National Centre for Radio Astrophysics

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Technical Report on

Recommended Attenuation Setting for GAB system

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Giant Metrewave Radio Telescope

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Abstract

A versatile GMRT Analog Back-end System (GAB) has been developed to process the RF signal received from antennas using high dynamic range circuits. This RF frequencys (100 MHz to 1600 MHz) are down converted to a baseband signal and the input power level to ADC unit is adjusted in GAB system. Befor converting the RF signal, gain of different Rf band is varied because of slope in the pass band i.e. from 100 MHz to 1600 MHz. Input power of the higher frequency band is low and changing the variable attenuation value will not help to increase the power level because the variable attenuation value reaches to its minimum value and ADC will get low input power. To overcome this problem, an experiment has been done in order to increase the GAB system gain and calculate the fixed attenution values for a variable attenuation of different RF bands. This report describes the details of the experiment done.

Aim of the experiment :

To increase the Gab system gain and fix the value of attenuation of variable attenuator for adjust the equal output power for all RF bands.

Introduction :

In GAB system, The incoming RF signal is passed through a variable gain circuit whose gain can be adjusted in steps of 0.5 dB so that any variation in signal levels between antennas can be corrected at this stage and the ADC will receive same power levels. The RF signals are then passed through a RF filter bank which will have same filter as of the one used immediately after the feed. This filter is used to improve the out of band rejection and provide a clean signal to the later stages. Since the ADC is operating at 800 MHz sampling rate, we need to down convert all signals above 400 MHz to a lower frequency. So the frequency conversion stage is provided with a bypass stage so that whenever the observation frequency is lower than 400 MHz, one can use the bypass path and the RF signal will be directly given to the ADC circuits. System gain is adjusted to 12 dB constant power while adjusting a variable attenuator value from 12 dB for 100 Mhz and 4 dB for 1500 Mhz.

Basic block diagram of GAB system

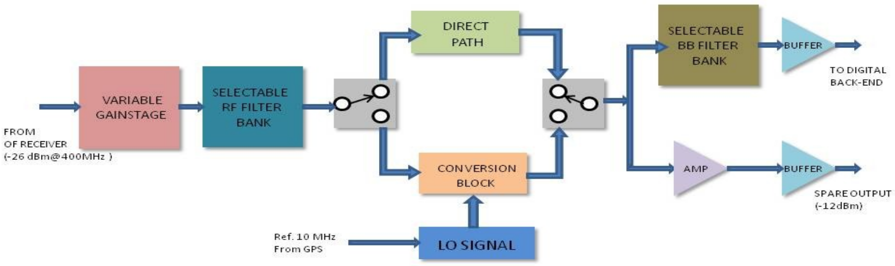
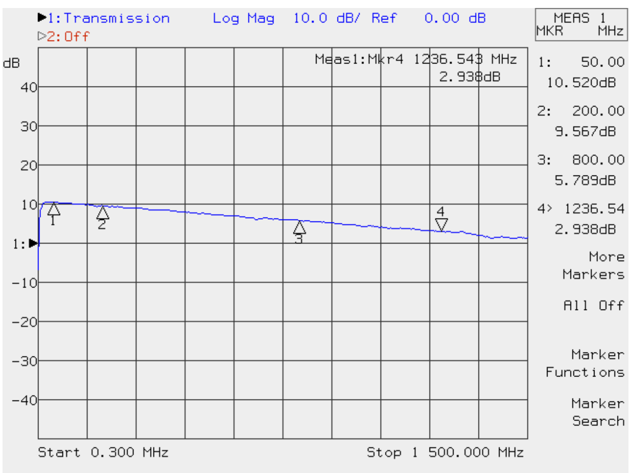


Fig 1: Generic block diagram describing signal flow of GAB stystem.

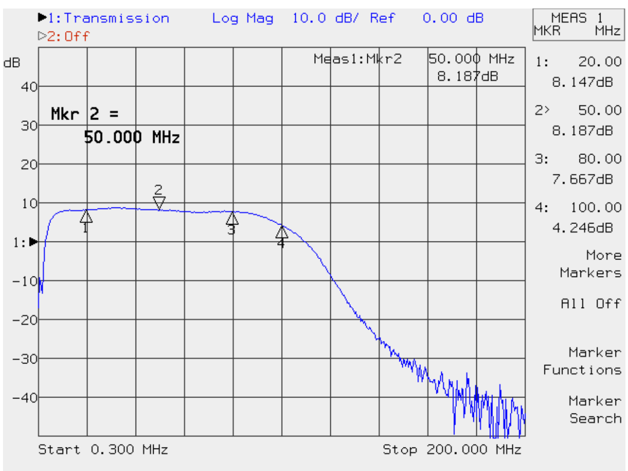
Description:

When the RF signal passes through the variable gain stage (VGA) and RF filter unit, the insertion loss is increasing over the frequency band i.e.100 Mhz to 1600 Mhz because of the slope in the pass band.

