NAVPERS 93500

TROUBLESHOOTING COMMUNICATIONS EQUIPMENT

Bureau of Naval Personnel
Washington, D.C. 20370

June 1965

FOREWORD

This text was developed by the Chief of Naval Personnel for use in schools that provide instruction in troubleshooting communication equipment.

Since it is written in a programed-learning format, the text can also be used by individuals or groups in ships or activities where no formal training is conducted.

G. D. HARRELSON
Captain, USN
Director, Service Schools
Training Division
Bureau of Naval Personnel

PREFACE

This book has been prepared for Navy technicians whose rating requires a troubleshooting capability in communications equipment. It is a sequel to NAVPERS 93083A, Troubleshooting Electronic Equipments; successful completion of NAVPERS 93083A is prerequisite to this book. The text is similar in scope and content to volume 2 of NAVPERS 93083A. It provides the reader with practice in applying logical troubleshooting techniques to the AN/URC-32 Radio Set.

Although the troubleshooting problems presented in this text are specific to the AN/URC-32 Radio Set, the principles and techniques demonstrated are applicable to any communications equipment.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

INTRODUCTION

The purpose of this text is to demonstrate how the six-step logical troubleshooting procedure is applied to Navy communications equipment and to provide you with practice in application of the logical troubleshooting procedure. The text is designed for self-study by technicians completing their final weeks of Class A school and technicians who are working with communications equipment in the fleet.

The text is organized into four chapters. Each chapter consists of text and/or reading assignments, plus self-test questions for self-evaluation of your knowledge. It is important that you attempt to answer every question; it is also very important that you write down your answer to each question – don't fool yourself by saying "Oh, I know this one"! The four chapters are organized as follows:

Chapter I – Logical Troubleshooting. This chapter reviews the six-step troubleshooting procedure presented in NAVPERS 93083.

Chapter II – Introduction to the AN/URC-32 Radio Set. This chapter presents information and reading assignments for self-study of the AN/URC-32 technical manual, NAVSHIPS 93285(B). The chapter is structured as a series of lessons, each of which presents a small "bite" of the technical information you will need to troubleshoot the AN/URC-32.

Chapter III – Application of the Six-Step Troubleshooting Procedure. Three troubleshooting practice problems are given in this chapter to demonstrate application of the six-step troubleshooting procedure to typical faults which may occur within the AN/URC-32.

Chapter IV – Troubleshooting Problems. This chapter presents three troubleshooting problems to give you an opportunity to apply the logical troubleshooting procedure to typical faults.

Each of the first three chapters concludes with a series of review questions on the material covered by the chapter. After you complete each chapter, answer all of the review questions, then check you answers against the correct answers in appendix A. Each answer includes a page reference to the text wherein the subject material was presented, to simplify review of material you do not fully understand.

Appendix B contains the criterion test. When you complete study of this course you should be able to obtain a score of 80 percent or better. The criterion test measures successful accomplishment of the course objectives. Answers for the criterion test are in appendix C.

OBJECTIVES

To successfully complete this self-study course, you should obtain a score of 80 percent on the criterion test which is based on the following objectives.

Chapter I. Logical Troubleshooting

Upon completion of chapter I, you should be able to:

1. State in the proper sequence of application the six steps in logical troubleshooting as defined in NAVPERS 93083A.
2. Define in your own words each step of the six-step troubleshooting process as described in NAVPERS 93083A.
3. State the advantages of using the six-step troubleshooting procedure in electronics maintenance.

Chapter II. Introduction to the AN/URC-32 Radio Set

Upon completion of chapter II, you should be able to:

1. Correctly identify the functional units of typical communications equipment; i.e., transmit, receive, power supplv, control.
2. List at least five examples of trouble symptoms applicable to communications equipment.
3. Cite typical controls and indicators on communications equipment that should be used for symptom elaboration.
4. When given a functional block diagram of the AN/URC-32 Radio Set, correctly identify the function(s) of the: amplifier-control unit; converter-monitor; amplifier-converter-modulator; radio frequency amplifier; converter-oscillator; signal comparator; and low and high voltage power supplies.
5. Using NAVSHIPS 93285(B), Technical Manual for Radio Set AN/URC-32, identify functions of major front panel controls and indicators.

Chapter III. Application of the Six-Step Troubleshooting Procedure

Upon completion of chapter III, you should be able to:

1. Differentiate between normal and abnormal communications equipment indications (symptom recognition and elaboration).
2. Identify probable faulty functions based on symptom recognition and elaboration.
3. Localize communications equipment malfunctions to a functional unit, using information collected through symptom recognition and elaboration, listing of probable faulty functions, and making (simulated) tests of suspected functional units.
4. Localize the faulty circuit using the "bracketing" technique and equipment servicing diagrams.
5. Analyze communications equipment failures to determine possible causes.

Chapter IV. Troubleshooting Problems

Upon completion of chapter IV, you should be able to apply the six-step troubleshooting technique to isolate theoretical malfunotions in the AN/URC-32.

CHAPTER I. LOGICAL TROUBLESHOOTING

The Need for a Logical Troubleshooting Procedure

Troubleshooting is a skill which must be developed if you are to be proficient in operation and maintenance of a station or equipment. Good troubleshooting is not a talent with which a person is born. It is, however, a skill that can be acquired by anyone with a suitable electronics background. You can become a good troubleshooter if you have: (1) sufficient electronic knowledge to learn, or be taught, how an equipment works; (2) skill in reading and interpreting data contained in the equipment technical manuals; (3) skill in operating test equipment and interpreting test readings; and (4) a logical approach to troubleshooting.

Logical troubleshooting does not recognize "Easter-egging," "cookbooking," or "trial-and-error" methods. The "Easter-egger" makes unsupported guesses as to the location of the trouble. The "cook-booker" looks for trouble-locating clues in the trouble chart of the technical manuals, and is lost if the manual doesn't cover the particular fault. The "trial-and-error" man starts at one end of the equipment and works toward the other with the tube checker and test equipment. If any of the three finds the trouble in a reasonable length of time, he is lucky: finding the one bad part or wire or connection among hundreds or thousands is not easy to do by illogical methods.

Logical troubleshooting is a time-proven procedure used by all accomplished technicians. Most of them have applied the procedure so often that they no longer pay attention to its fine points. Through habit and years of experience they may have forgotten its specific details.

Probably no two technicians would explain the procedure alike, but all would agree that logical troubleshooting consists of a series of sequential steps that systematically isolate the trouble to the faulty part. Some would list the procedure in three or four steps; others would count a dozen, fifteen, or more. Regardless of the number, the principle would be the same. Six steps have been chosen as the easiest method of learning and applying this procedure. The steps in their sequential order are:

Step 1 – symptom recognition
Step 2 – symptom elaboration
Step 3 – listing the probable faulty functions
Step 4 – localizing the faulty function
Step 5 – localizing the faulty circuit
Step 6 – failure analysis.

QUESTIONS:

Q1. Good technicians use logical troubleshooting procedures to reduce troubleshooting ________________

Q2. The six-step troubleshooting procedure is a process of systematically locating a ______________________________.

Q3. As you become more experienced in troubleshooting, you may forget:

a. the logical approach to troubleshooting.

b. about using manuals.

c. the exact wording of the six-step troubleshooting procedure.

ANSWERS:

A1. Good technicians use logical troubleshooting procedures to reduce troubleshooting time.

A2. The six-step troubleshooting procedure is a process of systematically locating a fault or trouble. Usually you will troubleshoot to the part or component level; however, in systems which use modular construction, you may only be required to isolate the faulty circuit or circuit board.

A3. As you become more experienced in troubleshooting, you may forget:

a. the logical approach to troubleshooting. Incorrect. The technician who forgets the logical approach to troubleshooting will never make a good technician. A logical approach to troubleshooting should become a habit.

b. about using manuals. Wrong. The six-step troubleshooting procedure does not replace the technical manuals; it helps you use them to better advantage.

c. the exact wording of the six-step troubleshooting procedure. Correct. With practice, logical troubleshooting will become a habit. You will not think of the steps as such, but will follow the overall procedure automatically.

Step 1 – Symptom Recognition

The first step in any troubleshooting problem is recognition of a trouble indication. Recognizing that a trouble exists in an equipment is not always easy to do since conditions of less than peak performance are not always apparent. Lack of targets on a scope, timing error in a loran set, and decrease in the sensitivity of a receiver are just a few of hundreds of examples. Each of these is a trouble symptom that requires recognition.

There are many ways that the existence of a trouble can be brought to your attention. The obvious troubles will undoubtedly be noted during operation or preoperational checkout. These usually include complete, or almost complete, malfunction of the equipment or a part of the equipment. Troubles that are not easily noticed are those that cause degradation in equipment performance. A 125-mile radar that is only reaching 50 miles, a 100-watt transmitter that is only putting out 87 watts, a multimeter that provides readings that are 10 percent off, or a noisy telemeter record are examples of equipment faults that are difficult to recognize because there are no visible or audible indications that say they exist. Since a ship must depend on full-performance equipment, the hidden trouble symptoms must be found, the cause of the trouble located, and the repair made. If you make a point of looking for these "hidden" trouble symptoms every time you touch the equipment, most of the symptoms of degraded performance can be recognized. Compare performance between two similar equipments. Make the performance standard checks located in the preventive maintenance sections of the equipment manuals. Verify changes in performance since the last time you tuned, calibrated, or aligned the equipment. While you are troubleshooting, you can look for (and probably find) symptoms that signify degraded performance. Trouble symptoms can be recognized if you will look for them.

QUESTIONS:

Q1. The hardest trouble condition to recognize in equipment is degraded ________________________.

Q2. A technician can recognize trouble symptoms if he ____.

Q3. A technician should look for degraded performance in the equipment:

a. periodically during preventive maintenance.

b. whenever he observes or touches it.

c. when there is a definite malfunction.

ANSWERS:

A1. The hardest trouble condition to recognize in equipment is degraded performance.

A2. A technician can recognize trouble symptoms if he looks for them.

A3. A technician should look for degraded performance in the equipment:

a. periodically during preventive maintenance. Incomplete. True, he should look for poor performance during preventive maintenance, but he should also be alert for degraded performance whenever he comes in contact with the equipment.

b. whenever he observes or touches it. Excellent. A good technician should always be on the alert for symptoms which tell him something is wrong or going bad. Get in the habit of checking your equipments' performance every chance you get.

c. when there is a definite malfunction. No. If there is a definite malfunction, it is too late to start looking for degraded performance. First you must correct the malfunction. If you notice degraded performance, you may prevent a malfunction from occurring.

Step 2 – Symptom Elaboration

Breaking out the test equipment and equipment prints and proceeding headlong into troubleshooting on just the original identity of a trouble symptom is a very doubtful procedure. It could also be an unnecessary expenditure of energy. A dead scope, noise in a receiver, a zero reading on a panel meter, or a missing time pulse by itself is not sufficient identification of a trouble symptom. There is a tendency among noncompetent technicians to attempt a solution of a troubleshooting problem before they have completely defined it.

The procedures for symptom elaboration are dependent upon the available aids designed in the equipment and the nature of the original symptom. The aids include front panel controls and built-in performance measuring indicators. Additional information can be obtained about most malfunctions as the result of a systematic front panel check. If you have a good knowledge of how an equipment works, manipulation of appropriate controls and switches and corresponding checks of the equipment meters and indicators will reveal how the trouble is affecting the entire equipment. From these clues you can narrow down the probable areas of the equipment that could contain the trouble.

QUESTIONS:

Q1. Once it is decided that an equipment has a fault, a better idea of the trouble can be determined by:

a. analyzing circuit diagrams.

b. making voltage and resistance checks.

c. checking the effects of the trouble on equipment operation.

Q2. Noticing that a receiver is "dead" is an example of symptom ____________________. Checking the receiver's B+ voltmeter and finding that it indicates zero volts is an example of symptom ____________________.

Q3. In order to elaborate on the original fault symptom you must:

a. know your equipment.

b. ask the equipment operator to describe the symptoms.

c. check voltages at all power supply test points.

d. perform the official operating sequence.

ANSWERS:

A1. You get a better idea of the trouble by:

a. analyzing circuit diagrams. No, or at least not yet. In most cases you won't even know which diagrams to look at.

b. making voltage and resistance checks. Incorrect. Where will you start? At this point all you know for sure is that something is wrong – the trouble could be any place.

c. checking the effects of the trouble on equipment operation. Correct. The equipment may transmit ok, but not receive – you can cut down the "field" to the receive functions. The power supply meter may show all dc outputs are normal – you can eliminate the power supply from consideration. The front panel meters and indicators were installed for several purposes; obtaining information about malfunctions is one of them.

A2. Noticing that a receiver is "dead" is an example of symptom recognition. Checking the receiver's B+ voltmeter and finding that it indicates zero volts is an example of symptom elaboration.

A3. In order to elaborate on the original fault symptom you must:

a. know your equipment. Very good! If you know your equipment, you can elaborate on the symptom intelligently and possibly save many hours of troubleshooting time.

b. ask the equipment operator to describe the symptoms. This may help, but to elaborate on a malfunction symptom you should make knowledgeable checks of the equipment which will help you isolate the faulty function.

c. check voltages at all power supply test points. No, not yet. You may be able to eliminate the power supplies by symptom elaboration.

d. perform the official operating sequences. No! This won't help you if you don't know the equipment. A good technician will evaluate the bad indications from his knowledge of the equipment.

Step 3 – Listing the Probable Faulty Functions

The third step requires that you make an "educated guess" as to the probable cause of the trouble. From the trouble symptoms, as you have identified them, you determine the most logical locations of the trouble. Locations are generally confined to the major subdivisions of the equipment, the functional units.

The term "function" or "functional unit" is used to denote an electronic operation performed by a specific area of an equipment; for example, functions may be entitled transmitter, receiver, or modulator. These functions, combined together, make up an equipment set (radar set, transceiver set, sonar set, etc) and cause the set to perform the electronic purpose for which it was designed. Frequently, the terms "function" (an operational subdivision of a set) and "unit" (a physical subdivision) are synonymous. However, there are occasions when one or more circuits for a particular function may be physically located in other than the indicated unit. "Educated guesses" are made from a knowledge of how the equipment works and a study of the equipment's functional block diagrams.

As an example, assume there is no receiver audio from the remote amplifier located on the ship's bridge. The receiver is apparently operating properly. Your "educated guess" should include the audio patchboard, the receiver output to the patchboard, and the remote amplifier. Making an "educated guess" that it is a bad tube (just because the greater percentage of all equipment troubles are caused by bad tubes) is not acceptable – you still have to find the bad tube. The purpose here is to use valid reasoning to identify all probable, technically sensible functional areas which could contain the trouble. It may well be that the specific trouble is a bad tube, but wholesale tube substitution takes a lot of time and quite often introduces additional troubles, particularly in those circuits that operate close to critical tolerances or involve high frequencies.

Don't worry if you find your lists of "suspects" are incomplete; even the accomplished technician may not be able to list all the functional units that are probable sources of the trouble. Your lists will improve with practice until you don't have to even write the suspects down, but instinctively know which units the trouble could be in. On the other hand, don't worry if you end up with a "list" of only one item. In a well-designed equipment you will often be able to name the one functional unit which is causing the trouble.

QUESTIONS:

Q1. Functional block diagrams are useful to the technician in making

________________________________.

Q2. After performing step 2, the properly operating functions are

eliminated by ____.

Q3. The term "function" is used to denote an electronic operation performed by a specific area within an equipment. Which of the items listed below is best defined as a "functional unit"?

a. oscillator feedback circuit

b. frequency mixer

c. power supply

d. harmonic filter

ANSWERS:

A1. Functional block diagrams are useful to the technician in making educated guesses as to the possible locations of a fault.

A2. After performing step 2, the properly operating functions are eliminated by listing the probable faulty functions. By knowing the probable faulty functions, you have eliminated the properly operating functions.

A3. Your selection of the "functional unit" is:
a. oscillator feedback circuit. Incorrect. The feedback circuit is part of an oscillator, which in turn is generally part of a larger functional unit.
b. frequency mixer. Incorrect. A frequency mixer is normally one of the first stages of an RF or IF amplifier, which may be a functional unit.
c. power supply. Correct. The power supply performs a particular electronic function, that of "converting" ac power to dc power. The power supply is one of several functional units which make up an equipment.
d. harmonic filter. Incorrect. A harmonic filter is part of a nonlinear device, such as a mixer, and enables the device to perform its task.

Step 4 – Localizing the Faulty Function

In this step you select one of the "suspect" functions for testing. Your first choice is not necessarily the one you thought of first nor the one that past experience suggests as being the most probable. Selection of the first functional unit to be tested should be based not only on probability but also on the difficulties involved in making the necessary tests. Under some circumstances, you might elect to test the second most probable "suspect" rather than the most probable because the latter might involve testing difficulties that should be initially avoided, or require tampering with circuit adjustments that might later prove to have been unnecessary. Like all the others, this step in the troubleshooting procedure places emphasis on common-sense thinking rather than the resultant action. If you do your preliminary work properly, manual work in gaining access to test points and using test equipment can be limited to a bare minimum.

After selecting the order in which you will check the units you have listed, you proceed to verify your first selection. The check will normally be made at an output test point of the suspected unit. The test equipment reading is compared with the normal signal described in the technical manual. A "no output" condition is relatively easy to recognize. A distorted or abnormal output, however, should be carefully verified before arriving at a technical conclusion.

Upon completing a verification of the probable faulty unit you have selected, you will arrive at one of several conclusions. The test will verify that: (1) this is the unit in which the trouble lies; (2) the trouble could be in this plus another unit(s) from which it receives signal or control voltages; (3) the trouble is not in this unit; or (4) the output looks suspicious and further verifying tests need to be made. Whatever your conclusion, you have discovered information that can be used to substantiate or eliminate suspected units on your list or provide evidence for adding another. Tests of suspected unit outputs are continued until the single faulty unit is identified. You have narrowed down the trouble to a fraction of the total number of circuits and parts in the equipment. If you have done this much of the procedure properly, you can confine your search to the functional area you have isolated.

Note that this step can be eliminated if your symptom elaboration definitely identifies the one faulty functional unit.

QUESTIONS:

Q1. In localizing the faulty function you should eliminate each function one-by-one, starting with:

a. any probable function.

b. the most difficult function to test.

c. the first of the most probable functional units on the list.

d. the easiest to test of the most probable functions.

Q2. In localizing the faulty function you must rely on:

a. your own experience and common sense.

b. the technical manual trouble chart.

Q3. In the six-step troubleshooting procedure, step 4 is the first time that you will use:

a. the technical manual.

b. any bench test equipment.

c. the front panel indicators.

ANSWERS:

A1. Your starting point for isolation of the faulty function is:

a. any probable function. Not quite – you are looking for speed and efficiency; the function you choose at random may be very difficult to test.

b. the most difficult function to test. Incorrect. Before attempting this one you need very strong evidence that it is faulty!

c. the first of the most probable functional units on the list. Possibly, but not <u>because</u> it's first on the list. It should be chosen for ease of verification as well, to minimize your work.

d. the easiest to test of the most probable functions. Correct. Your goal here is to isolate the function in the most efficient manner possible, which requires that you select functions which are both "likely suspects" and easy to check out.

A2. Selection of the "tool" to rely on was:

a. your own experience and common sense. Correct. You must decide which tests to make first, and evaluate the results of the test to decide on your next check.

b. the technical manual trouble chart. Incorrect. The trouble chart may or may not cover the particular problem you are experiencing; its information may or may not be correct and up-to-date.

A3. Step 4 is the first time you will use:

a. the technical manual. Incorrect. You've been using the manual from the start to identify normal indications, examine the block diagrams, and read the technical descriptions.

b. any bench test equipment. Correct. Up to step 4 you've been concerned with the visible indications of the fault; now you're tracking the fault toward its source, which requires use of test equipment to look at waveforms, measure voltage, power, frequency, etc.

c. the front panel indicators. Incorrect. The front panel indicators very likely gave you the first "clue" that something was wrong with the equipment!

<u>Step 5 – Localizing the Faulty Circuit</u>

The next step after you have isolated the faulty function or functional area is to identify the faulty circuit. The same narrowing down procedures are used as before. First you subdivide the functional unit into circuit groups (IF strip, mixer, discriminator, etc). You then examine each circuit group to see if it could contain the fault. Finally, you make tests to isolate the faulty stage or stages. Using this procedure, you can find the faulty circuit without going through the unnecessary, time-wasting chore of test-point-to-test-point checking from one end of the unit to the other.

In narrowing down the trouble to a single functional group of circuits, you can employ a process called "bracketing." In this process brackets are placed on the schematic or service block diagram around the area in which the trouble lies. Initially brackets are placed at the inputs to the unit that are known to be good and at the outputs known to be bad. Next you select points at which you can test, to isolate or eliminate portions of the unit. As each test is made, an input or output bracket is moved to the point in the block diagram where the test was made. In this manner the closing brackets systematically narrow the fault to a single circuit.

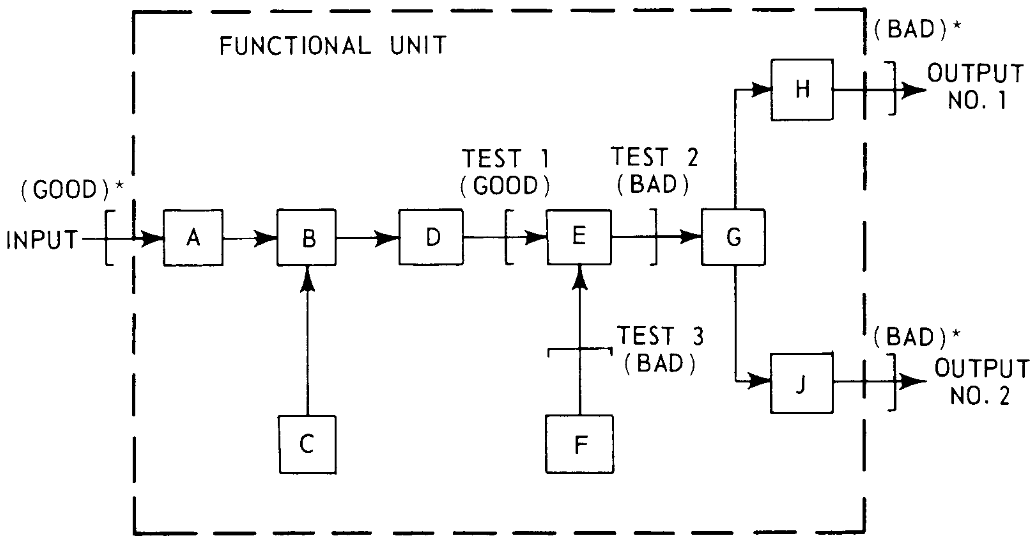
In selecting a point on a detailed block diagram to which one of the brackets is to be moved, you must consider two things – the characteristics of the improper output signal and the types of signal paths contained in the unit. The waveshape of a signal has certain characteristics – voltage, rise-time, noise content, frequency, etc – that can be measured or observed. When these characteristics are in accordance with the designated standards, the signal is considered to be good. In a bad signal the characteristics that are improper can reveal clues that will help to identify a circuit group whose function is to originate or control that portion of the waveshape. For example, the output of a unit is supposed to be a sawtooth waveform with six pulses equally spaced on its slope. If the pulses are there but the slope is nonexistent or insufficient, the sawtooth generating and shaping circuits would be suspected. If the proper slope is there but there are no pulses or an incorrect number of pulses, the pulse generating or controlling circuit groups probably contain the trouble.

The type of signal path contained in the unit is the other item to be considered before moving a bracket. There are four general types – linear, switching, convergent/divergent, and feedback. In a linear signal path the signal is processed through circuits that are connected in series. When identification of the faulty circuit group is difficult or impossible (that is, when the waveshape characteristics do not indicate the faulty circuit function), brackets are moved to successively smaller half-points in the linear string. Signals from two or more circuit channels that meet at a common point or a signal that leaves a common point to enter two or more channels are examples of convergent and divergent paths, respectively. Moving a bracket (after making the appropriate test) to the common point will separate the bad from the good signal paths. In the same manner, a test and bracket at the point where signal paths are connected by a switch will reveal the same information. The remaining type – feedback – is the hardest type to troubleshoot. Negative feedback circuits (automatic gain or frequency control, active filtering, etc) can be opened – by removing a tube or transistor – or in some cases grounded to remove the feedback effect. Positive feedback loops (regenerative receivers, oscillators) are more difficult since the regeneration will not occur if the positive feedback is removed. Signal insertion plus disabling of the feedback loop is effective in most cases.

There are no hard-and-fast, step-by-step procedures for bracketing, but there are some realistic rules. Examine the characteristics of the faulty output to determine the circuit group function that either generates or controls the improper characteristic. Study the detailed block diagram to determine the least number of bracket moves that will isolate the faulty circuit. Such moves will be dependent upon the types of signal paths contained in the unit and the electronic functions of circuit groups that may be responsible for distortions contained in the unit's output. Move only one bracket at a time after verifying the suitability of the signal by making a test. If the test does not reveal sufficient information for a valid bracket move, make another "educated guess." Determining which bracket to move is dependent upon circuit configuration within the unit and the number of circuits that will be enclosed. Figure 1-1 illustrates a logical sequence for isolating a fault by this procedure.

The servicing block diagram can serve as the instrument for the complete bracketing process. In some cases it will be necessary to refer to a schematic diagram for information regarding location of test points. There is sufficient diagram information available in the technical manual to support the bracketing procedure and preclude wasteful, unreliable, circuit-to-circuit checking; you must know the organization and content of the manual to make effective use of your time.

The bracketing step is completed when you have isolated the trouble to a single circuit and verified that the output of this circuit is the cause of the original symptoms.



NOTES:
1. *INITIAL CONDITIONS WHICH ISOLATE FAULT TO "FUNCTIONAL AREA".
2. TEST 1 DIVIDES SUSPECTED MODULES INTO APPROXIMATELY EQUAL GROUPS A-D AND E-G (IT IS UNLIKELY THAT BOTH H AND J WOULD BE DEFECTIVE).
3. TEST 2 ISOLATES FAULT TO EITHER MODULES E-F OR MODULE G.
4. TEST 3 DETERMINES F OUTPUT IS BAD AND ISOLATES DEFECTIVE CIRCUIT.

Figure 1-1. Example of Bracketing Procedure.

QUESTIONS:

Q1. In "bracketing" to isolate a fault you will need to use the ______________________ and ____________ diagrams in the equipment's technical manual.

Q2. The hardest type of circuit to troubleshoot is a ________________ circuit.

Q3. The "bracketing" technique is usually completed when you have isolated the faulty:

a. function.

b. circuit.

c. part.

ANSWERS:

A1. In "bracketing" to isolate a fault you will need to use the schematics and block diagrams in the equipment technical manual.

A2. Experience has shown that the feedback circuit, and especially the positive feedback circuit, is the most difficult type of circuit to troubleshoot. Operation of the positive feedback circuit is dependent on every part; if the "loop" is opened anywhere, the entire circuit generally ceases to function. This prevents use of one of the most useful tools you have, your oscilloscope.

A3. The point where the bracketing procedure is completed is the faulty:
- a. function. Incorrect. You start using the bracketing procedure after you have identified the faulty function.
- b. circuit. Correct. After the faulty circuit has been isolated you are ready to make the detailed tests and analysis to identify the faulty part; the bracketing procedure is not useful for these tests.
- c. part. Incorrect. The bracketing procedure is not useful for tests at this level since bracketing involves signal evaluation; isolation of the defective component requires more detailed tests.

Step 6 – Failure Analysis

The troubleshooting procedure thus far has narrowed the trouble to a single circuit consisting of a tube or a transistor and a few parts. If there is no output from the circuit, tube testing and voltage/resistance checks at tube pins are your best bet. However, such checks can be minimized if there is an output that can be examined for distortions that will reveal the circuit part(s) that are most likely at fault. Quite often the waveform will identify the malfunction to be in the grid, or cathode, or plate, or screen portions of the circuit. Such a study should be made before any of the parts are checked.

When the faulty part has been identified, it should not be replaced until you can substantiate that it is causing the actual trouble. A suspected open resistor, shorted capacitor, detuned coil, or weak tube may not be the reason (or the only reason) for the faulty output of the circuit. Such a defect may have resulted from another trouble. If you replace the part without an adequate technical reason, you may not cure the trouble. Analyze the failure before making the repair.

QUESTIONS:

Q1. Step 6 of the six-step troubleshooting procedure has two parts.

Which of the following are part of step 6? (Choose two.)

a. Isolate the faulty component.

b. Analyze the failure.

c. Replace the faulty component.

Q2. Distortion in a circuit can best be isolated by using:

a. a vtvm.

b. a vom.

c. an oscilloscope.

d. a signal generator.

ANSWERS:

A1. The two parts you chose for step 6 of the six-step troubleshooting procedure are:
   a. Isolate the faulty component. Correct. When you have isolated the faulty component, you are halfway through step 6.
   b. Analyze the failure. Correct. After you have isolated the faulty component, you should analyze the circuit and make any additional checks necessary to be sure you have the component(s) which actually caused the trouble.
   c. Replace the faulty component. Incorrect. When you replace the faulty component, you should be through troubleshooting. You should know if you are replacing the actual cause of the trouble.

A2. Distortion in a circuit can best be isolated by using:
   a. a vtvm. Incorrect. A vtvm would probably prove frustrating in isolating a malfunction which is causing distortion. The voltage and resistance measurements would probably be close to the expected value if you consider that some resistors have a 10% tolerance.
   b. vom. Incorrect. A vom would probably prove frustrating in isolating a malfunction which is causing distortion. The voltage and resistance measurements would probably be close to the expected value if you consider that some resistors have a 10% tolerance.
   c. an oscilloscope. Correct. Sources of distortions can be isolated easiest with an oscilloscope since the type of distortion can be observed and analyzed.
   d. a signal generator. Incorrect. The signal generator is a good tool when there is no signal (the generator supplies one); it is useless when the signal is present but not normal.

Advantages of Using the Six-Step Troubleshooting Procedure

If a radioman reported that a transmitter was not operating properly, you wouldn't rush to the transmitter and start taking voltage and resistance measurements without some idea of where the trouble existed. This approach would waste time and would probably not repair the equipment. For many years good technicians approached all malfunctioning equipment in a logical manner which helped them to locate and correct malfunctions in a relatively short period of time. The approach these good technicians used was studied; as a result the six-step troubleshooting procedure was evolved to help all technicians become better technicians. The six-step troubleshooting procedure helps technicians to troubleshoot even the most complex equipment in a logical manner and reduce equipment down-time.

The six-step troubleshooting procedure is designed to isolate a trouble in an orderly manner, with a minimum of time and effort. Success in using the procedure is dependent upon your knowledge of electronics and the equipment, and your skill in using the technical manual and test equipment. The process is no more complicated than your ability to subdivide an equipment into progressively smaller areas – from functional units to circuit groups, to a circuit, and finally a part or an adjustment within the circuit.

CHAPTER I REVIEW QUESTIONS

Note: See appendix A for correct answers.

Choose the best answers:

Q1. The six-step troubleshooting procedure is the application of:
- a. trial and error techniques.
- b. Easter-egging techniques.
- c. the trouble chart in the technical manual.
- d. systematic troubleshooting techniques.

Q2. An equipment has degraded performance. Before it can be repaired, the trouble symptom must first be:
- a. recognized.
- b. listed.
- c. localized.
- d. analyzed.

Q3. Once you have recognized a trouble symptom, your next step is to:
- a. replace the faulty part.
- b. elaborate on the symptom.
- c. write a description of the symptom.
- d. isolate the faulty circuit.

Q4. Determining the probable locations of a trouble is:
- a. symptom elaboration.
- b. listing the probable faulty functions.
- c. localizing the faulty function.
- d. localizing the faulty circuit.

Q5. The first time bench test equipment will be used is in:
- a. symptom elaboration.
- b. listing the probable faulty functions.
- c. localizing the faulty function.
- d. localizing the faulty circuit.

Q6. "Bracketing" is used to localize a faulty:
- a. function.
- b. circuit.
- c. part.

Q7. A technician replaces a faulty part in a circuit. When he turns on the equipment the part goes bad again. This technician did not do a good job of:
- a. symptom elaboration.
- b. symptom recognition.
- c. failure analysis.
- d. localizing the faulty circuit.

Q8. The six-step troubleshooting procedure usually:
- a. reduces circuit complexity.
- b. reduces troubleshooting time.
- c. eliminates the need for a technical manual.
- d. eliminates the need for test equipment

CHAPTER II

INTRODUCTION TO THE AN/URC-32 RADIO SET

This chapter consists of reading assignments in NAVSHIPS 93285(B), supplementary information, and self-test questions to help you become familiar with the AN/URC-32 Radio Set. The chapter is organized in four sections, as follows:

Section A (Lessons 1 through 7) General Description of the AN/URC-32 Radio Set

Section B (Lessons 8 through 19) Principles of Operation

Section C (Lessons 20 through 26) Front Panel Controls and Indicators

Section D (Lessons 27 through 30) Typical Trouble Symptoms in Communications Equipment.

Start at lesson 1 and work through the chapter in consecutive order. Answer all of the questions at the end of each lesson before starting the next lesson. When you complete this chapter you will have a good understanding of the operation of the AN/URC-32 Radio Set and will be ready for the troubleshooting problems in chapters III and IV.

If you are already familiar with the AN/URC-32 you may skip directly to the review questions at the end of the chapter. Answer all the review questions, then evaluate your knowledge by comparing your answers with those in appendix A. If you miss any of the questions, review the text referenced with the answer.

