Bendix

Aerospace Systems Division

ALSEP Array E, PSK Transmitter
Parts Application Analysis

NO.	REV. NO.
ATM 1006	A

PAGE i OF 7

DATE 12-1-71

This ATM document is the Reliability PAA (Parts Application Analysis) of the Teledyne Telemetry Company's PSK transmitter. The analysis reflects the operating stress levels and the failure rates obtained from designs prepared for the TTC Final Design Review.

The Rev. A of this document updates CDR design mainly by incorporating EMI modification as described in Section 1.0, Introduction.

All parts analyzed meet the derating criteria of ATM-241 Revision E, Acceptable Parts List for ALSEP Array E.

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ALSEP Reliability
Manager

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1.0 Introduction

The PSK (Phase Shift Keying) transmitter subcontract (SC-935) was let to Teledyne Telemetry Company (TTC) to fulfill the requirements in the NASA Contract NAS9-5829. An ALSEP Reliability Program Plan (BSR 3024) was written in accordance with NAS9-5829 to provide for a subcontract reliability program plan. TTC has a BxA approved Reliability Program Plan, #2005177B, providing for a PAA (Parts Application Analysis).

The phase modulated transmitter is an S-band frequency unit limited to 10 watts input and a minimum one watt output.

This PSK transmitter PAA is updated from that PAA presented at the TTC CDR to the present Revision A version based on the design presented at final design review (FDR) held at TTC.

Major reason for changes and details are as follows:

a) To enhance modulation, "Speed-up" capacitors were added to the mixer input

b) Ferrite beads (not included in this PAA) were added to the modulation input line adjacent to the connector for EMI attenuation

c) Micro-minature USCC filters (integral capacitor-inductors) were added to the telemetry lines for EMI radiation suppression.

In general, all the changes were incorporated to provide EMI and IFM attenuation and electrical improvement. Table 1 provides a detailed breakdown of all changes including additions, deletions, corrections and number of value changes. These changes are in accordance with TTC schematic 2005178C plus E.O.s D1 and D2.

2.0 Requirements

The PAA requirements include derating criteria as established for parts in ATM 241E and failure rates as given in ATM 605A.

This report was initially produced for presentation at the TTC PDR. It was revised for CDR, FDR and finalized at this post FDR writing.

TABLE 1

PARTS CHANGES AFTER CDR

Device Type	Synthesizer	Pwr Ampl.	Isofilter	Housing & Regulator	TLM
Capacitors					
Parts Added	C317, C318	--	--	4	C422, C429, C430, C431, C504
Correction	C362 (was C361)	C426, C427 (listed twice)	--	FL1, FL2 Added	--
Value Changes	(14 chgs to pts)	(3 chgs)	--		--
Deletions	--	C409	FL1, FL2 (In Reg. Ass'y)	--	C3, C421
Resistors					
Parts Added	R344, 345, 346, 347, 348	--	--	--	--
Value Changes	(9 chgs to pts)	--	1	--	--
Semiconductors					
Added	Q309	--	--	--	--
Inductors					
Added	--	L404, L407	L601, L602	--	--

The design was analyzed, based on the following functional blocks:

a) Synthesizer (temperature compensated crystal, PSK modulator, multiplier)

b) Power amplifier

c) Isofilter

d) Housing and regulator

3.0 Summary of Analysis Results

All parts analyzed met the requirements of the derating criteria given in ATM 241E.

Earlier analysis indicated collector-emitter voltages of power amplifier transistors were beyond the 50% derating limit. Circuit modifications eliminated the collector-emitter (with open base) voltage as a functional parameter. The breakdown voltages characteristic is presently established from collector to base where the voltage is at 50% of the rated value.

Junction temperatures of the two power amplifier transistors and step recovery diodes were the highest of all the devices in the transmitter. Worst case is the 2005209 (2N5764) power amplifier transistor with 127.7°C in accordance with ATM 241E.

4.0 Analysis Details

Table 2 gives the number of parts and related failure rate per hour for the transmitter subassemblies. The synthesizer has a majority of the parts with 70% of the total, excluding telemetry parts. The derating of the parts and type parts used in the synthesizer limits the failure rate to less than half of the total failure rate, excluding the telemetry.

The telemetry parts and failure rate are shown for information only as any failures in the telemetry will not affect the transmitter mission requirements. (See ATM 1005, FMECA, Appendix A for detailed analysis.) Only the thermistor and filtercon are non-standard parts in the two temperature sensing telemetry circuits. These non-standard parts are controlled by source control drawings.

The synthesizer has 131 parts, including 12 semiconductors, as shown in Table 2. The passive parts, such as resistors and capacitors have very low failure rates and although comprise a majority of the parts, provide only 10% of the total failure rate. The active parts in the synthesizer are primarily diodes and transistors.

Three diodes and nine transistors have a total failure rate in the synthesizer equal to 90% of the synthesizer failure rate. Thus, these parts have the highest failure probability of all the parts in the synthesizer.

TABLE 2

TRANSMITTER SUBASSEMBLY FAILURE RATE SUMMARY

Transmitter Subassembly	No. of Parts	$\lambda \times 10^{-5}$
Synthesizer	131	.066596
Power Amplifier	36	.015211
Isofilter	10	.020126
Housing and Regulator	11	.027140
Total	188	.129073
Telemetry	24	.069228

The two power amplifier transistors contribute about a third each to the overall power amplifier failure rate. These active elements are the major components in this two stage power amplifier.

In the isofilter, the isofilter circulator has the high failure rate for that subassembly, based on a failure rate derived from MIL-HDBK-217A, Low Population Parts. The rate of .02%/1000 hours is high when considering the fact that it is basicly a passive component.

The housing and regulator comprise the areas for remaining parts. Table 2 shows a total failure rate of .027140%/1000 hrs for this area. The MEMA comprises 74% of this failure rate as it consists of an integral package of IC's, discrete semiconductor elements and discrete passive components.

Table 3 summarizes the number of parts and failure rates in each functional block and the entire system. Totals at the bottom of Table 3 are for each functional block.

TABLE 3

PAA SUMMARY

Device Type	Synthesizer		Power Amplifier		Isofilter		Housing & Regulator		Sum	
	Pts	λ (1)	Pts	λ	Pts	λ	Pts	λ	Pts	λ
Capacitors	59	.003408	26	.001451	5	.000050	8	.000120	98	.005039
Coils	17	.000340	4	.000080	2	.000040	-	-	23	.000460
Resistors	41	.000828	4	.002780	1	.000020	1	.000020	47	.003648
Diodes	3	.022750	-	-	1	.000016	1	.007000	5	.029766
Transistors	9	.037240	2	.010900	-	-	-	-	11	.048140
Microcircuits	1	.002000	-	-	-	-	-	-	1	.002000
MEMA(3)	-	-	-	-	-	-	1	.020000	1	.020000
Crystal	1	.000020	-	-	-	-	-	-	1	.000020
Isofilter	-	-	-	-	1	.020000	-	-	1	.020000
Total(2)	131	.066596	36	.015211	10	.020126	11	.027140	188	.129073

NOTES: (1) All λs are $\times 10^{-5}$ failures per hour

(2) Total does not include 24 telemetry parts in the detailed PAA.

(3) Microelectronic Modular Assembly

The last two columns of Table 3 gives the total of each part type and the total failure rate obtained.

Table 4 is a summary of parts in each ten percent (10%) stress range. Approximately 79% of the parts have less than 10% of rated stress. Eight percent (8%) of the parts have stresses between 41 and 50% That leaves 13% of the parts in the three ranges between 11 to 40%.

Fourteen of the highest stress level parts are in the power amplifier. All are capacitors which have very low failure rates. Although the transistors in the power amplifier are close to the derating limit with respect to voltage, power ratios are .14 and .24 for the 2N5481, 2N5764, respectively.

TABLE 4

TTC PSK TRANSMITTER DERATING SUMMARY

Stress - %	Parts Quantity
0-10	149
11-20	11
21-30	4
31-40	9
41-50	15
50-100	0
Total Parts: 188	

5.0 Conclusions

The parts most critical in this design are those microwave semiconductors which have only recently (within the last few years) reached the production line status. These include the 2N5481, 2N5764 and the Hewlett Packard step recovery diode. The power ratios for the transistors are low (as given in previous paragraph) and the diode has an actual power dissipation to rated dissipation of less than 10%. Thus, these parts are used with conservative stress levels, enhancing the probability of long life for the transmitter.

All parts analyzed met the derating criteria specified in ATM-241, Revision E, "Acceptable Parts List in ALSEP Array E."

