RF E...R

March 26, 1979

RF Note # 42

J. Riedel

1. A review of the status of the RF System

For some months now the conceptual design of the rf system has been completed. Lately we have been involved in clearing up some misunderstood aspects of the transmitter. As reported in the last rf note, these have all been cleared up with the solution to the driver screen bypass problem, and now it is believed that the transmitter works as planned.

Meanwhile, we are preparing for the crucial test of the transmitter,driving the dummy dee in vacuo with its final stems and insulators. Hopefully these tests will commence by April 10, 1979. These tests are being made to determine if the following problems are surmountable:

A. The fingers on the moving short will survive.
B. The insulator will not overheat or spark down excessively.
C. We can achieve good criteria for servo control of the voltage and phase, and successfully close loops to regulate these (dee voltage to 10PPM, phase to 1^{o}).

This will easily be a six month program!

And then we cast our eye forward on the larger problem: to excite three such coupled dees and regulate them. A lot of water has to go under the bridge before then--and I have difficulty in seeing the source of it. Besides the larger easily observable problems of fabrication of the dee and dee stem hardware there looms before my eyes the equally time consuming problem of attending to the nitty gritty as follows:

A. Amplitude regulator. A design exists for the essential part of the regulator, in fact we have the three modules which were used to regulate the amplitude of the three phase model and one of these will do for the test set-up. But for the final set-up we need to add provision for remote turn on and for overriding the amplitude to prevent over screen current , overplate current, and over voltages in the line. Some design and development, prototyping and testing well be required here before we can construct the final three modules.

B. Phase Position Servos for Electric Motors. These are required for the driver grid, final grid and output resonating capacitor. Final design exists and we have two units in use on the test transmitter. They are satisfactory, although we have not closed phase loops yet.

C. Phase and Position Servos for Moog Hydraulic Motors and Pistons. We are presently using one of these units for positioning the transmitter stem short and it performs satisfactorily as mentioned in the last rf note. However, considerable modification is necessary to make it compatable with computer control. In a section below, the specifications will be delineated and W. Johnson will take

responsibility for producing the final modules.

D. Fast manual and electronic phase shifters.

These are designed, but someone has to see that the three modules are built.

E. Fast Phase Servo. This is trivial to design, but hasn't been designed yet. Perhaps it will be included in the electronic phase shifter module.

F. DA2 Power Supply. This is the 3KV, 15 amp supply obtained from PPA. New crowbar thyratrons and ignitrons are on order and when they arrive we will test the crowbar. Meanwhile we are in the procurement process to purchase a choke and some capacitors to reduce the output ripple to 0.1%. It is presumed that this filter will fit in a standard relay rack and cost about $15.00. Then we must buy Zener diodes and resistors to make the three final screen voltage outputs from this supply. Then we must design a mechanical layout for these components and install them in yet another relay rack.

G. Synthesizer. R. Gress has an rf note on this. Nothing presently exists in final form.

H. Then a flow diagram for the controls must be made. Fortunately this will only take a weekend of my time.

I. Then W. Johnson must convert this flow diagram into circuits and hardware. Again, a weekend of his time should be sufficient to accomplish this with the aid of this digital processors.

J. Station and Master Control Panels. These should not be designed until after the testing of the dummy dee + stems. But they must exist before DEE DAY. DEE DAY is the day we first try to turn on rf to the three dees and accelerate beam. Maybe the following will happen: on DEE DAY we turn the three rf systems on and after say an hour of fussing around,everything works fine, so we accelerate beam. Then the onus will be on the extractors. Ha! What a fantasy! This is because lately my dreams have been good and everyone was always smiling. This in contradistinction to the occassions when various parts of the rf system are burning up or exploding and everyone has a dour expression on his face.

K. Other Power Supplies. W. Johnson seems to be moving expeditiously towards the procurement of the various fairly low level power supplies he has contracted to acquire, add crowbars to, and provide for control. So all is well here.

