MODULE 40
AMPLIFIER-POWER SUPPLY GROUP
TESTS AND ADJUSTMENTS

OBJECTIVES

1. Given TO 31S1-2TSC60-12, adjust the Amplifier-Power Supply Group IAW para 5-346 thru 5-362 for the OG-90 and para 5-407 thru 5-423 for the OG-89.

2. Given TO 31S1-2TSC60-12, test and adjust the 915V-2 Amplifier Control IAW para 5-494 and Table 5-106.

3. Given TO 31S1-2TSC60-12, test and adjust the 652J-13 Power Supply IAW para 5-464 thru 5-468 and Table 5-99.

PREREQUISITES

1. Must complete Modules 1, 2, 3, 15, 36, and 39.

2. Must be able to operate the following test equipment:

a. HP-606A Signal Generator
b. DCR-150-5AM1 Power Supply
c. Fluke 8300A Digital Voltmeter
d. PSM-6 Multimeter
e. 340 RMS Voltmeter
f. 975K-4 Test Set
g. Tektronix 454 Oscilloscope
h. HP-6104A DC Power Supply

INFORMATION

In the last module we discussed taking meter readings on the PA using the 975K-4 Test Set. If any of those readings are incorrect, the unit either needs to be adjusted or repaired. Usually adjustment will do the trick. If repair is called for, the chances are adjustments will have to be accomplished with the new components in the system. In either case, the checks need to be reaccomplished before returning the unit to operation.

The adjustment procedures are contained in the -12 TO. The adjustment procedures for the 208U-3A are almost exactly the same as those for the 208U-10A. For this reason, we'll only address the 208U-3A in this module. If you can perform the adjustments on one, you should be able to perform them on the other.

The procedures in the TO are pretty straightforward and easy to follow. Therefore, we'll limit our discussion primarily to what you will be measuring and adjusting. Before we begin, read the preliminary procedures para 5-346 and 5-347 of the -12 TO.

SCREEN CURRENT OVERLOAD ADJUSTMENT. Read para 5-348. The control circuits sample the screen current by measuring the voltage across the 1-ohm resistor, 2R14. By connecting a power supply across this resistor, you can simulate any screen current by simply varying the voltage. You use the PSM-6 as an ammeter to monitor the current you are sending through the resistor. You then adjust the threshold of the overload sensor so that the overload circuit trips at 200ma. When performing this type of adjustment, it is usually simplest to do it as follows:

1. Set the power supply output for an indication of 200mA on the PSM-6.

2. Adjust the threshold for an overload indication.

3. Reduce the power supply output below the 200ma indication and reset the fault circuits.

4. Slowly increase the power supply until the fault is indicated.

5. Read the current. If it is not 200ma, readjust the threshold and repeat the procedure.

Notice that the procedure in the TO called for only the Filament switch to be energized on the Test Set, **Not the High Voltage switch.** In this test you are controlling the current with an external power supply. If you turn on the High Voltage switch on the Test Set, the cabinet's internal power supplies will energize, and you will have two different supplies feeding R14. This is a good example of your need to follow the steps in the TO very closely. Don't ever rely on your own memory to do a procedure.

PLATE CURRENT OVERLOAD ADJUSTMENT. Read para 5-349. This procedure is almost exactly the same as the screen current overload procedure. The only difference is that you don't need the 100-ohm resistor or the Multimeter. The ammeter on the front panel of the 975K-4 is already connected exactly where you need it. Both these adjustments are simple enough. But what do you do if they don't go right? Get TO 31R2-2TSC60-32 (208U-3A TO) and we'll see how to trace the signals using the TO.

A good starting point would be the two resistors across which you cross connect the power supply. Turn to the schematic of the power supply, sheet three. Here you see the schematics for the plate supply and the screen supply. Find the two resistors, R7 and R14, and trace the sample lines from each to the feed-thru capacitors. Notice the

plate voltage sample and the cathode voltage sample adjacent to the ones we're tracing. Let's see where the wires are physically located in the cabinet, and then we'll trace them on the schematics.

Turn to the reference designator index in the IPB and look for the two capacitors 2C32 and 2C34. The index refers you to Figure 6-30. This figure shows where the capacitors are located on the electronic components assembly. But where is the assembly located in the power supply? The description of Figure 6-30 says the NHA (next higher assembly) is shown as item 70 in Figure 6-28. Let's look at that.

Figure 6-28 consists of four sheets. You'll find item 70 on detail B of sheet 2 located next to three big bars labeled CR2. CR2 is the rectifier for the plate voltage supply. Now turn to the first sheet of Figure 6-28, and let's see where detail B is located in the power supply compartment.

