



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

### PRODUCT SUMMARY

| $V_{DS}$ (V) | $r_{DS(on)}$ ( $\Omega$ ) | $I_D$ (mA) |
|--------------|---------------------------|------------|
| 60           | 3 @ $V_{GS} = 10$ V       | 240        |

### FEATURES

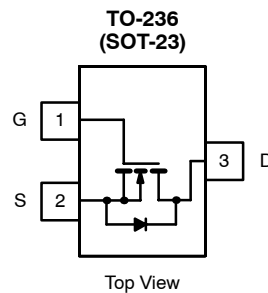
- Low On-Resistance: 3  $\Omega$
- Low Threshold: 2 V (typ)
- Low Input Capacitance: 25 pF
- Fast Switching Speed: 7.5 ns
- Low Input and Output Leakage

### BENEFITS

- Low Offset Voltage
- Low-Voltage Operation
- Easily Driven Without Buffer
- High-Speed Circuits
- Low Error Voltage

### APPLICATIONS

- Direct Logic-Level Interface: TTL/CMOS
- Drivers: Relays, Solenoids, Lamps, Hammers, Display, Memories, Transistors, etc.
- Battery Operated Systems
- Solid-State Relays



Marking Code: 7Ew/

E = Part Number Code for 2N7002E

w = Week Code

/ = Lot Traceability

Ordering Information: 2N7002E-T1

### ABSOLUTE MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ UNLESS OTHERWISE NOTED)

| Parameter                                              | Symbol         | Limit      | Unit                      |
|--------------------------------------------------------|----------------|------------|---------------------------|
| Drain-Source Voltage                                   | $V_{DS}$       | 60         | V                         |
| Gate-Source Voltage                                    | $V_{GS}$       | $\pm 20$   |                           |
| Continuous Drain Current ( $T_J = 150^\circ\text{C}$ ) | $I_D$          | 240        | mA                        |
|                                                        |                | 190        |                           |
| Pulsed Drain Current <sup>a</sup>                      | $I_{DM}$       | 1300       |                           |
| Power Dissipation                                      | $P_D$          | 0.35       | W                         |
|                                                        |                | 0.22       |                           |
| Thermal Resistance, Junction-to-Ambient                | $R_{thJA}$     | 357        | $^\circ\text{C}/\text{W}$ |
| Operating Junction and Storage Temperature Range       | $T_J, T_{stg}$ | -55 to 150 | $^\circ\text{C}$          |

#### Notes

a. Pulse width limited by maximum junction temperature.

