Analyze Hundreds of Channels with one Receiver

Wideband receivers & digital channelization

NOVATOR SOLUTIONS

NC-10 USRP

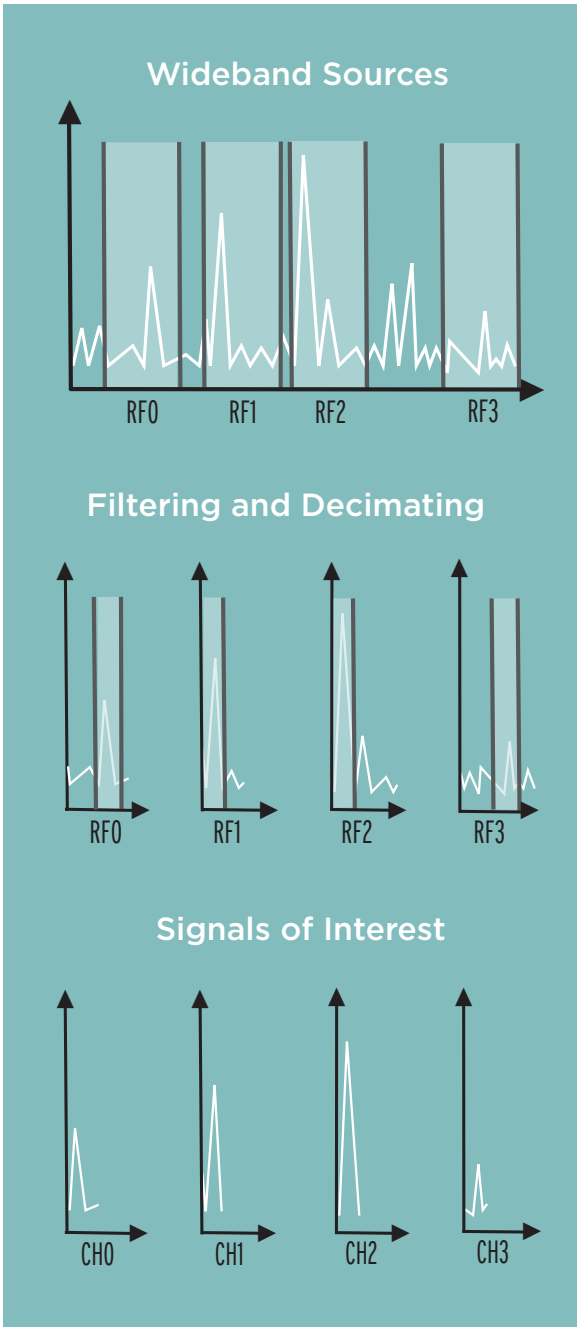
NC-10 USRP Channelizer is a toolkit for USRP-2955. It contains software as well as FPGA-bitfiles to turn the device into a powerful channelized radio, allowing users and system integrators to extract 512 GPS-timestamped signals of interest from four RF inputs and stream the extracted signals as well as the original wideband RF input via UDP.

Channelization

Spectrum monitoring and signal analysis have many application areas, both civilian and defense. The RF spectrum is getting crowded and having the right tools to a quire and analyze the wireless en vironment is crucial.

When monitoring a wideband source, many different signals of interest must be analyzed, demodulated, decoded, or processed in other ways. However, processing the entire wideband source for every signal of interest is not effective. Instead, the signals of interest should be extracted from the wideband source so that each signal is processed individually. This extraction can be achieved by filtering and decimating the wideband signal, resulting in a lower sample rate that contains only the signal of interest. By using channelization, it is possible to use a single wide-band receiver and still analyze hundreds of sig-nals.

NC-10 USRP Channelizer combines excellent performance with low cost and a small footprint. It provides four 80 MHz RF-inputs and by sharing LOs it can channelize phase coherently on all inputs making it possible to create COMINT and direction finding systems as well as many other types of applications.



Use Cases

Given the possibilities offered by NC-10 USRP, such as multiple RF inputs and 512 output channels, LO sharing and GPS timestamping, many different kinds of applications can make use of NC-10. The way the toolkit is used defines the final application.

