Institute of Applied Astronomy Technology Development Center

Alexander Ipatov, Nikolay Koltsov, Valery Grachev, Leonid Kuptsov, Michael Kaydanovsky, Andrey Mikhailov

Abstract

The field of IAA TDC includes the devices of receiving, recording and processing of radio signals on QUASAR dishes.

1. New VLBI Data Acquisition System for S2-RT Recorder Terminal

In 2001 the new VLBI data acquisition system for the S2-RT recorder terminal was worked out by Prof. Koltsov's group.

This system includes a distributor with frequency range 100–1000 MHz and up to eight base-band converters (BBC's). They are controlled by the radiotelescope computer with the Field System software.

The system consists of a main module and up to three added modules. The main module includes a distributor with two IF inputs and two BBCs and a microprocessor board with the RS-232 interface and a board of total power detectors and two narrow-pass filters of 10 kHz and clocks of 32 MHz and of one pulse per second (1PPS) connected to S2-RT recorder terminal (Figure 1). In the added module the 32 MHz clock and the 1PPS clock are excluded.

The distributor ensures the attenuation of every input IF signal with 0 - 18 dB range and 6 dB step size. One can connect each of the BBCs to each of the IF inputs.

BBC Parameters are the following:

Local oscillator (LO) range — from 100 to 1000 MHz

LO step size — 10 kHz

Attenuation of input IF signal — from 0 to 15 dB

Attenuation step size — 2dB

Conversion method — a single sideband mixer (SSBM)

Outputs per BBC — upper and lower sideband (USB, LSB)

Bandwidths — 0.25 MHz, 2 MHz, 8 MHz and 16 MHz

Number of digitizer bits — 1 or 2

Nonlinearity of amplitude-frequency response (into bandwidth) — < 0.3 dB

Nonlinearity of phase-frequency response (root-mean-square) — $< 2^\circ$

Image rejection in SSBM — > 23 dB

Two IF total power detectors and four video total power detectors are located on the detector's board. They ensure a measurement of IF and video signal levels by the 10-bit analog-to-digital converter.

The 10 kHz filters ensure the phase calibration signal monitoring.

In September 2001 an experimental module with one BBC was installed at the Svetloe observatory for VLBI observations. It is working rather well.

The first main module is completed, but it must be tested now. In two or three months it will be installed in Svetloe.

For 2002 we plan to produce four modules (8 BBCs) for Svetloe and Zelenchukskaya.

2. PARSEC Correlator

IAA TDC has started to build a new-generation correlator named "PARSEC" as part of QUASAR VLBI system with Mark IV specification. This system will include three Canadian S2- playback terminals and 3-baseline and 3-station correlation capability. Options are included for expansion up to the 6-station and 15-baseline capabilities, along with options for six additional new Mark IV compatible playback systems and/or development of new real-time techniques using an IP-network.

The new correlator system design is based on good experience with IAA S-2 correlator (TISS-1M) applications and development of adaptable processing algorithms. The TISS-1M correlator has been under operation since 1993. Tracking of orbit of VLBI observations of GRANAT, GLONASS and NAVSTAR spacecrafts, extragalactic source and spectral line VLBI observations and Venus and Mars differential radar VLBI observations were supported by successful data processing at IAA. Unfortunately, the TISS-1M correlator has not yet been utilized in a general Mark III processing mode due to the absence of corresponding data acquisition terminals in Russia.

The PARSEC correlator system will offer the following features:

1. A new Compact PCI-bus correlator board supporting 16 cross-correlation channels for 64 complex lags or 48 cross-correlation channels for 16 complex lags will provide processing capacities and productivity superior to those of TISS-1M.
2. Operation at input data rates to 64 M samples/sec/channel, 1 or 2 bits/sample.
3. Integrated input data rates to 1 G samples/sec/station, 1 or 2 bit/sample.
4. Compatibility with Mark IV, K-4, VLBA, S3 via VLBI Standard Interface.
5. Both "baseline-based" and "station-based" electronics can provide the most economical and adaptive future expansion path for large or individual correlator system.
6. Modern LINUX-based and/or Windows NT-based computer-control system.

The base correlator unit consists of six correlator modules, four station modules and one switch module. Each correlator module includes 16 correlator chips in FPGA Altera ACEX1K100 or Xilinx XC2S200 with PQ208 package, RAM for 32 data-streams delay according to a polynomial model, and matrix switch for "64 input $\times$ 32 output" 2-bit streams. The correlator chip has one 2-bit 64-lag or four 2-bit 16-lag complex cross-correlators including a fringe rotator and vernier time delay in general mode. The correlator, station and switch modules will be housed on a Compact PCI-system with rear I/O.

3. New Controller for the 32-m Radiotelescope in Svetloe Observatory

A new controller for the 32-m radiotelescope in Svetloe is almost ready. The principal motivations for creation of a new controller are: replacement of old-fashioned equipment; improvements of pointing and tracking accuracies, higher reliability; automatic control of the sub-reflector positioning.

