

Using Block Diagrams and Schematics to Understand Your Rig

It's Great for Troubleshooting!!

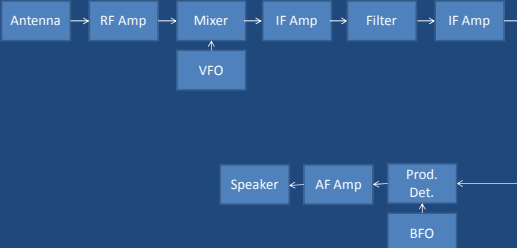
What We Will Cover!

- What are block diagrams?
- Why are they important?
- How can we develop a block diagram?
- How do they relate to a schematic?
- How can they help us understand our rig?
- How can they be used to troubleshoot our rig?

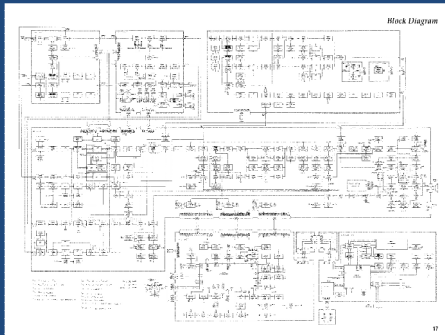
What is a Block Diagram?

- A block diagram gives us a simplified "flow diagram," or picture, of the major electronic sections of our rig
- It is based on the signal path of either our receiver or transmitter
- Helps us find where rig problems are located

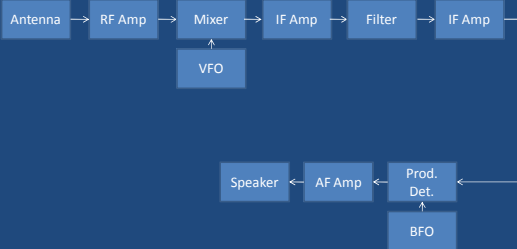
Let's Build a Block Diagram of a Single Conversion Receiver

