JERROLD

Technical Bulletin

JERROLD ELECTRONICS CORPORATION • 15th and Lehigh Ave., Philadelphia 32, Pa.

#142

Subject: VSWR Measurement Using the Delay Line Technique

The relative impedance match of amplifiers and auxiliary equipment may be accurately and readily determined, using the method described in this bulletin.

PROCEDURE

The following equipment is required to perform this test:

Sweep Generator (Frequency Range 54-220 megacycles)
Jerrold A-72 Attenuator
Jerrold D-85 Detector
Jerrold LHS-76 Splitter
PD-6
100' to 150' JEL-101 Coaxial Cable

NOTE: All markers at band edges

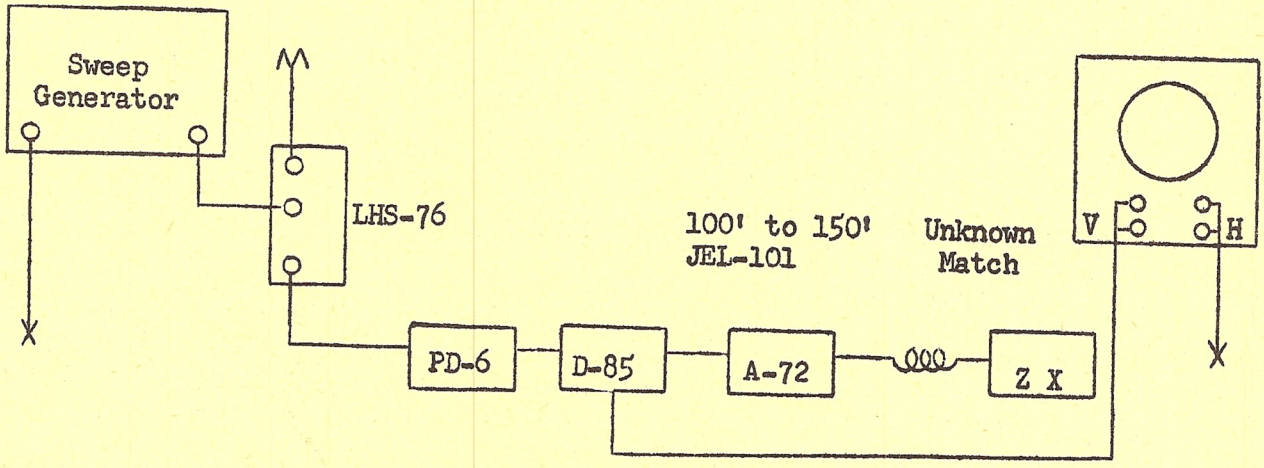

FIGURE 1

Equipment Setup (Refer to Figure 1)

1. With delay line unterminated and 0 db attenuation in A-72, adjust sweep generator output and oscilloscope vertical gain control for convenient reference level (example: 10 divisions). Refer to Figure 2.

   Vertical gain control of the scope should be set to maximum gain for best results. A broadband amplifier may be required on some tests to obtain the required presentation. Make certain that the amplifier's response is flat and covers the band to be checked.

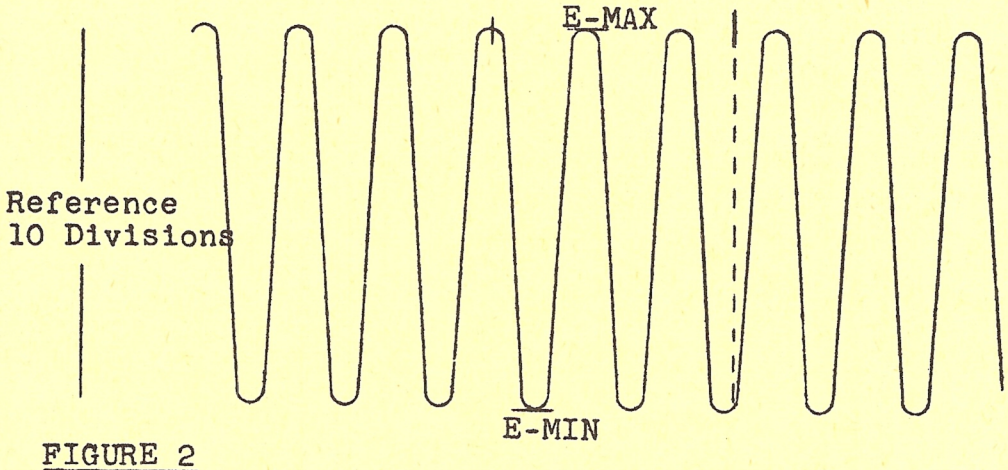

FIGURE 2

Figure 2 - 100% Reflection Open Circuited Line

2. Terminate end of delay line in 72 ohm resistor (TR-72). Adjust sweep generator for maximum sweep over band of frequencies in question. An approximately flat response (Figure 3) should now be seen. Any slight irregularities represent discontinuities in cable and/or connectors.

