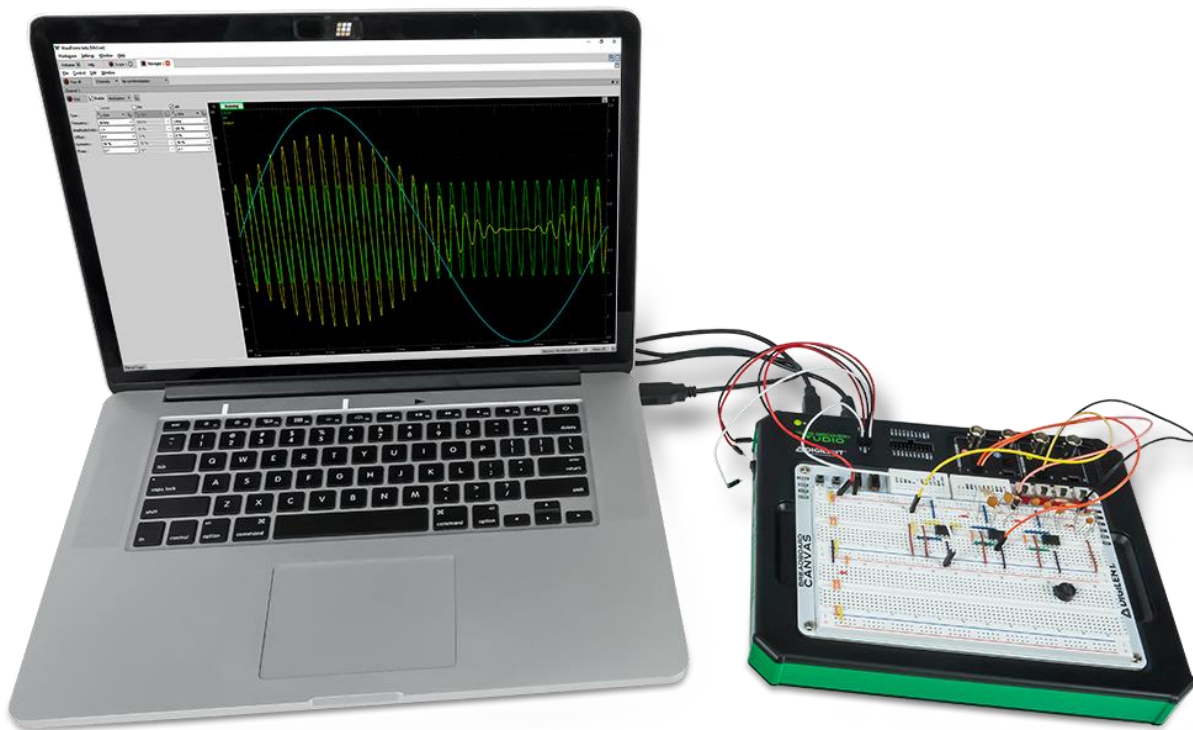
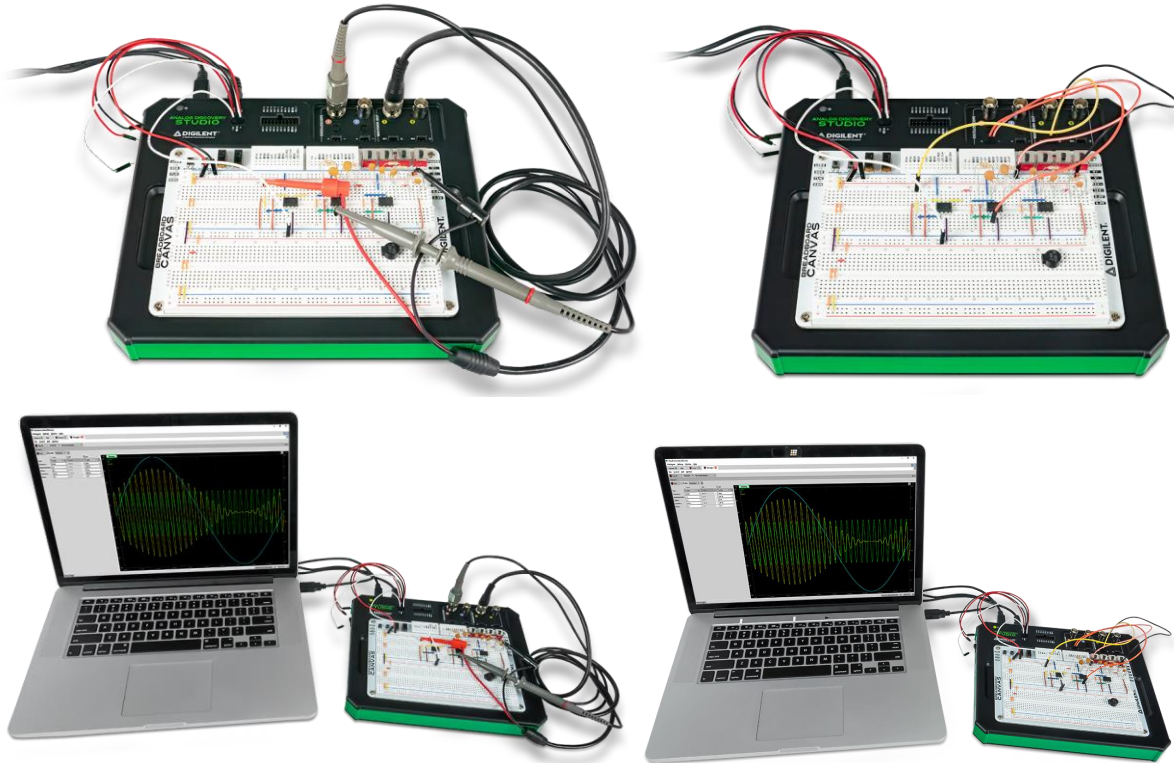


