RTCA
1828 L Street, NW, Suite 805
Washington, DC  20036-5133 USA

# Minimum Performance Standards-Airborne Radio Marker Receiving Equipment Operating on 75 MHz

RTCA DO-143
January 8, 1970

Prepared by: SC-115

Copies of this document may be obtained from

RTCA, Inc.

Telephone: 202-833-9339
Facsimile: 202-833-9434
Internet: www.rtca.org

Please visit the RTCA Online Store for document pricing and ordering information.

# F O R E W O R D

This Paper was prepared by Special Committee 115, International Coordination Group 7 (ICG-7), of the Radio Technical Commission for Aeronautics (RTCA). It was approved by RTCA on January 8, 1970 and supersedes RTCA Paper 87-54/DO-57A, dated March 8, 1962.

RTCA is an association of aeronautical organizations of the United States from both government and industry. Dedicated to the advancement of aeronautics, RTCA seeks sound technical solutions to problems involving the application of electronics and telecommunications to aeronautical operations. Its objective is the resolution of such problems by mutual agreement of its member organizations.

The findings of RTCA are in the nature of recommendations to all organizations concerned. As RTCA is not an official agency of the government of the United States, its recommendations may not be regarded as statements of official government policy unless so enunciated by the government organization or agency having statutory jurisdiction over any matters to which the recommendations relate.

The European Organization for Civil Aviation Electronics (EUROCAE) concurs with RTCA on the Minimum Performance Standards set forth herein, except for the performance standards under the humidity environmental test condition specified in Paragraph 3.2. Coordination of these standards was accomplished by RTCA SC-115's International Coordination Group 7 (ICG-7) and EUROCAE Working Group 7 (WG-7).

THIS PAGE INTENTIONALLY LEFT BLANK

# TABLE OF CONTENTS

THIS PAGE INTENTIONALLY LEFT BLANK

# INTRODUCTION

This Paper sets forth minimum performance standards for airborne radio marker receiving equipment operating on 75 MHz.

Compliance with these standards by manufacturers and users is recommended as a means of assuring that the equipment will satisfactorily perform its intended function under all conditions normally encountered in routine aeronautical operations.

In any application of these minimum performance standards, due allowance should be made, where necessary, for equipments in current use which do not fully meet the standards contained herein.

It is recognized that any regulatory application of these standards is the responsibility of governmental agencies.

Inasmuch as the measured values of radio equipment performance characteristics may be a function of the method of measurement, standard test conditions and methods of test are also recommended in this Paper.

The word "equipment" as used herein includes all of the components or units necessary (as determined by the equipment manufacturer) for the equipment to properly perform its intended function. For example, an airborne radio marker receiving "equipment" may include an antenna, a control box, an indicator, a power supply, a shock mount, etc. In the case of this example, all of the foregoing components or units comprise the "equipment." It should not be inferred from this example, however, that every "equipment" will necessarily include all of the foregoing components. This will depend on the design used by the "equipment" manufacturer.

THIS PAGE INTENTIONALLY LEFT BLANK

# 1.0 GENERAL STANDARDS

NOTE: Two categories of equipment are specified for some of the standards contained in this Paper. These categories are identified as Category A and Category B. Definitions of the categories are stated below. If a particular standard is not categorized, it applies as written to both Categories A and B types of equipment.

Category A. Equipment intended for use in the European-Mediterranean area and wherever marker beacon signals are required for both enroute and approach operations.

Category B. Equipment intended for use in the United States of America and wherever marker beacon signals are required only for approach operations.

## 1.1 Operation of Controls

The operation of controls intended for use during flight, in all possible combinations and sequences, shall not result in a condition whose presence or continuation would be detrimental to the continued performance of the equipment.

## 1.2 Accessibility of Controls

Controls which are not normally adjusted in flight shall not be readily accessible to flight personnel.

## 1.3 Effects of Tests

Unless otherwise provided, the application of the specified tests shall produce no subsequently discernible condition which would be detrimental to the continued performance of the equipment.

## 1.4 Receiver Threshold Adjustment Range

### Category A

At least two preset levels of Receiver Threshold shall be provided, selectable by the pilot. Means shall be provided for adjusting each level so that the Receiver Threshold can be set to any value between 200 and 4000 microvolts.

Category B

Only one preset level of Receiver Threshold need be provided. Means shall be provided for adjusting the level to that specified in Paragraph 1.7.

1.5 Lamp Actuation (Single Lamp)

In the case of equipment designed to operate a single lamp, the lamp shall be actuated by each of the three modulation frequencies 400, 1300 and 3000 Hertz.

1.6 Lamp Actuation (Three Lamps)

In the case of equipment designed to operate a separate lamp for each of the three modulation frequencies, the 400 Hertz tone shall actuate the blue light, the 1300 Hertz tone the amber light, and the 3000 Hertz tone the white light.

1.7 Receiver Threshold Adjustment Setting 1/

Category A

The Receiver Threshold shall be adjusted to 200 microvolts for enroute operations, and 1000 microvolts for approach operations.

Category B

The Receiver Threshold shall be adjusted to 1000 microvolts.

1.8 Antenna Polarization

The antenna to be used on the aircraft shall be designed so as to produce, when installed according to the manufacturer's instructions, a maximum response from 75 MHz signals radiated from below the aircraft with the received electric field component parallel to the line of flight.

---

1/ The signal levels contained herein are predicated on the value contained in ICAO Annex 10, Paragraph 3.1.6.9, Calibrated Marker Receiver and Standard Antenna, which is based on a specified antenna/lead-in configuration. Where the antenna and/or lead-in configuration differs from that standard, an appropriate correction factor should be applied to the signal levels to provide equivalent results.

## 2.0 MINIMUM PERFORMANCE STANDARDS UNDER STANDARD TEST CONDITIONS

The test procedures, applicable to a determination of the performance of airborne 75 MHz radio marker receiving equipment under standard test conditions, are set forth in Appendix "A" of this Paper.

### 2.1 Audio Frequency Response

The total spread in audio output of the receiver shall not exceed 9 db, when the frequency of the modulation on the input signal is varied over the combined ranges of 380 to 420 Hertz, 1235 to 1365 Hertz, and 2850 to 3150 Hertz. The level of the rf input signal shall be ten times that producing Receiver Threshold at 1300 Hertz.

### 2.2 Lamp Frequency Response

The variation in rf input level required to produce Receiver Threshold shall not exceed 9 db, when the frequency of the modulation on the input signal is varied over the combined ranges of 390 to 410 Hertz, 1270 to 1330 Hertz, and 2920 to 3080 Hertz.

