

## Analog Discovery Pro 5000 Series Datasheet

All-In-One Mixed Signal Oscilloscope, Function Generator, Power Supply, and DMM



### Highlighted Features

- USB-based Mixed Signal Oscilloscopes
- Four analog input channels, with sample rates and bandwidths from 1.5 to 2 GS/s and 350 to 500 MHz
- 34 digital inputs at 1 GS/s
- Digital Multimeter supporting CAT II measurements
- Three programmable power supplies
- An analog output with up to 40 MHz bandwidth
- Bode plot, FFT, impedance analyzer, and more
- Extensive software support with WaveForms, WaveForms SDK, and LabVIEW

## Overview

The Analog Discovery Pro 5000 Series devices, the ADP5470 and the ADP5490, are Digilent's most ambitious mixed signal oscilloscopes to date, bringing higher sample rates, wider bandwidth, and more power to your benchtop.

Classifying the ADP5000 devices as 'just' mixed signal oscilloscopes would be doing them a disservice. Each product sports an integrated CAT II Digital Multimeter, three programmable power supplies, a dedicated trigger line, and arbitrary waveform generator to complement the mixed signal oscilloscope. With 34 digital inputs operating at 1 GS/s working in tandem with the analog system, the rugged 5000 Series devices. The rugged 5000 Series devices provide the high bandwidth and sample rates you need for your analog inputs. Options are available for either 350 MHz at 1.5 GS/s or 500 MHz at 2 GS/s for all four channels.

Driven by Digilent's free WaveForms software and with everything included with a one-time purchase of the hardware, the Analog Discovery Pro 5000 Series is more than just a tool – it's analysis uncompromised.

# 1 Features

## Analog Inputs

- Analog Discovery Pro 5470
  - Four BNC input channels with 8-bit resolution with up to  $\pm 20$  V input range
  - 350 MHz bandwidth, 1.5 GS/s per channel
- Analog Discovery Pro 5490
  - Four BNC input channels with 8-bit resolution with up to  $\pm 20$  V input range
  - 500 MHz bandwidth, 2 GS/s per channel

## Analog Output

- One BNC output channel with 14-bit resolution,  $\pm 12$  V output range
- Analog Discovery Pro 5470
  - 20 MHz bandwidth, up to 125 MS/s
- Analog Discovery Pro 5490
  - 40 MHz bandwidth, up to 200 MS/s

## Logic Analyzer

- 34 digital inputs with configurable voltage threshold
- Up to 1 GS/s per channel

## Power Supplies

- Three programmable power supplies (0 V to 6 V, 0 V to 25 V, 0 V to -25 V)
- Up to 3 A output on the 6 V rail, up to 1 A each on the  $\pm 25$  V rails
- Integrated hardware readback of voltage and current output for each rail

## Additional Features

- Integrated CAT II Digital Multimeter
- Triggering and cross triggering between instruments

## Software Support

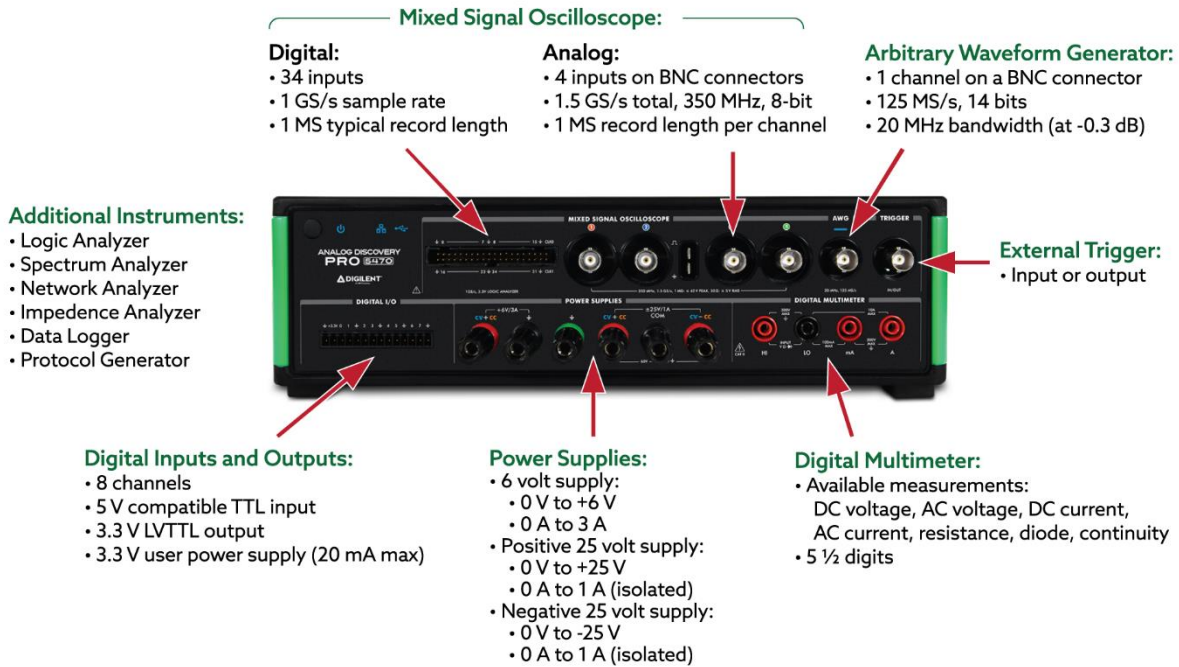
- Digilent's WaveForms software
- WaveForms SDK for custom applications and scripting through C/C++, Python, C#, Visual Basic
- LabVIEW support
- The Analog Discovery Pro 5000 Series can only be used on computers with Windows operating systems running on 32-and 64-bit Intel processors

