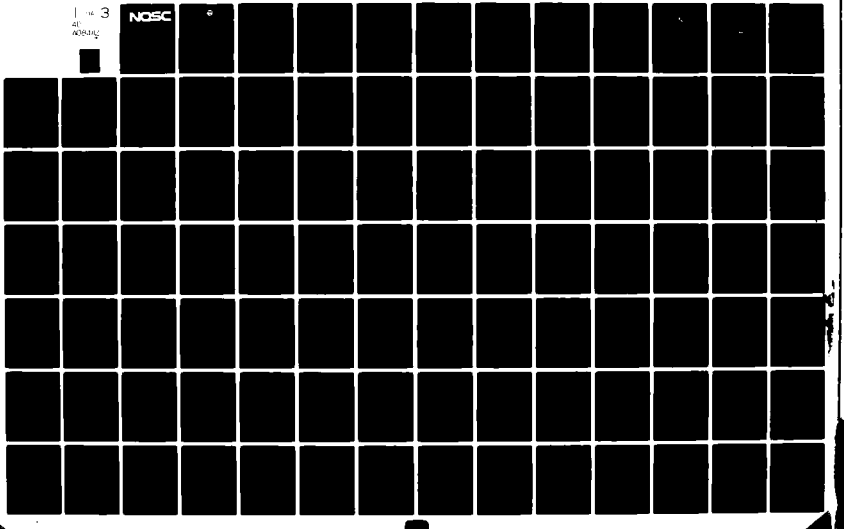
AD-A084 112 NAVAL OCEAN SYSTEMS CENTER SAN DIEGO CA F/G 9/5
AVAILABILITY ESTIMATE OF A CONCEPTUAL ESM SYSTEM.(U)
JUN 79 J VALENZUELA
UNCLASSIFIED NOSC-TR-501 NL



NOSC

NOSC TR 501

NOSC TR 501

Technical Report 501

AVAILABILITY ESTIMATE OF A CONCEPTUAL ESM SYSTEM

J Valenzuela,
Evaluation Research Corp.
Monitored by DH Marx,
NOSC

June 1979

Approved for public release; distribution unlimited

NAVAL OCEAN SYSTEMS CENTER
SAN DIEGO, CALIFORNIA 92152

NAVAL OCEAN SYSTEMS CENTER, SAN DIEGO, CA 92152

AN ACTIVITY OF THE NAVAL MATERIAL COMMAND

SL GUILLE, CAPT, USN
Commander

HL BLOOD
Technical Director

ADMINISTRATIVE INFORMATION

Work reported herein was sponsored by the Naval Material Command under subproject ZF12-113-001, program element 62712N (NOSC project SS21). The work was performed over the period March-June 1979 by Evaluation Research Corporation – West Coast Division, under contract N66001-78-R-0318 with the Naval Ocean Systems Center.

Released by
R.L. Petty, Head
Sensor Processing and
Analysis Division

Under authority of
R.E. Shutters, Head
Surface/Aerospace
Surveillance Department

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER
NOSC Technical Report 501 (TR 501)

2. GOVT ACCESSION NO.
AD-A084 112

3. RECIPIENT'S CATALOG NUMBER

4. TITLE *(and Subtitle)*
Availability Estimate of a Conceptual ESM System

5. TYPE OF REPORT & PERIOD COVERED
Final report,
March - June 1979

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)
J. Valenzuela/Evaluation Research Corp.

8. CONTRACT OR GRANT NUMBER(s)
N66001-79-C-0511

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Naval Ocean Systems Center
San Diego, California 92152

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
ZF12-113-001/62712N

11. CONTROLLING OFFICE NAME AND ADDRESS
Naval Material Command
Washington, DC

12. REPORT DATE
June 1979

13. NUMBER OF PAGES
222

14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)*

15. SECURITY CLASS. *(of this report)*
Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*
Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*
Electronic Support Measures
Failure analysis
Availability analysis
Reliability and maintainability

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

An availability estimate was made for a new-generation ESM system conceived by staff at the Naval Ocean Systems Center. The system, which focuses on surveillance requirements, was found to have an availability of approximately 0.997 for various operating modes examined. Availability was also found to have reached its steady-state value by 30 days, regardless of the specific mission application.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-LF-014-6601

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

393159

CONTENTS

APPENDICES

CONTENTS (CONTINUED)

ILLUSTRATIONS

TABLES

1.0 EXECUTIVE SUMMARY

1.1 OBJECTIVE

As part of an overall Electronic Support Measures (ESM) improvement program, a study was performed to define a high-availability conceptual ESM system. Prior studies of existing shipboard ESM systems have (1) outlined component units needing improvement (Ref. 1) and (2) established the characteristic availabilities of two existing systems as well as goals (or standards) for ESM availability (Ref. 2). This report defines the operating, support, and maintenance requirements of a proposed ESM (conceptual design) system with a potential for performance modernization and availability improvement over existing shipboard systems. Modernization as used here refers to configuration redundancy for broad frequency coverage and independent performance modes (for easy growth to meet new threats) and configuration flexibility to permit incorporation of advanced technology.

1.2 METHODOLOGY

The first task was to determine the performance requirements of the conceptual ESM by means of a functional block diagram. Existing off-the-shelf components were identified to represent nearly all of the exterior mast-mounted equipment and some of the interior below-deck equipment. The remaining portion of the equipment was modeled by selecting representative quantities and types of active devices. Failure rates and cost figures were compiled for all components. Next, modes of operation and operating requirements were established along with the attendant automatic and operator-controlled functions and types of operator interfaces. System redundancy was defined for each mode of operation.

Finally, maintenance and support requirements were established which would support the performance modes and operating requirements. Availability and reliability figures were developed by modeling the reliability and maintainability parameters as exponential functions and solving for probability of system success and system degradation.

1.3 RESULTS

Summary results of availability, mean-time-between-failure (MTBF), and mean-time-to-repair (MTTR), computed for the conceptual ESM system are shown in Table 1-1. The figures are similar for 30-, 90- or 365-day mission times since steady-state values have been reached by 30 days. The graceful degradation* features incorporated into the study are summarized in Table 1-2. The amount of redundancy that can be said to exist as the result of allowable performance degradation causes the series elements of the reliability model (Fig. 4-12) to overwhelm the parallel elements' probability of failure. Thus, MTBF, MTTR, and availability values become effectively equal for loss of either two or three channels. Operating and support requirements are summarized in Table 1-3.

*Graceful degradation means partial loss of system performance without loss of function.

Component areas at the ship-replaceable unit (SRU) level were determined to have the following apportioned impact on reliability and availability:

Intermediate frequency (IF) converters	33%
Radio frequency (RF) filters (including YIG tuning components)	16%
Control & Display	16%
Remaining system	35%

At the piece-part level, the component impact on reliability and availability was distributed as follows (excluding computer, control and display):

Gallium arsenide field effect transistors (GaAs FET)	23%
Microwave diodes	21%
Coax connectors	12%
Ferrite isolators	12%
Bandpass filters	8%
Integrated circuits, linear	10%
Integrated circuits, digital	3%
Remaining parts	11%

1.4 RECOMMENDATIONS

Based on the work reported herein, the following recommendations are offered:

1. Investigate the potential for reducing part count by reducing the number of bands or channels without significantly sacrificing performance.

2. Investigate the feasibility and reliability of integrating RF components into "plug-in" packages similar to Standard Electronic Modules (SEM).

3. Investigate the availability of microwave devices with reliability higher than commercial or JAN level.

2.0 INTRODUCTION

The continually increasing development of highly sophisticated electronic weapons systems has led to greater interest in more sophisticated Electronic Support Measures (ESM) equipment. The study reported herein is part of an overall ESM improvement effort. It involves component research and specifically addresses the feasibility of obtaining a high-availability design.

Normally in a conceptual design, component definition is in broad terms, and therefore the resultant prediction of either reliability or availability is also an estimate in broad terms. The approach used in this study was to describe system performance requirements to the point where functional hardware could be defined. The hardware characteristics were then used as the basis for availability-related calculations. Although this approach may yield a more accurate feasibility study, care should be exercised in projecting details of

Table 1-1. Summary of Conceptual ESM Inherent Availability.

System-Up Condition	MTBF, hours			MTTR, hours			Availability		
	Exterior	Interior	Total	Exterior	Interior	Total	Exterior	Interior	Total
Complete System (all 4 channels)	253	460	163	.32	.55	.40	.9987	.9988	.9976
3 Channels (Degraded DF)	2007	546	429	.36	.68	.61	.9998	.9988	.9986
2 Channels (DF Failed Long-Range Surveillance & Threat Warning Degraded)	2018	546	430	.36	.68	.61	.9998	.9988	.9986
1 Channel (DF & Long-Range Surveillance Failed)	2018	546	430	.36	.68	.61	.9998	.9988	.9986

Table 1-2. Conceptual ESM Graceful Degradation.

No. of Failed Channels	Loss of Sensitivity, dB			Loss of Azimuth Coverage, deg azimuth		
	Long-Range Surveillance	Threat Warning	Direction Finding	Long-Range Surveillance	Threat Warning	Direction Finding
0	0	0	0	0	0	0
1	-6	-6	-6	0	0	*
2	-8	-8	Failed	0	0	Failed
3	Failed	-17	Failed	Failed	0	Failed

*Degraded performance bearing determination to within a quadrant.

Table 1-3. Recommended Operating & Support Personnel.

	Critical Mission Conditions	Non-Critical Mission Conditions
Hours/Shift	as required	4
Number of dedicated Operators/Shift	1	0*
Number of dedicated Repairmen/Shift	1	0†

*Operator will be required on a part-time basis to verify and check alarms given off by the system.

†Operator/repairman may be the same crew member.

the architecture as representative of a final production version. A final production model will contain the complexity of this conceptual architecture but with added development for integration, packaging, and ease of manufacture.

2.1 SCOPE

The intent of this study was to perform a conceptual assessment of the potential inherent reliability and availability of a newly proposed ESM architecture. Reliability and maintainability of the proposed configuration were predicted and based on the performance, operation, and support requirements outlined in Section 3.

3.0 SYSTEM DESCRIPTION

The Conceptual ESM architecture studied is a four-channel down converter system with multiple demodulation capability. Signals received are processed by various receivers and a computer subsystem to enable rapid parameter measurement, classification, identification, and bearing estimation. Superheterodyne receivers, fed from the down converter, have sensitivities that typically allow long-range intercept (beyond-the-horizon surveillance). The four-channel down converter configuration utilizes special frequency and amplitude measurement components to obtain threat warning reception (line-of-sight surveillance) together with bearing determination.

The equipment has been divided into two main groups, exterior and interior. The exterior group is the four-channel down converter portion mounted on the mast. The interior group contains the IF receiver and signal processing elements located belowdecks with a control and display console. This would most probably be located in the Combat Information Center (CIC). Figure 3-1 is an artist's concept of the exterior group, and Figs. 3-2 and 3-3 depict the interior group. Figure 3-4 is the functional block diagram.

3.1 PERFORMANCE REQUIREMENTS

The performance features of the conceptual architecture pertinent to this study are the modes of operation and their attendant definitions of success. Typically, the operational modes are energized simultaneously. They have been arbitrarily defined as follows:

1. Long-Range Surveillance: Long-range surveillance (or long-range intercept) involves frequency determination, pulse repetition interval (PRI) determination, and bearing determination to within a quadrant or better. Signal levels across the antenna are never more than 8 dB down relative to the best achievable performance.

2. Threat Warning: Threat warning refers to strong signal (line-of-sight) intercept. It involves frequency and PRI determination and computer sorting for threats. Signal levels across the antenna may be down as much as 17 dB relative to best performance.

3. DF Mode: The direction-finding mode is strong-signal (line-of-sight) bearing determination to within ±2 deg for signals down no more than 17 dB. Equivalent accuracy is expected but not required for the long-range surveillance condition.

The sensitivity for these three modes is dependent upon the number of channels operating and the demodulation parameters. As the number of channels drops, sensitivity degrades due to decreased antenna coverage. Therefore, successful – but degraded – operation

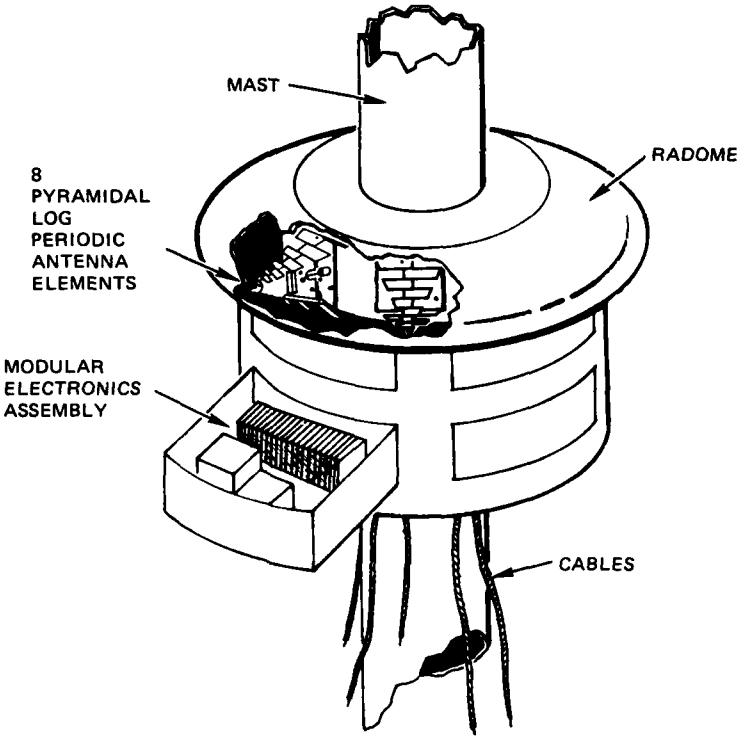


Figure 3-1. Exterior group pictorial diagram.

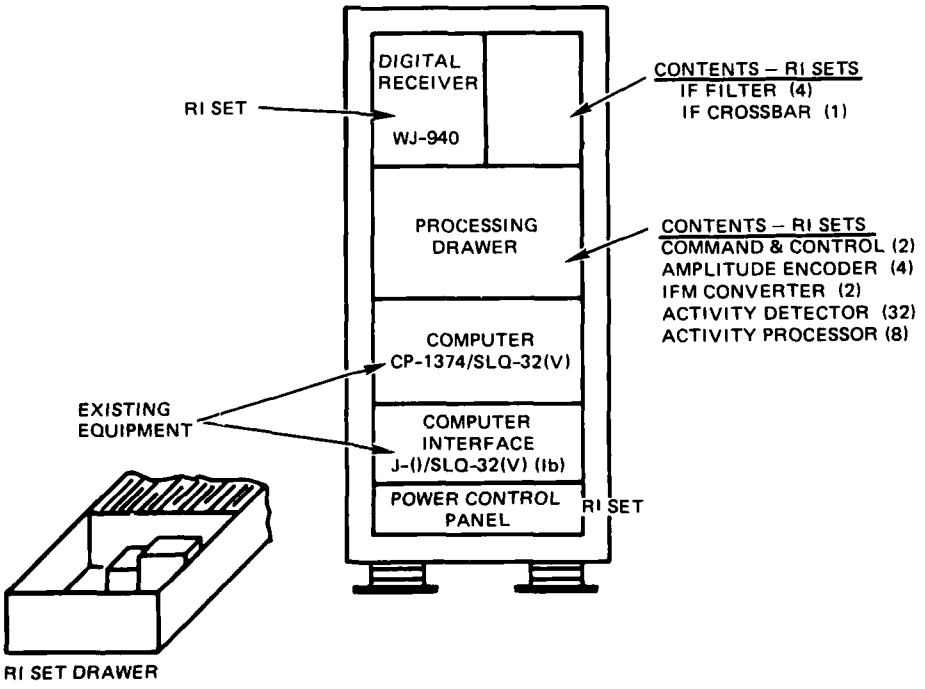
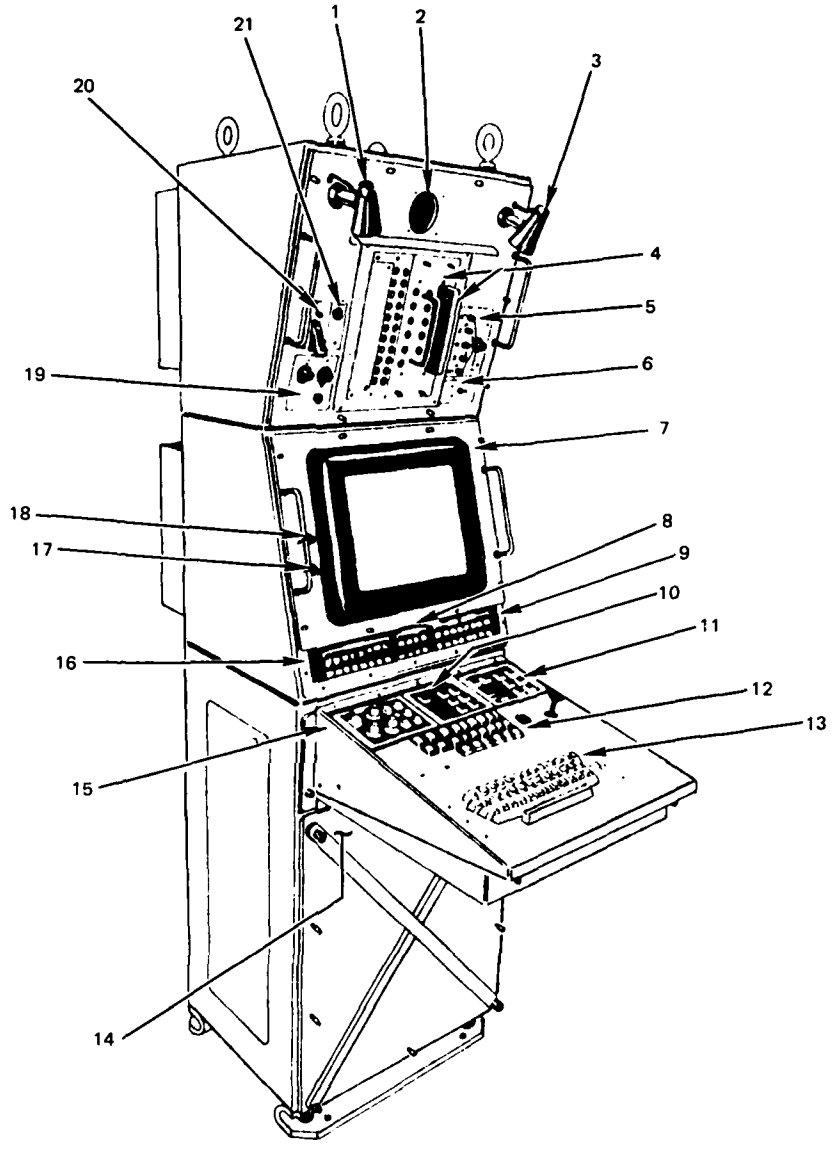
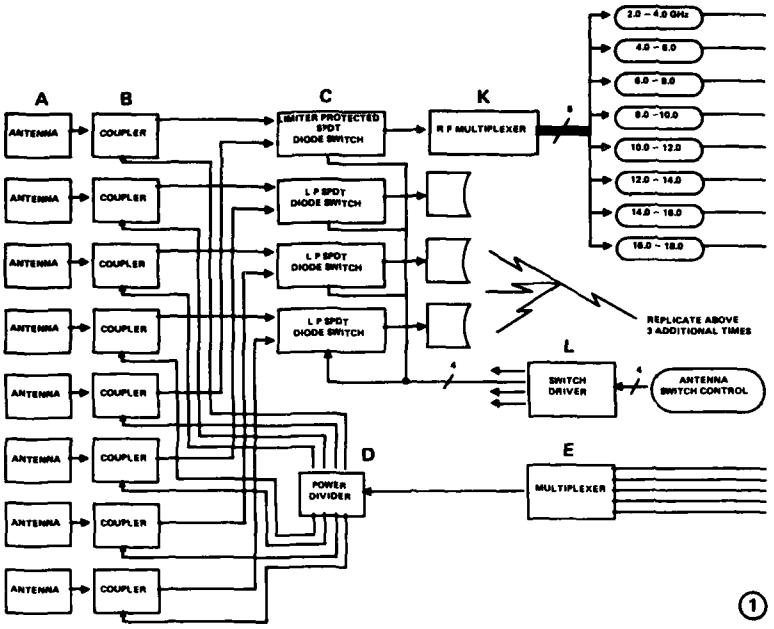


Figure 3-2. Interior Group Processing Equipment Pictorial Diagram.

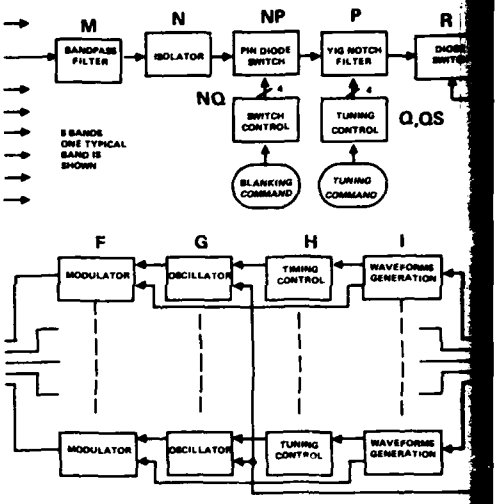


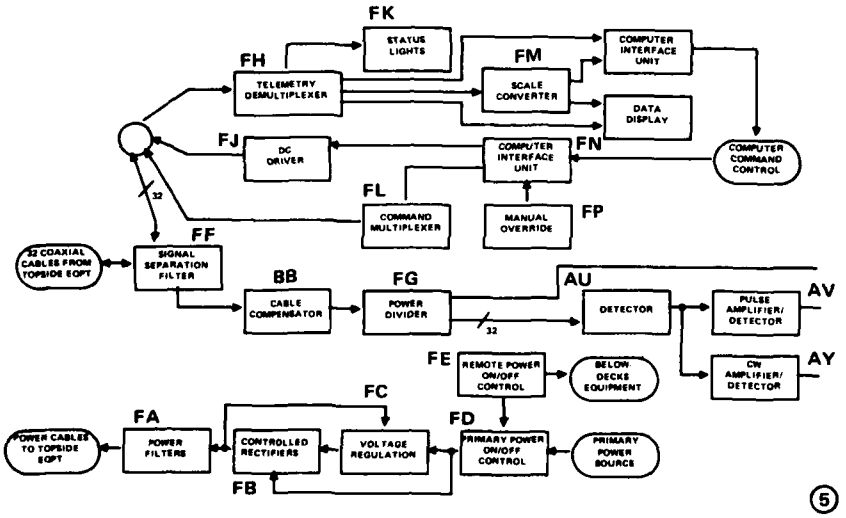
1. UPPER LEFT FLOOD LIGHT
2. SPEAKER
3. UPPER RIGHT FLOOD LIGHT
4. CARTRIDGE DRIVE ASSEMBLY AND CARTRIDGE
5. SYSTEM POWER CONTROL
6. CONSOLE BREAKER
7. MONITOR ASSEMBLY
8. INTERLOCK STATUS INDICATOR
9. OVERLOAD STATUS INDICATOR
10. AECM CONTROL GROUP
11. CHAFF LAUNCHER CONTROL GROUP
12. UPPER OPERATOR PANEL CONTROLS
13. KEYBOARD CONTROL GROUP
14. COMMUNICATIONS CONNECTORS (NOT VISIBLE)
15. AUDIO CONTROL GROUP
16. BIT STATUS INDICATOR
17. CONTRAST CONTROL
18. BRIGHTNESS CONTROL
19. CONSOLE ILLUMINATION CONTROL
20. BATTLESHORT CONTROL
21. PROGRAM LOAD CONTROL

Figure 3-3. Interior group display console and control and indicators.

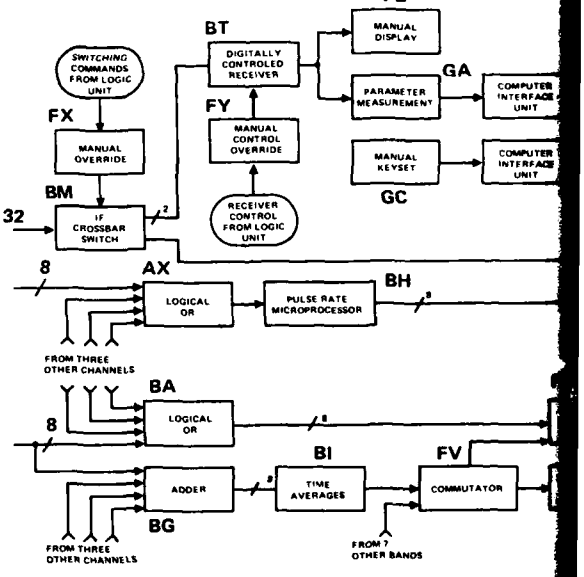

A
B
C
K
ANTENNA
COUPLER
LIMITER PROTECTED SPDT DIODE SWITCH
L P SPDT DIODE SWITCH
R F MULTIPLEXER
2.0 ~ 4.0 GHz
4.0 ~ 6.0
6.0 ~ 8.0
8.0 ~ 10.0
10.0 ~ 12.0
12.0 ~ 14.0
14.0 ~ 16.0
16.0 ~ 18.0
REPLICATE ABOVE 3 ADDITIONAL TIMES
L
SWITCH DRIVER
ANTENNA SWITCH CONTROL
D
POWER DIVIDER
E
MULTIPLEXER

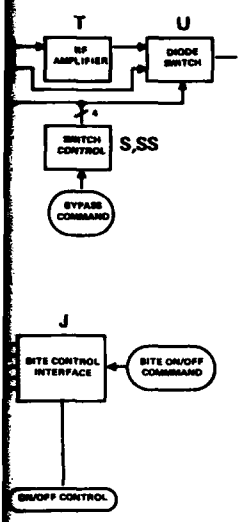
①


M
N
NP
P
R
BANDPASS FILTER
ISOLATOR
PIN DIODE SWITCH
YIG NOTCH FILTER
NQ
SWITCH CONTROL
TUNING CONTROL
Q,QS
8 BANDS ONE TYPICAL BAND IS SHOWN
BLANKING COMMAND
TUNING COMMAND
F
G
H
I
MODULATOR
OSCILLATOR
TIMING CONTROL
WAVEFORMS GENERATION

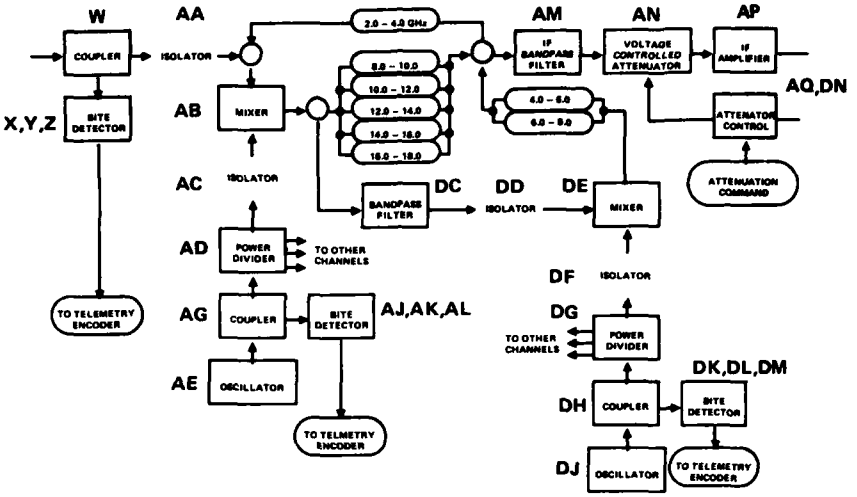

FK
STATUS LIGHTS
FH
TELEMETRY DEMULTIPLEXER
FM
SCALE CONVERTER
COMPUTER INTERFACE UNIT
DATA DISPLAY
FJ
DC DRIVER
FN
COMPUTER INTERFACE UNIT
COMPUTER COMMAND CONTROL
FL
COMMAND MULTIPLEXER
MANUAL OVERRIDE
FP
32
FF
32 COAXIAL CABLES FROM TOPSIDE EQPT
SIGNAL SEPARATION FILTER
BB
CABLE COMPENSATOR
FG
POWER DIVIDER
AU
DETECTOR
PULSE AMPLIFIER/ DETECTOR
AV
FE
REMOTE POWER ON/OFF CONTROL
BELOW DECKS EQUIPMENT
CW AMPLIFIER/ DETECTOR
AY
FC
FA
FD
POWER CABLES TO TOPSIDE EQPT
POWER FILTERS
CONTROLLED RECTIFIERS
VOLTAGE REGULATION
PRIMARY POWER ON/OFF CONTROL
PRIMARY POWER SOURCE
FB

⑤

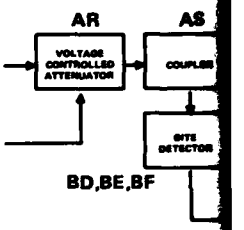

FZ
BT
SWITCHING COMMANDS FROM LOGIC UNIT
DIGITALLY CONTROLED RECEIVER
MANUAL DISPLAY
GA
PARAMETER MEASUREMENT
COMPUTER INTERFACE UNIT
FX
FY
MANUAL OVERRIDE
MANUAL CONTROL OVERRIDE
MANUAL KEYSET
COMPUTER INTERFACE UNIT
GC
32
BM
IF CROSSBAR SWITCH
RECEIVER CONTROL FROM LOGIC UNIT
8
AX
LOGICAL OR
PULSE RATE MICROPROCESSOR
BH
FROM THREE OTHER CHANNELS
BA
8
LOGICAL OR
BI
FV
ADDER
TIME AVERAGES
COMMUTATOR
BG
FROM THREE OTHER CHANNELS
FROM 7 OTHER BANDS

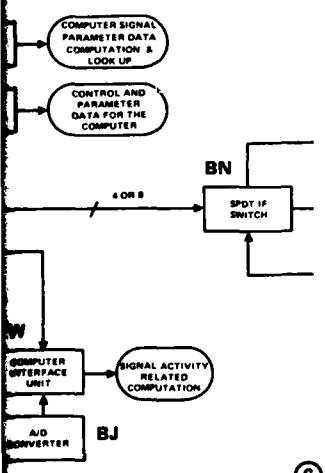


2

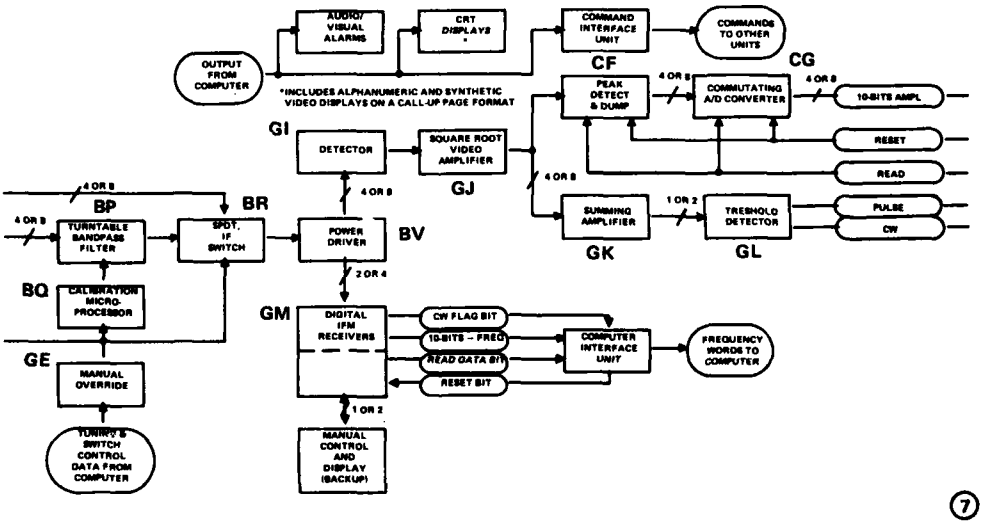


3





6



7

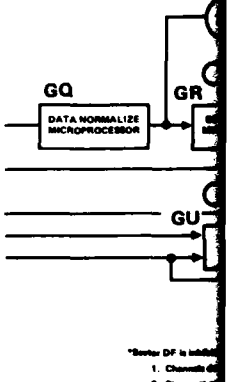


Figure 3-

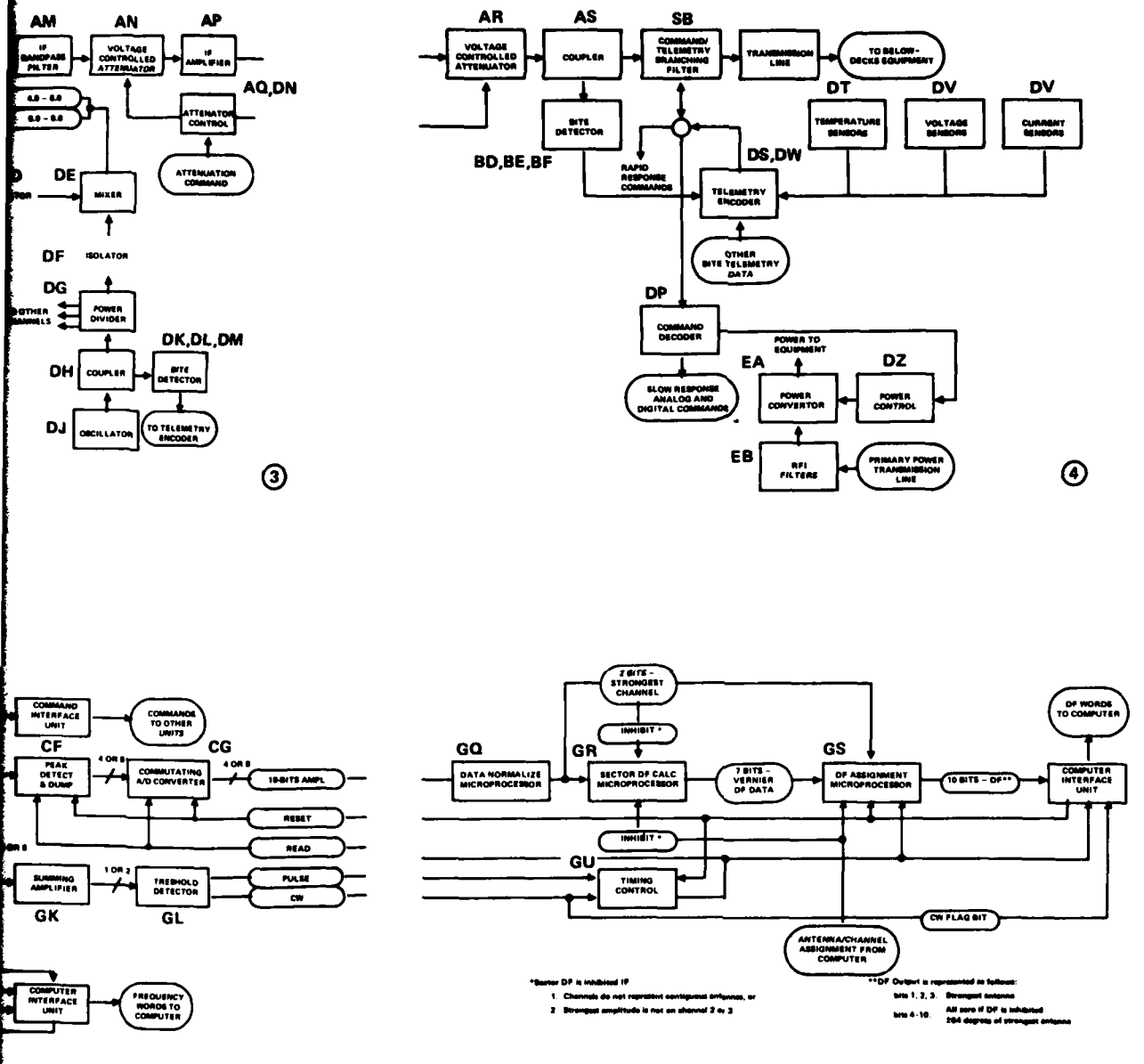


Figure 3-4. Functional block diagram, ESM availability improvement.

3

may exist for each functional mode with some channels in a failed state. Table 3-1 provides a summary of the degree and type of graceful degradation seen as a function of failed channels. The failure of individual bands within a channel (see Fig. 3-4, block 1) simply limits the frequency coverage in a given channel. Hence it would be synonymous with a channel failure for that frequency band.

Table 3-1. Conceptual ESM Graceful Degradation Criteria.

No. of Failed Channels	Loss of Sensitivity, dB			Loss of Azimuth Coverage, deg azimuth		
	Long-Range Surveillance	Threat Warning	Direction Finding	Long-Range Surveillance	Threat Warning	Direction Finding
0	0	0	0	0	0	0
1	6	6	6	0	0	*
2	8	8	Failed	0	0	Failed
3	Failed	17	Failed	Failed	0	Failed

*Degraded performance bearing determination to within a quadrant.

Notch filter failures, where the component is not burned out (but no longer attenuates strong signals), would be of no consequence except in the presence of interfering CW signals. This situation is handled by assigning an arbitrary probability to the event. Local oscillator (LO) failures are more damaging than most other hardware failures because an LO failure causes a failure in all channels for that band. While it results in a somewhat pessimistic assessment, LO failures are treated as a system failure (failure of all channels) because of the difficulty in assigning probability to reception in respective frequency bands. Channel failure effects are defined in Table 3-1.

3.2 OPERATIONAL REQUIREMENTS

The conceptual ESM system is a fully automatic receiving system with multifunctional capability that permits the following:

- simultaneous intercept over 360 deg of azimuth
- determination of pulse or CW parameters for intercepted emitters
- matching an emitter's parameters to stored data library
- reporting the information, either visually on a CRT or digitally on a printed message, to a human observer
- issuing an alarm for threats or equipment failure

In addition, the capability exists to have an operator interrupt the automatic routine and perform his own diagnosis of intercepted signals. Should the automatic control function (central computer) fail under a critical mission situation, manually operated backup controls exist for tuning receivers and switching frequency bands or channels.

Under non-critical mission conditions, operation may be accomplished without an operator, with messages transmitted to the watch officer, or operation can be sustained by one operator/repairman. A single operator may be shared among other commonly located equipments since he will be required only to acknowledge an alarm and possibly make repairs. A non-critical mission condition is one where the system, if allowed to go down (fail) for the duration of the repair time, will not result in a critical effect to the ship's safety.

Under critical mission situations, two or more operator/repairmen will be required and may be assigned to 4-hour (or longer) shifts, depending on the degree of operator intervention the ship's commander may require. The second operator/repairman is needed to cover in the event of a system failure. While a repairman performs corrective action, the operator maintains watch on the remaining operational portions of the system. A critical mission situation is one in which the ship's safety would be jeopardized were the system allowed to remain down for the duration of repair time.

The required skill level of operator/repairmen will be at least E4, with intermediate- and organizational-level operation and maintenance training.

3.3 MAINTENANCE CONCEPT AND SUPPORT REQUIREMENTS

The basic concept for packaging the conceptual ESM is to optimize maintainability at the organizational level without sacrificing optimum performance and reliability. The concepts developed are:

1. The mast-mounted exterior group is to be packaged in segments of bands or channels with outputs at intermediate frequencies (IF) on transistor-to-transistor logic (TTL) signal levels.

2. The IF signal processing, display, and control group is to be packaged together and located belowdecks as close to the operator room as possible.

3. The exterior group is to be entirely packaged into similar replaceable assemblies (containing SRUs with common functions for fault-isolation purposes) and be both easily replaceable and easily carried between the spares location and the mast location.

4. The signal processing display and control group is to be packaged as much as possible into similar replaceable units [such as (3) above] with repairable items held to a minimum quantity and repair time.

The maintenance concept developed for the conceptual ESM considers the following in order of priority:

1. Minimum repair time
2. Commonality of SRUs, SRAs, and components as much as possible
3. Automatic fault isolation
4. Minimum training required for operation and maintenance.

The concept to be followed is that repair will be accomplished by three levels as follows:

Organizational – Replacement of an SRU which is isolated and located by the built-in test equipment (BITE). Check-out and calibration will be accomplished

automatically by injected signals and measurements. For the exterior group, BITE will totally isolate and localize to an SRU. For the interior group, faults are isolated and localized by a combination of BITE and operator interpretation of display information.

