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MagnaStar® ARTU FCC Transmitter and Receiver Verification Test Procedures

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ABSTRACT

This test plan provides the information and procedures needed to perform FCC transmitter and receiver verification tests on the MagnaStar® Air Radio Telecommunications Unit (ARTU). ARTU transmitter certification test procedures are contained in Section 2. Receiver verification test procedures are contained in Section 3.

Rev-A	6/25/02	Replaced the Antenna Factor/Cable loss Charts for B100, B200, B300, & EMCO 3120 Antennas and revised 3.2.1 & 3.2.2 to utilize the new Rohde & Schwart, Model ESI7, EMI receiver.
Rev-B	7/01/02	Added Control Channel occupied bandwidth and spurious emission at the antenna terminal tests.

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1.0 GENERAL

1.1 Scope

This test plan provides the general information and the measurement procedures needed to perform FCC transmitter and receiver verification tests on the MagnaStar® Air Radio Telecommunications Unit (ARTU).

Section 2 of this document contains ARTU transmitter test procedures. This section includes procedures for the following measurements: Radio Frequency Power Output and PA Input Voltage/Current, Occupied Bandwidth, Spurious Emissions at Antenna Terminals, Field Strength of Spurious Emissions, and Frequency Stability. Sections 1 and 2 will be attached to the application for equipment authorization (FCC Form 731) in accordance with Part 2, §2.947(c) of the Rules and Regulations. Section 3 contains ARTU receiver verification test procedures. This section includes procedures for receiver Radiated Emissions measurements and receiver Antenna Power Conduction measurements. Sections 1 and 3 will form an appendix of the ARTU receiver verification data retention file.

Square brackets are used in this document to denote references to paragraphs contained in 47 CFR Ch. I.

1.2 Applicable Documents

Documents	Title
47 CFR Ch. 1, Part 2, Subpart J 10-1-2001 Ed.	Frequency Allocation and Radio Treaty Matters; General Rules Authorization Proceedures
47 CFR Ch. 1, Part 15, Subpart B 10-1-2001 Ed.	Radio Frequency Devices, Unintentional Radiators
47 CFR Ch. 1, Part 22, Subpart G 10-1-2001 Ed.	Air-Ground Radiotelephone Service
FCC Bulletin ANSI 63.4	Characteristic of Open Field Test Sites

1.3 Standard Conditions

The standard test conditions listed in this section shall apply unless otherwise specified.

Primary Power Characteristics

The ARTU is designed to be powered by 28 VDC (nominal) aircraft electrical power. During testing, the transmitter will be powered by a 28 VDC +/- 0.5 VDC power source, unless specified otherwise. All voltage measurements shall be made at the primary power input connector of the ARTU.

Atmospheric Conditions

Laboratory tests shall be performed within the limits of the conditions listed below

Temperature	Relative Humidity	Barometric Pressure
20°C to 30°C	100% (max.)	25.3 to 31.3 inches Hg

Radiated emissions measurements shall be performed under the ambient temperature, humidity and barometric conditions prevailing at the open field test site at the time of the test.

1.4 Test Equipment

The test equipment, which is recommended for use in testing, is identified on the test setup diagrams contained herein. Equipment with equivalent characteristics may be substituted for the recommended items. Logs identifying the equipment, which was actually used to make each of the measurements, shall be maintained and shall be included with the associated test data. The logs shall include the manufacturer's name and model number, a description of the equipment, and calibration dates.

2.0 ARTU TRANSMITTER CERTIFICATION TESTS

2.1 Radio Frequency Power Output [2.1046]

RF Power output measurements shall be performed in accordance with the requirements of FCC Part 2, §2.1046 (a) and (c).

Power Amplifier Input Voltage/Current [2.1033(c)(8)]

To satisfy the requirement of §2.1033(c)(8), PA input voltage and current measurements will be made in conjunction with the RF power output measurement. PA voltage and current test points are identified in Figure 2.1-1

Measurements

Measurements will be made without external modulation. Under this condition, a pseudo-random data stream will modulate the transmitter. The pseudo-random data stream will contain pilot symbols and represents the maximum data rate and the full range of symbol amplitudes encountered during normal operation of the transmitter.

Measurements will be made at three frequencies in the 894 to 896 MHz operating frequency range of the transmitter with the transmitter operating at minimum and maximum RF power output levels. Channel/Block assignments and corresponding operating frequencies are listed in Table 2.1-1.

Table 2.1-1. Channel Assignments & Measurement Frequencies

Channel/Block Assignment	Frequency (MHz)
Ch. 17/Blk 10	894.101500
Ch. 1/Blk 5	895.005500
Ch. 17/Blk 1	895.901500

Electrical Characteristics of RF Load

The transmitter will be operated into a nominal 50 ohm load impedance (VSWR < .2:1) during testing.

RF Power Measurement Devices

Average power measurements will be made using precision RF attenuaters, a HP-437B Power Meter, and a HP-8482A thermocouple power sensor. This equipment is calibrated and is directly traceable to the National Institute of Standards and Technology (NIST).

