



**Space
Systems Division**

Parts Application Analysis A/D Converter ALSEP Array D		NO. ATM 904	REV. NO.
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The purpose of this ATM is to document the results of the Parts Application Analysis study conducted on the A/D Converter portion of the Dual 90 Channel Multiplexer. This A/D Converter represents the Bendix designed unit which uses a high degree of SSI and MSI integrated circuitry.

The A/D Converter was integrated with the Bendix designed 90 Channel Multiplexer. The A/D Converter design provides for complete redundancy for ALSEP analog housekeeping engineering status data. Of the two converters, one is on standby and full capability can be restored in the event of any failure by switching the redundant unit.

The stress levels shown were determined in the basis of electronic piece parts operating at their nominal values of resistance, capacitance, etc., and nominal application of voltage and current signal levels. A conservative temperature average of 55°C was used for determining device ratings. The resultant stress ratios provided the basis for determining the devices' failure rate. In addition, all stress levels were evaluated in terms of maximum applied voltage and current levels to preclude misapplication during peak or translational periods.

Because of the extensive use of integrated circuitry, a new Parts Application Analysis form has been created for microcircuits. This form allows the reliability engineer to evaluate the application of an integrated circuit on the basis of junction temperature, derated applied voltages, fan-in, and fan-out. These derating criteria items are thought as most important in NASA Document MSCM 5320, which discusses derating requirements for electronic devices. In addition, the reliability engineer may evaluate the integrated circuit application on the basis of speed and clock width requirements. This second set of items, although not mentioned anywhere as derating or application requirements, insure that Bendix is applying it's integrated circuits properly and they will perform any or all of the many functions required of them.



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The attached summary sheets demonstrate that all parts are applied well within both ALSEP and Bendix established derating criteria. From the analysis, it can be concluded the multiplexer is designed in a manner to ensure reliable and long operational life.

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Table I

A/D Converter Derating Summary

<u>Stress</u>	<u>Quantity*</u>	<u>Comments</u>
0 - 12 %	27	-
13 - 25%	2	-
26 - 35%	3	-
35 - 50%	0	-
51 - 60%	1	Tantalum Capacitor, Allowed 60%

*The quantity listed reflects the number of parts operating at the specified stress levels. Not included in Table I are the integrated circuits which can not be derated in the standard manner. See "Parts Application Analysis - Microcircuits" of this ATM for the stress levels of the integrated circuits.

PARTS APPLICATION ANALYSIS
SUMMARY

PROJECT: ALSEPDATE: 7/23/70ASSEMBLY: 90 Ch. MUX SUB ASSEMBLY: A/D Conv.SCHEMATIC NO: 2345516

Analog Board

DEVICE TYPE	TOTAL NO, USED	TOTAL FAILURE RATE %/1000 Hours	COMMENTS
CAPACITORS	9	.001579	
RESISTORS	13	.008404	
DIODES	2	.009870	
TRANSISTORS	1	.001950	
MICROCIRCUITS	5	.013950	
CRYSTALS	1	.006000	
CONNECTORS			
COILS & CHOKES			
		.041753	

TOTAL ASSEMBLY FAILURE RATE _____ %/1000 HOURS

MEAN-TIME-TO-FAILURE _____ HOURS

MISSION SUCCESS PROBABILITY _____

PARTS APPLICATION ANALYSIS
SUMMARY

PROJECT: ALSEPDATE: 7/23/70ASSEMBLY: 90 Ch. MUX SUB ASSEMBLY: A/D Conv.SCHEMATIC NO: 2345521

Digital Board

DEVICE TYPE	TOTAL NO, USED	TOTAL FAILURE RATE %/1000 Hours	COMMENTS
CAPACITORS	1	.000175	
RESISTORS	1	.000167	
DIODES	0	-----	
TRANSISTORS	0	-----	
MICROCIRCUITS	8	.001000	
TRANSFORMERS			
CONNECTORS			
COILS & CHOKES			
		.001342	

TOTAL ASSEMBLY FAILURE RATE .043095 %/1000 HOURSMEAN-TIME-TO-FAILURE 2,280,000 HOURSMISSION SUCCESS PROBABILITY .99622 for one year

PARTS APPLICATION ANALYSIS

(SEMICONDUCTORS)

PROJECT: ALSEP

DATE: 7/23/70

ASSEMBLY: Multiplexer - A/D Converter

SUB ASSEMBLY: A/D Converter, Analog Board

SCHEMATIC NO: 2345516

(Semiconductors)

