214-0081-01-01_00

R.F. Note 80

March 9, 1982
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K800 TRANSMITTER

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80 & 82

Grid Circuit

RF Note 75 described various possible grid circuit configurations. For some time now we have settled on the circuit of Fig. 7B of that note which appears as Fig. 1 of this note. Here we use a combination of a variable inductor and a variable capacitor to tune over the range 9 to 32 MHz. The inductor is a 1/2" ID x 6" OD transmission line with a sliding short capable of varying the length from 14 to 43 inches. The variable vacuum capacitor must vary from 10 to 370 pf. The design of this circuit is well underway.

Anode Circuit

Electrically, the anode circuit will be identical to the anode circuit for the K500 transmitter. RF Note 73 (5/8/81) describes this circuit and presents calculated results. Since that time evolution has occurred and we have now decided to not copy the K500 hardware. The output coupler and the fine tuner will be different. Taking into consideration the reduced power requirement at low frequencies (due primarily to reduced dee voltage) we find that the output coupler can be a fixed capacitor. We propose to use a Jennings CTV2-26-0050 vacuum trimmable fixed capacitor. This is a ceramic envelope capacitor rated at 90 amps rms at 30 MHz (compared with 50 amps for the K500 coupler) and should not have to be cooled with an air blast. Our actual maximum current is $I = \sqrt{WZ_o} = 63$ amps.

For the fine tuner capacitor we propose to switch to one made by Comet of Switzerland, specifically, the CV3C75E rated at 100 amps for C = 25 pf or the CV5C rated at 200 amps for 25pf and 30 MHz. Using this latter capacitor will permit us to operate at different nominal settings for high and low frequencies to achieve constant $\Delta F/F$ tuning for the same Δturns/turns, resulting in constant open loop servo gain over our frequency range.

We propose to use the same blocker as in the K500 and the same method of connecting the water cooling and B^+ lead to the tube.

The big difference between the anode circuit of the K800 and K500 transmitters is in the stem configuration. Figure 2 shows the dodecagon stem for the dees.

The considerations that prompted us to not copy the K500 design are:

1. The ID of the inner conductor should be larger than the 3.75 inches we have in the K500.
2. Since we have to manufacture dee stems and short carriages for them, it would make fabrication simpler to copy the cross section geometry of dee stem and short in the region where the short has to move.

3. Because it is desirable to get the transmitters off the main floor, where they interfere with probes, injection line and extraction line, we have decided to place the transmitters on the basement level, thus limiting the total height from the top of the grid circuit to the bottom of the stem to about 17½ ft. The K500 transmiter total length is about 25 ft.

4. If possible, we should use push rods so that the drive mechanisms, water, air, and cabling are identical to what we have in the dee stems.

Table I shows the results of 8 possible options for the geometry. I hope the symbology is self-explanatory. Reference to Figs. 3&4 might be helpful.

Analysis of the Options in Table I

Run

#1. This is an effort to achieve a very short overall length and a short variable length. Thus only 40 inches of short travel is necessary, and push rods could be used even with the screen plane of the transmitter three feet below the basement ceiling. The bottom of the stem would be 140 below the main floor, and 40 inches for the push rods leaves us 36 inches above the subbasement floor, enough room for motors and access for the water and B^+ lead.

The objection is that the short and the stem would have to be water cooled, and we are consuming 2500 watts per transmitter more than other designs do.

#2. Here we use a more conservative 1.5 inch spacing to the inner conductor for the 36 inch long low Z section (L6), resulting in a 20 inch increase in stem length. Since this extra length precludes using push rods, this and subsequent designs presume that bicycle chains or side mount screws are used to move the short. The power is still fairly high, so that the short and stem would have to be water cooled.

#3. Here we add a 5 inch long high Z section immediately above the low Z section in order to reduce V5 and thus lower the circulating energy. The reduced current and power is dramatic at no increase in overall length.

