

# 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)

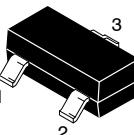
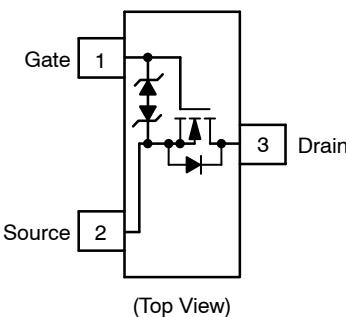
Rating	Symbol	Value	Unit
Drain-to-Source Voltage	$V_{DSS}$	60	V
Gate-to-Source Voltage	$V_{GS}$	$\pm 20$	V
Drain Current (Note 1) Steady State 1 sq in Pad	$I_D$	380 270	mA
Drain Current (Note 2) Steady State Minimum Pad	$I_D$	320 230	mA
Power Dissipation Steady State 1 sq in Pad Steady State Minimum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

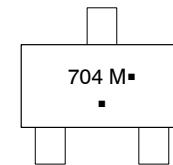
$V_{(BR)DSS}$	$R_{DS(on)} \text{ MAX}$	$I_D \text{ MAX}$
60 V	1.6 Ω @ 10 V 2.5 Ω @ 4.5 V	380 mA

## SIMPLIFIED SCHEMATIC



**SOT-23  
CASE 318**

## MARKING DIAGRAM



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

(NOTE: Microdot may be in either location)

\*Date Code orientation and/or location may vary depending upon manufacturing location.

## ORDERING INFORMATION

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

# 2N7002K, 2V7002K

## THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Junction-to-Ambient – Steady State (Note 3)	$R_{\theta JA}$	300	°C/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 ( $T_J = 25^\circ C$ unless otherwise specified)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
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### OFF CHARACTERISTICS

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

### ON CHARACTERISTICS (Note 5)

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

### CHARGES AND CAPACITANCES

Input Capacitance	$C_{ISS}$	$V_{GS} = 0$ V, $f = 1$ MHz, $V_{DS} = 20$ V		24.5	45	pF
Output Capacitance	$C_{OSS}$			4.2	8.0	
Reverse Transfer Capacitance	$C_{RSS}$			2.2	5.0	
Total Gate Charge	$Q_{G(TOT)}$	$V_{GS} = 4.5$ V, $V_{DS} = 10$ V; $I_D = 200$ mA		0.7		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	$t_d(ON)$	$V_{GS} = 10$ V, $V_{DD} = 25$ V, $I_D = 500$ mA, $R_G = 25$ $\Omega$		12.2		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	$V_{SD}$	$V_{GS} = 0$ V, $I_S = 200$ mA	$T_J = 25^\circ C$		0.8	1.2	V
			$T_J = 85^\circ C$		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  $\leq 300$   $\mu s$ , duty cycle  $\leq 2\%$   
 6. Switching characteristics are independent of operating junction temperatures

