

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
- S Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q101 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

Applications

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

MAXIMUM RATINGS ($T_J = 25^\circ\text{C}$ 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) Steady State | I_D | $T_A = 25^\circ\text{C}$ | 260 |
| | | $T_A = 85^\circ\text{C}$ | 190 |
| $t < 5$ s | I_D | $T_A = 25^\circ\text{C}$ | 310 |
| | | $T_A = 85^\circ\text{C}$ | 220 |
| Power Dissipation (Note 1) Steady State $t < 5$ s | P_D | | 300 |
| | | | 420 |
| Pulsed Drain Current ($t_p = 10 \mu\text{s}$) | I_{DM} | 1.2 | A |
| Operating Junction and Storage Temperature Range | T_J, T_{STG} | -55 to +150 | $^\circ\text{C}$ |
| Source Current (Body Diode) | I_S | 300 | mA |
| Lead Temperature for Soldering Purposes (1/8" from case for 10 s) | T_L | 260 | $^\circ\text{C}$ |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|--|-----------------|-----|---------------------------|
| Junction-to-Ambient - Steady State (Note 1) | $R_{\theta JA}$ | 417 | $^\circ\text{C}/\text{W}$ |
| Junction-to-Ambient - $t \leq 5$ 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)

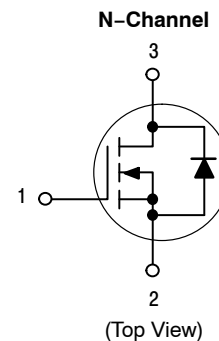


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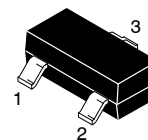
www.onsemi.com

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

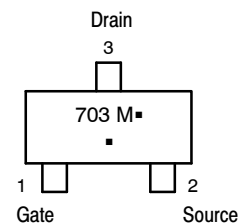
Simplified Schematic



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, S2N7002ET1G | SOT-23 (Pb-Free) | 3000 / Tape & Reel |
| 2N7002ET7G, S2N7002ET7G | SOT-23 (Pb-Free) | 3500 / 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.

2N7002E

ELECTRICAL CHARACTERISTICS ($T_J = 25^\circ\text{C}$ unless otherwise specified)

| Parameter | Symbol | Test Condition | Min | Typ | Max | Units |
|---|-------------------|--|---------------------------|-----|-----------|----------------------------|
| OFF CHARACTERISTICS | | | | | | |
| Drain-to-Source Breakdown Voltage | $V_{(BR)DSS}$ | $V_{GS} = 0\text{ V}, I_D = 250\ \mu\text{A}$ | 60 | | | V |
| Drain-to-Source Breakdown Voltage Temperature Coefficient | $V_{(BR)DSS}/T_J$ | | | 75 | | $\text{mV}/^\circ\text{C}$ |
| Zero Gate Voltage Drain Current | I_{DSS} | $V_{GS} = 0\text{ V},$ $V_{DS} = 60\text{ V}$ | $T_J = 25^\circ\text{C}$ | | 1 | μA |
| | | | $T_J = 125^\circ\text{C}$ | | 500 | |
| Gate-to-Source Leakage Current | I_{GSS} | $V_{DS} = 0\text{ V}, V_{GS} = \pm 20\text{ V}$ | | | ± 100 | nA |

ON CHARACTERISTICS (Note 2)

| | | | | | | |
|--|------------------|---|-----|------|-----|----------------------------|
| Gate Threshold Voltage | $V_{GS(TH)}$ | $V_{GS} = V_{DS}, I_D = 250\ \mu\text{A}$ | 1.0 | | 2.5 | V |
| Negative Threshold Temperature Coefficient | $V_{GS(TH)}/T_J$ | | | 4.4 | | $\text{mV}/^\circ\text{C}$ |
| Drain-to-Source On Resistance | $R_{DS(on)}$ | $V_{GS} = 10\text{ V}, I_D = 240\text{ mA}$ | | 0.86 | 2.5 | Ω |
| | | $V_{GS} = 4.5\text{ V}, I_D = 50\text{ mA}$ | | 1.1 | 3.0 | |
| Forward Transconductance | g_{FS} | $V_{DS} = 5\text{ V}, I_D = 200\text{ mA}$ | | 530 | | mS |

