RF Book

RF Note #46

J. Riedel
May 7, 1979

Single dee stem operation

In order to expedite initial high power testing into our vacuum test station we will start by using the simulated dee and only the lower stem. So our program was modified to find out what the stem position vs frequency would be, and by how much the maximum short circuit current will have increased.

The method used is as follows: from MSUDS we can find, for each frequency, the voltage and current at the point where the stem ties onto the dee. This then can result in arriving at an equivalent half dee capacity by calculating C=IV/W. MSUDS gives a fairly frequency independent (2% variation) for this value of 75 pf per half dee. We divide this capacity into three parts, putting 1/2 at the extraction radius, 2/10 at the injection radius and 3/10 at the center; these are added to lumped capacities we already had there due to edge effects and trimmers).

The results are shown in the table below.

FREQ	L	L'	I	I'	W	W'
10	106	84	1400	1700	36	22
15	45	32	1900	2200	40	26
20	21	12	2200	2600	44	30
25	9	2	2500	2800	48	34
30	3	193	2600	2800	52	149

TABLE I

where the primes refer to the single stem and

L = inches - short to M/P
I = total short current
W = Power, KW

Note that 26 MHz is the maximum frequency on the $\gamma/4$ mode, the primed figures for 30 MHz are for the $3\gamma/4$ mode. The power is about 60% of the two stem situation.

Amplitude Detection

In RF Note #19 the preferred scheme for amplitude detection was elucidated (detector C on page 4), and a heuristic argument given to explain its performance, which basically meant that my intuition said it was good. Fortunately, in these days where computers are available, we can back up our intuition with exact calculations. So a program called MIXER was written, and after considerable trivial and programming error correction, it runs fine.

This program has a subroutine to calculate the current through a real diode in series with a resistor. The Equation arrived at is

$$I = C1^{x}EXP(C2^{x}\ T + C3^{x}\ Abs\ V)^{x}\ (EXP(C4^{x}V/T)-1)$$

where V is the voltage across the diode + resistor, T is the temperature in degrees Kelvin and C1, C2, C3, C4 are constants obtained from the manufacturers data sheets for the particular diode.

The program divides the full wave time interval into N parts ($\approx$500) where a fourth order Runga Kutta integration routine calculates Fourier components of the 21 variables and prints out the dc output component, the first four harmonics, and the impedance presented to the inputs.

The results were as anticipated: The output was linear down to 0 volts, and independent of the phase difference between the reference and the rf to be measured.

The circuit is in Fig. 1. We will probably not use it. The computer showed that the termination of Vdee was very bad, varying 2 to 1. Laisne has shown that a biased full wave peak detector is pretty linear down to 3 mv so we will start by using it. It has a bad temperature coeffecient for voltages less than .1 volt but is OK for 5 volts in.

