FCC CERTIFICATION REPORT

FOR VHF-920

VHF COMMUNICATIONS TRANSCEIVER

CPN 653-9908-304

ORIGINAL ON FILE IN

MELBOURNE DESIGN CENTER VAULT

AUGUST 27, 2000

Rockwell Collins, Inc.

Cedar Rapids, Iowa 52904

PREPARED BY ____________________

T. PRZEWOZNIK

VHF-920 PROJECT ENGINEER

APPROVED BY _____________________

F.J. STUDENBERG

VHF COMM / NAV GROUP MANAGER

Signatures on Original Page On File in Melbourne Design Center Vault

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CERTIFICATE

The VHF-920 has been tested in accordance with the requirements contained in the appropriate Commission regulations. To the best of my knowledge, these tests were performed using measurement procedures consistent with industry or Commission standards and demonstrate that the VHF-920 complies with the appropriate standards. Each unit manufactured, imported, or marketed, as defined in the Commission's regulations, will conform to the sample(s) tested within the variations that can be expected due to quantity production and testing on a statistical basis. I hereby certify that the tests described in this report were performed at my direction and under my supervision, and that the results and test data contained in this report truly and accurately show the performance of the transmitter in the VHF-920 transceiver. I further certify that the ancillary information contained herein accurately reflects the design, installation requirements, alignment procedures, and operational instructions of and for this transceiver.

Signed. ____________________________

Tom Przewoznik

Project Engineer, VHF-920

VHF Comm/Nav Group

CNS Engineering

Melbourne Design Center

Rockwell Collins, Inc.

(Signature on Original File in Melbourne Design Center Vault)

QUALIFICATIONS OF CERTIFYING ENGINEER

T.J. Przewoznick, Project Engineer, VHF-920 program, VHF Comm/Nav Group, Rockwell Collins, Inc.

BSEE 1985, University of Massachusetts

MSEE 1988, Syracuse University

MBA 1997, University of Central Florida

I have a total of 15 years of experience in the design and testing of both Hardware and Software aspects of Avionics Equipment.

1. PRODUCT DESCRIPTION – EXHIBIT A

1.1 SCOPE

This report and its exhibits provide the information required by parts 2 and 87 of the FCC Rules and Regulations for Certification of the transmitter portion of the VHF-920 VHF Communications Transceiver. The Collins part number for the VHF-920 is 822-1250-001.

The units tested were engineering units representative of production configurations of the VHF-920, Collins part number 822-1250-001. Unless otherwise noted, all tests were conducted at the Rockwell Collins Melbourne Design Center in Melbourne, FL.

1.2 EQUIPMENT DESCRIPTION

The VHF-920 VHF Transceiver is a solid state, 2280 channel AM transceiver designed to provide air-to-air or air-to-ground AM voice or analog data communications in the 118.000 to 137.000 MHz Aeronautical communications band. It operates in communications systems having 25 kHz or 8.33 kHz channel spacing.

In addition to AM operation voice or analog data operation, the VHF-920 will provide air-to-ground packet digital data communications (VDL Mode 2) in the 118.000 to 136.975 MHz band in communications systems having 25 kHz channel spacing.

The unit operates on 27.5 VDC and is packaged in an ARINC 600 standard 3 MCU configuration.

1.2.1 CERTIFICATION BASED ON SIMILARITY

The VHF-920 is a derivative design of the VHF-900B, CPN 822-1047-003 which received FCC Type Acceptance in 1997 (FCC ID AJKPN822-1047).

The VHF-920 uses the same hardware platform and provides the same functions (AM Voice and data) as the Type Accepted VHF-900B. By upgrade of software, the VHF-920 also provides new additional capability for VDL Mode 2 operation. VDL Mode 2 is a digital modulation using a 31.5 kb/sec D8PSK waveform.

Because of the similarity of VHF-920 Hardware and Voice/Analog Data operations with the VHF-900B, the Certification testing of the VHF-920 will be by similarity to the VHF-900B with only with new testing and results provided for test cases related to VDL Mode 2 operation.

Test results based on similarity will be those provided for Certification of the VHF-900B in Rockwell Collins document 653-9907-100 (originally submitted for Type Approval of the VHF-900B in 1997). For completeness, these test results are included in this document.

While not required for this report, testing for FCC Part 15 Declaration of Conformity as a non-intentional radiator for the receiver portion of the VHF-920 is also by similarity to the VHF-900B.

2. TECHNICAL REPORT – EXHIBIT B

2.1 NAME OF APPLICANT

Rockwell Collins, Inc

400 Collins Road NW

Cedar Rapids, Iowa 52904

Applicant is manufacturer of the equipment

2.2 FCC IDENTIFICATION OF EQUIPMENT

VHF-920, Collins part number 822-1250-001

FCC ID: AJKPN822-1250

2.3 INSTALLATION MANUAL

Rockwell Collins, Inc. does not supply an instruction book with the VHF-920 transceiver. The transceiver is supplied to airframe manufacturers and airlines, and designed to meet the requirements of ARINC 716-8 and ARINC 750. Operating instructions are not necessary because the unit is part of a larger VHF communications system. Rockwell Collins does produce the VHF-920 Component Maintenance Manual, a comprehensive installation manual which, pursuant to an agreement with the FCC staff, is available upon request but in not included in this electronic exhibit.

2.4 TYPES OF EMISSIONS

When 25 kHz AM operation is selected, voice or analog data modes are enabled. The types of emissions on 25 kHz analog channels are:

5K00A3E and 10K00A3D

When 8.33 kHz AM operation is selected, only voice is enabled. The type of emission on 8.33 kHz analog channels is:

5K00A3E

When 25 kHz channel VDL Mode 2 operation is selected, the digital data mode is enabled. The transmit waveform is a 31.5 Kb/sec D8PSK signal using raised cosine filtering with excess bandwidth of 0.6. The type of emission on 25 kHz digital data channels is:

14K0G1DE

2.5 FREQUENCY RANGE

Frequency range: 118.000 through 136.975 MHz (including two 8.33 kHz channels at 136.98333 and 136.991633 KHz)

2.6 OPERATING POWER

AM voice and analog data modes - 30 watts carrier power (not adjustable by operator)

Minimum carrier power is 16 watts under any single aircraft normal environmental condition, to satisfy the requirements of airworthiness authorities.

VDL Mode 2 – 18 watts average power (not adjustable by operator)

Minimum average power is 15 watts under any single aircraft normal environmental condition, to satisfy the requirements of airworthiness authorities.

2.7 MAXIMUM POWER RATING

Part 87 of the FCC Rules and Regulations, Section 87.131, defines a maximum power rating of 55 watts for an Aircraft (Communication) Class of station. The VHF-920 does not exceed this limitation.

2.8 DC VOLTAGES AND CURRENTS

The VHF-920 utilizes a push-pull type of final PA stage. The DC voltage applied to the collectors of the final transistors is 27 VDC. Un-modulated DC current into the final amplifier stage typically total 4 amperes in voice and analog data modes. In VDL Mode 2, the modulated DC current into the final amplifier stages typically totals 3.7 amperes.

The emitters of A1Q3 and A1Q4 (the power output stages) are grounded.

The bases of A1Q3 and A1Q4 are connected to bias circuits. The extremely low base-circuit impedance and the critical circuit geometry make it impractical to attempt to measure the transistor base current. Introducing any available measuring device into the base circuit materially alters the operating conditions. Un-modulated RF power into the transistor bases is typically six watts.

2.9 TUNE UP PROCEDURE

Alignment procedures are included in the draft Production Test Requirement (PTR) attached to this report as Exhibit D. Both the FCC and the Federal Aviation Administration intend these procedures for use only by factory personnel or by avionics repairmen licensed. The only transmitter control available to the equipment operator (the aircraft pilot of other flight crew member is selection of the operating frequency channel.

2.10 DESCRIPTION OF CIRCUITRY

2.10.1 CIRCUIT SCHEMATICS

Major circuit schematics are attached to this report as Exhibit E.

2.10.2 GENERAL DESCRIPTION OF CIRCUITRY

The VHF-920 consists of 6 sub-assemblies; A1 VHF RF Assembly, A2 Signal Processor/Frequency Synthesizer Assembly, A3 System Processor Assembly, A4 Power Supply and I/O Assembly, A5 Rear Connector Interface Assembly, and A6 LED Indicator Assembly. For unit cost and production efficiencies, some versions of the VHF-920 will utilize a single A3 assembly that combines the functions of the A3 System Processor Assembly and the A4 Power Supply and I/O Assembly into one circuit card assembly (A3 Power Supply/System Processor) along with an auxiliary energy storage capacitor board (A4). The performance of the unit is the same with either configuration.

The VHF-920 power amplifier linearly amplifies the transmitter synthesizer output to a 25 watt (minimum) carrier power level for AM voice or analog data operation. The power output in VDL Mode 2 is a nominal 20 watts. Voice, analog data, or digital data is impressed on the input RF from the synthesizer in a vector (I-Q) modulator, used as a variable RF attenuator and phase modulator. A synchronous detector sampling the RF power output provides amplitude and phase (I-Q) feedback information to the vector modulator to linearize the amplitude and phase characteristics of the power amplifier. A low pass filter at the output attenuates the transmitter harmonics to a level at least 60 dB below the carrier level.

The VHF-920 receiver utilizes a dual conversion design. The receiver synthesizer injection is applied to the first mixer, generating a 20.125 MHz first IF frequency (high side injection). A second mixer, using the 19.6 MHz Frequency Synthesizer Reference (TCXO) as the Local Oscillator (LO), generates a 525 kHz second IF frequency which is amplified and then detected for AM voice, analog data, and digital data operation. For voice operation, a noise quieting squelch and carrier squelch is provided.

For receive operation, the VHF-920 frequency synthesizer is a single loop, TXCO reference controlled design and provides the receiver's first LO for any 25 kHz or 8.33 kHz channel selected in the 118.000 to 136.975 MHz frequency range. As preciously mentioned, the 19.6 MHz temperature compensated reference oscillator (TCXO) provides injection to the 2nd mixer.

A second, dedicated frequency synthesizer is used for transmit operation. It is a single loop, TXCO reference controlled design and provides the direct transmit frequency RF drive for any 25 kHz or 8.33 kHz channel selected in the 118.000 to 137.000 MHz frequency range to the vector modulator and RF power amplifier.

Both receive and transmit frequency synthesizers operate from a common 19.6 MHz TCXO that provides a frequency stability of better than 5 PPM over the operating temperature range of the VHF-920.

2.10.3 CIRCUITRY FOR DETERMINING AND STABILIZING FREQUENCY

Two frequency synthesizer circuits contained in the A2 Signal Processor/Frequency Synthesizer Assembly 676-7353-105 (see schematics in Exhibit E) provides frequency-stable excitation for all selectable transmit and receive frequencies.

A2U6, A2U27, and A2U37 accomplish most of the transmitter synthesizer functions in Transmit Synthesizer assembly. A2U6 is a multi-modulus prescaler, dividing the VCO output by values ranging from 16 to 32 as determined by the Modulated Fractional Divider controller, A2U27. The STRBOUT signal from A2U27 provides the variable signal to the phase detector, A2U37. The 1.96 MHz reference for the phase detector is provided by A2U19. The phase detector reference signal, 1.96MHZ_RX, is derived by dividing the 19.6 TCXO (Temperature compensated crystal oscillator) by ten.

The TCXO, A2U45, is a purchased component and will be within the operating frequency +/- 5 PPM over the –40 to +71 degree C operating range of the VHF-920. An internal adjustment permits setting the TCXO frequency to precisely 19.6 MHz during alignment.

The voltage controlled oscillator (VCO) A2U16 generates transmitter injection signals. The frequency of the oscillator is controlled by the DC output of the PLL loop lowpass filter (A2U10, A2U12, and associated components).

There are two RF outputs from the VCO. One provides the feedback signal to the prescaler A2U6. The other supplies the RF signal for amplification to the +20 dBm level by A2U24 and A2Q10.

The feedback signal is amplified by A2U35. This amplifier and the 20 dB attenuator provide isolation to maintain good spectral purity.

The microprocessor, A2U46 produces a serial data stream to program the counters in A2U27. This data is in binary format, based on the operating frequency selected by the aircraft flight crew. One portion of the data stream programs the modulus that determines the fractional MHz portion of the operating frequency. The remainder of the data stream programs another counter in A2U27 that determines the integer MHz portion of the operating frequency.

2.10.4 CIRCUITRY FOR SUPPRESSION OF SPURIOUS RADIATION

The low-pass filter A1A1 suppresses transmitter spurious radiator. This is located on the A1 RF Assembly and shown on schematic 828-5051-105. An additional low pass filter, common to both transmit and receive functions is in the common antenna cable from the unit. This filter provides additional filtering for transmitter harmonics in the 1.5 GHz GPS band.

2.10.5 CIRCUITRY FOR LIMITING MODULATION

Modulation limiting is achieved in the audio compressor that is implemented in software on the A2 Signal Processor/Frequency Synthesizer Assembly. As the compressor characteristic curves in this report show, this compressor circuit operates as a linear amplifier until the input signal reaches such level that the software begins to reduce the gain by mathematically scaling the internal digitally processed signal. The large dynamic range above the compression knee minimizes the possibility of over-modulation. To further assure that over-modulation cannot occur, the peak negative modulation signal is set in software to be equal to the maximum full scale reading of the 12 bit processor. This guarantees that the RF output cannot go to zero, even during severe overdrive of the audio input to the compressor.

2.10.6 CIRCUITRY FOR LIMITING POWER

The carrier power output is controlled by adjusting the DC component of the audio signal applied to the modulator controller, A1U1a on the RF assembly, 676-7351-105. This DC level is a service adjustment, no accessible to the operator.

A software controlled reduction of peak power occurs during times of low power supply voltage (less than 22.0 VDC) so to prevent distortion of the positive modulation peaks. This is also a service adjustment and not accessible to the operator.

Separate modulation adjustments are provided for 25 KHz channel and 8.33 KHz channel operation. The 25 KHz channel and 8.33 channel modulation levels are set in software by values written into non-volatile memory. This is a service adjustment and not accessible to the operator.

2.11 IDENTIFICATION PLATE

A drawing of the equipment nameplate is attached to this report as Exhibit F

2.12 PHOTOGRAPHS

External and Internal view photographs of the equipment are attached to this report as Exhibits G and H.

2.13 DIGITAL MODULATION TECHNIQUES

One of the Modulation formats of the VHF-920 is emission designator 14K0G1DE. This is a digital 31.5 kB/sec (10.5 Ksym/sec) D8PSK waveform using raised cosine shaping with excess bandwidth factor of 0.6.

The modulation waveform is generated in software by a Digital Signal Processor in complex form (I,Q) with 12 bit precision. 12 bit resolution D/A converter outputs at an 84 k/sample rate is filtered by a 2 section linear phase type low pass filter with –3 dB cutoff frequency of 8.5 kHz. The amplitude and phase response of the low pass filters is shown in Table 1.