2.1.5 Measurement Procedures

1. Prepare the test setup shown in Figure 2.1-2. All RF connections shall be made using 50 ohm coaxial cables.
2. Power the ARTU from a 28 VDC power source.
3. Via the MagnaStar® Maintenance Terminal (MMT), program the transmitter to operate at the maximum power output level at 894.101500 MHz (Ch. 17, Blk 10).
4. Energize the transmitter and measure the average power output.
5. Record the average power output in the space provided on a test data sheet of the type shown in Figure 2.1-3. The recorded value must reflect the losses (measured at the transmitter operating frequency) of the cables and attenuaters present in the signal path between the antenna terminal and the power meter.
6. With transmitter energized, measure PA input voltage and current. Record the results in the spaces provided on the test data sheet.
7. Via the MMT, program the transmitter to operate at minimum power output and repeat Steps 4 through 6.
8. Via the MMT, program the transmitter to operate at maximum power output at 895.005500 MHz (Ch. 1, Blk 5) and repeat Steps 4 through 7.
9. Via the MMT, program the transmitter to operate at maximum power output at 895.901500 MHz (Ch. 17, Blk 1) and repeat Steps 4 through 7.
10. List all of the test equipment used in these measurements. Include the manufacturer's name and model number, a description of the equipment, and the equipment calibration dates.

