

# Field Effect Transistor - N-Channel, Enhancement Mode

## 2N7002K

### Features

- Low On-Resistance
- Low Gate Threshold Voltage
- Low Input Capacitance
- Fast Switching Speed
- Low Input / Output Leakage
- Ultra-Small Surface Mount Package
- ESD HBM = 2000 V (Typical: 3000 V) as per JESD22 A114 and ESD CDM = 2000 V as per JESD22 C101
- This Device is Pb-Free, Halogen Free/BFR Free and is RoHS Compliant

### ABSOLUTE MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ unless otherwise specified)

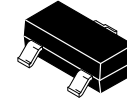
| Symbol    | Parameter  | Value       | Unit             |
|-----------|--|-------------|------------------|
| $V_{DSS}$ | Drain-Source Voltage                                     | 60          | V                |
| $V_{DGR}$ | Drain-Gate Voltage ( $R_{GS} \leq 1.0 \text{ M}\Omega$ ) | 60          | V                |
| $V_{GSS}$ | Gate-Source Voltage                                      | $\pm 20$    | V                |
| $I_D$     | Drain Current  | Continuous  | 300              |
|           |  | Pulsed      | 800              |
| $T_J$     | Operating Junction Temperature Range                     | -55 to +150 | $^\circ\text{C}$ |
| $T_{STG}$ | Storage Temperature Range                                | -55 to +150 | $^\circ\text{C}$ |

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 ( $T_A = 25^\circ\text{C}$ unless otherwise specified)

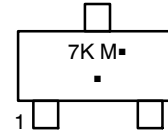
| Symbol          | Parameter  | Value | Unit                      |
|-----------------|--|-------|---------------------------|
| $P_D$           | Total Device Dissipation                         | 350   | mW                        |
|                 | Derate Above $T_A = 25^\circ\text{C}$            | 2.8   | mW/ $^\circ\text{C}$      |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient (Note 1) | 350   | $^\circ\text{C}/\text{W}$ |

1. Device mounted on FR-4 PCB, 1 inch x 0.85 inch x 0.062 inch; Minimum land pad size.



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

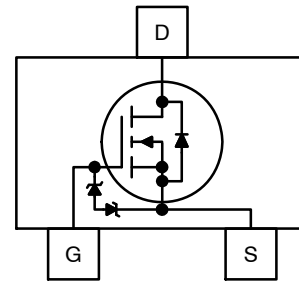
### MARKING DIAGRAM



- 7K = Specific Device Code
- M = Date Code
- = Pb-Free Package

(Note: Microdot may be in either location)  
 \*Date Code orientation may vary depending upon manufacturing location.

### FUNCTIONAL SCHEMATIC



### ORDERING INFORMATION

See detailed ordering and shipping information on page 4 of this data sheet.

# 2N7002K

## ELECTRICAL CHARACTERISTICS (T<sub>J</sub> = 25°C unless otherwise noted)

| Symbol | Parameter | Conditions | Min | Max | Unit |
|--------|-----------|------------|-----|-----|------|
|--------|-----------|------------|-----|-----|------|

### OFF CHARACTERISTICS (Note 2)

|                   |                                 |   |    |     |    |
|-------------------|---------------------------------|---|----|-----|----|
| BV <sub>DSS</sub> | Drain–Source Breakdown Voltage  | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 10 μA                         | 60 | –   | V  |
| I <sub>DSS</sub>  | Zero Gate Voltage Drain Current | V <sub>DS</sub> = 60 V, V <sub>GS</sub> = 0 V                         | –  | 1.0 | μA |
|                   |                                 | V <sub>DS</sub> = 60 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125°C | –  | 500 |    |
| I <sub>GSS</sub>  | Gate–Body Leakage               | V <sub>GS</sub> = ±20 V, V <sub>DS</sub> = 0 V                        | –  | ±10 | μA |

