



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

| PRODUCT SUMMARY | | | | |
|-----------------|-----------------------|-------------------------------|------------------|-----------|
| Part Number | $V_{(BR)DSS}$ Min (V) | $r_{DS(on)}$ Max (Ω) | $V_{GS(th)}$ (V) | I_D (A) |
| 2N7000 | 60 | 5 @ $V_{GS} = 10$ V | 0.8 to 3 | 0.2 |
| 2N7002 | | 7.5 @ $V_{GS} = 10$ V | 1 to 2.5 | 0.115 |
| VQ1000J | | 5.5 @ $V_{GS} = 10$ V | 0.8 to 2.5 | 0.225 |
| VQ1000P | | 5.5 @ $V_{GS} = 10$ V | 0.8 to 2.5 | 0.225 |
| BS170 | | 5 @ $V_{GS} = 10$ V | 0.8 to 3 | 0.5 |

FEATURES

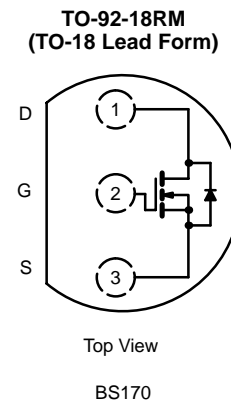
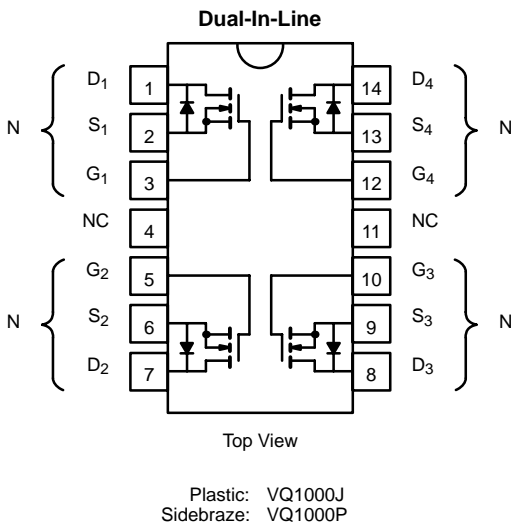
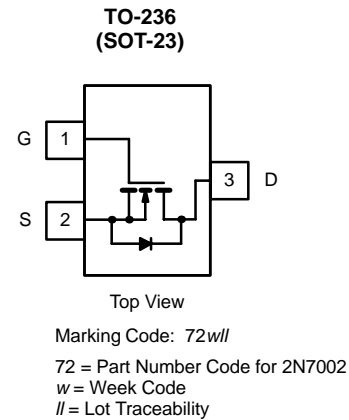
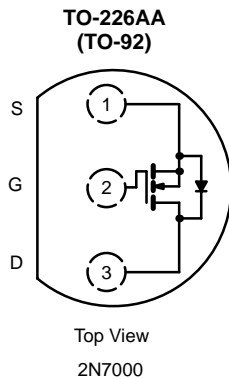
- Low On-Resistance: 2.5 Ω
- Low Threshold: 2.1 V
- Low Input Capacitance: 22 pF
- Fast Switching Speed: 7 ns
- Low Input and Output Leakage

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, Displays, Memories, Transistors, etc.
- Battery Operated Systems
- Solid-State Relays





