Linear Power Transistors HXTR-5001 Chip

Technical Data

2N6701 (HXTR-5101, TX and TXV)
2N6741 (HXTR-5103, TX and TXV)

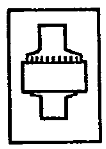
Features

- **High Output Power**
  23 dBm Typical P_{1dB} at 2 GHz
  22 dBm Typical P_{1dB} at 4 GHz
- **High P_{1dB} Gain**
  23 dB Typical G_{1dB} at 2 GHz
  22 dB Typical G_{1dB} at 4 GHz
- **High Power-Added Efficiency**
- **Hermetic Package**

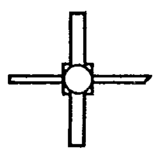
Recommended Die Attach and Bonding Procedures

Eutectic Die Attach at a stage temperature of 410 ± 10°C under an N_2 ambient. Chip should be lightly scrubbed using a tweezer or collet and eutectic should flow within five seconds.

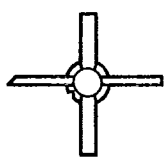
Thermocompression Wire Bond at a stage temperature of 310 ± 10°C, using a tip force of 30 ± 5 grams with 0.7 or 1.0 mil gold wire. A one mil minimum wire clearance at the passivation edge is recommended. (Ultrasonic bonding is not recommended.)



Generic Chip
HXTR-5001



HPAC-100
2N6701
(HXTR-5101)



HPAC-200
2N6741
(HXTR-5103)

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

Description

The HXTR-5001 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 has Ta_2N ballast resistors for ruggedness.

The HXTR-5001 chip is available in two package styles. The 2N6701 (HXTR-5101) is supplied in the HPAC-100 metal/ceramic hermetic package, while the 2N6741 (HXTR-5103) is supplied in the HPAC-200 metal/ceramic package with a BeO heat conductor. Both packaged devices are capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.

Both the common-emitter 2N6701 (HXTR-5101) and 2N6741 (HXTR-5103) have superior gain, power and distortion performance, and are ideally suited for use in radar, ECM, space, and commercial and military communications.

Electrical Specifications

Symbol	Parameters and Test Conditions	Test Method MIL-STD-750	Units	HXTR-5001 [1]			HXTR-5101 [2]			HXTR-5103 [2]		
				Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at $I_C = 3$ mA	3001*	V	40			40			40		
BV_{CEO}	Collector-Emitter Breakdown Voltage at $I_C = 15$ mA	3011*	V	24			24			24		
BV_{EBO}	Emitter-Base Breakdown Voltage at $I_E = 30$ µA	3026*	V	3.3			3.3			3.3		
I_{EBO}	Emitter-Base Leakage Current at $V_{EB} = 2$ V	3061	µA			2			2			2
I_{CES}	Collector-Emitter Leakage Current at $V_{CE} = 32$ V	3041**	nA			200			200			200
I_{CBO}	Collector-Base Cutoff Current at $V_{CB} = 20$ V	3036**	nA			100			100			100
h_{FE}	Forward Current Transfer Ratio $V_{CE} = 18$ V, $I_C = 30$ mA	3076*		15	35	85	15	35	85	15	35	85
P_{1dB}	Power Output at 1 dB Gain Compression f = 2 GHz f = 4 GHz $V_{CE} = 18$ V, $I_C = 30$ mA		dBm		23.0 22.0		 21.0	23.0 22.0		22.0	23.0	
G_{1dB}	Associated 1 dB Compressed Gain f = 2 GHz f = 4 GHz $V_{CE} = 18$ V, $I_C = 30$ mA		dB	 7.5	13.5	 6.5	 7.5	13		9.5	11.0	
P_{SAT}	Saturated Power Output at 1 dB Gain Compression (8 dB Gain) f = 2 GHz (5 dB Gain) f = 2 GHz (3 dB Gain) f = 4 GHz $V_{CE} = 18$ V, $I_C = 30$ mA		dBm	 25.0	25.5		 25.0	25.5			 25.0	
η	Power-Added Efficiency at 1 dB Compression f = 2 GHz f = 4 GHz $V_{CE} = 18$ V, $I_C = 30$ mA		%		35 25			35 24			34	
IP_3	Third Order Intercept Point f = 4 GHz $V_{CE} = 18$ V, $I_C = 30$ mA		dBm		32			31			32	
C_{rb}	Reverse Transfer Capacitance f = 1 MHz $V_{CB} = 10$ V, $I_C = 0$ mA		pF					0.27				