Intermediate – Repair of an SRU is done by replacement of an SRA. A fault, to the SRA level, is detected by special-purpose test equipment aboard ship. Check-out and some calibration are performed using standard and special-purpose test equipment.

Depot – As a guideline, no more than 13% of the SRAs will be returned to the depot for repair. The remaining portion is to be discarded. The repairable SRAs will be reconditioned by the equipment manufacturer or the Navy using standard test equipment. Replacement of piece-parts will be the primary method.

The preventive maintenance schedule, as identified by the planned maintenance system (PMS) for the conceptual ESM, is intended to be at some minimum level of effort. Except for normal daily walk-around inspection, there is no need for any daily PMS. Check-out of the system is performed by use of the BITE and calibration generator and control at any time while the system is operational. Monthly or quarterly inspection of rack cooling fans and cleaning of air filters may be required for below-deck equipment.

4.0 SYSTEM AVAILABILITY AND RELIABILITY

The Conceptual ESM reliability and availability model has been developed to reflect the equipment's capability relative to the mission requirements and designed-in graceful degradation. Mission requirements are given in terms of equipment performance over the specified mission time. Graceful degradation features are given in terms of system capability versus loss of redundant channels.

4.1 FAILURE RATE SOURCE DATA

The approach used in this study has resulted in component definition for most of the equipment. Components are separated into two categories: RF and printed circuit board (PCB) types. RF components are such items as couplers, isolators, YIG oscillators, and solid state microwave amplifiers. The PCB components are the more common electronic parts, such as resistors, capacitors, transistors, and integrated circuits (ICs). PCB-type component failure rates have been modeled directly, using MIL-Handbook 217B data. RF component failure rates are based on: (1) manufacturer's estimate, (2) engineering estimate, or (3) 217B generic failure rates. Appendix A, Part III, contains the detailed reliability prediction, including the applicable Pi factors used in the 217B models. The environments used were Naval Unsheltered for the exterior group and Naval Sheltered for the interior group. An assembly operating temperature in the range 45 to 55°C was estimated, with assemblies having higher power dissipation (such as power supplies) operating at 55°C.

Table 4-1 provides a summary of the individual component failure rates arranged in descending order of percentage of overall failure rate. Some components, however, do not contribute to the reliability and availability model. For example, the BITE detector is 8.5% of overall failure rate but does not contribute to the system reliability/availability models in Figs. 4-1 through 4-5. Failure rates for the computer, CP-1374/SLQ-32(V) and J-( )/ SLQ-32(V), and the control and display, OJ-466/ SLQ-32(V), are taken from Ref. 5.

Table 4-1. Piece-Part Failure Rate Breakdown.

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 140

PROJECT: FSM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: ESM 0 ASSEMBLY TEMP: 25.C

COMPONENT	QTY	PERCENT OF TOTAL QTY	FAILURE RATE	PERCENT OF TOTAL F.R.
ATTENUATOR, VOLTAGE CONTROLLED*	64.0	1.03	1318.39917	11.23
AMPLIFIER, GAAS FET	228.0	3.67	1253.99878	10.68
IF AMPLIFIER*	32.0	.51	1065.59961	9.08
BITE DETECTOR W/AMPLIFIER*	73.0	1.17	997.68848	8.50
DIODE SWITCH*	96.0	1.54	960.00000	8.18
YIG TUNED FILTER*	32.0	.51	768.00000	6.54
CONN, RF COAXIAL, TYPE C	329.0	5.29	747.49756	6.37
RF AMPLIFIER*	32.0	.51	710.39941	6.05
DIODE, DETECTOR, SI	50.0	.80	412.70776	3.52
FERRITE ISOLATOR	76.0	1.22	380.00000	3.24
BANDPASS FILTER	72.0	1.16	360.00000	3.07
POWER SUPPLY*	22.0	.35	331.27979	2.82
OSCILLATOR*	9.0	.14	180.00000	1.53
IC, BIPOLAR LINEAR	430.0	6.92	174.42845	1.49
IND, RF COIL, CLASS D	206.0	3.31	160.68361	1.37
FERRITE, ISOLATOR	32.0	.51	160.00000	1.36
POWER DIVIDER	48.0	.77	135.09993	1.15
IC, BIPOLAR DIGITAL SSI/MSI	590.0	9.49	133.14557	1.13
DIRECTIONAL COUPLER	81.0	1.30	129.59991	1.10
RESISTOR, NONWIREWOUND TRIMMER	65.0	1.05	111.88617	.95
CONN, PWR, TYPE B	77.0	1.24	111.00716	.95
SIGNAL SEPARATOR	64.0	1.03	102.39995	.87
VOLTAGE CONTROLLED OSCILLATOR*	5.0	.08	100.00000	.85
DIODE, GENERAL PURPOSE, SI	219.0	3.52	83.46960	.71
DIODE SWITCH W/AMPL	8.0	.13	80.00000	.68
MIXER, DOUBLE BALANCED	36.0	.58	61.56761	.52
LIMITER PROT SPDT DIODE SW,	4.0	.06	53.19997	.45
CAP, CERAMIC, CK 125C	482.0	7.75	52.54634	.45
COMPENSATOR	32.0	.51	51.19998	.44
RF MULTIPLEXER	5.0	.08	50.00000	.43
FINE SECTOR ENCODER	4.0	.06	42.79997	.36
RES, LEAD SCREW VAR WW, RT	44.0	.71	40.41202	.34
FERRITE ISOLATOR	2.0	.03	40.00000	.34

*See Appendix A for active piece-part breakdown

Table 4-1. Continued.

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 141

PROJECT: FSM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: ESM 0 ASSEMBLY TEMP: 25.C

COMPONENT	QTY	PERCENT OF TOTAL QTY	FAILURE RATE	PERCENT OF TOTAL F.R.
RELAY	12.0	.19	38.69997	.33
SWITCH, TOGGLE	10.0	.16	26.99998	.23
CONNECTOR, RACK, INSERT B	106.0	1.70	26.48203	.23
TRANSISTOR, NPN, SI	94.0	1.51	26.30867	.22
MODULATOR	5.0	.08	25.00000	.21
DIODE, ZENER / AVALANCHE	26.0	.42	22.32890	.19
FAN, TUBEAXIAL	2.0	.03	22.00000	.19
DIODE, BRIDGE	10.0	.16	21.24985	.18
DISCRIMINATOR	4.0	.06	20.00000	.17
CONVERTER	2.0	.03	20.00000	.17
OSC., YIG FILTER	2.0	.03	20.00000	.17
TRANSISTOR, PNP, SI	71.0	1.14	17.19963	.15
IC, MOS DIGITAL LSI	16.0	.26	11.30220	.10
RES, ACCURATE FIXED WW, RR	26.0	.42	9.85772	.08
CONN, CIRCULAR CABLE, TYPE R	5.0	.08	6.60713	.06
RES, INSULATED FIXED FILM, RN	308.0	4.95	5.26721	.04
RES, POWER FIXED WW, RW	32.0	.51	5.26361	.04
INCANDESCENT LAMP	5.0	.08	5.00000	.04
IC, BIPOLAR ECL DIGITAL SSI/MSI	10.0	.16	4.80840	.04
RES, THERMISTOR, RTH	12.0	.19	4.60000	.04
FILTER	20.0	.32	4.39323	.04
CAP, NONSOLID TANT, CL	2.0	.03	4.33003	.04
IND, POWER, CLASS Q	6.0	.10	4.21698	.04
HEATER	4.0	.06	4.00000	.03
ANTENNA, LOG PERIODIC	8.0	.13	4.00000	.03
TRANS, POWER, CLASS Q	5.0	.08	2.92604	.02
RES, PWR FXD WW CHAS MOUNT, RE	4.0	.06	2.73750	.02
CAP, SOLID TANT, CSR	361.0	5.81	2.70282	.02
CONN, RACK AND PANEL, TYPE H	4.0	.06	2.60021	.02
SWITCH, POWER	2.0	.03	1.80000	.02
IND, POWER, CLASS T	2.0	.03	.84978	.01
IND, POWER, CLASS R	8.0	.13	.78271	.01
TRT SENS.	2.0	.03	.60000	.01

Table 4-1. Continued.

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 142

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: ESM 0 ASSEMBLY TEMP: 25.C

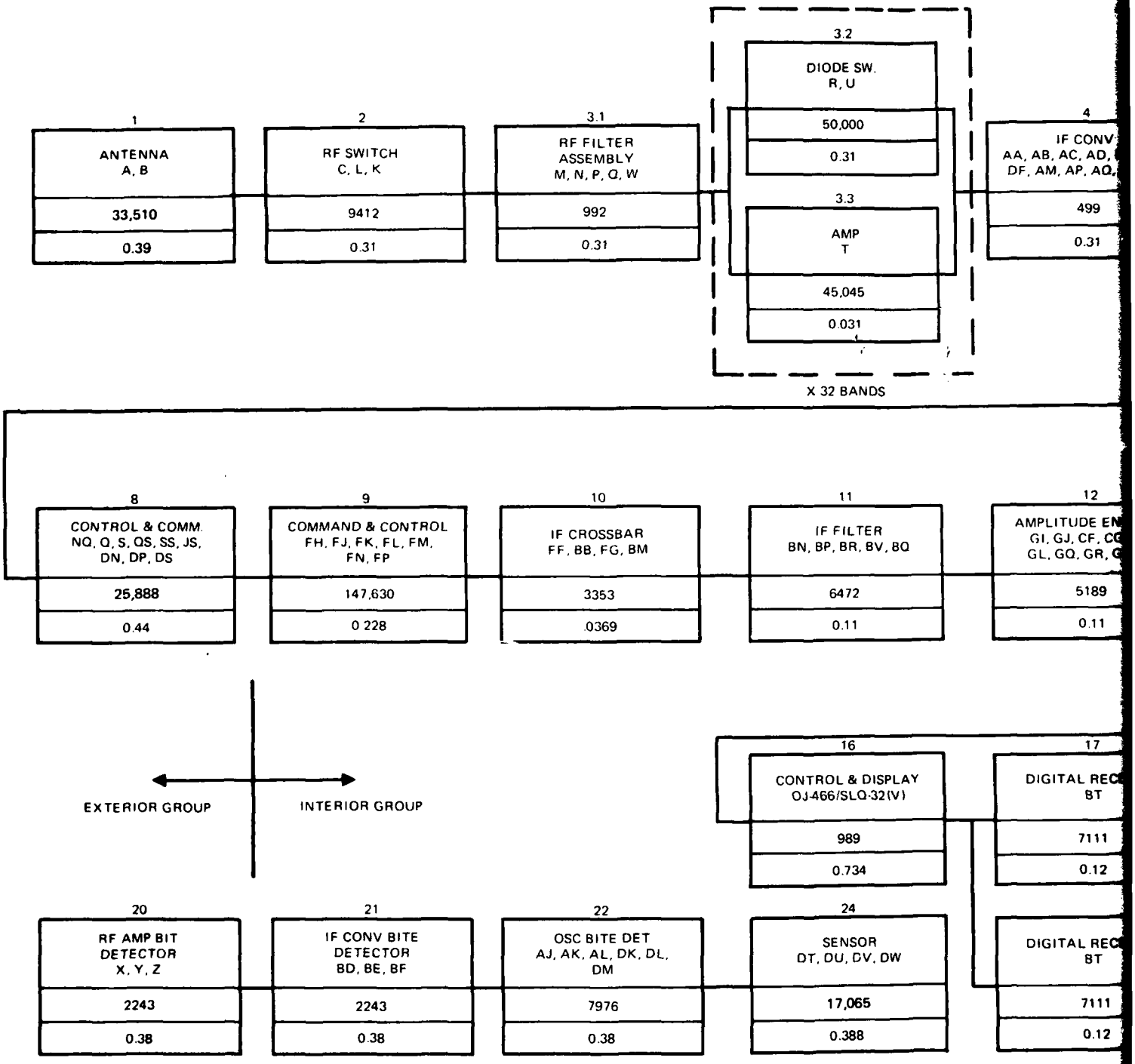
COMPONENT	QTY	PERCENT OF TOTAL QTY	FAILURE RATE	PERCENT OF TOTAL F.R.
RES, WELDABLE FXD FILM, RNC	32.0	.51	.58163	.00
IC, MOS DIGITAL SSI/MSI	2.0	.03	.55745	.00
TRANS, POWER, CLASS T	1.0	.02	.42489	.00
FUSE	4.0	.06	.40000	.00
RES, INSULATED FIXED FILM, RLR	161.0	2.59	.25879	.00
CAP, CERAMIC, CKR 125C	154.0	2.48	.17952	.00
RES, INSULATED FIXED COMP, RCR	1065.0	17.13	.17241	.00
CAP, MICA, CM	6.0	.10	.16635	.00
CAP, MICA, CMR	26.0	.42	.14417	.00
PWB, TWO-SIDED BOARDS	20.0	.32	.13200	.00
DIRECTIONAL COUPLER	8.0	.13	.08000	.00
CAP, PAPER-PLASTIC, CQR 125C	4.0	.06	.00092	.00

TOTAL QUANTITY EQUALS 6218.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 11737.00000 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 85.2 HOURS

EXIT


1
ANTENNA
A, B
33,510
0.39
2
RF SWITCH
C, L, K
9412
0.31
3.1
RF FILTER
ASSEMBLY
M, N, P, Q, W
992
0.31
3.2
DIODE SW.
R, U
50,000
0.31
3.3
AMP
T
45,045
0.031
X 32 BANDS
4
IF CONV
AA, AB, AC, AD,
DF, AM, AP, AQ,
499
0.31
8
CONTROL & COMM.
NQ, Q, S, QS, SS, JS,
DN, DP, DS
25,888
0.44
9
COMMAND & CONTROL
FH, FJ, FK, FL, FM,
FN, FP
147,630
0 228
10
IF CROSSBAR
FF, BB, FG, BM
3353
.0369
11
IF FILTER
BN, BP, BR, BV, BQ
6472
0.11
12
AMPLITUDE EN
GI, GJ, CF, CC
GL, GQ, GR, G
5189
0.11
EXTERIOR GROUP
INTERIOR GROUP
16
CONTROL & DISPLAY
OJ-466/SLQ-32(V)
989
0.734
17
DIGITAL REC
BT
7111
0.12
20
RF AMP BIT
DETECTOR
X, Y, Z
2243
0.38
21
IF CONV BITE
DETECTOR
BD, BE, BF
2243
0.38
22
OSC BITE DET
AJ, AK, AL, DK, DL,
DM
7976
0.38
24
SENSOR
DT, DU, DV, DW
17,065
0.388
DIGITAL REC
BT
7111
0.12

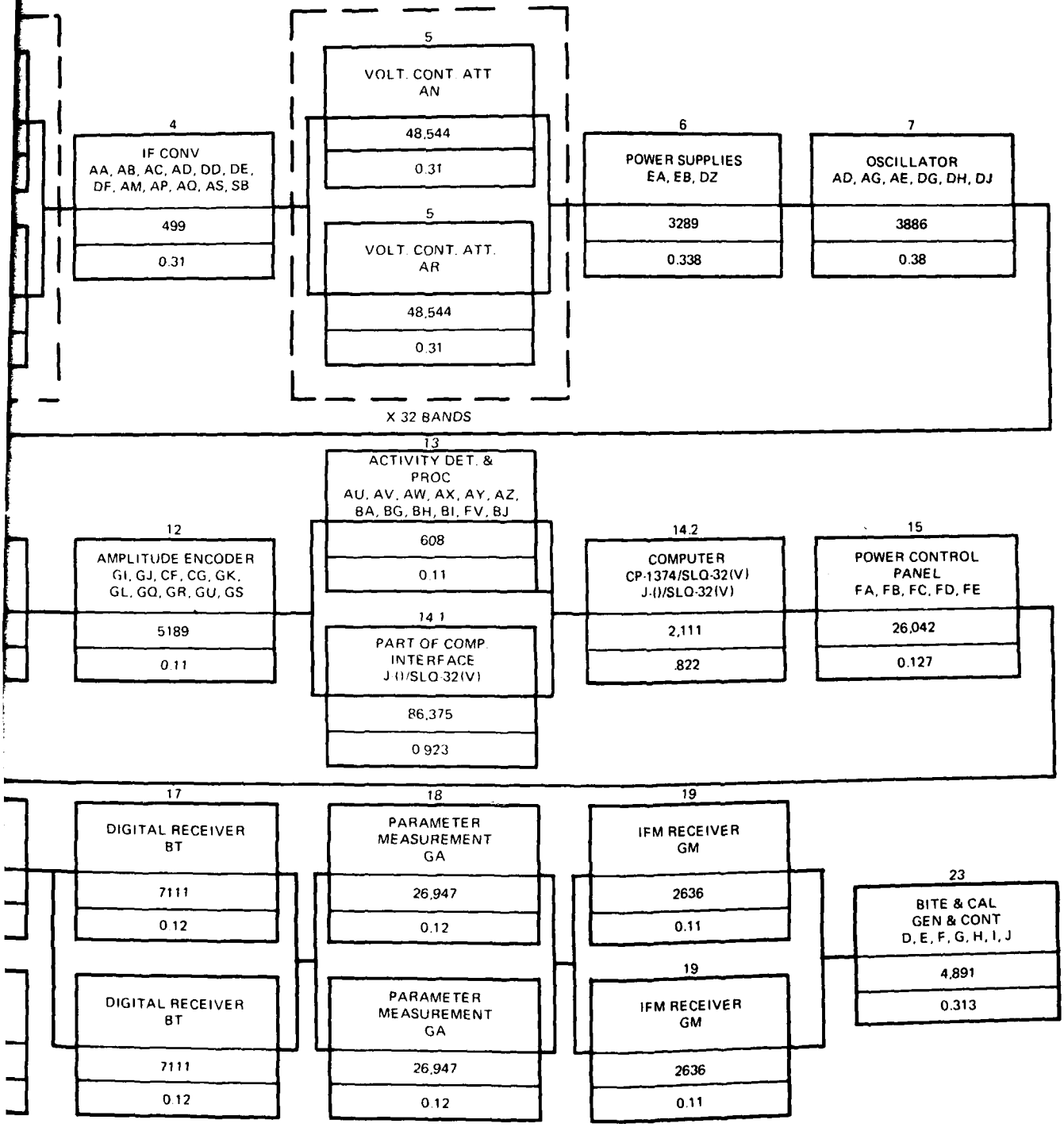
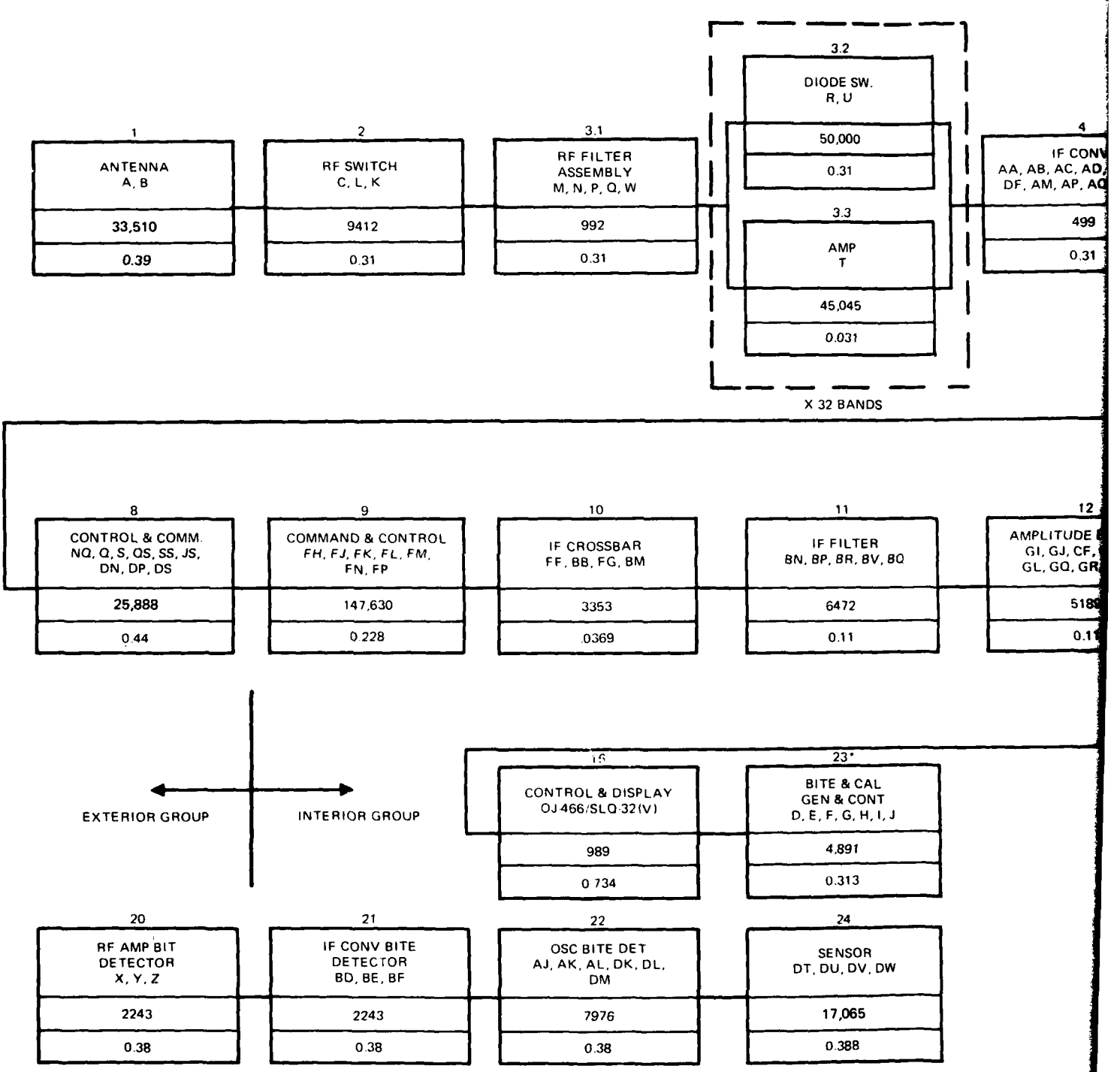


Figure 4-1. System reliability block diagram.


1
ANTENNA
A, B
33,510
0.39
2
RF SWITCH
C, L, K
9412
0.31
3.1
RF FILTER
ASSEMBLY
M, N, P, Q, W
992
0.31
3.2
DIODE SW.
R, U
50,000
0.31
3.3
AMP
T
45,045
0.031
X 32 BANDS
4
IF CONV
AA, AB, AC, AD,
DF, AM, AP, AQ
499
0.31
8
CONTROL & COMM.
NQ, Q, S, QS, SS, JS,
DN, DP, DS
25,888
0.44
9
COMMAND & CONTROL
FH, FJ, FK, FL, FM,
FN, FP
147,630
0.228
10
IF CROSSBAR
FF, BB, FG, BM
3353
.0369
11
IF FILTER
BN, BP, BR, BV, BQ
6472
0.11
12
AMPLITUDE
GI, GJ, CF,
GL, GQ, GR
5185
0.11
EXTERIOR GROUP
INTERIOR GROUP
16
CONTROL & DISPLAY
OJ-466/SLQ-32(V)
989
0.734
23*
BITE & CAL
GEN & CONT
D, E, F, G, H, I, J
4,891
0.313
20
RF AMP BIT
DETECTOR
X, Y, Z
2243
0.38
21
IF CONV BITE
DETECTOR
BD, BE, BF
2243
0.38
22
OSC BITE DET
AJ, AK, AL, DK, DL,
DM
7976
0.38
24
SENSOR
DT, DU, DV, DW
17,065
0.388

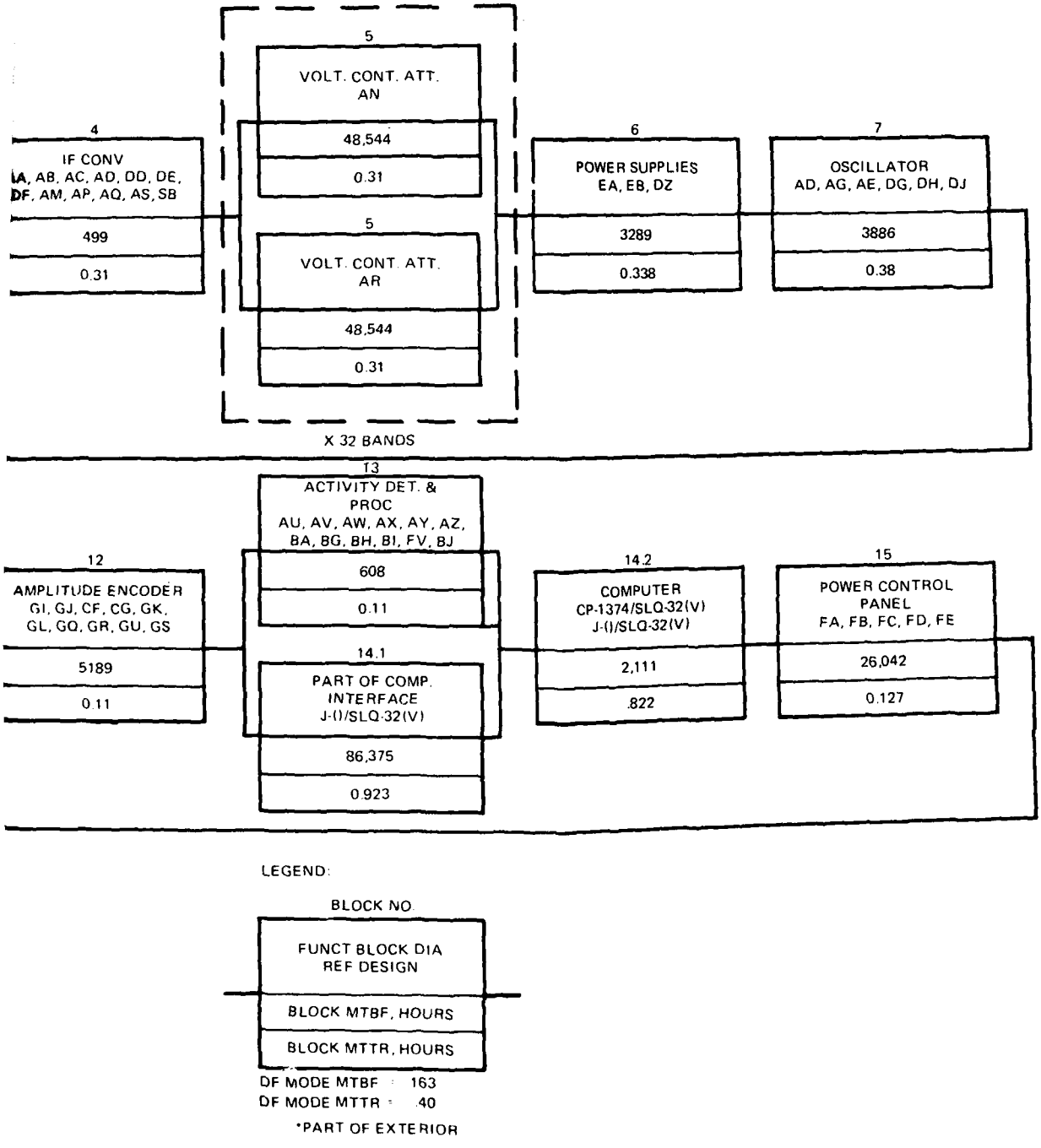
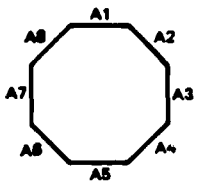


Figure 4-2. DF mode reliability block diagram.



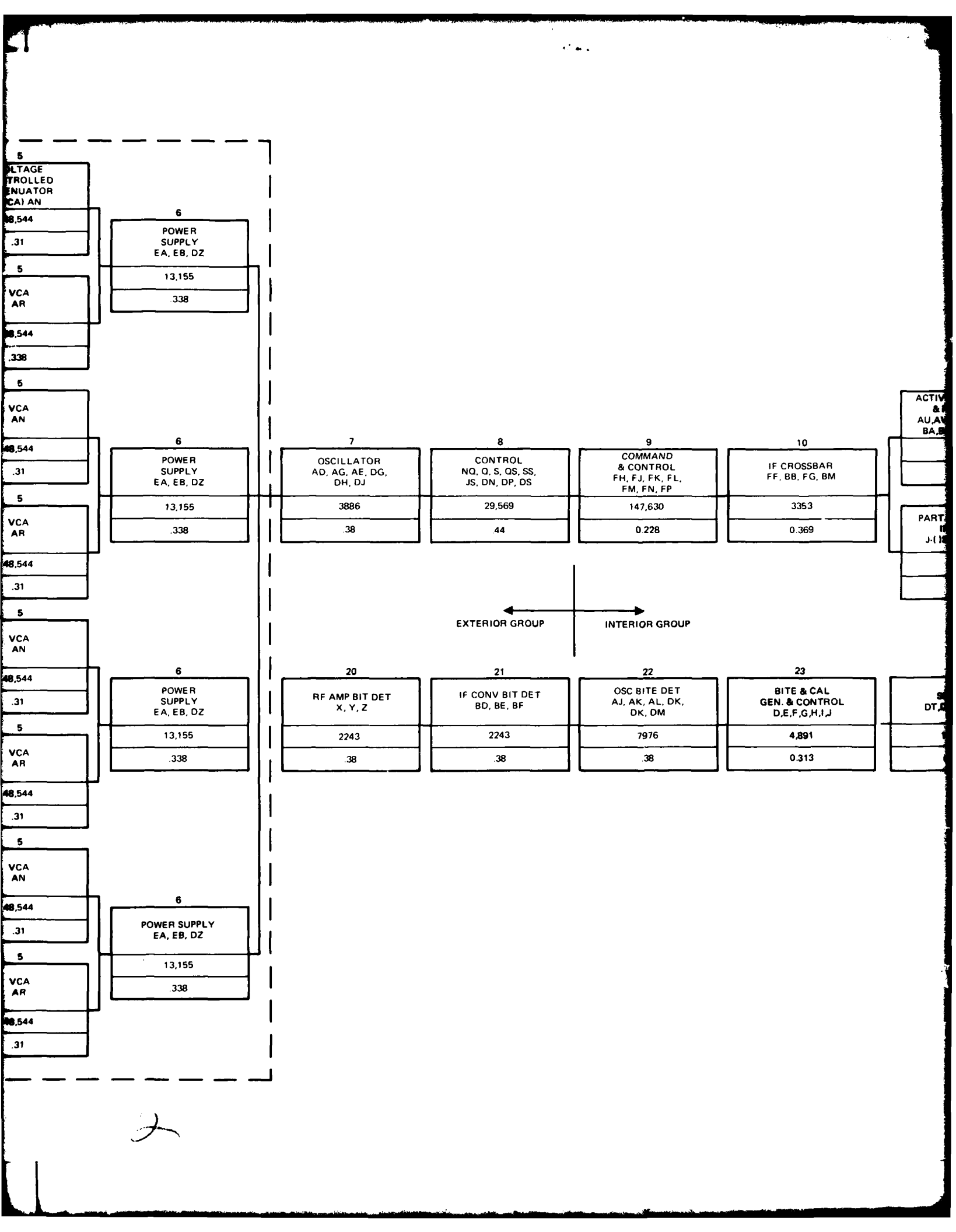
1	2	3.1	3.2	3.3	4
ANTENNA A1, A5, B1, B5	RF SWITCH C1, L1, K1	REFILTER ASSEMBLY M, N, NP, P, W	DIODE SWITCH R, U	AMP T	IF CONV S AA, AB, AC, DC, DD, DE, DF, AM, AP, AQ, AS, SB
134.039	37.650	3968	50,000	45,045	1996
.390	.31	.31	31	.31	.31

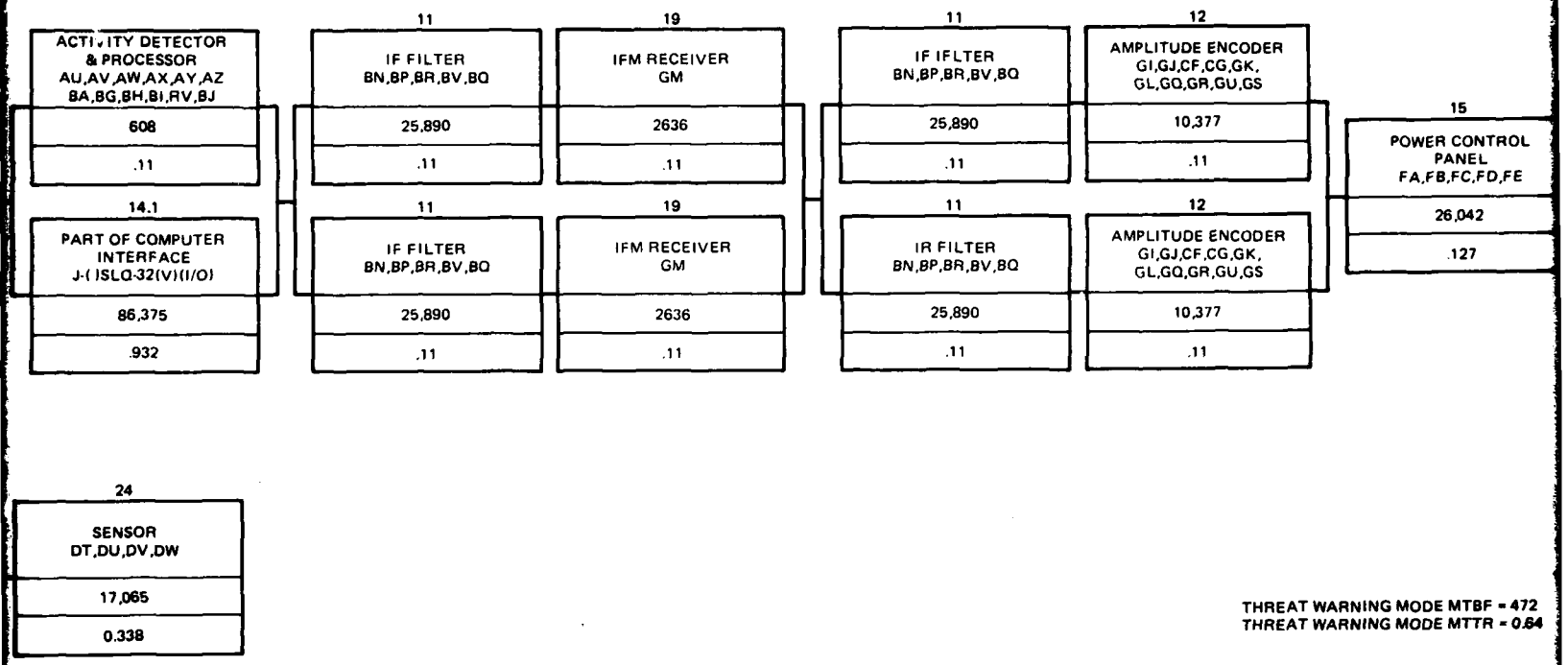
1	2	3.1	3.2	3.3	4
ANTENNA A2, A6, B2, B6	RF SWITCH C2, L2, K2	RF FILTER ASSEMBLY M, N, P, P, NP, W	DIODE SWITCH R, U	AMP T	IF CONV AA, AB, AC, DC, DD, DE, DF, AM, AP, AQ, AS, SB
134.039	37.650	3968	50,000	45,045	1996
.390	.31	.31		.31	.31

1	2	3.1	3.2	3.3	4
ANTENNA A3, A7, B3, B7	RF SWITCH C3, L3, K3	RF FILTER ASSEMBLY M, N, NP, P, W	DIODE SWITCH R, U	AMP T	IF CONV AA, AB, AC, DC, DD, DE, DF, AM, AP, AQ, AS, SB
134.039	37.650	3968	50,000	45,045	1996
.390	.31	.31	.31	.31	.31

1	2	3.1	3.2	3.3	4
ANTENNA A4, A8, B4, B8	RF SWITCH C4, L4, K4	RF FILTER ASSEMBLY M, N, NP, P, W	DIODE SWITCH R, U	AMP T	IF CONV AA, AB, AC, DC, DD, DE, DF, AM, AP, AQ, AS, SB
134.039	37.650	3968	50,000	45,045	1996
.390	.31	.31	.31	.31	.31

1 OUT OF 4
REQUIRED

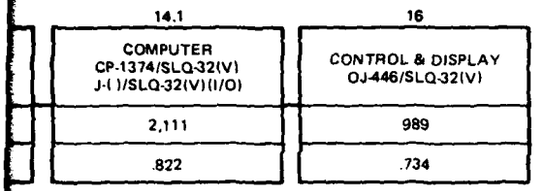

5
LTAGE
TROLLED
NUATOR
CA) AN
8,544
.31
5
VCA
AR
8,544
.338
5
VCA
AN
48,544
.31
5
VCA
AR
48,544
.31
5
VCA
AN
48,544
.31
5
VCA
AR
48,544
.31
5
VCA
AN
48,544
.31
5
VCA
AR
48,544
.31
6
POWER
SUPPLY
EA, EB, DZ
13,155
.338
6
POWER
SUPPLY
EA, EB, DZ
13,155
.338
6
POWER
SUPPLY
EA, EB, DZ
13,155
.338
6
POWER SUPPLY
EA, EB, DZ
13,155
.338
7
OSCILLATOR
AD, AG, AE, DG,
DH, DJ
3886
.38
8
CONTROL
NQ, Q, S, QS, SS,
JS, DN, DP, DS
29,569
.44
9
COMMAND
& CONTROL
FH, FJ, FK, FL,
FM, FN, FP
147,630
0.228
10
IF CROSSBAR
FF, BB, FG, BM
3353
0.369
ACTIV
& I
AU,AV
BA,B
PART
J-( )
EXTERIOR GROUP
INTERIOR GROUP
20
RF AMP BIT DET
X, Y, Z
2243
.38
21
IF CONV BIT DET
BD, BE, BF
2243
.38
22
OSC BITE DET
AJ, AK, AL, DK,
DK, DM
7976
.38
23
BITE & CAL
GEN. & CONTROL
D,E,F,G,H,I,J
4,891
0.313
DT,D

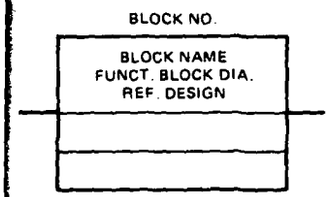


THREAT WARNING MODE MTBF = 472
THREAT WARNING MODE MTTR = 0.64

PRECEDING PAGE BLANK-NOT FILMED

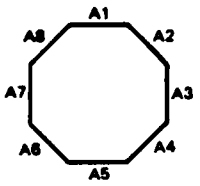
Figure 4-3. Threat warning m





node reliability block diagram.