Throughout this chapter (and chapters III and IV) the military nomenclature has been used in preference to the informal descriptive names for the various units. The reason for this will become clear when you begin working with the servicing block diagrams and schematics; however, you will probably find it rather confusing at first. A cross reference list has been printed on the last page of this book to help overcome this confusion; the list is on a foldout page so it can be seen at all times.

LESSON NO. 1

INTRODUCTION

The AN/URC-32 Radio Set is representative of a class of communications equipments called "transceivers." The basic difference between a transmitter-receiver and a transceiver is that the transceiver includes functions which are used during both transmit and receive operations; the transmitter-receiver is essentially a combination of a transmitter and receiver in a single cabinet.

Some of the functions of the AN/URC-32 are used during both transmit and receive operations. You will become familiar with these functions as you read through this chapter.

Read paragraph 1-2, page 1-1 in NAVSHIPS 93285(B), then answer the self-test questions listed below.

Q1. What is the frequency range of the AN/URC-32? ____________

Q2. What is the main mode of operation? ____________

Q3. What other modes of operation are available? ____________

____

Q4. What is the peak envelope power (PEP) of the AN/URC-32 transmission? ____________

Q5. Is the AN/URC-32 a transmitter-receiver or a transceiver?

____

ANSWERS:

A1. The AN/URC-32 can transmit and receive over a range of frequencies from <u>2 to 30 megacycles</u>.

A2. The main mode of operation of the AN/URC-32 is <u>single-sideband (SSB)</u>.

A3. The Radio Set can also operate in <u>AM (compatible), CW, and FSK</u> modes.

A4. The maximum transmitted signal power is <u>500 watts PEP</u>.

A5. The AN/URC-32 is a <u>transceiver</u>; many of its circuits are shared by both the transmit and receive functions.

LESSON NO. 2

AN/URC-32 TRANSMIT SIGNAL

Read paragraphs 4-2 and 4-2a, pages 4-1 and 4-2 of NAVSHIPS 93285(B). Note that in CW operation, the tone is keyed on or off; there are no "mark" and "space" frequencies. A CW tone of 1.0 kc or 1.5 kc can be used.

Answer the following questions.

Q1. The AN/URC-32 transmits and receives at the same frequency because ______________________________

Q2. The audio from the control-power supply unit goes to the ______________________.

Q3. The LSB audio from the amplifier-control unit goes to the ______________________.

Q4. The USB audio from the amplifier-control unit goes to the ______________ and then to the ______________.

Q5. If the CW or FSK mode of operation is used, the output from the key is routed from the converter-monitor unit to the ______________________.

Q6. The amplifier-converter-modulator output frequency is ________.

Q7. In CW operation the frequency of the CW tone is ______ or ______.

Q8. The FSK "mark" tone frequency is _____ and the "space" tone frequency is _______.

Q9. What unit determines the transmitting frequency of the AN/URC-32?

____.

Q10. The amplifier-converter-modulator is similar to _______________ _______________________________ in an ordinary AM transmitter.

a. an oscillator-amplifier

b. an RF power amplifier

c. a speech amplifier

d. a modulator

Q11. The converter-oscillator is similar to _________________________ in an ordinary AM transmitter.

a. an oscillator-amplifier

b. an RF power amplifier

c. a speech amplifier

d. a modulator

Q12. The amplifier-control is similar to ___________________________ in an ordinary AM transmitter.

a. an oscillator-amplifier

b. an RF power amplifier

c. a speech amplifier

d. a modulator

ANSWERS:

A1. The AN/URC-32 transmits and receives at the same frequency because it has common tuned circuits and a common injection signal.

A2. The audio from the control-power supply unit goes to the amplifier-control unit. See figure 4-1.

A3. The LSB audio from the amplifier-control unit goes to the amplifier-converter-modulator unit. See figure 4-1.

A4. The USB audio from the amplifier control unit goes to the converter-monitor unit and then to the amplifier-converter-modulator unit. See figure 4-1.

A5. If the CW or FSK mode of operation is used, the output from the key is routed from the converter-monitor unit to the amplifier-converter-modulator unit. See figure 4-1.

A6. The amplifier-converter-modulator output frequency is 300 kc.

A7. In CW operation the frequency of the CW tone is 1.0 kc or 1.5 kc.

A8. The FSK "mark" tone frequency is 2425 cps and the "space" tone frequency is 1575 cps.

A9. The converter-oscillator unit determines the transmitting frequency of the AN/URC-32.

A10. The unit you selected as being similar to the amplifier-converter-modulator is:

a. an oscillator-amplifier. Incorrect. The amplifier-converter-modulator does not determine the operating frequency of the AN/URC-32.

b. an RF power amplifier. Incorrect. The amplifier-converter-modulator does not amplify the signal to maximum output power.

c. a speech amplifier. Incorrect. Amplification of the voice audio is accomplished before the amplifier-converter-modulator.

d. a modulator. Correct. The amplifier-converter-modulator modulates an RF signal in the balanced modulator.

A11. The unit you selected as being similar to the converter-oscillator unit is:

a. an oscillator-amplifier. Correct. The converter-oscillator contains the oscillator and amplifier which determine the operating frequency of the AN/URC-32, amplify this signal, and feed it to the power amplifier.

b. an RF power amplifier. Incorrect. Power amplification takes place following the converter-oscillator unit.

c. a speech amplifier. Incorrect. Audio is not amplified in the converter-oscillator.

d. a modulator. Incorrect. Modulation takes place in the amplifier-converter-modulator.

A12. The unit you selected as being similar to the amplifier-control unit is:

a. an oscillator-amplifier. Incorrect. The amplifier-control unit does not generate the transceiver operating frequency.

b. an RF power amplifier. Incorrect. There are no RF signals in the amplifier-control unit.

c. a speech amplifier. Correct. The audio is amplified in the amplifier-control unit by the USB and LSB amplifiers, then sent to the sideband generators.

d. a modulator. Incorrect. Modulation takes place in the amplifier-converter-modulator.

LESSON NO. 3

AN/URC-32 RECEIVE SIGNAL

The AN/URC-32 tunes from 2 mc to 30 mc. In the receive mode the transceiver acts as a double-conversion superheterodyne over the frequency range of 3.7 mc to 30 mc and a single-conversion superheterodyne in the 2.0 mc to 3.7 mc band. The two IF frequencies are 300 kc and a variable 1.7 mc to 3.7 mc. The variable 1.7 mc to 3.7 mc IF is used as the receiver input when the transceiver is used as a single-conversion superhetrodyne.

Read NAVSHIPS 93285(B) paragraph 4-2b, page 4-5, then answer the following questions:

Q1. The input received signal is fed to the ______________________.

Q2. The frequency of the IF signal sent to the amplifier-converter-modulator unit from the converter-oscillator unit is ___________.

Q3. Which unit provides the bfo signal? ______________________.

Q4. Which unit contains the demodulator circuit? ________________

Q5. The LSB audio from the amplifier-converter-modulator unit is fed to the:

a. amplifier-control unit.

b. converter-monitor unit.

c. converter-oscillator unit.

d. signal comparator unit.

Q6. During receive operation the converter-oscillator unit is similar to the ______________ in an ordinary communications receiver.

a. RF amplifier, mixer, and oscillator

b. IF amplifier and detector

c. audio amplifier

Q7. During receive operation the amplifier-converter-modulator unit is similar to the ________________________________ in an ordinary communications receiver.

a. RF amplifier, mixer, and oscillator

b. IF amplifier and detector

c. audio amplifier

ANSWERS:

A1. The input received signal is fed to the converter-oscillator unit.

A2. The frequency of the IF signal sent to the amplifier-converter-modulator unit from the converter-oscillator unit is 300 kc.

A3. The converter-monitor unit provides the bfo signal.

A4. The amplifier-converter-modulator unit contains the demodulator circuit.

A5. The LSB audio from the amplifier-converter-modulator is fed to the:

a. amplifier-control unit. Incorrect. The LSB audio is fed to the signal comparator where it is used in making off-the-air frequency checks. If no off-the-air frequency checks are being made, the LSB audio is sent from the signal comparator to the amplifier-control unit.

b. converter-monitor unit. Incorrect. No audio is sent to the converter-monitor in the receive function. The converter-monitor is only used in the transmit function. In USB, LSB, and AM modes of operation, the converter-monitor only monitors these audio signals with the audio level (VU) meter. In CW and FSK modes of operation the converter-monitor provides the keyed audio tones.

c. converter-oscillator. Incorrect. In the receive function the converter-oscillator is an RF to IF translator. There is no LSB or USB audio associated with this unit.

d. signal comparator. Correct. The LSB audio is used to make frequency checks using another station's signal (such as WWV). The audio is fed from the amplifier-converter-modulator to the signal comparator for this purpose.

A6. The unit you selected as being similar to the converter-oscillator unit is:

a. RF amplifier, mixer, and oscillator. Correct. The incoming signal is amplified, mixed with the oscillator signal, and fed to the amplifier-converter-modulator unit.

b. IF amplifier and detector. Incorrect. The IF frequency is 300 kc which is the output of the converter-modulator. The amplifier-converter-modulator amplifies the IF signal and removes the audio.

c. audio amplifier. Incorrect. Audio amplification takes place in amplifier-converter-modulator and the amplifier-control unit.

A7. The unit you selected as being similar to the amplifier-converter-modulator unit is:

a. RF amplifier, mixer, and oscillator. Incorrect. The amplifier-converter-modulator only amplifies the 300 kc IF signal.

b. IF amplifier and detector. Correct. The amplifier-converter-modulator amplifies and detects the audio on the 300 kc signal. The audio is then sent to the amplifier-control unit.

c. audio amplifier. Incorrect. Although the audio is amplified in the amplifier-converter-modulator, the main purpose is IF amplification and audio detection.

LESSON NO. 4

AN/URC-32 CONTROL CIRCUITS

Read NAVSHIPS 93285(B) paragraph 4-2c, pages 4-5 and 4-6. Refer to the Control Circuit Functional Block Diagram, figure 4-4 on page 4-7, to answer the following questions:

Q1. The relay amplifier is used to key the transmitter when the OCS CONTROL switch is in the ___________ and ___________ positions.

Q2. If the REMOTE-LOCAL switch were in the LOCAL position, could a teletype operator key the transceiver and transmit a message?

______________________.

Q3. The function of R16 in the radio frequency amplifier is to:

a. prevent arcing of the relay contacts.

b. reduce power output from the radio frequency amplifier during tuning.

c. lower the 2000v for tuning.

Q4. The TRANSMIT TEST switch is located on the:

a. converter-monitor.

b. amplifier-control.

c. converter-oscillator.

d. amplifier-converter-modulator.

Q5. Relay K2 in the converter-oscillator performs two functions. They are: (a) ____

and (b) ____.

Q6. The buffer amplifier in the converter-monitor unit has a blocking voltage applied to its grids when the OSC CONTROL switch is in the ______________________ or ____________________ position.

ANSWERS:

A1. The relay amplifier is used to key the transmitter when the OSC CONTROL switch is in the CW1 and CW1.5 positions.

A2. No. With the REMOTE-LOCAL switch in the LOCAL position the teletype operator has no means of keying the transmitter.

A3. The function of R16 in the radio frequency amplifier is to:
  a. prevent arcing of the relay contacts. Incorrect. Resistors are seldom used for this purpose.
  b. reduce power output from the radio frequency amplifier. Correct. R16, when inserted into the circuit by switch S1B, reduces the voltage to the driver plates and the power amplifier screens, thus reducing signal power for tuning.
  c. lower the 2000v for tuning. Incorrect. R16 affects only the 400v supply.

A4. The TRANSMIT TEST switch is located on the:
  a. converter-monitor unit. Correct. The TRANSMIT TEST switch grounds the keyline in the converter-monitor unit.
  b. amplifier-control unit. Incorrect. The TRANSMIT TEST switch is located on the converter-monitor unit.
  c. converter-oscillator unit. Incorrect. The TRANSMIT TEST switch is located on the converter-monitor unit.
  d. amplifier-converter-modulator unit. Incorrect. The TRANSMIT TEST switch is located on the converter-monitor unit.

A5. Relay K2 in the converter-oscillator (a) disconnects the receive rf input and (b) applies a blocking bias to the receiver circuits.

A6. The buffer amplifier in the converter-monitor unit has a blocking voltage applied to its grids when the OSC CONTROL switch is in the CW1 or CW1.5 position.

LESSON NO. 5

AN/URC-32 POWER SUPPLIES

Read NAVSHIPS 93285(B) paragraph 4-2d, page 4-6.

In addition to the power supplies shown in figure 4-1 there are two other smaller power supplies located in the radio frequency amplifier and control-power supply. The power supply in the radio frequency amplifier supplies bias voltage to the power amplifier tubes; the power supply in the control-power supply supplies microphone voltage to the handset. Refer to figure 4-1, AN/URC-32 Functional Block Diagram, on page 4-2 to answer the following questions.

Q1. The high voltage power supply provides voltage for the __________

____.

Q2. The high voltage power supply output voltages are ___________ and

______________.

Q3. The voltage outputs from the low voltage power supply are

____.

Q4. The radio frequency amplifier obtains bias voltage from:

a. the low voltage supply.

b. the high voltage supply.

c. the control-power supply.

d. an internal bias supply.

Q5. All voltages from the high and low voltage power supplies go through Junction Box J-1007/U except the:

a. +400 vdc.

b. +2000 vdc.

c. +250 vdc.

d. +28 vdc.

ANSWERS:

A1. The high voltage power supply provides voltage for the radio frequency amplifier.

A2. The high voltage power supply provides +2000v and +400 vdc.

A3. The low voltage power supply provides 6.3 vac and +28v, -90v, +130v, and +250 vdc.

A4. The radio frequency amplifier obtains bias voltage from:
   a. the low voltage supply. Incorrect. The low voltage supply does not supply any voltages to the radio frequency amplifier.
   b. the high voltage supply. Incorrect. The high voltage supply contains only the +400v and +2000v supplies for radio frequency amplifier plate and screen voltages.
   c. the control-power supply. Incorrect. The control-power supply contains only the microphone power supply.
   d. an internal supply. Correct. The radio frequency amplifier contains its own bias voltage supply.

A5. All voltages from the high and low voltage power supplies go through Junction Box J-1007/U except the:
   a. +400 vdc. Incorrect. The 400 vdc is routed through J-1007/U.
   b. +2000 vdc. Correct. The 2000 vdc is routed directly to the radio frequency amplifier.
   c. +250 vdc. Incorrect. The 250 vdc is routed through J-1007/U.
   d. +28 vdc. Incorrect. The 28 vdc is routed through J-1007/U.

LESSON NO. 6

AN/SRA-22, ANTENNA COUPLER GROUP

Antenna Coupler Group AN/SRA-22 consists of two units, the antenna coupler (tuning) unit and the antenna coupler control unit. The antenna coupler is mounted near the antenna and contains the variable inductance and capacitance components needed for impedance matching the transceiver to the antenna. The antenna coupler control unit is mounted in the AN/URC-32 transceiver and is the remote control unit for the antenna coupler. The antenna coupler control unit contains a directional wattmeter which measures the forward or reflected power of the transceiver. The antenna relay, which switches the antenna for transmit or receive operation, is also in the antenna coupler control unit.

During tune or test operations the transceiver output may be connected to an external dummy load via the LOAD-ANT switch on the antenna coupler control unit. The TUNE-OPERATE interlock circuit (in the radio frequency amplifier unit) is completed through the TUNE-OPERATE switch on the antenna coupler control unit; full transceiver power output cannot be obtained unless this interlock circuit is "closed" by placing both switches in their OPERATE positions.

Schematics for the antenna coupler group are provided in NAVSHIPS 93285(B), figures 5-129 and 5-130, pages 5-132 and 5-133.

QUESTIONS:

Q1. The antenna coupler group consists of the ______________________ unit and the __________________________________ unit.

Q2. The WATTMETER is located in the ______________________ unit.

Q3. The dummy load is connected to the ______________________ unit.

Q4. Components L1 and C7 in the antenna coupler unit (figure 5-129) are used to ____ .

ANSWERS:

A1. The antenna coupler group consists of the antenna coupler unit, which is located near the antenna, and the antenna coupler control unit, which is mounted in the AN/URC-32 Radio Set.

A2. The WATTMETER is mounted in the antenna coupler control unit. The WATTMETER indicates forward or reverse power for achieving proper transceiver-to-antenna impedance match, and forward power to monitor the transmission signal level.

A3. The dummy load is connected to the antenna coupler control unit. The LOAD-ANT switch connects the transceiver output to either the dummy load or the antenna.

A4. Components L1 and C7 in the antenna coupler unit are used to match the impedance of the antenna to that of the transceiver. The coil (L1) tap position and the capacitor connection are motor driven under control from the antenna coupler control unit.

LESSON NO. 7

AN/URC-32 FUNCTIONAL BLOCK DIAGRAM

To efficiently troubleshoot any electronic equipment you must have a thorough understanding of the functional signal flow through the equipment. The second and third steps of the six-step troubleshooting procedure, symptom elaboration and listing the probable faulty functions, cannot be efficiently and quickly performed if you have not taken time to study the equipment manual. If you know your equipment well you will be able to plan symptom elaboration in your head, on the spot, and have a good idea in which functional unit the fault could be before you ever pick up the tech manual.

In the previous lessons you studied the overall functions of the radio set, its receive and transmit signals, and its power supply and control functions. As an exercise to see how well you have learned the material presented this far, close the AN/URC-32 manual and answer the following questions. Refer to the AN/URC-32 functional block diagram in Appendix D, if necessary:

Q1. The received RF signal from the antenna coupler goes to the

____.

Q2. The received RF signal is heterodyned to an intermediate frequency

of ______________.

Q3. The IF output from the converter-oscillator is routed to the

____.

Q4. The received (demodulated) LSB audio is routed to the ____________ __________________ and from there to the _______________________.

Q5. The demodulated USB audio is routed from the amplifier-converter-modulator directly to the _______________________________________ for distribution to the local and remote audio locations.

Q6. The signal comparator receives a 1 kc signal from the ____________________________________ during receive operation.

Q7. During transmission the LSB audio is sent from the amplifier-control unit directly to the _________________________________ unit; the USB audio is routed through the ____________________________.

Q8. During transmission the audio is fed to a balanced modulator to produce a modulated SSB IF signal at ________ kc (approximately).

Q9. The amplifier-converter-modulator receives tgc (transmitted gain control) voltage from the __________________________________ and sends tgc voltage to the _______________________________________.

ANSWERS:

A1. The received RF signal from the antenna coupler goes to the converter-oscillator unit.

A2. The received RF signal is heterodyned in the converter-oscillator to produce a 300 kc IF signal.

A3. The IF output from the converter-oscillator is routed to the amplifier-converter-modulator unit.

A4. The demodulated LSB audio is routed to the signal comparator and from there to the amplifier-control unit.

A5. The demodulated USB audio is sent from the amplifier-converter-modulator unit directly to the amplifier-control unit for distribution to the local and remote audio locations.

A6. The signal comparator receives a 1 kc signal from the converter-oscillator unit during receive operation. The 1 kc signal is used for monitoring.

A7. During transmission the LSB audio is sent from the amplifier-control unit directly to the amplifier-converter-modulator unit; the USB signal is routed through the converter-monitor unit.

A8. During transmission the audio is fed to a balanced modulator to produce a modulated SSB IF signal at 300 kc.

A9. The amplifier-converter-modulator receives tgc voltage from the radio frequency amplifier and sends tgc voltage to the converter-oscillator.

NOTE: This completes Section A, General Description. Lessons 8 through 19 make up Section B, which presents principles of operation of each of the functional units in the AN/URC-32.

LESSON NO. 8

INTERCONNECTING BOX J-1007/U

Read NAVSHIPS 93285(B) paragraphs 4-3 and 4-3a on page 4-6 and answer the following questions.

Q1. The fuses contained in box J-1007/U are the:

a. 400v and 2000v high voltage fuses.

b. 250v low voltage fuses.

c. primary power fuses.

d. blower motor fuses.

Q2. The thermal relay in the junction box prevents excessive antenna current from damaging the:

a. converter-oscillator.

b. wattmeter circuit.

c. antenna coupler.

d. radio frequency amplifier.

Q3. The red indicator light, DS1, will light when:

a. the transmitter interlocks are open.

b. the receiver antenna has been disconnected.

c. the fuses in J-1007/U are blown.

ANSWERS:

A1. The fuses contained in box J-1007/U are the:

a. 400v and 2000v high voltage fuses. Incorrect. The high voltage fuses are located in the high voltage power supply.

b. 250v low voltage fuses. Incorrect. The +250v fuse is located in the low voltage power supply.

c. primary power fuses. Correct. Primary power is connected to the AN/URC-32 through the interconnection box. The fuses are placed in this unit before the primary power is distributed to other units.

d. blower motor fuses. Incorrect. The blower motor "shares" the low voltage power supply fuses which are located in the low voltage supply.

A2. The thermal relay prevents excessive antenna current from damaging the:

a. converter-oscillator unit. Correct. The thermal relay prevents damage to the converter-oscillator during the receive function.
b. wattmeter circuit. Incorrect. The thermal relay protector would be of no use to the wattmeter circuit since the thermal relay protector is connected between the converter-oscillator and the antenna coupler control.
c. antenna coupler. Incorrect. The antenna coupler is designed for high RF power; it needs no protection.
d. radio frequency amplifier. Incorrect. The radio frequency amplifier is not connected in any way to the thermal relay.

A3. The red indicator light, DS1, will light when:

a. the transmitter interlocks are open. Incorrect. There is no indicator for the transmitter interlocks on J-1007/U.
b. the receiver antenna has been disconnected. Correct. DS1 lights when the thermal relay has been actuated.
c. the fuses in J-1007/U are blown. Incorrect. Blown fuses are indicated by the FUSE INDICATORS.

LESSON NO. 9

RADIO FREQUENCY AMPLIFIER AM-2061/URT

Read NAVSHIPS 93285(B) paragraph 4-3b, pages 4-9 through 4-13. Refer to the radio frequency amplifier servicing and schematic diagrams, figures 4-6 and 5-99, when answering the following questions.

Q1. The radio frequency amplifier driver tubes (V1 and V2) are connected in:

a. push-pull.

b. parallel.

c. cascade.

Q2. Negative feedback is used in the radio frequency amplifier to increase:

a. gain.

b. linearity.

c. distortion.

Q3. Filament voltage for the radio frequency amplifier is obtained from:

a. the high voltage power supply.

b. the low voltage power supply.

c. an internal filament transformer.

Q4. R16 in the radio frequency amplifier is used to reduce the power output by reducing ______________________________.

Q5. The +2000 vdc plate supply is connected to V3 and V4 approximately 20 seconds after the filament voltage is supplied due to the time delay action of relay __________.

Q6. High voltage (2000 vdc) to the radio frequency amplifier is indicated by:

a. M1.

b. DS1.

c. K1.

d. K3.

Q7. During CW operation, the radio frequency amplifier uses:

a. plate keying.

b. cathode keying.

c. grid block keying.

ANSWERS:

A1. The radio frequency amplifier driver tubes are connected in:
   a. push-pull. Incorrect. In push-pull the plate currents flow 180° out-of-phase. Referring to figure 5-99 you will notice that the plates, grids, and cathodes of the tubes are connected together; the plate currents are in-phase.
   b. parallel. Correct. The grid and plate currents of both tubes are in-phase because of the wiring arrangement.
   c. cascade. Incorrect. In a cascade circuit, the V1 output would be applied to the grid of V2. In this case, the driver plates, cathodes, and grids are connected together, in parallel.

A2. Negative feedback is used in the radio frequency amplifier to increase:
   a. gain. Incorrect. Negative feedback reduces gain.
   b. linearity. Correct. Negative feedback stabilizes gain and broadens frequency response, thus increasing linearity.
   c. distortion. Incorrect. Negative feedback is used to reduce distortion.

A3. Filament voltage for the radio frequency amplifier is obtained from:
   a. the high-voltage power supply. Incorrect. The high voltage power supply does not provide any filament voltages.
   b. the low voltage power supply. Incorrect. The low voltage power supply supplies all filaments except those in the radio frequency amplifier.
   c. an internal transformer. Correct. T1 in the radio frequency amplifier supplies the required filament voltage.

A4. R16 reduces the power output by reducing the plate voltage to the driver amplifiers and the screen voltage to the power amplifiers. This drops the gain at the four tubes, reducing the power output. R16 is inserted in the +400v line when the tune-operate interlock is opened.

A5. V3 and V4 are protected by time delay relay K1. The cathodes of V3 and V4 could be "stripped" if the tubes were allowed to conduct before the filaments were hot.

A6. High voltage (2000v) to the radio frequency amplifier is indicated by:
   a. M1. Incorrect. Meter M1 measures the plate current through V3 and V4.
   b. DS1. Correct. When 2000v is present to the radio frequency amplifier, DS1 will illuminate.
   c. K1. Incorrect. Relay K1 is the time delay relay.
   d. K3. Incorrect. Relay K3 is the 400v interlock relay.

A7. During CW operation, the radio frequency amplifier uses:
   a. plate keying. Incorrect. The plate voltage is continuously applied during CW operation.
   b. cathode keying. Incorrect. The cathode circuit is not opened at any time during operation.
   c. grid block keying. Correct. In the key-up condition the grids of the driver and power amplifier tubes are biased at cutoff.

LESSON NO. 10

CONVERTER-OSCILLATOR CV-731/URC

The converter-oscillator employs a stabilized master oscillator (smo) circuit to maintain the transceiver on frequency. Take a look at the simplified oscillator stabilization system in figure 2-1, below. The master oscillator output drives the transmitter and at the same time provides an output to the stabilization circuits. In the stabilization circuits the mo output is mixed with a signal from the sidestep oscillator. The output of the mixer goes to the discriminator and its frequency is compared to a reference frequency. If the mo drifts, the discriminator senses a frequency shift and sends a correction (afc) voltage to the mo to shift its frequency so that the two frequencies at the discriminator will be equal. This stabilizes the output frequency from the mo to the transmitter.

Note that changing the frequency of the sidestep oscillator will also cause a different frequency output from the mixer. The discriminator senses the frequency shift and sends a "correction" voltage to the mo. The mo shifts frequency until the mixer output frequency is the same as the reference frequency, which nulls the correction voltage. Thus by changing the sidestep oscillator frequency, the mo frequency will change. The AN/URC-32 uses a more complex version of this method to obtain small frequency changes.

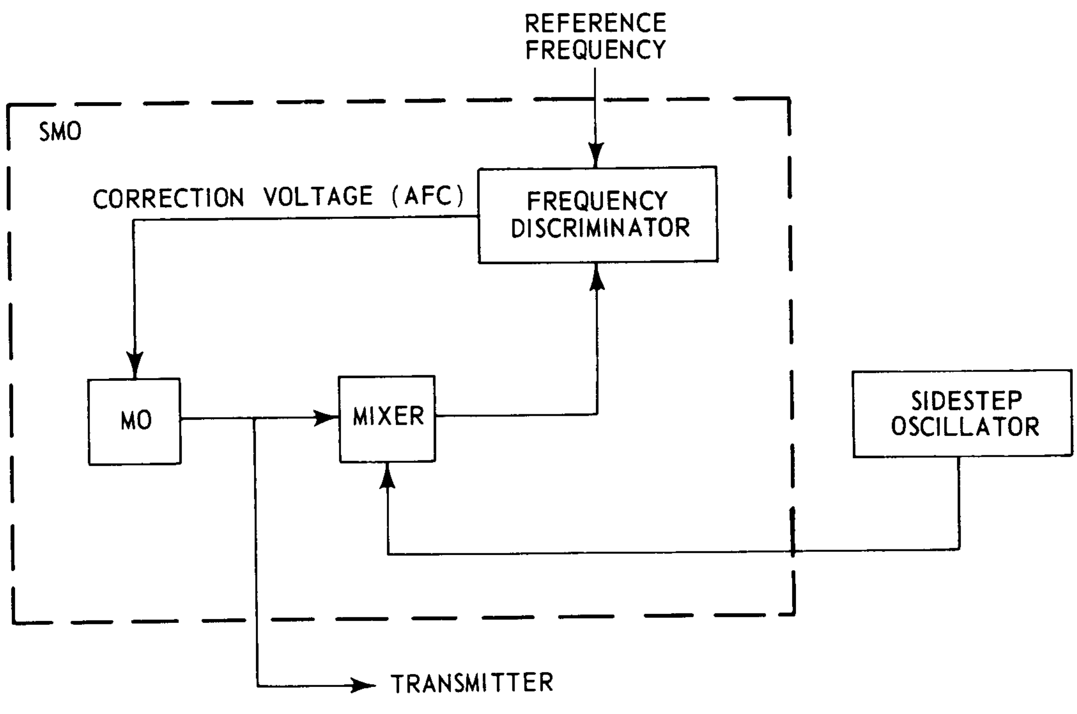


Figure 2-1. Simplified Smo and Sidestep Oscillator Block Diagram.

Read NAVSHIPS 93285(B) paragraphs 4-3c through 4-3c(1), pages 4-13 through 4-20, and answer the following questions.

Q1. The converter-oscillator supplies a 100 kc signal to the

________________________________ .

Q2. The converter-oscillator supplies a 1 kc signal to the

________________________________ .

Q3. When is the isolation amplifier used? __________________________

Q4. During receive operation, the RF tuner uses double conversion on all bands except the _________________ to _______________ mc band.

Q5. The injection signal used in the RF tuner is received from the

________________________.

Q6. The smo can be mechanically tuned in increments of _________ kc.

Q7. On bands 3 and 4, the smo may require both mechanical and

__________________ tuning.

Q8. The sidestep oscillator is used to generate:

a. the reference frequency.

b. the basic frequencies which are used for electrical tuning.

c. the injection signal for the RF tuner.

Q9. The smo is phase-locked to the reference oscillator to maintain frequency _________________________.

Q10. The frequency divider supplies a _________ kc signal to the smo and a _________ kc signal to the sidestep oscillator.

Q11. The oven heater and temperature sensor in the reference oscillator module consists of a:

a. mercury thermometer.

b. thermocouple.

c. temperature sensitive bridge.

Q12. The transmitted (or the received) signal is mixed with injection signal in the ______________________________ module.

Q13. The tgc voltage from the amplifier-converter-modulator is fed to the ___________________________ in the RF tuner.

Q14. The reference oscillator provides reference signals of ________kc and ___________ mc.

Q15. The RF output from the converter-oscillator can be monitored by using the meter on the _______________________________ unit.

ANSWERS:

A1. The converter-oscillator supplies a 100 kc signal to the amplifier-converter-modulator.

A2. The converter-oscillator supplies a 1 kc signal to the signal comparator.

A3. The isolation amplifier is used when an external reference frequency is used in place of the reference oscillator.

A4. During receive operation, the RF tuner uses double conversion on all bands except the 2.0 to 3.7 mc band.

A5. The injection signal used in the RF tuner is received from the smo.

A6. The smo can be mechanically tuned in increments of 0.5 kc.

A7. On Bands 3 and 4, the smo may require both mechanical and electrical tuning.

A8. The sidestep oscillator is used to generate:
   a. the reference frequency. Incorrect. The reference frequency is generated by the reference oscillator or an external frequency standard.
   b. the basic frequencies which are used for electrical tuning. Correct. The sidestep oscillator provides the signal which is mixed with the master oscillator signal. The difference between these signals is compared to a reference signal by the discriminator. The discriminator output causes the mo to change frequency.
   c. the injection signal for the RF tuner. Incorrect. The injection signal for the RF tuner is provided by the smo.

A9. The smo is phase-locked to the reference oscillator to maintain frequency stability.

A10. The frequency divider supplies a 4 kc signal to the smo and a 1 kc signal to the sidestep oscillator.

A11. The oven heater and temperature sensor in the reference oscillator module consists of a:
   a. mercury thermometer. Incorrect. A mercury thermometer would not be able to maintain the close temperature tolerance required by the reference oscillator. Also, the mercury thermometer could not provide heating.
   b. thermocouple. Incorrect. A thermocouple could maintain the close temperature tolerance required by the reference oscillator, but could not provide heating.
   c. temperature sensitive bridge. Correct. A temperature sensitive bridge is used to sense temperature variations and to heat the oscillator oven.

A12. The transmitted (or received) signal is mixed with the injection signal in the RF tuner module.

A13. The tgc voltage from the amplifier-converter-modulator is fed to the transmitter IF amplifier in the RF tuner.

A14. The reference oscillator provides reference signals of 100 kc and 2.4 mc.

A15. The RF output from the converter-oscillator can be monitored by using the meter on the amplifier-converter-modulator unit.

LESSON NO. 11

AMPLIFIER-CONVERTER-MODULATOR AM-2064/URC

Read NAVSHIPS 93285(B) paragraph 4-3d, pages 4-59 through 4-67, and answer the following questions.

Q1. The 300 kc carrier for AM operation is reinserted:

a. in the balanced modulator modules.

b. in the transmit gain control module.

c. at the output of the amplifier-converter-modulator unit.

Q2. The only difference between the two balanced modulator modules is the ______________________________.

Q3. The output frequency of V1 in the carrier generator module is __________ kc.

Q4. If the 100 kc input to carrier generator module shifted frequency by 10 cps, the 300 kc output would:

a. change by 10 cps.

b. change by 30 cps.

c. not change.

Q5. The output from the tgc module is sent to the:

a. radio frequency amplifier.

b. RF tuner in the converter-oscillator.

c. carrier generator module.

Q6. In the AM IF/AF amplifier module, CR1 functions as the ______________________________.

Q7. The output of the balanced modulator goes to the:

a. carrier generator.

b. converter-oscillator.

c. amplifier-control.

d. tgc module.

