DOCUMENT RESUME

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ABSTRACT

These individualized learning modules on basic troubleshooting skills are one unit in a series of modules for a course in basic electricity and electronics. The course is one of a number of military-developed curriculum packages selected for adaptation to vocational instructional and curriculum development in a civilian setting. Five modules are included in the set: Introduction to Electronic Maintenance: (2) Assembly and Repair Techniques: (3) Introduction to the 6B25 Radio Receiver: (4) Basic Troubleshooting: Radio Frequency and Intermediate Frequency Amplifier: and (5) Basic Troubleshooting: Systems Concept and Navy Documentation. Each module is comprised of individualized lessons. Each lesson follows a typical format including a lesson overview, a list of study resources, the lesson content, a programmed instruction section, and a lesson summary. (Progress checks are provided for each lesson.) (LRA)

Military Curricula for Vocational & Technical Education

CHIEF OF NAVAL EDUCATION AND TRAINING

MARCH 1977

BASIC ELECTRONICS SCHOOL.

MODULES 15 - 19. BASIC TROUBLESHOOTING SKILLS.

STUDY AND PROGRESS CHECK BOOKLET.

THE NATIONAL CENTER
FOR RESEARCH IN VOCATIONAL EDUCATION
THE OHIO STATE UNIVERSITY

MILITARY CURRICULUM MATERIALS

The military-developed curriculum materials in this course package were selected by the National Center for Research in Vocational Education Military Curriculum Project for dissemination to the six regional Curriculum Coordination Centers and other instructional materials agencies. The purpose of disseminating these courses was to make curriculum materials developed by the military more accessible to vocational educators in the civilian setting.

The course materials were acquired, evaluated by project staff and practitioners in the field, and prepared for dissemination. Materials which were specific to the military were deleted, copyrighted materials were either omitted or approval for their use was obtained. These course packages contain curriculum resource materials which can be adapted to support vocational instruction and curriculum development.

Military Curriculum Materials Dissemination Is . . .

an activity to increase the accessibility of military-developed curriculum materials to vocational and technical educators.

This project, funded by the U.S. Office of Education, includes the identification and acquisition of curriculum materials in print form from the Coast Guard, Air Force, Army, Marine Corps and Navy.

Access to military curriculum materials is provided through a "Joint Memorandum of Understanding" between the U.S. Office of Education and the Department of Defense.

The acquired materials are reviewed by staff and subject matter specialists, and courses deemed applicable to vocational and technical education are selected for dissemination.

The National Center for Research in Vocational Education is the U.S. Office of Education's designated representative to acquire the materials and conduct the project activities.

Project Staff:

Wesley E. Budke, Ph.D., Director
National Center Clearinghouse

Shirley A. Chase, Ph.D.
Project Director

What Materials Are Available?

One hundred twenty courses on microfiche (thirteen in paper form) and descriptions of each have been provided to the vocational Curriculum Coordination Centers and other instructional materials agencies for dissemination.

Course materials include programmed instruction, curriculum outlines, instructor guides, student workbooks and technical manuals.

The 120 courses represent the following sixteen vocational subject areas:

Agriculture	Food Service
Aviation	Health
Building & Construction Trades	Heating & Air Conditioning
Clerical Occupations	Machine Shop
Communications	Management & Supervision
Drafting	Meteorology & Navigation
Electronics	Photography
Engine Mechanics	Public Service

The number of courses and the subject areas represented will expand as additional materials with application to vocational and technical education are identified and selected for dissemination.

How Can These Materials Be Obtained?

Contact the Curriculum Coordination Center in your region for information on obtaining materials (e.g., availability and cost). They will respond to your request directly or refer you to an instructional materials agency closer to you.

CURRICULUM COORDINATION CENTERS

EAST CENTRAL
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The National Center Mission Statement

The National Center for Research in Vocational Education's mission is to increase the ability of diverse agencies, institutions, and organizations to solve educational problems relating to individual career planning, preparation, and progression. The National Center fulfills its mission by:

- Generating knowledge through research
- Developing educational programs and products
- Evaluating individual program needs and outcomes
- Installing educational programs and products
- Operating information systems and services
- Conducting leadership development and training programs

FOR FURTHER INFORMATION ABOUT
Military Curriculum Materials
WRITE OR CALL

Program Information Office
The National Center for Research in Vocational Education
The Ohio State University
1960 Kenny Road, Columbus, Ohio 43210
Telephone: 614/486-3655 or Toll Free 800/848-4815 within the continental U.S. (except Ohio)

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Military Curriculum Materials for Vocational and Technical Education

Information and Field Services Division

The National Center for Research in Vocational Education

THIS IS A COMBINED STUDY AND PROGRESS CHECK BOOKLET. IT IS YOURS TO KEEP FOR LATER REFERENCE. RECORD YOUR ANSWERS IN THIS BOOKLET AND IF YOU DESIRE, WRITE IN ANY NOTES THAT MAY HELP YOU UNDERSTAND THE MATERIAL.

8

INTRODUCTION

Having successfully completed modules one through fourteen, you are now ready to concentrate on the kind of electrical/electronic machinery and circuits you will be working on in the Fleet. All of the electrical/electronics ratings have a need to know something about electronic circuits; some need a great deal, and some need very little. Some of the most common electronic circuits are power supplies and amplifiers, so they will be among the first that you will study.

When you complete your shore-based training, you should be able to troubleshoot and maintain the "simple" circuits and have the basic skills and knowledge that will help you to quickly learn how to handle "complex" circuits.

Troubleshooting techniques are simply a matter of using a good, logical approach to problem solving. (Sometimes, even recognizing that there is a problem is a difficult step.) However, logic can only do part of the job. You must gather evidence to make the logic useful. In general, there are two stages: (1) diagnosis and (2) remedy. The first requires knowledge (information) and the second requires skills (use of tools and equipment). This stage of your training is designed to provide a large amount of both.

It will be necessary for you to learn how to use some very sophisticated test equipments and to interpret the information they provide. It will also be necessary that you learn some elegant repair techniques so that you will be able to fix not damage equipment. There will be a good deal of "hands on" learning experience followed by sufficient practice so that you will be able to perform well in the fleet.

You may find tube, solid state, or both types of electronic equipment in the fleet. Since we are moving rapidly toward solid state systems, we will concentrate our efforts in that direction, but the older types of ships and equipment still utilize tube type circuits, so you will probably have to know something about both types.

Probably the most useful source of maintenance information is the technical manual for the equipment, so we will provide for training and practice in the use of this resource to help you make maximum use of it.

The Basic Electronics School was designed to provide training needed by all, or nearly all, of the ratings responsible for electrical and electronic equipment maintenance. You will now be routed through the modules of basic training needed by your particular rating.

The goal of shore-based training is to produce a technician who can "do a job" the day he reports on board his permanent duty station. When you get there, your most important job will be to "keep the gear up"--the Navy way of saying that the equipments you are responsible for are ready to go when needed. You will have to know (a) when your gear is not working, (b) how to find out what's wrong with it, and (c) how to fix it. Your next phase of training will focus on troubleshooting and repair techniques. Experience and practice in the use of tools and test equipment will be provided at every opportunity and there will be many performance tests.

Don't be surprised if you finish a lesson or module without understanding everything there is to know about the subject. A journeyman technician has spent years in learning about his rating and still doesn't know everything about it. You are looking for BASIC understanding.

MODULE FIFTEEN

INTRODUCTION TO ELECTRONICS MAINTENANCE

STUDY AND PROGRESS CHECK BOOKLET

OVERVIEW
MODULE FIFTEEN

Solid State Power Supply Construction and Testing

All electrical or mechanical devices depend on a supply of power (or energy) in some form, and different devices need different amounts of power in different forms. A power supply of some sort is used to provide the right amount in the right form for every unit.

module is designed to provide:

1. The application of some concepts learned in the first fourteen modules.
2. Practice in the use of a multimeter.
3. Practice in the use of an equipment technical manual.
4. Breadboarding and testing a circuit.
5. An introduction to the input-conversion-output (ICO) concept.
6. Practice in performing preventive mainenance steps.

MODULE FIFTEEN

LESSON 1

USING THE SIMPSON-260 AND AN/PSM-4 MULTIMETERS TO MEASURE VOLTAGE, CURRENT, AND RESISTANCE

OVERVIEW
LESSON I

<u>Using the Simpson-260 and AN/PSM-4 Multimeters to Measure Voltage, Current, and Resistance</u>

You have learned to use a Simpson-260 Multimeter to measure E, I, and R in simple circuits. Simpsons are commonly used meters, and your next duty station may be equipped with them. Another multimeter that you should be able to use is the AN/PSM-4. It is very similar to a Simpson, and has only minor differences in scales and controls.

To help you transfer your Simpson training, you will (1) review the Simpson, (2) preview the AN/PSM-4, and (3) operate the AN/PSM-4. The job sheets look like tests but they will not be graded. They are designed to be review and learning sequences, and will be used as such.

In this Lesson, you will

- review the Simpson-260 Multimeter
- preview the AN/PSM-4 Multimeter
- make voltage, current, and resistance measurements with the AN/PSM-4 Multimeter

BEFORE YOU START THIS LESSON, PREVIEW THE LIST OF STUDY RESOURCES ON THE NEXT PAGE.

LIST OF STUDY RESOURCES
LESSON I

<u>Using the Simpson-260 and AN/PSM-4 Multimeters to Measure Voltage, Current, and Resistance</u>

To learn the material in this lesson, you will use

STUDY AND PROGRESS CHECK BOOKLET:

- Experiment, EXP. Fifteen-I-1, "Simpson-260 Multimeter Review: Measuring E, I, and R"
- Operating Instruction, O.I. Fifteen-I, "Operation of the AN/PSM-4 Multimeter"
- Experiment, EXP. Fifteen-I-2, "Using the AN/PSM-4 Multimeter to Measure E, I, and R"

A copy of the AN/PSM-4 Technical Manual is available as an additional resource.

YOU MAY NOW STUDY ANY OR ALL OF THE RESOURCES LISTED ABOVE.

EXPERIMENT
LESSON I
PART I

Simpson-260 Multimeter Review

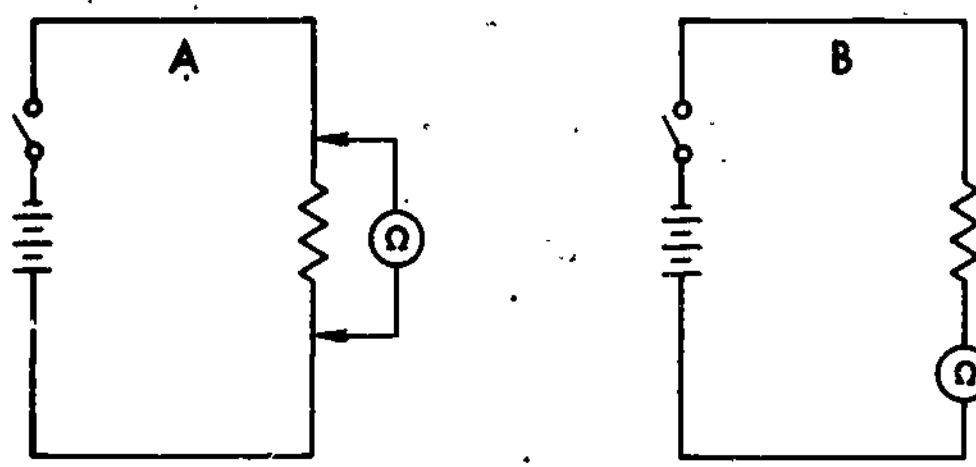
Not all of the Navy's multimeters are Simpson 260's, but if you know the function of each control and how to read the scales you will be able to transfer this knowledge to other multimeters. In Part 1 of this lesson you will be provided a review to refresh your memory of the Simpson 260.

PROCEDURE:

ANSWER THE FOLLOWING QUESTIONS.
WRITE YOUR ANSWERS ON THE EXPERIMENT. ANSWERS TO THIS EXPERIMENT ARE PROVIDED ON ANSWER SHEET A.S. FIFTEEN-I-1, IN THE BACK OF THIS BOOK.

Remember that a multimeter should be connected in series with the circuit or component you are checking when measuring current and in parallel when measuring voltage and resistance.

1. Which of the following illustrations shows an ohmmeter correctly connected to measure resistance?



a. Circuit A
b. Circuit B

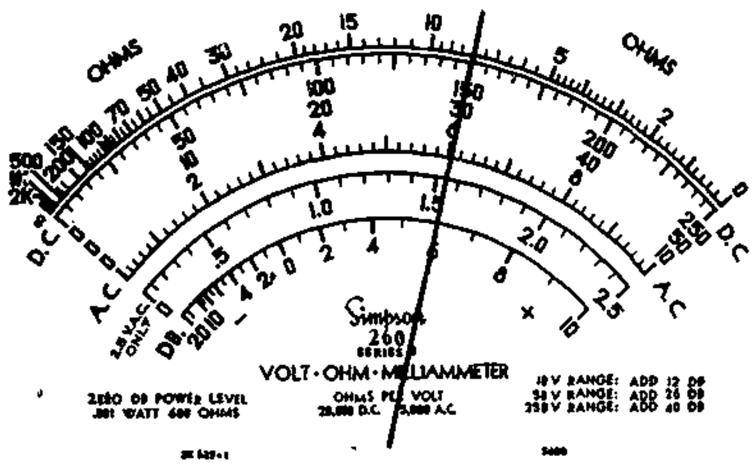
2. For the most accurate reading of a resistance of 1,000 Ω place the range switch on the _______ scale.

a. R x 1
b. R x 100
c. DC
d. R x 10,000

3. To properly use the ohmmeter as an effective aid in troubleshooting equipment;

   a. use the meter only in an upright position.
   b. secure the power to avoid damage to the meter.
   c. make sure the function switch is set to the AC position.
   d. make sure the range switch is on the highest range.

4. With the range selector switch set on the R x 100 position, what ohmic value is indicated in this illustration?

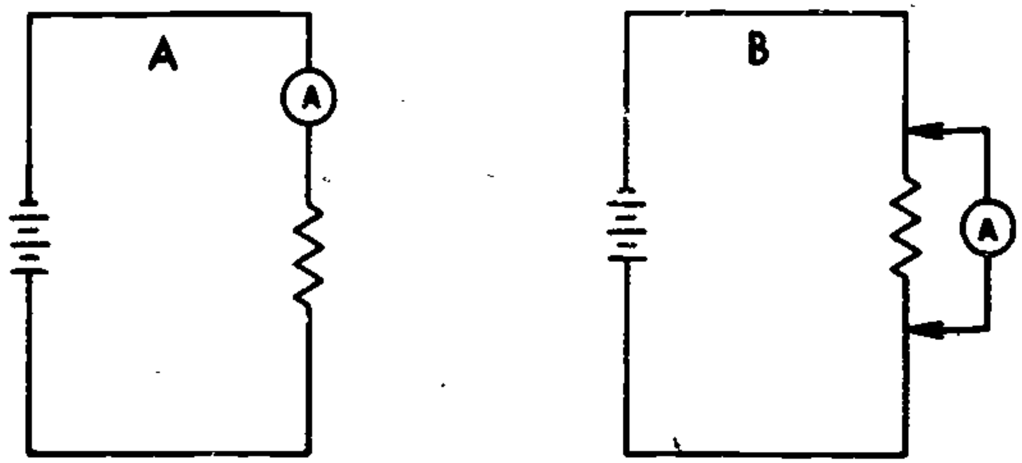


   a. 150 Ω
   b. 80 Ω
   c. 800 Ω
   d. 15000 Ω

5. When changing from one resistance range to another, always:

   a. observe correct polarity.
   b. secure power from equipment.
   c. re-zero the meter.

6. Which of the following illustrations depict an ammeter correctly connected to measure current?



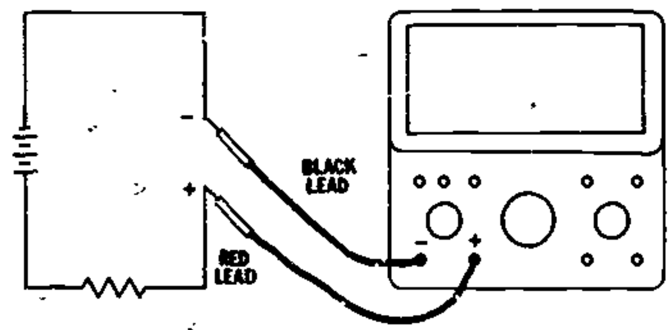
a. Circuit A
b. Circuit B

7. To properly measure current, the ammeter must become:

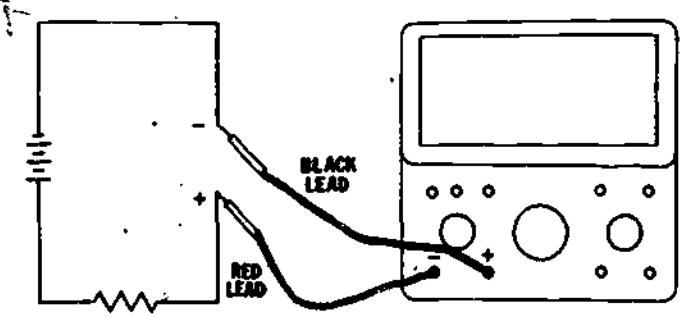
a. a parallel branch of the circuit.
b. a secondary source to the circuit.
c. an actual part of the series circuit.
d. an additional load to the parallel circuit.

8. Which illustration shows the correct meter connections for measuring DC current?

a.

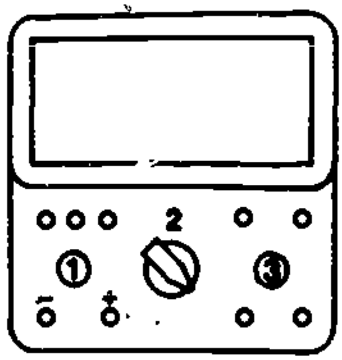


b.



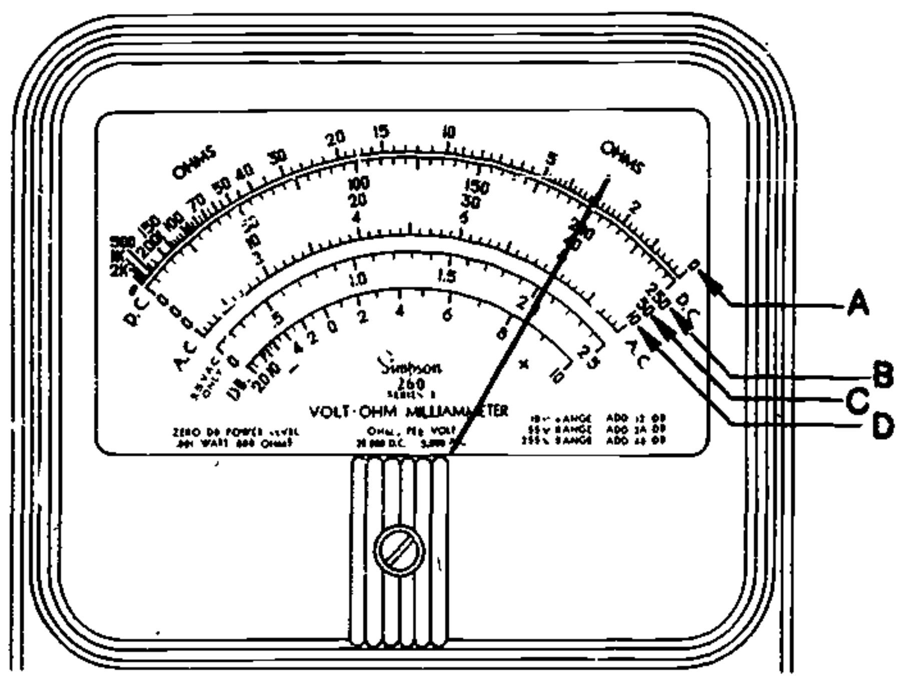
9. To be useful, a meter must be able to measure different values of current. Which number indicates the control used for this purpose?

   a. 1
   b. 2
   c. 3



10. The range selector switch is set on the 10 MA scale. Which meter scale would be used to read current?

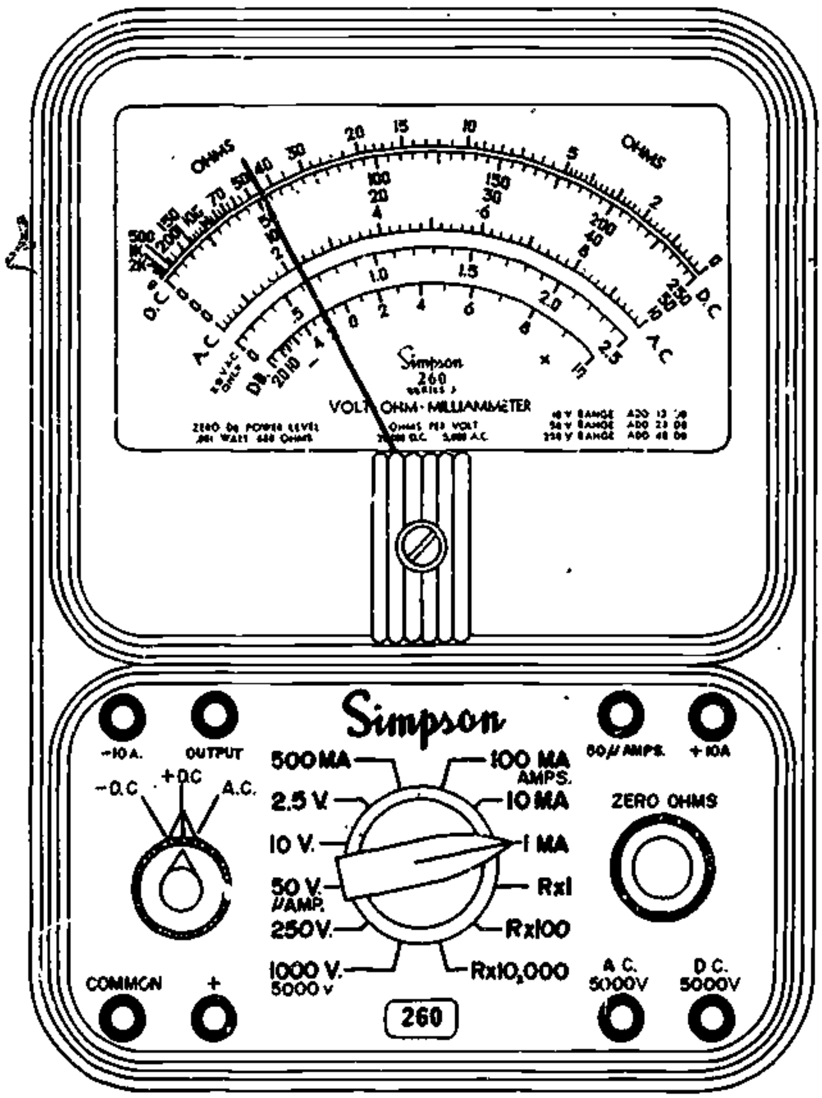
   a. A
   b. B
   c. C
   d. D



11. The range selector switch is set to the 10 MA scale. In the illustration for question #10, what is the indicated current value?

   a. 2 ma.
   b. 8 ma.
   c. 40 ma.
   d. 3 ma.

12. With the meter set up as illustrated, what is the indicated value of current?



a. 52 ma.
b. 110 ma.
c. .21 ma.
d. 2.2 ma.

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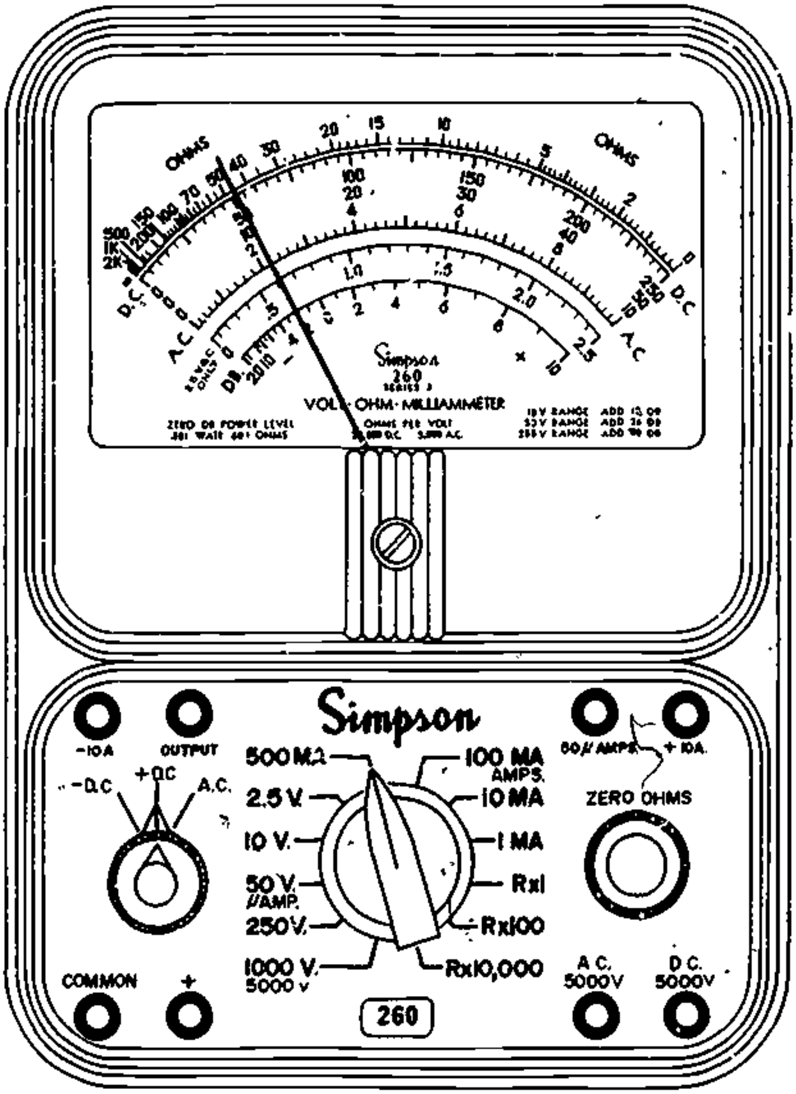
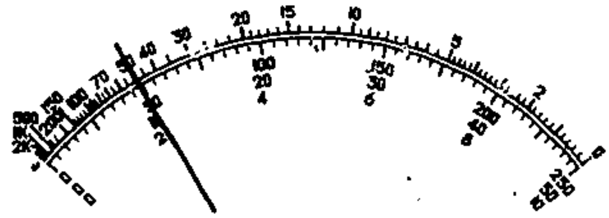
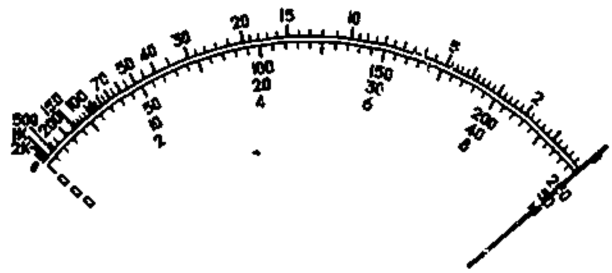
13. With the meter set up as shown, what is the indicated reading?



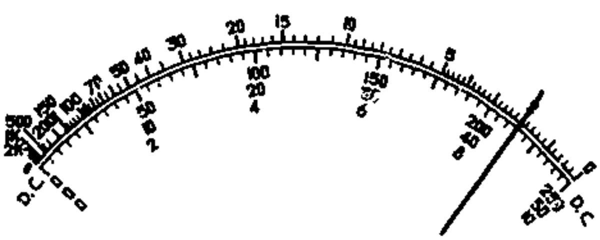
a. 50.5 ma
b. 10.2ma
c. 102 ma
d. 210 ma

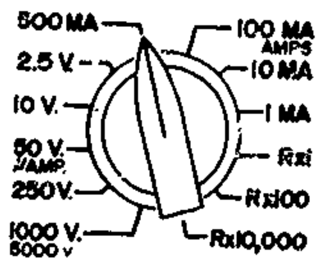
14. Which illustration indicates a current value of 10 µa when using the 50 µamp range?

A


B


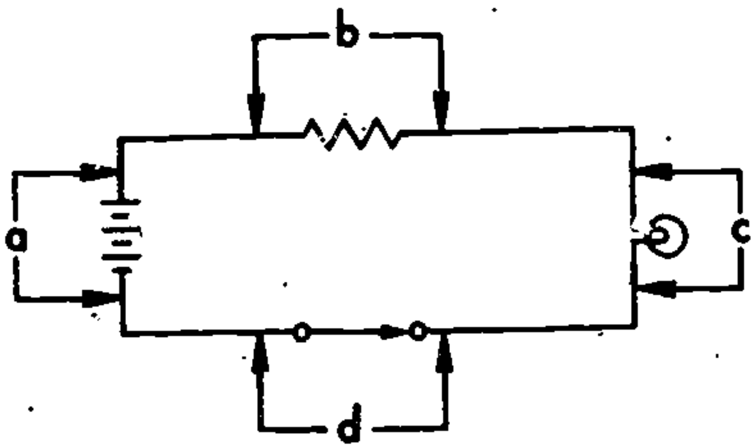
15. What is the current reading indicated below?





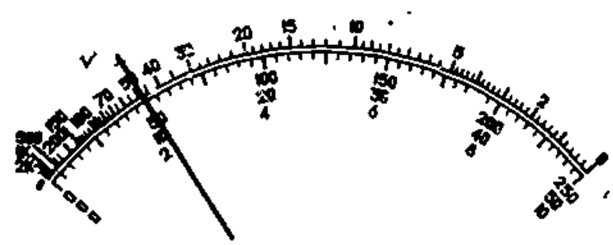
a. 43 ma
b. 430 ma
c. 215 ma
d. 86 ma

16. At what point(s) in the circuit below will a zero voltage drop be measured?

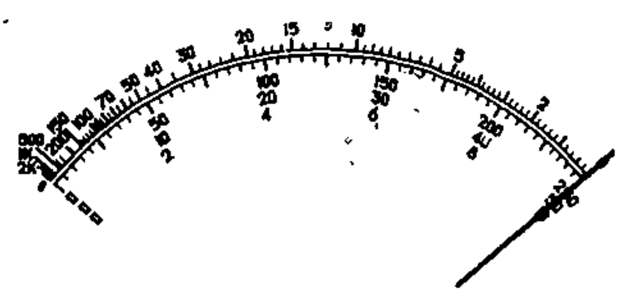


17. With the range switch set at 50V which illustration could indicate a voltage value of 10 volts on the Simpson-260 Meter?

A

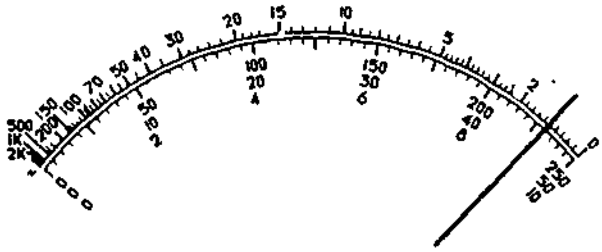


B

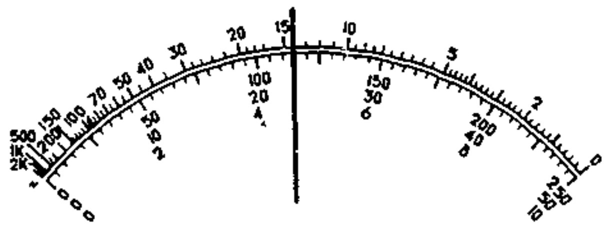


EXP.

18. Which illustration indicates a voltage value of 460 volts on the Simpson-260 when using the 1,000V Scale?

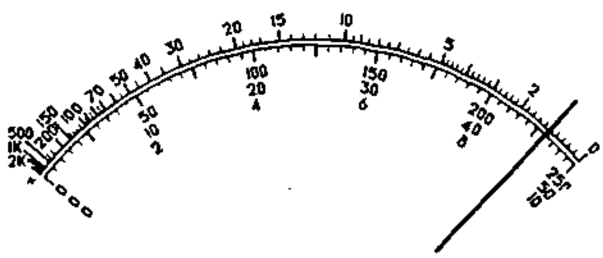


A

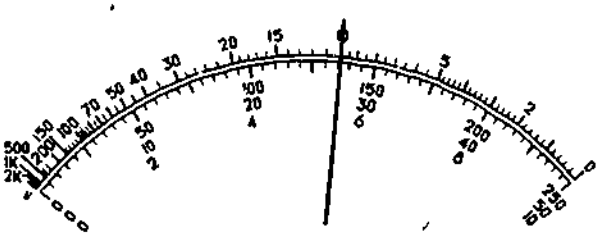


B

19. Which illustration indicates a resistance reading of 10 KΩ on the Simpson-260 when using the R x 10,000?



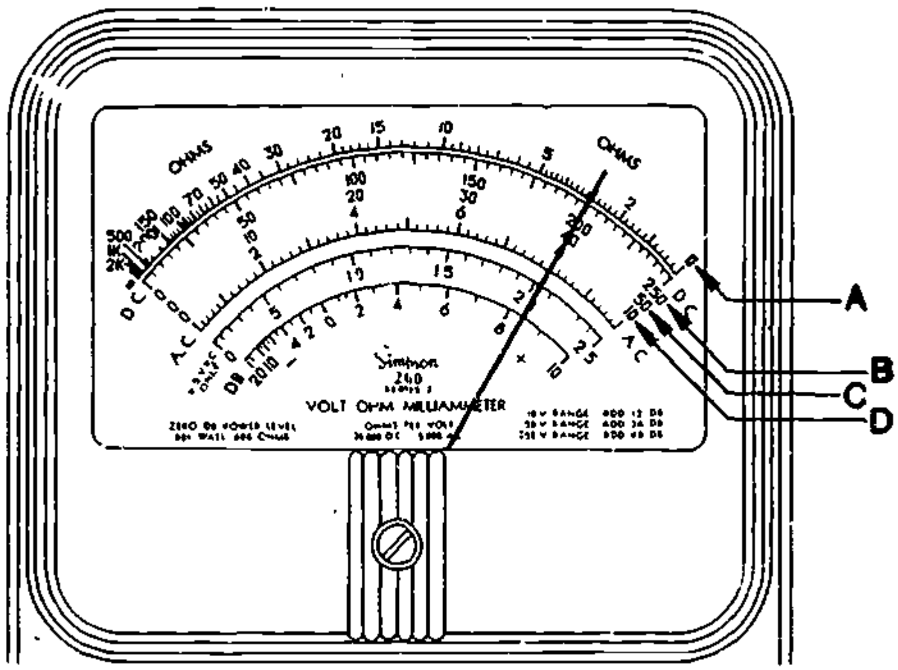
A



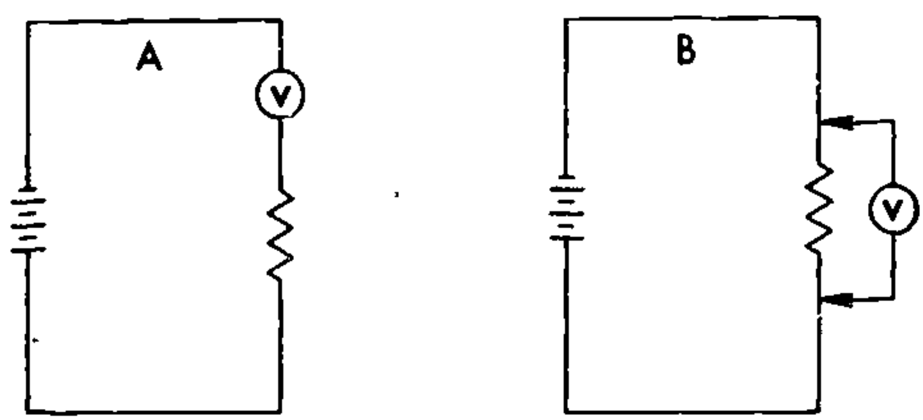
B

20. The range selector switch is set on the R x 100 scale. Which meter scale should you use?

a. A
b. B
c. C
d. D

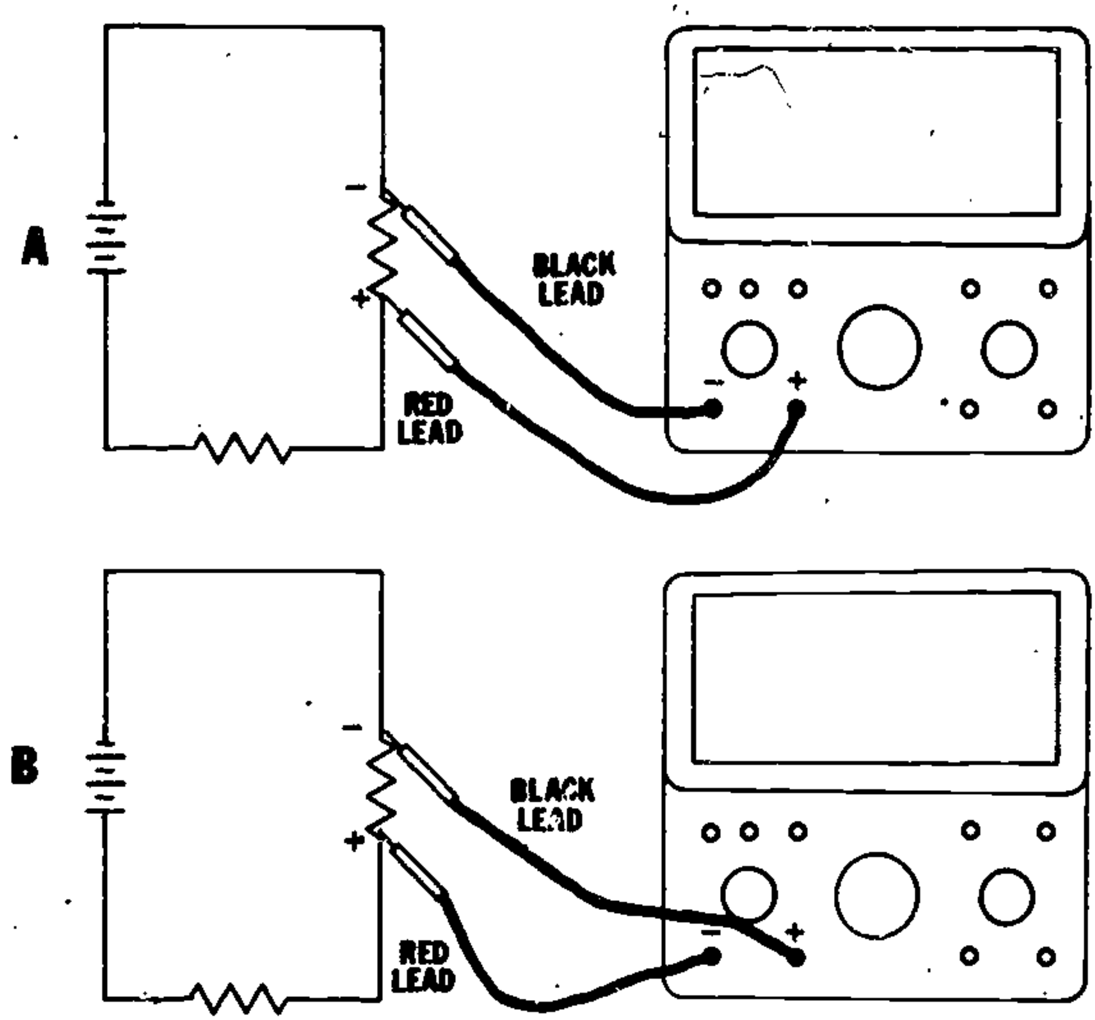


21. Which of the following illustrations depicts a voltmeter correctly connected?



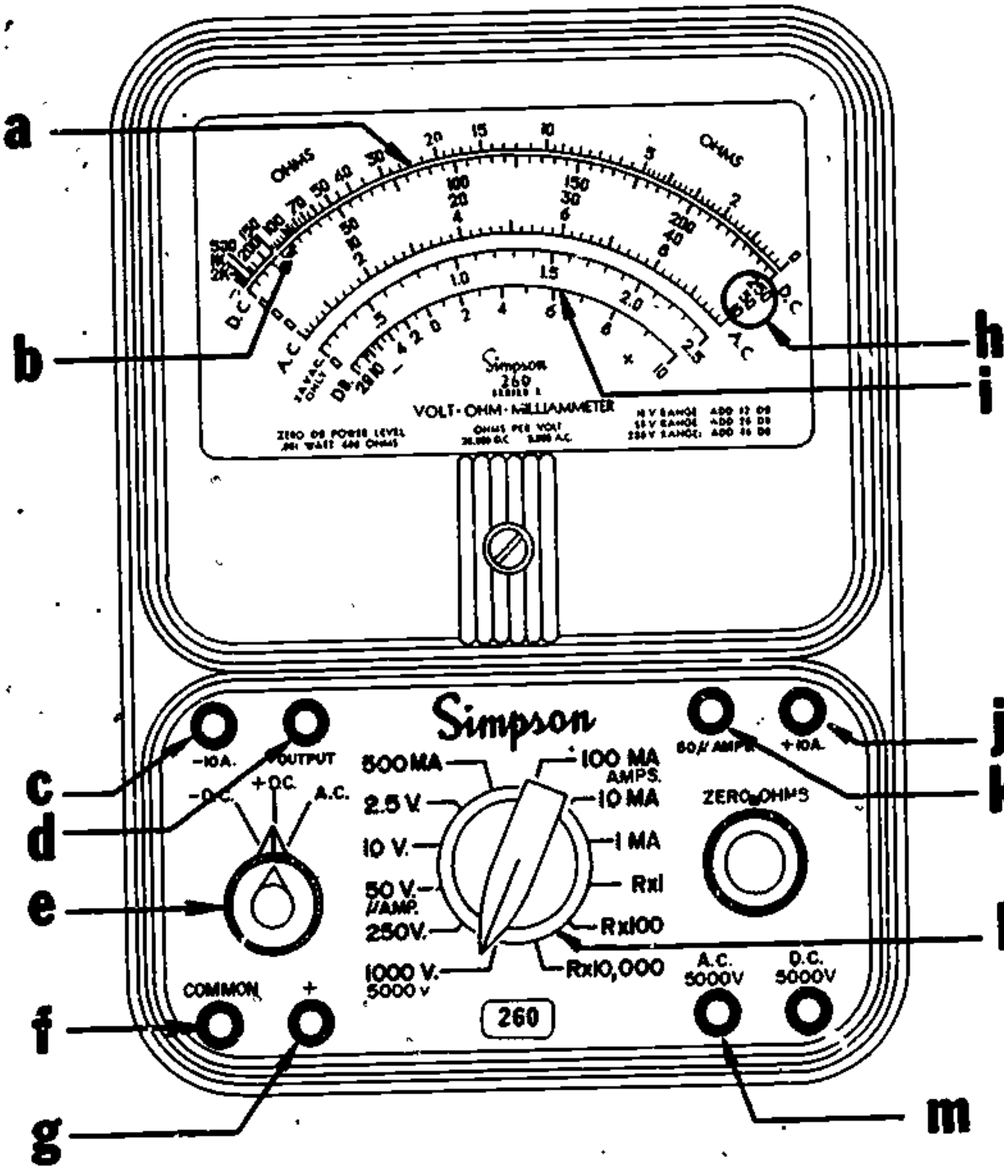
a. Circuit A
b. Circuit B

22. Which drawing shows the multimeter correctly connected for measuring DC voltage?

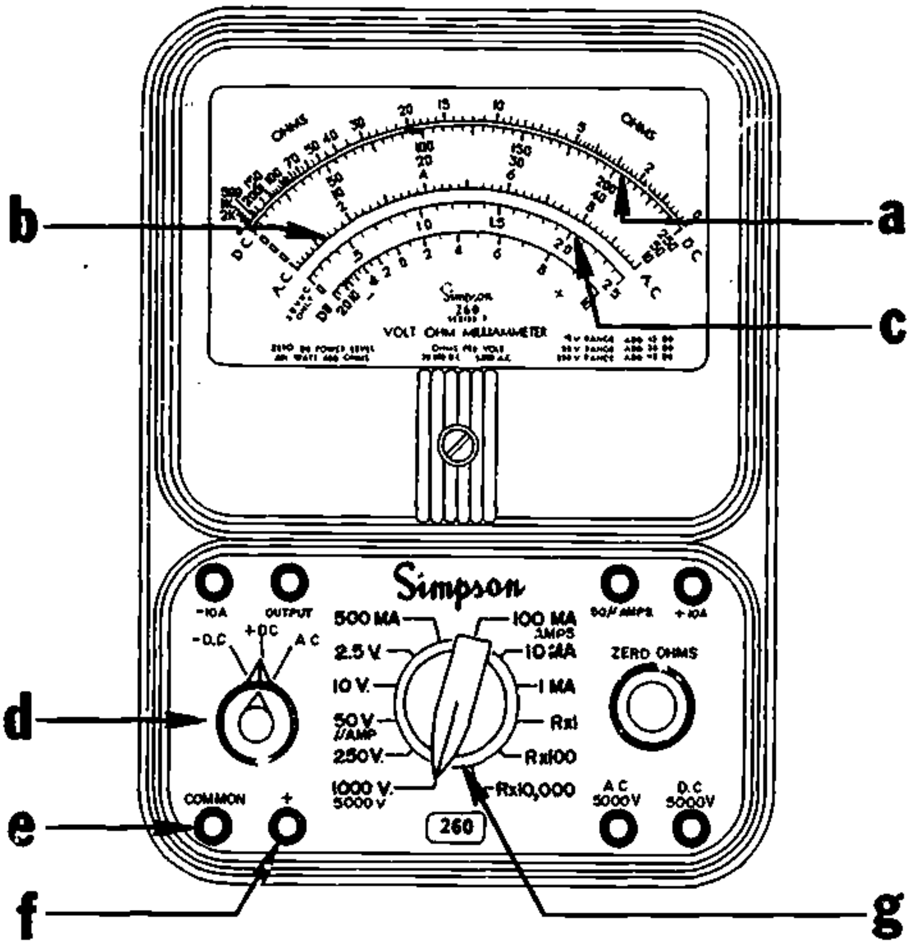


26

23. Circle the letters indicating parts and scales of the multimeter that are used for measuring DC voltage.

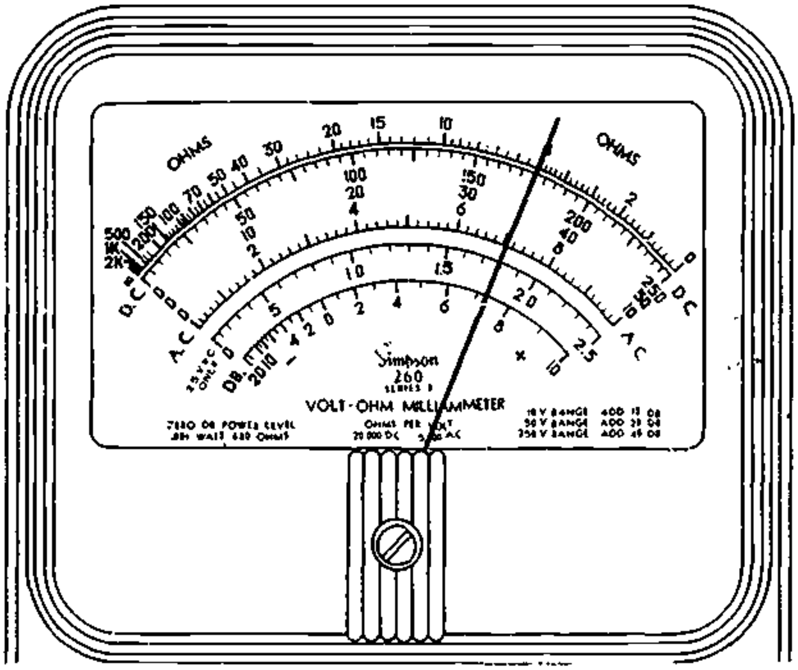


24. The illustration below shows the components and controls associated with the voltmeter function of the Simpson 260-5P Multimeter. Study the illustration and the meter provided, then match the letters to the names of the parts of the multimeter.



