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October 2014

# 2N7002L

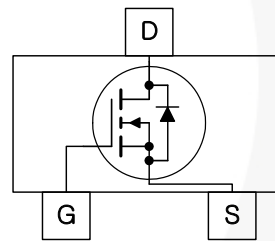
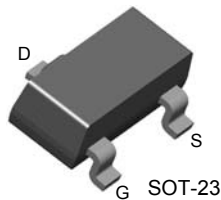
## N-Channel Enhancement Mode Field Effect Transistor

### Features

- High Density Cell Design for Low  $R_{DS(ON)}$
- Voltage Controlled Small Signal Switch
- Rugged and Reliable
- High Saturation Current Capability
- Very Low Capacitance
- Fast Switching Speed

### Description

This N-channel enhancement mode field effect transistor is produced using high cell density, trench MOSFET technology. This product minimizes on-state resistance while providing rugged, reliable and fast switching performance. This product is particularly suited for low-voltage, low-current applications such as small servo motor control, power MOSFET gate drivers, logic level translator, high speed line drivers, power management/power supply, and switching applications.



### Ordering Information

Part Number	Marking	Package	Packing Method
2N7002L	70L	SOT-23 3L	Tape and Reel

2N7002L — N-Channel Enhancement Mode Field Effect Transistor

## Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only. Values are at  $T_A = 25^\circ\text{C}$  unless otherwise noted.

Symbol	Parameter	Value	Unit
$V_{DSS}$	Drain-Source Voltage	60	V
$V_{DGR}$	Drain-Gate Voltage ( $R_{GS} \leq 1\text{ M}\Omega$ )	60	V
$V_{GSS}$	Gate-Source Voltage	Continuous	$\pm 20$
		Non Repetitive ( $t_p < 50\ \mu\text{s}$ )	$\pm 40$
$I_D$	Maximum Drain Current	Continuous	115
		Pulsed	800
$T_J, T_{STG}$	Operating and Storage Temperature Range	-55 to +150	$^\circ\text{C}$
$T_L$	Maximum Lead Temperature for Soldering Purposes, 1/16 inch from Case for 10 Seconds	300	$^\circ\text{C}$

## Thermal Characteristics<sup>(1)</sup>

Values are at  $T_A = 25^\circ\text{C}$  unless otherwise noted.

Symbol	Parameter	Value	Unit
$P_D$	Maximum Power Dissipation	200	mW
	Derate Above $25^\circ\text{C}$	1.6	$\text{mW}/^\circ\text{C}$
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient	380	$^\circ\text{C}/\text{W}$

### Note:

- $R_{\theta JA}$  is the sum of the junction-to-case and case-to-ambient thermal resistance where the case thermal reference is defined as the solder mounting surface of the drain pins.  $R_{\theta JC}$  is guaranteed by design while  $R_{\theta CA}$  is determined by the user's board design.



a)  $380^\circ\text{C}/\text{W}$  when mounted on a minimum pad.

Scale 1: 1 on letter size paper

## ESD Rating<sup>(2)</sup>

Symbol	Parameter	Value	Unit
HBM	Human Body Model per ANSI/ESDA/JEDEC JS-001-2012	50	V
CDM	Charged Device Model per JEDEC C101C	>2000	V

### Note:

- ESD values are in typical, no over-voltage rating is implied, ESD CDM zap voltage is 2000 V maximum.

