The Six Step Troubleshooting Process
Lecture Notes

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Six-Step Troubleshooting Process

During your career as an electronic technician; you will maintain or help maintain some electrical or electronic system, subsystem, or unit. These tasks seem complex, but even complex tasks can be broken down into simpler ones. The key is breaking down a complex system into functional systems. Any repair should follow the steps of the six-step troubleshooting process. We will execute these steps on a VHF radio to illustrate this process.

In our example, the work order states no one could hear the operator but the operator could hear everyone else on the VHF radio. You take the radio to your workbench and set it up to verify the complaint.
Step 1. Symptom recognition. This is recognizing some disorder or malfunction in the system.

In the technician’s toolbox, you have your:
- senses [sight, sound, smell, touch, and taste]
- knowledge

Former UCLA Coach John Wooden once said, Failure to prepare is preparing to fail. You must prepare your intellectual asset through constant review of technical materials. Your intellectual asset, knowledge, combined with the input from your senses allows you to ascertain whether the system is operating within general specifications. You do not use all five senses in the troubleshooting process. You do not touch or taste energized circuits.

A two-way radio has these functions:
- transmits intelligible audio on a specified frequency
- receives intelligible audio on a specified frequency
- selects the channel and displays the channel number

Problems can be a complete failure in any functions or degraded performance in one or more of the functions. Checking the basic functions will eliminate those that appear to be working. If all functions appear to be working, then execute a detailed functional check.

Step 2. Symptom elaboration. We obtain a detailed description of the trouble in the system during this step.

In the technician’s toolbox you have:
- your senses [sight, sound, smell, touch, and taste]
- your knowledge
- your observations when manipulating the operational controls
- your notes

Remember this Chinese proverb: The faintest ink is brighter than the brightest mind.

After setting up the test equipment, measure and record the results from these tests:

When transmitting measure and record:
- Transmitter Power
- Transmitter Frequency
- Frequency deviation when speaking into the microphone
- Frequency deviation w/o speaking into the microphone

When receiving measure and record:
- Receiver sensitivity w/CTCSS
- Receiver sensitivity w/o CTCSS if the test above fails

Change Channels and repeat above tests

The Results of the test were:
- Transmitter Power PASSED
- Transmitter Frequency PASSED
- Frequency deviation when speaking into the microphone FAILED
- Frequency deviation w/o speaking into the microphone PASSED
- Receiver sensitivity w/CTCSS PASSED
- Receiver sensitivity w/o CTCSS if the test above fails ------ NOT RUN
- Change Channels and retested above Similar results
Step 3. **Listing probable faulty functions.** During this step, we break down a complex system into simpler functions. We answer the question, which function works and which doesn’t. From this functional analysis, we logically conclude, which functions can be eliminated as the cause of the symptoms. The remaining functions will be scrutinized during the troubleshooting process.

In the technician’s toolbox you have:
- your senses [sight, sound, smell, touch, and taste]
- your knowledge
- your notes
- equipment diagrams

This is the first step we view an equipment diagram; either on paper or in our head. Experienced technicians have mental images of the functional diagrams. View the functional diagram to determine what we can eliminate as the cause of the failure in the previous step’s tests:
Transmitter Tests

- Transmitter Power: **PASSED**: Eliminated the Driver, Power Amplifier, LP Filter, Power Control, Antenna Relay, and Output Jack.

- Transmitter Frequency: **PASSED**: Eliminated OSC, Buffer, and Multipliers. Partially eliminated the Phase Modulator.
- Frequency deviation when speaking into the microphone: **FAILED** : Nothing new is eliminated

- Frequency deviation w/o speaking into the microphone: **PASSED** : Eliminated CTCSS, 3rd and 4th AF Amplifier, Pre-Emphasis, and the Phase Modulator

Receiver

- Receiver sensitivity w/CTCSS: **PASSED** : Eliminated Receiver Section
- Receiver sensitivity w/o CTCSS if the test above fails: Same circuits were covered by the w/CTCSS test.

Channel

- Change Channels and repeat the transmitter and receiver measurements. : **PASSED** : Eliminated Frequency Synthesizer.
Step 4. **Localizing the faulty function.** During this step, we eliminate the working functions in our list developed in Step 3. We will use signal tracing to determine which function or functions are actually at fault.