### ON CHARACTERISTICS (Note 2)

|                     |                                   |   |     |     |    |
|---------------------|-----------------------------------|---|-----|-----|----|
| V <sub>GS(th)</sub> | Gate Threshold Voltage            | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA | 1.0 | 2.5 | V  |
| R <sub>DS(ON)</sub> | Static Drain–Source On–Resistance | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 0.5 A              | –   | 2   | Ω  |
|                     |                                   | V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 200 mA            | –   | 4   |    |
| I <sub>D(ON)</sub>  | On–State Drain Current            | V <sub>GS</sub> = 10 V, V <sub>DS</sub> = 7.5 V             | 1.5 | –   | A  |
| g <sub>FS</sub>     | Forward Transconductance          | V <sub>DS</sub> = 10 V, I <sub>D</sub> = 0.2 A              | 200 | –   | mS |

### DYNAMIC CHARACTERISTICS

|                  |                              |  |   |    |    |
|------------------|------------------------------|--|---|----|----|
| C <sub>iss</sub> | Input Capacitance            | V <sub>DS</sub> = 25 V, V <sub>GS</sub> = 0 V, f = 1.0 MHz | – | 50 | pF |
| C <sub>oss</sub> | Output Capacitance           |  | – | 15 | pF |
| C <sub>rss</sub> | Reverse Transfer Capacitance |  | – | 6  | pF |

### SWITCHING CHARACTERISTICS

|                     |                     |   |   |    |    |
|---------------------|---------------------|---|---|----|----|
| t <sub>D(ON)</sub>  | Turn–On Delay Time  | V <sub>DD</sub> = 30 V, I <sub>DSS</sub> = 200 mA, R <sub>G</sub> = 10 Ω,<br>V <sub>GS</sub> = 10 V | – | 5  | ns |
| t <sub>D(OFF)</sub> | Turn–Off Delay Time |   | – | 30 | ns |

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. Short duration test pulse used to minimize self–heating effect.

