

## NCE N-Channel Enhancement Mode Power MOSFET

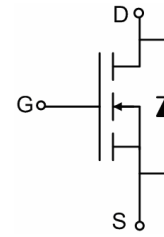
### General Features

- $V_{DS} = 60V, I_D = 0.115A$   
 $R_{DS(ON)} < 3.5\Omega @ V_{GS}=5V$   
 $R_{DS(ON)} < 3\Omega @ V_{GS}=10V$

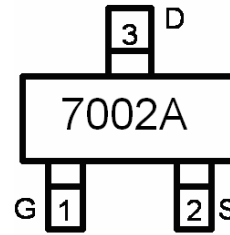
- Lead free product is acquired
- Surface mount package

### Application

- Direct logic-level interface: TTL/CMOS
- Drivers: relays, solenoids, lamps, hammers, display, memories, transistors, etc.
- Battery operated systems
- Solid-state relays



Schematic diagram



Marking and pin assignment



SOT-23 top view

### Package Marking and Ordering Information

| Device Marking | Device  | Device Package | Reel Size | Tape width | Quantity   |
|----------------|---------|----------------|-----------|------------|------------|
| 7002A          | 2N7002A | SOT-23         | Ø180mm    | 8 mm       | 3000 units |

### Absolute Maximum Ratings (TC=25°C unless otherwise noted)

| Parameter  | Symbol         | Limit      | Unit |
|--|----------------|------------|------|
| Drain-Source Voltage   | $V_{DS}$       | 60         | V    |
| Gate-Source Voltage  | $V_{GS}$       | ±20        | V    |
| Drain Current-Continuous@ Current-Pulsed <sup>(Note 1)</sup> | $I_D$          | 0.115      | A    |
|  | $I_{DM}$       | 0.8        | A    |
| Maximum Power Dissipation                                    | $P_D$          | 0.2        | W    |
| Operating Junction and Storage Temperature Range             | $T_J, T_{STG}$ | -55 To 150 | °C   |

### Thermal Characteristic

|   |                 |     |      |
|---|-----------------|-----|------|
| Thermal Resistance, Junction-to-Ambient <sup>(Note 2)</sup> | $R_{\theta JA}$ | 625 | °C/W |
|---|-----------------|-----|------|

### Electrical Characteristics (TC=25°C unless otherwise noted)

| Parameter                       | Symbol     | Condition                 | Min | Typ | Max | Unit |
|---------------------------------|------------|---------------------------|-----|-----|-----|------|
| <b>Off Characteristics</b>      |            |                           |     |     |     |      |
| Drain-Source Breakdown Voltage  | $BV_{DSS}$ | $V_{GS}=0V, I_D=250\mu A$ | 60  | 68  | -   | V    |
| Zero Gate Voltage Drain Current | $I_{DSS}$  | $V_{DS}=60V, V_{GS}=0V$   | -   | -   | 1   | μA   |