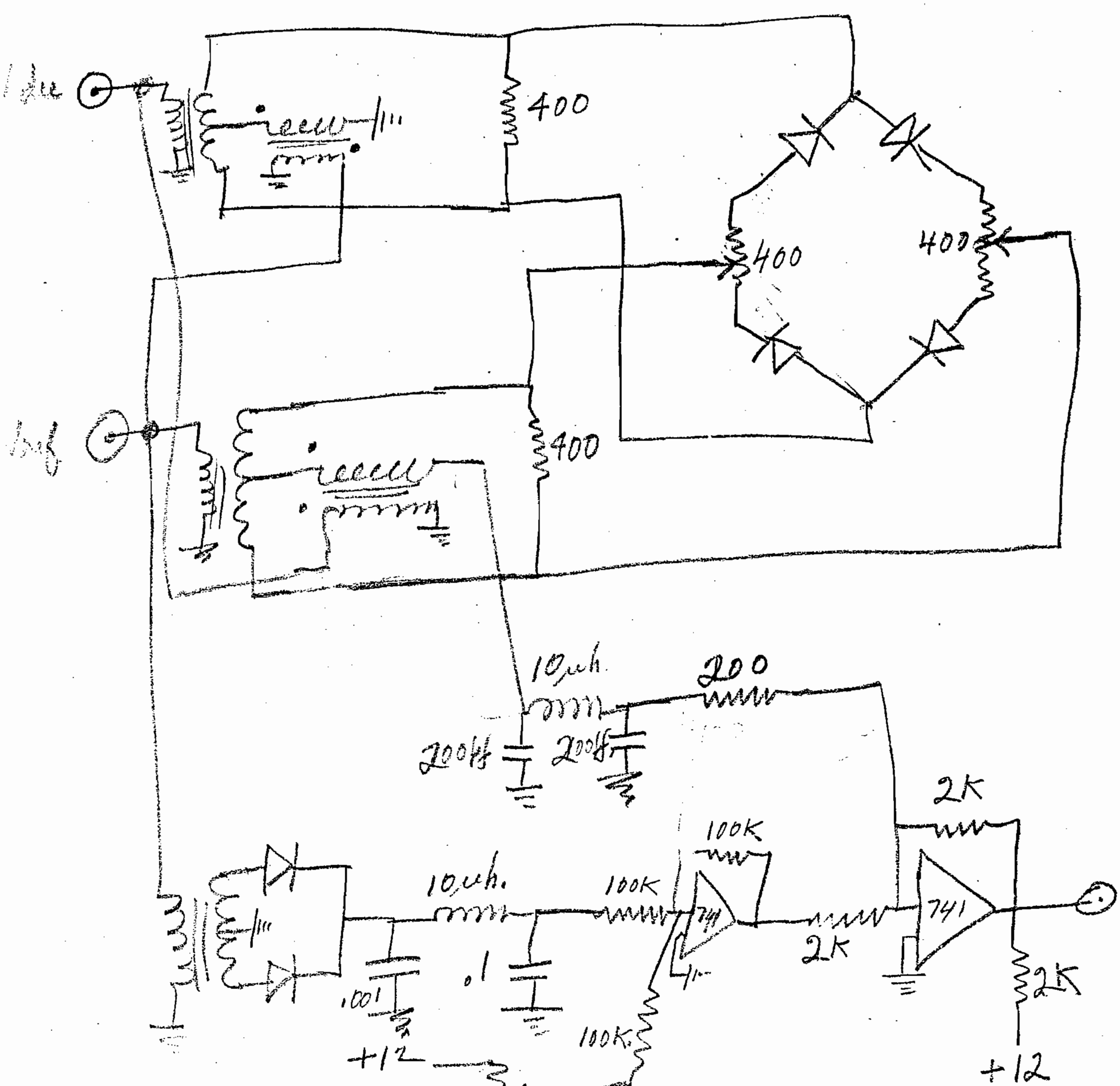

400
400
400
400
10 uh
200
200pf
200pf
2K
100K
10 uh.
100K
741
2K
741
.001
.1
2K
100K
+12
10K
-12
+12

FIG 1

Biasing the transmission line and coupling capacitor

Possible multipactoring in the vacuum portion of the above has always been a concern, because there are two insulators involved. Now that we use a vacuum capacitor in series with this line at the transmitter, so that dc isolation exists, we have decided to clobber this problem. Below is a sketch showing how we did this.

