

# Small Signal MOSFET

60 V, 380 mA, Single, N-Channel, SOT-23

## 2N7002K, 2V7002K

### Features

- ESD Protected
- Low  $R_{DS(on)}$
- Surface Mount Package
- 2V Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q101 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

### Applications

- Low Side Load Switch
- Level Shift Circuits
- DC-DC Converter
- Portable Applications i.e. DSC, PDA, Cell Phone, etc.

### MAXIMUM RATINGS ( $T_J = 25^\circ\text{C}$ unless otherwise stated)

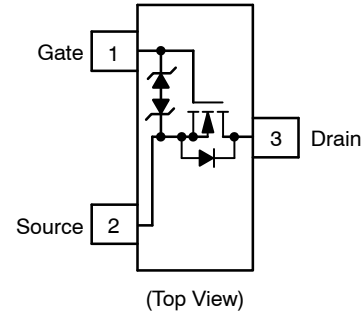
| Rating  | Symbol         | Value                           | Unit             |
|---|----------------|---------------------------------|------------------|
| Drain-to-Source Voltage   | $V_{DSS}$      | 60                              | V                |
| Gate-to-Source Voltage  | $V_{GS}$       | $\pm 20$                        | V                |
| Drain Current (Note 1)<br>Steady State 1 sq in Pad                        | $I_D$          | $T_A = 25^\circ\text{C}$<br>380 | mA               |
|   |                | $T_A = 85^\circ\text{C}$<br>270 |                  |
| Drain Current (Note 2)<br>Steady State Minimum Pad                        | $I_D$          | $T_A = 25^\circ\text{C}$<br>320 | mA               |
|   |                | $T_A = 85^\circ\text{C}$<br>230 |                  |
| Power Dissipation<br>Steady State 1 sq in Pad<br>Steady State Minimum Pad | $P_D$          | 420                             | mW               |
|   |                | 300                             |                  |
| Pulsed Drain Current ( $t_p = 10 \mu\text{s}$ )                           | $I_{DM}$       | 5.0                             | A                |
| Operating Junction and Storage<br>Temperature Range                       | $T_J, T_{STG}$ | -55 to<br>+150                  | $^\circ\text{C}$ |
| Source Current (Body Diode)   | $I_S$          | 300                             | mA               |
| Lead Temperature for Soldering Purposes<br>(1/8" from case for 10 s)      | $T_L$          | 260                             | $^\circ\text{C}$ |
| Gate-Source ESD Rating<br>(HBM, Method 3015)                              | ESD            | 2000                            | V                |

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.

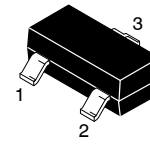
1. Surface-mounted on FR4 board using 1 sq in pad size with 1 oz Cu.
2. Surface-mounted on FR4 board using 0.08 sq in pad size with 1 oz Cu.

| $V_{(BR)DSS}$ | $R_{DS(on)}$ MAX     | $I_D$ MAX |
|---------------|----------------------|-----------|
| 60 V          | 1.6 $\Omega$ @ 10 V  | 380 mA    |
|               | 2.5 $\Omega$ @ 4.5 V |           |

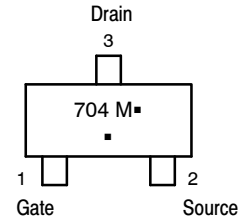
### SIMPLIFIED SCHEMATIC



### MARKING DIAGRAM & PIN ASSIGNMENT



**SOT-23  
CASE 318  
STYLE 21**



704 = Specific Device Code\*  
M = Date Code\*  
▪ = Pb-Free Package

(Note: Microdot may be in either location)  
\*Specific Device Code, Date Code or overbar orientation and/or location may vary depending upon manufacturing location. This is a representation only and actual devices may not match this drawing exactly.

### ORDERING INFORMATION

| Device                    | Package             | Shipping†          |
|---------------------------|---------------------|--------------------|
| 2N7002KT1G,<br>2V7002KT1G | SOT-23<br>(Pb-Free) | 3000 / Tape & Reel |
| 2N7002KT7G                | SOT-23<br>(Pb-Free) | 3500 / Tape & Reel |

†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.

