Pulse cal Injection for 7 mm band.

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I have tested in the lab for amplitude of the phase cal signal by injecting the output from Alan Roger's tunnel diode comb generator. When used with the Narda S213 microwave gating switch, the signal level at 7 mm is hopelessly inadequate (I got <~0.4% pcal amplitude in the lab when the signal is injeted directly in the feed horn of the receiver and use 5 MHz rail spacing alongwith 125 kHz bandwidth for the BBC). But this is due to the gating switch being very lossy. With the gating switch removed from the output of the pulse generator the pcal amplitude is about 2-3% for the receiver input shorted (for pcal injected at the FE pcal port and using BBC bandwidth of 2 MHz). Also the option of injecting the pcal at first IF was tested using a two way power adder at the input of the first IF amplifier. The pcal signal with 20 dB attenuation was connected to the two way power adder, with other input of the power adder having signal from the first mixer and the output of the power adder going to the first IF amplifier. This gave a reasonable pcal amplitude of about 2-3% for 1 MHz rail spacing and BBC bandwidth of 2 MHz.

From above tests it seems we have the following options:

(1) Use a seperate PCAL generator with a suitable microwave gating switch which has a low insertion loss at 7 mm. This needs a new pulsecal box which may cost about $6k plus cost of the gating switch of about $1.5k. Also I donot think that the gating switch Narda S217 (VLBA Acq. Memo #297) which requires 125 nsec of switching time will do the job. We will have to find another switch with low enough switching time for this band.

(2) Use a SPDT switch at the output of the tunnel diode and use two seperate gating switches, one for the frequencies upto 1.3 cm and second for the 7 mm band. This needs a SPDT switch with wide bandwidth low loss operation. However this switch can be a slow electoro mechanical relay. Also we need to find a fast speed gating switch as in option (1) above. We will have to run about 13 ft of waveguide (loss ~2-3 dB) from the pcal bin to 7 mm FE. I am guessing that whole thing may cost about $4k per system.

(3) Use pcal injection at first IF. We will need a power divider for splitting the pcal signal for injecting in both polarizations, and two directional couplers. Also we will need to modify the FE layout to accomodate these additional components. I guess it may cost around $2k per system.

Injecting the pcal signal at rf in the front end is desirable but will need some developement work in addition to $4-8k per system. On the other hand the IF injection may introduce uncertain crosspolarized phase as pointed out by B. Clark. However it should be possible to determine this by injecting third harmonic of the LO signal from the third (unused) 2-16 GHz Synthesizer at a frequency near the observing rf in the front end pcal port. This may cause some complexity in observing and data reduction, but simplifies the hardware and should be necessary in only a limited number of observations. Therefore I suggest that we implement the IF pcal injection scheme (option 3). In addition it will be useful to implement rf injection of the third harmonic of the unused 2-16 GHz synthesizer to determine crosspolarized phase at one station as a development effort which can be extended to other stations if found useful. This approach has additional advantage, namely if it works then the same scheme can be used at 4 mm.