Giant Metrewave Radio Telescope

Technical note

Isolation performance for 60 to 1 System

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Ver1

Introduction:

GMRT Analog Backend (GAB) system

The main function of the GMRT analog backend receiver (GAB) is conversion of the signal at RF frequencies received from antennas through the optical fiber cables to baseband signal

The RF signals are passed through a RF filter bank which includes the same filter as the one used in the frontend electronics at the antenna. This filter bank is used to improve the output of band rejection and provide a clean signal to the later stages.

The incoming RF signal is first passed through a variable gain circuit with 0.5 dB step size so that any variation in signal levels between antennas can be corrected at this stage to equalize the powers for further processing.

The RF signals is processed using analog circuits to provide a signal with max BW 400 MHz and power levels suitable for digitisation in high speed ADCs of the Digital backend system also called as GMRT wideband backend (GWB).

The baseband signal of GAB system has bandwidth 100 /200 / 400 Mhz

60 to 1 System

The 60 to 1 system is the continuous monitoring of baseband signal of GAB system from the control room by switching between the 60 channels of GMRT antennas.

The baseband signal is tapped using directional coupler connected between GAB baseband filter and GWB system

The 60to1 system is very useful tool for checking GAB system

Signals from 60 channels of all 30 GMRT antennas can be monitored in single window during observation .This is also used for checking deflection at GAB system from control room for each antenna

