# **SDR-IQ CODAR Reception**

**Rev. 1.00** 

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This document describes the procedures needed to receive CODAR pulses with the SDR-IQ.

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# **Table of Contents**

SDR-IQ CODAR Reception	
1 Introduction	3
2 Setup	5
2.1 What you will need:	5
2.2 Hardware Setup	5
2.3 SpectraVue Setup for CODAR	6
2.4 Disclaimer	10

### 1 Introduction

Many have run across some strange sweeping signals on the HF bands and discovered something called "CODAR" (Coastal Ocean Dynamics Applications Radar). Typical signals are a downward sweeping carrier at a 1 second rate with various sweep widths. They can be found all across the HF band:

4-6 MHz

12-14 MHz

24-27 MHz

47-50 MHz

Reaction has been anything from mild interest to livid hatred of these "interference" signals. Rather than try to get the transmitters and their owners destroyed, one could see if a possible amateur use can be made of them. One idea is for propagation studies. The codar signal is essentially a radar pulse on the HF band used to measure ocean waves but these signals also manage to illuminate the various ionosphere layers. By knowing where the transmitters are and your own location it may be possible to perform meaningful research into various propagation modes.

Googling CODAR shows there is a lot of information out there.

http://cordc.ucsd.edu/projects/mapping/maps/

http://www.codar.com/index.htm

Since these CODAR signals are a sweeping carrier, listening to them as a normal radio signal is of little use. However if one processes the signal as a frequency chirp radar signal, the signal can be displayed in the time domain as a single pulse and its reflections.

A couple of example waterfalls of an overnight capture from Atlanta Georgia of one of the coastal CODAR stations.

The center part of the image shows activity before and after sunrise as the ionosphere is moving.





## 2 Setup

The following block diagram shows the basic setup for receiving CODAR signals.



### 2.1 What you will need:

- SDR-IQ receiver with latest firmware(Ver 1.05 or greater)
- SpectraVue Software
- GPS receiver with 1pps 3 to 5 volt logic output
- HF Antenna

### 2.2 Hardware Setup

The 1pps signal from the GPS receiver connects to the SDR-IQ as follows:

HW Trigger Mode



Rev. 1.00 2011-11-01

### 2.3 SpectraVue Setup for CODAR

Go to SDR-IQ Setup menu and set Filter bandwidth to 50KHz.

Select "External HW Sync" checkbox

SDR-IQ Setup	$\mathbf{X}$		
Update Firmware 666666667 A/D Sample 6620 Digital Downconv CIC2 Rate 8 CIC2 Scale 4 CIC5 Rate 30 CIC5 Scale 20 RCF Rate 5 RCF Scale 0 RCF TAPS 256 Total Decimation = Final Sample Rate =	7   Ref 10000000   RF Gain     9 Freq(H2)   Meas   10000000     erter Settings   Calc   If Use Fixed Settings     Image: Settings   Image: Settings   Image: Settings     Image: Setings   Image: Settings		
Filter Bandwidth   Network SDR-IQ Setup     IP Address   192     10 KHz   100 KHz     10 KHz   150 KHz     10 KHz   150 KHz     10 KHz   150 KHz     10 KHz   100 KHz     10 KHz </th			

Go to General Setup Menu and select "Pulse Mode Enable"

Enter -0.018378 for the chirp rate. For Display Units select MHz(km)

General Pr	rogram Setup		
FFT Window Type C Rectangle I Hamming	e 75 JPEG Compression Quality(10 to 10 Assign Display Color Waterfall Rate(0 to 60 Secs/update) 0	s US FM 🔽	
C Hanning C Flat Top C Blackman	Select Waterfall Color Palette File Default.pal		
C Blackman-Harris Display Units Hz (Sec) KHz (mSec) MHz (uSec)	Memory Modes Cursor Mode 3D   Memory Display OFF Cursor Mode 3D   Max Memory Display Cursor X-Y 3D xy Pixel Shift   Delta Memory Display Cursor Plot 1/N 3D Plot Scale(	Options X Y (1-100) 0 3 1 to 1/10) 5 N	
GHz (usec)   Markers   Auto Statt     GHz (usec)   Markers   Image: Construction of the state of th			

Select 65536 as the FFT/BLK size.

Set the vertical scale to 3 to 5 dB/div depending on signal strength.

For Center frequency, select 4.543MHz or 4.66MHz



The button above the frequency control toggles the control between center frequency of the radio and the display time(distance) center of the screen. The Span control adjusts the span in time(distance) units. Start out with maximum span to initially find the pulses.

Start the SDR-IQ and the screen should update every 2 seconds if the trigger is working properly. Adjust the vertical scale and you should see something like this:



Note the largest pulses position then reduce the span to zoom the screen while readjusting the time center value close to the pulses position until you are able to center it on the screen.

SpectraVue Ver. 3.22 SpectraVue.ini	
Eile ⊻iew InputDevice SDR-IQ Setup OutputSetup ExtRadio Setup G	eneral Setup <u>H</u> elp
299700 300200 300700 301200 301700 302200 302700 303	200 303700 304200 304700
-109     -109     -102     -102     -108     -114     -120     -128     Raw Data   2D Plot     3D Plot   V Waterfall     H   Waterfall     Combo   Continuum     Offsel   .     Time Center - Ins   .     1   FFT Ave     L   302,200 km     Auto Scale     (A)   .     Span     Stop-F10   Pause-F11     Start-F12     NC0 Null   Mute     SpaceBar	Phase Ph
SDR-IQ 2	1 Nov 2011 15:04:07 UTC 🥢

There are multiple pulses due to having several transmitters on the same frequency but shifted in time. Also there are pulse artifacts from the signal since the sweep has blanking intervals that codar uses to be able to listen for reflections while transmitting.

The pulse position is sensitive to center frequency changes so the SDR-IQ will drift a bit especially if it hasn't warmed up for a while. It is advised to have the SDR-IQ powered on for several hours and kept at a reasonably stable room temperature before doing long data captures. Also it is easier to capture the raw I/Q data to a wave file then play it back later for analysis since you can still adjust a lot of display parameters. If you just save the waterfall graphics you are stuck with the display settings as they were recorded.

#### 2.4 Disclaimer

The frequencies and sweep rates givien here are a good starting point for the eastern part of the US. Other areas are on their own in finding the CODAR stations that are within range and figuring out their frequencies and sweep rates.

Obtaining critical information concerning the CODAR transmitters can be difficult. Their frequencies may change or other timing parameters without any notice as these stations adjust for various data collecting tasks. The most critical is the sweep rate as it must be very accurate or one will not see any pulses at all.

One can look at a CODAR signal in the normal frequency domain and try and determine the min and max sweep frequency to get the sweep rate in MHz/Sec as well as if it has a one second period. Using a 1pps GPS trigger limits it to only those CODAR sweeps that are also 1 second(or perhaps multiples of 1 sec). Note that if the sweep goes from high to low then a negative sign is required for the sweep rate.

While one can get lots of pretty displays, interpreting them is quite another issue. Perhaps as more knowledgeable users start gathering data, more interesting results can be obtained.