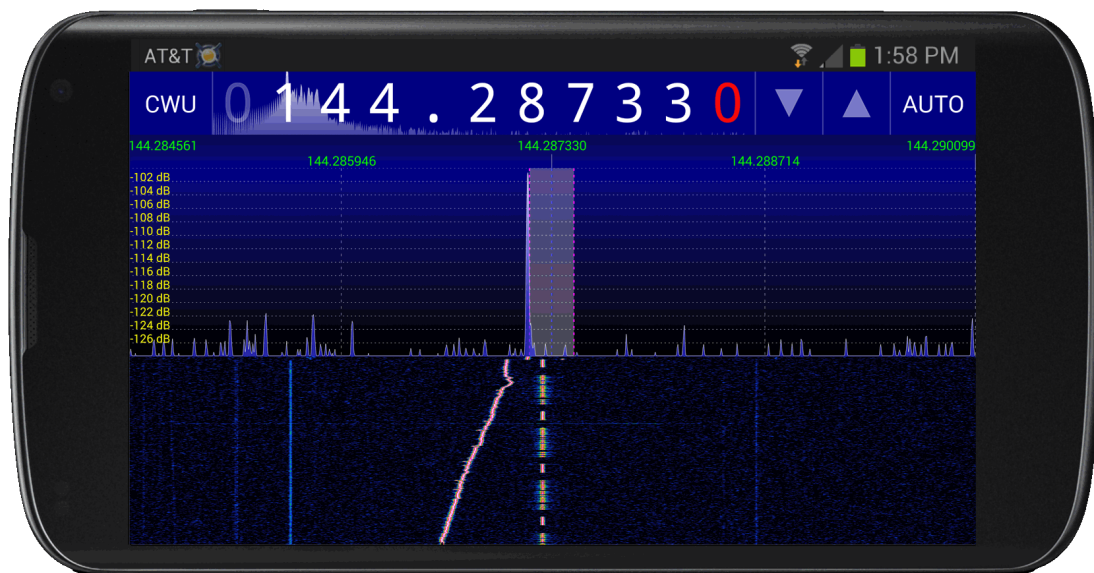


#CONNECTED SOFTWARE DEFINED RADIO



RFSPACE CLOUD-IQ

INTRODUCTION

The RFSPACE Cloud-IQ is a high performance, direct sampling software radio with an ethernet interface. It offers outstanding low distortion, low noise and low spurious characteristics. The Cloud-IQ radio was developed for both direct streaming of I/Q data to the PC, as well as, remote radio monitoring anywhere in the world. It performs spectrum analysis, demodulation, and streaming to a computer.

The Cloud-IQ features a direct sampled 9kHz to 56 MHz RF port. It includes a two input antenna switch that can be remotely selected. One input can be used for VHF and one for HF. The RF port has built-in variable attenuation, preselection and surge protection. The Cloud-IQ is designed to be connected directly to antennas without the need of external amplifiers or extra filtering.

The Cloud-IQ handles all of the streaming via ethernet. It offers an I/Q streaming mode where the radio sends 24 bit I/Q pairs to the PC for processing. This I/Q mode offers one of the cleanest and highest dynamic range baseband signals that we have seen in any commercial receiver. The I/Q balance, DC spur, IMD and phase noise performance is superb. This mode of operation has a very high ethernet bandwidth utilization which limits the use to direct to PC connections.

In addition to the I/Q streaming mode, the Cloud-IQ has a low bandwidth, cloud mode for internet operation. In this mode, the radio will capture spectrum data as well as demodulate the signals of interest. The radio has built in demodulators for AM, SAM, LSB, USB, WFN, FM, CW, ASK, OOK, and PSK31. The radio will compress the demodulated waveform using the high performance and phase continuous G726 and G711 codecs. The raw 64 kbit/s stream can also be selected if that is preferred.

1. CloudIQ Model

The Cloud-IQ's cloud mode also offers a variable width spectrum analyzer with adjustable spans up to 10 MHz wide. The spectrum update rate can be adjusted up to 10 Hz or turned off to limit the bandwidth utilization. In addition, the built-in squelch can be used to limit data transmission when no signals are present.

