Interoffice

National Radio Astronomy Observatory

Charlottesville, Virginia

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VLB ARRAY MEMO No. 254

To: VLBA Electronics Group

From: L. D'Addario

Subject: A Possible Double-Conversion Receiver Configuration for the VLBA

The frequency conversion scheme suggested in VLBA Proposal Vol. 1 (red book) and revised in VLBA Memos #170 and #218 involves a fixed-frequency first L.O. for most of the 10 signal bands, converting to a first I.F. in the range 300-1500 MHz. This is followed by a tunable second conversion (10 MHz steps) to a second I.F. at 300-500 MHz. Finally, image-rejecting mixers convert any 32-MHz wide band within the second I.F. to baseband, with tuning in 10 kHz steps.

This scheme may be unnecessarily complex. First of all, it should not be necessary for the first I.F. to be 2½ octaves wide. Secondly, in view of the fine tuning available in the baseband converters, much coarser tuning in the second (or first) L.O. should be adequate. Detailed consideration of the frequencies involved shows that it is possible to eliminate the second L.O. ("I.F. processor") entirely. It is the purpose of this note to describe such a scheme. There are some small differences in performance compared with the existing scheme, and these need to be evaluated.

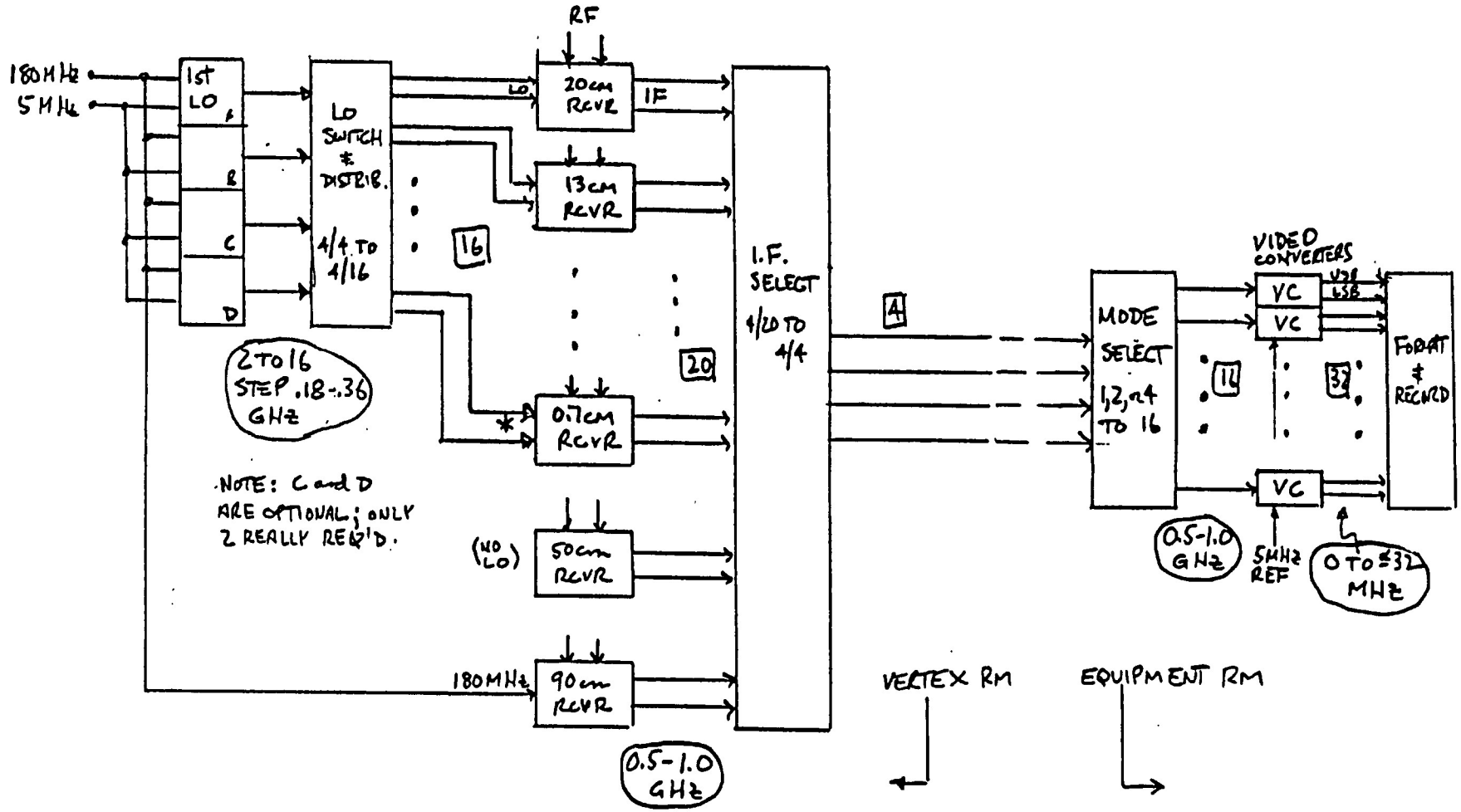
By relaxing the requirement that the first L.O. be fixed, it is possible to cover all signal bands and convert them to an I.F. of 500-1000 MHz. This can be done with at most three L.O. frequencies per band, and all of these can be multiples of 180 MHz. By reducing the I.F. bandwidth to one octave, the requirements on the amplifiers and mixers which process this signal are greatly relaxed; in fact, the multioctave scheme may be difficult to implement with standard components, since the dynamic range would be limited by second-order distortion. With a single octave (or less), only third-order distortion is important.

