INCH-POUND

MIL-S-19500/378B
21 June 1990
SUPERSEDING
MIL-S-19500/378A
18 March 1968

MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, FIELD-EFFECT TRANSISTOR, P-CHANNEL, SILICON, TYPES 2N2497 THROUGH 2N2500, 2N3329 THROUGH 2N3332, JANTX

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 P-channel, junction, silicon field-effect transistors. One level of product assurance is provided for each device type as specified in MIL-S-19500.

1.2 Physical dimensions. See figures 1 and 3.

1.3 Maximum ratings.

	P_T T_A = 25°C	V_{DG} and V_{DS}	V_{GS}	I_G	T_J and T_{STG}
	mW	V dc	V dc	mA dc	°C
2N2497-2N2500	500 1/	20	20	10	
2N3329-2N3332	300 2/	20	20	10	-65 to +200

1/ Derate linearly 3.3 mW/°C above T_A = 25°C.
2/ Derate linearly 2.0 mW/°C above T_A = 25°C.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Defense Electronics Supply Center, ATTN: DESC-ES, 1507 Wilmington Pike, Dayton, OH 45444-5276 by using the self-addressed Standardization Document Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 5961

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

1.4 Primary electrical characteristics.

	I_{DSS} V_{DS} = 10 V dc, V_{GS} = 0				$V_{GS(off)}$ V_{DS} = 15 V dc, I_D = 10 µA dc			
	2N2497 2N3329	2N2498 2N3330	2N2499 2N3331	2N2500 2N3332	2N2497 2N3329	2N2498 2N3330	2N2499 2N3331	2N2500 2N3332
	mA dc	mA dc	mA dc	mA dc	V dc	V dc	V dc	V dc
Min	1	2	5	1				
Max	3	6	15	6	5	6	8	6

	NF V_{DS} = 5 V dc, I_D = 1 mA dc, R_G = 1 MΩ, f = 1 kHz			C_{iss} V_{DS} = 10 V dc, V_{GS} = 0, f = 1 MHz	C_{iss} V_{DS} = 10 V dc, V_{GS} = 1 V dc, f = 1 MHz
	2N2497, 2N2498, 2N3329, 2N3330	2N2499, 2N3331	2N2500, 2N3332	2N2497 through 2N2500	2N3329 through 2N3332
	dB	dB	dB	pF	pF
Min					
Max	3	4	1	32	20

	$\|y_{fs}\|$ V_{DS} = 10 V dc, f = 10 kHz			
	I_D = 1 mA dc	I_D = 2 mA dc	I_D = 5 mA dc	I_D = 1 mA dc
	2N2497 2N3329	2N2498 2N3330	2N2499 2N3331	2N2500 2N3332
	µmho	µmho	µmho	µmho
Min	1000	1500	2000	1000
Max	2000	3000	4000	2200

1.4 Primary electrical characteristics - Continued.

	$\lvert y_{fs} \rvert$		
	V_{DS} = 10 V dc, f = 10 kHz		
	I_D = 1 mA dc	I_D = 2 mA dc	I_D = 5 mA dc
	2N2497, 2N2500 2N3329, 2N3332	2N2498 2N3330	2N2499 2N3331
	µmho	µmho	µmho
Min	900	1350	1800
Max			

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.

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 Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

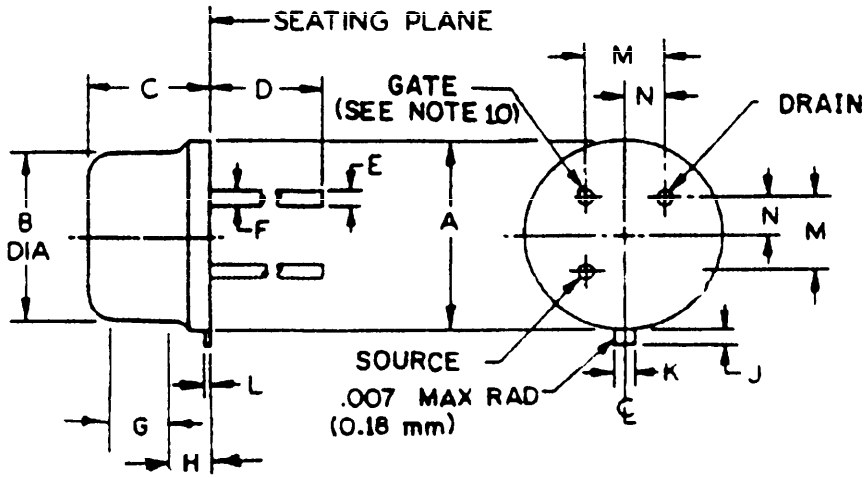
2.2 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated detail specifications, specification sheets, or MS standards), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 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 figures 1 and 3 herein.



