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DUPLEX OPERATION CURVES FOR 450-470 MC PROGRESS LINE TRANSMITTERS AND RECEIVERS (ET-24-A and ER-26-B)

The curves included in this Bulletin have been compiled from extensive laboratory tests and theoretical propagation data, for use in solving problems that result from the simultaneous transmission and reception of multiple signals. The methods used in the laboratory tests are similar to those described in DATAFILE Bulletin 10007-1. The information supplied in these instructions should solve most problems. In other cases, further investigation and consultation with Engineering will be necessary.

METHODS OF REDUCING LOSS IN DESIRED SIGNAL

Two methods are commonly used for reducing loss in desired signal due to interference caused by desensitization or noise from a nearby transmitter:

1. Increase the attenuation between transmitters and receivers by using separate antennas, spaced the required amount vertically or horizontally.

2. Increase the selectivity of both transmitters and receivers by adding cavity filters. (Slot filters may also be used.)

For a detailed discussion of how desensitization and transmitter noise affected the receiver, refer to DATAFILE Bulletin 10002-2.

EXPLANATION OF CURVES

The curves provided in this Bulletin may be considered as typical and only slight variations will be noted when Transmitter ET-24-A and Receiver ER-26-B are operated under the same conditions. Under different conditions, consideration must be given to the type of operation employed.

FIGURE A

<u>Curve 1</u>

Curve 1 gives the attenuation required, due to transmitter noise, between a 15-watt transmitter and an appropriate receiver, so as not to reduce the 12-db sinad* ratio more than 6 db. When the transmitter power output is not adjusted for 15 watts, Curve 10 must be used to apply the proper power correction. The required ATTENUATION is found by reading the value from Curve 1 which corresponds to the FREQUENCY SEPARATION between the transmitter and the receiver.

Curve 2

This curve gives the attenuation required between a 15-watt transmitter, assuming no transmitter noise interference, and an appropriate receiver which requires 0.8 microvolt to produce a 12-db sinad ratio, so as not to reduce the 12-db sinad more than 6 db. If the receiver is not operated at an 0.8-microvolt sensitivity, Curve 11 should be used to make the proper sensitivity corrections. The proper correction must also be made, using Curve 10, if the transmitter power output is not 15 watts. The required ATTENUATION can be read from Curve 2 which corresponds to the FREQUENCY SEPARATION between the transmitter and the receiver. Interference caused by transmitter and receiver spurious radiation is not covered in these curves.

Some variation in the required attenuation may be experienced if the receiver is operated under conditions different from those used in making the measurements. This variation can be attributed to the fact that, because the r-f transformer in the receiver is tuned to the desired signal, a large VSWR will result when undesired signals are introduced into the receiver. In most cases, the resulting VSWR will cause little variation from Curve 2.

Curves 3, 4, 5 and 6

Curves 3, 4, 5 and 6 give the attenuation required between the transmitter and the receiver to prevent greater than 12-db or 20-db reduction in desired signal performance. These curves represent the combined effect of transmitter noise and receiver desensitization. For frequency separations of less than about one megacycle, transmitter noise is the controlling type of interference. Above one megacycle, receiver desensitization is the controlling factor. Curves 3 and 5 should be used when the receiver frequency is above the transmitter frequency and Curves 4 and 6 are used when the receiver is below the transmitter. The curves are normalized for a 15-watt transmitter and an 0.8-microvolt receiver. For different transmitter power outputs or receiver sensitivities, use the appropriate correction curves.

Curve 7

Curve 7 is the attenuation curve for cavity PL-7487012-G1. The use of this curve is explained with FIGURE C.

Curves 8 and 9

Curves 8 and 9 can be used to find the attenuation between either vertically- or horizontally-spaced, half-wave dipoles, when both are mounted for vertical polarization. The attenuation thus obtained is

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* Sinad is the ratio of (signal + noise + distortion) to (noise + distortion).

given at the receiver terminals when the receiver is assumed to have the same impedance as the antenna. As explained above for receiver desensitization, a slight variation in attenuation will be experienced as the length of transmission line between the antenna and the receiver is adjusted. This variation becomes less and less as the transmission line becomes longer. Curve 8 is based on free-space propagation, while Curve 9 is based on calculated and measured data. The ATTENUATION in db corresponding to the ANTENNA SPACING in feet between centers of any two antennas may be determined from Curves 8 and 9.

