MICROWAVE ANTENNAS
KS-5759 DELAY LENS ANTENNA
GAIN MEASUREMENT

1. GENERAL

1.01 This section covers the procedure and gives a general outline of the material and equipment required to measure the relative gain of the KS-5759 Delay Lens Antenna. This method of evaluation of the gain of an antenna requires only the knowledge of the transmitter outputs, and the use of a few miscellaneous components available in most radio maintenance centers. The equal level energy contours at the face of a normal antenna are somewhat oval in shape and generally concentric about the center of the face. By sampling a sufficiently large number of small areas within the major energy contours and summing them up, the energy output of a particular antenna may be compared with one which is known to be normal.

1.02 The following procedure is particularly helpful in testing when moisture accumulation in the antenna is suspected of causing deterioration of the antenna gain. The readings obtained are checked against similar readings made on a known good antenna. Such readings are included in this section for comparison, with instructions for calculating the amount of deterioration of the antenna to be tested. When it is desired to test a receive antenna, the transmit and receive antennas may be frogged and the same procedure followed as with the transmit antenna.

1.03 The items listed below are needed to perform the test.

Material:

2 — Wood details, 1″ x 2″ x 5-1/2′ white pine or equivalent
1 — Panel, masonite, tempered, 1/4″ x 7″ x 4″, notched to mount RF Detector
2 — Plates, aluminum, 1/8″ x 3/4″ x 5″
2 — Screws, machine RH, 1-1/2″ x 12-24 equipped with wing nuts
2 — Washers, 1/4″ lock
4 — Screws, wood, RH, #12 x 3/4″
4 — Washers, 3/16″
3 — Washers, 1/8″

Equipment and Miscellaneous Apparatus:

1 — RF Detector, ED-59096-90 G1 or ED-63906-01 G4
1 — Capacitor, mica, 1000 mmf
1 — Potentiometer, 3000 ohms, wire wound
1 — Meter, 0 to 100 microamperes, KS-14510 volt-ohm-milliammeter or equivalent
25 feet — 2 Conductor, 20 gauge wire

2. PRELIMINARY PREPARATION

2.01 Fig. 1 shows the general construction of the assembly used to extend the RF Detector to the various locations on the face of the antenna. It is extremely important that the number of metal bolts, screws and plates be kept to a minimum in constructing the RF Detector holder. Paint with a lead or metallic base should not be used to paint the 1″ x 2″ piece of wood.

2.02 The masonite and RF Detector must be securely fastened to permit extensive movement over the face of the antenna. The DC leads from the RF Detector to the meter should be taped to the 1″ x 2″ wood details to prevent entanglement while making the various readings. It is essential that the 1000 mmf capacitor be placed physically as near the RF Detector as possible to eliminate possible interference from other radio sources.

2.03 Mount the potentiometer and microammeter on any available box or mounting board that can be utilized on the antenna platform. It is suggested that appropriate terminals be installed to insure a fast and reliable electrical connection from the potentiometer to the 25