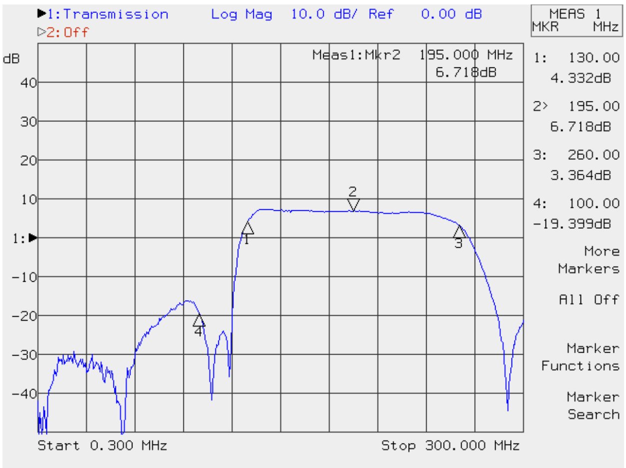
While testing the response of the analog receiver piu (RF Input to output of Amplifier(Amp out)) and RF Filter bank (RF input to output of filter (out)) with 0dB attenuation setting in variable attenutor. The response shows around 10 dB slope in 100 Mhz to 1600 Mhz pass band in VGA uint of analog receiver piu and different insertion loss in all RF bands of filter bank unit. Fig below shows the Response plots.



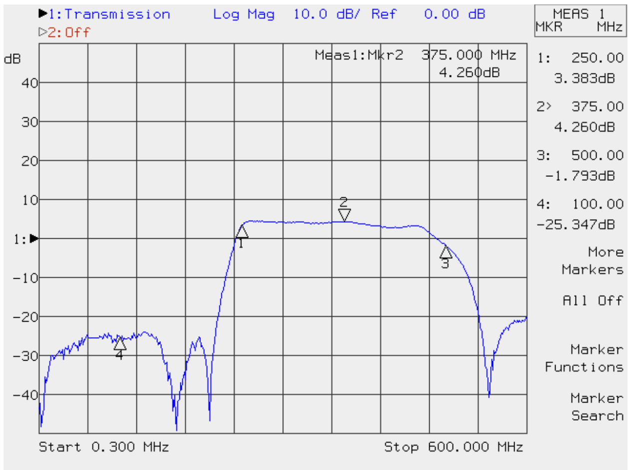
Input to Amp Out in Analog Receiver PIU



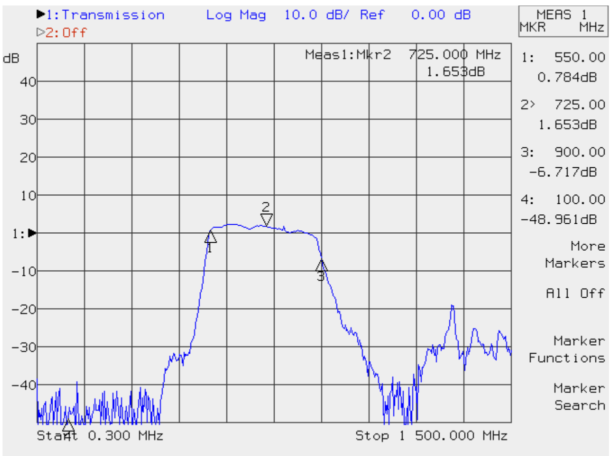
Input to RF filter Output - 100 Mhz Filter



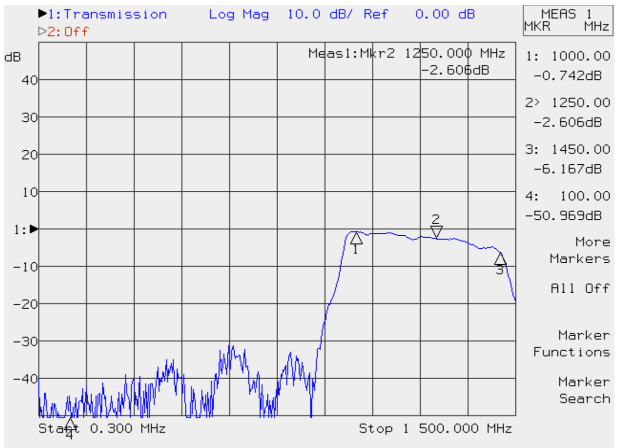
Input to RF FIlter Output - 130-260 Fiilter



Input to RF FIlter Output - 250-550 Fiilter



Input to RF FIlter Output -550-900 Fiilter



Input to RF FIlter Output - L- Band Fiilter

As mention above, the system gain is adjusted constant by varing the variable attenuator value in the VGA unit. Variable attenuator values for 100 Mhz is 12 dB and 1500 Mhz is 4 db before adding RF filter bank unit.