CHARGES AND CAPACITANCES

| | | | | | | |
|------------------------------|--------------|---|--|------|----|-------------|
| Input Capacitance | C_{ISS} | $V_{GS} = 0\text{ V}, f = 1\text{ MHz},$ $V_{DS} = 25\text{ V}$ | | 26.7 | 40 | pF |
| Output Capacitance | C_{OSS} | | | 4.6 | | |
| Reverse Transfer Capacitance | C_{RSS} | | | 2.9 | | |
| Total Gate Charge | $Q_{G(TOT)}$ | $V_{GS} = 5\text{ V}, V_{DS} = 10\text{ V};$ $I_D = 240\text{ mA}$ | | 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 | $t_{d(ON)}$ | $V_{GS} = 10\text{ V}, V_{DD} = 30\text{ V},$ $I_D = 200\text{ mA}, R_G = 10\ \Omega$ | | 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} | $V_{GS} = 0\text{ V},$ $I_S = 200\text{ mA}$ | $T_J = 25^\circ\text{C}$ | | 0.79 | 1.2 | V |
| | | | $T_J = 85^\circ\text{C}$ | | 0.7 | | |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

2. Pulse Test: pulse width $\leq 300\ \mu\text{s}$, duty cycle $\leq 2\%$

3. Switching characteristics are independent of operating junction temperatures

TYPICAL CHARACTERISTICS

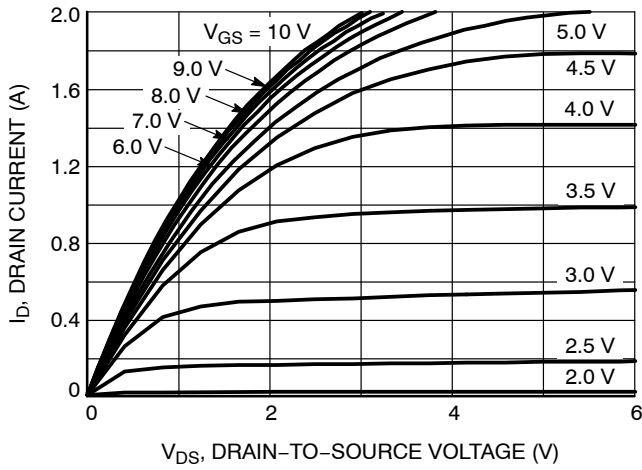


Figure 1. On-Region Characteristics

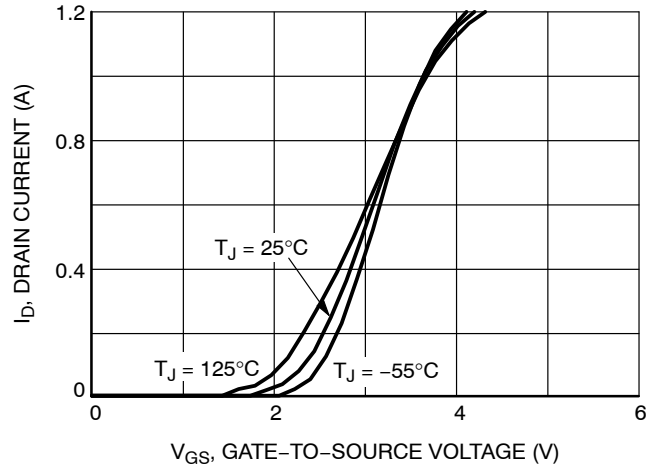


Figure 2. Transfer Characteristics

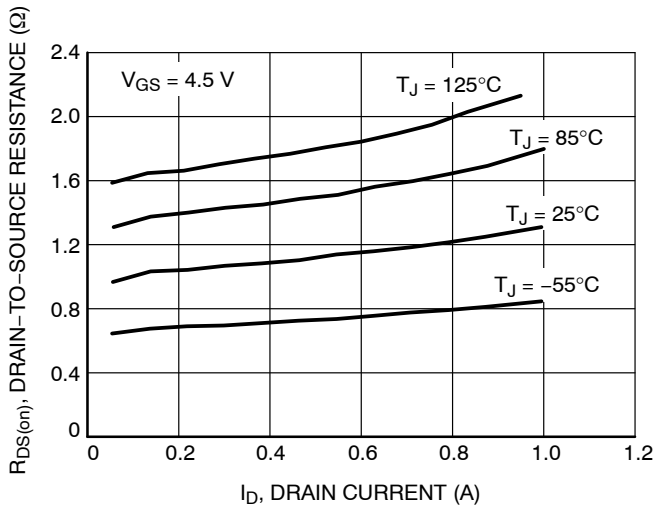


Figure 3. On-Resistance vs. Drain Current and Temperature

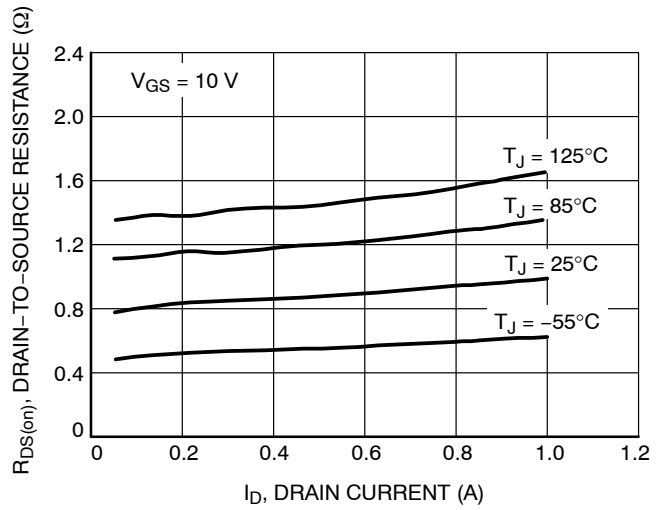


Figure 4. On-Resistance vs. Drain Current and Temperature

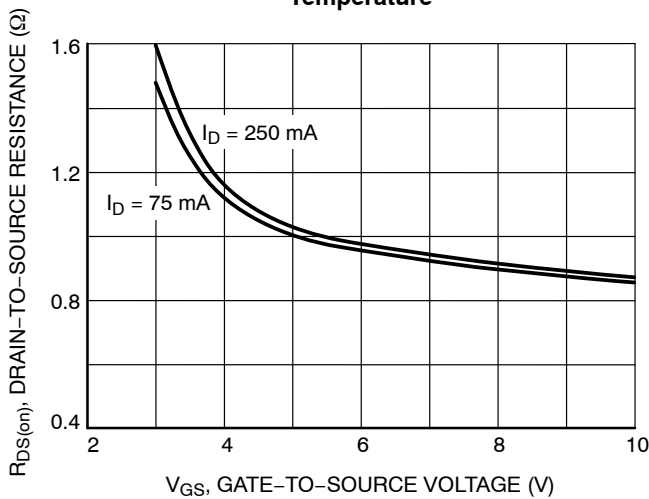


Figure 5. On-Resistance vs. Gate-to-Source Voltage

