Using the QST Spectrum Analyzer with a Digital Storage Oscilloscope.

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In the autumn of 2009 I purchased a Rigol DS1052E Digital Storage Oscilloscope (DSO.)   By now, in 2013, I continue to be quite pleased with the instrument.   One of the main applications is as the display for my homebrew spectrum analyzer (SA).   This instrument was described in QST for August and September of 1998.   The QST analyzer has a built in time base.   This controls both the external scope display and the swept VCO within the spectrum analyzer.   The external oscilloscope operated in the XY mode.

A local friend (K7CVU) who has a Tektronix DSO as well as one of our spectrum analyzers discovered that his Tektronix DSO does not perform well in the XY mode.   Another friend (K3NHI) has a Chinese DSO that he uses with his home brew analyzers, and also finds that the XY mode is less than useful. I confirmed this with the Rigol.   Following the lead from K3NHI, I started looking at suitable places where I could extract a trigger pulse within the time base on my oscilloscope. The original horizontal output signal is excellent, for it has a high amplitude and a relatively steep voltage edge at the beginning of the actual sweep that controls the analyzer VCO.

The purpose of this note is to document the process I'm presently using with the analyzer and the DSO.   The horizontal ramp that sweeps the display no longer comes from the spectrum analyzer.   Instead, this ramp is created within the oscilloscope.   A pulse is extracted from the spectrum analyzer that triggers the scope sweep.

The DSO was set up with Channel 1 connected to the vertical or Y output of the SA. The sensitivity was 0.5 volt per division, the same as was used before.   The DSO is set for a 1X probe to account for the direct connection between scope and analyzer.   The DSO can be set for either NORMAL or AUTO mode horizontal operation. Channel 2 was set to look at the horizontal signal from the spectrum analyzer, which is a positive going ramp with an amplified pulse for the reset.   The DSO is triggered with Channel 2.

Our spectrum analyzer is a free running instrument.   One sweep follows the next without interruption with analyzer data applied to the DSO.   The sweep signal entering CH2 causes the DSO to trigger.
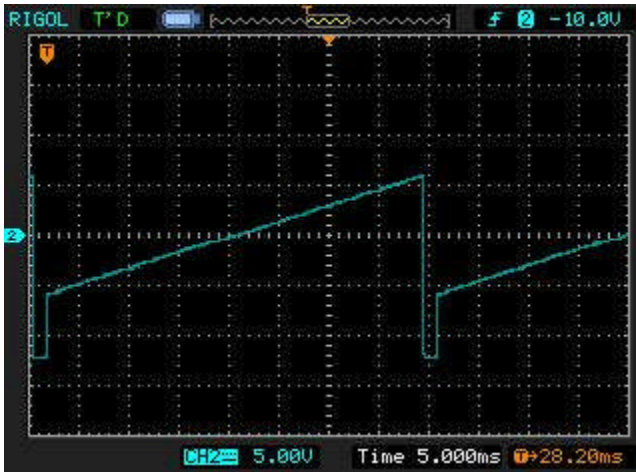
Fig 1.

The first figure shows the channel 2 result, which is the normal, horizontal output from the spectrum analyzer. This trace is at 5 volts per division. The horizontal center line is zero volts.   The DSO, for this particular trace, was set to trigger at -10 volts with a positive going signal.   The Time where triggering occurs is marked with the "T" in an orange box at the top left of the screen. The trigger happens with the almost vertical positive going pulse, just before the slower linear ramp.

The display shown above will change when the spectrum analyzer sweep rate control is adjusted.   It will not, however, change when the span is adjusted. The span only alters the signal reaching the spectrum analyzer VCO.

In the above figure the 'scope horizontal position control has been adjusted to move the trigger point almost to the left edge of the display.   Adjusting the spectrum analyzer sweep rate control will move the data on the right side of the sweep, leaving the beginning unchanged at the left.
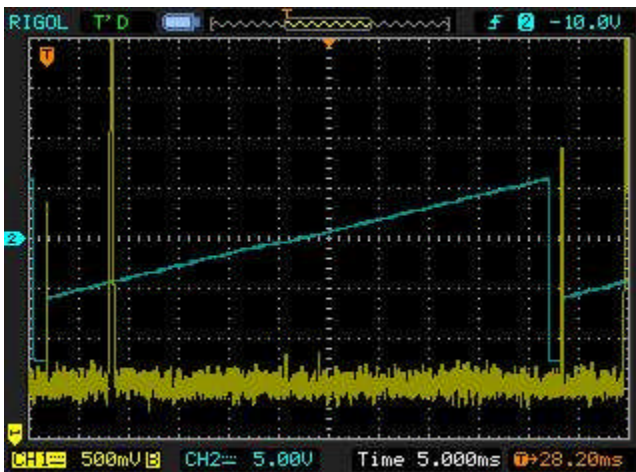

Fig 2.

In the next figure, shown above, the spectrum analyzer sweep rate was changed slightly and the Channel 1 button was pushed, turning that trace on for viewing. This trace is yellow while the horizontal sweep is in blue-green. The large yellow signal going to the top of the screen is the familiar zero spur. The other two lower amplitude signals are also spurious responses that occur during the retrace. The A to D in the DSO may grab some data with these, even though little would have appeared with a conventional 'scope display.