Insertion Loss of various RF filters used in the RF filter PIU.

- 100 Mhz Low pass filter - 2.5 dB
- 130-260 Mhz Band pass filter - 3.0 dB
- 250-500 Mhz band Pass filter - 3.5 dB
- 550-900 Mhz Band Pass Filter - 4.5 dB
- L-Band (1000 to 1450 Mhz) Filter - 5.0 dB

Overall gain of the system was decreasing because of insertion loss of filter bank being added into it. Adjusting the output power to -12 dBm constant, variable attenuator value is changed accordingly but for higher frequency the value of variable attenuator reaches to its lowest value. There is no margin for varing the attenuator value for equlising the output power. To keep the margin in the variable attenuator, it is necessary to increase the gain of the system.

Present VGA unit has a fixed 6 dB attenuator before ampifier. Removing the fixed attenuator is the simplest way to increase the system gain by 6 dB. So for the test purpose, four unit of analog receiver piu has been modified and installed in C00 and C01 antenna system and characterized the system..

While charecterizing the system, broad band noise is injected as a input and final output power checked while setting different RF filter setting. For adjusting the constant output power, the variable attenuation values are adjusted to keep the output power constant. Below table shows the constant gain for all the frequency band with fixed varaible attenuator value.

Test Result:

RF Band : 150 Mhz (130 – 260 Mhz)
GAB Setting : Noise + Mixer path, LO: 270 Mhz, RF filter: 130-260 BPF, BB filter: 200 Mhz
GAB ATT: 18 dB.

Ant.	Input power @130-260Mhz (BW- 130Mhz)	Output power @ BBout (BW-130mhz)	Gain (system)	Output power @ BB Mon (BW-130Mhz)	Gain @Monitor
C00- CH1	-24.6	-12.2	12.4	-39.1	-15.5
C00- CH2	-24.6	-12.8	11.6	-39.4	-15.2
C01- CH1	-24.6	-11.8	12.8	-38.6	-14.0
C01- CH2	-24.6	-12.3	12.3	-38.9	-14.0

RF Band : 327Mhz (250 – 500 Mhz)
GAB Setting : Noise + Mixer path, LO: 510 Mhz, RF filter: 250-500 BPF, BB filter: 400 Mhz
GAB ATT: 17 dB.

Ant.	Input power @250-500Mhz BW-250Mhz	Output power @ BBout (BW- 250Mhz)	Gain (system)	Output power @ BB Mon (BW- 250Mhz)	Gain @Monitor
C00- CH1	-22.6	-10.3	12.3	-37.3	-14.7
C00- CH2	-22.6	-10.8	11.7	-37.8	-15.2
C01- CH1	-22.6	-10.5	12.1	-37.4	-14.8
C01- CH2	-22.6	-10.8	11.7	-37.8	-15.2.

RF Band : 610 Mhz (550 – 900 Mhz)
GAB Setting : Noise + Mixer path, LO: 910 Mhz, RF filter: 550-900 BPF, BB filter: 400 Mhz
GAB ATT: 10 dB.

Ant.	Input power @550-900Mhz BW- 350Mhz	Output power @ BBout (BW- 350 Mhz)	Gain (system)	Output power @ BB Mon (BW-350Mhz)	Gain @Monitor
C00- CH1	-22.9	-10.4	12.5	-37.5	-14.6
C00- CH2	-22.9	-10.2	12.7	-37.2	-14.3
C01- CH1	-22.9	-10.1	12.8	-37.1	-14.2
C01- CH2	-22.9	-10.6	12.3	-37.7	-14.8

RF Band : L-Band (1000 – 1400 Mhz)
GAB Setting : Noise + Mixer path, LO: 1410 Mhz, RF filter: L-BAND BPF, BB filter: 400 Mhz
GAB ATT: 6 dB.

Ant.	Input power @1000-1400Mhz BW - 400 Mhz	Output power @ BBout (BW- 400Mhz)	Gain (system)	Output power @ BB Mon (BW - 400Mhz)	Gain @Monitor
C00- CH1	-24.0	-12.6	11.4	-39.6	-15.6
C00- CH2	-24.0	-11.7	12.3	-38.7	-14.7
C01- CH1	-24.0	-12.1	11.9	-39.1	-15.1
C01- CH2	-24.0	-12.0	12.0	-39.1	-15.1

Conclusion:

After removing the fixed attenuator of 6 dB, the gain of the system is increased by 6 dB and it helps to equalized the output power of the system. Following are the tested fixed attenuation values for variable attenuator setting of differnet bands.

- 130-260 Mhz band - 18 dB
- 250-500 Mhz band – 17 db
- 550-900 Mhz band – 10 dB
- L- band - 6 db

Above mention fixed attenuation value will adjust the GAB system gain around 12 db for every RF band.