

The documentation and process conversion measures necessary to comply with this revision shall be completed by 12 December 2011.

INCH-POUND

MIL-PRF-19500/431E  
 12 September 2011  
 SUPERSEDING  
 MIL-PRF-19500/431D  
 21 November 2006

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, FIELD EFFECT TRANSISTORS, N-CHANNEL, SILICON,  
 TYPES 2N4091, 2N4092, 2N4093, 2N4091UB, 2N4092UB, AND 2N4093UB,  
 JAN, JANTX, AND JANTXV

This specification is approved for use by all Departments and Agencies of the Department of Defense.

The requirements for acquiring the product described herein shall consist of this specification sheet and [MIL-PRF-19500](#).

1. SCOPE

1.1 Scope. This specification covers the performance requirements for N-channel, junction, silicon field-effect transistors intended for use in chopper and analog gate circuit applications. Three levels of product assurance are provided for each device type as specified in [MIL-PRF-19500](#).

1.2 Physical dimensions. See [figure 1](#) (similar to TO-18) and [figure 2](#) (UB devices).

1.3 Maximum ratings.  $T_A = +25^\circ\text{C}$ , unless otherwise specified.

Type	$P_T$ (1) $T_A = +25^\circ\text{C}$ (free air)	$V_{DS}$	$V_{DG}$	$V_{GS}$	$I_G$	$T_J$	$T_{STG}$
	<u>W</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>mA d</u>	<u>°C</u>	<u>°C</u>
2N4091, UB	0.36	40	40	-40	10	-65 to +175	-65 to +200
2N4092, UB	0.36	40	40	-40	10	-65 to +175	-65 to +200
2N4093, UB	0.36	40	40	-40	10	-65 to +175	-65 to +200

(1) Derate linearly 2.4 mW/°C for  $T_A > +25^\circ\text{C}$ .

\* Comments, suggestions, or questions on this document should be addressed to DLA Land and Maritime, ATTN: VAC, P.O. Box 3990, Columbus, OH 43218-3990, or emailed to [Semiconductor@dla.mil](mailto:Semiconductor@dla.mil). Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <https://assist.daps.dla.mil/>.

1.4 Primary electrical characteristics.  $T_C = +25^\circ\text{C}$ , unless otherwise specified.

Type	$r_{ds(on)}$ $V_{GS} = 0$ $I_D = 1 \text{ mA}$		Max $I_{DSS}$ (1) $V_{GS} = 0 \text{ V}$ $V_{DS} = 20 \text{ V dc}$		$V_{DS(on)}$ maximum		
					$I_D = 6.6 \text{ mA}$ $V_{GS} = 0$	$I_D = 4.0 \text{ mA}$ $V_{GS} = 0$	$I_D = 2.5 \text{ mA}$ $V_{GS} = 0$
	$\Omega$	mA dc		V dc	V dc	V dc	
	Min	Max	Min	Max			
2N4091, UB 2N4092, UB 2N4093, UB		30 50 80	30 15 8		.20	.20	.20

(1) Pulsed (see 4.5.1).

## 2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

## DEPARTMENT OF DEFENSE SPECIFICATIONS

[MIL-PRF-19500](#) - Semiconductor Devices, General Specification for.

