The documentation and process conversion measures necessary to comply with this revision shall be completed by 18 Oct 95.

INCH-POUND

MIL-S-19500/485E
18 April 1995
SUPERSEDING
MIL-S-19500/485D
15 November 1994

MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, SILICON, LOW-POWER
TYPES: 2N5415, 2N5415S, 2N5416, AND 2N5416S
JAN, JANTX, JANTXV, JANS, JANHC, AND JANKC

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

1. SCOPE

1.1 Scope. This specification covers the detail requirements for a PNP, silicon, low-power transistor. Four levels of product assurance are provided for each device type as specified in MIL-S-19500. Two levels of product assurance are provided for die (element evaluation).

1.2 Physical dimensions. See figures 1 (similar to TO-5), and 2 for JANHC and JANKC (die) dimensions.

1.3 Maximum ratings.

Type	P_T T_A = +25°C 1/	P_T T_C = +25°C 2/	V_{CBO}	V_{CEO}	V_{EBO}	I_C	T_{STG} and T_J	$R_{\theta JC}$
	W	W	V dc	V dc	V dc	A dc	°C	°C/W
2N5415,S	0.75	10	200	200	6	1	-65 to +200	17.5
2N5416,S	0.75	10	350	300	6	1	-65 to +200	17.5

1/ Derate linearly 4.28 mW/°C for T_A > +25°C.
2/ Derate linearly 57.1 mW/°C for T_C > +25°C.

1.4 Primary electrical characteristics.

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

1/ Pulsed (see 4.5.1).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: NASA/Parts Project Office (NPPO), NASA Goddard Space Flight Center, Code 310.A Greenbelt, MD 20771 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A
FSC 5961

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 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 listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATION

MILITARY

MIL-S-19500 - Semiconductor Devices, General Specification for.

STANDARD

MILITARY

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

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Defense Printing Service Detachment Office, Building 4D (Customer Service), 700 Robbins Avenue, Philadelphia, PA 19111-5094).

2.2 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.

3. REQUIREMENTS

3.1 Associated detail specification. The individual item requirements shall be in accordance with MIL-S-19500 and as specified herein.

3.2 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-S-19500.

3.3 Design, construction, and physical dimensions. The design, construction, and physical dimensions shall be as specified in MIL-S-19500, and on figures 1, 2, and 3 herein.

3.3.1 Lead material and finish. Lead material shall be Kovar, Alloy 52, or approved equivalent. Lead finish shall be solderable in accordance with MIL-STD-750, MIL-S-19500 and as specified herein. Where a choice of lead finish is desired, it shall be specified in the acquisition document (see 6.2).

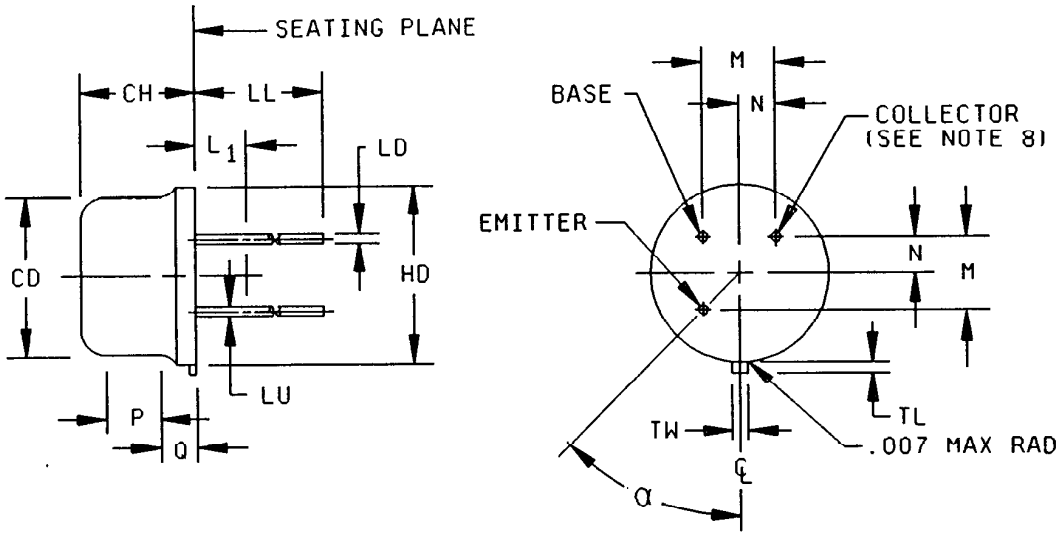
3.4 Marking. Marking shall be in accordance with MIL-S-19500. At the option of the manufacturer, the marking of the country of origin may be omitted from the body of the transistor, but shall be retained on the container.

