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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, dualpolarization 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.

The DOW dual-frequency, dual-pol design



DOW7, 2009

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.

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 LDR Receive: H and V
 - Freq2: Transmit both Receive: H and V ZDR, φDP, ρHV
 - Independent 2x, full power, V (from H(ω 1) and 45(ω 2))
 - Independent 2x, full power, Z (from H(ω 1) 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





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.

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.





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

DOW7hiał	г	7 87	ис				
2013/09		202					
21:38:35	F	IELD	LIST				
Fixed ang	4.00	Name	Key	Raw	Filt		
Elevation	3.99	DBZHC	1	۲	0		
Azimuth	107.50	DBZVC	2	0	0		
Volume	213	VEL	2	0	0		
Sweep	1	VEL	2	0	0		
N samples	32	WIDTH	4	0	0		
N gates	981	ZDR	5	0	0		
Pulse width	0.50	ZDRM	6	0	0		
PRF mode	staggered	RHOHV	7	0	0		
PRF	2000(4/5)	PHIDP	8	0	0		
Nyquist	63.1	KDP	9	0	0	Contraction of the Contraction o	
Max range	73.6	SNRHC		0	0		
nambig range	74.9	CNIDVC	Ч.	~	~		
Scan mode	SUR	SNRVC	w	0	0		
Pol mode	hv_sim	DBMHC	e	0	0		
Lat	40.037	DBMVC	r	0	0	Notion / View Article Article	
Lon	1 6220	VELPS	t	0	0		
AIL(KM)	39 531	VELPL	у	0	0		
Sun az (dog)	226.241	NCP		0	0		

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

Example plots from 2013/09/09



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

ew Freeze	Show Click	Unzoom	n Cl	lear	<u>H</u> elp	
W7high 2013/09/	:MGEN	R	нс	энν		
20:46:32.	733	FI	IELD	LIST		
xed ang	0.50	Name	Key	Raw	Filt	
levation	0.49	DBZHC	1	0	0	
Azimuth	77.00	002110	-	~	~	40.0km
Volume	164	DBZVC	2	0	0	
Sweep	1	VEL	3	0	0	
V samples	38	WIDTH	4	0	0	
N gates	977	ZDR	5	0	0	
ate space	0.060	7004		0	0	
ulse width	0.40	ZDRM	6	0	0	

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

<u>F</u> ile <u>V</u> iew Freeze Sh	ow Click Unzoon	n Cl	lear	<u>H</u> elp		
DOW7high:M0 2013/09/09	GEN	VE	ΞL			m/s 75.0 55.0
20:47:58.258	F	IELD	LIST			40.0
Fixed ang	6.00 Name	Key	Raw	Filt	A CONTRACT OF	40.0
Elevation 0	DBZHC	1	0	0		50.0
Volume	0.00 164 DBZVC	2	$^{\circ}$	$^{\circ}$		20.0
Sweep	7 VEL	3	۲	0		15.0
N samples	36 WIDTH	4	0	0		10.0
N gates	977 ZDR	5	0	0		5.0
Gate space 0	.060	6	0	0		5.0
Pulse width	0.40	0	~	0		1.0
PRF mode stagg	ered RHOHV	7	0	0		-1.0
PRF 2500	(4/5) PHIDP	8	0	0		5.0
Nyquist	78.9 KDP	9	0	0		-5.0
Max range	58.6 SNRHC	a	0	0		-10.0
Unambig range	60.0 END/C		0	0		-15.0
Scan mode	SUR SINKVC	w	0	0		20.0
Pol mode hv	_sim DBMHC	e	0	0		-20.0
Lat 40	.037 DBMVC	r	0	0		-30.0
Lon -105	.228 VELPS	t	0	0		-40.0
Alt(km) 1.6	5220 VELPL	v	0	0		40.0
Sun el (deg) 46	.901		0	0		-55.0
Sun az (deg) 222	.237 NCP	u	0	0		-75.0

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

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



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



<u>File</u>



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

<u>F</u> ile <u>V</u> iew Freez	e Show Click	Unzoom	C	lear	<u>H</u> elp		
DOW7hig 2013/09	KDP					deg/km 99.00 10.00 8.00	
20:49:41	FIELD LIST					7.00	
Fixed ang	0.50	Name	Key	Raw	Filt		7.00
Elevation	0.49	DBZHC	1	0	0		6.00
Azimuth	86.00	DBZVC	2	0	0	40.0km	5.00
volume	100	VEL	з	0	0		4.00
N samples	38	WIDTH	4	~	~		3.00
N gates	977	WIDTH	4	0	0	20.0km	2.50
Gate space	0.060	ZDR	5	0	0		2.00
Pulse width	0.40	ZDRM	6	0	0		1.50
PRF mode	staggered	RHOHV	7	\odot	0		1.00
PRF	2500(4/5)	PHIDP	8	0	0		0.50
Nyquist	78.9	KDP	9	۲	0		0.30
Max range	58.6	SNRUC	~	0	0		0.30
Unambig range	60.0	SINKIC	ч	~	0		0.10
Scan mode	SUR	SNRVC	w	0	0		-0.10
Pol mode	hv_sim	DBMHC	е	0	0	40.0km	-0.20
Lat	40.037	DBMVC	r	\odot	0		-0.30
Lon	-105.228	VELPS	t	0	0		-0.50
Alt(km)	1.6220	VEL PL	v	0	0		-1.00
Sun el (deg)	46.678	NCD		0	0		-2.00
Sun az (deg)	222.771	NCP	u	0	0		-20.00

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

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