JRO: R&D (IDI)
Acquisition Systems

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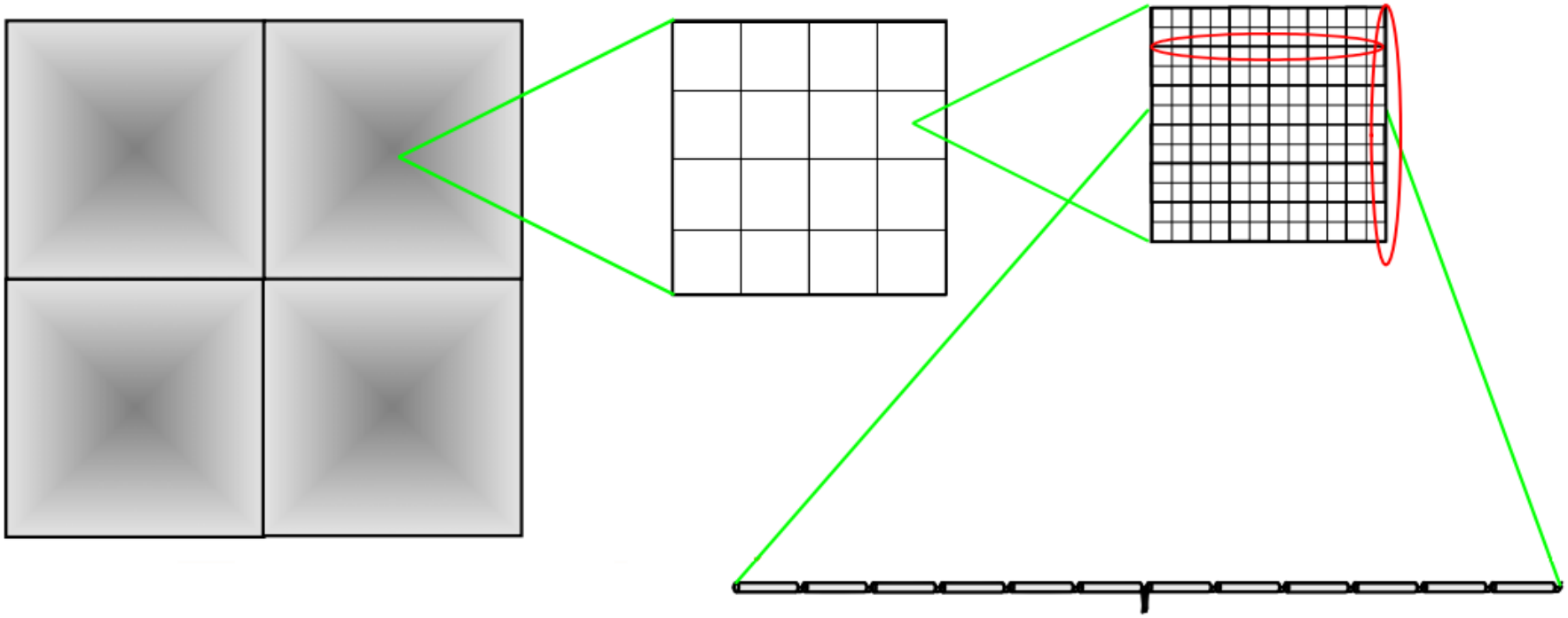
2018

Main Radar

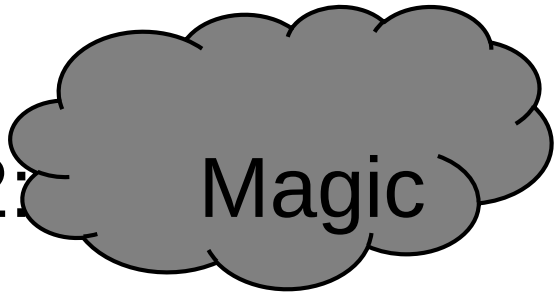
- Located 20 Km North of Lima
- 18,432 dipoles
- Area: 85,000 m^2
- Working frequency 49.92 MHz
- 6MW Power (4 Tx, each 1.5 MW)

Antenna



How do we get radar data?

Step 1: Get Radar

Step 2: 

Step 3: Data!

How do we get radar data?

Step 1: Get Radar

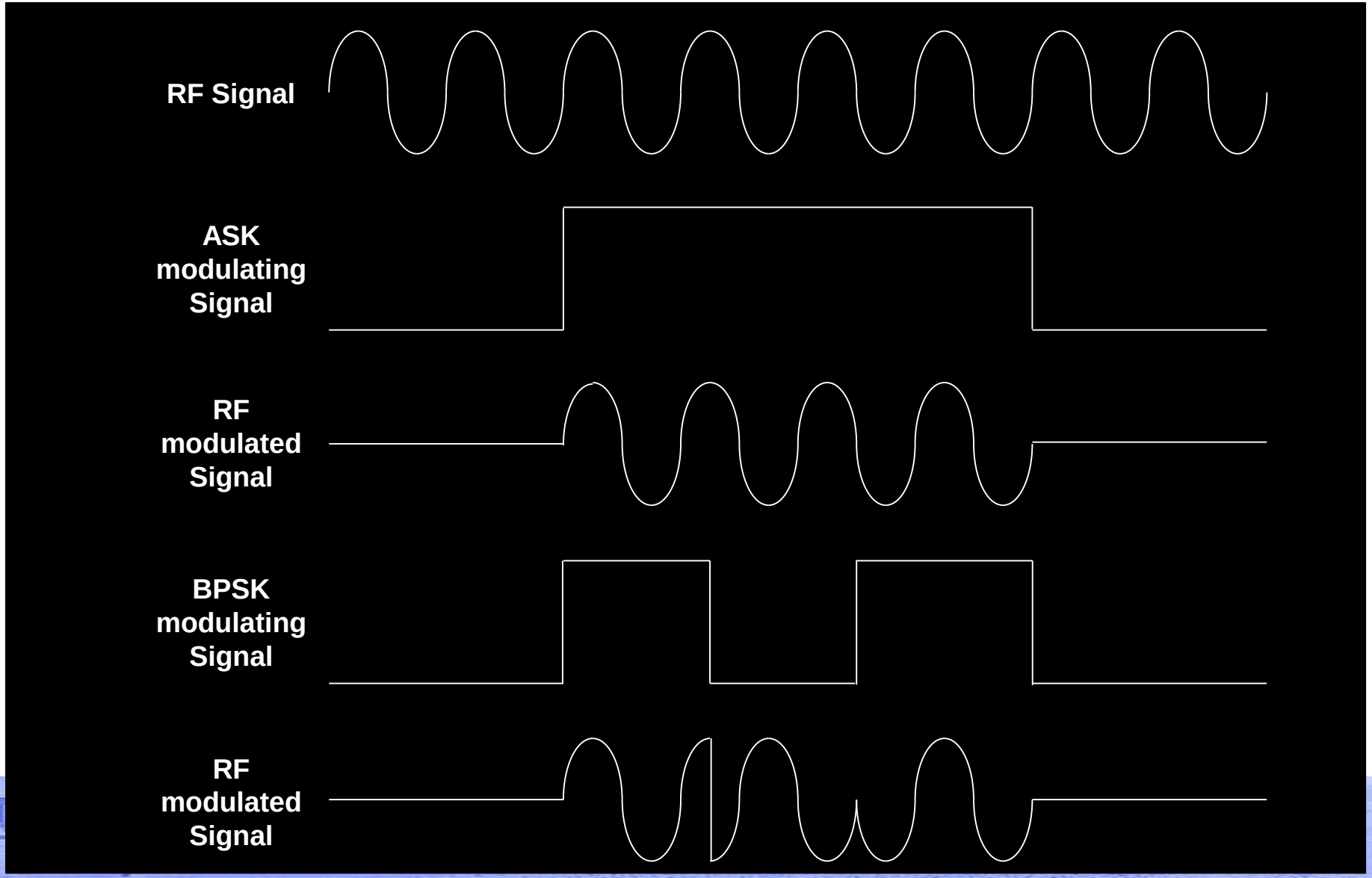
- RF signal, Amps, Tx, T/R, Antenna, Rx

Step 2: Magic

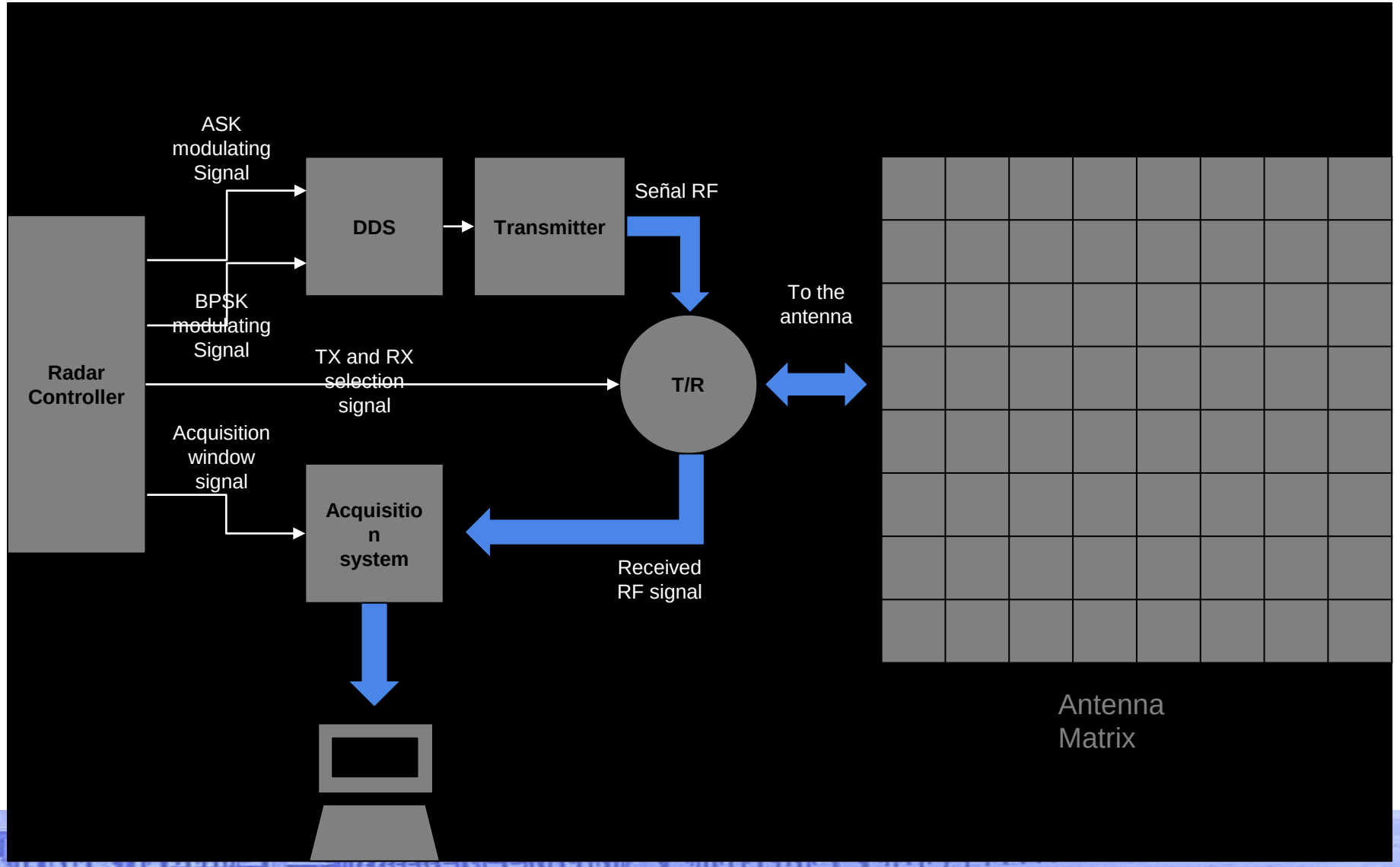
- Digital Synthesizer, Radar Controller, Data Acquisition System, Monitoring, Visualisation, Pre Processing, Storage

Step 3: Data!