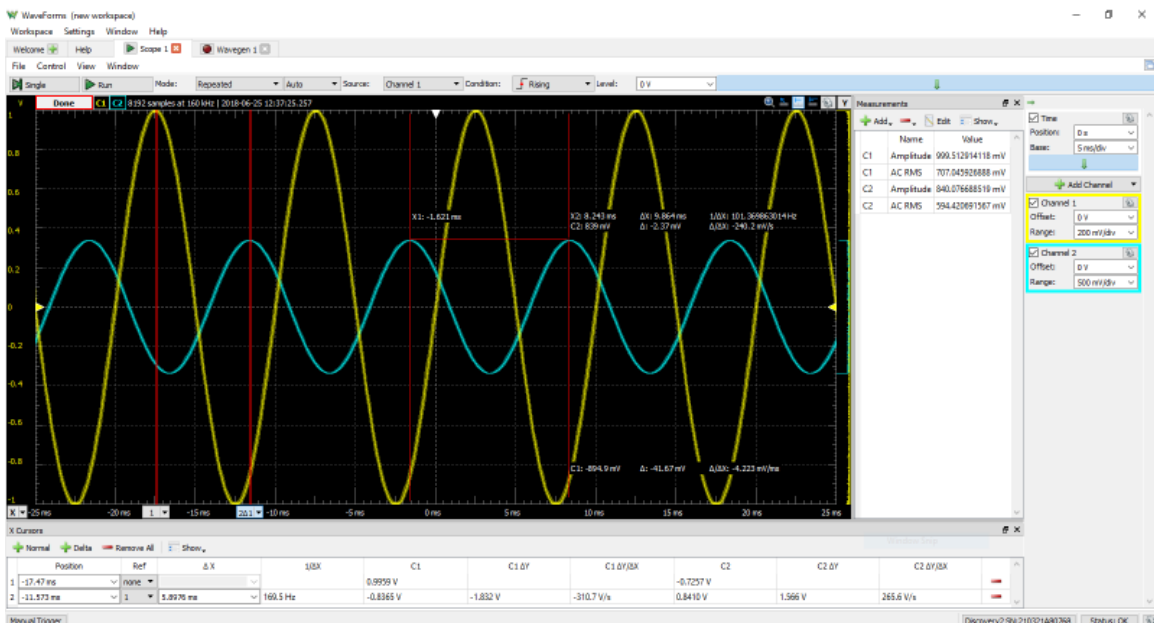
Analog Discovery Studio Reference Manual

The Analog Discovery Studio equipped with 13 test and measurement instruments providing the functionality of an entire benchtop worth of equipment in one device. The Oscilloscope, Waveform Generator, Logic Analyzer, Protocol Analyzer, Spectrum Analyzer, Power Supplies and more provide a device that can become a pop-up electronics laboratory anywhere. The physical design of the Analog Discovery Studio provides BNC connectors or MTE cables for the analog inputs and outputs, MTE cables for the digital I/O, triggers, and power supplies, and a large removable and breadboardable design surface supporting a large variety of designs or projects.





Oscilloscope



The Analog Discovery Studio can be used with WaveForms' Oscilloscope instrument to capture analog input data via the analog input ("Scope") channels, using either BNC cables or MTE cables. When this instrument is used, the Analog Discovery Studio's analog input channels act as a two-channel, 14-bit, 100 MS/s oscilloscope.

When used with BNC cables, the oscilloscope channels are single-ended, however, the circuit under test must still share a common ground with the Analog Discovery Studio. With BNC cables, the analog input channels have a bandwidth of 30+ MHz.