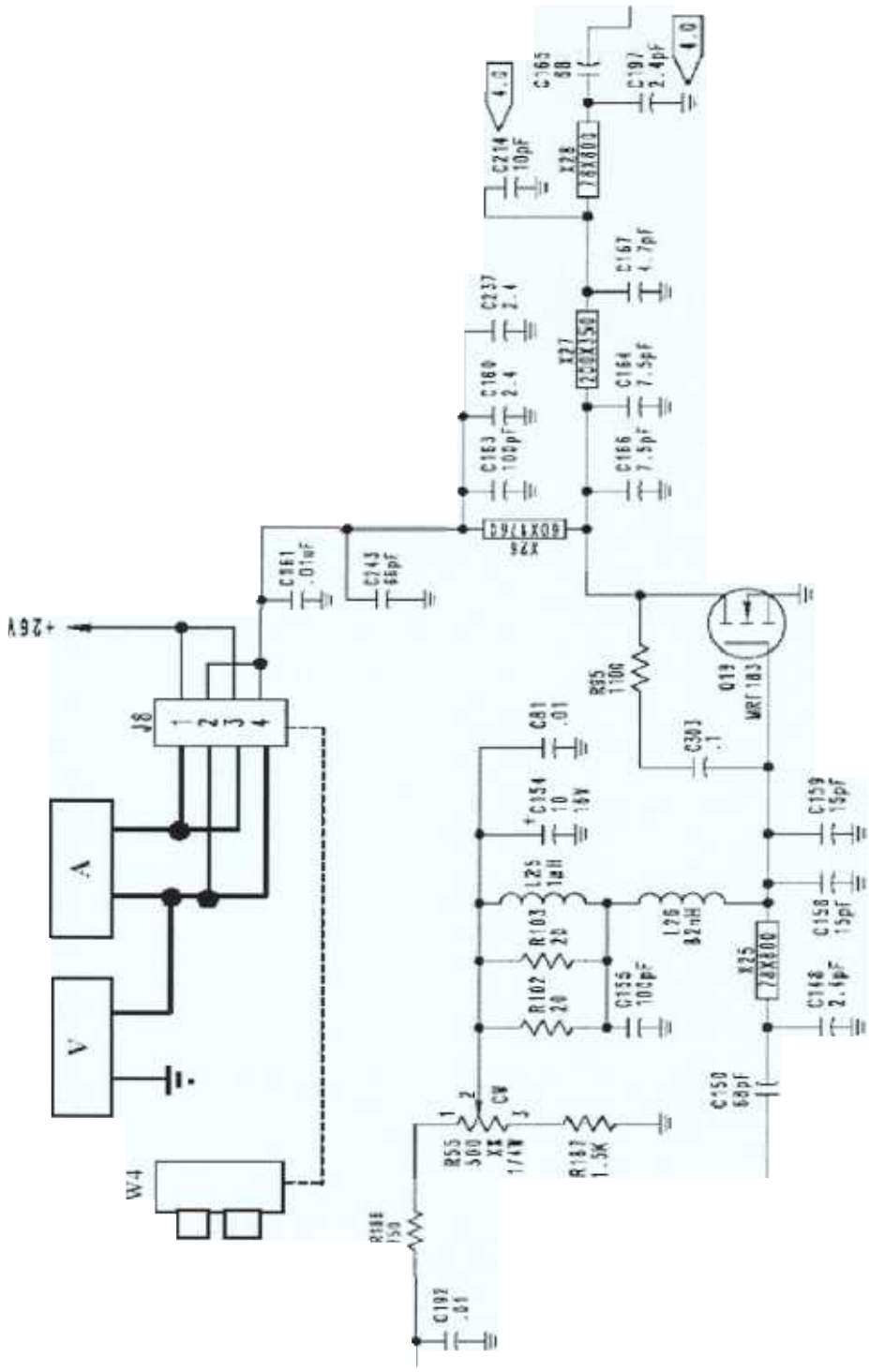

Figure 2.1-1 PA input Voltage/Current Test Points

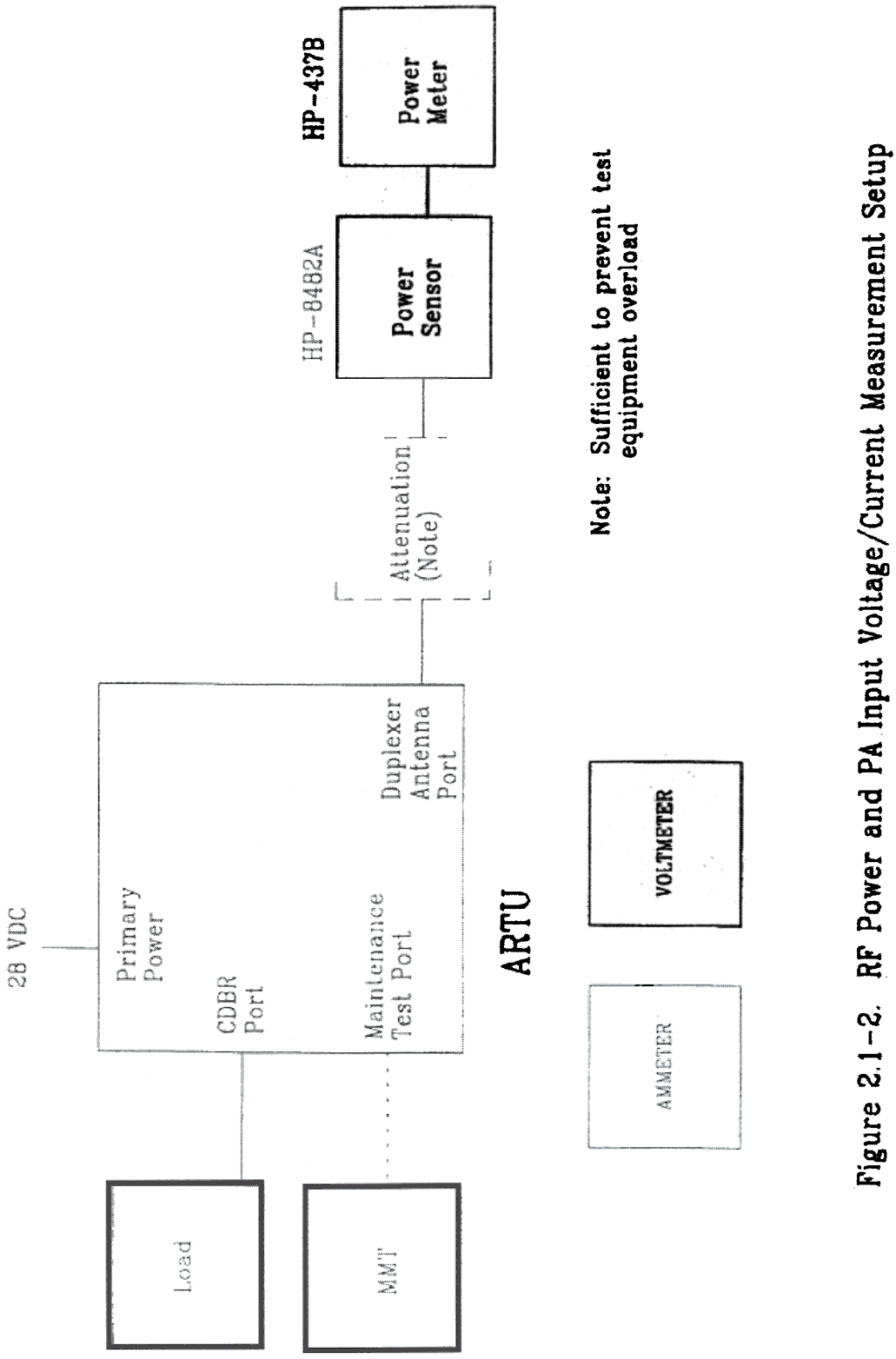

Figure 2.1-2. RF Power and PA Input Voltage/Current Measurement Setup

Figure 2.1-2 RF Power Output and PA Input Voltage/Current Measurement Setup

RF POWER OUTPUT & PA INPUT VOLTAGE/CURRENT [2.1046 & 2.1033(c)(8)]

Tester _____ Date _____ EUT _____

Witness _____ Date _____ EUT SN _____

Transmitter Operating Frequency 894.101500 MHz

Average Power Output (max.) _____ W

PA Input Voltage _____ V

PA Input Current _____ A

Transmitter Operating Frequency 894.101500 MHz

Average Power Output (min.) _____ W

PA Input Voltage _____ V

PA Input Current _____ A

Transmitter Operating Frequency 895.005500 MHz

Average Power Output (max.) _____ W

PA Input Voltage _____ V

PA Input Current _____ A

Transmitter Operating Frequency 895.005500 MHz

Average Power Output (min.) _____ W

PA Input Voltage _____ V

PA Input Current _____ A

Transmitter Operating Frequency 895.901500 MHz

Average Power Output (max.) _____ W

PA Input Voltage _____ V

PA Input Current _____ A

Transmitter Operating Frequency 895.901500 MHz

Average Power Output (min.) _____ W

PA Input Voltage _____ V

PA Input Current _____ A

Figure 2.1-3 RF Power Output & PA Input Voltage/Current Data Sheet

2.2 Occupied Bandwidth [2.1049(h)]

The occupied bandwidth measurement shall be performed in accordance with the requirements of FCC Part 2, §2.1049 (h).