Detail B is in the upper-right corner of sheet 1 and is pointing to CR2. So Detail B on sheet 2 is shown upside down. That means that our feed-thru capacitors are on the top of the power supply compartment, towards the back. Now look back at the schematic and we'll find out where the lines go from the capacitors.

The two lines are labeled 1P18-120(3) and 1P18-119(3). 1P18 represents unit 1, connector P18. The 120 and 119 are the pins on connector P18 and the (3) indicates that these are found on sheet 3 of the schematics for unit 1, the power amplifier. So, turn to sheet 3 of the PA schematic.

In the lower-right corner you can see connector P18 with pins 119 and 120. But P18 doesn't appear to be connected to

anything. What the drawing doesn't tell you is that P18 is connected to the motherboard for the control black boxes. So, turn to Figure 7-1 and you will see all the connectors for the black boxes shown. P18 connects to the one on the right.

The motherboard reference designator is 1A12 and the connectors on it are numbered J1 thru J7. The remainder of Figure 7-1 is a listing of all the pins and their signals for each of those seven connectors. The labels at the beginning of the drawing, underneath the connector numbers, identify which black box is connected at that location.

Figure 7-2 is the wiring diagram for the motherboard. It shows you how the slices are interconnected. Remember, we are looking for P18, pins 119 and 120. The beginning of the Figure shows P18 is the first connector listed. Along the left of the drawing are the titles of all the connections in alphabetical order. We could find our connections by either looking for the titles or tracing down from P18 until we find pins 119 and 120. Since we know the titles, PA plate current sample and PA screen current sample, the easiest method is to look for the title.

You should have found the two connections about 3/4 down the first sheet. From the PA plate current sample title, follow along to the right. The first connection you come to is pin 119 on P18. Continuing to the right you will see that this pin is connected to pin 145 of "something". To find what that is, you have to go to the top of the drawing. Pin 145 is connected to 1A9, which happens to be the 915V-2. Now find where pin 120 is connected. Did you come up with pin 141 of the 915V-2? If not, try again.

Now where do we go? Well, we've done as much as we can in this TO. Next, we'll need the TO on the 915V-2 (C-8366).

But which TO is that? There are a number of ways to find out. You could look in the TO index, you could look in the list in the front of the -12, or you could look at Table 4-1 in this same TO.

Table 4-1 gives you all kinds of good information. It lists both Rockwell nomenclature and government nomenclature for each slice. It also lists which slot on the motherboard each slice is plugged into and which TO covers that slice. In this case you need TO 31R2-2TSC60-22.

Figure 7-3 shows the wiring of the motherboard. It shows you the interconnections between all the circuit cards and the connector on the rear of the unit. We are looking for pins 141 and 145. You should have found them on sheet 4 and discovered that they are connected to the A5 card on pins 31 and 37. Now turn to Figure 7-8.

This figure shows that both samples are fed to the plate current metering circuit. The screen current sample is also fed separately to the screen current metering circuit. The output of the plate current metering amplifier, U1, is the plate current analog signal. This signal is read on the plate current meter. The resistor, R3, is not what you adjust for the overload threshold. This resistor adjusts the output of the metering amplifier used to calibrate the meter readings.

This same signal is applied to one input of the overload sensor, U2. The other input is derived from the adjustment of the overload threshold. The overload sensor is operated as a comparator. It compares the input from the metering amplifier with that of the threshold adjustment. If they are equal, or the metering input is larger, the output of the sensor indicates a fault. That signal is applied to the control circuits to shut down the amplifier and give you a

fault indication. Now that you know how these two circuits function and how to trace the wiring using the TOs, you should be able to locate a malfunction in this area.

VOLTAGE REGULATOR ADJUSTMENT. Read para 5-350. Here again you shouldn't have any trouble following the procedure in the TO. But what if it doesn't work? To find a trouble you need to know how it is supposed to function. Look at Figure 4-13 in TO 31R2-2TSC60-32 as you read para 4-134 thru 4-144.

FILAMENT VOLTAGE ADJUSTMENT. Read para 5-351. This adjustment depends on the voltage regulator adjustment. Anytime the voltage regulator is changed, the filament voltage must be readjusted. Look at the schematic of the power supply, Figure 7-4 of TO 31R2-2TSC60-32, and follow our discussion.

You've already seen that the line voltage is applied through the boost transformer to the filament contactor. From here the regulated 225VAC is applied through rheostat R17 to the filament transformer. Once the regulated voltage is set to 225 volts, the Filament Adjustment rheostat is set for 7.2VAC on the secondary of the filament transformer. Obviously, if the 225 volts changes, the 7.2-volts from the secondary of the filament transformer will also change.