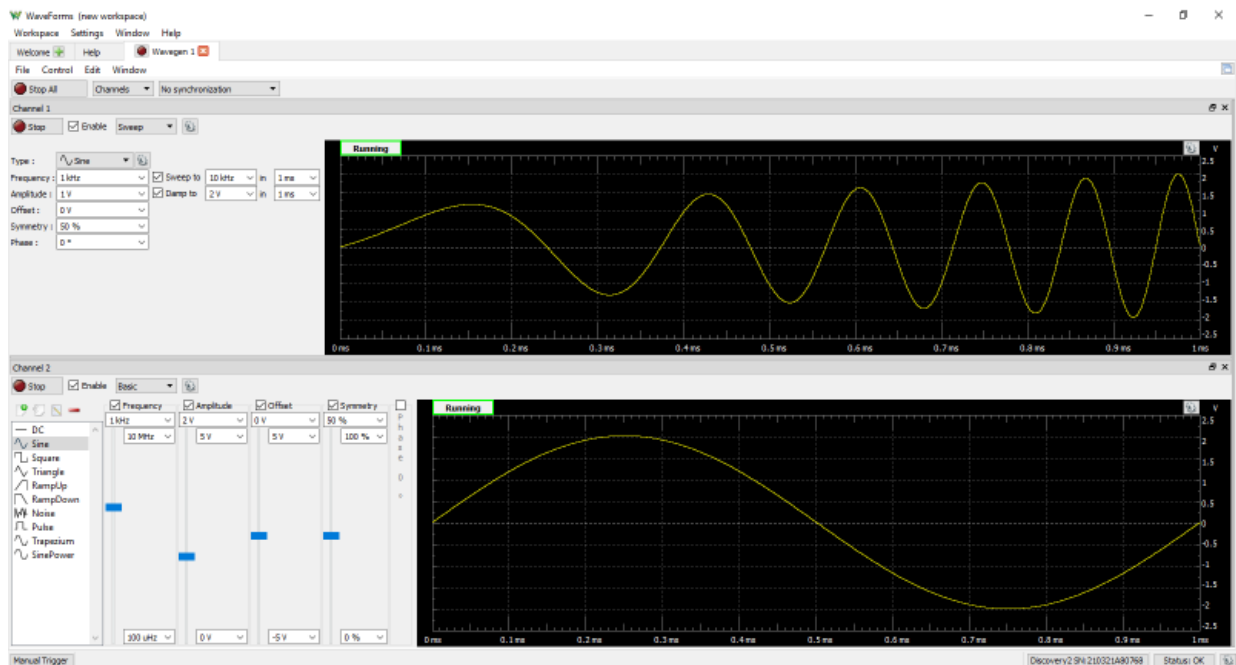
When used with MTE cables, the oscilloscope channels' + and - pins are differentially paired. The - pins can be attached to a non-ground circuit net, but the circuit under test must still share a common ground with the Analog Discovery Studio. With MTE cables, the analog input channels have a bandwidth of 9 MHz.

Since the Analog Discovery Studio's analog input channels are shared, the Oscilloscope instrument cannot be used at the same time as the Voltmeter, Data Logger, Spectrum Analyzer, Network Analyzer, or Impedance Analyzer instruments.

For more information on the analog input ("Scope") channels, please visit the [Analog Discovery Studio Specifications](#). For a walkthrough of the different features of WaveForms' Oscilloscope instrument, please visit the [Using the Oscilloscope](#) guide.

Important Note: Grounding Circuitry

Waveform Generator



The Analog Discovery Studio can be used with WaveForms' Waveform Generator instrument to output analog voltage waves via either BNC cables or MTE cables. The Waveform Generator converts 14-bit digital samples to analog at a rate of up to 100 MS/s on each of two channels. When the Waveform Generator instrument is used, the Analog Discovery Studio's analog

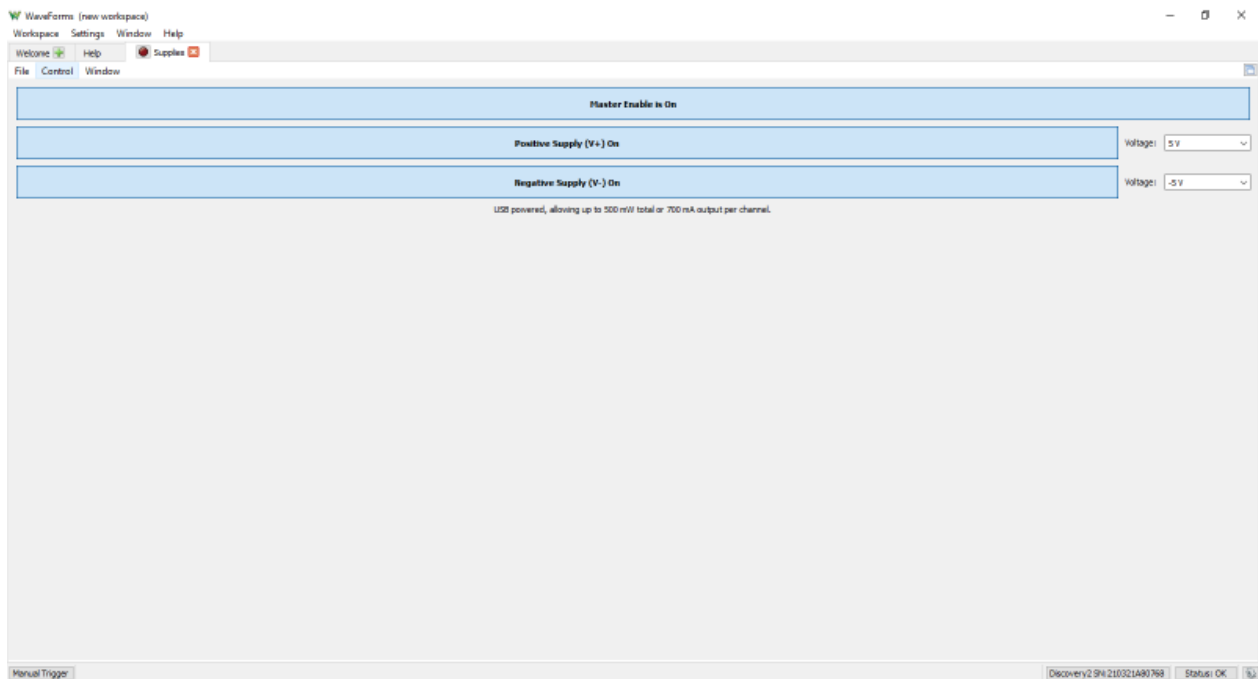
output channels act as an Arbitrary Waveform Generator. The instrument supports everything from simple waveforms like Sine and Triangle waves, up to more complicated functions like AM and FM modulation. Custom sets of samples can be defined by the user in applications like Excel and imported to WaveForms.