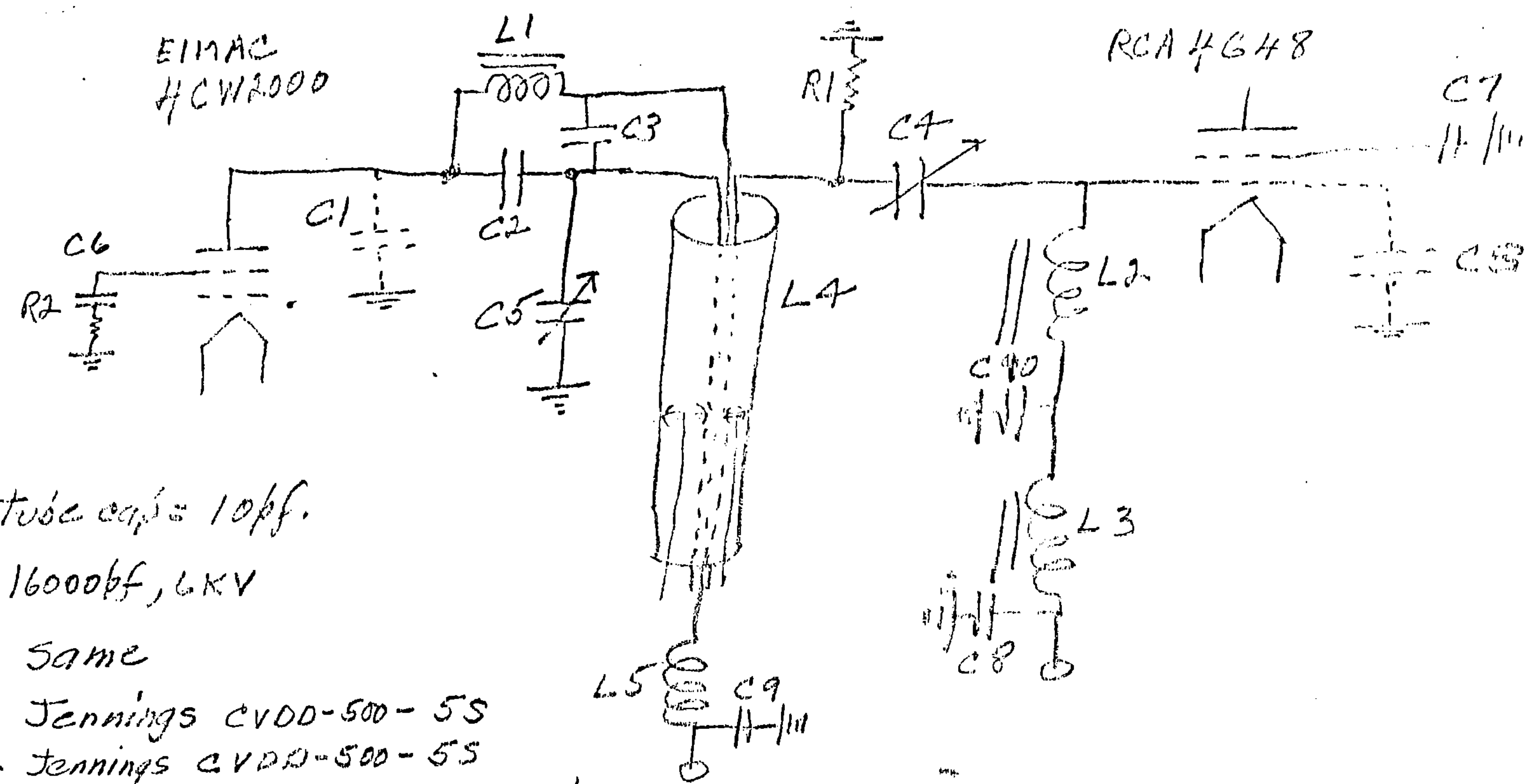
#4. Here we reduce the length of the low Z section, resulting in even less power but an increase in length.

#5. Here we carry this a little further.

#6&7. Here we go back to a 2 ft. low Z section and try two high Z lengths.

#8. Here we carry the length of the high Z section to an extreme and thus achieve the lowest power.

Conclusions: Designs #6 or 7 seem to be a good compromise. If we allow an additional 8 inches for L7 for safety factor, we have a length from the main floor to the bottom of the sort of 36" to 136" = 172 = 14.3 ft, leaving about 4 ft to the sub-basement floor. Since design #8 requires only 4 inches more total length, then it is in the running also. However, I now realize that my prejudices have excessively influenced my conclusions. Item 4, under "considerations", above, should dominate the choice. So, therefore, reluctantly I must opt for option 1 or a small modification of it to achieve a little better efficiency at the cost of another foot or two or space which is available. The fact that the short current is some three times higher and the power ten times higher than for option 8 is irrelevant, as this current is still only half of what will be present at the dee shorts.