CKT SYM NO.	TYPE DESIGNATION, SEMICONDUCTOR, POLARITY	M A N U F A C T U R E R	MAX. TEMP °C		AVG PWR DISSIPATION (mw)						POWER RATIO		MAXIMUM VOLTAGES				DIODE PIV		CIRCUIT FUNCTION or APPLI- CATION	PART SPECIAL ENVIRON- MENT (Define)	FOR RELIABILITY USE ONLY							
			A M B I E N T T _A	J U N C T I O N T _J	C A S E H O T S P O T T _C	RATED AT						ACTUAL RATED 25°C Amb.or case	ACTUAL RATED T _A or T _C	V C B O R A T E D	V C B A C T U A L	V C E O R A T E D	V C K A C T U A L	R A T E D			A C C U R E N T	R A T E (%/1000 HRS)	S O U R C E (See below)	F A I L U R E R A T E (%/1000 HRS)	F I L I T A T I O N R A T E (%/1000 HRS)	T O T A L F A I L U R E R A T E (%/1000 HRS)		
						25°C		A M B I E N T T _A	C A S E T _C	A M B I E N T T _A	C A S E T _C																A C T U A L	A C T U A L
						A	C																					
CR1	Diode, Switch- ing TXIN914	FCH	55°	200°		360	298		10.5 mW	3%					75	12				A		1	.00217					
CR2	Zener 6.4V DT60826V	Dick- son	55°	175°		240		24		10%										A		1	.0077					
Q1	Transistor NPN Jan TX2N2222A	T.I.	55°	175°		400	334		<1 mW	<1%		75	3	50	10					A		1	.00195					
²⁸ FAILURE RATE SOURCE (See Column 23) A <u>ATM 605</u> C _____ B _____ D _____											²⁹ NOTE: It is assumed the transient and peak power does not exceed the safe limit.						³⁰ TOTAL FAILURE RATE <u>.01182</u> %/1000 HRS.											

PARTS APPLICATION ANALYSIS

(MICROCIRCUITS)

PROJECT: ALSEP
 ASSEMBLY: 90 Ch. MUX. - A/D Converter

SUB ASSEMBLY: A/D Converter, Analog Board

DATE: 5/23/70
 SCHEMATIC NO: 2345516

(Microcircuits)

CKT SYM NO.	TYPE DESIGNATION	MANU FACTURER	TYPE	MAX TEMP °C			VOLTAGES			INPUTS		OUTPUTS		SPEED	CLOCK WIDTH	CIRCUIT FUNCTION OR APPLI- CATION	FOR RELIABILITY USE ONLY					
				A C T U A L	J U N C T I O N	J U N C T I O N	D E R A T E D	A C T U A L	D E R A T E D	FAN IN %	% OF MAX I OR V	FAN OUT %	L O A D I N G	% OF MAX	MIN ACTUAL %		RATE (%/ 1000 HRS)	S O U R C E (SEE NOTE)	F A I L U R E R A T E P E R T Y P E	T O T A L F A I L U R E R A T E (%/1000 HRS)		
X1	SM5400F BxA 2346207-1	T.I.	Dig.	55°	150°	75°	5.15	5.0	4.85			30% 20%				NGIA Clock Gen NGIB	.00030 .00030	A	1	.00090		
												2% Un- used				NGIC Clock Gen NGID	.00030 .00030	A				
X2	LM 102F/883 BxA 2340307-1	N/S	Lin.	55°	150°	75°	+15.6	+12	+11.4			80% V	80% V	1%		Buffer	.00435	C	1	.00435		
X3	LM 111H/883 BxA 2340311-1	N/S	Lin.	55°	150°	90°	+15.6	+12	+6.3			75% V		1%		Compara- tor	.00405	C	1	.00405		
X4	LM107F/883 BxA 2340312-1	N/S	Lin.	55°	150°	75°	+18.0	+12	+7.8					3%		Ramp Generator	.00405	C	1	.00405		
X5	SM 5400 BxA 2346207-1	T.I.	Dig.	55°	150°	75°	5.15	5.0	4.85			1% 10%				NG2A Latch NG2B	.00030 .00030	A	1	.00060		
												Un- used Un- used				NG2C Unused NG2D	.00030 .00030	A				
				23 FAILURE RATE SOURCE (See Column 19) A <u>ATM 605</u> C <u>N/A Rel. Rpt.</u> B _____ 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 <u>.01395</u> %/1000 HRS		

PARTS APPLICATION ANALYSIS

(MICROCIRCUITS)

PROJECT: ALSEP
 ASSEMBLY: 90 Ch. MUX. - A/D Converter

SUB ASSEMBLY: A/D Converter, Digital Board

DATE: 7/23/70
 SCHEMATIC NO: 2345521

(Microcircuits)

