VLBP Memo Number 13

To: VLBP Project Group

From: R.C.Walker, J.Benson, W.D.Cotton

Subject: Project Goals

This memo presents the current views of the VLB scientists in the group (except KIK) on design goals for the processor and on areas that need investigation. None of this should be taken as sacred; for the first several months of the study, we should be open to all ideas and suggestions. It should also be remembered that the ideas presented here are from people who understand the science and the software, but who know little about hardware.

1. Our primary goal should be to build a multi-station (five to start), wide bandwidth (probably Mark III) VLBI processor dedicated to astronomy. We should try to have something that represents an improvement on the current processor in 1984.

2. The design should be such that it could be expanded easily to the size of the VLB Array processor (10-14 stations).

3. The design should be as independent of the recording medium as possible. Specifically, it should be capable of processing Mark II and Mark III tapes and should be able to use wide bandwidth recordings when they become available.

4. The design should allow production of a multi-station, Mark II processor with a low level of funding. This is to guarantee a useful product in case funding for the Mark III processor is not available. (Are we being too timid?)

5. The processor should be capable of correlating spectral line observations. This will require 512 spectral channels (1024 complex lags, 2024 accumulators) per baseline in an 8 Mhz (16 Mbit) bandwidth (eg. 4 Mark III tracks). It will also require 512 real autocorrelation lags (512 accumulators) per station.

6. The processor should provide full Stokes parameters for data recorded with half the available bandwidth in each polarization (eg. for Mark III, 14 tracks R, 14 tracks L; for Mark II, two recorders, one R and one L - correlate RR,LL,RL,LR). The correlation functions should cover a range of at least 2 microsec (8 lags for 2 Mhz (4 Mbit) tracks) in order to allow for clock drifts.

7. The processor should be able to play Mark III tapes at the 8 Mbit rate in order to keep up with full time observations with an eventual VLB Array. If the tapes are recorded at 8 Mbit, a total

delay range of 1 microsecond is tolerable.

Note that constraints 5, 6, and 7 are the parameters specified for the correlator in the VLB Array Design Study.

8. The processor should be flexible in the sense that many combinations of stations, tracks, and channel number can be processed.

9. When processing multi-band data (eg, the 28 Mk III channels), the fringe rotators, etc. should be independent for each band so that widely different RF frequencies can be processed at the same time.

10. It should be possible to move tapes from one station from one tape player to another without changing cables and without changing the logical position of the station in the processing setup. This greatly simplifies dealing with poor recordings and is a lesson learned on both US Mark II correlators.

11. In order to accomodate differing start times etc. the correlator should not require any particular tape to be running in order to operate.

12. We should investigate schemes that would allow the fringe rotators to be in the station modules. We (esp JB) are looking at schemes in which the data is transformed before correlation.

13. We should be watching carefully for alternatives to Mark III. The 28 tracks adds tremendously to the complexity of both the record terminals and the processor. Also the system is very expensive, especially if there are problems with the bit density increase efforts. Between 6 and 8 independent IF's are needed in an alternative system. They could conceivably be multiplexed onto a single, high frequency recording.

14. We have limited in-house geodetic expertise. We should consult with outsiders to be sure that we do not preclude geodesy in our design.

15. A known geodetic and astrometric requirement is for at least 6 to 8 separate IF bands in order to do bandwidth synthesis at two different RF frequencies.

16. All necessary hardware for calibration should be included in the design. This specifically calls for the capability of extracting phase cal tones from Mark III recordings. We should also consider methods of dealing with other desired calibrations such as system temperature measurement.

17. The program that calculates the model parameters (delays, rates, etc.) should be in a high level language (eg. FORTRAN) and written so that it can be easily understood by persons unfamiliar with the processor computer's machine code. That program should be

