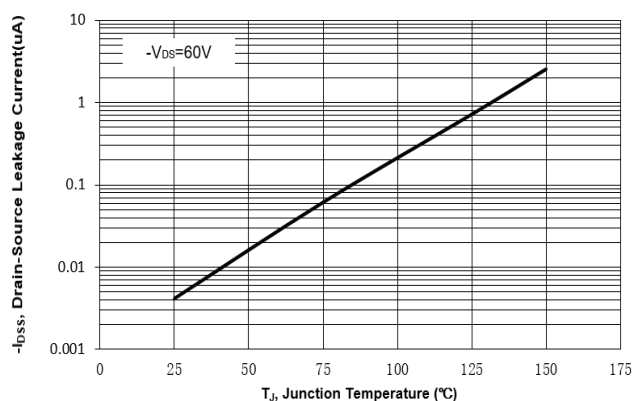


Fig. 9  $V_{(BR)DSS}$  vs. Junction Temperature

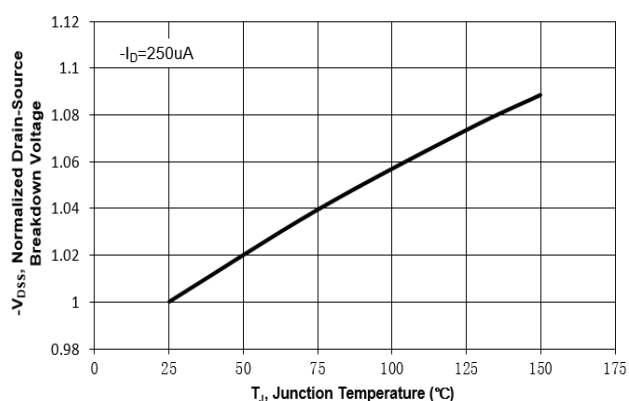


Fig. 10 Gate Threshold Variation vs.  $T_j$

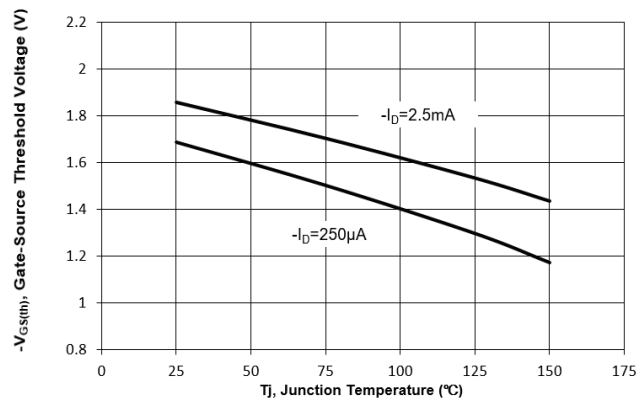


Fig. 11 Gate Charge

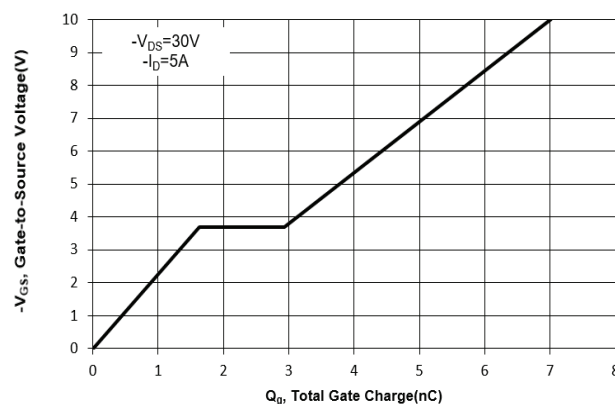
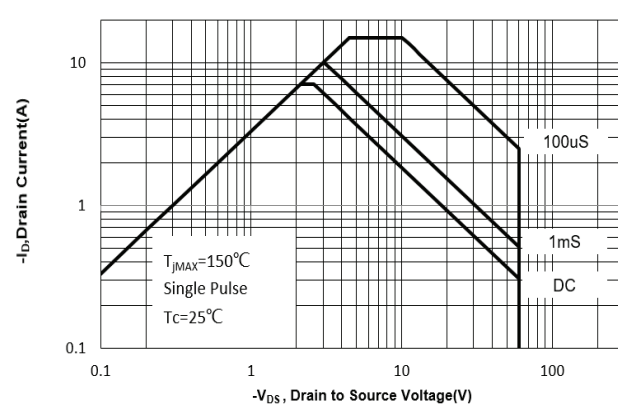