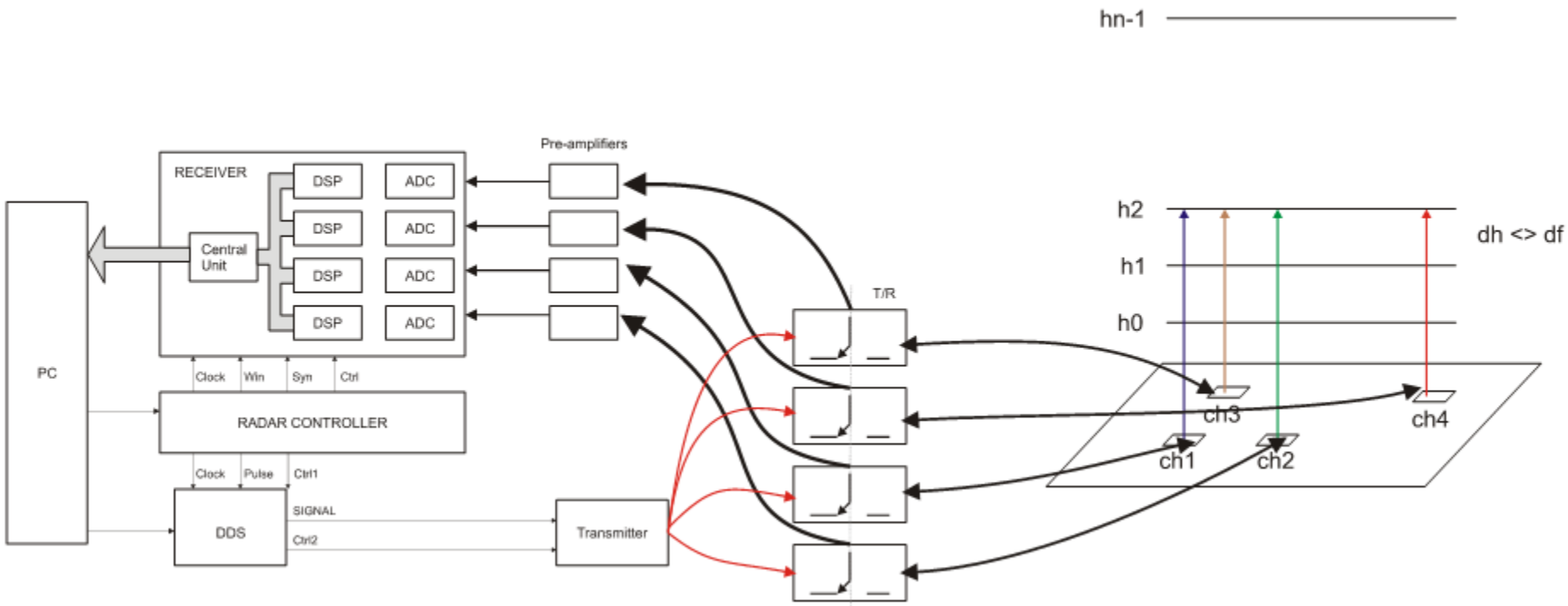
System Block Diagram



System Block Diagram

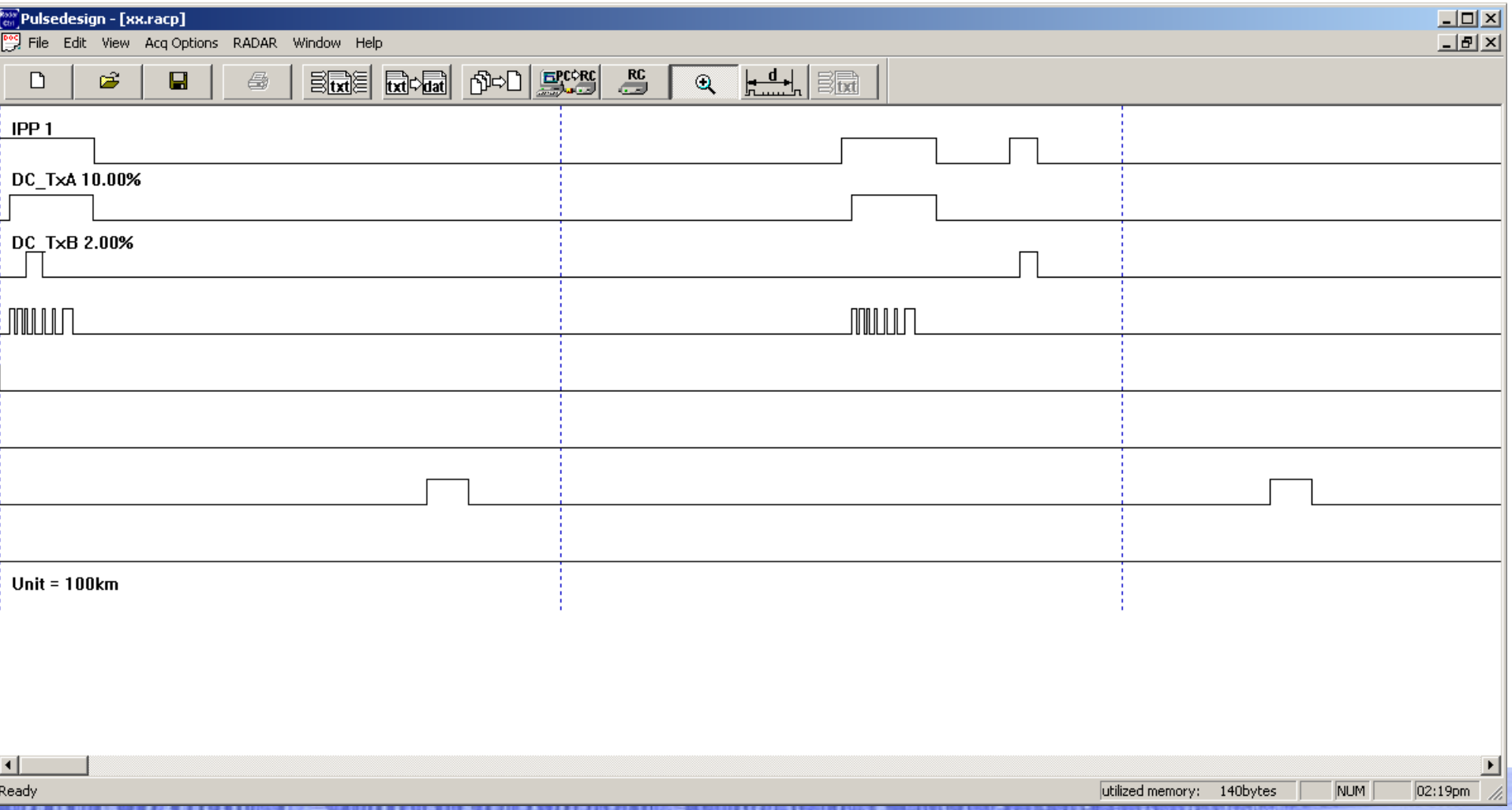


System Block Diagram

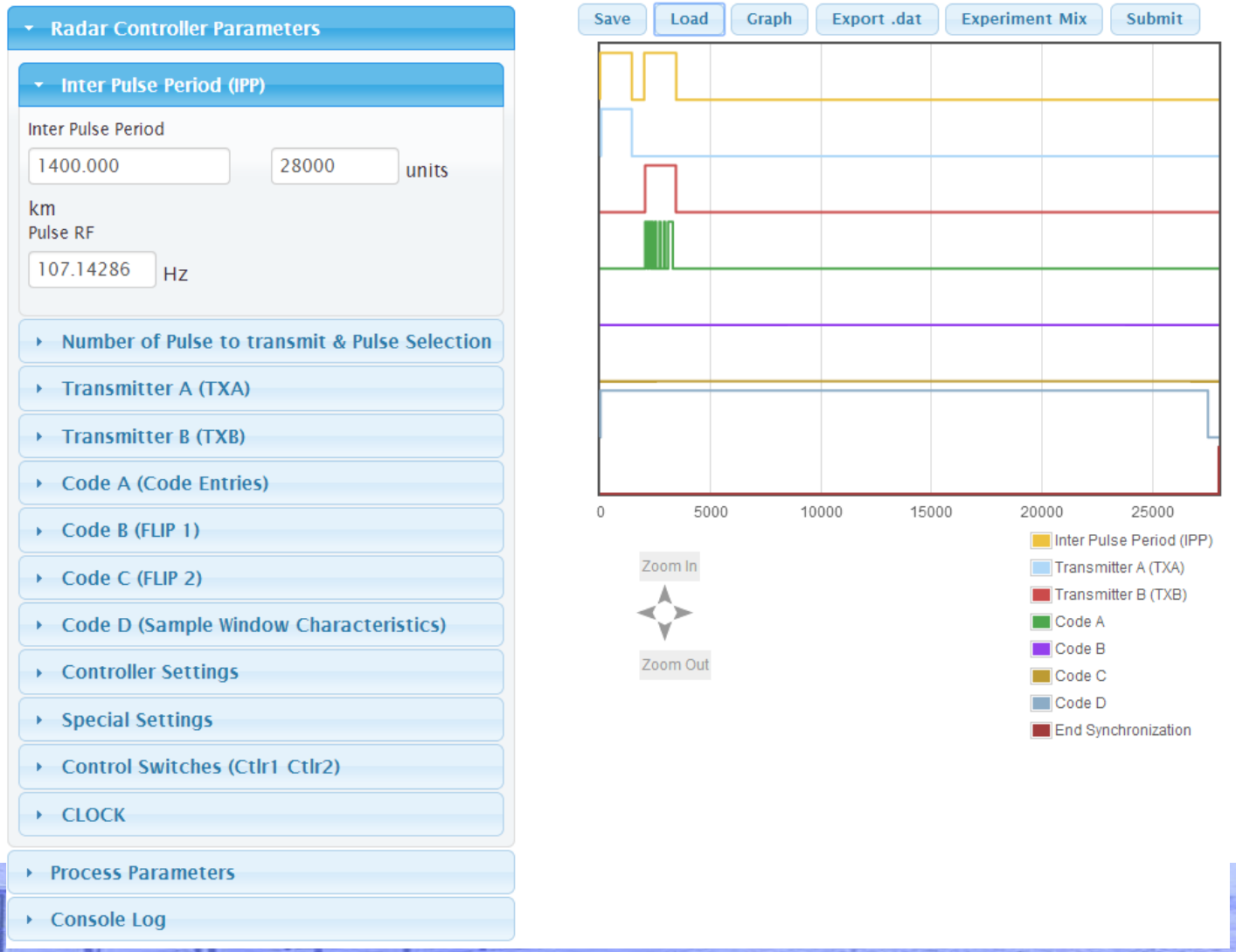


1. Radar Controller (CR)

Radar Controller - Pulse Design



Radar Controller - Pulse Design



Radar Controller - Pulse Design

Radar Controller - V 1.0 USB

- CPLD
- 8 Channel
- Programmed by USB

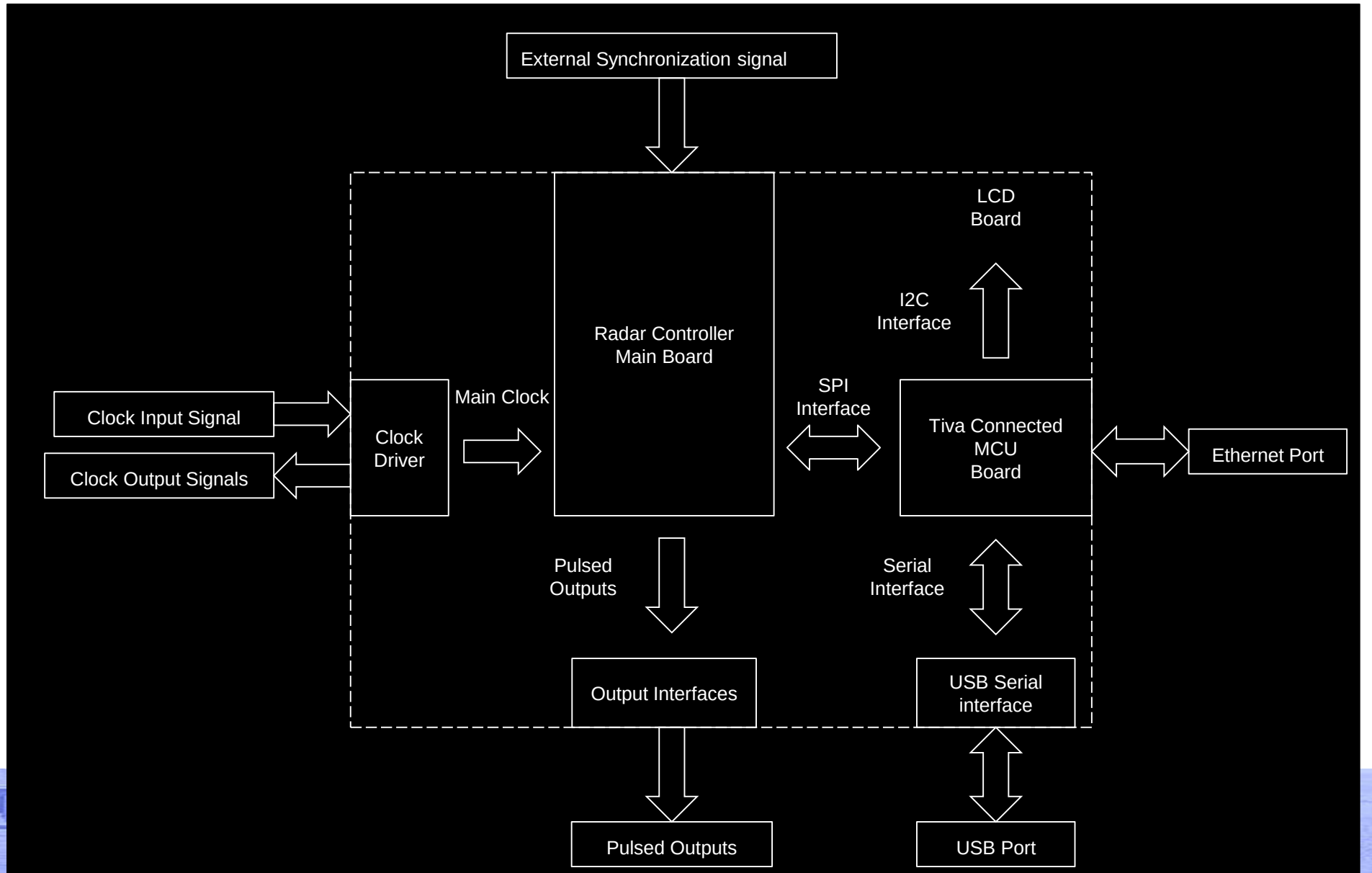
Radar Controller - V 1.1 USB

- CPLD
- 8 Channel
- Programmed by USB
- Increased resilience to EM interference from circuitry, clock

