Small Signal MOSFET

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

2N7002K, 2V7002K

V$_{(BR)DSS}$	R$_{DS(on)}$ MAX	I$_D$ MAX
60 V	1.6 Ω @ 10 V	380 mA
	2.5 Ω @ 4.5 V	

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.
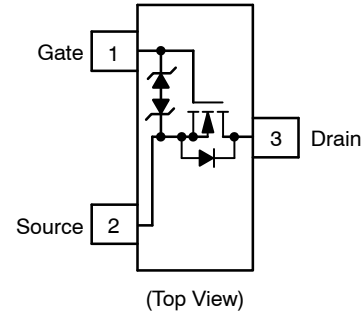
MAXIMUM RATINGS (T_J = 25°C unless otherwise stated)

Rating	Symbol	Value	Unit
Drain−to−Source Voltage	V$_{DSS}$	60	V
Gate−to−Source Voltage	V$_{GS}$	±20	V
Drain Current (Note 1) Steady State 1 sq in Pad T_A = 25°C T_A = 85°C	I$_D$	380 270	mA
Drain Current (Note 2) Steady State Minimum Pad T_A = 25°C T_A = 85°C	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 μs)	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.
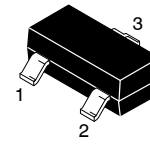1. Surface−mounted on FR4 board using 1 sq in pad size with 1 oz Cu.
2. Surface−mounted on FR4 board using 0.08 sq in pad size with 1 oz Cu.
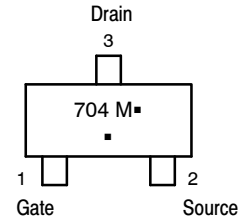
SIMPLIFIED SCHEMATIC

(Top View)

MARKING DIAGRAM & PIN ASSIGNMENT

**SOT−23
CASE 318
STYLE 21**

704 M∎

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, 2V7002KT1G	SOT−23 (Pb−Free)	3000 / Tape & Reel
2N7002KT7G	SOT−23 (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.

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Junction−to−Ambient − Steady State (Note 3)	$R_{\theta JA}$	300	°C/W
Junction−to−Ambient − t ≤ 5 s (Note 3)		92	
Junction−to−Ambient − Steady State (Note 4)		417	
Junction−to−Ambient − t ≤ 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°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 V, I_D = 250 μA		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°C			1	μA
			T_J = 125°C			10	
		V_{GS} = 0 V, V_{DS} = 50 V	T_J = 25°C			100	nA
Gate−to−Source Leakage Current	I_{GSS}	V_{DS} = 0 V, V_{GS} = ±20 V				±10	μA
		V_{DS} = 0 V, V_{GS} = ±10 V				450	nA
		V_{DS} = 0 V, V_{GS} = ±5.0 V				150	nA
ON CHARACTERISTICS (Note 5)							
Gate Threshold Voltage	$V_{GS(TH)}$	V_{GS} = V_{DS}, I_D = 250 μA		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	Ω
		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 Ω			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°C			0.8	1.2	V
			T_J = 85°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 ≤ 300 μs, duty cycle ≤ 2%
6. Switching characteristics are independent of operating junction temperatures