The controller is designed on the basis of the OCTAGON SYSTEMS Micro PC workstation with the UNIX operating system. Special interface modules are made for connection with the position sensors and with the antenna drives. The workstation performs the following functions:

- Digital signal input from the azimuth and elevation angular sensors;
- Analog signal input from four sub-reflector position sensors;
- Time signal input from the frequency standard;
- Status signal input from the antenna drives and facilities;
- Command and data input from the Field System;
- Analog and digital signal output to the antenna;
- Registration and presentation of data on the control system state and on the tracking accuracies;
- Antenna pointing accuracy is in the range of 3-6 arcseconds;
- Antenna tracking accuracy is within 3 arcseconds;
- Sub-reflector positioning accuracy is about 0.01 mm in X, Y, Z and 1.4 arcmin in Gamma.

Presently the work on the controller is basically finished. Testing of the new system is under way.

4. Zelenchukskaya Station

The radiometer device was installed at the Zelenchukskaya station. The device is intended for observation at single dish mode and for investigations of antenna performance using Field System software. Pointing correction models were measured at X-band. New scanning algorithms were implemented in the antenna control system. These improvements are useful for single dish observations.

New automatic meteorological stations were installed at Zelenchukskaya. The software for meteo data acquisition to the Field System was developed.

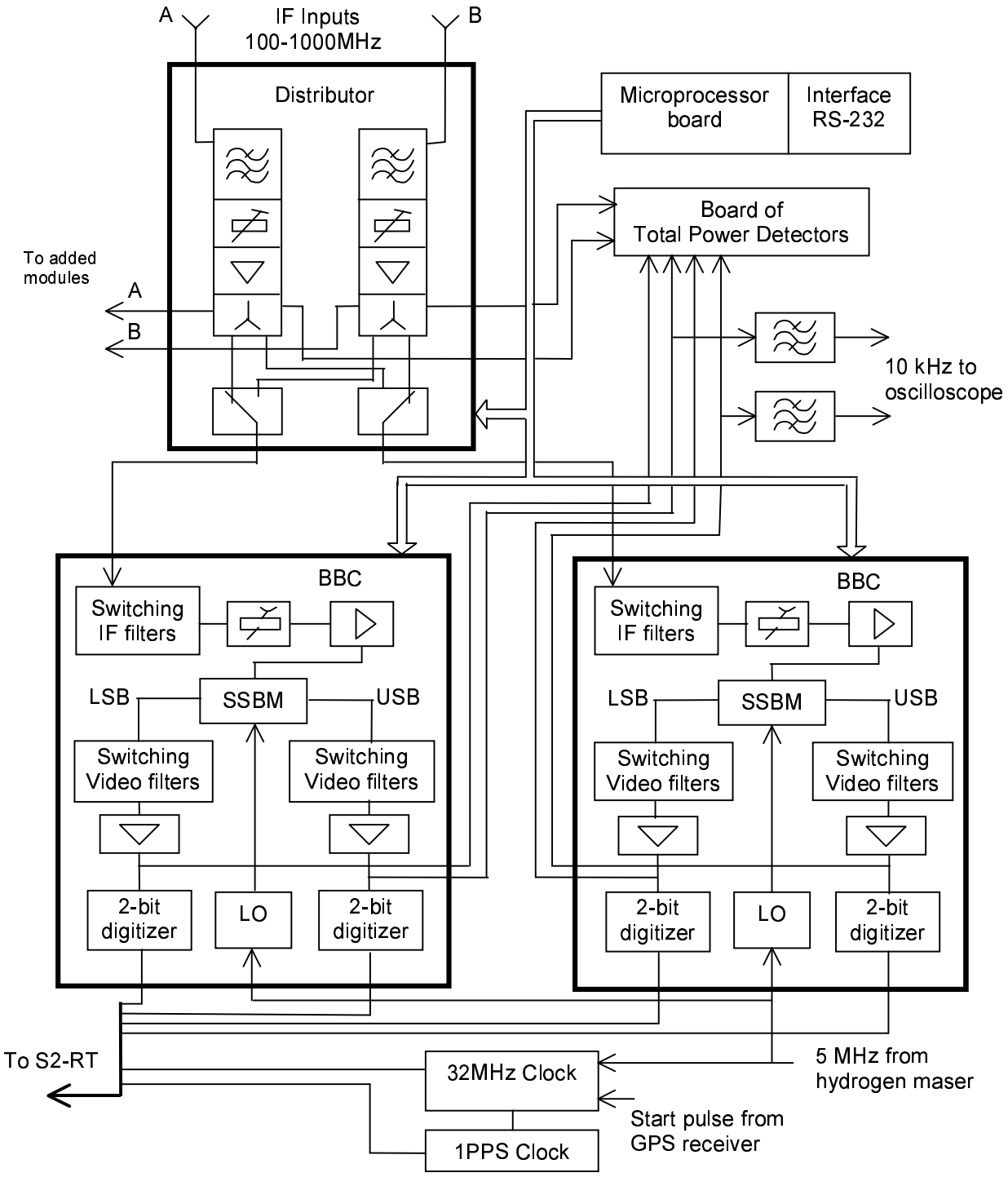

Figure 1. VLBI data acquisition system for the S2-RT recorder terminal.