

# Spectrum Analyzer Instruction Manual

## SPECTRUM-1 and SPECTRUM-PRO-2R



## Spectrum Analyzer Software Instruction Manual

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## About This Software Manual

This manual covers the operation of the SPECTRUM-1 and SPECTRUM-PRO-2R options for 64-bit MAUI oscilloscopes.

These options enables features not included in our legacy Spectrum Analyzer software. If you are familiar with the legacy Spectrum Analyzer, you'll want to pay particular attention to changes in functionality within these areas.

- New Display features, including:
  - Logarithmic scale display grids
  - Integrated waveform display, showing spectrums on grids alongside other types of traces
  - Drag-and-drop spectrum waveforms
- Spectral mask testing (SPECTRUM-PRO-2R only)
- Stored Ref(erence) spectrum (SPECTRUM-PRO-2R only)

If you are using the legacy Spectrum Analyzer, you can still use this manual for instructions on spectrum configuration and display. Features that are not available to you will be noted in the text.

	<b>SPECTRUM-1</b>	<b>SPECTRUM-PRO-2R</b>
<b>Number of spectrum traces</b>	1	2
<b>Logarithmic scale</b>	✓	✓
<b>Spectrogram (2D/3D)</b>	✓ *	✓
<b>Sniffer probe/CA10 support</b>	✓ *	✓
<b>Pop up Peaks and Markers table</b>	✓	✓
<b>Reference trace</b>		✓
<b>Spectral background removal</b>		✓
<b>Spectral mask testing</b>		✓

\* Feature not available on WaveSurfer 3000z and WaveSurfer 4000HD oscilloscopes.

## Spectrum Analyzer

The SPECTRUM-1 and SPECTRUM-PRO-2R software options simplify the debugging of frequency-related effects, presenting a tool kit that mimics the interface of a traditional RF spectrum analyzer. You can start using the Fast Fourier Transform (FFT) with little or no concern about setting up an FFT. All spectral views can be displayed alongside other types of waveform traces for a comprehensive analysis of a signal's time and frequency response.

SPECTRUM-1 supports the creation and display of a single spectrum trace (SpecAn1) plus spectrogram (Spectro1). Optional [peak labels and other markers](#) add detail to the spectrum trace. The colored 2D or 3D [spectrogram](#) helps to visualize the frequency pattern.

In addition to all the features included with SPECTRUM-1, SPECTRUM-PRO-2R allows you to:

- Simultaneously generate two spectrums, both of which can be viewed as various types of spectral traces (Magnitude, Power, etc.) or as spectrograms
- Remove background noise
- Save either spectrum to a third, Ref(erence) spectrum
- Use [Spectral mask testing](#) to confirm that the frequency response of the DUT is within design limits

Choose **Analysis > Spectrum Analyzer** to access the software and begin to [set up a spectrum](#).

SPECTRUM-PRO-2R users can use the [quick setup](#) features once spectrum configurations are in place.

## Frequency and Sample Rate

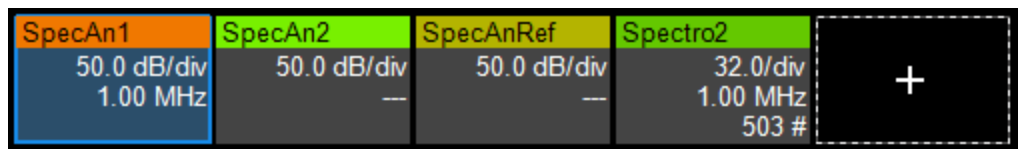
Spectrum Analyzer can only calculate frequency to half the acquisition sample rate. Therefore, the acquisition used as the spectrum source must be within the following limits.

Sample Rate	Lowest Frequency	Minimum Acquisition Length
10 GS/s and up		20 ns
5 GS/s	50 kHz	20 us
2.5 GS/s	25 kHz	40 us
2.5 MS/s	25 Hz	40 ms
500 kS/s	5 Hz	200 ms

## Integration with Other Applications

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Spectrums are now a type of trace that can be added to any other waveform display. If you are working in another oscilloscope application and turn on the Spectrum Analyzer, you will see the SpecAn dialogs at the bottom of the screen, but the rest of your waveform display will not change until you enable a spectrum or spectrogram. Then, a new SpecAnN or SpectroN descriptor box and trace will appear on the existing display.



Drag the new descriptor to whichever grid you'd like to move the spectrum/spectrogram and continue to modify it as you wish.

You will have to manually turn off any other traces you do not wish to view.

## Quick Setup

All features on the SpectrumPro dialog are only available with SPECTRUM-PRO-2R.

If you have previously configured spectrum traces, they can be quickly turned on/off or copied from the SpectrumPro dialog.

## Turn On/Off Spectrum Traces

To turn on/off spectral views, simply check **Enable** and **Spectrum** or **Sectrogram**.

The settings used to calculate the view are shown next to the selections.

SpectrumPro		SpecAn1	SpecAn2	Ref	Spectral Mask	Peaks / Markers					
Copy Analyzer Setup	Store SpecAn1 to Ref	Copy of SpecAn1	Enable	Spectrum	Spectro	Input(s)	Frequency Range	Points & Sample Rate	Duration	Window & ResBW	Mode
			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	C1	10.00 Hz to 10.00 MHz	4.2 MS @ 25 MS/s	168 mS	VonHann, 150 kHz	Normal
			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	C1	10.00 Hz to 10.00 MHz	4.2 MS @ 25 MS/s	168 mS	VonHann, 150 kHz	Normal
			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	C1(copy)	1.000 kHz to 6.500 MHz	4.2 MS @ 25 MS/s	168 mS	VonHann, 150 kHz	Normal

## Copy Setup

A quick way to set up a new spectrum is to copy the setup of another spectrum. Select the **Copy Analyzer Setup** button, choose the **Copy From Lane** and **Copy To Lane**, then **Copy Now**.

Open the SpecAnN tab to modify any settings.

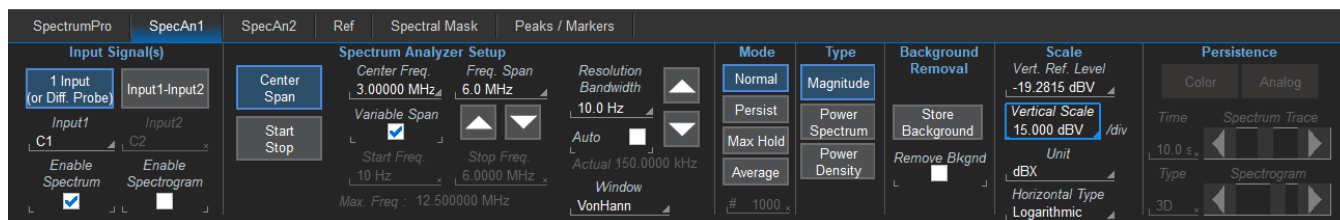
## Store to Reference

Either spectrum can be stored as a Ref(erence) for future viewing and comparison with the other spectrums. Select the **SpecAn1** or **SpecAn2** button, then press **Store SpecAnN to Ref**.

Open the **Ref** dialog to modify the type and scale of the Reference lane display. Those settings that can be modified function exactly as do the equivalent [SpecAnN dialog settings](#).

## Set Up Spectrum

For the most basic spectrum set up, you need only choose the input signal and a frequency span. The software calculates the FFT and translates scope sample rate, memory, and acquisition length settings into frequency domain relevant units. The resolution bandwidth is automatically set to optimum resolution based on the acquisition record length.



## Input Signal

Begin by selecting the signal(s) to be transformed.

To transform a differential probe signal or other single-ended input, touch **Input 1** and choose the source.

To transform the difference between two single-ended inputs, select **Input 1-Input 2**, then choose the source for each input. This option eliminates the need to first set up a math trace to calculate the difference.



**Note:** The sources can be memory or math traces, as well as live channels, but it is not required to first create a math function for a differential signal.

**Enable Spectrum** displays an FFT of the last oscilloscope acquisition. This will be generated continuously if the oscilloscope is triggered in Normal or Auto modes.

**Enable Spectrogram** generates a 2D or 3D rendering of the historical data, up-to-256 spectra displayed in a vertically stacked display. See [Spectrogram Display](#) for instructions on controlling the spectrogram view.



**Note:** Spectrogram display is not supported on WaveSurfer model oscilloscopes.

## Frequency Span



**Note:** The software always sets the oscilloscope sample rate equal to or higher than twice the frequency span entered.