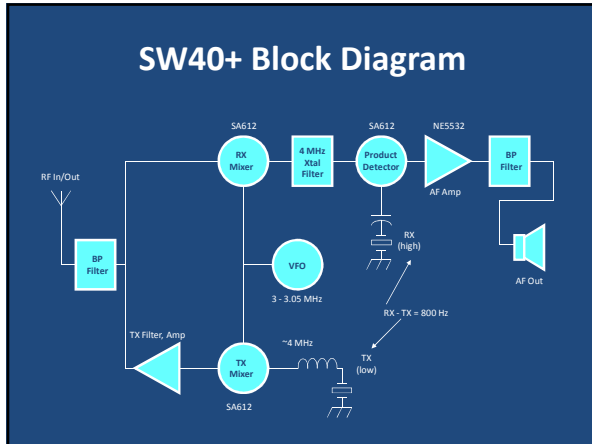


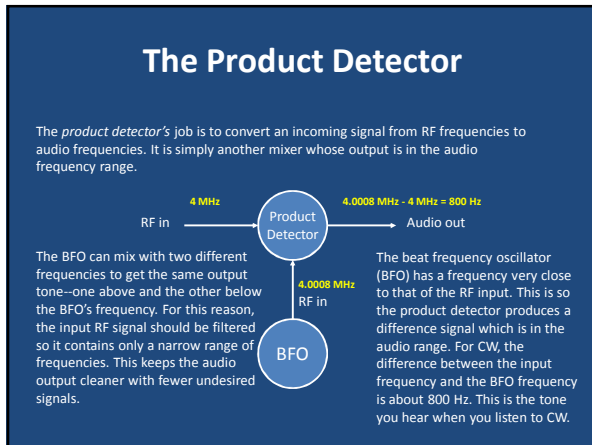
Yaesu FT-100D

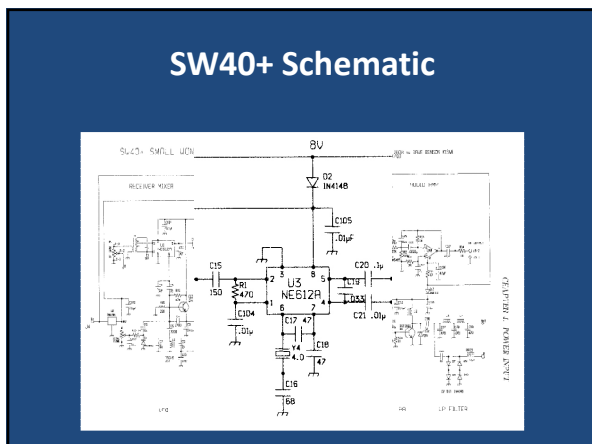


Nothing Different – Just More Detailed









How Does the Block Diagram Help to Troubleshoot Your Rig?

- What is the best single piece of test equipment to have?
–Your brain!!!!
- You are like a doctor – problems have symptoms; symptoms have a cause; and the cause identifies where to look for the solution.
- What we need is an organized way to go from problem to solution

Let's Practice Troubleshooting!

- The antenna is connected to the antenna input
- We turn on the rig and we hear white noise in the speaker
 - The volume goes up and down as we turn the volume control
 - We change bands and the same noise is present in the speaker
 - Moving the VFO does not seem to change the white noise

Let's Practice Troubleshooting!

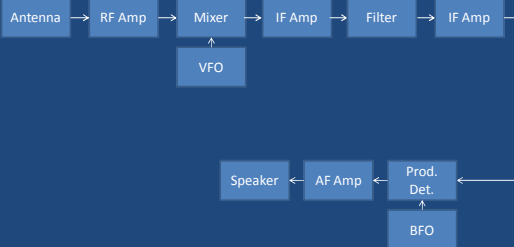
(continued)

- We try a "reset" if the rig has one
 - No change
- We happen to have an old crystal calibrator
 - The calibrator has a signal every 100 khz through 30 mhz
 - We remove the antenna and inject the calibrator signal into the antenna input
 - We try the rig on several different bands
- Tuning the rig does not change the white noise in the speaker
- We turn the RF Amp on and off – no change

Let's Practice Troubleshooting!

(continued)

- Let's take a look at the block diagram again



What part of the block diagram seems to be where the problem is?

- Do you think the problem is in the audio sections?
- Why or why not?
 - The white noise says the audio amps are working
 - The fact that the volume control works seems to indicate the problem is before the audio section
- Lets look at the other symptoms

What part of the block diagram seems to be where the problem is?

(continued)

- We reset the processor (if it has one) and that did not help.
 - Does not rule out the processor, but it does eliminate several possible problems
 - Sometimes we “diddle” with the menus and get things so far off the radio will not work properly
 - Static electricity can corrupt the processor
 - A reset eliminates this possibility

What part of the block diagram seems to be where the problem is?

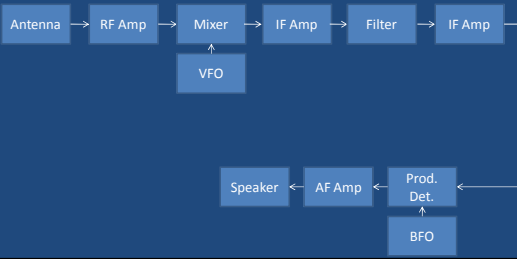
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- We injected a signal into the antenna input and did not get any change in the audio
 - We know there was a signal at the antenna input
 - We know the rig did not process the input signal properly
 - Since we tried several bands, the problem is related to any band reception
 - Turning the RF Amp on and off resulted in no change

What part of the block diagram seems to be where the problem is?

(continued)

- Let's take another look at the block diagram



So where is the problem located?

- Most likely the problem is in the blocks after the RF Amp and before the AF Amp
- Now what do we do?
- Most of us will send the rig to a repair facility!
- But some will try to narrow down the problem
- How can we do this?
 - We can use a signal tracer or signal injector

What is a signal injector/tracer?