Definition - Occupied bandwidth is the 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 [2.1049].

Occupied Bandwidth of the communication channels [§22.857 (2) (ii)]

2.2.1.1 Measurements

Measurements shall be made at the maximum, 50%, and minimum RF power output levels with the transmitter continuously modulated by a pseudo-random data stream. The pseudo-random data stream will contain pilot symbols and represents the maximum data rate and the full range of symbol amplitudes encountered during normal operation of the transmitter.

Measurements will be made at three frequencies in the 894 to 896 MHz operating frequency range of the transmitter. Channel/Block assignments and operating frequencies (f_os) are listed in Table 2.1-1 (page 2-1).

An HP-70000 spectrum analyzer and an HP computer will be used to make 99% power bandwidth measurements. This spectrum analyzer incorporates a function, which can be employed to determine the 99% power bandwidth of a displayed emission. When this function is invoked, the spectrum analyzer sweeps a user-designated band of frequencies around the emission center frequency. The resulting amplitude versus frequency information is stored in an array referred to as the trace array. The power bandwidth algorithm calculates the total power in the band of frequencies displayed on the CRT by eliminating trace elements from the frequency extremes of the array until the combined power of the remaining elements (responses) equals 99% of the total power. A number representing the 99% power bandwidth is displayed on the screen when the algorithm ends.

During testing, the spectrum analyzer will be operated in the "Max Hold" mode until no further change in the spectrum is noted (a minimum of ten sweeps shall be taken).

Occupied Bandwidth Measurement Procedure

Prepare the test setup shown in Figure 2.2-1. All RF connections shall be made using 50 ohm coaxial cables.

Power the ARTU from a 28 VDC power source.

3. Via the MMT, program the transmitter to operate at the maximum power output level at 894.101500 MHz (Ch. 17, Blk 10).
4. Energize the transmitter and measure the average power output. Note the power output, accounting for all losses in the measurement path.

5. With the transmitter energized, operate the computer, spectrum analyzer, and plotter to measure and record the 99% power bandwidth over the range from f_O - 250 % of the authorized bandwidth to f_O + 250 % of the authorized bandwidth (f_O + 15 kHz). The spectrum analyzer shall be operated in the "MAX HOLD" mode for a minimum of 10 sweeps or until the display ceases to show a change in the emissions spectrum.

   Record the measured average power output (Step 4) on the data plot.

6. Via the MMT, program the transmitter to operate at an RF output power level 3 dB below the maximum power output level and repeat Steps 4 and 5.

7. Via the MMT, program the transmitter to operate at the minimum RF output power level and repeat Steps 4 and 5.

8. Via the MMT, program the transmitter to operate at the maximum power output level at 895.005500 MHz (Ch. 1, Blk 5) and repeat Steps 4 through 7.

9 Via the MMT, program the transmitter to operate at the maximum power output level at 895.901500 MHz (Ch. 17, Blk 1) and repeat Steps 4 through 7.

10. List all test equipment used in these measurements. Include the manufacturer's name and model number, a description of the equipment, and the equipment calibration dates.