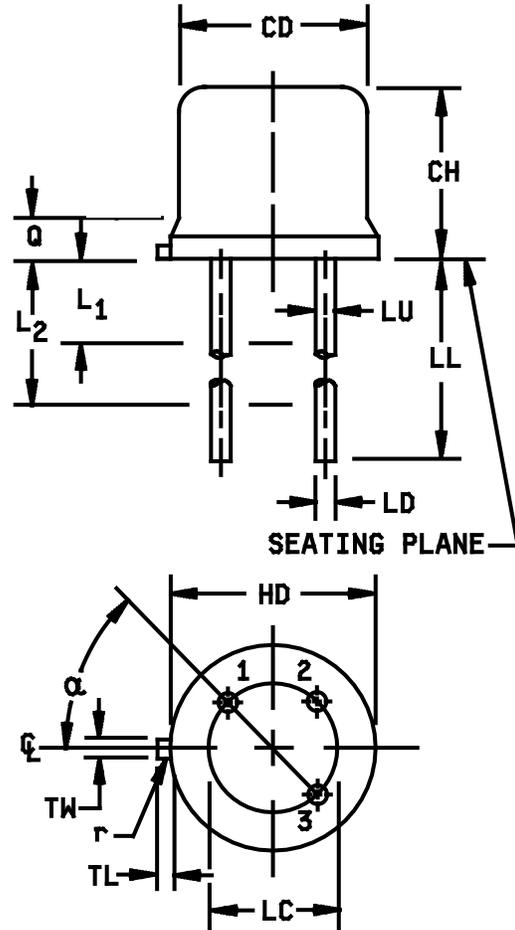
## DEPARTMENT OF DEFENSE STANDARDS

[MIL-STD-750](#) - Test Methods for Semiconductor Devices.

\* (Copies of these documents are available online at <https://assist.daps.dla.mil/quicksearch/> or <https://assist.daps.dla.mil/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

\* 2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

Symbol	Dimensions				Note
	Inches		Millimeters		
	Min	Max	Min	Max	
CD	.178	.195	4.52	4.95	
CH	.170	.210	4.32	5.33	
HD	.209	.230	5.31	5.84	
LC	.100 TP		2.54 TP		6
LD	.016	.021	0.41	0.53	7,8
LL	.500	.750	12.7	19.05	7,8
LU	.016	.019	0.41	0.48	7,8
L <sub>1</sub>		.050		1.27	7,8
L <sub>2</sub>	.250		6.35		7,8
Q		.030		0.76	5
TL	.028	.048	0.71	1.22	3,4
TW	.036	.046	0.91	1.17	3
r		.010		0.25	10
α	45° TP		45° TP		6

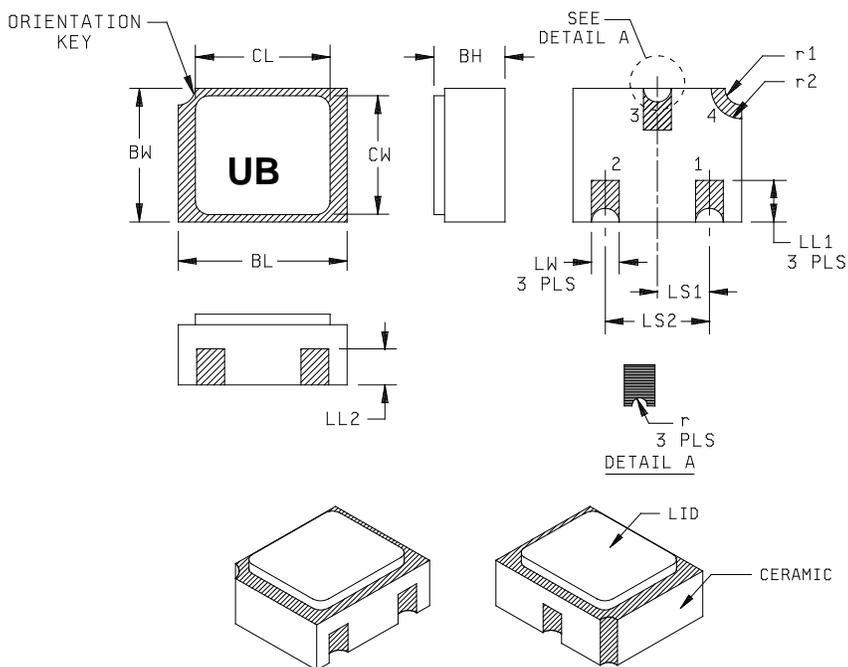


NOTES:

1. Dimension are in inches.
2. Millimeters are given for general information only.
3. Beyond r (radius) maximum, TL shall be held for a minimum length of .011 (0.28 mm).
4. Dimension TL measured from maximum HD.
5. Body contour optional within zone defined by HD, CD, and Q.
6. Leads at gauge plane .054 +.001 -.000 inch (1.37 +0.03 -0.00 mm) below seating plane shall be within .007 inch (0.18 mm) radius of true position (TP) at maximum material condition (MMC) relative to tab at MMC.
7. Dimension LU applies between L<sub>1</sub> and L<sub>2</sub>. Dimension LD applies between L<sub>2</sub> and LL minimum. Diameter is uncontrolled in L<sub>1</sub> and beyond LL minimum.
8. All three leads.
9. The collector shall be internally connected to the case.
10. Dimension r (radius) applies to both inside corners of tab.
11. In accordance with ASME Y14.5M, diameters are equivalent to φx symbology.
12. Lead 1 = source, lead 2 = drain, lead 3 = gate.

