

The documentation and process conversion measures necessary to comply with this document shall be completed by 16 August 2006.

INCH-POUND

MIL-PRF-19500/612C
 16 May 2006
 SUPERSEDING
 MIL-PRF-19500/612B
 17 December 2004

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, SILICON, POWER,
 TYPE 2N7372, JAN, JANTX, JANTXV, AND JANS

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 PNP, silicon, power transistors for use in high-speed power switching applications. Four levels of product assurance are provided as specified in MIL-PRF-19500.

1.2 Physical dimensions. See figure 1 (TO-254AA).

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

Type	P_T (1) $T_A = +25^\circ\text{C}$	P_T (2) $T_C = +25^\circ\text{C}$	$R_{\theta JA}$	$R_{\theta JC}$	V_{CBO}	V_{CEO}	V_{EBO}	I_C	I_C (3)	T_J and T_{STG}
	<u>W</u>	<u>W</u>	<u>$^\circ\text{C/W}$</u>	<u>$^\circ\text{C/W}$</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>A dc</u>	<u>A dc</u>	<u>$^\circ\text{C}$</u>
2N7372	4	58	40	3	100	80	5.5	5.0	10	-65 to +200

- (1) Derate linearly 22.8 mW/ $^\circ\text{C}$ for $T_A > +25^\circ\text{C}$.
- (2) Derate linearly 331 mW/ $^\circ\text{C}$ for $T_C > +25^\circ\text{C}$.
- (3) This value applies for $PW \leq 8.3$ ms, duty cycle ≤ 1 percent.

Comments, suggestions, or questions on this document should be addressed to Defense Supply Center, Columbus, ATTN: DSCC-VAC, P.O. Box 3990, Columbus, OH 43218-3990, or emailed to Semiconductor@dsc.dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <http://assist.daps.dla.mil/>.

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

	h_{FE2}	$ h_{fe} $	$V_{BE(SAT)2}$ (1)	$V_{CE(SAT)2}$ (1)	C_{obo}	Reverse pulse energy (2)	Safe operating area
	$V_{CE} = 5.0 \text{ V dc}$ $I_C = 2.5 \text{ A dc}$	$V_{CE} = 5.0 \text{ V dc}$ $I_C = 500 \text{ mA dc}$ $f = 10 \text{ MHz}$	$I_C = 5.0 \text{ A dc}$ $I_B = 500 \text{ mA dc}$	$I_C = 5.0 \text{ A dc}$ $I_B = 500 \text{ mA dc}$	$V_{CB} = 10 \text{ V dc}$ $I_E = 0 \text{ A dc}$ $100\text{kHz} \leq f \leq 1\text{MHz}$		
Min	70	7.0	<u>V dc</u>	<u>V dc</u>	<u>pF</u>	<u>mJ</u>	See figure 2
Max	200		2.2	1.5	250	15	

(1) Pulse (see 4.5.1).

(2) This rating is based on the capability of the transistors to operate safely in the unclamped inductive load energy test circuit of figure 3.

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.

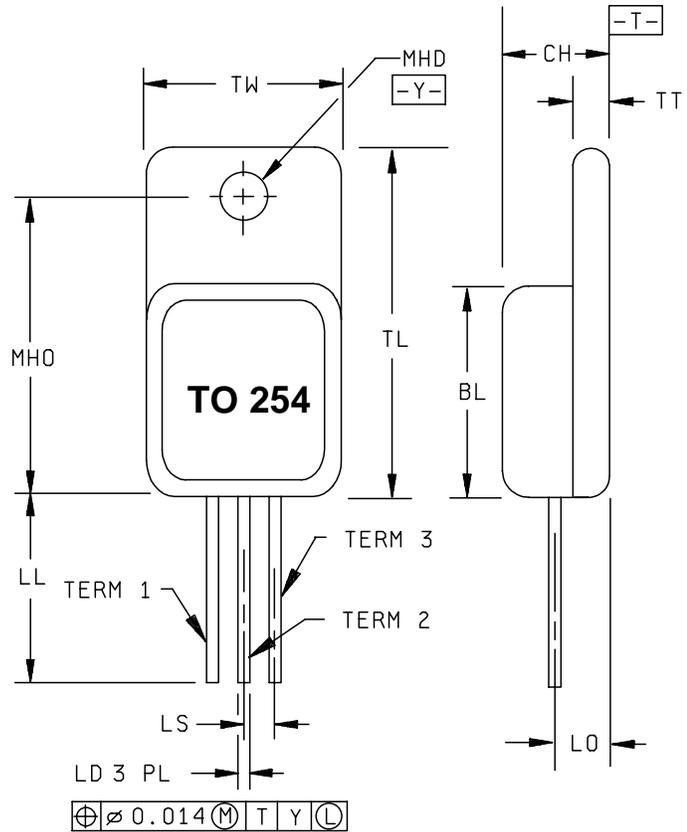
DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Copies of these documents are available online at <http://assist.daps.dla.mil/quicksearch/> or <http://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. 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.