Specify the frequency span to calculate by doing either of the following.

Select **Center Span**, then enter the **Center Freq.**(uency). A total **Freq.**(uency) **Span** will be calculated so that an equal span of frequencies appear on either side of the Center Freq. (i.e., a Center Frequency of 4 MHz will result in a total Frequency Span of 8 MHz). If you are using Linear scale, the Center Freq. will be at the center axis of the grid. (This will not necessarily be the case in Log scale).



You can adjust the total Freq. Span by using the Up or Down arrows below the field. Check **Variable Span** to make single increment adjustments with each touch; uncheck it to make stepped adjustments.

Alternatively, you can select **Start Stop**, then enter the absolute **Start Freq.** and **Stop Freq.** that constitutes the entire span.



**Note:** The Start frequency cannot be less than the Resolution Bandwidth setting.

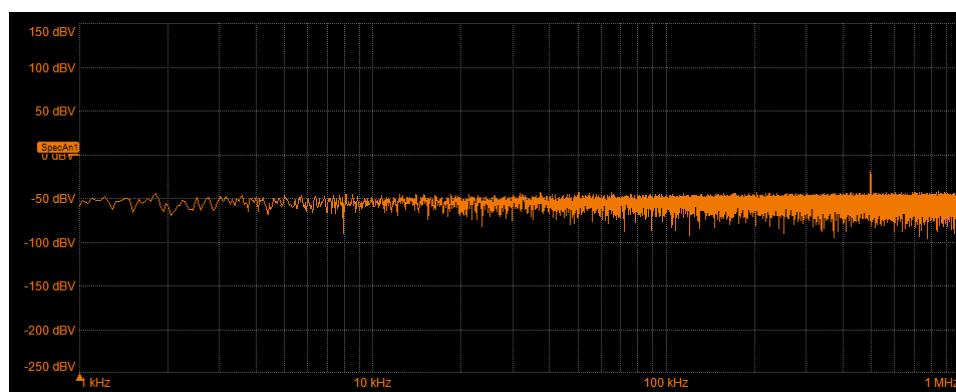
## Resolution Bandwidth

Resolution Bandwidth is the frequency resolution, the spacing of samples in the spectrum trace. It is inversely proportional to the input record length.

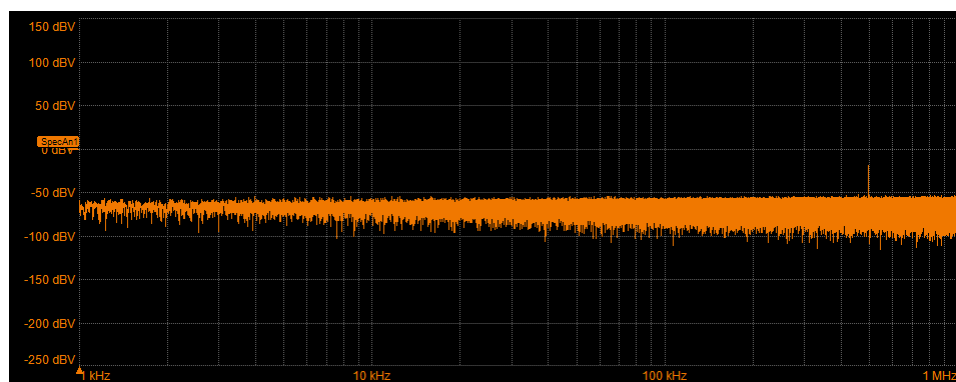
Changing Resolution Bandwidth is equivalent to changing the Timebase to increase or decrease memory. Reducing the resolution bandwidth will increase the available memory, enabling a faster update rate, but will decrease the resolution of the resulting spectrum trace.

By default, the spectrum is set to **Auto** Resolution Bandwidth, which will automatically set the highest resolution bandwidth possible based on the sampling rate of the input signal.

You can manually adjust this value by unchecking Auto and entering a new **Resolution Bandwidth** value.



*Signal at 100 Hz Resolution Bandwidth.*



*Same signal and frequency span at 10 Hz Resolution Bandwidth.*

## FFT Window

If you think of an FFT as synthesizing a bank of parallel band-pass filters, weighting functions control the filter response shape and affect noise bandwidth as well as side lobe levels. Ideally, the main lobe should be as narrow and flat as possible to effectively discriminate all spectral components, while all side lobes should be infinitely attenuated. The window type defines the bandwidth and shape of the equivalent filter to be used in the FFT processing.

The choice of a spectral window is dictated by the signal's characteristics. Rectangular windows provide the highest frequency resolution and are useful for estimating the type of harmonics present in the signal. Because the rectangular window decays as a  $(\text{SinX})/X$  function in the spectral domain, slight attenuation will be induced. Functions with less attenuation (Flat Top and Blackman-Harris) provide maximum amplitude at the expense of frequency resolution, whereas Hamming and Von Hann are good for general purpose use with continuous waveforms.

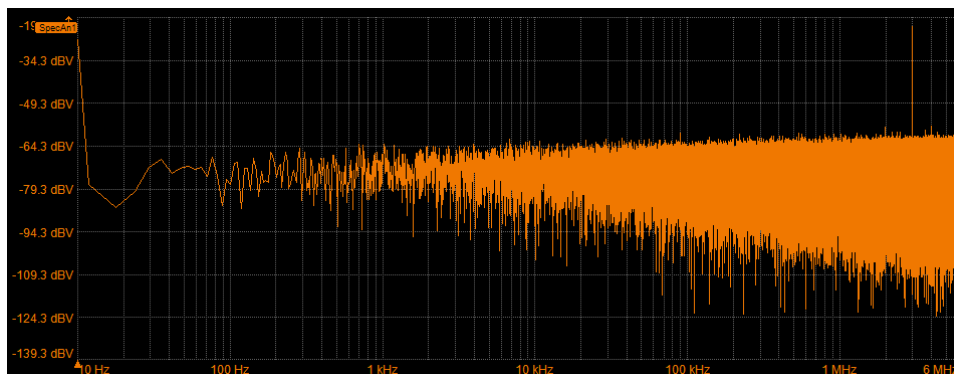
Window Type	Applications and Limitations
Rectangular	Normally used when the signal is transient (completely contained in the time-domain window) or known to have a fundamental frequency component that is an integer multiple of the fundamental frequency of the window. Signals other than these types will show varying amounts of spectral leakage and scallop loss, which can be corrected by selecting another type of window.
Hanning (Von Hann) & Hamming	Reduces leakage and improves amplitude accuracy. However, frequency resolution is also reduced.
Flat Top	Provides excellent amplitude accuracy with moderate reduction of leakage, but with reduced frequency resolution.
Blackman-Harris	Reduces leakage to a minimum, but with reduced frequency resolution.

FFT Window Filter Parameters				
Window Type	Highest Side Lobe (dB)	Scallop Loss (dB)	ENBW (bins)	Coherent Gain (dB)
Rectangular	-13	3.92	1.0	0.0
Von Hann	-32	1.42	1.5	-6.02
Hamming	-43	1.78	1.37	-5.35
Flat Top	-44	0.01	3.43	-11.05
Blackman-Harris	-67	1.13	1.71	-7.53

## Operating Mode

Choose an operating **Mode** to determine how the spectrum trace is calculated and displayed.

**Normal** (default) displays the Fast Fourier Transform of the input source. With a live oscilloscope input, this is a continuous transformation of time domain acquisitions.

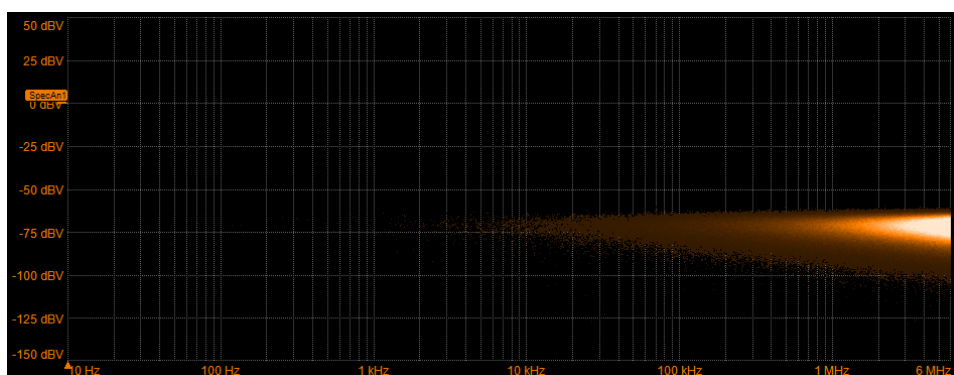


*Normal mode magnitude spectrum in log scale.*

**Persistence** mode displays a history of spectra that are retained on screen, similar to the display of an RF spectrum analyzer. Use the Persistence controls at the right side of the dialog to select the persistence display type (Analog or Color) and adjust the level of saturation. See [Persistence Display](#).