Each waveform generator channel is considered a single ended pin, however, a connected circuit must share a ground with the Analog Discovery Studio. Each channel has a bandwidth of 8MHz through both the BNC and MTE connectors. AC amplitudes of +-5V and DC offsets of +-5V are supported.

Since the Analog Discovery Studio's analog output channels are shared, the Waveform Generator instrument cannot be used at the same time as the Network Analyzer, or Impedance Analyzer instruments.

For more information on the analog output (“Wavegen”) channels, please visit the [Analog Discovery Studio Specifications](#). For a walkthrough of the different features of WaveForms' Waveform Generator instrument, please visit the [Using the Waveform Generator](#) guide.

Power Supplies



The Analog Discovery Studio has a variety of different power supply rails that can be used to power circuits under test. The **V+** and **V-** rails are variable, while the rest are fixed. The fixed rails are summarized in the table below:

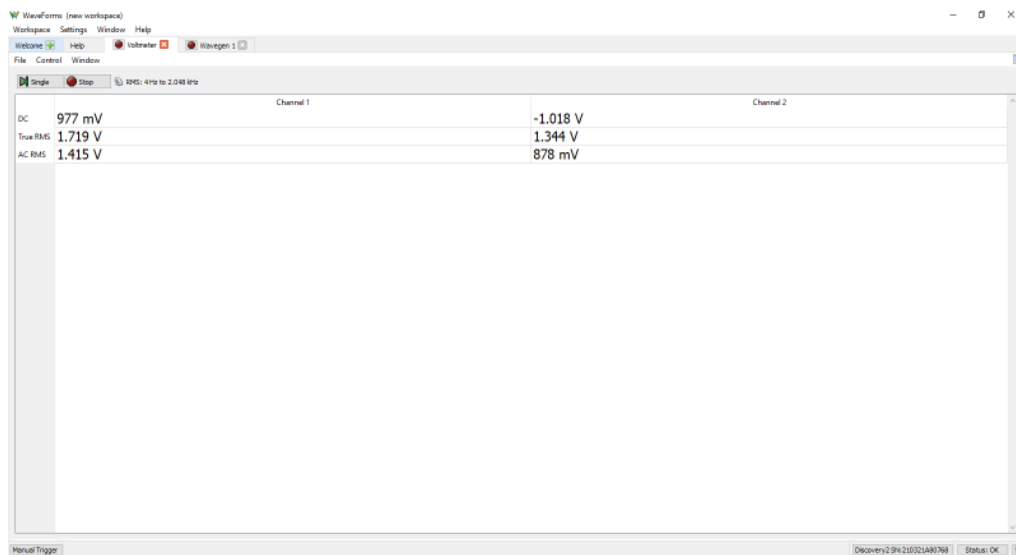
Label	Voltage	Maximum Current
+12V	12V +/-5%	0.2A
-12V	-12V +/-5%	0.2A
5.0V	5V +/-5%	1.0A
3.3V	3.3V +/-5%	1.0A

Note: The 3.3V and 5.0V power supply rails are only available from pins located on the Canvas.

The Analog Discovery Studio also features two variable power supply rails, labeled **V+** and **V-**, which can be set to voltage levels between 1 to 5V and -1 to -5V respectively, through the use of WaveForms' "Supplies" instrument. Each of these supplies can provide at most 2.1 W or 700 mA.

For more information on using the programmable power supplies, please visit the [Analog Discovery Studio Specifications](#). For a walkthrough of the different features of WaveForms' Power Supplies instrument, please visit the [Using the Power Supplies](#) guide.

Voltmeter

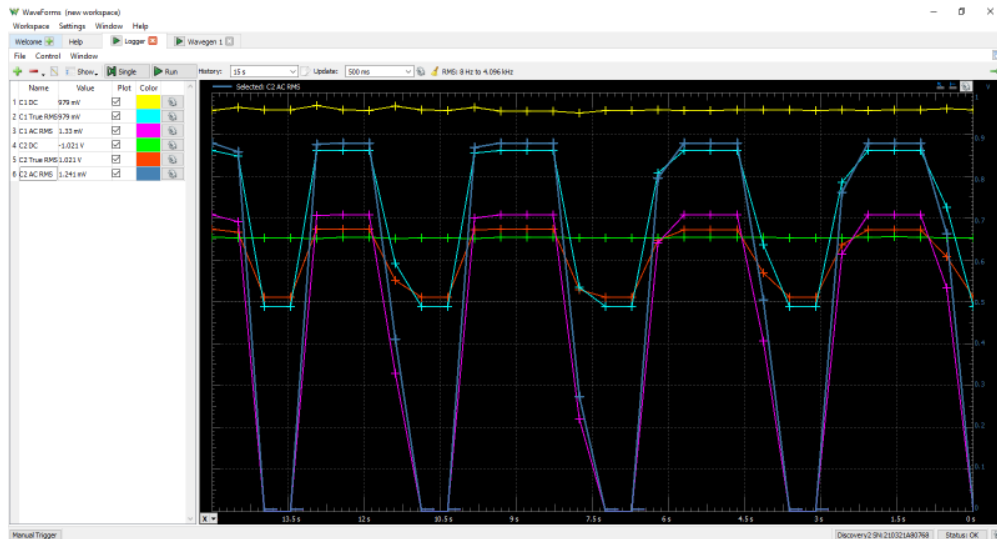


The Analog Discovery Studio's analog input pins can be used with WaveForms' Voltmeter instrument to act as a simple voltmeter. DC voltages, AC RMS voltages, and True RMS voltages can be viewed for each of the two Scope channels.