CAUTION!

Do not energize the plate voltage while performing the filament adjustment. This would cause -790 volts to be applied to the filament transformer.

STATIC ADJUSTMENTS. These include the bias for the tubes and neutralization of the PA tube. These adjustments set the static condition of the PA, that is, with no RF input. The bias adjustments are simply adjusting the voltages applied to the grids of the tubes. These are simple adjustments that should be checked each time you are performing adjustments on the PA. The neutralization adjustment prevents the amplifier from oscillating. It should be performed each time the PA tube is replaced or when oscillation is detected at 29.9999MHz. Read para 5-352 and 5-353 of the -12 TO.

COARSE and FINE TUNING ADJUSTMENTS. These adjustments should be made if the servo counter readings differ from the values listed in Tables 5-85 and 5-87. Now you're probably wondering, what servo counters? Each of the four servo tuning mechanisms in the PA has a mechanical counter that gives an indication of the relative position of the servo within its tuning range. The servo positions should be checked periodically. An incorrect servo counter could indicate the unit is not properly tuned or something has happened in the system that requires the servo to tune differently to compensate for it. Read para 5-354, and then we'll discuss the procedure.

Look at Figure 40-1. The voltage source for the frequency analog voltages is developed in the 309F-1. The voltage applied to the digital-to-analog converter is adjustable only by R5 on the A1 module. Even though the voltage applied across the follow potentiometer comes from the DAC and varies with the digital frequency selected, adjusting R5 will vary that voltage. The first step in the procedure is to set the frequency to 15MHz and adjust R5 for 20VDC across the follow potentiometer. Next, you adjust R18 and R19. These three adjustments must be done in sequence

since R5 will vary all three voltages and the voltages from TP2 and TP3 are referenced to TP1.

If the correct readings are still not obtained after the above adjustments, the follow potentiometer is defective and must be mechanically aligned to its servo mechanism. This is done by manually setting the servo so that the counter reads zero and then adjusting the potentiometer while observing the Ohmmeter. Table 5-86 gives the required values for each follow pot. After this adjustment, check the coarse positioning again. If it's still off, you have a problem that requires troubleshooting.

