The documentation and process conversion measures necessary to comply with this document shall be completed by 10 September 2013.

INCH-POUND

MIL-PRF-19500/485N
10 June 2013
SUPERSEDING
MIL-PRF-19500/485M
1 June 2010

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, SILICON, LOW-POWER TYPES: 2N5415, 2N5415S, 2N5415UA, 2N5415U4, 2N5416, 2N5416S, 2N5416UA, AND 2N5416U4, JAN, JANTX, JANTXV, JANS, JANSM, JANSD, JANSP, JANSL, JANSR, JANSF, JANSG, JANSH, JANHCB, JANHCD, JANKCB, JANKCD, JANKCBM, JANKCBD, JANKCBP, JANKCBL, JANKCBR, JANKCBF, JANKCBG, AND JANKCBH

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, switching transistors. Four levels of product assurance are provided for each device type as specified in MIL-PRF-19500. Two levels of product assurance are provided for each unencapsulated device type. Provisions for radiation hardness assurance (RHA) to eight radiation levels is provided for JANTXV, JANS, JANHC, and JANKC product assurance levels. RHA level designators “M”, “D”, “P“, “L”, “R”, “F”, “G”, and “H” are appended to the device prefix to identify devices, which have passed RHA requirements.

1.2 Physical dimensions. See figure 1 (similar to TO-5), figures 2 and 3 for JANHC and JANKC (die) dimensions, figure 4 for UA package, and figure 5 for U4.

1.3 Maximum ratings. Unless otherwise specified, T_A = +25°C.

Types	P_T (1) T_A = +25°C	P_T (2) T_C = +25°C	P_T (3) T_{SP} = +25°C	$R_{\theta JA}$	$R_{\theta JC}$	$R_{\theta JSP}$	V_{CBO}	V_{CEO}	V_{EBO}	I_C	T_{STG} and T_J
	W	W	W	°C/W	°C/W	°C/W	V dc	V dc	V dc	A dc	°C
2N5415, S	0.75	10		234	17.5	N/A	200	200	6.0	1.0	
2N5415UA	0.75		2	234		80	200	200	6.0	1.0	-65 to +200
2N5415U4	1	15		145	12	N/A	200	200	6.0	1.0	
2N5416, S	0.75	10		234	17.5	N/A	350	300	6.0	1.0	
2N5416UA	0.75		2	234		80	350	300	6.0	1.0	
2N5416U4	1	15		145	12	N/A	350	300	6.0	1.0	

(1) Derate linearly 4.29 mW/°C for T_A > +25°C. 6.90 mW/°C for U4.
(2) Derate linearly 57.2 mW/°C for T_C > +25°C. 86 mW/°C for U4.
(3) Derate linearly 12.5 mW/°C for T_{SP} > +25°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 . Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil .

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1.4 Primary electrical characteristics.

	h_{FE1} I_C = 50 mA dc, (1) V_{CE} = 10 V dc	C_{obo} I_E = 0 V_{CB} = 10 V dc, 100 kHz $\leq$ f $\leq$ 1 MHz	$\|h_{fe}\|$ I_C = 10 mA dc V_{CE} = 10 V dc, f = 5 MHz	V_{BE} I_C = 50 mA dc, (1) V_{CE} = 10 V dc	$V_{CE(sat)}$ I_C = 50 mA dc, (1) I_B = 5 mA dc
		pF		V dc	V dc
Min	30		3		
Max	120	15	15	1.5	2.0

(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 http://quicksearch.dla.mil or https://assist.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.

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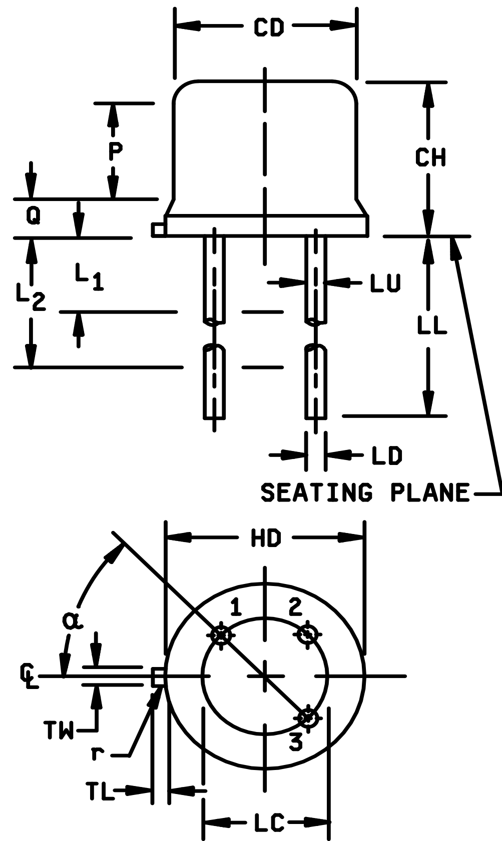
Dimensions					
Symbol	Inches		Millimeters		Notes
	Min	Max	Min	Max	
CD	.305	.335	7.75	8.51	
CH	.240	.260	6.10	6.60	
HD	.335	.370	8.51	9.40	
LC	.200 TP		5.08 TP		6
LD	.016	.021	0.41	0.53	7, 8
LL	See notes				7, 8, 11,12
LU	.016	.019	0.41	0.48	7, 8
L_1		.050		1.27	7, 8
L_2	.250		6.35		7, 8
P	.100		2.54		5
Q		.050		1.27	4
r		.010		0.25	10
TL	.029	.045	0.74	1.14	3
TW	.028	.034	0.71	0.86	2
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, TH shall be held for a minimum length of .011 inch (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_1 and L_2. Dimension LD applies between L_2 and LL minimum. Diameter is uncontrolled in L_1 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. For transistor types 2N5415 and 2N5416, dimension LL shall be 1.5 inches (38.1 mm) minimum and 1.75 inches (44.4 mm) maximum.
12. For transistor types 2N5415S and 2N5416S, dimension LL shall be .5 inch (12.7 mm) minimum and .75 inch (19.0 mm) maximum.
13. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.
14. Lead 1 = emitter, lead 2 = base, lead 3 = collector.

FIGURE 1. Physical dimensions (similar to TO-5).

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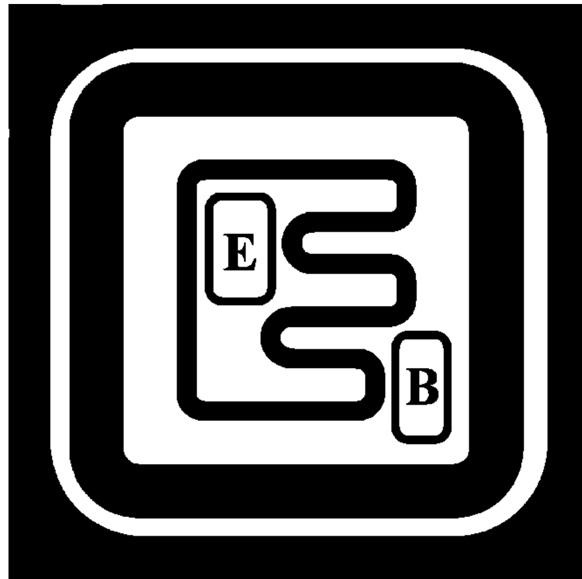

1. Chip size: .046 x .046 inch ±.002 inch (1.1684 x 1.1684 mm ±.0508 mm).
2. Chip thickness: .010 ±.0015 inch (.254 ±.0381 mm) nominal.
3. Top metal: Aluminum 30, 000 Å minimum, 33, 000 Å nominal.
4. Back metal: A. Gold 3, 500 Å minimum, 5, 000 Å nominal.
5. Backside: Collector.
6. Bonding pad: B = .005 x .008 inch (.127 x .2032 mm), E = .010 x .007 inch (.254 x .1778 mm).

FIGURE 2. JANHCB and JANKCB (B-version) die dimensions.