## Electrical Characteristics

Values are at  $T_A = 25^\circ\text{C}$  unless otherwise noted.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
<b>Off Characteristics</b>						
$BV_{DSS}$	Drain-Source Breakdown Voltage	$V_{GS} = 0\text{ V}, I_D = 10\ \mu\text{A}$	60.0	65.2		V
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS} = 60\text{ V}, V_{GS} = 0\text{ V}$		0.024	1	$\mu\text{A}$
		$V_{DS} = 60\text{ V}, V_{GS} = 0\text{ V}, T_J = 125^\circ\text{C}$		0.080	500	
$I_{GSSF}$	Gate-Body Leakage, Forward	$V_{GS} = 20\text{ V}, V_{DS} = 0\text{ V}$		0.107	100	nA
$I_{GSSR}$	Gate-Body Leakage, Reverse	$V_{GS} = -20\text{ V}, V_{DS} = 0\text{ V}$		-0.037	-100	nA
<b>On Characteristics<sup>(3)</sup></b>						
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS} = V_{GS}, I_D = 250\ \mu\text{A}$	0.80	1.81	2.50	V
$R_{DS(ON)}$	Static Drain-Source On-Resistance	$V_{GS} = 10\text{ V}, I_D = 500\text{ mA}$		3.35	7.50	$\Omega$
		$V_{GS} = 10\text{ V}, I_D = 500\text{ mA}, T_J = 100^\circ\text{C}$		5.62	13.50	
		$V_{GS} = 5\text{ V}, I_D = 50\text{ mA}$		2.68	7.50	
		$V_{GS} = 5\text{ V}, I_D = 50\text{ mA}, T_J = 100^\circ\text{C}$		3.97	13.50	
$V_{DS(ON)}$	Drain-Source On-Voltage	$V_{GS} = 10\text{ V}, I_D = 500\text{ mA}$		1.68	3.75	V
		$V_{GS} = 5\text{ V}, I_D = 50\text{ mA}$		0.13	1.50	
$I_{D(ON)}$	On-State Drain Current	$V_{GS} = 10\text{ V}, V_{DS} \geq 2 V_{DS(ON)}$	500	557		mA
		$V_{GS} = 4.5\text{ V}, V_{DS} = 10\text{ V}$	75	571		
$g_{FS}$	Forward Trans-conductance	$V_{DS} \geq 2 V_{DS(ON)}, I_D = 200\text{ mA}$	80	214		mS
<b>Dynamic Characteristics</b>						
$C_{iss}$	Input Capacitance	$V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V}, f = 1.0\text{ MHz}$		12.8	50	pF
$C_{oss}$	Output Capacitance			3.25	25	pF
$C_{rss}$	Reverse Transfer Capacitance			1.52	5	pF
$R_G$	Gate Resistance		$V_{GS} = 0\text{ V}, f = 1.0\text{ MHz}$		22.2	
<b>Switching Characteristics<sup>(3)</sup></b>						
$t_{on}$	Turn-On Time	$V_{DD} = 30\text{ V}, R_L = 150\ \Omega, I_D = 200\text{ mA}, V_{GS} = 10\text{ V}, R_{GEN} = 25\ \Omega$		4.35	20	ns
$t_{off}$	Turn-Off Time			15.6	20	ns
<b>Drain-Source Diode Characteristics and Maximum Ratings</b>						
$I_S$	Maximum Continuous Drain-Source Diode Forward Current				115	mA
$I_{SM}$	Maximum Pulsed Drain-Source Diode Forward Current				0.8	A
$V_{SD}$	Drain-Source Diode Forward Voltage	$V_{GS} = 0\text{ V}, I_S = 115\text{ mA}^{(3)}$		0.818	1.5	V

