Signal Processing in the DOWs using Pentek® Processors

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HISTORY of DOW6 and DOW7

DOW6 and DOW7 started life in 2008 as single-polarization, single frequency magnetron-based truck-mounted mobile radars.

Early field projects included ROTATE and the first year of VORTEX 2.

In 2010, these DOWs were upgraded to dual-frequency, dual-polarization magnetron capability, using the HIQ data acquisition system of the Advanced Radar Corporation (ARC).

At that time, the data system was upgraded to the NCAR TITAN system.

Field projects in this mode included VORTEX2 year 2, ROTATE and various educational projects.

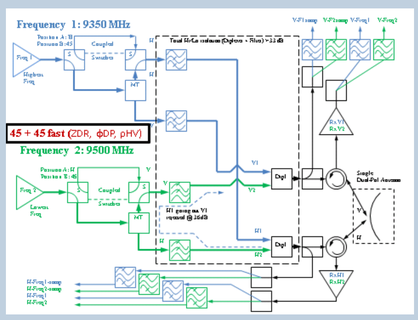
DOW7, 2009

The DOW dual-frequency, dual-pol design

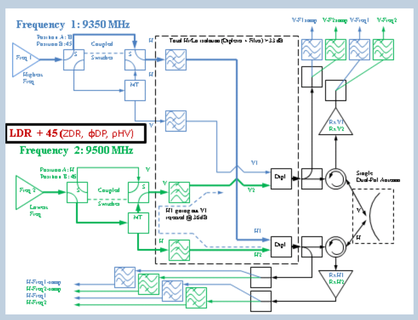
Most dual-pol operations are too slow for scanning the rapidly-evolving weather that the DOWs are intended to study – e.g. tornadoes, hurricanes.

Therefore the latest DOWs were designed with 2 transmitters, 150 MHz apart:

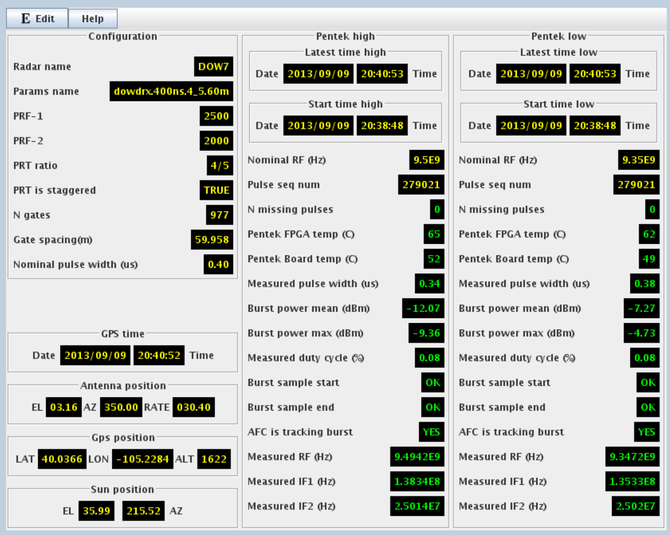
- LDR + slant-45 Mode
  - Freq1: Transmit H Receive: H and V LDR
  - Freq2: Transmit both Receive: H and V ZDR, ϕDP, ρHV
  - Independent 2x, full power, V (from H(ω1) and 45(ω 2))
  - Independent 2x, full power, Z (from H(ω1) and 45(ω 2))
- ZDR Fast slant-45 Mode
  - Freq 1: Transmit both Receive: H and V ZDR, ϕDP, ρHV
  - Freq 1: Transmit both Receive: H and V ZDR, ϕDP, ρHV
  - Independent 2x, full power, V, Z, ZDR, ϕDP, ρHV



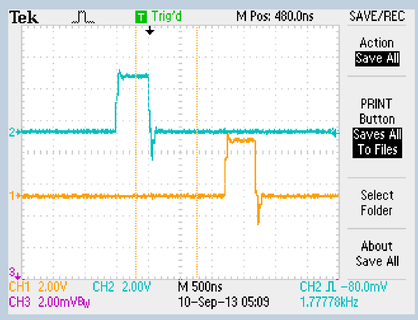
Schematic for ZDR mode



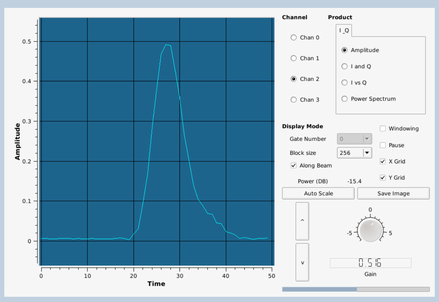
Schematic for LDR mode



Java-based GUI for controlling the Pentek system
Note data from the two independent frequencies.



Triggers for pulses of the high and low frequency radars are offset in time to prevent overloading of waveguide components



Digitized burst pulse, 200 ns width.
This is the shortest possible pulse width with the DOW6/7 magnetron design.
Longer pulse widths are more rectangular.

