

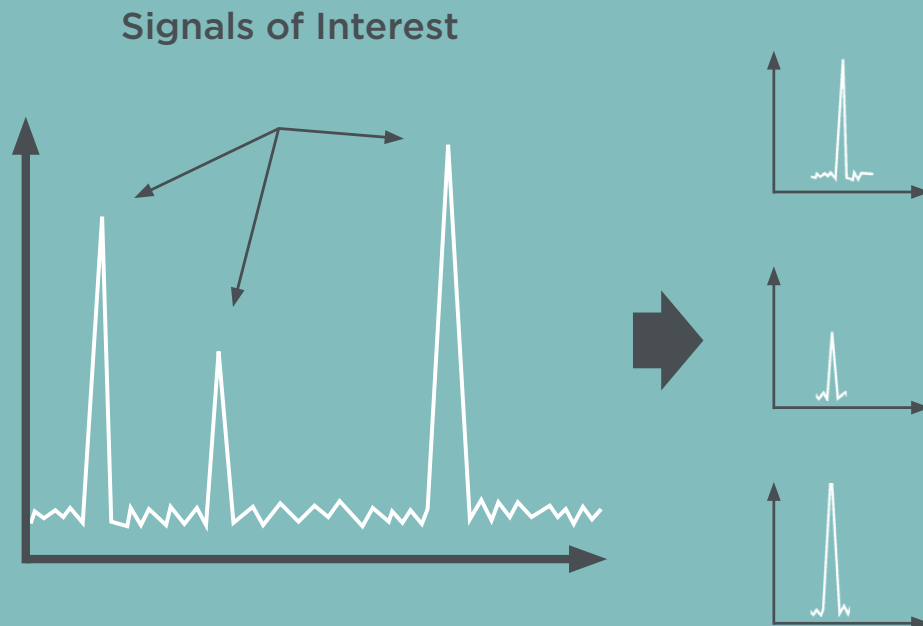
NC-10 USRP

Channelization Toolkit



Channelization and Channelized Receivers

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



Spectrum monitoring and signal analysis have many application areas, both civilian and military. The RF spectrum is getting crowded and having the right tools to acquire and analyze the wireless environment 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.

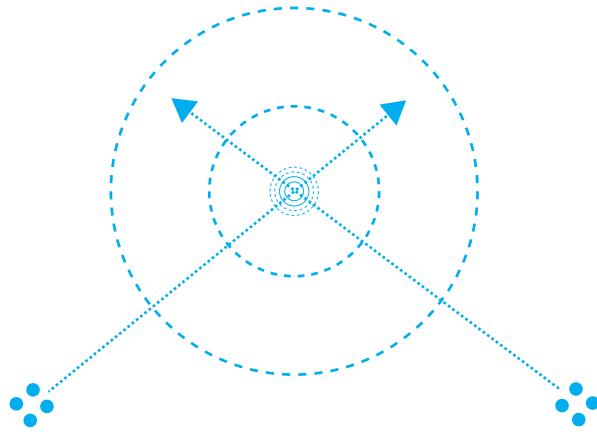
This extraction can be achieved by filtering and decimating the wideband signal, resulting in a lower sample rate that contains only the signal of interest. By using channelization, it is possible to use a single wideband receiver and still analyze thousands of signals.

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 receiver, allowing users and system integrators to extract signals of interest from four phase synchronized RF-inputs.

Use Cases

Direction Finding

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



Direction Finding
Station NC-10 USRP

Direction Finding
Station NC-10 USRP

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.

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.

Geolocation

GPS timestamping and positioning can be used to synchronize systems across large distances. Direction finding applications can, together with other DF-systems provide a geo location by using triangulation techniques.

Beamforming

The USRP 2955, with its' four RF-inputs, is capable to alone, or stacked with several USRPs', provide beamforming capabilities. This means that an otherwise omnidirectional antenna lobe can be electronically manipulated to obtain directivity features.

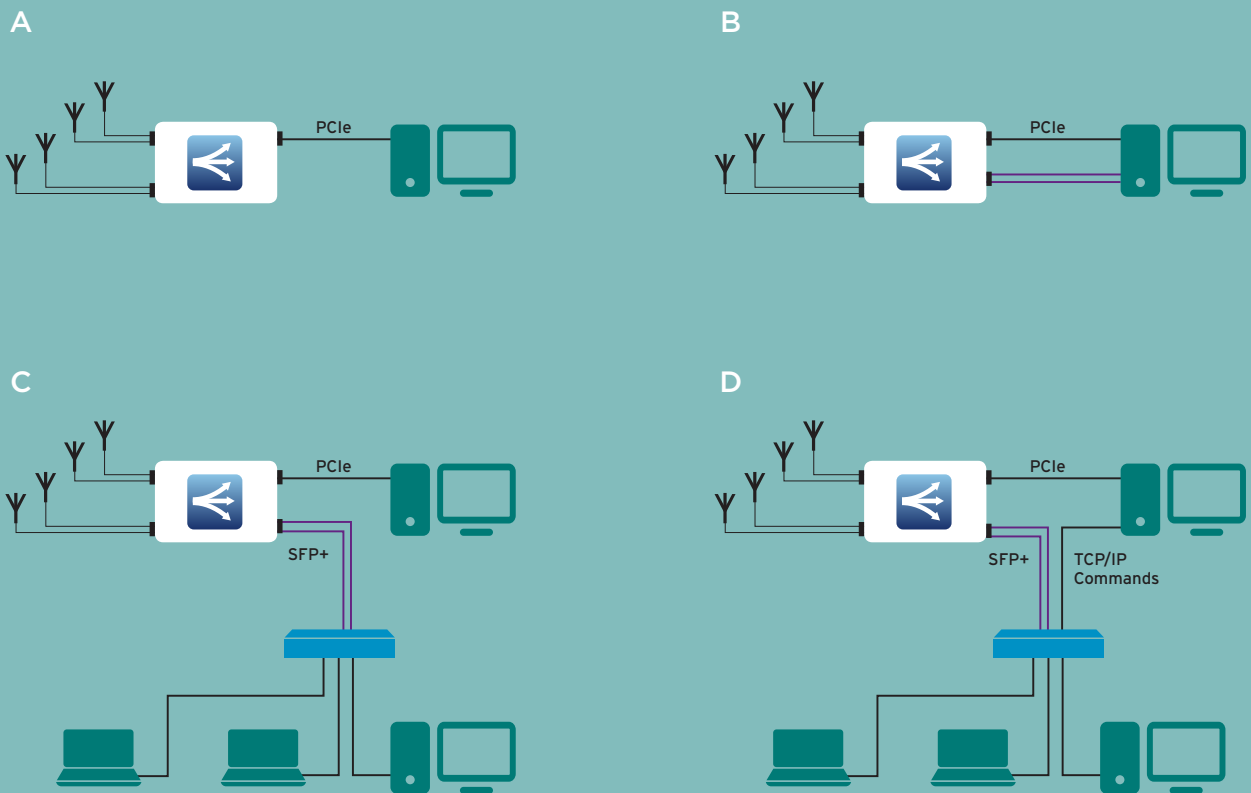
Directivity features can be used to enhance reception of signals in desired directions and to discriminate signals in undesired directions.