*300 µs wide pulse measurement at ≤ 2% duty cycle
**Measured under low ambient light conditions, for chip only.

Notes:
1. $T_A = 25°C$
2. $T_{CASE} = 25°C$

Absolute Maximum Ratings*

Symbol	Parameter	HXTR-5001[1] (T_A = 25°C)	HXTR-5101[2] (T_{CASE} = 25°C)	HXTR-5103[2] (T_{CASE} = 25°C)
V_{CBO}	Collector to Base Voltage	45 V	45 V	45 V
V_{CEO}	Collector to Emitter Voltage	27 V	27 V	27 V
V_{EBO}	Emitter to Base Voltage	4 V	4 V	4 V
I_C	DC Collector Current	100 mA	100 mA	100 mA
P_T	Total Device Dissipation	1.4 W	1.1 W	1.4 W
T_J	Junction Temperature	200°C	200°C	200°C
T_{STG}	Storage Temperature	-65°C to 300°C	-65°C to 200°C	-65°C to 200°C
–	Lead Temperature (Soldering 10 seconds each lead)		250°C	250°C

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

Notes:

1. Power dissipation derating should include a θ_{JB} (Junction-to-Back contact thermal resistance) of 70°C/W. Total θ_{JA} (Junction to Ambient) will be dependent upon the heat sinking provided in the individual application.
2. A θ_{JC} maximum of 125°C/W for the HXTR-5101, and 70°C/W for the HXTR-5103 should be used for derating and junction temperature calculations ($T_J = P_D \times \theta_{JC} + T_{CASE}$).

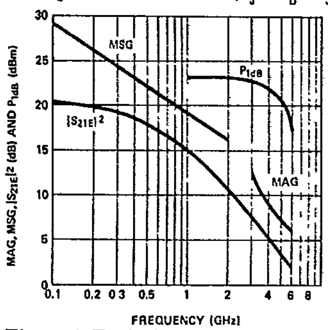


Figure 1. Typical MAG, Maximum Stable Gain (MSG), $|S_{21E}|^2$ and P_{1dB} Linear Power vs. Frequency (V_{CE} = 18 V, I_C = 30 mA), for the HXTR-5001.

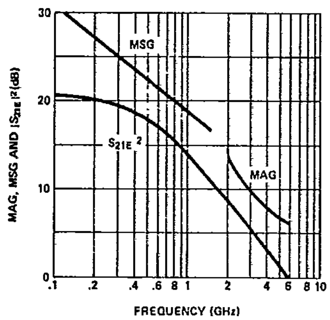


Figure 2. Typical MAG, Maximum Stable Gain (MSG) and $|S_{21E}|^2$ vs. Frequency (V_{CE} = 18 V, I_C = 30 mA), for the HXTR-5101.

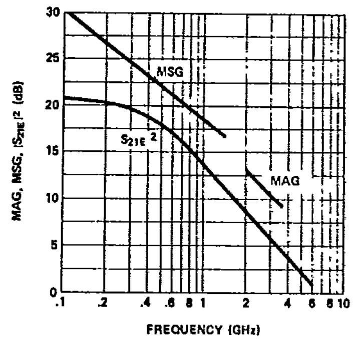


Figure 3. Typical MAG, Maximum Stable Gain (MSG), and $|S_{21E}|^2$ vs. Frequency (V_{CE} = 18 V, I_C = 30 mA), for the HXTR-5103.

