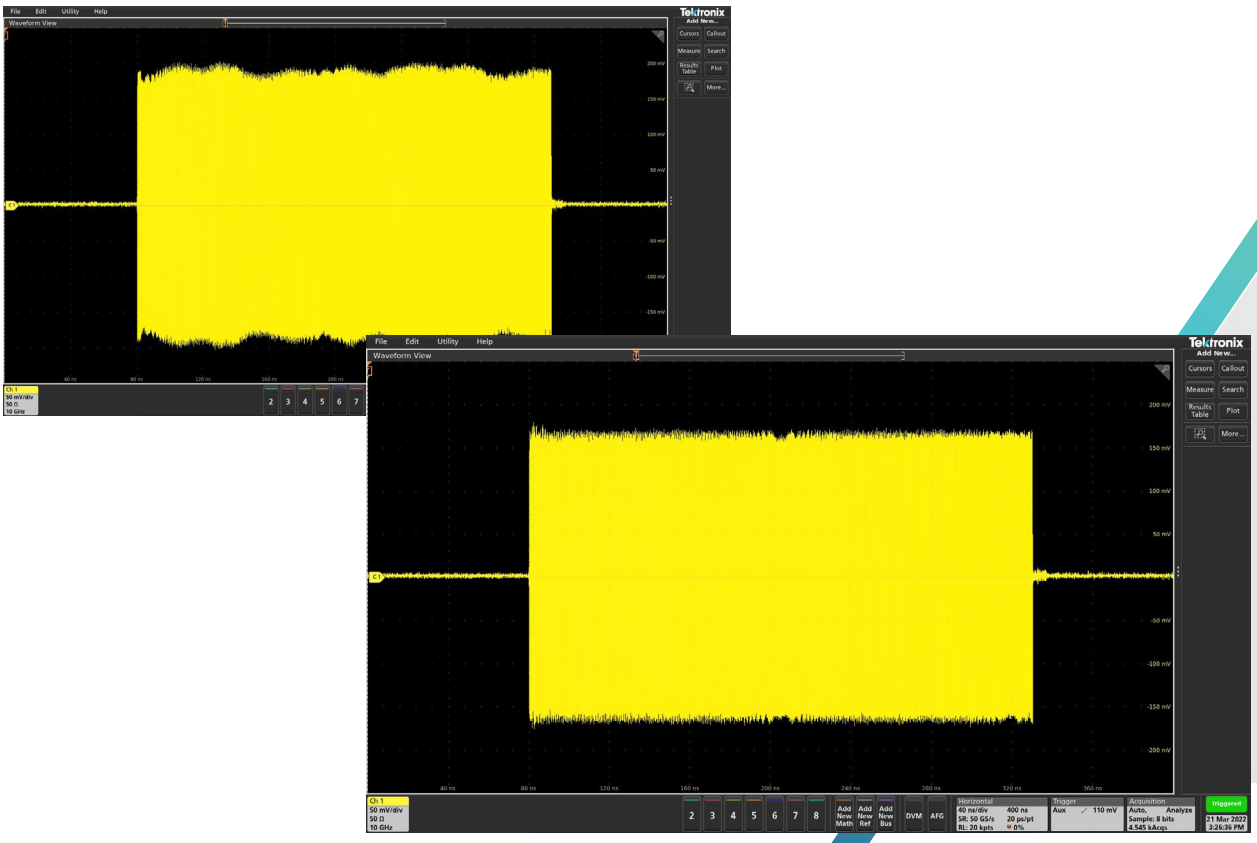
Pre-compensation Can Flatten Your Response