Block diagram

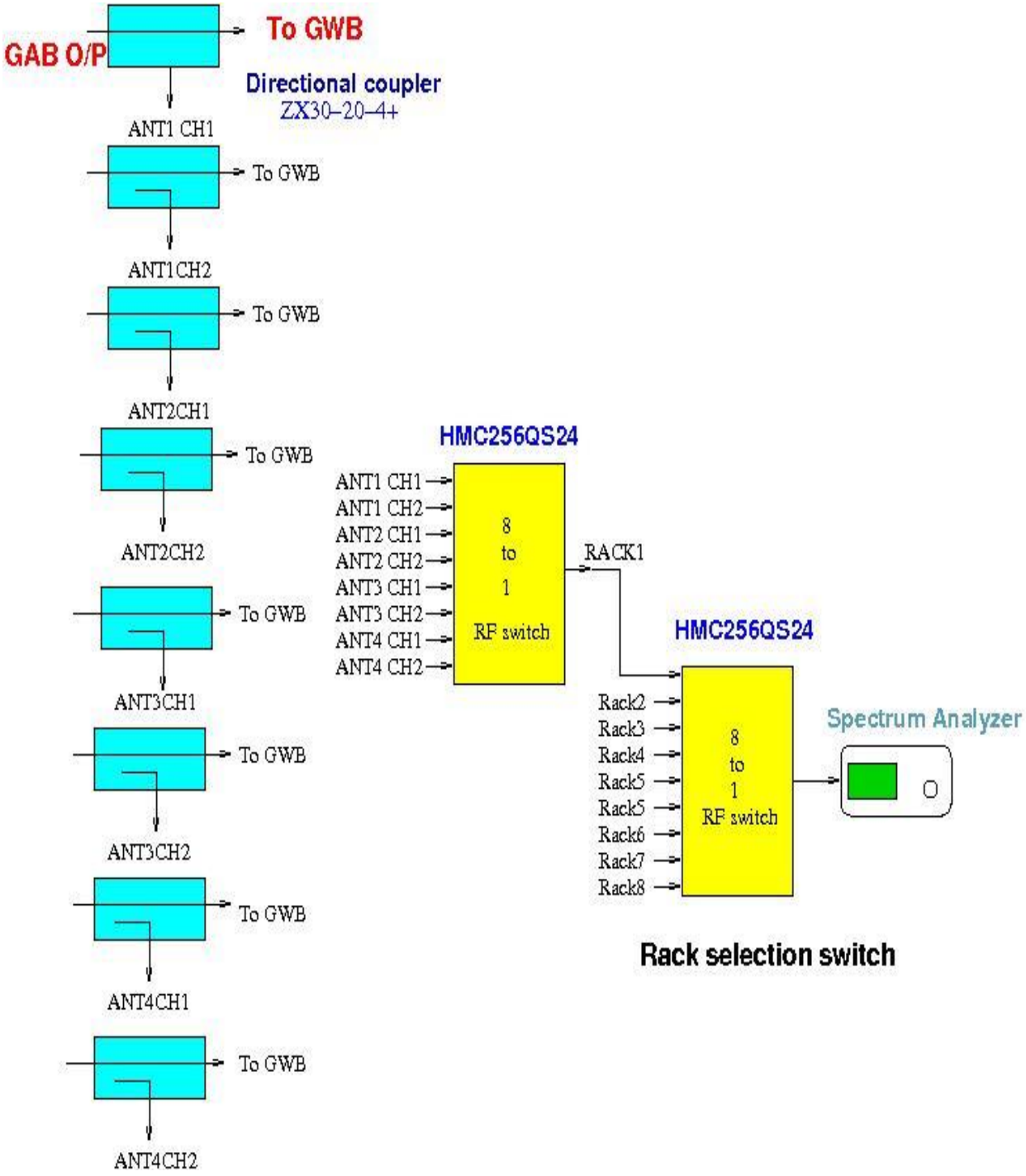


Fig 1

Installation details

4 Antennas 8 Channels GAB system installed in each rack in receiver room.

So there are total 60 outputs for 30 antennas installed in 8 rack

Fig 1 Shows block diagram for typical connections in single GAB rack

Output of GAB system (analog out) is tapped using directional coupler ZX ***30-20-4+*** connected in Baseband filter PIU of GAB system

Out- port of directional coupler is connected to GWB system

Coupled port which is 20 dB down is connected to 8:1 RF switch ***HMC253QS24***

Each rack will have 1 output from 8:1 RF switch so there are total 8 outputs.

These outputs are brought together at final stage 8:1 RF switch which is located at rack 4 this will have an advantage of RF cable length will be minimize and equal length is maintain to make RF cable loss equal output of the last 8:1 RF switch is connected to a HP Spectrum analyzer

Block diagram of RF switch matrix and spectrum analyzer is shown in ***Fig 2***

The 60 to 1 RF switch matrix in control by a program wrote in LabVIEW. This program controls MCM

This will switch between all 60 channels sequentially starting from Antenna C00-CH1, CH2……..

W06 – CH1, CH2. After switch one channel data of that particular channel is getting recorded

A separate program (splot) is used to shows all 60 channels in one windows simultaneously

60 to 1 system Block diagram

RF Switch controlling pc

Fig-2

Leakage paths in the systems

In such type of switching system Antenna signal quality will degrade due to Co-channel interference and Noise due to switching of RF switch

Testing of Isolation performance of system is important

Isolation is the degree of attenuation from an unwanted signal detected at the port of interest.

High isolation reduces the influence of signals from other channels, sustains the integrity of the measured signal

For instance, a switch matrix may need to route a signal to a spectrum analyzer for measurement at –70 dBm and to simultaneously route another signal at +20 dBm. In this case, switches with high isolation, 90 dB or more, will keep the measurement integrity of the low-power signal.

Theoretical calculation of the leakage levels

	ISOLATION As per Specification (dB)
• Directional coupler Out port to coupled port (@ 200 MHz)	44
• RF switch adjacent port	32
• Directional coupler Out port to coupled port (@ 200 MHz)	44
Total	120

Test setup to check reverse isolation of directional coupler

Measurement Setup

Instrument used Signal Generator and spectrum analyzer

Steps to measure isolation:

Step 1: 200 MHz @ +15 dBm power is fed to OUT -port of 1st directional coupler and power measured at coupled port with IN- port terminated

Step 2: 200 MHz @ +15 dBm power is fed to OUT- port of 1st directional coupler and coupled port connected to out port of 2nd directional coupler power measured at coupled port with IN- port terminated

Step 3: with step 2 coupled port connected to port 1 of RF switch and power measured at out port of RF switch with port 1 selected

