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To: VLBA Data Acquisition Group

From: Alan E.E. Rogers

Subject: Suggested Interfaces to the Data Acquisition System (DAS)

1] I.F. Signals (500 - 1000 MHz)

The four I.F. cables from the vertex room could terminate in a passive power divider (or active buffer amplifiers) and then proceed to each DAS. Type N connectors are suggested. Double-shielded, low-loss cable, like RG-9 (or a modern equivalent), might be a good choice. -40 dBm (at 500 MHz bandwidth) is the nominal signal level.

2] A.C. Power (110 volts)

The MkIII has a built-in battery supply to maintain power on the formatter clock. This feature has never proven to be very useful and has been difficult to maintain. At places where power glitches are common it would be beneficial to use UPS power (without UPS power, the tape may be damaged when the power fails).

3] 5 MHz

A single 5 MHz signal to each DAS (+ 13 dBm nominal on a Type N connector) is a good choice for a primary reference frequency.

4] Maser (or "station") 1 pps

A single 1 pps signal to each DAS (5 volt pulse on a 50 Ω cable with BNC connector) should be available for initial synchronization of the formatter and subsequent checking by the formatter. A checking feature is useful as a means of detecting a glitch which might occur in either clock. However once synchronized the Maser (or "station") 1 pps will not be used for any other purpose. A formatter 1 pps will be generated in the DAS and used to synchronize all other internal reference signals to the same cycle of the 5 MHz reference.

Discussion

a] Racks

If necessary, each DAS will be packaged in three racks as follows:

Rack 1: I.F. Distributor + Baseband Converters

Rack 2: Digitizers + Formatter

Rack 3: Recorder(s)

However this arrangement will require a bundle of cables between Racks 1 and 2. I would much prefer combining racks 1 and 2 (see VLBA Acquisition Memo #35). Both racks 1 and 2 will have analog electronics and both could benefit from a stable environment.

b] 1 pps

The purpose of the 1 pps is to resolve the 200 nanosecond ambiguity in the positive going zero-crossing of the 5 MHz reference. In the MkIII there is no attempt to initialize the 10 KHz reference in the baseband converters so that there are, in general, 500 possible phases of the baseband L.O.'s which are arbitrarily determined upon power-up. This deficiency should be corrected in the VLBA DAS by using the formatter 1 pps (whose +ve going transition should occur at a +ve going transition of the 5 MHz $\pm$50 nanosec) to arm the initialization of the 10 KHz reference. If the formatter 1 pps is used for this purpose rather than the "station" 1 pps, an unambiguous relation between Formatter clock, sampler clock and baseband L.O. phase can be achieved - otherwide the synchronization will depend on the relative cable lengths which connect to the DAS.

c] "Singleband" and "Multiband" Delays

In the jargon of MkIII there are two different instrumental group delays known as singleband and multiband delays. The singleband delay is the derivative of phase across each individual baseband channel. This delay depends on the group delay through the equipment, the sampler phases and any digital delays in the formatter - but is independent of baseband convertor or first L.O. phases. The multiband or bandwidth synthesis delay is the derivative of phase across the I.F. and depends on the group delay through the equipment and the baseband L.O. phases but is independent of the video delay, sampler phases and digital delays at least in a system for which all baseband channels are treated equally. In MkIII, there is no attempt to make the single and multiband delays equal although both instrumental delays are reasonably constant as long as power is sustained. MkIII uses the pulse calibrator for calibration of the multiband delay. The less precise singleband delay is not calibrated although it could be calibrated by extracting two phase cal tones in each baseband channel. In the VLBA DAS we want to make both the singleband and multiband instrumental delays constant and independent of power on/off cycles. In this way the "clock" will be continuous as long as the maser clock is continuous except for a possible synchronization ambiguity of one cycle of 200 ns. This final ambiguity could be removed by placing a requirement that the leading edge of the maser 1 pps be coincident with a +ve going transition of the 5 MHz to within ±50 nanosec. However, it should be emphasized that no matter what the phasing of the station 1 pps (which might come from a GPS receiver - not the maser) there should be no ambiguity between signals within the DAS and no need to allow for different values of singleband and multiband delay in the post-correlation software ("fringe" program). Thus, from the users point of view, there will be only one group delay. From another viewpoint the bandwidth synthesis sampling process involves a "coarse" sampling in the digitizers and a "vernier" sampling in the baseband converters. In MkIII the zero point of the coarse and vernier delays may differ. This deficiency should be eliminated in the VLBA.

d] Multiple DAS

For reasons of redundancy and module expansion, we have proposed (see Acquisition Memo #42) that there be 2 DAS at each antenna as shown in the attached figure. Since all cycle ambiguities are resolved in each DAS to instrumental delays in each DAS would be the same provided:

1] 1 pps be coincident with 5 MHz transition - see c] above.