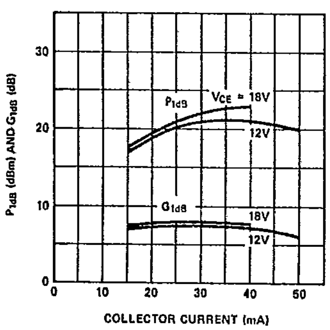


Figure 4. Typical P_{1dB}, Linear Power and Associated 1 dB Compressed Gain vs. Collector Current (V_{CE} = 12 V and 18 V at 4 GHz), for the HXTR-5001.

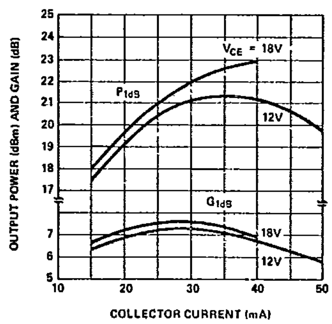


Figure 5. Typical P_{1dB} Linear Power and Associated 1 dB Compressed Gain vs. Collector Current (V_{CE} = 12 V and 18 V at 4 GHz), for the HXTR-5101.

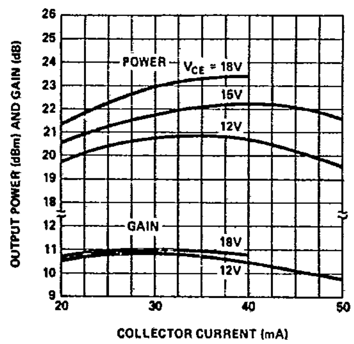


Figure 6. Typical P_{1dB} and Associated 1 dB Compressed Gain vs. Collector Current at 2 GHz, for the HXTR-5103.

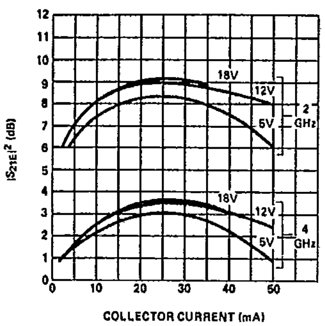


Figure 7. Typical $|S_{21E}|^2$ vs. Collector Current at 2 and 4 GHz, for the HXTR-5101.

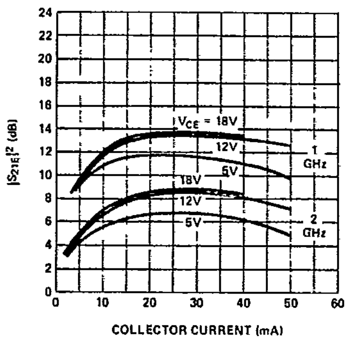


Figure 8. Typical $|S_{21E}|^2$ vs. Collector Current at 1 and 2 GHz, for the HXTR-5103.

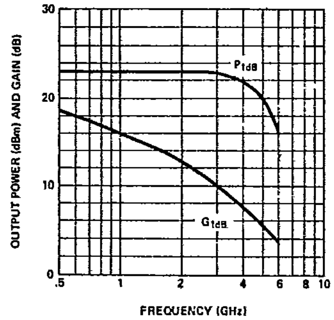


Figure 9. Typical P_{1dB} Linear Power and Associated 1 dB Compressed Gain vs. Frequency (V_{CE} = 18 V, I_C = 30 mA), for the HXTR-5101.

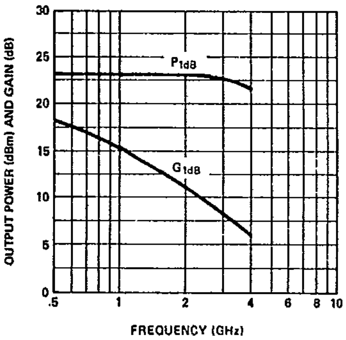


Figure 10. Typical P_{1dB} and Associated 1 dB Compressed Gain vs. Frequency (V_{CE} = 18 V, I_C = 30 mA, for the HXTR-5103.