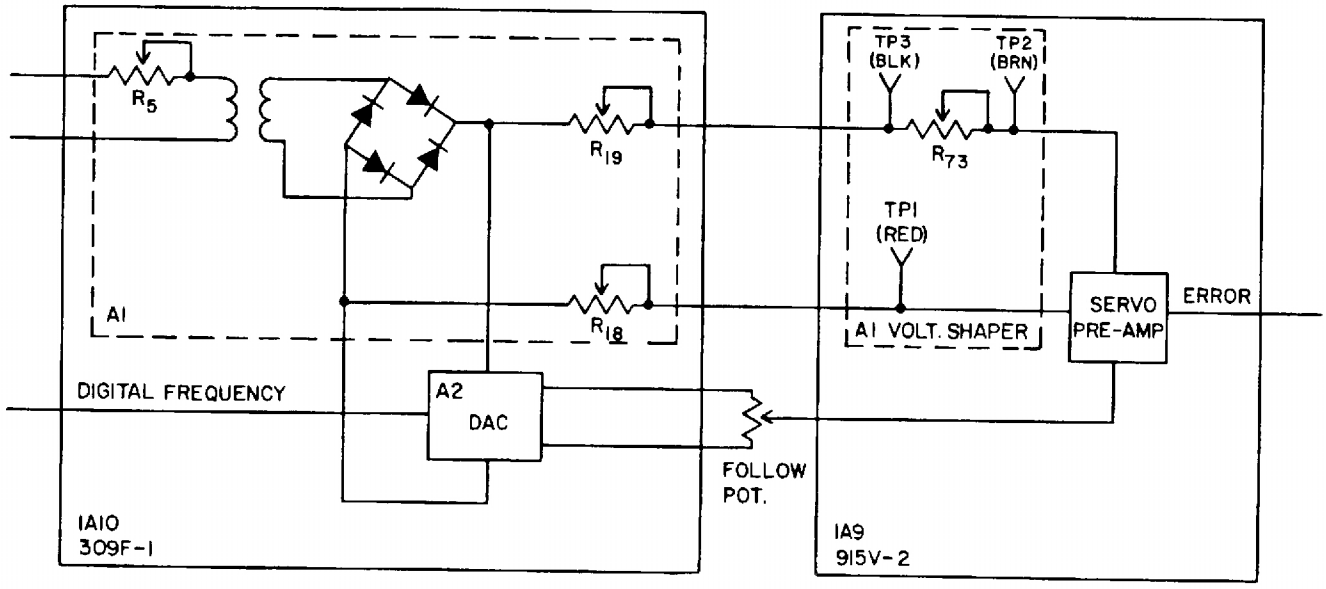

Figure 40-1. Coarse Tune Adjustments

After the coarse tuning is satisfactory, you need to check the fine tuning. Here again, the counter indications are compared with a chart listing (Table 5-87). If the count is not within the limits of the table, the mechanical synchronization of the tuning element to the counter itself is defective. The mechanical synchronization of each tuning assembly is covered in para 5-389 thru 5-391.

TUNE POWER ADJUSTMENT. Read para 5-355. The tune power control circuit is easy to understand. The output power of the PA is sampled by the directional coupler and applied to the internal gain control (IGC) circuit. In tune step 5, the tune power control transistor applies a bias voltage to the output power sample. Any output power above the specified level causes the IGC circuit to change the bias to the input amplifier, thereby controlling the output level of the PA. If you encounter a problem with tune power control, the difficulty could be in the directional coupler, the tune power control transistor (1A9A5Q3), or the IGC circuit (1A9A5U8).

LOADING ADJUSTMENT. The loading adjustment is performed to ensure the tube is conducting properly. Loading is correct when plate current is 1.5 amps and screen current is 60 milliamps. During this adjustment, you must watch the plate current meter very closely to keep the plate current at 1.5 amps. You will have to vary the output level of the Signal Generator to maintain this plate current level. Read para 5-356, and then we'll discuss the procedure.

The loading servo tunes the loading coil for the proper gain of the PA tube. The loading comparator circuit compares the RF input voltage to the RF output voltage of the tube and adjusts the loading coil for the proper ratio. The RF input sample is fed to one side of the loading adjustment potentiometer, 1A21R5, and the RF output sample

is fed to the other side. Thus, the ratio of input to output is determined by the setting of the wiper. Adjusting the pot effectively sets the desired ratio. The ratio of screen current to plate current should be equal to the ratio of RF input to RF output.

This loading adjustment is critical to proper operation of the system and increases tube life. The adjustment can tend to be a little touchy at times, so make adjustments in small steps and keep a close eye on the plate current.

SAMPLE LEVEL ADJUSTMENTS. The anode dissipation limiter (ADL) is another protective device for the PA. A defect in the tube or mistuning could cause a rise in the PA plate current and not in the RF output voltage. If this happens, a signal is sent to the IGC circuit to reduce the input level. The levels of the plate current sample and the RF voltage sample are adjustable. Read para 5-357, and then follow our discussion.

First, you tune the PA in the automatic mode. You then set the plate current and the plate RF voltage potentiometers for a minimum sample. It would be a good idea to unkey the amplifier while you're doing this. You also set the ALC so that it does not control the PA while you're making the ADL adjustments. When you do this, there is no automatic protection for the PA; so you have to exercise caution as you proceed.

Next, key the Transmitter and adjust the ADL Plate Current control for 0.865 amps of plate current with an input of 1.0 volt from the Signal Generator. That sets the plate current side of the ADL. You then adjust the Signal Generator for a Transmitter output of 2.8kW to set the RF sample. In this adjustment you are trying to set the ADL plate RF voltage so that it is just on the edge of

controlling the output of the PA. You can verify this by slightly reducing the output of the Signal Generator so that the Transmitter output should fall slightly. When you increase the Signal Generator output, the Transmitter output should be limited to 2.8kW.

ALC/TGC ADJUSTMENTS. Once the ADL procedure is completed, you need to reset the ALC. ALC adjustment is normally done with the Exciter connected to the PA; however, you can adjust it without the Exciter. You simply tune the PA in the automatic mode and adjust the ALC control for 2230 watts. After you have finished the adjustments of the PA and reconnected the system for normal operation, you must readjust the ALC and the TGC. These adjustments are covered in another module.

VSWR OVERLOAD ADJUSTMENT. To perform this adjustment, you must create a high VSWR on the PA output. Here again, you're purposely creating a hazardous condition in order to adjust a self-protection circuit. Read over the procedure in para 5-360 of the TO.

First, you tune the PA in the automatic mode, and then you turn off the Key and Plate switches on the 975K-4. Ensure the RF Output Vernier on the Signal Generator is set to minimum at this point. That way, when you turn the PA back on and key it, you don't hit it with full power.