|  |              |  |      |     |           |          |
|--|--------------|--|------|-----|-----------|----------|
| Gate-Body Leakage Current                            | $I_{GSS}$    | $V_{GS}=\pm 20V, V_{DS}=0V$                              | -    | -   | $\pm 100$ | nA       |
| <b>On Characteristics</b> <sup>(Note 3)</sup>        |              |  |      |     |           |          |
| Gate Threshold Voltage                               | $V_{GS(th)}$ | $V_{DS}=V_{GS}, I_D=250\mu A$                            | 1    | 1.7 | 2.5       | V        |
| Drain-Source On-State Resistance                     | $R_{DS(ON)}$ | $V_{GS}=5V, I_D=0.05A$                                   | -    | 2.3 | 3.5       | $\Omega$ |
|  |              | $V_{GS}=10V, I_D=0.5A$                                   | -    | 2.1 | 3         | $\Omega$ |
| Forward Transconductance                             | $g_{FS}$     | $V_{DS}=10V, I_D=0.2A$                                   | 0.08 | -   | -         | S        |
| <b>Dynamic Characteristics</b> <sup>(Note4)</sup>    |              |  |      |     |           |          |
| Input Capacitance                                    | $C_{iss}$    | $V_{DS}=30V, V_{GS}=0V,$<br>$F=1.0MHz$                   | -    | 20  | 50        | PF       |
| Output Capacitance                                   | $C_{oss}$    |  | -    | 10  | 20        | PF       |
| Reverse Transfer Capacitance                         | $C_{rss}$    |  | -    | 3.6 | 5         | PF       |
| <b>Switching Characteristics</b> <sup>(Note 4)</sup> |              |  |      |     |           |          |
| Turn-on Delay Time                                   | $t_{d(on)}$  | $V_{DD}=30V, I_D=0.2A$<br>$V_{GS}=10V, R_{GEN}=10\Omega$ | -    | 10  | -         | nS       |
| Turn-on Rise Time                                    | $t_r$        |  | -    | 50  | -         | nS       |
| Turn-Off Delay Time                                  | $t_{d(off)}$ |  | -    | 17  | -         | nS       |
| Turn-Off Fall Time                                   | $t_f$        |  | -    | 10  | -         | nS       |
| Total Gate Charge                                    | $Q_g$        | $V_{DS}=10V, I_D=0.115A,$<br>$V_{GS}=4.5V$               | -    | 1.7 | 3         | nC       |
| <b>Drain-Source Diode Characteristics</b>            |              |  |      |     |           |          |
| Diode Forward Voltage <sup>(Note 3)</sup>            | $V_{SD}$     | $V_{GS}=0V, I_S=0.115A$                                  | -    | -   | 1.2       | V        |
| Diode Forward Current <sup>(Note 2)</sup>            | $I_S$        |  | -    | -   | 0.115     | A        |

**Notes:**

1. Repetitive Rating: Pulse width limited by maximum junction temperature.
2. Surface Mounted on FR4 Board,  $t \leq 10$  sec.
3. Pulse Test: Pulse Width  $\leq 300\mu s$ , Duty Cycle  $\leq 2\%$ .
4. Guaranteed by design, not subject to production

