# 2N7002E

# Small Signal MOSFET

## 60 V, 310 mA, Single, N−Channel, SOT−23

### Features

- Low $R_{DS(on)}$
- Small Footprint Surface Mount Package
- Trench Technology
- This is a Pb−Free Device

### Applications

- Low Side Load Switch
- Level Shift Circuits
- DC−DC Converter
- Portable Applications i.e. DSC, PDA, Cell Phone, etc.

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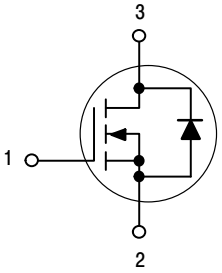
| $V_{(BR)DSS}$ | $R_{DS(on)}$ MAX | $I_D$ MAX (Note 1) |
|---|---|---|
| 60 V | 3.0 Ω @ 4.5 V | 310 mA |
| | 2.5 Ω @ 10 V | |

### Simplified Schematic

**N−Channel**




(Top View)

### MAXIMUM RATINGS ($T_J$ = 25°C unless otherwise stated)

| Rating | | Symbol | Value | Unit |
|---|---|---|---|---|
| Drain−to−Source Voltage | | $V_{DSS}$ | 60 | V |
| Gate−to−Source Voltage | | $V_{GS}$ | ±20 | V |
| Drain Current (Note 1) | | $I_D$ | | mA |
| Steady State | $T_A$ = 25°C | | 260 | |
| | $T_A$ = 85°C | | 190 | |
| t < 5 s | $T_A$ = 25°C | | 310 | |
| | $T_A$ = 85°C | | 220 | |
| Power Dissipation (Note 1) | | $P_D$ | | mW |
| Steady State | | | 300 | |
| t < 5 s | | | 420 | |
| Pulsed Drain Current ($t_p$ = 10 μs) | | $I_{DM}$ | 1.2 | A |
| Operating Junction and Storage Temperature Range | | $T_J$, $T_{STG}$ | −55 to +150 | °C |
| Source Current (Body Diode) | | $I_S$ | 300 | mA |
| Lead Temperature for Soldering Purposes (1/8″ from case for 10 s) | | $T_L$ | 260 | °C |

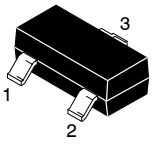
Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

### THERMAL CHARACTERISTICS

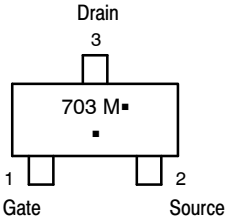
| Characteristic | Symbol | Max | Unit |
|---|---|---|---|
| Junction−to−Ambient − Steady State (Note 1) | $R_{\theta JA}$ | 417 | °C/W |
| Junction−to−Ambient − t ≤ 5 s (Note 1) | $R_{\theta JA}$ | 300 | |

1. Surface−mounted on FR4 board using 1 in sq pad size (Cu area = 1.127 in sq [1 oz] including traces)

### MARKING DIAGRAM & PIN ASSIGNMENT




**SOT−23**
**CASE 318**
**STYLE 21**




703 = Device Code
M = Date Code
▪ = Pb−Free Package

(Note: Microdot may be in either location)

### ORDERING INFORMATION

| Device | Package | Shipping† |
|---|---|---|
| 2N7002ET1G | SOT−23 (Pb−Free) | 3000/Tape & Reel |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