## Comparison Chart

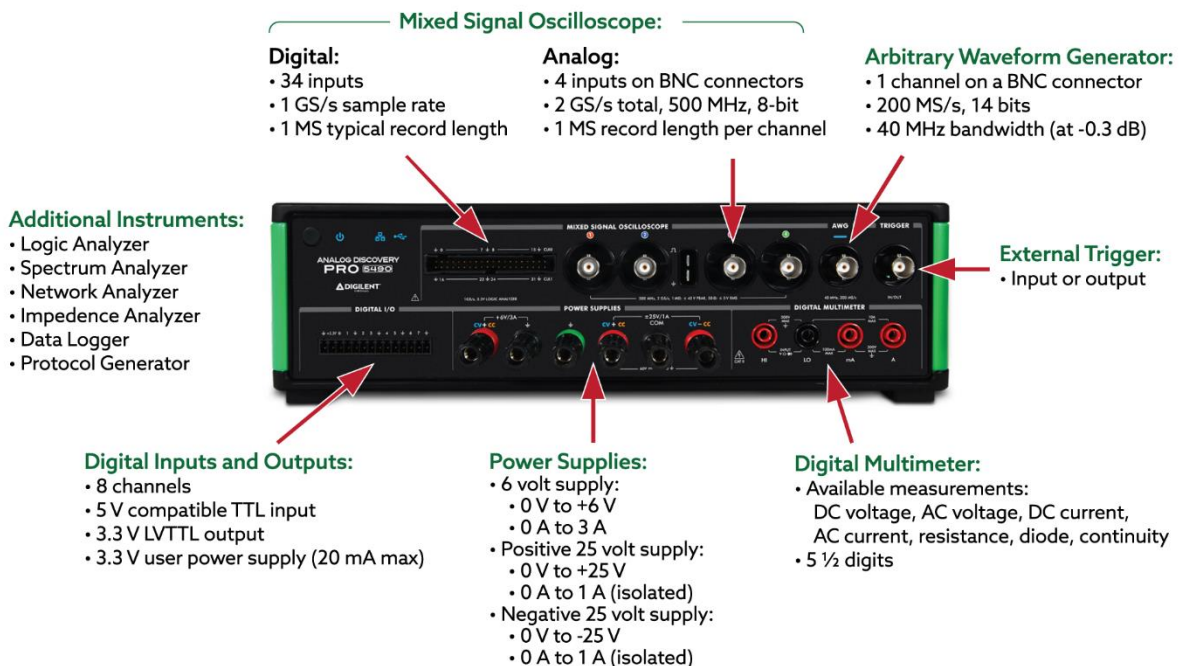
What do you need?		ADP5470	ADP5490
High Sample Rate and Bandwidth?	1.5 GS/s and 350 MHz for all 4 channels	●	●
	2 GS/s and 500 MHz for all 4 channels		●
34 Digital Inputs operating at up to 1 GS/s?		●	●
Bode plot, FFT, and Impedance Analyzers?		●	●
DMM supporting CAT II measurements?		●	●
Arbitrary Waveform Generator?	20 MHz bandwidth for sine, square and ramp signals, and custom waveforms?	●	●
	40 MHz bandwidth for sine, square and ramp signals, and custom waveforms?		●
Multiple programmable power supplies?	6 V – 3 A, +25 V – 1 A, -25 V – 1 A	●	●
To have everything from the Scope Probes to software to functionality to product support included in a single one-time price?		●	●

## Callout Diagrams

### Analog Discovery Pro (ADP5470)



### Analog Discovery Pro (ADP5490)



## 2 WaveForms Software

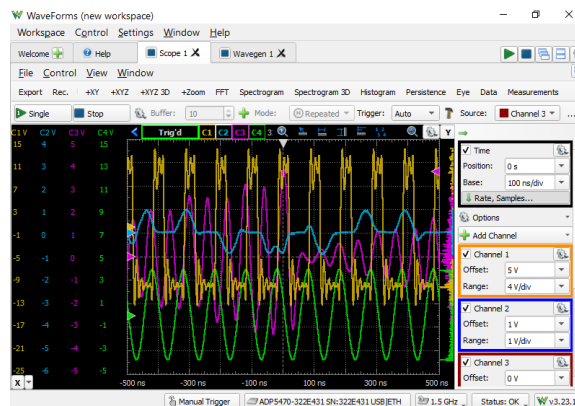
Digilent's WaveForms software offers a unified device experience across all our Test and Measurement devices, enabling use of all hardware features and instruments. It features a friendly user interface that has the feel of traditional benchtop devices. WaveForms makes it easy to acquire, visualize, analyze, produce, and reuse both analog and digital signals simultaneously.

For even more customization potential, the WaveForms Software Development Kit (SDK) can be used to create custom applications and scripts to control the T&M device in Python, C, and additional languages.

The Analog Discovery Pro 5000 Series is compatible with the Windows version of WaveForms.

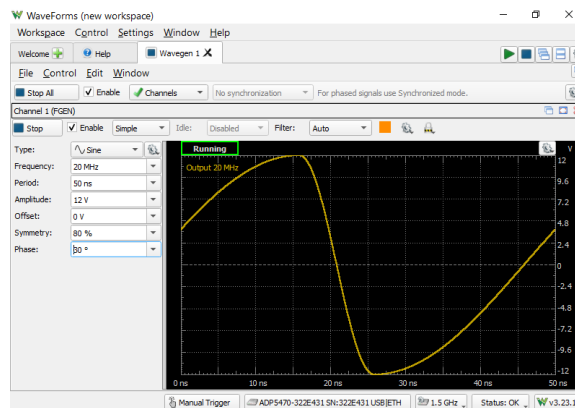
### 2.1 Oscilloscope

The Oscilloscope instrument captures analog input data via the analog input scope channels. When this instrument is used, each of the Analog Discovery Pro 5000 Series analog input channels act as an 8-bit oscilloscope, providing up to 500 MHz of bandwidth at 2 GS/s with the ADP5490. Multiple triggering modes are supported.



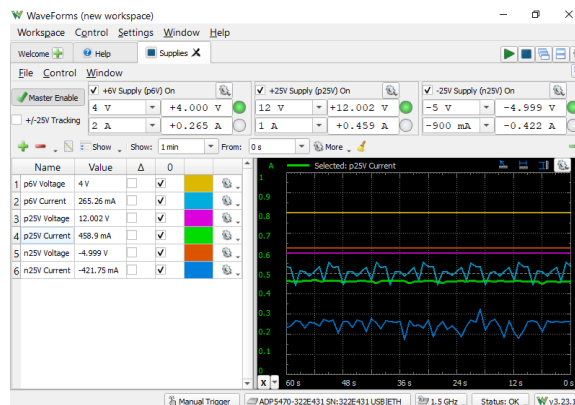
### 2.2 Waveform Generator

The Waveform Generator instrument can output analog voltage waveforms. The Analog Discovery Pro 5000 Series devices support simple waveforms like Sine and Triangle waves as well as custom sets of samples can be defined by the user in applications like Excel and imported to WaveForms.



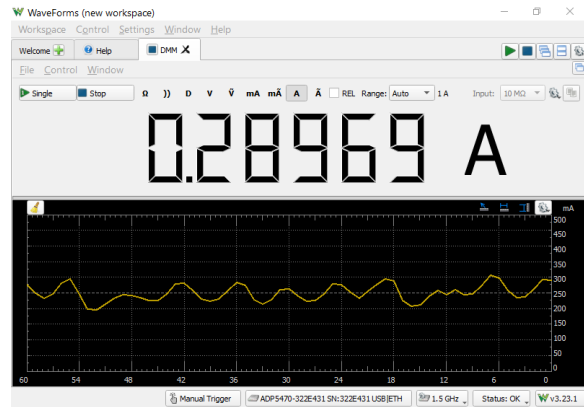
### 2.3 Power Supplies

The Analog Discovery Pro 5000 Series have three variable power supply rails that can be used to power circuits under test – a 0 to 6 V rail, a 0 V to 25 V rail, and a 0 V to -25 V rail. The ADP5470 and ADP5490 can supply 3 A on the 6 V rail and 1 A on each  $\pm 25$  V rail.



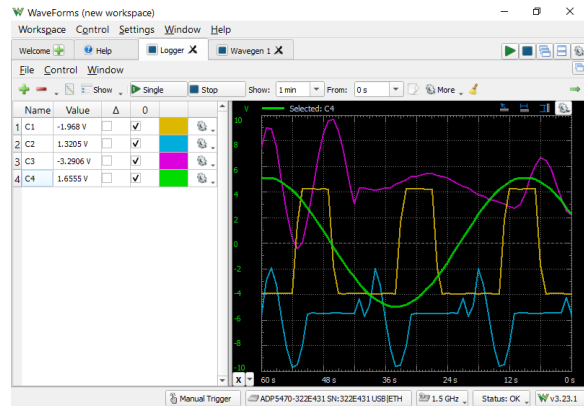
## 2.4 Digital Multimeter

The Analog Discovery Pro 5000 Series devices have a dedicated CAT II DMM, letting users measure voltage, current, resistance, continuity, and more within a single instrument.