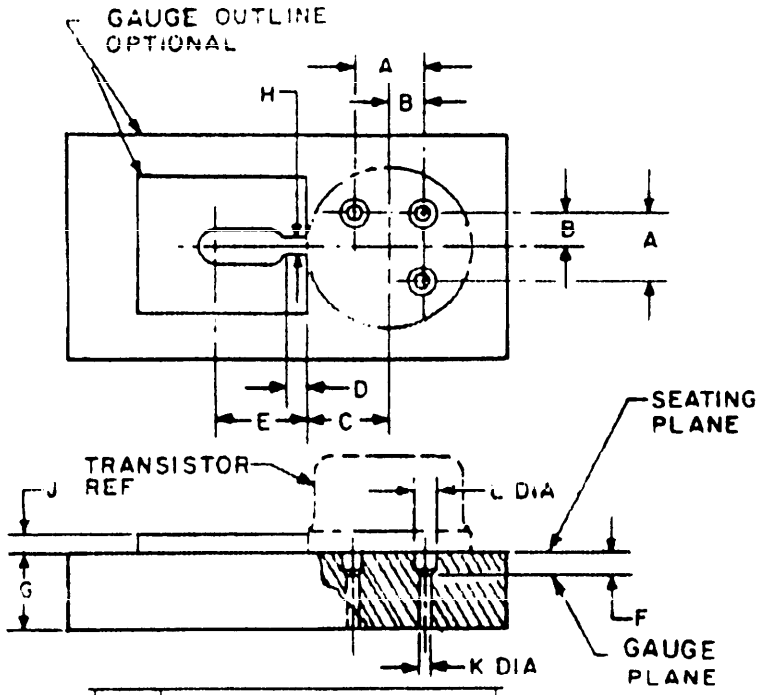
Ltr	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
A	.335	.370	8.51	9.40	
B	.305	.335	7.75	8.51	
C	.240	.260	6.10	6.60	
D	1.500	1.750	38.10	44.45	9
E	.016	.021	0.41	0.53	3, 9
F	.016	.019	0.41	0.48	4, 9
G	.100	---	2.54	---	5
H	---	---	---	---	6
J	.029	.045	0.74	1.14	8
K	.028	.034	0.71	0.86	
L	.009	.125	0.23	3.18	
M	.1414 Nom		3.592 Nom		7
N	.0707 Nom		1.796 Nom		7

FIGURE 1. Physical dimensions of transistor types (TX) 2N2497, 2N2498, 2N2499, and 2N2500 (TO-5).

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Measured in the zone beyond .250 (6.35 mm) from the seating plane.
4. Measured in the zone .050 (1.27 mm) and .250 (6.35 mm) from the seating plane.
5. Variations on dimension B in this zone shall not exceed .010 (0.25 mm).
6. Outline in this zone is not controlled.
7. When measured in a gauging plane .054 +.001, -.000 (1.37 +0.03, -0.00 mm) below the seating plane of the transistor maximum diameter leads shall be within .007 (0.18 mm) of their true location relative to a maximum width tab. Smaller diameter leads shall fall within the outline of the maximum diameter lead tolerance. Figure 2 is the preferred measured method.
8. Measured from the maximum diameter of the actual device.
9. All three leads.
10. Gate is in electrical contact with the case.

FIGURE 1. Physical dimensions of transistor types (TX) 2N2497, 2N2498, 2N2499, and 2N2500 (TO-5) - Continued.