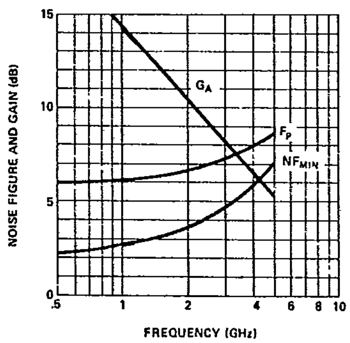


Figure 11. Typical Noise Figure NF_{MIN} and Associated Gain (G_A) When Tuned for Minimum Noise vs. Frequency (V_{CE} = 18 V, I_C = 10 mA), Typical Noise Figure (Fp) When Tuned for Max P_{1dB}, (V_{CE} = 18 V, I_C = 30 mA), for the HXTR-5101 and HXTR-5103.

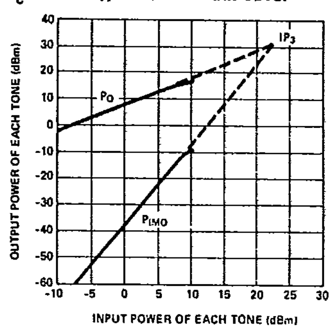


Figure 12. Typical Two Tone Third Order Intermodulation Distortion at 2 GHz for a Frequency Separation of 5 MHz (V_{CE} = 18 V, I_C = 30 mA) for the HXTR-5101.

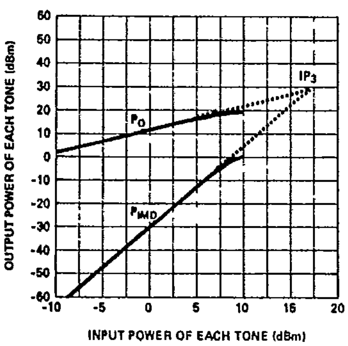


Figure 13. Typical Two Tone Third Order Intermodulation Distortion at 2 GHz for a Frequency Separation of 5 MHz (V_{CE} = 18 V, I_C = 30 mA) for the HXTR-5103.

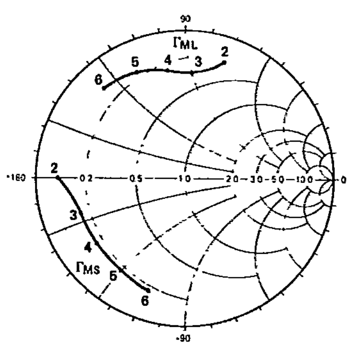


Figure 14. Typical Γ_{MS}, Γ_{ML}, (Calculated From the Average S-Parameters) in the 2 to 6 GHz Frequency Range (V_{CE} = 18 V, I_C = 30 mA), for the HXTR-5101.

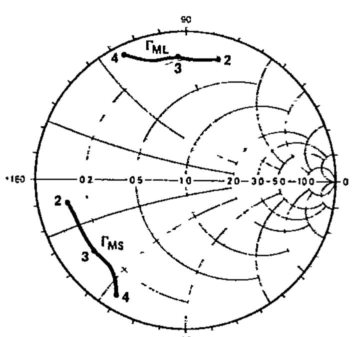


Figure 15. Typical Γ_{MS}, Γ_{ML}, (Calculated From the Average S-Parameters) in the 2 to 4 GHz Frequency Range (V_{CE} = 18 V, I_C = 30 mA), for the HXTR-5103.