Features

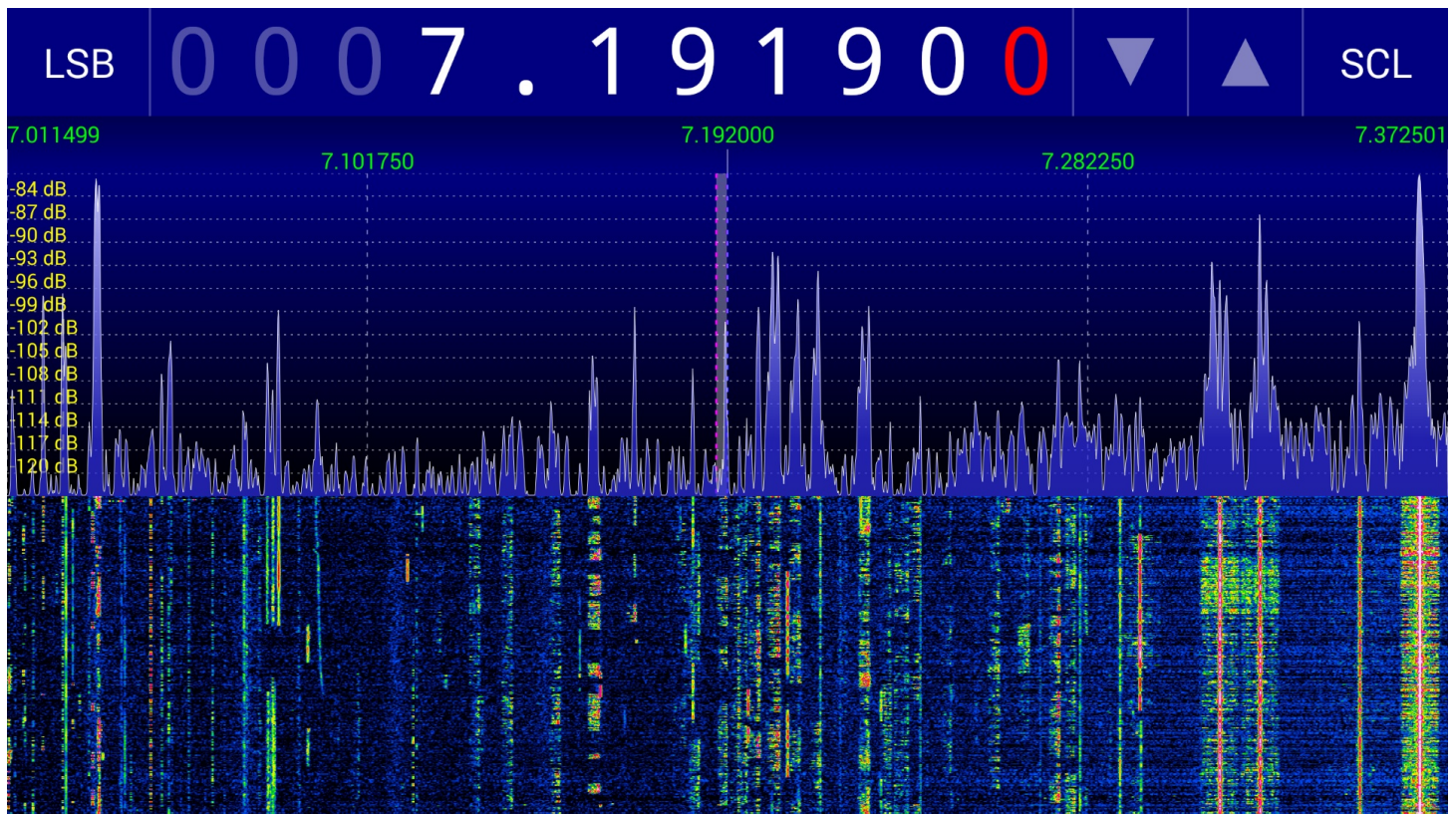
- Wideband spectrum analyzer mode offers 56 MHz wide spectral captures in both 2D, 3D and waterfall formats.
- 9kHz low end frequency range allows SONAR, VLF and ultrasound applications.
- TCXO for best frequency stability.
- The Cloud-IQ has an internal triggering mode for capturing repetitive signals. The internal trigger mode allows the phase to be adjusted, as well as the frequency in steps of 1 nHz.
- The built-in remote server allows the Cloud-IQ to be placed anywhere in the world. A PC running Windows, Linux, Android or MacOS is able to access the radio with very low latency. It does not require a PC at the server side and the server is available within 10 seconds of boot up.
- An Android application has been developed to access the Cloud-IQ in cloud mode. In addition, an open source client is available license free for Windows, Linux and MacOS. Programming is extremely easy since all of the DSP, FFTs and scaling are done inside the radio.
- Built-in RS-232 connector for logging and control of external radios.