____ 1. function switch
____ 2. (+) test jack
____ 3. range switch
____ 4. common (-) jack
____ 5. DC voltage scale
____ 6. AC voltage scale
____ 7. 2.5V AC scale

25. Interpret the meter reading and record the indicated AC voltage for each range switch position. Be as accurate as you can!



1. 10 v Range _____ volts AC
2. 50 v Range _____ volts AC
3. 2.5 v Range ____ volts AC
4. 250 v Range ____ volts AC
5. 1000 v Range ____ volts AC

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO OPERATING INSTRUCTIONS, FIFTEEN-I, IN THIS BOOKLET.

IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR.

OPERATING INSTRUCTIONS
LESSON I

Operation of the AN/PSM-4 Multimeter

The AN/PSM-4 Multimeter is a completely portable volt-ohm-milliammeter. It can be used to measure DC current, DC resistance, and DC and AC voltages. A high voltage probe (included) makes it possible to measure voltages up to 5,000 VDC. This probe contains a warning light to indicate the presence of high voltages.

NOW OBTAIN AN AN/PSM-4 MULTIMETER.

There are three controls on the face of the meter. There is a ten-position rotary switch in the lower left hand corner which is used as a function switch. Five of these positions set up ohmmeter connections within the meter. For these resistance positions the function switch also acts as a range selector. The eight-position switch in the lower right hand corner selects ranges of current and voltage. On this switch the voltage values are written on top and the current values are on the bottom.

To measure DC voltage, the function switch is set to either DIRECT or REVERSE DCV, and the range switch set to the applicable range. REMEMBER, WHEN MEASURING UNKNOWN VALUES OF VOLTAGE AND CURRENT, ALWAYS START AT THE HIGHEST POSITION ON THE RANGE SWITCH.

To measure AC volts the function switch must be set to the ACV position and the range switch to the applicable range. The meter is calibrated to indicate the RMS value of AC voltage.

To measure DC current, the function switch is set to the DC μA/MA/AMPS position and the range switch set to the applicable position.

To measure DC resistance the function switch is set to any of the applicable resistance ranges. When measuring resistance, the range switch has no effect on the measurement and may be placed in any position. NOTE: WHEN MEASURING RESISTANCE, MAKE SURE THE POWER TO THE CIRCUIT IS SECURED.

NOTES:

(1) Insure that the function switch is not set to a resistance position when securing a multimeter.

(2) All measurements should be taken keeping the AN/PSM-4 in a horizontal position.

EXPERIMENT, EXP. FIFTEEN-I-2 IN THIS BOOKLET COVERS THE PERFORMANCE OBJECTIVES FOR THIS LESSON. EXPERIMENTS ARE A PART OF THIS LESSON PROGRESS CHECKS WHICH YOU MAY TAKE AT THIS TIME.

EXPERIMENT
LESSON 1
PART 2

Using the AN/PSM-4 Multimeter to Measure E, I, and R

Materials:

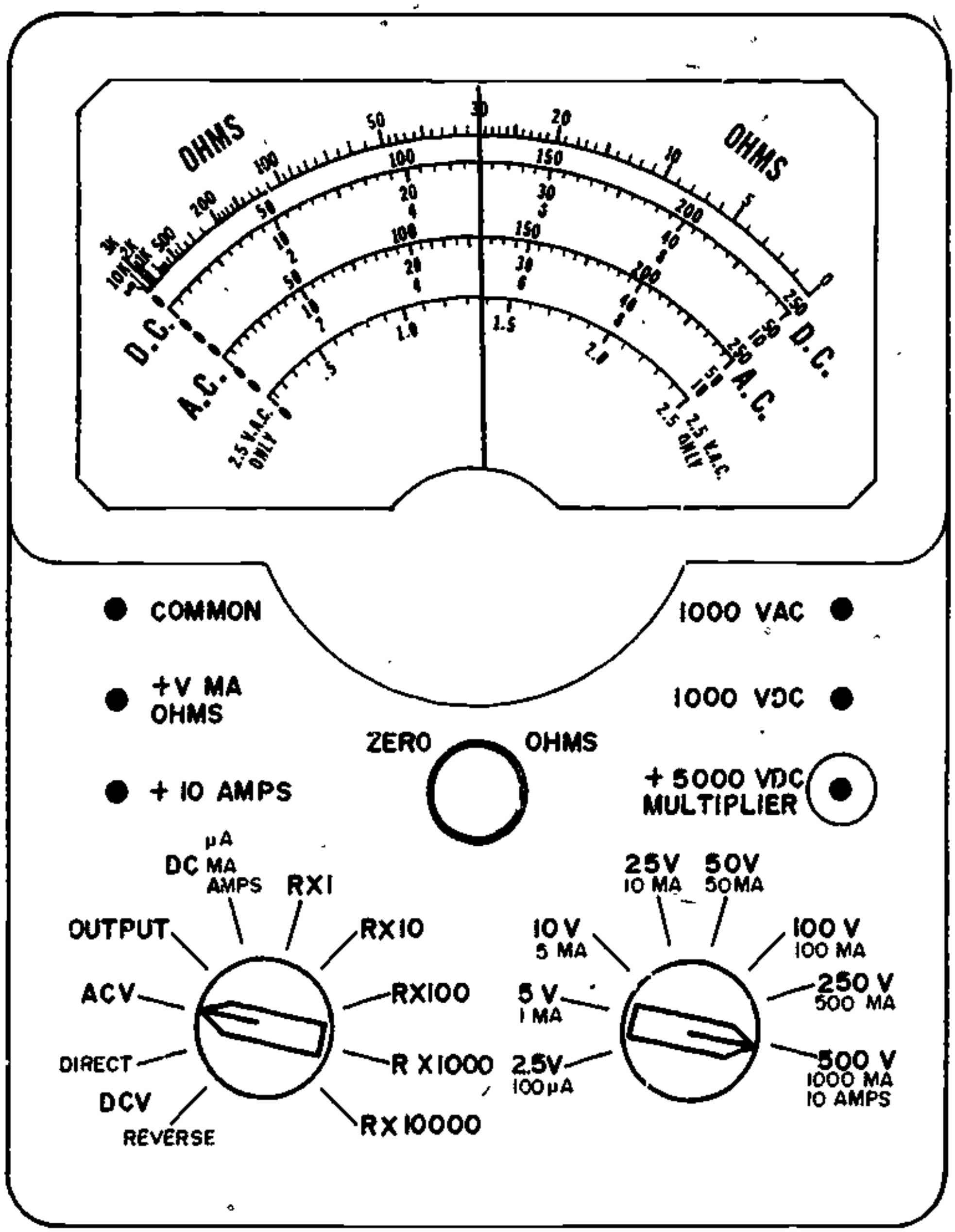
1. AN/PSM-4 Multimeter
2. AN/PSM-4 Multimeter operating instructions
3. NEAT board #1
4. NEAT board #8
5. Exact Model 124 Multigenerator

Procedure:

In this part of the experiment you will be required to answer questions concerning the AN/PSM-4 Multimeter. Note the positions of the range switch, function switch, and the pointer on each illustration to determine the indicated voltage, current, or resistance. You will then use the NEAT board #1 to make in-circuit DC measurements with the AN/PSM-4. Upon completion of this exercise you will use NEAT board #8 and make in-circuit AC measurements with the AN/PSM-4 Multimeter.

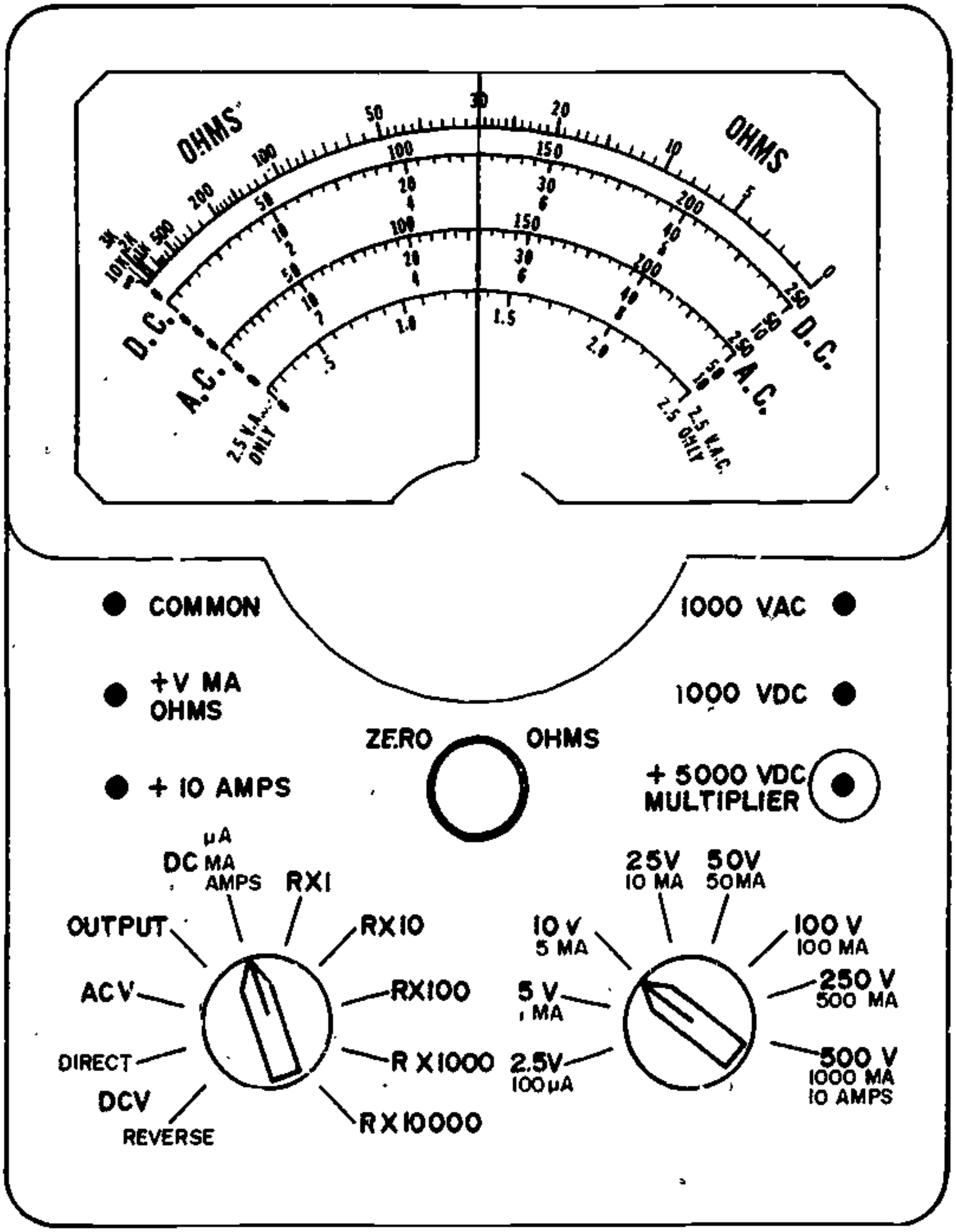
Using the following illustrations determine the value of the voltage, current or resistance as indicated by the position of the range switch, function switch, and pointer. The correct answer will be at the top of the following page.

1


OHMS
OHMS
D.C.
A.C.
D.C.
A.C.
2.5 V.A.C. ONLY
2.5 V.A.C. ONLY
COMMON
+V MA OHMS
+ 10 AMPS
1000 VAC
1000 VDC
+ 5000 VDC MULTIPLIER
ZERO
OHMS
DC μA MA AMPS
RX1
RX10
RX100
R X1000
RX 10000
OUTPUT
ACV
DIRECT
DCV
REVERSE
25V 10 MA
50V 50MA
10 V 5 MA
100 V 100 MA
5 V 1 MA
250 V 500 MA
2.5V 100μA
500 V 1000 MA 10 AMPS

ANS. TO #1: 260 VOLTS A.C.

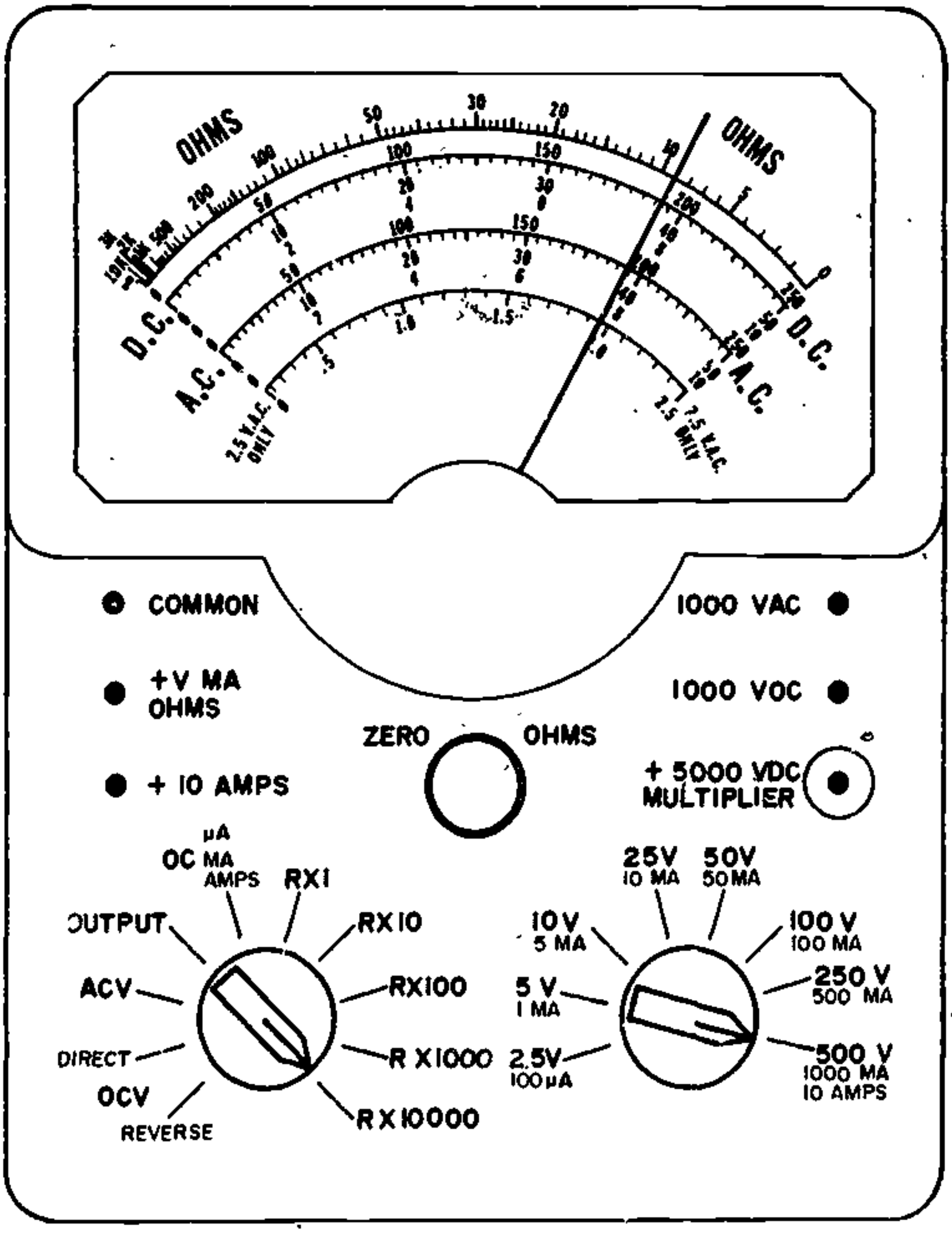
2



33

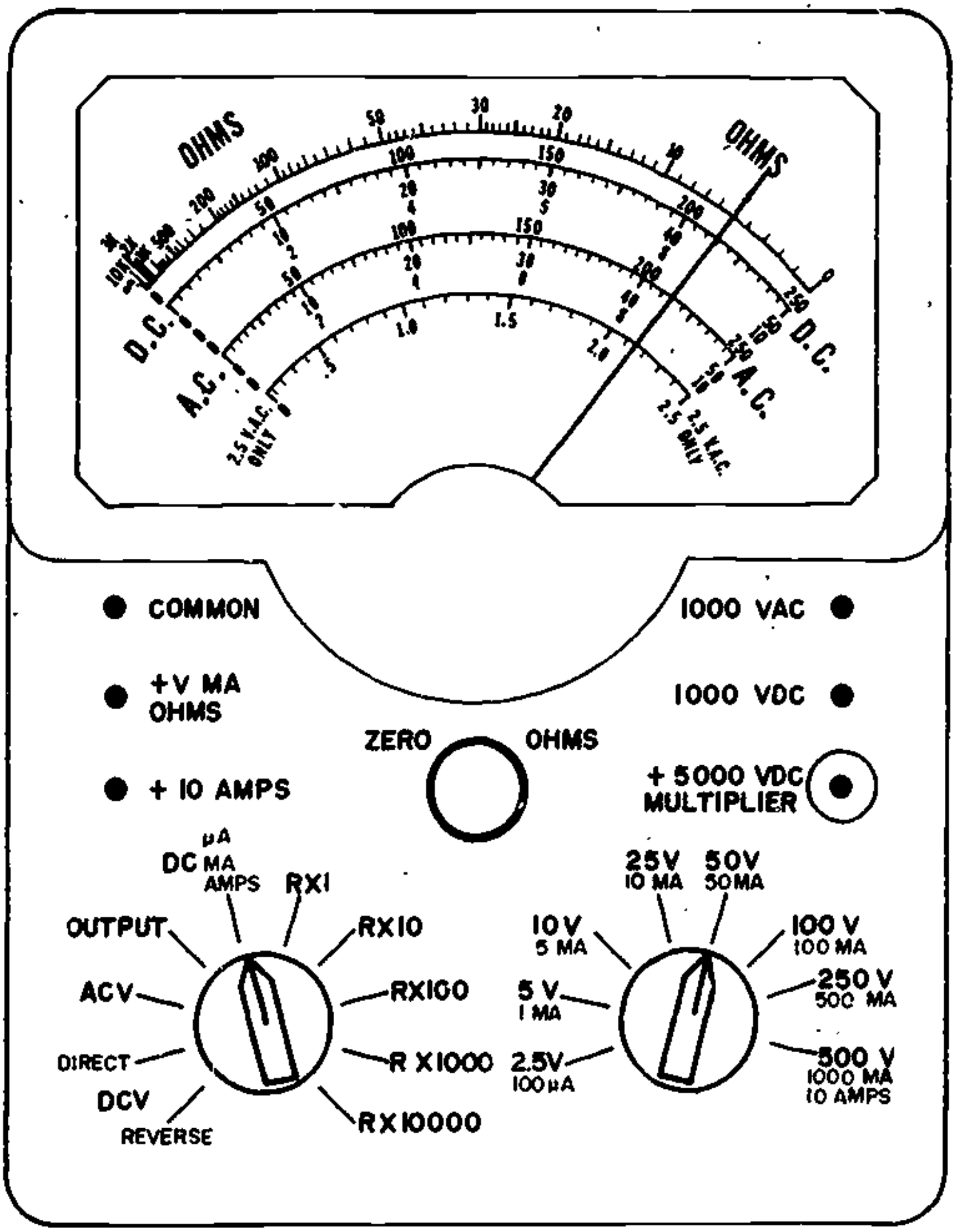
ANS. TO #2: 2.5 MA

3



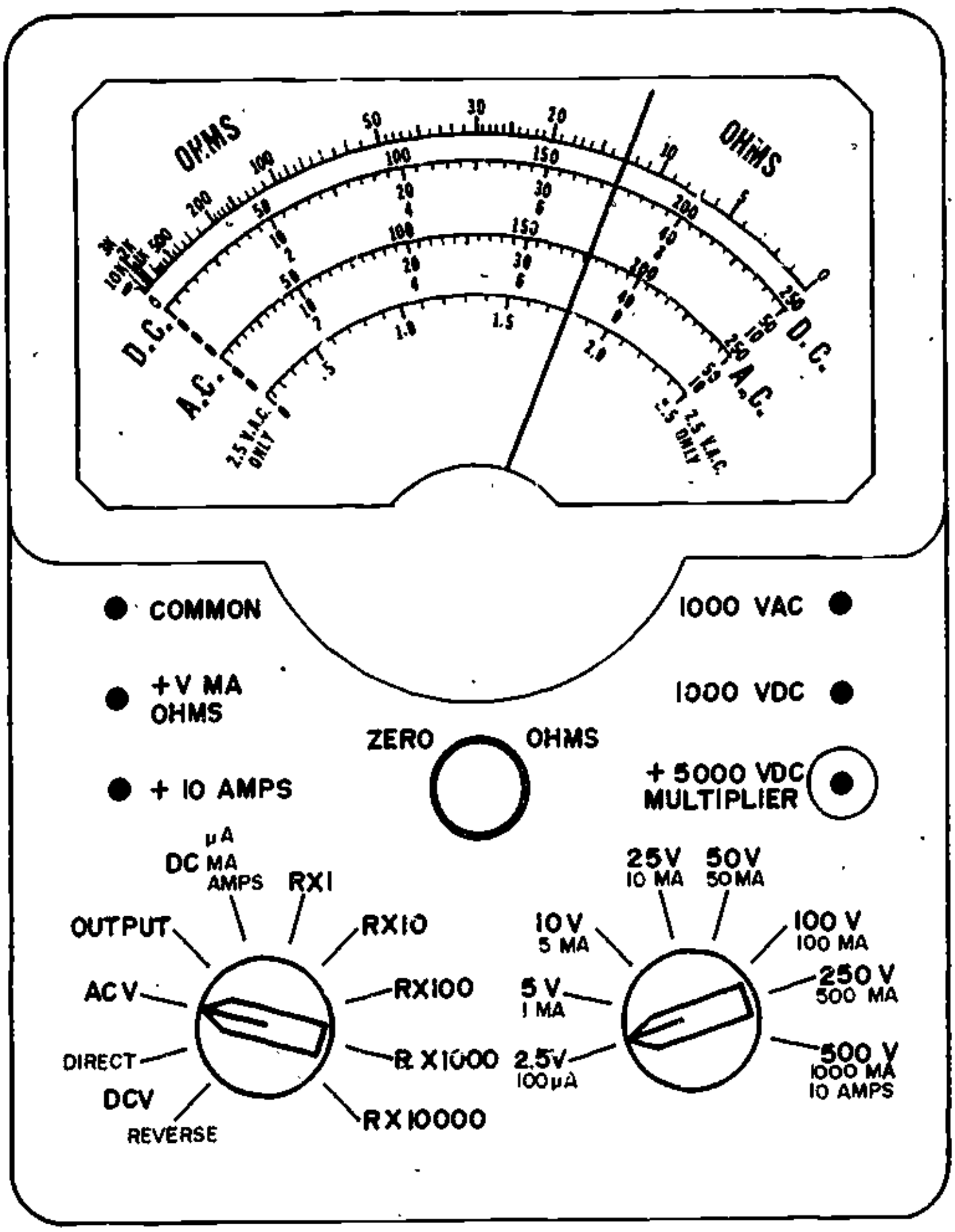
ANS. TO #3: 90KΩ

4



ANS. TO #4: 42.9 MA

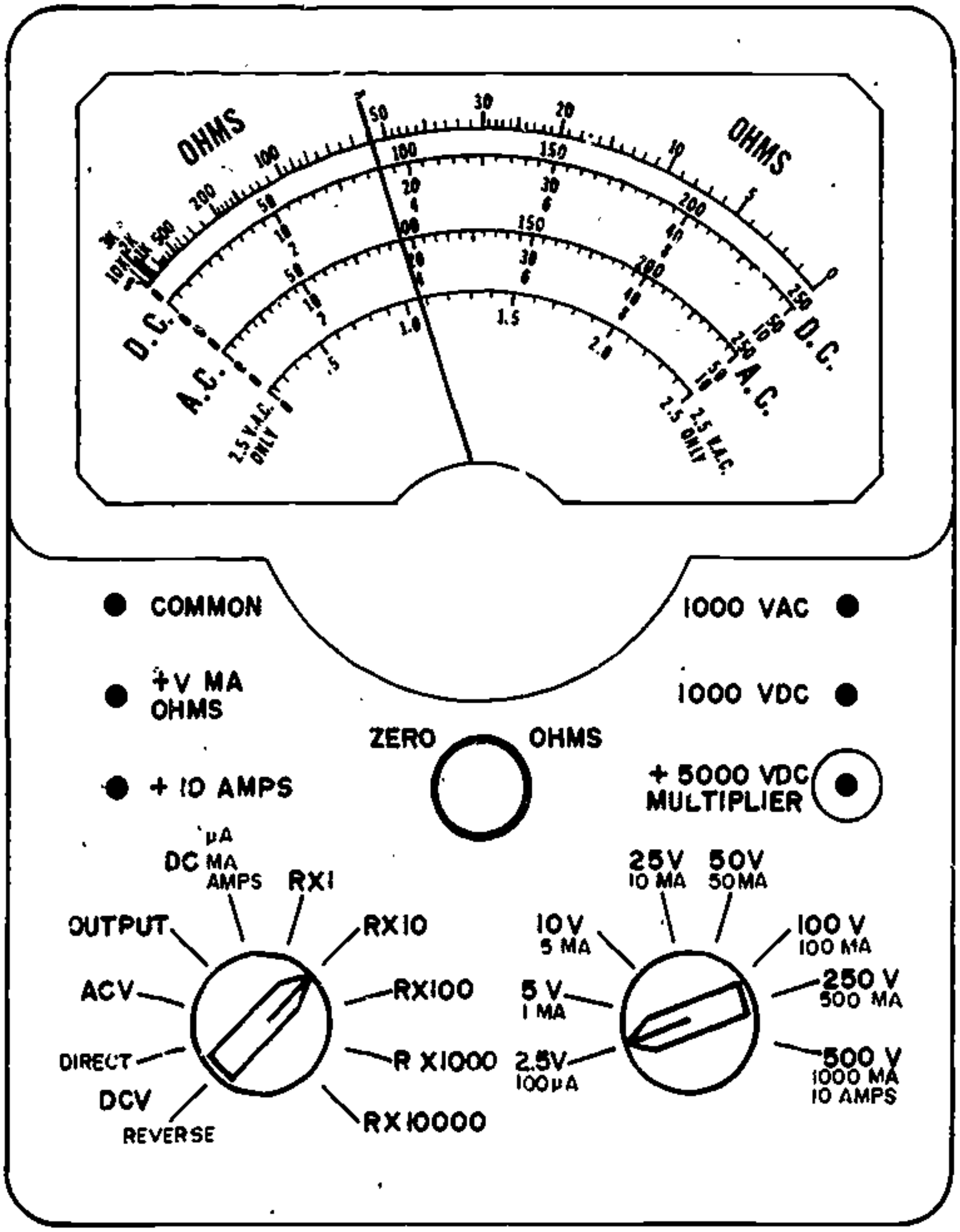
5



36

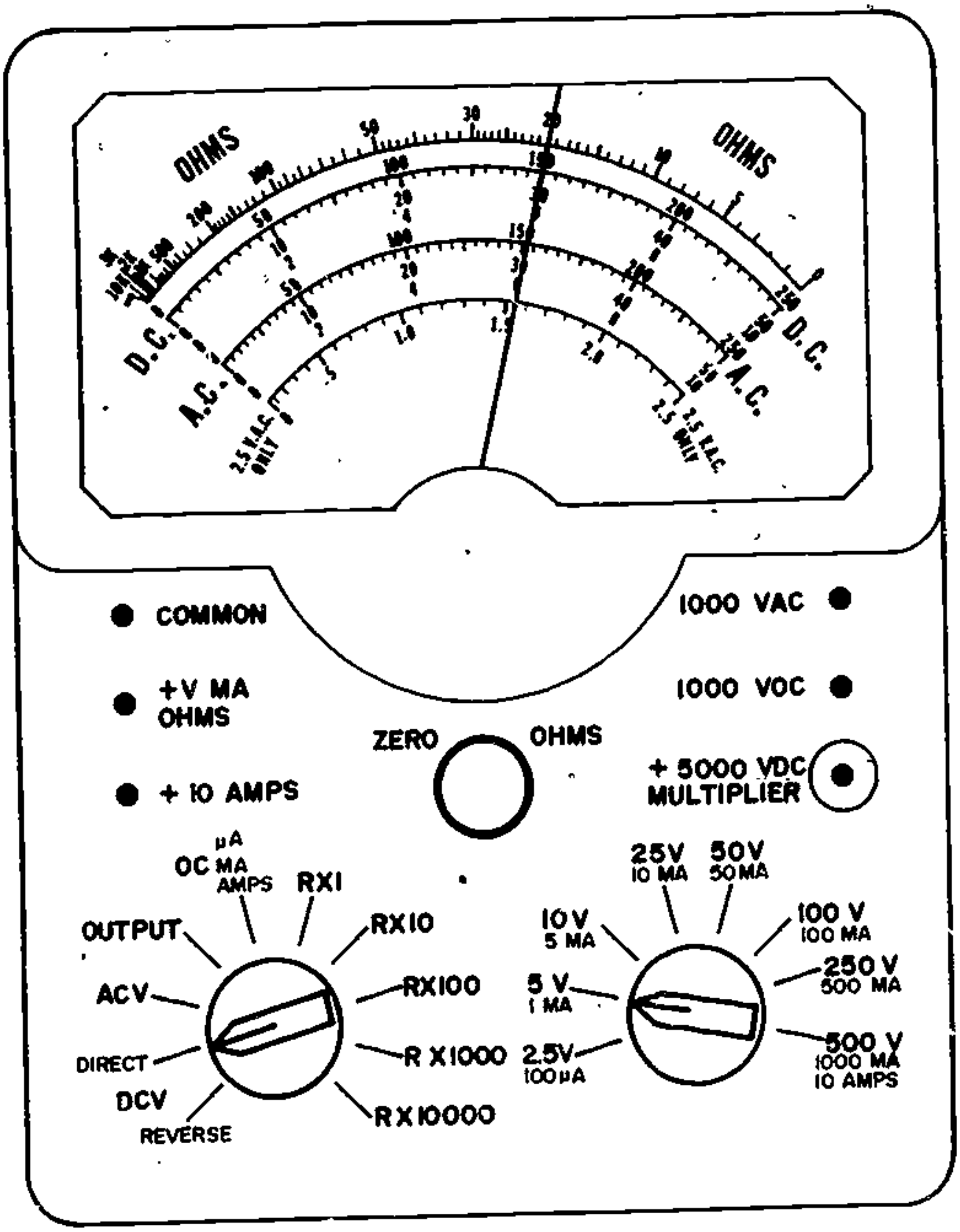
ANS. TO #5: 1.80 VAC

6



ANS. TO #6: 550 ohms

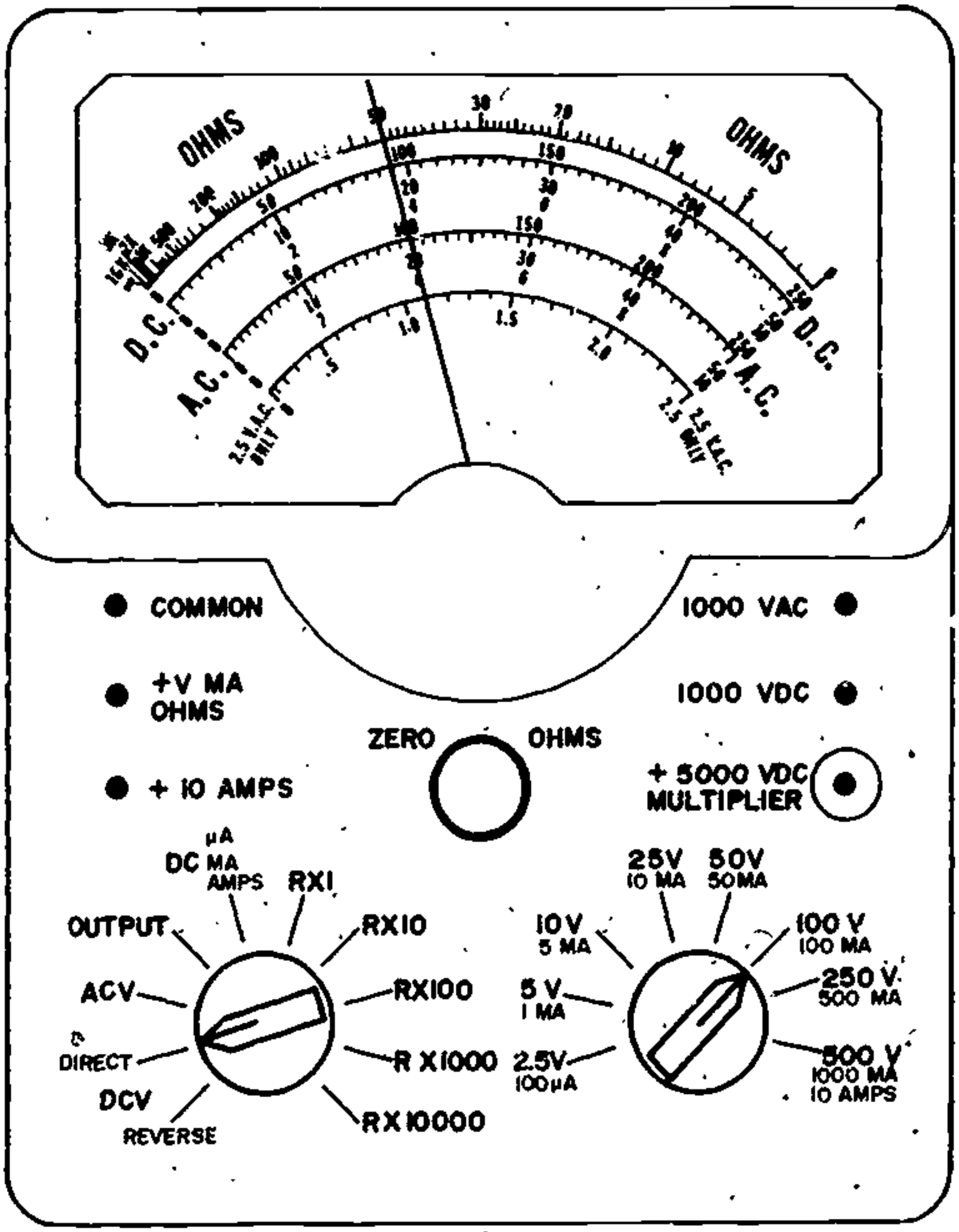
7



38

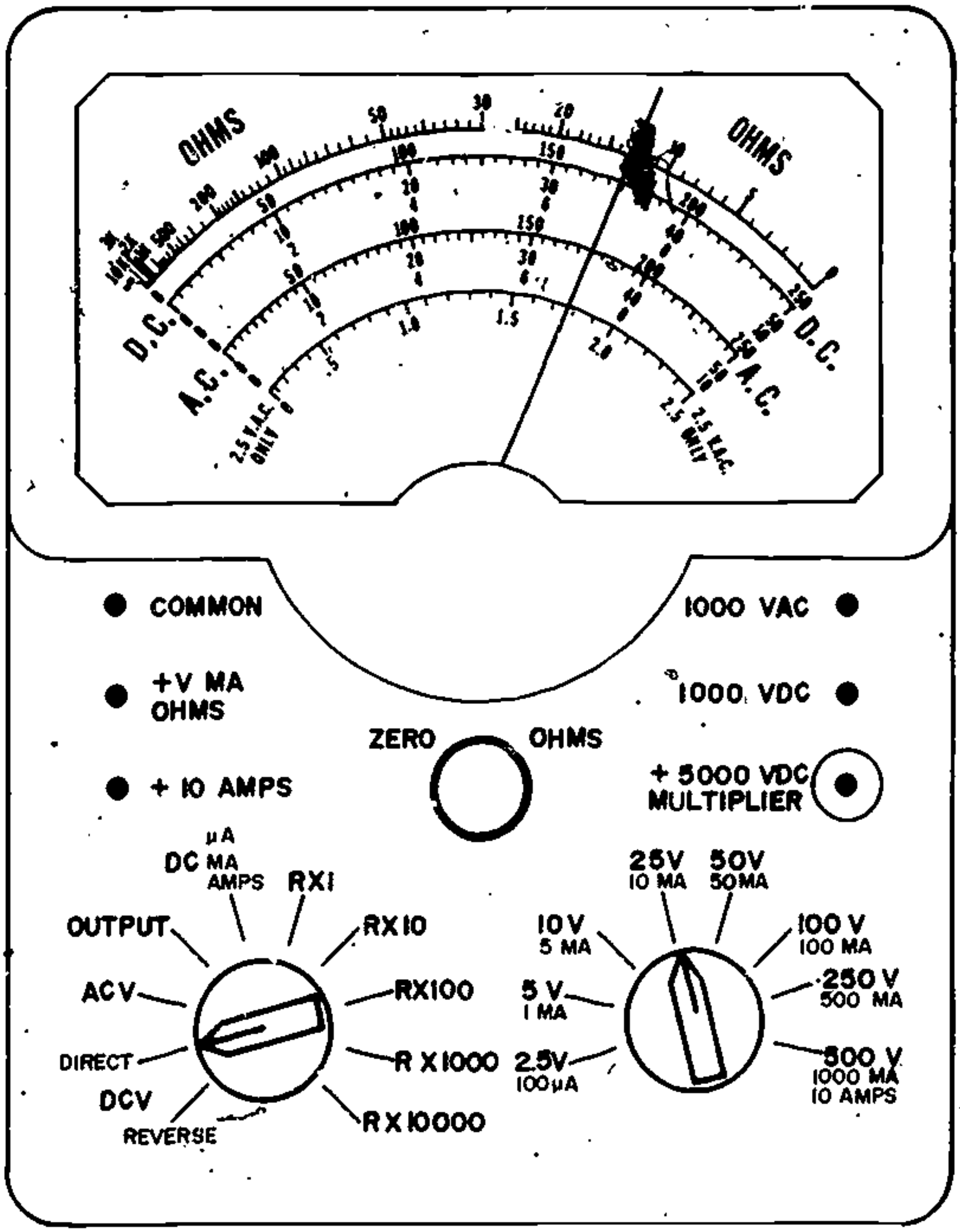
ANS. TO #7: 3.0 VDC

8



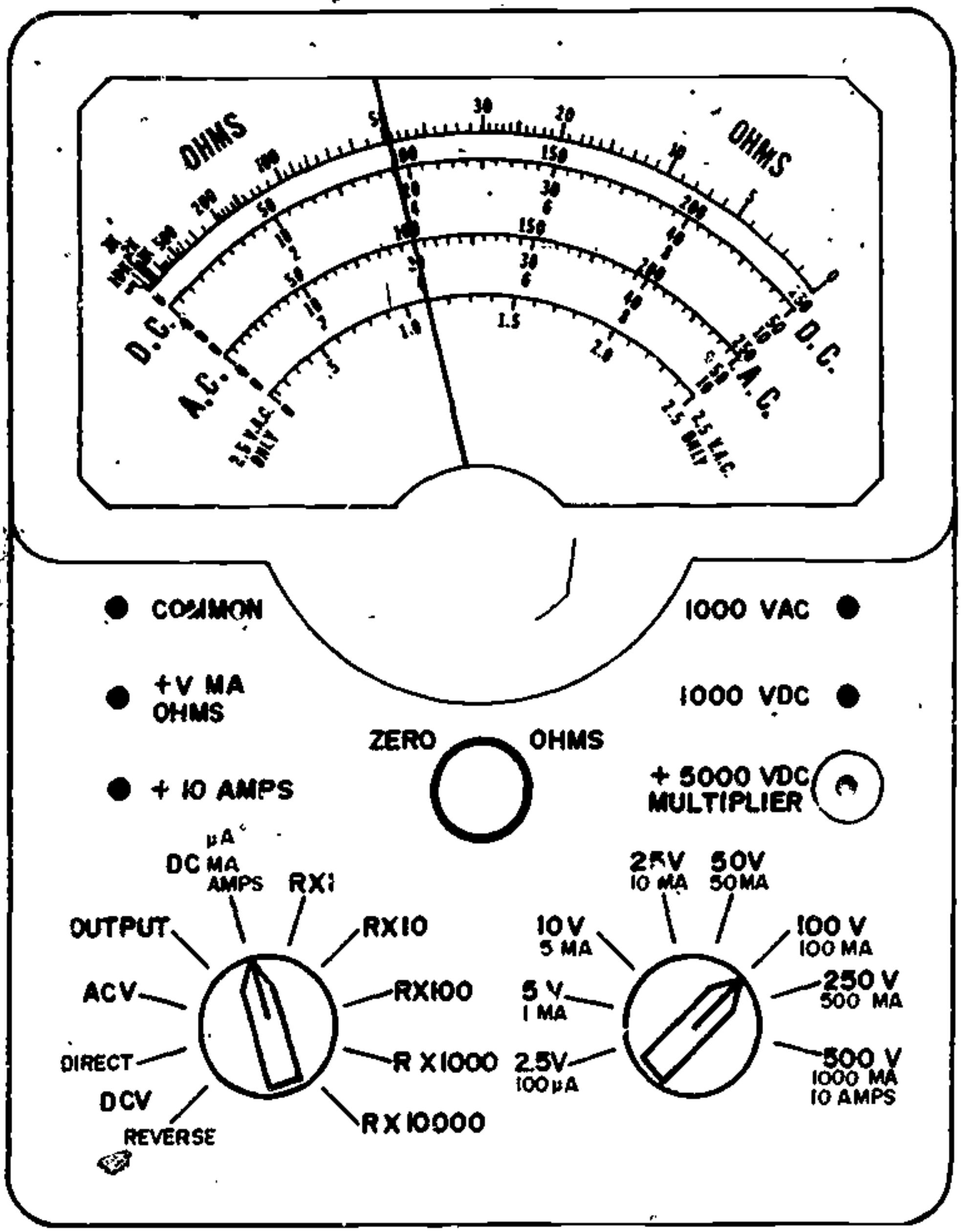
ANS. TO #8: 38 VDC

9



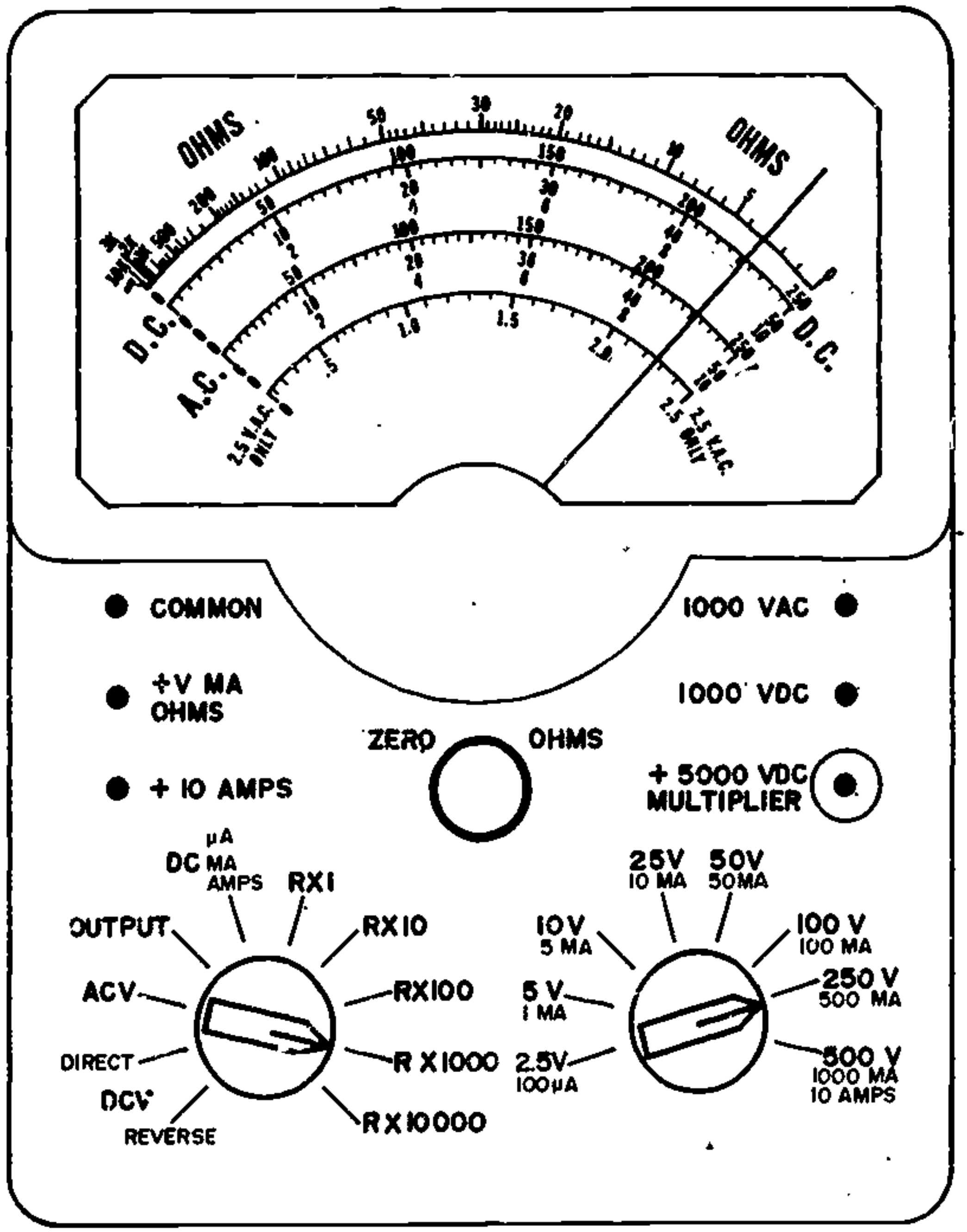
ANS. TO #9: 17.45 VDC

10



ANS. TO #'0: 38.25 MA

11



ANS. TO #11: 3K Ω

GO GET NEAT BOARD #1 AND TAKE IT TO A LABORATORY CARREL TO COMPLETE THIS SECTION OF THE EXPERIMENT.

This part of the experiment will be used to judge your proficiency in using the AN/PSM-4 Multimeter. You will measure voltage, current, and resistance in a series-parallel DC circuit and a series-parallel RLC AC circuit. A tolerance of $\pm 5\%$ accuracy will be expected.

On NEAT Board #1 set up a series-parallel circuit by setting the switches as follows:

S 101 to B 102
S 102 to ON
S 104 to ON
S 105 to A
S 103 to ON

Write the results of each measurement in the blanks provided.

12. Measure the voltage drop across each load resistor. _____ _____ _____

13. Measure the battery voltage. __________

14. Measure the resistance of network R103 and R102. __________

15. Measure the total circuit resistance of the series-parallel circuit. _____

16. Measure the load current of R101. __________

17. Measure the total circuit current. __________

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, COMPLETE THE LAST PART OF THIS EXPERIMENT.

IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR.

On N.E.A.T. Board #8, set up a parallel RLC circuit consisting of C802, L801, R805. Place S-803 in position A.

Using a double BNC connector inject an AC voltage from test output #1 of the junction box into the N.E.A.T. Board. Write the values you measure in the proper blanks.