WHITE PAPER



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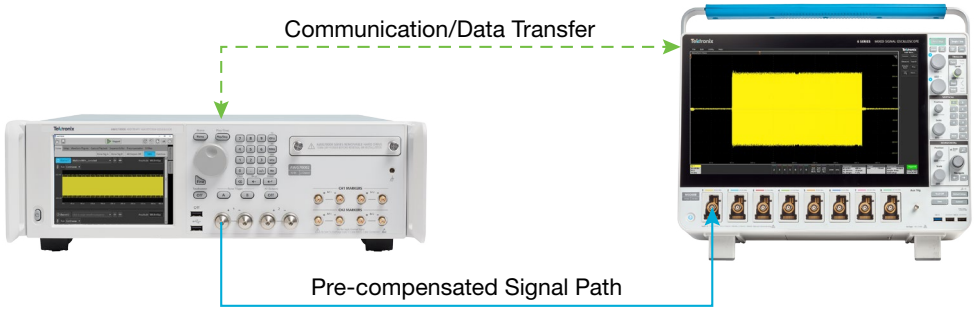
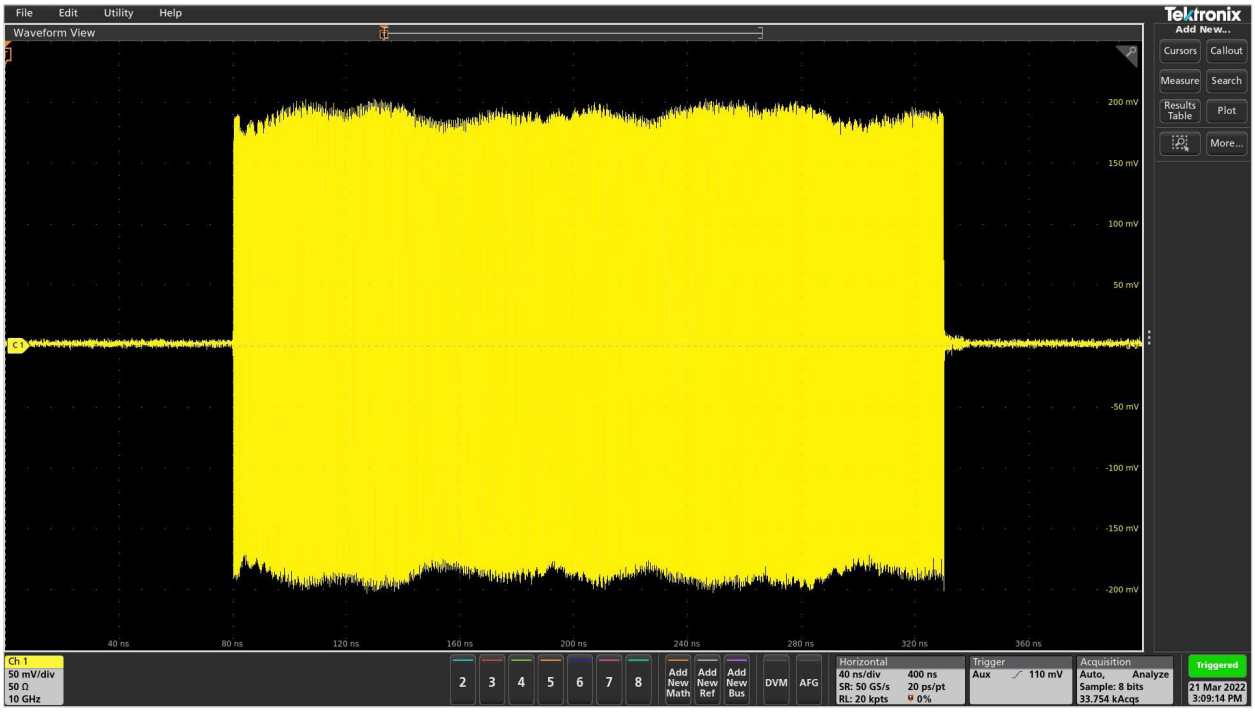
When generating wideband signals, minor impedance discontinuities in the interconnect cables can affect the amplitude and phase flatness. Additionally, as signal frequencies increase, they can be subject to the analog bandwidth and sinx/x rolloff characteristics of the AWG. These signal impairments can be corrected by pre-distorting, or pre-compensating the waveform data to counteract the degradation.