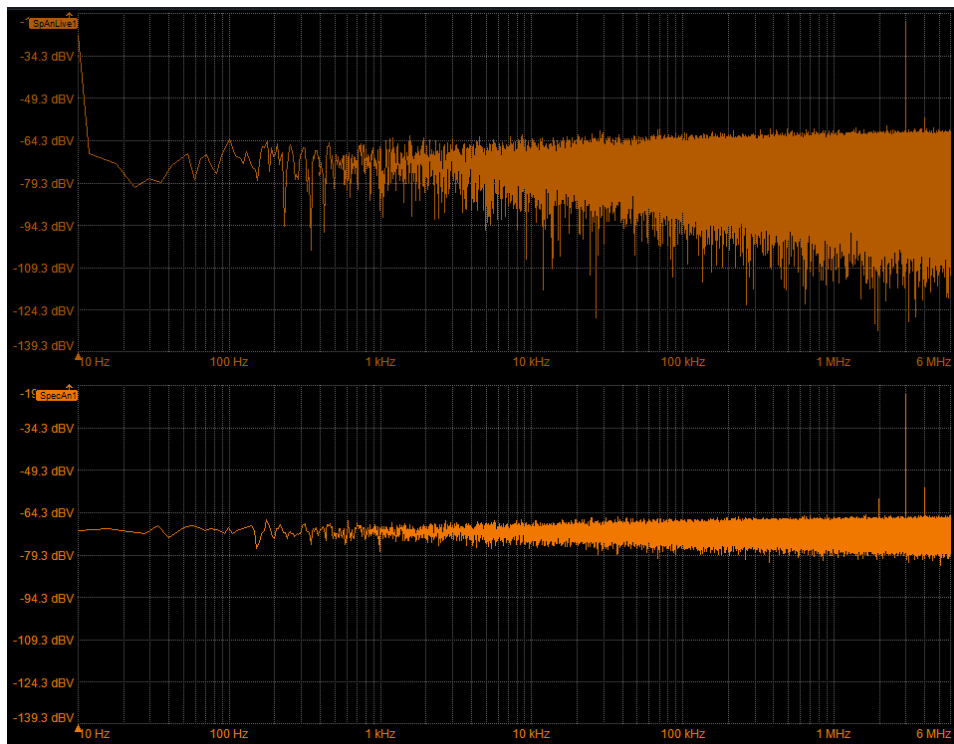
**Note:** Persistence mode requires a repetitive trigger to build the persistence map upon which the display is based.



*Same signal as an analog persistence mode spectrum.*

**Max Hold** displays a history of peak values across the frequency axis, essentially a "ceiling" calculator, useful for swept frequency measurements. As with persistence mode, the spectrum builds over multiple acquisitions. When this mode is selected, the normal FFT trace appears on screen as SpAnLiveN, while the Max Hold trace appears as SpecAnN. Because the each new peak is held for the maximum amount of time possible, changes from the live trace only become apparent after long periods of time. The best use case for this operating mode is to leave the acquisition running for several hours or days to capture peak events.

**Average** displays a rolling average of the last # of FFT calculations. This mode effectively reduces the noise of the signal and displays more of the harmonic carrier detail. As with Max Hold mode, the normal FFT appears on screen as SpAnLiveN, while the Average trace is presented as SpecAnN.



*Live magnitude spectrum and Average spectrum of same input.*

## Spectrum Type

Choose the spectrum type, which will determine the default vertical unit of the trace.

**Magnitude** is the amplitude output in linear units (see examples above). This reads the peak value of a sine at each frequency. This trace is useful as an input to math operations, like adding and subtracting spectra. It may yield an unremarkable spectrum if viewed in linear units rather than decibels.



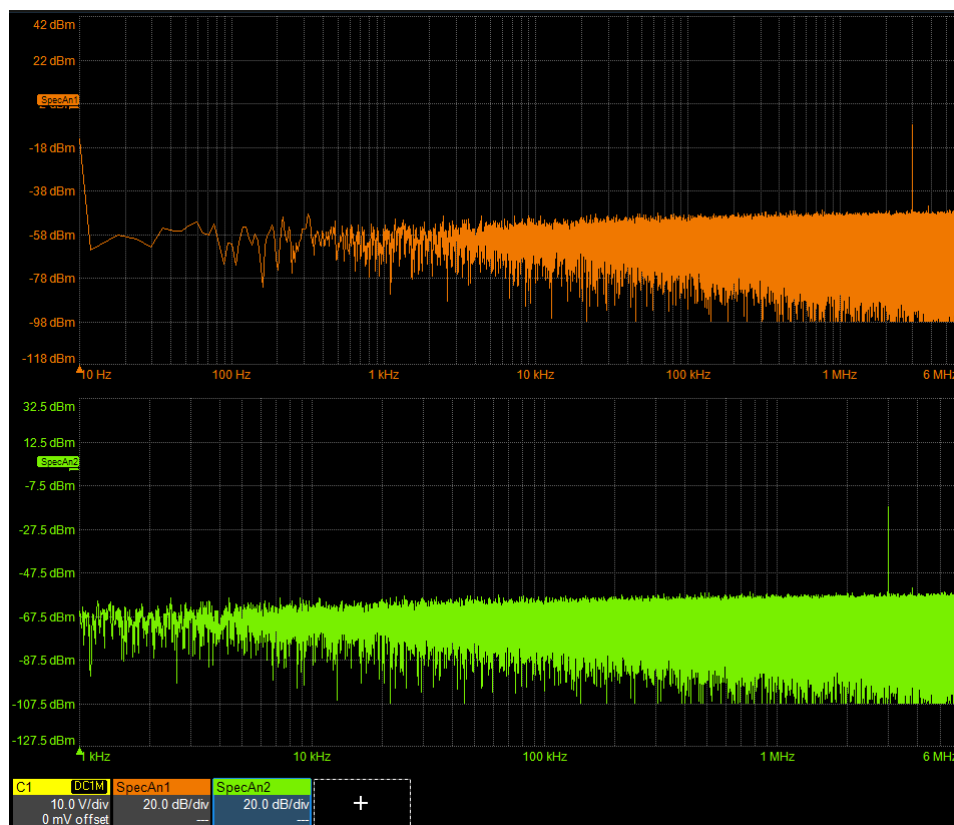
**Note:** A Magnitude spectrum will normally display the input source unit on the vertical axis. See Scale below for exceptions to this.

**Power Spectrum** is the power as a function of frequency using a logarithmic amplitude scale in units of decibels relative to 1 mW (dBm). This is a good general purpose view offering wide dynamic range so that you can see small spectral details.

**Power Density** is the power per unit frequency (power spectrum divided by the equivalent noise bandwidth of the FFT); the vertical scaling is also logarithmic with units of dBm. This view provides spectrum noise amplitude measurements that do not vary with the resolution bandwidth of the FFT, as they are normalized to the bandwidth.



**Note:** The Power Density selection works best for broad-band signals where noise amplitude remains the same, because as the Resolution Bandwidth (RBW) decreases or increases, the noise power in each (histogram) bin decreases or increases proportionally, and so the normalization for RBW is appropriate. However, for sine waves, all power is in one bin, regardless how many Hz wide the bin is. In this case, the power spectral density normalization is not appropriate, because power in each bin does not vary proportionally to the RBW. Therefore, the power for a sharp peak will change with RBW, as is to be expected.



Normal mode power (top) and power density (bottom) spectrums of same signal.  
Note the change in frequency span and vertical reference, although the vertical scale/div is the same.

## Background Removal

Background removal is available only with SPECTRUM-PRO-2R.

Background removal assists with removing noise due to a known interference signal, ADC spike or other unwanted effect that occurs in the signal path.

With the oscilloscope connected to DUT, but prior to starting the test signal, select **Store Background**. This will save a record of perturbations found in the channel. The example below shows the spikes found in a noisy channel, marked as Peaks 1 and 2.

