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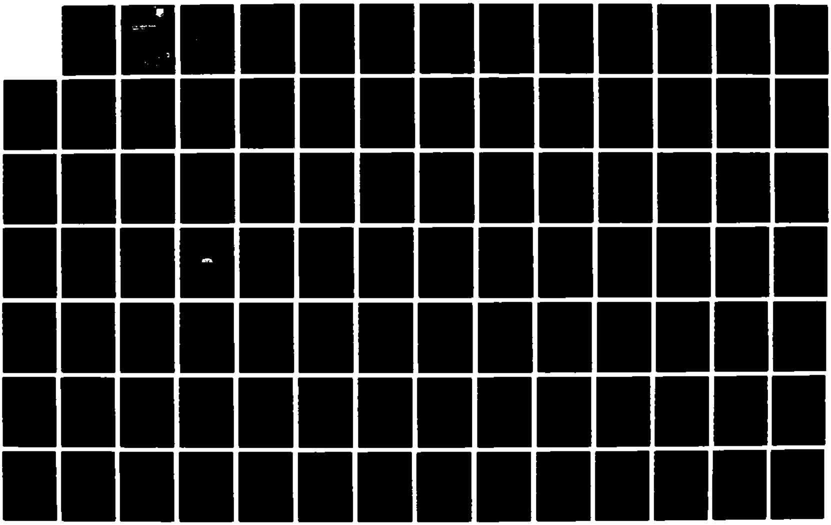

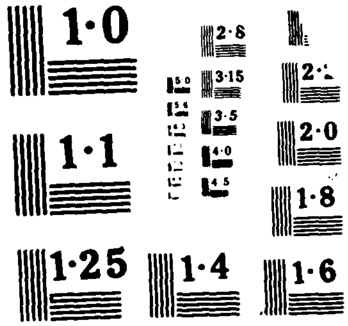
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RADC-TR-87-166, Vol II (of two)
Final Technical Report
October 1987

TACTICAL RUBIDIUM FREQUENCY STANDARD (TRFS)

EG&G, Inc.

Thomas J. Lynch and William J. Riley

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ROME AIR DEVELOPMENT CENTER
Air Force Systems Command
Griffiss Air Force Base, NY 13441-5700

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RFS (Rubidium Frequency Standard)
TRFS (Tactical Rubidium Frequency Standard
RB Frequency Reference (See Reverse)

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This report describes the accomplishments during a 3-year R&D program to design, develop, fabricate and evaluate two full scale engineering models of a Tactical Rubidium Frequency Standard (TRFS). The TRFS is a miniature atomic time and frequency source that is capable of operation in a harsh tactical military environment. In particular, it incorporates advances in miniaturization, ruggedness, fast warmup and high temperature operation that are required for aircraft applications. The report includes a detailed description of the TRFS design and the results of qualification tests on the two full scale engineering models. All program objectives were met.

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18. SUBJECT TERMS (Continued)

RB Physics Package
VCXO (Voltage Controlled Crystal Oscillator
Wideband Servo Loop
High Modulation Rate
Vibration Isolation

VOLUME II

APPENDICES

APPENDIX A

TRFS SPECIFICATIONS

SPECIFICATIONS FOR

RUBIDIUM FREQUENCY STANDARD

REVISION E

DRAWING NO. 332819

18 JUNE 1985

SOLID STATE SCIENCES DIVISION
ROME AIR DEVELOPMENT CENTER
HANSCOM AFB, MA 01731

SHEET 1 OF 36

1. SCOPE.

1.1 SCOPE. THIS SPECIFICATION ESTABLISHES THE REQUIREMENTS FOR PERFORMANCE, DEVELOPMENT AND TEST FOR A RUBIDIUM FREQUENCY STANDARD, HEREINAFTER REFERRED TO AS THE RFS.

2. APPLICABLE DOCUMENTS.

2.1 GOVERNMENT DOCUMENTS. THE FOLLOWING DOCUMENTS OF THE EXACT ISSUE SHOWN FORM A PART OF THIS SPECIFICATION TO THE EXTENT SPECIFIED HEREIN. IN THE EVENT OF CONFLICT BETWEEN THE DOCUMENTS REFERENCED HEREIN AND THE CONTENTS OF THIS SPECIFICATION, THE CONTENTS OF THIS SPECIFICATION SHALL BE CONSIDERED A SUPERSEDING REQUIREMENT.

2.1.1 SPECIFICATIONS.

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MIL-C-3098	REV. F, 28 FEBRUARY 1974. CRYSTAL UNIT, QUARTZ, GENERAL SPECIFICATION FOR
MIL-B-5087	REV. B, 15 OCTOBER 1964 AMENDMENT 2, 31 AUGUST 1970, BONDING, ELECTRICAL AND LIGHTNING PROTECTION FOR AEROSPACE SYSTEMS.
MIL-E-5400	REV. R, 31 OCTOBER 1975 ELECTRONIC EQUIPMENT, AIRBORNE, GENERAL SPECIFICATION FOR
MIL-S-8516	REV. E, 29 SEPTEMBER 1972 SEALING COMPOUND POLYSULFIDE RUBBER ELECTRIC CONNECTOR AND ELECTRIC SYSTEMS CHEMICALLY CURED.
MIL-S-19500	REV. F, 15 OCTOBER 1977 SEMICONDUCTOR DEVICES, GENERAL SPECIFICATION FOR
MIL-S-23586	REV. C, 2 MARCH 1973 SEALING COMPOUND ELECTRICAL, SILICONE RUBBER ACCELERATOR REQUIRED
MIL-M-38510	REV. D, 31 AUGUST 1977 SUPPLEMENT 1, 28 FEBRUARY 1978, MICROCIRCUITS, GENERAL SPECIFICATION FOR
MIL-H-46855	REV. B, 31 JANUARY 1979 HUMAN ENGINEERING REQUIREMENTS FOR MILITARY SYSTEMS EQUIPMENT AND FACILITIES
MIL-E-4158	REV. E, 11 JANUARY 1973 ELECTRONIC EQUIPMENT GROUND: GENERAL REQUIREMENTS FOR

MIL-C-38999	REV. H, 27 FEBRUARY 1981 CONNECTOR, ELECTRICAL, CIRCULAR, MINIATURE
MIL-C-39012	REV. C, 11 AUGUST 1982 CONNECTOR, COAXIAL, RADIO FREQUENCY
MIL-I-81550	REV. B, 28 FEBRUARY 1973 INSULATING COMPOUND, ELECTRICAL EMBEDDING, REVERSION RESISTANT SILICONE

2.1.2 STANDARDS

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MIL-STD-130	REV. E, 5 AUGUST 1977 IDENTIFICATION MARKING OF U.S. MILITARY PROPERTY
MIL-STD-143	REV. B, 12 NOVEMBER 1969 STANDARDS AND SPECIFICATIONS, ORDER OF PRECEDENCE FOR AND SELECTION OF
MIL-STD-210	REV. B, 15 DECEMBER 1973 CLIMATIC EXTREMES FOR MILITARY EQUIPMENT
MIL-STD-415	REV. D, 1 OCTOBER 1969 NOTICE 1, 8 OCTOBER 1971 TEST PROVISIONS FOR ELECTRONIC SYSTEMS AND ASSOCIATED EQUIPMENT, DESIGN CRITERIA FOR
MIL-STD-454	REV. F, 15 MARCH 1978 NOTICE 1, 1 SEPTEMBER 1978, NOTICE 2, 30 JUNE 1979 STANDARD GENERAL REQUIREMENTS FOR ELECTRICAL EQUIPMENT
MIL-STD-461	REV. B, 1 APRIL 1983 ELECTROMAGNETIC INTERFERENCE CHARACTERISTICS, REQUIREMENTS FOR EQUIPMENT
MIL-STD-462	31 JULY 1967, NOTICE 1, 1 AUGUST 1968, NOTICE 2, 1 MAY 1970 ELECTROMAGNETIC CHARACTERISTICS, MEASUREMENT OF
MIL-STD-701	REV. K, 16 MAY 1976 LIST OF STANDARD SEMICONDUCTOR DEVICES
MIL-STD-704	REV. A, 9 AUGUST 1966 NOTICE 1, 7 FEBRUARY 1968, NOTICE 2, 5 MAY 1970, NOTICE 3, 11 APRIL 1973 PLATFORM ELECTRIC POWER CHARACTERISTICS

MIL-STD-781	REV. C, 21 OCTOBER 1977 NOTICE 1, 20 MARCH 1981 RELIABILITY DESIGN QUALIFICATION AND PRODUCTION ACCEPTANCE TESTS: EXPONENTIAL DISTRIBUTION
MIL-STD-785	REV. B, 15 SEPTEMBER 1980 RELIABILITY PROGRAM FOR SYSTEM AND EQUIPMENT, DEVELOPMENT AND PRODUCTION
MIL-STD-794	REV. D, 15 DECEMBER 1971 NOTICES 1 THROUGH 4, PARTS AND EQUIPMENT, PROCEDURES FOR PACKAGING AND PACKING OF
MIL-STD-810	REV. C, 10 MARCH 1975 ENVIRONMENTAL TEST METHODS
MIL-STD-882	REV. A, 28 JUNE 1977 SYSTEM SAFETY REQUIREMENTS
MIL-STD-965	15 APRIL 1977 NOTICE 1, 22 DECEMBER 1978, PARTS CONTROL PROGRAM
MIL-STD-1275	REV. A (AT), 17 SEPTEMBER 1976, CHARACTERISTICS OF 28 VDC ELECTRICAL SYSTEM IN MILITARY VEHICLES.
MIL-STD-1472	REV. B, 31 DECEMBER 1974 NOTICE 1, 10 MAY 1976, NOTICE 2, 10 MAY 1978, HUMAN ENGINEERING DESIGN CRITERIA FOR MILITARY SYSTEMS, EQUIPMENT AND FACILITIES
MIL-STD-1562	REV. A, 15 APRIL 1977 NOTICE 2, 11 JANUARY 1978, LIST OF STANDARD MICROCIRCUITS
DOD-STD-100	REV. C, 22 DECEMBER 1978 NOTICE 1, 30 APRIL 1980 NOTICE 2, 28 NOVEMBER 1980 ENGINEERING DRAWING PRACTICES
DDD-5000.39	17 JANUARY 1980, ACQUISITION AND MANAGEMENT OF INTEGRATED LOGISTIC SUPPORT FOR SYSTEMS AND EQUIPMENT (COPIES OF SPECIFICATIONS, STANDARDS, DRAWINGS, AND PUBLICATIONS REQUIRED BY SUPPLIERS IN CONNECTION WITH SPECIFIED PROCUREMENT FUNCTIONS SHOULD BE OBTAINED FROM HAZELTINE).

OTHER PUBLICATIONS

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AFSC DH 1-3	1 JANUARY 1977, HUMAN FACTORS ENGINEERING
AFSC DH 1-6	20 DECEMBER 1978, SYSTEM SAFETY
MIL-HDBK-157	15 OCTOBER 1979 NOTICE 1, 6 MARCH 1980 TRANSPORTABILITY CRITERIA
MIL-HDBK-217	REV. D, 15 JANUARY 1982, RELIABILITY PREDICTIONS OF ELECTRONIC EQUIPMENT
MIL-HDBK-300	REV. H, 1 AUGUST 1978, TECHNICAL INFORMATION FILE OF GROUND SUPPORT EQUIPMENT
MIL-HDBK-472	24 MAY 1966, MAINTAINABILITY PREDICTIONS

2.2 NON-GOVERNMENT DOCUMENTS. THE FOLLOWING DOCUMENTS OF THE EXACT ISSUE SHOWN FORM A PART OF THIS SPECIFICATION TO THE EXTENT SPECIFIED HEREIN. IN THE EVENT OF CONFLICT BETWEEN THE DOCUMENTS REFERENCED HEREIN AND THE CONTENTS OF THIS SPECIFICATION, THE CONTENTS OF THIS SPECIFICATION SHALL BE CONSIDERED A SUPERSEDING REQUIREMENT.

AERONAUTICAL RADIO, INC.

ARINC REPORT 413	REV. A, DECEMBER 30, 1976 GUIDANCE FOR AIRCRAFT AND ELECTRICAL POWER UTILIZATION AND TRANSIENT PROTECTION

3. REQUIREMENTS.

3.1 ITEM DEFINITION. THE RFS IS AN ATOMIC FREQUENCY STANDARD WHICH UTILIZES AN INTERNAL RUBIDIUM CELL RESONATOR TO CONTROL THE FREQUENCY OF A QUARTZ CRYSTAL OSCILLATOR, WHICH PROVIDES A 10 MHz STABLE REFERENCE FREQUENCY OUTPUT. THE FREQUENCY STANDARD WILL BE USED IN MILITARY GROUND AND AIRBORNE ENVIRONMENTS, AND MUST GENERALLY SATISFY THE REQUIREMENTS OF MIL-E-4158 AND MIL-E-5400.

3.1.1 INTERFACE DEFINITION. THE RFS SHALL PROVIDE A 10 MHz SIGNAL OUTPUT, A BUILT-IN-TEST SIGNAL OUTPUT, AND A CRYSTAL CONTROL SIGNAL OUTPUT. THE INTERFACE SHALL BE ACCOMPLISHED UTILIZING CABLE CONNECTIONS. THE RFS INTERFACE DETAILS ARE PRESENTED IN FIGURE 1 AND THE INTERFACE LEVELS ARE SPECIFIED IN 3.2.1 HEREIN. POWER INPUT TO THE RFS SHALL BE AS SPECIFIED IN 3.2.1.10.

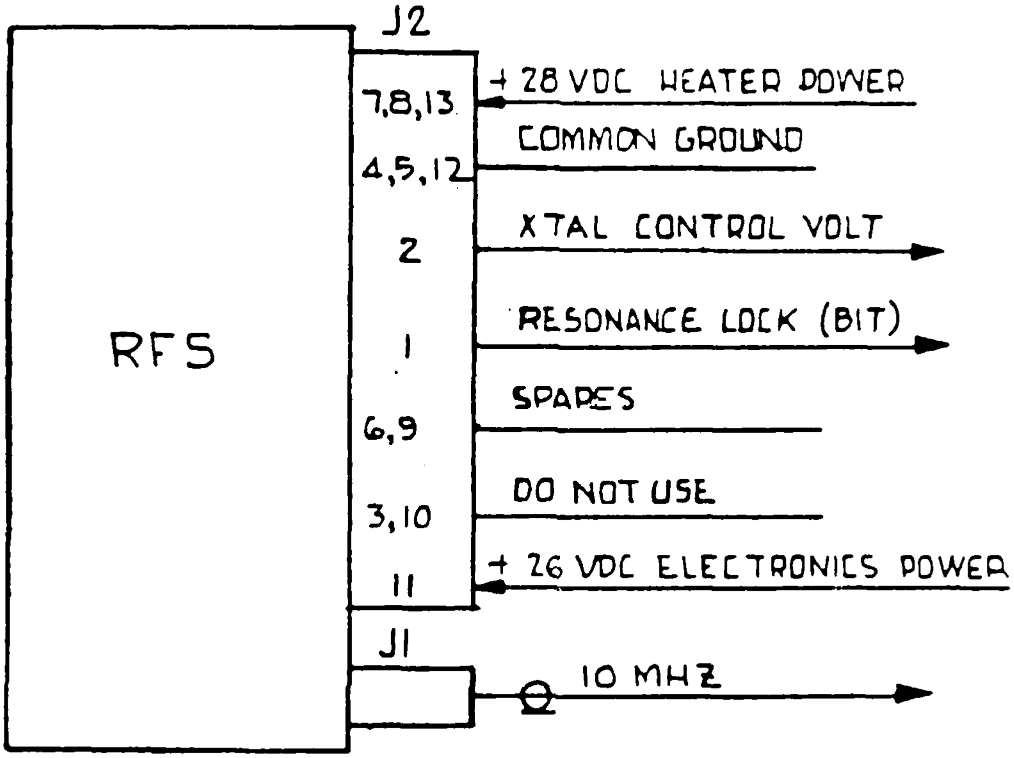

FIGURE 1. RFS INTERFACE DIAGRAM

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3.1.2 OUTPUT SIGNALS. THE INTERFACE SIGNALS FROM THE RFS SHALL BE AS FOLLOWS:

A. THE 10 MHz SIGNAL SHALL BE THE STABLE FREQUENCY REFERENCE.

B. THE BUILT-IN-TEST (BIT) SIGNAL SHALL BE PRESENTED TO THE EXTERNAL BIT CIRCUITRY TO MONITOR AS A GO-NO/GO INDICATION OF RFS OPERATION.

C. THE CRYSTAL CONTROL SIGNAL SHALL IDENTIFY THE NECESSITY FOR ADJUSTMENT OF THE RFS AS INDICATED BY UPPER AND LOWER LIMITS OF THE DC VOLTAGE.

3.2 CHARACTERISTICS. THE RFS CHARACTERISTICS SHALL BE AS SPECIFIED IN THE FOLLOWING PARAGRAPHS.

3.2.1 PERFORMANCE.

3.2.1.1 OUTPUT. THE RFS OUTPUTS SHALL BE AS FOLLOWS:

A. 10 MHz REFERENCE. THE 10 MHz REFERENCE OUTPUT SHALL BE A 10 MHz SINEWAVE, 0.5 VRMS (+30%, -10%) INTO A 50 OHM ±10% RESISTIVE LOAD. THE OUTPUT IMPEDANCE SHALL BE 50 OHMS ±10%

B. BUILT-IN-TEST (BIT). THE BIT OUTPUT SHALL BE CAPABLE OF SINKING 20 mA WITH A VOLTAGE DROP OF LESS THAN 1 VOLT TO INDICATE A GO CONDITION AND SHALL HAVE A LEAKAGE CURRENT OF LESS THAN 100 uA AT 30 VDC TO INDICATE A NO-GO CONDITION.

C. CRYSTAL CONTROL VOLTAGE. THE CRYSTAL CONTROL VOLTAGE SHALL BE A SIGNAL THAT IDENTIFIES THE NECESSITY FOR RECALIBRATION OF THE RFS AS INDICATED BY A DC VOLTAGE OF LESS THAN +3.0 VOLTS OR GREATER THAN +12.0 VOLTS. THIS VOLTAGE SHALL BE 7.5 ±2 VDC AT SHIPMENT.

3.2.1.2 FREQUENCY ACCURACY AT SHIPMENT. ONE HOUR AFTER TURN ON, THE FRACTIONAL ERROR OF THE RFS AT TIME OF SHIPMENT SHALL BE LESS THAN 5 PARTS IN 10^{11}.

3.2.1.3 FREQUENCY ADJUSTMENT. THE FREQUENCY OF THE RFS SHALL BE ADJUSTABLE TO WITHIN 2 PARTS IN 10^{11} OVER THE RANGE OF 3 PARTS IN 10^{9}.

3.2.1.4 STABILITY.

3.2.1.4.1 LONG TERM STABILITY. THE LONG TERM DRIFT OVER ANY COMBINATION OF ENVIRONMENTAL CONDITIONS SHALL BE LESS THAN 5 PARTS IN 10^{10}/YEAR.

3.2.1.4.2 SHORT TERM STABILITY. THE SQUARE ROOT OF THE ALLAN VARIANCE $\sigma_y(\tau)$ OF THE FRACTIONAL FREQUENCY OFFSET Y FROM NOMINAL FOR SAMPLING INTERVALS τ BETWEEN 1 AND 100 SECONDS SHALL BE LESS THAN $(4 \times 10^{-11})(\tau^{-1/2})$ UNDER QUIESCENT CONDITIONS.

3.2.1.5 FREQUENCY RETRACE. THE RETRACE ERROR AT A CONSTANT TEMPERATURE SHALL BE LESS THAN 5 PARTS IN 10^{11} WHEN THE DURATION OF THE POWER-OFF STATE HAS BEEN LESS THAN 24 HOURS. THE RETRACE ERROR SHALL NOT BE CUMULATIVE FOR MULTIPLE CYCLES.

3.2.1.6 FREQUENCY VARIATION WITH VOLTAGE. OUTPUT FREQUENCY VARIATIONS SHALL BE LESS THAN 1 PART IN 10^{11} FOR AN INPUT VOLTAGE OF +26 VOLTS VARIED BY ±10% AND SHALL BE LESS THAN 5 PARTS IN 10^{11} FOR THE VOLTAGE RANGE SPECIFIED IN 3.2.1.10. THE OUTPUT FREQUENCY VARIATION SHALL BE LESS THAN 1 PART IN 10^{8} FOR HEATER VOLTAGE DROPOUT OF 10 SECONDS MAXIMUM DURATION.

3.2.1.7 SIGNAL TO NOISE (SSB 1 Hz BW). THE OUTPUT SIGNAL-TO-NOISE RATIO SHALL BE GREATER THAN 80 dB AT 100 Hz FROM THE CARRIER, GREATER THAN 95 dB AT 1kHz FROM THE CARRIER, AND GREATER THAN 60 dB AT 1 Hz FROM THE CARRIER OVER ANY COMBINATION OF ENVIRONMENTAL CONDITIONS SPECIFIED HEREIN.

3.2.1.8 HARMONIC/NON-HARMONIC COMPONENTS. HARMONIC DISTORTION COMPONENTS SHALL BE 30 dB BELOW THE CARRIER LEVEL. NON-HARMONIC DISTORTION COMPONENTS SHALL BE 60 dB OR MORE DOWN ALL THE WAY INTO THE CARRIER. THE DISTORTION REQUIREMENTS SHALL BE MET OVER ANY COMBINATION OF ENVIRONMENTAL CONDITIONS SPECIFIED HEREIN.

3.2.1.9 MAGNETIC FIELD. FRACTIONAL FREQUENCY ERROR DUE TO MAGNETIC FIELD EFFECTS SHALL BE LESS THAN 2 PARTS IN 10^{11} PER GUASS (WORST CASE ORIENTATION).

3.2.1.10 INPUT VOLTAGE. TWO INPUT VOLTAGE LINES SHALL BE PROVIDED WITH A SINGLE GROUND RETURN.

A. THE RFS HEATER CIRCUIT INPUT SHALL BE +28 VDC IN ACCORDANCE WITH THE REQUIREMENTS SPECIFIED IN MIL-STD-704, CATEGORY B, MIL-STD-1275, AND 3.3.2.1 OF THIS SPECIFICATION.

B. THE RFS ELECTRONIC CIRCUITS INPUT WILL BE +26 VDC AND IN ACCORDANCE WITH THE REQUIREMENTS SPECIFIED IN MIL-STD-704, CATEGORY B AND MIL-STD-1275 EXCEPT FOR:

- o VOLTAGE RANGE INCLUDING RIPPLE COMPONENTS: 26 ±4 V AT 400 mA MAX
- o TRANSIENTS: 50 V MAX WITH RESPECT TO GROUND FOR 1 SEC MAX.

3.2.1.11 <u>POWER CONSUMPTION.</u> THE TOTAL RFS POWER CONSUMPTION INCLUDING ELECTRONICS AND HEATER POWER SHALL NOT EXCEED THE FOLLOWING:

	25°C	-55°C
STEADY STATE MAXIMUM FOR HEATERS AND ELECTRONICS	17 W	23 W
PEAK DURING WARM-UP FOR HEATERS AND ELECTRONICS	110 W*	110 W*

*FOR 2 MINUTES MAXIMUM

3.2.1.2 <u>WARM-UP.</u> FOR ANY COMBINATION OF ENVIRONMENTAL CONDITIONS AND THE VOLTAGE RANGE AS SPECIFIED IN 3.2.1.10, THE RFS SHALL REQUIRE NO LONGER THAN FOUR MINUTES TO ACHIEVE A FREQUENCY ACCURACY OF 5×10^{-10}. AT AN AMBIENT TEMPERATURE OF 25°C, THE RFS SHALL REQUIRE NO LONGER THAN 1.5 MINUTES TO LOCK, 2.0 MIN TO 1 PART IN 10^9 AND 2.5 MIN TO 5 PARTS IN 10^{10}.

3.2.1.13 <u>FREQUENCY VARIATION WITH OPERATING TEMPERATURES.</u> FREQUENCY VARIATIONS WITH TEMPERATURE SHALL BE LESS THAN 3 PARTS IN 10^{10} OVER THE TEMPERATURE RANGE SPECIFIED IN 3.2.5.1.1.

3.2.1.14 <u>FREQUENCY VARIATION WITH PRESSURE.</u> FREQUENCY VARIATION WITH PRESSURE SHALL BE LESS THAN 1×10^{-13}M BAR.

3.2.1.15 <u>SHORT-CIRCUIT PROTECTION.</u> ALL OUTPUTS SHALL BE PROTECTED FROM DAMAGE DUE TO SHORT CIRCUITS AT ANY OF THE TERMINALS. THERE SHALL BE NO DEGRADATION BELOW THE SPECIFIED PERFORMANCE LIMITS HEREIN OF THE 10 MHz OUTPUT BY SHORT CIRCUIT OF ANY OTHER OUTPUT OR COMBINATION OF OUTPUTS.

3.2.2 <u>PHYSICAL CHARACTERISTICS.</u> THE RFS PHYSICAL CHARACTERISTICS SHALL BE AS SPECIFIED IN THE FOLLOWING PARAGRAPHS AND AS SHOWN IN FIGURE 2.

3.2.2.1 DIMENSIONAL AND VOLUMETRIC LIMITATIONS. THE RFS SHALL NOT EXCEED THE FOLLOWING DIMENSIONAL PARAMETERS WITH ADDITIONAL SPACE (K FACTOR) FOR CONNECTORS, HANDLES, ETC.:

SIZE (IN)	K FACTOR TOTAL LENGTH (IN)
3.25 H X 3.25 W X 4.5L	0.97 (0.72 FRONT, 0.25 REAR)

3.2.2.2 WEIGHT. THE WEIGHT OF THE RFS SHALL NOT EXCEED 3.0 POUNDS.

3.2.2.3 FRONT PANEL REQUIREMENTS. THE FRONT PANEL SHALL INCLUDE THE FOLLOWING:

A. CONNECTOR PER MIL-C-38999 SERIES I, SHELL SIZE 11, AND INSERT ARRANGEMENT 35.
B. COAXIAL CONNECTOR TYPE "TNC" IN ACCORDANCE WITH MIL-C-39012. THE CONNECTOR FLANGE SHALL BE GROUNDED.

3.2.2.4 OTHER REQUIREMENTS.

A. MANUFACTURER MARKING SHALL BE AFFIXED TO THE EXTERIOR FRONT OF THE RFS.
B. FREQUBNCY ADJUSTMENT CONTROL SHALL BE ACCESSIBLE FROM THE BACK OF THE RFS.
C. MOUNTING HOLES FOR SCREWS SHALL BE PROVIDED AS SHOWN IN FIGURE 2. THESE SHALL BE BLIND HOLES, SEALED INTERNALLY.

3.2.2.5 ORIENTATION. THE RFS SHALL MEET ALL PERFORMANCE REQUIREMENTS REGARDLESS OF ORIENTATION.

3.2.3 RELIABILITY. THE RFS SHALL HAVE THE FOLLOWING MINIMUM RELIABILITY VALUES:

ENVIRONMENT	DESIGN MTBF (HRS)	TEST MTBF (HRS)
AIRBORNE UNINHABITED FIGHTER	12975	5310
GROUND FIXED	34408	14027
GROUND MOBILE	21352	8754

THE DESIGN MTBF IS THE VALUE WHICH THE RELIABILITY PREDICTIONS MUST ACHIEVE AND SHALL BE CONSIDERED THE SAME AS THE SERIES MTBF.

3.2.3.1 USEFUL LIFE. THE RFS SHALL HAVE A USEFUL LIFETIME OF 25 YEARS.

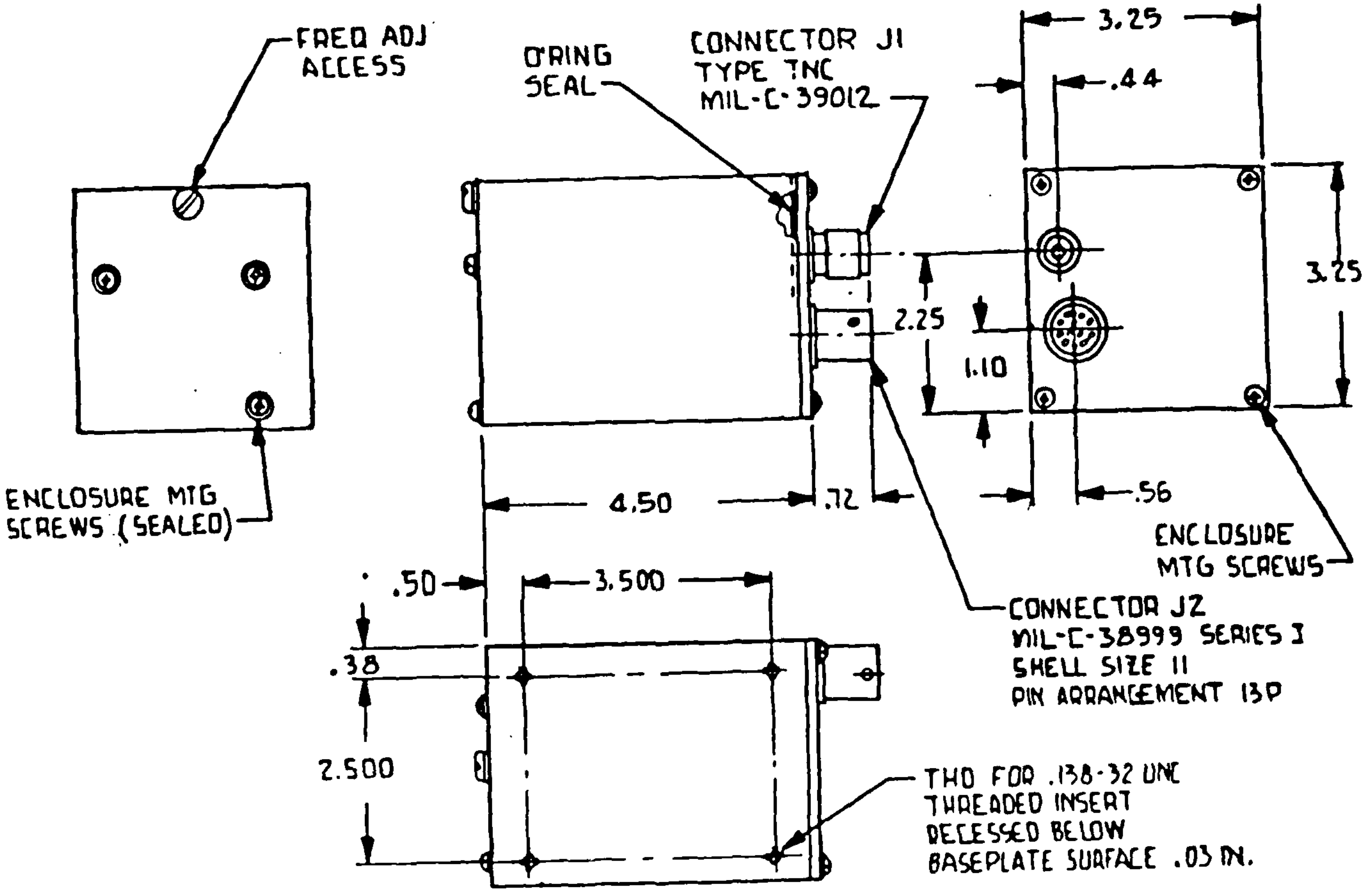

FIG. 2. RFS PHYSICAL CHARACTERISTICS

3.2.3.2 DESIGN PRACTICES.

3.2.3.2.1 RELIABILITY DESIGN REQUIREMENTS. THE RFS SHALL BE DESIGNED SUCH THAT A FAILURE SHALL NOT RESULT IN THE FAILURE OF ANY INTERFACING ITEM. FURTHER, THE RFS DESIGN SHALL NOT DEGRADE THE PERFORMANCE OF ANY INTERFACING ITEM.

3.2.3.2.2 RELIABILITY PREDICTIONS. RELIABILITY PREDICTIONS FOR THE RFS SHALL BE DONE IN ACCORDANCE WITH THE DETAILED PARTS STRESS PROCEDURE OF MIL-HDBK-217, USING THE ENVIRONMENTS LISTED IN 3.2.3 HEREIN. PART AMBIENT TEMPERATURES USED FOR THE RELIABILITY PREDICTIONS SHALL BE THOSE OBTAINED WHEN THE RFS IS MOUNTED TO THE HEAT SINK DESCRIBED IN 3.2.5.1.1 UNDER THE FOLLOWING COOLING AIR CONDITIONS:

ENVIRONMENT	COOLING AIR TEMPERATURE	FLOW RATE
AIRBORNE UNINHABITED FIGHTER	2°C	0.15 LB/MIN
GROUND FIXED	30°C	1.9 LB/MIN
GROUND MOBILE	40°C	1.9 LB/MIN

3.2.4 MAINTAINABILITY. THE RFS SHALL BE DESIGNED TO ACHIEVE THE MAINTENANCE TIME REQUIREMENTS SPECIFIED HEREIN. THE REQUIREMENTS ARE BASED ON THE UTILIZATION OF SUITABLY TRAINED MAINTENANCE PERSONNEL OF THE PROPER SKILL LEVEL.

3.2.4.1 QUANTITATIVE MAINTENANCE VALUES.

3.2.4.1.1 SELF-TEST. THE RFS SHALL CONTAIN SELF-TEST PROVISIONS WHICH CONTINUOUSLY MONITOR RFS OPERATION. FAULT DETECTION PROVIDED BY BUILT-IN TEST (BIT) SHALL DETECT 98.6% OF ALL RFS FAILURES, BASED ON PROBABILITY OF OCCURRENCE. UPON THE OCCURRENCE OF A FAULT, THE RFS SHALL SET THE BIT SIGNAL TO THE NO-GO INDICATION.

3.2.4.1.2 CORRECTIVE MAINTENANCE. THE RFS SHALL BE CAPABLE OF BEING MAINTAINED WITHIN THE FOLLOWING TIME CONSTRAINTS:

A. MEAN CORRECTIVE MAINTENANCE TIME ($\bar{M}_{CT}$) OF NOT MORE THAN 4.0 HOURS.

B. MAXIMUM CORRECTIVE MAINTENANCE TIME (M_{MAXCT}) OF NOT MORE THAN 10 HOURS AT THE 95TH PERCENTILE.

3.2.4.1.3 PREVENTIVE MAINTENANCE. THE FOLLOWING CONDITIONS ARE INDICATIONS OF THE NEED FOR REPLACEMENT OR ADJUSTMENT. A CRYSTAL VOLTAGE OUTSIDE THE RANGE SPECIFIED IN 3.2.1.1C INDICATES THE NECESSITY FOR ADJUSTMENT TO THE LEVEL SPECIFIED IN PARAGRAPH 3.2.1.1A. INABILITY TO SO ADJUST IS AN INDICATION OF APPROACHING CRYSTAL END OF LIFE. THIS ADJUSTMENT SHALL NOT BE REQUIRED MORE FREQUENTLY THAN ONCE EVERY 10,000 HOURS OF OPERATION.

3.2.5 ENVIRONMENTAL CONDITIONS. THE RFS SHALL MEET ALL THE PERFORMANCE REQUIREMENTS SPECIFIED HEREIN WHEN SUBJECTED TO ANY INDIVIDUAL OR PROBABLE COMBINATION OF SERVICE OR INDUCED ENVIRONMENTAL CONDITIONS AS DEFINED IN MIL-E-5400 CLASS I AND MIL-E-4158, EXCEPT AS SPECIFIED HEREIN. NO ELECTRICAL OR MECHANICAL DAMAGE, OR PERFORMANCE DEGRADATION SHALL OCCUR DURING OPERATION OR AFTER STORAGE UNDER THE CONDITIONS SPECIFIED HEREIN.

3.2.5.1 TEMPERATURE.

3.2.5.1.1 OPERATING TEMPERATURE. THE RFS SHALL MEET THE PERFORMANCE REQUIREMENTS SPECIFIED HEREIN WHEN SUBJECTED TO EXTENDED EXPOSURE TO AMBIENT TEMPERATURE FROM -55°C TO +71°C DURING CONTINUOUS OPERATION. THE RFS SHALL MEET THESE REQUIREMENTS WHEN MOUNTED TO A HEAT SINK WHICH IS FORCED CONVECTION COOLED. THE HEAT SINK SIZE WILL NOT BE LARGER THAN THE RFS DIMENSIONS IN WIDTH AND DEPTH AND WILL BE LIMITED TO A 1.0 INCH HEIGHT. THE HEAT SINK THERMAL RESISTANCE WILL BE 0.45°C/W FROM AMBIENT AIR TO THE MOUNTING SURFACE OF THE HEAT SINK. THE HEAT SINK MOUNTING SURFACE WILL HAVE A SURFACE FINISH OF 32 uIN AND A FLATNESS OF 0.003 IN TIR.

3.2.5.1.2 STORAGE TEMPERATURE (NON-OPERATING). THE RFS SHALL WITHSTAND WITHOUT DAMAGE AMBIENT TEMPERATURES FROM -62°C TO +95°C WHILE NON-OPERATING.

3.2.5.1.3 TRANSIENT TEMPERATURE. THE RFS SHALL WITHSTAND VARIATION IN AIR TEMPERATURE AS HIGH AS 2°C PER MINUTE WITHIN THE TEMPERATURE RANGES DEFINED IN 3.2.5.1.1. AND 3.2.5.1.2.

3.2.5.1.4 TEMPERATURE SHOCK. THE RFS, WHILE NON-OPERATING, SHALL WITHSTAND SUDDEN CHANGES IN TEMPERATURE WITHIN THE TEMPERATURE RANGE OF -57°C TO +71°C

3.2.5.1.5 TEMPERATURE ALTITUDE. THE RFS SHALL MEET THE PERFORMANCE REQUIREMENTS SPECIFIED HEREIN WHEN SUBJECTED TO TEMPERATURES IN ACCORDANCE WITH 3.2.5.1.1 AND ALTITUDES FROM SEA LEVEL TO 70,000 FEET.

3.2.5.2 SHOCK.

3.2.5.2.1 BENCH HANDLING SHOCK. THE RFS SHALL WITHSTAND THE SHOCK ENCOUNTERED DURING SERVICING. THE EQUIPMENT SHALL WITHSTAND THIS SHOCK REMOVED FROM ITS NORMAL ENCLOSURE AS IT WOULD APPEAR ON THE REPAIR BENCH.

3.2.5.2.2 OPERATION SHOCK. THE RFS SHALL OPERATE WITHIN SPECIFIED PERFORMANCE REQUIREMENTS WHEN BEING SUBJECTED TO 18 IMPACT SHOCKS, CONSISTING OF 6 SHOCKS (3 IN EACH OPPOSITE DIRECTION) ALONG EACH OF THREE ORTHOGONAL AXES. THE WAVEFORM AND AMPLITUDE OF SHOCK PULSES SHALL BE HALF SINE WAVE 20G PEAK, 11 MILLISECONDS NOMINAL DURATION.

3.2.5.2.3 ACCELERATION. FREQUENCY ERROR SHALL BE LESS THAN 4×10^{-1} WHEN SUBJECTED TO ACCELERATION FORCES OF MAGNITUDES AND DIRECTIONS SPECIFIED IN THE FOLLOWING TABLE:

ACCELERATION FORCES

DIRECTION	LEVEL (G)
PERPENDICULAR TO BASE OF EQUIPMENT	
DOWNWARD	10
UPWARD	10
PERPENDICULAR TO SIDE OF EQUIPMENT	
LATERAL (RIGHT AND LEFT)	10
PERPENDICULAR TO FRONT OF EQUIPMENT	
FOR AND AFT	10

3.2.5.3 VIBRATION. THE RFS SHALL MEET THE FOLLOWING REQUIREMENTS WHEN HARD MOUNTED.

3.2.5.3.1 RANDOM VIBRATION. THIS VIBRATION REQUIREMENT SHALL BE VERIFIED IN ACCORDANCE WITH THE GENERAL REQUIREMENTS OF MIL-STD-810, METHOD 514.2. TEST TIMES SHALL BE 0.5 HOUR PER AXIS FOR THE PERFORMANCE LEVELS AND 2.0 HOURS PPER AXIS FOR THE ENDURANCE LEVELS.

3.2.5.3.1.1 PERFORMANCE LEVEL. THE FREQUENCY ERROR SHALL BE LESS THAN 5×10^{10} WHEN MEASURED ON A CLOCK OVER A ONE HALF (1/2) HOUR INTERVAL AT THE FOLLOWING PERFORMANCE VIBRATION LEVELS:

PERFORMANCE LEVEL	FOR	VERTICAL AXIS
15 - 20 Hz	-	.086 g^2/Hz
20 - 30 Hz	-	.332 g^2/Hz
30 - 40 Hz	-	.564 g^2/Hz
40 - 50 Hz	-	.226 g^2/Hz
50 - 60 Hz	-	.037 g^2/Hz
60 - 70 Hz	-	.0123 g^2/Hz
70 - 300 Hz	-	.01 g^2/Hz
300- 2000 Hz	-	.005 g^2/Hz

NOTE: IF UNABLE TO TEST WITH .005 G^2/HZ, THEN TEST WITH .01 G^2/HZ.

PERFORMANCE LEVEL	FOR	HORIZONTAL AXIS
15 - 20 Hz	-	.223 g^2/Hz
20 - 30 Hz	-	.462 g^2/Hz
30 - 40 Hz	-	.138 g^2/Hz
40 - 50 Hz	-	.133 g^2/Hz
50 - 60 Hz	-	.170 g^2/Hz
60 - 70 Hz	-	.175 g^2/Hz
70 - 80 Hz	-	.136 g^2/Hz
80 - 90 Hz	-	.089 g^2/Hz
90 - 100 Hz	-	.059 g^2/Hz
100 - 110 Hz	-	.041 g^2/Hz
110 - 120 Hz	-	.030 g^2/Hz
120 - 130 Hz	-	.023 g^2/Hz
130 - 140 Hz	-	.019 g^2/Hz
140 - 150 Hz	-	.016 g^2/Hz
150 - 160 Hz	-	.014 g^2/Hz
160 - 170 Hz	-	.012 g^2/Hz
170 - 180 Hz	-	.011 g^2/Hz
180 - 300 Hz	-	.01 g^2/Hz
300 - 2000 Hz	-	.005 g^2/Hz

3.2.5.3.1.2 ENDURANCE LEVEL. THE RFS SHALL MEET ALL PERFORMANCE REQUIREMENTS OF THIS SPECIFICATION AFTER VIBRATION AT THE FOLLOWING ENDURANCE LEVELS.

ENDURANCE LEVEL	FOR	VERTICAL AXIS
15 - 20 Hz	-	.0857 g^2/Hz
20 - 30 Hz	-	.332 g^2/Hz
30 - 40 Hz	-	.564 g^2/Hz
40 - 50 Hz	-	.226 g^2/Hz
50 - 60 Hz	-	.037 g^2/Hz
60 - 70 Hz	-	.013 g^2/Hz
70 - 2000 Hz	-	.01 g^2/Hz

ENDURANCE LEVEL	FOR	HORIZONTAL AXIS
15 - 20 Hz	-	.223 g^2/Hz
20 - 30 HZ	-	.465 g^2/Hz
30 - 40 HZ	-	.137 g^2/Hz
40 - 50 HZ	-	.088 g^2/Hz
50 - 60 HZ	-	.133 g^2/Hz
60 - 70 HZ	-	.185 g^2/Hz
70 - 80 HZ	-	.171 g^2/Hz
80 - 90 HZ	-	.119 g^2/Hz
90 - 100 HZ	-	.078 g^2/Hz
100 - 110 HZ	-	.054 g^2/Hz
110 - 120 HZ	-	.040 g^2/Hz
120 - 130 HZ	-	.032 g^2/Hz
130 - 140 HZ	-	.026 g^2/Hz
140 - 150 HZ	-	.022 g^2/Hz
150 - 160 HZ	-	.019 g^2/Hz
160 - 170 HZ	-	.016 g^2/Hz
170 - 180 Hz	-	.014 g^2/Hz
180 - 190 Hz	-	.013 g^2/Hz
190 - 200 Hz	-	.012 g^2/Hz
200 - 2000 Hz	-	.01 g^2/Hz

3.2.5.3.2 SINUSOIDAL VIBRATION. THE FREQUENCY ERROR SHALL BE LESS THAN 1 X 10^{-9} MEASURED WITH T = 1 SECOND BELOW 20 HZ AND T = 0.1 SECOND ABOVE 20 HZ, AT THE FOLLOWING SINUSOIDAL VIBRATION LEVELS:

A. MINIMUM SINUSOID VIBRATION.

THIS VIBRATION REQUIREMENT SHALL BE VERIFIED IN ACCORDANCE WITH MIL-STD-810, METHOD 514.2, PROCEDURE VIII, CURVE V. CYCLING SHALL BE 5.5 HOURS PER AXIS.

PERFORMANCE LEVEL	FOR	HORIZONTAL AND VERTICAL AXIS
5.0 - 5.5 Hz	-	1.0 INCH DOUBLE AMPLITUDE
5.5 - 200 Hz	-	± 1.5 g PEAK

B. MAXIMUM SINUSOIDAL VIBRATION.

THIS VIBRATION REQUIREMENT SHALL BE VERIFIED IN ACCORDANCE WITH THE GENERAL REQUIREMENTS OF MIL-STD-810, METHOD 514.2. CYCLING SHALL BE 60 MINUTES PER AXIS AND RESONANT DWELL SHALL BE 10 MINUTES AT EACH OF THE FOLLOWING POINTS:

VERTICAL AXIS	HORIZONTAL AXIS
35 Hz	25 Hz
52 Hz	35 Hz
70 Hz	50 Hz
105 Hz	62 Hz

PERFORMANCE LEVEL				FOR	VERTICAL AXIS
5	-	10	Hz	-	1 g PEAK
10	-	20	Hz	-	1.5 g PEAK
20	-	22.5	Hz	-	2.5 g PEAK
22.5	-	25	Hz	-	3.75 g PEAK
25	-	27.5	Hz	-	5.5 g PEAK
27.5	-	30	Hz	-	8.0 g PEAK
30	-	32.5	Hz	-	11.5 g PEAK
32.5	-	37.5	Hz	-	14.25 g PEAK
37.5	-	40	Hz	-	13.5 g PEAK
40	-	42.5	Hz	-	12 g PEAK
42.5	-	45	Hz	-	9 g PEAK
45	-	47.5	Hz	-	7 g PEAK
47.5	-	50	Hz	-	5.5 g PEAK
50	-	52.5	Hz	-	4.75 g PEAK
52.5	-	55	Hz	-	4.0 g PEAK
55	-	60	Hz	-	3.5 g PEAK
60	-	65	Hz	-	2.75 g PEAK
65	-	70	Hz	-	2.25 g PEAK
70	-	80	Hz	-	2.0 g PEAK
80	-	90	Hz	-	1.5 g PEAK
90	-	100	Hz	-	1.0 g PEAK
100	-	150	Hz	-	1.0 g PEAK
150	-	500	Hz	-	.5 g PEAK
500	-	2000	Hz	-	.25 g PEAK

PERFORMANCE LEVEL				FOR	HORIZONTAL AXIS	
5	-	10	Hz	-	1	g PEAK
10	-	20	Hz	-	2.5	g PEAK
20	-	22.5	Hz	-	5	g PEAK
22.5	-	25	Hz	-	6.5	g PEAK
25	-	27.5	Hz	-	6.5	g PEAK
27.5	-	30	Hz	-	6.0	g PEAK
30	-	35	Hz	-	5.0	g PEAK
35	-	37.5	Hz	-	6.0	g PEAK
37.5	-	40	Hz	-	7.5	g PEAK
40	-	45	Hz	-	8.25	g PEAK
45	-	50	Hz	-	9.0	g PEAK
50	-	55	Hz	-	10.0	g PEAK
55	-	60	Hz	-	10.5	g PEAK
60	-	65	Hz	-	10.5	g PEAK
65	-	70	Hz	-	10.5	g PEAK
70	-	75	Hz	-	9.5	g PEAK
75	-	80	Hz	-	8.0	g PEAK
80	-	85	Hz	-	7.0	g PEAK
85	-	90	Hz	-	6.0	g PEAK
90	-	95	Hz	-	5.5	g PEAK
95	-	100	Hz	-	4.5	g PEAK
100	-	125	Hz	-	4.0	g PEAK
125	-	150	Hz	-	2.5	g PEAK
150	-	400	Hz	-	2.0	g PEAK
400	-	1000	Hz	-	1.0	g PEAK
1000	-	2000	Hz	-	.5	g PEAK

3.2.5.4 ACOUSTIC NOISE. THE RFS SHALL MEET THE PERFORMANCE REQUIREMENTS SPECIFIED HEREIN WHEN SUBJECTED TO THE ACOUSTIC NOISE TEST CONDITIONS SPECIFIED IN MIL-STD-810, METHOD 512.2

3.2.5.5 HUMIDITY. THE RPS SHALL MEET THE PERFORMANCE REQUIREMENTS SPECIFIED HEREIN OVER THE FOLLOWING RANGE OF HUMIDITY CONDITIONS.