4



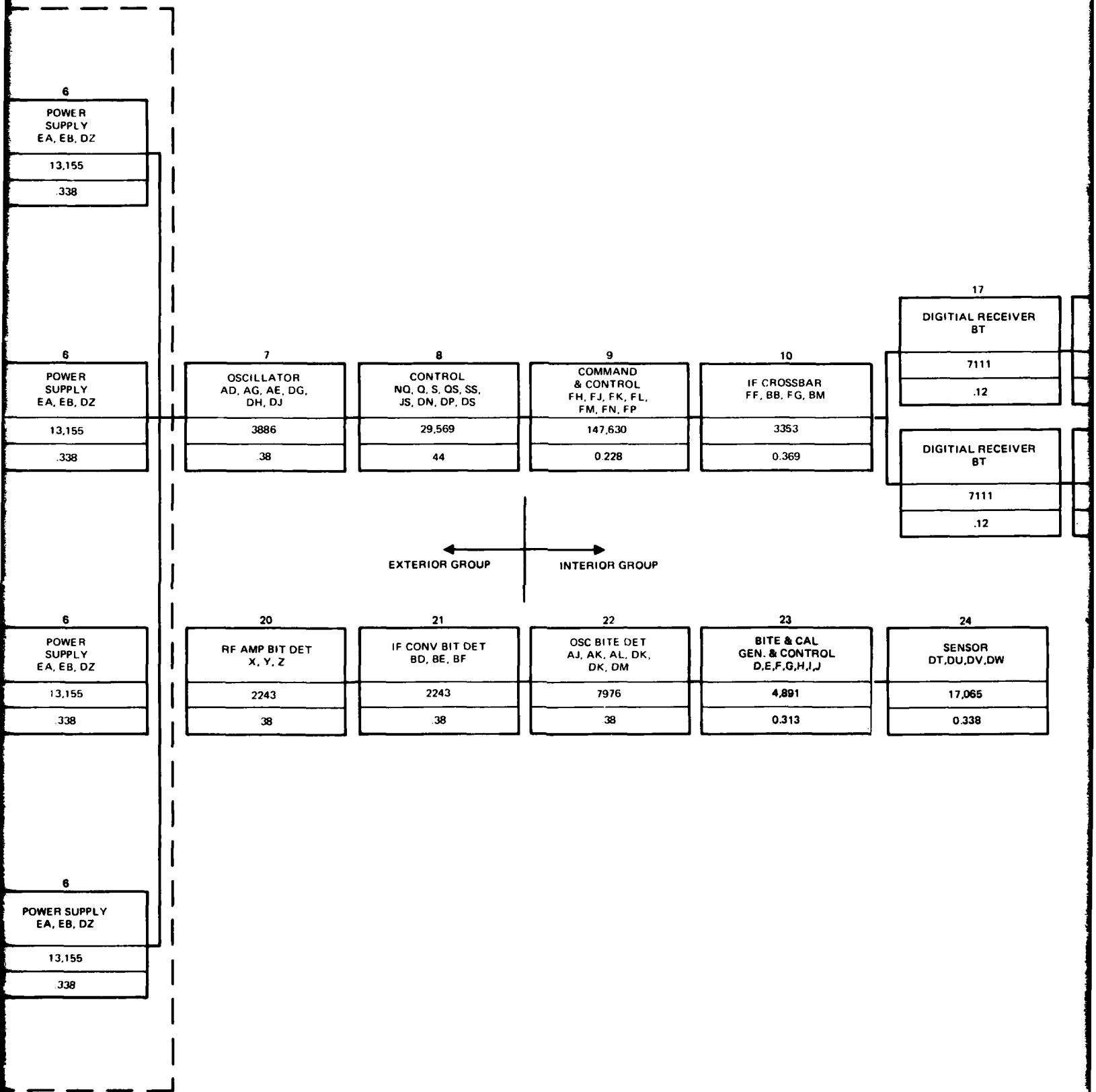
1	2	3	4	5
ANTENNA A1, A5, B1, B5	RF SWITCH C1, L1, K1	RF FILTER ASSEMBLY M,N,NP,P,R T,U,W	IF CONV S AA, AB, AC, DC, DD, DE, DF, AM, AP, AQ, AS, SB	VOLTAGE CONTROLLED ATTENUATOR (VCA) AN
134.039	37.650	1368	1996	48.544
.390	.31	.31	.31	.31
				5
				VCA AR
				48.544
				.338

1	2	3	4	5
ANTENNA A2, A6, B2, B6	RF SWITCH C2, L2, K2	RF FILTER ASSEMBLY M,N,P,P,NP,R,T,U W	IF CONV AA, AB, AC, DC, DD, DE, DF, AM, AP, AQ, AS, SB	VCA AN
134.039	37.650	1368	1996	48.544
.390	.31	.31	.31	.31
				5
				VCA AR
				48.544
				.31

1	2	3	4	5
ANTENNA A3, A7, B3, B7	RF SWITCH C3, L3, K3	RF FILTER ASSEMBLY M,N,P,P,NP,R,T,U W	IF CONV AA, AB, AC, DC, DD, DE, DF, AM, AP, AQ, AS, SB	VCA AN
134.039	37.650	1368	1996	48.544
.390	.31	.31	.31	.31
				5
				VCA AR
				48.544
				.31

1	2	3	4	5
ANTENNA A4, A8, B4, B8	RF SWITCH C4, L4, K4	RF FILTER ASSEMBLY M,N,P,P,NP,R,T,U W	IF CONV AA, AB, AC, DC, DD, DE, DF, AM, AP, AQ, AS, SB	VCA AN
134.039	37.650	1368	1996	48.544
.390	.31	.31	.31	.31
				5
				VCA AR
				48.544
				.31

2 OUT OF 4 REQUIRED


6
POWER SUPPLY EA, EB, DZ
13,155
.338
6
POWER SUPPLY EA, EB, DZ
13,155
.338
7
OSCILLATOR AD, AG, AE, DG, DH, DJ
3886
.38
8
CONTROL NQ, Q, S, QS, SS, JS, DN, DP, DS
29,569
44
9
COMMAND & CONTROL FH, FJ, FK, FL, FM, FN, FP
147,630
0.228
10
IF CROSSBAR FF, BB, FG, BM
3353
0.369
17
DIGITIAL RECEIVER BT
7111
.12
DIGITIAL RECEIVER BT
7111
.12
EXTERIOR GROUP
INTERIOR GROUP
6
POWER SUPPLY EA, EB, DZ
13,155
.338
20
RF AMP BIT DET X, Y, Z
2243
38
21
IF CONV BIT DET BD, BE, BF
2243
.38
22
OSC BITE DET AJ, AK, AL, DK, DK, DM
7976
38
23
BITE & CAL GEN. & CONTROL D,E,F,G,H,I,J
4,891
0.313
24
SENSOR DT,DU,DV,DW
17,065
0.338
6
POWER SUPPLY EA, EB, DZ
13,155
.338

2

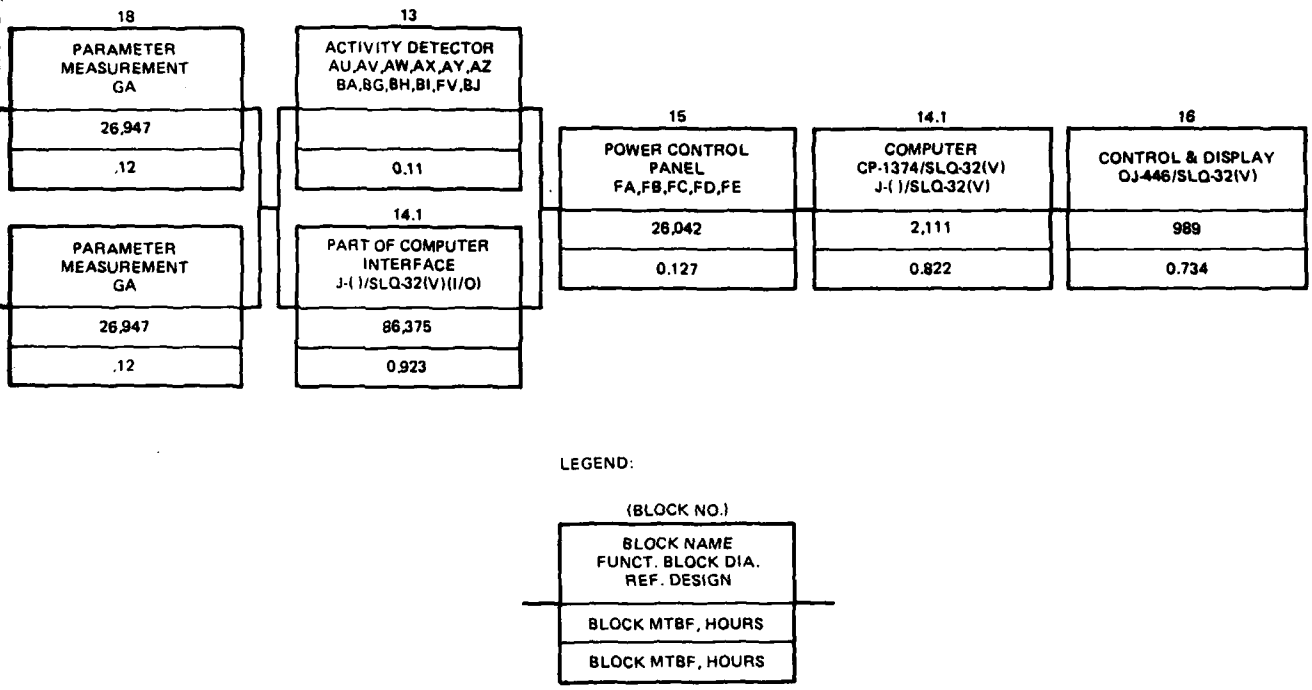
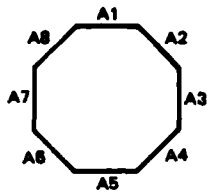


Figure 4-4. Long-range surveillance mode reliability block diagram.

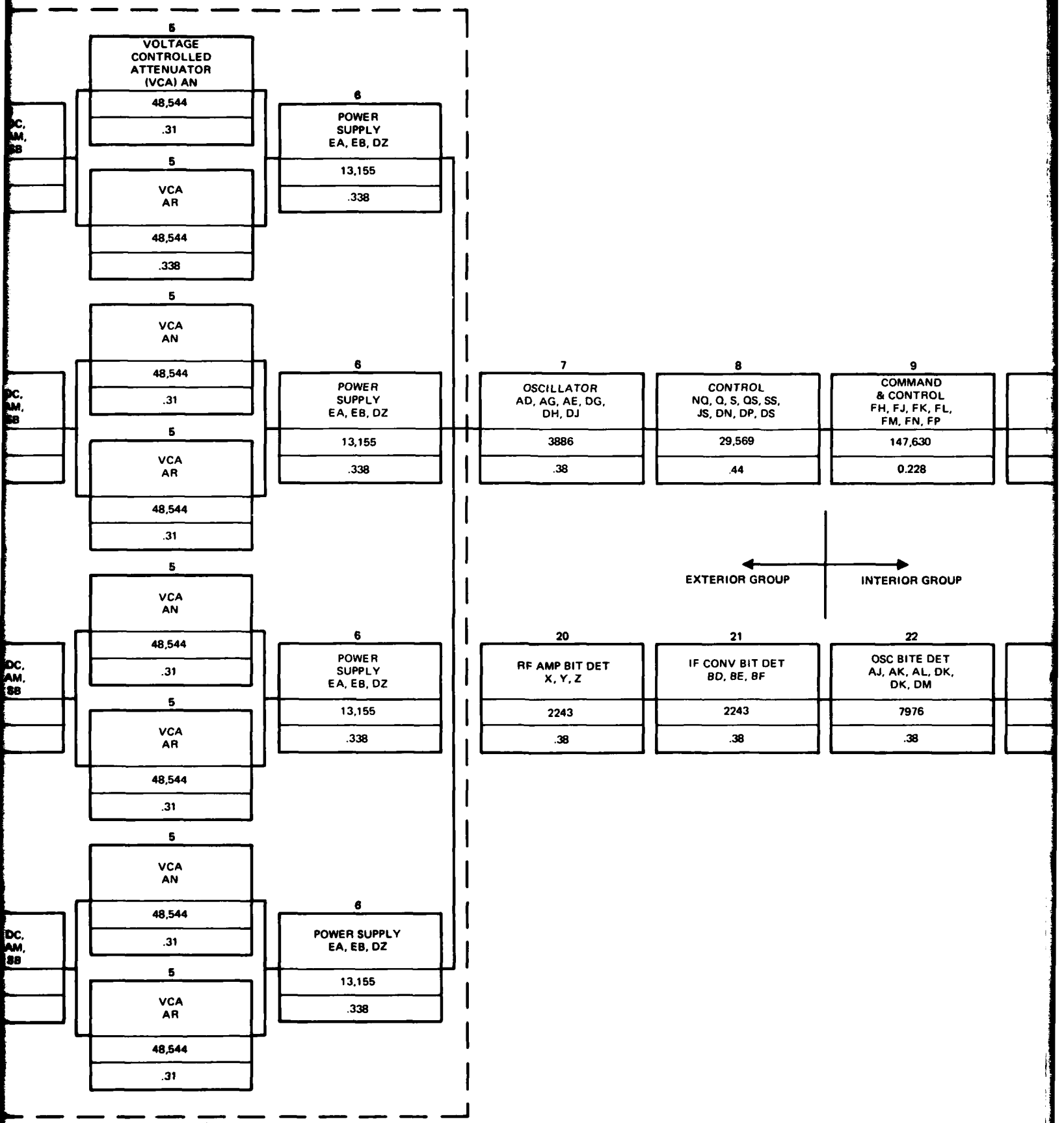


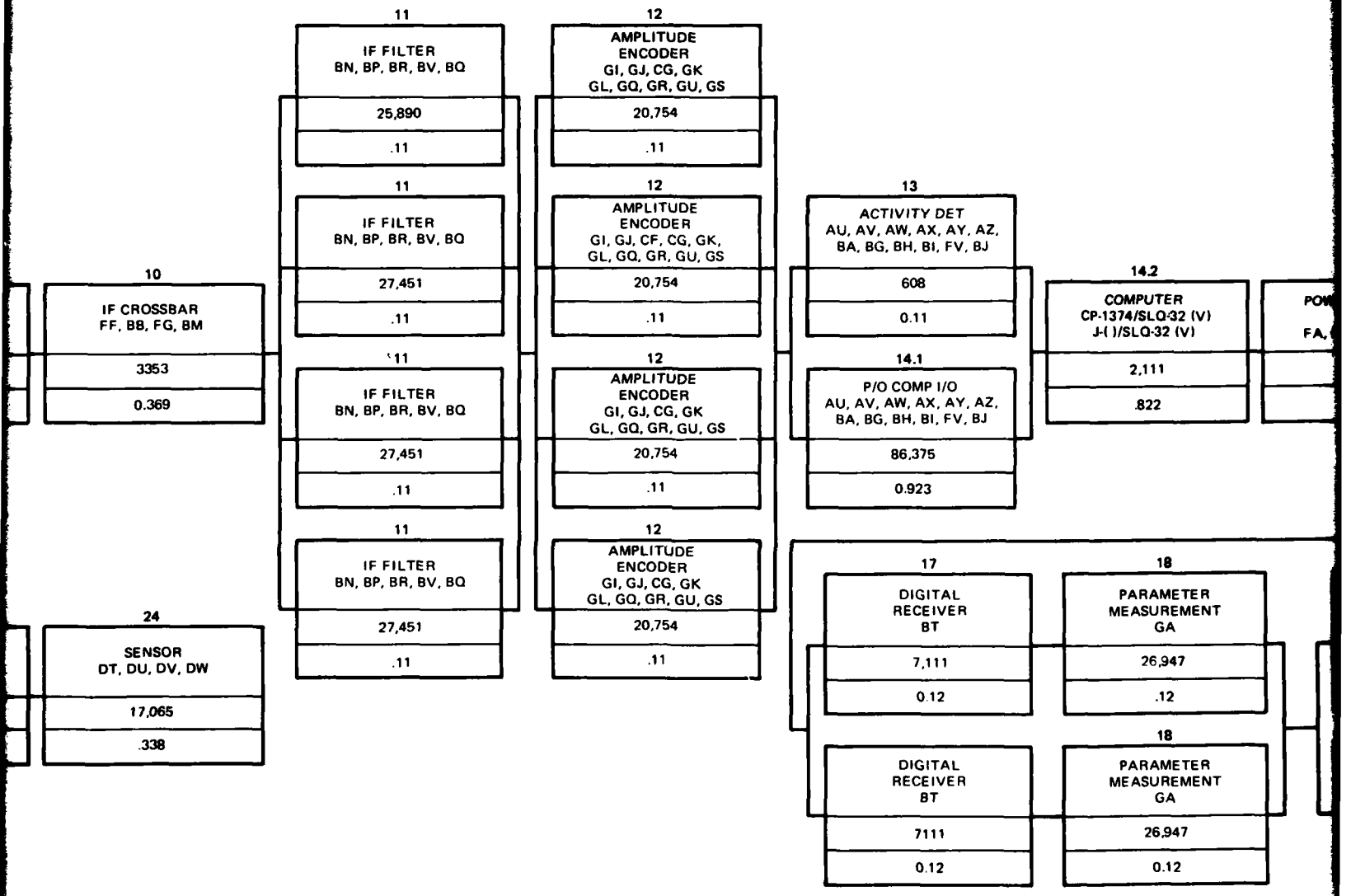
1	2	3.1	3.2	3.3	4
ANTENNA A1, A5, B1, B5	RF SWITCH C1, L1, K1	REFILTER ASSEMBLY M, N, NP, P, W	DIODE SWITCH R, U	AMP T	IF CONV S AA, AB, AC, DC, DD, DE, DF, AM, AP, AQ, AS, SB
134,039	37,650	3968	50,000	45,045	1996
.390	.31	.31	.31	.31	.31

1	2	3.1	3.2	3.3	4
ANTENNA A2, A6, B2, B6	RF SWITCH C2, L2, K2	RF FILTER ASSEMBLY M, N, P, P, NP, W	DIODE SWITCH R, U	AMP T	IF CONV AA, AB, AC, DC, DD, DE, DF, AM, AP, AQ, AS, SB
134,039	37,650	3968	50,000	45,045	1996
.390	.31	.31		.31	.31

1	2	3.1	3.2	3.3	4
ANTENNA A3, A7, B3, B7	RF SWITCH C3, L3, K3	RF FILTER ASSEMBLY M, N, NP, P, W	DIODE SWITCH R, U	AMP T	IF CONV AA, AB, AC, DC, DD, DE, DF, AM, AP, AQ, AS, SB
134,039	37,650	3968	50,000	45,045	1996
.390	.31	.31	.31	.31	.31

1	2	3.1	3.2	3.3	4
ANTENNA A4, A8, B4, B8	RF SWITCH C4, L4, K4	RF FILTER ASSEMBLY M, N, NP, P, W	DIODE SWITCH R, U	AMP T	IF CONV AA, AB, AC, DC, DD, DE, DF, AM, AP, AQ, AS, SB
134,039	37,650	3968	50,000	45,045	1996
.390	.31	.31	.31	.31	.31

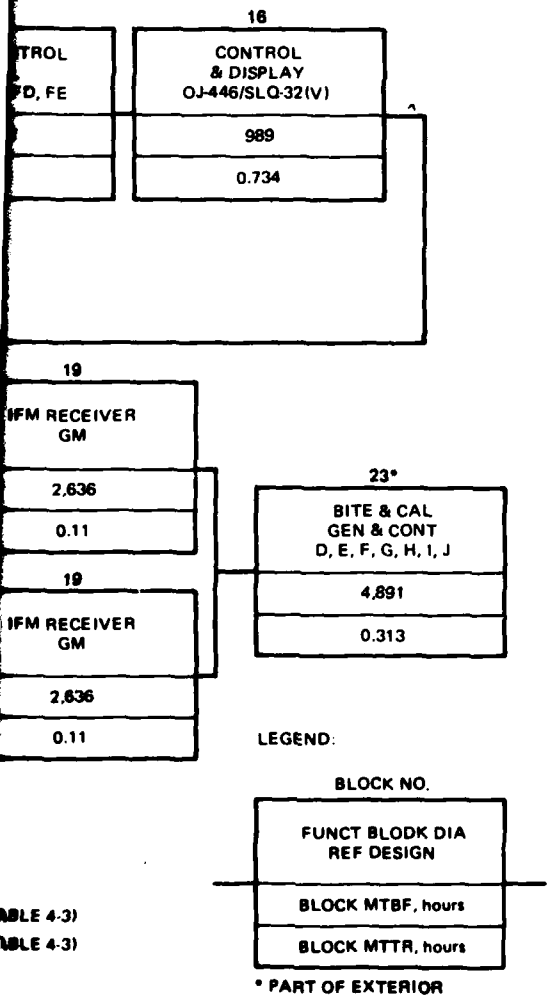

5
VOLTAGE CONTROLLED ATTENUATOR (VCA) AN
48,544
.31
5
VCA AR
48,544
.338
6
POWER SUPPLY EA, EB, DZ
13,155
.338
5
VCA AN
48,544
.31
5
VCA AR
48,544
.31
6
POWER SUPPLY EA, EB, DZ
13,155
.338
5
VCA AN
48,544
.31
5
VCA AR
48,544
.31
6
POWER SUPPLY EA, EB, DZ
13,155
.338
5
VCA AN
48,544
.31
5
VCA AR
48,544
.31
6
POWER SUPPLY EA, EB, DZ
13,155
.338
7
OSCILLATOR AD, AG, AE, DG, DH, DJ
3886
.38
8
CONTROL NQ, Q, S, QS, SS, JS, DN, DP, DS
29,569
.44
9
COMMAND & CONTROL FH, FJ, FK, FL, FM, FN, FP
147,630
0.228
EXTERIOR GROUP
INTERIOR GROUP
20
RF AMP BIT DET X, Y, Z
2243
.38
21
IF CONV BIT DET BD, BE, BF
2243
.38
22
OSC BITE DET AJ, AK, AL, DK, DK, DM
7976
.38



MTBF =
MTTR =

Figure 4-5. Redun

3



BLE 4-3)
BLE 4-3)

hannel reliability block diagram.

5 4

4.2 BASIS FOR MAINTAINABILITY ESTIMATE

A maintainability estimate has been provided by following the guidelines contained in Ref. 4. This document was chosen because of the more recent data it uses as a base and because it supplies a prediction method for the early stages of a program. The same model baseline may be applied in later stages of design to better assess the impact of changes in design. Repair task times, such as assembly, disassembly, and interchange, are taken from the time standards in Ref. 4 or they are postulated via an engineering estimate for the equipment being considered. Appendix B contains the detailed data of the maintainability prediction. Table 4-2 is the summary of the SRU MTTR. The MTTR for the computer, CP-1374/SLQ-32(V) and J-( )/SLQ-32(V), and the control and display, OJ-446/SLQ-32(V), is taken from Ref. 6.

Table 4-2. Summary of Conceptual ESM MTTR (SRU level).

Block* No.	Description	MTTR, hours	Block* No.	Description	MTTR, hours
1	Antenna	0.39	13	Activity Detector	0.11
2	RF Switch	0.31	14.1	Computer Interface	0.923
3	RF Filter Assembly	0.31	14.2	Computer	0.822
3.1	Filter Control Circuitry	0.31	15	Power Control Panel	0.127
3.2	Diode Switch	0.31	16	Control & Display	0.734
3.3	RF Amplifier	0.31	17	Digital Receiver	0.12
4	IF Converter	0.31	18	Parameter Measurement	0.12
5	Voltage-Controlled Attenuator	0.31	19	IFM Receiver	0.11
6	Power Supply	0.338	20	RF Amplifier BITE Detector	0.38
7	Oscillator	0.38	21	IF Amplifier BITE Detector	0.38
8	Control	0.44	22	Oscillator BITE Detector	0.38
9	Command & Control	0.228	23	BITE & Calibration Generator Control	0.313
10	IF Crossbar	0.369	24	Sensor	0.338
11	IF Filter	0.11			
12	Amplitude Encoder	0.11			

*Refer to Figs. 4-1 through 4-5 for block designation

4.3 DEFINITION OF MISSION REQUIREMENTS

Because of the varied installation and operational requirements, the mission requirements for ESM equipment are not fixed. Installation will vary from a small vessel, such as a frigate, to a major combatant, such as a carrier. Operations may vary from as little as 1 or 2 weeks during training, to as long as 1-year deployments for the major combatant class of ships. To best represent this variety of situations, mission times of 30, 90, and 365 days have been used for study.

Regardless of the installation or mission time, the equipment will be on demand (in an energized condition) on a 24-hour basis for the duration of the mission. The four redundant channels provide varying degrees of graceful degradation to each of the three modes of operation defined in Section 3.1 and shown in Table 3-1. The designation "system" means that all three modes of operation are demanded at all times. The designations "DF mode," "Threat-Warning mode," or "Long-Range Surveillance mode" refer to demand of equipment necessary to perform those particular functions.* The equipment reliability and availability, therefore, has been modeled to reflect equipment performance relative to the variation in degree of graceful degradation.

4.4 RESULTS OF AVAILABILITY AND RELIABILITY COMPUTATIONS

The resultant reliability and availability computations are shown in Table 4-3 for a 30-day mission. Figures 4-1 through 4-5 show, respectively, reliability block diagrams for the entire system, the DF mode only, the Threat-Warning mode only, the Long-Range Surveillance mode, and Redundant-Channel configuration. These diagrams and the associated calculations are intended to provide reliability and availability assessment when considering only that portion of the equipment in operation during the mission. For example, the numerics in Table 4-3 associated with the complete "system" consider that all three modes of operation are demanded during the 30-day mission, while "Long-range Surveillance" numerics reflect the equipment necessary to provide that function, the remaining portion of the equipment not being required.

Figure 4-5 is intended to show the equipment reliability configuration in the light of the four-channel redundancy, i.e., without regard to demand of any specific mode(s) of operation. From this diagram, equipment reliability, availability, and performance is assessed as a function of the probability of losing one channel, two channels, and three channels.** The results of computations for all models are presented in Table 4-3 for a 30-day mission. The computations have been derived to show separately the reliability, maintainability, and availability (RMA) numerics for the exterior and the interior equipment groups. The RMA numerics for the combined exterior and interior groups are shown in the "total" columns. Appendix A (Part VII) contains an explanation of the equations used to compute the availability, MTBF, and MTTR values shown in Table 4-3.

Failure rate data of block 3.1 in Figs. 4-1 through 4-5 have been adjusted to exclude certain failures of the YIG notch filter (reference designation P in Fig. 3-5); these are assumed not to affect mission operation.† A functional block level failure modes and effects analysis (FMEA) performed on the filter resulted in an assessed failure rate for the YIG notch filter of 6.3221 failures/million hours.

*Figures 4-1 through 4-5 aid in understanding which components are utilized in each mode.

**Figure 4-1 for the system reflects demand for all channels simultaneously.

†This is based on the assumption that the dominant failure mode is for the YIG to pass all signals and not be able to notch. It also assumes that CW signals strong enough to defeat the system if not notched are not present. The failure mode assumption is based on the concentration of failure probability in tuning-related circuitry. See Section 5.1 for additional discussion.

Table 4-3. Summary of Conceptual ESM Availability.

System-Up Condition	MTBF, hours			MTTR, hours			Availability		
	Exterior	Interior	Total	Exterior	Interior	Total	Exterior	Interior	Total
System (all 4 channels)	217	432	145	0.32	0.58	0.41	0.9985	0.9986	0.9972
3 Channels (Degraded DF)	1860	503	396	0.36	0.65	0.59	0.9998	0.9987	0.9985
2 Channels (DF Failed Long-Range Surveillance & Threat Warning Degraded)	2099	561	442	0.38	0.69	0.63	0.9998	0.9988	0.9986
1 Channel (DF & Long-Range Surveillance Failed)	2100	561	442	0.38	0.69	0.63	0.9998	0.9988	0.9886

5.0 DISCUSSION OF RESULTS

The available computations for the 90- and 365-day missions were the same as for the 30-day mission. Equipment availability, therefore, has reached a steady-state value at 30 days. Availability is relatively high because the predicted repair time is relatively short. The MTTRs for the various system-up conditions shown in Table 4-3 range from 25 to 38 minutes. Short repair times are predicted on the basis of BITE isolation and localization and modularity of the hardware. Clearance to access mast-mounted equipment may vary from a few minutes to several hours, depending upon the ship's operating situation. All repair times exclude this time delay in order to best reflect inherent design features of maintainability. It is unlikely that shorter repair times could be achieved on the exterior equipment unless accessibility (or location) is improved.

The reliability of the exterior group is seen to be lower than that of the interior group for those system operational modes requiring all four channels. The interior group reliability is not seen to change as much as that of the exterior group for the various modes of operation because of the smaller amount of redundancy. Some of the significant contributors to overall failure rate are discussed below.

5.1 HIGH FAILURE RATE CONTRIBUTORS

Among the high contributors to overall failure rate for the exterior group are the RF filter and the IF converter assemblies. From Fig. 4-1, it is seen that the RF filter assembly (*without the amplifier and diode switch*) and the IF converter make up 23% and 33%, respectively, of the entire system failure rate of, respectively, 34 and 44% of the exterior group failure rate. A closer look at the RF filter assembly shows that the YIG tuned notch filter is 20% of the RF filter failure rate. The YIG filter failure rate is based on an FMEA of failures that disable the function (see Appendix A). A further

examination of the filter piece-parts reveals that the driver electronics are the real failure contributors in this component. The driver electronics consist of a PCB with hybrid linear integrated circuits. The failure rate of the internal heater element is not a driving force.

The IF converter failure rate is attributable mainly to the IF amplifier itself – at 35% of the total (less the voltage-controlled attenuators and BITE detectors). The amplifier failure rate used was taken from manufacturer's estimate for a GaAs FET amplifier. MIL Handbook 217B does not provide a specific model for this device, which uses GaAs as the semiconductor material rather than silicon or a metal oxide. The technology of construction is not considered advanced, and the failure rate is probably representative of a medium-power transistor amplifier of about six stages.

Based on manufacturer's information, the RF and the IF amplifiers have been modeled as four- and six-stage amplifiers, respectively, with two FETs in each stage. For 32 of each type of amplifier, a total of 640 devices are represented in the RF and IF amplifiers. An additional 228 devices have been modeled for the activity detector. A total of 868 GaAs FET devices are represented for the entire system at an estimated average failure rate of 5.5×10^{-6} for each device and associated circuitry.

The BITE detector w/amplifiers are significant failure items because of the quantity (73) used. Although their failure does not cause down time, they will require repair. At a predicted individual failure rate of 18.667 failures/million hours, a maximum of one repair every 730 hours of operation would be expected from among the 73 BITE detectors.

The high contributors to failure rate in the interior group are the activity detector and the control and display. The activity detector failure rate derives mainly from GaAs FET amplifiers and detectors. These devices are used to model the detectors, pulse amplifiers, and CW amplifiers that monitor signal activity in the 32 bands. These devices make up approximately 47% of the activity detector failure rate.

The control and display unit, OJ-445/SLQ-32(V), is existing equipment. The significant contributors to its failure rate are the tape transport unit and the cathode ray tube (CRT), contributing 14% and 10%, respectively. The remaining failure rate is distributed among 37 SRAs, mostly PCBs.

5.2 SYSTEM INTEGRATION AND PACKAGING CONSTRAINTS

The system maintainability has been modeled to address primarily the difficulty of repairing mast-mounted equipment. Many of the resulting interface and packaging constraints are due to the requirements of mast-mounted equipment. The major interface elements are:

- A blanking signal against the ship's radars must be provided.
- A semi-rigid cable of approximately 200 ft, containing 32 RF coaxial conductors and 8 power lines with appropriate loss parameters, must be specified.
- The cable, running from belowdecks to the mast-mounted equipment, should either be armored or in a protected containment.
- Existing mast structures must be modified, if required, to accommodate the mast-mounted equipment.
- The location and structure of the mast holding the mast-mounted equipment must allow a repairman access to the entire equipment circumference at any time without hazard, or a special equipment-lowering design must be conceived.

- Redundant primary power must be supplied to the mast-mounted electronics.
- All digital signal inputs and outputs will be specified to be compatible to interface with the computer interface J-( )/SLQ-32(V) I/O.

5.3 HARDWARE REQUIRING ADDITIONAL RESEARCH

Although the system has yet to be developed into an operational model, there are three areas which will require additional research. These are:

1. IF crossbar switch (block BM, Fig. 4-1). To date no switch has been found that fits the exact needs, although preliminary information indicates some manufacturers are able to fabricate the item.

2. The cable connecting the mast-mounted equipment belowdecks requires more definition as to type, losses, location, and problem areas to be encountered.

3. The intermediate-level test equipment to be utilized requires study to determine the applicability of types in use now or being developed by the military. Further, the applicability of standard test equipment interfaces, such as the IEEE 4 88 bus, should be investigated.

Study should also be given to consideration of this architecture for possible application on platforms other than surface ships. Early consideration of such application may result in subsequent cost savings and aid in the standardization effort for the developed equipment.

6.0 RECOMMENDATIONS

The conceptual ESM analyzed under this study has led to a high-performance, high-availability system at the cost of a large amount of hardware and modularized RF assemblies. The complexity of the equipment required to perform the intended function limits the degree of reliability that can be achieved. It is recommended, therefore, that some primary areas be investigated further. The recommendations are:

1. Investigate the potential for reducing the part count by reducing the number of bands or channels without significantly sacrificing performance.

2. Investigate the feasibility and reliability of integrating RF components into "plug-in" type packages and standardizing in the manner of the SEM program.

3. Investigate the availability of microwave devices with higher reliability than commercial or JAN levels.

REFERENCES

1. Electronic Support Measures (ESM) Availability – Problem Assessment, D.H. Marx, et al., NOSC TR 264, March 1978.

2. Report on Availability Study of the AN/WLR-1G and AN/SLQ-32(V) 2 ESM Systems, prepared by Evaluation Research Corporation, NOSC TR 426, Feb. 1979.

3. "Reliability Prediction of Electronic Equipment," MIL-HDBK-217B.

4. Maintainability Prediction and Analysis Study, T.F. Pliska, et al., July 1978, Rome Air Development Center TR-78-169, Final Technical Report.

5. Reliability Prediction Report, CDRL A00N, Raytheon Document No. 061290625, 15 July 1978.

6. Maintainability Analysis and Prediction Report, CDRL NO. A00V, Raytheon Document No. 0612900626, 30 July 1978.

ABBREVIATIONS

ATE	Automatic test equipment
BITE	Built-in test equipment
CCA	Circuit card assembly
CIC	Combat Information Center
CRT	Cathode ray tube
CW	Continuous wave
DAC	Digital-to-analog converter
DC	Direct current
DF	Direction finding
ESM	Electronic Support Measures
FMEA	Failure modes and effects analysis
FMPO	Frequency modulated power oscillator
FR	Failure rate
GaAs FET	Gallium arsenide field effect transistor
IC	Integrated circuit
IF	Intermediate frequency
IFM	Instantaneous frequency measurement
I/O	Input/output
JAN	Joint Army-Navy
LO	Local oscillator
LP	*Limiter protected*
MTBF	Mean-time-between-failure
MTTR	Mean-time-to-repair
N_S	Naval sheltered environment
PCB	Printed circuit board
PMS	Planned maintenance system
PRI	Pulse repetition interval
RF	Radio frequency
RI	Repairable item
RMA	Reliability-maintainability-availability
SEM	Standard electronic module
SPDT	Single pole, double throw
SPST	Single pole, single throw
SRA	Ship-replaceable assembly
SRU	Ship-replaceable unit
TTL	Transistor-transistor logic
YIG	Ytrium-iron-garnet

APPENDIX A
PART I – RELIABILITY PREDICTION UNDERLYING METHODOLOGY

AVAILABILITY, MTBF, AND MTTR COMPUTATIONS

Availability has been determined by assuming an exponential distribution for both reliability and repair time and using the basic equation,*

$$A_i = \frac{\mu_i + \lambda_i \exp\left[-(\mu_i + \lambda_i)t\right]}{\mu_i + \lambda_i} \tag{A-1}$$

where

A = Instantaneous Availability of i^{th} block.
$1/\mu_i$ = Repair Time of i^{th} block in hours.
λ_i = Failure rate of i^{th} block in hours.
t = Time in hours.

The availability of several blocks connected in series in a reliability block diagram was determined by,

$$A_s = \prod_{i=1}^{n} A_i \tag{A-2}$$

and, the equivalent failure rate and repair rate was determined by,

$$\lambda_s = \sum_{i=1}^{n} \lambda_i \tag{A-3}$$

and

$$\mu_s = \left(\frac{A_s}{1 - A_s}\right) \sum_{i=1}^{n} \frac{(1 - A_i)\,\mu_i}{A_i} \tag{A-4}$$

where

λ_s = equivalent failure rate for the series blocks
$1/\mu_s$ = equivalent repair time for the series blocks.

For the parallel blocks, where one of two is required, λ and μ were determined by,

$$\lambda_E = \frac{\lambda_1 \cdot a \cdot a' + \lambda_2 \cdot b \cdot b'}{A} \tag{A-5}$$

and

$$\mu_E = \mu_1 + \mu_2 \tag{A-6}$$

*Derivation of this equation is provided in Part VII of this appendix.

where

$$a = 1 - \frac{\mu_2 + \lambda_2 e^{-a't}}{a'} \quad \text{(A-7)}$$

$$b = 1 - \frac{\mu_1 + \lambda_1 e^{-b't}}{b'} \quad \text{(A-8)}$$

$$a' = \mu_2 + \lambda_2 \quad \text{(A-9)}$$

$$b' = \mu_1 + \lambda_1 \quad \text{(A-10)}$$

$$A = 1 - (a)(b) \quad \text{(A-11)}$$

For the parallel blocks of four, where at least three out of four are required and the blocks are identical,

$$A = a^4 + 4a^3(1 - a)$$

$$\mu_E = \frac{(4\mu)(1 - a)^4 + 4(3\mu)(1 - a)^3 (a) + (2\mu)\, 6(1 - a)^2 a^2}{1 - A}$$

$$\lambda_E = \frac{\mu_E(1 - A)}{A}$$

where

$$a = \frac{\mu_i + \lambda_i \exp\left[-(\mu_i + \lambda_i)t\right]}{\mu_i + \lambda_i}$$

$$\lambda = \lambda_i$$

$$\mu = \mu_i$$

Similarly for the condition of at least two out of four required,

$$A = a^4 + 4a^3(1 - a) + 6a^2(1 - a)^2$$

$$\mu_E = \frac{4\mu(1 - a)^4 + (3)\, 4(1 - a)^3 a}{1 - A}$$

$$\lambda_E = \frac{\mu_E(1 - A)}{A}$$

and for at least one out of four required,

$$A = a^4 + 4a^3(1 - a) + 6a^2(1 - a)^2 + 4a(1 - a)^3$$

$$\mu_E = \frac{4(1 - a)}{1 - A}$$

$$\lambda_E = \frac{M_{E(1 - A)}}{A}$$

Values of failure rate (λ) are taken from the prediction in this appendix. The assembly number and failure rates shown in the prediction correspond to the blocks defined in the reliability block diagrams, Figs. 4-1 through 4-5. The lettered reference designations shown in the blocks of the reliability block diagrams correspond to the lettered items in the functional block diagram, Fig. 3-4.

APPENDIX A

PART II – SOURCE DATA FOR ENGINEERING ESTIMATES OF RELIABILITY PREDICTION

ADJUSTMENT OF YIG NOTCH FILTER FAILURE RATE

The failure rate of the YIG notch filter was adjusted to exclude failures of the filter that do not affect mission operation. This adjustment was made based on the low probability that interference is present.

Figure A-1 presents a functional block diagram of the filter. A breakdown of the failure rates for the blocks is contained in this appendix. The failure modes and effect analysis is shown in Table A-1. Failure rate for loss of RF output is negligible compared with those of the other two failure modes shown in Table A-1 and summarized below; therefore it is not considered for this analysis. The failure mode "continuous filtering at one frequency" will always affect mission operation at that particular frequency. It was assumed for this analysis that the probability of an emitter of interest at the failed frequency is 0. The failure mode "loss of filtering" will affect mission operation only when signals reaching the antenna are being masked by strong interference. The probability of the presence of strong interference was assumed to be 0.1. The adjusted rate then is

Status	Initial FR	Conditional Probability	Adjusted FR
1. Loss of RF Output	negligible	–	0.0
2. Loss of Filtering	19.206×10^{-6}	0.1	1.9106×10^{-6}
3. Continuous Filtering at One Frequency	4.4015×10^{-6}	1.0	4.4015×10^{-6}
		Total	6.3221×10^{-6}

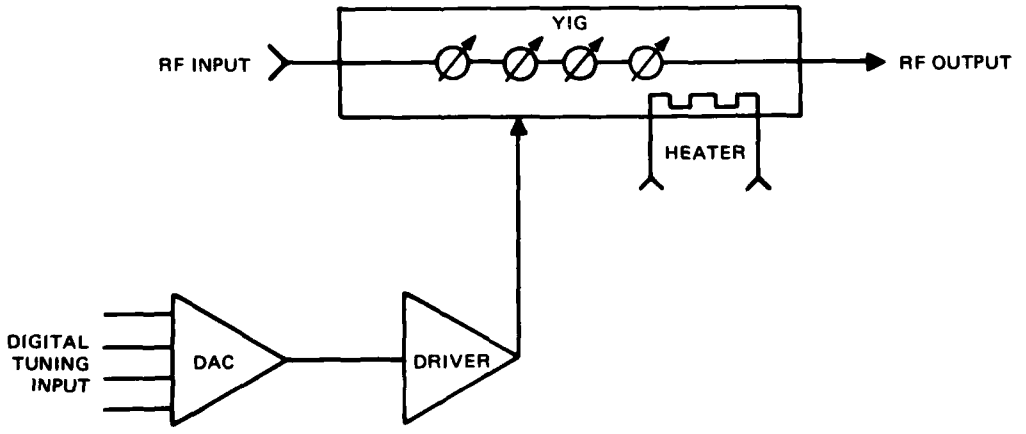


Figure A-1. YIG notch filter block diagram.

