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HYSPEC MEMO NO. 12

National Radio Astronomy Observatory
Tucson, Arizona

January 28, 1987

MEMORANDUM

To: Hybrid Spectrometer Group

From: Andrew Dowd and Bob Freund

Subject: Hybrid Spectrometer Meeting

The intent of this report is to summarize the results of a meeting which was held in Tucson to update the progress of the Hybrid-Spectrometer. The meeting was held on Monday, January 12, 1987. The participants were: Dr. Darrel Emerson, John Payne Robert Freund, and Andrew Dowd.

The following is a brief summary of the information presented in the meeting. Addenda refer to information that was not presented in the meetings, but is relevant to the discussed topic.

I. FILTER MODULES:

A. Test Module - Postponed until completion of individual board changes have been completed.

B. Filter board - The filters for the full system implementation were ordered in December by Robert Freund. Delivery is expected June 1, 1987. The ordered filters incorporate the necessary modifications to allow connection to the PC board without conductive epoxy.

Addendum - In the end of January, Andrew will order the other components that will be required to construct the filter board.

C. Mixer Board - For the sake of expediency, attempt to provide image rejection for broad-band operation will be abandoned. Instead the modules will be tweaked for a fixed frequency range.

Addendum - Consequently, next week Andrew will start working on the steps necessary to constructing the 36 modules needed for the final system. First orders will be made on

long lead time components, which are not going to be changed. Also, modifications will made to the circuit board to reflect changes. Several of these modified printed circuit boards will be ordered and connected to verify performance, then the full system count will be ordered along with the new components.

Addendum - The changes that are planned for the modified mixer board will be presented for comment. The power splitter designated PSC 2-4 will be changed to a more phase accurate splitter. (ie.: Olketron FP-HJ-302G). SMB connectors will be used for internal wiring of IF signal connections.

D. Gated ALC board - The modifications in the ALC circuit board have been pushed ahead to the end of January.

II. DATABASE: A database of components in the filter modules has been built in Lotus 123. The database will be expanded and used in purchasing of the parts.

III. SOFTWARE DEVELOPMENT: The software necessary to accommodate the multitude of operating modes is being developed for the PC. This software will be written in "C". This change to "C" will allow the potentially volatile interface to the control computer to be written in high level language. This will aid in future maintenance.

IV. SYSTEM TESTING: System testing was summarized in the last Hybrid Spectrometer Memo #11. Suggestions for future testing are always welcome -- especially in reference to the clock stability question.

Addendum - Possible Calibration of the Power Conversion - The last Hybrid Spectrometer Memo #11 indicated some trouble with non-linearity in the power conversion system. As a possible solution to this problem, a method of calibrating this non-linearity will be presented. This technique was the result of several conversations with James Lamb and Bob Freund. The point of this technique is to create a model of the power conversion curve and use that curve to correct, in software, the measurements of power. The conversion curve, input power vs. power counts(vf), will be created with a calibration cycle that will be run before an observation.

This will require additional hardware in the IF to implement the noise sources for this special calibration. The following figure shows the necessary hardware.