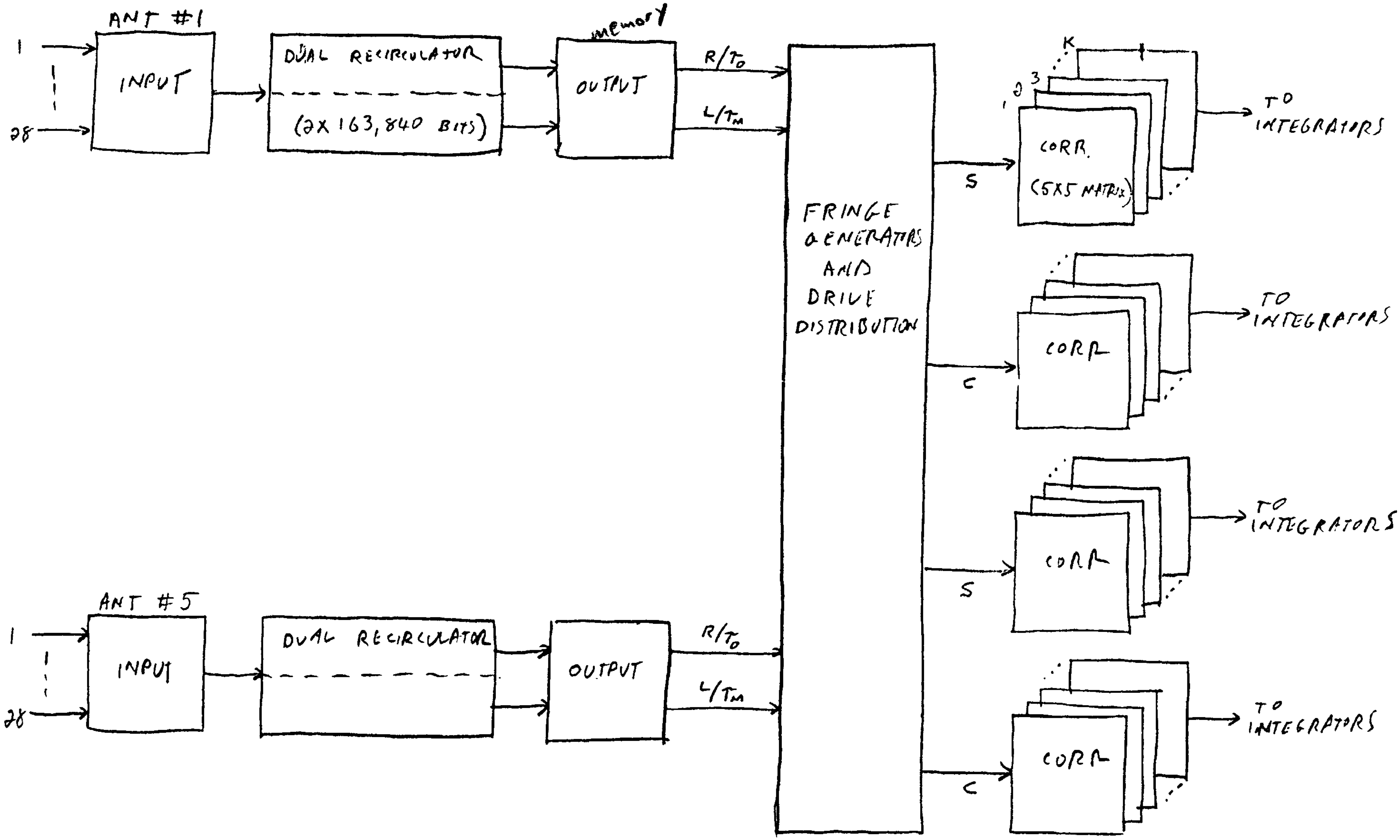
easily modified for new types of experiments. Maybe the best way to accomplish this is to have the VAX calculate the models although many modern computers could do the job.

18. As much of the data reduction as possible should be done by the correlator although the option must be retained to pass nearly raw data. For continuum observations of strong sources, the fringe fitting could be done on-line as it will be done on the JPL Block II processor. For spectral-line observations, output data should be spectra with any desired shifts applied.

19. We should start considering the nature of the post-correlation software. One consideration is the desirability to have a data base structure that would allow multi-baseline fringe searches as a matter of routine.

***** This text resides in [RCW.VLBP]MEMOA.TXT on the VAX ****

memory 10 ...



