# SignalVu Demonstration Guide

Bringing the Benefits of Vector Signal Analysis
to Wideband Acquisitions

Demonstration Guide with Live Signals

What You'll Need

- DPO7000 or DPO/DSA70000 Series digital oscilloscope with version 4.2.0 or later. The latest version can be downloaded at www.tektronix.com

- AWG7000 Series Arbitrary Waveform Generator capable of 10 GS or higher

- SignalVu vector signal analysis software and setup files for the oscilloscope and AWG. These can be found at www.tektronix.com/signalvu

SignalVu vector signal analysis software helps you easily validate wideband designs and characterize wideband spectral events. By combining the signal analysis software of the RSA6100A Real-Time Spectrum Analyzer with that of the industry's widest bandwidth digital oscilloscopes, designers can now evaluate complex signals up to 20 GHz without an external down converter. You get the functionality of a vector signal analyzer and spectrum analyzer combined with the powerful trigger capabilities of a digital oscilloscope — all in a single package. Whether your design validation needs include wideband radar, high data rate satellite links or frequency hopping communications, SignalVu vector signal analysis software can speed your time-to-insight by showing you the time variant behavior of these wideband signals.

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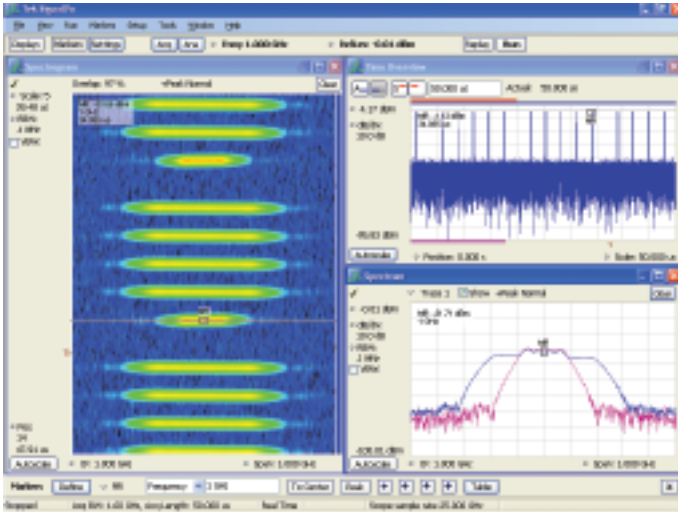
Figure 1. SignalVu allows users to see the time-varying nature of complex signals. In this example, the Spectrogram shows four wideband radar chirps followed by a relatively narrow one. The Spectrum display in the lower right shows how the signal changes over time as the marker is moved through the time record.

This demonstration guide is designed to help you understand the benefits of SignalVu when running on a DPO7000 or DPO/DSA70000 series digital oscilloscope. The guide is divided into four application sections:

- CW Tone
- Wideband Radar
- Hopping Waveforms
- Wideband Modulation

If you are already familiar with the above applications and the SignalVu user interface, you may choose to focus only on the actions described in the Application Overview boxes. Feel free to explore other SignalVu and oscilloscope features as you work through these examples. If you prefer a more guided approach, you will want to read the surrounding discussion for each application. Though the demos may be performed in any order, you will gain the most insight from SignalVu's value by working through each demo in order.

SignalVu's user interface is based on the success of the RSA6100A Real-Time Spectrum Analyzer user interface. For those not familiar with the RSA6100A, an introduction can be found in the RSA6100A's Quick Reference. It describes the look and feel of the RSA6100A and the many ways users can interact with this powerful user interface to make measurements most efficiently.
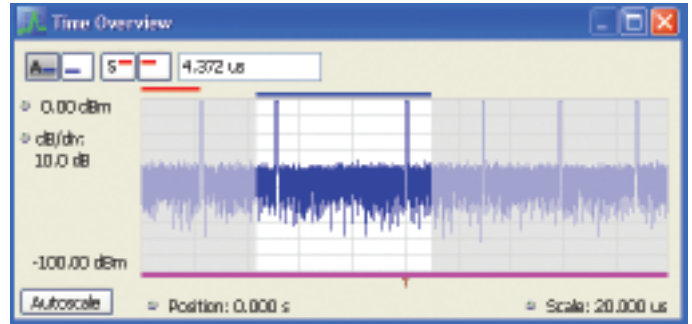
Figure 2. Easily select the portion of the acquisition to be analyzed using the analysis curtain. Simply drag the left and right edges of the curtain (shaded areas) to exclude acquisition time from the analysis.