Step 4: with step 3 power measured at adjacent port i.e. port 2

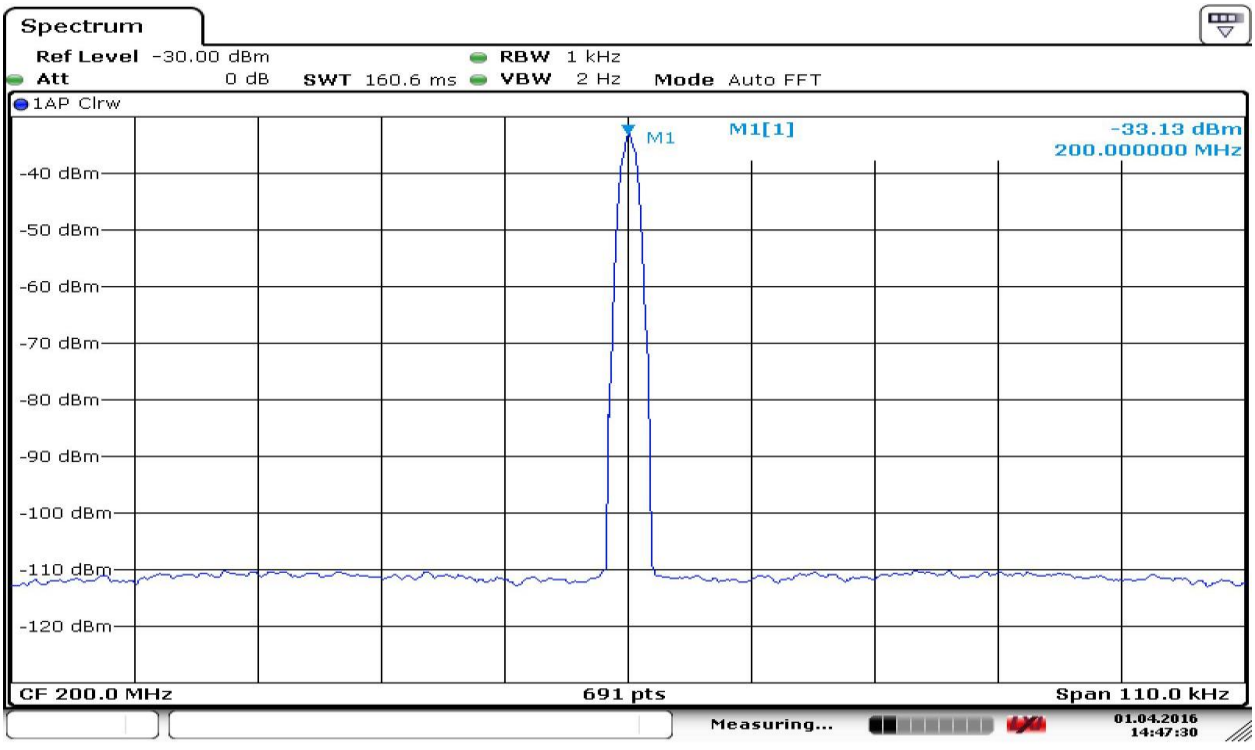
200 MHz + 15 dBm power from signal generator is fed to out port of directional coupler

Power measured		isolation
-33.13 dBm	Coupled port of 1st directional coupler	48.13
-79.92 dBm	Coupled port of 2nd directional coupler	94.92
-82.17 dBm	out port of RF switch port 1 selected	97.17
-121.43 dBm	Port 2 of 8:1 RF switch port 1 selected	136.43