| ABSOLUTE MAXIMUM RATINGS (T _A = 25 °C UNLESS OTHERWISE NOTED) | | | | | | | | | |
|--|-----------------------------------|----------------|--------|---------|---------|------------|-------|-------|----|
| Parameter | Symbol | 2N7000 | 2N7002 | Single | | Total Quad | BS170 | Unit | |
| | | | | VQ1000J | VQ1000P | VQ1000J/P | | | |
| Drain-Source Voltage | V _{DS} | 60 | 60 | 60 | 60 | | 60 | V | |
| Gate-Source Voltage—Non-Repetitive | V _{GSM} | ±40 | ±40 | ±30 | | | ±25 | | |
| Gate-Source Voltage—Continuous | V _{GS} | ±20 | ±20 | ±20 | ±20 | | ±20 | | |
| Continuous Drain Current (T _J = 150 °C) | T _A = 25 °C | I _D | 0.2 | 0.115 | 0.225 | 0.225 | | 0.5 | A |
| | T _A = 100 °C | | 0.13 | 0.073 | 0.14 | 0.14 | | 0.175 | |
| Pulsed Drain Current ^a | I _{DM} | 0.5 | 0.8 | 1 | 1 | | | | |
| Power Dissipation | T _A = 25 °C | P _D | 0.4 | 0.2 | 1.3 | 1.3 | 2 | 0.83 | W |
| | T _A = 100 °C | | 0.16 | 0.08 | 0.52 | 0.52 | 0.8 | | |
| Thermal Resistance, Junction-to-Ambient | R _{thJA} | 312.5 | 625 | 96 | 96 | 62.5 | 156 | °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.
- b. t_p ≤ 50 μs.

| SPECIFICATIONS—2N7000 AND 2N7002 (T _A = 25 °C UNLESS OTHERWISE NOTED) | | | | | | | | |
|--|----------------------|--|------------------|--------|------|--------|------|------|
| Parameter | Symbol | Test Conditions | Typ ^a | Limits | | | | Unit |
| | | | | 2N7000 | | 2N7002 | | |
| | | | | Min | Max | Min | Max | |
| Static | | | | | | | | |
| Drain-Source Breakdown Voltage | V _{(BR)DSS} | V _{GS} = 0 V, I _D = 10 μA | 70 | 60 | | 60 | | V |
| Gate-Threshold Voltage | V _{GS(th)} | V _{DS} = V _{GS} , I _D = 1 mA | 2.1 | 0.8 | 3 | | | |
| | | V _{DS} = V _{GS} , I _D = 0.25 mA | 2.0 | | | 1 | 2.5 | |
| Gate-Body Leakage | I _{GSS} | V _{DS} = 0 V, V _{GS} = ±15 V | | | ±10 | | | nA |
| | | V _{DS} = 0 V, V _{GS} = ±20 V | | | | | ±100 | |
| Zero Gate Voltage Drain Current | I _{DSS} | V _{DS} = 48 V, V _{GS} = 0 V | | | 1 | | | μA |
| | | T _C = 125 °C | | | 1000 | | | |
| | | V _{DS} = 60 V, V _{GS} = 0 V | | | | | 1 | |
| On-State Drain Current ^b | I _{D(on)} | V _{DS} = 10 V, V _{GS} = 4.5 V | 0.35 | 0.075 | | | | A |
| | | V _{DS} = 7.5 V, V _{GS} = 10 V | 1 | | | 0.5 | | |
| | | V _{GS} = 4.5 V, I _D = 0.075 A | 4.5 | | 5.3 | | | |
| Drain-Source On-Resistance ^b | r _{DS(on)} | V _{GS} = 5 V, I _D = 0.05 A | 3.2 | | | | 7.5 | Ω |
| | | T _C = 125 °C | 5.8 | | | | 13.5 | |
| | | V _{GS} = 10 V, I _D = 0.5 A | 2.4 | | 5 | | 7.5 | |
| | | T _J = 125 °C | 4.4 | | 9 | | 13.5 | |
| Forward Transconductance ^b | g _{fs} | V _{DS} = 10 V, I _D = 0.2 A | | 100 | | 80 | | mS |
| Common Source Output Conductance ^b | g _{os} | V _{DS} = 5 V, I _D = 0.05 A | 0.5 | | | | | |
| Dynamic | | | | | | | | |
| Input Capacitance | C _{iss} | V _{DS} = 25 V, V _{GS} = 0 V f = 1 MHz | 22 | | 60 | | 50 | pF |
| Output Capacitance | C _{oss} | | 11 | | 25 | | 25 | |
| Reverse Transfer Capacitance | C _{rss} | | 2 | | 5 | | 5 | |



