

# Low Noise Transistors HXTR-6001 Chip

## Technical Data

2N6617 (HXTR-6101, TX  
and TXV)  
2N6742 (HXTR-6102, TX  
and TXV)  
2N6618 (HXTR-6103, TX  
and TXV)  
2N6743 (HXTR-6104, TX  
and TXV)



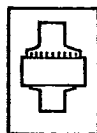
### Features

- **Low Noise Figure**  
1.7 dB Typical  $NF_{MIN}$  at  
2 GHz  
2.7 dB Typical  $NF_{MIN}$  at  
4 GHz
- **High Associated Gain**  
13.0 dB Typical  $G_A$  at 2 GHz  
9.0 dB Typical  $G_A$  at 4 GHz
- **Hermetic Package**

### Recommended Die Attach and Bonding Procedures

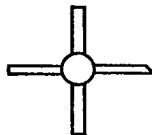
Eutectic Die Attach at a stage temperature of  $410 \pm 10^\circ\text{C}$  under an  $N_2$  ambient. Chip should be lightly scrubbed using a tweezer or collet and eutectic should flow within five seconds.

Thermocompression Wire Bond at a stage temperature of  $310 \pm 10^\circ\text{C}$ , using a tip force of  $30 \pm 5$  grams with 0.7 or 1.0 mil gold wire. A one mil minimum wire clearance at the passivation edge is recommended. (Ultrasonic bonding is not recommended.)



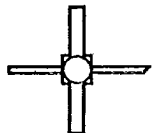
Generic Chip

HXTR-6001



HPAC-70GT

HXTR-6101  
HXTR-6102



HPAC-100

HXTR-6103  
HXTR-6104

### Description

The HXTR-6001 is an NPN silicon bipolar transistor chip designed for use in hybrid applications requiring superior noise figure and associated gain performance at VHF, UHF, and microwave frequencies. The chip is protected by silicon nitride passivation, and is provided with gold bonding pads for ease of use in most hybrid applications.

The HXTR-6001 chip is available in two package styles. The HXTR-6101 and HXTR-6102 are supplied in the HPAC-70GT, and the HXTR-6103 and HXTR-6104 are supplied in the HPAC-100. Both the HPAC-70GT and the HPAC-100 are rugged metal/ceramic hermetic packages, and are capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.

**Note:** See the Package Outline section, page 16-7, for complete dimensions.

## Electrical Specifications (HXTR-6001, HXTR-6101, HXTR-6102)

Symbol	Parameters and Test Conditions	Test Method MIL-STD-750	Units	HXTR-6001 <sup>(1)</sup>			HXTR-6101 <sup>(2)</sup>			HXTR-6102 <sup>(2)</sup>			
				Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
$BV_{CEB}$	Collector-Emitter Breakdown Voltage at $I_C = 100 \mu A$	3011*	V	30			30			30			
$I_{CEO}$	Collector-Emitter Leakage Current at $V_{CE} = 10 V$	3041**	nA			500			500			500	
$I_{CBO}$	Collector Cutoff Current at $V_{CB} = 10 V$	3036**	nA			100			100			100	
$h_{FE}$	Forward Current Transfer Ratio at $V_{CE} = 10 V$ , $I_C = 4 mA$	3076*		50	100	250	50	100	250	50	150	250	
$NF_{MIN}$	Minimum Noise Figure $V_{CE} = 10 V$ , $I_C = 4 mA$ $f = 2 GHz$ 4 GHz	3246	dB		1.7	2.7		1.6	2.8	3.0		1.6	2.7
$G_A$	Associated Gain $V_{CE} = 10 V$ , $I_C = 4 mA$ $f = 2 GHz$ 4 GHz	3246	dB		13.0	9.0		8.0	13.5	9.0		8.0	13.5
$C_{cb}$	Reverse Transfer Capacitance $I_C = 0 mA$ ; $V_{CB} = 10 V$ ; $f = 1 MHz$		pF					0.11					