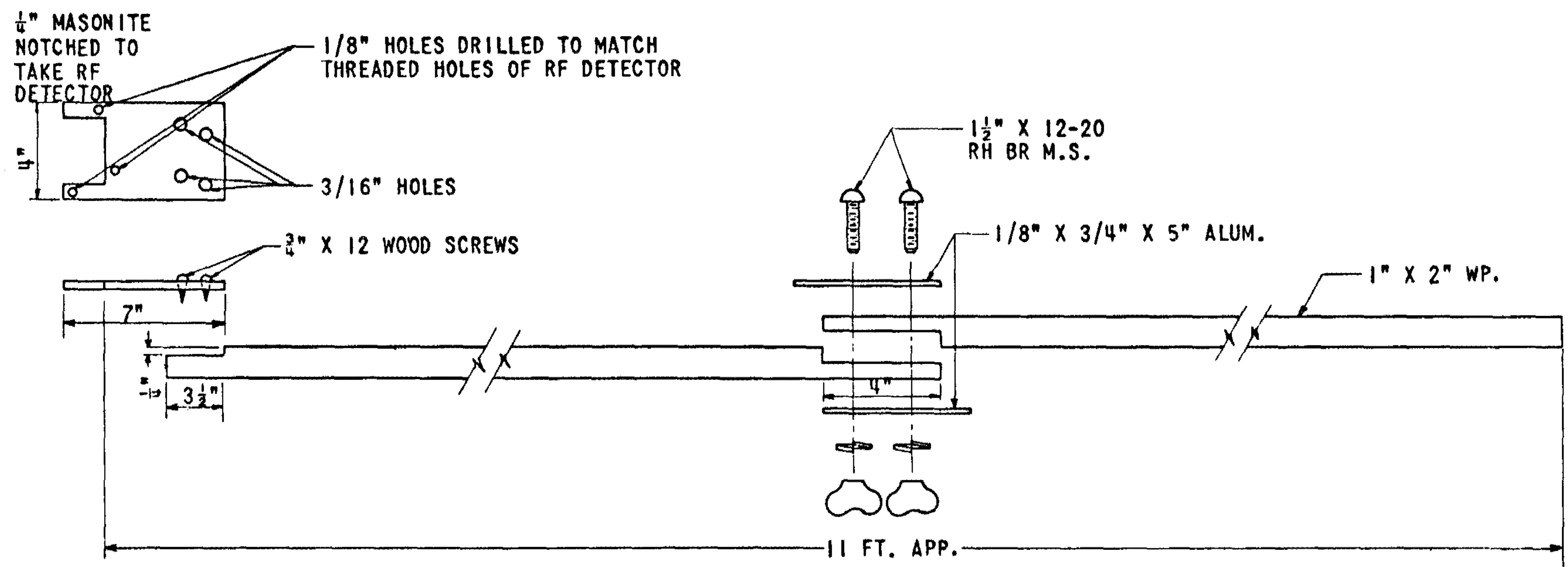
1/4" MASONITE
NOTCHED TO
TAKE RF
DETECTOR
1/8" HOLES DRILLED TO MATCH
THREADED HOLES OF RF DETECTOR
4"
3/16" HOLES
3/4" X 12 WOOD SCREWS
7"
3 1/2"
1 1/2" X 12-20
RH BR M.S.
1/8" X 3/4" X 5" ALUM.
1" X 2" WP.
4"
11 FT. APP.

Fig. 1

feet of cable which connects to the RF Detector. See Fig. 2.

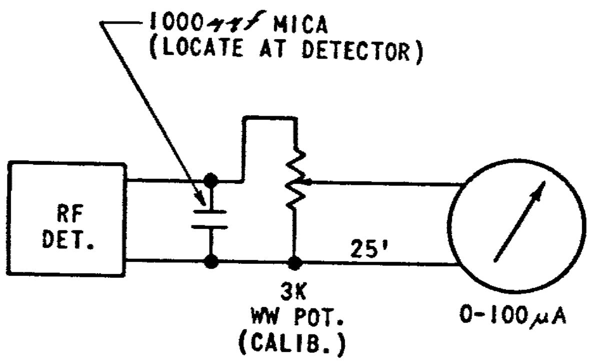

Fig. 2

2.04 To assist in locating the areas to be measured on the face of the antenna, while manipulating the RF Detector on the 1″ x 2″ wood details from the top of the antenna, the side of the wood detail which has the open throat of the RF Detector should be marked at one-foot intervals, starting one foot three inches from the center of the detector. Designate these marks "A", "B", "C", etc., to "J".

2.05 Locate the center of the upper edge of the antenna under test and mark this point on the top near the face. Measure and mark two one-foot sections on each side of the center line and designate the marks "1" to "5" from left to right across the top of the antenna. You should now be able to position the 1″ x 2″ stick in positions shown in Fig. 3 by placing in position of readings desired.

3. CALIBRATION

3.01 Check all TD-2 transmitters feeding the antenna under test and recalibrate if necessary to insure a +27 dbm output from each transmitter.

