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

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

## FEATURES

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

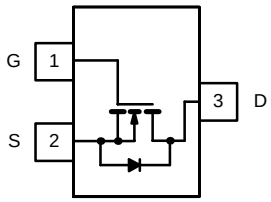
## BENEFITS

- 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

**TO-236**
**(SOT-23)**




Top View

Marking Code: 7E*w*/*l*

E = Part Number Code for 2N7002E
*w* = Week Code
*l* = Lot Traceability

| ABSOLUTE MAXIMUM RATINGS ($T_A$ = 25°C UNLESS OTHERWISE NOTED) | | | | |
|---|---|---|---|---|
| **Parameter** | | **Symbol** | **Limit** | **Unit** |
| Drain-Source Voltage | | $V_{DS}$ | 60 | V |
| Gate-Source Voltage | | $V_{GS}$ | ±20 | |
| Continuous Drain Current ($T_J$ = 150°C) | $T_A$ = 25°C | $I_D$ | 240 | mA |
| | $T_A$ = 70°C | | 190 | |
| Pulsed Drain Current[a] | | $I_{DM}$ | 1300 | |
| Power Dissipation | $T_A$ = 25°C | $P_D$ | 0.35 | W |
| | $T_A$ = 70°C | | 0.22 | |
| Thermal Resistance, Junction-to-Ambient | | $R_{thJA}$ | 357 | °C/W |
| Operating Junction and Storage Temperature Range | | $T_J$, $T_{stg}$ | –55 to 150 | °C |

Notes
a. Pulse width limited by maximum junction temperature.

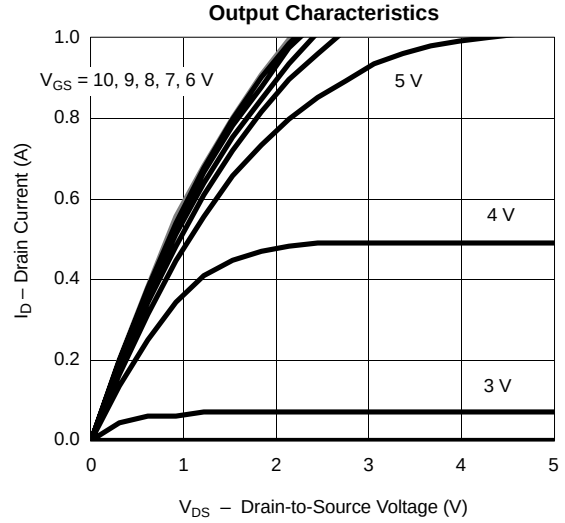
## SPECIFICATIONS ($T_J$ = 25°C UNLESS OTHERWISE NOTED)

| Parameter | Symbol | Test Conditions | Limits Min | Limits Typ[a] | Limits Max | Unit |
|---|---|---|---|---|---|---|
| **Static** | | | | | | |
| Drain-Source Breakdown Voltage | $V_{(BR)DSS}$ | $V_{GS}$ = 0 V, $I_D$ = 10 μA | 60 | 68 | | V |
| Gate-Threshold Voltage | $V_{GS(th)}$ | $V_{DS}$ = $V_{GS}$, $I_D$ = 250 μA | 1 | 2 | 2.5 | V |
| Gate-Body Leakage | $I_{GSS}$ | $V_{DS}$ = 0 V, $V_{GS}$ = ±15 V | | | ±10 | nA |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{DS}$ = 60 V, $V_{GS}$ = 0 V | | | 1 | μA |
| | | $V_{DS}$ = 60 V, $V_{GS}$ = 0 V, $T_C$ = 125°C | | | 500 | μA |
| On-State Drain Current[b] | $I_{D(on)}$ | $V_{GS}$ = 10 V, $V_{DS}$ = 7.5 V | 800 | 1300 | | mA |
| | | $V_{GS}$ = 4.5 V, $V_{DS}$ = 10 V | 500 | 700 | | mA |
| Drain-Source On-Resistance[b] | $r_{DS(on)}$ | $V_{GS}$ = 10 V, $I_D$ = 250 mA | | 1.2 | 3 | Ω |
| | | $V_{GS}$ = 4.5 V, $I_D$ = 200 mA | | 1.8 | 4 | Ω |
| Forward Transconductance[b] | $g_{fs}$ | $V_{DS}$ = 15 V, $I_D$ = 200 mA | | 600 | | mS |
| Diode Forward Voltage | $V_{SD}$ | $I_S$ = 200 mA, $V_{GS}$ = 0 V | | 0.85 | 1.2 | V |
| **Dynamic[a]** | | | | | | |
| Total Gate Charge | $Q_g$ | $V_{DS}$ = 10 V, $V_{GS}$ = 4.5 V<br>$I_D$ ≅ 250 mA | | 0.4 | 0.6 | nC |
| Gate-Source Charge | $Q_{gs}$ | | | 0.06 | | nC |
| Gate-Drain Charge | $Q_{gd}$ | | | 0.06 | | nC |
| Input Capacitance | $C_{iss}$ | $V_{DS}$ = 25 V, $V_{GS}$ = 0 V, f = 1 MHz | | 21 | | pF |
| Output Capacitance | $C_{oss}$ | | | 7 | | pF |
| Reverse Transfer Capacitance | $C_{rss}$ | | | 2.5 | | pF |
| **Switching[a, c]** | | | | | | |
| Turn-On Time | $t_{on}$ | $V_{DD}$ = 10 V, $R_L$ = 40 Ω<br>$I_D$ ≅ 250 mA, $V_{GEN}$ = 10V<br>$R_G$ = 10 Ω | | 13 | 20 | ns |
| Turn-Off Time | $t_{off}$ | | | 18 | 25 | ns |

