60V N-Channel Enhancement Mode MOSFET

## Features

- Trench Power MV MOSFET technology
- Voltage controlled small signal switch
- Low input Capacitance
- Fast Switching Speed
- Low Input / Output Leakage
- ESD Protected up to 2KV(HBM)

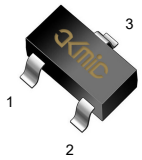
## Product Summary

| $V_{(BR)DSS}$ | $R_{DS(on)}$MAX | $I_D$ |
|---|---|---|
| 60V | 2.5Ω@10V | 115mA |
| | 3.0Ω@4.5V | |

## Application

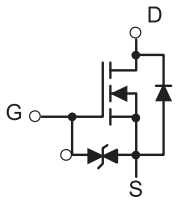
- Battery operated systems
- Solid-state relays
- Direct logic-level interface：TTL/CMOS

## SOT-23




1. Gate
2. Source
3. Drain

## Equivalent Circuit




## Absolute Maximum Ratings ($T_A$=25℃unless otherwise noted)

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Drain-Source Voltage | $V_{DS}$ | 60 | V |
| Gate-Source Voltage | $V_{GS}$ | ±20 | V |
| Continuous Drain Current | $I_D$ | 115 | mA |
| Pulsed Drain Current (Note 1) | $I_{DM}$ | 1.5 | A |
| Power Dissipation(Note 2) | $P_D$ | 300 | mW |
| Thermal Resistance from Junction to Ambient(Note 2) | $R_{\theta JA}$ | 416 | ℃/W |
| Junction Temperature and Storage Temperature | $T_J$,$T_{stg}$ | -50 ~150 | ℃ |

Notes: Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

## DEVICE MARKING AND ORDERING INFORMATION

| Device | Pack | Marking | Qty(PCS) |
|---|---|---|---|
| 2N7002K-T1-GE3-AK | SOT-23 | 72K | 3000 |

## Ta = 25℃ unless otherwise specified

| Symbol | Parameter | Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-Source Breakdown Voltage | $V_{GS}$=0V, $I_D$=250μA | 60 | -- | -- | V |
| $I_{DSS}$ | Drain-Source Leakage Current | $V_{DS}$=60V, $V_{GS}$=0V | -- | -- | 1 | uA |
| $I_{GSS}$ | Gate-Source Leakage Current | $V_{GS}$=±20V, $V_{DS}$=0V | -- | -- | ±10 | uA |
| $V_{GS(TH)}$ | Gate Threshold Voltage | $V_{DS}$=$V_{GS}$, $I_D$=250μA | 1 | 1.5 | 2.5 | V |
| $R_{DS(ON)}$ | Drain-Source On-State Resistance(Note 3) | $V_{GS}$=10V, $I_D$=300mA | -- | 1.9 | 2.5 | Ω |
| | | $V_{GS}$=4.5V, $I_D$=200mA | -- | 2.0 | 3.0 | Ω |

## Dynamic Electrical Characteristics

| Symbol | Parameter | Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $C_{iss}$ | Input Capacitance | $V_{DS}$=30V<br>$V_{GS}$=0V<br>f=1MHz | -- | 21 | -- | pF |
| $C_{oss}$ | Output Capacitance | | -- | 9 | -- | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | -- | 4 | -- | pF |
| $Q_g$ | Total Gate Charge | $V_{DS}$=30V<br>$V_{GS}$=10V<br>$I_D$=0.3A | -- | 1.22 | 2.4 | nC |
| $Q_{gs}$ | Gate Source Charge | | -- | 0.5 | -- | nC |
| $Q_{gd}$ | Gate Drain Charge | | -- | 0.18 | -- | nC |

## Switching Characteristics

| Symbol | Parameter | Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$ | Turn on Delay Time | $V_{DS}$=30V<br>$V_{GS}$ =10V<br>$I_D$=300mA<br>$R_G$=6Ω | -- | 7 | -- | ns |
| $t_r$ | Turn on Rise Time | | -- | 19 | -- | ns |
| $t_{d(off)}$ | Turn Off Delay Time | | -- | 20 | -- | ns |
| $t_f$ | Turn Off Fall Time | | -- | 84 | -- | ns |

## Source Drain Diode Characteristics

| Symbol | Parameter | Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $I_{SD}$ | Source drain current(Body Diode) | $T_A$=25℃ | -- | -- | 300 | mA |
| $V_{SD}$ | Drain-Source Diode Forward Voltage | $I_S$=300mA, $V_{GS}$=0V | -- | -- | 1.2 | V |

**Notes:** 1.Pulse width limited by maximum allowable junction temperature

2.The value of $P_D$&$R_{\theta JA}$ is measured with the device mounted on 1 $in^2$ FR-4 board with 2oz.Copper, double sided, in a still air environment with Ta=25℃.