Curve 10

Curve 10 is provided for making corrections for transmitter power outputs other than 15 watts. Since the attenuation curves are based on a 15-watt output, the correction is zero for that value of power. Correction should also be made for transmission line losses, when applicable.

Curve 11

This curve is included as an aid in calculating the correction in db that is required when the receiver is operated at various sensitivities. For example, the correction for a receiver with a sensitivity of 0.6 microvolt (for 12-db sinad ratio) and a 100-foot transmission line of RG-17/U would be:

+ 2.5 db for 0.6 microvolt sensitivity
- 2.2 db for 100 feet of RG-17/U
+ 0.3 db correction

FIGURE B

Figure B is included for making rough calculations of antenna spacings and should not be followed when accurate figures are desired. The two curves were taken from an average of the values found in Figure A. In making the curves, transmission line loss was neglected and transmitter noise and receiver desensitization curves were combined. The receiver sensitivity was assumed to be 0.6 microvolt.

FIGURE C

The curves provided on Figure C give the length of RG-58A/U required to make a quarter-wave line for Transmitter ET-24-A ("A"), for receiver cavity PL-7487012-G1 ("B"), for RG-58A/U cable ("C"), and for Receiver ER-26-B ("D"). The lengths are measured from tip to tip for straight phono type connectors (male). For right-angle phono connectors, subtract 0.9 inch from the calculated length, measuring to the center-line of the conductor. Length "X" is the amount to be removed from length "C" when a tee connector is used. Length "X" is 0.3 inch for a cable terminated in a UG-88/U plug and connected to a UG-274/U tee. Cables connected between cavities are 3/4-wavelength long, but may be increased by any even number of quarter-wavelengths (2NC).

CAUTION

> Do not use cavity PL-7487012-G1 in the transmitter leg of the transmission line if the RF power output of the transmitter exceeds 15 watts.

ILLUSTRATIVE EXAMPLE

The following example is provided to illustrate the use of the Duplex Operation Curves.

EXAMPLE

Find the parameters required for duplex operation of the following transmitter and receiver:

Transmitter Frequency	456.95 megacycles
Transmitter Power Output	10 watts (power to antenna)
Receiver Frequency	457.45 megacycles
Receiver Sensitivity	0.6 microvolt (corrected for transmission line loss)
Maximum allowable loss of desired signal	4 db

SOLUTION USING FIGURE A

This problem can be solved by using the following steps. Other installations using duplex operation may be worked out in a similar manner.

1. Find the frequency separation between the transmitter frequency and the receiver frequency.

Receiver Frequency	457.45 MC
Transmitter Frequency	456.95 MC
Frequency Separation	0.50 MC

2. From Figure A, find the attenuation required to prevent greater than 3-db loss of signal due to transmitter noise.

Attenuation required for 0.5-MC separation (Curve 1)	+ 60.0 db
Correction for receiver sensitivity (Curve 11)	+ 2.5 db
Correction for transmitter power output (Curve 10)	- 1.8 db
Total attenuation required at 457.45 MC	60.7 db

3. From Figure A, find the attenuation required to prevent greater than 3-db loss of signal due to receiver desensitization.

Attenuation required for 0.5-MC separation (Curve 2)	+ 52.0 db
Correction for receiver sensitivity (Curve 11)	+ 2.5 db
Correction for transmitter power output (Curve 10)	- 1.8 db
Total attenuation required	52.7 db

4. 8.0 db more attenuation is required to prevent desensitization due to transmitter noise (60.7 db) than to prevent desensitization due to carrier desensitization of the receiver (52.7 db). The antenna spacing must therefore be based on transmitter noise desensitization. Since the maximum allowable loss in desired signal is 4 db (one db more than Curve 1 allows), the required attenuation is about 60.7 db - 1.0 db or 59.7 db.

5. The vertical or horizontal antenna spacing required to obtain an attenuation of 59.7 db may be determined from Curves 8 and 9 on Figure A.

