



**Aerospace
Systems Division**

Parts Application Analysis
ASE 16 Channel
Multiplexer-A/D Converter

NO.	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 ASE 16 Channel Multiplexer-A/D Converter. This Multiplexer-Converter represents the Bendix designed unit which uses a high degree of SSI and MSI integrated circuitry.

The stress levels shown were determined in the basis of electronic piece parts operation 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 mis-application during peak or translational periods.

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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ALSEP Reliability



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Table I

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: ALSEP

DATE: 8/20/70

ASSEMBLY: 16 Ch Mux

SUB ASSEMBLY: Multiplexer

SCHEMATIC NO: 2346711

DEVICE TYPE	TOTAL NO. USED	TOTAL FAILURE RATE	COMMENTS
CAPACITORS			
RESISTORS			
DIODES			
TRANSISTORS			
MICROCIRCUITS	13	.0563	
TRANSFORMERS			
CONNECTORS			
COILS & CHOKES			
		.0563	

TOTAL ASSEMBLY FAILURE RATE _____ %/1000 HOURS

MEAN-TIME-TO-FAILURE _____ HOURS

MISSION SUCCESS PROBABILITY _____

PARTS APPLICATION ANALYSIS
SUMMARY

PROJECT: ALSEP

DATE: 8/20/70

ASSEMBLY: 16 Ch. MUX SUB ASSEMBLY: A/D Conv.
Analog Board

SCHEMATIC NO: 234671a

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	
CONNECTCRS			
COILS & CHOKES			
		.041753	

TOTAL ASSEMBLY FAILURE RATE _____ %/1000 HOURS

MEAN-TIME-TO-FAILURE _____ HOURS

MISSION SUCCESS PROBABILITY _____

PARTS APPLICATION ANALYSIS
SUMMARY

PROJECT: ALSEPDATE: 8/20/70ASSEMBLY: 16 Ch. MUX SUB ASSEMBLY: A/D Conv.SCHEMATIC NO: 2346722

Digital Board

DEVICE TYPE	TOTAL NO. USED	TOTAL FAILURE RATE %/1000 Hours	COMMENTS
CAPACITORS	1	.000175	
RESISTORS	1	.000167	
DIODES	0	-----	
TRANSISTORS	0	-----	
MICROCIRCUITS	10	.013400	
TRANSFORMERS			
CONNECTORS			
COILS & CHOKES			
		.013742	

TOTAL ASSEMBLY FAILURE RATE .105795 %/1000 HOURSMEAN-TIME-TO-FAILURE 945,200 HOURSMISSION SUCCESS PROBABILITY .99988

* MISSION IS DEFINED AS 30 HOURS OPERATION, 8730 HOURS STANDBY.

PARTS APPLICATION ANALYSIS

RESISTORS

PROJECT: ALSEP

DATE: 8/20/70

ASSEMBLY: Multiplexer - A/D Conv.