# 2N7002K, 2V7002K

## TYPICAL CHARACTERISTICS

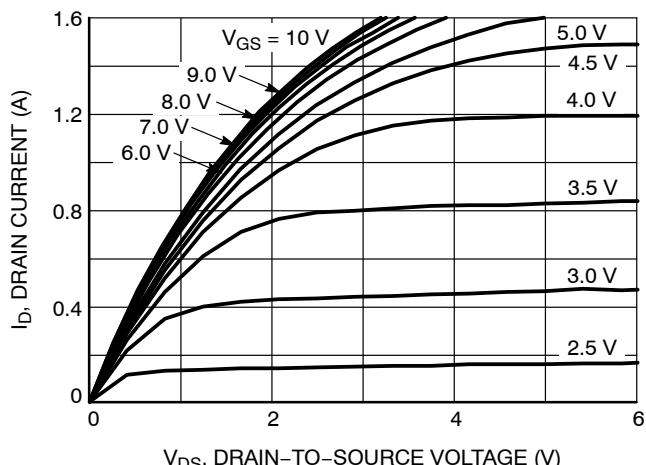


Figure 1. On-Region Characteristics

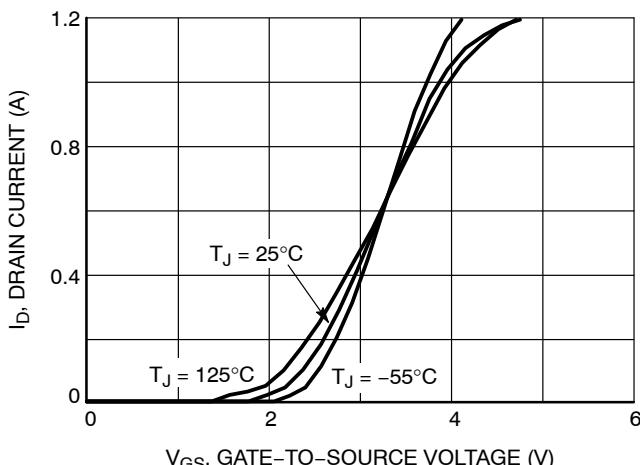


Figure 2. Transfer Characteristics

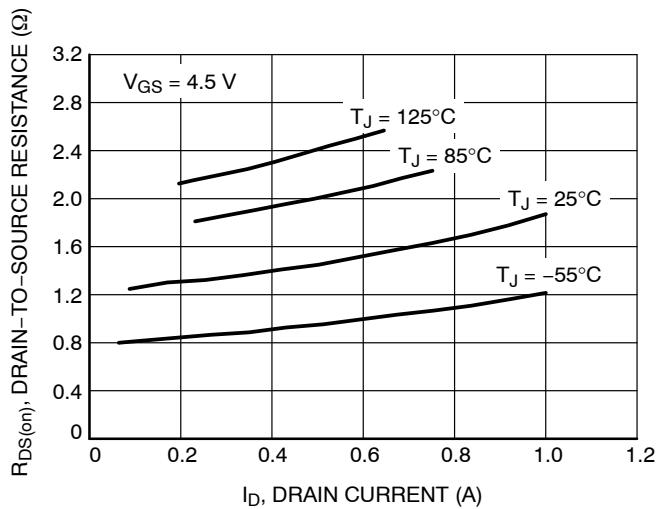


Figure 3. On-Resistance vs. Drain Current and Temperature

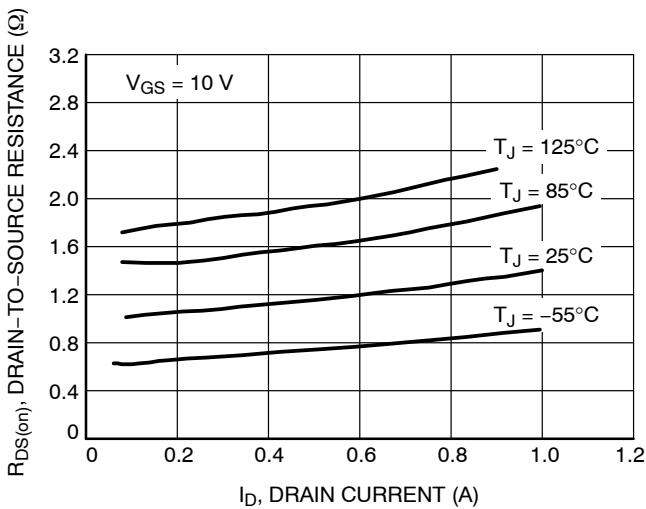


Figure 4. On-Resistance vs. Drain Current and Temperature

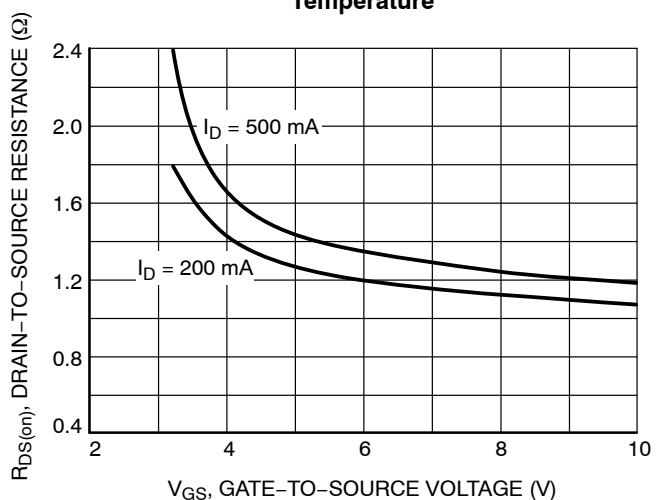


Figure 5. On-Resistance vs. Gate-to-Source Voltage