## 2.5 Data Logger

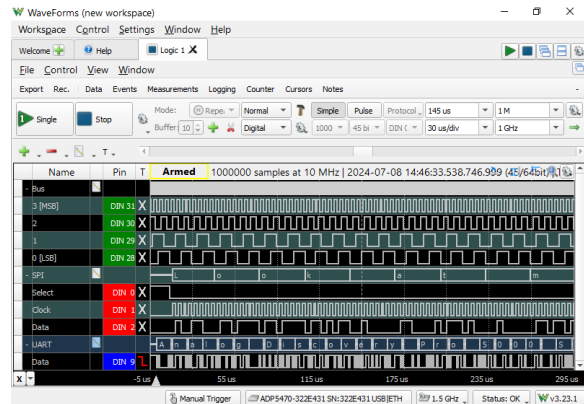
The Data Logger instrument can capture large buffers of analog input data on the Scope pins. The Data Logger can capture up to 10 million samples at a defined update rate ranging from 10 Hz to once an hour.



## 2.6 Logic Analyzer

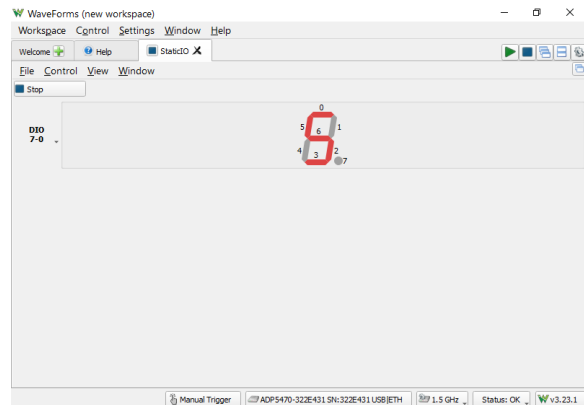
With the Logic Analyzer, the 34 digital input channels are equipped to capture digital data at up to 1 GS/s. With a user configurable threshold of 0 V to 2 V, numerous logic standards are supported up to 5 V TTL.

Individual input/output channels can be grouped as buses and protocols. Protocol groups can be used to view the decoded contents of packets of many common communications protocols, including SPI, I2C, UART, CAN, and I2S.



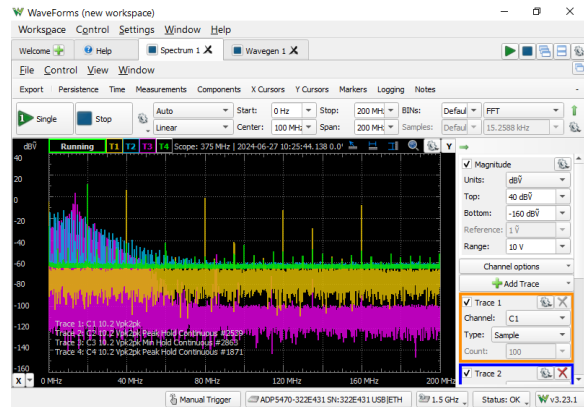
## 2.7 Static I/O

The Static I/O instrument can emulate a variety of user input/output devices on the eight dedicated 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.



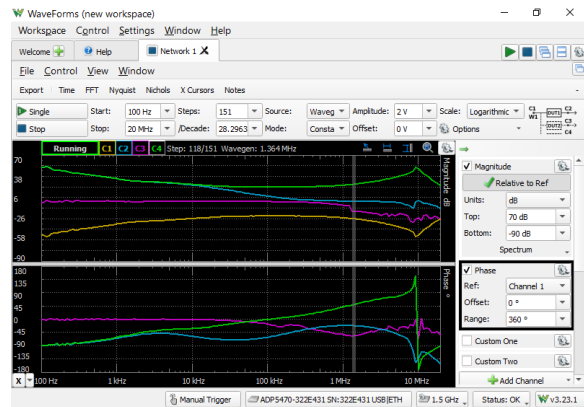
## 2.8 Spectrum Analyzer

The Spectrum Analyzer instrument is used to view the power of frequency-domain components of analog signals captured on the analog input channels. Cursors and automatic measurements include noise floor, SFDR, SNR, THD and more.



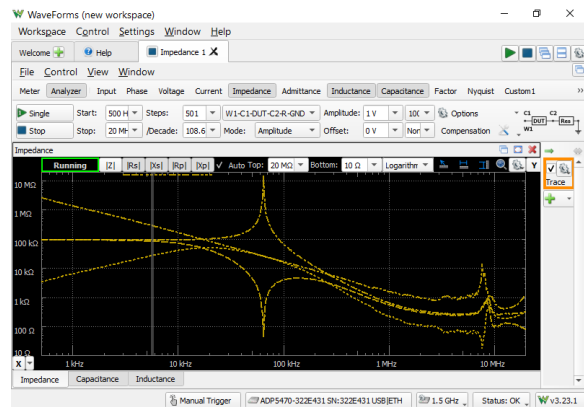
## 2.9 Network Analyzer

The Network Analyzer instrument can be used to view the amplitude and phase response of a circuit under test. Bode, Nichols, and Nyquist plots can also be viewed with this instrument. The Network Analyzer instrument uses the analog output and analog input channels of the Analog Discovery Pro 5000 Series device to probe a test circuit, by generating a frequency sweep and measuring the circuit's response. 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 channel.



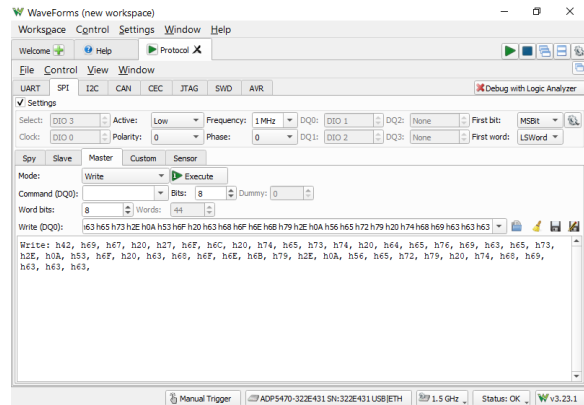
## 2.10 Impedance Analyzer

The Impedance Analyzer instrument is used 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.



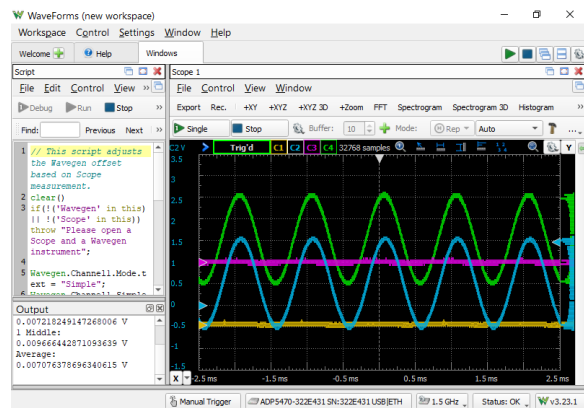
## 2.11 Protocol Analyzer

The Protocol Analyzer instrument generates SPI and I2C transactions through the ADP5000’s dedicated digital input/output pins. Custom scripts can also be written within the Protocol Analyzer instrument to generate transaction sequences.