K=8 @ 128 MHZ
K=4 @ 256 MHZ

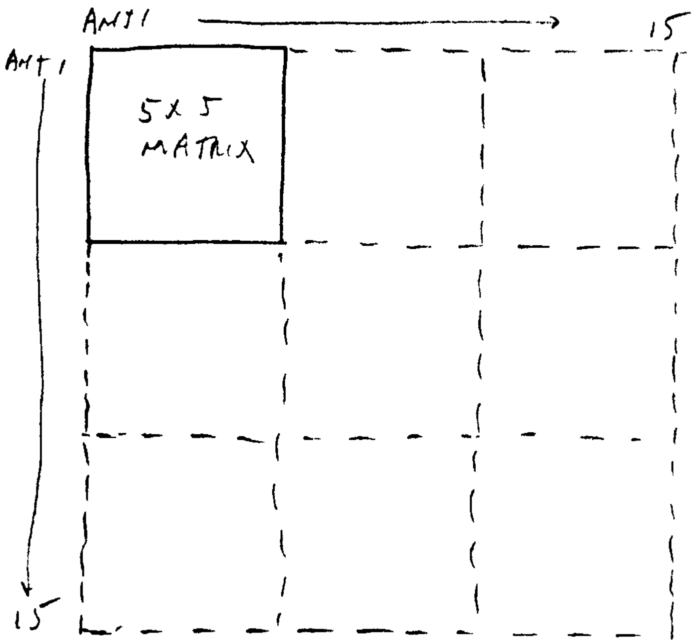
5 ANT	5 CARDS	5 CARDS	5 CARDS	7 CARDS	32 CARDS	~ 54 CARDS
15 ANT	15 CARDS	15 CARDS	15 CARDS	60 CARDS	288 CARDS	~ 390 CARDS

288 → 7200 MULTP.

Ray Conceptual design

Walker June 10 1981

EXPANSION TO 15 ANT.



(1) FRINGE ROT & CORR CARD EXPANDS AS ABOVE.

(2) INPUT, RECIRCULATOR, OUTPUT EXPAND LINEARLY

ALTINATE CONFIG.

7 X 7 MATRICES (4 NEEDED) ⇒ 14 ANT

8 X 8 MAT. (4 NEEDED) ⇒ 16 ANT

4 X 4 X 7 (8 NEEDED) ⇒ 16 ANT

7 X 1 X 4

5 X 1 X 8

MODES

① 28 INPUTS

Think about getting two processings with different stations rotated

Ⓐ 8 MHZ PLAY BACK

8 COMPLEX LEAD AND 8 COMPLEX LAGS / BASELINE

- - - Ⓑ 4 MHZ PLAY BACK

8 COMPLEX L/L PER BASELINE
+ 8 MORE WITH OPPOSITE QUAD GENERATION

② 14 INPUT PAIRS (POLARIZATION) (4 MHZ PLAYBACK)

8 COMPLEX L/L PER BASELINE OF

R*R
L*L
L*R
R*L

③ $N \leq 16$ INPUTS (SPECT LINE)