User Interface Conventions

The following conventions are used in this guide to help facilitate parameter entry on the instrument front panel and GUI:

- Instrument **Hard Key** entries are shown in bold, such as on the AWG7000 **[CH1] [On]**.
- {Soft Key} entries refer to soft buttons and menu selections on the screen and are listed in brackets, such as {Settings}.
- Numeric Data *Entry* _ entries are italicized showing the value to be entered, such as *RBW _ 50 kHz*

You will see references to applying "focus" to measurement windows in each of the demonstrations. Applying focus refers to mouse clicking anywhere inside the measurement window so that the title bar is highlighted.

The wideband radar and modulation demos refer to the "analysis curtain". This feature is simply the gray area on the left and right of the analysis area in the Time Overview display. The analysis curtain can be used to select that portion of the acquisition you wish to analyze. Adjust the end of the analysis period by dragging the left-hand portion of the curtain with the mouse. If the curtain is not visible, simply move your cursor to the left-hand edge of the Time Overview display and hold down the left mouse button. Then drag the curtain over to the desired start of the analysis area. The end of the analysis area can be set by dragging the right-hand curtain in a similar fashion.

Measuring a Simple CW Tone

A CW tone is a simple, but useful example to highlight some of the key benefits of the SignalVu software. Most importantly, the SignalVu user interface is familiar to users of both traditional spectrum analyzers and vector signal analyzers, alike. However, one of the biggest differences between a traditional spectrum analyzer and SignalVu is the dramatic improvement in real-time bandwidth. Real-time bandwidths of 500 MHz to 20 GHz are possible with the appropriate Tektronix oscilloscope. This becomes especially useful for users who need to make direct measurements into microwave frequencies as an external down converter is no longer required.

The CW tone example highlights how quickly you can setup and measure your signal of interest with just a few simple mouse clicks. After setting the basic measurement parameters, use the mouse right-click to move the trace so the peak and noise floor are both clearly visible on the display. Now, find the peak of the CW tone with another right-click selecting Marker to peak. Add another marker and either move the delta marker to the next highest peak or use the marker menu at the bottom of the display and choose the down arrow to find the next lower peak. Note the wide spurious free dynamic range with this signal applied.
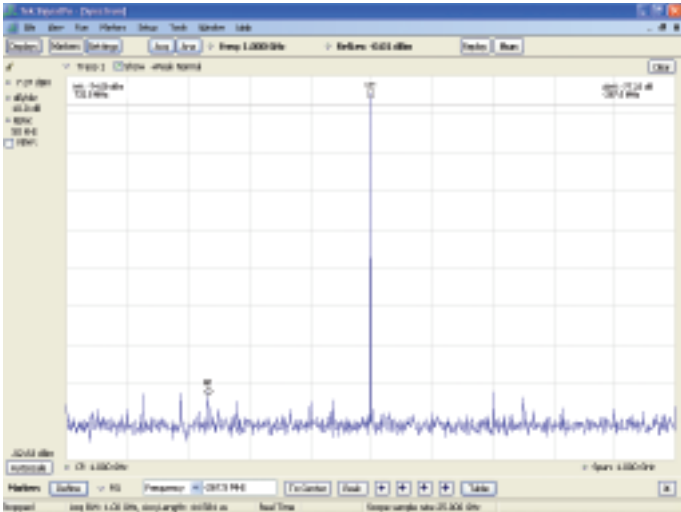

Figure 3. This simple example shows how markers and mouse right-clicks can be used to quickly measure the performance of a CW tone in a 1 GHz span.