b. Subgroups 3 and 6, see table II herein, steps 3 and 4

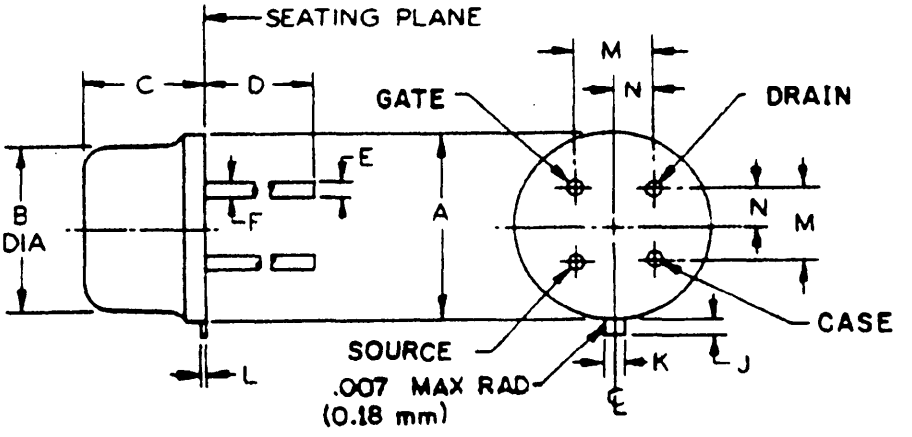


Ltr	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
A	.1409	.1419	3.579	3.604
B	.0702	.0712	1.783	1.808
C	.182	.199	4.62	5.05
D	.009	.011	0.23	0.28
E	.125 Nom		3.18 Nom	
F	.054	.055	1.37	1.40
G	.372	.378	9.45	9.60
H	.0350	.0355	0.889	0.902
J	.150 Nom		3.81 Nom	
K	.0325	.0335	0.826	0.851
L	.0595	.0605	1.511	1.537

FIGURE 2. Gauge for lead and tab location for transistor types (TX) 2N2497, 2N2498, 2N2499, and 2N2500.

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. The following gauging procedure shall be used: The use of a pin straightener prior to insertion in the gauge is permissible. The device being measured shall be inserted until its seating plane is .125 ±.010 (3.18 ±0.25 mm) from the seating surface of the gauge. A spacer may be used to obtain the .125 (3.18 mm) distance from the gauge seat prior to force application. A force of 8 ounces ±.5 ounce shall then be applied parallel and symmetrical to the device's cylindrical axis. When examined visually after the force application, (the force need not be removed), the seating plane of the device shall be seated against the gauge.
4. The location of the tab locator, within the limits of dimension C, will be determined by the tab and flange dimension of the device being checked.

FIGURE 2. Gauge for lead and tab location for transistor types (TX) 2N2497, 2N2498, 2N2499, and 2N2500 - Continued.

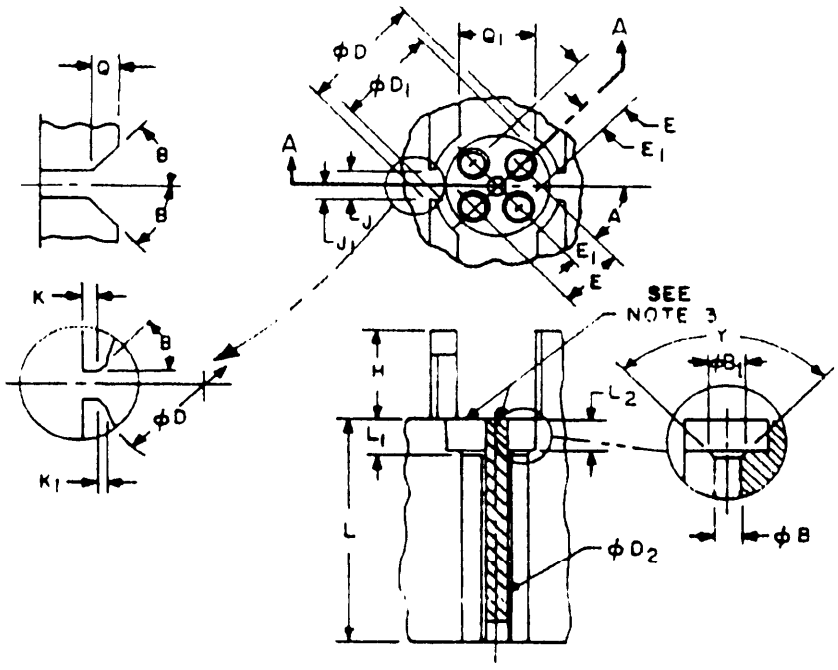


Ltr	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
A	.209	.230	5.31	5.84	
B	.178	.195	4.52	4.95	
C	.170	.210	4.32	5.38	
D	.500	.750	12.70	19.05	8
E	---	.021	---	0.53	3, 8
F	.016	.019	0.41	0.48	4, 8
J	.028	.048	0.71	1.22	7
K	.036	.046	0.91	1.17	
L	---	.020	---	0.51	
M	.0707 Nom		1.796 Nom		5
N	.0354 Nom		0.899 Nom		5

FIGURE 3. Physical dimensons of transistor types (TX) 2N3329, 2N3330, 2N3331, and 2N3332(TO-72).