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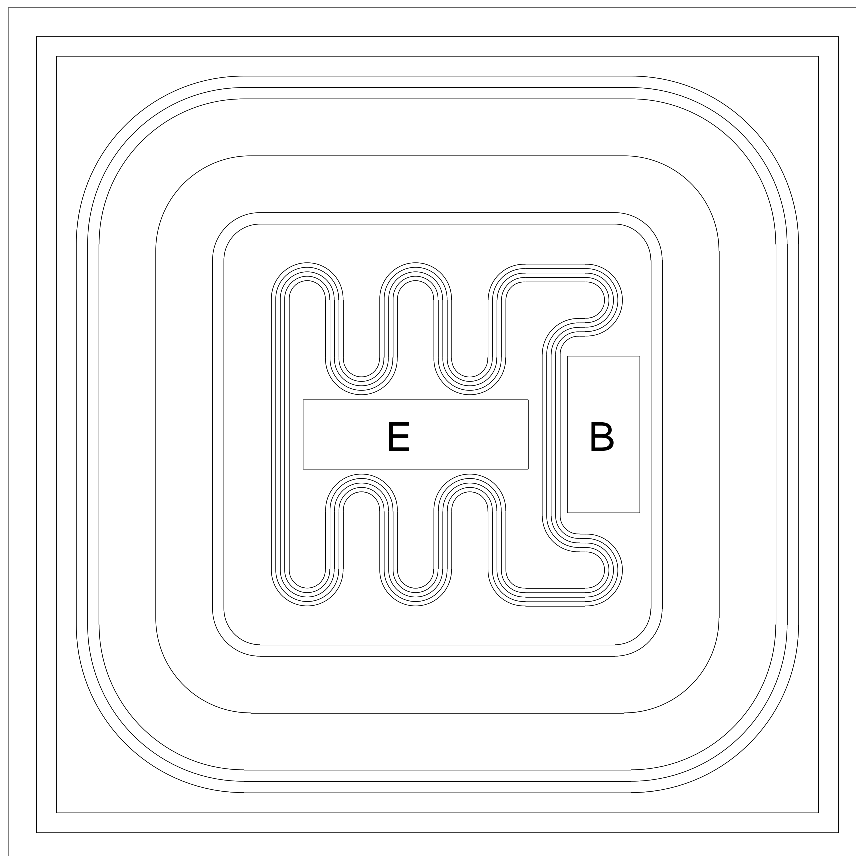

Die size:	.045 x .045 inch (1.143 x 1.143 mm).
Die thickness:	.008 ±.0016 inch (0.2032 ±0.04064 mm).
Base pad:	.0085 x .00425 inch (0.2159 x 0.10795 mm).
Emitter pad:	.004 x .0125 inch (0.1016 x 0.3175 mm).
Back metal:	Gold, 6,500 ±1,950 Å.
Top metal:	Aluminum, 20,000 ±2,000 Å.
Back side:	Collector.
Glassivation:	SiO_2, 7,500 ±1,500 Å.

FIGURE 3. JANHCD and JANKCD (D-version) die dimensions.

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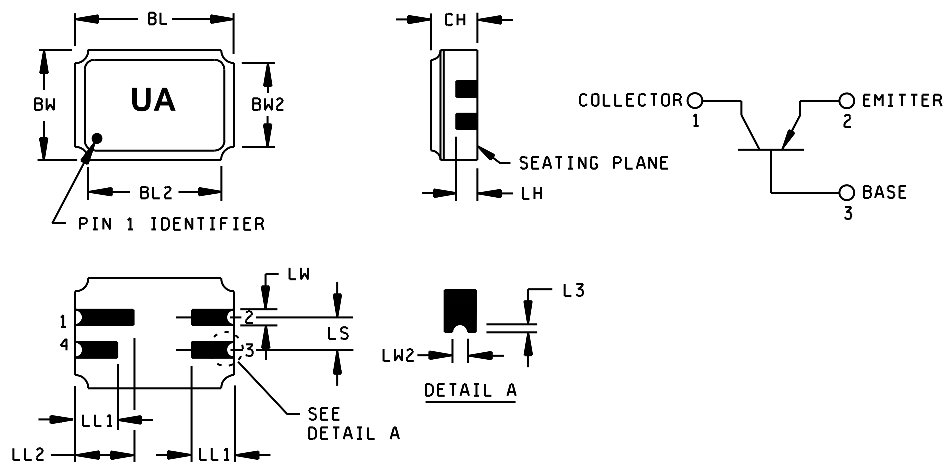

Symbol	Dimensions				Note
	Inches		Millimeters		
	Min	Max	Min	Max	
BL	.215	.225	5.46	5.71	
BL2		.225		5.71	
BW	.145	.155	3.68	3.93	
BW2		.155		3.93	
CH	.061	.075	1.55	1.91	3
L3	.003		0.08		5
LH	.029	.042	0.74	1.07	

Symbol	Dimensions				Note
	Inches		Millimeters		
	Min	Max	Min	Max	
LL1	.032	.048	0.81	1.22	
LL2	.072	.088	1.83	2.23	
LS	.045	.055	1.14	1.39	
LW	.022	.028	0.56	0.71	
LW2	.006	.022	0.15	0.56	5

Pin Number	1	2	3	4
Transistor	Collector	Emitter	Base	N/C

NOTES:
1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Dimension "CH" controls the overall package thickness. When a window lid is used, dimension "CH" must increase by a minimum of .010 inch (0.254 mm) and a maximum of .040 inch (1.016 mm).
4. The corner shape (square, notch, radius, etc.) may vary at the manufacturer's option, from that shown on the drawing.
* 5. Dimensions "LW2" minimum and "L3" minimum and the appropriate castellation length define an unobstructed three-dimensional space traversing all of the ceramic layers in which a castellation was designed. (Castellations are required on bottom two layers, optional on top ceramic layer.) Dimension "LW2" maximum define the maximum width and depth of the castellation at any point on its surface. Measurement of this dimension may be made prior to solder dipping.
6. The coplanarity deviation of all terminal contact points, as defined by the device seating plane, shall not exceed .006 inch (0.15mm) for solder dipped leadless chip carriers.
7. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

* FIGURE 4. Physical dimensions, surface mount (UA version).

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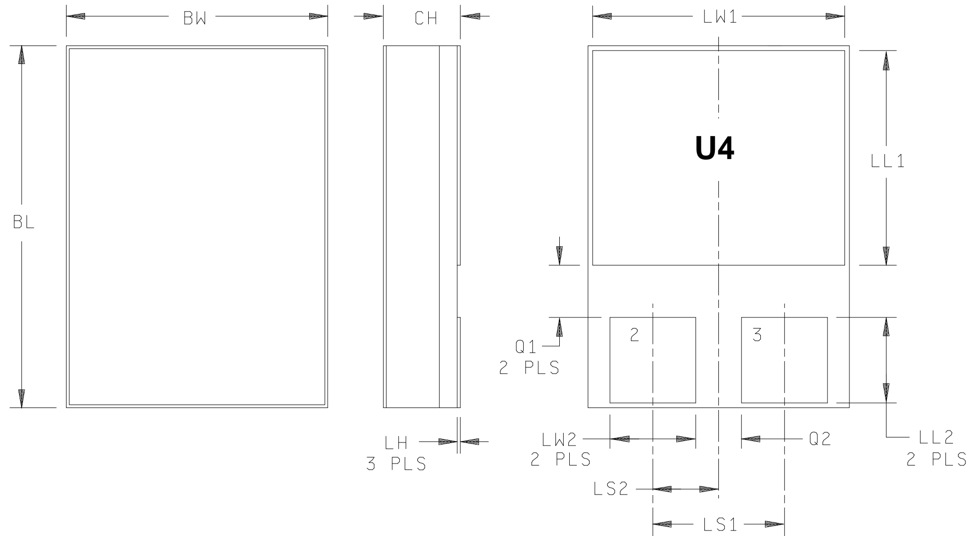

Symbol	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
BL	.215	.225	5.46	5.71
BW	.145	.155	3.68	3.94
CH	.049	.075	1.24	1.90
LH		.020		0.508
LL1	.085	.125	2.16	3.17
LL2	.045	.075	1.14	1.91
LS1	.070	.095	1.78	2.41
LS2	.035	.048	0.89	1.22
LW1	.135	.145	3.43	3.68
LW2	.047	.057	1.19	1.45
Q1	.030	.070	0.76	1.78
Q2	.020	.035	0.51	0.89

NOTES:
1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Terminal 1 is collector.
4. Terminal 2 is base.
5. Terminal 3 is emitter.
6. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

FIGURE 5. Physical dimensions, surface mount (2N5415U4, 2N5416U4) version (U4) (SMD-.22).