ANSWERS:

A1. The 300 kc carrier for AM operation is reinserted:
   a. in the balanced modulator modules. Incorrect. The 300 kc carrier is cancelled out (removed) in the balanced modulators.
   b. in the transmit gain control module. Incorrect. The tgc module has only two inputs, the balanced modulator output and the radio frequency amplifier tgc voltage output.
   c. at the output of the amplifier-converter-modulator unit. Correct. The 300 kc signal is reinserted between J6 and J9 of the amplifier-converter-modulator.

A2. The only difference between the two balanced modulators is the mechanical filters.

A3. The output frequency of V1 in the carrier generator module is 300 kc. The 100 kc reference signal is multiplied 3 times to obtain 300 kc at the output of V1.

A4. If the 100 kc input to the carrier generator module shifted frequency by 10 cps, the 300 kc output would:
   a. change by 10 cps. Incorrect. Any change in the reference frequency would be multiplied by three in the output.
   b. change by 30 cps. Correct. The 10 cps change in the reference frequency is multiplied by three, producing a 30 cps change in the output.
   c. not change. Incorrect. The 10 cps change in the reference frequency is multiplied by three, producing a 30 cps change in the output.

A5. The output from the tgc module is sent to the:
   a. radio frequency amplifier. Incorrect. The output of the tgc module is the modulated 300 kc signal which goes to the converter-oscillator. The radio frequency amplifier generates the tgc voltage.
   b. RF tuner in the converter-oscillator. Correct. The output of the tgc is the modulated 300 kc signal which goes to the RF tuner.
   c. carrier generator module. Incorrect. The output of carrier generator is connected to the balanced modulator and the output of tgc module (reinsertion). The carrier generator does not receive tgc voltage.

A6. In the AM IF/AF amplifier module, CR1 functions as the audio detector.

A7. The output of the balanced modulator goes to the:

a. carrier generator. Incorrect. The output of the carrier generator goes to the balanced modulator and tgc module. The input to the carrier generator is the 100 kc signal from the reference oscillator.

b. converter-oscillator. Incorrect. The balanced modulator outputs are fed to the tgc circuit for amplitude control, then to the converter-oscillator.

c. amplifier-control unit. Incorrect. The balanced modulators are fed by the amplifier-control unit.

d. tgc module. Correct. The tgc module receives the output of the balanced modulators and regulates the output signal amplitude before sending the signal to the converter-oscillator.

LESSON NO. 12

CONVERTER-MONITOR CV-730/URC

Read NAVSHIPS 93285(B) paragraph 4-3e, pages 4-67 through 4-70 and answer the following questions.

Q1. The transmit tones for FSK operation are ______ cps for mark and ______ cps for space.

Q2. The bfo is used only in the ________ receive mode.

Q3. The relay amplifier has:

a. a fast key time and a slow release time.

b. a slow key time and a fast release time.

c. the same key and release times.

Q4. The 100 kc signal output at J3 is replaced by a _________ kc signal from the bfo in the FSK receive mode.

Q5. Limiter R6 is not used when switch S1 is in the _________ position.

ANSWERS:

A1. The transmit tones for FSK operation are 2425 cps for mark and 1575 cps for space.

A2. The bfo is used in the FSK receive mode.

A3. The relay amplifier has:

a. a fast key time and a slow release time. Correct. The RC circuit in the grid of V2B controls the keying attack and release times. The circuit prevents the transmitter from switching to receive condition during the key-up times at a CW transmission.

b. a slow key time and a fast release time. Incorrect. A slow key time and a fast release time would not allow proper CW operation.

c. the same key and release time. Incorrect. The two RC circuits in the grid of the relay amplifier which control the key and release time of the relay amplifier have different charge-discharge time constants.

A4. The 100 kc signal output at J3 is replaced by a 300.550 kc signal from the bfo in the FSK receive mode.

A5. Limiter R6 is not used when switch S1 is in the FSK position.

LESSON NO. 13

AMPLIFIER-CONTROL AM-2062/URC

Read NAVSHIPS 93285(B) paragraph 4-3f, pages 4-70 through 4-79 and answer the following questions. The questions apply only to AM/2062A/URC.

Q1. When the SIDEBAND SELECTOR switch is in the LOWER position, the microphone amplifier is:

a. connected to the LSB line amplifier.

b. connected to the USB line amplifier.

c. disconnected.

Q2. The speaker amplifier is a class _____ push-pull amplifier.

Q3. The speaker amplifier has a maximum power output of __________.

Q4. When the SIDEBAND SELECTOR switch is in the LOWER position, the LSB audio input through T3 is connected to:

a. the LSB line amplifier.

b. the USB line amplifier.

c. terminating resistor R15.

ANSWERS:

A1. When the SIDEBAND SELECTOR switch is in the LOWER position, the microphone amplifier is:

a. connected to LSB line amplifier. Correct. In the LOWER position the microphone input is connected to the LSB line amplifier to allow the operator to use the LSB mode of operation. See figure 4-24.

b. connected to the USB line amplifier. Incorrect. The USB line amplifier is connected to the USB audio input through T2. See figure 4-24.

c. disconnected. Incorrect. The microphone amplifier is only disconnected in the OFF position. See figure 4-24.

A2. The speaker amplifier is a class <u>B</u> push-pull amplifier.

A3. The speaker amplifier has a maximum power output of <u>3 watts</u>.

A4. When the SIDEBAND SELECTOR switch is in the LOWER position, the LSB audio input through T3 is connected to:

a. the LSB line amplifier. Incorrect. The LSB line amplifier is only connected in the OFF and UPPER positions.

b. the USB line amplifier. Incorrect. The USB line amplifier is connected to the USB audio input.

c. terminating resistor R15. Correct. The microphone amplifier is connected to the LSB line amplifier and the LSB audio input is terminated by R15.

LESSON NO. 14

SIGNAL COMPARATOR CM-126/UR

Read NAVSHIPS 93285(B) paragraph 4-3g, pages 4-79 and 4-80, and answer the following questions.

Q1. There are two methods of comparison in the signal comparator:

a. comparing the 100 kc signal from the reference generator to ______________________.

b. comparing the 1 kc signal from the reference generator to ______________________.

Q2. Pins 3 and 4 of J4 are the ______________________ input to the signal comparator.

Q3. During frequency comparisons the difference, or beat, frequency is determined by:

a. reading the deflection of meter M1.

b. counting the oscillations of the meter M1 needle.

c. measuring the ac voltage at J3 with a vtvm.

ANSWERS:

A1. There are two methods of comparison in the signal comparator:
   a. comparing the 100 kc signal from the reference generator to an external 100 kc reference.
   b. comparing the 1 kc signal from the reference generator to a received 1 kc reference.

A2. Pins 3 and 4 of J4 are the LSB audio (received 1 kc) input to the signal comparator.

A3. You determine the beat frequency by:
   a. reading the deflection of meter M1. Incorrect. M1 is a dc meter; displacement from zero is proportional to voltage, not frequency.
   b. counting the oscillations of the meter M1 needle. Correct. The needle makes one complete oscillation for each cycle of the beat note (as long as the beat frequency is fairly low).
   c. measuring the ac voltage at J3 with a vtvm. Incorrect. The signal at J3 is the ac beat frequency; its amplitude is not proportional to frequency.

LESSON NO. 15

CONTROL-POWER SUPPLY C-2691/URC

Read NAVSHIPS 93285(B) paragraph 4-3h, pages 4-80 through 4-83 and answer the following questions.

Q1. The control-power supply switching function selects either

_________________ control or _______________ handset operation.

Q2. The 12v power supply provides operating power for relay ________

and the __________________________.

Q3. The test instrument used for functional testing of the control-power

supply is a _______________.

ANSWERS:

A1. The control-power supply switching function selects either remote control or local handset operation.

A2. The 12v power supply provides power for relay K1 and the handset microphone.

A3. The test instrument used for functional testing of the control-power supply is a vtvm.

LESSON NO. 16

DYNAMIC HANDSET H-169/U

Read NAVSHIPS 93285(B) paragraph 4-3i on page 4-83 and answer the following questions.

Q1. If the handset amplifier is defective, it should be:

a. repaired in the usual manner.

b. repaired using sensitive meters.

c. replaced.

Q2. The voltage applied to the transistor amplifier is ________ volts.

Q3. The dynamic handset is superior to the Navy 51007A carbon handset in:

a. output level.

b. output impedance.

c. audio quality.

ANSWERS:

A1. If the handset amplifier is defective, it should be:

a. repaired in the usual manner. Incorrect. The transistor amplifier is a sealed plug-in module and cannot be repaired in the field.

b. repaired using sensitive meters. Incorrect. The transistor amplifier is a sealed plug-in module and cannot be repaired in the field.

c. replaced. Correct. The transistor amplifier is a sealed plug-in module which must be replaced if faulty.

A2. The voltage applied to the transistor amplifier is 12 volts.

A3. The dynamic handset is superior to the Navy 51007A carbon handset in:

a. output level. Incorrect. The two handsets have about the same output level.

b. output impedance. Incorrect. The two handsets have approximately the same output impedance.

c. audio quality. Correct. The dynamic microphone has better quality characteristics than the carbon microphone.

LESSON NO. 17

LOW VOLTAGE POWER SUPPLY PP-2154/U

Read NAVSHIPS 93285(B) paragraph 4-3j on page 4-83 and answer the following questions.

Q1. Match the type of rectification used in the low voltage power supply to obtain the following voltages:

a. +250 volts _________	1. half-wave
b. +130 volts__________	2. full-wave center-tap
c. +28 volts __________	3. full-wave bridge
d. -90 volts __________	

Q2. If a diode rectifier is suspected of being faulty, a vtvm might be used to measure the forward and reverse resistance. The forward resistance of a good diode should be approximately ___ ohms and the reverse resistance, approximately ___________.

ANSWERS:

A1. Match type of rectification used in the low voltage power supply to obtain the following voltages:

a. +250 volts 3. full-wave bridge

b. +130 volts 2. full-wave center-tap

c. +28 volts 2. full-wave center-tap

d. -90 volts 1. half-wave

A2. If a diode rectifier is suspected of being faulty, a vtvm might be used to measure the forward and reverse resistance. The forward resistance of a good diode should be approximately 5 ohms and the reverse resistance, approximately infinity.

LESSON NO. 18

ELECTRONIC EQUIPMENT AIR COOLER HD-347/U AND PRIMARY POWER DISTRIBUTION

Read NAVSHIPS 93285(B) paragraph 4-3k, page 4-83. Refer to figure 5-89, Primary Power Distribution Schematic Diagram, page 5-65 to answer the following questions.

Q1. Relay K1 in the high voltage power supply, PP-2153/U, receives 115/230 vac from:

a. the radio frequency amplifier.

b. F2 at fuse block 1 (FB1) directly.

c. the low voltage power supply.

Q2. If the blower stops running because of a fault in the motor, the transceiver will:

a. keep on operating normally.

b. keep on operating, but get very hot.

c. not operate.

Q3. The blower motor receives ac operating voltage from the:

a. fuse block 1 (FB1) directly.

b. low voltage power supply, PP-2154/U.

c. high voltage power supply, PP-2153/U.

ANSWERS:

A1. Relay K1 in the high voltage power supply receives 115/230 vac from:

a. the radio frequency amplifier. Correct. Relay K1 is energized through S9 and time delay relay K1 in the radio frequency amplifier.

b. F2 at fuse block 1 (FB1) directly. Incorrect. Ac power is routed to the radio frequency amplifier before going to K1. The ac <u>return</u> is directly to FB1.

c. the low voltage power supply. Incorrect. Relay K1 is not connected in any way to the low voltage power supply.

A2. If the blower stops running because of a fault in the motor, the transceiver will:

a. keep on operating normally. Incorrect. S1 will open because of a lack of air pressure and turn off the transceiver.

b. keep on operating, but get very hot. Incorrect. S1 will open because of a lack of air pressure and turn off the transceiver.

c. not operate. Correct. The air stream from blower blows air cooler interlock switch S1 closed. If the blower stops, S1 will open and turn off the transceiver.

A3. The blower motor receives ac operating voltage from the:

a. fuse block 1 (FB1) directly. Incorrect. The blower motor is energized through ON-OFF switch S1 in the low voltage power supply.

b. low voltage power supply. Correct. The blower is turned on by the low voltage power supply ON-OFF switch.

c. high voltage power supply. Incorrect. The blower motor is energized through the ON-OFF switch in the low voltage power supply.

LESSON NO. 19

HIGH VOLTAGE POWER SUPPLY PP-2153/U

Read NAVSHIPS 93285(B) paragraph 4-31, pages 4-83 and 4-84, and answer the following questions.

Q1. Rectification in the high voltage supply is:

a. half-wave rectification.

b. full-wave center-tap rectification.

c. full-wave bridge rectification.

Q2. Two outputs are supplied. They are 2000 volts at _____ ma and 400 volts at ______ ma.

Q3. See figure 4-28, page 4-85 of NAVSHIPS 93285(B). The 2000 volts output is obtained by summing ______ and ______ volts.

Q4. If F2 were to open, there would not be any:

a. 400 or 2000 volts.

b. 2000 volts.

c. 400 volts.

ANSWERS:

A1. Rectification in the high voltage supply is:
  a. half-wave rectification. Incorrect. Full-wave bridge rectification is used.
  b. full-wave center-tap rectification. Incorrect. Full-wave bridge rectification is used.
  c. full-wave bridge rectification. Correct. Both the 400 and 2000 volt supplies are wired for full-wave bridge rectification.

A2. Two outputs are supplied. They are 2000 volts at 500 ma and 400 volts at 80 ma.

A3. 2000 volts output is obtained by summing 1600 and 400 volts.

A4. If F2 were to open, there would not be any:
  a. 400 or 2000 volts. Incorrect. F2 is in the 400 volt supply only.
  b. 2000 volts. Incorrect. F2 is in the 400 volt supply.
  c. 400 volts. Correct. F2 is in the 400 volt supply. The fuse is in the 400v output; it will not affect the 2000v output if blown.

NOTE: This completes Section B, Principles of Operation of the AN/URC-32. Lessons 20 through 26 make up Section C, which covers use of the front panel controls and indicators of the AN/URC-32.

LESSON NO. 20

RADIO FREQUENCY AMPLIFIER AM-2061/URC
FRONT PANEL CONTROLS AND INDICATORS

Use the radio frequency amplifier schematic diagram, figure 5-98, and table 3-1 (volume 2) of NAVSHIPS 93285(B) to match the circuit and transceiver functions to the controls and indicators numbered in figure 2-2 of this text (page 2-61).

In the blanks following "Q(no.)" below, you should write the letter that describes the circuit function and the number that describes the transceiver function of the switch. For example, the FIL OFF-TUNE-OPERATE switch is numbered Q3 in figure 2-2. In this example the circuit function is c and the transceiver function is 4.

Q1. _____ _____

Q2. _____ _____

Q3. c 4

Q4. _____ _____

Q5. _____ _____

Q6. _____ _____

Q7. _____ _____

Q8. _____ _____

Q9. _____ _____

Circuit Function

a. Disconnects cathode of V4 from PLATE CURRENT meter.
b. Disconnects cathode of V3 from PLATE CURRENT meter.
c. Connects/disconnects 115 vac from T1; places R16 in +400v supply circuit.
d. Measures cathode current of V3 and/or V4.
e. Selects various plate capacitors.
f. Connected through voltage-dropping resistors to +2000 vdc high voltage.
g. Adjusts L4.
h. Adjusts L10.
i. Disconnects pin 5 of K1 from circuit.

Transceiver Function

1. Tests balance of power amplifier stages.
2. Tunes the driver amplifier to frequency.
3. Tunes the final amplifier to frequency.
4. Turns radio frequency amplifier off or on; reduces power output.
5. Controls plate and screen voltage and keys transceiver.
6. Determines the operating frequency band.
7. Indicates high voltage is present in radio frequency amplifier.
8. Indicates individual or total plate current of power amplifier tubes.

ANSWERS:

A1. b 1 PL NO. 1 TEST switch S2 disconnects the cathode of V3 from the PLATE CURRENT meter to test balance of the power amplifier stages.

A2. d 8 PLATE CURRENT meter measures the cathode current of V3 and V4.

A3. c 4 FIL OFF-TUNE-OPERATE switch S1 connects or disconnects 115 vac from T1; places R16 in the +400v supply circuit in the TUNE position.

A4. a 1 PL NO. 2 TEST switch S3 disconnects the cathode of V4 from the PLATE CURRENT meter to test balance of power amplifier stages.

A5. e 6 The bandswitch (S4, S5, and S6) selects the proper plate capacitors to correspond to the desired band of frequencies.

A6. h 3 The PA TUNE knob adjusts L10 to tune the load for the power amplifiers to the frequency being used.

A7. g 2 The DRIVER TUNE knob adjusts L4 to tune the load for the driver amplifiers to the frequency being used.

A8. f 7 PLATE lamp DS1 is connected to +2000 vdc through a series of voltage-dropping resistors. DS1 lights when high voltage is applied to the radio frequency amplifier to indicate presence of high voltage.

A9. i 5 PLATE switch S9 disconnects pin 5 of relay K1 and also grounds the keyline in the KEY position. This switch controls the plate and screen voltages to the radio frequency amplifier through the HV interlock.

LESSON NO. 21

CONVERTER-OSCILLATOR CV-731/URC
FRONT PANEL CONTROLS AND INDICATORS

Use the converter-oscillator servicing diagram, figure 4-11 in volume 1 and table 3-1 in volume 2 of NAVSHIPS 93285(B) to match the circuit and transceiver functions with the indicators and controls numbered in figure 2-3 of this text (page 2-63).

Q1. _____ _____

Q2. _____ _____

Q3. _____ _____

Q4. _____ _____

Q5. _____ _____

Q6. _____ _____

Circuit Function

a. None
b. Tunes the coils in the smo.
c. Measures the current across the smo phase and frequency discriminator.
d. Grounds pin 1 of J7 (smo) and pin C of J4 (signal IF amplifier).
e. Selects various tuned circuits in the RF tuner.

Transceiver Function

1. Disables smo feedback loop to prevent tuning on an undesired frequency.
2. Selects the desired band of frequencies.
3. Selects the desired frequency.
4. Prevents shock and vibration from changing the frequency.
5. Indicates the corrective current to the master oscillator.
6. Light to identify frequency band selected.

ANSWERS:

A1. c	5	AFC meter M1 measures the current across the phase and frequency discriminator in the smo to indicate the amount of corrective current being fed back to the master oscillator.
A2. a	6	The band indicating lights identify the band of frequencies selected by the operator. The lights have no circuit function.
A3. a	4	DIAL LOCK prevents shock or vibration from changing the frequency of the transceiver. The lock has no circuit function.
A4. b	3	The FREQUENCY CHANGE control selects a desired operating frequency by tuning the coils in the smo.
A5. e	2	The BAND CHANGE control selects the desired band of frequencies by selecting appropriate tuned circuit in the RF tuner.
A6. d	1	OPERATE TUNE switch S2 grounds pin 2 of J7 (smo) and pin C of J4 (signal IF amplifier) to disable the smo feedback loop and prevent the transceiver from being tuned to an undesired frequency.

LESSON NO. 22

AMPLIFIER-CONVERTER-MODULATOR AM-2064/URC FRONT PANEL CONTROLS AND INDICATORS

Use the amplifier-converter-modulator schematic, figure 5-112, servicing diagram, figure 4-21, and table 3-1 (volume 2) of NAVSHIPS 93285(B) to match the indicators and controls called out in figure 2-4 of this text (page 2-65) with their circuit and transceiver functions.

Q1. _____ _____

Q2. _____ _____

Q3. _____ _____

Q4. _____ _____

Q5. _____ _____

Q6. _____ _____

Q7. _____ _____

Circuit Functions

a. Connects M1 to various voltage sources.
b. Grounds pin L of S1 (rear).
c. Switches the cathode circuit of the meter amplifier.
d. Adjusts the tgc voltage.
e. Controls the signal level in the IF/AF amplifiers.
f. Measures voltages and frequency generator RF output.
g. Connects the IF/AF amplifiers to the USB and LSB audio input lines.

Transceiver Functions

1. Controls RF gain of receive circuits.
2. Controls the RF power output of the amplifier-converter-modulator.
3. Provides an RF carrier for tuning or allows a remote RF gain control and tgc meter to be used.
4. Selects one of two modes of operation.
5. Measures and displays value of functions selected by function switch.
6. Selects functions for display on meter.
7. Applies a portion of the transmit audio to the receive audio circuit.

ANSWERS:

A1. g 7 SIDETONE switch S5 connects the IF/AF amplifier modules to the USB and LSB transmit audio input lines for monitoring during receive.

A2. b 4 The SSB-AM switch is connected between S1 and ground and selects either SSB or AM as the mode of operation.

A3. f 5 Meter M1 measures and displays the value of the RF output of the frequency generator and of the various dc voltages from the low voltage power supply.

A4. a 6 The meter function switch selects the function to be displayed on meter M1.

A5. d 2 EXCITER RF GAIN control is connected to the tuner tgc circuit and controls the power output of the amplifier-converter-modulator.

A6. c 3 The TUNE-LOCAL-EXTERNAL CONTROL switch performs several functions, two of which are switching the meter amplifier cathodes and providing RF carrier reinsertion for tuning.

A7. e 1 RECEIVER RF GAIN controls the gain of the IF/AF amplifiers when the transceiver is receiving.

LESSON NO. 23

CONVERTER-MONITOR CV-730/URC
FRONT PANEL CONTROLS AND INDICATORS

Use the converter-monitor schematic diagram, figure 5-119, servicing diagram, figure 4-22, and table 3-1 (volume 2) of NAVSHIPS 93285(B) to match the indicators and controls called out in figure 2-5 of this text(page 2-67) with their circuit and transceiver functions.

Q1. _____ _____

Q2. _____ _____

Q3. _____ _____

Q4. _____ _____

Q5. _____ _____

Q6. _____ _____

Q7. _____ _____

Q8. _____ _____

Q9. _____ _____

Circuit Functions

a. Measures selected signal levels.
b. Selects frequency and control circuit for af converter-monitor.
c. Controls amplitude of signal applied to V2A.
d. Selects scaling resistors for M1.
e. Varies the frequency of oscillator Q1.
f. Selects input to M1.
g. Illuminates when keyline is grounded.
h. Illuminates when OSC CONTROL switch (S1) is in any position but OFF.
i. Grounds keyline and/or relay amplifier grid bias circuit.

Transceiver Functions

1. Selects either CW or FSK as a mode of operation.
2. Indicates converter-monitor is on.
3. Indicates transceiver is transmitting.
4. Connects selected audio signal to VU meter.
5. Selects 0 DBM or +8 DBM meter range.
6. Controls bfo frequency on FSK receive operation.
7. Keys the transceiver during test.
8. Displays audio level.
9. Adjusts audio output level.

ANSWERS:

A1.	d	5	METER MULTR switch selects scaling resistors for the VU METER to establish a 0 DBM or +8 DBM meter range, respectively.
A2.	f	4	MONITOR switch S2 selects an audio input from the amplifier-control unit to be monitored on the VU meter.
A3.	a	8	VU meter M1 measures and displays the audio level of the function selected by MONITOR switch S2.
A4.	b	1	OSC CONTROL switch S1 turns on the converter-monitor unit and selects either CW or FSK as the mode of operation.
A5.	h	2	OSC ON lamp DS2 is connected to the OSC CONTROL switch and is illuminated when the converter-monitor unit is turned on.
A6.	g	3	XMIT lamp DS1 is connected between the keyline and +28 vdc. When the keyline is grounded, the XMIT lamp lights to indicate that the transceiver is transmitting.
A7.	c	9	OUTPUT potentiometer R19 controls the signal level of the grid of V2A to vary the audio output level from the converter-monitor unit.
A8.	e	6	Bfo control C11 varies the frequency of oscillator Q1, which provides the "beat" signal during FSK receive operation.
A9.	i	7	XMIT-REC-CW TEST switch S3 keys the transceiver during test by grounding the keyline and/or the grid of the relay amplifier.

LESSON NO. 24

AMPLIFIER-CONTROL AM-2062/URC FRONT PANEL CONTROLS AND INDICATORS

Use the amplifier-control servicing diagram, figure 4-24, and table 3-1 (volume 2) of NAVSHIPS 93285(B) to match the indicators and controls called out in figure 2-6 of this text (page 2-69) with their circuit and transceiver functions.

Q1. _____ _____

Q2. _____ _____

Q3. _____ _____

Circuit Functions

a. Output jack.
b. Varies amplitude of the signal applied to pin 2 of S1A.
c. Selects connections of the amplifier-control unit modules.

Transceiver Functions

1. Selects USB or LSB output to speaker, disconnects telephone line input, and connects MIC and PHONES to the desired audio channel.
2. Controls the gain of the microphone input channel.
3. Headphone output.

ANSWERS:

A1. b 2 MIC GAIN controls the gain of the microphone input channel by varying the amplitude of the signal applied to pin 2 of S1A.

A2. c 1 The SIDEBAND SELECTOR switch is a three-wafer switch which selects either the LSB or USB channel for the speaker amplifier, disconnects the telephone line input, and connects the MIC and PHONES jacks to the proper audio channel.

A3. a 3 PHONES jack J6 is connected to the speaker amplifier output, and is the connection point for a set of headphones.

LESSON NO. 25

SIGNAL COMPARATOR CM-126/UR
FRONT PANEL CONTROLS AND INDICATORS

Use the signal comparator schematic diagram, figure 5-122, and table 3-1 (volume 2) in NAVSHIPS 93285(B) to match the indicators and controls called out in figure 2-7 of this text (page 2-71) with their circuit and transceiver functions.

Q1. _____ _____

Q2. _____ _____

Q3. _____ _____

Q4. _____ _____

Circuit Functions

a. Adjusts voltage across meter under no-signal-input conditions.
b. Controls amplitude of audio signal voltage applied to V2.
c. Selects the signal to be fed to pin 7 of V2.
d. Indicates the relative voltage between the screen and plate of V2.

Transceiver Functions

1. Adjusts the input signal level to the mixer.
2. Balances M1 meter circuit.
3. Selects 1 kc or 100 kc signal to be compared.
4. Displays frequency difference between two signals.

ANSWERS:

A1. b 1 GAIN potentiometer R2 adjusts the input signal to the control grid of the mixer, V2.

A2. d 4 The comparator meter, M1, indicates the frequency difference between two signals by measuring the relative voltage between the screen and plate circuits of the mixer, V2.

A3. c 3 FREQUENCY SELECTOR switch S1 selects the desired reference signal, 1 kc or 100 kc, to be fed to the mixer for comparison to the audio signal.

A4. a 2 METER ZERO potentiometer R8 balances the zero-center meter, M1, to zero by varying the voltage applied to the meter under no-signal-input conditions.

LESSON NO. 26

POWER SUPPLY PP-2154/U, AND CONTROL-POWER SUPPLY C-2691/URC FRONT PANEL CONTROLS AND INDICATORS

Refer to control-power supply and low voltage power supply schematic diagrams, figures 5-124 and 5-125, in NAVSHIPS 93285(B) to match the controls called out in figures 2-8 and 2-9 of this text (pages 2-73 and 2-75) with their transceiver functions.

Transceiver Functions

Q1. _____ a. Applies primary power.

Q2. _____ b. Indicates power supply is on.

Q3. _____ c. Handset connector.

Q4. _____ d. Selects remote or local handset.

ANSWERS:

A1. c — The HANDSET jack is the connection for local handset.

A2. d — The HANDSET switch selects either the local handset or a remote unit.

A3. a — The OFF-ON switch applies primary power to the low voltage power supply. When the switch is in the ON position the indicator lamp will light.

A4. b — The low voltage power supply indicator lamp is illuminated when the unit is on.

This completes Section C, Front Panel Controls and Indicators. Lessons 27 through 30 make up Section D which discusses the symptoms produced by failures in typical communications equipments.

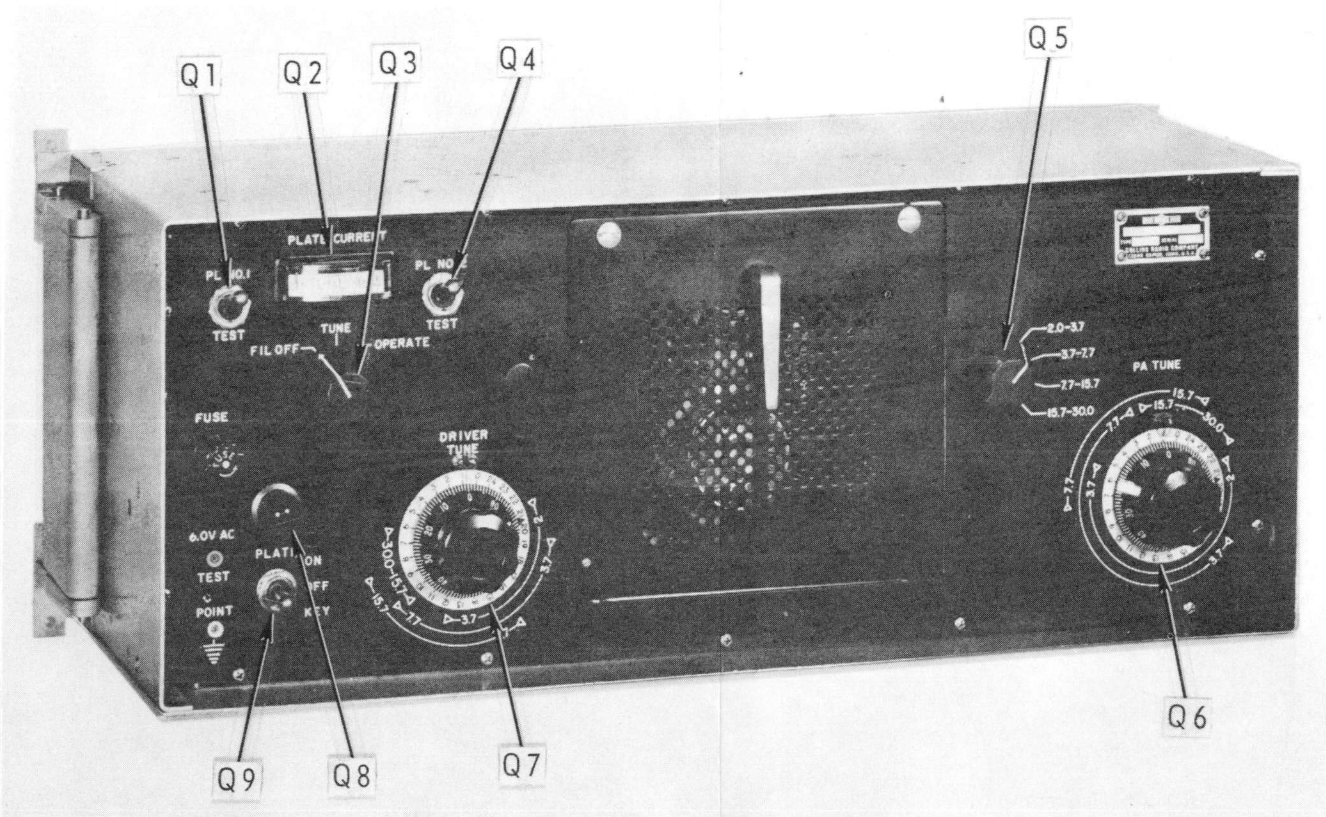


Figure 2-2. Radio Frequency
Amplifier AM-2061/URT Front View.

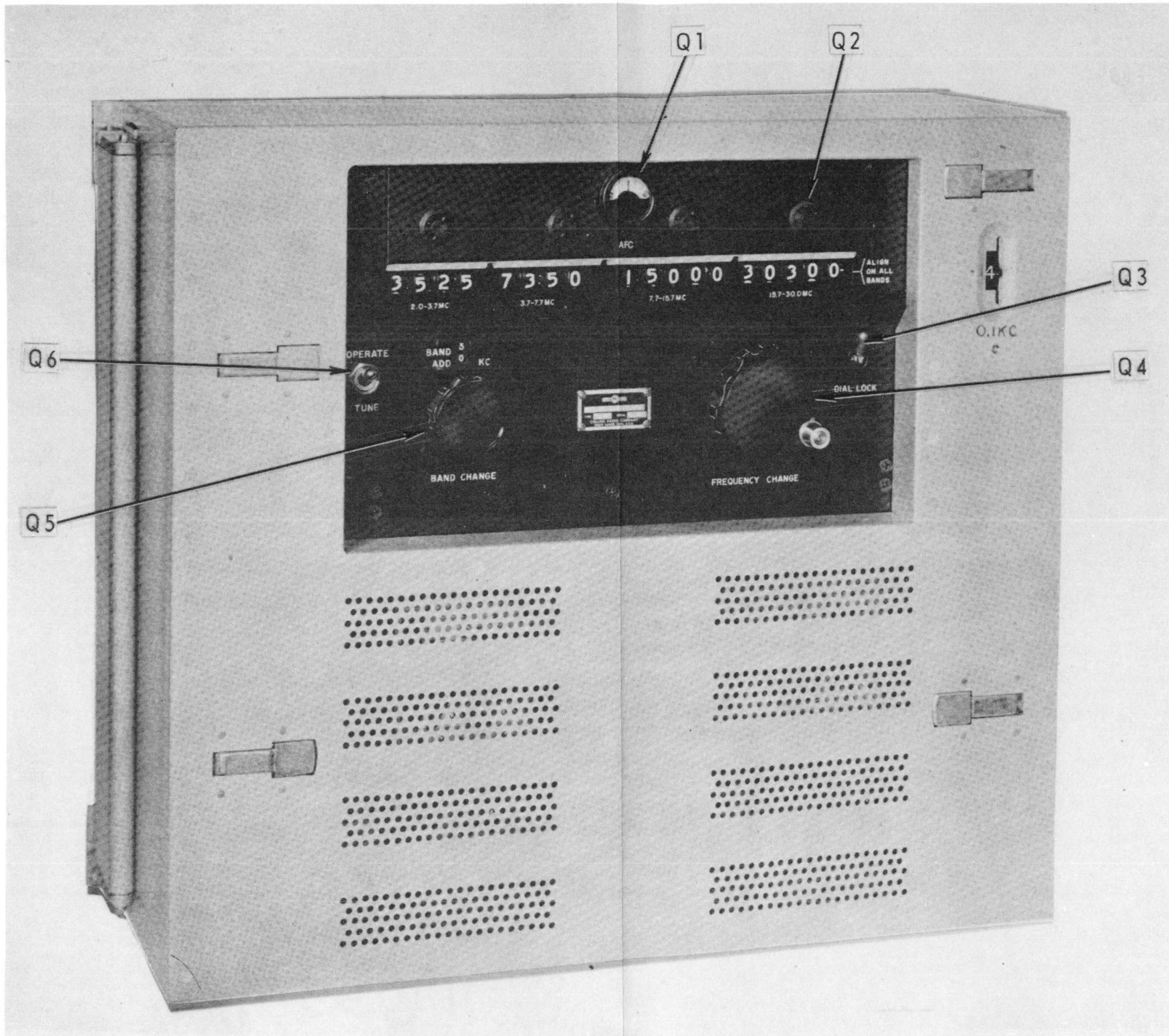


Figure 2-3. Converter-Oscillator CV-731/URT Front View.