COMINT

The four RF inputs can be configured individually and cover four separate bands of 80 MHz. Up to 512 channels in total can be extracted from the inputs. The channels will continuously stream the channelized data for further processing. Because the stream is continuous it is possible to use it for demodulation of signals and listen to traffic.

Direction Finding

The USRP 2955 supports sharing LOs between the RF inputs which gives phase coherent acquisition. This combined with phase synchronized channelization allows the user to create powerful direction finding application with up to 128 direction finding channels.

Beamforming

The USRP 2955, with its' four RF-inputs, is capable to provide beamforming capabilities. This means that an otherwise omnidirectional antenna lobe can be electronically manipulated to obtain directivity features. Directivity features can be used to enhance reception of signals in desired directions and to discriminate signals in undesired directions.

Geolocation

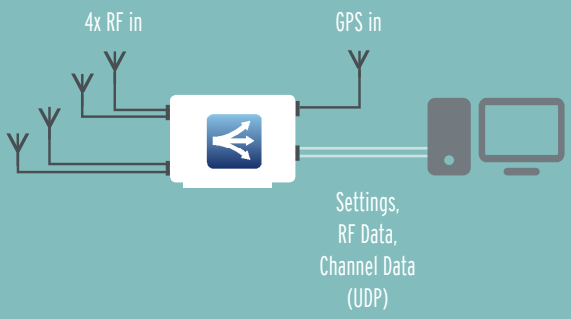
GPS timestamping and positioning can be used to synchronize systems across large distances. When multiple Direction Finding applications are coupled together with triangulation, geolocation can be provided.

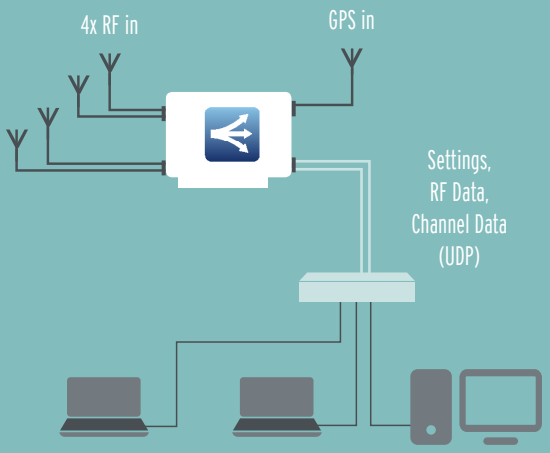
Reducing Data Rates

Due to data bandwidth limitations, reducing the data rate is important when transferring data between different locations. Covering a wide RF bandwidth means large data rates and 80 MHz is approximately 400 MB/s. By extracting the signals of interests and discarding undesired data, the data rate can be drastically decreased.

USRP System Setup

NC-10 USRP can be a building block for larger systems and is designed to easily be integrated into other environments. NC-10 USRP can be configured from Windows computers and the data can be streamed via UDP to applications in any OS.





System Setup

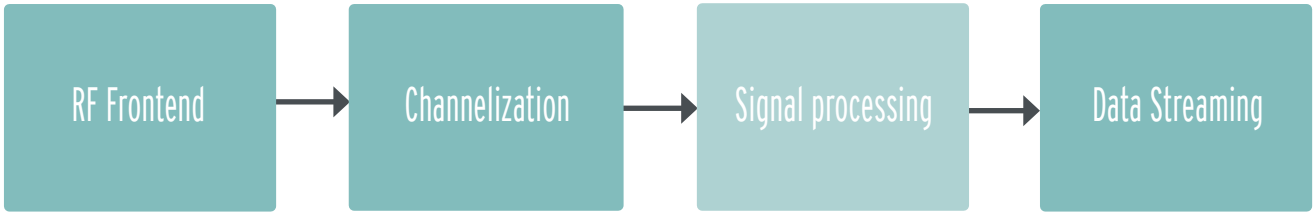
NC-10 USRP features two 10 GbE SFP+ ports which are used to control the unit and to stream RF data and channelized data. The simplest setup connects the USRP-2955 directly to a single computer with SFP+ ports. The other option is to connect the USRP-2955 to a switch which is then connected to one or multiple computers. The commands and data to/from the USRP is sent using UDP.