4. QUALITY ASSURANCE PROVISIONS

4.1 Sampling and inspection. Sampling and inspection shall be in accordance with MIL-S-19500, and as specified herein.

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-S-19500.

4.2.1 JANHC and JANKC devices. Qualification for devices shall be in accordance with appendix H of MIL-S-19500.



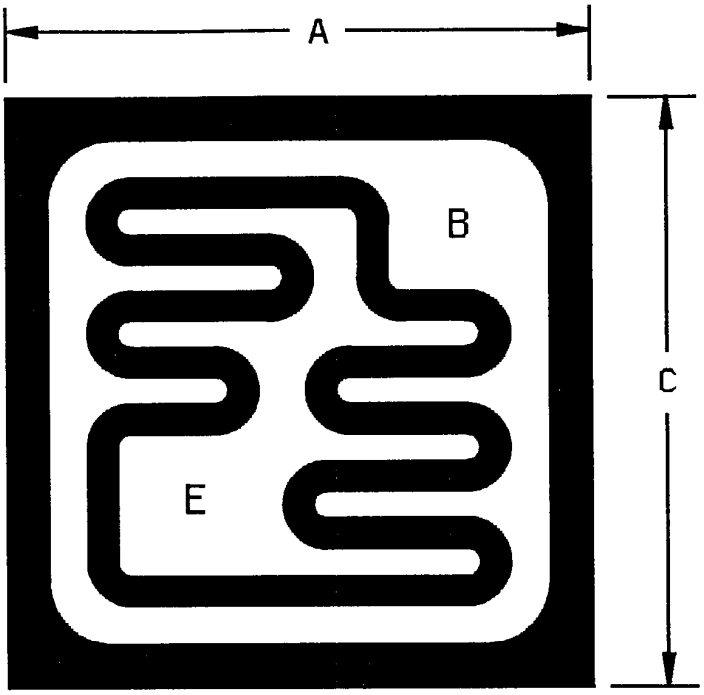
Ltr	Dimensions				Notes	Ltr	Dimensions				Notes
	Inches		Millimeters				Inches		Millimeters		
	Min	Max	Min	Max			Min	Max	Min	Max	
HD	.335	.370	8.51	9.40		P	.100		2.54		5
CD	.305	.335	7.75	8.51		Q					6
CH	.240	.260	6.10	6.60		TL	.029	.045	0.74	1.14	9
LL	See notes				10,12,13	TW	.028	.034	0.71	0.86	
L_1		.050		1.27	11	a	45° TP				7
LD	.016	.021	0.41	0.53	3,10	M	.1414 Nom		3.59 Nom		7
LU	.016	.019	0.41	0.48	4,10	N	.0707 Nom		1.80 Nom		7

FIGURE 1. Physical dimensions.

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Measured in the zone beyond .250 inch (6.35 mm) from the seating plane.
4. Measured in the zone .050 inch (1.27 mm) and .250 inch (6.35 mm) from the seating plane.
5. Variations on dimension CD in this zone shall not exceed .010 inch (0.25 mm).
6. Outline in this zone is not controlled.
7. When measured in gauging plane .054 +.001, -.000 inch (1.37 +0.03, -0.00 mm) below the seating plane of the transistor, maximum diameter leads shall be within .007 inch (0.18 mm) of their true location relative to tab. Smaller diameter leads shall fall within the outline of the maximum diameter lead tolerance. Figure 2 shows the preferred method of measurement.
8. The collector shall be electrically connected to the case.
9. Measured from the maximum diameter of the actual device.
10. All 3 leads (see 3.3.1).
11. Diameter of leads in this zone is not controlled.
12. For transistor types 2N5415 and 2N5416, dimension LL shall be 1.500 inches (38.10 mm) minimum and 1.75 inches (44.45 mm) maximum.
13. For transistor types 2N5415S and 2N5416S, dimension LL shall be 0.5 inch (12.70 mm) minimum and 0.75 inch (19.05 mm) maximum.
14. In accordance with ANSI Y14.5M, diameters are equivalent to ϕx symbology.