3. Remove TR-72 and connect delay line to input of unit under test. Count divisions on scope trace from maximum to minimum within desired band (example: 3 divisions). (Figure 4)

FIGURE 3

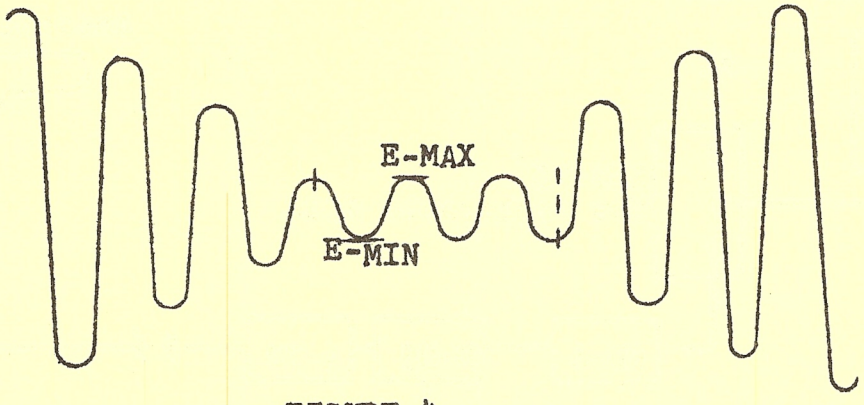

FIGURE 4

4. Remove test unit so standing wave pattern returns to 100% reflection (Step 1); introduce attenuation in A-72 until oscilloscope presentation is attenuated to level in Step 3. Read A-72 and refer to attached chart for determination of VSWR.

5. Example: A-72 reads 8 db; from chart, VSWR = 1.4. Observe that reflections are attenuated by an amount twice the setting on the A-72. Thus, for 8 db of attenuation in A-72, reflections are attenuated 16 db, or are 16 db down from the open circuited condition. 16 db = 6.3:1. - 100%/6.3 = 16% reflection.

6. The delay line technique is also very convenient for checking antenna arrays, using the transmission line itself as the delay line (see Figure 5). Here, the open circuit reference is established with the A-72 unterminated. Then the transmission line, terminated by the antenna, is connected to the A-72 and the scope deflection observed over the desired bandwidth. The transmission line is removed and attenuation is inserted in A-72 until standing wave returns to previous level (established with antenna terminated over desired frequency band). The transmission line loss should be subtracted from the A-72 reading to obtain "reflection db down". Refer to chart for VSWR of antenna.

   This result is approximate, but accurate enough for most field tests.

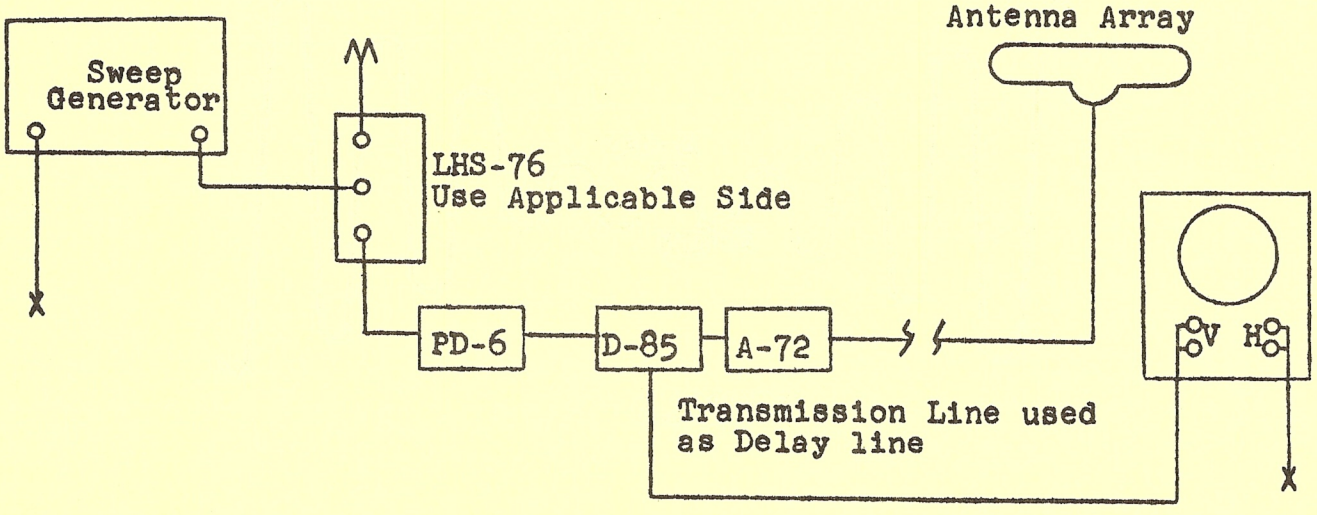

Figure 5 - Measuring Antenna VSWR

RECOMMENDATIONS

The method described above has advantage over both the half wave stub and impedance bridge method. The latter methods are subject to errors introduced by resonant line lengths and/or bridge components.

