MODULE 30
EXCITER BLACK BOXES

OBJECTIVE

Explain the function of each black box in the AN/GRT-17(V)1 Exciter.

PREREQUISITES

Must complete Modules 1, 2, 3, 15, 20, 21, 25, and 29.

INFORMATION

In this stop on our trip, we'll take a guided tour of the AN/GRT-17(V)1. The GRT-17 is actually just an Exciter; the Power Amplifier is a separate unit. If you only wanted to transmit .25 Watts, the GRT-17 would qualify as a Transmitter. However, we know that isn't practical; so the transmitting system consists of a GRT-17 and its associated Power Amplifier (2.5kW or 10kW).

Like the Receiver, each black box in the Exciter has its own TO. We'll cover each black box separately and give you a chance to become familiar with the TO for it. Two of the black boxes, the 887B-1 Electrical Frequency Synthesizer and the 652J-4 Power Supply, are exactly the same as those used in the Receiver. Since we've already gone through these two boxes, we will only discuss the others.

Look at the block diagram of the Exciter, Figure 18 in your Diagrams booklet. Remember the audio input is applied to the 599H-2 Audio Oscillator. This unit is covered in TO

33A1-8-592-2. Read para 4-1 thru 4-13 before continuing.

The 599H-2 provides the following:

1. A 1kHz tone for self-test and CW operation
2. VOX operation for the Exciter
3. Key line for Exciter and mute line for Receiver

Look at the top of Figure 19 in your Diagrams booklet. The 1kHz oscillator is contained on card A7. The tone is fed to R14, which adjusts the output level. Remember, the Desired Interface Level (DIL) of the system is adjustable. You must match the level of the tone to the interface level of your system. (Table 5-40 of the -12 TO provides more information about interface levels.) The tone is fed through the contacts of relay K1. This relay is energized when the CW key is pressed or self-test is selected on the control head. Let's see what happens when self-test is selected.

The line labeled self-test high is not referring to the power of the Transmitter. That high/low power selection is completely separate from this point. The equipment was designed to use two self-test modes, high and low. The TSC-60 only uses the high mode. When self-test is **not** selected, a logic 1 is felt on the input to U1A, producing a logic 0 (ground) on the output. This ground prevents Q5 from being able to energize the relay. When self-test is selected, a logic 0 (ground) is applied to U1A. The output of U1A is a logic 1, which reverse biases diode CR13. Because of the diode, the high from U1A doesn't turn on Q5, but a high from U2C will.

Tracing backwards from U2C, you can see that its input comes from the three key lines: PTT, data, and CW. Any one

of these key lines will apply a logic 0 to Q7, which in turn applies a logic 1 to Q8 and Q9. Q9 provides a logic 0 to the external key line, which goes to the PA and the Antenna Coupler. Q8 provides a logic 0 to the radio key line for the Exciter and to U2C, which is what we needed to energize relay K1 and apply the tone down to relay K3. The logic 1 from U2C is also applied to Q10, which energizes relay K3 so the tone is applied to the input of the Exciter. Now let's recap.

A logic 1 on the self-test high line (no self-test) prevents relay K1 from being energized by Q5. A logic 0 on the self-test high line removes this "lock-out" feature. When self-test is selected and a key signal is applied, K1 energizes to apply the tone to K3, and K3 energizes to apply the tone to the Exciter.

In VOX operation, the transmit audio is applied to the circuit on the VOX card (A3). Does this circuit look familiar to you? It should. It's exactly the same circuit that's on the squelch card in the Receiver. Remember from our discussion in the Receiver, this circuit detects syllables. Actually, it detects intermittent presence of audio in both the 600Hz and 2.5kHz range. If such audio is detected, a low is applied to the key circuits on the VOX command line.

If VOX is **not** selected by the VOX enable line or the Receiver is sending an anti-VOX signal to the Transmitter, the VOX disable line from Q27 is low. This prevents the VOX command line from going low to key the Transmitter.

One final note about the 599H-2: The tone, VOX input, and VOX sensitivity levels must be adjusted to match the interface level you're using. Table 5-40 tells you which adjustments need to be made. Now look back at the Exciter

block diagram, Figure 18, for a moment.

Here you see the four audio inputs to the 599H-2, the four anti-VOX inputs from the Receiver, and the key lines. The PA key line is applied to the appropriate Power Amplifier, and the radio key line is applied to the IF and RF translators. The four audio outputs are applied to the 889A-7 IF Translator, the next stop on our tour. Read para 4-1 thru 4-25 of TO 31R2-2GRT17-12.

The 889A-7 serves two purposes in the Exciter:

1. Converts audio to IF frequency
2. Combines the four IF signals

Take a look at Figure 20 in your Diagrams booklet. Audio from the 599H-2 is applied to the data AF amplifier. This is simply a small audio amplifier circuit. The gain of this circuit is adjustable and needs to be set to match the interface level you are using. (See Table 5-40 in the -12 TO.)

The output of the AF amplifier is fed to the balanced modulator circuit, where it is mixed with the IF injection frequency. For the A1 and B1 sidebands, the injection frequency is 250kHz; for A2 and B2, it is 256.290kHz and 243.710kHz respectively. The AF-to-IF conversion is done by four separate balanced modulator circuits, one for each sideband.