Results

200 MHz + 15 dBm power from signal generator is fed to out port of 1st directional coupler

Coupled port of 1st directional coupler



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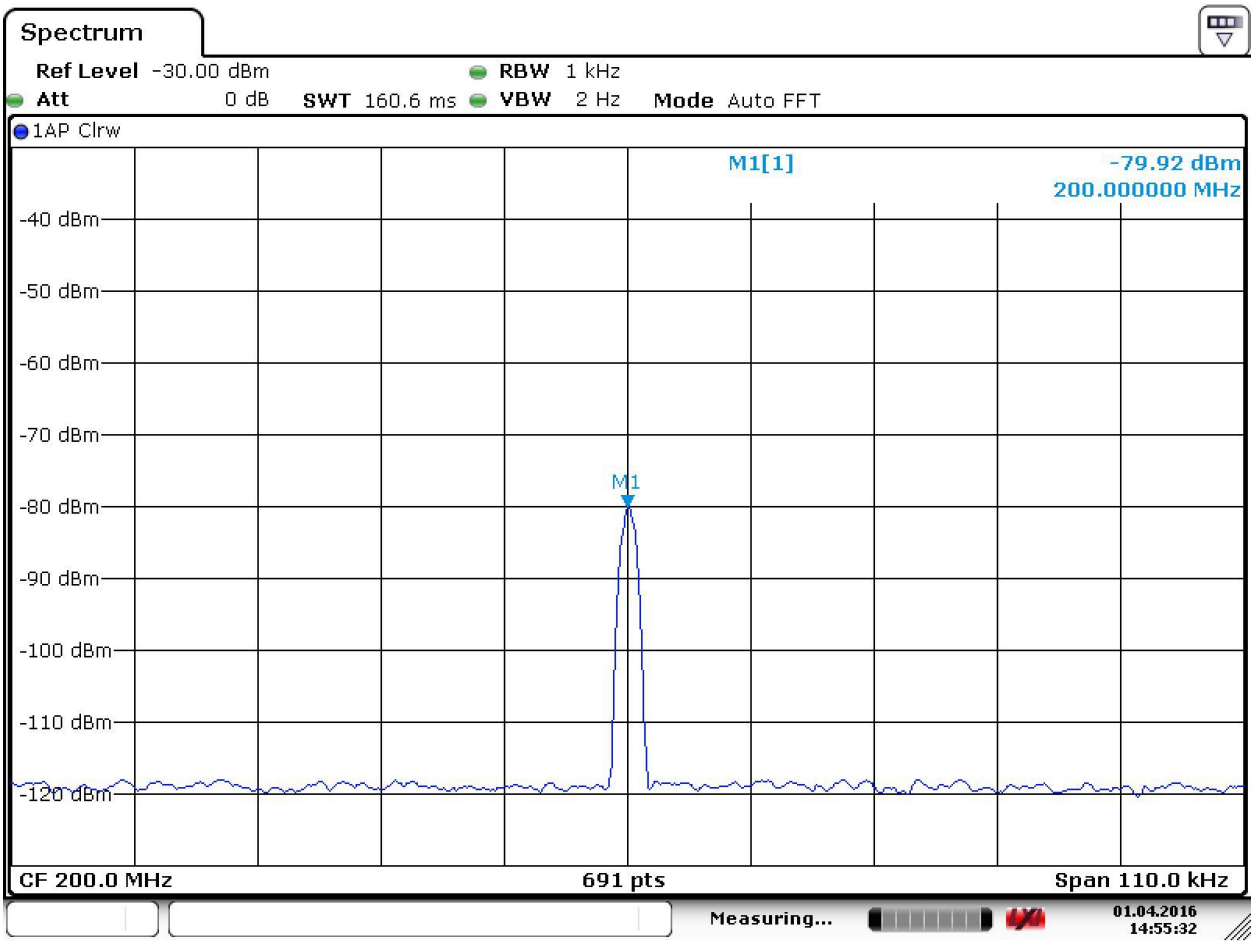
200 MHz + 15 dBm power from signal generator is fed to out port of 1st directional coupler

