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Technical Correspondence

Conducted By
Bob Schetgen,* KU7G

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BUILD A DUMMY DIPOLE!

☐ The review of the Maxcom Antenna Matcher in Nov. 1984 *QST* fascinated me. In fact, I was so stimulated by the article that I promptly constructed a "Dummy Dipole" patterned along similar lines. First, I mounted a 50-Ω Globar® noninductive resistor (of unknown power rating) and an SO-239 connector on a piece of 3/16-inch-thick Lucite®, and then attached two 50-ft dipole legs. The antenna was installed as an inverted-V with the apex about 22 ft above ground (see Fig. 1).

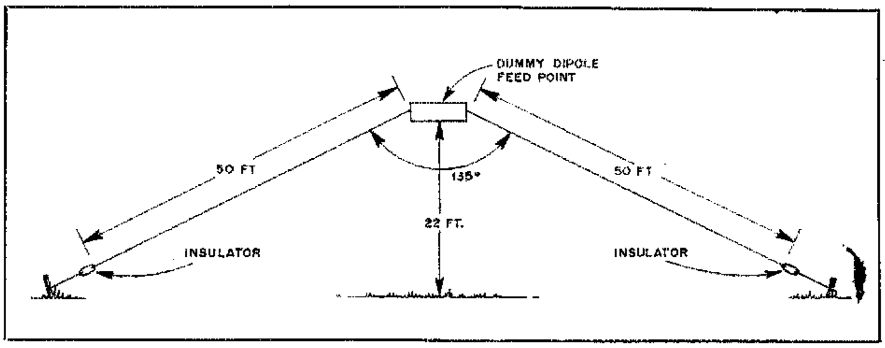


Fig. 1 — K3FGB's Dummy Dipole antenna. The ends are 3-4 ft above the earth. [Keep the ends of all transmitting antennas several feet from the reach of passersby. — Ed.]

I wondered how well the system would radiate a signal — replies to test calls were sometimes heard when using a light bulb as a dummy load in the "old days." The results certainly are surprising! The IC-730 protective circuitry did not reduce output power, the SWR was negligible on all ham bands, and within 15 minutes of completing the installation, I worked the three stations listed in Table 1.

My next effort was to try the dummy matcher across the feed point of my delta-loop antenna. The loop is oriented horizontally, 25 ft above the ground. One corner of the triangle is to the north, another is to the south, and the feed is at the third corner, in the west. The perimeter of the loop is 260 ft, and it was previously fed with 300-Ω line and a Transmatch.

Results with the delta loop do not seem as good as those with the dipole. The SWR is flat across all bands, however, and the rig loads perfectly. Initial tests yielded the contacts shown in Table 2. Helmut, HBØCBJ, could hear me when I used the "Delta Dummy," but did not have solid copy.

Since my original tests, additional work with the Dummy Dipole and the Delta Dummy has led me to the following conclusions:

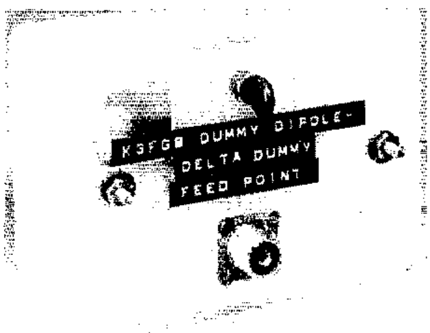
1) Resistance-loaded antennas are not as efficient as a resonant dipole or delta loop on a given frequency, but they permit all-band operation from 1.8-144 MHz with SWR-protected transceivers. Incidentally, the Delta Dummy system works well enough for local repeater work on 2 meters.

2) A 1-kW model can be assembled with all new parts for $20. (The noninductive resistors in the Heath and MFJ paint-can dummy loads can probably dissipate 1 kW in SSB or CW service. MFJ sells the resistor for $15.)

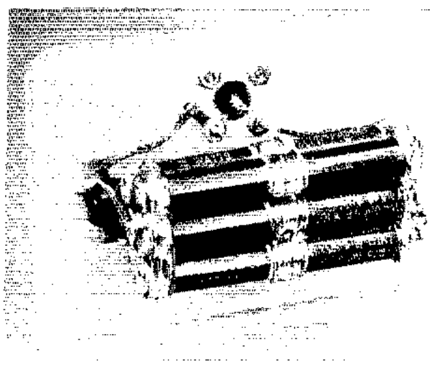
Fig. 2 shows a second model. Twelve 150-Ω, 15-W resistors can dissipate 180 W continuously and should handle 1 kW for low-duty-cycle applications (SSB and CW). Lucite is used to reinforce the lid of a plastic food-storage container. Alternative packages could be fabricated from plastic pipe fittings.