## 2N7002K, 2V7002K

### THERMAL CHARACTERISTICS

| Characteristic                              | Symbol          | Max | Unit                        |
|---|-----------------|-----|-----------------------------|
| Junction-to-Ambient – Steady State (Note 3) | $R_{\theta JA}$ | 300 | $^{\circ}\text{C}/\text{W}$ |
| Junction-to-Ambient – $t \leq 5$ s (Note 3) |                 | 92  |                             |
| Junction-to-Ambient – Steady State (Note 4) |                 | 417 |                             |
| Junction-to-Ambient – $t \leq 5$ s (Note 4) |                 | 154 |                             |

3. Surface-mounted on FR4 board using 1 sq in pad size with 1 oz Cu.  
 4. Surface-mounted on FR4 board using 0.08 sq in pad size with 1 oz Cu.

### ELECTRICAL CHARACTERISTICS ( $T_J = 25^{\circ}\text{C}$ unless otherwise specified)

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|-----------|--------|----------------|-----|-----|-----|------|
|-----------|--------|----------------|-----|-----|-----|------|

#### OFF CHARACTERISTICS

|   |                   |  |                             |    |          |                              |
|---|-------------------|--|-----------------------------|----|----------|------------------------------|
| Drain-to-Source Breakdown Voltage                         | $V_{(BR)DSS}$     | $V_{GS} = 0\text{ V}, I_D = 250\ \mu\text{A}$    | 60                          |    |          | V                            |
| Drain-to-Source Breakdown Voltage Temperature Coefficient | $V_{(BR)DSS}/T_J$ |  |                             | 71 |          | $\text{mV}/^{\circ}\text{C}$ |
| Zero Gate Voltage Drain Current                           | $I_{DSS}$         | $V_{GS} = 0\text{ V},$<br>$V_{DS} = 60\text{ V}$ | $T_J = 25^{\circ}\text{C}$  |    | 1        | $\mu\text{A}$                |
|   |                   |  | $T_J = 125^{\circ}\text{C}$ |    | 10       |                              |
|   |                   | $V_{GS} = 0\text{ V},$<br>$V_{DS} = 50\text{ V}$ | $T_J = 25^{\circ}\text{C}$  |    | 100      | nA                           |
| Gate-to-Source Leakage Current                            | $I_{GSS}$         | $V_{DS} = 0\text{ V}, V_{GS} = \pm 20\text{ V}$  |                             |    | $\pm 10$ | $\mu\text{A}$                |
|   |                   | $V_{DS} = 0\text{ V}, V_{GS} = \pm 10\text{ V}$  |                             |    | 450      | nA                           |
|   |                   | $V_{DS} = 0\text{ V}, V_{GS} = \pm 5.0\text{ V}$ |                             |    | 150      | nA                           |

#### ON CHARACTERISTICS (Note 5)

|  |                  |  |     |      |     |                              |
|--|------------------|--|-----|------|-----|------------------------------|
| Gate Threshold Voltage                     | $V_{GS(TH)}$     | $V_{GS} = V_{DS}, I_D = 250\ \mu\text{A}$    | 1.0 |      | 2.3 | V                            |
| Negative Threshold Temperature Coefficient | $V_{GS(TH)}/T_J$ |  |     | 4.0  |     | $\text{mV}/^{\circ}\text{C}$ |
| Drain-to-Source On Resistance              | $R_{DS(on)}$     | $V_{GS} = 10\text{ V}, I_D = 500\text{ mA}$  |     | 1.19 | 1.6 | $\Omega$                     |
|  |                  | $V_{GS} = 4.5\text{ V}, I_D = 200\text{ mA}$ |     | 1.33 | 2.5 |                              |
| Forward Transconductance                   | $g_{FS}$         | $V_{DS} = 5\text{ V}, I_D = 200\text{ mA}$   |     | 530  |     | mS                           |