### 2.3 Automatic Gain Control

When the level of a Standard Test Signal, applied to the receiver input, is varied over the range from that producing Receiver Threshold to 50,000 microvolts:

(a) The appropriate indicator lamp shall be ON and the remaining lamps (if fitted) shall be OFF.

(b) The audio frequency output power shall not vary by more than 10 db.

This requirement shall be met at all settings of the rf gain control(s) and at each appropriate modulation frequency.

### 2.4 Rated Audio Power Output

The audio output power of the receiver shall be not less than the rated output, when an rf signal having a level ten times that producing Receiver Threshold at 1300 Hertz is applied to the receiver input.

2.5 Audio Noise Level - Without Signal

(a) The level of the noise output of the receiver, in the absence of an rf input signal, shall be at least 26 db below the output obtained with an rf input signal having a level ten times that producing Receiver Threshold.

(b) The level of the receiver output at discrete audio frequencies, in the absence of an rf input signal, shall be at least 40 db below that output obtained with an rf input signal having a level ten times that producing Receiver Threshold. Equipment designed for an AC power source shall meet this requirement at all power frequencies within the range for which the equipment is designed.

2.6 Audio Noise Level - With Signal

(a) The receiver output signal + noise/noise ratio shall be at least 15 db, over the range of rf input signal levels from that producing Receiver Threshold to 50,000 microvolts.

(b) The level of the receiver output at discrete audio frequencies shall be at least 30 db below the signal + noise output over the range of rf input signal levels from that producing Receiver Threshold to 50,000 microvolts. Equipment designed for an AC power source shall meet this requirement at all power frequencies within the range for which the equipment is designed.

2.7 Distortion

Over the range of rf signal input levels from that producing Receiver Threshold to 50,000 microvolts, the combined noise and distortion in the receiver output shall not exceed 30% of the total output.

2.8 Output Regulation

With an output load of 200% of design impedance and with an output load of 50% of design impedance, the distortion in the output shall not exceed 30%, and the output voltage level shall be within 2:1 of the level obtained when the load is that for which the receiver is designed.

2.9 Emission of Spurious Radio-Frequency Energy

Category A

(a) When the receiver input is terminated in a resistive load equal to the nominal receiver input impedance, the level of any spurious emission appearing across the load shall not exceed 2000 micro-microwatts. This requirement shall be met over the frequency range of 50 kHz to 1200 MHz.

(b) The levels of conducted and radiated spurious radio-frequency energy emitted by the equipment shall not exceed those levels specified in Section I of Appendix A to RTCA Document DO-138, "Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments," dated June 27, 1968, for the aircraft category for which the equipment is designed.

Category B

The levels of conducted and radiated spurious radio-frequency energy emitted by the equipment shall not exceed those levels specified in Appendix A to RTCA Document DO-138, "Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments," dated June 27, 1968, for the aircraft category for which the equipment is designed.

2.10 Sensitivity Depression

Category A

In addition to meeting the requirements for Category B equipment stated below, Category A equipment shall meet the following:

The level of a Standard Test Signal required to produce Receiver Threshold shall not increase more than 3 db, when there is added to the receiver input an unmodulated 0.5 volt rf signal on any frequency within the band 50 kHz to 1200 MHz, excluding the band from 63 to 85 MHz.

Category B

(a) The level of a Standard Test Signal required to produce Receiver Threshold shall not increase more than 4 db, when there is added to the receiver input channels 4 and 5 television signals having a level of 3.5 volts.

(b) The level of a Standard Test Signal required to produce Receiver Threshold shall not increase more than 4 db, when there is added to the receiver input a 0.5 volt rf signal frequency modulated 1300 Hertz at a deviation of ±15 kHz. This standard shall be met over the FM signal frequency ranges of 72.02 to 74.58 MHz and 75.42 to 75.98 MHz.

2.11 Input Operating Differential

The ratio of the rf input signal level required to produce that lamp voltage which is obtained at Receiver Threshold, when the rf input signal level is increasing, to the rf input signal level required to produce that same lamp voltage, when the rf input signal level is decreasing, shall not exceed 2:1.

2.12 Receiver Input Impedance

The input impedance of the receiver over the rf frequency range 75 MHz ±10 kHz shall not depart from the design value by more than a factor of 2:1.

2.13 Cross Modulation

Category A

In addition to meeting the requirements for Category B equipment stated below, Category A equipment shall meet the following:

The voltage across the indicator lamp(s) due to cross modulation shall not reach the voltage reached at Receiver Threshold nor shall the audio output reach one-half the manufacturer's rated output, when there are applied to the receiver input an unmodulated carrier at center response frequency having a level between that which produces Receiver Threshold and 50,000 microvolts, plus a 0.15 volt signal amplitude modulated 30%, in turn, at 400, 1300 and 3000 Hertz on any rf frequency within the band 65 to 85 MHz, excluding the band 74.5 to 75.5 MHz.

Category B

(a) The voltage across the indicator lamp(s) due to cross modulation shall not reach the voltage reached at Receiver Threshold nor shall the audio output reach one-half the manufacturer's rated output, when there are applied simultaneously to the receiver input an unmodulated carrier at center response frequency having a level equal to that of a signal producing Receiver Threshold and a television signal having a level of 3.5 volts. This standard shall be met at the television signal frequencies of channels 2 through 6.

(b) The voltage across the indicator lamp(s) due to cross modulation shall not reach the voltage reached at Receiver Threshold nor shall the audio output reach one-half the manufacturer's rated output, when there are applied simultaneously to the receiver input an unmodulated carrier at center response frequency having a level equal to that of a signal producing Receiver Threshold and a 0.5 volt rf signal frequency modulated 1300 Hertz at a deviation of ±15 kHz. This standard shall be met over the FM signal frequency ranges of 72.02 to 74.58 MHz and 75.42 to 75.98 MHz.

2.14 Spurious Response

Category A

In addition to meeting the requirements for Category B equipment stated below, Category A equipment shall meet the following:

The voltage across the indicator lamp(s) shall not reach the Receiver Threshold voltage nor shall the audio output reach one-half the manufacturer's rated output, when an rf input signal of 0.5 volt, amplitude modulated 30%, in turn, at 400, 1300, and 3000 Hertz, is varied over the frequency range of 50 kHz to 1200 MHz, excluding the band from 68 to 85 MHz.

Category B

(a) The voltage across the indicator lamp(s) shall not reach the Receiver Threshold voltage nor shall the

audio output reach one-half the manufacturer's rated output, when an rf input signal of 0.5 volt, amplitude modulated 30%, in turn, at 400, 1300, and 3000 Hertz, is varied over the frequency range of 0.190 to 1215 MHz excluding the band from 65 to 85 MHz.