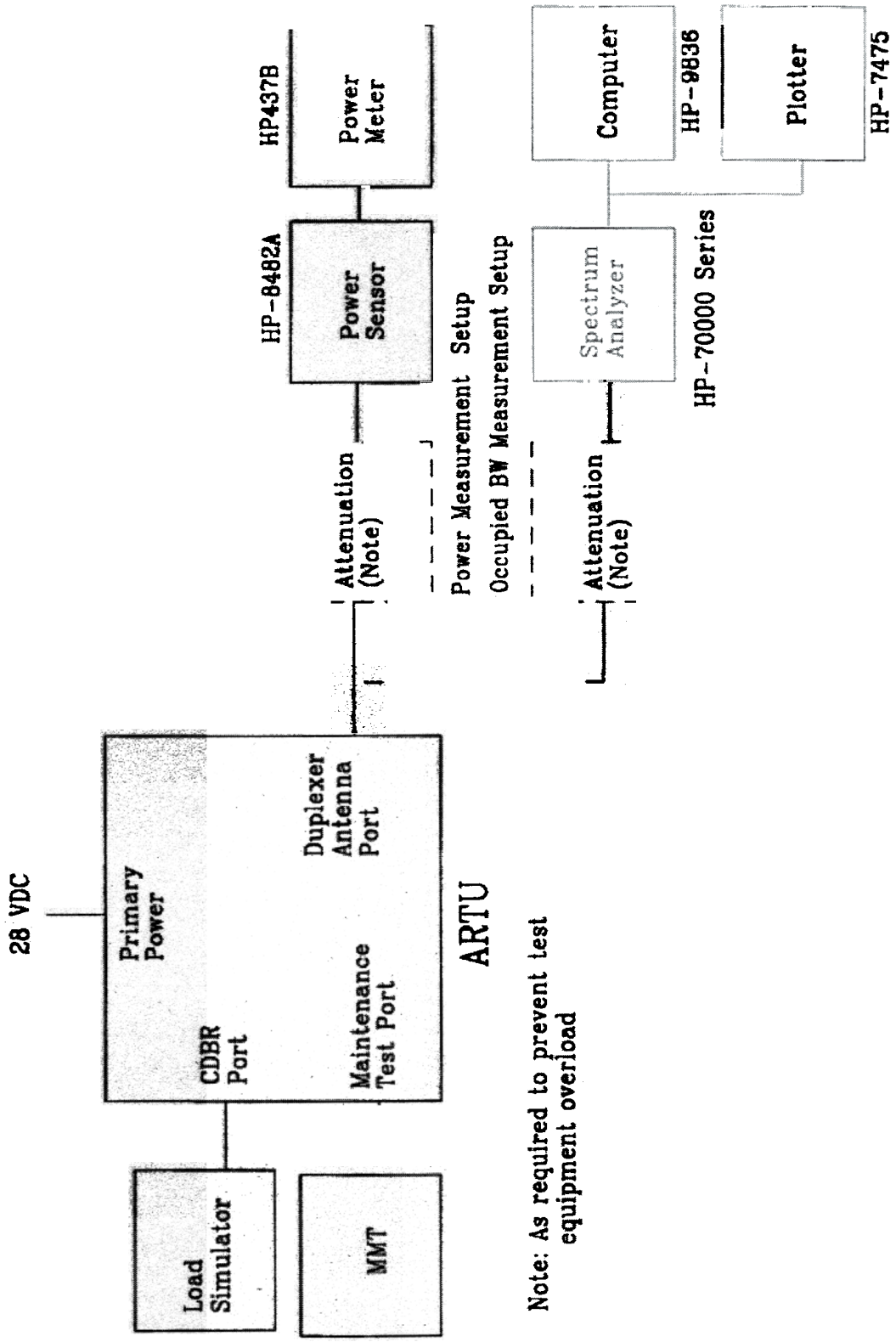

Figure 2.2-1 Occupied Bandwidth Measurement Setup (Communication Channel)

2.2.2 Occupied Bandwidth of the control channels [§22.857 (2) (i)]

2.2.2.1 Measurements

Measurements shall be made at the maximum, -3 dB, -13dB, and minimum RF power output levels with the transmitter continuously modulated by a pseudo-random data stream. The pseudo-random data stream will contain pilot symbols and represents the maximum data rate and the full range of symbol amplitudes encountered during normal operation of the transmitter.

Measurements will be made at two frequencies in the 894 to 896 MHz operating frequency range of the transmitter. Channel/Block assignments and operating frequencies are as follows. Control channel P2 Block 10 that has a center frequency of 894.1941 MHz and Control channel P2 Block 1 that has a center frequency of 895.9941 MHz.

A Rohde & Schwarz ESI EMI receiver will be used to make 99% power bandwidth measurements. This EMI receiver incorporates a function, which can be employed to determine the 99% power bandwidth of a displayed emission.

During testing, the EMI receiver will be operated in the "Max Hold" mode.

2.2.2.2 Occupied Bandwidth Measurement Procedure

Prepare the test setup shown in Figure 2.2-2. All RF connections shall be made using 50 ohm coaxial cables.

2. Power the ARTU from a 28 VDC power source.
3. Via the MMT, program the transmitter to operate, as a control channel, at the maximum power output level at 894.194100 MHz (P2, Blk 10).
4. Energize the transmitter and measure the average power output. Note the power output, accounting for all losses in the measurement path.
5. With the transmitter energized, operate the EMI receiver and record the 99% power bandwidth over the range from f_O - 250 % of the authorized bandwidth to f_O + 250 % of the authorized bandwidth (f_O + 15 kHz). The EMI receiver shall be operated in the "MAX HOLD" mode for a minimum of 10 sweeps or until the display ceases to show a change in the emissions spectrum.

   Record the measured average power output (Step 4) on the data plot.
6. Via the MMT, program the transmitter to operate at an RF output power level 3 dB below the maximum power output level and repeat Steps 4 and 5.
7. Via the MMT, program the transmitter to operate at an RF output power level 13 dB below the maximum power output level and repeat Steps 4 and 5.
8. Via the MMT, program the transmitter to operate at the minimum RF output power level and repeat Steps 4 and 5.
8. Via the MMT, program the transmitter to operate at the maximum power output level at 895.994100 MHz (P2 Blk 1) and repeat Steps 4 through 7.
9 List all test equipment used in these measurements. Include the manufacturer's name and model number, a description of the equipment, and the equipment calibration dates.