C1 = tube cap = 10pf.

C2 = 1600pf, 6KV

C3 = same

C4 = Jennings CVDD-500-5S

C5 = Jennings CVDD-500-5S

C6, R2 6 parallel 1.5Ω, 1/2W in series with .01 mucons, 400V.

C8, 4648 grid cap = 1200pf.

C7 Screen bypass, as in K500

C8 same as C2

C 8,10 .1uf, 500V

R1 = 1250Ω water cooled as in K500

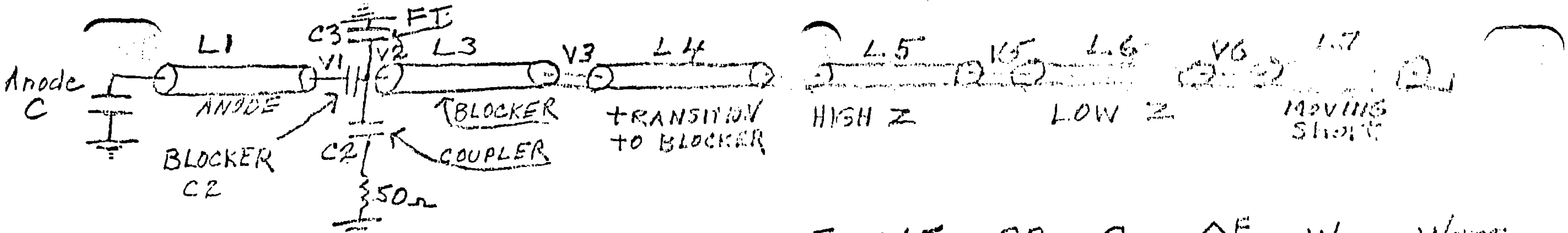
L1 = 20 Turns on F1707-1-01 core, 75uh.

L2, 3, 5 same

L4 = 5×10^{-7} to 1.4×10^{-7} remote position control — 1/2" pipe in 6" pipe 40" long.

C5 = 500pf to 15 pf, servoed

FIG 1



RUN #	I_{max}	LΣ	L7	L6	B6	L5	B5	V5	C2	C_{eq}	ΔF/F	Wsh	Wtot
1	1400	64 / 104	4 / 44	36	26	5	25	13 KV	27 / 25	497 / 811	[illegible] / .01	1300	3000
2	1100	65 / 119	5 / 65	36	25	5	25	13 KV	"	366 / 590	.027 / .017	729	2000
3	850	65 / 122	5 / 64	36	25	5	6.125	10 KV	"	234 / 521	.04 / .018	420	1200
4	700	55 / 128	7 / 80	24	25	5	6.125	11 KV	"	221 / 417	.045 / .023	327	944
5	600	49 / 145	9 / 105	16	25	5	6.125	10	"	174 / 312	.05 / .03	198	643
6	660	57 / 134	7 / 84	24	25	7	6.125	9 KV	"	180 / 392	.05 / .0211	248	764
7	592	59 / 136	6 / 83	24	25	10	6.125	7.1	"	153 / 387	.06 / .025	200	652
8	470	61 / 140	4 / 82	24	25	15	6.125	4.2	"	123 / 379	.014 / .025	130	500

I_{max} = rms current at short at 27 MHz.
LΣ = length in inches from screen flange to short
L7 = range of short
A6–B6 = gap in L6 = 1.5 inches for B6 = 25
V5 = peak volts entering L6 for 1.8 KV peak at anode
C_{eq} = equivalent capacity in pf.
ΔF/F = fractional change in tuning for ± 10 pf in C3
Wsh = Power in short at 27 MHz.
Wtot = total power diss. in anode circuit at 27 MHz.

For #6, $\frac{\Delta F}{\Delta L_7}$ = 1.5 MHz/in at 27 MHz.
= .075 MHz/in at 9 MHz

FIG 2.