FIGURE 1. Physical dimensions (similar to TO-18).

MIL-PRF-19500/431E



Symbol	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
BH	.046	.056	1.17	1.42
BL	.115	.128	2.92	3.25
BW	.085	.108	2.16	2.74
CL		.128		3.25
CW		.108		2.74
LL1	.022	.038	0.56	0.96
LL2	.017	.035	0.43	0.89
LS <sub>1</sub>	.036	.040	0.91	1.02
LS <sub>2</sub>	.071	.079	1.81	2.01
LW	.016	.024	0.41	0.61
r		.008		.203
r1		.012		.305
r2		.022		.559

NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Hatched areas on package denote metallized areas.
4. Lid material: Kovar.
5. Pad 1 = Drain, Pad 2 = Source, Pad 3 = Gate, Pad 4 = Shielding connected to the lid.
6. In accordance with ASME Y14.5M, diameters are equivalent to  $\phi$ x symbology.

\* FIGURE 2. Physical dimensions, surface mount (UB version).

### 3. REQUIREMENTS

3.1 General. The individual item requirements shall be as specified in [MIL-PRF-19500](#) and as modified herein.

3.2 Qualification. Devices furnished under this specification shall be products that are manufactured by a manufacturer authorized by the qualifying activity for listing on the applicable qualified manufacturers list before contract award (see [4.2](#) and [6.3](#)).

3.3 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in [MIL-PRF-19500](#).

3.4 Interface and physical dimensions. The interface and physical dimensions shall be as specified [MIL-PRF-19500](#), and [figure 1](#) (similar to TO-18) and [figure 2](#) (UB devices).

3.4.1 Lead finish. Lead finish shall be solderable in accordance with [MIL-PRF-19500](#), [MIL-STD-750](#), and herein. Where a choice of lead finish is desired, it shall be specified in the acquisition document (see [6.2](#)).

3.4.2 Internal construction. Multiple chip construction is not permitted to meet the requirements of this specification.

3.5 Electrostatic discharge protection. The devices covered by this specification require electrostatic discharge protection.

3.5.1 Handling. Metal oxide semiconductor (MOS) devices must be handled with certain precautions to avoid damage due to the accumulation of static charge. However, the following handling practices are recommended (see [3.5](#)).

- a. Devices should be handled on benches with conductive handling devices.
- b. Ground test equipment, tools, and personnel handling devices.
- c. Do not handle devices by the leads.
- d. Store devices in conductive foam or carriers.
- e. Avoid use of plastic, rubber or silk in MOS areas.
- f. Maintain relative humidity above 50 percent if practical.
- g. Care should be exercised during test and troubleshooting to apply not more than maximum rated voltage to any lead.
- h. Gate must be terminated to source,  $R \leq$  or 100 k $\Omega$ , whenever bias voltage is applied drain to source.

3.6 Marking. Marking shall be in accordance with [MIL-PRF-19500](#), except for the UB suffix package. Marking on the UB package shall consist of an abbreviated part number, the date code, and the manufacturer's symbol or logo. The prefixes JAN, JANTX, and JANTXV can be abbreviated as J, JX, and JV respectively. The "2N" prefix and the "UB" suffix can also be omitted.

3.7 Electrical performance characteristics. Unless otherwise specified herein, the electrical performance characteristics are as specified in [1.3](#), [1.4](#), and [table I](#).

3.8 Electrical test requirements. The electrical test requirements shall be as specified in [table I](#).

3.9 Workmanship. Semiconductor devices shall be processed in such a manner as to be uniform in quality and shall be free from other defects that will affect life, serviceability, or appearance.