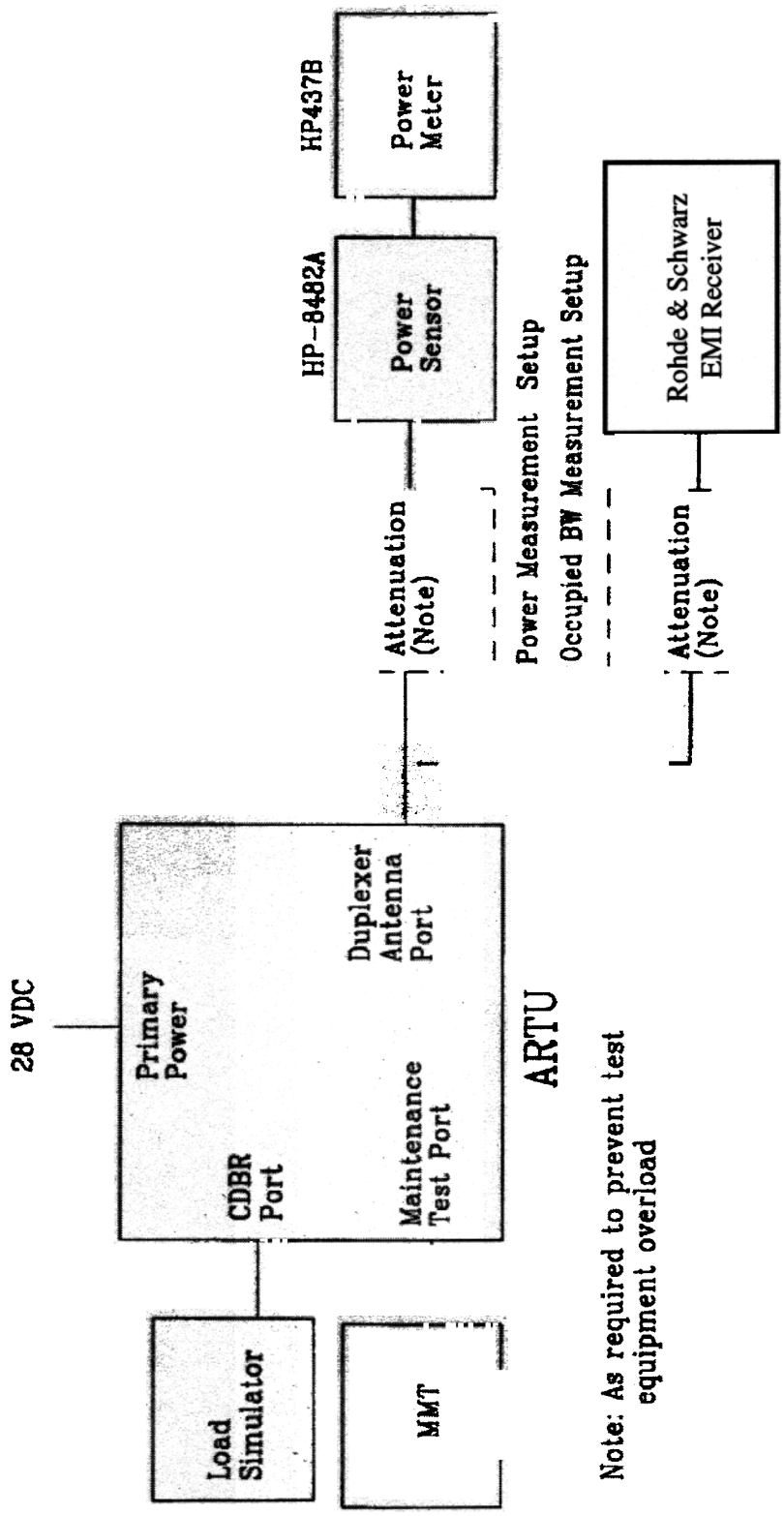

Figure 2.2-2 Occupied Bandwidth Measurement Setup (Control Channel)

2.3 Spurious Emissions at Antenna Terminals [2.1051]

Spurious emissions measurements shall be performed in accordance with the requirements of FCC Part 2, §2.1051.

2.3.1 Spurious Emissions at Antenna Terminal for Communication Channel mode

The power of any emission in each of the adjacent channels must be at least 30 dB below the peak envelope power of the main emission. The power of any emission in any of the channels other than the one being used and the adjacent channels must be at least 50 dB below the peak envelope power of the main emission [Ref. FCC Part 2, §22.861]

The frequency spectrum, which shall be investigated, extends from 10.0 MHz (the lowest radio frequency generated in the transmitter) to the tenth harmonic of the carrier frequency [2.1051]. A measurement system bandwidth of 300 Hz shall be employed for measurements over the range from 894 to 896 MHz. A measurement system bandwidth of 30 kHz shall be employed at all other frequencies in the measurement frequency spectrum.

Emissions plots will be marked with the limits identified in §22.861. Limits for emissions at frequencies outside of the 894 to 896 MHz air-to-ground band are not specified in §22.861. Consequently, limit lines will not appear on plots presenting emissions levels on the interval from 10 to 894 MHz and at frequencies greater than 896 MHz. At measurement frequencies outside of the air-to-ground band, the measurement system shall be capable of detecting emissions that are attenuated 63 + 10log(P) dB, where P is the average transmitter power output in watts.