| SPECIFICATIONS (T <sub>J</sub> = 25° C UNLESS OTHERWISE NOTED) |                      |                                                                                                                           |        |                  |      |      |
|----------------------------------------------------------------|----------------------|---------------------------------------------------------------------------------------------------------------------------|--------|------------------|------|------|
| Parameter                                                      | Symbol               | Test Conditions                                                                                                           | Limits |                  |      | Unit |
|                                                                |                      |                                                                                                                           | Min    | Typ <sup>a</sup> | Max  |      |
| Static                                                         |                      |                                                                                                                           |        |                  |      |      |
| Drain-Source Breakdown Voltage                                 | V <sub>(BR)DSS</sub> | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 10 μA                                                                             | 60     | 68               |      | V    |
| Gate-Threshold Voltage                                         | V <sub>GS(th)</sub>  | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA                                                               | 1      | 2                | 2.5  |      |
| Gate-Body Leakage                                              | I <sub>GSS</sub>     | V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 15 V                                                                           |        |                  | ± 10 | nA   |
| Zero Gate Voltage Drain Current                                | I <sub>DSS</sub>     | V <sub>DS</sub> = 60 V, V <sub>GS</sub> = 0 V                                                                             |        |                  | 1    | μA   |
|                                                                |                      | V <sub>DS</sub> = 60 V, V <sub>GS</sub> = 0 V, T <sub>C</sub> = 125°C                                                     |        |                  | 500  |      |
| On-State Drain Current <sup>b</sup>                            | I <sub>D(on)</sub>   | V <sub>GS</sub> = 10 V, V <sub>DS</sub> = 7.5 V                                                                           | 800    | 1300             |      | mA   |
|                                                                |                      | V <sub>GS</sub> = 4.5 V, V <sub>DS</sub> = 10 V                                                                           | 500    | 700              |      |      |
| Drain-Source On-Resistance <sup>b</sup>                        | r <sub>DS(on)</sub>  | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 250 mA                                                                           |        | 1.2              | 3    | Ω    |
|                                                                |                      | V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 200 mA                                                                          |        | 1.8              | 4    |      |
| Forward Transconductance <sup>b</sup>                          | g <sub>fs</sub>      | V <sub>DS</sub> = 15 V, I <sub>D</sub> = 200 mA                                                                           |        | 600              |      | mS   |
| Diode Forward Voltage                                          | V <sub>SD</sub>      | I <sub>S</sub> = 200 mA, V <sub>GS</sub> = 0 V                                                                            |        | 0.85             | 1.2  | V    |
| Dynamic <sup>a</sup>                                           |                      |                                                                                                                           |        |                  |      |      |
| Total Gate Charge                                              | Q <sub>g</sub>       | V <sub>DS</sub> = 10 V, V <sub>GS</sub> = 4.5 V<br>I <sub>D</sub> ≅ 250 mA                                                |        | 0.4              | 0.6  | nC   |
| Gate-Source Charge                                             | Q <sub>gs</sub>      |                                                                                                                           |        | 0.06             |      |      |
| Gate-Drain Charge                                              | Q <sub>gd</sub>      |                                                                                                                           |        | 0.06             |      |      |
| Input Capacitance                                              | C <sub>iss</sub>     | V <sub>DS</sub> = 5 V, V <sub>GS</sub> = 0 V, f = 1 MHz                                                                   |        | 21               |      | pF   |
| Output Capacitance                                             | C <sub>oss</sub>     |                                                                                                                           |        | 7                |      |      |
| Reverse Transfer Capacitance                                   | C <sub>rss</sub>     |                                                                                                                           |        | 2.5              |      |      |
| Switching <sup>a, c</sup>                                      |                      |                                                                                                                           |        |                  |      |      |
| Turn-On Time                                                   | t <sub>on</sub>      | V <sub>DD</sub> = 10 V, R <sub>L</sub> = 40 Ω<br>I <sub>D</sub> ≅ 250 mA, V <sub>GEN</sub> = 10V<br>R <sub>G</sub> = 10 Ω |        | 13               | 20   | ns   |
| Turn-Off Time                                                  | t <sub>off</sub>     |                                                                                                                           |        | 18               | 25   |      |