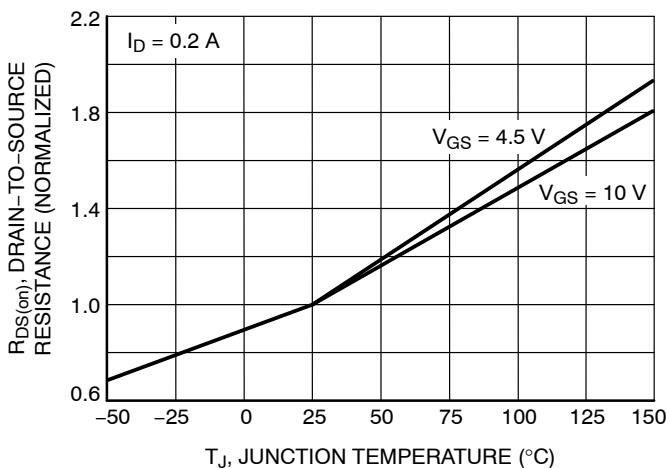


Figure 6. On-Resistance Variation with Temperature

## TYPICAL CHARACTERISTICS

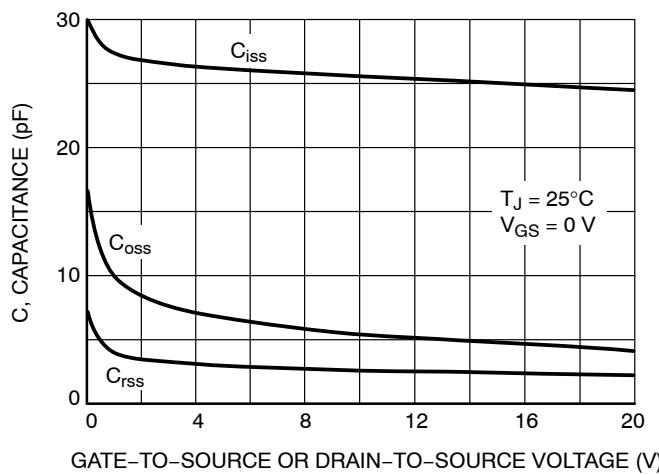


Figure 7. Capacitance Variation

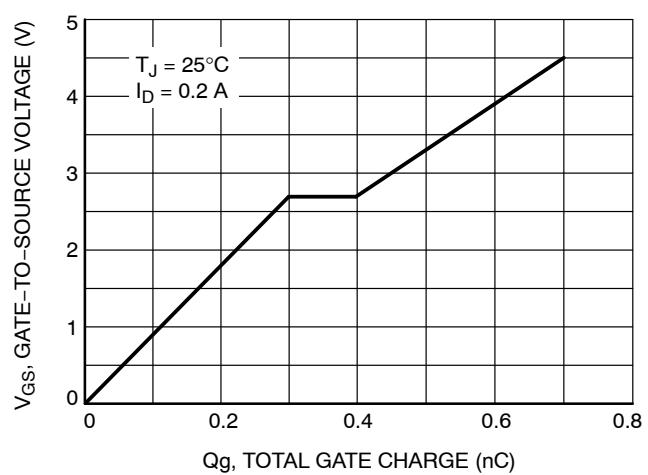


Figure 8. Gate-to-Source and Drain-to-Source Voltage vs. Total Charge

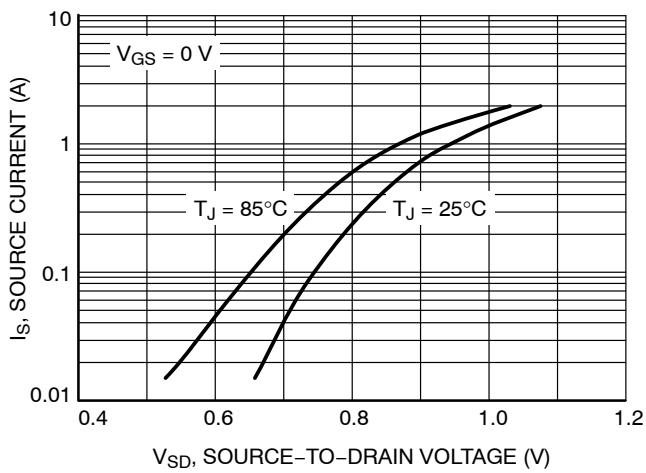


Figure 9. Diode Forward Voltage vs. Current

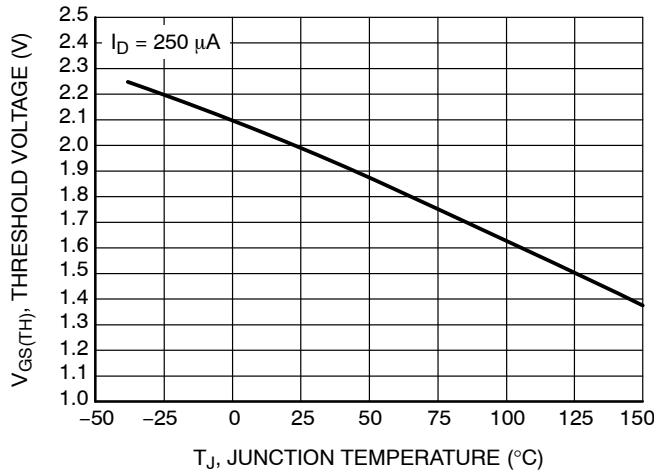