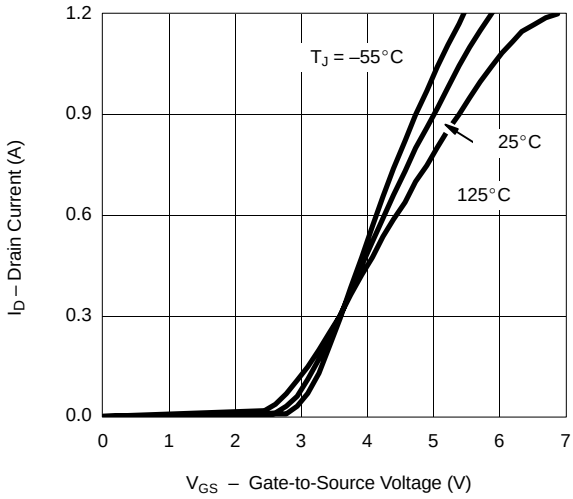
Notes
a. For DESIGN AID ONLY, not subject to production testing.
b. Pulse test: PW ≤ 300 μs duty cycle ≤ 2%.
c. Switching time is essentially independent of operating temperature.

## TYPICAL CHARACTERISTICS ($T_A$ = 25°C UNLESS OTHERWISE NOTED)

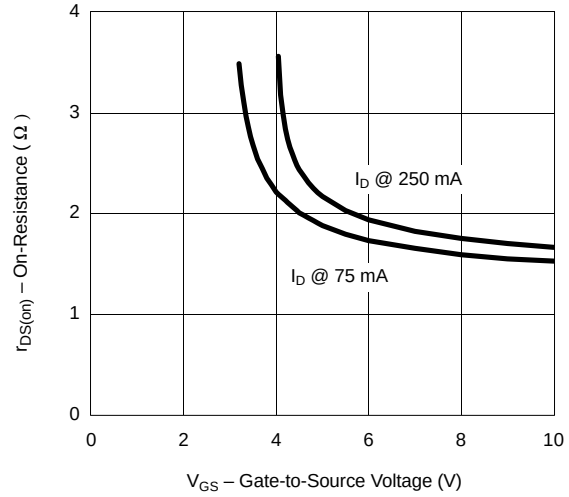
**Output Characteristics**



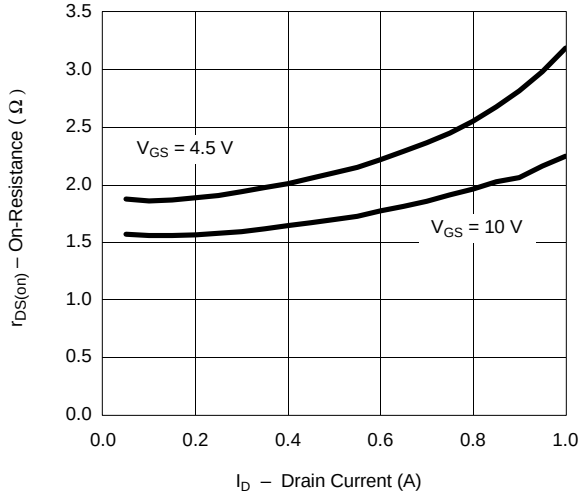

**Transfer Characteristics**



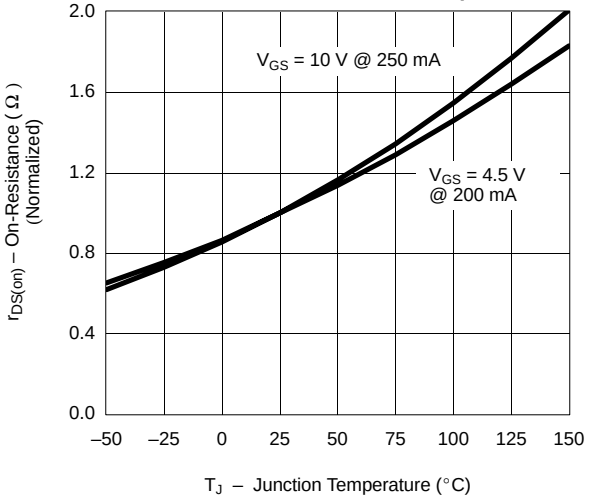

**On-Resistance vs. Gate-Source Voltage**



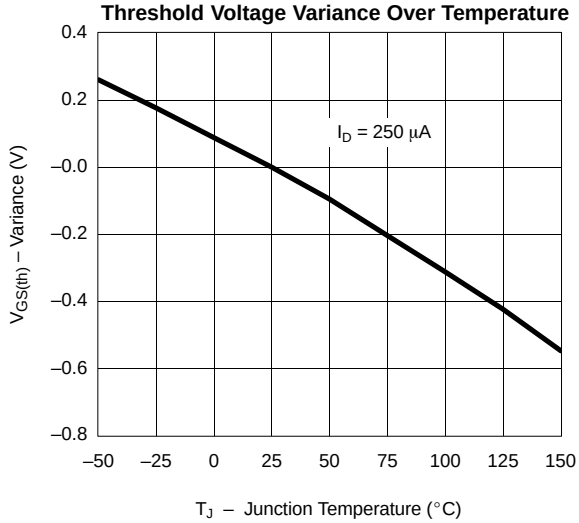

**On-Resistance vs. Drain Current**




**On-Resistance vs. Junction Temperature**




**Threshold Voltage Variance Over Temperature**



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