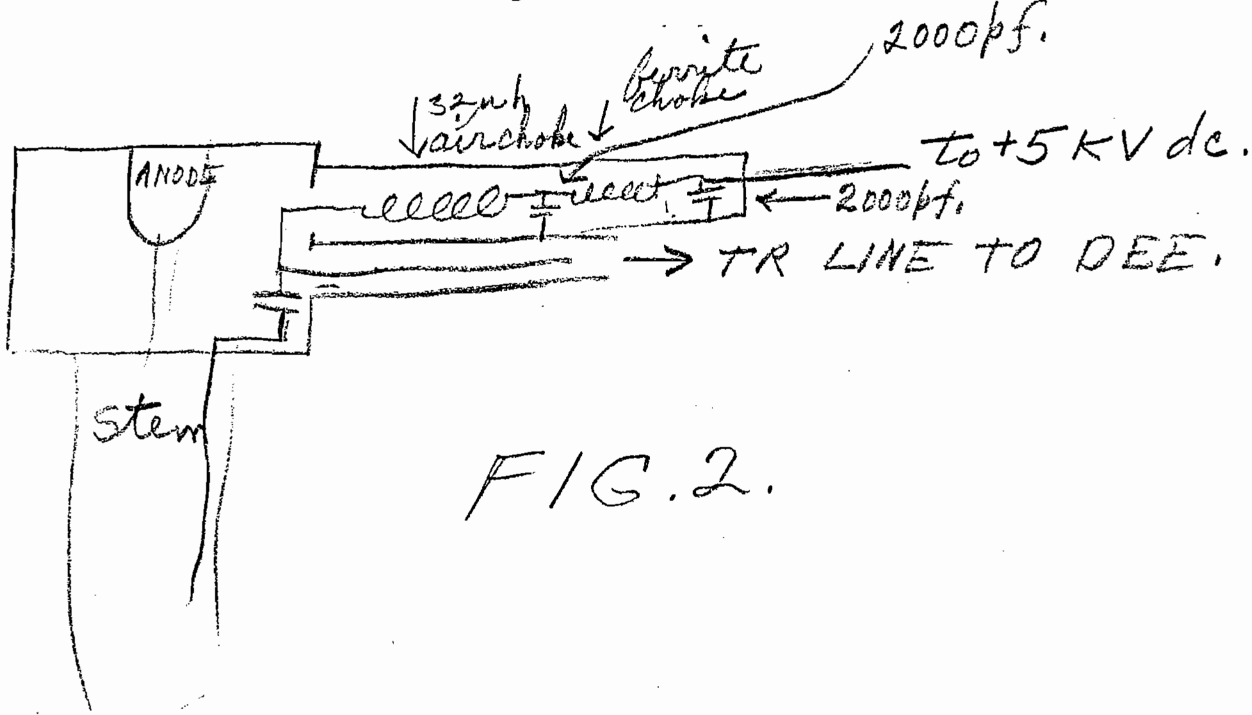


FIG. 2.

RF Tests

On Saturday, April 28, 1979 at about noon we had the model together and started tests. First, using the 50 watt amplifier, we found correct positions for the coupling capacitor for the two frequency extremes: 9.795 and 22.819 MHz. My program did not include any inductance between the top and bottom of the dee, which perhaps can explain the 10% discrepancy in the top frequency. The lower frequency agrees with the calculations within 2% which is acceptable.

Then we excited the model with the transmitter and, using a spark gap, calibrated our loop (dee voltage monitor) at 22.8MHz. Calibration is 1 volt peak = 7.2 KV peak dee volts. Then we removed the spark gap and observed that the coupling capacitor sparked at 21 KV, which is not unreasonable.

The Q was only 920 at 32 MHz, but there were several places where poor connections were evident. While these were being fixed we measured the transmitter Q. Results:

32	MHz	Q =	2050
24	"	" "	2300
12	"	" "	3100
9	"	" "	2500

This is not unreasonable considering that the tube 100 pf capacity has tungsten electrodes for much of the current path.

During the first part of the next week we, that is Don Lawton and his fabulous crew of draftsmen, did a variety of things calculated to improve the Q. I think everything was taken apart and put back at least 7 times. The best results were:

Q	F
2700	22 MHz
3100	9.8 MHz

Then we removed the dee from the stems

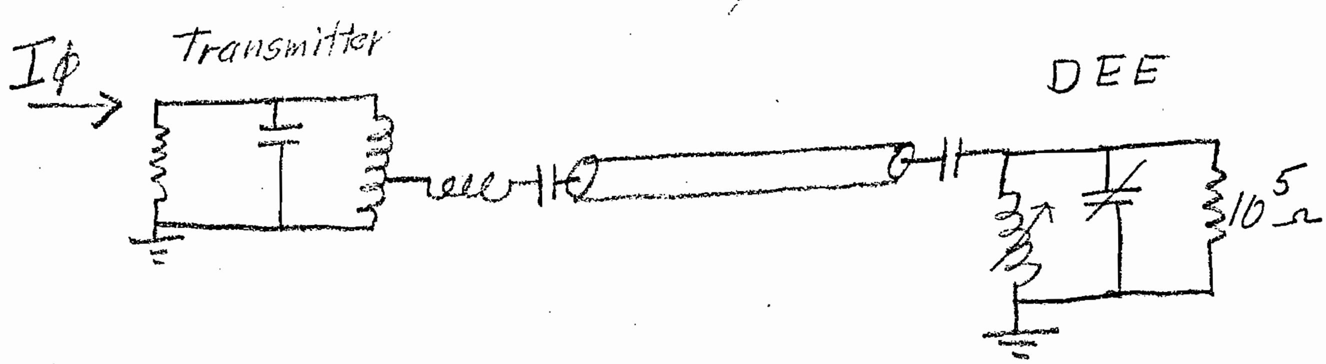
Q	F
2300	22
4200	9.8

Then we decided to put everything back together and find out how much power was required to get 21KV, and perhaps we would fill it with SF6 and go to 50KV.