The analyzer span control was set to the "max span" condition, so the sweep will cause the entire spectrum between 0 and 70 MHz to be presented.

Channel 2 could be turned off without altering the triggering. The trigger signal is still detected by channel 2 and continues to control the DSO.
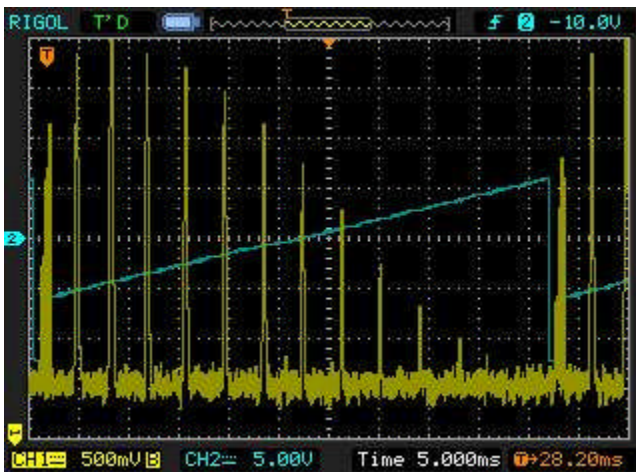
Fig 3.

In Fig 3 (above) a 7 MHz, harmonic-rich crystal oscillator is turned on with the output attached to the spectrum analyzer input. This source is used as a spectrum analyzer calibrator. If the SA center frequency knob is tuned, the whole yellow display will move left or right, leaving the blue data of Channel 2 fixed.

Note Fig 3 that the 5th harmonic of the comb crosses the linear ramp at exactly 0 volts. We can tune the SA center frequency to move other lines to this point. Leaving the tuning alone, we now slowly adjust the span control, "spanning in" on that 35 MHz 5th harmonic. The eventual result is the next photo, Fig 4.
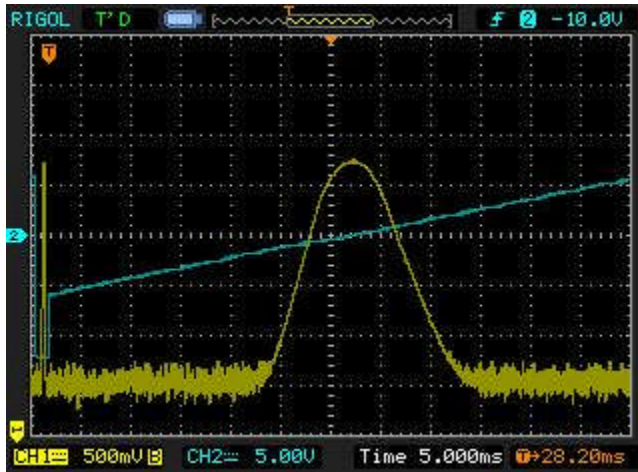
Fig 4.

The span control expands or compresses the displayed spectrum about the place where the sweep signal is zero. A serendipity has occurred: The blue-green line crossing the zero volt line on screen provides a marker for the screen center for the point where we span in or out. This is a very handy sign post that can be used during analyzer operation.

Figure 4 still contains a false zero spur. The oscilloscope horizontal position control and/or the sweep rate control can be used to move this off screen to the left. I've found that a scope sweep rate of 5 ms/div works well for the range of sweeps in my analyzer. Experimentation is certainly to be expected in other situations.

A final figure is presented below after we pushed in on both the horizontal position and the trigger level pots. This set the trigger level to 0 volts and set the trigger point to the center of the screen. It's conceptually uncomfortable for those used to a trigger point as being the beginning of a trace to have a trigger occur in the middle of a trace, but it is OK with a digital storage
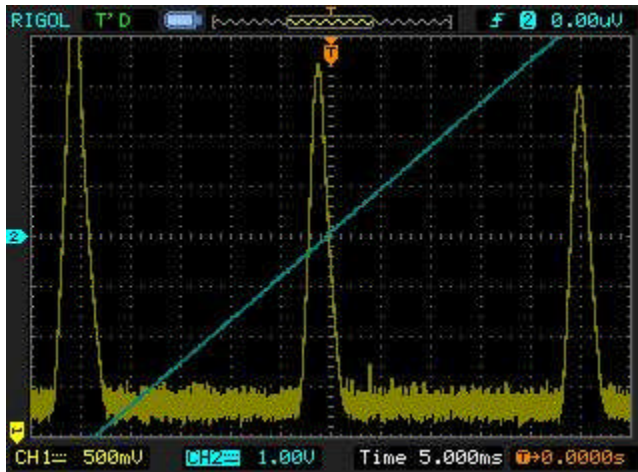
instant.

Fig 5.

The sensitivity was changed to 1 volt/div for the Channel 2 vertical.   The sweep rate control was adjusted to move unwanted fine structure away from the displayed area.   The three signals remaining on screen are at 0, 7, and 14 MHz where the 0 MHz line is the usual analyzer zero spur.

The delayed sweep feature of the DSO can be used to span in on display features, although the span control in the analyzer is probably preferred.   The fat yellow noise trace across the screen can be thinned by turning the SA video filter on.   Alternatively, digital averaging is available with the DSO, allowing many traces to pile up.   16 traces seems to do a nice job in this regard.