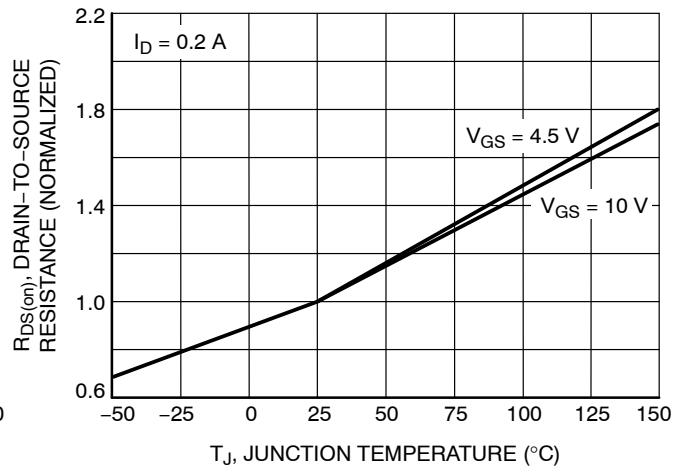


Figure 6. On-Resistance Variation with Temperature

TYPICAL CHARACTERISTICS

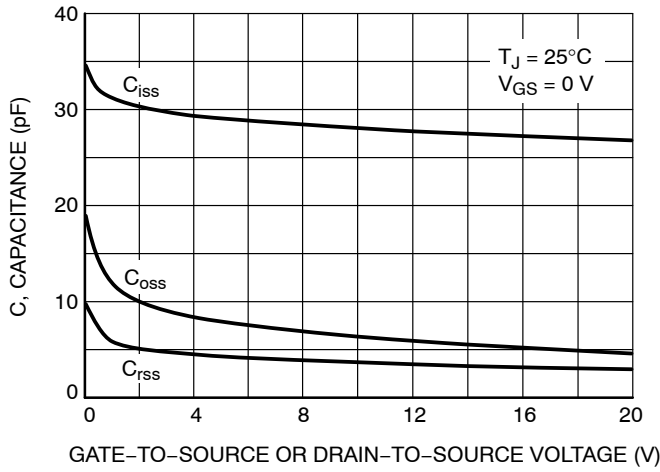


Figure 7. Capacitance Variation

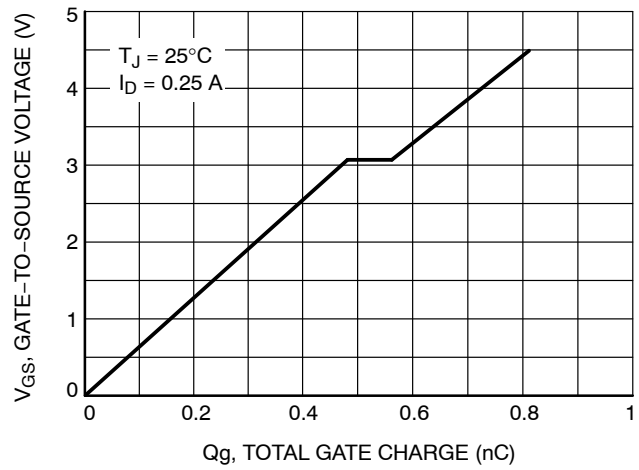


Figure 8. Gate-to-Source and Drain-to-Source Voltage vs. Total Charge

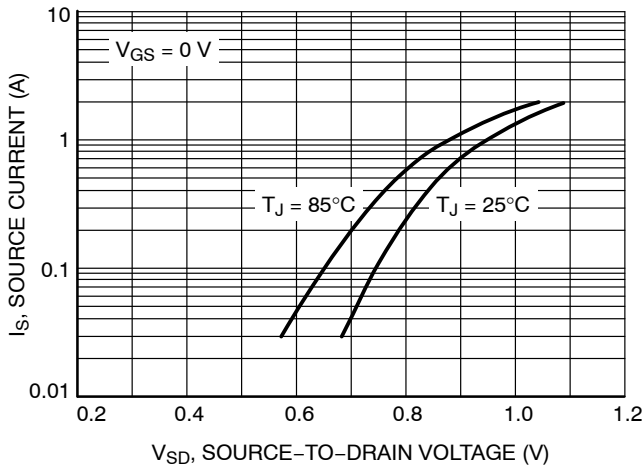


Figure 9. Diode Forward Voltage vs. Current

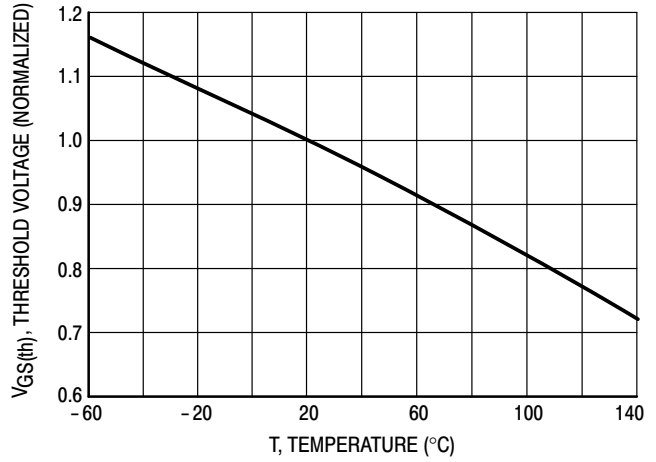
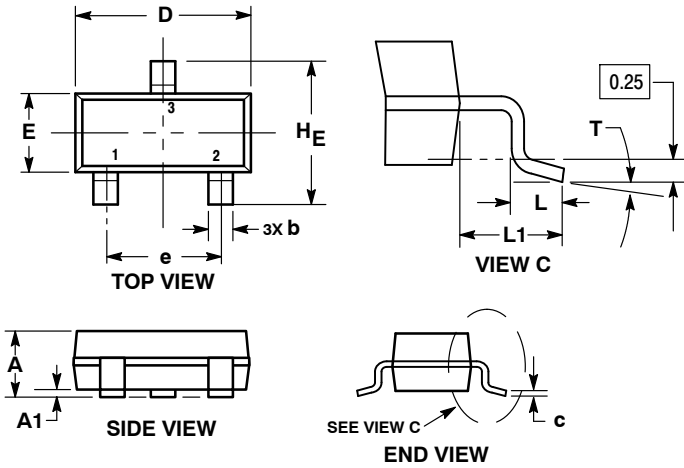


Figure 10. Temperature versus Gate Threshold Voltage

2N7002E

PACKAGE DIMENSIONS

SOT-23 (TO-236)
CASE 318-08
ISSUE AS



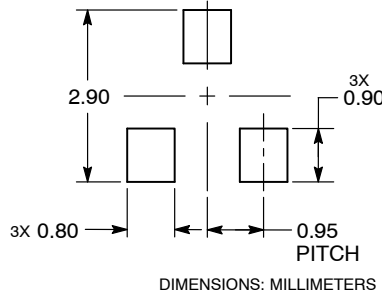
NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF THE BASE MATERIAL.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

| DIM | MILLIMETERS | | | INCHES | | |
|-----|-------------|------|------|--------|-------|-------|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 0.89 | 1.00 | 1.11 | 0.035 | 0.039 | 0.044 |
| A1 | 0.01 | 0.06 | 0.10 | 0.000 | 0.002 | 0.004 |
| b | 0.37 | 0.44 | 0.50 | 0.015 | 0.017 | 0.020 |
| c | 0.08 | 0.14 | 0.20 | 0.003 | 0.006 | 0.008 |
| 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 | 0.080 |
| L | 0.30 | 0.43 | 0.55 | 0.012 | 0.017 | 0.022 |
| L1 | 0.35 | 0.54 | 0.69 | 0.014 | 0.021 | 0.027 |
| HE | 2.10 | 2.40 | 2.64 | 0.083 | 0.094 | 0.104 |
| T | 0° | --- | 10° | 0° | --- | 10° |

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

RECOMMENDED SOLDERING FOOTPRINT



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