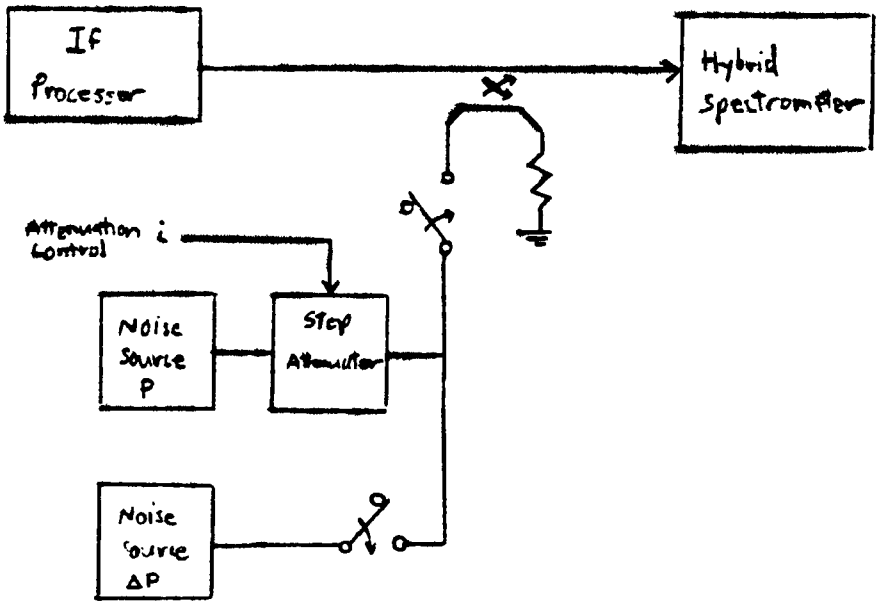

Figure #1 Calibration Noise Sources in IF Processor

This technique will create a calibration curve by measuring the slope of the power conversion (power in vs. power counts) at several points on the curve. Also the y-intercept will be measured absolutely. (See Figure #3) This data will be used to fit a polynomial and create a correction equation. The sequence of calibration will be:

1. Set attenuators to maximum and read the resulting power count (y-intercept).

2. Step the attenuator to increase the absolute noise power.

3. Switch the small incremental noise source in and read power.

4. Switch the small incremental noise source out and read power.

5. Use the results of steps 3,4 to create an approximation of slope, ie. dC/dp.

6. Repeat 2-5 for many values of absolute noise power.

7. Use the resulting slopes and Y-intercept to fit a correction polynomial.

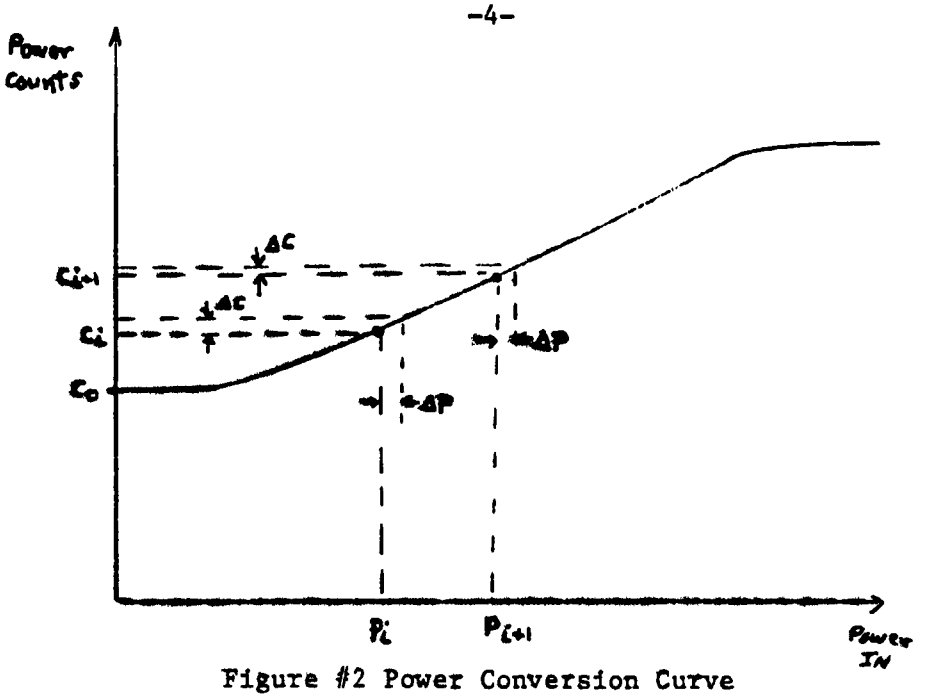

Figure #2 Power Conversion Curve

The advantage of this technique is that the accuracy of the power steps is not very important to the resulting conversion accuracy. The incremental increase must be accurate, which is easier to implement.

Addendum - Maximum resolution with two IF channels - The Hybrid Spectrometer has one limitation that makes it fall short of the Filter bank. This short coming is in the minimum resolution mode with 2 IF channels. The filter bank is able to cover two IF channels with 128 points each with a resolution of 30 Khz (approximate). The Hybrid Spectrometer is limited to 768 points each channel with a resolution of 49 Khz. Therefore it will be necessary to maintain some filter bank capability, even after the Hybrid-Spectrometer has been installed and validated.