NC-10 USRP can be used directly from the start without any programming. A Windows based configuration tool with an easy to use UI is included in which it is possible to control the RF settings as well as the channelization settings. Spectrum views of the incoming RF data is also available. To retrieve the data, the included C, Matlab or Python examples can be used to get the data into your favorite analysis tool. This makes it possible to quickly get up and running with NC-10 USRP.

To create more advanced systems where also the channel allocation and RF control is integrated into your environment NC-10 USRP can be programmed either by using a LabVIEW API or by using an included TCP/IP server. This server runs on a Windows computer connected to the USRP and communicates with other systems using TCP/IP. Via an open protocol it is possible to configure the different parameters of the system. The server is running on a Windows computer but the systems communicating with the server can be running any operating system. The only requirement is that it is possible to communicate with TCP/IP commands. Examples of how to communicate, what commands to send and in which order are included in the protocol documentation. Examples on how to send commands are included for C, Matlab and Python. By using the configuration protocol to the server and the data streams it is possible to tailor the NC-10 into your workflow.

Signal Path

The signal path starts with the RF Frontend where the four analog wideband signals are downconverted and digitized. Afterwards, channelization takes place. In customized solutions signal processing is done on channelized data and finally, processed or raw channel data are streamed via UDP.



RF Frontend

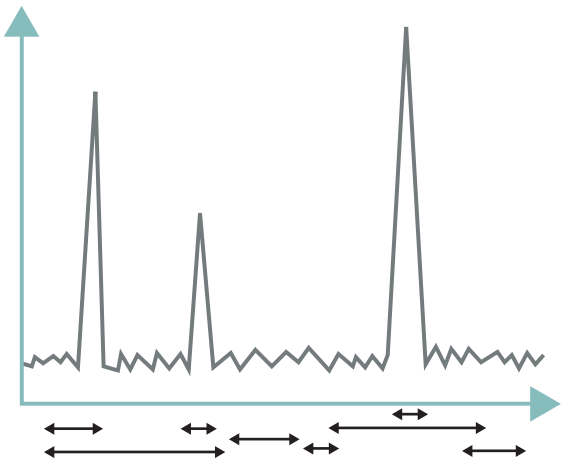
The USRP-2955 features four two-stage superheterodyne receiver channels. Each of the four inputs have a real-time bandwidth of 80 MHz and are tunable in a span from 10 MHz to 6 GHz. The inputs can be configured to share LO to enable phase coherent acquisition, or independently to be able to cover a larger frequency span. Data from the RF inputs can be streamed from the USRP to be analyzed and identify signals of interest.

Channelization

The heart of NC-10 USRP is the FPGA-based channelizer and the user can configure up to 512 channels in total with no restrictions on which RF input the channels use as source. The channels can be made to overlap, have different bandwidth and are independent of each other, unless they are configured for phase synchronized channelization. The channels can be reallocated dynamically when running and modifying one channel does not affect the operation of the other ones. The channelized data is output as IQ-data that is sent for analysis with the streaming interfaces.

Data Streaming

Data can be streamed through the two SFP+ ports. Both RF-data as well as channelized data can be streamed through the two different interfaces. Data sent through the SFP+ ports are sent as VITA49 UDP packages and can be routed over long distances either through switches or by connecting fiber optic cables to the SFP+ ports. The UDP packaging is performed directly on the FPGA and each channel can be sent to a specific address and UDP port, making it easier for processing nodes to filter out channels of interest. The 512 channels could for example be streamed to 512 different UDP ports.



Customization

NC-10 USRP is a toolkit, and as such, it is easy to use as a part of larger, more complex systems. In case NC-10 USRP alone does not fulfill all customer requirements, Novator Solutions offers design services where our USRP channelizer is integrated in a ready to run turnkey solution. Some examples of additional features that can be added either to the FPGA of the USRP or as surrounding software are listed below:

FFT

The NC-10 server can stream FFT-data of the RF inputs but this can be added directly to the FPGA as well and be streamed instead of, or together with the RF data. The FFTs can be gapless, overlapping, averaged and used for example in spectrums or spectrograms.