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*Spectrum of background noise prior to background removal.*

When the spectrum of the signal to be measured is displayed, check **Remove Bkgnd**. The Spectrum Analyzer will adjust the FFT calculation to account for the background noise.



*Spectrum of input signal prior to background removal. A third peak belonging to the signal is identified.*



Same spectrum after background removal. Now that the noise is suppressed, the peak attributed to the signal is ranked 1.

## Scale

Rescaling (adapter/probe correction) features are not available on WaveSurfer model oscilloscopes.

**Vertical Ref. Level** sets the amplitude represented by the top of the vertical axis, although the exact unit depends on the spectrum trace type and the input scale.

**Vertical Scale** sets the amplitude/div of the vertical axis.

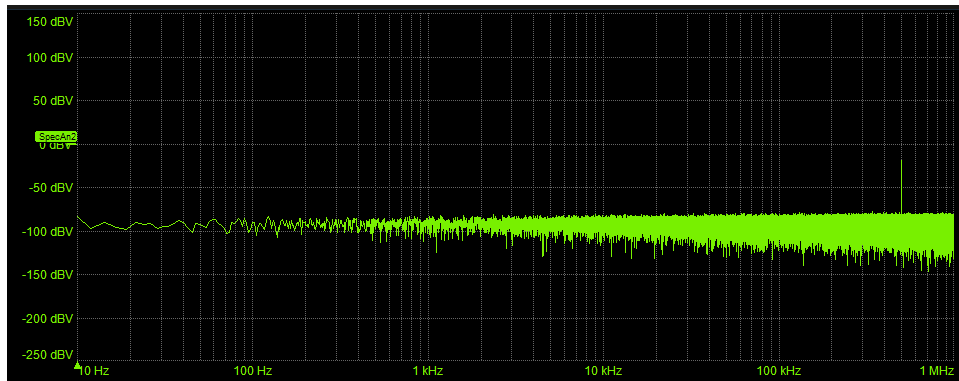


**Tip:** If you wish to change the unit of the vertical axis, do so before changing the reference level or scale. These values will revert to the default if the unit is changed to ensure that enough of a span is displayed that the spectrum appears on the grid.

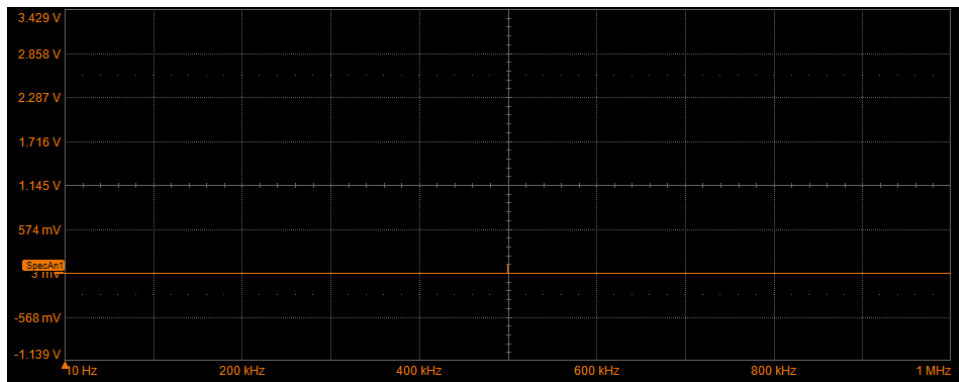
**Unit** sets the units shown on the vertical axis.

- Linear utilizes the same unit as is configured for the input signal. If you change the unit on the channel setup dialog (e.g., C5) that change is carried into the Spectrum Analyzer.
- Other selections convert the vertical unit to decibels at the same scale (dBX), milli-decibels (dBmX) or micro-decibels (dBuX). If the source is in units other than V, the vertical axis may not display milli- or micro-dB units (e.g., dBmT); the dBmX and dBuX selections will be disabled, in this case. Also, if the input unit is A, the vertical axis will simply say dB. However, the measured values will be rescaled according to your settings, and these will be displayed on the Spectrum Analyzer dialogs and tables.

Horizontal Type sets the horizontal axis to either Linear or Logarithmic scale.



*Magnitude spectrum with dB units and Logarithmic horizontal type.*



*Magnitude spectrum of same signal and span in Linear units and Linear horizontal type.*



## Persistence Display

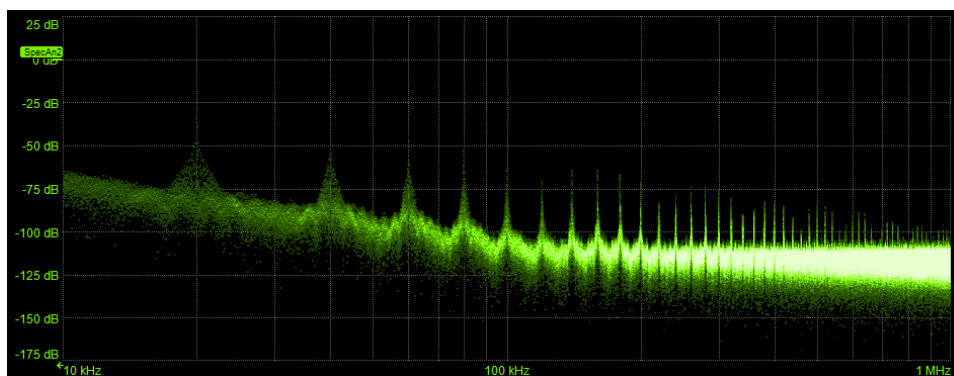
Persistence can be added to the spectrum or spectrogram views. Persistence shows the most frequent signal path as different intensities of the same color, or a graded spectrum of colors.

The Persistence feature retains spectra on the display for a set amount of time before allowing them to gradually "decay," similar to the analog-style display of old, phosphor screen oscilloscopes. The display is generated by repeated sampling of events over time and the accumulation of the sampled data into "persistence maps". Statistical integrity is preserved because the duration (decay) is proportional to the persistence population for each amplitude or time combination in the data.

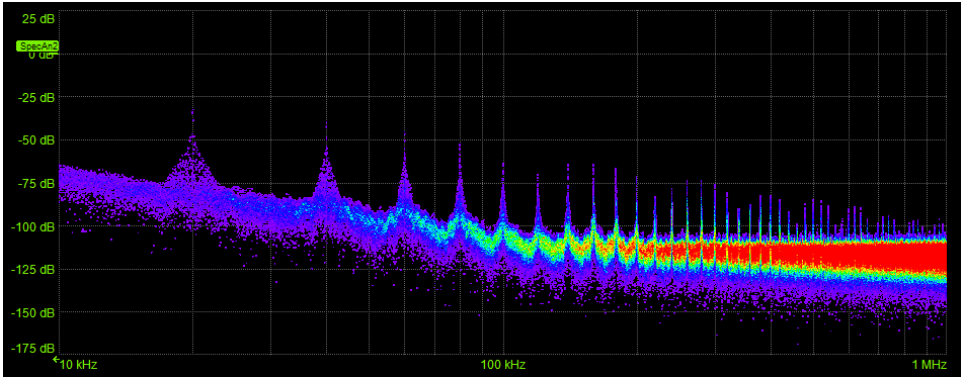
With **Analog** persistence, as a persistence data map develops, different intensities of the same color are assigned to the range between a minimum and a maximum population. The maximum population automatically gets the highest intensity, the minimum population gets the lowest intensity, and intermediate populations get intensities in between these extremes.

**Color** persistence works on the same principle as Analog persistence, but instead of different intensities (light vs. dark), variations in hue correspond to the occurrence of a frequency in the spectrum. "Hotter" hues indicate more frequent events, with red for maximum population and violet for minimum population. Color persistence is helpful for comparing amplitudes by seeking like colors among the traces, especially when used with the spectrogram view.

The saturation level, controlled by the **Spectrum Trace** or **Spectrogram** slider bar, represents a certain percentage of the total population. All populations above the saturation level are assigned the highest color intensity. At the same time, all populations below the saturation level are assigned the remaining intensities. Data populations are dynamically updated as data from new acquisitions is accumulated. A saturation level of 100% spreads the intensity variation across the entire distribution; at lower saturation levels the intensity will saturate (become brighter) at a lower population, making visible those events rarely seen at higher saturation levels.