A preliminary study of the baseband converter design indicates that it should be possible to construct such devices for 500-1000 MHz input, 0-32 MHz output, and 10 kHz tuning steps, while achieving the same specifications and about the same cost as the 300-500 MHz input design.

A block diagram of a possible arrangement is given in Fig. 1. Although it would be possible to implement a first L.O. for each front-end separately (as has been contemplated heretofore), it is fairly easy to construct a single module which will produce any multiple of 180 MHz

from 2 to 8 GHz, and any multiple of 360 MHz from 8 to 16 GHz (see Fig. 2). This module can then provide the first L.O. for all bands except 90 cm, 50 cm, 1.3 cm, and 0.7 cm. For 90 cm, only a fixed L.O. at 360 MHz is needed; for 50 cm, no L.O. is needed; and for the highest-frequency bands, additional circuitry is required (e.g., Fig. 3). Two of the general-purpose L.O. modules would be sufficient to support four I.F. channels in the dual-band modes (two polarizations per band); in single-band modes, independent tuning of the two polarizations would be possible (however, only two front-ends - 3 cm and 2 cm - are expected to have more than 500 MHz instantaneous bandwidth).

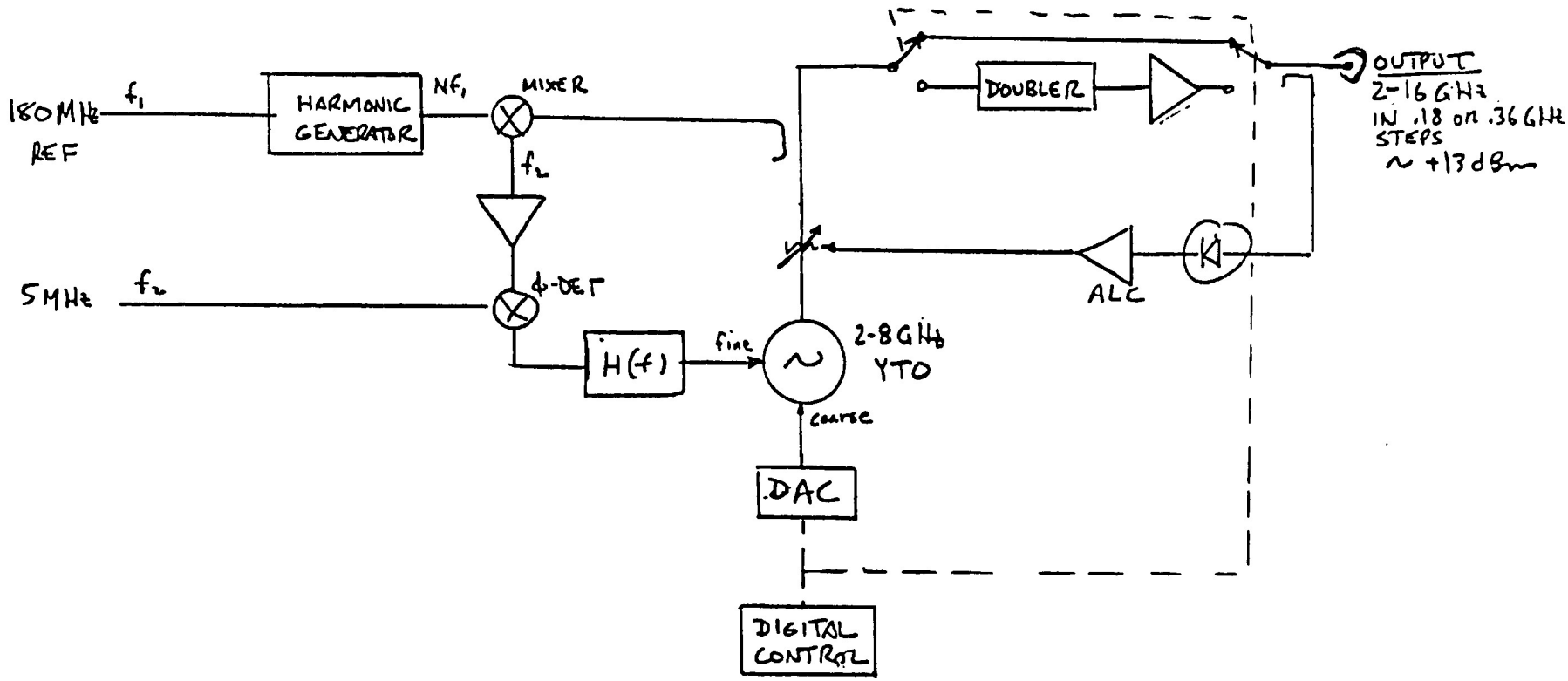
Two limitations of this scheme, compared to that of VLBA Memo #218, have become apparent so far. First, any frequency switching of less than 180 MHz would have to be done in the baseband converters. This should not be a problem unless extremely rapid switching is required. Second, it will be difficult to process more than a 500 MHz portion of any band at one time. Only two of the presently-planned front-ends have more than 500 MHz bandwidth: the 3 cm and 2 cm receivers have 1000 MHz each. With the tunable I.F. processors, two processors could be connected to the same first I.F. signal but tuned to opposite ends of the band, thus achieving larger frequency diversity but not larger total bandwidth. With the new scheme, frequency diversity for each front-end output is limited to the 500 MHz range of the baseband converters. There are ways around this limitation if it is considered important. It should be emphasized that the new scheme does not limit the total bandwidth that can be instantaneously processed; in fact, the bandwidth at the baseband converter inputs is increased from 800 MHz to 2000 MHz.