SUB ASSEMBLY: A/D Converter, Analog Board

SCHEMATIC NO: 2346719

(Resistors)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
CIRCUIT SYMBOL NUMBER	TYPE DESIGNATION (MFG OR MIL-STD CONSTRUCTION)	MANUFACTURER	RESISTANCE VALUE (OHMS)	TOLERANCE (%)	POWER RATING (WATTS)	OPERATING POWER (WATTS)	MAXIMUM OPERATING POWER RATIO (MAXIMUM RATED)	MAXIMUM DUTY CYCLE	BULK AIR TEMPERATURE °C	CIRCUIT FUNCTION OR APPLICATION	BASIC FAILURE RATE (X/1000 HRS) - A - SOURCE (SEE BELOW)	SPECIAL ENVIRONMENTAL STRESSING	FAILURE RATE MULTIPLIER	FINAL FAILURE RATE (X/1000 HRS)	TOTAL RESISTOR COUNT PER TYPE	TOTAL FAILURE RATE (X/1000 HRS)	
R1	RCR07G333JS	Al. Brad	33K	5%	250	2.4	1%		55°	Osc. Bias Resistor	.167 A		.001	1	.000167		
R2	RCR07G511JS	Al. Brad	510	5%	250	2.4	2%		55°	Osc. Bias Resistor	.167 A		.001	1	.000167		
R3	RCR07G511JS	Al. Brad	510	5%	250	4	2%		55°	Osc. Bias Resistor	.167 A		.001	1	.000167		
R4	RCR07G102JS	Al. Brad	1K	5%	250	9	4%		55°	Osc. Bias Resistor	.167 A		.001	1	.000167		
R5	RCR07G332JS	Al. Brad.	3.3K	5%	250	3	2%		55°	Osc. Bias Resistor	.167 A		.001	1	.000167		
R6	deleted																
R7	RCR07G272JS	Al. Brad	2.7K	5%	250	12	5%		55°	Zener Current Bias	.167 A		.001	1	.000167		
R8	RNR55E3012FR	Al. Brad	30.1K	1%	250	1.2	<1%		55°	Ramp Voltage Divider	.167 A		.001	1	.000167		
R9	RTR22DP502P	Bourns	5K	5%	500	<1	<1%		55°	Ramp Voltage Divider	.032 A		.1	1	.003200		
R10	RNR55E4992FR	Al. Brad	49.9K	1%	250	.56	<1%		55°	Ramp Voltage Divider	.167 A		.001	1	.000167		
R11	RTR22DP202P	Bourns	2K	5%	500	<1	<1%		55°	Ramp Voltage Divider	.037 A		.1	1	.003200		
R12	RCR07G103JS	Al. Brad	10K	5%	250	neg.	<1%		55°	Noise Sup.	.167 A		.001	1	.000167		
R13	RCR07G472JS	Al. Brad	4.7K	5%	250	5.3	2%		55°	Pull-up Resistor	.167 A		.001	1	.000167		
R14	RCR07G123JS	Al. Brad	12K	5%	250	12	5%		55°	Pull-Down Resistor	.167 A		.001	1	.000167		
R15	RCR07G102JS	Al. Brad.	2K	5%	250	25	10%		55°	Level Shifting	.167 A		.001	1	.000167		
19											20				21		
FAILURE RATE SOURCES (FOR COLUMN #12) A ATM 605 B _____ C _____ D _____											CALCULATED MTBF _____ HRS				TOTAL FAILURE RATE <u>.00840</u> %/1000 HRS		

PARTS APPLICATION ANALYSIS

CAPACITORS

PROJECT: ALSEP

DATE: 8/20/70

ASSEMBLY: Multiplexer - A/D Conv.

SUBASSEMBLY: A/D Converter, Analog Board

SCHEMATIC NO: 2346719

(Capacitors)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
CIRCUIT SYMBOL NUMBER	TYPE DESIGNATION (A/E/L or MFR) CONSTRUCTION	MANUFACTURER	CAPACITANCE VALUE	TOLERANCE %	MANUFACTURER'S RATED VOLTAGE	DC PEAK FACTOR	OPERATING VOLTAGE	VOLTAGE RATIO OPERATING/RATED	MAXIMUM DUTY CYCLE	BULK AIR TEMPERATURE (°C)	CIRCUIT FUNCTION OR ORIGIN APPLICATION	BASIC FAILURE RATE (S/1000 HRS) AT 25°C	STRESS CORRECTION FACTOR	ENVIRONMENTAL (TEMPERATURE) FAILURE RATE MULTIPLIER	FINAL FAILURE RATE	TOTAL CAPACITOR COUNT PER TYPE	TOTAL FAILURE RATE (S/1000 HRS)		
C1	CKR12BX103KR	Aerovox	.01 μ f	10%	100	4	4%				Clock Feedback	.0175		1	1	.000175			
C2	CKR12BX103KR	Aerovox	.01 μ f	10%	100	4	4%				Clock Feedback	.0175		1	1	.000175			
C3	WM2DM20F51ZFO	Elmenco	5100		100	12	12%				Ramp Integration	.0167		1	1	.000167			
C4	CKR12BX472KR	Aerovox	4700		100	24	24%				Analog Noise Sup.	.0167		1	1	.000167			
C5	CKR12BX680KR	Aerovox	68		100	12	12%				Comparator Noise Sup.	.0039		1	1	.000039			
C6	CSR13E225KR	Sprague	2.2 μ f		20	6	30%				+12V Noise Sup.	.0214		1	1	.000214			
C7	CSR13E225KR	Sprague	2.2 μ f		20	6	30%				+12V Noise Sup.	.0214		1	1	.000214			
C8	CSR13E225KR	Sprague	2.2 μ f		20	5	25%				+5V Noise Sup.	.0214		1	1	.000214			
C9	CSR13E225KR	Sprague	2.2 μ f	10%	20	12	60%				-12V Noise Sup.	.0214	1	1	1	.000214			
												FOR USE OF RELIABILITY DEPT							
20												21				22			
FAILURE RATE SOURCES (FOR COLUMN #14)												CALCULATED MTBF _____ HRS				TOTAL FAILURE RATE .001579 / 1000 HRS			
A _____ B ATM 507A																			
C _____ D _____																			