Typical Electrical and Thermal Characteristics

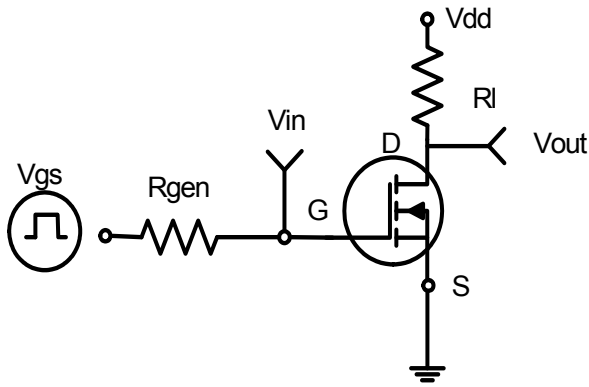


Figure 1: Switching Test Circuit

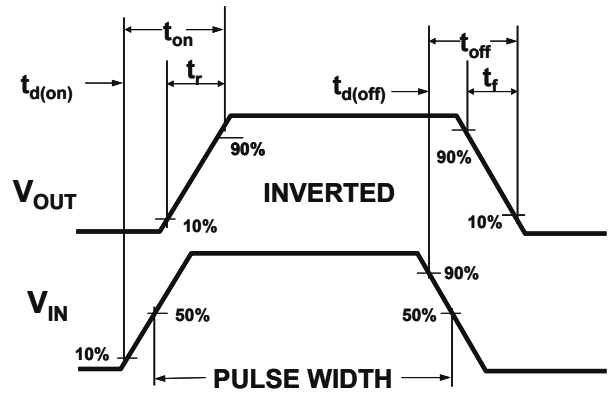


Figure 2: Switching Waveforms

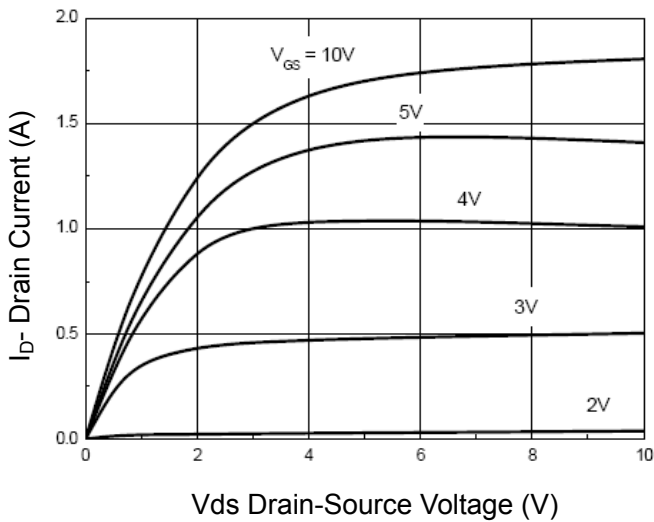


Figure 3 Output Characteristics

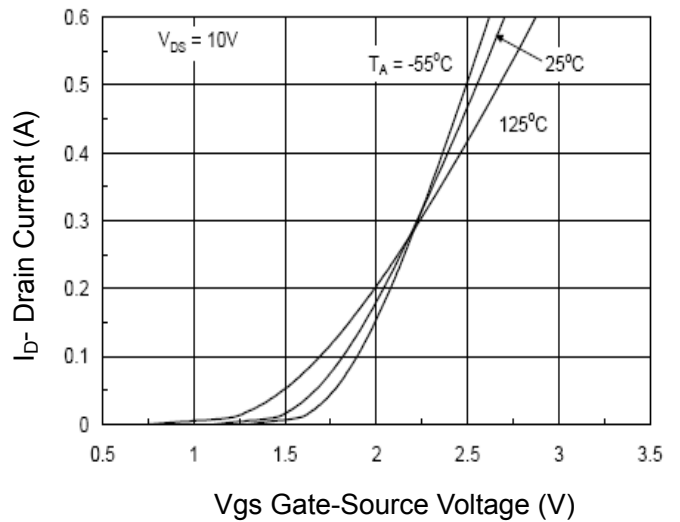


Figure 4 Transfer Characteristics

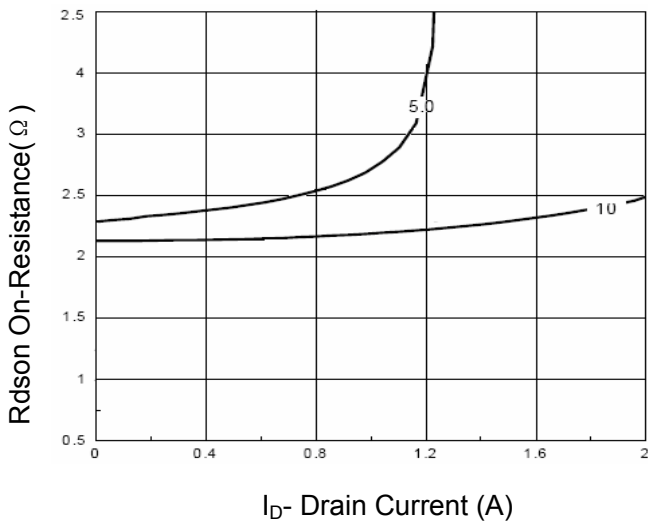


Figure 5 Drain-Source On-Resistance

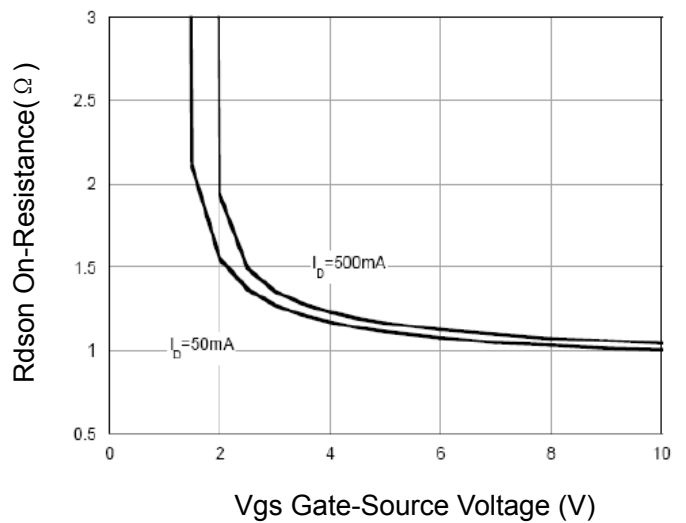


Figure 6 Rdson vs Vgs

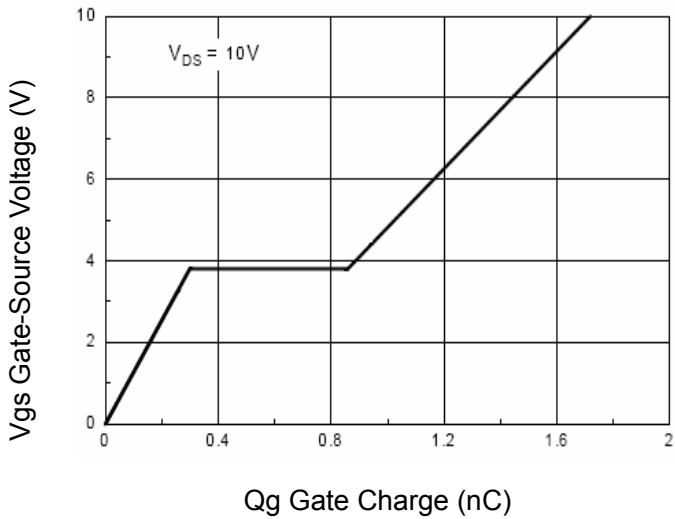


Figure 7 Gate Charge