HXTR-5001 Typical Common Emitter S-Parameters (V_{CE} = 18 V, I_C = 30 mA)*

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
0.100	0.74	-15	20.2	10.2	171	-38	0.01	83	0.99	-5
0.200	0.73	-30	19.9	9.88	162	-33	0.02	75	0.97	-10
0.300	0.72	-44	19.5	9.42	154	-30	0.03	69	0.93	-15
0.400	0.71	-57	19.0	8.87	146	-28	0.04	63	0.89	-19
0.500	0.70	-68	18.4	8.28	140	-26	0.05	58	0.85	-22
0.600	0.69	-78	17.7	7.71	134	-25	0.06	54	0.80	-24
0.700	0.67	-87	17.1	7.16	129	-25	0.06	50	0.76	-26
0.800	0.67	-94	16.5	6.65	124	-24	0.06	47	0.73	-28
0.900	0.66	-101	15.8	6.19	120	-24	0.07	44	0.70	-29
1.000	0.65	-107	15.2	5.78	117	-23	0.07	42	0.67	-30
1.500	0.63	-128	12.6	4.25	103	-22	0.08	37	0.58	-32
2.000	0.62	-140	10.5	3.33	94	-22	0.08	35	0.53	-32
2.500	0.61	-148	8.7	2.73	87	-21	0.09	34	0.51	-33
3.000	0.61	-154	7.3	2.32	81	-21	0.09	35	0.50	-35
3.500	0.61	-158	6.1	2.02	76	-20	0.10	36	0.49	-36
4.000	0.60	-161	5.8	1.79	71	-20	0.20	37	0.49	-38
4.500	0.60	-164	4.1	1.61	66	-19	0.11	38	0.49	-40
5.000	0.60	-166	3.3	1.47	62	-19	0.11	39	0.49	-43
5.500	0.59	-168	2.6	1.35	58	-19	0.12	40	0.49	-45
6.000	0.59	-169	2.0	1.25	55	-18	0.12	40	0.49	-47

*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-5101 Typical Common Emitter S-Parameters (V_{CE} = 18 V, I_C = 30 mA)

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.80	-19	20.6	10.7	165	-37	0.01	77	0.98	-8
200	0.78	-37	20.1	10.2	154	-31	0.03	67	0.94	-15
300	0.75	-53	19.5	9.44	143	-28	0.04	80	0.88	-21
400	0.72	-88	18.7	8.63	133	-27	0.05	53	0.83	-26
500	0.68	-81	17.9	7.87	124	-28	0.05	47	0.78	-30
600	0.66	-92	17.0	7.15	117	-25	0.06	42	0.73	-33
700	0.64	-102	16.2	6.52	110	-24	0.06	39	0.69	-36
800	0.62	-111	15.5	5.98	104	-24	0.07	36	0.66	-38
900	0.61	-119	14.8	5.49	99	-23	0.07	33	0.64	-41
1000	0.60	-126	14.1	5.08	94	-23	0.07	31	0.61	-43
1500	0.56	-151	11.2	3.64	75	-23	0.08	25	0.55	-51
2000	0.55	-169	8.9	2.80	59	-22	0.08	22	0.52	-61
2500	0.56	179	7.2	2.29	45	-21	0.09	21	0.53	-72
3000	0.55	168	5.7	1.93	33	-21	0.09	21	0.52	-79
3500	0.56	158	4.5	1.69	21	-20	0.10	20	0.55	-89
4000	0.54	148	3.5	1.50	10	-19	0.11	19	0.58	-96
4500	0.54	137	2.5	1.33	0	-19	0.11	18	0.58	-106
5000	0.52	128	1.6	1.21	-11	-18	0.13	16	0.62	-113
5500	0.54	115	1.0	1.12	-23	-17	0.14	14	0.60	-122
6000	0.54	108	0.0	1.01	-32	-17	0.15	11	0.64	-132

HXTR-5101 Typical Common Emitter S-Parameters (V_{CE} = 18 V, I_C = 15 mA)