MINIMUM REFLECTIONS

It is, of course, desirable to keep reflections in a system to a minimum, since they can produce ghosts, smear and loss of signal. As an arbitrary guide, reflections in a line should

be kept below 10% (or a VSWR of 1.2). With a knowledge of the VSWR of a particular piece of equipment, the chart quickly shows how much attenuation or padding is necessary to minimize the relections. Thus, if a line is terminated in equipment having an input VSWR of 1.5, 3 db of padding, or cable attenuation ahead of the mismatch will attenuate reflections 6 db (attenuating both direct and reflected signals) and improve the VSWR to 1.2.

V.S.W.R. NOMOGRAPH

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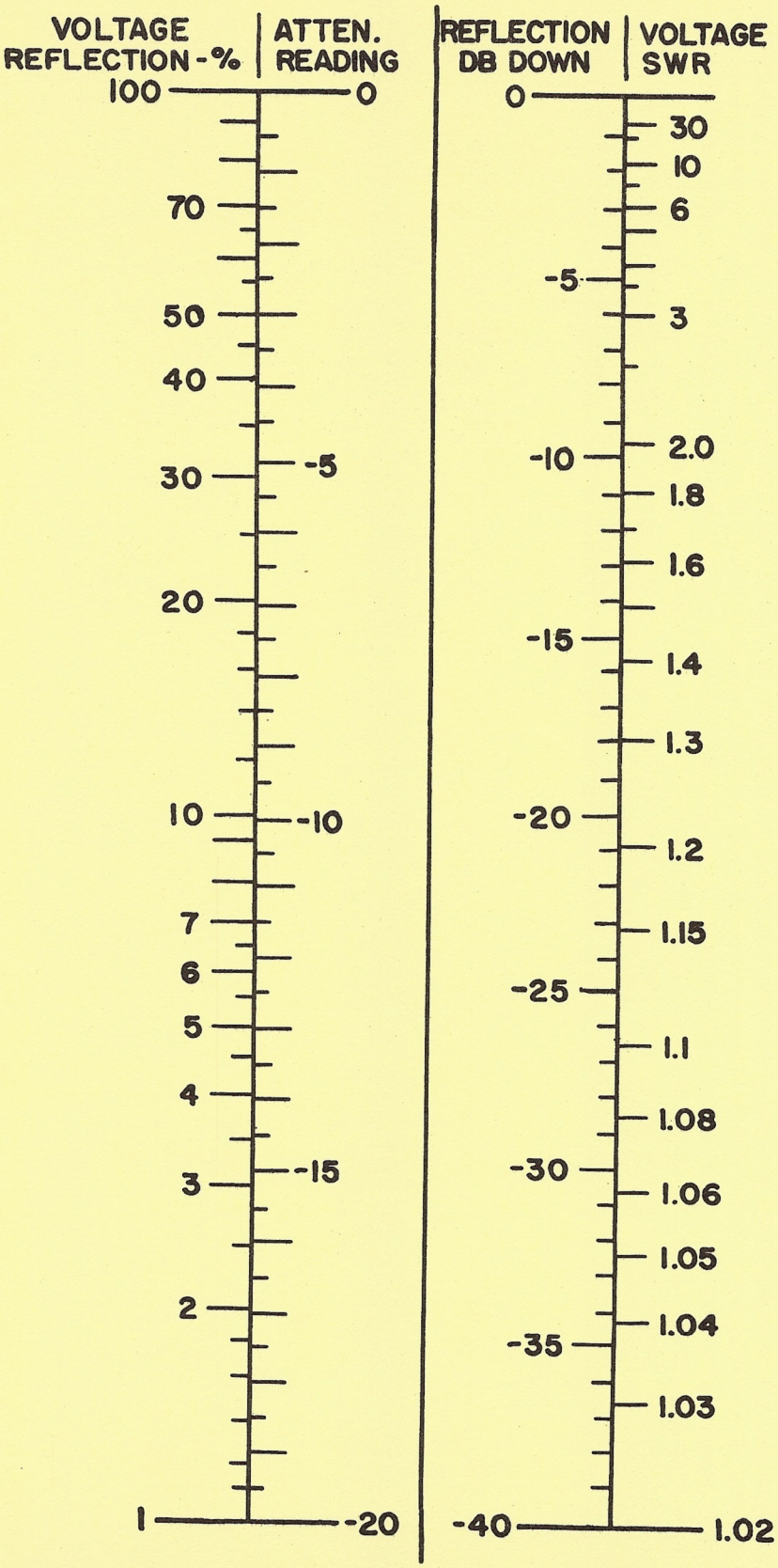

NOTE: $SWR = \frac{E\ MAX.}{E\ MIN.}$ AND $\%\ REFLECTION = \frac{(SWR)-1}{(SWR)+1} \times 100$

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PRINTED IN U.S.A. C, MARCH 1959 NOM-1