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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 and as follows.

$R_{\theta JA}$ .... Thermal resistance junction to ambient.
$R_{\theta JC}$ .... Thermal resistance junction to case.
$R_{\theta JSP}$........................Thermal resistance junction to solder pads.
T_{SP} ....Temperature of solder pads.

3.4 Interface and physical dimensions. Interface and physical dimensions shall be as specified in MIL-PRF-19500 and on figures 1, 2, 3, 4, and 5 herein.

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 Construction. These devices shall be constructed in a manner and using materials which enable the devices to meet the applicable requirements of MIL-PRF-19500 and this document.

3.5 Radiation hardness assurance (RHA). Radiation hardness assurance requirements, PIN designators, and test levels shall be as defined in 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 and II.

3.7 Electrical test requirements. The electrical test requirements shall be the subgroups specified in table I and II herein.

3.8 Marking. Marking shall be in accordance with MIL-PRF-19500. The radiation hardened designator M, D, P, L, R, F, G, or H shall immediately precede (or replace) the device “2N” identifier (depending upon degree of abbreviation required).

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 tables I, II, and III).

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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 III tests, the tests specified in table III herein that were not performed in the prior revision shall be performed on the first inspection lot of this revision to maintain qualification.

4.2.2 JANHC and JANKC die. Qualification for die shall be in accordance with MIL-PRF-19500.

4.3 Screening (list applicable JAN levels). 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	
	JANS level	JANTX and JANTXV levels
(1) 3c	Thermal impedance method 3131 of MIL-STD-750, see 4.3.2.	Thermal impedance method 3131 of MIL-STD-750, see 4.3.2.
9	I_{CEX} and h_{FE1}	Not applicable.
10	48 hours minimum.	48 hours minimum.
11	I_{CEX} , h_{FE1} ΔI_{CEX} = 100 percent of initial value or 2.5 µA dc, whichever is greater; Δh_{FE1} = ±15 percent of initial value.	I_{CEX} and h_{FE1}
12	See 4.3.1.	See 4.3.1.
13	Subgroups 2 and 3 of table I herein; ΔI_{CEX} = 100 percent of initial value or 2.5 µA dc, whichever is greater; Δh_{FE1} = ±15 percent of initial value.	Subgroup 2 of table I herein; ΔI_{CEX} = 100 percent of initial value or 2.5 µA dc, whichever is greater; Δh_{FE1} = ±20 percent of initial value.

(1) Shall be performed any time after temperature cycling, screen 3a; JANTX and JANTXV levels do not need to be repeated in screening requirements.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows: Method 1039 of MIL-STD-750, test condition B, V_{CB} = 10 - 30 V dc. Power shall be applied to achieve T_J = +135°C minimum using a minimum P_D = 75 percent of P_T maximum rated as defined in 1.3. With approval of the qualifying activity and preparing activity, alternate burn-in criteria (hours, bias conditions, T_J, and mounting conditions) may be used for JANTX and JANTXV quality levels. A justification demonstrating equivalence is required. In addition, the manufacturing site’s burn-in data and performance history will be essential criteria for burn-in modification approval.

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4.3.2 Thermal impedance. The thermal impedance measurements shall be performed in accordance with method 3131 of MIL-STD-750 using the guidelines in that method for determining I_M, I_H, t_H, t_{SW} (V_C and V_H where appropriate). Measurement delay time (t_{MD}) = 70 μs max. See table II, group E, subgroup 4 and figures 6, 7, and 8 herein.

4.3.3 Screening (JANHC and JANKC). Screening of JANHC and JANKC die shall be in accordance with MIL-PRF-19500, "Discrete Semiconductor Die/Chip Lot Acceptance". Burn-in duration for the JANKC level follows JANS requirements; the JANHC follows JANTX requirements.

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500, and as specified herein. If alternate screening is being performed per MIL-PRF-19500, a sample of screened devices shall be submitted to and pass the requirements of group A1 and A2 inspection only (table VIb, group B, subgroup 1 is not required to be performed again if group B has already been satisfied in accordance with 4.4.2).

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-PRF-19500, and table I herein. Electrical measurements (end-points) shall be in accordance with the applicable inspections of table I, subgroup 2 herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the tests and conditions specified for subgroup testing in table E-VIa (JANS) of MIL-PRF-19500 and 4.4.2.1 herein. Electrical measurements (end-points) requirements shall be in accordance with table I, subgroup 2 herein. See 4.4.2.2 for JAN, JANTX, and JANTXV group B testing. Electrical measurements (end-points) for JAN, JANTX, and JANTXV shall be after each step in 4.4.2.2 and shall be in accordance with table I, subgroup 2 herein.

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

Subgroup	Method	Conditions
B4	1037	V_{CB} = 10 V dc; 2,000 cycles. Adjust device current, or power, to achieve a minimum ΔT_J of 100°C.
B5	1027	(NOTE: If a failure occurs, resubmission shall be at the test conditions of the original sample.) V_{CB} = 10 V dc, $P_D \geq$ 100 percent of maximum rated P_T (see 1.3). Option 1: 96 hours minimum sample size in accordance with table E-VIa of MIL-PRF-19500, adjust T_A or P_D to achieve T_J = +275°C minimum. Option 2: 216 hours minimum, sample size = 45, c = 0; adjust T_A or P_D to achieve T_J = +225°C minimum.

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4.4.2.2 Group B inspection, (JAN, JANTX, and JANTXV). Separate samples may be used for each step. In the event of a lot failure, the resubmission requirements of MIL-PRF-19500 shall apply. In addition, all catastrophic failures during CI shall be analyzed to the extent possible to identify root cause and corrective action.

Step	Method	Conditions
1	1026	Steady-state life: 1,000 hours minimum, V_{CB} = 10 V dc, power shall be applied to achieve T_J = +150°C minimum using a minimum of P_D = 75 percent of maximum rated P_T as defined in 1.3. n = 45 devices, c = 0. The sample size may be increased and the test time decreased as long as the devices are stressed for a total of 45,000 device hours minimum, and the actual time of test is at least 340 hours.
2	1048	Blocking life, T_A = +150°C, V_{CB} = 80 percent of rated voltage, 48 hours minimum. n = 45 devices, c = 0.
3	1032	High-temperature life (non-operating), t = 340 hours, T_A = +200°C. n = 22, c = 0.

4.4.2.3 Group B sample selection. Samples selected from group B inspection shall meet all of the following requirements:

a. For JAN, JANTX, and JANTXV samples shall be selected randomly from a minimum of three wafers (or from each wafer in the lot) from each wafer lot. For JANS, samples shall be selected from each inspection lot. See MIL-PRF-19500.

b. Shall be chosen from an inspection lot that has been submitted to and passed table I, subgroup 2, conformance inspection. When the final lead finish is solder or any plating prone to oxidation at high temperature, the samples for life test (subgroups B4 and B5 for JANS, and group B for JAN, JANTX, and JANTXV) may be pulled prior to the application of final lead finish.