FIGURE 1. Physical dimensions - Continued.



A version

Ltr	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
A	.039	.043	0.99	1.09
C	.039	.043	0.99	1.09

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. The physical characteristics of the die are:
   Thickness: .006 inch (0.15 mm) to .012 inch (0.30 mm).
   Top metal: Aluminum 17,500 Å minimum, 20,000 Å nominal.
   Back metal: Gold 2,500 Å minimum, 3,000 Å nominal.
   Back side: Collector.
   Bonding pad: B = .004 inch (0.10 mm) x .005 inch (0.13 mm).
   E = .004 inch (0.10 mm) x .0055 inch (0.14 mm).

FIGURE 2. JANHC and JANKC (A-version) die dimensions.

4.3 Screening (JANS, JANTX, and JANTXV levels only). Screening shall be in accordance with table II of MIL-S-19500, and as specified herein. The following measurement shall be made in accordance with table I herein. Devices that exceed the limits of tables I and II herein shall not be acceptable.

Screen (see table II of MIL-S-19500)	Measurement	
	JANS level	JANTX and JANTXV levels
9	I_{CEX}	Not applicable
11	I_{CEX} and h_{FE1} ΔI_{CEX} = 100 percent of initial value or 500 nA dc, whichever is greater.	I_{CEO1} 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 500 nA dc, whichever is greater; Δh_{FE1} = ±15 percent.	Subgroup 2 of table I herein; ΔI_{CEO1} = 100 percent of initial value or 10 μA dc, whichever is greater; Δh_{FE1} = ±20 percent.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows:

T_A = Room ambient as defined in the general requirements of MIL-STD-750, (see 4.5).
$V_{CB} \geq 35$ V dc; P_T = 700 mW.

NOTE: No heatsink or forced air cooling on the devices shall be permitted.

4.3.2 Screening JANHC or JANKC. Screening of die shall be in accordance with MIL-S-19500, appendix H.

4.4 Quality conformance inspection. Quality conformance inspection shall be in accordance with MIL-S-19500.

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

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in tables IVa (JANS) and IVb (JAN, JANTX, and JANTXV) of MIL-S-19500. Electrical measurements (end-points) shall be in accordance with the inspections of table I, group A, subgroup 2 herein.

4.4.2.1 Group B inspection, table IVa (JANS) of MIL-S-19500.

Subgroup	Method	Condition
B4	1037	V_{CB} = 35 V dc; apply P_T to achieve $\Delta T_J \geq +100°C$. No heat sink on the device shall be permitted.
B5	1027	V_{CB} = 35 V dc; P_T adjusted as required to achieve T_J and time of MIL-S-19500.

4.4.2.2 Group B inspection, table IVb (JAN, JANTX, and JANTXV) of MIL-S-19500.

Subgroup	Method	Condition
B3	1027	T_A = +30°C ±5°C; V_{CB} ≥ 100 V dc; adjust P_T to achieve a T_J of +187.5°C ±12.5°C.
B5	3131	See 4.5.2
B6	1032	T_{STG} = +200°C.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table V of MIL-S-19500. Electrical measurements (end-points) shall be in accordance with the inspections of table I, group A, subgroup 2 herein.

4.4.3.1 Group C inspection, table V of MIL-S-19500.

Subgroup	Method	Condition
C2	2036	Test condition E.
C6	1026	T_A = +30°C ±5°C; V_{CB} ≥ 100 V dc; P_T = 700 mW.

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.

4.5.2 Thermal resistance for JAN, JANTX, and JANTXV. Thermal resistance measurements shall be performed in accordance with MIL-STD-750. The maximum limit of $\Theta_{JC(max)}$ shall be 17.5°C/W. The following test conditions shall apply:

a. I_M: Measurement current . . . . . 10 mA.

b. V_{CE}: Measurements current (same as V_H) . . . . . 30 V dc.

c. I_H: Collector heating current . . . . . 0.33 A.

d. V_H: Collector-emitter heating voltage . . . . . 30 V dc.

e. t_H: Heating time . . . . . 1 second minimum.

f. t_{MD}: Measurement delay time . . . . . 15 µs.

g. t_{SW}: Sampling window time . . . . . 10 µs maximum.