18. Measure the input voltage with the AN/PSM-4. ____________

19. Remembering Kirchoff's Parallel Voltage Law, should the voltage across the capacitor be the same as voltage in? __________

20. Measure the voltage drop across the capacitor (C802). Connect AN/PSM-4 between TP-804 and TP-805. Note S 802 must be in position M 803.

    ____

21. Measure the following currents. Connect AN/PSM-4 between TP-806 and TP-807.

    I_{line} = ________

    I_C = ________

    I_L = ________

    I_R = ________

22. What would happen to I_{Line} if R803 were placed in the circuit? ______
    ____

23. Set S 803 to position D and measure I_{Line}. Were you right? ________

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO MODULE FIFTEEN LESSON II.

IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR.

MODULE FIFTEEN

LESSON II

INTRODUCTION TO A NAVY TECHNICAL MANUAL

OVERVIEW
LESSON II

Introduction To A Navy Technical Manual

In this lesson you will learn about one of the most valuable books aboard ship. Without a good working knowledge of how, when, and why to use this book, you will probably waste many hours that could be spent, for instance, on LIBERTY. This lesson describes the sections of a technical manual and their function in detail.

BEFORE YOU START THIS LESSON, PREVIEW THE LIST OF STUDY RESOURCES ON THE NEXT PAGE.

LIST OF STUDY RESOURCES
LESSON II

Introduction to a Navy Technical Manual

To learn the material in this lesson, you have the option of choosing, according to your experience and your preferences, any or all of the following:

STUDY AND PROGRESS CHECK BOOKLET:

Lesson Narrative
Lesson Summary
Experiment, Exp. Fifteen-II "Introduction to a Navy Technical Manual"

ENRICHMENT MATERIAL:

EIMB
Equipment Technical Manuals

YOU MAY NOW STUDY ANY OR ALL OF THE RESOURCES LISTED ABOVE. YOU MAY REVIEW PREVIOUS LESSONS IF YOU WISH.

NARRATIVE
LESSON II

Introduction to a Navy Technical Manual

In this lesson you will learn the sections of a standard Navy technical manual and what information is contained in each section. Although there are several types of technical manuals available in the Fleet, we shall cover the seven-part technical manual here, for it seems to be the most popular. The seven parts are:

Section I	General Description
Section II	Installation
Section III	Operation
Section IV	Theory of Operation
Section V	Troubleshooting
Section VI	Maintenance
Section VII	Parts List

Section I - General Description. This section provides a non-technical description of the equipment. It is intended for those who seek a general understanding of the equipment's capabilities, purpose, and intended use. Illustrations show the functional relationships and relative sizes of the basic units. A listing of all equipments, accessories, and documents is included. Dimensions, weight, and volume are given.

Section II - Installation. This section contains a description of everything necessary or useful for installing the equipment. A list of tests and test procedures to insure that the equipment can meet operational requirements is included.

Section III - Operation. This section describes the procedures to be used by a person operating the equipment. The procedures include both routine and emergency operating instructions and safety precautions. Steps to prepare the equipment and complete starting and stopping procedures are described in detail. Tables, charts, and illustrations are usually included as aids for easier understanding.

Section IV - Theory of Operation. This section usually includes a detailed analysis of electronic circuits. Block diagrams are used to show functional relationships and signal flow paths. The functions of circuits and sub-circuits are explained in detail. Component functions are explained in text, charts, tables, and diagrams. Schematic diagrams showing signal flow and component values are included.

Section V - Troubleshooting. This section is intended for the technician responsible for maintenance. It includes troubleshooting guides, diagrams, and procedures. Complete signal tracing instructions are given. Test equipment and special servicing techniques are described. The maintenance schematic diagrams include all circuit elements and major and minor signal paths. Resistance and voltage charts are provided.

Section VI - Maintenance. This section describes the preventative maintenance and performance tests which are required on a scheduled basis. Periodic checks include safety, inspection, cleaning, lubrication, and performance.

Section VII - Parts List. The parts carried on board ship, tender, or ashore are itemized. Manufacturer's part numbers, federal stock numbers, and descriptions of common items are given. Exploded views of units are provided.

All of the sections described can be of great value to you as a technician. Knowing what is contained in which section of this seven part technical manual will help you to use an eight part or a nine part technical manual.

THIS COMPLETES THE NARRATIVE FOR LESSON II, MODULE FIFTEEN. EXPERIMENT EXP. FIFTEEN II IN THIS BOOKLET COVERS THE PERFORMANCE OBJECTIVES FOR THIS LESSON. IF YOU FEEL THAT YOU NEED FURTHER STUDY BEFORE YOU DO THE JOB SHEET, THIS LESSON IS COVERED BY:

SUMMARY

SUMMARY
LESSON 11

Introduction to a Navy Technical Manual

In this lesson, you will be exposed to the seven part Navy technical manual. Although technical manuals may contain more or fewer sections, the seven part is the most common.

The first section - General Description contains a functional description of the equipment. It has illustrations of the unit for physical identification along with dimensions and weight.

Section II - Installation tells you the correct procedures for unpacking, installation, and initial set-up to check the gear for proper operation.

Section III - Operation provides a step-by-step procedure for the operator's efficient use of the equipment. In addition, safety precautions, operating limits, tables and charts for operation are included in this section.

Section IV - Theory of operation gives the reader information on how the components and circuits function. It explains in detail the signal flow. voltage requirements, and Input-Conversion-Output concepts of each unit.

Section V - Troubleshooting can be one of the most useful chapters if utilized properly. It has troubleshooting guides and diagrams, meter readings, resistance measurements, schematic diagrams, wiring diagrams, and troubleshooting flow charts.

Section VI - Maintenance contains the preventive maintenance procedures and performance test instructions required on a scheduled basis. These instructions will help keep equipment failures to a minimum, if followed.

Section VII - Parts List is just what the name implies - a listing of all the parts. It contains a component's description, part number, manufacturer, and stock number.

All in all, these parts make up a valuable tool. One that, if utilized effectively, can be as important to you as your multimeter and oscilloscope.

THIS COMPLETES THE SUMMARY FOR LESSON 11, MODULE FIFTEEN. EXPERIMENT EXP. FIFTEEN 11 IN THIS BOOKLET COVERS THE PERFORMANCE OBJECTIVES FOR THIS LESSON. IF YOU FEEL THAT YOU NEED FURTHER STUDY BEFORE YOU DO THE EXPERIMENT, THIS LESSON IS COVERED BY:

NARRATIVE

"?ERIMENT
.ESSON II

Introduction to a Navy Technical Manual

This experiment will be used to measure your knowledge of the seven section Navy technical manual. You will be asked to locate information in the 6B25 technical manual.

(Write your answers in the spaces provided below.)

1. In which section of the 6B25 Technical Manual can the operating procedures be found?

____

2. What is the figure number of the overall schematic of the 6B25?

____

3. In which section can the audio output specification in watts be found?

____

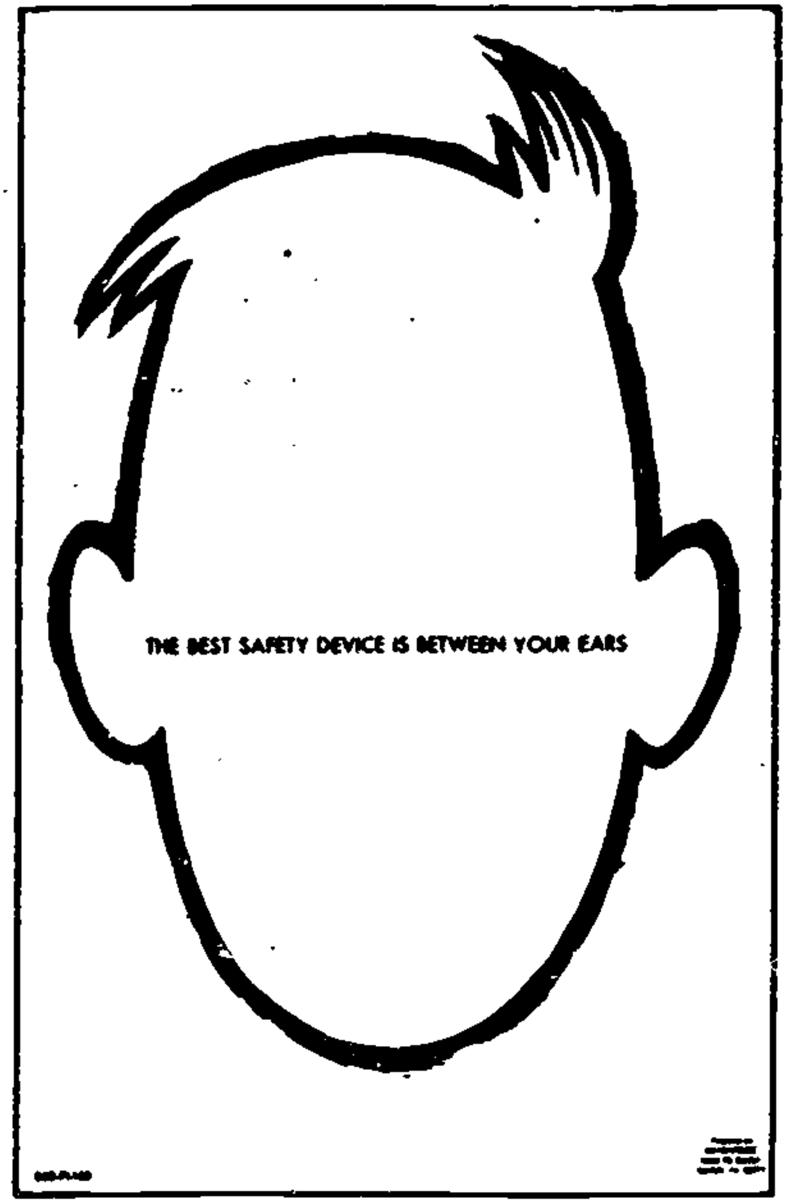
4. Record the manufacturer's part number for Q5.

____

5. In which section can the number of the pin that connects the fuse to the power supply printed circuit board be found?

____

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON FIFTEEN-III.


THE BEST SAFETY DEVICE IS BETWEEN YOUR EARS

MODULE FIFTEEN

LESSON III

PART AND SYMBOL IDENTIFICATION USING THE TECHNICAL MANUAL

OVERVIEW
LESSON III

Part and Symbol Identification Using the Technical Manual

An equipment technical manual or manufacturer's instruction book is usually the best (and sometimes the only) source of equipment information for a technician. In this lesson you will use information from Sections VI and VII of the 6B25 Technical Manual.

In this Lesson, you will:

- -locate and use schematics in the technical manual
- -locate and use pictorials in the technical manual
- -locate and use the part lists in the technical manual
- -learn new schematic symbols and correlate the symbols to physical components.

BEFORE YOU START THIS LESSON, PREVIEW THE LIST OF STUDY RESOURCES ON THE NEXT PAGE.

LIST OF STUDY RESOURCES
LESSON III

Part and Symbol Identification Using the Technical Manual

To learn the material in this Lesson you will need the following in your carrel:

STUDY AND PROGRESS CHECK BOOKLET:
Lesson Narrative
Experiment, EXP. Fifteen-III "Part and Symbol Identification Using the Technical Manual"

TECHNICAL MANUAL:
6B25 Radio Receiver

NOTE: Your learning center is equipped with some supplementary reference material that you may find helpful. Three very useful references are:

Electronics & Nucleonics Dictionary
Electronics Installation and Maintenance Books (EIMB)
Basic Electronics, NAVPERS 10087C, Vol I & II

The Electronics Dictionary is a convenient and accurate source of definitions.

The EIMB is a source, in several volumes, of a wide range of information and Navy policy regarding electronics.

Basic Electronics is a Navy Training Manual which provides a clear and easy means for understanding the basics of electronics circuits and components.

YOU MAY NOW STUDY ANY OR ALL OF THE RESOURCES LISTED ABOVE.

NARRATIVE
LESSON III

Part and Symbol Identification Using the Technical Manual

In this module, you will assemble and test a power supply on a "breadboard." In order to do this accurately and with understanding, you must first be able to identify schematic symbols and then correlate these symbols to the actual physical components. The primary aid in accomplishing this task is the Technical Manual.

The Technical Manual is composed of several sections. The major titles of each section can be found in the Table of Contents located in front of your technical manual. A list of figures and tables can also be found in the Table of Contents.

At this point it is suggested that you leaf through your technical manual noting the major headings, figures, and tables of each section as listed in the Table of Contents. Thumb through the manual to get a feel of how it is generally laid out. Not all Navy technical manuals are arranged exactly the same way. There may be more or fewer sections and the titles may differ somewhat, but the 6825 Technical Manual is very similar to what you will see in the Fleet. The section on "General Maintenance" in the E.I.M.B. contains the recommended format for standard Navy technical manuals.

Now that you are familar with the general organization of the technical manual it is time to put the technical manual to use. Turn to Section VI, figure 6-7, in your technical manual. This figure is the overall schematic diagram of the 6825 Radio Receiver. This schematic ties all of the components (resistors, capacitors, diodes, etc) into stages, such as the push-pull amplifier stage or detector stage. The schematic then ties the stages into sections, such as the RF Amplifier/Converter section; and finally ties these sections together into the 6825 Receiver System. A system schematic is organized so that signal flow is easy to follow, so the schematic will not necessarily be identical to the actual physical layout. The schematic does not indicate on which printed circuit card the component is located or even its physical location with respect to the other components.

Now locate the power supply section on the schematic. The numbers in parentheses [(1), (2), and (3)] indicate that they are tied directly to other points on the schematic with the same number in parentheses. The numbers within a circle ① indicate testpoints. Look at the input of the power supply section. The input is at the lower left hand corner of the schematic. Note that S1 (a switch), F1 (a fuse), and DS1 (an indicator light) make up part of the input circuitry.

Now turn to figure 6-2 of the technical manual. This figure has two parts: a schematic diagram of the parts actually on the power supply printed circuit card; and a pictorial of the components as they are physically mounted on the card. Note that S1, F1, and DS1 do not appear in either part of this figure. This is because these three components are physically located on the chassis. Also note that there are no particular similarities between a component's position in the schematic diagram and that component's physical position on the printed circuit card shown in the pictorial.

It is now time to correlate a schematic symbol to the physical component. For example, look at component C23. The circuit designator "C" indicates that it is a capacitor. Find C23 on your schematic diagram. Notice that capacitors are indicated on the schematic by the symbol —)|—+. Also notice that the symbol contains a small plus sign. This sign indicates the positive side of an electrolytic capacitor. You should also notice that the value of the capacitor is written beside the symbol indicating that it has a value of 100 µf (one hundred microfarads). Now find C23 on the pictorial. From the pictorial you should gain some idea as to the physical size, shape, and location of the component. For information on additional electronic symbols see Appendix VII of Basic Electronics. (See List of Study Resources).

More detailed information about the component can be found in Section VII, Table 7-1, the Part Listing. Here its nomenclature, function, circuit designation, value, and part number can generally be found. Any component or test point can be found in the above described manner. A further aid to component location may be found in Section VI, figure 6-6, Chassis Wiring Diagram. This diagram shows the interconnecting wiring between each printed circuit card. It also shows connections to components mounted on the chassis.

THIS COMPLETES THE NARRATIVE FOR LESSON III, MODULE FIFTEEN. EXPERIMENT EXP. FIFTEEN III IN THIS BOOKLET COVERS THE PERFORMANCE OBJECTIVES FOR THIS LESSON. EXPERIMENTS ARE A PART OF THE LESSON PROGRESS CHECKS WHICH YOU MAY TAKE AT ANY TIME.

EXPERIMENT
LESSON III

Part and Symbol Identification Using the Technical Manual

This experiment will be used to measure your ability to correlate component parts to schematic symbols. You are expected to complete this assignment with 100% accuracy.

For this exercise you will need:

1. 6B25 Technical Manual
2. Power Supply Breadboard Kit
3. Module Fifteen-III Narrative

See your learning supervisor for any listed item that you do not already have.

INSTRUCTIONS:

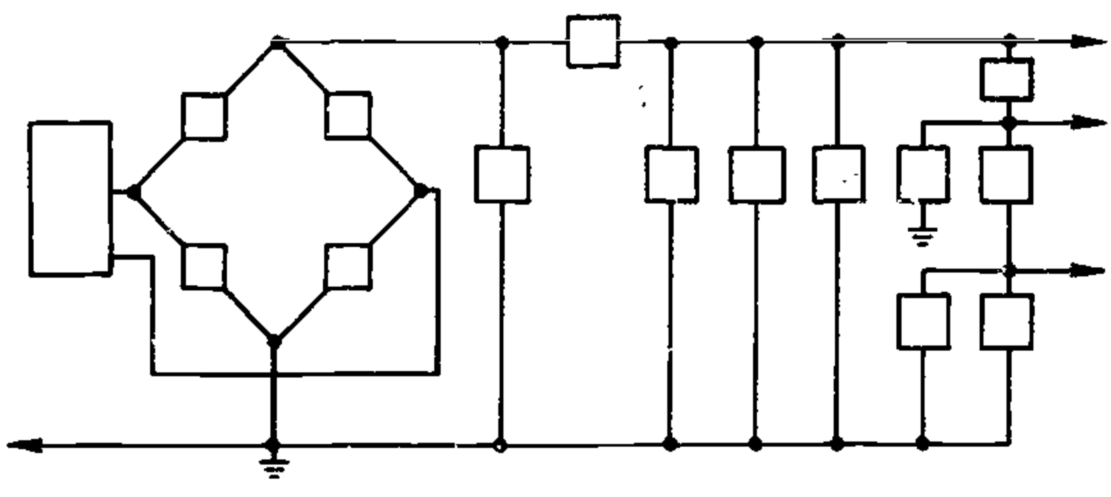
1. Count the number of components in your breadboard kit. There should be a total of fifteen components including the one already mounted on the breadboard.

2. Each of your breadboard component mounting blocks is labeled with a number from 1 through 7. For instance, the block with the 100 Ω resistor is number 6.

3. Look at the schematic, Fig. 6-2, in the 6B25 Technical Manual and compare it with figure below.

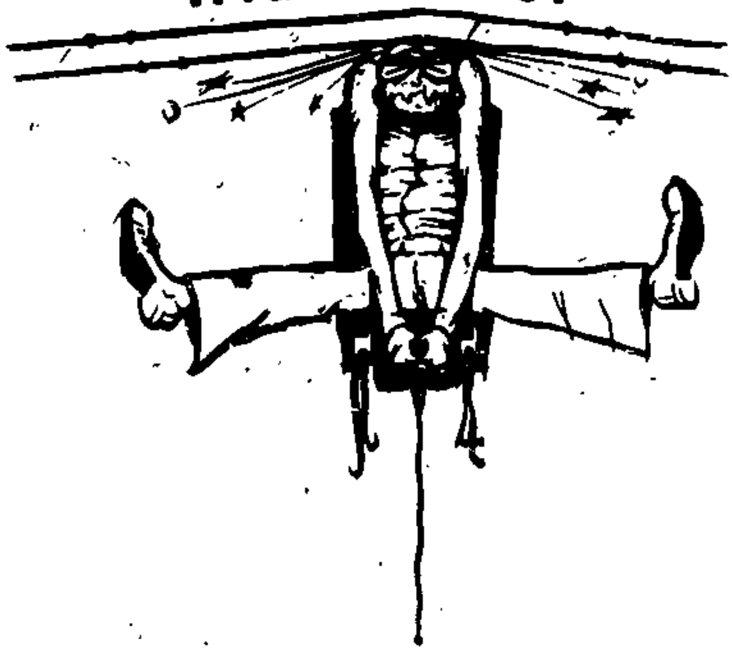
4. Now find the 100 Ω resistor on the schematic then write its block number (6) in the proper space below.

5. Continue this process until you have filled all of the spaces with the proper number. NOTE: The transformer is number 1.



CHECK YOUR RESPONSES WITH THE ANSWERS PROVIOEO IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEEO TO MOOULE FIFTEEN, LESSON IV. IF YOUR RESPONSES OIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS ANO PROCEOURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR.

Trial and Error



CAN BE A DEADLY TEACHER

MODULE FIFTEEN

LESSON IV

BREADBOARDING AND TESTING A SOLID STATE POWER SUPPLY

OVERVIEW
LESSON IV

Breadboarding and Testing a Solid State Power Supply

In this Lesson you will:

- -use a technical manual
- -make resistance and voltage measurements
- -construct a circuit from a schematic and/or pictorial
- -learn some new terms
- -identify electronic components

BEFORE YOU START THIS LESSON, PREVIEW THE LIST OF STUDY RESOURCES ON THE NEXT PAGE.

LIST OF STUDY RESOURCES
LESSON IV

Breadboarding and Testing a Solid State Power Supply

To help you learn the material in this Lesson, the following resources are available:

STUDY AND PROGRESS CHECK BOOKLET
- Lesson Narrative
- Experiment EXP. Fifteen-IV, "Breadboarding and Testing a Solid State Power Supply"

AUDIO VISUAL:
- Static/Motion - "Constructing a Bridge Rectifier Power Supply"

EQUIPMENT
- Power Supply Components Kit
- Multimeter

TECHNICAL MANUAL
- 6B25 Technical Manual

IT IS HIGHLY RECOMMENDED THAT THE STATIC/MOTION PROGRAM BE VIEWED IN ORDER TO COMPLETE THIS LESSON.

YOU MAY NOW STUDY ANY OR ALL OF THE RESOURCES LISTED ABOVE.


Time waits for no man. . .
ACCIDENTS
WAIT
FOR
EVERYONE
COMPLACENCY KILLS!

NARRATIVE
LESSON IV

Breadboarding and Testing a Solid State Power Supply

Most electronic equipment requires a source of DC. Large, permanently installed, or semi-portable equipments most often convert AC to DC, while small, portable equipments frequently use a DC supply from a battery pack. Some equipments have provisions for choosing either an AC or a DC source.

A power supply is often used to convert (rectify) AC to usable DC. Some power supplies are very simple, have a few components, and provide only one or two DC output voltages while others are very complex and produce a number of different outputs, each of which may be carefully regulated to very narrow tolerance limits.

When electronic circuits are assembled for a temporary purpose, "breadboard" circuits are usually used. The components are not "hard wired" or soldered, but are simply supported on a base and wired with temporary connections (usually called "patch cords"). This makes it easy to modify the circuits and to reclaim the components for re-use.

What does "solid state" mean? There are two general types of electronic devices: solid state and tube (vacuum or gaseous). A solid state device is a device other than a conductor that uses magnetic, electric, and other properties of <u>solid</u> materials as opposed to vacuum or gaseous devices. Transistors, crystal diodes, and integrated circuit chips are examples of solid state devices. For more details, see Markus' <u>Electronics and Nucleonics Dictionary</u>.

You should now gather the following in your carrel:

1. Experiment (EXP. Fifteen-III) "Breadboarding and Testing a Solid State Power Supply."

2. Power Supply Components Kit

3. 6B25 Radio Receiver Technical Manual

4. Multimeter

You should now view the slide/sound lesson "Breadboarding and Testing a Solid State Power Supply" unless you have assembled electronic kits or built circuits before.

THIS COMPLETES THE NARRATIVE FOR LESSON IV, MODULE FIFTEEN. EXPERIMENT EXP. FIFTEEN-IV COVERS THE PERFORMANCE OBJECTIVES FOR THIS LESSON. IF YOU FEEL THAT YOU NEED FURTHER STUDY BEFORE YOU DO THE EXPERIMENT, THIS LESSON IS COVERED BY:

AUDIOVISUALS

EXPERIMENT
LESSON IV

Breadboarding And Testing A Solid State Power Supply

Obtain a Power Supply Breadboard kit, and inventory the parts by comparing them with the list supplied with the kit.

Experiment Fifteen-II may be of use when you are inventorying these parts.

You will also need
1. 6825 Technical Manual
2. Multimeter

As you assemble the Bre...board, install the components on the board and connect them with small patch wires.

FOR EXAMPLE,

This....

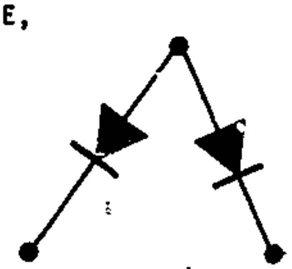


Figure 1

becomes this

(NOTE: Refer to Page 85, Item 15)

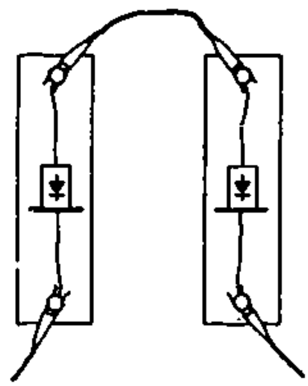


Figure 2

Assembly Procedure

1. Open the 6825 Technical Manual to Figure 6-2. Use this schematic to guide you as you wire your breadboard. Refer to Page 57, Figure 3 in your Module 15 for suggested component layout.

2. Lay out the four Bridge Rectifier Diodes. NOTE: The arrow points toward the banded end.

3. Use a short patch wire to connect CR3 to CR4. Put them one above the other with the banded ends on the top.

4. With a short patch wire connect CR5 to CR6. Place these diodes (with their banded ends up) beside the first two on the board.

66

5. Using the RX1000 Scale on the AN/PSM-4 measure the combined series resistance of CR3 and CR4; then reverse the meter leads and measure the resistance in the opposite direction. The resistance should be very high in one direction (near infinity) and small in the other.

6. Measure the series resistance of CR5 and CR6 in the same way that you did CR3 and CR4.

7. Connect the top of CR4 to the top of CR5 with a short patch wire. This is the positive side of the bridge.

8. Next connect CR3 (bottom) to CR6 (bottom). This point is the negative or ground side of this bridge.

9. Notice in Fig 6-2 in the Technical Manual that the secondary leads of the transformer (T5) are connected into the middle of the bridge. Make these connections. NOTE: The secondary leads of T5 are red.

10. Connect the positive (+) ends of C22 and C23 to R17, one capacitor to each end of the resistor.

11. Connect the positive (+) end of C22 to the positive (+) end of the bridge, and the negative (-) end of the two capacitors to the negative (-) end of the bridge.

12. Now connect the Zener regulator CR7 into the circuit Be sure the polarity is correct. The band should be at the positive (+) or upper end.

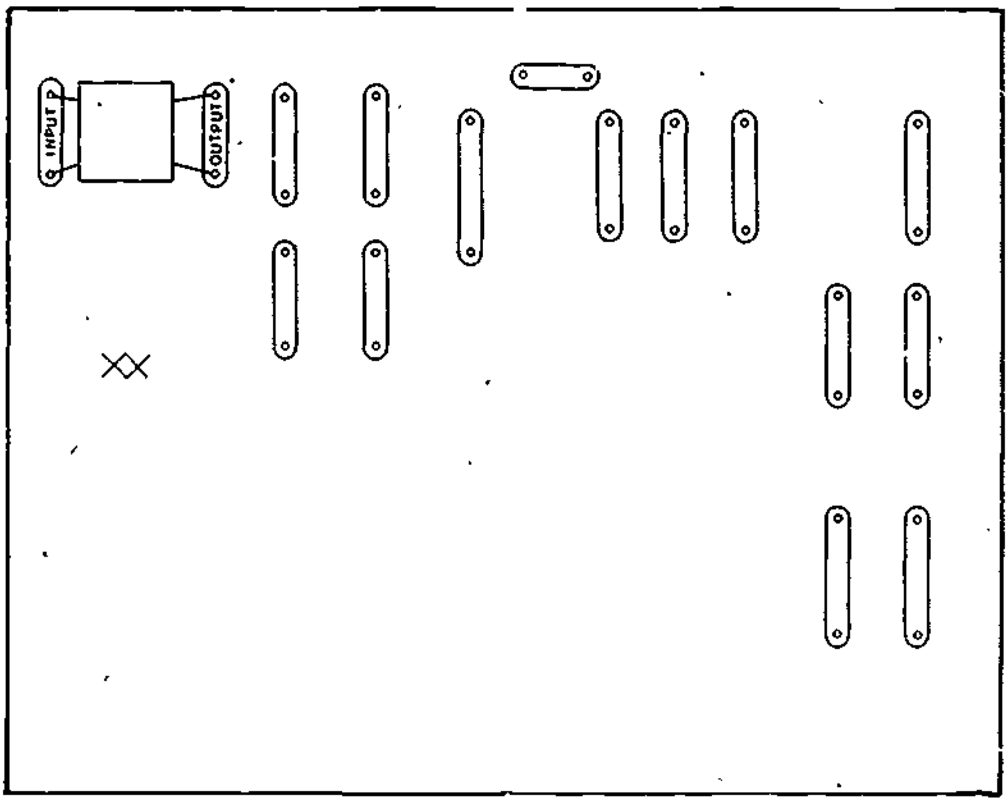
13. Next install the bleeder resistor (R18). Connect it in parallel with CR7.

14. Look at the schematic of the output section (R19, R20, R21, C24, C25.) Notice that this circuit is parallel to R18, and that the negative ends of both capacitors are connected to ground. Now lay out these components and connect them into the circuit.

15. As a check of your circuit, see if you can follow a continuous path for current flow from the bottom of R21 through R21, R20, R19, and R17 to the positive (+), top, side of the bridge. Now check to see whether the negative (-) side of the bridge (ground) is connected to the negative side of each of the capacitors, CR7, and the bottom of R18 and R21.

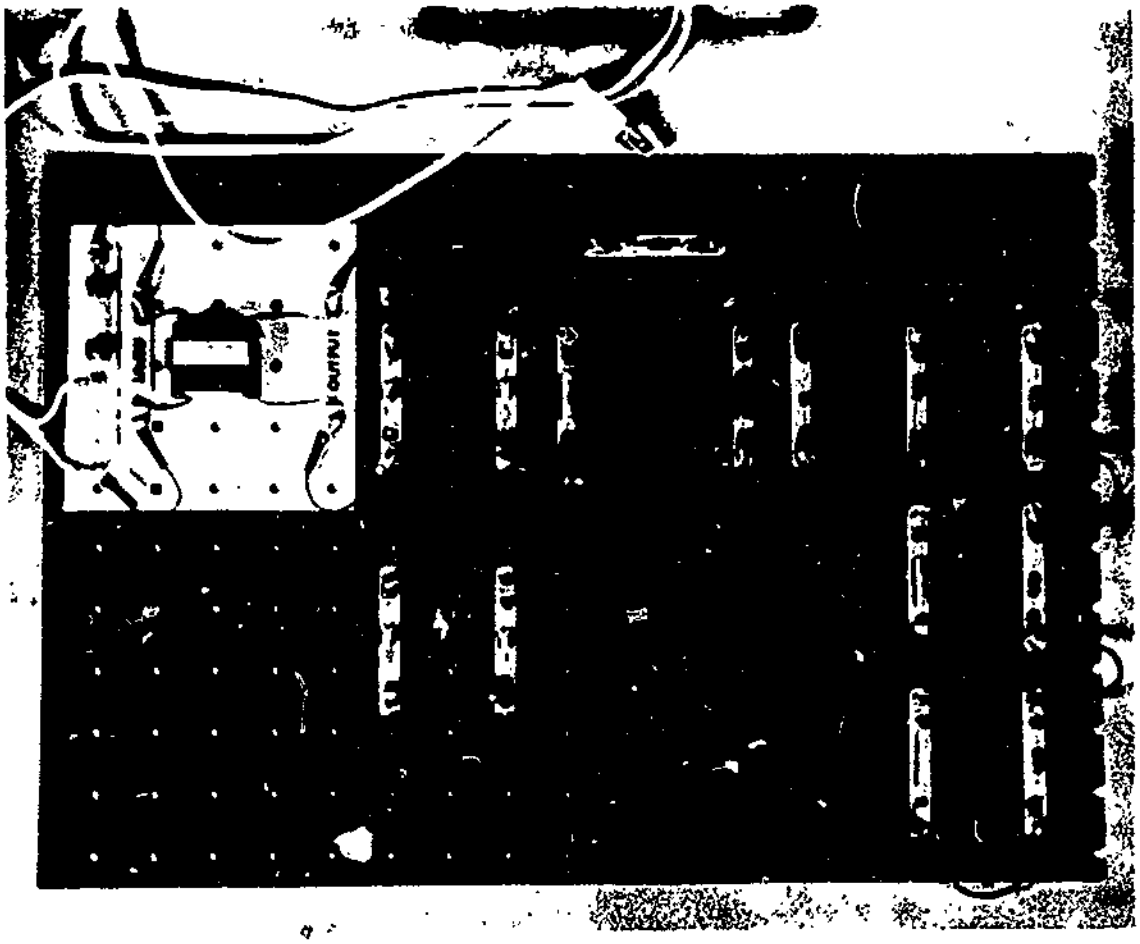
If you still are not sure that your breadboard is right, look at Fig. 4 for some more help.

WHEN YOU HAVE COMPLETED THE BREADBOARD TAKE IT TO YOUR LEARNING SUPERVISOR TO CHECK, THEN GET THE INPUT POWER CORD. NOW DO STEP 16 OF THIS EXPERIMENT.



Suggested Component Layout For Breadboard

Figure 3



Layout of Power Supply Breadboard

Figure 4

16. Now before plugging the power cord into an AC outlet, connect the power cord to your breadboard power supply using the two short patch wires remaining (fig. 4)..

17 The following steps could result in personal injury or loss of life if not correctly followed.

Next plug in the power cord to the receptacle in your study carrel.

WARNING - LETHAL VOLTAGES PRESENT

18. Set the VOM to measure DC voltages.

19. Connect the (+) meter lead to junction of R18 and R19 (TP5) and the (-) meter lead to ground; meter should indicate 9.1 VDC ± 10%.

20. Connect the (+) meter lead to the junction of R20 and C24 (TP6) and the (-) meter lead to ground; the meter should indicate 8.8 VDC ± 10%.

21. Connect the (+) meter lead to the junction of R21 and C25 (TP7) and the (-) meter lead to ground; the meter should indicate 8.6 VDC ± 10%.

22. Remove the meter leads and de-energize the breadboard power supply.

IF YOUR RESPONSES DIFFER FROM THOSE GIVEN SEE YOUR LEARNING SUPERVISOR.

23. Remove components from breadboard and restore your power supply breadboard kit.

THIS COMPLETES THIS EXPERIMENT. PROCEED TO LESSON V.

MODULE FIFTEEN

LESSON V

INPUT-CONVERSION-OUTPUT (ICO) CONCEPTS

OVERVIEW
LESSON V

Input-Conversion-Output (ICO) Concepts

In this lesson, you will learn what ICO is and how you can apply this simple concept to aid you in effectively troubleshooting. In addition you will:

- apply the Input-Conversion-Output concept to electronic components and circuits.

- interpret block diagrams.

BEFORE YOU START THIS LESSON, PREVIEW THE LIST OF STUDY RESOURCES ON THE NEXT PAGE

LIST OF STUDY RESOURCES
LESSON V

Input-Conversion-Output (ICO) Concepts

To learn the material in this Lesson, you may use:

STUDY AND PROGRESS CHECK BOOKLET

Lesson Narrative

REFERENCES

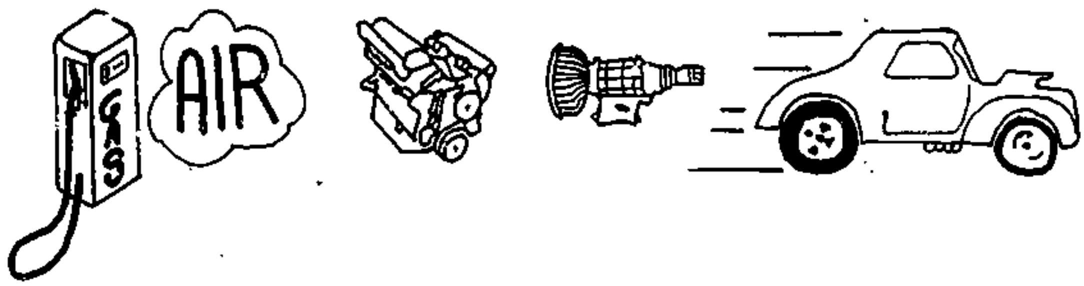
Electronics and Nucleonics Dictionary, Markus
EIMB

YOU MAY NOW STUDY ANY OR ALL OF THE RESOURCES LISTED ABOVE

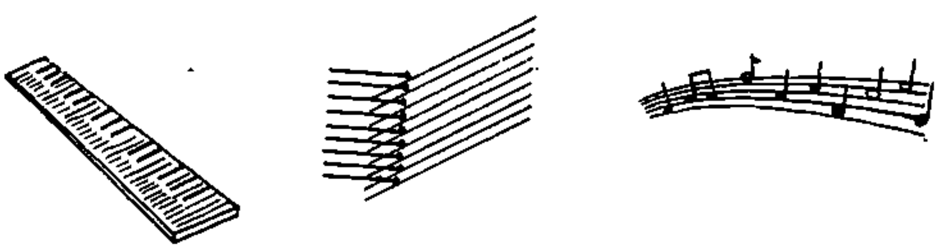
NARRATIVE
LESSON V

Input-Conversion-Output (ICO) Concepts

Input-Conversion-Output is not a new idea for you. An automobile has an input of fuel and air and an output of mechanical motion. The engine and drive train must convert the chemical input to the mechanical output.



A musician playing a piano can be thought of in the same way:
The musician moves his fingers skillfully over a keyboard. (Input)
The keys are connected to hammers which strike tuned strings.
The vibrating strings set air in motion to produce sound. (Output)



In many cases, a mental exercise like this is not especially useful - - until something goes wrong in the conversion process. When this happens, the output changes and we are likely to be unhappy with the result.

In electronic circuits, the input-conversion-output (abbreviated ICO) concept is extremely important to the technician because it tells him when something is wrong in the conversion process. It is also a powerful tool in helping to locate the fault.

In this Lesson you will:

- apply the input-conversion-output concept to electronic components and circuits
- interpret block diagrams

All electronic equipment--no matter how complex--is composed of one or more of the basic circuits you will study in the next few modules. You will learn about the types of circuits and you will practice using test equipment and repair techniques.

The training devices you will work with will include all the common circuit configurations in solid state versions (we will deal with vacuum tube versions a little later). The basic circuit TYPES you will become familiar with are:

1. POWER SUPPLIES - convert AC line voltages to AC or DC OPERATING voltages.

2. REGULATORS - stabilize the OPERATING voltages against input or output fluctuations.

3. OSCILLATORS - generate continuous SIGNAL voltages from OPERATING voltages.

4. AMPLIFIERS - increase SIGNAL power.

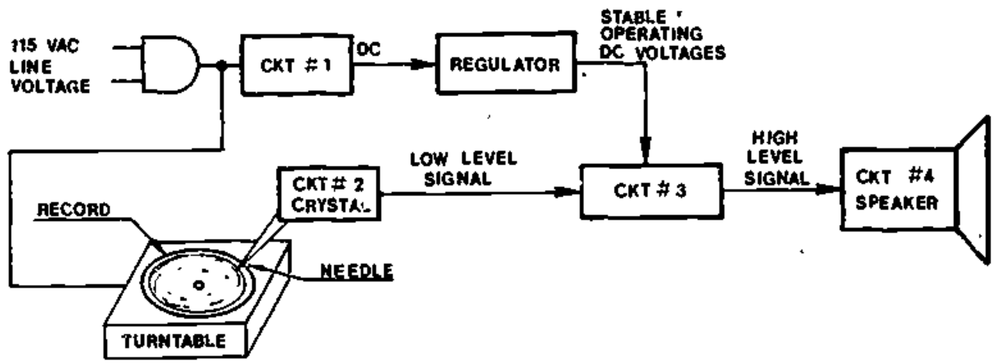
5. TRANSDUCERS - change ENERGY from one FORM to another (motors, meters, or loudspeakers convert electrical energy to mechanical energy; crystals do the opposite; lamps convert electrical energy to light and heat).

And, of course, there's a whole bunch of things (like wires, cables, switches, plugs, etc.) needed to CONNECT the SIGNALS between CIRCUITS and TRANSDUCERS.

Here is a simple block diagram showing applications for three of these basic circuits:

A. POWER SUPPLY
B. AMPLIFIER
C. TRANSDUCER.

BLOCK DIAGRAM OF PHONOGRAPH



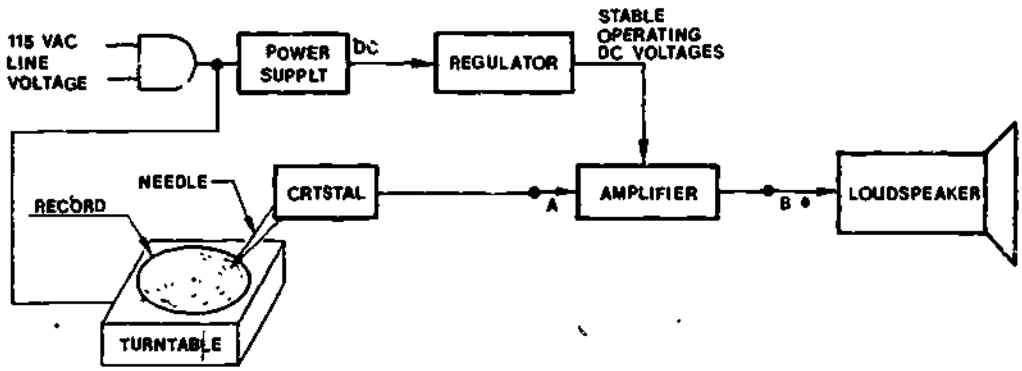
Now match the following circuits with their general classifications.

CKT #1	A. POWER SUPPLY
CKT #2	B. AMPLIFIER
CKT #3	C. TRANSDUCER
CKT #4	

- -

CKT #1 A	CKT #3 B
CKT# 2 C	CKT #4 C

Now let's apply the ICO concept to our phonograph.



If you turn your record player on and find it won't make a sound, you will try to find out what is wrong with it.

One of the first things you will notice is whether or not the record is turning. If it is, then you have eliminated the turntable as the possible trouble. Next we measure the signal voltage at Point A, and find a low level signal there with our meter. Now, what can we say about the crystal? Is it good or bad?

- -

The crystal is good.

Next we measure the signal at point B. If we find no (zero) signal here what might be wrong? List on a separate sheet the blocks that might have failed. (Hint: The amplifier has more than one input.)

A. POWER SUPPLY	D. CRYSTAL
B. REGULATOR	E. AMPLIFIER
C. TURNTABLE	F. LOUD SPEAKER

- -

A. POWER SUPPLY
B. REGULATOR
E. AMPLIFIER

What you are doing is known as TROUBLESHOOTING. Tracing signal voltages and trying to isolate a failure to a specific circuit type will be one of your major jobs.

WHAT THIS COURSE WILL DO:

Develop your skills as a technician by a series of learning exercises which will:

DEMONSTRATE	"each needed KNOWLEDGE and each practical SKILL."
Give you: PRACTICE	"Using each skill and knowledge until you are confident."
and (finally): EVALUATE	"Your ability to use the skills and knowledge, to prove your qualification to progress in the course."

IF YOU FEEL THAT YOU HAVE UNDERSTOOD THE INFORMATION IN THIS LESSON YOU HAVE COMPLETED MODULE FIFTEEN. THERE IS NO MODULE TEST FOR FIFTEEN, YOUR LEARNING SUPERVISOR WILL EVALUATE YOUR EXPERIMENTS AND MARK AN ADMINISTRATIVE FORM.

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MODULE SIXTEEN

ASSEMBLY AND REPAIR TECHNIQUES

STUDY AND PROGRESS CHECK BOOKLET

OVERVIEW
MODULE SIXTEEN

Introduction to Printed Circuit Card Assembly and Repair Techniques

This Module is designed to provide instruction and practice in soldering on printed circuit cards. You will practice the techniques using the proper tools for the job by reconstructing the power supply you "breadboarded" in Module Fifteen on a printed circuit card and testing the finished product. In addition, you will use a logical troubleshooting technique to locate faulty components which will then be replaced. To help you learn and practice these skills, this module has been divided into three lessons:

- Lesson I - Basic Soldering on Printed Circuit Cards
- Lesson II - Printed Circuit Card Power Supply Assembly and Testing
- Lesson III - Troubleshooting the Power Supply Using the Six-step Troubleshooting method

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MODULE SIXTEEN

LESSON I

BASIC SOLDERING ON PRINTED CIRCUIT CARDS

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OVERVIEW
LESSON I

Basic Soldering on Printed Circuit Cards

The name of the game is "troubleshoot and repair." You are being trained to isolate and repair malfunctions in the equipment your rating is responsible for. Soldering tools use heat and liquified metal to remove and replace faulty components. Properly controlled, heat can be used to make effective repairs; improperly used, heat can destroy electronic components.

In this lesson you will learn how to solder and de-solder components on printed circuit card connection points called "pads." You will learn about:

- soldering tools and equipment
- soldering techniques
- de-soldering techniques

Be sure you follow directions carefully.

BEFORE YOU START THIS LESSON, PREVIEW THE LIST OF STUDY RESOURCES ON THE NEXT PAGE.

LIST OF STUDY RESOURCES
LESSON I

Basic Soldering on Printed Circuit Cards

The following material is available for this lesson.

STUDY AND PROGRESS CHECK BOOKLET
Lesson Summary
Experiment, EXP. Sixteen-I "Basic soldering on printed circuit cards."

AUDIO VISUAL
Static/Motion - Basic Soldering I "Tool Identification"
Static/Motion - Basic Soldering II "Component Replacement"

IT IS HIGHLY RECOMMENDED THAT THE STATIC/MOTION PROGRAM BE VIEWED IN ORDER TO COMPLETE THIS LESSON.

IF YOU HAVE HAD SIGNIFICANT EXPERIENCE IN PRINTED CIRCUIT CARD ASSEMBLY AND REPAIR, SEE YOUR LEARNING SUPERVISOR.

SUMMARY
LESSON 1

Basic Soldering on Printed Circuit Cards

In this Lesson you will learn to solder on printed circuit cards using the latest soldering/de-soldering techniques.

In order to produce effective solder connections on printed circuit cards, proper tools and techniques must be used. The most important steps are:

a. Cleaning leads and connectors.
b. Forming or bending leads.
c. Positioning and holding components.
d. Using the proper soldering tool.
e. Using heat sinks.
f. Application of heat and solder.
g. Trimming excess lead wires.
h. Inspection and testing.

In addition, when components are being removed, proper de-soldering tools and techniques must be used.

VIEW A/V "BASIC SOLDERING I" AND "BASIC SOLDERING II" BEFORE COMPLETING EXPERIMENT EXP. SIXTEEN-1.

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EXPERIMENT.
LESSON 1

Basic Soldering on Printed Circuit Cards

Materials: 1. Practice card.
2. Soldering Kit.

Inventory Soldering Kit, using "Soldering Tool Inventory List" below.

