

PERFORMANCE REQUIREMENTS
TE RADIO SYSTEM
GENERAL EQUIPMENT REQUIREMENTS
RADIO SYSTEMS

1. GENERAL

1.01 This section covers the performance requirements which TE Radio Systems installed by the Western Electric Co. shall meet before turnover to the Telephone Company. It is expected that the tests will be made by the Telephone Company. The services of a licensed radio operator are required for certain of the tests.

1.02 This specification is reissued to incorporate previous appendix changes.

1.03 Reference shall be made to Section 800-630-180 covering General Requirements and Definitions for additional information necessary for the proper application of the requirements.

1.04 **Test Equipment:** The requirements are based on the use of the following test equipment, or its equivalent:

- 2—80A Oscilloscopes
- 1—62A RF Signal Generator
- 1—71A Frequency Power Meter
- 1—61A or 61B Video Signal Generator
- 1—70A Power Meter
- 1—1AJ IF Detector
- 1—X-64603 (63X) Video Signal Generator
- 1—Ballantine Model 300A Vacuum Tube Voltmeter
- 1—Coaxial Drum Type Attenuator per KS-9534, List 3
- 1—Weston Model 772 Voltohmmeter

1—Dumont Type 208 Oscilloscope

2—P2AW Cords, 6 feet long

1—P2BA Cord

1—P2BC Cord

2. INSTALLATION AND PREPARATION

2.01 **General:** It is expected that these tests will ordinarily be made under conditions of complete installation between permanent transmitting and receiving location.

2.02 **Antenna Placement:** It is assumed that the placement of the transmitter and receiver is such that a line-of-sight transmission path is provided. Where the installation is a permanent or semi-permanent one, the antennas will be aligned as carefully as possible by optical means or by a geographical survey. The shielded lens antenna has an available range of only ± 2.5 degrees in azimuth and ± 5 degrees in elevation. On temporary installations or on short links the parabolic dish antenna may be used and the placement problem becomes much less critical, since the size and weight of the mounting structure are such that the final placement may be made before securing the base. It is only necessary that the dishes be approximately aligned by eye and that sufficient latitude of adjustment be available for final alignment on the carrier. In either case, final alignment must be made on the basis of carrier transmission.

2.03 **Communication Facilities:** Telephone communication is required between the transmitter and receiver locations. In some cases, it will also be necessary to provide communication between the receiving antenna location and the receiver video cabinet. This is most conveniently furnished by an extension on the order wire from the transmitter.

3. PRELIMINARY ADJUSTMENTS

(A) Transmitter Adjustments

3.01 Turn the transmitter GAIN ADJ switch to its maximum counterclockwise position and set the wave guide switch in the transmitter RF cabinet so that the transmitting oscillator feeds into the artificial load.

3.02 If the POWER LEVEL meter gives no indication that the transmitter is oscillating, adjust the -250-volt supply and the variable piston at the end of the oscillator tube mount until the meter reads a maximum. Allow approximately 15 minutes for the oscillator to stabilize before making further adjustments.

3.03 Maximize the transmitter oscillator output at the frequency of the receiver RF filter by adjustment of the -250-volt power supply, the mechanical tuning of the oscillator cavity and the piston on the tube mount. These adjustments are interactive and it will be necessary to approach the maximum by a series of successive approximations. The general procedure is as follows:

- (1) Set the wave meter to the position corresponding to the desired frequency and adjust the mechanical tuning knob until the POWER LEVEL meter dips to a minimum.
- (2) Turn the wave meter a couple of revolutions off the dip and maximize the oscillator output first with the -250-volt supply and then with the variable piston on the tube mount.
- (3) Recheck the frequency and adjust the mechanical tuning as required. If the tuning screw needs to be turned more than about half a revolution, it is desirable to recheck the position of the piston since the latter has considerable effect upon the frequency as well as upon the power output.
- (4) Final frequency adjustment is made with the mechanical tuning knob on the oscillator.

The operating mode of the oscillator should now be smooth and without abrupt changes in amplitude as the repeller voltage is varied slowly through the normal point of operation.

3.04 Turn the wave guide switch so that the transmitting oscillator is working into the antenna. If necessary, readjust the frequency to compensate for this change in loading. The POWER LEVEL meter shall read at least 0.65 ma.

