



## N-Channel 60V (D-S) MOSFET

### General Description

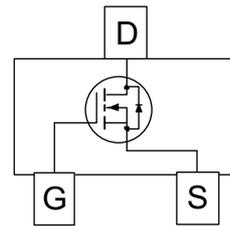
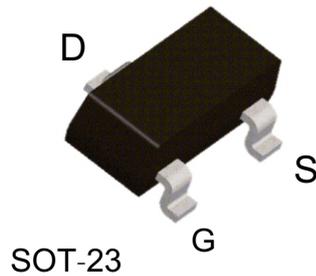
These products have been designed to minimize on-State resistance while provide rugged, reliable, and fast switching performance. It can be used in most applications requiring up to 250mA DC and can deliver pulsed currents up to 1A. These products are particularly suited for low voltage, low current applications such as small servo motor control, power MOSFET gate drivers, and other switching applications.

### Applications

- Direct Logic-level Interface: TTL/CMOS
- Battery Operated Systems
- Solid-state Relays
- Drivers: Relays, Lamps, Display, Transistors, Solenoids, Memories, etc

### Features

- $V_{DS}$  (V) = 60V
- $I_D$  (A) = 250mA ( $V_{GS} = 10V$ )
- $R_{DS(on)}$  = 5ohm @  $V_{GS} = 10V$
- $R_{DS(on)}$  = 7.5 ohm @  $V_{GS} = 5V$
- High density cell design for low  $R_{DS(ON)}$ .
- Voltage controlled small signal switch.
- Rugged and reliable.
- High saturation current capability



### ABSOLUTE MAXIMUM RATINGS (TA = 25°C UNLESS OTHERWISE NOTED)

| Parameter   | Symbol                 | Maximum    | Units |
|---|------------------------|------------|-------|
| Drain-Source Voltage                                      | $V_{DS}$               | 60         | V     |
| Gate-Source Voltage                                       | $V_{GS}$               | ± 20       |       |
| Continuous Drain Current <sup>a</sup>                     | $T_A=25^\circ\text{C}$ | 250        | mA    |
|   | $T_A=70^\circ\text{C}$ | 200        |       |
| Pulsed Drain Current <sup>b</sup>                         | $I_{DM}$               | 1.0        | A     |
| Continuous Source Current (Diode Conduction) <sup>a</sup> | $I_S$                  | 250        | mA    |
| Power Dissipation <sup>a</sup>                            | $T_A=25^\circ\text{C}$ | 300        | mW    |
|   | $T_A=70^\circ\text{C}$ | 190        |       |
| Operating Junction and Storage Temperature Range          | $T_J, T_{stg}$         | -55 to 150 | °C    |

### THERMAL RESISTANCE RATINGS

| Parameter                              | Symbol                  | Maximum         | Units    |
|--|-------------------------|-----------------|----------|
| Thermal Resistance Junction-to-Ambient | $t \leq 10 \text{ sec}$ | $R_{\theta JA}$ | 350 °C/W |



**Package Outlines and Ordering Information**

| Device | Device Marking | Reel Size | Tape Width | Quantity   |
|--------|----------------|-----------|------------|------------|
| 2N7002 | 702            | 7"        | 8mm        | 3000 units |

**SPECIFICATIONS (TA = 25°C UNLESS OTHERWISE NOTED)**

| Parameter                       | Symbol        | Test Conditions                         | Limits |      |           | Units    |
|---------------------------------|---------------|---|--------|------|-----------|----------|
|                                 |               |   | Min    | Typ  | Max       |          |
| <b>Static</b>                   |               |   |        |      |           |          |
| Drain-Source Breakdown Voltage  | $V_{(BR)DSS}$ | $V_{GS}=0V, I_D=10\mu A$                | 60     |      |           | V        |
| Gate-Threshold Voltage          | $V_{GS(th)}$  | $V_{DS}=V_{GS}, I_D=250\mu A$           | 1.0    | 2.0  | 2.5       | V        |
| Gate-Body Leakage               | $I_{GSS}$     | $V_{DS}=0V, V_{GS}=\pm 20V$             |        |      | $\pm 100$ | nA       |
| Zero Gate Voltage Drain Current | $I_{DSS}$     | $V_{DS}=60V, V_{GS}=0V$                 |        |      | 1         | $\mu A$  |
|                                 |               | $V_{DS}=60V, V_{GS}=0V, T_J=55^\circ C$ |        |      | 10        |          |
| On-State Drain Current °        | $I_{D(on)}$   | $V_{DS}=7V, V_{GS}=10V$                 | 0.5    |      |           | A        |
| Drain-Source On-Resistance °    | $R_{DS(on)}$  | $V_{GS}=10V, I_D=250mA$                 |        | 1.4  | 5.0       | $\Omega$ |
|                                 |               | $V_{GS}=5.0V, I_D=50mA$                 |        | 3.0  | 7.5       |          |
| Forward Transconductance °      | $g_{fs}$      | $V_{DS}=7V, I_D=200mA$                  | 78     | 200  |           | mS       |
| Diode Forward Voltage           | $V_{SD}$      | $I_S=250mA, V_{GS}=0V$                  |        | 0.75 | 1.5       | V        |

