
TL-1 MICROWAVE RADIO

RECEIVER TESTS

AFC ALIGNMENT AND IN-SERVICE CHECKS

This section describes in-service performance checks of the automatic frequency control (AFC) loop and certain out-of-service tests and procedures to be used after replacing a beat-oscillator (BO) klystron.

This section is reissued to reorganize the section into charts and to add test information for TL-1 receivers that may now be equipped with either of the following:

- (a) The modulator-preamplifier unit (J99296AA-2, List 3) with the receiver IF and baseband unit (J99296G-2).
- (b) The modulator-preamplifier unit (J99296AA-2, List 3) with the IF amplifier unit (J99351E-1) and the FM receiver unit (J99351J-1).

Since this is a general revision, arrows ordinarily used have been omitted.

This reissue affects the Equipment Test List.

Section 409-303-500 describes system lineup. Each radio bay has been completely aligned with the AFC loop properly adjusted before shipment. Care should be taken *not* to disturb any settings during installation. Mechanical alignment of the antennas requires the use of received signal strength indications as outlined in Sections 409-302-501 and 409-306-503. When an input of -75 dBm has been achieved, the AFC switch can be operated to the ON position and locking should occur. Chart 1 should be performed for possible minor adjustments.

Chart 1 contains routine AFC checks and minor AFC adjustments which may be performed on an in-service basis. Chart 2 contains out-of-service tests and adjustments which should be performed after replacement of the BO klystron or if the requirements of Chart 1 cannot be met.

Table A summarizes the meanings of certain meter indications. Table B lists the receiver and beat-oscillator frequencies corresponding to the various channel assignments as well as the associated microwave filters and wiring options. The latter depend upon whether the beat-oscillator frequency is above or below the frequency of the received signal. Consult Section 409-306-500 for procedures on removing and restoring service when it is necessary to perform any out-of-service tests.

Warning: Voltages applied to the klystron are higher than those normally encountered in the telephone plant. General instructions on the maintenance and handling of electronic equipment involving hazardous voltages as contained in Section 010-110-001 shall be strictly observed.

TABLE A
SUMMARY OF METER INDICATIONS

RESULT OF CLOCKWISE ROTATION OF RCVR KLY ADJ OR BO RPLR CONTROLS		
FUNCTION	OPTION A (BO BELOW INCOMING CARRIER)	OPTION B (BO ABOVE INCOMING CARRIER)
BO frequency Intermediate frequency Upper meter Lower meter (Selector switch: AFC) (AFC switch: ON)	Increases Decreases Moves to right Moves to left	Increases Increases Moves to right Moves to left
Example of condition of BO and intermediate frequencies for upper meter indication (+) and lower meter (AFC position) indication.*		
FUNCTION	OPTION A	OPTION B
BO frequency Intermediate frequency	Too high Too low	Too high Too high
* A change of 1 volt on the lower meter corresponds to a change of BO klystron frequency of 1.5 to 3 MHz. The sensitivity of the upper meter depends upon the position of the AFC switch on the receiver control unit. For AFC OFF, 4 μ A represents approximately 1-MHz change of intermediate frequency. For AFC ON, 36 μ A represents approximately 1-MHz change of intermediate frequency. In the latter case because of AFC action, a 1-MHz shift between the incoming carrier and the free-running BO frequency results in approximately one 36-MHz shift in intermediate frequency or a 1- μ A shift on the upper meter.		

CHART

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APPARATUS:

- 1—J99262AA TL Test Set
- 1—KS-14510 Volt-Ohm-Milliammeter (VOM)

TABLE B

FREQUENCY PLAN				
CHANNEL NUMBER	RECEIVED FREQ	1307 FILTER	RECEIVER KLYSTRON FREQ	WIRING OPTION ON SD-97038-01
1A	10,755	B	10,825	B
1B	11,405	T	11,335	A
2A	10,955	G	11,025	B
2B	11,685	AD	11,615	A
3A	10,995	H	11,065	B
3B	11,645	AC	11,575	A
4A	10,715	A	10,785	B
4B	11,445	U	11,375	A
5A	11,155	M	11,085	A
5B	11,325	R	11,255	A
6A	10,875	E	10,805	A
6B	11,605	AB	11,535	A
7A	10,915	F	10,845	A
7B	11,565	AA	11,495	A
8A	11,115	L	11,045	A
8B	11,365	S	11,295	A
9A	11,075	K	11,145	B
9B	11,245	N	11,315	B
10A	10,795	C	10,865	B
10B	11,525	Y	11,595	B
11A	10,835	D	10,905	B
11B	11,485	W	11,555	B
12A	11,035	J	11,105	B
12B	11,285	P	11,355	B