(b) The voltage across the indicator lamp(s) shall not reach the Receiver Threshold voltage nor shall the audio output reach one-half the manufacturer's rated output, when an rf input signal of 0.5 volt frequency modulated, in turn, at 400, 1300, and 3000 Hertz at a deviation of ±15 kHz, is varied over the frequency ranges of 72.02 to 74.58 MHz and 75.42 to 75.98 MHz.

(c) The voltage across the indicator lamp(s) shall not reach the Receiver Threshold voltage nor shall the audio output reach one-half the manufacturer's rated output, when an rf input signal of 3.5 volts with television signal modulation is applied at television signal frequencies of channels 2 through 6.

2.15 Lamp Actuation - Keying

When the audio frequency modulation of a Standard Test Signal applied to the receiver input is keyed, in turn, at 6 dots per second and 2 dashes per second, both the visual and aural indications shall be substantially in synchronism with the keying. This requirement shall be met over the range of rf input levels from that producing Receiver Threshold to 50,000 microvolts, and at all settings of the rf gain control(s). The modulation ON time to modulation OFF time for dots shall be 1:1.

2.16 Variation in Receiver Threshold

The root-sum-square (RSS) of the maximum deviations in Receiver Threshold caused by the following variable conditions shall not exceed 13 db:

(a) Variation of the input rf carrier between 74.990 and 75.010 MHz. (0 db = 75.000 MHz)

(b) Variation of the modulation depth of the input signal over the range 91% to 99%. (0 db = 95%)

(c) Variation of the frequency of the modulation of the input signal over the range ±2.5%. (0 db = 400 Hz, 1300 Hz, or 3000 Hz)

(d) Variation of temperature over the range of the environmental category for which the equipment is certified. (0 db = 20°C)

(e) Variation of atmospheric pressure over the range of the environmental category for which the equipment is certified. (0 db = 29.92")

(f) After subjection to the humidity test. (0 db = pre-test)

(g) Variation of the primary power supply voltage over the range ±10%. (0 db = mfgrs. design voltage)

(h) During the conduct of the Vibration Test for the Vibration category for which the equipment is certified. (0 db = zero vibration)

2.17 Receiver Selectivity

Category A

The receiver response at all frequencies outside the band 74.8 to 75.2 MHz shall be at least minus 40 db with reference to the response at 75.00 MHz.

Category B

There is no Receiver Selectivity requirement for Category B equipment. 1/

2.18 Warm-Up Characteristics

Under Standard Test Conditions and within five minutes from the time of switch-on of all supply voltages, the Receiver Threshold shall be within 2 db of the adjustment specified in Paragraph 1.7 for the appropriate Category.

1/ This parameter is effectively covered by the requirements of Paragraph 2.14, Category B.

THIS PAGE INTENTIONALLY LEFT BLANK

## 3.0 MINIMUM PERFORMANCE STANDARDS UNDER ENVIRONMENTAL TEST CONDITIONS 1/

Unless otherwise specified, the test procedures applicable to a determination of the performance of radio equipment under environmental test conditions shall be those set forth in RTCA Document DO-138, "Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments," dated June 27, 1968.

### 3.1 Temperature - Altitude Test

#### 3.1.1 Low Temperature Test

When the equipment is subjected to this test:

(a) All mechanical devices shall operate satisfactorily;

(b) The requirements of Paragraphs 2.4, Rated Audio Power Output, and 2.17, Receiver Selectivity (Category A only), shall be met;

(c) The level of a Standard Test Signal required to produce Receiver Threshold shall be within 6 db of that required under standard test conditions.

#### 3.1.2 High Temperature Test

(a) When subjected to the Short-Time Operating High Temperature, the equipment shall operate both electrically and mechanically.

(b) When the equipment is operated at the High Operating Temperature:

(1) All mechanical devices shall operate satisfactorily;

---

1/ It will be noted that some of the performance parameters addressed in the paragraphs of Section 2.0, Minimum Performance Standards Under Standard Test Conditions, are not enumerated in the several specific environmental tests contained in this section. This is so because engineering judgment and experience has indicated that these particular performance parameters are not susceptible to certain of these environmental conditions and that the level of performance specified in Section 2.0 will, therefore, not be measurably degraded by exposure to these particular environmental conditions.

(2) The requirements of Paragraphs 2.4, Rated Audio Power Output, and 2.17, Receiver Selectivity (Category A only), shall be met;

(3) The level of a Standard Test Signal required to produce Receiver Threshold shall be within 6 db of that required under standard test conditions.

3.1.3 Altitude Test

When the equipment is subject to this test:

(a) The appropriate requirements of Paragraph 2.16, Variation in Receiver Threshold, shall be met;

(b) The requirements of Paragraphs 2.4, Rated Audio Power Output, and 2.17, Receiver Selectivity (Category A only), shall be met;

(c) All mechanical devices shall operate satisfactorily.

3.1.4 Decompression Test (When required)

When the equipment has been subjected to this test:

(a) All mechanical devices shall operate satisfactorily;

(b) The level of a Standard Test Signal required to produce Receiver Threshold shall be within 2 db of that required under standard test condition.

3.1.5 Overpressure Test (When required)

When the equipment has been subjected to this test:

(a) All mechanical devices shall operate satisfactorily;

(b) The level of a Standard Test Signal required to produce Receiver Threshold shall be unchanged from that required under standard test conditions.

3.2 Humidity Test

(a) After subjection to humidity and within 15 minutes after primary power is applied:

(1) The level of a Standard Test Signal required to produce Receiver Threshold shall be within 4:1 of that required under standard test conditions;

(2) All mechanical devices shall operate satisfactorily.

(b) After subjection to humidity and within four hours from the time primary power is applied:

(1) The appropriate requirements of Paragraph 2.16, Variation in Receiver Threshold, shall be met;

(2) The requirements of Paragraphs 2.4, Rated Audio Power Output, and 2.17, Receiver Selectivity (Category A only), shall be met.

3.3 Shock Test

(a) Following the application of the Operational Shocks:

(1) The level of a Standard Test Signal required to produce Receiver Threshold shall be within 2 db of that required under standard test conditions;

(2) The requirements of Paragraph 2.17, Receiver Selectivity (Category A only), shall be met;

(3) All mechanical devices shall operate satisfactorily.

(b) Following the application of the Crash Safety Shocks, the equipment under test shall have remained in its mounting, and no parts of the equipment or its mounting shall have become detached and free of the equipment or of the shock table. 1/

3.4 Vibration Test

When subjected to this test:

(a) The appropriate requirements of Paragraph 2.16, Variation in Receiver Threshold, shall be met;

(b) The requirements of Paragraphs 2.4, Rated Audio Power Output, 2.5, Audio Noise Level - Without Signal, 2.6, Audio Noise Level - With Signal, and 2.17, Receiver Selectivity (Category A only), shall be met.