RF frequencies	X-band
Intermediate frequency 1	132.5 MHz
Intermediate frequency 2	25 MHz
Pentek sampling frequency	100 MHz
Min PRF	800
Max PRF	5000
Max nyquist (4000/5000 stagger)	79 m/s
Dual-pol products	ZDR, PHIDP, KDP, RHOHV (LDR)
Pulse widths	1000, 800, 500, 400, 200 ns

Pentek-based system Specifications

GOALS of the Pentek Upgrade

- To upgrade to a more powerful signal processing system
- To migrate to off-the-shelf hardware as much as possible.
- To significantly increase the digital sampling frequency (from 20 MHz to 100 MHz)
- To support a decrease in the minimum pulse width to 200 ns, thereby decreasing the minimum gate spacing to 30 m (or 15m in range-oversampling mode).

NCAR/CSWR Collaboration

The Earth Observing Laboratory (EOL) at NCAR has over the past 8 years developed Pentek®-based solutions for various radar applications, including wind profilers, the Ka-Band radar that is part of SPOL, and the w-band HCR radar on the HIAPER aircraft.

As a result, EOL has gained considerable experience with the Pentek-based technology, and has found this to be a flexible way to use common hardware on a wide variety of radar types.

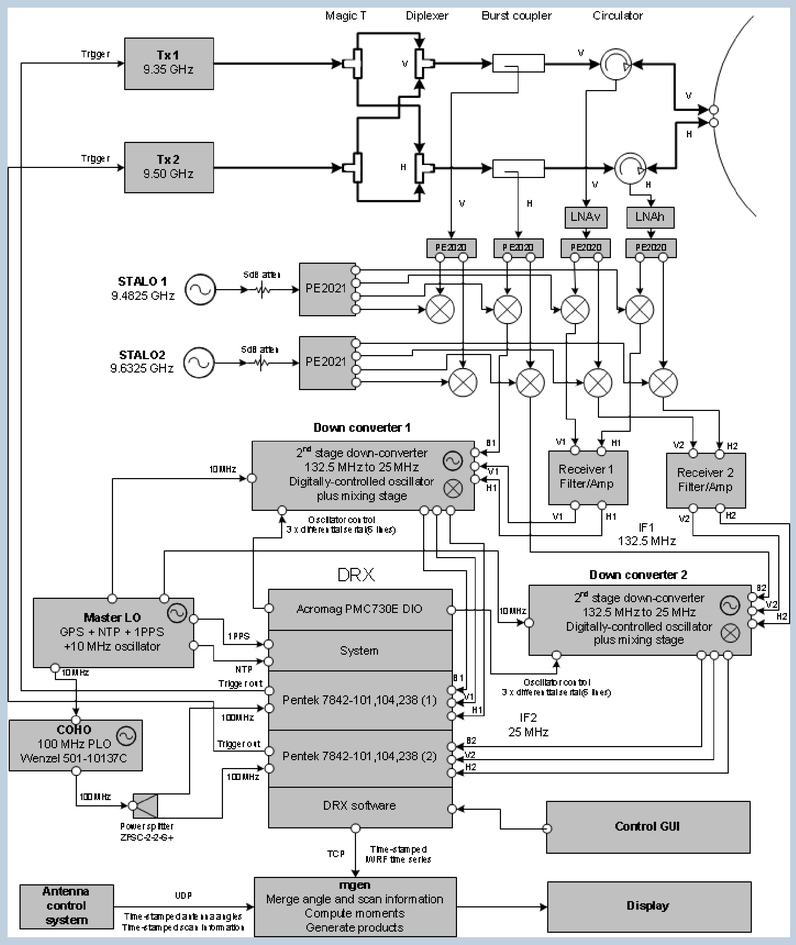
CSWR and NCAR formed a collaborative partnership to facilitate the transfer of this technology to CSWR. Since both organizations are sponsored by NSF, this type of partnership is ideal, and it helps to keep down the costs of development.

Pentek system DESIGN

DOW6 and DOW7 have a dual-transmitter, dual-frequency design to provide twice as many samples as a single transmitter, leading to better data quality at the high scan rates at which the DOWs operate.

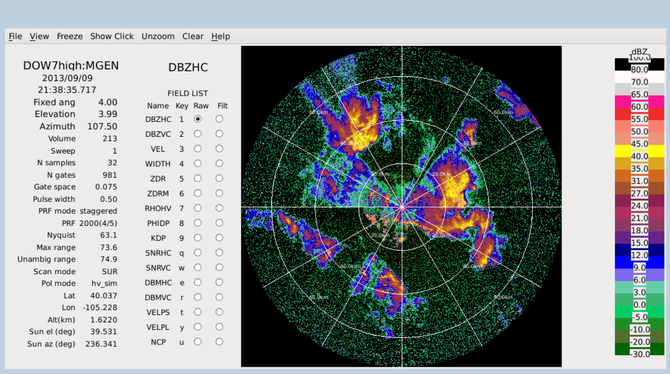
The system is treated as 2 complete radars, sharing a common antenna. One Pentek board is used for each frequency. Data products are merged downstream.

