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NATIONAL RADIO ASTRONOMY OBSERVATORY

MEMORANDUM June 1, 1966
IG 66 027

To: IG File

From: K. H. Wesseling

Subject: Interferometer Local Oscillator Distribution — Program of Activities

Type	Theory	Detailed Block Dia.	Construction
1. A possible LO distribution system for the NRAO interferometer	Manuscript of report in the process of final writing		
2. Simple phase locked loop (PLL)	Ready; report to be written	Ready	To be started now
3. Other PLL's	Detailed studies ready or to be started soon.		
4. Swarup and Yang type cable measurements	Ready, and well known	Under way	To be started soon
5. Legg - systems of cable measurements	Study to be started		
6. Phase bridges	Almost ready	Under way	To be started soon
7. Final LO system design and components evaluation		Data required	

Comments on Items

1. This report describes a non-phase-locked distribution system using frequency multipliers. It gives graphs for deriving the optimum transmission frequency from a loss point of view. An analysis of the sources of phase instability is given together with data on the obtainable stability. Finally, a number of recommendations is given on how to make a distribution system with as good as possible an intrinsic stability.

2. This is essentially the PLL as described in S. Weinreb's memorandum (dated April 15, 1966). An analysis of the circuit shows that if the loop is to be closed the compensating phase shifter has to be located in the 1300 MHz line. If this is done the system only compensates for variations in the high frequency line and not for phase shifts in mixers and amplifiers and delay variations in the 30 MHz line. Nevertheless, there is good hope that such a system will have a ± 3 degree phase stability if carefully constructed. The system may be used as a low noise LO signal generator in each of the feed box assemblies, even if not in a PLL.

3. A number of other PLL's or calibration schemes is possible. A few examples:

   a. B. G. Clark's system as described in a memo dated January 27, 1966, "Two Possible VLA Local Oscillator Distribution Systems".

   b. ITT's system as given in its Design Study Proposal in paragraph 2.5.

   c. The switched system as described by J. E. Bringe in Electronics Division Internal Report No. 53.

   d. A Swarup and Yang, or a Legg system. Theories and operational results of some of these systems are developed and known; others need a detailed analysis.

4. Swarup and Yang type cable length measurements do not depend on phase stabilities of components except for the modulated termination. The method is extensively used. Accuracies of ± 0.1° phase at 30 MHz and of ± 0.5° phase at 1600 MHz are reported. The system will be used to actually measure cable stabilities, temperature coefficients, etc., and can also be used for final system phase monitoring or phase locking by incorporating it into a servo loop.

5. A Legg system is a Swarup and Yang type of measurement but compares two cables instead of measuring one cable. The system is more complicated. Sensitivities obtained are comparable to the Swarup and Yang system.

6. In any LO system the finally obtained stability will depend on the phase stability of passive components, amplifiers, and frequency multipliers. In order to test these stabilities in a laboratory environment, phase bridges at various frequencies have to be built. Known bridges use the direct interference method or an amplitude modulation scheme. A refinement of the first mentioned method, using balanced mixers, is believed to be possible. This new method misses the sources of inaccuracy and insufficient sensitivity of the two other methods.

7. No further comment.

KHW/cjd

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