CHART 1

ROUTINE AFC CHECKS AND MINOR ADJUSTMENTS

The AFC checks and adjustments described in this chart are performed on an in-service basis. The routine checks of the AFC system that are described in tabular form in Section 409-302-501 may be referred to for additional information. Many TL-1 microwave radio systems have been modified as indicated by (a) or (b) in the second paragraph on page 1 of this section. The TL-1 systems that have been modified as indicated by (a) or (b) will in many instances have special test indications or requirements. *These special indications or requirements will be in parentheses.*

CHART 1 (Cont)

STEP

PROCEDURE

Routine AFC Check

- 1 Operate the FREQ switch on the meter unit to the IF position, and turn the selector switch to the AFC position.
- 2 Observe the upper and lower meter indications.

Requirement 1: The upper meter shall indicate $0 \pm 2 \mu\text{A}$.

Requirement 2: The lower meter shall indicate 16 ± 1 volts (or 14 ± 1 volts).

Note 1: This represents a maximum shift of the intermediate frequency of approximately 50 kHz.

Note 2: If these requirements are not met but the upper meter indicates $0 \pm 7 \mu\text{A}$ and the lower meter indicates within 16 ± 4 volts (or 14 ± 4 volts), follow the minor adjustment of AFC procedures outlined below. If the requirements are outside these limits, the preceding transmitter frequency should be checked. If the preceding transmitter frequency is correct and the meter indications are still outside the limits, the bay should be taken out of service and the AFC alignment of Chart 2 should be performed.

Minor AFC Adjustment

For an upper meter indication of up to $\pm 7 \mu\text{A}$ and a lower meter indication of 16 ± 4 volts (or 14 ± 4 volts), the relative shift between the beat oscillator and incoming carrier may be as much as 8 MHz.

- 3 Adjust the BO RPLR control to obtain an indication of 16 volts (or 14 volts) on the lower meter.
- 4 If the upper meter is outside the range of $0 \pm 2 \mu\text{A}$, adjust R27 to obtain an indication of zero.
- 5 Because Steps 3 and 4 interact, repeat them as necessary for the best possible indications on the upper and lower meters.

Note: The readjustments do not necessarily correct the component which caused the relative frequency shift, since it might have been the preceding transmitter, but only center the regulating range of the AFC circuit. Therefore, make an in-service check of the preceding transmitter frequency as described in Section 409-304-501 at a favorable opportunity. Any adjustment of the transmitter frequency should be followed by a readjustment of the receiver AFC circuit.

CHART 2
AFC ALIGNMENT

This is an out-of-service test procedure. Be certain that the radio channel is removed from service as specified in Section 409-306-500.

Complete alignment of the AFC system requires reception of the carrier frequency from the preceding transmitter. Since the alignment depends upon the incoming carrier, it is important that it be on the correct frequency. (Refer to Section 409-304-501 for transmitter alignment.)

Many TL-1 microwave radio systems have been modified as indicated by (a) or (b) in the second paragraph on page 1 of this section. The TL-1 systems that have been modified as indicated by (a) or (b) will in many instances have special test indications or requirements. *These special indications or requirements will be in parentheses.*

STEP**PROCEDURE**
AFC Amplifier Zero Check

This test requires that an unmodulated 70-MHz signal be applied to the input of the IF amplifier on an out-of-service basis. With the AFC control loop open, the voltage output from the AFC amplifier should be zero. As a general precaution, the mechanical zero of the upper meter is first checked.