Table A-1. YIG Notch Filter Failure Modes and Effects Analysis.

Block Location On Diagram	Block Failure Mode	Effect on Equipment Performance	Failure Rate $\times 10^{-6}$
YIG	Open	Loss of RF Output	Negligible (<0.1)
	Loss of Filtering	Loss of Filtering	1.6
DRIVER	No Output	Loss of Filtering	17.895 X 80%*
	Continuous Output	Continuous RF Filtering at One Frequency	17.895 X 20%*
DAC	No Output	Loss of Filtering	4.1125 X 80%*
	Continuous Output	Continuous RF Filtering at One Frequency	4.1125 X 20%*
	Totals:	1. Loss of RF Output	Negligible
		2. Loss of Filtering	19.206
		3. Continuous Filtering at One Frequency	4.4015

*Percentages are estimated probability of failure mode.

APPENDIX A
PART III – PIECE-PART FAILURE RATE LISTINGS

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 1

PROJECT: FSM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: FINE SECTOR ENCODER 3A3 ASSEMBLY TEMP: 65.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
CAP, CERAMIC, CK 125C	11015	33.0	20.	65.	QUALITY LEVEL	MIL	.10789	3.56033	E	4.00
									Q	10.0
CAP, SOLID TANT, CSR	39003	7.0	50.	65.	QUALITY LEVEL	L	.00675	.04727	E	4.00
					SERIES R	3.000			Q	1.50
									SR	7.000E-02
IND, RF COIL, CLASS O	15305	7.0	N/A	65.	QUALITY LEVEL	LOWER	.43841	3.06884	E	5.00
									F	30.0
CONN, PWR, TYPE B	21097	.5	N/A	65.	QUALITY LEVEL	LOWER	2.25856	1.12928	E	12.0
					ACTIVE CONTACTS	47			P	8.85
					CONTACT GAUGE	20			N	47.0
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				
RES, INSULATED FIXED COMP, RCR	39008	36.0	20.	65.	QUALITY LEVEL	S	.00014	.00502	E	5.00
					VALUE	1.000E 05			Q	3.000E-02
									R	1.00
RES, INSULATED FIXED FILM, RN	10509	21.0	10.	65.	QUALITY LEVEL	MIL	.01658	.34828	E	7.50
					VALUE	1.000E 05			Q	1.00
									R	1.00
RES, LEAD SCREW VAR WW, RT	27208	2.0	20.	65.	QUALITY LEVEL	MIL	.58857	1.17714	E	7.00
					VALUE	5.000E 01			Q	5.00
					VOLTAGE RATIO	.500			R	1.00
									V	1.00

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: FINE SECTOR ENCODER 3A3 ASSEMBLY TEMP: 65.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR SE527K	883	8.0	N/A	65.	QUALITY LEVEL	B-1	.36603	2.92825	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	23			L	1.00
									T2	2.52
									C1	6.126E-03
									C2	1.445E-02
IC, BIPOLAR LINEAR LM0033CG	883	2.0	N/A	65.	QUALITY LEVEL	B-1	.31663	.63325	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	18			L	1.00
									T2	2.52
									C1	5.081E-03
									C2	1.264E-02
IC, BIPOLAR DIGITAL SSI/MSI SN74LS86J	883	2.0	N/A	65.	QUALITY LEVEL	B-1	.13904	.27808	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	4			T1	.671
									C1	3.297E-03
									C2	6.399E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI SN74LS174J	883	2.0	N/A	65.	QUALITY LEVEL	B-1	.33062	.66123	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	36			T1	.671
									C1	1.460E-02
									C2	1.408E-02
									P	1.00

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: FINE SECTOR ENCODER 3A3 ASSEMBLY TEMP: 65.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR DIGITAL SSI/MSI 9318DC	883	1.0	N/A	65.	QUALITY LEVEL	B-1	.28071	.28071	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	24			T1	.671
									C1	1.109E-02
									C2	1.217E-02
									P	1.00

TOTAL QUANTITY EQUALS 121.5 PIECE PARTS

TOTAL FAILURE RATE EQUALS 14.11768 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 70833.1 HOURS

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: ABS. VALUE AMP 3A1 ASSEMBLY TEMP: 65.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
CAP, CERAMIC, CK 125C	11015	19.0	20.	65.	QUALITY LEVEL	MIL	.10789	2.04989	E	4.00
									Q	10.0
CAP, SOLID TANT, CSR	39003	14.0	50.	65.	QUALITY LEVEL	L	.00675	.09455	E	4.00
					SERIES R	3.000			Q	1.50
									SR	7.000E-02
DIODE, GENERAL PURPOSE, SI 1N4153	19500	6.0	20.	65.	QUALITY LEVEL	JAN	.48694	2.92165	E	25.0
					CONSTRUCTION	NON			Q	5.00
					APPLICATION	SIG			A	1.00
					VOLTAGE RATIO	.200			C	2.00
					RATED POWER	.500			S2	.700
									R	1.00
IND, RF COIL, CLASS 0	15305	11.0	N/A	65.	QUALITY LEVEL	LOWER	.43841	4.82246	E	5.00
									F	30.0
CONN, PWB, TYPE B	21097	.5	N/A	65.	QUALITY LEVEL	LOWER	2.25856	1.12928	E	12.0
					ACTIVE CONTACTS	47			P	8.85
					CONTACT GAUGE	20			N	47.0
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				
TRANSISTOR, NPN, SI 2N2916A	19500	3.0	20.	65.	QUALITY LEVEL	JAN	.22848	.68543	E	25.0
					COMPLEXITY	DMA			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.20
					RATED POWER	1.000			S2	.300
									R	1.00

PROJECT: FSM FSM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: ABS. VALUE AMP 3A1 ASSEMBLY TEMP: 65.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
TRANSISTOR, NPN, SI MD2369A	19500	2.0	20.	65.	QUALITY LEVEL	JAN	.22848	.45695	E	25.0
					COMPLEXITY	DMA			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.20
					RATED POWER	1.000			S2	.300
									R	1.00
TRANSISTOR, NPN, SI 2N2369A	19500	2.0	20.	65.	QUALITY LEVEL	JAN	.19040	.38079	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	.360			S2	.300
									R	1.00
TRANSISTOR, PNP, SI 2N3811A	19500	1.0	20.	65.	QUALITY LEVEL	JAN	.35371	.35371	E	25.0
					COMPLEXITY	DMA			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.20
					RATED POWER	1.000			S2	.300
									R	1.00
RES, INSULATED FIXED FILM, RN	10509	24.0	10.	65.	QUALITY LEVEL	MIL	.01658	.39804	E	7.50
					VALUE	1.000E 05			Q	1.00
									R	1.00
RES, INSULATED FIXED COMP, RCR	39008	41.0	20.	65.	QUALITY LEVEL	S	.00014	.00571	E	5.00
					VALUE	1.000E 05			Q	3.000E-02
									R	1.00

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: ABS. VALUE AMP 3A1 ASSEMBLY TEMP: 65.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR LH0033CG	883	2.0	N/A	65.	QUALITY LEVEL	B-1	.31663	.63325	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	18			L	1.00
									T2	2.52
									C1	5.081E-03
									C2	1.264E-02
IC, BIPOLAR LINEAR SE527K	883	3.0	N/A	65.	QUALITY LEVEL	B-1	.36603	1.09809	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	23			L	1.00
									T2	2.52
									C1	6.126E-03
									C2	1.445E-02
PWB, TWO-SIDED BOARDS	55110	1.0	N/A	65.	PLATED HOLES	350	.00840	.00840	E	4.00

TOTAL QUANTITY EQUALS 129.5 PIECE PARTS

TOTAL FAILURE RATE EQUALS 15.03820 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 66497.3 HOURS

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: DGTL CONTROL CARD 1A2 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
CAP, CERAMIC, CK 125C	11015	10.0	20.	75.	QUALITY LEVEL	MIL	.11063	1.10634	E	4.00
									Q	10.0
CAP, SOLID TANT, CSR	39003	1.0	50.	75.	QUALITY LEVEL	L	.00808	.00808	E	4.00
					SERIES R	3.000			Q	1.50
									SR	7.000E-02
CONN, PWR, TYPE B	21097	.5	N/A	75.	QUALITY LEVEL	LOWER	2.19387	1.09694	E	12.0
					ACTIVE CONTACTS	37			P	6.84
					CONTACT GAUGE	20			N	37.0
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				
CONN, PWR, TYPE B	21097	.5	N/A	75.	QUALITY LEVEL	LOWER	1.05098	.52549	E	12.0
					ACTIVE CONTACTS	15			P	3.28
					CONTACT GAUGE	20			N	15.0
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				
CONN, RF COAXIAL, TYPE C	39012	.5	N/A	75.	QUALITY LEVEL	LOWER	5.56609	2.78305	E	36.0
					ACTIVE CONTACTS	1			P	1.00
					CONTACT GAUGE	22			N	1.00
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				
IND, POWER, CLASS Q	27	2.0	N/A	75.	QUALITY LEVEL	LOWER	.70283	1.40566	E	5.00
									F	20.0

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 A

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: DGTL CONTROL CARD 1A2 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
TRANSISTOR, PNP, SI 2N2907	19500	1.0	20.	75.	QUALITY LEVEL	JAN	.15564	.15564	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LOG			A	.700
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	.400			S2	.300
									R	1.00
RES, INSULATED FIXED FILM, RN	10509	2.0	10.	75.	QUALITY LEVEL	MIL	.01818	.03635	E	7.50
					VALUE	1.000E 04			Q	1.00
									R	1.00
RESISTOR, NONWIREWOUND TRIMMER	22097	2.0	20.	75.	SOURCE	RJ	1.66834	3.33668	E	8.00
					MULTIPLIER	.300			Q	1.00
					QUALITY LEVEL	UPPER			R	1.00
					VALUE	2.000E 04			V	1.00
					VOLTAGE RATIO	.500			TAP	1.00
					TAPS	3				
RES, INSULATED FIXED COMP, RCR	39008	25.0	20.	75.	QUALITY LEVEL	S	.00020	.00500	E	5.00
					VALUE	1.000E 04			Q	3.000E-02
									R	1.00
IC, BIPOLAR DIGITAL SSI/MSI 93L14	883	4.0	N/A	75.	QUALITY LEVEL	B-1	.30460	1.21839	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	25			T1	1.01
									C1	1.140E-02
									C2	1.235E-02
									P	1.00

PROJECT: FSM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: DGTL CONTROL CARD 1A2 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR DIGITAL SSI/MSI 93L24	883	2.0	N/A	75.	QUALITY LEVEL	B-1	.35103	.70207	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	35			T1	1.01
									C1	1.432E-02
									C2	1.394E-02
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 7438	883	2.0	N/A	75.	QUALITY LEVEL	B-1	.14461	.28921	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	4			T1	1.01
									C1	3.297E-03
									C2	6.399E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 74L02	883	2.0	N/A	75.	QUALITY LEVEL	B-1	.14461	.28921	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	4			T1	1.01
									C1	3.297E-03
									C2	6.399E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 74L00	883	1.0	N/A	75.	QUALITY LEVEL	B-1	.14461	.14461	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	4			T1	1.01
									C1	3.297E-03
									C2	6.399E-03
									P	1.00

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: DGTL CONTROL CARD 1A2 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR DIGITAL SSI/MSI 7404	883	1.0	N/A	75.	QUALITY LEVEL	B-1	.16991	.16991	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	6			T1	1.01
									C1	4.339E-03
									C2	7.401E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 96L02	883	1.0	N/A	75.	QUALITY LEVEL	B-1	.28875	.28875	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	22			T1	1.01
									C1	1.046E-02
									C2	1.180E-02
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 74L74	883	1.0	N/A	75.	QUALITY LEVEL	B-1	.22484	.22484	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	12			T1	1.01
									C1	6.937E-03
									C2	9.492E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI FMI9525C	883	1.0	N/A	75.	QUALITY LEVEL	B-1	.53630	.53630	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	24			L	1.00
					GATES	75			T1	1.01
									C1	2.399E-02
									C2	1.833E-02
									P	1.10

PROJECT: FSM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: DGTL CONTROL CARD 1A2 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR LM747	883	1.0	N/A	75.	QUALITY LEVEL	B-1	1.02988	1.02988	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	88			L	1.00
									T2	5.02
									C1	1.705E-02
									C2	3.010E-02
DIODE, ZENER / AVALANCHE 1N748	19500	1.0	10.	75.	QUALITY LEVEL	JAN	.58167	.58167	E	25.0
					APPLICATION	REG			Q	5.00
									A	1.00

TOTAL QUANTITY EQUALS 61.5 PIECE PARTS

TOTAL FAILURE RATE EQUALS 15.93406 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 62758.6 HOURS

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: CHASSIS PARTS 1A1 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
FUSE	N/A	1.0	N/A	75.			.10000	.10000		
FILTER	N/A	4.0	20.	75.	SOURCE	CK125	.22127	.88507	E	4.00
					MULTIPLIER	2.000			Q	10.0
					QUALITY LEVEL	MIL				
CONN, CIRCULAR CABLE, TYPE B	26482	.5	N/A	75.	QUALITY LEVEL	LOWER	2.19387	1.09694	E	12.0
					ACTIVE CONTACTS	37			P	6.84
					CONTACT GAUGE	20			N	37.0
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				
CONN, CIRCULAR CABLE, TYPE B	26482	.5	N/A	75.	QUALITY LEVEL	LOWER	.49752	.24876	E	12.0
					ACTIVE CONTACTS	3			P	1.55
					CONTACT GAUGE	20			N	3.00
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				
CONN, RF COAXIAL, TYPE C	39012	2.5	N/A	75.	QUALITY LEVEL	LOWER	5.56609	13.91523	E	36.0
					ACTIVE CONTACTS	1			P	1.00
					CONTACT GAUGE	22			N	1.00
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				
POWER SUPPLY	N/A	1.0	N/A	75.	SOURCE	ENG. EST.	25.00000	25.00000		
					SEE ACCOMPANYING REPORT					
SWITCH, POWER	N/A	1.0	N/A	75.	SOURCE	MIL-HDBK-217B	.90000	.90000		
					SEE ACCOMPANYING REPORT					

PROJECT: FSM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: CHASSIS PARTS 1A1 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR 629162-001	883	1.0	N/A	75.	QUALITY LEVEL	R-1	.52241	.52241	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	30			L	1.00
									T2	5.02
									C1	7.503E-03
									C2	1.671E-02
DIRECTIONAL COUPLER	N/A	1.0	N/A	75.			.01000	.01000		
FILTER	N/A	1.0	20.	75.	SOURCE	CK125	.22127	.22127	E	4.00
					MULTIPLIER	2.000			Q	10.0
					QUALITY LEVEL	MIL				

TOTAL QUANTITY EQUALS 13.5 PIECE PARTS

TOTAL FAILURE RATE EQUALS 42.89966 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 23310.2 HOURS

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: YIG DRIVER CARD 2A3 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR 101A	883	2.0	N/A	75.	QUALITY LEVEL	B-1	.41833	.83666	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	21			L	1.00
									T2	5.02
									C1	5.715E-03
									C2	1.375E-02
IC, BIPOLAR LINEAR 741	883	1.0	N/A	75.	QUALITY LEVEL	B-1	.44266	.44266	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	23			L	1.00
									T2	5.02
									C1	6.126E-03
									C2	1.445E-02
CAP, CERAMIC, CK 125C	11015	8.0	20.	75.	QUALITY LEVEL	MIL	.11063	.88507	E	4.00
									Q	10.0
CAP, MICA, CM	5	1.0	20.	75.	QUALITY LEVEL	MIL	.02773	.02773	E	6.00
					STYLE	DIPPED			Q	5.00
DIODE, GENERAL PURPOSE, SI IN461	19500	4.0	20.	75.	QUALITY LEVEL	JAN	.57855	2.31419	E	25.0
					CONSTRUCTION	NON			Q	5.00
					APPLICATION	SIG			A	1.00
					VOLTAGE RATIO	.200			C	2.00
					RATED POWER	1.000			S2	.700
									R	1.00

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: YIG DRIVER CARD 2A3 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
TRANSISTOR, NPN, SI 2N2222A	19500	2.0	20.	75.	QUALITY LEVEL	JAN	.21399	.42799	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	.500			S2	.300
									R	1.00
TRANSISTOR, PNP, SI 2N2907	19500	1.0	20.	75.	QUALITY LEVEL	JAN	.33352	.33352	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	.400			S2	.300
									R	1.00
RES, LEAD SCREW VAR WW, RT	27208	3.0	20.	75.	QUALITY LEVEL	MIL	.66698	2.00095	E	7.00
					VALUE	2.000E 03			Q	5.00
					VOLTAGE RATIO	.500			R	1.00
									V	1.00
RES, ACCURATE FIXED WW, RB	93	5.0	10.	75.	QUALITY LEVEL	MIL	.37914	1.89571	E	18.0
					VALUE	1.000E 04			Q	5.00
									R	1.00
RES, INSULATED FIXED COMP, RCR	39008	13.0	20.	75.	QUALITY LEVEL	S	.00020	.00260	E	5.00
					VALUE	1.000E 05			Q	3.000E-02
									R	1.00
RES, INSULATED FIXED FILM, RN	10509	3.0	10.	75.	QUALITY LEVEL	MIL	.01818	.05453	E	7.50
					VALUE	1.000E 03			Q	1.00
									R	1.00

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: YIG DRIVER CARD 2A3 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
RES, THERMISTOR, RTH	2364A	1.0	N/A	75.	STYLE	BEAD	.30000	.30000		
DIODE, ZENER / AVALANCHE 1N829A	19500	1.0	40.	75.	QUALITY LEVEL	JAN	1.38279	1.38279	E	25.0
					APPLICATION	REF			Q	5.00
									A	1.50
DIODE, ZENER / AVALANCHE UZ4743	19500	1.0	40.	75.	QUALITY LEVEL	JAN	.92186	.92186	E	25.0
					APPLICATION	REG			Q	5.00
									A	1.00
PWB, TWO-SIDED BOARDS	55110	1.0	N/A	75.	PLATED HOLES	150	.00360	.00360	E	4.00
CONN, PWR, TYPE B	21097	.5	N/A	75.	QUALITY LEVEL	LOWER	1.05098	.52549	E	12.0
					ACTIVE CONTACTS	15			P	3.28
					CONTACT GAUGE	20			N	15.0
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				

TOTAL QUANTITY EQUALS 47.5 PIECE PARTS

TOTAL FAILURE RATE EQUALS 12.35535 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 80936.5 HOURS

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: ANALOG SHAPER CARD 2A4 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR 101A	883	2.0	N/A	75.	QUALITY LEVEL	B-1	.41833	.83666	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	21			L	1.00
									T2	5.02
									C1	5.715E-03
									C2	1.375E-02
IC, BIPOLAR LINEAR 4136	883	1.0	N/A	75.	QUALITY LEVEL	B-1	1.02988	1.0298B	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	8B			L	1.00
									T2	5.02
									C1	1.705E-02
									C2	3.010E-02
CAP, MICA, CM	5	2.0	20.	75.	QUALITY LEVEL	MIL	.02773	.05545	E	6.00
					STYLE	DIPPED			Q	5.00
CAP, CERAMIC, CK 125C	11015	2.0	20.	75.	QUALITY LEVEL	MIL	.11063	.22127	E	4.00
									Q	10.0
DIODE, GENERAL PURPOSE, SI 1N914	19500	1.0	20.	75.	QUALITY LEVEL	JAN	.57855	.57855	E	25.0
					CONSTRUCTION	NON			Q	5.00
					APPLICATION	SIG			A	1.00
					VOLTAGE RATIO	.200			C	2.00
					RATED POWER	.150			S2	.700
									R	1.00

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: ANALOG SHAPER CARD 2A4 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
TRANSISTOR, NPN, SI 2N2223A	19500	2.0	20.	75.	QUALITY LEVEL	JAN	.21399	.42799	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	.500			S2	.300
									R	1.00
TRANSISTOR, NPN, SI 2N2219	19500	1.0	20.	75.	QUALITY LEVEL	JAN	.21399	.21399	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	.500			S2	.300
									R	1.00
RES, ACCURATE FIXED WW, RR	93	4.0	10.	75.	QUALITY LEVEL	MIL	.37914	1.51657	E	18.0
					VALUE	1.000E 04			Q	5.00
									R	1.00
RES, INSULATED FIXED COMP, RCR	39008	19.0	20.	75.	QUALITY LEVEL	S	.00020	.00380	E	5.00
					VALUE	1.000E 05			Q	3.000E-02
									R	1.00
RES, LEAD SCREW VAR WW, RT	27208	9.0	20.	75.	QUALITY LEVEL	MIL	1.33397	12.00570	E	7.00
					VALUE	2.000E 04			Q	5.00
					VOLTAGE RATIO	.500			R	2.00
									V	1.00
RES, INSULATED FIXED FILM, RN	10509	9.0	10.	75.	QUALITY LEVEL	MIL	.01818	.16358	E	7.50
					VALUE	1.000E 05			Q	1.00
									R	1.00

PROJECT: FSM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: ANALOG SHAPER CARD 2A4 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
RESISTOR, NONWIREWOUND TRIMMER	22097	1.0	20.	75.	SOURCE	RJ	1.66834	1.66834	E	8.00
					MULTIPLIER	.300			Q	1.00
					QUALITY LEVEL	UPPER			R	1.00
					VALUE	5.000E 01			V	1.00
					VOLTAGE RATIO	.500			TAP	1.00
					TAPS	3				

TOTAL QUANTITY EQUALS 53.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 18.72176 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 53413.8 HOURS

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: CHASSIS PARTS 2A1 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
OSC., YIG FILTER	N/A	1.0	N/A	75.	SOURCE SEE ACCOMPANYING REPORT	ENG.EST.	10.00000	10.00000		
CONVERTER	N/A	1.0	N/A	75.	SOURCE SEE ACCOMPANYING REPORT	ENG.EST.	10.00000	10.00000		
CONN, RF COAXIAL, TYPE C (NOTE 1)	39012	1.0	N/A	75.	QUALITY LEVEL ACTIVE CONTACTS CONTACT GAUGE CONTACT CURRENT CYCLING RATE	LOWER 1 22 .010 1	5.56609	5.56609	E P N CYC	36.0 1.00 1.00 .000
RES, INSULATED FIXED COMP, RCR (NOTE 1)	39008	1.0	20.	75.	QUALITY LEVEL VALUE	S 5.000E 01	.00020	.00020	E Q R	5.00 3.000E-02 1.00
FERRITE ISOLATOR	N/A	1.0	N/A	75.			20.00000	20.00000		
CAP, CERAMIC, CK 125C	11015	1.0	20.	75.	QUALITY LEVEL	MIL	.11063	.11063	E Q	4.00 10.0
FUSE	N/A	1.0	N/A	75.			.10000	.10000		
TRANSISTOR, NPN, SI 2N5976	19500	1.0	20.	75.	QUALITY LEVEL COMPLEXITY APPLICATION VOLTAGE RATIO RATED POWER	JAN SIN RFL .200 75.000	3.56658	3.56658	E Q A C S2 R	25.0 2.00 5.00 1.00 .300 5.00

PROJECT: FSM FSM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: CHASSIS PARTS 2A1 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
RES, PWR FXD WW CHAS MOUNT, RE	18546	1.0	40.	75.	QUALITY LEVEL	MIL	.68437	.68437	E	7.00
					STYLE	60N			Q	5.00
					VALUE	3.000E 00			R	1.00
RES, PWR FXD WW CHAS MOUNT, RE	18546	1.0	40.	75.	QUALITY LEVEL	MIL	.68437	.68437	E	7.00
					STYLE	60N			Q	5.00
					VALUE	2.000E 01			R	1.00
RES, INSULATED FIXED COMP, RCR	3900A	3.0	20.	75.	QUALITY LEVEL	S	.00020	.00060	E	5.00
					VALUE	1.000E 05			Q	3.000E-02
									R	1.00

TOTAL QUANTITY EQUALS 13.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 50.71284 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 19718.9 HOURS

NOTES
1 THESE PARTS MAKE UP THE TERMINATION.

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: CHASSIS PARTS X1 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IND, POWER, CLASS Q (NOTE 3)	27	1.0	N/A	75.	QUALITY LEVEL	LOWER	.70283	.70283	E F	5.00 20.0
CONN, RF COAXIAL, TYPE C	39012	5.0	N/A	75.	QUALITY LEVEL ACTIVE CONTACTS CONTACT GAUGE CONTACT CURRENT CYCLING RATE	LOWER 1 22 .010 1	5.56609	27.83046	E P N CYC	36.0 1.00 1.00 .000
DIRECTIONAL COUPLER	N/A	3.0	N/A	75.			.01000	.03000		
DISCRIMINATOR	N/A	2.0	N/A	75.	SOURCE SEE ACCOMPANYING REPORT	ENG, EST.	5.00000	10.00000		
RES, ACCURATE FIXED WW, RR	93	2.0	10.	75.	QUALITY LEVEL VALUE	MIL 3.500E 01	.37914	.75829	E Q R	18.0 5.00 1.00
RES, ACCURATE FIXED WW, RR	93	2.0	10.	75.	QUALITY LEVEL VALUE	MIL 2.000E 01	.37914	.75829	E Q R	18.0 5.00 1.00
RESISTOR, NONWIREWOUND TRIMMER	22097	1.0	20.	75.	SOURCE MULTIPLIER QUALITY LEVEL VALUE VOLTAGE RATIO TAPS	RJ .300 UPPER 5.000E 03 .500 3	1.66834	1.66834	E Q R V TAP	8.00 1.00 1.00 1.00 1.00

PROJECT: FSM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: CHASSIS PARTS X1 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
RES. INSULATED FIXED FILM, RN	10509	1.0	10.	75.	QUALITY LEVEL	MIL	.01818	.01818	E	7.50
					VALUE	1.200E 03			Q	1.00
									R	1.00
TRT SENS.	N/A	1.0	N/A	75.	SOURCE	RTH	.30000	.30000		
					MULTIPLIER	1.000				
					STYLE	READ				
CONN. PWR. TYPE R	21097	3.5	N/A	75.	QUALITY LEVEL	LOWER	1.43076	5.00764	E	12.0
					ACTIVE CONTACTS	23			P	4.46
					CONTACT GAUGE	20			N	23.0
					CONTACT CURRENT	.100			CYC	.000
					CYCLING RATE	1				

TOTAL QUANTITY EQUALS 21.5 PIECE PARTS

TOTAL FAILURE RATE EQUALS 47.07399 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 21243.1 HOURS

NOTES
3 THERMOFOIL HEATER.

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: POWER SUPPLY PS1 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
CAP, SOLID TANT, CSR	39003	17.0	50.	75.	QUALITY LEVEL	L	.00808	.13729	E	4.00
					SERIES R	3.000			Q	1.50
									SR	7.000E-02
CAP, CERAMIC, CK 125C	11015	2.0	20.	75.	QUALITY LEVEL	MIL	.11063	.22127	E	4.00
									Q	10.0
DIODE, BRIDGE SCA:1M	N/A	2.0	20.	75.	SOURCE	D/GEN/SI	2.31419	4.62838	E	25.0
					MULTIPLIER	4.000			Q	5.00
					QUALITY LEVEL	JAN			A	1.00
					CONSTRUCTION	NON			C	2.00
					APPLICATION	SIG			S2	.700
					VOLTAGE RATIO	.200			R	1.00
					RATED POWER	1.000				
DIODE, GENERAL PURPOSE, SI 1N4245	19500	12.0	20.	75.	QUALITY LEVEL	JAN	.57855	6.94257	E	25.0
					CONSTRUCTION	NON			Q	5.00
					APPLICATION	SIG			A	1.00
					VOLTAGE RATIO	.200			C	2.00
					RATED POWER	1.000			S2	.700
									R	1.00
DIODE, GENERAL PURPOSE, SI 1N4153	19500	1.0	20.	75.	QUALITY LEVEL	JAN	.57855	.57855	E	25.0
					CONSTRUCTION	NON			Q	5.00
					APPLICATION	SIG			A	1.00
					VOLTAGE RATIO	.200			C	2.00
					RATED POWER	.500			S2	.700
									R	1.00
INCANDESCENT LAMP	N/A	1.0	N/A	75.			1.00000	1.00000		

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: POWER SUPPLY PS1 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
FILTER	N/A	2.0	20.	75.	SOURCE	CK125	.22127	.44254	E	4.00
					MULTIPLIER	2.000			Q	10.0
					QUALITY LEVEL	MIL				
RELAY	N/A	1.0	N/A	75.	SOURCE 217B TRL 3-10		1.60000	1.60000		
					SEE ACCOMPANYING REPORT					
SWITCH, TOGGLE	N/A	2.0	N/A	75.	SOURCE MIL-HDBK-217B		2.70000	5.40000		
					SEE ACCOMPANYING REPORT					
TRANS, POWER, CLASS 0	27	1.0	N/A	75.	QUALITY LEVEL	LOWER	.70283	.70283	F	5.00
									F	20.0
IC, BIPOLAR LINEAR	883	3.0	N/A	75.	QUALITY LEVEL	B-1	.24808	.74425	E	4.00
(NOTE 4)					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	9			L	1.00
									T2	5.02
									C1	2.994E-03
									C2	8.649E-03
IC, BIPOLAR LINEAR	883	1.0	N/A	75.	QUALITY LEVEL	B-1	.39314	.39314	E	4.00
LM309KC					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	19			L	1.00
									T2	5.02
									C1	5.295E-03
									C2	1.302E-02

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: POWER SUPPLY PS1 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR LM320KC-15	883	2.0	N/A	75.	QUALITY LEVEL	B-1	.39314	.7862A	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	19			L	1.00
									T2	5.02
									C1	5.295E-03
									C2	1.302E-02
CONN, PWR, TYPE B (NOTE 5)	55302	3.0	N/A	75.	QUALITY LEVEL	LOWER	1.00564	3.01693	E	12.0
					ACTIVE CONTACTS	14			P	3.14
					CONTACT GAUGE	22			N	14.0
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				

TOTAL QUANTITY EQUALS 50.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 26.59399 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 37602.5 HOURS

NOTES
4 7806KC, 7906KC, AND 7815KC.
5 IC SOCKETS.

PROJECT: FSM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: X/Y VIDEO AMP A1 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR 733HM	883	1.0	N/A	75.	QUALITY LEVEL	B-1	.46624	.46624	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	25			L	1.00
									T2	5.02
									C1	6.529E-03
									C2	1.512E-02
IC, BIPOLAR LINEAR LH0002CH	883	1.0	N/A	75.	QUALITY LEVEL	B-1	.38019	.38019	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	18			L	1.00
									T2	5.07
									C1	5.081E-03
									C2	1.264E-02
CAP, SOLID TANT, CSR	39003	20.0	50.	75.	QUALITY LEVEL	L	.00808	.16152	E	4.00
					SERIES R	3.000			Q	1.50
									SR	7.000E-02
CAP, CERAMIC, CK 125C	11015	15.0	20.	75.	QUALITY LEVEL	MIL	.11063	1.65951	E	4.00
									Q	10.0
CAP, MICA, CMR	39001	3.0	20.	75.	QUALITY LEVEL	M	.00555	.01664	E	6.00
									Q	1.00
DIODE, GENERAL PURPOSE, SI 1N4153	19500	5.0	20.	75.	QUALITY LEVEL	JAN	.57855	2.89274	E	25.0
					CONSTRUCTION	NON			Q	5.00
					APPLICATION	SIG			A	1.00
					VOLTAGE RATIO	.200			C	2.00
					RATED POWER	.500			S2	.700
									R	1.00

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: X/Y VIDEO AMP A1 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
CONN, PWB, TYPE B	55302	1.5	N/A	75.	QUALITY LEVEL	LOWER	1.53105	2.29658	E	12.0
					ACTIVE CONTACTS	25			P	4.78
					CONTACT GAUGE	20			N	25.0
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				
IND, RF COIL, CLASS 0	15305	12.0	N/A	75.	QUALITY LEVEL	LOWER	1.05424	12.65094	E	5.00
									F	30.0
CONN, PWB, TYPE B	21097	.5	N/A	75.	QUALITY LEVEL	LOWER	2.07579	1.03789	E	12.0
					ACTIVE CONTACTS	35			P	6.48
					CONTACT GAUGE	20			N	35.0
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				
TRANSISTOR, PNP, SI 2N4209	19500	2.0	0.	75.	QUALITY LEVEL	JAN	.23179	.46359	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	1.000			S2	.300
									R	1.00
TRANSISTOR, PNP, SI 2N4035	19500	2.0	0.	75.	QUALITY LEVEL	JAN	.23179	.46359	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	1.000			S2	.300
									R	1.00

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: X/Y VIDEO AMP A1 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
TRANSISTOR, NPN, SI 2N2369A	19500	3.0	20.	75.	QUALITY LEVEL	JAN	.21399	.64198	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	.360			S2	.300
									R	1.00
TRANSISTOR, NPN, SI 2N3947	19500	2.0	20.	75.	QUALITY LEVEL	JAN	.21399	.42799	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	.360			S2	.300
									R	1.00
RES, INSULATED FIXED COMP, RCR	39008	41.0	20.	75.	QUALITY LEVEL	S	.00020	.00821	E	5.00
					VALUE	1.000E 05			Q	3.000E-02
									R	1.00
RES, WELDABLE FXD FILM, RNC	55182	4.0	10.	75.	SOURCE	RNR	.01818	.07270	E	7.50
					MULTIPLIER	1.000			Q	1.00
					QUALITY LEVEL	M			R	1.00
					VALUE	1.000E 05				
RES, INSULATED FIXED FILM, RN	10509	4.0	10.	75.	QUALITY LEVEL	MIL	.01818	.07270	E	7.50
					VALUE	1.000E 05			Q	1.00
									R	1.00
RES, LEAD SCREW VAR WW, RT	27208	1.0	20.	75.	QUALITY LEVEL	MIL	.66698	.66698	E	7.00
					VALUE	1.000E 03			Q	5.00
					VOLTAGE RATIO	.500			R	1.00
									V	1.00

PROJECT: FSM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: X/Y VIDEO AMP A1 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
RESISTOR, NONWIREWOUND TRIMMER	22097	3.0	20.	75.	SOURCE	RJ	1.66834	5.00502	E	8.00
					MULTIPLIER	.300			Q	1.00
					QUALITY LEVEL	UPPER			R	1.00
					VALUE	5.000F 03			V	1.00
					VOLTAGE RATIO	.500			TAP	1.00
					TAPS	3				
PWB, TWO-SIDED BOARDS	55110	1.0	N/A	75.	PLATED HOLES	300	.00720	.00720	E	4.00

TOTAL QUANTITY EQUALS 122.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 29.39214 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 34022.7 HOURS

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: X/Y VIDEO AMP A2 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR 733HM	883	1.0	N/A	75.	QUALITY LEVEL	B-1	.46624	.46624	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	25			L	1.00
									T2	5.02
									C1	6.529E-03
									C2	1.512E-02
IC, BIPOLAR LINEAR LH0002CH	883	1.0	N/A	75.	QUALITY LEVEL	B-1	.38019	.38019	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	18			L	1.00
									T2	5.02
									C1	5.081E-03
									C2	1.264E-02
CAP, SOLID TANT, CSR	39003	20.0	50.	75.	QUALITY LEVEL	L	.00808	.16152	E	4.00
					SERIES R	3.000			Q	1.50
									SR	7.000E-02
CAP, CERAMIC, CK 125C	11015	15.0	20.	75.	QUALITY LEVEL	MIL	.11063	1.65951	E	4.00
									Q	10.0
CAP, MICA, CMR	39001	3.0	20.	75.	QUALITY LEVEL	M	.00555	.01664	E	6.00
									Q	1.00
DIODE, GENERAL PURPOSE, SI 1N4153	19500	5.0	20.	75.	QUALITY LEVEL	JAN	.57855	2.89274	E	25.0
					CONSTRUCTION	NON			Q	5.00
					APPLICATION	SIG			A	1.00
					VOLTAGE RATIO	.200			C	2.00
					RATED POWER	.500			S2	.700
									R	1.00

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: X/Y VIDEO AMP A2 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
CONN, PWB, TYPE B	55302	1.5	N/A	75.	QUALITY LEVEL	LOWER	1.53105	2.29658	E	12.0
					ACTIVE CONTACTS	25			P	4.78
					CONTACT GAUGE	20			N	25.0
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				
IND, RF COIL, CLASS O	15305	12.0	N/A	75.	QUALITY LEVEL	LOWER	1.05424	12.65094	E	5.00
									F	30.0
CONN, PWB, TYPE B	21097	.5	N/A	75.	QUALITY LEVEL	LOWER	2.07579	1.03789	E	12.0
					ACTIVE CONTACTS	35			P	6.48
					CONTACT GAUGE	20			N	35.0
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				
TRANSISTOR, PNP, SI 2N4209	19500	2.0	0.	75.	QUALITY LEVEL	JAN	.23179	.46359	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	1.000			S2	.300
									R	1.00
TRANSISTOR, PNP, SI 2N4035	19500	2.0	0.	75.	QUALITY LEVEL	JAN	.23179	.46359	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	1.000			S2	.300
									R	1.00

PROJECT: FSM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: X/Y VIDEO AMP A2 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
TRANSISTOR, NPN, SI 2N2369A	19500	3.0	20.	75.	QUALITY LEVEL	JAN	.21399	.64198	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	.360			S2	.300
									R	1.00
TRANSISTOR, NPN, SI 2N3947	19500	2.0	20.	75.	QUALITY LEVEL	JAN	.21399	.42799	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	.360			S2	.300
									R	1.00
RES, INSULATED FIXED COMP, RCR	39008	41.0	20.	75.	QUALITY LEVEL	S	.00020	.00821	E	5.00
					VALUE	1.000E 05			Q	3.000E-02
									R	1.00
RES, WELDABLE FXD FILM, RNC	55182	4.0	10.	75.	SOURCE	RNR	.01818	.07270	E	7.50
					MULTIPLIER	1.000			Q	1.00
					QUALITY LEVEL	M			R	1.00
					VALUE	1.000E 05				
RES, INSULATED FIXED FILM, RN	10509	4.0	10.	75.	QUALITY LEVEL	MIL	.01818	.07270	E	7.50
					VALUE	1.000E 05			Q	1.00
									R	1.00
RES, LEAD SCREW VAR WW, RT	27208	1.0	20.	75.	QUALITY LEVEL	MIL	.66698	.66698	E	7.00
					VALUE	1.000E 03			Q	5.00
					VOLTAGE RATIO	.500			R	1.00
									V	1.00

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: X/Y VIDEO AMP A2 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
RESISTOR, NONWIREWOUND TRIMMER	22097	3.0	20.	75.	SOURCE	RJ	1.66834	5.00502	E	8.00
					MULTIPLIER	.300			Q	1.00
					QUALITY LEVEL	UPPER			R	1.00
					VALUE	5.000E 03			V	1.00
					VOLTAGE RATIO	.500			TAP	1.00
					TAPS	3				
PWB, TWO-SIDED BOARDS	55110	1.0	N/A	75.	PLATED HOLES	300	.00720	.00720	E	4.00

TOTAL QUANTITY EQUALS 122.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 29.39214 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 34022.7 HOURS

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: VIDEO & CW ALARM A3 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR 733HM	883	1.0	N/A	75.	QUALITY LEVEL	B-1	.46624	.46624	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	25			L	1.00
									T2	5.02
									C1	6.529E-03
									C2	1.512E-02
IC, BIPOLAR LINEAR LH0002CH	883	1.0	N/A	75.	QUALITY LEVEL	B-1	.38019	.38019	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	18			L	1.00
									T2	5.02
									C1	5.081E-03
									C2	1.264E-02
IC, BIPOLAR LINEAR SSS725J	883	1.0	N/A	75.	QUALITY LEVEL	B-1	.40585	.40585	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	20			L	1.00
									T2	5.02
									C1	5.506E-03
									C2	1.339E-02
IC, BIPOLAR LINEAR 710HM	883	2.0	N/A	75.	QUALITY LEVEL	B-1	.24808	.49617	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	9			L	1.00
									T2	5.02
									C1	2.994E-03
									C2	8.649E-03