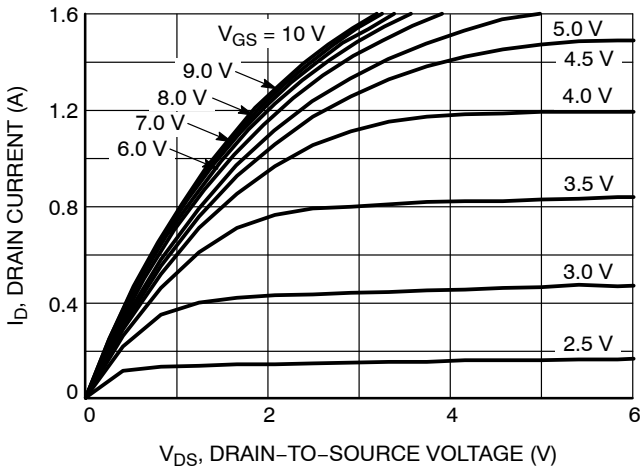# 2N7002K, 2V7002K

TYPICAL CHARACTERISTICS

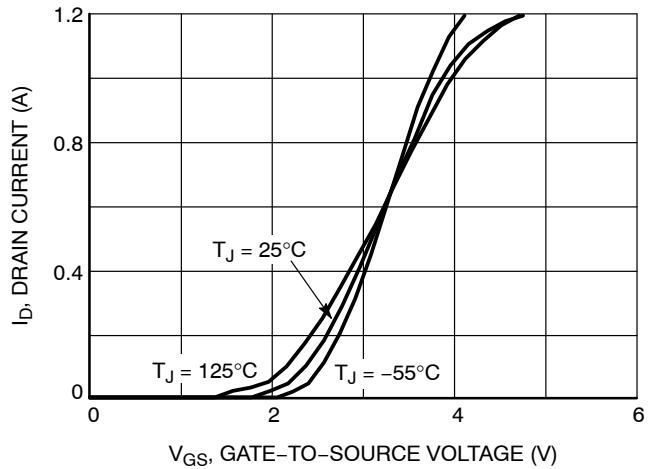Figure 1. On−Region Characteristics

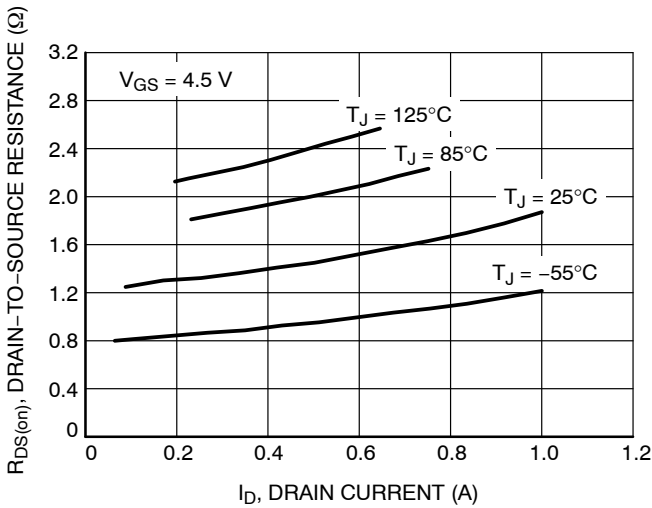Figure 2. Transfer Characteristics

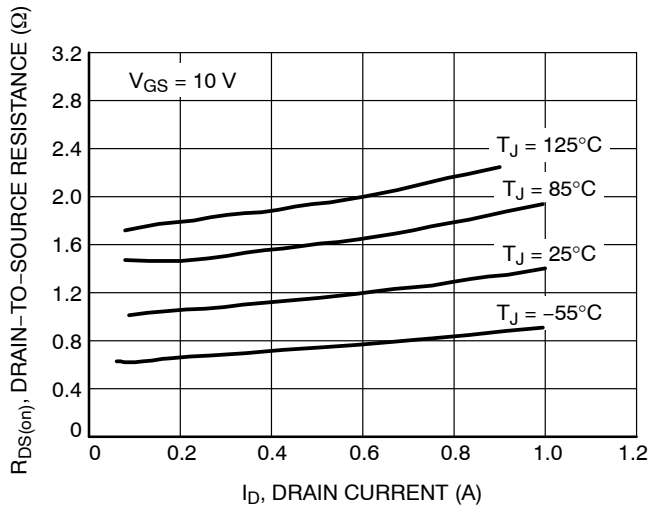Figure 3. On−Resistance vs. Drain Current and Temperature

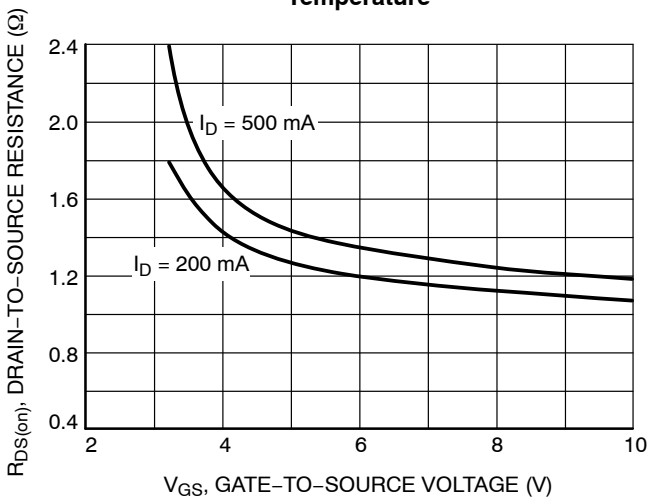Figure 4. On−Resistance vs. Drain Current and Temperature
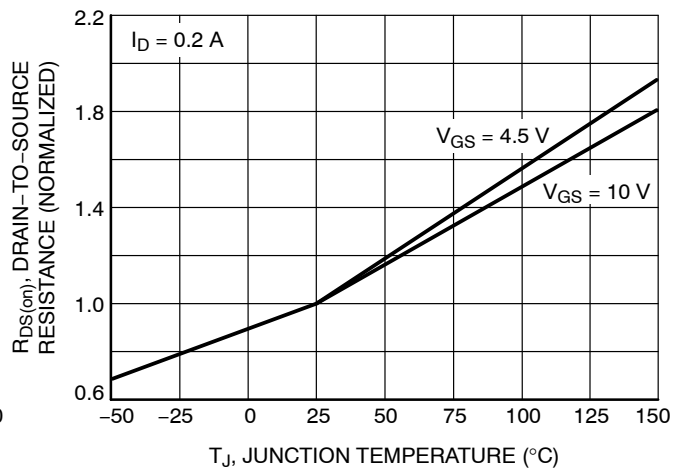