#### CHARGES AND CAPACITANCES

|                              |              |   |  |      |     |             |
|------------------------------|--------------|---|--|------|-----|-------------|
| Input Capacitance            | $C_{ISS}$    | $V_{GS} = 0\text{ V}, f = 1\text{ MHz},$<br>$V_{DS} = 20\text{ V}$      |  | 24.5 | 45  | $\text{pF}$ |
| Output Capacitance           | $C_{OSS}$    |   |  | 4.2  | 8.0 |             |
| Reverse Transfer Capacitance | $C_{RSS}$    |   |  | 2.2  | 5.0 |             |
| Total Gate Charge            | $Q_{G(TOT)}$ | $V_{GS} = 4.5\text{ V}, V_{DS} = 10\text{ V};$<br>$I_D = 200\text{ mA}$ |  | 0.7  |     | $\text{nC}$ |
| Threshold Gate Charge        | $Q_{G(TH)}$  |   |  | 0.1  |     |             |
| Gate-to-Source Charge        | $Q_{GS}$     |   |  | 0.3  |     |             |
| Gate-to-Drain Charge         | $Q_{GD}$     |   |  | 0.1  |     |             |

#### SWITCHING CHARACTERISTICS, $V_{GS} = V$ (Note 6)

|                     |              |  |  |      |  |             |
|---------------------|--------------|--|--|------|--|-------------|
| Turn-On Delay Time  | $t_{d(ON)}$  | $V_{GS} = 10\text{ V}, V_{DD} = 25\text{ V},$<br>$I_D = 500\text{ mA}, R_G = 25\ \Omega$ |  | 12.2 |  | $\text{ns}$ |
| Rise Time           | $t_r$        |  |  | 9.0  |  |             |
| Turn-Off Delay Time | $t_{d(OFF)}$ |  |  | 55.8 |  |             |
| Fall Time           | $t_f$        |  |  | 29   |  |             |

#### DRAIN-SOURCE DIODE CHARACTERISTICS

|                       |          |   |                            |  |     |     |   |
|-----------------------|----------|---|----------------------------|--|-----|-----|---|
| Forward Diode Voltage | $V_{SD}$ | $V_{GS} = 0\text{ V},$<br>$I_S = 200\text{ mA}$ | $T_J = 25^{\circ}\text{C}$ |  | 0.8 | 1.2 | V |
|                       |          |   | $T_J = 85^{\circ}\text{C}$ |  | 0.7 |     |   |

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.

5. Pulse Test: pulse width  $\leq 300\ \mu\text{s}$ , duty cycle  $\leq 2\%$   
 6. Switching characteristics are independent of operating junction temperatures