MINIMUM: 20 PERCENT RELATIVE HUMIDITY (RH) FROM THE OPERATING TEMPERATURE TO +16°C. ABOVE +16°C, THE RH SHALL BE BASED ON A DEW POINT OF -7°C

MAXIMUM: 100 PERCENT RH INCLUDING CONDENSATION FROM THE MINIMUM OPERATING TEMPERATURE TO +27°C. ABOVE +27°C, THE RH SHALL BE BASED ON A DEW POINT OF +27°C.

3.2.5.6 SALT FOG. THE RFS SHALL MEET THE PERFORMANCE REQUIREMENTS SPECIFIED HEREIN WHEN EXPOSED TO A SALT ATMOSPHERE IN BOTH AN OPERATING AND NON-OPERATING MODE WHEN TESTED AS SPECIFIED IN MIL-STD-810, METHOD 509.1

3.2.5.7 FUNGUS RESISTANCE. THE RFS SHALL RESIST ANY DETRIMENTAL EFFECT ON PERFORMANCE IN BOTH AN OPERATING AND NON-OPERATING MODE BY THE GROWTH OF FUNGUS WHEN TESTED AS SPECIFIED IN MIL-STD-810, METHOD 508.1. ONLY INHERENTLY FUNGUS-INERT MATERIALS SHALL BE USED.

3.2.5.8 EXPLOSIVE CONDITIONS. THE RFS SHALL OPERATE WITHOUT DEGRADATION IN AN EXPLOSIVE ATMOSPHERE ON THE GROUND AND WHEN SUBJECTED TO DECREASED BAROMETRIC PRESSURES AT 70,000 FEET WITHOUT CREATING AN EXPLOSION.

3.2.5.9 SAND AND DUST. THE RFS SHALL OPERATE AS SPECIFIED WHILE BEING SUBJECTED TO CONDITIONS DEFINED IN MIL-STD-210, PARAGRAPH 5.1.2.1.3 GIVEN CLOSE PROXIMITY TO AIRCRAFT OPERATING OVER UNPAVED SURFACES.

3.2.5.10 RAIN. THE RFS SHALL MEET THE PERFORMANCE REQUIREMENTS SPECIFIED HEREIN WHEN EXPOSED TO THE CONDITIONS SPECIFIED IN THE RAINFALL RATE REQUIREMENT OF MIL-STD-210 FOR AN ESTIMATED DURATION OF EXPOSURE (EDE) OF 25 YEARS.

3.2.5.11 PRESSURIZATION. THE RFS SHALL WITHSTAND DIFFERENTIAL PRESSURES, AND REDUCED PRESSURE SHALL NOT CAUSE DEGRADATION IN PERFORMANCE BELOW THE REQUIREMENTS OF THIS SPECIFICATION. THE EQUIPMENT SHALL BE COMPLETELY ENCLOSED FOR PROTECTION AGAINST DUST, DIRT OR ANY OTHER CONTAMINANTS. EXTERNALLY INDUCED COOLING AIR, WHICH MAY BE CONTAMINATED BY DIRT AND THE COLLECTION OF WATER, SHALL NOT BE CIRCULATED ACROSS PARTS AND COMPONENTS. PROVISIONS SHALL BE MADE FOR THE DRAINAGE OF CONDENSED MOISTURE.

3.2.6 TRANSPORTABILITY. THE RFS SHALL BE TRANSPORTABLE, WITHOUT SPECIAL PACKING PROVISIONS, BY EITHER GOVERNMENT OR COMMERCIAL CARRIERS, INCLUDING BUT NOT LIMITED TO AIR OR SEA SHIPMENT. THE REQUIREMENTS OF MIL-HDBK-157 SHALL APPLY.

3.3 DESIGN AND CONSTRUCTION. THE REQUIREMENTS OF MIL-E-5400 AND MIL-E-4158 SHALL APPLY WITH ADDITIONS AND EXCEPTIONS TO THE PARAGRAPHS OF MIL-E-5400 AND MIL-E-4158 AS IDENTIFIED BY SIMILARITY OF PARAGRAPH HEADINGS, CALLED OUT HEREIN. WHEN THE TWO DOCUMENTS CONFLICT, THIS SPECIFICATION SHALL GOVERN. THE RFS DESIGN SHALL EMPHASIZE MINIMUM REQUIREMENTS FOR SUPPORT EQUIPMENT.

3.3.1 MATERIALS, PROCESSES AND PARTS.

3.1.1.1 STANDARD AND COMMERCIAL PARTS. ALL STANDARD AND NON-STANDARD PARTS SHALL BE SELECTED IN ACCORDANCE WITH MIL-E-540, MIL-E-4158 AND MIL-STD-956, PROCEDURE 1. MILITARY STANDARD (MS) OR ARMY-NAVY (AN) MATERIALS, PARTS, PROCESSES AND TECHNIQUES SHALL BE USED IN THE RFS DESCRIBED HEREIN, TO THE GREATEST EXTENT PRACTICAL, AND SHALL BE SPECIFIED ON THE DRAWING BY THE MS OR AN NUMBERS AND IN ACCORDANCE WITH DOD-STD-100. SPECIFICATIONS AND STANDARDS FOR MATERIALS, PROCESSES, PARTS AND EQUIPMENT OTHER THAN THOSE SPECIFICALLY DESIGNATED HEREIN SHALL BE SELECTED IN ACCORDANCE WITH THE ORDER OF PRECEDENCE SPECIFIED IN MIL-STD-143.

3.3.1.2 PARTS APPROVAL. USE OF ALL NON-STANDARD PARTS WILL REQUIRE PRIOR WRITTEN APPROVAL OF HAZELTINE.

3.3.1.2.1 SEMICONDUCTORS. ALL SEMICONDUCTORS SHALL BE SELECTED IN ACCORDANCE WITH MIL-STD-454 REQUIREMENT 30 AND THE FOLLOWING:

A. AXIAL LEADED DIODES AND RECTIFIERS SHALL BE OF A SOLID GLASS METALLURGICALLY BONDED CONSTRUCTION. POINT CONTACT DIODES SHALL NOT BE USED.

B. WHEN TO-5 AND TO-18 PACKAGES ARE REQUIRED, THEY SHALL BE LIMITED TO THE SOLID METAL HEADER TYPE.

C. ALL SEMICONDUCTOR DEVICE JUNCTIONS MUST BE PROTECTED AND NO ORGANIC OR DESICCANT MATERIALS SHALL BE INCLUDED IN THE PACKAGE.

D. THERMOCOMPRESSION WEDGE BONDING SHALL NOT BE USED WITH ALUMINUM WIRE.

E. ALUMINUM TO-3 PACKAGES SHALL NOT BE USED.

F. GERMANIUM DEVICES SHALL NOT BE USED.

G. PEAK JUNCTION TEMPERATURES OF SEMICONDUCTORS SHALL NOT EXCEED THE FOLLOWING:

(1) POWER DEVICES +150°C (302°F)

(2) SMALL SIGNAL DEVICES +125°C (257°F)

3.3.1.2.2 MICROELECTRONIC DEVICES. ALL MICROELECTRONIC DEVICES SHALL BE SELECTED IN ACCORDANCE WITH REQUIREMENT 64 OF MIL-STD-454 AND THE FOLLOWING:

A. HYBRID MICROCIRCUITS, INCLUDING RADIO FREQUENCY, MICROWAVE, AND MILLIMETER TYPES, ARE CONSIDERED MICROELECTRONIC DEVICES AND SHALL BE CONTROLLED BY REQUIREMENT 64 OF MIL-STD-454.

B. INTEGRATED CIRCUITS SHALL NOT HAVE PEAK JUNCTION TEMPERATURES EXCEEDING 125°C (257°F).

3.3.1.2.3 CRITICAL ITEMS. HYBRID (INCLUDING RADIO FREQUENCY, MICROWAVE AND MILLIMETER TYPES) AND COMPLEX MONOLITHIC MICROCIRCUITS ARE CONSIDERED CRITICAL ITEMS AND SHALL BE TREATED IN ACCORDANCE WITH THE RELIABILITY CRITICAL ITEMS REQUIREMENTS OF MIL-STD-785.

3.3.1.3 MOUNTINGS. MOUNTINGS FOR THE RFS SHALL BE AS SHOWN IN FIGURE 2.

3.3.1.4 RELAYS. THE USE OF ELECTROMECHANICAL RELAYS IS DISCOURAGED. WHEN THEY MUST BE USED, THEY SHALL BE SELECTED IN ACCORDANCE WITH MIL-STD-454, REQUIREMENT 57.

3.3.1.5 ELECTRONIC DEVICES.

3.3.1.5.1 ELECTRON TUBES. EXCEPT FOR RUBIDIUM TUBES, ELECTRON TUBES SHALL NOT BE USED IN THIS EQUIPMENT.

3.3.1.5.2 SEMICONDUCTOR DEVICES. ONLY JANTX SEMICONDUCTOR DEVICES SELECTED FROM MIL-STD-701 ARE STANDARD. WHEN A JANTX DEVICE IS NOT LISTED, THE SELECTION OF NON-STANDARD DEVICES SHALL CONFORM TO THE FOLLOWING ORDER OF PRECEDENCE.

A. A JAN DEVICE LISTED IN MIL-STD-701.
B. A JAN DEVICE COVERED BY MIL-S-19500 BUT NOT LISTED IN MIL-STD-701.
C. A COMMERCIAL DEVICE.

THE DEFINITION OF JANTX, JAN AND TX SHALL BE IN ACCORDANCE WITH MIL-S-19500. AS A MINIMUM, A TX BURN-IN REQUIREMENT IN ACCORDANCE WITH MIL-STD-454, REQUIREMENT 30, SHALL BE REQUIRED FOR ALL NON-STANDARD DEVICES.

3.3.1.5.3 HERMETIC PACKAGES. ALL MICROCIRCUITS AND SEMICONDUCTORS SHALL BE PACKAGES IN HERMETIC PACKAGES. NO PLASTIC ENCAPSULATED DEVICES OR POLYMER SEALED DEVICES SHALL BE USED WITHOUT WRITTEN APPROVAL OF HAZELTINE.

3.3.1.5.4 HYBRID FILM CIRCUITS AND DISCRETE SEMICONDUCTOR DEVICES. THE USE OF HYBRID FILM CIRCUITS AND DISCRETE SEMICONDUCTOR DEVICES (TRANSISTORS, DIODES) SHALL BE PERMISSIBLE WHEN IT CAN BE SHOWN THAT SUCH USE IS MORE EFFECTIVE IN TERMS OF SIGNIFICANT PERFORMANCE OR LIFE-CYCLE COST OWNERSHIP. DISCRETE SEMICONDUCTOR DEVICES SHALL BE IN ACCORDANCE WITH MIL-S-19500. TX (EXTRA TESTING), OR EQUIVALENT, SHALL BE USED TO THE MAXIMUM EXTENT POSSIBLE. HYBRID CIRCUITS SHALL BE IN ACCORDANCE WITH MIL-M-38510, CLASS B.

3.3.1.5.5 MICROCIRCUITS. MICROCIRCUITS LISTED IN MIL-STD-1562 AND PROCURED IN ACCORDANCE WITH MIL-M-38510 SHALL BE USED WHENEVER SUCH USE IS FEASIBLE AND COMPATIBLE WITH OTHER REQUIREMENTS OF THIS SPECIFICATION. NON-STANDARD DEVICES SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF MIL-M-38510, CLASS B. QUALIFICATION AND SCREENING REQUIREMENTS FOR NON-STANDARD DEVICES WILL BE DETERMINED AS PART OF DEVICE APPROVAL PROCEDURES.

3.3.1.6 FREQUENCY STANDARDS. NO PART OF THE RFS SHALL REQUIRE FREQUENCY CALIBRATION MORE OFTEN THAN ONCE PER MONTH.

3.3.1.7 QUARTZ CRYSTAL UNITS. ALL QUARTS CRYSTAL UNITS USED IN THE RFS SHALL BE IN ACCORDANCE WITH MIL-C-3098.

3.3.1.8 COMPONENT ORIENTATION. PARTS OR SUB-ASSEMBLIES WHICH COULD CAUSE MALFUNCTION WHEN INSTALLED IMPROPERLY SHALL BE DESIGNED AND FABRICATED SO THAT THEY CAN BE INSTALLED ONLY IN THEIR PROPER OPERATING POSITION.

3.3.1.9 CIRCUITS. NO DAMAGE SHALL OCCUR IF THE RFS IS OPERATING ALONE OR WITH ASSOCIATED EQUIPMENT AND THE RFS SHALL NOT BE DAMAGED WHEN OPERATED WITH AN OPEN OR SHORT CIRCUIT AT ANY OF THE ELECTRICAL OR MECHANICAL INTERFACES.

3.3.1.9.1 CIRCUIT ADJUSTMENTS. THE RFS SHALL NOT BE DAMAGED WHEN ANY OF THE OPERATING CONTROLS OR SERVICE ADJUSTMENTS ARE PLACED IN EXTREME OR INCORRECT POSITIONS. THE NUMBER OF ADJUSTMENTS CONTAINED WITHIN THE RFS SHALL BE HELD TO AN ABSOLUTE MINIMUM COMMENSURATE WITH THE STATE-OF-THE-ART AND GOOD ENGINEERING PRACTICE. INTERNAL ADJUSTMENTS SHALL BE ELIMINATED WHEN TECHNICALLY FEASIBLE.

3.3.1.10 FINISHES.

3.3.1.10.1 CASES AND FRONT PANELS. THE CASE AND FRONT PANEL OF THE RFS SHALL BE FINISHED IN ACCORDANCE WITH THE EQUIPMENT COLOR REQUIREMENTS OF MIL-STD-1472.

3.3.1.10.2 CONTROL KNOB COLORS. KNOBS AND CONTROLS SHALL BE FINISHED IN ACCORDANCE WITH THE EQUIPMENT COLOR REQUIREMENTS OF MIL-STD-1472.

3.3.1.10.3 BASEPLATE. THE BASEPLATE SHALL HAVE A FINISH OF 32 uIN OR BETTER AND A FLATNESS OF 0.003 IN TIR. ALL END AND SIDE PLATES SHALL BE FLUSH OR RECESSED 0.10 IN FROM THE BASEPLATE SURFACE. THE BASEPLATE SHALL BE FINISHED WITH A CHEMICAL FILM PER MIL-C-5541, CLASS 3.

3.3.11 CORROSION OF METAL PARTS. CORROSION PROTECTION AND RESISTANCE SHALL BE AS SPECIFIED IN MIL-STD-454, REQUIREMENT 15. DISSIMILAR METALS SHALL BE SELECTED AND PROTECTED IN ACCORDANCE WITH MIL-STD-454, REQUIREMENT 16.

3.3.1.12 MOISTURE AND FUNGUS RESISTANCE. THE RFS SHALL USE MATERIALS THAT ARE MOISTURE RESISTANT AND ARE NON-NUTRIENT FOR FUNGI. FUNGI-INERT MATERIALS ARE SPECIFIED IN MIL-STD-454, REQUIREMENT 4.

3.3.1.13 ENCAPSULATION. MATERIALS USED FOR ENCAPSULATION AND EMBEDMENT SHALL BE SELECTED FOR THEIR OPERATIONAL ENVIRONMENT CONDITIONS. ONLY THOSE MATERIALS WHICH MEET OR EXCEED THE REQUIREMENTS OF MIL-S-8516, MIL-S-23586 AND MIL-I-81550 SHALL BE USED.

3.3.2 ELECTROMAGNETIC INTERFERENCE. THE RFS SHALL COMPLY WITH THE FOLLOWING ELECTROMAGNETIC INTERFERENCE (EMI) REQUIREMENTS SPECIFIED IN MIL-STD-461 FOR CLASS A1 AND A3 EQUIPMENT:

CE	03, 07
CS	01, 02, 06
RE	02
RS	02, 03

FOR CLASS A1 EQUIPMENT, RS03 SHALL BE EXPANDED TO INCLUDE FREQUENCIES BETWEEN 10 GHz AND 40 GHz AT FIELD STRENGTH OF 20 V/m.

3.3.2.1 TRANSIENT PROTECTION.

A. THE RFS HEATER CIRCUIT SHALL NOT BE ADVERSELY AFFECTED BY POWER HAVING TRANSIENT CHARACTERISTICS WITHIN THE LIMITS SPECIFIED IN MIL-STD-704, CATEGORY B. HOWEVER, THE VOLTAGE EXCURSION LIMITS FOR DC LINE TRANSIENTS SHALL BE EXPANDED TO ±600 VOLTS FOR 0 TO 10 MICROSECONDS, DECREASING LINEARLY (ON SEMI-LOG SCALE) TO ±140 VOLTS AT 1 MILLISECOND, THEN LINEARLY TO ±80 VOLTS AT 10 MILLISECONDS. AS APPLIED HEREIN, MIL-STD-704 SHALL BE INTERPRETED AS COVERING ALL NEGATIVE TRANSIENTS BELOW 40

MILLISECONDS IN DURATION AND ALL POSITIVE TRANSIENTS, HOWEVER SHORT, IN ACCORDANCE WITH THE CONVERSION FORMULAS OF THAT DOCUMENT. ADDITIONALLY THE ZERO DC VOLTAGE PORTION OF MIL-STD-704, FIGURE 9, LIMIT 4, SHALL EXTEND TO 10 SECONDS, FOLLOWED BY A STEP TO THE ACTUAL CURVE. TRANSIENT SOURCE IMPEDANCES SHALL BE PER ARINC SPECIFICATION NO. 413 AND IAW THE TABLE BELOW. WHEN THE EQUIPMENT IS OPERATING AND AN INADVERTENT POWER INTERRUPT OCCURS (GREATER THAN 50 MILLISECONDS), THE EQUIPMENT SHALL BE FULLY OPERATIONAL AGAIN WITHIN 10 SECONDS AFTER THE END OF INTERRUPTION WITHOUT HUMAN ACTION. THE EQUIPMENT SHALL BE FULLY OPERATIONAL AGAIN IN LESS THAN 200 MILLISECONDS AFTER THE END OF A MOMENTARY TRANSIENT LASTING UP TO 50 MILLISECONDS, WITHOUT HUMAN ACTION.

THE RFS HEATER +28 VDC INPUT FOR GROUND INSTALLATIONS SHALL NOT BE ADVERSELY AFFECTED BY POWER HAVING TRANSIENT CHARACTERISTICS AS DEFINED BY MIL-STD-1275, EXCEPT THAT PERFORMANCE IS NOT REQUIRED DURING THE INITIAL START TRANSIENT (NO LESS THAN SIX VOLTS FOR NOT MORE THAN FOUR SECONDS). THE STEADY STATE VOLTAGE AS DEFINED IN THE STEADY STATE VOLTAGE REQUIREMENTS OF MIL-STD-1275 SHALL BE EQUAL TO OR GREATER THAN 23 VOLTS.

TRANSIENT IMPEDANCES

TRANSIENT VOLTAGE	DURATION	IMPEDANCE (±10%)
600 V	0 TO 1 MILLISECOND	50 OHMS
80 V	1 - 10 MILLISECONDS	15 OHMS
75 V	10 - 50 MILLISECONDS	5 OHMS
70 V	50 - 750 MILLISECONDS	0.2 OHMS

B. THE RFS ELECTRONIC CIRCUITS SHALL BE PROTECTED AGAINST THE FOLLOWING POWER CONDITIONS:

- o VOLTAGE DROP TO 22 VOLTS DC FOR 10 SECONDS FOLLOWED BY STEP TO THE ORIGINAL VOLTAGE.
- o VOLTAGE TRANSIENTS ± 50 V MAX FOR 1 SEC MAX.

3.3.2.2 BONDING. THE RFS SHALL COMPLY WITH THE REQUIREMENTS OF MIL-B-5087. EQUIPMENT MOUNTED ON RAILS OR TO A STRUCTURE, SHALL BE INTEGRALLY BONDED BY PREPARED SURFACES AT THE EQUIPMENT TO A STRUCTURE, INTERFACE. MAXIMUM DC RESISTANCE SHALL BE 2.5 MILLIOHMS.

3.3 PRODUCT MARKING. ALL MARKING SHALL BE IN ACCORDANCE WITH MIL-STD-130. PART AND ASSEMBLY MARKING SHALL INCLUDE PART NUMBER AND MANUFACTURER CODE IDENTIFICATION.

3.3.4 WORKMANSHIP. WORKMANSHIP SHALL BE IN ACCORDANCE WITH MIL-STD-454, REQUIREMENT 9. REWORK OF PRINTED WIRING BOARDS SHALL BE ALLOWED ONLY DURING PRE-PRODUCTION PHASES WHEN A HAZELTINE APPROVED PROCEDURE IS FOLLOWED. A MAXIMUM OF 3 JUMPER WIRES WILL BE ALLOWED FOR EACH PRINTED WIRING ASSEMBLY AND ALL SUCH JUMPERS SHALL BE ELIMINATED BY APPROPRIATE DESIGN CHANGES FOR PRODUCTION.

3.3.5 INTERCHANGEABILITY. THE RFS SHALL BE CONSTRUCTED OF EASILY IDENTIFIED MODULES AND SUBASSEMBLIES. ACCESS TO SUBASSEMBLIES, MODULES AND PARTS SHALL REQUIRE A MINIMUM OF TIME AND EFFORT BY MAINTENANCE PERSONNEL.

3.3.5.1 COMPONENT PROTECTION. THE RFS, IN OR OUT OF THE CASE, SHALL BE SO CONSTRUCTED THAT NO DAMAGE TO ANY UNIT OR COMPONENT, OR ANY UNDUE DISTORTION TO ANY STRUCTURAL MEMBER WILL BE CAUSED BY PLACING ANY FLAT SIDE OF THE RFS ON A FLAT SURFACE.

3.3.5.2 SERVICE AND ACCESS. ACCESS DOORS AND COVERS, IF REQUIRED, SHALL BE SO CONSTRUCTED AND INSTALLED WITH A MINIMUM NUMBER OF FASTENERS CONSISTENT WITH SOUND ENGINEERING PRACTICE.

3.3.6 SAFETY. SAFETY ENGINEERING SHALL BE APPLIED THROUGHOUT THE DESIGN, DEVELOPMENT, MANUFACTURER, TEST, OPERATION, AND MAINTENANCE IN ACCORDANCE WITH THE PRINCIPLES OF MIL-STD-882. EQUIPMENT DESIGN SHALL BE IN ACCORDANCE WITH AFSC DH 1-6, SECTION 2C, MIL-STD-454, REQUIREMENTS 1, 3, AND 8, AND THE HAZARDS AND SAFETY REQUIREMENTS OF MIL-STD-1472.

3.3.6.1 PERSONNEL SAFETY. SAFETY REQUIREMENTS SHALL BE IN ACCORDANCE WITH MIL-STD-454, REQUIREMENT 1.

3.3.6.2 SYSTEM SAFETY. CONTROL AND MODULAR CONSTRUCTION SHALL BE SUCH THAT OPERATOR/MAINTENANCE PERSONNEL CANNOT INDUCE FAILURES OF THE EQUIPMENT WHILE OPERATING/TESTING/PERFORMING MAINTENANCE IN ACCORDANCE WITH THE TECHNICAL DATA, OPERATIONAL HANDBOOKS AND TEST PROCEDURES PROVIDED.

3.3.6.3 CORONA AND ELECTRICAL BREAKDOWN. CORONA AND ELECTRICAL BREAKDOWN PREVENTION SHALL BE IN ACCORDANCE WITH MIL-STD-454, REQUIREMENT 45.

3.3.6.4 LIGHTNING PROTECTION. THIS EQUIPMENT SHALL BE DESIGNED TO PROVIDE LIGHTNING PROTECTION IN ACCORDANCE WITH MIL-B-5087.

3.3.6.5 REVERSE POLARITY PROTECTION. THIS EQUIPMENT SHALL BE PROVIDED WITH A REVERSE POLARITY PROTECTION CIRCUIT THAT PREVENTS DAMAGE TO ANY PART OF THE EQUIPMENT BY INADVERTENT CONNECTION TO A DC POWER SOURCE HAVING THE WRONG POLARITY.

3.3.7 HUMAN PERFORMANCE/HUMAN ENGINEERING. THE RFS SHALL REFLECT THE APPLICATION OF HUMAN ENGINEERING AS DEFINED BY MIL-H-46855. AFSC DH 1-3 SHALL BE USED AS A GUIDE. THE DETAILED DESIGN SHALL BE IN ACCORDANCE WITH MIL-STD-1472. PARAGRAPHS 5.10, 5.12, AND 5.14 OF MIL-STD-1472 DO NOT APPLY.

3.4 DOCUMENTATION. DOCUMENTATION, INCLUDING TEST PLANS, PROCEDURES, SPECIFICATIONS, DRAWINGS, AND TECHNICAL ORDERS SHALL BE PROVIDED IN ACCORDANCE WITH CONTRACT DATA REQUIREMENTS.

3.5 LOGISTICS. THIS EQUIPMENT SHALL BE DESIGNED TO MINIMIZE LIFE-CYCLE-COST CONSISTENT WITH PERFORMANCE TO MEET MISSION NEEDS. THE INTERFACE REQUIREMENTS AND LOGISTICS DISCIPLINES OF DOD-5000.39 SHALL BE INTEGRATED INTO THE DESIGN AND ENGINEERING CONSTRAINTS CITED IN OTHER SECTIONS OF THIS SPECIFICATION.

3.5.1 MAINTENANCE. THE MAINTAINABILITY REQUIREMENTS AND CRITERIA FOR MAINTAINABILITY DESIGN ARE ESTABLISHED IN 3.2.4 HEREIN. SCHEDULED OR PREVENTIVE MAINTENANCE, EXCLUDING NORMAL HOUSEKEEPING CHORES, SUCH AS CLEANING OR REPLACEMENT OF AIR FILTERS, CLEANING OF EXTERIOR SURFACES, ETC., SHALL NOT REQUIRE MORE THAN 0.1 HOUR TO ACCOMPLISH EXCLUDING WARM-UP TIME. THE FREQUENCY OF SUCH SCHEDULED OR PREVENTIVE MAINTENANCE SHALL NOT BE MORE OFTEN THAN 30 DAYS. THE RFS SHALL INCLUDE BIT CIRCUITRY AND OTHER FEATURES TO ENABLE MAINTENANCE.

3.5.1.1 MAINTENANCE REQUIREMENTS. THE RFS SHALL BE DESIGNED TO MINIMIZE THE REQUIREMENTS FOR SPARES AND SUPPLY SUPPORT, SUPPORT EQUIPMENT, AND SKILL LEVEL AND TRAINING OF MAINTENANCE PERSONNEL. IT SHALL UTILIZE TO THE MAXIMUM EXTENT FEASIBLE THE CURRENTLY OPERATIONAL LOGISTICS SYSTEMS THAT ARE SUPPORTING UHF RADIOS AND OTHER EXISTING ELECTRONICS ON THE HOST PLATFORMS.

3.5.1.2 FAULT DETECTION AND ISOLATION. FAULTS SHALL BE DETECTED AND ISOLATED BY A COMBINATION OF BUILT-IN TEST (BIT) CIRCUITS AND EXTERNAL SUPPORT EQUIPMENT. THESE TECHNIQUES, IN CONJUNCTION WITH OPERATOR OBSERVATIONS, SHALL ENABLE THE PERFORMANCE OF THE FOLLOWING BASIC FAULT DETECTION AND ISOLATION STEPS:

A. RECOGNITION THAT A FAULT EXISTS.

B. ISOLATION OF THE FAULT TO A POINT AT WHICH REPAIR CAN EFFECTIVELY BE ACHIEVED AT THE OPERATING LOCATION.

C. NO LESS THAN 98.6 PERCENT OF THE FAULTS SHALL BE DETECTED USING BUILT IN TEST.

D. USING TECHNICAL ORDERS (TO) AND A COMBINATION OF INDICATORS, TEST POINTS, SELF TEST CIRCUITRY, TEST JACKS, AUTHORIZED TEST EQUIPMENT AND DIAGNOSTIC COMPUTER PROGRAMS, 100 PERCENT OF THE DETECTED FAULTS SHALL BE ISOLATED TO A SINGLE ASSEMBLY IDENTIFIED AS REPLACEABLE OR REPAIRABLE FOR THE GIVEN MAINTENANCE LEVEL, WITHIN THE REPAIR TIME CONSTRAINTS OF 3.2.4.

E. THE RATIO OF FALSE DETECTIONS OF A FAULT TO FAULTS DETECTED SHALL BE NO GREATER THAN 0.01.

3.5.1.3 TEST POINTS. TEST POINTS FOR INTERCONNECTING TEST AND SUPPORT EQUIPMENT SHALL BE PROVIDED FOR DETERMINING THE PERFORMANCE OF THIS EQUIPMENT AND FOR PERFORMING ORGANIZATIONAL AND INTERMEDIATE MAINTENANCE. TEST POINTS SHALL MEET THE REQUIREMENTS OF MIL-STD-415, CLASS C. TEST POINTS SHALL BE DESIGNED AND PLACED WITH DUE CONSIDERATION FOR ISOLATION AND SAFETY. ALL COMPONENTS, CONNECTORS, AND ASSEMBLIES SHALL BE READILY IDENTIFIED AS TO REFERENCE DESIGNATOR AND LOCATION. CIRCUIT BREAKERS SHALL BE EASILY ACCESSIBLE. ALL CONNECTORS SHALL BE APPROPRIATELY KEYED TO PREVENT IMPROPER INSERTION OR CONNECTION TO THE WIRING TERMINAL.

3.5.2 SUPPLY. THIS EQUIPMENT SHALL BE DESIGNED TO MAKE MAXIMUM USE OF STANDARD APPROVED ITEMS THAT ARE FROM QUALIFIED PRODUCT LISTS AND ARE ALREADY CATALOGED IN THE DOD SUPPLY SYSTEM. DESIGNERS SHALL CONSIDER THE COST OF INTRODUCING NEW EQUIPMENTS OR ITEMS, THE COST OR RESUPPLY, AND THE DISTRIBUTION/LOCATION OF SYSTEM STOCKS.

3.5.3 FACILITIES AND FACILITY EQUIPMENT. THE RFS SHALL BE DESIGNED TO BE MAINTAINED AND REPAIRED USING, TO THE MAXIMUM EXTENT POSSIBLE, THE STANDARD (COMMON) SUPPORT EQUIPMENT THAT IS IDENTIFIED IN MIL-HDBK-300. ONLY AS A LAST RESORT SHOULD NEW MAJOR ITEMS OF SUPPORT EQUIPMENT BE INTRODUCED INTO BASE OR DEPOT INVENTORIES.

3.6 PERSONNEL AND TRAINING.

3.6.1 PERSONNEL. THE RFS SHALL BE DESIGNED FOR OPERATION AND MAINTENANCE BY PERSONNEL WHO HAVE RECEIVED APPROPRIATE TRAINING.

3.6.2 TRAINING. TO THE EXTENT PRACTICAL, EXISTING OPERATIONAL EQUIPMENT AND STANDARD TRAINING DEVICES SHALL BE USED FOR BOTH OPERATIONS AND MAINTENANCE TRAINING.

4. QUALITY ASSURANCE PROVISIONS.

4.1 GENERAL. THIS SECTION ESTABLISHES THE REQUIREMENTS FOR THE FORMAL VERIFICATION OF THE PERFORMANCE REQUIREMENTS SET FORTH IN SECTION 3. THE OBJECTIVE OF THESE VERIFICATIONS IS TO PROVIDE ASSURANCE THAT THE REQUIREMENTS AND CHARACTERISTICS IN SECTION 3 ARE MET BY THE DESIGN. SUCCESSFUL COMPLETION OF THE VERIFICATION SHALL CONSTITUTE COMPLIANCE WITH SECTION 3. SUCCESS SHALL BE DETERMINED BASED ON THE SUCCESS CRITERIA SET FORTH IN SECTION 4 HEREIN. IF ANY OUT-OF-SPECIFICATION TEST RESULTS ARE OBSERVED, IMMEDIATE NOTIFICATION SHALL BE MADE TO HAZELTINE ALONG WITH A SUGGESTED APPROACH FOR RESOLVING THE PROBLEM. THE QUALITY ASSURANCE PROVISIONS SHALL INCLUDE THE FOLLOWING ACTIVITIES.

A. SPECIAL TEST AND EXAMINATIONS CONSISTING OF:

1. MATERIALS, PARTS AND PROCESSES
2. PROCUREMENT TESTS, AND
3. ENGINEERING TESTS AND EVALUATION

B. QUALITY CONFORMANCE INSPECTIONS CONSISTING OF SUBCONTRACTOR DEVELOPMENT TESTS AND EVALUATIONS AND ACCEPTANCE TESTS.

4.1.1 RESPONSIBILITY FOR TESTS. THE SUBCONTRACTOR SHALL BE RESPONSIBLE FOR THE CONDUCT OF ALL TESTS AND INSPECTIONS HEREIN. ALL TEST PLANS, INSTRUCTIONS, AND DIRECTIVES SHALL BE WRITTEN BY THE SUBCONTRACTOR AND SUBJECT TO THE APPROVAL BY HAZELTINE PRIOR TO THE EXECUTION OF THE TEST.

4.1.2 SPECIAL TESTS AND EXAMINATIONS. THESE TESTS AND INSPECTIONS SHALL BE CONDUCTED BY THE SUBCONTRACTOR AND REVIEWED BY HAZELTINE OR ITS DESIGNATED REPRESENTATIVE ON SELECTED PARTS AND PROCESSES USED IN THE DESIGN AND CONSTRUCTION OF THE RFS.

4.1.2.1 MATERIAL, PARTS AND PROCESSES. INSPECTION, MEASUREMENTS, TEST OR ANALYSIS AS APPROPRIATE SHALL BE CONDUCTED TO ENSURE THAT MATERIAL, PARTS, AND PROCESSES SATISFY THE REQUIREMENTS SPECIFIED IN 3.3.1 HEREIN.

4.1.2.1.1 DESIGN AND CONSTRUCTION PRACTICES. DESIGN AND CONSTRUCTION PRACTICES SHALL BE VERIFIED BY MECHANICAL AND VISUAL INSPECTION TO ENSURE THAT THEY CONFORM TO THE REQUIREMENTS OF 3.3 HEREIN.

4.1.2.2 PROCUREMENT TESTS. RECEIVING INSPECTION TESTS SHALL BE PERFORMED AS APPLICABLE ON MAJOR PROCURED ITEMS. THE ITEMS MAY BE TESTED AT THE MANUFACTURER'S FACILITY. THESE TESTS SHALL INCLUDE, BUT NOT NECESSARILY BE LIMITED TO: VISUAL AND MECHANICAL INSPECTIONS, GROSS FUNCTIONAL TESTS AND DOCUMENTATION INSPECTIONS.

4.1.2.3 ENGINEERING TESTS AND EVALUATION. ENGINEERING TEST AND EVALUATION SHALL BE CONDUCTED AS REQUIRED TO SUPPORT ENGINEERING DEVELOPED AND DESIGN. THESE TESTS AND EVALUATIONS ARE TO BE PERFORMED IN PARALLEL WITH DEVELOPMENT TO PROVIDE A MEANS FOR EARLY DETECTION AND CORRECTION OF PERFORMANCE AND DESIGN DEFICIENCIES. COPIES OF ENGINEERING TEST DATA SHALL BE MADE AVAILABLE TO HAZELTINE UPON REQUEST.

4.2 QUALITY CONFORMANCE. SUBCONTRACTOR DEVELOPMENT TEST AND EVALUATION (SDT&E) SHALL VERIFY THAT THE DESIGN OF THE RFS MEETS ALL OF THE SPECIFIED PERFORMANCE, ENVIRONMENTAL, RELIABILITY, AND MAINTAINABILITY REQUIREMENTS.

4.2.1 VERIFICATION METHODS. COMPLIANCE WITH REQUIREMENTS SHALL BE VERIFIED BY ONE OR MORE OF THE FOLLOWING METHODS:

A. INSPECTION. VERIFICATION BY A VISUAL EXAMINATION OF THE RFS, REVIEWING DESCRIPTIVE DOCUMENTATION, GAUGING OR MEASUREMENT, AND COMPARING THE APPROPRIATE CHARACTERISTICS WITH A PREDETERMINED STANDARD TO DETERMINE CONFORMANCE TO REQUIREMENTS WITHOUT THE USE OF SPECIAL LABORATORY EQUIPMENT OR PROCEDURES.

B. ANALYSIS. VERIFICATION BY TECHNICAL/MATHEMATICAL EVALUATION USING MATHEMATICAL REPRESENTATIONS (I.E., MATHEMATICAL MODELS, ALGORITHMS, EQUATIONS), CHARTS, GRAPHS, CIRCUIT DIAGRAMS, DATA REDUCTION AND/OR REPRESENTATIVE DATA TO SHOW THAT THE REQUIREMENTS HAVE BEEN MET.

C. DEMONSTRATION. VERIFICATION OF OPERATION, MOVEMENT, AND/OR ADJUSTMENT OF THE RFS UNDER A SPECIFIC CONDITION TO PERFORM THE DESIGN FUNCTION WITHOUT RECORDING OF QUANTITATIVE DATA EXCEPT FOR CHECK SHEETS. THE RFS MAY BE INSTRUMENTED AND QUANTITATIVE LIMITS OF PERFORMANCE MONITORED, BUT ACTUAL DATA IS NOT REQUIRED TO BE RECORDED.

D. TEST. VERIFICATION THROUGH THE SYSTEMATIC EXERCISING OF THE RFS UNDER ALL APPROPRIATE CONDITIONS WITH INSTRUMENTATION AND COLLECTION/ANALYSIS/EVALUATION OF QUANTITATIVE DATA.

4.2.2 SUBCONTRACTOR DEVELOPMENT TEST AND EVALUATION. SDT&E SHALL VERIFY THAT THE RFS DESIGN SATISFIES THE PERFORMANCE AND ENVIRONMENTAL REQUIREMENTS OF 3.0 HEREIN. VERIFICATION SHALL BE PERFORMED IN TWO STAGES, PRELIMINARY QUALIFICATION TESTS AND FORMAL QUALIFICATION TESTS.

4.2.2.1 PRELIMINARY QUALIFICATION TESTS (PQT). THE FRS SHALL BE SUBJECTED TO PRELIMINARY QUALIFICATION TESTS IN ORDER TO VERIFY THAT THE DESIGN APPROACH AND CONSTRUCTION PRACTICES COMPLY WITH THE REQUIREMENTS OF 3.0 HEREIN USING THE VERIFICATION METHODS DEFINED IN 4.0 HEREIN AND TO ENSURE THE RFS IS READY TO BEGIN FORMAL QUALIFICATION TESTING. ENGINEERING DEVELOPMENT TEST DATA, WHERE APPLICABLE AND SUPPORTED BY ENGINEERING RATIONALE, MAY BE SUBSTITUTED FOR SELECTED PRELIMINARY QUALIFICATION TESTS. SUBSTITUTION OF ALL SUCH DATA IS SUBJECT TO APPROVAL BY HAZELTINE.

4.2.2.2 FORMAL QUALIFICATION TESTS (FQT). FORMAL QUALIFICATION TESTS SHALL BE CONDUCTED AFTER SATISFACTORY COMPLETION OF PQT. FQT SHALL BE PERFORMED IN ACCORDANCE WITH THE VERIFICATION METHODS INDICATED IN TABLE I. THE PURPOSE OF FORMAL QUALIFICATION TESTS SHALL BE TO VERIFY COMPLIANCE WITH ALL REQUIREMENTS OF 3.0 HEREIN. THE TESTS SHALL BE CONDUCTED USING TEST PLANS AND PROCEDURES PREPARED BY THE CONTRACTOR AND APPROVED BY HAZELTINE. THE SUBCONTRACTOR SHALL NOTIFY HAZELTINE AT LEAST ONE WEEK PRIOR TO THE START OF ANY QUALIFICATION TESTING SO THAT HAZELTINE AND/OR A GOVERNMENT REPRESENTATIVE MAY WITNESS THE TESTS AT THEIR DISCRETION.

4.2.2.2.1 FUNCTIONAL PERFORMANCE TESTS. FUNCTIONAL PERFORMANCE TESTS SHALL BE PER AN APPROVED TEST PROCEDURE TO VERIFY COMPLIANCE WITH 3.2.1 HEREIN AT ROOM TEMPERATURE.

4.2.2.2.2. ENVIRONMENTAL COMPLIANCE. ANALYSES AND TESTS SHALL BE PERFORMED TO VERIFY THAT THE EQUIPMENT IS CAPABLE OF WITHSTANDING AND/OR OPERATING UNDER THE SERVICE AND INDUCED CONDITIONS SPECIFIED IN 3.2.5. THE VERIFICATION METHOD TO BE USED IS GIVEN IN TABLE I. FOR TEST REQUIRING EQUIPMENT OPERATION, SOFTWARE AND HARDWARE SHALL OPERATE AT NORMAL CONDITIONS OF VOLTAGE, FREQUENCY, AND COOLING CONSISTENT WITH AMBIENT TEST CONDITIONS; UNLESS SPECIFIED OTHERWISE BELOW OR IN THE APPLICABLE MIL-STD-810 TEST METHOD.

TABLE I

VERIFICATION METHOD FOR ENVIRONMENTAL COMPLIANCE

REQUIREMENTS PARAGRAPH	TITLE	VERIFICATION METHOD
3.2.5	ENVIRONMENTAL CONDITIONS, MIL-E-4158 AND MIL-E-5400, CLASS 2 EXCEPT AS SPECIFIED IN 3.2.5.1 TO 3.2.5.11	
3.2.5.1.1	OPERATING TEMPERATURE	TEST AS PART OF TEMPERATURE/ALTITUDE
3.2.5.1.2	STORAGE TEMPERATURE	TEST AS PART OF TEMPERATURE/ALTITUDE
3.2.5.1.3	TRANSIENT TEMPERATURE	TEST AS PART OF TEMPERATURE/ALTITUDE
3.2.5.1.4	TEMPERATURE SHOCK	TEST IAW MIL-STD-810 METHOD 503.1, PROCEDURE I
3.2.5.1.5	TEMPERATURE/ALTITUDE	TEST IAW MIL-STD-810 METHOD 504.1, PROCEDURE I, CATEGORY 6 AND AS SPECIFIED IN 3.2.5.1.5
3.2.5.2.1	BENCH HANDLING SHOCK	TEST IAW MIL-STD-810 METHOD 516.2, PROCEDURE V AND AS SPECIFIED IN 3.2.5.2.1
3.2.5.2.2	OPERATIONAL SHOCK	TEST IAW MIL-STD-810 METHOD 516.2, PROCEDURE I AND AS SPECIFIED IN 3.2.5.2.2
3.2.5.2.3	ACCELERATION	TEST IAW MIL-STD-810 METHOD 513.2 PROCEDURE II

TABLE I

VERIFICATION METHOD FOR ENVIRONMENTAL COMPLIANCE (CONT)

REQUIREMENT PARAGRAPH	TITLE	VERIFICATION METHOD
3.2.5.3	VIBRATION	TEST IAW THE GENERAL REQUIREMENTS OF MIL-STD-810 METHOD 514.2 AND AS SPECIFIED IN 3.2.5.3
3.2.5.4	ACOUSTIC NOISE	TEST IAW MIL-STD-810 METHOD 515.2, CATEGORY A, PROCEDURE I
3.2.5.5	HUMIDITY	TEST IAW MIL-STD-810 METHOD 507.1, PROCEDURE II
3.2.5.6	SALT FOG	TEST IAW MIL-STD-810 METHOD 509.1, PROCEDURE I
3.2.5.7	FUNGUS RESISTANCE	CONTRACTOR CERTIFICATION OR TEST IAW MIL-STD-810 METHOD 508.1, PROCEDURE I
3.2.5.8	EXPLOSIVE CONDITIONS	TEST IAW MIL-STD-810 METHOD 511.1, PROCEDURE I
3.2.5.9	SAND AND DUST	TEST IAW MIL-STD-810 METHOD 510.1, PROCEDURE I
3.2.5.10	RAIN	TEST IAW MIL-STD-810 TEST METHOD 506.1, PROCEDURE I
3.2.5.11	PRESSURIZATION	TEST AS PART OF TEMPERATURE/ALTITUDE

4.2.2.2.3 RELIABILITY VERIFICATION. THE RELIABILITY REQUIREMENTS OF 3.2.3 SHALL BE VERIFIED BY A PREDICTION IN ACCORDANCE WITH MIL-HDBK-217, SECTION 2, PARTS STRESS RELIABILITY. THE PREDICTION RESULTS SHALL INDICATE PART TYPE, GENERIC MANUFACTURER OR MILITARY PART NUMBER, PART VALUE WHERE APPLICABLE, PART STRESS, AND FAILURE RATE FOR ALL PARTS SUCH THAT TRACEABILITY EXISTS TO THE FAILURE RATE DERIVED FROM MIL-HDBK-217. VERIFICATION TESTING MAY BE PERFORMED BY HAZELTINE AS PART OF A SET (SYSTEM) LEVEL TEST. DURING THIS TEST, THE RFS WILL BE OPERATED WITHIN THE ENVIRONMENTAL LIMITS SPECIFIED HEREIN. THE SUBCONTRACTOR IS REQUIRED TO SUPPORT THIS TEST BY ANALYZING AND IMPLEMENTING CORRECTIVE ACTION, INCLUDING REDESIGN IF NECESSARY, FOR ALL FAILURES OF THE RFS WHICH OCCUR DURING THIS TEST. DURING THIS TEST, THE MINIMUM ACCEPTABLE MTBF SHALL BE AS PER 3.2.3 OF THIS DOCUMENT AND FAILURE TO EXHIBIT THIS MTBF SHALL BE CONSIDERED A RELIABILITY TEST FAILURE.

4.2.2.2.4 MAINTAINABILITY VERIFICATION. DEMONSTRATION OF COMPLIANCE WITH THE FAULT DETECTION REQUIREMENTS SHALL BE ACCOMPLISHED BY ANALYSIS. THE METHOD OF ANALYSIS SHALL BE PROPOSED BY THE SUBCONTRACTOR AND APPROVED BY HAZELTINE. VERIFICATION OF THE $\bar{M}_{CT}$ REQUIREMENTS OF 3.2.4.1.2 SHALL BE ACCOMPLISHED BY A REPAIR TIME PREDICTION.