BS-321A

PARTS APPLICATION ANALYSIS

CAPACITORS

PROJECT: ALSEP

DATE: 8/20/70

ASSEMBLY: Multiplexer - A/D Conv.

SUBASSEMBLY: A/D Converter, Digital Board

SCHEMATIC NO: 2746722

(Capacitors)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
CIRCUIT SYMBOL NUMBER	TYPE DESCRIPTION (Mfg or MFR) CONSTRUCTION	MANUFACTURER	CAPACITANCE VALUE μ F	TOLERANCE %	TEMPERATURE COEFFICIENT	MANUFACTURER'S RATED VOLTAGE		OPERATING VOLTAGE	VOLTAGE OPERATING RATED	MAXIMUM DUTY CYCLE	BULK AIR TEMPERATURE (°C)	CIRCUIT FUNCTION OR APPLICATION	FAILURE RATE AT 1000 HRS	FAILURE RATE AT 1000 HRS	SPECIAL ENVIRONMENT (OP/TEMP)	FAILURE RATE MULTIPLIER	FINAL FAILURE RATE	TOTAL CAPACITOR COUNT PER TYPE	TOTAL FAILURE RATE (87600 HRS)
						DC VOLTAGE	AC VOLTAGE												
C1	CKR12BX103KR	Aerovox	.01 μ f	10%	100	5	5%					+5V Noise Suppression	.0179					1	.000175
20						21						22							
FAILURE RATE SOURCES (FOR COLUMN #14)						CALCULATED MTBF _____ HRS						TOTAL FAILURE RATE .000175 @ 1000 HRS							
A _____																			
B ATM 507A																			
C _____																			
D _____																			

PARTS APPLICATION ANALYSIS

(SEMICONDUCTORS)

PROJECT: ALSEP

DATE: 8/20/70

ASSEMBLY: Multiplexer - A/D Converter

SUB ASSEMBLY: A/D Converter Analog Board

SCHEMATIC NO: 24-719

(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	A C T U A L T _J	J U N C T I O N T _J	A C T U A L C A S E H O T S P O T T _C	RATED AT		A C T U A L T _A	A C T U A L T _C	A C T U A L	A C T U A L R A T E D 25°C (Amb. or case)	A C T U A L R A T E D 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 E A C T U A L	V R A T E D			V A C T U A L	R A T E	S O U R C E	F A I L U R E R A T E (% /1000 HRS)	F A I L U R E R A T E (% /1000 HRS)	F A I L U R E R A T E (% /1000 HRS)	F A I L U R E R A T E (% /1000 HRS)	T O T A L F A I L U R E R A T E (%/1000 HRS)	
							A M B I E N T	C A S E																					A M B I E N T
CR1	Diode, Switching TXIN914	FCH	55°	200°		360	298	10.5 mW	3%									75	12	Current Directing		A			1	.00217			
CR2	Zener 6.4V DT60826V	Dickson	55°	175°		350	240	24	10%											Voltage Reference		A			1	.0077			
Q1	Transistor NPN Jan TX2N2222A	T.I.	55°	175°		400	334	<1 mW	<1%			75	3	50	10					Switching		A			1	.00195			
18 FAILURE RATE SOURCE (See Column 23) A <u>ATM 605</u> C _____ B _____ D _____										19 NOTE: It is assumed the transient and peak power does not exceed the safe limit.										20 TOTAL FAILURE RATE <u>.01182</u> %/1000 HRS.									