DODECAGON

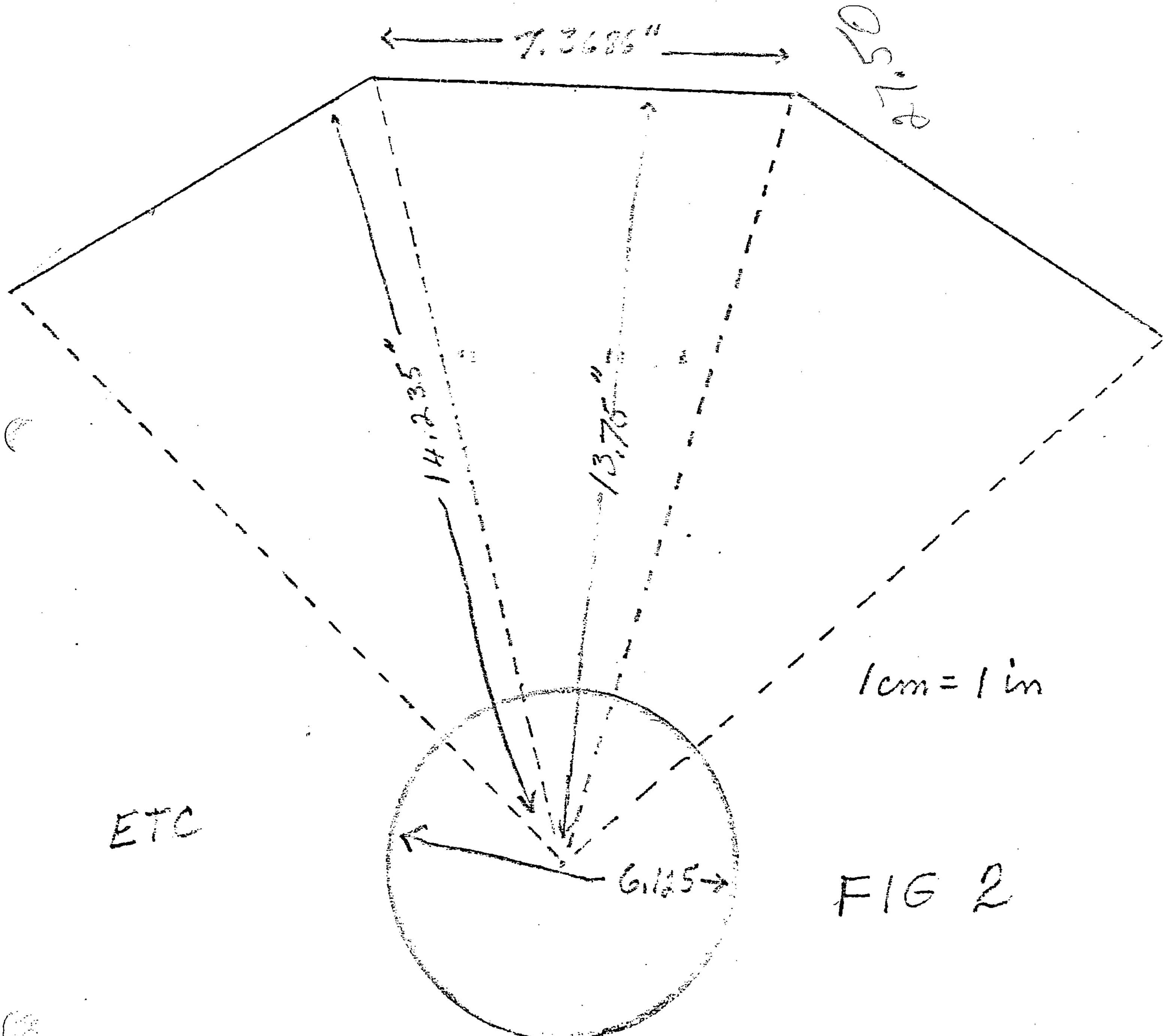