## 2.12 WaveForms Script Editor

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.



## 3 Extended Software Support

Digilent has created a package for LabVIEW to provide users with flexibility in the environment used for both data acquisition and subsequent analysis, providing a curated experience to let users that are more comfortable in different development environments still have access to all the power contained within the Analog Discovery Pro 5000 Series devices.

Users are also able to leverage existing NI VirtualBench applications created within LabVIEW with the equivalent Analog Discovery Pro 5000 Series device. Further customization and control of the 5000 Series can be done through Digilent's WaveForms SDK, letting users create their own applications in C/C++, Python, C#, and Visual Basic.

## 4 Analog Discovery Pro 5000 Series Specifications

These specifications are typical unless otherwise stated and are valid following 30 minutes of warm-up at 25 °C unless otherwise noted. Warranted specifications are valid at T<sub>cal</sub> ±5 °C. Temperature coefficients are calculated using the temperature change from the last external calibration.

Specifications not assigned to an individual device are valid for all Analog Discovery Pro 5000 Series devices.

## 4.1 Mixed Signal Oscilloscope

### Analog Input Channels

Supports the Oscilloscope, Voltmeter, Data Logger, Spectrum Analyzer, Network Analyzer, Impedance Analyzer, and Script Editor instruments.

#### Vertical System

	ADP5470	ADP5490
<b>Number of Channels</b>	Four	Four
<b>Input Type</b>	Single-ended, non-isolated	
<b>Connector Type</b>	Front Panel BNC	
<b>Hardware Input Range<sup>1</sup></b>	10 mV / div 20 mV / div 40 mV / div 100 mV / div 200 mV / div 400 mV / div 1 V / div 2 V / div 4 V / div	4 mV / div 10 mV / div 20 mV / div 40 mV / div 100 mV / div 200 mV / div 400 mV / div 1 V / div 2 V / div 4 V / div
<b>Resolution</b>	8 bits	
<b>Absolute Resolution</b>	up to 0.391 mV (at 10 mV/div range)	up to 0.156 mV (at 4 mV/div range)
<b>Accuracy (warranted)</b>	±2% of input ±1% full scale (V peak to peak)	
<b>Bandwidth (-3 dB)<sup>2</sup></b>	350 MHz	500 MHz
<b>Hardware Bandwidth Limit (-3 dB)</b>	20 MHz, can be enabled or disabled in software per channel	
<b>Input Impedance</b>	1 MΩ     15 pF or 50 Ω <sup>3</sup>	1 MΩ     12 pF or 50 Ω <sup>3</sup>
<b>Input Coupling</b>	DC or AC	
<b>Vertical Sensitivity (range)</b>	200 μV/div to 4 V/div (10 divisions) <sup>4</sup>	
<b>Acquisition Modes</b>	Average, decimate, min/max	

#### DC Offset Range

Range	Full Scale	Programmable Offset Range
Low range (≤40 mV/div)	10 V peak-to-peak	±5 V
High range (≥100 mV/div)	40 V peak-to-peak	±20 V

<sup>1</sup> There are 10 divisions for each hardware input range. Divisions in this context are the ten horizontal strips in the Analog Input graph windows within WaveForms. The hardware input range of value / div specifies the height of one strip in the plot.

<sup>2</sup> When using a probe with the appropriate frequency response.

<sup>3</sup> Maximum voltage when using 50 Ω input mode is 5 V RMS. For a periodic waveform with frequency below 100 kHz, the maximum voltage is derated to 2.5 V RMS.

<sup>4</sup> Divisions in this context are the ten horizontal strips in the Analog Input graph windows within WaveForms. Vertical sensitivity specifies the height of one strip in the plot.

## Horizontal System

	ADP5470	ADP5490
Maximum Sample Rate	1.5 GS/s per channel	2 GS/s per channel
Maximum Record Length	1 M Samples per channel	

**Note:** Acquisitions are made simultaneously on all enabled channels in all modes.

## Digital Input Channels

Supports the Logic Analyzer and Script Editor instruments.

### Vertical System

Number of Channels	34
Connector	100 mil 2×20 MTE Header
Input Voltage	0 V to 5 V <sup>1</sup>
Input Current	≤50 μA
Input Threshold	Adjustable, 0 V to 2 V
Threshold Accuracy	350 mV
Input Impedance	100 kΩ    7.5 pF (nominal) pulled to -2.0 V to +6.5 V, varies with the input threshold setting
Logic Analyzer Interpreters	SPI, I2C, UART, CAN, I2S, 1-Wire, PS/2, HDMI CEC, Manchester codes, JTAG, GPIB, SWD, custom, and more

### Horizontal System

Maximum Sampling Rate (warranted)	1 GS/s (down to ~15 kS/s) per channel
Record Length (Typical)	1 million Samples per channel
Record Length (Minimum) <sup>2</sup>	4 kS

**Note:** Memory sizes, including buffer sizes, specified in units like kS and MS, are rounded from equivalent binary power units, such as MiS. For example, a listed 64 MS is rounded from 64 MiS, which is 67,108,864 samples.

<sup>1</sup> Mixed signal oscilloscope digital channels are designed to withstand accidental overvoltage from signals on both Analog Discovery Pro 5000 Series devices. They are not recommended for use with signals likely to exceed 0 V to 5 V in normal operation.

<sup>2</sup> Under most conditions, the logic analyzer can acquire 1 MS of data. Under some conditions with very high sustained activity on multiple inputs, the logic analyzer may only capture 4 kS of data.

## 4.2 Arbitrary Waveform Generator (Wavegen)

Supports the Waveform Generator, Network Analyzer, Impedance Analyzer, and Script Editor instruments.

### Vertical System

	ADP5470	ADP5490
Number of Channels	One	
Output Type	Single-ended	
Connector Type	BNC	
Standard Functions	Sine, square, triangle, pulse, ramp, DC voltage, noise, others	
Output Voltage Range <sup>1</sup>	±6 V at 50 Ω output impedance ±12 V at high (>10 kΩ) output impedance <sup>2</sup>	
Resolution	14 bits	
Absolute Resolution	0.732 mV at 50 Ω output impedance 1.46 mV at high (>10 kΩ) output impedance <sup>2</sup>	
Accuracy	±(1% of output value ± 5 mV) <sup>3</sup>	
Output Impedance	50 Ω	
Bandwidth <sup>4</sup>	±0.3 dB to 20 MHz	±0.3 dB to 40 MHz
Total Harmonic Distortion (1 MHz)	-55 dBC	
Total Harmonic Distortion (10 MHz)	-50 dBC	
Phase Noise	-125 dBC/Hz at 10 kHz offset	
Rise/fall time	<20 ns (10% to 90%)	
Overshoot	<5% <sup>5</sup>	
Jitter	8 ns cycle-to-cycle	
Overvoltage Protection	Short-circuit protected	
Custom Waveform Files Supported	Import files *.csv, *.txt, *.mp3, *.wav, *.wmv & *.avi, export as image, or as raw data in *.csv, *.txt or *.tdms formats	

### DC Offset Range

Output Impedance	Offset Range <sup>1</sup>
50 Ω	±6 V
High (>10 kΩ) output impedance <sup>2</sup>	±12 V

### Horizontal System

	ADP5470	ADP5490
Maximum Sample Rate	125 MS/s	200 MS/s
Buffer Size	Up to 1 million samples	

<sup>1</sup> The combination of signal amplitude and DC offset cannot exceed the output range specifications.