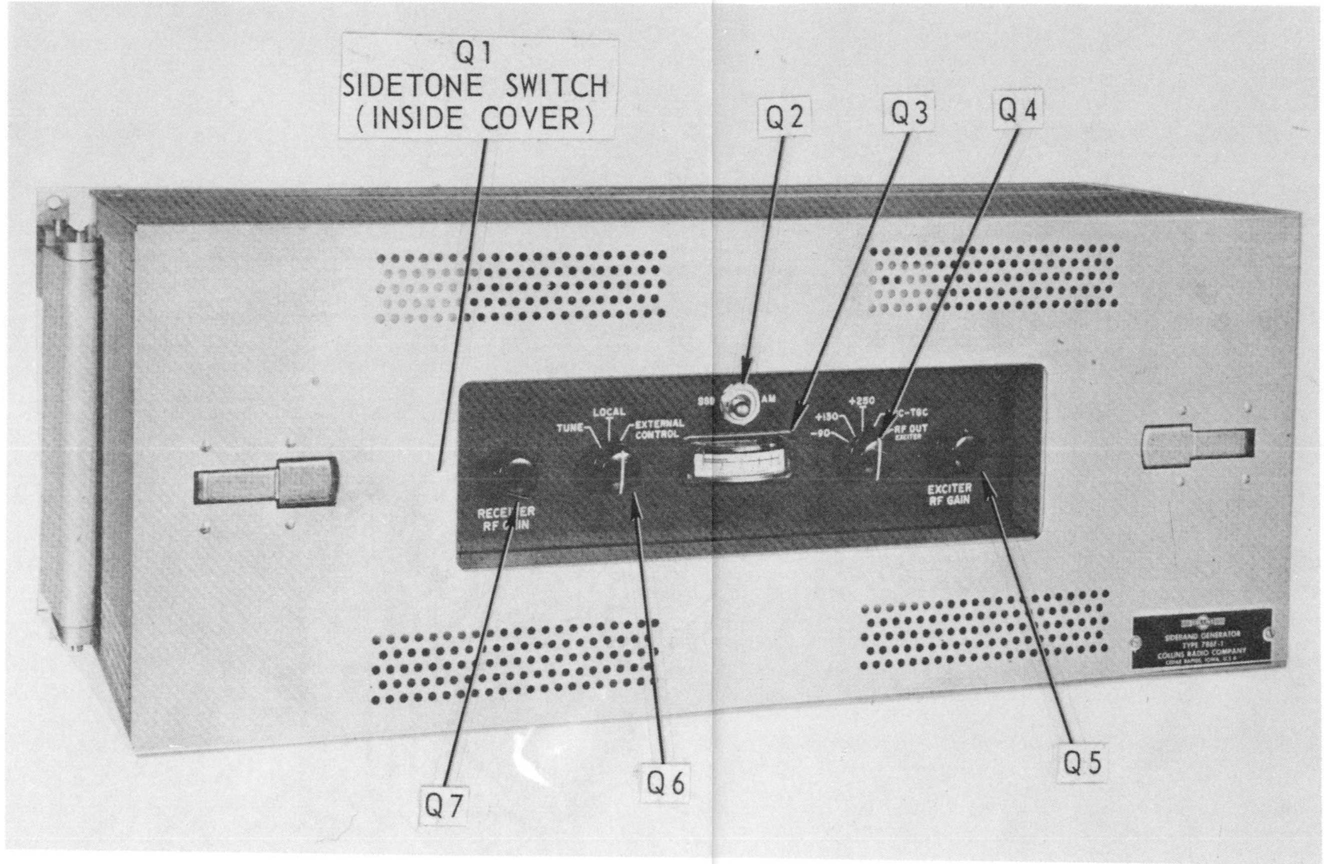


Figure 2-4. Amplifier-Converter-Modulator, AM-2064/URC Front View.

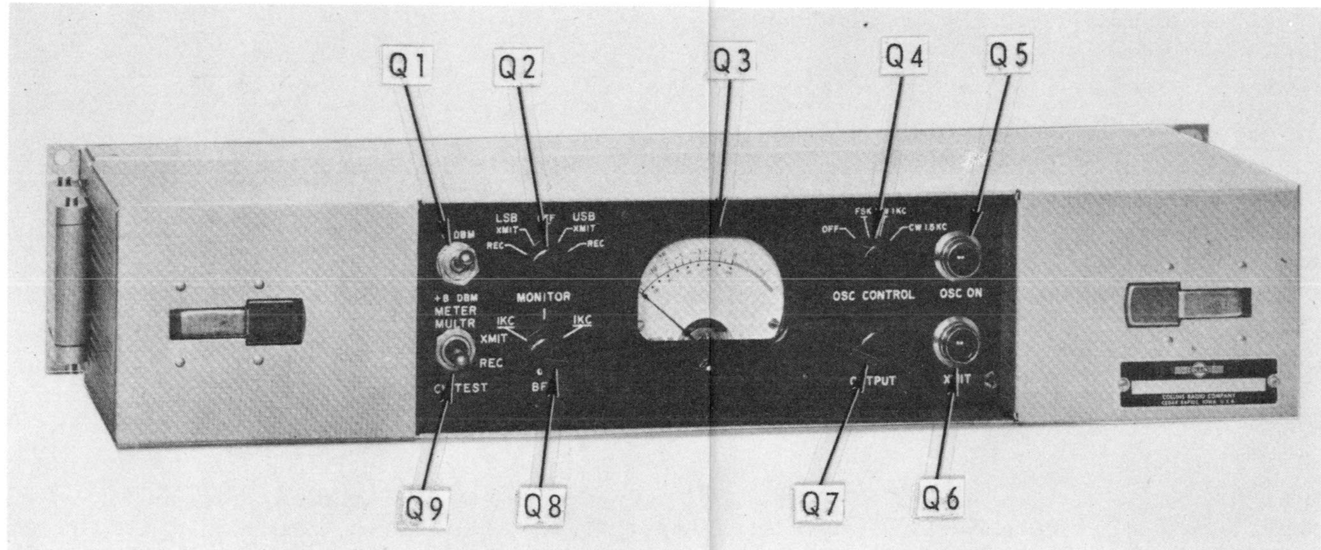


Figure 2-5. Converter-Monitor
CV-730/URC Front View.

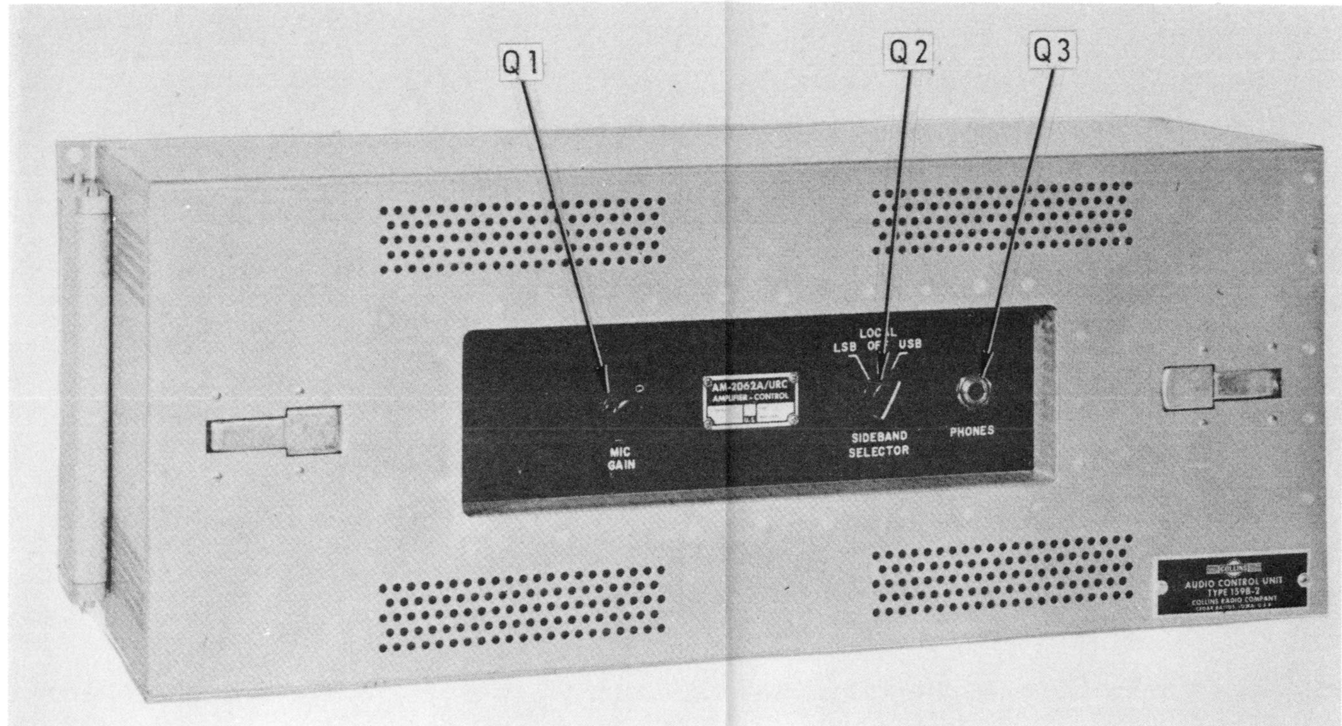


Figure 2-6. Amplifier-Control
AM-2062/URC Front View.

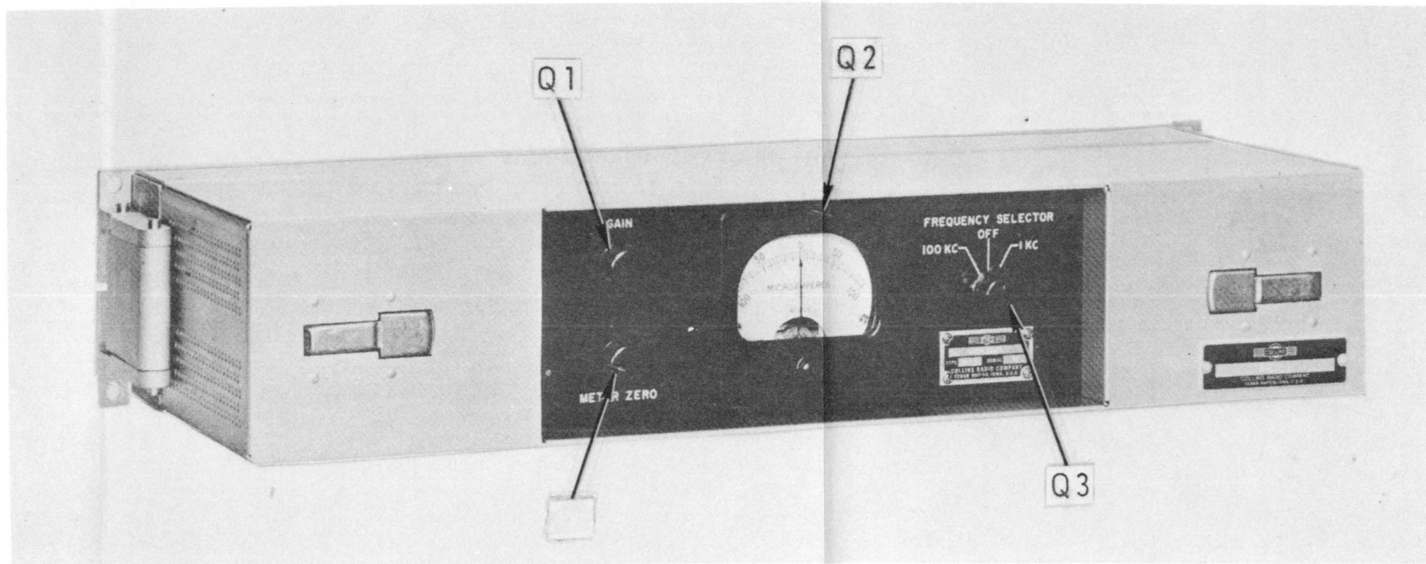


Figure 2-7. Signal Comparator
CM-126/UR Front View.

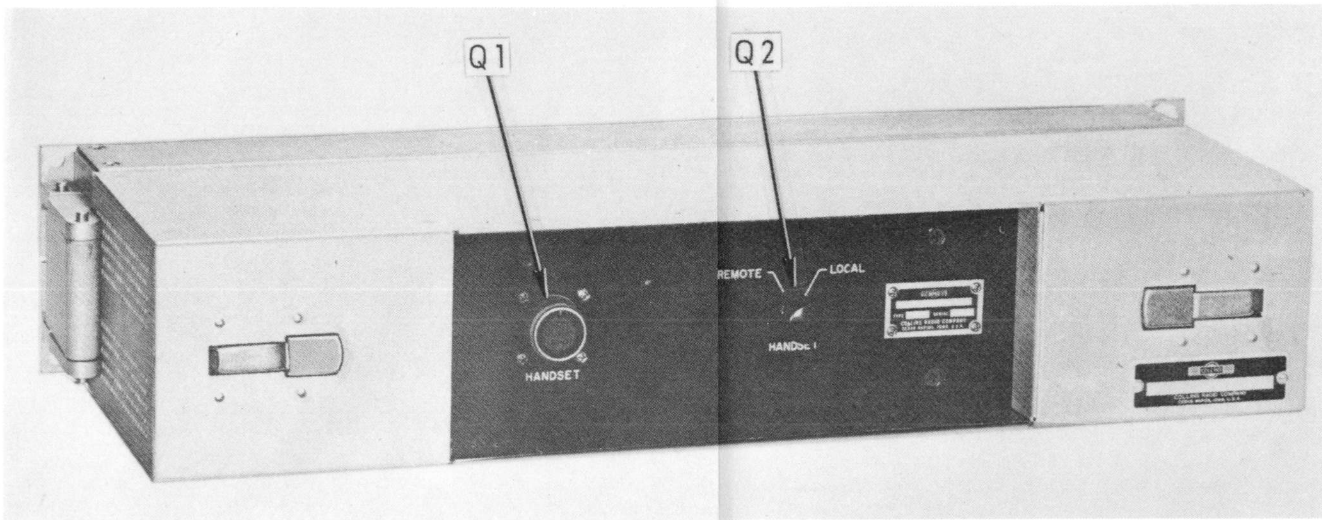


Figure 2-8. Control-Power Supply
C-2691/URC Front View.

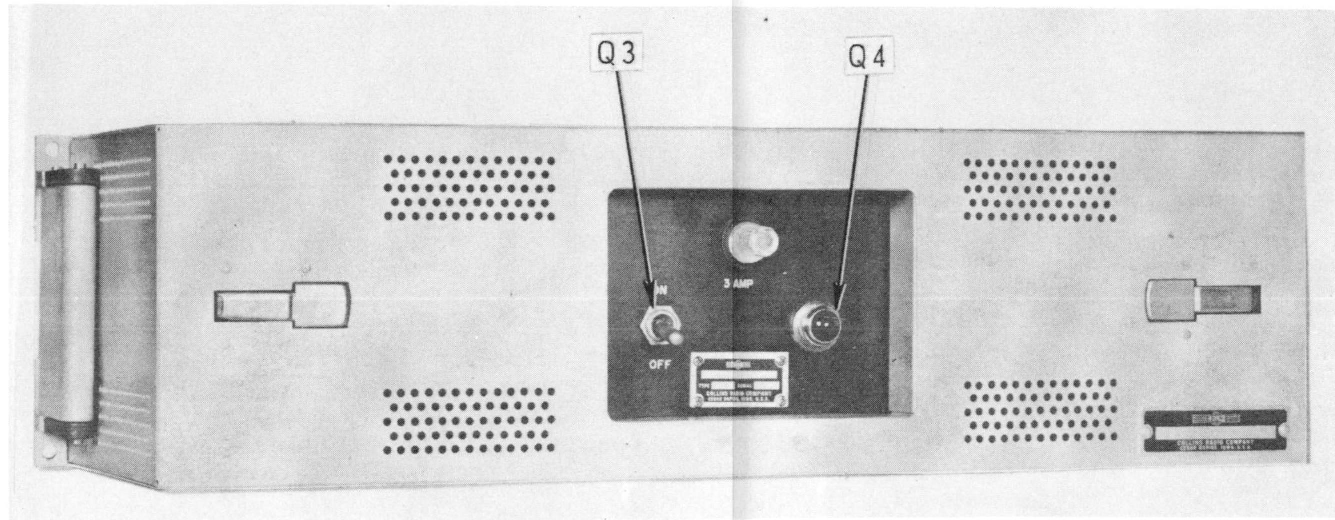


Figure 2-9. Low Voltage Power Supply PP-2154/U Front View.

LESSON NO. 27

TYPICAL TRANSMITTER MALFUNCTION SYMPTOMS

A wide variety of transmitter failure symptoms are possible depending on the circuits involved and the mode of operation of the transmitter. A simple CW transmitter contains three functions: RF, control, and power supply. In simple transmitters, elaboration of the initial symptom (through manipulation of the front panel controls and observation of the front panel indicators) will usually define the fault to the specific circuit in which it occurred, such that you can skip steps 3, 4, and 5 of the six-step troubleshooting procedure. AM and CW transmitters, such as the TBM, are of this type.

The TBM transmitter has grid and plate current meters for each RF stage plus meters to monitor high voltage, low voltage, bias voltage, and filament voltages. Once you become familiar with the TBM transmitter, isolating a faulty circuit becomes a matter of routine. As an example, you notice that a TBM's plate and grid current meters indicate zero milliamps. The motor generator lights are on with the exception of the bias and high voltage lights. You check the voltage meters: the filament voltage is normal, but there is no high voltage or bias voltage. If you are familiar with the TBM, you will know that the bias voltage is used as the excitation for the high voltage generator. If there is no bias voltage, there can be no high voltage, and the transmitter grid and plate current meters will indicate zero milliamps. A methodical study of the front panel indicators, as above, will tell you the trouble is most likely in the bias voltage generator. You went from step 2, symptom elaboration, to a knowledge of the faulty circuit, and are ready to begin step 6, failure analysis. (Note that in some cases, depending on the complexity of the bias voltage generator, it may be necessary to perform step 5, localizing the faulty circuit.)

Consider the simple transmitter in figure 2-10. I_g indicates grid current, I_p indicates plate current, and L-V and H-V are the low and high voltage meters, respectively.

Column 1 below indicates the normal readings for these meters and column 2 indicates the actual readings (trouble indications) which now exist:

	1 Normal Indications	2 Actual Indications
$I_p(1)$ meter	50 ma	50 ma
$I_g(2)$ meter	10 ma	3 ma
$I_p(2)$ meter	100 ma	175 ma
$I_g(3)$ meter	60 ma	20 ma
$I_p(3)$ meter	300 ma	500 ma
L-V meter	300v	300v
H-V meter	800v	800v
Filament voltage meter	12.6v	12.6v

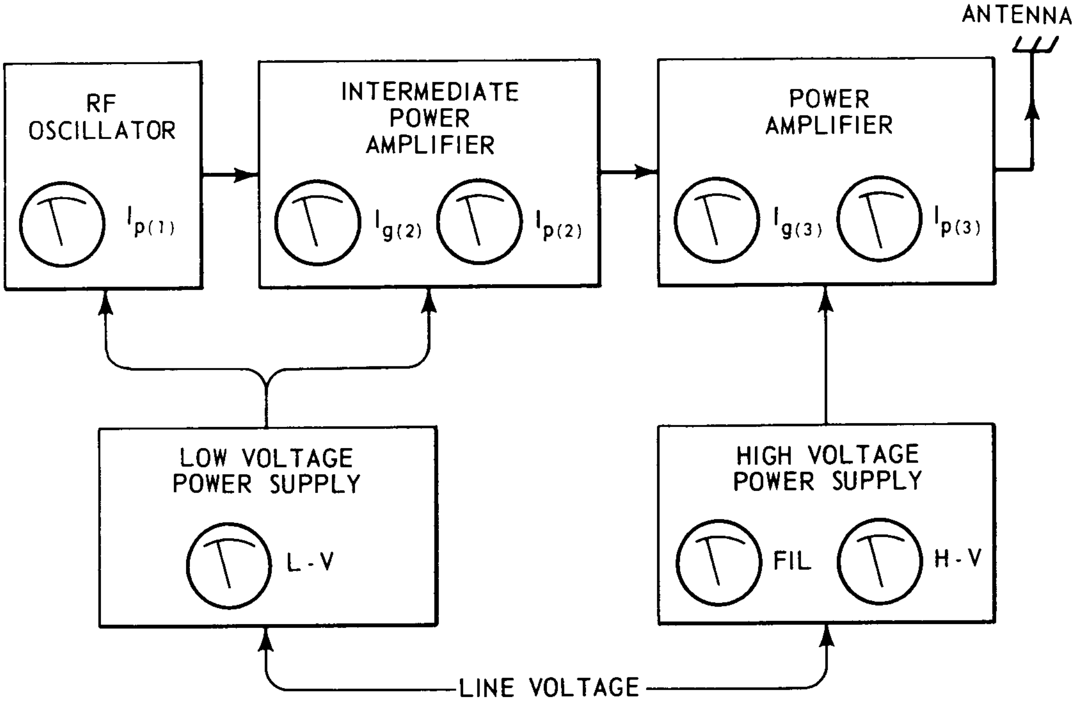


Figure 2-10. Typical Transmitter Functional Block Diagram.

Manipulation of the frequency controls reveals that the intermediate and power amplifier cannot be tuned. Where is the trouble? First, you must recognize the trouble symptoms, step 1. The grid and plate currents to the intermediate and power amplifiers are abnormal. Second, you elaborate on the symptom, step 2. The intermediate and power amplifiers can not be tuned, and the power supply voltages are normal. The power supply and RF oscillator are operating properly. The intermediate and power amplifier meter readings are abnormal. If the fault was in the power amplifier, then the indications in the intermediate amplifier would be normal since the power amplifier follows the intermediate amplifier. Therefore, the fault must be in the intermediate amplifier circuit. In this transmitter each amplifier consists of a single stage; therefore, you have isolated the fault to a single circuit and now you can proceed with step 6, failure analysis, to locate the faulty component. Analysis of the failure symptoms has enabled you to "skip" steps 3, 4, and 5!

In more complicated transmitters and transceivers, symptom elaboration may enable isolation of the functional unit, but only occasionally will the trouble be defined to a circuit group or smaller area. You will be able to skip steps 3 and 4, but you will have to isolate the faulty circuit (step 5) through detailed circuit tests (bracketing). For example, assume that the AN/URC-32 audio level meter indication is normal, but the radio frequency amplifier PLATE CURRENT meter indicates zero milliamps with modulation applied. The H-V ON lamp is illuminated and the indication of the RF EXCITER OUTPUT meter on the amplifier-converter-modulator is normal. If you check the functional block diagram for the AN/URC-32, Appendix D, you should be fairly certain the fault is in the radio frequency amplifier because the converter-oscillator is operating normally.

(Remember the meter in the amplifier-converter-modulator measures the output of the converter-oscillator in the RF EXCITER OUTPUT position.) The next step is to isolate the faulty circuit with the proper test equipment, step 5.

Summary

Symptom elaboration of transmitter malfunctions using the meters and controls on the transmitter can usually help you identify the faulty functions, and often the faulty circuit or circuit group. Because most transmitters consist of only two or three functional units, steps 3 and 4 in the six-step troubleshooting procedure are usually unnecessary. Remember that the external symptoms associated with a malfunction will, when properly analyzed, provide much valuable information to help you locate the fault.

QUESTIONS:

Using the transmitter block diagram, figure 2-10 of this text, and the normal readings in column 1 on page 2-77, isolate the faulty circuit in the following three problems:

Q1. The following meter readings are observed.

$I_p(1)$ = 50 ma
$I_g(2)$ = 10 ma
$I_p(2)$ = 100 ma
$I_g(3)$ = 40 ma
$I_p(3)$ = 0 ma
L-V = 300v
H-V = 0v
Filament voltage = 12.6v

The faulty circuit is ____________________.

Q2. The following meter readings are observed. None of the stages can be tuned.

$I_p(1)$ = 70 ma
$I_g(2)$ = 3 ma
$I_p(2)$ = 175 ma
$I_g(3)$ = 20 ma
$I_p(3)$ = 500 ma
L-V = 300v
H-V = 800v
Filament voltage = 12.6v

The faulty circuit is ____________________.

Q3. The following readings are observed. None of the stages can be tuned.

$I_p(1)$ = 0 ma

$I_g(2)$ = 0 ma

$I_p(2)$ = 0 ma

$I_g(3)$ = 0 ma

$I_p(3)$ = 0 ma

L-V = 300v

H-V = 800v

Filament voltage = 0v

The faulty circuit is ____________________.

Using the AN/URC-32 functional block diagram in Appendix D and the information given in NAVSHIPS 93285(B), isolate the faulty functional unit in each of the following problems. (Normal indications for the AN/URC-32 are given in Appendix E of this text.)

Q4. In the CW transmit mode the following indications are observed with the transmitter keyed:

Indicator	Indication
(antenna coupler control unit)	
WATTMETER	0 watts
(radio frequency amplifier)	
PLATE CURRENT meter.	0 ma
PLATE ON lamp	off
(converter-oscillator)	
AFC meter	+3 ua(≈ midscale)
(amplifier-converter-modulator)	
meter position: -90.	40 db (midscale)
+130	40 db
+250	40 db
AGC-TGC	40 db
RF OUT EXCITER .	20 db
(converter-monitor)	
XMIT lamp	on
(high voltage power supply)	
H-V ON	off
fuse F1	OK
(low voltage power supply)	
power indicator lamp	on
fuse F1	OK

The probable faulty functional unit is the ____________________.

Q5. The following indications are observed in the CW transmit mode with the transmitter keyed. Varying the frequency does not affect the indications.

Indicator	Indication
(antenna coupler control unit)	
WATTMETER	500 watts
(radio frequency amplifier)	
PLATE CURRENT meter	550 ma
PLATE ON lamp	on
(converter-oscillator)	
AFC meter	+95 ua
(amplifier-converter-modulator)	
meter position: -90.	midscale
+130	400 db
+250	40 db
AGC-TGC	0 db
RF OUT EXCITER .	20 db
(converter-monitor)	
XMIT lamp	on
(high voltage power supply)	
H-V ON	on
fuse F1	OK
(low voltage power supply)	
power indicator lamp	on
fuse F1	OK

The probable faulty functional unit is the ____________________.

ANSWERS:

A1. The faulty circuit is the high voltage power supply. Note that the abnormal indications are the grid and plate current of the power amplifier and the high voltage meter reading. The low voltage reading is normal. The abnormal grid and plate currents must be the result of no high voltage.

A2. The faulty circuit is the RF oscillator. In this problem all the indications are abnormal with the exception of the low voltage, high voltage, and filament voltage meters. Since the oscillator is the first abnormal indication in the signal flow line, you should suspect it as being the faulty circuit.

A3. The faulty circuit is the filament supply. There can be no plate or grid current without filament voltage.

A4. The probable faulty functional unit is the high voltage power supply. The only abnormal indications are the WATTMETER reading, PLATE CURRENT reading, and the PLATE ON and H-V ON lamps. Power output depends on plate current in the radio frequency amplifier, which in turn depends on the high voltage supply. The PLATE ON and H-V ON lamps indicate the high voltage supply output is not present.

A5. The probable faulty functional unit is the converter-oscillator. This is a sneaky one – all of the indications are nearly correct except the AFC meter; even the power output is about right. The AFC meter indication should be approximately 0 microamperes, or midscale, if the smo is working correctly. In this problem, excessive frequency correction signal (AFC) is present, indicating the stabilization loop in the converter-oscillator is malfunctioning.

LESSON NO. 28

TYPICAL RECEIVER MALFUNCTION SYMPTOMS

Communications receivers do not vary significantly in their basic design. A receiver is usually considered to have only two functions, the receive function and the power supply function. The symptoms associated with specific faults in these functions are generally similar in all receivers.

Troubleshooting modern receivers is a little more difficult than troubleshooting transmitters, primarily because receivers include fewer metering circuits. Receivers are physically small, however, which partially compensates for the lack of meters – you can work on most receivers at a work bench, where your tools and test equipments are handy.

Power supply troubles are the easiest to recognize and isolate to the power supply function: if the receiver includes a power supply metering circuit, symptom elaboration will quickly eliminate either the receive function or the power supply function, such that step 2, symptom elaboration, allows you to skip steps 3 and 4; if no power supply metering circuits are included, detail tests during step 4, localizing the faulty function, will quickly isolate the fault to either the power supply or the receive function. Two specific failure symptoms which are readily identified as power supply troubles are (a) hum in the audio signal (poor filtering in the B+ or bias supply) and (b) an acrid or pungent smell coming from the receiver which is a sign that the dry rectifiers in the power supply are failing. This smell is usually accompanied by no reception or a crackling and popping sound in the receiver. Sometimes a quick check of the power supply function can be made by switching the STANDBY-OPERATE (B+) switch on and off. If a "pop" is heard in the receiver loudspeaker or headset, you can usually assume there is plate voltage. Note that if a "pop" sound is heard there is probably B+, but if one is not heard, don't assume that there isn't any B+. There are many reasons a "pop" might not be heard – for example, a faulty audio amplifier or no filament voltage.

Figure 2-11 of this text is a block diagram of the receive function of a typical receiver. Some receivers may have two or even three local oscillators, depending on the frequency and mode of operation for which they were designed. Receivers designed for SSB and CW operation are usually more selective than receivers designed for AM or FM operation. Modern communications receivers are usually designed for more than one mode of operation. For example, most CW receivers are capable of receiving AM and SSB signals.

Recognition of failure symptoms within the receive function may be very difficult if the failure results in degraded performance rather than complete failure to receive. Degraded performance may occur over a long period of time and at a rate so slow that you may never realize anything is wrong. Therefore, good preventive maintenance is very important. Sensitivity and distortion checks should be made periodically to ensure that the receiver is functioning properly. If performance of any circuit is degraded, the receiver sensitivity will be reduced. Degraded performance within the detector or audio circuits will usually result in distortion of the audio signal. Symptom recognition of more serious failures is, of course, much easier: inability of the receiver to tune in signals, no audio output, and lack of such signals as the beat note during CW receptions, are easily recognized.

Certain malfunctioning circuits, such as the bfo, noise limiters, and avc circuits, can be isolated during symptom elaboration. On most receivers these circuits can be switched in and out of the receive function; in addition, the avc signal is usually monitored by a signal strength meter. Some communications receivers have additional monitoring circuits (for example, an output vu meter and afc meter), but as a general rule the receive function will include only the avc (signal strength) meter.

The following paragraphs present two examples of troubleshooting in a typical receiver. The receive function is shown in figure 2-11 of this text. Assume that the power supply function does not include a metering circuit, and that a POWER ON lamp is provided which indicates when prime power has been applied to the set.

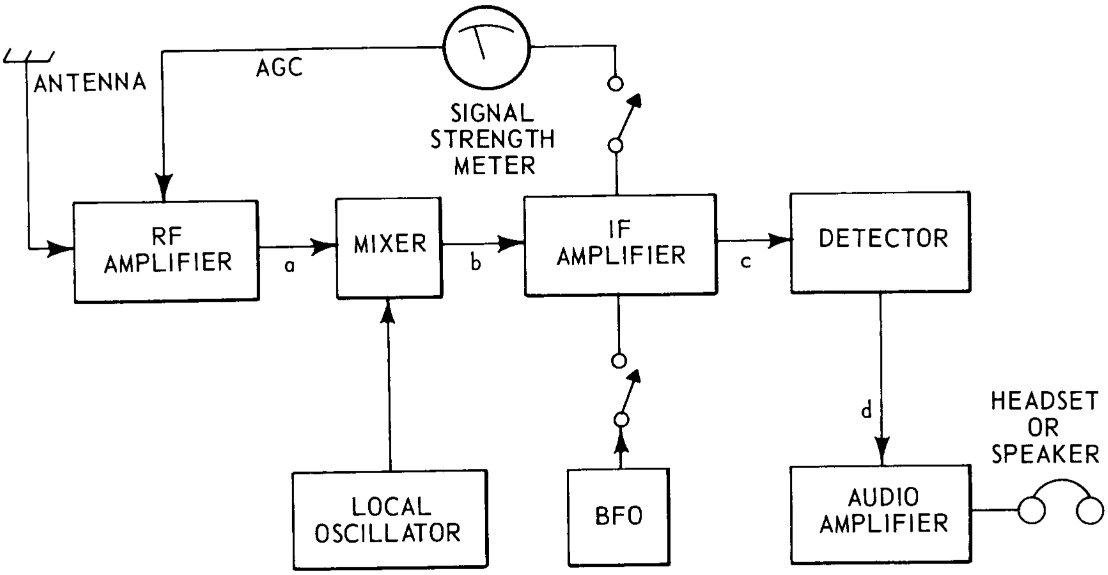


Figure 2-11. Typical Receiver Functional Block Diagram.