| SPECIFICATIONS—2N7000 AND 2N7002 (T _A = 25 °C UNLESS OTHERWISE NOTED) | | | | | | | | |
|--|------------------|--|------------------|--------|-----|--------|-----|------|
| Parameter | Symbol | Test Conditions | Typ ^a | Limits | | | | Unit |
| | | | | 2N7000 | | 2N7002 | | |
| | | | | Min | Max | Min | Max | |
| Switching^d | | | | | | | | |
| Turn-On Time | t _{ON} | V _{DD} = 15 V, R _L = 25 Ω I _D ≅ 0.5 A, V _{GEN} = 10 V, R _G = 25 Ω | 7 | | 10 | | | ns |
| Turn-Off Time | t _{OFF} | | 7 | | 10 | | | |
| Turn-On Time | t _{ON} | V _{DD} = 30 V, R _L = 150 Ω I _D ≅ 0.2 A, V _{GEN} = 10 V, R _G = 25 Ω | 7 | | | | 20 | |
| Turn-Off Time | t _{OFF} | | 11 | | | | 20 | |

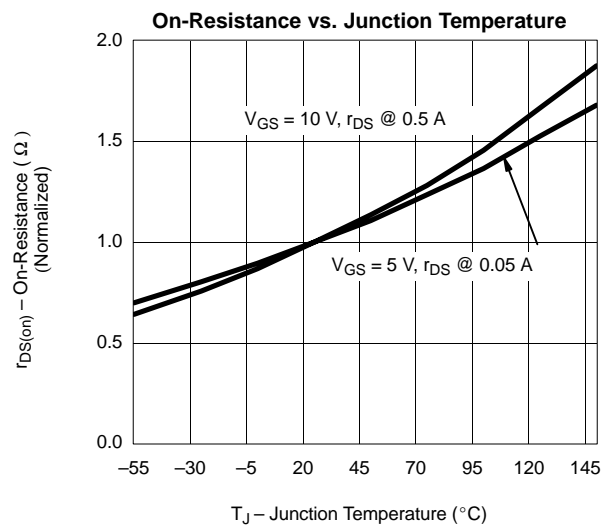
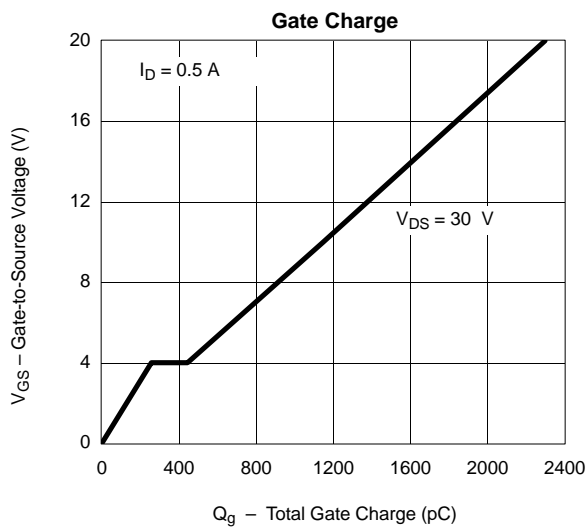
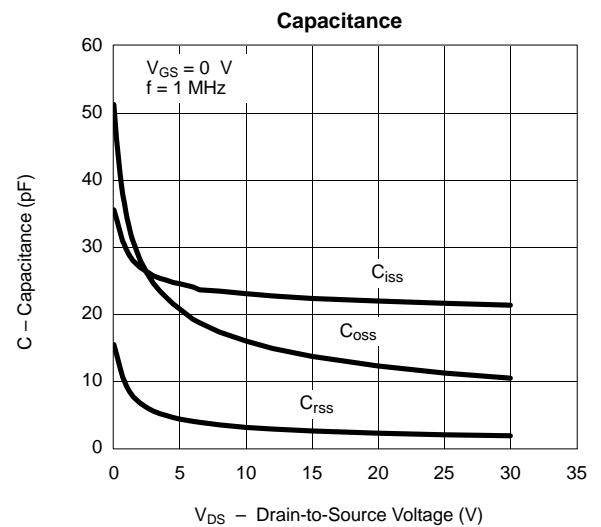
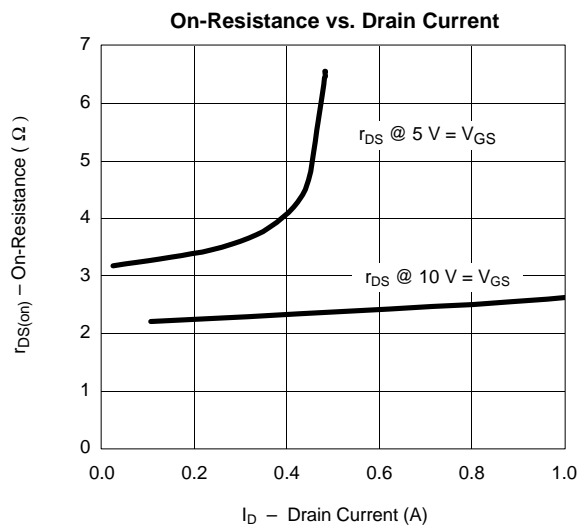
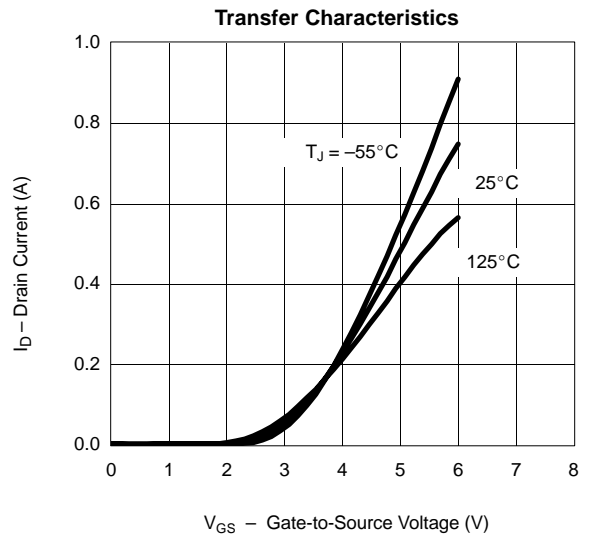
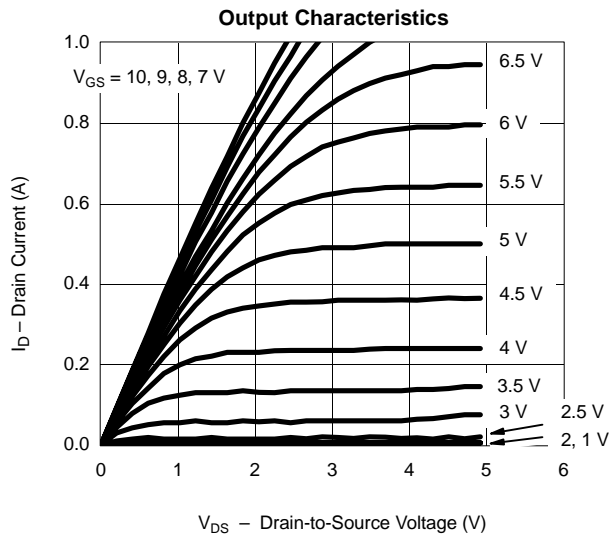
| SPECIFICATIONS—VQ1000J/P AND BS170 (T _A = 25 °C UNLESS OTHERWISE NOTED) | | | | | | | | |