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

- a. Qualification inspection (see 4.2).
- b. Screening (see 4.3).
- c. Conformance inspection (see 4.4 and table I).

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-PRF-19500 and as specified herein.

4.2.1 Group E qualification. Group E inspection shall be performed for qualification or re-qualification only. In case qualification was awarded to a prior revision of the specification sheet that did not request the performance of table II tests, the tests specified in table II herein that were not performed in the prior revision shall be performed on the first inspection lot of this revision to maintain qualification.

\* 4.3 Screening (JANTX and JANTXV levels only). Screening shall be in accordance with table E-IV of MIL-PRF-19500, and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

Screen (see table E-IV of MIL-PRF-19500)	Measurement
	JANTX and JANTXV levels
9 , 10	Not applicable.
11	$I_{GSS1}$ , $I_{DSS}$ , $r_{DS(on)}$
12	See 4.3.1.
13	Subgroup 2 of table I herein; $\Delta I_{GSS1} = \pm 50$ pA dc or $\pm 100$ percent of initial value, whichever is greater. $\Delta r_{DS(on)} = \pm 20$ percent of initial value. $\Delta I_{DSS} = \pm 20$ percent of initial value.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows: Method 1039 of MIL-STD-750, condition A;  $T_A = +175^\circ\text{C}$ ;  $V_{GS} = -24$  V dc;  $V_{DS} = 0$ .

4.4 Conformance inspection. Conformance inspection shall be in accordance with [MIL-PRF-19500](#), and as specified herein.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with [MIL-PRF-19500](#) and [table I](#) herein.

\* 4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VIB (JAN, JANTX, and JANTXV) of [MIL-PRF-19500](#) and as follows. Electrical measurements (end-points) shall be in accordance with [table I](#), subgroup 2 herein.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B2	1051	Test condition G.
B3	1027	Condition A, $T_A = +175^{\circ}\text{C}$ ; $V_{DS} = 0$ ; $V_{GS} = -24\text{ V dc}$ , 340 hours.
B6	1032	$T_{STG} = +200^{\circ}\text{C}$ .

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VII of [MIL-PRF-19500](#), and as follows. Electrical measurements (end-points) shall be in accordance with [table I](#), subgroup 2 herein.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	2036	Test condition E, not applicable to UB suffix devices.
C6	1026	$V_{GS} = -24\text{ V dc}$ ; $V_{DS} = 0$ ; $T_J = +175^{\circ}\text{C} \pm 3^{\circ}\text{C}$ .

4.4.4 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-IX of [MIL-PRF-19500](#) and as specified in [table II](#) herein. Electrical measurements (end-points) shall be in accordance with [table I](#), subgroup 2 herein.

4.5 Methods of inspection. Methods of inspection shall be as specified in the appropriate tables and as follows.

4.5.1 Pulse measurements. Conditions for pulse measurement shall be as specified in section 4 of [MIL-STD-750](#).

TABLE I. Group A inspection.

Inspection <sup>1/</sup>	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical examination	2071					
<u>Subgroup 2</u>						
Breakdown voltage, gate to source	3401	Bias condition C; $V_{DS} = 0$ V dc; $I_G = -1.0$ $\mu$ A dc	$V_{(BR)GSS}$	-40		V dc
Gate reverse current	3411	$V_{GS} = -20$ V dc; $V_{DS} = 0$ ; bias condition C	$I_{GSS1}$		-0.1	nA dc
Drain current	3413	$V_{DS} = 20$ V dc; bias condition C	$I_{D(off)1}$		-0.1	nA dc
2N4091, UB		$V_{GS} = -12$ V dc				
2N4092, UB		$V_{GS} = -8$ V dc				
2N4093, UB		$V_{GS} = -6$ V dc				
Drain current	3413	$V_{DS} = 20$ V dc; $V_{GS} = 0$ (pulsed, see 4.5.1); bias condition C	$I_{DSS}$			
2N4091, UB				30		mA dc
2N4092, UB				15		mA dc
2N4093, UB				8		mA dc
Static drain to source on-state resistance	3421	$V_{GS} = 0$ ; pulsed (see 4.5.1); bias condition B; $I_D = 1.0$ mA dc	$r_{DS(on)}$			
2N4091, UB					30	$\Omega$
2N4092, UB					50	$\Omega$
2N4093, UB					80	$\Omega$
Drain to source "on" state voltage	3405	$V_{GS} = 0$ ; bias condition B	$V_{DS(on)}$			
2N4091, UB		$I_D = 6.6$ mA dc			0.2	V dc
2N4092, UB		$I_D = 4.0$ mA dc			0.2	V dc
2N4093, UB		$I_D = 2.5$ mA dc			0.2	V dc