Ltr	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
BL	.535	.545	13.59	13.84
CH	.249	.260	6.32	6.60
LD	.035	.045	0.89	1.14
LL	.53	.55	13.46	13.97
LO	.150 BSC		3.81 BSC	
LS	.150 BSC		3.81 BSC	
MHD	.139	.149	3.53	3.78
MHO	.665	.685	16.89	17.40
TL	.790	.800	20.07	20.32
TT	.040	.050	1.02	1.27
TW	.535	.545	13.59	13.84
Term 1	Base			
Term 2	Collector			
Term 3	Emitter			



NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. All terminals are isolated from case.
4. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

FIGURE 1. Dimensions and configuration (TO-254AA).

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 requirements and physical dimensions. The interface requirements and physical dimensions shall be as specified on figure 1. Methods used for electrical isolation of the terminal feedthroughs shall employ materials that contain a minimum of 90 percent AL_2O_3 (ceramic). Examples of such construction techniques are metallized ceramic eyelets or ceramic walled packages.

3.4.1 Lead finish and formation. Lead finish shall be solderable in accordance with MIL-STD-750, MIL-PRF-19500, and herein. Where a choice of lead finish or formation is desired, it shall be specified in the acquisition requirements (see 6.2). When lead formation is performed, as a minimum, the vendor shall perform 100 percent hermetic seal in accordance with screen 14 of MIL-PRF-19500 and 100 percent dc testing in accordance with table I, subgroup 2 herein.

3.5 Marking. Marking shall be in accordance with MIL-PRF-19500.

3.6 Electrical performance characteristics. Unless otherwise specified herein, the electrical performance characteristics are as specified in 1.3, 1.4, and table I herein.

3.7 Electrical test requirements. The electrical test requirements shall be as specified in table I.

3.8 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.

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 (JANS, JANTX, and JANTXV levels only). Screening shall be in accordance with MIL-PRF-19500 (appendix E, table IV), 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	
	JANS level	JANTX and JANTXV levels
(1) 3c	Thermal impedance (see 4.3.1)	Thermal impedance (see 4.3.1)
7	Optional.	Optional.
9	I_{CES1} and h_{FE2}	Not applicable
11	Subgroup 2 of table I herein; I_{CES1} and h_{FE2} ; $\Delta I_{CES1} = 100$ percent of initial value or 100 nA dc whichever is greater. $\Delta h_{FE2} = \pm 20$ percent of initial value.	I_{CES1} and h_{FE2}
12	See 4.3.2	$t = 80$ hours minimum, see 4.3.2
13	Subgroups 2 and 3 of table I herein; I_{CES1} and h_{FE2} ; $\Delta I_{CES1} = 100$ percent of initial value or 100 nA dc, whichever is greater. $\Delta h_{FE2} = \pm 20$ percent of initial value.	Subgroup 2 of table I herein; I_{CES1} and h_{FE2} ; $\Delta I_{CES1} = 100$ percent of initial value or 100 nA dc, whichever is greater. $\Delta h_{FE2} = \pm 20$ percent of initial value.
14	Required.	Required.

- (1) Shall be performed anytime after temperature cycling, screen 3a; and does not need to be repeated in screening requirements.

* 4.3.1 Thermal impedance. The thermal impedance measurements shall be performed in accordance with method 3161 of MIL-STD-750 using the guidelines in that method for determining I_M , I_H , t_H , t_{SW} , (and V_H where appropriate). Measurement delay time (t_{MD}) = 70 μ s max. See table II, group E, subgroup 4 herein.

4.3.2 Power burn-in conditions. Power burn-in conditions are as follows: $T_J = 187.5 \pm 12.5^\circ\text{C}$, $V_{CE} = 30$ V dc ± 10 V dc, $C T_A =$ room ambient as defined in the general requirements, 4.5 of MIL-STD-750.