Fig. 12 Safe Operation Area



## Electrical Characteristics Curves

Fig. 13 Normalized Maximum Transient Thermal Impedance( $z_{\theta JC}$ )

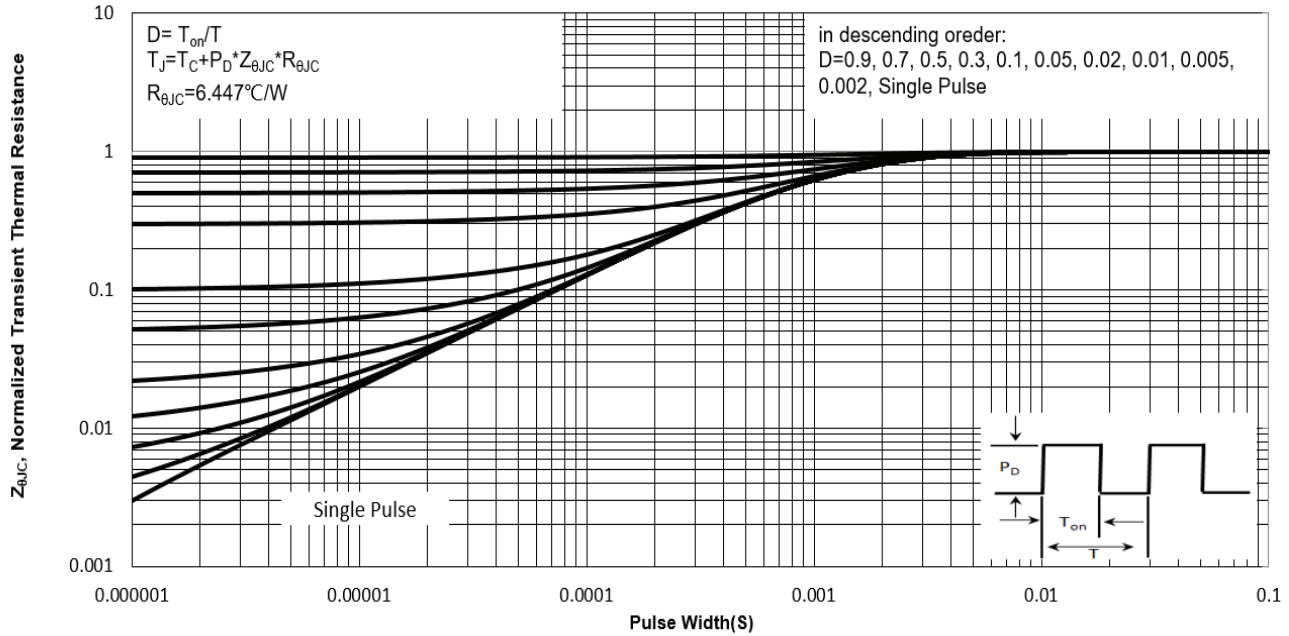
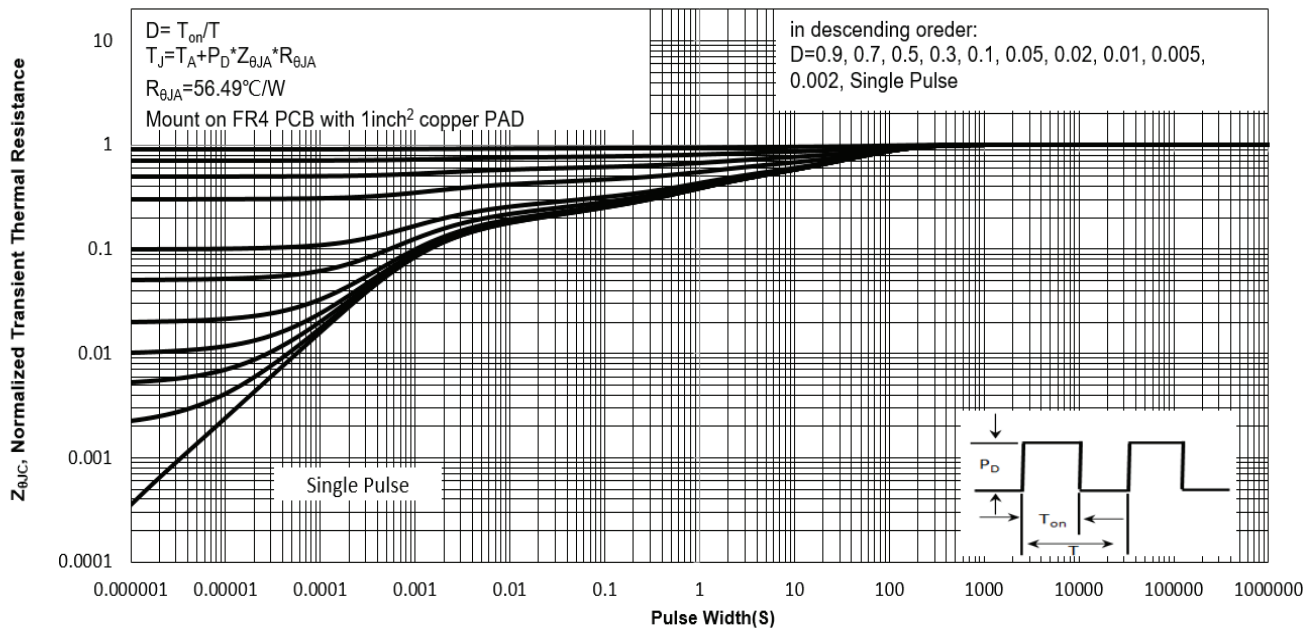