TYPICAL PERFORMANCE CHARACTERISTICS

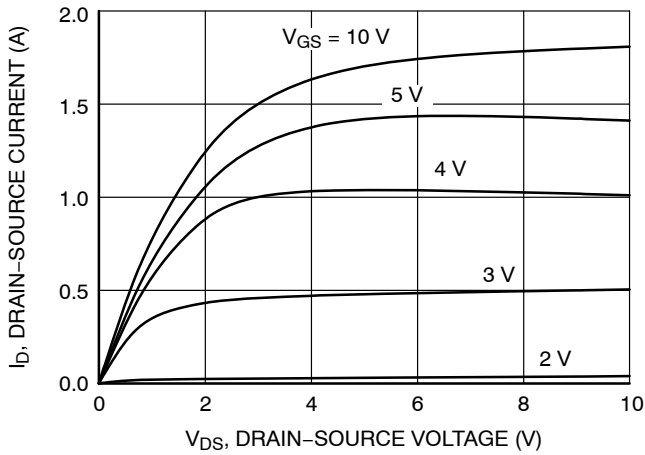


Figure 1. On-Region Characteristics

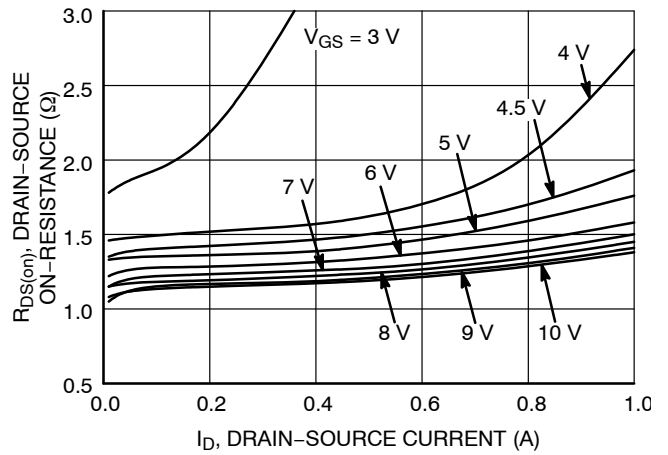


Figure 2. On-Resistance Variation with Gate Voltage and Drain Current

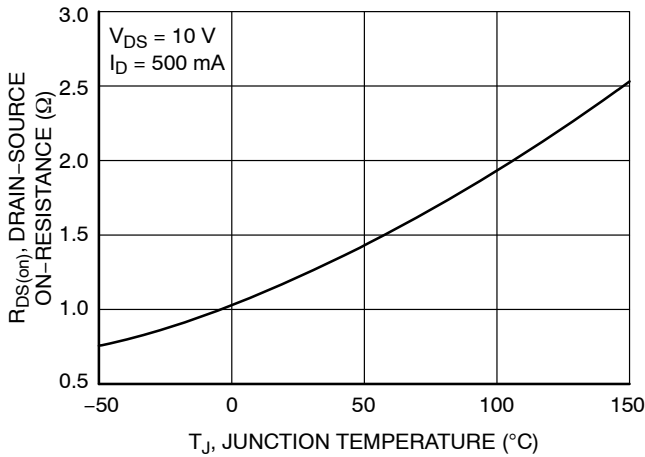


Figure 3. On-Resistance Variation with Temperature

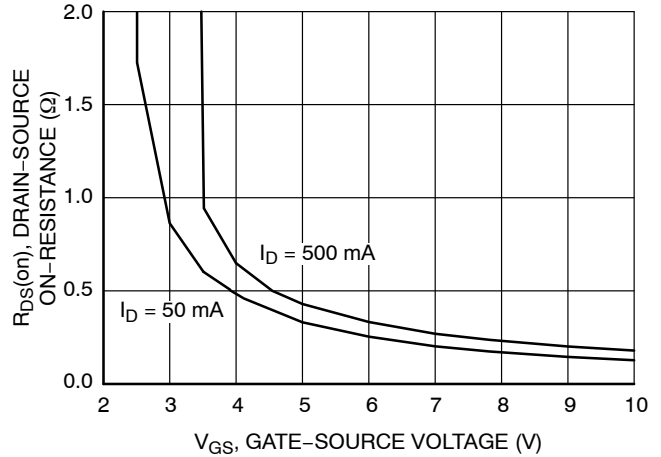


Figure 4. On-Resistance Variation with Gate-Source Voltage

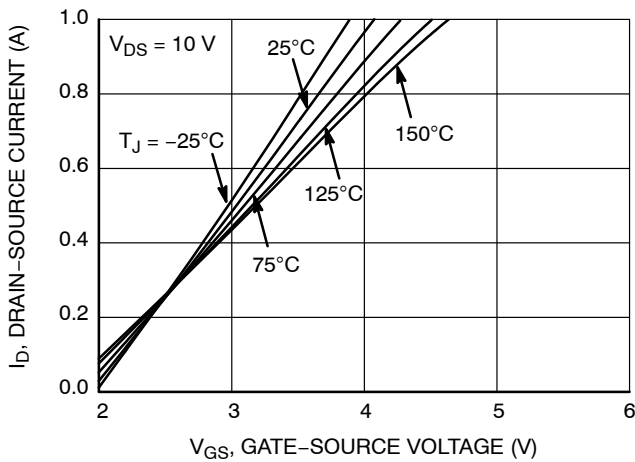


Figure 5. Transfer Characteristics

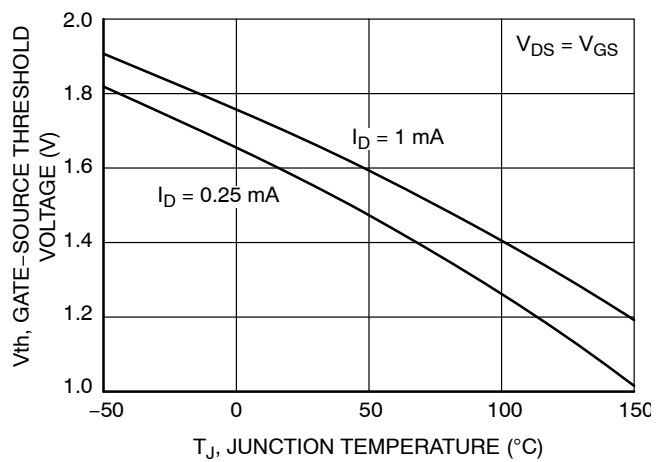
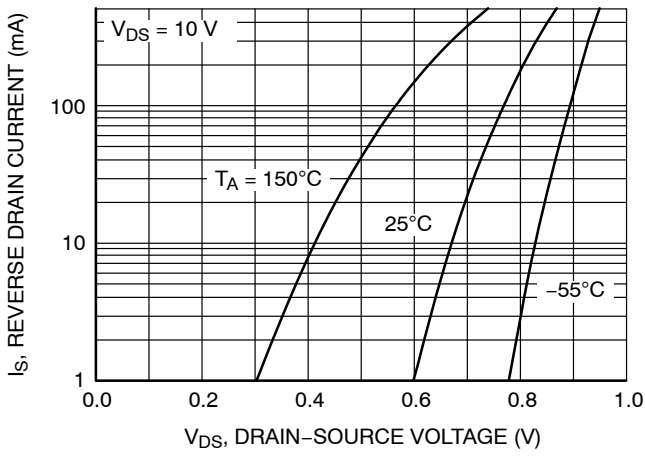
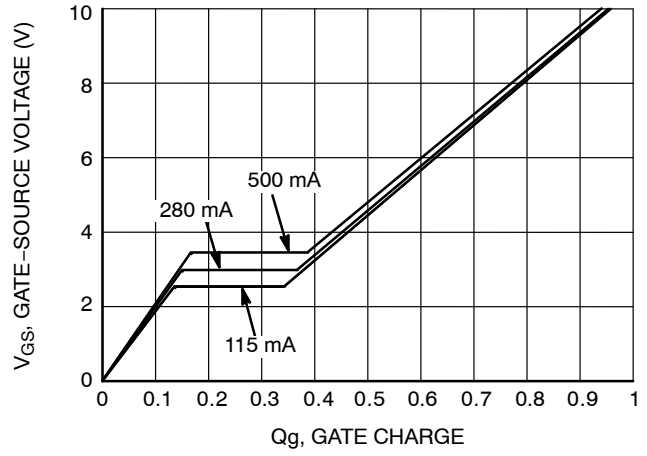