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Measured in the zone beyond .250 (6.35 mm) from the seating plane.
4. Measured in the zone .050 (1.27 mm) and .250 (6.35 mm) from the seating plane.
5. When measured in a gauging plane .054 +.001, -.000 (1.37 +0.03, -0.00 mm) below the seating plane of the transistor, maximum diameter leads shall be within .007 (0.18 mm) of their true location relative to a maximum width tab. Smaller diameter leads shall fall within the outline of the maximum diameter lead tolerance. Figure 4 is the preferred gaging method.
6. The active elements are electrically insulated from the case.
7. Measured from the maximum diameter of the actual device.
8. All four leads.

FIGURE 3. Physical dimensons of transistor types (TX) 2N3329, 2N3330, 2N3331, and 2N3332(TO-72) - Continued.



SECTION A-A

Ltr	Dimensions				Notes	Ltr	Dimensions				Notes
	Inches		Millimeters				Inches		Millimeters		
	Min	Max	Min	Max			Min	Max	Min	Max	
øB	.0325	.0335	0.826	0.851	5	K	.009	.011	0.23	0.28	
$øB_1$	.043 Nom		1.09 Nom		5	K_1	.005 Nom		0.13 Nom		
øD	.2310	.2315	5.867	5.880		L	.372	.378	9.45	9.60	
$øD_1$	.159	.161	4.04	4.09		L_1	.054	.055	1.37	1.40	
$øD_2$	.040 Nom		1.02 Nom		6	L_2	.043 Nom		1.09 Nom		
E	.0995	.1005	2.527	2.553		Q	.040 Nom		1.02 Nom		
E_1	.0495	.0505	1.257	1.283		Q_1	.123	.127	3.12	3.23	
H	.145	.155	3.68	3.94		A	44.90°	45.10°	---	---	
J	.0470	.0475	1.194	1.207		B	45° Nom		---	---	
J_1	.0235	.0245	0.597	0.622		Y	90° Nom		---	---	

FIGURE 4. Gauge for lead and tab location for transistor types (TX) 2N3329, 2N3330, 2N3331, and 2N3332.

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. The following gauging procedures shall be used: The device being measured shall be inserted until its seating plane is .125 (3.18 mm) +.010 (0.25 mm) from the seating surface of the gauge. A force of 8 ounces ±.5 ounce shall then be applied parallel and symmetrical to the device's cylindrical axis. When examined visually after the force application (the force need not be removed), the seating plane of the device shall be seated against the gauge. The use of a pin straightener prior to insertion in the gauge is permissible. A spacer may be used to obtain the .125 (3.18 mm) distance from the gauge seat prior to force application.
4. These surfaces to be parallel and in same plane within ±.001 (0.03 mm).
5. Four holes.
6. Pressed in.

FIGURE 4. Gauge for lead and tab location for transistor types (TX) 2N3329, 2N3330, 2N3331, and 2N3332 - Continued.

3.3.1 Lead material and finish. Lead material shall be Kovar or Alloy 52. Lead finish shall be gold, tin, or solder. Where a choice of lead material or finish is desired, it shall be specified in the contract or purchase order (see 6.2).

3.4 Marking. Marking shall be in accordance with MIL-S-19500 except at the option of the manufacturer, the following marking may be omitted from the body of the transistor:

a. Country of origin.

b. Manufacturer's identification.

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, and as specified herein.

4.2.1 Group E inspection. Group E inspection shall be in accordance with table IV herein.

4.3 Screening (JANTX level only). Screening shall be in accordance with MIL-S-19500 (table II), 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 II of MIL-S-19500)	Measurement
	JANTX level
9	Not applicable
11	I_{GSS1}; $\lvert y_{fs2} \rvert$
12	See 4.3.1
13	ΔI_{GSS} = 100 percent of initial value or 5 nA dc, whichever is greater; $\Delta \lvert y_{fs} \rvert$ = 20 percent of initial value; Subgroup 2 of table I herein.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows: T_A = 175°C; V_{GS} = 16 V dc; V_{DS} = 0.