In this white paper we describe how an available pre-compensation plug-in for Tektronix SourceXpress software used in conjunction with either an AWG5200 or AWG70000B arbitrary waveform generator and Tektronix 5 Series MSO, 6 Series B MSO, or DPO70000 oscilloscopes enables automatic generation of a correction filter that you can apply to your generated waveforms, especially wideband RF signals. The following figure illustrates how the AWG and the oscilloscope connect to generate and acquire a test waveform, process the measured waveform, and then generate the correction coefficients.



The simple example shown here illustrates how the application of pre-compensation can flatten the RF amplitude of a 1 GHz wide Linear Frequency Modulated (LFM) pulse that is centered at 5 GHz.

Here's what the RF envelope of this pulse looks like on the oscilloscope using a typical SMA RF cable in the lab:

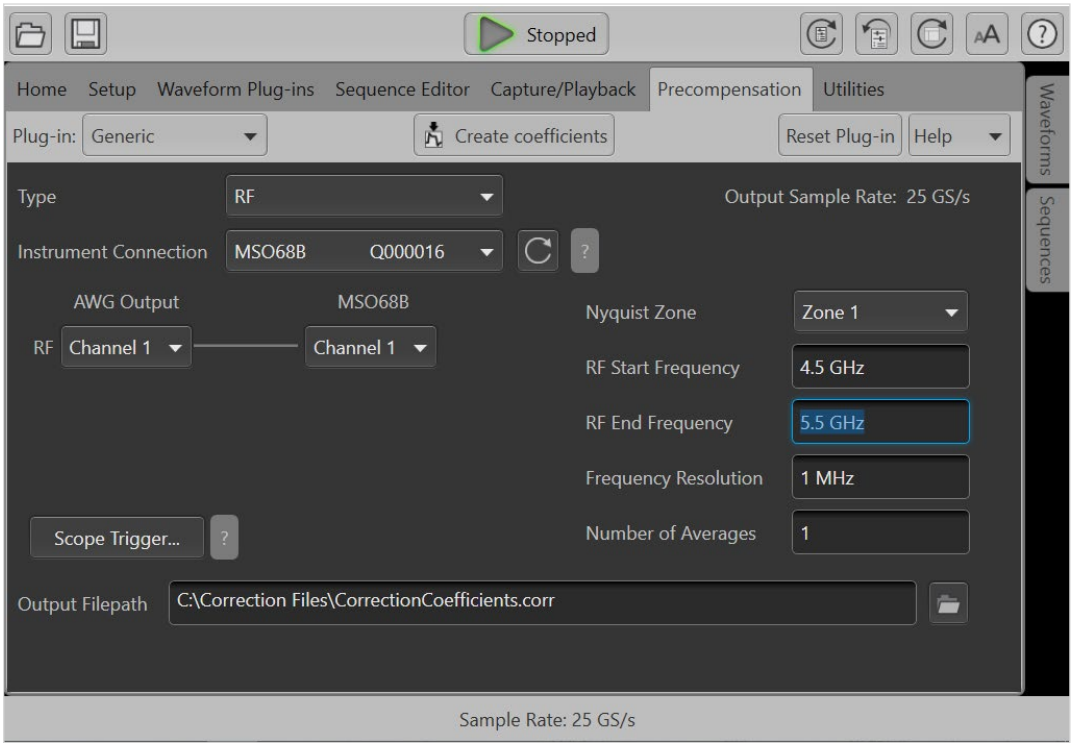


We can observe a fair amount of ripple and some droop in the RF envelope, resulting from the RF cable and the AWG's output.

The pre-compensation plug-in in the AWG can correct this response by automatically generating a set of correction coefficients, and then processing the waveform through this filter to "pre-distort" the waveform data and present a much higher quality signal at the end of the cable, right at the interface of the device under test (DUT).