We started at 9.9 MHz. The voltage monitor calibration is 1 volt = 33KV. By measuring the incident power when the coupler was adjusted for zero reflected power we could extrapolate to requiring 20KW to achieve 100 KV dee volts. The calculations gave 22 KW. So here is good agreement and all is well. The dee sparks down (at the coupler) at 24 KV. The calibration at 22.2 MHz is 1 volt = 9.1 KV. I consider that all these numbers are good to better than 10%.

Everything seemed fine; but when trying to tune up at the top frequency, 22.8 MHz, we failed to find a criteria for adjustment! So we backed down to 10 MHz and found that twiddling the knobs quickly led us astray and again, without referring to look up tables for some settings, we could not adjust everything properly.

There are two or three modes, depending on what frequency you are trying to tune to. It is my opinion that there are three modes, but degeneracy can set in and two modes can overlap and when this happens we are in trouble. Fortunately we have a computer program that can explain all this. It is called TRED 3 and computes results near resonance for the following circuit.



The various L's, R's, and C's are chosen to be exactly correct for the right mode, and Iφ, the tube current is a constant which produces exactly 100KV on the dee at Fφ (20MHz). The frequency is then scanned from Fφ-200KHz to Fφ + 200 KHz in steps of Fφ/50,000, and printouts are limited to events where the phase differences between any two phases since the last printout are more than π/20.

Table II and III show the computer spillout of the results for two lengths of TR line. All relevant information is presented. Under "FREQ" we list the difference in KHz from Fφ, V DEE is obvious, P DEE is phase difference, in degrees, between the dee voltage and the end of the transmission line, and is exactly 90° at Fφ. V CAP is the voltage at the end of the transmission line. R CAP and X CAP are the equivalent R & X into which the end of the transmission line looks. The second V CAP is the voltage across the resonating capacitor at the output of the transmitter. V AN and P AN are the voltage and phase of the anode (the phase with respect to Iφ). R AN and X AN are the equivalent parallel resistance and reactance into which the anode looks.

Now note Table II. There are three modes: #1 at 19,968,000 Hz, #2 at 20,000,000 Hz and #3 at 20,013,000 Hz. #2 is the correct mode showing 90° across the coupling capacitor and all voltage are correct. #2 and #3 modes are associated with the transmitter and transmission line. It is believed that operation at this frequency and line length is impossible. This is the frequency and line length we have on the model, and so far we have been unable to find a criteria for adjusting the various parameters to achieve dee volts and no reflected power.

Table III shows how this situation can be remedied by merely changing the line length. There are still three modes, but they cause no trouble at all. At 10MHz we observed these modes and noted that they indeed did not cause any trouble.

If we tuned to these modes without reducing $I\phi$(the drive) the screen overload would trip us off, because the anode would try to rise to 1.5 MV., and the dee to 700Kv, if we had a 2MV B^+ supply. Of course almost everything would spark down.

So here we see the frightfull consequences of having not only a very complicated RF circuit (Many elements) but also of loose coupling. Still, we can learn to cope with it. We will need to make more computer studies, and abet these with many measurements on our model. When everything is thoroughly understood, a solution will become manifest. However it is possible that we may have to have a trombone in our transmission lines to duck degeneracies, and also we may have to switch over to a water load on the line to independently tune the transmitter. I am sorry, but these may be the grim facts of life with this rf system.

Transmitter & Neutralization

At 30 MHz we are neutralized, and, while not perfectly neutralized at lower frequencies, since the neutralizing capacitor would have to be readjusted for each frequency, we are still almost neutralized. In any case we observe that the consequences of the feedback capacity at any frequency are no longer a threat. Je suis content. The transmitter seems perfectly behaved. This last lash did it in!