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.80	-18	19.4	9.35	166	-37	0.01	78	0.98	-7
200	0.78	-35	19.1	9.07	155	-31	0.02	69	0.95	-14
300	0.76	-50	18.5	8.44	145	-28	0.03	61	0.91	-20
400	0.73	-64	17.6	7.79	135	-26	0.04	55	0.86	-25
500	0.69	-77	17.1	7.16	127	-25	0.05	49	0.61	-29
600	0.67	-88	16.3	6.58	119	-24	0.06	44	0.76	-32
700	0.64	-97	15.5	6.02	113	-23	0.06	40	0.72	-35
800	0.62	-107	14.8	5.54	107	-23	0.06	37	0.69	-38
900	0.60	-115	14.2	5.13	101	-23	0.07	34	0.68	-40
1000	0.60	-122	13.5	4.76	96	-23	0.07	32	0.63	-43
1500	0.57	-148	10.8	3.47	78	-22	0.08	24	0.57	-53
2000	0.55	-168	8.6	2.69	60	-21	0.08	21	0.54	-63
2500	0.56	-178	6.9	2.21	46	-21	0.09	19	0.55	-75
3000	0.56	171	5.1	1.80	36	-20	0.09	21	0.50	-85
3500	0.56	160	4.3	1.65	21	-20	0.10	18	0.56	-91
4000	0.53	151	3.3	1.47	10	-19	0.11	18	0.59	-99
4500	0.53	141	2.3	1.30	0	-19	0.11	17	0.59	-108
5000	0.50	130	1.5	1.18	-10	-18	0.12	15	0.62	-116
5500	0.52	118	0.8	1.10	-22	-17	0.14	13	0.61	-124
6000	0.53	110	0.0	0.99	-31	-16	0.15	11	0.64	-135

HXTR-5103 Typical Common Emitter S-Parameters (V_{CE} = 18 V, I_C = 30 mA)

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.74	-20	20.7	10.90	185	-37	0.01	79	0.98	-9
200	0.71	-40	20.3	10.30	152	-32	0.03	68	0.94	-17
300	0.68	-57	19.6	9.49	140	-29	0.04	62	0.89	-23
400	0.65	-72	18.7	8.65	130	-27	0.04	55	0.84	-28
500	0.62	-86	17.8	7.77	121	-26	0.05	49	0.79	-33
600	0.60	-97	16.9	7.01	113	-25	0.06	44	0.75	-37
700	0.58	-108	16.2	6.43	106	-25	0.06	41	0.71	-40
800	0.55	-118	15.4	5.87	100	-24	0.06	38	0.68	-42
900	0.54	-124	14.6	5.38	94	-24	0.07	35	0.85	-44
1000	0.52	-131	13.8	4.91	88	-23	0.07	33	0.63	-18
1500	0.49	-159	11.0	3.53	66	-22	0.08	25	0.58	-59
2000	0.47	-179	8.8	2.77	48	-21	0.09	22	0.58	-67
2500	0.47	185	7.1	2.27	32	-20	0.10	18	0.56	-81
3000	0.45	151	5.8	1.95	17	-19	0.11	15	0.59	-90
3500	0.45	138	4.7	1.71	2	-18	0.12	10	0.59	-103
4000	0.42	123	3.7	1.54	-11	-17	0./14	4	0.64	-111
4500	0.41	110	3.2	1.44	-24	-16	0.16	1	0.65	-121
5000	0.39	89	2.2	1.29	-38	-15	0.17	-6	0.69	-131
5500	0.39	74	1.4	1.18	-53	-14	0.19	-12	0.69	-139
6000	0.37	55	0.7	1.09	-64	-13	0.22	-17	0.69	-148

HXTR-5103 Typical Common Emitter S-Parameters (V_{CE} = 15 V, I_C = 15 mA)