Table 1

Frequency (Hz)	Amplitude (dBr)	Phase (Degrees)
100	0	-32
1000	0	-35
2000	-0.2	-40
3000	-0.3	-43
4000	-0.5	-46
5000	-1.5	-48
8500	-3	-50
10000	-4	-55
20000	-10	-70
100000	-30	-80

The filtered I, Q outputs are applied to a Vector (I,Q) modulator which creates the composite D8PSK waveform directly at the desired transmit frequency. Figure 1 show a typical I channel baseband modulation signal during transmission of a VDL Mode 2 message. The Q channel will be similar. Figure 2 shows the transmitted I and Q constellation showing the composite phase and amplitude characteristics produced by the I and Q signals.

Figure 1

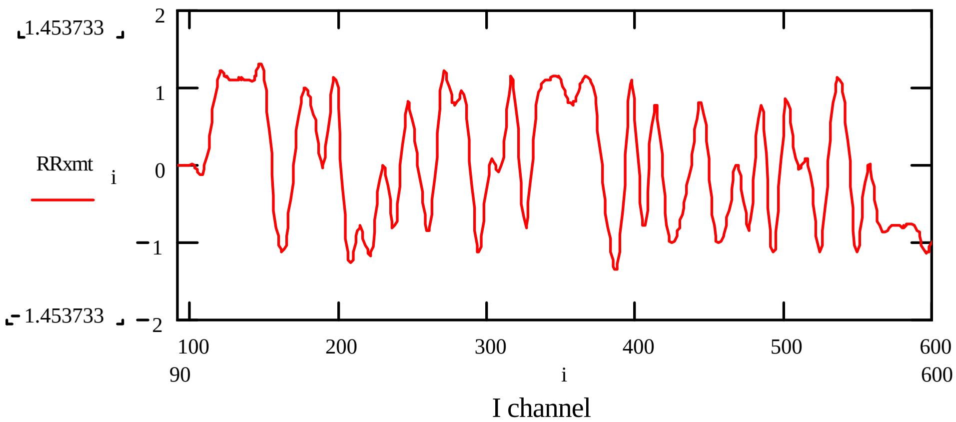
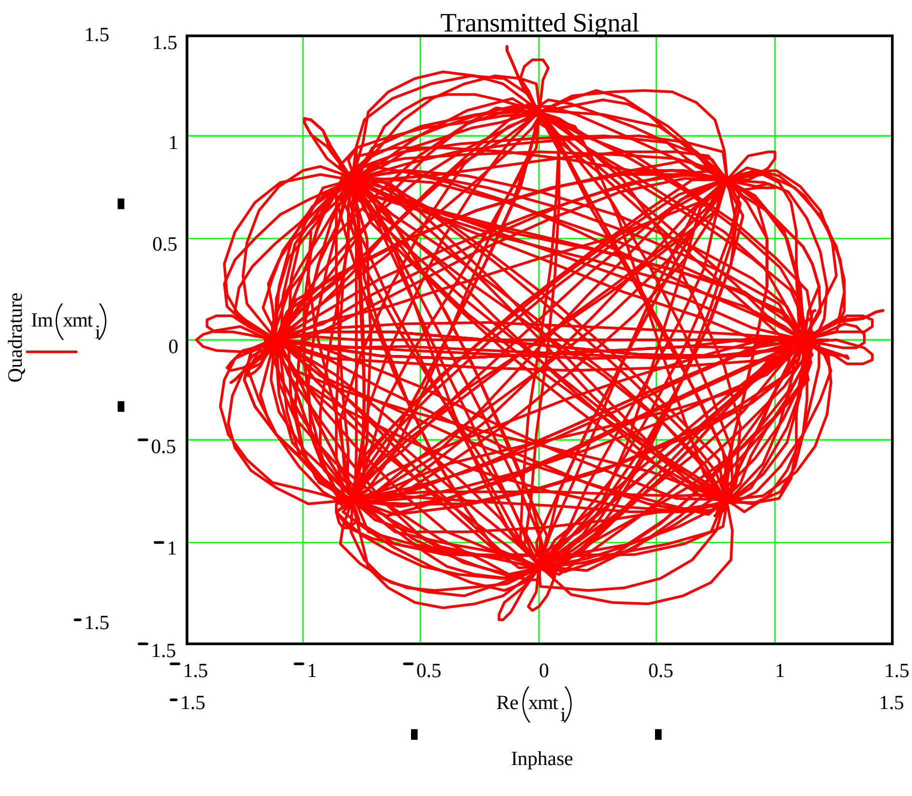


Figure 2



2.14 PERFORMANCE DATA

The data required by paragraphs 2.1046 through 2.1057, inclusive, of the FCC Rules and Regulations are in Exhibit I, titled “Transmitter Performance Tests”

3. INSTALLATION AND OPERATING INSTRUCTIONS – EXHIBIT C

Pursuant to an agreement with the FCC staff, the document is available upon request but in not included in this electronic exhibit

4. VHF-920 TUNE UP INSTRUCTIONS – EXHIBIT D

VHF-920 Production Test Requirements CPN: 815-1098-001

5. SCHEMATICS OF VHF-920 – EXHIBIT E

Description	Assembly	Schematic
A1 RF Assembly Card	676-7351-105	828-5051-105
A2 Signal Processor Card	676-7353-105	828-5053-105
A4 Combo Card	828-0676-101	828-5676-101
Daughter Card	828-1255-002	828-6255-002
A3 System Processor	676-7352-004	828-5052-004
A4 Power Supply	676-7356-002	828-5056-002

Note: Configuration can be either individual A3 and A4 assemblies or A4 “Combo” Assembly which combines functions of individual A3 and A4 assemblies.

6. NAMEPLATE LABEL DRAWING – EXHIBIT F

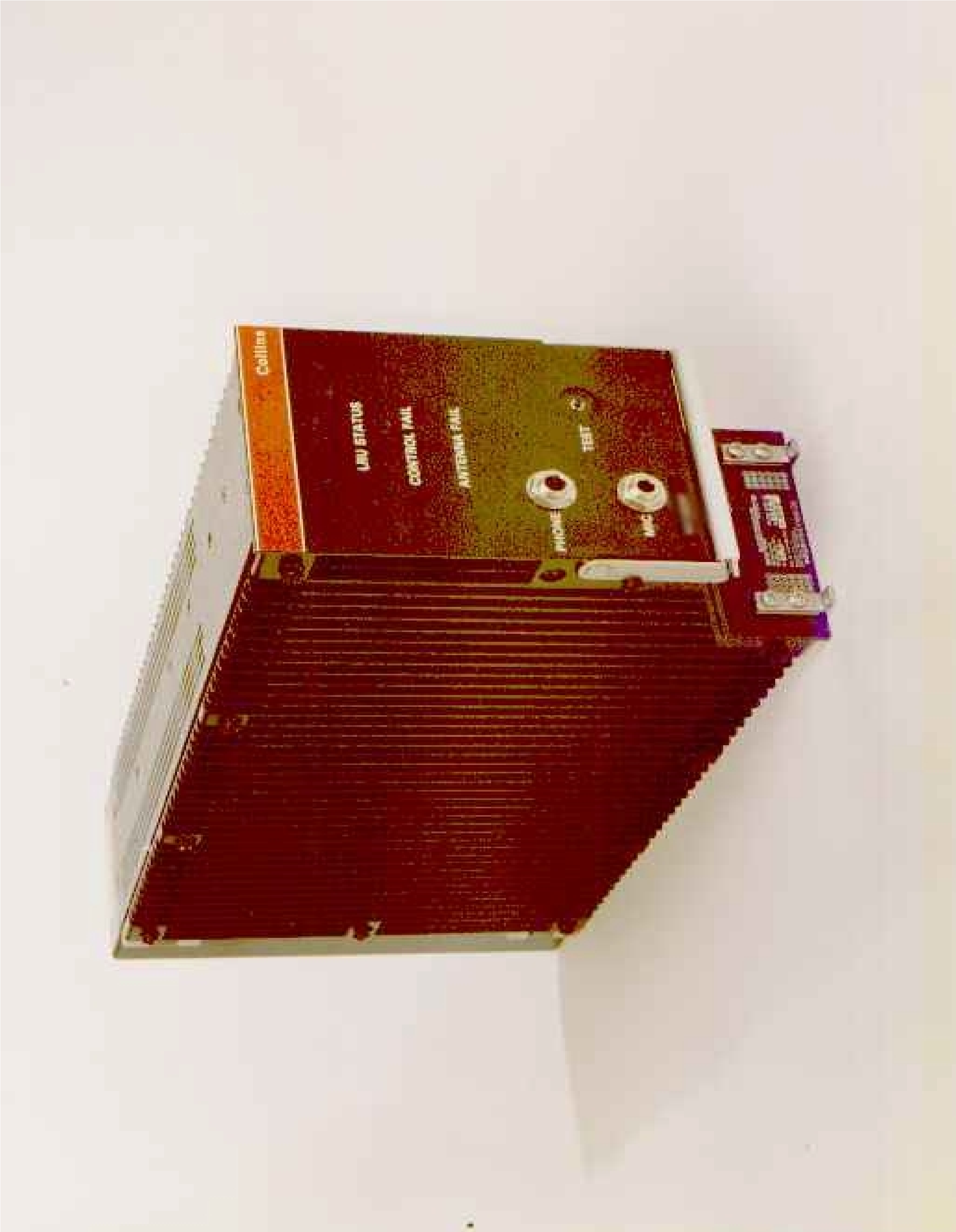
The nameplate appears on the front of the transceiver. Its location is identified in the photographs and the drawing 829-0413-002 included in this Exhibit. Note that FCC Identifier and FAA TSO Approval Information is not shown on the nameplate drawing prior to approval by regulatory agencies. This information will be placed between the Type Identifier and Collins Part Number when granted. A copy of the final nameplate drawing will be furnished on request.

7. EQUIPMENT PHOTOGRAPH - EXTERNAL VIEWS - EXHIBIT G

Photographs of VHF-920

Index of Photographs

Photo #	**Description**
1.jpg	Transceiver left with cover
2.jpg	Transceiver right with cover.
3.jpg	Transceiver rear view.



