VLBA Electronics Memo No. 125

# BASEBAND CONVERTER IMAGE REJECTION IMPROVEMENTS

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Various methods of meeting the 26dB image rejection specification have been discussed in previous VLBA acquisition memos (#162,#199,#213,#215).

A number of changes have been made to the SSB mixer since these memos were written that have made achievement of the original specification more practical. Among these, a change in P.C. board material from G-10 to Duroid, a 'matching' low pass network on the mixer 'I' port outputs (consisting of a 50 ohm chip resistor in series and a 10 pf chip capacitor to ground), and subtle changes to the stripline layout.

The careful matching of mixer pairs using the test fixture is of primary importance in achieving the necessary image rejection (see figure 1). Matching of mixers to within+/-.1 dB of amplitude @ 550 Mhz,750 Mhz, and 950 Mhz, and to within +/-1 degree of phase error at these frequencies will yield SSB mixers of a more predictable nature.

-NOTE- The gain and phase measurements are performed on an H.P. 3575A gain phase meter, with an R.F. input level of -10 dBm, an L.O. input level of +10 dBm and an offset frequency of 1 Mhz..

## -NOTES ON TUNING UP MIXERS-

After SSB mixer submodule construction is complete perform an initial 'bench' test to determine the accuracy of each All Pass stage's phase shift and gain. A test set up is shown in figure #2. Each stage should have a 90 degree phase shift at the pole frequency, and the gain of each stage should be unity except for the first stage out of each mixer which each have 6dB of gain. -NOTE- Before submodule construction it is necessary to match the200 ohm gain resistors of each unity gain stage to within +/-1 ohm.

- During final module testing a number of steps are required to meet the 26dB specification-

1] -AMPLITUDE MATCHING- A 5000 ohm cermet potentiometer set at midscale is used to determine if there is a significant amplitude imbalance at the output of one of the mixers.

This can be done by first offsetting the L.O. and the R.F. by 100Khz and observing the final output of the BBC's upper and lower sidebands on an oscilloscope. To achieve an easily observable amplitude, use the test program to set the module gain on automatic ( mode 1 on the Initial Test screen). Before checking the mixer amplitude match, make sure to set the gain back to manual (mode 0). Once this is done, place the potentiometer on each mixer's 'I' port output (from the 50 ohm resistor to ground), and watch the o'scope for an attenuation of the unwanted 'image'. After the imbalanced mixer is discovered, solder the potentiometer in place and adjust for the best response. This adjustment is initially performed at 550 Mhz., but may have to be performed again at a higher frequency to achieve the proper rejection across the entire bandwidth.

2] -GROUNDING-

It has been determined that soldering the mixer and the hybrid's cases to the P.C. board ground plane does not necessarily contribute to the attainment of the specified image rejection of the mixer, but selectively grounding the mixers and hybrid cases together and to ground can achieve results. This is done by first looking at the image rejection at 950 Mhz on an oscilloscope as previously described and using a small screwdriver to connect the corner of the hybrid case first to one mixer case, and then to the other, and watching for attenuation of the unwanted 'image' frequency.

If an improvement is noted, solder a small piece of bus wire from the case of the hybrid to the case of the mixer. Another area to check is from both mixer cases near the 'R' port to ground. This grounding technique is not going to yield equal results across the entire bandwidth, and the final result will be determined by a combination of these grounds that will vary from module to module.

3] -LOOKING FOR A PHASE IMBALANCE-

Use a tuning stick (a toothpick with copper tape on the end) to determine if a phase imbalance exists between the 'L' ports of the mixers and the 'A' and 'B' ports of the quadrature hybrid. If after touching the stripline between either of these ports an improvement is noted (perform this test at 850 Mhz), solder a small piece of copper tape on to the stripline at the offending hybrid output. Sometimes results can be improved by trimming the corner off of the other hybrid output stripline connection.