Troubleshooting Example No. 1

The receiver has no audio output at the headset. The signal strength meter shows normal deflection as the receiver is tuned across the band, and that the POWER ON lamp is lighted. Step 1, symptom recognition, is fairly obvious – there is no receiver output. In step 2, symptom elaboration, you note that the signal strength meter seems to be working normally and that there is power to the set. Step 3 is automatic – the unit has only the two functions, receive and power supply. Step 4 in this problem can be accomplished by reasoning: the signal strength meter indications are normal; this meter cannot receive a signal if either the B+ or filament power is bad; therefore, the power supply is operating normally. (Note that POWER ON lamp does not indicate B+ voltage. This lamp is generally connected across the ac power input or the filament voltage output, and there is no assurance that there is any B+ voltage when this lamp is on.) You first use your test equipment in step 5, localizing the faulty circuit. You should use the bracketing technique, with one bracket at the audio output and the other just after the avc circuit. (Remember the original symptom was no output, and the avc meter indication was normal.) Now you will use the bench test equipment to isolate the faulty circuit, then perform step 6, failure analysis, to isolate and replace the faulty part(s).

Troubleshooting Example No. 2

You are performing a routine sensitivity check on a receiver. You find the sensitivity is below normal for a given input signal level. The below normal reading is obtained in all positions of the BAND SWITCH and with the AVC switch in both the ON and OFF positions. Step 1: the symptom is degraded performance – poor sensitivity. Step 2: the symptom occurs in all positions of the BAND SWITCH and in both positions of the AVC switch. Step 3: the fault could be in either the power supply or the receive circuits. Step 4: you check the power supply voltages to localize the faulty function; the B+ and filament voltages are normal, so the fault is in the receive function. Step 5: you place brackets at the antenna input and audio output. You can eliminate only the avc circuits (the indications did not change when this circuit was switched in and out of the receiver). You cannot eliminate the local oscillator although you know the band change circuits are not at fault. You then proceed to make measurements to isolate the defective circuit, then perform step 6 to repair the fault.

The AN/URC-32 is somewhat more than a typical receiver. The AN/URC-32 is a transceiver – it utilizes a common "local oscillator" (the smo) and power supply in both receive and transmit. The power supply is metered, such that isolation of a fault to the receive function can always be accomplished during symptom elaboration. Because of this, and the fact that the receive function is physically located in four different cabinets (converter-oscillator, amplifier-converter-modulator, amplifier-control, and signal comparator), the AN/URC-32 receive function is considered to include four functional units. During steps 2, 3, and 4 of the six-step troubleshooting procedure you will be concerned with isolating the fault to one of these four "functional units," rather than to the power supply or receive function.

Summary

Receivers are generally more difficult to troubleshoot than transmitters because receivers are not metered as well as transmitters. The number of steps used in the six-step troubleshooting procedure will depend on the fault and its symptoms. All six steps will be required for some malfunctions while in others, steps 3 and 4 may be omitted. Preventive maintenance is important because degraded performance may occur at a slow rate, and the operator may not realize that he is using a faulty receiver.

QUESTIONS:

Refer to figure 2-11 of this text to answer the following questions.

Q1. A radio operator reports that his receiver doesn't work on CW, but that he can hear AM stations. You check out the receiver, and find his report is accurate and complete. What is most likely at fault?

a. Power supply function.

b. Receive function.

c. Audio amplifier (in receive function)

d. Bfo (in receive function)

e. Not enough information has been given to determine the faulty function.

Q2. You are checking a receiver with no output in either AM or CW. You find that there is no indication on the signal strength meter, the AVC and BFO switches have no effect, there is no "pop" sound when the STANDBY-OPERATE (B+) switch is operated, and the POWER ON lamp is illuminated. What is most likely at fault?

a. Power supply function.

b. Receive function

c. Not enough information has been given to isolate the faulty function.

Q3. Refer to the symptoms of problem Q2, above. You notice that when you turn the audio volume control you hear a scratching noise in the headset. The fault is probably in the:

a. Power supply function.

b. Receive function.

c. Not enough information has been given to determine the faulty function.

Q4. An inoperative receiver (no output) is being tested on the workbench. You apply a signal at the IF amplifier input (point b in the block diagram, figure 2-11) and an output is obtained. You have isolated the fault to either the radio frequency amplifier, mixer, or local oscillator. What step in the six-step troubleshooting procedure are you performing? Step ___, ________________________.

Q5. You are checking an inoperative receiver (no output). In performing step 2 of the six-step procedure you check the following items:

Signal strength meter	no indications
POWER ON lamp	illuminated
AVC and BFO	have no effect
STANDBY-OPERATE (B+) switch .	a "popping" sound is heard when switch is operated.

Which function is faulty? ________________________________

Q6. You are troubleshooting an inoperative receiver. In performing step 5 you apply signals at the following points in the block diagram (figure 2-11) and observe the results listed:

Input	Results
point a	no output
point b	no output
point c	no output
point d	output

What is the faulty circuit? ________________________________

ANSWERS:

A1. A radio operator reports that his receiver doesn't work on CW, but he can hear AM stations. You decide the fault is in the:

a. Power supply function. Incorrect. If the power supply were at fault, there would be some indication of the fault when listening to AM stations.

b. Receive function. Nearly correct, but you can isolate the fault to one of the receiver circuits with a little thought. What circuit is used in CW that is not used in AM?

c. Audio amplifier. Incorrect. There is audio when listening to AM stations; therefore, it is most unlikely that the audic is at fault.

d. Bfo. Excellent. The receiver works normally on AM, but not on CW. You conclude that the fault is in the bfo, since this is the only circuit which is not used in both modes.

e. Not enough information has been given to isolate the faulty function. Incorrect. The fact that the receiver works normally on AM and not on CW should indicate the fault is not in the power supply. If you compare the CW and AM circuits, you should be able to isolate the fault to the bfo circuit.

A2. You are checking a receiver with no output in either AM or CW. You find that there is no indication on the signal strength meter, the AVC and BFO switches have no effect, there is no "pop" sound in the loudspeaker when the STANDBY-OPERATE (B+) switch is operated, and the POWER ON lamp is illuminated. What is most likely at fault?

a. Power supply. Incorrect. The POWER ON lamp and the lack of a "popping" do not necessarily indicate that the power supply is at fault. (Refer to the text for an explanation of these symptoms.) You don't have enough informatio to eliminate either the power supply or receive functions.

b. Receive function. Incorrect. A lack of an output signal could be caused by a lack of plate voltage. You need more information.

c. Not enough information has been given to isolate the faulty function. Correct. You do not have enough information to be certain that either the power supply or the receive function is operating normally. You must perform step 4, localizing the faulty function.

A3. Refer to the symptoms of problem Q2. You notice that when turning the audio volume control you hear a scratching noise in the headset. The fault is probably in the:

a. Power supply. Incorrect. The scratching sound is produced by amplifying noise generated in the volume control. This requires both B+ and filament voltage.

b. Receive function. Correct. The power supply has been eliminated. The scratching noise indicates there is B+ and filament voltage.

c. Not enough information has been given to determine the faulty function. Incorrect. The scratching sound is produced by amplifying noise generated in the volume control. This requires both B+ and filament voltage.

A4. An inoperative receiver (no output) is being tested on the workbench. You apply a signal at the IF amplifier input (point b in the block diagram) and an output is obtained. You have isolated the fault to either the radio frequency amplifier, mixer, or local oscillator. You are performing step 5, localizing the faulty circuit, of the six-step troubleshooting procedure.

A5. You conclude that the receive function is faulty. The "popping" indicates there is B+ to the receiver, eliminating the power supply.

A6. The detector is the faulty circuit. You obtained an output with a signal at the audio amplifier input, point d, but not at any other point. If the detector were normal, you would get an output with an input at point c.

LESSON NO. 29

TYPICAL CONTROL CIRCUIT MALFUNCTION SYMPTOMS

The control circuits in a transmitter or transceiver consist of circuits which control power and select transmit-receive functions and mode of operation. Transmit-receive functions include transmitter keying, antenna change-over, and various circuit changes from the transmit function to the receive functions such as take place in the AN/URC-32 frequency generator. Mode selection includes circuit changes between SSB, CW, FSK, AM, etc. Power control includes the circuits which turn the equipment on and off, the safety interlock circuits, and power output reduction circuits for tuning.

Control circuit symptoms cannot be explained in general terms because the control circuits will vary somewhat depending on the equipment design. The control circuits can be considered a function in most cases; when a malfunction occurs in the control circuits, you can isolate the control circuits as the faulty function in step 4 of the six-step troubleshooting procedure and then isolate the faulty circuit within the control circuitry, step 5. In most cases step 2 will give you a good idea if the fault is in the control circuit. For example, the antenna fails to switch over from the transmitter to the receiver. The fault can only be in the power supply or the antenna control circuit. If the fault is not in the power supply function it must be in the antenna change-over circuit. (In some units the antenna change-over circuit is a simple relay circuit; in others it may be quite complex. Radar and some special purpose transmitting sets, for example, use electronic switching (T-R tubes) and require other special circuits for antenna change-over.)

QUESTIONS:

Refer to figures 5-89 and 5-90 in NAVSHIPS 93285(B), pages 5-65 and 5-67, to answer the following questions. These questions list symptoms of failures within the control circuits of the AN/URC-32. Perform steps 5 or 6 of the six-step troubleshooting procedure to determine the faulty circuit or component.

Q1. The transceiver runs at reduced power output. Rotating FIL OFF-TUNE-OPERATE switch S1 on the radio frequency amplifier to the TUNE and OPERATE positions has no effect on the output. The faulty circuit or component is the:

a. TUNE-OPERATE interlock.

b. K3 in the radio frequency amplifier.

c. K2 in the radio frequency amplifier.

d. R16 in the radio frequency amplifier.

Q2. The OSC CONTROL switch on the converter-monitor is in the CW 1 position. The XMIT lamp does not light and the transceiver cannot be keyed from either the remote location or by using the CW TEST switch on the converter-monitor unit. The transmitter <u>can</u> be keyed when the OSC CONTROL switch is in the FSK position. The faulty circuit or component would be the:

a. remote keyline.

b. relay amplifier V2A in the converter-monitor.

c. K1 in the amplifier-converter-modulator.

d. REMOTE-LOCAL switch in the handset adapter.

Q3. (Use figure 5-89, Primary Power Distribution, to answer this question.) Placing the OFF-ON switch on the power supply PP-2154/U to the ON position does not turn on the power supply. You also notice the blower is not operating. There are five possible causes for this trouble; list at least three of them.

____

____

____.

Q4. The radio frequency amplifier PLATE ON lamp is lighted and relay K2 in the radio frequency amplifier energizes when the transceiver is keyed. However, there is no RF output from the radio frequency amplifier when the transceiver is keyed, and the PLATE CURRENT meter reads 150 ma. Assume the fault has been isolated to the radio frequency amplifier. The control circuit most likely at fault is the ______________________________.

ANSWERS:

A1. The transceiver runs at reduced power output. Rotating FIL OFF-TUNE-OPERATE switch S1 on the radio frequency amplifier to the TUNE and OPERATE positions has no effect on the output. The faulty circuit or component is the:

a. TUNE-OPERATE interlock. Correct. If this interlock is open, the transceiver will run at reduced power irrespective of the FIL OFF-TUNE-OPERATE switch position.
b. K3 in the radio frequency amplifier. Incorrect. If K3 were at fault, there would be no power output.
c. K2 in the radio frequency amplifier. Incorrect. If K2 were at fault, there would be no power output.
d. R16 in the radio frequency amplifier. Incorrect. If R16 were at fault, there would probably be no output in the TUNE position and full output in the OPERATE position.

A2. The OSC CONTROL switch on the converter-monitor is in the CW 1 position. The XMIT lamp does not light and the transceiver cannot be keyed from either the remote location or the CW TEST switch on the converter-monitor unit. The transmitter can be keyed when the OSC CONTROL switch is in the FSK position. The faulty circuit or component would be the:

a. remote keyline. Incorrect. The fact that transceivers cannot be keyed locally removes the possibility of the remote keyline being at fault.
b. relay amplifier V2A in the converter-monitor. Correct. The fact that the transceiver cannot be keyed locally with CW TEST switch but can be keyed in FSK, which does not use the relay circuit, indicates the fault is in the relay amplifier.
c. K1 in the amplifier-converter-modulator. Incorrect. If K1 were faulty, the XMIT lamp would still light.
d. REMOTE-LOCAL switch in the handset adapter. Incorrect. The CW TEST switch bypasses the REMOTE-LOCAL switch.

A3. Placing the OFF-ON switch on the power supply PP-2145/U to the ON position does not turn on the power supply. You also notice the blower is not operating. The five possible troubles are: Fuse F1, Fuse F2, the blower interlock circuit, the blower, low voltage power supply switch S1.

A4. The radio frequency amplifier PLATE ON lamp is illuminated and relay K2 energizes when the transceiver is keyed. However, there is no RF output from the amplifier when the transceiver is keyed, and the PLATE CURRENT meter reads 150 ma. The fault has been isolated to the radio frequency amplifier. The control circuit most likely at fault is the XMTR interlock. The low plate current indication shows that the power amplifier hasn't any drive power. Since the trouble is in the radio frequency amplifier, the XMTR interlock (which removes the high negative bias voltage from the radio frequency driver stage) must be defective.

LESSON NO. 30

TYPICAL SYMPTOMS OF POWER SUPPLY MALFUNCTIONS

The power supply in a communications equipment is almost always considered a functional unit. The power supply provides all of the operating voltages for the equipment. Often the power supply is physically located in several different areas, other times in a single cabinet or chassis. The power supply function may include circuits which supply ac and/or dc filament voltages, B+ plate voltage(s), and negative bias (C-) voltage(s).

Dc power supply circuits may be of many types, but in small communications equipments will generally fall into one of three types: half-wave (figure 2-12); full-wave center-tap (figure 2-13); and full-wave bridge (figure 2-14). The half-wave supply is used to supply low-current, constant load circuits, such as the bias supply for the power amplifier stage(s) of a transmitter. The full-wave bridge and full-wave center-tap supplies are used with heavier, higher-voltage loads such as the B+ for an entire transmitter or receiver.

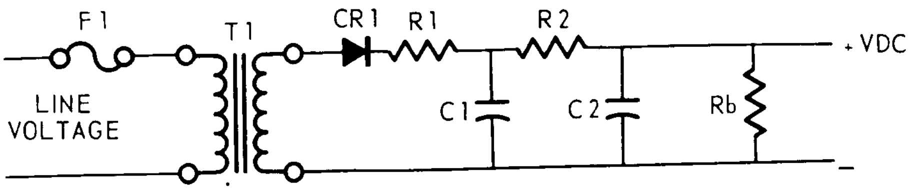


Figure 2-12. Half-Wave Power Supply.

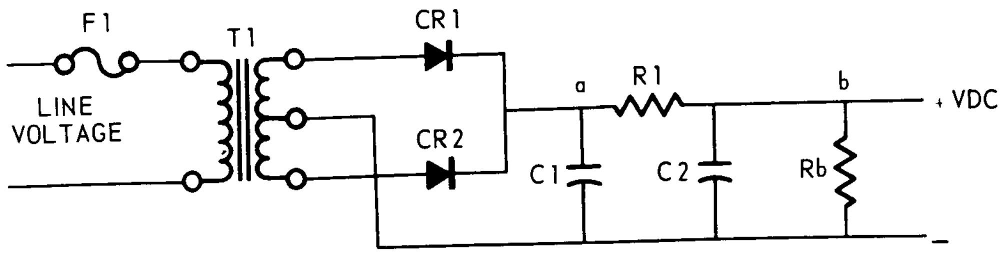


Figure 2-13. Full-Wave Center Tap Power Supply.

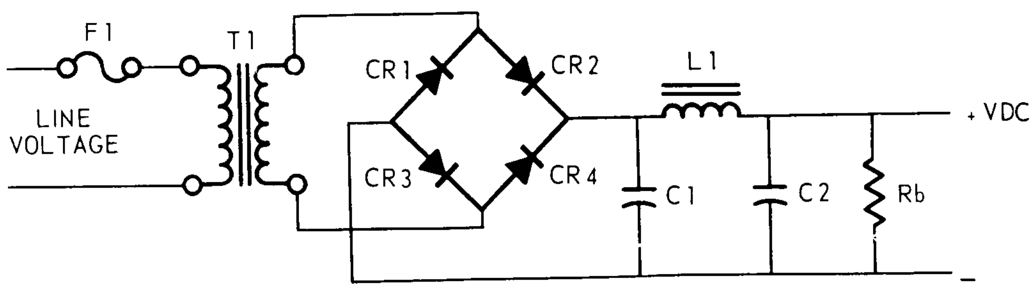


Figure 2-14. Full-Wave Bridge Power Supply.

The ability of a power supply circuit to maintain a constant output under changes in load is called regulation, and is primarily related to the type of filter used with the supply and, in some cases, the type of regulator circuit at the output. Filter circuits range from a simple capacitor, to π-type resistance-capacitance or inductance-capacitance circuits, to L-type, choke input circuits. Regulator circuits have a wide range of design features but fall, in general, into two classes: shunt regulation and series regulation. A power supply "circuit" includes the rectifier, a filter, and (if necessary for the supply's design purpose) a regulator.

There are many symptoms that can be attributed to the power supply circuits. When these symptoms occur, the power supply should always be considered as a possible faulty function. A few of these symptoms are: hum in the audio output of a receiver, caused by poor filtering at the power supply output; a "motor-boating" sound, caused by loss or degradation of the B+ decoupling networks between amplifier stages; overall degradation of performance of a transceiver, caused by reduced output from a B+ or bias supply; complete failure of an equipment, caused by loss of one of the power supply voltages; frequency shift in oscillator circuits, caused by poor voltage regulation of either the input line voltage or the power supply output; and many others. Some of these can only be caused by power supply faults, others could be due to a failure in the power supply or in one of the other functional units in the equipment.

Power supply circuits are fused to protect the power supply from external failures (shorts). A blown fuse may result from a failure in the power supply circuit (such as a shorted filter capacitor), but will more often reflect a temporary overload or a failure in the circuits energized from the supply. If a blown fuse is replaced and immediately blows again, it is almost certain there is a failure in the equipment. You should isolate and correct such failures before replacing the fuse a second time.

Assume the line fuse in a transmitter has blown. You replace the fuse, and it blows again. You know the fault is either in the power supply or in the circuit it supplies; the probable faulty functions are the power supply and the transmitter (or, more specifically, the transmitter load).

Since the line fuse blows each time you energize the equipment, there is no easy way to isolate the faulty function. You may need to try one or more of the following procedures:

(1) Disconnect the power supply and measure the power supply internal resistance to determine if there is a short or an unusually low resistance.

(2) Measure the dc load resistance in the transmitter with the power supply disconnected. Remember the continual fuse blowing indicates excessive current flow, which is usually caused by a short in the circuit. However, the short circuit may not appear as a direct short (zero ohms) if there is a series dropping resistor.

(3) With the power supply circuit disconnected from its load, insert a good fuse in the power supply and turn it on again. This time if the fuse blows, the fault is obviously in the power supply. If it doesn't blow, start looking in the transmitter for the fault. Some components may break down only when high voltage is applied; this latter method is the simplest way to isolate the faulty function in this event.

The method of (1) above, is probably the most useful technique. Refer to figure 2-13. Two resistance measurements at point b (across the bleeder resistor, with the load disconnected) can tell you a lot about the power supply circuit. Assume you measure 20K ohms, then reverse the leads and measure 300 ohms. The power supply is probably alright! The first measurement reflects only the impedance of the bleeder resistor, Rb – if either of the capacitors or the diodes were shorted, you would probably read a fairly low resistance. The diodes are reverse biased by the ohmmeter voltage, and have a very high reverse resistance. The second measurement reflects the resistance of resistor R1, the forward resistance of the diodes, and the parallel resistance of the transformer secondary windings.

Suppose you measured 100 ohms in the reverse direction and 65 ohms in the forward direction. What would you suspect? Very likely capacitor C2 is leaky. If capacitor C1 were leaky, your measurement would reflect the series resistance of R1.

Troubleshooting Example Problem

The performance of a typical communication receiver is noticeably degraded. Signals are barely heard.

The first step of the six-step troubleshooting procedure is fairly obvious: degraded performance as indicated by weak signals. To perform step 2, you change bands and adjust the various receiver controls, but neither the signals or the noise level will increase. Step 3. What are your probable faulty functions? You only have two to choose from and step 2 did not eliminate either of the functions. Therefore, your list must include the receive and power supply functions.

In this problem, the receiver uses a 300v, full-wave rectifier similar to figure 2-13. To isolate the faulty function, step 4, you measure the voltage of the power supply and find that the B+ is only 225 volts. What function contains the fault? Obviously something is wrong in the power supply.

Step 5 of the six-step troubleshooting procedure can be skipped in this problem; you know the fault is in the B+ supply circuit.

You perform step 6 by making the following resistance and voltage measurements (resistance measurements are made with the power supply disconnected from the receiver; voltage measurements are made with a load):

Test Point	Resistance	Voltage
point b to ground	20000 ohms (forward) 300 ohms (reverse)	225v
point a to ground	21k ohms (forward) 200 ohms (reverse)	220v
top of T1 secondary to ground	100 ohms	300 vac
bottom of T1 secondary to ground	infinite ohms	0 vac
T1 primary		110 vac

What component is at fault? Would the failure of that component cause the voltage of the power supply to be lowered? Generally the resistances are normal until you get to the secondary of T1. Here you should notice that the voltage across the secondary and resistances of the secondary are abnormal. You should conclude that the lower half of the secondary of T1 is open and the power supply is working as a half-wave power supply. The amount of voltage drop will depend on the power supply load.

Summary

The power supply is a functional unit and is always used with some other function such as receive, transmit, etc. Power supply circuits used in communications equipment are generally one of the three basic types, half-wave, full-wave, and full-wave bridge.

A blown fuse in a power supply circuit may result from a temporary overload, but if the fuse is replaced and it blows agains, there is probably more serious trouble. Power supply circuits which use solid state rectifiers can be checked out fairly well using only a vom; vacuum or mercury-vapor type rectifier circuits require a tube tester as well as a vom for thorough checkout.

QUESTIONS:

Q1. Audible hum in a receiver may be caused by several faults, including poor shielding, poor ground connections, and __________ __________ in the power supply.

Q2. Figure 2-13 is a +100 volt power supply circuit. No voltage is measured at point b, but 130 volts is measured at point a. The probable fault is component __________.

Q3. A voltmeter indicates that a +300 volt bridge rectifier circuit (figure 2-14) is only supplying +180 volts. The possible trouble could be:

a. shorted filter capacitor.

b. power transformer secondary winding open.

c. open rectifier.

d. open filter choke.

Q4. The line fuse in the full-wave bridge circuit of figure 2-14 keeps blowing. Which of the components listed could be at fault?

a. Open power transformer winding

b. Open rectifier

c. Shorted filter capacitor

d. Open filter choke.

ANSWERS:

A1. Audible hum in a receiver may be caused by several faults, including poor shielding, poor ground connections, and poor filtering in the power supply.

A2. Figure 2-13 is a +100 volt power supply circuit. No voltage is measured at point b, but +130 volts is measured at point a. The probable fault is the resistor R1. The resistor must be open. The voltage at point a is high because there is no load current.

A3. A voltmeter indicates that a +300 volt bridge rectifier circuit (figure 2-14) is only supplying +180 volts. The possible trouble could be:

a. shorted filter capacitor. Incorrect. If the filter capacitor were shorted, there would not be any voltage at the output.
b. power transformer secondary winding open. Incorrect. If the transformer secondary was open, there would not be any voltage at the output.
c. open rectifier. Correct. If one of the rectifiers were open, there would still be a reduced output voltage. The circuit would operate as a half-wave rectifier.
d. open filter choke. Incorrect. There would be no output voltage if the filter choke were open.

A4. The line fuse in the full-wave bridge circuit of figure 2-14 keeps blowing. Which of the components listed could be at fault?

a. Open power transformer winding. Incorrect. A fuse will blow when the current exceeds its rated capacity. An open winding in the transformer would not cause excessive current to flow.
b. Open rectifier. Incorrect. A fuse will blow when the current exceeds its rated capacity. An open rectifier in the power supply would not cause excessive current to flow.
c. Shorted filter capacitor. Correct. A shorted filter capacitor would cause excessive current to flow, thus blowing the primary fuse.
d. Open filter choke. Incorrect. A fuse will blow when the current exceeds its rated capacity. An open filter choke would not cause excessive current to flow.

CHAPTER II REVIEW QUESTIONS

Note: See appendix A for correct answers.

Study figure 4-1, page 4-2 of the instruction book before attempting to answer the following questions.

Choose the best answers.

Q1. The AN/URC-32 is a:
- a. transmitter.
- b. receiver.
- c. transmitter-receiver.
- d. transceiver.

Q2. The AN/URC-32 principal mode of operation is:
- a. AM.
- b. SSB.
- c. FSK.
- d. CW.

Q3. The AN/URC-32 operating frequency range is:
- a. 3 to 40 mc.
- b. 2 to 30 mc.
- c. 3 to 30 mc.
- d. 2 to 40 mc.

Q4. The unit which determines the specific operating frequency of the AN/URC-32 is the:
- a. converter-oscillator.
- b. amplifier-converter-modulator.
- c. signal comparator.
- d. radio frequency amplifier.

Q5. The unit which allows a continuous frequency check with an external frequency standard is:
- a. converter-oscillator.
- b. amplifier-converter-modulator.
- c. signal comparator.
- d. radio frequency amplifier.

Q6. The unit which determines whether USB or LSB will be used is the:
- a. converter-monitor.
- b. converter-oscillator.
- c. amplifier-converter-modulator.
- d. amplifier-control.

Q7. The unit which contains the WATTMETER is the:
- a. radio frequency amplifier.
- b. antenna coupler control unit.
- c. converter-oscillator.
- d. signal comparator.

Q8. The smo (stabilized master oscillator) is located in the:
a. converter-oscillator.
b. amplifier-converter-modulator.
c. signal comparator.
d. radio frequency amplifier.

Q9. The balanced modulators are located in the:
a. converter-oscillator.
b. signal comparator.
c. amplifier-converter-modulator.
d. converter-monitor.

Q10. +400 vdc is supplied to the AN/URC-32 from the:
a. high voltage power supply.
b. low voltage power supply.
c. converter-oscillator.
d. amplifier-converter-modulator.

Q11. The PLATE ON lamp is located in the:
a. radio frequency amplifier.
b. high voltage power supply.
c. amplifier-control.
d. converter-monitor.

Q12. The XMIT lamp is located in the:
a. radio frequency amplifier.
b. high voltage power supply.
c. amplifier-control.
d. converter-monitor.

Q13. The audio level meter is located in the:
a. amplifier-converter-modulator.
b. amplifier-control.
c. signal comparator.
d. converter-monitor.

Q14. The FIL OFF-TUNE-OPERATE switch is located in the:
a. radio frequency amplifier.
b. converter-oscillator.
c. amplifier-control
d. converter-monitor.

Q15. The primary power fuses are located in the:
a. junction box.
b. low voltage power supply.
c. high voltage power supply.
d. radio frequency amplifier.

Q16. If the blower is not operating, the blower interlock (which is actuated by air pressure) disconnects the:

a. 2000v.
b. 250v.
c. line voltage.
d. 28v.

Q17. When the radio frequency amplifier is being tuned, RF power output is reduced by lowering the:

a. driver plate and power amplifier screen voltage.
b. driver screen and power amplifier screen voltage.
c. driver plate and power amplifier plate voltage.
d. driver amplifier plate and screen voltages.

Q18. The output of the balanced-modulators drive the:

a. agc module.
b. tgc module.
c. converter-oscillator.
d. radio frequency amplifier.

Q19. The signal comparator, when used for making off-the-air frequency checks, receives the ____________ audio.

a. AM
b. CW
c. USB
d. LSB

Q20. In the receive function, the antenna input is connected to the:

a. radio frequency amplifier.
b. converter-oscillator.
c. amplifier-converter-modulator.
d. signal comparator.

Q21. The audio amplifier in the dynamic handset receives its power from the:

a. high voltage power supply.
b. low voltage power supply.
c. control-power supply.
d. internal power supply.

Q22. The bfo oscillator in the converter-monitor is used in the ____________ mode of operation.

a. FSK
b. CW
c. USB
d. LSB

Q23. The smo is tuned by ______________________________ method(s).
a. mechanical
b. electrical
c. mechanical and electrical
d. It is not tuned.

Q24. The low voltage and high voltage power supply rectifiers are:
a. high vacuum.
b. mercury vapor.
c. cold cathode (vacuum).
d. solid state.

Q25. The best indication of low power output in the transmit function can be obtained from the:
a. PLATE CURRENT meter.
b. WATTMETER.
c. SIGNAL COMPARATOR meter.
d. AUDIO LEVEL meter.

Q26. Transmitters are usually easier to troubleshoot than receivers because:
a. transmitters are metered better.
b. transmitters are usually larger.
c. receivers employ too many feedback loops.
d. it is harder to recognize malfunction symptoms in a receiver.

Q27. The POWER ON lamp in a receiver usually indicates the presence of:
a. B+ voltage.
b. filament or line voltage.
c. bias voltage.

Q28. Control circuits in transmitters:
a. are all alike.
b. vary from one transmitter design to another.
c. employ only relays.
d. are always very simple.

Q29. Poor voltage regulation in an AM transmitter power supply can cause:
a. hum on the carrier.
b. frequency drift.
c. arcing in the transmitter.

CHAPTER III

APPLICATION OF THE SIX-STEP TROUBLESHOOTING PROCEDURE

Chapters III and IV each contain three troubleshooting problems on the AN/URC-32 which you are expected to solve by applying the six-step troubleshooting procedure. In this chapter you will be aided in applying the six steps to the problems. The three problems in chapter IV you will be expected to solve "on your own."

Before you start working the troubleshooting problems, let's review the terms "functions" and "functional units." A function is usually considered to be the performance of a major electronic task or operation such as receiving, transmitting, supplying power. A functional unit is the piece of equipment which contains the function. Functional units are normally the power supply, receiver, transmitter, etc. However, in troubleshooting the AN/URC-32, the application of the six-step troubleshooting procedure becomes easier if each <u>cabinet</u> is considered as a functional unit (that is, the AN/URC-32 functional units are the radio frequency amplifier, converter-oscillator, amplifier-converter-modulator, etc). In step 4, localizing the faulty function, you will be localizing the faulty cabinet, which we have defined as a "functional unit."

NOTE: Be certain to mark your answers or record them on a separate sheet of paper so that you can later evaluate your performance using the criterion test, appendix B.

TROUBLESHOOTING PROBLEM NO. 1

Problem Statement

A radioman reports that he is unable to transmit with an AN/URC-32. Upon checking the transceiver you obtain the following indications in the CW transmit mode:

NOTE: The normal readings for the transmit modes are given in appendix E of this text.

Indicator	Indication
WATTMETER	zero watts
PLATE ON lamp	off
PLATE CURRENT meter	zero ma
AFC meter	midscale
OSC ON lamp	on
XMIT lamp	on
Amplifier-converter-modulator meter in the RF OUT EXCITER position	15 db

Step 1 of Troubleshooting Problem No. 1

The first step of the six-step troubleshooting procedure is symptom recognition. Before you can find a fault, you must be able to recognize the symptoms of the fault. Only by recognizing the symptoms of the fault can it be determined that equipment is operating improperly.

Which of the statements below best describes the operation of the transceiver as shown above? (Q1)

a. A fault in the transmit function is indicated.
b. The transceiver has no RF output as indicated by the WATTMETER and the PLATE CURRENT meter.
c. The possible faulty function could be in the radio frequency amplifier, low voltage power supply, or the converter-oscillator.
d. The transceiver is operating normally.

ANSWERS:

The statement you chose which best describes operation of the transceiver is:

a. A fault in the transmit function is indicated. Not necessarily. The transceiver is in the transmit mode, but the fault could easily be in the power supply or the control function. Don't get ahead of yourself. You are trying to perform step 4, localizing the faulty function. Before you can identify the faulty function, you must be able to recognize the symptoms of the fault. What are these symptoms? What indications tell you something is wrong?
b. The transceiver has no RF output as indicated by the WATTMETER and the PLATE CURRENT meter. Correct. These are the indications which tell you that there is something wrong with the transceiver. As yet you have no idea as to what the fault might be or even the faulty functional unit.
c. The possible faulty function could be in the radio frequency amplifier, low voltage power supply, or the converter-oscillator. Incorrect. You are trying to perform step 3, listing the possible faulty functions. Don't rush; you will eventually get there, but right now you should be concerned with recognizing the symptoms of the fault. Before you get to step 3 there will be other information available from step 2, symptom elaboration, which will help you in listing the possible faulty functions.
d. The transceiver is operating normally. Incorrect. There are four indications that a failure has occurred. Compare the indications with the normal readings given on sheet 1 of appendix E.