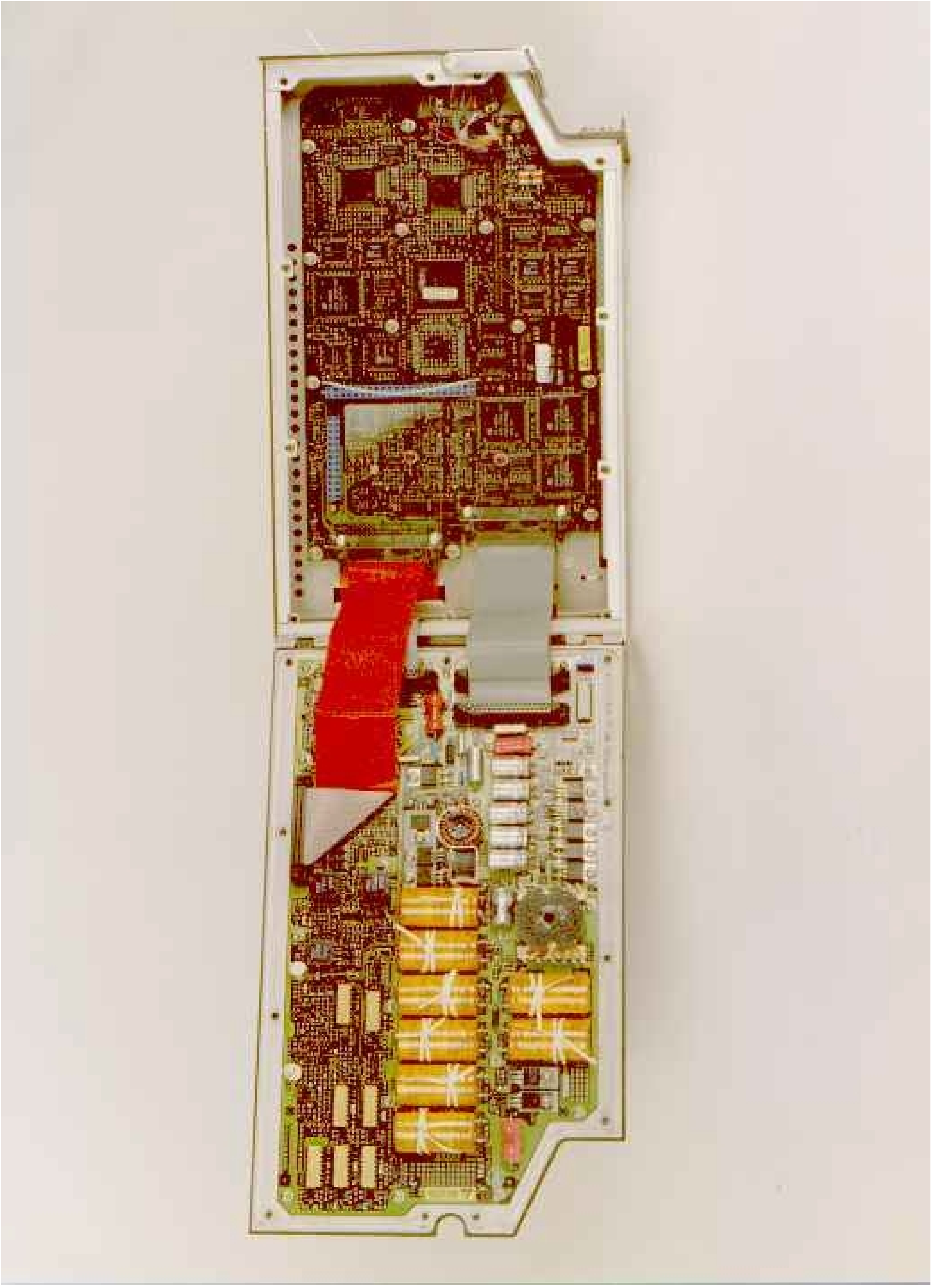

Collins
LRU STATUS
CONTROL FAIL
ANTENNA FAIL
TEST
PHONE
MIC

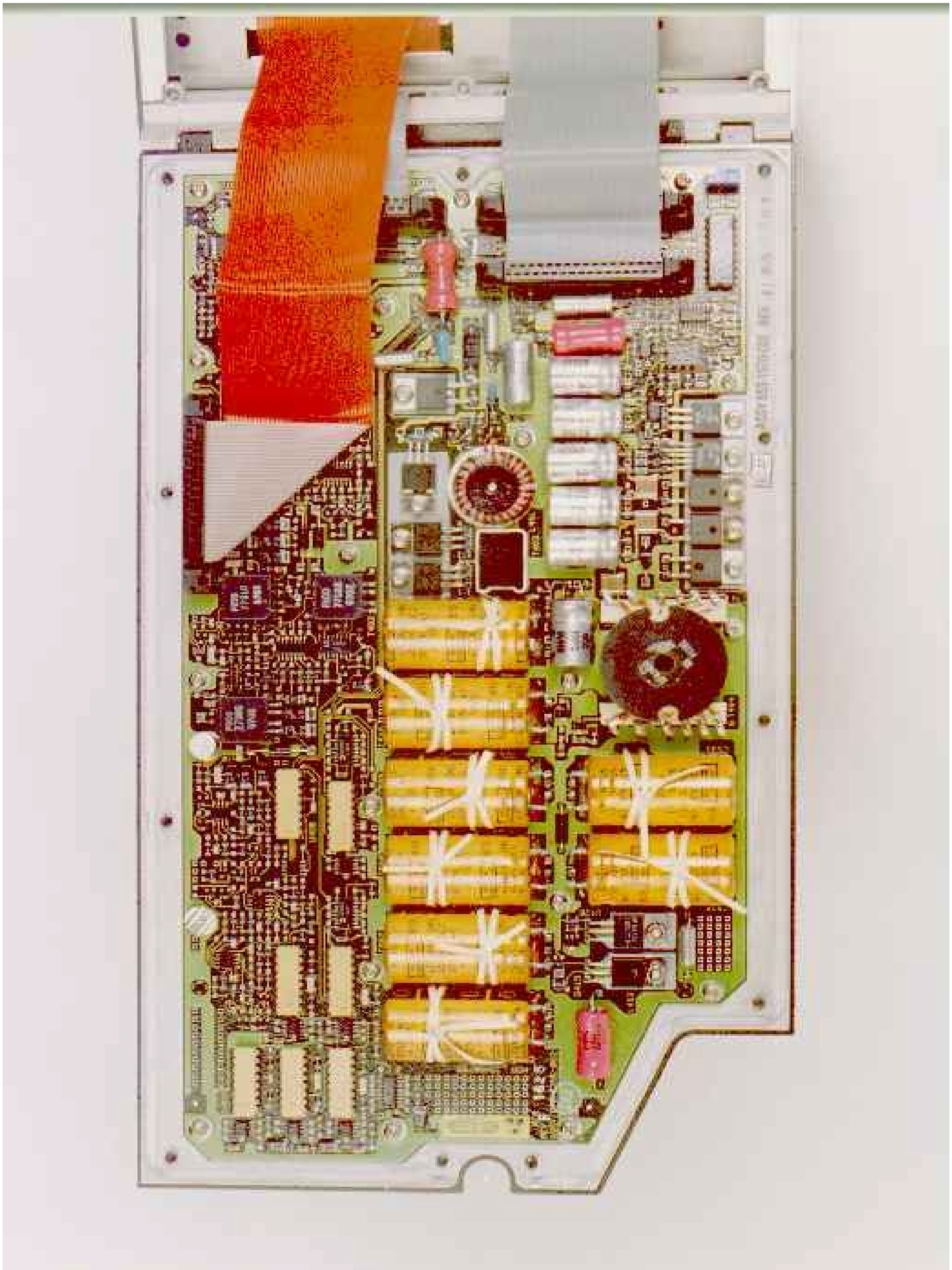
8. EQUIPMENT PHOTOGRAPH – INTERNAL VIEWS - EXHIBIT H

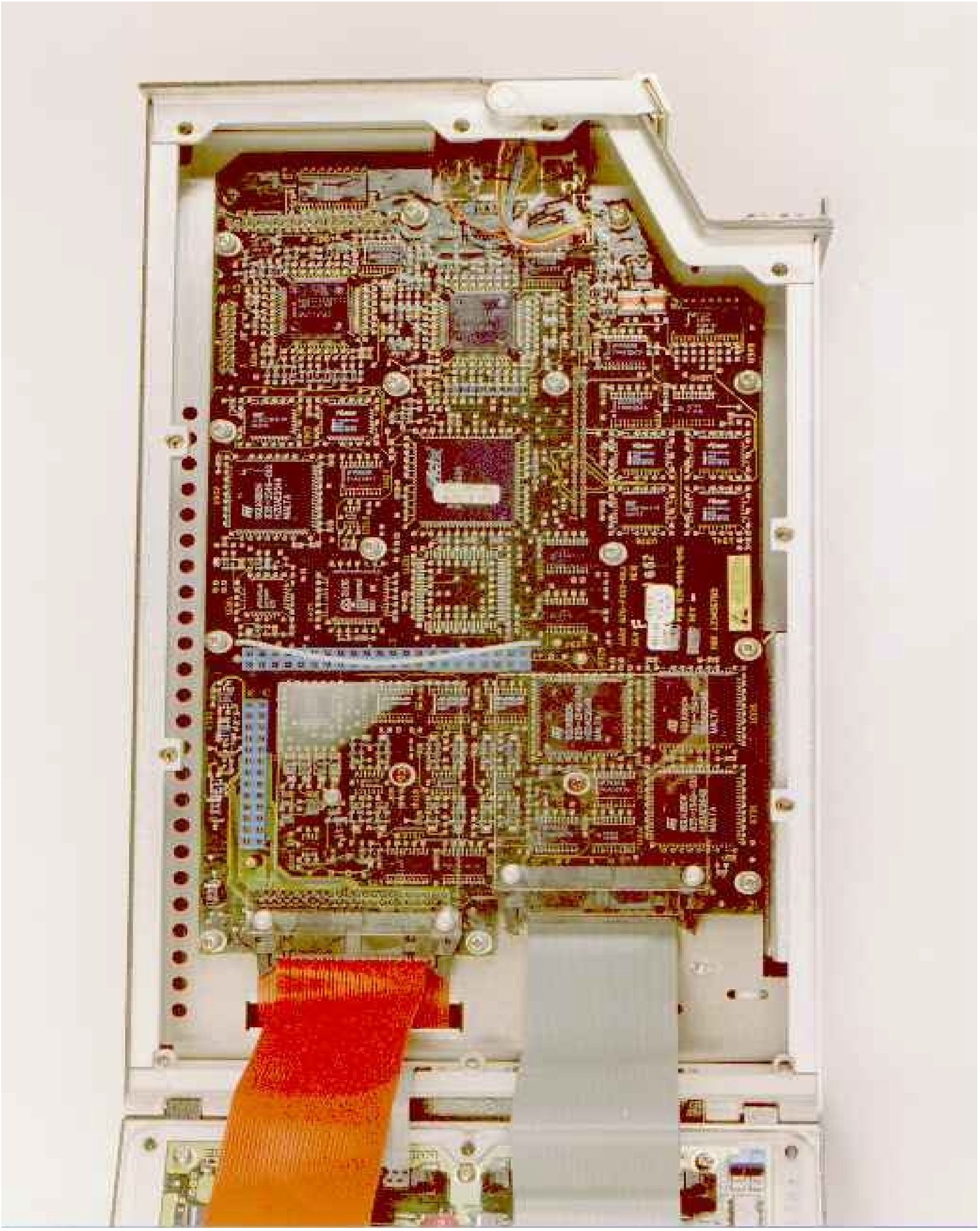
Photographs of VHF-920

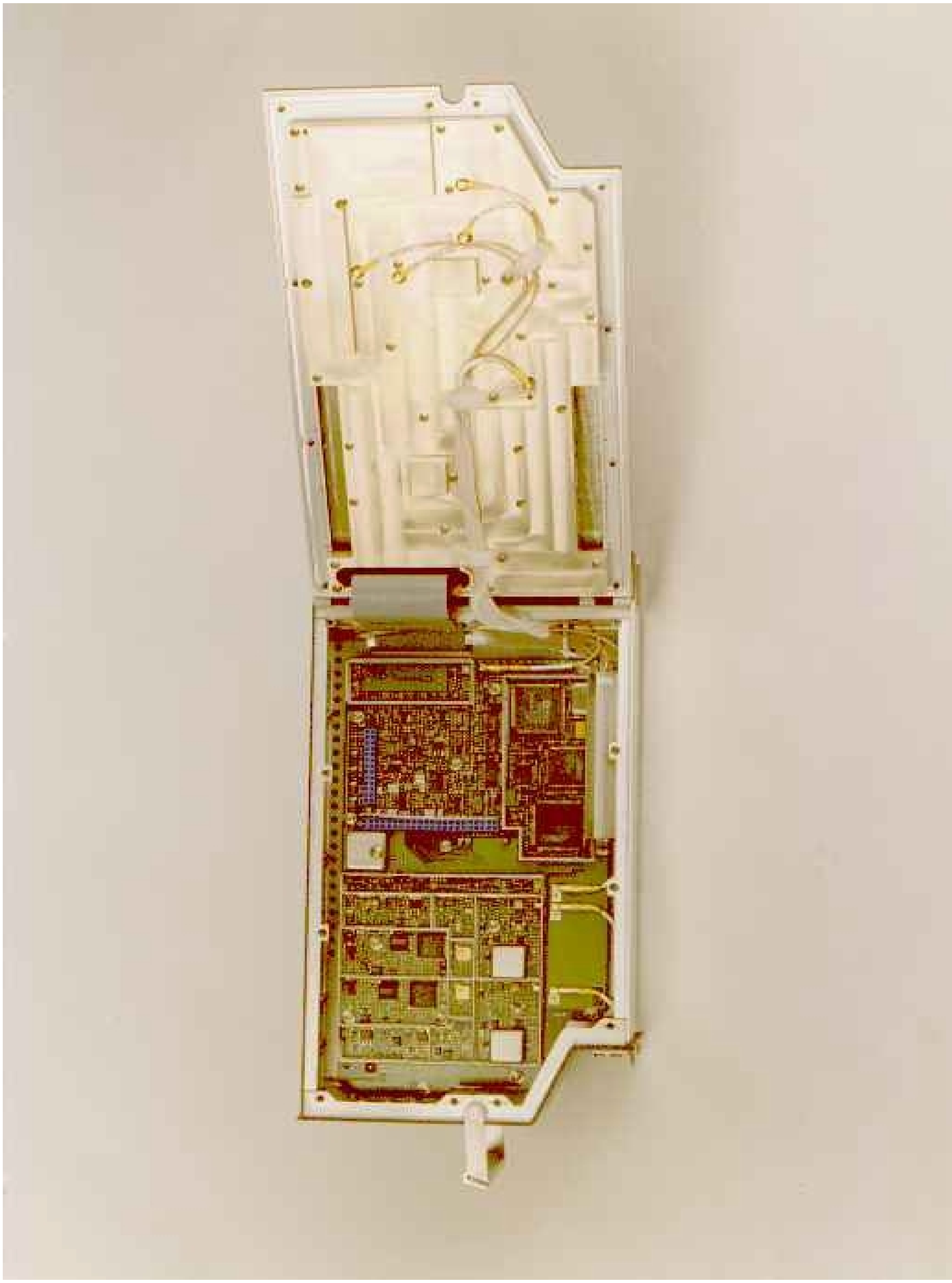
Index of Photographs

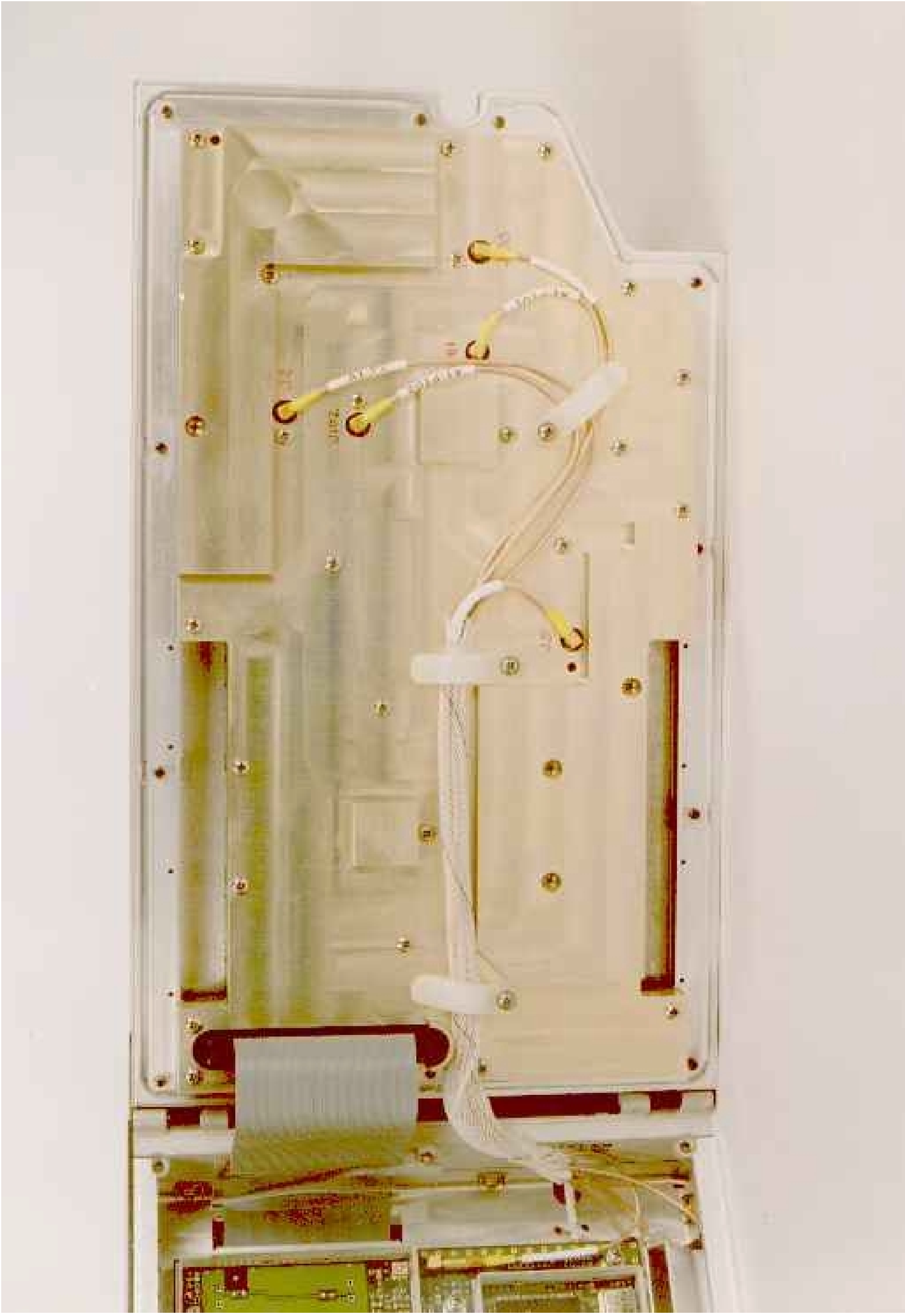
Photo #	Description
4.jpg	Transceiver front left cover open showing A4 Power Supply and I/O Assembly on left and A3 System Processor Assembly on right.
5.jpg	Close up of A4 Power Supply
6.jpg	Close up of A3 System Processor
7.jpg	Transceiver right side with cover open showing A2 Signal Processor/Frequency Synthesizer Assembly on left and A1 VHF RF Assembly on right.
8.jpg	Transceiver right side with close up of A1 VHF RF Assembly with cover .
9.jpg	Close up of A2 Signal Processor
10.jpg	Transceiver right side with close up of A1 VHF RF Assembly with cover removed
11.jpg	Transceiver front left cover open showing version with combined A3 Power Supply and I/O Assembly (“Combo”).
12.jpg	Close up of A3 Power Supply and I/O Assembly (“Combo” unit)
13.jpg	Close up of A1A1 Daughter Card, 828-1255-002
14.jpg	Transceiver front left cover open showing version with Capacitor Card used with A3 Power Supply and I/o Assembly (“Combo”)