<sup>2</sup> The high output impedance is a load applied by the user to the AWG output.

<sup>3</sup> Into a >10 kΩ load applied by the user

<sup>4</sup> When using a connection with the appropriate frequency response.

<sup>5</sup> At 5 MHz and slower Square wave

## 4.3 Digital I/O

Supports the Static I/O and Protocol instruments.

### Digital I/O Channels

<b>Number of Channels</b>	Eight
<b>Connector</b>	1x14 Terminal Block
<b>Function Control</b>	Individually programmable as Digital I/O
<b>Input Voltage</b>	0 V to 5 V TTL <sup>1</sup>
<b>Output Voltage</b>	3.3 V LVTTTL
<b>Drive Strength</b>	4 mA
<b>Pull Resistors</b>	10 kΩ pull-down to 0 V for all I/O pins 1.5 kΩ pull-up to 3.3 V on I/O 6 and 7 when I2C is used

### External Power

<b>Number of Channels</b>	One
<b>Connector</b>	1x14 Terminal block
<b>Voltage</b>	3.3 V ± 10%
<b>Current</b>	20 mA

## 4.4 Trigger System

### Trigger Features

	ADP5470	ADP5490
<b>System Trigger Sources</b>	Oscilloscope analog channels, Oscilloscope digital channels, Arbitrary waveform generator start, External trigger (TRIG1), Power line frequency, Manual	
<b>Trigger Modes</b>	None, Auto, Normal, Manual (Forced Trigger), Single	
<b>Analog Trigger</b>	Edge, pulse, hysteresis	
<b>Digital Trigger</b>	Edge, level, pattern, glitch	
<b>Analog/Oscilloscope Trigger Resolution</b>	667 ps	500 ps
<b>Digital/Logic Analyzer Trigger Resolution</b>	1 ns	
<b>Wavegen Output Trigger Resolution</b>	8 ns	5 ns
<b>Output Trigger Sources</b>	Oscilloscope Start, Waveform Generator Start, Power line frequency, Drive low, Drive high	

<sup>1</sup> Digital I/O channels are designed to withstand accidental overvoltage from digital signals on Digiilent's Test and Measurement boards or similar devices. They are not recommended for use with signals likely to exceed 0 V to 5 V in normal operation.

## External Trigger (TRIG1) Characteristics

Trigger 1 can be used as a trigger input or output for multiple instruments.

Number of Channels	One
Trigger Type	Digital
Connector	Front Panel BNC
Input Voltage	5 V compatible TTL <sup>1</sup>
Output Voltage	3.3 V LVTTTL output
Channel Pull Resistors	1 M $\Omega$ pull-down
Direction Control	Programmable as input or output

## 4.5 Digital Multimeter

### Functionality

Functions	DC Voltage, AC Voltage, DC current, AC current, resistance, diode, continuity
Resolution	5½ digits
Sample Rate	5 S/s


**Caution:** Do not use this device for connection to signals or for measurements within Measurement Categories III or IV. For more information about Measurement Categories, refer to the [Safety Voltages](#) section.

### Input Protection

Resistance, Diode	Up to 300 V DC
DC and AC Voltage	Up to 300 V DC or 265 V AC RMS, 400 V AC (peak)
DMM A Current Connector Fuse <sup>2,3</sup>	Internal ceramic fuse, 11 A, 1 kV AC, 10.3 × 38 mm, F 11A 1000V (SIBA part number 5019906.11 at <a href="http://www.siba-fuses.com/">http://www.siba-fuses.com/</a> )
DMM mA Current Connector Fuse <sup>2,3</sup>	Internal ceramic fuse, 1 A, 500 V AC, 5 × 20 mm, T 1A H 400V (Littelfuse part number 0477001.MXP at <a href="http://www.littelfuse.com">http://www.littelfuse.com</a> )
Maximum common-mode voltage	300 V DC or AC (rms)

<sup>1</sup> The external trigger line is designed to withstand accidental overvoltage from digital signals on Digilent's Test and Measurement boards or similar devices. They are not recommended for use with signals likely to exceed 0 V to 5 V in normal operation.

<sup>2</sup> Fuses are located on bottom of device underneath door. Use Phillips #1 screwdriver for removal. Ensure all hazardous voltages are disconnected from the device prior to removal of door.

<sup>3</sup> When the fuse symbol, , is marked on a device, take proper precautions.

## DC

## DC Voltage Accuracy

Range	Input Impedance	1-Year Accuracy $\pm$ (% of Reading + % of Range) (warranted)	Temperature Coefficient $\pm$ (% of Reading + % of Range)/C° (warranted)
100 mV <sup>1</sup>	<10 G $\Omega$ , 10 M $\Omega$	0.015 + 0.005	0.001 + 0.0005
1 V	<10 G $\Omega$ , 10 M $\Omega$	0.015 + 0.005	0.001 + 0.0005
10 V	<10 G $\Omega$ , 10 M $\Omega$	0.015 + 0.005	0.001 + 0.0005
100 V	10 M $\Omega$	0.035 + 0.005	0.005 + 0.0005
300 V	10 M $\Omega$	0.035 + 0.005	0.005 + 0.0005

## DC Current Accuracy

Range	Burden Voltage	1-Year Accuracy $\pm$ (% of Reading + % of Range) (warranted)	Temperature Coefficient $\pm$ (% of Reading + % of Range)/C° (warranted)
10 mA	<0.03 V	0.070 + 0.020	0.0035 + 0.0010
100 mA	<0.3 V	0.070 + 0.003	0.0020 + 0.0010
1 A	<0.03 V	0.130 + 0.025	0.0065 + 0.0010
10 A <sup>2</sup>	<0.3 V	0.130 + 0.004	0.0045 + 0.0010

## DC Resistance Accuracy (2-Wire), 1 V Open Circuit Voltage

Range	Short-Circuit Current	1-Year Accuracy $\pm$ (% of Reading + % of Range) <sup>3</sup> (warranted)	Temperature Coefficient $\pm$ (% of Reading + % of Range)/C° (warranted)
100 $\Omega$	170 $\mu$ A	0.018 + 0.050	0.0010 + 0.0005
1 k $\Omega$	170 $\mu$ A	0.018 + 0.005	0.0010 + 0.0005
10 k $\Omega$	70 $\mu$ A	0.018 + 0.005	0.0010 + 0.0005
100 k $\Omega$	10 $\mu$ A	0.018 + 0.005	0.0010 + 0.0005
1 M $\Omega$	1.1 $\mu$ A	0.035 + 0.005	0.0040 + 0.0005
10 M $\Omega$	1.1 $\mu$ A	0.150 + 0.005	0.0100 + 0.0005
100 M $\Omega$	1.1 $\mu$ A	0.150 + 0.005	0.1000 + 0.0005

**Caution:** The input terminals of the DMM are not protected for electromagnetic interference. As a result, the DMM may experience reduced measurement accuracy or other temporary performance degradation when connected to unshielded test leads in an environment with radiated or conducted radio frequency electromagnetic interference.