3.5 Temperature Variation Test

When the equipment is subjected to this test, the appropriate requirements of Paragraph 2.16, Variation in Receiver Threshold, shall be met.

---

1/ The application of this test may result in damage to the equipment under test. Therefore, it may be conducted after the other tests are completed. Paragraph 1.3 does not apply.

3.6 Power Input Test

3.6.1 Electrical Input Variation Test

When subjected to this test:

(a) The appropriate requirements of Paragraph 2.16, Variation in Receiver Threshold, shall be met;

(b) The requirements of Paragraph 2.4, Rated Audio Power Output shall be met;

(c) All mechanical devices shall operate satisfactorily.

3.6.2 Low Voltage Test

(a) When the primary voltage(s) of DC operated equipment is 80% and when that of AC operated equipment is 87-1/2% of standard design voltage(s), the equipment shall start and continue to operate electrically and mechanically. Degradation of performance is tolerable.

(b) DC operated equipment shall operate satisfactorily within two (2) minutes upon returning the primary power voltage(s) to normal after the gradual reduction of the primary power voltage(s) from 80% to 50% of standard design voltage(s).

(c) The gradual reduction of the primary power voltage(s) of DC operated equipment from 50% to 0% of standard design voltage(s) shall produce no evidence of the presence of fire or smoke. 1/

3.7 Conducted Voltage Transient Test

3.7.1 Equipment Operated from DC Power

(a) Following the application of Intermittent Transients:

(1) The level of a Standard Test Signal required to produce Receiver Threshold shall be the same (±1 db) as was required immediately before the application of Intermittent Transients.

NOTE: The ±1 db value does not relate to degradation of performance but, rather, takes into account the practical aspects of laboratory measurement techniques.

1/ The application of this test may result in damage to the equipment under test. Therefore, it may be conducted after the other tests are completed. Paragraph 1.3 does not apply.

(2) The requirements of Paragraph 2.4, Rated Audio Power Output, shall be met.

(b) During the application of Repetitive Transients:

(1) The lamp operation shall be normal using a Standard Test Signal varying in rf level from that which produces Receiver Threshold to 50,000 microvolts.

(2) The requirements of Paragraphs 2.5, Audio Noise Level - Without Signal, and 2.6, Audio Noise Level - With Signal, shall be met.

(c) During the application of Interconnecting Wire Induced Transients:

(1) The lamp operation shall be normal using a Standard Test Signal varying in rf level from that which produces Receiver Threshold to 50,000 microvolts.

(2) The requirements of Paragraphs 2.5, Audio Noise Level - Without Signal, and 2.6, Audio Noise Level - With Signal, shall be met.

3.7.2 Equipment Operated from AC Power

During the application of Positive and Negative Voltage Transients:

(a) The lamp operation shall be normal using a Standard Test Signal varying in rf level from that which produces Receiver Threshold to 50,000 microvolts.

(b) The requirements of Paragraphs 2.5, Audio Noise Level - Without Signal, and 2.6, Audio Noise Level - With Signal, shall be met.

3.8 Audio-Frequency Conducted Susceptibility Test

When the equipment is subjected to this test, the requirements of Paragraphs 2.5, Audio Noise Level - Without Signal, and 2.6, Audio Noise Level - With Signal, shall be met. In addition, there shall be no "lamp-on" indication.

3.9 Audio-Frequency Magnetic Field Susceptibility Test

When the equipment is subjected to this test, the requirements of Paragraphs 2.5, Audio Noise Level - Without Signal, and 2.6, Audio Noise Level - With Signal, shall be met. In addition, there shall be no "lamp-on" indication.

3.10 Radio-Frequency Susceptibility Test (Radiated and Conducted)

When the equipment is subjected to this test:

(a) The lamp operation shall be normal using a Standard Test Signal varying in rf level from that which produces Receiver Threshold to 50,000 microvolts, except for frequencies within the band ±100 kHz of 75 MHz;

(b) The requirements of Paragraphs 2.5, Audio Noise Level - Without Signal, and 2.6, Audio Noise Level - With Signal, shall be met, except for frequencies within the band ±100 kHz of 75 MHz.

3.11 Explosion Test (When required)

During the application of this test, the equipment shall not cause detonation of the explosive mixture within the test chamber.

3.12 Waterproofness (Drip Proof) Test (When required)

After subjection to this test, the lamp operation shall be normal using a Standard Test Signal varying in rf level from that which produces Receiver Threshold to 50,000 microvolts.

3.13 Hydraulic Fluid Test (When required)

After subjection to this test, the lamp operation shall be normal using a Standard Test Signal varying in rf level from that which produces Receiver Threshold to 50,000 microvolts.

3.14 Sand and Dust Test (When required)

After subjection to this test, the lamp operation shall be normal using a Standard Test Signal varying in rf level from that which produces Receiver Threshold to 50,000 microvolts.

3.15 Fungus Resistance Test (When required)

After subjection to this test, the lamp operation shall be normal using a Standard Test Signal varying in rf level from that which produces Receiver Threshold to 50,000 microvolts.

3.16 Salt Spray Test (When required)

After subjection to this test, the lamp operation shall be normal using a Standard Test Signal varying in rf level from that which produces Receiver Threshold to 50,000 microvolts.

THIS PAGE INTENTIONALLY LEFT BLANK

# M E M B E R S H I P

## Special Committee 115
## International Coordination Group 7

## MINIMUM PERFORMANCE STANDARDS - AIRBORNE RADIO MARKER RECEIVING EQUIPMENT OPERATING ON 75 MEGAHERTZ

CHAIRMAN

| | |
|---|---|
| A. R. Applegarth | ARADAR Corporation |

SECRETARY

| | |
|---|---|
| G. F. Schillinger | Radio Tech. Comm. for Aeronautics |

MEMBERS AND ADVISERS

| | |
|---|---|
| H. W. Anderson | Federal Aviation Administration |
| J. W. Bail | NARCO Avionics |
| F. O. Budge | Federal Communications Commission |
| W. T. Carnes | Aeronautical Radio, Inc. |
| W. H. Greene | Bendix Avionics Division |
| E. Grillot | King Radio Corporation |
| L. B. Hallman, Jr. | Department of the Air Force |
| A. Hemphill | Bendix Avionics |
| G. Jensen | Department of the Navy |
| A. H. Jessell | British Embassy |
| W. E. Macklon | Department of Transport, Canada |
| A. Mayer | Collins Radio Company |
| R. C. McGraw | Collins Radio Company |
| H. P. Miller, III | Bayside Electronics, Inc. |
| L. Milosevic | Thomson-CSF, France |
| J. C. Nielson | Collins Radio Company |
| R. G. Nyberg | Aircraft Radio Corporation |
| R. G. Payne | Civil Aviation, Australia |
| A. L. Peters, Jr. | Department of the Air Force |
| S. B. Poritzky | Air Transport Association |
| W. C. Robinson | Department of the Army |
| D. J. Scardino | Bendix Avionics Division |
| G. R. Schneider | Collins Radio Company |
| E. A. Sornberger | Dorne & Margolin, Inc. |
| D. W. Stratton | AUTONETICS |
| L. C. Wells | NARCO Avionics |
| J. A. Zieger | Aircraft Radio Corporation |