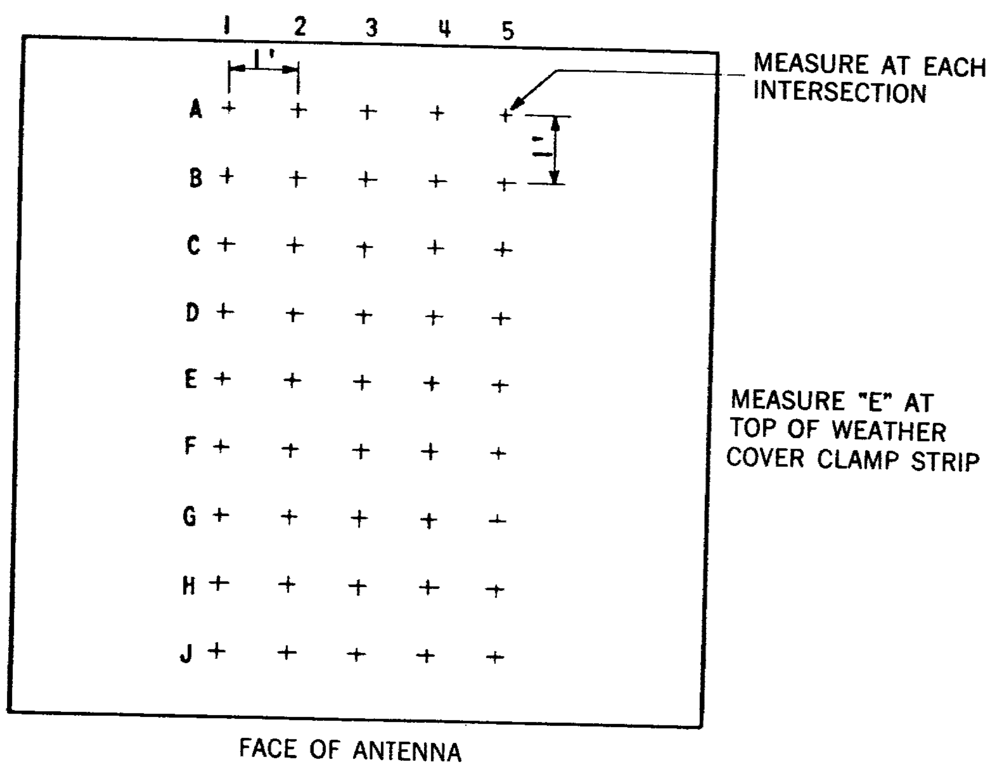

Fig. 3

3.02 Place the RF Detector flush against the face of the antenna and determine the exact location that gives a maximum reading on the microammeter.

3.03 With the RF Detector in the position that gives the maximum readings, adjust the potentiometer of the test circuit to give a reading approximately 90% of full scale on the microammeter. Note this reading and record for future use. The potentiometer should now be locked in place and must not be moved during the remainder of the test.

3.04 As we are comparing the power ratio of a suspected defective antenna against a known good antenna it is necessary to know the exact power required to deflect the meter to the maximum reading recorded in Paragraph 3.03 for future calculations. Determine the exact power which gives the above maximum reading by comparing with a known level obtained from the radio test bay. The power required to produce the same maximum reading obtained on the antenna measurement should be recorded for future calculation.

4. MEASURING PROCEDURE

4.01 Using the designations on the 1″ x 2″ wood detail and on the top of the antenna, position the RF Detector flush against the antenna face in the 45 positions A1-A5, B1-B5, etc., J1-J5 (see Fig. 3) and record meter reading for each position.

Caution: The potentiometer adjustment must not be changed during the readings or subsequent to setting as described in Paragraph 3.03.

5. CALCULATIONS

5.02 Table I is an example of the readings taken on a good antenna. The power required to obtain a reading of 80 microamperes was +7 dbm. Do not attempt to compare the individual readings of the example with those obtained in the test as this is a power ratio comparison which must be calculated for both antennas.

TABLE I

AREA	MICRO-AMPERES	AREA	MICRO-AMPERES	AREA	MICRO-AMPERES
A-1	11	D-1	24	G-1	14
A-2	15	D-2	33	G-2	18
A-3	18	D-3	34	G-3	29
A-4	16	D-4	28	G-4	20
A-5	8	D-5	18	G-5	16
B-1	15.5	E-1	27	H-1	11
B-2	17	E-2	23	H-2	22
B-3	21	E-3	31	H-3	43
B-4	19	E-4	37.5	H-4	30.5
B-5	14.5	E-5	20	H-5	12
C-1	17.5	F-1	25	J-1	12.5
C-2	24	F-2	31	J-2	16
C-3	28	F-3	36	J-3	22
C-4	24	F-4	36	J-4	19
C-5	18	F-5	17	J-5	13