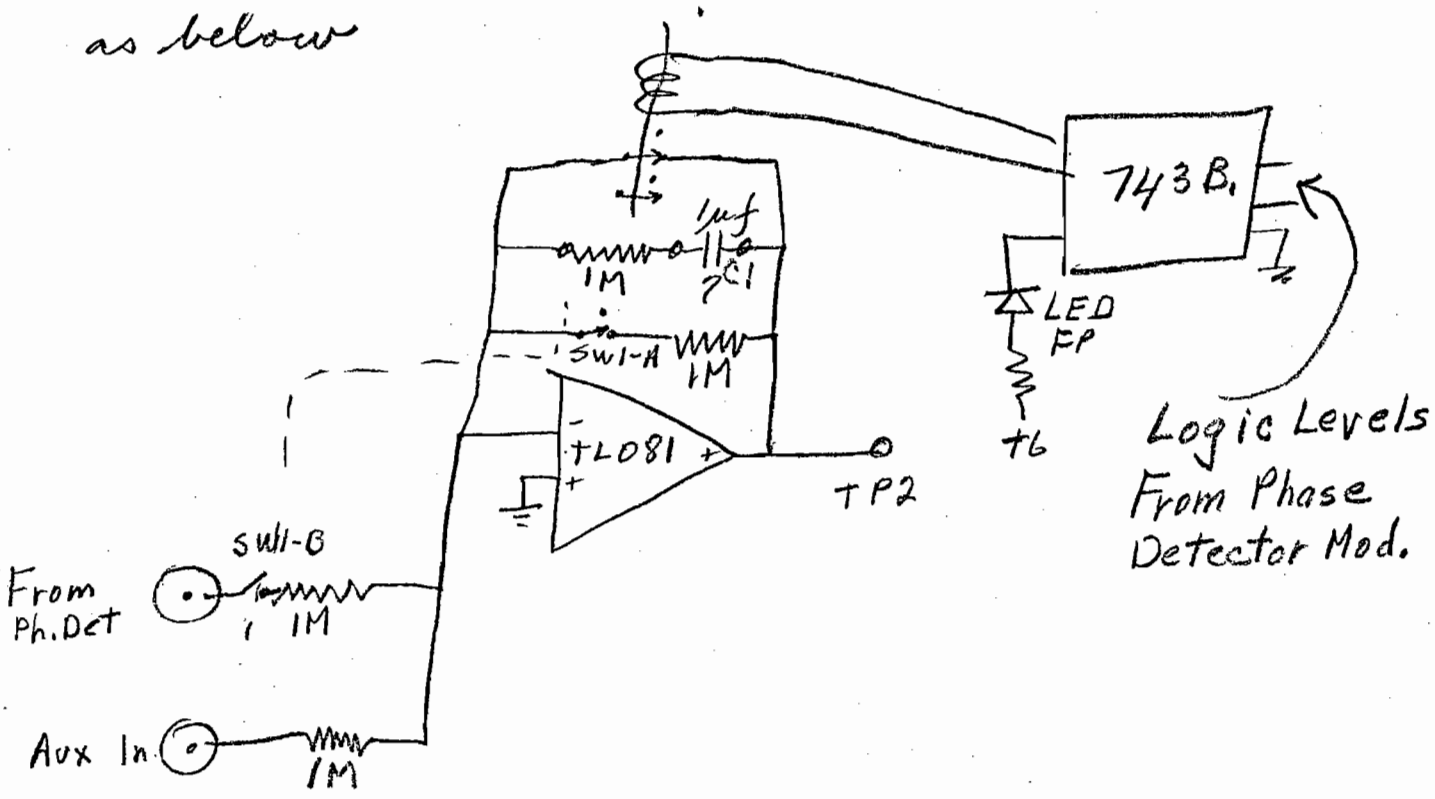
Phase and position servos for hydraulic motors and pistons.

This is the section referred to in "C" above. Herein I propose to draw the "intrinsic" diagrams, explain their functions, and

specify inputs and outputs. Then it will be up to W. Johnson to choose connectors, designate pin numbers, produce cabling diagrams, circuit board diagrams, have art work done, p.c. boards, front and back panels made, compile a parts list, and finally construct the final units. It's a good thing that we have ten W. Johnsons here.

Phase Servo

The intrinsic part of the phase servo is as below:

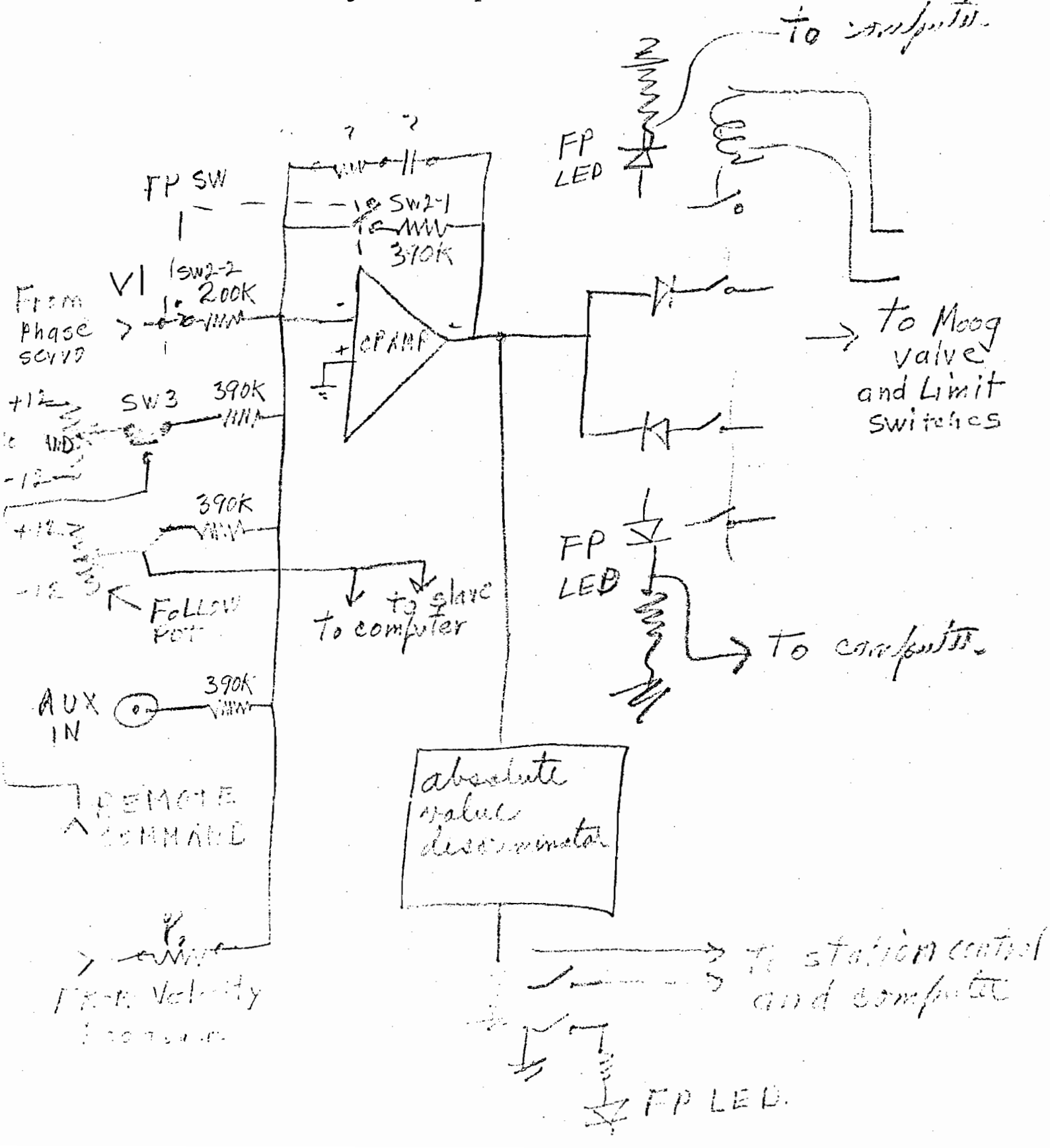


TL 081 is an opamp of dc gain 10^5. The 743B serves the purpose of clamping the op amp to 0 when either of the two rf signals going into the phase detector are less than a certain value (200 µV), and when the FP LED is lit it means the phase loop is open. We will start with C1 = 1 µf but suitable tie points should be provided to permit ease of change of this component. The purpose of SW_1, as in all Riedel servos is to make it easy to permit open loop measurements using auxilliary FP BNC input via a Wavetek This is the very same circuit used at Princeton, Orsay and on the high Q model and is known to perform well.

Position Servo

The purpose of the position servo is twofold. First, it permits me, (by pulling the cables to the phase detector) to manually set the position of whatever it is positioning, and secondly, to linearize the response of the mechanism capable of making a phase change so that the phase servo need only cope with it's problems. Sometimes this is called a feed forward servo.

The intrinsic diagram of a position servo is as below.



Explanation

SW2, again, is to permit easy measurement of the open loop performance of the servo, in conjunction with the auxiliary input. SW3 is for the later possible command coming from the computer (very likely). The relays and diodes necessary to limit the positions are detailed in the accompanying diagrams. I have added (not in a detailed way) outputs to the computer so that when the computer is controlling motion, it can know when a limit has been reached.

The absolute value discriminator (here there should be a pot on the board to set the level) tells the operator at the station control panel, or the computer, that the desired position has been ach ved, and switches can be activated to freeze the positions. Thus until the position of the stems has been frozen, the rf cannot be turned on "HIGH". But on "LOW" is O.K. Let me make it clear that until we have had operating experience with the dummy dee in vacuo, I wish to retain the option of positioning the dee stem shorts under phase and position servo control.

A Note on Switches and Knobs

Some people are worried that strangers, or maybe even friends, will casually twiddle in-sight knobs and flick switches indiscriminately. I say we should not worry about that. People who do that sort of thing must be eliminated from the laboratory, as there is no reasonable way to protect our equipment from that sort of thing. Besides, it is more likely that a malfunction in a switch or valve will occur and we try to build in protection from these occurrences.

For this reason I plea that the various switches and knobs be there on the front panels, for ease of initial debugging and subsequent trouble shooting.

Slaves

Slaves are supposed to do what they are told to do. However, sometimes a slave is rebellious and it is necessary to probe into the why and where. Therefore I like to make provision, by a few switches, to temporarily make the slave free and thus find out how it operates independently. Thus I would like to see the slave position servo differ from its master only in that instead of an input from the phase servo, the input is from the follow pot of the master; and by switching to "open loop" I can investigate its behavior.

Now whether the slave unit is in the phase + position servo module, or two slave units are in a separate module is for W. Johnson to decide, based on front and back panel space availability.

I imagine this reads more like a horror story than a sexy novel. In any case, Spring is here and I must go and attend my garden in Arkansas. And my new beer needs bottling.