SOLDERING TOOL INVENTORY LIST

1. 6" long nose pliers
2. 4" long nose pliers
3. Diagonal cutting pliers
4. 6" wire bending pliers
5. 4" wire bending pliers
6. Clock tweezers
7. Self-closing tweezers
8. Anti-wicking tool
9. Soldering iron and stand
10. Solder removing tool
11. File
12. Heat Sinks
13. Solder
14. Wire stripper
15. Work position stand
16. Tool box
17. Cleaning brush
18. Cleaning solvent
19. Liquid flux
20. Rubber Eraser

Soldering tools. Identification:

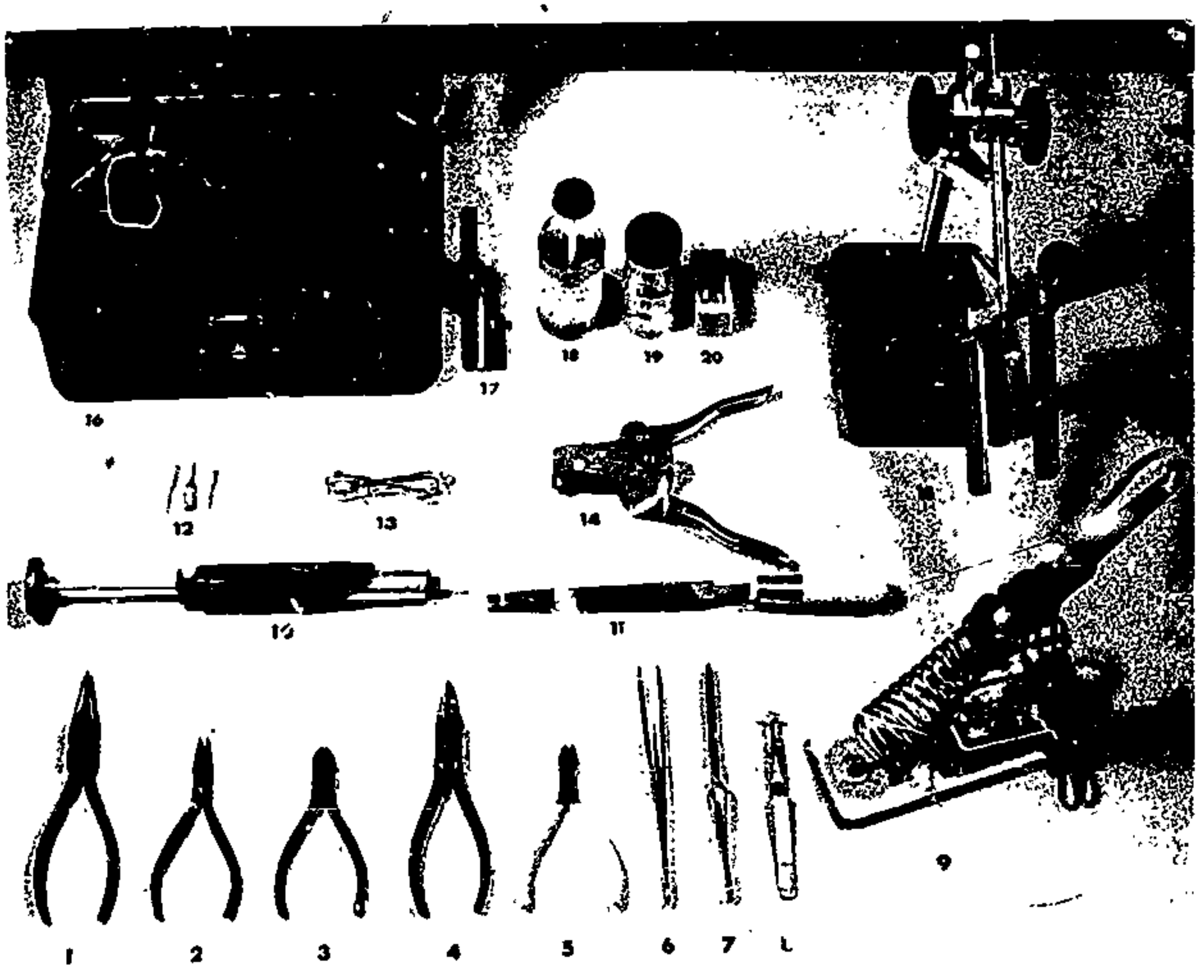

Figure 1

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A. De-soldering components:

PROCEDURE:

1. Layout and inventory the soldering kit.

2. If there are any missing parts, see your Learning Supervisor.

3. Plug in the soldering iron and place it in the soldering iron stand.

4. Place the practice PC Card in the work positioner foil side up.

5. Wipe the tip of the heated soldering iron quickly across the dampened sponge.

6. Cock the solder removing tool.

7. Place the tip of the iron so that one surface of the tip touches the lead of the resistor and another surface touches the pad.

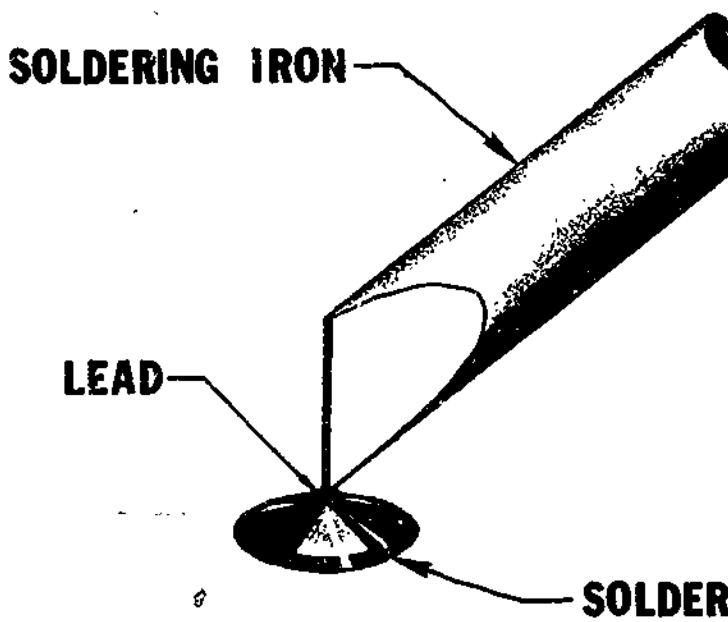

Figure 2

8. As the solder begins to melt, position the solder removing tool directly over the pad and press the release button. (WARNING: Aim the plunger away from your body when pressing the release button.) Repeat this process until all solder is removed from the pad. Usually two passes removes all the solder. To avoid overheating the connection, remove the soldering iron as soon as you have completed the pass with the solder removing tool.

9. Repeat steps 4 through 8 for the other lead of the resistor.

10. Move the printed circuit card to the vertical position.

11. With the long nose pliers grasp the resistor in the center. Place the tip of the iron against one pad and gently lift the lead from that pad. Repeat this process for the other lead.

B. Soldering components:
PROCEDURE:

1. Straighten the leads of the new resistor by using the flat edges of the long nose pliers to remove any kinks. Do not scrape or nick the leads. The leads should point straight out from the body of the resistor.

2. Clean the leads with a slotted rubber eraser by drawing the leads through the slot until they are bright and shiny.

3. Use the self-closing tweezers to dip the leads into the cleaning solvent. Remove any remaining grease or grime.

4. Grip the resistor with the self-closing tweezers and center the component between the pad eyes.

5. With the wire bending pliers, grip the lead at a point directly over one of the pad eyes.

6. Remove the self-closing tweezers and make a 90° bend in the lead.

7. Make a 90° bend at the proper point on the other lead. Be careful not to contaminate the leads with oil or grease from your fingers.

8. Place the leads of the resistor through the holes in the pad eye until the resistor body comes in contact with the card. The leads should fit smoothly without binding. Use the self-closing tweezers to hold the component in place.

9. Turn the PC Card over so that the foil side is up.

10. Scrub the pad eye areas and the leads with the brush and cleaning solvent. Allow sufficient time for the area to dry before soldering. CAUTION: Whenever using the brush and solvent, be careful not to splash solvent in your eyes.

11. Obtain solder and straighten one end to approximately 3 inches.

12. Wipe the tip of the iron across the dampened sponge and apply the iron to the lead and pad simultaneously as was done during desoldering.

13. Apply the solder to the connection, not the iron.

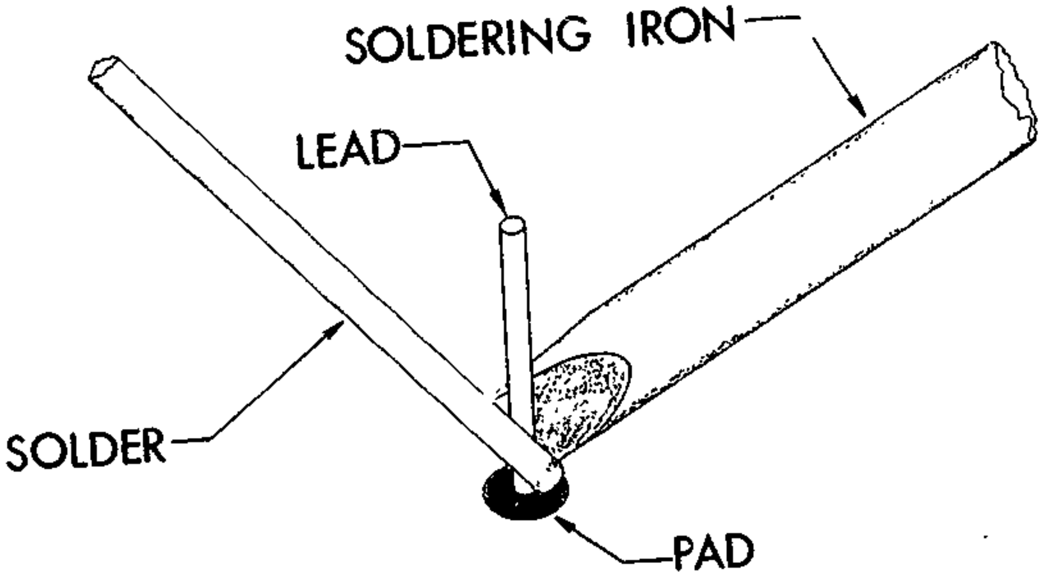

Figure 3

14. When the solder starts to melt, feed only enough solder to completely and uniformly surround the lead.

15. Remove the solder and allow the iron to remain until the solder completely flows over the connection and has a smooth shiny surface. Quickly withdraw the iron.

16. Repeat steps 12 through 15 for the other lead.

17. With the diagonal cutting pliers (dikes) cut the component leads off at the point where they emerge from the solder.

18. Scrub the pad eye areas with cleaning solvent to remove all traces of flux.

C. De-soldering and soldering capacitors.

PROCEDURE:

1. The basic technique outlined in sections A and B of this Job Sheet apply for all components.

2. Remove and replace the capacitor.

D. Heat Sensitive components:

Diodes, Transistors, Integrated Circuit Chips.

PROCEDURE:

1. When working with heat sensitive components, care must be taken not to damage them with excessive heat. The chance of heat damage is reduced by placing a heat sink on the lead between the body of the component and the tip of the iron during both the de-soldering and soldering. Ensure good contact is made.

2. Remove and replace the diode.

UPON COMPLETION OF STEP 02., TAKE THE COMPLETED CARD TO YOUR LEARNING SUPERVISOR FOR INSPECTION AND CRITIQUE, THEN CONTINUE ON TO LESSON SIXTEEN-II.

MODULE SIXTEEN

LESSON II

PRINTED CIRCUIT CARD POWER SUPPLY ASSEMBLY AND TESTING

OVERVIEW
LESSON II

Printed Circuit Card Power Supply Assembly and Testing

In Lesson II you will get a chance to put to practical use the soldering theory you have learned. In Module 15 you assembled a breadboarded power supply. In this lesson you will be provided a kit for assembling that same power supply to enable you to obtain more practical experience. To determine if you have constructed this power supply correctly, you will insert it in the 6B25 Radio Receiver. If, after energizing the 6B25, there is sound coming from the earphones and the power supply output voltages agree with the technical manual, you can assume the power supply is functioning properly.

In this lesson, you will

- use soldering tools and equipment
- solder all components using proper safety requirements and component polarity
- test output voltages

Be sure you follow directions carefully.

BEFORE YOU START THIS LESSON, PREVIEW THE LIST OF STUDY RESOURCES ON THE NEXT PAGE.

LIST OF STUDY RESOURCES
LESSON II

Printed Circuit Card Power Supply Assembly and Testing

The following material is available for this lesson.

STUDY AND PROGRESS CHECK BOOKLET
Lesson Summary
Experiment, EXP. Sixteen-II Printed Circuit card power supply assembly and testing.

AUDIO/VISUAL
Static/Motion - "Printed Circuit Card Assembly and Testing"

IT IS HIGHLY RECOMMENDED THAT THE STATIC/MOTION PROGRAM BE VIEWED IN ORDER TO COMPLETE THIS LESSON.

IF YOU HAVE HAD SIGNIFICANT EXPERIENCE IN PRINTED CIRCUIT CARD ASSEMBLY AND SOLDERING, SEE YOUR LEARNING SUPERVISOR.

SUMMARY
LESSON II

Printed Circuit Card Power Supply Assembly and Testing

In this lesson you will put into practice the soldering theory you learned in Lesson I. This will be accomplished by building the same power supply you previously breadboarded on a functional printed circuit board. You will then test your power supply by plugging it into the 6B25 and checking at the earphones for sound and at the power supply output for proper voltages.

In order to build a power supply that will function properly, you must adhere to certain requirements and procedures. The most important of these are:

a. Use proper soldering techniques (diodes are easily damaged by heat).

b. Observe proper polarity of diodes and electrolytic capacitors.

c. Inspect the PC card after completion of soldering.

d. Test the power supply output for proper voltages.

VIEW THE AUDIO-VISUAL PRESENTATION, THEN COMPLETE EXPERIMENT EXP SIXTEEN-II IN THIS BOOKLET.

NOTICE!! THE SOLDERING PORTION OF EXPERIMENT EXP. SIXTEEN-II IS A PERFORMANCE TEST.

EXPERIMENT
LESSON II

Printed Circuit Card Power Supply Assembly and Testing

Materials:
- Printed Circuit Card Power Supply kit and inventory list.
- 6B25 Technical Manual.
- Soldering station kit.

A. Assembly of the Printed Circuit Card Power Supply: (Refer to Technical Manual, Fig. 6-2, for PC Board Layout)

NOTICE!! THE SOLDERING PORTION OF THIS EXPERIMENT IS A PERFORMANCE TEST.

PROCEDURE:

1. Inventory the printed circuit card power supply by comparing the parts with the parts list provided in 6B25 Technical Manual. Inventory the soldering station with the inventory list provided in Experiment Sixteen-I of this booklet.

2. Report any discrepancies to your Learning Supervisor.

3. Place the printed circuit card in the work positioner, foil side down.

4. Select the Zener diode from the printed circuit card power supply kit and use the procedures you have previously learned to clean the leads.

5. Bend the leads of the Zener diode to fit the pad eyes, and using the self-closing tweezers, dip the leads into the cleaning solvent to remove any oil picked up from your fingers during the bending procedures.

6. With the self-closing tweezers, insert the Zener diode leads into the proper pads directing the diode's band towards the center of the board. Hold the diode in this position with the self-closing tweezers. DO NOT SOLDER, yet!

7. Select one of the 10 kohm resistors from the kit, perform the cleaning and lead bending procedures, then insert the resistor leads into the proper pads for R-18.

8. With the resistor in place, connect the heat sinks to the leads of the zener diode between the solder pad and the body of the zener diode.

9. Rotate the work positioner.

10. Clean the pads and leads and solder both components at the same time remove the heat sinks.

11. Clip the leads of both components as close to the solder as possible. This should be done as you complete the soldering of each component.

12. Following the same procedures, mount the following resistors: R21 (10 kohm), R20. (100 ohm) and R19 (220 ohm).

13. Mount R17 and the two 100 uf capacitors, C22 and C23. Use the same procedure you used to mount the zener diode and the 10 kohm resistor.

<u>NOTE</u>: The positive ends of the capacitors will be toward the center of the board!

14. Follow the same procedure for the other two 100 uf capacitors (C24, C25). (Don't forget the polarities!)

15. The final step in the installation of components is the one which requires the most care in soldering -- the construction of the bridge rectifier. Look carefully at the picture:

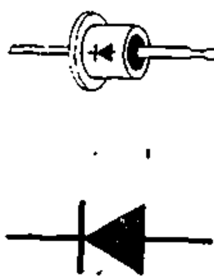

figure 1

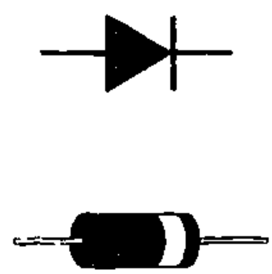

figure 2

Your power supply kit contains four diodes. They are one of the two types shown in figures 1 and 2.

When mounting the diodes shown in figure 1 we make two 90^{o} bends in the lead at the small end and mount them as shown in figure 3.

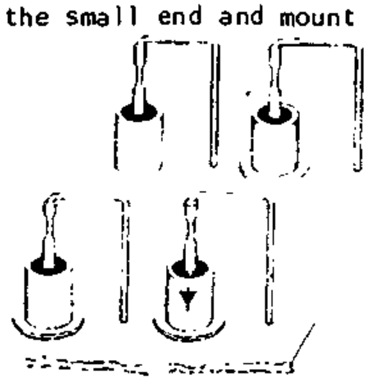

figure 3

When mounting these top hat diodes, it is imperative that a heat sink be used to protect the small end of each diode. Due to the large amount of metal on the large end of the diode, a heat sink will not be needed <u>provided</u> the solder connection is made quickly.

If your kit has the diodes shown in figure 2 you will notice a ring or band around one end. This indicates the direction the arrow points (see fig. 2). You will need heat sinks on both ends of this type diode when mounting (see fig. 4).

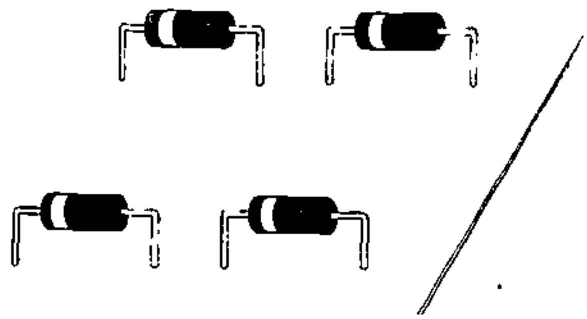

figure 4

16. Mount the four diodes using the appropriate soldering and clipping techniques.

17. Clean all pad eyes with the brush and cleaning fluid provided.

18. Check your card using the check list below. When you are satisfied with your power supply soldering job, take this booklet and printed circuit card to your learning supervisor. He will inspect it using the check list below and certify it.

STUDENT CHECK	L/S CHECK	
		1. No cold solder connections.
		2. No excessive solder on the connections.
		3. Properly bent and clipped leads.
		4. No rosin residue.
		5. No lifted pads or foils.
		6. No cracked solder connections.
		7. Good electrical characteristics of the components (i.e., diodes not shorted or open, resistors of indicated value, etc.)

SOLDERING SATISFACTORY: ______________________________
L/S Signature

B. Testing the Printed Circuit Card Power Supply.

After the Learning Supervisor has certified your board:

1. Ensure that the radio chassis is unplugged and the ON-OFF switch is OFF.

2. Plug the printed circuit card into the proper connector, aligning the pins of the connector with the alignment slots cut into the card, and plug in the line cord. DO NOT ENERGIZE!

3. Set the multimeter to read +DC volts.

4. Clip the negative lead from the multimeter to the radio chassis. This is the ground connection which will remain in place for all voltage readings.

5. Energize the 6B25 Receiver and measure the following voltages:

   a. TP5 to ground. This point should read approximately 9.2 VDC.

   b. TP6 to ground. This point should read approximately 7.6 VDC.

   c. TP7 to ground. This point should read approximately 7.5 VDC.

6. If the correct voltages are not present at the indicated test points, see your Learning Supervisor.

7. If your voltages are correct, tune the 6B25 to the station of your choice, then listen to a melodious tune for a while.

8. Desolder all power supply components except the transformer and clean up the P.C. board for the next student.

9. Completely secure your work area and test equipment. Take your desoldered P.C. board and this booklet to your Learning Supervisor when completed.

Desoldering Satisfactory: ______________________
L/S Signature

GO TO LESSON SIXTEEN-III, "TROUBLESHOOTING THE POWER SUPPLY USING THE SIX-STEP TROUBLESHOOTING METHOD".

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MODULE SIXTEEN

LESSON III

TROUBLESHOOTING THE POWER SUPPLY USING THE SIX-STEP TROUBLESHOOTING METHOD

OVERVIEW
LESSON III

<u>Troubleshooting the Power Supply Using the Six-step Troubleshooting Method</u>

In order to effectively troubleshoot a piece of equipment a logical sequence of steps called the "Six-step Troubleshooting Procedure" is used. When properly followed these steps can save a lot of time and confusion for the technician.

In this lesson you will learn:

- the six-step troubleshooting procedure
- how to combine steps when troubleshooting small equipments
- how to use a flow diagram to troubleshoot
- how to use the half-splitting method to troubleshoot

BEFORE YOU START THIS LESSON, PREVIEW THE LIST OF STUDY RESOURCES ON THE NEXT PAGE

LIST OF STUDY RESOURCES
LESSON III

Troubleshooting the Power Supply Using the Six-step Troubleshooting Method

The following material is available for this lesson. You may choose, according to your needs and past experience, from:

STUDY AND PROGRESS CHECK BOOKLET:
- Lesson Narrative
- Experiment EXP. Sixteen-III: Troubleshooting the power supply using the six step troubleshooting method.

INFORMATION SHEET:
- Information Sheet I.S. Sixteen-III: Troubleshooting the Power Supply using the Six-step Troubleshooting method.

TECHNICAL MANUAL:
- 6B25 Radio Receiver

YOU MAY NOW STUDY ANY OR ALL OF THE RESOURCES LISTED ABOVE.

NARRATIVE
LESSON III

Troubleshooting the Power Supply Using the Six-Step Troubleshooting Method

You have now completed the assembly and testing of your printed circuit power supply card. Your printed circuit card may or may not work. If it does, you will be issued a faulty card to troubleshoot; if it doesn't, you will find out why. First, read this lesson for helpful hints then follow the instructions at the end of the lesson for practice in logical troubleshooting.

Let's analyze the two terms "logical" and "troubleshooting". Webster defines "logical" as: "Necessary or to be expected because of what has gone before; that follows as reasonable." What this really means is to arrive at a conclusion, using small steps that are closely related. Now for the term "troubleshooting:" This, in a nutshell, means locating a trouble or malfunction and correcting it by the most efficient and fastest method.

The Navy utilizes the "Six-step Troubleshooting Method," which naturally has six clearly defined steps. The following is an outline of these steps and a description of each.

STEP 1: Symptom Recognition

Just by the title alone you might think this one is "gedunk." Well -- most of the time it is. Usually it is very easy to determine that the gear is not working properly, but you cannot rely on hearsay. You must determine for yourself that a problem really exists and that not just another "operator error" has been made. (This occurs quite often.) Then, there is the problem which is not quite so easy to recognize. Here is where past experience and knowledge really lend a helping hand. Once you are sure that a problem exists, you are ready for the next step.

STEP 2: Symptom Elaboration

S-T-O-P ! ...Don't go running for all the test equipment and reference material you THINK You may need. This will come in due time. Symptom elaboration is simply checking any meters, or front panel indications available on the equipment itself. Most equipments have some form of built-in test features. Utilizing your background knowledge and these test features, you may obtain a more detailed determination of the indications or symptoms of failure. The elaboration process means "refinement of symptoms." You are not going to check for symptoms of malfunctions unless they relate directly to the problem at hand. This will help you get a clearer picture of the next step.

STEP 3: List the Probable Faulty Functions

The term "function" is used here to denote an operation performed by a specific area of an equipment or system. Generally each major equipment has one or more functions to perform. What this means is that we are now using logic to get us in the "ball park." The "ball park" is the specific area(s) that the problem may be in. In this step it is important to eliminate as many areas (functions) as possible. You now have a list of probable faulty functions. To determine the malfunction you have to eliminate all of the items except the one that is faulty. Now, you're getting close to the problem.

STEP 4: Localizing the Faulty Function

Some areas may be tested more rapidly and easily than others. These should be eliminated first. After selecting the order in which you will test, proceed to check the OUTPUT of each area or whatever test points are available for that particular area. After the test you will arrive at one of three conclusions:

(1) This is where the trouble is.
(2) This is where the trouble "ain't."
(3) This and an associated function is where the trouble is.

Whatever your conclusion, you have discovered information that can be used to help you eliminate areas or functions. These tests are continued until the single faulty area is identified. You have narrowed the trouble to a small fraction of the total number of circuits. Next comes the step of troubleshooting the faulty circuit.

STEP 5: Localizing the Faulty Circuit

Generally you will use one of two methods. Depending on the type of equipment, one method may be more useful than the other.

(1) BRACKETING - You will put brackets at the known good input(s) and at the bad output(s), make a test between them, move the brackets one at a time, and make further tests in the new bracketed areas. This process is repeated until the problem is isolated.

(2) HALF-SPLITTING - This technique operates by taking a faulty area, splitting it in half, and checking at the half-way point to see if the operation is correct at that point. If it is, we have eliminated the circuitry up to this point and we now know that the problem is in the circuitry following the mid-way point. Now, split the half that is known to be bad again. This process is repeated until the faulty circuit is isolated.

In actual practice, you will probably combine these two approaches to solve your problem.

STEP 6: Failure Analysis

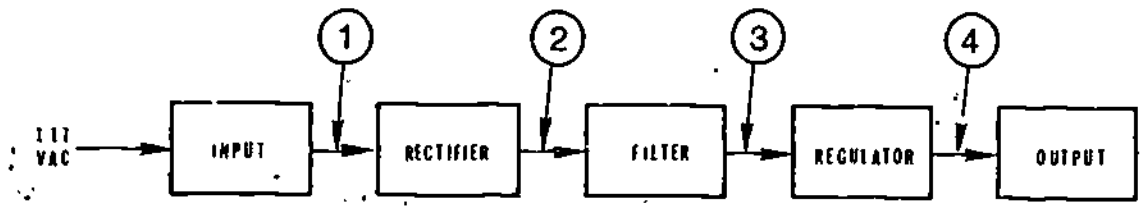
Once we have found the malfunction, we could just replace the bad component and return the gear to service. But suppose it happens again? We must determine why the malfunction occurred and set up some method to prevent its happening again. Something might be worn, old, improperly adjusted, or something else may have caused the failure.

When troubleshooting the bad power supply cards, you will be required to use this six-step troubleshooting method. First we have to determine whether or not the radio is working. Is there any sound from the headset? Is the power cord plugged in? Is the volume control turned up sufficiently? These are all examples of questions you should be asking yourself. This is an example of Step 1, Symptom Recognition - "Does it work?"

Since the power supply is a small unit and is normally thought of as part of a system, we can incorporate or combine several of the six steps. For example, steps 2, 3, and 4 may be combined in this instance. "Why?" you ask. Since the receiver has no front panel meters, dials, etc., not much of Step 2, Symptom elaboration, need be utilized. Step 3, List the probable faulty functions, is not needed because the radio worked when the good power supply card was installed.

The same logic applies for Step 4, Localizing the Faulty Function. You know it's the power supply card, so there is no need to localize it.

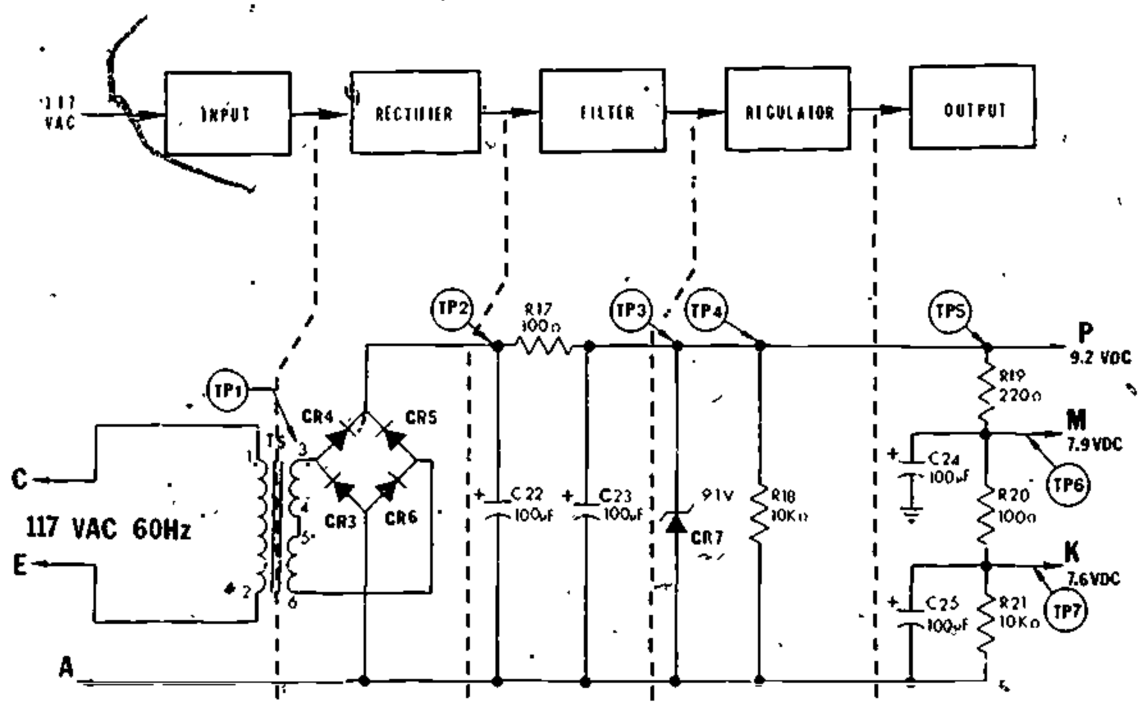
Now let's look at a functional block diagram of the Power Supply.



Each block represents some circuitry in which the problem may lie. Step 5, Localizing the Faulty Circuit, is where you will determine which circuit is causing the problem.

To Localize the Faulty Circuit, the BRACKETING method or HALF-SPLITTING method is used. Let's use the HALF-SPLITTING method to isolate a faulty circuit in our Power Supply. Refer to the schematic diagram on the next page. In a hypothetical case, let's pick TP-3 as our first test point since it is approximately the half-way point in the function circuit. We find 9.1 VDC at this point and by referring to the technical manual we can see that this voltage is correct. We know now that our problem must be in the circuitry following TP-3. Now we half-split the determined faulty area and take a voltage reading at TP-4. Once again we find 9.1 VDC, which is correct, so the problem must be in the circuitry following TP-4. Our next logical test point using the half-splitting method is TP-5 and again we find the correct reading of 9.1 VDC. At this stage we are fairly certain that the problem must be in the output circuit. Let's confirm our suspicion, though, and half-split the output circuit. By taking a voltage reading at TP-7 we find zero volts instead of the 7.6. VDC that the technical manual calls for. Suspicion confirmed! We have just completed step 5 and Localized the Faulty Circuit which in this case is the output circuit.

It must be noted here that even though TP-3, TP-4, and TP-5 can be considered one and the same test point since there are no components between them, schematic diagrams often show test points in this manner for the purpose of testing wiring or foil strip continuity.



POWER SUPPLY

Now, we must complete Step 6, Failure Analysis, and find the bad components. We can use either resistance or voltage measurements. We will use the resistance method because it is the best way to determine whether or not a component is good. Sometimes it is necessary to unsolder a component in order to make a resistance measurement. If the component checks good, re-solder it and check another one until the faulty component has been found. In our hypothetical problem, we would find R-19 to be open. After the bad component is found and replaced, we must determine why the malfunction occurred and take action to prevent it's happening again. Let's say, for instance, R-19 opened because of an incorrect potentiometer setting somewhere in the radio. It is not enough just to find and replace R-19 but you must also find and correctly adjust the potentiometer. After all this has been completed and the radio is once again operating properly you can take pride in a job well done.

THIS COMPLETES THE NARRATIVE FOR LESSON III, MODULE SIXTEEN.

EXPERIMENT EXP. SIXTEEN-III IN THIS BOOKLET COVERS THE PERFORMANCE OBJECTIVES FOR THIS LESSON. EXPERIMENTS ARE A PART OF THE LESSON PROGRESS CHECKS WHICH YOU MAY TAKE AT ANY TIME.

EXPERIMENT
LESSON III

Troubleshooting the Power Supply Using the Six Step Troubleshooting Method

You are now going to troubleshoot a faulty power supply using a logical troubleshooting method to isolate the trouble to a single component.

MATERIALS:
- 6B25 Radio Receiver
- Prefaulted printed circuit power supply card
- Multimeter
- Technical Manual for 6B25 Radio Receiver

NOTES:

1. A schematic and Block Diagram of the Power Supply can be found on the last page of Narrative Sixteen-III.

2. There is also a Flow (Logical Decision Making) Diagram, Information Sheet I.S. Sixteen-III, in this Booklet to help you in applying the half-splitting method of troubleshooting.

3. Flow diagrams are always read from the top down and from left to right unless arrows show otherwise. This diagram may be used to check your progress as you execute the necessary tests. Each time you make a test, follow the results on the flow diagram. A circle with a letter inside tells you to go back to the beginning and test again. This will enable you to find any other trouble which may be in the unit.

PROCEDURE:

ENSURE THAT THE 6B25 IS DEENERGIZED

Remove the power supply printed circuit card and insert a prefaulted power supply card.

Energize the 6B25 Radio Receiver and record the results of your tests in the spaces provided.

1. Measure the voltage at TP 5. ________
   A. If this voltage is correct go to step 2.
   B. If this voltage is wrong go to step 4.

2. Measure the voltage at TP 6. ________
   A. If this voltage is correct go to step 3.
   B. If this voltage is wrong deenergize the device and troubleshoot the 7.9 V output; go to step 7 and follow the directions given.

3. Measure the voltage at TP 7. ______________________

   A. If this voltage is correct the power supply is supplying all required voltages.

   B. If the voltage is wrong deenergize the device and troubleshoot the 7.6 V output; go to step 7 and follow the directions given.

4. Measure the voltage at TP 2. ______________________

   A. If this voltage is correct go to step 6.

   B. If this voltage is wrong go to step 5.

5. Measure the voltage at TP 1. ______________________

   A. If this voltage is correct, deenergize the device and troubleshoot the rectifier circuit; go to step 7 and follow the directions given.

   B. If this voltage is wrong deenergize the device and troubleshoot the input of the power supply; go to step 7 and follow the directions given.

6. Measure the voltage at TP 3. ______________________

   A. If this voltage is correct look for an open circuit between TP 3 and TP 5 (they should be the same point electrically); go to step 7 and follow the directions given.

   B. If this voltage is wrong deenergize the device and troubleshoot the regulator and filter; go to step 7 and follow the directions given.

7. What is the faulty block? ______________________
   Go to step 8.

<u>BE SURE THE DEVICE IS UNPLUGGED!!</u>

8. After you have identified the faulty block, inspect the components for burnt resistors, leaking capacitors, frayed wiring open connections, etc.

   If you fail to visually locate the faulty component you must check the resistance of the components and compare their values with the correct values which can be found in the technical manual.

   Notice that if you measure TP5 to ground and find zero ohms (a short to ground) the casualty could still be C 23, CR 7, R 18 or the 9.2V output. In order to isolate the malfunction to a specific component each component must be removed from the circuit and tested.... <u>BUT</u> ....

YOU WILL <u>NOT</u> REMOVE ANY COMPONENTS FROM THESE PRINTED CIRCUIT CARDS. IF YOU CANNOT ISOLATE THE CASUALTY TO A SPECIFIC COMPONENT, STATE WHICH <u>ONES</u> COULD BE FAULTY!!

The faulty component(s) is/are ______________________________

WHEN YOU HAVE FOUND THE FAULTY COMPONENT TAKE THIS EXPERIMENT AND THE PREFAULTED CARD TO YOUR LEARNING SUPERVISOR.

YOU [illegible] OW COMPLETED THIS MODULE. THE PERFORMANCE TEST WILL REQU[illegible] SAME SKILLS AS THIS EXPERIMENT. IF YOU FEEL THAT THE RESULT[illegible] THIS EXPERIMENT INDICATE THAT YOU ARE READY TO TAKE THE END OF MODULE PERFORMANCE TEST, SEE YOUR LEARNING SUPERVISOR. IF YOU FEEL YOU NEED FURTHER STUDY BEFORE TAKING THE PERFORMANCE TEST, YOU MAY REVIEW ANY PART OF THIS MODULE.

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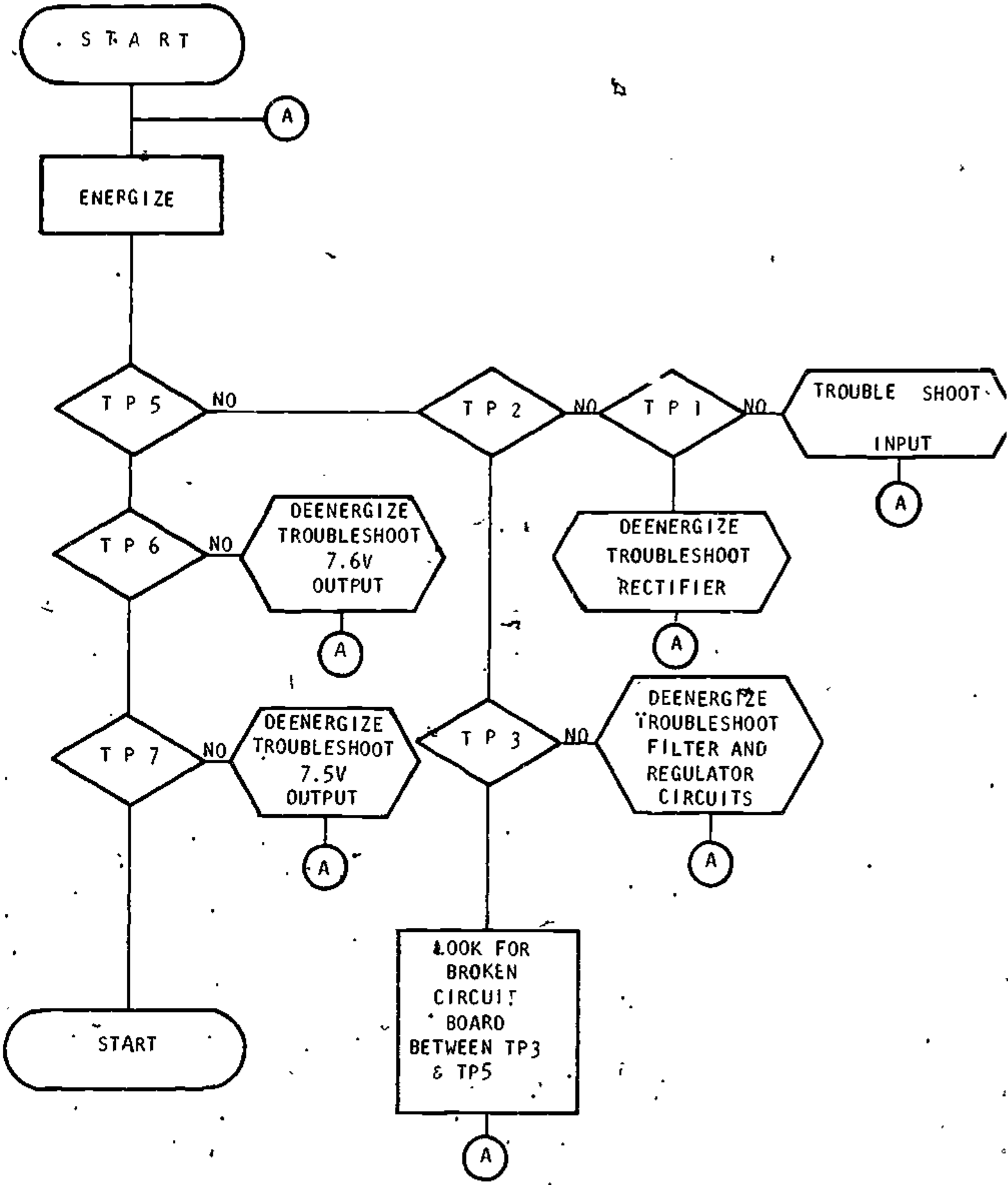
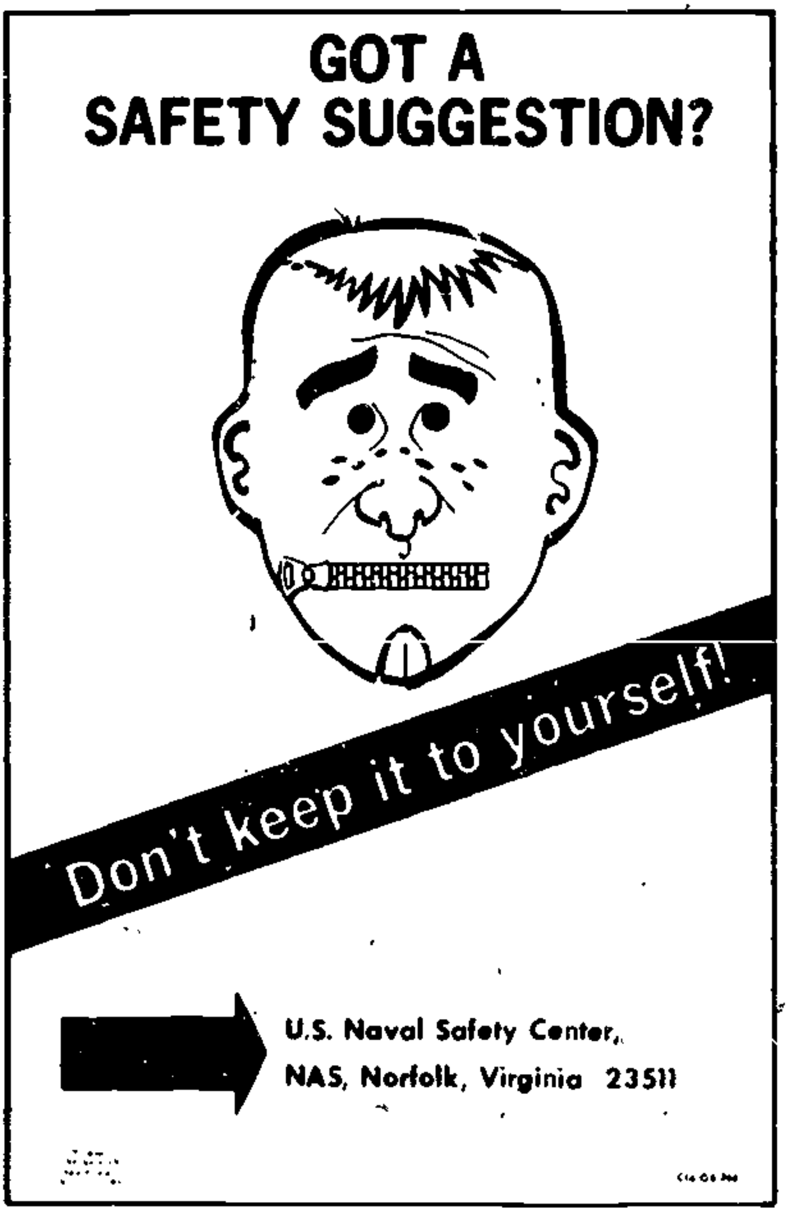
INFORMATION SHEET
LESSON III

Flow Diagram For Troubleshooting The Power Supply For The Six Step Troubleshooting Method




GOT A
SAFETY SUGGESTION?
Don't keep it to yourself!
U.S. Naval Safety Center,
NAS, Norfolk, Virginia 23511

MODULE SEVENTEEN

INTRODUCTION TO THE 6B25 RADIO RECEIVER

STUDY AND PROGRESS CHECK BOOKLET

OVERVIEW
MODULE SEVENTEEN

Introduction to the 6B25 Training Device

This module is designed to acquaint you with the basic radio receiver and the test equipment required to maintain this receiver. In addition you will learn to "signal trace" and "troubleshoot" an AF amplifier using the ICO concept. This sounds like quite a lot, but I assure you, once you have mastered the troubleshooting techniques and the use of test equipment, the door to electronic equipment repair is wide open and can never be closed again. To help you learn and practice these skills, this module has been divided into five lessons:

Introduction	6B25 Radio
Lesson I	Using the Signal Generator
Lesson II	Obtaining a Line Trace
Lesson III	Signal Interpretation
Lesson IV	AF Amplifier ICO Signal Tracing
Lesson V	Troubleshooting an AF Amplifier

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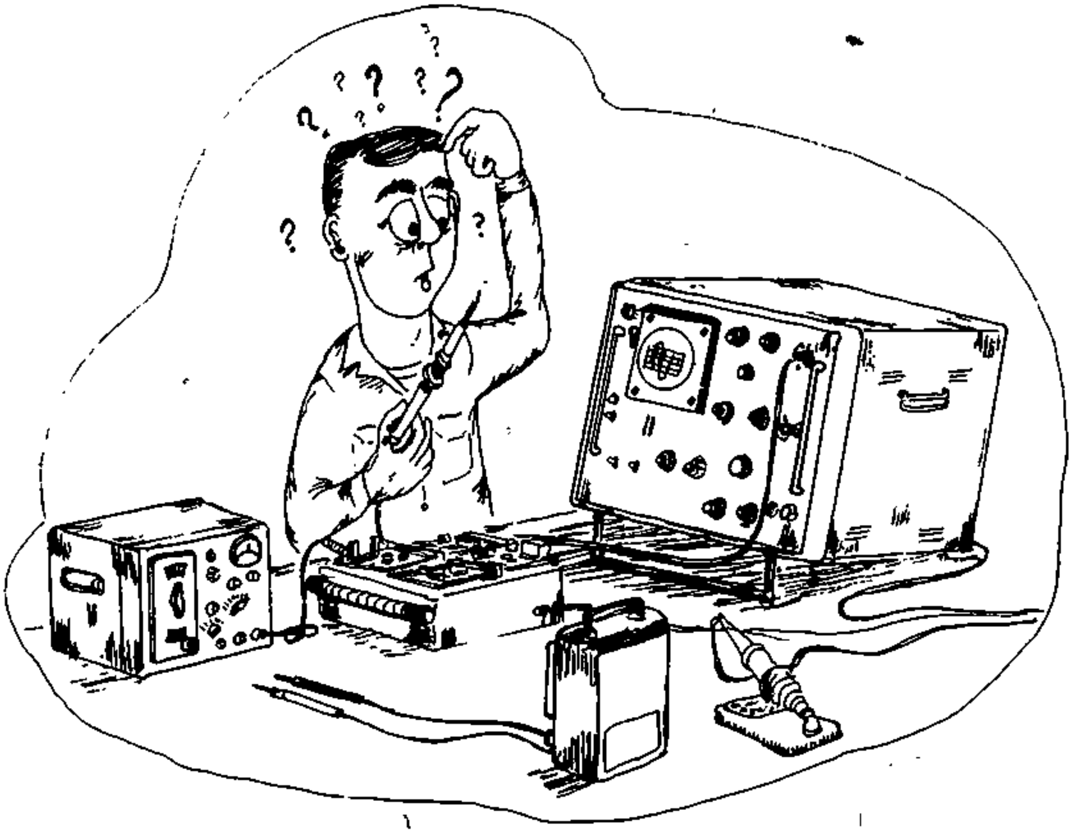
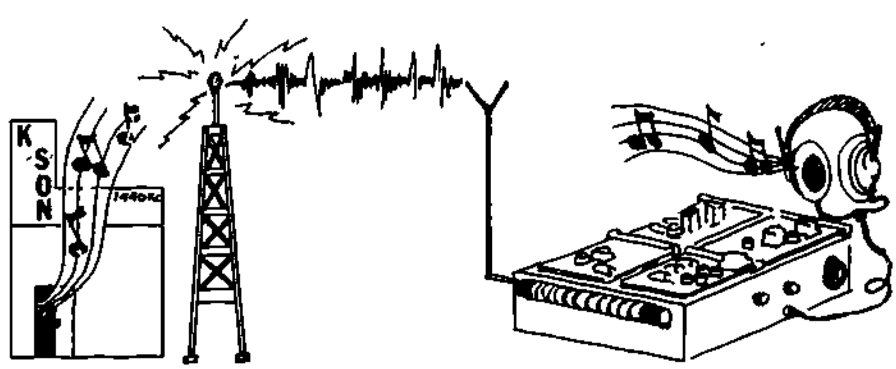
MODULE SEVENTEEN

INTRODUCTION 6B25 RADIO



Have you ever wondered just how a radio receiver works? We all know that a radio station transmits (broadcasts) their programs and the radio receiver picks-up the broadcast. The receiver's antenna takes this signal and sends it to the electronic part of the radio. The electronic part of the radio "<u>does something</u>" that puts sound out of the speaker or headset.