FREQ	V DEE	P DEE	V CAP	R CAP	X CAP	V CAP	V AN	° P AN	R AN	X AN
-200.	29E+03	180.	3.77E+03	9.44E+05	-2.00E+03	3.91 3	1.88E+04	89.6	3.64E+05	2.35E+03
-50.4	3.95E+04	178.	2.87E+04	5.88E+04	-1.12E+03	3.07E+04	1.43E+05	86.5	2.95E+05	1.79E+04
-40.8	9.57E+04	178.	5.63E+04	3.85E+04	-986.	6.07E+04	2.81E+05	82.4	2.67E+05	3.54E+04
-37.6	1.56E+05	177.	8.48E+04	3.27E+04	-936.	9.15E+04	4.22E+05	78.0	2.54E+05	5.39E+04
-36.0	2.19E+05	177.	1.14E+05	3.00E+04	-909.	1.23E+05	5.66E+05	73.3	2.47E+05	7.39E+04
-34.8	3.03E+05	177.	1.52E+05	2.80E+04	-889.	1.65E+05	7.58E+05	66.9	2.41E+05	1.03E+05
-34.0	3.96E+05	177.	1.95E+05	2.68E+04	-876.	2.11E+05	9.68E+05	59.4	2.37E+05	1.41E+05
-33.6	4.61E+05	177.	2.24E+05	2.61E+04	-869.	2.42E+05	1.11E+06	53.8	2.35E+05	1.72E+05
-33.2	5.41E+05	177.	2.59E+05	2.55E+04	-862.	2.81E+05	1.29E+06	46.3	2.33E+05	2.23E+05
-32.8	6.34E+05	177.	3.00E+05	2.49E+04	-855.	3.26E+05	1.49E+06	36.1	2.31E+05	3.17E+05
-32.4	7.27E+05	177.	3.40E+05	2.43E+04	-848.	3.69E+05	1.69E+06	22.7	2.29E+05	5.49E+05
-32.0	7.85E+05	177.	3.63E+05	2.37E+04	-840.	3.94E+05	1.81E+06	6.16	2.27E+05	2.10E+06
-31.6	7.77E+05	177.	3.54E+05	2.31E+04	-833.	3.85E+05	1.76E+06	-11.2	2.25E+05	-1.14E+06
-31.2	7.10E+05	177.	3.20E+05	2.25E+04	-826.	3.48E+05	1.59E+06	-26.6	2.22E+05	-4.45E+05
-30.8	6.22E+05	177.	2.77E+05	2.20E+04	-819.	3.01E+05	1.38E+06	-38.6	2.20E+05	-2.76E+05
-30.4	5.39E+05	177.	2.37E+05	2.14E+04	-811.	2.57E+05	1.18E+06	-47.5	2.18E+05	-2.00E+05
-30.0	4.69E+05	177.	2.03E+05	2.08E+04	-804.	2.21E+05	1.01E+06	-54.1	2.15E+05	-1.56E+05
-29.6	4.12E+05	177.	1.76E+05	2.03E+04	-797.	1.92E+05	8.77E+05	-59.0	2.13E+05	-1.28E+05
-28.8	3.30E+05	177.	1.37E+05	1.92E+04	-781.	1.50E+05	6.83E+05	-65.8	2.08E+05	-9.35E+04
-27.6	2.54E+05	177.	1.01E+05	1.77E+04	-758.	1.10E+05	5.03E+05	-71.7	2.00E+05	-6.63E+04
-26.0	1.96E+05	176.	7.37E+04	1.57E+04	-726.	8.07E+04	3.66E+05	-76.0	1.89E+05	-4.72E+04
-22.8	1.40E+05	176.	4.62E+04	1.21E+04	-660.	5.08E+04	2.29E+05	-80.0	1.65E+05	-2.91E+04
-14.4	9.49E+04	173.	1.99E+04	4.86E+03	-462.	2.25E+04	9.85E+04	-82.2	9.03E+04	-1.24E+04
-6.80	9.04E+04	166.	9.17E+03	1.14E+03	-251.	1.12E+04	4.51E+04	-77.3	2.58E+04	-5.78E+03
-4.80	9.26E+04	161.	6.84E+03	605.	-192.	8.73E+03	3.35E+04	-72.6	1.40E+04	-4.39E+03
-3.60	9.46E+04	156.	5.47E+03	371.	-158.	7.29E+03	2.67E+04	-67.2	8.62E+03	-3.62E+03
-2.80	9.64E+04	150.	4.59E+03	251.	-138.	6.34E+03	2.23E+04	-61.5	5.84E+03	-3.17E+03
-2.00	9.84E+04	141.	3.75E+03	161.	-124.	5.39E+03	1.82E+04	-52.6	3.74E+03	-2.86E+03
-1.60	9.96E+04	135.	3.37E+03	127.	-121.	4.93E+03	1.63E+04	-46.3	2.95E+03	-2.82E+03
-1.20	1.01E+05	127.	3.03E+03	100.	-125.	4.48E+03	1.47E+04	-38.2	2.34E+03	-2.96E+03
-.800	1.02E+05	117.	2.75E+03	80.5	-146.	4.05E+03	1.34E+04	-28.1	1.90E+03	-3.56E+03
-.400	1.04E+05	106.	2.57E+03	68.3	-224.	3.64E+03	1.27E+04	-16.0	1.65E+03	-5.74E+03