TYPICAL CHARACTERISTICS

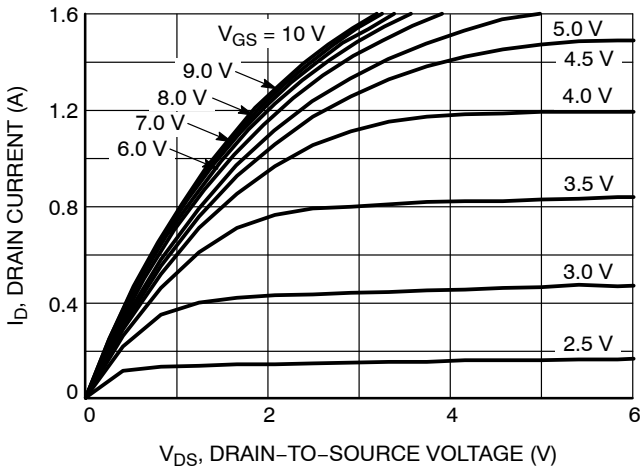


Figure 1. On-Region Characteristics

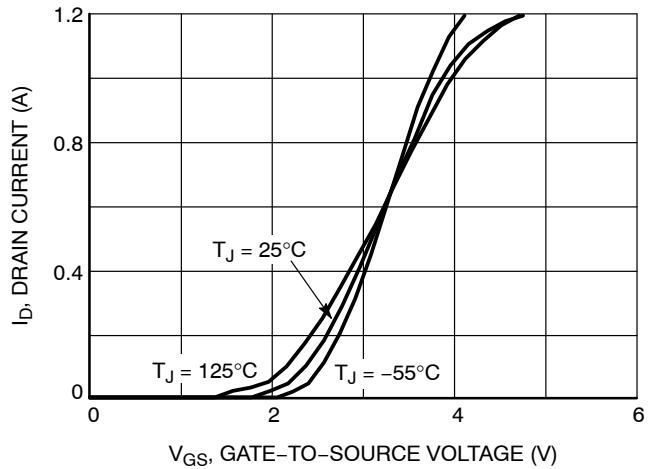


Figure 2. Transfer Characteristics

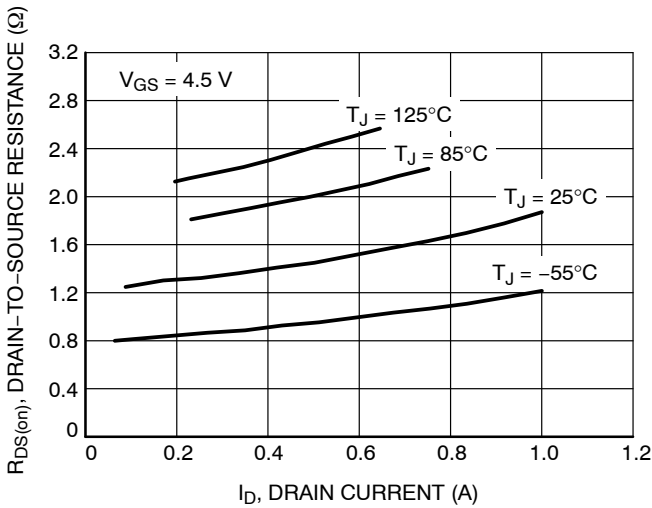


Figure 3. On-Resistance vs. Drain Current and Temperature

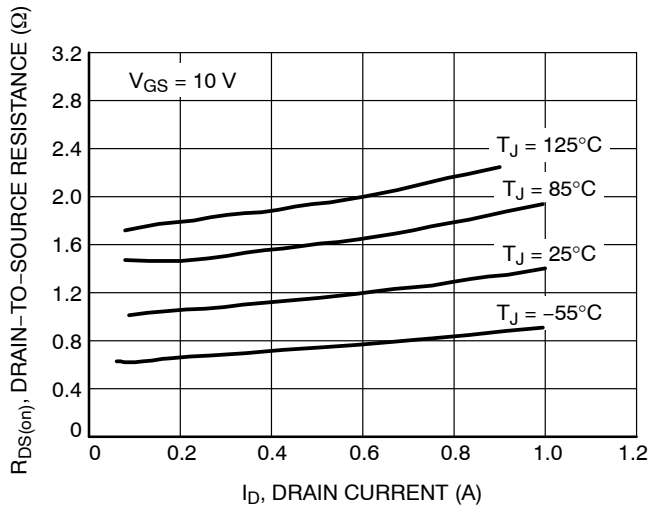