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 appendix E, table V of 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 appendix E, tables E-VIA (JANS) and E-VIB (JAN, JANTX, and JANTXV) of MIL-PRF-19500. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein.

4.4.2.1 Group B inspection, appendix E, table E-VIA (JANS) of MIL-PRF-19500.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	2037	Test condition A.
B4	1037	$V_{CB} = 10$ V dc minimum, 2,000 cycles.
B5	1027	See 4.5.2.

4.4.2.2 Group B inspection, appendix E, table E-VIB (JAN, JANTX, and JANTXV) of MIL-PRF-19500.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	1037	$V_{CB} = 10$ V dc minimum, 2,000 cycles.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in appendix E, table E-VII of MIL-PRF-19500. 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	Tension: test condition A; weight 10 pounds \pm 5 ounces; time 15 seconds. Bend strength: test condition F; bending stress 2 pounds, time 15 seconds.
* C5	3131	See 4.3.1, $R_{\theta JC} = 3.0^{\circ}\text{C}/\text{W}$.
C6	1037	$V_{CB} = 10$ V dc minimum, 6,000 cycles

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 Method 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.

4.5.2 Group B accelerated life test. This test shall be conducted using one of the two options listed below with the following conditions applying to all options: $V_{CB} = 20$ V minimum dc; $T_J = +275^{\circ}\text{C}$.

a. $P_T = 2.5$; P_T adjusted to give a lot average of $T_J = +275^{\circ}\text{C}$ with $T_A = +125^{\circ}\text{C} \pm 25^{\circ}\text{C}$.

b. $T_A = +25^{\circ}\text{C} \pm 3^{\circ}\text{C}$ with P_T adjusted to give a lot average of $T_J = +275^{\circ}\text{C}$.

4.5.3 Inspection conditions. Unless otherwise specified in MIL-PRF-19500 or herein, all inspections shall be conducted at a case temperature (T_C) of $+25^{\circ}\text{C} \pm 3^{\circ}\text{C}$.

* TABLE I. Group A inspection.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical examination	2071					
<u>Subgroup 2</u>						
* Thermal impedance <u>2/</u>	3131	See 4.3.1	$Z_{\theta JX}$			°C/W
Collector to emitter breakdown voltage	3011	Bias condition D; $I_C = 100$ mA dc; $I_B = 0$; pulsed (see 4.5.1)	$V_{(BR)CEO}$	80		V dc
Collector to emitter cutoff current	3041	Bias condition C; $V_{CE} = 60$ V dc; $V_{BE} = 0$	I_{CES1}		1.0	μA dc
Collector to emitter cutoff current	3041	Bias condition C; $V_{CE} = 100$ V dc; $V_{BE} = 0$	I_{CES2}		1.0	mA dc
Collector to emitter cutoff current	3041	Bias condition D; $V_{CE} = 40$ V dc; $I_B = 0$	I_{CEO}		50	μA dc
Emitter to base cutoff current	3061	Bias condition D; $V_{EB} = 4$ dc; $I_C = 0$	I_{EBO1}		1.0	μA dc
Emitter to base cutoff current	3061	Bias condition D; $V_{EB} = 5.5$ dc; $I_C = 0$	I_{EBO2}		1.0	mA dc
Forward-current transfer ratio	3076	$V_{CE} = 5.0$ V dc; $I_C = 50$ mA dc; pulsed (see 4.5.1)	h_{FE1}	50		
Forward-current transfer ratio	3076	$V_{CE} = 5.0$ V dc; $I_C = 2.5$ A dc; pulsed (see 4.5.1)	h_{FE2}	70	200	
Forward-current transfer ratio	3076	$V_{CE} = 5.0$ V dc; $I_C = 5.0$ A dc; pulsed (see 4.5.1)	h_{FE3}	40		
Base to emitter non-saturated voltage	3066	Test condition B; $V_{CE} = 5.0$ V dc, $I_C = 2.5$ A dc, pulsed (see 4.5.1)	V_{BE}		1.45	V dc
Base to emitter saturated voltage	3066	Test condition A; $I_C = 2.5$ A dc $I_B = 250$ mA dc, pulsed (see 4.5.1)	$V_{BE(SAT)1}$		1.45	V dc

See footnote at end of table.