- It's a simple piece of test equipment that consists of a signal source (like a calibrator) and an AF amp with a diode detector.
- You can inject a signal into any RF or AF stage to see if that stage is working
- Or you can use the detector and AF amp to see if a signal is properly passing through a stage

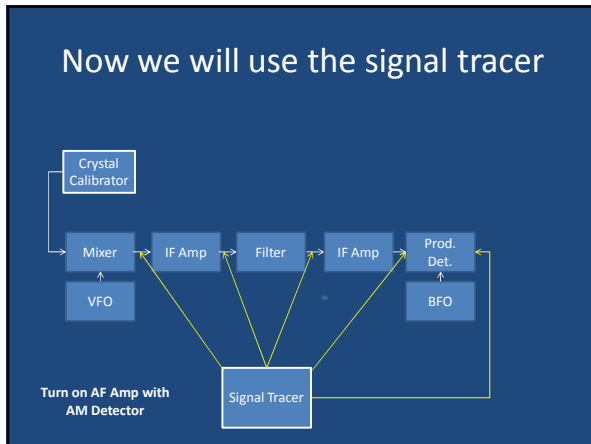
The MFJ-5012 Signal Tracer/Injector



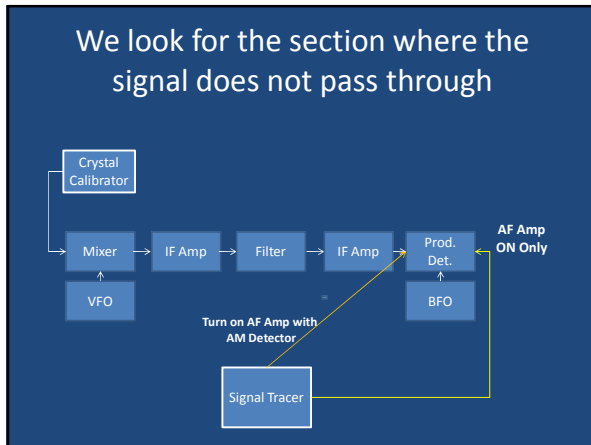
Heathkit IT-12 Signal Tracer



Now we will use the signal tracer



We look for the section where the signal does not pass through



What do we have?

- We have a RF signal going into the product detector
- No AF signal out of the product detector
- Now we can use the signal tracer on the BFO output
 - If a signal there, then the product detector circuit is probably the problem
 - If there is no signal out of the BFO, then the problem is probably the BFO circuit
- You now have narrowed the search for the problem to the BFO and/or product detector circuits

What's next in the troubleshooting process?

- We go to the schematic to locate the components used in those two circuits
- Most rigs have a "Service Manual" that not only gives the block diagram and schematic, they have figures of the circuit boards showing the location of the components
- Locate the product detector/BFO components and find them on the circuit board using the figures of the boards

What's next in the troubleshooting process? (continued)

- Most Service Manuals give the voltages expected on most active components (transistors, pins on integrated circuits, etc.)
- If the voltages are close (+/- 10% from listed voltages, we can assume this part of the circuit is okay (still may be a problem, but not likely)
- If voltages are incorrect, the components associated with this voltage are the most probable cause of the problem
- These parts can be replaced and the rig should be retested

Conclusions

- Even if you cannot repair the rig, knowing what is probably wrong will:
 - help you describe the problem to the repair technician
 - may reduce the cost of repair by helping the technician find the problem more quickly
 - increase the probability of the rig being fixed the first time and returned quickly
- Give you the satisfaction of locating the problem

References

- "Signal Injection in Ham Receivers," by Larry Allen, *Ham Radio Magazine*, May 1972, pp. 72-75.
- "Signal Tracing in Ham Receivers," by Larry Allen, *Ham Radio Magazine*, April 1968, pp. 52-56.
- "Troubleshooting I: Signal Tracing/Injection," by Joe Carr, K4PIV, *Ham Radio Magazine*, January 1986, pp. 59-62.
- "Elmer 101," www.qsl.net/kf4trd/faq.html
- "Some Basics for Equipment Servicing, Pt. 3," by George Collins, KC3V, *QST*, Feb. 1982, pp. 40-44.
- *How to Troubleshoot and Repair Amateur Radio Equipment*, by Joseph Carr, K4IPV, Tab Books, Blue Ridge Summit, PA, 1980.

QUESTIONS?