Pre-compensation Procedure

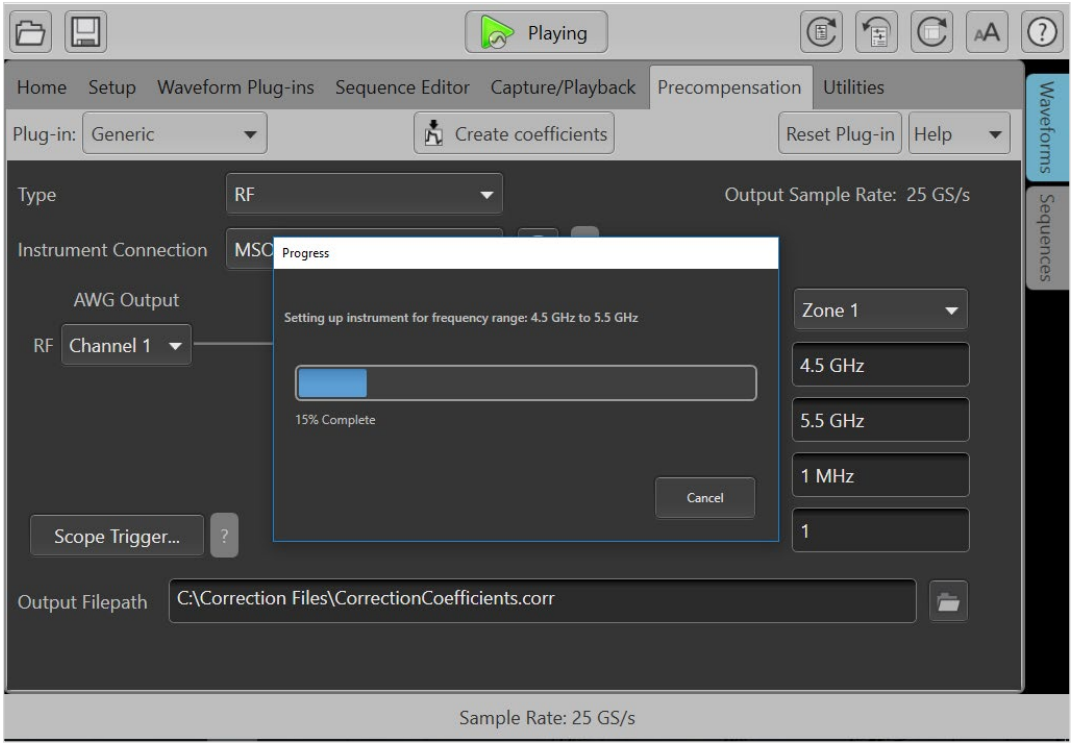
To start, simply open the pre-compensation tab in the AWG user interface:



This plug-in generates a test signal which is measured on the oscilloscope, and it uses that measured result to generate the filter. The first thing to do is tell the AWG to "connect" to the oscilloscope by providing its IP address. This is most often done through Ethernet using VISA. As long as the VISA server on the AWG can "see" the scope, it will show up on the drop-down "Instrument Connection" list.

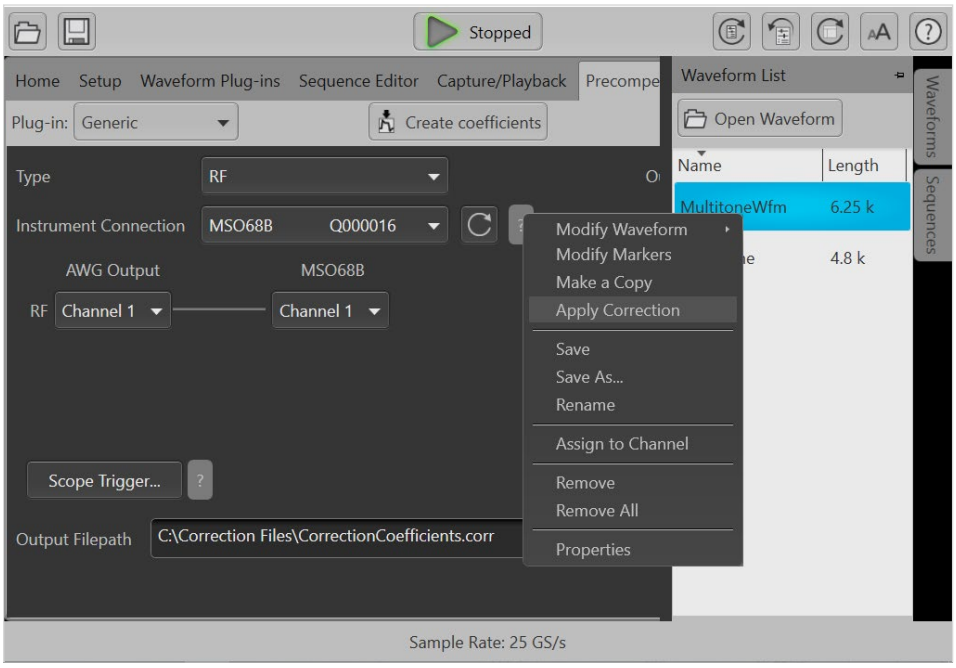
Next, configure the appropriate settings for the AWG output and scope input channels. Select the RF Start and End Frequency values to cover the frequency range of your waveform. For example, for a 1 GHz wide chirp centered at 5 GHz, the RF start frequency would be at 4.5 GHz, and the end frequency would be at 5.5 GHz. The frequency resolution value should be a small fraction of the signal bandwidth, usually between 0.1% and 1%. In this example, we selected a value of 1 MHz.