Radar Controller - V 2.0 Ethernet

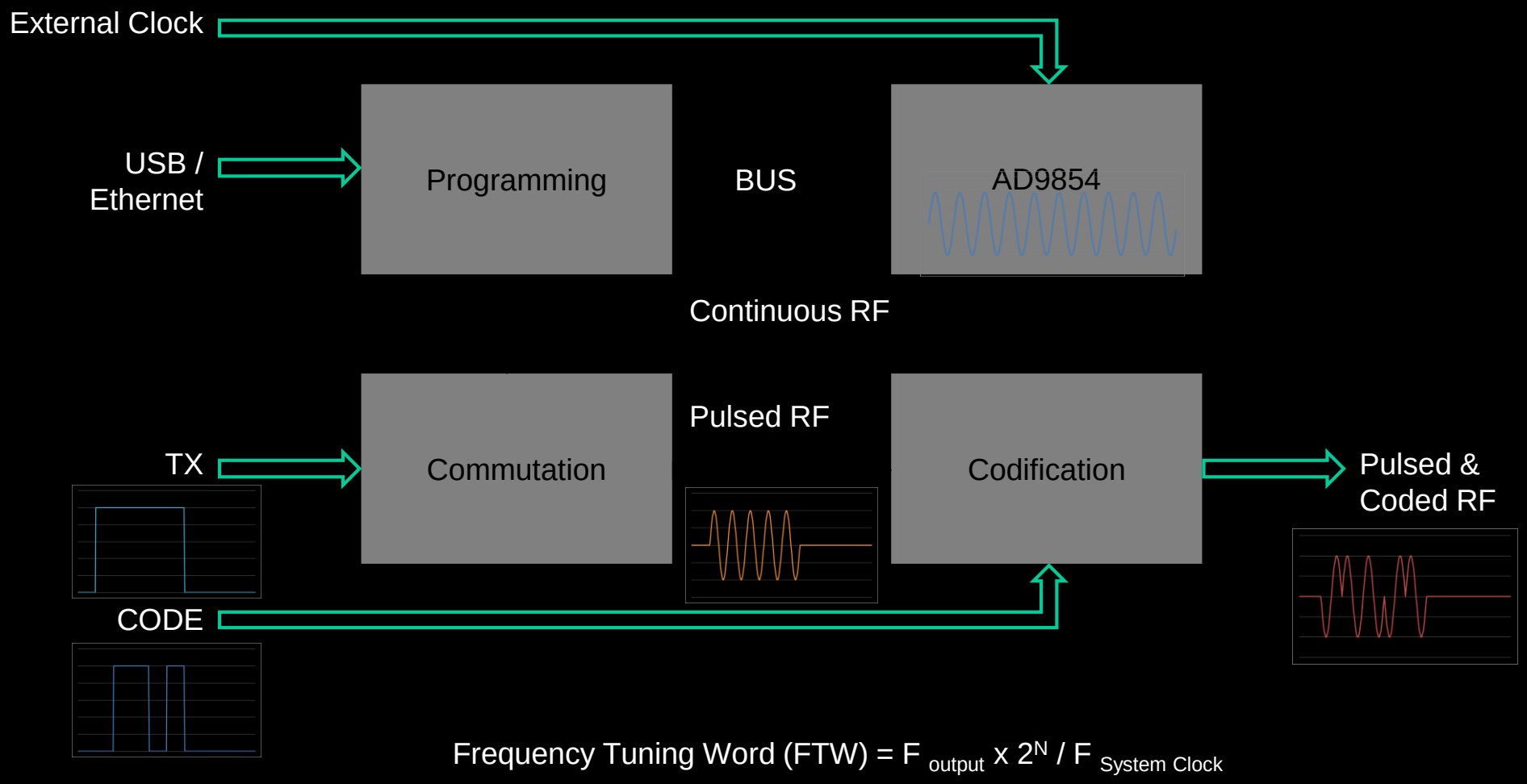
- Spartan 6 FPGA
- 16 programmable channels
- Additional Memory
- Programmed by Ethernet
- Backward USB compatibility
- Real-time monitoring of

Radar Controller - V 2.0 Ethernet



2. Direct Digital Synthesizer (DDS)

Direct Digital Synthesizer (DDS)

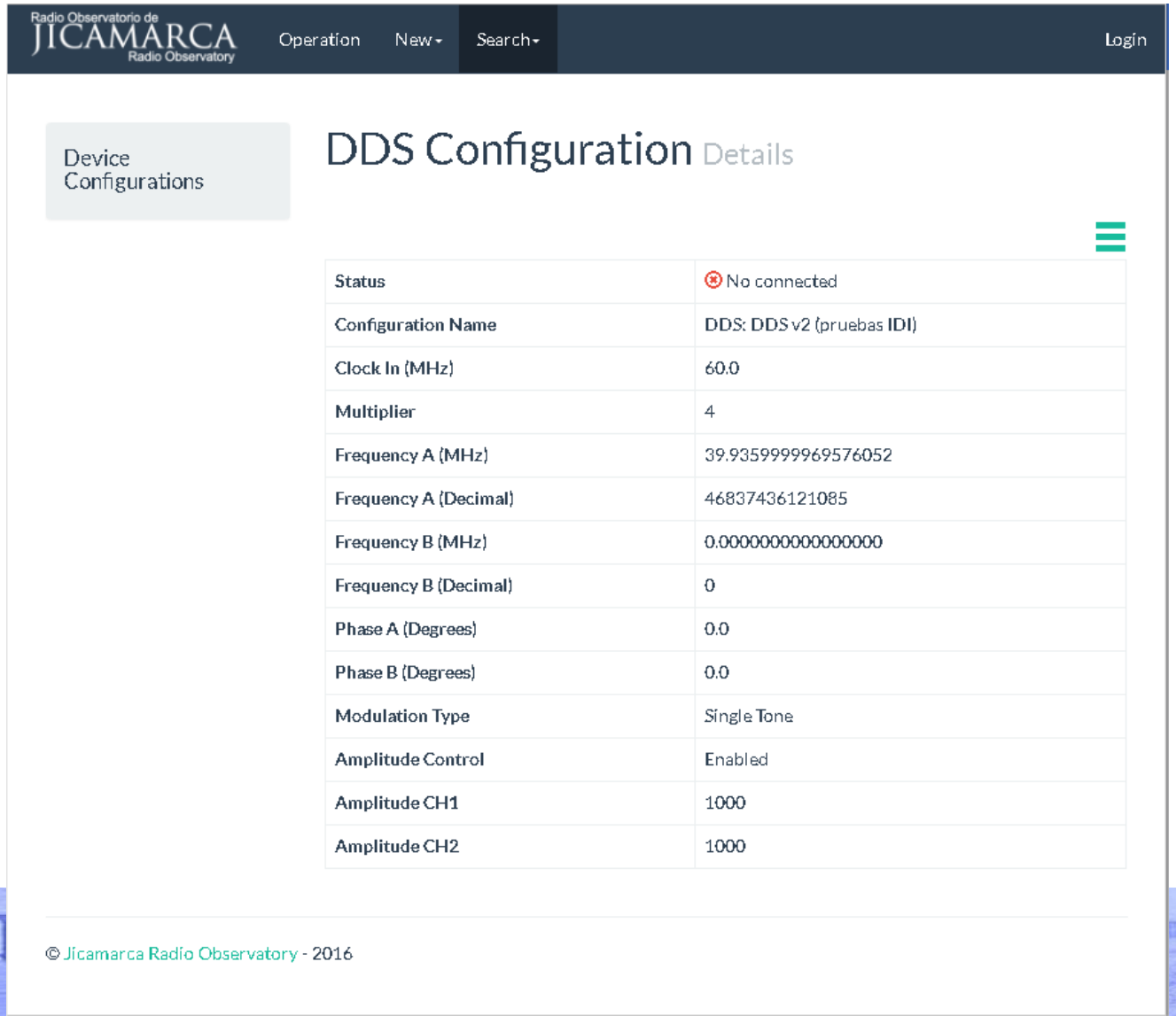


Frequency Tuning Word (FTW) = $F_{output} \times 2^N / F_{System\ Clock}$

Direct Digital Synthesizer (DDS)

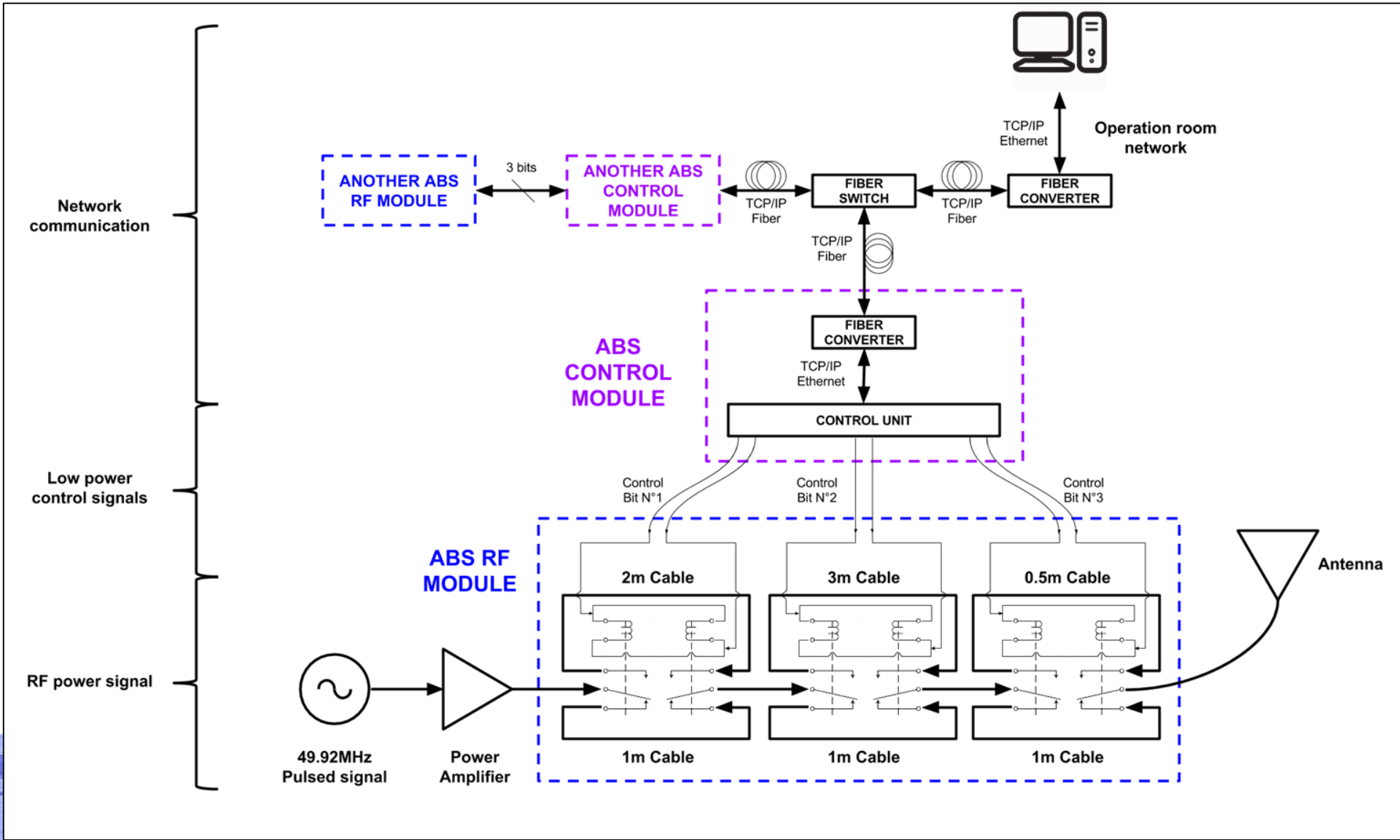
- 48-bit resolution
- 4x Multiplier
- 2 Channels
- 60dB crosstalk
- Programmed by USB / Ethernet

Direct Digital Synthesizer (DDS)