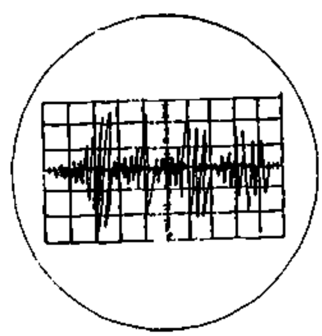
The purpose of these modules is to provide you with an opportunity to apply some of your previous training in electronics to actual "real life" electronic circuits. You will be introduced to new technical terms and concepts, general radio operation, schematics, a typical Navy Technical Manual for a specific radio receiver, and the tools and test equipment necessary to isolate and identify primary circuit malfunctions or failures. Upon finishing the "How to do" and the "What to do" portion of these modules, satisfactory completion of all module objectives will be indicated by your passing a radio receiver system 6825 troubleshooting performance test. Although you are not expected to become an instant master radio repairman--these modules will be a giant step forward in repairing any type of electronic equipment.

The various electronic circuits and their functions cannot be clearly understood without the use of test equipment. As a technician your primary job in the fleet will be the repair and maintenance of electronic equipment. To perform your job well, you must learn how to troubleshoot your equipment. Test equipment is the key. It is easy to determine that a radio does not work when you cannot hear any sound, but in order to fix it, you must isolate the part that failed.

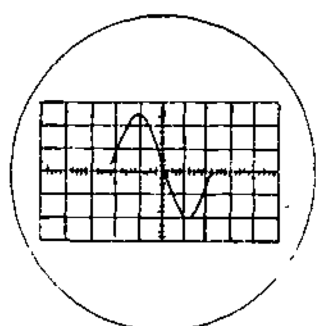
A thorough knowledge of test equipment's capabilities and techniques for proper use are the technician's most important tools in troubleshooting electronic equipment.

A type of test equipment commonly found in the fleet is an oscilloscope. Using a technique called signal tracing, you will use the oscilloscope to troubleshoot the radio receiver. The oscilloscope (sometimes called an "O" scope) has a screen similiar to a TV. It is used to display the waveforms that are found in the different circuits of the radio receiver. This is a great troubleshooting device because if we know what waveform we should have, then we can compare it to the waveform we actually have. ~~If~~ it is the same, the radio must be working up to that point. On the other hand, if it is not the same, as shown below, something must be bad before that point.

<u>A. What we expected to find</u>



<u>B. What we actually found</u>



The multimeter cannot tell us that a difference exists between these waveforms. If we had used it to try to find the trouble, it is likely that we would have missed this malfunction.

Another common type of test equipment is the signal generator. With a signal generator a technician can obtain a known frequency at a known modulation and amplitude. By applying this known standard to a circuit component and then observing the output with an oscilloscope, the technician can determine if the circuit is functioning correctly. The technique of using the signal generator and the oscilloscope will be developed later.

The electronics of the radio can be broken into several blocks or stages. Each block or stage performs one major function. A radio system for sending and receiving signals has been previously broken down to a transmitter and receiver and their functions have been identified. Looking at just the receiver portion of the radio, we can break it up further into five stages.

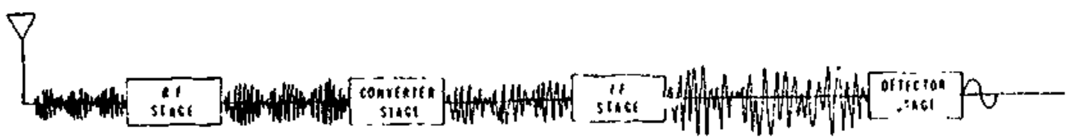
The first stage is called the radio frequency amplifier Stage (RF stage). Radio stations (transmitters) broadcast their programs at some designated high frequency called a radio frequency (RF). The antenna picks up this RF signal and sends it to the RF stage of the receiver which has the primary function of amplifying (making larger) the RF signal.

The output of the RF stage of the receiver is of greater amplitude than the input and is sent to the second stage of the receiver, the converter stage. The converter stage, as the name implies, changes (or converts) the amplified RF signal into a lower frequency signal called the intermediate frequency signal (IF signal). The reduction from the high RF signal to the lower IF signal is done because lower frequency signals are easier to amplify.

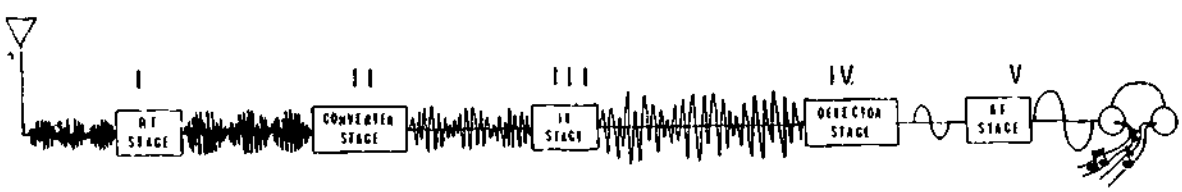
11.

The IF signal from the converter stage of the receiver is then sent to the next stage for amplification. The third stage is called the IF amplifier stage. It's function is to enlarge the IF signal received from the converter.

The amplified IF signal is then sent to the fourth stage, called the detector stage, which converts the IF signal to an audio frequency signal (AF signal).



The audio frequency stage (AF stage) amplifies the output of the detector stage to drive the speaker or headset.



You have now been exposed to the five functional stages of the 6B25 Training Device. In subsequent instruction you will be given each block or stage to examine in more detail. In the next lesson you will receive basic test equipment usage (signal generator and oscilloscope) and a more detailed breakdown of the AF stage.

MODULE SEVENTEEN

LESSON I

USING A SIGNAL GENERATOR

OVERVIEW
LESSON I

Using a Signal Generator for Signal Injection

In this lesson you will learn to set up an AN/URM-25 Signal Generator to inject an audio signal into a circuit. It is imperative that you understand the use of this equipment fully as the signal generator is one of your most important tools in troubleshooting.

There are several choices of media you may use to effectively learn this subject. If you need any of these sources, do not hesitate to utilize them to the fullest extent.

BEFORE YOU START THIS LESSON, PREVIEW THE LIST OF STUDY RESOURCES ON THE NEXT PAGE.

LIST OF STUDY RESOURCES
LESSON I

Using a Signal Generator for Signal Injection

The following materials are available for this lesson. You may choose, according to your needs and past experience, from:

STUDY AND PROGRESS CHECK BOOKLET:
- Lesson Narrative
- Lesson Summary

AUDIO/VISUAL:
- Static/Motion - "Using the AN/URM-25 Signal Generator"

REFERENCE MATERIAL:
- NAVSHIPS 92134(A) Instruction Book for R.F. Signal Generator Set AN/URM-25

IT IS HIGHLY RECOMMENDED THAT THE STATIC/MOTION PROGRAM BE VIEWED IN ORDER TO COMPLETE THIS LESSON.

YOU MAY NOW STUDY ANY OR ALL OF THE RESOURCES LISTED ABOVE.

NARRATIVE
LESSON I

Using a Signal Generator for Signal Injection

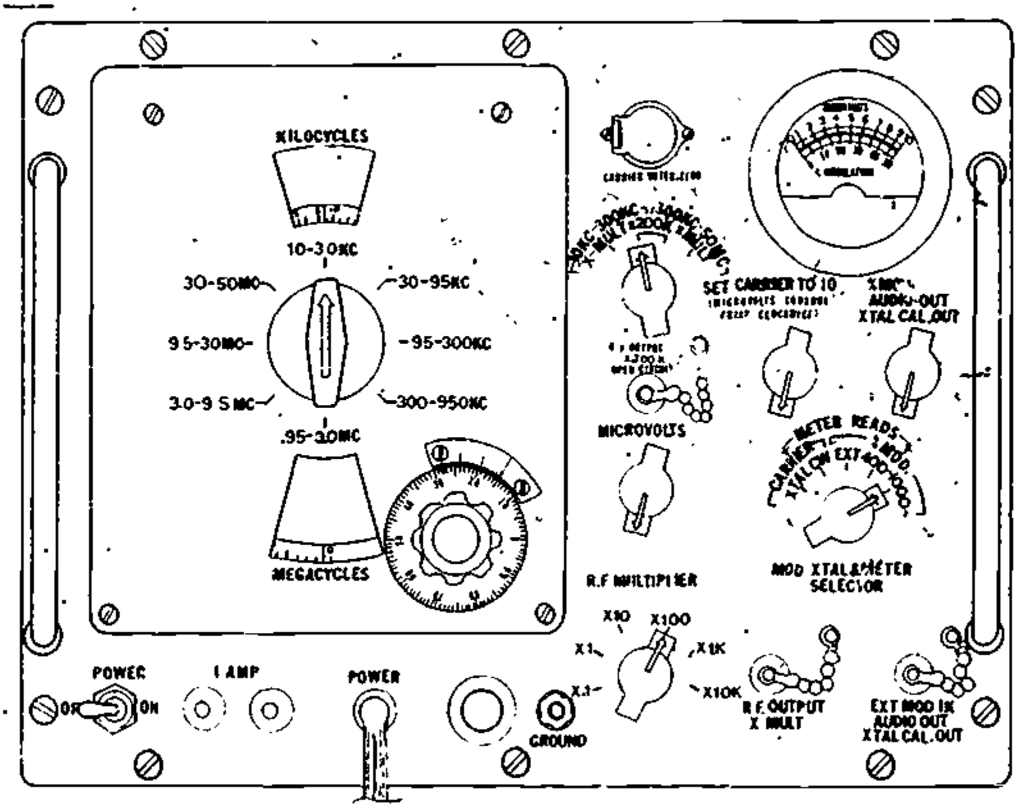
The AN/URM-25 Signal Generator is a device used to generate audio frequency and radio frequency signals. This device is a very common piece of test equipment in the fleet. Its primary use is to inject signals into actual electronic circuits for use in troubleshooting. As you may have learned in the past, troubleshooting is far easier when you have a known signal input with which to compare the output signal.

In this lesson you will learn how to set up the AN/URM-25 Signal Generator to inject a signal with a known voltage amplitude at a known frequency. The way you will accomplish this is to actually perform some task while going through the narrative. Each time the narrative describes a step, you will do the same step on the equipment.

GO TO A LAB CARREL TO DO THIS NARRATIVE.

The first thing to do is to remove the front cover of the signal generator by releasing the four latches. Then lay the cover to the side. Look at the power switch - Is it off? If not, turn it to the OFF position. Now plug the power cord into a 115V 60 Hz receptacle.

Using the illustration below locate these three controls; Microvolts Control, Carrier Control (it will be labeled SET CARRIER TO 10), and AUDIO OUT.



Now find these controls on the signal generator. Turn them all fully counterclockwise, then turn the power switch to the ON position.

Look at the front panel of the AN/URM-25 Signal Generator and you will see that the controls are grouped into roughly two sections. The raised section on the left side of the panel has controls and dials used for setting the FREQUENCY of the output signal. Any frequency between 10 kHz and 50 MHz can be selected by setting the Frequency Band Switch (the knob in the middle of the raised section) to the proper band and then adjusting the Main Frequency Tuning Knob (the one near the bottom of the raised section) so that the exact frequency number appears on either the kilocycle or megacycle dial.

To generate a 13 kHz signal, turn the Frequency Band Switch so that the arrow on the knob points to the 10-30 kHz band position. Next, adjust the Main Frequency Tuning Knob until the number 13 appears under the hairline on the upper dial. Make these adjustments on the signal generator now.

Note: The older term kilocycle (KC) has been replaced by kilohertz (kHz).

Since we have set the frequency, now all we have to do is adjust the output amplitude. There are two jacks from which we select our output. The one you choose will depend upon how much output you want. The RF OUTPUT X 200 K is located almost directly in the center of the generator. This jack will provide an output of 0-2 V. The other jack is the RF X-MULT. This jack provides an output of .1 microvolts to 100,000 microvolts and it is located at the bottom right hand corner. Locate both of these jacks on the signal generator. To the immediate left of the RF OUTPUT X-MULT is the RF MULTIPLIER switch. Notice it has six (6) positions: X.1, X1, X10, X100, X1K, and X10K. This switch will be used in conjunction with the RF OUTPUT X-MULT jack. The positions and their functions will be explained fully later on in this narrative. Now set the RF Multiplier Switch to X1K.

Next we will look at the Meter, located in the upper right corner. You will notice that the Meter has two scales - the upper scale is used to adjust for signal amplitude and the lower scale is used to adjust for percent of the modulation.

Immediately to the left of the Meter is the Carrier Range switch. This switch will be set to one of four positions depending upon the output frequency and the output jack. The four positions are:

X200K Jack	10KC - 300KC
	300KC - 50MC
X-MULT-Jack	10KC - 300KC
	300KC - 50MC

Now set the Carrier Range switch on X-MULT 10KC - 300KC to provide 13 kHz at the X-MULT jack.

The next control is the Meter Selector switch. This is a five position switch in the lower right corner. Locate this switch on your signal generator. The Meter Selector switch must be set in one of the five positions: Crystal - for frequency calibration in the higher frequencies; CW - for a Continuous Wave signal which is not modulated; Ext - for external modulation of some frequency other than 400 Hz or 1000 Hz; 400 Hz - for internal modulation; and 1000 Hz - for internal modulation. We will use this switch in the CW (Continuous Wave) position. Place the Meter Selector switch in the CW position.

The Audio Out control establishes the percent of modulation when the Meter Selector switch is in the Ext, 400, and 1000 Hz positions. We will leave this control turned fully counterclockwise.

The Carrier control sets the level of carrier in the output. It will always be set to indicate 10 on the Meter when the Microvolts control is fully clockwise.

The Microvolts control establishes the amount of output amplitude. To set the output, first turn the Microvolts control fully clockwise, set the Carrier control to 10 on the meter's microvolts scale (upper scale) and go back to the Microvolts control to adjust for the desired output. Set the output for 1 microvolt.

Note: The Carrier control setting should be checked each time the frequency is changed.

Remember the R.F. Multiplier switch? We set it on X1K. What this switch does is multiply the value on the meter by what is shown by the position of the RF Multiplier switch. (Don't forget your powers of ten). Let's see now, if we have 1 microvolt on the meter and the switch reads X1K that's $(1 \times 10^{-6}) \times (1 \times 10^{3}) = 1 \times 10^{-3}$ or 1 millivolt.

At this point we should have 13 kHz at 1 millivolt from the R.F. Output X-Mult jack. Now for a quick review of the controls:

1.	Frequency Band Switch	10-30KC
2.	Main Tuning Dial	13 kHz
3.	R.F. Multiplier	X1K
4.	Carrier Range Switch	10KC-300KC-X-MULT
5.	Meter Selector Switch	CW
6.	Audio Out	Fully Counterclockwise
7.	Carrier Control (Microvolts fully clockwise)	Set to 10
8.	Microvolts control	Set to read 1 Microvolt

If you have made the settings correctly, output at the RF X-MULT jack will be 13 kHz @ 1 millivolt.

THIS COMPLETES THE NARRATIVE FOR LESSON I, MODULE SEVENTEEN.

IF YOU FEEL THAT YOU NEED FURTHER STUDY BEFORE DOING LESSON II, THIS LESSON IS COVERED BY:

SUMMARY AUDIOVISUALS

SUMMARY
LESSON I

Using a Signal Generator for Signal Injection

The AN/URM-25 Signal Generator is a piece of test equipment intended primarily for testing electronic equipment. Test signals, either modulated or unmodulated, can be generated over a continuous range of frequencies from 10 kHz to 50,000 kHz.

The 10 kHz to 50 MHz frequency range is covered by the following eight (8) bands:

1. 10 kHz - 30 kHz
2. 30 kHz - 95 kHz
3. 95 kHz - 300 kHz
4. 300 kHz - 950 kHz
5. .95 MHz - 3.0 MHz
6. 3.0 MHz - 9.5 MHz
7. 9.5 MHz - 30 MHz
8. 30 MHz - 50 MHz

Within each band the desired frequency is tuned using the Main Frequency Tuning Knob.

The voltage output at the RF OUTPUT X-MULT jack is continuously variable from .1 microvolt to 100,000 microvolts providing the probe is properly terminated. Approximately 2 volts open circuit is available at the RF OUTPUT X-200K jack. At both of these jacks the voltage may be varied by means of the Microvolts control.

At the RF OUTPUT X-MULT jack the voltage is also variable by means of the six-step RF Multiplier switch.

1. X.1
2. X 1
3. X 10
4. X 100
5. X 1K
6. X 10K

When initially setting up the AN/URM-25 signal generator or when changing the output frequency, you must always:

1. rotate the Microvolts control fully clockwise

2. using the Carrier control, set the carrier to 10 on the Meter microvolts scale

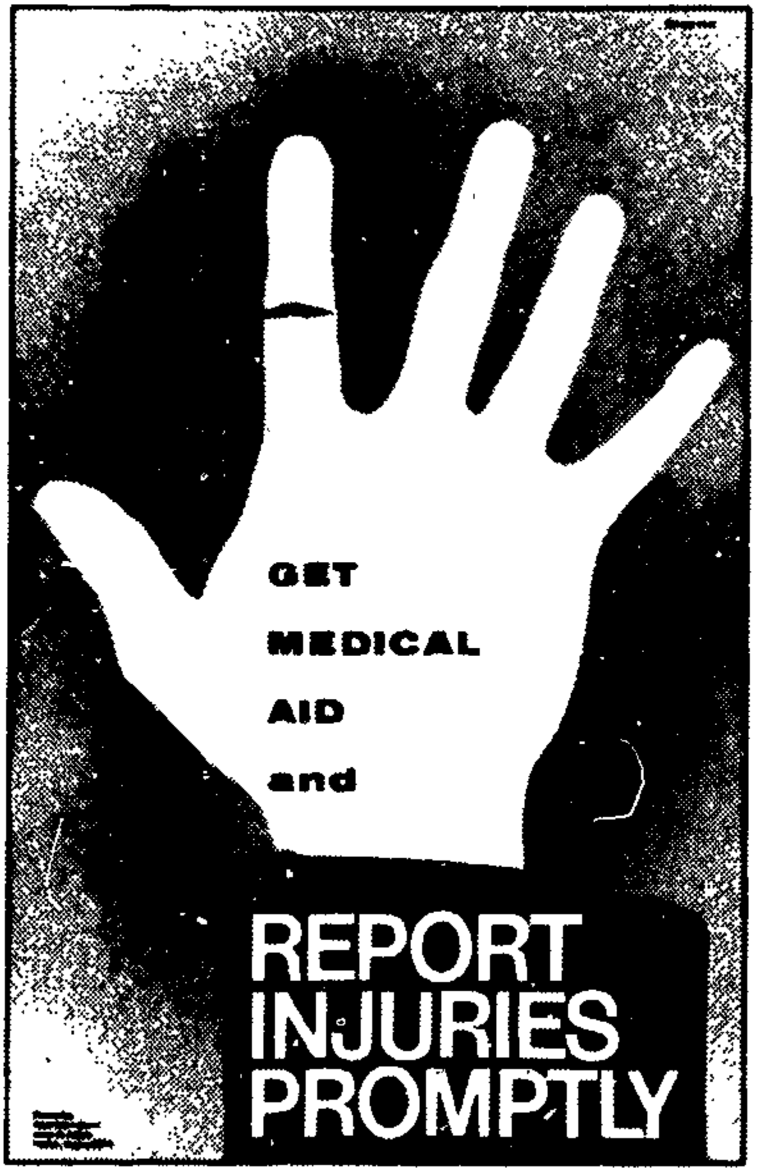
3. using the Microvolts control adjust for the desired voltage output on the Meter

4. Place the Carrier Range switch in the correct position depending upon the output jack and frequency utilized.

THIS COMPLETES THE SUMMARY FOR LESSON I, MODULE SEVENTEEN.

IF YOU FEEL THAT YOU NEED FURTHER STUDY BEFORE GOING TO LESSON II, THIS LESSON IS COVERED BY:

NARRATIVE AUDIOVISUALS



12b

MODULE SEVENTEEN

LESSON II

OBTAINING A LINE TRACE

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OVERVIEW
LESSON II

Obtaining a Line Trace

In the previous lesson you learned how to produce a desired frequency and inject it into a circuit. Now you are going to learn how to look at that frequency at the input and output of some circuit. Just what is an Oscilloscope and what does it do?

If we know what frequency and amplitude we are putting into a circuit, and we know what frequency and amplitude we are supposed to be getting out of a circuit, we can use an oscilloscope to see whether or not the circuit is functioning properly.

In this lesson, there also is an excellent audio-visual presentation of the operation of the oscilloscope. This will be of great help to you in understanding the function of each control.

BEFORE YOU START THIS LESSON, PREVIEW THE LIST OF STUDY RESOURCES ON THE NEXT PAGE.

LIST OF STUDY RESOURCES
LESSON II

Obtaining a Line Trace

The following material is available for this lesson. You may choose, according to your needs and past experiences, from:

STUDY AND PROGRESS CHECK BOOKLET:
- Lesson Narrative
- Lesson Summary
- Progress Check P.C. Seventeen II-1 - Obtaining a Line Trace

AUDIO-VISUAL:

Static/Motion - "Obtaining a Line Trace" (Seventeen II-1)

REFERENCE MATERIAL:

NAVSHIPS 95706, Technical Manual for Osci. .scope AN/USM-140B and AN/USM-141A

6B25 Technical Manual

IT IS HIGHLY RECOMMENDED THAT THE STATIC/MOTION PROGRAM BE VIEWED IN ORDER TO COMPLETE THIS LESSON.

YOU MAY NOW STUDY ANY OR ALL OF THE RESOURCES LISTED ABOVE.

NARRATIVE
LESSON II

Obtaining A Line Trace

In this Lesson, you will operate oscilloscope controls and begin to learn their names and their functions. As you follow this narrative, you should operate each control after its operation is described. Near the end of the lesson you will observe the effect the controls have on the oscilloscope presentation.

An oscilloscope is a very complex, precision instrument with some of the characteristics of a television set. Most of the controls and adjustments on a television set are pre-set and then protected from the "knob twisters" so that only the technician can adjust them. The controls and adjustments on an oscilloscope must be accessible; therefore, the operator must be much more than a "knob twister."

When routinely setting up an oscilloscope for use, the first series of steps is to obtain a line trace--always using the proper procedures. Even experts use a series of steps to do this instead of a time-consuming trial and error approach.

Before energizing the oscilloscope, turn the Intensity control fully counterclockwise. This will avoid excessive intensity of the electron beam which may damage the cathode ray tube (CRT).

With the Power switch in the "OFF" position, connect and lock the power cord into its socket on the rear of the oscilloscope case and plug the other end into a grounded 115v AC outlet.

Now turn the Power switch to the "ON" position. The indicator light should come on, and you should hear the cooling motor running.

Place the black Vertical controls for channels A and B so that the indicator dots are up. This action will set these controls near their mid-range position. Next "click" the red channel A and B Polarity switches to the "Positive Up" position.

Now set the black channel A and B Sensitivity controls to the "one volt per centimeter" (1 v/cm) positions. Next set the red channel A and channel B Vernier controls to the "calibrate" position.

CAUTION: Do not force these controls! First turn each control counterclockwise (CCW) a little bit, then slowly clockwise until it "clicks" into the "calibrate" position.

Now set both the Channel A and the Channel B Input switches to the "AC" position.

Next go to the middle portion of the oscilloscope, find the black Horizontal Display switch and place it in the "X1" position. Set the red Vernier control on the same switch to the "calibrate" position, being careful not to force it.

Got it? Okay, now find the black Sweep Time switch and place it in the "1 millisecond/cm" position. Set the red Vernier control on the same switch to the "calibrate" position.

Near the bottom left section of the oscilloscope there are two toggle switches -- Intensity Modulation and Sweep Occurance. Place these in the "normal" position.

Look to the bottom right now. See the Trigger Level control? Turn the black control to the "mid-range" or "Ø" position. Next turn the red Trigger Slope switch to the "positive" position.

Directly to the right is the black Trigger Source control. Place it in the "internal" (INT) position. The red Sweep Mode Control is then turned counterclockwise until it "clicks" into the "Trigger Preset" position.

Directly above the Trigger Source control is the Horizontal Position control. This control will rotate three (3) full turns. Turn the control fully counterclockwise (CCW) and then rotate it clockwise (CW) one and one-half (1 1/2) turns--the white dot should be up.

Now, find the Scale Light control. This control will be set according to room illumination. Go ahead and adjust the control so you can observe the effect on the graticule or grid of the oscilloscope CRT. Set the control so that the grids are barely visible.

To the right of the scale light control is the Vertical Presentation selector. Set the Vertical Presentation selector to "Channel A."

Look to the upper left of the oscilloscope and find the Calibrator switch. Place this switch in the "OFF" position.

With your left hand, depress the Beam Finder button, located directly below the Scale Light Knob, and with your right hand increase the Intensity control until a spot appears. Now, still depressing the Beam Finder, rotate the red Sweep Mode control located in the lower right corner, clockwise until the spot broadens into a line. Keep the Beam Finder depressed and center the trace in the middle of CRT using the Vertical and Horizontal controls. Since you're using Channel "A", use the Vertical Position control for Channel "A". The Horizontal Position control is used for both A and B channels. Release the Beam Finder button. Now adjust the Intensity control to obtain a sweep.

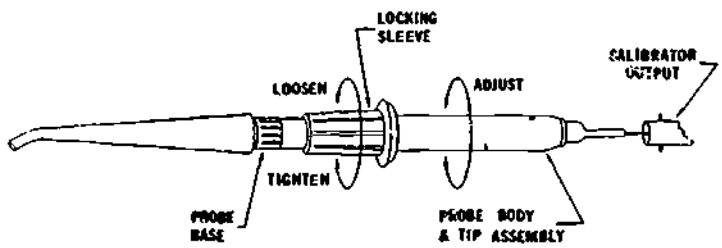
Now that you have a trace you will want to make it as clear and sharp as possible. To do this. adjust the Astigmatism and Focus controls. Don't turn either control fully clockwise or counterclockwise and try to compensate with the other one. It just won't do it.

In order to use the oscilloscope, some means of connecting it to the equipment being tested must be used. For this purpose there are a multitude of different connectors with different tips. Since a 10X probe is often used, you will have to learn how to calibrate one. In the next lesson, you will also learn how to use it effectively in voltage measurements.

Probe values are read on the sleeve of the probe. 10X is the multiplication factor of this probe. What this actually means is that the probe attenuates (divides) the voltage by a ratio of 10:1. When using a 10X probe the voltage measured with the oscilloscope must be multiplied by 10 to compensate for the probe's attenuation.

The probe's capacitance is adjustable so that it can be matched to the oscilloscope with which it is being used. Probe calibration should be checked daily and adjusted as necessary.

The probe is calibrated by unscrewing the locking sleeve (see illustration) about one quarter (1/4) turn and turning the probe body and tip assembly as necessary while holding the probe base.



To calibrate the probe, obtain a line trace on the oscilloscope, then connect the BNC end of the probe to the Channel A Vertical Input jack as the below illustration depicts.
If you have a shielded tip probe, expose the tip by pulling back the spring loaded shleid and hooking the probe tip over the end of it. Now remove the protective cover from the calibrator VOLTS output jack Hold the probe in your left hand and touch the tip to the center conductor of the jack. DO NOT insert the tip into the jack. Inserting the tip will cause conductor to expand and break.

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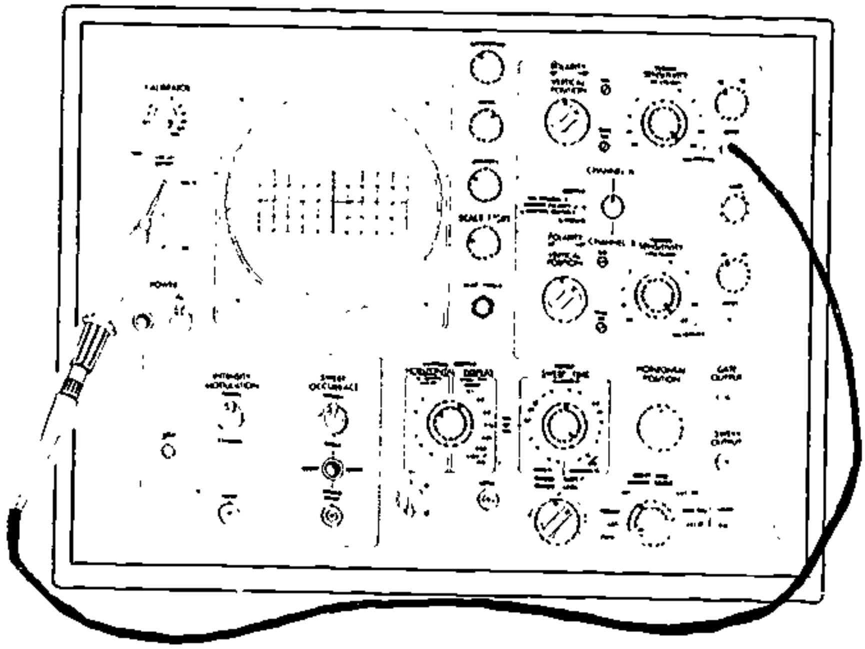
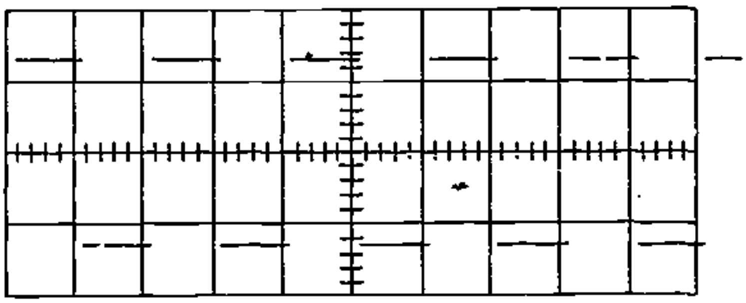
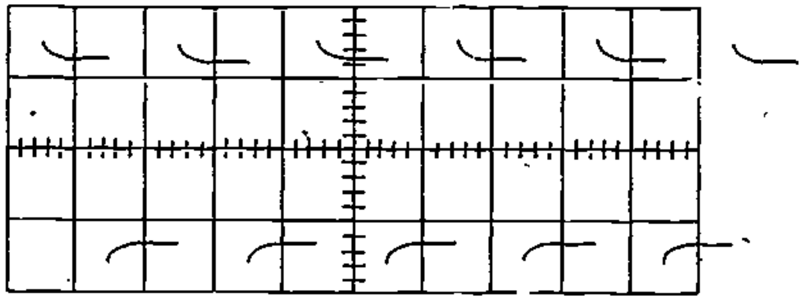


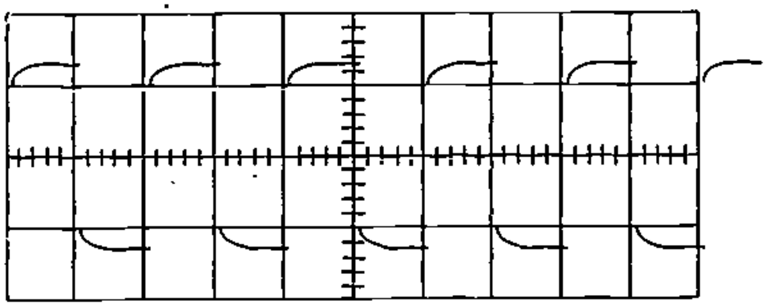
Turn the Calibrator switch to 20 while holding the probe in the jack. Now set the Sweep Time control to .5 millisec/cm. Center the trace vertically so that the negative peaks are on a grid line. The trace will have negative and positive peaks exactly 2 centimeters apart and, if the probe is calibrated, the peaks will be absolutely flat. Note that the signals in the following illustrations are shown off-center; this is done to make the drawings easier to see.



If the probe is over-corrected the sweep will have peaks on the leading edge (see illustration).



If your probe is under-corrected the leading edges will be rounded (see illustration).



To calibrate the probe, hold the adjusting collar with the right hand, loosen the locking sleeve about one quarter (1/4) turn with the left hand. While watching the trace on the CRT, turn the adjusting collar until the peaks are absolutely flat. Now, slowly turn the locking sleeve until it is "finger tight." Look at the waveform to ensure the trace on the CRT hasn't changed while locking the probe.

THIS COMPLETES THE NARRATIVE FOR LESSON II MODULE SEVENTEEN. PROGRESS CHECK P.C. SEVENTEEN II IN THIS BOOKLET COVERS THE PERFORMANCE OBJECTIVES FOR THIS LESSON. IF YOU WISH TO TAKE THE CHECK NOW, SEE YOUR LEARNING SUPERVISOR. IF YOU FEEL THAT YOU NEED FURTHER STUDY BEFORE YOU DO SO, THIS LESSON IS COVERED BY:

SUMMARY AUDIOVISUALS

SUMMARY
LESSON II

Obtaining a Line Trace

In order for you to become an effective troubleshooter, you must be familiar with the operation of an oscilloscope; therefore, you must also have a working knowledge of the controls and their functions. In many cases troubleshooting is delayed due to a person's inability to use test equipment effectively. Sometimes a "technician" can't even get a line trace, so he will not use an oscilloscope, one of the most helpful pieces of test equipment.

If you have used an oscilloscope you will probably be familiar with such controls as Sensitivity, Horizontal and Vertical Position, Sweep Time, Trigger, Horizontal Display, Focus, Astigmatism, Intensity, and Channel Selector.

Listed below is the suggested sequence of control manipulation for obtaining a line trace:

1. Intensity - CCW
2. Power - OFF
3. Line cord - ATTACH BOTH ENDS
4. Power - ON
5. Channel selector - CHANNEL A
6. Trigger Source - INT
7. Sweep Mode - FREE RUN
8. Horizontal Display - X1 (Internal Sweep Magnifier)
9. Sweep Time - 1 milliseconds/cm
10. Sweep Time Vernier - CW to CAL
11. Sweep Occurance - NORMAL
    Intensity Modulation - NORMAL
12. Beamfinder - PUSH
    Horizontal Position - Adjust as necessary
    Vertical Position - Adjust as necessary
    Intensity - CW as necessary
13. Intensity - Adjust for clear trace
    Focus - Adjust for clear trace
    Astigmatism - Adjust for clear trace

14. Sensitivity - 1 volt/cm

15. Sensitivity Vernier - CW to CAL

16. Polarity - + UP

17. Input Coupling - AC

18. Scale light - Adjust as necessary

Once you have obtained a line trace, you should check your probe to ensure that it is calibrated. Use the calibrator output section of the oscilloscope. If there is not a perfectly flat square wave, calibrate the probe by loosening the locking sleeve and turning the adjusting collar to obtain a flat square wave.

THIS COMPLETES THE SUMMARY FOR LESSON II, MODULE SEVENTEEN. PROGRESS CHECK P.C. SEVENTEEN II IN THIS BOOKLET COVERS THE PERFORMANCE OBJECTIVES FOR THIS LESSON. IF YOU WISH TO TAKE THE PROGRESS CHECK NOW, SEE YOUR LEARNING SUPERVISOR. IF YOU FEEL THAT YOU NEED FURTHER STUDY BEFORE YOU DO SO, THIS LESSON IS COVERED BY:

NARRATIVE ✓ AUDIOVISUALS

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PROGRESS CHECK
LESSON II

Obtaining A Line Trace

This Progress Check is designed to determine whether or not you can obtain a line trace within ten minutes.

Turn all the knobs on the face of the oscilloscope counterclockwise (ccw), then begin timing yourself.

Indicate, in the spaces provided, the settings you made for the indicated control.

Time Started: ____________ Time Finished: ____________

1. Sensitivity Control ____________________
2. Horizontal Display ____________________
3. Sweep Time Control ____________________
4. Sweep Occurance ____________________
5. Trigger Source ____________________

WHEN YOU HAVE OBTAINED A LINE TRACE ON YOUR OSCILLOSCOPE CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO MODULE SEVENTEEN LESSON III.

IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR.


makeshift
platforms
could be your
Down
fall

MODULE SEVENTEEN

LESSON III

SIGNAL INTERPRETATION

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OVERVIEW
LESSON III

Signal Interpretation

In the previous lesson you learned how to obtain a line trace with the AN/USM-140 oscilloscope.

In this lesson you will learn how to interpret wave forms.

BEFORE YOU START THIS LESSON, PREVIEW THE LIST OF STUDY RESOURCES ON THE NEXT PAGE.

LIST OF STUDY RESOURCES
LESSON III

Signal Interpretation

The following material is available for this lesson. You may choose, according to your needs and past experience, from:

STUDY AND PROGRESS CHECK BOOKLET:
- Lesson Narrative
- Lesson Summary
- Progress Check P.C. Seventeen-III "Signal Interpretation"
- Practice Sheet Seventeen-III "Signal Interpretation"

AUDIO-VISUAL:
- Static/Motion - Seventeen-III "Voltage Measurement"

REFERENCE MATERIAL:
- NAVSHIPS 95706, Technical Manual for Oscilloscope AN/USM-140B and AN/USM-141A
- 6B25 Technical Manual

IT IS HIGHLY RECOMMENDED THAT THE STATIC/MOTION PROGRAM BE VIEWED IN ORDER TO COMPLETE THIS LESSON.

YOU MAY NOW STUDY ANY OR ALL OF THE RESOURCES LISTED ABOVE.

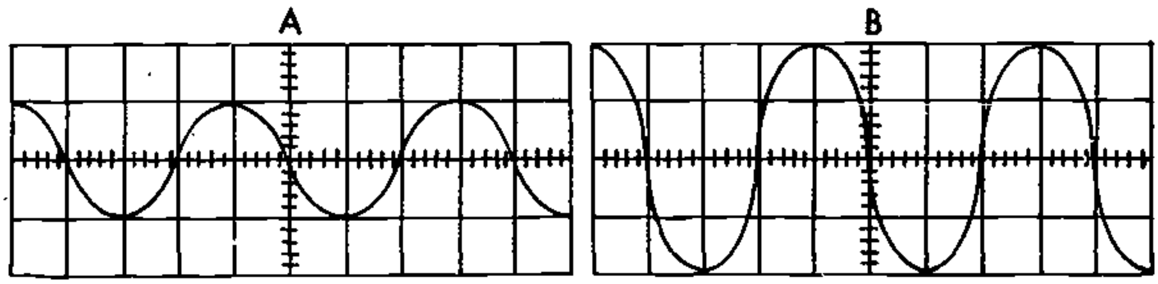
NARRATIVE
LESSON III

Signal Interpretation

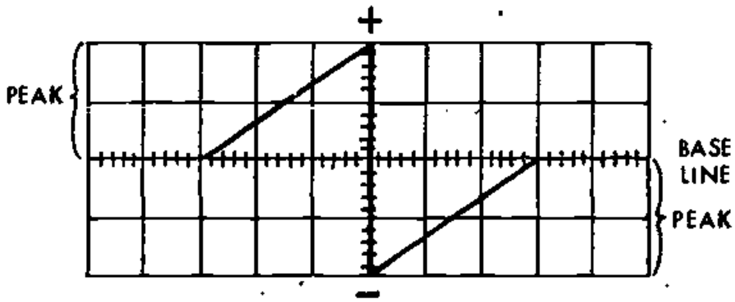
Now that you have learned how to obtain a line trace on the AN/USM-140 oscilloscope and have observed a square wave, it is time to learn how to interpret waveforms. In order to troubleshoot effectively, you must be able to determine the voltage amplitude of a waveform present at a given point so that you can compare it to what you should have.

You will be using the AN/USM-140 oscilloscope during this lesson, so follow the correct procedures to energize the oscilloscope and let it warm up.

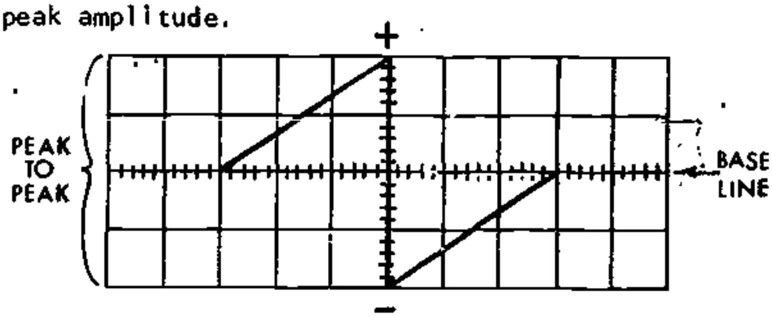
The shape of a waveform tells you something about what is going on in the circuit. With this oscilloscope you can make accurate peak-to-peak voltage measurements. From your previous training, you should remember some characteristics of waveforms. For example, we know that example B has the greatest amplitude.



A wave has both a peak amplitude



and a peak-to-peak amplitude.

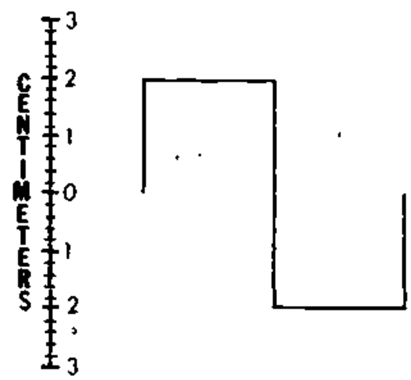


The peak amplitude is measured from the base line to the top of the positive peak or from the base line to the bottom of the negative peak.

The peak-to-peak amplitude is measured just as its name implies; from the top of the positive peak to the bottom of the negative peak.

What is the peak-to-peak amplitude (in centimeters) of the waveform illustrated below?

1. ______________________________ cm



- -

4 cm

When you are indicating peak-to-peak voltages, always include the letters "p-p" after your answer. This will clarify and identify what type of voltage measurements you have made.

Now you are going to use the oscilloscope. Follow the standard procedures for obtaining a line trace. Connect and calibrate the 10:1 (X10) probe. (If you have difficulty in doing either of these, review Lesson II. If you are still having trouble, see your Learning Supervisor.)

Hold the 10:1 (X10) probe to the calibrator circuit Volts Output jack and turn the Calibrator control to the 20 position.

With the Channel A Sensitivity control in the 1 volt per centimeter position, you should have a square wave that measures 2 centimeters peak-to-peak. If not, check your control settings and then ask your Learning Supervisor for help if needed.

Now you must learn how to calculate the amount of input voltage shown on the scope face. This is done by multiplying the peak-to-peak measurement in centimeters by the sensitivity setting and the probe attenuation value.

Example: Height (p-p) x Sensitivity x Probe attenuation = Voltage
2 cm x 1 volt/cm x 10 = 20 v p-p

This waveform is from an internal source with a known voltage, so you can check your calculation by reading the setting on the Calibrator control. By setting the Calibrator control to 20, you selected a 20 volt peak-to-peak output.

Now we will use the AN/URM-25 Signal Generator as a signal source so you can practice making voltage measurements with the oscilloscope.

The control set-up and connections are as follows:

a. the Power switch - set it to OFF

b. the Meter Selector switch - set it to 1000 Hz

c. the % Modulation control - set it fully counterclockwise

d. plug in the line cord and energize the signal generator

e. using a double male BNC coaxial cable, patch from the Signal Generator Audio Out jack to the oscilloscope Channel A Input jack

f. set the oscilloscope Channel A Input switch to AC

g. set the Channel A Sensitivity control to 1 volt/cm

h. set Horizontal Display to X1

i. set Sweep Time to 1 millisecond/cm

j. if the line trace is not centered, vertically center it with the Vertical Position control

k. on the signal generator, turn the % Modulation control clockwise very slowly while observing the Meter. Set the output as indicated on the Meter to exactly 10% modulation.

You should now have a 1000 Hz sine wave on the oscilloscope CRT. (If you do not have this waveform on your oscilloscope CRT or if you do not have a line trace, follow the standard procedures for getting a line trace, and repeat steps a through k.

You are now ready to calculate the peak-to-peak voltage of the input signal. Use the Vertical Position control to set the bottom of the negative peak exactly on a major line and the Horizontal Position control to position the top of a positive peak over the fine divisions in the center.

Position your eyes level with the center of the CRT to avoid parallax and then determine the number of centimeters from the bottom of the negative peak to the top of the positive peak.

2. What is the peak to peak amplitude?
   ________________ cm ________________ volts p-p

- -

1.1 - 1.7 cm, 1.1 - 1.7 volts p-p

You are now ready to change the input voltage and practice reading and calculating voltages.

a. set the % Modulation control to 20
b. set the Channel A Sensitivity control to 10

You should now have a waveform of very small amplitude on the oscilloscope.

3. What is the peak-to-peak voltage of the waveform?

- -

3-4 volts p-p

You have just read a voltage with a small amplitude to give you practice. When possible, you should use the largest amplitude that stays on the graticule (CRT face) so that your reading will be more accurate. To illustrate this, change the Channel A Sensitivity control to obtain the most accurate reading.

4. What is the peak-to-peak voltage of the waveform?

- -

2-3 volts p-p

5. To what position is the Channel A Sensitivity control set?

- -

1 volts/cm

This completes the lesson on measuring peak-to-peak voltages with an oscilloscope.

Following standard procedures secure the oscilloscope and signal generator.

THIS COMPLETES THE NARRATIVE FOR LESSON III MODULE SEVENTEEN. PROGRESS CHECK P.C. SEVENTEEN III IN THIS BOOKLET COVERS THE PERFORMANCE OBJECTIVES FOR THIS LESSON. IF YOU WISH TO CHECK YOUR KNOWLEDGE OF THIS MATERIAL, YOU MAY TAKE THE PROGRESS CHECK NOW. IF YOU FEEL THAT YOU NEED FURTHER STUDY BEFORE YOU DO SO, THIS LESSON IS COVERED BY:

SUMMARY
PRACTICE SHEET
AUDIOVISUALS

SUMMARY
LESSON III

Signal Interpretation

In troubleshooting electronic equipment it is necessary to obtain voltage measurements and compare various waveforms using an oscilloscope. As a result it is important that you acquire sufficient skill in effectively utilizing this testing device.

An oscilloscope can display only peak-to-peak voltages. In this lesson we will learn to interpret and calculate peak-to-peak voltage measurements.

Peak-to-peak is defined as the distance from the top of the positive going portion of the waveform to the bottom of the negative going portion of the waveform. In other words, it is the overall amplitude of a waveform.

On the AN/USM-140 Oscilloscope the graticule (grid on the CRT face) is divided into centimeters. If there is a waveform whose peak-to-peak amplitude measures two of these spaces, we can say the amplitude is 2 cm. Now we must convert centimeters to volts. The sensitivity control has ten positions, each indicating a certain number of volts per centimeter. Another factor we must take into consideration is the attenuation factor of the probe--some probes may have an attenuation factor of 10:1 (X10); that is, the voltage is attenuated, or divided, by 10. others may be a 1:1 (X1); they provide no attenuation. There are three factors to consider when calculating voltage: (1) the peak-to-peak amplitude in centimeters, (2) the sensitivity setting, and (3) the amount of probe attenuation. Assume we are viewing a waveform which has caused us to set up the oscilloscope in the following manner: 4 cm peak-to-peak, sensitivity set on 2 v/cm and a probe attentuation of 10:1. To obtain the peak-to-peak voltage we must multiply these factors as shown: 4 cm x 2 v/cm x 10 = 80 v peak-to-peak.