THIS PAGE INTENTIONALLY LEFT BLANK

# A P P E N D I X  A

## TEST PROCEDURES -
## AIRBORNE RADIO MARKER RECEIVING EQUIPMENT
## OPERATING ON 75 MEGAHERTZ

NOTE:

THE TEST PROCEDURES SET FORTH IN PART II OF THIS APPENDIX ARE SATISFACTORY FOR USE IN DETERMINING THE PERFORMANCE OF AIRBORNE RADIO MARKER RECEIVING EQUIPMENT OPERATING ON 75 MEGAHERTZ. TEST PROCEDURES WHICH PROVIDE EQUIVALENT INFORMATION MAY BE USED.

THIS PAGE INTENTIONALLY LEFT BLANK

# PART I

## DEFINITIONS OF TERMS AND CONDITIONS OF TEST

The following definitions of terms and conditions of test are applicable to the test procedures specified herein.

A. Power Input Voltage - Direct Current

Unless otherwise specified, when the receiver is designed for operation from a direct current power source, all measurements shall be conducted with the power input voltage adjusted to 13.75 volts, ±2% for 12-14 volt equipment, or to 27.5 volts, ±2% for 24-28 volt equipment. The input voltage shall be measured at the receiver power input terminals.

B. Power Input Voltage - Alternating Current

Unless otherwise specified, when the equipment is designed for operation from an alternating current power source, all tests shall be conducted with the power input voltage adjusted to design voltage ±2%. In the case of receivers designed for operation from a power source of essentially constant frequency (e.g., 400 Hz), the input frequency shall be adjusted to design frequency ±2%. In the case of receivers designed for operation from a power source of variable frequency (e.g., 350 to 1000 Hz), tests shall be conducted with the input frequency adjusted to within 5% of a selected frequency within the range of which the receiver is designed.

C. Adjustment of Equipment

The circuits of the equipment under test shall be properly aligned and otherwise adjusted in accordance with the manufacturer's recommended practices, prior to the application of the specified tests.

D. Test Instrument Precautions

Due precautions shall be taken during the conduct of the tests to prevent the introduction of errors resulting from the improper connection of headphones, voltmeters,

oscilloscopes, and other test instruments across the input and output impedances of the equipment under test.

E. Ambient Conditions

Unless otherwise specified, all tests shall be conducted under conditions of ambient room temperature, pressure, and humidity. However, the room temperature shall be not lower than 10°C.

F. Warm-Up Period

Unless otherwise specified, all tests shall be conducted after a warm-up period of not less than fifteen (15) minutes.

G. Connected Loads

Unless otherwise specified, all tests shall be performed with the equipment connected to loads having the impedance value for which it is designed.

H. RF Input Voltage

The "rf input voltage" is defined as the "open circuit" voltage of the circuit connected to the receiver input. The circuit connected to the receiver input shall be the equivalent of the rf input voltage in series with an impedance having a resistance within 10% and a reactance of not more than 10% of the characteristic impedance of the transmission line for which the receiver is designed.

NOTE 1: The terminal voltage at an antenna is one-half the induced voltage (open circuit voltage) when the antenna is terminated in its characteristic impedance. Most signal generators indicate terminal voltage when terminated in their characteristic impedance. Therefore, when the signal generator voltage is applied to a receiver, the indicated generator voltage must be multiplied by two to obtain the antenna induced voltage. By placing 6 db attenuation between the generator and the receiver, the induced voltage may be read directly on the generator output indicator, which is the voltage referred to in the tests unless otherwise specified.

NOTE 2: The rf input voltages specified herein are for the case of a receiver designed for a transmission line having a nominal characteristic impedance of 52 ohms. In the case of a receiver designed for a transmission line having a nominal characteristic impedance of other than 52 ohms, the rf input voltage values shall be computed according to the following equation:

$$E_2 = \sqrt{E_1^2 \frac{R_2}{52}}$$

Where:

$E_2$ is the rf input voltage to be used in the case of a receiver designed for a transmission line having a nominal characteristic impedance other than 52 ohms -

$E_1$ is the rf input voltage specified herein -

$R_2$ is the nominal characteristic impedance of the transmission line for which the receiver is designed.

I. Standard Test Signal

Unless otherwise specified, the rf input signal shall be a 75 MHz ±.005% signal amplitude modulated 95±3% successively at 400 ±1% Hertz, 1300 ±1% Hertz, and 3000 ±1% Hertz.

J. Lamp-on and Lamp-off Indication (Lamp Operation)

(a) A Lamp-on condition exists when either--

(1) The operating relay, or its equivalent, is supplying power to the lamp, or

(2) The RMS voltage appearing across the lamp terminals is at least one-half of the equipment manufacturer's rated value.

(b) A Lamp-off condition exists when either--

(1) The operating relay, or its equivalent, is not supplying power to the lamp, or

(2) The RMS voltage across the lamp terminals is less than 25% of the equipment manufacturer's rated value.

K. Receiver Threshold

Receiver Threshold is that condition when a specified level of a Standard Test Signal, with the signal level increasing, produces a Lamp-on indication and at least 20% of rated audio power output.

L. Receiver Threshold Setting

Except for the "enroute" mode of Category A equipment, the receiver gain shall be adjusted to produce a Lamp-on condition with an rf input signal level of 1000 microvolts. For the "enroute" mode, of Category A equipment, an rf input signal level of 200 microvolts shall be used.

## PART II

## DETAILED TEST PROCEDURES 1/

### T-1 Audio Frequency Response

#### Equipment Required

RF Signal Generator (Hewlett-Packard Model 608B or equivalent)

AF Signal Generator (Hewlett-Packard Model 200B or equivalent)

Audio Output Meter (General Radio Model 583A or equivalent)

Voltmeter of suitable impedance and range (if required) for determining Receiver Threshold.