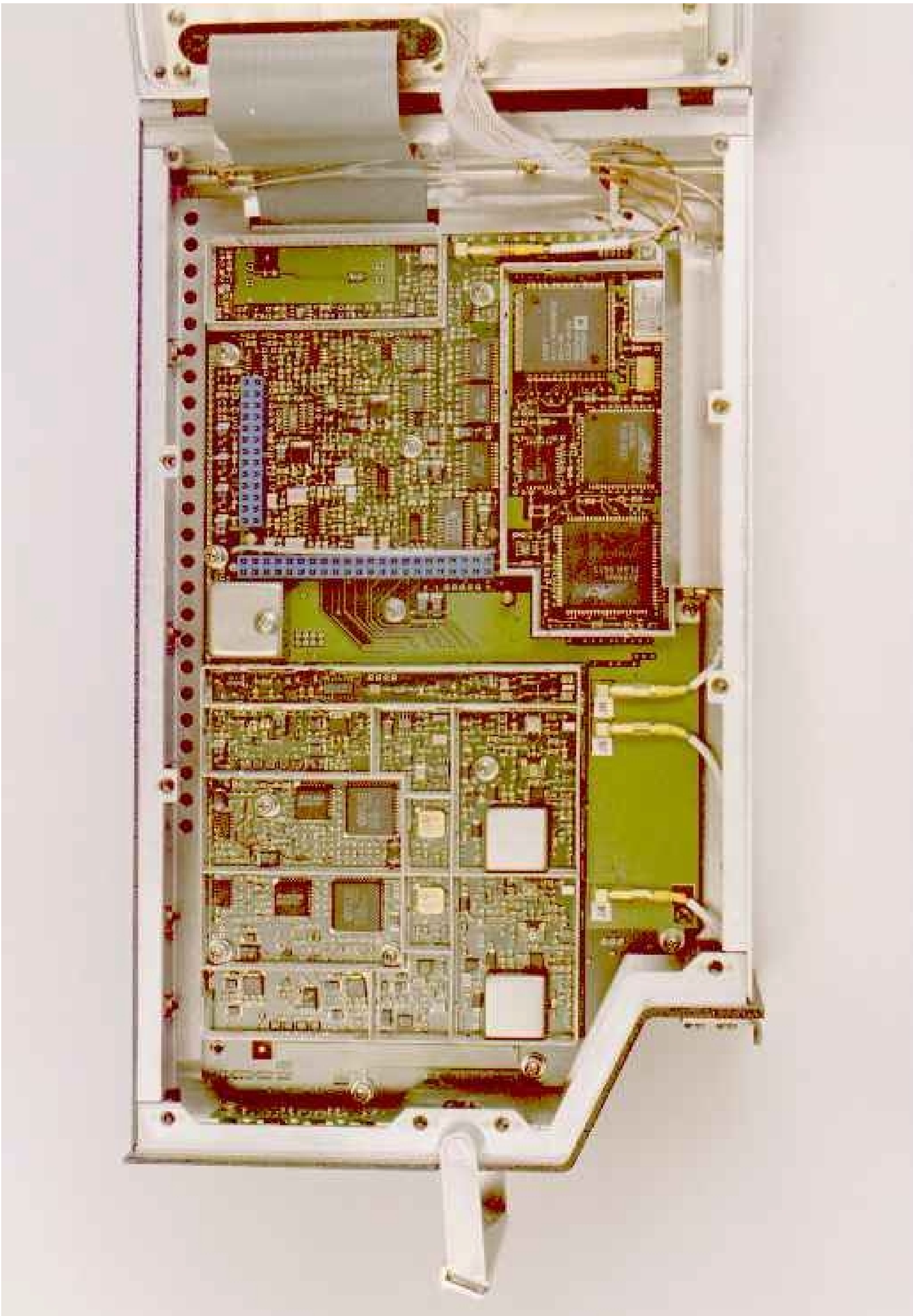


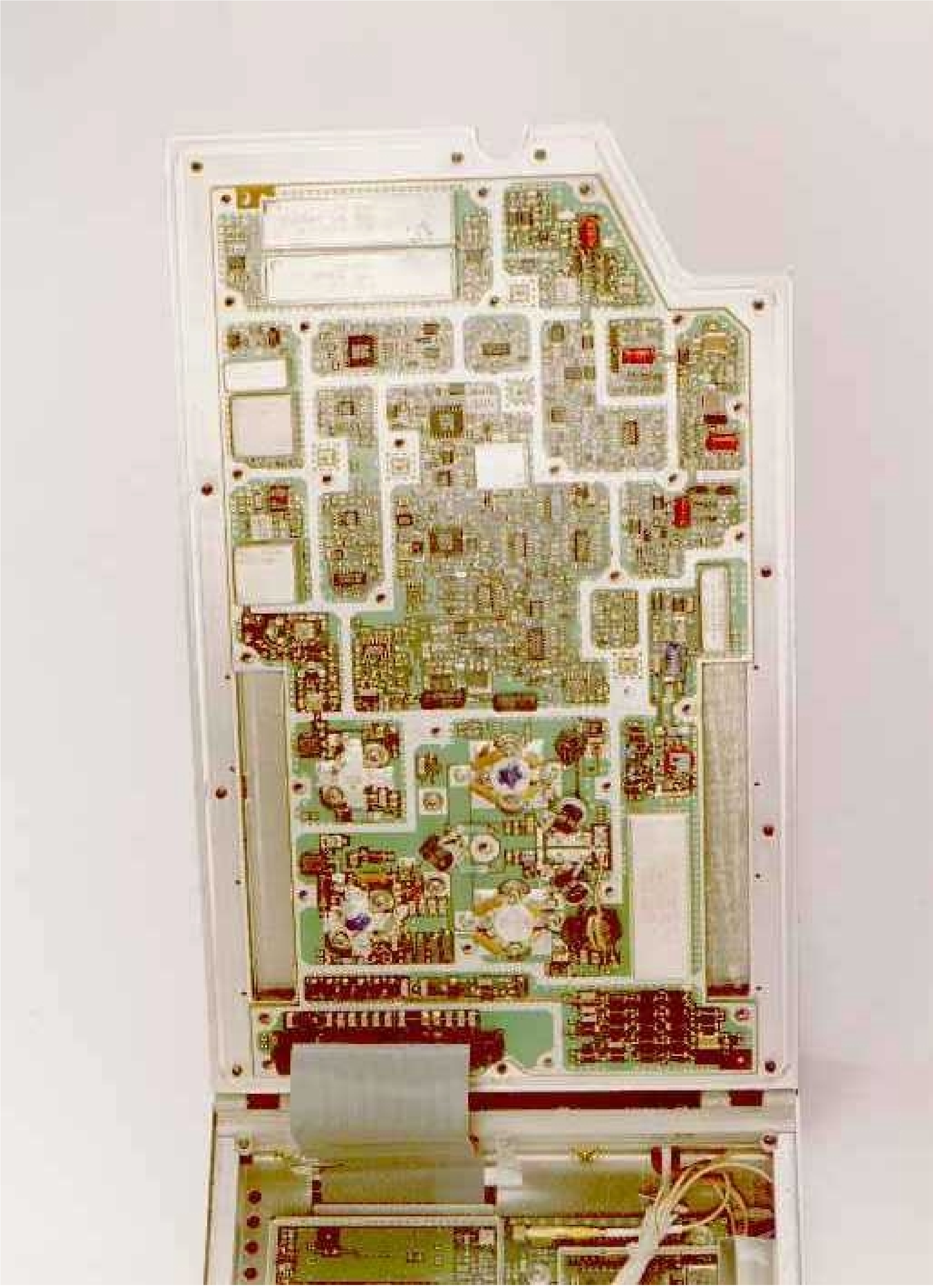


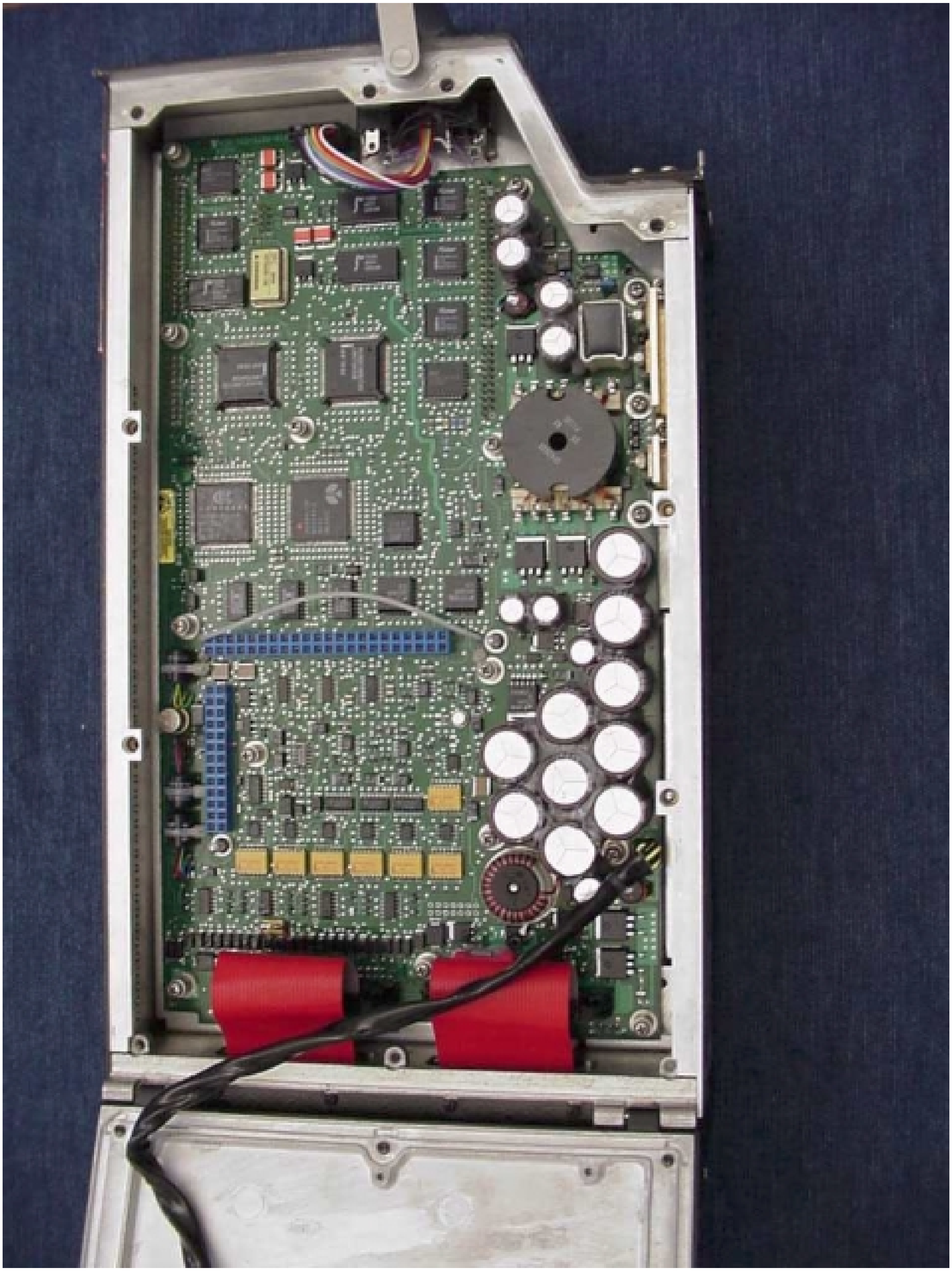


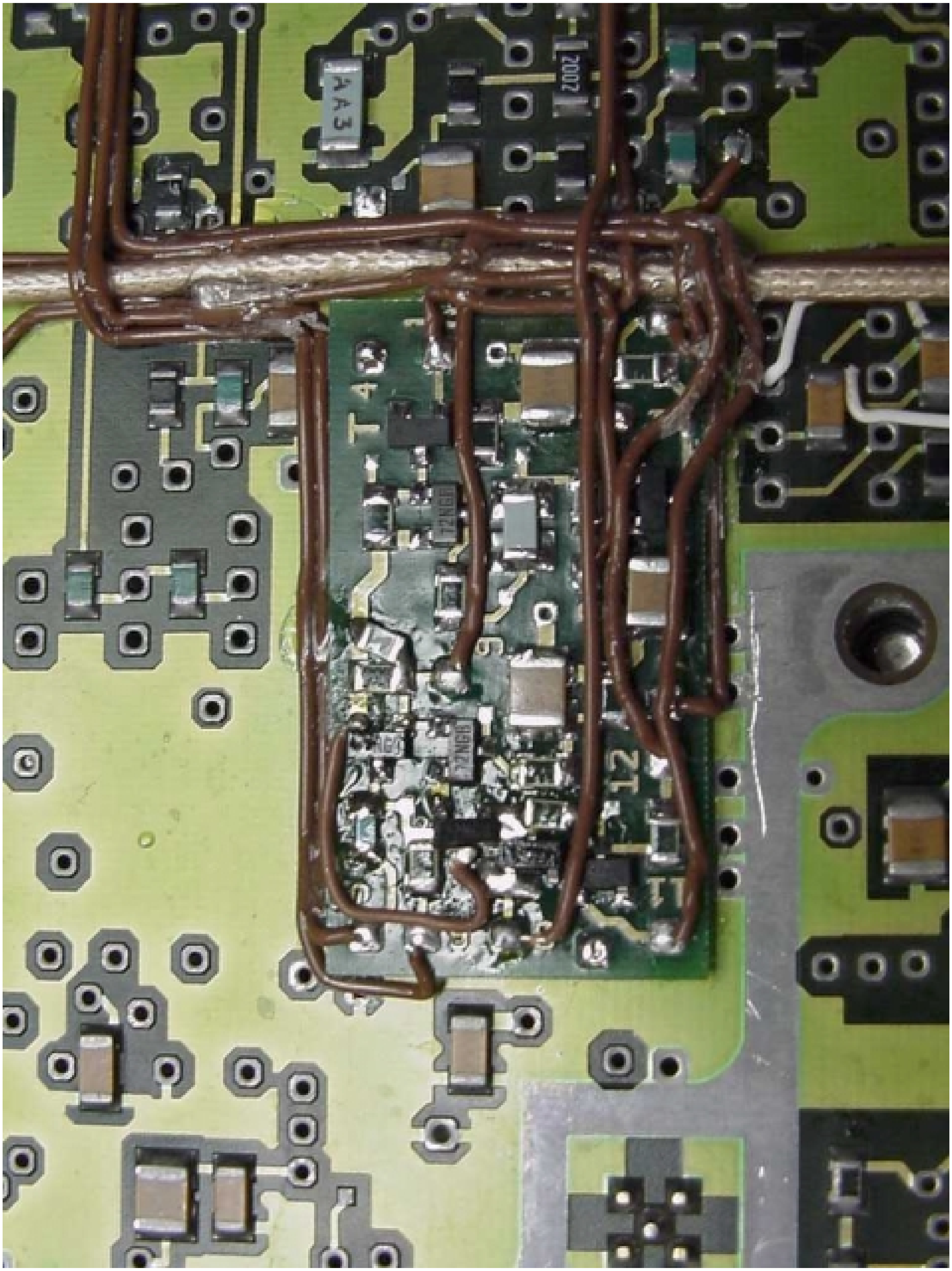












9. TRANSMITTER PERFORMANCE TESTS – EXHIBIT I

This section documents the test procedures used, and records the results of tests to demonstrate compliance with the applicable requirements of parts 2 and 87 of the FC Rules and Regulations.