THIS COMPLETES THE SUMMARY FOR LESSON III MODULE SEVENTEEN. PROGRESS CHECK SEVENTEEN III IN THIS BOOKLET COVERS THE PERFORMANCE OBJECTIVES FOR THIS LESSON. IF YOU FEEL THAT YOU NEED FURTHER STUDY BEFORE YOU DO SO, THIS LESSON IS COVERED BY:

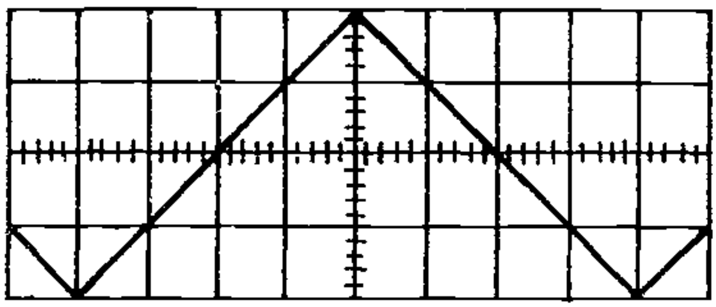
NARRATIVE AUDIOVISUALS
PRACTICE SHEET

PRACTICE SHEET
LESSON III

Peak-to-Peak Voltage Calculations

Calculate the peak-to-peak voltages indicated by the drawings.

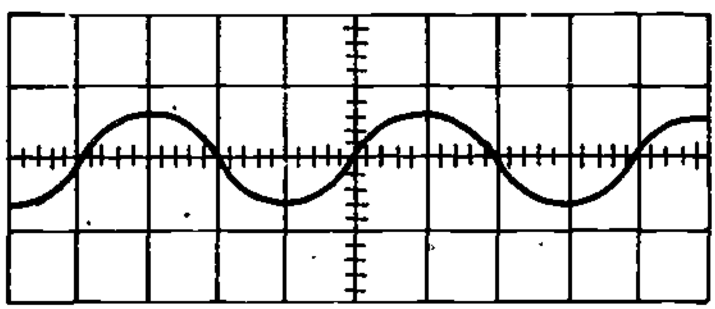
1.



SENSITIVITY = .1 volts/cm
PROBE = 10:1

ANSWER ____________

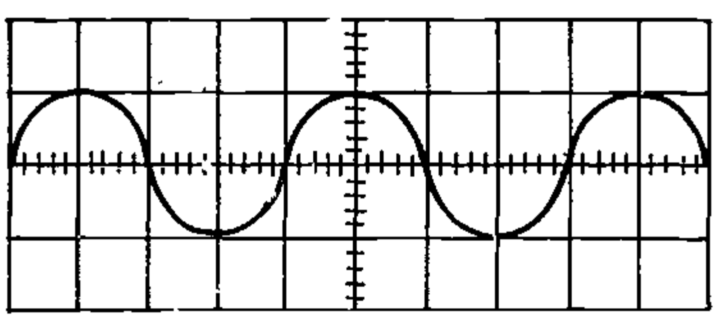
2.



SENSITIVITY = 1 volt/cm
PROBE = 1:1

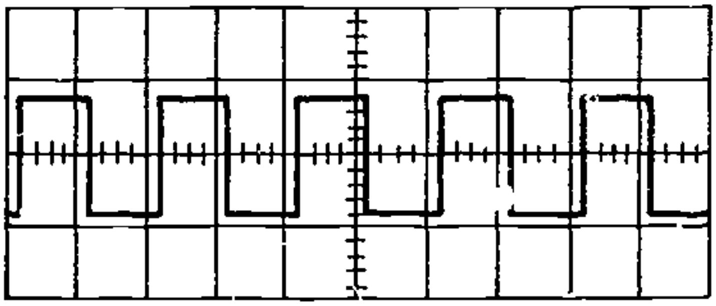
ANSWER ____________

3.



SENSITIVITY = 5 volts/cm
PROBE = 10:1

ANSWER ____________

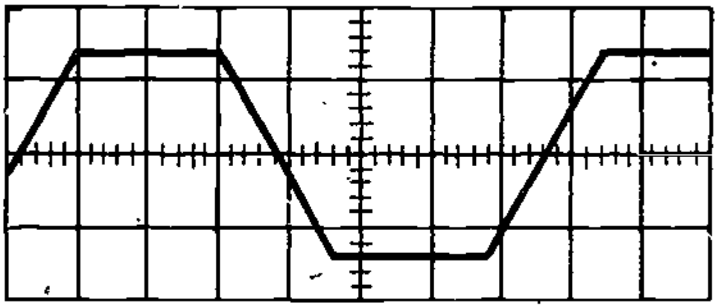


SENSITIVITY = 2 volts/cm
PROBE = 1:1

ANSWER ____________

5.

SENSITIVITY = .02 volts/cm
PROBE = 10:1



ANSWER ____________

CHECK YOUR RESPONSES WITH THE ANSWER PROVIDED IN THE BACK OF THIS BOOKLET.

PROGRESS CHECK
LESSON III
Part 2

Signal Interpretation

In this test you will calculate the peak-to-peak voltage of various waveforms. You will be required to set up and use the oscilloscope to make your voltage calculations. Your answers must be accurate to ± 5%.

Connect the test probe to the designated test jack and calculate the peak-to-peak voltage.

Jack #1 = ____________

Jack #2 = ____________

Jack #3 = ____________

Jack #4 = ____________

Jack #5 = ____________

The use of correct procedures for securing the oscilloscope is also a part of this test.

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON IV.

IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR.

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AV RESPONSE SHEET
LESSON III

Measuring Voltage With An Oscilloscope

1. What is the peak to peak amplitude in centimeters?

_______________________________ cm.

2. What is the peak to peak amplitude in centimeters?

_______________________________ cm.

3. What is the peak to peak voltage of the waveform?

_______________________________ Vpp.

4. What is the peak to peak voltage of the waveform?

_______________________________ Vpp.

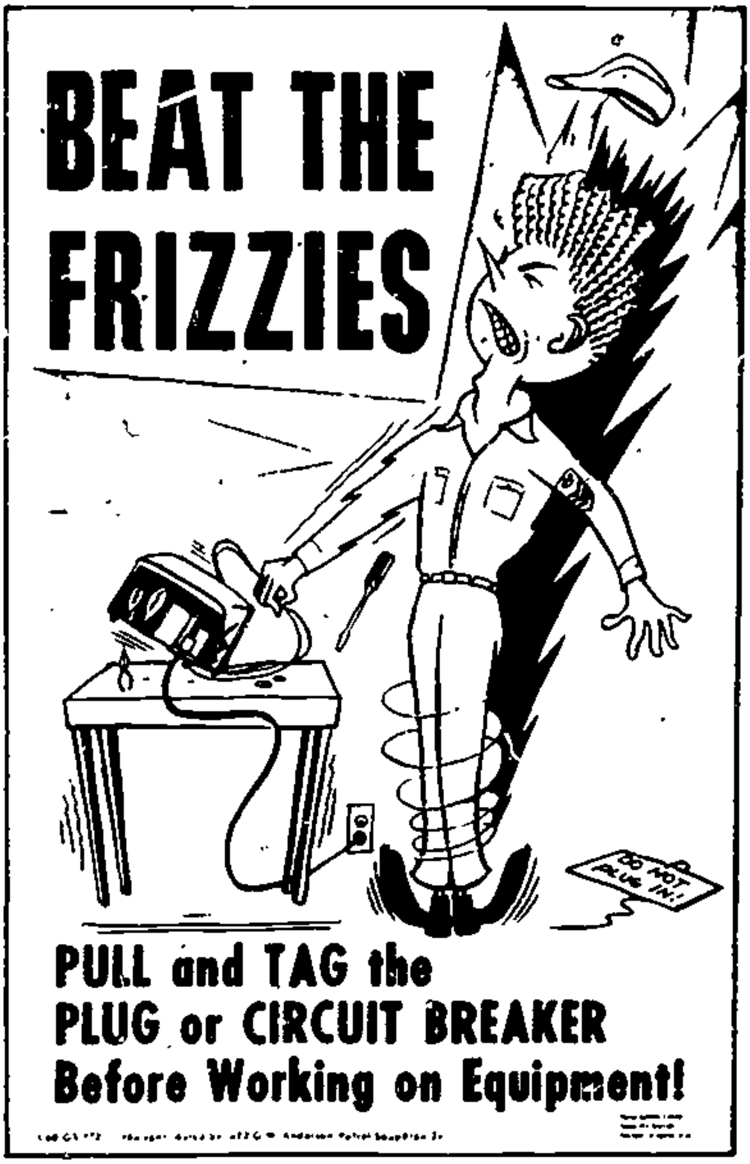
5. What is the peak to peak voltage of the waveform?

_______________________________ Vpp.

6. To what position is the channel A sensitivity control set?

_______________________________ Volts/Centimeter

The answers to this response sheet are provided in the back of this book.


BEAT THE FRIZZIES
DO NOT PLUG IN!
PULL and TAG the
PLUG or CIRCUIT BREAKER
Before Working on Equipment!

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MODULE SEVENTEEN

LESSON IV

AUDIO FREQUENCY AMPLIFIER AND SIGNAL TRACING

OVERVIEW
LESSON IV

Audio Frequency Amplifier ICO Signal Tracing

The primary purpose of this lesson is to:

1. Familiarize you with the functional operation (what it does) of the Audio Amplifier Section of the 6B25 Training Device.

2. Teach the proper use of test equipment for signal tracing the audio amplifier section of the 6B25 Training Device.

3. Teach the proper techniques for component and/or test point location using a Navy-type technical manual.

To accomplish these objectives, you will be introduced to some "Paper Tools." These tools include a Navy-type technical manual for the 6B25 training Device, several new electronic terms, and block and schematic diagrams.

BEFORE YOU START THIS LESSON, PREVIEW THE LIST OF STUDY RESOURCES ON THE NEXT PAGE.

LIST OF STUDY RESOURCES
LESSON IV

Audio Frequency Amplifier ICO Signal Tracing

The following material is available for this lesson. You may choose, according to your needs and past experiences, from:

STUDY AND PROGRESS CHECK BOOKLET:
- Lesson Narrative
- Lesson Summary
- Experiment EXP. Seventeen-IV Audio Frequency Amplifier ICO Signal Tracing

AUDIO/VISUAL:
- Static/Motion - "Audio Frequency Amplifier ICO Signal Tracing"

REFERENCE MATERIAL:
- 6B25 Training Device Technical Manual

IT IS HIGHLY RECOMMENDED THAT THE STATIC/MOTION PROGRAM BE VIEWED IN ORDER TO COMPLETE THIS LESSON.

YOU MAY NOW STUDY ANY OR ALL OF THE RESOURCES LISTED ABOVE.

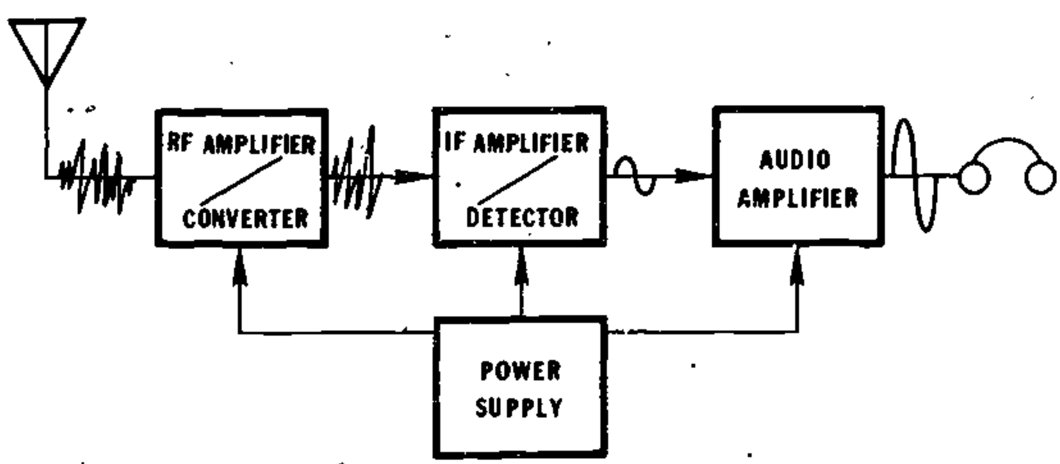
NARRATIVE
LESSON IV

Audio Frequency Amplifier ICO Signal Tracing

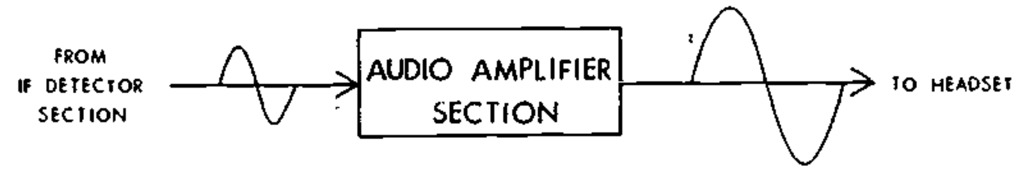
What is an audio frequency amplifier? First, let's define the term audio frequency. Audio frequencies are those frequencies which can be detected (heard) by the human ear. It has been determined by scientists that the human ear is capable of detecting a range of frequencies from 10 Hz to 20,000 Hz. Therefore, mechanical wavefronts (sound) and electrical impulses which are of a frequency between 10 Hz and 20,000 Hz are called audio frequencies.

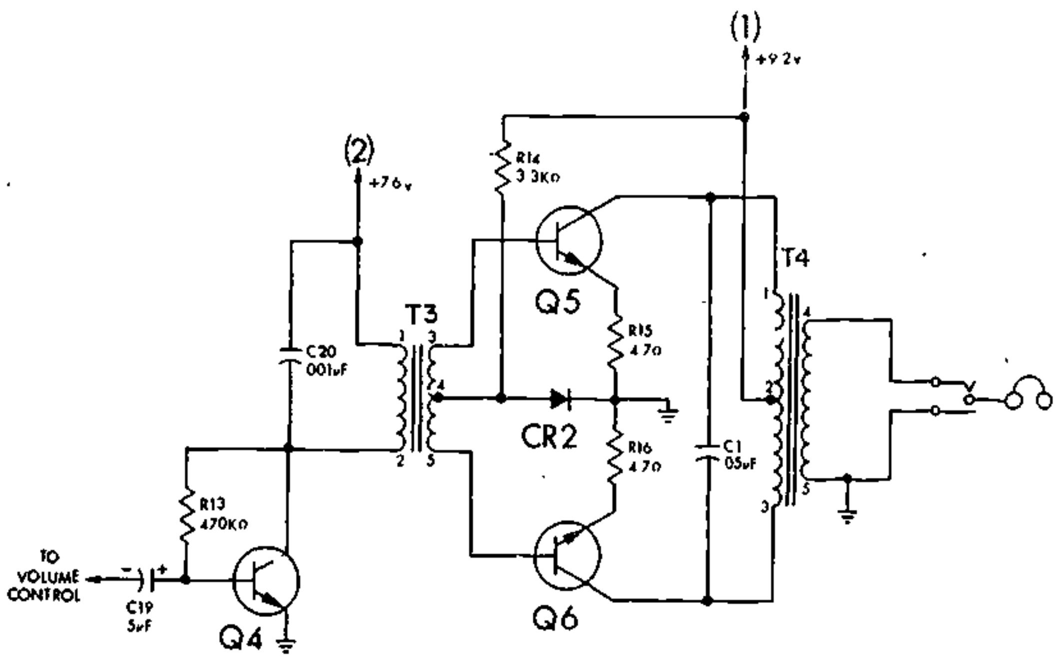
Now that you realize that an audio frequency is any frequency between 10 Hz and 20,000 Hz, you must define the term amplifier. In electronics, an amplifier is a device used to increase the strength of a signal. Electron tubes, transistors, and magnetic units are some of the components used as amplifying devices. Basically, an amplifier transfers additional power to a signal from an external source. This increase in signal power is usually called gain. The power gain may be in voltage or current amplitude, and in many applications both may be increased. In any case, the signal applied to an amplifier will be increased in power. It should be noted that transformers are not amplifying devices. They are capable of increasing voltage amplitude with a consequent loss of current amplitude, and vice versa, but disregarding circuit losses, the power out of a transformer remains the same as the power applied. Now that you understand the terms audio frequency and amplifier it becomes only a matter of combining these two terms to define an audio frequency amplifier. An audio frequency amplifier is a device which increases the strength or power of signals which are in the audio frequency range of 10 Hz to 20,000 Hz.

Telephones, public address systems, record players, and tape recorders are some of the equipments which use audio frequency amplifiers. The 6B25 training device also uses audio frequency amplifiers in its AF (audio frequency) amplifier section. The 6B25 system is subdivided into the following additional sections: the power supply section, the radio frequency (RF) amplifier/converter section, the intermediate frequency (IF) amplifier section.



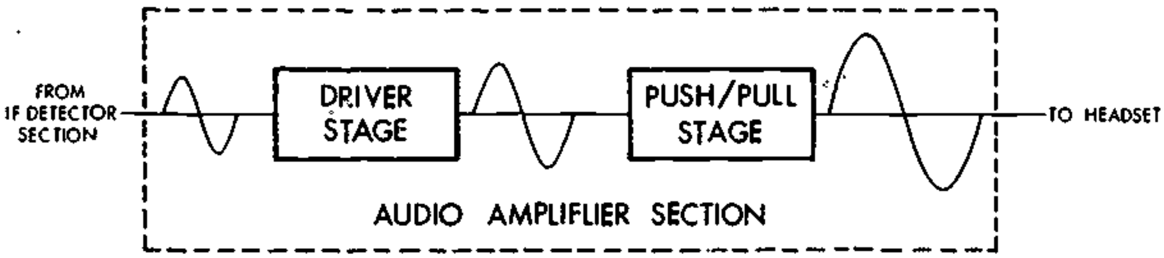
The AF amplifier section receives a very low amplitude audio signal from the IF amplifier/detector section and increases the signal strength (power) to a level sufficient to drive the head set.



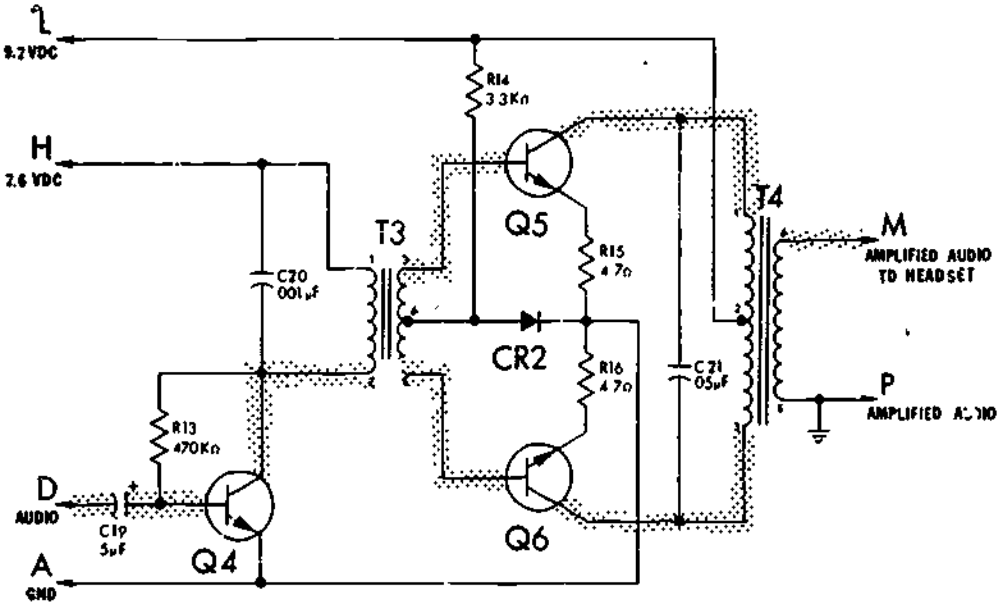


AUDIO SECTION

The AF amplifier section is divided into two parts called stages; the driver stage and the push-pull stage.



AUDIO SECTION



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Note that the two stages are divided at transformer T3. The primary of T3 is the output of the driver stage and the secondary of T3 is the input to the push-pull stage. The function of the driver stage is to increase the power of the small audio signal from the IF amplifier/detector section to a level that will drive the push-pull stage. The function of the push-pull stage is to take the amplified signal from the driver stage and increase its power to a level that will produce sound in a headset. Two stages are used to increase the input signals power sufficiently.

The signal enters the AF amplifier section printed circuit card at pin D of the connector. From there it is coupled through capacitor C19 to transistor Q4. Q4 amplifies the signal and passes it to the primary of transformer T3. The primary of T3, which is a voltage step-down transformer, couples the signal to its secondary which splits the signal and passes it on to transistors Q5 and Q6. Although the signal is taking two different paths, the signal and its conversion are essentially the same. Q5 and Q6 amplify the signal and pass it to the primary of transformer T4 where the two paths again unite. The primary of T4, which is a voltage step-down transformer, couples the signal to its secondary and then on to the headset jack. The signal by this time has the voltage and current amplitude necessary to drive the headset.

THIS COMPLETES THE NARRATIVE FOR LESSON IV MODULE SEVENTEEN. EXPERIMENT EXP. SEVENTEEN IV IN THIS BOOKLET COVERS THE PERFORMANCE OBJECTIVES FOR THIS LESSON. EXPERIMENTS ARE A PART OF THE LESSON PROGRESS CHECKS WHICH YOU MAY TAKE AT ANY TIME. IF YOU WISH TO CHECK YOUR KNOWLEDGE OF THIS MATERIAL YOU MAY TAKE THE EXPERIMENT NOW IF YOU FEEL THAT YOU NEED FURTHER STUDY BEFORE YOU DO SO. THIS LESSON IS COVERED BY:

SUMMARY AUDIO-VISUAL

SUMMARY
LESSON IV

Audio Frequency Amplifier ICO Signal Tracing

The 6B25 audio frequency amplifier is a relatively simple device. It receives an audio signal and amplifies it to a point where it will drive a speaker or a headset producing sound.

When reading the remainder of this Summary, follow along on the 6B25 schematic (located on Figure 6-7 in the 6B25 Radio Receiver Technical Manual).

The signal comes into the audio amplifier at TP18. It is coupled through C-19 to the Base of Q4. Q4 amplifies the signal which continues on through step-down transformer T3. (The amplified signal can be seen at TP19.) The signal is coupled through T3 to the bases of both Q5 and Q6. (Q5 & Q6 make up a push-pull amplifier.) The signal at TP20 and TP21 will be of the same waveform and amplitude because of the balanced components forming the push-pull. The amplified signals at TP22 & TP23 also will be of the same waveform and amplitude. The end product (actual audio) can be seen at TP24 after it is coupled through T4. T4 is also a step-down transformer.

NOTE: If you feel this brief summary is sufficient for you to troubleshoot the audio section, proceed to Lesson IV.

THIS COMPLETES THE SUMMARY FOR LESSON IV MODULE SEVENTEEN. EXPERIMENT EXP. SEVENTEEN IV IN THIS BOOKLET COVERS THE PERFORMANCE OBJECTIVES FOR THIS LESSON. IF YOU WISH TO CHECK YOUR ABILITY TO SIGNAL TRACE, YOU MAY DO THE EXPERIMENT NOW. IF YOU FEEL THAT YOU NEED FURTHER STUDY BEFORE YOU DO SO, THIS LESSON IS COVERED BY:

NARRATIVE AUDIO-VISUAL

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EXPERIMENT
LESSON IV

Audio Frequency Amplifier ICO Signal Tracing

Materials:

6B25 Technical Manual
6B25 Training Device System
XI Probes (2 each)
Signal Generator
Oscilloscope

In order to observe the operation of the AF amplifier section, the functioning of each stage and of the primary components within these stages, you will use ICO (input-conversion-output) signal tracing. ICO signal tracing requires the use of a signal generator which produces a known reference input signal and an oscilloscope which is used to observe the input and output signals. You will be able to ascertain the conversion function of the section, stage, or component by comparing the output waveform to the input waveform.

Procedure:

1. Using the standard procedures learned in previous lessons, set up the signal generator and the oscilloscope as follows:

SIGNAL GENERATOR - 13 kHz
CW
10 millivolts

OSCILLOSCOPE -0.02 volts/centimeter sensitivity
0.1 millisecond/centimeter sweep time
Internal trigger.

Connect a XI probe to the RF output X MULT jack on the signal generator. Connect a XI probe to the channel A input jack on the oscilloscope. Touch the two probe tips together to see if you have a signal out of the signal generator. If the waveform display is not synchronized, adjust the oscilloscope Sweep Mode, Trigger Slope, and Sweep Time Vernier controls to stabilize the display. Disconnect the probe tips.

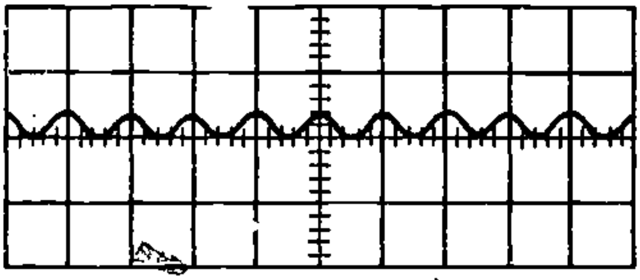
2. You are now going to determine the function of the audio frequency amplifier section using the ICO method.

   a. On your radio, identify and locate the signal input to the audio frequency (AF) amplifier section using the technical manual schematics and pictorials.

b. Connect the signal generator X1 probe to the input of the AF amplifier section. Plug in the 6B25 radio receiver and turn its power switch ON.

Place the Test/Normal switch on the RF card to "Test".

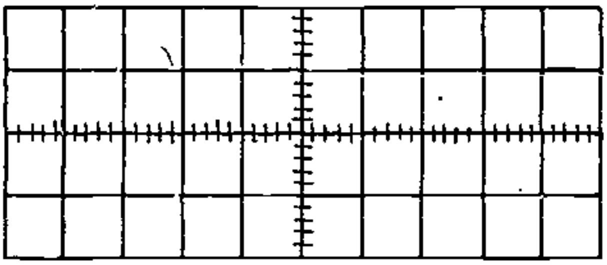
c. Connect the oscilloscope X1 probe to the input of the AF amplifier section. Because the position of the 6B25 volume control has an effect on the amount of signal, turn the volume control fully clockwise, then carefully rotate the micro volt control on the signal generator until the signal displayed on the oscilloscope just fills two small vertical divisions on the oscilloscope face as illustrated below.



This adjustment will set up a standard input amplitude that will not overdrive the AF amplifier section.

Note: The signal generator settings, volume control position, and point of signal injection will remain the same throughout the remainder of this job sheet.

d. On the grid below draw the waveform displayed on your oscilloscope and calculate its peak-to-peak amplitude

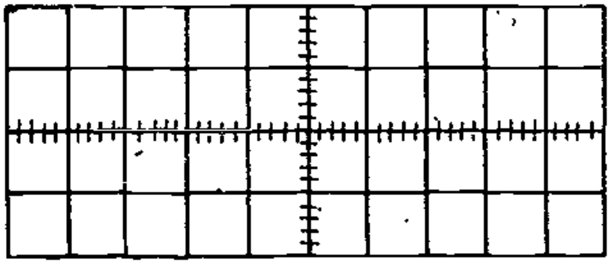


TP 18 signal amplitude ______________ v p-p

e. Identify and locate the AF amplifier section output with the aid of the technical manual schematics and pictorials.

f. Remove the oscilloscope probe from the AF amplifier section input and connect it to the AF amplifier section output. It may be necessary to adjust the oscilloscope sensitivity control in order to get all of the signal displayed within the grid on the scope face.

g. On the grid below, draw the waveform displayed on your oscilloscope and calculate its peak-to-peak amplitude.

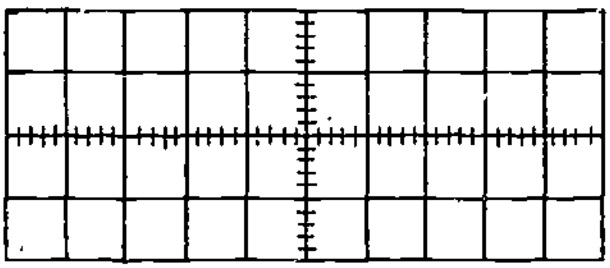


TP 24 signal amplitude ____________ v p-p

h. Compare the waveform shape of the output signal to that of the input signal. The shape should be the same. Now compare the amplitude of the two signals. It should be readily apparent that the output signal has been greatly increased in amplitude as compared to the input signal.

3. You are now going to determine the function of each of the two stages within the AF amplifier section.

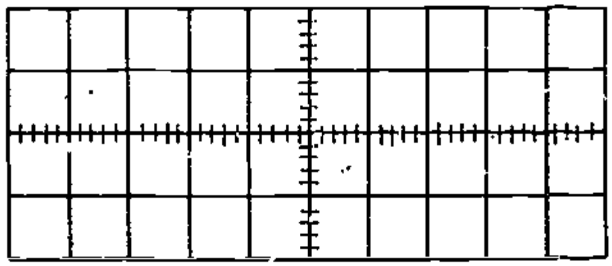
a. The signal generator should still be connected to the input of the driver stage (TP18). In step 2 you have drawn and calculated the peak-to-peak amplitude of this input signal. Using your technical manual, find the output of the driver stage and connect your oscilloscope probe to it. On the grid below draw the waveform displayed on your oscilloscope and calculate its peak-to-peak amplitude.



TP19 signal amplitude ____________ v p-p

b. Compare the shapes and amplitudes of the driver stage input (TP18) and output (TP19). The shape should be the same, but the amplitude of the signal should have increased through the driver stage.

c. Using the technical manual find the inputs to the push-pull stage. Notice that there are two inputs and two signal flow paths which combine in the output. Both paths are identical, so it will make no difference which path you choose to trace. Connect the oscilloscope probe to one of the inputs. On the grid below, draw the waveform displayed on your oscilloscope and calculate its peak-to-peak amplitude.



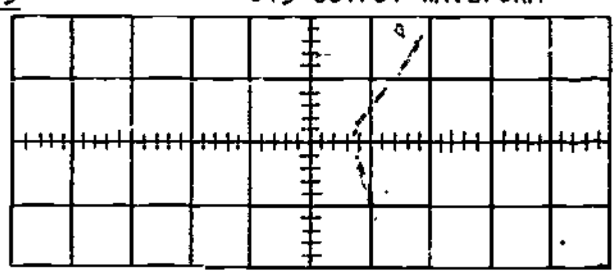
TP20 or TP21 signal amplitude ____________ v p-p

d. The output of the push-pull stage is the same as the output of the AF amplifier section which you measured and recorded in step 2. Compare the shape and amplitude of this output signal to the stage input. The same waveform shape with a increase in signal amplitude should be noted.

Using the ICO signal tracing method, you have seen the operation of the AF amplifier section and the operation of each of the two stages within the section. Your last observations will show you the function of each individual component in the signal flow path of the AF amplifier section.

4. Using the ICO signal tracing method, follow the signal flow path through the AF amplifier. Fill in the blanks and grids below as you proceed.

Component C19 C19 OUTPUT WAVEFORM



C19 output signal amplitude ____________ v p-p.

Output signal shape changed? YES/NO (if YES, describe the change)

____

Output signal amplitude changed? YES/NO (if YES, describe the change)

____

Component Q4

Output signal shape changed? YES/NO (if YES, describe the change)

____

Output signal amplitude changed? YES/NO (if YES, describe the change)

____

Component T3

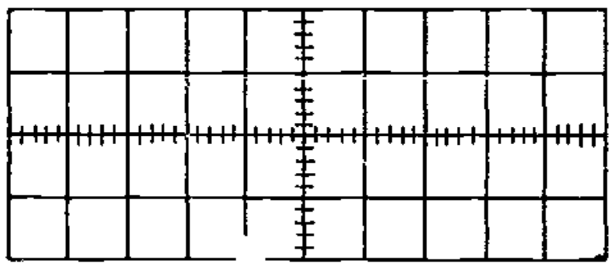
Output signal shape changed? YES/NO (if YES, describe the change)

____

Output signal amplitude changed? YES/NO (if YES, describe the change)

____

Component Q5 or Q6



TP22 or TP23 signal amplitude __________ v p-p

Output signal shape changed? YES/NO (if YES, describe the change)

____

Output signal amplitude changed? YES/NO (if YES, describe the change)

____

Component T4

Output signal shape changed? YES/NO (if YES, describe the change)

____

Output signal amplitude changed? YES/NO (if YES, describe the change)

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON V.

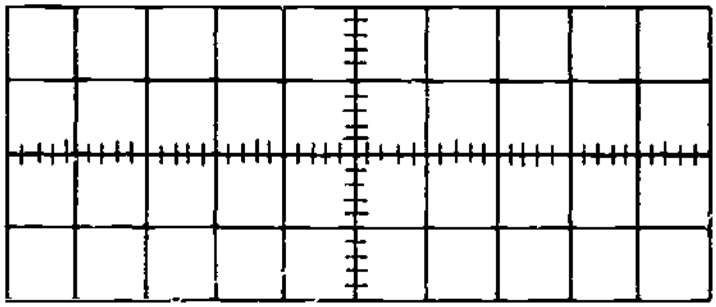
IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR.

THIS COMPLETES THE EXPERIMENT FOR LESSON IV, MODULE SEVENTEEN.

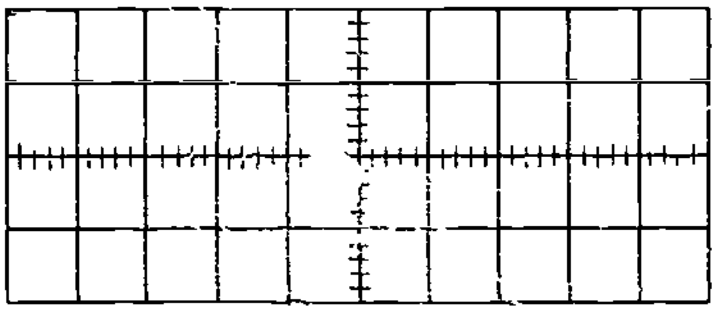
AV RESPONSE SHEET
LESSON IV

Signal Tracing The Audio Frequency Amplifier

1. Draw the waveform displayed on the oscilloscope and calculate its amplitude:

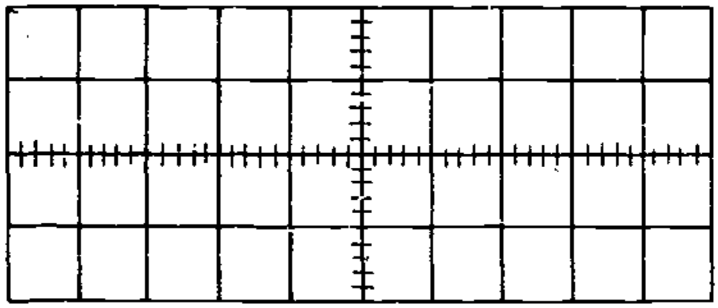


2. Draw the waveform at TP 24 and calculate its amplitude.

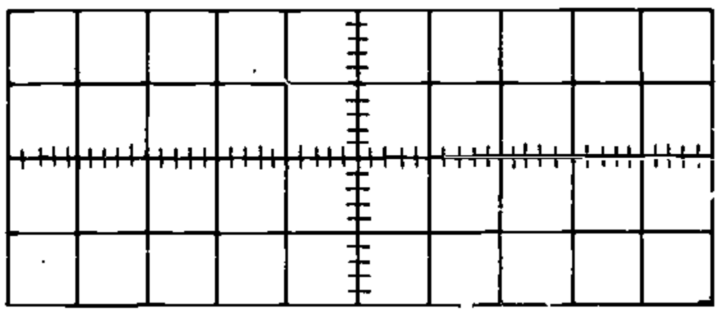


____________________ Volts p-p

3. Draw the waveform at TP19 and calculate the amplitude.

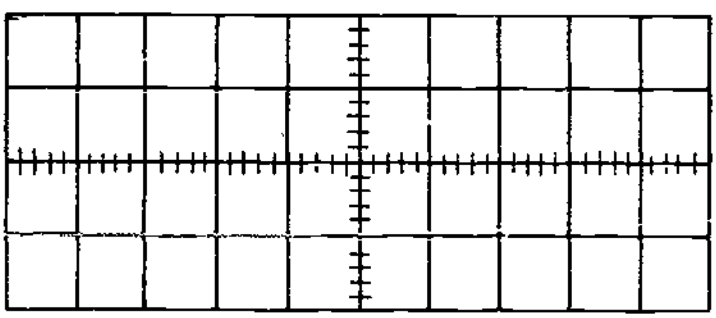


4. Oraw the waveform at TP20 or TP21 and calculate the amplitude.



____________________ volts p-p

5. Draw the waveform at TP22 or TP23 and calculate the amplitude.



____________________ volts p-p

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIOED IN THE BACK OF THIS BOOKLET.

MODULE SEVENTEEN

LESSON V

TROUBLESHOOTING AN AF AMPLIFIER

OVERVIEW
LESSON V

Troubleshooting an AF Amplifier

Now that you have learned how an Audio Frequency Amplifier basically works, it is time to learn something about what to do if it doesn't work. Stated briefly, you are about to troubleshoot the Audio Frequency Amplifier.

The primary purpose of this lesson is to:

(1) Provide a review of the basic troubleshooting techniques.

(2) Provide actual in-circuit use of test equipment.

(3) Locate and correct malfunctions in the Audio Frequency Amplifier of the 6B25 Training Device.

BEFORE YOU START THIS LESSON, PREVIEW THE LIST OF STUDY RESOURCES ON THE NEXT PAGE.

LIST OF STUDY RESOURCES
LESSON V

Troubleshooting an AF Amplifier

The following is a list of study resources for this lesson. You may refer to all or any of them according to your acquired knowledge and/or past experience:

STUDY AND PROGRESS CHECK BOOKLET:
Lesson Narrative
Experiment EXP. Seventeen-V Troubleshooting an AF Amplifier

REFERENCE MATERIAL:
6B25 Radio Receiver Technical Manual

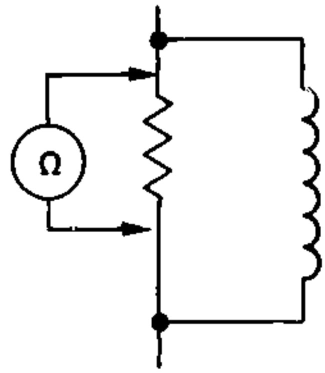
YOU MAY NOW STUDY ANY OR ALL OF THE RESOURCES LISTED ABOVE.

NARRATIVE
LESSON V

Troubleshooting an AF Amplifier

In this and the following modules you will be troubleshooting circuits containing transistors. Using an oscilloscope and a signal generator you can check the input and output of each stage of the 6B25 receiver until you find the defective stage. When you reach this point you will then have to measure voltages and resistances to find the faulty component in that stage. Generally, it is a good idea to first measure voltages, then turn off the power; remove the circuit card, then check resistances.

You learned about basic components (resistors, capacitors, coils, and transformers). Windings usually read very low resistances (nearly short circuits). Trying to read the value of a resistor that is in parallel with a winding is nearly impossible, for the low coil resistance will bypass the DC from the ohmmeter, and the meter will indicate a low value.



For much the same reason, checking resistance values of components connected to transistors requires special care. Two connections on a transistor act just like diodes--that is, they have high resistance to current flow in one direction and low resistance to current in the other direction. To keep these low resistances from leading you astray, always check a suspicious resistance reading by reversing the meter probes. If, for example, you think you have found a shorted resistor connected to a transistor, reverse the meter probes and try again. If the reading is then normal, a transistor probably caused the first reading to be wrong.

To check the transistor itself with an ohmmeter you must also check readings for both directions of current flow. Looking at a transistor from the top like this

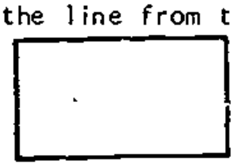
the readings between leads 1 and 3 should be high with the meter probes connected one way and low when they are reversed.

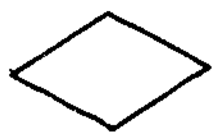
NOTE: Use the Rx100 scale for making these readings. You should get the same kind of readings between points 2 and 3. Most transistors will read a fairly high resistance both ways between leads 1 and 2.

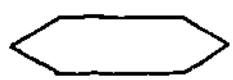
On the following pages you will find a logical flow diagram for troubleshooting the Audio Amplifier section of your radio. You will be required to use a signal generator, an oscilloscope, troubleshooting techniques, a Technical Manual, and the knowledge you have gained concerning the audio section of your receiver. Then you will actually locate a faulty component within the audio amplifier. You will be given two problems to work on. While working with each board and the flow diagram you may refer back to any and all learning material for comparison or evaluation.

INSTRUCTIONS FOR FLOW DIAGRAM USE:

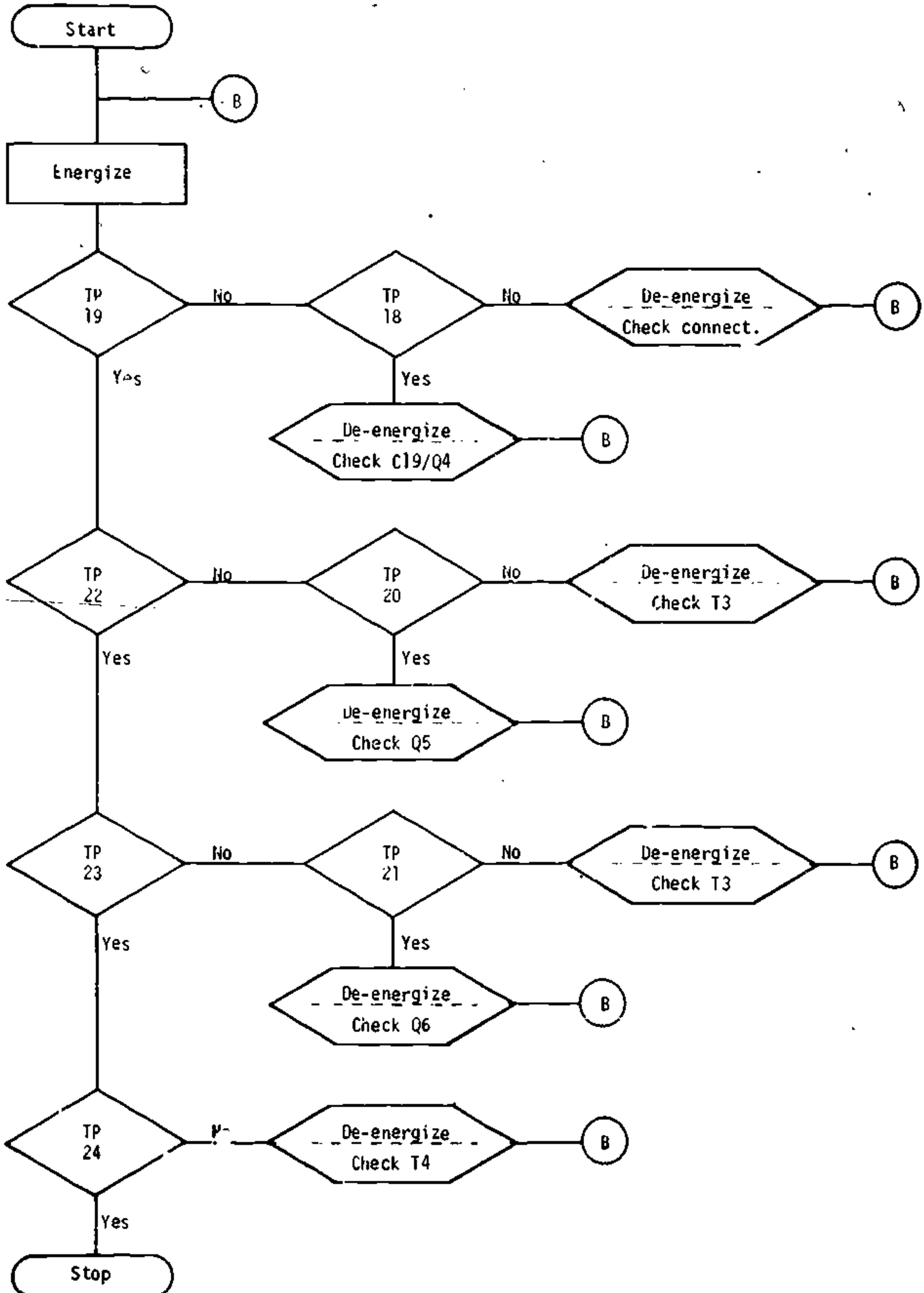
1. Locate the start symbol in the upper left hand corner of the next page. 

2. Follow the line from the start symbol to the first instruction block. 

3. A block shaped like this  requires that you make a YES or NO decision. If the signal is good, your decisions is yes. If the signal is bad or not present the decision is no. Follow the line that is labeled the same as the decision you have made.

4. A block shaped like this  indicates the conclusion you should have drawn from the observations you have made.

5. A circle with a letter inside requires you to go back to where that letter first appears and start again. This is to ascertain that there are no additional malfunctions. To flow from the start symbol to the stop symbol with all decision blocks answered yes, indicates the section is working properly. Examine the troubleshooting flow diagram on the next page.


Start
B
Energize
TP 19
No
TP 18
No
De-energize
Check connect.
B
Yes
Yes
De-energize
Check C19/Q4
B
TP 22
No
TP 20
No
De-energize
Check T3
B
Yes
Yes
De-energize
Check Q5
B
TP 23
No
TP 21
No
De-energize
Check T3
B
Yes
Yes
De-energize
Check Q6
B
TP 24
De-energize
Check T4
B
Yes
Stop

THIS COMPLETES THE NARRATIVE FOR LESSON V, MODULE SEVENTEEN EXPERIMENT EXP. SEVENTEEN-V IN THIS BOOKLET COVERS THE PERFORMANCE OBJECTIVES FOR THIS LESSON. EXPERIMENTS ARE A PART OF THE LESSON PROGRESS CHECKS WHICH YOU MAY TAKE AT ANY TIME. IF YOU WISH TO CHECK YOUR KNOWLEDGE OF THIS MATERIAL, YOU MAY DO THE EXPERIMENT NOW.

EXPERIMENT
LESSON V

Troubleshooting an AF Amplifier

Up to this point you have learned:

(1) the correct procedures for soldering.
(2) the correct procedures for setting up and adjusting the signal generator.
(3) the correct procedures for setting up and adjusting the oscilloscope.
(4) the basis of logical troubleshooting.

DRAW A 6B25 TRAINING DEVICE AND GO TO A LAB CARREL.

The purpose of this job sheet is to use all the information and skills you have learned to actually troubleshoot and repair an electronic circuit assembly.

The 6B25 is a delicate piece of equipment and is subject to damage unless the following rules are followed:

(1) NEVER remove or insert any of the printed circuit cards unless you are told to do so.
(2) Always make sure your radio is turned off when removing or inserting printed circuit cards.
(3) When inserting a printed circuit card, always insure it has been inserted into the proper receptacle and the pins of the printed circuit card are properly aligned with the plug.

INSTRUCTIONS: To complete this experiment, you must find the malfunction(s) in your 6B25. You will need all of the information you have studied so far in this course. Starting with Step One, work methodically through the experiment, carefully completing each step before you go to the next. In several of the steps you will have to draw conclusions or make decisions. When this happens, follow the instructions that correspond to the conclusions you drew. GO to STEP ONE.

1. Turn on the 6B25 and manipulate the station selector and volume control. Is the radio working properly? If not, go to your Learning Supervisor and tell him your radio is not working. If it is working properly go to Step Two.