APPENDIX A

DETAILED PAA

PARTS APPLICATION ANALYSIS

CAPACITORS

PROJECT: BxA

ASSEMBLY: PSK Xmtr

SUBASSEMBLY: Synthesizer

DATE: 12-1-71

SCHEMATIC NO: 2005178

(Capacitors)

1 Circuit Symbol Number C	2 Type Designation (MIL or EIA) and Construction	3 Manufacturer	4 Capacitance Value PF	5 Tolerance %	6 Manufacturer's Rated Voltage DC	6 Operating Voltage DC	6 Operating Voltage PEAK AC	7 Voltage Ratio, Operating/Rated	8 Maximum Duty Cycle	9 Ambient Temperature (°C)	10 Circuit Function or Application	11 Basic Failure Rate (%/1000 Hrs) At 25°C, 20% Stress Ratio	12 Special Environment (Derating) Failure Rate Multiplier	13 Final Failure Rate	14 Capacitor Total Per Type	15 Total Failure Rate (%/1000 Hrs)
301	UY01	JFD	1.5		300	9	.03	50		40	RF Tuning	.01	A .005		1	.00005
302	"	"	18			0.5	.0017				Output Div.	.01	.005		1	.00005
305	"	"	10			9	.03				Cplng	.01	.005		1	.00005
316	Red Cap	Erie	T&C		100	2.0	.02				Tuning	.01	.005		1	.00005
307	UY01	JFD	6.2		300	6	.07 .02				Cplng	.01	.005		1	.00005
308			48			9	1.0 .3				Cplng	.01	.005		1	.00005
310			47			1.0	0.5 .0033				Tuning	.01	.005		1	.00005
311			39			1.0	0.5 .0033				Cplng	.01	.005		1	.00005
312			39			2	.0066				Logic Speed-Up	.01	.005		1	.00005
313			47			1.0	0.5 .0033				Tuning	.01	.005		1	.00005
356			300				.0033				Cplng	.01	.005		1	.00005
357			300				.0033				Cplng	.01	.005		1	.00005
323			3.6			5	1 .02				Tuning	.01	.005		1	.00005
309	W050FH	USCC	.015 µF		50	17	.34				B+ By-Pass	.01	.005		1	.00005
315	CSR-13	Sprague	1 µF		50	5	.10					.001	.008		1	.000008
355	W050FH	USCC	.015 µF		50	5	.10					.01	.005		1	.00005
321			.015 µF		50	17	.34					.01	.005		1	.00005
322	UY01	JFD	17		300	17	0.5 .07				Cplng	.01	.005		1	.00005
328			3			17	0.5 .07					.01	.005		1	.00005

FOR USE OF RELIABILITY DEPT.

20 FAILURE RATE SOURCES (FOR COLUMN #14)

A ATM 605 B _____

C _____ D _____

21 CALCULATED MTBF _____ HRS

22 TOTAL FAILURE RATE _____ % 1000 HRS

BS-321A

PARTS APPLICATION ANALYSIS

CAPACITORS

PROJECT: BxA
ASSEMBLY: PSK Xmtr
SUBASSEMBLY: Synthesizer
DATE: 12-1-71
SCHEMATIC NO: 2005178

(Capacitors)

1 Circuit Symbol Number	2 Type Designation (Mil. or RETMA) and Construction	3 Manufacturer	4 Capacitance Value MFD	5 Tolerance %	6 Nominal Design Rated Voltage	7 Operating Voltage DC	7 Operating Voltage Peak AC	8 Voltage Ratio, Operating/Rated	9 Maximum Duty Cycle	10 Rule Air Temperature (°C)	11 Circuit Function or Application	12 Basic Failure Rate λb (%/1000 Hrs)	13 Techniques Used (Optional)	14 Special Environment (Optional)	15 Failure Rate Multiplier	16 Final Failure Rate	17 Total Capacitor Count Per Type	18 Total Failure Rate (%/1000 Hrs)
329	UY01	JFD	47		300	6	.07	.02	50	40	Cplng	.01	A		.005		1	.00005
330			24			12	1.0	0.4				.01			.005		1	.00005
334			0.5			5	.05	.07				.01			.005		1	.00005
336			5.1			11	0.1	.037				.01			.005		1	.00005
324	W050FH	USCC	.015		50	5		.10			Emitter By-Pass	.01			.005		1	.00005
325			.015			17		.34			B+ By-Pass	.01			.005		1	.00005
331			.015			17		.34				.01			.005		1	.00005
332			.015			5		.10			Emitter By-Pass	.01			.005		1	.00005
338			.015			5		.10				.01			.005		1	.00005
337	UY01	JFD	9.1PF		300	9	.05	.03			Tuning	.01			.005		1	.00005
341			0.5 PF			17	0.5	.07			Coupling	.01			.005		1	.00005
343			5.1PF			11	0.1	.037			Tuning	.01			.005		1	.00005
342	W050FH	USCC	.015μF		50	17		.34			B+ By-Pass	.01			.005		1	.00005
345			.015μF			17		.34				.01			.005		1	.00005
348			.015μF			5		.10			Emitter By-Pass	.01			.005		1	.00005
349	CSR-13	Sprague	1μF			5		.10			Tuning	.001			.008		1	.00005
350	W050FH	USCC	.015μF		50	17		.34			B+ By-Pass	.01			.005		1	.00005
344	UY01	JFD	9.1PF		300	11	0.1	.037			Tuning	.01			.005		1	.00005
347			1.5			9	1.5	.03			Cplng	.01			.005		1	.00005

FOR USE OF RELIABILITY DEPT.

20 FAILURE RATE SOURCES (FOR COLUMN 12)
A ATM 605A B _____
C _____ D _____

21 CALCULATED MTBF _____ HRS

22 TOTAL FAILURE RATE _____ % 1000 HRS

BS-321A

PARTS APPLICATION ANALYSIS

CAPACITORS

PROJECT: BxA DATE: 12-1-71

ASSEMBLY: PSK Xmtr SUBASSEMBLY: Synthesizer SCHEMATIC NO: 2005178

(Capacitors)

1 CIRCUIT SYMBOL NUMBER	2 TYPE DESIGNATION (MIL or MFR) AND CONSTRUCTION	3 MANUFACTURER	4 CAPACITANCE VALUE, mfd	5 TOLERANCE %	6 MANUFACTURER'S RATED VOLTAGE	7 OPERATING VOLTAGE DC	8 OPERATING VOLTAGE PEAK AC	9 VOLTAGE DERATING RATIO, OPERATING/RATED	10 MAXIMUM DUTY CYCLE	11 BULB AIR TEMPERATURE °C	12 CIRCUIT FUNCTION OR APPLICATION	13 BASIC FAILURE RATE (λb) PER 1000 HRS	14 SOURCE	15 SPECIAL ENVIRONMENT (πE) FAILURE RATE MULTIPLIER	16	17 FINAL FAILURE RATE	18 TOTAL CAPACITORS COUNT PER TYPE	19 TOTAL FAILURE RATE (λ) PER 1000 HRS
354	UY01	JFD	2.2		300	231	.13	50		40	Output Divider	.01	A	.005			1	.00005
352	W050FH	USCC	.015μF		50	5	.10				Emitter By-Pass	.01		.005			1	.00005
306	2346283-10	Johanson	Var.		250	5	.024				RF Tuning	.01	C	.01			1	.0001
319						5	.024					.01		.01			1	.0001
314						5	.024					.01		.01			1	.0001
326						17	2.8	.08				.01		.01			1	.0001
327						5	.024					.01		.01			1	.0001
333						17	2.8	.08				.01		.01			1	.0001
335						5	.024					.01		.01			1	.0001
339	2346283-10	Johanson	Var.		250	17	2.8	.08			RF Tuning	.01	C	.01			1	.0001
340						5	.024					.01		.01			1	.0001
346						5	.024					.01		.01			1	.0001
351						5	.024					.01		.01			1	.0001
353						5	.024					.01		.01			1	.0001
358	Red Cap	Erie	T&C		100	0	.01				Temp. Comp.	.01	A	.005			1	.00005
359						0	.01					.01		.005			1	.00005
360	UY01	JFD	5.1PF		300	17	.05				Collector Tun.	.01		.005			1	.00005
361			5.1PF			17	.05					.01		.005			1	.00005
317			22			5	.02				Logic Speed	.01		.005			1	.0005

FOR USE OF RELIABILITY DEPT.

20 FAILURE RATE SOURCES (FOR COLUMN #14)

A ATM 605 B

C MIL HDBK 217A

21 CALCULATED MTBF _____ HRS

22 TOTAL FAILURE RATE _____ X 1000 HRS

BS-321A

PARTS APPLICATION ANALYSIS

CAPACITORS

PROJECT: BxA

ASSEMBLY: PSK Xmtr

SUBASSEMBLY: Synthesizer

DATE: 12-1-71

SCHEMATIC NO: 2005178

(Capacitors)

1 CIRCUIT SYMBOL NUMBER	2 TYPE DESIGNATION (MIL. or MFR) AND CONSTRUCTION	3 MANUFACTURER	4 CAPACITANCE VALUE mfd	4 TOLERANCE %	5 MANUFACTURER'S RATED VOLTAGE	6 OPERATING VOLTAGE DC	6 OPERATING VOLTAGE PEAK AC	7 VOLTAGE ULTIM. OPERATING RATED	8 MAXIMUM DUTY CYCLE	10 BULK AIR TEMPERATURE (°C)	11 CIRCUIT FUNCTION OR APPLICATION	12 BASIC FAILURE RATE (% / 1000 HRS)	13 SOURCE	14 ENVIRONMENT (SEE NOTE)	15 SPECIAL ENVIRONMENT (DEFINE) FAILURE RATE MULTIPLIER	16	17 FINAL FAILURE RATE	18 TOTAL CAPACITOR COUNT PER TYPE	19 TOTAL FAILURE RATE (%/1000 HRS)
318	UY01	JFD	22		300	5	.02	.02	50	40	Logic Speed	.01	A		.005			1	.0005
362	"	"	62		"	17		.3	"	"	Coupling	.01			.005			1	.0005

FOR USE OF RELIABILITY DEPT.