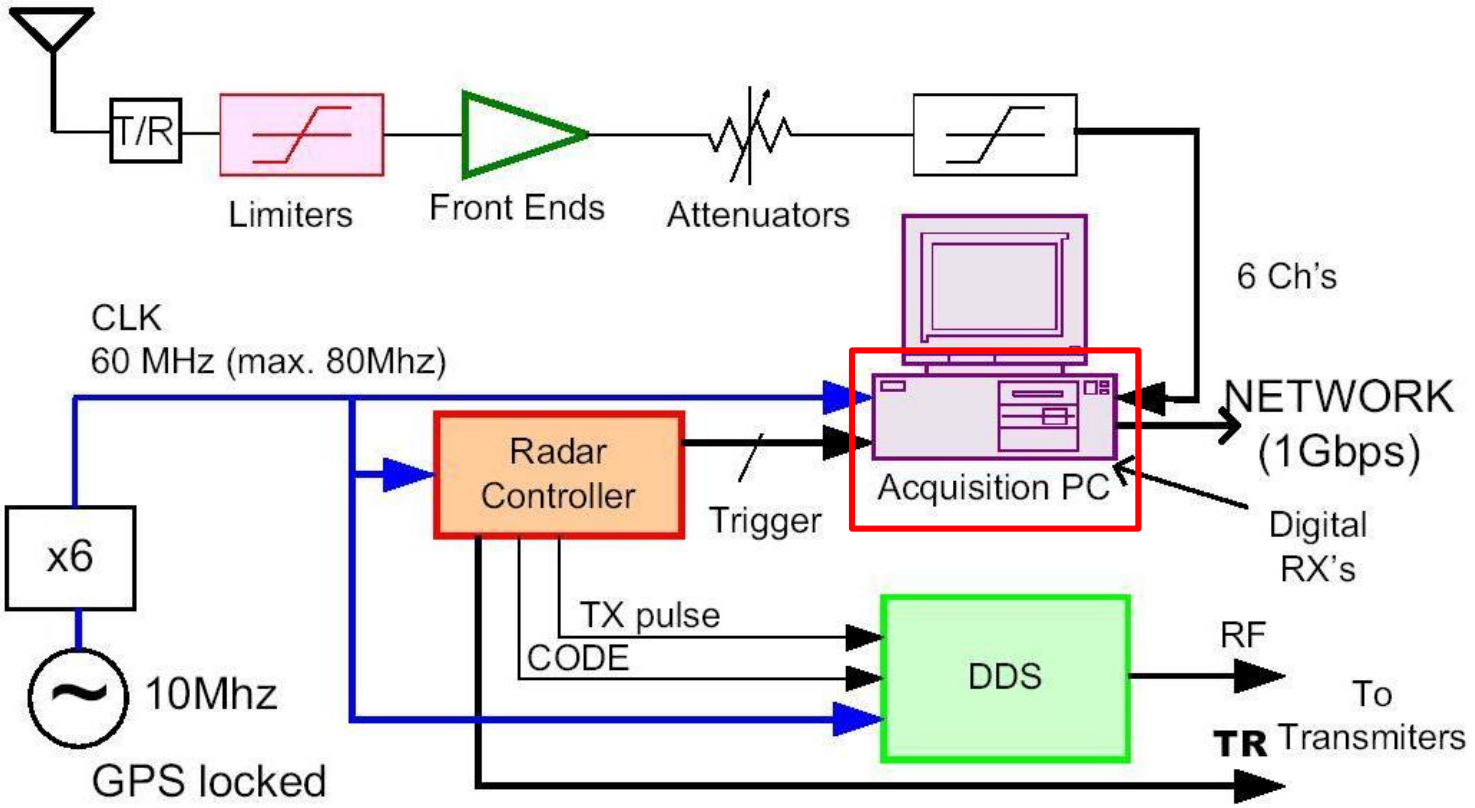
3. ABS (Automatic Beam Stearing)

ABS Diagram

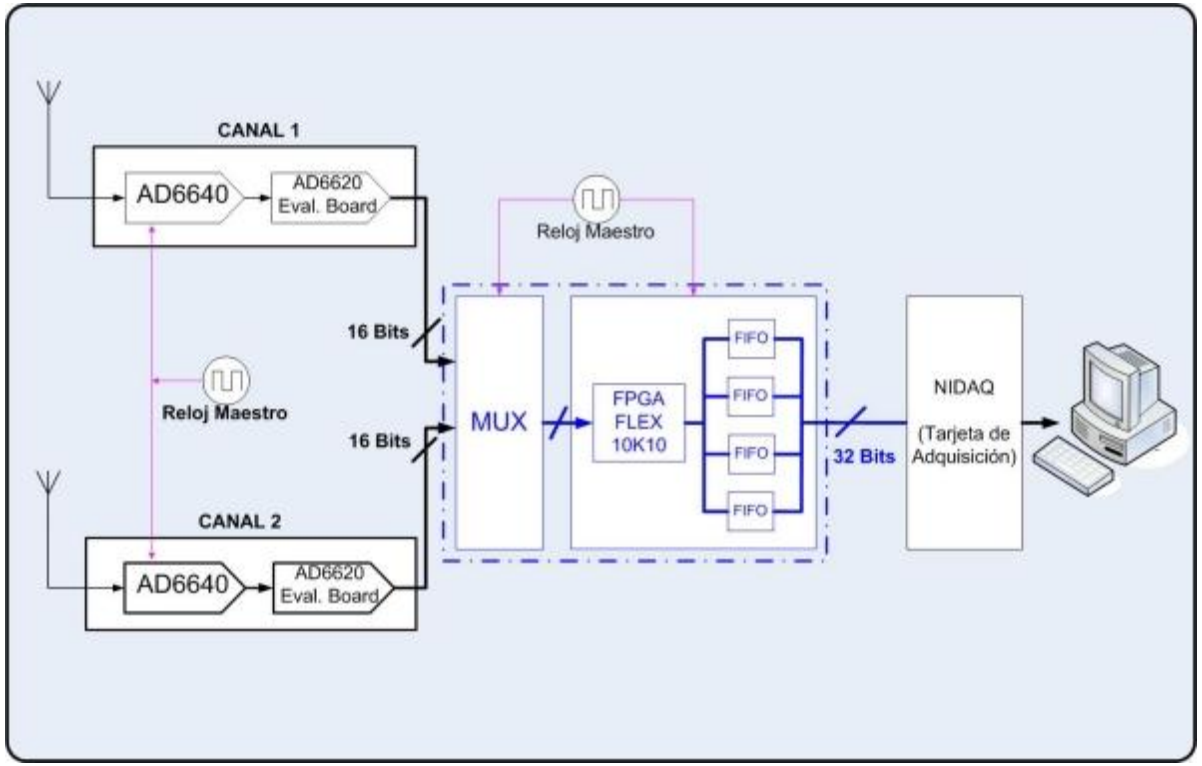

Network communication
Low power control signals
RF power signal
TCP/IP Ethernet
Operation room network
ANOTHER ABS RF MODULE
3 bits
ANOTHER ABS CONTROL MODULE
TCP/IP Fiber
FIBER SWITCH
TCP/IP Fiber
FIBER CONVERTER
TCP/IP Fiber
ABS CONTROL MODULE
FIBER CONVERTER
TCP/IP Ethernet
CONTROL UNIT
Control Bit N°1
Control Bit N°2
Control Bit N°3
ABS RF MODULE
2m Cable
3m Cable
0.5m Cable
Antenna
49.92MHz Pulsed signal
Power Amplifier
1m Cable
1m Cable
1m Cable

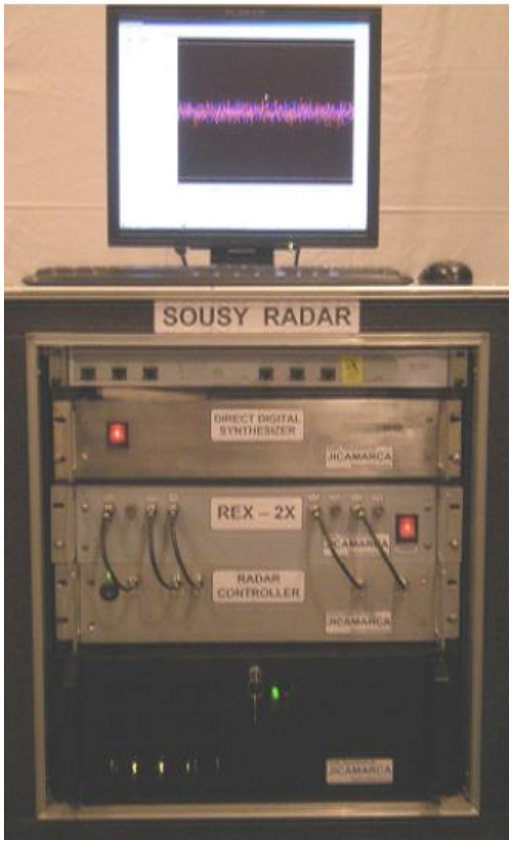
4. JARS (JRO Acquisition Radar System)

Acquisition system using ECHOTEK Digital Receiver



REX2 Reception System using AD6620 digital receiver



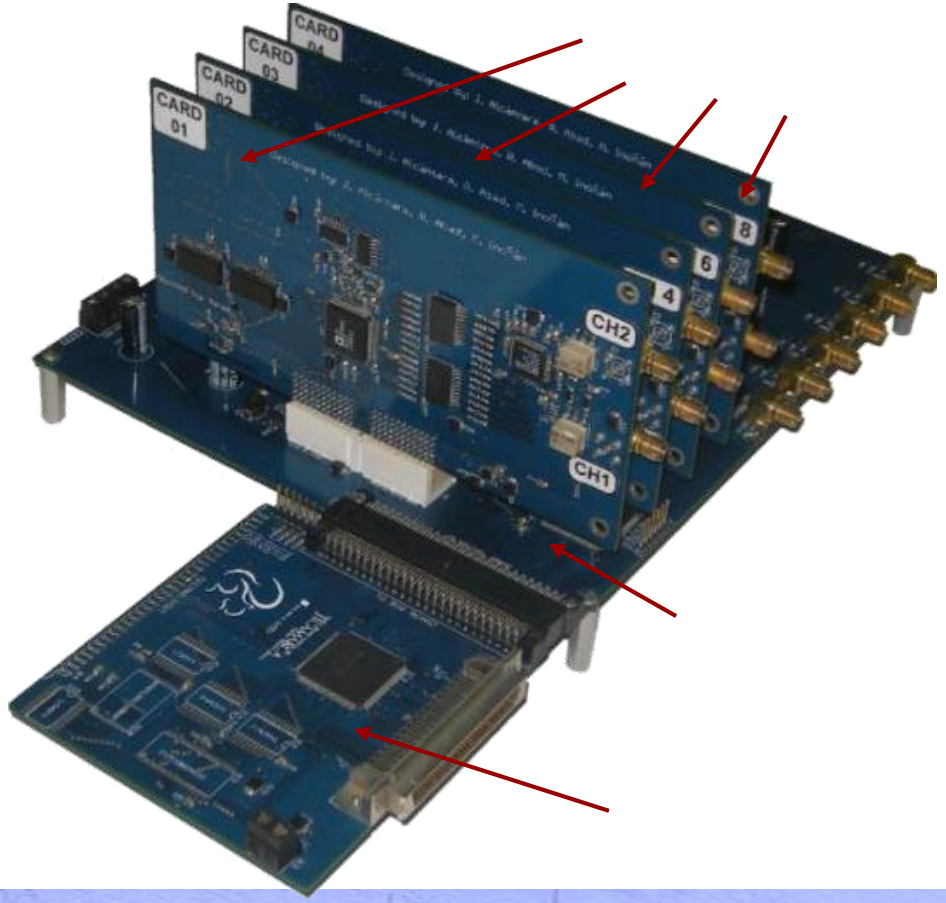


JARS 1 (JRO Acquisition Radar System)

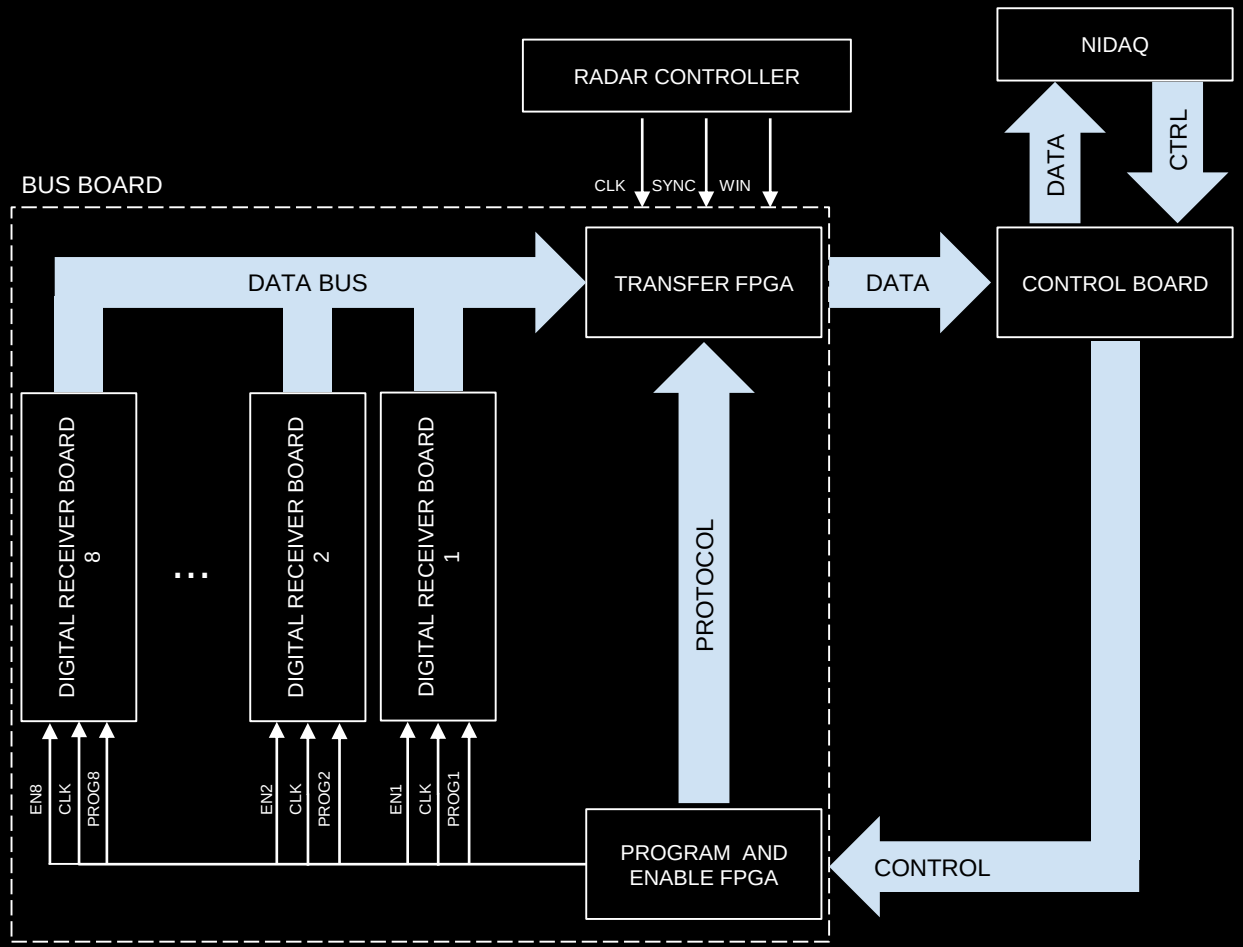
JARS characteristics

- 8 channels system.
- 60MHz main clock.
- Based on three Altera MAXII CPLD.
- Based on National Instruments NiDAQ acquisition system with PCI connection.
- Dynamic range: 80dB.
- Bandwidth in baseband per channel: 4MHz using one channel and 1MHz using eight channels.
- Decimation range: 4 to 16384.
- Full scale voltage: 1.41Vpp @ 50 ohm.