-2.98E-11	1.05E+05	92.2	2.52E+03	63.5	-1.01E+03	3.28E+03	1.25E+04	-2.60	1.57E+03	-3.46E+04
.400	1.07E+05	78.6	2.61E+03	66.0	374.	3.00E+03	1.32E+04	10.6	1.68E+03	8.92E+03
.800	1.09E+05	66.2	2.84E+03	75.7	183.	2.82E+03	1.45E+04	22.4	1.96E+03	4.75E+03
1.20	1.11E+05	55.7	3.21E+03	92.9	144.	2.78E+03	1.64E+04	32.1	2.43E+03	3.86E+03
1.60	1.13E+05	47.3	3.67E+03	117.	134.	2.90E+03	1.89E+04	39.8	3.07E+03	3.68E+03
2.00	1.15E+05	40.7	4.22E+03	149.	135.	3.19E+03	2.17E+04	45.8	3.89E+03	3.78E+03
2.40	1.18E+05	35.5	4.85E+03	188.	141.	3.62E+03	2.49E+04	50.5	4.88E+03	4.03E+03
3.20	1.23E+05	28.0	6.29E+03	288.	162.	4.80E+03	3.22E+04	57.0	7.38E+03	4.79E+03
4.40	1.34E+05	21.0	8.92E+03	493.	204.	7.23E+03	4.54E+04	62.6	1.23E+04	6.39E+03
8.00	1.91E+05	11.8	2.22E+04	1.50E+03	358.	2.01E+04	1.12E+05	66.2	3.47E+04	1.53E+04
9.60	2.43E+05	9.90	3.38E+04	2.14E+03	435.	3.13E+04	1.70E+05	63.3	4.74E+04	2.38E+04
10.8	3.10E+05	8.82	4.83E+04	2.70E+03	496.	4.54E+04	2.43E+05	58.2	5.77E+04	3.57E+04
11.6	3.78E+05	8.21	6.32E+04	3.10E+03	539.	5.99E+04	3.18E+05	52.1	6.48E+04	5.04E+04
12.0	4.23E+05	7.94	7.32E+04	3.32E+03	561.	6.96E+04	3.68E+05	47.7	6.84E+04	6.22E+04
12.4	4.78E+05	7.69	8.53E+04	3.54E+03	583.	8.14E+04	4.29E+05	41.9	7.20E+04	8.02E+04
12.8	5.40E+05	7.45	9.95E+04	3.77E+03	605.	9.53E+04	5.00E+05	34.3	7.57E+04	1.11E+05
13.2	6.06E+05	7.22	1.15E+05	4.00E+03	628.	1.11E+05	5.78E+05	24.4	7.94E+04	1.75E+05
13.6	6.62E+05	7.01	1.30E+05	4.25E+03	651.	1.25E+05	6.51E+05	11.9	8.31E+04	3.94E+05
14.0	6.86E+05	6.81	1.38E+05	4.50E+03	674.	1.33E+05	6.94E+05	-2.56	8.68E+04	-1.94E+06
14.4	6.65E+05	6.63	1.38E+05	4.76E+03	698.	1.33E+05	6.92E+05	-17.4	9.06E+04	-2.90E+05
14.8	6.08E+05	6.45	1.29E+05	5.02E+03	722.	1.25E+05	6.49E+05	-30.7	9.43E+04	-1.59E+05
15.2	5.36E+05	6.28	1.17E+05	5.29E+03	746.	1.14E+05	5.87E+05	-41.5	9.80E+04	-1.11E+05
15.6	4.66E+05	6.12	1.04E+05	5.57E+03	771.	1.02E+05	5.24E+05	-49.9	1.02E+05	-8.56E+04
16.0	4.05E+05	5.97	9.32E+04	5.86E+03	796.	9.09E+04	4.68E+05	-56.4	1.05E+05	-7.02E+04
16.4	3.55E+05	5.82	8.36E+04	6.15E+03	822.	8.17E+04	4.19E+05	-61.3	1.09E+05	-5.97E+04
17.2	2.79E+05	5.55	6.89E+04	6.76E+03	874.	6.76E+04	3.45E+05	-68.3	1.17E+05	-4.65E+04
18.0	2.27E+05	5.30	5.85E+04	7.40E+03	928.	5.76E+04	2.94E+05	-72.8	1.24E+05	-3.84E+04
19.2	1.74E+05	4.97	4.80E+04	8.42E+03	1.01E+03	4.74E+04	2.41E+05	-77.1	1.35E+05	-3.09E+04
21.6	1.16E+05	4.42	3.59E+04	1.06E+04	1.19E+03	3.58E+04	1.80E+05	-81.7	1.55E+05	-2.27E+04
26.8	6.34E+04	3.56	2.43E+04	1.64E+04	1.66E+03	2.45E+04	1.22E+05	-85.5	1.94E+05	-1.53E+04
[37.6]	[illegible]	[3.01]	1.22E+04	5.14E+04	5.65E+03	1.25E+04	6.09E+04	[-88.5]	2.87E+05	-7.61E[illegible]

```
>101 LO=LO*1.5
>RUN
>RUN
09:26    MAY 04   TRED3...
TRED3      ONE DEE,+ TR LINE  + XMITTER
FO=2E7
```