#### Measurement Procedure

Apply to the receiver input an rf signal having a level ten times that producing Receiver Threshold at 1300 Hz and measure the audio output over the input signal modulation frequency ranges of 380-420 Hz, 1235-1365 Hz, and 2850-3150 Hz.

### T-2 Lamp Frequency Response

#### Equipment Required

RF Signal Generator (Hewlett-Packard Model 608B or equivalent)

AF Signal Generator (Hewlett-Packard Model 200B or equivalent)

Voltmeter, if required, of suitable impedance and range for determining Receiver Threshold.

---

1/ See note on cover page of Appendix A.

Measurement Procedure

Apply to the receiver input an rf signal amplitude modulated 95% at each of the following frequencies: 390, 400, 410, 1270, 1300, 1330, 2920, 3000 and 3080 Hz. For each modulation frequency, determine the level of the input signal required to produce Receiver Threshold. Compute the difference in db between the maximum and minimum input signal levels.

T-3 Automatic Gain Control

Equipment Required

RF Signal Generator (Hewlett-Packard Model 608B or equivalent)

AF Signal Generator (Hewlett-Packard Model 200B or equivalent)

Audio Output Meter (General Radio Model 583A or equivalent)

Voltmeter of suitable impedance and range (if required) for determining Lamp-on or Lamp-off condition.

Measurement Procedure

Apply an rf signal to the receiver input and measure the audio output at each of the modulation frequencies of 400, 1300, and 3000 Hz over the rf signal input level range from that producing Receiver Threshold to 50,000 microvolts. Determine the difference in db between the maximum and minimum output levels. In the case of equipment designed to operate a separate lamp for each of the three modulation frequencies, determine that the two lamps not intended to be ON are in the OFF condition. If more than one Receiver Threshold setting is incorporated in the equipment, repeat the test for the additional settings.

T-4 Rated Audio Power Output

Equipment Required

RF Signal Generator (Hewlett-Packard Model 608B or equivalent)

AF Signal Generator (Hewlett-Packard Model 200B or equivalent)

Audio Output Meter (General Radio Model 583A or equivalent)

Voltmeter of suitable impedance and range (if required) for determining Receiver Threshold.

Measurement Procedure

Apply to the receiver input an rf signal having a level ten times that producing Receiver Threshold at 1300 Hz. Determine the audio power output at the modulation frequencies of 400, 1300, and 3000 Hz.

T-5 Audio Noise Level - Without Signal

Equipment Required

Resistance having a value equal to the impedance for which the receiver output is designed

Vacuum Tube Voltmeter (Ballantine Model 300 or equivalent)

Wave Analyzer (General Radio Model 736A or equivalent)

Measurement Procedure

Connect to the receiver input an impedance equal to that for which the receiver is designed. Measure (a) the wide-band audio noise output and (b) the output at discrete frequencies over the range of 50 to 10,000 Hz.

In the case of receivers designed for an AC power source, determine the maximum audio output over the range of input power frequencies for which the equipment is designed.

T-6 Audio Noise Level - With Signal

Equipment Required

RF Signal Generator (Hewlett-Packard Model 608B or equivalent)

AF Signal Generator (Hewlett-Packard Model 200B or equivalent)

Audio Output Meter (General Radio Model 583A or equivalent)

Wave Analyzer (General Radio Model 736A or equivalent)

Measurement Procedure

Apply to the receiver input an rf signal amplitude modulated (in turn) 95% at 400, 1300 and 3000 Hz.

(a) At each modulation frequency, determine the minimum signal + noise/noise ratio over the range of input signal level from that producing Receiver Threshold to 50,000 microvolts.

(b) Remove the modulation from the input signal and determine the maximum output at discrete frequencies over the range of 50 to 10,000 Hz when the input signal level is varied over the range from that producing Receiver Threshold to 50,000 microvolts.

In the case of receivers designed for an AC power source, make the above determinations over the combined ranges of signal input level from that producing Receiver Threshold to 50,000 microvolts and the input power frequency(s) for which the receiver is designed.

T-7 Distortion

Equipment Required

RF Signal Generator (Hewlett-Packard Model 608B or equivalent)

AF Signal Generator (Hewlett-Packard Model 200B or equivalent)

Distortion and Noise Meter (RCA 69B or equivalent)

Measurement Procedure

Terminate the receiver output with an impedance equal to that for which the receiver is designed. Apply to the receiver input an rf signal amplitude modulated (in turn) 95% at each of the following frequencies: 400, 1300 and 3000 Hz. Determine the maximum percentage of distortion plus noise at each modulation frequency at input signal levels from that producing Receiver Threshold at 1300 Hz to 50,000 microvolts.

T-8 Output Regulation

Equipment Required

RF Signal Generator (Hewlett-Packard Model 608B or equivalent)

AF Signal Generator (Hewlett-Packard Model 200B or equivalent)

Distortion and Noise Meter (RCA Model 69B or equivalent)

Output load resistors having values equal to 50%, 100% and 200% of the output load impedance for which the receiver is designed.

Measurement Procedure

Apply to the receiver input an rf signal having a level ten times that producing Receiver Threshold at 1300 Hz. Determine, at the modulation frequencies of 400, 1300 and 3000 Hz, the percentage of distortion plus noise in the audio output and the audio output voltage level with output loads equal to 50%, 100% and 200% of that for which the receiver is designed.

T-9 Emission of Spurious Radio-Frequency Energy

Equipment Required

See Section II, Test Procedures, of Appendix A of RTCA Document DO-138.

Measurement Procedure

See Section II, Test Procedures, of Appendix A of RTCA Document DO-138.

T-10 Sensitivity Depression

Equipment Required

A Combining Unit as shown in Figure 1.

AF Signal Generator (Hewlett-Packard Model 200B or equivalent)

Two RF Signal Generators (Hewlett-Packard Model 608B or equivalent)

RF Signal Generator (Hewlett-Packard Model 612 or equivalent)

Frequency modulated signal generator

Television signal amplifier capable of boosting the level of a TV signal to at least 3.5 volts peak. The frequency response characteristic of the amplifier shall be within 3 db over the frequency range from -0.5 MHz to +4.0 MHz of the video carrier frequency. For the purpose of this test, a signal simulating that of a TV signal may be used. Such simulated TV signal shall be a 3.5 volts peak rf signal pulse modulated at a rate of 60 pps. The pulse duration shall be 800 to 1000 microseconds and the rise time and decay time shall not exceed .08 microseconds.

Measurement Procedure

Connect the two signal generators (or the amplitude modulated signal generator and the television signal amplifier) as shown in Figure 1.

Apply a 75 MHz desired signal modulated 1300 Hz. Adjust the signal input level to produce Receiver Threshold.