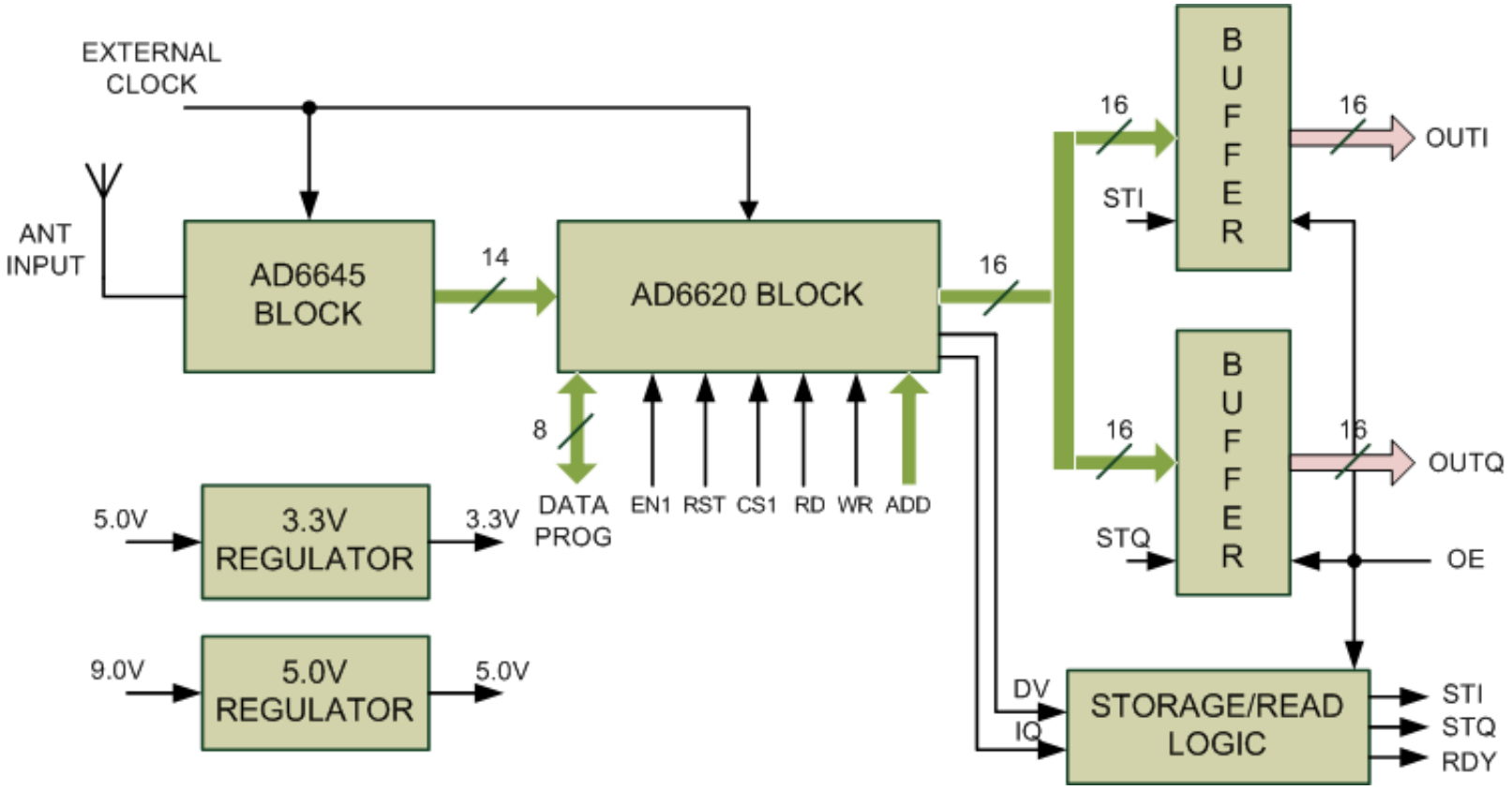
JARS system



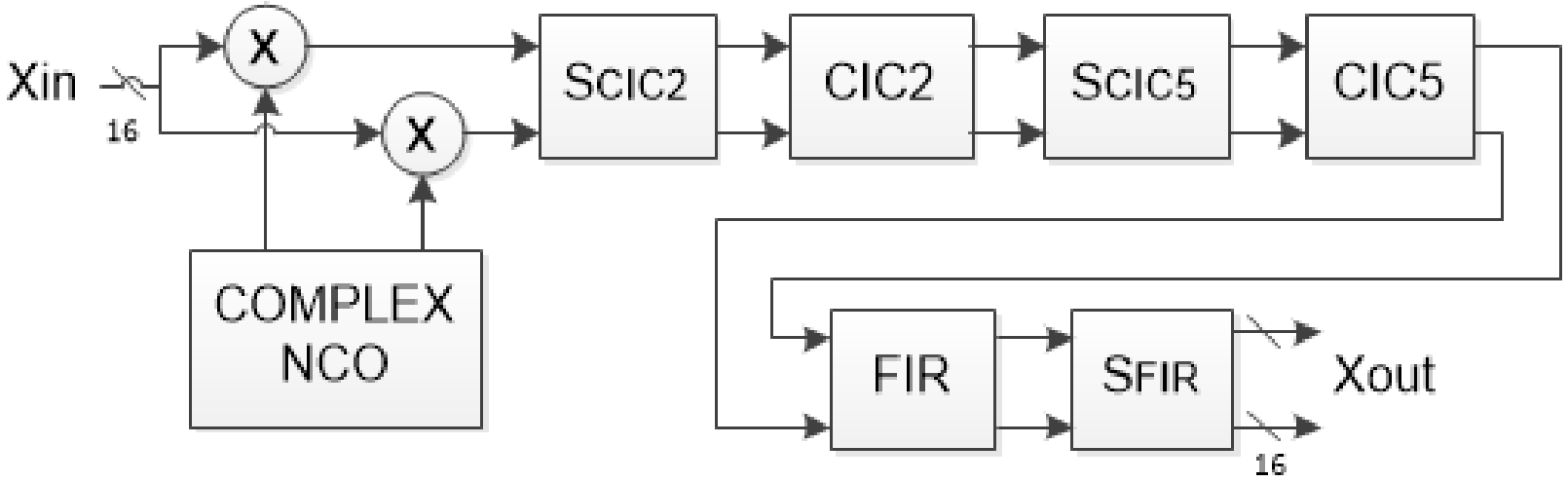
JARS system

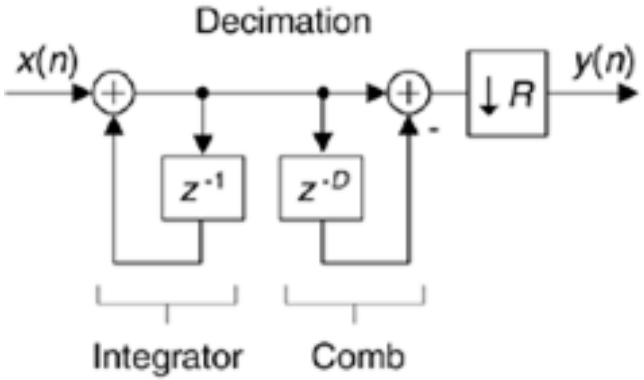

RADAR CONTROLLER
NIDAQ
DATA
CTRL
BUS BOARD
CLK
SYNC
WIN
DATA BUS
TRANSFER FPGA
DATA
CONTROL BOARD
DIGITAL RECEIVER BOARD 8
DIGITAL RECEIVER BOARD 2
DIGITAL RECEIVER BOARD 1
PROTOCOL
EN8
CLK
PROG8
EN2
CLK
PROG2
EN1
CLK
PROG1
PROGRAM AND ENABLE FPGA
CONTROL

Digital receiver design



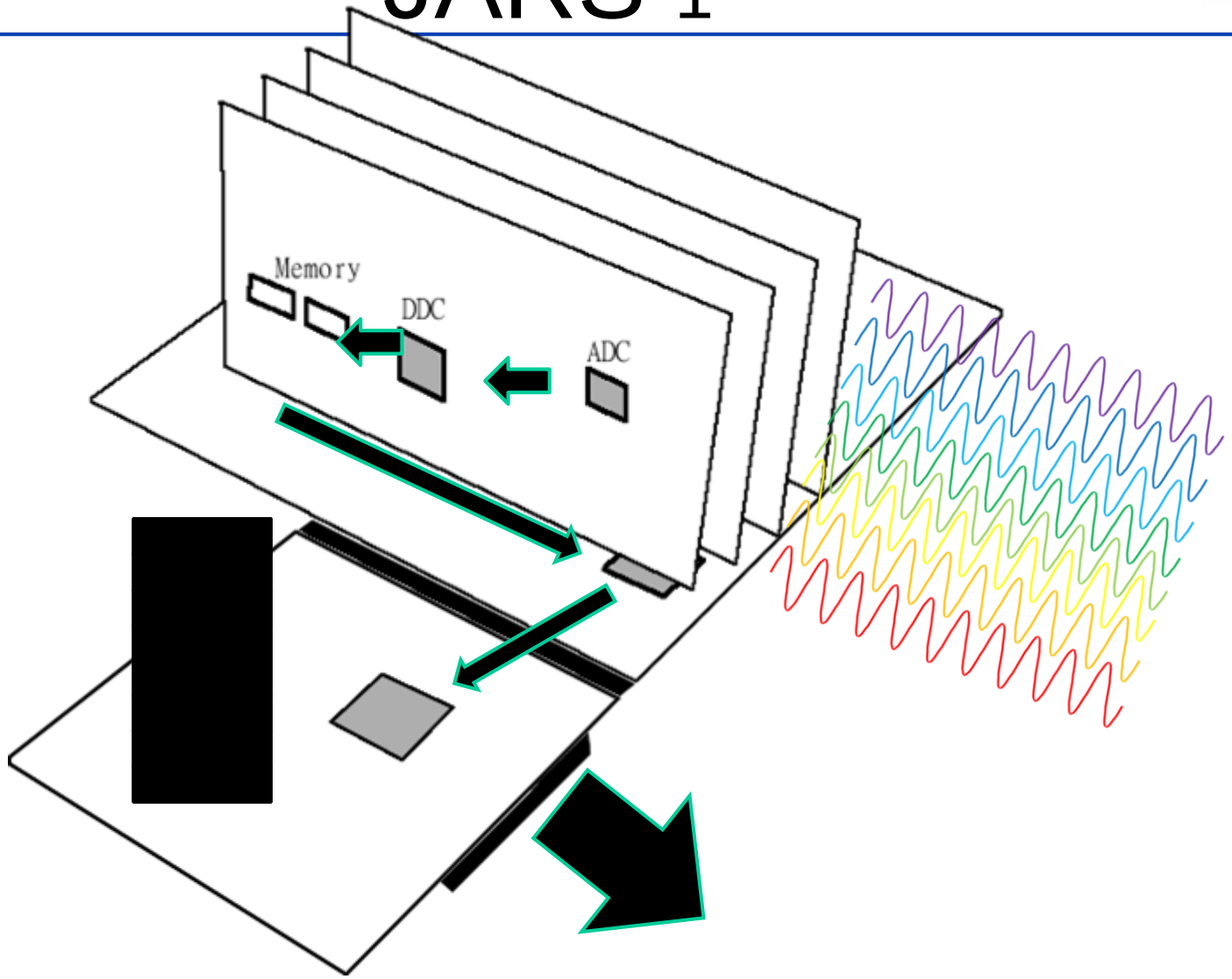
AD6620 design





(a)

JARS 1



JARS 1

JARS 1

- 8 Channel
- 60 MHZ clock
- CPLD
- NiDAQ Connection to PCI Express

JARS 1

ADC (Analog to Digital Converter)

- 14 bits
- 500ps aperture delay

DDC (Digital Down Converter)