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REMOTE OPERATION

The RFSPACE Cloud-IQ is designed for streaming I/Q spectrum data to a PC or to be remotely located anywhere on the internet. The built-in remote server allows the Cloud-IQ to serve as a remote receiver node or receive gateway anywhere in the world. The fact that the Cloud-IQ does not require a computer, makes it highly reliable. During remote operation, the radio handles all of the demodulation, compression, directory listing, spectrum FFT processing and packetizing. The client application just sends the center frequency, demod mode and other settings and gets the formatted audio and spectrum packets. All of the DSP is handled server side. In order to make custom application development easy, RFSPACE supplies an open source and license free RemoteSDRClient application using the QT framework. It can be compiled for Windows, Mac OS and Linux. RFSPACE also supplies a compiled Android client that has been optimized for 3G and LTE connections.

For applications requiring remote access to external hardware, a bi-directional RS-232 port is supplied on the rear of the Cloud-IQ. This port can be used to control remote rotors or to read sensors. The Cloud-IQ now includes a remote raw IQ mode that sends a 500-16000 samples/s IQ spectrum to the client instead of the demod audio. This is ideal for client side demodulation from remote sites.

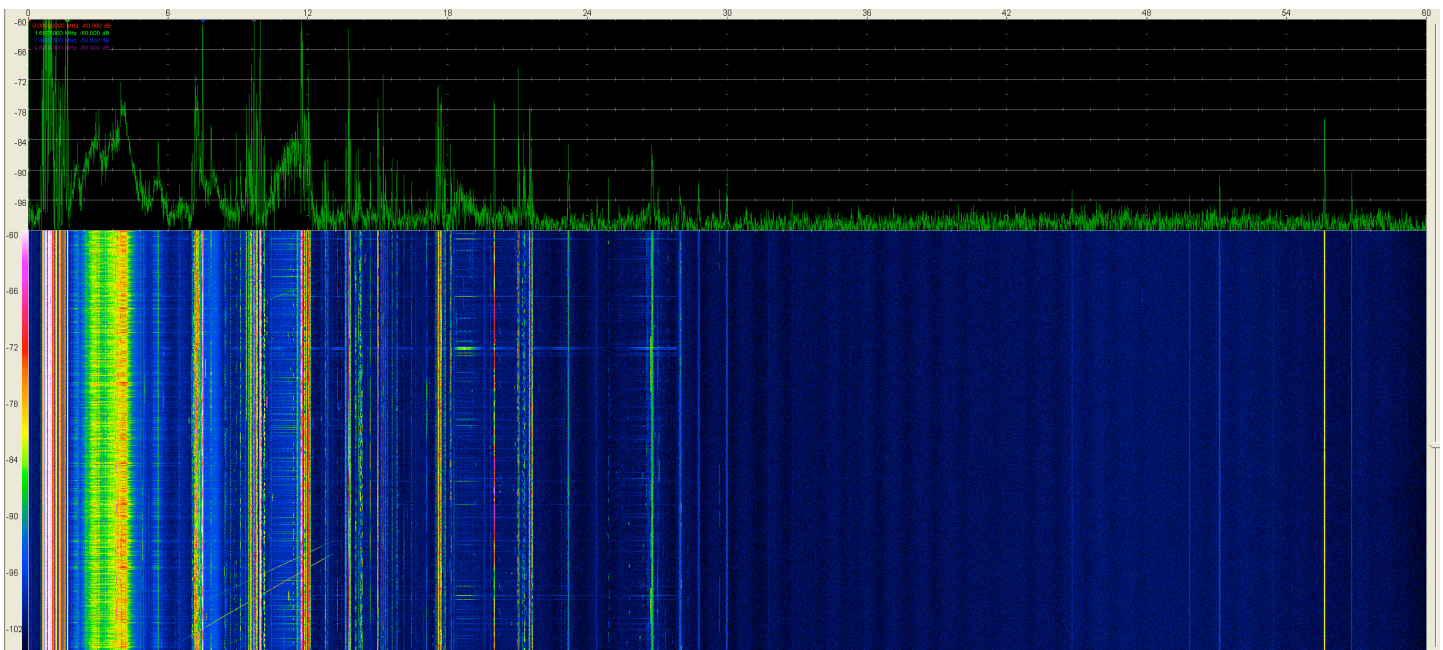


Spectrum display screen of the SDRanywhere Android application used with a remote Cloud-IQ.

RFSPACE CLOUD-IQ

SPECTRUM DISPLAY

The RFSPACE Cloud-IQ has three different spectrum analyzer modes. These are the realtime complex, non-realtime real and non-realtime complex modes. These modes are all supported by the SpectraVue software. The first mode is a realtime complex mode. This mode offers adjustable spans between 10 kHz and 1 MHz wide. The FFT size is adjustable between 2048 and 2097152 points. At the lower sample rates, resolution bandwidths (RBW) of less than 1 MHz are supported. At the 1.288 MHz sample rate, the minimum RBW is 0.6 Hz. This mode is supported by both the internal trigger and external trigger functionality. The second mode of operation is a real data mode that offers a display that is 61.44 MHz wide. The usable spectrum is limited by the antialias filter to about 56 MHz. This mode offers a very fast display with up to 32768 point FFTs. The minimum RBW in this mode is around 3.5 kHz. This mode can be used to monitor the whole HF/6m band at once. The third mode is an adjustable bandwidth complex mode with 16384 point FFTs. This mode allows spectral scans from 2-10 MHz wide with resolution RBW of less than 1 kHz at 10 MHz wide. This mode is also supported by the internal triggering functionality.