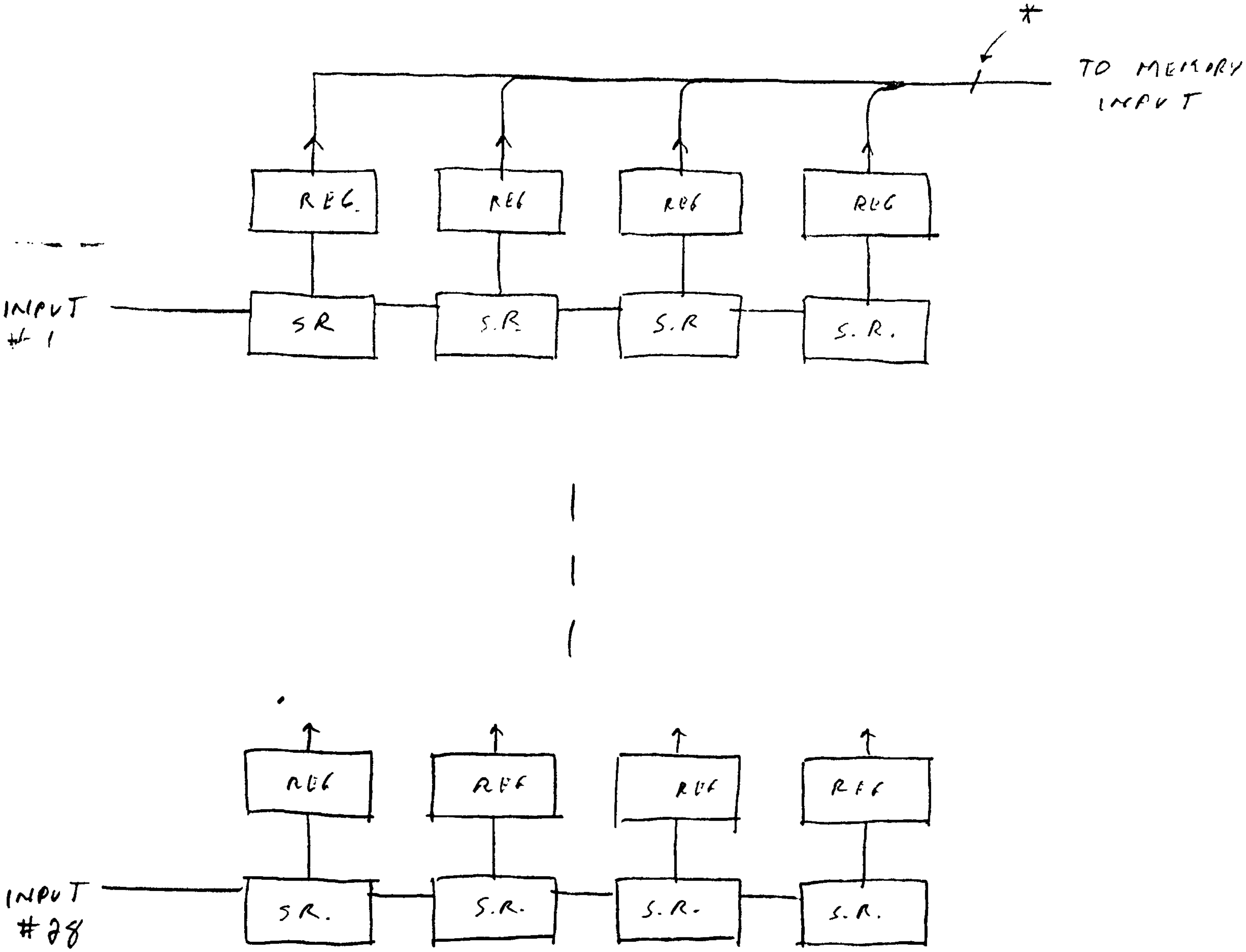
$(32/N)(16)$ COMPLEX L/L CH'S PER BASELINE

④ $N \leq 8$ INPUT PAIRS (POLARIZATION)