When you click the "Create Coefficients" button, you'll see a progress bar in the user interface while the AWG creates the test waveform and outputs it to the scope. The scope automatically selects the proper acquisition settings, captures multiple waveform measurements, and passes the data back to the AWG for analysis.

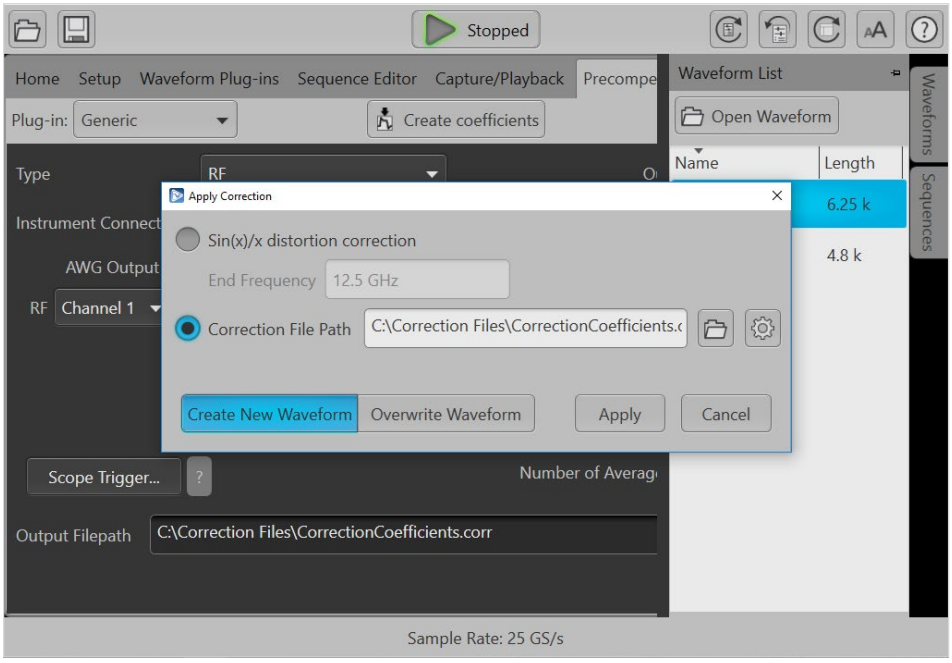


When the process of creating the filter coefficients is complete, a dialog box will display the amplitude and phase response of the correction filter:

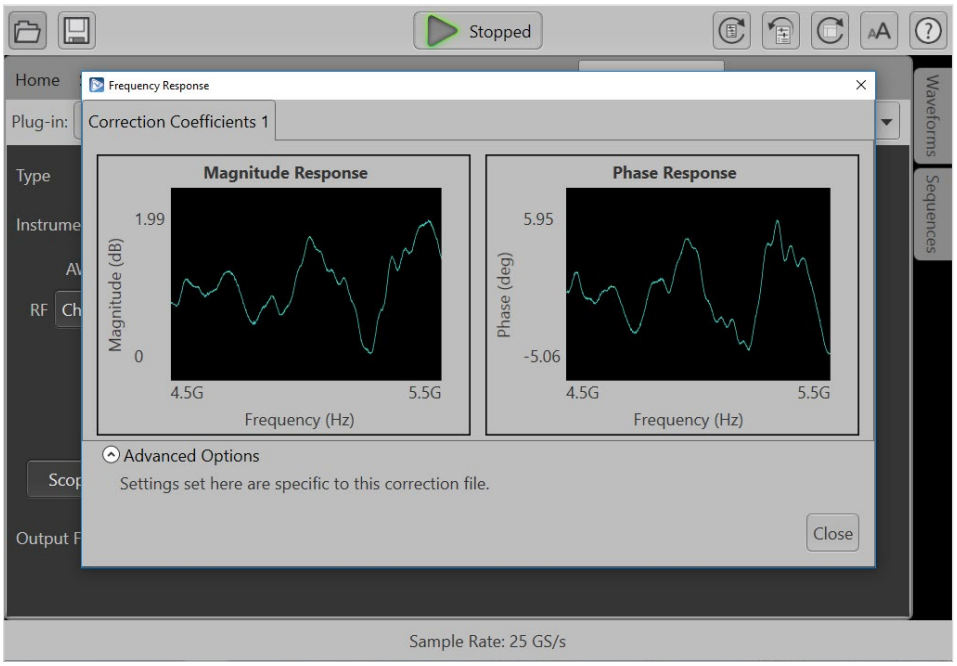
The next step is to apply the corrections to the waveform. In the Waveform List, right-click on the waveform that you want to correct, and select the “Apply Correction” item in the pop-up menu:



Select the “Correction File Path” radio button, and use the folder icon to navigate to the correction filter file you just created. Select the “Create New Waveform” button, and hit APPLY to create a pre-compensated version of your original waveform.

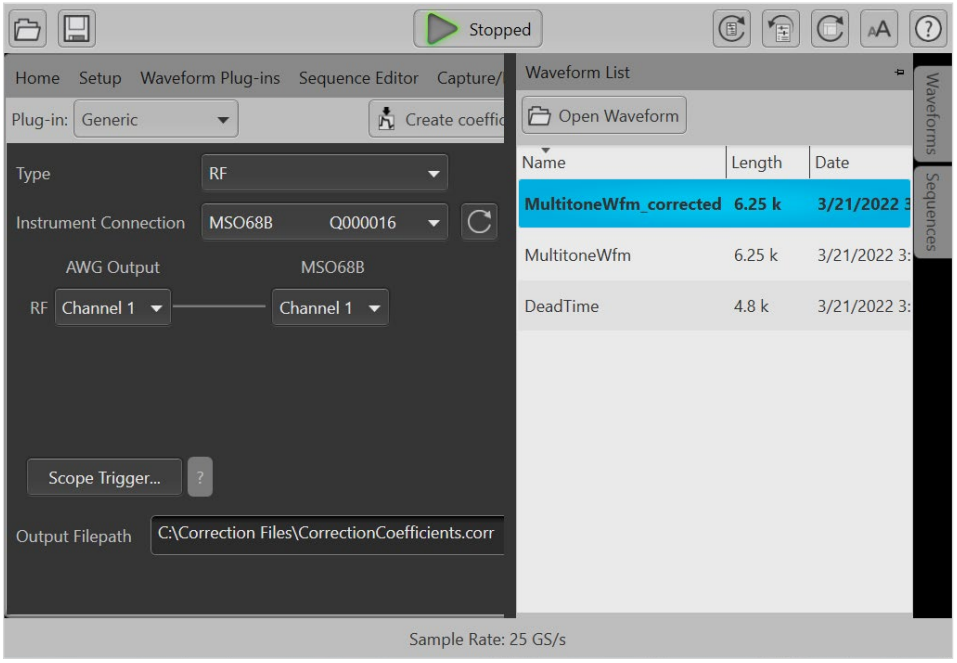


When you select the coefficients, a dialog box will show up to show you the filter's characteristics that the AWG will apply to the waveform:

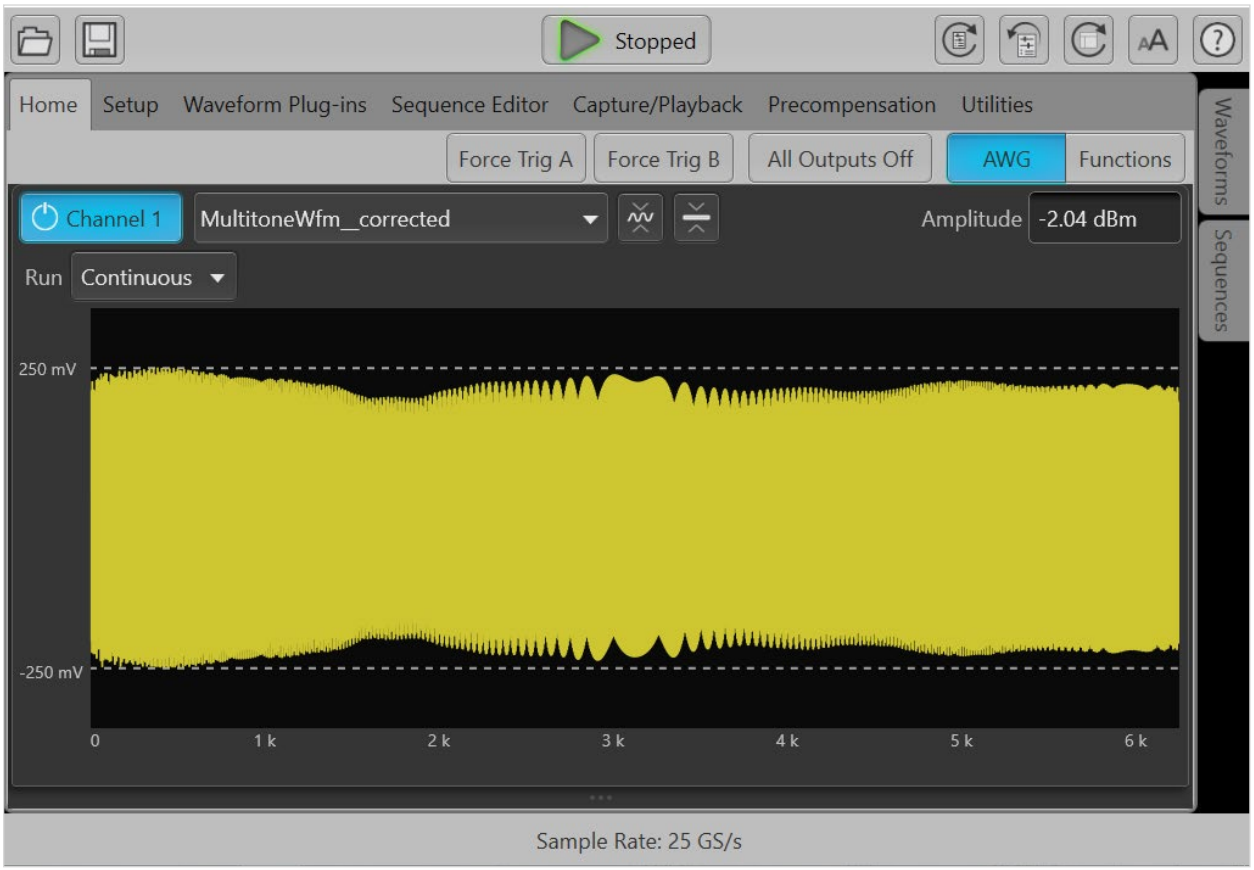


The plug-in also allows you to apply a simple Gaussian filter to your signals, as well as simply compensating for the sinx/x rolloff of the sampled data.