4] - IMPROVING THE TERMINATION ON THE HYBRID 'C' PORT-

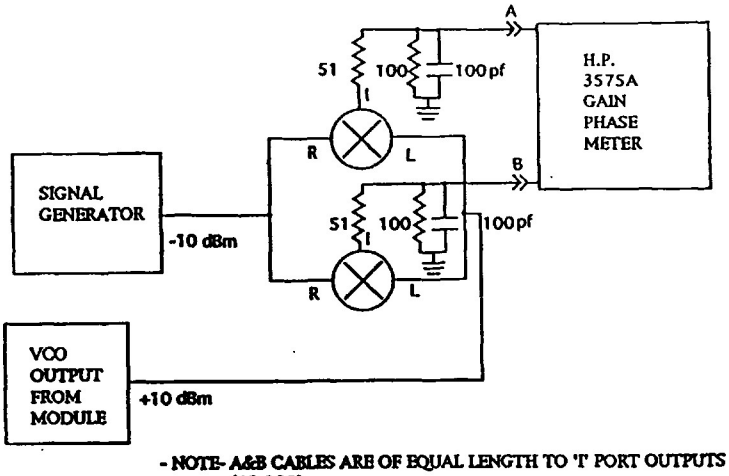
If the image rejection tends to worsen between the frequencies of 850 Mhz and 950 Mhz, change the value of the termination resistor on the hybrid 'C' port slightly. Changing the 51 ohm resistor to a 47 ohm resistor will sometimes yield results.

5] - ALL PASS STAGES

As a final step you may need to slightly vary the phase shift across some of the all pass networks if a persistent pattern emerges on the image rejection print outs from the test program (see figure 3).

This can be done by using a 20,000 ohm potentiometer and soldering it across the resistor of the offending network, adjusting for an improvement which can be seen on your oscilloscope,and then running a plot on the test program to make sure you haven't degraded the other sideband or another pole.It may be necessary to change the capacitance value of the network if decreasing the resistance doesn't have the desired effect.

FIGURE #1 MIXER TEST FIXTURE LAYOUT




- NOTE- A&B CABLES ARE OF EQUAL LENGTH TO 'T' PORT OUTPUTS (RG-188)

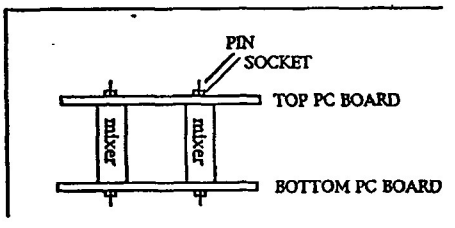



FIGURE #2- SSB MIXER BENCH TEST SET-UP

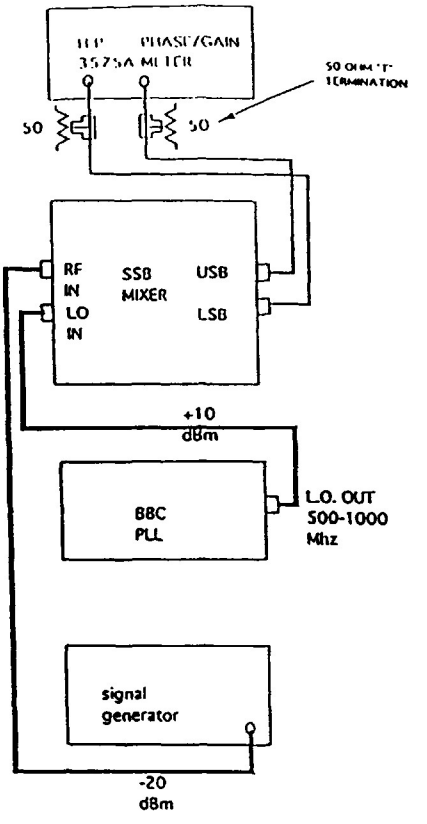



Figure #3- Mixer all-pass filter stage
66.3 Khz 'pole'