*Spectrum with analog persistence*



*Spectrum with color persistence*

## Spectrogram Display

Spectrogram display is not supported on WaveSurfer model oscilloscopes.

The spectrogram is a 2D or 3D rendering of the historical frequency data, up to 256 spectra in a vertically stacked display. Because spectrograms are type of persistence display, they require a repetitive trigger to build the persistence map. They can also be colorized like persistence spectrums to show different populations in different intensities or colors.

Spectrograms stop building after 256 acquisitions. Thereafter, they are calculated on the last 256 acquisitions in the buffer.

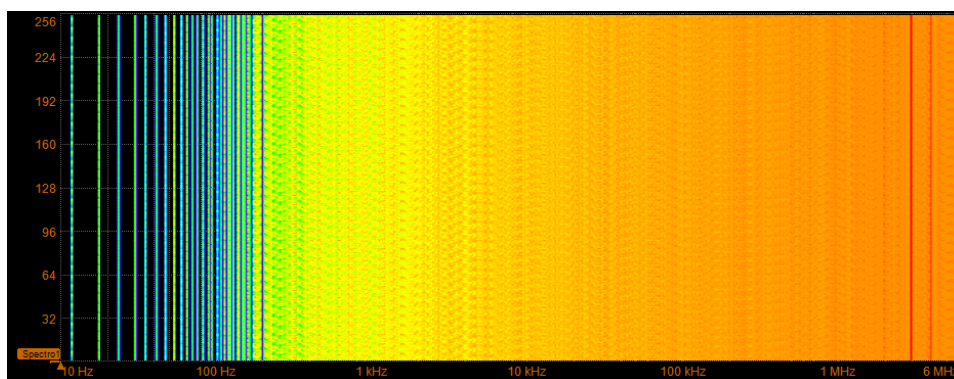
1. [Set up the spectrum trace](#) as usual.
2. On the SpectrumPro or SpecAnN dialog, select the **Enable Spectrogram** checkbox.

You may need to retrigger the acquisition to begin building the persistence map.

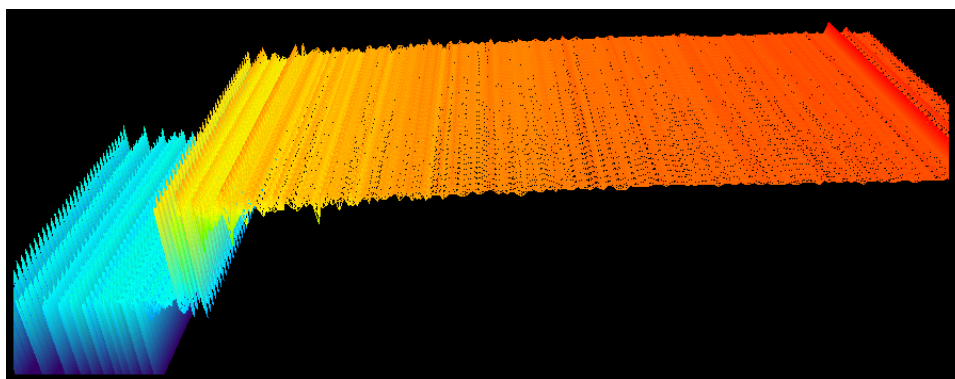
3. Choose a spectrogram **Type** of 2D or 3D.

The 3D spectrogram view can be rotated on any of its axes by grabbing an edge of the display with a finger or pointer and dragging. The display is active when you see the cross-hatch symbol.

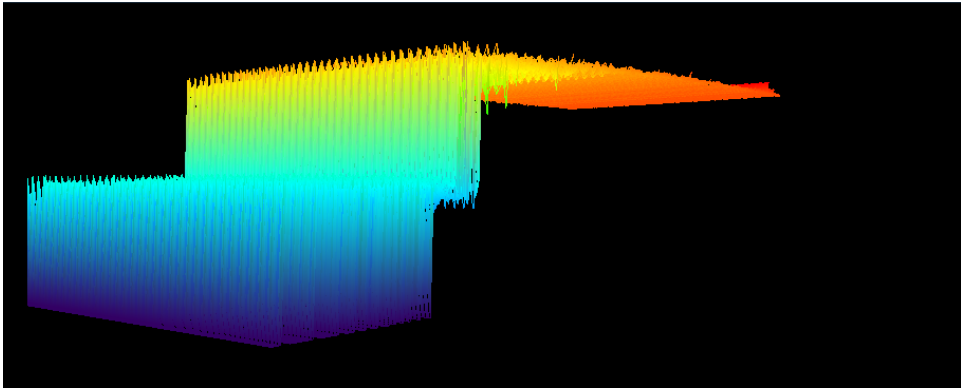
4. Choose how to colorize the spectrogram by selecting the **Analog** or **Color Persistence** button.
5. Move the **Spectrogram** slider to increase/decrease persistence saturation level.



*2D color spectrogram*



*Same signal as 3D color spectrogram*



*Same 3D spectrogram, rotated.*

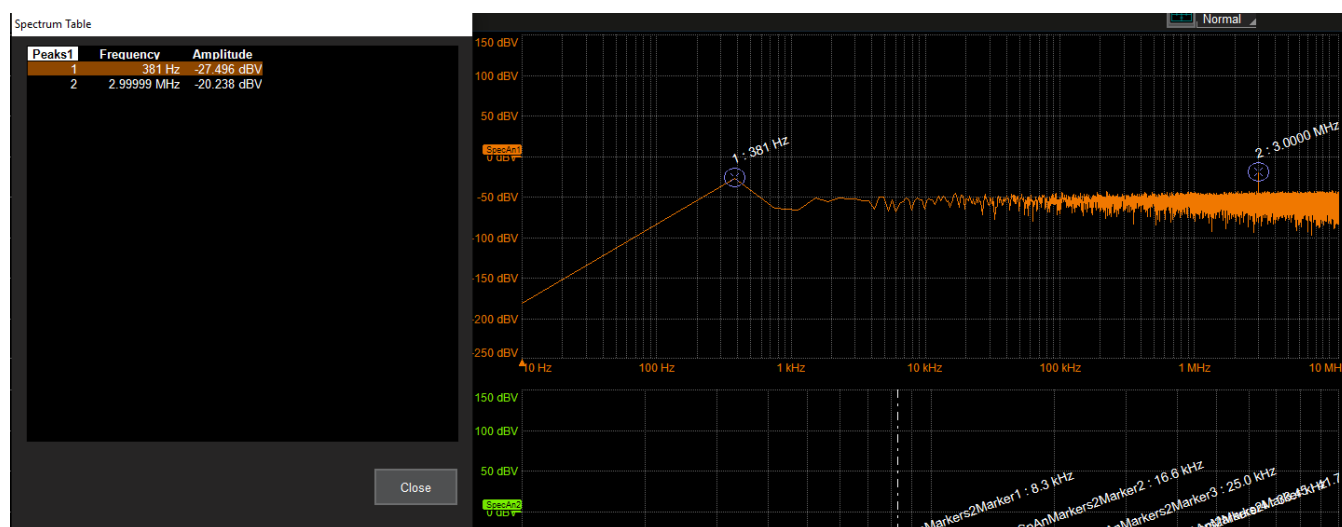
## Peaks and Markers

Two special annotations help you find frequencies or amplitudes of interest in the spectrum trace: Peak frequencies and user-defined Markers.

Begin by opening the Peaks/Markers tab and selecting the button for the spectrum (SpecAnN or Ref) to annotate from the left side of the dialog.

### Peaks

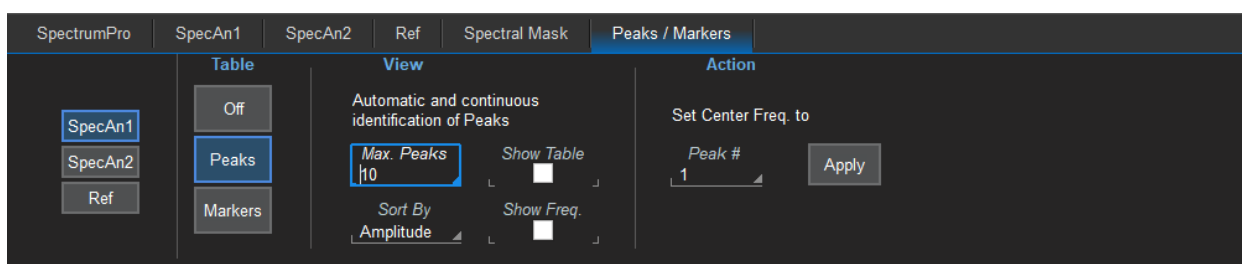
The peaks features is an automatic and continuous identification of waveform peaks. As the range of frequencies measured changes, peak values are recalculated and markers are moved. The values tabulated are always absolute values for the marked peak.