20 FAILURE RATE SOURCES (FOR COLUMN #14)

A _____ B _____

C _____ D _____

21 CALCULATED MTBF _____ HRS

22 TOTAL FAILURE RATE _____ % 1000 HRS

BS-321A

PARTS APPLICATION ANALYSIS

RESISTORS

(Resistors)

PROJECT: BxA

ASSEMBLY: PSK Xmtr

SUB ASSEMBLY: Synthesizer

DATE: 12-1-71

SCHEMATIC NO: 2005178

1 CIRCUIT SYMBOL NUMBER R	2 TYPE DESIGNATION (MIL or ER#) AND CONSTRUCTION	3 MANUFACTURER	4 RESISTANCE VALUE (OHMS)	5 TOLERANCE (%)	6 POWER RATING (WATTS)	7 MAXIMUM OPERATING POWER (WATTS)	8 POWER RATIO OPERATING/ RATED	9 MAXIMUM BUTT CYCLES	10 BULK AIR TEMPERATURE °C	11 CIRCUIT FUNCTION OR APPLICATION	12 BASIC FAILURE RATE (% /1000 HRS) AT 50% STRESS (SEE BELOW)	13 FOR USE OF RELIABILITY DEPT	14 SPECIAL ENVIRONMENTS (DERIVE)	15 FAILURE RATE MULTIPLIER	16 FINAL FAILURE RATE (% /1000 HRS)	17 TOTAL RESISTOR COUNT PER TYPE	18 TOTAL FAILURE RATE (% /1000 HRS)
301	RCR05 JS	A-B	9.1K	5	1/8	.009	.072	50	40	Bias Div.	.001 A			.02		1	.00002
303			11K			.0075	.06			Bias Resis.	.001			.02		1	00002
304			1.5K			.015	.150			Emitter	.001			.022		1	.000022
336			18			.0014	.011			Balancing Pad	.001			.02		1	.00002
337			18			.0014	.011			↓	.001			.02		1	.00002
338			18			.0014	.011			↓	.001			.02		1	.00002
309			36			16.3×10^{-6}	.001			Divider	.001			.02		1	.00002
310			36			17.7×10^{-6}	.001			↓	.001			.02		1	.00002
311			150			"	.001			↓	.001			.02		1	.00002
312			150			16.3×10^{-6}	.001			↓	.001			.02		1	.00002
313			150			"	.001			↓	.001			.02		1	.00002
314	↓	↓	150	↓	↓	"	.001			↓	.001			.02		1	.00002
305	RCR05G JS	A-B	12K	5	1/8	.001	.009			Base Res.	.001			.02		1	.00002
316			12K			.0025	.02			Emitter	.001			.02		1	.00002
317			430			.05	.23			Bias Div.	.001			.02		1	.00002
318	↓		430		↓	.05	.23			↓	.001			.02		1	.00002
319	RCR07G JS		3.9K		1/4	.006	.05			↓	.001			.02		1	.00002
339	RCR05G JS	↓	27	↓	1/8	.001	.008	↓	↓	Summing Netw	.001	↓		.02		1	.00002

19 FAILURE RATE SOURCES (FOR COLUMN #16)

A ATM 605 B _____

C _____ D _____

20 CALCULATED MTBF _____ HRS

21 TOTAL FAILURE RATE _____ %/1000 HRS

FORM 9221

BS-321A

PARTS APPLICATION ANALYSIS

RESISTORS

(Resistors)

PROJECT: BxA

ASSEMBLY: PSK Xmtr

SUB ASSEMBLY: Synthesizer

DATE: 12-1-71

SCHEMATIC NO: 2005178

1 CIRCUIT SYMBOL NUMBER R	2 TYPE DESIGNATION (MIL or MFR) AND CONSTRUCTION	3 MANUFACTURER	4 RESISTANCE VALUE (OHMS)	5 TOLERANCE (%)	6 POWER RATING (WATTS)	7 MAXIMUM OPERATING POWER (WATTS)	8 POWER RATIO, OPERATING/ RATED	9 MAXIMUM DUTY CYCLE	10 BULK AIR TEMPERATURE °C	11 CIRCUIT FUNCTION OR APPLICATION	12 BASIC FAILURE RATE (%/1000 HRS) AT 25°C	13 SOURCE (SEE BELOW)	14 SPECIAL ENVIRONMENTS (DESIRED)	15 FAILURE RATE MULTIPLIER	16 FINAL FAILURE RATE (%/1000 HRS)	17 TOTAL RESISTOR COUNT PER TYPE	18 TOTAL FAILURE RATE (%/1000 HRS)
341	RCR05G JS	A-B	27	5	1/8	.001	.008	50	40	Summing Netw	.001	A		.02		1	.00002
342			27			.001	.008				.001			.02		1	.00002
343			160			.001	.008				.001			.02		1	.00002
321			5.1K			.007	.056			Bias Div.	.001			.02		1	.00002
320			12K			.012	.096			Bias Div.	.001			.02		1	.00002
322			1.1K			.007	.06			Emitter	.001			.022		1	.000022
323	RCR05 JS	A-B	10K			.003	.027			Bias Div.	.001			.02		1	.00002
324			20K			.007	.056				.001			.02		1	.00002
326			820			.007	.06			Emitter	.001			.02		1	.00002
327			10K			.003	.027			Bias Div	.001			.02		1	.00002
328			20K			.007	.056				.001			.02		1	.00002
329			820			.007	.06			Emitter	.001			.02		1	.00002
330			12K			.007	.056			Bias Div	.001			.02		1	.00002
331			2.7K			.007	.056				.001			.02		1	.00002
332			470			.045	.36			Emitter	.001			.022		1	.000022
333			12K			.009	.072			Bias	.001			.02		1	.00002
334			2.7K			.009	.072				.001			.02		1	.00002
335			430			.07	.28			Emitter	.001			.022		1	.000022

FOR USE OF RELIABILITY DEPT

19 FAILURE RATE SOURCES (FOR COLUMN #14)

A ATM 605 B

C D

20 CALCULATED MTBF _____ HRS

21 TOTAL FAILURE RATE _____ %/1000 HRS

FORM 6031

BS-321A

PARTS APPLICATION ANALYSIS

RESISTORS

PROJECT: BxA DATE: 12-1-71

ASSEMBLY: PSK Xmtr SUB ASSEMBLY: Synthesizer SCHEMATIC NO: 2005178

1 CIRCUIT SYMBOL NUMBER R	2 TYPE DESIGNATION (MIL OR MFR) AND CONSTRUCTION	3 MANUFACTURER	4 RESISTANCE VALUE (OHMS)	5 TOLERANCE (%)	6 POWER RATING (WATTS)	7 MAXIMUM OPERATING POWER (WATTS)	8 POWER RATIO, OPERATING / RATED	9 MAXIMUM DUTY CYCLE	10 BULK AIR TEMPERATURE °C	11 CIRCUIT FUNCTION OR APPLICATION	12 BASIC FAILURE RATE (%/1000 HRS) AT 40°C	13 SOURCE (SEE BELOW)	14 SPECIAL ENVIRONMENTS (DEFINE)	15 FAILURE RATE MULTIPLIER	16 FINAL FAILURE RATE (%/1000 HRS)	17 TOTAL RESISTOR COUNT PER TYPE	18 TOTAL FAILURE RATE (%/1000 HRS)
347	RCR05-JS	A-B	1.2K	5	.125	.053	.42	50	40	Emitter	.001	A		.02		1	.00002
344	RCR05-JS	A-B	1K	5	.125	.04	.03	50	40	Mod. Bal.	.001	A		.02		1	.00002
345	RCR05-JS	A-B	12K	5	.125	.006	.06	50	40	Bias	.001	A		.02		1	.00002
346	RCR05-JS	A-B	12K	5	.125	.006	.06	50	40	Bias	.001	A		.02		1	.00002
348	RCR05-JS	A-B	150	5	.125	.006	.05	50	40	Decoupling	.001	A		.02		1	.00002

FOR USE OF RELIABILITY DEPARTMENT ONLY

19 FAILURE RATE SOURCES (FOR COLUMN #14)
A ATM 605 B _____
C _____ D _____

20 CALCULATED MTBF _____ HRS

21 TOTAL FAILURE RATE _____ %/1000 HRS

FORM 3081

BS-321A

(Resistors)

PARTS APPLICATION ANALYSIS

(SEMICONDUCTORS)