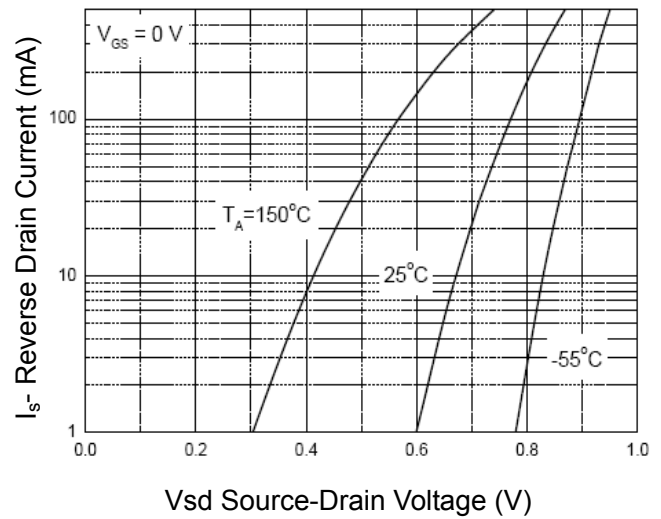


Figure 8 Source-Drain Diode Forward

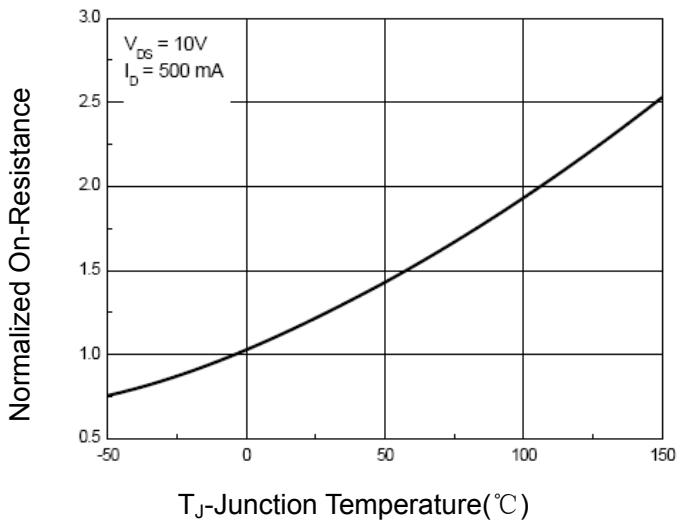


Figure 9 Drain-Source On-Resistance

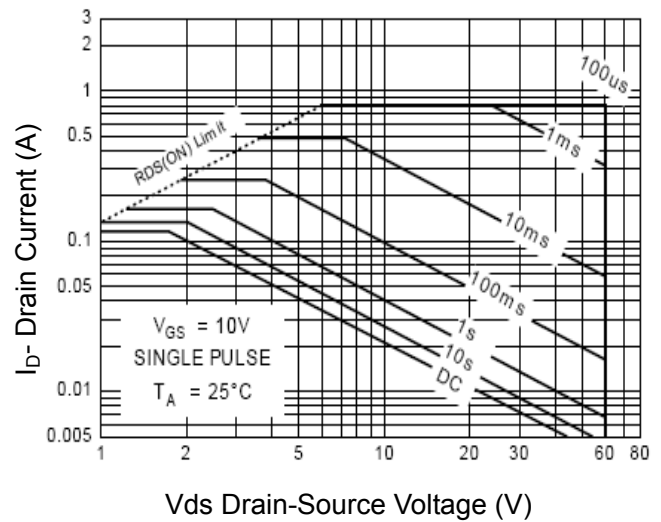


Figure 10 Safe Operation Area

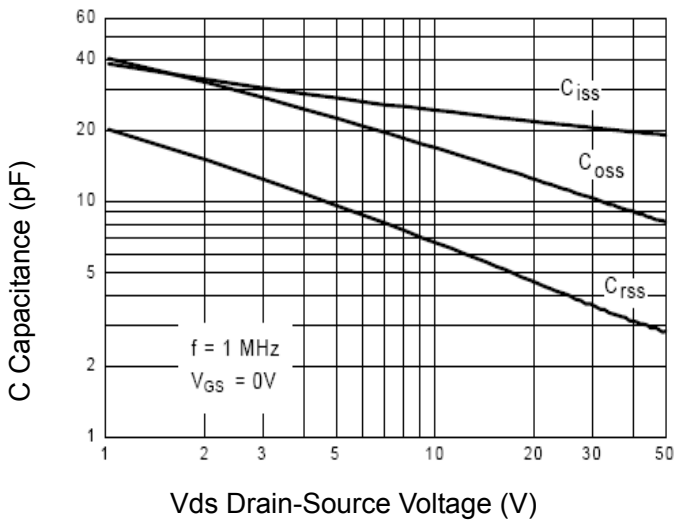


Figure 11 Capacitance vs Vds

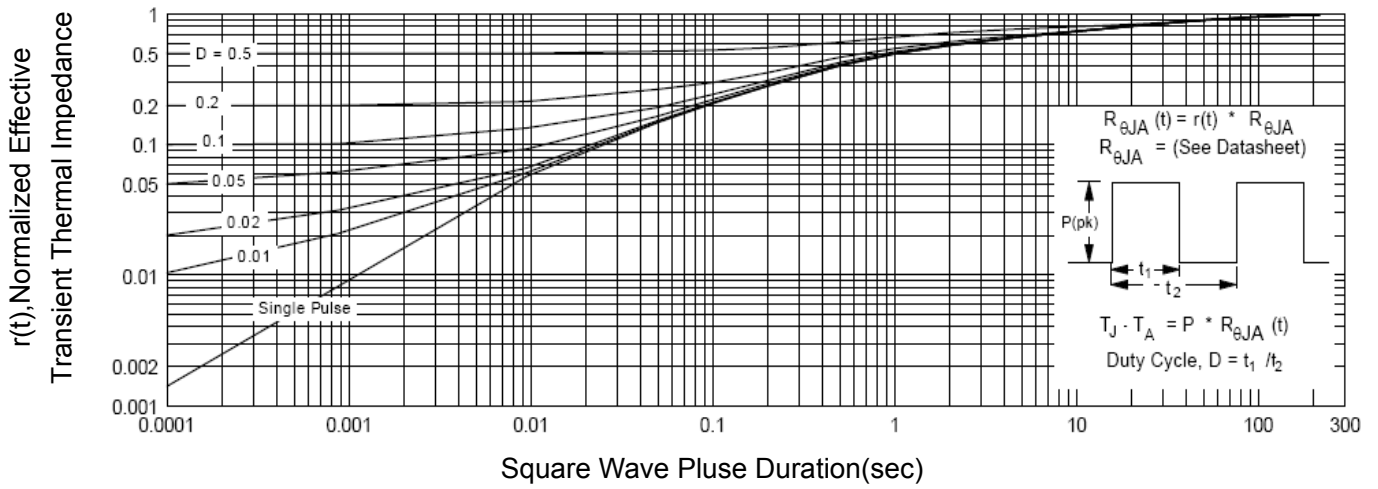
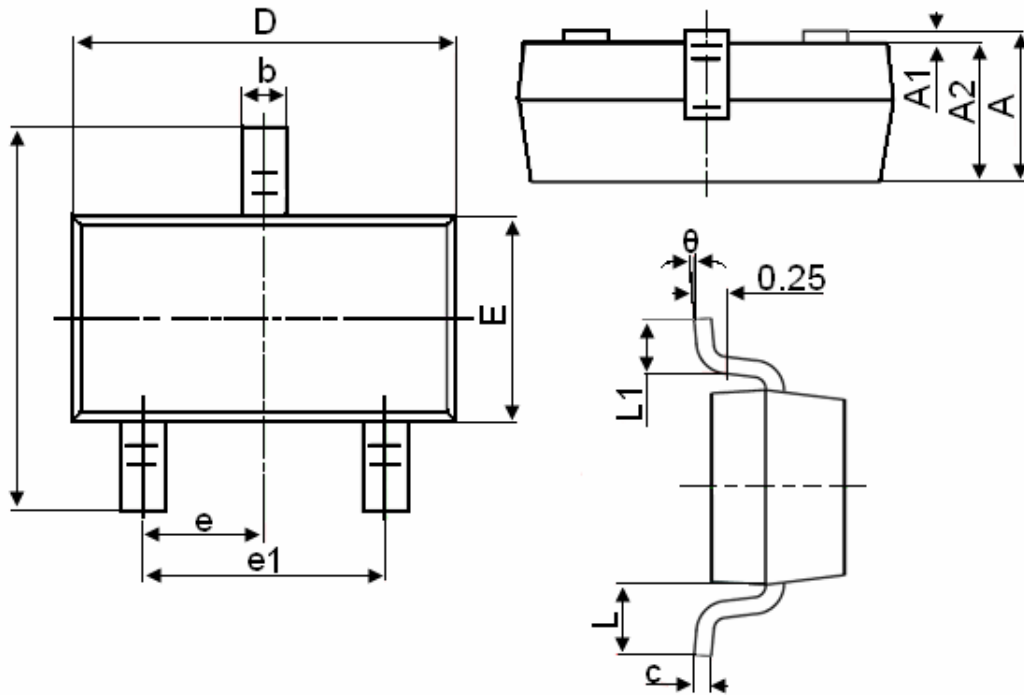


Figure 12 Normalized Maximum Transient Thermal Impedance

SOT-23 Package Information



| Symbol | Dimensions in Millimeters |       |
|--------|---------------------------|-------|
|        | MIN.                      | MAX.  |
| A      | 0.900                     | 1.150 |
| A1     | 0.000                     | 0.100 |
| A2     | 0.900                     | 1.050 |
| b      | 0.300                     | 0.500 |
| c      | 0.080                     | 0.150 |
| D      | 2.800                     | 3.000 |
| E      | 1.200                     | 1.400 |
| E1     | 2.250                     | 2.550 |
| e      | 0.950TYP                  |       |
| e1     | 1.800                     | 2.000 |
| L      | 0.550REF                  |       |
| L1     | 0.300                     | 0.500 |
| θ      | 0°                        | 8°    |

Notes

1. All dimensions are in millimeters.
2. Tolerance  $\pm 0.10\text{mm}$  (4 mil) unless otherwise specified
3. Package body sizes exclude mold flash and gate burrs. Mold flash at the non-lead sides should be less than 5 mils.
4. Dimension L is measured in gauge plane.
5. Controlling dimension is millimeter, converted inch dimensions are not necessarily exact.

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