4.4.3 Group C inspection, Group C inspection shall be conducted in accordance with the test and conditions specified for subgroup testing in table E-VII of MIL-PRF-19500, and in 4.4.3.1 (JANS) and 4.4.3.2 (JAN, JANTX, and JANTXV) herein for group C testing. Electrical measurements (end-points) requirements shall be in accordance with table I, subgroup 2 herein.

4.4.3.1 Group C inspection (JANS), table E-VII of MIL-PRF-19500.

Subgroup	Method	Condition
C2	2036	Test condition E; (not applicable for UA and U4 devices).
C5	3131	$R_{\theta JA}$ and $R_{\theta JC}$ only, as applicable (see 1.3) and in accordance with thermal impedance curves.
C6	1026	V_{CB} = 10 - 30 V dc; power shall be applied to achieve T_J = +150°C minimum and a minimum of P_D = 75 percent of maximum rated P_T as defined in 1.3. n = 45 devices, c = 0. The sample size may be increased and the test time decreased as long as the devices are stressed for a total of 45,000 device hours minimum, and the actual time of test is at least 340 hours.

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4.4.3.2 Group C inspection (JAN, JANTX, and JANTXV), table E-VII of MIL-PRF-19500.

Subgroup	Method	Condition
C2	2036	Test condition E; not applicable for UA and U4 devices.
C5	3131	$R_{\theta JA}$ and $R_{\theta JC}$ only, as applicable (see 1.3 and 4.3.2) and in accordance with thermal impedance curves.
C6		Not applicable.

4.4.3.3 Group C sample selection. Samples for subgroups in group C shall be chosen at random from any inspection lot containing the intended package type and lead finish procured to the same specification which is submitted to and passes group A tests for conformance inspection. When the final lead finish is solder or any plating prone to oxidation at high temperature, the samples for C6 life test may be pulled prior to the application of final lead finish. Testing of a subgroup using a single device type enclosed in the intended package type shall be considered as complying with the requirements for that subgroup.

4.4.4 Group D inspection. Conformance inspection for hardness assured JANS and JANKC types shall include the group D tests specified in table II herein. These tests shall be performed as required in accordance with MIL-PRF-19500 and method 1019 of MIL-STD-750, for total ionizing dose or method 1017 of MIL-STD-750 for neutron fluence as applicable (see 6.2 herein), except group D, subgroup 2 may be performed separate from other subgroups. Alternate package options may also be substituted for the testing provided there is no adverse effect to the fluence profile.

4.4.5 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.

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TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 1 2/						
Visual and mechanical 3/ examination	2071					
Solderability 3/ 4/	2026	n = 15 leads, c = 0				
Resistance to solvents 3/ 4/ 5/	1022	n = 15 devices, c = 0				
Temp cycling 3/ 4/	1051	Test condition C, 25 cycles. n = 22 devices, c = 0				
Hermetic seal 4/ Fine leak Gross leak	1071	n = 22 devices, c = 0				
Electrical measurements 4/		Table I, subgroup 2				
Bond strength 3/ 4/	2037	Precondition T_A = +250°C at t = 24 hrs or T_A = +300°C at t = 2 hrs n = 11 wires, c = 0				
Decap internal visual design verification	2075	n = 4, c = 0.				
Subgroup 2						
Thermal impedance 6/	3131	See 4.3.2	$Z_{\theta JX}$			°C/W
Collector to emitter cutoff current	3041	Bias condition D	I_{CE01}		50	µA dc
2N5415, S, UA, U4		V_{CE} = 150 V dc				
2N5416, S, UA, U4		V_{CE} = 250 V dc				
Collector to emitter cutoff current	3041	Bias condition D	I_{CE02}		1	mA dc
2N5415, S, UA, U4		V_{CE} = 200 V dc				
2N5416, S, UA, U4		V_{CE} = 300 V dc				
Collector to emitter cutoff current	3041	Bias condition A, V_{BE} = 1.5 V dc	I_{CEX}		50	µA dc
2N5415, S, UA, U4		V_{CE} = 200 V dc				
2N5416, S, UA, U4		V_{CE} = 300 V dc				
Emitter to base cutoff current	3061	Bias condition D, V_{EB} = 6 V dc	I_{EBO}		20	µA dc

See footnotes at end of table.

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TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 2 – Continued.						
Collector to base cutoff current	3036	Bias condition D	I_{CBO1}		50	µA dc
2N5415, S, UA, U4		V_{CB} = 175 V dc				
2N5416, S, UA, U4		V_{CB} = 280 V dc				
Collector to base cutoff current	3036	Bias condition D	I_{CBO2}		500	µA dc
2N5415, S, UA, U4		V_{CB} = 200 V dc				
2N5416, S, UA, U4		V_{CB} = 350 V dc				
Forward-current transfer ratio	3076	V_{CE} = 10 V dc, I_C = 50 mA dc, pulsed (see 4.5.1)	h_{FE1}	30	120	
Forward-current transfer ratio	3076	V_{CE} = 10 V dc, I_C = 1 mA dc, pulsed (see 4.5.1)	h_{FE2}	15		
Collector to emitter voltage (saturated)	3071	I_C = 50 mA dc, I_B = 5 mA dc, pulsed (see 4.5.1)	$V_{CE(sat)}$		2.0	V dc
Base emitter voltage saturation	3066	Test condition B, V_{CE} = 10 V dc, I_C = 50 mA dc, pulsed (see 4.5.1)	V_{BE}		1.5	V dc
Subgroup 3						
High temperature operation:		T_A = +150°C				
Collector to base cutoff current	3036	Bias condition D	I_{CB03}		1	mA dc
2N5415, S, UA, U4		V_{CB} = 175 V dc				
2N5416, S, UA, U4		V_{CE} = 280 V dc				
Low temperature operation:		T_A = -65°C				
Forward-current transfer ratio	3076	V_{CE} = 10 V dc, I_C = 50 mA dc, pulsed (see 4.5.1)	h_{FE3}	15		
Subgroup 4						
Small-signal short- circuit forward-current transfer ratio	3306	V_{CE} = 10 V dc, I_C = 10 mA dc, f = 5 MHz	$\|h_{fe}\|$	3	15	
Small-signal short- circuit forward-current transfer ratio	3206	V_{CE} = 10 V dc, I_C = 5 mA dc, $f \leq 1$ kHz	h_{fe}	25		
Open circuit output capacitance	3236	V_{CB} = 10 V dc, I_E = 0, 100 kHz $\leq f \leq$ 1 MHz	C_{obo}		15	pF
Input capacitance (output open-circuited)	3240	V_{EB} = 5 V dc, I_C = 0, 100 kHz $\leq f \leq$ 1 MHz	C_{ibo}		75	pF

See footnotes at end of table.

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TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 5						
Pulse response	3251	Test condition A				
Turn-on time		V_{CC} = 200 V dc, I_C = 50 mA dc, I_{B1} = 5 mA dc, (see figure 9).	t_{on}		1	μs
Turn-off time		V_{CC} = 200 V dc, I_C = 50 mA dc, I_{B1} = I_{B2} = 5 mA dc, (see figure 9).	t_{off}		10	μs
Subgroup 6						
Not applicable						
Subgroup 7						
Breakdown voltage, collector to emitter	3011	I_C = 50 mA dc, I_B = 5 mA dc, L = 25 mH; f = 30 - 60 Hz, (see figure 10).	$V_{(BR)CEO}$			
2N5415, S, UA, U4				200		V dc
2N5416, S, UA, U4				300		V dc
Safe operating area (continuous dc)	3051	T_C = +25°C, 1 cycle, t = 0.4 s, (see figures 11, 12, and 13). n = 22, c = 0				
Test 1 (except UA)		V_{CE} = 10 V dc, I_C = 1 A dc.				
Test 2 (except UA)		V_{CE} = 100 V dc, I_C = 100 mA dc.				
Test 3 (except UA)		V_{CE} = 200 V dc.				
(2N5415, S, U4 only)		I_C = 24 mA dc.				
Test 4		V_{CE} = 300 V dc.				
(2N5416, S, U4 only)		I_C = 10 mA dc.				
Test 1 UA only		V_{CE} = 10 V dc, I_C = 0.3 A dc.				
Test 2 UA only		V_{CE} = 100 V dc, I_C = 30 mA dc.				
Test 3 UA only		V_{CE} = 200 V dc.				
(2N5415UA only)		I_C = 12 mA dc.				
Test 4		V_{CE} = 300 V dc.				
(2N5416UA only)		I_C = 5 mA dc.				
Electrical measurements		See table I, subgroup 2 herein.				