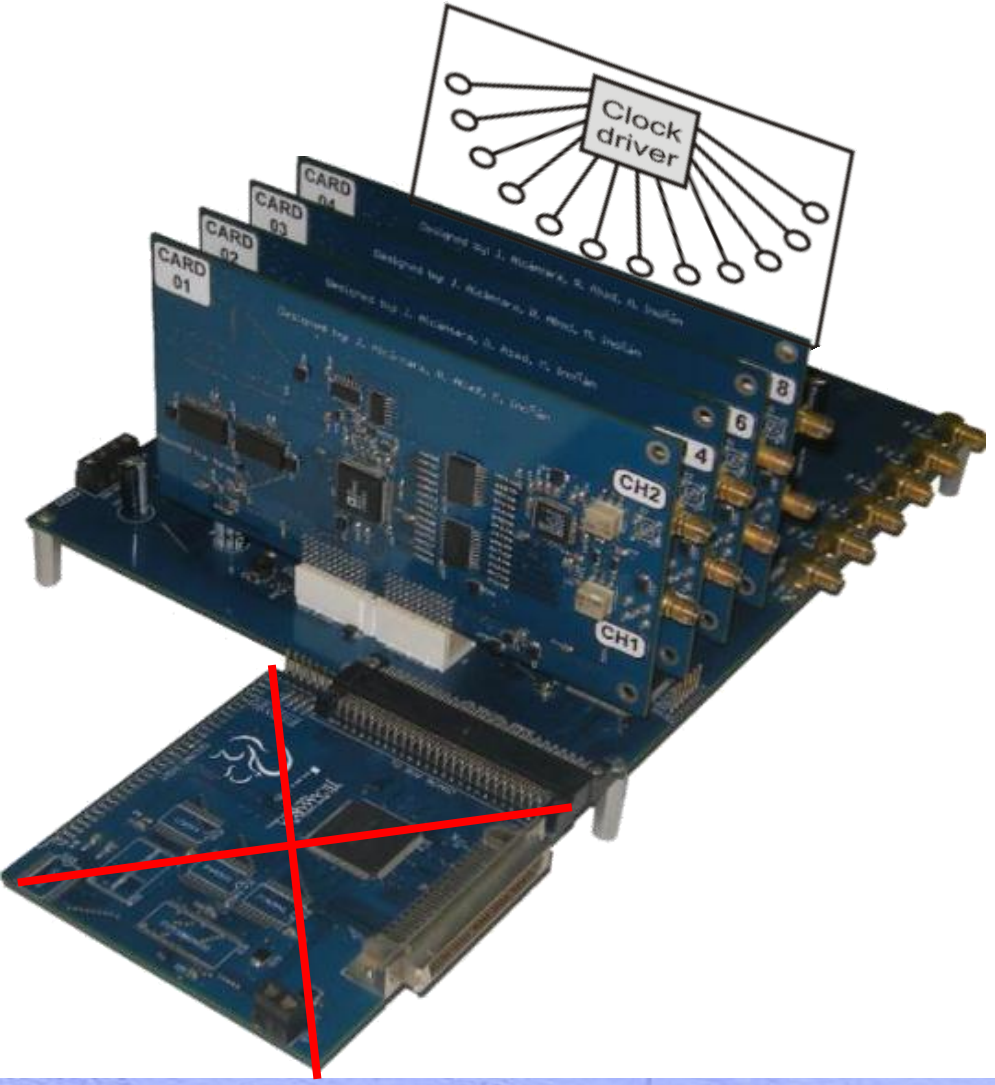
- 32 bits NCO (Numerically Controlled Oscillator)
- 2 CIC (Cascaded Integrator–Comb) and 1 FIR (Finite Impulse Response) filter

JARS 1

- Dynamic Range: 80dB
- Maximum transfer per channel: 1 MHz
- Decimation range: 4 to 16384
- Maximum signal level: 1.41 Vpp @ 50 ohm

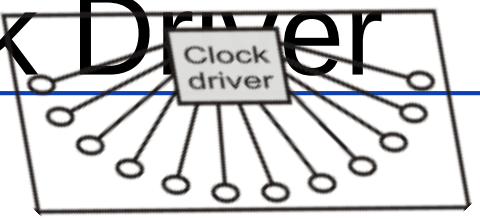
JARS 2.0

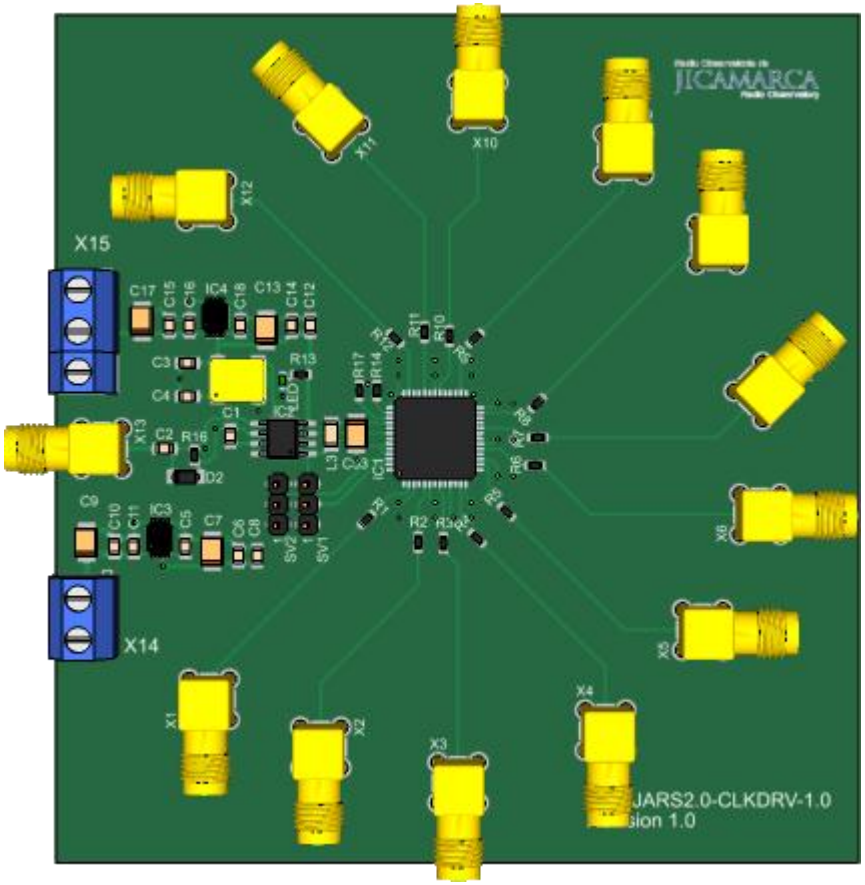
JARS 2.0



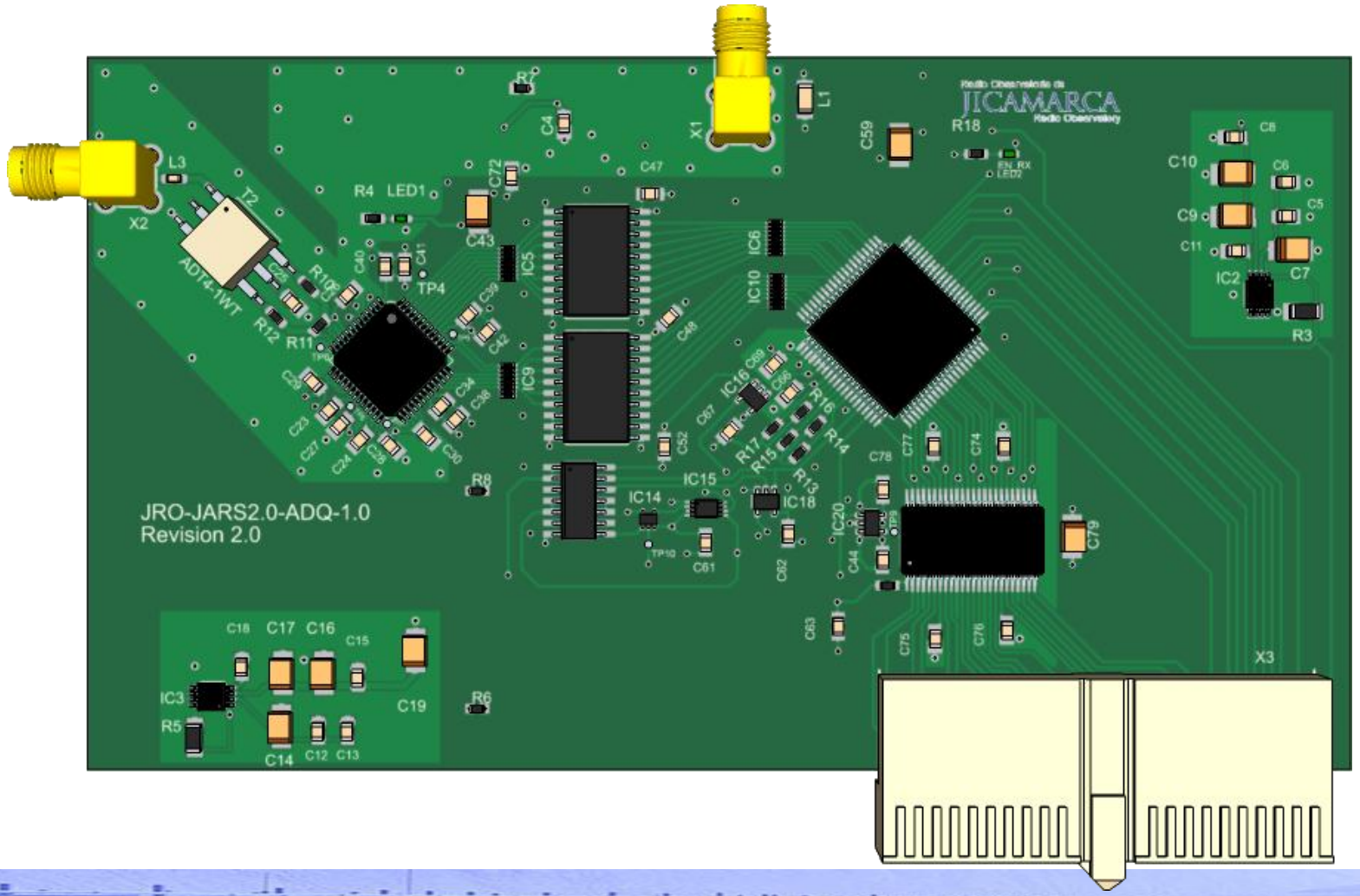
- Avoid Proprietary technology (NiDAQ)
- OS agnostic
- Distributed clock to acquisition boards
- Better signal routing to avoid EMI
- Faster transfer rate (Gigabit Ethernet)