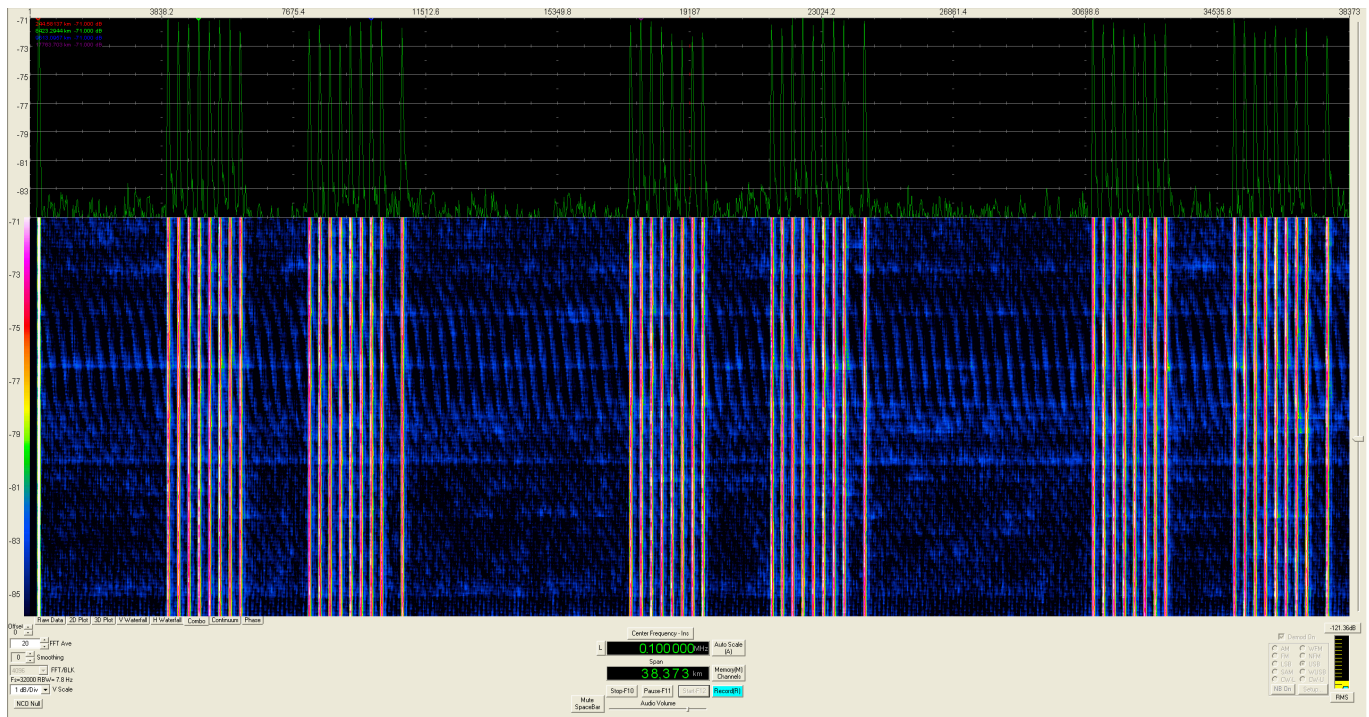


Spectral scan of the whole 0-60 MHz HF spectrum showing ionospheric sweeps around 9 MHz.