### Note:

3. Pulse test: pulse width  $\leq 300\ \mu\text{s}$ , duty cycle  $\leq 2.0\%$ .

## Typical Performance Characteristics

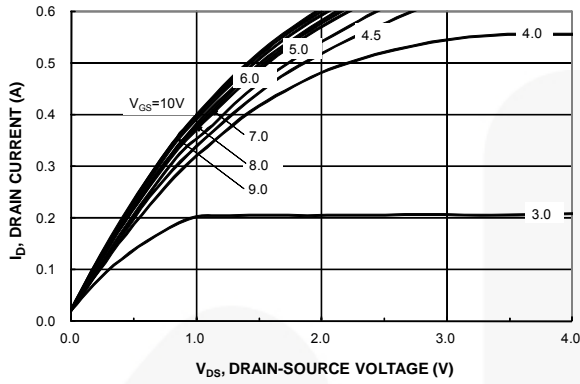


Figure 1. On-Region Characteristics

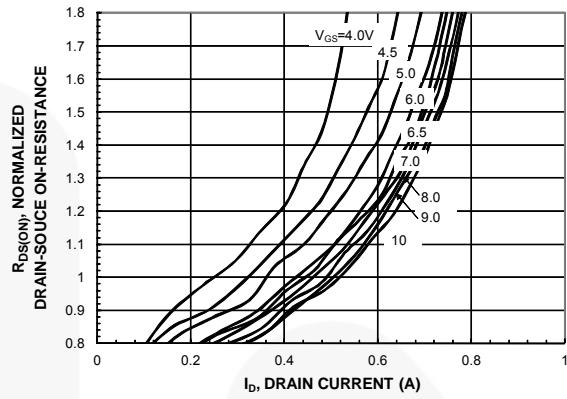


Figure 2. On-Resistance Variation with Gate Voltage and Drain Current

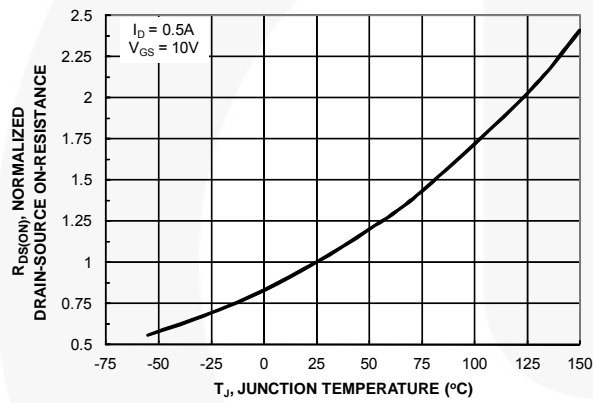


Figure 3. On-Resistance Variation with Temperature

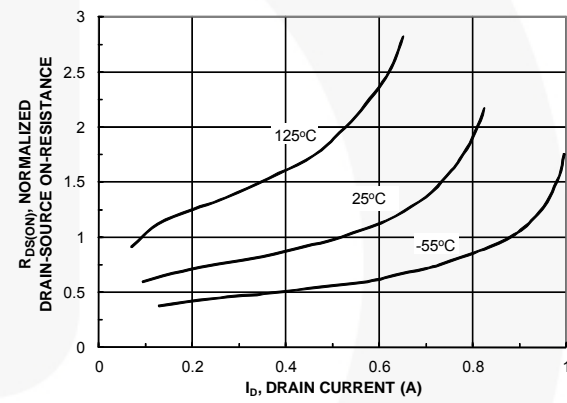


Figure 4. On-Resistance Variation with Drain Current and Temperature

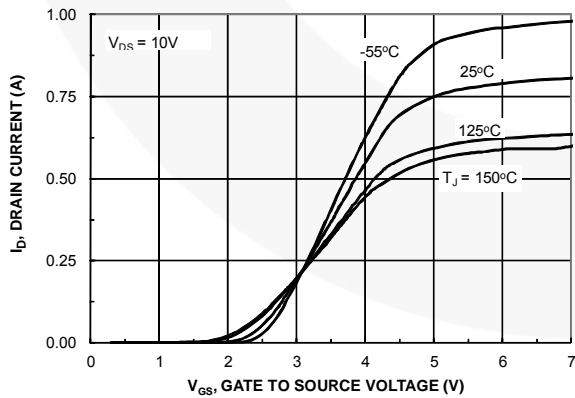


