Development of the new Jicamarca Acquisition Radar System: JARS

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INTRODUCTION

The need for high-precision radar measurements of the upper atmosphere has motivated the development of new acquisition systems at the Jicamarca Radio Observatory (JRO). Digital receivers have replaced the old analog receivers, providing higher dynamic range, faster sampling rates, and more flexibility in configuration.

At JRO, off-the-shelf Digitals Receivers (Echotek GC214) are used, but they are not as flexible as we need, so we decided to develop our own digital receiver system. The first prototype we built was a two-channel data acquisition system (REX-2X). The system was finished in 2008 and it has been used to modernize the SOUSY radar at Jicamarca. In 2009, after the experience gained from REX-2X, a new project was started. An eight-channel acquisition system named JARS (Jicamarca Acquisition Radar System) was designed.

COMPARISON TABLE

Reception System	Analog	Digital REX-2X	Digital JARS
Receivers	- Analog Parts: mixers, filters, attenuators. - Different performance among receivers (e.g. Bandwidth, gain, I&Q).	Digital Receiver: - Perfect coherent quadrature detector - Programmable filter - Matching Filter - No Cross Talk	
Sensibility	A/D of 8 bits	A/D of 12 bits	A/D of 14 bits
Dynamic Range	48 dB	70 dB	84 dB
Numbers of channels	Up to 8 channels	Up to 2 channels	Up to 8 channels
Programmable filter	NO	Mechanical	Automatic
Configuration change experiment	Laborious	Mechanical	Automatic
Software for programming filters	NO	Software of evaluations boards AD6620	System Software

Tabla. 1: Comparison table of some reception systems developed in the JRO

HIGHLIGHTED FEATURES

- ***Maximum transfer*:** Currently, the maximum transfer rate of JARS is 1 MHz per channel.
- ***Hardware and software integration*:** A single port communicates with the PC via a NIDAQ 6534 PCI card interface, which operates bidirectionally. This reads files that contain the experiment parameters.
- ***Flexibility*:** The hardware is controlled by Programmable Logic Devices CPLD's, which also manage the communication protocol between the system and the PC.

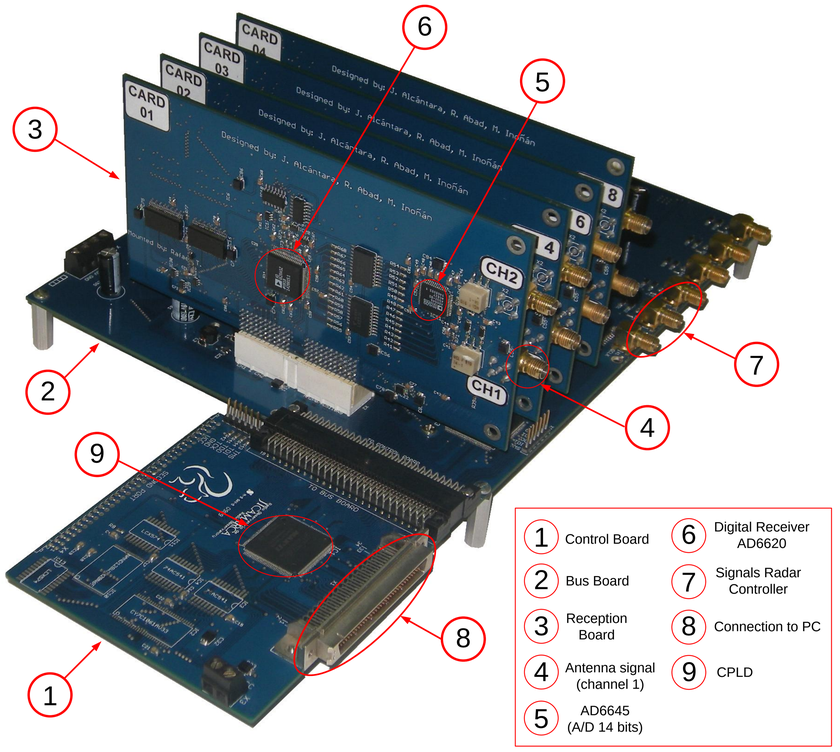

Fig. 1: Picture of the new digital reception system: JARS

JARS SYSTEM DESCRIPTION

JARS is composed of 03 cards: (1) Control, (2) Bus and (3) Reception. The logic of the JARS is controlled by 03 CPLD's MAX II.

