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TECHNICAL NOTE

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SUB : Preliminary Note on Modifications/ Additions to ABR for supporting 50 Mhz RF band of GMRT

1.0 Introduction:

Work on 50 Mhz RF band of GMRT is scheduled to be taken up for implementation during the Second phase of the project. This note describes some ideas to cater to this additional RF band. Possible schemes for addition and/ or modification to ABR system are discussed. The implication on Feed, Front-end, Optical Fibre, Base-band and Correlator systems are mentioned.

The purpose of this note is not to propose a solution but to start a dialogue on how to go ahead and narrow down the options for executing the job in hand.

2.0 The Location of the Pre-ABR Systems for 50 Mhz RF band:

2.1 Feed:

It now appears almost certain that the feeds for 50 Mhz RF band will not be a part of the rotating turret but will be strung across the adjacent legs of the quadripod at a location close to the vertex. Hence, it is important to remember that the band of 50 Mhz is ALWAYS available to the user ALONGWITH the band/s decided by the feed at the rotating turret.

The feed may be made of four elements (like the GMRT 150 Mhz system) with the pair of parallel opposite elements combined in a passive unit which is potted for water proofing. Thus, the feeds would produce two linear outputs for processing in the FE system.

2.2 The Front-end:

It also appears certain that the outputs of the dipoles will not go back to the stools located in the rotating turret via the python for FE processing (polarisation conversion ***[Is it needed?],*** noise generation and injection, RF amplification, band shaping and Walsh switching) and Common Box processing (solar attenuation, swap and total power detection). Instead, these signals would be brought down the antenna structure and these processings are to be done at some convenient location.

The convenient location for the 50 Mhz RF band electronics (FE procesing + Common box processing + MCM + Control and Monitor circuits), to be done in a "30-100 Mhz RF Box" seems to be:

(a) The end of Elevation loop, probably near the yoke;

(b) The end of Azimuth loop, probably on the concrete wall;

(c) On the OUTSIDE wall of the RFI cage, probably on the roof;

(d) On the INSIDE wall of the RFI cage, probably on one of the side walls;

(e) In the OFT rack, as a 19" wide 6(?)U high "Ooty-type" aluminium box;

(f) in the OFT rack as a set of PIUs in a sub-rack (either existing or new sub-rack) or

(g) In the ABR rack as a set of PIUs.

While options (a) to (c) are simple and straight forward to implement, choice (d) may make the RFI cage more cramped to work. Choices (e) to (g) would need a careful study and should not come in the way of future plans for the already existing systems in these locations.

It should also be remembered that Walsh switching is more meaningful for option (a) than for the others.

3.0 The Frequency Coverage of the Pre-ABR Systems for 50 Mhz :

3.1 Frequency response of the feed:

There is considerable interest among astronomers (especially solar radio astronomers) on our target for the order of bandwidth. It appears that we should be aiming for an RF capability from 30 to 100 Mhz. The "< 1.5 VSWR" bandwidth achieved with a simple fat dipole and a reflector is around 20 Mhz, as per Shri. GSS.

Methods to widen the bandwidth by actively varying the dipole length using diodes which are switched on and off is under preliminary investigation, as per Prof. GS. We may also explore alternate choices like Bow-tie or Bi-conical antennas, which give a wide bandwidth in a single passive structure. There may be many other alternatives, whose choice would depend on shadowing and any interaction with the existing feeds in the rotating turret.

3.2 Frequency Response of the Front-end:

This is least likely to be an issue as standard off-the-shelf devices are available. The important question likely to need a scientific feed back is whether LCP and RCP need to be supported OR it is adequate to process the signals in linear domain, as has been decided for the L-band of GMRT.

4.0 Conditioning the 30-100 Mhz RF signal before the ABR:

The RF outputs from the existing feeds are processed in existing individual FE boxes and in the existing Common Box located in the rotating turret. They are available at the base of the antenna in RG 214 cables. Let us call these outputs EC1 (≡ Existing Channel 1) and EC2. Similarly, the 30-100 Mhz RF box must provide two outputs, with all the facilities now available for other bands and must be made available at the base of the antenna in cables which might be called NC1 (≡ New Channel 1) and NC2.