Since the Analog Discovery Studio's analog input channels are shared, the Voltmeter instrument cannot be used at the same time as the Oscilloscope, Data Logger, Spectrum Analyzer, Network Analyzer, or Impedance Analyzer instruments.

For more information on the analog input (“Scope”) channels, please visit the [Analog Discovery Studio Specifications](#). For a walkthrough of the different features of WaveForms' Voltmeter instrument, please visit the [Using the Voltmeter](#) guide.

Data Logger



The Analog Discovery Studio can be used with WaveForms' “Logger” instrument in order to capture large buffers of analog input data on the Scope pins.

The Data Logger can capture buffers of data at update rates of up to 10 samples per second. The maximum duration of a log is dependent on the update rate, but at the extreme, can run for over a thousand hours.

Since the Analog Discovery Studio's analog input channels are shared, the Data Logger instrument cannot be used at the same time as the Oscilloscope, Voltmeter, Spectrum Analyzer, Network Analyzer, or Impedance Analyzer instruments.

For more information on the analog input (“Scope”) channels, please visit the [Analog Discovery Studio Specifications](#). For a walkthrough of the different features of WaveForms' Data Logger instrument, please visit the [Using the Data Logger](#) guide.

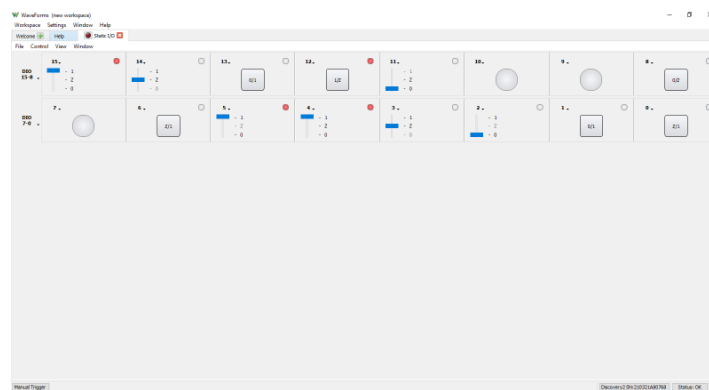
The Analog Discovery Studio can be used with WaveForms' "Patterns" instrument to generate logic signal sequences on the digital input/output pins.

The pins can be configured to be push/pull, open drain, open source, or three-state logic. The logic high output voltage level is 3.3V. Sample rates can go as high as 100 MS/s.

Digital input/output channels used by the Pattern Generator instrument can still be used by other instruments using the same digital input/output channels, however, other instruments can only use these shared channels as inputs.

For more information on the digital input/output channels, please visit the [Analog Discovery Studio Specifications](#). For a walkthrough of the different features of WaveForms' Pattern Generator instrument, please visit the [Using the Pattern Generator](#) guide.

Digital I/O



The Analog Discovery Studio can be used with WaveForms' Static I/O instrument to emulate a variety of user input/output devices on the digital input/output pins. Virtual LEDs, buttons, switches, sliders, and displays can be assigned to specific digital I/O pins, and interacted with within the WaveForms user interface.

The Analog Discovery Studio's digital input/output channels use a 3.3V logic standard for output, and can accept either 1.8V or 3.3V logic signals as inputs. The digital input/output pins are tolerant to input signals up to 5V.

Important Note: *To prevent damage to the device, care must be taken not to drive input signals to the digital input/output channels over 5V.*

Digital input/output channels used by the Static I/O instrument can still be used by other instruments using the same digital input/output channels, however, other instruments can only use these shared channels as inputs.

For more information on the digital input/output channels, please visit the [Analog Discovery Studio Specifications](#). For a walkthrough of the different features of WaveForms' Static I/O instrument, please visit the [Using the Digital I/O](#) guide.

Spectrum Analyzer



The Analog Discovery Studio can be used with WaveForms' "Spectrum" instrument to view the power of frequency-domain components of analog signals captured on the analog input channels.

