The Ultra-Wideband Receiver System for RT-13 Radio Telescope
IAA RAS QUASAR Network

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The report describes results of development in IAA RAS receiving system, operating in ultra-wide 4-16 GHz band (UWB). An overview of existing and developing UWB systems for VOOS network is provided. The principles of design, management, integration unit, test and other technical aspects are discussed. This technical overview provides an overview of the basic structure, front-end cooled feed, splitter and up-down convertor are presented. Special attention is focused on the front-end cryoelectronic unit, the information about the design, feed, LNAs used, results and parameters obtained during the test is provided.

Introduction

The UWB (ultra-wideband) receiving system designed in IAA RAS is being implemented in QUASAR VLBI network. The main dish radio telescopes are based in «Zelenchukskaya» and «Bukhtyanovka» stations and working now with Tri-band S/X/Ka receiving system [1]. UWB receiving system operates in 4-16 GHz band on dual linear orthogonal polarizations and it is fully compatible with RT-13 mechanical, cryogenic and electric interfaces. As supposed, it can replace Tri-band system and be replaced by it on demand.

The System

Like the Tri-band, UWB receiving system is made as focal container with working position near the dish secondary focus. According to schematic diagram (fig. 2) and photo (fig. 3), the receiver consists of following main components:

- cryoelectronic focal receiving unit (cryounit). This is hard-walled vacuum chamber that contains cooled QRFH and horizontal linear polarizations. The terms «vertical» and «horizontal» are nominal because of non-strict position of feed.
- power amplifiers with gain about 20 K.
- wideband noise generator.
- four dual-polarization FCUs (frequency conversion units, prototyped), that converts tunable 1 GHz band to 4-16 GHz band on dual linear orthogonal polarizations and it is fully compatible with RT-13 mechanical, cryogenic and electric interfaces. As supposed, it can replace Tri-band system and be replaced by it on demand.
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The calculations of main UWB system parameters, such as gain and noise temperature, is presented in the table above. According to given data, total system noise should be less than 1 K for both channels and they provide 1-2 GHz band filtering with additional gain variable up to 30 dB.

Noise temperature of FCU is compensated with wideband preamplifier in splitter unit. To increase dynamic range, IF1 20-db amplifier was removed from FCU, with the increasing of constant. Total deviation of LO frequency assumed and fine tuned was tabled and it is less than 5 Hz. This results must be taken in calculations of Doppler shift during VLBI observations.

Conclusion

The module of new generation UWB receiving system was designed and prototyped in IAA RAS. This module contains all necessary equipment for system functioning and it is fully compatible by cryoelectric, output signal, primary power and Ethernet-control interfaces with RT-13 radio telescope. First cycle of laboratory tests has shown good match of expected and measured parameters, revealed problems and verified solutions. The UWB system will be ready for field tests soon.

Links

1. Evgeniy Khvostov. The S/X/Ka receiver system for radio telescope RT-13 of Quasar VLBI Network.