(B) Receiver RF Adjustments

3.05 Turn the receiver GAIN ADJ switch to the maximum counterclockwise position, the AFC switch to OFF, and switch D2 to the NORM position.

3.06 Maximize the local oscillator output at a frequency 63 mc above that of the RF channel filter. The procedure for adjustment of the local oscillator is essentially the same as that described in 3.03 above, except that in the receiver, the repeller voltage is varied by means of the TUNE COARSE and the TUNE FINE potentiometers instead of by changing the rectifier output voltage. The repeller voltage at which the oscillator output is maximum for the proper frequency shall occur between 80 and 160 volts. The output of the oscillator shall vary smoothly through the maximum as the tune control is rotated through the operating point.

3.07 After the local oscillator output has been maximized at the proper frequency, adjust the RF attenuator in the receiver RF cabinet until the XTAL CUR meter reads 1.5 ma with the switches in both the RF and video cabinets on position 1. Turn both switches to the opposite position. The meter reading shall change by not more than 0.3 ma. The XTAL CUR meter in the receiver video cabinet shall agree with that in the RF cabinet within ± 0.1 ma for either position of the panel switches.

(C) AGC and AFC Adjustments

3.08 Check that the transmitter has not drifted from the assigned carrier frequency. Set the FREQ DRIFT meter to 0 by means of the MTR BAL FINE and MTR BAL COARSE potentiometers. Connect the IF detector to the limiter test output. Determine the IF frequency by adjusting the detector frequency knob until the meter dips sharply. If the transmitter and receiver RF wave meters have been exactly calibrated and the frequencies carefully set, the detector should read 63 ± 0.5 megacycles. Because of small cumulative errors, it may be necessary to

readjust the receiver tuning slightly until the detector reads 63 megacycles. If necessary, reset the **FREQ DRIFT** meter to zero.

3.09 Check that the limiter bias voltages E1 and E2 read 250 ± 10 microamperes and 100 ± 10 microamperes, respectively. If necessary, readjust these by means of the E1 ADJ and E2 ADJ potentiometers. Set the **AGC LEVEL** potentiometer until the **LIM CUR** meter reads 1.0 ma.

3.10 Set the **TUNE FINE** potentiometer at approximately the middle of its range. Adjust the **TUNE COARSE** potentiometers until the **FREQ DRIFT** meter reads approximately 0. It will be somewhat difficult to set the meter to exactly 0 with this control but it is only necessary to be within 2 to 3 volts of the reference reading. Depress the **BAL** key and adjust the **BAL** potentiometer until the **FREQ DRIFT** meter reads 0. Release the **BAL** key and readjust the **TUNE COARSE** potentiometer until the meter again reads approximately 0. Set the meter on 0 means of the **TUNE FINE** potentiometer and again check the balance with the **BAL** key depressed. It may be necessary to repeat this procedure until the meter reads 0 with the **BAL** key both depressed and released, since the tuning adjustments and the balance potentiometer are somewhat interactive.

3.11 Switch to **AFC ON**. If the frequency is not 63 ± 0.25 mc, adjust C58 on the **AFC** chassis. The adjustment of C58 should be made only with a non-metallic screwdriver. The **FREQ DRIFT** meter should now read the same with **AFC ON** or **OFF**, or can be made so by slight readjustment of **TUNE FINE**.

3.12 With **AFC ON**, turn the **TUNE FINE** control to each extreme of its rotation. The **FREQ DRIFT** meter should not change by more than ± 100 microamperes. Switch to **AFC OFF** and return the meter to zero with the manual control (**TUNE FINE**).

3.13 Connect the Ballantine voltmeter between terminal 3 of V11 and ground on the receiver panel. The voltage at this point shall not exceed 3.0 millivolts with **AFC OFF** or 1.0 millivolt with **AFC ON**.

4. TRANSMITTER RF TESTS

4.01 Connect the 71A Frequency-Power Meter to the test output of the directional coupler and record the frequency and power level at this point. The power output is equal to the indicated power plus the loss of the RF cord plus the directional coupler loss. The loss of the directional coupler is calibrated at two frequencies and the value used in determining transmitter power output should be that corresponding to the frequency which is closest to the carrier frequency.

Requirements: The frequency shall agree with that indicated by the wave meter in the RF cabinet within ± 1.0 mc. The transmitter power shall be not less than +22 dbm.