- 1 Remove the power plug from the IF and baseband unit.
- 2 With the **FREQ** switch operated to the **IF** position, check that the upper meter indicates zero. If it does not, readjust the mechanical zero of the meter.
- 3 Restore the power plug to the IF and baseband unit.
- 4 Remove the patch cord between the **PRE AMPL IN** jack of the IF and baseband unit and **OUT** jack **J3** of the 1A receiver modulator (or remove the patch cord between the **IF IN** jack of the J99296G IF and baseband unit, or the input to the 1075A filter and the **PREAMP OUT** jack of the modulator-preamplifier).
- 5 Arrange the TL test set to send 70 MHz at a level of -40 dBm into the **PRE AMPL IN** jack of the IF and baseband unit (or at a level of -25 dBm into the **IF IN** jack of the J99296G IF and baseband unit, or at a level of -12 dBm into the input of the 1075A filter).
- 6 Operate the AFC switch on the meter and control unit to the **ON** position.
- 7 Check that the upper meter indicates zero. If it does not, readjust the **AFC ZERO** control on the IF and baseband unit (or the FM receiver unit) so that the meter indicates zero. Inability to make this adjustment indicates that the IF and baseband unit (or the FM receiver unit) should be replaced.

CHART 2 (Cont)

STEP	PROCEDURE
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- 8 Restore the circuit to normal by replacing the input patch cord.

Magnetic Amplifier Bias

On an out-of-service basis, the AFC switch on the meter and control unit is operated to the OFF position, thus breaking the AFC loop between the input of the magnetic amplifier and the output of the AFC amplifier. The indication of the lower meter with the selector switch at the AFC position is then controlled only by the dc bias on the magnetic amplifier.

Note: It is possible that the AFC voltage cannot be adjusted properly if potentiometer R27 has been rotated to the maximum clockwise position, resulting in a minimum AFC voltage indication. This condition can be corrected by rotating potentiometer R27 to the maximum counterclockwise position and then waiting approximately 10 seconds for the AFC voltage to rise to the maximum indication after which the adjustment can be made.

- 9 Operate the AFC switch on the meter and control unit to the OFF position.
- 10 With the selector switch at the AFC position, the lower meter should indicate 16.0 ± 0.5 volts on the 30-volt scale (or 14.0 ± 0.5 volts). If it does not, adjust potentiometer R27 of the control panel so that the meter indicates 16.0 volts (or 14.0 volts). Inability to make this adjustment indicates absence of 1800-Hz power, 20-volt regulated power, or a defective 13A magnetic amplifier.
- 11 Restore the circuit to normal by operating the AFC switch to the ON position.

Receiver Klystron Output Adjustment

The following adjustments are performed on an out-of-service basis and must be made after the vapor-phase cooler and the klystrons have reached thermal equilibrium. By referring to the channel number in Table B, it can be determined if the receiver klystron frequency is 70 MHz above or below the incoming carrier frequency. An approximate mechanical adjustment of the klystron cavity may now be made. The repeller voltage is adjusted to give maximum output power, resulting in optimum frequency stability with voltage changes.

Caution: *When the BO klystron is mechanically tuned to the extreme ends of its frequency range, care should be taken not to put excessive pressure on the travel stop. Failure to observe this caution may result in flashover between elements of the klystron or permanent damage to the tuning mechanism.*

- 12 Remove the cover enclosing both klystrons. Adjust the tuning screw of the BO klystron so that the pointer on top indicates frequency approximately 200 MHz above or below the desired frequency. The frequency should be above if the desired BO frequency is 70 MHz above the incoming carrier and vice versa as determined from Table B.
- 13 Replace the cover and wait several minutes for the BO klystron to warm up.

CHART 2 (Cont)

STEP**PROCEDURE**

Note: After a BO klystron has been replaced and power reapplied, it takes approximately 20 minutes for the klystron to rise to final operating temperature. If the power has been off long enough to permit the vapor-phase cooler to drop to ambient temperature, approximately 40 minutes are required for temperature stabilization. While steps in the procedure for adjustment of receiver klystron frequency can be performed almost immediately, meter indications should be monitored long enough to assure that the klystron has reached a stable operating temperature. A final touchup of the repeller voltage should then be made. The RF power switch controlling transmittal of carrier from the associated transmitter klystron should not be operated to the ON position until final temperature stabilization has been achieved. This prevents interference in adjacent channels.

- 14 On the meter and control panel operate the AFC switch to OFF and the selector switch to CR1.
- 15 Adjust the BO RRLR control for a maximum CR1 crystal current on the lower meter.
- 16 Check the lower meter indication with the selector switch on CR2.