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: VIDEO & CW ALARM A3 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR 741HM	883	1.0	N/A	75.	QUALITY LEVEL	B-1	.44266	.44266	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	23			L	1.00
									T2	5.02
									C1	6.126E-03
									C2	1.445E-02
CAP, CERAMIC, CK 125C	11015	17.0	20.	75.	QUALITY LEVEL	MIL	.11063	1.88078	E	4.00
									Q	10.0
CAP, NONSOLID TANT, CL	3965	1.0	60.	75.	QUALITY LEVEL	MIL	2.16502	2.16502	E	6.00
									Q	10.0
CAP, SOLID TANT, CSR	39003	14.0	50.	75.	QUALITY LEVEL	L	.00808	.11307	E	4.00
					SERIES R	3.000			Q	1.50
									SR	7.000E-02
CAP, MICA, CMR	39001	1.0	20.	75.	QUALITY LEVEL	M	.00555	.00555	E	6.00
									Q	1.00
CONN, PWR, TYPE B	55302	1.0	N/A	75.	QUALITY LEVEL	LOWER	1.53105	1.53105	E	12.0
					ACTIVE CONTACTS	25			P	4.78
					CONTACT GAUGE	20			N	25.0
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				
IND, RF COIL, CLASS O	15305	10.0	N/A	75.	QUALITY LEVEL	LOWER	1.05424	10.54245	E	5.00
									F	30.0

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: VIDEO & CW ALARM A3 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
CONN, PWR, TYPE B	21097	.5	N/A	75.	QUALITY LEVEL	LOWER	2.07579	1.03789	E	12.0
					ACTIVE CONTACTS	35			P	6.48
					CONTACT GAUGE	20			N	35.0
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				
TRANSISTOR, NPN, SI JAN2N918	19500	2.0	20.	75.	QUALITY LEVEL	JAN	.21399	.42799	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	.500			S2	.300
									R	1.00
TRANSISTOR, PNP, SI 2N4035	19500	1.0	20.	75.	QUALITY LEVEL	JAN	.33352	.33352	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	1.000			S2	.300
									R	1.00
RES, INSULATED FIXED FILM, RN	10509	16.0	10.	75.	QUALITY LEVEL	MIL	.01818	.29081	E	7.50
					VALUE	1.000E 05			Q	1.00
									R	1.00
RES, INSULATED FIXED COMP, RCR	39008	35.0	20.	75.	QUALITY LEVEL	S	.00020	.00700	E	5.00
					VALUE	1.000E 05			Q	3.000E-02
									R	1.00

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: VIDEO & CW ALARM A3 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
RESISTOR, NONWIREWOUND TRIMMER	22097	3.0	20.	75.	SOURCE	RJ	1.66834	5.00502	E	8.00
					MULTIPLIER	.300			Q	1.00
					QUALITY LEVEL	UPPER			R	1.00
					VALUE	1.000E 04			V	1.00
					VOLTAGE RATIO	.500			TAP	1.00
					TAPS	3				
DIODE, ZENER / AVALANCHE 1N829	19500	1.0	40.	75.	QUALITY LEVEL	JAN	1.38279	1.38279	E	25.0
					APPLICATION	REF			Q	5.00
									A	1.50
PWB, TWO-SIDED BOARDS	55110	1.0	N/A	75.	PLATED HOLES	300	.00720	.00720	E	4.00

TOTAL QUANTITY EQUALS 109.5 PIECE PARTS

TOTAL FAILURE RATE EQUALS 26.92119 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 37145.5 HOURS

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: X/Y VIDEO AMP A4 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR 733HM	883	1.0	N/A	75.	QUALITY LEVEL	B-1	.46624	.46624	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	25			L	1.00
									T2	5.02
									C1	6.529E-03
									C2	1.512E-02
IC, BIPOLAR LINEAR LH0002CH	883	1.0	N/A	75.	QUALITY LEVEL	B-1	.38019	.38019	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	18			L	1.00
									T2	5.02
									C1	5.081E-03
									C2	1.264E-02
CAP, SOLID TANT, CSR	39003	20.0	50.	75.	QUALITY LEVEL	L	.00808	.16152	E	4.00
					SERIES R	3.000			Q	1.50
									SR	7.000E-02
CAP, CERAMIC, CK 125C	11015	15.0	20.	75.	QUALITY LEVEL	MIL	.11063	1.65951	E	4.00
									Q	10.0
CAP, MICA, CMR	39001	3.0	20.	75.	QUALITY LEVEL	M	.00555	.01664	E	6.00
									Q	1.00
DIODE, GENERAL PURPOSE, SI 1N4153	19500	5.0	20.	75.	QUALITY LEVEL	JAN	.57855	2.89274	E	25.0
					CONSTRUCTION	NON			Q	5.00
					APPLICATION	SIG			A	1.00
					VOLTAGE RATIO	.200			C	2.00
					RATED POWER	.500			S2	.700
									R	1.00

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: X/Y VIDEO AMP A4 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
CONN, PWB, TYPE B	55302	1.5	N/A	75.	QUALITY LEVEL	LOWER	1.53105	2.29658	E	12.0
					ACTIVE CONTACTS	25			P	4.78
					CONTACT GAUGE	20			N	25.0
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				
IND, RF COIL, CLASS O	15305	12.0	N/A	75.	QUALITY LEVEL	LOWER	1.05424	12.65094	E	5.00
									F	30.0
CONN, PWB, TYPE B	21097	.5	N/A	75.	QUALITY LEVEL	LOWER	2.07579	1.03789	E	12.0
					ACTIVE CONTACTS	35			P	6.48
					CONTACT GAUGE	20			N	35.0
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				
TRANSISTOR, PNP, SI 2N4209	19500	2.0	0.	75.	QUALITY LEVEL	JAN	.23179	.46359	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	1.000			S2	.300
									R	1.00
TRANSISTOR, PNP, SI 2N4035	19500	2.0	0.	75.	QUALITY LEVEL	JAN	.23179	.46359	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	1.000			S2	.300
									R	1.00

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: X/Y VIDEO AMP A4 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
TRANSISTOR, NPN, SI 2N2369A	19500	3.0	20.	75.	QUALITY LEVEL	JAN	.21399	.64198	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	.360			S?	.300
									R	1.00
TRANSISTOR, NPN, SI 2N3947	19500	2.0	20.	75.	QUALITY LEVEL	JAN	.21399	.42799	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	.360			S?	.300
									R	1.00
RES, INSULATED FIXED COMP, RCR	39008	41.0	20.	75.	QUALITY LEVEL	S	.00020	.00821	E	5.00
					VALUE	1.000E 05			Q	3.000E-02
									R	1.00
RES, WELDABLE FXD FILM, RNC	55182	4.0	10.	75.	SOURCE	RNR	.01818	.07270	E	7.50
					MULTIPLIER	1.000			Q	1.00
					QUALITY LEVEL	M			R	1.00
					VALUE	1.000E 05				
RES, INSULATED FIXED FILM, RN	10509	4.0	10.	75.	QUALITY LEVEL	MIL	.01818	.07270	E	7.50
					VALUE	1.000E 05			Q	1.00
									R	1.00
RES, LEAD SCREW VAR WW, RT	27208	1.0	20.	75.	QUALITY LEVEL	MIL	.66698	.66698	E	7.00
					VALUE	1.000E 03			Q	5.00
					VOLTAGE RATIO	.500			R	1.00
									V	1.00

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: X/Y VIDEO AMP A4 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
RESISTOR, NONWIREWOUND TRIMMER	22097	3.0	20.	75.	SOURCE	RJ	1.66834	5.00502	E	8.00
					MULTIPLIER	.300			Q	1.00
					QUALITY LEVEL	UPPER			R	1.00
					VALUE	5.000E 03			V	1.00
					VOLTAGE RATIO	.500			TAP	1.00
					TAPS	3				
PWB, TWO-SIDED BOARDS	55110	1.0	N/A	75.	PLATED HOLES	300	.00720	.00720	E	4.00

TOTAL QUANTITY EQUALS 122.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 29.39214 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 34022.7 HOURS

PROJECT: FSM FSM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: X/Y VIDEO AMP A5 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR 733HM	883	1.0	N/A	75.	QUALITY LEVEL	B-1	.46624	.46624	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	25			L	1.00
									T2	5.02
									C1	6.529E-03
									C2	1.512E-02
IC, BIPOLAR LINEAR LH0002CH	883	1.0	N/A	75.	QUALITY LEVEL	B-1	.38019	.38019	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	18			L	1.00
									T2	5.02
									C1	5.081E-03
									C2	1.264E-02
CAP, SOLID TANT, CSR	39003	20.0	50.	75.	QUALITY LEVEL	L	.00808	.16152	E	4.00
					SERIES R	3.000			Q	1.50
									SR	7.000E-02
CAP, CERAMIC, CK 125C	11015	15.0	20.	75.	QUALITY LEVEL	MIL	.11063	1.65951	E	4.00
									Q	10.0
CAP, MICA, CMR	39001	3.0	20.	75.	QUALITY LEVEL	M	.00555	.01664	E	4.00
									Q	1.00
DIODE, GENERAL PURPOSE, SI 1N4153	19500	5.0	20.	75.	QUALITY LEVEL	JAN	.57855	2.89274	E	25.0
					CONSTRUCTION	NON			Q	5.00
					APPLICATION	SIG			A	1.00
					VOLTAGE RATIO	.200			C	2.00
					RATED POWER	.500			S2	.700
									R	1.00

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: X/Y VIDEO AMP A5 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
CONN, PWB, TYPE B	55302	1.5	N/A	75.	QUALITY LEVEL	LOWER	1.53105	2.2965A	E	12.0
					ACTIVE CONTACTS	25			P	4.78
					CONTACT GAUGE	20			N	25.0
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				
IND, RF COIL, CLASS D	15305	12.0	N/A	75.	QUALITY LEVEL	LOWER	1.05424	12.65094	E	5.00
									F	30.0
CONN, PWB, TYPE B	21097	.5	N/A	75.	QUALITY LEVEL	LOWER	2.07579	1.03789	E	12.0
					ACTIVE CONTACTS	35			P	6.48
					CONTACT GAUGE	20			N	35.0
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				
TRANSISTOR, PNP, SI 2N4209	19500	2.0	0.	75.	QUALITY LEVEL	JAN	.23179	.46359	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	1.000			S2	.300
									R	1.00
TRANSISTOR, PNP, SI 2N4035	19500	2.0	0.	75.	QUALITY LEVEL	JAN	.23179	.46359	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	1.000			S2	.300
									R	1.00

PROJECT: FSM FSM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: X/Y VIDEO AMP A5 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
TRANSISTOR, NPN, SI 2N2369A	19500	3.0	20.	75.	QUALITY LEVEL	JAN	.21399	.64198	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	.360			S2	.300
									R	1.00
TRANSISTOR, NPN, SI 2N3947	19500	2.0	20.	75.	QUALITY LEVEL	JAN	.21399	.42799	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	.360			S2	.300
									R	1.00
RES, INSULATED FIXED COMP, RCR	39008	41.0	20.	75.	QUALITY LEVEL	S	.00020	.00821	E	5.00
					VALUE	1.000E 05			Q	3.000E-02
									R	1.00
RES, WELDABLE FXD FILM, RNC	55182	4.0	10.	75.	SOURCE	RNR	.01818	.07270	E	7.50
					MULTIPLIER	1.000			Q	1.00
					QUALITY LEVEL	M			R	1.00
					VALUE	1.000E 05				
RES, INSULATED FIXED FILM, RN	10509	4.0	10.	75.	QUALITY LEVEL	MIL	.01818	.07270	E	7.50
					VALUE	1.000E 05			Q	1.00
									R	1.00
RES, LEAD SCREW VAR WW, RT	27208	1.0	20.	75.	QUALITY LEVEL	MIL	.66698	.66698	E	7.00
					VALUE	1.000E 03			Q	5.00
					VOLTAGE RATIO	.500			R	1.00
									V	1.00

PROJECT: FSM FSM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: X/Y VIDEO AMP A5 ASSEMBLY TEMP: 75.C

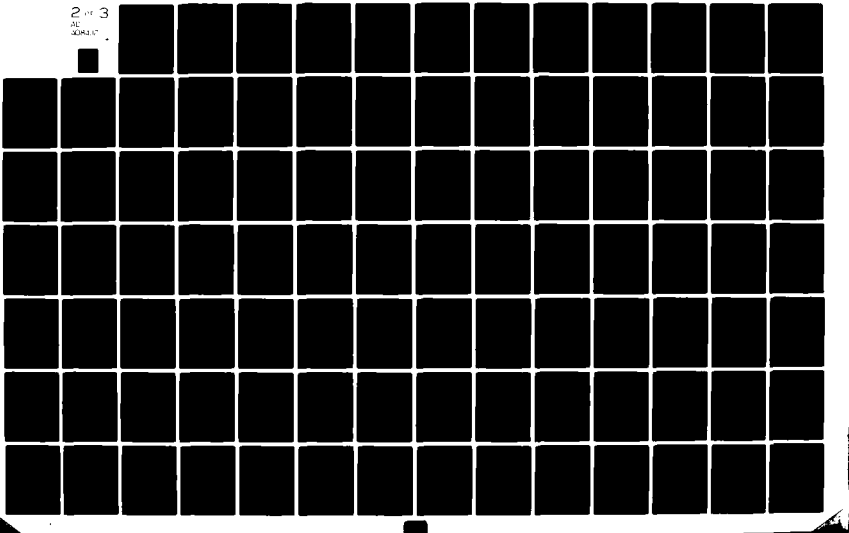
COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
RESISTOR, NONWIREWOUND TRIMMER	22 /7	3.0	20.	75.	SOURCE	RJ	1.66834	5.00502	E	8.00
					MULTIPLIER	.300			Q	1.00
					QUALITY LEVEL	UPPER			R	1.00
					VALUE	5.000E 03			V	1.00
					VOLTAGE RATIO	.500			TAP	1.00
					TAPS	3				
PWB, TWO-SIDED BOARDS	55110	1.0	N/A	75.	PLATED HOLES	300	.00720	.00720	E	4.00

TOTAL QUANTITY EQUALS 122.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 29.39214 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 34022.7 HOURS

AD-A084 112 NAVAL OCEAN SYSTEMS CENTER SAN DIEGO CA F/G 9/5
AVAILABILITY ESTIMATE OF A CONCEPTUAL ESM SYSTEM.(U)
JUN 79 J VALENZUELA
UNCLASSIFIED NOSC-TR-501 NL



PROJECT: FSM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: DISRIM, HEAT CTRL AB ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR LM311JG	883	1.0	N/A	75.	QUALITY LEVEL	B-1	.44266	.44266	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	23			L	1.00
									T2	5.02
									C1	6.126E-03
									C2	1.445E-02
CAP, CERAMIC, CK 125C	11015	1.0	20.	75.	QUALITY LEVEL	MIL	.11063	.11063	E	4.00
									Q	10.0
RELAY	N/A	1.0	N/A	75.	SOURCE 217B, THL 3-10		1.60000	1.60000		
					SEE ACCOMPANYING REPORT					
RESISTOR, NONWIREWOUND TRIMMER	22097	1.0	20.	75.	SOURCE	RJ	1.66834	1.66834	E	8.00
					MULTIPLIER	.300			Q	1.00
					QUALITY LEVEL	UPPER			R	1.00
					VALUE	1.000E 02			V	1.00
					VOLTAGE RATIO	.500			TAP	1.00
					TAPS	3				
RES, INSULATED FIXED FILM, RN	10509	3.0	10.	75.	QUALITY LEVEL	MIL	.01818	.05453	E	7.50
					VALUE	1.000E 05			Q	1.00
									R	1.00
RES, INSULATED FIXED COMP, RCR	39008	1.0	20.	75.	QUALITY LEVEL	S	.00022	.00022	E	5.00
					VALUE	1.800E 05			Q	3.000E-02
									R	1.10
RES, INSULATED FIXED COMP, RCR	39008	1.0	20.	75.	QUALITY LEVEL	S	.00020	.00020	E	5.00
					VALUE	3.900E 02			Q	3.000E-02
									R	1.00

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: DISPLM, HEAT CTRL AA ASSEMBLY TEMP: 75.C

	COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
90	PWB, TWO-SIDED BOARDS	55110	1.0	N/A	75.	PLATED HOLES	50	.00120	.00120	E	4.00

TOTAL QUANTITY EQUALS 10.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 3.87778 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 257879.3 HOURS

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: CHASSIS PARTS Z1 ASSEMBLY TEMP: 65.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
FAN, TUBEAXIAL	N/A	1.0	N/A	65.	SOURCE 217B, TBL 3-10		11.00000	11.00000		
					SEE ACCOMPANYING REPORT					
CAP, CERAMIC, CK 125C	11015	2.0	20.	65.	QUALITY LEVEL	MIL	.10749	.21578	E	4.00
									Q	10.0
CONN, RF COAXIAL, TYPE C	39012	6.0	N/A	65.	QUALITY LEVEL	LOWER	4.57022	27.42128	E	36.0
					ACTIVE CONTACTS	1			P	1.00
					CONTACT GAUGE	22			N	1.00
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				
CONN, CIRCULAR CABLE, TYPE A	26482	1.0	N/A	65.	QUALITY LEVEL	LOWER	1.70028	1.70028	E	12.0
					ACTIVE CONTACTS	36			P	6.66
					CONTACT GAUGE	20			N	36.0
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				
CONN, CIRCULAR CABLE, TYPE A	26482	.5	N/A	65.	QUALITY LEVEL	LOWER	.51519	.25759	E	12.0
					ACTIVE CONTACTS	6			P	2.02
					CONTACT GAUGE	20			N	6.00
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				
CONN, PWB, TYPE A	21097	7.0	N/A	65.	QUALITY LEVEL	LOWER	2.25856	15.80996	E	12.0
					ACTIVE CONTACTS	47			P	8.85
					CONTACT GAUGE	20			N	47.0
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 50

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: CHASSIS PARTS Z1 ASSEMBLY TEMP: 65.C

92

TOTAL QUANTITY EQUALS 17.5 PIECE PARTS

TOTAL FAILURE RATE EQUALS 56.40486 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 17729.0 HOURS

PROJECT: FSM FSM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: POWER SUPPLY 3PS1 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
CAP, SOLID TANT, CSR	39003	9.0	50.	75.	QUALITY LEVEL	L	.00808	.07268	E	4.00
					SERIES R	3.000			Q	1.50
									SR	7.000E-02
DIODE, BRIDGE SCAJ1M	N/A	2.0	20.	75.	SOURCE	D/GEN/SI	2.31419	4.62838	E	25.0
					MULTIPLIER	4.000			Q	5.00
					QUALITY LEVEL	JAN			A	1.00
					CONSTRUCTION	NON			C	2.00
					APPLICATION	SIG			S2	.700
					VOLTAGE RATIO	.200			R	1.00
					RATED POWER	1.000				
DIODE, GENERAL PURPOSE, SI 1N4245	19500	6.0	20.	75.	QUALITY LEVEL	JAN	.57855	3.47128	E	25.0
					CONSTRUCTION	NON			Q	5.00
					APPLICATION	SIG			A	1.00
					VOLTAGE RATIO	.200			C	2.00
					RATED POWER	1.000			S2	.700
									R	1.00
DIODE, GENERAL PURPOSE, SI 1N4153	19500	1.0	20.	75.	QUALITY LEVEL	JAN	.57855	.57855	E	25.0
					CONSTRUCTION	NON			Q	5.00
					APPLICATION	SIG			A	1.00
					VOLTAGE RATIO	.200			C	2.00
					RATED POWER	.500			S2	.700
									R	1.00
INCANDESCENT LAMP	N/A	1.0	N/A	75.			1.00000	1.00000		
FILTER	N/A	2.0	20.	75.	SOURCE	CK125	.22127	.44254	E	4.00
					MULTIPLIER	2.000			Q	10.0
					QUALITY LEVEL	MIL				

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: POWER SUPPLY 3PS1 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA	ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
RELAY	N/A	1.0	N/A	75.	SOURCE 217A, TBL 3-10 SEE ACCOMPANYING REPORT	1.60000	1.60000		
SWITCH, TOGGLE	N/A	2.0	N/A	75.	SOURCE MIL-HDBK-217A SEE ACCOMPANYING REPORT	2.70000	5.40000		
TRANS, POWER, CLASS Q	27	1.0	N/A	75.	QUALITY LEVEL LOWER	.70283	.70283	E F	5.00 20.0
IC, BIPOLAR LINEAR LM323K	883	1.0	N/A	75.	QUALITY LEVEL B-1 LEARNING FACTOR 1 TRANSISTORS 9	.24808	.24808	E Q L T2 C1 C2	4.00 5.00 1.00 5.02 2.994E-03 8.649E-03
IC, BIPOLAR LINEAR 7812KC	883	1.0	N/A	75.	QUALITY LEVEL B-1 LEARNING FACTOR 1 TRANSISTORS 9	.24808	.24808	E Q L T2 C1 C2	4.00 5.00 1.00 5.02 2.994E-03 8.649E-03
IC, BIPOLAR LINEAR LM320KC-12	883	1.0	N/A	75.	QUALITY LEVEL B-1 LEARNING FACTOR 1 TRANSISTORS 19	.39314	.39314	E Q L T2 C1 C2	4.00 5.00 1.00 5.02 5.295E-03 1.302E-02

PROJECT: FSM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: POWER SUPPLY 3PS1 ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
CONN, PWR, TYPE H	55302	3.0	N/A	75.	QUALITY LEVEL	LOWER	1.00564	3.01693	E	12.0
					ACTIVE CONTACTS	14			P	3.14
					CONTACT GAUGE	20			N	14.0
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				

TOTAL QUANTITY EQUALS 31.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 21.80247 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 45866.4 HOURS

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: ABS. VALUE AMP 3A1 ASSEMBLY TEMP: 65.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
CAP, CERAMIC, CK 125C	11015	19.0	20.	65.	QUALITY LEVEL	MIL	.10789	2.04989	E	4.00
									Q	10.0
CAP, SOLID TANT, CSR	39003	14.0	50.	65.	QUALITY LEVEL	L	.00675	.09455	E	4.00
					SERIES R	3.000			Q	1.50
									SR	7.000E-02
DIODE, GENERAL PURPOSE, SI 1N4153	19500	6.0	20.	65.	QUALITY LEVEL	JAN	.48694	2.92165	E	25.0
					CONSTRUCTION	NON			Q	5.00
					APPLICATION	SIG			A	1.00
					VOLTAGE RATIO	.200			C	2.00
					RATED POWER	.500			S2	.700
									R	1.00
IND, RF COIL, CLASS 0	15305	11.0	N/A	65.	QUALITY LEVEL	LOWER	.43841	4.82246	E	5.00
									F	30.0
CONN, PWR, TYPE B	21097	.5	N/A	65.	QUALITY LEVEL	LOWER	2.25856	1.12928	E	12.0
					ACTIVE CONTACTS	47			P	8.85
					CONTACT GAUGE	20			N	47.0
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				
TRANSISTOR, NPN, SI 2N2916A	19500	3.0	20.	65.	QUALITY LEVEL	JAN	.22848	.68543	E	25.0
					COMPLEXITY	DMA			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.20
					RATED POWER	1.000			S2	.300
									R	1.00

PROJECT: ESM FSM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: ABS, VALUE AMP 341 ASSEMBLY TEMP: 65,C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
TRANSISTOR, NPN, SI 2N2369A	19500	2.0	20.	65.	QUALITY LEVEL	JAN	.22848	.45695	E	25.0
					COMPLEXITY	DMA			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.20
					RATED POWER	1.000			S2	.300
									R	1.00
TRANSISTOR, NPN, SI 2N2369A	19500	2.0	20.	65.	QUALITY LEVEL	JAN	.19040	.38079	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	.360			S2	.300
									R	1.00
TRANSISTOR, PNP, SI 2N3811A	19500	1.0	20.	65.	QUALITY LEVEL	JAN	.35371	.35371	E	25.0
					COMPLEXITY	DMA			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.20
					RATED POWER	1.000			S2	.300
									R	1.00
RES, INSULATED FIXED FILM, RN	10509	24.0	10.	65.	QUALITY LEVEL	MIL	.01658	.39804	E	7.50
					VALUE	1.000E 05			Q	1.00
									R	1.00
RES, INSULATED FIXED COMP, RCR	39008	41.0	20.	65.	QUALITY LEVEL	S	.00014	.00571	E	5.00
					VALUE	1.000E 05			Q	3.000E-02
									R	1.00

FAILURE RATE DETERMINATION MIL-HDBK-2178 NOTICE 2 14:05 AUG 22,'79 56

PROJECT: ESM FSM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: AHS, VALUE AMP 3A1 ASSEMBLY TEMP: 65.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR LM0033CG	883	2.0	N/A	65.	QUALITY LEVEL	B-1	.31663	.63325	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	18			L	1.00
									T2	2.52
									C1	5.081E-03
									C2	1.264E-02
IC, BIPOLAR LINEAR SE527K	883	3.0	N/A	65.	QUALITY LEVEL	B-1	.36603	1.09809	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	23			L	1.00
									T2	2.52
									C1	6.126E-03
									C2	1.445E-02
PWB, TWO-SIDED BOARDS	55110	1.0	N/A	65.	PLATED HOLES	350	.00840	.00840	E	4.00

TOTAL QUANTITY EQUALS 129.5 PIECE PARTS

TOTAL FAILURE RATE EQUALS 15.03820 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 66497.3 HOURS

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: COARSE SECT ENCODER 3A2 ASSEMBLY TEMP: 65.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
CAP, CERAMIC, CK 125C	11015	27.0	20.	65.	QUALITY LEVEL	MIL	.10789	2.91300	E Q	4.00 10.0
CAP, SOLID TANT, CSR	39003	5.0	50.	65.	QUALITY LEVEL SERIES R	L 3.000	.00675	.03377	E Q SR	4.00 1.50 7.000E-02
IND, RF COIL, CLASS O	15305	7.0	N/A	65.	QUALITY LEVEL	LOWER	.43841	3.06884	E F	5.00 30.0
CONN, PWB, TYPE H	21097	.5	N/A	65.	QUALITY LEVEL ACTIVE CONTACTS CONTACT GAUGE CONTACT CURRENT CYCLING RATE	LOWER 47 20 .010 1	2.25856	1.12928	E P N CYC	12.0 8.85 47.0 .000
RES, INSULATED FIXED COMP, RCR	39008	28.0	20.	65.	QUALITY LEVEL VALUE	S 1.000E 05	.00014	.00390	E Q R	5.00 3.000E-02 1.00
RES, INSULATED FIXED FILM, RN	10509	14.0	10.	65.	QUALITY LEVEL VALUE	MIL 1.000E 05	.01658	.23219	E Q R	7.50 1.00 1.00
RES, LEAD SCREW VAR WW, RT	27208	2.0	20.	65.	QUALITY LEVEL VALUE VOLTAGE RATIO	MIL 5.000E 01 .500	.58857	1.17714	E Q R V	7.00 5.00 1.00 1.00

PROJECT: FSM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: COARSE SECT ENCODER 3A2 ASSEMBLY TEMP: 65.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR SE527K	883	6.0	N/A	65.	QUALITY LEVEL	B-1	.36603	2.19619	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	23			L	1.00
									T2	2.52
									C1	6.126E-03
									C2	1.445E-02
IC, BIPOLAR DIGITAL SSI/MSI SN5486J	883	1.0	N/A	65.	QUALITY LEVEL	B-1	.13904	.13904	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	4			T1	.671
									C1	3.297E-03
									C2	6.399E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI SN54LS174J	883	1.0	N/A	65.	QUALITY LEVEL	B-1	.33062	.33062	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	36			T1	.671
									C1	1.460E-02
									C2	1.408E-02
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI SN54LS00J	883	2.0	N/A	65.	QUALITY LEVEL	B-1	.13904	.27808	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	4			T1	.671
									C1	3.297E-03
									C2	6.399E-03
									P	1.00

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: COARSE SECT ENCODER 342 ASSEMBLY TEMP: 65.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR LH0033G	883	2.0	N/A	65.	QUALITY LEVEL	B-1	.31663	.63325	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	18			L	1.00
									T2	2.52
									C1	5.0A1E-03
									C2	1.264E-02
PWB, TWO-SIDED BOARDS	55110	1.0	N/A	65.	PLATED HOLES	350	.00840	.00840	E	4.00

TOTAL QUANTITY EQUALS 96.5 PIECE PARTS

TOTAL FAILURE RATE EQUALS 12.14369 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 82347.3 HOURS

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: FINE SECTOR ENCODER 3A3 ASSEMBLY TEMP: 65.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
CAP, CERAMIC, CK 125C	11015	33.0	20.	65.	QUALITY LEVEL	MIL	.10789	3.56033	E	4.00
									Q	10.0
CAP, SOLID TANT, CSR	39003	7.0	50.	65.	QUALITY LEVEL	L	.00675	.04727	E	4.00
					SERIES R	3.000			Q	1.50
									SR	7.000E-02
IND, RF COIL, CLASS O	15305	7.0	N/A	65.	QUALITY LEVEL	LOWER	.43841	3.06884	E	5.00
									F	30.0
CONN, PWR, TYPE B	21097	.5	N/A	65.	QUALITY LEVEL	LOWER	2.25856	1.12928	E	12.0
					ACTIVE CONTACTS	47			P	8.85
					CONTACT GAUGE	20			N	47.0
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				
RES, INSULATED FIXED COMP, RCR	39008	36.0	20.	65.	QUALITY LEVEL	S	.00014	.00502	E	5.00
					VALUE	1.000E 05			Q	3.000E-02
									R	1.00
RES, INSULATED FIXED FILM, RN	10509	21.0	10.	65.	QUALITY LEVEL	MIL	.01658	.34828	E	7.50
					VALUE	1.000E 05			Q	1.00
									R	1.00
RES, LEAD SCREW VAR WW, RT	27208	2.0	20.	65.	QUALITY LEVEL	MIL	.58857	1.17714	E	7.00
					VALUE	5.000E 01			Q	5.00
					VOLTAGE RATIO	.500			R	1.00
									V	1.00

PROJECT: FSM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: FINE SECTOR ENCODER 3A3 ASSEMBLY TEMP: 65.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR SE527K	883	8.0	N/A	65.	QUALITY LEVEL	B-1	.36603	2.92825	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	23			L	1.00
									T2	2.52
									C1	6.126E-03
									C2	1.445E-02
IC, BIPOLAR LINEAR LH0033CG	883	2.0	N/A	65.	QUALITY LEVEL	B-1	.31663	.63325	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	18			L	1.00
									T2	2.52
									C1	5.081E-03
									C2	1.264E-02
IC, BIPOLAR DIGITAL SSI/MSI SN74LS86J	883	2.0	N/A	65.	QUALITY LEVEL	B-1	.13904	.27808	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	4			T1	.671
									C1	3.297E-03
									C2	6.399E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI SN74LS174J	883	2.0	N/A	65.	QUALITY LEVEL	B-1	.33062	.66123	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	36			T1	.671
									C1	1.460E-02
									C2	1.408E-02
									P	1.00

FAILURE RATE DETERMINATION MIL-HDBK-2178 NOTICE 2 14:05 AUG 22,'79 62

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: FINE SECTOR ENCODER 3A3 ASSEMBLY TEMP: 65.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR DIGITAL SSI/MSI 9318DC	883	1.0	N/A	65.	QUALITY LEVEL	B-1	.28071	.28071	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	24			T1	.671
									C1	1.109E-02
									C2	1.217E-02
									P	1.00

TOTAL QUANTITY EQUALS 121.5 PIECE PARTS

TOTAL FAILURE RATE EQUALS 14.11768 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 70833.1 HOURS

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 63

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: FINE SECTOR ENCODER 3A4 ASSEMBLY TEMP: 65.C

COMPONENT	COMPONENT NUMBER	QTY	TEMP	ITEM FAILURE RATE	TOTAL FAILURE RATE
FINE SECTOR ENCODER	3A3	1.0	65.	14.11768	14.11768

TOTAL QUANTITY EQUALS 1.0 ASSEMBLIES

TOTAL FAILURE RATE EQUALS 14.11768 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 70833.1 HOURS

PROJECT: FSM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: ARS VALUE AMP 3A5 ASSEMBLY TEMP: 65.C

COMPONENT	COMPONENT NUMBER	QTY	TEMP	ITEM FAILURE RATE	TOTAL FAILURE RATE
ABS. VALUE AMP	3A1	1.0	65.	15.03820	15.03820

TOTAL QUANTITY EQUALS 1.0 ASSEMBLIES

TOTAL FAILURE RATE EQUALS 15.03820 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 66497.3 HOURS

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: FMOP DET/OUT DRIVER 3A14 ASSEMBLY TEMP: 65.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
CAP, SOLID TANT, CSR	39003	1.0	50.	65.	QUALITY LEVEL	L	.00675	.00675	E	4.00
					SERIES R	3.000			Q	1.50
									SR	7.000E-02
CAP, CERAMIC, CK 125C	11015	6.0	20.	65.	QUALITY LEVEL	MIL	.10789	.64733	E	4.00
									Q	10.0
RES, INSULATED FIXED COMP, RCR	39008	27.0	20.	65.	QUALITY LEVEL	S	.00014	.00376	E	5.00
					VALUE	1.000E 05			Q	3.000E-02
									R	1.00
IC, BIPOLAR DIGITAL SSI/MSI SN74LS04J	883	1.0	N/A	65.	QUALITY LEVEL	B-1	.16259	.16259	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	6			T1	.671
									C1	4.339E-03
									C2	7.401E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI SN74LS54J	883	2.0	N/A	65.	QUALITY LEVEL	B-1	.15152	.30303	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	5			T1	.671
									C1	3.835E-03
									C2	6.932E-03
									P	1.00

PROJECT: FSM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: FMOP DET/OUT DRIVER 3A14 ASSEMBLY TEMP: 65.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR DIGITAL SSI/MSI SN74LS00J	883	1.0	N/A	65.	QUALITY LEVEL	B-1	.13904	.13904	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	4			T1	.671
									C1	3.297E-03
									C2	6.399E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI SN74LS02J	883	1.0	N/A	65.	QUALITY LEVEL	B-1	.13904	.13904	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	4			T1	.671
									C1	3.297E-03
									C2	6.399E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI SN74LS83J	883	7.0	N/A	65.	QUALITY LEVEL	B-1	.33062	2.31431	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	36			T1	.671
									C1	1.460E-02
									C2	1.408E-02
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI SN74LS157J	883	1.0	N/A	65.	QUALITY LEVEL	B-1	.25567	.25567	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	19			T1	.671
									C1	9.469E-03
									C2	1.119E-02
									P	1.00

PROJECT: FSM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: FMOP DET/OUT DRIVER 3A14 ASSEMBLY TEMP: 65.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR DIGITAL SSI/MSI SN74LS174J	883	2.0	N/A	65.	QUALITY LEVEL	B-1	.33062	.66123	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	36			T1	.671
									C1	1.460E-02
									C2	1.408E-02
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 93L24DC	883	4.0	N/A	65.	QUALITY LEVEL	B-1	.31520	1.26081	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	32			T1	.671
									C1	1.348E-02
									C2	1.350E-02
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI SN74LS08J	883	1.0	N/A	65.	QUALITY LEVEL	B-1	.13904	.13904	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	4			T1	.671
									C1	3.297E-03
									C2	6.399E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI SN74LS32J	883	1.0	N/A	65.	QUALITY LEVEL	B-1	.13904	.13904	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	4			T1	.671
									C1	3.297E-03
									C2	6.399E-03
									P	1.00

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:?? AUG 22,'79 68

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: FMOP UFT/OUT DRIVER 3A14 ASSEMBLY TEMP: 65.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR 9614DC	883	5.0	N/A	65.	QUALITY LEVEL	B-1	.50867	2.54334	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	40			L	1.00
									T2	2.52
									C1	9.345E-03
									C2	1.956E-02

TOTAL QUANTITY EQUALS 60.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 8.71498 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 114744.9 HOURS

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: MAINFRAME ASSEMBLY TEMP: 75.C

COMPONENT	COMPONENT NUMBER	QTY	TEMP	ITEM FAILURE RATE	TOTAL FAILURE RATE
DGTL CONTROL CARD	1A2	1.0	75.	15.93406	15.93406
CHASSIS PARTS	1A1	1.0	75.	42.89966	42.89966

TOTAL QUANTITY EQUALS 2.0 ASSEMBLIES

TOTAL FAILURE RATE EQUALS 58.83371 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 16997.1 HOURS

PROJECT: FSM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: RF TUNER PLUG-IN ASSEMBLY TEMP: 75.C

COMPONENT	COMPONENT NUMBER	QTY	TEMP	ITEM FAILURE RATE	TOTAL FAILURE RATE
YIG DRIVER CARD	2A3	1.0	75.	12.35535	12.35535
ANALOG SHAPER CARD	2A4	1.0	75.	18.72176	18.72176
CHASSIS PARTS	2A1	1.0	75.	50.71284	50.71284

TOTAL QUANTITY EQUALS 3.0 ASSEMBLIES

TOTAL FAILURE RATE EQUALS 81.78995 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 12226.4 HOURS

PROJECT: FSM FSM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: PARAMETER MEAS. ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
DIODE, DETECTOR, SI	19500	3.0	20.	75.	QUALITY LEVEL	JAN	9.69533	29.08598	E	50.0
									Q	3.50
IC, BIPOLAR LINEAR 741	883	3.0	N/A	75.	QUALITY LEVEL	B-1	.43060	1.29179	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	22			L	1.00
									T2	5.02
									C1	5.922E-03
									C2	1.410E-02
IC, BIPOLAR DIGITAL SSI/MSI 5413	883	2.0	N/A	75.	QUALITY LEVEL	B-1	.11018	.22037	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	2			T1	1.01
									C1	2.062E-03
									C2	4.989E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 5414	883	2.0	N/A	75.	QUALITY LEVEL	B-1	.16991	.33982	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	6			T1	1.01
									C1	4.339E-03
									C2	7.401E-03
									P	1.00

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: PARAMETER MEAS. ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR DIGITAL SSI/MSI 5426	883	4.0	N/A	75.	QUALITY LEVEL	B-1	.14461	.57843	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	4			T1	1.01
									C1	3.297E-03
									C2	6.399E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 54S194	883	3.0	N/A	75.	QUALITY LEVEL	B-1	.41235	1.23705	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	51			T1	1.01
									C1	1.848E-02
									C2	1.596E-02
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 54160	883	6.0	N/A	75.	QUALITY LEVEL	B-1	.40173	2.4103B	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	48			T1	1.01
									C1	1.773E-02
									C2	1.561E-02
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 54S22	883	6.0	N/A	75.	QUALITY LEVEL	B-1	.11018	.66111	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	2			T1	1.01
									C1	2.062E-03
									C2	4.989E-03
									P	1.00

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 73

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: PARAMETER MEAS. ASSEMBLY TEMP: 75.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
CONN, PWB, TYPE B	21097	1.0	N/A	75.	QUALITY LEVEL	LOWER	1.28444	1.28444	E	12.0
					ACTIVE CONTACTS	20			P	4.01
					CONTACT GAUGE	20			N	20.0
					CONTACT CURRENT	.100			CYC	.000
					CYCLING RATE	1				

TOTAL QUANTITY EQUALS 30.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 37.10934 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 26947.4 HOURS

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: UNIT 2 12-18GHZ RF Y ASSEMBLY TEMP: 75.C

COMPONENT	COMPONENT NUMBER	QTY	TEMP	ITEM FAILURE RATE	TOTAL FAILURE RATE
CHASSIS PARTS	X1	1.0	75.	47.07399	47.07399
POWER SUPPLY	PS1	1.0	75.	26.59399	26.59399
X/Y VIDEO AMP	A1	1.0	75.	29.39214	29.39214
X/Y VIDEO AMP	A2	1.0	75.	29.39214	29.39214
VIDEO & CW ALARM	A3	1.0	75.	26.92119	26.92119
X/Y VIDEO AMP	A4	1.0	75.	29.39214	29.39214
X/Y VIDEO AMP	A5	1.0	75.	29.39214	29.39214
DISRIM, HEAT CTRL	A8	1.0	75.	3.87778	3.87778

TOTAL QUANTITY EQUALS 8.0 ASSEMBLIES

TOTAL FAILURE RATE EQUALS 222.03549 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 4503.8 HOURS