Caution: *The wave meter must be turned well away from resonance during the power measurement in order to avoid errors.*

5. RECEIVER TESTS

5.01 The transmitter should remain off the air during the receiver tests by turning the RF switch to the dummy load.

(A) Application of Test Equipment

5.02 Set up the 62A Signal Generator and 71A Frequency-Power Meter at the receiver location so that the output of the signal generator may be connected to the directional coupler in the RF cabinet. The Frequency-Power Meter is required to determine the frequency and output level of the signal generator since the latter is uncalibrated. There are two jacks on the signal generator which differ in output level by approximately 20 db, the exact difference depending upon the frequency. Monitor power and frequency at the **HIGH LEVEL** output jack while delivering signal from the **LOW LEVEL** output jack to the input of the directional coupler. In this manner power may be measured at a level which is within the limited range of the power measuring set while the signal delivered to the equipment under test is 20 db lower. At any particular frequency the exact difference in level between the two jacks may be determined from the calibration on the signal generator. For convenience this ratio will be called D (in db). The test signal output will then be the measured power, P, plus D if the power measuring set is connected to the **LOW**

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output, or minus D if it is connected to the HIGH output.

(B) Limiter Response

5.03 Set the level at the input to the directional coupler at approximately -10 dbm and at the assigned carrier frequency. Connect the IF detector, using the HIGH sensitivity input, to the test output of the limiter with the cable to the discriminator normally connected. Connect the coaxial attenuator in series with the input to the IF amplifier. Remove V5 from the AGC chassis, switch AFC to OFF, and adjust the attenuator until the limiter current is 1.0 milliamperes. Check the IF frequency with the detector and adjust the manual tuning so that this frequency is 65 megacycles. Connect the Dumont oscilloscope to the detector, switch D2 to the test position and observe the response through the limiter.

Requirements: The characteristic at the test output of the limiter shall have a bandwidth of not less than 56 to 74 mc measured at points 10% down from maximum amplitude. There shall be no slope across the band or deviations from flatness within the band exceeding 5% of maximum amplitude. When the IF attenuation is increased by 10 db, the characteristic shall remain essentially unchanged but the bandwidth may be decreased to not less than 58 to 72 mc.

(C) IF Amplifier Response

5.04 Move the IF detector to the output of the main IF amplifier using the LOW sensitivity input. Set the attenuator 10 db above that loss required to produce 1.0 ma limiter current in paragraph 5.03 above. Readjust the oscilloscope controls as required to produce a display having a maximum amplitude of one inch and observe the amplifier characteristic.

Requirements: The amplitude variation between peaks and valleys in the characteristic shall not exceed 10% of the maximum amplitude (peaks and valleys shall fall within one vertical division on the scope scale if maximum amplitude is 10 divisions). The bandwidth, measured at points 10% down from maximum, shall be not less than 57 to 73 mc. The amplitudes of the three peaks (nominally at 58, 65 and 72 mc) shall be equal within 5%.

Note: It will be found that with a signal deflection of 10 divisions, one division corresponds to a difference in signal level of slightly less than 1 db.

(D) Sensitivity Measurement

5.05 Remove the signal generator from the directional coupler input and return D2 to NORMAL. Switch the detector so as to obtain a meter reading instead of a display on the oscilloscope. Reduce the attenuation until the meter reads about 2/3 full scale. Normally this will be found with the attenuator at minimum loss. Record the attenuation (A1) and meter reading which will be called the reference noise reading.

5.06 Increase the attenuation to about 50 db and reconnect the signal generator. Check that the frequency is correct and adjust the level at the input to about -10 dbm. The IF frequency should now be checked on the detector and, if necessary, readjusted to 65 mc. Reduce the IF attenuation until the reference noise reading is obtained. Record this setting of the attenuator (A2) to the nearest db.

5.07 Sensitivity of the receiver may now be found by the relation:

$$N = A1 - A2 - B + C$$

Where N is sensitivity in dbm, A1 is the attenuation used for the reference noise reading, A2 is the attenuation required to reduce the signal to the reference level, B is the loss of the directional coupler at the carrier frequency, and C is the level of the signal delivered to the directional coupler input.

Requirement: The sensitivity shall be -85 dbm or better.

6. TRANSMISSION TESTS

(A) Antenna Alignment

6.01 Alignment of the antennas for maximum signal transmission should proceed as follows:

1. Replace V5 in the receiver and set the coaxial attenuator to zero. Remove the 62A Signal Generator and reconnect the output cable to the IF amplifier.