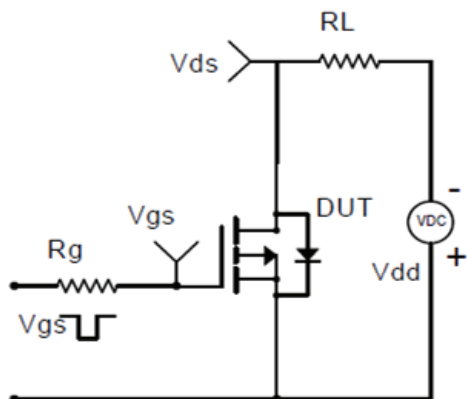
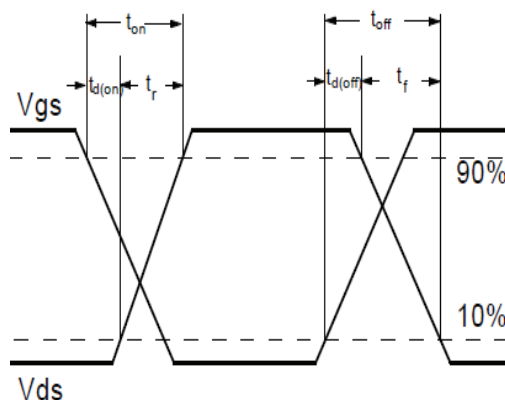
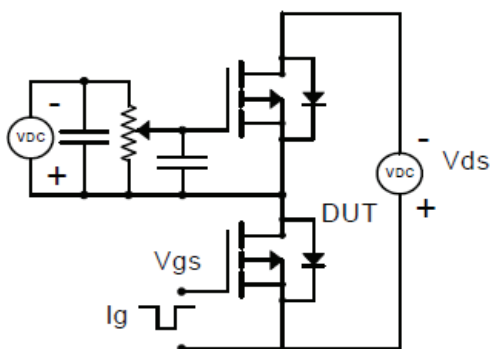
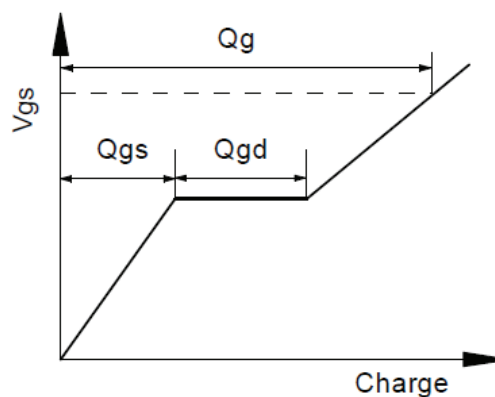
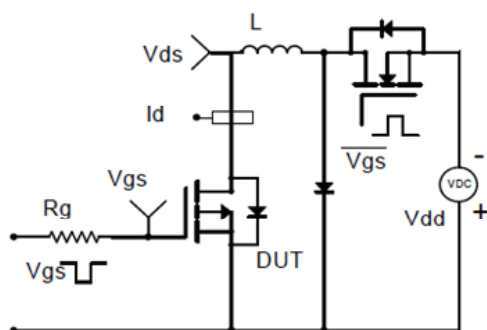
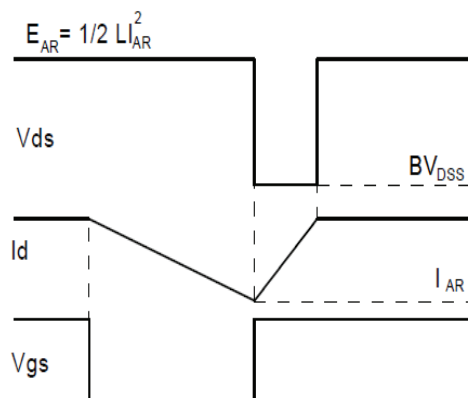