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: UNIT 3 RCVR INTFC Z ASSEMBLY TEMP: 65.C

COMPONENT	COMPONENT NUMBER	QTY	TEMP	ITEM FAILURE RATE	TOTAL FAILURE RATE
CHASSIS PARTS	Z1	1.0	65.	56.40486	56.40486
POWER SUPPLY	3PS1	1.0	75.	21.80247	21.80247
ARS, VALUE AMP	3A1	1.0	65.	15.03820	15.03820
COARSE SECT ENCODER	3A2	1.0	65.	12.14369	12.14369
FINE SECTOR ENCODER	3A3	1.0	65.	14.11768	14.11768
FINE SECTOR ENCODER	3A4	1.0	65.	14.11768	14.11768
ARS VALUE AMP	3A5	1.0	65.	15.03820	15.03820
FMOP DET/OUT DRIVER	3A14	1.0	65.	8.71498	8.71498

TOTAL QUANTITY EQUALS 8.0 ASSEMBLIES

TOTAL FAILURE RATE EQUALS 157.37772 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 6354.1 HOURS

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 76

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: FLT MISC PARTS 52A ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
DIODE SWITCH W/AMPL	N/A	2.0	N/A	45.	SOURCE ENG. EST. SEE ACCOMPANYING REPORT		10.00000	20.00000		
POWER DIVIDER	N/A	1.0	N/A	45.	SOURCE VENDOR SEE ACCOMPANYING REPORT		2.50000	2.50000		
IC, MOS DIGITAL LSI 8080	38510	1.0	N/A	45.	QUALITY LEVEL	B	.70639	.70639	E	4.00
					LEARNING FACTOR	1			Q	2.00
					PINS	40			L	1.00
					GATES	1200			T2	.555
									C1	.169
									C2	5.677E-02
									P	1.10
IC, BIPOLAR DIGITAL SSI/MSI 5401	883	4.0	N/A	45.	QUALITY LEVEL	B-1	.13251	.53003	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	4			T1	.275
									C1	3.297E-03
									C2	6.399E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 54160	883	4.0	N/A	45.	QUALITY LEVEL	B-1	.33667	1.34667	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	48			T1	.275
									C1	1.773E-02
									C2	1.561E-02
									P	1.00

FAILURE RATE DETERMINATION MIL-HDBK-217A NOTICE 2 14:05 AUG 22,'79 77

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: FLT MISC PARTS 52A ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR DIGITAL SSI/MSI 54198	883	4.0	N/A	45.	QUALITY LEVEL	B-1	.43031	1.72124	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	24			L	1.00
					GATES	71			T1	.275
									C1	2.311F-02
									C2	1.797F-02
									P	1.10

TOTAL QUANTITY EQUALS 16.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 26.80432 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 37307.4 HOURS

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 78

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: YIG TUNED FILTER 52B ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
HEATER	N/A	1.0	N/A	45.			1.00000	1.00000		
IND, RF COIL, CLASS 0	15305	1.0	N/A	45.	QUALITY LEVEL	LOWER	.17208	.17208	E	5.00
									F	30.0
TRANSISTOR, NPN, SI 2N2222A	19500	2.0	20.	45.	QUALITY LEVEL	JAN	.15271	.30542	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	.500			S2	.300
									R	1.00
TRANSISTOR, PNP, SI 2N2907A	19500	6.0	20.	45.	QUALITY LEVEL	JAN	.23179	1.39074	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	.400			S2	.300
									R	1.00
DIODE, GENERAL PURPOSE, SI	19500	2.0	20.	45.	QUALITY LEVEL	JAN	.34204	.68409	E	25.0
					CONSTRUCTION	NON			Q	5.00
					APPLICATION	SIG			A	1.00
					VOLTAGE RATIO	.200			C	2.00
					RATED POWER	.150			S2	.700
									R	1.00
DIODE, ZENER / AVALANCHE	19500	4.0	50.	45.	QUALITY LEVEL	JAN	.76615	3.06459	E	25.0
					APPLICATION	REG			Q	5.00
									A	1.00

PROJECT: FSM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: YIG TUNED FILTER 52B ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR 741	883	1.0	N/A	45.	QUALITY LEVEL	B-1	.29847	.29847	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	22			L	1.00
									T2	.555
									C1	5.922E-03
									C2	1.410E-02
RES, INSULATED FIXED FILM, RLR	39017	24.0	10.	45.	QUALITY LEVEL	R	.00130	.03111	E	8.00
					VALUE	1.000E 05			Q	.100
									R	1.00
RES, POWER FIXED WW, RW	26	6.0	10.	45.	QUALITY LEVEL	MIL	.13107	.78644	E	7.00
					STYLE	80			Q	5.00
					VALUE	1.000E 01			R	1.00
RESISTOR, NONWIREWOUND TRIMMER	22097	2.0	10.	45.	SOURCE	RJ	1.29227	2.58454	E	8.00
					MULTIPLIER	.300			Q	1.00
					QUALITY LEVEL	UPPER			R	1.00
					VALUE	1.000E 01			V	1.00
					VOLTAGE RATIO	.500			TAP	1.00
					TAPS	3				
IC, BIPOLAR LINEAR MC1508L-8	883	1.0	N/A	45.	QUALITY LEVEL	B-1	.67395	.67395	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	94			L	1.00
									T2	.555
									C1	1.793E-02
									C2	3.121E-02
CAP, CERAMIC, CKR 125C	39014	10.0	10.	45.	QUALITY LEVEL	R	.00082	.00821	E	4.00
									Q	.100

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 80

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: YIG TUNED FILTER 52B ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
CONN, PWR, TYPE R	21097	2.0	N/A	45.	QUALITY LEVEL	LOWER	.41056	.82112	E	12.0
					ACTIVE CONTACTS	10			P	2.58
					CONTACT GAUGE	20			N	10.0
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				

TOTAL QUANTITY EQUALS 62.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 11.82077 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 84596.8 HOURS

PROJECT: FSM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: POWER SUPPLY PS1 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
CAP, SOLID TANT, CSR	39003	17.0	50.	45.	QUALITY LEVEL	L	.00525	.08925	E	4.00
					SERIES R	3.000			Q	1.50
									SR	7.000E-02
CAP, CERAMIC, CK 125C	11015	2.0	20.	45.	QUALITY LEVEL	MIL	.10260	.20520	E	4.00
									Q	10.0
DIODE, BRIDGE SCAJ1M	N/A	2.0	20.	45.	SOURCE	D/GEN/SI	1.36817	2.73634	E	25.0
					MULTIPLIER	4.000			Q	5.00
					QUALITY LEVEL	JAN			A	1.00
					CONSTRUCTION	NON			C	2.00
					APPLICATION	SIG			S2	.700
					VOLTAGE RATIO	.200			R	1.00
					RATED POWER	1.000				
DIODE, GENERAL PURPOSE, ST 1N4245	19500	12.0	20.	45.	QUALITY LEVEL	JAN	.34204	4.10451	E	25.0
					CONSTRUCTION	NON			Q	5.00
					APPLICATION	SIG			A	1.00
					VOLTAGE RATIO	.200			C	2.00
					RATED POWER	1.000			S2	.700
									R	1.00
DIODE, GENERAL PURPOSE, ST 1N4153	19500	1.0	20.	45.	QUALITY LEVEL	JAN	.34204	.34204	E	25.0
					CONSTRUCTION	NON			Q	5.00
					APPLICATION	SIG			A	1.00
					VOLTAGE RATIO	.200			C	2.00
					RATED POWER	.500			S2	.700
									R	1.00
INCANDESCENT LAMP	N/A	1.0	N/A	45.			1.00000	1.00000		

PROJECT: FSM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: POWER SUPPLY PS1 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
FILTER	N/A	2.0	20.	45.	SOURCE	CK125	.20520	.41040	E	4.00
					MULTIPLIER	2.000			Q	10.0
					QUALITY LEVEL	MIL				
RELAY	N/A	1.0	N/A	45.	SOURCE 217B TRL 3-10		1.60000	1.60000		
					SEE ACCOMPANYING REPORT					
SWITCH, TOGGLE	N/A	2.0	N/A	45.	SOURCE MIL-HDBK-217B		2.70000	5.40000		
					SEE ACCOMPANYING REPORT					
TRANS, POWER, CLASS O	27	1.0	N/A	45.	QUALITY LEVEL	LOWER	.11472	.11472	E	5.00
									F	20.0
IC, BIPOLAR LINEAR	883	3.0	N/A	45.	QUALITY LEVEL	B-1	.18128	.54384	E	4.00
(NOTE 4)					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	9			L	1.00
									T2	.555
									C1	2.994E-03
									C2	8.649E-03
IC, BIPOLAR LINEAR	883	1.0	N/A	45.	QUALITY LEVEL	B-1	.27500	.27500	E	4.00
LM309KC					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	19			L	1.00
									T2	.555
									C1	5.295E-03
									C2	1.302E-02

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 83

PROJECT: FSM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: POWER SUPPLY PS1 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR	883	2.0	N/A	45.	QUALITY LEVEL	B-1	.27500	.55000	E	4.00
L4320KC-15					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	19			L	1.00
									T2	.555
									C1	5.295E-03
									C2	1.302E-02
CONN, PWR, TYPE B	55302	3.0	N/A	45.	QUALITY LEVEL	LOWER	.49933	1.4979A	E	12.0
(NOTE 5)					ACTIVE CONTACTS	14			P	3.14
					CONTACT GAUGE	22			N	14.0
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				

TOTAL QUANTITY EQUALS 50.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 18.86929 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 52996.2 HOURS

NOTES
4 7806KC, 7906KC, AND 7815KC.
5 IC SOCKETS.

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: PWR CNTRL MISC PARTS 57A ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
RELAY	N/A	1.0	N/A	45.	SOURCE 217B TBL 3-10 SEE ACCOMPANYING REPORT		5.50000	5.50000		
IC, BIPOLAR LINEAR 741	883	1.0	N/A	45.	QUALITY LEVEL LEARNING FACTOR TRANSISTORS	B-1 1 22	.29847	.29847	E Q L T2 C1 C2	4.00 5.00 1.00 .555 5.922E-03 1.410E-02
TRANSISTOR, NPN, SI 2N2131	19500	2.0	20.	45.	QUALITY LEVEL COMPLEXITY APPLICATION VOLTAGE RATIO RATED POWER	JAN SIN LIN .200 .500	.15271	.30542	E Q A C S2 R	25.0 2.00 1.50 1.00 .300 1.00
DIODE, GENERAL PURPOSE, SI 1N249A	19500	6.0	20.	45.	QUALITY LEVEL CONSTRUCTION APPLICATION VOLTAGE RATIO RATED POWER	JAN NON SIG .200 1.000	.34204	2.05225	E Q A C S2 R	25.0 5.00 1.00 2.00 .700 1.00
TRANSISTOR, PNP, SI 2N2908	19500	2.0	20.	45.	QUALITY LEVEL COMPLEXITY APPLICATION VOLTAGE RATIO RATED POWER	JAN SIN LIN .200 .400	.23179	.46359	E Q A C S2 R	25.0 2.00 1.50 1.00 .300 1.00

PROJECT: FSM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: PWR CNTRL MISC PARTS 57A ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
DIODE, ZENER / AVALANCHE 1N756	19500	2.0	50.	45.	QUALITY LEVEL	JAN	.76615	1.53230	[illegible]	25.0
					APPLICATION	REG			U	5.00
									A	1.00
RESISTOR, NONWIREWOUND TRIMMER	22097	2.0	10.	45.	SOURCE	RJ	1.42149	2.84299	E	8.00
					MULTIPLIER	.300			Q	1.00
					QUALITY LEVEL	UPPER			R	1.10
					VALUE	1.000E 05			V	1.00
					VOLTAGE RATIO	.500			TAP	1.00
					TAPS	3				
RES, POWER FIXED WW, RW	26	8.0	20.	45.	QUALITY LEVEL	MIL	.26473	2.11786	E	7.00
					STYLE	80			Q	5.00
					VALUE	5.000E 03			R	1.60
CAP, SOLID TANT, CSR	39003	6.0	10.	45.	QUALITY LEVEL	L	.00181	.01083	E	4.00
					SERIES R	3.000			Q	1.50
									SR	7.000E-02
DIODE, GENERAL PURPOSE, SI 1N1259	19500	2.0	20.	45.	QUALITY LEVEL	JAN	.34204	.68409	E	25.0
					CONSTRUCTION	NON			Q	5.00
					APPLICATION	SIG			A	1.00
					VOLTAGE RATIO	.200			C	2.00
					RATED POWER	1.000			SP	.700
									R	1.00
TRANS, POWER, CLASS T	27	1.0	N/A	95.	QUALITY LEVEL	LOWER	.42489	.42489	E	5.00
									F	20.0
IND, POWER, CLASS T	27	2.0	N/A	95.	QUALITY LEVEL	LOWER	.42489	.84978	E	5.00
									F	20.0

PROJECT: ESM FSM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: PWR CNTRL MISC PARTS 57A ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
CAP, PAPER-PLASTIC, CDR 125C	19978	4.0	10.	45.	QUALITY LEVEL	M	.00023	.00092	E	4.00
									Q	1.00
CONN, PWR, TYPE H	21097	1.0	N/A	45.	QUALITY LEVEL	LOWER	.63777	.63777	E	12.0
					ACTIVE CONTACTS	20			P	4.01
					CONTACT GAUGE	20			N	20.0
					CONTACT CURRENT	.100			CYC	.000
					CYCLING RATE	1				

TOTAL QUANTITY EQUALS 40.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 17.72115 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 56429.8 HOURS

PROJECT: FSM FSM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: REMOTE PWR CNTRL 57A ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR DIGITAL SSI/MSI SN5406	883	1.0	N/A	45.	QUALITY LEVEL	B-1	.15399	.15399	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	6			T1	.275
									C1	4.339E-03
									C2	7.401E-03
									P	1.00
IC, BIPOLAR LINEAR 741	883	1.0	N/A	45.	QUALITY LEVEL	B-1	.29847	.29847	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	22			L	1.00
									T2	.555
									C1	5.922E-03
									C2	1.410E-02
TRANSISTOR, PNP, SI 2N2907A	19500	3.0	20.	45.	QUALITY LEVEL	JAN	.23179	.69538	E	25.0
					COMPLEXITY	SIN			Q	2.00
					APPLICATION	LIN			A	1.50
					VOLTAGE RATIO	.200			C	1.00
					RATED POWER	.400			S2	.300
									R	1.00
RES, INSULATED FIXED FILM, RLR	39017	15.0	10.	45.	QUALITY LEVEL	R	.00130	.01944	E	8.00
					VALUE	1.000E 05			Q	.100
									R	1.00
CAP, CERAMIC, CKR 125C	39014	5.0	10.	45.	QUALITY LEVEL	R	.00082	.00410	E	4.00
									Q	.100

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 88

PROJECT: FSM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: REMOTE PWR CNTRL 578 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
CONN, PWR, TYPE B	21097	1.0	N/A	45.	QUALITY LEVEL	LOWER	.63777	.63777	E	12.0
					ACTIVE CONTACTS	20			P	4.01
					CONTACT GAUGE	20			N	20.0
					CONTACT CURRENT	.100			CYC	.000
					CYCLING RATE	1				

TOTAL QUANTITY EQUALS 26.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 1.80916 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 552742.3 HOURS

PROJECT: ESM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: ANTENNA 1 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA	ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS
DIRECTIONAL COUPLER	N/A	1.0	N/A	45.	SOURCE VENDOR SEE ACCOMPANYING REPORT	1.60000	1.60000	
CONN, RF COAXIAL, TYPE C	39012	1.0	N/A	45.	QUALITY LEVEL LOWER ACTIVE CONTACTS 1 CONTACT GAUGE 22 CONTACT CURRENT .010 CYCLING RATE 1	1.63025	1.63025	E 19.0 P 1.00 N 1.00 CYC .000
ANTENNA, LOG PERIODIC	N/A	1.0	N/A	45.	SOURCE ENG. EST. SEE ACCOMPANYING REPORT	.50000	.50000	

TOTAL QUANTITY EQUALS 3.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 3.73025 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 268078.8 HOURS

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 90

PROJECT: ESM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: RF SWITCH 2 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA	ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS
LIMITER PROT SPDT DIODE SW.	N/A	1.0	N/A	45.	SOURCE VENDOR SEE ACCOMPANYING REPORT	13.29999	13.29999	
CONN. RF COAXIAL, TYPE C	39012	2.0	N/A	45.	QUALITY LEVEL LOWER ACTIVE CONTACTS 1 CONTACT GAUGE 22 CONTACT CURRENT .010 CYCLING RATE 1	1.63025	3.26049	E 19.0 P 1.00 N 1.00 CYC .000
RF MULTIPLEXER	N/A	1.0	N/A	45.	SOURCE ENG. EST. SEE ACCOMPANYING REPORT	10.00000	10.00000	

TOTAL QUANTITY EQUALS 4.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 26.56049 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 37649.9 HOURS

PROJECT: FSM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: RF FILTER 3 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA	ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS
BITE DETECTOR W/AMPLIFIER	N/A	1.0	N/A	45.	SOURCE VENDOR SEE ACCOMPANYING REPORT	13.66698	13.66698	
IC, BIPOLAR LINEAR MC1710 (20)	883	1.0	N/A	45.	QUALITY LEVEL B-1 LEARNING FACTOR 1 TRANSISTORS 12	.26341	.26341	E 5.00 Q 5.00 L 1.00 T2 .555 C1 3.729E-03 C2 1.012E-02
CONN, RF COAXIAL, TYPE C	39012	2.0	N/A	45.	QUALITY LEVEL LOWER ACTIVE CONTACTS 1 CONTACT GAUGE 22 CONTACT CURRENT .010 CYCLING RATE 1	1.63025	3.26049	E 19.0 P 1.00 N 1.00 CYC .000
BANDPASS FILTER	N/A	1.0	N/A	45.	SOURCE ENG. EST. SEE ACCOMPANYING REPORT	5.00000	5.00000	
FERRITE, ISOLATOR	N/A	1.0	N/A	45.	SOURCE ENG. EST. SEE ACCOMPANYING REPORT	5.00000	5.00000	
YIG TUNED FILTER	N/A	1.0	N/A	45.	SOURCE VENDOR SEE ACCOMPANYING REPORT	24.00000	24.00000	(2.323/x10-6)
DIODE SWITCH	N/A	3.0	N/A	45.	SOURCE VENDOR SEE ACCOMPANYING REPORT	10.00000	30.00000	
RF AMPLIFIER	N/A	1.0	N/A	45.	SOURCE VENDOR SEE ACCOMPANYING REPORT	22.19998	22.19998	

PROJECT: ESM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: RF FILTER ? ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA	ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS
DIRECTIONAL COUPLER	N/A	1.0	N/A	45.	SOURCE VENDOR SEE ACCOMPANYING REPORT	1.60000	1.60000	
CONNECTOR, RACK, INSERT B	24308	1.0	N/A	45.	SOURCE CONN/RACK/B MULTIPLIER 1.000 QUALITY LEVEL MIL ACTIVE CONTACTS 10 CONTACT GAUGE 20 CONTACT CURRENT .010 CYCLING RATE 1	.30792	.30792	E 9.00 P 2.58 N 10.0 CYC .000

TOTAL QUANTITY EQUALS 13.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 105.29875 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 9496.8 HOURS

PROJECT: FSM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: POWER SUPPLY 6 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA	ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
POWER SUPPLY	N/A	4.0	N/A	45.	SOURCE VENDOR SEE ACCOMPANYING REPORT	8.32999	33.31996		
POWER SUPPLY	N/A	1.0	N/A	45.	SOURCE VENDOR SEE ACCOMPANYING REPORT	37.00000	37.00000		
RELAY	N/A	1.0	N/A	45.	SOURCE ENG. EST. SEE ACCOMPANYING REPORT	5.50000	5.50000		
IND. POWER, CLASS R	27	2.0	N/A	51.	QUALITY LEVEL LOWER	.09784	.1956R	E F	5.00 20.0
CAP, CERAMIC, CKR 125C	39014	2.0	10.	45.	QUALITY LEVEL R	.00164	.0032R	E Q	8.00 .100

TOTAL QUANTITY EQUALS 10.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 76.01891 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 13154.6 HOURS

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 94

PROJECT: FSM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: OSCILLATOR 1 7A ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
CONNECTOR, RACK, INSERT B	24308	1.0	N/A	45.	SOURCE	CONN/RACK/B	.30792	.30792	E	9.00
					MULTIPLIER	1.000			P	2.58
					QUALITY LEVEL	MIL			N	10.0
					ACTIVE CONTACTS	10			CYC	.000
					CONTACT GAUGE	20				
					CONTACT CURRENT	.010				
					CYCLING RATE	1				
POWER DIVIDER	N/A	1.0	N/A	45.	SOURCE	VENDOR	4.00000	4.00000		
					SEE ACCOMPANYING	REPORT				
OSCILLATOR	N/A	1.0	N/A	45.	SOURCE	VENDOR	20.00000	20.00000		
					SEE ACCOMPANYING	REPORT				
DIRECTIONAL COUPLER	N/A	1.0	N/A	45.	SOURCE	VENDOR	1.60000	1.60000		
					SEE ACCOMPANYING	REPORT				
CONN, RF COAXIAL, TYPE C	39012	2.0	N/A	45.	QUALITY LEVEL	LOWER	1.63025	3.26049	E	19.0
					ACTIVE CONTACTS	1			P	1.00
					CONTACT GAUGE	22			N	1.00
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				
BITE DETECTOR W/AMPLIFIER } 22	N/A	1.0	N/A	45.	SOURCE	VENDOR	13.66698	13.66698		
					SEE ACCOMPANYING	REPORT				

FAILURE RATE DETERMINATION MIL-HDBK-217A NOTICE 2 14:05 AUG 22,'79 95

PROJECT: ESM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: OSCILLATOR 1 7A ASSEMBLY TEMP: 45.C

COMPONENT		MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR MC1710	22	883	1.0	N/A	45.	QUALITY LEVEL	B-1	.26341	.26341	E	5.00
						LEARNING FACTOR	1			Q	5.00
						TRANSISTORS	12			L	1.00
										T2	.555
										C1	3.729E-03
										C2	1.012E-02

TOTAL QUANTITY EQUALS 8.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 43.09877 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 23202.5 HOURS

PROJECT: ESM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: IF CONVERTER 1 4A ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA	ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IF AMPLIFIER	N/A	1.0	N/A	45.	SOURCE VENDOR SEE ACCOMPANYING REPORT	33.29999	33.29999		
ATTENUATOR, VOLTAGE CONTROLLED	N/A	2.0	N/A	45.	SOURCE VENDOR SEE ACCOMPANYING REPORT	20.59999	41.19998		
CONN, RF COAXIAL, TYPE C	39012	2.0	N/A	45.	QUALITY LEVEL LOWER ACTIVE CONTACTS 1 CONTACT GAUGE 22 CONTACT CURRENT .010 CYCLING RATE 1	1.63025	3.26049	E P N CYC	19.0 1.00 1.00 .000
FERRITE ISOLATOR	N/A	1.0	N/A	45.	SOURCE ENG, EST. SEE ACCOMPANYING REPORT	5.00000	5.00000		
CONNECTOR, RACK, INSERT B	24308	1.0	N/A	45.	SOURCE CONN/RACK/B MULTIPLIER 1.000 QUALITY LEVEL MIL ACTIVE CONTACTS 10 CONTACT GAUGE 20 CONTACT CURRENT .010 CYCLING RATE 1	.30792	.30792	E P N CYC	9.00 2.58 10.0 .000
CONN, RF COAXIAL, TYPE C (NOTE 1)	39012	2.0	N/A	45.	QUALITY LEVEL LOWER ACTIVE CONTACTS 1 CONTACT GAUGE 22 CONTACT CURRENT .010 CYCLING RATE 1	1.63025	3.26049	E P N CYC	19.0 1.00 1.00 .000
BANDPASS FILTER	N/A	1.0	N/A	45.	SOURCE ENG, EST. SEE ACCOMPANYING REPORT	5.00000	5.00000		

PROJECT: FSM FSM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: IF CONVERTER 1 4A ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA	ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS
DIRECTIONAL COUPLER	N/A	1.0	N/A	45.	SOURCE VENDOR SEE ACCOMPANYING REPORT	1.60000	1.60000	
BITE DETECTOR W/AMPLIFIER	N/A	1.0	N/A	45.	SOURCE VENDOR SEE ACCOMPANYING REPORT	13.66698	13.66698	
IC, BIPOLAR LINEAR MC1710 (21A)	883	1.0	N/A	45.	QUALITY LEVEL B-1 LEARNING FACTOR 1 TRANSISTORS 12	.26341	.26341	E 5.00 Q 5.00 L 1.00 T2 .555 C1 3.729E-03 C2 1.012E-02
SIGNAL SEPARATOR	N/A	1.0	N/A	45.	SOURCE ENG. EST. SEE ACCOMPANYING REPORT	1.60000	1.60000	

TOTAL QUANTITY EQUALS 14.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 108.45923 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 9220.1 HOURS

NOTES
1 THESE PARTS MAKE UP THE L1-324JJ BND PASS FILTER.

PROJECT: FSM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: OSCILLATOR 2 7B ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
OSCILLATOR	N/A	2.0	N/A	45.	SOURCE SEE ACCOMPANYING REPORT	ENG. EST.	20.00000	40.00000		
DIRECTIONAL COUPLER	N/A	2.0	N/A	45.	SOURCE SEE ACCOMPANYING REPORT	VENDOR	1.60000	3.20000		
POWER DIVIDER	N/A	2.0	N/A	45.	SOURCE SEE ACCOMPANYING REPORT	VENDOR	4.00000	8.00000		
RITE DETECTOR W/AMPLIFIER	N/A	2.0	N/A	45.	SOURCE SEE ACCOMPANYING REPORT	VENDOR	13.66698	27.33395		
IC, BIPOLAR LINEAR MC1710 (22B)	883	2.0	N/A	45.	QUALITY LEVEL LEARNING FACTOR TRANSISTORS	B-1 1 12	.26341	.52682	E Q L T2 C1 C2	5.00 5.00 1.00 .555 3.729E-03 1.012E-02
CONN, RF COAXIAL, TYPE C	39012	2.0	N/A	45.	QUALITY LEVEL ACTIVE CONTACTS CONTACT GAUGE CONTACT CURRENT CYCLING RATE	LOWER 1 22 .010 1	1.63025	3.26049	E P N CYC	19.0 1.00 1.00 .000
CONN, RACK AND PANEL, TYPE R	24308	2.0	N/A	45.	QUALITY LEVEL ACTIVE CONTACTS CONTACT GAUGE CONTACT CURRENT CYCLING RATE	LOWER 10 20 .010 1	.65005	1.30011	E P N CYC	19.0 2.58 10.0 .000

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 99

PROJECT: FSM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: OSCILLATOR 2 7B ASSEMBLY TEMP: 45.C

TOTAL QUANTITY EQUALS 14.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 83.62137 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 11958.7 HOURS

PROJECT: ESM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: IF CONVERTER 2 4B ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA	ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IF AMPLIFIER	N/A	1.0	N/A	45.	SOURCE VENDOR SEE ACCOMPANYING REPORT	33.29999	33.29999		
ATTENUATOR, VOLTAGE CONTROLLED	N/A	2.0	N/A	45.	SOURCE VENDOR SEE ACCOMPANYING REPORT	20.59999	41.19998		
CONN, RF COAXIAL, TYPE C	39012	2.0	N/A	45.	QUALITY LEVEL LOWER ACTIVE CONTACTS 1 CONTACT GAUGE 22 CONTACT CURRENT .010 CYCLING RATE 1	1.63025	3.26049	E P N CYC	19.0 1.00 1.00 .000
FERRITE ISOLATOR	N/A	1.0	N/A	45.	SOURCE ENG, EST. SEE ACCOMPANYING REPORT	5.00000	5.00000		
CONNECTOR, RACK, INSERT B	24308	1.0	N/A	45.	SOURCE CONN/RACK/B MULTIPLIER 1.000 QUALITY LEVEL MIL ACTIVE CONTACTS 10 CONTACT GAUGE 20 CONTACT CURRENT .010 CYCLING RATE 1	.30792	.30792	E P N CYC	9.00 2.58 10.0 .000
CONN, RF COAXIAL, TYPE C (NOTE 1)	39012	2.0	N/A	45.	QUALITY LEVEL LOWER ACTIVE CONTACTS 1 CONTACT GAUGE 22 CONTACT CURRENT .010 CYCLING RATE 1	1.63025	3.26049	E P N CYC	19.0 1.00 1.00 .000
BANDPASS FILTER	N/A	1.0	N/A	45.	SOURCE ENG, EST. SEE ACCOMPANYING REPORT	5.00000	5.00000		

PROJECT: ESM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: IF CONVERTER 2 4B ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA	ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS
DIRECTIONAL COUPLER	N/A	1.0	N/A	45.	SOURCE VENDOR SEE ACCOMPANYING REPORT	1.60000	1.60000	
21B BITE DETECTOR W/AMPLIFIER	N/A	1.0	N/A	45.	SOURCE VENDOR SEE ACCOMPANYING REPORT	13.66698	13.66698	
IC, BIPOLAR LINEAR MC1710	883	1.0	N/A	45.	QUALITY LEVEL B-1 LEARNING FACTOR 1 TRANSISTORS 12	.26341	.26341	E 5.00 Q 5.00 L 1.00 T2 .555 C1 3.729E-03 C2 1.012E-02
SIGNAL SEPARATOR	N/A	1.0	N/A	45.	SOURCE ENG. EST. SEE ACCOMPANYING REPORT	1.60000	1.60000	
MIXER, DOUBLE BALANCED	N/A	1.0	20.	45.	SOURCE D/GEN/SI MULTIPLIER 10.000 QUALITY LEVEL JAN CONSTRUCTION MET APPLICATION SIG VOLTAGE RATIO .200 RATED POWER .500	1.71021	1.71021	E 25.0 Q 5.00 A 1.00 C 1.00 S2 .700 R 1.00
FERRITE ISOLATOR	N/A	1.0	N/A	45.	SOURCE ENG. EST. SEE ACCOMPANYING REPORT	5.00000	5.00000	

PROJECT: FSM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: IF CONVERTER 2 4B ASSEMBLY TEMP: 45.C

TOTAL QUANTITY EQUALS 16.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 115.16943 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 8682.9 HOURS

NOTES
1 THESE PARTS MAKE UP THE L1-324JJ BND PASS FILTER.

PROJECT: ESM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: RITE&CAL, GEN&CNTRL 23 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA	ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
CONN, RF COAXIAL, TYPE C	39012	5.0	N/A	45.	QUALITY LEVEL LOWER ACTIVE CONTACTS 1 CONTACT GAUGE 22 CONTACT CURRENT .010 CYCLING RATE 1	1.63025	8.15124	E P N CYC	19.0 1.00 1.00 .000
POWER DIVIDER	N/A	1.0	N/A	45.	SOURCE VENDOR SEE ACCOMPANYING REPORT	2.50000	2.50000		
RF MULTIPLEXER	N/A	1.0	N/A	45.	SOURCE ENG, EST. SEE ACCOMPANYING REPORT	10.00000	10.00000		
MODULATOR	N/A	5.0	N/A	45.	SOURCE ENG, EST. SEE ACCOMPANYING REPORT	5.00000	25.00000		
VOLTAGE CONTROLLED OSCILLATOR	N/A	5.0	N/A	45.	SOURCE VENDOR SEE ACCOMPANYING REPORT	20.00000	100.00000		
CONNECTOR, RACK, INSERT B	24308	1.0	N/A	45.	SOURCE CONN/RACK/B MULTIPLIER 1.000 QUALITY LEVEL MIL ACTIVE CONTACTS 10 CONTACT GAUGE 20 CONTACT CURRENT .010 CYCLING RATE 1	.30792	.30792	E P N CYC	9.00 2.58 10.0 .000
POWER DIVIDER	N/A	2.0	N/A	45.	SOURCE VENDOR SEE ACCOMPANYING REPORT	3.30000	6.60000		

PROJECT: FSM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: RITE&CAL, GEN&CNTRL 23 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR DIGITAL SSI/MSI DM54LS124	883	5.0	N/A	50.	QUALITY LEVEL	B-1	.23292	1.16462	E	5.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	10			T1	.347
									C1	6.132E-03
									C2	8.891E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI SN54196	883	5.0	N/A	55.	QUALITY LEVEL	B-1	.33368	1.66841	E	5.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	25			T1	.436
									C1	1.140E-02
									C2	1.235E-02
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI SN5400	883	5.0	N/A	55.	QUALITY LEVEL	B-1	.16715	.83574	E	5.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	4			T1	.436
									C1	3.297E-03
									C2	6.399E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI SN54164	883	5.0	N/A	70.	QUALITY LEVEL	B-1	.41227	2.06137	E	5.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	36			T1	.825
									C1	1.460E-02
									C2	1.408E-02
									P	1.00

PROJECT: ESM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: BITE&CAL, GEN&CNTRL 23 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR MC1508	883	5.0	N/A	55.	QUALITY LEVEL	B-1	.88864	4.44321	E	5.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	94			L	1.00
									T2	1.21
									C1	1.793E-02
									C2	3.121E-02
IC, BIPOLAR LINEAR UA741	883	5.0	N/A	55.	QUALITY LEVEL	B-1	.36793	1.83965	E	5.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	20			L	1.00
									T2	1.21
									C1	5.506E-03
									C2	1.339E-02
IC, BIPOLAR DIGITAL SSI/MSI SN5430	883	5.0	N/A	55.	QUALITY LEVEL	B-1	.10006	.50030	E	5.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	1			T1	.436
									C1	1.290E-03
									C2	3.890E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI SN5470	883	5.0	N/A	55.	QUALITY LEVEL	B-1	.21664	1.08322	E	5.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	8			T1	.436
									C1	5.272E-03
									C2	8.207E-03
									P	1.00

PROJECT: ESM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: BITE&CAL, GEN&CNTRL 23 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR DIGITAL SSI/MSI SN54121	883	5.0	N/A	55.	QUALITY LEVEL	B-1	.21664	1.08322	E	5.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	8			T1	.436
									C1	5.272E-03
									C2	8.287E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI SN5402	883	5.0	N/A	55.	QUALITY LEVEL	B-1	.16715	.83574	E	5.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	4			T1	.436
									C1	3.297E-03
									C2	6.399E-03
									P	1.00
IC, BIPOLAR LINEAR LH0032	883	5.0	N/A	55.	QUALITY LEVEL	B-1	.52972	2.64862	E	5.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	38			L	1.00
									T2	1.21
									C1	8.986E-03
									C2	1.902E-02
IC, BIPOLAR DIGITAL SSI/MSI DM7820	883	5.0	N/A	55.	QUALITY LEVEL	B-1	.33368	1.66841	E	5.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	25			T1	.436
									C1	1.140E-02
									C2	1.235E-02
									P	1.00

PROJECT: ESM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: BITE&CAL, GEN&CNTRL 23 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
RES, INSULATED FIXED FILM, RLR	39017	40.0	20.	45.	QUALITY LEVEL	R	.00255	.10194	E	14.0
					VALUE	1.000E 04			Q	.100
									R	1.00
RESISTOR, NONWIREWOUND TRIMMER	22097	15.0	20.	45.	SOURCE	RJ	2.13143	31.97144	E	12.5
					MULTIPLIER	.300			Q	1.00
					QUALITY LEVEL	UPPER			R	1.00
					VALUE	1.000F 04			V	1.00
					VOLTAGE RATIO	.500			TAP	1.00
					TAPS	3				

TOTAL QUANTITY EQUALS 135.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 204.46498 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 4890.8 HOURS

PROJECT: ESM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: IF CONVERTER 3 4C ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA	ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IF AMPLIFIER	N/A	1.0	N/A	45.	SOURCE VENDOR SEE ACCOMPANYING REPORT	33.29999	33.29999		
ATTENUATOR, VOLTAGE CONTROLLED	N/A	2.0	N/A	45.	SOURCE VENDOR SEE ACCOMPANYING REPORT	20.59999	41.19998		
CONN, RF COAXIAL, TYPE C	39012	2.0	N/A	45.	QUALITY LEVEL LOWER ACTIVE CONTACTS 1 CONTACT GAUGE 22 CONTACT CURRENT .010 CYCLING RATE 1	1.63025	3.26049	E 19.0 P 1.00 N 1.00 CYC .000	
FERRITE ISOLATOR	N/A	1.0	N/A	45.	SOURCE ENG. EST. SEE ACCOMPANYING REPORT	5.00000	5.00000		
CONNECTOR, RACK, INSERT B	24308	1.0	N/A	45.	SOURCE CONN/RACK/B MULTIPLIER 1.000 QUALITY LEVEL MIL ACTIVE CONTACTS 10 CONTACT GAUGE 20 CONTACT CURRENT .010 CYCLING RATE 1	.30792	.30792	E 9.00 P 2.58 N 10.0 CYC .000	
CONN, RF COAXIAL, TYPE C (NOTE 1)	39012	2.0	N/A	45.	QUALITY LEVEL LOWER ACTIVE CONTACTS 1 CONTACT GAUGE 22 CONTACT CURRENT .010 CYCLING RATE 1	1.63025	3.26049	E 19.0 P 1.00 N 1.00 CYC .000	
BANDPASS FILTER	N/A	1.0	N/A	45.	SOURCE ENG. EST. SEE ACCOMPANYING REPORT	5.00000	5.00000		

PROJECT: ESM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: IF CONVERTER 3 4C ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
DIRECTIONAL COUPLER	N/A	1.0	N/A	45.	SOURCE	VENDOR	1.60000	1.60000		
					SEE ACCOMPANYING REPORT					
BITE DETECTOR W/AMPLIFIER	N/A	1.0	N/A	45.	SOURCE	VENDOR	13.66698	13.66698		
					SEE ACCOMPANYING REPORT					
IC, BIPOLAR LINEAR (21C)										
MC1710	883	1.0	N/A	45.	QUALITY LEVEL	B-1	.26341	.26341	E	5.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	12			L	1.00
									T2	.555
									C1	3.729E-03
									C2	1.012E-02
SIGNAL SEPARATOR	N/A	1.0	N/A	45.	SOURCE	ENG. EST.	1.60000	1.60000		
					SEE ACCOMPANYING REPORT					
BANDPASS FILTER	N/A	1.0	N/A	45.	SOURCE	ENG. EST.	5.00000	5.00000		
					SEE ACCOMPANYING REPORT					
FERRITE ISOLATOR	N/A	3.0	N/A	45.	SOURCE	ENG. EST.	5.00000	15.00000		
					SEE ACCOMPANYING REPORT					
MIXER, DOUBLE BALANCED	N/A	2.0	20.	45.	SOURCE	D/GEN/SI	1.71021	3.42042	E	25.0
					MULTIPLIER	10.000			Q	5.00
					QUALITY LEVEL	JAN			A	1.00
					CONSTRUCTION	MET			C	1.00
					APPLICATION	SIG			S2	.700
					VOLTAGE RATIO	.200			R	1.00
					RATED POWER	.500				

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 110

PROJECT: ESM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: IF CONVERTER 3 4C ASSEMBLY TEMP: 45.C

TOTAL QUANTITY EQUALS 20.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 131.87964 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 7582.7 HOURS

NOTES
1 THESE PARTS MAKE UP THE L1-324JJ BND PASS FILTER.