Requirement: The sum of the two currents shall be 1.6 ± 0.1 mA.

Note: If this requirement is not met, adjust attenuator AT1 until each crystal current is within the range of 0.4 through 1.2 mA and the sum is 1.6 mA. See Section 409-306-501 for this adjustment.

Receiver Klystron Frequency Adjustment

It is assumed that the adjustments in accordance with Steps 1 through 16 have been made and that the incoming frequency is correct as specified in Section 409-304-501.

For BO Frequency Below the Incoming Carrier

- 17 On the meter and control panel, operate the FREQ switch to the IF position, the AFC switch to the OFF position, and the selector switch to the AGC position.
- 18 Observing both the upper and lower meters, slowly increase the BO klystron frequency by rotating the RCVR KLY ADJ control clockwise. When the upper meter indicates 0 ± 10 μ A and moves to the right with rotation of the control clockwise and at the same time the AGC indication on the lower meter is a maximum and corresponds to the meter indication recorded in the station records, the BO klystron is set at the correct frequency except for a final trimming.
- 19 Trim the upper meter indication to zero by means of the BO RPLR control. The meter will go to the right for clockwise rotation of the control.
- 20 Operate the AFC switch to the ON position.

CHART 2 (Cont)

STEP

PROCEDURE

Requirement 1: The lower meter shall indicate the same as in Step 18.

Requirement 2: The upper meter shall still indicate zero.

Note: If these requirements are not met on closure of the AFC switch, the BO klystron frequency is not locked with the incoming carrier. Turn the mechanical adjustment of the BO klystron one or two turns counterclockwise and repeat Steps 17 through 20.

- 21 Trim the upper meter indication to zero by means of the BO RPLR control.
- 22 Set the selector switch to the AFC position. The lower meter will indicate 16 ± 0.5 volts (or 14 ± 0.5 volts) if the magnetic amplifier bias is correct as checked in Step 10.
- 23 Repeat Steps 15 and 16.

For BO Frequency Above the Incoming Carrier

- 24 Operate the AFC switch to the OFF position, the FREQ switch to the IF position, and the selector switch to the AGC position.
- 25 Observing both the upper and lower meters, slowly decrease the BO klystron frequency by rotating the RCVR KLY ADJ control counterclockwise. When the upper meter indicates $0 \pm 10 \mu\text{A}$ and moves to the left with rotation of the control counterclockwise and at the same time the AGC indication on the lower meter is a maximum and corresponds to the meter indication recorded in the station records, the BO klystron is set at the correct frequency except for a final trimming.
- 26 Trim the upper meter indication to zero by means of the BO RPLR control. The meter will go to the right for clockwise rotation of the control.
- 27 Operate the AFC switch to ON.

Requirement 1: The lower meter shall indicate the same as in Step 25.

Requirement 2: The upper meter shall still indicate zero.

Note 1: If the upper meter was not exactly on zero in Step 26, the error indication will be expanded about nine times because the sensitivity of the meter is increased by a factor of 9 when the AFC switch is in the ON position.

Note 2: If these requirements are not met on closure of the AFC switch, the BO klystron frequency is not locked with the incoming carrier. Turn the mechanical adjustment of the BO klystron one or two turns clockwise, and repeat Steps 24 through 27.

- 28 Trim the upper meter indication with the BO RPLR control.

CHART 2 (Cont)

STEP	PROCEDURE
29	Set the selector switch to the AFC position. The lower meter will indicate 16 ± 0.5 volts (or 14 ± 0.5 volts) if the magnetic amplifier bias is correct as checked in Step 10.
30	Repeat Steps 15 and 16. <i>Note:</i> It is possible to lock the receiver false AFC zero; for example, when the BO klystron frequency is 35 instead of 70 MHz away from the incoming carrier. In these cases the upper meter may be normal, but the AGC meter peak will not be as great as the correct lineup point. In addition, the pilot level at the receiver output (Section 409-303-501) will be 6 dB too high. If this situation is found, repeat the alignment procedure. In setting the upper meter indication to zero, if it is found that the meter swings to the left for clockwise rotation of the BO RPLR control, the BO klystron frequency is on the wrong side of received carrier and the receiver will not lock onto the incoming carrier.
31	Restore the radio channel to service as specified in Section 409-306-500.