## Electrical Specifications (HXTR-6103, HXTR-6104)

Symbol	Parameters and Test Conditions	Test Method MIL-STD-750	Units	HXTR-6103 <sup>(2)</sup>			HXTR-6104 <sup>(2)</sup>		
				Min.	Typ.	Max.	Min.	Typ.	Max.
$BV_{CEB}$	Collector-Emitter Breakdown Voltage at $I_C = 100 \mu A$	3011*	V	30			30		
$I_{CEO}$	Collector-Emitter Leakage Current at $V_{CE} = 10 V$	3041**	nA			500			500
$I_{CBO}$	Collector-Cutoff Current at $V_{CB} = 10 V$	3036**	nA			100			100
$h_{FE}$	Forward Current Transfer Ratio at $V_{CE} = 10 V$ , $I_C = 4 mA$	3076*		50	100	250	50	100	250
$NF_{MIN}$	Minimum Noise Figure $V_{CE} = 10 V$ , $I_C = 3 mA$ $f = 1.5 GHz$ 2 GHz	3246	dB		1.8	2.2		1.4	1.6
$G_A$	Associated Gain $V_{CE} = 10 V$ , $I_C = 3 mA$ $f = 1.5 GHz$ 2 GHz	3246	dB	11.0	12.0		13.0	14.0	
$C_{cb}$	Reverse Transfer Capacitance $I_C = 0 mA$ ; $V_{CB} = 10 V$ ; $f = 1 MHz$		pF		0.14				

\*300  $\mu s$  wide pulse measurement at  $\leq 2\%$  duty cycle

\*\*Measured under low ambient light conditions, for chip only.

## Notes:

1.  $T_A = 25^\circ C$
2.  $T_{CASE} = 25^\circ C$

**Absolute Maximum Ratings\***

Symbol	Parameter	HXTR-6001 <sup>(1)</sup> (T <sub>A</sub> = 25°C)	HXTR-6101/2/3/4 <sup>(2)</sup> (T <sub>CASE</sub> = 25°C)
V <sub>CBO</sub>	Collector to Base Voltage	35 V	35 V
V <sub>CEO</sub>	Collector to Emitter Voltage	20 V	20 V
V <sub>EBO</sub>	Emitter to Base Voltage	1.5 V	1.5 V
I <sub>C</sub>	DC Collector Current	20 mA	20 mA
P <sub>T</sub>	Total Device Dissipation	300 mW	300 mW
T <sub>J</sub>	Junction Temperature	200°C	200°C
T <sub>STG</sub>	Storage Temperature	-65°C to 300°C	-65°C to 200°C
-	Lead Temperature (Soldering 10 seconds each lead)		+250°C



\*Operation in excess of any one of these conditions may result in permanent damage to this device.

**Notes:**

- Power dissipation derating should include a  $\theta_{JB}$  (Junction-to-Back contact thermal resistance) of 100°C/W. Total  $\theta_{JA}$  (Junction to Ambient) will be dependent upon the heat sinking provided in the individual application.
- For the 2N6617 (HXTR-6101TX) and the 2N6742 (HXTR-6102) a  $\theta_{JC} = 160^\circ\text{C/W}$  maximum should be used for derating and junction temperature calculations. For the 2N6618 (HXTR-6103) and the 2N6743 (HXTR-6104) a  $\theta_{JC} = 150^\circ\text{C/W}$  maximum should be used for calculating junction temperature  $T_J = P_D \times \theta_{JC} + T_{CASE}$ .

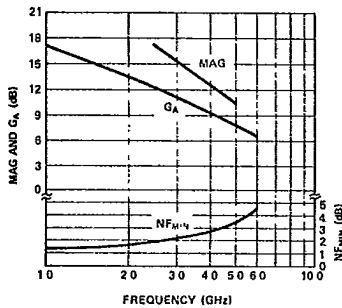


Figure 1. Typical MAG, Noise Figure (NF<sub>MIN</sub>), and Associated Gain vs. Frequency (V<sub>GR</sub> = 10 V, I<sub>C</sub> = 4 mA), for the HXTR-6001.

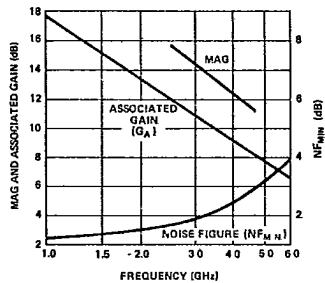


Figure 2. Typical MAG, Noise Figure (NF<sub>MIN</sub>) and Associated Gain vs. Frequency (V<sub>GR</sub> = 10 V, I<sub>C</sub> = 4 mA), for the HXTR-6101 and HXTR-6102.

