Brief Experience with DRS4 Evaluation Board

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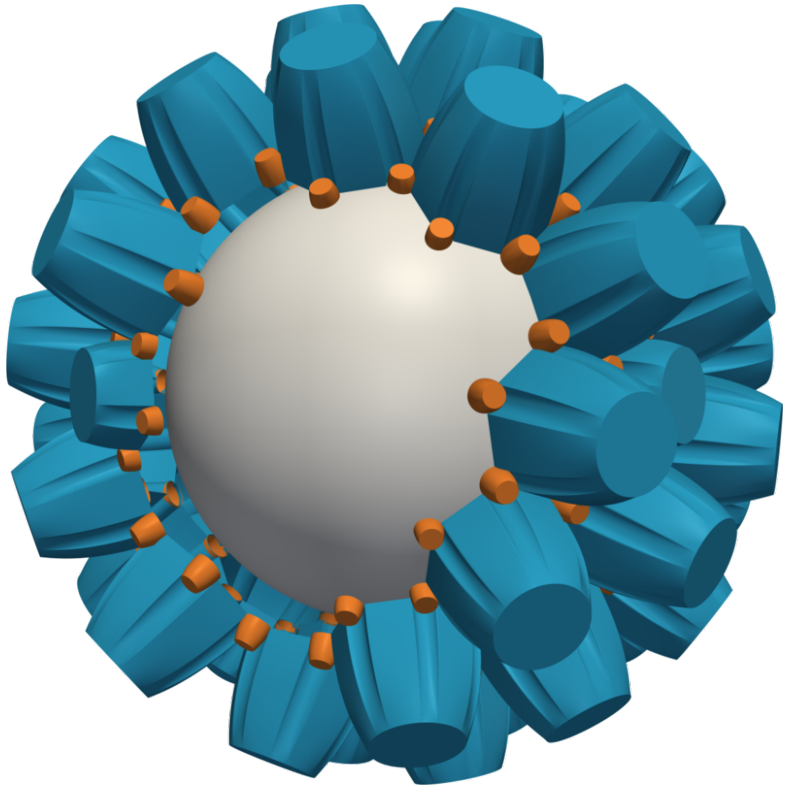
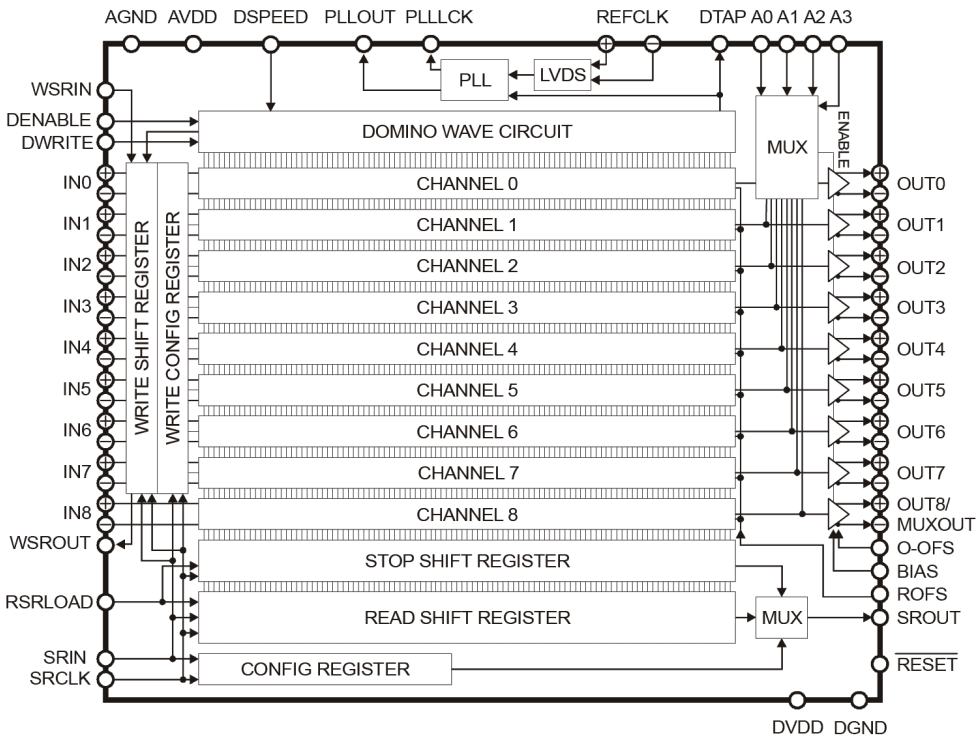
NuDot Motivation