JARS 2.0 - Clock Driver



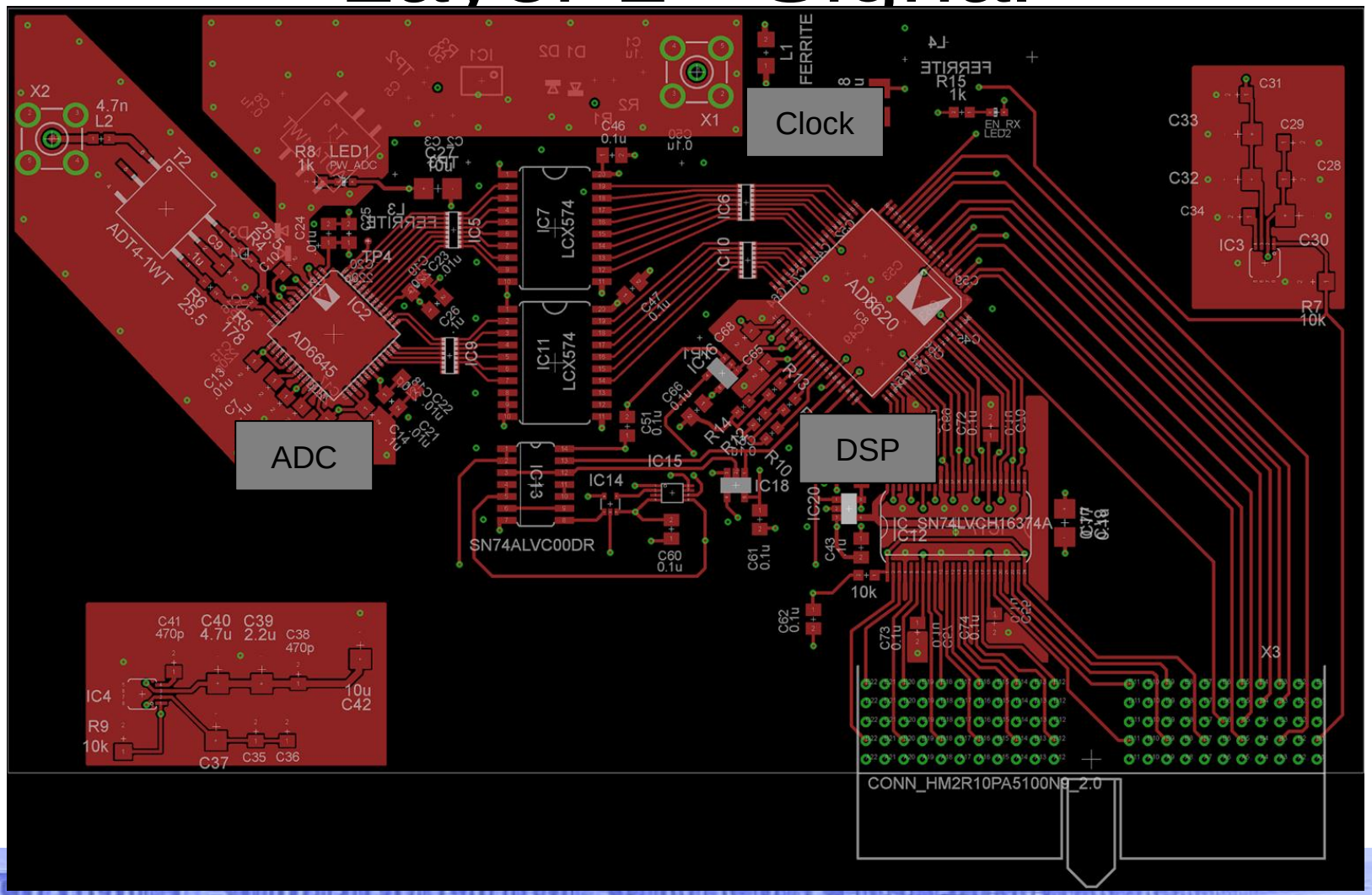


JARS 2.0 - Acquisition Board



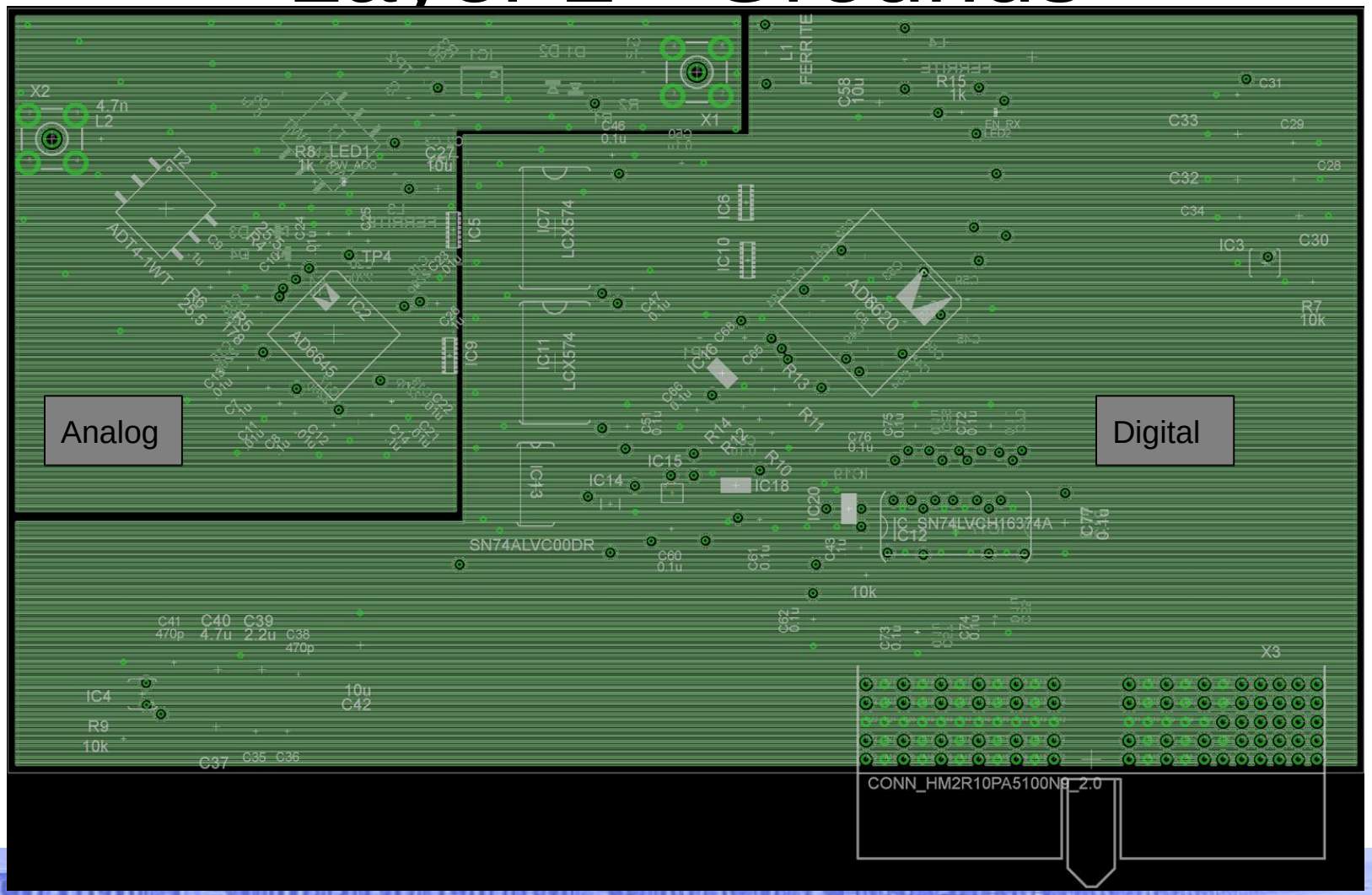
JARS 2.0 - Acquisition Board

Layer 1 - Signal



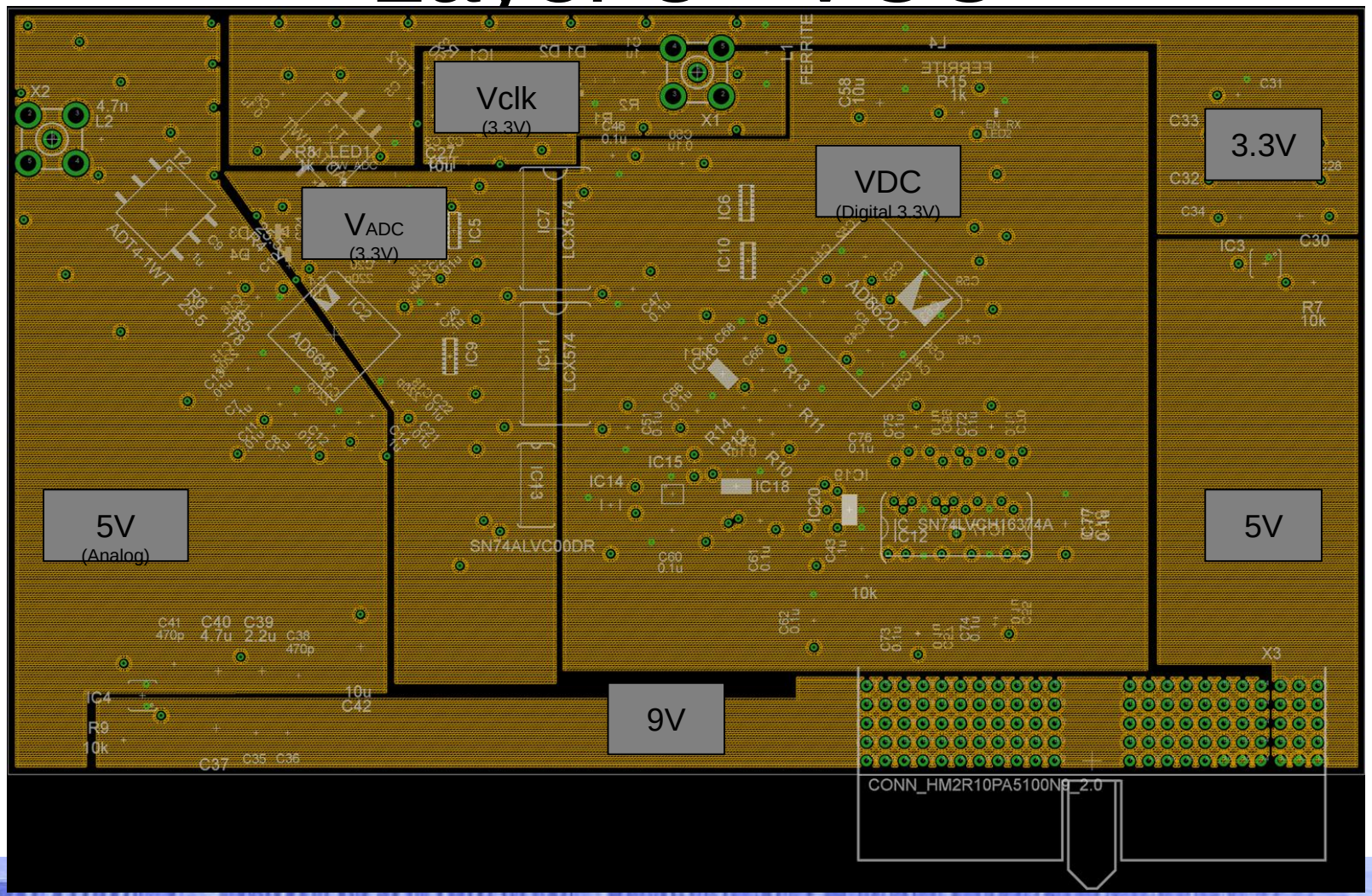
JARS 2.0 - Acquisition Board

Layer 2 - Grounds



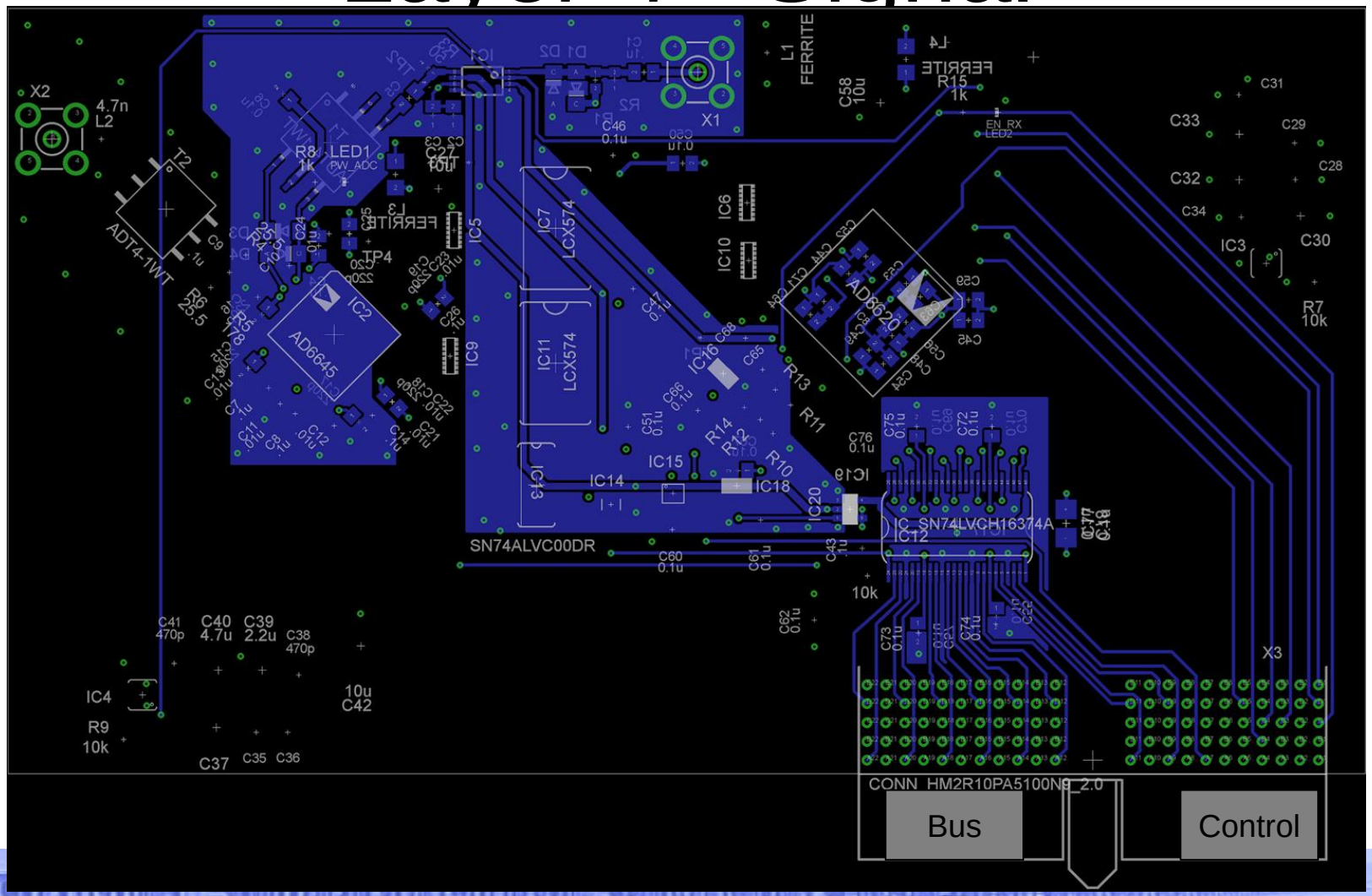
JARS 2.0 - Acquisition Board

Layer 3 - VCC

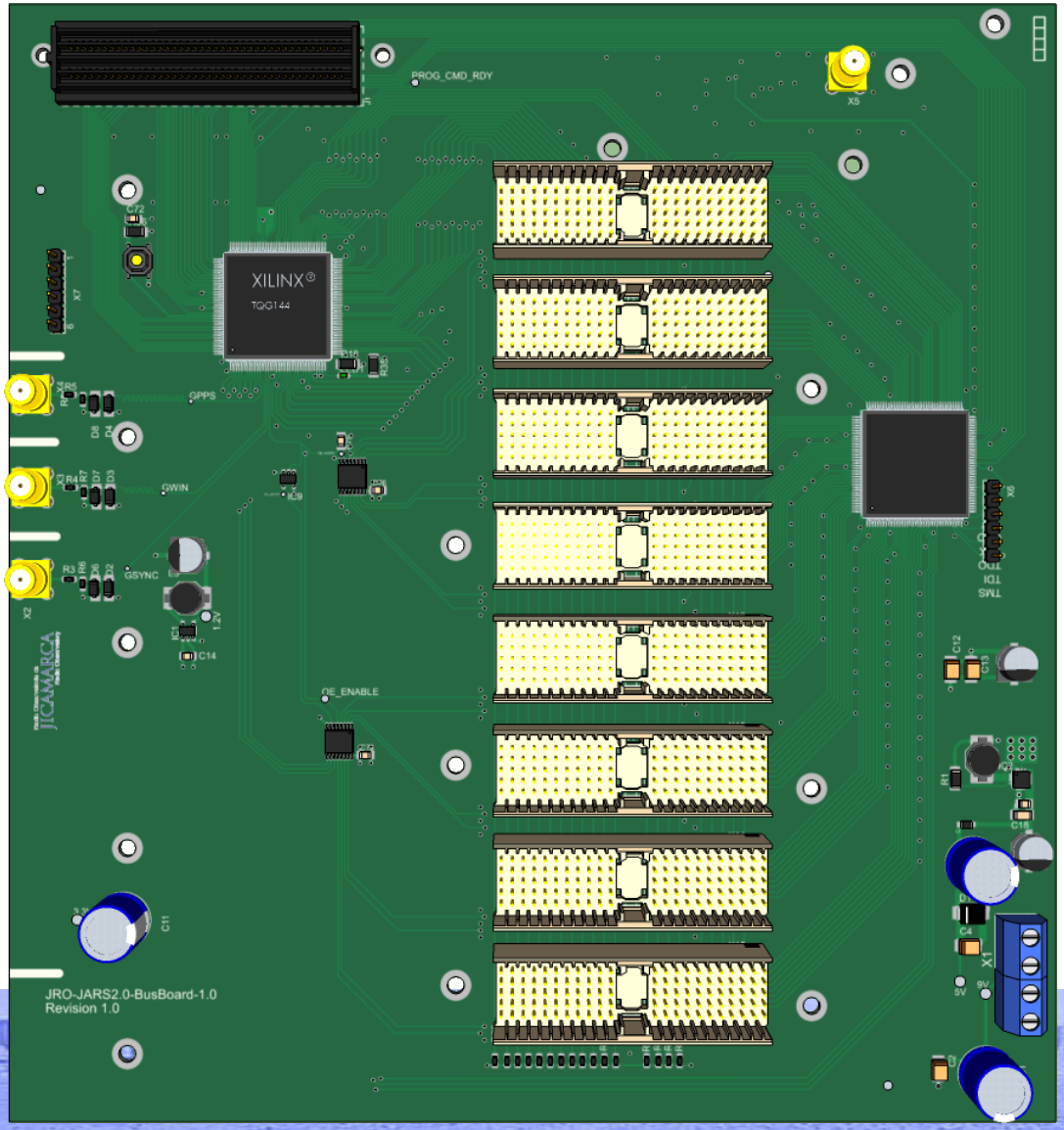


JARS 2.0 - Acquisition Board

Layer 4 - Signal

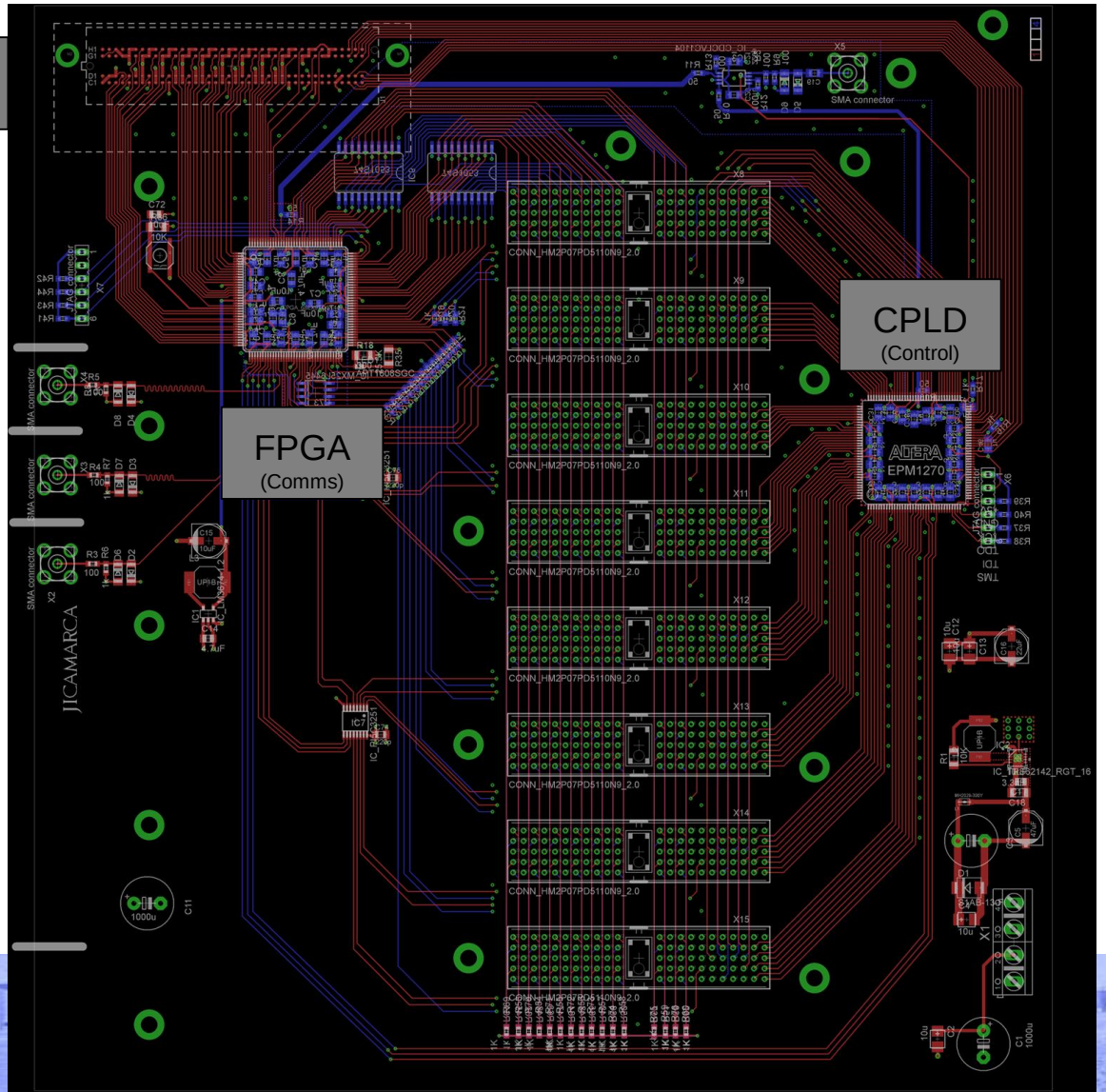


JARS 2.0 - Bus Board

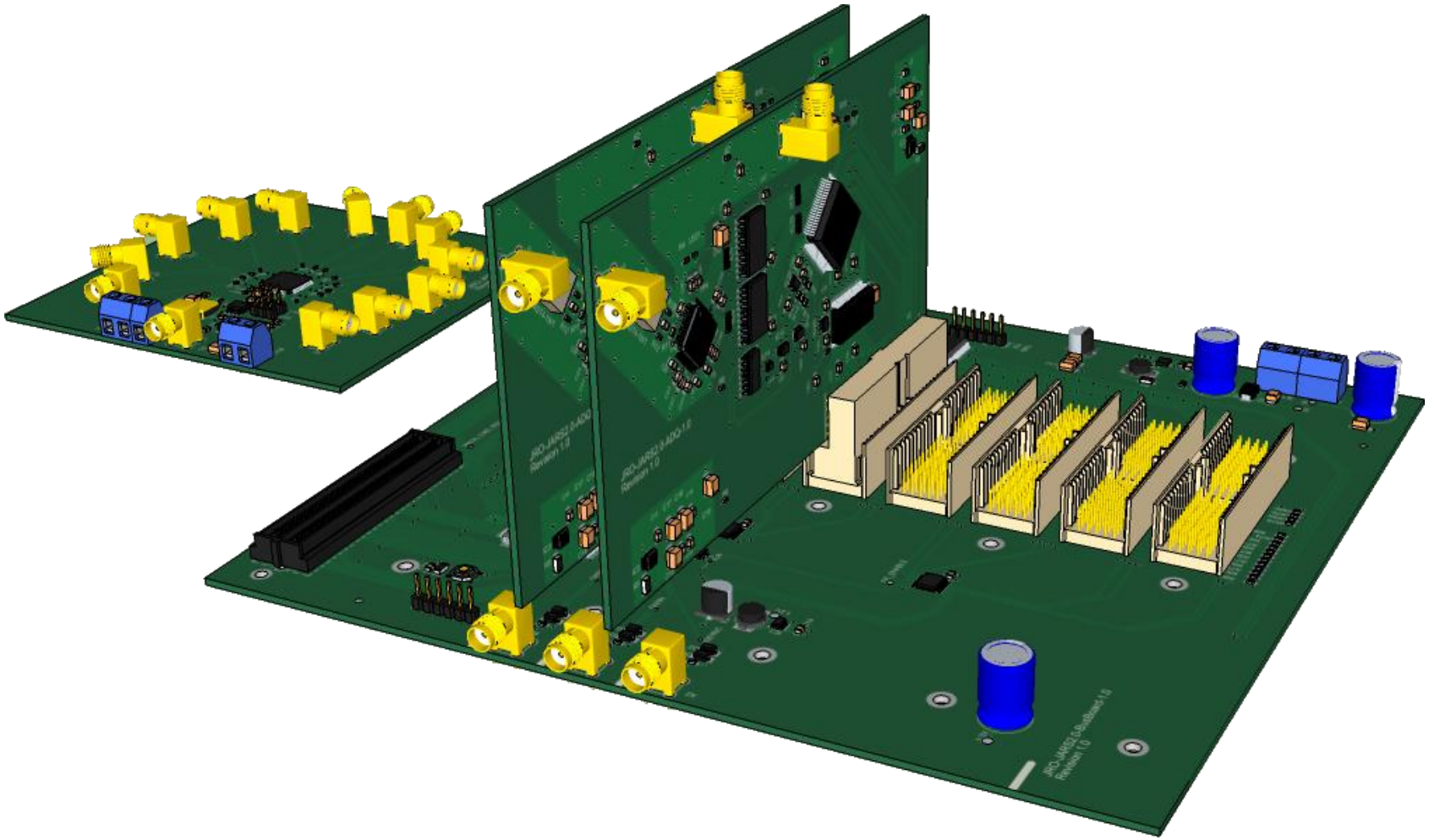