Application Overview

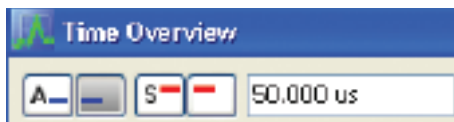| Objective	Keystrokes
Recall a 1 GHz CW Tone on AWG7000	**AWG7000**
	{File} {Open File} CW_1GHz_tone.awg
	[Ch1] [On]
Display a 1 GHz CW Tone	**SignalVu**
	{File} {Preset}
	Freq _ 1GHz, Span _ 1GHz
	Mouse right-click, {Pan} and move the trace down so the peak of the CW tone is visible
Observe Residual Spurs with Signal Applied	*RBW _ 50 kHz*
	Mouse right-click, select {Marker to Peak}
	Mouse right-click, select {Add marker}
	Drag the M1 marker to next highest peak and observe the delta readout in the upper right hand corner of the display

Wideband Radar

SignaVu is ideally suited for designers and troubleshooters of wideband radar systems. Frequency coverage through Ku-band, automated pulse characterization and SignalVu's numerous displays for showing the time-varying nature of these waveforms are just some of the benefits the radar engineer will enjoy. In addition, signals that vary in time or in amplitude can be captured by the oscilloscope's sophisticated triggers. These include external gating signals with the RF signal to produce the composite trigger condition.

The radar signal in this demo consists of a series of 500 MHz wide linear FM (LFM) chirps followed by a chirp of narrower bandwidth and longer pulse repetition interval (PRI). You will have a chance to view these signals and their time varying nature. Using the oscilloscope's advanced triggering capabilities you will trigger on the pulse with the long PRI and examine its characteristics in detail.

Before starting this demonstration, let's discuss an important display for configuring and analyzing signal captures. The Time Overview is a display that shows the entire acquisition record and shows you how the spectrum time and analysis time fit within the acquisition record. This enables you to see how you can adjust the spectrum time and analysis time to measure portions of the data.

The Time Overview window shows the user the total power of the RF present during each sample period within the acquisition bandwidth. Time Overview can also set the length of the analysis. The two blue buttons on the left are used to set the analysis offset ![button] (the left-most button) and total analysis length ![button] (right blue button). Similarly, the two red buttons set the spectrum offset ![button] (left red button) and length of the time used to compute the spectrum ![button] (right red button). In this demonstration, both the acquisition length and spectrum length are set to 50 us. The offset values are left unchanged after the Preset.


Application Overview

Objective	Keystrokes
Recall a 500 MHz LFM chirp on AWG7000	**AWG7000**
	{File} {Open File} Radar_LFM500MHz.awg
	[Ch1] [On]
Display spectrum of LFM chirps	**SignalVu**
	{File} {Preset}
	Freq _ 1GHz, Span _ 1 GHz
Set the analysis time	{Displays} double click {Time Overview} {OK}
	Acquisition Length _ 50 us
	Spectrum Length _ 50 us
View the spectrogram	{Displays} double click {Spectrogram} {OK}
	Scale _ 4 (94% Overlap)
Trigger on the pulse with a long PRI	**DPO/DSA scope**
	{File} {Recall} Radar_LFM500MHz.set
Display pulse parameter details	**SignalVu**
	{Displays} double-click {Spectrogram} to remove
	Select {Pulsed RF} folder and double-click on {Pulse Table} and {Pulse Trace} {OK}
	Apply focus to Pulse Table window
	Click {Settings} Params tab, {Measurement Filter} {No Filter - Max BW}
	Select Measurements tab, check-box Rise Time and Frequency Deviation
	Select Frequency Estimation tab {Modulation Type} {Linear Chirp}
	Close the Pulse Table Settings menu
	Pause the acquisition by pressing {Run}
	Apply focus to the Pulse Table. Click on the cell for Rise for pulse # 1. Click on the cell for Freq Dev for pulse # 1. Note how this affects the Pulse Trace display
	Click on Freq Dev for pulse # 5
Display spectrum detail of long PRI chirp	Apply focus on Time Overview
	Set Time Overview Spectrum Length around only one of the long PRI pulses. First, push the Time Overview right red button (Spectrum Length). Then drag the left curtain, then the right curtain so only the 5th pulse is visible inside the curtain. Place the left and right edges of the curtain so that the pulse on-time is approximately in the center.
	Restart acquisitions by pressing {Run}