Figure 4. On-Resistance vs. Drain Current and Temperature

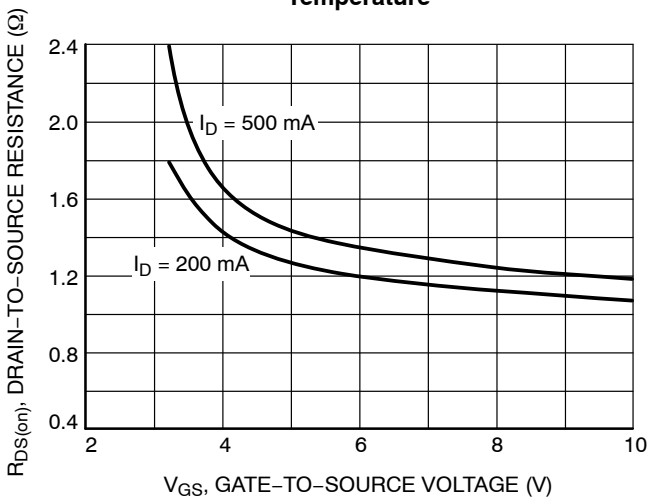


Figure 5. On-Resistance vs. Gate-to-Source Voltage

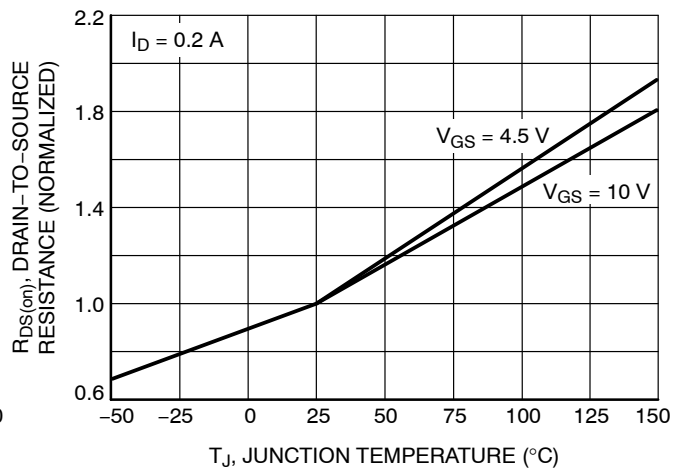
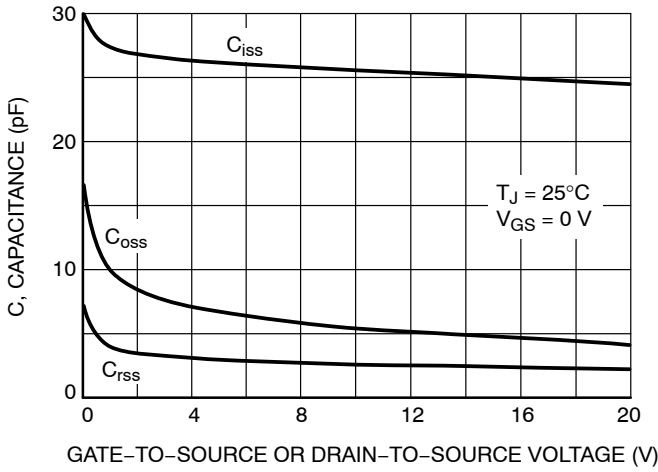


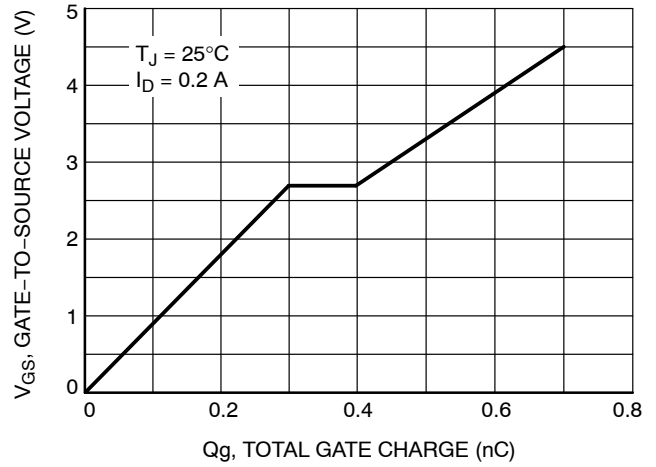
Figure 6. On-Resistance Variation with Temperature