1/ For sampling plan see MIL-PRF-19500.
2/ For resubmission of failed subgroup 1, double the sample size of the failed test or sequence of tests. A failure in table I, subgroup 1 shall not require retest of the entire subgroup. Only the failed test shall be rerun upon submission.
3/ Separate samples may be used.
4/ Not required for JANS devices.
5/ Not required for laser marked devices.
6/ This test required for the following end-point measurements only:
Group B, step 1 of 4.4.2.2 herein (JAN, JANTX, and JANTXV).
Group B, subgroups 3, 4, and 5 (JANS).
Group C, subgroup 2 and 6.
Group E, subgroup 1 and 2.

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TABLE II. Group D inspection.

Inspection 1/ 2/ 3/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 1 4/						
Neutron irradiation	1017	Neutron exposure Vces = 0 V				
Collector to emitter cutoff current 2N5415, S, UA, U4 2N5416, S, UA, U4	3041	Bias condition D V_{CE} = 150 V dc V_{CE} = 250 V dc	I_{CE01}		100	µA dc
Collector to emitter cutoff current 2N5415, S, UA, U4 2N5416, S, UA, U4	3041	Bias condition D V_{CE} = 200 V dc V_{CE} = 300 V dc	I_{CE02}		2	mA dc
Collector to emitter cutoff current 2N5415, S, UA, U4 2N5416, S, UA, U4	3041	Bias condition D, V_{BE} = 1.5 V dc V_{CE} = 200 V dc V_{CE} = 300 V dc	I_{CEX}		100	µA dc
Emitter to base cutoff current	3061	Bias condition D, V_{EB} = 6 V dc	I_{EBO}		40	µA dc
Collector to base cutoff current 2N5415, S, UA, U4 2N5416, S, UA, U4	3036	Bias condition D V_{CB} = 175 V dc V_{CB} = 280 V dc	I_{CBO1}		100	µA dc
Collector to base cutoff current 2N5415, S, UA, U4 2N5416, S, UA, U4	3036	Bias condition D V_{CB} = 200 V dc V_{CB} = 350 V dc	I_{CBO2}		1	mA dc
Forward-current transfer ratio	3076	V_{CE} = 10 V dc, I_C = 50 mA dc, pulsed (see 4.5.1)	[h_{FE1}] 5/	[15]	120	
Forward-current transfer ratio	3076	V_{CE} = 10 V dc, I_C = 1 mA dc, pulsed (see 4.5.1)	[h_{FE2}] 5/	[7.5]		
Collector to emitter voltage (saturated)	3071	I_C = 50 mA dc, I_B = 5 mA dc, pulsed (see 4.5.1)	$V_{CE(sat)}$		2.3	V dc
Base emitter voltage saturation	3066	Test condition B, V_{CE} = 10 V dc, I_C = 50 mA dc, pulsed (see 4.5.1)	V_{BE}		1.73	V dc

See footnotes at end of table.

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TABLE II. Group D inspection - Continued

Inspection 1/ 2/ 3/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 2						
Total dose irradiation 2N5415 2N5416	1019	Gamma exposure Vces = 160V Vces = 240V				
Collector to emitter cutoff current 2N5415, S, UA, U4 2N5416, S, UA, U4	3041	Bias condition D V_{CE} = 150 V dc V_{CE} = 250 V dc	I_{CE01}		100	µA dc
Collector to emitter cutoff current 2N5415, S, UA, U4 2N5416, S, UA, U4	3041	Bias condition D V_{CE} = 200 V dc V_{CE} = 300 V dc	I_{CE02}		2	mA dc
Collector to emitter cutoff current 2N5415, S, UA, U4 2N5416, S, UA, U4	3041	Bias condition D, V_{BE} = 1.5 V dc V_{CE} = 200 V dc V_{CE} = 300 V dc	I_{CEX}		100	µA dc
Emitter to base cutoff current	3061	Bias condition D, V_{EB} = 6 V dc	I_{EBO}		40	µA dc
Collector to base cutoff current 2N5415, S, UA, U4 2N5416, S, UA, U4	3036	Bias condition D V_{CB} = 175 V dc V_{CB} = 280 V dc	I_{CBO1}		100	µA dc
Collector to base cutoff current 2N5415, S, UA, U4 2N5416, S, UA, U4	3036	Bias condition D V_{CB} = 200 V dc V_{CB} = 350 V dc	I_{CBO2}		1	mA dc
Forward-current transfer ratio	3076	V_{CE} = 10 V dc, I_C = 50 mA dc, pulsed (see 4.5.1)	[h_{FE1}] 5/	[15]	120	
Forward-current transfer ratio	3076	V_{CE} = 10 V dc, I_C = 1 mA dc, pulsed (see 4.5.1)	[h_{FE2}] 5/	[7.5]		
Collector to emitter voltage (saturated)	3071	I_C = 50 mA dc, I_B = 5 mA dc, pulsed (see 4.5.1)	$V_{CE(sat)}$		2.3	V dc
Base emitter voltage saturation	3066	Test condition B, V_{CE} = 10 V dc, I_C = 50 mA dc, pulsed (see 4.5.1)	V_{BE}		1.73	V dc

1/ Tests to be performed on all devices receiving radiation exposure.
2/ For sampling plan, see MIL-PRF-19500.
3/ Electrical characteristics apply to all device types unless otherwise noted.
4/ See 6.2.e herein.
5/ See method 1019 of MIL-STD-750 for how to determine [h_{FE}] by first calculating the delta(1/h_{FE}) from the pre and post radiation h_{FE}. Notice that [h_{FE}] is not the same as h_{FE} and cannot be measured directly. The [h_{FE}] value can never exceed the pre-radiation minimum h_{FE} that it is based upon.

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TABLE III. Group E inspection (all quality levels) - for qualification or requalification only.

Inspection	MIL-STD-750		Qualification
	Method	Conditions	
Subgroup 1			45 devices c = 0
Temperature cycling (air to air)	1051	Test condition C, 500 cycles.	
Hermetic seal	1071		
Fine leak Gross leak			
Electrical measurements		See table I, subgroup 2 herein.	
Subgroup 2			45 devices c = 0
Intermittent life	1037	V_{CB} = 10 V dc, 6,000 cycles. Adjust device current, or power, to achieve a minimum ΔT_J of +100°C.	
Electrical measurements		See table I, subgroup 2 herein.	
Subgroup 4			15 devices, c = 0
Thermal resistance	3131	$R_{\theta JSP}$ can be calculated but shall be measured once in the same package with a similar die size to confirm calculations (may apply to multiple specification sheets).	
Thermal impedance curves		See MIL-PRF-19500, table E-IX, group E, subgroup 4.	
Subgroup 5			15 devices c = 0
Barometric pressure reduced (altitude operation).	1001	Normal mounting; pressure = 8 mm Hg for 60 seconds minimum.	
Subgroup 6			11 devices
ESD	1020		
Subgroup 8			45 devices c = 0
Reverse stability	1033	Condition A for devices ≥ 400 V dc. Condition B for devices < 400 V dc.	