## Notes

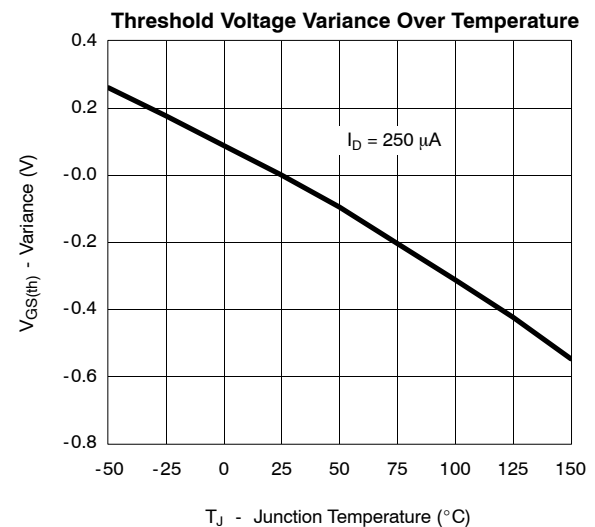
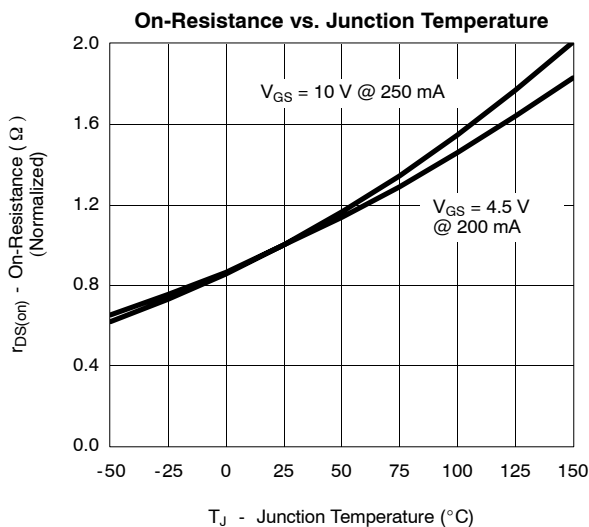
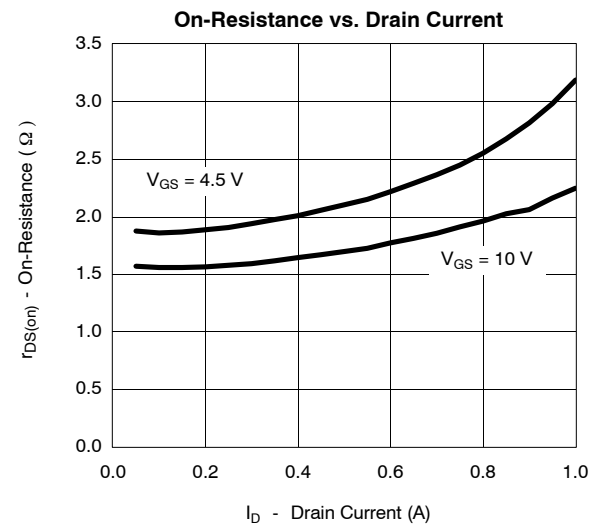
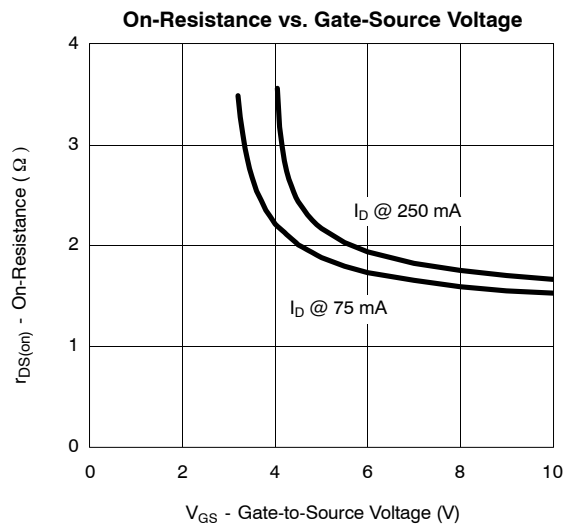
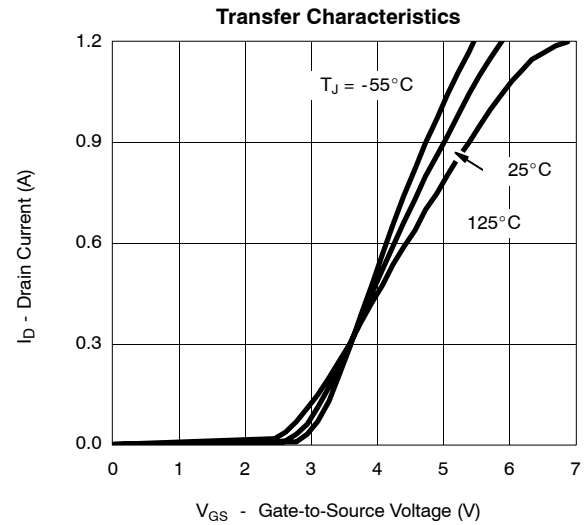
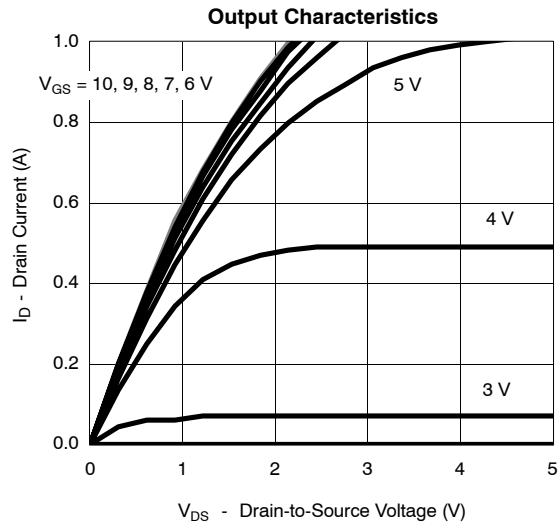
a. For DESIGN AID ONLY, not subject to production testing.