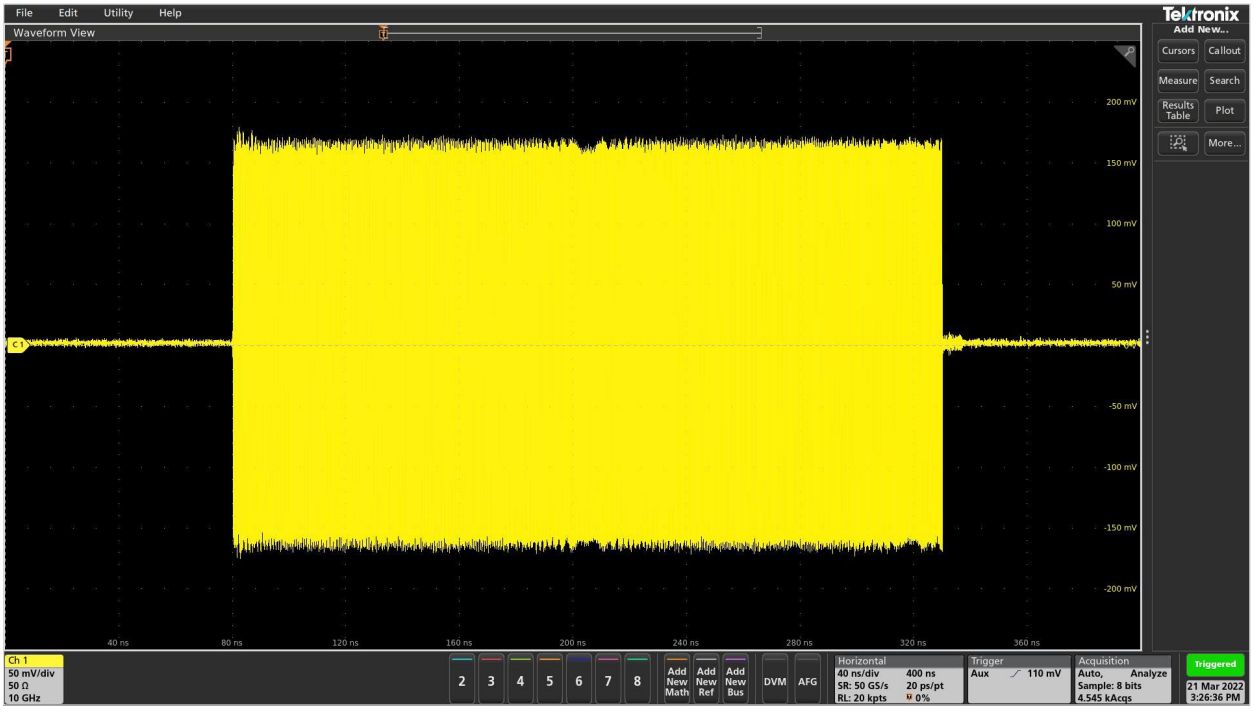
In a few seconds, a new waveform (with "_corrected" appended) will appear in the Waveform List:



Drag the waveform into the channel (Ch1, in this example) to load it and get it ready for playback. Click on the “play” button to generate the pre-compensated waveform.



The connected oscilloscope (Ch1 in this example) should now show the result of sending the pre-compensated 1 GHz wide chirp to the scope:



The pre-compensation process has measured the amplitude and phase response of the AWG and attached coaxial cable, built a filter to compensate for this response, and then pre-distorted the waveform so that the resulting output is closer to an ideal waveform at the end of the cable.

Conclusion

This pre-compensation capability is applicable to all types of waveforms, not just wideband RF. These same corrections can be applied to pulsed waveforms, high speed serial data streams, and more. You can customize the frequency range that you'd like perform the corrections over to ensure that your signal is properly precompensated.

The pre-compensation capability described here can be accomplished using either a Tektronix AWG5200 or AWG70000B arbitrary waveform generator in combination with Tektronix SourceXpress software and is supported by 5 Series MSO, 6 Series B MSO or DPO70000 oscilloscopes. A video showcasing this capability can be viewed on Tek.com.

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