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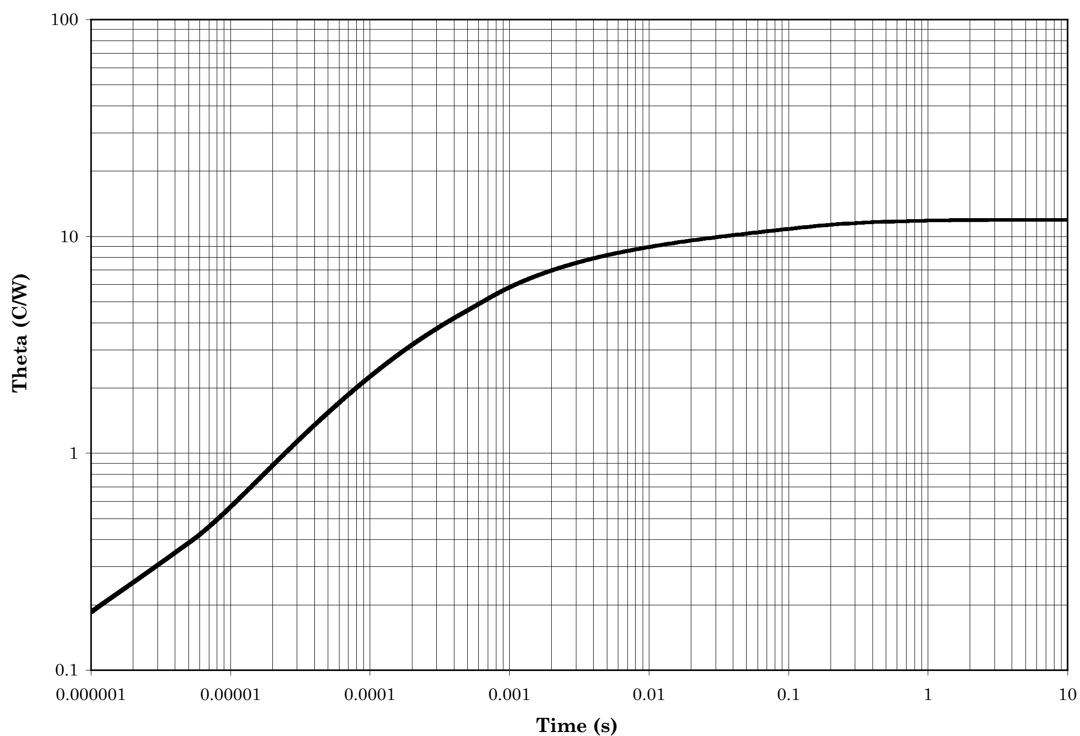

FIGURE 6. Thermal impedance graph ($R_{\theta JC}$) for 2N54115 and 2N5416 (U4).

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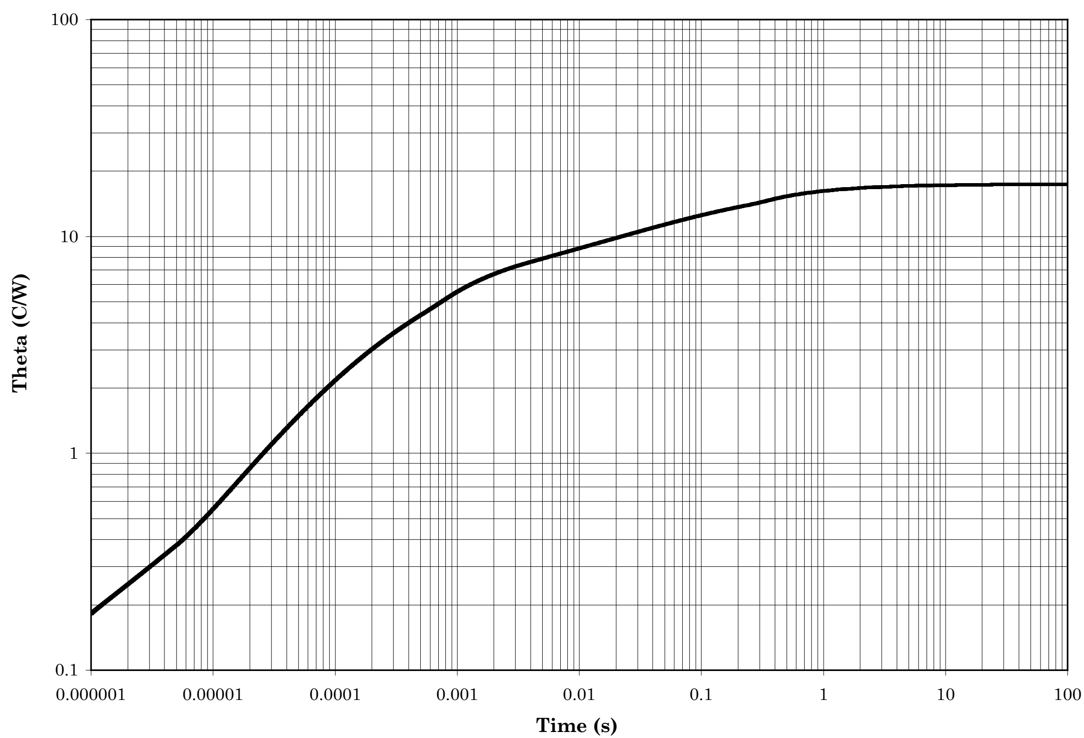

FIGURE 7. Thermal impedance graph ($R_{\theta JC}$) for 2N54115 and 2N5416 (TO-5).

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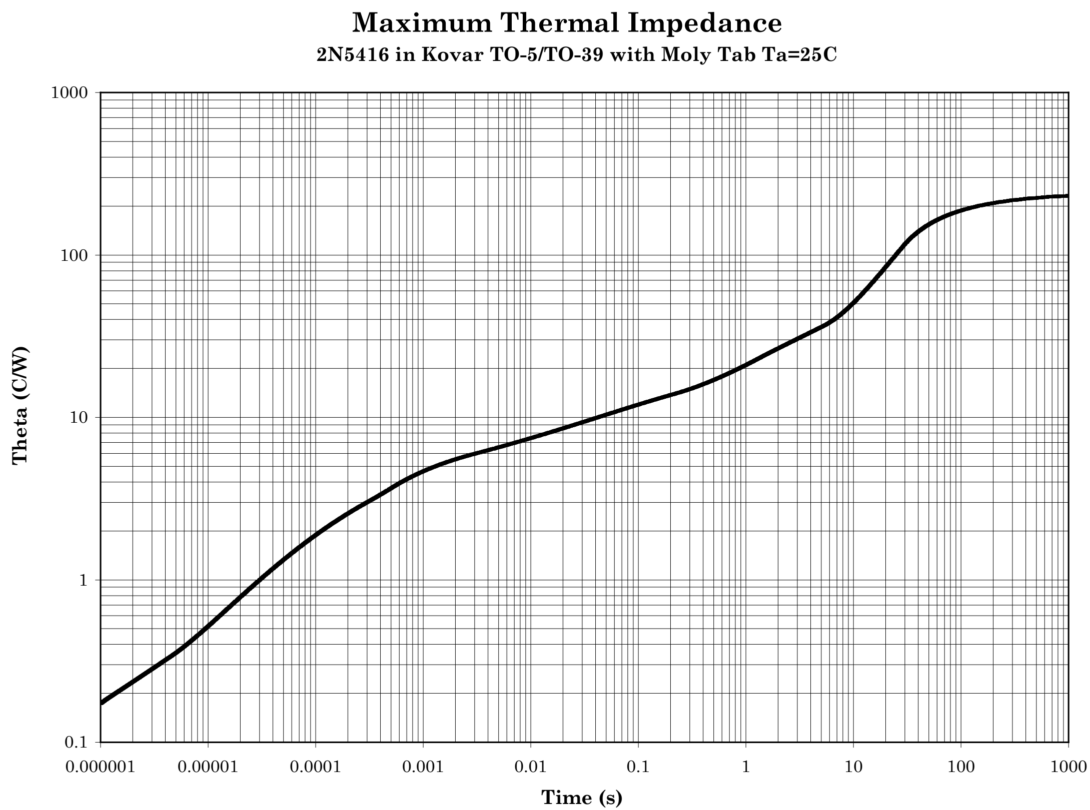

FIGURE 8. Thermal impedance graph ($R_{\theta JA}$) for 2N54115 and 2N5416 (TO-5).