MIL-PRF-19500/612C

* TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 2</u> - Continued						
Base to emitter saturated voltage	3066	Test condition A; $I_C = 5.0$ A dc, $I_B = 500$ mA dc; pulsed (see 4.5.1)	$V_{BE(SAT)2}$		2.2	V dc
Collector to emitter saturated voltage	3071	$I_C = 2.5$ A dc; $I_B = 250$ mA dc; pulsed (see 4.5.1)	$V_{CE(sat)1}$		0.75	V dc
Collector to emitter saturated voltage	3071	$I_C = 5.0$ A dc; $I_B = 500$ mA dc; pulsed (see 4.5.1)	$V_{CE(sat)2}$		1.5	V dc
<u>Subgroup 3</u>						
High-temperature operation:		$T_A = +150^\circ\text{C}$				
Collector to emitter cutoff current	3041	Bias condition A; $V_{CE} = 60$ V dc; $V_{BE(OFF)} = +2$ V dc	I_{CEX}		500	μA dc
Low-temperature operation:		$T_A = -55^\circ\text{C}$				
Forward-current transfer ratio	3076	$V_{CE} = 5.0$ V dc; $I_C = 2.5$ A dc	h_{FE4}	25		
<u>Subgroup 4</u>						
Common-emitter, small-signal short-circuit forward-current transfer ratio	3206	$V_{CE} = 5$ V dc; $I_C = 100$ mA dc; $f = 1$ kHz	h_{fe}	50		
Magnitude of common emitter small-signal short-circuit forward-current transfer ratio	3206	$V_{CE} = 5$ V dc; $I_C = 500$ mA dc; $f = 10$ MHz	$ h_{fe} $	7		
Open circuit output capacitance	3236	$V_{CB} = 10$ V dc; $I_E = 0$; 100 kHz $\leq f \leq 1$ MHz	C_{obo}		250	pF
* Switching time	3251	Test condition A; except test circuit figure 4 and as follows: $I_C = 5$ A dc; $I_{B1} = 500$ mA dc, $I_{B2} = -500$ mA dc, $V_{BE(off)} = 3.7$ V dc, $R_L = 6 \Omega$;	t_{on} t_s t_f t_{off}		0.5 1.4 0.5 1.5	μs μs μs μs

See footnote at end of table.

* TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 5</u>						
Safe operating area (continuous dc)	3055	Pre-pulse condition for each test: $V_{CE} = 0, I_C = 0, T_C = +25^\circ\text{C}$ Pulse condition for each test: $t_p = 1$ second, 1 cycle $T_C = +25^\circ\text{C}$ (see figure 2)				
<u>Test 1</u>		$V_{CE} = 12$ V dc, $I_C = 5$ A dc				
<u>Test 2</u>		$V_{CE} = 32$ V dc, $I_C = 1.5$ A dc				
<u>Test 3</u>		$V_{CE} = 80$ V dc, $I_C = 100$ mA dc				
Safe operating area (unclamped inductive)	3053	$T_C = +25^\circ\text{C}; R_{BB1} = 10$ ohms; $R_{BB2} = 100$ ohms; $L = 0.3$ mH $R_L = 0.1$ ohms; $V_{CC} = 10$ V dc $V_{BB1} = 10$ V dc; $V_{BB2} = 4$ V dc $I_{CM} = 10$ A dc (see figure 3)				
* Electrical measurements		Table I, subgroup 2, except for thermal impedance.				
<u>Subgroups 6 and 7</u>						
Not applicable.						

1/ For sampling plan, see MIL-PRF-19500.

2/ This test required for the following end-point measurements only:
Group B, subgroups 3, 4, and 5 (JANS).
Group B, subgroups 2 and 3 (JAN, JANTX, and JANTXV).
Group C, subgroups 2 and 6.
Group E, subgroup 1.

MIL-PRF-19500/612C

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

Inspection	MIL-STD-750		Qualification and large lot quality conformance inspection
	Method	Conditions	
<u>Subgroup 1</u>			45 devices c = 0
Temperature cycling	1051	500 cycles	
Hermetic seal	1071		
Fine leak		Test conditions G or H	
Gross leak		Test conditions C or D	
Electrical measurements		Table I, subgroup 2 herein.	
<u>Subgroup 2</u>			45 devices c = 0
Blocking life	1048	Test temperature = +125°C; V _{CB} = 30 V dc; T = 1,000 hours.	
Electrical measurements		Table I, subgroup 2 herein.	
<u>Subgroup 4</u>			Sample size N/A
Thermal impedance curves		See MIL-PRF-19500.	
<u>Subgroup 5</u>			
Not applicable			
<u>Subgroup 6</u>			3 devices
ESD	1020	Testing not required for devices listed as class 3. Testing required for nonsensitive listing to prove capability.	
<u>Subgroup 8</u>			45 devices c = 0
Reverse stability	1033	Condition A	