CKT SYM NO.	TYPE DESIGNATION	MANUFACTURER	TYPE	MAX TEMP °C			VOLTAGES			INPUTS		OUTPUTS		SPEED	CLOCK WIDTH	CIRCUIT FUNCTION OR APPLICATION	FOR RELIABILITY USE ONLY				
				Ambient	Junction	Actual	Derated	Actual	Derated	Fan In %	% of Max I or V	Fan Out %	Load %	% of Max	Min Actual %		Rate (%/1000 HRS)	Source	Fault Rate	Total Rate	Total Failure Rate (%/1000 HRS)
X1	SM54L10F11 BxA 2346201-3	T. I.	Dig.	55°	150°	60°	5.3	5.0	4.7			10% 20%				NG1A Cntr. Control NG1B	.00040 .00040	A	1	.00120	
												75%				NG1C Cntr. Control	.00040	A			
X2	SM 54L93F11 BxA 2346201-14	T. I.	Dig.	55°	150°	65°	5.3	5.0	4.7			20%				Counter Syncro.	.0018	A	1	.00180	
X3	SM 54L10F11 BxA 2346201-3	T. I.	Dig.	55°	150°	65°	5.3	5.0	4.7			20% 10%				NG2A Cntr. Control NG2B	.00040 .00040	A	1	.00120	
												30%				NG2C Cntr. Con.	.00040	A			
X4	SM 54L93F11 BxA 2346201-14	T. I.	Dig.	55°	150°	60°	5.3	5.0	4.7			20%				Counter	.00180	A		.00180	
X5	SM 54L93F11 BxA 2346201-14	T. I.	Dig.	55°	150°	65°	5.3	5.0	4.7			20%				Counter	.00180	A		.00180	
X6	SM 54L30 BxA 2346201-5	T. I.	Dig.	55°	150°	65°	5.3	5.0	4.7			10%				Overflow Detector	.00120			.00120	
X7	SM 54L04 BxA 2346201-3	T. I.	Dig.	55°	150°	60°	5.3	5.0	4.7			10%				Output Buffer	.00120			.00120	

23 FAILURE RATE SOURCE (See Column 19)
 A ATM 507 C _____
 B _____ 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 .01020 %/1000 HRS

PARTS APPLICATION ANALYSIS

(MICROCIRCUITS)

PROJECT: ALEP

DATE: 7/23/70

ASSEMBLY: 90 Ch. MUX. - A/D Converter

SUB ASSEMBLY: A/D Converter, Digital Board

SCHEMATIC NO: 2345521

(Microcircuits)

1 CKT SYM NO.	2 TYPE DESIGNATION	3 M A N U F A C T U R E R	4 T Y P E	5 MAX TEMP °C			6 VOLTAGES			7 INPUTS		8 OUTPUTS		9 SPEED	10 CLOCK WIDTH	11 CIRCUIT FUNCTION OR APPLI- CATION	12 FOR RELIABILITY USE ONLY				
				13 A M B I E N T	14 R U N T E M P	15 J U N C T I O N	16 D E R I V E D	17 A C T U A L	18 D E R I V E D	19 F A N I N %	20 % O F M A X I O R V	21 F A N O U T %	22 L O A D I N G %	23 % O F M A X	24 M I N A C T U A L %		25 R A T E (%/1000 HRS)	26 S O U R C E (See Detail)	27 F A I L U R E R A T E	28 T O T A L P E R T Y P E	29 T O T A L F A I L U R E R A T E (%/1000 HRS)
X8	SM 54L04 BxA 2346201-3	T. I.	Dig.	55°	150°	60°	5.3	5.0	4.7			20%			H1A	.00020	A	1	.00100		
												10%				H1B				.00020	
												10% Un- Used				H1C				.00020	
																H1D				.00020	
												10% 10%				H1E Output Buf				.00020	
	H1F	.00020																			
				23 FAILURE RATE SOURCE (See Column 19)			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 <u>.00100</u> %/1000 HRS							

PARTS APPLICATION ANALYSIS

(MISC. PARTS)

PROJECT: ALSEP

DATE: 7-23-70

ASSEMBLY: 90 Ch. MUX - A/D Converter

SUB ASSEMBLY: A/D Converter, Analog Board

SCHEMATIC NO: 2345516

(Misc. Parts)

CIRCUIT SYMBOL NUMBER	TYPE DESIGNATION (CEC, MIL OR MFR) and CONSTRUCTION	MANUFACTURER	TEMPERATURE RANGE °C		ELECTRICAL STRESS		PERCENT DUTY CYCLE	MAJOR CHARACTERISTICS and APPLICATION	FOR RELIABILITY USE ONLY					
			MAX	MIN	RATED	USE			BASIC FAILURE RATE (%/1000 HOURS) at °C	S O U R C E (SEE #15)	PART SPECIAL ENVIRONMENT (DEFINE)	FAILURE RATE MULTIPLIER	TOTAL FAILURE RATE (%/1000 HOURS)	
														4
Y1	Crystal, 2 MHz BxA 2340313-1	Monitor	125	-55	2mW	0.6mW	40%	2 MHz Clock Pulse Generator	.006	A				.0060
15 FAILURE RATE SOURCES (FOR COLUMN 11) A. <u>Philco</u> B. _____ C. _____ D. <u>MIL Std 217 Chart XXIV</u>								16 CALCULATED MTBF _____ HOURS		17 TOTAL FAILURE RATE <u>.0060</u> %/1000 HOURS				

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