PROJECT: BxA
ASSEMBLY: PSK Xmtr
SUB ASSEMBLY: Synthesizer
DATE: 12-1-71
SCHEMATIC NO: 2005178

(Semiconductors)

CKT SYM NO. Q	TYPE DESIGNATION, SEMICONDUCTOR, POLARITY	MANUFACTURER	MAX. TEMP °C: AMBIENT ACTUAL T_A	JUNCTION RATED T_J	CASE ACTUAL HOT SPOT T_C	AVG PWR DISSIPATION (mw) RATED AT 25°C: AMBIENT	CASE	AMBIENT ACTUAL T_A	CASE ACTUAL T_C	ACTUAL	POWER RATIO: ACTUAL RATED 25°C (Amb.or case)	ACTUAL RATED T_A or T_C	MAXIMUM VOLTAGES: V_{CBO} RATED V	V_{CB} ACTUAL V	V_{CEO} RATED V	V_{CE} ACTUAL V	DIODE PIV: RATED V	ACTUAL V	CIRCUIT FUNCTION or APPLICATION	PART SPECIAL ENVIRONMENT (Define) T_{JN}	FOR RELIABILITY USE ONLY: RATE (% / 1000 HRS)	SOURCE (See below) A	FAIL RATE MULTIPLIER	FINAL FAIL RATE (% / 1000 HRS)	TOTAL COUNT	PER TYPE	TOTAL FAILURE RATE (%/1000 HRS)
Q301	2N4959			200						20	.11	.07									26	56×10^{-4}				1	.00560
Q307	PNP	MOT	40	200	53	200	300	175	284	20	.11	.07	30	8.3	30	9.0			Amp		26	56×10^{-4}				1	.00560
Q308				150						52	.30	.18									5	125×10^{-4}				1	.01250
Q302	S2N2222A	TI		150	53	500	1800	470	464	25	.05	.02	75	"	40	"			Sw.		284	67×10^{-4}				1	.00670
Q303	NPN											.02										67×10^{-4}				1	.00670
Q305	S2N918	TI		200	53	200	300	175	284	54	.31	.19	30	"	15	"			Amp		5	41×10^{-4}				1	.00400
Q306																						41×10^{-4}				1	.00400
CR302	SIN4449	TI		200	53							.07	I 10MA				75	5	Sw		20	97×10^{-10}				1	.009700
CR303					+4							.07	150MA									97×10^{-10}				1	.009700
CR301	SIN827A	Dksn		175	53	250				18		.07							Zener		23	335×10^{-10}				1	.00335
Q304	S2N918	TI	40	200	53	200	300	175	284	54	.31	.19	30	11	15	9.0			Amp		5	41×10^{-4}				1	.00400
Q309	S2N4959 PNP	Mot	40	200	53	200	300	175	284	20	.11	107	30	8.3	30	9.0			Amp		26	56×10^{-4}				1	.00560

FAILURE RATE SOURCE (See Column 23)
A ATM605 C
B D

NOTE: It is assumed the transient and peak power does not exceed the safe limit.

TOTAL FAILURE RATE .054390 %/1000 HRS.

BS-321A

PARTS APPLICATION ANALYSIS

(INDUCTORS & TRANSFORMERS)

PROJECT: BxA DATE: 12-1-71

ASSEMBLY: PSK Xmtr SUB ASSEMBLY: Synthesizer SCHEMATIC NO: 2005178

(Inductors & Transformers)

1 CIRCUIT SYMBOL NUMBER L	2 TYPE DESIGNATION (MIL or MFR) AND CONSTRUCTION	3 MANUFACTURER	CONSTRUCTION 4 TYPE OF CASE (SEE BELOW)	5 WIRE SIZE, PRIMARY	6 WIRE SIZE, SECONDARY	7 INSULATION CLASS	8 VA RATING	9 REACTANCE AT RATED CUR.	10 SPECIFIED FREQ	11 MISCELLANEOUS	TEMPERATURE (°C): 12 OPERATING AMBIENT (HOT SPOT (SURFACE))	13 RISE (OR METHOD)	14 EST. ACTUAL RISE	15 OPERATING TEMP MAX.	16 ACTUAL	17 RATED	PRIMARY CURRENT 18 PRIMARY VOLTAGE	19 NO. WINDINGS	SECONDARY 20 WINDING NO.	21 VOLTAGE	22 WINDINGS	HIPOT READING 23 VOLTS	24 BASIC FAILURE RATE (λb/1000 HRS)	25 C SOURCE (SEE BELOW)	26 TOTAL FAILURE RATE (λ/1000 HRS)
																								REL. DEPT USE ONLY		
301	2005205	Delevan					.10				40	53		125							1	.001	.02	C	.00002
302							3.3														1	.001	.02		.00002
303							.15														1	.001	.02		.00002
304							.15														1	.001	.02		.00002
305							.68														1	.001	.02		.00002
306							.10														1	.001	.02		.00002
307							.10														1	.001	.02		.00002
308	↓	↓					3.3														1	.001	.02		.00002
309	2005204	TTC					-														1	.001	.02		.00002
310	2005304	Delevan					.47														1	.001	.02		.00002
311	2005204	TTC					-														1	.001	.02		.00002
312	↓	↓					-														1	.001	.02		.00002
313	2005205	Delevan					.47														1	.001	.02		.00002
314	2005204	TTC					-														1	.001	.02		.00002
315	2005205	Delevan					.10														1	.001	.02		.00002
316	2005204	TTC					-				↓	↓		↓							1	.001	.02	↓	.00002
317	2005204-5	TTC																			1	.00	.02		.00002

28 TYPES OF CASE
A. HER. SEAL
B. VAC. IMP.
C. ENCAP.
D. OPEN

29 FAILURE RATE SOURCES (FOR COLUMN #25)
A. _____ B. _____
C. MIL-HDBK-217A D. _____

30 CALCULATED MTBF _____ HRS

31 TOTAL FAILURE RATE _____ λ/1000 HRS

DD FORM 9248

PARTS APPLICATION ANALYSIS

(MICROCIRCUITS)

PROJECT: BxA

ASSEMBLY: PSK Xmtr SUB ASSEMBLY: Synthesizer

DATE: 12-1-71

SCHEMATIC NO: 2005178

(Microcircuits)

CKT SYM NO. (1)	TYPE DESIGNATION (2)	MANUFACTURER (3)	TYPE (4)	MAX TEMP °C: ACTUAL AMBIENT (5)	MAX TEMP °C: RATED JUNCTION (6)	MAX TEMP °C: ACTUAL JUNCTION (7)	VOLTAGES: DERATED MAXIMUM (9)	VOLTAGES: ACTUAL (8)	VOLTAGES: DERATED MINIMUM (10)	INPUTS: FAN IN (11)	INPUTS: % OF MAX I OR V (12)	OUTPUTS: FAN OUT (13)	OUTPUTS: LOADING % (14)	SPEED: % OF MAX (15)	CLOCK WIDTH: MIN / ACTUAL % (16)	CIRCUIT FUNCTION OR APPLICATION (17)	FOR RELIABILITY USE ONLY: RATE (%/1000 HRS) (18)	SOURCE (See below) (19)	FAIL. RATE MULTIPLIER (20)	TOTAL PER TYPE (21)	TOTAL FAILURE RATE (%/1000 HRS) (22)
Z 302	SM54L00L	T.I.	TTL	40	125	53	5.3	5.0	4.7	.1	.5	.5	.5	.1	NA	Nand Gate	.002	A		1	.002

(23) FAILURE RATE SOURCE (See Column 19)
A ATM 605
B
C
D

(24) NOTE: DERATED VOLTAGE IS DETERMINED BY:
$V_{MAX} = V_{NOM} + .6 (V_{RATED\ MAX} - V_{NOM})$
$V_{MIN} = V_{NOM} - .6 (V_{NOM} - V_{RATED\ MIN})$

(25) TOTAL FAILURE RATE .002 %/1000 HRS

BxA 679

PARTS APPLICATION ANALYSIS

(MISC. PARTS)

(Misc. Parts)

PROJECT: BxA

ASSEMBLY: PSK Xmtr

SUB ASSEMBLY: Synthesizer

DATE: 12-1-71

SCHEMATIC NO: 2005178

1 CIRCUIT SYMBOL NUMBER	2 TYPE DESIGNATION (REC, MIL OR MFR) and CONSTRUCTION	3 MANUFACTURER	TEMPERATURE RANGE 4 MAX	TEMPERATURE RANGE 5 MIN	ELECTRICAL STRESS 6 RATED	ELECTRICAL STRESS 7 USE	8 PERCENT DUTY CYCLE	9 MAJOR CHARACTERISTICS and APPLICATION	FOR RELIABILITY USE ONLY 10 BASIC FAILURE RATE (%/1000 HOURS) at °C	11 SOURCE (SEE #15)	12 PART SPECIAL ENVIRONMENT (DSFINS) Qty	13 FAILURE RATE MULTIPLIER	14 TOTAL FAILURE RATE (%/1000 HOURS)
Y 301	Crystal	McCoy					50	94 MHZ Osc.	.02	C	1	.001	.00002