Coupled port of 2nd directional coupler



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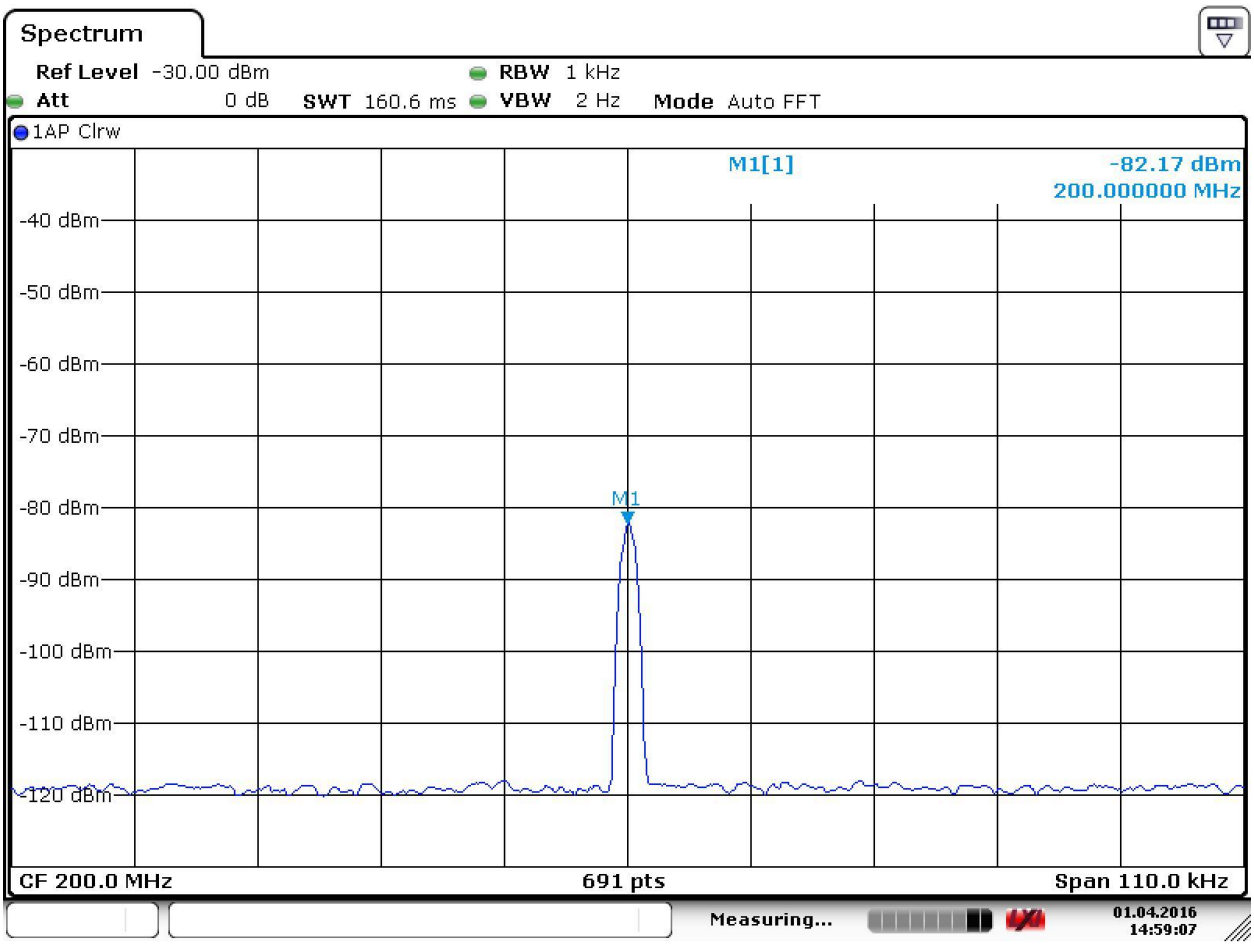
200 MHz + 15 dBm power from signal generator is fed to out port of 1st directional coupler

