VLBA ACQUISITION MEMO #177

Notes on Meeting on Baseband Converters

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Oct. 18, 1989.

A teleconference to discuss problems encountered in checkout of Baseband Converter Modules was held on Oct. 18. Those participating were D. Bagri, E. Childers, R. Lacasse, R. Simon, A. Rogers, E. Schlecht, and W. Vrable.

A rather large number of problems have been encountered in bringing into operation the first two BBC's built by NRAO from the design by Haystack. As a result, checkout of these modules has so far required more than four weeks of concentrated effort for each one. Notes on these problems and proposed actions to be taken are given below.

(1) Printed circuit boards. Problems include traces that are very closely spaced making it easy to make solder bridges, pads of small size that tend to separate from the board if components have to be changed to adjust critical values, and traces close to mounting screws that require insulating washers to avoid shorts to ground. Also there are components and jumper connections on the back side of the boards that are easily overlooked. E.S. and R.S. will identify problem areas on the boards and improve the board layouts as is feasible before the next build. If any changes are made to traces for which the stray capacitance is critical, compensating changes in component values may be required. Boards already constructed will be carefully examined for possible problems before checkout. E.S. has found that resistor values chosen to optimize frequency response tend to be lower than those used by A.R. in the Haystack build. The dielectric constants of the boards may be different, and an NRAO board is being sent to Haystack to be investigated.

(2) Components with critical values. A number of resistors and capacitors in the mixer and baseband filter sections require values correct to 1% or 2%. For most of these resistors 1% components have been used, but capacitor tolerances have been in the 5-20% range. E.S. will identify these components on the circuit diagrams and the capacitors will be reordered with 2% tolerances. Boards already built will be retrofitted before units are checked out, and all future construction will use the higher tolerances. In addition there are two resistors and one capacitor in each baseband filter board for which the values must be chosen to adjust the measured frequency responses. These will also be identified on the circuit diagrams, and in future construction two short lengths of wire to act as soldering posts will be inserted in the position of each such component to facilitate changing values during the checkout operation. These wires can be removed and the resistor or capacitor soldered directly into the board when the value is finally selected. In the mixer unit some resistors or capacitors usually have to be added to trim the amplitudes and phases of the mixer responses to obtain the necessary sideband separation. These are added to the trace side of the board in parallel with other components and no change to this procedure is presently envisaged.

(3) MOSFET switch chip, SD5002N. This is used to select the resistor and capacitor values that determine the bandwidths of the baseband filters. There are 22 such chips on each baseband filter board (i.e. 44 per module), and

about 10-20% of these have been found to be defective at checkout and have had to be replaced. The defective ones showed either drain-to-source impedance of a few tens of ohms, or a low impedance on the gate. It is not clear what caused these chips to blow. Electrostatic charges or ungrounded soldering irons are possibilities. Better precautions will be taken in future, and advice of the Ivy Road group, who have experience with electrically fragile chips, will be sought. A.R. noted that no special precautions were used for the units constructed at Haystack, and no problems were found.

(4) Mixer units. The printed circuit boards of these units should be modified so that all components (other than the trimming components mentioned above) are on the same side. The image-rejection specification is now reduced from 26 dB to 23 dB. Major factors in getting good image rejection have been found to be use of 2% capacitors and mixers with matched characteristics. A.R. is looking into ways of selecting well matched pairs of mixers before these are inserted into the board. LMX-149 may be a better choice of mixer than LMX-113 which is currently used: both of these are made by Minicircuits Inc. Soldering the mixer case to the ground plane may be helpful.

(5) Submodule testing. The mixer, baseband filter and square-law detector submodules should be adjusted and calibrated before being put into the modules. A working BBC module can be used as a test unit for the baseband filter units, the monitor and control lines for the module being interfaced with a p.c. using software developed by E.S. Test setups for the other two units will be investigated and recommendations made. Test setups should be available both in Charlottesville and Green Bank. The local oscillator is another candidate for submodule testing, but this is less important than for the other three units.

(6) Miscellaneous suggestions.

A.R. suggests use of solder wick rather than a solder sucker when changing components to prevent damage to traces.

In some cases where pad spacing is narrower than component leads, the required bends in the leads have resulted in contact with the ground plane. These cases should be checked by inspection when boards are constructed.

It is agreed that all square-law detector units should be calibrated at 10 MHz which is appropriate for their use in the BBC modules. The calibration will be off by one or two decibels for those detectors used in the IFD's, but this is not important.

AD5539, made by Analog Devices, has slightly better specs than NE5539, made by Signetics, and may be better for the baseband amplifiers for which NE5539 is currently used. R.S. will order some AD5539's to try out.

(7) Implementation of changes. We should start to implement the changes described as soon as possible. Procurement of 2% capacitors will probably be a limiting factor. I would hope that in about six to eight weeks, and two or three BBC's further down the line, we shall find checkout reduced to no more than one per module. If this is not the case, some more drastic modifications may be needed.

Addendum

A.E.E. Rogers, 26 October 1989

The reason for the compensation resistor values on the NRAO filter boards was found to be due to a lossy capacitor. One of the filter section capacitors (1000 pf on A = 2.56 section) used by NRAO, was a lossy ($Q \approx 10$) type (not the "J" value specified). When replaced with a CoG "J" type, the compensation resistor value was close to the range used in the BBCs built at Haystack. Perhaps a Q test should also be performed on the critical capacitors in the SSB mixers and active filter.. There was no evidence for differences in stray capacitance between the NRAO and Haystack boards.