In the technician’s toolbox you have:
- your senses [sight, sound, smell, touch, and taste]
- your knowledge
- your notes
- equipment diagrams
- testing devices

This is the first step using testing devices. Testing devices include multi meter, capacitor checker, inductor checker, transistor checker, oscilloscope, etc . . . Use the technical manual schematic for the remaining steps.

Functionally we are concentrating the troubleshooting in the microphone, the 1st AF Amp, and the 2nd AF Amp. Those three areas directly relate to the failed test.

We look at the schematic and see what we have eliminated in the audio section. We have eliminated all after the CTCSS injection point. We place our right hand bracket at that point. Place the left hand bracket at the known defective point, the microphone input. Inject an audio signal [ 1 kHz ] into the microphone input and key the transmitter so we can signal trace the signal. Verify the loss of the 1 kHz signal at the junction of R507 and R510 and place the right hand bracket at that point.
Step 5. **Localizing trouble to the circuit.** Once we determine which function is at fault, we can use signal tracing or signal injection to localize the problem to a circuit. Either signal tracing or signal injection is acceptable and you will use the half-split method to quickly determine the faulty circuit.

In the technician’s toolbox you have:
- your senses [sight, sound, smell, touch, and taste]
- your knowledge
- your notes
- equipment diagrams
- testing devices

Our next step is to eliminate the maximum number of circuits. We use the half-split method and signal tracing.

Half-splitting the circuit has us testing for a 1 kHz signal at the output of the 1<sup>st</sup> AF Amplifier. A 1 kHz signal at that test point indicates all the circuits that precede the test point are operating normally and the microphone is probably good. We eliminated the 1<sup>st</sup> AF Amplifier circuits and possibly the microphone. We have narrowed down the problem to somewhere after the test point (output of the 1<sup>st</sup> AF Amplifier) and before the CTCSS injection point into the 3<sup>rd</sup> AF Amplifier. We have bracketed the problem to one function, the 2<sup>nd</sup> AF Amplifier.
Half-split the circuit. We move the left bracket to the known good point at the output of the 1st AF Amplifier. Half-splitting the brackets eliminates the maximum number of components. The half-split test point becomes the input of the 2nd AF Amplifier.

This test fails, so move the right bracket to this point. Half-split the circuit. The test point becomes the junction of R504 and C503.
The test passes. Move the left bracket to this test point.

We can not half-split any more. The defective component is within the brackets, or loading the device within the brackets. Use a multi meter to ensure the voltages are proper within the circuit. Use a capacitance checker to ensure the capacitor is within tolerance and the ESR is within specifications.
6. **Failure analysis.** The final step.

In the technician’s toolbox you have:

- your senses [sight, sound, smell, touch, and taste]
- your knowledge
- your notes
- equipment diagrams
- testing devices
- your review

This step has multiple tasks:

- You renew the faulty part
- You determine what caused the failure
- You restore the equipment to the minimum operating specifications
- You update the maintenance logs
- You update the reorder parts list to replenish the stock.

After you replaced C503, the open capacitor, execute the same basic test that failed step 1 to verify the repair.

The maintenance record includes the following:

- Technician
- Date of Failure
- Model
- Symptoms
- Solutions

A maintenance record develops the history of the equipment and is very useful.

Common symptoms resulting in the same faulty part reveals potential problems in the component parameters. The problem could be caused by an improper procedure resulting in the application of excessive signals to the component. An Engineering Change Order would recommend changing the component to a higher value or change the procedure to ensure the proper signal level is applied to the component.

Sometimes you may run into difficulty troubleshooting the problem. This usually results from a misunderstanding during an early step in the process. Some hints to help your efforts are:

- Observe the equipment's operation for any and all faults
- Check for any defective components with your eyes and nose
- Analyze the cause of the failure for a possible underlying problem
The six-step troubleshooting process

STEP 1
SYMPTOM RECOGNITION

STEP 2
SYMPTOM ELABORATION

STEP 3
LISTING OF PROBABLY FAULTY FUNCTION

STEP 4
LOCALIZING THE FAULTY FUNCTION

STEP 5
LOCALIZING TROUBLE TO THE CIRCUIT

STEP 6
FAILURE ANALYSIS

The technician's toolbox