OPERATIONAL 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 AND LIST OF SEMICONDUCTOR DEVICES

Alignment procedures and list of semi-conductor devices 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

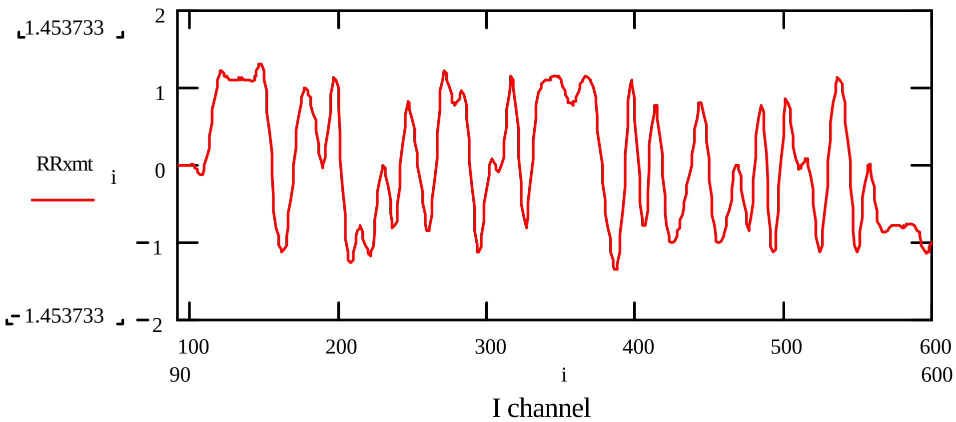

Figure 2