Once you've set the Spectrum length, note how the signal changes its relative time position from acquisition to acquisition. The oscilloscope can be used to trigger on the time-varying nature of the chirps so that the trigger begins precisely at the same point for each acquisition. A width trigger function will be defined that looks for the chirp signal to remain low for a defined period of time. We can precisely set the start of this low time period by first defining when the long PRI pulse turns off (specific voltage level). Then, define the period of time the chirp remains off and set the level of the next pulse as it begins to turn on. Scope cursors can be used to measure these time windows very precisely. Because the Pinpoint trigger system has two timers you are able to set minimum and maximum time durations between the RF pulses. To simplify the demonstration, recall the oscilloscope setup file that allows you to trigger on the 5th pulse with the longer PRI. Switch to the oscilloscope user interface and explore the setup conditions under the Trig menu.

SignalVu can calculate up to twenty-one measurements on every pulse acquired, up to a limit of 10,000 pulses, to help engineers validate the radar is operating within designed parameters. In this example, you are only calculating a few parameters, but the results clearly show that the 5th pulse is unique. Besides its longer PRI, the pulse table indicates the total frequency deviation to be approximately 240 MHz, chirping from a high frequency down to a low frequency. The other pulses are nearly 500 MHz wide and chirp from a low frequency to high.
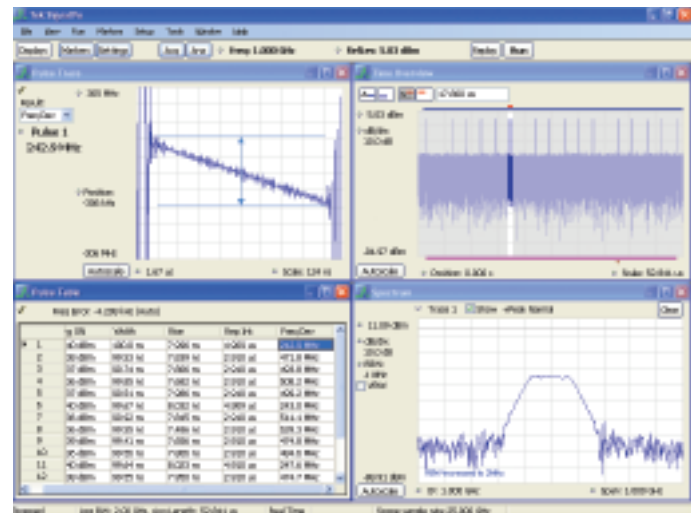
Figure 4. Automated pulse parameter measurements are included in SignalVu option SVP. The pulse trace in the upper left highlights the deviation a linear FM chirp of pulse number 1 in the table in the lower left. The lower right display shows the spectrum of a single pulse defined by the acquisition in the upper right.