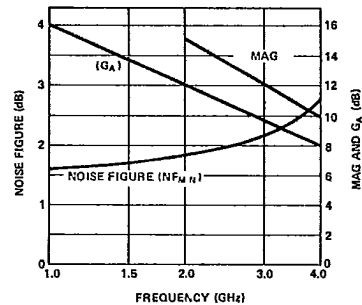


Figure 3. Typical MAG, Noise Figure (NF<sub>MIN</sub>) and Associated Gain vs. Frequency (V<sub>GR</sub> = 10 V, I<sub>C</sub> = 3 mA), for the HXTR-6103.

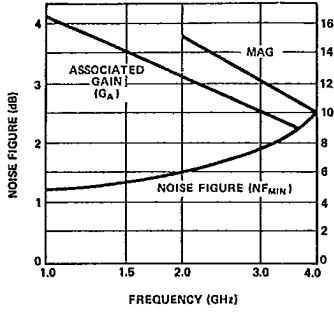


Figure 4. Typical MAG,  $NF_{MIN}$  and Associated Gain vs. Frequency ( $V_{CE} = 10$  V,  $I_C = 3$  mA), for the HXTR-6104.

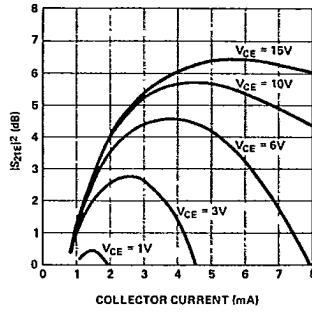


Figure 5. Typical  $|S_{21}|^2$  vs. Bias at 4 GHz, for the HXTR-6001.

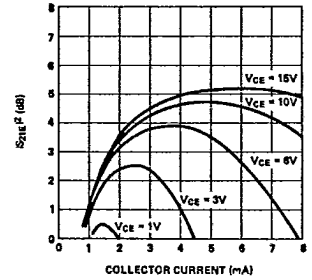


Figure 6. Typical  $|S_{21}|^2$  vs. Bias at 4 GHz, for the HXTR-6101 and HXTR-6102.

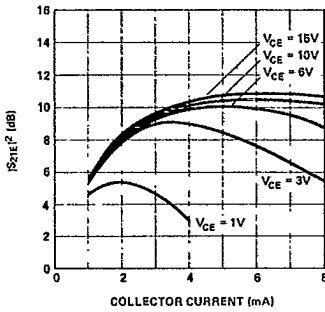


Figure 7. Typical  $|S_{21}|^2$  vs. Bias at 2 GHz, for the HXTR-6103.

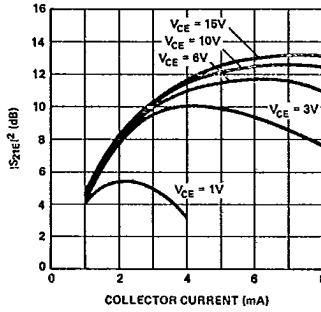


Figure 8. Typical  $|S_{21}|^2$  vs. Bias at 1.5 GHz for the HXTR-6104.

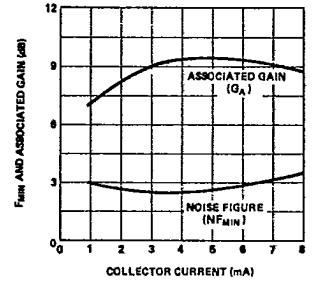


Figure 9.  $NF_{MIN}$  and  $G_A$  vs. Collector Current at 4 GHz for  $V_{CE} = 10$  V, for the HXTR-6101 and HXTR-6102.

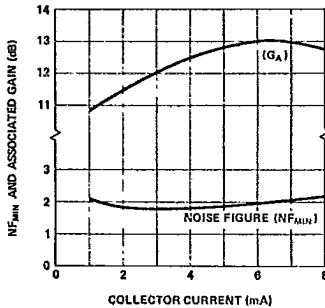


Figure 10. Typical  $NF_{MIN}$  and Associated Gain vs. Collector Current at 2 GHz for  $V_{CE} = 10$  V (Tuned for  $NF_{MIN}$ ), for the HXTR-6103.