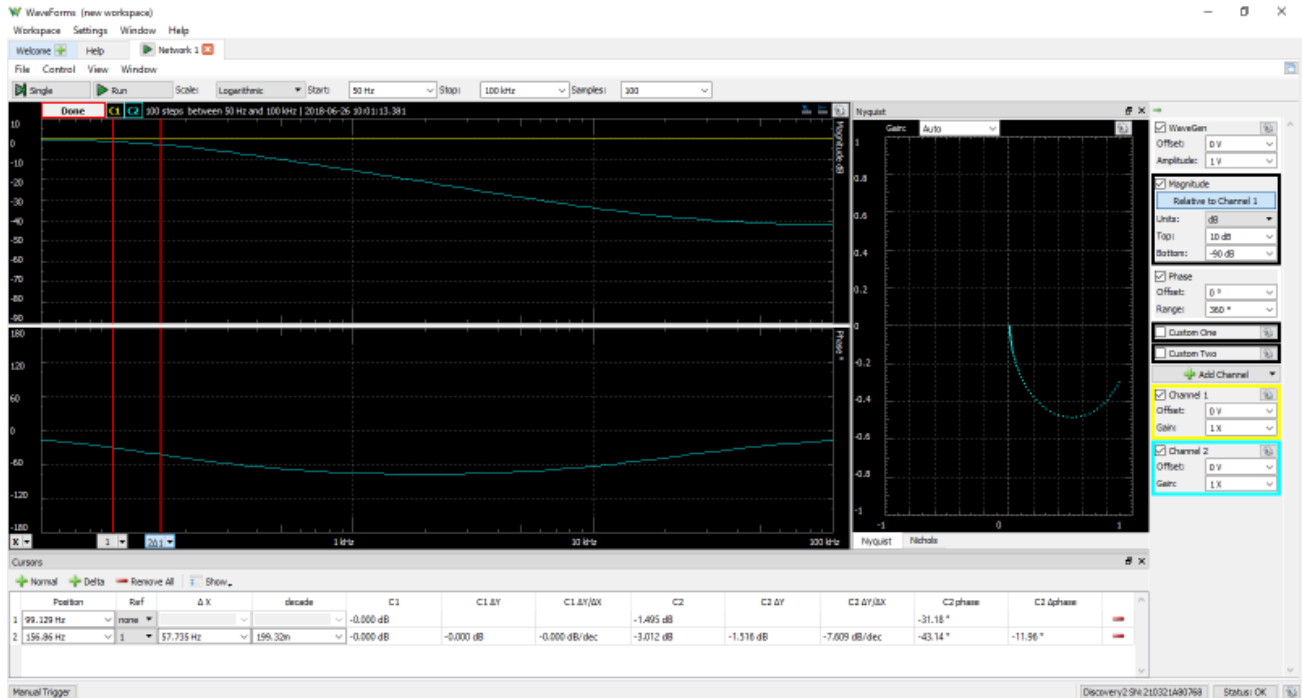
Signals with minimum/maximum frequencies between 0 Hz and 50Mhz can be plotted in units of peak voltage, RMS voltage, and various voltage level ratio units.

Since the Spectrum Analyzer instrument uses the same hardware resources as the Oscilloscope, Network Analyzer, and Impedance Analyzer instruments, it cannot be used at the same time as these other instruments.

Since the Analog Discovery Studio's analog input channels are shared, the Oscilloscope instrument cannot be used at the same time as the Oscilloscope, Voltmeter, Data Logger, Network Analyzer, or Impedance Analyzer instruments.

For more information on the analog input channels, please visit the [Analog Discovery Studio Specifications](#). For a walkthrough of the different features of WaveForms' Spectrum Analyzer instrument, please visit the [Using the Spectrum Analyzer](#) guide.

Network Analyzer



The Analog Discovery Studio can be used with WaveForms' "Network" instrument to view the amplitude and phase response of a circuit under test. Nichols and Nyquist plots can also be viewed with this instrument.

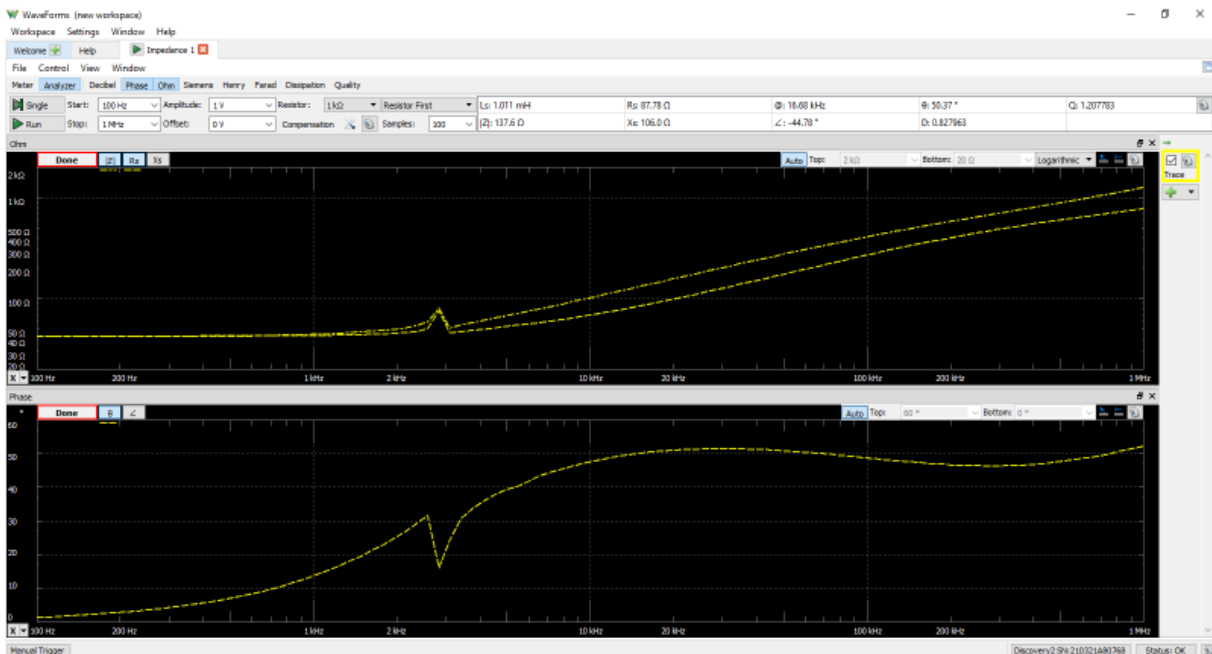
Frequency sweeps can be performed in ranges between 1 mHz and 10 MHz with up to 10k samples per decade. The wave used for the sweep can be customized, and uses the same resources as the Waveform Generator instrument.