3.Pulse test ; Pulse width≤300us, duty cycle≤2%

## ■ Typical Performance Characteristics

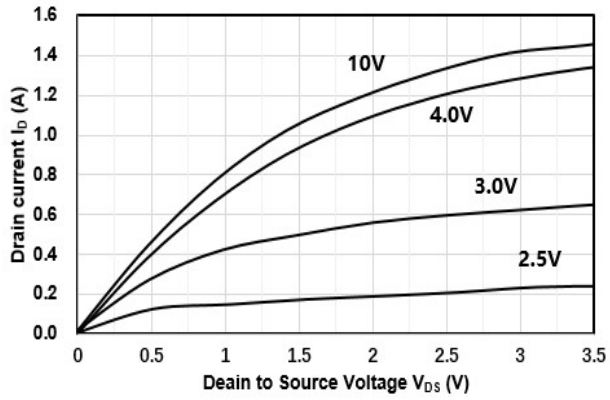



Figure1. Output Characteristics

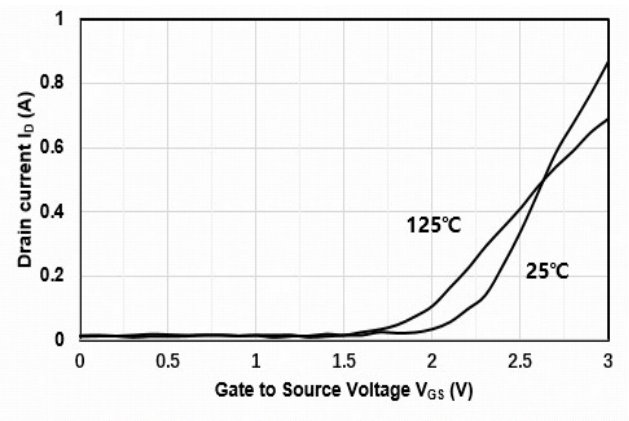



Figure2. Transfer Characteristics

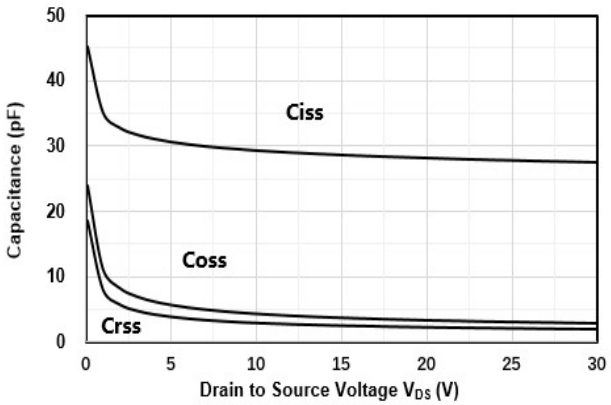



Figure3. Capacitance Characteristics

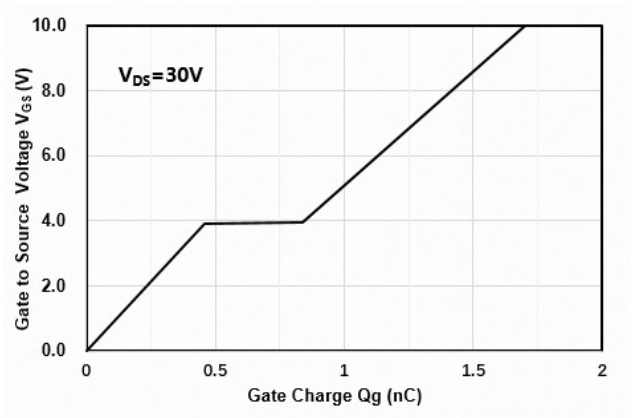



Figure4. Gate Charge

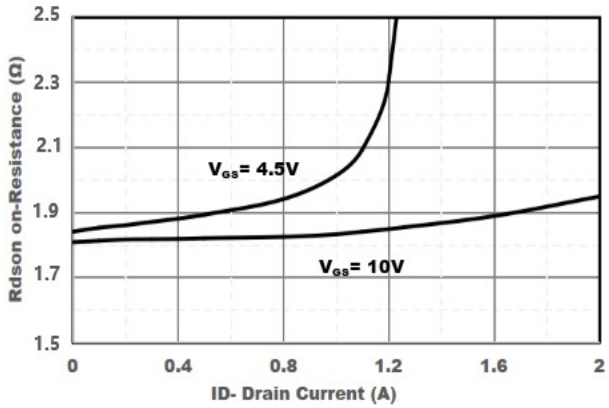



Figure5. Drain-Source on Resistance

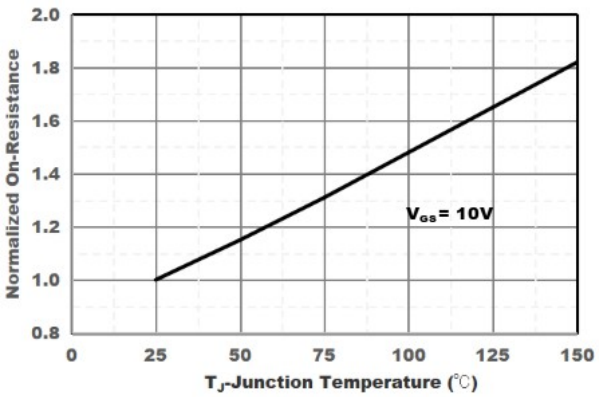



Figure6. Drain-Source on Resistance

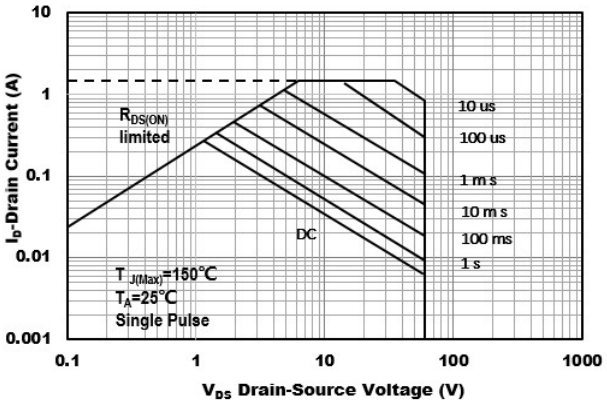



Figure7. Safe Operation Area

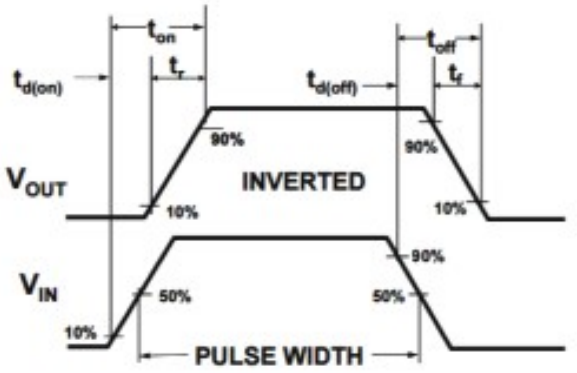