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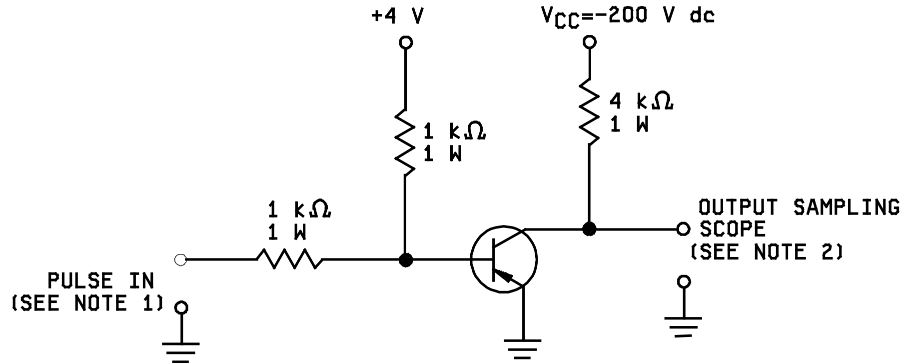

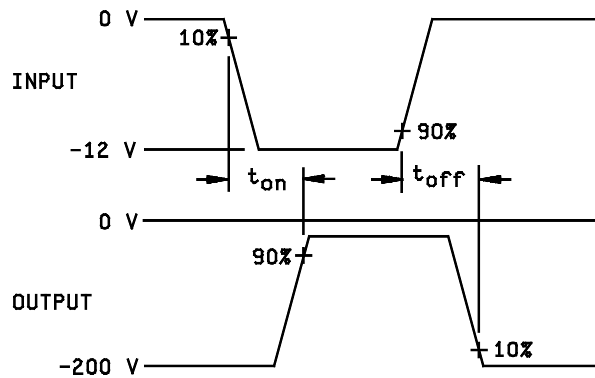

NOTES:

1. The rise time (t_r) and fall time (t_f) of applied pulse shall be each < 20 ns; duty cycle < 2 percent; generator source impedance shall be 50 Ω; pulse width = 20 µs.
2. Output sampling oscilloscope: Z_{in} > 100 kΩ; C_{in} < 50 pF; rise time < 2 ns.

FIGURE 9. Pulse response test circuit.

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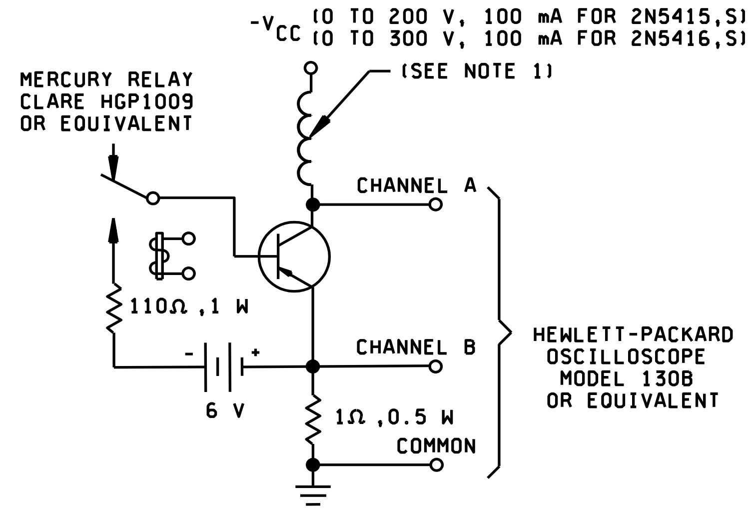

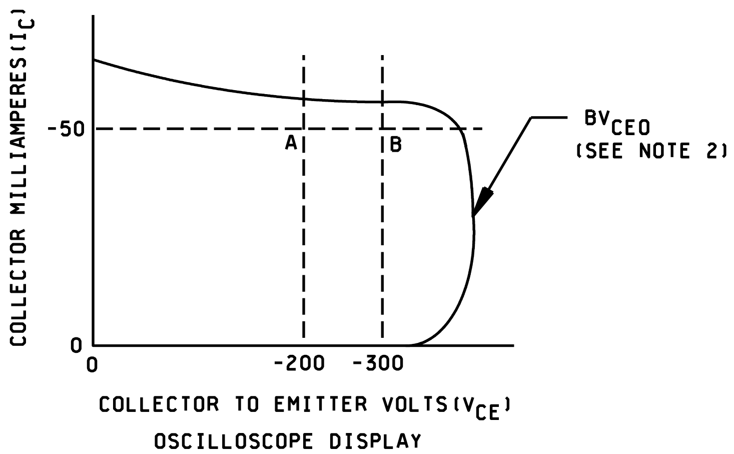

NOTES:

1. L = 25 mH, Q = 76, R = 83.4 Ω, I = 75 mA (J.W. Miller number 6308 or equivalent).
2. BV_{CEO} is acceptable when the trace falls to the right and above point “A” for type 2N5415. The trace shall fall to the right and above point “B” for type 2N5416.

FIGURE 10. BV_{CEO} measurement test circuit.

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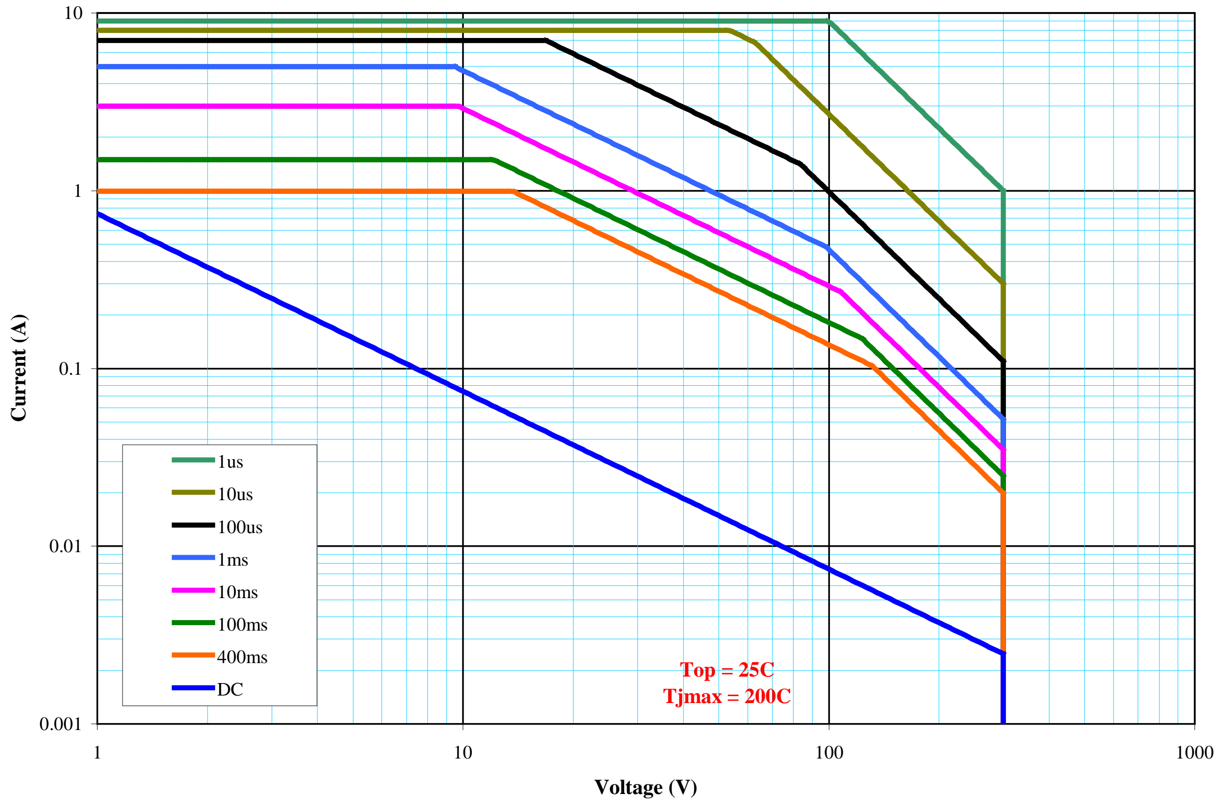

FIGURE 11. Maximum safe operating graph (continuous dc).