Figure 5. Transfer Characteristics

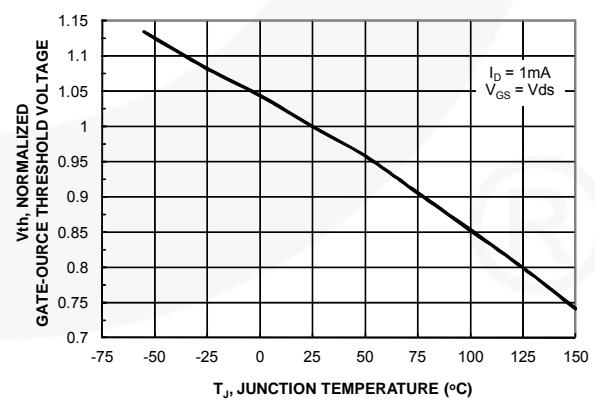
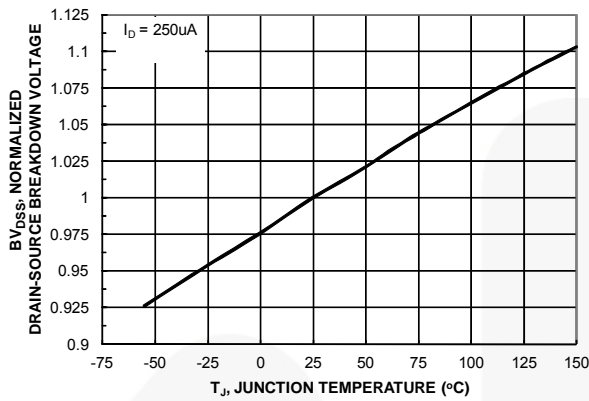
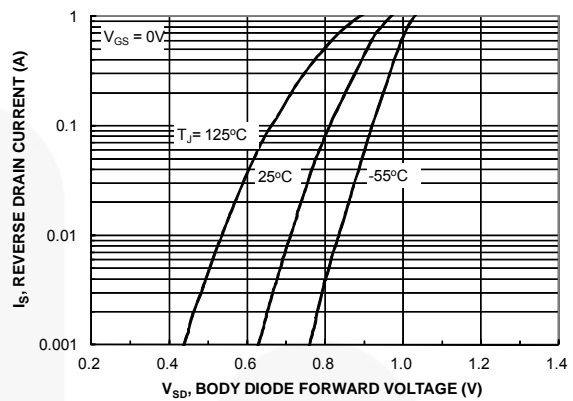


Figure 6. Gate Threshold Variation with Temperature

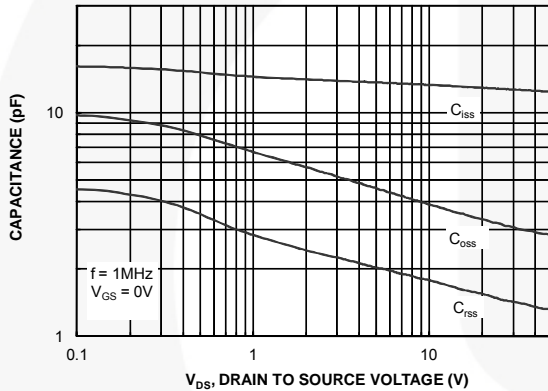
**Typical Performance Characteristics** (Continued)



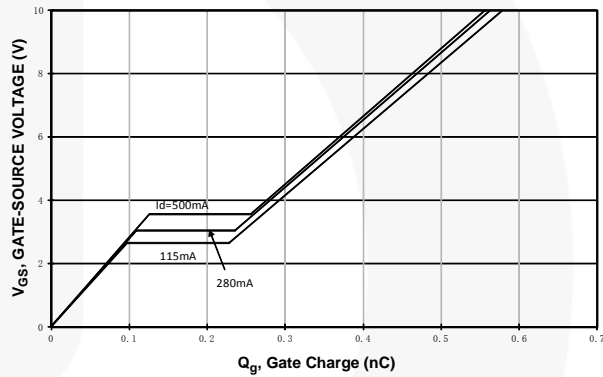
**Figure 7. Breakdown Voltage Variation with Temperature**



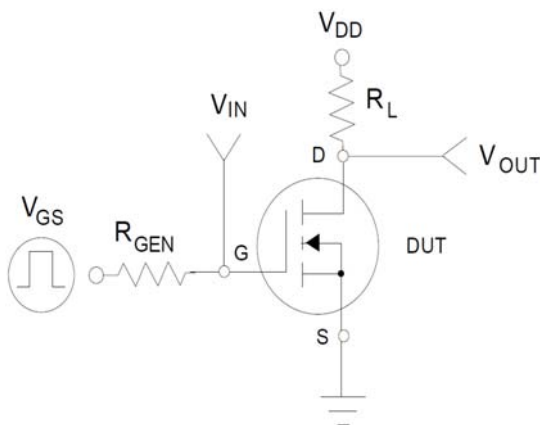
**Figure 8. Body Diode Forward Voltage Variation with Source Current and Temperature**