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 MBps. By extracting the signals of interests and discarding undesired data, the data rate can be drastically decreased.

USRP System Setup

NC-10 USRP is a building block for larger systems and is designed to easily be integrated into other environments. NC-10 USRP can be connected to Windows computers with a PCIe or Expresscard-slot and connected to other systems in different ways.



The simplest setup connects USRP-2955 to a single computer/server running NC-10 API. Both RF-data and channelized data is streamed to the computer (A).

To increase the streaming rate an additional network interface card with SFP+ connections can be added to the computer to stream the data (B).

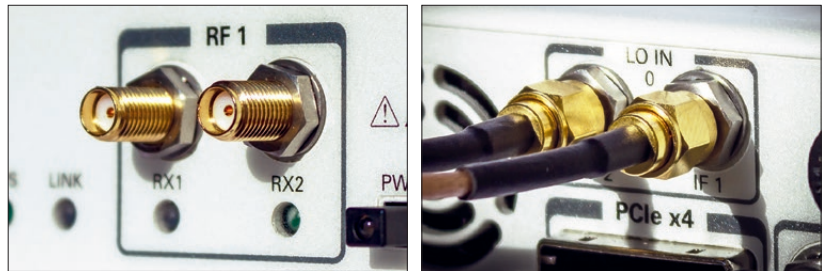
If processing needs to be distributed across multiple computers, the SFP+ connections can

be connected to a switch instead and the data is distributed across the network (C).

NC-10 can also be used as a channelization server and the computer connected to the USRP via PCIe is then also connected to a network and receives commands from other computers, telling NC-10 server which frequencies to channelize (D).

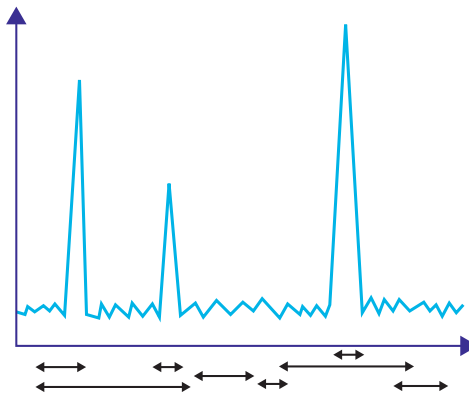
RF Frontend

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 channelization 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 either through the PCIe-link or 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. Other streaming protocols such as Xilinx Aurora are available on request.



Using NC-10 USRP Toolkit

The software is used to configure all the parameters of the hardware such as the RF frontend settings, channelization settings as well as the streaming location and many more parameters. The NC-10 software (including FPGA personality) can be used in three different ways, either locally by calling a DLL, using LabVIEW or as a server, receiving commands via TCP/IP. All three methods allows you to integrate NC-10 USRP into your own application.

DLL

The DLL can be called from any programming language capable of loading a DLL, such as C and Python. To help you get started more quickly, ready to run examples can be obtained in the following languages:

- C
- C#
- LabVIEW
- Matlab

LabVIEW

Apart for configuring the RF frontend and channelization, with the LabVIEW API it is possible to connect NC-10 to other hardware from National Instruments. Through peer-to-peer streaming data can be streamed to additional FPGA boards to process the RF data or the channelized data.

Server Software

Included in the software package is also a server software that is ready-to-run. This software 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.

From the server software it is also possible to stream spectrum-data from the inputs via UDP, which gives a good overview of the present signals.

NC-10 is a toolkit and to make the most of it, it should be integrated into another system. If no such system exist Novator Solutions offer design services where we make a tailored NC-10 system to meet your requirements.

Specifications

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

Channelizer Specifications

Number of RF inputs	4
Number of output channels	512
Output channel center frequency resolution	<1 Hz
Output channel sample rate	Min: 3k MSps Max: 50 MSps
Spurious-free dynamic range	>100 dBFS
Signal to noise and distortion ratio	>90 dB

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)

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 (EMEA).

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.