$(32/N)(8)$ COMPLEX L/L CH'S PER BASELINE OF

R*R
L*L
L*R
R*L

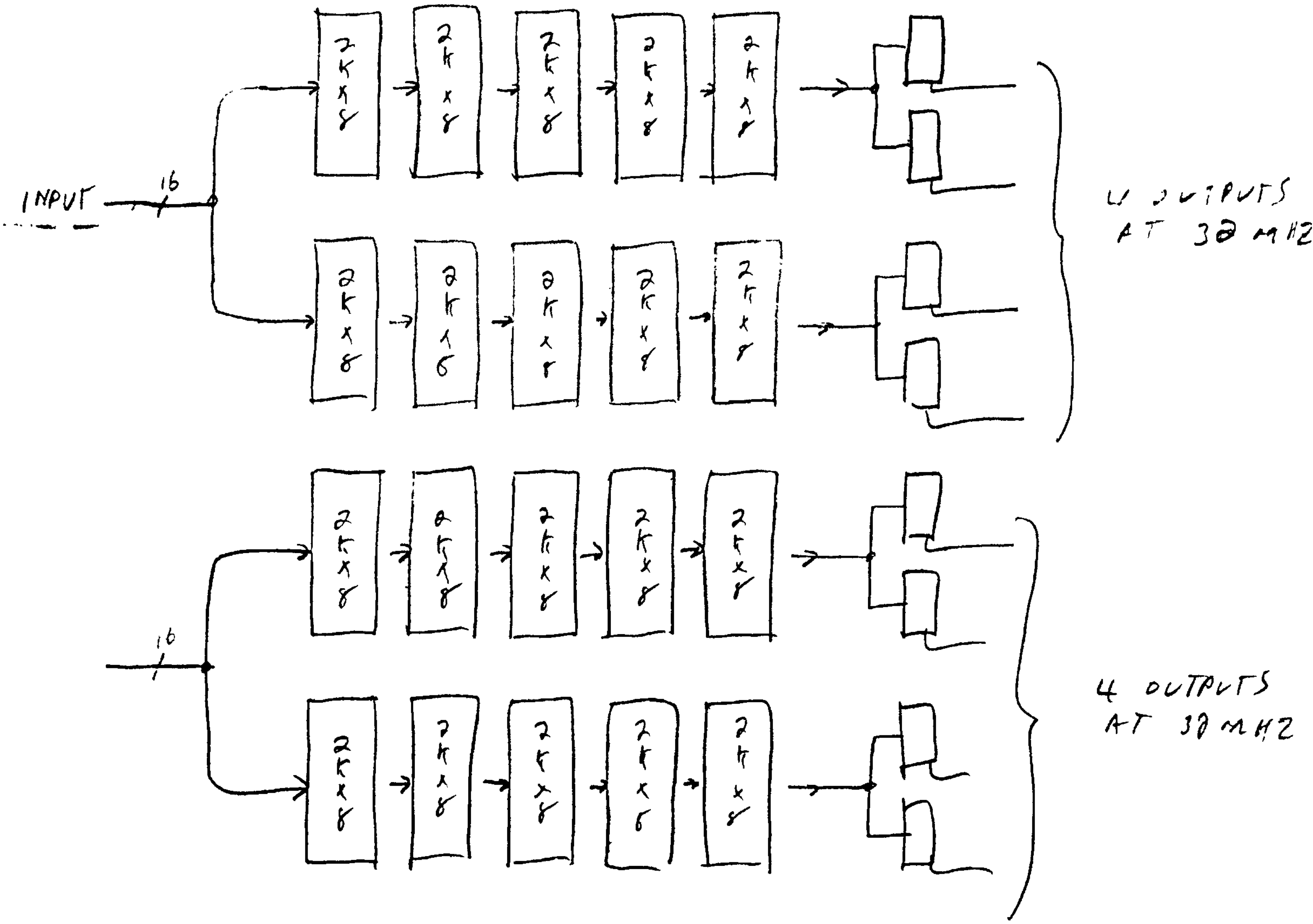
INPU TAGE



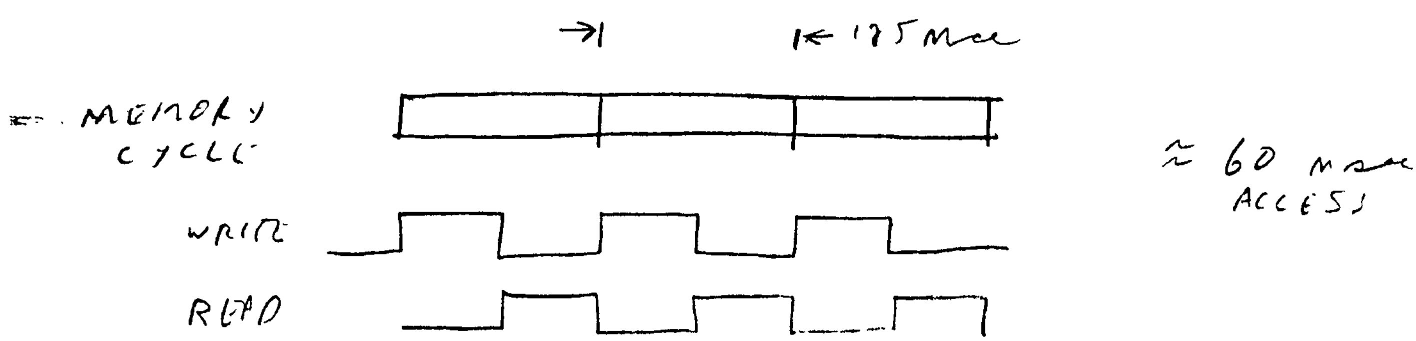
* ① 2 SETS OF 16 FOR 128 MHZ CORRELATOR
② 2 SETS OF 32 FOR 256 MHZ CORR.