9.1 RF POWER OUTPUT

9.1.1 REQUIREMENTS

FCC Sec. 2.1046

Measurements required: RF power output.

(a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in Sec. 2.1033(c)(8). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.

FCC 87.131

Power must be determined by direct measurement. The following lists authorized emissions and maximum power.

Class of Station	**Frequency Band**	**Emissions**	**Power**
Aircraft (Communications)	VHF	A3E, A9W	55 w

The power is measured at the transmitter output terminals and the type of power is determined according to the emission designator as follows:

> Mean power (pY) for amplitude modulated emissions and transmitting both sidebands using unmodulated full carrier.

Power is restricted to the minimum necessary to achieve the required service.

9.1.2 TEST PROCEDURE

The VHF-920 was adjusted in accordance with the tune-up instructions. Primary power supply was set to 27.5 VDC. Unmodulated carrier power was measured at carrier frequency intervals beginning at 118.000 MHz.

The RF load for these measurements was a Bird 30 dB attenuator with an HP435B Power Meter. The characteristics of the attenuator and Power Meter were measured with an HP8753C network analyzer and 856046A S-Parameter test set. A plot of the Smith Chart display, from 118 to 137 MHz, follows the power data, and shows that the load is a essentially 50 ohms resistive over this frequency range.

9.1.3 TEST RESULTS

The data sheet that follows is from the original test on the VHF-900B (predecessor to VHF-920) in AM mode and shows power measurements across the band covered by this transmitter. The power level is the same for 25 kHz channels as it is for 8.33 kHz channels. Part 87 of the FCC Rules does not define a maximum authorized power. The measured power output is typical of that provided in VHF transceivers for commercial aircraft.

The second data sheet which follows is from new tests on the VHF-920 in digital data VDL Mode 2 and shows power measurements across the band covered by this transmitter. The measured power output is typical of that provided in VHF transceivers for commercial aircraft for VDL Mode 2 operations.

9.1.4 POWER OUTPUT DATA SHEET

Type Number:	**VHF-900B**	Serial Number:	**E576**
Date Tested:	**6/23/97**	Tested by:	**Jerry Chetwynd**

Frequency	Tx Power Output	
118.000 MHz	29	Watts
122.000 MHz	30	Watts
125.000 MHz	30.5	Watts
129.000 MHz	30	Watts
131.000 MHz	30	Watts
133.000 MHz	31	Watts
136.975 MHz	29.5	Watts

Type Number:	**VHF-920 VDL MODE 2**	Serial Number: 6800
Date Tested:	**8/03/00**	Tested by: R. Kautz

Frequency (MHz)	Tx Power Output	
118.000	18	Watts
122.000	18	Watts
125.000	18	Watts
129.000	18	Watts
131.000	18	Watts
133.000	18	Watts
136.975	18	Watts

9.1.5 RF LOAD CHARACTERISTICS

Frequency (MHz)	RF Load VSWR
118.000	1.05:1
122.000	1.05:1
125.000	1.05:1
129.000	1.05:1
131.000	1.05:1
133.000	1.05:1
136.975	1.05:1

9.2 MODULATION CHARACTERISTICS

9.2.1 REQUIREMENTS

FCC Sec. 2.1047

Measurements required: Modulation characteristics.

(a) Voice modulated communication equipment. A curve or equivalent data showing the frequency response of the audio modulating circuit over a range of 100 to 5000 Hz shall be submitted. For equipment required to have an audio low-pass filter, a curve showing the frequency response of the filter, or of all circuitry installed between the modulation limiter and the modulated stage shall be submitted.

(b) Equipment which employs modulation limiting. A curve or family of curves showing the percentage of modulation versus the modulation input voltage shall be supplied. The information submitted shall be sufficient to show modulation limiting capability throughout the range of modulating frequencies and input modulating signal levels employed.

FCC Sec. 87.141

Modulation requirements.

(a) When A3E emission is used, the modulation percentage must not exceed 100 percent. This requirement does not apply to emergency locator transmitters or survival craft transmitters.

(b) A double sideband full carrier amplitude modulated radiotelephone transmitter with rated carrier power output exceeding 10 watts must be capable of automatically preventing modulation in excess of 100 percent.

9.2.2 TEST PROCEDURE

Frequency Response Data

The audio generator is set to 1000 Hz, and its level adjusted to 0.25 Vrms. The transmitter modulation was adjusted to produce 90% modulation on the 25 kHz channels and 85% modulation on the 8.33 kHz channels. While maintaining this input level, the modulation depth is recorded over the frequency range of 100 Hz to 5000 Hz.

Compression Characteristic Data

Next, with audio generator set to 1000 Hz, the modulation depth was recorded for audio generator output levels over the range of 10 mVrms to 1.0 Vrms. This procedure was repeated at modulating frequencies of 100 Hz, 350 Hz, 2500 Hz, and 5000 Hz.

9.2.3 TEST RESULTS

The data following represents the results of these measurements of modulation frequency response and compressor limiting characteristics on the baseline VHF-920 (predecessor to VHF-920).

The data sheet that follows is from the original test on the VHF-900B (predecessor to VHF-920)

Type Number:	**VHF-900B**	Serial Number:	**576**
Date Tested:	**6/23/97**	Tested by:	**Jerry Chetwynd**

Frequency Response Data

	25 KHz Channel, 126.600 MHz		**8.33 KHz Channel, 126.500 MHz**	
Frequency (Hz)	Modulation Depth (%)	Relative Response (dB)	Modulation Depth (%)	Relative Response (dB)
100	33	-11.2	33.8	-11.2
350	83.9	-0.88	84.6	-0.8
600	93.6	0	94	0
1000	93	0	93	0
1500	93.6	-0.1	93.6	-0.1
2000	93	0	93	0
2500	92	0.1	92	0.1
3000	46	-6.1	46	-6.1
4000	1.5	-24	1.5	-24
5000	1.2	-26	1.2	-26

Compression Characteristic Data

Frequency: 100 Hz

Input Level (mVrms)	**25 KHz Channel, 126.500 MHz** Modulation Depth (%)	**8.33 KHz Channel, 126.500 MHz** Modulation Depth (%)
10	1.3	1.3
20	1.8	1.8
30	2.1	2.1
40	2.6	2.6
60	3.8	3.8
80	4.9	4.9
100	6.2	6.5
150	8.8	9.0
300	16.4	16.5
600	31.3	31.0
1000	52.4	52.5

Frequency: 350 Hz

Input Level (mVrms)	**25 KHz Channel, 126.500 MHz** Modulation Depth (%)	**8.33 KHz Channel, 126.500 MHz** Modulation Depth (%)
10	3.2	3.0
20	4.3	4.1
30	6.1	5.5
40	7.1	6.8
60	10.1	9.8
100	14.9	12.4
150	21.2	15.0
300	41.6	42.0
600	78.0	78.5
1000	95	95.5

Frequency: 600 Hz

	25 KHz Channel, 126.500 MHz	**8.33 KHz Channel, 126.500 MHz**
Input Level (mVrms)	Modulation Depth (%)	Modulation Depth (%)
10	3.3	3.4
20	5.0	4.9
30	6.0	6.2
40	7.5	7.4
60	10.0	9.5
80	12.5	12.6
100	15.5	15.8
150	23	23
300	47	46.5
600	93	92
1000	95.3	95

Frequency: 1000 Hz

	25 KHz Channel, 126.500 MHz	**8.33 KHz Channel, 126.500 MHz**
Input Level (mVrms)	Modulation Depth (%)	Modulation Depth (%)
10	2.8	2.4
20	3.7	3.6
30	5.2	5.2
40	7.0	7.2
60	10.2	10.0
80	16	15.5
100	17	16.5
150	25	24.5
300	52	50
600	94.9	94.5
1000	96	95.1

Frequency: 2000 Hz

Input Level (mVrms)	**25 KHz Channel, 126.500 MHz** Modulation Depth (%)	**8.33 KHz Channel, 126.500 MHz** Modulation Depth (%)
10	2.6	2.4
20	6.3	6.5
30	5.9	6.0
40	6.9	7.3
60	12.4	15.1
80	17	16.9
100	20	19.8
150	27	26.6
300	52	51.5
600	94.5	94
1000	95	95.1

Frequency: 3000 Hz

Input Level (mVrms)	**25 KHz Channel, 126.500 MHz** Modulation Depth (%)	**8.33 KHz Channel, 126.500 MHz** Modulation Depth (%)
10	1.57	1.40
20	2.38	2.19
30	3.0	4.0
40	4.9	4.3
60	6.0	6.0
80	7.1	9.0
100	11	9.2
150	12.8	14.4
300	25.5	25.7
600	47	47
1000	46.5	47

Frequency: 4000 Hz

	25 KHz Channel, 126.500 MHz	**8.33 KHz Channel, 126.500 MHz**
Input Level (mVrms)	Modulation Depth (%)	Modulation Depth (%)
10	1.63	1.20
20	1.73	1.54
30	1.93	1.40
40	1.80	1.56
60	1.50	1.30
80	1.40	1.60
100	1.45	0.80
150	0.70	0.60
300	0.70	0.72
600	0.90	0.90
1000	0.60	0.60

Frequency: 5000 Hz

	25 KHz Channel, 126.500 MHz	**8.33 KHz Channel, 126.500 MHz**
Input Level (mVrms)	Modulation Depth (%)	Modulation Depth (%)
10	0.71	0.80
20	0.70	0.75
30	0.70	0.80
40	0.80	0.80
60	0.70	0.80
80	0.90	1.0
100	0.80	0.80
150	0.80	0.80
300	0.90	0.90
600	1.0	0.90
1000	0.70	0.60

9.3 OCCUPIED BANDWIDTH

9.3.1 REQUIREMENTS

FCC Sec. 2.1049

Measurements required: Occupied bandwidth.

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the following conditions as applicable:

(c) Radiotelephone transmitters equipped with a device to limit modulation or peak envelope power shall be modulated as follows. For single sideband and independent sideband transmitters, the input level of the modulating signal shall be 10 dB greater than that necessary to produce rated peak envelope power.

(1) Other than single sideband or independent sideband transmitters--when modulated by a 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50 percent modulation. The input level shall be established at the frequency of maximum response of the audio modulating circuit.

FCC Sec. 87.135

Bandwidth of emission.

(a) Occupied bandwidth is the width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to 0.5 percent of the total mean power of a given emission.

(b) The authorized bandwidth is the maximum occupied bandwidth authorized to be used by a station.

(c) The necessary bandwidth for a given class of emission is the width of the frequency band which is just sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions.

FCC 87.137

In the band, 117.975-136 MHz, the authorized bandwidth is 25 KHz for all transmitter type accepted after 1 January 1974.

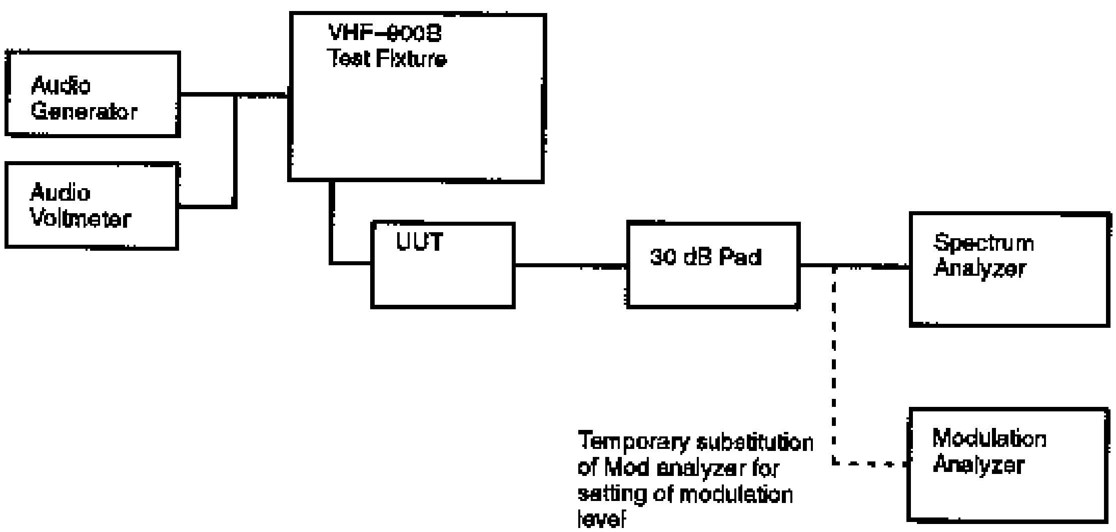
9.3.2 TESTS FOR TYPE 5K00A3E EMISSIONS

The VHF-920 is capable of 5K00A3E emissions on 25 kHz and 8.33 KHz spaced channels. The following tests demonstrate the occupied bandwidth for 25 kHz and 8.33 KHz channels is less than 25 KHz. The following test demonstrates the occupied bandwidth for 8.33 KHz channel operation is less than 8.33 KHz. It also demonstrates that operation on 8.33 KHz channels will have an occupied bandwidth of less than or equal to 5.0 KHz.

9.3.2.1 TEST PROCEDURE

With the radio tuned to 126.5 MHz (25 kHz channel) and at the frequency of maximum response, the audio input level required to produce 50% modulation was determined by temporarily substituting a modulation analyzer for the spectrum analyzer (see test set-up below). The modulating frequency was then set to 2500 Hz, and the input level was 16 dB above that level determined above.

The transmitted spectrum was then displayed with resolution sufficient to resolve adjacent sidebands. The spectral data were recorded and converted to relative power levels. These data were then analyzed to determine the occupied bandwidth such that no more than 0.5 percent of the total radiated power occupied the spectrum above or below this band.