4.5.2.1 Thermal resistance for JANS. Thermal resistance measurements shall be performed in accordance with MIL-STD-750. The maximum limit of $\Theta_{JC(max)}$ shall be 17.5°C/W. The following test conditions shall apply:

a. I_M: Measurement current . . . . . 10 mA.

b. V_{CE}: Measurements current (same as V_H) . . . . . 25 V dc.

c. I_H: Collector heating current . . . . . 0.2 A.

d. V_H: Collector-emitter heating voltage . . . . . 25 V dc.

e. t_H: Heating time . . . . . 1 second minimum.

f. t_{MD}: Measurement delay time . . . . . 50 µs.

g. t_{SW}: Sampling window time . . . . . 10 µs maximum.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical inspection	2071					
Subgroup 2						
Collector to emitter cutoff current	3041	Bias condition D	I_{CEO1}		50	µA dc
2N5415,S		V_{CE} = 150 V dc				
2N5416,S		V_{CE} = 250 V dc				
Collector to emitter cutoff current	3041	Bias condition D	I_{CEO2}		1	mA dc
2N5415,S		V_{CE} = 200 V dc				
2N5416,S		V_{CE} = 300 V dc				
Collector to emitter cutoff current	3041	Bias condition D, V_{BE} = 1.5 V dc	I_{CEX}		50	µA dc
2N5415,S		V_{CE} = 200 V dc				
2N5416,S		V_{CE} = 300 V dc				
Emitter to base cutoff current	3061	Bias condition D, V_{EB} = 6 V dc	I_{EBO}		20	µA dc
Collector to base cutoff current	3036	Bias condition D	I_{CBO1}		50	µA dc
2N5415,S		V_{CB} = 175 V dc				
2N5416,S		V_{CB} = 280 V dc				
Collector to base cutoff current	3036	Bias condition D	I_{CBO2}		500	µA dc
2N5415,S		V_{CB} = 200 V dc				
2N5416,S		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

See footnote at end of table.

TABLE I. Group A inspection - Continued.

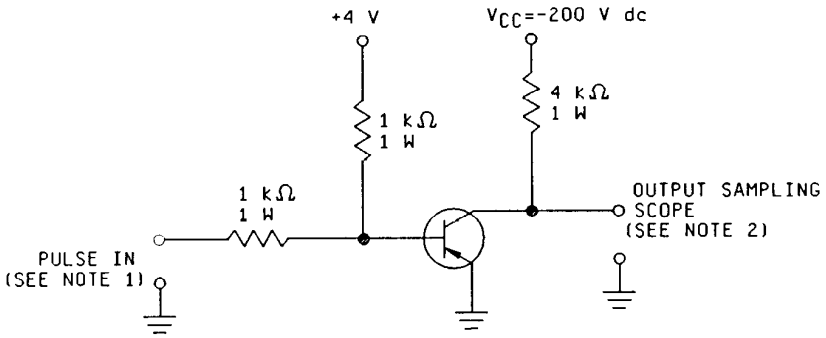
Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 2 - Continued						
Base emitter voltage saturation	3066	Test condition B, V_{CE} = 10 V dc, I_C = 50 mA dc, pulsed (see 4.5.1)	V_{BE}		1.5	V dc
Subgroup 3						
High temperature operation:		T_A = +150°C				
Collector to base cutoff current	3036	Bias condition D	I_{CBO3}		1	mA dc
2N5415,S 2N5416,S		V_{CB} = 175 V dc 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	$\lvert h_{fe} \rvert$	3	15	
Small-signal short-circuit forward-current transfer ratio	3206	V_{CE} = 10 V dc, I_C = 5 mA dc, f ≤ 1 kHz	h_{fe}	25		
Open circuit output capacitance	3236	V_{CB} = 10 V dc, I_E = 0, 100 kHz ≤ f ≤ 1 MHz	C_{obo}		15	pF
Input capacitance (output open-circuited)	3240	V_{EB} = 5 V dc, I_C = 0, 100 kHz ≤ f ≤ 1 MHz	C_{ibo}		75	pF