15 FAILURE RATE SOURCES (FOR COLUMN 11)
A. _____ B. _____
C. MIL HDBK 217 A D. MR Std 217 Chart XXIV

16 CALCULATED MTBF _____ HOURS

17 .00002 TOTAL FAILURE RATE _____ %/1000 HOURS

DRO Form 9258

BS-321A

PARTS APPLICATION ANALYSIS

CAPACITORS

PROJECT: BxA

ASSEMBLY: PSK Xmtr SUBASSEMBLY: Power Amp

DATE: 12-1-71

SCHEMATIC NO: 2005178

(Capacitors)

1 CIRCUIT SYMBOL NUMBER C	2 TYPE DESIGNATION (MIL SPEC & P/N) AND CONSTRUCTION	3 MANUFACTURER	4 CAPACITANCE VALUE (MF)	5 TOLERANCE %	6 MANUFACTURER'S RATED VOLTAGE DC	7 OPERATING VOLTAGE DC	7 OPERATING VOLTAGE PEAK AC	8 VOLTAGE RATIO, OPERATING/RATED	9 MAXIMUM DUTY CYCLE	10 BULK AIR TEMPERATURE (°C)	11 CIRCUIT FUNCTION OR APPLICATION	12 BASIC FAILURE RATE (% / 1000 HRS)	13 SOURCE (SEE BELOW)	14 SPECIAL ENVIRONMENT (DSFTBD)	15 FAILURE RATE MULTIPLIER	16 FINAL FAILURE RATE	17 TOTAL CAPACITOR COUNT PER TYPE	18 TOTAL FAILURE RATE (% / 1000 HRS)
401	UY01	JFD	6.2PF	300	500	128	.016	50		40	Cplng	.01	A	.005			1	.00005
403			3.6PF				.016					.01		.005			1	.00005
425			T&C				.016					.01		.005			1	.00005
419			6.2PF			011	.04				Tuning	.01		.005			1	.00005
412	2346283-10	Johanson	Var.		250	249	.18				Tuning	.01	C	.01			1	.0001
413						138	.16					.01		.01			1	.0001
414						223	.09					.01		.01			1	.0001
418						011	.044					.01		.01			1	0001
402						5	.032					.01		.01			1	.0001
404	W050FH	USCC	.015		50	50	.1				Emitter By-pass	.01	A	.005			1	.00005
405												.01		.005			1	.00005
406												.01		.005			1	.00005
407												.01		.005			1	00005
408						23	.46				Cplng	.01		.005			1	.00005
426						23						.01		.005			1	.00005
427						23						.01		.005			1	.00005
410																		
411	W050FH	USCC	.015		50	230	.46				B+ By-Pass	.01		.005			1	.00005

FOR USE OF RELIABILITY DEPT.

20 FAILURE RATE SOURCES (FOR COLUMN #14)

A ATM 605 B

C MIL-HDBK-217A D

21 CALCULATED MTBF _____ HRS

22 TOTAL FAILURE RATE _____ % / 1000 HRS

BS-321A

PARTS APPLICATION ANALYSIS

CAPACITORS

PROJECT: ExA

ASSEMBLY: PSK Xmtr SUBASSEMBLY: Power Amp

DATE: 12-1-71

SCHEMATIC NO: 2005178

(Capacitors)

1 Ckt Unit Symbol Number	2 Type Designation (Mil. or Mfr) and Construction	3 Manufacturer	4 Capacitance Value mfd	5 Tolerance %	6 Manufacturer's Rated Voltage	8 Operating Voltage DC	8 Operating Voltage Peak AC	7 Voltage Ratio Operating/Rated	9 Maximum Duty Cycle	10 Ambient Air Temperature (°C)	11 12 Circuit Function or Application	13 Basic Failure Rate % (%/1000 hrs)	14 Source (See Below)	15 Special Environment (Distress) Failure Rate Multiplier	16 Total Failure Rate	17 Total Capacitor Count Per Type	18 Total Failure Rate (%/1000 hrs)	19
424	CSR-13	Sprague	1.0		50	23	0	.46	50	40	B+ By Pass	.001	A	.017		1	.000017	
423	↓	↓	1.0		↓	23	↓	.46			↓	.001		.017		1	.000017	
420	↓	↓	4.7		↓	23	↓	.46			↓	.001		.017		1	.000017	
415	W050FH	USCC	.015		50	23	0	.46			B+ By-Pass	.01		.005		1	.00005	
416	↓	↓	↓		↓	↓	↓	↓			↓	.01		.005		1	.00005	
417	↓	↓	↓		↓	↓	↓	↓			↓	.01		.005		1	.00005	
422	UY01	JFD	4.7PF		300	29	0	.10			P.S. Filter	.01		.005		1	.00005	
428	UY01	JFD	12PF		300	9	5	.03			Collector Cplng	.01		.005		1	.00005	

FOR USE OF REL

20 FAILURE RATE SOURCES (FOR COLUMN #14)

A ATM 605 B

C D

21 CALCULATED MTBF ____ HRS

22 TOTAL FAILURE RATE ____ % 1000 HRS

BS-321A

PARTS APPLICATION ANALYSIS

RESISTORS

(Resistors)

PROJECT: BxA DATE: 12-1-71

ASSEMBLY: PSK Xmtr SUB ASSEMBLY: Power Amp SCHEMATIC NO: 2005178

1 CIRCUIT SYMBOL NUMBER	2 TYPE DESIGNATION (MIL or MFR) AND CONSTRUCTION	3 MANUFACTURER	4 RESISTANCE VALUE (OHMS)	5 TOLERANCE (%)	6 POWER RATING (WATTS)	7 MAXIMUM OPERATING POWER (WATTS)	8 POWER RATIO OPERATING/ RATED	9 MAXIMUM DUTY CYCLE	10 BULK AIR TEMPERATURE °C	11 CIRCUIT FUNCTION OR APPLICATION	12 BASIC FAILURE RATE (%/1000 HRS) @ 1T °C SOURCE (SEE BELOW)	13 FOR USE OF RELIABILITY DEPT	14 SPECIAL ENVIRONMENTS (DEFINE)	15 FAILURE RATE MULTIPLIER	16 FINAL FAILURE RATE (%/1000 HRS)	17 TOTAL RESISTOR COUNT PER TYPE	18 TOTAL FAILURE RATE (%/1000 HRS)
401	RWR FR	Dale	100	±1	1.0			50	40	Bias Div.	.01 A			.034		1	.00034
402	↓	↓	2.2K	↓	↓			↓	↓	↓	.01			.09		1	.00090
403	↓	↓	10	↓	↓			↓	↓	Emitter	.01			.09		1	.00090
404	↓	↓	100	↓	↓			↓	↓	Base	.01			.064		1	.00064

19 FAILURE RATE SOURCES (FOR COLUMN #14)

A ATM 605 B _____

C _____ D _____

20 CALCULATED MTBF _____ HRS

21 TOTAL FAILURE RATE _____ %/1000 HRS

BS-321A

PARTS APPLICATION ANALYSIS

(INDUCTORS & TRANSFORMERS)

PROJECT: BxA
ASSEMBLY: PSK Xmtr
SUB ASSEMBLY: Power Amp
DATE: 12-1-71
SCHEMATIC NO: 2005178

(Inductors & Transformers)

1 CIRCUIT SYMBOL NUMBER L	2 TYPE DESIGNATION (MIL or MFR) AND CONSTRUCTION	3 MANUFACTURER	CONSTRUCTION 4 TYPE OF CASE (SEE BELOW)	5 WIRE SIZE, PRIMARY	6 WIRE SIZE, SECONDARY	7 INSULATION CLASS	8 VA RATING	9 INDUCTANCE AT RATED CUR.	10 SPECIFIED FREQ	11 MEGOHMS/VOLTS	TEMPERATURE (°C) 12 OPERATING AMBIENT HOT SPOT (SURFACE)	13 RISE (AIR METHOD)	14 EST. ACTUAL RISE	15 OPERATING TEMP MAX.	16 ACTUAL	PRIMARY CURRENT 17 RATED	18 ACTUAL	19 PRIMARY VOLTAGE	SECONDARY 20 NO. WINDINGS	21 WINDING NO.	22 VOLTAGE	23 WINDINGS	24 VOLTS	HI-POT REQ'D.	25 BASIC FAILURE RATE (%/1000 HRS)	26 SOURCE (SEE BELOW)	27 TOTAL FAILURE RATE (%/1000 HRS)
																										REL. DEPT USE ONLY		
403	2005205	Delevan					.10			40	53		125										.001		.02	C	.00002
406	↓	↓					.10			40	53		125										.001		.02	C	.00002
404							.10			40	53		125										.001		.02	C	.00002
407							.10			40	53		125										.005		.02	C	.00002

28 TYPE OF CASE
A. HER. SEAL
B. VAC. IMP.
C. ENCAP.
D. OPEN

29 FAILURE RATE SOURCES (FOR COLUMN #26)
A. MIL HDBK 217A
C. _____ D. _____

30 CALCULATED MTBF _____ HRS

31 TOTAL FAILURE RATE .000040 %/1000 HRS

BxA 321A

PARTS APPLICATION ANALYSIS

(SEMICONDUCTORS)