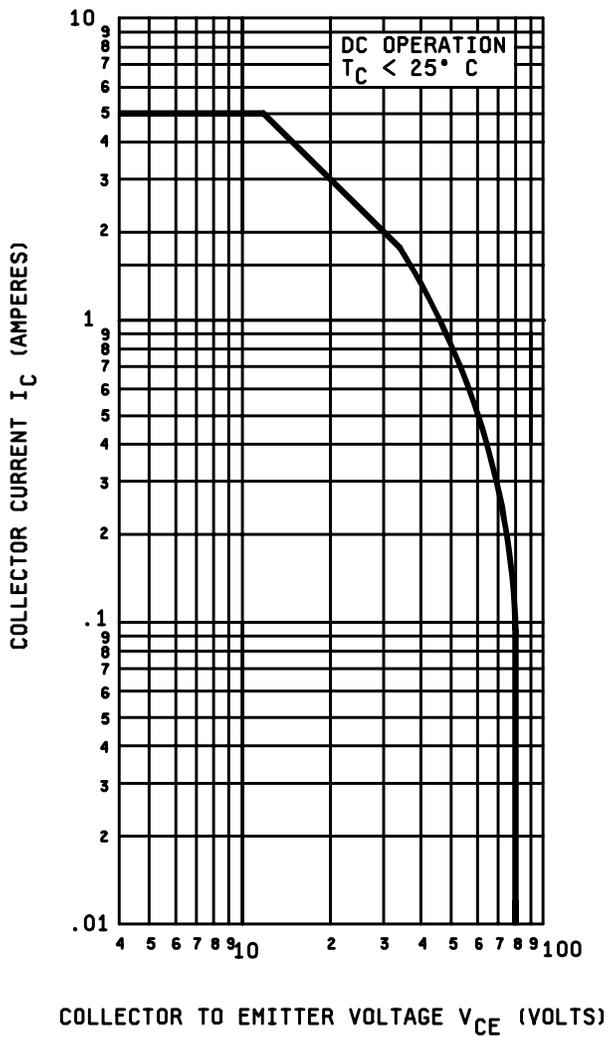


FIGURE 2. Maximum safe operating area.