For vertical antenna spacing (Curve 8)	18 feet
For horizontal antenna spacing (Curve 9)	120 feet

SOLUTION USING FIGURE B

Antenna spacings can also be estimated by using Figure B, but Figure A must be used when accuracy is required. Figure B gives the following spacings for the preceding problem:

For vertical antenna spacing	Approximately 23 feet
For horizontal antenna spacing	Approximately 190 feet

FIG. A — DUPLEX OPERATION CURVES (450 - 470 MC)

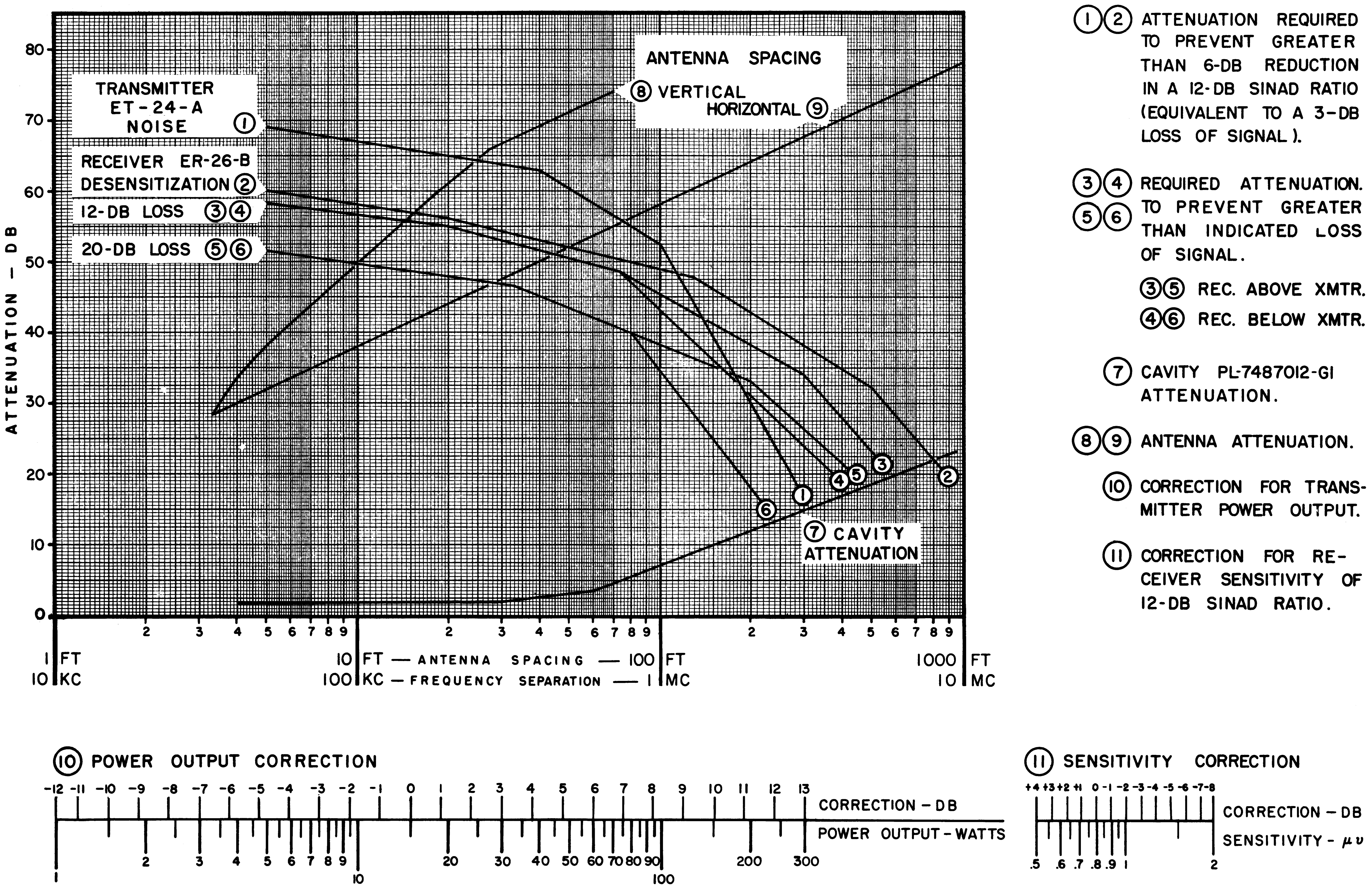


FIG. A

FIG. B — COMPOSITE DUPLEX OPERATION CURVES (450 - 470 MC)