|--|----------------------|--|------------------|-----------|------|-------|-----|------|
| Parameter | Symbol | Test Conditions | Typ ^a | Limits | | | | Unit |
| | | | | VQ1000J/P | | BS170 | | |
| | | | | Min | Max | Min | Max | |
| Static | | | | | | | | |
| Drain-Source Breakdown Voltage | V _{(BR)DSS} | V _{GS} = 0 V, I _D = 100 μA | 70 | 60 | | 60 | | V |
| Gate-Threshold Voltage | V _{GS(th)} | V _{DS} = V _{GS} , I _D = 1 mA | 2.1 | 0.8 | 2.5 | 0.8 | 3 | |
| Gate-Body Leakage | I _{GSS} | V _{DS} = 0 V, V _{GS} = ±10 V | | | ±100 | | | nA |
| | | T _J = 125 °C | | | ±500 | | | |
| Zero Gate Voltage Drain Current | I _{DSS} | V _{DS} = 0 V, V _{GS} = ±15 V | | | | | ±10 | μA |
| | | V _{DS} = 25 V, V _{GS} = 0 V | | | | | 0.5 | |
| | | V _{DS} = 48 V, V _{GS} = 0 V, T _J = 125 °C | | | 500 | | | |
| On-State Drain Current ^b | I _{D(on)} | V _{DS} = 10 V, V _{GS} = 10 V | 1 | 0.5 | | | | A |
| | | V _{GS} = 5 V, I _D = 0.2 A | 4 | | 7.5 | | | Ω |