Step 2 of Troubleshooting Problem No. 1

You have recognized the symptoms of the fault, now you should elaborate on these symptoms, step 2 of the six-step troubleshooting procedure.

You probably noticed that the PLATE ON lamp was not illuminated. This is a very big clue – think about it a minute. What does this fact (that the PLATE ON lamp is not illuminated) tell you? (Q2)

ANSWER:

The fact that the PLATE ON lamp is not illuminated tells you there is is no high voltage (+2000v) present at the radio frequency amplifier.

The absence of plate current supports this conclusion.

As a normal precaution you would check that the high voltage power supply HV ON lamp is lighted and that the fuse (F1) is not blown. Assuming these are normal, what would you do next? (Q3)

a. Operate the equipment in receive mode to elaborate on the symptom.

b. List the probable faulty functions.

ANSWERS:

Your next step is to:

a. Operate the equipment in receive mode to elaborate on the symptom. Incorrect. You know all you need to know to list the faulty function: (1) there is no RF output, (2) the PLATE ON lamp is out, and (3) the HV ON lamp is on.

b. List the probable faulty functions. Correct. You have learned all you can from the front panel indications and are ready for the next logical step.

Step 3 of Troubleshooting Problem No. 1

The next step is to list the possible faulty functions. Remember to list all possible faulty functions. Your list should include: (Q4)

a. high voltage power supply and low voltage power supply.
b. high voltage power supply and radio frequency amplifier.
c. low voltage power supply and radio frequency amplifier.

ANSWERS:

Your list of probable faulty functions is:

a. high voltage power supply and low voltage power supply. Incorrect. The fault may be in the high voltage power supply, but it could not be in the low voltage power supply because the low voltage power supply is not connected to the radio frequency amplifier which displays the malfunction symptoms.

b. high voltage power supply and radio frequency amplifier. Correct. The fault could be in either of these units; you must list both, even though one of the units is more probable than the other.

c. low voltage power supply and radio frequency amplifier. Incorrect. The fault may be in the radio frequency amplifier but it could not be in the low voltage power supply because the low voltage power supply is not connected to the radio frequency amplifier which displays the malfunction symptoms.

Step 4 of Troubleshooting Problem No. 1

In step 4, localizing the faulty function, you should start with the most probable and easiest-to-test function. In this problem the most probable and easiest-to-test function is the (Q5)

____.

ANSWER:

The most probable and easiest-to-test function is the high voltage power supply. The high voltage power supply is most likely at fault because the PLATE ON lamp did not light and the other indications are the indications you would expect if there is no high voltage. The high voltage power supply is also the easiest-to-test since a single test (which can be made with a vom) will check it out.

Refer to figure 4-28, Power Supply PP-2153/U Servicing Block Diagram, page 4-85 of NAVSHIPS 93285(B). What would you check in the high voltage power supply before making any other checks?_______________(Q6)

ANSWER:

You should check fuse F2 before making any other checks.

You check fuse F2 – it is OK. Next you must make one or more tests to determine whether the high voltage power supply or the radio frequency amplifier is defective. The high voltage power supply may be checked by measuring the voltage at connector J1.

WARNING

The +2000 vdc at J1 is lethal – it can kill you if you are careless. The proper procedure to measure this voltage is as follows:

1. Deenergize the power supply.
2. Open the cover and use the capacitor shorting bar to discharge all capacitors.
3. Remove the HV OUT cable from J1 and attach the multimeter leads to chassis ground and the center conductor of J1.
4. Set the multimeter to its 5000 vdc range. Place the meter where you can read the voltage indication without touching the meter.
5. Close the cover, energize the power supply, and read the meter indication.
6. Repeat steps 1 and 2, disconnect the meter, and reconnect the HV OUT cable.

You measure the voltage at J1 and obtain a reading of zero. The faulty function is: (Q7)

a. the high voltage power supply.
b. the radio frequency amplifier.

ANSWERS:

The faulty function is:

a. the high voltage power supply. Correct. There is no output voltage, therefore the supply must be defective.

b. the radio frequency amplifier. Incorrect. If the 2000 volt output had been normal you would know this unit was defective. There was no output at J1!

Which statement most accurately describes the fault? (Q8)

a. The fault is in the +2000 volt section of the power supply.
b. The fault is in the +400 volt section of the power supply.
c. The fault could be in either section.

ANSWERS:

The statement which most accurately describes the fault is:

a. The fault is in the +2000 volt section of the power supply. Possibly. You may be lucky and find the fault in the high voltage power supply. However, notice in figure 4-28 that the power supply contains two sections, the 2000v and 400v sections. The 2000v section is in series with the 400v section. The possibility exists that if the 400v supply is faulty, there would not be any voltage at J1.

b. The fault is in the +400v section of the power supply. Possibly. However, the 400v section of the power supply has not been checked to see if it is faulty, so you don't know for sure.

c. The fault could be in either section. Correct. Figure 4-28 shows the two sections in series. It is possible that a fault in the 400v section could cause the observed symptoms.

Step 5 of Troubleshooting Problem No. 1

In the high voltage power supply there are two power supply sections, the 400v and 2000v circuits. Step 5, localizing the faulty circuit, is the next step you must perform. What should you do next? (Q9)

a. Measure the voltage at pin 6 of TB1.
b. Measure the voltage at pin 9 of TB1.
c. Start checking components.

ANSWERS:

Your next action is to:

a. Measure the voltage at pin 6 of TB1. Right! If you do this you will have isolated the faulty circuit and will have a better idea where to start looking for the faulty component.
b. Measure the voltage at pin.9 of TB1. Incorrect. You know 115 vac is present – HV ON indicator DS1 is lighted.
c. Start checking components. Incorrect. You can save some time if you check the 400v supply and isolate the faulty circuit. By doing this you will reduce the number of components you would have to check by about half.

Measuring the voltage between pin 6 and ground you obtain a 400v reading on your meter. The faulty circuit is the: (Q10)

a. 2000v circuit.
b. 400v circuit.

ANSWERS:

The faulty circuit is the:

a. 2000v circuit. Correct. If 400v is present but the 2000v is not, then the 2000v circuit is faulty.

b. 400v circuit. Incorrect. You just measured 400v at the output terminal so how could it be at fault?

Step 6 of Troubleshooting Problem No. 1

To perform step 6, failure analysis of the six-step troubleshooting procedure refer to figure 5-123, power supply schematic, page 5-126 in NAVSHIPS 93285(B).

What should you do next? (Q11)

a. Remove and test individual components.
b. Make in-circuit resistance measurements.
c. Replace the power transformer (T1).

ANSWERS:

What should you do next?

a. Remove and test individual components. Poor choice. You will eventually find the trouble, but it may take you two weeks. Also, you may damage good parts during removal. There is a better way.
b. Make in-circuit resistance measurements. Good. You are about to locate the faulty component. It is much easier to make resistance measurements than to arbitrarily remove, test, and replace components until you find the fault.
c. Replace the power transformer (T1). Incorrect. Replacing T1 would be a lot of work for nothing. Locate the faulty component systematically and save your time and energy.

Using a vom similar to the AN/PSM-4, you obtain the following resistance measurements at the indicated points.

Test Points	Resistance
Junction L1-R2 to ground	
positive lead of meter at R2	54K ohms
negative lead of meter at R2	54K ohms
Junction of rectifiers and L1 to ground	
positive lead of meter at L1	infinity
negative lead of meter at L1	150 ohms
T1 between pins 7 and 8	45 ohms

The fault is most likely: (Q12)

a. C1 or C2.
b. CR 13-44.
c. L1.
d. R2-R4.
e. T1.

ANSWERS:

From the data given the fault is most likely:

a. C1 or C2. Incorrect. If either unit was shorted the resistance from the L1-R2 junction would be almost zero ohms.

b. CR13-44. Incorrect. There are no indications that the rectifiers are faulty; in fact, there are strong indications the rectifiers are normal.

c. L1. Correct. Between R2 and ground you measured only the bleeder resistance. Ordinarily the resistance of L1 plus the resistance of the rectifiers (250 ohms) should have been measured with the negative lead of the vom at R2.

d. R2-R4. Incorrect. The L1-R2 to ground resistance was 54K ohms, which is the total resistance of R2 + R3 + R4.

e. T1. Incorrect. T1 shows continuity in both the primary and secondary windings, which indicates that the transformer is alright. The primary resistance is low because winding 1-2 is in parallel with winding 3-4.

The last part of step 6 is to analyze the circuit to substantiate that the faulty component is the only component that is causing the trouble. In this problem L1 must have been a substandard item since none of the fuses were blown. Otherwise the excess current required to burn L1 out would have blown one of the fuses.

This completes troubleshooting problem no. 1.

TROUBLESHOOTING PROBLEM NO. 2

Problem Statement

You are given a radioman's report that he was unable to make CW transmissions with an AN/URC-32. Upon checking the transceiver, you obtain the following indications when the XMIT-CW TEST switch is depressed to CW TEST:

Indicator	Indication
WATTMETER	zero watts
PLATE ON lamp	on
PLATE CURRENT	0 ma
Amplifier-converter-modulator meter in the RF OUT EXCITER position	0 db
OSC ON lamp	on
XMIT lamp	off

Step 1 of Troubleshooting Problem No. 2

Step 1 of the six-step troubleshooting procedure is symptom recognition. You note immediately that RF power is not being transmitted. Which of the statements below lists all of the abnormal indications? (Q1)

a. The WATTMETER, PLATE CURRENT meter, and amplifier-converter-modulator meter readings are abnormal and the XMIT lamp should be on.
b. The WATTMETER, PLATE CURRENT meter, and amplifier-converter-modulator meter readings are abnormal.
c. The WATTMETER and PLATE CURRENT meter readings are abnormal and the XMIT lamp should be on.

ANSWERS:

The only complete list is:

a. The WATTMETER, PLATE CURRENT meter, and amplifier-converter-modulator meter readings are abnormal and the XMIT lamp should be on. Correct. All of these are abnormal, indicating that the transceiver is not transmitting.
b. The WATTMETER, PLATE CURRENT meter, and amplifier-converter-modulator meter readings are abnormal. Incomplete. You are missing a very important indication, one which will give you a good clue as to the location of the fault.
c. The WATTMETER and PLATE CURRENT meter readings are abnormal and the XMIT lamp should be on. Incorrect. You have picked out most of the important indications but have overlooked one which will give you a good clue as to the location of the fault.

What is your next step? (Q2)

a. Elaborate on the symptoms.
b. List the probable faulty functions.
c. Localize the faulty functions.

ANSWERS:

Your next step is:

a. Elaborate on the symptoms. Correct. Find out as much information about the trouble as possible. Only when you are sure that you have enough information or that no other information can be obtained do you start listing the probable faulty functions.

b. List the probable faulty functions. Possibly, but are you confident you have all the information you need? It would be worthwhile to spend a few more minutes to get additional information on the symptoms.

c. Localize the faulty functions. Incorrect. The trouble could be in any one of several units. Even though you may have a good idea of the faulty function, get in the habit of going through <u>all</u> of the six steps in the troubleshooting procedure. If you form this habit, you are on your way to being a good technician.

Step 2 of Troubleshooting Problem No. 2

To elaborate on the malfunctions symptoms, you place the transceiver in the tune mode by placing the TUNE-LOCAL-EXTERNAL switch on the amplifier-converter-modulator in the TUNE position. This action disconnects the audio and reinserts the 300 kc carrier. The OSC CONTROL switch on the converter-monitor is placed in the OFF position. Now you key the transceiver by positioning the XMIT-CW TEST switch on the converter-monitor to the XMIT position and obtain the following:

Indicator	Indication
WATTMETER	125 watts
PLATE ON lamp	on
PLATE CURRENT	300 ma
Amplifier-converter-modulator meter in the RF OUT EXCITER position	10 db
OSC ON lamp	off
XMIT lamp	on

The above indicate transceiver operation in the tune mode is: (Q3)

a. normal.
b. marginal.
c. abnormal.

ANSWERS:

The tune-mode indications are:

a. normal. Correct. All of the indications agree with the normal readings listed on sheet 2 of appendix E.

b. marginal. Incorrect. See sheet 2 of appendix E.

c. abnormal. Incorrect. See sheet 2 of appendix E.

Step 3 of Troubleshooting Problem No. 2

You should now be able to list the probable faulty functions, step 4. Before listing the faulty functional units remember that the transceiver could not be keyed in the CW mode of operation. The transceiver could be keyed and all indications were normal in the tune mode with the carrier reinserted and the OSC CONTROL switch in the OFF position.

Your list of probable faulty functional units should include: (Q4)

a. amplifier-converter-modulator, converter-oscillator, and converter-monitor.

b. amplifier-converter-modulator and converter-oscillator.

c. converter-monitor.

ANSWERS:

Your list of possible faulty functional units should include:

a. amplifier-converter-modulator, converter-oscillator, converter-monitor. Incorrect. The amplifier-converter-modulator and converter-oscillator are apparently working properly. The indications obtained in the tune mode are all normal.
b. amplifier-converter-modulator and converter-oscillator. Incorrect. The amplifier-converter-modulator and converter-oscillator are apparently working properly. The indications obtained in the tune mode are all normal.
c. converter-monitor. Correct. The converter-monitor is the only probable faulty unit. The transceiver could not be keyed in the CW mode of operation, but could be keyed when the transceiver was in the tune mode.

Steps 4 and 5 of Troubleshooting Problem No. 2

Step 4 of the six-step troubleshooting procedure can be skipped in this problem; you identified the faulty function as the converter-monitor in step 3.

Next you must localize the trouble to the faulty circuit, step 5. Remember that one of the original symptoms was that the XMIT lamp did not light. Refer to figure 5-119, Converter-Monitor Schematic Diagram, page 5-122 in NAVSHIPS 93285(B).

Where is the XMIT lamp connected? ______________________________ (Q5)

ANSWER:

The XMIT lamp is connected between the keyline and +28 vdc.

Remember the XMIT lamp came on in the tune mode, when the keyline was grounded in the XMIT position of the XMIT-CW TEST switch, but not in the CW mode, where the CW TEST position is used. If you analyze the difference between these circuits you should be able to identify the faulty circuit, without even using a test equipment.

The faulty circuit is the: (Q6)

a. relay amplifier.
b. output amplifier.
c. buffer amplifier.

ANSWERS:

The faulty circuit is the:

a. relay amplifier. Correct. The relay amplifier circuit controls relay K1 and the XMIT lamp in the CW mode. Since the transceiver can be keyed in the tune mode but not in the CW mode, the fault must be in this circuit.

b. output amplifier. Incorrect. The output amplifier circuit controls the audio tone. Failure of this circuit cannot cause the particular symptoms you observed.

c. buffer amplifier. Incorrect. The buffer amplifier circuit amplifies the tone for CW and FSK operations; it is controlled by the keyline. Failure of this circuit could not cause the symptoms you observed.

Step 6 of Troubleshooting Problem No. 2

Step 6, failure analysis, of the six-step troubleshooting procedure consists of isolating the faulty component and analyzing the faulty circuit to be sure you located the component that is actually causing the trouble.

The first step would probably be to check V2. You do this and find V2 is normal. You're going to have to dig into the circuit.

Which of the following test equipments would you use? (Q7)

a. An oscilloscope.
b. A signal generator.
c. A vom.

ANSWERS:

The test equipment you will use is:

a. An oscilloscope. Incorrect. The relay amplifier is a switching circuit which has two states, off and on. Use of an oscilloscope would prove to be awkward; there are no waveforms as such, only voltage levels associated within the two states of the circuit.

b. A signal generator. Incorrect. The relay amplifier is a switching circuit with two states, off and on – either V2B is conducting or it isn't. A signal generator would not "key" the circuit, and would thus provide no useful information.

c. A vom. Correct. The relay amplifier is a switching circuit; it has only two states, off and on. Each state has an associated "set" of voltage levels. The voltmeter is best for measuring dc voltages.

The voltage and resistance measurements at each pin of V2 are shown below. Refer to figure 5-119, page 5-122, and isolate the defective part.

Pin No.	Voltage	Resistance
V2-1	+125v	75K ohms
2	0v	25K ohms
3	+4v	820 ohms
4	6 vac	10 ohms
5	6 vac	10 ohms
6	0 vac	infinity
7	-20v (key up)	150K ohms
8	0v	15 ohms
9	0v	0 ohms

The faulty component is: (Q8)

a. K1.
b. R18.
c. R21.

ANSWERS:

The faulty component is:

a. K1. Correct. The plate of V2A (pin 1) has 125 volts, indicating that the +130 volt supply is present at the top of relay K1. However, pin 6, the plate of V2B, has no plate voltage. Relay K1 must be open.

b. R18. Incorrect. Both the resistance and voltage at pin 7 of V2B are normal.

c. R21. Incorrect. R21 is the 15 ohm cathode resistor connected to pin 8 of V2. Even though there is no cathode voltage the resistance checks show 15 ohms indicating R21 is good.

The last part of step 6 is to substantiate whether the fault is the actual cause of the problem. The only component failure which could possibly cause relay K1 to open would be a shorted tube, V2B. But since V2 was a good tube, relay K1 must have been a substandard product.

Take a break, then try troubleshooting problem number 3.

Problem Statement

You are given a radioman's report that an AN/URC-32 is inoperative in transmit. Upon setting the transceiver up in the CW mode you observe the following:

Indicator	Indication
WATTMETER	zero watts
PLATE ON lamp	on
PLATE CURRENT	150 ma
AFC meter	midscale
OSC ON lamp	on
XMIT lamp	on
Amplifier-converter-modulator meter in the RF OUT EXCITER position	0 db
Audio Level (vu) meter	0 vu

Step 1 of Troubleshooting Problem No. 3

Step 1 of the six-step troubleshooting procedure is symptom recognition. Which of the lists below includes all of the indicators which tell you something is wrong? (Q1)

a. WATTMETER, PLATE CURRENT meter, and AFC meter.
b. WATTMETER, amplifier-converter-modulator meter, and audio level meter.
c. WATTMETER, PLATE CURRENT meter, and amplifier-converter-modulator meter.

ANSWERS:

The only complete list is:

a. WATTMETER, PLATE CURRENT meter, and AFC meter. Incorrect. The WATTMETER and PLATE CURRENT meter readings are incorrect, but the AFC meter indication is normal (see sheet 1 of appendix E).

b. WATTMETER, amplifier-converter-modulator meter, and audio level meter. Incorrect. The WATTMETER indicates no power output and the amplifier-converter-modulator meter reading is low, but the audio level meter reading is normal and there is another important indication which should be observed.

c. WATTMETER, PLATE CURRENT meter, and amplifier-converter-modulator meter. Correct. All three of these meters reflect symptoms of the malfunction. The plate current reading (150 ma) is the amount of plate current that would be expected if there was no drive to the radio frequency amplifier. The lack of RF drive is also indicated by the amplifier-converter-modulator meter.

The next step in the troubleshooting procedure is ______________ (Q2)

____.

ANSWER:

The next step in the troubleshooting procedure is symptom elaboration.

Step 2 of Troubleshooting Problem No. 3

To further check out the transceiver you make the following checks:

1. The radio frequency amplifier tuning control is adjusted with no effect on the meter indications.
2. The BAND switch is turned and the AFC meter is observed. It is noticed that the meter varies slightly from band to band.
3. The XMIT lamp lights when the transceiver is keyed.
4. The transmitter is placed in the AM transmit mode. The PLATE CURRENT meter still indicates 150 ma, and the WATTMETER remains at zero. Also it is noted that the audio level (VU) meter fluctuates normally with modulation in USB XMIT.
5. The meter on the amplifier-converter-modulator is switched through its various positions with the following results:

Switch Position	Reading
AGC-TGC	zero (transceiver keyed)
-90v	40 db
130v	40 db
250v	40 db

6. In the receive function, stations are heard in all modes.

QUESTIONS:

Q1. The smo (is) (is not) working properly. (Q3)

Q2. +28 vdc (is) (is not) being supplied from the low voltage power supply. (Q4)

Q3. The malfunction (could) (could not) be in a functional unit used only during receive. (Q5)

ANSWERS:

A1. The smo is working properly. First, reception is impossible if the smo is defective; second, the AFC meter varied as the frequency band was changed.

A2. +28 vdc is being supplied. The XMIT lamp lighted when the transceiver was keyed; one side of this light goes to +28 vdc, the other side to ground via the keyline.

A3. The malfunction could not be in a functional unit used only during receive. First, reception was normal; second, if the malfunction affected only the receive function, you should be able to transmit normally.

Step 3 of Troubleshooting Problem No. 3

Step 3 is listing the probable faulty functions. Remember that the functional units in the AN/URC-32 were defined as the individual cabinets.

Your list of probable faulty functional units includes: (Q6)

a. amplifier-control and amplifier-converter-modulator
b. amplifier-converter-modulator and converter-oscillator
c. converter-oscillator and radio frequency amplifier

ANSWERS:

Your list of probable faulty functional units includes:

a. amplifier-control and amplifier-converter-modulator. Incorrect. The amplifier-control was apparently working normally as indicated by the fluctuations on the audio level (VU) meter in the converter-monitor. The USB audio output is fed to the converter-monitor's VU meter and then to the amplifier-converter-modulator. Therefore, the audio signal from the amplifier-control to the amplifier-converter-modulator was good. Since the audio input to the amplifier-converter-modulator was good and you have not checked the output from the amplifier-converter-modulator to determine if it is good, this unit is a good choice as a possible faulty unit.

b. amplifier-converter-modulator and converter-oscillator. Correct. The audio level (VU) meter fluctuations in the USB mode of operation indicate that the amplifier control unit is operating properly. The audio is fed from the amplifier-control through the converter-monitor where it is monitored by the audio level meter to the amplifier-converter-modulator. Therefore, you know that you have a good input to the amplifier-converter-modulator. There is no output from the converter-oscillator as indicated by the amplifier-converter-modulator meter which monitors the RF EXCITER output. The fault must be in either the converter-oscillator or amplifier-converter-modulator.

c. converter-oscillator and radio frequency amplifier. Incorrect. The radio frequency amplifier can be eliminated, since there was no input to this unit from the converter-oscillator (as indicated by the meter in the amplifier-converter-modulator). If there is no input to the radio frequency amplifier, you couldn't expect any output. The fault must be located in the preceding units. The converter-oscillator precedes the radio frequency amplifier and is a good choice as a possible faulty unit.

Step 4 of Troubleshooting Problem No. 3

Step 4 of the six-step troubleshooting procedure is localizing the faulty functions. Refer to the servicing block diagrams of the converter-oscillator

Step 4 of the six-step troubleshooting procedure is localizing the faulty functions. Refer to the overall servicing block diagram for the AN/URC-32, Appendix D. How can you determine if the converter-oscillator or the amplifier-converter-modulator is at fault? (Q7)

amplifier-converter-modulator is at fault?

a. Check the input signal to the amplifier-converter-modulator.
b. Check the output signal from the amplifier-converter-modulator.
c. Check the output signal from the converter-oscillator.

ANSWERS:

To determine which functional unit is faulty, you:

a. Check the input signal to the amplifier-converter-modulator. Incorrect. You already know that the input to the amplifier-converter-modulator is good because of the indication on the audio level (VU) meter. You should observe the signal between the two units to determine if the output from the first unit is good or bad.

b. Check the output signal from the amplifier-converter-modulator. Good! The amplifier-converter-modulator output is fed to the converter-oscillator. If this signal is bad, then the fault must be in the amplifier-converter-modulator; if the signal is good, the fault is in the converter-oscillator.

c. Check the output signal from the converter-oscillator. Incorrect. You already know that there is no output from the converter-oscillator – the meter in the amplifier-converter-modulator in the RF OUT EXCITER position measures this output. It won't do much good to measure it again.

Refer to the servicing block diagram for the amplifier-converter-modulator, figure 4-21. Which of the test points will allow you to isolate the faulty functional unit with a single measurement? (Q8)

a. J1 of the TGC module.
b. J1 of the USB module.
c. J2 of the USB module.
d. J8 (cabinet connector).
e. J9 (cabinet connector).

ANSWERS:

You can isolate the faulty functional unit with a single measurement at:

a. J1 of the TGC module. Incorrect. This test point will allow you to check most of the amplifier-converter-modulator, but not all of it. If the signal at this point is good, you still cannot say definitely that the fault is in the converter-oscillator because it could be in the remaining tgc circuits.

b. J1 of the USB module. Incorrect. This test point is near the input of the amplifier-converter-modulator and would not be a good point to isolate the fault to one of the functional units. If the signal was good at this point, the fault could still be in either unit.

c. J2 of the USB module. Incorrect. Too many circuits follow this point to definitely isolate the fault to one or the other of the two units.

d. J8 (cabinet connector). Incorrect. This is the 300 kc input from the converter-oscillator during receive. You know this signal will be present (during receive).

e. J9 (cabinet connector). Correct. This is the 300 kc output of the amplifier-converter-modulator during transmit. If there is an output at J9, then the fault is in the converter-oscillator; if there is no output, the fault is in the amplifier-converter-modulator.

Using an oscilloscope you observe a 300 kc signal at J9. The faulty unit is the: (Q9)

a. amplifier-converter-modulator.
b. converter-oscillator.

ANSWERS:

The faulty unit is the:

a. amplifier-converter-modulator. Incorrect. The output at J9 was normal. If there is a 300 kc signal being fed to the converter-oscillator and if that unit is functioning properly, there would be an output to the radio frequency amplifier.

b. converter-oscillator. Correct. The output at J9 was normal for the amplifier-converter-modulator. Therefore, the fault must be in the converter-oscillator.

Step 5 of Troubleshooting Problem No. 3

Look at figure 4-11, pages 4-42 and 4-43 of NAVSHIPS 93285(B). During transmit the 300 kc output from the amplifier-converter-modulator is fed through the 0.1 kc tuning unit to the input of the RF tuner, and through the RF tuner to the radio frequency amplifier via connector J10. With respect to the 0.1 kc tuning unit, the transmit 300 kc signal enters through connector A2 and exits via connector A4.

Initially, where should you place brackets to enclose the faulty circuit? (Q10)

a. Input connector J11 and output connector J12.
b. Input connector J13 and output connector J10.
c. Input connector J11 and output connector J10.
d. Input connector J13 and output connector J12.

ANSWERS:

You place the enclosing brackets at:

a. Input connector J11 and output connector J12. Incorrect. J11 is the receive RF input; J12 is the receive 300 kc signal to the amplifier-converter-modulator.

b. Input connector J13 and output connector J10. Correct. You know the input from the amplifier-converter-modulator is correct; you know there is no output to the radio frequency amplifier.

c. Input connector J11 and output connector J10. Incorrect. Input connector J11 is the receive RF input. J10 is correct; you know there is no output to the radio frequency amplifier.

d. Input connector J13 and output connector J12. Incorrect. Connector J13 is correct; you just verified that the input from the amplifier-converter-modulator was correct. Connector J12 is the receive 300 kc output to the amplifier; this signal is not used during transmit, and was normal during receive.

Where would you measure the signal to move your input brackets such that you divide the questionable circuits approximately in half? (Q11)

a. 0.1 kc tuning unit connector A4.
b. RF tuner test point J1.
c. RF tuner test point J6.
d. RF tuner test point J8.

ANSWERS:

You would reduce the number of suspect circuits by approximately half by making a measurement at:

a. 0.1 kc tuning unit connector A4. Poor. This test would isolate the fault to either the tuning unit or the RF tuner; however, the RF tuner is much more complex than the 0.1 kc tuning unit, and the division is unequal.

b. RF tuner test point J1. Poor. Essentially this isolates the fault to either the 0.1 kc tuning unit or the RF tuner. The RF tuner is much more complex than the 0.1 kc tuning unit.

c. RF tuner test point J6. Very good. A measurement here will isolate the fault to the high-frequency circuits of the RF tuner or to the preceding circuits (0.1 kc tuning unit and low-frequency circuits of the RF tuner).

d. RF tuner test point J8. Very poor. This would only eliminate a single stage in the RF tuner; if the signal at J8 was bad, you would still be left with most of the RF tuner and the 0.1 kc tuning unit.

Refer to table 4-3, page 4-23 in NAVSHIPS 93285(B). With the transceiver adjusted to transmit in band 1 at 1.9 mc, you measure 11.8 millivolts at J6; the frequency is 1.9 mc. Where should you make your next test? (Q12)

a. RF tuner test point J1.
b. RF tuner test point J4.
c. RF tuner test point J8.

ANSWERS:

You make your next test at:

a. RF tuner test point J1. Incorrect. The measurement at J6 eliminated the circuits preceding J6.
b. RF tuner test point J4. Incorrect. The measurement at J6 eliminated the circuits preceding J6.
c. RF tuner test point J8. Good. This effectively isolates the fault to either transmitter RF amplifier V4 or transmitter output amplifier V6. Transmitter RF amplifier V5 could not be defective since it is only used on band 2; the transceiver will not transmit on any band.

With the transceiver adjusted to transmit in band 1 at 1.9 mc, you measure 215 millivolts at J8; the frequency is 1.9 mc. You conclude that the fault is ______________________________ (Q13)

ANSWER:

On the basis of your test results you conclude that the fault is in transmitter output amplifier V6 or its associated circuit.

Step 6 of Troubleshooting Problem No. 3

Your next step is to find the faulty component. Refer to figure 5-103 (pages 5-92 and 5-93 of NAVSHIPS 93285(B), RF Tuner Module Schematic Diagram, and locate the stage which contains the fault. Find test point J8, the RF EXCITER meter output (pin 24 of P2), and pin 5 of P1, the transmit output. You have a good signal at J8; your input bracket goes here. You have no RF output and no RF EXCITER meter output, so your output brackets go at P1-5 and P2-24. The faulty component must be located in the circuit between the closing brackets.

Examine the circuit closely. The one component in the circuit that would most likely be at fault is ________________________. (Q14)

ANSWER:

The one component in the circuit that would most likely be at fault is V6. Once you isolate a vacuum tube stage, a check of the tube will often isolate the trouble.

When you check V6 you find it contains a screen grid to suppressor grid short. When you replace V6 with a new tube and test the transceiver, you find that the original symptoms still remain.

Now what should you do? (Q15)

a. Start troubleshooting again at step 1.
b. Start troubleshooting again at step 3.
c. Continue trouble analysis, step 6.

ANSWERS:

Now what should you do? (Q16)

a. Start troubleshooting again at step 1. Incorrect. Why start all over again? You can be fairly certain the trouble is in the same circuit. Did you analyze the fault you found to determine its cause or its effects? Don't start over when you are so close to locating the trouble.
b. Start troubleshooting again at step 3. Incorrect. You could, but you'll end up back at this same circuit. Did you analyze the fault you found to determine its possible cause, or its effects?
c. Continue trouble analysis, step 6. Correct. You have only performed half of step 6. Now complete step 6 by analyzing the circuit and locating the other faulty component(s).

To obtain additional information you measure voltages and resistances around the socket of V6. Resistance measurements are made with the chassis connector removed from P2. You obtain the following:

V6 Pin No.	Voltage	Resistance
1	0 vdc	68 ohms
4	6 vac	1 ohm
5	6 vac	0 ohms
6	250 vdc	infinity
7	0 vdc	0 ohms
8	0 vdc	infinity
9	0 vdc	19 ohms

From the voltage and resistance measurements; which component is most likely at fault? (Q17)

a. R15 open.
b. L34 open.
c. L21 open.
d. R16 open.

ANSWERS:

The component which is most likely defective is:

a. R15 open. Incorrect. R15 (cathode resistor) measured 68 ohms which is normal.

b. L34 open. Incorrect. The resistance between pin 9 of V6 is 19 ohms through L34. The resistance of L34 is printed on the schematic as 19 ohms.

c. L21 open. Incorrect. If L21 were open there would not be any plate voltage. Since there is plate voltage L21 is not open.

d. R16 open. Correct. Since there is plate voltage and no screen voltage R16 must be open.

Analyzing the fault, which statement best describes the cause of the fault? (Q18)

a. The shorted tube probably caused R16 to open.

b. R16 probably caused the tube to short.

ANSWERS:

The statement which best describes the cause of the fault is:

a. The shorted tube probably caused R16 to open. Correct. The short in the tube would cause excessive current to flow through R16, developing approximately 4 watts; R16 is a two-watt resistor.
b. R16 probably caused the tube to short. Incorrect. It is very unlikely that an open resistor could cause a short in the tube. If R16 opened, the loss of screen voltage would probably cut off the tube, but would not cause any damage.

This completes chapter III. A number of review questions follow for self-evaluation.

CHAPTER III REVIEW QUESTIONS

Note: See appendix A for correct answers.

Q1. The indicator which indicates the performance of the converter-oscillator and the preceding equipment in the transmit function is the amplifier-converter-modulator meter when in the ________________ position.

Q2. The high voltage (+2000v) is obtained by summing the _____________ and ___________ volt supply outputs.

Q3. Voltage checks of the low voltage power supply are made with the built-in meter on the _________________________________ unit.

Q4. In localizing the faulty function and circuit (steps 4 and 5 of the six-step troubleshooting procedure), the diagram that is the easiest to use and the most useful is the:

a. functional block diagram.

b. servicing block diagram.

c. schematic diagram.