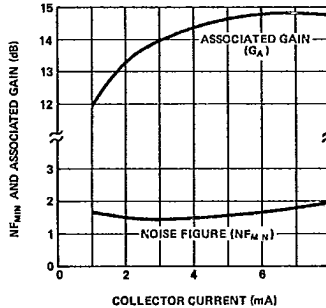


Figure 11. Typical Noise Figure and Associated Gain vs.  $I_C$  at 1.5 GHz for  $V_{CE} = 10$  V (Tuned for  $NF_{MIN}$ ), for the HXTR-6104.

### Typical Noise Parameters

HXTR-6101 and HXTR-6102 ( $V_{CR} = 10\text{ V}$ ,  $I_C = 4\text{ mA}$ )

Freq. (MHz)	$\Gamma_o$ (Mag./Ang.)	$R_N$ (Ohms)	$NF_{MIN}$ (dB)
1000	0.480/23°	23.31	1.45
1500	0.450/61°	15.57	1.58
2000	0.410/88°	15.73	1.72
3000	0.425/121°	10.72	2.18
4000	0.475/166°	3.50	2.75
5000	0.530/-164°	2.81	3.67
6000	0.520/-131°	7.23	4.78

HXTR-6103 ( $V_{CR} = 10\text{ V}$ ,  $I_C = 3\text{ mA}$ )

Freq. (MHz)	$\Gamma_o$ (Mag./Ang.)	$R_N$ (Ohms)	$NF_{MIN}$ (dB)
1000	0.465/36°	25.1	1.55
1500	0.369/67°	22.5	1.65
2000	0.323/94°	23.3	1.80

HXTR-6104 ( $V_{CR} = 10\text{ V}$ ,  $I_C = 3\text{ mA}$ )

Freq. (MHz)	$\Gamma_o$ (Mag./Ang.)	$R_N$ (Ohms)	$NF_{MIN}$ (dB)
1000	0.465/36°	25.09	1.20
1500	0.369/67°	22.47	1.40
2000	0.323/94°	23.31	1.50

HXTR-6102 Low Power Bias Performance, Noise Parameters at 1000 MHz

Bias		$NF_{MIN}$ (dB)	$G_A$ (dB)	$R_N$ (Ohms)	$\Gamma_o$ (Mag./Ang.)
$V_{CR}$ (V)	$I_C$ (mA)				
3	0.25	2.25	8.5	60.5	0.805/31°
3	0.50	1.87	12.7	25.5	0.713/38°
3	1.00	1.55	15.7	13.9	0.571/39°

HXTR-6102 Noise Performance vs. Frequency and Bias

Bias		Frequency							
		1000 MHz		1500 MHz		2000 MHz		3000 MHz	
$V_{CR}$ (V)	$I_C$ (mA)	$NF_{MIN}$ (dB)	$G_A$ (dB)	$NF_{MIN}$ (dB)	$G_A$ (dB)	$NF_{MIN}$ (dB)	$G_A$ (dB)	$NF_{MIN}$ (dB)	$G_A$ (dB)
3	0.25	2.25	8.5	2.67	5.0	2.83	4.7	3.88	4.1
3	0.50	1.87	12.7	2.06	9.9	2.23	7.9	2.93	6.4
3	1.00	1.55	15.7	1.73	11.7	1.79	10.2	2.38	8.1



HXTR-6001 Typical Common-Emitter S-Parameters ( $V_{CE} = 10\text{ V}$ ,  $I_C = 4\text{ mA}$ )\*