See footnote at end of table.

TABLE I. Group A inspection - Continued.

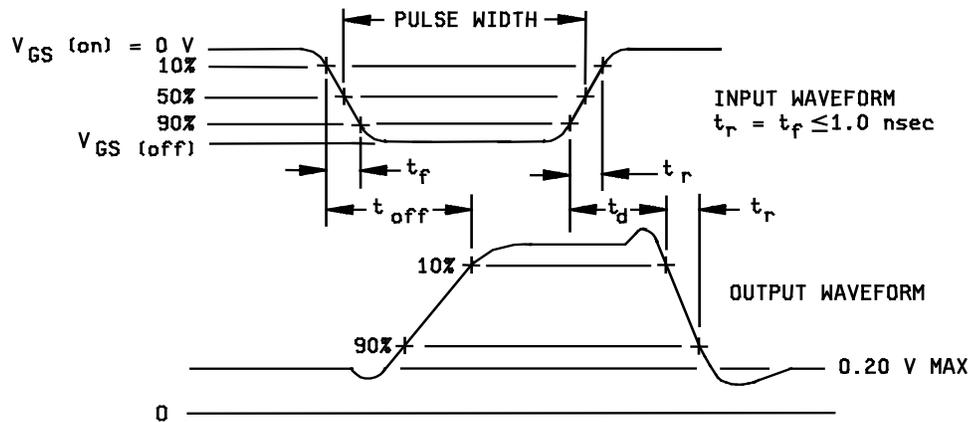
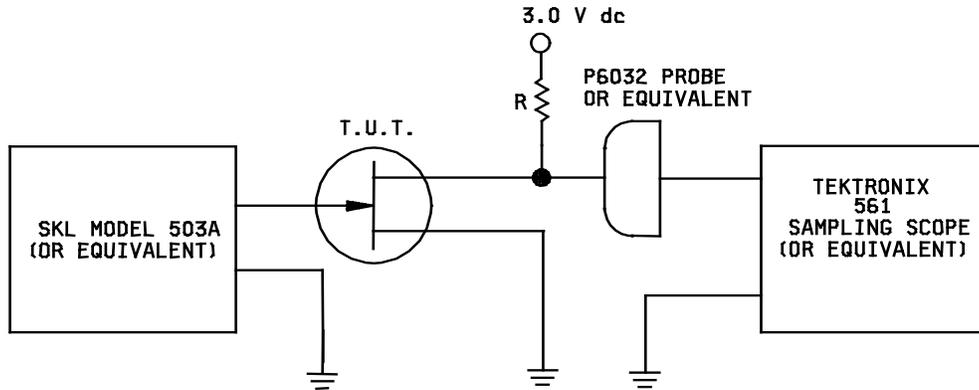
Inspection <u>1/</u>	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 3</u>						
High temperature operation:		$T_A = +150^\circ\text{C}$				
Gate current	3411	Bias condition C; $V_{DS} = 0\text{ V dc}$ $V_{GS} = -20\text{ V dc}$ ;	$I_{GSS2}$		-0.2	$\mu\text{A dc}$
Drain current	3413	$V_{DS} = 20\text{ V dc}$ ; bias condition A	$I_{D(off)2}$			
2N4091, UB		$V_{GS} = -12\text{ V dc}$			0.2	$\mu\text{A dc}$
2N4092, UB		$V_{GS} = -8\text{ V dc}$			0.2	$\mu\text{A dc}$
2N4093, UB		$V_{GS} = -6\text{ V dc}$			0.2	$\mu\text{A dc}$
<u>Subgroup 4</u>						
Small-signal common-source short-circuit input capacitance	3431	$V_{DS} = 20\text{ V dc}$ ; $V_{GS} = 0$ ; $f = 1\text{ MHz}$	$C_{iss}$		16	pF
Small-signal common-source reverse transfer capacitance	3433	$V_{DS} = 0\text{ V dc}$ ; $V_{GS} = 20$ ; $f = 1\text{ MHz}$	$C_{rss}$		5	pF
Turn-on delay time		See <a href="#">figure 3</a>	$t_{d(on)}$			
2N4091, UB					15	ns
2N4092, UB					15	ns
2N4093, UB					15	ns
Rise time		See <a href="#">figure 3</a>	$t_r$			
2N4091, UB					10	ns
2N4092, UB					20	ns
2N4093, UB					40	ns
Turn-off delay time		See <a href="#">figure 3</a>	$t_{d(off)}$			
2N4091, UB					40	ns
2N4092, UB					60	ns
2N4093, UB					80	ns
<u>Subgroups 5, 6, 7</u>						
Not applicable						