High Channel Count Systems

More synchronized RF inputs and channels leads to higher accuracy in many algorithms. By using the octoclock clock distributor module it is possible to synchronize channelization across multiple USRP devices making it possible to connect large arrays of antennas.

Automatic Signal Detection

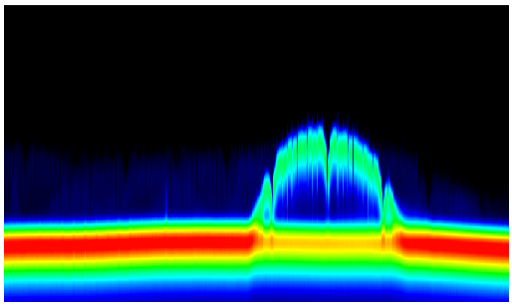
Automatically detect signals of interest when they break a frequency mask configured for the spectrum of the incoming RF signal, extract the signals of interest and stream the data.

Signal Processing

The default output from NC-10 USRP is the raw channelized IQ data that can be analyzed on the computers that receive the data. Some signal processing are however better suited to be done on the onboard FPGA. The signals could be demodulated or processed in other ways. The processed data instead is then streamed instead of the channelized data.

Persistence display

Real-time Spectrum analysis with a persistence display can be added to be able to monitor the incoming wideband RF signals in order to detect signals of short duration.



Specifications

For detailed USRP 2955 specifications please visit National Instruments homepage: www.ni.com

RF Frontend Specifications

Number of RF Inputs	4
Frequency Range	10 MHz to 6 GHz
Frequency Step	< 1 kHz
Instantaneous Real-time Bandwidth	80 MHz
ADC Resolution	14-bit
ADC Spurious Free Dynamic Range	88 dB
RF Architecture	Two-Stage Superheterodyne

Channelizer Specifications

Number of Output Channels	512
Output Channel Center Frequency Resolution	<1 Hz
Output Channel Sample Rate	Min: 0.76kSps Max: 50MSps
Spurious-free Dynamic Range	>100 dBFS
Signal to Noise and Distortion Ratio	>90 dB
RF and Channel Output Data Format	16-bit I and Q
RF and Channel Data Output Protocol	VITA49 (UDP)
Configuration Protocol	TCP/IP

Mechanical / Environmental

Dimensions (L x W x B)	26.67 cm x 4.06 cm x 21.84 cm (10.5 in. x 1.6 in. x 8.6 in.)
Weight	1.59 kg (3.50 lb)
Ambient Temperature	0–55 °C
Maximum Altitude	2 000 m (800 mbar @ 25 °C amb temp)
RF Input Connector	SMA
Data/Control Connector	SFP+ (10GgE)

Electrical

Input Voltage	9-16 VDC
Input Current	7.5 A (max)
Power Consumption	38 - 44 W (depending on application)

Specifications are subject to change without notice.

About Novator Solutions

Based in Stockholm, Sweden, Novator Solutions are specialized in developing FPGA-based software defined radio instruments on National Instruments platforms such as PXIe and USRP. We offer turn-key solutions for channelization, analysis, wideband recording and playback of RF signals in various scenarios.

Novator Solutions is a National Instruments Gold Alliance Partner, as well as winner of numerous awards including Alliance Partner of the Year 2015 in northern Europe and Alliance Partner of the Year 2016 in Europe, Middle East, India and Africa Region (EMEIA).

Our Partners

National Instruments (NI) is an American company based in Austin, Texas, with over 7000 employees worldwide. NI provides an integrated hardware and software platform that helps engineers and scientists in nearly every industry. NI RF products and solutions span from design to test. Its high-performance PXI platform and RF instrumentation deliver unprecedented flexibility, accuracy, and measurement speed.

RFEL is a UK based Technology Company providing high specification signal, image and video processing solutions to government, defence, security and industrial customers.
As world leaders in high performance software defined digital receiver designs for Electronic Warfare systems, RFEL offers rapid and flexible design services based on an extensive library of multi-award winning, patented FPGA IP-Cores.

Novator Solutions AB, Hammarbacken 6A, SE-191 27 Sollentuna, Sweden, info@novatorsolutions.se, Switchboard: +46 8 622 63 50
www.novatorsolutions.com