Freq. (MHz)	$S_{11}$		$S_{21}$			$S_{12}$			$S_{22}$	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.87	-16	22.0	12.60	170	-46	0.005	82	0.99	-3
200	0.85	-30	21.7	12.10	160	-40	0.010	75	0.98	-5
300	0.82	-44	21.1	11.40	151	-36	0.015	68	0.95	-7
400	0.79	-57	20.5	10.60	144	-35	0.018	63	0.93	-9
500	0.76	-68	19.8	9.77	137	-34	0.021	58	0.91	-10
600	0.73	-78	19.1	9.00	131	-32	0.024	55	0.89	-10
700	0.70	-86	18.5	8.37	126	-32	0.025	52	0.87	-11
800	0.68	-94	17.6	7.62	121	-31	0.027	50	0.85	-11
900	0.66	-100	17.0	7.05	118	-31	0.028	48	0.84	-11
1000	0.65	-106	16.3	6.54	114	-31	0.029	47	0.82	-11
1500	0.60	-126	13.5	4.73	102	-29	0.034	45	0.79	-12
2000	0.58	-139	11.3	3.67	93	-29	0.037	45	0.78	-13
2500	0.57	-146	9.5	2.99	87	-28	0.041	47	0.77	-14
3000	0.56	-152	8.1	2.53	82	-27	0.045	49	0.77	-15
3500	0.56	-156	6.8	2.19	77	-26	0.049	51	0.76	-16
4000	0.55	-159	5.7	1.93	72	-26	0.053	52	0.76	-18
4500	0.55	-162	4.8	1.73	68	-25	0.057	53	0.76	-19
5000	0.55	-164	3.9	1.57	65	-24	0.062	54	0.76	-21
5500	0.55	-165	3.2	1.44	61	-24	0.066	55	0.76	-23
6000	0.54	-167	2.5	1.34	57	-23	0.071	55	0.76	-24
7000	0.54	-169	1.4	1.17	51	-22	0.080	56	0.77	-28

\*Values do not include any parasitic bonding inductances and were generated by use of a computer model.

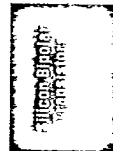
RF Equivalent Circuit See page 3-7.

HXTR-6101 and HXTR-6102 Typical Common-Emitter S-Parameters ( $V_{CE} = 10\text{ V}$ ,  $I_C = 4\text{ mA}$ )

Freq. (MHz)	$S_{11}$		$S_{21}$		$S_{12}$		$S_{22}$	
	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.
100	0.91	-11	7.14	168	0.007	79	0.99	-4
500	0.78	-54	6.27	135	0.026	54	0.90	-18
1000	0.63	-98	5.03	113	0.037	33	0.78	-30
1500	0.59	-127	3.88	87	0.039	28	0.76	-35
2000	0.58	-149	3.14	71	0.042	26	0.75	-43
2500	0.57	-163	2.64	59	0.042	25	0.76	-50
3000	0.57	-173	2.20	48	0.043	25	0.77	-58
3500	0.56	180	1.94	37	0.046	25	0.79	-64
4000	0.54	173	1.66	29	0.049	24	0.81	-71
4500	0.53	167	1.45	20	0.053	24	0.85	-76
5000	0.51	160	1.34	11	0.058	23	0.86	-84
5500	0.50	152	1.21	-1	0.060	22	0.88	-92
6000	0.48	146	1.07	-7	0.063	20	0.87	-99
7000	0.49	132	0.89	-23	0.069	15	0.87	-108

HXTR-6103 and HXTR-6104 Typical Common-Emitter S-Parameters ( $V_{CE} = 10 \text{ V}$ ,  $I_C = 3 \text{ mA}$ )

Freq. (MHz)	$S_{11}$		$S_{21}$			$S_{12}$			$S_{22}$	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.93	-11.5	16.2	6.46	168.0	-42.0	0.01	77.0	0.99	-4.0
200	0.89	-23.0	17.1	7.13	158.0	-37.0	0.01	77.0	0.97	-8.0
300	0.86	-34.0	16.4	6.58	149.0	-34.0	0.02	66.0	0.94	-12.0
400	0.83	-44.0	15.9	6.26	142.0	-32.0	0.03	60.0	0.92	-16.0
500	0.79	-54.0	15.6	6.02	135.0	-30.0	0.03	55.0	0.89	-19.0
600	0.75	-65.0	15.4	5.91	128.0	-29.0	0.04	51.0	0.87	-21.0
700	0.71	-73.0	15.0	5.62	121.0	-29.0	0.04	48.0	0.85	-24.0
800	0.68	-81.0	14.4	5.25	116.0	-28.0	0.04	45.0	0.84	-25.0
900	0.65	-91.0	14.0	4.99	111.0	-28.0	0.04	43.0	0.83	-27.0
1000	0.62	-97.0	13.5	4.72	106.0	-27.0	0.04	41.0	0.81	-28.0
1500	0.52	-129.0	11.4	3.71	84.0	-27.0	0.05	32.0	0.74	-35.0
2000	0.50	-151.0	9.3	2.93	69.0	-26.0	0.05	31.0	0.72	-43.0
2500	0.50	-169.0	7.8	2.45	55.0	-26.0	0.05	31.0	0.69	-51.0
3000	0.49	175.0	6.5	2.12	42.0	-26.0	0.06	33.0	0.68	-57.0
3500	0.54	165.0	5.4	1.87	29.0	-25.0	0.06	35.0	0.65	-68.0
4000	0.52	156.0	4.5	1.67	19.0	-24.0	0.06	37.0	0.68	-76.0
5000	0.53	140.0	2.6	1.35	-3.0	-23.0	0.08	35.0	0.71	-96.0
6000	0.48	120.0	0.9	1.11	-22.0	-21.0	0.09	34.0	0.73	-112.0