THE REPAIR TIME PREDICTION SHALL UTILIZE THE ELEMENTAL TIME APPROACH OF MIL-HDBK-472 PROCEDURE IIB TO DETERMINE THE REPAIR TIME FOR A MINIMUM OF 50 TASKS. THE TASKS SHALL BE SELECTED USING THE RANDOM TECHNIQUES OF MIL-HDBK-472, PROCEDURE III.

ADDITIONAL VERIFICATION OF THE QUANTATIVE FAULT DETECTION, REQUIREMENTS MAY BE PERFORMED BY TESTING AT HAZELTINE AS PART OF A SYSTEM. THE SUBCONTRACTOR WILL BE REQUIRED TO SUPPORT THIS TEST BY IMPLEMENTING CORRECTIVE ACTION, INCLUDING REDESIGN, IN THE EVENT THAT THE TEST RESULTS INDICATE THAT THE RFS FAILS TO MEET ANY OF ITS REQUIREMENTS.

4.2.2.2.5 EMC/EMI TESTS. VERIFICATION OF THE REQUIREMENTS OF 3.3.2 HEREIN SHALL BE IN ACCORDANCE WITH MIL-STD-462, AND THE EMI TEST PLAN APPROVED BY HAZELTINE.

4.2.3 ACCEPTANCE TESTING.

4.2.3.1 ENVIRONMENTAL STRESS SCREENING (ESS). EACH UNIT SHALL BE SUBJECTED TO A MINIMUM ESS CONSISTING OF 50 "ON" HOURS, I.E., OPERATING HOURS, IN ACCORDANCE WITH THE PROFILE GIVEN IN FIGURE 3. THE TEST SHALL BE CONDUCTED AT AMBIENT PRESSURE CONDITIONS. A BASELINE PERFORMANCE TEST SHALL BE PERFORMED PRIOR TO THE START OF THE TEST AND DURING EACH HOT (71°C) TEMPERATURE STABILIZATION PERIOD. PERFORMANCE SHALL BE CHECKED AT LEAST ONCE EVERY 10 OPERATING HOURS AND FAILURES REPAIRED AS THEY ARE

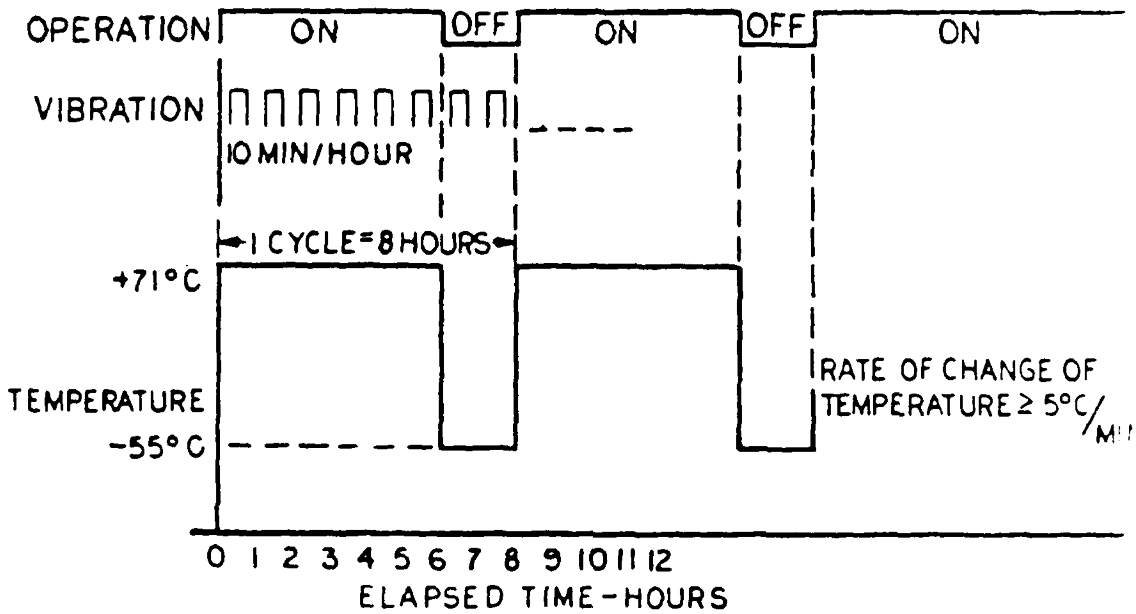

FIGURE 3-ESS CYCLE

IDENTIFIED. IF A FAILURE IS DETECTED, THE OPERATING TIME SINCE THE LAST SUCCESSFUL CHECK SHALL NOT BE COUNTED. ONLY ESS TIME ACCUMULATED WHEN THE EQUIPMENT IS IN A NON-FAILED CONDITION WILL BE COUNTED TOWARD THE 50 "ON" HOUR REQUIREMENT. THE LAST THREE CYCLES SHALL BE FAILURE FREE. THIS REQUIREMENT SHALL BE SATISFIED TO THE EXTENT THAT THE ESS CAN BE EXTENDED BEYOND THE 50 "ON" HOURS. THE TEMPERATURE SHALL BE CYCLED PER FIGURE 3. THE RATE OF CHANGE OF TEMPERATURE SHALL BE NO LESS THAN $50^{\circ}C$/MIN AND VIBRATION SHALL BE THE SAME AS THAT PROVIDED FOR THE PRODUCTION RELIABILITY ACCEPTANCE TEST (OPTION I, PARAGRAPH 4.4.1 OF MIL-STD-781, EXCEPT THAT THE MAXIMUM ACCELERATION SPECTRAL DENSITY SHALL BE 0.04 G^2/HZ AND SHALL BE APPLIED FOR 10 MINUTES EACH HOUR). THE INPUT VOLTAGE SHALL REMAIN CONSTANT DURING ESS. SHOCK MOUNTS SHALL NOT BE USED. THE SUBCONTRACTOR SHALL NOTIFY HAZELTINE AT LEAST ONE WEEK PRIOR TO THE START OF ACCEPTANCE TESTING SO THAT HAZELTINE AND/OR A GOVERNMENT REPRESENTATIVE MAY WITNESS THE TESTS AT THEIR DISCRETION.

4.2.4 NOTES ON PERFORMANCE TESTING. THE PARAMETERS THAT SHALL BE TESTED BY THE CONTRACTOR DURING QUALIFYING TESTS TO VERIFY THE UNITS SATISFY THE REQUIREMENTS SPECIFIED IN 3.2.1 SHALL, AS A MINIMUM, INCLUDE THE PARAMETERS SPECIFIED IN 3.2.1.1, 3.2.1.2, 3.2.1.7, AND 3.2.1.8. THESE PARAMETERS SHALL BE USED BY THE CONTRACTOR IN PREPARING TEST PLANS WHICH SHALL BE APPROVED BY HAZELTINE.

ALL PARAMETERS SHALL BE TESTED UNDER ALL CONDITIONS DEFINED IN TABLE I. EXTREMES OF CONDITIONS AND POINTS WITHIN EXTREMES SHALL BE TESTED TO ASSURE HAZELTINE THAT ALL RFS'S WILL WORK AS SPECIFIED HEREIN.

5. PREPARATION FOR DELIVERY. ALL ITEMS TO BE DELIVERED IN ACCORDANCE WITH THE TERMS OF THE CONTRACT SHALL BE PREPARED FOR SHIPMENT WITH THE APPROPRIATE PRESERVATION PACKAGING, PACKING AND MARKING SUCH THAT ADEQUATE PROTECTION IS AGAINST CORROSION, DETERIORATION AND PHYSICAL DAMAGE DURING SHIPMENT AND HANDLING FROM THE SOURCE OF SUPPLY TO THE ULTIMATE DESTINATION.

6. NOTES.

6.1 ACRONYMS AND ABBREVIATIONS. THE ACRONYMS AND THE ABBREVIATIONS USED IN THIS SPECIFICATION ARE DEFINED AS FOLLOWS:

AFSC	AIR FORCE SYSTEMS COMMAND
BIT	BUILT-IN TEST
BW	BANDWIDTH
EDE	ESTIMATED DURATION OF EXPOSURE
ESS	ENVIRONMENTAL STRESS SCREENING

FEDB	FAILURE EXPERIENCE DATA BANK
FQT	FORMAL QUALIFICATION TEST
GIDEP	GOVERNMENT INDUSTRY DATA EXCHANGE PROGRAM
JAN	JOINT ARMY NAVY
JANTX	JOINT ARMY NAVY EXTRA TESTING
K FACTOR	ADDITIONAL LENGTH REQUIRED FOR CONNECTORS AND HANDLES
LRU	LINE REPLACEMENT UNIT
$\bar{M}_{CT}$	MEAN CORRECTIVE MAINTENANCE TIME
M_{MAXCT}	MAXIMUM CORRECTIVE MAINTENANCE TIME
M_{PT}	PREVENTIVE MAINTENANCE TIME
MS	MILITARY STANDARDS
PQT	PRELIMINARY QUALIFICATION TEST
RQT	RELIABILITY QUALIFICATION TEST
RFS	RUBIDIUM FREQUENCY STANDARD
SDT&E	SUBCONTRACTOR DEVELOPMENT TEST & EVALUATION
TX	EXTRA TESTING
TO	TECHNICAL ORDERS
UDL	UNIT DETAIL LISTING

APPENDIX B

RELIABILITY PREDICTION

ATC REPORT NO. 5672

RELIABILITY PREDICTION
FOR
TACTICAL RUBIDIUM FREQUENCY STANDARD (TRFS)

ASSURANCE TECHNOLOGY CORPORATION

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Prepared For

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27 NOVEMBER 1985

Assurance Technology Corporation (ATC) is an engineering and management consulting firm dedicated to the resolution of the technical and management problems inherent in the design, development, manufacture, and use of today's complex hardware and software systems.

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- PROGRAM PLANNING/MANAGEMENT
- PROPOSAL PREPARATION & EVALUATION
- OPERATING POLICIES AND PROCEDURES
- MANAGEMENT VISIBILITY & CONTROL SYSTEMS
- CONFIGURATION & DATA MANAGEMENT
- NETWORK MANAGEMENT SYSTEMS (CPM/PERT)
- COST/SCHEDULE CONTROL SYSTEMS (C/SCS)
- SYSTEMS ENGINEERING MANAGEMENT PLANS (SEMP)

DESIGN ASSURANCE/ HARDWARE ANALYSIS

- DESIGN REVIEW/AUTOMATED DESIGN ANALYSIS
- HUMAN FACTORS/SYSTEMS SAFETY
- EQUIPMENT QUALIFICATION TEST & EVALUATION
- PARTS SCREENING & QUALIFICATION
- DESTRUCTIVE PHYSICAL ANALYSIS
- FAILURE ANALYSIS
- SCANNING ELECTRON MICROSCOPE (SEM) ANALYSIS
- MATERIAL/PROCESS EVALUATION & CONTROL

RELIABILITY/ MAINTAINABILITY/ LOGISTICS SUPPORT

- PROGRAM PLANNING & IMPLEMENTATION
- DESIGN REVIEW AND TRADEOFF STUDIES
- FAILURE MODE, EFFECT & CRITICALITY ANALYSIS
- RMA MODELING, PREDICTION AND ASSESSMENT
- RMA DEMONSTRATION TEST & EVALUATION
- MAINTENANCE PLANNING & ANALYSIS
- ILS, LOGISTICS SUPPORT, PROVISIONING
- LIFE CYCLE COST ANALYSIS

QUALITY ASSURANCE/ PARTS ENGINEERING

- PARTS & MATERIALS SELECTION/APPROVAL
- PROCUREMENT & PROCESS SPECIFICATIONS
- PARTS APPLICATION REVIEW
- FAILURE REPORTING SYSTEMS
- QUALITY ASSURANCE PLANNING
- QUALITY CONTROL SYSTEMS
- PRODUCTION SYSTEMS PLANNING
- VENDOR SURVEILLANCE/PRE-CAP VISUAL

ENGINEERING DOCUMENTATION

- PROPOSALS, PLANS AND PROCEDURES
- ENGINEERING DRAWING PACKAGES
- OPERATIONS & MAINTENANCE MANUALS
- TECHNICAL SPECIFICATIONS AND REPORTS
- FABRICATION/TEST INSPECTION PROCEDURES
- CDRL/DID IMPLEMENTATION
- TRAINING PROGRAMS & LESSON PLANS
- PROVISIONING TECHNICAL DOCUMENTATION

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1.0 INTRODUCTION

This report documents the results of a reliability prediction performed on the Tactical Rubidium Frequency Standard (TRFS) developed by the E G & G Frequency Products Division of Salem, Massachusetts.

The purpose of this prediction, which was conducted in accordance with the detailed parts stress procedure of paragraph 5-1 of MIL-HDBK-217D (with Notice 1), was to predict the mean time between failures (MTBF) of the TRFS for three (3) different sets of environment/cooling air temperature conditions.

Section 2.0 presents the summary results of the TRFS reliability prediction, while Section 3.0 describes the reliability mathematical model which was used in performing the prediction. In Section 4.0 the detailed part level stress and reliability data are compiled.

2.0 SUMMARY RESULTS

The reliability prediction performed on the TRFS indicates that for each of the three (3) environment/cooling air temperature conditions, the predicted MTBF of the TRFS exceeds the MTBF requirement specified in paragraph 3.2.3 of Hazeltine Corporation Specification Number 332819. This information is summarized in Table 2-1.

TABLE 2-2

TRFS MTBF PREDICTION SUMMARY

ENVIRONMENT	COOLING AIR TEMPERATURE	MTBF (HOURS) SPECIFIED	PREDICTED
Airborne Uninhabited, Fighter (AUF)	2°C	12,975	23,683
Ground Fixed (GF)	30°C	34,408	101,802
Ground Mobile (GM)	40°C	21,352	36,224

The prediction was performed utilizing detailed parts stress analysis data and localized TRFS assembly thermal data developed by E G & G engineering personnel and reflects the use of B, B-0 or B-1 quality level integrated circuits, JANTX quality level discrete semiconductors and "M" quality level passive components. Table 2-2 provides a matrix of predicted failure rate by assembly by environment/cooling air conditions for the TRFS.

TABLE 2-2

TRFS PREDICTED FAILURE RATE BY ASSEMBLY

TRFS ASSEMBLY	REF. TABLES	PREDICTED FAILURE RATE (FPMH)		
		ENVIRONMENT/COOLING AIR TEMPERATURE		
		AUF @ 2°C	GF @ 30°C	GM @ 40°C
Pre-Amp PWB	4-1A, B, C	0.944	0.200	0.560
VCXO PWB	4-2A, B, C	2.787	0.686	1.370
Input Filter	4-3A, B, C	0.417	0.057	0.231
Power Supplv	4-4A, B, C	8.164	2.921	7.093
SRD Multiplier	4-5A, B, C	2.669	0.178	0.780
Lamp Exciter PBW	4-6A, B, C	7.059	1.427	5.524
RF PWB	4-7A, B, C	11.280	1.967	6.461
Servo PWB	4-8A, B, C	3.176	0.769	2.059
Thermoelectric Controller	4-9A, B, C	1.843	0.521	1.363
Physics Package & Misc. Parts	4-10A, B, C	3.886	1.097	2.165
Failure Rate Totals:		42.225	9.823	27.606
MTBF (HOURS):		23,683	101,802	36,224

3.0 RELIABILITY MATHEMATICAL MODEL

In performing the TRFS reliability prediction a strictly series reliability model was assumed in accordance with paragraph 3.2.3 of Specification 332819. In addition, the standard assumption of constant part failure rates was employed. As a result of these assumptions, the total failure rate of the TRFS is the sum of the failure rates of the TRFS parts, and the TRFS MTBF is simply the reciprocal of the total TRFS failure rate.

4.0 PART LEVEL STRESS AND RELIABILITY DATA

The tables in this section provide a compilation of the detailed part level stress and reliability data which was developed in performing the TRFS reliability prediction. The tables are numbered 4-1 through 4-10 with a set of "A" tables containing the Airborne Uninhabited, Fighter (AUF) @ 2°C data, a set of "B" tables containing the Ground Fixed (GF) @ 30°C data and a set of "C" tables containing the Ground Modile (GM) @ 40°C data. In performing the prediction, the temperatures entered into the MIL-HDBK-217D failure rate algorithms were the actual local TRFS assembly ambient temperatures and not the overall TRFS cooling air temperature. These local ambients were developed from TRFS thermal studies and measurements performed by E G & G engineering personnel. The assemblv ambient temperature which was used for a particular assembly under a specific cooling air condition can be determined by examining the applied junction temperature for a discrete semiconductor with zero power dissipation. Here, the applied junction temperature equals the assembly ambient temperature. For example on Table 4-1A, the applied junction temperature of CR1 which is normally non-conducting (zero power dissipation) is seen to be 40°C, and this is the temperature at which the reliability prediction was performed for this assembly, the Pre-Amp PWB, at a TRFS cooling air temperature of 2°C.

An explanation of the information recorded in each column of the tables in this section and the ground rules and/or assumptions pertinent to the derivation of this information is as follows:

COLUMN	CONTENTS, GROUND RULES AND/OR ASSUMPTIONS
1	REF. SYMBOL: This column contains the reference symbol of each part from the schematic and parts list.
2	PART DESCRIPTION: This column provides a narrative description of the part.
3	PART NUMBER: This column provides the part number as given on the parts list.
4	RATED STRESS: This column lists the manufacturer's rated stress(s) for each part. The listed stresses are as follows: a. Integrated Circuits: The maximum rated junction temperature; b. Transistors: The maximum rated V_{CEO}, power dissipation and junction temperature; c. Diodes: The maximum rated reverse voltage (except for Zener diodes), the maximum rated average forward current and the maximum rated junction temperature; d. Capacitors: The maximum rated voltage; e. Resistors: The maximum rated power dissipation; f. Magnetics: The maximum insulation temperature.
5	APPLIED STRESS: This column provides the applied stress for each part as derived by E G & G engineering personnel. The stresses were tabulated for these parameters enumerated under the foregoing discussion of Column 4.

COLUMN	CONTENTS, GROUND RULES AND/OR ASSUMPTIONS
6	STRESS RATIO: The computed stress ratios are direct ratios of applied electrical stress to manufacturer's rated stress;
7	FAILURE RATE: This column contains the part failure rate in failures per million hours for the TRFS environment and cooling air temperature specified in the top left hand corner of the sheet;
8	F.R. SOURCE: This column lists the source of the failure rate listed in column 7 and the key to the contents of this column is as follows:

217D - MIL-HDBK-217D (With Notice 1)

NOTE 1 - Physics Package Rubidium cell failure rate was derived from Rockwell/Global Positioning System information

NOTE 2 - Heater failure rates were derived from Rockwell data and MINCO life test results

NOTE 3 - The thermoelectric modules will be non-operational under the prediction conditions.

TABLE 4-1A

PRE-AMP PRINTED WIRING BOARD RELIABILITY DATA

P/N C316629, REV. C

(AUF @ 2°C) Sheet 1 of 2

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
U1	IC, Linear, Dual Op Amp.	SCD 316786 (OP-14AZ/883B)	125°C	45°C		0.0898	217D
CR1	Diode, SI, GP	MIL-S-19500/116	75V	6V	0.08	0.0020	217D
		(JANTX1N4148-1)	500mA	0mW	0.00		
			200°C	40°C			
C1	Capacitor, Ceramic, 0.001μf	M39014/5C-2637	100V	0V	0.00	0.0087	217D
C2	Capacitor, Ceramic, 100pF	M39014/5C-2619	100V	3V	0.03	0.0067	217D
C3	Capacitor, Ceramic, 56pF	M39014/5C-2615	100V	5V	0.05	0.0063	217D
C4	Capacitor, Solid, Tantalum, 5.6μf	M39003/01-5043	35V	6V	0.17	0.2009	217D
C5	Capacitor, Ceramic, 0.01μf	M39014/5C-2655	50V	15V	0.30	0.0223	217D
C6	Capacitor, Ceramic, 0.01μf	M39014/5C-2655	50V	15V	0.30	0.0223	217D
C7	Capacitor, Ceramic, 0.01μf	M39014/5C-2655	50V	2V	0.04	0.0112	217D
C8	Capacitor, Ceramic, 0.01μf	M39014/5C-2655	50V	8V	0.16	0.0129	217D
R1	Resistor, Fixed Film, 18.2KΩ	RNC50H1822FM	100mW	1mW	0.01	0.0159	217D
R2	Resistor, Fixed Film, 13.7kΩ	RNC50H1372FM	100mW	0mW	0.00	0.0159	217D
R3	Resistor, Fixed Film, 100Ω	RNC50H1000FM	100mW	0mW	0.00	0.0159	217D
R4	Resistor, Fixed Film, 18.2KΩ	RNC50H1822FM	100mW	1mW	0.01	0.0159	217D
R5	Resistor, Fixed Film, 100Ω	RNC50H1000FM	100mW	1mW	0.01	0.0159	217D
R6	Resistor, Fixed Film, 24.9KΩ	RNC50H2492FM	100mW	0mW	0.00	0.0159	217D
R7	Resistor, Fixed Film, 49.9KΩ	RNC50H4992FM	100mW	3mW	0.03	0.0162	217D
R8	Resistor, Fixed Film, 20.1KΩ	RNC50H2012FM	100mW	2mW	0.02	0.0161	217D
R9	Resistor, Fixed Film, 8.25KΩ	RNC50H8251FM	100mW	1mW	0.01	0.0159	217D
R10	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	1mW	0.01	0.0159	217D

TABLE 4-1A

PRE-AMP PRINTED WIRING BOARD RELIABILITY DATA

P/N C316629, Rev. C

(AUF @ 2°C)

Sheet 2 of 2

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
R11	Resistor, Fixed WW, 4.64Ω	RWR81S4R64FM	1000mW	5mW	0.01	0.0913	217D
R12	Resistor, Fixed Film, 30.1KΩ	RNC50H3012FM	100mW	2mW	0.02	0.0161	217D
E1	Terminal (9 @ 0.0247 ECH.)	SCD 316774				0.2223	217D
PWB1	Printed Wiring Board (2-sided)	C316629PWB				0.0718	217D

TOTAL: 0.944

TABLE 4-1B

PRE-AMP PRINTED WIRING BOARD RELIABILITY DATA

P/N C316629, REV. C

(GF @ 30°C)

Sheet 1 of 2

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
U1	IC, Linear, Dual Op Amp.	SCD 316786 (OP-14AZ/883B)	125°C	65°C		0.0826	217D
CR1	Diode, SI, GP	MIL-S-19500/116	75V	6V	0.08	0.0002	217D
		(JANTX1N4148-1)	500mA	0mW	0.00		
			200°C	60°C			
C1	Capacitor, Ceramic, 0.001μf	M39014/5C-2637	100V	0V	0.00	0.0010	217D
C2	Capacitor, Ceramic, 100pF	M39014/5C-2619	100V	3V	0.03	0.0007	217D
C3	Capacitor, Ceramic, 56pF	M39014/5C-2615	100V	5V	0.05	0.0007	217D
C4	Capacitor, Solid, Tantalum, 5.6μf	M39003/01-5043	35V	6V	0.17	0.0201	217D
C5	Capacitor, Ceramic, 0.01μf	M39014/5C-2655	50V	15V	0.30	0.0025	217D
C6	Capacitor, Ceramic, 0.01μf	M39014/5C-2655	50V	15V	0.30	0.0025	217D
C7	Capacitor, Ceramic, 0.01μf	M39014/5C-2655	50V	2V	0.04	0.0013	217D
C8	Capacitor, Ceramic, 0.01μf	M39014/5C-2655	50V	8V	0.16	0.0014	217D
R1	Resistor, Fixed Film, 18.2KΩ	RNC50H1822FM	100mW	1mW	0.01	0.0023	217D
R2	Resistor, Fixed Film, 13.7kΩ	RNC50H1372FM	100mW	0mW	0.00	0.0023	217D
R3	Resistor, Fixed Film, 100Ω	RNC50H1000FM	100mW	0mW	0.00	0.0023	217D
R4	Resistor, Fixed Film, 18.2KΩ	RNC50H1822FM	100mW	1mW	0.01	0.0023	217D
R5	Resistor, Fixed Film, 100Ω	RNC50H1000FM	100mW	1mW	0.01	0.0023	217D
R6	Resistor, Fixed Film, 24.9KΩ	RNC50H2492FM	100mW	0mW	0.00	0.0023	217D
R7	Resistor, Fixed Film, 49.9KΩ	RNC50H4992FM	100mW	3mW	0.03	0.0023	217D
R8	Resistor, Fixed Film, 20.1KΩ	RNC50H2012FM	100mW	2mW	0.02	0.0023	217D
R9	Resistor, Fixed Film, 8.25KΩ	RNC50H8251FM	100mW	1mW	0.01	0.0023	217D
R10	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	1mW	0.01	0.0023	217D

TABLE 4-1B

PRE-AMP PRINTED WIRING BOARD RELIABILITY DATA

(GF @ 30°C) P/N C316629, Rev. C

Sheet 2 of 2

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
R11	Resistor, Fixed WW, 4.64Ω	RWR81S4R64FM	1000mW	5mW	0.01	0.0079	217D
R12	Resistor, Fixed Film, 30.1KΩ	RNC50H3012FM	100mW	2mW	0.02	0.0023	217D
E1	Terminal (9 @ 0.0055 ECH.)	SCD 316774				0.0495	217D
PWB1	Printed Wiring Board (2-sided)	C316629PWB				0.0047	217D
					TOTAL	0.[illegible]00	

TABLE 4-1C

PRE-AMP PRINTED WIRING BOARD RELIABILITY DATA

P/N C316629, REV. C

(GM @ 40°C)

Sheet 1 of 2

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
U1	IC, Linear, Dual Op Amp.	SCD 316786 (OP-14AZ/883B)	125°C	70°C		0.1205	217D
CR1	Diode, SI, GP	MIL-S-19500/116	75V	6V	0.08	0.0012	217D
		(JANTX1N4148-1)	500mA	0mW	0.00		
			200°C	65°C			
C1	Capacitor, Ceramic, 0.001µf	M39014/5C-2637	100V	0V	0.00	0.0048	217D
C2	Capacitor, Ceramic, 100pF	M39014/5C-2619	100V	3V	0.03	0.0037	217D
C3	Capacitor, Ceramic, 56pF	M39014/5C-2615	100V	5V	0.05	0.0035	217D
C4	Capacitor, Solid, Tantalum, 5.6µf	M39003/01-5043	35V	6V	0.17	0.0704	217D
C5	Capacitor, Ceramic, 0.01µf	M39014/5C-2655	50V	15V	0.30	0.0124	217D
C6	Capacitor, Ceramic, 0.01µf	M39014/5C-2655	50V	15V	0.30	0.0124	217D
C7	Capacitor, Ceramic, 0.01µf	M39014/5C-2655	50V	2V	0.04	0.0062	217D
C8	Capacitor, Ceramic, 0.01µf	M39014/5C-2655	50V	8V	0.16	0.0071	217D
R1	Resistor, Fixed Film, 18.2KΩ	RNC50H1822FM	100mW	1mW	0.01	0.0077	217D
R2	Resistor, Fixed Film, 13.7kΩ	RNC50H1372FM	100mW	0mW	0.00	0.0077	217D
R3	Resistor, Fixed Film, 100Ω	RNC50H1000FM	100mW	0mW	0.00	0.0077	217D
R4	Resistor, Fixed Film, 18.2KΩ	RNC50H1822FM	100mW	1mW	0.01	0.0077	217D
R5	Resistor, Fixed Film, 100Ω	RNC50H1000FM	100mW	1mW	0.01	0.0077	217D
R6	Resistor, Fixed Film, 24.9KΩ	RNC50H2492FM	100mW	0mW	0.00	0.0077	217D
R7	Resistor, Fixed Film, 49.9KΩ	RNC50H4992FM	100mW	3mW	0.03	0.0079	217D
R8	Resistor, Fixed Film, 20.1KΩ	RNC50H2012FM	100mW	2mW	0.02	0.0078	217D
R9	Resistor, Fixed Film, 8.25KΩ	RNC50H8251FM	100mW	1mW	0.01	0.0077	217D
R10	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	1mW	0.01	0.0077	217D

TABLE 4-1C

PRE-AMP PRINTED WIRING BOARD RELIABILITY DATA

(C... of 40°C)

P/N C316629, Rev. C

Sheet 2 of 2

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
R11	Resistor, Fixed WW, 4.64Ω	RWR81S4R64FM	1000mW	5mW	0.01	0.0456	217D
R12	Resistor, Fixed Film, 30.1KΩ	RNC50H3012FM	100mW	2mW	0.02	0.0078	217D
E1	Terminal (9 @ 0.0190 ECH)	SCD 316774				0.1710	217D
PWB1	Printed Wiring Board (2-sided)	C316629PWB				0.0158	217D

TOTAL 0.560

TABLE 4-2A

VCXO PRINTED WIRING BOARD RELIABILITY DATA

P/N C314314, REV.

(AUF @ 2°C) Sheet 1 of 2

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
U1	IC, Linear, Quad Xistor Array	SCD 316785	450mW	34mW	0.08	0.4770	217D
			125°C	80°C			
CR1	Diode, SI, Varactor	MIL-S-19500/436	30V	10V	0.33	1.2770	217D
		(JANTX1N5474B	400mW	0mW	0.00		
			175°C	80°C			
C1	Capacitor, Ceramic Chip, 0.01μf	SCD 316788	50V	10V	0.20	0.0160	217D
		(200A103KP50)					
C2	Capacitor, Ceramic Chip, 0.01μf	SCD 316788	50V	10V	0.20	0.0160	217D
		(200A103KP50)					
C3	Capacitor, Ceramic Chip, 150pF	CDR12BP151AJSM	50V	0V	0.00	0.0078	217D
C4	Capacitor, Ceramic Chip, 0.001μf	SCD 316788	50V	5V	0.10	0.0099	217D
		(200A102KP50)					
C5	Capacitor, Ceramic Chip, Select	CDR12BPXXXAJSM	50V	10V	0.20	0.0089	217D
C6	Capacitor, Ceramic Chip, 47pF	CDR12BP470AJSM	50V	1V	0.02	0.0068	217D
C7	Capacitor, Ceramic Chip, 180pF	CDR12BP181AJSM	50V	0V	0.00	0.0079	217D
C8	Capacitor, Ceramic Chip, Select	CDR12BPXXXAJSM	50V	10V	0.20	0.0089	217D
C9	Capacitor, Ceramic Chip, 0.1μf	SCD 316788	50V	5V	0.10	0.0165	217D
		(200B104KP50X)					
C10	Capacitor, Ceramic Chip, 0.01μf	SCD 316788	50V	10V	0.20	0.0160	217D
		(200A103KP50)					
R1	Resistor, Fixed Film Chip, 100Ω	M55342/4-M101GRM	330mW	2mW	0.01	0.0226	217D
R2	Resistor, Fixed Film Chip, 10KΩ	M55342/4-M103GRM	330mW	3mW	0.01	0.0226	217D

TABLE 4-2A

VCXO PRINTED WIRING BOARD RELIABILITY DATA

P/N C314314, REV.

(AUF @ 2°C)

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
R3	Resistor, Fixed Film Chip, 22KΩ	M55342/4-M223GRM	330mW	1mW	0.00	0.0226	217D
R4	Resistor, Fixed Film Chip, 47KΩ	M55342/4-M473GRM	330mW	1mW	0.00	0.0226	217D
R5	Resistor, Fixed Film Chip, 47KΩ	M55342/4-M473GRM	330mW	1mW	0.00	0.0226	217D
R6	Resistor, Fixed Film Chip, 100Ω	M55342/4-M101GRM	330mW	0mW	0.00	0.0226	217D
R7	Resistor, Fixed Film Chip, 100KΩ	M55342/4-M104GRM	330mW	0mW	0.00	0.0226	217D
R8	Resistor, Fixed Film Chip, 100KΩ	M55342/4-M104GRM	330mW	0mW	0.00	0.0226	217D
R9	Resistor, Fixed Film Chip, 15Ω	M55342/4-M15RGRM	330mW	0mW	0.00	0.0226	217D
R10	Resistor, Fixed Film Chip, 1KΩ	M55342/4-M102GRM	330mW	4mW	0.01	0.0226	217D
L1	Inductor	T-25-6 Core	105°C	80°C		0.0429	217D
L2	Inductor	SCD 316771	105°C	80°C		0.0429	217D
T1	Transformer	T-25-6 Core	105°C	80°C		0.0764	217D
X1	Crystal, 10MHz	2830027				0.2000	217D
E1	Terminals (9 @ 0.0247 ECH)	SCD 316774				0.2223	217D
PWB1	Printed Wiring Bd.(2-sided)	C314314 PWB				0.1076	217D

TOTAL 2.787

TABLE 4-2B

VCXO PRINTED WIRING BOARD RELIABILITY DATA

P/N C314314, REV.

(GF @ 30°C) Sheet 1 of 2

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
U1	IC, Linear, Quad Xistor Array	SCD 316785	450mW	34mW	0.08	0.2440	217D
			125°C	80°C			
CR1	Diode, SI, Varactor	MIL-S-19500/436	30V	10V	0.33	0.0711	217D
		(JANTX1N5474B	400mW	0mW	0.00		
			175°C	80°C			
C1	Capacitor, Ceramic Chip, 0.01µf	SCD 316788 (200A103KP50)	50V	10V	0.20	0.0017	217D
C2	Capacitor, Ceramic Chip, 0.01µf	SCD 316788 (200A103KP50)	50V	10V	0.20	0.0017	217D
C3	Capacitor, Ceramic Chip, 150pF	CDR12BP151AJSM	50V	0V	0.00	0.0008	217D
C4	Capacitor, Ceramic Chip, 0.001µf	SCD 316788 (200A102KP50)	50V	5V	0.10	0.0011	217D
C5	Capacitor, Ceramic Chip, Select	CDR12BPXXXAJSM	50V	10V	0.20	0.0010	217D
C6	Capacitor, Ceramic Chip, 47pF	CDR12BP470AJSM	50V	1V	0.02	0.0007	217D
C7	Capacitor, Ceramic Chip, 180pF	CDR12BP181AJSM	50V	0V	0.00	0.0008	217D
C8	Capacitor, Ceramic Chip, Select	CDR12BPXXXAJSM	50V	10V	0.20	0.0009	217D
C9	Capacitor, Ceramic Chip, 0.1µf	SCD 316788 (200B104KP50X)	50V	5V	0.10	0.0018	217D
C10	Capacitor, Ceramic Chip, 0.01µf	SCD 316788 (200A103KP50)	50V	10V	0.20	0.0017	217D
R1	Resistor, Fixed Film Chip, 100Ω	M55342/4-M101GRM	330mW	2mW	0.01	0.0027	217D
R2	Resistor, Fixed Film Chip, 10KΩ	M55342/4-M103GRM	330mW	3mW	0.01	0.0027	217D

TABLE 4-2B

VCXO PRINTED WIRING BOARD RELIABILITY DATA

P/N C314314, REV.

(GF @ 30°C) Sheet 2 of 2

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
R3	Resistor, Fixed Film Chip, 22KΩ	M55342/4-M223GRM	330mW	1mW	0.00	0.0027	217D
R4	Resistor, Fixed Film Chip, 47KΩ	M55342/4-M473GRM	330mW	1mW	0.00	0.0027	217D
R5	Resistor, Fixed Film Chip, 47KΩ	M55342/4-M473GRM	330mW	1mW	0.00	0.0027	217D
R6	Resistor, Fixed Film Chip, 100Ω	M55342/4-M101GRM	330mW	0mW	0.00	0.0027	217D
R7	Resistor, Fixed Film Chip, 100KΩ	M55342/4-M104GRM	330mW	0mW	0.00	0.0027	217D
R8	Resistor, Fixed Film Chip, 100KΩ	M55342/4-M104GRM	330mW	0mW	0.00	0.0027	217D
R9	Resistor, Fixed Film Chip, 15Ω	M55342/4-M15RGRM	330mW	0mW	0.00	0.0027	217D
R10	Resistor, Fixed Film Chip, 1KΩ	M55342/4-M102GRM	330mW	4mW	0.01	0.0027	217D
L1	Inductor	T-25-6 Core	105°C	80°C		0.0155	217D
L2	Inductor	SCD 316771	105°C	80°C		0.0155	217D
T1	Transformer	T-25-6 Core	105°C	80°C		0.0436	217D
X1	Crystal, 10MHz	2830027				0.2000	217D
E1	Terminals (9 @ 0.0055 ECH)	SCD 316774				0.0495	217D
PWB1	Printed Wiring Bd.(2-sided)	C314314 PWB				0.0071	217D
					TOTAL	0.686	

TABLE 4-2C

VCXO PRINTED WIRING BOARD RELIABILITY DATA

P/N C314314, REV.

(GM @ 40°C)

Sheet 1 of 2

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
U1	IC, Linear, Quad Xistor Array	SCD 316785	450mW	34mW	0.08	0.3050	217D
			125°C	80°C			
CR1	Diode, SI, Varactor	MIL-S-19500/436	30V	10V	0.33	0.3284	217D
		(JANTX1N5474B	400mW	0mW	0.00		
			175°C	80°C			
C1	Capacitor, Ceramic Chip, 0.01μf	SCD 316788	50V	10V	0.20	0.0083	217D
		(200A103KP50)					
C2	Capacitor, Ceramic Chip, 0.01μf	SCD 316788	50V	10V	0.20	0.0083	217D
		(200A103KP50)					
C3	Capacitor, Ceramic Chip, 150pF	CDR12BP151AJSM	50V	0V	0.00	0.0040	217D
C4	Capacitor, Ceramic Chip, 0.001μf	SCD 316788	50V	5V	0.10	0.0052	217D
		(200A102KP50)					
C5	Capacitor, Ceramic Chip, Select	CDR12BPXXXAJSM	50V	10V	0.20	0.0046	217D
C6	Capacitor, Ceramic Chip, 47pF	CDR12BP470AJSM	50V	1V	0.02	0.0036	217D
C7	Capacitor, Ceramic Chip, 180pF	CDR12BP181AJSM	50V	0V	0.00	0.0041	217D
C8	Capacitor, Ceramic Chip, Select	CDR12BPXXXAJSM	50V	10V	0.20	0.0046	217D
C9	Capacitor, Ceramic Chip, 0.1μf	SCD 316788	50V	5V	0.10	0.0086	217D
		(200B104KP50X)					
C10	Capacitor, Ceramic Chip, 0.01μf	SCD 316788	50V	10V	0.20	0.0083	217D
		(200A103KP50)					
R1	Resistor, Fixed Film Chip, 100Ω	M55342/4-M101GRM	330mW	2mW	0.01	0.0088	217D
R2	Resistor, Fixed Film Chip, 10KΩ	M55342/4-M103GRM	330mW	3mW	0.01	0.0088	217D

TABLE 4-2C

VCXO PRINTED WIRING BOARD RELIABILITY DATA

P/N C314314, REV.

(GM @ 40°C) Sheet 2 of 2

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
R3	Resistor, Fixed Film Chip, 22KΩ	M55342/4-M223GRM	330mW	1mW	0.00	0.0088	217D
R4	Resistor, Fixed Film Chip, 47KΩ	M55342/4-M473GRM	330mW	1mW	0.00	0.0088	217D
R5	Resistor, Fixed Film Chip, 47KΩ	M55342/4-M473GRM	330mW	1mW	0.00	0.0088	217D
R6	Resistor, Fixed Film Chip, 100Ω	M55342/4-M101GPM	330mW	0mW	0.00	0.0088	217D
R7	Resistor, Fixed Film Chip, 100KΩ	M55342/4-M104GRM	330mW	0mW	0.00	0.0088	217D
R8	Resistor, Fixed Film Chip, 100KΩ	M55342/4-M104GRM	330mW	0mW	0.00	0.0088	217D
R9	Resistor, Fixed Film Chip, 15Ω	M55342/4-M15RGRM	330mW	0mW	0.00	0.0088	217D
R10	Resistor, Fixed Film Chip, 1KΩ	M55342/4-M102GRM	330mW	4mW	0.01	0.0088	217D
L1	Inductor	T-25-6 Core	105°C	80°C		0.0515	217D
L2	Inductor	SCD 316771	105°C	80°C		0.0515	217D
T1	Transformer	T-25-6 Core	105°C	80°C		0.0917	217D
X1	Crystal, 10MHz	2830027				0.2000	217D
E1	Terminals (9 @ 0.0190 ECH)	SCD 316774				0.1710	217D
PWB1	Printed Wiring Bd.(2-sided)	C314314 PWB				0.0237	217D
					TOTAL	1.370	

TABLE 4-3A

INPUT FILTER RELIABILITY DATA

P/N 8314338 REV.

(AUF @ 2°C) Sheet 1 of 1

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
CR1	Diode, SI, Rectifier	MIL-S-19500/477	100V	0V	0.00	0.0039	217D
		(JANTX1N5809)	3A	0.3A	0.10		
			175°C	30°C			
CR2	Diode, SI, Rectifier	MIL-S-19500/420	800V	0V	0.00	0.0037	217D
		(JANTX1N5553)	5A	0.4A	0.08		
			175°C	35°C			
CR3	Diode, SI, Power Zener	MIL-S-19500/434	3W	0W	0.00	0.0189	217D
		(JANTX1N5613)	175°C	20°C			
C1	Capacitor, Tantalum, Non-solid, 33µf	MIL-C-39006/4364	75V	26V	0.35	0.1205	217D
C2	Capacitor, Tantalum, Non-solid, 5µf	MIL-C-39006/1379	200V	28V	0.07	0.0641	217D
L1	Inductor, 2.4mH	1408PA315-368	105°C	22°C		0.0041	217D
L2	Inductor, 2.4mH	1408PA315-368	105°C	25°C		0.0042	217D
E1	Terminal (8 @ 0.0247 ECH)	SCD 316774				0.1976	217D
					TOTAL	0.417	

TABLE 4-3B

INPUT FILTER RELIABILITY DATA

P/N 8314338 REV.

(GF @ 30°C)

Sheet 1 of 1

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
CR1	Diode, SI, Rectifier	MIL-S-19500/477	100V	0V	0.00	0.0006	217D
		(JANTX1N5809)	3A	0.3A	0.10		
			175°C	58°C			
CR2	Diode, SI, Rectifier	MIL-S-19500/420	800V	0V	0.00	0.0005	217D
		(JANTX1N5553)	5A	0.4A	0.08		
			175°C	63°C			
CR3	Diode, SI, Power Zener	MIL-S-19500/434	3W	0W	0.00	0.0014	217D
		(JANTX1N5613)	175°C	48°C			
C1	Capacitor, Tantalum, Non-solid, 33µf	MIL-C-39006/4364	75V	26V	0.35	0.0045	217D
C2	Capacitor, Tantalum, Non-solid, 5µf	MIL-C-39006/1379	200V	28V	0.07	0.0024	217D
L1	Inductor, 2.4mH	1408PA315-368	105°C	50°C		0.0018	217D
L2	Inductor, 2.4mH	1408PA315-368	105°C	53°C		0.0019	217D
E1	Terminal (8 @ 0.0055 ECH)	SCD 316774				0.0440	217D
					TOTAL	0.057	

TABLE 4-3C

INPUT FILTER RELIABILITY DATA

P/N 8314338 REV.

(GM @ 40°C)

Sheet 1 of 1

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
CR1	Diode, SI, Rectifier	MIL-S-19500/477	100V	0V	0.00	0.0031	217D
		(JANTX1N5809)	3A	0.3A	0.10		
			175°C	68°C			
CR2	Diode, SI, Rectifier	MIL-S-19500/420	800V	0V	0.00	0.0029	217D
		(JANTX1N5553)	5A	0.4A	0.08		
			175°C	73°C			
CR3	Diode, SI, Power Zener	MIL-S-19500/434	3W	0W	0.00	0.0067	217D
		(JANTX1N5613)	175°C	58°C			
C1	Capacitor, Tantalum, Non-solid, 33μf	MIL-C-39006/4364	75V	26V	0.35	0.0338	217D
C2	Capacitor, Tantalum, Non-solid, 5μf	MIL-C-39006/1379	200V	28V	0.07	0.0179	217D
L1	Inductor, 2.4mH	1408PA315-368	105°C	60°C		0.0072	217D
L2	Inductor, 2.4mH	1408PA315-368	105°C	63°C		0.0077	217D
E1	Terminal (8 @ 0.0190 ECH)	SCD 316774				0.1520	217D
					TOTAL	0.231	

TABLE 4-4A

POWER SUPPLY RELIABILITY DATA

P/N D314311, REV.

(AUF @ 2°C) Sheet 1 of 6

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
U1	IC, Linear, SW. Voltage Regulator	UA78S40DM (883B)	125°C	48°C		0.4586	217D
U2	IC, Linear, Dual Comparator	LM193JG/883B	125°C	22°C		0.1545	217D
U3	IC, Linear, SW. Voltage Regulator	UA78S40DM (883B)	125°C	51°C		0.4787	217D
U4	IC, Linear, Sw. Voltage Regulator	UA78S40DM (883B)	125°C	27°C		0.3919	217D
U5	IC, Linear, Quad OP Amp.	M38510/11005BCB (LM124AJ)	125°C	45°C		0.2399	217D
U6	IC, Linear, Voltage Ref. 10V	LH0070-H/883B	125°C	40°C		0.0811	217D
Q1	Transistor, Power FET, N	RFL4N15/JANTX	8.33W 150°C	0W 20°C	0.00	0.1505	217D
Q2	Transistor, Power FET, N	RFL4N15/JANTX	8.33W 150°C	0W 20°C	0.00	0.1505	217D
Q3	Transistor, Power FET, N	RFL4N15/JANTX	8.33W 150°C	1.42W 70°C	0.17	0.1889	217D
Q4	Transistor, SI, PNP	MIL-S-19500/290 (JANTX2N2905)	40V 600mW 200°C	1V 100mW 30°C	0.03 0.17	0.0053	217D
Q5	Transistor, SI, NPN	MIL-S-19500/251 (JANTX2N2219)	30V 800mW 200°C	1V 100mW 30°C	0.03 0.13	0.0047	217D
Q6	Transistor, SI, PNP	MIL-S-19500/290 (JANTX2N2905)	40V 600mW 200°C	1V 70mW 32°C	0.03 0.12	0.0065	217D

TABLE 4-4A

POWER SUPPLY RELIABILITY DATA

P/N D314311, REV.