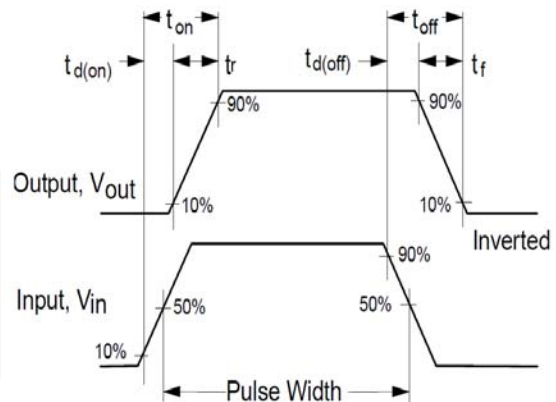
**Figure 9. Capacitance Characteristics**



**Figure 10. Gate Charge Characteristics**



**Figure 11.**



**Figure 12. Switching Waveforms**

Typical Performance Characteristics (Continued)

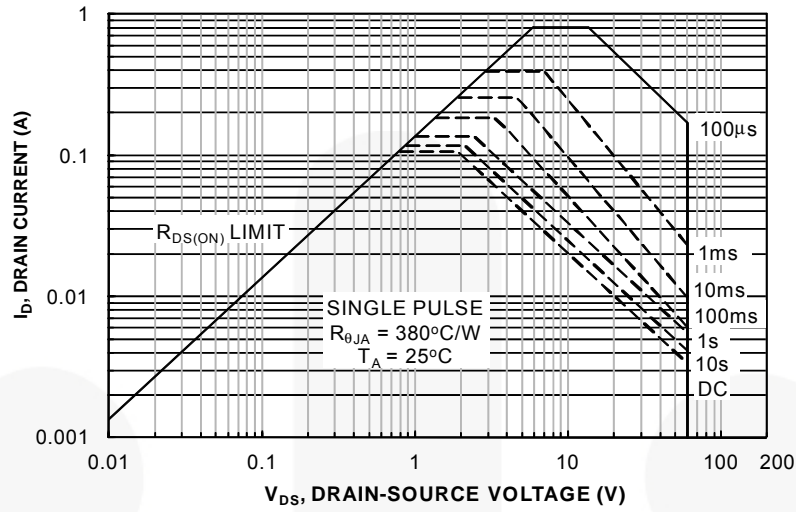


Figure 13. Maximum Safe Operating Area

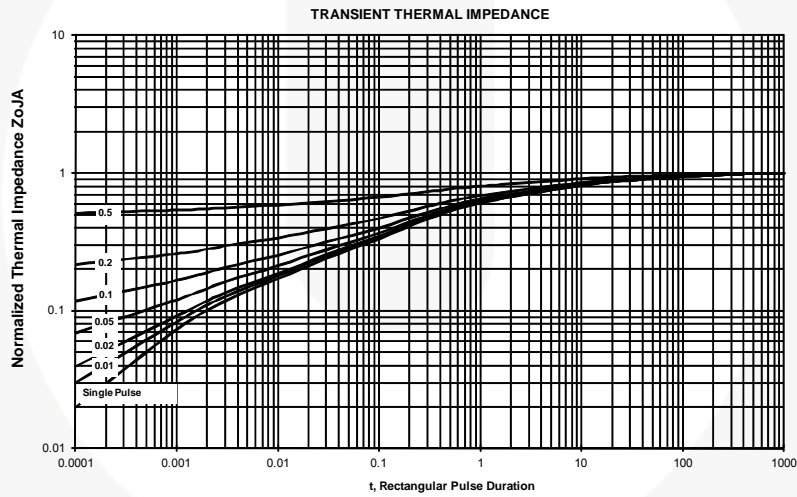