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.74	-19	19.1	9.05	164	-37	0.01	81	0.98	-8
200	0.70	-37	18.8	8.76	152	-31	0.03	68	094	-15
300	0.67	-54	18.2	8.16	141	-28	0.04	60	0.90	-21
400	0.63	-69	17.5	7.52	130	-27	0.05	53	0.85	-26
500	0.60	-83	16.8	6.90	121	-26	0.05	48	0.80	-31
600	0.58	-95	16.0	6.32	113	-25	0.06	43	0.76	-35
700	0.57	-105	15.2	5.78	107	-24	0.06	40	0.73	-38
800	0.55	-113	14.5	5.29	101	-24	0.07	37	0.70	-40
900	0.54	-121	13.8	4.68	95	-23	0.07	34	0.67	-43
1000	0.52	-128	13.0	4.48	89	-23	0.07	31	0.65	-45
1500	0.48	-156	10.2	3.23	66	-22	0.08	25	0.60	-55
2000	0.46	-177	8.0	2.51	48	-21	0.09	21	0.56	-65
2500	0.46	167	6.3	2.00	31	-20	0.10	18	0.56	-77
3000	0.45	153	5.0	1.78	16	-19	0.11	16	0.59	-86
3500	0.44	140	3.8	1.56	0	-18	0.12	12	0.60	-98
4000	0.43	126	2.8	1.38	-13	-17	0.14	8	0.64	-106
4500	0.41	112	1.9	1.24	-26	-18	0.15	4	0.64	-114
5000	0.38	93	1.0	1.12	-40	-15	0.17	-1	0.68	-123
5500	0.39	74	0.8	1.09	-55	-14	0.20	-6	0.70	-130
6000	0.37	56	-0.3	0.96	-67	-13	0.23	-12	0.69	-139

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

Part Number System for Order and RFQ Information

Part Number Prefix	Screening Level
2N6701 (HXTR-5101) 2N6741 (HXTR-5103)	Commercial
2N6701TX (HXTR-5101TX) 2N6741TX (HXTR-5103TX)	100% Screen (per Tables II and III)
2N5701TXV (HXTR-5101TXV) 2N6741TXV (HXTR-5103TXV)	100% Screen and Internal Visual

*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)*	HXTR-5101	All DC parameters; I_{CES}, I_{CBO}, I_{EBO}, BV_{CBO}, BV_{CEO}, BV_{EBO} and h_{FE} at 25°C, per data sheet Electrical Specifications table
		HXTR-5103	All DC parameters; BV_{CBO}, BV_{CEO}, BV_{EBO}, I_{EBO}, I_{CES}, I_{CBO} and h_{FE} at 25°C, per data sheet Electrical Specifications table
	Burn In Conditions (Screen 12)*	HXTR-5101	P_T = 450 mW, T_A = 25°C
		HXTR-5103	P_T = 700 mW, T_A = 25°C
	Post Burn In Tests and Deltas (Screen 13)*	HXTR-5101	All DC parameters; I_{CES}, I_{CBO}, I_{EBO}, BV_{CBO}, BV_{CEO}, BV_{EBO} and h_{FE} at 25°C, per data sheet Electrical Specifications table
		HXTR-5103	All DC parameters; BV_{CBO}, BV_{CEO}, BV_{EBO}, I_{EBO}, I_{CES}, I_{CBO} and h_{FE} at 25°C, per data sheet Electrical Specifications table
		Delta Limits:	ΔI_{CES} = ±50 nA or 100%, whichever is greater ΔI_{CBO} = ±25 nA or 100%, whichever is greater Δh_{FE} = ±25%
Group A	Per MIL-S-19500, Table III, and the following:		
	Subgroup 2	HXTR-5101	I_{CES}, I_{CBO}, I_{EBO}, BV_{CEO}, BV_{CBO}, BV_{CEO}, BV_{EBO} and h_{FE} at 25°C per data sheet Electrical Specifications table
		HXTR-5103	BV_{CBO}, BV_{CEO}, BV_{EBO}, I_{EBO}, I_{CES}, I_{CBO} and h_{FE} per data sheet Electrical Specifications table
	Subgroup 3	T_A = +150°C, I_{CBO} = 10 µA at V_{CB} = 20 V T_A = -55°C, h_{FE} = 5 minimum at I_C = 30 mA, V_{CE} = 18 V	
	Subgroup 4	P_{1dB} and G_{1dB} per data sheet Electrical Specifications table	
	Subgroups 5, 6, and 7 are not applicable.		
Group B	Per MIL-S-19500, Table IVb. End point tests per Group A Subgroup 2, with the 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, and with the following conditions:		
	Subgroup 6	Operating Life conditions same as 100% burn-in.	

*Refer to MIL-S-19500 screen numbers.