3) If the builder is not satisfied with the resistance-loaded feed point, the feed system is not lost — a dummy load is gained!

*Technical Editorial Assistant



(A)



(B)

Fig. 2 — Outside (A) and inside (B) views of the K3FGB Dummy Dipole feed point.

Table 1
Initial contacts with the Dummy Dipole

Date	*Freq.*	*Mode*	*UTC*	*Call*	*Location*
10/30/84	14.200	SSB	0455	W3IOW	Pittsburgh, PA
	3.900	SSB	0505	N4JST	West Palm Beach, FL
	14.200	SSB	0552	HH5MV	Cape Haitien, Haiti

Table 2
Initial contacts with the Delta Dummy

Date	*Freq.*	*Mode*	*UTC*	*Call*	*Location*
10/31/84	7.200	SSB	1237	W5RUT	Biloxi, MS
	14.200	SSB	1240	N1CJQ	Avon, CT
	14.200	SSB	1302	W2FMR	Levittown, NY
	14.200	SSB	1315	WB3DFQ	Greensboro, MD
	21.300	SSB	1338	HBØCBJ	Liechtenstein

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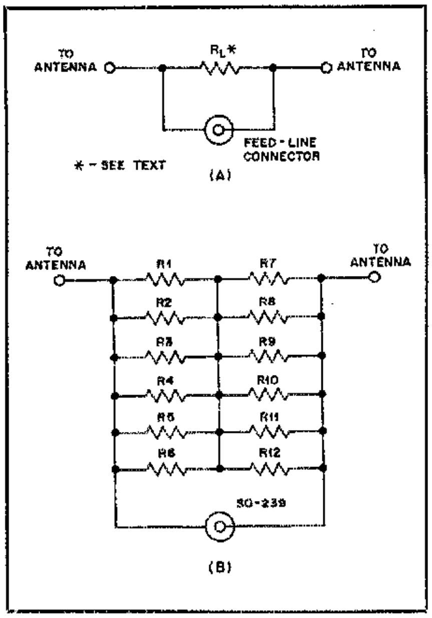

Fig. 3 — The Dummy Dipole feed-point circuit places a load resistance, R_L, across the antenna feed point at (A). The resistance can be assembled from any combination of non-inductive resistors that provide the desired resistance and power rating. A schematic of the unit in Fig. 2 appears at (B).

R1-R12 — 150-Ω, 15-W noninductive resistors.

The most difficult aspect of assembling the unit in Figs. 2 and 3 is connecting the block of resistors. I use a technique known as "whipping" in my Navy days. Wrap each end of each resistor with thin, bare, copper wire. Then, tie the individual resistors together with additional wire and solder the connections. This problem can be eliminated by using a single resistor of appropriate value and power rating.

My data is offered on a "seat-of-the-pants" basis. Perhaps someone could make measurements to determine what percentage of the power is dissipated in the load resistor. I feel that the loop antenna is about 24 dB down from my beam, but I have no reference dipole for comparison. I would also like to make some tests with R_L in the far side of the loop, opposite the feed point.

My greatest thrill from the project is duplication of an expensive commercial product for a few dollars. This is very satisfying to a ham who had to "do it yourself" in the 1930s. I have thoroughly enjoyed diddling with the Dummy Dipole and the Delta Dummy, but I hope you won't classify me as the "dauntless Dummy Designer." — *Mort Slavin, K3FGB, West Palm Beach, Florida*

☐ There are two kinds of resistive loading in use to broaden the response of antenna systems. One method connects all open-circuit antenna ends to ground through a resistance. The other method places a resistance across the antenna feed point. Mr. Slavin's letter discusses the second method, and I will analyze that case.

For an accurate idea of the effect of a loading resistor, R_L, we must examine two aspects of the antenna system. First, we must consider the distribution of power between the antenna radiation resistance (R_R) and R_L. Second, we must

Table 3

Data for 3.5 to 4 MHz with 50-Ω Line and a 50-Ω Resistor Across the Antenna Feed Point

Freq.	*Z*	*SWR*		*Loss*
MHz		*Ant.*	*With R_L*	*(dB)*
3.50	70 − j130.152	6.782	1.366	8.598
3.60	70 − j 76.969	3.514	1.512	6.121
3.70	70 − j 25.303	1.710	1.680	4.122
3.80	70 + j 24.967	1.702	1.680	4.114
3.90	70 + j 73.948	3.376	1.522	5.980
4.00	70 + j121.736	6.168	1.383	8.218

Table 4

Data for 14 to 14.35 MHz with 50-Ω Line and a 50-Ω Resistor Across the Antenna Feed Point