The output of the balanced modulator is fed through a crystal filter to remove the unwanted sideband, and then through the interstage amplifier and equalizer circuit. The balanced modulator circuit contains another gain adjustment. The output of the interstage amplifier is fed to the multiplex combiner and the performance monitor. The

performance monitor is represented by lamps 21 thru 24 (one for each sideband) on the Maintenance Display Panel.

The multiplex combiner is a mixer circuit that combines all four sidebands into a single IF signal. The multiplex (mux for short) combiner is also fed by the combiner gain adjust logic circuit. This circuit controls the output level of the combiner to prevent overdriving the PA. You may be thinking that ALC and TGC would prevent overdriving the PA. If so, you're right. They would, but let's see what would happen if we relied solely on these control circuits.

Let's say, for example, you're transmitting a tone on the upper sideband (A1) at full power (2.5kW). If you apply a tone to the B1 sideband in addition to the existing tone on A1, the PA would try to put out 2.5kW on B1 also. Since the PA can only put out 2.5kW total, A1 and B1 sidebands would each contain 50% of the power. If the audio applied to one sideband were speech instead of a tone, the level of the tone on the other sideband would go up and down inversely to the amplitude of the speech.

However, the gain adjust circuits in the combiner prevent the level of one sideband from affecting the output on another sideband. This is done by reducing the output level of the combiner. If two sidebands are turned on, the combiner output is cut in half. If three sidebands are enabled, the output is reduced to one third. If all four sidebands are turned on, the combiner output is reduced to 25%. The output of the mux combiner circuit is adjustable and is also monitored with a performance monitor circuit that controls lamp 18 on the Maintenance Display.

The mux combiner output is applied to the IF amplifier circuit. The gain of this circuit is controlled by ALC and TGC. The output is fed to the 888B-1 Amplifier Converter

and to another performance monitor. The performance monitor controls lamp 20 on the Maintenance Display Panel. The 888B-1 is covered in TO 31R2-2GRT17-2. Read para 4-1 thru 4-14 of that TO before going on.

Remember in our tour through the 888B-2 Amplifier Converter for the Receiver, Module 21, we said that the RF translator is the same as the one used in the Exciter. The only difference is that the 888B-1 has an additional circuit card, A8, that the Receiver doesn't have. Refer to Figure 21 of the Diagrams booklet, and let's trace the signal through the 888B-1.

The 250kHz IF signal from the 889A-7 Synthesizer comes into the 888B-1 tune/operate relay on card A6. In the operate condition, the IF signal is applied to the 1st transmit mixer on the A5 card. Here, it is mixed with 9.9MHz to provide the 10.15MHz IF. The 10.15MHz is mixed with 99MHz in the 2nd transmit mixer to provide 109.15MHz. The 109.15MHz is filtered and applied to the 3rd transmit mixer, where it is mixed with the variable injection frequency. The variable injection frequency is derived the same way it was for receive, 109.15MHz minus the operating frequency.

The operating frequency from the 3rd mixer is amplified and sent to the 3-pole filter. From the 3-pole filter, the signal is passed through the receive/transmit relay to the broadband amplifier on the A6 card. Here, the signal is amplified and sent to the appropriate PA. A sample of the signal is sent to the performance monitor that controls lamp 19 on the Maintenance Display.

The requirements for ALC and TGC originate in the PA. TGC sets the gain of the Transmitter for the frequency selected and the conditions at the time of tuning. ALC is

used to control the input so that variations in the audio levels don't overdrive the PA. Remember, the DC voltages representing ALC and TGC ride the coax line between the Exciter and the PA. During the tune cycle, the relay on the A8 card in the 888B-1 applies the voltage from the PA along with a sample of the 888B-1 output to the TGC circuits in the 889A-7. In the 889A-7, this TGC voltage controls the output level. A memory circuit retains this level control until the Transmitter is retuned.

After tuning is complete, the relay deenergizes, applying the ALC voltage from the PA to the 889A-7 ALC circuits. The ALC circuits provide gain control to the output of the 889A-7 in addition to the gain control from the TGC memory circuit. This ALC circuits constantly work while the Transmitter is operating (tune complete Step 7) to prevent peaks in audio input from overdriving the PA.

Tuning of the 888B-1 is accomplished the same as the 888B-2 in the Receiver. If you don't remember how this was done, review Module 21.

ADDITIONAL INSTRUCTIONS

Answer the review questions and check your answers with the confirmation key. Review the material and references in the module for any questions you missed. Next, ask your trainer for the KEP questions. After your trainer checks your answers and reviews the questions missed with you, go on to the next module.

REVIEW QUESTIONS

1. List the black boxes and their main functions in the GRT-17 Exciter.

2. What is the output frequency of the IF translator applied to the RF translator?

3. Which signal controls the gain of the Exciter during tuning?

4. Which stages in the Exciter (covered in this module) have performance monitors?

5. What happens to the output level of the IF translator when two sidebands are selected compared to when only one sideband is selected?

6. If the Exciter is operating in the independent sideband voice mode, what effect does the 599H-2 have on the audio signal being applied to the IF translator?