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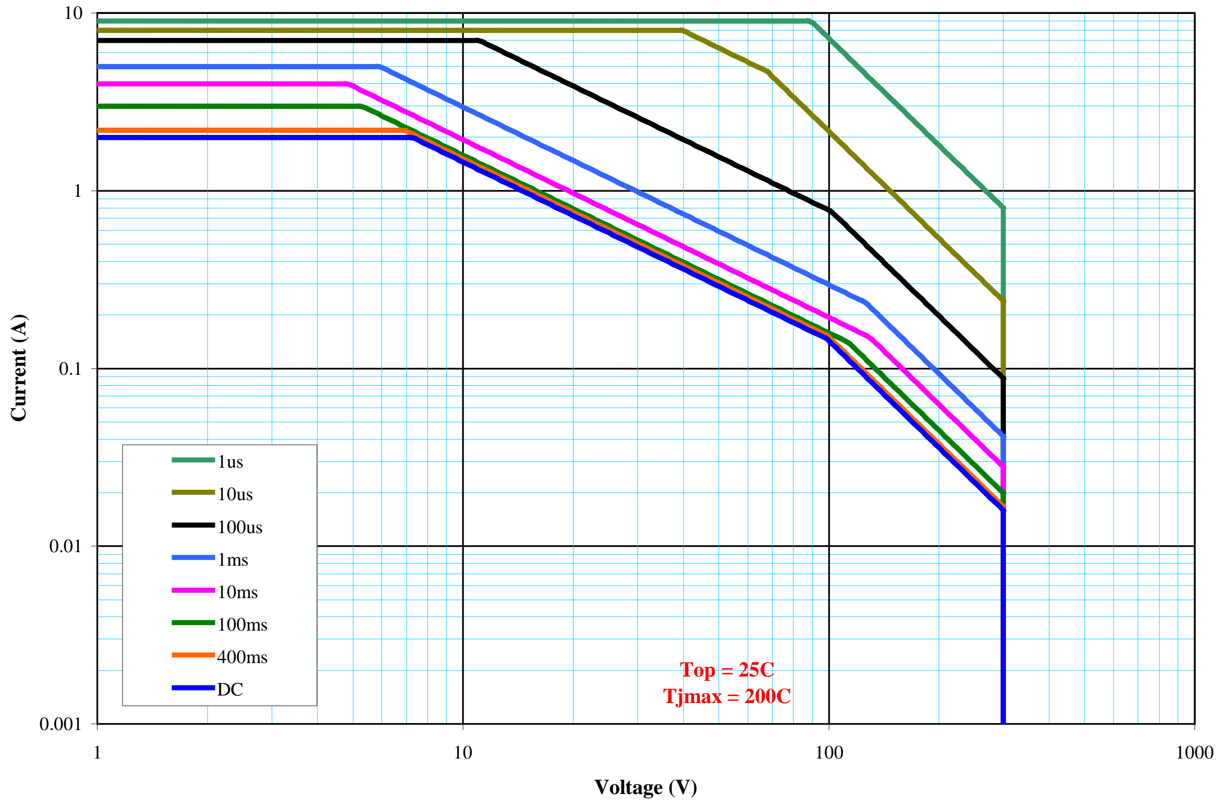

FIGURE 12. Maximum safe operating graph (continuous dc).

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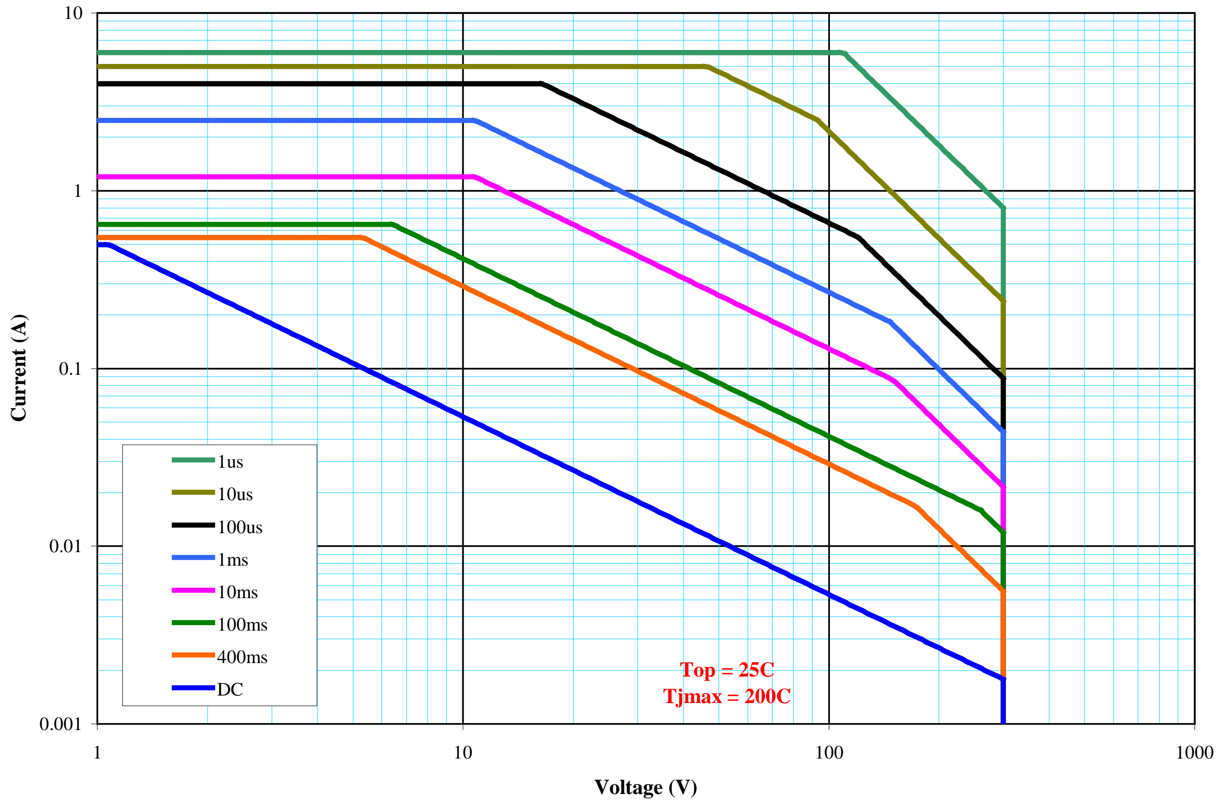

FIGURE 13. Maximum safe operating graph (continuous dc).

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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.

e. For acquisition of RHA designated devices, table II, subgroup 1 testing of group D is optional. If subgroup 1 testing is desired, it should be specified in the contract.

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 . An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at https://assist.dla.mil.

6.4 Suppliers of JANHC and JANKC die. The qualified JANHC and JANKC suppliers with the applicable letter version (example, JANHCA2N5415) will be identified on the QPL.

JANC ordering information		
PIN	Manufacturers CAGE	
	34156	43611
2N5415	JANHCD2N5415 JANKCD2N5415	JANHCB2N5415 JANKCB2N5415
2N5416	JANHCD2N5416 JANKCD2N5416	JANHCB2N5416 JANKCB2N5416

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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 - 85
DLA - CC

Preparing activity:
DLA - CC

(Project 5961-2013-020)

Review activities:
Army - AR, MI
Air Force - 19, 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.dla.mil.

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