<sup>1</sup> Add 15  $\mu$ V if not immediately following offset null.

<sup>2</sup> 30 seconds on, 30 seconds off. Add 300 ppm for currents >2.2 A. After measuring >5 A, wait two minutes to get full accuracy in the 1 A range.

<sup>3</sup> Perform offset nulling for these values.

## Additional DC Characteristics

DC Continuity Accuracy Range	100 $\Omega$
DC Diode Test Range	2 V
Effective Common-Mode Rejection-Mode Ratio (CMRR), 1 k $\Omega$ resistance in LO lead	>100 dB
Normal-Mode Rejection Ratio (NMRR), 50/60 Hz $\pm$ 0.1%	>100 dB
Overrange	105% of range except 300 V

## AC

### AC Voltage Accuracy

Range (rms)	Peak Voltage	Frequency	1-Year Accuracy $\pm$ (% of Reading + % of Range) (warranted)	Temperature Coefficient $\pm$ (% of Reading + % of Range)/C $^{\circ}$ (warranted)
100 mV, 1 V, 10 V, 100 V, 265 V	$\pm$ 210 mV, $\pm$ 2.1 V, $\pm$ 21 V, $\pm$ 210 V, $\pm$ 400 V	20 Hz to 45 Hz	0.91 + 0.10	0.01 + 0.005
		45 Hz to 65 Hz	0.30 + 0.05	0.01 + 0.005
		65 Hz to 1 kHz	0.21 + 0.05	0.01 + 0.005
		1 kHz to 5 kHz	0.12 + 0.05	0.01 + 0.005
		5 kHz to 20 kHz	0.35 + 0.05	0.01 + 0.005

### AC Current Accuracy

Range (rms)	Short-Circuit Current	Burden Voltage (rms)	Frequency	1-Year Accuracy $\pm$ (% of Reading + % of Range) (warranted)	Temperature Coefficient $\pm$ (% of Reading + % of Range)/C $^{\circ}$ (warranted)
5 mA	$\pm$ 10.5 mA	<0.02	20 Hz to 1 kHz	0.20 + 0.01	0.01 + 0.005
5 mA	$\pm$ 10.5 mA	<0.02	1 kHz to 5 kHz	0.60 + 0.01	0.01 + 0.005
50 mA	$\pm$ 105 mA	<0.2 V	20 Hz to 1 kHz	0.20 + 0.01	0.01 + 0.005
50 mA	$\pm$ 105 mA	<0.2 V	1 kHz to 5 kHz	0.50 + 0.01	0.01 + 0.005
500 mA	$\pm$ 1.05 A	<0.02 V	20 Hz to 1 kHz	0.15 + 0.01	0.01 + 0.005
500 mA	$\pm$ 1.05 A	<0.02 V	1 kHz to 5 kHz	0.50 + 0.01	0.01 + 0.005
5 A	$\pm$ 1.05 A	<0.02 V	20 Hz to 1 kHz	0.25 + 0.03	0.01 + 0.005
5 A	$\pm$ 1.05 A	<0.02 V	1 kHz to 5 kHz	0.60 + 0.03	0.01 + 0.005

**Caution:** The input terminals of the DMM are not protected for electromagnetic interference. As a result, the DMM may experience reduced measurement accuracy or other temporary performance degradation when connected to unshielded test leads in an environment with radiated or conducted radio frequency electromagnetic interference.

## Additional AC Characteristics

<b>Input Impedance</b>	10 MΩ    200 pF
<b>Effective Common-Mode Rejection-Mode Ratio (CMRR), 1 kΩ resistance in LO lead</b>	>70 dB (DC to Hz)

## 4.6 Programmable Power Supply

	+6 V	+25 V	-25 V
<b>DC Voltage Output (warranted)</b>	0 V to +6 V	0 V to +25 V	0 V to -25 V
<b>DC Current Output (warranted)<sup>1,2</sup></b>	3 A	1 A (isolated)	1 A (isolated)
<b>Voltage Programming Accuracy<sup>3</sup>, ±(% of reading + offset) (warranted)</b>	0.1% + 5 mV	0.1% + 20 mV	0.1% + 20 mV
<b>Current Programming Accuracy<sup>1,3</sup>, ±(% of reading + offset) (warranted)</b>	0.2% + 10 mA	0.15% + 4 mA	0.15% + 4 mA
<b>Voltage Readback Accuracy<sup>3</sup>, ±(% of reading + offset) (warranted)</b>	0.1% + 5 mV	0.1% + 20 mV	0.1% + 20 mV
<b>Current Readback Accuracy<sup>3</sup>, ±(% of reading + offset) (warranted)</b>	0.2% + 10 mA	0.15% + 4 mA	0.15% + 4 mA
<b>Voltage Programming Resolution</b>	1.6 mV	6.6 mV	6.6 mV
<b>Current Programming Resolution</b>	0.90 mA	0.30 mA	0.30 mA
<b>Voltage Readback Resolution</b>	0.40 mV	1.7 mV	1.7 mV
<b>Current Readback Resolution</b>	210 μA	70 μA	70 μA
<b>Load Regulation<sup>4</sup> ±(% of reading + offset)</b>	0.01% + 25 mV	0.03% + 5 mV	0.03% + 5 mV
<b>Overvoltage Protection</b>	30 V		
<b>Reverse Voltage Protection</b>	Reverse clamp diode, protected by self-resetting fuse		
<b>Connector Type</b>	1×6 Pluggable Screw Terminal Block		

<sup>1</sup> Minimum programmable current limit is 1% of range.

<sup>2</sup> The +25 V and -25 V channels are bank isolated from ground but not from each other.

<sup>3</sup> Programming and readback accuracy specified at no load.

<sup>4</sup> Change in output voltage for any load within range.

## 4.7 Device Configurations

The Analog Discovery Pro 5000 Series devices each have a single device configuration.

Configuration	Scope Buffer Size	Wavegen Buffer Size	Logic Buffer Size
1	One million points per channel	64 kS for each channel, one million point buffer when used in play mode	One million samples aggregate

**Note:** Memory sizes, including buffer sizes, specified in units like kS and MS, are rounded from equivalent binary power units, such as MiS. For example, a listed 64 MS is rounded from 64 MiS, which is 67,108,864 samples.