Q5. In performing step 6 of the six-step troubleshooting procedure, you would normally use the:

a. functional block diagram.

b. servicing block diagram.

c. circuit schematic.

Q6. Normally you use test equipment for the first time during which step of the six-step troubleshooting procedure? _______________________

Q7. After you have located a faulty component, you should next:

a. analyze the circuit to see if it is the only component causing trouble.

b. replace the component.

c. see if the component can be repaired.

d. fill out a failure report.

Q8. In troubleshooting a transmitter, step 4 of the six-step troubleshooting procedure can be skipped if:

a. the transmitter is metered thoroughly.

b. step 3 lists only one possible functional unit.

c. step 5 is going to be performed.

d. step 2 has many indications.

Q9. If a technician overlooks the fact that a 500 watt transmitter is radiating only 400 watts, he is not doing step _______ of the six-step troubleshooting procedure.

a. step 1

b. step 2

c. step 3

d. step 4

Q10. The AN/URC-32 is keyed with the CW TEST switch and the XMIT lamp does not light. The list of probable faulty units should include:

a. converter-oscillator and low voltage power supply.

b. low voltage power supply and high voltage power supply.

c. converter-monitor and low voltage power supply.

d. converter-monitor and converter-oscillator.

Q11. With the carrier reinserted and no modulation, the PLATE CURRENT meter should indicate:

a. 0 ma.

b. 150 ma.

c. 300 ma.

d. 450 ma.

Q12. With no modulation and no carrier reinsertion, the PLATE CURRENT meter should indicate:

a. 0 ma.

b. 150 ma.

c. 300 ma.

d. 450 ma.

CHAPTER IV. TROUBLESHOOTING PROBLEMS

This chapter contains three troubleshooting problems which you are to solve using the six-step troubleshooting procedure.

In a few places you'll have to skip pages, rather than go page-by-page as in chapter III. When answering questions, be alert for page numbers following the alternate answers.

TROUBLESHOOTING PROBLEM NO. 4

Problem Statement

A radioman reports he can't establish two-way contact with another station on the AN/URC-32 in the USB mode of operation. Reception of the other station is good.

Which of the following best describes your knowledge of the situation at this point? (Q1)

a. The other station's receiver is not functioning.
b. The local station's smo is defective.
c. The local receiver is not functioning.
d Either the local transmitter or the other receiver is not functioning.

ANSWERS:

The statement you selected was:

a. The other station's receiver is not functioning. Possible. Without checking further, you don't really know.
b. The local station's smo is not functioning. Incorrect. The smo is used in both transmit and receive; reception is clear, therefore the smo must be working.
c. The local receiver is not functioning. Incorrect. Reread the problem statement.
d. Either the local transmitter or the other receiver is not functioning. Correct. At this point, all you know for sure is that the other station is not receiving your signal; either "end" could be faulty.

What should you do next? (Q2)

a. Send a message directing the other station to repair their receiver.
b. Check the AN/URC-32 indicators to see whether it is transmitting.

ANSWERS:

Your next action is to:

a. Send a message directing the other station to repair their receiver. Hardly! It would be pretty embarrassing if your equipment was at fault. You'd better check out your own equipment first.

b. Check the AN/URC-32 indicators to see whether it is transmitting. Correct. The indicators built into the equipment were put there to tell you whether or not the equipment is operating correctly.

Troubleshooting Procedure

After energizing the AN/URC-32 in the USB mode of operation, you obtain the following indications:

Indicator	Indication
WATTMETER (modulation)	zero watts
WATTMETER (no modulation)	zero watts
PLATE CURRENT (modulation)	150 ma
PLATE CURRENT (no modulation)	150 ma
PLATE ON lamp	on
Amplifier-converter-modulator meter in RF OUT EXCITER position	fluctuates with modulation
OSC ON lamp	off
XMIT lamp	on

Are you transmitting RF power? Obviously not; the wattmeter reads zero.

Which of the following statements best describes your next action: (Q3)

a. You are ready to list the possible faulty functions.
b. You want to look at indications in other modes of operation to see if you can learn more about the problem.
c. You know which function is defective and are ready to begin making circuit checks.

ANSWERS:

Your next action is:

a. You are ready to list the possible faulty functions. You could, but your list will probably be pretty long, and you may spend a lot more time isolating the faulty function than is really necessary. At this point it would be wise to see if more can be learned about the fault.
b. You want to look at indications in other modes of operation to see if you can learn more about the problem. Correct. At this point you know quite a bit about the fault, but it is probable you will learn more by trying operation in other modes.
c. You know which function is defective and are ready to begin making circuit checks. Very doubtful. At this point you do not have enough information to specify, with certainty, which functional unit is defective (although a lucky guess is always possible).

You place the TUNE-LOCAL-EXTERNAL switch on the amplifier-converter-modulator to TUNE. This disconnects the ____________________ ____________________ and reinserts the ____________________. (Q4)
(Refer to figure 5-112, page 5-114 of NAVSHIPS 93285(B).)

ANSWER:

Placing the TUNE-LOCAL-EXTERNAL switch on the amplifier-converter-modulator to TUNE disconnects the audio input and reinserts the 300 kc carrier.

You then obtain the following:

Indicator	Indication
WATTMETER	zero watts
PLATE CURRENT	150 ma
PLATE ON lamp	on
Amplifier-converter-modulator meter in RF OUT EXCITER position	15 db
OSC ON lamp	off
XMIT lamp	on

Adjusting the DRIVER TUNE and PA TUNE has no effect on the WATTMETER or PLATE CURRENT meter. You switch the amplifier-converter-modulator meter through its switch positions and observe the following:

Switch Position	Meter Indication
-90	40 db (midscale)
+130	40 db (midscale)
+250	40 db (midscale)
AGC-TGC (transmit)	zero

Pressing the PL NO. 1 and PL NO. 2 switches on the radio frequency amplifier to the TEST positions you read 75 ma and 80 ma, respectively

Now what should you do? (Q5)

a. List the possible faulty functions.
b. Begin making circuit checks.
c. Look at operation in other modes.

ANSWERS:

You decide to:

a. List the possible faulty functions. In most cases this would be the correct answer. However, if you look at the data very closely, you should be able to determine exactly which functional unit is at fault. Review the preceding pages, then try again.

b. Begin making circuit checks. Very good. You correctly noted that in this case, only one functional unit could be at fault, and you can skip step 3 of the troubleshooting procedure.

c. Look at operation in other modes. Incorrect. You have looked at everything pertinent during transmit, and you know the receive section works normally.

What is the faulty functional unit? ______________________________ (Q6)

ANSWER:

The radio frequency amplifier is the faulty functional unit.

The RF output from the converter-oscillator is present, but the plate current is very low (150 ma vs the normal level of about 300 ma) and there is no output from the radio frequency amplifier (as indicated by the zero level on the WATTMETER). Presence of both 2000 volts and 400 volts is indicated. The meter readings for the -90v, +130v, and +250v low voltage power supply outputs are normal. The XMIT lamp is on, indicating presence of +28 volts. The output from the converter-oscillator is normal, indicating that it and all the preceding units are functioning normally. The fault must be in the radio frequency amplifier.

You are ready to isolate the faulty circuit. Where would you place your brackets (representing points of known good signal, and verified absence of signal) on figure 5-98 of NAVSHIPS 93285(B) (page 5-81)? (Q7)

a. RF input to driver stage (J1) and output of power amplifier stage (J2).
b. RF input to driver stage (J1) and output of driver stage (junction of C9 and L4).
c. Input to power amplifier stage (junction of C9 and L4) and output of the power amplifier stage (J2).

ANSWERS:

You would place the brackets at the:

a. RF input to driver stage (J1) and output of power amplifier stage (J2). Not bad, but you know more about the fault than this. Look at the PLATE CURRENT meter indication, then try again.

b. RF input to driver stage (J1) and output of driver stage (junction of C9 and L4). Very good! The indications are that proper drive is being applied to the input; the PLATE CURRENT meter indicates there is no RF drive to the power amplifier. The fault must lie in the driver stage. You should, of course, verify these conclusions by checking the input and output waveforms for the driver stage.

c. Input to power amplifier stage (junction of C9 and L4) and output of the power amplifier stage (J2). Incorrect. Plate current is present, and is in fact, normal for the condition where no RF drive exists. Think about this fact, and the fact that proper drive signal input to the radio frequency amplifier is indicated, then try again.

NOTE: Follow page directions carefully during the remainder of this problem.

What do you want to do next? (Q8)

a. Check voltages around V1 and V2 . . . . turn to page 4-17

b. Check V1 and V2 . . . . turn to page 4-21

c. Check resistances at V1 and V2 sockets . . . . turn to page 4-19

The following resistance measurements were obtained with the transceiver power off and V1 and V2 removed from their sockets (resistance measured to ground):

Socket-Pin	Resistance V1	Resistance V2
1	40	40
2	47K	47K
3	infinity	infinity
6	2630	2630
7	0	0
8	infinity	infinity
9	47K	47K

You examine these values and replace: (Q10)

a. Z1.
b. L1.
c. Z2.
d. R3.
e. R4.
f. C6.

Go to the next page

ANSWERS:

You replaced:

a. Z1. Incorrect. You measured 2630 ohms at pin 6; this is the total dc resistance of Z1, L3, R25, and R5 to ground through contacts of relay K2, which is deenergized.
b. L1. Incorrect. You measured 40 ohms at pin 1; this is the total resistance of L1 and R3 in series.
c. Z2. Incorrect. You measured 2630 ohms at pin 6; this is the total dc resistance of Z1, L3, R25, and R5 to ground through contacts of relay K2, which is deenergized.
d. R3. Incorrect. You measured 40 ohms at pin 1; this is the total resistance of L1 and R3 in series.
e. R4. Correct. If everything is normal you should see approximately 10.8K ohms from V1 pin 3 or 8 (R24 + R4 + R5) and 10.7K from V2 pin 3 or 8. You measured infinity. R4 must be open.
f. C6. Incorrect. If C6 were shorted, pin 6 of V1 and V6 would indicate approximately 130 ohms to ground (Z1 or Z2 + L3 + R25).

Go to page 4-23

You decided to check voltages around the sockets of V1 and V2. In this instance, this would represent poor practice. First, you would have to bypass the cabinet interlocks to maintain the 400 volt and 2000 volt inputs and the 115 vac input to the bias supply. Second, gaining access to the V1 and V2 tube sockets places your hands in close proximity to exposed 400 volt potentials. Finally, no reference values are given for the radio frequency amplifier stages. Voltage readings within the radio frequency amplifier are difficult and dangerous to obtain, and are also difficult to evaluate. They should be used in fault isolation of this particular cabinet only as a last resort.

Return to page 4-14 and select another answer.

You replaced V2 with a new tube. When you checked operation, the symptoms evident at the start of this problem still existed – the fault was not repaired.

You had better turn to page 4-15 and do some more checking.

You decided to measure resistances at the sockets of V1 and V2. You remove power from the set, take V1 and V2 from their sockets, and measure the following resistances to ground:

Socket-Pin	Resistance V1	Resistance V2
1	40	40
2	47K	47K
3	infinity	infinity
6	2630	2630
7	0	0
8	infinity	infinity
9	47K	47K

You examine these values and decide to replace: (Q11)

a. Z1.
b. L1.
c. Z2.
d. R3.
e. R4.
f. C6.

Go to the next page

ANSWERS:

You replaced:

a. Z1. Incorrect. You measured 2630 ohms at pin 6; this is the total dc resistance of Z1, L3, R25, and R5 to ground through contacts of relay K2, which is deenergized.

b. L1. Incorrect. You measured 40 ohms at pin 1; this is the total resistance of L1 and R3 in series.

c. Z2. Incorrect. You measured 2630 ohms at pin 6; this is the total dc resistance of Z1, L3, R25, and R5 to ground through contacts of relay K2, which is deenergized.

d. R3. Incorrect. You measured 40 ohms at pin 1; this is the total resistance of L1 and R3 in series.

e. R4. Correct. You should see approximately 10.8K ohms from V1 pin 3 or 8 (R24 + R4 + R5) and 10.7K from V2 pin 3 or 8. You measured infinity. R4 must be open.

f. C6. Incorrect. If C6 were shorted, pin 6 of V1 and V6 would indicate approximately 130 ohms to ground.

When you look at resistor R4 from the other side of the chassis, you note it is very burnt looking. You replace R4. What do you do next? (Q12)

a. Turn on the equipment and check out operation.

b. Check V1 and V2.

Go to page 4-22

You want to check V1 and V2. Good – this is a relatively easy check, and good practice at this point in your procedure.

Using a tube tester, you check V1 and V2. V1 checks good; V2 has a short between the suppressor and screen grids (pins 7 and 8)

Now what do you want to do? (Q9)

a. Replace V2; the fault is repaired . . . . turn to page 4-18

b. Do some more checking before replacing V2 and turning on the equipment . . . . turn to page 4-15

ANSWERS:

After replacing R4 you decide to:

a. Turn on the equipment and check out operation. Well, maybe - but what caused R4 to open? It must have received more current than it would take. Evidently something is shorting out; if you replace R4 without eliminating the short you may have to replace R4 twice!

b. Check V1 and V2. Very Good. You find a screen-to-suppressor short (pin 7 to 8) in V2. You knew that something was shorted; the tubes are all that are left:

Go to the next page

Which statement best describes how the two faults (R4 and V2) occurred? (Q13)

a. The shorted tube probably caused R4 to open.
b. The open resistor (R4) probably caused the tube to short.

Go to the next page

ANSWERS:

Your answer is:

a. The shorted tube probably caused R4 to open. Correct. With pins 7 and 8 shorted, the entire 400 volt screen supply is impressed across R5, R25, and R4; a current of approximately 37 ma (400v/(100 ohms + 2500 ohms + 8200 ohms)) flowed through R4, developing about 11 watts ($(37\text{ ma})^2$ 8.2K). R4 is a 2 watt resistor; it opened!

b. The open resistor (R4) probably caused the tube to short. Incorrect. If R4 had opened before the tube shorted, the plate currents of V1 and V2 would have been greatly reduced, but no other effect would have been noted. Reduced plate current will not cause a tube to short.

Go have a coke or a coffee, then try Troubleshooting Problem 5, on page 4-25.

Problem Statement

While in communication with another station using USB as the mode of operation, the operator completes a transmission and listens. The station he has been talking to does not reply.

Which statement best describes this situation? (Q1)

a. The other station is having transmitter trouble.
b. You are having receiver trouble.
c. You are having transmitter trouble and the other station did not reply because the operator couldn't tell when you signed over.
d. The trouble may be either your own receiver or the other station's transmitter.

ANSWERS:

Your description of the situation is:

a. The other station is having transmitter trouble. Possible. However, if you assume the other fellow is having trouble, you may get yourself into trouble – of a different kind! The best bet is to check out your equipment.

b. You are having receiver trouble. Possible, but it could be the other station's transmitter. You won't know 'till you check.

c. You are having transmitter trouble and the other station did not reply because it couldn't tell when you signed over. Not very likely. A very slim possibility exists that you are having transmitter trouble; however, if your signal ceased unexpectedly the other station would very likely inform you your signal had been lost.

d. The trouble may be either your own receiver or the other station's transmitter. Correct. A fault in either one of these units would disrupt communications as described. To be on the safe side, your best bet would be to check out your own equipment immediately.

In the USB receive mode of operation, no signals are heard as the unit is tuned. The amplifier-converter-modulator meter in the AGC-TGC position fluctuates as the transceiver is tuned across the band.

Choose the most accurate statement: (Q2)

a. The other station was having trouble.

b. You have receiver trouble.

ANSWERS:

The most accurate statement is:

a. The other station was having trouble. Incorrect. You have missed a very important point: when you tuned the receiver, no signals were heard. Normally you would expect to hear some signal.

b. You have receiver trouble. Correct. As you tune across the band you would expect to hear some kind of signal. The lack of any signal indicates something is wrong in the receive mode of operation.

If you think that you have enough information to list the probable faulty functions, select the list that you think is correct. On the other hand, if you feel more information is needed, turn to page 4-31 and continue reading.

Your list of faulty functions should include: (Q3)

a. converter-oscillator, amplifier-converter-modulator, amplifier-control, control-power supply.
b. converter-oscillator, amplifier-converter-modulator, amplifier-control.
c. converter-oscillator, amplifier-converter-modulator.

Turn to the next page or turn to page 4-31

ANSWERS:

Your list of faulty functions includes:

a. converter-oscillator, amplifier-converter-modulator, amplifier-control, control-power supply. Correct. If you are going to list the faulty functions at this time, then your list should include all of these units. No doubt you will eventually find the fault, but you could do it much faster if you manipulate some of the other controls first and examine the resulting indications. You may be able to reduce your list considerably.

b. converter-oscillator, amplifier-converter-modulator, amplifier-control. Incorrect. All the units which are used in the receive mode should be included in your list. You should find out more about the fault before listing the probable faulty functions; if you list them now, but not completely, you're really wasting your time!

c. converter-oscillator, amplifier-converter-modulator. Incorrect. All the units which are used in the receive mode should be included in your list. You should find out more about the fault before listing the probable faulty functions; if you list them now, but not completely, you're really wasting your time!

Let's go back and see how symptom elaboration can make your job easier.

To gain more information about the fault, you perform the following steps.

1. You change the receive mode from USB to AM and tune the receiver; this time you hear stations coming in.
2. Signals are again heard when the SIDEBAND SELECTOR is placed in the LSB position.
3. You check the amplifier-converter-modulator meter indications:

Switch Position	Meter Indication
-90	40 db
+130	40 db
+250	40 db
AGC-TGC	varies as receiver is tuned

Your list of probable faulty functions can now be limited to: (Q4)

a. converter-oscillator unit.
b. amplifier-control unit.
c. amplifier-converter-modulator unit.

ANSWERS:

You limited your list of possible faulty functions to:

a. converter-oscillator unit. Incorrect. The 300 kc output from this unit is fed to the three IF/AF amplifiers in the amplifier-converter-modulator unit. Since AM and LSB signals were received properly, the converter-oscillator must be working properly.

b. amplifier-control unit. Incorrect. Proper reception of AM and LSB signals checks out both audio channels of this unit.

c. amplifier-converter-modulator. Correct. The amplifier-control unit is checked out completely during AM and LSB reception. The converter-oscillator and part of the amplifier-converter-modulator also checked out OK. The transceiver failed only in USB reception, so the fault is limited to the amplifier-converter-modulator since this is the only unit which uses separate amplifiers for each mode of operation.

Examine the amplifier-converter-modulator servicing block diagram, figure 4-21. Where would you place the input and output brackets to enclose all the possible faulty circuits? (Q5)

a. Input connector J8 and cabinet jack J11 (pins 3 and 4).
b. Input connector J8 and cabinet jack J11 (pins 5 and 6).
c. Input connector J10 and cabinet jack J11 (pins 3 and 4).

ANSWERS:

You would place the enclosing brackets at:

a. Input connector J8 and cabinet jack J11 (pins 3 and 4). Partially right. J8 is the 300 kc input from the converter-oscillator; you know this signal is good. J11 (pins 3 and 4) is the LSB audio output which is also good. You won't isolate a faulty circuit by placing brackets around a good circuit.

b. Input connector J8 and cabinet jack J11 (pins 5 and 6). Correct. The 300 kc signal at J8 is good and the output J11 (pins 5 and 6) is bad in the USB mode of operation. Therefore, the fault is between these two terminals.

c. Input connector J10 and cabinet jack J11 (pins 3 and 4). Incorrect. J10 is the 100 kc input for the carrier oscillator which supplies the injection signal in the USB and LSB IF/AF amplifiers. You know the injection signal is good because it is used in the transmit mode and in the LSB IF/AF amplifiers. If the injections were not present there would be no output in the USB transmit mode. J11 (pins 3 and 4) is the LSB audio output; this signal is also good.

NOTE: Follow page directions carefully during the remainder of this problem.

The next step you would perform is: (Q6)

a. Exchange the USB and LSB IF/AF amplifiers to see if the USB IF/AF amplifier will work in the LSB socket . . . . turn to page 4-36
b. Move the brackets by using the SIDETONE switch to inject an audio signal at test point J1 of the USB IF/AF amplifier to check the audio amplifiers in the USB IF/AF amplifier (figure 5-112, page 5-114) . . . . turn to page 4-39
c. Move the brackets by injecting a 100 microvolt 300 kc signal at J8 and measuring the output voltage at J1 . . . . turn to page 4-41

The next step you would perform is:

a. Exchange the USB and LSB IF/AF amplifiers to see if the USB IF/AF amplifier will work in the LSB socket.

When you change the USB and LSB IF/AF amplifiers, you find the USB IF/AF amplifier still doesn't work. This extra effort did not help you isolate the faulty circuit; you already knew the USB IF/AF amplifier was faulty.

Return to page 4-35 and select another step.

You want to make resistance checks next.

The following resistance measurements are made at Q1 with the IF/AF amplifier removed from the transceiver (see note 5 on figure 5-116)

Q1-E = 6K ohms
Q1-C = 6K ohms
Q1-B = 120 K ohms

If you feel you can isolate the faulty component. . . . . turn to page 4-47
If you would like to take voltage measurements . . . . turn to page 4-38

You want to make voltage checks.

The following dc voltages were obtained with the IF/AF amplifier in the circuit and with no signal applied, (see note 5 on figure 5-116):

Q1-E = 0 volts
Q1-C = +28 volts
Q1-B = +12.5 volts

If you feel that you have enough information to isolate the fault . . . . turn to page 4-47

If you want to make resistance measurements . . . . turn to page 4-37

The next step you would perform is:

b. Move the brackets by using the SIDETONE switch to inject an audio signal at test point J1 of the USB IF/AF amplifier to check the audio amplifier in the USB IF/AF amplifier. Very good. By using the SIDETONE switch (which takes a portion of the transmitted audio and injects it at test point J1) the audio amplifier in the USB IF/AF amplifier can be checked. You can use a signal generator for this check; however, using the SIDETONE switch allows you to check the audio amplifier without bothering to get out a signal generator.

You place the SIDETONE switch in the ON position with the transceiver in the USB transmit mode. No audio is heard from the USB output.

The fault is in the: (Q7)

a. IF section of the USB IF/AF amplifier.
b. AF section of the USB IF/AF amplifier.

Go to the next page

ANSWERS:

The fault is in the:

a. IF section of the IF/AF amplifier. Incorrect. You tested the audio amplifier and found it to be faulty. There is no reason to suspect the IF amplifier.

b. AF section of the IF/AF amplifier. Correct. You checked the AF section and found no audio output. The fault must be in this section.

Go to page 4-43

The next step you perform is:

c. Move the brackets by injecting a 100 microvolt 300 kc signal at J8 and measuring the output voltage at test point J1 of the USB IF/AF amplifier. Good. By checking the output at J1 with a 300 kc input, you can determine if the IF section of the USB IF/AF amplifier is working properly.

You inject a 300kc signal at J8 and measure the voltage level at J1. You find the voltage level is satisfactory.

The fault is in the: (Q8)

a. IF section of the IF/AF amplifier.
b. AF section of the IF/AF amplitier.

Go to the next page

ANSWERS:

The fault is in the:

a. IF section of the IF/AF amplifier. Incorrect. You checked the IF amplifier section and found it to be working satisfactorily. Therefore, the fault could not be in the IF section.

b. AF section of the IF/AF amplifier. Correct. You checked the IF section and found it working. The fault must be in the audio amplifier.

Go to the next page

You have isolated the fault to the AF section of the USB IF/AF amplifier. Refer to figure 5-116, the schematic diagram for the USB IF/AF amplifier (page 5-119) in NAVSHIPS 93285(B).

To further isolate the fault, what should you do? (Q9)

a. Place an audio signal at the collector of Q1.
b. Place an audio signal at the base of Q1.
c. Place an audio signal at the collectors of Q2 and Q3.

Go to the next page

ANSWERS:

To further isolate the fault you:

a. Place an audio signal at the collector of Q1. Correct. This procedure divides the audio amplifier in half and will allow you to determine if the fault is in the Q1 stage or the power output stage Q2-Q3.

b. Place an audio signal at the base of Q1. Incorrect. You already know that there is no output when a signal is applied at the input to the audio amplifier.

c. Place an audio signal at the collectors of Q2 and Q3. Incorrect. You may be lucky and find the fault in the output of the audio power amplifier. But to use the bracketing technique efficiently, each test should divide suspect circuits in half until the faulty circuit is isolated. In this case you have brackets initially at the input of Q1 and the output of Q2-Q3. The next check would logically be between Q1 and the power amplifier Q2 and Q3.

Go to the next page

You place an audio signal at the collector of Q1 and hear an audio signal in the loudspeaker.

The fault is between __________ and ______________________________ (Q10)

Go to the next page

ANSWER:

The fault is between J1 and the collector of Q1. You have eliminated audio power amplifier Q2-Q3.

Do you want to make voltage checks or resistance checks of the Q1 circuit? (Q11)

a. Resistance checks . . . . turn to page 4-37
b. Voltage checks . . . . turn to page 4-38

The fault is:

a. Q1.
b. R15.
c. R17.
d. T2.

Go to the next page

ANSWERS:

You identified the faulty part as:

a. Q1. Correct. The checks that indicate Q1 is bad are the high collector and base voltages and no emitter voltage which indicates that Q1 is not conducting. The resistance obtained for the Q1 collector is approximately correct even though it does not agree with the voltage-resistance table in NAVSHIPS 93285(B). If you trace out the collector circuit to ground you will see that it goes through T2 (3900 ohms), R19 (2K ohms), and R21 (100 ohms), which add up to 6K ohms. If Q1 is not conducting and there is no base current, the voltage at the base connection will be developed across R16 and will be considerably higher than normal.

b. R17. Incorrect. The resistance measurement for R17 (emitter to ground) is correct, approximately 6.8K ohms. If you look only at the voltage measurements, you could be led to believe that R17 is faulty – the voltage measurements are about what you'd get if R17 were open.

c. T2. Incorrect. There is no reason to suspect T2. If T2 were open you would see 0 vdc at the collector of Q1. If T2 were shorted, you would see the full +28 vdc at Q1-C; current would flow through Q1 to develop a voltage across R17. Neither of these conditions are indicated by the measurements.

d. R15. Incorrect. If R15 were open, there would be no voltage at the base of Q1. If by some chance R15 were shorted, then +28 vdc would be present at the base.

Go to the next page

Which statement describes your next action? (Q13)

a. Replace the transistor and tell the radio watch the transceiver is OK.
b. Replace the transistor and repeat the voltage and resistance readings to see if any other parts are defective.
c. Analyze the circuit and determine if Q1 is the cause of the problem or the result of another failure.

Go to the next page

ANSWERS:

Your next action is:

a. Replace the transistor and tell the radio watch the transceiver is OK. Incorrect. You may be pretty embarrassed if the radio watch turns the set on and it still doesn't work. You have not completed step 6 of the troubleshooting procedure until you know for sure that the transceiver will work when you turn it on.

b. Replace the transistor and repeat the voltage and resistance readings to see if any other parts are defective. Incorrect. If you are going to make additional measurements, do it before you replace Q1. If the failure of Q1 is the result of another failure, the new Q1 will likely be damaged when you apply voltage to take readings.

c. Analyze the circuit and determine if Q1 is the cause of the problem or the result of another failure. Correct. Before you apply power to the set you should be as certain as possible that Q1 is the only failed part in the set. To do this, you can re-examine the voltage and readings you have already taken, make additional voltage and resistance readings in associated circuits with Q1 out of the circuit, and/or analyze the fault itself to see if it could have occurred "naturally" or had to be damaged by another failure.

In this failure, Q1 must have been the original failure. The voltage and resistance readings accurately reflect the circuit condition which exists if Q1 is open or removed from the circuit. A series of failures (C17 and C18 shorted) could cause the fault; however, this would have affected the resistance reading at Q1-B and operation of detector V3. It is safe to replace Q1, energize the set, and verify that normal operation has been restored.

This completes troubleshooting problem no. 5. Take a break, then try your luck on the last problem, on page 4-51.

TROUBLESHOOTING PROBLEM NO. 6

Problem Statement

The radio watch reports it is unable to use the AN/URC-32A. The radio operator said the radio set doesn't work.

Which of the following actions should you take? (Q1)

a. Assume the radio operator is mistaken and don't worry about it.
b. Ask the operator to describe the trouble symptoms, then verify the symptoms by checking out the radio set.
c. Locate your test equipment and begin troubleshooting.
d. Check out the radio set to identify the trouble symptoms.

ANSWERS:

You decided to:

a. Assume the radio operator is mistaken and don't worry about it. Incorrect. The operator may have made a mistake, but you can't affort to take the chance. You must always consider a report of equipment failure as true until you can prove otherwise.

b. Ask the operator to describe the trouble symptoms, then verify the symptoms by checking out the radio set. Excellent. If the operator is available, you may obtain valuable information to help you repair the equipment. While you still should verify the symptoms, at least you have an idea of where to start looking.

c. Locate your test equipment and begin troubleshooting. Incorrect. You wouldn't even know where to start. Is it power supply trouble? One of the bands not operating? Failure to receive? Failure to transmit? You may spend all week working this way, and still not get the fault repaired.

d. Check out the radio set to identify the trouble symptoms. Good, but you can do better. The operator may be able to give you information which will greatly speed up troubleshooting. For example, the operator may be able to tell you that failure was only in one mode of operation, or that he could receive satisfactorily but couldn't transmit.

The radio operator tells you he was using the CW 1 mode, and that he could hear other stations but could not make two-way contact.

You energize the radio set, transfer the RF output to the dummy load, turn the OSC CONTROL switch to CW 1, the MONITOR switch to USB XMIT, and place the AM-SSB switch in the SSB position. When you depress the XMIT-CW TEST switch to CW TEST you observe the following:

Indicator	Indication
WATTMETER	0 watts
PLATE ON lamp	on
PLATE CURRENT meter	150 ma
AFC meter	slight deflection
Amplifier-converter-modulator meter in RF OUT EXCITER position	0 db
Audio level meter (vu)	-15 vu
OSC ON lamp	on
XMIT lamp	on

What do you think? (Q2)

a. The operator is mistaken – the set is working properly.
b. There's something wrong, all right, and you should do some more checking.

ANSWERS:

You think:

a. The operator is mistaken – the set is working properly. You've worked five problems and still can't spot abnormal readings? Four of the eight indications are incorrect!
b. There's something wrong, all right, and you should do some more checking. Absolutely right. In fact, with some careful thought you can identify the one faulty functional unit. To be safe, though, you should do some more symptom elaboration.

You obtain the following indications by placing the OSC-CONTROL switch to OFF, the TUNE-LOCAL-EXTERNAL switch to TUNE, the AM-SSB switch to SSB, and set the XMIT-CW TEST switch to the XMIT position:

Indicator	Indication
WATTMETER	125 watts
PLATE CURRENT meter	300 ma
PLATE ON lamp	on
Amplifier-converter-modulator meter in RF OUT EXCITER position	10 db
Audio level meter (vu)	-15 vu
OSC ON lamp	off
XMIT lamp	on

As a final check of USB operation you place the TUNE-LOCAL-REMOTE switch to LOCAL and set the XMIT-CW TEST switch to the XMIT position. You observe the following:

	Indication	
Indicator	No Modulation	Modulation
WATTMETER	0	400 watts
PLATE CURRENT meter	150 ma	400 ma
PLATE ON lamp	on	on

Indicator	Indication	
	No Modulation	Modulation
Amplifier-converter-modulator meter in RF OUT EXCITER position	10 db	20 db
Audio level meter (vu)	-15 vu	varies
OSC ON lamp	off	off
XMIT lamp	on	on
Amplifier-converter-oscillator meter: -90 position	40 db	
+130 position	40 db	
+250 position	40 db	

A check of the FSK operation is made by placing the OSC CONTROL switch in the FSK position and keying the transceiver. You observe the following:

Indicator	Indications
WATTMETER	0 watts
PLATE ON lamp	on
PLATE CURRENT meter	150 ma
Amplifier-converter-modulator meter in the RF OUT EXCITER position	0 db
Audio level meter (vu)	-15 vu
OSC ON lamp	on
XMIT lamp	on

You should now be able to say with certainty that the faulty functional unit is the: (Q3)

a. converter-oscillator.
b. amplifier-converter-modulator.
c. converter-monitor.
d. radio frequency amplifier.

ANSWERS:

You selected:

a. converter-oscillator. Incorrect. This unit functioned normally in the TUNE and USB modes of operation.
b. amplifier-converter-modulator. Incorrect. There was no input to this unit in CW 1; the unit worked normally during TUNE and USB operation.
c. converter-monitor. Correct. In CW 1 the vu meter indicates this unit did not produce an audio output. This unit is not used in the TUNE and USB modes of operation, and the transceiver worked normally.
d. radio frequency amplifier. Incorrect. The transmitter output appears normal in TUNE and USB; in CW 1, the indications are the ones you get when there is no audio applied to the unit.

OK, the converter-monitor is defective. Refer to figure 4-22, Converter-Monitor Servicing Block Diagram, and decide where you should place the brackets: (Q4)

a. Input tuning circuit and J1 pins 5 and 6.
b. Buffer amplifier V1B input and J1 pins 5 and 6.
c. Input tuning circuit and buffer amplifier V1B output.

ANSWERS:

You placed the brackets at:

a. Input tuning circuit and J1 pins 5 and 6. Very good. The input tuning circuit determines the oscillator frequency; there is no input signal to this unit in CW. There is no output signal from the unit in CW, so the output brackets properly go at J1 pins 5 and 6.

b. Buffer amplifier V1B input and J1 pins 5 and 6. No, although you may be lucky and find the fault within this area. However, you have no way of knowing whether the input to V1B is good.

c. Input tuning circuit and buffer amplifier V1B output. No, although you may be lucky and find the fault inside your brackets. However, you do not know whether the buffer amplifier output is bad. You must select a point where you know for sure that the output is bad.