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2. Turn on your signal generator and oscilloscope observing all safety precautions. Set them up to the following specifications:

SIGNAL GENERATOR
- Frequency Band Switch set to 10-30 kHz
- Frequency Vernier Dial set to 13 kHz
- Meter Selector set to CW
- % Modulation Control set fully counter-clockwise
- Carrier Range Switch set to 10-300 kHz X-MULT
- RF Multiplier switch set to X10K
- Microvolts Control set to 1 on the top scale of the Meter

OSCILLOSCOPE
- Sensitivity set to .02 v/cm
- Sweep Time set to .1 milliseconds/cm
- Horizontal Display set to X1
- Trigger Source set to INT

After your signal generator and oscilloscope have been set up, turn off your radio and remove the AF amplifier printed circuit card. Take the printed circuit card to your Learning Supervisor and exchange it for a pre-faulted printed circuit card. Connect an X1 probe to the RF OUTPUT X-MULT jack on the signal generator and another X1 probe to the CHANNEL A INPUT jack of the oscilloscope. Touch the signal generator and oscilloscope probes together to ensure that you have the correct signal out of your signal generator. If the waveform is not synchronized adjust the oscilloscope Sweep Mode, Trigger Slope, and Sweep Time Vernier controls to stabilize the display. If your test equipment is not working properly see your Learning Supervisor. If your test equipment is working properly, disconnect the probe tips. Go to Step Three.

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3. Insert the AF amplifier section pre-faulted printed circuit card you received from the Learning Supervisor into the radio and turn it on. Manipulate the station selector and volume control. Is the radio working properly? If so, go to your Learning Supervisor and tell him. If not, go to Step Four.

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4. Turn off the radio and remove the RF Amplifier printed circuit card. This is done to prevent signals from going to the AF section and interfering with the known signals you are going to inject with your signal generator. After the RF section printed circuit card has been removed, turn on your radio. Go to Step Five.

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5. Refer to the schematic diagram (Figure 6-7) in your technical manual and locate test point TP18 (the input to the AF section printed circuit card). Connect the signal generator probe to this point. Turn the volume control on the radio fully clockwise. Go to Step Six.

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6. Refer to the schematic diagram (Figure 6-7) and locate test point TP24. Now locate it on your radio. Connect the oscilloscope probe to TP24. Is the correct signal present at test point TP24? If the correct signal is present at test point TP24, re-check your work. If you have followed instructions properly and still have the correct signal present at test point TP24, go to your Learning Supervisor. If the correct signal is not present go to Step Seven.

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7. Change the oscilloscope sensitivity to .5 volts/cm. Refer to Figure 6-7 and locate test point TP19. If the correct signal is present at test point TP19 go to Step Eight. If the correct signal is not present at test point TP19 go to Step Ten.

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8. Change the oscilloscope sensitivity to 2 volts/cm. You have established that the signal at test point TP19 is correct. You have, therefore, isolated the faulty stage. There is no correct signal at test point TP24 and there is a correct signal at test point TP19. The faulty component must be between these two points (the push-pull stage). Locate test point TP22 or TP23 in the radio and connect the oscilloscope probe to either one. Is the correct signal present at this test point? A correct signal at this point means that transformer T4 is the faulty component. If T4 is the faulty component go to Step Eleven. If the signal at the test point you have selected is not the correct signal, go to Step Nine.

---

9. Change the oscilloscope sensitivity to .2 volts/cm. Locate test point TP20 or TP21 in your radio. Connect the oscilloscope probe to either one. Is the correct signal present at this point? If the signal is correct transistor Q5 or Q6 is the faulty component. If the signal is not correct and the signal at test point TP19 is correct, tranformer T3 is the faulty component. Go to Step Fleven.

- -

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10. Change the oscilloscope sensitivity to .02 volts/cm. There is no correct signal at test point TP19; therefore, the problem is in the driver stage of the Amplifier. Locate the lead that connects the positive end of C19 to R13. Connect the oscilloscope probe to this lead. Is the correct signal present at this point? If you have the correct signal at this point, transistor Q4 is the faulty component. If the correct signal is not present at this test point C19 is the faulty component. Go to Step Eleven.

- -

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11. You have now located the faulty component. Turn off the radio. You must now determine if the failed component has opened or shorted. Remove the pre-faulted board to isolate any external parallel DC current paths which might give you an erroneous reading. Using your multimeter, determine if the bad component is open or shorted. Mark your response below.

Which component is bad? ____________________

What is wrong with the component?

OPEN __________ SHORT ______________

- -

TAKE THE PRE-FAULTED PRINTED CIRCUIT CARD AND THIS EXPERIMENT TO YOUR LEARNING SUPERVISOR. HE WILL CHECK YOUR ANSWERS AND ISSUE YOU A PRACTICE SOLDERING BOARD AND COMPONENT.

12. The last step in the troubleshooting procedure is replacing the faulty component. Take the practice soldering board and component issued to you by your Learning Supervisor to the soldering station. On the practice soldering board select a component similar to the failed component. According to the procedures you learned previously, remove the component you selected and replace it with the component issued to you by the Learning Supervisor. Check your soldering with the check list below.

STUDENT CHECK	L/S CHECK	
		1. No cold solder connections.
		2. No excessive solder on connections.
		3. Properly bent and clipped leads.
		4. No rosin residue.
		5. No lifted pads or foils.
		6. No cracked solder connections.
		7. Good electrical characteristics of component (i.e., diodes not shorted or open, resistors of indicated value, etc.)

Soldering Satisfactory: ______________________
(L/S Signature)

- -

TAKE YOUR "REPAIRED" PC CARD TO THE LEARNING SUPERVISOR FOR HIS INSPECTION.

YOU HAVE NOW COMPLETED THIS MODULE. THE PERFORMANCE TEST WILL REQUIRE THE SAME SKILLS AS THIS EXPERIMENT. IF YOU FEEL THAT THE RESULTS OF THIS EXPERIMENT INDICATE THAT YOU ARE READY TO TAKE THE END OF MODULE PERFORMANCE TEST, SEE YOUR LEARNING SUPERVISOR. IF YOU FEEL YOU NEED FURTHER STUDY BEFORE TAKING THE PERFORMANCE TEST, YOU MAY REVIEW ANY PART OF THIS MODULE.

- -

MODULE EIGHTEEN

BASIC TROUBLESHOOTING: RADIO FREQUENCY AND

INTERMEDIATE FREQUENCY AMPLIFIER

STUDY AND PROGRESS CHECK BOOKLET

OVERVIEW
MODULE EIGHTEEN

Basic Troubleshooting: Radio Frequency and Intermediate Frequency Amplifier

This module is designed to introduce you to the functions of basic intermediate frequency and radio frequency amplifiers and their application within a superheterodyne receiver. You will also be required to troubleshoot these sections in the 6825 Training Device. To troubleshoot and understand the functions of these sections, you must apply the electronic theory you learned in the first seventeen modules. You will also use soldering techniques and the skills acquired in the use of test equipment such as the oscilloscope, signal generator, and multimeter. This module has been divided into two lessons:

Lesson I	Radio Frequency and Intermediate Frequency Amplifier ICO Signal Tracing
Lesson II	Troubleshooting an IF Amplifier and an RF Amplifier

MODULE EIGHTEEN

LESSON I

RADIO FREQUENCY AND INTERMEDIATE FREQUENCY AMPLIFIER ICO SIGNAL TRACING

OVERVIEW
LESSON I

Radio Frequency and Intermediate Frequency - Amplifier ICO Signal Tracing

Now that you have learned how to use the signal generator and the oscilloscope as effective tools in troubleshooting, you will use these tools once again to help you become a more effective technician.

In this lesson you will learn to utilize the I.C.O. (input-conversion-output) concept to isolate the malfunction of circuitry in both the R.F. and I.F. sections of the 6B25. You will be required to observe a waveform at a given test point (input), compare this to another test point (output), and determine whether or not the output signal is correct.

BEFORE YOU START THIS LESSON, PREVIEW THE LIST OF STUDY RESOURCES ON THE NEXT PAGE.

LIST OF STUDY RESOURCES
LESSON I

Radio Frequency and Intermediate Frequency
Amplifier ICO Signal Tracing

To learn the material in this lesson, you have the option of choosing, according to your experience and preferences, any or all of the following:

STUDY AND PROGRESS CHECK BOOKLET:

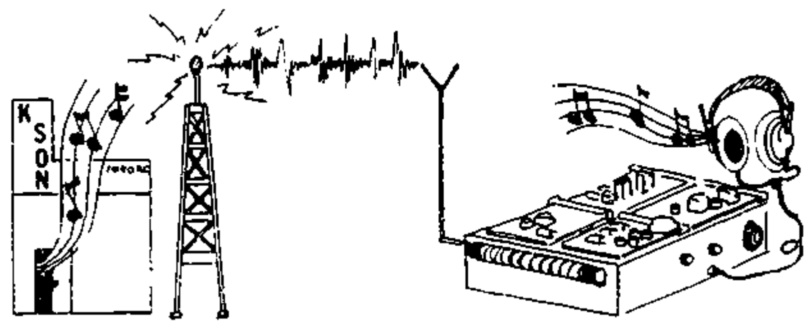
Lesson Narrative
Lesson Summary
Experiment EXP. Eighteen-1 Radio Frequency and Intermediate Frequency Amplifier ICO Signal Tracing

REFERENCE MATERIAL:
6B25 Training Device Technical Manual

YOU MAY NOW STUDY ANY OR ALL OF THE RESOURCES LISTED ABOVE. YOU MAY TAKE THE PROGRESS CHECK AT ANY TIME.

NARRATIVE
LESSON 1

Radio Frequency and Intermediate Frequency Amplifier ICO Signal Tracing

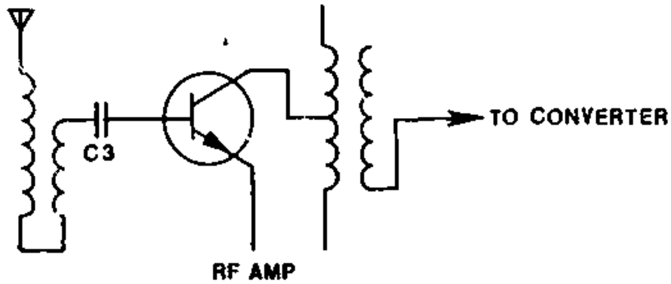


All radio and television stations transmit (broadcast) their programs in the form of electromagnetic waves, called RF (Radio Frequency) waves. This RF energy moves from the transmitting antenna through the air to the antenna of a receiver; in this case, the 6B25. These electro-magnetic waves induce a small alternating current into the antenna circuit. This lesson will give you an idea of what happens to the received signal on its way through the receiver to the audio section.

A major function of the RF Amplifier/Converter Section is to amplify the received signal and convert it to an IF (Intermediate Frequency) signal. This conversion brings the frequency down to a lower frequency that is easier to amplify to the needed signal voltage.

The RF Amplifier stage produces the first amplification of the received signal. The RF stage increases the voltage or power of the received signal. This is necessary to make the signal large enough to be useful and to compensate for any losses that might take place in the next stage.

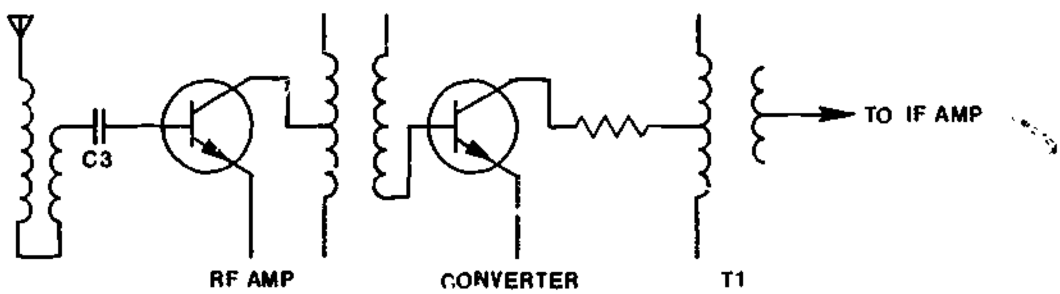
Now let's take a more detailed look at the RF amplifier stage. During this explanation we will only be concerned with those components in the main signal flow path.



The small induced RF signal on the antenna is developed across inductor L1 and fed to capacitor C3. It is then coupled across capacitor C3 without any change to the base of the RF amplifier transistor. The transistor greatly increases this small signal's amplitude to a size that is easier to work with electronically. The amplified RF signal is fed out of the transistor, and passed through an inductor (transformer) becoming the input to the converter stage.

The signal, after leaving the RF Amplifier stage, goes directly to the Converter Stage. This stage is so named because it changes or converts the incoming frequency to the frequency that is going to be used by the next stage - the IF Amplifier stage. The converter stage has two major functions. First, it takes the Radio Frequency from the RF Amplifier and combines this with a frequency of its own to produce four frequencies. The sum of the two frequencies, the difference between the two frequencies, and the original two frequencies. Only the difference frequency (455 kHz) leaves the converter stage; the remaining three frequencies are eliminated. Second, the converter stage further amplifies this IF frequency.

Again let's take a detailed look at the main signal flow path.



The RF signal on the secondary of the inductor (transformer) is fed to the converter transistor. This transistor combines (mixes) the input RF signal with another internally generated frequency and produces four amplified output frequencies. These four signals are fed from the transistor through a resistor, with a small decrease in amplitude. The four signals pass on to the primary of transformer T1. This transformer is designed to pass only the IF frequency signal (455 kHz difference frequency), thus eliminating the other three frequencies. The IF signal is coupled from the primary to the secondary of T1 and on to the IF amplifier stage.

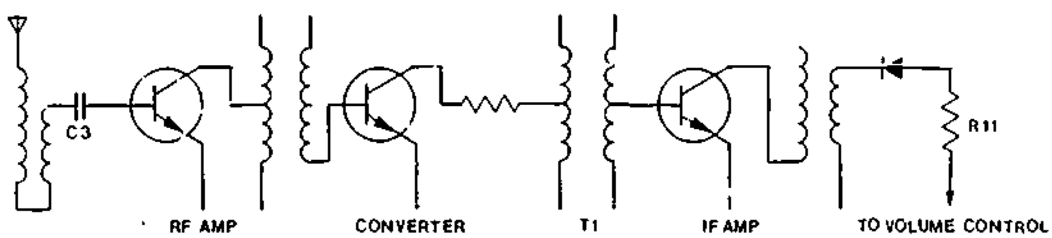
The intermediate frequency 455 kHz goes into the IF amplifier; the function of this amplifier is to produce high gain and increase selectivity. Let's eliminate all possible confusion and define the terms gain and selectivity.

1. Gain is an increase in signal power.

2. Selectivity is the ability of a receiver to separate one desired signal from all other frequencies.

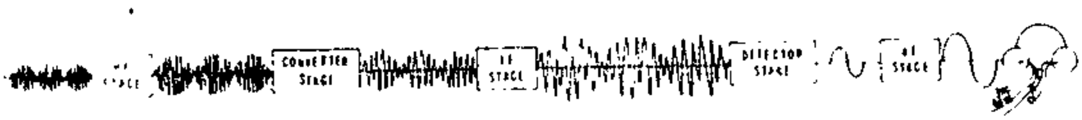
The amplified signal from the IF amplifier stage continues to the detector. The detector's function is to remove the carrier wave (the high frequency used for transmission) so that the remaining intelligence (the audio signal) can be amplified.

The audio signal derived by the action of the detector diode passes into the audio amplifier section where it will be amplified again. The amplified audio signal is applied across the speaker or headset to be heard as sound.



The detailed main signal flow path for this section starts at the secondary of T1 and is passed on to the IF amplifier transistor. The 455 kHz IF signal is greatly amplified by this transistor. This amplified output is passed on to the primary of another transformer. The IF signal is coupled from primary to secondary and on to the diode detector. The diode detector removes the IF frequency and passes only the audio intelligence through resistor R11 to the volume potentiometer of the audio amplifier section.

In summary, we have taken a very small RF signal and increased its amplitude in the RF amplifier stage and then reduced the frequency to an IF frequency of 455 kHz and again amplified it in the converter stage.



The signal is again amplified in the IF amplifier stage, then the audio intelligence is removed by the detector stage and passed on to the audio amplifier section that you have just studied.

THIS COMPLETES THE NARRATIVE FOR LESSON I, MODULE EIGHTEEN.

EXPERIMENT EXP. EIGHTEEN I IN THIS BOOKLET COVERS THE PERFORMANCE OBJECTIVES FOR THIS LESSON. EXPERIMENTS ARE A PART OF THE LESSON PROGRESS CHECKS WHICH YOU MAY TAKE AT ANY TIME. IF YOU WISH TO TEST YOUR ABILITY TO MEET THESE OBJECTIVES, YOU MAY DO THE EXPERIMENT NOW. IF YOU FEEL THAT YOU NEED FURTHER STUDY BEFORE YOU DO SO, THIS LESSON IS COVERED BY:

SUMMARY

SUMMARY
LESSON I

Radio Frequency and Intermediate Frequency
Amplifier ICO Signal Tracing

In this lesson you will learn how to utilize the ICO concept to trace the signal through the RF/Converter section and the IF/Detector section. To do this, a given signal will be injected into the antenna section, and an oscilloscope will be used to "look" at the signal at test points along the signal flow path.

The function of the RF/Converter is to amplify the received signal and convert it to an IF (intermediate f equency). You will be able to actually see the amplification and the conversion using the oscilloscope.

The function of the IF/Detector Section is to provide high gain and selectivity in addition to extracting the intelligence (audio) from the modulated carrier (transmitted high frequency) wave. This amplification and detection can be clearly seen with the oscilloscope.

THIS COMPLETES THE SUMMARY FOR LESSON I, MODULE EIGHTEEN.

EXPERIMENT EXP. EIGHTEEN I IN THIS BOOKLET COVERS THE PERFORMANCE OBJECTIVES FOR THIS LESSON. EXPERIMENTS ARE A PART OF THE LESSON PROGRESS CHECKS WHICH YOU MAY TAKE AT ANY TIME. IF YOU WISH TO CHECK YOUR ABILITY TO MEET THESE OBJECTIVES NOW, YOU MAY DO THE EXPERIMENTS. IF YOU FEEL THAT YOU NEED FURTHER STUDY BEFORE YOU DO SO, THIS LESSON IS COVERED BY:

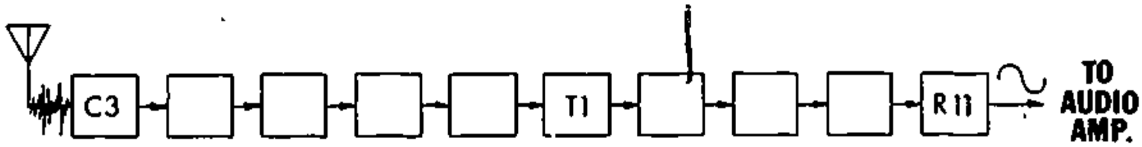
NARRATIVE

EXPERIMENT
LESSON I

Radio Frequency and Intermediate Frequency Amplifier ICO Signal Tracing

In this Experiment, you will use the ICO concept to study and compare inputs with outputs at different points in both the RF Amplifier/Converter and IF Amplifier/Detector Sections of the 6B25 radio receiver.

1. Using the schematic diagram (Figure 6-7) in your technical manual and the block diagram below. list the primary components (in sequence) of the main signal path.



Energize the Signal Generator and Oscilloscope so that they will be warmed up and stable by the time you are ready to use them.

AT VARIOUS INTERVALS IN THIS EXPERIMENT, YOU WILL BE REQUIRED TO DRAW THE WAVEFORMS YOU HAVE OBSERVED AT A TEST POINT AND YOU MAY BE REQUIRED TO INTERPRET VOLTAGE MEASUREMENTS. PLACE THESE RESPONSES IN THE SPACES PROVIDED IN THIS BOOK.

Set up the test equipment with the controls in the indicated positions:

SIGNAL GENERATOR

Frequency - 1.0 MHz
Output - 4000 u volts
Modulation - 30% at 1000 Hz

(NOTE: Follow standard procedures to set carrier to 10, then re-adjust the Microvolts Control to 4. Adjust for desired modulation by placing the Meter Selector switch into the 1000∿ position and adjusting the Audio Out control clockwise (CW) until the meter reads 30% on the bottom scale.)

RF Multiplier - X1K
Probe - 1:1 BNC to BNC Cable

OSCILLOSCOPE

(Note: Obtain a line trace before setting the controls).

SETTINGS:

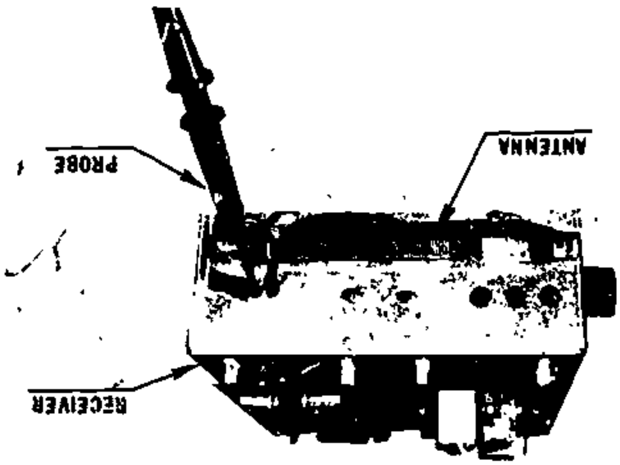
Sensitivity - .02 v/cm

Sweep Time - 2 millisec/cm

Trigger Source - INT

Probe - 1X

As in all previous lessons you have studied, a signal has to be inserted to enable you to see what a circuit is doing. This time the signal will be injected into a BNC connector located next to the antenna.



Check out the test equipment by connecting the oscilloscope input to the signal generator output (RF OUT) to insure that each is operating properly. After checking the test equipment, disconnect the oscilloscope from the signal generator. Connect the BNC to BNC cable from the signal generator RF Output X-Mult to the radio antenna input. Connect the (1X) probe to the Channel A input terminal on the oscilloscope.

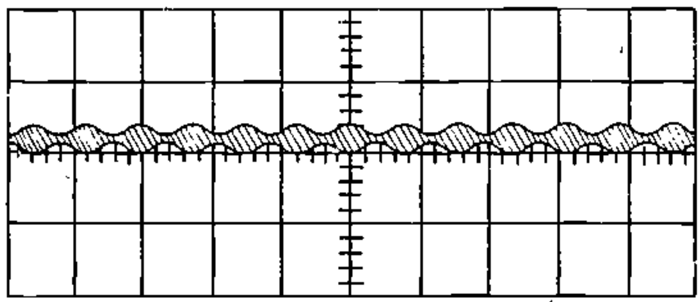
When the test equipment is set up you may continue.

Make sure that the 6B25 is de-energized.

Connect the oscilloscope probe (1X) to TP 8 and adjust the tuning control on the 6B25 to obtain maximum amplitude. (Set sensitivity of the oscilloscope to .02 v/cm.)

This step insures that the receiver is tuned to the frequency being injected by the signal generator.

The waveform should approximate the signal shown below.



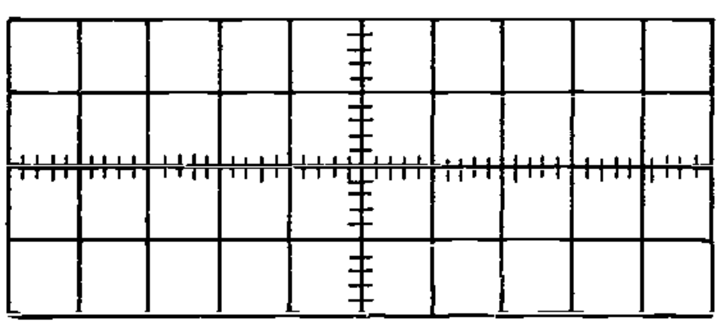
Check the local oscillator disable switch (S2), located on the RF amplifier/converter PC card, and ensure that it is in the TEST position. (In the TEST position, this switch will disable the local oscillator so that you will be able to see more clearly the signals in the front end of the receiver (capacitor C3, transistor Q1, and transformer L2).)

Energize the 6B25 receiver.

The waveforms you find may not look <u>exactly</u> like those in the book. The main objective is to calculate the differences in voltage at various test points and to understand these differences.

For clarity of the signal presentation on the oscilloscope face, it may be necessary to fine tune the radio. Move the station selector slightly to the right or left to get the clearest possible signal on the oscilloscope.

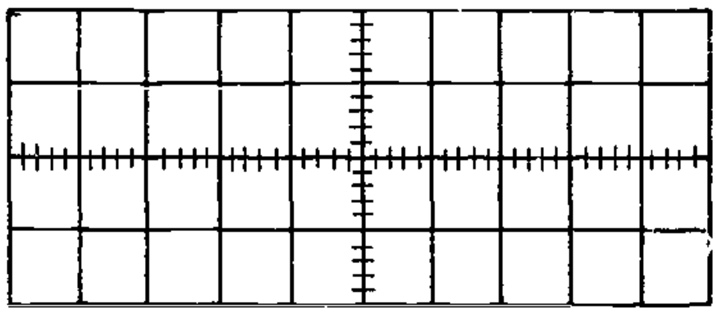
2. Draw the observed waveform and indicate the signal amplitude.



The amount of voltage will vary slightly depending on your receiver.

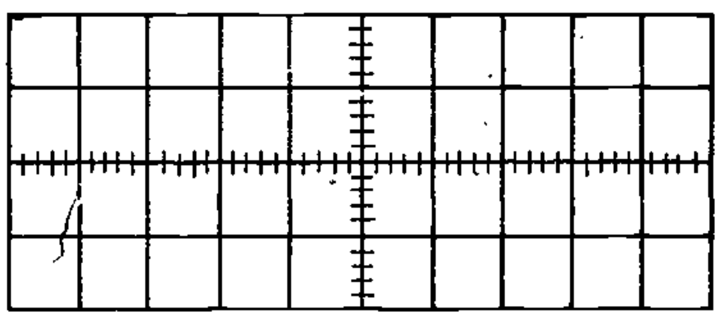
3. Now, disconnect the oscilloscope probe and connect it to TP9. Draw the waveform and indicate the signal amplitude. Compare the waveform at TP8 to TP9.

Note: At different steps you may have to decrease or increase the oscilloscope sensitivity setting to measure the voltage.



The amount of voltage may vary somewhat.
As you have noticed, the transistor's function is to amplify.

4. Now place your oscilloscope probe on test point 10. Draw the observed waveform and indicate the voltage. Compare the waveform at TP9 to the waveform at TP10.



The amount of voltage may vary somewhat.

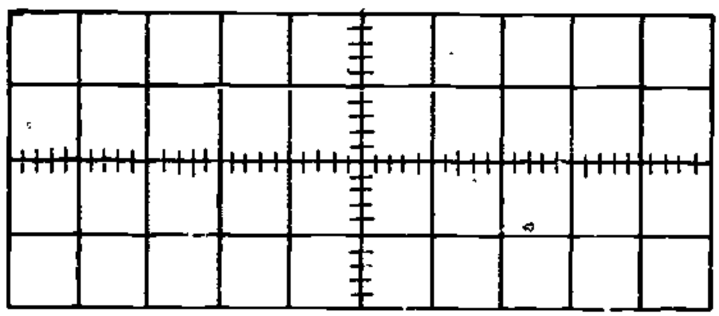
As you have noticed the voltage has decreased from one side of the transformer to the other. This is a voltage step-down transformer. Since transistors are current devices, a voltage step-down transformer, or in other words a current step-up transformer as indicated by the formula

$$\frac{Es}{Ep} = \frac{Ip}{Is}$$

is used for inter-stage coupling.

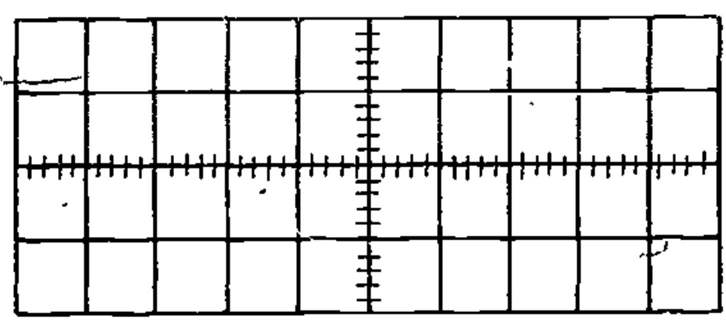
5. Connect the oscilloscope probe to TP11. Place the local oscillator disable switch (S2) in the NORMAL position. Draw the waveform and indicate the voltage amplitude. Compare the waveforms at TP10 and TP11. The waveform you will see is a combination of four separate frequencies.

a. The original frequency coming from the RF stage.
b. The frequency generated in the tank circuit (L3, C11, and C12).
c. The sum frequency which is produced by the addition of the original frequency, and the frequency generated in the tank circuit.
d. The difference frequency which is produced by the subtraction of the original frequency from the frequency generated in the tank.



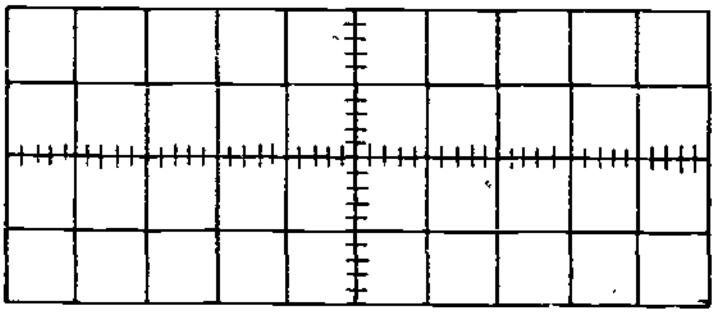
The amount of voltage will vary.

6. Now move the oscilloscope probe to TP12. Draw the waveform and calculate the voltage amplitude. Compare the waveforms at TP11 and TP12.



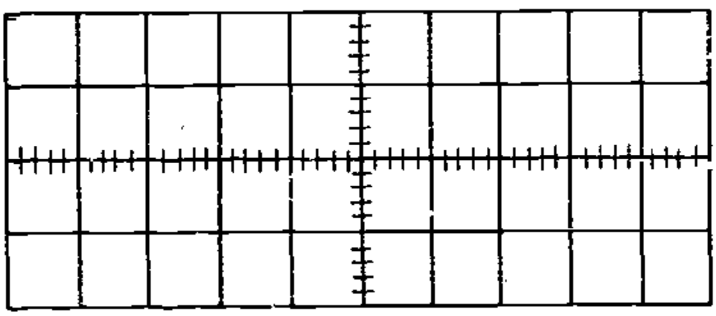
The amount of voltage will vary.

7. Note the decreased amplitude. This is due to R6's action as a current limiter. From the converter, the signal goes to the tank circuit T1. Now place the probe on TP13. Draw the observed waveform and calculate the voltage. Compare the waveform at TP12 to the TP13 waveform. Notice the absence of multiple signals. They have been removed by T1, which is acting to block all frequencies except 455 kHz. This frequency will be the only one to pass through T1 and into the IF stage. 455 kHz is the intermediate frequency.



The amount of voltage will vary.

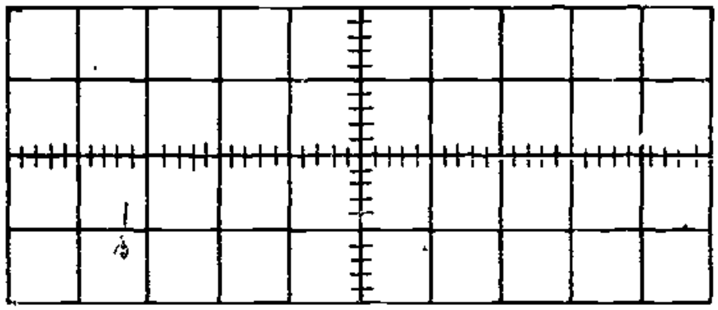
8. Now move the probe to TP 14. Draw the observed waveform and calculate the voltage amplitude. Compare the waveforms at TP13 and TP14.



The amount of voltage will vary.

19

9. Now connect the oscilloscope probe to TP16. Draw the observed waveform and calculate the voltage amplitude.



The amount of voltage will vary.

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR.

WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON EIGHTEEN II.

...The Only Thing Between You and The Deep Six!

19?

MODULE EIGHTEEN

LESSON II

TROUBLESHOOTING AN IF AND RF AMPLIFIER USING ICO CONCEPTS

199

OVERVIEW
LESSON II

Troubleshooting an IF and RF Amplifier Using ICO Concepts

In this lesson you will study and learn about the following:

- ICO concepts on a system level.
- Half-splitting methods.
- Using a signal generator for signal injection.
- Using an oscilloscope for signal tracing.

BEFORE YOU START THIS LESSON, PREVIEW THE LIST OF STUDY RESOURCES ON THE NEXT PAGE.

LIST OF STUDY RESOURCES
LESSON II

Troubleshooting an IF and RF Amplifier
Using ICO Concepts

To learn the material in this lesson, you have the option of choosing, according to your experience and preferences, any or all of the following:

STUDY AND PROGRESS CHECK BOOKLET:

Lesson Narrative
Lesson Summary
Experiment EXP. Eighteen-II "Troubleshooting an IF and RF Amplifiers using ICO concepts"

REFERENCE MATERIAL:

6B25 Technical Manual

YOU MAY NOW STUDY ANY OR ALL OF THE RESOURCES LISTED ABOVE.

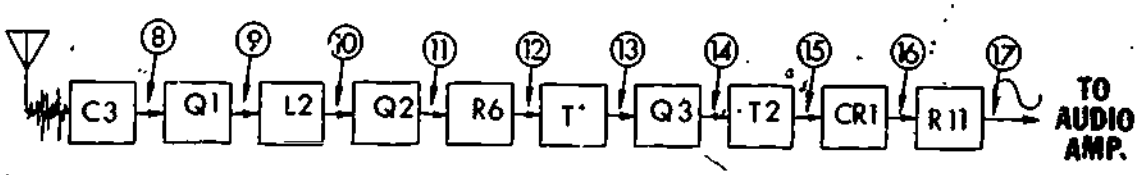
NARRATIVE
LESSON II

Troubleshooting an IF and RF Amplifier Using ICO Concepts

In this lesson, you will find material designed to take you through a logical sequence of actions to locate a faulty component in the RF/Converter or the IF/Detector sections of the 6B25. These instructions are similar to the Module Seventeen instructions, but they are not as detailed. This is to enable you to become more proficient in using the knowledge and techniques presented in previous lessons. While troubleshooting, you must never assume anything! Base your answers only on the observations you actually make.

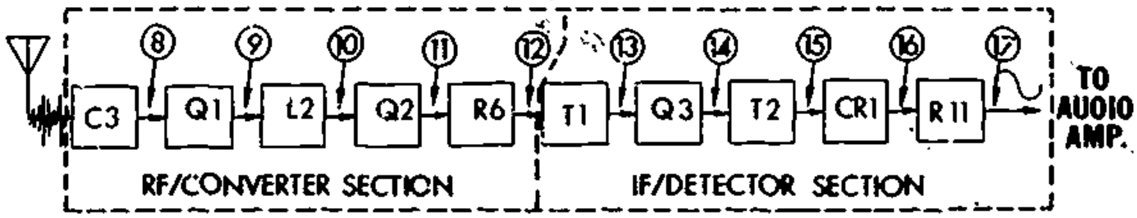
Now, energize the 6B25 and ensure the receiver is working properly. If the receiver is not working properly, inform your Learning Supervisor. Next, de-energize the radio and remove the RF/Converter section and IF/Detector section printed circuit cards and take them to your Learning Supervisor. At this time you will receive one RF/Converter printed circuit and one IF/Detector printed circuit card, one of which is prefaulted. Following standard procedures, insert the cards into the receiver.

Now we come to the actual troubeshooting. Since we have the possibility of the trouble being in either of two cards, the best method for logical troubleshooting is "half-splitting." To do this, we first have to ascertain there actually is a trouble by checking the output of the IF/Detector section. If there is no signal or an abnormal signal at this point, we can logically deduce that the trouble lies somewhere between the point at which we injected a test signal and the point at which we are observing the signal. (Look at the block diagram below.)



The next logical step is to split the circuitry in half - how about at TP12? Is the signal there normal or abnormal? If the signal is normal we have logically eliminated the RF Amplifier/Converter section. If the signal is abnormal, we have logically eliminated the IF Amplifier/Detector.

Assume that the signal at TP12 is abnormal. To continue with the half-splitting method, look at the block diagram below and divide the RF Amplifier/Converter section into parts.



Let's try TP-10. If the signal is normal, we can logically eliminate Q1, L2, and C3. If the signal is abnormal, we can eliminate Q2 and R6. Are you catching on to half-splitting? Let's troubleshoot a hypothetical problem to give you a better understanding of halfsplitting.

First we check the output (TP17) to ensure there is a problem. Using the oscilloscope we find there is no output. Next, we go to TP-12 to eliminate one half of the circuitry. Here there is a normal, discernable signal, so we can eliminate all of the RF Amplifier/Converter. We now go to TP-15 and we find an abnormal signal (no signal), so we know the trouble lies somewhere between TP12 and TP15.. One logical move is to test at TP14, so let's try that ---Hey, we've got a normal signal! Look at your schematic (figure 6-7 in the Technical Manual). Now we have isolated the trouble to a block; the only thing between TP14 and TP15 is the transformer T-2. This isolates the trouble down to a component, and the next thing to do is to determine what is wrong with it. Is it open, shorted, or is the ground removed?

A multimeter is used to make the final diagnosis. Using the multimeter we find transformer T-2 primary to be open. See, that wasn't so hard, because we used a logical troubleshooting method.

NOW YOU WILL BE REQUIRED TO LOGICALLY TROUBLESHOOT A PRE-FAULTED CARD. FOLLOW THE INSTRUCTIONS IN EXPERIMENT EXP. EIGHTEEN-II IN THIS BOOKLET.

YOU HAVE NOW COMPLETED THIS MODULE. IF YOU FEEL THAT YOUR PROGRESS CHECK RESULTS INDICATE THAT YOU ARE READY TO TAKE THE END OF MODULE TESTS, SEE YOUR LEARNING SUPERVISOR. IF YOU FEEL YOU NEED FURTHER STUDY BEFORE TAKING THE END OF MODULE TESTS, YOU MAY REVIEW ANY PART OF THIS MODULE.

SUMMARY
LESSON II

Troubleshooting an IF and RF Amplifier Using ICO Concepts

In this lesson, half-splitting is shown to be an important mainstay in the art of troubleshooti g. Using the ICO concept, a test at the input and a test at the output of the system will show whether or not a particular system is functioning properly. In case of a malfunction the ne* step would be to divide the system into sections; in this case, /Converter and the IF/Detector sections. Once you make a test : output of one of these sections and find that the conversi process is not functioning properly, you can logically eliminate one-half of the circuitry. When the faulty section is isolated, we can half-split again, and again, until we isolate the faulty stage. We can then (you guessed it) half split again. This will isolate the malfunction down to a circuit within the stage. Half-splitting again, we find the faulty component. The next step is to use a multimeter to determine what is wrong with the component - is it open, shorted, or is a ground removed?

In Job Sheet Eighteen-II you will be required to troubleshoot a pre-faulted set of IF/Detector and RF/Converter printed circuit cards. There will be only one trouble per set of cards. Effective use of the ICO concept and the half-splitting method will greatly enhance your abilities to troubleshoot.

IF YOU FEEL YOU CAN SUCCESSFULLY TROUBLESHOOT, YOU MAY PROCEED DIRECTLY TO EXPERIMENT EXP. EIGHTEEN-II IN THIS BOOKLET. IF YOU DESIRE ADDITIONAL INFORMATION ON TECHNIQUES AND/OR A MORE DETAILED EXPLANATION, GO TO NARRATIVE EIGHTEEN-II.

EXPERIMENT
LESSON II

Troubleshooting an IF and RF Amplifier Using ICO Concepts

To utilize the concept of logical troubleshooting, we will follow a flow diagram. You must realize that flow diagrams are only an aid to troubleshooting. The flow diagram can be extremely helpful in localizing the faulty component, but do not become dependent on it. Each time you make a test, follow the result on the flow diagram (Figure 5-3) and the 6B25 schematic, (Figure 6-7)--both in the 6B25 Technical Manual.

EQUIPMENT REQUIRED:

1. Oscilloscope
2. Signal Generator
3. Multimeter
4. 6B25 Training Device and Technical Manual
5. Prefaulted Card Set (obtain from your Learning Supervisor)

PROCEDURE:

1. Using all safety precautions applicable:
   a. Set up and energize the Signal Generator for an output of 4 millivolts at 1.0 MHz, modulated with 1000 Hz at 30%.
   b. Set up and energize the Oscillocope to obtain a line trace.
2. a. Connect one end of a BNC-BNC connector cable to the X1K RF X-MULT output jack of the Signal Generator and the other end to the channel A input of the Oscilloscope. Draw the observed waveform, and record the voltage.
   b. Connect the Signal Generator to the 6B25 input as you did in Module Eighteen, Lesson I. (Connect the R.F. X-MULT on the Signal Generator to the 6B25 input. Also connect a 1X probe to Channel A input on the oscilloscope.) Tune the radio to the frequency provided by the Signal Generator.

3. Measure and record the voltage at TP 12. Is this a normal reading? ________ Volts

   _____ If YES, go to step 4.
   _____ If NO, go to step 5.

4. Measure and record the voltage at TP17. Is this a normal reading? ________ Volts

   _____ If YES, see your Laboratory Supervisor
   _____ If NO, go to step 9

5. Measure and record the voltage at TP10. Remember to place S2 in the TEST position. Is this a normal reading? ________ Volts

   _____ If YES, go to step 6
   _____ If NO, go to step 7

6. Measure and record the voltage at TP11. Is this a normal reading? ________ Volts

   _____ If YES, name the suspected component ____________
   _____ If NO, name the suspected component ____________

WHEN YOU HAVE IDENTIFIED A PROBABLE FAULTY COMPONENT GO TO STEP 13

7. Measure and record the voltage at TP9. Is this a normal reading? ________ Volts

   _____ If YES, name the suspected component ____________
   _____ If NO, go to step 8

WHEN YOU HAVE IDENTIFIED A PROBABLE FAULTY COMPONENT GO TO STEP 13

8. MEASURE and record the voltage at TP8. Is this a normal reading? ________ Volts

   _____ If YES, name the suspected component ____________
   _____ If NO, name the suspected component ____________

WHEN YOU HAVE IDENTIFIED A PROBABLE FAULTY COMPONENT GO TO STEP 13

9. Measure and record the voltage at TP15. Is this a normal reading? ________ Volts

   _____ If YES, go to step 10
   _____ If NO, go to step 11

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10. Measure and record the voltage at TP16. Is this a normal reading? __________ Volts

 _____ If YES, name the suspected component _____________.
 _____ If NO, name the suspected component _____________.

WHEN YOU HAVE IDENTIFIED A PROBABLE FAULTY COMPONENT GO TO STEP 13.

11. Measure and record the voltage at TP14. Is this a normal reading? __________ Volts

 _____ If YES, name the suspected component _____________.
 _____ If NO, go to step 12

12. Measure and record the voltage at TP13. Is this a normal reading? __________ Volts

 _____ If YES, name the suspected component _____________.
 _____ If NO, name the suspected component

13. Now that you have isolated the malfunction down to the component level, use the multimeter to ascertain what type of problem has occurred (shorted, open, ground removed).

The malfunction is ________(trouble).

WHEN YOU HAVE FOUND THE MALFUNCTION, SECURE ALL TEST EQUIPMENT AND TAKE THIS EXPERIMENT TO YOUR LEARNING SUPERVISOR FOR EVALUATION.

YOU HAVE NOW COMPLETED THIS MODULE. IF YOU FEEL THAT YOUR PROGRESS CHECK RESULTS INDICATE THAT YOU ARE READY TO TAKE THE END OF MODULE TESTS, SEE YOUR LEARNING SUPERVISOR. IF YOU FEEL YOU NEED FURTHER STUDY BEFORE TAKING THE END OF MODULE TESTS, YOU MAY REVIEW ANY PART OF THIS MODULE.

SAFETY NEEDS YOU!

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MODULE NINETEEN

BASIC TROUBLESHOOTING: SYSTEMS CONCEPT
AND
NAVY DOCUMENTATION

STUDY AND PROGRESS CHECK BOOKLET

OVERVIEW
MODULE NINETEEN

Basic Troubleshooting: Systems Concept

In this module you will be introduced to the concept of electronic systems and the method of troubleshooting these systems. To demonstrate the knowledge and skills you learned in past modules and the new knowledge you will gain in this module, you will be required to troubleshoot the entire 6B25 Radio Receiver System using a six-step troubleshooting method. This module also contains an explanation of the Navy's system of documentation (paperwork). You will practice filling out the various forms that are required when you repair a casualty. For you to learn more easily and practice system troubleshooting, this module has been divided into the following lessons.

Lesson I — Introduction to the Electronic System Concept and Troubleshooting Techniques

Lesson II — Navy Documentation

Lesson III — Troubleshooting a Radio Receiver System.

MODULE NINETEEN

LESSON I

INTRODUCTION TO THE ELECTRONIC SYSTEM CONCEPT AND TROUBLESHOOTING TECHNIQUES

OVERVIEW
LESSON I

Introduction to the Electronic System Concept and Troubleshooting Techniques

In this lesson, you will learn about systems and how these systems will affect you as a technician. In addition, you will learn a systematic, logical troubleshooting approach in its entirety. You will learn what each step signifies and how each step relates to forming an effective method of locating a malfunction within a system.

BEFORE YOU START THIS LESSON, PREVIEW THE LIST OF STUDY RESOURCES.

LIST OF STUDY RESOURCES
LESSON I

Introduction to the Electronic System Concept and Troubleshooting Techniques

To learn the material in this lesson, you have the option of choosing, according to your experience and preferences, any or all of the following:

STUDY AND PROGRESS CHECK BOOKLET:

Lesson Narrative
Lesson Summary

REFERENCE MATERIAL:

EIMB

YOU MAY NOW STUDY ANY OR ALL OF THE RESOURCES LISTED ABOVE.

NARRATIVE
LESSON I

Introduction to the Electronic Systems Concept and Troubleshooting Techniques

Suppose it's liberty call and you have a hot date. You rush out to your car, turn the key, and nothing happens! There you are, trying to find out what's wrong - hopefully in time for your date. Do you check the tires, or the water level in the radiator? Of course not! You only check the things that are associated with the trouble - but - some of us may not know what these things are. We have to have some knowledge of the car's system and how all of the components fit together to accomplish the car's function.