PROJECT: BxA

ASSEMBLY: PSK Xmtr SUB ASSEMBLY: Power Amp

DATE: 12-1-71

SCHEMATIC NO: 2005178

(Semiconductors)

CKT SYM NO. (1)	TYPE DESIGNATION, SEMICONDUCTOR, POLARITY (2)	MANUFACTURER (3)	MAX. TEMP °C: AMBIENT ACTUAL T_A (4)	MAX. TEMP °C: JUNCTION RATED T_J (5)	MAX. TEMP °C: CASE ACTUAL HOT SPOT T_C (6)	AVG PWR DISSIPATION (mw): RATED AT 25°C AMBIENT (7)	AVG PWR DISSIPATION (mw): RATED AT 25°C CASE (8)	AVG PWR DISSIPATION (mw): ACTUAL AMBIENT T_A (9)	AVG PWR DISSIPATION (mw): ACTUAL CASE T_C (10)	AVG PWR DISSIPATION (mw): ACTUAL (11)	POWER RATIO: ACTUAL / RATED (Amb or case) (12)	POWER RATIO: ACTUAL T_A or T_C / RATED (13)	MAXIMUM VOLTAGES: V_{CBO} RATED V (14)	MAXIMUM VOLTAGES: V_{CB} ACTUAL V (15)	MAXIMUM VOLTAGES: V_{CEO} RATED V (16)	MAXIMUM VOLTAGES: V_{CE} ACTUAL V (17)	DIODE PIV: RATED V (18)	DIODE PIV: ACTUAL V (19)	CIRCUIT FUNCTION OR APPLICATION (20)	PART SPECIAL ENVIRONMENT (Define) T_{JN} (21)	FOR RELIABILITY USE ONLY: RATE (%/1000 HRS) (22)	SOURCE (See below) (23)	FAIL. RATE MULTIPLIER (24)	FINAL RATE (%/1000 HRS) (25)	TOTAL PER TYPE (26)	COUNT (26)	TOTAL FAILURE RATE (%/1000 HRS) (27)
401	2N5481 NPN	TRW	40	200	53		5000		4200	600		0.14	45	18	35	18			Power Amp	.28	0051						.0051
402	2N5764 NPN	TRW	40	200	53		10000		8400	1900		0.236	55	24	35	23			"	.34	0058						.0058

(28) FAILURE RATE SOURCE (See Column 23)

A ATM 605 C

B D

(29) NOTE: It is assumed the transient and peak power does not exceed the safe limit.

(30) TOTAL FAILURE RATE .0109 %/1000 HRS.

scota

BS-321A

PARTS APPLICATION ANALYSIS

CAPACITORS

PROJECT: BxA

ASSEMBLY: PSK Xmtr

SUBASSEMBLY: Isofilter

DATE: 12-1-71

SCHEMATIC NO: 2005178

(Capacitors)

1 CIRCUIT SYMBOL NUMBER C	2 TYPE DESIGNATION (MIL or MFR) AND CONSTRUCTION	3 MANUFACTURER	4 CAPACITANCE VALUE mfd PF	TOLERANCE %	5 MANUFACTURER'S RATED VOLTAGE	6 OPERATING VOLTAGE DC	6 OPERATING VOLTAGE PEAK AC	7 VOLTAGE STRESS RATIO OPERATING / RATED	8 MAXIMUM DUTY CYCLE	9 BULK AIR TEMPERATURE (°C)	10 CIRCUIT FUNCTION OR APPLICATION	11 BASIC FAILURE RATE (%/1000 HRS) AT 50% C.L.	11 SOURCE (SEE BELOW)	12 SPECIAL ENVIRONMENT (DESCRIBE) FAILURE RATE MULTIPLIER	13 FINAL FAILURE RATE	14 TOTAL CAPACITOR COUNT PER TYPE	15 TOTAL FAILURE RATE (%/1000 HRS)
604	2005200	JFD	3.3		300	15	.05	50	40	Tuning	.01	A	.001		1	.00001
603			2.7			15	.05				.01		.001		1	.00001
605			5.1			15	.05				.01		.001		1	.00001
601	2346283-10	Johanson	Var.		250	10	.04			Tuning	.01		.001		1	.00001
602						10	.04				.01		.001		1	.00001

FOR USE OF RELIABILITY DEPT.

20 FAILURE RATE SOURCES (FOR COLUMN #14)

A ATM 605 B _____

C MIL HDBK 217A D _____

21 CALCULATED MTBF _____ HRS

22 TOTAL FAILURE RATE .00005 X 1000 HRS

BS-321A

PARTS APPLICATION ANALYSIS

RESISTORS

(Resistors)

PROJECT: BxA DATE: 12-1-71

ASSEMBLY: PSK Xmtr SUB ASSEMBLY: Isofilter SCHEMATIC NO: 2005178

1 CIRCUIT SYMBOL NUMBER R	2 TYPE DESIGNATION (MIL or RETMA) AND CONSTRUCTION	3 MANUFACTURER	4 RESISTANCE VALUE (OHMS)	5 TOLERANCE ± (%)	6 POWER RATING (WATTS)	7 MAXIMUM OPERATING POWER (WATTS)	8 POWER RATIO OPERATING/ RATED	9 MAXIMUM DUTY CYCLE	10 BULK AIR TEMPERATURE °C	11 CIRCUIT FUNCTION OR APPLICATION	12 BASIC FAILURE RATE (%/1000 HRS) AT 40°C	13 SOURCE (SEE BELOW)	14 SPECIAL ENVIRONMENTS (DEFINE)	15 FAILURE RATE MULTIPLIER	16 FINAL FAILURE RATE (%/1000 HRS)	17 TOTAL RESISTOR COUNT PER TYPE	18 TOTAL FAILURE RATE (%/1000 HRS)
601	RCR07 FS	A-B	12K	5	1/4	.0012	.0049	50	40	Imped. Match	.001	A			.02		.00002

FOR USE OF R RELIABILITY DEPT.

19 FAILURE RATE SOURCES (FOR COLUMN #14)

A ATM 605 B _____

C _____ D _____

20 CALCULATED MTBF _____ HRS

21 TOTAL FAILURE RATE .00002 %/1000 HRS

Form 9281

BS-321A

PARTS APPLICATION ANALYSIS

(SEMICONDUCTORS)

PROJECT: BxA

ASSEMBLY: PSK Xmtr

SUB ASSEMBLY: Isofilter

DATE: 12-1-71

SCHEMATIC NO: 2005178

(Semiconductors)

CKT SYM NO. (1)	TYPE DESIGNATION, SEMICONDUCTOR, POLARITY (2)	MANUFACTURER (3)	MAX. TEMP °C: AMBIENT ACTUAL T_A (4)	MAX. TEMP °C: JUNCTION RATED T_J (5)	MAX. TEMP °C: CASE ACTUAL HOT SPOT T_C (6)	AVG PWR DISSIPATION (mw): RATED AT 25°C AMBIENT (7)	AVG PWR DISSIPATION (mw): RATED AT 25°C CASE (8)	AVG PWR DISSIPATION (mw): ACTUAL AMBIENT T_A (9)	AVG PWR DISSIPATION (mw): ACTUAL CASE T_C (10)	AVG PWR DISSIPATION (mw): ACTUAL (11)	POWER RATIO: ACTUAL RATED 25°C (Amb. or case) (12)	POWER RATIO: ACTUAL RATED T_A or T_C (13)	MAXIMUM VOLTAGES: V_{CBO} RATED V (14)	MAXIMUM VOLTAGES: V_{CB} ACTUAL V (15)	MAXIMUM VOLTAGES: V_{CEO} RATED V (16)	MAXIMUM VOLTAGES: V_{CE} ACTUAL V (17)	DIODE PIV: RATED V (18)	DIODE PIV: ACTUAL V (19)	CIRCUIT FUNCTION or APPLICATION (20)	PART SPECIAL ENVIRON MENT (Define) (21)	FOR RELIABILITY USE ONLY: RATE (%/1000 HRS) (22)	FAIL. RATE SOURCE (See below) (23)	MULTIPLIER (24)	FINAL FAIL. RATE (%/1000 HRS) (25)	TOTAL COUNT PER TYPE (26)	TOTAL FAILURE RATE (%/1000 HRS) (27)
CR 601	2005211	HP	40	200	53		15 W		1.25 W			.084					75	10	Step Recovery Varactor		.0016	A	.01			.0016

(28) FAILURE RATE SOURCE (See Column 23)

A ATM 605 C

B D

(29) NOTE: It is assumed the transient and peak power does not exceed the safe limit.

(30) TOTAL FAILURE RATE .001600 %/1000 HRS.