2. Put the transmitter on the air at its assigned frequency with unmodulated carrier.
3. Operate the receiver on AFC OFF and tune manually until the presence of carrier is indicated by the SIG LEVEL meter.
4. Switch to AFC ON and adjust the FREQ DRIFT meter to zero. Return to AFC OFF and adjust the manual tuning (TUNE FINE) until FREQ DRIFT is again zero. If the signal should be lost in the course of antenna alignment, tuning may now be restored by switching to AFC OFF. Return to AFC ON.
5. Set the AGC LEVEL control so that the SIG LEVEL meter reads about 80 volts. Move the transmitting antenna so as to produce a maximum reading on the meter. If necessary, readjust the AGC LEVEL control so as to keep the meter reading below 110, where sensitivity is greater.
6. Repeat this alignment on the receiving antenna.

(B) Signal-to-Noise Measurement

6.02 At the receiver, adjust the manual tuning so that the IF frequency is 65 mc and adjust the attenuation until the reference noise level is indicated by the detector at the output of the IF amplifier. The difference between this attenuation and that required for the reference noise reading (A1) represents the actual signal-to-noise ratio (S/N) of the system.

6.03 The theoretical signal-to-noise ratios for each type of antenna and for distances between one and 100 miles are shown on Figure 1. These curves assume no fading and a clear line-of-sight path between two similar antennas. Since it is not possible accurately to predict the actual path loss because of fading, atmospheric attenuation or other causes, the curves are given only as an indication of what might be expected under ideal conditions and do not necessarily represent a minimum standard.

Requirements: The minimum signal-to-noise ratio permissible is limited only by the picture quality and fading margin which can be tolerated. In general, anything less than about 35 db can be detected in the picture. The S/N ratio should be within 3 db of the

theoretical value during periods of little or no fading.

(C) Video Noise Test

6.04 Terminate the receiver AMP OUT T jack in 75 ohms and connect the Ballantine voltmeter between terminal TP6 on the video amplifier chassis and ground. Turn the receiver GAIN ADJ switch to the maximum clockwise position, leaving the transmitter gain switch at the maximum counterclockwise position.

Requirement: The voltage at terminal TP6 shall not exceed 2 millivolts with the AFC either ON or OFF.

Note: If any clamp "sing" exists in the transmitter, it will be necessary to remove V6 in the transmitter video amplifier during this measurement. It should be noted, however, that such a condition is permissible in the transmitter only if the peak-to-peak amplitude of the oscillation is not over 0.05 volt at the transmitter OUT TST jack and if the clamping action is normal and stable in the presence of video signals having an amplitude of 0.4 volt or greater.

(D) Frequency Characteristic

6.05 Set up the 61A or 61B Signal Generator at the transmitter and the 70A Power Meter at the receiver. Connect the latter to the AMP OUT T jack. Remove the coaxial attenuator and replace the normal connection to the IF amplifier. Turn both transmitter and receiver gain controls to the maximum counterclockwise position. Temporarily remove V5 from both the transmitting and receiving video amplifiers. Turn the AFC switch OFF and set the manual tuning so that the local oscillator frequency is 2 mc higher than that on AFC, thus making the IF 65 mc. Then turn AFC to ON and adjust C58 on the AFC chassis so that the FREQ DRIFT meter reads the same as with AFC OFF.

6.06 Set the signal generator at 50 kc and adjust its output level to about -10 dbv. Turn both gain controls to maximum. Connect to the AMP IN jack of the transmitter and adjust the level as required to make the reading of the 70A Power Meter at the receiver 0 dbv.