The control system performs the following tasks:

- Communication protocol
- Setup the CLOCK DRIVER
- POWER MANAGEMENT (selected channels)
- Programming of the reception cards (filters)
- Transfer data (data acquisition reception cards, synchronization with the Radar Controller and sending data to the NIDAQ 6534)

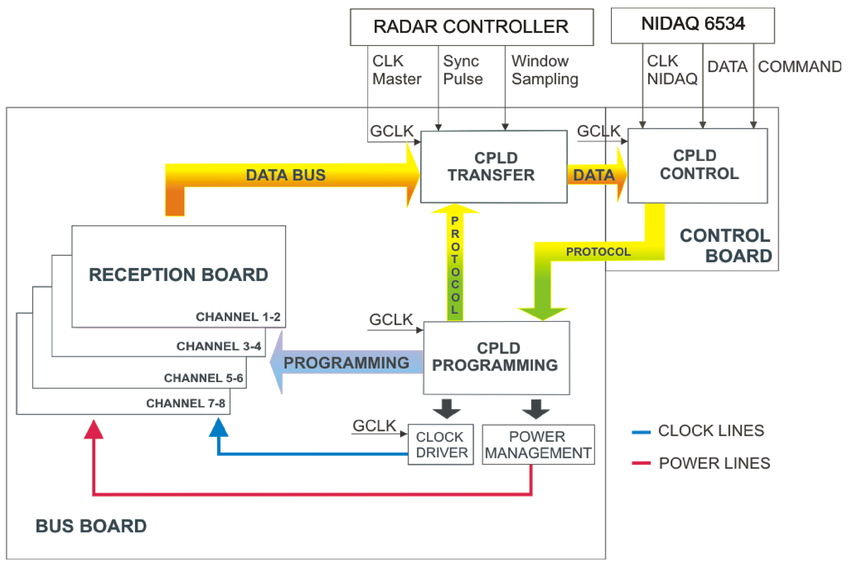

Fig. 2: Block diagram of the JARS

DIGITAL RECEIVER

The reception card is mainly composed of two chips: the AD6645 ADC and the AD6620 digital receiver. The AD6620 performs quadrature demodulation, filtering and decimates the data. The AD6620 chip must be programmed through the lines (RST, CS,WR, ADD and DATA PROG) to start the system operation.

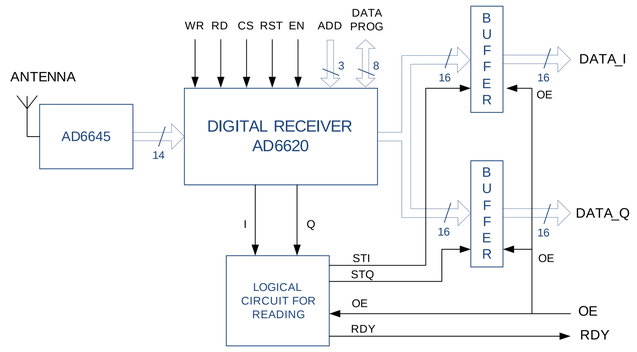

Fig. 3: Block diagram of the reception board

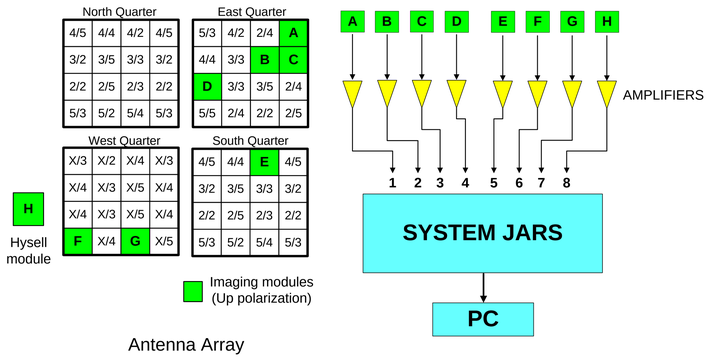

Fig. 4: Block diagram of possible configuration of JRO radar reception with the JARS system

FUTURE WORK

- Increase the number of channels to 12, with a bandwidth of 1 MHz per channel.
- Use the control board to pre-process the signal in hardware.
- Independent programming of each channel of the AD6620 digital receiver with different settings.
- Improve the control of the CLOCK DRIVER. Different clocks for each reception channel will make the system more flexible.
- Improve the matching of the circuit lines. Match the master clock to reduce hardware interference.
- Improve the transfer speed by exchanging the NIDAQ 6534 (20MHz clock) by the NIDAQ 6537 (50MHz clock).

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