### High Reliability Testing\*

Two basic levels of High-Reliability testing are offered.

1. The TX suffix indicates a part that is preconditioned and screened to the program shown in Table II and III, and is marked with an orange dot.
2. The TXV suffix indicates that an internal visual inspection per MIL-STD-750 Method 2072 is included as part of the preconditioning screening and is marked with a green dot.

Group B quality conformance inspections are performed on each inspection lot in accordance with Table IVb. Group C quality conformance inspections

### Part Number System for Order and RFQ Information

Part Number Prefix	Screening Level
2N6617 (HXTR-6101) 2N6742 (HXTR-6102) 2N6618 (HXTR-6103) 2N6743 (HXTR-6104)	Commercial
2N6617TX (HXTR-6101TX) 2N6742TX (HXTR-6102TX) 2N6618TX (HXTR-6103TX) 2N6743TX (HXTR-6104TX)	100% Screen (per Tables II and III)
2N6617TXV (HXTR-6101TXV) 2N6742TXV (HXTR-6102TXV) 2N6618TXV (HXTR-6103TXV) 2N6743TXV (HXTR-6104TXV)	100% Screen Internal Visual

are performed periodically at six month intervals in accordance with Table V.

\*Please refer to MIL-S-19500 for Tables II, III, IVb, and V.

100% Screen	Screened per MIL-S-19500, Table II, TX or TXV, with the following specified tests and conditions:	
	Pre Burn In Tests (Screen 11)*	All DC parameters; $BV_{CES}$ , $I_{CEO}$ , $I_{CBO}$ and $h_{FE}$ at 25°C, per data sheet Electrical Specifications table
	Burn In Conditions (Screen 12)*	$P_T = 150 \text{ mW}$ , $T_A = 25^\circ\text{C}$
	Post Burn In Tests and Deltas (Screen 13)*	All DC parameters; $BV_{CES}$ , $I_{CEO}$ , $I_{CBO}$ and $h_{FE}$ at 25°C, per data sheet Electrical Specifications table  Delta Limits: $\Delta I_{CBO} = \pm 25 \text{ nA}$ or 100%, whichever is greater $\Delta h_{FE} = \pm 25\%$
Group A	Per MIL-S-19500, Table III, and the following:	
	Subgroup 2	$BV_{CES}$ , $I_{CEO}$ , $I_{CBO}$ and $h_{FE}$ per data sheet Electrical Specifications table
	Subgroup 3	$T_A = +150^\circ\text{C}$ , $I_{CBO} = 10 \mu\text{A}$ at $V_{CB} = 10 \text{ V}$
		HXTR-6101 $T_A = -55^\circ\text{C}$ , $h_{FE} = 10$ minimum at HXTR-6102 $I_C = 4 \text{ mA}$ , $V_{CE} = 10 \text{ V}$
		HXTR-6103 $T_A = -55^\circ\text{C}$ , $h_{FE} = 20$ minimum at HXTR-6104 $I_C = 3 \text{ mA}$ , $V_{CE} = 10 \text{ V}$
		Subgroup 4
Subgroups 5, 6, and 7 are not applicable.		
Group B	Per MIL-S-19500, Table IVb. End point tests per Group A Subgroup 2, and with the following conditions and exceptions:	
	Subgroup 3	Operating Life conditions same as 100% burn-in.
	except Subgroup 4	SEM, done prior to assembly
	except Subgroup 5	Thermal resistance, per MIL-STD-750 Method 3151
Group C	Per MIL-S-19500, Table V. No exceptions. End point tests per Group A Subgroup 2, with the following conditions:	
	Subgroup 6	Operating Life conditions same as 100% burn-in.

\*Refer to MIL-S-19500 screen numbers.