## 4.8 Additional Features

### Spectrum Analyzer

	ADP5470	ADP5490
Frequency Range <sup>1</sup>	0 Hz to 350 MHz, up to 10 001 samples	0 Hz to 500 MHz, up to 10 001 samples
Display Modes	Magnitude, average, peak hold, min hold, count, and more	
Y Axis	Peak (V), $\tilde{V}/\sqrt{\text{Hz}}$ , dB $\tilde{V}$ , dBu, dBm, dBFS, and more	
X Axis	Linear or Logarithmic	
Power Spectrum Algorithms	FFT, CZT	
Windowing Functions	Rectangular, Triangular, Hamming, Hann, Cosine, Blackman-Harris, Flat Top, Kaiser	

### Network Analyzer

	ADP5470	ADP5490
Frequency Range <sup>2</sup>	10 Hz to 350 MHz, up to 10 001 samples	10 Hz to 500 MHz, up to 10 001 samples
Display Modes	Magnitude, Phase	
Y Axis	Linear or Logarithmic, dB, gain, $V_{\text{peak}}$ , and more magnitude representations	
X Axis	Linear or Logarithmic	
Plots	Bode, Time, FFT, Nichols, Nyquist	

<sup>1</sup> Higher frequencies may be selected within WaveForms, but results may be limited by the analog input bandwidth of the hardware.

<sup>2</sup> Higher frequencies may be selected within WaveForms, but results may be limited by the analog input and output bandwidth of the hardware.

## Impedance Analyzer

	ADP5470	ADP5490
Frequency Range	10 Hz to 20 MHz, up to 10 001 samples	10 Hz to 40 MHz, up to 10 001 samples
Display Modes	Magnitude, Phase	
Y Axis	Linear or Logarithmic	
X Axis	Linear or Logarithmic	
Plots	Bode, Time, FFT, Nichols, Nyquist, Custom	
Measurements	Impedance, Admittance, Inductance, Capacitance, and more	

## Protocol Analyzer

Shares digital input/output channels with the Static I/O instrument. See [Digital I/O](#) for electrical characteristics.

Protocols <sup>1</sup>	SPI and I2C, host controller mode and custom only
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## Math Channels

Operations	Addition "+", Subtraction "-", Multiplication "*", Division "/", Remainder "%"
Brackets	Parenthesis "()", Square "[]"
Constants	Exp, Ln, Log, Pi
Functions	Logarithm, power, minimum, maximum, square root, sine, cos, tan, arccos, arctan, arctan2, absolute value, floor, ceiling, and more
Operands	All analog and digital input channels, reference waveforms, time, constants, Pi, and more
Custom Software Channels	Butterworth, Chebyshev, Lock-In Amplifier

## 4.9 Connectivity

### USB Interface

Device to Computer Interface	USB 2.0 Hi-Speed, Type B
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### Ethernet Interface

Network Interface	1000 Base-TX, full-duplex 100 Base-TX, full-duplex 100 Base-TX, half-duplex 10 Base-T, full-duplex 10 Base-T, half-duplex
Communication Rates	10/100/1000 Mbps, auto-negotiated
Connector Type	RJ-45

**Note:** The MAC address of the Ethernet port is listed on the sticker located on the underside of the device.

<sup>1</sup> This functionality is implemented by WaveForms software on the host system.

## 4.10 Power Requirements

The ADP5000 Series devices require external power.

<b>Voltage Input Range</b>	120 V <sub>AC</sub> to 240 V <sub>AC</sub> , 50/60 Hz
<b>Power Consumption</b>	150 W maximum
<b>Power Input Connector</b>	IEC C13 power connector
<b>Power Disconnect</b>	The AC power cable provides main power disconnect. Do not position the equipment so that it is difficult to disconnect the power cable. Depressing the front panel power button does not inhibit the internal power supply.

## 4.11 Physical Characteristics

### Dimensions

<b>Dimensions (Width x Depth x Height)</b>	30.48 cm × 20.32 cm × 9.40 cm (12.0 in. × 8.0 in. × 3.7 in.)
<b>Weight</b>	3.130 kg (6 lb 4.4 oz)

**Note:** If the device needs to be cleaned, wipe with a dry towel.

**Note:** Use the ADP5000 devices in a horizontal orientation. Allow at least 10.16 cm (4.0 in.) of clearance in front and behind the device for USB, power, and common connector cabling.

### Physical Connectivity

<b>Mixed Signal Oscilloscope</b>	Four BNC
<b>Logic Analyzer</b>	One 2x20 shrouded IDC header
<b>External Trigger</b>	One BNC
<b>Arbitrary Waveform Generator</b>	One BNC
<b>Digital I/O Connector Type</b>	One Pluggable Screw Terminal, 3.5 mm (14 position)
<b>Digital I/O Screw Terminal Wiring</b>	0.1 mm <sup>2</sup> to 2.0 mm <sup>2</sup> (30 AWG to 14 AWG)
<b>Digital IO Screw Terminal Torque</b>	0.25 N · m (2.2 lb · in.)
<b>Digital Multimeter</b>	Four 4 mm banana jacks
<b>DC Power Supply Connector Type</b>	Six 4 mm binding posts
<b>DC Power Supply Screw Terminal Wiring</b>	N/A
<b>DC Power Supply Screw Terminal Torque</b>	N/A
<b>Security Cable Slot</b>	1, complies with Kensington security slot dimensions

## 4.12 Safety Voltages

Connect only voltages that are within these limits.

### Digital Multimeter Isolation Voltages (Ground to Earth)



**Hazardous Voltage:** This icon denotes a warning advising you to take precautions to avoid electrical shock.

#### Channel-to-earth Ground

<b>Continuous</b>	300 V, Measurement Category II <sup>1</sup>
<b>Withstand</b>	3000 V (RMS), verified by a 5 s dielectric withstand test

**Caution:** Do not connect the ADP5000 Series hardware to signals or use for measurements within Measurement Categories III or IV.

### DC Power Supply Isolation Voltages

<b>+25 V and -25 V to earth ground, continuous</b>	60 V <sub>DC</sub> , Measurement Category I <sup>2</sup>
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## 4.13 Environmental

<b>Ambient Operating Temperature</b>	0 °C to 40 °C (32 °F to 104 °F)
<b>Storage Temperature</b>	-20 °C to 70 °C (-4 °F to 158 °F)
<b>Operating Humidity</b>	10% to 90% RH non-condensing DMM full accuracy at 10% to 80%
<b>Storage Humidity</b>	5% to 95% RH non-condensing
<b>Cooling</b>	Forced air circulation (positive pressurization) through a fan. Fan speed automatically adjusts according to operating conditions. Intake and exhaust locations are on the sides and rear of device. Ensure that the intake and exhaust locations are not obstructed.
<b>Pollution Degree</b>	2
<b>Maximum Altitude</b>	2000 m

**Note:** For indoor use only.

<sup>1</sup> Measurement Category II is for measurements performed on circuits directly connected to the electrical distribution system. This category refers to local-level electrical distribution, such as that provided by a standard wall outlet, for example, 115 V for U.S. or 230 V for Europe.

<sup>2</sup> Measurement Categories CAT I and CAT O (Other) are equivalent. The input circuits are not intended for direct connection to the MAINS building installations of Categories CAT II, CAT III, or CAT IV.

## Shock and Vibration:

<b>Operational Shock</b>	30 g peak, half sine, 11 ns pulse (Tested in accordance with IEC 60068-2-27. Test profile developed in accordance with MIL-PRF-28800F.)
<b>Random Vibration (Operating)</b>	5 Hz to 500 Hz, 0.3 g <sub>rms</sub>
<b>Random Vibration (Non-operating)</b>	5 Hz to 500 Hz, 2.4 g <sub>rms</sub> (Tested in accordance with IEC 60068-64. Nonoperating test profile exceeds the requirements of MIL-PRF-28800F, Class 3.)