Sum of Readings = 985 microamperes
Calibration +7 dbm = 80 microamperes

5.02 Calculations for standard value obtained on good antenna, in Table I:

Calibration +7 dbm = 80 μA (I_o)

Sum of Readings = 985 μA (I_s)

Power Summation in db:

$$20 \log \frac{I_s}{I_o} =$$

$$20 \log \frac{985}{80} = 21.8 \text{ db}$$

Calculated waveguide loss (78 feet rectangular copper) = .7 db

21.8 db + 0.7 db = 22.5 db

22.5 dbm will be used as a reference standard to compare with suspected defective antennas.

5.03 Calculations for defective antenna.

Assume:

Calibration reading recorded in Paragraph 3.04 = +3.0 dbm = 90 μA
Waveguide loss (200′ rectangular copper) = 1.8 db
Cord loss (used in frogging transmitting and receiving antenna — if required — See Paragraph 1.02) = 1.2 db
Sum of readings —(Paragraph 4.01) = 660 μA
Power Summation

$$20 \log \frac{660}{90} = 17.3 \text{ db}$$

5.04 As we are comparing a power summation which was calibrated as +7 dbm = 80 μA against one which was calibrated as +3.0 dbm = 90 μA, the antenna under test must be corrected to the +7 dbm reading:

17.3 db − (7 − 3) = 13.3 db

5.05 The readings that are used to obtain the total power summation are taken at the face of the antenna. As the power source of the readings obtained on the good and the defective antenna is +27 dbm from each transmitter, the loss of the waveguide must be considered in the calculations of the defective antenna. The waveguide loss (and the cord loss if a receiving antenna is frogged) is added to the power summation ratio:

13.3 db + 1.8 = 15.1 db

5.06 Gain of defective antenna compared to standard:

22.5 db − 15.1 db = 7.4 db (Amount antenna gain is low)

5.07 The above calculations are based on a TD-2 route of six channels. On partially loaded routes, a correction is necessary to relate the actual power to the power of six channels. Table II has been calculated for this purpose. For example, if the defective antenna in Paragraph 5.05 has transmitting channels 1, 2 and 3 in operation:

15.1 db + 2.8 db = 17.9 db

22.5 − 17.9 = 4.6 db (Gain is low)

5.08 These corrections take into account the loss in channel separation networks and variations of antenna gain across the 3700-4200 mc band. They assume that channels are built up in normal sequence. If this is not the case a different correction factor should be computed. For example, if only channels 4, 5 and 6 were transmitting, the power ratios for these channels should be added (Table II, column 6) giving a total power ratio of 1076. This ratio is then converted to the equivalent relative power level, 20 log 1076 = 30.3 db. Subtract 30.3 from 33.5 to obtain the correction factor of +3.2 db.

5.09 In the absence of accurate knowledge of waveguide losses, it will be satisfactory to use a figure obtained by adding 40 feet to the antenna centerline height for the waveguide length. For tower heights less than 50 feet, or in cases where the antennas are on buildings, a more precise determination of waveguide length will be necessary. The waveguide loss per foot for rectangular copper waveguide is 0.009 db and for brass 0.012 db.

TABLE II

CHANNEL NUMBER	CHAN. BR. NETWORK LOSSES	POWER INTO WAVEGUIDE	ANTENNA GAIN CORRECTION	RELATIVE ANTENNA OUTPUT	POWER RATIO	POWER RATIO (CUMULATIVE)	RELATIVE ANTENNA OUTPUT (CUMULATIVE)	CORRECTION FACTOR
1 or 7	0.5 db	26.5 dbm	−0.7 db	25.8 db	380	380	25.8 db	+7.7 db
2 or 8	0.7	26.3	−0.4	25.9	389	769	28.9	+4.6
3 or 9	0.9	26.1	0	26.1	407	1176	30.7	+2.8
4 or 10	1.1	25.9	0	25.9	389	1565	31.9	+1.6
5 or 11	1.3	25.7	−0.1	25.6	363	1928	32.9	+0.6
6 or 12	1.5	25.5	−0.4	25.1	324	2252	33.5	0