The ARTU will be tested while operating at three frequencies in the 894 to 896 MHz operating range of the transmitter. Channel/Block assignments and operating frequencies are listed in Table 2.1-1 (page 2-1). At each operating frequency, measurements shall be made at the maximum and minimum RF power output levels, and at power levels 1, 2, 3 and 13 dB below the maximum power output level.

During testing, the transmitter will be continuously modulated by a pseudo-random data stream. The pseudo-random data stream contains pilot symbols and represents the maximum data rate and the full range of symbol amplitudes encountered during normal operation of the transmitter.

Measurements will be performed using an HP-70000 series spectrum analyzer.

The loss of the cables and attenuaters in the signal path between the transmitter antenna terminal and the spectrum analyzer, will be measured at the transmit frequency.

When spurious emissions measurements are made, the spectrum analyzer will be operated in the "MAX HOLD" mode until no further change in the spectrum is noted (a minimum of ten sweeps shall be taken).

2.3.1.1 Spurious Emissions Measurement Procedure

Prepare the test setup shown in Figure 2.3-1. All RF connections shall be made using 50ohm coaxial cables.

Power the ARTU from a 28 VDC power source.

3. Via the MMT, program the transmitter to operate at the maximum power output level at 894.101500 MHz (Ch. 17, Blk 10).
4. With the transmitter energized, use the spectrum analyzer and plotter to produce a plot of the spurious emissions appearing at the transmitter antenna terminal over the range from 10.0 MHz to 1 GHz. Record the transmitter operating frequency and the spectrum analyzer resolution/video bandwidth on the emissions plot.
5. With the transmitter energized, use the spectrum analyzer and plotter to produce a plot of the spurious emissions appearing at the transmitter antenna terminal over the range from 1 GHz to the tenth harmonic of the transmitter operating frequency. Record transmitter operating frequency, power output reference level (Step 5), and spectrum analyzer resolution/video bandwidth on the emissions plot.
6. With the transmitter energized, use the spectrum analyzer and plotter to produce a plot of the spurious emissions appearing at the transmitter antenna terminal over the range from 894 to 896 MHz. Record transmitter operating frequency, power output reference level (Step 5), and spectrum analyzer resolution/video bandwidth on the emissions plot.
7. With the transmitter energized, use the spectrum analyzer and plotter to produce a plot of the spurious emissions appearing at the transmitter antenna terminal in the band $f_o \pm 21$ kHz. Record transmitter operating frequency, power output reference level (Step 5), and spectrum analyzer resolution/video bandwidth on the emissions plot.
8. Via the MMT, program the transmitter to operate at an RF output power level 1 dB below the maximum power output level and repeat Steps 4 through 7.
9. Via the MMT, program the transmitter to operate at an RF output power level 2 dB below the maximum power output level and repeat Steps 4 through 7.
10. Via the MMT, program the transmitter to operate at an RF output power level 3 dB below the maximum power output level and repeat Steps 4 through 7.
11. Via the MMT, program the transmitter to operate at an RF output power level 13 dB below the maximum power output level and repeat Steps 4 through 7.
12. Via the MMT, program the transmitter to operate at the minimum RF output power level and repeat Steps 4 through 7.
13. Via the MMT, program the transmitter to operate at maximum RF power output at 895.005500 MHz (Ch. 1, Blk 5) and repeat Steps 4 through 12.
14. Via the MMT, program the transmitter to operate at maximum RF power output at 895.901500 MHz (Ch. 17, Blk 1) and repeat Steps 4 through 12.
15. List all test equipment used in these measurements. Include the manufacturer's name and model number, a description of the equipment, and the date that the equipment was last calibrated.