*0.7 and 1.3 cm RCVRS REQUIRE ADDITIONAL LO CIRCUITRY; SEE SEP. SHEET

VLBA SIGNAL PROCESSING
CONCEPTUAL BLOCK DIAGRAM

FIGURE 1



FIRST L.O. MODULE

FIGURE 2

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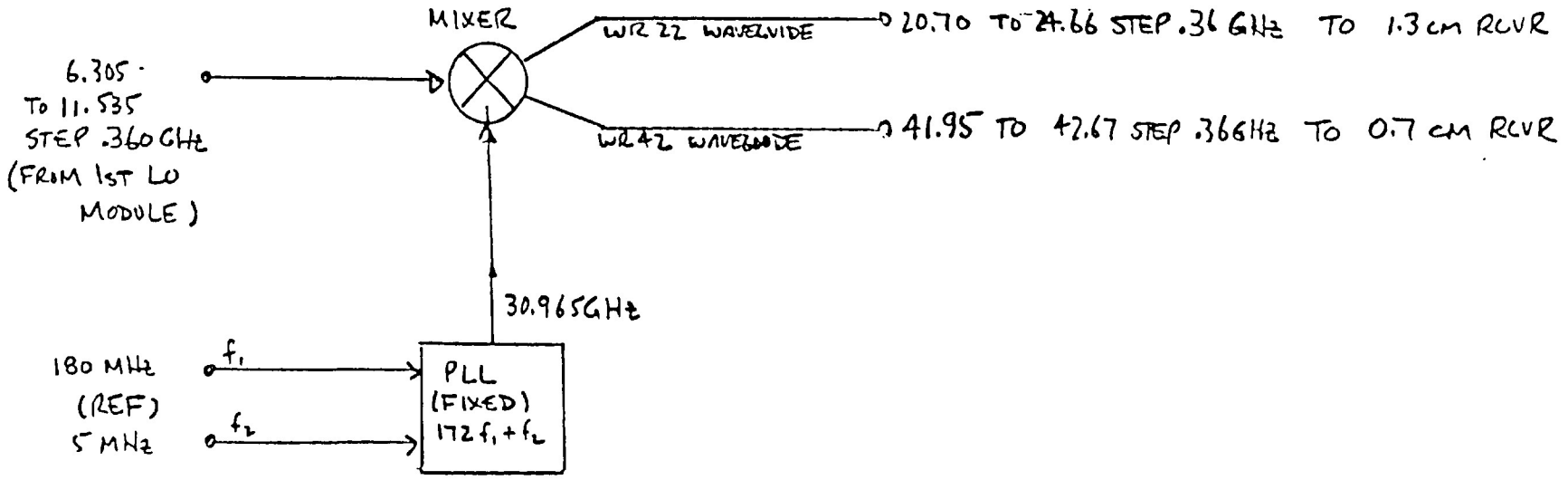

Note: This scheme may not allow generation of much power at 42GHz. Suitable for SIS mixer, however.

0.7 AND 1.3 cm LO

FIGURE 3