(AUF @ 2°C)

Sheet 2 of 6

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
CR1	Diode, SI, Zener	MIL-S-19500/434 (JANTX1N5610)	3W 175°C	0W 20°C	0.00	0.0013	217D
CR2	Diode, SI, Zener	MIL-S-19500/434 (JANTX1N5610)	3W 175°C	0W 20°C	0.00	0.0189	217D
CR3	Diode, SI, Zener	1N5257/JANTX	0.5W 200°C	0W 20°C	0.00	0.0189	217D
CR4	Diode, SI, Zener	1N5257/JANTX	0.5W 200°C	0W 20°C	0.00	0.0189	217D
CR5	Diode, SI, Rectifier	MIL-S-19500/477 (JANTX1N5804)	100V 1A 150°C	6V 0.3A 30°C	0.06 0.30	0.0673	217D
CR6	Diode, SI, Rectifier	MIL-S-19500/477 (JANTX1N5804)	100V 1A 150°C	15V 0.3A 28°C	0.15 .30	0.0673	217D
CR7	Diode, SI, Rectifier	MIL-S-19500/477 (JANTX1N5804)	100V 1A 150°C	15V 0.2A 26°C	0.15 0.20	0.0054	217D
CR8	Diode, SI, Zener	1N5231/JANTX	0.5W 150°C	0W 20°C	0.00	0.0235	217D
CR9	Diode, SI, Zener	1N5231/JANTX	0.5W 150°C	0W 20°C	0.00	0.0235	217D
CR10	Diode, SI, GP	MIL-S-19500/231 (JANTX1N3600)	50V 200mA 175°C	1V 0mA 20°C	0.02 0.00	0.0013	217D

TABLE 4-4A

POWER SUPPLY RELIABILITY DATA

(AUF @ 2°C) P/N D314311, REV. Sheet 3 of 6

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
C1	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	15V	0.15	0.0119	217D
C2	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	0V	0.00	0.0106	217D
C3	Capacitor, Ceramic, 1μf	M39014/2E-1407	50V	18V	0.36	0.0480	217D
C4	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	50V	28V	0.56	0.1026	217D
C5	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	15V	0.15	0.0119	217D
C6.	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	0V	0.00	0.0106	217D
C7	Capacitor, Ceramic, 1μf	M39014/2E-1407	50V	18V	0.36	0.0480	217D
C8	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	50V	28V	0.56	0.1026	217D
C9	Capacitor, Solid Tantalum, 6.8μf	M39003/03-0180	50V	17V	0.34	0.2157	217D
C10	Capacitor, Solid Tantalum, 6.8μf	M39003/03-0116	10V	1V	0.10	0.1357	217D
C11	Capacitor, Ceramic, 33pF	M39014/1C-1210	200V	17V	0.09	0.0058	217D
C12	Capacitor, Ceramic, 0.001μf	CCR05CG102JM	100V	1V	0.01	0.0059	217D
C13	Capacitor, Solid Tantalum, 82μf	M39003/03-0124	10V	6V	0.60	0.7881	217D
C14	Capacitor, Solid Tantalum, 47μf	M39003/03-0171	35V	16V	0.46	0.4248	217D
C15	Capacitor, Solid Tantalum, 47μf	M39003/03-0171	35V	16V	0.46	0.4248	217D
C16	Capacitor, Ceramic, 0.001μf	M39014/1C-1237	200V	30V	0.15	0.0093	217D
C17	Capacitor, Solid Tantalum, 1.8μf	M39003/03-0164	35V	15V	0.43	0.2554	217D
C18	Capacitor, Ceramic, 0.001μf	M39014/1C-1237	200V	30V	0.15	0.0093	217D
C19	Capacitor, Ceramic, 0.001μf	M39014/1C-1237	200V	30V	0.15	0.0093	217D
C20	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	50V	15V	0.30	0.0106	217D
C21	Capacitor, Ceramic, 0.001μf	M39014/1C-1237	200V	20V	0.10	0.0085	217D
C22	Capacitor, Solid Tantalum, 8.2μf	M39003/03-0118	10V	5V	0.50	0.4036	217D

TABLE 4-4A

POWER SUPPLY RELIABILITY DATA

P/N D314311, REV.

(AUF @ 2°C)

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
C23	Capacitor, Solid Tantalum, 1.8μf	M39003/03-0164	35V	15V	0.43	0.2554	217D
C24	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	15V	0.15	0.0119	217D
C25	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	15V	0.15	0.0119	217D
C26	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	15V	0.15	0.0119	217D
C27	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	15V	0.15	0.0119	217D
C28	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	15V	0.15	0.0154	217D
C29	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	15V	0.15	0.0154	217D
R2	Resistor, Fixed Film, Select	RNC50HXXXXFM	100mW	12mW	0.12	0.0150	217D
R3	Resistor, Fixed Film, Select	RNC50HXXXXFM	100mW	1mW	0.01	0.0133	217D
R4	Resistor, Fixed Film, 49.9Ω	RNC50H49R9FM	100mW	0mW	0.00	0.0133	217D
R7	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	24mW	0.24	0.0170	217D
R12	Resistor, Fixed Film, 8.2KΩ	RNC50H8201FM	100mW	20mW	0.20	0.0163	217D
R14	Resistor, Fixed Film, Select	RNC50HXXXXFM	100mW	12mW	0.12	0.0150	217D
R15	Resistor, Fixed Film, Select	RNC50HXXXXFM	100mW	1mW	0.01	0.0133	217D
R16	Resistor, Fixed Film, 49.9Ω	RNC50H49R9FM	100mW	0mW	0.00	0.0133	217D
R19	Resistor, Fixed Film, 110KΩ	RNC50H1002FM	100mW	24mW	0.24	0.0187	217D
R24	Resistor, Fixed Film, 8.2KΩ	RNC50H8201FM	100mW	20mW	0.20	0.0163	217D
R30	Resistor, Fixed Composition, 1KΩ	RCR07G102KM	250mW	81mW	0.32	0.0034	217D
R31	Resistor, Fixed Composition, 1KΩ	RCR07G102KM	250mW	230mW	0.92	0.0099	217D
R32	Resistor, Fixed Film, 20KΩ	RNC50H2002FM	100mW	1mW	0.01	0.0133	217D
R33	Resistor, Fixed Film, Select	RNC50HXXXXFM	100mW	3mW	0.03	0.0136	217D
R34	Resistor, Fixed Film, 499Ω	RNC55H4990FM	125mW	120mW	0.96	0.0369	217D
R35	Resistor, Fixed Composition, 1KΩ	RCR07G102KM	250mW	150mW	0.60	0.0056	217D

TABLE 4-4A

POWER SUPPLY RELIABILITY DATA

P/N D31 11, REV.

(AUF @ 2°C)

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
R36	Resistor, Fixed Film, 200Ω	RNC50H2000FM	100mW	2mW	0.02	0.0134	217D
R37	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	80mW	0.80	0.0310	217D
R38	Resistor, Fixed Film, 200Ω	RNC50H2000FM	100mW	2mW	0.02	0.0134	217D
R39	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	80mW	0.80	0.0310	217D
R40	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	3mW	0.03	0.0136	217D
R41	Resistor, Fixed Film, 4.99KΩ	RNC50H4991FM	100mW	0mW	0.00	0.0133	217D
R42	Resistor, Fixed Film, Select	RNC50HXXXXFM	100mW	5mW	0.05	0.0139	217D
R43	Resistor, Fixed Film, 4.99KΩ	RNC50H4991FM	100mW	45mW	0.45	0.0213	217D
R44	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0133	217D
R45	Resistor, Fixed Film, 20KΩ	RNC50H2002FM	100mW	13mW	0.13	0.0151	217D
R46	Resistor, Fixed Film, 20KΩ	RNC50H2002FM	100mW	13mW	0.13	0.0151	217D
R47	Resistor, Fixed Film, 200Ω	RNC50H2000FM	100mW	2mW	0.02	0.0134	217D
R48	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	80mW	0.80	0.0310	217D
R49	Resistor, Fixed Film, 6.65KΩ	RNC50H6601FM	100mW	0mW	0.00	0.0133	217D
R50	Resistor, Fixed Film, 20KΩ	RNC50H2002FM	100mW	5mW	0.05	0.0139	217D
R51	Resistor, Fixed Film, Select	RNC50HXXXXFM	100mW	3mW	0.03	0.0136	217D
R52	Resistor, Potentiometer, 5KΩ	RJR26HW502M	250mW	13mW	0.05	0.0174	217D
R53	Resistor, Fixed Film, 1.2KΩ	RNC90Y1K2000TM	300mW	77mW	0.26	0.0139	217D
Z1	Resistor Network	SCD	125mW	27mW	0.22	0.0725	217D
	R1, 60.4KΩ			3mW			
	R5, 10KΩ			3mW			
	R6, 1KΩ			19mW			
	R54, 60.4KΩ			2mW			

TABLE 4-4A

POWER SUPPLY RELIABILITY DATA

P/N D314311, REV.

(AUF @ 2°C)

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
Z2	Resistor Network	SCD	125mW	28mW	0.22	0.0725	217D
	R13, 60.4KΩ			3mW			
	R17, 10KΩ			3mW			
	R18, 1KΩ			20mW			
	R55, 60.4KΩ			2mW			
Z3	Resistor Network	SCD	125mW	27mW	0.22	0.0906	217D
	R25, 1KΩ			0mW			
	R26, 1KΩ			0mW			
	R27, 750KΩ			0mW			
	R28, 10KΩ			24mW			
	R29, 1KΩ			3mW			
Z4	Resistor Network	SCD	125mW	11mW	0.09	0.0659	217D
	R8, 499KΩ			1mW			
	R9, 1MΩ			0mW			
	R10, 499KΩ			1mW			
	R11, 10KΩ			9mW			
Z5	Resistor Network	SCD	125mW	11mW	0.09	0.0659	217D
	R20, 499KΩ			1mW			
	R21, 1MΩ			0mW			
	R22, 499KΩ			1mW			
	R23, 10KΩ			9mW			
E1	Terminal (26 @ 0.0247 ECH)	SCD 316774				0.6422	217D
PWB1	Printed Wiring Bd. (2-sided)					0.4492	217D

TOTAL 8.164

TABLE 4-4B

POWER SUPPLY RELIABILITY DATA

(GF @ 30°C) P/N D314311, REV. Sheet 1 of 6

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
U1	IC, Linear, SW. Voltage Regulator	UA78S40DM (883B)	125°C	76°C		0.6478	217D
U2	IC, Linear, Dual Comparator	LM193JG/883B	125°C	50°C		0.0710	217D
U3	IC, Linear, SW. Voltage Regulator	UA78S40DM (883B)	125°C	79°C		0.7575	217D
U4	IC, Linear, Sw. Voltage Regulator	UA78S40DM (883B)	125°C	55°C		0.2409	217D
U5	IC, Linear, Quad OP Amp.	M38510/11005BCB	125°C	73°C		0.2855	217D
		(LM124AJ)					
U6	IC, Linear, Voltage Ref. 10V	LH0070-H/883B	125°C	68°C		0.0781	217D
Q1	Transistor, Power FET, N	RFL4N15/JANTX	8.33W	0W	0.00	0.0127	217D
			150°C	48°C			
Q2	Transistor, Power FET, N	RFL4N15/JANTX	8.33W	0W	0.00	0.0127	217D
			150°C	48°C			
Q3	Transistor, Power FET, N	RFL4N15/JANTX	8.33W	1.42W	0.17	0.0158	217D
			150°C	98°C			
Q4	Transistor, SI, PNP	MIL-S-19500/290	40V	1V	0.03	0.0007	217D
		(JANTX2N2905)	600mW	100mW	0.17		
			200°C	58°C			
Q5	Transistor, SI, NPN	MIL-S-19500/251	30V	1V	0.03	0.0006	217D
		(JANTX2N2219)	800mW	100mW	0.13		
			200°C	58°C			
Q6	Transistor, SI, PNP	MIL-S-19500/290	40V	1V	0.03	0.0008	217D
		(JANTX2N2905)	600mW	70mW	0.12		
			200°C	60°C			

TABLE 4-4B

POWER SUPPLY RELIABILITY DATA

P/N D314311, REV.

(GF @ 30°C) Sheet 2 of 6

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
CR1	Diode, SI, Zener	MIL-S-19500/434 (JANTX1N5610)	3W 175°C	0W 48°C	0.00	0.0013	217D
CR2	Diode, SI, Zener	MIL-S-19500/434 (JANTX1N5610)	3W 175°C	0W 48°C	0.00	0.0013	217D
CR3	Diode, SI, Zener	1N5257/JANTX	0.5W 200°C	0W 48°C	0.00	0.0013	217D
CR4	Diode, SI, Zener	1N5257/JANTX	0.5W 200°C	0W 48°C	0.00	0.0013	217D
CR5	Diode, SI, Rectifier	MIL-S-19500/477 (JANTX1N5804)	100V 1A 150°C	6V 0.3A 58°C	0.06 0.30	0.0009	217D
CR6	Diode, SI, Rectifier	MIL-S-19500/477 (JANTX1N5804)	100V 1A 150°C	15V 0.3A 56°C	0.15 .30	0.0009	217D
CR7	Diode, SI, Rectifier	MIL-S-19500/477 (JANTX1N5804)	100V 1A 150°C	15V 0.2A 54°C	0.15 0.20	0.0007	217D
CR8	Diode, SI, Zener	1N5231/JANTX	0.5W 150°C	0W 48°C	0.00	0.0016	217D
CR9	Diode, SI, Zener	1N5231/JANTX	0.5W 150°C	0W 48°C	0.00	0.0016	217D
CR10	Diode, SI, GP	MIL-S-19500/231 (JANTX1N3600)	50V 200mA 175°C	1V 0mA 48°C	0.02 0.00	0.0002	217D

TABLE 4-4B

POWER SUPPLY RELIABILITY DATA

(GF @ 30°C) P/N D314311, REV. Sheet 3 of 6

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
C1	Capacitor, Ceramic, 0.01µf	M39014/1C-1455	100V	15V	0.15	0.0014	217D
C2	Capacitor, Ceramic, 0.01µf	M39014/1C-1455	100V	0V	0.00	0.0012	217D
C3	Capacitor, Ceramic, 1µf	M39014/2E-1407	50V	18V	0.36	0.0055	217D
C4	Capacitor, Ceramic, 0.1µf	M39014/1C-1473	50V	28V	0.56	0.0117	217D
C5	Capacitor, Ceramic, 0.01µf	M39014/1C-1455	100V	15V	0.15	0.0014	217D
C6	Capacitor, Ceramic, 0.01µf	M39014/1C-1455	100V	0V	0.00	0.0012	217D
C7	Capacitor, Ceramic, 1µf	M39014/2E-1407	50V	18V	0.36	0.0055	217D
C8	Capacitor, Ceramic, 0.1µf	M39014/1C-1473	50V	28V	0.56	0.0117	217D
C9	Capacitor, Solid Tantalum, 6.8µf	M39003/03-0180	50V	17V	0.34	0.0213	217D
C10	Capacitor, Solid Tantalum, 6.8µf	M39003/03-0116	10V	1V	0.10	0.0134	217D
C11	Capacitor, Ceramic, 33pf	M39014/1C-1210	200V	17V	0.09	0.0007	217D
C12	Capacitor, Ceramic, 0.001µf	CCR05CG102 M	100V	1V	0.01	0.0009	217D
C13	Capacitor, Solid Tantalum, 82µf	M39003/03-0124	10V	6V	0.60	0.0778	217D
C14	Capacitor, Solid Tantalum, 47µf	M39003/03-0171	35V	16V	0.46	0.0419	217D
C15	Capacitor, Solid Tantalum, 47µf	M39003/03-0171	35V	16V	0.46	0.0419	217D
C16	Capacitor, Ceramic, 0.001µf	M39014/1C-1237	200V	30V	0.15	0.0011	217D
C17	Capacitor, Solid Tantalum, 1.8µf	M39003/03-0164	35V	15V	0.43	0.0252	217D
C18	Capacitor, Ceramic, 0.001µf	M39014/1C-1237	200V	30V	0.15	0.0011	217D
C19	Capacitor, Ceramic, 0.001µf	M39014/1C-1237	200V	30V	0.15	0.0011	217D
C20	Capacitor, Ceramic, 0.1µf	M39014/1C-1473	50V	15V	0.30	0.0031	217D
C21	Capacitor, Ceramic, 0.001µf	M39014/1C-1237	200V	20V	0.10	0.0010	217D
C22	Capacitor, Solid Tantalum, 8.2µf	M39003/03-0118	10V	5V	0.50	0.0398	217D

TABLE 4-4B

POWER SUPPLY RELIABILITY DATA

P/N D314311, REV.

(GF @ 30°C)

Sheet 4 of 6

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
C23	Capacitor, Solid Tantalum, 1.8μf	M39003/03-0164	35V	15V	0.43	0.0252	217D
C24	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	15V	0.15	0.0014	217D
C25	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	15V	0.15	0.0014	217D
C26	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	15V	0.15	0.0014	217D
C27	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	15V	0.15	0.0014	217D
C28	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	15V	0.15	0.0018	217D
C29	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	15V	0.15	0.0018	217D
R2	Resistor, Fixed Film, Select	RNC50HXXXXFM	100mW	12mW	0.12	0.0023	217D
R3	Resistor, Fixed Film, Select	RNC50HXXXXFM	100mW	1mW	0.01	0.0020	217D
R4	Resistor, Fixed Film, 49.9Ω	RNC50H49R9FM	100mW	0mW	0.00	0.0020	217D
R7	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	24mW	0.24	0.0027	217D
R12	Resistor, Fixed Film, 8.2KΩ	RNC50H8201FM	100mW	20mW	0.20	0.0026	217D
R14	Resistor, Fixed Film, Select	RNC50HXXXXFM	100mW	12mW	0.12	0.0023	217D
R15	Resistor, Fixed Film, Select	RNC50HXXXXFM	100mW	1mW	0.01	0.0020	217D
R16	Resistor, Fixed Film, 49.9Ω	RNC50H49R9FM	100mW	0mW	0.00	0.0020	217D
R19	Resistor, Fixed Film, 110KΩ	RNC50H1002FM	100mW	24mW	0.24	0.0027	217D
R24	Resistor, Fixed Film, 8.2KΩ	RNC50H8201FM	100mW	20mW	0.20	0.0026	217D
R30	Resistor, Fixed Composition, 1KΩ	RCR07G102KM	250mW	81mW	0.32	0.0018	217D
R31	Resistor, Fixed Composition, 1KΩ	RCR07G102KM	250mW	230mW	0.92	0.0060	217D
R32	Resistor, Fixed Film, 20KΩ	RNC50H2002FM	100mW	1mW	0.01	0.0020	217D
R33	Resistor, Fixed Film, Select	RNC50HXXXXFM	100mW	3mW	0.03	0.0021	217D
R34	Resistor, Fixed Film, 499Ω	RNC55H4990FM	125mW	120mW	0.96	0.0062	217D
R35	Resistor, Fixed Composition, 1KΩ	RCR07G102KM	250mW	150mW	0.60	0.0032	217D

TABLE 4-4B

POWER SUPPLY RELIABILITY DATA

(GF @ 50°C) P/N D314311, REV.

Sheet 5 of 6

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
R36	Resistor, Fixed Film, 200Ω	RNC50H2000FM	100mW	2mW	0.02	0.0021	217D
R37	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	80mW	0.80	0.0052	217D
R38	Resistor, Fixed Film, 200Ω	RNC50H2000FM	100mW	2mW	0.02	0.0021	217D
R39	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	80mW	0.80	0.0052	217D
R40	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	3mW	0.03	0.0021	217D
R41	Resistor, Fixed Film, 4.99KΩ	RNC50H4991FM	100mW	0mW	0.00	0.0020	217D
R42	Resistor, Fixed Film, Select	RNC50HXXXXFM	100mW	5mW	0.05	0.0021	217D
R43	Resistor, Fixed Film, 4.99KΩ	RNC50H4991FM	100mW	45mW	0.45	0.0034	217D
R44	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0020	217D
R45	Resistor, Fixed Film, 20KΩ	RNC50H2002FM	100mW	13mW	0.13	0.0024	217D
R46	Resistor, Fixed Film, 20KΩ	RNC50H2002FM	100mW	13mW	0.13	0.0024	217D
R47	Resistor, Fixed Film, 200Ω	RNC50H2000FM	100mW	2mW	0.02	0.0021	217D
R48	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	80mW	0.80	0.0052	217D
R49	Resistor, Fixed Film, 6.65KΩ	RNC50H6601FM	100mW	0mW	0.00	0.0020	217D
R50	Resistor, Fixed Film, 20KΩ	RNC50H2002FM	100mW	5mW	0.05	0.0021	217D
R51	Resistor, Fixed Film, Select	RNC50HXXXXFM	100mW	3mW	0.03	0.0021	217D
R52	Resistor, Potentiometer, 5KΩ	RJR26HW502M	250mW	13mW	0.05	0.0404	217D
R53	Resistor, Fixed Film, 1.2KΩ	RNC90Y1K2000TM	300mW	77mW	0.26	0.0027	217D
Z1	Resistor Network	SCD	125mW	27mW	0.22	0.0266	217D
	R1, 60.4KΩ			3mW			
	R5, 10KΩ			3mW			
	R6, 1KΩ			19mW			
	R54, 60.4KΩ			2mW			

TABLE 4-4B

POWER SUPPLY RELIABILITY DATA

P/N D314311, REV.

(GF @ 30°C) Sheet 6 of 6

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
Z2	Resistor Network	SCD	125mW	28mW	0.22	0.0266	217D
	R13, 60.4KΩ			3mW			
	R17, 10KΩ			3mW			
	R18, 1KΩ			20mW			
	R55, 60.4KΩ			2mW			
Z3	Resistor Network	SCD	125mW	27mW	0.22	0.0332	217D
	R25, 1KΩ			0mW			
	R26, 1KΩ			0mW			
	R27, 750KΩ			0mW			
	R28, 10KΩ			24mW			
	R29, 1KΩ			3mW			
Z4	Resistor Network	SCD	125mW	11mW	0.09	0.0254	217D
	R8, 499KΩ			1mW			
	R9, 1MΩ			0mW			
	R10, 499KΩ			1mW			
	R11, 10KΩ			9mW			
Z5	Resistor Network	SCD	125mW	11mW	0.09	0.0254	217D
	R20, 499KΩ			1mW			
	R21, 1MΩ			0mW			
	R22, 499KΩ			1mW			
	R23, 10KΩ			9mW			
E1	Terminal (26 @ 0.0055 ECH)	SCD 316774				0.1430	217D
PWB1	Printed Wiring Bd. (2-sided)					0.0295	217D
					TOTAL	2.921	

TABLE 4-4C

POWER SUPPLY RELIABILITY DATA

P/N D314311, REV.

(GM @ 40°C) Sheet 1 of 6

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
U1	IC, Linear, SW. Voltage Regulator	UA78S40DM (883B)	[illegible]	[illegible]		[illegible]	2170
U2	IC, Linear, Dual Comparator	LM193J6/883B	[illegible]	[illegible]		[illegible]	2170
U3	IC, Linear, SW. Voltage Regulator	UA78S40DM (883B)	[illegible]	[illegible]		[illegible]	2170
U4	IC, Linear, SW. Voltage Regulator	UA78S40DM (883B)	125	[illegible]		[illegible]	2170
U5	IC, Linear, Quad Op Amp	M38510/[illegible] (LM124AJ)	[illegible]	[illegible]		[illegible]	2170
U6	IC, Linear, Voltage Ref. 10V	[illegible]	[illegible]	[illegible]		[illegible]	2170
Q1	Transistor, Power FET, N	RFL4N15/JANTX	8.33W [illegible]°C	0W [illegible]°C	[illegible]	[illegible]	2170
Q2	Transistor, Power FET, N	RFL4N15 JANTX	[illegible]W [illegible]	0W [illegible]	0.00	[illegible]	2170
[illegible]	Transistor, Power FET, N	RFL4N15 JANTX	[illegible]W 15[illegible]	1.40W [illegible]	0.17	[illegible]	2170
Q4	Transistor, [illegible], PNP	MIL-S-19500/[illegible] (JANTX2N2905)	40V 600mW 200°C	1V 100mW [illegible]	0.03 0.17	[illegible]	2170
[illegible]	Transistor, [illegible], NPN	MIL-S-19500/[illegible] (JANTX2N2219)	30V [illegible]mW [illegible]°C	1V 100mW [illegible]	[illegible] [illegible]	[illegible]	2170
[illegible]	Transistor, [illegible], PNP	MIL-S-19500/[illegible] (JANTX2N2905)	40V 600mW 200°C	1V 75mW [illegible]	0.03 0.12	[illegible]	2170

TABLE 4-4C

POWER SUPPLY RELIABILITY DATA

P N D314311, REV.

PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
MIL-S-19500/434 (JANTX1N5610)	3W 175°C	0W 58°C	0.00	0.0067	217D
MIL-S-19500/434 (JANTX1N5610)	3W 175°C	0W 58°C	0.00	0.0067	217D
1N5257/JANTX	0.5W 200°C	0W 58°C	0.00	0.0067	217D
1N5257/JANTX	0.5W 200°C	0W 58°C	0.00	0.0067	217D
MIL-S-19500/477 (JANTX1N5804)	100V 1A 150°C	6V 0.3A 68°C	0.06 0.30	0.0047	217D
MIL-S-19500/477 (JANTX1N5804)	100V 1A 150°C	15V 0.3A 66°C	0.15 .30	0.0047	217D
[illegible]	100V 1A 150°C	15V 0.2A [illegible]	0.15 0.20	0.0038	217D
[illegible]	0.5W [illegible]	0W [illegible]	0.00	0.0082	217D
[illegible]	0.5W [illegible]	0W [illegible]	0.00	0.0082	217D
[illegible]	[illegible]	1V [illegible]	0.02 0.00	[illegible]	217D

STRESS RATIO	FAILURE RATE	F.R. SOURCE
0.15	0.0068	217D
[illegible]	0.0061	217D
0.36	0.0075	217D
0.56	0.0587	217D
0.15	0.0068	217D
[illegible]	0.0061	217D
0.36	0.0075	217D
0.56	0.0587	217D
0.34	0.0783	217D
0.10	0.0491	217D
0.09	0.0433	217D
0.01	0.0045	217D
0.60	0.1849	217D
0.46	0.1536	217D
0.46	0.1536	217D
0.15	0.0053	217D
0.43	0.0924	217D
0.15	0.0053	217D
0.15	0.0053	217D
0.30	0.0156	217D
0.10	0.0049	217D
0.50	0.1459	217D

TABLE 4-4C

POWER SUPPLY RELIABILITY DATA

P/N D314311, REV.

Sheet 4 of 6

[illegible]	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
[illegible], Solid Tantalum, [illegible]	M39003/03-0164	35V	15V	0.43	0.0924	217D
[illegible], Ceramic, [illegible]	M39014/1C-1455	100V	15V	0.15	0.0068	217D
[illegible], Ceramic, [illegible]	M39014/1C-1455	100V	15V	0.15	0.0068	217D
[illegible], Ceramic, [illegible]	M39014/1C-1455	100V	15V	0.15	0.0068	217D
[illegible], Ceramic, [illegible]	M39014/1C-1455	100V	15V	0.15	0.0068	217D
[illegible], Ceramic, [illegible]	M39014/1C-1455	100V	15V	0.15	0.0088	217D
[illegible], Ceramic, [illegible]	M39014/1C-1455	100V	15V	0.15	0.0088	217D
[illegible], Fixed Film, Select	RNC50HXXXXFM	100mW	12mW	0.12	0.0083	217D
[illegible], Fixed Film, Select	RNC50HXXXXFM	100mW	1mW	0.01	0.0073	217D
[illegible], Fixed Film, 49.9Ω	RNC50H49R9FM	100mW	0mW	0.00	0.0073	217D
[illegible], Fixed Film, [illegible]	RNC50H1002FM	100mW	24mW	0.24	0.0096	217D
[illegible], Fixed Film, [illegible]	RNC50H8201FM	100mW	20mW	0.20	0.0091	217D
[illegible], Fixed Film, Select	RNC50HXXXXFM	100mW	12mW	0.12	0.0083	217D
[illegible], Fixed Film, Select	RNC50HXXXXFM	100mW	1mW	0.01	0.0073	217D
[illegible]	RNC50H49R9FM	100mW	0mW	0.00	0.0073	217D
[illegible]	RNC50H1002FM	100mW	24mW	0.24	0.0096	217D
[illegible]	RNC50H8201FM	100mW	20mW	0.20	0.0091	217D
[illegible]	RCR07G102KM	250mW	81mW	0.32	0.0076	217D
[illegible]	RCR07G102KM	250mW	230mW	0.92	0.0256	217D
[illegible]	RNC50H2002FM	100mW	1mW	0.01	0.0073	217D
[illegible], Select	RNC50HXXXXFM	100mW	3mW	0.03	0.0074	217D
[illegible]	RNC55H4990FM	125mW	120mW	0.96	0.0230	217D
[illegible]	RCR07G102KM	250mW	150mW	0.60	0.0134	217D

TABLE 4-4C

POWER SUPPLY RELIABILITY DATA

P/N D314311, REV.

Sheet 5 of 6

[illegible]	[illegible]	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
[illegible]	[illegible]	RNC50H2000FM	100mW	2mW	0.02	0.0073	217D
[illegible]	[illegible]	RNC50H3011FM	100mW	80mW	0.80	0.0189	217D
[illegible]	[illegible]	RNC50H2000FM	100mW	2mW	0.02	0.0073	217D
[illegible]	[illegible]	RNC50H3011FM	100mW	80mW	0.80	0.0189	217D
[illegible]	[illegible]	RNC50H1002FM	100mW	3mW	0.03	0.0074	217D
[illegible]	[illegible]	RNC50H4991FM	100mW	0mW	0.00	0.0073	217D
[illegible]	[illegible]	RNC50HXXXXFM	100mW	5mW	0.05	0.0073	217D
[illegible]	[illegible]	RNC50H4991FM	100mW	45mW	0.45	0.0124	217D
[illegible]	[illegible]	RNC50H1002FM	100mW	0mW	0.00	0.0073	217D
[illegible]	[illegible]	RNC50H2002FM	100mW	13mW	0.13	0.0084	217D
[illegible]	[illegible]	RNC50H2002FM	100mW	13mW	0.13	0.0084	217D
[illegible]	[illegible]	RNC50H2000FM	100mW	2mW	0.02	0.0073	217D
[illegible]	[illegible]	RNC50H3011FM	100mW	80mW	0.80	0.0189	217D
[illegible]	[illegible]	RNC50H6601FM	100mW	0mW	0.00	0.0073	217D
[illegible]	[illegible]	RNC50H2002FM	100mW	5mW	0.05	0.0076	217D
[illegible]	[illegible]	RNC50HXXXXFM	100mW	3mW	0.03	0.0074	217D
[illegible]	[illegible]	RJR26HW502M	250mW	13mW	0.05	0.1612	217D
[illegible]	[illegible]	RNC90Y1K2000TM	300mW	77mW	0.26	0.0096	217D
[illegible]	[illegible]	SCD	125mW	27mW	0.22	0.1232	217D
	[illegible]			3mW			
	[illegible]			3mW			
	[illegible]			19mW			
	[illegible]			2mW			

TABLE 4-4C

POWER SUPPLY RELIABILITY DATA

P/N D314311, REV.

Sheet 6 of 6

[illegible]	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
Network	SCD	125mW	28mW	0.22	0.1232	217D
[illegible]			3mW			
[illegible]			3mW			
[illegible]			20mW			
[illegible]			2mW			
Network	SCD	125mW	27mW	0.22	0.1540	217D
[illegible]			0mW			
[illegible]			0mW			
[illegible]			0mW			
[illegible]			24mW			
[illegible]			3mW			
Network		125mW	11mW	0.09	0.1198	217D
[illegible]			1mW			
[illegible]			0mW			
[illegible]			1mW			
[illegible]			9mW			
Network		125mW	11mW	0.09	0.1198	217D
[illegible]			1mW			
[illegible]			0mW			
[illegible]			1mW			
[illegible]			9mW			
[illegible]	[illegible]				0.4940	217D
[illegible]					0.0988	217D

TOTAL 7.093

TABLE 4-5A

RF MULTIPLIER RELIABILITY DATA

Sheet 1 of 1

REF SYMB	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
CR1	Diode, Step Recovery	Aertech No. A4X707	1W	0.01W	0.01	2.5540	217D
			200°C	80°C			
C1	Capacitor, Ceramic, 15pF	CDR12BP150AJSM	50V	10V	0.20	0.0078	217D
C2	Capacitor, Ceramic, 5pF	Epsilam	50V	10V	0.20	0.0069	217D
C3	Capacitor, Ceramic, 5pF	Epsilam	50V	10V	0.20	0.0069	217D
L1	Inductor, (2T, #26 wire)		105°C	82°C		0.0468	217D
L2	Inductor, (1/2", #26 wire)		105°C	82°C		0.0468	217D
					TOTAL	2.669	

TABLE 4-56

SRD MULTIPLIER RELIABILITY DATA

Sheet 1 of 1

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
CR1	Diode, Step Recovery	Aertech No. A4X707	1W	0.01W	0.01	0.1423	217D
			200°C	80°C			
C1	Capacitor, Ceramic, 15pF	CDR12BP150AJSM	50V	10V	0.20	0.0008	217D
C2	Capacitor, Ceramic, 5pF	Epsilam	50V	10V	0.20	0.0007	217D
C3	Capacitor, Ceramic, 5pF	Epsilam	50V	10V	0.20	0.0007	217D
L1	Inductor, (2T, #28 Wire)		105°C	82°C		0.0168	217D
L2	Inductor, (1/2", #28 Wire)		105°C	82°C		0.0168	217D

TOTAL 0.178

TABLE 4-5C

[illegible] MULTIPLIER RELIABILITY DATA

Sheet 1 of 1

[illegible]	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
[illegible]	[illegible] Recovery	Aertech No. A4X707	>1W	0.01W	0.01	0.6567	217D
			200°C	80°C			
	Capacitor, Ceramic, [illegible]	CDR12BP150AJSM	50V	10V	0.20	0.0041	217D
	Capacitor, Ceramic, 5pF	Epsilam	50V	10V	0.20	0.0036	217D
	Capacitor, Ceramic, 5pF	Epsilam	50V	10V	0.20	0.0036	217D
[illegible]	Inductor, [illegible], # Wire)		105°C	82°C		0.0561	217D
[illegible]	Inductor, (1/2", #26 Wire)		105°C	82°C		0.0561	217D

TOTAL 0.780

TABLE 4-6A

LAMP EXCITER PRINTED WIRING BOARD RELIABILITY DATA

P/N C316627, REV. A

(A(T = 2°C) Sheet 1 of 1

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
Q1	Transistor, SI, RF Power	SCD 316782	45V	15V	0.33	6.6560	217D
		(MSC82919)	21.8W	1.5W	0.07		
			150°C	127°C			
CR1	Diode, SI, General Purpose	MIL-S-19500/231	50V	1V	0.02	0.0081	217D
		(JANTX3600)	200mA	2mA	0.01		
			175°C	116°C			
C1	Capacitor, Ceramic Chip, 3.6pF		50V	14V	0.28	0.0102	217D
C2	Capacitor, Ceramic Chip, 150pF		50V	1V	0.02	0.0085	217D
C3	Capacitor, Ceramic Chip, 27pF		50V	15V	0.30	0.0141	217D
C4	Capacitor, Ceramic, 0.015μf		50V	15V	0.30	0.0282	217D
C5	Capacitor, Ceramic, 0.015μf		50V	8V	0.16	0.0162	217D
R1	Resistor, Fixed Film, 2KΩ	RNC50H2001FM	100mW	18mW	0.18	0.0392	217D
R2	Resistor, Fixed Film, 100Ω	RNC50H1000FM	100mW	0mW	0.00	0.0308	217D
L1	Inductor, 0.7μH		150°C	116°C		0.0706	217D
L2	Inductor, 2.2μH		150°C	116°C		0.0706	217D
L3	Inductor, 2.2μH		150°C	116°C		0.0706	217D
PWB1	Printed Wiring Bd. (2-sided)	B316627 PWB				0.0359	217D

TOTAL 7.059

TABLE 4-6B

LAMP EXCITER PRINTED WIRING BOARD RELIABILITY DATA

P/N C316627, REV. A

(GF @ 30°C)

Sheet 1 of 1

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
Q1	Transistor, SI, RF Power	SCD 316782	45V	15V	0.33	1.3310	217D
		(MSC82919)	21.8W	1.5W	0.07		
			150°C	127°C			
CR1	Diode, SI, General Purpose	MIL-S-19500/231	50V	1V	0.02	0.0006	217D
		(JANTX3600)	200mA	2mA	0.01		
			175°C	116°C			
C1	Capacitor, Ceramic Chip, 3.6pF		50V	14V	0.28	0.0011	217D
C2	Capacitor, Ceramic Chip, 150pF		50V	1V	0.02	0.0009	217D
C3	Capacitor, Ceramic Chip, 27pF		50V	15V	0.30	0.0015	217D
C4	Capacitor, Ceramic, 0.015μf		50V	15V	0.30	0.0030	217D
C5	Capacitor, Ceramic, 0.015μf		50V	8V	0.16	0.0017	217D
R1	Resistor, Fixed Film, 2KΩ	RNC50H2001FM	100mW	18mW	0.18	0.0047	217D
R2	Resistor, Fixed Film, 100Ω	RNC50H1000FM	100mW	0mW	0.00	0.0037	217D
L1	Inductor, 0.7μH		150°C	116°C		0.0254	217D
L2	Inductor, 2.2μH		150°C	116°C		0.0254	217D
L3	Inductor, 2.2μH		150°C	116°C		0.0254	217D
PWB1	Printed Wiring Bd. (2-sided)	B316627 PWB				0.0024	217D

TOTAL 1.427

TABLE 4-6C

LAMP EXCITER PRINTED WIRING BOARD RELIABILITY DATA

(GM @ 40°C) P/N C316627, REV. A Sheet 1 of 1

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
Q1	Transistor, SI, RF Power	SCD 316782	45V	15V	0.33	5.1920	217D
		(MSC82919)	21.8W	1.5W	0.07		
			150°C	127°C			
CR1	Diode, SI, General Purpose	MIL-S-19500/231	50V	1V	0.02	0.0029	217D
		(JANTX3600)	200mA	2mA	0.01		
			175°C	116°C			
C1	Capacitor, Ceramic Chip, 3.6pF		50V	14V	0.28	0.0053	217D
C2	Capacitor, Ceramic Chip, 150pF		50V	1V	0.02	0.0044	217D
C3	Capacitor, Ceramic Chip, 27pF		50V	15V	0.30	0.0073	217D
C4	Capacitor, Ceramic, 0.015µf		50V	15V	0.30	0.0147	217D
C5	Capacitor, Ceramic, 0.015µf		50V	8V	0.16	0.0084	217D
R1	Resistor, Fixed Film, 2KΩ	RNC50H2001FM	100mW	18mW	0.18	0.0153	217D
R2	Resistor, Fixed Film, 100Ω	RNC50H1000FM	100mW	0mW	0.00	0.0120	217D
L1	Inductor, 0.7µH		150°C	116°C		0.0847	217D
L2	Inductor, 2.2µH		150°C	116°C		0.0847	217D
L3	Inductor, 2.2µH		150°C	116°C		0.0847	217D
PWB1	Printed Wiring Bd. (2-sided)	B316627 PWB				0.0079	217D
					TOTAL	5.524	

TABLE 4-7A

RF PRINTED WIRING BOARD RELIABILITY DATA

P/N C314303, REV. B

(AUF @ 2°C)

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
U1	IC, Linear, Line Receiver	SNJ55140JG/883B	150°C	50°C		0.1013	217D
U2	IC, Digital, Counter	JM38510/31504BEB (54LS161J)	200°C	28°C		0.0634	217D
U3	IC, Digital, NAND Gate	JM38510/30001BCC (54LS00J)	200°C	21°C		0.0470	217D
U4	IC, Digital, Counter	JM38510/31504BEB (54LS161J)	200°C	28°C		0.0634	217D
U5	IC, Linear, Op Amp	SCD 316TBD (LM192H)	150°C	35°C		0.1745	217D
U6	IC, Digital, OR Gate	JM38510/05303BCB (CD4030BF)	150°C	27°C		0.0475	217D
Q1	Transistor, SI, NPN	SCD 316783 (2N6304)	15V 200mW 200°C	10V 100mW 108°C	0.67 0.50	0.0314	217D
Q2	Transistor, SI, NPN	SCD 316784 (MRF525)	25V 2.5W 175°C	20V 0.5W 49°C	0.80 0.20	0.0428	217D
Q3	Transistor, SI, NPN	MIL-S-19500/343 JANTX2N2857)	15V 200mW 200°C	3V 4mW 24°C	0.20 0.02	0.0038	217D
Q4	Transistor, SI, NPN	MIL-S-19500/255 (JANTX2N2222A)	40V 400mW 200°C	20V 100mW 63°C	0.50 0.25	0.0186	217D

TABLE 4-2A

RF PRINTED WIRING BOARD RELIABILITY DATA

P/N [illegible]14303, REV. B

(AUE @ 2°C)

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
Q5	Transistor, SI, NPN	MIL-S-19500/[illegible]	40V	15V	0.38	0.0056	217D
		(JANTX2N[illegible]A)	4[illegible]mW	3mW	0.01		
			200°C	[illegible]°C			
CR1	Diode, Varactor	SCD [illegible]	250mW	0mW	0.00	1.1400	217D
		[illegible]	125°C	20°C			
CR2	Diode, SI, GP	MIL-S-19500/444	55V	5V	0.09	0.0013	217D
		JANTX1N[illegible]	[illegible]mW	[illegible]mW	0.02		
			200°C	24°C			
CR3	Diode, SI, GP	MIL-S-19500/444	55V	5V	0.09	[illegible]	217D
		JANTX1N[illegible]	25[illegible]mW	5mW	0.02		
			200°C	[illegible]4°C			
CR4	Diode, SI, GP	MIL-[illegible]	[illegible]	[illegible]	[illegible]	[illegible]14	217D
		JANTX1N[illegible]	[illegible]mW	[illegible]mW	[illegible]		
			[illegible]	[illegible]			
CR5	Diode, [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	217[illegible]
		[illegible]	[illegible]mW	[illegible]			
C1	Capacitor, [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
C2	Capacitor, [illegible]	[illegible]	[illegible]	[illegible]		[illegible]	217[illegible]
C3	Capacitor, [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
C4	Capacitor, [illegible]	[illegible]		[illegible]			[illegible]
C5	Capacitor, [illegible]	[illegible]					[illegible]
C6	Capacitor, [illegible]	[illegible]		[illegible]			[illegible]

AD-A191 190 TACTICAL RUBIDIUM FREQUENCY STANDARD (TRFS) VOLUME 2 2/3
(U) EG AND G INC SALEM MA T J LYNCH ET AL. OCT 87
RADC-TR-87-166-VOL-2 F19628-83-C-0175

UNCLASSIFIED F/G 14/2 NL

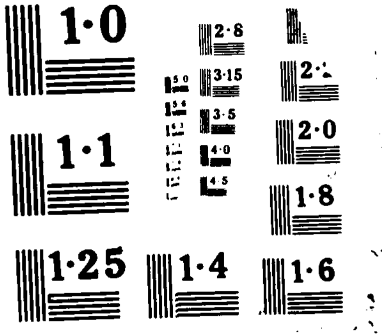
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TABLE 4-7A

RF PRINTED WIRING BOARD RELIABILITY DATA

(AUF @ 2°C) P/N C314303, REV. B

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
C7	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	15V	0.15	0.0154	217D
C8	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	15V	0.15	0.0154	217D
C9	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	15V	0.15	0.0119	217D
C10	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	15V	0.15	0.0119	217D
C11	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	15V	0.15	0.0119	217D
C12	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	7V	0.07	0.0107	217D
C13	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	10V	0.10	0.0142	217D
C14	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	10V	0.10	0.0110	217D
C15	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	2V	0.02	0.0137	217D
C16	Capacitor, Ceramic, 30pF	CCR05CGXXXJM	100V	10V	0.10	0.0040	217D
C17	Capacitor, Ceramic, 6800pF	CCR05CG682JM	100V	8V	0.08	0.0076	217D
C18	Capacitor, Ceramic, 4700pF	CCR05CG472JM	100V	8V	0.08	0.0072	217D
C19	Capacitor, Ceramic, Chip, 15pF	CDR12BP150AJSM	50V	10V	0.20	0.0067	217D
C20	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	2V	0.02	0.0137	217D
C21	Capacitor, Ceramic, 0.001μf	CCR05CG102JM	100V	0V	0.00	0.0059	217D
C22	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	5V	0.05	0.0107	217D
C23	Capacitor, Tantalum, 6.8μf	M39003/01-2304	35V	15V	0.43	0.2996	217D
C24	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	10V	0.10	0.0110	217D
C25	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	5V	0.05	0.0137	217D
C26	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	3V	0.03	0.0137	217D
C27	Capacitor, Ceramic, 0.001μf	CCR05CG102JM	100V	0V	0.00	0.0059	217D
C28	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	5V	0.05	0.0137	217D

TABLE 4-7A

RF PRINTED WIRING BOARD RELIABILITY DATA

P/N C314303, REV. B

(AUF @ 2°C)

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
C29	Capacitor, Ceramic, 0.1µf	M39014/1C-1473	100V	5V	0.05	0.0137	217D
C30	Capacitor, Ceramic, 0.1µf	M39014/1C-1473	100V	5V	0.05	0.0137	217D
C31	Capacitor, Ceramic, 0.1µf	M39014/1C-1473	100V	5V	0.05	0.0137	217D
C33	Capacitor, Ceramic, 0.1µf	M39014/1C-1473	100V	15V	0.15	0.0154	217D
C34	Capacitor, Ceramic, 60pF	CCR05CG680JM	100V	0V	0.00	0.0042	217D
C35	Capacitor, Ceramic, 330pF	CCR05CG331JM	100V	0V	0.00	0.0052	217D
C36	Capacitor, Tantalum, 33µf	M39003/01-2304	10V	5V	0.50	0.4769	217D
C37	Capacitor, Ceramic, 0.1µf	M39014/1C-1473	100V	15V	0.15	0.0154	217D
C38	Capacitor, Ceramic, 0.1µf	M39014/1C-1473	100V	8V	0.08	0.0139	217D
R1	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0133	217D
R2	Resistor, Fixed Film, 5.11KΩ	RNC50H5111FM	100mW	5mW	0.05	0.0134	217D
R3	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	7mW	0.07	0.0142	217D
R4	Resistor, Fixed Film, 510Ω	RCR07G511KM	250mW	100mW	0.40	0.0039	217D
R5	Resistor, Fixed Film, 5.46KΩ	RNC50H5461FM	100mW	10mW	0.10	0.0147	217D
R6	Resistor, Fixed Film, 7.5KΩ	RNC50H7501FM	100mW	5mW	0.05	0.0139	217D
R7	Resistor, Fixed Film, 10Ω	RNC50H10R0FM	100mW	12mW	0.12	0.0150	217D
R8	Resistor, Fixed Film, 274Ω	RNC50H2740FM	100mW	20mW	0.20	0.0163	217D
R9	Resistor, Fixed Film, 18.2Ω	RNC50H18R2FM	100mW	50mW	0.50	0.0225	217D
R10	Resistor, Fixed Film, 274Ω	RNC50H2740FM	100mW	20mW	0.20	0.0163	217D
R11	Resistor, Fixed Film, 50Ω	RNC50HXXXXFM	100mW	5mW	0.05	0.0139	217D
R12	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mw	0.00	0.0133	217D
R13	Resistor, Fixed Film, 1.5KΩ	RNC50H1501FM	100mW	34mW	0.34	0.0190	217D
R14	Resistor, Fixed Film, 121KΩ	RNC50H1213FM	100mW	1mW	0.01	0.0146	217D

TABLE 4-7A

RF PRINTED WIRING BOARD RELIABILITY DATA

P/N C314303, REV. B

(AUF @ 2°C)