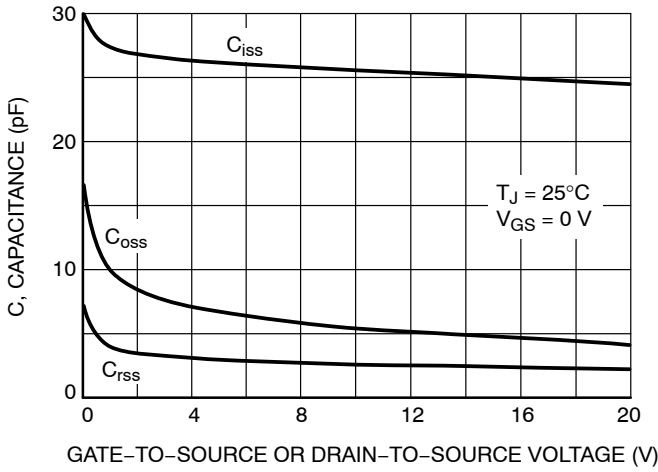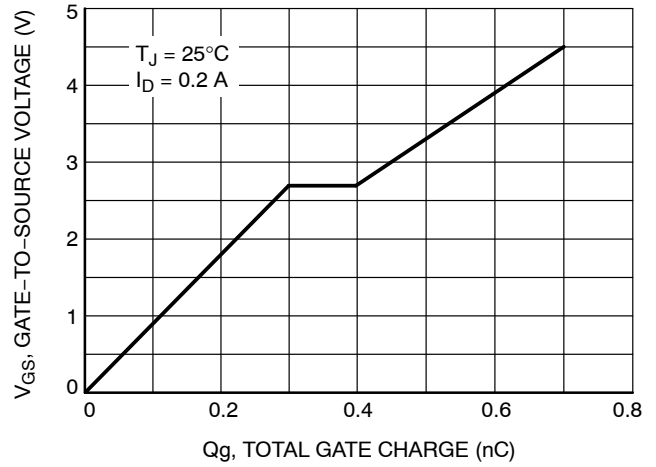Figure 5. On−Resistance vs. Gate−to−Source Voltage

Figure 6. On−Resistance Variation with Temperature

2N7002K, 2V7002K

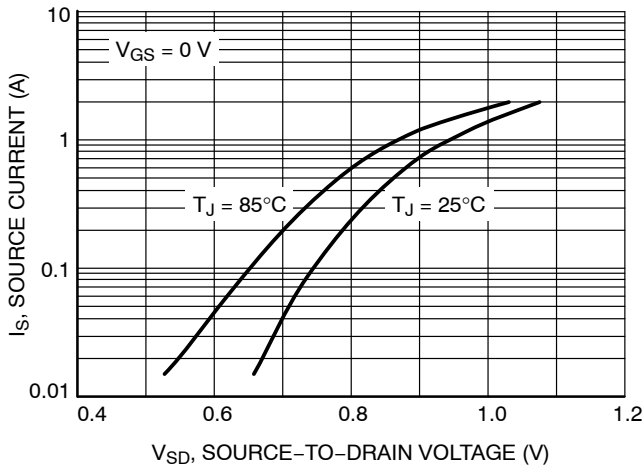## TYPICAL CHARACTERISTICS

Figure 7. Capacitance Variation

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

Figure 9. Diode Forward Voltage vs. Current
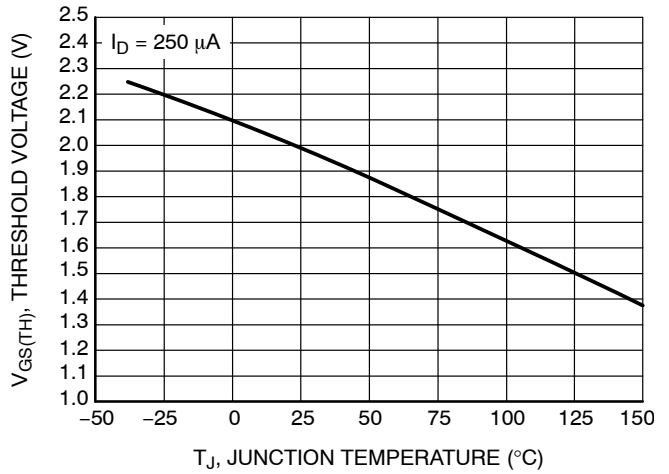
Figure 10. Threshold Voltage with Temperature