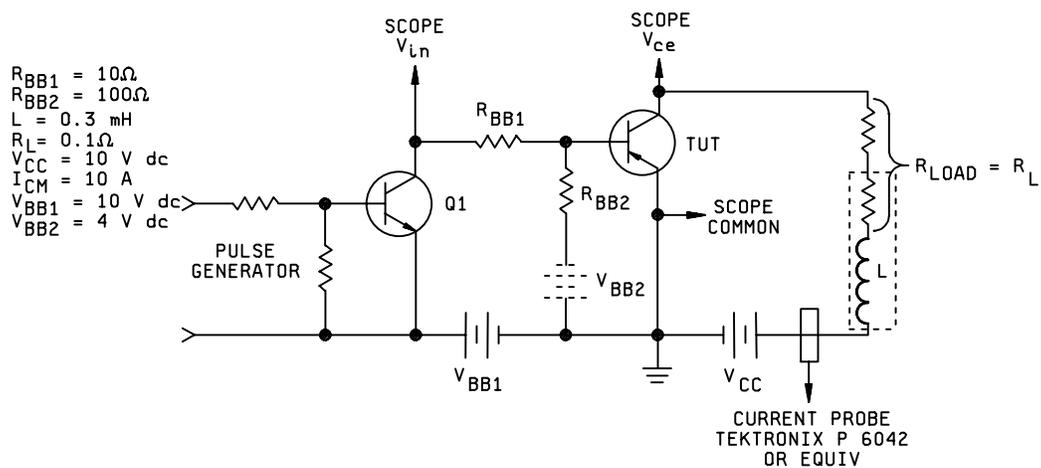
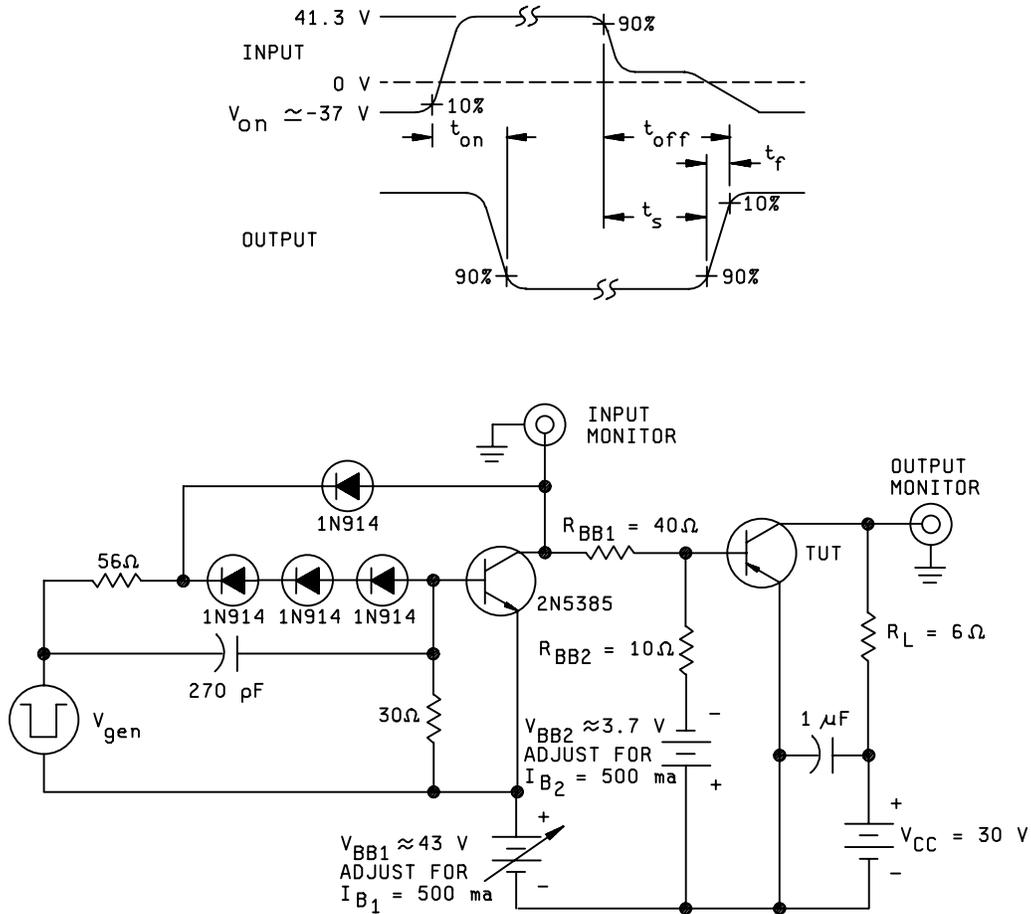


FIGURE 3. Unclamped inductive load energy test circuit.



NOTES:

1. V_{gen} is -30 pulse (from 0 V) into a 50 ohm termination.
2. The V_{gen} waveform is supplied by a generator with the following characteristics: $t_r \leq 15$ ns, $t_f = 15$ ns, $Z_{OUT} = 50$ ohm, duty cycle ≤ 2 percent.
3. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 15$ ns, $R_{IN} \geq 10$ M Ω , $C_{IN} \leq 11.5$ pF.
4. Resistors shall be noninductive types.
5. The dc power supplies may require additional bypassing in order to minimize ringing.

FIGURE 4. Switching time test circuit.

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.)

6.1 Intended use. The notes specified in MIL-PRF-19500 are applicable to this specification.

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 or formation (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 Defense Supply Center, Columbus, ATTN: DSCC/VQE, P.O. Box 3990, Columbus, OH 43218-3990 or e-mail vqe.chief@dla.mil.

6.4 Interchangeability information. MIL-PRF-19500/612 is a TO-254 package version of MIL-PRF-19500/535, which is a TO-210 (TO-59) package version. The military 2N7372 contains the same die as the military 2N5005. The MIL-PRF-19500/612 is preferred over the MIL-PRF-19500/535 whenever interchangeability is not a problem. For new design use 2N7372. The 2N5005 is inactive for new design.

6.5 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 - 11
NASA - NA
DLA - CC

Preparing activity:
DLA - CC

(Project 5961-2005-019)

Review activities:

Army - AR, MI, SM
Navy - AS, MC
Air Force - 19, 99

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