The Network Analyzer instrument uses the analog output and analog input channels of the Analog Discovery Studio to probe a test circuit. The Network Analyzer can be configured to use an external signal to provide input to the circuit under test, rather than using the analog output channels.

Since the Analog Discovery Studio's analog input and output channels are shared, the Network Analyzer instrument cannot be used at the same time as the Oscilloscope, Waveform Generator, Voltmeter, Data Logger, Spectrum Analyzer, or Impedance Analyzer instruments.

For more information on the analog output and analog input channels, please visit the [Analog Discovery Studio Specifications](#). For a walkthrough of the different features of WaveForms' Network Analyzer instrument, please visit the [Using the Network Analyzer](#) guide.

Impedance Analyzer



The Analog Discovery Studio can be used with WaveForms' "Impedance" instrument to view a wide variety of frequency response characteristics of a circuit under test. Input, Phase, Voltage, Current, Impedance, Admittance, Inductance, Factor, and Nyquist plots are all available. In addition, Custom plots can be used to present the results of a wide variety of different mathematical operations on buffered data.

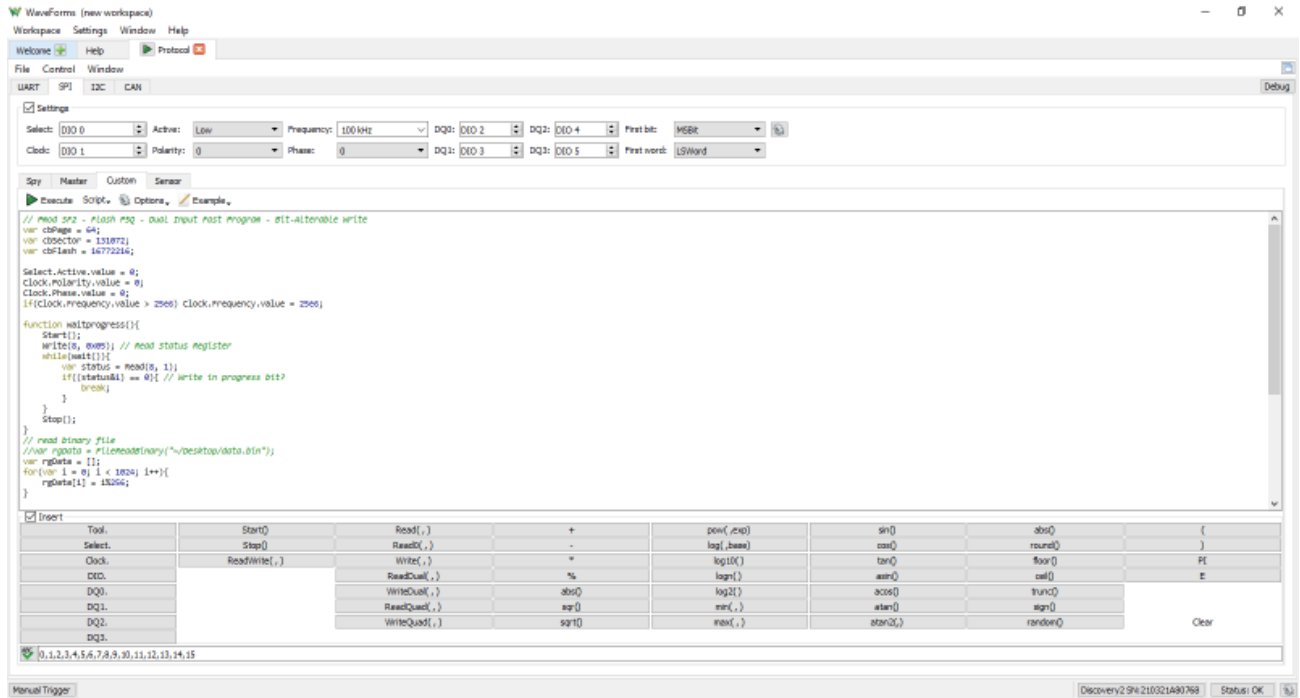
Frequency sweeps can be performed with in ranges between 100 uHz and 25 MHz, with as many as 10k samples per decade. The signal used to perform the sweep can be selected from a variety of preset, with configurable amplitude and offset. An external network analyzer reference circuit can be selected from a variety of options.

The Impedance Analyzer instrument uses the analog output channels and analog input channels of the Analog Discovery Studio to probe a test circuit.

Since the Analog Discovery Studio's analog input and output channels are shared, the Impedance Analyzer instrument cannot be used at the same time as the Oscilloscope, Waveform Generator, Voltmeter, Data Logger, Spectrum Analyzer, or Network Analyzer instruments.

For more information on the analog output and analog input channels, please visit the [Analog Discovery Studio Specifications](#). For a walkthrough of the different features of WaveForms' Impedance Analyzer instrument, please visit the [Using the Impedance Analyzer](#) guide.