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
R15	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	40mW	0.40	0.0202	217D
R16	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	40mW	0.40	0.0202	217D
R17	Resistor, Fixed Film, 100KΩ	RNC50H1003FM	100mW	0mW	0.00	0.0133	217D
R18	Resistor, Fixed Film, 2KΩ	RNC50H2001FM	100mW	2mW	0.02	0.0134	217D
R19	Resistor, Fixed Film, 82.5Ω	RNC50H82R5FM	100mW	4mW	0.04	0.0137	217D
R20	Resistor, Fixed Film, 7.5KΩ	RNC50H7501FM	100mW	1mW	0.01	0.0133	217D
R21	Resistor, Fixed Film, 100Ω	RNC50H1000FM	100mW	3mw	0.03	0.0136	217D
R22	Resistor, Fixed Film, 4.7KΩ	RNC50H4751FM	100mW	1mW	0.01	0.0133	217D
R23	Resistor, Fixed Film, 4.7KΩ	RNC50H4751FM	100mW	1mW	0.01	0.0133	217D
R24	Resistor, Fixed Film, 33.2Ω	RNC50H33R2FM	100mW	20mW	0.20	0.0163	217D
R25	Resistor, Fixed Film, 619Ω	RNC55H6190FM	125mW	40mW	0.32	0.0185	217D
R26	Resistor, (Thermistor) 3.3KΩ	RTH42ES332K	100mW	2mW	0.02	6.195	217D
R27	Resistor, Fixed Composition, 301Ω	RCR07G301KM	250mW	8mW	0.03	0.0020	217D
R29	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0133	217D
R30	Resistor, Fixed Film, 500Ω	RNC50H5000FM	100mW	0mW	0.00	0.0133	217D
R31	Resistor, Fixed Film, 7.5KΩ	RNC50H7501FM	100mW	7mW	0.07	0.0142	217D
R32	Resistor, Fixed Film, 475Ω	RNC50H4750FM	100mW	1mW	0.01	0.0133	217D
R33	Resistor, Fixed Film, 27Ω	RNC50H27R0FM	100mW	2mW	0.02	0.0134	217D
Y1	Crystal, 90MHz	A316630				0.2000	217D
T1	Transformer, 90MHz (OUT)	B316778	105°C	21°C		0.2341	217D
T2	Transformer, RF	SCD 316787	105°C	21°C		0.2341	217D
T3	Transformer, 5MHz (OUT)	B316770	105°C	21°C		0.2341	217D

TABLE 4-7A

RF PRINTED WIRING BOARD RELIABILITY DATA

P/N C314303, REV. B

(AUF @ 2°C)

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
L1	Inductor, Tuning	B316779	105°C	21°C		0.0164	217D
L2	Inductor, 0.22μH	M39003/3 -AR22KM	105°C	21°C		0.0164	217D
L3	Inductor, 4.7μH	M39010/1 -A4R7KM	105°C	21°C		0.0164	217D
L4	Inductor, 15mH	M39010/3 -A153KM	105°C	21°C		0.0164	217D
L5	Inductor, 2.2mH	M39010/3 -A222KM	105°C	21°C		0.0164	217D
L6	Inductor, 470μH	M39010/3 -A471KM	105°C	21°C		0.0164	217D
L7	Inductor, 220μH	M39010/3 -A221KM	105°C	21°C		0.0164	217D
L8	Inductor, 220μH	M39010/3 -A221KM	105°C	21°C		0.0164	217D
J1	Connector	SCD 316777				0.0732	217D
E1	Terminal (Qty. 9)	SCD 316774				0.2223	217D
PWB1	Printed Wiring Bd (2-sided)					0.4104	217D

TOTAL 11.280

TABLE 4-7B

RF PRINTED WIRING BOARD RELIABILITY DATA

(GF @ 30°C) P/N C314303, REV. B

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
U1	IC, Linear, Line Receiver	SNJ55140JG/883B	150°C	78°C		0.1200	217D
U2	IC, Digital, Counter	JM38510/31504BEB (54LS161J)	200°C	56°C		0.0240	217D
U3	IC, Digital, NAND Gate	JM38510/30001BCC (54LS00J)	200°C	49°C		0.0138	217D
U4	IC, Digital, Counter	JM38510/31504BEB (54LS161J)	200°C	56°C		0.0240	217D
U5	IC, Linear, Op Amp	SCD 316TBD (LM192H)	150°C	63°C		0.1336	217D
U6	IC, Digital, OR Gate	JM38510/05303BCB (CD4030BF)	150°C	55°C		0.0167	217D
Q1	Transistor, SI, NPN	SCD 316783 (2N6304)	15V 200mW 200°C	10V 100mW 136°C	0.67 0.50	0.0040	217D
Q2	Transistor, SI, NPN	SCD 316784 (MRF525)	25V 2.5W 175°C	20V 0.5W 77°C	0.80 0.20	0.0052	217D
Q3	Transistor, SI, NPN	MIL-S-19500/343 JANTX2N2857)	15V 200mW 200°C	3V 4mW 52°C	0.20 0.02	0.0005	217D
Q4	Transistor, SI, NPN	MIL-S-19500/255 (JANTX2N2222A)	40V 400mW 200°C	20V 100mW 91°C	0.50 0.25	0.0024	217D

TABLE 4-7B

RF PRINTED WIRING BOARD RELIABILITY DATA

(GF @ 30°C) P/N C314303, REV. B

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
Q5	Transistor, SI, NPN	MIL-S-19500/255	40V	15V	0.38	0.0007	217D
		(JANTX2N2222A)	400mW	3mW	0.01		
			200°C	49°C			
CR1	Diode, Varactor	SCD 316781	250mW	0mW	0.00	0.0862	217D
		(DKV6534C)	125°C	48°C			
CR2	Diode, SI, GP	MIL-S-19500/444	55V	5V	0.09	0.0002	217D
		(JANTX1N5711)	250mW	5mW	0.02		
			200°C	52°C			
CR3	Diode, SI, GP	MIL-S-19500/444	55V	5V	0.09	0.0002	217D
		(JANTX1N5711)	250mW	5mW	0.02		
			200°C	52°C			
CR4	Diode, SI, GP	MIL-S-19500/116	100V	3V	0.03	0.0002	217D
		(JANTX1N4148-1	200mW	6mW	0.03		
			175°C	52°C			
CR5	Diode, SI, GP	MIL-S-19500/116	100V	1V	0.01	0.0002	217D
		(JANTX1N4148-1)	200mW	0mW	0.00		
			175°C	48°C			
C1	Capacitor, Ceramic, 22pF	CCR05CG220JM	100V	15V	0.15	0.0006	217D
C2	Capacitor, Ceramic, 82pF	CCR05CG820JM	100V	10V	0.10	0.0007	217D
C3	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	7V	0.07	0.0015	217D
C4	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	9V	0.09	0.0012	217D
C5	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	1V	0.01	0.0012	217D
C6	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	15V	0.15	0.0018	217D

TABLE 4-7B

RF PRINTED WIRING BOARD RELIABILITY DATA

(GF @ 30°C) P/N C314303, REV. B

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
C7	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	15V	0.15	0.0018	217D
C8	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	15V	0.15	0.0018	217D
C9	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	15V	0.15	0.0014	217D
C10	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	15V	0.15	0.0014	217D
C11	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	15V	0.15	0.0014	217D
C12	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	7V	0.07	0.0012	217D
C13	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	10V	0.10	0.0016	217D
C14	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	10V	0.10	0.0013	217D
C15	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	2V	0.02	0.0016	217D
C16	Capacitor, Ceramic, 30pF	CCR05CGXXXJM	100V	10V	0.10	0.0059	217D
C17	Capacitor, Ceramic, 6800pF	CCR05CG682JM	100V	8V	0.08	0.0011	217D
C18	Capacitor, Ceramic, 4700pF	CCR05CG472JM	100V	8V	0.08	0.0011	217D
C19	Capacitor, Ceramic, Chip, 15pF	CDR12BP150AJSM	50V	10V	0.20	0.0008	217D
C20	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	2V	0.02	0.0016	217D
C21	Capacitor, Ceramic, 0.001μf	CCR05CG102JM	100V	0V	0.00	0.0009	217D
C22	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	5V	0.05	0.0012	217D
C23	Capacitor, Tantalum, 6.8μf	M39003/01-2304	35V	15V	0.43	0.0296	217D
C24	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	10V	0.10	0.0013	217D
C25	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	5V	0.05	0.0016	217D
C26	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	3V	0.03	0.0016	217D
C27	Capacitor, Ceramic, 0.001μf	CCR05CG102JM	100V	0V	0.00	0.0009	217D
C28	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	5V	0.05	0.0016	217D

TABLE 4-7B

RF PRINTED WIRING BOARD RELIABILITY DATA

P/N C314303, REV. B

(GF @ 30°C)

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
C29	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	5V	0.05	0.0016	217D
C30	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	5V	0.05	0.0016	217D
C31	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	5V	0.05	0.0016	217D
C33	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	15V	0.15	0.0018	217D
C34	Capacitor, Ceramic, 60pF	CCR05CG680JM	100V	0V	0.00	0.0006	217D
C35	Capacitor, Ceramic, 330pF	CCR05CG331JM	100V	0V	0.00	0.0008	217D
C36	Capacitor, Tantalum, 33μf	M39003/01-2304	10V	5V	0.50	0.0471	217D
C37	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	15V	0.15	0.0018	217D
C38	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	8V	0.08	0.0016	217D
R1	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0010	217D
R2	Resistor, Fixed Film, 5.11KΩ	RNC50H5111FM	100mW	5mW	0.05	0.0021	217D
R3	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	7mW	0.07	0.0022	217D
R4	Resistor, Fixed Film, 510Ω	RCR07G511KM	250mW	100mW	0.40	0.0022	217D
R5	Resistor, Fixed Film, 5.46KΩ	RNC50H5461FM	100mW	10mW	0.10	0.0023	217D
R6	Resistor, Fixed Film, 7.5KΩ	RNC50H7501FM	100mW	5mW	0.05	0.0021	217D
R7	Resistor, Fixed Film, 10Ω	RNC50H10R0FM	100mW	12mW	0.12	0.0023	217D
R8	Resistor, Fixed Film, 274Ω	RNC50H2740FM	100mW	20mW	0.20	0.0026	217D
R9	Resistor, Fixed Film, 18.2Ω	RNC50H18R2FM	100mW	50mW	0.50	0.0036	217D
R10	Resistor, Fixed Film, 274Ω	RNC50H2740FM	100mW	20mW	0.20	0.0026	217D
R11	Resistor, Fixed Film, 50Ω	RNC50HXXXXFM	100mW	5mW	0.05	0.0021	217D
R12	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mw	0.00	0.0020	217D
R13	Resistor, Fixed Film, 1.5KΩ	RNC50H1501FM	100mW	34mW	0.34	0.0030	217D
R14	Resistor, Fixed Film, 121KΩ	RNC50H1213FM	100mW	1mW	0.01	0.0022	217D

TABLE 4-7B

RF PRINTED WIRING BOARD RELIABILITY DATA

P/N C314303, REV. B

(GF @ 30°C)

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
R15	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	40mW	0.40	0.0032	217D
R16	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	40mW	0.40	0.0032	217D
R17	Resistor, Fixed Film, 100KΩ	RNC50H1003FM	100mW	0mW	0.00	0.0020	217D
R18	Resistor, Fixed Film, 2KΩ	RNC50H2001FM	100mW	2mW	0.02	0.0021	217D
R19	Resistor, Fixed Film, 82.5Ω	RNC50H82R5FM	100mW	4mW	0.04	0.0021	217D
R20	Resistor, Fixed Film, 7.5KΩ	RNC50H7501FM	100mW	1mW	0.01	0.0020	217D
R21	Resistor, Fixed Film, 100Ω	RNC50H1000FM	100mW	3mw	0.03	0.0021	217D
R22	Resistor, Fixed Film, 4.7KΩ	RNC50H4751FM	100mW	1mW	0.01	0.0020	217D
R23	Resistor, Fixed Film, 4.7KΩ	RNC50H4751FM	100mW	1mW	0.01	0.0020	217D
R24	Resistor, Fixed Film, 33.2Ω	RNC50H33R2FM	100mW	20mW	0.20	0.0026	217D
R25	Resistor, Fixed Film, 619Ω	RNC55H6190FM	125mW	40mW	0.32	0.0029	217D
R26	Resistor, (Thermistor) 3.3KΩ	RTH42ES332K	100mW	2mW	0.02	0.5040	217D
R27	Resistor, Fixed Composition, 301Ω	RCR07G301KM	250mW	8mW	0.03	0.0010	217D
R29	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0020	217D
R30	Resistor, Fixed Film, 500Ω	RNC50H5000FM	100mW	0mW	0.00	0.0020	217D
R31	Resistor, Fixed Film, 7.5KΩ	RNC50H7501FM	100mW	7mW	0.07	0.0022	217D
R32	Resistor, Fixed Film, 475Ω	RNC50H4750FM	100mW	1mW	0.01	0.0020	217D
R33	Resistor, Fixed Film, 27Ω	RNC50H27R0FM	100mW	2mW	0.02	0.0021	217D
Y1	Crystal, 90MHz	A316630				0.2000	217D
T1	Transformer, 90MHz (OUT)	B316778	105°C	49°C		0.1641	217D
T2	Transformer, RF	SCD 316787	105°C	49°C		0.1641	217D
T3	Transformer, 5MHz (OUT)	B316770	105°C	49°C		0.1641	217D

TABLE 4-7B

RF PRINTED WIRING BOARD RELIABILITY DATA

P/N C314303, REV. B

(GF @ 30°C)

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
L1	Inductor, Tuning	B316779	105°C	49°C		0.0073	217D
L2	Inductor, 0.22μH	M39003/3 -AR22KM	105°C	49°C		0.0073	217D
L3	Inductor, 4.7μH	M39010/1 -A4R7KM	105°C	49°C		0.0073	217D
L4	Inductor, 15mH	M39010/3 -A153KM	105°C	49°C		0.0073	217D
L5	Inductor, 2.2mH	M39010/3 -A222KM	105°C	49°C		0.0073	217D
L6	Inductor, 470μH	M39010/3 -A471KM	105°C	49°C		0.0073	217D
L7	Inductor, 220μH	M39010/3 -A221KM	105°C	49°C		0.0073	217D
L8	Inductor, 220μH	M39010/3 -A221KM	105°C	49°C		0.0073	217D
J1	Connector	SCD 316777				0.0102	217D
E1	Terminal (Qty. 9)	SCD 316774				0.0495	217D
PWB1	Printed Wiring Bd (2-sided)					0.0270	217D

TOTAL 1.967

TABLE 4-7C

RF PRINTED WIRING BOARD RELIABILITY DATA

P/N C314303, REV. B

(GM @ 40°C)

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
U1	IC, Linear, Line Receiver	SNJ55140JG/883B	150°C	88°C		0.2142	217D
U2	IC, Digital, Counter	JM38510/31504BEB (54LS161J)	200°C	66°C		0.0404	217D
U3	IC, Digital, NAND Gate	JM38510/30001BCC (54LS00J)	200°C	59°C		0.0232	217D
U4	IC, Digital, Counter	JM38510/31504BEB (54LS161J)	200°C	66°C		0.0404	217D
U5	IC, Linear, Op Amp	SCD 316TBD (LM192H)	150°C	73°C		0.2448	217D
U6	IC, Digital, OR Gate	JM38510/05303BCB (CD4030BF)	150°C	65°C		0.0297	217D
Q1	Transistor, SI, NPN	SCD 316783 (2N6304)	15V 200mW 200°C	10V 100mW 146°C	0.67 0.50	0.0143	217D
Q2	Transistor, SI, NPN	SCD 316784 (MRF525)	25V 2.5W 175°C	20V 0.5W 81°C	0.80 0.20	0.0179	217D
Q3	Transistor, SI, NPN	MIL-S-19500/343 JANTX2N2857)	15V 200mW 200°C	3V 4mW 62°C	0.20 0.02	0.0016	217D
Q4	Transistor, SI, NPN	MIL-S-19500/255 (JANTX2N2222A)	40V 400mW 200°C	20V 100mW 101°C	0.50 0.25	0.0085	217D

TABLE 4-7C

RF PRINTED WIRING BOARD RELIABILITY DATA

P/N C314303, REV. B

(GM @ 40°C)

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
Q5	Transistor, SI, NPN	MIL-S-19500/255	40V	15V	0.38	0.0024	217D
		(JANTX2N2222A)	400mW	3mW	0.01		
			200°C	59°C			
CR1	Diode, Varactor	SCD 316781	250mW	0mW	0.00	0.4465	217D
		(DKV6534C)	125°C	58°C			
CR2	Diode, SI, GP	MIL-S-19500/444	55V	5V	0.09	0.0011	217D
		(JANTX1N5711)	250mW	5mW	0.02		
			200°C	62°C			
CR3	Diode, SI, GP	MIL-S-19500/444	55V	5V	0.09	0.0011	217D
		(JANTX1N5711)	250mW	5mW	0.02		
			200°C	62°C			
CR4	Diode, SI, GP	MIL-S-19500/116	100V	3V	0.03	0.0011	217D
		(JANTX1N4148-1	200mW	6mW	0.03		
			175°C	62°C			
CR5	Diode, SI, GP	MIL-S-19500/116	100V	1V	0.01	0.0011	217D
		(JANTX1N4148-1)	200mW	0mW	0.00		
			175°C	58°C			
C1	Capacitor, Ceramic, 22pf	CCR05CG220JM	100V	15V	0.15	0.0032	217D
C2	Capacitor, Ceramic, 82pf	CCR05CG820JM	100V	10V	0.10	0.0035	217D
C3	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	7V	0.07	0.0080	217D
C4	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	9V	0.09	0.0062	217D
C5	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	1V	0.01	0.0061	217D
C6	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	15V	0.15	0.0088	217D

TABLE 4-7C

RF PRINTED WIRING BOARD RELIABILITY DATA

(GM @ 40°C)

P/N C314303, REV. B

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
C7	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	15V	0.15	0.0088	217D
C8	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	15V	0.15	0.0088	217D
C9	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	15V	0.15	0.0068	217D
C10	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	15V	0.15	0.0068	217D
C11	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	15V	0.15	0.0068	217D
C12	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	7V	0.07	0.0061	217D
C13	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	10V	0.10	0.0081	217D
C14	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	10V	0.10	0.0063	217D
C15	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	2V	0.02	0.0078	217D
C16	Capacitor, Ceramic, 30pF	CCR05CGXXXJM	100V	10V	0.10	0.0031	217D
C17	Capacitor, Ceramic, 6800pF	CCR05CG682JM	100V	8V	0.08	0.0058	217D
C18	Capacitor, Ceramic, 4700pF	CCR05CG472JM	100V	8V	0.08	0.0055	217D
C19	Capacitor, Ceramic, Chip, 15pF	CDR12BP150AJSM	50V	10V	0.20	0.0038	217D
C20	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	2V	0.02	0.0078	217D
C21	Capacitor, Ceramic, 0.001μf	CCR05CG102JM	100V	0V	0.00	0.0045	217D
C22	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	5V	0.05	0.0061	217D
C23	Capacitor, Tantalum, 6.8μf	M39003/01-2304	35V	15V	0.43	0.1083	217D
C24	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	10V	0.10	0.0063	217D
C25	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	5V	0.05	0.0079	217D
C26	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	3V	0.03	0.0078	217D
C27	Capacitor, Ceramic, 0.001μf	CCR05CG102JM	100V	0V	0.00	0.0045	217D
C28	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	5V	0.05	0.0079	217D

TABLE 4-7C

RF PRINTED WIRING BOARD RELIABILITY DATA

(GM @ 40°C) P/N C314303, REV. B

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
C29	Capacitor, Ceramic, 0.1µf	M39014/1C-1473	100V	5V	0.05	0.0079	217D
C30	Capacitor, Ceramic, 0.1µf	M39014/1C-1473	100V	5V	0.05	0.0079	217D
C31	Capacitor, Ceramic, 0.1µf	M39014/1C-1473	100V	5V	0.05	0.0079	217D
C33	Capacitor, Ceramic, 0.1µf	M39014/1C-1473	100V	15V	0.15	0.0088	217D
C34	Capacitor, Ceramic, 60pF	CCR05CG680JM	100V	0V	0.00	0.0032	217D
C35	Capacitor, Ceramic, 330pF	CCR05CG331JM	100V	0V	0.00	0.0040	217D
C36	Capacitor, Tantalum, 33µf	M39003/01-2304	10V	5V	0.50	0.1724	217D
C37	Capacitor, Ceramic, 0.1µf	M39014/1C-1473	100V	15V	0.15	0.0088	217D
C38	Capacitor, Ceramic, 0.1µf	M39014/1C-1473	100V	8V	0.08	0.0080	217D
R1	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0073	217D
R2	Resistor, Fixed Film, 5.11KΩ	RNC50H5111FM	100mW	5mW	0.05	0.0076	217D
R3	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	7mW	0.07	0.0078	217D
R4	Resistor, Fixed Film, 510Ω	RCR07G511KM	250mW	100mW	0.40	0.0090	217D
R5	Resistor, Fixed Film, 5.46KΩ	RNC50H5461FM	100mW	10mW	0.10	0.0081	217D
R6	Resistor, Fixed Film, 7.5KΩ	RNC50H7501FM	100mW	5mW	0.05	0.0076	217D
R7	Resistor, Fixed Film, 10Ω	RNC50H10R0FM	100mW	12mW	0.12	0.0083	217D
R8	Resistor, Fixed Film, 274Ω	RNC50H2740FM	100mW	20mW	0.20	0.0091	217D
R9	Resistor, Fixed Film, 18.2Ω	RNC50H18R2FM	100mW	50mW	0.50	0.0131	217D
R10	Resistor, Fixed Film, 274Ω	RNC50H2740FM	100mW	20mW	0.20	0.0091	217D
R11	Resistor, Fixed Film, 50Ω	RNC50HXXXXFM	100mW	5mW	0.05	0.0076	217D
R12	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mw	0.00	0.0073	217D
R13	Resistor, Fixed Film, 1.5KΩ	RNC50H1501FM	100mW	34mW	0.34	0.0108	217D
R14	Resistor, Fixed Film, 121KΩ	RNC50H1213FM	100mW	1mW	0.01	0.0080	217D

TABLE 4-7C

RF PRINTED WIRING BOARD RELIABILITY DATA

P/N C314303, REV. B

(GM @ 40°C)

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
R15	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	40mW	0.40	0.0116	217D
R16	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	40mW	0.40	0.0116	217D
R17	Resistor, Fixed Film, 100KΩ	RNC50H1003FM	100mW	0mW	0.00	0.0073	217D
R18	Resistor, Fixed Film, 2KΩ	RNC50H2001FM	100mW	2mW	0.02	0.0073	217D
R19	Resistor, Fixed Film, 82.5Ω	RNC50H82R5FM	100mW	4mW	0.04	0.0075	217D
R20	Resistor, Fixed Film, 7.5KΩ	RNC50H7501FM	100mW	1mW	0.01	0.0073	217D
R21	Resistor, Fixed Film, 100Ω	RNC50H1000FM	100mW	3mW	0.03	0.0074	217D
R22	Resistor, Fixed Film, 4.7KΩ	RNC50H4751FM	100mW	1mW	0.01	0.0073	217D
R23	Resistor, Fixed Film, 4.7KΩ	RNC50H4751FM	100mW	1mW	0.01	0.0073	217D
R24	Resistor, Fixed Film, 33.2Ω	RNC50H33R2FM	100mW	20mW	0.20	0.0091	217D
R25	Resistor, Fixed Film, 619Ω	RNC55H6190FM	125mW	40mW	0.32	0.0106	217D
R26	Resistor, (Thermistor) 3.3KΩ	RTH42ES332K	100mW	2mW	0.02	2.6250	217D
R27	Resistor, Fixed Composition, 301Ω	RCR07G301KM	250mW	8mW	0.03	0.0042	217D
R29	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0073	217D
R30	Resistor, Fixed Film, 500Ω	RNC50H5000FM	100mW	0mW	0.00	0.0073	217D
R31	Resistor, Fixed Film, 7.5KΩ	RNC50H7501FM	100mW	7mW	0.07	0.0078	217D
R32	Resistor, Fixed Film, 475Ω	RNC50H4750FM	100mW	1mW	0.01	0.0073	217D
R33	Resistor, Fixed Film, 27Ω	RNC50H27R0FM	100mW	2mW	0.02	0.0073	217D
Y1	Crystal, 90MHz	A316630				0.2000	217D
T1	Transformer, 90MHz (OUT)	B316778	105°C	59°C		0.4028	217D
T2	Transformer, RF	SCD 316787	105°C	59°C		0.4028	217D
T3	Transformer, 5MHz (OUT)	B316770	105°C	59°C		0.4028	217D

TABLE 4-7C

RF PRINTED WIRING BOARD RELIABILITY DATA

P/N C314303, REV. B

(GM @ 40°C)

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
L1	Inductor, Tuning	B316779	105°C	59°C		0.0283	217D
L2	Inductor, 0.22μH	M39003/3 -AR22KM	105°C	59°C		0.0283	217D
L3	Inductor, 4.7μH	M39010/1 -A4R7KM	105°C	59°C		0.0283	217D
L4	Inductor, 15mH	M39010/3 -A153KM	105°C	59°C		0.0283	217D
L5	Inductor, 2.2mH	M39010/3 -A222KM	105°C	59°C		0.0283	217D
L6	Inductor, 470μH	M39010/3 -A471KM	105°C	59°C		0.0283	217D
L7	Inductor, 220μH	M39010/3 -A221KM	105°C	59°C		0.0283	217D
L8	Inductor, 220μH	M39010/3 -A221KM	105°C	59°C		0.0283	217D
J1	Connector	SCD 316777				0.0857	217D
E1	Terminal (Qty. 9)	SCD 316774				0.1710	217D
PWB1	Printed Wiring Bd (2-sided)					0.0903	217D
					TOTAL	6.461	

TABLE 4-8A

SERVO PRINTED WIRING BOARD RELIABILITY DATA

P/N C314300, REV.

(AUF @ 2°C)

Sheet 1 of 4

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
U1	IC, Linear, Op. Amp.	SCD 316786 (OP-14AZ/883B)	125°C	47°C		0.1823	217D
U2	IC, Digital, Switch	J38510/05802BCC (CD4056BF)	150°C	21°C		0.0473	217D
U3	IC, Digital, Flip-Flop	MIL-M-38510 (CD4013AJ)	150°C	30°C		0.0475	217D
U4	IC, Linear, Comparator	LM139/883B	150°C	27°C		0.2090	217D
Q1	Transistor, SI, J FET	2N5116/JANTX	500mW 200°C	0mW 20°C	0.00	0.2360	217D
Q2	Transistor, SI, NPN	MIL-S-19500/255 (2N2222A)	40V 400mW 200°C	30V 3mW 21°C	0.75 0.01	0.0175	217D
CR1	Diode, SI, GP	MIL-S-19500/116 (JANTX1N4148-1)	100V 200mW 175°C	8V 0mW 20°C	0.08 0.00	0.0013	217D
CR2	Diode, SI, Zener, 7.5V	MIL-S-19500/127 (JANTX1N755A-1)	400mW 175°C	75mW 43°C	0.19	0.0240	217D
C1	Capacitor, Ceramic, 1μf	M39014/2E-1407	50V	1V	0.02	0.0176	217D
C2	Capacitor, Ceramic, 33pF	M39014/1C-XXXX	100V	0V	0.00	0.0057	217D
C3	Capacitor, Ceramic, 33pF	M39014/1C-XXXX	100V	0V	0.00	0.0057	217D

TABLE 4-8A

SERVO PRINTED WIRING BOARD RELIABILITY DATA

(AUF @ 2°C) P/N C314300, REV. Sheet 2 of 4

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
C4	Capacitor, Ceramic, 1µf	M39014/2E-1407	50V	0V	0.00	0.0176	217D
C5	Capacitor, Ceramic, 0.1µf	M39014/1C-1473	100V	15V	0.15	0.0154	217D
C6	Capacitor, Ceramic, 1µf	M39014/2E-1407	50V	4V	0.08	0.0179	217D
C7	Capacitor, Ceramic, 1µf	M39014/2E-1407	50V	0V	0.00	0.0176	217D
C8	Capacitor, Ceramic, 1µf	M39014/2E-1407	50V	11V	0.22	0.0246	217D
C9	Capacitor, Ceramic, 0.01µf	CCR06CG103JM	50V	8V	0.16	0.0090	217D
C10	Capacitor, Ceramic, 0.10µf	M39014/1C-1473	100V	15V	0.30	0.0273	217D
C11	Capacitor, Ceramic, 0.1µF	M39014/1C-1473	100V	15V	0.30	0.0273	217D
C12	Capacitor, Tantalum, 10µf	M39003/01-2304	35V	15V	0.43	0.3138	217D
C13	Capacitor, Ceramic, 0.1µf	M39014/1C-1473	100V	15V	0.15	0.0154	217D
C14	Capacitor, Ceramic, 0.01µf	M39014/1C-1455	100V	8V	0.08	0.0108	217D
C15	Capacitor, Ceramic, 0.1µf	M39014/1C-1473	100V	11V	0.11	0.0143	217D
C16	Capacitor, Tantalum, 15µf	M39003/01-2304	35V	15V	0.43	0.3294	217D
C17	Capacitor, Tantalum, 15µf	M39003/01-2304	35V	15V	0.43	0.3294	217D
R1	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0133	217D
R2	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0133	217D
R3	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0133	217D
R4	Resistor, Fixed Film, 20KΩ	RNC50H2002FM	100mW	0mW	0.00	0.0133	217D
R5	Resistor, Fixed Film, 499KΩ	RNC50H4993FM	100mW	0mW	0.00	0.0146	217D
R6	Resistor, Fixed Film, 499KΩ	RNC50H4993FM	100mW	0mW	0.00	0.0146	217D
R7	Resistor, Fixed Film, 20KΩ	RNC50H2002FM	100mW	0mW	0.00	0.0133	217D
R8	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0133	217D
R9	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0133	217D

TABLE 4-8A

SERVO PRINTED WIRING BOARD RELIABILITY DATA

(AUF @ 2°C) P/N C314300, REV.

Sheet 3 of 4

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
R10	Resistor, Fixed Film, 100KΩ	RNC50H1003FM	100mW	0mW	0.00	0.0133	217D
R11	Resistor, Fixed Film, 100KΩ	RNC50H1003FM	100mW	0mW	0.00	0.0133	217D
R12	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0133	217D
R13	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	0mW	0.00	0.0133	217D
R14	Resistor, Fixed Film, 50KΩ	RNC50H5002FM	100mW	0mW	0.00	0.0133	217D
R15	Resistor, Fixed Film, 100KΩ	RNC50H1003FM	100mW	0mW	0.00	0.0133	217D
R16	Resistor, Fixed Film, 24KΩ	RNC50HXXXXFM	100mW	3mW	0.03	0.0136	217D
R17	Resistor, Fixed Film, 4.99KΩ	RNC50H4991FM	100mW	0mW	0.00	0.0133	217D
R18	Resistor, Fixed Film, 1.5KΩ	RNC55H1501FM	125mW	38mW	0.30	0.0182	217D
R19	Resistor, Fixed Film, 30Ω	RNC50HXXXXFM	100mW	3mW	0.03	0.0136	217D
R24	Resistor, Fixed Film, 100KΩ	RNC50H1003FM	100mW	1mW	0.01	0.0133	217D
R25	Resistor, Fixed Film, 49.9KΩ	RNC50H4991FM	100mW	0mW	0.00	0.0133	217D
R26	Resistor, Fixed Film, 698KΩ	RNC50H6983FM	100mW	0mW	0.00	0.0146	217D
R27	Resistor, Fixed Film, 100KΩ	RNC50H1003FM	100mW	1mW	0.01	0.0133	217D
R28	Resistor, Fixed Film, 62KΩ	RNC50H6202FM	100mW	0mW	0.00	0.0133	217D
R29	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	37mW	0.37	0.0196	217D
R30	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	3mW	0.03	0.0136	217D
R31	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	23mW	0.23	0.0168	217D
R32	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	0mW	0.00	0.0133	217D
R33	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	0mW	0.00	0.0133	217D
R34	Resistor, Fixed Film, 11.3KΩ	RNC50H1132FM	100mW	11mW	0.11	0.0148	217D
R35	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0133	217D
R36	Resistor, Fixed Film, 100KΩ	RNC50H1003FM	100mW	2mW	0.02	0.0134	217D

TABLE 4-8A

SERVO PRINTED WIRING BOARD RELIABILITY DATA

(AUF @ 2°C) P/N C314300, REV.

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
R37	Resistor, Fixed Film, 3.4KΩ	RNC50HXXXXFM	100mW	0mW	0.00	0.0133	217D
R38	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	0mW	0.00	0.0133	217D
R39	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	0mW	0.00	0.0133	217D
R40	Resistor, Fixed Film, 20KΩ	RNC50H2002FM	100mW	0mW	0.00	0.0133	217D
R41	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	1mW	0.01	0.0133	217D
L1	Inductor, 220μH	M39010/3 -AA21KM	105°C	30°C		0.0043	217D
L2	Inductor, 220μH	M39010/2 -AA21KM	105°C	30°C		0.0043	217D
E1	Terminal (Qty. 17)	SCD 316774				0.4199	217D
PWB1	Printed Wiring Bd. (2-sided)	D314300				0.2712	217D
					TOTAL	3.176	

TABLE 4-8B

SERVO PRINTED WIRING BOARD RELIABILITY DATA

P/N C314300, REV.

(GF @ 30°C

Sheet 1 of 4

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
U1	IC, Linear, Op. Amp.	SCD 316786	125°C	75°C		0.2758	217D
		(OP-14AZ/883B)					
U2	IC, Digital, Switch	J38510/05802BCC	150°C	49°C		0.0147	217D
		(CD4056BF)					
U3	IC, Digital, Flip-Flop	MIL-M-38510	150°C	58°C		0.0162	217D
		(CD4013AJ)					
U4	IC, Linear, Comparator	LM139/883B	150°C	55°C		0.1208	217D
Q1	Transistor, SI, J FET	2N5116/JANTX	500mW	0mW	0.00	0.0206	217D
			200°C	48°C			
Q2	Transistor, SI, NPN	MIL-S-19500/255	40V	30V	0.75	0.0022	217D
		(2N2222A)	400mW	3mW	0.01		
			200°C	49°C			
CR1	Diode, SI, GP	MIL-S-19500/116	100V	8V	0.08	0.0002	217D
		(JANTX1N4148-1)	200mW	0mW	0.00		
			175°C	48°C			
CR2	Diode, SI, Zener, 7.5V	MIL-S-19500/127	400mW	75mW	0.19	0.0017	217D
		(JANTX1N755A-1)	175°C	71°C			
C1	Capacitor, Ceramic, 1μf	M39014/2E-1407	50V	1V	0.02	0.0020	217D
C2	Capacitor, Ceramic, 33pF	M39014/1C-XXXX	100V	0V	0.00	0.0006	217D
C3	Capacitor, Ceramic, 33pF	M39014/1C-XXXX	100V	0V	0.00	0.0006	217D

TABLE 4-8B

SERVO PRINTED WIRING BOARD RELIABILITY DATA

(GF @ 30°C) P/N C314300, REV. Sheet 2 of 4

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
C4	Capacitor, Ceramic, 1μf	M39014/2E-1407	50V	0V	0.00	0.0020	217D
C5	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	15V	0.15	0.0018	217D
C6	Capacitor, Ceramic, 1μf	M39014/2E-1407	50V	4V	0.08	0.0021	217D
C7	Capacitor, Ceramic, 1μf	M39014/2E-1407	50V	0V	0.00	0.0020	217D
C8	Capacitor, Ceramic, 1μf	M39014/2E-1407	50V	11V	0.22	0.0028	217D
C9	Capacitor, Ceramic, 0.01μf	CCR06CG103JM	50V	8V	0.16	0.0013	217D
C10	Capacitor, Ceramic, 0.10μf	M39014/1C-1473	100V	15V	0.30	0.0031	217D
C11	Capacitor, Ceramic, 0.1μF	M39014/1C-1473	100V	15V	0.30	0.0031	217D
C12	Capacitor, Tantalum, 10μf	M39003/01-2304	35V	15V	0.43	0.0310	217D
C13	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	15V	0.15	0.0018	217D
C14	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	8V	0.08	0.0012	217D
C15	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	11V	0.11	0.0016	217D
C16	Capacitor, Tantalum, 15μf	M39003/01-2304	35V	15V	0.43	0.0325	217D
C17	Capacitor, Tantalum, 15μf	M39003/01-2304	35V	15V	0.43	0.0325	217D
R1	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0020	217D
R2	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0020	217D
R3	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0020	217D
R4	Resistor, Fixed Film, 20KΩ	RNC50H2002FM	100mW	0mW	0.00	0.0020	217D
R5	Resistor, Fixed Film, 499KΩ	RNC50H4993FM	100mW	0mW	0.00	0.0022	217D
R6	Resistor, Fixed Film, 499KΩ	RNC50H4993FM	100mW	0mW	0.00	0.0022	217D
R7	Resistor, Fixed Film, 20KΩ	RNC50H2002FM	100mW	0mW	0.00	0.0020	217D
R8	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0020	217D
R9	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0020	217D

TABLE 4-8B

SERVO PRINTED WIRING BOARD RELIABILITY DATA

P/N C314300, REV.

(GF @ 30°C)

Sheet 3 of 4

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
R10	Resistor, Fixed Film, 100KΩ	RNC50H1003FM	100mW	0mW	0.00	0.0020	217D
R11	Resistor, Fixed Film, 100KΩ	RNC50H1003FM	100mW	0mW	0.00	0.0020	217D
R12	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0020	217D
R13	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	0mW	0.00	0.0020	217D
R14	Resistor, Fixed Film, 50KΩ	RNC50H5002FM	100mW	0mW	0.00	0.0020	217D
R15	Resistor, Fixed Film, 100KΩ	RNC50H1003FM	100mW	0mW	0.00	0.0020	217D
R16	Resistor, Fixed Film, 24KΩ	RNC50HXXXXFM	100mW	3mW	0.03	0.0021	217D
R17	Resistor, Fixed Film, 4.99KΩ	RNC50H4991FM	100mW	0mW	0.00	0.0020	217D
R18	Resistor, Fixed Film, 1.5KΩ	RNC55H1501FM	125mW	38mW	0.30	0.0029	217D
R19	Resistor, Fixed Film, 30Ω	RNC50HXXXXFM	100mW	3mW	0.03	0.0021	217D
R24	Resistor, Fixed Film, 100KΩ	RNC50H1003FM	100mW	1mW	0.01	0.0020	217D
R25	Resistor, Fixed Film, 49.9KΩ	RNC50H4991FM	100mW	0mW	0.00	0.0020	217D
R26	Resistor, Fixed Film, 698KΩ	RNC50H6983FM	100mW	0mW	0.00	0.0022	217D
R27	Resistor, Fixed Film, 100KΩ	RNC50H1003FM	100mW	1mW	0.01	0.0020	217D
R28	Resistor, Fixed Film, 62KΩ	RNC50H6202FM	100mW	0mW	0.00	0.0020	217D
R29	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	37mW	0.37	0.0031	217D
R30	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	3mW	0.03	0.0021	217D
R31	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	23mW	0.23	0.0026	217D
R32	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	0mW	0.00	0.0020	217D
R33	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	0mW	0.00	0.0020	217D
R34	Resistor, Fixed Film, 11.3KΩ	RNC50H1132FM	100mW	11mW	0.11	0.0023	217D
R35	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0020	217D
R36	Resistor, Fixed Film, 100KΩ	RNC50H1003FM	100mW	2mW	0.02	0.0021	217D

TABLE 4-8B

SERVO PRINTED WIRING BOARD RELIABILITY DATA

(GF @ 30°C) P/N C314300, REV.

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
R37	Resistor, Fixed Film, 3.4KΩ	RNC50HXXXXFM	100mW	0mW	0.00	0.0020	217D
R38	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	0mW	0.00	0.0020	217D
R39	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	0mW	0.00	0.0020	217D
R40	Resistor, Fixed Film, 20KΩ	RNC50H2002FM	100mW	0mW	0.00	0.0020	217D
R41	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	1mW	0.01	0.0020	217D
L1	Inductor, 220μH	M39010/3 -AA21KM	105°C	58°C		0.0021	217D
L2	Inductor, 220μH	M39010/2 -AA21KM	105°C	58°C		0.0021	217D
E1	Terminal (Qty. 17)	SCD 316774				0.0935	217D
PWB1	Printed Wiring Bd. (2-sided)	D314300				0.0178	217D

TOTAL 0.769

TABLE 4-8C

SERVO PRINTED WIRING BOARD RELIABILITY DATA

P/N C314300, REV.

(GM @ 40°C)

Sheet 1 of 4

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
U1	IC, Linear, Op. Amp.	SCD 316786 (OP-14AZ/883B)	125°C	85°C		0.4987	217D
U2	IC, Digital, Switch	J38510/05802BCC (CD4056BF)	150°C	59°C		0.0254	217D
U3	IC, Digital, Flip-Flop	MIL-M-38510 (CD4013AJ)	150°C	68°C		0.0285	217D
U4	IC, Linear, Comparator	LM139/883B	150°C	65°C		0.2220	217D
Q1	Transistor, SI, J FET	2N5116/JANTX	500mW 200°C	0mW 58°C	0.00	0.1040	217D
Q2	Transistor, SI, NPN	MIL-S-19500/255 (2N2222A)	40V 400mW 200°C	30V 3mW 59°C	0.75 0.01	0.0075	217D
CR1	Diode, SI, GP	MIL-S-19500/116 (JANTX1N4148-1)	100V 200mW 175°C	8V 0mW 58°C	0.08 0.00	0.0010	217D
CR2	Diode, SI, Zener, 7.5V	MIL-S-19500/127 (JANTX1N755A-1)	400mW 175°C	75mW 81°C	0.19	0.0083	217D
C1	Capacitor, Ceramic, 1uf	M39014/2L-1407	50V	1V	0.02	0.0100	217D
C2	Capacitor, Ceramic, 33pf	M39014/1C-XXXX	100V	0V	0.00	0.0032	217D
C3	Capacitor, Ceramic, 33pf	M39014/1C-XXXX	100V	0V	0.00	0.0032	217D

TABLE 4-8C

SERVO PRINTED WIRING BOARD RELIABILITY DATA

(GM @ 40°C) P/N C314300, REV. Sheet 2 of 4

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
C4	Capacitor, Ceramic, 1μf	M39014/2E-1407	50V	0V	0.00	0.0100	217D
C5	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	15V	0.15	0.0088	217D
C6	Capacitor, Ceramic, 1μf	M39014/2E-1407	50V	4V	0.08	0.0103	217D
C7	Capacitor, Ceramic, 1μf	M39014/2E-1407	50V	0V	0.00	0.0101	217D
C8	Capacitor, Ceramic, 1μf	M39014/2E-1407	50V	11V	0.22	0.0141	217D
C9	Capacitor, Ceramic, 0.01μf	CCR06CG103JM	50V	8V	0.16	0.0068	217D
C10	Capacitor, Ceramic, 0.10μf	M39014/1C-1473	100V	15V	0.30	0.0156	217D
C11	Capacitor, Ceramic, 0.1μF	M39014/1C-1473	100V	15V	0.30	0.0156	217D
C12	Capacitor, Tantalum, 10μf	M39003/01-2304	35V	15V	0.43	0.1135	217D
C13	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	15V	0.15	0.0088	217D
C14	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	8V	0.08	0.0062	217D
C15	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	11V	0.11	0.0082	217D
C16	Capacitor, Tantalum, 15μf	M39003/01-2304	35V	15V	0.43	0.1191	217D
C17	Capacitor, Tantalum, 15μf	M39003/01-2304	35V	15V	0.43	0.1191	217D
R1	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0073	217D
R2	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0073	217D
R3	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0073	217D
R4	Resistor, Fixed Film, 20KΩ	RNC50H2002FM	100mW	0mW	0.00	0.0073	217D
R5	Resistor, Fixed Film, 499KΩ	RNC50H4993FM	100mW	0mW	0.00	0.0080	217D
R6	Resistor, Fixed Film, 499KΩ	RNC50H4993FM	100mW	0mW	0.00	0.0080	217D
R7	Resistor, Fixed Film, 20KΩ	RNC50H2002FM	100mW	0mW	0.00	0.0073	217D
R8	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0073	217D
R9	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0073	217D

TABLE 4-8C

SERVO PRINTED WIRING BOARD RELIABILITY DATA

(GM @ 40°C) P/N C314300, REV.

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
R10	Resistor, Fixed Film, 100KΩ	RNC50H1003FM	100mW	0mW	0.00	0.0073	217D
R11	Resistor, Fixed Film, 100KΩ	RNC50H1003FM	100mW	0mW	0.00	0.0073	217D
R12	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0073	217D
R13	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	0mW	0.00	0.0073	217D
R14	Resistor, Fixed Film, 50KΩ	RNC50H5002FM	100mW	0mW	0.00	0.0073	217D
R15	Resistor, Fixed Film, 100KΩ	RNC50H1003FM	100mW	0mW	0.00	0.0073	217D
R16	Resistor, Fixed Film, 24KΩ	RNC50HXXXXFM	100mW	3mW	0.03	0.0074	217D
R17	Resistor, Fixed Film, 4.99KΩ	RNC50H4991FM	100mW	0mW	0.00	0.0073	217D
R18	Resistor, Fixed Film, 1.5KΩ	RNC55H1501FM	125mW	38mW	0.30	0.0103	217D
R19	Resistor, Fixed Film, 30Ω	RNC50HXXXXFM	100mW	3mW	0.03	0.0074	217D
R24	Resistor, Fixed Film, 100KΩ	RNC50H1003FM	100mW	1mW	0.01	0.0073	217D
R25	Resistor, Fixed Film, 49.9KΩ	RNC50H4991FM	100mW	0mW	0.00	0.0073	217D
R26	Resistor, Fixed Film, 698KΩ	RNC50H6983FM	100mW	0mW	0.00	0.0080	217D
R27	Resistor, Fixed Film, 100KΩ	RNC50H1003FM	100mW	1mW	0.01	0.0073	217D
R28	Resistor, Fixed Film, 62KΩ	RNC50H6202FM	100mW	0mW	0.00	0.0073	217D
R29	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	37mW	0.37	0.0112	217D
R30	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	3mW	0.03	0.0074	217D
R31	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	23mW	0.23	0.0095	217D
R32	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	0mW	0.00	0.0073	217D
R33	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	0mW	0.00	0.0073	217D
R34	Resistor, Fixed Film, 11.3KΩ	RNC50H1132FM	100mW	11mW	0.11	0.0073	217D
R35	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0073	217D
R36	Resistor, Fixed Film, 100KΩ	RNC50H1003FM	100mW	2mW	0.02	0.0073	217D

TABLE 4-8C

SERVO PRINTED WIRING BOARD RELIABILITY DATA

P/N C314300, REV.

(GM @ 40°C) Sheet 4 of 4

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
R37	Resistor, Fixed Film, 3.4KΩ	RNC50HXXXXFM	100mW	0mW	0.00	0.0073	217D
R38	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	0mW	0.00	0.0073	217D
R39	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	0mW	0.00	0.0073	217D
R40	Resistor, Fixed Film, 20KΩ	RNC50H2002FM	100mW	0mW	0.00	0.0073	217D
R41	Resistor, Fixed Film, 3.01KΩ	RNC50H3011FM	100mW	1mW	0.01	0.0073	217D
L1	Inductor, 220μH	M39010/3 -AA21KM	105°C	68°C		0.0086	217D
L2	Inductor, 220μH	M39010/2 -AA21KM	105°C	68°C		0.0086	217D
E1	Terminal (Qty. 17)	SCD 316774				0.3230	217D
PWB1	Printed Wiring Bd. (2-sided)	D314300				0.0597	217D
					TOTAL	2.059	

TABLE 4-9A

THERMOELECTRIC CONTROLLER RELIABILITY DATA

P/N C314296, REV.