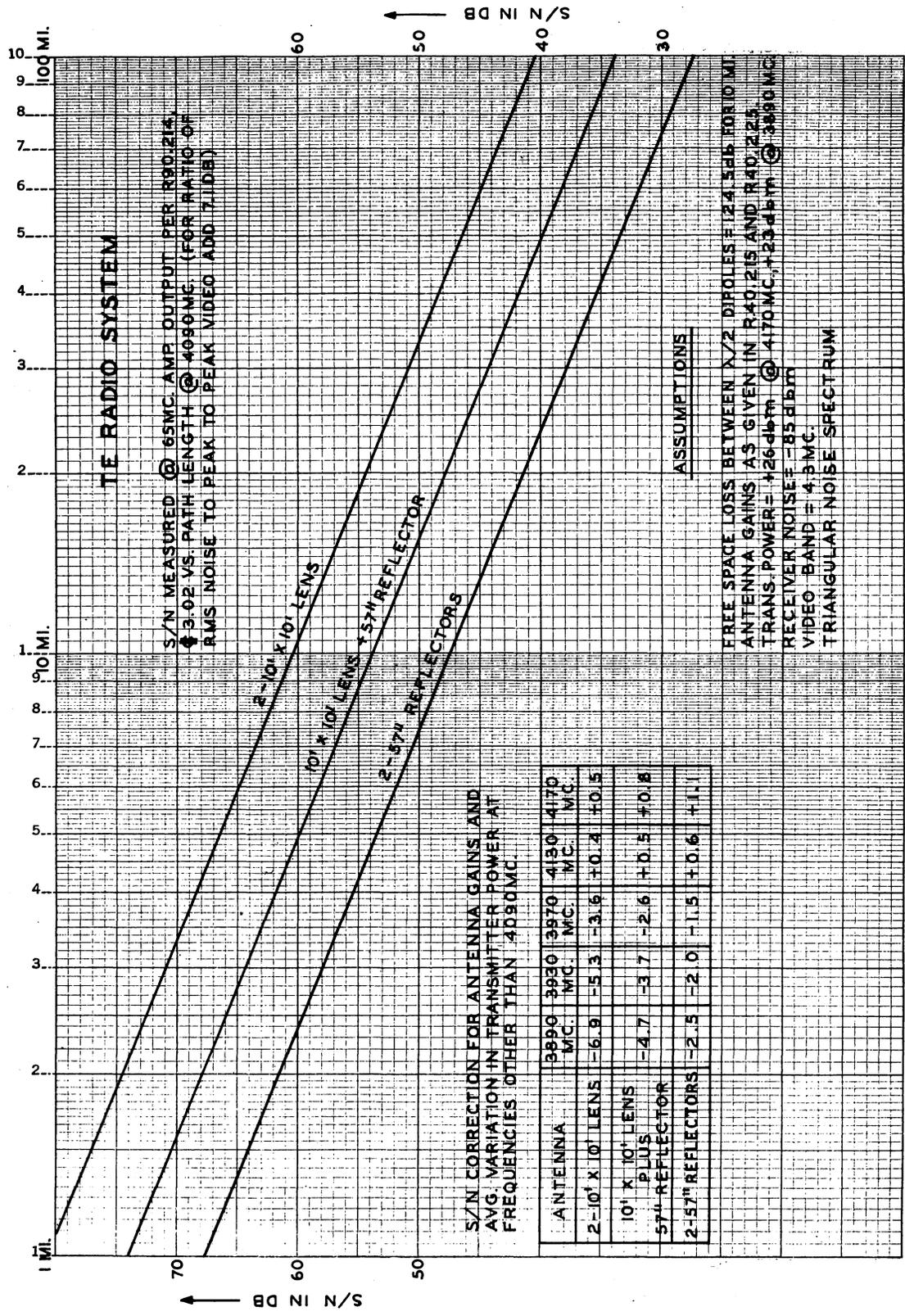


Fig. 1—Transmission for Two Similar Antennas

6.07 Change the oscillator output to 1 mc at the same level and record the output of the receiver. If necessary, adjust the voltage divider condenser, C10, in the transmitting tube mount until the output level at the receiver is the same as that measured in 6.06 above.

6.08 Measure and record transmission at the following frequencies, keeping the input level constant:

50 kc	2.0 mc
100 kc	2.5 mc
200 kc	3.0 mc
400 kc	3.5 mc
700 kc	4.0 mc
1.0 mc	5.0 mc
1.5 mc	6.0 mc

Requirements: (1) A curve plotted on the above results shall agree with that shown in Figure 2 within ± 0.2 db up to 2 megacycles and within ± 0.3 db between 2.5 and 4 mc. The curve shown in Figure 2 represents the average characteristic which will be obtained if all previous tests have been met. However, the cut-off frequency and slope of the curve beyond 4 mc may vary considerably. The small rise between 100 kc and 1 mc and the *slight* slope between 1 mc and the cut-off are typical. In general, the response at 3 mc should not be more than 0.5 db below that at 50 kc while that at 4 mc (the nominal cut-off frequency) should not be down more than 1.0 db. It is not cause for rejection, however, if the response should appear to be flat to 4 mc or even beyond, provided the further transmission requirements of the following section are met. (2) The input level required to produce 0 dbv output at 50 kc shall be not more than -5 dbv.