Next, you remove the RF output connection on the top of the cabinet coming from the T/R relay and short the output of the PA. Obviously this is going to create maximum VSWR. You control the amount of reflected RF by controlling the RF output of the Signal Generator.

Once you've made your connection, you're ready to bring the PA back up by turning the plate voltage back on and turning on the Key switch. Before you do, double-check that the output of the Signal Generator is reduced to zero. Then key the PA and slowly bring up the RF input level while monitoring the reflected power on the RF patch panel. If the reflected power overload is properly adjusted, the Reflected Power Fault lamp should come on at 1.0kW of reflected power. If not, readjust the Reflected Power Overload control, 1A21R7. Now we come to the feedback adjustment para 5-361.

FEEDBACK ADJUSTMENT. Since the PA is designed to provide 10dB of negative feedback, You check and adjust that feedback by first measuring the RF output with no feedback. You then reconnect the feedback and increase the input 10dB. The output should be the same. If not, simply adjust feedback capacitor 1C24.

> WARNING! The plate compartment contains very high voltage. Any time the cover of this compartment is removed, use the shorting stick before touching anything in the compartment.

GUARD AMPLIFIER CHECK. The guard amplifier circuit prevents the loading circuit from traveling too far away from the coarse tuning point during fine tuning. The guard amplifier is in parallel with the loading error amplifier that controls the loading servo. During coarse tuning, both are fed with the coarse tuning frequency analog voltage, and so both outputs are the same. Read para 5-362.

During fine tuning, the inputs of the loading circuit revert to fine tuning inputs, while one of the inputs to the guard amplifier remains the coarse tuning voltage. If the two inputs to the guard amplifier differ greatly, the difference in the outputs of the two amplifiers in parallel prevents tuning, and the PA will tune-fault. There are no adjustments for this condition. So if proper indications are not achieved, troubleshooting the guard amplifier circuit will be required.

915V-2 AMPLIFIER CONTROL ADJUSTMENTS. Read para 5-494 and Table 5-106 in the -12 TO. As you can see, you will be checking and adjusting such things as the 915V-2 voltage shaper circuits, servo amplifier outputs, and the error sensing outputs. Before making any adjustments, remember to check the output voltages from the 309F-1 module. These voltages affect the voltage shaper voltages in the 915V-2. You should also review Module 36 for the theory and purpose of the 915V-2 Amplifier Control.

652J-13 POWER SUPPLY TEST AND ADJUSTMENTS. Take a look at para 5-464 thru 5-468 and Table 5-99 in the -12 TO. As you can see the 652J-13 test and adjustments are very easy. Basically, you are testing and adjusting the control voltages used by the other slices in the PA. Review Module 36 for the theory and purpose of the 652J-13 Power Supply.

That completes our discussion of the adjustments of the Amplifier-Power Supply Group. Remember, if the performance tests provide improper indications, adjustment of the PA may correct the problem. You now have a good idea of how to perform each adjustment and what that adjustment accomplishes within the system. With this knowledge you can not only keep your amplifiers in tip-top condition, but rapidly isolate malfunctions should they occur.

ADDITIONAL INSTRUCTIONS

Answer the review questions and check your answers with the confirmation key. Review the material 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 performance procedures.

REVIEW QUESTIONS

1. During the screen current overload adjustment, how is screen current simulated?

2. Why shouldn't the High Voltage switch on the Test Set be energized when performing the screen current overload adjustment?

3. What is the first step in finding the location of a particular component?

4. On the schematics of the Power Amplifier, what does the designator 1P18-120(3) represent?

5. What additional adjustment must be accomplished anytime the regulator adjustment is performed?

6. What would indicate that the coarse tuning adjustment is required?

7. What adjustment must be reaccomplished after the ADL adjustment is completed?

8. What is the purpose of the guard amplifier?

9. If all of the electrical adjustments of the coarse tuning procedure have been accomplished, but one of the servo counters is still incorrect, what is the next step?

10. The PA digital-to-analog converter for supplying coarse tuning voltages is contained in which module?

11. What is the purpose of checking the output voltages from the digital-to-analog converter?

12. With the DVM connected to test points TP-1 and TP-2, to what voltage is A1R73 in the 915V-2 adjusted?

13. List the control and operating voltages produced by the 652J-13 Power Supply.

14. At what input level should DC current limiting begin in the 652J-13?

PERFORMANCE PROCEDURES

Have your trainer demonstrate performance of the Amplifier-Power Supply Group adjustments. Practice performing these adjustments under the supervision of your trainer until you feel confident. Your trainer will annotate your training records when he/she feels you are proficient.