(AUF @ 2°C)

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
U1	IC, Linear, Switch, Voltage Regulator	UA78S40DM (883B)	125°C	24°C		0.3883	217D
CR1	Diode, Zener, 33V	1N5257/JANTX	500mW 200°C	0mW 20°C	0.00	0.0284	217D
CR2	DIODE, SI, Zener, Power, 33V	MIL-S-19500/434 (JANTX1N5610)	1.5KW 200°C	0KW 20°C	o.00	0.0189	217D
CR3	Diode, SI, Rectifier	MIL-S-19500/286 (JANTX1N4942)	200V 500mW 175°C	0V 0mW 20°C	0.00 0.00	0.0019	217D
CR4	Diode, SI, Rectifier	MIL-S-19500/286 (JANTX1N4942)	200V 500mW 175°C	0V 0mW 20°C	0.00 0.00	0.0019	217D
C1	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	5V	0.05	0.0107	217D
C2	Capacitor, Ceramic, 0.1μf	M39014/1C-1473	100V	23V	0.23	0.0198	217D
C3	Capacitor, Tantalum, 6.8μf	M39003/02-0180	50V	25V	0.50	0.3946	217D
C4	Capacitor, Ceramic, 22pF	CCR05CG220JM	100V	1V	0.01	0.0037	217D
C5	Capacitor, Ceramic, 0.01μf	M39014/1C-1455	100V	28V	0.28	0.0192	217D
C6	Capacitor, Tantalum, 5μf	M39006/03-1379	200V	0V	0.00	0.0637	217D
C7	Capacitor, Ceramic, 1μf	M39014/2E-1407	100V	0V	0.00	0.0176	217D
R1	Resistor, Fixed Film, 20KΩ	RNC50HXXXXFM	100mW	2mW	0.02	0.0134	217D

TABLE 4-9A

THERMOELECTRIC CONTROLLER RELIABILITY DATA

P/N C314296, REV.

(AUF @ 2°C)

Sheet 2 of 2

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
R2	Resistor, Fixed Film, 90.9KΩ	RNC50HXXXXFM	100mW	1mW	0.01	0.0133	217D
R3	Resistor, Fixed Film, 1KΩ	RNC50H1001FM	100mW	10mW	0.10	0.0146	217D
R4	Resistor, Fixed Film, 68.1KΩ	RNC50HXXXXFM	100mW	2mW	0.02	0.0134	217D
R5	Resistor, Fixed Film, 49.9KΩ	RNC50HXXXXFM	100mW	0mW	0.00	0.0133	217D
R6	Resistor, Fixed Film, 49.9KΩ	RNC50HXXXXFM	100mW	1mW	0.01	0.0133	217D
R7	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	65mW	0.65	0.0264	217D
R8	Resistor, Fixed Film, 1KΩ	RNC50H1001FM	100mW	1mW	0.01	0.0133	217D
R9	Resistor, Fixed Film, 1KΩ	RNC50H1001FM	100mW	0mW	0.00	0.0133	217D
R10	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0133	217D
T1	Transformer, Power	B316747	105°C	20°C		0.0292	217D
T2	Transformer	B314327	105°C	20°C		0.1555	217D
E1	Terminal (Qty. 17)	140-1385-02				0.4199	217D
PWB1	Printed Wiring Bd (2-sided)	TBD				0.1220	217D
					TOTAL	1.843	

TABLE 4-9B

THERMOELECTRIC CONTROLLER RELIABILITY DATA

P/N C314296, REV.

(GF @ 30°C)

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
U1	IC, Linear, Switch, Voltage Regulator	UA78S40DM (883B)	125°C	52°C		0.2148	217D
CR1	Diode, Zener, 33V	1N5257/JANTX	500mW 200°C	0mW 48°C	0.00	0.0020	217D
CR2	DIODE, SI, Zener, Power, 33V	MIL-S-19500/434 (JANTX1N5610)	1.5KW 200°C	0KW 48°C	0.00	0.0013	217D
CR3	Diode, SI, Rectifier	MIL-S-19500/286 (JANTX1N4942)	200V 500mW 175°C	0V 0mW 48°C	0.00 0.00	0.0003	217D
CR4	Diode, SI, Rectifier	MIL-S-19500/286 (JANTX1N4942)	200V 500mW 175°C	0V 0mW 48°C	0.00 0.00	0.0003	217D
C1	Capacitor, Ceramic, 0.01µf	M39014/1C-1455	100V	5V	0.05	0.0012	217D
C2	Capacitor, Ceramic, 0.1µf	M39014/1C-1473	100V	23V	0.23	0.0023	217D
C3	Capacitor, Tantalum, 6.8µf	M39003/02-0180	50V	25V	0.50	0.0390	217D
C4	Capacitor, Ceramic, 22pF	CCR05CG220JM	100V	1V	0.01	0.0005	217D
C5	Capacitor, Ceramic, 0.01µf	M39014/1C-1455	100V	28V	0.28	0.0022	217D
C6	Capacitor, Tantalum, 5µf	M39006/03-1379	200V	0V	0.00	0.0024	217D
C7	Capacitor, Ceramic, 1µf	M39014/2E-1407	100V	0V	0.00	0.0020	217D
R1	Resistor, Fixed Film, 20KΩ	RNC50HXXXXFM	100mW	2mW	0.02	0.0021	217D

TABLE 4-9B

THERMOELECTRIC CONTROLLER RELIABILITY DATA

(GF @ 30°C) P/N C314296, REV.

Sheet 2 of 2

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
R2	Resistor, Fixed Film, 90.9KΩ	RNC50HXXXXFM	100mW	1mW	0.01	0.0020	217D
R3	Resistor, Fixed Film, 1KΩ	RNC50H1001FM	100mW	10mW	0.10	0.0023	217D
R4	Resistor, Fixed Film, 68.1KΩ	RNC50HXXXXFM	100mW	2mW	0.02	0.0021	217D
R5	Resistor, Fixed Film, 49.9KΩ	RNC50HXXXXFM	100mW	0mW	0.00	0.0020	217D
R6	Resistor, Fixed Film, 49.9KΩ	RNC50HXXXXFM	100mW	1mW	0.01	0.0020	217D
R7	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	65mW	0.65	0.0043	217D
R8	Resistor, Fixed Film, 1KΩ	RNC50H1001FM	100mW	1mW	0.01	0.0020	217D
R9	Resistor, Fixed Film, 1KΩ	RNC50H1001FM	100mW	0mW	0.00	0.0020	217D
R10	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0020	217D
T1	Transformer, Power	B316747	105°C	48°C		0.0203	217D
T2	Transformer	B314327	105°C	48°C		0.1081	217D
E1	Terminal (Qty. 17)	140-1385-02				0.0935	217D
PWB1	Printed Wiring Bd (2-sided)	TBD				0.0080	217D

TOTAL 0.521

TABLE 4-9C

THERMOELECTRIC CONTROLLER RELIABILITY DATA

P/N C314296, REV.

(GM @ 40°C)

Sheet 1 of 2

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
U1	IC, Linear, Switch, Voltage Regulator	UA78S40DM (883B)	125°C	62°C		0.3959	217D
CR1	Diode, Zener, 33V	1N5257/JANTX	500mW 200°C	0mW 58°C	0.00	0.0101	217D
CR2	DIODE, SI, Zener, Power, 33V	MIL-S-19500/434 (JANTX1N5610)	1.5KW 200°C	0KW 58°C	0.00	0.0067	217D
CR3	Diode, SI, Rectifier	MIL-S-19500/286 (JANTX1N4942)	200V 500mW 175°C	0V 0mW 58°C	0.00 0.00	0.0016	217D
CR4	Diode, SI, Rectifier	MIL-S-19500/286 (JANTX1N4942)	200V 500mW 175°C	0V 0mW 58°C	0.00 0.00	0.0016	217D
C1	Capacitor, Ceramic, 0.01µf	M39014/1C-1455	100V	5V	0.05	0.0061	217D
C2	Capacitor, Ceramic, 0.1µf	M39014/1C-1473	100V	23V	0.23	0.0113	217D
C3	Capacitor, Tantalum, 6.8µf	M39003/02-0180	50V	25V	0.50	0.1427	217D
C4	Capacitor, Ceramic, 22pf	CCR05CG220JM	100V	1V	0.01	0.0029	217D
C5	Capacitor, Ceramic, 0.01µf	M39014/1C-1455	100V	28V	0.28	0.0110	217D
C6	Capacitor, Tantalum, 5µf	M39006/03-1379	200V	0V	0.00	0.0179	217D
C7	Capacitor, Ceramic, 1µf	M39014/2E-1407	100V	0V	0.00	0.0101	217D
R1	Resistor, Fixed Film, 20K	RNC50HXXXXFM	100mW	2mW	0.02	0.0073	217D

TABLE 4-9C

THERMOELECTRIC CONTROLLER RELIABILITY DATA

P/N C314296, REV.

(GM = 40°C) Sheet 2 of 2

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
R2	Resistor, Fixed Film, 90.9KΩ	RNC50HXXXXFM	100mW	1mW	0.01	0.0073	217D
R3	Resistor, Fixed Film, 1KΩ	RNC50H1001FM	100mW	10mW	0.10	0.0081	217D
R4	Resistor, Fixed Film, 68.1KΩ	RNC50HXXXXFM	100mW	2mW	0.02	0.0073	217D
R5	Resistor, Fixed Film, 49.9KΩ	RNC50HXXXXFM	100mW	0mW	0.00	0.0073	217D
R6	Resistor, Fixed Film, 49.9KΩ	RNC50HXXXXFM	100mW	1mW	0.01	0.0073	217D
R7	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	65mW	0.65	0.0158	217D
R8	Resistor, Fixed Film, 1KΩ	RNC50H1001FM	100mW	1mW	0.01	0.0073	217D
R9	Resistor, Fixed Film, 1KΩ	RNC50H1001FM	100mW	0mW	0.00	0.0073	217D
R10	Resistor, Fixed Film, 10KΩ	RNC50H1002FM	100mW	0mW	0.00	0.0073	217D
T1	Transformer, Power	B316747	105°C	58°C		0.0494	217D
T2	Transformer	B314327	105°C	58°C		0.2637	217D
E1	Terminal (Qty. 17)	140-1385-02				0.3230	217D
PWB1	Printed Wiring Bd (2-sided)	TBD				0.0268	217D

TOTAL 1.363

TABLE 4-10A

PHYSICS PACKAGE AND MISCELLANEOUS PART RELIABILITY DATA

(AUT @ 2°C) Sheet 1 of 1

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
PP1	Physics Package Cells					0.6850	Note 1
PD1	Photodetector		150°C	75°C		0.1110	217D
H1	Heater, Lamp Oven					0.0950	Note 2
H2	Heater, Cavity Oven					0.0190	Note 2
TH1	Thermistor, Bead Type					1.2390	217D
TH2	Thermistor, Bead Type					1.2390	217D
L1	Coil, C-Field					0.4980	217D
TE	Thermoelectric Modules (4)					0.0000	Note 3
					TOTAL	3.886	

TABLE 4-10B

PHYSICS PACKAGE AND MISCELLANEOUS PART RELIABILITY DATA

(GF @ 30°C) Sheet 1 of 1

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
PP1	Physics Package Cells					0.6850	Note 1
PD1	Photodetector		150°C	75°C		0.0320	217D
H1	Heater, Lamp Oven					0.0950	Note 2
H2	Heater, Cabity Oven					0.0190	Note 2
TH1	Thermistor, Bead Type					0.1008	217D
TH2	Thermistor, Bead Type					0.1008	217D
L1	Coil, C-Field					0.0640	217D
TE	Thermoelectric Modules (4)					0.0000	Note 3
					TOTAL	1.097	

TABLE 4-10C

PHYSICS PACKAGE AND MISCELLANEOUS PART RELIABILITY DATA

(GM @ 40°C) Sheet 1 of 1

REF SYMBOL	PART DESCRIPTION	PART NUMBER	RATED STRESS	APPLIED STRESS	STRESS RATIO	FAILURE RATE	F.R. SOURCE
PP1	Physics Package Cells					0.6850	Note 1
PD1	Photodetector		150°C	75°C		0.1030	217D
H1	Heater, Lamp Oven					0.0950	Note 2
H2	Heater, Cavity Oven					0.0190	Note 2
TH1	Thermistor, Bead Type					0.5250	217D
TH2	Thermistor, Bead Type					0.5250	217D
L1	Coil, C-Field					0.2130	217D
TE	Thermoelectric Modules (4)					0.0000	Note 3
					TOTAL	2.165	

APPENDIX C

TRFS QUALIFICATION TEST PLAN

Qualification Test Plan
Tactical Rubidium Frequency Standard
(TRFS)

ELECTRONIC SYSTEMS DIVISION
HANSCOM AFB, MASSACHUSETTS 01731

DATE: 10 March 1986

TABLE OF CONTENTS

1.0 SCOPE

1.1 This document describes the qualification tests to be performed on the Tactical Rubidium Frequency Standard (TRFS). The purpose of these tests is to ensure that the TRFS meets the requirements of the Tactical Rubidium Frequency Standard Specifications.

2.0 APPLICABLE DOCUMENTS

The following documents of the exact issue shown form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.

2.1 Military Specifications and Standards

MIL-C-38999 H 27 February 1981	Connector, Electrical, Circular, Miniature.
MIL-C-39012 C 11 August 1982	Connector, Coaxial, Radio Frequency.
MIL-STD-810C 10 March 1975	Environmental Test Method
MIL-STD-45662 10 June 1980	Calibration System Requirement
Notice 1, 5 Jan 1983	
Notice 2 16 May 1984	
Notice 3 14 Dec 1984	
MIL-STD-461 B 1 April 1983	Electromagnetic Interference Characteristics, Requirements for Equipment.
MIL-STD-462 31 July 1967	Electromagentic Interference Characteristics, Measurement of.
Notice 1, 1 August 1968	
Notice 2, 1 May 1970	
MIL-E-5400 R 31 October 1975	Electronic Equipment Airborne, General Specification for.

MIL-STD-415 D 1 October 1969	Test Provisions for Electronic Systems and Associated Equipment, Design Criteria for.
Notice 1, 8 October 1971	
MIL-STD-454 F 15 March 1978	Standard General Electrical Equipment.
Notice 1, 1 September 1978	
Notice 2, 30 June 1979	
MIL-STD-704 A 9 August 1966	Platform Electric Power Characteristics.
Notice 1, 7 February 1968	
Notice 2, 5 May 1970	
Notice 3, 11 April 1973	
MIL-STD-1275 A (AT) 17 September 1976	Characteristics of 28 Vdc Electrical System in Military Vehicles.
MIL-STD-210 15 December 1973	Climatic Extremes for Military Equipment.

2.2 Non - Military Documents

Solid State Sciences Division Rome Air Development Center 10 December 1982	Specifications for Tactical Rubidium Frequency Standard
ARINC - 413	Transient Protection
Hazeltine Corp. 332819 Rev. E 18 June 85	Rubidium Frequency Standard Unit
CN59097 to Rev. E 8-26-85	

3.0 GENERAL REQUIREMENTS

a. Unless otherwise specified all tests are to be conducted under the standard operating conditions specified in Table 3-1.

b. All test data and pertinent information shall be recorded on Qualification Test Data Sheets. All Test Data Sheets will be signed and dated by the person conducting the test.

c. Whenever possible, electrical tests are to be made through connector savers, whose purpose is to minimize wear on the unit connectors.

d. The TRFS final assembly will have completed all inprocess manufacturing procedures, inspections, environmental stress screening, and Acceptance Test Procedures (ATP), prior to formal qualification testing.

e. All testing shall be conducted using test equipment and measuring instruments whose accuracy and/or calibration has been verified in accordance with MIL-STD-45662 and whose resolution is adequate for the required measurement.

f. Notification of testing shall be made to RADC 3 days prior to the start of each test. Failure notification to RADC within 24 hours of failure. Failure analysis shall be performed for each failure, and provide to RADC within 5 days. A qualification test log book shall be maintained throughout testing.

4.0 QUALIFICATION TEST SEQUENCE

The required Qualification Tests may be performed on one or two TRFS units. The sequence of environmental testing is optional, with the exceptions; that the Rain test must follow both Vibration tests and EMI testing must follow Environmental Testing.

Unit A	Unit B
Physical Inspection	Physical Inspection
Performance Tests	Performance Tests
Functional Tests	Functional Tests
Environmental Tests	Environmental Tests
Temperature/Altitude	Humidity
Temperature/Shock	Fungus (by analysis)
Random Vibration	Explosive/Atmosphere
Sinusoidal Vibration	Salt/Fog
Rain	Sand & Dust
Bench Handling Shock	Final Performance Tests
Operational Shock	
Acceleration	
Acoustic Noise	
EMI Tests	
Final Performance Tests	

TABLE 3-1

STANDARD OPERATING CONDITIONS

PARAMETER	CONDITION
Mounting	TRFS Baseplate attached to a suitable heat sink.
Ambient Air Temperature	$+25^{o}C \pm 5^{o}C$
Input Supply Voltage (Heater and Electronic)	$+25.0 \pm 0.5$ Vdc without ripple, transients or other perturbations.
Shock, Vibration & Noise	None deliberately applied.
Barometric Pressure	Normal room ambient.
Humidity	Normal room ambient.
Load Impedance on 10 MHz RF output	50 ohms $\pm 5\%$
Frequency Adjustment	The TRFS frequency shall be adjusted to 10 MHz ± 5pp 10^{11}nominal using its C-field Frequency adjustment.

5.0 PHYSICAL INSPECTION/REQUIREMENTS

Weight (3.2.2.2).

a. Weigh the unit under test.

b. The weight of the TRFS shall not exceed 3.0 pounds. Indicate compliance on Test Data Sheet.

Dimensions (3.2.2.1).

The TRFS shall not exceed the following dimensional parameters: size(inches) 3.25 H X 3.25W X 4.5L; k factor total length 0.97 inches (0.72" front and 0.25" rear). Indicate compliance on Test Data Sheets.

Plating and Sealing (3.3.1.10).

The unit shall be free of nicks, flaking and rust. Surface flatness of the FSU baseplates shall be 0.005 inches TIR or better. Surface finish shall be 32 microinches RMS or better. Indicate compliance on Test Data Sheets.

Connectors (3.2.2.3).

Connector pins shall be straight and free of solder or corrosion. Connectors shall be per MIL-C-38999 series I, shell size 11, insert arrangement 35. Coaxial connector type "TNC" shall be IAW MIL-C-39012.

Other Requirements (3.2.2.4)

Manufacturing marking shall be affixed to the exterior front panel of the TRFS.
Frequency adjustment control shall be accessable from the back of the TRFS.
Mounting holes shall be per Figure 2 of Hazeltine 332819.
Indicate compliance on Test Data Sheets.

6.0 PERFORMANCE TESTS

The purpose of the performance tests is to verify that the TRFS meets all the electrical performance requirements as specified in Hazeltine Document 332819.

Performance testing shall be performed prior to applications of any of the environmental tests specified in Paragraph 8 to the TRFS. Data obtained from these tests shall provide the criteria by which all further performance testing shall be judged.

After completion of all environmental and EMI testing, the TRFS shall be subjected to a final electrical performance test. This final test shall be a repeat of performance testing.

6.1 Harmonic/Nonharmonic Distortion (3.2.1.8).

Harmonics.

A. Connect the TRFS as shown in Figure 6-1, using a direct connection spectrum analyzer. Apply input voltage and allow 1 hour warmup.

B. Observe all harmonics on the spectrum analyzer. Harmonic distortion shall be down greater than 30 dB from the carrier.

C. Record all out of spec readings on the test data sheet.

Nonharmonic/Spurious.

A. Connect the TRFS as shown in Figure 6-1, using a 10 MHZ reject filter, if required, in series with the spectrum analyzer. Apply input voltage and allow 1 hour warmup.

B. Observe all spurious and nonharmonic outputs on the spectrum analyzer. These outputs shall be down by 60 dB or greater.

C. Record all out of spec readings on the test data sheet.

6.2 Frequency Stability Vs. Input Voltage (3.2.1.6).

A. Connect the TRFS to an appropriate test setup. Apply input voltage and allow 1 hour warmup.

B. Sequentially set the input voltage to the following values while observing the chart recording of the frequency shift ($\Delta f/f$) at each input voltage setting.

Input Voltage Setting

Electronics Input	Heater Input
22 Vdc	22 Vdc
26 Vdc	28 Vdc
23.4 Vdc	28 Vdc
28.6 Vdc	28 Vdc
32 Vdc	29 Vdc

C. The frequency shift for electronic input voltage setting from 23.4 Vdc to 28.6 Vdc shall be less than 1 pp 10^{11}, for electronic input voltage of 22 Vdc and 32 Vdc frequency shift shall be less than 5 pp 10^{11}. Record readings on test data sheet.

D. With the input voltages set to 26 Vdc, drop the heater input voltage to 0 Vdc for 10 seconds. Observe and record the frequency prior to the voltage dropout and after 10 seconds of voltage dropout. The frequency variation shall be less than 1×10^{-8}.

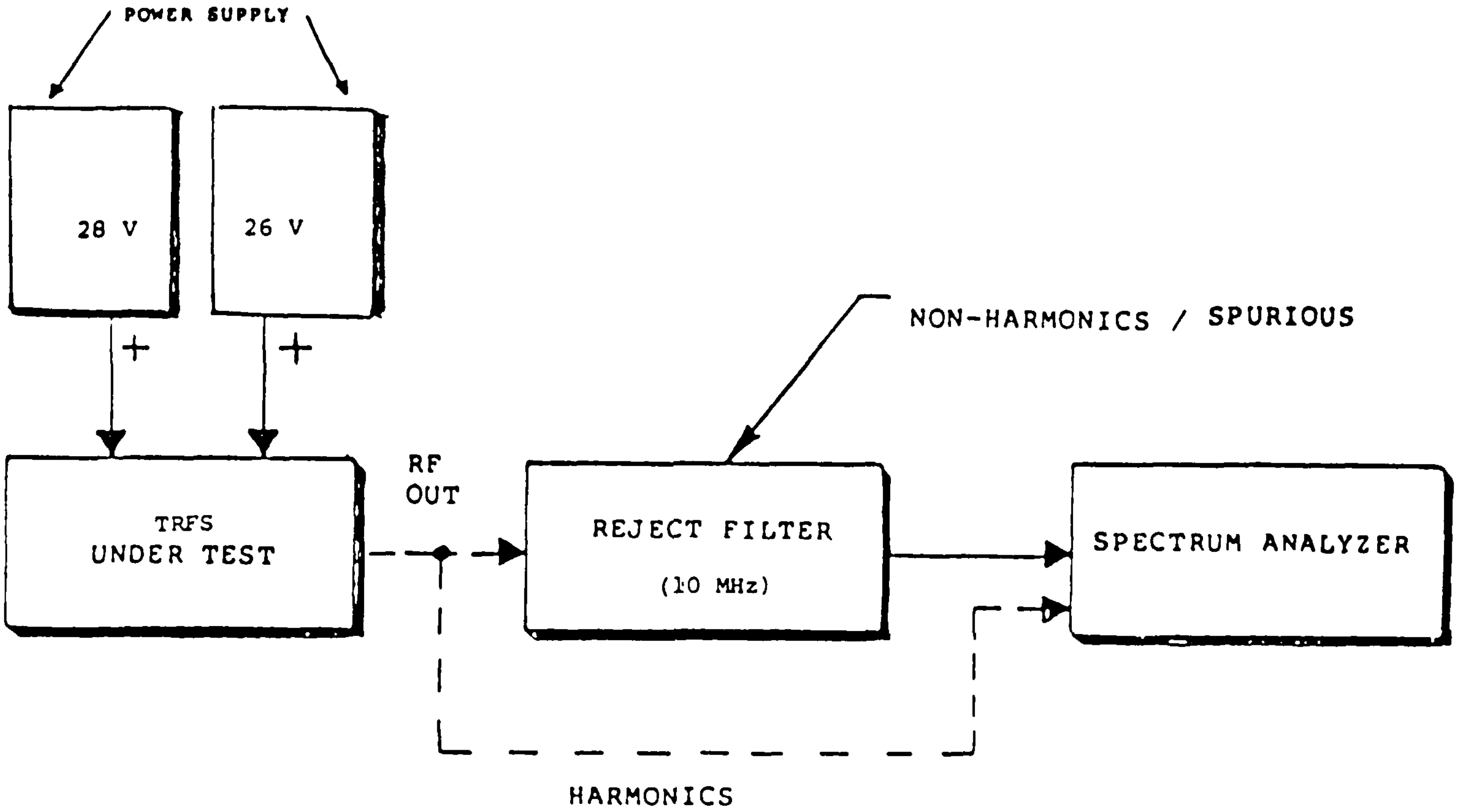


Figure 6-1 HARMONIC AND SPURIOUS TEST SETUP

6.3 Frequency Adjustability (3.2.1.3).

A. Connect the TRFS to an appropriate test setup. Apply input voltage and allow 1 hour warmup.

B. Vary the mechanical frequency adjust, observe and record the output frequency. Insure that the output frequency is capable of being adjusted over the range of 3 pp 10^9. Record the minimum and maximum limits of adjustment on the test data sheet.

C. Insure that the output frequency is capable of being set to a resolution of 2 pp 10^{11}. Record data on test data sheet.

D. Reset the output frequency to 10 MHz and record the frequency value.

6.4 Frequency Stability Vs. Orientation (3.2.2.5).

A. Connect the TRFS to an appropriate test setup. Apply input voltage and allow 1 hour warmup.

B. Measure the output frequency (F_O) while the TRFS is mounted in its normal orientation. Record on data sheet.

C. Sequentially place the TRFS in the 5 remaining orientations (left side down, top side down, right side down, back side down, front side down).

D. Observe and record the frequency shift ($\Delta f/f$) at each position after 5 minutes stabilization time and record on data sheet.

E. The frequency shift at each position shall not be greater than 5 parts in 10^{11} relative to the output frequency (F_O) reading recorded in step B.

6.5 Frequency Stability Vs. DC Magnetic Field (3.2.1.9).

A. Setup a uniform magnetic field of 2 Gauss DC minimum.

B. Connect the TRFS to an appropriate test setup. Apply input voltage and allow 1 hour warmup.

C. Mount the TRFS within the field with its X-axis in the direction of the field. Observe & record the frequency on the chart recorder.

D. Reverse the magnetic field and observe the frequency change ($\Delta f/f$).

E. Repeat parts C and D with the Y-axis and Z-axis in the magnetic field direction.

F. The frequency shift at each reversal of magnetic field exposure shall not be greater than 2 pp 10^{11}/Gauss. Record data for each case.

6.6 Frequency Retrace (3.2.1.5)

A. Connect the TRFS to an appropriate test setup. Apply input voltage and allow 1 hour warmup.

B. Measure the output frequency (F_O) of the TRFS and record on test data sheet.

C. Remove all power from the TRFS for at least eight hours.

D. At the end of step C, apply power to the TRFS. Allow one hour for warmup and remeasure the output frequency. Record reading on test data sheet.

E. Repeat steps C and D two additional times.

F. The total retrace error shall be less than 5 pp 10^{11} from the initial measurement.

6.7 Built-In-Test (BIT) (3.2.1.16)

A. Connect the TRFS to an appropriate test setup.

B. With the TRFS in an unpowered state connect pin 1 of connector J2 through a current limiting 1.5 Kohm resistor to a 30 Vdc power source. With the unit deenergized the leakage current shall be less than 100 microamps.

C. Energize the unit and allow 1.5 minutes warmup, the voltage drop to ground from Pin 1 shall not exceed 1 volt to indicate a "go" condition.

6.8 Crystal Control Voltage Test (3.2.1.17)

A. Connect the TRFS to an appropriate test setup.

B. Connect a digital voltmeter across pin 2 on connector J2 and ground.

C. Measure the output voltage indicated at pin 2 and record on test data sheet.

D. The voltage indicated shall be 7.5 +/-2VDC.

6.9 Short Circuit Protection (3.2.1.15)

A. Connect the TRFS to an appropriate test setup.

B. Measure and record the 10 MHz output frequency and amplitude at J1 output port, using an RF voltmeter. Output amplitude shall be 0.5 Vrms. Required limits: 0.650 Vrms max., 0.450 Vrms min. Frequency shall be 10 MHz ± 5 pp 10^{11}.

C. Short circuit the output at J1 to ground.

D. Remove the ground and repeat step (B). Record reading on test data sheet.

E. With the TRFS energized, sequentially ground each output pin of the J2 connector for at least 30 seconds.

F. Measure frequency and voltage output at the J1 connector. Frequency variation shall be less than 5 pp 10^{11}.

6.10 Short Term Stability (3.2.1.5 of Solid State Sciences Division, Specifications for TRFS)

The short-term stability test setup is to determine the Allan Variance.

A minimum of 3 1/2 hours of data (at least 100 samples for each averaging time) shall be collected for the Allan Variance computation. A plotted graph will be attached to the data sheets.

Averaging Time	Required
1.0 second	4×10^{-11}
10.0 seconds	1.265×10^{-11}
100.0 seconds	4×10^{-12}

6.11 Output Impedance (3.2.1.1)

A. Connect the TRFS to an appropriate test setup.

B. Apply input power to the TRFS. Measure and record output impedance at the J1 connector.

6.12 Warmup and Power Consumption (3.2.1.10),(3.2.1.11),(3.2.1.12)

A. Connect the TRFS to an appropriate test setup. Turn off unit power for a minimum of 30 minutes.

B. Apply input voltages to the TRFS and immediately measure and record the peak input currents, input voltages (both the 28V and 26V) and output frequency. Calculate input power from the input current and voltage readings (P = EI).

C. Requirements are as follows:

Input Power	Requirement
Peak during warm-up for heaters and electronics	<110 watts (for 2 minutes maximum)
Steady State Maximum solid state heater and electronics	<17 watts

Output Frequency

Within	Required Accuracy
2 minutes	1×10^{-9}
2.5 minutes	5×10^{-10}

D. Measure and record the time to lock-on. Time to lock-on is $\leq$ 90 seconds at ambient temperature (25°C). Increase the time to lock by 1sec/°C for lower temperatures.

6.13 Signal to Noise Test (3.2.1.7)

A. Connect the TRFS to an appropriate test setup.

B. Measure the phase noise at 1Hz from the carrier. Record reading on the test data sheet.

C. Measure the phase noise at 100 Hz from the carrier. Record reading on the test sheet.

D. Measure the phase noise at 1k Hz from the carrier. Record reading on the test data sheet. Attach plot of the output phase noise to test data sheet.

E. The phase noise limits are specified below:

Offset From 10MHz	Signal/Noise Ratio-Required dBC Hz
1 Hz	> 60 dB
100 Hz	> 80 dB
1K Hz	> 95 dB

7.0 FUNCTIONAL TEST

The purpose of the functional test is to verify that the TRFS is operating normally before and after exposure to each of the environmental tests described in this document.

A functional test conducted after the completion of one environmental exposure may be used as the pretest for the next environmental exposure.

7.1 Output Level and Frequency (3.2.1.1) (3.2.1.2)

A. After stabilization measure and record the output frequency and amplitude.

B. The output frequency shall be 10 MHz and the fractional frequency offset be no greater than 5×10^{-11}.

C. The output amplitude, as measured with the RF voltmeter shall be 0.5 Vrms into a 50 ohm load. Required limits: 0.650 Vrms max., 0.450 Vrms min.

D. Total input power should not exceed 17 watts.

E. Measure VCXO control voltage. Acceptable voltage range shall be 3-12 Vdc.

8.0 ENVIRONMENTAL TESTS

Output voltage throughout all environmental tests shall remain between .45Vrms and .65Vrms.

8.1 Temperature/Altitude Test (3.2.1.13), (3.2.1.14), (3.2.5.1.5),(3.2.5.1.1),(3.2.5.1.3)

Pre-Temperature Altitude Functional Test

Prior to commencing the temperature altitude environmental test, the TRFS shall be subjected to the test detailed in paragraph 7.0

Test Procedures

Perform test in accordance with MIL-STD-810 Test Method 504.1, Procedure I.

A. Install the the TRFS on heatsink, install the unit in the test chamber in a way that allows circulating air to flow over the heatsink only. Route all functional cables from the test unit to the test console, and all thermocouple leads from the chamber via the chamber port. Connect all required cables and leads and seal port.

B. Attach thermocouples at following locations to monitor temperature stabilization periods during test: Thermocouple No. 1 at test unit base plate, Thermocouple No. 2 at chamber air.

Temperature stabilization will have been attained when the temperature of the baseplate does not change more than 2°C per hour.

Thermocouple reading intervals shall be 15 minutes during the power on periods of this step and one hour during stabilization periods.

C. With the test unit deenergized, adjust the chamber temperature to -62°C and allow the unit to stabilize. Maintain this condition for a period of two hours minimum. The thermocouple reading interval shall be 30 minutes during this step. During the test, observe the test unit through the chamber window to determine, to the extent possible, any damage or deterioration.

D. With the test unit deenergized, adjust the chamber temperature to -54°C and allow the unit to stabilize. After stabilization and with the chamber maintained at -54°C, energize the test unit using an input voltage of 22+/-.1Vdc. Perform an output frequency check and ensure that the time necessary to achieve frequency offset of less than 5×10^{-10} is less than four minutes. Measure peak input power and output amplitude of the 10MHz signal and VXCO voltage.

Input Power	Requirement
Peak during warm-up for heaters and electronics	<110 watts (for 2 minutes maximum)
Steady State Maximum solid state heater and electronics	<23 watts

Output Frequency

Within	Required Accuracy
2 minutes	1×10^{-9}
4 minutes	5×10^{-10}

Record data on test data sheet. Frequency offset after one hour shall be less than 3×10^{-10}. Deenergize the test unit and restabilize it at -54°C. This operational sequence shall be repeated two additional times. Subsequent frequency reading for the last two cycles shall deviate less than 5×10^{-11} from the first reading.

E. With the test unit deenergized, adjust chamber temperature to -54°C and allow the unit to stabilize. After stabilization, energize the test unit using the input voltage of 32+/-.1Vdc allow 1/2 hour warmup time, measure and record output frequency and voltage. Adjust the chamber pressure to simulate an altitude of 70,000 feet.

F. Upon reaching the specified chamber pressure (70,000 feet) and while maintaining the chamber temperature, measure and record the test unit output frequency and voltage. Frequency variation shall be less than 1×10^{-13}/mbar (1 pp 10^{10}). Adjust chamber pressure to ambient condition. Thermocouple reading intervals shall be every 15 minutes during the power on period of this test and 30 minutes during stabilization periods.

G. With the test unit deenergized, adjust the chamber temperature to -10°C and allow the unit to stabilize. Open the chamber door and allow frost to form on the test unit. If no frost forms, artificially increase the chamber humidity until it does. Leave the door open until the frost melts then close the door before the moisture evaporates.

After closing the chamber door, energize the test unit using an input voltage of 32+/-.1Vdc. Allow the TRFS to operate for a period of five minutes then turn off power for five minutes. Repeat the five minute on/off procedure two additional times to confirm that no malfunction was caused by formation of the moisture. Thermocouple reading intervals shall be 15 minutes from the time the chamber door is first open until this test step is completed. Perform a Functional Test as specified in paragraph 7.0.

H. With power to the test unit off, allow the test chamber to return to standard ambient conditions. Allow the test unit to stabilize for one hour. Perform test specified in paragraph 7.0.

I. With the test unit deenergized adjust the chamber temperature to +95°C and allow the unit to stabilize. Maintain this condition for a period of 16 hours minimum. The thermocouple reading interval shall be 30 minutes during this step. During the test, observe the test unit through the chamber window to determine, to the extent possible, any damage or deterioration.

J. With the test unit deenergized, adjust the chamber temperature to 71°C and allow the unit to stabilize. With the chamber temperature maintained at 71°C, energize the TRFS using an input voltage of 32 Vdc and maintain for a period of four hours. Monitor baseplate temperature and raise chamber temperature to ensure that baseplate temperature equals 71°C plus .45°C per watt of power consumption. At no time shall chamber temperature fall below 71°C. Thermocouple reading intervals shall be every 30 minutes during this step. At the end of the four hour period, measure and record output frequency. Frequency offset shall be less than 3×10^{-10}.

K. With the test unit deenergized, adjust the chamber temperature to 36°C and allow the test unit to stabilize. After stabilization, energize the unit using an input voltage of 32Vdc and allow to stabilize. With the unit operating, reduce the chamber pressure to simulate an altitude of 50,000 feet. Maintain these conditions for a period of four hours. At the end of the four hour period measure and record output frequency and voltage. Frequency variation shall be less than 1×10^{-13}/mbar (8.5×10^{-11}). Then increase chamber pressure to the ambient level. Thermocouple reading intervals shall be 30 minutes during the power on period of this test step and one hour during the stabilization period.

L. With the TRFS deenergized, adjust the chamber temperature to 60°C and allow the test unit to stabilize. After stabilization energize the unit using an input voltage of 32 Vdc. With the unit operating, reduce the chamber pressure to simulate an altitude of 50,000 feet and maintain for a total energized time of 30 minutes, then turn off for 15 minutes.

Repeat the 30 minute on/15 minute off sequence three additional times. thermocouple reading intervals shall be 15 minutes during this test step. Printouts shall be set to occur at power on, mid sequence, and power off. During each operating time period, measure and record output frequency. Frequency offset shall be less than 1 X 10^{-13}/mbar (8.5 x 10^{-11}).

M. With the TRFS deenergized, adjust the chamber temperature to 10°C and allow the test unit to stabilize. After stabilization, energize the unit using an input voltage of 32Vdc. With the unit operating, reduce the chamber pressure to simulate an altitude of 70,000 feet. Maintain these conditions for a period of four hours. At the end of the four hour period measure and record output frequency and voltage. Frequency variation shall be less than 1 X 10^{-13}/m bar (1 x 10^{-10}). Increase chamber pressure to ambient level. Thermocouple reading intervals shall be 15 minutes during the power on period of this test and 30 minutes during the stabilization period.

N. With the TRFS deenergized, adjust the chamber temperature to 35°C and allow the test unit to stabilize. After stabilization, energize the unit using an input voltage of 32 Vdc. With the unit operating, reduce the chamber pressure to simulate an altitude of 70,000 feet and maintain in this mode for a total energized time of 30 minutes, then turn off for 15 minutes. Repeat the 30 minute on, 15 minute off sequence three additional times, then increase the chamber pressure to the ambient level. Thermocouple reading intervals shall be every 10 minutes during this test step.

Printouts shall be set to occur at power on, mid sequence, and power off.

During each operating time period measure and record the frequency output and voltage. Frequency offset shall be less than 1 X 10^{-13}/m bar (1 x 10^{-10}).

O. Adjust chamber test conditions to standard ambient. After the test unit has stabilized, visually inspect the unit for signs of damage and perform the tests detailed in paragraph 7.0.

8.2 Temperature/Shock Test (3.2.5.1.3),(3.2.1.13),(3.2.5.1.4)

Pretemperature/Shock Functional Test

Prior to commencing the temperature shock test, the TRFS shall be subjected to the test detailed in paragraph 7.0.

Test Procedure.

Perform test in accordance with MIL-STD-810, Test Method 503.1, Procedure I.

A. Place the TRFS into the test chamber in its normal mountin. position. The test unit shall be in a deenergized mode during this test.

B. Raise the internal chamber temperature to 71°C and maintain this condition for a period of 4 hours or more.

C. At the conclusion of this time period, transfer the unit, within five minutes, to a cold chamber with an internal chamber temperature of -57°C. Maintain for a period of four hours or more.

D. At the conclusion of this time period, transfer the unit, within five minutes, to a hot chamber with an internal chamber temperature of 71°C. Maintain for a period of four hours or more.

E. Repeat steps C and D.

F. Repeat step C.

G. Return the unit to room ambient temperature until stabilized.

H. Inspect the unit for damage. Conduct the Functional Test detailed in Paragraph 7.0.

I. With the TRFS mounted in the test chamber raise the temperature to 71°C and allow the unit to stabilize. Apply input voltage and allow one hour warmup time.

J. Decrease the ambient temperature at a rate of between 2°C and 3°C per minute to -55°C maintain chamber temperature for 30 minutes. Monitor and record baseplate temperature, transient chamber temperature, and frequency offset continuously. Frequency variation shall be less than 3 parts in 10^{10}.

K. Increase ambient chamber temperature to 71°C at a rate of between 2°C and 3°C per minute. Maintain chamber temperature for 30 minutes. Monitor and record baseplate temperature, transient chamber temperature, and frequency offset continuously. Frequency variation shall be less than 3 parts in 10^{10}.

L. Repeat step J.

M. Repeat step K.

N. Repeat steps J.

O. Repeat steps K.

8.3 Random Vibration Test (3.2.5.3.1)

Prerandom Vibration Functional Test

Prior to commencing the random vibration test, the TRFS shall be subjected to the test detailed in Paragraph 7.0

Test Procedure

Perform test in accordance with MIL-STD-810, Test Method 514.2, Procedure IA. Two test levels are required, a perfromance level and an endurance level.

Performance Level Vibration

A. Install the test unit on the vibration fixture and mount the fixture on the vibration table. Vibration shall be applied along each of the three orthogonal axes of the unit while it is in the energized mode.

See Figure 8-1 for axis designation.

B. Energize the test unit and allow 5 minutes for stabilization.

C. Subject the test unit to the random vibration levels as shown in Tables 8-1 and 8-2. Random vibration test time shall be 30 minutes per axis. During the first twenty minutes measure phase noise over the range of 1 Hz to 1 KHz from the carrier. For the last 5 minutes monitor output frequency and voltage.

D. During the vibration exposure along each axis, output frequency error shall be less than 5 x 10^{-10}. Phase noise limits are as specified in paragraph 6.13. Plot results.

E. At the completion of each axis vibration exposure, examine the test unit for damage.

F. Prior to conducting the endurance level vibration, perform the test detailed in Paragraph 7.0.

Endurance Level Vibration

A. Install the test unit on the vibration test fixture and mount the fixture on the vibration table. Vibration shall be applied along each of the three orthogonal axes of the unit while it is in a deenergized mode.

See figure 8-1 for axis designation.

B. Subject the test unit to the random vibration levels as shoen in Tables 8-3 and 8-4. The endurance level test time shall be two hours per axis.

C. At the completion of the two hour endurance vibration exposure along each axis, inspect the test unit for damage and perform the test detailed in Paragraph 7.0.

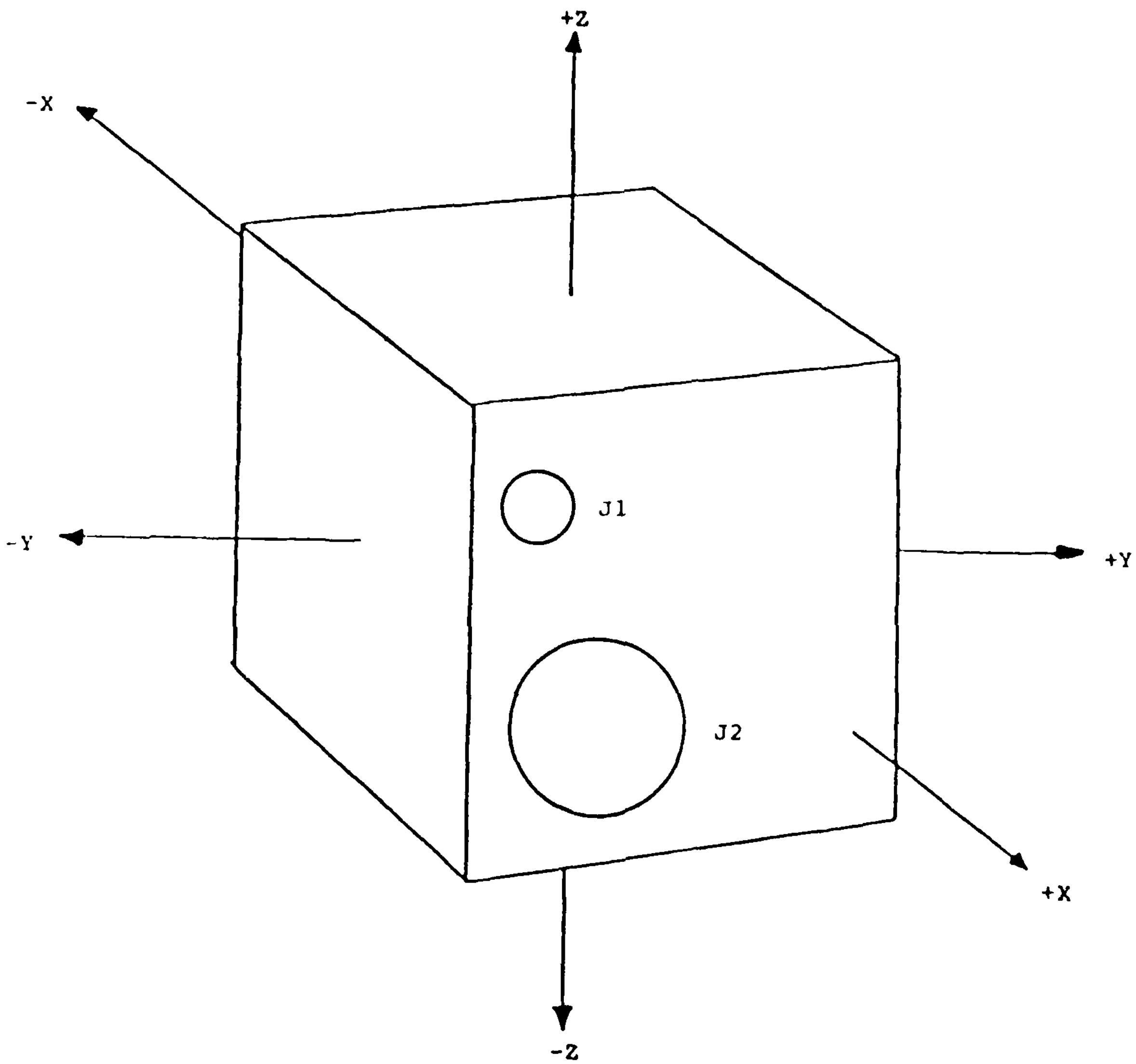


FIGURE 8-1 AXES DESIGNATION

TABLE 8-1. RANDOM PERFORMANCE LEVEL - Z AXIS

Hz	G^2/Hz
15 - 20	0.086
20 - 30	0.332
30 - 40	0.564
40 - 50	0.226
50 - 60	0.037
60 - 70	0.0123
70 - 300	0.01
300 -2000	0.005

NOTE: If unable to test with 0.005 g^2 /Hz then test with 0.01 g^2 /Hz.

TABLE 8-2. RANDOM PERFORMANCE LEVEL VIBRATION - X & Y AXES

Hz	G^2 /Hz
15 - 20	0.223
20 - 30	0.462
30 - 40	0.138
40 - 50	0.133
50 - 60	0.170
60 - 70	0.175
70 - 80	0.136
80 - 90	0.089
90 -100	0.059
100 -110	0.041
110 -120	0.030
120 -130	0.023
130 -140	0.019
140 -150	0.016
150 -160	0.014
160 -170	0.012
170 -180	0.011
180 -300	0.01
300 -2000	0.005

TABLE 8-3. RANDOM ENDURANCE LEVEL VIBRATION - Z AXIS

Hz	G^2/Hz
15 - 20	0.0857
20 - 30	0.332
30 - 40	0.564
40 - 50	0.226
50 - 60	0.037
60 - 70	0.013
70 - 2000	0.01

8.4 Sinusoidal Vibration Test (3.2.5.3.2a) (3.2.5.3.2b)

Pre-Sinusoidal Vibration Functional Test

Prior to commencing the sinusoidal vibration test, the TRFS shall be subjected to the test detailed in Paragraph 7.0.

Test Procedure.