PARTS APPLICATION ANALYSIS

(MICROCIRCUITS)

PROJECT: ALSEP
 ASSEMBLY: A. S. E.

SUB ASSEMBLY: 16 Channel Multiplexer

DATE: July 29, 1970
 SCHEMATIC NO: 2346711

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			
				A	B	C	D	E	F	G	H	I	J	K	L		M	N	O	P
	Dual 4-Input NAND Gates 2346201-4	T.I.	Dig.	55	125		5.3	5.0	4.7			2.5%				Channel Encoding	.0015	A	4	.0060
	Dual Voltage Translator 2390305	N.S.	Dig.	55	125		6.2 +14.8	5.0 +12	4.7 +7.8			<1%				MOS-FET Drivers	.0085	C	4	.0048
	HEX MOS Gates 2340329	AMI	Dig.	55	125		28.6	24	23.6			<1%				MOS-FET Gates	.0085	C	5	.0455
23 FAILURE RATE SOURCE (See Column 19) A <u>T.I.</u> C <u>AMI</u> B <u>ATM 605</u> 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>.0563</u> / 1000 HRS						

PARTS APPLICATION ANALYSIS

(MICROCIRCUITS)

PROJECT: ALSEP
 ASSEMBLY: 16 Ch. MUX. - A/D Converter

SUB ASSEMBLY: A/D Converter, Analog Board

DATE: 8/20/70
 SCHEMATIC NO: 2346719

(Microcircuits)

CKT SYM NO.	TYPE DESIGNATION	MANUFACTURER	TYPE	MAX TEMP °C			VOLTAGES			INPUTS		OUTPUTS		SPEED % OF MAX	CLOCK WIDTH MIN ACTUAL %	CIRCUIT FUNCTION OR APPLICATION	FOR RELIABILITY USE ONLY				
				Ambient	Junction	Junction	Max Extremum	Actual	Min Extremum	Fan In %	% of Max I/O V	Fan Out %	Load %				Rate (%/1000 HRS)	Source	Fault Rate	Total Failure Rate	
X1	SM5400F BxA 2346207-1	T.I.	Dig.	55°	150°	75°	5.15	5.0	4.85			30%			NGIA Clock Gen	.00030	A	1	.00090		
												20%				NGIC Clock Gen				.00030	
												2% Un-used			NGID Clock Gen	.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%		Comparator	.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%			NG2A Latch	.00030	A	1	.00060		
												10%				NG2B				.00030	
												Un-used Un-used			NG2C Unused	.00030	A				
															NG2D	.00030	A				

22 FAILURE RATE SOURCE (See Column 19)
 A T.I. C N/A Rel. Rpt.
 B _____ D _____

23 NOTE: DERATED VOLTAGE IS DETERMINED BY
 $V_{MAX} = V_{NOM} \cdot 6 \cdot (V_{RATED} / V_{NOM})$
 $V_{MIN} = V_{NOM} \cdot 6 \cdot (V_{RATED} / V_{MIN})$

24 TOTAL FAILURE RATE .01395 %/1000 HRS

PARTS APPLICATION ANALYSIS

(MICROCIRCUITS)