TABLE III

FREQ	V DEE	P DEE	V CAP	R CAP	X CAP	V CAP	V AN	P AN	R AN	X AN
-200.	987.	180.	2.88E+03	9.44E+05	-2.00E+03	1.76E+03	743.	89.9	5.37E+04	92.8
-19.2	1.07E+04	175.	2.99E+03	8.58E+03	-579.	1.39E+03	2.97E+03	87.4	8.29E+03	371.
-10.0	2.06E+04	171.	3.02E+03	2.39E+03	-343.	1.12E+03	4.40E+03	83.7	5.01E+03	554.
-6.40	3.18E+04	166.	3.05E+03	1.02E+03	-239.	849.	5.99E+03	78.9	3.90E+03	762.
-4.80	4.15E+04	161.	3.07E+03	605.	-192.	698.	7.35E+03	74.5	3.45E+03	953.
-4.00	4.88E+04	158.	3.08E+03	442.	-169.	682.	8.36E+03	71.1	3.23E+03	1.10E+03
-3.20	5.88E+04	153.	3.10E+03	307.	-148.	816.	9.74E+03	66.2	3.01E+03	1.33E+03
-2.40	7.29E+04	146.	3.12E+03	202.	-130.	1.21E+03	1.16E+04	58.8	2.81E+03	1.70E+03
-2.00	8.20E+04	141.	3.12E+03	161.	-124.	1.53E+03	1.29E+04	53.6	2.71E+03	2.00E+03
-1.60	9.25E+04	135.	3.13E+03	127.	-121.	1.94E+03	1.42E+04	47.0	2.61E+03	2.43E+03
-1.20	1.04E+05	127.	3.12E+03	100.	-125.	2.45E+03	1.57E+04	38.6	2.51E+03	3.14E+03
-.800	1.15E+05	117.	3.10E+03	80.5	-146.	3.03E+03	1.70E+04	28.1	2.41E+03	4.51E+03
-.400	1.23E+05	106.	3.06E+03	68.3	-224.	3.59E+03	1.79E+04	15.7	2.32E+03	8.27E+03
-2.98E-11	1.25E+05	92.2	3.00E+03	63.5	-1.01E+03	4.02E+03	1.78E+04	2.09	2.22E+03	6.09E+04
.400	1.20E+05	78.6	2.94E+03	66.0	374.	4.22E+03	1.67E+04	-11.2	2.13E+03	-1.08E+04
.800	1.11E+05	66.2	2.89E+03	75.7	183.	4.22E+03	1.51E+04	-22.8	2.04E+03	-4.86E+03
1.20	9.93E+04	55.7	2.87E+03	92.9	144.	4.08E+03	1.32E+04	-32.4	1.96E+03	-3.08E+03
1.60	8.81E+04	47.3	2.86E+03	117.	134.	3.89E+03	1.15E+04	-40.0	1.87E+03	-2.23E+03
2.00	7.82E+04	40.7	2.87E+03	149.	135.	3.70E+03	9.94E+03	-45.9	1.79E+03	-1.73E+03
2.40	6.98E+04	35.5	2.87E+03	188.	141.	3.52E+03	8.66E+03	-50.5	1.70E+03	-1.40E+03
3.20	5.67E+04	28.0	2.89E+03	288.	162.	3.21E+03	6.69E+03	-57.1	1.54E+03	-996.
4.00	4.73E+04	22.9	2.90E+03	417.	189.	2.98E+03	5.30E+03	-61.5	1.39E+03	-755.