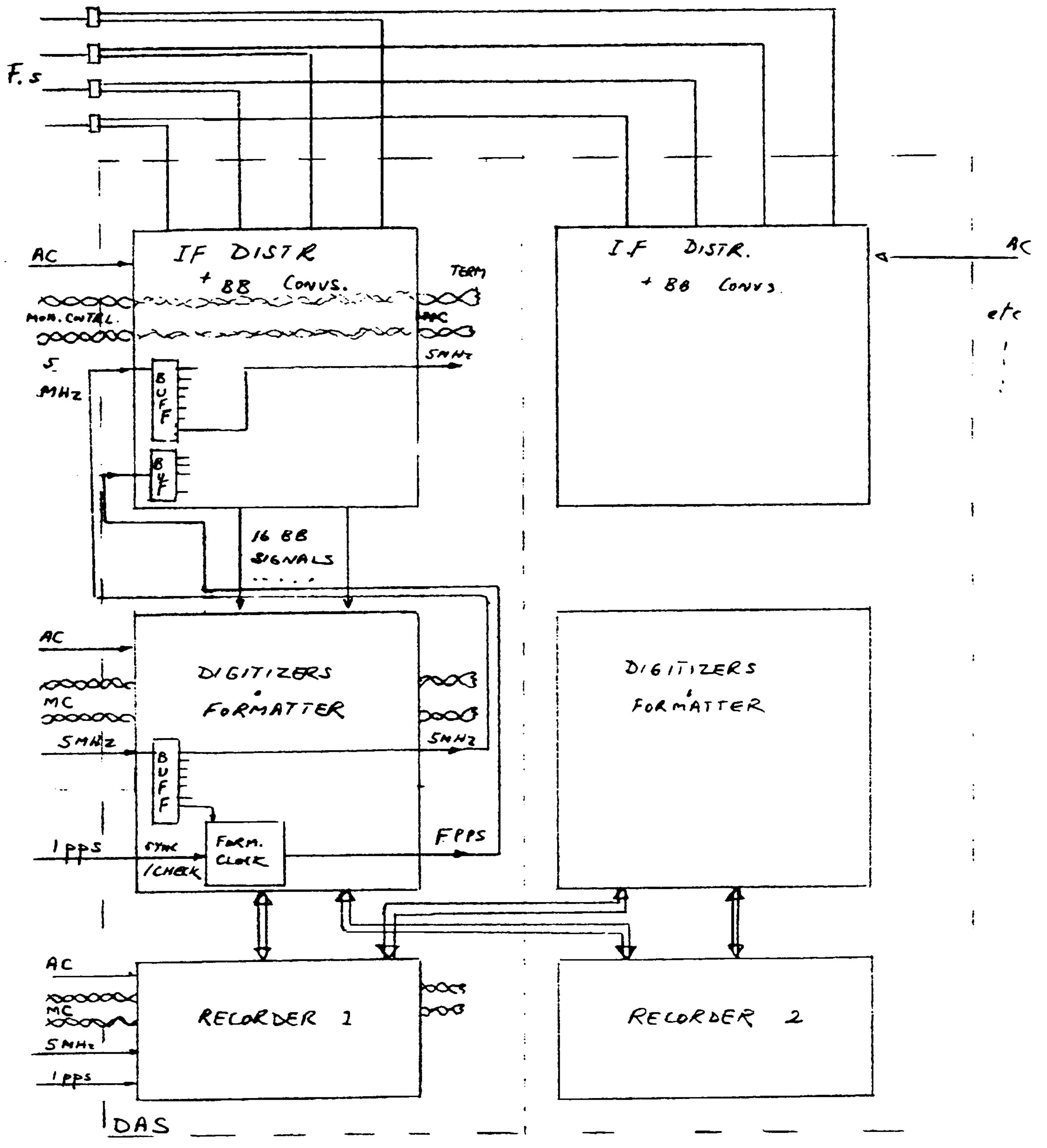
2] 5 MHz phases going to each DAS are the same.

3] IF cable lengths to each DAS are the same.

e] Reference Generator Module

The DAS needs a number of different frequencies - like 10 KHz for the baseband converter synthesizer, 32 MHz divided by 1, 2, 4,--8, etc., for the sampler and 20 Hz for the total power integration and AGC. These frequencies need to be derived and buffered for use in many places.

The relative phasing of these signals should be initialized so that all signals have +ve going transition coincident with the formatter 1 pps and a +ve transition of the 5 MHz. This reference generator is probably best placed in a separate module with a separate monitor/control interface. It might be best to make the "20 Hz" frequency programmable rather than a hard wired 20 Hz.



Notes: 1] Each rack accepts AC, MC, 5MHz & 1PPS
2] In order to make "single"- and multi-band delays equal cables between BB conv. & Formatter racks have to be of fixed length and BB conv. rack should get 5MHz & 1PPS from the Formatter rack (FPPS = Formatter 1pps output)

STATION INTERFACES TO DAS

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