What should you do next? (Q5)

a. Isolate the faulty circuit by making tests and moving the brackets.
b. Check V1 and V2 in a tube tester.
c. Make voltage and resistance readings around V1 and V2 to find the bad part.

ANSWERS:

Next you will:

a. Isolate the faulty circuit by making tests and moving the brackets. Right. There are three stages which could be faulty; the most efficient method is to find the faulty stage before looking for the bad part(s).

b. Check V1 and V2 in a tube tester. Not bad, since there are only two tubes. If the tubes aren't defective, you're back at the above question. What do you do then?

c. Make voltage and resistance readings around V1 and V2 to find the bad part. Pretty inefficient. In the first place, there are three stages, any one of which could be bad. In addition, if you'll check the converter-monitor schematic (figure 5-119) you'll find the manual doesn't include normal voltage and resistance information – you'll have to figure each reading out to see if it is normal.

Look at figure 4-22 again. What "type" of circuit is enclosed in your brackets? (Q6)

a. Linear
b. Switching
c. Convergent-divergent
d. Feedback

ANSWERS:

The circuit is:

a. Linear. Excellent. You weren't thrown by the switches and extraneous circuits. When S1 is in CW 1 the circuit is strictly linear, from the oscillator (V1A) through the buffer (V1B) and output amplifier (V2A) to J1 pins 5 and 6.

b. Switching. No. Although this circuit includes switches, it is not a switching-type circuit. In every position of S1 the signal goes through the same stages (with the exception of limiter resistor R6 which is shorted out in FSK). Try again.

c. Convergent-divergent. No, although this is a good second choice. However, the bfo signal does not converge with the CW signal, and the relay circuit is operating satisfactorily (as indicated by the XMIT lamp).

d. Feedback. Incorrect. Only the first stage (the oscillator) utilizes feedback. There is no feedback from the output to the input.

What test equipment should you use in testing to move the brackets?(Q7)

a. Oscilloscope
b. Dc voltmeter
c. Distortion analyzer
d. Ohmmeter

ANSWERS:

You chose to use:

a. Oscilloscope. Very good. The oscilloscope display will tell you signal amplitude, approximate frequency, and let you make an estimate as to distortion content. If there is no signal, this will also be apparent.

   Note that a signal generator could also be used for signal injection. This would be an equally effective item of test equipment for use at this point. The VU meter would be used to monitor signal status using the signal injection technique.

b. Dc voltmeter. Incorrect. You are interested in a 1.0 kc audio signal. A dc voltmeter is worthless for ac measurement.

c. Distortion analyzer. Incorrect. Perhaps after you find the faulty stage, the distortion analyzer might be useful for further troubleshooting, but not at this point.

d. Ohmmeter. Incorrect. You are interested in a 1 kc audio signal. An ohmmeter will not tell you if you have a good or bad signal.

Where should you make your first check with the oscilloscope? (Q8)

a. Pin 1 (plate) of V1A
b. Pin 6 (plate) of V1B
c. Pin 1 (plate) of V2A
d. Pin 6 (plate) of V2B

ANSWERS:

You will make your first waveform check at:

a. Pin 1 (plate) of V1A. Poor. You will find the fault eventually by tracing from stage to stage. There's a better starting point, though.
b. Pin 6 (plate) of V1B. Good. A test here will effectively split the linear circuit in two parts.
c. Pin 1 (plate) of V2A. Poor. You will find the fault eventually by tracing from stage to stage. There's a better starting point, though.
d. Pin 6 (plate) of V2B. Absolutely wrong. V2B is the relay amplifier; it is working normally.

A waveform check at pin 6 of V1 yields no signal. Where should you make your next test? (Q9)

a. Pin 1 (plate) of V1A

b. Pin 1 (plate) of V2A

ANSWERS:

You make your next check at:

a. Pin 1 (plate) of V1A. Correct. The signal is not getting through the buffer amplifier, therefore either the oscillator or the buffer is not operating.

b. Pin 1 (plate) of V2A. Incorrect. There is no signal out of V1B; how could there be a signal out of V2A?

NOTE: Follow page directions carefully during the remainder of this problem.

The oscilloscope displays a sine wave of approximately 60 volts peak-to-peak amplitude at pin 1 of V1A. What would you do next? (Q10)

a. Replace limiter R6 . . . . turn to page 4-70
b. Check V1 with a tube tester . . . . turn to page 4-72
c. Measure voltages and resistances at pins 6, 7, and 8 of V1. . . . . turn to page 4-76
d. Measure voltages and resistances at pins 1, 2, and 3 of V1. . . . . turn to page 4-75

You decided to replace R6. Why? What evidence do you have that R6 is defective? You may be right, but you might as easily be wrong – and you'll spend a lot of effort finding out.

Return to page 4-69 and try again.

You decided to check V1 with a tube tester. V1 checks good.

This is a good check to make, even though it should be clear by now that the primary fault is elsewhere. V1 could have caused the fault.

Turn the page and repair the fault.

Turn to page 4-73 and repair the fault.

You decided to check V1 with a tube tester. V1 checks good. Now what do you want to do? (Q11)

a. Measure voltages and resistances at pins 6, 7, and 8 of V1. . . . . turn to page 4-76

b. Measure voltages and resistances at pins 1, 2, and 3 of V1. . . . . turn to page 4-75

You are ready to replace the defective component. Which of the following is defective? (Q13)

a. R6
b. R8
c. R14
d. R15

Go to the next page

ANSWERS:

You replaced:

a. R6. No! You have no evidence that R6 is either bad or good. Go back to page 4-53 and look again.
b. R8. Incorrect. The resistance at pin 7 was 230K. The path to ground consists of R8 (47K), R9 (100K), and R17 (82K). Return to page 4-53).
c. R14. Incorrect. The path to ground from pin 6 goes through R14 (18K), contacts 5 and 3 of S1C, R1 (68K), and R2 (6800 ohms). Return to page 4-53.
d. R15. Correct. The resistance at pin 8 is infinite, indicating an open circuit.

Go to page 4-77

You decided to check voltages and resistances at pins 1, 2, and 3 of V1.

Pin No.	Voltage[1]	Resistance[2]
V1-1	+85v	75K
2	0v	33K
3	+1v	390 ohms

What have you learned? These look reasonable when compared to the schematic; are they abnormal?

You have goofed. V1A is the oscillator; the trouble was isolated to the buffer amplifier. Go back to page 4-69 and start over.

[1]Equipment energized in CW 1 mode.

[2]Equipment deenergized. V1 removed from socket and J1 disconnected. S1 in CW 1 position.

You decided to measure voltages and resistances at pins 6, 7, and 8 of V1.

Pin No.	Voltage[1]	Resistance[2]
V1-6	+130v	93K
7	0 (key down); -20 (key up)	230K
8	0v	infinity

Now what do you want to do? (Q12)

a. Measure voltages and resistances at pins at pins 1, 2, and 3 of V1. . . . . turn to page 4-75
b. Check V1 with a tube tester . . . . turn to page 4-71
c. Replace the defective component . . . . turn to page 4-73

[1]Equipment energized in CW 1 mode.
[2]Equipment deenergized. V1 removed from socket and J1 disconnected. S1 in CW 1 position.

Now that you have located the faulty part, what can you say about the cause of the fault? (Q14)

a. Excessive current through V1B overheated R15, causing it to open.
b. Age, shock, heat, or substandard composition caused R15 to open.

Go to the next page

ANSWERS:

You decided the cause of the fault was:

a. Excessive current through V1B overheated R15, causing it to open. There is no evidence to support this statement; in fact, there is evidence to the contrary (V1 checked good). A better choice is the statement below.
b. Age, shock, heat, or substandard composition caused R15 to open. Very likely. When there is no evidence to show otherwise (such as a shorted tube or capacitor, etc), this is about the only assumption you can make. Remember to always look for this cause of a failure to be sure you have corrected the malfunction.

By now you should have aquired sufficient troubleshooting experience to maintain other equipments.

Remember, you should always check out the equipment after any repairs to make certain it is operating properly.

This completes the last problem. You may score yourself using the criteria of Appendix C, pages C-2 through C-4.

A25.	b.	WATTMETER. The PLATE CURRENT meter, answer a, is a fair indicator	2-63
A26.	a.	transmitters are metered better	2-69
A27.	b.	filament or line voltage	2-69
A28.	b.	vary from one transmitter design to another	2-76
A29.	b.	frequency drift	2-80

Following each answer is a page number which references you back to the appropriate lesson that covers the question subject. If you miss any of the questions you are encouraged to review the question subject.

Chapter I			Reference Page
A1.	d.	systematic troubleshooting techniques	1-1
A2.	a.	recognized	1-3
A3.	b.	elaborate on the symptom	1-5
A4.	b.	listing the probable faulty functions	1-7
A5.	c.	localizing the faulty function	1-9
A6.	b.	circuit	1-11
A7.	c.	failure analysis	1-15
A8.	b.	reduces troubleshooting time	1-1, 1-17

Chapter II

A1.	d.	transceiver	2-1
A2.	b.	SSB	2-1
A3.	b.	2-30 mc	2-1
A4.	a.	converter-oscillator	2-3, 2-24
A5.	c.	signal comparator	2-3, 2-6, 2-35
A6.	d.	amplifier-control	2-3, 2-33
A7.	b.	antenna coupler control unit	2-14
A8.	a.	converter-oscillator	2-24
A9.	c.	amplifier-converter-modulator	2-29
A10.	a.	high voltage power supply	2-12, 2-41
A11.	a.	radio frequency amplifier	2-20, 2-43
A12.	d.	converter-monitor	2-31, 2-49
A13.	d.	converter-monitor	2-31, 2-49
A14.	a.	radio frequency amplifier	2-20, 2-43
A15.	a.	junction box	2-18
A16.	c.	line voltage	2-39
A17.	a.	driver plate and power amplifier screen voltage	2-20
A18.	b.	tgc module	2-29
A19.	d.	LSB	2-6, 2-35
A20.	b.	converter-oscillator	2-6, 2-24
A21.	c.	control-power supply	2-36
A22.	a.	FSK	2-31
A23.	c.	mechanical and electrical	2-24
A24.	d.	solid state	2-38, 2-41

Chapter III			Reference Page
A1.		RF OUT EXCITER	3-24, 2-29
A2.		1600 and 400 volt	2-41, 3-8
A3.		amplifier-converter-modulator	2-29, 3-36
A4.	b.	servicing block diagram	1-9, 3-7, 3-28
A5.	c.	circuit schematic	1-15, 3-12, 3-21 3-25
A6.		step 4, localizing the faulty function	1-9, 3-6
A7.	a.	analyze the circuit to see if it is the only component causing trouble	1-15, 3-12, 3-21 3-35
A8.	b.	step 3 lists only one possible functional unit	2-63, 3-19
A9.	a.	step 1, symptom recognition	1-1, 3-2, 3-15, 3-24
A10.	c.	converter-monitor and low voltage power supply	2-31, 3-15
A11.	c.	300 ma	3-17
A12.	b.	150 ma	3-24

APPENDIX B. CRITERION TEST

Due to the nature of the subject matter in chapters III and IV, you can best evaluate your performance by seeing how well you applied the six-step procedure in solving the troubleshooting problems. As you probably noted, most of the questions in Chapters III and IV are numbered. The scoring key, appendix C, will explain how to evaluate your performance using your response (right or wrong) to each numbered question.

Q1. List the six steps of the six-step troubleshooting procedure in the correct sequence of application.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

Q2. List two advantages of using the six-step procedure when troubleshooting communications or other electronic equipment.

a. ______________________________

b. ______________________________

Q3. Match the statement in the left-hand column which corresponds to one of the six-step troubleshooting procedures listed on the right-hand column:

a. _____ A transmitter is not operating properly. Tuning the intermediate power amplifier stage, does not cause a plate current dip.

b. _____ During routine preventive maintenance on a receiver you notice that the output signal level is down for a given input signal level.

c. _____ In a radar set you notice there is no sweep on the plan position indicator (PPI). You decide that something is wrong in either the sweep generator circuits or the sweep power supply.

d. _____ You find a screen to suppressor grid short in an amplifier tube. You decide to check the resistor and capacitor connected to the screen grid.

e. _____ You make voltage and resistance measurements around a tube socket.

f. _____ Using a vom, you find that there is no high voltage getting to the transmitter.

1. Localizing the faulty function.
2. Listing the probable faulty functions.
3. Failure analysis.
4. Localizing the faulty circuit.
5. Symptom recognition.
6. Symptom elaboration.

Q4. List the four major functions which comprise a typical transceiver:

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

Q5. Match the functions listed in the left-hand column which correspond to one of the functional units of the AN/URC-32 listed in the right-hand column. Refer to figure 4-1, Over-all Functional Block Diagram, in NAVSHIPS 93285(B).

a. _____ Supplies CW audio tone to the USB balanced modulator.

b. _____ Translates the audio signal to the selected sideband on transmit.

c. _____ Amplifies the RF signal on transmit.

d. _____ Supplies voltage for the radio frequency amplifier.

e. _____ Translates the IF signal to an RF signal on transmit.

f. _____ Provides bfo signal during FSK receive.

g. _____ Converts RF signals to IF signals on receive.

h. _____ Permits either local or remote operation of the AN/URC-32.

i. _____ Amplifies and demodulates IF signal on receive.

1. Converter-monitor.
2. Low voltage power supply.
3. High voltage power supply.
4. Amplifier-control.
5. Converter-oscillator.
6. Dynamic handset.
7. Junction box.
8. Signal comparator.
9. Control-power supply.
10. Radio frequency amplifier.
11. Amplifier-converter-modulator.

Q6. Functions of AN/URC-32 front panel controls and indicators can be most readily identified by referring to NAVSHIPS 93285(B):

a. Section 1, General Information.
b. Section 2, Installation.
c. Section 3, Operation.
d. Section 4, Troubleshooting.

Q7. Match the AN/URC-32 trouble symptom in the left-hand column to the indicator(s) in the right-hand column that would display the symptom. (There may be more than one indicator for each symptom.)

a. _____ Transceiver drifts off frequency.

b. _____ The transceiver operates at reduced power.

c. _____ No audio.

d. _____ No high voltage from high voltage power supply.

1. Radio frequency amplifier PLATE CURRENT meter.

2. Radio frequency amplifier PLATE ON lamp.

3. Signal comparator meter.

4. Converter-monitor AUDIO LEVEL meter.

5. Antenna coupler control unit WATTMETER.

Q8. The relative performance of the AN/URC-32 transceiver can be determined from six meters on the transceiver and antenna coupler control unit. They are (refer to NAVSHIPS 93285(B), if necessary):

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

Q9. The indicator that shows the transceiver is keyed is the __________ and it is located on the ______________________________ unit.

Q10. The controls used to check the balance of the power amplifier tubes are ____________________ and ____________________.

Q11. The control used to apply power to the blower also applies power to the ______________________________.

Q12. The amplifier-converter-modulator meter when in the RF OUT EXCITER position measures the RF output of the ____________________ ____________________ unit.

APPENDIX C. CRITERION TEST SCORING KEY

See page C-4 for grading to obtain numerical score.

ANSWERS:

A1. a. Symptom recognition
    b. Symptom elaboration
    c. Listing the probable faulty functions
    d. Localizing the faulty function
    e. Localizing the faulty circuit
    f. Failure analysis

A2. a. Saves time
    b. Helps technician troubleshoot in a logical manner

A3. a - 6 Symptom elaboration
    b - 5 Symptom recognition
    c - 2 Listing the probable faulty functions
    d - 3 Failure analysis
    e - 3 Failure analysis
    f - 1 Localizing the faulty function

A4. a. Transmit function
    b. Receive function
    c. Power supply function
    d. Control function

A5. a - 1 Converter-monitor
    b - 11 Amplifier-converter-modulator
    c - 10 Radio frequency amplifier
    d - 3 High voltage power supply
    e - 5 Converter-oscillator
    f - 1 Converter-monitor
    g - 5 Converter-oscillator
    h - 9 Control-power supply
    i - 11 Amplifier-converter-modulator

A6. c. Section 3, Operation

A7. a - 3 Signal comparator meter
b - 5 AN/SRA-22 WATTMETER
c - 4 Converter-monitor AUDIO LEVEL meter
d - 2 Radio frequency PLATE ON lamp

A8. a. WATTMETER
b. PLATE CURRENT meter
c. AFC meter
d. AUDIO LEVEL meter
e. Amplifier-converter-modulator meter
f. Signal comparator meter

A9. XMIT lamp, converter-monitor

A10. PL NO. 1 TEST, PL NO. 2 TEST

A11. Low voltage power supply OFF-ON switch

A12. Converter-oscillator

Chapters III and IV

Troubleshooting Problem No. 1

Record the numbers of the questions in Troubleshooting Problem No. 1 that you answered incorrectly: ______________________.

If you missed no more than three questions, congratulations. You have shown a good grasp of both the six-step troubleshooting procedure and the AN/URC-32 high voltage power supply.

If you missed more than two of the following questions (1, 3, 5, 9, or 11) you need to review the six-step troubleshooting procedure, chapter I.

If you missed three or more of the following questions (2, 4, 5, 7, 8, 9, or 12) you need to review the theory of operation of the AN/URC-32 high voltage power supply, chapter II, lessons 4 and 17.

Troubleshooting Problem No. 2

Record the numbers of the questions that you answered incorrectly:

______________________.

If you missed no more than one question, you did very well.

If you answered question 2 incorrectly, you are still not quite sure of all of the six steps in the troubleshooting procedure. You should review chapter I.

If you missed two or more of the following questions (1, 4, 5, or 6) you need to review the theory of operation of the AN/URC-32 transmit circuits, chapter II, lessons 2, 9, 10, and 11.

Troubleshooting Problem No. 3

Record the numbers of the questions that you answered incorrectly:

____ .

If you missed no more than three questions, you have done very well.
If you missed one or more of the following questions (2, 7, 10, or 15) you should re-study chapter I.

If you missed three or more of the following questions (1, 3, 4, 5, 6, 8, 9, 12, 13, 14, or 17) you should re-study lessons 10 and 11 of chapter II before proceeding to the troubleshooting problems in chapter IV.

Troubleshooting Problem No. 4

Record the numbers of the questions that you answered incorrectly:

____ .

If you missed no more than two questions, good work!
If you missed any of the following questions (2, 3, 5, 7, 9, or 12) you are still not sure of the application of the six troubleshooting steps. If you missed more than two of these questions, it is recommended that chapters I and III be re-studied.

If you missed more than two of the following questions (4, 6, 8, 10, or 11) you are not thoroughly familiar with the AN/URC-32 theory of operation. Re-study chapter II.

Troubleshooting Problem No. 5

Record the numbers of the questions that you answered incorrectly:

____ .

You should be getting close to perfection. If you answered more than two questions incorrectly, you are still having difficulty in applying the six-step troubleshooting procedure to communications equipment.

If you missed any of the following questions (1, 3, 5, 6, 9, or 13) your trouble is improper application of the recommended six-step procedure. Re-study chapters I and III. Incorrect answers to any of the following questions (2, 4, 7, 8, 10, or 12) indicates that you are not sure of the AN/URC-32 theory of operation. Re-study chapter II.

Troubleshooting Problem No. 6

You should not have missed any of the questions in this problem. If you missed only one or two questions, you have still done a good job.

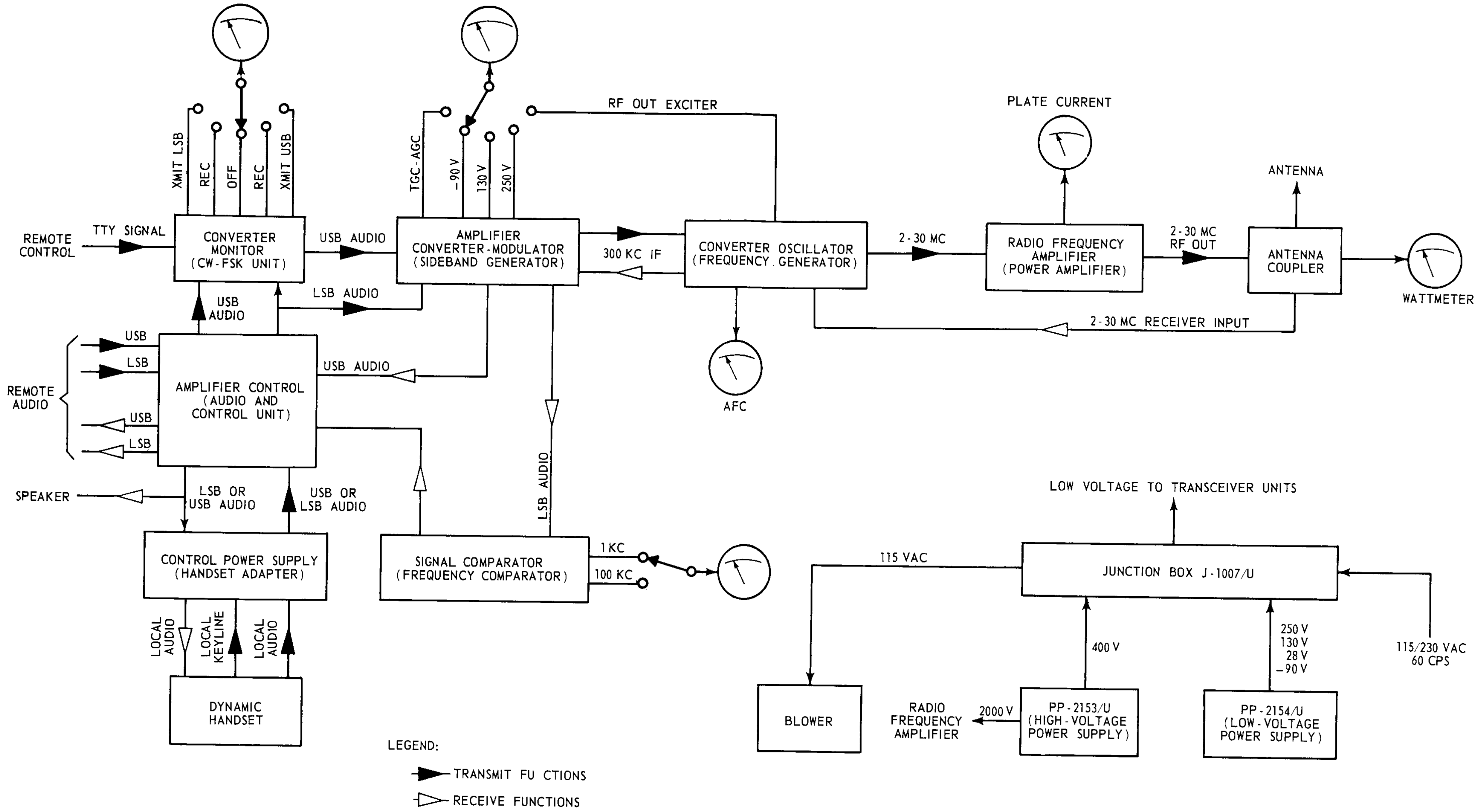
If you missed any of the following questions (1, 3, 4, 5, or 12) you are still having difficulty in applying the six-step procedure. It is recommended that you re-study NAVPERS 93083, Trouble-Shooting Electronic Equipment, and then re-work the problems in this text.

GRADING:

Count the total number of incorrect answers to the test questions and as recorded for the troubleshooting problems. Read your score on the criterion test opposite the number of incorrect answers on the list, below:

No. Incorrect Answers	Criterion Score	Rating
0	100%	Excellent
1	99%	Excellent
2	98%	Excellent
3	97%	Excellent
4	95%	Excellent
5	94%	Very Good
6	93%	Very Good
7	92%	Very Good
8	91%	Very Good
9	90%	Very Good
10	88%	Very Good
11	87%	Satisfactory
12	86%	Satisfactory
13	85%	Satisfactory
14	84%	Satisfactory
15	83%	Satisfactory
16	82%	Satisfactory
17	81%	Satisfactory
18	80%	Satisfactory
19 or more	--	Unsatisfactory

☆ U.S. GOVERNMENT PRINTING OFFICE : 1965 O—786-572



Appendix D. AN/URC-32 Functional Block Diagram.

CONTROL SETTINGS (CW MODE)

The following controls are placed in their respective positions:

Control	Position
Radio Frequency Amplifier AM-2061/URT	
FIL OFF - TUNE - OPERATE	OPERATE
PLATE Switch	ON
Band Switch	BAND 1
DRIVER TUNE	properly adjusted
PA TUNE	properly adjusted
Converter-Oscillator CV-731/URC	
OPERATE - TUNE	OPERATE
Amplifier-Converter-Modulator AM-2064/URC	
SSB-AM Switch	SSB
RECEIVER RF GAIN	properly adjusted
TUNE-LOCAL-EXTERNAL	LOCAL
Meter Switch	RF OUT EXCITER
EXCITER RF GAIN	properly adjusted
SIDETONE Switch	OFF
Converter-Monitor CV-730/URC	
METER MULTR Switch	8 dbm
XMIT-REC-CW TEST Switch	CW TEST
MONITOR Switch	USB
BFO Switch	OFF
OSC CONTROL Switch	CW 1
OUTPUT	properly adjusted
Amplifier-Control AM-2062/URC	
SIDEBAND SELECTOR	USB
MIC GAIN	properly adjusted

NORMAL READINGS (KEY DOWN)

Indicator	Indication
Antenna Coupler AN/SRA-22	
WATTMETER	500 watts
Radio Frequency Amplifier AM-2061/URT	
PLATE CURRENT Meter	550 ma
PLATE ON Lamp	ON
Converter-Oscillator CV-731/URC	
AFC Meter	midscale
Amplifier-Converter-Modulator AM-2064/URC	
Meter positions:	
-90v	40 db (midscale)
130v	40 db (midscale)
250v	40 db (midscale)
RF OUT EXCITER	20 db (midscale)
Meter in RF OUT EXCITER Position	20 db
Converter-Monitor CV-730/URC	
OSC ON Lamp	ON
XMIT Lamp	ON
VU (audio level) Meter	0 vu

NOTE: All low-voltage power supply meter readings should be at least 40 db.

Appendix E. Normal Readings (Sheet 1 of 4).

CONTROL SETTINGS (TUNE MODE)

The following controls are placed in their respective positions:

Control	Position
Radio Frequency Amplifier AM-2061/URT	
FIL OFF - TUNE - OPERATE	OPERATE
PLATE Switch	ON
Band Switch	BAND 1
DRIVER TUNE	properly adjusted
PA TUNE	properly adjusted
Converter-Oscillator CV-731/URC	
OPERATE - TUNE	OPERATE
Amplifier-Converter-Modulator AM-2064/URC	
SSB-AM Switch	SSB
RECEIVER RF GAIN	properly adjusted
TUNE-LOCAL-EXTERNAL	TUNE
Meter Switch	RF OUT EXCITER
EXCITER RF GAIN	properly adjusted
SIDETONE Switch	OFF
Converter-Monitor CV-730/URC	
METER MULTR Switch	8 dbm
SMIT-REC-CW TEST Switch	XMIT
MONITOR Switch	USB
BFO Switch	OFF
OSC CONTROL Switch	OFF
OUTPUT	properly adjusted
Amplifier-Control AM-2062/URC	
SIDEBAND SELECTOR	USB
MIC GAIN	properly adjusted

NORMAL READINGS

	Indication
Antenna Coupler AN/SRA-22	
WATTMETER	125 watts
Radio Frequency Amplifier AM-2061/URT	
PLATE CURRENT Meter	300 ma
PLATE CURRENT with PL 1 TEST Switch depressed	150 ma
PLATE CURRENT with PL 2 TEST Switch depressed	150 ma
PLATE ON Lamp	ON
Converter-Oscillator CV-731/URC	
AFC Meter	midscale
Amplifier-Converter-Modulator AM-2064/URC	
Meter positions:	
-90v	40 db (midscale)
130v	40 db (midscale)
250v	40 db (midscale)
RF OUT EXCITER	10 db (midscale)
Meter in RF OUT EXCITER Position	10 db
Converter-Monitor CV-730/URC	
OSC ON Lamp	OFF
XMIT Lamp	ON
VU (audio level) Meter	-15 vu

NOTES:
1. These indications are the normal indications when the TUNE-LOCAL-EXTERNAL switch is in the TUNE position. In this position the audio is disconnected and a carrier is reinserted.
2. If the radio frequency amplifier's FIL OFF - TUNE - OPERATE switch is placed in the TUNE position, the PLATE CURRENT and WATTMETER indications will be considerably less.
3. All low voltage power supply meter readings should be at least 40 db.

Appendix E. Normal Readings (Sheet 2 of 4).

CONTROL SETTINGS (USB MODE)

The following controls are placed in their respective positions:

Control	Position
Radio Frequency Amplifier AM-2061/URT	
FIL OFF - TUNE - OPERATE	OPERATE
PLATE Switch	ON
Band Switch	BAND 1
DRIVER TUNE	properly adjusted
PA TUNE	properly adjusted
Converter-Oscillator CV-731/URC	
OPERATE TUNE	OPERATE
Amplifier-Converter-Modulator AM-2064/URC	
SSB-AM Switch	SSB
RECEIVER RF GAIN	properly adjusted
TUNE-LOCAL-EXTERNAL	LOCAL
Meter Switch	RF OUT EXCITER
EXCITER RF GAIN	properly adjusted
SIDETONE Switch	OFF
Converter-Monitor CV-730/URC	
METER MULTR Switch	8 dbm
XMIT-REC-CW TEST Switch	XMIT
MONITOR Switch	USB
BFO Switch	OFF
OSC CONTROL Switch	OFF
OUTPUT	properly adjusted
Amplifier-Control AM-2062/URC	
SIDEBAND SELECTOR	USB
MIC GAIN	properly adjusted

NORMAL READINGS (USB MODE)

Indicator	Indication: Modulation (None)	Indication: Modulation (Peak)
Antenna Coupler AN/SRA-22		
WATTMETER	0	400 watts
Radio Frequency Amplifier AM-2061/URT		
PLATE CURRENT Meter	150 ma	400 ma
PLATE ON Lamp	ON	ON
Converter-Oscillator CV-731/URC		
AFC Meter	midscale	midscale
Amplifier-Converter-Modulator AM-2064/URC		
Meter positions:		
-90v	40 db	40 db
130v	40 db	40 db
250v	40 db	40 db
Meter in RF OUT EXCITER Pos	0	20 db
Converter-Monitor CV-730/URC		
OSC ON Lamp	OFF	OFF
XMIT Lamp	ON	ON
VU (audio level) Meter	-	varies

NOTE: All low-voltage power supply meter readings should be at least 40 db.

Appendix E. Normal Readings (Sheet 3 of 4).

CONTROL SETTINGS (AM MODE)

The following controls are placed in their respective positions:

Control	Position
Radio Frequency Amplifier AM-2061/URT	
FIL OFF - TUNE - OPERATE	OPERATE
PLATE Switch	ON
Band Switch	BAND 1
DRIVER TUNE	properly adjusted
PA TUNE	properly adjusted
Converter-Oscillator CV-731/URC	
OPERATE TUNE	OPERATE
Amplifier-Converter-Modulator AM-2064/URC	
SSB-AM Switch	AM
RECEIVER RF GAIN	properly adjusted
TUNE-LOCAL-EXTERNAL	LOCAL
Meter Switch	RF OUT EXCITER
EXCITER RF GAIN	properly adjusted
SIDETONE Switch	OFF
Converter-Monitor CV-730/URC	
METER MULTR Switch	8 dbm
XMIT-REC-CW TEST Switch	XMIT
MONITOR Switch	USB
BFO Switch	OFF
OSC CONTROL Switch	OFF
OUTPUT	properly adjusted
Amplifier-Control AM-2062/URC	
SIDEBAND SELECTOR	USB
MIC GAIN	properly adjusted

NORMAL READINGS (AM MODE)

Indicator	Indication	
	Modulation (None)	Modulation (Peak)
Antenna Coupler AN/SRA-22		
WATTMETER	125 watts	400 watts
Radio Frequency Amplifier AM-2061/URT		
PLATE CURRENT Meter	300 ma	375 ma
PLATE ON Lamp	ON	ON
Converter-Oscillator CV-731/URC		
AFC Meter	midscale	midscale
Amplifier-Converter-Modulator AM-2064/URC		
Meter positions:		
-90v	40 db	40 db
130v	40 db	40 db
250v	40 db	40 db
RF OUT EXCITER	0	20 db
Converter-Monitor CV-730/URC		
OSC ON Lamp	OFF	OFF
XMIT Lamp	ON	ON
VU (audio level) Meter	-	varies

NOTE: All low-voltage power supply meter readings should be at least 40 db.

Appendix E. Normal Readings (Sheet 4 of 4).

APPENDIX F
MILITARY TO INFORMAL NOMENCLATURE CROSS INDEX

Nomenclature Used in This Book	Informal Nomenclature	Military Identification No.
Amplifier-control	Audio and control	AM-2062/URC
Amplifier-converter-modulator	Sideband generator	AM-2064/URC
Control-power supply	Handset adapter	C-2691/URC
Converter-oscillator	Frequency generator	CV-731/URC
Converter-monitor	CW and FSK unit	CV-730/URC
High-voltage power supply	High-voltage power supply	PP-2153/U
Low-voltage power supply	Low-voltage power supply	PP-2154/U
Signal comparator	Frequency comparator	CM-126/UR
Radio frequency amplifier	Power amplifier	AM-2061/URT