4.4 Quality conformance inspection. Quality conformance inspection shall be in accordance with MIL-S-19500, and as specified herein.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-S-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 IVb (JANTX) of MIL-S-19500, and table II herein. Electrical measurements (end points) and delta requirements shall be in accordance with the applicable steps of table IV herein.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical examination	2071					
Subgroup 2						
Breakdown voltage, gate-to-source	3041	Bias condition C; I_G = 10 µA dc; V_{DS} = 0	$V_{(BR)GSS}$	20		V dc
Gate leakage current	3411	Bias condition C; V_{GS} = 10 V dc; V_{DS} = 0	I_{GSSI}		10	nA dc
Zero gate-voltage drain current	3413	Bias condition C; V_{DS} = 10 V dc; V_{DS} = 0	I_{DSS}			
2N2497, 2N3329				1	3	mA dc
2N2498, 2N3330				2	6	
2N2499, 2N3331				5	15	
2N2500, 2N3332				1	6	
Static drain to source on-state resistance	3421	V_{GS} = 0; I_D = 100 µA dc	$r_{DS(on)}$			
2N2497, 2N3329					1000	ohms
2N2498, 2N3330					800	
2N2499, 2N3331					600	
2N2500, 2N3332					800	
Gate to source cutoff voltage	3403	I_D = 10 µA dc; V_{DS} = 15 V dc	$V_{GS(off)}$			
2N2497, 2N3329					5	V dc
2N2498, 2N3330					6	
2N2499, 2N3331					8	
2N2500, 2N3332					6	

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 3						
High-temperature operation		T_A = +150°C				
Gate leakage current	3411	Bias condition C; V_{GS} = 10 V dc; V_{DS} = 0	I_{GSS2}		10	µA dc
Low-temperature operation		T_A = -55°C				
Magnitude of small-signal common-source short-circuit forward	3455	V_{DS} = 10 V dc; f = 1 kHz	$\lvert y_{fs} \rvert$			
2N2497, 2N3329		I_D = 1 mA dc			3000	µmho
2N2498, 2N3330		I_D = 2 mA dc			4500	
2N2499, 2N3331		I_D = 5 mA dc			6000	
2N2500, 2N3332		I_D = 1 mA dc			3300	
Subgroup 4						
Magnitude of small-signal common-source short-circuit forward transadmittance	3455	V_{DS} = 10 V dc; f = 1 kHz	$\lvert y_{fs} \rvert$ 2			
2N2497, 2N3329		I_D = 1 mA dc		1000	2000	µmho
2N2498, 2N3330		I_D = 2 mA dc		1500	3000	
2N2499, 2N3331		I_D = 5 mA dc		2000	4000	
2N2500, 2N3332		I_D = 1 mA dc		1000	2200	
Magnitude of small-signal common-source short-circuit output admittance	3453	V_{DS} = 10 V dc; f = 1 kHz	$\lvert y_{os} \rvert$			
2N2497, 2N3329		I_D = 1 mA dc			20	µmho
2N2498, 2N3330		I_D = 2 mA dc			40	
2N2499, 2N3331		I_D = 5 mA dc			100	
2N2500, 2N3332		I_D = 1 mA dc			20	

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 4 - Continued						
Magnitude of small-signal common-source short-circuit forward transadmittance	3455	V_{DS} = 10 V dc; f = 10 MHz	$|y_{fs}|$3			
2N2497, 2N3329		I_D = 1 mA dc		900		µmho
2N2498, 2N3330		I_D = 2 mA dc		1350		
2N2499, 2N3331		I_D = 5 mA dc		1350		
2N2500, 2N3332		I_D = 1 mA dc		900		
Small-signal common-source short-circuit input capacitance	3431	V_{DS} = 10 V dc; V_{GS} = 0; f = 1 MHz	$|C_{iss}|$1			
2N3329 through 2N3332 only					32	pF
Small-signal common-source short-circuit input capacitance	3431	V_{DS} = 10 V dc; V_{GS} = 1 V dc; f = 1 MHz	$|C_{iss}|$2			
2N3329 through 2N3332 only					20	pF
Common-source spot noise figure		V_{DS} = 5 V dc; I_D = 1 mA dc; R_G = 1 MΩ	NF_1			
2N2497, 2N3329		f = 1 kHz			3	dB
2N2498, 2N3330					3	dB
2N2499, 2N3331					4	dB
2N2500, 2N3332					1	dB

1/ For sampling plan see MIL-S-19500.
2/ 10 Hz and 1 kHz spot noise figure tests. These tests shall be conducted with a model 2173C Quan Tech Laboratories test set, or equivalent.