Peaks identified on spectrum.

To show peaks:

1. With the correct **SpecAnN** selected and visible, select the **Peaks** button.



2. Enter the **Max.**(number of) **Peaks** to mark. Circular markers appear over the trace, representing the x peak measurements.
3. Choose to **Sort By** amplitude or frequency. Peaks will be renumbered from highest (1) to lowest (x) corresponding value.
4. To display the frequency of the peak on the marker, check **Show Frequency**.

- For a tabular listing of peaks, check **Show Table**. The frequency and amplitude of each peak will appear in a pop-up dialog over the grid display.



**Note:** Only those peaks visible on the display will be listed in the table, even if other peaks have been identified in the acquisition.

- Optionally, reposition the display by choosing a peak to **Set Center Freq. to**. Enter the **Peak #** and touch **Apply**. If using Linear horizontal scale, the spectrum will shift to place that peak at the center of the grid.

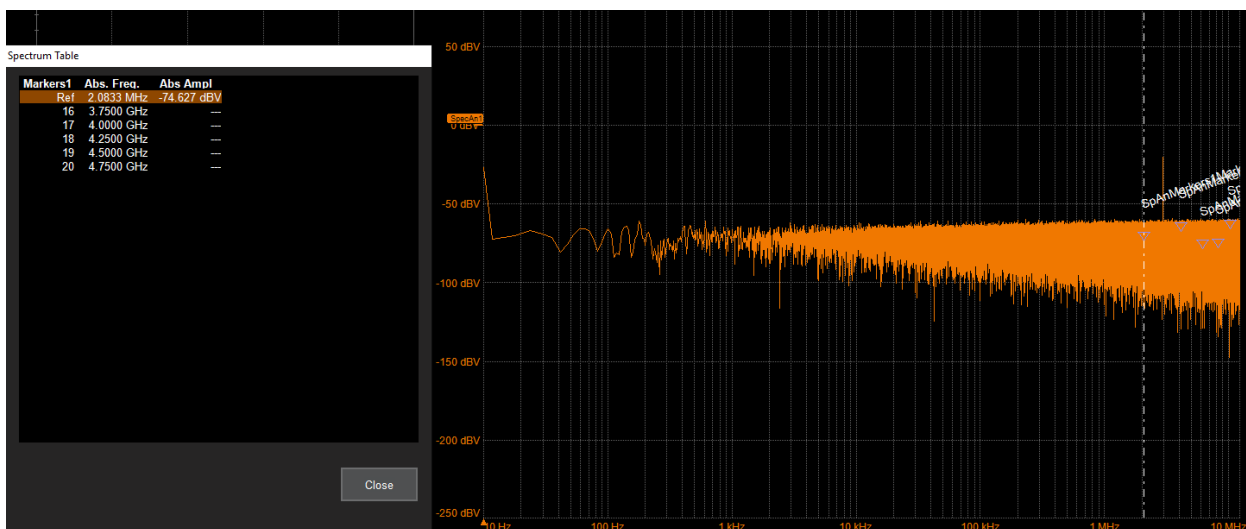
## Markers

Markers are not Supported on WaveSurfer model oscilloscopes.

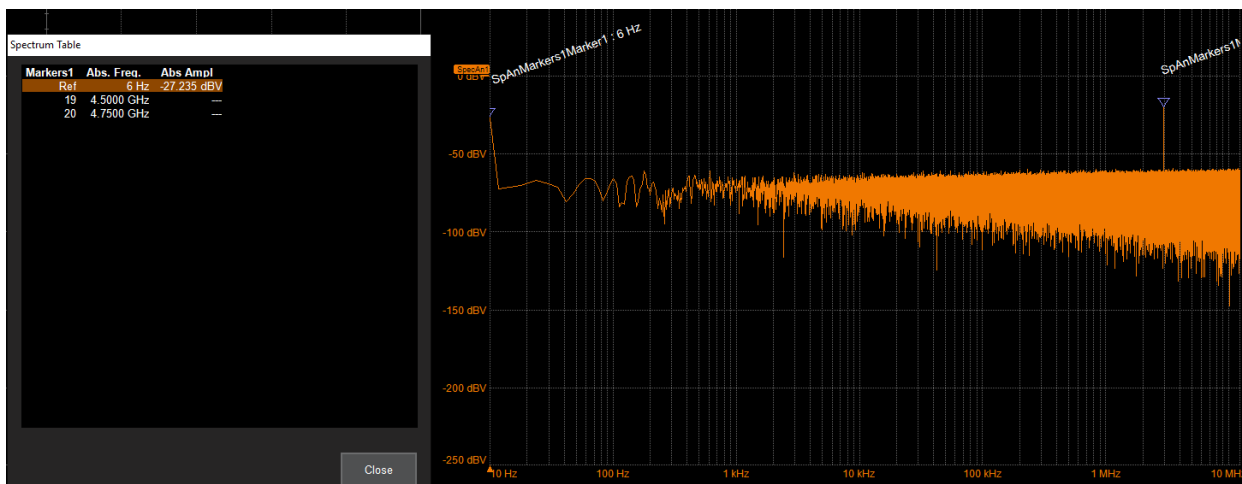
You can apply up-to-20 markers to frequencies of interest, which are indicated by blue triangles over the trace. Marker 1 is always the Ref(ERENCE) Marker, indicated by a thick, white cursor line. Delta measurements of the other markers are made in reference to this frequency.

Three pre-defined sets of markers can be quickly displayed over the spectrum to save the work of manually placing each marker.

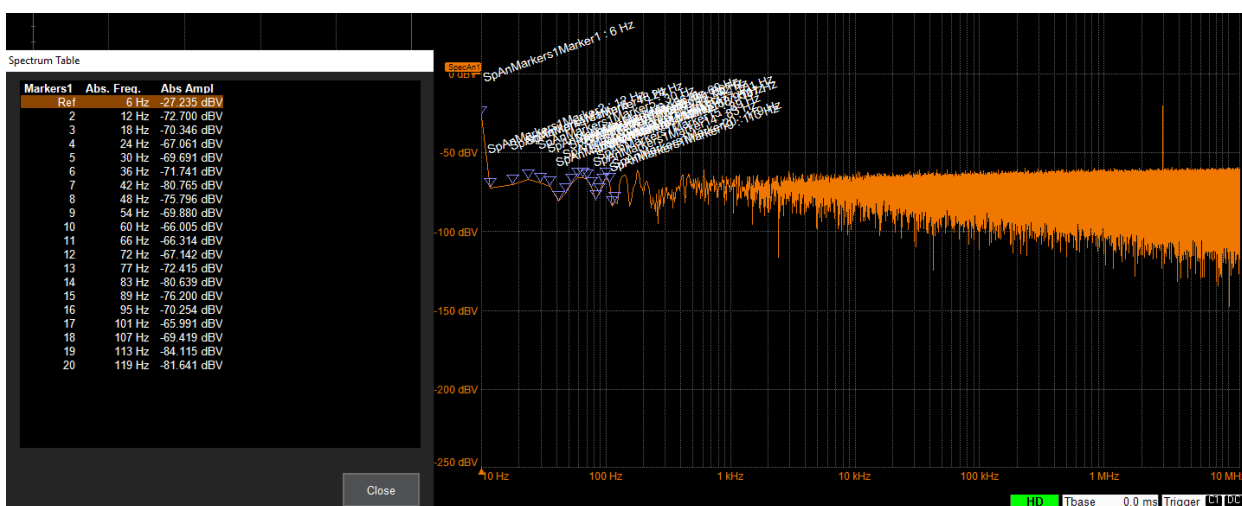
- Set 5 Default Markers** marks five frequencies spread evenly over the spectrum. This is a good way to begin placing markers, moving them to the desired points on the spectrum using any of the marker controls (below).



- **Set Markers on Peaks** marks the peak amplitudes in the spectrum, same as Peaks, only the annotation is different and will not automatically update with each new acquisition, only when you move the marker.