6.09 Return the manual tuning to the proper voltage and switch to AFC ON. Replace the tubes in the transmitter and receiver and reset C58 to the normal position.

(E) Transmission of Composite Signal

6.10 In the following tests, the WIDE pulse condition on the 63X Video Signal Generator is defined as that condition which produces a

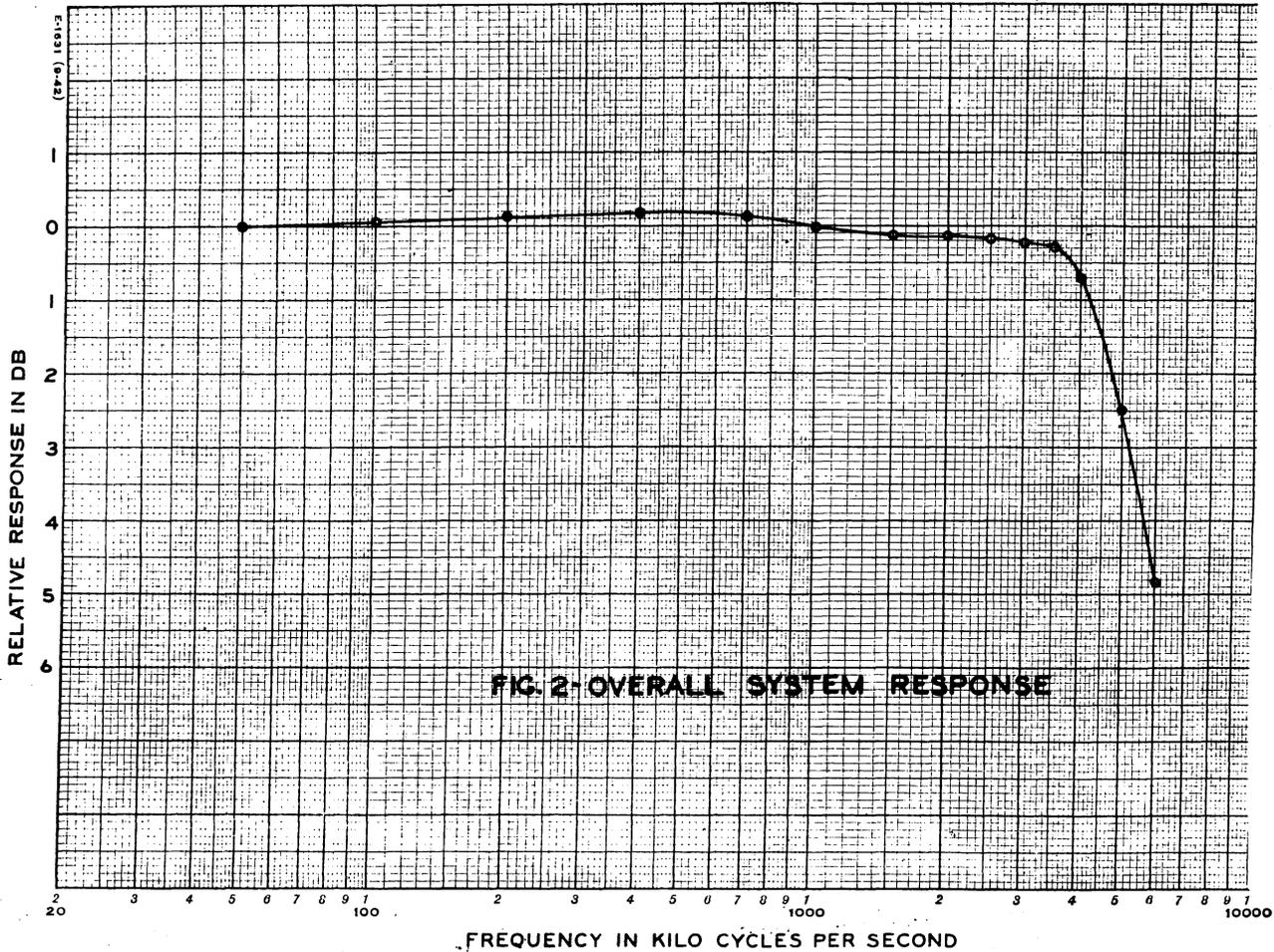
"picture" signal having a width at least 3/4 of the distance between successive sync pulses. The peak-to-peak amplitude of the composite signal is standardly 1 volt. The amplitude of the negative sync pulses is 30% of the peak-to-peak amplitude. The HEIGHT CONTROL is adjusted so that the "picture" pulse, when viewed on the slow speed sweep of the oscilloscope, appears on approximately 1/2 of the total number of lines or sync pulses, with the sync pulse only occurring during the remaining lines. The NARROW pulse condition is that which produces a single narrow positive spike following the negative sync pulse by approximately half the width of the sync pulse. The amplitude and proportions are the same as in the WIDE pulse condition.