TABLE II. Group B inspection for JANTX devices.

Inspection 1/	MIL-STD-750	
	Method	Conditions
Subgroup 1		
Solderability	2026	
Resistance to solvents	1022	
Subgroup 2		
Thermal shock (temperature cycling)	1051	
Hermetic seal	1071	
a. Fine leak		
b. Gross leak		
Subgroup 3		
Steady-state operation life	1026	T_A = 175°C; V_{DS} = 0; V_{GS} = 16 V dc
Electrical measurements		See table IV, steps 1 and 3
Subgroup 4		
Decap internal visual (design verification)	2075	
Bond strength	2037	Test condition A
Subgroup 5		
N/A		
Subgroup 6		
High-temperature life (nonoperating)	1031	T_{STG} = 200°C
Electrical measurements		See table IV, steps 2 and 4

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

TABLE III. Group C inspection inspection (all quality levels).

Inspection 1/	MIL-STD-750	
	Method	Conditions
Subgroup 1		
Physical dimensions	2066	See figure 1 or 3
Subgroup 2		
Thermal shock (glass strain)	1056	
Thermal strength	2036	Test condition A
Hermetic seal	1071	
a. Fine leak		
b. Gross leak		
Moisture resistance	1021	
Electrical measurements		See table IV, steps 1 and 3
Subgroup 3		
Shock	2016	
Vibration, variable frequency	2056	
Constant acceleration	2006	
Electrical measurements		See table IV, steps 1 and 3
Subgroup 4		
Salt atmosphere (corrosion)	1041	
Subgroup 5		
N/A		
Subgroup 6		
Steady-state operation life	1026	V_{GS} = 16 V dc; V_{DS} = 0; T_A = 175°C
Electrical measurements		See table IV, steps 2 and 4
Subgroup 7		
N/A		

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

TABLE IV. Groups A, B, and C electrical measurements.

Step	Inspection	MIL-STD-750		Symbol	Limit		Unit
		Method	Conditions		Min	Max	
1.	Gate reverse current	3411	Bias condition C; V_{GS} = 10 V dc; V_{DS} = 0	I_{GSS1}		10	nA dc
2.	Gate reverse current	3411	Bias condition C; V_{GS} = 10 V dc; V_{DS} = 0	I_{GSS2}		20	nA dc
3.	Magnitude of small-signal common-source short-circuit forward transadmittance	3455	V_{DS} = 10 V dc; f = 1 kHz	$\lvert y_{fs} \rvert 2$			
	2N2497, 2N3329		I_D = 1 mA dc		1000	2000	µmho
	2N2498, 2N3330		I_D = 2 mA dc		1500	3000	
	2N2499, 2N3331		I_D = 5 mA dc		2000	4000	
	2N2500, 2N3332		I_D = 1 mA dc		1000	2200	
4.	Magnitude of small-signal common-source short-circuit forward transadmittance	3455	V_{DS} = 10 V dc; f = 1 kHz	$\lvert \Delta y_{fs} 2 \rvert$		±20% change from initial group A reading	
	2N2497, 2N3329		I_D = 1 mA dc				
	2N2498, 2N3330		I_D = 2 mA dc				
	2N2499, 2N3331		I_D = 5 mA dc				
	2N2500, 2N3332		I_D = 1 mA dc				

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, and table III herein. Electrical measurements (end points) and delta requirements shall be in accordance with the applicable steps of table IV 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 Input capacitance. This test shall be conducted in accordance with MIL-STD-750, method 3240, except the output capacitor shall be omitted.

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 may specify the following:

a. Title, number, and date of the specification.

b. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1).

c. Lead finish may be specified (see 3.3.1).

6.3 Substitution. JANTX devices shall be a direct replacement for JAN devices.

6.3.1 Substitution information. Devices covered by this specification are substitutable for the manufacturer's and user's part number. This information in no way implies that manufacturer's Part or Identifying Numbers (PINs) are suitable as a substitute for the military PIN.

Military PIN	Manufacturer's CAGE code	Manufacturer's and user's part number

6.4 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

Review activities:
Army - MI
Air Force - 11, 19,
DLA - ES

User activities:
Navy - AS, CG, MC

Preparing activity:
Air Force - 17

Agent:
DLA - ES

(Project 5961-1160)