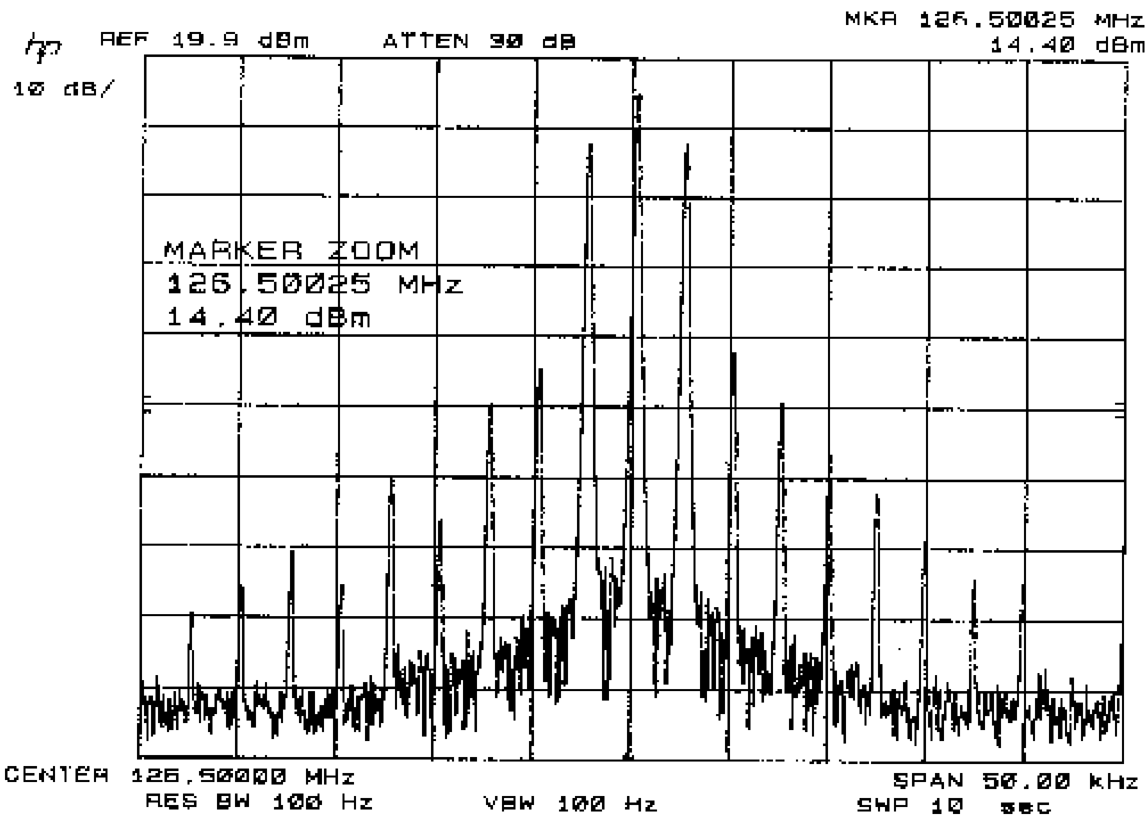


The test was repeated on 126.505 (8.33 kHz channel on 126.500 MHz) using modulating tones of 2500 Hz.

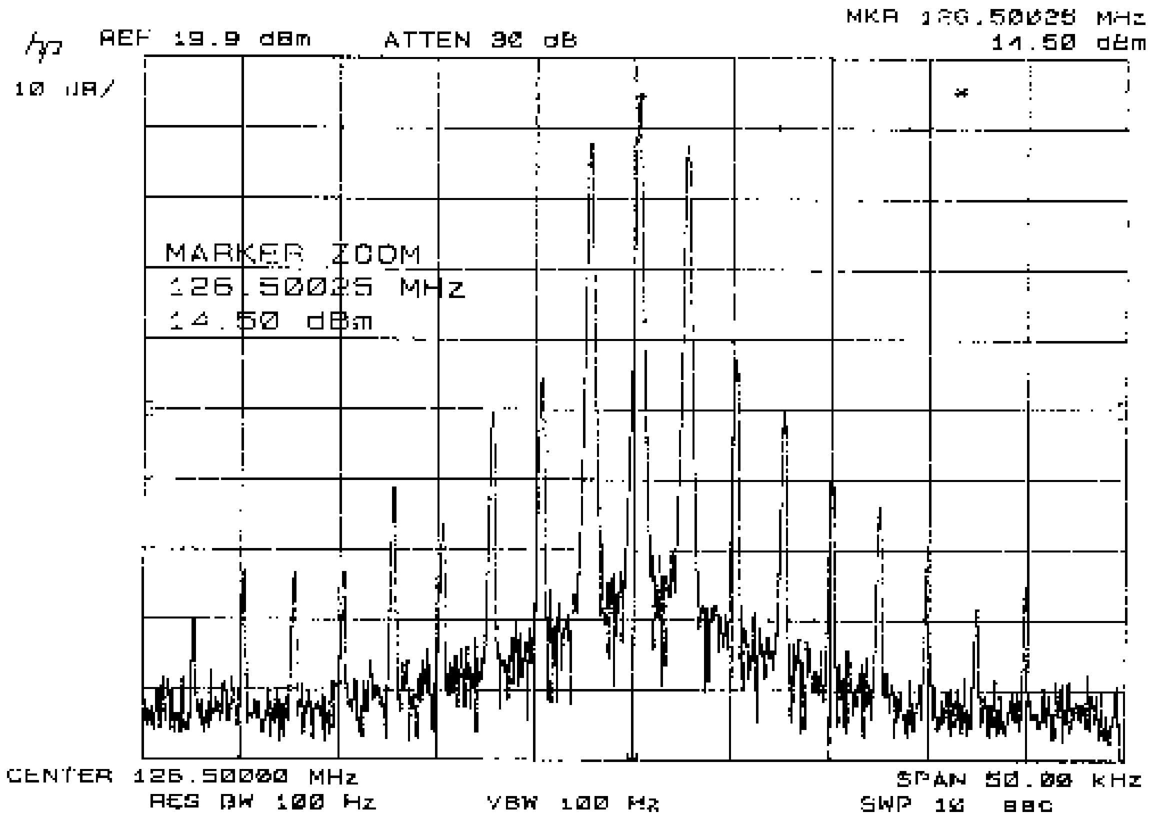
9.3.2.2 TEST RESULTS

The occupied bandwidth is 5 kHz. The plots shown below show the radiated spectrum. The data that follows also shows the measurements and calculations. The data sheet that follows is from the original test on the VHF-900B (predecessor to VHF-920)

25 KHz channel & 2.5 KHz Mod tone



8.33 KHz channel & 2.5 KHz Mod tone



Occupied Bandwidth Data Sheet

Type Number: **VHF-900B**

Serial Number: **E576**

Date tested: **6/23/97**

Tested by: **Jerry Chetwynd**

25 KHz channel & 2.5 KHz Mod tone

Carrier Power = **30.5 watts**

Frequency 126.500 MHZ

Frequency (MHz)	Relative Level (dBc)	Absolute Power (Watts)	% Power outside ±2.5KHz
126.5125	**-56.50**	6.6 E-5	.018667%
126.5100	**-51**	2.344 E-4	
126.5075	**-43.8**	1.23 E-3	
126.5050	**-36.7**	6.31 E-3	
126.5025	**-6.8**	6.166	
126.5000	**0**	2.951 E1	Occupied BW 5 KHz
126.4975	**-6.7**	6.31	
126.4950	**-39.4**	3.388 E-3	
126.4925	**-44.1**	1.148 E-3	
126.4900	**-60.7**	2.51 E-5	
126.4875	**-54.9**	9.55 E-5	.011089%

Total Power = 42.00011 watts

0.5% of total power = 0.21 watts

Power over +/- 2.5 KHz = 41.98762 watts

Percent of total power over =/- 2.5 KHz = 99.970%

Occupied Bandwidth Data Sheet

Type Number: **VHF-900B** Serial Number: **E576**

Date tested: **6/23/97** Tested by: **Jerry Chetwynd**

8.33 KHz channel & 2.5 KHz Mod tone

Carrier Power = **30.5 watts** **Frequency 126.500 MHZ**

Frequency (MHz)	Relative Level (dBc)	Absolute Power (Watts)	% Power outside ±2.5KHz
126.5125	**-57.8**	**4.898 E-5**	(.015849%)
126.5100	**-52.4**	1.698 E-4	
126.5075	**-44.6**	1.023 E-3	
126.5050	**-37.4**	5.37 E-3	
126.5025	**-7**	5.888	
126.5000	**0**	2.951 E1	Occupied BW 5 KHz
126.4975	**-6.7**	6.311	
126.4950	**-39.9**	3.020 E-3	
126.4925	**-45.0**	9.33 E-4	
126.4900	**-61.2**	2.239 E-5	
126.4875	**-55.9**	7.586 E-5	.009711%

Total Power = 41.72077 watts 0.5% of total power = 0.208 watts

Power over +/- 2.5 KHz = 41.71312 watts

Percent of total power over =/- 2.5 KHz = 99.982%

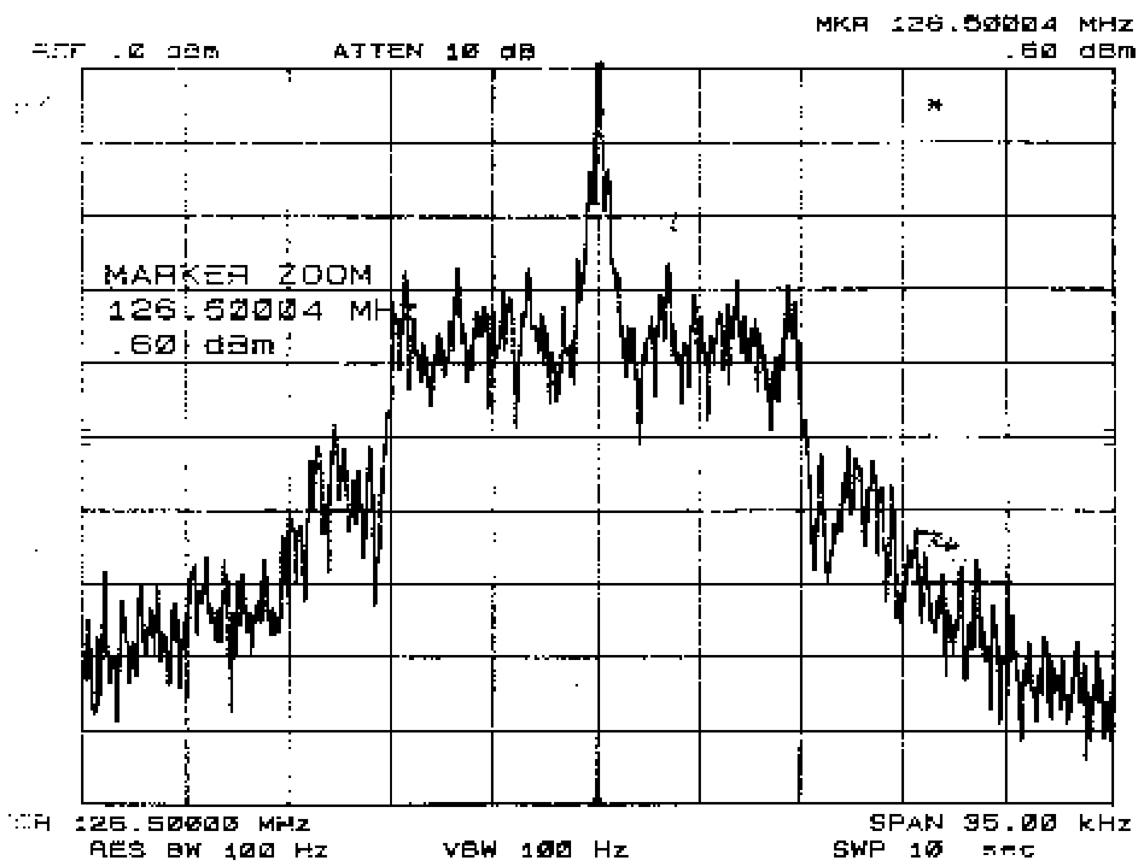
9.3.3 TESTS FOR TYPE 10K0A3D EMISSIONS

9.3.3.1 TEST PROCEDURE

A test generator simulating a standard Aviation Data MODEM (Collins Type DLM-700) was connected to the analog data terminals of the unit. This MODEM provides 2400 bits per second MSK data at a nominal 1 V RMS which is the specified nominal level for data audio into the VHF-920. With continuous random data being transmitted from the ACARS MODEM, the transmitted spectrum was displayed. The spectral data were recorded and converted to relative power levels. These data were then analyzed to determine the occupied bandwidth such that no more than 0.5 percent of the total radiated power occupied the spectrum above or below this band.

9.3.3.2 TEST RESULTS

The occupied bandwidth is 10 KHz. The photo below shows the radiated spectrum. The data sheet that follows show the measurements and calculations. The data sheet that follows is from the original test on the VHF-900B (predecessor to VHF-920)



Occupied Bandwidth Data Sheet

Type Number: **VHF-900B** Serial Number: **E576**

Date tested: **6/23/97** Tested by: **Jerry Chetwynd**

25 KHz channel & Modulating using MODEM

Carrier Power = **30.5 watts** **Frequency 126.500 MHZ**

Frequency (MHz)	Relative Level (dBc)	Absolute Power (Watts)	% Power outside ±2.5KHz
126.5125	**-68.00**	4.677 E-6	(0.001324 %)
126.5100	**-55.00**	9.33 E-5	
126.5075	**-50.00**	2.95 E-4	
126.5050	**-29.0**	3.715 E-2	
126.5025	**-27.00**	5.88 E-2	
126.5000	**0**	2.951 E1	Occupied BW 10 KHz
126.4975	**-27.76**	4.943 E-2	
126.4950	**-29.00**	3.71 E-2	
126.4925	**-50.00**	2.951 E-4	
126.4900	**-55.00**	9.333 E-5	
126.4875	**-68.00**	4.677 E-6	(0.001324%)

Total Power = 29.69550 watts 0.5% of total power = 0.148 watts

Power over +/- 5 KHz = 29.69471 watts

Percent of total power over =/- 5 KHz = 99.997%

9.3.4 TESTS FOR TYPE 14K0G1DE EMISSIONS

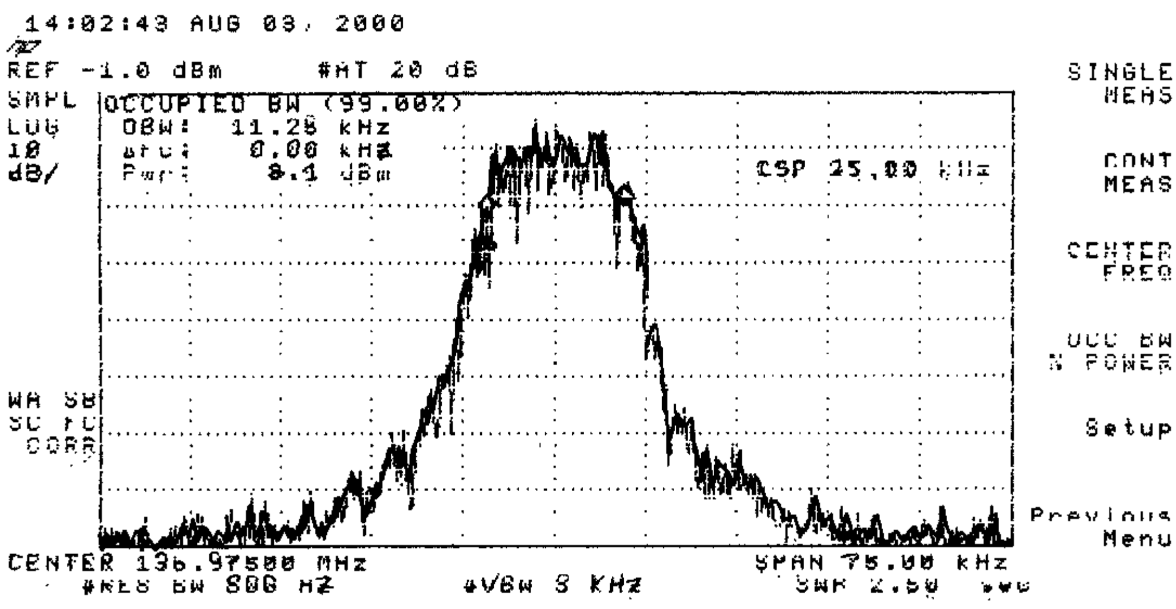
9.3.4.1 TEST PROCEDURE

The transceiver was configured to generate a continuous transmission with random characters. With continuous random data being transmitted, the transmitted spectrum was displayed. The spectral data were recorded and converted to occupied channel bandwidth by software within the Hewlett Packard Model 8594E spectrum analyzer. This instrument determines the occupied bandwidth such that 0.5 percent of the total radiated power occupies the spectrum above and 0.5 percent below this band.