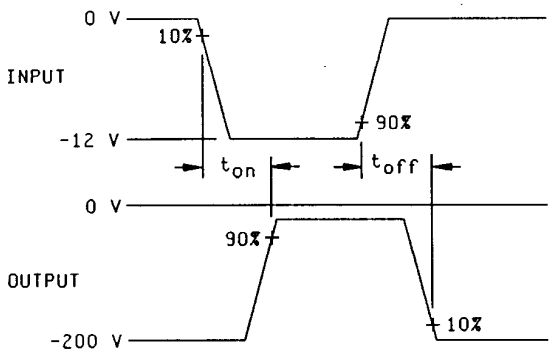
See footnote at end of table.

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 3)	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 3)	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	$V_{(BR)CEO}$			
2N5415,S				200		V dc
2N5416,S				300		V dc
Safe operating area (continuous dc)	3051	T_C = +25°C, 1 cycle, t = 0.4 s, (see figure 5)				
Test 1		V_{CE} = 10 V dc, I_C = 1 A dc				
Test 2		V_{CE} = 100 V dc, I_C = 100 mA dc				
Test 3		V_{CE} = 200 V dc				
(2N5415,S only)		I_C = 24 mA dc				
Test 4		V_{CE} = 300 V dc				
(2N5416,S only)		I_C = 10 mA dc				
Electrical measurements		See table II, steps 2 and 3				

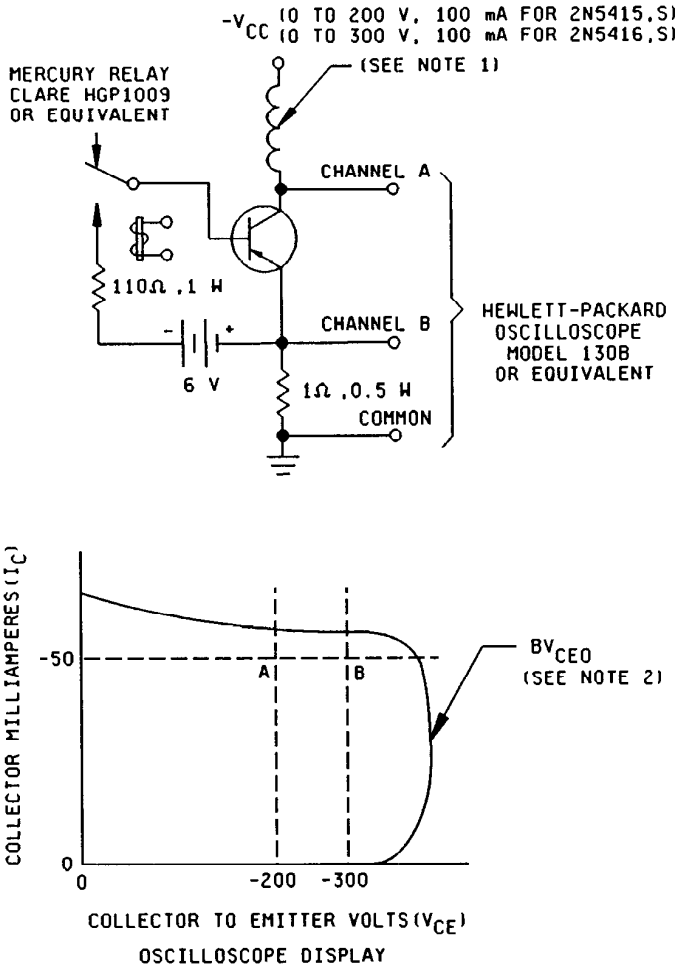
1/ For sampling plan, see MIL-S-19500.





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 3. Pulse response test circuit.



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 4. BV_{CEO} measurement test circuit.