PROJECT: FSM FSM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: SENSOR 24 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
RES, THERMISTOR, RTH	23648	10.0	N/A	45.	STYLE	BEAD	.40000	4.00000		
IC, BIPOLAR LINEAR 741	883	10.0	N/A	45.	QUALITY LEVEL	B-1	.36898	3.68983	E	5.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	22			L	1.00
									T2	.555
									C1	5.922E-03
									C2	1.410E-02
IC, BIPOLAR LINEAR LM111	883	40.0	N/A	45.	QUALITY LEVEL	B-1	.39620	15.84805	E	5.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	25			L	1.00
									T2	.555
									C1	6.529E-03
									C2	1.512E-02
IC, BIPOLAR DIGITAL SSI/MSI 5400	883	40.0	N/A	45.	QUALITY LEVEL	B-1	.16450	6.58005	E	5.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	4			T1	.275
									C1	3.297E-03
									C2	6.399E-03
									P	1.00
DIODE, GENERAL PURPOSE, SI CURRENT SENSOR	19500	40.0	10.	45.	QUALITY LEVEL	JAN	.12888	5.15504	E	25.0
					CONSTRUCTION	MET			Q	5.00
					APPLICATION	SIG			A	1.00
					VOLTAGE RATIO	.100			C	1.00
					RATED POWER	.500			S2	.700
									R	1.00

FAILURE RATE DETERMINATION MIL-HDBK-217A NOTICE 2 14:05 AUG 22,'79 112

PROJECT: FSM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: SENSOR 24 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR ADC82AG	883	40.0	N/A	45.	QUALITY LEVEL	B-1	.58314	23.32573	E	5.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	50			L	1.00
									T2	.555
									C1	1.108E-02
									C2	2.210E-02

TOTAL QUANTITY EQUALS 180.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 58.59866 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 17065.2 HOURS

PROJECT: ESM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: CONTROL 8 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR DS7820	883	2.0	N/A	45.	QUALITY LEVEL	B-1	.34992	.69984	E	5.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	20			L	1.00
									T2	.555
									C1	5.506E-03
									C2	1.339E-02
IC, BIPOLAR LINEAR DAC1118	883	2.0	N/A	45.	QUALITY LEVEL	B-1	.58314	1.16629	E	5.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	50			L	1.00
									T2	.555
									C1	1.108E-02
									C2	2.210E-02
RES, INSULATED FIXED COMP, RCR	39008	1.0	10.	45.	QUALITY LEVEL	S	.00008	.00008	E	7.50
					VALUE	1.000E 05			Q	3.000E-02
									R	1.00
CAP, CERAMIC, CKR 125C	39014	1.0	10.	45.	QUALITY LEVEL	R	.00164	.00164	E	8.00
									Q	.100
IC, BIPOLAR LINEAR SHA-5	883	16.0	N/A	45.	QUALITY LEVEL	B-1	.58314	9.33029	E	5.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	50			L	1.00
									T2	.555
									C1	1.108E-02
									C2	2.210E-02

PROJECT: FSM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: CONTROL 8 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR DIGITAL SSI/MSI 54164	883	4.0	N/A	45.	QUALITY LEVEL	B-1	.42748	1.70990	E	5.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	52			T1	.275
									C1	1.872E-02
									C2	1.607E-02
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 5404	883	6.0	N/A	45.	QUALITY LEVEL	B-1	.19100	1.14599	E	5.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	6			T1	.275
									C1	4.339E-03
									C2	7.401E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 5473	883	36.0	N/A	45.	QUALITY LEVEL	B-1	.24685	8.88660	E	5.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	12			T1	.275
									C1	6.937E-03
									C2	9.492E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 5414	883	1.0	N/A	45.	QUALITY LEVEL	B-1	.19100	.19100	E	5.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	6			T1	.275
									C1	4.339E-03
									C2	7.401E-03
									P	1.00

PROJECT: ESM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: CONTROL 8 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR DIGITAL SSI/MSI 5430	883	5.0	N/A	45.	QUALITY LEVEL	B-1	.09902	.49512	E	5.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	1			T1	.275
									C1	1.290E-03
									C2	3.890E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 5432	883	1.0	N/A	45.	QUALITY LEVEL	B-1	.16450	.16450	E	5.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	4			T1	.275
									C1	3.297E-03
									C2	6.399E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 9602	883	3.0	N/A	45.	QUALITY LEVEL	B-1	.36820	1.10459	E	5.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	35			T1	.275
									C1	1.432E-02
									C2	1.394E-02
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 5408	883	1.0	N/A	45.	QUALITY LEVEL	B-1	.16450	.16450	E	5.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	4			T1	.275
									C1	3.297E-03
									C2	6.399E-03
									P	1.00

PROJECT: FSM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: CONTROL 8 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR DIGITAL SSI/MSI 54145	883	1.0	N/A	45.	QUALITY LEVEL	B-1	.28705	.28705	E	5.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	18			T1	.275
									C1	9.129E-03
									C2	1.098E-02
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 5402	883	1.0	N/A	45.	QUALITY LEVEL	B-1	.16450	.16450	E	5.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	4			T1	.275
									C1	3.297E-03
									C2	6.399E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 7220	883	5.0	N/A	45.	QUALITY LEVEL	B-1	.32453	1.62266	E	5.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	25			T1	.275
									C1	1.140E-02
									C2	1.235E-02
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 5417	883	35.0	N/A	45.	QUALITY LEVEL	B-1	.19100	6.68496	E	5.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	6			T1	.275
									C1	4.339E-03
									C2	7.401E-03
									P	1.00

PROJECT: ESM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: CONTROL 8 ASSEMBLY TEMP: 45.C

TOTAL QUANTITY EQUALS 121.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 33.81950 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 29568.7 HOURS

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 118

PROJECT: FSM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: COMMUTATOR 8 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR ECL DIGITAL SSI/MSI F100164	883	5.0	N/A	45.	QUALITY LEVEL	B-1	.34351	1.71756	E	5.00
					LEARNING FACTOR	1			Q	5.00
					PINS	24			L	1.00
					GATES	20			T2	.555
									C1	9.804E-03
									C2	1.140E-02
									P	1.10
IC, BIPOLAR ECL DIGITAL SSI/MSI F100136	883	5.0	N/A	45.	QUALITY LEVEL	B-1	.61817	3.09084	E	5.00
					LEARNING FACTOR	1			Q	5.00
					PINS	24			L	1.00
					GATES	89			T2	.555
									C1	2.694E-02
									C2	1.949E-02
									P	1.10

TOTAL QUANTITY EQUALS 10.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 4.80840 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 207969.1 HOURS

PROJECT: FSM FSM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: AMPLITUDE ENCODER 12 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR 741	883	2.0	N/A	45.	QUALITY LEVEL	B-1	.29847	.59695	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	22			L	1.00
									T2	.555
									C1	5.922E-03
									C2	1.410E-02
DIODE, DETECTOR, SI 1N32	19500	3.0	20.	45.	QUALITY LEVEL	JAN	8.05764	24.17290	E	50.0
									Q	3.50
IC, MOS DIGITAL LSI 8080	38510	1.0	N/A	45.	QUALITY LEVEL	B	.70639	.70639	E	4.00
					LEARNING FACTOR	1			Q	2.00
					PINS	40			L	1.00
					GATES	1200			T2	.555
									C1	.169
									C2	5.677E-02
									P	1.10
IC, BIPOLAR DIGITAL SSI/MSI 5401	883	4.0	N/A	45.	QUALITY LEVEL	B-1	.13251	.53003	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	4			T1	.275
									C1	3.297E-03
									C2	6.399E-03
									P	1.00

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 120

PROJECT: FSM FSM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: AMPLITUDE ENCODER 12 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR DIGITAL SSI/MSI 54160	883	2.0	N/A	45.	QUALITY LEVEL	B-1	.33667	.67334	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	48			T1	.275
									C1	1.773E-02
									C2	1.561E-02
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 54175	883	4.0	N/A	45.	QUALITY LEVEL	B-1	.22210	.88838	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	16			T1	.275
									C1	8.429E-03
									C2	1.053E-02
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 54123	883	2.0	N/A	45.	QUALITY LEVEL	B-1	.22210	.44419	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	16			T1	.275
									C1	8.429E-03
									C2	1.053E-02
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 5473	883	4.0	N/A	45.	QUALITY LEVEL	B-1	.18625	.74501	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	10			T1	.275
									C1	6.132E-03
									C2	8.891E-03
									P	1.00

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 121

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: AMPLITUDE ENCODER 12 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
AMPLIFIER, GaAS FET	N/A	1.0	N/A	45.	SOURCE	VENDOR	5.50000	5.50000		
					SEF ACCOMPANYING	REPORT				
FINE SECTOR ENCODER	N/A	1.0	N/A	45.	SOURCE	VENDOR	10.70000	10.70000		
					SEF ACCOMPANYING	REPORT				
CONN, RF COAXIAL, TYPE C	39012	1.0	N/A	45.	QUALITY LEVEL	LOWER	3.08889	3.08889	E	36.0
					ACTIVE CONTACTS	1			P	1.00
					CONTACT GAUGE	22			N	1.00
					CONTACT CURRENT	.010			CYC	.000
					CYCLING RATE	1				
CONNECTOR, RACK, INSERT B	24308	1.0	N/A	45.	SOURCE	CONN/RACK/B	.13685	.13685	E	4.00
					MULTIPLIER	1.000			P	2.58
					QUALITY LEVEL	MIL			N	10.0
					ACTIVE CONTACTS	10			CYC	.000
					CONTACT GAUGE	20				
					CONTACT CURRENT	.010				
					CYCLING RATE	1				

TOTAL QUANTITY EQUALS 26.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 48.18286 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 20754.3 HOURS

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 122

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: IF FILTER 11 ASSEMBLY TEMP: 45.C

COMPONENT	COMPONENT NUMBER	QTY	TEMP	ITEM FAILURE RATE	TOTAL FAILURE RATE
FLT MISC PARTS	52A	1.0	45.	26.80432	26.80432
YIG TUNED FILTER	52B	1.0	45.	11.82077	11.82077

TOTAL QUANTITY EQUALS 2.0 ASSEMBLIES

TOTAL FAILURE RATE EQUALS 38.62509 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 25889.9 HOURS

PROJECT: FSM FSM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: IF CROSSBAR 10 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA	ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS
COMPENSATOR	N/A	32.0	N/A	45.	SOURCE ENG. EST. SEE ACCOMPANYING REPORT	1.60000	51.19998	
DIODE, GENERAL PURPOSE, SI (NOTE 1)	19500	36.0	10.	45.	QUALITY LEVEL JAN CONSTRUCTION MET APPLICATION SIG VOLTAGE RATIO .100 RATED POWER .500	.12488	4.63954	E 25.0 Q 5.00 A 1.00 C 1.00 S2 .700 R 1.00
CAP, CERAMIC, CKR 125C (NOTE 1)	39014	36.0	10.	45.	QUALITY LEVEL R	.00082	.02955	E 4.00 Q .100
RES, INSULATED FIXED COMP, RCR (NOTE 1)	39008	32.0	10.	45.	QUALITY LEVEL S VALUE 5.000E 01	.00006	.00178	E 5.00 Q 3.000E-02 R 1.00
CONN, RF COAXIAL, TYPE C (NOTE 1)	39012	36.0	N/A	45.	QUALITY LEVEL LOWER ACTIVE CONTACTS 1 CONTACT GAUGE 22 CONTACT CURRENT .010 CYCLING RATE 1	3.08489	111.20000	E 36.0 P 1.00 N 1.00 CYC .000
SIGNAL SEPARATOR	N/A	32.0	N/A	45.	SOURCE ENG, EST. SEE ACCOMPANYING REPORT	1.60000	51.19998	
POWER DIVIDER	N/A	32.0	N/A	45.	SOURCE VENDOR SEE ACCOMPANYING REPORT	2.50000	79.99997	

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 124

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: IF CROSSBAR 10 ASSEMBLY TEMP: 45.C

TOTAL QUANTITY EQUALS 236.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 298.27075 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 3352.7 HOURS

NOTES
1 THESE UNITS MAKE UP THE 32 WAY SWITCH MATRIX.

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 125

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: IFM RECEIVER 19 ASSEMBLY TEMP: 45.C

COMPONENT	COMPONENT NUMBER	QTY	TEMP	ITEM FAILURE RATE	TOTAL FAILURE RATE
UNIT 2 12-18GH7 RF	Y	1.0	75.	222.03571	222.03571
UNIT 3 RCVR INTFC	Z	1.0	65.	157.37766	157.37766

TOTAL QUANTITY EQUALS 2.0 ASSEMBLIES

TOTAL FAILURE RATE EQUALS 379.41333 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 2635.6 HOURS

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 126

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: DIGITAL RCVR ,'17 ASSEMBLY TEMP: 45.C

COMPONENT	COMPONENT NUMBER	QTY	TEMP	ITEM FAILURE RATE	TOTAL FAILURE RATE
MAINFRAME		1.0	75.	58.83369	58.83369
RF TUNER PLUG-IN		1.0	75.	81.78992	81.78992
PARAMETER MEAS.		1.0	75.	37.10934	37.10934

TOTAL QUANTITY EQUALS 3.0 ASSEMBLIES

TOTAL FAILURE RATE EQUALS 177.73296 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 5626.4 HOURS

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: COMMAND & CONTROL 9 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR DIGITAL SSI/MSI SN5406	883	7.0	N/A	45.	QUALITY LEVEL	B-1	.15399	1.07795	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	6			T1	.275
									C1	4.339E-03
									C2	7.401E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI SN54166	883	4.0	N/A	45.	QUALITY LEVEL	B-1	.36669	1.46676	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	60			T1	.275
									C1	2.063E-02
									C2	1.692E-02
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI SN5401	883	2.0	N/A	45.	QUALITY LEVEL	B-1	.13251	.26502	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	4			T1	.275
									C1	3.297E-03
									C2	6.399E-03
									P	1.00
IC, BIPOLAR LINEAR DS7820	883	2.0	N/A	45.	QUALITY LEVEL	B-1	.28299	.56599	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	20			L	1.00
									T2	.555
									C1	5.506E-03
									C2	1.339E-02

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: COMMAND & CONTROL 9 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR DIGITAL SSI/MSI SN54164	883	4.0	N/A	45.	QUALITY LEVEL	B-1	.34713	1.38852	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	52			T1	.275
									C1	1.872E-02
									C2	1.607E-02
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI SN5473	883	3.0	N/A	45.	QUALITY LEVEL	B-1	.18625	.55876	F	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	10			T1	.275
									C1	6.132E-03
									C2	8.891E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI SN5430	883	2.0	N/A	45.	QUALITY LEVEL	B-1	.07957	.15915	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	1			T1	.275
									C1	1.290E-03
									C2	3.890E-03
									P	1.00
RES, INSULATED FIXED FILM, WLR	39017	10.0	10.	45.	QUALITY LEVEL	R	.00130	.01296	E	8.00
					VALUE	5.000E 04			Q	.100
									R	1.00
CAP, CERAMIC, CKR 125C	39014	4.0	10.	45.	QUALITY LEVEL	R	.00082	.00328	E	4.00
									Q	.100

PROJECT: FSM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: COMMAND & CONTROL 9 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
CONN, PWR, TYPE B	21097	2.0	N/A	45.	QUALITY LEVEL	LOWER	.63766	1.27533	E	12.0
					ACTIVE CONTACTS	20			P	4.01
					CONTACT GAUGE	20			N	20.0
					CONTACT CURRENT	.050			CYC	.000
					CYCLING RATE	1				

TOTAL QUANTITY EQUALS 40.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 6.77371 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 147629.6 HOURS

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 130

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: PWR CNTRL PANEL 15 ASSEMBLY TEMP: 45.C

COMPONENT	COMPONENT NUMBER	QTY	TEMP	ITEM FAILURE RATE	TOTAL FAILURE RATE
POWER SUPPLY	PS1	1.0	45.	18.86929	18.86929
PWR CNTRL MISC PARTS	57A	1.0	45.	17.72115	17.72115
REMOTE PWR CNTRL	57B	1.0	45.	1.80916	1.80916

TOTAL QUANTITY EQUALS 3.0 ASSEMBLIES

TOTAL FAILURE RATE EQUALS 38.39960 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 26041.9 HOURS

PROJECT: FSM FSM

ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: ACTIVITY DETECTOR 13

ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
DIODE, DETECTOR, SI 1N32	19500	1.0	20.	45.	QUALITY LEVEL	JAN	8.05764	8.05764	E Q	50.0 3.50
AMPLIFIER, GAAS FET	N/A	7.0	N/A	45.	SOURCE SEE ACCOMPANYING REPORT	VENDOR	5.50000	38.49997		
CONNECTOR, RACK, INSERT B	24308	1.0	N/A	45.	SOURCE MULTIPLIER QUALITY LEVEL ACTIVE CONTACTS CONTACT GAUGE CONTACT CURRENT CYCLING RATE	CONN/RACK/B 1.000 MIL 10 20 .100 1	.13688	.13688	E P N CYC	4.00 2.58 10.0 .000
CONN, RF COAXIAL, TYPE C	39012	1.0	N/A	45.	QUALITY LEVEL ACTIVE CONTACTS CONTACT GAUGE CONTACT CURRENT CYCLING RATE	LOWER 1 22 .010 1	3.08889	3.08889	E P N CYC	36.0 1.00 1.00 .000

TOTAL QUANTITY EQUALS 10.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 49.78337 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 20087.0 HOURS

FAILURE RATE DETERMINATION MIL-HDBK-217A NOTICE 2 14:05 AUG 22,'79 132

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: ACTIVITY PROCESSOR 13 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR DIGITAL SSI/MSI SN5432	883	24.0	N/A	55.	QUALITY LEVEL	B-1	.13515	3.24360	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	4			T1	.436
									C1	3.297E-03
									C2	6.399E-03
									P	1.00
IC, BIPOLAR LINEAR MC1741	883	24.0	N/A	55.	QUALITY LEVEL	B-1	.29232	7.01564	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	19			L	1.00
									T2	1.21
									C1	5.295E-03
									C2	1.302E-02
RES, INSULATED FIXED COMP, MCR	39008	90.0	30.	45.	QUALITY LEVEL	S	.00008	.00738	E	5.00
					VALUE	1.000E 04			Q	3.000E-02
									R	1.00
CAP, CERAMIC, CKR 125C	39014	60.0	30.	45.	QUALITY LEVEL	R	.00158	.09498	E	4.00
									Q	.100
IC, MOS DIGITAL LSI 8080	38510	8.0	N/A	45.	QUALITY LEVEL	B	.70639	5.65110	E	4.00
					LEARNING FACTOR	1			Q	2.00
					PINS	40			L	1.00
					GATES	1200			T2	.555
									C1	.169
									C2	5.677E-02
									P	1.10

PROJECT: FSM FSM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: ACTIVITY PROCESSOR 13 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR DIGITAL SSI/MSI 5401	883	32.0	N/A	45.	QUALITY LEVEL	B-1	.13251	4.24025	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	4			T1	.275
									C1	3.297E-03
									C2	6.399E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 54160	883	16.0	N/A	45.	QUALITY LEVEL	B-1	.33667	5.38669	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	48			T1	.275
									C1	1.773E-02
									C2	1.561E-02
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 54175	883	16.0	N/A	45.	QUALITY LEVEL	B-1	.23215	3.71438	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	18			T1	.275
									C1	9.129E-03
									C2	1.098E-02
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 54123	883	16.0	N/A	45.	QUALITY LEVEL	B-1	.22210	3.55352	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	16			T1	.275
									C1	8.429E-03
									C2	1.053E-02
									P	1.00

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: ACTIVITY PROCESSOR 13 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR DIGITAL SSI/MSI 5473	883	16.0	N/A	45.	QUALITY LEVEL	B-1	.19939	3.19021	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	12			T1	.275
									C1	6.937E-03
									C2	9.492E-03
									P	1.00
IC, BIPOLAR LINEAR MC3416	883	8.0	N/A	45.	QUALITY LEVEL	B-1	.61548	4.92385	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	80			L	1.00
									T2	.555
									C1	1.586E-02
									C2	2.857E-02
IC, BIPOLAR LINEAR MC1505	883	8.0	N/A	45.	QUALITY LEVEL	B-1	.69784	5.58271	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	100			L	1.00
									T2	.555
									C1	1.880E-02
									C2	3.228E-02
IC, MOS DIGITAL SSI/MSI MC14435	883	2.0	N/A	45.	QUALITY LEVEL	B-1	.27873	.55745	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	25			T2	.555
									C1	1.140E-02
									C2	1.235E-02
									P	1.00

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: ACTIVITY PROCESSOR 13 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR DIGITAL SSI/MSI SN74LS86J	883	2.0	N/A	45.	QUALITY LEVEL	B-1	.13251	.26502	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	14			L	1.00
					GATES	4			T1	.275
									C1	3.297E-03
									C2	6.399E-03
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI SN74174	883	2.0	N/A	45.	QUALITY LEVEL	B-1	.28851	.57702	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	32			T1	.275
									C1	1.348E-02
									C2	1.350E-02
									P	1.00
IC, BIPOLAR DIGITAL SSI/MSI 9318DC	883	1.0	N/A	45.	QUALITY LEVEL	B-1	.26276	.26276	E	4.00
					LEARNING FACTOR	1			Q	5.00
					PINS	16			L	1.00
					GATES	25			T1	.275
									C1	1.140E-02
									C2	1.235E-02
									P	1.00
IC, BIPOLAR LINEAR SE529K	883	8.0	N/A	45.	QUALITY LEVEL	B-1	.47266	3.78131	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	50			L	1.00
									T2	.555
									C1	1.108E-02
									C2	2.210E-02

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 136

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: ACTIVITY PROCESSOR 13 ASSEMBLY TEMP: 45.C

COMPONENT	MIL SPEC	QTY	% STRESS	TEMP	CRITERIA		ITEM FAILURE RATE	TOTAL FAILURE RATE	PI FACTORS	
IC, BIPOLAR LINEAR LM0033C	883	2.0	N/A	45.	QUALITY LEVEL	B-1	.26682	.53364	E	4.00
					LEARNING FACTOR	1			Q	5.00
					TRANSISTORS	18			L	1.00
									T2	.555
									C1	5.081E-03
									C2	1.264E-02

TOTAL QUANTITY EQUALS 335.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 52.58154 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 19018.1 HOURS

APPENDIX A
PART IV – SUMMARY FAILURE RATES

PROJECT: ESM ESM ENVIRONMENT: NAVAL, UNSHELTERED

ASSEMBLY: EXTERIOR GROUP ASSEMBLY TEMP: 25.C

COMPONENT	COMPONENT NUMBER	QTY	TEMP	ITEM FAILURE RATE	TOTAL FAILURE RATE
ANTENNA	1	8.0	45.	3.73025	29.84196
RF SWITCH	2	4.0	45.	26.56049	106.24194
RF	3	32.0	45.	105.29875	3369.56006
POWER SUPPLY	6	4.0	45.	76.01891	304.07544
OSCILLATOR 1	7A	5.0	45.	43.09877	215.49385
IF CONVERTER 1	4A	4.0	45.	108.45923	433.83691
OSCILLATOR 2	7B	2.0	45.	83.62137	167.24274
IF CONVERTER 2	4B	20.0	45.	115.16943	2303.38867
BITE&CAL, GEN&CNTRL	23	1.0	45.	204.46498	204.46498
IF CONVERTER 3	4C	8.0	45.	131.87964	1055.03711
SENSOR	24	1.0	45.	58.59866	58.59866
CONTROL	8	1.0	45.	33.81950	33.81950
COMMUTATOR	8	1.0	45.	4.80840	4.80840

TOTAL QUANTITY EQUALS 91.0 ASSEMBLIES

TOTAL FAILURE RATE EQUALS 8286.39453 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 120.7 HOURS

FAILURE RATE DETERMINATION MIL-HDBK-217A NOTICE 2 14:05 AUG 22,'79 138

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: INTERIOR GROUP ASSEMBLY TEMP: 45.C

COMPONENT	COMPONENT NUMBER	QTY	TEMP	ITEM FAILURE RATE	TOTAL FAILURE RATE
AMPLITUDE ENCODER	12	4.0	45.	48.18286	192.73145
IF FILTER	11	4.0	45.	38.62509	154.50037
IF CROSSBAR	10	1.0	45.	298.27075	298.27075
IFM CONVERTER	19	2.0	45.	379.41211	758.82422
DIGITAL RCVR	17	2.0	45.	177.73297	355.46582
COMMAND & CONTROL	9	1.0	45.	6.77371	6.77371
PWR CNTRL PANEL	15	1.0	45.	38.39957	38.39957
ACTIVITY DETECTOR	13	32.0	45.	49.78337	1593.06787
ACTIVITY PROCESSOR	13	1.0	45.	52.58154	52.58154

TOTAL QUANTITY EQUALS 48.0 ASSEMBLIES

TOTAL FAILURE RATE EQUALS 3450.61499 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 289.8 HOURS

FAILURE RATE DETERMINATION MIL-HDBK-217B NOTICE 2 14:05 AUG 22,'79 139

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: ESM 0 ASSEMBLY TEMP: 25.C

COMPONENT	COMPONENT NUMBER	QTY	TEMP	ITEM FAILURE RATE	TOTAL FAILURE RATE
EXTERIOR GROUP		1.0	25.	8286.39453	8286.39453
INTERIOR GROUP		1.0	45.	3450.61401	3450.61401

TOTAL QUANTITY EQUALS 2.0 ASSEMBLIES

TOTAL FAILURE RATE EQUALS 11737.00781 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 85.2 HOURS

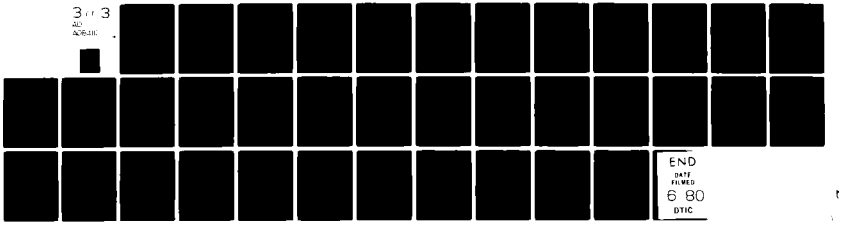
APPENDIX A
PART V – FAILURE RATE PIECE-PART LISTING

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: ESM 0 ASSEMBLY TEMP: 25.C

COMPONENT	QTY	PERCENT OF TOTAL QTY	FAILURE RATE	PERCENT OF TOTAL F.R.
ATTENUATOR, VOLTAGE CONTROLLED	64.0	1.03	1318.39917	11.23
AMPLIFIER, GAAS FET	228.0	3.67	1253.99878	10.68
IF AMPLIFIER	32.0	.51	1065.59961	9.08
BITE DETECTOR W/AMPLIFIER	73.0	1.17	997.68848	8.50
DIODE SWITCH	96.0	1.54	960.00000	8.18
YIG TUNED FILTER	32.0	.51	768.00000	6.54
CONN, RF COAXIAL, TYPE C	329.0	5.29	747.49756	6.37
RF AMPLIFIER	32.0	.51	710.39941	6.05
DIODE, DETECTOR, SI	50.0	.80	412.70776	3.52
FERRITE ISOLATOR	76.0	1.22	380.00000	3.24
BANDPASS FILTER	72.0	1.16	360.00000	3.07
POWER SUPPLY	22.0	.35	331.27979	2.82
OSCILLATOR	9.0	.14	180.00000	1.53
IC, BIPOLAR LINEAR	430.0	6.92	174.42845	1.49
IND, RF COIL, CLASS 0	206.0	3.31	160.68361	1.37
FERRITE, ISOLATOR	32.0	.51	160.00000	1.36
POWER DIVIDER	48.0	.77	135.09993	1.15
IC, BIPOLAR DIGITAL SSI/MSI	590.0	9.49	133.14557	1.13
DIRECTIONAL COUPLER	81.0	1.30	129.59991	1.10
RESISTOR, NONWIREWOUND TRIMMER	65.0	1.05	111.88617	.95
CONN, PWR, TYPE B	77.0	1.24	111.00716	.95
SIGNAL SEPARATOR	64.0	1.03	102.39995	.87
VOLTAGE CONTROLLED OSCILLATOR	5.0	.08	100.00000	.85
DIODE, GENERAL PURPOSE, SI	219.0	3.52	83.46960	.71
DIODE SWITCH W/AMPL	8.0	.13	80.00000	.68
MIXER, DOUBLE BALANCED	36.0	.58	61.56761	.52
LIMITER PROT SPDT DIODE SW,	4.0	.06	53.19997	.45
CAP, CERAMIC, CK 125C	482.0	7.75	52.54634	.45
COMPENSATOR	32.0	.51	51.19998	.44
RF MULTIPLEXER	5.0	.08	50.00000	.43
FINE SECTOR ENCODER	4.0	.06	42.79997	.36
RES, LEAD SCREW VAR WW, RT	44.0	.71	40.41202	.34
FERRITE ISOLATOR	2.0	.03	40.00000	.34

AD-A084 112 NAVAL OCEAN SYSTEMS CENTER SAN DIEGO CA F/G 9/5
AVAILABILITY ESTIMATE OF A CONCEPTUAL ESM SYSTEM.(U)
JUN 79 J VALENZUELA
UNCLASSIFIED NOSC-TR-501 NL



PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: ESM 0 ASSEMBLY TEMP: 25.C

COMPONENT	QTY	PERCENT OF TOTAL QTY	FAILURE RATE	PERCENT OF TOTAL F.R.
RELAY	12.0	.19	38.69997	.33
SWITCH, TOGGLE	10.0	.16	26.99998	.23
CONNECTOR, RACK, INSERT B	106.0	1.70	26.48203	.23
TRANSISTOR, NPN, SI	94.0	1.51	26.30867	.22
MODULATOR	5.0	.08	25.00000	.21
DIODE, ZENER / AVALANCHE	26.0	.42	22.32890	.19
FAN, TUBEAXIAL	2.0	.03	22.00000	.19
DIODE, BRIDGE	10.0	.16	21.24985	.18
DISCRIMINATOR	4.0	.06	20.00000	.17
CONVERTER	2.0	.03	20.00000	.17
OSC., YIG FILTER	2.0	.03	20.00000	.17
TRANSISTOR, PNP, SI	71.0	1.14	17.19963	.15
IC, MOS DIGITAL LSI	16.0	.26	11.30220	.10
RES, ACCURATE FIXED WW, RR	26.0	.42	9.85772	.08
CONN, CIRCULAR CABLE, TYPE B	5.0	.08	6.60713	.06
RES, INSULATED FIXED FILM, RN	308.0	4.95	5.26721	.04
RES, POWER FIXED WW, RW	32.0	.51	5.26361	.04
INCANDESCENT LAMP	5.0	.08	5.00000	.04
IC, BIPOLAR ECL DIGITAL SSI/MSI	10.0	.16	4.80840	.04
RES, THERMISTOR, RTH	12.0	.19	4.60000	.04
FILTER	20.0	.32	4.39323	.04
CAP, NONSOLID TANT, CL	2.0	.03	4.33003	.04
IND, POWER, CLASS Q	6.0	.10	4.21698	.04
HEATER	4.0	.06	4.00000	.03
ANTENNA, LOG PERIODIC	8.0	.13	4.00000	.03
TRANS, POWER, CLASS Q	5.0	.08	2.92604	.02
RES, PWR FXD WW CHAS MOUNT, RE	4.0	.06	2.73750	.02
CAP, SOLID TANT, CSR	361.0	5.81	2.70282	.02
CONN, RACK AND PANEL, TYPE B	4.0	.06	2.60021	.02
SWITCH, POWER	2.0	.03	1.80000	.02
IND, POWER, CLASS T	2.0	.03	.84978	.01
IND, POWER, CLASS R	8.0	.13	.78271	.01
TRT SENS.	2.0	.03	.60000	.01

FAILURE RATE DETERMINATION MIL-HDBK-217A NOTICE 2 14:05 AUG 22,'79 142

PROJECT: ESM ESM ENVIRONMENT: NAVAL, SHELTERED

ASSEMBLY: ESM 0 ASSEMBLY TEMP: 25.C

COMPONENT	QTY	PERCENT OF TOTAL QTY	FAILURE RATE	PERCENT OF TOTAL F.R.
RES, WELDABLE FXD FILM, RNC	32.0	.51	.58163	.00
IC, MOS DIGITAL SSI/MSI	2.0	.03	.55745	.00
TRANS, POWER, CLASS T	1.0	.02	.42489	.00
FUSE	4.0	.06	.40000	.00
RES, INSULATED FIXED FILM, RLR	161.0	2.59	.25879	.00
CAP, CERAMIC, CKR 125C	154.0	2.48	.17952	.00
RES, INSULATED FIXED COMP, RCR	1065.0	17.13	.17241	.00
CAP, MICA, CM	6.0	.10	.16635	.00
CAP, MICA, CMR	26.0	.42	.14417	.00
PWB, TWO-SIDED BOARDS	20.0	.32	.13200	.00
DIRECTIONAL COUPLER	8.0	.13	.08000	.00
CAP, PAPER-PLASTIC, CQR 125C	4.0	.06	.00092	.00

TOTAL QUANTITY EQUALS 6218.0 PIECE PARTS

TOTAL FAILURE RATE EQUALS 11737.00000 FAILURES PER MILLION HOURS

MEAN TIME BETWEEN FAILURES EQUALS 85.2 HOURS

EXIT

APPENDIX A
PART VI – FAILURE RATE COMPUTATIONAL WORK SHEETS

FAILURE RATE BACKUP DATA

POWER SWITCHES

Toggle switch; part of digital receiver, component No. 17; mainframe chassis part module 1A1.

Assumptions

Switch type: snap action

Environment: $N_S \rightarrow \Pi_E = 1.2$

Contact form: SPST $\rightarrow \Pi_c = 1.0$

Cycling rate: <1/hour $\rightarrow \Pi_{cycle} = 1.0$

Quality level: commercial $\rightarrow \lambda_b = 0.75$

$$\lambda_p = \lambda_b (\Pi_E \times \Pi_c \times \Pi_{cycle})$$

$$= 0.75 (1.2 \times 1.0 \times 1.0)$$

$$= 0.90$$

Toggle switch; part of units 2 and 3 of the IFM converter power control panel, component 15; mainframe chassis module PS1.

Assumptions

Switch type: snap action

Environment: $N_S \rightarrow \Pi_E = 1.2$

Contact form: DPDT $\rightarrow \Pi_c = 3.0$

Cycling rate: <1/hour $\rightarrow \Pi_{cycle} = 1.0$

Quality level: commercial $\rightarrow \lambda_b = 0.75$

$$\lambda_p = \lambda_b (\Pi_E \times \Pi_{cycle} \times \Pi_c)$$

$$= 0.75 (1.2 \times 1 \times 3)$$

$$= 2.7$$

COMPONENT NAME: BITE DETECTOR W/AMPLIFIER

Piece-Part Name	Quantity	λ	Source
Detector, Si, Schottky microwave	1	11.75	MIL-HDBK 217B, 50°C, 20% stress
IC, linear, 25 transistors	1	0.825	MIL-HDBK 217B, 45°C, Class B-2
IC, linear, 15 transistors	1	0.655	MIL-HDBK 217B, 45°C, Class B-2
IC, linear, 6 transistors	1	0.437	MIL-HDBK 217B, 45°C, Class B-2
Total:		13.667	

λ = Failure rate in failures/million hours

COMPONENT NAME: IF AMPLIFIER

Piece-Part Name	Quantity	λ	Source
FET, dual	6	32.55	MIL-HDBK 217B, 75°C, 50% stress
Other	–	0.75	
Total:		3.33	Vendor estimate

λ = Failure rate in failures/million hours

COMPONENT NAME: DIODE SWITCH

Piece-Part Name	Quantity	λ	*Source*
Point contact diode	6	4.25	MIL-HDBK 217B, 50°C, 30% stress
Transistor, NPN, Si, general purpose	4	1.26	MIL-HDBK 217B, 50°C, 10% stress
Diode, general purpose	4	1.68	MIL-HDBK 217B, 50°C, 10% stress
Other	–	2.8	
Total:		9.99	Vendor estimate

λ = Failure rate in failures/million hours

COMPONENT NAME: RF AMPLIFIER

Piece-Part Name	Quantity	λ	Source
Transistor, FET, dual	4	21.7	MIL-HDBK 217B, 75°C, 50% stress*
Other	–	0.5	
Total:		22.2	Vendor estimate

λ = Failure rate in failures/million hours

*Temperature and stress raised to account for GaAs material processing

COMPONENT NAME: POWER SUPPLY, +15 V or -15 V

Piece-Part Name	Quantity	λ	Source
IC linear, 20 transistors	2	1.53	MIL-HDBK 217B
Transistor, NPN, Si, power	3	3.6	MIL-HDBK 217B, 55°C, 80% stress
Transistor, NPN, Si, general purpose	5	.315	MIL-HDBK 217B, 50°C, 70% stress
Other		2.88	
Total:		8.33	Vendor estimate

λ = Failure rate in failures/million hours

COMPONENT NAME: POWER SUPPLY, ±5 V

Piece-Part	Quantity	λ	Source
IC, linear, 20 resistors	4	3.06	MIL-HDBK 217B
Transistor, NPN, Si, power	6	13.5	MIL-HDBK 217B, 55°C, 80% stress
Transistor, NPN, Si, general purpose	10	.63	MIL-HDBK 217B, 50°C, 10% stress
Resistor, RJ	2	10.35	MIL-HDBK 217B, 50°C, 10% stress, (staked position factor of 0.3)
Other		9.46	
Total:		37.0	Vendor estimate

λ = Failure rate in failures/million hours

COMPONENT NAME: VOLTAGE-CONTROLLED ATTENUATOR

Piece-Part Name	Quantity	λ*	Source
Diode, pin	6		
Hybrid IC, 100 transistors	1		
Total:		20.0	Vendor estimate

λ = Failure rate in failures/million hours

*Failure rates not yet apportioned. Vendor estimate is assumed.

COMPONENT NAME: VOLTAGE-CONTROLLED OSCILLATOR

Piece-Part Name	Quantity	λ*	Source
Varactor diode	1		
Transistor, NPN, Si, low-power, 25 V, 50 Ma	2		
Transistor, NPN, Si, power, 100 V, 5 A	2		
IC, hybrid	1		
IC linear	4		
Total:		20.6	Vendor estimate

λ = Failure rate in failures/million hours
*Failure rates not yet apportioned. Vendor estimate is assumed.

COMPONENT NAME: OSCILLATOR (CAVITY)

Piece-Part Name	Quantity	λ	Source
Diode, avalanche	1	1.8	MIL-HDBK 217B, 50°C, estimated correction factor of 20 for Gunn device
IC, linear, 20 transistors	1	11.477	MIL-HDBK 217B, 50°C
Transistor, NPN, Si	1	1.068	MIL-HDBK 217B, 50°C, 30% stress
Diode, rectifier, Si	1	0.45	MIL-HDBK 217B, 40°C
Connector, RF coax	2	3.26	MIL-HDBK 217B
Resistors, film, QN	20	.46	MIL-HDBK 217B, 50°C, 30% stress
Capacitor, CKR, 125°C	5	0.1	MIL-HDBK 217B, 50°C, 20% stress
Capacitor, CSR	4	.047	MIL-HDBK 217B, 50°C, 50% stress
Hybrid microstrip	1	1.0	Engineering estimate
Total:		19.662	

λ = Failure rate in failures/million hours

COMPONENT NAME: YIG NOTCH FILTER

Piece-Part Name	Quantity	λ $\times 10^{-6}$	Source
YIG			
YIG device	4	negligible	
Heater	4	1.6	MIL-HDBK 217B, thermistor bead
Connections	20	negligible	($<0.1 \times 10^{-6}$)
DRIVER			
Transistor, PNP, Si, >1 W	4	1.84	MIL-HDBK 217B, Sec. 3
Transistor, NPN, Si	1	0.28	MIL-HDBK 217B, Sec. 3
Diode, Zener	4	0.96	MIL-HDBK 217B, Sec. 3
Diode, general purpose	2	0.44	MIL-HDBK 217B, Sec. 3
IC, linear <32 transistors, class C-1	1	12.15	MIL-HDBK 217B, Sec. 3
Resistor, RJ	2	2.225	MIL-HDBK 217B, 50°C, 10% stress
DAC			
IC, linear, >32 transistors, class B-2	1	3.0	MIL-HDBK 217B, Sec. 3
Resistor, RJ	1	1.1125	MIL-HDBK 217B, 50°C, 10% stress
Total:		23.6075	

λ = Failure rate in failures/million hours

APPENDIX A
PART VII – DERIVATION OF AVAILABILITY EQUATION

Reprint of "System Availability Analysis" by I Bosinoff and D Fradette, Sylvania Electronic Systems Co. Paper *presented at Electronic Industries Association meeting* MS.3, 28 June 1969.

A mathematical model of system availability is developed for application to electronic systems. The application of this model results in a complete reliability and maintainability analysis and formalizes the evaluation of these systems.

