MASSACHUSETTS INSTITUTE OF TECHNOLOGY
HAYSTACK OBSERVATORY
WESTFORD, MASSACHUSETTS 01886

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Area Code 617
692-4765

To: VLBA Data Acquisition Group

From: Alan E.E. Rogers

Subject: Extending the Baseband Bandwidth of the Baseband Converter to 16 MHz

In Memo #46, I presented some tentative circuits for the VLBA baseband converters. Since that time, I have studied the possibility of extending the maximum baseband bandwidth from 8 MHz to 16 MHz and I have been able to breadboard some of the circuits. My basic conclusion is that the designs presented in Memo #46 will not operate up to 16 MHz, but I have developed some improved designs which will work at 16 MHz bandwidth with slight degradation of the closure phase performance (to 0.2 degrees without baseline dependent software corrections). The improved designs proposed to make heavy use of the Signetics NE5539 ultra-high frequency operational amplifier (a $2.50 monolithic chip) and the Siliconix SD5002N x 4 SPDT analog switch. The NE5539 provides 30 dB open loop gain and an open loop phase shift of 100 degrees at 20 MHz so that for frequencies up to 20 MHz the closed loop performance is determined almost entirely by the external components in the feedback path. The following are some comments on my latest proposed designs:

1] SSB Mixer

NE5539 active all pass filters - takes more components than passive design, but requires only precision capacitors and resistors. If we support 16 MHz, I would recommend scaling the all-pass frequencies up by a factor of 2 from those given in Memo #50.

2] Low Pass Filters

NE5539 and CD5002N provide switched active filters. The advantage of this approach is all bandwidths can be obtained with one set of precision capacitors. The bandwidth being changed by switching precision resistors. Owing to the high component sensitivity of high Q poles, I would recommend we adopt the 8-pole Butterworth function - see Memo #48.

3] Gain Control

The circuit proposed in Memo #46 used an analog multiplier D/A converter combination to provide a digitally controlled attenuator. The AD539 multiplier performance is marginal above 8 MHz (see HF response in Figure 6b of AD catalog) and better approach may be to use the CD5002N switches to provide the digital control of resistors in an operational amplifier citcuit. A simple circuit which I have just breadboarded has a typical phase shift of 100 ps/dB. A more complex circuit in which the switch isolation is improved (by using normally closed paths to ground) is needed to meet the very stringent phase shift specification of <0.5 deg/30 dB.

4] Output Amplifier

Since the LH0032 will not provide a flat response above 8 MHz and the NE5539 has limited output drive capability, it looks like the best combination is to follow a NE5539 with a LH0033 buffer.

5] 500-1000 MHz Oscillator

A printed circuit board has been designed using ACAD2 and I hope to have a prototype ready for testing within a week.

6] Oscillator Divider

In order to meet the stringent L.O. stability specifications it looks like it may not be possible to use the low power two modulus prescalers like the MC12022 (which are not yet available anyway) and we need to use a faster version of the 11C90 ECL prescaler like the GBL 10G070-4F.

7] 4-Way Input Selector

A prototype should be available for testing soon. An isolation of >70 dB is expected from the circuit which uses relatively inexpensive mini-circuits lab components.

Overall Cost and Conclusion

The latest designs are expected to be less expensive owing to the low cost of the active filters - whose cost is expected to be about $200 per sideband compared with original estimates of $400 per sideband. The baseband converters could support 16 MHz bandwidth without additional cost.