## 4.14 Certifications

- [Analog Discovery Pro \(ADP5470\) Declaration of Conformity](#)
- [Analog Discovery Pro \(ADP5490\) Declaration of Conformity](#)

## 5 Ordering Information and Purchasing Options



### Digilent Part Numbers:

- 411-002 – Analog Discovery Pro (ADP5470) Kit:
  - One (1) ADP5470
  - Four (4) T2500 500 MHz x1/x10 Oscilloscope Probes
  - One (1) Digilent Screwdriver
  - Additional components, listed below
- 411-003 – Analog Discovery Pro (ADP5490) Kit:
  - One (1) ADP5490
  - Four (4) T2500 500 MHz x1/x10 Oscilloscope Probes
  - One (1) Digilent Screwdriver
  - Additional components, listed below

All Analog Discovery Pro 5000 Series product kits come with:

- One (1) USB A to B cable
- One (1) 2x20 Logic Analyzer MTE Cable
- One (1) Set of Red and Black DMM Probes
- One (1) 1x14 Digital I/O Screw Terminal Adapter
- One (1) US IEC Cable, with EU and UK adapters

## 6 Recommended Accessories

Digilent Part Number: 240-136 – [BNC to Minigrabber Cable](#)

Digilent Part Number: 240-134 – [BNC to Alligator Clip Cable](#)

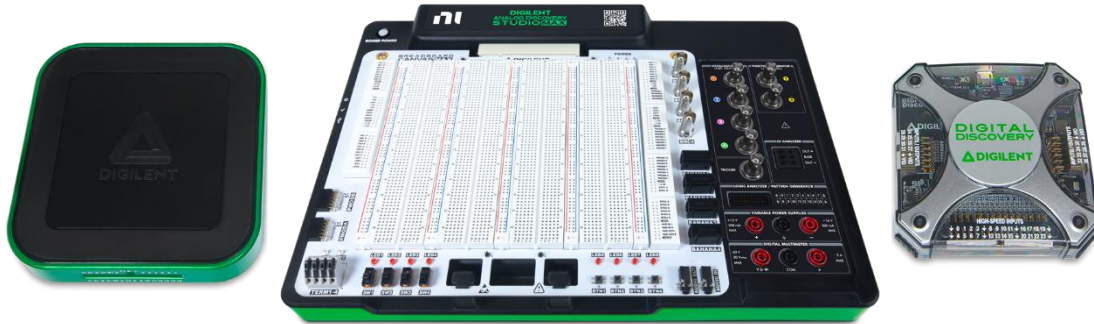
Use of these BNC cables is recommended for analog output. BNC Oscilloscope Probes should not be used with the AWG.

Banana cables for the ADP5470 and ADP5490 power supplies are not included.

## 7 Additional Resources

Reference material for all of the Analog Discovery Pro 5000 Series devices including a getting started guide, reference manual, specifications, and tutorials on each of the instruments within WaveForms can be found on the [Analog Discovery Pro 5000 Series' Resource Center](#) on Digilent's Reference site.

## 8 The Essential Instruments Family



Digilent's Essential Instruments family is perfect for engineers looking for a low barrier to entry while broadening their expertise with Test and Measurement equipment. These devices are cost-optimized for students and engineers alike, provide maximum value for minimal cost. From the Digital Discovery, a dedicated workhorse for debugging digital interfaces, to the Analog Discovery Studio Max, an all-in-one electronics laboratory, to the legendary Analog Discovery 3, in conjunction with Digilent's freely available WaveForms software, each device provides a solid foundation for any engineer who needs to test or debug their projects.

### Analog Discovery 3

The Analog Discovery 3 is a multi-function test and measurement device, providing a digital oscilloscope, logic analyzer, waveform generator, pattern generator, and much more – all in a device that fits in the palm of your hand. Building on the foundation set by the Analog Discovery 2, the Analog Discovery 3 offers a faster and flexible sampling rate, double the memory buffer, and more robust power supplies. Using the flexible WaveForms software (supported by Windows, Mac, and Linux), the Analog Discovery 3 can be used in the lab, in the field, or even at home - you're no longer tied down to a traditional benchtop and stacks of expensive test instruments.

### Digital Discovery

The Digital Discovery is a combination USB logic analyzer and pattern generator, featuring 24 high-speed digital inputs and 16 digital I/O channels. With a high-speed adapter, the device can sample up to 800 MS/s on up to 8 input channels. Sampling up to 100 MS/s is supported on all channels. DDR memory offers deep input buffers, with 64 MS of input buffer per high-speed input channel.

### Analog Discovery Studio Max

The Analog Discovery Studio is versatile and comprehensive electronics laboratory solution tailored for academic environment, integrating everything from a digital multimeter to spectrum analyzer and protocol generator to power supplies all in a single device. It also featuring removable Canvas modules – A modular ecosystem of top boards that let you customize the Analog Discovery Studio Max platform for your learning environment, from both Digilent and our partners around the globe. The accessibility is expanded even further beyond the WaveForms software with the LabVIEW WaveForms Toolkit to leverage LabVIEW's extensive analysis tools.

## 9 Analog Discovery Pro Line



Digilent's Analog Discovery Pro line is for users who are ready to go pro. With expanded feature sets not offered in Digilent's Test and Measurement Essentials line including deep memory, higher bandwidth, networking capability, and USB 3.0, an Analog Discovery Pro device has already stepped up to the challenging task ahead of you.

Devices in the Analog Discovery Pro family provide the utility of professional benchtop equipment with the flexibility of a portable instrument. The series includes mixed signal oscilloscope and programmable power supply instruments that give engineers the ability to tap into the efficiency of the WaveForms software while offering a wider selection of specifications in products created with the professional in mind. Other members of the Analog Discovery Pro family include:

### Analog Discovery Pro 2000 Series

- Mixed signal oscilloscope
- BNC connectors and an aluminum case
- Two analog inputs – 50+ MHz bandwidth
- One analog output – 15 MHz bandwidth
- 16 Digital I/O
- Sample rates up to 125 MS/s
- Two programmable power supply outputs
- Deep memory buffers for long acquisitions – up to 128 MS per channel for analog input
- USB 3.0 connectivity
- Dual Mode for synchronization of multiple devices

### Analog Discovery Pro 3000 Series

- Mixed signal oscilloscope
- Two or four analog inputs, two analog outputs
- 0.5 GS/s sample rate (with oversampling), per channel
- 55+ MHz bandwidth
- 16 Digital I/O
- Ethernet connectivity
- Linux Mode

## Discovery USB Programmable Power Supply (DPS3340)

- USB programmable power supply
- Three channels
- 1 V to 5 V, -1 V to -15 V, 1 V to 15 V

## 10 About Digiilent

We're committed to making engineering accessible, offering competitive pricing, portable products, and comprehensive documentation. With a global presence spanning three continents, Digiilent ensures speedy and cost-effective access to our products through an extensive distribution network. Specializing in USB-based test and measurement devices, flexible and intuitive software, low-cost data acquisition and data logging tools, and AMD-based FPGA development boards, our products' design philosophy champions your creativity. By providing world class documentation and support and keeping our hardware and software flexible and practical, we are continuing to provide the building blocks while you bring the brilliance.