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To: Mark 5 Development Group
 From: A.E.E. Rogers
 Subject: Proposed phase calibration scheme

1] Block Diagram

Figure 1 shows a proposed phase/delay calibration scheme for the geodetic VLBI system using DBEs. The 5 or 10 MHz from the frequency/time standard is taken from the control room to a pulse generator module placed at the output of the LNA. It should be located as close to the dewar as possible. The pulses define the phase and delay (to within a 100 ns ambiguity for 10 MHz). The epoch of these pulses relative to the positive zero crossing in the control room is given by

$$\tau_{cable} - \tau_{LNA} - \tau_{feed} - \tau_{ant}$$

where τ_{cable} = delay through phase cal. Cable
 τ_{LNA} = delay through LNA
 τ_{feed} = delay through Feed
 τ_{ant} = delay through antenna

This scheme calibrates everything following the injection point.

2] Expected temperature coefficient

If the cable is an LMR type or phase compensated the temperature coefficient should be under 10 ppm/K (compared with ~130 ppm for an RG-9 equivalent cable). If 10 meters of this cable is exposed to significant temperature changes the stability should be under 0.3 ps/K. Typical cable change with a 360° wrap on 4 inch radius is under 1 ps.

The ADCMP572 has a specified stability of less than 0.5 ps/K.

3] Power output

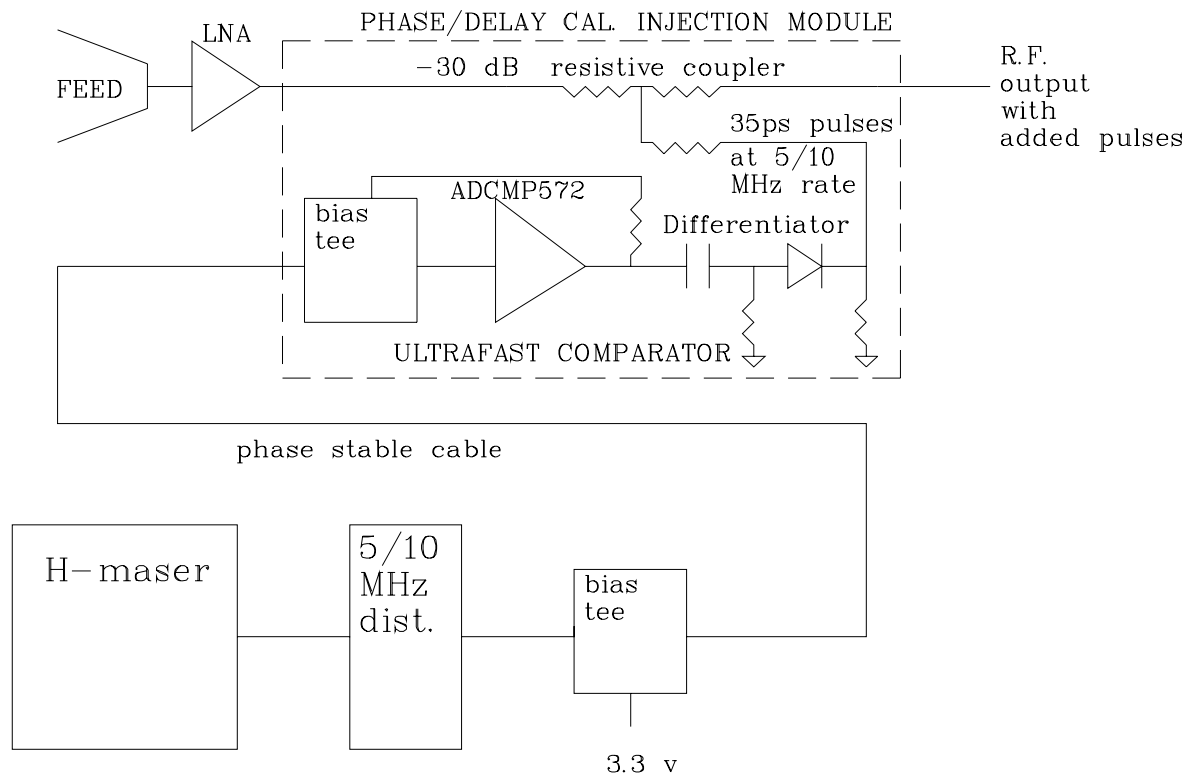
If the pulse output rate is 5 MHz, the pulse width 35 ps, and the pulse height 1 volt the signal strength is expected to be about -68 dBm/MHz prior to the coupling loss. If the LNA gain is 40 dB the calibrator total power strength referred to the LNA input would be about 10³ K so we can afford a coupling of about -30 dB to bring the calibrator strength down to 1 K.

Proposed calibrator specifications:

Pulse width	< 30 ps
Pulse rate	5 or 10 MHz
Temperature coefficient (including 30 m cable)	< 1 ps/K
Peak pulse power (assuming -30 dB coupling)	> -20 dBm
Rejection of negative pulses	> 20 dB

References:

- 1] ADCMP572 data sheet
- 2] "Frequency dependency of Phase stability of RF cables" Hejc et al. IEEE 2007
- 3] "Phase stable cables" www.iw-microwave.com



Simplified block/circuit diagram of phase/delay calibrator

Figure 1.