**ELECTRICAL CHARACTERISTICS** ($T_J$ = 25°C unless otherwise specified)

| Parameter | Symbol | Test Condition | | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| Drain−to−Source Breakdown Voltage | $V_{(BR)DSS}$ | $V_{GS}$ = 0 V, $I_D$ = 250 μA | | 60 | | | V |
| Drain−to−Source Breakdown Voltage Temperature Coefficient | $V_{(BR)DSS}/T_J$ | | | | 75 | | mV/°C |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{GS}$ = 0 V, $V_{DS}$ = 60 V | $T_J$ = 25°C | | | 1 | μA |
| | | | $T_J$ = 125°C | | | 500 | |
| Gate−to−Source Leakage Current | $I_{GSS}$ | $V_{DS}$ = 0 V, $V_{GS}$ = ±20 V | | | | ±100 | nA |
| **ON CHARACTERISTICS** (Note 2) | | | | | | | |
| Gate Threshold Voltage | $V_{GS(TH)}$ | $V_{GS}$ = $V_{DS}$, $I_D$ = 250 μA | | 1.0 | | 2.5 | V |
| Negative Threshold Temperature Coefficient | $V_{GS(TH)}/T_J$ | | | | 4.4 | | mV/°C |
| Drain−to−Source On Resistance | $R_{DS(on)}$ | $V_{GS}$ = 10 V, $I_D$ = 240 mA | | | 0.86 | 2.5 | Ω |
| | | $V_{GS}$ = 4.5 V, $I_D$ = 50 mA | | | 1.1 | 3.0 | |
| Forward Transconductance | $g_{FS}$ | $V_{DS}$ = 5 V, $I_D$ = 200 mA | | | 80 | | S |
| **CHARGES AND CAPACITANCES** | | | | | | | |
| Input Capacitance | $C_{ISS}$ | $V_{GS}$ = 0 V, f = 1 MHz, $V_{DS}$ = 25 V | | | 26.7 | 40 | pF |
| Output Capacitance | $C_{OSS}$ | | | | 4.6 | | |
| Reverse Transfer Capacitance | $C_{RSS}$ | | | | 2.9 | | |
| Total Gate Charge | $Q_{G(TOT)}$ | $V_{GS}$ = 5 V, $V_{DS}$ = 10 V; $I_D$ = 240 mA | | | 0.81 | | nC |
| Threshold Gate Charge | $Q_{G(TH)}$ | | | | 0.31 | | |
| Gate−to−Source Charge | $Q_{GS}$ | | | | 0.48 | | |
| Gate−to−Drain Charge | $Q_{GD}$ | | | | 0.08 | | |
| **SWITCHING CHARACTERISTICS, $V_{GS}$ = V** (Note 3) | | | | | | | |
| Turn−On Delay Time | $t_{d(ON)}$ | $V_{GS}$ = 10 V, $V_{DD}$ = 30 V, $I_D$ = 200 mA, $R_G$ = 10 Ω | | | 1.7 | | ns |
| Rise Time | $t_r$ | | | | 1.2 | | |
| Turn−Off Delay Time | $t_{d(OFF)}$ | | | | 4.8 | | |
| Fall Time | $t_f$ | | | | 3.6 | | |
| **DRAIN−SOURCE DIODE CHARACTERISTICS** | | | | | | | |
| Forward Diode Voltage | $V_{SD}$ | $V_{GS}$ = 0 V, $I_S$ = 200 mA | $T_J$ = 25°C | | 0.79 | 1.2 | V |
| | | | $T_J$ = 85°C | | 0.7 | | |

2. Pulse Test: pulse width ≤ 300 μs, duty cycle ≤ 2%
3. Switching characteristics are independent of operating junction temperatures