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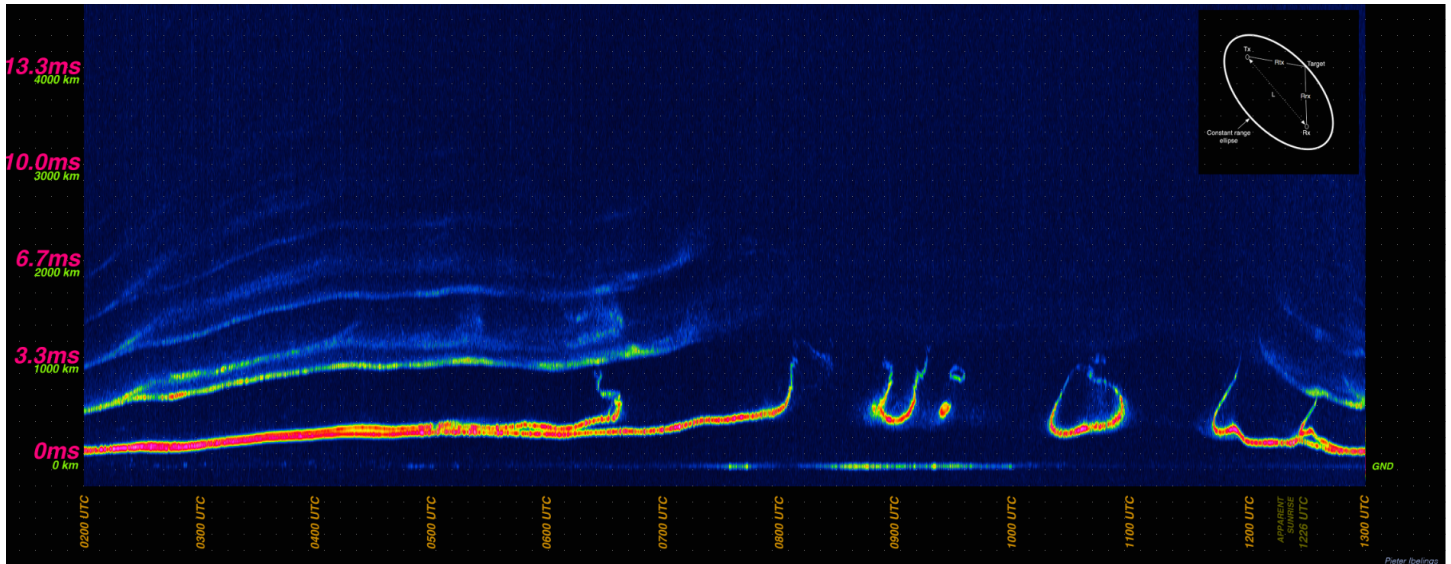
INTERNAL TRIGGER, AND PULSE OPERATION