A. Install the test unit on the vibration test fixture and mount the fixture on the vibration table. Vibration shall be applied along each of the three orthogonal axes of the unit while it is in the energized mode.

See Figure 8-1 for axis designation.

B. Energize the test unit using input voltage of +28Vdc and 26 Vdc (conditioned).

C. During the vibration exposure along each axis, output frequency error shall be less than 1 X 10^{-9}. For frequencies scanned below 20 Hz a gate time of 1 second is used. For frequencies scanned above 20 Hz a gate time of 0.1 second is used. Monitor output frequency and voltage continuously throughout one cycle of the vibration exposure. Measure nonharmonic distortion at the vibration frequencies throughout another cycle.

Record results on data sheet. At the completion of each axis vibration exposure, examine the test unit for damage.

D. Test in accordance with MIL-STD 810, Test Method 514.2, Prodcedure VIII, curve W. Subject the test unit to the sinusoidal performance vibration levels as shown in Table 8-5. Frequency cycling shall be from 5 Hz to 500 Hz to 5 Hz in 15 minutes. Frequency cycling shall be 3 hours per axis. Monitor output frequency continuously throughout the vibration exposure.

E. Test in accordance with MIL-STD 810, method 514.2, Procedure I. Subject the three orthogonal axes of the test unit to the sinusoidal performance vibration cycling and resonant dwells as shown in Tables 8-6 , 8-7 and 8-8. Frequency cycling shall be from 5-2000-5 Hz in 20 minutes. Frequency cycling shall be 60 minutes per axis, and resonant dwells shall be 10 minutes at each of the specified frequencies.

8.5 Bench Handling Shock Test (3.2.5.2.1)

Pre-Bench Handling Shock Functional Test.

Prior to commencing the bench handling shock test, the TRFS shall be subjected to the test detailed in Paragraph 7.0.

TABLE 8-4. RANDOM ENDURANCE LEVEL VIBRATION - X & Y AXES

Hz	G^2 / Hz
15 - 20	0.223
20 - 30	0.465
30 - 40	0.137
40 - 50	0.088
50 - 60	0.133
60 - 70	0.185
70 - 80	0.171
80 - 90	0.119
90 -100	0.078
100 -110	0.054
110 -120	0.040
120 -130	0.032
130 -140	0.026
140 -150	0.022
150 -160	0.019
160 -170	0.016
170 -180	0.014
180 -190	0.013
190 -200	0.012
200 -2000	0.01

TABLE 8-5. SINUSOIDAL PERFORMANCE LEVEL VIBRATION - X, Y, & Z AXES

Hz	Input
5.0 - 5.5	1.0 inch double amplitude
5.5 - 30	± 1.5 g peak
30 - 30	0.033 inches double amplitude
50 - 500	4.2 g peak

TABLE 8-6. SINUSOIDAL VIBRATION DWELL - X, Y, & Z AXES

Z Axis		X and Y Axes	
Hz	Input Level	Hz	Input Level
35	14.25 g peak	25	6.5 g peak
52	4.75 g peak	35	6.0 g peak
70	2.0 g peak	50	10.0 g peak
105	1.0 g peak	62	10.5 g peak

TABLE 8-7. SINUSOIDAL PERFORMANCE LEVEL VIBRATION - Z AXIS

Hz	g Peak
5 - 10	1
10 - 20	1.5
20 -22.5	2.5
22.5 - 25	3.75
25 -27.5	5.5
27.5 - 30	8.0
30 -32.5	11.5
32.5 -37.5	14.25
37.5 - 40	13.5
40 -42.5	12
42.5 - 45	9
45 -47.5	7
47.5 - 50	5.5
50 -52.5	4.75
52.5 - 55	4.0
55 - 60	3.5
60 - 65	2.75
65 - 70	2.25
70 - 80	2.0
80 - 90	1.5
90 - 100	1.0
100 - 150	1.0
150 - 500	0.5
500 -2000	0.25

TABLE 8-8. SINUSOIDAL PERFORMANCE LEVEL VIBRATION - X & Y AXES

Hz	g Peak
5 - 10	1
10 - 20	2.5
20 - 22.5	5
22.5 - 27.5	6.5
27.5 - 30	6.0
30 - 35	5.0
35 - 37.5	6.0
37.5 - 40	7.5
40 - 45	8.25
45 - 50	9.0
50 - 55	10.0
55 - 60	10.5
60 - 65	10.5
65 - 70	10.5
70 - 75	9.5
75 - 80	8.0
80 - 85	7.0
85 - 90	6.0
90 - 95	5.5
95 - 100	4.5
100 - 125	4.0
125 - 150	2.5
150 - 400	2.0
400 - 1000	1.0
1000 - 2000	0.5

Test Procedure

Perform test in accordance with MIL-STD-810, Test Method 516.2, Procedure V.

A. Remove the test unit from its enclosure, as if it was being prepared for servicing, and place it on a solid wooden bench top at least 1 5/8 inches thick. The TRFS shall be in a nonoperating mode during test.

B. To simulate shocks liable to occur during service, use one edge of the test unit chassis as a pivot and lift the opposite edge of the chassis until one of the following conditions occurs (whichever occurs first):

  o The chassis forms an angle of 45 degrees with the horizontal bench top.

  o The lifted edge of the chassis has been raised 4 inches above the horizontal bench top.

  o The lifted edge of the chassis is just below the point of perfect balance.

C. Let the chassis drop back freely to the horizontal bench top. Repeat, using other practical edges for the same horizontal face as pivots points, for a total of four drops.

D. Repeat steps (B) and (C) with the test unit resting on other faces until it has been dropped for a total of four times on each face.

E. At the conclusion of tests, examine the test unit for any damage that may have occurred during the test.

8.6 Operational Shock Test (3.2.5.2.2).

Pre-Operational Shock Functional Test

Prior to commencing the operational shock test, the TRFS shall be subjected to the test detailed in Paragraph 7.0.

Test Procedure

Perform test in accordance with MIL-STD-810, Test Method 516.2, Procedure I.

A. Rigidly attach the test unit to the shock machine table by a test fixture. The test unit shall be in an operating mode during the shock exposure.

B. Subject the unit to three half-sinusoidal shocks, of 20 g (+/- 15%) amplitude and 11ms nominal duration, applied in each direction along three mutually perpendicular axes (total of 18 shocks). Record the time keeping performance of the TRFS before, during and after each shock.

C. At the conclusion of test, examine the test unit for any damage that may have been induced by the shock exposure.

8.7 Acceleration Test (3.2.5.2.3)

Pre-Acceleration Functional Test

Prior to commencing the acceleration test, the TRFS shall be subjected to the test detailed in Paragraph 7.0.

Test Procedure

Perform test in accordance with MIL-STD-810, Test Method 513.2, Procedure II (10 g level).

A. Mount the test unit on a centrifuge using its normal mounting means and oriented in the direction of forward acceleration.

B. The location of the test unit (with reference to the g level established) shall be determined by a measurement from the rotational center of the centrifuge to the geometric center of the test item. Should any point of the test unit nearest the center of the centrifuge experience less than 90 percent of the specified g level, the test item shall be moved outward on a radius of the centrifuge or the speed of rotation shall be increased until not less than 90 percent of the specified g level is obtained. The test unit shall be oriented as follows:

Fore: Front or forward end of the unit shall face toward center of centrifuge.

Aft: Reverse unit 180 degrees from the fore position.

Up: Top of unit shall face toward center of centrifuge.

Down: Reverse unit 180 degrees from the position.

Lateral: Each side (right, left) in turn face toward center of centrifuge.

C. During all of the acceleration tests monitor output frequency and voltage. Frequency error during acceleration force shall be less than 4×10^{-11}.

D. The operating test unit shall be subjected to 10 g acceleration along three mutually perpendicular axes in two opposite directions along each axis. The test duration in each direction shall be 1 minute following centrifuge stabilization. The unit shall be observed for any damage that may have been induced by the acceleration environment during each axis change.

8.8 **Acoustic Noise Test (3.2.5.4).**

Pre-Acoustic Noise Functional Test.

Prior to commencing the acoustic noise test, the TRFS shall be subjected to the test detailed in Paragraph 7.0.

Test Procedure

Perform test in accordance with MIL-STD-810, Test Method 515.2, Procedure I, Category A.

A. The sound pressure profile specified in Figure 8-2, shall be introduced into the test chamber. The average sound pressure distribution (overall level) shall be uniform within -2 to +4 dB of the desired value. The sound pressure field shall be measured without the test unit mounted in the test chamber. Measurements shall be made by using a microphone (more than one if desired) to define the sound field within the test volume (control 10 percent of the chamber volume).

B. Suspend the test unit in the center of the test chamber by means of springs or elastic cord. The natural frequency of suspension shall be less than 25 Hz. Care must be exercised to insure that no spurious acoustic or vibratory inputs are introduced by the suspension mounting structure. If the test chamber is rectangular, the surfaces of the test unit must not be parallel to the chamber walls.

C. Mount three microphones in the chamber, each located in proximity to a major dissimilar test unit surface. Each is to be 18 inches or more from the test unit or 1/2 the distance to the nearest wall, whichever is less. The average overall sound pressure distribution around the test unit shall be measured and be uniform within -2 to +4 dB of the desired value.

D. During the following test, the unit will be operational. Frequency offset and phase noise are to be recorded throughout the test. During the first twenty minutes measure phase noise over the range of 1 Hz to 1 KHz from the carrier. For the last 5 minutes monitor output frequency and voltage. Allow the unit to stabilize, then record the frequency offset before the acoustic test on the data sheet.

E. Monitor the three microphones and subject the unit to the overall sound pressure level of 140 dB conforming to the octave band spectrum of Figure 8-2 for a period of 30 minutes or more. The average overall sound pressure distribution around the test unit shall be measured to be uniform within -2 to +4 dB of the specified value.

F. Record the frequency offset during and after the test on the data sheet. The difference between the offset before and the offset during the test shall be less than 5×10^{-10}. Phase noise limits are the same as specified in paragraph 6.13.

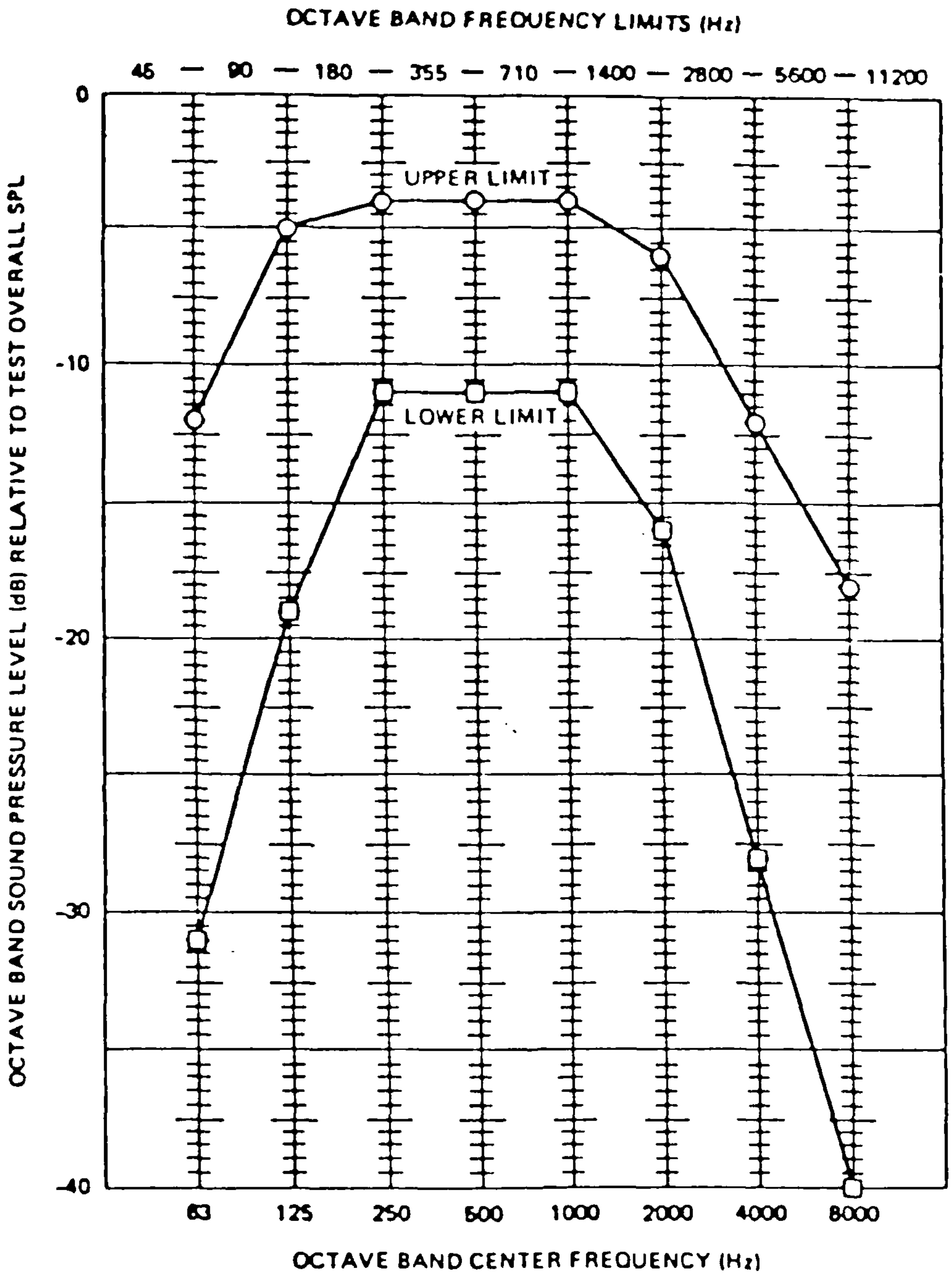


FIGURE 8-2

OCTAVE BAND SPECTRUM FOR THE ACCOUSTIAL NOISE TEST

G. At the conclusion of the acoustic noise test, examine the TRFS for damage.

8.9 Humidity Test (3.2.5.5).

Pre-Humidity Functional Test.

Prior to commencement of the humidity test, the TRFS shall be subjected to the test detailed in Paragraph 7.0.

Test Procedure.

Perform test in accordance with MIL-STD-810, Test Method 507.1, Procedure II. Tests and measurements called out in MIL-STD 810 shall consist of the functional test defined in paragraph 7. Operation of the test unit shall be at the end of each 48 hour cycle.

8.10 Fungus Test (3.2.5.7).

Fungus test shall be conducted by analysis or in accordance with MIL-STD 810C, Paragraphs 3.1.1 and 3.1.2 respectivley.

8.11 Explosive Atmosphere Test (3.2.5.8).

Pre-Explosive Atmosphere Functional Test.

Prior to commencing the explosive atmosphere test, the TRFS shall be subjected to the test detailed in Paragraph 7.0.

Test Performance.

Perform test in accordance with MIL-STD-810, Test Method 511.1, Procedure I.

A. The test is to be conducted at each of the following simulated altitudes:

Sea Level; 5,000 ft; 10,000 ft; 15,000 ft; 20,000 ft; 30,000 ft; 40,000 ft; 50,000 ft above sea level.

B. Install the TRFS in the chamber in such a manner that normal electrical operation is possible through the pressure seals from the exterior of the chamber.

C. Remove or loosen the test unit cover to facilitate the penetration of the explosive mixture.

D. Seal the test chamber and raise the temperature within to 71 +/- 3°C.

E. The internal test chamber pressure shall be reduced sufficiently to simulate an altitude approximately 10,000 feet above the desired test altitude. The weight of fuel necessary to produce an air-vapor ratio of 13 to 1 at the desired test altitude shall be admitted to the chamber. A time of 2 to 4 minutes shall be allowed for introduction and vaporization of the fuel. Air shall be admitted into the chamber until a simulated altitude of 5,000 feet above the test altitude is attained.

F. Apply 26 +/- 1.3 Vdc power to the unit and allow five minutes warmup time.

G. If no explosion results, continue to operate the unit and steadily admit air into the chamber until a pressure of 5,000 feet below the test altitude is reached. (Pressurize chamber if necessary to reach sea level pressure when required. Do not test below sea level during sea level test).

H. If the unit causes an explosion, it has failed the test and no further trials should be attempted.

I. Turn off unit power. If no explosion has occurred, a sample of the air-vapor mixture is to be ignited by spark-gap or glow plug to verify its potential explosiveness. The sample shall ignite immediately within 3,000 feet of any test altitude below 20,000 feet. For test altitudes of 20,000 feet or higher, ignition at any altitude shall be sufficient evidence to verify that the mixture was ignitable. If the mixture is not explosive, the test is void and the entire procedure must be repeated.

J. Repeat steps D through I for each of the altitudes in Para A above.

K. Upon completing the explosive atmosphere environment, the TRFS shall be examined for evidence or damage induced by the explosive atmosphere exposure.

8.12 Rain Test (3.2.5.10).

Pre-Rain Functional Test.

Prior to commencing the rain test, the TRFS shall be subjected to the Test detailed in Paragraph 7.0.

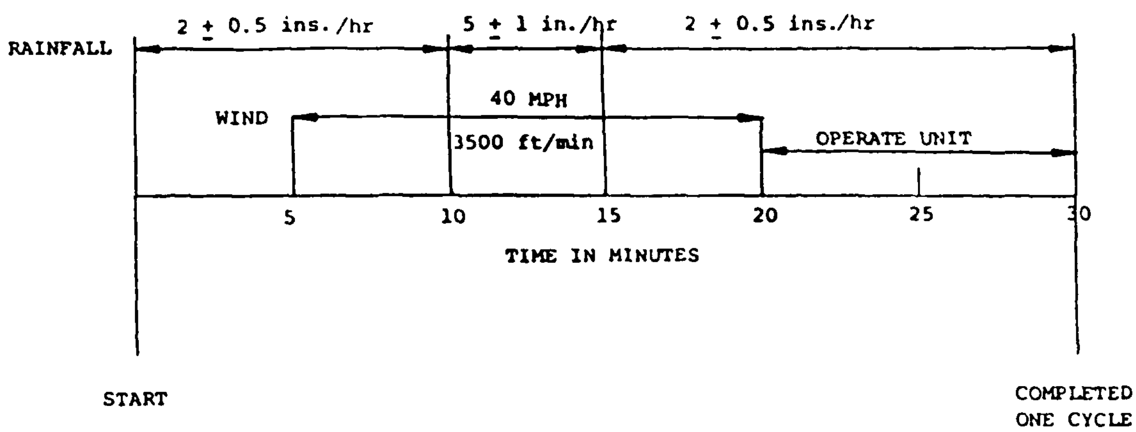
Test Procedure

Perform test in accordance with MIL-STD-810, Test Method 506.1 Procedure I.

A. Mount the unit to be tested, baseplate down, on an adapter plate and firmly attach using the normal baseplate mounting screws. Securely mount the assembly inside the test chamber in the proper test location such that one side of the unit will be properly exposed to the simulated rainfall. Use waterproof connectors and test cables within the test chamber.

B. The test item is to be exposed to a simulated rain and wind and operated per the schedule illustrated in Figure 8-3 and described below.

GRAPH 1


RAINFALL
2 ± 0.5 ins./hr
5 ± 1 in./hr
2 ± 0.5 ins./hr
WIND
40 MPH
3500 ft/min
OPERATE UNIT
5
10
15
20
25
30
TIME IN MINUTES
START
COMPLETED
ONE CYCLE

Each of the sides of the unit, including the top, but not the baseplate side, (5 sides total) shall be exposed to the 30 minute test for a total duration of 2 1/2 hours.

C. Produce a simulated falling rain in the test chamber stabilized at a constant rate of 2 +/- 0.5 inches per hour for ten minutes. The rate of rainfall shall then be raised to 5 +/- 1 inches per hour and held at this rate for five minutes. The rate shall then be reduced to 2 +/- 0.5 inches per hour for the next fifteen minutes.

D. Starting five minutes after the initation of the rain, the wind source shall be turned on and adjusted to produce a horizontal wind velocity of 40 miles per hour (3,500 feet per minute). The wind source shall be maintained at this velocity for fifteen minutes after which the wind source shall be turned off. At this time, apply power to the unit and check the output frequency and voltage level. Operate for 10 minutes for a total test time of 30 minutes. Upon completion of the 30 minutes test, turn unit power off. Turn the unit to expose an untested side of the unit toward the wind source. Repeat the procedures in Paragraphs C and D above for each of the sides of the unit.

E. Visually inspect the outside of the unit for damage. Remove the test connectors and the unit cover.

8.13 Salt Fog Test (3.2.5.6).

Pre-Salt Fog Functional Test.

Prior to subjecting the TRFS to salt fog test, perform the test detailed in Paragraph 7.0.

Test Procedure.

Perform test in accordance with MIL-STD-810, Test Method 509.1, Procedure I.

A. Prepare the test unit for exposure by thoroughly cleaning the outside surfaces of oil, dirt or grease until they are free of water break. Use a non-corrosive solvent that does not leave a film deposit.

B. Place the unit in the test chamber, baseplate down on an aluminum plate, with all connectors, covers, and inspection plates used in service either in place or adequately covered.

C. Prepare a 5 percent salt solution (specific gravity 1.027 to 1.041) and ascertain that the pH is in the range 6.5 to 7.2.

D. Place receptacle for collecting salt fog samples in the chamber, in a central location. Place the receptacle so that it is not shielded by the test unit and so that no drops of solution will be collected from the unit or other sources.

The receptacle is to collect 0.5 to 3 milliliters of solution per hour for each 80 square centimeters of horizontal collecting area (10 cm diameter) based on an average of at least 16 hours.

E. Expose the unit to the salt fog as specified in the above MIL-STD for a period of 48 hours at a temperature of 35°C.

F. At the end of the 48 hour exposure period, apply input power to the test unit and perform functional test as detailed in paragraph 7.0. Visually inspect the unit for signs or corrosion or degradation.

G. Store the test unit in an ambient atmosphere for 48 hours. Reexamine for signs of damage, corrosion, or degradation.

H. At the end of the 48 hour storage period reaccomplish the tests detailed in Paragraphs 7.0 through 7.3.

8.14 <u>Sand and Dust Test (3.2.5.9)</u>

<u>Pre-Sand and Dust Functional Test.</u>

Prior to commencing the sand and dust test, the TRFS shall be subjected to the test detailed in Paragraph 7.0.

<u>Test Procedure.</u>

Perform test in accordance with MIL-STD-810, Test Method 510.1, Procedure I.

<u>Facility.</u>

The test facility shall consist of a chamber and accessories to control dust concentration, velocity, temperature, and humidity of dust-laden air, no more than 50 percent of the cross-sectional area (normal to air flow) and 30 percent of the volume of the chamber shall be occupied by the test unit. The chamber shall be provided with a suitable means of maintaining and verifying the dust concentration in circulation. A minimum acceptable means for doing this is by use of a properly calibrated smoke meter and standard light source. The dust-laden air shall be introduced into the test space in such a manner as to allow it to become approximately laminar in flow before it strikes the test item.

<u>Dust Requirements.</u>

The dust used in this test shall be a fine sand (97-99 percent by weight SiO_2) of angular structure, and shall have the following size distribution as determined by weight, using the U.S. Standard Sieve Series:

a) 100 percent of this dust shall pass through a 100-mesh screen.
b) 98 +/- 2 percent of the dust shall pass through a [illegible]-mesh screen.

c) 90 +/- 2 percent of the dust shall pass through a 200-mesh screen.

d) 75 +/- 2 percent of the dust shall pass through a 325-mesh screen.

Note: 140-mesh silica flour as produced by Ottawa Silica Company, Ottawa, Illinois, or equal, is satisfactory for use in the performance of these tests.

Procedure.

A. Install the test unit in the dust test chamber in a nonoperating condition. Position the unit in the center of the chamber, ensuring a minimum clearance of four inches between surfaces of the unit and any other object or material capable of providing protection. Orient the test unit to expose the front face to the dust stream.

B. Set the chamber controls to maintain an internal chamber temperature of 23°C (73°F) and a relative humidity of less than 22 percent. Adjust the air velocity to 1,750 +/- 250 feet per minute. Adjust the dust feeder to control the dust concentration at 0.3 +/-0.2 grams per cubic foot. Maintain these conditions for 6 hours with the test item non-operating.

C. Stop the dust feed and reduce the air velocity to 300 +/- 200 feet per minute. Raise the internal chamber air temperature to 63°C (145°F) and adjust humidity control to maintain a relative humidity of less than 10 percent. Maintain these conditions for 16 hours.

D. While holding chamber temperature at 63°C (145°F) adjust the air velocity to 1,750 +/- 250 fpm. Adjust the dust feeder to control the dust concentration at 0.3 +/- 0.2 grams per cubic foot. Maintain these conditions for 6 hours.

E. Turn off all chamber controls and allow the test unit to return to standard ambient conditions. Remove accumulated dust from the test unit by brushing, wiping, or shaking, care being taken to avoid introduction of additional dust into the test unit. Dust shall not be removed by either air blast or vacuum cleaning.

F. Perform the tests detailed in Paragraph 7.0.

G. Remove the test unit from the chamber and visually inspect for damage. Examine the connectors internally for dust deposits and evidence of particle penetration.

H. Remove the cover from the unit and visually inspect the interior and components for dust deposits and evidence of particle penetration. Record all data on the data sheets.

9.0 EMI TESTS (4.2.2.2.5)

The purpose of the EMI tests is to assure that the TRFS complies with all EMI aspects of the equipment specification. This includes the characteristics of the dc power input as stated in paragraphs 3.2.1.10 and 3.3.2.1 as well as the EMI requirements of paragraph 3.3.2.

The following MIL-STD-461B, Class A1 EMI tests shall be performed on the TRFS:

Test Method	Test Title
CE01	30 Hz to 20 kHz, Power Leads
CE03	20 kHz to 50 MHz, Power Leads
CE07	Heater Power Only
CS01	30 Hz to 50 kHz, Power Leads
CS02	50 kHz to 400 MHz, Power Leads
CS06	Spike Susceptibility, Power Leads
RE02	14 kHz to 10 GHz, Radiated Emission, Electric Field
RS01	30 Hz to 30 kHz, Magnetic Field
RS02	Magnetic Induction Field
RS03	14 kHz to 10 GHz Electric Field

In addition, tests shall be performed to verify compliance with the specified power input transient conditions of MIL-STD-704, Category B and paragraph 3.3.2.1 of Hazeltine Specification 332819, Rev E.

9.1 Test Conditions

Laboratory environmental conditions shall be as follows:

Temperature:	25°C (+15 /-5°C)
Humidity:	90% or less
Barometric Pressure:	Normal ground
Vibration:	No appreciable vibration

Primary power, applied to the system under test, shall be maintained in accordance with MIL-STD-704A and the equipment specification.

9.2 Test Procedure

The EMI Tests shall be conducted in accordance with the relevant sections of MIL-STD-461B, MIL-STD-462, MIL-STD-

9.3 **Pass/Fail Criteria**

The TRFS shall not be damaged or lose lock to its Rb reference under the specified conditions of dc power input and conducted and radiated susceptibility. Nor shall the frequency stability of the unit be impaired so that it would fail to perform its function. A frequency error limit of 1 x 10^{-10} is consistent with the overall requirements. The pass/fail criteria for conducted and radiated emissions is given in sections of MIL-STD-461B.

10.0 **FINAL PERFORMANCE TESTS**

Final Performance Tests are conducted to ensure that TRFS performance, after all qualification tests, meets the performance requirements specified in the equipment specification.

Final Performance Tests are a retest of the Performance Tests specified in Paragraphs 6.0 through 6.13. A Long-Term Stability test is also included in Final Performance Tests.

10.1 **Long-Term Stability Test (3.2.1.4)**

Pre-Long-Term Stability Functional Test

Prior to subjecting the TRFS to the long-term stability test, perform the test detailed in paragraph 7.0.

Test Procedure

A. Conect unit to test equipment. Apply 26 $\pm$ 1.3 Vdc input power. Measure and record input voltage on data sheet.

B. To calculate long term drift, a series of 7 to 30 daily readings must be taken. Determine the daily average fractional frequency offset.

C. Record the daily readings on graph paper. After a sufficient number of readings have been taken that a trend is evident on the graph, the long term drift may be extrapolated. Record the extrapolated rate of drift.

APPENDIX D

EMI TEST REPORT

REPORT OF

ELECTROMAGNETIC COMPATIBILITY

TEST ON A

RUBIDIUM FREQUENCY STANDARD

(TRFS) S/N 101

FOR

EG&G CORPORATION

TEST PERFORMED BY

SANDERS ASSOCIATES, INC.
95 CANAL STREET
NASHUA, NH 03061

P.O. NO. 20575

	DATE	SIGNATURE
TEST INITIATED	8/25/86	*******************************
TEST COMPLETED	9/19/86	*******************************
REPORT WRITTEN BY	9/30/86	Brian B. Vaillancourt
TEST TECHNICIAN	10/7/86	Brian B. Vaillancourt
TEST COORDINATOR	10/7/86	R. Lamson
GOVERNMENT REP. (If Applicable)		
FINAL RELEASE SL	10/7/86	*******************************

ABSTRACT

Reported in this document are the results of electromagnetic interference (EMI) and electromagnetic compatibility (EMC) testing performed at the Sanders Associates Electromagnetic Compatibility Test Facility, Nashua, NH in August and September, 1986. The item tested was a Rubidium Frequency Standard.

INDEX TERMS: Rubidium Frequency Standard, electromagnetic compatibility.

ELECTROMAGNETIC INTERFERENCE REPORT TEST SUMMARY SHEET

TEST ITEM: Rubidium Frequency Standard	REPORT NO. 4484	TEST COMPL 9/19/86 REPT COMPL 9/30/86
MANUFACTURER: EG&G Corp.	SPECIFICATION: MIL-STD-461B Part 4 (USAF)	

SUMMARY OF TEST RESULTS

TEST METHOD	TITLE	SPEC. PARA.	REMARKS	PASS	FAIL
CE01	Conducted Emissions, Signal & Power Leads, 30 Hz to 15 kHz	4.2		X	
CE03	Conducted Emissions, Signal & Power Leads, 15 kHz to 50 MHz	4.3	With shielded power cable installed; shield not grounded on 10 uF side.		X
CE07	Conducted Emissions, Antenna Terminal, 10 kHz - 12.4 GHz	4.5		X	
CS01	Conducted Susceptibility, Power Leads, 30 Hz - 50 kHz	4.6		X	
CS02	Conducted Susceptibility, Power Leads, 50 kHz - 400 MHz	4.7			X
CS06	Conducted Susceptibility, Spike, DC Power Leads	4.11		X	
RE02	Radiated Emissions, Electric Field, 14 kHz - 10 GHz	4.15	With shielded power cable installed: shield grounded at both ends.	X	
RS01	Radiated Susceptibility, Magnetic Field, 30 Hz - 50 kHz	4.17		X	
RS02	Radiated Susceptibility, Magnetic Induction Fields	4.18		X	
RS03	Radiated Susceptibility, Electric Field, 14 kHz - 10 GHz	4.19		X	

SUMMARY OF REPORT

Paragraph 4.3 CE03

Narrowband conducted levels at .048 and 10 MHz* on the EUT DC hi leads exceed the CE03 limit by 1.0 and 4.0 dB respectively. See graph 3.

Paragraph 4.7 CS02

A frequency error of greater than 1×10^{-10} was detected at .4902 MHz during CS02 testing on the system DC hi lead. The threshold of susceptibility was determined to be 0.5 volts rms.

* The conducted level at 10 MHz was reduced 17 dB by installing a shielded power cable (shield not grounded on 10 uF side). This cable did not eliminate the excursion at .048 MHz.

ADMINISTRATIVE DATA

1.0 PURPOSE/REASON FOR TEST

A qualification test to determine compliance of the EG&G Rubidium Frequency Standard S/N 101 to the applicable requirements of MIL-STD-461B Part 4 (USAF) for Class A1C.

1.1 DESCRIPTION OF TEST SAMPLE(S)

Submitted for EMI testing was a Rubidium Frequency Standard (TRFS) S/N 101. Power requirements are +26 volts DC.

1.2 DISPOSITION OF TEST SAMPLE(S)

Returned to EG&G via program personnel.

1.3 REFERENCES

MIL-STD-461B Part 4 (USAF)	Electromagnetic Emissions and Susceptibility Requirements for the Control of Electromagnetic Interference
MIL-STD-462, N2	Electromagnetic Interference Characteristics Measurement of
MIL-STD-463	Definitions and Systems of Units Electromagnetic Interference Technology

FACTUAL DATA

2.0 GENERAL

2.1 Accuracy of Measurements

2.1.1 Field Intensity Meters

The principle means of determining frequency and amplitude during the test was one or more of the following field intensity meters:

Model No.	Mfr.	Frequency Range	Frequency Accuracy	Amplitude Accuracy
EMC-10 Calibrated every 6 months	Fairchild	20 Hz-50 kHz	±(1/2% + 5 Hz)	±1/2 dB
EMC-25 MKIII Calibrated every 6 months	Fairchild	10 kHz-1 GHz	±2%	±1.5 dB
8566A Calibrated every 6 months	Hewlett Packard	100 Hz-22 GHz	±2 counts	±.2 dB
8568B Calibrated every 6 months	Hewlett Packard	100 Hz-1.5 GHz	±2 counts	±.2 dB

These instruments were calibrated by the Sanders Associates Instrumentation Calibration/Standards Laboratory, which operates a government approved calibration program in accordance with MIL-C-45662A, "Calibration System Requirements". The calibrating equipment accuracy required by MIL-C-45662A is several orders of magnitude greater than that of the EMC instrumentation listed above. This ensures the greatest possible frequency and amplitude data accuracy.

2.2 Transducers

All antennas--(with one exception)--and current probes use the correction factors supplied by their respective manufacturers. The single exception is the Empire VA-105 41-inch vertical rod antenna (150 kHz to 30 MHz) which is calibrated every twelve months by the Sanders' Calibration Laboratory.

2.3 Signal Sources

A variety of signal sources were used to develop the r.f. environment for system susceptibility tests. The field intensity was monitored by the field intensity meters described above, and so the signal source was not a primary consideration in determining the accuracy of measurement.

The signal sources are calibrated by the S/A Instrument Calibration/Standards Laboratory on a 12 month cycle.

2.4 Description of Shielded Enclosure

a) Type Construction:	Per MIL-E-8881, Type IB per Table I, Single Shield, Solid Metal, Class C per Table II
b) Manufacturer:	Universal Shielding Corp.
c) Model No.:	USC-2034
d) Size:	12' x 32' with 8' x 12' instrumentation room
e) Door Clearance:	8' wide x 7' high double door 3' x 7' personnel door
f) Filters, Current & Voltage Rating	USC-50-2X50, 50 amp, 0-400 Hz 115V 3 phase
g) Ground Plane Size and Material:	32 mil copper
h) DC Bonding Resistance of Ground Plane:	.2 milliohms

3.0 TEST SAMPLE OPERATION

The Rubidium Frequency Standard (also referred to as EUT*, system, TRFS, unit) was placed on the ground plane 4.0 inches from its leading edge. Bonding of the plate to the ground plane surface was accomplished through the use of C clamps or bolts, while all cabling was given a 2.0 inch non-conductive standoff. Signal/exercise equipment cables were patched into the system via BNC connectors on the enclosure access panel and required +26 volt DC power was applied to the TRFS via filter capacitors, also located on the panel. The EUT was then activated and placed into a normal mode of operation by program personnel.

3.1 Susceptibility Monitoring & Criteria

During testing, the system was monitored to ensure that it remained locked to its Rb reference, and that its frequency stability did not exceed an error of greater than 1×10^{-10}. All monitoring was performed by program personnel.

* EUT - Equipment Under Test

TEST PARAGRAPH 4.2

TEST METHOD CE01

CONDUCTED EMISSIONS,

SIGNAL AND POWER LEADS,

30 Hz to 15 kHz

TEST EQUIPMENT

Description	Model/Mfg.	Serial No.	Cal Date	Cal Due
EMI Meter	EMC-11/Fairchild	51391	8/11/86	10/11/86
Capacitors	10 uF/Sanders	N/A	NCR	NCR
Current Probe	91550-1/Stoddart	BF-496	NCR	NCR

TEST PROCEDURE

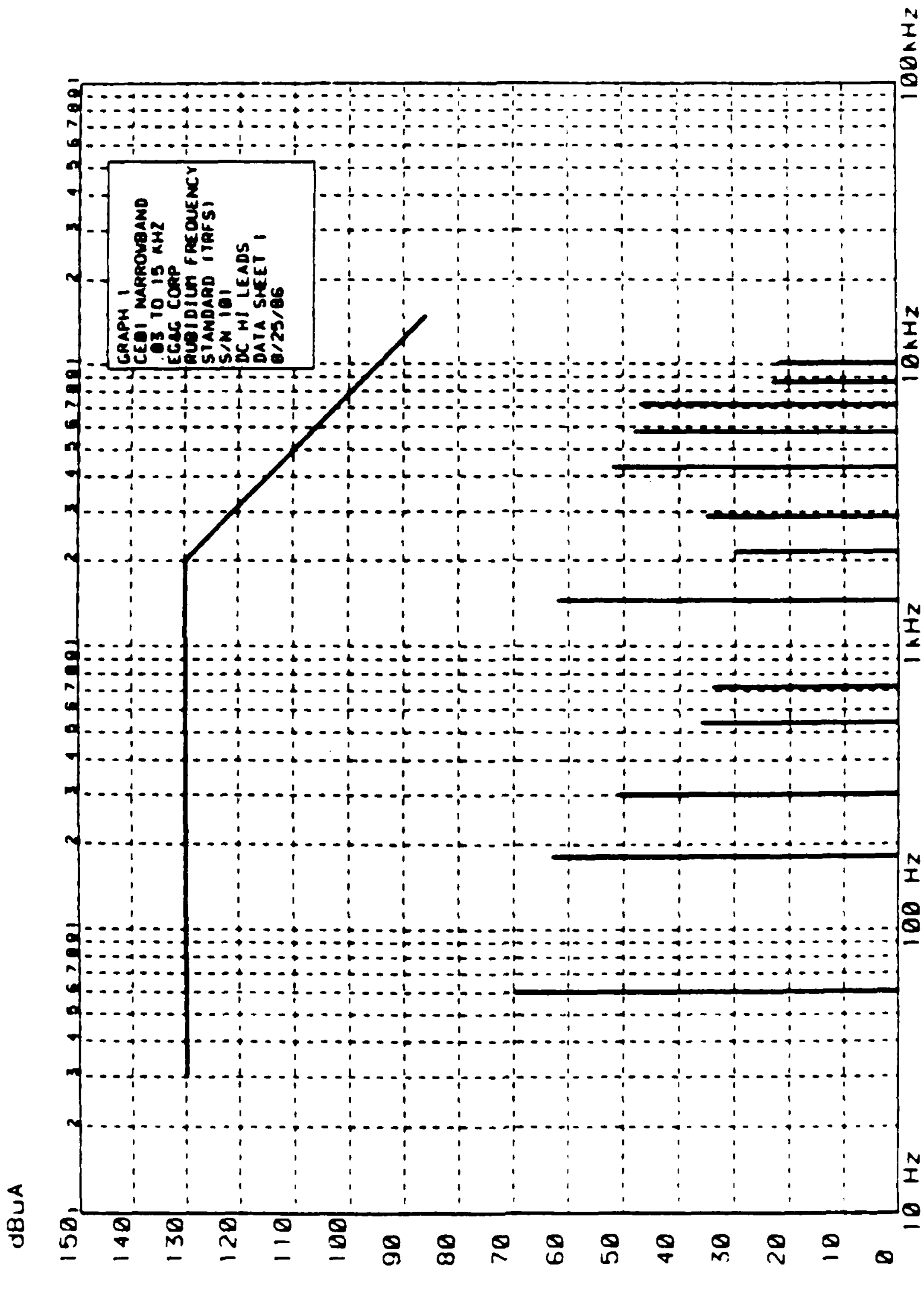
Required +26 volt DC power was applied to the test EUT via the 10 uF fixture. The current probe was clamped around the DC Hi power lead and connected via RG-223 coaxial cable to the EMI meter input, which was activated and calibrated for CE01 testing. Once the system was activated and placed into a normal mode of operation, the frequency range of 30 Hz to 15 kHz was slowly scanned for evidence of narrowband conducted emissions. Narrowband data is recorded as detected, or at the rate of the three highest peaks per octave. This test was repeated on the DC return lead.

TEST RESULTS

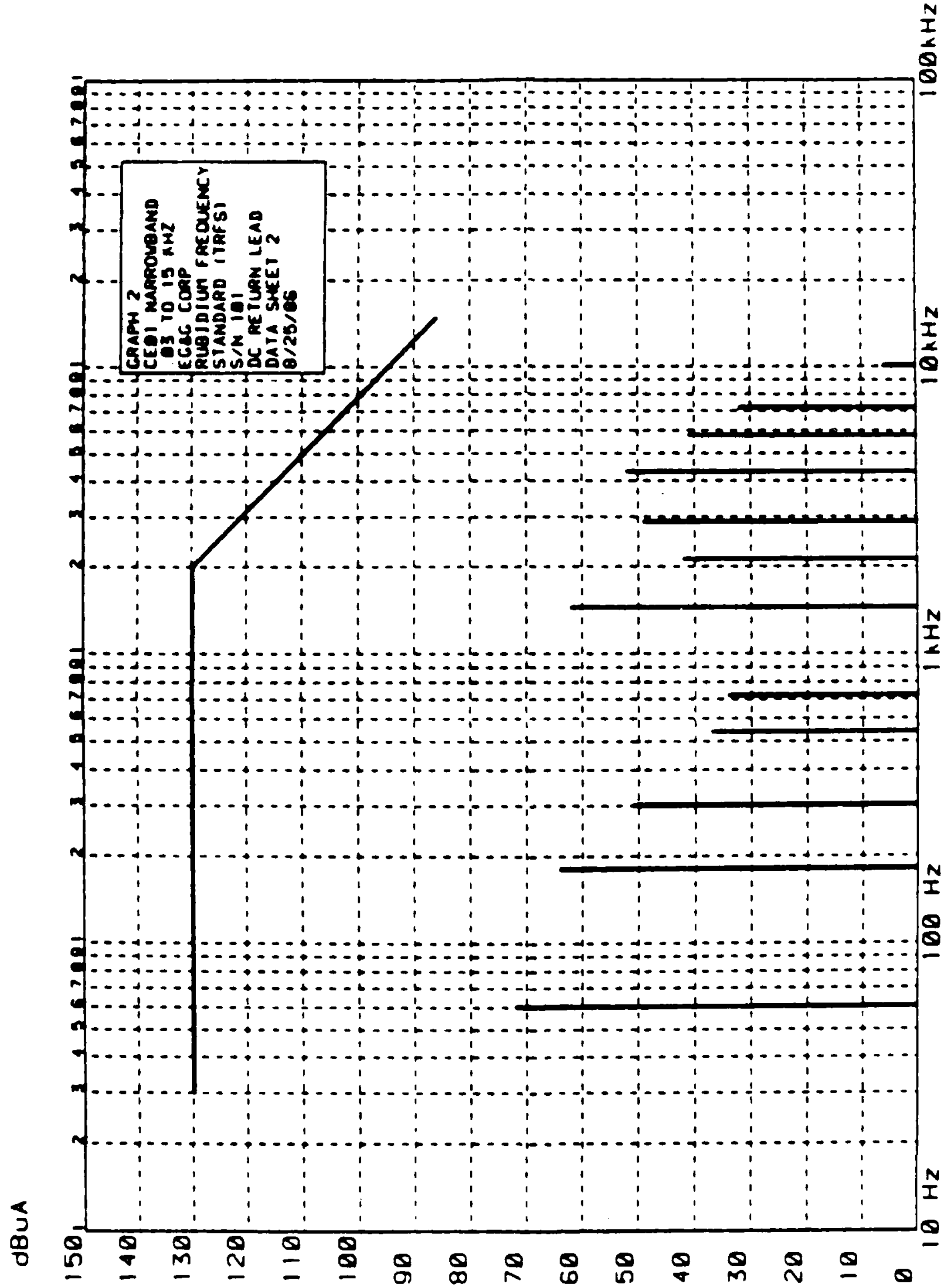
Narrowband conducted emissions comply with the CE01 limit. See graphs 1 and 2.

CONCLUSIONS

The EG&G Rubidium Frequency Standard S/N 101 complies with Paragraph 4.2 of MIL-STD-461B Part 4 (USAF) for Class A1C equipment.



GRAPH 1
CE01 NARROWBAND
03 TO 15 KHZ
EG&G CORP
RUBIDIUM FREQUENCY
STANDARD (TRFS)
S/N 101
DC HI LEADS
DATA SHEET 1
8/25/86
dBuA
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
10 Hz
100 Hz
1kHz
10kHz
100kHz



GRAPH 2
CE01 NARROWBAND
03 TO 15 KHZ
EG&G CORP
RUBIDIUM FREQUENCY
STANDARD (TRFS)
S/N 101
DC RETURN LEAD
DATA SHEET 2
8/25/86
dBuA
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
10 Hz
100 Hz
1 kHz
10kHz
100kHz

TEST PARAGRAPH 4.3

TEST METHOD CE03

CONDUCTED EMISSIONS,

SIGNAL AND POWER LEADS,

15 kHz to 50 MHz

TEST EQUIPMENT

Description	Model/Mfg.	Serial No.	Cal Date	Cal Due
EMI Meter	EMC-25 MKIII/Fairchild	51390	9/3/86	2/3/87
Current Probe	91550-1/Stoddart	BF-496	NCR	NCR
Capacitors	10 uF/Sanders	N/A	NCR	NCR

TEST PROCEDURE

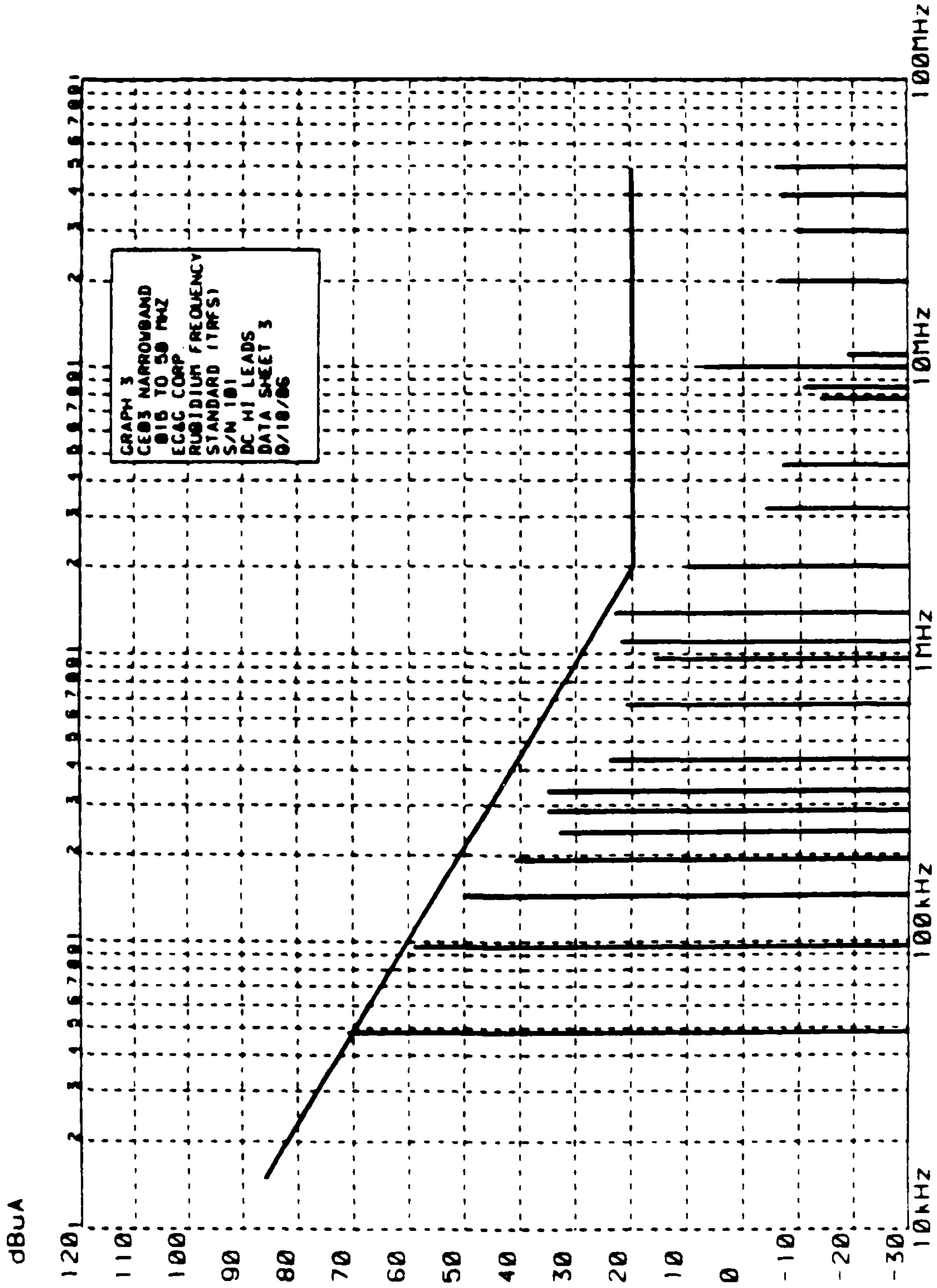
Required power was applied to the TRFS via the 10 uF fixture. The current probe was clamped around the DC Hi power lead and connected via RG-223 coaxial cable to the EMI meter input. Once the EMI meter was activated and calibrated for CE03 testing, the unit was activated and placed into a normal mode of operation. The frequency range of 15 kHz to 50 MHz was slowly scanned for evidence of narrowband and broadband conducted emissions. Narrowband data is recorded as detected, or at the rate of the three highest peaks per octave as a minimum. Broadband data is recorded at the rate of the three highest peaks per octave. This test was performed on the DC return power lead.