# 2N7002K, 2V7002K

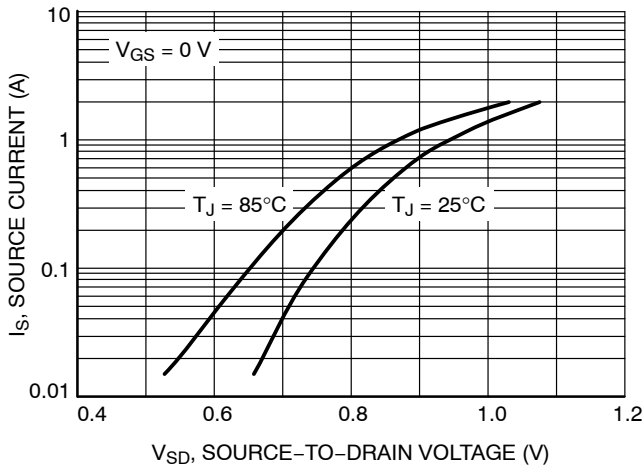
## TYPICAL CHARACTERISTICS



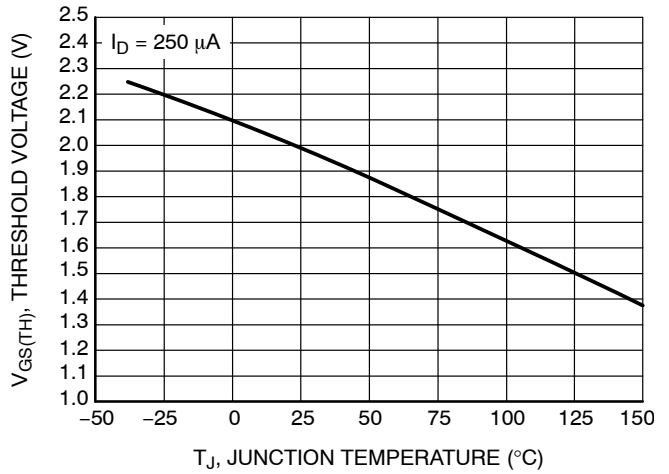
**Figure 7. Capacitance Variation**



**Figure 8. Gate-to-Source and Drain-to-Source Voltage vs. Total Charge**



**Figure 9. Diode Forward Voltage vs. Current**



**Figure 10. Threshold Voltage with Temperature**

# 2N7002K, 2V7002K

## TYPICAL CHARACTERISTICS

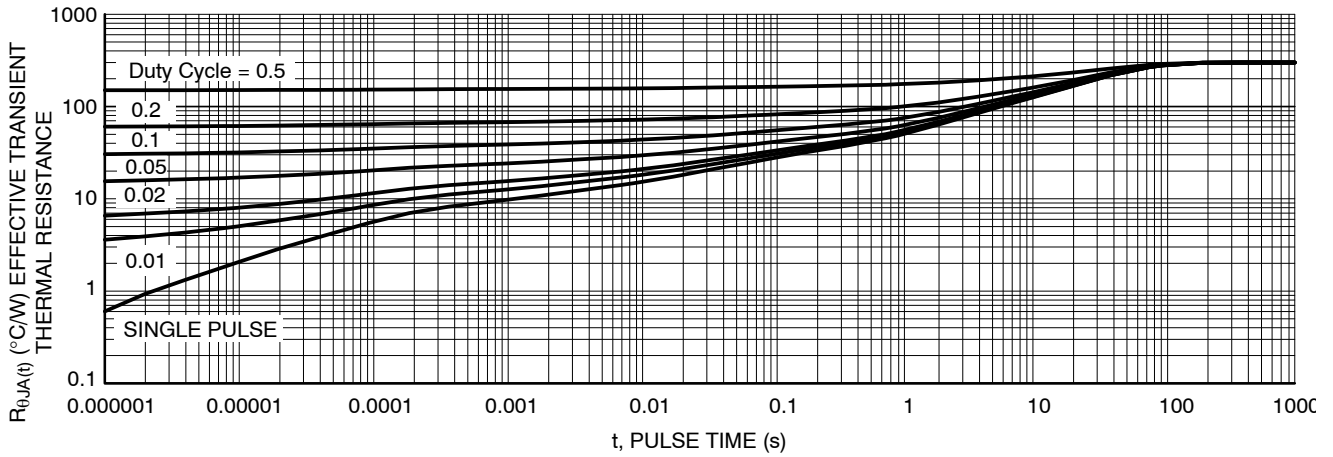


Figure 11. Thermal Response - 1 sq in pad

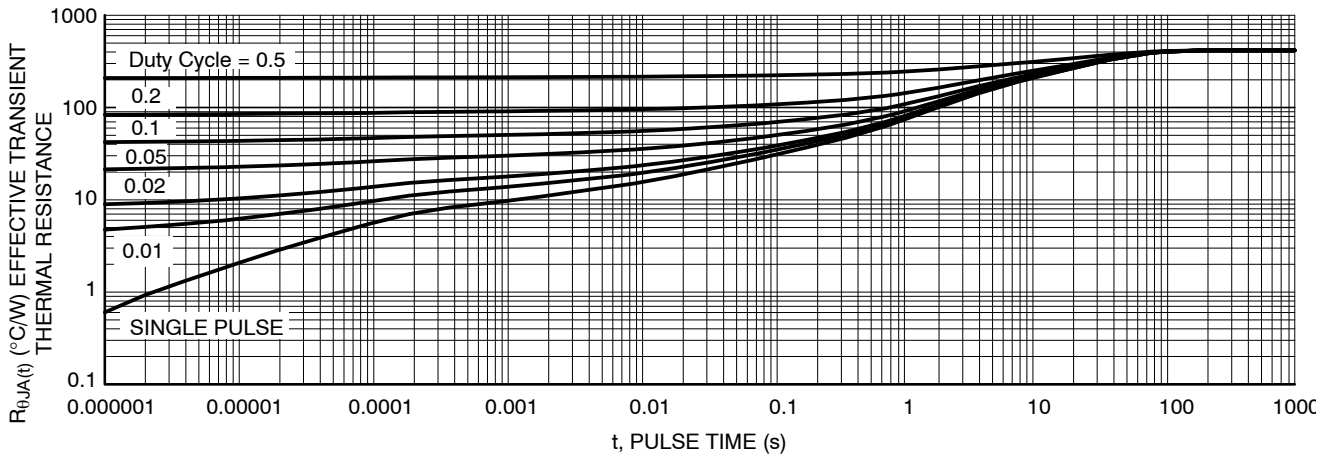


Figure 12. Thermal Response - minimum pad

# 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:  
CANCELLED

STYLE 6:  
PIN 1. BASE  
2. EMITTER  
3. COLLECTOR

STYLE 7:  
PIN 1. EMITTER  
2. BASE  
3. COLLECTOR

STYLE 8:  
PIN 1. ANODE  
2. NO CONNECTION  
3. CATHODE

STYLE 9:  
PIN 1. ANODE  
2. ANODE  
3. CATHODE

STYLE 10:  
PIN 1. DRAIN  
2. SOURCE  
3. GATE

STYLE 11:  
PIN 1. ANODE  
2. CATHODE  
3. CATHODE-ANODE

STYLE 12:  