The RFSPACE Cloud-IQ includes an internal generated trigger mode. The internal mode is adjustable from 1 nHz to 100 Hz in steps of 1 nHz and includes adjustable phase offset. This mode coupled with the pulse mode (I/Q magnitude over time) allows for the detection and display of time varying waveforms like radar, ASK and line rate interference. The pulse mode also includes the ability to pulse compress chirped or other linear FM waveforms by entering the correct chirp rate in MHz/s. This is done in the supplied SpectraVue application by using fast correlation.



Loran-C signal at 100 kHz synchronized to the correct GRI in the pulse mode of SpectraVue. Uses internal trigger mode set to GRI rate.

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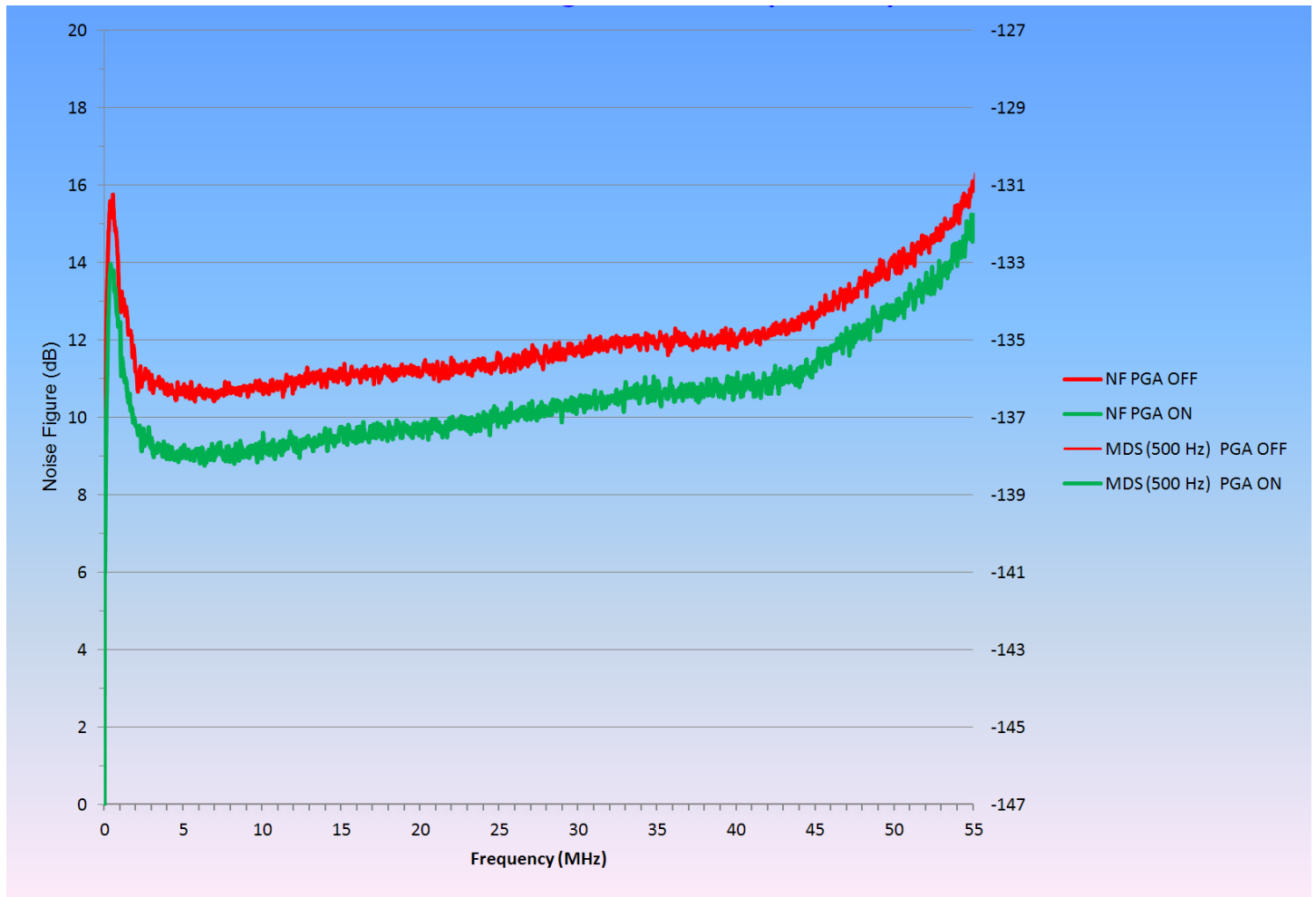


