Low Cost RF Sensors

APPLICATION NOTE

Tektronix®

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Introduction

Radio monitoring systems have historically been operated by government and military organization who need to have situational awareness of the radio spectrum. These large systems were expensive and required significant resource to manage the infrastructure. With the explosion in growth of wireless enabled devices (ie. LoRA,NBIoT), many non-traditional organizations are looking for tools to monitor the health and security of their wireless networks. While there are many low-cost Software Defined Receivers (SDR) on the market, most suffer from some common technical limitations;

1. Demodulation/Real time bandwidth < 10MHz

2. Tuning range limits (frequency range)

3. Lack of RF pre-selection

4. Basic API provides only bare-bones support

A more modern approach is needed so smaller and smarter monitoring systems can be integrated together in such a way that they can grow with the radio network in question.

Tektronix USB Spectrum Analyzers

Tektronix offers the RSA 300/500/600 lines of USB real time spectrum analyzers. Using the latest in commercial interfaces and available computing power, the RSA USB spectrum analyzer series separates signal acquisition from measurement, dramatically lowering the cost of instrument hardware. The RSA USB spectrum analyzer series are well suited for applications need automatic measurements or remote control.

The programs can be created in the host PC, and the remote control can be implemented over an Ethernet connection through a small size and low cost PC, such as Intel NUC, paired with each RSA. Tektronix provides programmatic control using a number of different interfaces to support your applications.
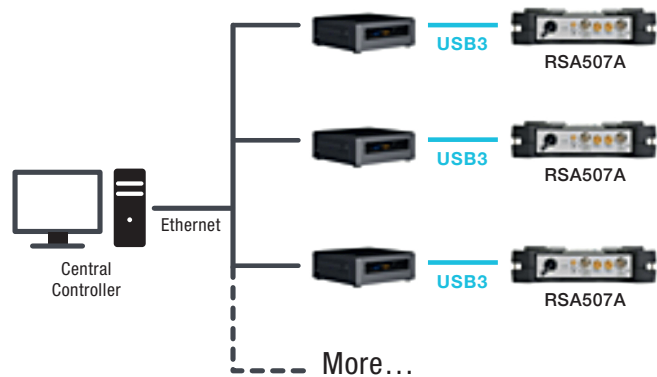

Figure 1 Multiple point remote control with Tektronix RSA507A spectrum analyzers with Intel NUC mini PCs

Functional Block Diagram

Within the spectrum analyzer hardware, an RF downconverter translates the input RF signal to the IF (Intermediate frequency) with 40 MHz Bandwidth. The IF is sampled at 112 Msamples/sec by a 14-bit Analog to Digital Converter, producing a stream of IF samples which are formatted and transferred by a USB-3.0 connection to the PC. Other brick inputs allow the internal reference oscillator to be synchronized to an external reference source, and enable use of external trigger or GPS timing pulses.
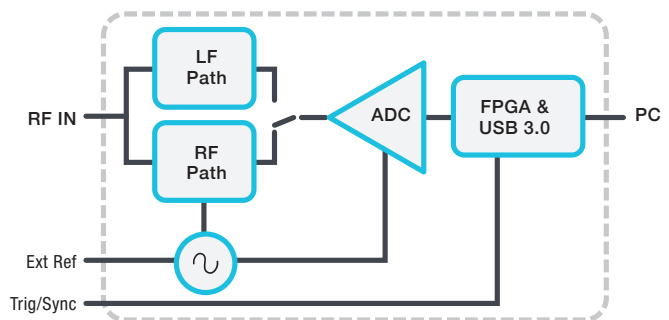

Figure 2 Simplified hardware structure of Tektronix RSA306B

The PC platform (a workstation, laptop, or tablet) provides control to the spectrum analyzer hardware via the USB-3.0 connection. In the PC, the IF samples are received by the USB Host HW and Driver, which pass them to the RSA306 API SW DLL. The API (application programming interface) provides public access to the four different formats of the signal data including:

■ processed IQ data blocks,

■ complete DPX bitmap images,

■ demodulated audio,

■ raw ADC samples,

as well as providing the control interface to the hardware. Applications such as SignalVu-PC use the API to configure the hardware, and retrieve DPX image blocks and IQ samples for analysis, as well as supporting continuous storage of raw sample data to file. User applications can also access the API for customized developments.
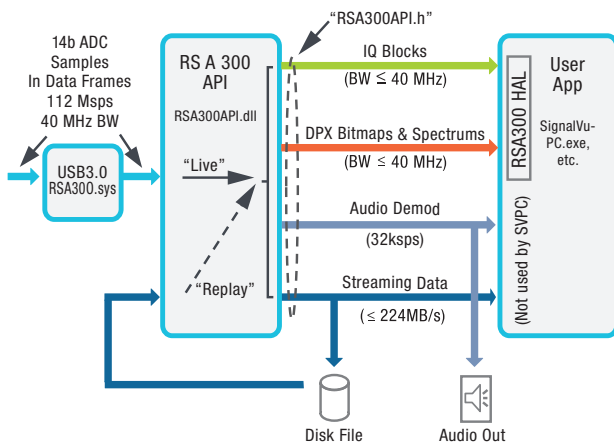

Figure 3 Simplified software architecture of Tektronix RSA306B

The Two Programmatic Control Methods

There are two methods to control Tektronix USB spect rum analyzers programmatically. Both of them can be implemented in different programming platform, such as C, C++, C#, Matlab, Python, LabVIEW …

Method 1 SignalVu-PC PI: Traditional benchtop spectrum analyzers, like Tektronix RSA5000 and RSA6000, have always had a PI (programming interface) to allow remote control of the instruments, remote data gathering, and automated testing. The PI implemented SCPI (Standard Commands for Programmable Instruments) commands that could be sent to the controlling software do such operation as instrument setup, start acquisitions, retrieve spectra and calculated data, etc. With the USB controlled spectrum analyzers, RSA300/500/600 series, the application software, SignalVu-PC, maintained the same interface as the spectrum analysis software controlling the Tektronix benchtop spectrum analyzers, and consequently the same PI is still in place for these USB spectrum analyzers for programmatic control. PI SCPI commands can be sent to the SignalVu-PC code that controls the USB spectrum analyzer via either the TekVISA VXI-11 Server (virtual GPIB) or the TekVISA Socket Server (Windows sockets). The RSA API is the new piece of code written to interface the hardware to the data ports of the SignalVu-PC software.

Method 2 RSA API: Sometime, users do not need many high level complicated signal analysis in SignalVu-PC, but want to implement fast and basic code, or do the further and deep processing based the acquired data themselves. In this case, the RSA API provides a better option to meet the needs. SignalVu-PC does not need to be run, and user can access the low level API for those fast data processing.
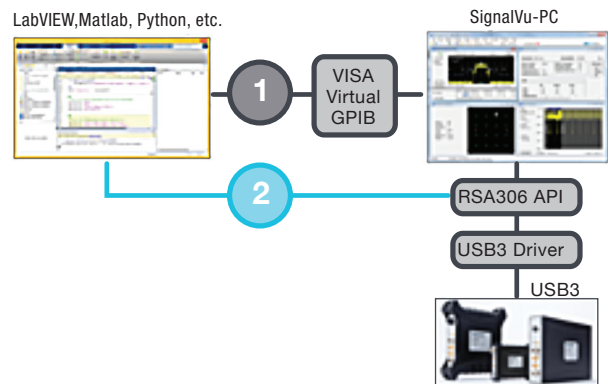

Figure 4 The two programming Interface of Tektronix RSAs

Depends on your applications, both the PI and API methods have pros and cons. We have our recommendations on which programming method is preferred based on the different purposes below.

PROGRAMMING PURPOSES	SIGNALVU-PC PI	RSA API
Making RF measurements that are included in SignalVu-PC, particularly when analysis results are returned on screen	✓	
Testing RF standards supported by SignalVu-PC where measurement limits are included in the software, many of which are pass/fail	✓	
Collecting streaming data for later analysis		✓
Capture data fast and efficiently		✓
Creating complicated HIGHER LEVEL applications by yourselves		✓
Streaming data with narrow bandwidth		✓

Table 1 When to use PI and when to use API

Control by SignalVu-PC PI

To program the RSAs through the SCPI commands with SignalVu-PC software, below are the four steps to follow:

1	Download and install the SignalVu-PC with TekVISA
2	Launch SignalVu-PC with a connect the USB RSA
3	Install the drivers for your selected programming platform when necessary*
4	Start to make your program

* You need to install the LabVIEW driver to use NI LabVIEW, but do not need additional drivers for platforms like C, C++, C#, Matlab, and Python.

The PI of SignalVu-PC uses SCPI and IEEE 488.2 Common Commands. The following figure shows command parts as described in the Command Syntax subsection.
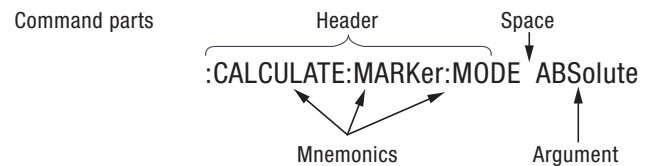

Figure 5 SCPI Command Parts

Each command works in a particular measurement view(s). The following table lists all available measurement displays supported by the SignalVu-PC software, which measurement view it is in, and if it requires an installed option.