PROJECT: ALSEP
 ASSEMBLY: 16 Ch. MUX. - A/D Converter

SUB ASSEMBLY: A/D Converter, Digital Board

DATE: 8/20/70
 SCHEMATIC NO: 234622

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			
				A/C AMBIENT	R/JUNCTION	A/JUNCTION	D/E MAXIMUM	A/C ACTUAL	D/E ACTUAL	FAN IN %	% OF MAX I/O V	FAN OUT %	LOADING %				% OF MAX	MIN ACTUAL %	RATE (%/1000 HRS)	ENVIRONMENTAL RELIABILITY
X1	SM54L10F11 BxA 2346201-3	T.I.	Dig.	55°	150°	60°	5.3	5.0	4.7			10%			NG1A Cntr. Control	00040	A	1	.00120	
												20%				00040				
												75%				00040				
X2	SM 54L93F11 BxA 2346201-14	T.I.	Dig.	55°	150°	65°	5.3	5.0	4.7			20%			Counter Synchro.	0018	A	1	.00180	
X3	SM 54L10F11 BxA 2346201-3	T.I.	Dig.	55°	150°	65°	5.3	5.0	4.7			20%			NG2A Cntr. Control	00040	A	1	.00120	
												10%				00040				
												30%				00040				
X4	SM 54L93F11 BxA 2346201-14	T.I.	Dig.	55°	150°	60°	5.3	5.0	4.7			20%			Counter	00180	A	1	.00180	
X5	SM 54L93F11 BxA 2346201-14	T.I.	Dig.	55°	150°	65°	5.3	5.0	4.7			20%			Counter	00180	A	1	.00180	
X6	SM 54L30 BxA 2346201-5	T.I.	Dig.	55°	150°	65°	5.3	5.0	4.7			10%			Overflow Detector	00120		1	.00120	
X7 X9	SM 54L04 BxA 2346201-3	T.I.	Dig.	55°	150°	60°	5.3	5.0	4.7			10%			Output Buffer	00120		2	.00240	

20 FAILURE RATE SOURCE (See Column 19)
 A T.I. _____ C _____
 B _____ D _____

21 NOTE: DERATED VOLTAGE IS DETERMINED BY:
 $V_{MAX} = V_{NOM} \cdot S / (V_{RATED} \cdot MAX \cdot V_{NOM})$
 $V_{MIN} = V_{NOM} \cdot 6 / (V_{NOM} \cdot V_{RATED} \cdot MIN)$

22 TOTAL FAILURE RATE .01140 %/1000 HRS

PARTS APPLICATION ANALYSIS

(MICROCIRCUITS)

PROJECT: ALEP
 ASSEMBLY: 16 Ch. MUX. - A/D Converter

DATE: 8/20/70
 SUB ASSEMBLY: A/D Converter, Digital Board SCHEMATIC NO: 2546722

(Microcircuits)

CKT SYM NO.	TYPE DESIGNATION	MANUFACTURER	TYPE	MAX TEMP °C			VOLTAGES			INPUTS		OUTPUTS		SPEED % OF MAX	CLOCK WIDTH MIN ACTUAL %	CIRCUIT FUNCTION OR APPLICATION	FOR RELIABILITY USE ONLY							
				AMBIENT	JUNCTION	ACTUAL	DE RATED	ACTUAL	DE RATED	FAN IN %	% OF MAX IOR V	FAN OUT %	LOADING %				RATE (%/1000 HRS)	SOURCE	FM ALT RATE	TC TO ALT PER TYPE	TOTAL FAILURE RATE / 1000 HRS			
X8	SM 54L04	T.I.	Dig.	55°	150°	60°	5.3	5.0	4.7			20%			H1A	.00020	A	2	.00200					
X10	BxA 2346201-3										10%			H1B	.00020									
											Un-Used			H1C	.00020									
											10%			H1D	.00020									
											10%			H1E	.00020	A								
											10%			Output Buf H1F	.00020									
FAILURE RATE SOURCE (See Column 19) A <u>T.I.</u> C _____ B _____ D _____																	NOTE: DERATED VOLTAGE IS DETERMINED BY: $V_{MAX} = V_{NOM} \cdot .8 (V_{RATED MAX} \cdot V_{NOM})$ $V_{MIN} = V_{NOM} \cdot .6 (V_{NOM} \cdot V_{RATED MIN})$				TOTAL FAILURE RATE <u>.00200</u> / 1000 HRS			

PARTS APPLICATION ANALYSIS

(MISC. PARTS)

PROJECT: ALSEP

DATE: 8/20/70

ASSEMBLY: 16 Ch. MUX - A/D Converter

SUB ASSEMBLY: A/D Converter, Analog Board

SCHEMATIC NO: 234551

(Misc. Parts)

CIRCUIT SYMBOL NUMBER	TYPE DESIGNATION (CFC, 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 (1/1000 HOURS) at 25°C (SEE #15)	SPECIAL ENVIRONMENT (DEFINE)	FAILURE RATE MULTIPLIER	TOTAL FAILURE RATE (1/1000 HOURS)	
													8
1	2	3	4	5	6	7	8	9	10	11	12	13	14
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>.006</u> 1/1000 HOURS			