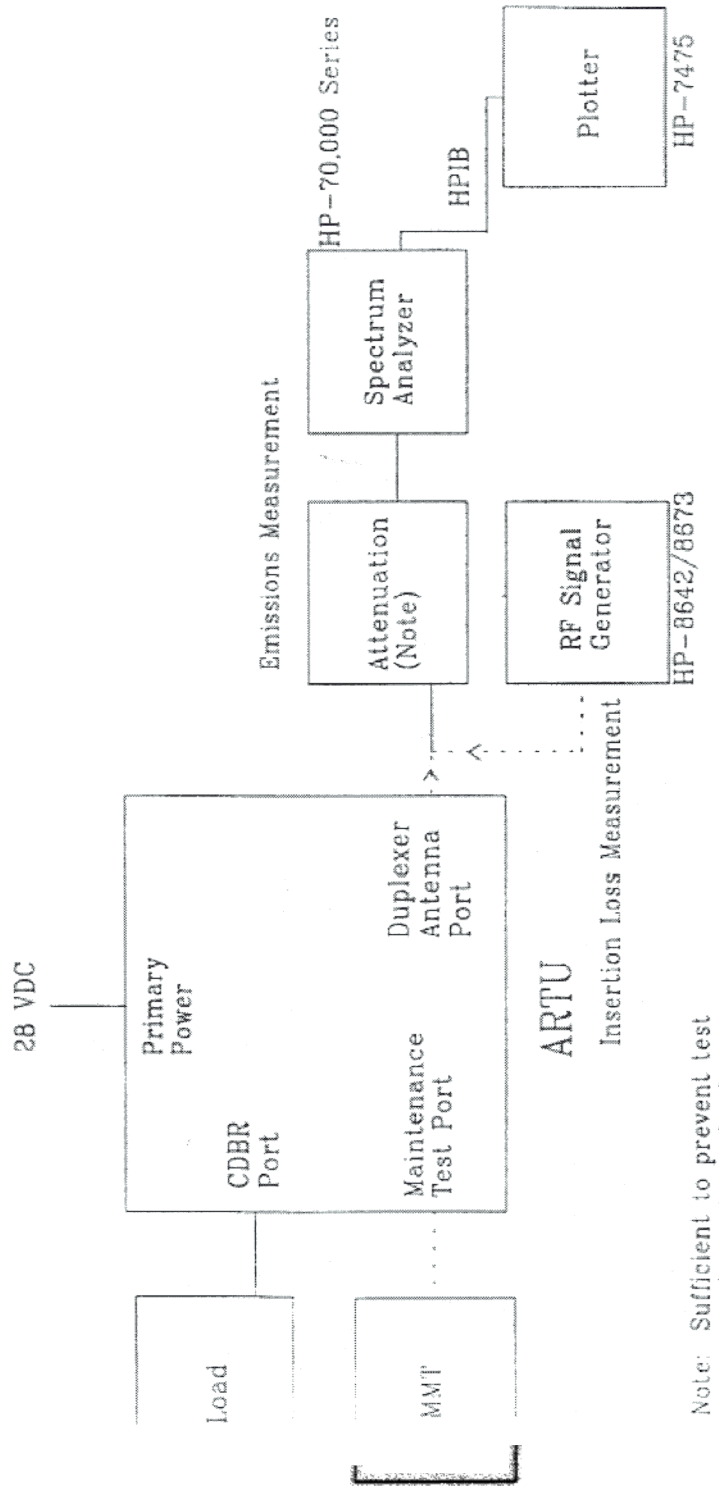

Figure 2.3-1 Antenna Terminal Emissions Measurement Setup (Communications Channels)

2.3.2 Spurious Emissions at Antenna Terminal for Control Channel mode

The power of any emission in each of the adjacent channels must be at least 30 dB below the peak envelope power of the main emission. The power of any emission in any of the channels other than the one being used and the adjacent channels must be at least 50 dB below the peak envelope power of the main emission {Ref. FCC Part 2, §22.861Measurements

The frequency spectrum, which shall be investigated, extends from 10.0 MHz (the lowest radio frequency generated in the transmitter) to the tenth harmonic of the carrier frequency [2.1051]. A measurement system bandwidth of 300 Hz shall be employed for measurements over the range from 894 to 896 MHz. A measurement system bandwidth of 30 kHz shall be employed at all other frequencies in the measurement frequency spectrum.

Emissions plots will be marked with the limits identified in §22.861. Limits for emissions at frequencies outside of the 894 to 896 MHz air-to-ground band are not specified in §22.861. Consequently, limit lines will not appear on plots presenting emissions levels on the interval from 10 to 894 MHz and at frequencies greater than 896 MHz. At measurement frequencies outside of the air-to-ground band, the measurement system shall be capable of detecting emissions that are attenuated 63 + 10log(P) dB, where P is the average transmitter power output in watts.

The ARTU will be tested while operating at three frequencies in the 894 to 896 MHz operating range of the transmitter. Channel/Block assignments and operating frequencies are P2 Block 1 and P2 block 10. At each operating frequency, measurements shall be made at the maximum and minimum RF power output levels, and at power levels 3 dB and 13 dB below the maximum power output level.

During testing, the transmitter will be continuously modulated by a pseudo-random data stream. The pseudo-random data stream contains pilot symbols and represents the maximum data rate and the full range of symbol amplitudes encountered during normal operation of the transmitter.

Measurements will be performed using the Rohde & Schwarz EMI Receiver for data below 1 GHz and an HP-70000 series spectrum analyzer for data above 1GHz.

The loss of the cables and attenuators in the signal path between the transmitter antenna terminal and the spectrum analyzer, will be measured at the transmit frequency.

When spurious emissions measurements are made, the spectrum analyzer will be operated in the "MAX HOLD" mode until no further change in the spectrum is noted (a minimum of ten sweeps shall be taken).

2.3.2.1 Spurious Emissions Measurement Procedure

Prepare the test setup shown in Figure 2.3-2. All RF connections shall be made using 50ohm coaxial cables.

2. Power the ARTU from a 28 VDC power source.
3. Via the MMT, program the transmitter to operate at the maximum power output level at 894.194100 MHz (P2, Blk 10).
4. With the transmitter energized, use the Rohde & Schwarz EMI Receiver and record a data file of the spurious emissions appearing at the transmitter antenna terminal over the range from 10.0 MHz to 1 GHz.