Categories A and B

Apply, successively, a television signal having a level of 3.5 volts and an FM signal modulated 1300 Hz at a deviation of ±15 kHz and having a level of 0.5 volt and determine the db increase in level of the desired signal required to produce Receiver Threshold. Conduct this test at television channel frequencies 4 and 5 in the case of the television signal and from 72.02 MHz to 74.58 MHz and 75.42 to 75.98 MHz in the case of the FM signal.

Category A Only

Apply an unmodulated 0.5 volt rf signal at frequencies from 50 kHz to 63 MHz, and 85 MHz to 1200 MHz, and determine the db increase in level of the desired signal required to produce Receiver Threshold.

T-11 Input Operating Differential

Equipment Required

RF Signal Generator (Hewlett-Packard Model 608B or equivalent)

AF Signal Generator (Hewlett-Packard Model 200B or equivalent)

Measurement Procedure

Apply to the receiver input an rf signal. Determine the ratio in db of the rf input signal level required to produce that lamp voltage which is obtained at Receiver Threshold when the input signal level is slowly increasing to the rf input signal level required to produce that same lamp voltage when the input signal level is slowly decreasing.

T-12 Receiver Input Impedance

Equipment Required

RF Signal Generator (Hewlett-Packard Model 608B or equivalent)

Slotted line or impedance bridge

PRD Electronics Standing Wave Detector Model 219L and Indicator PRD 227-D or General Radio Admittance Meter Type 1602-B and suitable detector; or equivalent.

Measurement Procedure

(a) When the slotted line is used:

Connect the slotted line between the receiver input and the signal generator. Turn the receiver on and operate it normally. Set the level of the input signal below the level which overloads the receiver input circuit. Measure the maximum and minimum voltages along the slotted line and the actual input impedance variation over the range of 75 MHz ±10 kHz using the following equation:

$$\text{Actual Impedance} = \left(\text{Design Value Input Impedance}\right)\left[(\text{VSWR})^{\pm 1}\right]$$

This relationship is also used when the Standing Wave Detector or Admittance meter is used.

(b) When the impedance bridge is used, measure the impedance of the input circuit and determine the maximum deviation from the design value.

T-13 Cross Modulation

Equipment Required

Two RF Signal Generators (Hewlett-Packard Model 608B or equivalent)

AF Signal Generator (Hewlett-Packard Model 200B or equivalent)

Frequency Modulated Signal Generator

Television signal amplifier capable of boosting the level of a TV signal to at least 3.5 volts peak. The frequency response characteristic of the amplifier shall be within 3 db over the range from -0.5 MHz to +4.0 MHz of the video carrier frequency. For the purpose of this test, a simulated TV signal may be used. Such simulated TV signal shall be a 3.5 volts peak rf signal pulse modulated at a rate of 60 pps. The pulse duration shall be 800 to 1000 microseconds and the rise time and decay time shall not exceed .08 microseconds.

A Combining Unit as shown in Figure 1.

Audio Output Meter (General Radio Model 583A or equivalent)

Measurement Procedure

Connect the two signal generators together by means of the "Combining Unit" as shown in Figure 1.

Apply to the receiver input a 75 MHz desired signal modulated 1300 Hz. Adjust the signal input level to produce Receiver Threshold. Remove the modulation from the desired carrier.

Categories A and B

Apply successively, a television signal having a level of 3.5 volts and an FM signal modulated 1300 Hz at a deviation of ±15 kHz and having a level of 0.5 volt and determine whether the lamp voltage reaches that reached at Receiver Threshold and whether the audio output reaches one-half of the manufacturer's rated output. Conduct this test at television channel frequencies 2 through 6 in the case of the television signal and over the ranges of 72.02 to 74.58 MHz and 75.42 to 75.98 MHz in the case of the FM signal.

Category A Only

Apply an rf signal amplitude modulated 30% in turn at 400, 1300 and 3000 Hz, at a level of 0.15 volt, and determine whether the lamp voltage reaches that reached at Receiver Threshold and whether the audio output reaches one-half of the manufacturer's rated output. Conduct this test over the range 65 to 74.5 MHz and 75.5 to 85 MHz. Repeat this test with the desired (center response) signal (unmodulated) set to 50,000 microvolts.

NOTE: At each setting, determine whether the output is due to cross modulation or to direct demodulation of the undesired signal. Make this determination by turning off the desired carrier and noting audio output. If the output drops, cross modulation has been encountered, and the data should be recorded. If the output does not drop, the undesired signal is at a spurious response frequency, and the data should not be recorded.

T-14 Spurious Response

Equipment Required

AM signal generators to cover the band from 50 kHz to 1215 MHz

Audio Output Meter (General Radio Model 583A or equivalent)

Voltmeter, if required, of suitable impedance and range for determining Receiver Threshold

FM Signal Generator

Television signal amplifier capable of boosting the level of a TV signal to at least 3.5 volts peak. The frequency response characteristic of the amplifier shall be within 3 db over the range from -0.5 MHz to +4.0 MHz of the video carrier frequency. For the purpose of this test, a simulated TV signal may be used. Such simulated TV signal shall be an rf signal pulse modulated at a rate of 60 pps. The pulse duration shall be 800 to 1000 microseconds and the rise time and decay time shall not exceed .08 microseconds.

Measurement Procedure

Determine whether the voltage across the indicator lamp(s) reaches that reached at Receiver Threshold or the audio output reaches one-half rated output when:

1. (Category A Only) - The rf input signal has a level of 0.5 volt, is amplitude modulated 30% successively at 400, 1300 and 3000 Hz, and its frequency is varied over the range from 50 kHz to 68 MHz, and from 85 MHz to 1200 MHz.

2. (Categories A and B) - The rf input signal has a level of 0.5 volt, is amplitude modulated 30% successively at 400, 1300 and 3000 Hz and its radio-frequency is varied over the range from 0.190 MHz to 1215 MHz, excluding the band 65 MHz to 85 MHz.

3. (Categories A and B) - The rf input signal is a television signal having a level of 3.5 volts and frequencies of television channels 2 through 6.

4. (Categories A and B) - The rf input signal has a level of 0.5 volt, is frequency modulated successively at 400, 1300 and 3000 Hz, at a deviation of ±15 kHz, and its center frequency is varied over the ranges of 72.02 to 74.58 MHz and 75.42 to 75.98 MHz.

T-15 Lamp Actuation - Keying

Equipment Required

RF Signal Generator (Hewlett-Packard Model 608B or equivalent)

AF Signal Generator (Hewlett-Packard Model 200B or equivalent)

Keying device adjustable to 6 dots per second and 2 dashes per second.