The controls in Time Overview allows you to customize not only which portion of the acquisition to analyzed by the Pulse Table, they also allow you to precisely set the spectrum length to be used to compute the spectrum. In this case, the Spectrum time has been offset by 17.8 us so that only the spectrum of the 5th pulse is now calculated. Since the oscilloscope is now triggered, the same pulse will be analyzed in each acquisition cycle. The Spectrum time can also be extended to the limits of the acquisition to view the composite spectrum of all pulses.
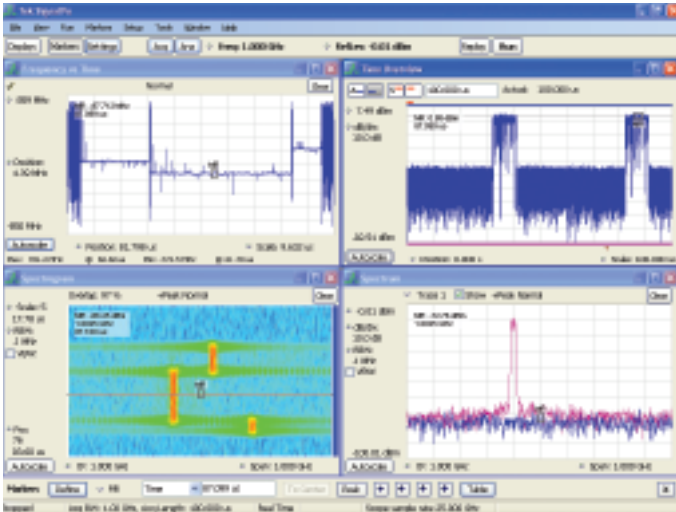
Figure 5. Correlated markers track the signal in all displays.

Hopping Waveforms

While the Spectrogram display is not new to the wideband engineer, they have not always had sufficient time and frequency resolution to precisely measure signal hop characteristics. In this demonstration, the Frequency vs. Time display is used to precisely measure the hop distance within a single burst, as well as, the hop distances between bursts. This demonstration will also show you how markers are correlated between different measurement displays.

First, observe the hopping nature of the signal. Be sure to drag the marker through the Spectrogram to observe the hop characteristics in the Spectrum display. The bottom of the Spectrogram's display shows the most recently acquired data. Adding a marker in one display adds the same marker in all displays. Watch how the Spectrum replays the event and how the marker tracks frequency and time movements in all displays. Such correlated behavior is also available using SignalVu's additional markers.

Pan and Zoom are right-click mouse features that allow the user to rapidly find a specific portion of the signal. Because modern oscilloscopes offer sampling rates up to 50 GSample/sec, extreme timing resolution is possible. The Pan feature allows the user to move the position of the trace in both the horizontal and vertical dimensions without having to rescale axes or change acquisition settings.

Application Overview

Objective	Keystrokes
Recall a Hopping Waveform on AWG7000	**AWG7000**
	{File} {Open File} Hopping Waveform.awg
	[Ch1] [On]
Display Hop Characteristics	**SignalVu**
	{File} {Preset}
	Freq _ 1GHz, Span _ 1 GHz
	{Displays} double click {Time Overview} {Spectrogram} {Frequency vs Time} {Ok}
	Apply focus to Time Overview, set Analysis *Length _ 100 us*
Zoom in on the Spectrogram of the 3 consecutive bursts	Apply focus to Spectrogram, set *Scale _ 3*
	Pause the acquisition by pressing {Run}
	Right-click {Pan} drag mouse to position the 3 hops clearly on-screen (if needed)
	Right-click {Zoom} drag mouse vertically to display the 3 hops clearly
	Right-click {Add marker} and drag the MR marker slowly through the Spectrogram of each burst
Measure the hop distance within a single burst	Apply focus to Frequency vs Time
	Right-click {Zoom} drag mouse to right over the center of the hopping signal.
	Right-click {Pan} drag display to right to recenter it on the display. Repeat {Zoom} if needed, so the 3 hops dominate the display
	Drag the MR (marker reference) to the start of the first hop. Use the keyboard up and down arrow keys to precisely position the marker at the start of the first hop
	Right-click {Add marker} and drag M1 to the end of the third hop (about 8.6 us and 160 MHz away)
	Repeat this process to see the hop distance (time and frequency) for the second hop
Measure hop distances between bursts	{Autoscale}
	Move M1 to the start of the next burst. {Zoom} on the start of the second burst and reposition M1 until it is precisely located at the start of the burst (about 50 us away).