MEASUREMENT SETS	OPTIONS
General signal viewing	Free
Analog modulation	Free
General purpose digital modulation	Option SVM
RF measurements	Free
OFDM analysis	Option SVO
Audio analysis	Option SVA
Bluetooth analysis	Option SV27
LTE Analysis	Option SV28
P25 analysis	Option SV26
Pulsed RF	Option SVP
WLAN analysis	Options SV23, SV24, SV25
Tracking generator	Option SV60 and 04 (HW)

Table 2 The PI measurements supported in SignalVu-PC

Control by RSA API

To program the RSAs directly through the API driver, one of the benefits is that you do not need to keep SignalVu-PC software running all the time. Also, there is no need to install any VISA drivers. Therefore, there are only three steps to follow:

1	Download and install the RSA API driver
2	Install the drivers for your selected programming platform when necessary**
3	Start to make your program

** For RSA API programming, we provide Matlab driver for Matlab, and IVI driver for LabVIEW. The API itself was implemented by C++, so it is compatible with C/C++ very well. Also, controlling RSAs with Python is also very straightforward without any additional drivers.

Again, the API driver of RSA provides a simple, basic, and fast way to program the instrument. Therefore, the number of the available measurements of the API is limited compared to SignalVu-PC. However, it still make the most common actions available for the programmers for their needs:

FUNCTIONALITIES	OPTIONS
Instrument Setup (Alignment, Configure, Device, GNSS, Trigger, power, Time)	No Charge
DPX	
Spectrum	
IQ block	
IQ streaming	
IF streaming	
Playback	
Tracking generator	

Table 3 The available API function sets

One of the benefits using API is the ability to stream the IQ and IF data down to as 200 kHz bandwidth, which is useful for reducing the total size of the captured streaming data. This will save you much more space if you're interested in narrow band signals.

Tektronix RF Sensor Solutions

Tektronix provides a wide variety of USB connected spectrum analyzers which make for an ideal RF sensor.

	RSA300	RSA500	RSA600
Frequency	9kHz -6.2 GHz	9kHz -3/7.5GHz	9kHz –/7.5GHz
IQ BW	40	40	40
IQ Streaming	Yes	Yes	Yes
IQ Block Mode	Yes	Yes	Yes
AM/FM Demod	Yes	Yes	Yes
Real Time	Yes	Yes	Yes
Power	USB 3.0	AC/DC/ Battery	AC

For more information on Tektronix USB spectrum analyzers please go to;

www.tek.com/rsa

Tektronix supports a wide variety of software environment for both Windows and LINUX. For more information and examples about the Tektronix USB software interface please go to;

https://github.com/TekRTSA/RSA_API

Contact Information:

Australia* 1 800 709 465

Austria 00800 2255 4835

Balkans, Israel, South Africa and other ISE Countries +41 52 675 3777

Belgium* 00800 2255 4835

Brazil +55 (11) 3759 7627

Canada 1 800 833 9200

Central East Europe / Baltics +41 52 675 3777

Central Europe / Greece +41 52 675 3777

Denmark +45 80 88 1401

Finland +41 52 675 3777

France* 00800 2255 4835

Germany* 00800 2255 4835

Hong Kong 400 820 5835

India 000 800 650 1835

Indonesia 007 803 601 5249

Italy 00800 2255 4835

Japan 81 (3) 6714 3086

Luxembourg +41 52 675 3777

Malaysia 1 800 22 55835

Mexico, Central/South America and Caribbean 52 (55) 56 04 50 90

Middle East, Asia, and North Africa +41 52 675 3777

The Netherlands* 00800 2255 4835

New Zealand 0800 800 238

Norway 800 16098

People's Republic of China 400 820 5835

Philippines 1 800 1601 0077

Poland +41 52 675 3777

Portugal 80 08 12370

Republic of Korea +82 2 6917 5000

Russia / CIS +7 (495) 6647564

Singapore 800 6011 473

South Africa +41 52 675 3777

Spain* 00800 2255 4835

Sweden* 00800 2255 4835

Switzerland* 00800 2255 4835

Taiwan 886 (2) 2656 6688

Thailand 1 800 011 931

United Kingdom / Ireland* 00800 2255 4835

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Vietnam 12060128

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