## TYPICAL CHARACTERISTICS

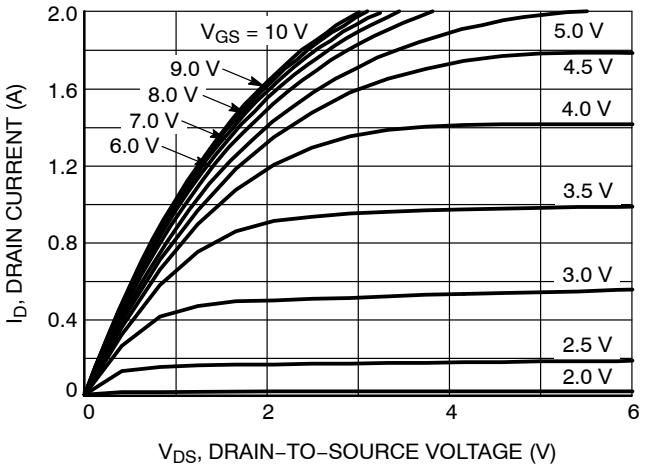



**Figure 1. On−Region Characteristics**

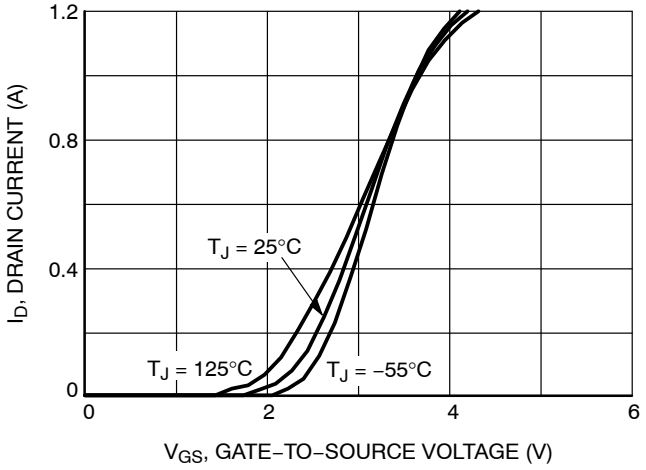



**Figure 2. Transfer Characteristics**

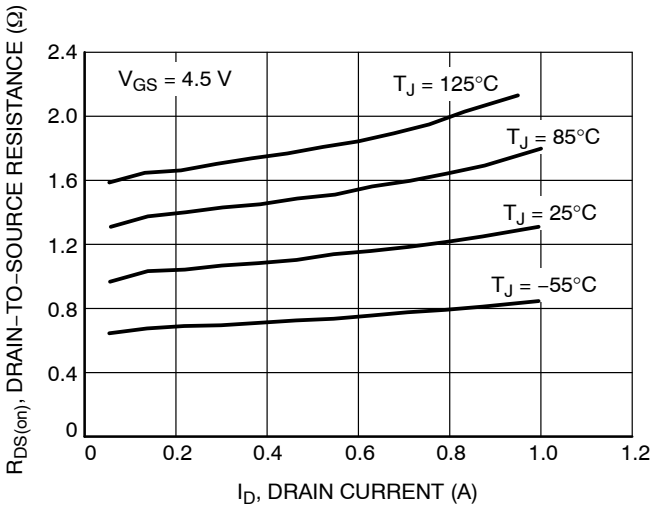



**Figure 3. On−Resistance vs. Drain Current and Temperature**

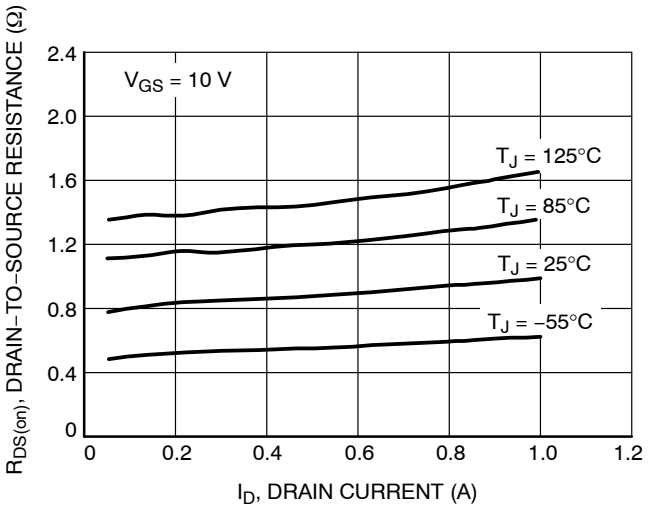



**Figure 4. On−Resistance vs. Drain Current and Temperature**

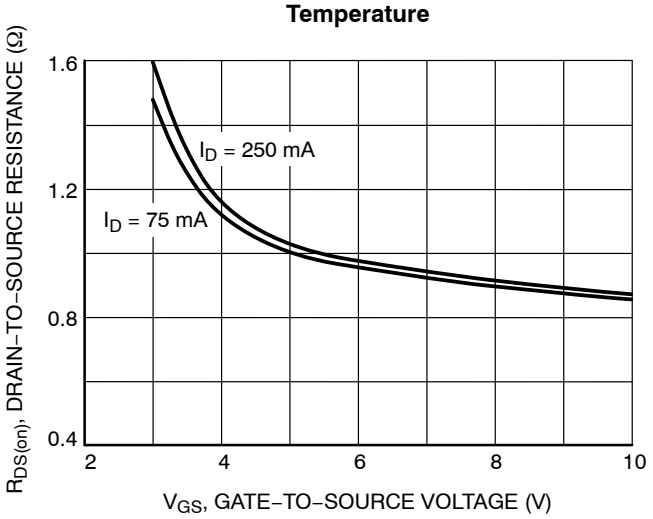



**Figure 5. On−Resistance vs. Gate−to−Source Voltage**

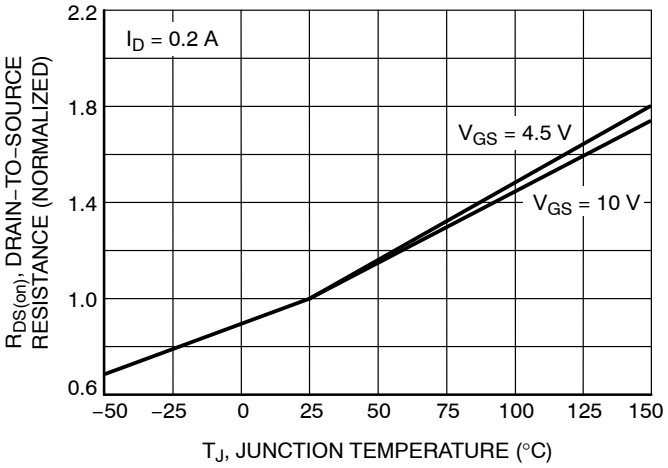



**Figure 6. On−Resistance Variation with Temperature**

## TYPICAL CHARACTERISTICS

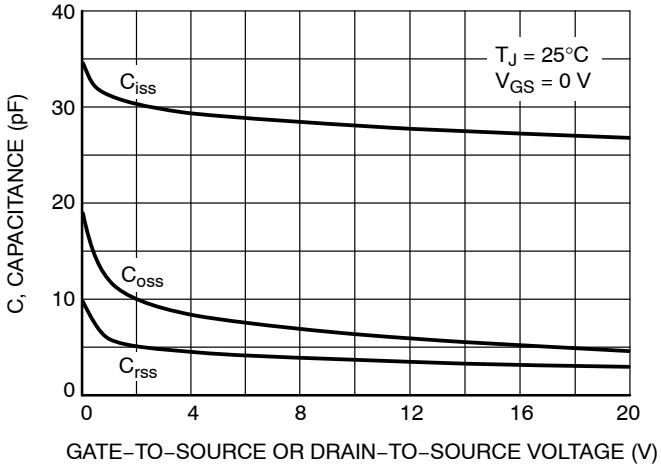