TYPICAL CHARACTERISTICS
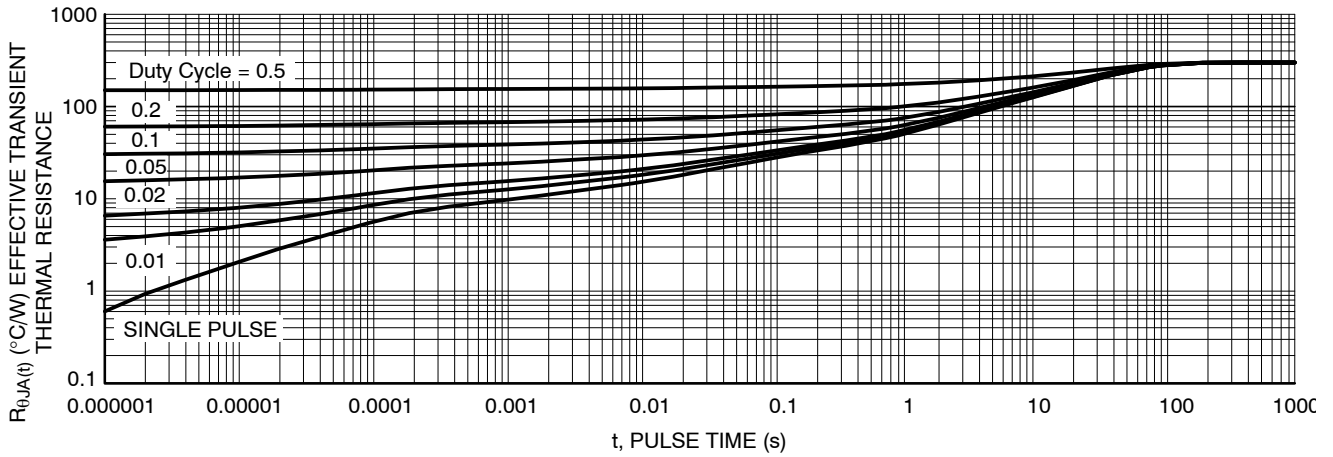
Figure 11. Thermal Response – 1 sq in pad

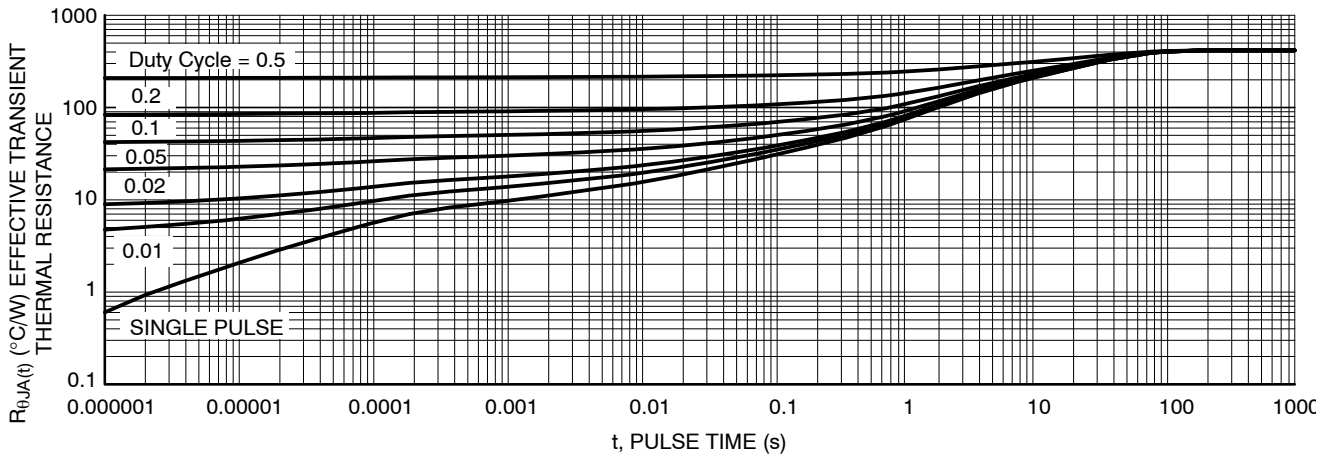**Figure 12. Thermal Response – minimum pad**

SOT−23 (TO−236)
CASE 318
ISSUE AT

DATE 01 MAR 2023

SCALE 4:1

TOP VIEW

DETAIL A

SIDE VIEW

DETAIL A END VIEW

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_E	2.10	2.40	2.64	0.083	0.094	0.104
T	0°	---	10°	0°	---	10°

GENERIC MARKING DIAGRAM*

XXXM■

1

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.

2.90

3X 0.95

3X 0.56

0.95

PITCH

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

DOCUMENT NUMBER:	98ASB42226B	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.	
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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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ADDITIONAL INFORMATION

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