6.11 Set up the 63X Signal Generator and one 80A oscilloscope at the transmitter location. With the oscilloscope connected directly to the signal generator, using a 75-ohm termination, adjust the composite signal to the two standard conditions described above. Leave the signal in the WIDE condition.

6.12 Connect the oscilloscope to the OUT TST jack, again using the 75-ohm termination, and adjust the GAIN switch until the signal at this point is approximately 0.8 volt peak-to-peak. Examine the signal at this test point, noting particularly the corners of the sync and "picture" pulses, the relative amplitudes of these portions of the composite signal, and the low frequency characteristics resulting from the 60-cycle gating. There should be no observable difference between the character of the signal at the test output and that previously observed at the signal generator directly, except that the clamping action of the transmitter should flatten out any residual low-frequency distortion which may have been present in the base line of the original signal.

6.13 Change the signal generator to SIG OFF so that the "picture" pulse is removed. There should be no observable change in the amplitude of the sync pulse at the test output.

6.14 Change the signal generator to the NARROW condition and return to SIG ON. Adjust the oscilloscope so that the sweep length is approximately one microsecond for 10 divisions on the horizontal scale. (This may be done by using a 1.0 mc signal from the 61-type Signal Generator as a time base.) Examine the character of the



signal at the test output, observing particularly the width of the narrow pulse at a point 1/10 of the distance from base line to peak, the overshoots and echoes following this pulse, if any are present, and the amplitudes of the sync and "picture" pulses. There should be no spreading of the pulse (as compared to the original signal) greater than 5% and no overshoots or echoes following the pulse greater than 5% of the pulse amplitude. The amplitude proportions should remain essentially the same as in the original signal.

6.15 Connect the second 80A Oscilloscope to the AMP OUT T jack of the receiver, using a 75-ohm termination. Adjust the receiver gain until the output signal is 1.0 volt peak-to-peak, measured into the 75-ohm termination of the oscilloscope.

6.16 Examine the WIDE wave form in the same manner as described in 6.12 above. There should be no low frequency distortion exceeding 5%

of the signal amplitude and no other noticeable difference in the signal characteristics. Check also for compression by switching off the "picture" and measuring the sync amplitude. There should be no observable difference in the signal with AFC OFF or ON.

6.17 With the WIDE wave form, measure the ripple at terminal 3 of V11 with the Ballantine voltmeter. The noise here should now be not over 3.0 millivolts with AFC ON or OFF. If it exceeds this value, check first that the period of the sync pulses in the 63X Signal Generator is 63 ± 2 microseconds and, secondly, that the natural period of the AFC gate pulse (rate with no video signal present) is 70 ± 2 microseconds.

6.18 Examine the NARROW wave form as described in 6.14 above. There should be no spreading of the narrow pulse in excess of 10% of the width measured on the original signal. There should be no echoes or overshoots exceeding 5% of the pulse

amplitude and the amplitude proportions should remain unchanged.

(F) Alarm Tests

6.19 Transfer the output of the transmitting oscillator to the dummy RF load. Connect an ohmmeter between terminals 5A and 6A on the transmitter meter panel; with normal carrier level this should be an open circuit. Reduce the transmitter repeller voltage until the PWR LEVEL meter

reads 0.5 ma. There shall now be a short circuit between terminals 5A and 6A. Reset the repeller to its former value.

6.20 With AFC OFF, set the receiver alarm switch to the ALM position. Set the ALM ADJ potentiometer until the alarm lamp lights and the buzzer operates. Again place the transmitter on the air. The lamp and buzzer shall go off. Remove the transmitter from the antenna. The lamp and buzzer shall operate again.

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