9.3.4.2 TEST RESULTS

The photo below shows the radiated spectrum. The measured occupied bandwidth is 11.28 kHz which is less than the declared 14 kHz bandwidth associated with the emission designator 14K0G1DE. The emission designator bandwidth was selected by VDL Mode 2 Industry committees at 14 kHz to allow for variances in bandwidth due to hardware and software implementations.

Type Number:	**VHF-920 VDL MODE 2**	Serial Number: 6800
Date Tested:	**8/03/00**	Tested by: R. Kautz



9.4 SPURIOUS EMISSIONS AT ANTENNA TERMINAL

9.4.1 REQUIREMENTS

FCC Sec. 2.1051

Measurements required: Spurious emissions at antenna terminals.

The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in Sec. 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

FCC Sec. 2.1057

Frequency spectrum to be investigated.

(a) In all of the measurements set forth in Secs. 2.1051 and 2.1053, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the frequency shown below:

(1) If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

(b) Particular attention should be paid to harmonics and subharmonics of the carrier frequency as well as to those frequencies removed from the carrier by multiples of the oscillator frequency. Radiation at the frequencies of multiplier stages should also be checked.

(c) The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.

FCC 87.139 (a)

The mean power of any emissions shall be attenuated below the mean output power of the transmitter (pY) as follows:

(1) When the frequency is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth the attenuation shall be at least 25 dB.

(2) When the frequency is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth the attenuation shall be at least 35 dB.

(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth the attenuation for aircraft station transmitters shall be at least 40 dB; and the attenuation of aeronautical station transmitters must be at least 43 +10 * $\log_{10}$(pY) dB.

9.4.2 TEST PROCEDURE

At the frequency of maximum response, the audio input level required to produce 50% modulation was determined by temporarily substituting a modulation analyzer for the spectrum analyzer (see test set-up for modulation characteristics measurements). The modulating frequency was then set to 2500 Hz, and the input level was set 16 dB above that level determined above. The transmitted spectrum was then examined with resolution sufficient to verify that on spurious output exceeded the allowable level. The spectrum was examined to beyond the tenth harmonic.

9.4.3 TEST RESULTS

No spurious output exceeded the allowable level. The following data sheets show the results of the measurements. The data sheet that follows is from the original test on the VHF-900B (predecessor to VHF-920)

Spurious Emissions Data Sheet

Type Number: **VHF-900B** Serial Number: **576**

Date tested: **6/23/97** Tested by: **Jerry Chetwynd**

Measurement at **118.000 MHz** Carried Power = **29 watts**

Maximum allowable power for any spurious emission: **-60 dBc**

Spurious Emission Frequency	**Relation to Carrier**	**DB Below Carrier**
236.0 MHz	2nd harmonic	-83.7
354.0 MHz	3rd harmonic	-89.7
472.0 MHz	4th harmonic	-83.9
590.0 MHz	5th harmonic	-103.9
708.0 MHz	6th harmonic	-104.9
826.0 MHz	7th harmonic	-99.4
944.0 MHz	8th harmonic	-94.9
1062.0 MHz	9th harmonic	-91.9

No non-harmonic spurious emission was noted.

Spurious Emissions Data Sheet

Type Number: **VHF-900B**

Serial Number: **576**

Date tested: **6/23/97**

Tested by: **Jerry Chetwynd**

Measurement at **127.000 MHz**

Carried Power = **30 watts**

Maximum allowable power for any spurious emission: **-60 dBc**

Spurious Emission Frequency	**Relation to Carrier**	**dB below Carrier**
254.0 MHz	2^{nd} harmonic	-83.4
381.0 MHz	3^{rd} harmonic	-90
508.0 MHz	4^{th} harmonic	-90.7
635.0 MHz	5^{th} harmonic	-110
762.0 MHz	6^{th} harmonic	-98.4
889.0 MHz	7^{th} harmonic	-92.9
1016.0 MHz	8^{th} harmonic	-88.6
1143.0 MHz	9^{th} harmonic	-91.4

No non-harmonic spurious emission was noted.

Spurious Emissions Data Sheet

Type Number: **VHF-900**

Serial Number: **576**

Date tested: **6/23/97**

Tested by: **Jerry Chetwynd**

Measurement at **136.975 MHz**

Carried Power = **29.5 watts**

Maximum allowable power for any spurious emission: **-60 dBc**

Spurious Emission Frequency	**Relation to Carrier**	**dB below Carrier**
273.95 MHz	2nd harmonic	91.5
410.925 MHz	3rd harmonic	91.3
547.9 MHz	4th harmonic	97.5
684.875 MHz	5th harmonic	102.6
821.85 MHz	6th harmonic	96.3
958.825 MHz	7th harmonic	91.1
1095.8 MHz	8th harmonic	93.8
1232.775 MHz	9th harmonic	94.2

No non-harmonic spurious emission was noted.

9.5 FIELD STRENGTH OF SPURIOUS RADIATION

9.5.1 REQUIREMENTS

FCC Sec. 2.1053

Measurements required: Field strength of spurious radiation.

(a) Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For equipment operating on frequencies below 890 MHz, an open field test is normally required, with the measuring instrument antenna located in the far-field at all test frequencies. Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from half-wave dipole antennas.

(b) The measurements specified in paragraph (a) of this section shall be made for the following equipment:

(1) Those in which the spurious emissions are required to be 60 dB or more below the mean power of the transmitter.

(2) (2) All equipment operating on frequencies higher than 25 MHz.

FCC Sec. 2.1057

Frequency spectrum to be investigated.

(a) In all of the measurements set forth in Secs. 2.1051 and 2.1053, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the frequency shown below:

(1) If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

(b) Particular attention should be paid to harmonics and subharmonics of the carrier frequency as well as to those frequencies removed from the carrier by multiples of the oscillator frequency. Radiation at the frequencies of multiplier stages should also be checked.

(c) The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.

FCC 87.139 (a)

The mean power of any emissions shall be attenuated below the mean output power of the transmitter (pY) as follows:

(1) When the frequency is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth the attenuation shall be at least 25 dB.

(2) When the frequency is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth the attenuation shall be at least 35 dB.

(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth the attenuation for aircraft station transmitters shall be at least 40 dB; and the attenuation for aeronautical station transmitters must be at least $43 + 10 * \log_{10}(pY)$ dB.

9.5.2 TEST PROCEDURE

This test was performed on an open-field range meeting the requirements of ANSI Standard c63.4-1992. Testing was performed in Rubicom Systems, Inc., 284 West Drive, Melbourne FL. Rockwell Collins supplied the VHF-900B unit to be tested, mounting tray, cables, interface unit and power supply. Rubicom supplied radiated measuring equipment (calibrated antennae and spectrum analyzer) and measurement platform.

9.5.3 TEST RESULTS

The test report indicates the requirements were met. The test report from Rubicom Systems, Inc. is in Exhibit K. Note: Test report is from the original test on the VHF-900B (predecessor to VHF-920)

9.6 FREQUENCY STABILITY

9.6.1 REQUIREMENTS

FCC Sec. 2.1055 (a)

Measurements required: Frequency stability.

(a) The frequency stability shall be measured with variation of ambient temperature as follows:

(2) From -20 deg. to +50 deg. centrigrade for equipment to be licensed for use in the Maritime Services under part 80 of this chapter, except for Class A, B, and S Emergency Position Indicating Radiobeacons (EPIRBS), and equipment to be licensed for use above 952 MHz at operational fixed stations in all services, stations in the Local Television Transmission Service and Point-to-Point Microwave Radio Service under part 21 of this chapter, and equipment licensed for use aboard aircraft in the Aviation Services under part 87 of this chapter.

FCC 2.1055 (b)

Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10 deg. centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.

FCC 2.1055 (d)

The frequency stability shall be measured with variation of primary supply voltage as follows:

(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

(2) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying at the nominal supply voltage and at each extreme also shall be shown.

FCC 87.133 (a)

The carrier frequency of each station in the Aviation Services shall be maintained with the following percentage of the assigned frequency:

Band – 100 to 137 MHz

Aircraft stations – 30 ppm (+/- 4109 Hz at test frequency of 136.975 MHz)

9.6.2 TEST PROCEDURE

Frequency Stability with Temperature

The transceiver was tuned to 136.975 Mhz. Due to the nature of the frequency synthesizer design, any frequency error will be the highest at this operating frequency. Chamber air temperature was adjusted to –20 degrees C, and maintained for at least thirty minutes to allow circuit element stabilization before data were taken. The transmitter was then keyed, and the steady state frequency was recorded.

To observe the keying transient, the transmitter output signal was mixed with the output of a signal generator. The signal generator frequency was adjusted to produce a low audio-frequency beat note against the transmitter steady-state frequency. The beat frequency was observed on an oscilloscope, triggered when the transmitter was keyed.

This procedure was repeated at 10 degrees C intervals to +50 degrees c. Steady state frequency measurements were taken every 10 degrees C. Keying transient measurements were taken at the temperature extremes and at 25 degrees C.

Frequency Stability with Supply Voltage

This transceiver is intended for operation in 27.5 VDC electrical systems. Steady-state and transient frequency measurements were made at nominal supply voltage, and at 85% and 115% of nominal voltage. The transceiver was tuned to a frequency of 136.975 MHz. These measurements were made at nominal room temperature.

9.6.3 TEST RESULTS

The requirements were met. The data sheets show steady-state frequency at each temperature and line voltage. The oscilloscope photographs show the beat frequency as a function of time, after keying the transmitter, between the transmit frequency and a stable reference oscillator offset 1 KHz from 136.975000 MHz. No keying transients were observable. The data that follows is from the original test on the VHF-900B (predecessor to VHF-920)

Frequency Stability Data Sheet

Type Number:	**VHF-900B**	Serial Number:	**576**
Data Tested	**6/26/97**	Tested by:	**Jerry Chetwynd**

Frequency Stability with Temperature

Temperature	Measured Frequency (MHz)	Frequency Error
-20 ° C	**136.974955**	**45**
-10 ° C	**136.975010**	**10**
-0 ° C	**136.975000**	**0**
+10 ° C	**136.974960**	**40**
+20 ° C	**136.974990**	**10**
+30 ° C	**136.975035**	**35**
+40 ° C	**136.975110**	**110**
+50 ° C	**136.975120**	**120**

Maximum Allowable Frequency Error = 4109 Hz

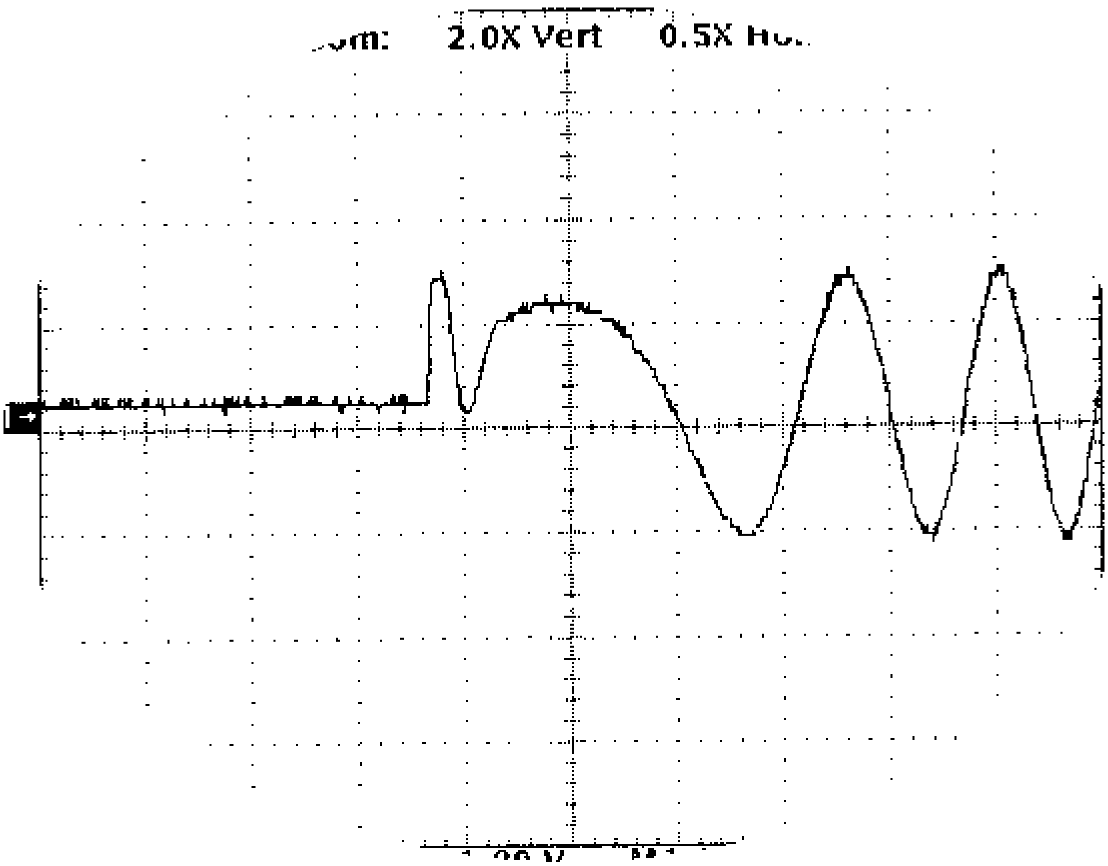
Frequency Stability with Supply Voltage

Supply Voltage	Measured Frequency	Frequency Error (Hz)
23.38 Vdc (85%)	**136.974998**	**1**
27.50 Vdc	**136.974999**	**1**
31.63 Vdc (115%)	**136.974999**	**1**