**Figure 7. Capacitance Variation**

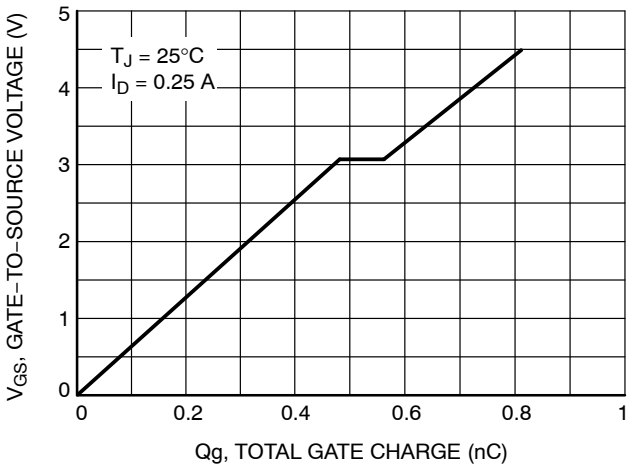



**Figure 8. Gate−to−Source and Drain−to−Source Voltage vs. Total Charge**

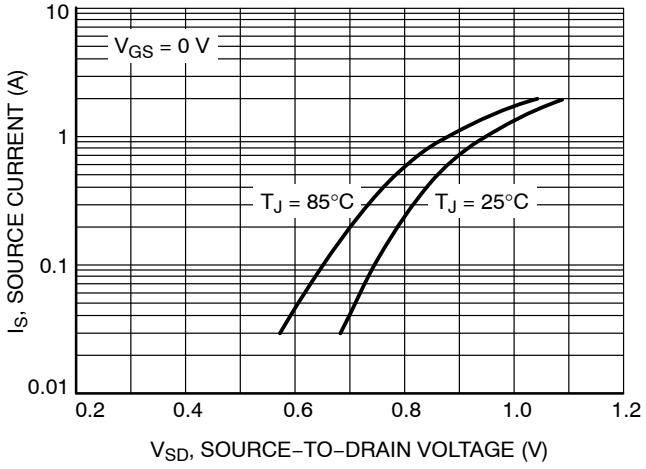
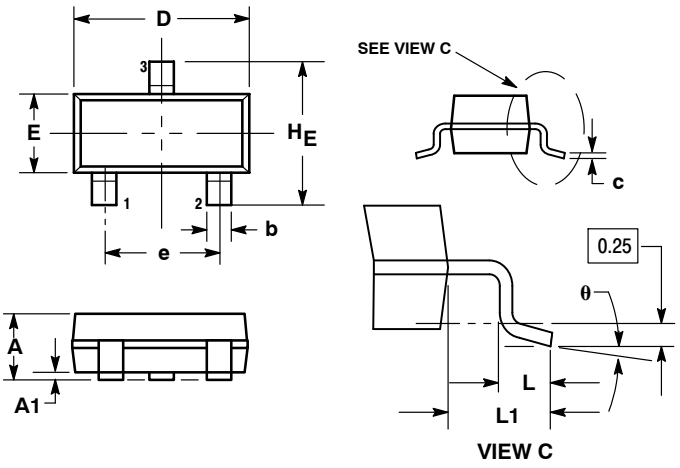



**Figure 9. Diode Forward Voltage vs. Current**

## PACKAGE DIMENSIONS

**SOT−23 (TO−236)**
CASE 318−08
ISSUE AP

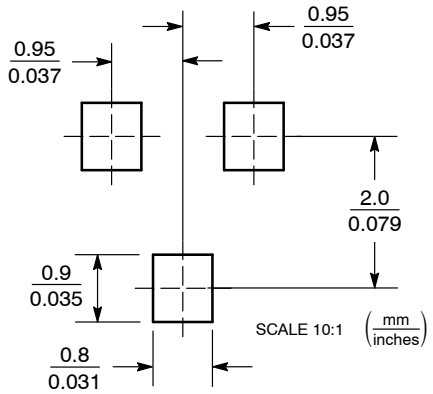



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

| | MILLIMETERS | | | INCHES | | |
|---|---|---|---|---|---|---|
| DIM | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 0.89 | 1.00 | 1.11 | 0.035 | 0.040 | 0.044 |
| A1 | 0.01 | 0.06 | 0.10 | 0.001 | 0.002 | 0.004 |
| b | 0.37 | 0.44 | 0.50 | 0.015 | 0.018 | 0.020 |
| c | 0.09 | 0.13 | 0.18 | 0.003 | 0.005 | 0.007 |
| D | 2.80 | 2.90 | 3.04 | 0.110 | 0.114 | 0.120 |
| E | 1.20 | 1.30 | 1.40 | 0.047 | 0.051 | 0.055 |
| e | 1.78 | 1.90 | 2.04 | 0.070 | 0.075 | 0.081 |
| L | 0.10 | 0.20 | 0.30 | 0.004 | 0.008 | 0.012 |
| L1 | 0.35 | 0.54 | 0.69 | 0.014 | 0.021 | 0.029 |
| $H_E$ | 2.10 | 2.40 | 2.64 | 0.083 | 0.094 | 0.104 |
| θ | 0° | −−− | 10° | 0° | −−− | 10° |

STYLE 21:
PIN 1. GATE
2. SOURCE
3. DRAIN

## SOLDERING FOOTPRINT



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