Freq.	*Z*	*SWR*		*Loss*
MHz		*Ant.*	*With R_L*	*(dB)*
14.00	70 − j23.417	1.670	1.684	4.077
14.10	70 − j10.000	1.453	1.706	3.854
14.20	70 + j 3.321	1.403	1.710	3.808
14.30	70 + j16.549	1.544	1.699	3.942
14.35	70 + j23.129	1.666	1.684	4.071

Table 5

Data for 3.5 to 4 MHz with 50-Ω Line and a 125-Ω Resistor Across the Antenna Feed Point

Freq.	*Z*	*SWR*		*Loss*
MHz		*Ant.*	*With R_L*	*(dB)*
3.50	70 − j130.152	6.782	2.003	5.436
3.60	70 − j 76.969	3.514	1.688	3.497
3.70	70 − j 25.303	1.710	1.252	2.131
3.80	70 + j 24.967	1.702	1.249	2.126
3.90	70 + j 73.948	3.376	1.663	3.395
4.00	70 + j121.736	6.168	1.962	5.124

determine the SWR both with and without R_L in the circuit.

Wes Hayward described an unbalanced, lumped-constant model of a nearly resonant dipole antenna in Technical Correspondence, July 1984 *QST*. The model consisted of a series-resonant circuit comprised of a resistor, inductor and capacitor with the following values:

$$R = 70\ \Omega \quad \text{(Eq. 1)}$$

$$L = \frac{150}{f_o} \quad \text{(Eq. 2)}$$

$$C = \frac{1}{2\pi(f_o)L} \quad \text{(Eq. 3)}$$

where

f_o = resonant frequency, in hertz
L = inductance, in henrys
C = capacitance, in farads

This formula is valid only for antennas operated near their resonant frequency. It cannot approximate impedance over a range of frequencies wide enough to allow the possibility of harmonic resonance. The model is sufficient, however, for study of a selected amateur band.

Given a band of frequencies, we can calculate the values for the model components at the center of the band. Next, we must determine the impedance of the model circuit for a specific frequency of interest. The reflection coefficient of the network is calculated from the complex circuit impedance and the transmission-line impedance.[1] From the reflection coefficient, we can determine the SWR.[2] This is all we need know about the circuit without resistive loading.

We can include the effects of R_L by placing it across the series-resonant circuit. The result is a ladder network. To obtain the reflection coefficient of this network, transform the model series circuit to its parallel-equivalent circuit, add R_L to the parallel network (this circuit determines the power distribution), and transform the result back to a series-equivalent network.[3,4] The reflection coefficient and SWR for the circuit with R_L are calculated from this series circuit.

Power is radiated according to a relationship of R_R and R_L:

$$\frac{P_R}{P_T} = \frac{R_{RP}}{R_L + R_{RP}} \quad \text{(Eq. 4)}$$

Then,

$$\text{loss} = 10 \log \frac{P_R}{P_T}\ \text{dB} \quad \text{(Eq. 5)}$$

where

P_R = radiated power
P_T = total power fed to the antenna system
R_{RP} = parallel-circuit equivalent of R_R
R_L = loading resistance

The calculation of SWR without R_L, SWR with R_L and P_R loss with R_L was repeated at the desired frequency intervals by a computer program. The results for a 50-Ω R_L across 80-meter and 20-meter antennas are shown in Tables 3 and 4, respectively. We can see that the 20-meter antenna easily covers the entire band without any resistive matching, while the 80-meter antenna covers only about 150 kHz without loading. The loaded 80-meter system, however, shows more bandwidth than is necessary.

Since loss varies inversely with the value of R_L, repeated calculations can yield an R_L value that provides any desired SWR range, over an entire band, with minimum loss. Results for an 80-meter antenna with a 125-Ω R_L are shown in Table 5. SWR is limited to about 2:1 across the 80-meter band, with 5.43-dB loss at the band edge. A transmitter that supplies 100 W to this system at 3.5 MHz applies 28 W to the antenna and 72 W to R_L. This situation is adequate for world communication with favorable propagation, but the radiation efficiency of the system is low.

I do not have facilities for practical prediction of feed-point impedance of nonresonant antennas. Thus, I cannot analyze a resistance-loaded, single-wire antenna over the entire HF spectrum. Whenever the antenna leg length approaches a multiple of λ/2, though, losses will be very great. — *Bob Schetgen, KU7G, Technical Editorial Assistant*

[1]C. L. Hutchinson, ed., *The ARRL 1985 Handbook for the Radio Amateur* (Newington: ARRL, 1984), p. 16-1, Eq. 1.
[2]Hutchinson, p. 16-2, Eq. 2.
[3]Hutchinson, pp. 2-21 and 2-22.
[4]Hutchinson, pp. 2-36 and 2-37.