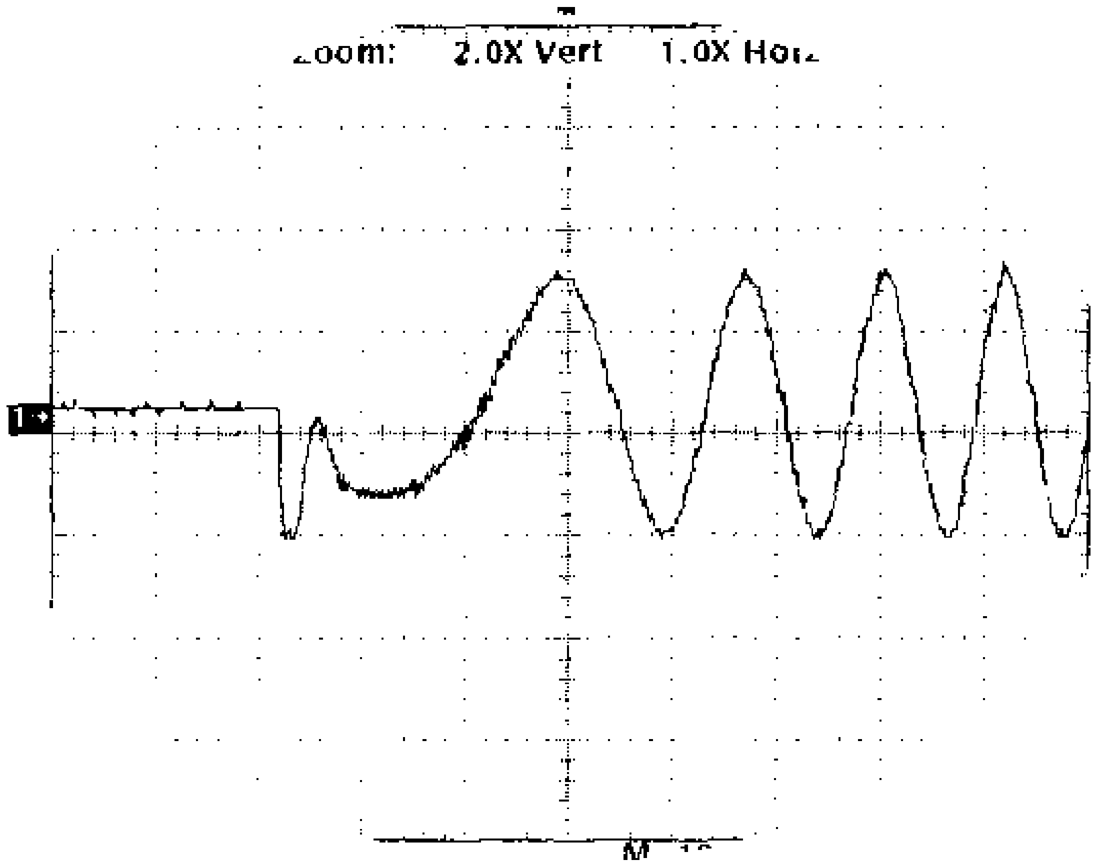
Maximum Allowable Frequency Error – 4109 Hz

Keying Transients with Temperature

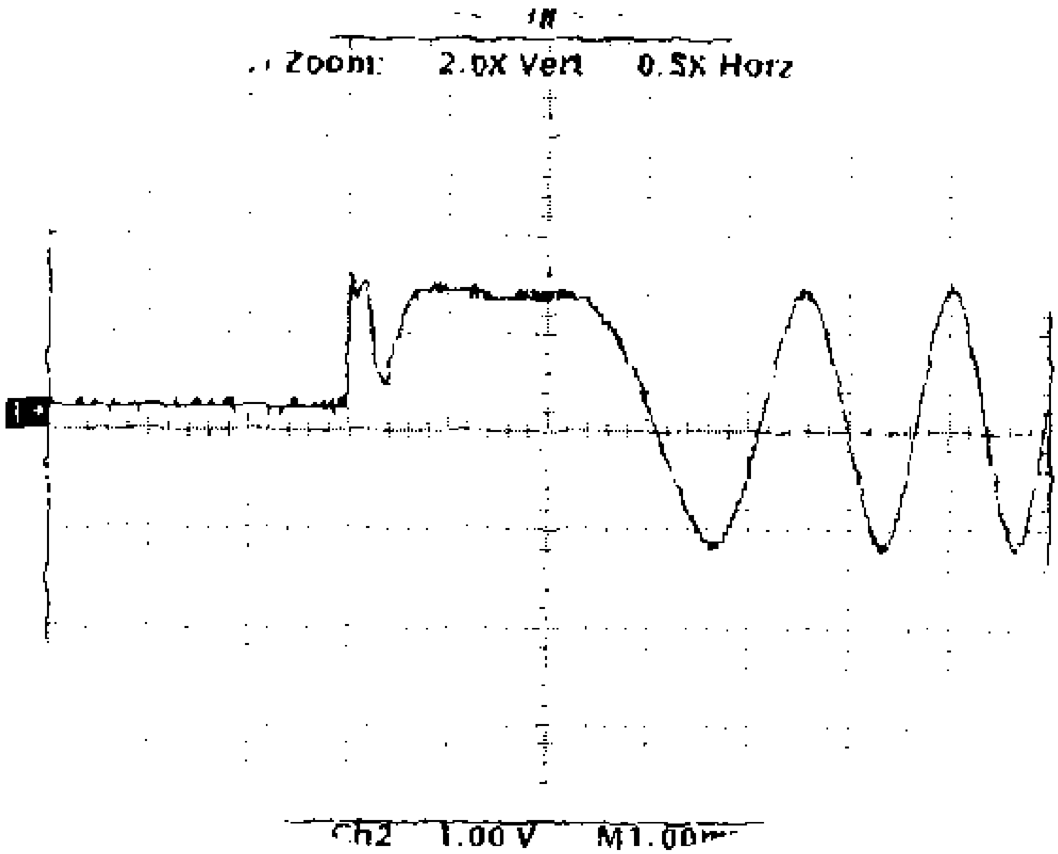
Keying Transients – Temperature –20 ° C



Keying Transients – Temperature 25 ° C

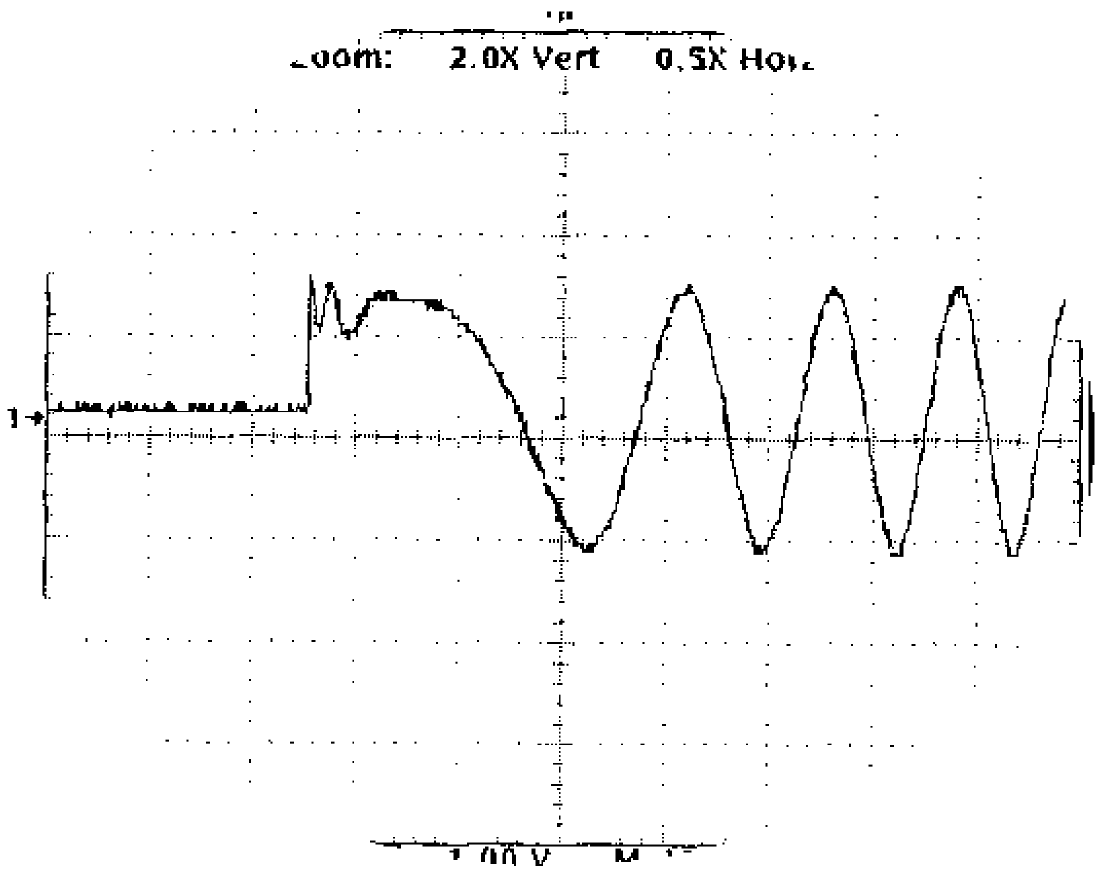


Keying Transients – Temperature +50 ° C

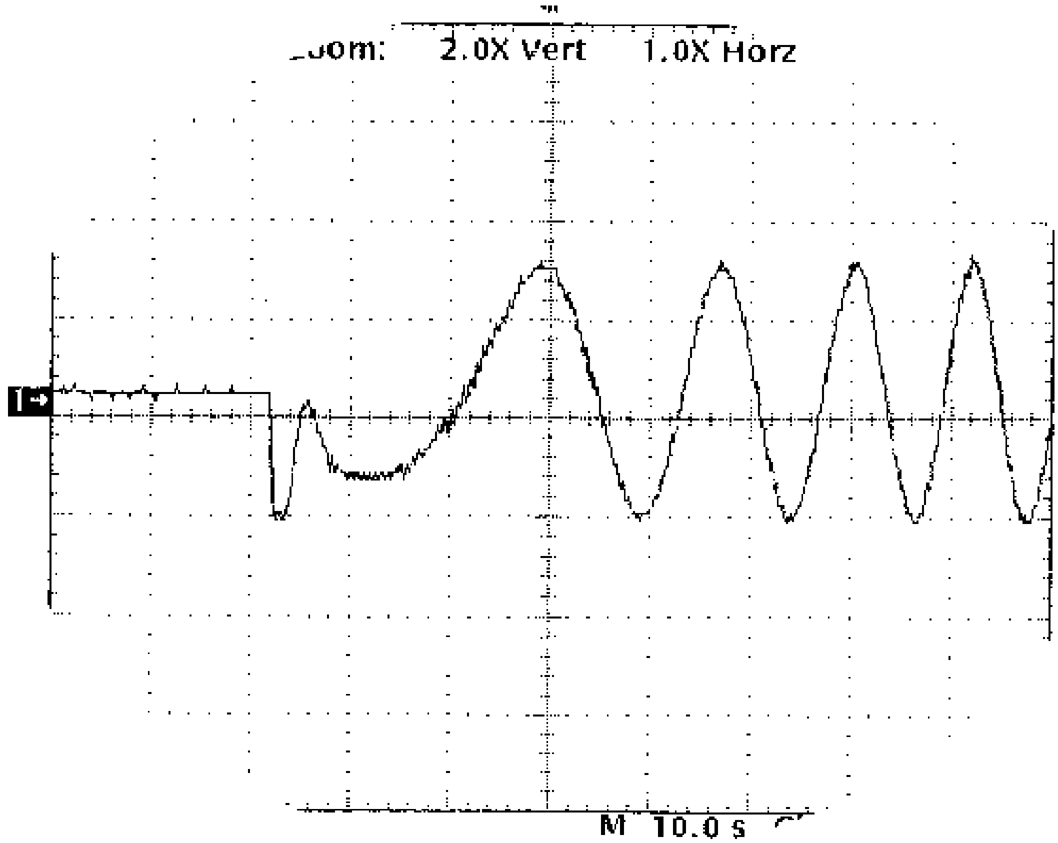


Keying Transients with Supply Voltage

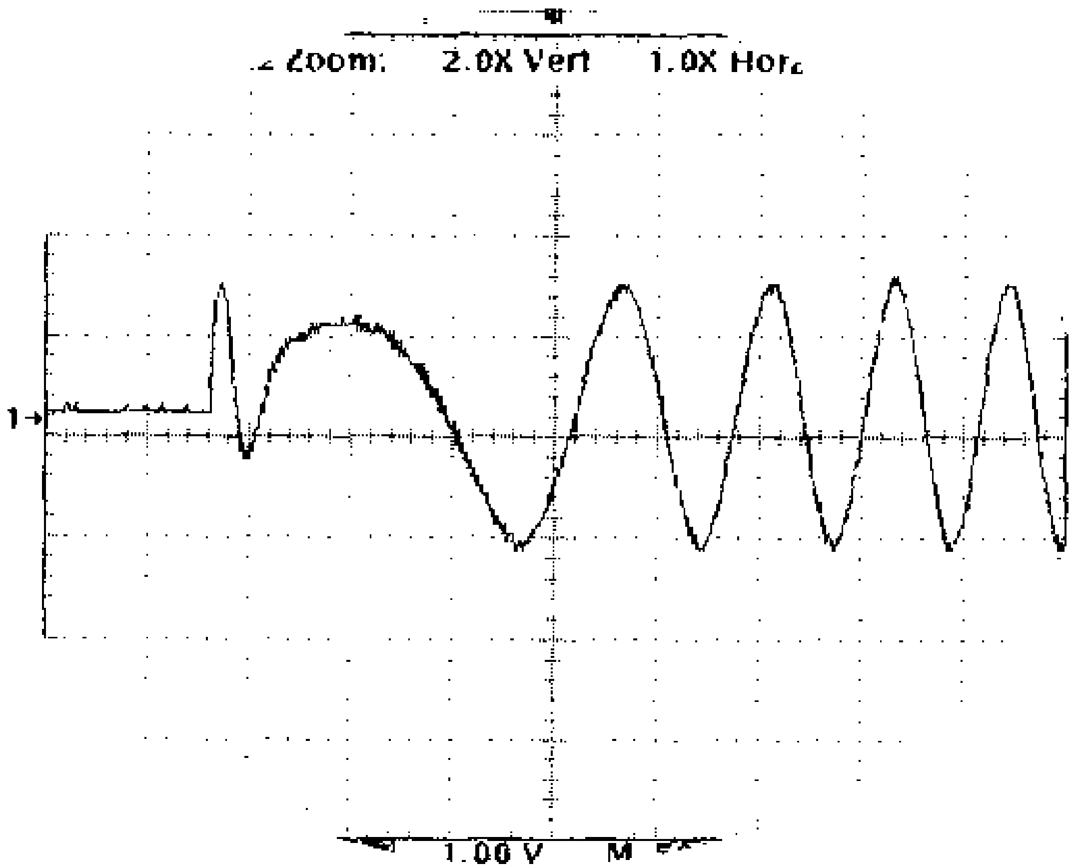
Keying Transients – Voltage 23.38 Vdc (85%)



Keying Transients – Voltage 27.50 Vdc



Keying Transients – Voltage 31.63 Vdc (115%)



10. FAA NOTIFICATION - EXHIBIT J

Provided by Rockwell Collins Governmental and Regulatory Affairs Department

11. SPURIOUS RADIATION MEASURMENT REPORT - EXHIBIT K