JARS 2.0 - Bus Board

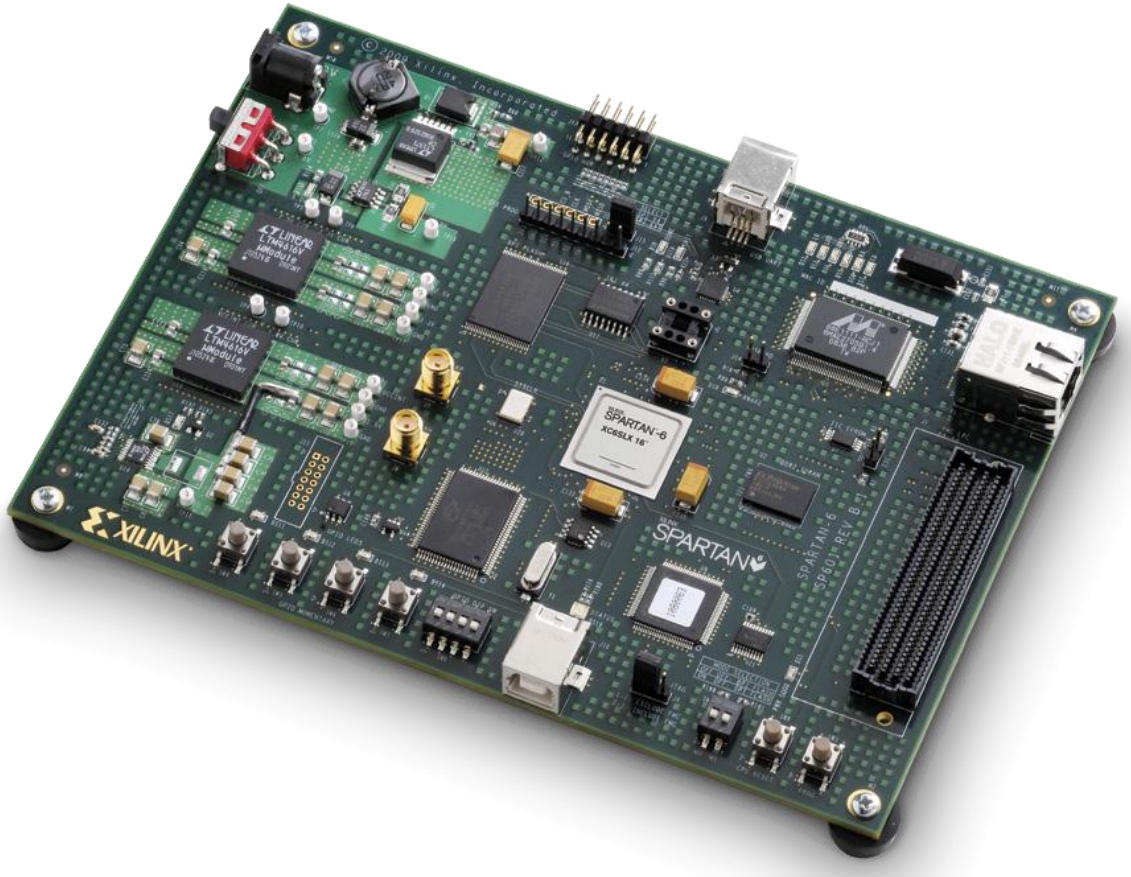
To SP601



JARS 2.0 - System



JARS 2.0 - Control Board SP601



- Spartan 6 SP601 Board
- Gigabit Ethernet

JARS 2.0 - Control Board SP601

Future: Integrated Radar System

Future: Integrated Radar System

- Web interface for users
- Real time data
- Gigabit Ethernet communication
- Flexible network topology
- Vendor-independent implementations
- Operating system independence
- Use of standard technologies to aid development (Arduino, Raspberry Pi)

Future: Integrated Radar System