This possible complication can be removed with a fairly cheap and simple piece of hardware that will exchange bandwidth for resolution on the Hybrid-Spectrometer. The limiting factor in any simple modification is the sampling frequency of the correlator, (100Mhz), which limits bandwidth to a minimum of 50 Mhz bands without radical modifications to the digital hardware. Therefore the proposed modification will use the digital hardware as built, but require an additional IF filter module. This special filter module will combine two IF signals with bandwidths of 25 Mhz into a single 50 Mhz signal for processing by the correlator as a single filter channel. The resulting spectra will have 2048 points over the 50 Mhz band. The two IF channels can be extracted from the single spectra that is created. Some points will be dumped to give about 700 points for each IF channel, with a resolution of 24 Khz.

The following is a sketch of the proposed special filter module that would be required.

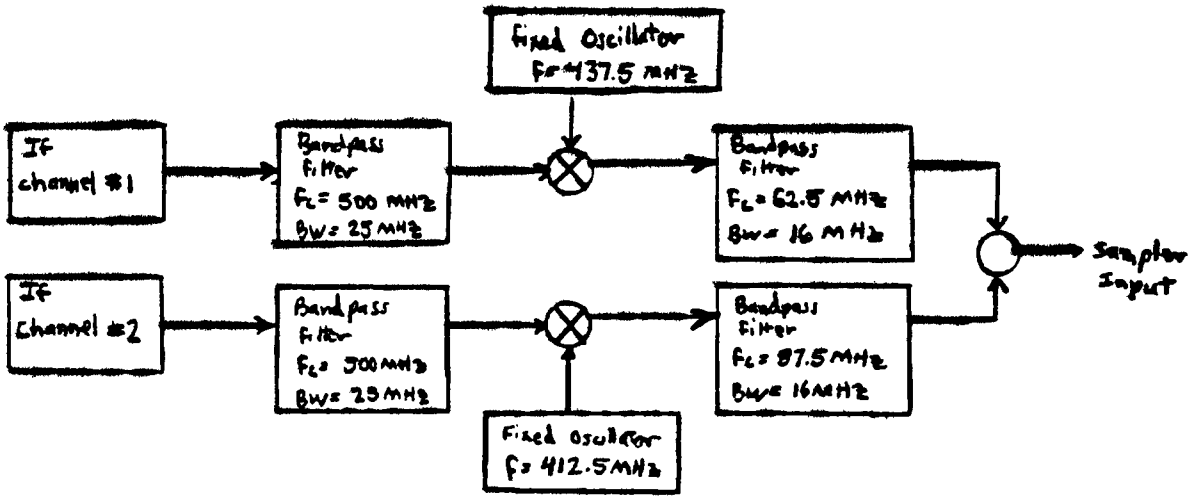

Figure #3 - 24Khz resolution filter module for 2 IF channels

V. IF PROCESSOR:

A. In an attempt to supply an IF processor system with eight (8) channels for use with the eight-feed 230 GHz receiver as soon as possible, it has been necessary to revise our planning. The present approach outlines a two stage design. The first stage is an interim step, replacing the wide-band YIG based frequency synthesizer with a commercial fixed frequency phase locked signal source. The final step is the design and installation of the full featured remote controlled frequency synthesizer.

B. The wideband input amplifier has been purchased. Delivery is expected in early February. This amplifier determines the present frequency response of the IF processor (0.5 GHz to 6 GHz). Quotes have been received for the two different mixers. Request for quotes for the LO chain power amplifiers, signal amplifiers, and the two single frequency phase locked signal sources (10.4 GHZ and 11.4 GHZ) are due by mid-February. Quotes for the remaining microwave components are arriving slowly.

C. The design, implementation, and installation of the wide-band YIG based frequency synthesizer has been postponed until 1988.

D. The IF processor will be assembled with coaxial techniques, not microstrip.