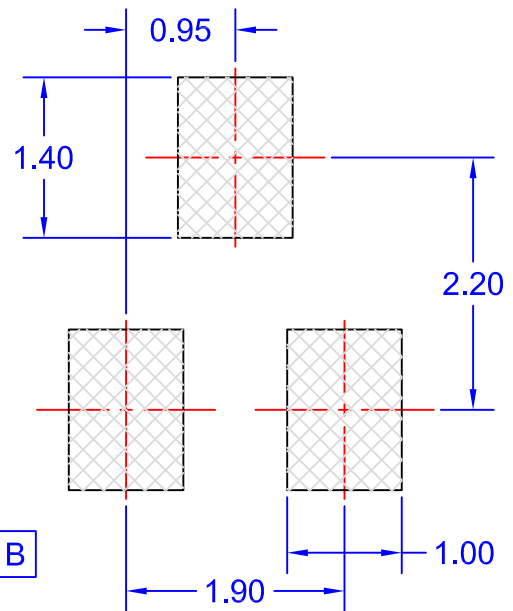
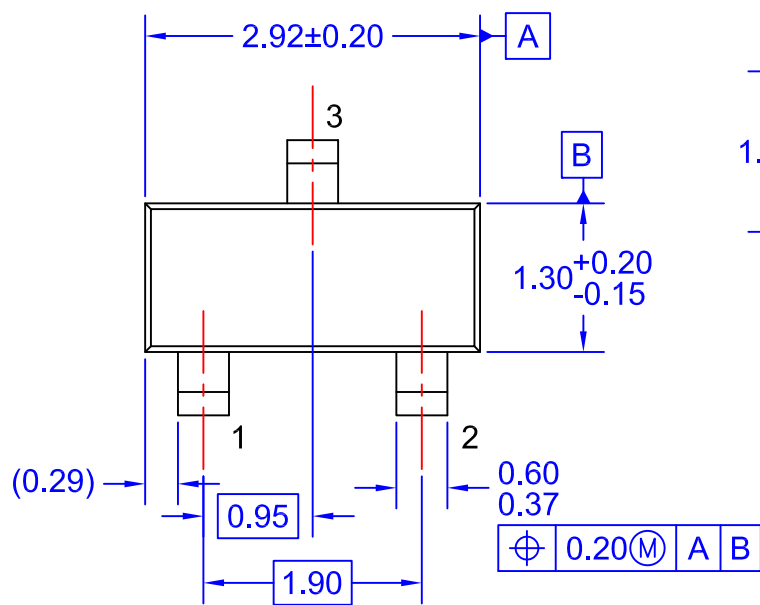
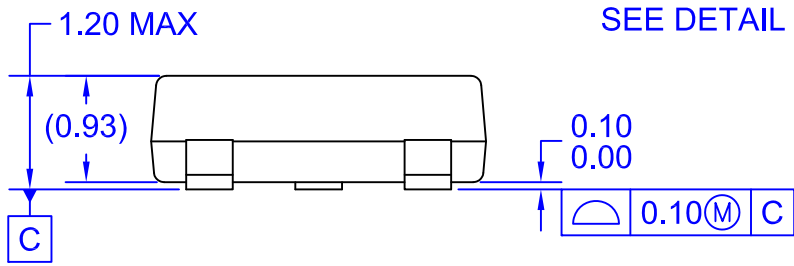


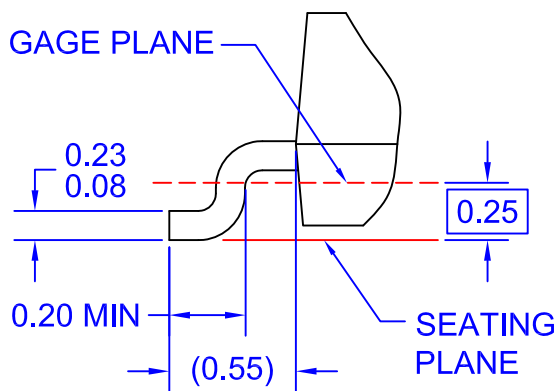
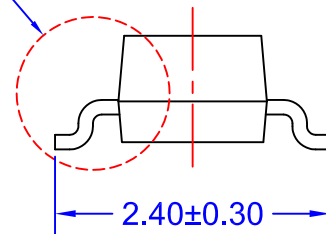
Figure 14. Transient Thermal Response Curve



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**DETAIL A**  
SCALE: 2X

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