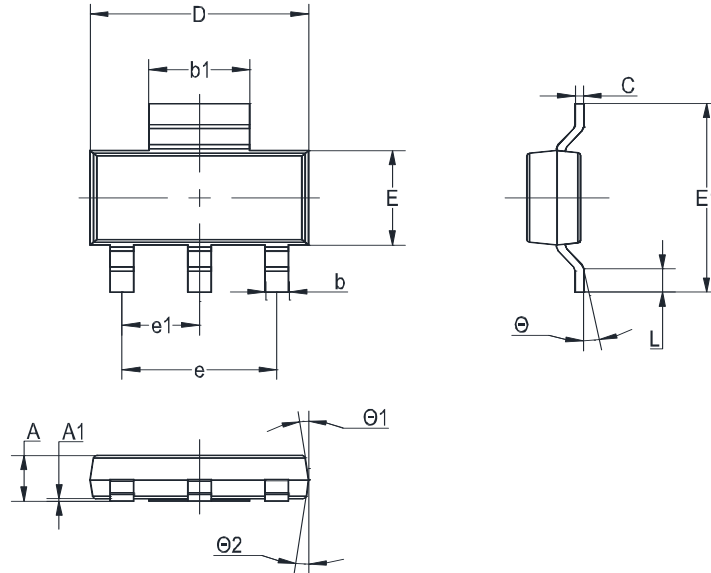
Fig. 14 Normalized Maximum Transient Thermal Impedance( $z_{\theta JA}$ )



**Test Circuits**
**Fig.1-1 Switching times test circuit**

**Fig.1-2 Switching Waveform**

**Fig.2-1 Gate charge test circuit**

**Fig.2-2 Gate charge waveform**

**Fig.3-1 Avalanche test circuit**

**Fig.3-2 Avalanche waveform**


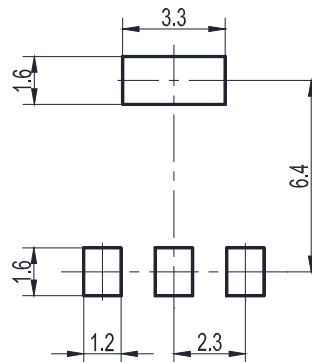
Package Outline (Dimensions in mm)

SOT-223



| Unit | A          | A1         | b          | b1         | C            | D          | E          | E1         | e          | e1         | L          | Θ         | Θ1       | Θ2       |
|------|------------|------------|------------|------------|--------------|------------|------------|------------|------------|------------|------------|-----------|----------|----------|
| mm   | 1.8<br>1.5 | 0.1<br>MAX | 0.8<br>0.6 | 3.1<br>2.9 | 0.32<br>0.22 | 6.7<br>6.3 | 3.7<br>3.3 | 7.3<br>6.7 | 4.6<br>TYP | 2.3<br>TYP | 1.1<br>0.7 | 10°<br>0° | 7°<br>0° | 7°<br>0° |

Recommended Soldering Footprint



Packing information

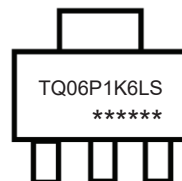
| Package | Tape Width (mm) | Pitch   |               | Reel Size |      | Per Reel Packing Quantity |
|---------|-----------------|---------|---------------|-----------|------|---------------------------|
|         |                 | mm      | inch          | mm        | inch |                           |
| SOT-223 | 12              | 8 ± 0.1 | 0.315 ± 0.004 | 330       | 13   | 3,000                     |

Marking information

" TQ06P1K6LS " = Part No.

" \*\*\*\*\* " = Date Code Marking

Font type: Arial



Disclaimer: Our company reserve the right to make modifications, enhancements, improvements, corrections or other changes to improve product design, functions and reliability, anytime without notice.