Figure 6. Gate Threshold Variation with Temperature

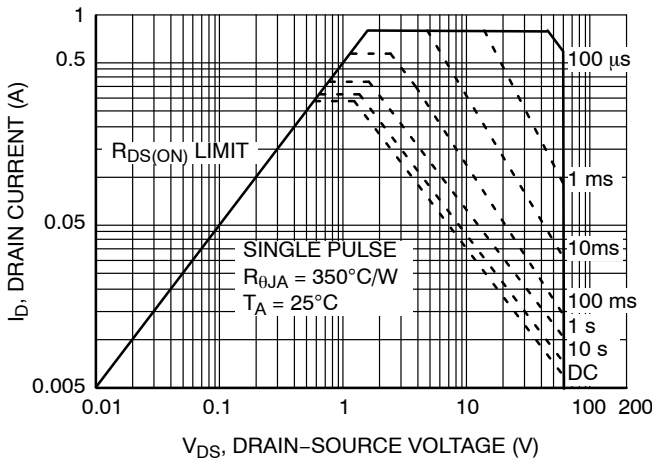
# 2N7002K



**Figure 7. Reverse Drain Current Variation with Diode Forward Voltage and Temperature**



**Figure 8. Gate Charge Characteristics**



**Figure 9. Maximum Safe Operating Area**

## ORDERING INFORMATION

| Part Number | Top Mark | Package                | Shipping <sup>†</sup> |
|-------------|----------|------------------------|-----------------------|
| 2N7002K     | 7K       | SOT-23 3L<br>(Pb-Free) | 3000 / Tape & Reel    |

<sup>†</sup>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.

# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



**SOT-23 (TO-236)**  
CASE 318  
ISSUE AT

DATE 01 MAR 2023

SCALE 4:1



**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 |
| H <sub>E</sub> | 2.10        | 2.40 | 2.64 | 0.083  | 0.094 | 0.104 |
| T              | 0°          | ---  | 10°  | 0°     | ---   | 10°   |

**GENERIC MARKING DIAGRAM\***



- XXX = Specific Device Code
- M = Date Code
- = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.



**RECOMMENDED MOUNTING FOOTPRINT**

\* For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

**STYLES ON PAGE 2**

|                         |                        |  |
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**MECHANICAL CASE OUTLINE  
PACKAGE DIMENSIONS**



**SOT-23 (TO-236)  
CASE 318  
ISSUE AT**

DATE 01 MAR 2023

- |   |   |   |   |   |   |
|---|---|---|---|---|---|
| STYLE 1 THRU 5:<br>CANCELLED                            | STYLE 6:<br>PIN 1. BASE<br>2. EMITTER<br>3. COLLECTOR | STYLE 7:<br>PIN 1. EMITTER<br>2. BASE<br>3. COLLECTOR       | STYLE 8:<br>PIN 1. ANODE<br>2. NO CONNECTION<br>3. CATHODE  |   |   |
| STYLE 9:<br>PIN 1. ANODE<br>2. ANODE<br>3. CATHODE      | STYLE 10:<br>PIN 1. DRAIN<br>2. SOURCE<br>3. GATE     | STYLE 11:<br>PIN 1. ANODE<br>2. CATHODE<br>3. CATHODE-ANODE | STYLE 12:<br>PIN 1. CATHODE<br>2. CATHODE<br>3. ANODE       | STYLE 13:<br>PIN 1. SOURCE<br>2. DRAIN<br>3. GATE           | STYLE 14:<br>PIN 1. CATHODE<br>2. GATE<br>3. ANODE          |
| STYLE 15:<br>PIN 1. GATE<br>2. CATHODE<br>3. ANODE      | STYLE 16:<br>PIN 1. ANODE<br>2. CATHODE<br>3. CATHODE | STYLE 17:<br>PIN 1. NO CONNECTION<br>2. ANODE<br>3. CATHODE | STYLE 18:<br>PIN 1. NO CONNECTION<br>2. CATHODE<br>3. ANODE | STYLE 19:<br>PIN 1. CATHODE<br>2. ANODE<br>3. CATHODE-ANODE | STYLE 20:<br>PIN 1. CATHODE<br>2. ANODE<br>3. GATE          |
| STYLE 21:<br>PIN 1. GATE<br>2. SOURCE<br>3. DRAIN       | STYLE 22:<br>PIN 1. RETURN<br>2. OUTPUT<br>3. INPUT   | STYLE 23:<br>PIN 1. ANODE<br>2. ANODE<br>3. CATHODE         | STYLE 24:<br>PIN 1. GATE<br>2. DRAIN<br>3. SOURCE           | STYLE 25:<br>PIN 1. ANODE<br>2. CATHODE<br>3. GATE          | STYLE 26:<br>PIN 1. CATHODE<br>2. ANODE<br>3. NO CONNECTION |
| STYLE 27:<br>PIN 1. CATHODE<br>2. CATHODE<br>3. CATHODE | STYLE 28:<br>PIN 1. ANODE<br>2. ANODE<br>3. ANODE     |   |   |   |   |

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