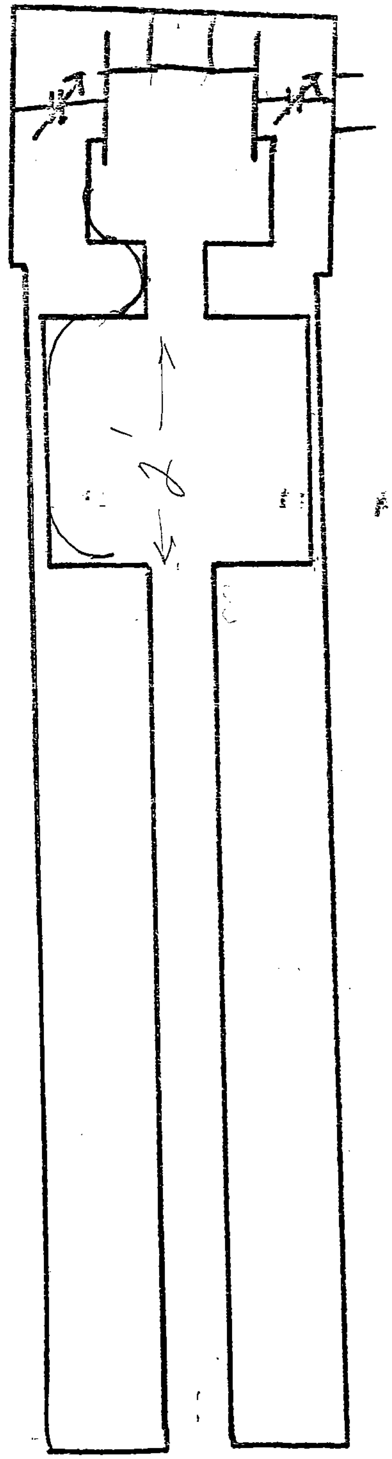
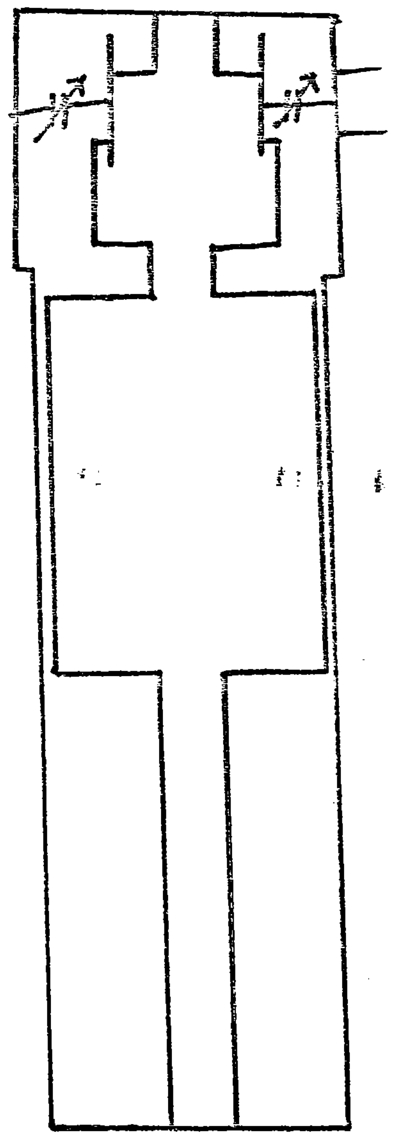