BS-321A

PARTS APPLICATION ANALYSIS

(INDUCTORS & TRANSFORMERS)

PROJECT: BxA

ASSEMBLY: PSK Xmtr

SUB ASSEMBLY: Isofilter

DATE: 12-1-71

SCHEMATIC NO: 2005178

(Inductors & Transformers)

1 CIRCUIT SYMBOL NUMBER L	2 TYPE DESIGNATION (MIL or MFR) AND CONSTRUCTION	3 MANUFACTURER	CONSTRUCTION 4 TYPE OF CASE (SEE BELOW)	5 WIRE SIZE, PRIMARY	6 WIRE SIZE, SECONDARY	7 INSULATION CLASS	8 VA RATING	9 INDUCTANCE AT RATED CUR.	10 SPECIFIED FREQ	11 MISCELLANEOUS	TEMPERATURE (°C) 12 OPERATING AMBIENT (OUTSIDE SURFACE)	13 RISE (AB METHOD) EST. ACTUAL	14 RISE EST. ACTUAL	15 OPERATING TEMP MAX.	16 ACTUAL	17 RATED	PRIMARY CURRENT 18 PRIMARY VOLTAGE	19 NO. WINDINGS	SECONDARY 20 WINDING NO.	21 VOLTAGE	22 WINDINGS	HIPOT READING 23 Multiple	24 BASIC FAILURE RATE (%/1000 HRS)	25 ΔT (°C) SOURCE (SEE BELOW)	26 TOTAL FAILURE RATE (%/1000 HRS)
																								REL. DEPT USE ONLY		
601	2005505	Delevan					0.1			40	53		125									.001	.02	C	.00002
602	2005504	TTC					--			40	53		125									.001	.02	C	.00002

25 TYPE OF CASE
A. HER. SEAL
B. VAC. IMP.
C. ENCAP.
D. OPEN

29 FAILURE RATE SOURCES (FOR COLUMN #26)
A. _____ B. _____
C. MIL-HDBK-217A D. _____

28 CALCULATED MTBF _____ HRS

31 TOTAL FAILURE RATE .00004 %/1000 HRS

BS-321A

PARTS APPLICATION ANALYSIS

(MISC. PARTS)

(Misc. Parts)

PROJECT: BxA

ASSEMBLY: PSK XMtr

SUB ASSEMBLY: Isofilter

DATE: 12-1-71

SCHEMATIC NO: 2005178

1 CIRCUIT SYMBOL NUMBER	2 TYPE DESIGNATION (CEC, MIL OR MFR) and CONSTRUCTION	3 MANUFACTURER	TEMPERATURE RANGE 4 MAX	TEMPERATURE RANGE 5 MIN	ELECTRICAL STRESS 6 RATED	ELECTRICAL STRESS 7 USE	8 PERCENT DUTY CYCLE	9 MAJOR CHARACTERISTICS and APPLICATION	FOR RELIABLITY USE ONLY 10 BASIC FAILURE RATE (%/1000 HOURS at ___°C)	11 SOURCE (SEE #15)	12 PART SPECIAL ENVIRONMENT (DEGREE)	13 FAILURE RATE MULTIPLIER	14 TOTAL FAILURE RATE (%/1000 HOURS)
	2005190 Isofilter	E&M Labs	150				50	Circulator	2.0	D		.01	.02

15 FAILURE RATE SOURCES (FOR COLUMN 11)

A. _____ B. _____

C. _____ D. Mil Std 217 Chart XXIV

16 CALCULATED MTBF _____ HOURS

17 TOTAL FAILURE RATE .02 %/1000 HOURS

DD Form 96256

BS-321A

PARTS APPLICATION ANALYSIS

CAPACITORS

PROJECT: BxA

DATE: 12-1-71

ASSEMBLY: Xmtr

SUBASSEMBLY: TLM

SCHEMATIC NO: 2005178

(Capacitors)

1 CIRCUIT SYMBOL NUMBER C	2 TYPE DESIGNATION (MIL or ASPR) AND CONSTRUCTION	3 MANUFACTURER	4 CAPACITANCE VALUE and	4 TOLERANCE %	5 MANUFACTURER'S RATED VOLTAGE	6 OPERATING VOLTAGE DC	6 OPERATING VOLTAGE PEAK AC	7 8 VOLTAGE RATIO, OPERATING/ RATED	9 MAXIMUM DUTY CYCLE	10 BULB AIR TEMPERATURE (°C)	11 CIRCUIT FUNCTION OR APPLICATION	12 BASIC FAILURE RATE (%/1000 HRS)	12 SOURCE (SEE BELOW)	13 SPECIAL ENVIRONMENT (DESCRIBE)	14 FAILURE RATE MULTIPLIER	15 FINAL FAILURE RATE	16 TOTAL CAPACITOR COUNT PER TYPE	17 TOTAL FAILURE RATE (%/1000 HRS)
501	W050FH	USCC	.015µf	10	50	5		.10	50	40	TLM Temp. Mon.	.01	A		.005		1	.000050
502	↓	↓	.015µf	10	50	5		.10	50	40	TLM Temp. Mon.	.01	A		.005		1	.000050
504	M39003/01-3076	Sprague	1µf		50	10		.2	50	40	TLM Temp. Mon.	.01	A		.005		1	.000050
431	2005201	US CC	.015µf		50	10		.1	50	40	TLM Temp. Mon.	.01	A		.005		1	.000050
430	2005201	US CC	.015µf		50	10		.1	50	40	TLM Temp. Mon.	.01	A		.005		1	.000050
429	2005201	US CC	.015µf		50	10		.1	50	40	TLM Temps Mon.	.01	A		.005		1	.000050

20 FAILURE RATE SOURCES (FOR COLUMN #14)

A ATM 605 B _____

C _____ D _____

21 CALCULATED MTBF _____ HRS

22 TOTAL FAILURE RATE .000350 %/1000 HRS

BS-321A

PARTS APPLICATION ANALYSIS

RESISTORS

(Resistors)

PROJECT: BxA DATE: 12-1-71

ASSEMBLY: Xmtr SUB ASSEMBLY: TLM SCHEMATIC NO: 2005178

1 CIRCUIT SYMBOL NUMBER R	2 TYPE DESIGNATION (MIL or MFR) AND CONSTRUCTION	3 MANUFACTURER	4 RESISTANCE VALUE (OHMS)	5 TOLERANCE (%)	6 POWER RATING (WATTS)	7 MAXIMUM OPERATING POWER (WATTS)	8 POWER RATIO OPERATING/RATED	9 MAXIMUM DUTY CYCLE	10 BULK AIR TEMPERATURE °C	11 CIRCUIT FUNCTION OR APPLICATION	12 BASIC FAILURE RATE (%/1000 HRS) AT 25°C	13 SOURCE (SEE BELOW)	14 SPECIAL ENVIRONMENTS (DEFINE)	15 FAILURE RATE MULTIPLIER	16 FINAL FAILURE RATE (%/1000 HRS)	16 TOTAL RESISTOR COUNT PER TYPE	17 TOTAL FAILURE RATE (%/1000 HRS)
405	RCR05G243J	A-B	24K		.125	.005	.04		40		.001	A		.02		1	.00002
406	RCR05G103JS	A-B	10K		.125	.0001	.008		40		.001	A		.02		1	.00002
408	"	A-B	10K		.125	.002	.016		40		.001	A		.02		1	.00002
RT401	2005288-1	Fenwal							40	Temp. Monitor	.03	D		.		1	.03
1	RCR05G243JS	A-B	24K		.125	.005	.04		40		001	A		.02		1	.00002
3	RCR05G103JS	A-B	10K		.125	.0001	.008		40		.001	A		.02		1	.00002
4	"	A-B	10K		.125	.002	.016		40		.001	A		.02		1	.00002
RT1	2005288-1	Fenwal							40	Temp. Monitor	.03	D		.		1	.03
517	RNR55-JS	A-B	21.5K	5	.1	8mw	.008	.50	40	Voltage Diviser	.001	A		.164	.00016	1	.000164
518	↓	↓	5.11K	↓	.1	2mw	.002	.50	40		.001			.164	.00016	1	.000164
519	RCR05-JS	A-B	39K		1/8	10mw	.08	.50	40		.001			.02	00002	1	.00002
520			4.7K		1/8	5mw	.04	.50	40		.001			.02	00002	1	.00002
521			10K		1/8	.001	.008	.50	40	Output Series Buffer	.001			.02	.00002	1	.00002
522	↓	↓	10K	↓	1/8	.001	.008	.50	40		.001	↓		.02	0002	1	.00002

FOR ANY ATTRIBUTE SEE FOOTNOTE

19 FAILURE RATE SOURCES (FOR COLUMN #14)

A ATM 605 B _____

C _____ D MIL STD-217

20 CALCULATED MTBF _____ HRS

21 TOTAL FAILURE RATE = .060528 %/1000 HRS

Form 8881

BS-321A

PARTS APPLICATION ANALYSIS

(SEMICONDUCTORS)

PROJECT: BxA

ASSEMBLY: Xmtr SUB ASSEMBLY: TLM DATE: 12-1-71

SCHEMATIC NO: 2005178

(Semiconductors)