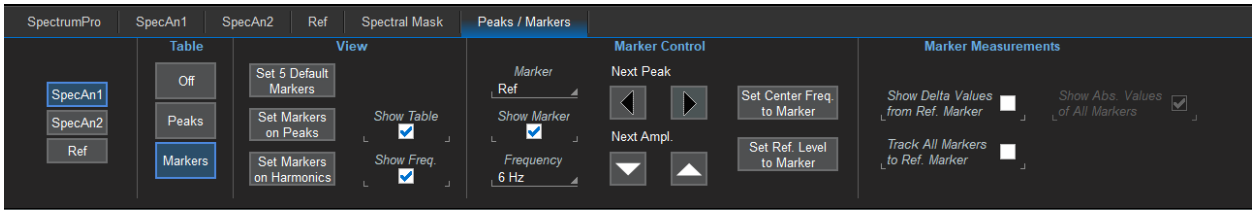
- **Set Markers on Harmonics** marks the fundamental frequency and its harmonic content.



If you turn off markers, the display will resume the set you last selected when they are turned on again.

To apply markers:

1. With the correct **SpecAnN** selected and visible, select the **Markers** button.



2. Choose a set of markers to view by clicking the button, or manually select the number of the **Marker** to place and check **Show Marker**. Use the marker controls (below) to move the marker to the desired position.



**Note:** The marker will be placed on the last sample closest to the frequency entered or calculated from the overall span. For example, a marker set on Frequency 3 MHz may be placed at 2.99 MHz. This will be reflected in the frequency shown on the marker and in the marker readout table.

3. To display the frequency represented by the marker on the waveform, check **Show Frequency**.
4. For a tabular listing of markers, check **Show Table**. The amplitude and frequency of each marker location will appear in a pop-up dialog over the grid display. You can optionally add the delta from the Ref marker frequency to the table. See Marker Measurements (below).

Spectrum Table

Markers1	Delta Freq.	Delta Ampl.	Abs. Freq.	Abs Ampl
Ref			6 Hz	-27.235 dBV
2-Ref	6 Hz	-45.4650 dB	12 Hz	-72.700 dBV
3-Ref	12 Hz	-43.1114 dB	18 Hz	-70.346 dBV
4-Ref	18 Hz	-39.8256 dB	24 Hz	-67.061 dBV
5-Ref	24 Hz	-42.4559 dB	30 Hz	-69.691 dBV
6-Ref	30 Hz	-44.5065 dB	36 Hz	-71.741 dBV
7-Ref	36 Hz	-53.5296 dB	42 Hz	-80.765 dBV
8-Ref	42 Hz	-48.5615 dB	48 Hz	-75.796 dBV
9-Ref	48 Hz	-42.6449 dB	54 Hz	-69.880 dBV
10-Ref	54 Hz	-38.7700 dB	60 Hz	-66.005 dBV
11-Ref	60 Hz	-39.0790 dB	66 Hz	-66.314 dBV
12-Ref	66 Hz	-39.9069 dB	72 Hz	-67.142 dBV
13-Ref	72 Hz	-45.1800 dB	77 Hz	-72.415 dBV
14-Ref	77 Hz	-53.4043 dB	83 Hz	-80.639 dBV
15-Ref	83 Hz	-48.9655 dB	89 Hz	-76.200 dBV
16-Ref	89 Hz	-43.0190 dB	95 Hz	-70.254 dBV
17-Ref	95 Hz	-38.7560 dB	101 Hz	-65.991 dBV
18-Ref	101 Hz	-42.1841 dB	107 Hz	-69.419 dBV
19-Ref	107 Hz	-56.8801 dB	113 Hz	-84.115 dBV
20-Ref	113 Hz	-54.4064 dB	119 Hz	-81.641 dBV

Close



## Marker Control

Use the Marker Controls to place, move or hide a particular marker after it's initial placement using one of the "Set..." buttons. All values in the Marker table and on the Marker annotation will update dynamically as the marker is moved.

First, enter the **Marker** number. A white cursor line now bisects that marker, and all other marker controls apply to it.



**Tip:** The easiest way to move the marker is to drag the cursor line to a new frequency. The tabular values are recalculated as the marker moves.

To show/hide the marker, select or deselect the **Show Marker** checkbox.

To move the marker to:

- The **Next Peak** in either direction, touch the **Left/Right Arrow**.
- The peak with the **Next Amplitude** (higher or lower), touch the **Up/Down Arrow**.
- A specific **Frequency**, enter the new value.

**Set Center Freq. to Marker** will make that marker value the center frequency of the span displayed.

To use a particular marker location as the new reference level, select **Set Ref. Level to Marker**. All delta measurements are now referenced to this frequency.

## Marker Measurements

You can modify the measurements displayed with each marker annotation and in the marker table by selecting/deselecting the checkboxes at the right of the dialog:

- **Show Abs. Value of All Markers** shows the absolute frequency value at the location of each marker. This is the default and is automatically selected when you turn on markers. If you choose to show Delta, you can optionally turn off the display of absolute values to view only the delta values.
- **Show Delta Values from Ref. Marker** shows the difference in frequency value between this marker location and the reference marker.
- **Track All Markers to Ref. Marker** locks all markers at their current delta from the Ref Marker. When the Ref marker is dragged, all the markers are moved as a group. This is useful for finding interesting harmonics in the spectrum.

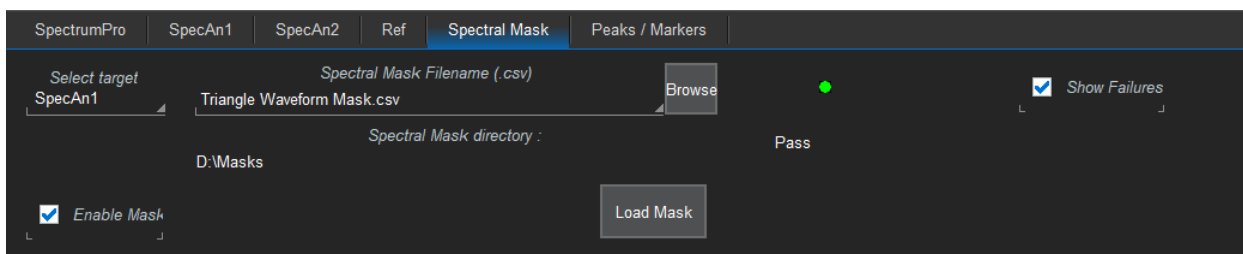
## Spectral Mask Testing

Spectral mask testing is available only with SPECTRUM-PRO-2R.

Spectral mask testing enables you to test that the frequency response of the DUT is within design limits. You generate data masks in a simple, .csv format and upload them for use within Spectrum Analyzer. The software will automatically calculate if the spectrum "passes" within the limits defined by your mask, optionally marking any violations on the display.

### Set Up Mask Test

1. Copy your mask file to oscilloscope D:\Masks (for ease of selection), or to a USB drive that can be connected to the oscilloscope.
2. Open the **Spectral Mask** dialog.



3. **Select Target** spectrum to test.
4. **Browse** to and select the spectral mask file to apply.
5. With the file loaded in the Spectral Mask Filename field, check **Enable Mask** to begin pass/fail testing.
6. Optionally, check **Show Failures** to mark violations on the spectrum trace. Circular red markers appear where the signal violates the mask.

You will see "Processing..." in the message bar while the mask test is calculating. Within a few seconds, a purple mask should appear over the spectrum trace marking the amplitudes and frequencies that are outside the mask limits. If you have chosen to show failures, any samples that occur in this masked area are marked by red circles.



**Note:** Masks and mask markers will appear in screen captures and reports saved with LabNotebook files, but they cannot be recalled ("Flashback") with LabNotebook waveform data, as they are calculated from a separate file.

## Mask File Format

Masks are created as .csv files.

- Any lines that start with a quote are handled as comments (e.g., rows 1 and 2 below).
- The first line read contains the X and Y axis units (row 3 below). PSD is ignored, do not add it.
- The second line read contains the keyword titles Frequency, Upper and Lower (row 4 below).
- Each subsequent line contains the upper and lower passing limits for each frequency. The value of upper should always represent a position above lower on the graticule.



**Note:** The output .csv file **must** use a comma delimiter, no other character. Commas must be placed after every value, including at the ends of lines.

Because the mask identifies data values, rather than pixel locations, the mask will automatically adjust with changes to the waveform scale, including changes from linear to log scale.