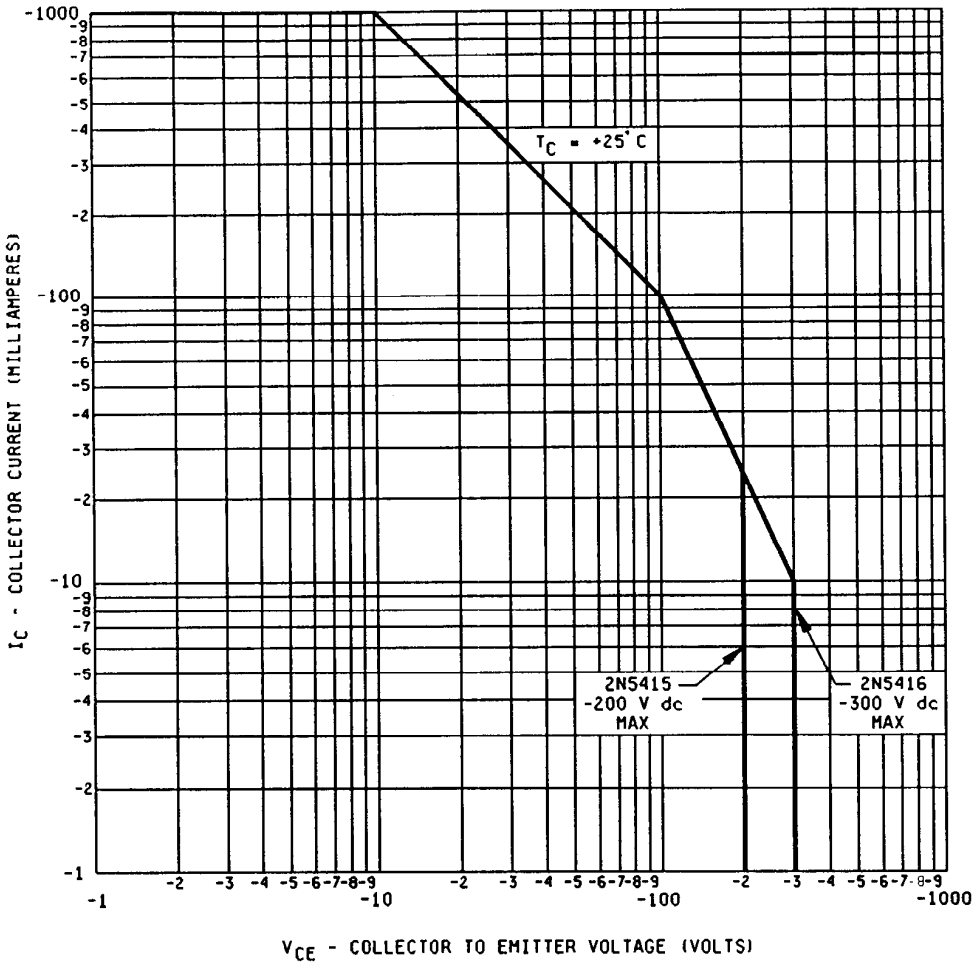


FIGURE 5. Maximum safe operating graph (continuous dc).

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-S-19500.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Notes. The notes specified in MIL-S-19500 are applicable to this specification.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Issue of DODISS to be cited in the solicitation.

b. Lead finish as specified (see 3.3.1).

c. Product assurance and type designation, and for die acquisition the JANHC and JANKC identification (see figure 3 and 6.4).

6.3 Substitution of JAN devices. JANTX devices shall be a direct replacement for JAN devices (example, JANTX2N5415 for JAN2N5415).

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

JANC ordering information		
PIN	Manufacturers	
	33178	
2N5415	JANHCA2N5415 JANKCA2N5415	

6.5 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

CONCLUDING MATERIAL

Custodians:
Army - ER
Navy - EC
Air Force - 17
NASA - NA

Review activities:
Air Force - 13, 15, 19, 85, 99
DLA - ES

Preparing activity:
NASA - NA

Agent:
DLA - ES

(Project 5961-1773)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.

2. The submitter of this form must complete blocks 4, 5, 6, and 7.

3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-S-19500/485E	2. DOCUMENT DATE (YYMMDD) 95-04-18

3. DOCUMENT TITLE
SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, SILICON, LOW-POWER, TYPES: 2N5415, 2N5415S, 2N5416, AND 2N5416S
JAN, JANTX, JANTXV, AND JANS

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (If applicable)	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. NAME Alan Barone	b. TELEPHONE (Include Area Code) (1) Commercial 513-296-6048 (2) AUTOVON 986-6048
ADDRESS (Include Zip Code) Defense Electronics Supply Center Attn: DESC-ELDT Dayton, Ohio 45444-5765	**IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:** Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340