5.0 Processing of the 30-100 Mhz signal in the ABR:

5.1 Scheme 1. 30-100 Mhz band treated like any other RF band in OF to Correlator:

The block diagram of Scheme 1 is given in Fig. 1. Here, the 30-100 Mhz RF band is upconverted to (say) 430-500 Mhz and then processed like any of the other existing RF bands by the ABR system.

The outputs of EC1 and EC2 are passed through high-pass filters HPF1 and HPF2, with cut-off at around 100 Mhz to eliminate the seep-through of 70 Mhz noise from the common box. The outputs NC1 and NC2 are passed through low-pass filters LPF1 and LPF2, with a cut-off at around 100 Mhz.. The 50 Mhz RF band is upconverted using a local oscillator at 400 Mhz. This LO is derived from the existing II LO of 200 Mhz at each antenna by using a doubler DO1, power amplifier AM5, band-pass filter BPF3 and power divider PD1. The power level at the output of PD1 is chosen to be +13 dBm, so that high dynamic range, low distortion mixers MX1 and MX2 can be used. AM1 to AM4 are buffer amplifiers located at the RF and IF ports of MX1 and MX2. The up-converted signals are then band-limited to 430-500 Mhz in band-pass filters BPF1 and BPF2. Two SPDT switches SW1 and SW2 are controlled through MCM, so as to choose between either ECn or NCn. The switch outputs, labelled CH1 and CH2 are the inputs to the existing IF system in the ABR rack.

It should be possible to house the units as per this block diagram in one or two PIUs within the ABR rack at each antenna. It may be preferable to locate HPF1, HPF2, LPF1 and LPF2 as part of the new 30-100 Mhz RF Box. MCM2 has spare bits to control the switches. As the overall gain of these additional units will be around -3 dB, the existing calculations for receiver parameters, optimum pre- and post- attenuation settings and system specifications will have to be suitably modified.

The IF system of the ABR will have to be upgraded to give a facility of choosing around 1 Mhz bandwidth at the First IF of 70 MHz, which would be essential when we use the 30-100 Mhz RF band. The details of IF system upgrade will be discussed in a subsequent note.

It appears that there would be no upgrades needed to the Optical fibre, Base-band and Correlator system for supporting the 50 Mhz RF band as per above scheme.

It may be noted that the up-conversion of 30-100 Mhz RF band to 430-500 Mhz does not negate the possibility of doing radio astronomy in the RF band of 430-500 Mhz, when desired. Also, single polarisation simultaneous observations of 30-100 Mhz RF band together with any of other bands can be supported.