TEST RESULTS

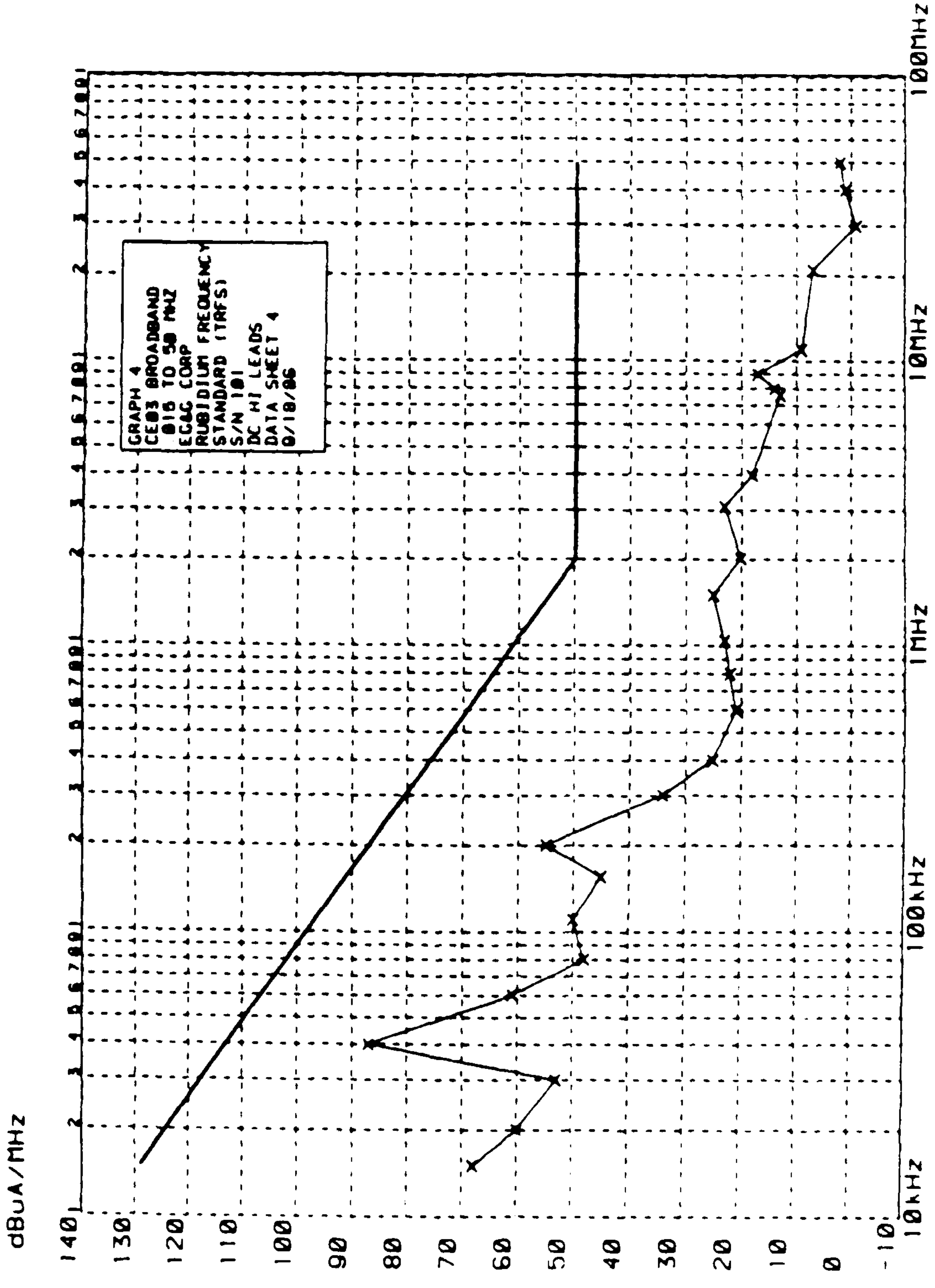
The narrowband conducted level at .048 MHz on the DC Hi power leads exceed the test limit by 1.0 dB. The level at 10 MHz was reduced 17 dB by installing a shielded power cable (shield not grounded at the 1.0 uF fixture), but did nothing to eliminate the 1.0 dB excursion at .048 MHz. See graph 3. Broadband emissions comply with the CE03 limit. See graph 4. Broadband and narrowband emissions on the unit's DC return lead comply with the test limits. See graphs 5 and 6.

CONCLUSIONS

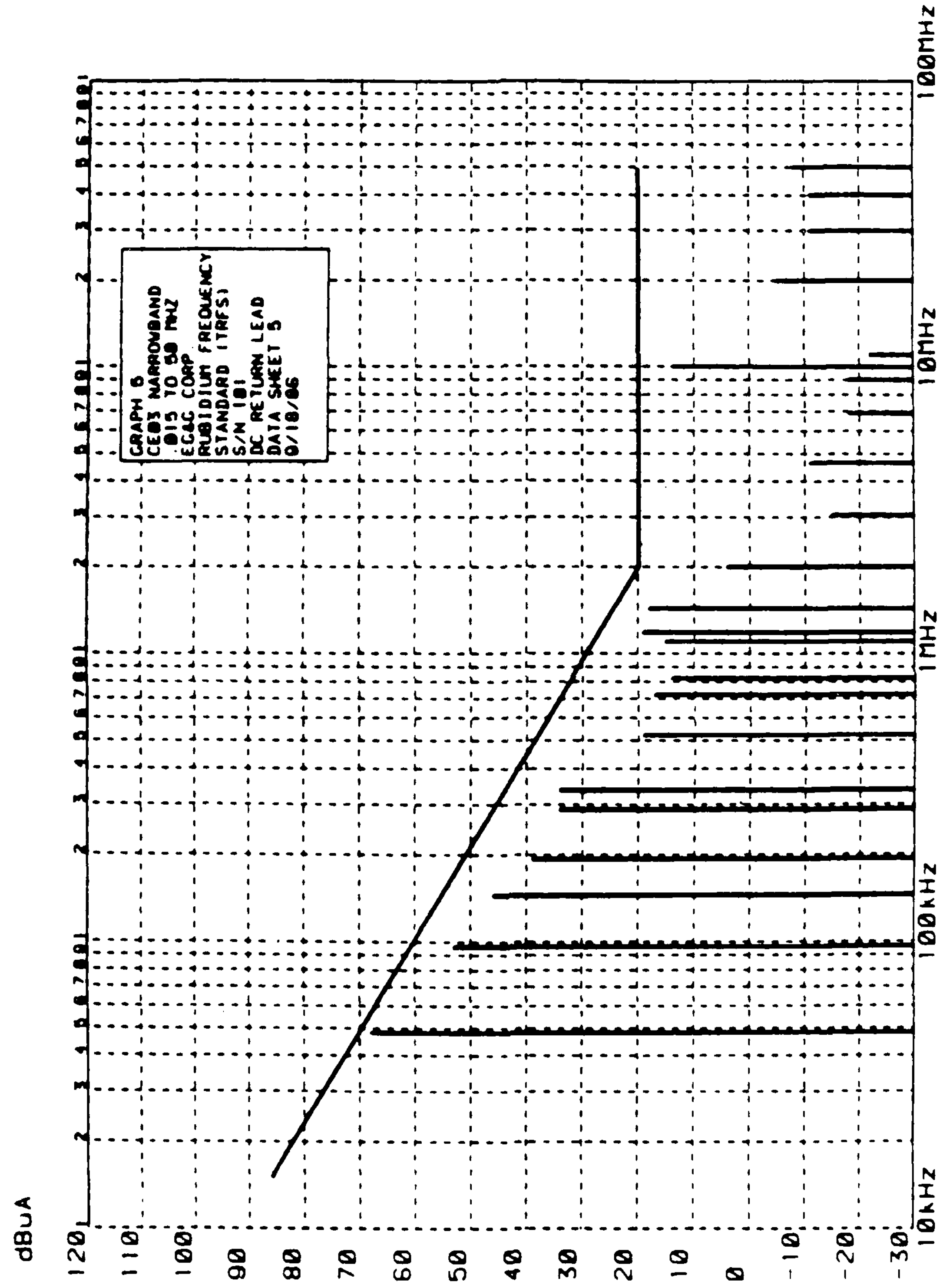
The EG&G Rubidium Frequency Standard S/N 101 does not comply with MIL-STD-461B Part 4 (USAF) for Class A1C equipment.

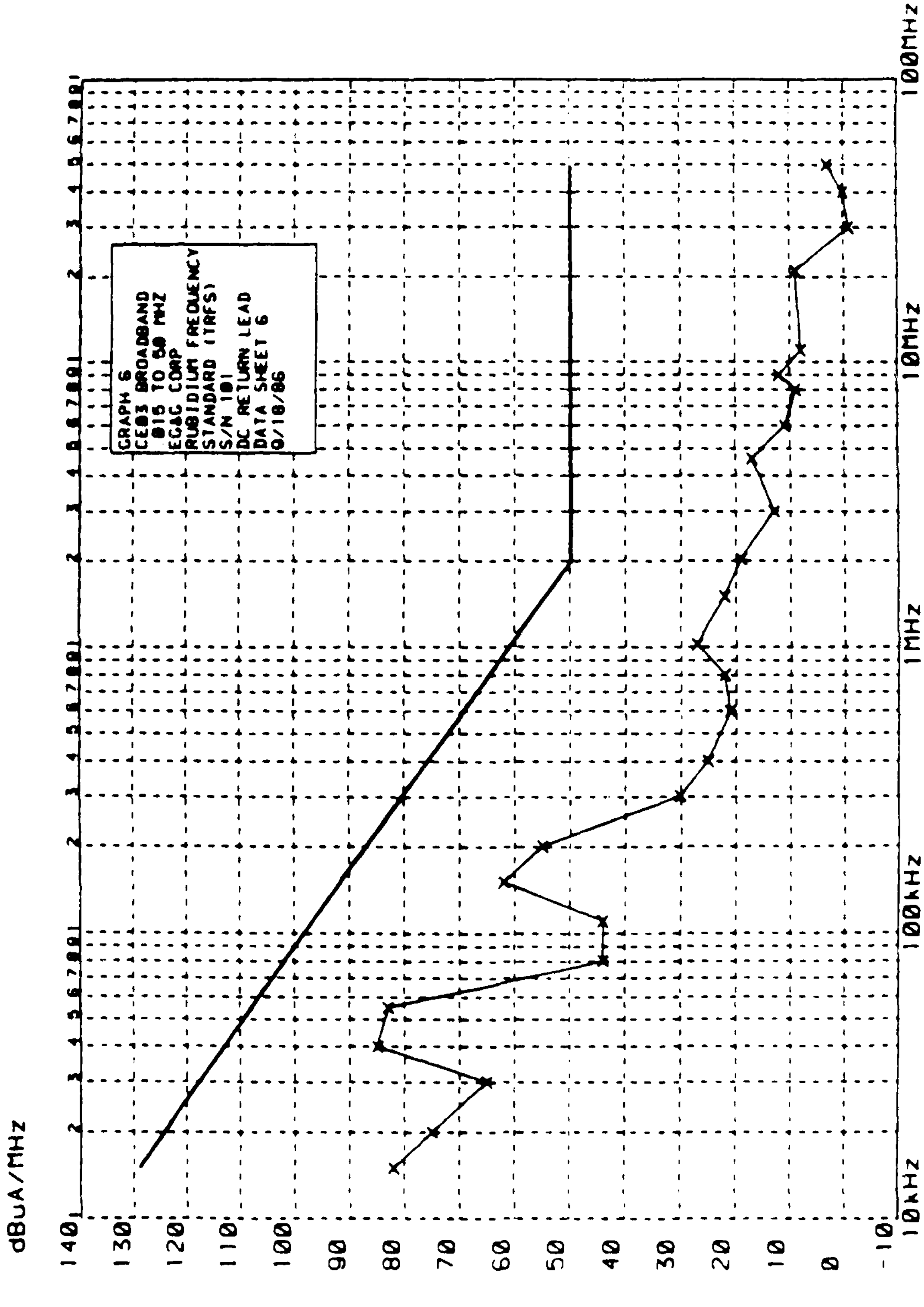


GRAPH 3
CE03 NARROWBAND
015 TO 50 MHZ
EG&C CORP.
RUBIDIUM FREQUENCY
STANDARD (TRFS)
S/N 101
DC HI LEADS
DATA SHEET 3
0/10/86
dBuA
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
10kHz
100kHz
1MHz
10MHz
100MHz



GRAPH 4
CE03 BROADBAND
015 TO 50 MHZ
EG&G CORP
RUBIDIUM FREQUENCY
STANDARD (TRFS)
S/N 101
DC HI LEADS
DATA SHEET 4
0/18/86
dBuA/MHz
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
10kHz
100kHz
1MHz
10MHz
100MHz


GRAPH 6
CE03 NARROWBAND
.015 TO 50 MHZ
EG&G CORP
RUBIDIUM FREQUENCY
STANDARD (TRFS)
S/N 101
DC RETURN LEAD
DATA SHEET 5
9/18/86
dBuA
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
10kHz
100kHz
1MHz
10MHz
100MHz



GRAPH 6
CE03 BROADBAND
015 TO 50 MHZ
EG&G CORP
RUBIDIUM FREQUENCY
STANDARD (TRFS)
S/N 101
DC RETURN LEAD
DATA SHEET 6
9/18/86
dBuA/MHz
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
10kHz
100kHz
1MHz
10MHz
100MHz

TEST PARAGRAPH 4.5

TEST METHOD CE07

CONDUCTED EMISSIONS,

SPIKE, TIME DOMAIN

TEST EQUIPMENT

Description	Model/Mfg.	Serial No.	Cal Date	Cal Due
LISN*	91221-1/Stoddart	N/A	NCR	NCR
Oscilloscope	466/Tektronix	16054	9/10/86	3/10/87

TEST PROCEDURE

The 91221-1 LISN was insertd into the +26 volt DC line. Once the oscilloscope was connected to the LISN measuring port, the system was cycled on and off, and the resultant transients photographed.

TEST RESULTS

On and off transients comply with the CE07 limit.

CONCLUSIONS

The EG&G Rubidium Frequency Standard S/N 101 complies with Paragraph 4.5 of MIL-STD-461B Part 4 (USAF) for Class A1C equipment.

* LISN - Line Impedance Stabilization Network

TEST PARAGRAPH 4.6

TEST METHOD CS01

CONDUCTED SUSCEPTIBILITY,

POWER LEADS,

30 Hz to 50 kHz

TEST EQUIPMENT

Description	Model/Mfg.	Serial No.	Cal Date	Cal Due
Oscillator	200S/Hewlett Packard	7153	NCR	NCR
Audio Amplifier	6552-1A/Solar	41546	NCR	NCR
RMS Voltmeter	3400A/Hewlett Packard	21043	7/17/86	11/17/
Isolation Transformer	6220-1A/Solar	N/A	NCR	NCR

TEST PROCEDURE

The EUT DC return power lead was placed in series with the isolation transformer secondary winding, while the audio signal source was placed across the primary. Once the rms voltmeter was connected to the transformer terminal marked "AC Voltmeter", the TRFS and test equipment were activated. The requir levels of AC ripple were injected into the return lead while monitoring the un for signs of susceptibility. This test was performed on the DC Hi power lead.

TEST RESULTS

No signs of susceptibility were detected during the course of CS01 testin on the system DC power input leads.

CONCLUSIONS

The EG&G Rubidium Frequency Standard S/N 101 complies with Paragraph 4.6 of MIL-STD-461B Part 4 (USAF) for Class A1C equipment.

TEST PARAGRAPH 4.7

TEST METHOD CS02

CONDUCTED SUSCEPTIBILITY, POWER LEADS, 50 kHz to 400 MHz

TEST EQUIPMENT

Description	Model/Mfg.	Serial No.	Cal Date	Cal Due
Signal Generator	8640B/Hewlett Packard	51392	9/2/86	3/2/87
Signal Generator	606A/Hewlett Packard	12969	4/17/86	9/17/86
Amplifier	5100/IFI	38108	NCR	NCR
RF Voltmeter	91CA/Boonton	2713	8/18/86	11/18/86
Test Fixture	CS02/Sanders	N/A	NCR	NCR

TEST PROCEDURE

The signal source, RF voltmeter, and TRFS DC Hi power lead were connected to the appropriate terminals on the CS02 test fixture. Once the system and test equipment were activated, the required 1.0 volt rms was injected into the power lead from 50 kHz to 400 MHz while monitoring for signs of susceptibility. This test was performed on the DC return input power lead.

TEST RESULTS

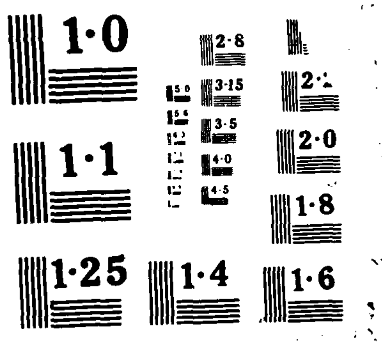
A frequency error of greater than 1×10^{-10} was detected at .4902 MHz while testing the system DC Hi power lead. The threshold of susceptibility was determined to be 0.5 volts rms. No signs of susceptibility were detected while testing the unit DC return lead.

CONCLUSIONS

The EG&G Rubidium Frequency Standard S/N 101 does not comply with Paragraph 4.7 of MIL-STD-461B Part 4 (USAF) for Class A1C equipment.

AD-A191 190 TACTICAL RUBIDIUM FREQUENCY STANDARD (TRFS) VOLUME 2 3/3
(U) EG AND G INC SALEM MA T J LYNCH ET AL. OCT 87
RADC-TR-87-166-VOL-2 F19628-83-C-0175

UNCLASSIFIED F/G 14/2 NL


1·0
2·8
3·15
3·5
4·0
4·5
2·0
1·1
1·8
1·25
1·4
1·6

TEST PARAGRAPH 4.11

TEST METHOD CS06

CONDUCTED SUSCEPTIBILITY,

SPIKE,

POWER LEADS

TEST EQUIPMENT

Description	Model/Mfg.	Serial No.	Cal Date	Cal Due
Spike Generator	8282-1/Solar	48792	NCR	NCR
Inductor	20 uH/Sanders	N/A	NCR	NCR
Oscilloscope	466/Tektronix	39644	11/22/85	11/22/86

TEST PROCEDURE

A 20 uH inductor was placed in series with the TRFS DC Hi power lead. Once the DC output of the spike generator and the oscilloscope input were placed across the unit DC power leads, the test equipment and EUT were activated and given an adequate warm-up period. The required ±200 volt peak, single random and repetitive 0.15 microsecond spikes were injected into the system DC power leads for 5.0 minute time durations each. The TRFS was constantly monitored for signs of susceptibility throughout CS06 testing.

TEST RESULTS

No signs of susceptibility were detected throughout the course of CS06 testing.

CONCLUSIONS

The EG&G Rubidium Frequency Standard S/N 101 complies with Paragraph 4.11 of MIL-STD-461B Part 4 (USAF) for Class A1C equipment.

TEST PARAGRAPH 4.15

TEST METHOD RE02

RADIATED EMISSIONS, ELECTRIC FIELD, 14 kHz to 10 GHz

TEST EQUIPMENT

Description	Model/Mfg.	Serial No.	Cal Date	Cal Due
EMI Meter	EMC-25 MK III/Fairchild	51392	9/3/86	2/3/87
Spectrum Analyzer	8566A/Hewlett Packard	42530	9/9/86	3/9/87
Capacitors	10 uF/Sanders	N/A	NCR	NCR
Rod Antenna	RVR-25/Fairchild	512	NCR	NCR
Biconical Antenna	BIA-25/Fairchild	512	NCR	NCR
Log Spiral Antenna	93490-1/Stoddart	10138, 25975	NCR	NCR
Double Ridged Guide Antenna	96001/Ail Tech	2051	NCR	NCR

TEST PROCEDURE

The appropriate EMI meter was activated and calibrated for RE02 testing. Required +26 volt DC power was applied to the TRFS via the 10 uF test fixture. Once the EUT was activated and placed into a normal mode of operation, the appropriate test antenna (see Table 1.0) was placed 1.0 meter from the unit and connected to the EMI meter input. RG-223 coaxial cable was used below 1.0 GHz, hardline thereafter. The frequency range of 14 kHz to 10 GHz was slowly scanned for evidence of narrowband radiated emissions, which are recorded as detected, or at the rate of the three highest frequencies per octave as a minimum. The frequency range of 14 kHz to 1.0 GHz was also scanned for evidence of broadband radiated emissions, which are recorded at the rate of the three highest peaks per octave. Above 25 MHz, linear test antennas were alternately positioned to measure both horizontally and vertically polarized fields.

TEST RESULTS

Broadband radiated emission levels comply with the test limit. See graph 8.

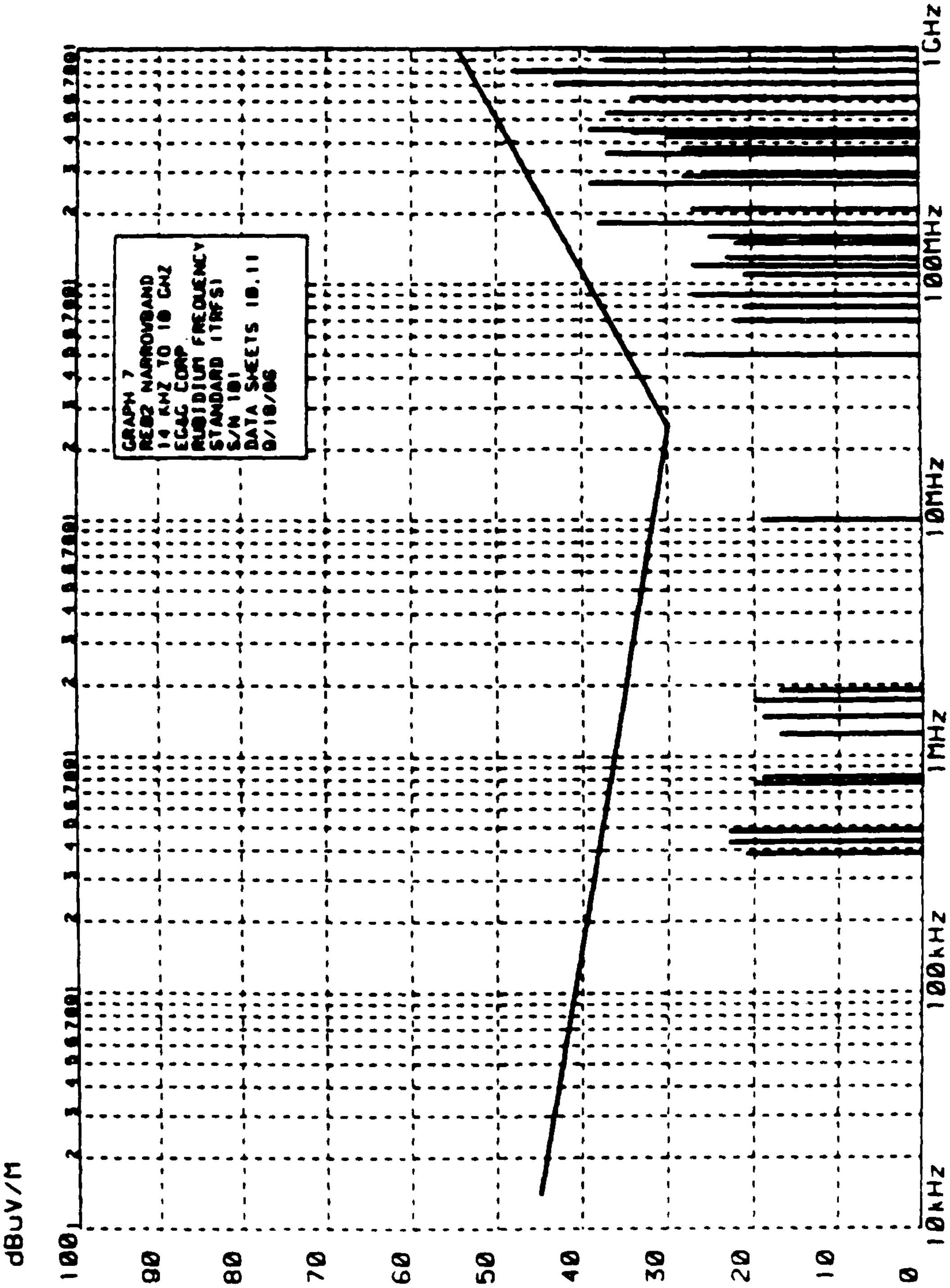
Narrowband levels - especially at 90 and 270 MHz - comply with the RE02 limit with a shielded power cable installed (shield grounded at both ends). See graph 7.

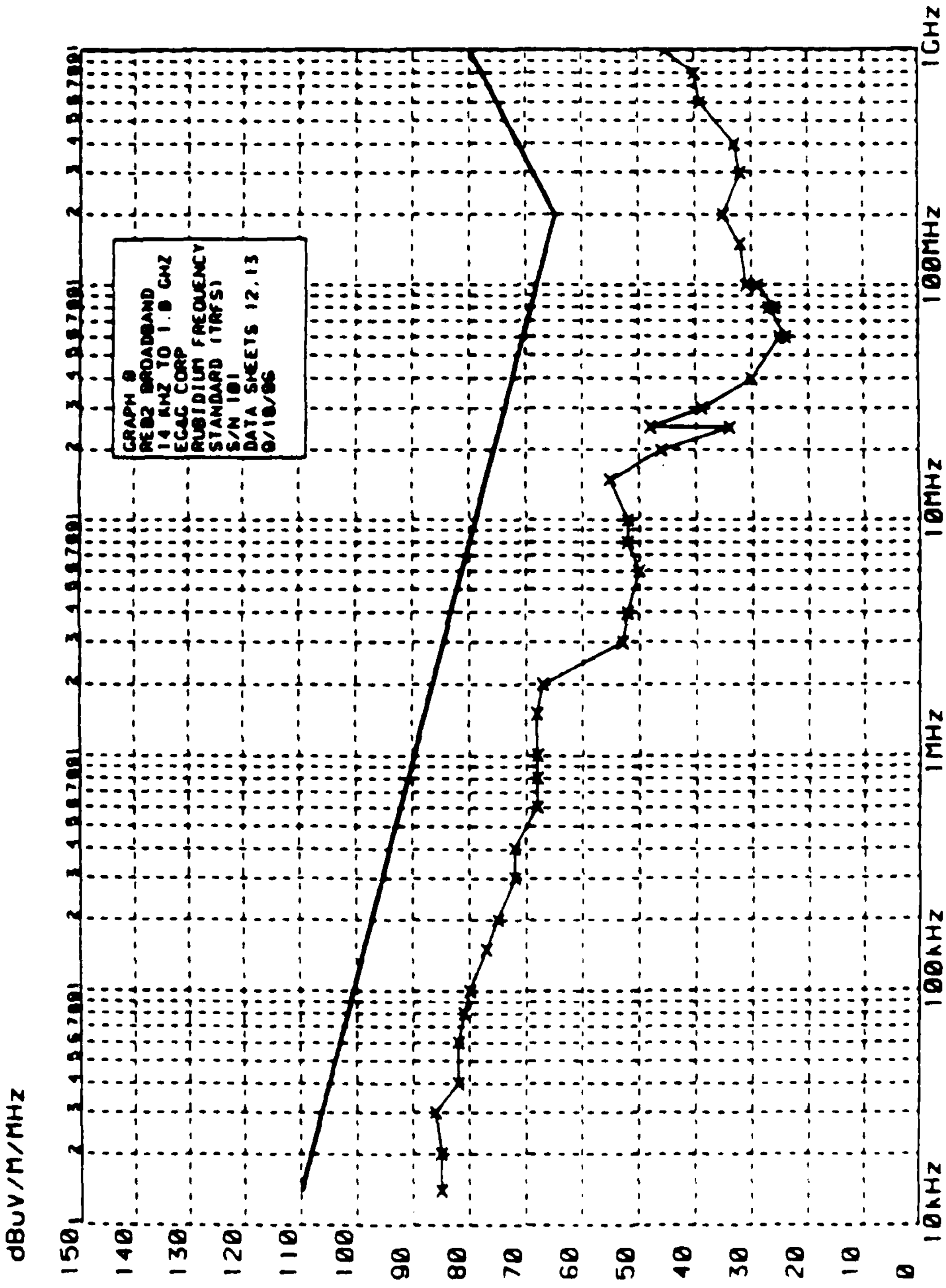
CONCLUSIONS

The EG&G Rubidium Frequency Standard S/N 101 (with shielded power cable installed) complies with Paragraph 4.15 of MIL-STD-461B Part 4 (USAF) for Class A1C equipment.

Frequency Range	Type Antenna
14 kHz to 25 MHz	41 Inch Monopole (with counterpoise)
25 to 200 MHz	Biconical (horizontal and vertical)
200 to 1,000 MHz	Log Spiral
1.0 to 10 GHz	Double Ridged Guide Antenna (horizontal and vertical)

Table 1.0 Antenna Schedule


GRAPH 7
RE02 NARROWBAND
14 KHZ TO 10 GHZ
EG&G CORP
RUBIDIUM FREQUENCY
STANDARD (TRFS)
S/N 101
DATA SHEETS 10.11
9/10/86
dBuV/M
100
90
80
70
60
50
40
30
20
10
0
10kHz
100kHz
1MHz
10MHz
100MHz
1GHz



dBuV/M/MHz
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
10kHz
100kHz
1MHz
10MHz
100MHz
1GHz
REB2 BROADBAND
EG&G CORP
RUBIDIUM FREQUENCY
STANDARD (TRFS)
DATA SHEETS 12.13

TEST PARAGRAPH 4.17

TEST METHOD RS01

RADIATED SUSCEPTIBILITY,

MAGNETIC FIELD,

30 Hz to 50 kHz

No signs of susceptibility were detected.

TEST PARAGRAPH 4.18

TEST METHOD RS02

RADIATED SUSCEPTIBILITY,

MAGNETIC INDUCTION FIELDS

TEST EQUIPMENT

Description	Model/Mfg.	Serial No.	Cal Date	Cal Due
Variac	W5M/Gen Rad	N/A	NCR	NCR
Isolation Transformer	6220-1A/Solar	N/A	NCR	NCR
Spike Generator	8282-1/Solar	48792	NCR	NCR
Oscilloscope	466/Tektronix	39644	11/22/85	11/22/86
Ammeter	25A/Simpson	103222	4/9/86	4/9/87

TEST PROCEDURE

A test wire was spiralled around the signal and power leads at the rate of two turns per meter (equally spaced), then taped in place. One turn of this same test wire was also wrapped around the unit case (parallel to the ground plane surface) then taped in place. Note that it was not possible to wrap the unit case with the test wire and keep it at least 15 centimeters from any TRFS connector. In an effort to expedite testing, all test wires (case, signal lead, power leads) were connected in series.

Current Test

The isolation transformer secondary winding was connected in series with the test wire and ammeter, while the variac output was connected across the primary. Once activated, the variac was adjusted to produce 20 amperes of 400 Hz current in the test wire for 1.0 minute.

Spike Test

The test wire was connected to the spike generator output. An oscilloscope, also connected across the spike generator output, was used to measure the 200 volt peak transients injected into the test wire at 1.0 and 10 Hz repetition rates for 1.0 minute each.

TEST RESULTS

No signs of susceptibility were detected during RS02 testing.

CONCLUSIONS

The EG&G Rubidium Frequency Standard S/N 101 complies with Paragraph 4.18 of MIL-STD-461B Part 4 (USAF) for Class A1C equipment.

TEST PARAGRAPH 4.19

TEST METHOD RS03

RADIATED SUSCEPTIBILITY,

ELECTRIC FIELD

14 kHz to 10 GHz

TEST EQUIPMENT

Description	Model/Mfg.	Serial No.	Cal Date	Cal Due
Display Section	141T/Hewlett Packard	40033	3/3/86	3/3/87
IF Section	8552A/Hewlett Packard	35233	4/9/86	4/9/87
RF Section	8555A/Hewlett Packard	40033-3	3/26/86	3/26/87
Field Intensity Meter	EFS-1/IFI	36629	1/8/86	1/8/87
Oscillator	200S/Hewlett Packard	7153	NCR	NCR
Signal Generator	8640B/Hewlett Packard	51392	9/2/86	3/2/87
Signal Generator	606A/Hewlett Packard	23764	6/18/86	11/18/86
Signal Generator	614A/Hewlett Packard	1677	12/31/85	9/30/86
Signal Generator	616B/Hewlett Packard	6080	4/15/86	1/15/87
Signal Generator	8683D/Hewlett Packard	57809	8/11/86	2/11/87
Wideband Amplifier	5100/IFI	38108	NCR	NCR
Broadband Power Amp.	35512/AIL Tech	41788	NCR	NCR
TWT Amplifier	1277HL/Hughes	38385	NCR	NCR
TWT Amplifier	8020H/Hughes	53257,53258	NCR	NCR
TWT Amplifier	1277HX/Hughes	36879	NCR	NCR
Power Rod Antenna	41"/Sanders	N/A	NCR	NCR
Power Biconical Antenna	RS03/Sanders	N/A	NCR	NCR
Log Spiral Antennas	93490-1/Stoddart	10138, 25975	NCR	NCR
Double Ridged Guide Antennas	96001/AIL Tech	2051, 2086	NCR	NCR
Attenuator	768-20/Narda	7519	4/27/86	4/27/88
Amplifier	15100B/Eaton	44182	NCR	NCR

TEST PROCEDURE

The appropriate transmit antenna (see Table 2.0) was placed 1.0 meter from the TRFS chassis and connected to the signal source. A field intensity meter, placed in the same geometry as the TRFS, was used to monitor the fields from 14 kHz to 200 MHz, While the field calibration antenna technique was used thereafter. Once the equipment and EUT were activated and allowed an adequate warm-up, the system was immersed in the required electric fields from 14 kHz to 10 GHz (see Table 3.0). During testing, the TRFS was constantly monitored for signs of susceptibility.

Frequency Range	Type Antenna
14 kHz to 25 MHz	41" Monopole (with counterpoise)
25 to 200 MHz	Biconical (horizontal and vertical)
200 to 1,000 MHz	Log Spiral
1.0 to 10 GHz	Double Ridged Guide (horizontal and vertical)

Table 2.0 Antenna Schedule

Frequency Range	Electric Field
14 kHz to 30 MHz	10 Volts/meter
30 to 10 GHz	5 Volts/meter

Table 3.0 Required Electric Fields

TEST RESULTS

No signs of susceptibility were detected during RS03 testing.

CONCLUSIONS

The EG&G Rubidium Frequency Standard S/N 101 complies with Paragraph 4.19 of MIL-STD-461B Part 4 (USAF) for Class A1C equipment.

APPENDIX E

FREQUENCY MEASURING SYSTEM

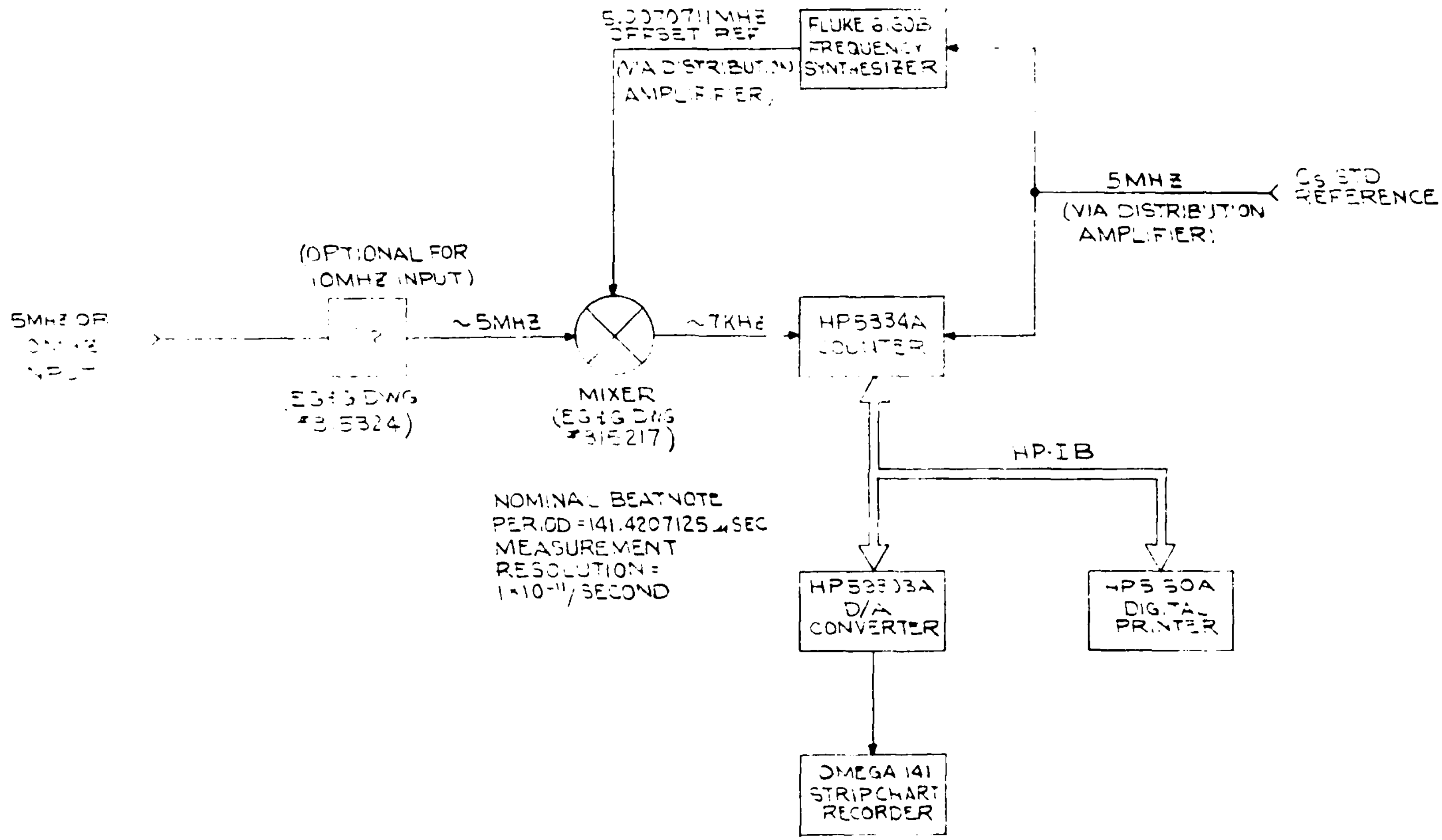


Figure E-1. Frequency Measuring System Block Diagram.

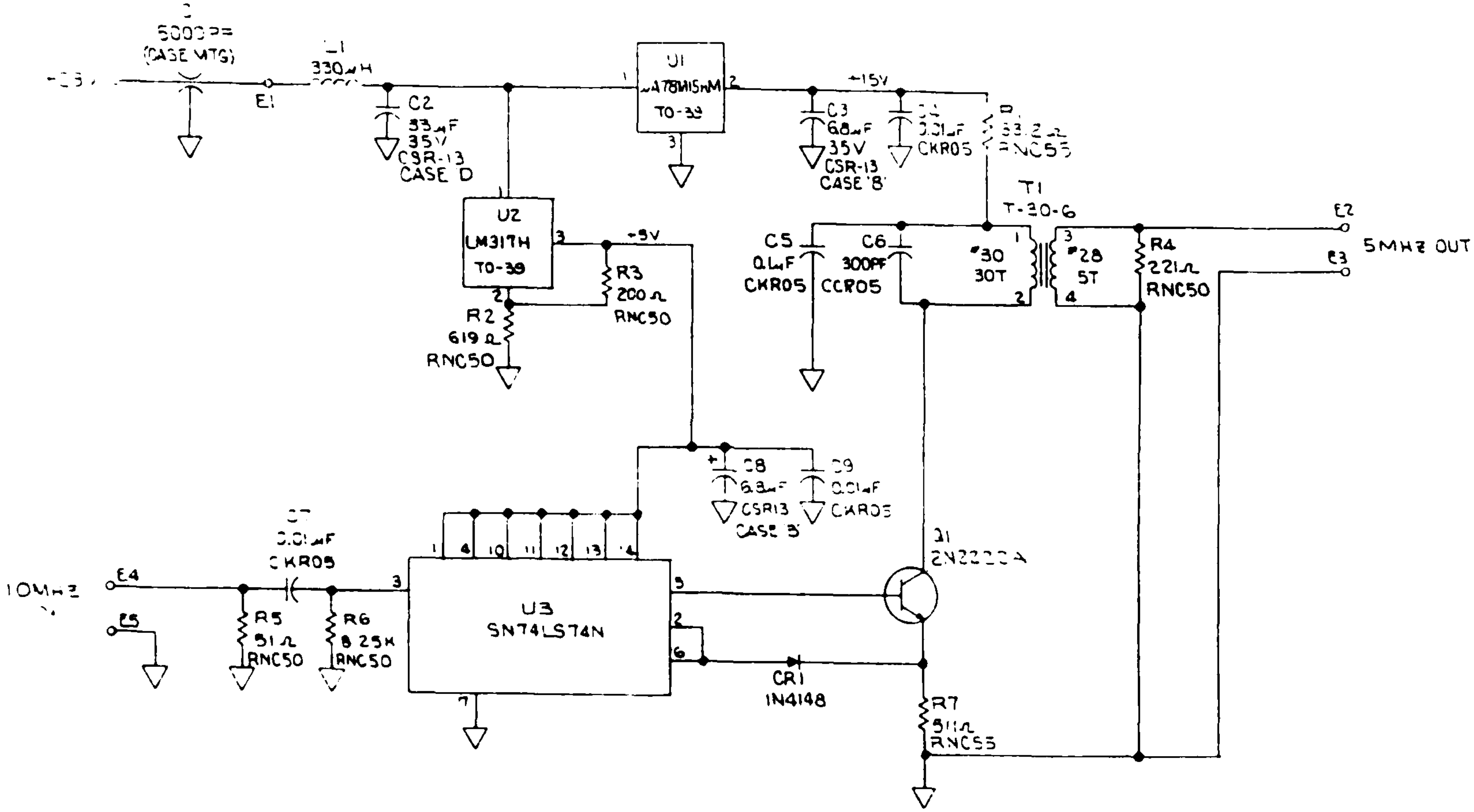


Figure E-2. 10 MHz Frequency Divider Measuring System Schematic.

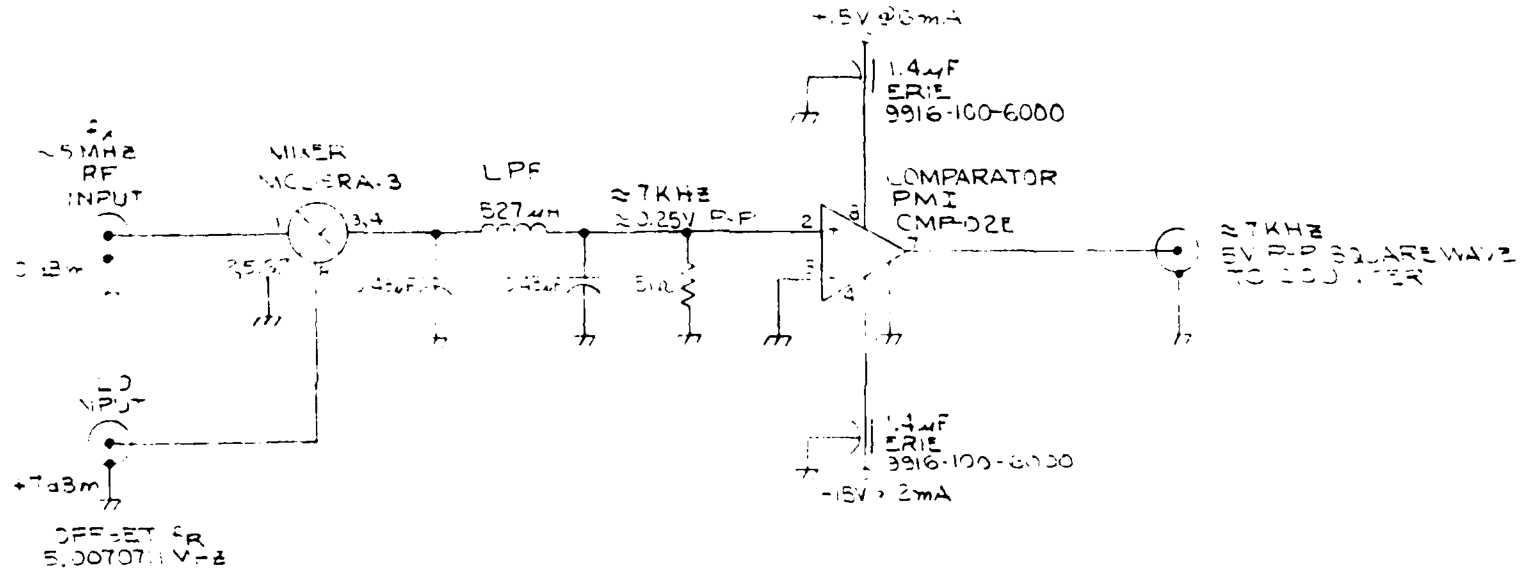


Figure E-3. Mixer Module for Frequency Measuring System.

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