Figure 10. Threshold Voltage with Temperature

# 2N7002K, 2V7002K

## TYPICAL CHARACTERISTICS

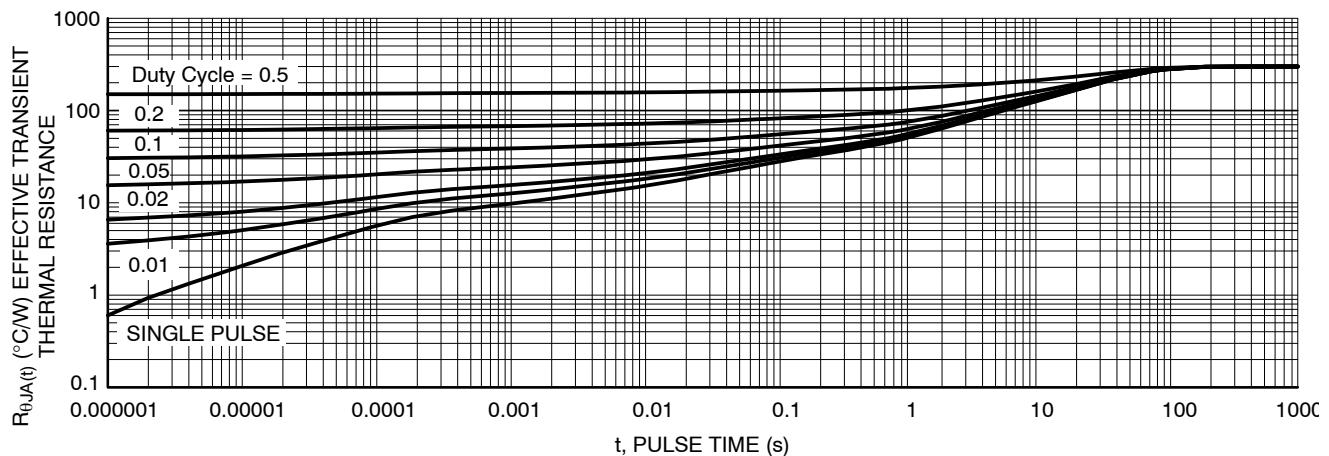


Figure 11. Thermal Response – 1 sq in pad

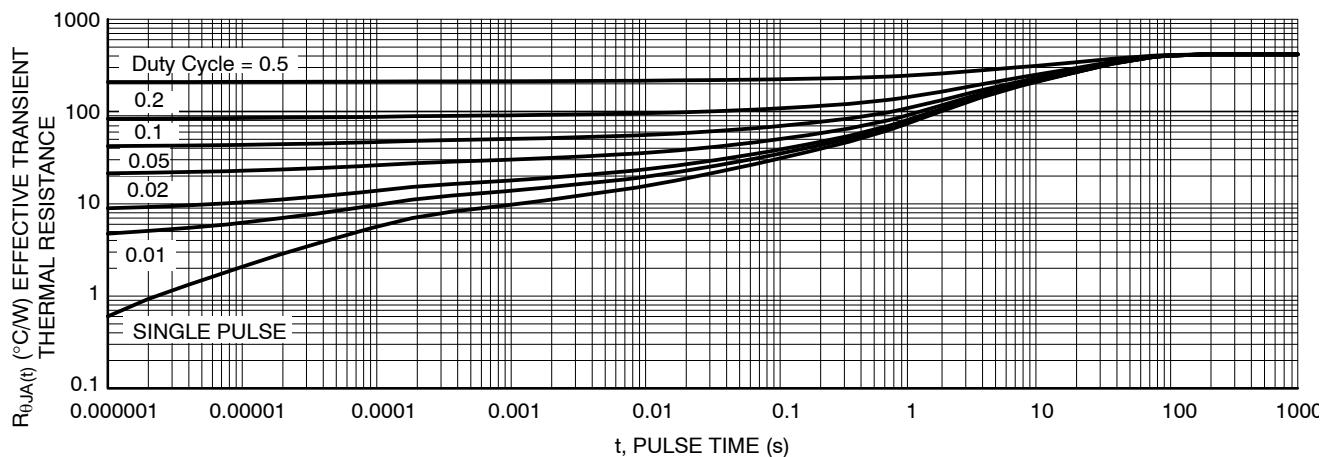
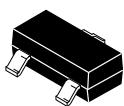


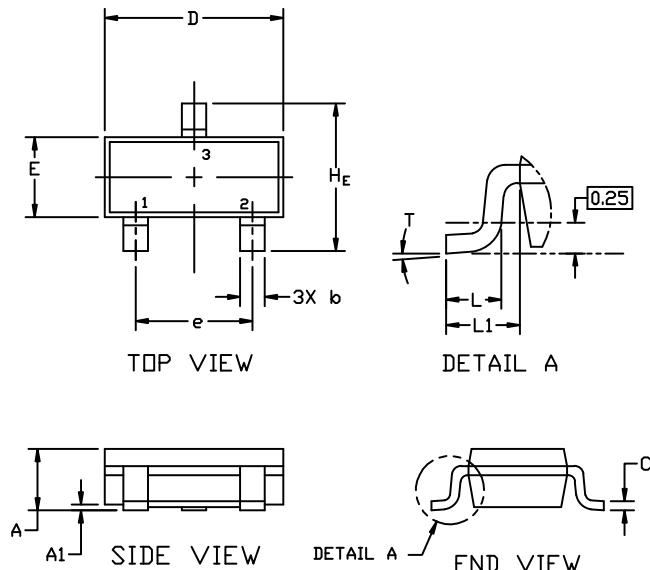
Figure 12. Thermal Response – minimum pad

**MECHANICAL CASE OUTLINE**  
PACKAGE DIMENSIONS

**onsemi**<sup>TM</sup>



SCALE 4:1



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

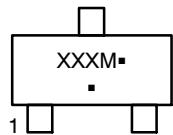
DATE 01 MAR 2023

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\***

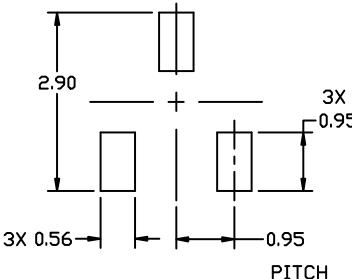


XXX = Specific Device Code

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 [DN Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D](#).

**STYLES ON PAGE 2**

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**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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