5.2 Scheme 2. 30-100 Mhz band brought as ADDITIONAL signal in the return link:

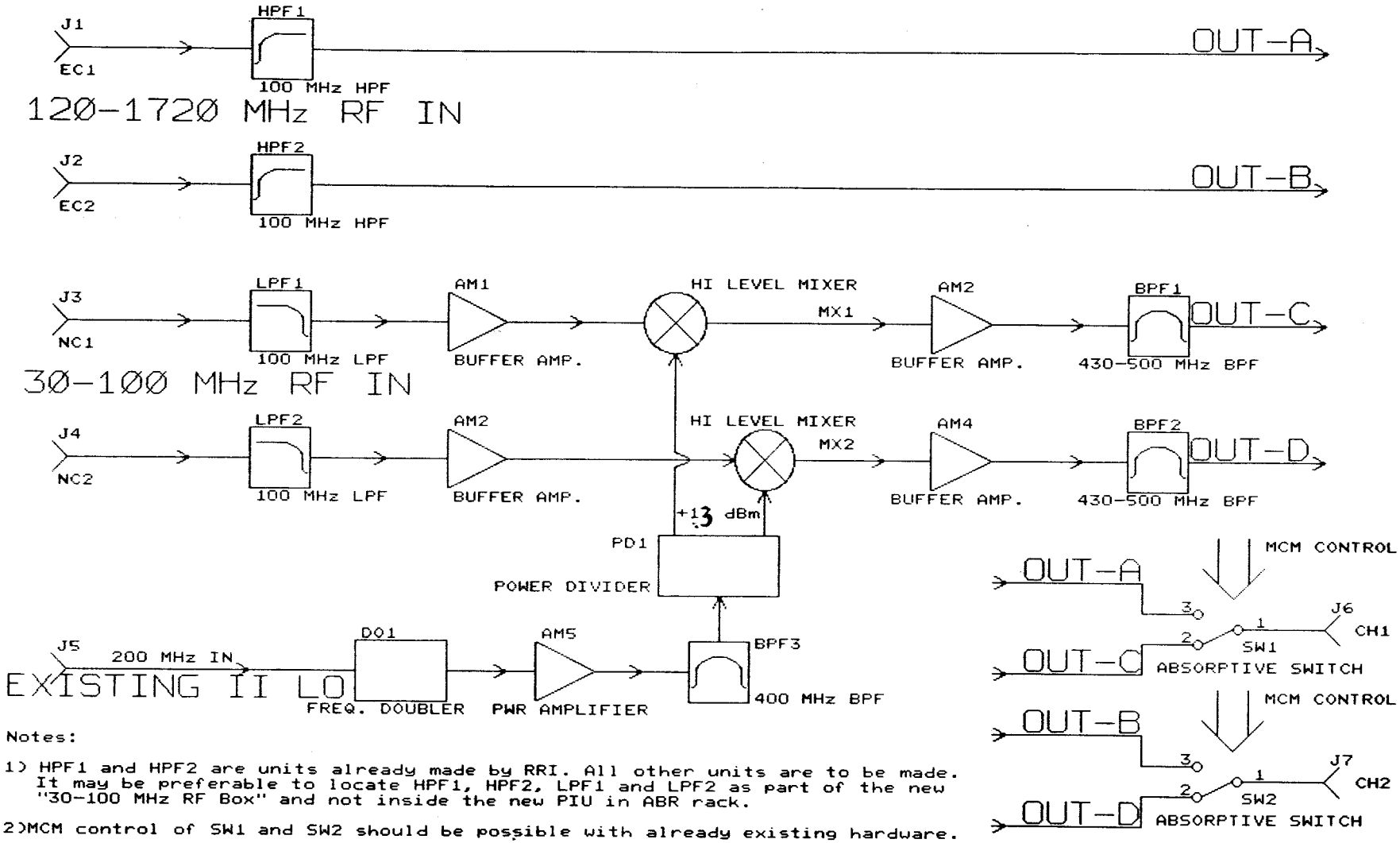
In this scheme, the 30-100 Mhz RF band is processed at the antenna, combined with the existing return link signals and retransmitted to the CEB, so that **SIMULTANEOUS OBSERVATIONS IN THREE RF FREQUENCY BANDS CAN BE SUPPORTED.**

The scheme is not elaborated for the present.

This idea could act as a jumping board for realising our nascent idea of retransmitting the full 1000-1500 Mhz RF band (now that we have a RF Filter Bank By-pass mode in the L-band front-end) on a carrier at 1500 nm from an antenna to CEB on the same optical fibre by Wavelength Division Multiplexing and building a separate base-band and correlator system for processing the same. In this connection, the recent colloquium by Dr. Ray Escoffier of NRAO regarding the Correlator technology of late 90s may be recalled.

6.0 Tailpiece:

It is difficult to summarise and conclude in notes of the current type, whose primary aim is to initiate a dialogue on the optimum (and practical) way of achieving a goal. It is hoped that this note serves as one of the approach papers for an open discussion on the topic in the near future.



Notes:

(1) HPF1 and HPF2 are units already made by RRI. All other units are to be made. It may be preferable to locate HPF1, HPF2, LPF1 and LPF2 as part of the new "30-100 MHz RF Box" and not inside the new PIU in ABR rack.

(2)MCM control of SW1 and SW2 should be possible with already existing hardware.

(3) CH1 and CH2 are outputs to existing IF system PIUs (C41) at the site.

(4) Radio Astronomy in the RF band of 430-500 MHz will be also possible.

(5) Single polarisation observation of 30-100 MHz RF band with ANY other RF band is possible.

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