- 72 8-inch PMTs and 140 2-inch PMTs
- One meter diameter sphere of liquid scintillator
- Want to separate prompt Cerenkov signal from slow scintillator signal
- Would like to record at least 100 ns, which may be difficult with PSEC4
- Let's check out Paul Scherrer Institute's (PSI) DRS4:
  - Slower chip (1-5 GSPS) with a longer SCA (1024 samples)
  - PSI tech transfer offer bulk pricing of $60 per chip for 1000+ chips
  - CAEN produces a commercial multi-chip VME module

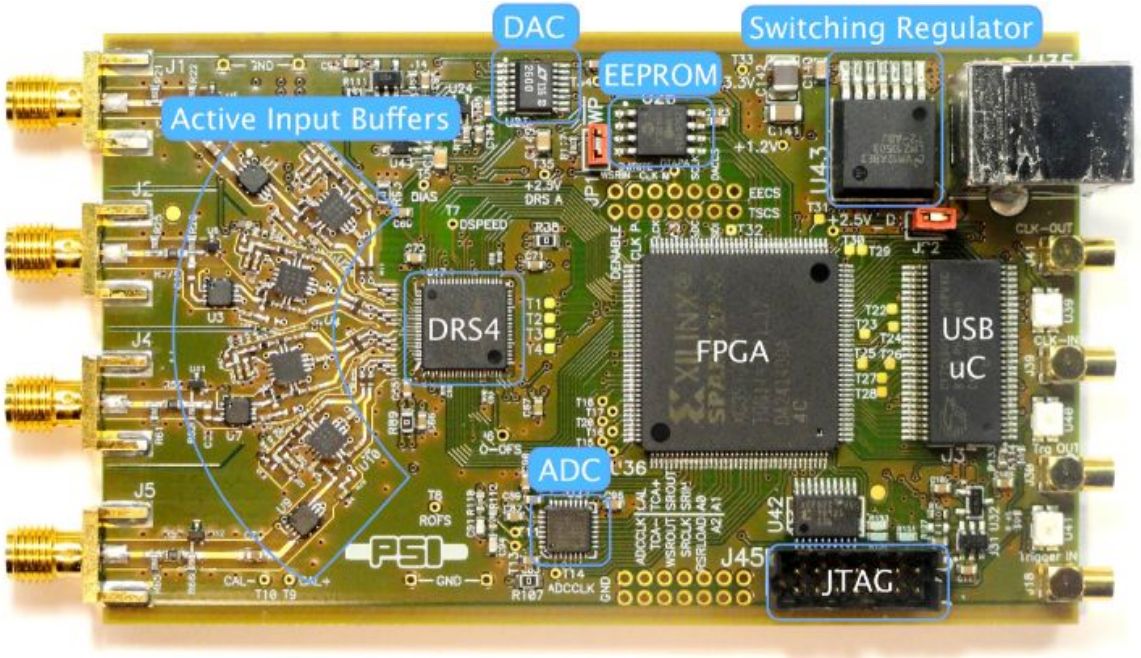
DRS4 Specs

FUNCTIONAL BLOCK DIAGRAM



- Switched-capacitor array
- Designed in 2007. Still in production.
- 9 channels per chip. 1024 samples per channel. Up to 5 GSPS.
- Read out charge samples serially with off-chip ADC.
- 950 MHz bandwidth