1/ For sampling plan, see [MIL-PRF-19500](#).

\* TABLE II. Group E inspection (all quality levels) for qualification or re-qualification only.

Inspection	MIL-STD-750		Sample size
	Method	Conditions	
<u>Subgroup 1</u> <sup>1/</sup>			45 devices c = 0
Temperature cycling	1051	-55°C to +150°C, 500 cycles	
Hermetic seal	1071	As applicable	
Fine leak			
Gross leak			
Electrical measurements		See <a href="#">table I</a> , subgroup 2	
<u>Subgroup 2</u> <sup>1/</sup>			45 devices c = 0
Blocking life	1048	1,000 hours minimum, T <sub>A</sub> = +150°C, V <sub>DG</sub> or V <sub>GS</sub> = 80 percent of rated.	
Electrical measurements		See <a href="#">table I</a> , subgroup 2	
<u>Subgroup 4</u>			
Not applicable			

<sup>1/</sup> A separate sample for each test shall be pulled.



NOTES:

1. Measure under pulse conditions: Pulse width  $\leq 300 \text{ ms}$ ; duty cycle  $\pm 3$  percent.
2. 2N4091, 2N4091UB:  $I_D = 6.6 \text{ mA}$ .  
 2N4092, 2N4092UB:  $I_D = 4.0 \text{ mA}$ .  
 2N4093, 2N4093UB:  $I_D = 2.5 \text{ mA}$ .
3. 2N4091, 2N4091UB:  $V_{GS(\text{off})} = -12 \text{ V}$ .  
 2N4092, 2N4092UB:  $V_{GS(\text{off})} = -8.0 \text{ V}$ .  
 2N4093, 2N4093UB:  $V_{GS(\text{off})} = -6.0 \text{ V}$ .

FIGURE 3. Switching time test circuit and waveforms.

## 5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the Military Service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

## 6. NOTES

\* (This section contains information of a general or explanatory nature that may be helpful, but is not mandatory. The notes specified in [MIL-PRF-19500](#) are applicable to this specification.)

\* 6.1 Intended use. Semiconductors conforming to this specification are intended for original equipment design applications and logistic support of existing equipment.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. Packaging requirements (see 5.1).
- c. Lead finish (see 3.4.1).
- d. Product assurance level and type designator.

\* 6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Manufacturers List (QML 19500) whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from DLA Land and Maritime, ATTN: VQE, P.O. Box 3990, Columbus, OH 43218-3990 or e-mail [vqe.chief@dla.mil](mailto:vqe.chief@dla.mil). An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at <https://assist.daps.dla.mil>.

6.4 Changes from previous issue. The margins of this specification are marked with asterisks to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodians:  
Army - CR  
Navy - EC  
Air Force - 85  
DLA - CC

Preparing activity:  
DLA - CC  
  
(Project 5961-2011-046)

Review activities:  
Air Force - 19, 71, 99

\* NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at <https://assist.daps.dla.mil/>.