| Drain-Source On-Resistance ^b | r _{DS(on)} | V _{GS} = 10 V, I _D = 0.2 A | 2.3 | | | | 5 | |
| | | V _{GS} = 10 V, I _D = 0.3 A | 2.3 | | 5.5 | | | |
| | | T _J = 125 °C | 4.2 | | 7.6 | | | |
| | | V _{DS} = 10 V, I _D = 0.2 A | | | | 100 | | mS |
| V _{DS} = 10 V, I _D = 0.5 A | | 100 | | | | | | |
| Common Source Output Conductance ^b | g _{os} | V _{DS} = 5 V, I _D = 0.05 A | 0.5 | | | | | |
| Dynamic | | | | | | | | |
| Input Capacitance | C _{iSS} | V _{DS} = 25 V, V _{GS} = 0 V f = 1 MHz | 22 | | 60 | | 60 | pF |
| Output Capacitance | C _{oss} | | 11 | | 25 | | | |
| Reverse Transfer Capacitance | C _{rSS} | | 2 | | 5 | | | |
| Switching^d | | | | | | | | |
| Turn-On Time | t _{ON} | V _{DD} = 15 V, R _L = 23 Ω I _D ≅ 0.6 A, V _{GEN} = 10 V, R _G = 25 Ω | 7 | | 10 | | | ns |
| Turn-Off Time | t _{OFF} | | 7 | | 10 | | | |
| Turn-On Time | t _{ON} | V _{DD} = 25 V, R _L = 125 Ω I _D ≅ 0.2 A, V _{GEN} = 10 V, R _G = 25 Ω | 7 | | | | 10 | |
| Turn-Off Time | t _{OFF} | | 7 | | | | 10 | |