PIN 1. CATHODE  
2. CATHODE  
3. ANODE

STYLE 13:  
PIN 1. SOURCE  
2. DRAIN  
3. GATE

STYLE 14:  
PIN 1. CATHODE  
2. GATE  
3. ANODE

STYLE 15:  
PIN 1. GATE  
2. CATHODE  
3. ANODE

STYLE 16:  
PIN 1. ANODE  
2. CATHODE  
3. CATHODE

STYLE 17:  
PIN 1. NO CONNECTION  
2. ANODE  
3. CATHODE

STYLE 18:  
PIN 1. NO CONNECTION  
2. CATHODE  
3. ANODE

STYLE 19:  
PIN 1. CATHODE  
2. ANODE  
3. CATHODE-ANODE

STYLE 20:  
PIN 1. CATHODE  
2. ANODE  
3. GATE

STYLE 21:  
PIN 1. GATE  
2. SOURCE  
3. DRAIN

STYLE 22:  
PIN 1. RETURN  
2. OUTPUT  
3. INPUT

STYLE 23:  
PIN 1. ANODE  
2. ANODE  
3. CATHODE

STYLE 24:  
PIN 1. GATE  
2. DRAIN  
3. SOURCE

STYLE 25:  
PIN 1. ANODE  
2. CATHODE  
3. GATE

STYLE 26:  
PIN 1. CATHODE  
2. ANODE  
3. NO CONNECTION

STYLE 27:  
PIN 1. CATHODE  
2. CATHODE  
3. CATHODE

STYLE 28:  
PIN 1. ANODE  
2. ANODE  
3. ANODE

|                         |                        |   |
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