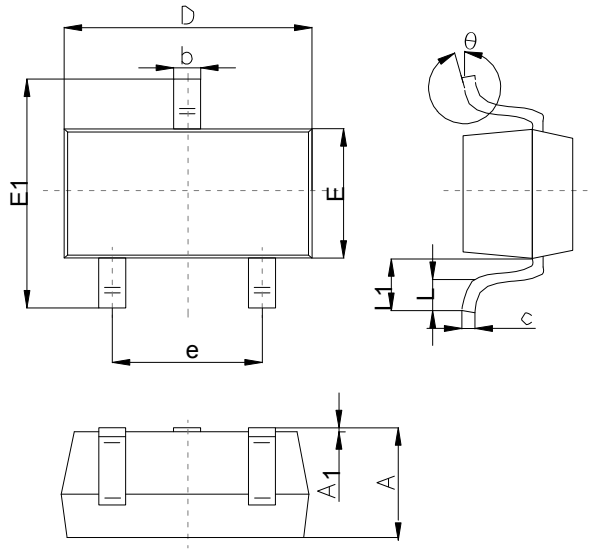



Figure8. Switching wave

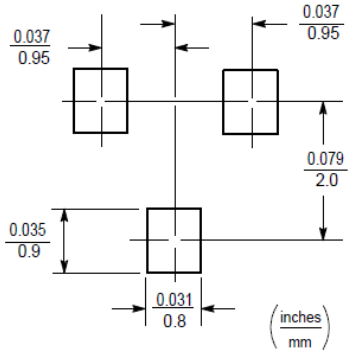
## Outlitne Drawing

SOT-23 Package Outline Dimensions




| Symbol | Dimensions In Millimeters | | |
|---|---|---|---|
| | Min | Typ | Max |
| A | 0.65 | | 1.40 |
| A1 | 0.00 | | 0.20 |
| b | 0.30 | | 0.55 |
| c | 0.08 | | 0.20 |
| D | 2.70 | | 3.10 |
| E | 1.15 | | 1.65 |
| E1 | 2.10 | | 2.80 |
| e | 1.70 | | 2.10 |
| L | 0.15 | | 0.50 |
| L1 | 0.35 | | 0.70 |
| θ | 0° | | 12° |

## Suggested Pad Layout




Note:
1.Controlling dimension:in/millimeters.
2.General tolerance: ±0.05mm.
3.The pad layout is for reference purposes only.