Let A(t), a vector, (probability of being in a specific state at a given time (t)) be defined as the availability of the system as a function of time. The definition of the derivative $\dot{A}(t)$ is:

$$\dot{A}(t) = \lim_{\Delta t \to 0} \frac{A(t + \Delta t) - A(t)}{\Delta t} \tag{1}$$

We further define $p(\Delta t)$, a matrix, as the transition probability, i.e., the probability of going from A(t) to $A(t + \Delta t)$. Therefore

$$A(t + \Delta t) = p(\Delta t)A(t) \tag{2}$$

Substituting equation (2) into (1) results in

$$\dot{A}(t) = \lim_{\Delta t \to 0} \frac{p(\Delta t)A(t) - A(t)}{\Delta t} \tag{3}$$

and

$$\dot{A}(t) = A(t) \lim_{\Delta t \to 0} \frac{\left[p(\Delta t) - I\right]}{\Delta t} \tag{4}$$

where I is the unit matrix. .

The matrix I is required because it enables A(t) to be factored out of the expression.

Define the matrix Q by

$$Q = \lim_{\Delta t \to 0} \frac{\left[p(\Delta t) - I\right]}{\Delta t} \tag{5}$$

then

$$\dot{A}(t) = A(t)Q \tag{6}$$

This is a set of first order linear differential equations. The solution of this system of equations is given by:

$$A(t) = A(o)e^{Qt} \tag{7}$$

where A(o) is the initial probability vector and e^{Qt} is defined by its Taylor series. Therefore,

$$A(t) = A(o)\left[1 + Qt + \frac{(Qt)^2}{2!} + \cdots\right] \tag{8}$$

This result can be verified by substitution in equation (6).

In a stationary system the rate of change of availability, defined by $\dot{A}(t)$, will approach zero as time increases. Specifically at $t = \infty$, $\dot{A}(t) = 0$ and therefore from equation (6) we have

$$0 = A(\infty)Q \tag{9}$$

Thus, this steady state solution can be satisfied only if the matrix Q is singular, i.e., its determinant is zero.

Demonstration Problems

An appreciation of the power of this model may be obtained by applying the above procedure to a one unit system and obtaining solutions for the availability. A second example of a two unit system will be given where the transition matrix is derived.

A. One Unit System

Figure 1 is a one unit system.

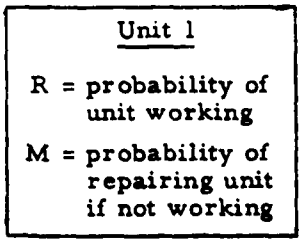


Figure 1

This system has 2^n possible states which are tabulated in Table 1.

State	Unit
1	Working (0)
2	Failed (1)

Table 1

The transition probabilities, $p(\Delta t)$, are the probabilities of being in a specific state and either remaining in that state or going to another state. These are given in Table 2.

P_{11}	P_{12}
P_{21}	P_{22}

Table 2

where

p_{11} = the probability of being in state one and remaining there.

p_{12} = the probability of being in state one and going to state two etc.

Substituting the probabilities shown in Figure 1 into Table 2 results in Table 3.

R	(1-R)
M	(1-M)

Table 3

where

(1-R) = probability of unit failing

(1-M) = probability of unit not being repaired

If the units are independent and the chance of failure or repair does not depend on past history, the exponential functions can be used to describe the probabilities of Table 3.

$$R(\Delta t) = e^{-\lambda \Delta t} \approx 1 - \lambda \Delta t \tag{10}$$

$$M(\Delta t) = 1 - e^{-\mu \Delta t} \approx \mu \Delta t \tag{11}$$

where

λ = failure rate

μ = repair rate

$e^{-\lambda \Delta t}$ = probability of zero failures in Δt

$1 - e^{-\mu \Delta t}$ = probability of at least one repair in Δt

We now solve for the terms of the Q matrix from the following relationship:

$$Q = \lim_{\Delta t \to 0} \frac{\left[P(\Delta t) - I \right]}{\Delta t} \tag{12}$$

therefore

$$q_{11} = \lim_{\Delta t \to 0} \frac{P_{11} - 1}{\Delta t} = \lim_{\Delta t \to 0} \frac{1 - \lambda \Delta t - 1}{\Delta t} = -\lambda \tag{13}$$

$$q_{21} = \lim_{\Delta t \to 0} \frac{P_{21}}{\Delta t} = \lim_{\Delta t \to 0} \frac{\mu \Delta t}{\Delta t} = \mu \tag{14}$$

$$q_{12} = \lim_{\Delta t \to 0} \frac{P_{12}}{\Delta t} = \lim_{\Delta t \to 0} \frac{\lambda \Delta t}{\Delta t} = \lambda \tag{15}$$

$$q_{22} = \lim_{\Delta t \to 0} \frac{P_{22} - 1}{\Delta t} = \lim_{\Delta t \to 0} \frac{1 - \mu \Delta t - 1}{\Delta t} = -\mu \tag{16}$$

The Q matrix is therefore

$$Q = \begin{pmatrix} -\lambda & \lambda \\ \mu & -\mu \end{pmatrix} \tag{17}$$

and since $\dot{A}(t) = A(t)Q$ it is possible to write the 2^n linear differential equations. These are

$$\dot{a}_1(t) = -\lambda a_1(t) + \mu a_2(t) \tag{18}$$

$$\dot{a}_2(t) = \lambda a_1(t) - \mu a_2(t) \tag{19}$$

To solve this system of equations we assume solutions of the form

$$a_1(t) = Ae^{st} \tag{20}$$

$$a_2(t) = Be^{st} \tag{21}$$

Substituting into equations (18) and (19) and simplifying one gets

$$\left.\begin{aligned} As &= -\lambda A + \mu B \\ Bs &= \lambda A - \mu B \end{aligned}\right\} \tag{22}$$

or

$$\left.\begin{aligned} 0 &= -A(s + \lambda) + \mu B \\ 0 &= \lambda A - B(s + \mu) \end{aligned}\right\} \tag{23}$$

We can now solve for s by setting the determinant equal to zero

$$D = \begin{vmatrix} -(s + \lambda) & \mu \\ \lambda & -(s + \mu) \end{vmatrix} = 0 \tag{24}$$

therefore

$$(s + \lambda)(s + \mu) - \lambda\mu = 0 \tag{25}$$

and

$$s = 0 \text{ and } s = -(\lambda + \mu)$$

Solutions to the system of equations given by (18) and (19) will therefore be of the form

$$\left.\begin{aligned} a_1(t) &= A_1 e^{-(\lambda+\mu)t} + A_2 \\ a_2(t) &= B_1 e^{-(\lambda+\mu)t} + B_2 \end{aligned}\right\} \tag{26}$$

First consider $s = -(\lambda + \mu)$ and substitute into equation (23).

$$\left.\begin{aligned} 0 &= -A_1\left[-(\lambda + \mu) + \lambda\right] + \mu B_1 \\ 0 &= \lambda A_1 - B_1\left[-(\lambda + \mu) + \mu\right] \end{aligned}\right\} \tag{27}$$

From this we have that $A_1 = -B_1$ (28)

For $s = 0$ we have

$$\left.\begin{aligned} 0 &= -A_2\lambda + \mu B_2 \\ 0 &= \lambda A_2 - \mu B_2 \end{aligned}\right\} \tag{29}$$

From this

$$A_2 = \frac{\mu B_2}{\lambda} \tag{30}$$

Using the initial conditions will enable us to get solutions for A_1, A_2, B_1, B_2

$$a_1(0) = 1 \qquad a_2(0) = 0 \tag{31}$$

From equation (26) this gives

$$\left.\begin{aligned} 1 &= A_1 + A_2 \\ 0 &= B_1 + B_2 \end{aligned}\right\} \tag{32}$$

or

$$A_1 = 1 - A_2 \text{ and } B_1 = - B_2 \tag{33}$$

Utilizing equations (28), (30), and (33) we solve for A_1, A_2, B_1, B_2.

$$A_1 = 1 - \frac{\mu B_2}{\lambda} = - B_1 = B_2 \tag{34}$$

Therefore

$$1 - \frac{\mu B_2}{\lambda} = B_2 \text{ or } B_2 = \frac{\lambda}{\lambda + \mu} \tag{35}$$

$$B_1 = - \frac{\lambda}{\lambda + \mu} \tag{36}$$

$$A_1 = 1 - \frac{\mu B_2}{\lambda} = 1 - \frac{\mu}{\lambda + \mu} = \frac{\lambda}{\lambda + \mu} \tag{37}$$

$$A_2 = 1 - A_1 = 1 - \frac{\lambda}{\lambda + \mu} = \frac{\mu}{\lambda + \mu} \tag{38}$$

The solutions for $a_1(t)$ and $a_2(t)$ are therefore

$$a_1(t) = \frac{\mu}{\lambda + \mu} + \frac{\lambda e^{-(\lambda+\mu)t}}{\lambda + \mu} \tag{39}$$

$$a_2(t) = \frac{\lambda}{\lambda + \mu} - \frac{\lambda e^{-(\lambda+\mu)t}}{\lambda + \mu} \tag{40}$$

The steady state availabilities are easily obtained from equations (39) and (40) by letting $t \to \infty$

$$a_1(\infty) = \frac{\mu}{\lambda + \mu} \tag{41}$$

$$a_2(\infty) = \frac{\lambda}{\lambda + \mu} \tag{42}$$

APPENDIX B
MAINTAINABILITY PREDICTION

1.0 DEFINITION OF PREDICTION EQUATIONS

The prediction equations used for the development of the conceptual ESM are taken from section 2.4 of Ref. 4. This model was chosen over MIL-HDBK-472 because it is based on more recent data analysis, more closely represents this equipment's state-of-the-art and may be updated with more detail as the development evolves. The mathematical model used is given by the following relationships:

$$MTTR = \sum_{m=1}^{\eta} \bar{T}_m \tag{B-1}$$

$$\bar{T}_M = \bar{T}_P + \bar{T}_{FI} + \bar{T}_{SR} + \bar{T}_D + \bar{T}_I + \bar{T}_R + \bar{T}_A + \bar{T}_C + \bar{T}_{ST} \tag{B-2}$$

$$\bar{T}_P = \frac{\sum_{v=1}^{V_P} \lambda_{P_v} T_{P_v}}{\sum_{v=1}^{v} \lambda_{P_v}} \tag{B-3}$$

$$\bar{T}_{FI} = \frac{\sum_{v=1}^{V_{FI}} \lambda_{FI_v} T_{FI_v}}{\sum_{v=1}^{v} \lambda_{FI_v}} \tag{B-4}$$

$$\bar{T}_{SR} = \frac{\sum_{v=1}^{V_{SR}} \lambda_{SR_v} T_{SR_v}}{\sum_{v=1}^{V_{SR}} \lambda_{SR_v}} \tag{B-5}$$

$$\bar{T}_D = \frac{\sum_{v=1}^{v_D} \lambda_{D_v} T_{D_v}}{\sum_{v=1}^{v_D} \lambda_{D_v}} \tag{B-6}$$

Definition of Prediction Equations (Cont.)

$$\bar{T}_I = \frac{\sum_{v=1}^{v_I} \lambda_{I_v} T_{I_v}}{\sum_{v=1}^{v_I} \lambda_{I_v}} \tag{B-7}$$

$$\bar{T}_R = \frac{\sum_{v=1}^{v_R} \lambda_{R_v} T_{R_v}}{\sum_{v=1}^{v_R} \lambda_{R_v}} \tag{B-8}$$

$$\bar{T}_A = \frac{\sum_{v=1}^{v_A} \lambda_{A_v} T_{A_v}}{\sum_{v=1}^{v_A} \lambda_{A_v}} \tag{B-9}$$

$$\bar{T}_C = \frac{\sum_{v=1}^{v_C} \lambda_{C_v} T_{C_v}}{\sum_{v=1}^{v_C} \lambda_{C_v}} \tag{B-10}$$

$$\bar{T}_{ST} = \frac{\sum_{v=1}^{v_{ST}} \lambda_{ST_v} T_{ST_v}}{\sum_{v=1}^{v_{ST}} \lambda_{ST_v}} \tag{B-11}$$

Table B-1, taken from Ref. 4, provides a definition of the maintenance task times and Table B-2, also from Ref. 4, provides a definition of the mathematical model terms used in this appendix.

Table B-1. Definition of Maintenance Task Times.

Maintenance Element Time	Abbreviation*	Definition
Preparation	$T_{P_{nj}}$	Time associated with those tasks required to be performed before fault isolation can be executed. Examples: obtain, set up, and warm up test equipment; apply power and cooling to system, warm up and stabilize; input system initialization parameters.
Fault Isolation	$T_{FI_{nj}}$	Time associated with those tasks required to isolate the fault to the level at which fault correction begins. Examples: load, run, and interpret results of a diagnostic program; examine fault isolation symptoms, locate symptoms in maintenance manual, follow manual procedures to point where replaceable item or group of replaceable items is identified.
Fault Correction		
• Spare Retrieval	$T_{SR_{nj}}$	Time associated with obtaining a spare replaceable item or group of replaceable items from the designated spares area.
• Disassembly	$T_{D_{nj}}$	Time associated with gaining access to the replaceable item(s) identified during the fault isolation process. Examples: opening cabinet doors, pulling out equipment drawers, removing CCA retaining bars; technician transit time to a remote equipment.
• Interchange	$T_{I_{nj}}$	Time associated with the removal and replacement of a fault replaceable item or suspected faulty items. Examples: removing screws, connectors, solder joints; extracting and inserting the replaceable item; application of conformal coating, heat transfer paste.
• Reassembly	$T_{R_{nj}}$	Time associated with closing up the equipment after interchange is performed, i.e., the opposite process of disassembly.

*Abbreviations used in the prediction mathematical models; Time to perform the m^{th} elemental task (P, FI, SR, D, I, R, A, C, ST) for the n^{th} RI given the j^{th} fault-isolation result.

Table B-1. Continued.

Maintenance Element Time	Abbreviation*	Definition
• Alignment	$T_{A_{nj}}$	Time associated with aligning or calibrating the system or RI after a fault has been corrected.
• Check-out	$T_{C_{nj}}$	Time associated with the verification that a fault has been corrected and the system is operational.
Start-up	$T_{ST_{nj}}$	Time associated bringing a system up to the operational state it was in prior to failure, once a fault has been corrected and verified.

*Abbreviation used in the prediction mathematical models.

Table B-2. Definition of Early Prediction Model Terms.

T_{P_v}	Time required to prepare a system for fault isolation using the v^{th} method
T_{FI_v}	Time required to isolate a fault using the v^{th} method
T_{SR_v}	Time required to obtain a spare using the v^{th} method
T_{D_v}	Time required to perform disassembly using the v^{th} method
T_{R_v}	Time required to perform reassembly using the v^{th} method
T_{I_v}	Time required to interchange an RI using the v^{th} method
T_{A_v}	Time required to align or calibrate an RI using the v^{th} method
T_{C_v}	Time required to check a repair using the v^{th} method
T_{ST_v}	Time required to start up a system using the v^{th} method
λ_{P_v}	Failure rate of RIs associated with the v^{th} method of performing preparation
λ_{FI_v}	Failure rate of RIs associated with the v^{th} method of performing fault isolation
λ_{SR_v}	Failure rate of RIs associated with the v^{th} method of performing spare retrieval
λ_{D_v}	Failure rate of RIs associated with the v^{th} method of performing disassembly
λ_{R_v}	Failure rate of RIs associated with the v^{th} method of performing reassembly
λ_{I_v}	Failure rate of RIs associated with the v^{th} method of performing interchange
λ_{A_v}	Failure rate of RIs associated with the v^{th} method of performing alignment
λ_{C_v}	Failure rate of RIs associated with the v^{th} method of performing check-out
λ_{ST_v}	Failure rate of RIs associated with the v^{th} method of performing start-up
V_P	Number of unique ways to perform preparation
V_{FI}	Number of unique ways to perform fault isolation
V_{SR}	Number of unique ways to perform spare retrieval
V_D	Number of unique ways to perform disassembly
V_R	Number of unique ways to perform reassembly
V_I	Number of unique ways to perform interchange
V_A	Number of unique ways to perform alignment

Table B-2. Continued.

V_C	Number of unique ways to perform check-out
V_{ST}	Number of unique ways to perform start-up
$\bar{S}_G$	Average number of RIs contained in a fault-isolation result
$\bar{S}_I$	Average number of interchanges required to correct a fault
A	Number of unique accesses ($A \leqslant V_D$ or V_R)
$\bar{A}$	Average number of unique accesses required per fault-isolation result
λ_a	Failure rate of the RIs that require the a^{th} type of access
λ_T	Total system failure rate
T_{D_a}	Time required to disassemble the a^{th} access
T_{R_a}	Time required to reassembly the a^{th} access

2.0 ASSUMPTIONS

The assumptions made for purposes of this prediction were:

- $\bar{T}_{SR}$ is equal to zero not considered part of inherent MTTR.
- $\bar{T}_P$ is equal to zero at organizational level, not required.
- $\bar{T}_A$ and $\bar{T}_C$ are equal to zero at organizational level; performed automatically by BITE and calibration.
- $\bar{T}_{ST}$ is equal to zero at organizational level; not required since system is not shut down.
- Access time for mast-mounted equipment assumes tolerable sea state, no stack gases interfere, and no coordinated shutdown of radar required.
- BITE isolates to an SRU for exterior group.

3.0 ORGANIZATIONAL-LEVEL REPAIR ANALYSIS

MTTR for equipment without regard to redundancy may be calculated using Eqs. (B-1) through (B-11); however, for purposes of this study and to incorporate the effect of redundancy, SRU repair times were computed according to,

$$R_i = \sum T_{M_v} = T_{P_v} + T_{FI_v} + T_{SR_v} + T_{D/R_v} + T_{I_v} + T_{A_v} + T_{C_v} \qquad \text{(B-12)}$$

where

R_i = SRU repair time of i^{th} SRU

Values of T_{M_v} are taken from Table B-3 and are shown in Table B-5, data analysis Sheet B. The time synthesis is shown in Table B-4.

Table B-3. SRU Time Summary.

INTERIOR

MTTR Element (m)	v	Description of the v^{th} Method	T_{MV}, min	λ_{MV}
Fault Isolation	4	Display patterns	4.0	2961.223
	5	Display patterns and computer diagnostics	11.0	54.917
Disassembly/ Reassembly	3	Interior equipment drawers	1.33	2716.852
	4	Digital receiver	1.14	299.288
Interchange	3	Digital receiver	1.90	299.288
	4	IF crossbar	16.81	260.304
	5	IF filter, IFM converter, amp. encoder	1.81	832.210
	6	PCB removal	1.06	1616.167
	7	Hardwired assembly removal	6.00	8.171
Check-out	1	No check-out	–	–
Start-up	1	No start-up	–	–
Alignment	1	No alignment	–	–

EXTERIOR

MTTR Element (m)	v	Description of the v^{th} method	T_{MV}, min	λ_{MV}
Fault Isolation	1	BITE check	0.0	9473.628
	2	Display patterns	4.0	249.325
	3	Display patterns and computer diagnostics	11.0	33.820
Disassembly/ Reassembly	1	Radome	16.07	29.842
	2	Exterior equipment drawers	15.47	9726.931
Interchange	1	RF RI sets (6)	3.31	9503.470
	2	Plug-in RI sets (4)	0.81	253.303
Spare Retrieval	1	No spare retrieval	–	–
Preparation	1	No preparation	–	–
Alignment	1	No alignment	–	–
Check-out	1	No check-out	–	–
Start-up	1	No start-up	–	–

Table B-4. SRU Time Synthesis.

INTERIOR

MTTR Element	Method	Step		Time, min
Fault Isolation	Display patterns	1. Interpret display		2.0*
		2. Operator control/interaction		2.0*
			Total Time	4.0
	Display patterns and computer diagnostics	1. Interpret display		2.0*
		2. Operator control/interaction		2.0*
		3. Load diagnostics		0.5*
		4. Run diagnostics		5.0*
		5. Interpret results		1.5*
			Total Time	11.0
Disassembly/ Reassembly	Interior equipment drawers	1. Remove/replace ATE latches (2)		1.14**
		2. Pull out push in drawer		0.19**
			Total Time	1.33
	Digital receiver	1. Remove/replace ATR latches (2)		1.14**
			Total Time	1.14
Interchange	Digital receiver	1. Disconnect/reconnect SMA cable		0.50*
		2. Disconnect/reconnect BNC cables (3)		0.51**
		3. Disconnect/reconnect circular cables (2)		0.40*
		4. Pull out/push in digital receiver RI set		0.49*
			Total Time	1.90
	IF crossbar	1. Disconnect/reconnect SMA cables (32)		16.0*
		2. Remove/replace RI set hold-down thumbscrews (4)		0.56**
		3. Remove/replace RI set		0.25*
			Total Time	16.81
	IF filter, IFM converter, amp encoder	1. Disconnect/reconnect SMA cables (32)		1.00*
		2. Remove/replace RI set hold-down thumbscrews (4)		0.56**
		3. Remove/replace RI set		0.25*
			Total Time	1.81
	PCB removal	1. Remove/replace PCB hold-down screw		0.56**
		2. Remove/replace PCB		0.5*
			Total Time	1.06
	Hardwired assembly removal	1. Remove/replace 5 wire connections		5.0*
		2. Remove/replace 4 hold-down screws		1.0*
			Total Time	6.0

*Engineering Estimate
**Time Standard

Table B-4. Continued.

EXTERIOR

MTTR Element	Method	Step		Time, min
Fault Isolation	BITE check	1. Check will be made automatically, interleaved with system operations		0.0*
		2. Respond to BITE analysis		0.0*
			Total Time	0.0*
	Display patterns	1. Interpret display		2.0*
		2. Operator control/interaction		2.0*
			Total Time	4.0
	Display patterns and computer diagnostics	1. Interpret display		2.0*
		2. Operator control/interaction		2.0*
		3. Load diagnostics		0.5*
		4. Run diagnostics		5.0*
		5. Interpret results		1.5*
			Total Time	11.0
Disassembly/ Reassembly	Radome	1. Access mast		15.0*
		2. Remove/replace radome clamp (similar to spring clip latch)		0.07**
		3. Remove/replace radome		1.0*
			Total Time	16.07
	Exterior equipment drawers	1. Access mast		15.0*
		2. Remove/replace drawer lift and turn latches (4)		0.28*
		3. Pull out/push in drawer		0.19**
			Total Time	15.47
Interchange	RF RI sets: Antenna RF amplifier IF converter Oscillator BITE RF switch	1. Remove/replace RI set thumbscrews (4)		0.56*
		2. Disconnect/reconnect SMA cables (average 5)		2.50*
		3. Remove/replace RI set		0.25*
			Total Time	3.31
	Plug-In RF Sets Power Supply Control Commutator Sensor	1. Remove/replace RI set thumbscrews (4)		0.56**
		2. Remove/replace RI set		0.25*
			Total Time	0.81

*Engineering Estimate
**Time standard

Table B-5. SRU Data Analysis Sheets.

Sheet A-1

SRU Description		QTY	λ_{FI_1}	λ_{FI_2}	λ_{FI_3}
Antenna		8		29.842	
RF Switch		4	106.242		
RF Amplifier		32	3997.816		
IF Converter	I	4	512.369		
	III	8	1212.101		
	II	20	2696.049		
Oscillator	II	2	330.927		
	I	5	413.659		
BITE & Cal Counter		1	204.465		
Control		1			33.820
Commutator		1		4.808	
Power Supply		4		156.076	
Sensor		1		58.599	
λ Totals			9473.628	249.325	33.820

Sheet A-2

SRU Description		QTY	λ_{D/R_1}	λ_{D/R_2}
Antenna		8	29.842	
RF Switch		4		106.242
RF Amplifier		32		3997.816
IF Converter	I	4		512.369
	III	8		1212.101
	II	20		2696.049
Oscillator	II	2		330.927
	I	5		413.659
BITE & Cal Control		1		204.465
Control		1		33.820
Commutator		1		4.808
Power Supply		4		156.076
Sensor		1		58.599
λ Totals			29.842	9726.931

Table B-5. Continued.

Sheet A-3

SRU Description		QTY	λ_{I_1}	λ_{I_2}
Antenna		8	29.842	
RF Switch		4	106.242	
RF Amplifier		32	3997.816	
IF Converter	I	4	512.369	
	III	8	1212.101	
	II	20	2696.049	
Oscillator	II	2	330.927	
	I	5	413.659	
BITE & Cal Counter		1	204.465	
Control		1		33.820
Commutator		1		4.808
Power Supply		4		156.076
Sensor		1		58.599
λ Totals			9503.470	253.303

Sheet A-4

SRU Description	QTY	λ_{FI_4}	λ_{FI_5}
IF Crossbar	1	260.304	
Digital Receiver	2	299.288	
IF Filter	4	145.715	
Amplitude Encoder	4	178.911	
IFM Conv	2	504.584	
Activity Detector	32	1536.737	
Activity Processor	8		48.866
Command & Control	1		6.051
Power Control Panel	1	32.684	
λ Totals		2961.223	54.917

Table B-5. Continued.

Sheet A-5

SRU Description	QTY	λ_{D/R_3}	λ_{D/R_4}
IF Crossbar	1	260.304	
Digital Receiver	2		299.288
IF Filter	4	145.715	
Amplitude Encoder	4	178.911	
IFM Conv	2	504.584	
Activity Detector	32	1536.737	
Activity Processor	8	48.866	
Command & Control	1	6.051	
Power Control Panel	1	32.684	
λ Totals		2716.852	299.288

Sheet A-6

SRU Description	QTY	λ_{I_3}	λ_{I_4}	λ_{I_5}	λ_{I_6}	λ_{I_7}
IF Crossbar	1		260.304			
Digital Receiver	2	299.288				
IF Filter	4			145.715		
Amplitude Encoder	4			178.911		
IFM Conv	2			507.584		
Activity Detector	32				1536.737	
Activity Processor	8				48.866	
Command & Control	1				6.051	
Power Control Panel	1				24.513	8.171
λ Totals		299.288	260.304	832.210	1616.167	8.171

Table B-5. Continued.

Sheet B-1

SRU Description	QTY	T_{FI_v}	T_{D/R_v}	T_{I_v}
Antenna	8	4.0	16.07	3.31
RF Switch	4	0.0	16.07	3.31
RF Preamp	32	0.0	16.07	3.31
IF Converter	32	0.0	16.07	3.31
Oscillator	78	0.0	16.07	3.31
BITE & Cal Control	1	0.0	16.07	3.31
Control	1	11.0	16.07	0.81
Commutator	1	4.0	16.07	0.81
Power Supply	4	4.0	16.07	0.81
Sensor	1	4.0	16.07	0.81

Sheet B-2

SRU Description	QTY	T_{FI_v}	T_{D/R_v}	T_{I_v}
IF Crossbar	1	4.0	1.33	16.81
Digital Receiver	2	4.0	1.14	1.9
IF Filter	4	4.0	1.33	1.81
Amplitude Encoder	4	4.0	1.33	1.81
IFM Conv	2	4.0	1.33	1.81
Activity Detector	32	4.0	1.33	1.06
Activity Processor	8	11.0	1.33	1.06
Command & Control	1	11.0	1.33	1.06
Power Control Panel	1	4.0	1.33	1.06 & 6.00

4.0 INTERMEDIATE-LEVEL REPAIR ANALYSIS

Intermediate-level repair does not affect inherent availability because it is assumed that organizational level always has a sufficient quantity of spare SRUs. This assumption is valid since the expected MTBF of SRUs is much greater than the expected repair time at the intermediate level. Intermediate-level repair time, however, becomes important to overall equipment operational support characteristics and life cycle costs and is, therefore, provided as reference information. Equations (B-1) through (B-11) were used to compute the MTTR and Eq. (B-12) was used to determine SRA level repair time. Tables B-6 through B-8 provide the intermediate-level repair data.

4.1 INTERMEDIATE-LEVEL MTTR

From the values shown in Table B-6,

$$\bar{T}_P = \frac{(5.25)(10014) + (0.0)(1961.27)}{11{,}975.27} = 4.39$$

Similarly,

$\bar{T}_{FI} = 20.37$

$\bar{T}_{SR} = 25.29$

$\bar{T}_{D/R} = 0.45$

$\bar{T}_I = 2.77$

$\bar{T}_A = 0.96$

$\bar{T}_C = 3.71$

and,

$$T_M = 4.39 + 20.37 + 25.29 + 0.45 + 2.77 + 0.96 + 3.71 = 57.94$$

Table B-6. SRA Time Summary.

INTERIOR

MTTR Element (m)	v	Description of the V^{th} Method	T_{MV}, min	λ_{MV}
Preparation (P)	1	Turn on, warm up automatic test equipment	5.25	–
	2	No preparation	0.0	–
Fault Isolation (FI)	4	Automatic test & operator interpretation of interior RI sets	23.5	1201.22
	5	No fault isolation	0.0	1536.74
Spare Retrieval (SR)	3	Interior RI spares	30.0	1201.22
	4	No spares	0.0	1536.74
Disassembly/ Reassembly (DR)	3	2nd IF amp., amplitude & frequency encoders	0.59	164.51
	4	No disassembly/reassembly	0.0	2573.45
Interchange (I)	4	RF RI	3.43	840.5
	5	PCB RI	0.11	360.7
	6	No interchange	0.0	1536.74
Alignment (A)	3	No alignment	–	–
Check-out (C)	4	Interior RI set	3.75	1201.22
Start-up (ST)	1	No start-up	–	–

Table B-6. Continued.

EXTERIOR

MTTR Element (m)	v	Description of the V^{th} Method	T_{MV}, min	λ_{MV}
Preparation (P)	1	Turn on, warm up automatic test equipment	5.25	10014
	2	No prep	0.0	1961.27
Fault Isolation (FI)	1	Automatic test & operator interpretation of exterior RF RI sets	24.24	8894.68
	2	Automatic test & operator interpretation of exterior plug-in RI set	24.25	–
	3	No fault isolation	0.0	342.63
Spare Retrieval (SR)	1	Exterior RI spares	30.0	8894.68
	2	No Spares	0.0	342.63
Disassembly/ Reassembly (D/R)	1	Exterior plug-in RI set	0.59	8894.68
	2	No Disassembly/reassembly	0.0	342.63
Interchange (I)	1	RF RI	3.43	8842.77
	2	PCB RI	0.11	51.91
	3	No interchange	0.0	342.63
Alignment (A)	1	RI sets w/BITE sensor	1.25	8277.37
	2	BITE RI set	5.25	219.51
	3	No alignment	0.0	740.43
Check-out (C)	1	RF RI set	4.5	8836.08
	2	Plug in RI set	3.5	58.60
	3	No check-out	0.0	342.63
Start-up (ST)	1	No start-up	–	–

Table B-7. SRA Time Synthesis.

INTERIOR

MTTR Element	Method	Step	Time, min
Preparation	Turn on, warm up automatic test equipment	1. Turn on	0.25*
		2. Allow warm-up time	5.00*
		Total Time	5.25
Fault Isolation	Automatic test of interior RI sets	1. Install and connect (average 2 SMAs) to ATE	0.50*
		2. Run test	3.00*
		3. Operator interpretation of test results	20.0
		Total Time	23.5
Spare Retrieval	Interior RI spares	1. Obtain from supply through normal channels	30.0*
		Total Time	30.0
Disassembly/ Reassembly	2nd IF amp., amplitude & encoders	1. Undo/redo DZUS fasteners (4)	0.25**
		2. Remove/replace RI set cover	0.07**
		Total Time	0.59
Interchange	RF RI	1. Remove/replace SMA cables (average 3)	1.50*
		2. Remove/replace hold-down screws (4)	1.68**
		3. Remove/replace RI	0.25*
		Total Time	3.43
	PCB RI	1. Remove/replace RI	0.11**
		Total Time	0.01
Check-out	Interior RI set	1. Run test	3.00*
		2. Disconnect RI set (average 2 SMAs) from ATE	0.50*
		3. Place RI set in spares rack	0.25*
		Total Time	3.75

*Engineering estimate
**Time standard

Table B-7. Continued.

EXTERIOR

MTTR Element	Method	Step		Time, min
Preparation	Turn on, warm up automatic test equipment	1. Turn on		0.25*
		2. Allow warm-up time		5.00*
			Total Time	5.25
Fault Isolation	Automatic test of exterior RF RI sets	1. Install & connect (average 5 SMAs) to ATE		1.25*
		2. Run test		3.00*
		3. Operator interpretation of test results		20.00*
	Automatic test of exterior plug-in RI set	1. Install (plug-in) in ATE		.25*
		2. Run test		3.00*
		3. Operator interpretation of test results		20.00*
			Total Time	24.35
Spare Retrieval	Exterior RI spares	1. Obtain from supply through normal channels		30.0*
			Total Time	30.0
Disassembly/	Exterior Plug-in RI set	1. Undo/redo DZUS fasteners (4)		0.52*
		2. Remove/replace RI set cover		0.59*
			Total Time	0.59**
Interchange	RF RI	1. Remove/replace SMA cables (average 3)		1.50*
		2. Remove/replace hold-down screws (4)		1.68*
		3. Remove/replace RI		0.25*
			Total Time	3.43
	PCB RI	1. Remove/replace RI		0.11**
			Total Time	0.11
Alignment	RI set w/BITE sensor	1. Activate alignment function on ATE		0.25*
		2. Adjust sensor threshold level to proper reading		1.00*
			Total time	1.25
	BITE RI set	1. Activate alignment function on ATE		0.25*
		2. Perform adjustment as needed to bring set into spec.		5.00*
			Total Time	5.25
Check-out	RF RI set	1. Run test		3.00*
		2. Disconnect RI set (average 5 SMAs) from ATE		1.25*
		3. Place RI set in spare rack		0.25*
			Total Time	4.50
	Plug in RI set	1. Run test		3.00*
		2. Disconnect RI set from ATE		0.25*
		3. Place RI set in spares rack		0.25*
			Total Time	3.50

*Engineering estimate
**Time standard

SRA Description	Qty	λ_{P_1}	λ_{P_2}	λ_{F_4}	λ_{F_5}	λ_{FI_1}	λ_{FI_3}	λ_{SR_1}	λ_{SR_3}	λ_{SR_4}	λ_{D/R_1}	λ_{D/R_2}	λ_{D/R_3}	λ_{D/R_4}
Cable compensator	32	51.2		51.2					51.2					51.2
IF crossbar	1		77.9	77.9					77.9					77.9
Tuner plug-in	2	145.1		145.1					145.1					145.1
Mainframe w/o A2	2	75.37		75.37					75.37					75.37
A2 PCB	2	24		24					24					24
SPDT IF switch	8	80		80					80				80	
Tunable bandpass filter, YIG	4	39.82		39.8					39.8				39.8	
Cal. microprocessor	4	3.97		3.97					3.97					3.97
Activity detector	32		1536.74		1536.74					1536.74				1536.74
Adder	8	9.58		9.58					9.58					9.58
A/D conv	1	5.16		5.16					5.16					5.16
Microprocessor	8	34.13		34.13					34.13					34.13
A/D converter	4	10.68		10.68					10.68				10.68	
Det/amp	4	29.75		29.75					29.75				29.75	
Microprocessor	4	4.28		4.28					4.28				4.28	
Data rcvr	1	3.03		3.03					3.03					3.03
Data xmtr	1	3.02		3.02					3.02					3.02
Relay	1	5.5		5.5					5.5					5.5
Regulator assy	1	7.43		7.43					7.43					7.43
Rectifier assy	1	1.4		1.4					1.4					1.4
Transformer assy	1	0.37		0.37					0.37					0.37
Filter assy	1	0.74		0.74					0.74					0.74
Remote power control	1	1.38		1.38					1.38					1.38
Parameter meas	1	64.16		64.16					64.16					64.16
Power supply	4		304					304				304		
Log periodic antenna	8		4.0			4.0		4.0			4.0			
Directional coupler	81	129.6				129.6		129.6			129.6			
Diode switch w/limiter	4	53.2				53.2		53.2			53.2			
Multiplexer	5	50.0				50.0		50.0			50.0			
Bandpass filter	72	360				360		360			360			
Isolator	108	540.0				540.0		540.0			540.0			
Notch filter, YIG	32	768				768		768			768			
Diode switch	64	640				640		640			640			
RF amplifier	32	710.4				710.4		710.4			710.4			
BITE detector/amp./BITE comparator	73	2430.9				2430.9		2430.9			2430.9			
Mixer	36	61.57				61.57		61.57			61.57			
Volt cont atten	64	1319				1319		1319			1319			
IF amplifier	32	1065				1065		1065			1065			
Oscillator	9	290				290		290			290			
Power divider, 2-way	37	92.5				92.5		92.5			92.5			
Modulator	5	25				25		25			25			
Oscillator, VCO	5	100				100		100			100			
Waveform generator	5	51.91				51.91		51.91			51.91			
Power divider, 4-way	11	42.6				42.6		42.6			42.6			
Signal separator	64	102.4				102.4		102.4			102.4			
Control	1		33.82				33.82					33.82		
Commutator	1		4.81				4.81					4.81		
Temperature board	1	7.69				7.69		7.69			7.69			
Voltage & current board	1	50.91				50.91		50.91			50.91			
Power supply	1	15.86		15.86					15.86					15.86
Chassis parts	2	70.49		70.49					70.49					70.49
Power supply	2	41.68		41.68					41.68					41.68
X/Y video amp	2	32.03		32.03					32.03					32.03
X/Y video amp	2	32.03		32.03					32.03					32.03
Video & CW alarm	2	30.91		30.91					30.91					30.91
X/Y video amp	2	32.03		32.03					32.03					32.03
X/Y video amp	2	32.03		32.03					32.03					32.03
Discrim heat ctrl	2	7.04		7.04					7.04					7.04
Chassis parts	2	81.63		81.63					81.63					81.63
Power supply	2	31.68		31.68					31.68					31.68
Abs value amp	2	19.93		19.93					19.93					19.93
Coarse sect encoder	2	17.86		17.86					17.86					17.86
Fine sector encoder	2	42.74		42.74					42.74					42.74
Abs value amp	2	19.93		19.93					19.93					19.93
FMPO det/out driver	2	15.57		15.57					15.57					15.57

Table B-8. SRA Data Analysis Sheet.

λ_{D/R_2}	λ_{D/R_3}	λ_{D/R_4}	λ_{I_1}	λ_{I_2}	λ_{I_3}	λ_{I_4}	λ_{I_5}	λ_{I_6}	λ_{A_1}	λ_{A_2}	λ_{A_3}	λ_{C_1}	λ_{C_2}	λ_{C_3}	λ_{C_4}
		51.2				51.2									51.2
		77.9				77.9									77.9
		145.1				145.1									145.1
		75.37				75.37									75.37
		24					24								24
	80					80									80
	39.8					39.8									39.8
		3.97					3.97								3.97
		1536.74						1536.74							
		9.58					9.58								9.59
		5.16					5.16								5.16
		34.13					34.13								34.13
	10.68						10.68								10.68
	29.75						29.25								29.25
	4.28						4.28								4.28
		3.03					3.03								3.03
		3.02					3.02								3.02
		5.5					5.5								5.5
		7.43					7.43								7.43
		1.4					1.4								1.4
		0.37					0.37								0.37
		0.74					0.74								0.74
		1.38					1.38								1.38
		64.16					64.16								64.16
04			304		304						3.04			3.04	
			4.0								4.0	4.0		4.0	
			129.6								129.6	129.6			
			53.2								53.2	53.2			
			50.0								50.0	50.0			
			360						360			360			
			540.0						*540.0*			*540.0*			
			768						768			768			
			640						640			640			
			710.4						710.4			710.4			
			2430.9						2430.9			2430.9			
			61.57			36			61.57			61.57			
			1319						1319			1319			
			1065						1065			1065			
			290						290			290			
			92.5						925			925			
			25							25		25			
			100							100		100			
				51.91						51.91		51.91			
			42.6							42.6		42.6			
			102.4								102.4	102.4			
33.82					33.82						33.82			33.82	
4.81					4.81						4.81			4.81	
			7.69								7.69		7.69		
			50.91								50.91		50.91		
		15.86				15.86									15.86
		70.49					70.49								70.49
		41.68				41.68									41.68
		32.03				32.03									32.03
		32.03				32.03									32.03
		30.91				30.91									30.91
		32.03				32.03									32.03
		32.03				32.03									32.03
		7.04				7.04									7.04
		81.63					81.63								81.63
		31.68				31.68									31.68
		19.93				19.93									19.93
		17.86				17.86									17.86
		42.74				42.74									42.74
		19.93				19.93									19.93
		15.57				15.57									15.57