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22/8/96

Hardware Development
Feeds and Receivers
AT/44.2/022
AT/39.3/043

Australia Telescope National Facility

MODIFIED MOPRA CONVERSION SYSTEM

Preamble

This note on proposed changes to the Mopra conversion system has been updated several times since it was first written. The basic concept has always remained the same. However, the frequency crossover point from the lower band (which I may call the L-band) to the upper band (S-band) has slightly shifted from that originally suggested, and the lower frequency limit for observations at Mopra is now 1.2 GHz instead of the original 1 GHz. This has changed the frequency bands of the filters a little. This note contains the frequency limits of the filters that will be made.

Introduction

For the SETI (Phoenix) Verification Site program to be conducted using the Mopra antenna, modifications need to be made to the conversion electronics for reception of the full 1.2 to 3 GHz band.

Proposed Changes.

At present, there are filters in the RF modules [L-Band RF (F10) and S-Band RF (F11)] that limit the bandwidth to slightly more than the present ATNF specified bands. These are 1.25 - 1.78 GHz and 2.2 - 2.5 GHz. These filters, which also attenuate the image band, need to be removed and replaced by several remotely selectable filters, covering the full 1.2 - 3 GHz band.

The Australia Telescope 22m antennas at Mopra and Narrabri usually operate with linearly polarised IF outputs. Only for the narrow-bandwidth requirements of VLBI (very long baseline interferometry) is circular polarisation required, and for that it is generated with a hybrid in the IF outputs. (Appropriate gain and phase corrections are applied to the linearly polarised IF outputs before they are connected to a hybrid.) However, for SETI, circular polarised outputs are required over the 1.2 - 3 GHz band. The polarisation purity required is fairly modest:- cross polarisation isolation of 16 dB or greater. It is proposed to form the circularly polarised outputs using a hybrid, at RF frequencies, after the Low Noise amplifiers (LNAs). Gain corrections, using attenuators, and phase (or actually delay) corrections using a line stretcher will be applied before the hybrid.

For the preceding reasons, it was decided to construct two new RF modules for the Mopra antenna.

The L-band Splitter (C22) and Conversion modules (C30) in the Conversion rack do not need to be altered to receive this wider band. However, the isolators in the S-band Splitter module (C23) need to be changed from the present 2 - 4 GHz ones to ones that work over the band 1.5 - 3 GHz. (This alteration has already occurred.)

The 2 GHz local module (L3) will need to be replaced with a systhesizer, as the current unit will not go high enough in frequency. The frequency steps for the present units are also not fine enough. (A Marconi 2042 synthesizer will be used.)

The 1 - 3 GHz band will be divided into two sections:- 1.2 - 1.85 GHz and 1.75 - 3 GHz, with a 100 MHz overlap. These two bands correspond to the LNA bandwidth and the feed bandwidth.

Local Oscillator Frequencies.

For a final IF frequency of 590 MHz (490 - 690 MHz required for the QBBC), the IF of the 'L/S band' conversion is suitable, with the output taken from modified 256 IF (C50) modules. The filters in these 256 IF modules have been replaced by ones that cover the 490 - 690 MHz band.

Following is the proposed split of the RF bands, giving the filter bandwidths and order. The (theoretical) attenuation given is that for the nearest image (the lower edge for the lower sideband conversion, and the lowest frequency in the filter band) for a 0.05 dB ripple Tchebyscheff design.

Observation Frequency	LO GHz	Image Band lower edge	Image Band upper edge	Filter	Order	Attn.
1175	1765	2255	2455	L0	4	47
1200	1790	2280	2480			
1250	1840	2330	2530			
1300	1890	2380	2580			
1350	1940	2430	2630			
1400	1990	2480	2680			
1450	2040	2530	2730			
1500	2090	2580	2780			
1525	2115	2605	2805			
1475	2065	2555	2755	L1	4	46
1500	2090	2580	2780			
1550	2140	2630	2830			
1600	2190	2680	2880			
1650	2240	2730	2930			
1700	2290	2780	2980			
1750	2340	2830	3030			
1800	2390	2880	3080			
1850	2440	2930	3130			
1750	2340	2830	3030	S0	4	46
1800	2390	2880	3080			
1850	2440	2930	3130			
1900	2490	2980	3180			
1950	2540	3030	3230			
2000	2590	3080	3280			
2050	2640	3130	3330			
2100	2690	3180	3380			
2125	2715	3205	3405			
2075	2665	3155	3355	S1	4	50
2100	2690	3180	3380			
2150	2740	3230	3430			
2200	2790	3280	3480			
2250	2840	3330	3530			
2300	2890	3380	3580			
2350	2940	3430	3630			
2400	2990	3500	3680			
2425	3015	3505	3705			

2375	2965	3455	3655	S2	4	50
2400	2990	3500	3680			
2450	3040	3550	3730			
2500	3090	3600	3780			
2550	3140	3650	3830			
2600	3190	3700	3880			
2650	3240	3750	3930			
2700	3290	3800	3980			
2725	3315	3805	4005			
2675	3265	3755	3955	S3	4	51
2700	3290	3800	3980			
2750	3340	3850	4030			
2800	3390	3900	4080			
2850	3440	3950	4130			
2900	3490	4000	4180			
2950	3540	4050	4230			
3000	3590	4080	4280			
3025	3615	4105	4305			

There is an alternative set of LO frequencies for the RF frequencies from 1.8 to 3 GHz. The LO is lower in frequency than the RF frequency. The IF band is inverted relative to that obtained for the 1 - 1.8 GHz section. As there are also second harmonic conversions present within some of the bands, this style of conversion system will not be used. The local oscillator will always be above the RF frequency.

Note that, for a particular RF frequency, the full 200 MHz bandwidth of the IF output may not be available. For the Parkes receiver, the filters in the RF modules cover 1.0 to 1.85 GHz and 1.75 to 3.0 GHz. The overlap is 100 MHz. Similarly, for the Mopra antenna, the overlap is less than 200 MHz, as may be seen from the above table. The overlap is at least 50 MHz. (The filters were designed with an extra 50 MHz of bandwidth. Without using much higher order filters, it was not possible to achieve the image rejection and a wider overlap for the filters.) The RF filter selected may attenuate some portion of the band. The centre section of the IF will always be satisfactory.

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20 Sept 1994.