**Dynamic**

|                              |           |  |  |      |     |    |
|------------------------------|-----------|--|--|------|-----|----|
| Total Gate Charge            | $Q_g$     | $V_{DS}=10V, V_{GS}=4.5V$<br>$I_D=250mA$ |  | 0.4  | 0.6 | nC |
| Gate-Source Charge           | $Q_{gs}$  |  |  | 0.06 |     |    |
| Gate-Drain Charge            | $Q_{gd}$  |  |  | 0.06 |     |    |
| Input Capacitance            | $C_{iss}$ | $V_{DS}=25V, V_{GS}=0V$<br>$f=1.0MHz$    |  | 20   | 50  | pF |
| Output Capacitance           | $C_{oss}$ |  |  | 11   | 25  |    |
| Reverse Transfer Capacitance | $C_{rss}$ |  |  | 2.5  | 5   |    |

**Switching**

|                     |              |  |  |     |    |    |
|---------------------|--------------|--|--|-----|----|----|
| Turn-On Delay Time  | $t_{d(on)}$  | $V_{DS}=30V, I_D=100mA,$<br>$R_G=10\text{ ohm}, V_{GEN}=10V$ |  | 7.8 | 20 | ns |
| Rise Time           | $t_r$        |  |  | 5.5 |    |    |
| Turn-Off Delay Time | $t_{d(off)}$ |  |  | 7.8 | 20 |    |
| Fall-Time           | $t_f$        |  |  | 2.8 |    |    |

- Notes: a. Surface Mounted on 1" x 1" FR4 Board.  
 b. Pulse width limited by maximum junction temperature  
 c. Pulse test: PW ≤ 300us duty cycle ≤ 2%.



TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

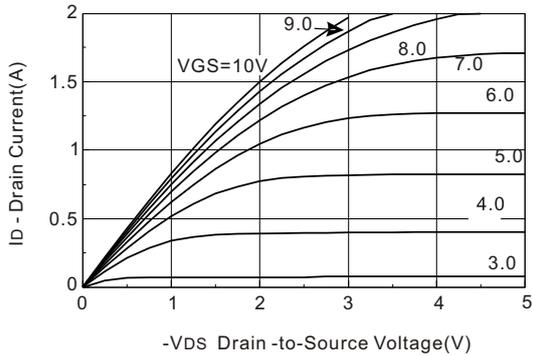


Figure 1. On-Region Characteristics

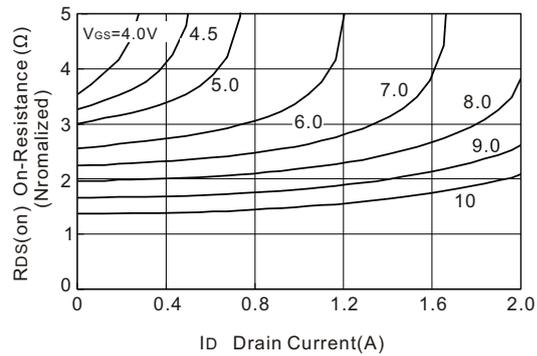


Figure 2. On-Resistance Variation With Gate Voltage and Drain Current

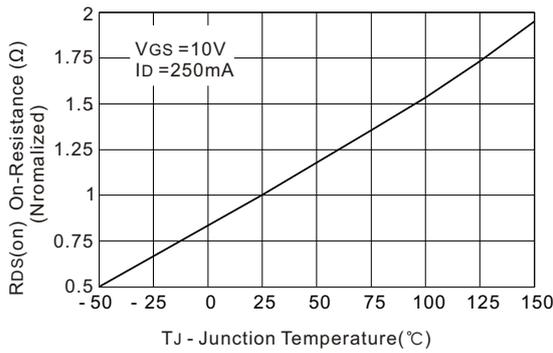


Figure 3. On-Resistance Variation with Temperature

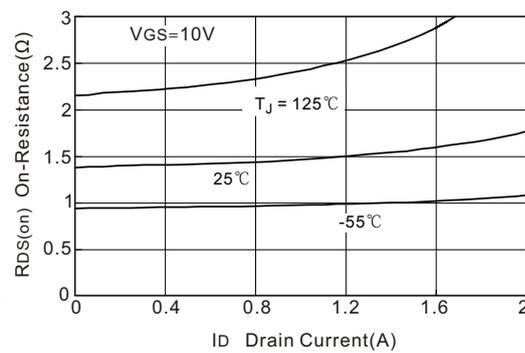


Figure 4. On-Resistance Variation With Drain Current and Temperature

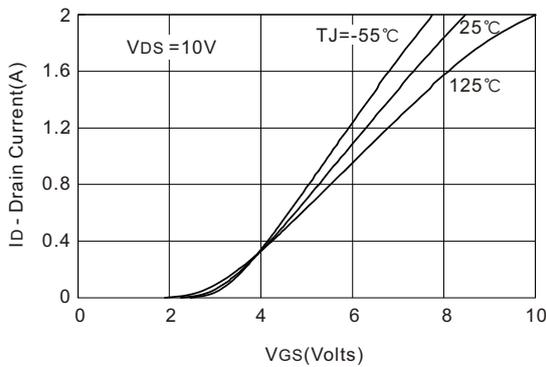


Figure 5. Transfer Characteristics

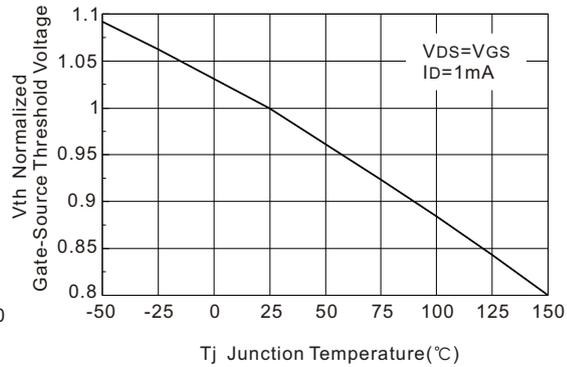


Figure 6. Gate Threshold Variation With Temperature



TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

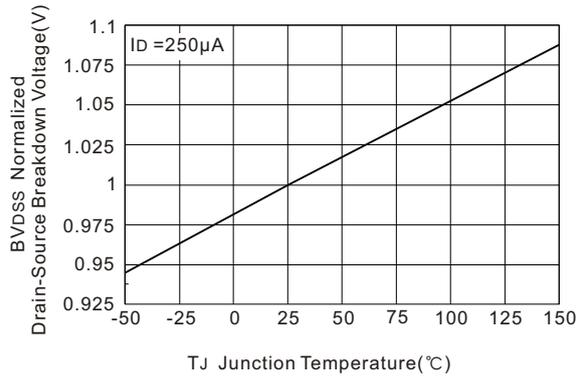


Figure 7. Breakdown Voltage Variation with Temperature

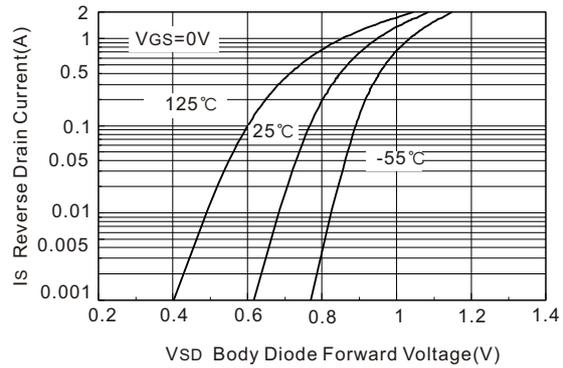


Figure 8. Body Diode Forward Voltage Variation with Temperature

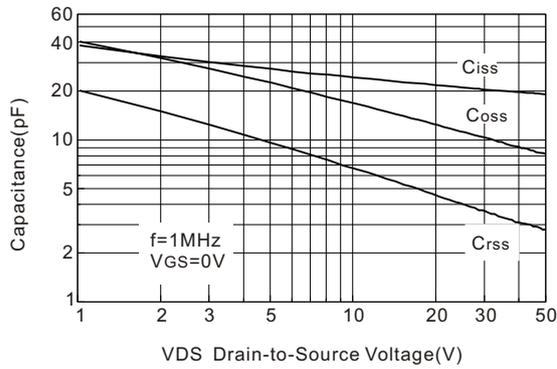


Figure 9. Capacitance Characteristics

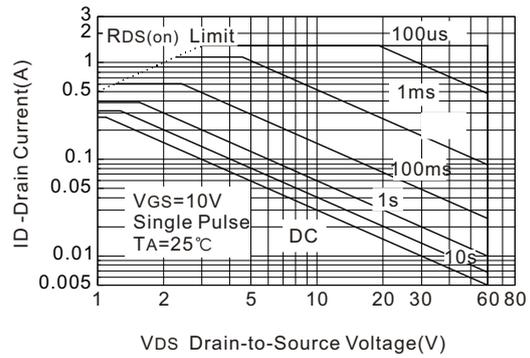