5.20	3.77E+04	18.0	2.92E+03	666.	235.	2.73E+03	3.88E+03	-65.6	1.17E+03	-533.
7.20	2.80E+04	13.1	2.94E+03	1.23E+03	321.	2.47E+03	2.46E+03	-68.9	853.	-329.
11.6	1.78E+04	8.21	2.97E+03	3.10E+03	539.	2.19E+03	958.	-68.2	323.	-129.
13.6	1.52E+04	7.01	2.98E+03	4.25E+03	651.	2.12E+03	588.	-63.7	166.	-82.1
14.8	1.40E+04	6.45	2.98E+03	5.02E+03	722.	2.09E+03	417.	-58.0	98.4	-61.5
15.6	1.33E+04	6.12	2.98E+03	5.57E+03	771.	2.07E+03	321.	-51.6	64.6	-51.2
16.0	1.30E+04	5.97	2.98E+03	5.86E+03	796.	2.06E+03	279.	-47.1	51.2	-47.6
16.4	1.27E+04	5.82	2.99E+03	6.15E+03	822.	2.05E+03	241.	-41.3	40.0	-45.6
16.8	1.24E+04	5.68	2.99E+03	6.46E+03	848.	2.04E+03	208.	-33.7	31.2	-46.7
17.2	1.21E+04	5.55	2.99E+03	6.76E+03	874.	2.03E+03	181.	-24.1	24.7	-55.3
17.6	1.18E+04	5.42	2.99E+03	7.08E+03	901.	2.02E+03	161.	-12.2	20.6	-95.7
18.0	1.16E+04	5.30	2.99E+03	7.40E+03	928.	2.02E+03	151.	1.60	18.9	678.
18.4	1.13E+04	5.19	2.99E+03	7.73E+03	956.	2.01E+03	150.	15.8	19.5	69.0
18.8	1.11E+04	5.08	2.99E+03	8.07E+03	984.	2.00E+03	158.	28.8	22.6	41.1
19.2	1.09E+04	4.97	2.99E+03	8.42E+03	1.01E+03	2.00E+03	173.	39.6	28.0	33.9
19.6	1.07E+04	4.87	2.99E+03	8.77E+03	1.04E+03	1.99E+03	192.	48.2	35.9	32.1
20.0	1.04E+04	4.77	3.00E+03	9.13E+03	1.07E+03	1.98E+03	213.	54.8	46.2	32.6
20.4	1.02E+04	4.68	3.00E+03	9.50E+03	1.10E+03	1.98E+03	236.	60.0	59.0	34.1
21.2	9.87E+03	4.51	3.00E+03	1.03E+04	1.16E+03	1.97E+03	284.	67.3	92.0	38.5
22.0	9.52E+03	4.34	3.00E+03	1.10E+04	1.23E+03	1.96E+03	332.	72.1	135.	43.6
23.2	9.03E+03	4.12	3.00E+03	1.23E+04	1.32E+03	1.94E+03	401.	76.7	219.	51.5
25.6	8.21E+03	3.73	3.01E+03	1.49E+04	1.54E+03	1.92E+03	526.	81.7	456.	66.5
31.6	6.68E+03	3.02	3.02E+03	2.27E+04	2.19E+03	1.88E+03	771.	86.2	1.47E+03	96.6
200.	1.23E+03	.479	3.49E+03	8.88E+05	-4.06E+03	1.81E+03	2.70E+03	89.9	2.18E+05	337.

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