Notes

- a. For DESIGN AID ONLY, not subject to production testing.
- b. Pulse test: PW ≤ 80 μs duty cycle ≤ 1%.
- c. This parameter not registered with JEDEC.
- d. Switching time is essentially independent of operating temperature.

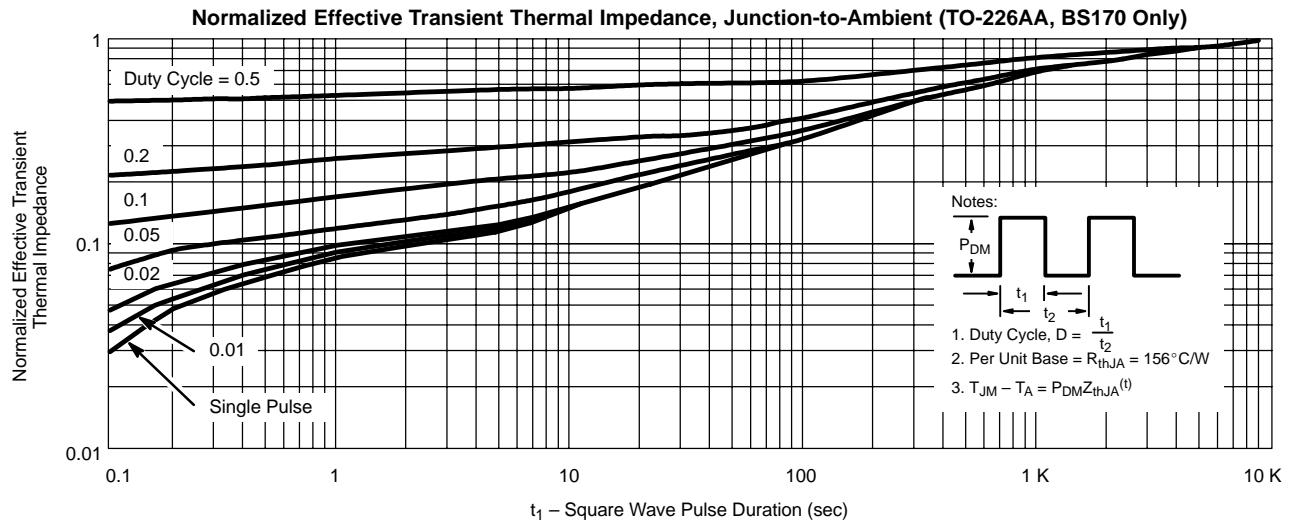
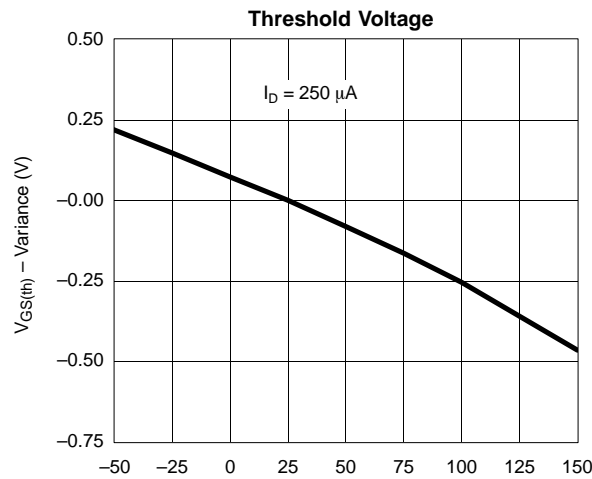
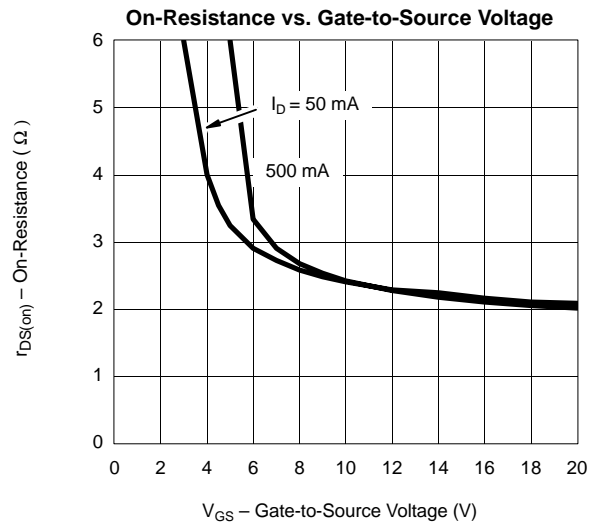
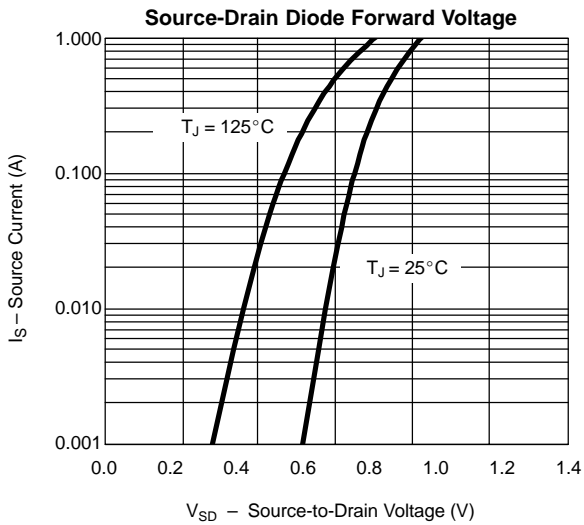
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TYPICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ UNLESS OTHERWISE NOTED)





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





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