Figure 10. Maximum Safe Operating Area

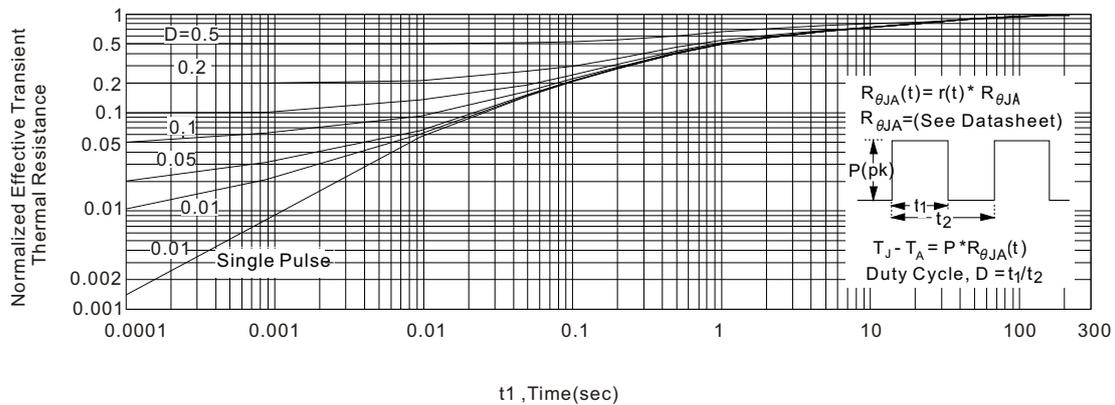


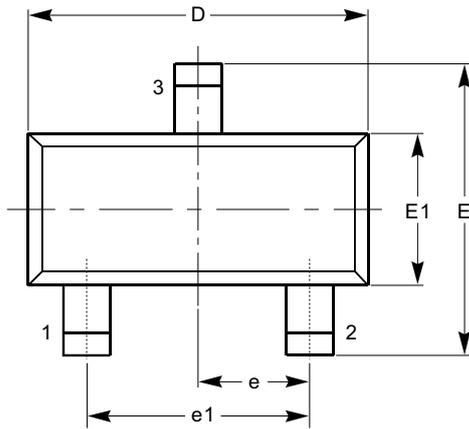
Figure 11. Transient Thermal Response Curve



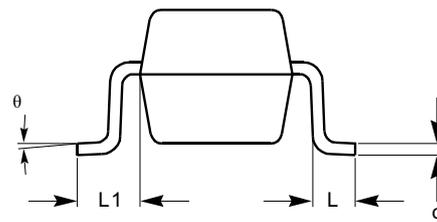
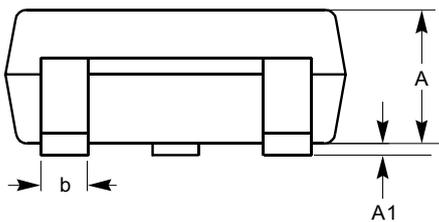
Package Outline

SOT23\_3Lead

Unit: mm



| Symbol   | Min      | Nom  | Max  |
|----------|----------|------|------|
| A        | 0.70     | 1.00 | 1.15 |
| A1       | 0.00     | ---  | 0.13 |
| b        | 0.30     | 0.40 | 0.50 |
| c        | 0.08     | 0.13 | 0.20 |
| D        | 2.80     | 2.90 | 3.10 |
| E        | 2.60     | 2.80 | 3.00 |
| E1       | 1.40     | 1.60 | 1.80 |
| e        | 0.95 BSC |      |      |
| e1       | 1.90 BSC |      |      |
| L        | 0.40 REF |      |      |
| L1       | 0.54 REF |      |      |
| $\theta$ | 0°       | 5°   | 8°   |



Notes:

- (1) All dimensions are in millimeters. Angles in degrees.
- (2) Package body sizes exclude mold flash and gate burrs.
- (3) Complies with JEDEC TO-236.

Doc.SOT23\_3L-071012

[www.s-manuals.com](http://www.s-manuals.com)