① ⇒ S.R. + REG = 4 BITS
② ⇒ S.R. + REG = 8 BITS

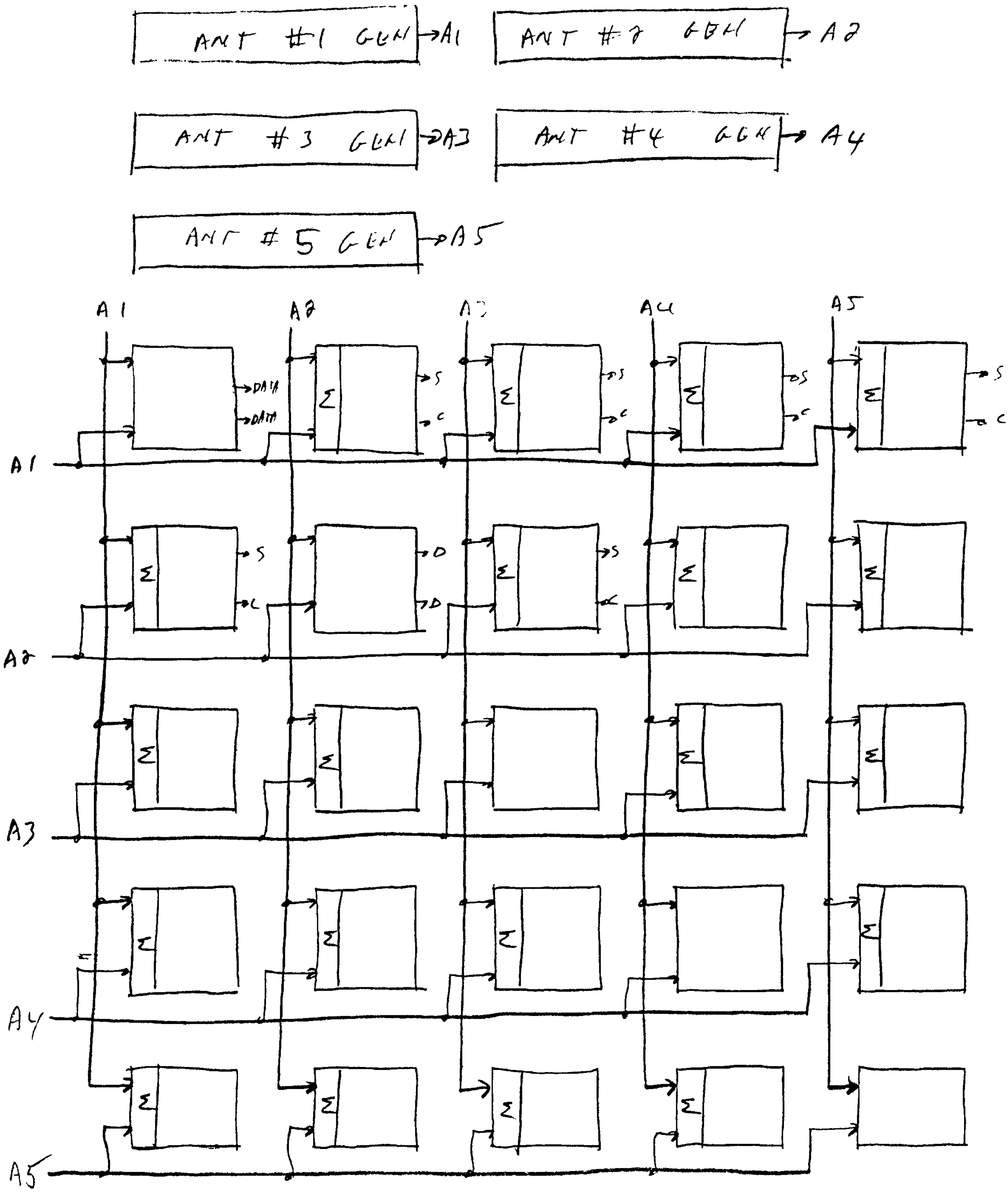
DUAL RECIRCULATOR



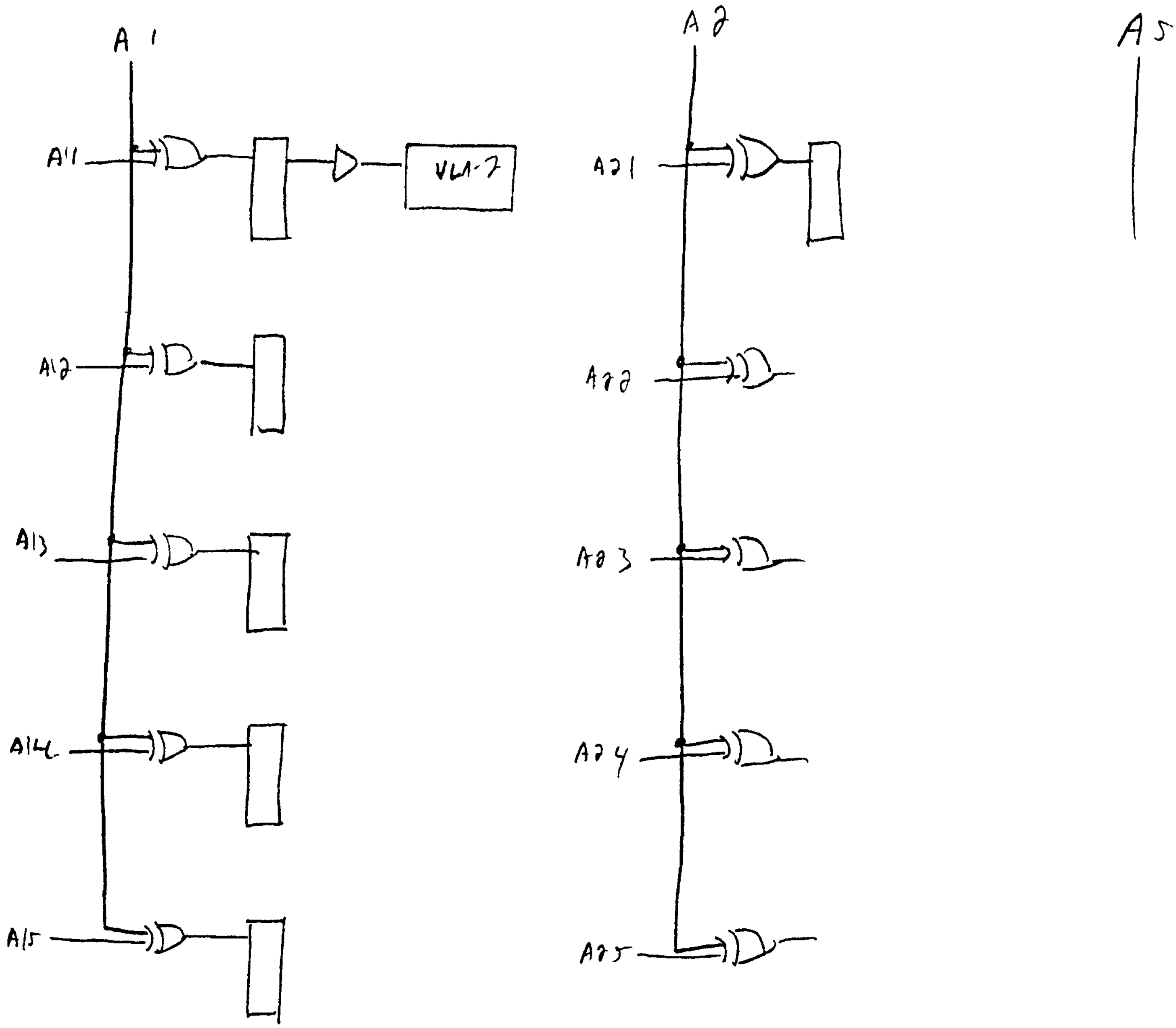
128 MHZ VERSION



FRINGE GENERATOR



CORRELATOR



A1 ... A5 ARE ANT 1→5 SIGNALS

A11 → A15
↓ ↓
A51 → A55

} ARE FRINGE GEN OUTPUTS OF ANT 1→5 SIN OR COS OUTPUTS FOR ANT 1→5 FRINGE RATES