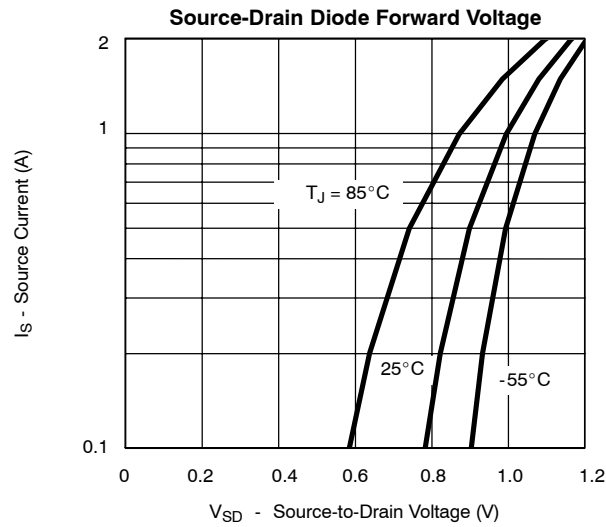
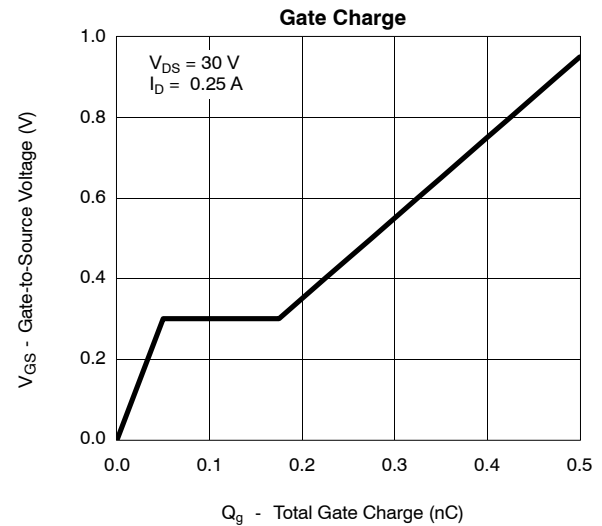
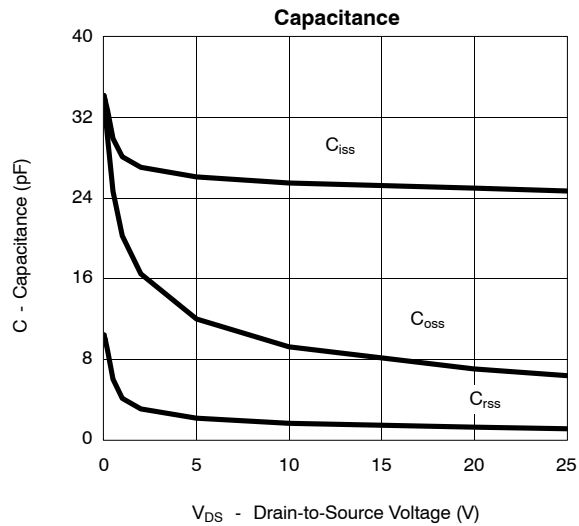
b. Pulse test: PW ≤ 300 μs duty cycle ≤ 2%.

c. Switching time is essentially independent of operating temperature.



**TYPICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$  UNLESS OTHERWISE NOTED)**



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