Wideband Modulation

Point-to-point microwave links operating at 14 GHz often need to be characterized to ensure emission compliance with local regulations. The wideband digital oscilloscope is a useful tool to characterize these transmissions because of their high analog bandwidths.

This demonstration will highlight how wideband digitally modulated signals can be generated with an AWG7000 and reliably demodulated with SignalVu.

Application Overview

| Objective	Keystrokes
Recall a 16QAM Signal on AWG7000	**AWG7000**
	{File} {Open File} Wideband 16QAM.awg
	[Ch1] [On]
Display Modulation Quality of 16QAM Signal	**SignalVu**
	{File} {Preset}
	_Freq _ 1GHz, Span _ 500 MHz_
	{Displays} double-click {Time Overview} and from the GP Digital Modulation folder double-click {Constellation} {EVM vs Time} and {Symbol Table} {OK}
	Apply focus to the Constellation display
	Click {Settings} Modulation tab and set Modulation type to 16QAM, Symbol Rate to 312.5 MHz and Filter Parameter to 0.35 (leave the Measurement and Reference filters unchanged).
	Close Constellation Settings window
	Pause the acquisition by pressing {Run}
	Right-click inside the EVM vs Time window {Add marker}. Use the mouse or up/down arrow keys to move the marker from symbol to symbol
Analyze a different portion of the time acquisition	Move the marker in EVM vs Time to the right hand side of the display.
	Apply focus to the Time Overview display
	Grab the left hand side of the analysis time curtain and move it right approximately one full analysis length (~409ns). Press {Replay} to re-analyze the new portion of the acquisition.
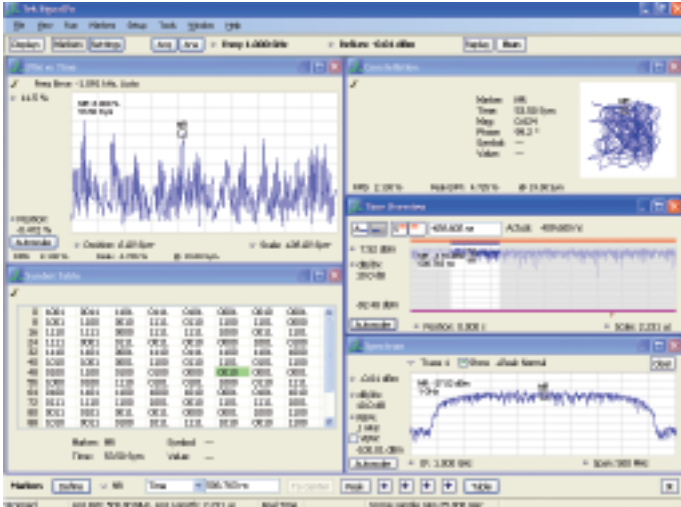
Figure 6. Wideband point-to-point microwave links can be easily demodulated with SignalVu's option SVM. Shown is a 16QAM signal operating at 312.5 Msymbols per second. Note the RMS EVM of less than 3%.

As in the other displays, correlated markers are useful in measuring changes from symbol to symbol. In this demonstration a 16QAM signal occupying nearly 500 MHz of spectrum is used to illustrate that both the AWG and digital oscilloscope can be used to measure relatively low EVM values. In this case, the RMS EVM value for this signal operating at 312.5MS/sec is less than 3%.

Once the measurement is configured, try moving the marker from within any of the displays. Notice that whether the marker is moved within the symbol table or EVM vs. Time or Constellation, it tracks in the other displays allowing the user to understand how EVM changes on a symbol-by-symbol basis, including the trajectory the symbol makes.

For Further Information

Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology. Please visit **www.tektronix.com**

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