Out port of RF switch port 1 selected



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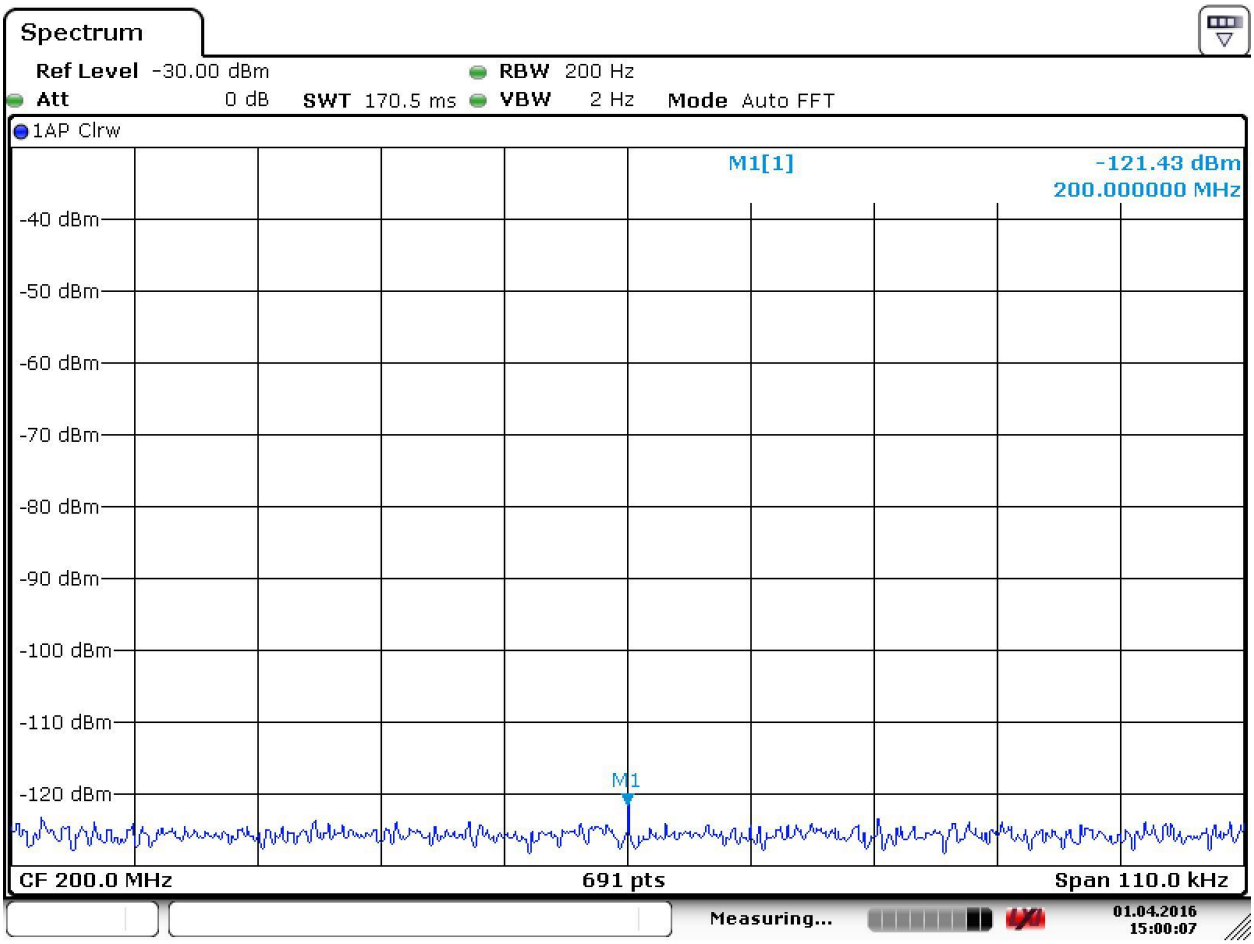
200 MHz + 15 dBm power from signal generator is fed to out port of directional coupler

Power measured at Port 2 of 8:1 RF switch with port 1 selected



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Comparison of theoretical and measured values

	ISOLATION	
	As per Specification (dB)	Measured (dB)
• Directional coupler OUT-port to coupled port (@ 200 MHz)	44	48.13
• RF switch	32	42.43
• Directional coupler OUT- port to coupled port (@200 MHz)	44	48.13
Total	**120**	**138.7**

Conclusion: After measurement isolation found to be better than the calculated theoretical value. Considering normal GAB system output power the leakage signal level will be insignificant & hence it will not affect receiver system performance