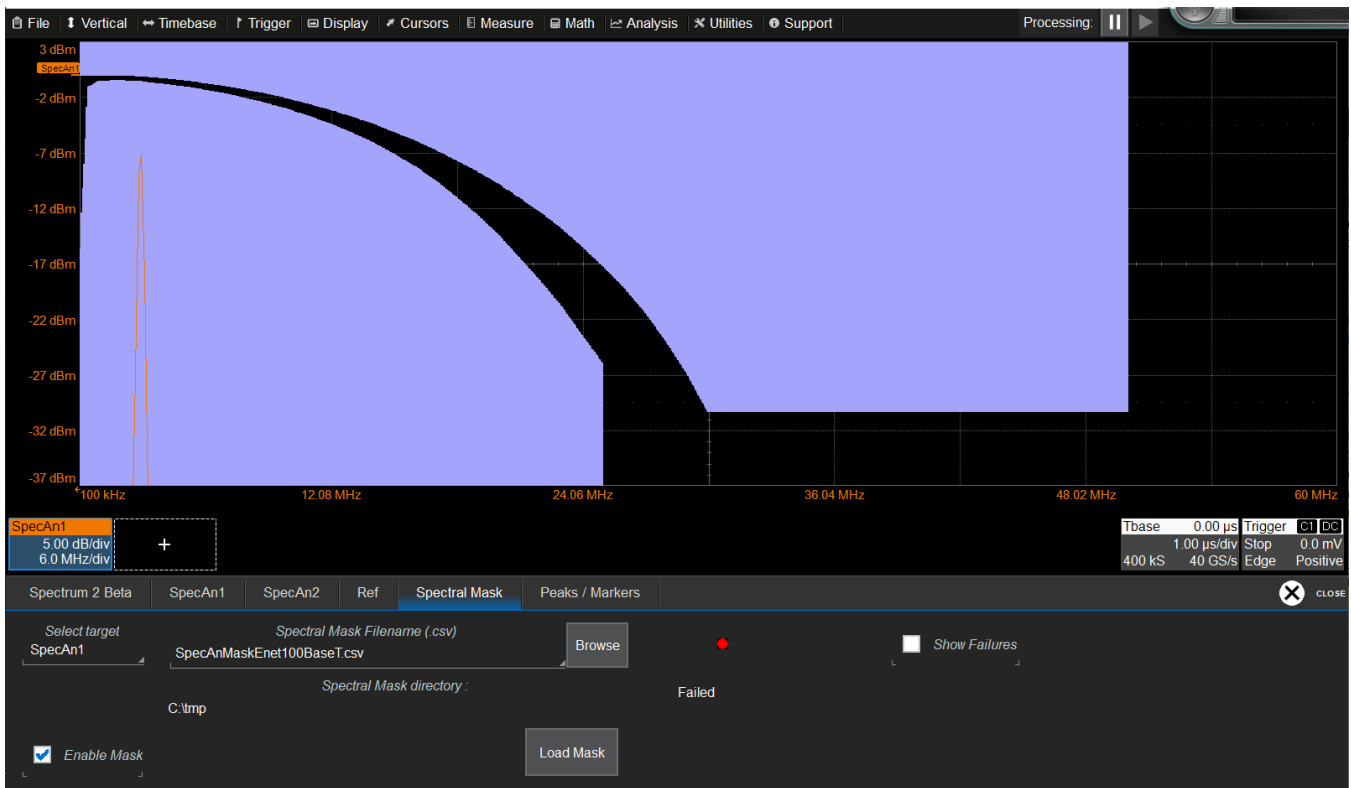


**Note:** The proper calculation of the mask area depends on the fill point being visible on screen. Rescaling, delay or offset that shifts this point off the grid will result in the area not filling, as in the second example below. Because the test is a mask test, if the mask fails, the Pass/Fail results will not be calculated properly. Be sure that your mask remains visible outside of your valid limits.

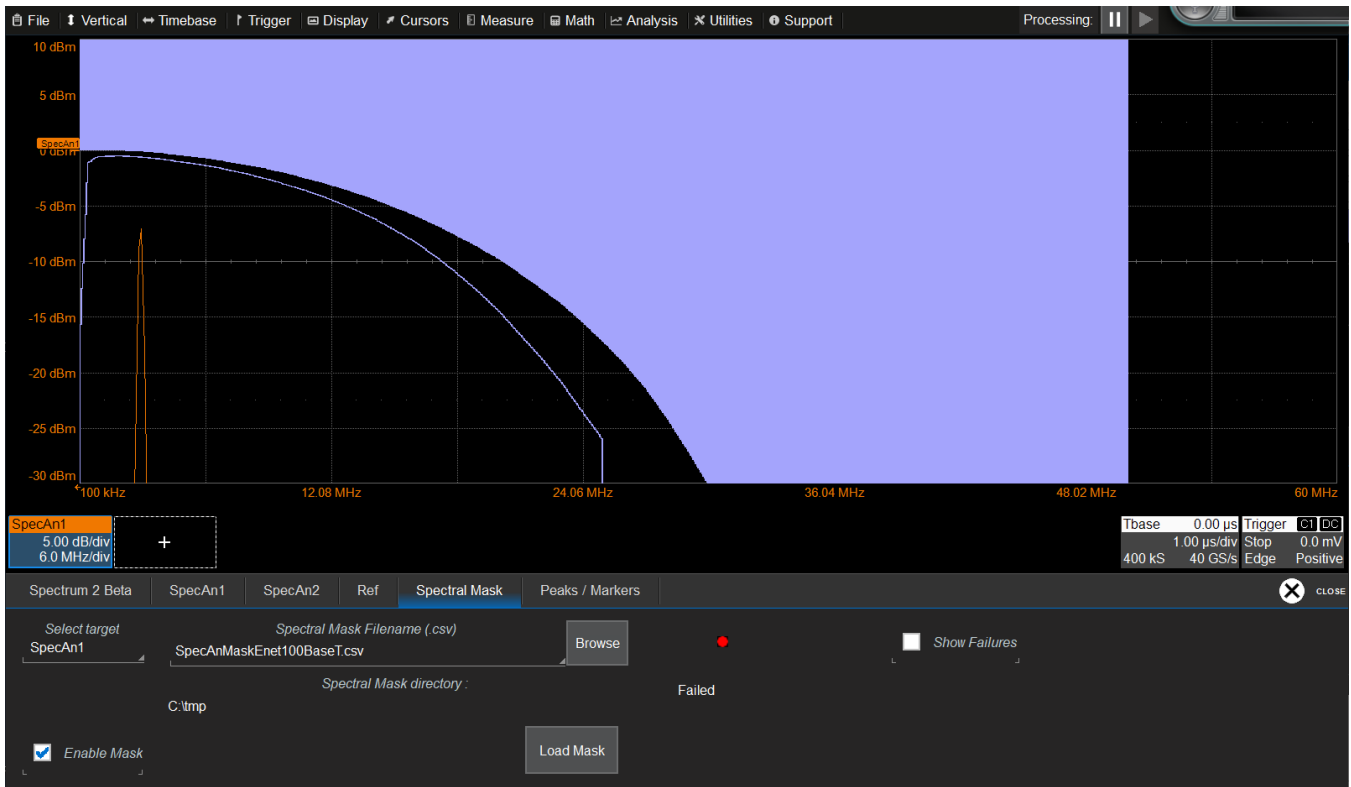
	A	B	C	D	E	F	G	H	I	J	K
1	"Line 1: Xin, [Hz KHz MHz GHz],Yin,[V,A,T,H,dB,dBm,dBA,dBT etc], [PSD] - add PSD if vertical units are per Hz										
2	"Line 2: keyword titles. Must be: Frequency, Uppper,Lower . Lines that start with a quote are ignored.										
3	Xin	MHz	Yin	dBm							
4	Frequency	Upper	Lower								
5	0.1	0	-17.88								
6	0.2	0	-13.49								
7	0.3	0	-9.09								
8	0.4	0	-4.7								
9	0.5	0	-1.13								
10	0.6	0	-1.01								
11	0.7	0	-0.9								
12	0.8	0	-0.78								
13	0.9	0	-0.66								
14	1	0	-0.59								
15	2	0	-0.52								

Sample spectral mask file

# Spectrum Analyzer Software Instruction Manual



Spectral mask prior to rescaling Y axis. Note how the test fails because the peak falls within the mask.



Spectral mask after rescaling Y axis. The bottom of the mask has dropped out because the fill point is off screen.



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