Protocol Analyzer



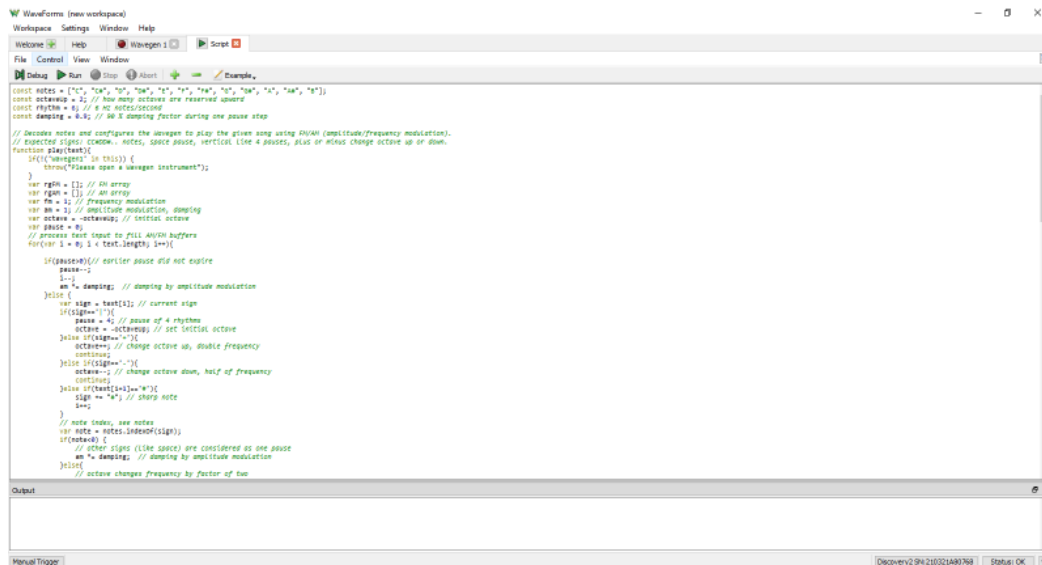
The Analog Discovery Studio can be used with WaveForms' "Protocol" instrument to work with common communications protocols. UART, SPI, I2C, and CAN transactions can be received, transmitted, and/or spied upon by the Analog Discovery Studio using any of the 16 digital input/output channels at a sample rate of 100 MS/s.

Custom scripts can be written within the Protocol Analyzer instrument to generate sequences of SPI or I2C transactions.

Since it uses the same hardware resources as the Logic Analyzer and Pattern Generator instruments, the Protocol Analyzer cannot be used at the same time as these instruments.

For more information on the digital input/output channels, please visit the [Analog Discovery Studio Specifications](#). For a walkthrough of the different features of WaveForms' Protocol Analyzer instrument, please visit the [Using the Protocol Analyzer](#) guide.

WaveForms Script Editor



```
WaveForms (new workspace)
Workspace Settings Window Help
Welcome HSB Wavegen1 Script
File Control View Window
Debug Run Stop Abort Example
const NOTES = ["C", "CA", "Cb", "Cb", "C#", "C#", "D", "D", "DA", "DA", "DA", "DA", "E"];
const OCTAVE = 2; // How many octaves are reserved upward
const FREQ = 440; // Hz, note frequency
const DAMPING = 0.5; // 0 is damping factor during one pause step
// Decodes notes and configures the Wavegen to play the given song using AM/FM (amplitude/frequency modulation).
// Expected steps: (C)note, (space) pause, (vertical line) a pause, plus or minus change octave up or down.
function play(text){
  let("changes" in this){
    throw("Please open a Wavegen instrument");
  }
  var rgn = []; // An array
  var fm = []; // An array
  var fm = 1; // Frequency modulation
  var am = 1; // Amplitude modulation, damping
  var octave = -OCTAVE; // Initial octave
  var pause = 0;
  // Process text input to fill AM/FM buffers
  for(var i = 0; i < text.length; i++){
    if(pause){ // earlier pause did not expire
      pause--;
    } else {
      am *= damping; // damping by amplitude modulation
    }
    var sign = text[i]; // current sign
    if(sign == "|"){
      pause = 0; // pause of a rhythm
      octave = -OCTAVE; // set initial octave
    } else if(sign == "-"){
      octave++; // change octave up, double frequency
    } else if(sign == "."){
      octave--; // change octave down, half of frequency
    } else if(sign == "w"){
      sign = "w"; // wrap note
    }
    // note index, see notes
    var note = NOTES.indexOf(sign);
    if(note < 0) {
      // other signs (like space) are considered as one pause
      am *= damping; // damping by amplitude modulation
    } else {
      // octave changes frequency by factor of two
    }
  }
}
```

Each of WaveForms' instruments can be controlled through scripts within the WaveForms application itself. WaveForms' "Script" instrument allows the user to write and run javascript code that can control the rest of the application through an extensive API. This allows the user to configure and run many instruments at the same time, in an easily repeatable way.

A variety of code examples are available in the application to aid in learning to write WaveForms scripts. Additional resources for writing scripts can be found on the Scopes and Instruments [Digilent Forum](#).

A plot pane within the Script instrument itself can be used to integrate data from many different instruments, and display it in a highly customizable way.

For a walkthrough of the different features of WaveForms' Script instrument, please visit the [Using Scripts](#) guide.

WaveForms Software Development Kit (SDK)

The WaveForms SDK is a set of software libraries and examples that can be used to develop custom applications that can control Digilent Test and Measurement devices. Supported languages include C, C++, C#, Visual Basic, and Python. Third party toolkits are available for LabVIEW and MATLAB. Instructions for using WaveForms with LabVIEW are available through the [National Instruments forum](#). The MATLAB support package is available through the [MathWorks website](#). More information about WaveForms SDK can be found through the [WaveForms SDK Reference Manual](#).