Progress on the VLBI Data Acquisition System of SHAO

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Abstract The Shanghai Astronomical Observatory (SHAO) started to develop a VLBI digital backend in 2004. In 2010, the first generation of digital backends named CDAS (Chinese VLBI Data Acquisition System) was installed at the CVN VLBI stations and applied in several projects. This paper introduces the history, the current status, and the future of the VLBI digital backends developed at SHAO.

Keywords VLBI, CDAS

1 Introduction

In 2004, the Shanghai Astronomical Observatory started to develop VLBI digital backends. In 2010, the first generation of digital backends named CDAS (Chinese VLBI Data Acquisition System) [1] was installed at the CVN VLBI stations. During the past ten years, CDAS has supported not only the Chinese Lunar Projects but also astrometric, geodetic, and astrophysical observing.

In 2016, a new VGOS station will be established near the Tianma station. The new generation backend CDAS2 [2] will be installed to meet the requirements of the VGOS. And CDAS3 [2] is still under development.

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2 The Application of CDAS

The CDAS has served the Chinese Lunar Project for several years. In the project, a narrow-band mode such as 2 MHz or 4 MHz x 8 channels was applied due to the speed limitation of the data link from the stations to the data center. The total data rate was no more than 64 Mbps, and the data was sent to the data center in real time by Mark 5B.

Furthermore, the full bandwidth mode such as 32 MHz x 16 channels was applied in a VLBI ecliptic plane survey. The total data rate is 2048 Mbps. In June 2013, the first trial of VEPS observations was made using a 1024(Mbps)-16(Channel)-1(bit) mode. Last year, eight sessions were observed, and a 2048(Mbps)-16(Channel)-2(bit) mode was applied by CDAS at the CVN stations [3] .

3 CDAS2

The hardware of CDAS2 was finished in 2014. The full IF bandwidth that can be accepted is 1024 MHz, which can be split into 2 x 512 MHz. The most significant improvement is that a 10Gig Ethernet interface is available. So it can connect with Mark 6 or the commercial disk array through Ethernet.

Now the firmware for PFB mode is almost finished. It can split the IF into several basebands in the same bandwidth. The maximum data rate is 4096 Mbps. The data that is sent by the UDP protocol by 10Gig Ethernet can be monitored by the DATA CAPTURE function in near-real time as Figure 1 shows. In 2 x 512 MHz mode, a thread id can be assigned to each IF.

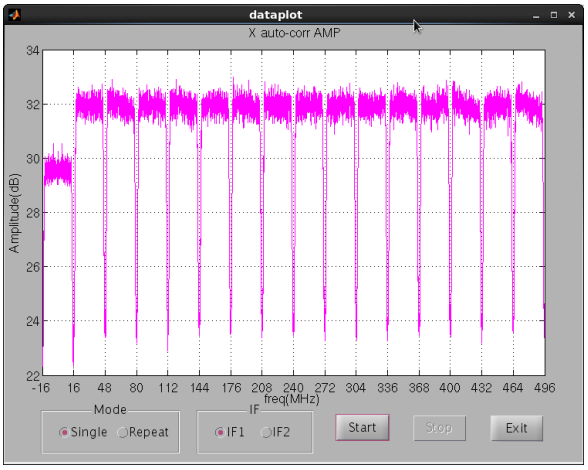

Fig. 1 Control Panel for DDC.

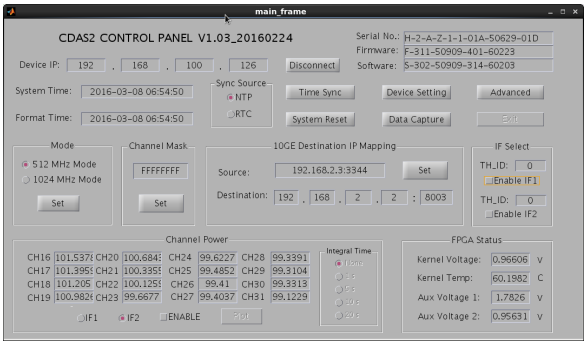

Fig. 2 Control Panel for PFB.

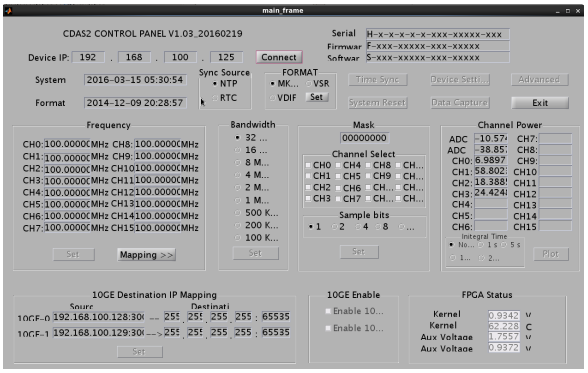

Fig. 3 Control Panel for PFB.

The DDC mode, in which the frequency and bandwidth are changeable, is in development. It is more suitable for astrophysics and deep space applications. The narrow bandwidth (below 1 MHz) and multi-sample-bits (4/8/16-bit) design is aimed at spacecraft tracking.

Figure 2 and Figure 3 show the different parameters needed by the firmware.

4 CDAS3

CDAS3 has improved the full IF bandwidth from 1024 MHz to 2048 MHz. Also it can be split into 2 x 1024 MHz or 4 x 512 MHz. The maximum data rate can be up to 8192 Mbps.

The performance of the ADC module has been tested. An 8 MHz sine wave has been sent to the ADC, and the digitalized data can be captured by FPGA. Then the data can be exported, and the ENOB and SFDR can be calculated using Matlab. Figure 4 shows the results for one channel.

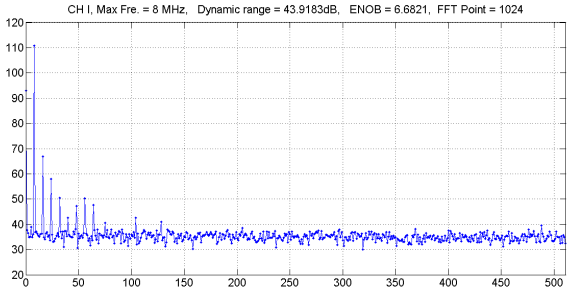

Fig. 4 The ADC performance of CDAS3.

5 Solution for VGOS Station

For the new VGOS station that will be built in Shanghai, a 512-MHz bandwidth observation mode will be achieved first. The maximum data rate is 1024 Msps x two bits x two polarizations x four bands = 16 Gbps. In this case, four sets of CDAS2 can meet the requirement because each set can deal with two polarizations for the 512 MHz bandwidth. And four data streams that come out from CDAS2 can be connected to four SPF+ ports in Mark 6 directly.

In the future, a 1024-MHz bandwidth observation mode will be achieved, and the data rate will be doubled. There are two solutions to meet the new requirement. One solution is simply to double the number of CDAS2 sets of equipment, from four to eight. Due

to the number of SFP+ ports in Mark 6, a 10Gigabit switch would be needed. The other solution is upgrading the four sets of CDAS2 to CDAS3 because each CDAS3 can deal with two polarizations for the 1024 MHz bandwidth.

References

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