DRS4 Evaluation Board Hardware

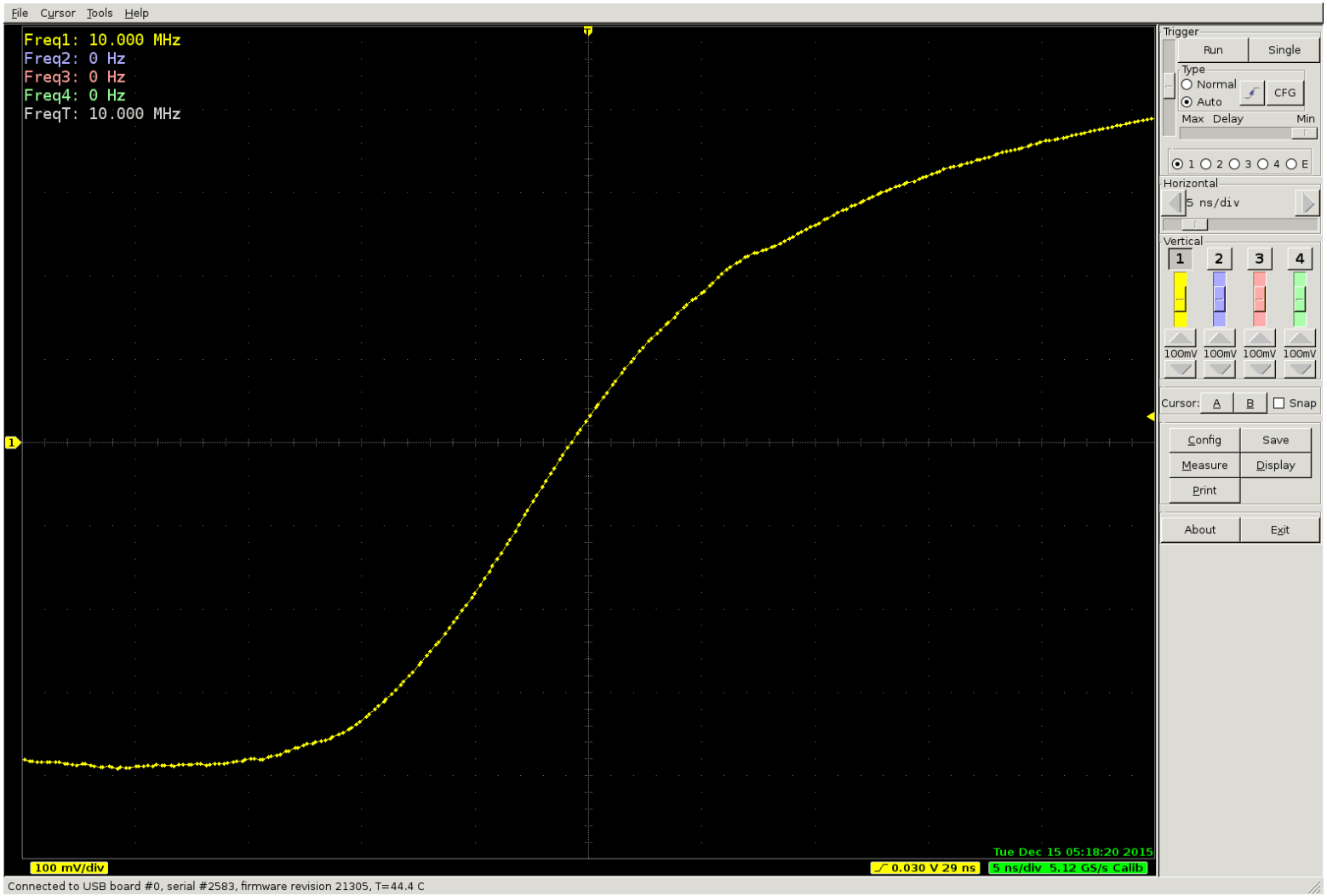


- Four AC-coupled 50-ohm terminated inputs with 1V peak-to-peak range
- Uses 14-bit AD9245 for charge sample readout.
- Cypress CY2C68013A USB microcontroller
- Xilinx Spartan 3 FPGA
- Additional connectors: optional clock IN/OUT and trigger IN/OUT

DRS4 Evaluation Board Software

- Software compiled cleanly under Debian 8.0 (amd64)
- FPGA VHDL source is included
- USB microcontroller C source is included

Oscilloscope Program 'drsosc'



- Timing calibration uses off-chip 100 MHz signal. Can achieve 3 ps resolution
- Note sampling period is not uniform.
- Offset and gain calibration uses off-chip 16-bit DAC

Command-line Program ‘drscl’

```
root@mothra:/home/naranjo/src/drs/drs-5.0.4# ./drscl
DRS command line tool, Revision 21435
Type 'help' for a list of available commands.

Found DRS4 board  0 on USB, serial #2583, firmware revision 21305

B0> info
==============================
Mezz. Board index:    0
DRS type:             DRS4
Board type:           9
Serial number:        2583
Firmware revision:    21305
Temperature:          47.0 C
Input range:          -0.5V...0.5V
Calibrated range:     -0.5V...0.5V
Calibrated frequency: 0.000 GHz
Status reg.:          0000009A
Control reg.:         08E00004
  DMODE circular
  TRANSP_MODE enabled
  Hardware trigger enabled
  Readout from stop
Trigger bus:          00000000
Frequency:            5.120 GHz
B0>
```

CAEN VX1742 32-channel VME Digitizer

- 32+2 channel 12-bit digitizer costs $9342
- Uses DRS4 chips
- Fixed sampling rates of 1 GS/s, 2.5 GS/s, or 5 GS/s
- Waveform length is 1024 samples
- Effective 11.5 bit resolution
- 160 MB/s data transfer bandwidth
- Overall dead time for complete event readout is 110 μs
- Global master clock source across multiple boards
- On-board 128 event buffer