The Pentek boards used in this application each have 4 channels, used to sample the H, V and burst signals respectively, with one channel unused. The two boards are synchronized using a high-accuracy GPS device, which is also used to discipline the down-converter oscillator.

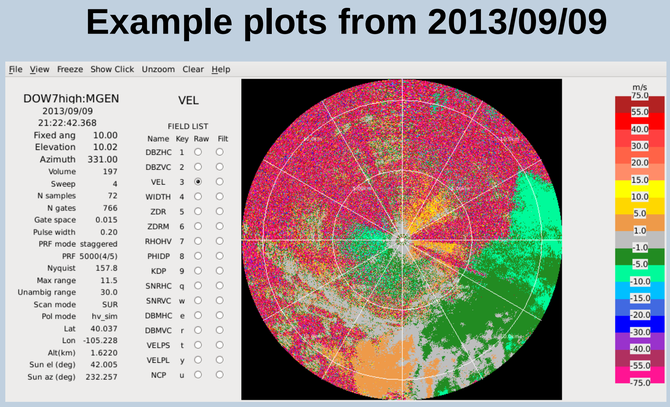


Pentek-based system schematic
The DRX is housed in a Dell T620 tower server

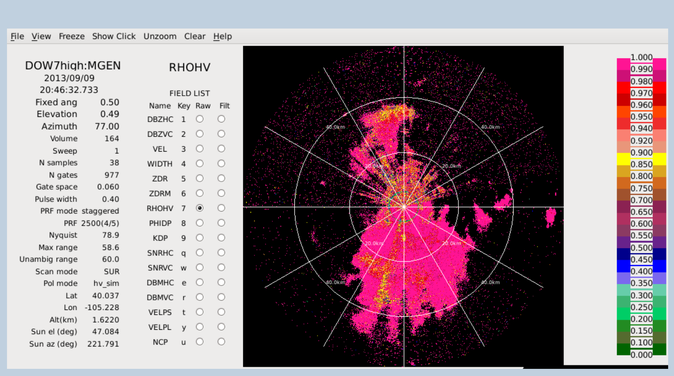
Example plots from 2013/09/09



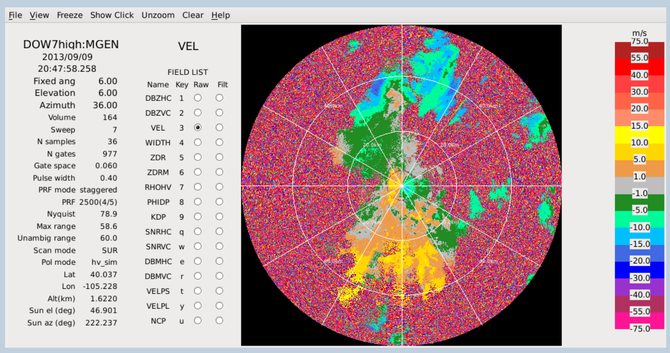
Reflectivity, PRF 2000, 4/5 stagger, pulse width 0.5us, 75 m gates



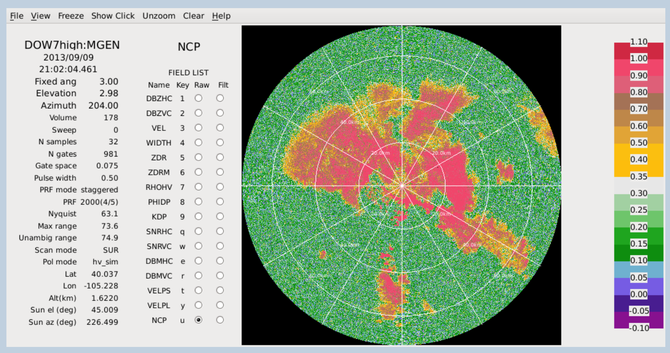
Velocity, PRF 5000, 4/5 stagger, pulse width 0.2us, 15 m gates



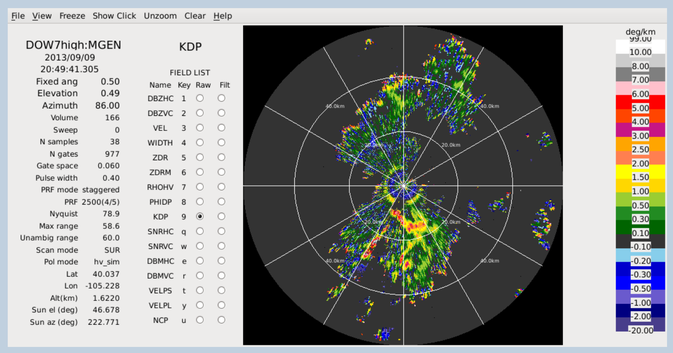
RHOHV, PRF 2500, 4/5 stagger, pulse width 0.4us, 60 m gates



Velocity, PRF 2500, 4/5 stagger, pulse width 0.4us, 60 m gates



NCP, PRF 2000, 4/5 stagger, pulse width 0.5us, 75 m gates



KDP, PRF 2500, 4/5 stagger, pulse width 0.4us, 60 m gates

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