Measurement Procedure

Apply to the antenna terminal of the receiver a Standard Test Signal modulated in turn at 400, 1300 and 3000 Hz. The modulation shall be applied at keying rates of 6 dots per second and 2 dashes per second with the modulation ON time to modulation OFF time for dots adjusted to a ratio of 1:1. While the rf level is varied from that producing Receiver Threshold to 50,000 microvolts, determine that the visual indication(s) and audio output signal are substantially in synchronism with the keying. Conduct this test at all settings of the rf gain control.

T-16 Variation in Receiver Threshold

Equipment Required

RF Signal Generator (Hewlett-Packard Model 608B or equivalent)

AF Signal Generator (Hewlett-Packard Model 200B or equivalent)

Necessary test equipment to simulate range of environmental conditions specified in Paragraph 2.16. (See RTCA Document, DO-138, for detailed environmental test procedures.)

Measurement Procedure

Adjust the Receiver Threshold adjustment(s) for the appropriate equipment category (see Paragraph 1.7). Cause the equipment to be subjected in turn, to the eight conditions specified in Paragraph 2.16(a) through 2.16(h) and determine and record the maximum deviation in db of the Receiver Threshold which obtains. Prepare a table similar to that of Figure 2 and insert the db figures noted in the preceding steps. Compute the Root-Sum-Square value in the manner shown in the example in the table.

T-17 Receiver Selectivity (For Category A equipment only)

Equipment Required

RF Signal Generator (Hewlett-Packard Model 608B or equivalent)

AF Signal Generator (Hewlett-Packard Model 200B or equivalent)

Audio Output Meter (General Radio Model 583A, or equivalent)

Measurement Procedure

Apply to the receiver input a Standard Test Signal at a level that obtains Receiver Threshold and note, as a reference, the audio output level. Increase the rf input level by 40 db and determine the frequencies either side of 75.0 MHz at which the reference audio output level is obtained.

T-18 Warm-Up Characteristics

Equipment Required

RF Signal Generator (Hewlett-Packard Model 608B or equivalent)

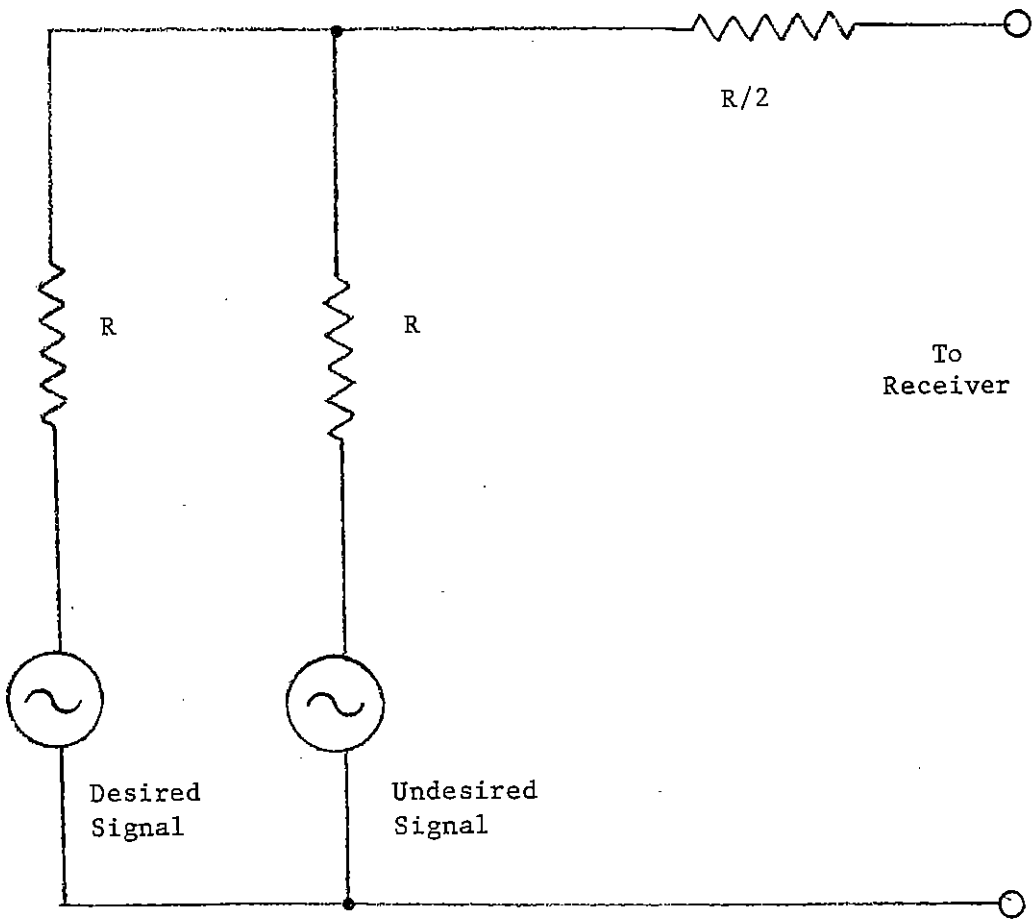
AF Signal Generator (Hewlett-Packard Model 200B or equivalent)

Audio Output Meter (General Radio Model 583A, or equivalent)

Voltmeter of suitable impedance and range (if required) for determining Receiver Threshold

Measurement Procedure

With the Receiver Threshold adjusted to that specified in Paragraph 1.7, allow the receiver to sit at ambient room temperature for at least four hours with no power applied. Then apply a Standard Test Signal to the receiver input and turn on all power. At the end of a five-minute period, determine the rf signal level required to obtain Receiver Threshold. Calculate in db the difference (if any) between this level and the level(s) specified in Paragraph 1.7 for the appropriate category of equipment.




R = characteristic impedance of the transmission line for which the receiver is designed.

FIGURE 1 - COMBINING UNIT

| Variable Condition | Maximum Deviation (in db) of Receiver Threshold | | (Maximum Deviation)$^2$ | |
|---|---|---|---|---|
| | (a) from that adjustment for Category A | (b) from that adjustment for Category B | (a) | (b) |
| a | 6 | 3 | 36 | 9 |
| b | 0.5 | 0.5 | 0.25 | 0.25 |
| c | 4 | 2 | 16 | 4 |
| d | 3 | 2 | 9 | 4 |
| e | 10 | 6 | 100 | 36 |
| f | 1 | 1 | 1 | 1 |
| g | 1 | 1 | 1 | 1 |
| h | 0 | 0 | 0 | 0 |
| | | Sum of squared values | 163.25 | 55.25 |
| | | Root-Sum-Square | 12.8 | 7.5 |

FIGURE 2 - EXAMPLE OF RSS CALCULATION