National radio Astronomy Observatory
Socorro, NM

VLA ELECTRONICS MEMO. 221

An inexpensive alternative to independent fringe rotation for phasing all four IFs

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1993Mar18

ABSTRACT

This memo describes an inexpensive ($10-15K plus labor) alternative to independent fringe rotation for simultaneous phasing of all four IFs.

INTRODUCTION

There has been a proposal to implement independent fringe rotation for all four IFs (IFs A, B, C, and D) by having independent Fringe Generator (L7) and 2-4 GHz Synthesizer (L6) modules for each of the four IFs. This requires adding two sets of L7 and L6 modules to the existing hardware. Independent fringe rotation for each of the four IFs will allow real time simultaneous observations at four independent frequencies in a band (or LP or LP4 bands). This may allow some special spectral line or frequency synthesis observations, but more importantly it will allow phasing all four IFs simultaneously. This will double the phased array bandwidth of the VLA for pulsar and (phased array) VLBI work, and allow simultaneous dual frequency (either within a band or LP or 4P bands) polarization observations of pulsars. It seems that most important advantage of the independent fringe rotation for all four IFs is to enable phasing the array simultaneously in all four IFs. Adding two more sets of L6 and L7 modules (to allow phasing all four IFs simultaneously) requires funds of the tune of $400K (from RE Budget) plus labor, and therefore it has not been possible to do so for the want of resources. This capability has very low priority at this time. As a result, at present VLA can only be used in phased array mode with two of the four IFs.

PHASE SHIFTERS IN LO PATHS FOR PHASING IFs

It seems to me that we should be able to add phase shifters in the path of local oscillator signals to various antennas for a small cost of the independent fringe rotation, and the phase shifters are needed for only two of the four IFs. Then the existing (two sets of) L6 and L7 modules can be used to phase the two IFs which donot have phase shifters, and the other two IFs (with the phase shifters) can be phased using the phase shifters. This way all four IFs can be phased. For phasing the array these phase shifters have to be under computer control, but otherwise they can be fairly simple. The requirements of phasing the array put very modest demands on the specifications for the phase shifters (i.e. insertion loss and its variations, accuracy of phase shift introduced, etc.). The phase shifters can be put in the LO signal paths for (two of) the IFs in the vertex room (i.e. in the path of the 300 MHz LO for IF A, etc.), or in the D-rack in the path of the Fluke signals (used for converting the signal to baseband). If the phase shifters are put in the Fluke signal paths, then they will need to have more than 50 MHz bandwidth, but

if they are introduced in the LO signals in the vertex room, then they can be fairly narrow band and can be built using very simple design, i.e. coaxial cables or some other form of transmission lines which can be switched in or out by using diode switches to control the phase shift. Also the image reject mixers in the D-rack are probably more sensitive to VSWR in the LO path then the mixers in the vertex room. From these considerations it may be desirable to introduce phase shifters in the path of the LO signals (300 MHz for IF A, etc.) in the vertex room. A very rough cost estimate for installing such phase shifters is $\approx$ \$10-15K, plus labor.

CONCLUSION

This seems to be a fairly inexpensive alternative to independent fringe rotation for phasing all the four IFs simultaneously. In fact these phase shifters should also allow independent frequency tunning for all four IF signals, as long as the frequencies for any pair of rcp and lcp signals (i.e. AC or BD pair) are such that the two signals fall within the same IF passband (say 50 MHz), provided the required frequency settings for the Fluke synthesizers are within their allowable range, and provided the control system can keep up with the differential phase change commands. This capability may be useful in some special cases where there are two spectral lines seperated by $\lesssim$ 50 MHz, and/or a user wishes to observe in two opposite polarizations with different bandwidths/resolutions simultaneously while observing with second pair of IFs at some other frequency.