CKT SYM NO.	TYPE DESIGNATION, SEMICONDUCTOR, POLARITY	MANUFACTURER	MAX. TEMP °C: AMBIENT ACTUAL T_A	MAX. TEMP °C: JUNCTION RATED T_J	MAX. TEMP °C: CASE ACTUAL HOT SPOT T_C	AVG PWR DISSIPATION (mw): RATED AT 25°C AMBIENT	AVG PWR DISSIPATION (mw): RATED AT 25°C CASE	AVG PWR DISSIPATION (mw): ACTUAL AMBIENT T_A	AVG PWR DISSIPATION (mw): ACTUAL CASE T_C	AVG PWR DISSIPATION (mw): ACTUAL	POWER RATIO: ACTUAL/RATED (Amb. or case)	POWER RATIO: ACTUAL T_J or T_A/RATED	MAXIMUM VOLTAGES: V_{CEO} RATED V	MAXIMUM VOLTAGES: V_{CB} ACTUAL V	MAXIMUM VOLTAGES: V_{CEO} RATED V	MAXIMUM VOLTAGES: V_{CE} ACTUAL V	DIODE PIV: RATED V	DIODE PIV: ACTUAL V	CIRCUIT FUNCTION or APPLICATION	PART SPECIAL ENVIRONMENT (Define)	FOR RELIABILITY USE ONLY: RATE (%/1000 HRS)	FOR RELIABILITY USE ONLY: SOURCE (See below)	FOR RELIABILITY USE ONLY: FAIL. RATE	FOR RELIABILITY USE ONLY: MULTIPLIER	FOR RELIABILITY USE ONLY: FINAL FAIL RATE (%/1000 HRS)	FOR RELIABILITY USE ONLY: TOTAL COUNT PER TYPE	TOTAL FAILURE RATE (%/1000 HRS)
CR 1	S1N758A	Dick	40	175		.25				0							10	5	Zener Output Protection		.0021	A			.00002	1	.0021
CR 401	S1N758A		40	175		.25				0							10	5			.0021						
CR 501	S1N758A		40	175		.25				0							10	5			.0021						
CR 502	S1N758A		40	175		.25				0							10	5			.0021						

FAILURE RATE SOURCE (See Column 23)

A ATM 605 C

B D

NOTE: It is assumed the transient and peak power does not exceed the safe limit.

TOTAL FAILURE RATE .0084 %/1000 HRS.

F245A

BS-321A

PARTS APPLICATION ANALYSIS

CAPACITORS

(Capacitors)

PROJECT: BxA

ASSEMBLY: PSK Xmtr

SUBASSEMBLY: Housing & Regulator

DATE: 12-1-71

SCHEMATIC NO: 2005178

1 CIRCUIT SYMBOL NUMBER C	2 TYPE DESIGNATION (MIL OR EIA) AND CONSTRUCTION	3 MANUFACTURER	4 CAPACITANCE VALUE mfd	TOLERANCE %	5 MANUFACTURER'S RATED VOLTAGE	6 OPERATING VOLTAGE DC	PEAK AC	7 VOLTAGE STRESS RATIO OPERATING/ RATED	8 MAXIMUM RATED CYCLES	9 HOT AIR TEMPERATURE (°C)	10 CIRCUIT FUNCTION OR APPLICATION	11 BASIC FAILURE RATE λb /1000 HRS	12 SOURCE (SEE BELOW)	13 SPECIAL ENVIRONMENT (DESIGN) FAILURE RATE MULTIPLIER	14 FINAL FAILURE RATE	15 TOTAL CAPACITOR COUNT PER TYPE	16 TOTAL FAILURE RATE (%/1000 HRS)
1	2005200	(JFD)	2.7		150	23		.15	50	40	P.S. Filter	.01	A	.001		1	.00001
2	2005200-31	(JFD)	33		150	17		.09	50	40	EMI Filter	.01	A	.001		1	.00001
503	2005200-38	(JFD)	470PF	10	300	10	0	.03	50	40	P.S. Filter	.01	A	.005		1	.00005
FL1	2005198	Erie			100	23		.10	50	40	EMI Filter	.01	A	.001		1	.00001
FL2	↓	↓			100	17			50	40	↓	.01		.001		1	.00001
FL3	↓	↓			100	17			50	40	↓	.01		.001		1	.00001
FL4	2005557-1-1	US CC			100	17			50	40	↓	.01		.001		1	.00001
FL5	↓	↓			100	23		↓	50	40	↓	.01		.001		1	.00001

FOR USE OF RELIABILITY DEPT

20 FAILURE RATE SOURCES (FOR COLUMN #14)

A ATM 605 B _____

C _____ D _____

21 CALCULATED MTBF _____ HRS

22 TOTAL FAILURE RATE .000120 λ 1000 HRS

BS-321A

PARTS APPLICATION ANALYSIS

RESISTORS

(Resistors)

PROJECT: BxA DATE: 12-1-71

ASSEMBLY: PSK Xmtr SUB ASSEMBLY: Housing & Regulator SCHEMATIC NO: 2005178

1 CIRCUIT SYMBOL NUMBER R	2 TYPE DESIGNATION (MIL or MFR) AND CONSTRUCTION	3 MANUFACTURER	4 RESISTANCE VALUE (OHMS)	5 TOLERANCE (%)	6 POWER RATING (WATTS)	7 MAXIMUM OPERATING POWER (WATTS)	8 POWER RATIO OPERATING/ RATED	9 MAXIMUM DUTY CYCLE	10 BULK AIR TEMPERATURE °C	11 CIRCUIT FUNCTION OR APPLICATION	12 BASIC FAILURE RATE (%/1000 HRS.) AT °C	13 SOURCE (SEE BELOW)	14 SPECIAL ENVIRONMENTS (DEFINE)	15 FAILURE RATE MULTIPLIER	16 FINAL FAILURE RATE (%/1000 HRS)	17 TOTAL RESISTOR COUNT PER TYPE	18 TOTAL FAILURE RATE (%/1000 HRS)
516	RCR05 FS	A-B	200	5	1/8	.02	.16	50	40	Volt. Set	.001	A		.022		1	.000022

FOR USE OF RELIABILITY DEPT.

19 FAILURE RATE SOURCES (FOR COLUMN #14)

A ATM 605 B

C D

20 CALCULATED MTBF HRS

21 TOTAL FAILURE RATE .000022 %/1000 HRS

FORM 0881

BS-321A

PARTS APPLICATION ANALYSIS

(SEMICONDUCTORS)

PROJECT: BxA

ASSEMBLY: PSK Xmtr

SUB ASSEMBLY: Housing & Regulator

DATE: 12-1-71

SCHEMATIC NO: 2005178

(Semiconductors)

CKT SYM NO. (1)	TYPE DESIGNATION, SEMICONDUCTOR, POLARITY (2)	MANUFACTURER (3)	MAX. TEMP °C: AMBIENT ACTUAL T_A (4)	MAX. TEMP °C: JUNCTION RATED T_J (5)	MAX. TEMP °C: CASE ACTUAL HOT SPOT T_C (6)	AVG PWR DISSIPATION (mw): RATED AT 25°C: AMBIENT (7)	AVG PWR DISSIPATION (mw): RATED AT 25°C: CASE (8)	AVG PWR DISSIPATION (mw): ACTUAL: AMBIENT T_A (9)	AVG PWR DISSIPATION (mw): ACTUAL: CASE T_C (10)	AVG PWR DISSIPATION (mw): ACTUAL (11)	POWER RATIO: ACTUAL/RATED 25°C (Amb.or case) (12)	POWER RATIO: ACTUAL T_A or T_C / RATED T_A or T_C (13)	MAXIMUM VOLTAGES: V_{CBO} RATED V (14)	MAXIMUM VOLTAGES: V_{CB} ACTUAL V (15)	MAXIMUM VOLTAGES: V_{CEO} RATED V (16)	MAXIMUM VOLTAGES: V_{CE} ACTUAL V (17)	DIODE PIV: RATED V (18)	DIODE PIV: ACTUAL V (19)	CIRCUIT FUNCTION or APPLICATION (20)	PART SPECIAL ENVIRONMENT (Define) (21)	FOR RELIABILITY USE ONLY: RATE (%/1000 HRS) (22)	SOURCE (See below) (23)	FAIL. RATE (24)	MULTIPLIER (24)	FINAL RATE (%/1000 HRS) (25)	TOTAL COUNT PER TYPE (26)	TOTAL FAILURE RATE (%/1000 HRS) (27)
CR 507	SIN4942	Sem-Tech	40	175	53		2100	250				.12			2.0	.35	200	23	Rev. Volt Prot.			A	.01		1	0.007
	Mema 2005163	Plt 4	40		125	30 W				1.5 W		.02							Volt. Reg.		2.0	D	.01		1	.02

(28) FAILURE RATE SOURCE (See Column 23)
A ATM 605
B
C
D MIL HDBK CH. XXIV

(29) NOTE: It is assumed the transient and peak power does not exceed the safe limit.

(30) TOTAL FAILURE RATE .027000 %/1000 HRS.

(31) BS-321A