THESE CURVES ARE AVERAGE CURVES AND SHOULD NOT BE USED WHEN ACCURACY IS DESIRED

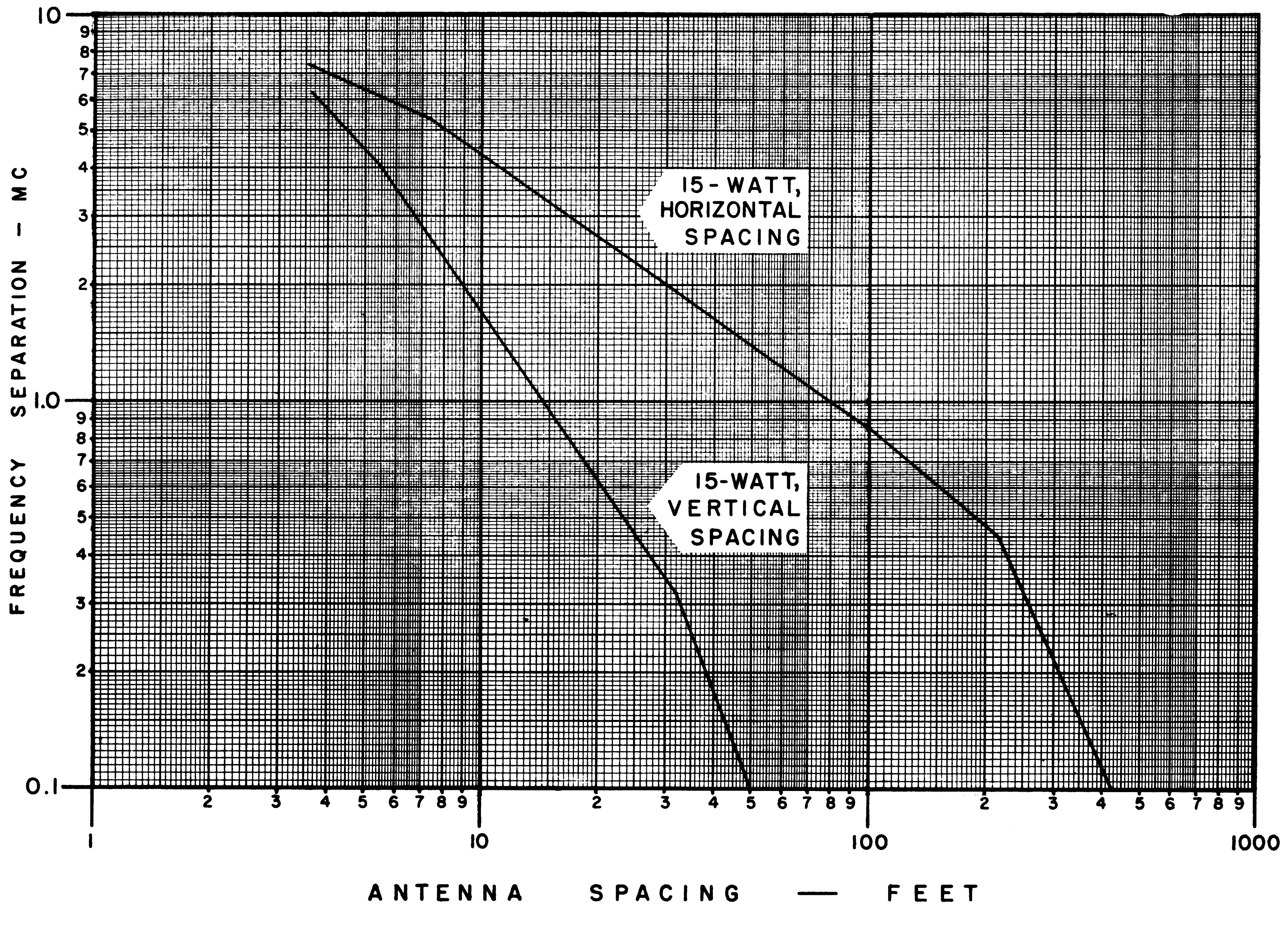
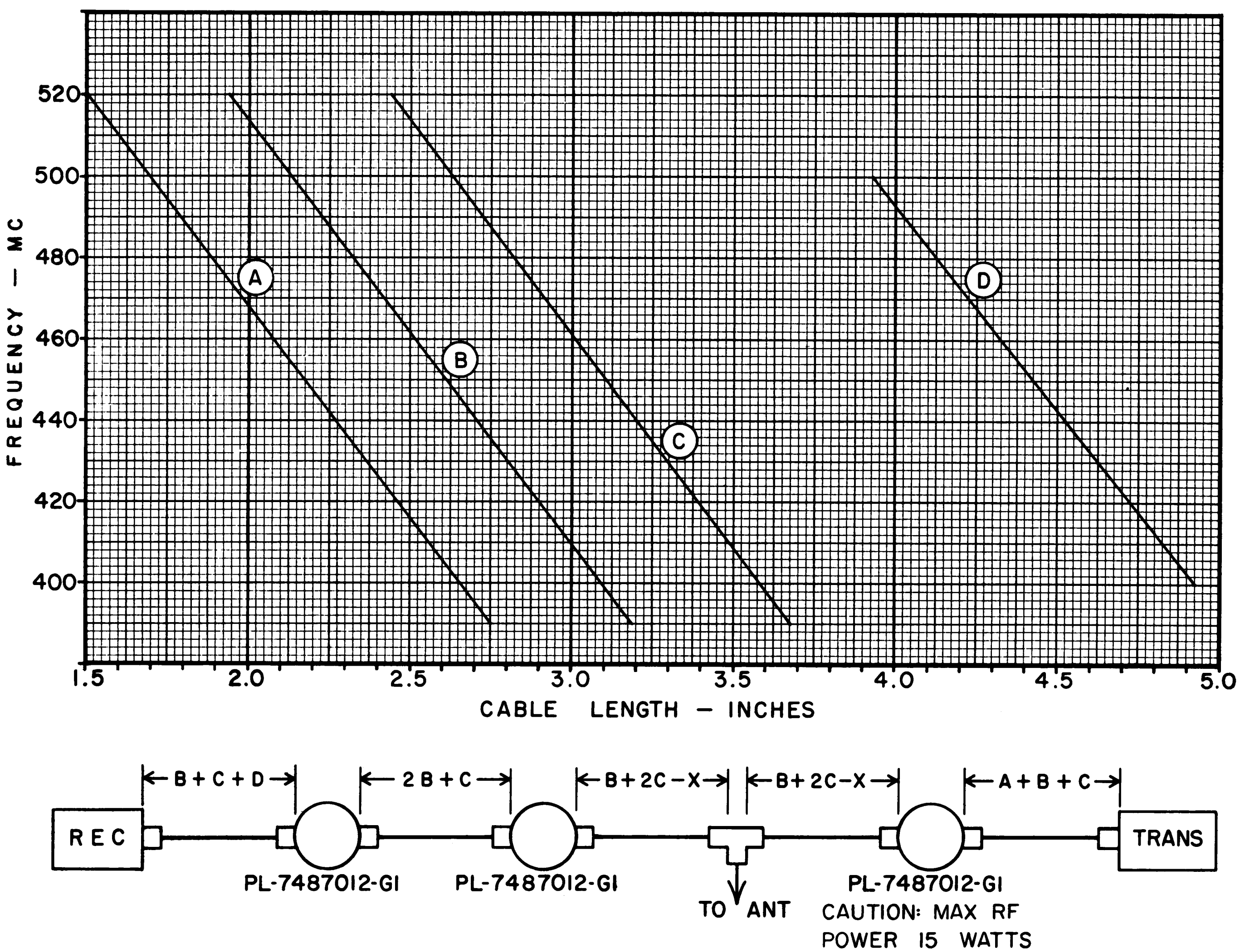


FIG. C — COAXIAL CABLE LENGTHS FOR QUARTER-WAVE, OPEN-ENDED LINE



(A) RG-58A/U LENGTH FOR TRANSMITTER ET-24-A CAVITY.

(B) RG-58A/U LENGTH FOR RECEIVER CAVITY PL-7487012-GI, USING STRAIGHT CONNECTOR.

(C) QUARTER-WAVE LENGTH FOR RG-58A/U.

(D) RG-58A/U LENGTH FOR PROGRESS LINE RECEIVER ER-26-B CAVITY (7491249-GI).

(X) LENGTH "X" IS 0.3 INCHES FOR A CABLE TERMINATED IN A UG-88/U PLUG AND CONNECTED TO A UG-274/U TEE.

NOTES

1. LENGTHS A, B, C, & D ARE MEASURED FROM TIP TO TIP OF PHONO CONNECTORS.
2. FOR RIGHT-ANGLE PHONO CONNECTORS, SUBTRACT 0.9 INCH FROM CALCULATED LENGTH AND MEASURE TO CENTER LINE OF CONDUCTOR.
3. LINE LENGTHS TO CAVITIES MAY BE INCREASED BY 2NC (AN EVEN NUMBER OF "C" LENGTHS).