FIG 2



1 cm = 7 in.

FIG. 3



1cm = 7 in.

FIG. 4

Appendix I: On the calculations.

Basic program "TRANS" is used to make the calculations. An effort was made to improve on the calculations used for the K500 transmitter by including the geometry between the blocker and the actual anode. Without an exploded view of the tube, this is admittedly a guess. Note, from Appendix II, that I have assigned L1 = 5 in., and B1 = 4 in. RCA is sending me a drawing which, when it arrives, will permit me to more accurately assign proper values for these parameters. The blocker is presented as a lumped capacitor of zero length which is of course not correct, but at 30 MHz is probably o.k. Note that because of L1 and Z1, the highest voltage is at the top of the blocker, not at the top of the anode (by about 1 kV). At a much higher frequency a more sophisticated calculation must be made to include the velocity of propagation down the 9 inch length of the blocker (v = 1/3 C), a challenging and formidable project.

```
THIS IS RUN #7    ^X

LIST 2010-2500
 2010 DATA 30,4,0,0,5
 2015 DATA 0,0,0,0,0
 2020 DATA 30,12.5,0,0,10
 2030 DATA 30,15,0,0,4
 2032 DATA 30,6.125,0,0,10
 2035 DATA 28,25,0,0,24
 2040 DATA 28,6.125,0,0,1
>RUN
09:56   MAR 02  TRANS6...
PROGRAM TRANS FOR K800

FOR 27.00 MHZ THE RESULTS ARE

 N      Z      L     A      B      G      H     K      O      C
 0     0.0     0  0.00   0.00   0.00   0.00  0.00    0.00  70.0
 1   120.8     5 30.00   4.00   0.00   0.00  1.00    4.11   0.0
 2     0.0     0  0.00   0.00   0.00   0.00  0.00    0.00  27.6
 3    52.5    10 30.00  12.50   0.00   0.00  1.00    8.23  20.0
 4    41.5     4 30.00  15.00   0.00   0.00  1.00    3.29   0.0
 5    95.2    10 30.00   6.12   0.00   0.00  1.00    8.23   0.0
 6     6.8    24 28.00  25.00   0.00   0.00  1.00   19.75   0.0
 7    91.1     6 28.00   6.12   0.00   0.00  1.00    4.66   0.0

 N    Z    L    DEG    DEG  R/M         V         I        W        E
 0   0.0   0     0      0 0.0        1.8E+04   1.5E+02 0.0       2.0E+06
 1 120.8   5    55     59 4.9E-03    1.6E+04   1.6E+02 15.       9.0E+04
 2   0.0   5     0      0 0.0        1.7E+04   2.6E+02 0.0       7.7E+04
 3  52.5  15    48     57 1.9E-03    1.4E+04   2.9E+02 37.       3.4E+05
 4  41.5  19    50     53 1.7E-03    1.3E+04   3.0E+02 15.       1.3E+05
 5  95.2  29    72     80 3.4E-03    7.2E+03   3.1E+02 82.       8.1E+04
 6   6.8  53    23     42 1.3E-03    5.8E+03   5.5E+02 1.5E+02 1.1E+06
 7  91.1  59    85     90 3.4E-03    1.4E-03   5.5E+02 1.5E+02 5.0E+03
 18   W ANNULUS=   200.705

W/DEE          E/DEE MVA      Q             R SH          C EQ PF        C COUP FOR   170  KW
 652            3            5854           258           153             29
-------------------------------------------------------------------------------------------
FOR  9.00 MHZ THE RESULTS ARE

 N      Z      L     A      B      G      H     K      O      C
 0     0.0     0  0.00   0.00   0.00   0.00  0.00    0.00  70.0
 1   120.8     5 30.00   4.00   0.00   0.00  1.00    1.37   0.0
 2     0.0     0  0.00   0.00   0.00   0.00  0.00    0.00  25.1
 3    52.5    10 30.00  12.50   0.00   0.00  1.00    2.74  20.0
 4    41.5     4 30.00  15.00   0.00   0.00  1.00    1.10   0.0
 5    95.2    10 30.00   6.12   0.00   0.00  1.00    2.74   0.0
 6     6.8    24 28.00  25.00   0.00   0.00  1.00    6.58   0.0
 7    91.1    83 28.00   6.12   0.00   0.00  1.00   22.76   0.0

 N    Z    L    DEG    DEG  R/M         V         I        W        E
 0   0.0   0     0      0 0.0        1.8E+04   51.      0.0       6.7E+05
 1 120.8   5    26     27 2.8E-03    1.8E+04   54.      .99       3.3E+04
 2   0.0   5     0      0 0.0        1.9E+04   88.      0.0       2.6E+04
 3  52.5  15    19     22 1.1E-03    1.9E+04   1.0E+02 2.5        1.6E+05
 4  41.5  19    18     19 9.9E-04    1.8E+04   1.1E+02 1.1        7.8E+04
 5  95.2  29    38     41 1.9E-03    1.8E+04   1.1E+02 5.9        8.2E+04
 6   6.8  53     3     10 7.5E-04    1.7E+04   3.2E+02 23.        2.6E+06
 7  91.1 136    67     90 2.0E-03    1.4E-03   3.5E+02 4.8E+02 2.3E+05
18   W ANNULUS=   46.8039

W/DEE          E/DEE MVA      Q             R SH          C EQ PF        C COUP FOR   18   KW
 563            3            6909           300           387             25
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