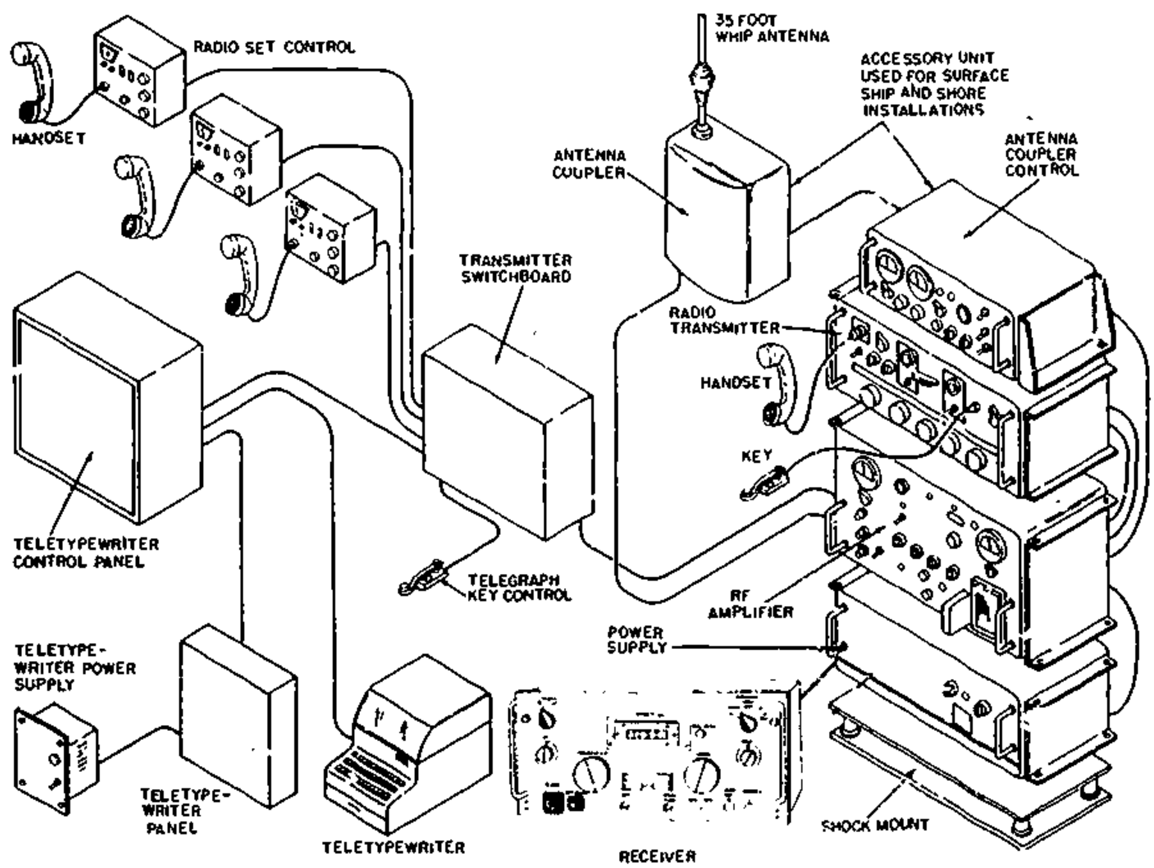

Figure 1

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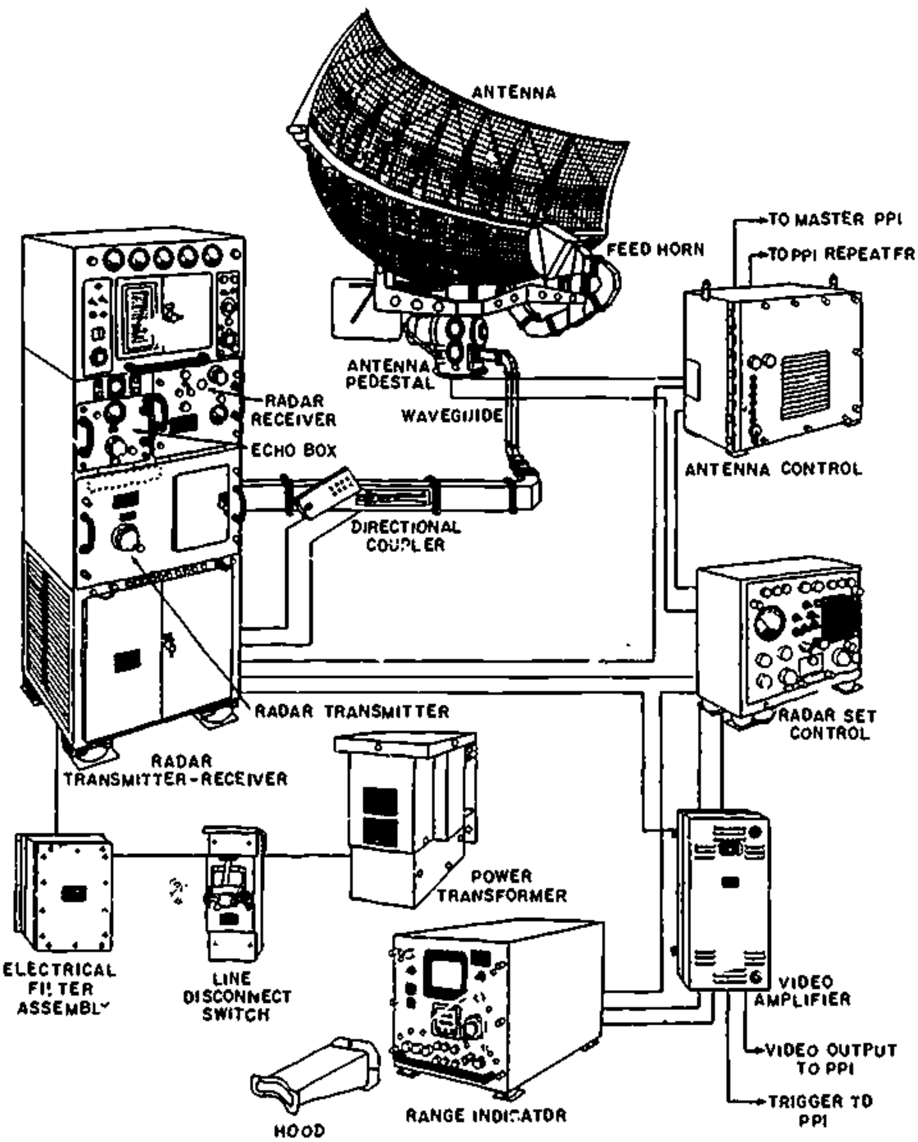
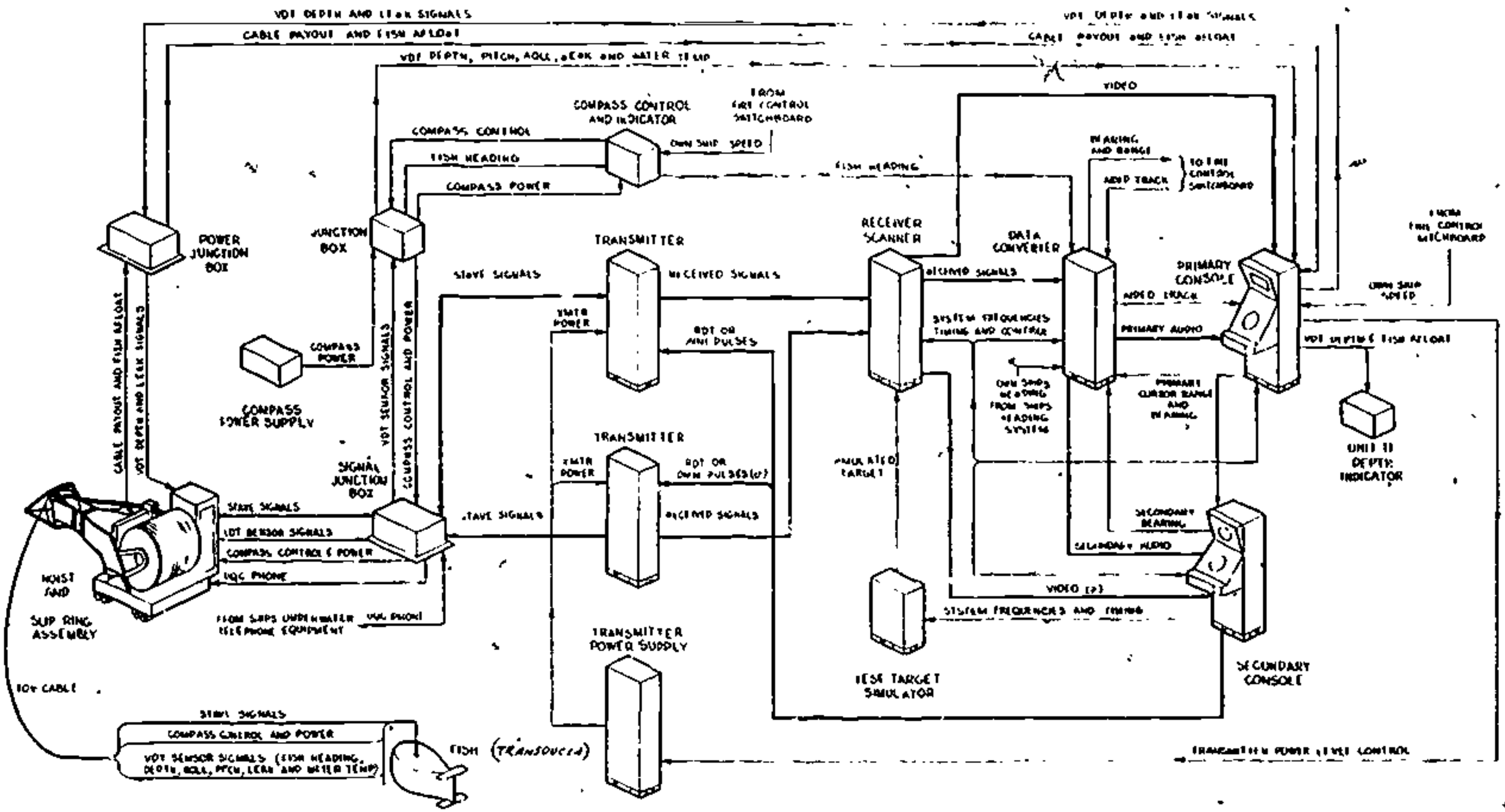


RADAR SYSTEM

Figure 2



VARIABLE DEPTH SONAR SYSTEM

Figure 3.

If you know the system, you can systematically isolate the problem in a minimum amount of time. This same concept applies to being a technician. If you have a working knowledge of the system's concept, your troubleshooting ability will be greatly improved. Just what is a system in electronics? Well, transceiver systems (see figure 1), or radar systems (see figure 2) or sonar systems (see figure 3), are three quite common systems aboard ship. Depending upon your rate, you will be required to learn and know your systems well enough to isolate a malfunction to the faulty stage. Often this can be accomplished by using the front panel indications and/or a multimeter. The six-step troubleshooting method will be very beneficial in isolating a malfunction using system ICO concepts. Let's take a closer look at an electronic system, the transmitter-receiver system. Two ships are steaming in close proximity and their captains want to communicate with one another (see figure 4). One captain uses a microphone connected to his transmitter and talks; the other captain receives on his receiver and talks back using his transmitter. This cycle continues until the communication is terminated.

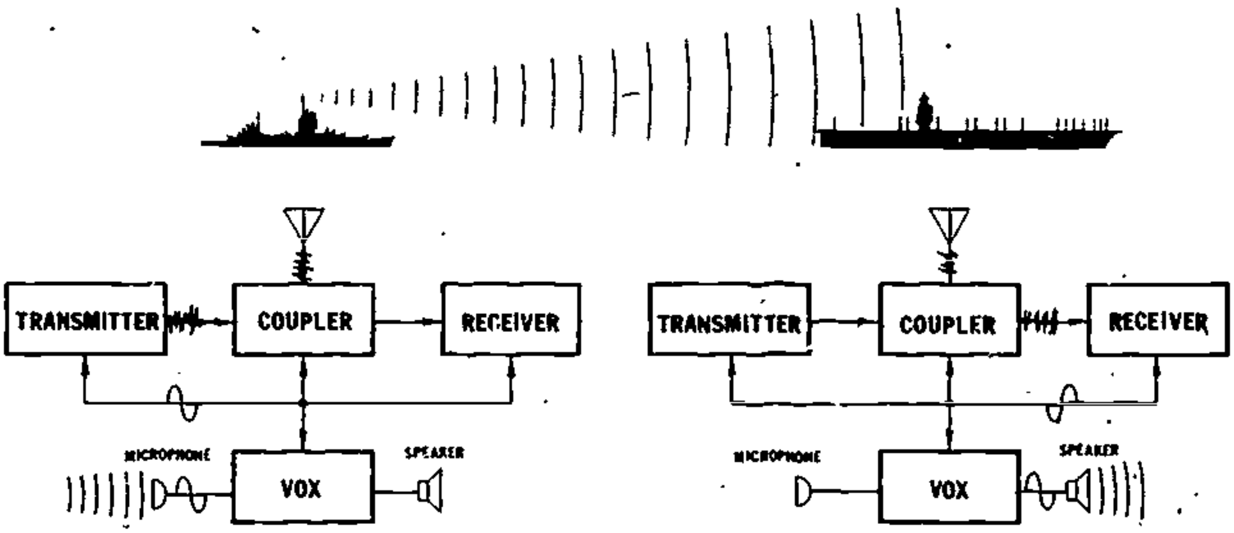


Figure 4

What would happen if suddenly the skipper couldn't understand the signal from the other ship? Well, for one thing, you would hear the squawk box chirp "Duty ET lay to the bridge". If you just happen to be the duty ET, you had better know the system - especially if the problem lies "at your end". The captain has just been interrupted in communicating with another ship, and you can bet this conversation is vitally important. So now it is up to you to systematically isolate the malfunction and repair the equipment as quickly as possible.

Now is the time to put logical troubleshooting into play. Troubleshooting is an acquired skill that requires the following:

1. Sufficient background knowledge to learn how a specific piece of equipment works.

2. Skill in reading and interpreting the information contained in the equipment technical manual.

3. Skill in using test equipment and the ability to correctly interpret the test results.

4. Ability to follow a logical sequence when troubleshooting.

Developing the ability to follow a logical sequence when troubleshooting will be our main concern in this lesson. Logical troubleshooting is a tool used by accomplished technicians to locate a malfunctioning circuit/component in the quickest and most efficient way. It is made up of distinct steps and each step is designed to eliminate a number of possible trouble areas until the faulty component is found. If a haphazard approach is used it may be difficult or virtually impossible to isolate a defective part, wire, connection or component from hundreds or even thousands of possibilities.

The easiest method of learning and applying a logical sequence to locate malfunctions consists of these six steps:

1. Symptom Recognition
2. Symptom Elaboration
3. List of Probable Faulty Functions
4. Localize Faulty Functions
5. Localize Faulty Circuit
6. Failure Analysis

STEP ONE: SYMPTOM RECOGNITION

The first step in troubleshooting any problem is to determine if a problem really exists. If someone tells you a system is malfunctioning, you must determine to your own satisfaction that a problem really exists and that it is not just an operator error.

Some problems are not easily recognized because they are not clearly understood to be a malfunction. For example:

> It has been 10,000 miles since your car was tuned-up. You may realize that its pep or performance is not exactly right, but the loss of power has been so gradual that you have become accustomed to poor performance. A mechanic, however, immediately recognizes this performance as poor and suggests a repair.

Electronic systems operate in the same manner. Their performance will get worse as components age. Low or marginal operation is not always reported to the technician so you must check for possible trouble symptoms during your routine maintenance.

The above problem is not obvious, yet such small troubles may lead to serious troubles if not detected early. You may compare the performance of a suspected system with other known reliable identical systems or determine whether or not the system's performance has changed since it was last used. You must question and observe, measure and compare.

The second type of problem is obvious, the system does not do the job or function it is supposed to do:

> You get in your car and it will not start no matter what you do.
>
> -or-
>
> You turn on your stereo and nothing happens.

You're sure something is definitely not working. This completes the first step - Symptom Recognition. Now you realize that more than one thing could cause your car not to start or your stereo to do nothing. This leads us to step two.

STEP TWO: SYMPTOM ELABORATION

Symptom Elaboration is simply the procedure used for checking sources provided by the system or your background knowledge of the system that may explain the failure.

> With your car you may consider the following without leaving the drivers seat.
>
> 1. Do the gauges, lights, etc. come on?
> 2. If so, what do they read?
> 3. Did the car sputter and fail to start or did it do absolutely nothing?
>
> -or-
>
> With your stereo you could check the following without even moving.
>
> 1. Does it light up?
> 2. Can you hear anything from either channel?
> 3. If you have any dials, what do they read?
> 4. If it is a combination stereo radio-phonograph, does one work and not the other?

The elaboration process needs refinement of symptoms. You are not going to check for symptoms of malfunction unless they relate to the problem. Now is the time to narrow down the number of symptoms to help get a clearer picture of what you will have to do in your next step.

At this point, some new technicians have a tendency to break out all their tools and test equipment. This is a big mistake. Mental work at this stage can save you a lot of time in finding the problem. If your train of thought is muddled by pulling out all your repair aids, then you may fail to recognize symptoms and will get off track when looking for the problem. You have not yet determined what tools are needed to repair the problem. Suppose, in the car example, you brought out all your tools, jacks, etc., when the problem is that your battery was stolen. Or in the case of the stereo, the plug was pulled out. These things happen! Navy electronic systems are complicated and many technicians mistakenly believe that all problems must be complicated.

STEP THREE: LISTING THE PROBABLE FAULTY FUNCTIONS

The term, "function", is used here to denote an operation performed by a specific area (or unit) of a system. Generally, each major subdivision has one or more functions to perform. If you have a functional block diagram, this is the time to break it out as an aid in localizing the faulty function.

The car may have a functional diagram with the following:

1. Engine
2. Transmission
3. Brakes
4. Electrical
5. Cooling

The Stereo may have a functional diagram with the following:

1. Antenna
2. RF section
3. Mixer or converter
4. IF section
5. AF section
6. Speakers
7. Power supply
8. Turntable
9. Tape deck

Now that we have basic functional diagrams of our examples, we must determine which function could conceivably cause our specific problem. Could the transmission or brakes cause the car not to start? Nope! We have been able to immediately reduce the size of our search. If you have a flat tire, you don't wash the car. It is important that we immediately eliminate as many areas as possible. If nothing works with the stereo, we may eliminate the antenna and the turntable right away.

We now have a list of possible faulty functions and must go to step four and try to localize the particular faulty function.

STEP FOUR: LOCALIZING THE FAULTY FUNCTION

In this step, one of the possible or probable trouble functions must be selected for testing. Some areas might involve more ease and speed in testing than others and they should be eliminated first.

In the case of the car:

1. Electrical system
   a. Do you have a battery?
   b. Are any wires broken or loose?
   c. Do the lights work?
   d. Does the starter turn?

2. Fuel system
   a. Is there gas in the tank?
   b. Are any gas lines broken?
   c. Do you get gas to the carburetor?

These things are easy to check and require little time or effort, yet if ignored, you may waste a lot of time by bypassing the obvious.

In the case of the stereo:

1. Power Supply
   a. Is the plug in?
   b. If tubes, are they lit?
   c. Are the dial lights on?

2. Speakers
   a. Are the speakers connected?
   b. Are there any broken speaker wires?

As functions are eliminated, your test equipment requirements become more complicated but your method will not change. Continue from the most simple to the most complex.

If you do your mental work properly, manual work can be reduced to a minimum. This systematic attack on the problem will lead you to step five---<u>Localizing the Faulty Circuit</u>.

STEP FIVE: LOCALIZING THE FAULTY CIRCUIT

Throughout the previous steps, you have been working to get to this step. You have already eliminated a number of probable faulty functions and are ready to really investigate a particular circuit or area.

Technicians generally have two methods to locate the faulty circuit or area. Depending on the type of system, one method will work better than another.

1. BRACKETING-The technician places brackets at the inputs he knows to be good and the outputs he knows to be bad. In the car, we may have gas in the tank but none in the carburetor. As we continue to test we move the correct inputs closer and closer to the incorrect output. We find that if gas gets through the fuel pump, then the fuel pump is pumping gas, etc.

2. HALF-SPLITTING-This technique is used by taking a faulty section and splitting it in half and then checking at that mid-point to see if operation is correct. If it is, we have eliminated the front half of the circuitry; if it isn't we have eliminated the other half. Then we split it in half again and again until the faulty circuit is identified. For example, consider our stereo; if we have isolated the faulty function to the audio stage, we split the total number of circuits in half and check if the signal it is good or bad at that point, and so on. If we have a hose that is ten miles long and we know we are putting water in one end and getting no water out of the other, we check the middle (5 miles) to see if there is water present, etc.

When we have found the faulty circuit or area and know what is bad, we have to determine why it went bad. This is step six - Failure Analysis.

STEP SIX: FAILURE ANALYSIS

The technician, by following the procedure in the five logical steps, has located the trouble to a single faulty circuit or area. He could replace the faulty component and eliminate the trouble-but what if the same thing happened again? We must now determine why it happened in the first place and set up some method to prevent its happening in the future.

Suppose we found that the hose leading from the fuel pump was clogged causing the car not to start. By cleaning the hose we eliminate the problem, but the cause of the problem might not be cured. We might put a gas filter in the line to protect us in the future. Suppose you found the carburetor was broken and replaced it. It might be that it was worn, orginally defective, improperly adjusted or a number of other things. If justification for component failure is not understood, you may be asking for future troubles with the same thing.

Hopefully this lesson will help make your job easier. Remember, if you cultivate a logical sequence when troubleshooting systems, the time saved in repair will allow you more time for liberty!

THIS COMPLETES THE NARRATIVE FOR LESSON I, MODULE NINETEEN.

IF YOU FEEL THAT YOU NEED FURTHER STUDY BEFORE YOU GO ON, THIS LESSON IS COVERED BY:

- SUMMARY

SUMMARY
LESSON I

Introduction--the Electronic System Concept and System Troubleshooting Techniques

In the fleet you will find many types of systems. There are transceiver systems, sonar systems, radar systems, fire control systems, controller systems, navigational systems ---- actually the entire ship is one large system, made up of many smaller systems. Each system has a specific job to perform in order to make the ship run smoothly. If one of these systems fails, it will be the job of some technician to find the problem and fix it. If you have been assigned to repair the faulty system, you will be that technician.

By using a good logical troubleshooting method a casualty in the most complicated system can be narrowed down quickly, and finding it will turn out to be no more complicated than finding a casualty in the 6B25 receiver.

The six step logical troubleshooting method is a good, clearly defined, step-by-step procedure that will enable you to logically and systematically locate the faulty component.

These six steps are:

1. Symptom Recognition

In order to repair a system you must first determine whether it is functioning correctly or incorrectly. To completely satisfy this step, you must be thoroughly familiar with the operational characteristics of the system in question. This means you can provide valid answers to the questions - What is this system supposed to do?" and "How well is this job being done?" Symptom recognition, then, is detecting abnormal performance.

2. Symptom Elaboration

As a second step, the obvious or not so obvious symptom should be further defined. Almost all electronic systems have front panel operating controls, indicating instruments, or other built-in aids for evaluating performance. These should be utilized at this point to see whether they will affect the symptom under observation or provide additional data to define the symptom. This step is the "I need more information" step in our systematic approach.

3. Listing of Probable Faulty Functions

The third step is an "estimation" step which makes maximum use of information from two sources: (1) the information gathered about the trouble symptom from the first two steps, and (2) your knowledge of the functional units of the equipment. The probable faulty function is really an "educated guesstimate" of the area in which the trouble might be located to cause the indicated symptoms. The term function is used here to denote an electronic operation performed by a specific area of an equipment. These functions, combined, make up an equipment system and cause the system to perform as it was designed. Whether or not you will proceed from step two to step three (listing of probable faulty function) or on to step five (localizing trouble to the circuit) will depend on the number of functions in the equipment and/or the complexity of a single function.

4. Localizing the Faulty Function

The fourth step involves choosing one of the probable faulty functions for further examination. The function chosen to be checked first should be based upon your knowledge of the system, ease of making the desired test, and possible elimination of one or more "educated guesses" by performing the test.

Most electronic systems can be sub-divided into units or areas which have a definite purpose or function. You might luck out and isolate the faulty function with your first test. If not, the information gained from the test can be applied toward deciding on the next function to check or it may even lead to the detection of other faults.

5. Localizing the Trouble to the Circuit

Just as it was necessary to localize the trouble to a specific function of the overall system in the preceding step, it will now be necessary to isolate or localize the trouble to a specific circuit or circuit group within the function.

The half-splitting method is most commonly used in this step. Here the signal is injected at the input, checked at the output, the stages are then divided and sub-divided until the malfunction is located.

By signal tracing, using I.C.O. concepts, you can systematically isolate the faulty circuit.

6. Failure Analysis

The sixth and final step in systematic troubleshooting is twofold. It includes (1) isolation of the bad or improperly adjusted circuit or component, and (2) verification of the troubleshooting findings. Isolation of the defective circuit component again requires application of educated guesses and use of the I.C.O. concepts.

Prior to replacement of the suspected component, you should stop and analyze the entire sequence of indications and measurements to verify that the defective components could produce the symptoms and variations you observed throughout the procedure. This final mental verification will enable you to determine whether some other component or malfunction could have caused the faulty component to fail, or whether the faulty component is the sole cause of the system's trouble.

Once you have mastered this six-step troubleshooting method; you will be able to find the majority of problems that occur in any Navy system in minimum time.

THIS COMPLETES THE SUMMARY FOR LESSON I, MODULE NINETEEN.

IF YOU FEEL THAT YOU NEED FURTHER STUDY BEFORE YOU GO ON, THIS LESSON IS COVERED BY:

NARRATIVE

MODULE NINETEEN

LESSON II

NAVY DOCUMENTATION

OVERVIEW
LESSON II

Navy Documentation

In this lesson you will learn how to fill out the forms that will order repair parts and report the repair to the proper people.

NOTICE

THIS LESSON IS TO BE DEVELOPED. GO DIRECTLY TO LESSON NINETEEN-III AND DISREGARD ALL DIRECTIONS CONCERNING SUPPLY AND MDC FORMS. IF YOU HAVE ANY QUESTIONS SEE YOUR LEARNING SUPERVISOR.

MODULE NINETEEN

LESSON III

TROUBLESHOOTING A RADIO RECEIVER SYSTEM

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OVERVIEW
LESSON III

Troubleshooting A Radio Receiver System

In this lesson you will learn how to utilize the Six-step Troubleshooting Procedure and the ICO concept in troubleshooting SYSTEMS.

In its own small way, the 6825 is a system. You can use a systematic approach to isolate a malfunction, thereby usefully applying your knowledge.

You will receive three prefaulted printed circuit boards and will isolate each malfunction and determine its trouble (open, short, etc.).

BEFORE YOU START THIS LESSON, PREVIEW THE LIST OF STUDY RESOURCES.

LIST OF STUDY RESOURCES
LESSON III

Troubleshooting a Radio Receiver

To learn the material in this lesson you have the option of choosing, according to your experience and preferences, any or all of the following.

STUDY AND PROGRESS CHECK BOOKLET:

- Lesson Narrative
- Lesson Summary
- Experiment EXP. Nineteen-III Troubleshooting a Radio Receiver system

REFERENCE MATERIAL:

EIMB

YOU MAY NOW STUDY ANY OR ALL OF THE RESOURCES LISTED ABOVE.

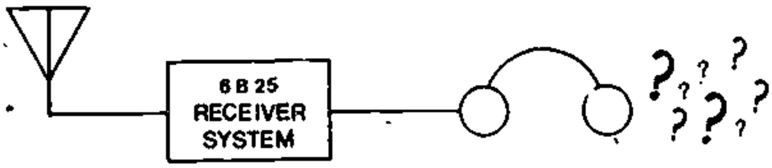
NARRATIVE
LESSON III

Troubleshooting a Radio Receiver System

So here you are, leaning back in your chair, listening to your very own 6B25, probably feeling a little proud of the job you have done up to this point. All of a sudden, disaster strikes! Your radio receiver goes dead! What happened? What do you do? Do you panic? Start banging on the receiver? Look around for help? No, not you, you manage a weak smile, sit back, and think.

Now comes the time to put together all of the information that you have learned about troubleshooting, systems, and the 6B25 Radio Receiver in order to recognize and repair malfunctioning electronic/electrical systems. In other words, LETS FIX THIS RADIO!

Since you are thinking system, mentally picture Input - Conversion-Output. Now, exactly what happened?



You no longer hear that melodious tune. Quick, clap your hands, well, you know you didn't suddenly go deaf! Hmmn - you have established step one, Symptom Recognition, no output.

So, now what do you do? Go running for the test equipment? Maybe an untrained person would, but not you, you elaborate on the trouble by thinking about it. Look at the operating controls and front panel indications. Is the on-off switch in the off position? Is the tuning dial on the wrong frequency? Is the volume turned all the way down? Is the plug out of the socket? These are all conditions that could cause the no-sound condition. So now you are doing step two - Symptom Elaboration.

You have to decide which functions could cause the trouble; in short, step three - the Listing of Probable Faulty Functions. The three major functions of the 6B25 are accomplished by the following; the power supply which supplies power, the audio amplifier which amplifies audio signals, and the RF section which converts RF to AF. You will be able to eliminate one of these three functions by using the operating controls. For example, if there is no sound or static coming from the speaker, and the volume control has no effect, then you could logically conclude that the trouble could be in either the Power Supply or the Audio Amplifier. If you can hear static or hum, and the frequency tuning control has no effect, you can logically eliminate the audio amplification function. The only probable function we can't readily eliminate through use of the operating controls is that accomplished by the power supply. Once you have listed two probable faulty functions of the three system functions, you have completed Step three-Listing of probable faulty components.

The next step, Localizing the Faulty Function is, in effect, narrowing the trouble down to a single function. Now the question is - How? This is the time to utilize the test equipment to its fullest advantage. If you have two possible abnormal functions, the power supply and one other, it is logical to check the power supply first, because in order to check the power supply, all you need is a multimeter. Assuming the power supply checks out good, you have localized the faulty function. Now you must go to step five - Localizing the Trouble to the Circuit.

This is where you really get "into the gear." You may utilize block diagrams, Technical Manuals, resistance - voltage - current measurements, half-splitting, and signal tracing.

All you have to do to repair the faulty circuit is to find the bad component and replace it. Wrong! Step Six - Failure analysis - does require that you test certain branches of the circuit to isolate the defect down to a component. However, locating the faulty component does not complete Step six. You will also be concerned with determining the cause of the failure. It is quite possible that this trouble has caused another failure or vice-versa. You must retest the system, dynamically, to ascertain that all troubles have been found. Last, but never least, complete the associated paper work.

This final step - Failure Analysis-has brought you to the end of the six-step troubleshooting method. You have "narrowed down" the trouble area with each successive step until the malfunctioning component has been isolated. You have reviewed your procedure to ensure that multiple malfunctions do not exist and to verify the cause of the malfunction. You have also made the necessary records of your actions. Athough not directly connected with troubleshooting procedures previously outlined, you should reorder any parts used in the repair of the faulty equipment. Proper supply support will enable you to return the equipment to the "line" (operating status) once the trouble has been located.

THIS COMPLETES THE NARRATIVE FOR LESSON III, MODULE NINETEEN. EXPERIMENT EXP. NINETEEN-III IN THIS BOOKLET COVERS THE PERFORMANCE OBJECTIVES FOR THIS LESSON. EXPERIMENTS ARE A PART OF THE LESSON PROGRESS CHECKS WHICH YOU MAY TAKE AT ANY TIME. IF YOU WISH TO CHECK YOUR ABILITY TO MEET THESE OBJECTIVES, YOU MAY DO THE EXPERIMENTS NOW. IF YOU FEEL THAT YOU NEED FURTHER STUDY BEFORE YOU DO SO, THIS LESSON IS COVERED BY:

SUMMARY

SUMMARY
LESSON III

Troubleshooting a Radio Receiver System

In this lesson you will apply the logical Six-step Troubleshooting Procedure to repair a malfunctioning 6B25 Receiver System. You will receive a receiver system with a prefaulted printed circuit card, and, within a reasonable time frame, you will be required to locate the malfunctioning component and repair or replace it.

If you utilize the I.C.O. concept and the six step troubleshooting procedure together, your efficiency will be greatly increased.

If the receiver system produces no audio from the speaker, you could logically eliminate some of the functions. By the same token, if you have some sound but cannot receive any stations, you could logically eliminate some other functions.

By using the operating controls, you could also eliminate some of the functions. In fact, the only function you can't eliminate is the power supply. Once you have found the faulty function, the next step is to localize the faulty circuit. Here the effective use of test equipment will aid you immensely.

Once the malfunction is isolated and repaired, the next step is Failure Analysis. This includes a dynamic retest of the receiver (to ascertain that there are no other malfunctions) and completion of the associated paperwork. Once this is done, you can feel proud of the fact that you have accomplished the job for which you have been trained as a technician in the United States Navy.

THIS COMPLETES THE SUMMARY FOR LESSON III, MODULE NINETEEN.

EXPERIMENT EXP. NINETEEN-III IN THIS BOOKLET COVERS THE PERFORMANCE OBJECTIVES FOR THIS LESSON. EXPERIMENTS ARE A PART OF THE LESSON PROGRESS CHECKS WHICH YOU MAY TAKE AT ANY TIME. IF YOU FEEL THAT YOU NEED FURTHER STUDY BEFORE YOU DO SO, THIS LESSON IS COVERED BY:

NARRATIVE

EXPERIMENT
LESSON III

Troubleshooting a Radio Receiver System

This Experiment is the Progress Check for Module Nineteen.

Go to your learning supervisor and tell him you need the materials for Experiment Nineteen-III.

Go to a lab carrel and check to see if you have the following materials:

1. 6B25 radio receiver with one casualty installed.
2. Practice soldering board.
3. Practice soldering component.
4. 6B25 technical manual.
5. Blank MDC forms.

If you are missing any of the above items, go get them now.

INSTRUCTIONS:

NOTE: If lesson II, Navy Documentation is NOT included in this module, disregard steps 2 and 6.

1. Check out and troubleshoot the 6B25 radio receiver.
2. Fill out the supply form required to order the part.
3. Go to the soldering area and replace one of the components on the practicing soldering board.
4. Take the 6B25, the supply form, and the practice soldering board to the learning supervisor. If you are correct he will replace the faulty board with one that works.
5. Check the radio. If it doesn't work you have not found the problem and must go back and continue troubleshooting.
6. When your radio works, fill out the MDC form and return it to your learning supervisor for evaluation.

YOU HAVE NOW COMPLETED THIS MODULE. THE PERFORMANCE TEST WILL REQUIRE THE SAME SKILLS AS THIS EXPERIMENT. IF YOU FEEL THAT THE RESULTS OF THIS EXPERIMENT INDICATE THAT YOU ARE READY TO TAKE THE END OF MODULE PERFORMANCE TEST, SEE YOUR LEARNING SUPERVISOR. IF YOU FEEL YOU NEED FURTHER STUDY BEFORE TAKING THE END OF MODULE TEST, YOU MAY REVIEW ANY PART OF THIS MODULE.


PORTRAIT OF
A MAN
ON THE WAY UP
GAS

ANSWER SHEETS

FOR

MODULES

FIFTEEN THRU NINETEEN

ANSWER SHEET FOR EXPERIMENT LESSON I PART I

Simpson-260 Multimeter Review

1. a
2. b
3. b
4. c
5. c
6. a
7. c
8. a
9. b
10. d
11. b
12. c
13. c
14. a
15. b
16. d
17. a
18. b
19. a
20. a
21. b
22. a
23. b, e, f, g, h, l
24.
    - D 1. Function Switch
    - F 2. Positive Test Jack
    - G 3. Range Switch
    - E 4. Common Test Jack
    - A 5. DC Voltage Scale
    - B 6. AC Voltage Scale
    - C 7. 2.5V AC Scale
25.
    1. 7.05V AC
    2. 35.2V AC
    3. 1.79V AC
    4. 176.5V AC
    5. 705V AC

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ANSWER SHEET
FOR
EXPERIMENT

LESSON 1
PART 2

Using the AN/PSM-4 Multimeter to Measure E, I, and R

12. ER-101-16-18 VDC, ER-102-11-13 VDC, ER-103-5-5.6 VDC

13. E_B = 16 - 18 VDC

14. R_{equiv} = 29k - 33k Ω

15. R = 6k - 9k Ω

16. I_{L1} = 1.6 - 1.8 ma

17. I_T = 2 - 3 ma

18. E_{in} = 6.5 - 7.5 VAC

19. YES

20. E_c = 6.5 - 7.5 VAC

21. I_{line} = 6.2 - 6.5 ma

    I_c = 3.5 - .55 ma

    I_L = 6 - 7 ma

    I_R = 24 - 28 µa

22. DECREASE

23. I_{line} = 1.0 - 1.4 ma

ANSWER SHEET FOR EXPERIMENT LESSON II

Introduction to a Navy Technical Manual

1. Section III, Operation
2. Figure 6-7
3. Section I, General Description
4. Part No. 2N2714
5. Section VI, Maintenance (Figure 6 - 6)

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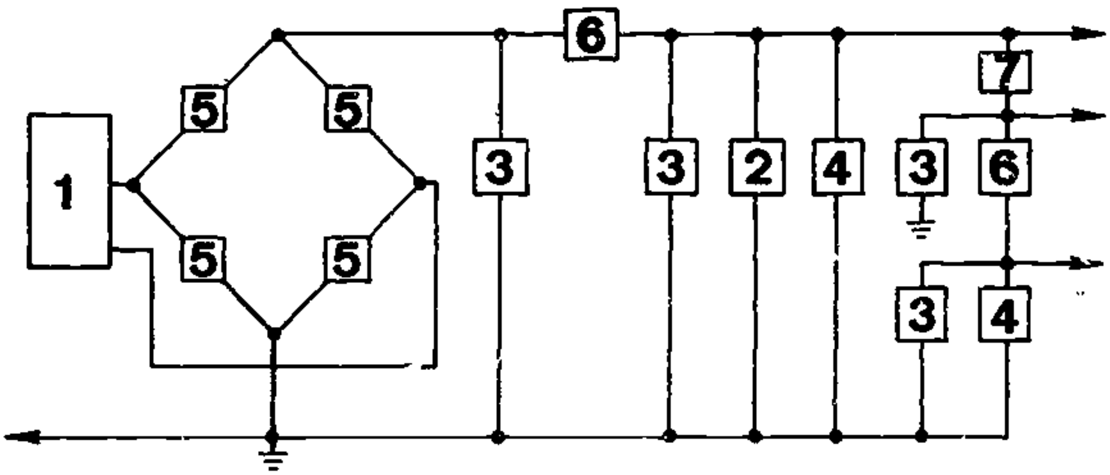
ANSWER SHEET
FOR
EXPERIMENT
LESSON III

Parts and Symbol Identification
Using the Technical Manual



ANSWER SHEET
TO
PROGRESS CHECK
LESSON II

Obtaining a Line Trace

1. Sensitivity Control 1 Volt/cm
2. Horizontal Display X 1
3. Sweep Time Control 1 msec
4. Sweep Occurance Normal
5. Trigger Source INT

ANSWER SHEET
FOR
PRACTICE SHEET
LESSON III

Peak-to-Peak Voltage Calculations

1. 4 volts p-p
2. 1.2 volts p-p
3. 100 volts p-p
4. 3.2 volts p-p
5. 0.56 volts p-p

ANSWER SHEET
TO
PROGRESS CHECK
LESSON III

Signal Interpretation

Jack # 1 18-20 V p-p

Jack # 2 19-23 V p-p

Jack # 3 0.4-0.5 V p-p

Jack # 4 5.6-6.6 V p-p

Jack # 5 0.13-0.16 V p-p

DUE TO EQUIPMENT DIFFERENCES YOUR ANSWERS MAY NOT BE EXACT; HOWEVER, THEY WHOULD BE WITHIN ± 10%.

24_

ANSWER SHEET
TO
A-V RESPONSE SHEET
LESSON III

Measuring Voltage with an Oscilloscope

1. 8 cm
2. 1.5-2.0 cm
3. 1.5-2.0 volts p-p
4. 4 volts p-p
5. 5.0-6.5 volts p-p
6. 2 volts/centimeters

DUE TO EQUIPMENT DIFFERENCES YOUR ANSWERS MAY NOT BE EXACT.

ANSWER SHEET FOR EXPERIMENT LESSON IV

Signal Tracing the Audio Frequency Amplifier

2. d TP 18 = 0.008 v p-p
   g TP 24 = 0.5-1.5 v p-p

3. a TP 19 = 2-3 v p-p
   c TP 20 or TP 21 = 0.4-0.6 v p-p

4. C19
   0.008 v p-p
   Shape change? NO
   Amplitude change? NO

   Q4 Shape change? NO
   Amplitude change? NO

   T3 Shape change? NO
   Amplitude change? YES increase.

   Q5 or Q6
   TP 22 or TP 23 = 5-8 v p-p
   Shape change? NO
   Amplitude change? YES increase.

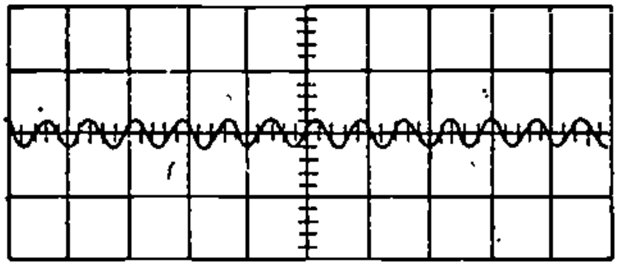
   T4 Shape change? NO
   Amplitude change? YES decrease.

DUE TO EQUIPMENT DIFFERENCES YOUR ANSWERS MAY VARY, HOWEVER, THE VOLTAGE RELATIONSHIPS SHOULD BE THE SAME.

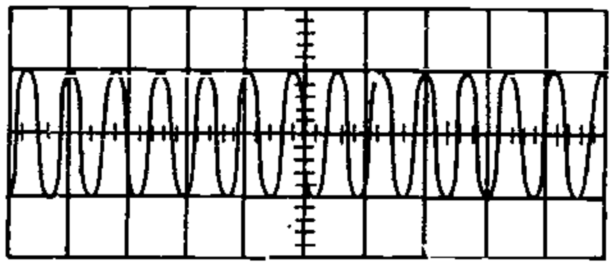
ANSWER SHEET
FOR
AUDIO VISUAL RESPONSE SHEET
LESSON IV

Signal Tracing the Audio Frequency Amplifier

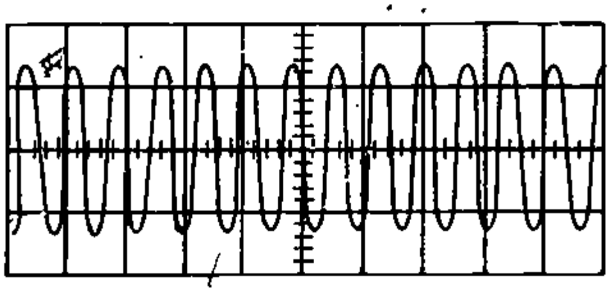
1. CRT GRID .008 Volts



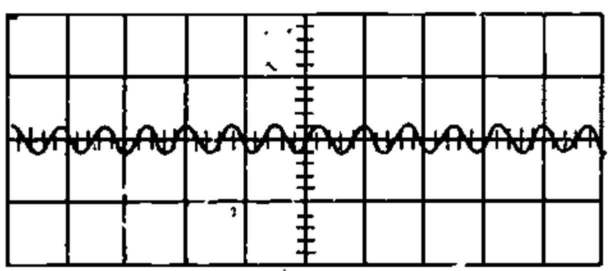
2. CRT GRID 1.8 Volts



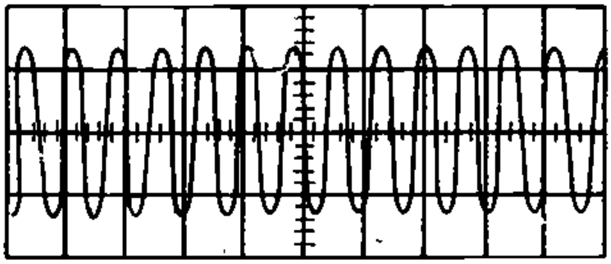
3. CRT GRID 2.5 Volts



4. CRT GRID .5 Volts



5. CRT GRID 8 Volts



OUE TO EQUIPMENT DIFFERENCES YOUR ANSWERS MAY NOT BE EXACT, HOWEVER, THE VOLTAGE RELATIONSHIPS SHOULD BE THE SAME.

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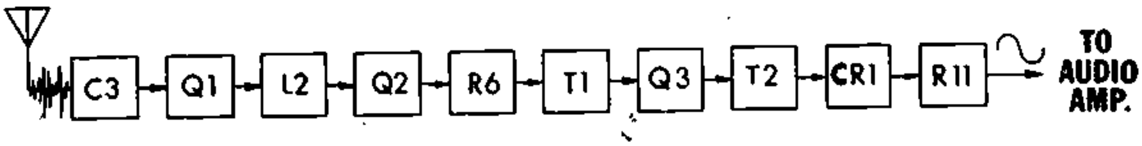
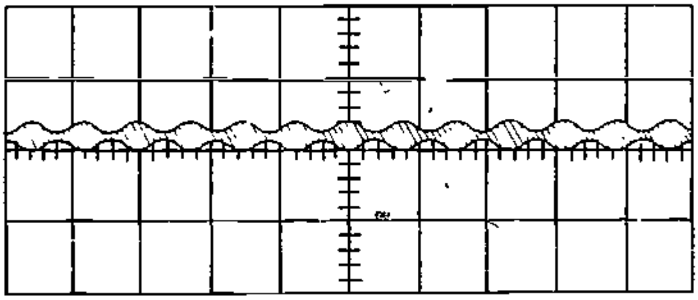
ANSWER SHEET
FOR
EXPERIMENT
LESSON I

Radio Frequency and Intermediate Frequency Amplifier Using ICO Signal Tracing

1.



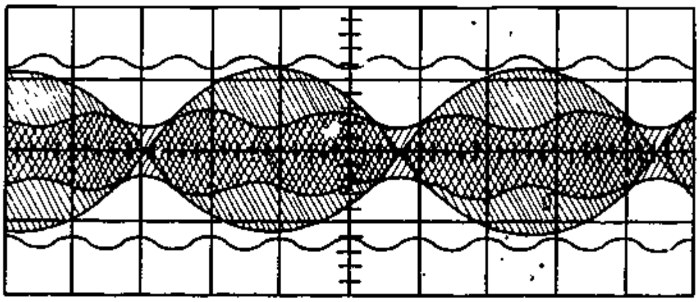
2. 0.06V p-p



3. SAME WAVEFORM AS #2 BUT WITH GREATER AMPLITUOE. 2 V p-p

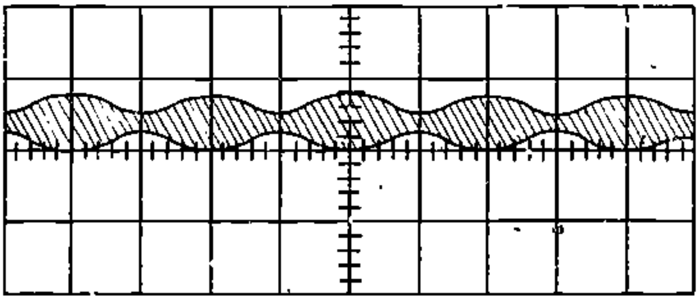
4. .125 V p-p

5. 6 V p-p



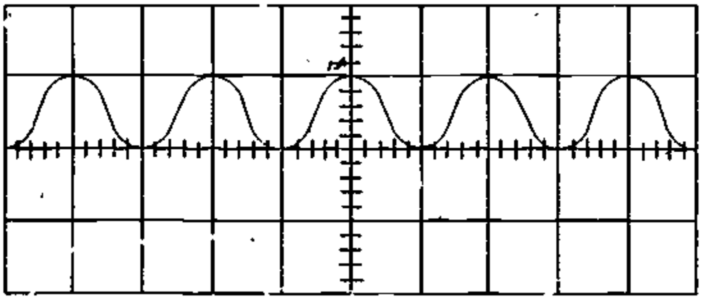
6. 3.5 V p-p SAME WAVEFORM AS NO. 5

7. .02 V p-p



8. .2V p-p SAME WAVEFORM AS NO. 7

9. .1V p-p



DUE TO EQUIPMENT DIFFERENCES YOUR ANSWERS MAY NOT BE EXACT; HOWEVER, THEY SHOULD BE WITHIN ± 10%.