This image shows a CODAR FMICW signal at 4.543 MHz synchronized to 1 Hz PRF and de-chirped using SpectraVue. The direct path is seen as a faint line on the bottom while all of the ionospheric paths are shown above. The plot range is 5000 km in the vertical axis and 11 hours in the horizontal axis. This was a passive radar reception. Uses internal trigger mode set to 1 Hz repetition.

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PERFORMANCE

The RFSPACE Cloud-IQ has a highly optimized input front end coupled with a 74 dBFS noise floor ADC. The performance is superb. At ADC clipping and with a 10.7 MHz test signal, the HD2 and HD3 components are -90 dB down. The minimum discernible signal at 10 MHz is -138 dBm typ. with the ADC in the high gain setting (PGA=on). The Cloud-IQ uses a completely shielded RF section. This minimizes any noise and any other internally generated spurs. In addition, the coupling of the digital ADC data back to the input is kept to a minimum.



The direct sampled 0.009 MHz - 56 MHz port has very low noise.

RFSPACE CLOUD-IQ

SPECIFICATIONS

KEY SPECIFICATIONS		
Direct sampling frequency range	0.009 - 56 MHz	
Antenna ports	Dual antenna ports	<i>remote selectable or auto</i>
ADC F_s / SNR / SFDR	122.88 MHz / 74.2 dBFS / 91 dB	<i>12 bits ENOB</i>
I/Q mode output sample rates	0.01 MHz - 1.288 MHz	<i>24 bit resolution</i>
Spectrum analyzer I/Q modes	2.458 MHz - 12.288 MHz	<i>16 bit / 16384 FFT points</i>
Spectrum analyzer real mode	56 MHz wide / 122.88 MHz sample rate	<i>16 bit / 32768 FFT point</i>
Minimum discernible signal DS port	-137 dBm/Hz / -135 dBm/Hz	<i>in 500 Hz BW PGA on/off at 15 MHz</i>
Minimum discernible signal tuner port	-139 dBm/Hz	<i>in 500 Hz BW max gain at 500 MHz</i>
Clipping point	-15dBm	<i>attenuator = 0 dB, ADC preamp on</i>
Cloud mode audio compression	G726,G711, Raw	<i>phase continuous</i>
Cloud mode demodulation	AM,FM,WFM,SSB,CW,SAM,DSB,ASK,OOK,PSK31,RAW IQ	
Cloud mode audio rates	16 kb/s - 64 kb/s	<i>audio is 8 KHz sample rate</i>
Cloud mode RAW IQ	500 samples/sec - 16 ksamples/sec	<i>at 8 bits resolution after AGC</i>
Cloud mode spectrum display	0.001 MHz - 10 MHz wide / 2048 FFT points	<i>with simultaneous demod</i>
TCXO	<2.5ppm over 0-40 °C	
Remote server boot time	10 seconds	<i>availability online after power cycle</i>
Power consumption	5 Volts - 0.8 Amps	
Compliance	CE, FCC, IC	
Dimensions	4.8 x 4.0 x 1.2 inches	
Suggested retail price	\$649	<i>US pricing. International pricing may vary.</i>
Warranty	1 year parts and labor.	