Analog Discovery Pro (ADP2230) Specifications

These specifications are typical unless otherwise stated and are valid following 30 minutes of warm-up at 25 °C unless otherwise noted. WaveForms was used to determine these specifications.

Mixed Signal Oscilloscope

Analog Input Channels

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

Vertical System

Number of Channels	Two
Input Type	Single-ended
Connector Type	BNC
Input Range	±2.5 V with respect to ground (5 V peak-to-peak) ±25 V with respect to ground (50 V peak-to-peak)
Resolution	14 bits (16-bit with averaging), 14-bit noise[1]
Absolute Resolution[2]	0.336 mV (scale ≤ 0.5 V/div) 3.36 mV (scale > 0.5 V/div)
Accuracy	±10 mV ± 0.5% (scale ≤ 0.5 V/div, V_{inCM} = 0 V) ±100 mV ± 0.5% (scale > 0.5 V/div, V_{inCM} = 0 V)
Bandwidth	50+ MHz @ -3 dB[3]
Input Impedance	1 MΩ ‖ 24 pF
Input Coupling	DC or AC
Vertical Sensitivity (range)	200 µV/div to 5 V/div (10 divisions)[4]
Acquisition Modes	average, decimate, min/max, full scale, record[5]

Additional Channels	On-device FIR and IIR filters for both inputs[6], on-device loopback for Wavegen and Supplies outputs
Overvoltage Protection	±50 V_{DC} or ±30 V_{RMS}

DC Offset Range

Range	Full Scale	Offset	Offset Accuracy
Low range (≤0.5 V/div)	5 V peak-to-peak	±2.5 V	±10 mV ±0.5%
High range (>0.5 V/div)	50 V peak-to-peak	±25 V	±100 mV ±0.5%

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1) A separate small buffer to collect maximum and minimum samples when the sample rate is slower than the system frequency and is represented within WaveForms as noise.
2) Ideal values based on hardware design ranges of 5.5 V and 55 V. Actual values may vary slightly due to component variations and are accounted for during factory calibration. WaveForms only exposes nominal ranges of 5 V and 50 V.
3) When using a probe with the appropriate frequency response.
4) 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.
5) Up to 10 MHz () for single channel acquisition.
6) The FIR filter supports up to 16 coefficients. The IIR filter uses a 2x2x5 structure and can implement either $2^{nd}/4^{th}$ order low or high pass or $4^{th}/8^{th}$ order band pass/stop filters

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Horizontal System

Maximum Sample Rate	125 MS/s () per channel
Fine System Frequency Adjustment	50 MHz to 125 MHz[1]
Buffer Size	Up to 128 MS[2] per channel in the default configuration.[3][4]
Noise Buffer	1,024 samples[5]

For longer acquisitions, Record mode allows streaming acquisition data into host computer RAM () (up to 200 MS) or to a file on the host computer disk (theoretically unlimited) at potentially reduced rates. Achievable sample rates and recording lengths depend on various factors, including host computer specifications and USB activity.

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.

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1) Adjustable through the WaveForms Device Options. Shared with the Analog Output and Digital I/O.
2) Up to 200 MS when a single channel is used.
3) Buffer size is limited to 32,768 samples when supplied power is insufficient to run DDR memory.

4) Different preset buffer sizes can be chosen based on device configuration within the WaveForms Device Manager. See the Device Configurations section of this document for more info.
5) In DDR configurations. 2,048 samples in BRAM configuration. See the Device Configurations section of this document for more info.

Digital Channels

Supports the Logic Analyzer, Pattern Generator, Static I/O, Protocol Analyzer, Oscilloscope, and Script Editor instruments.

Vertical System

Number of Channels	16
Connector	100 mil 2×16 MTE Header
Function Control	Individually programmable as Digital I/O, Logic Analyzer, Pattern Generator, or Protocol
Input Voltage	0 V to 3.3 V (5 V tolerant)
Input Type	LVCMOS (3.3 V, 5 V tolerant)
Input Logic Level	Input Low Voltage, VIL, Min 0 V, Max 0.8 V Input High Voltage, VIH, Min 2.0 V, Max 5 V
Output Type	LVCMOS (3.3 V)
Output Logic Level	Output Low Voltage, VOL, Min 0 V, Max 0.5 V Output High Voltage, VOH, Min 2.4 V, Max 3.3 V
Slew Rate	Slow (default), Fast[1]
Drive Strength	4, 8 (default), 12, or 16 mA[2]
Configurable Pull Resistors	None (default), pull-up, pull-down, or keeper[3]
Hardware Pull Resistors	1 MΩ pull-down resistors
Logic Analyzer Interpreters	SPI, I2C, UART, CAN, I2S, 1-Wire, PS/2, HDMI CEC, Manchester codes, JTAG, GPIB, SWD, custom[4]
Pattern Generator	Constant, clock, pulse, random, number, Binary counter, Gray counter, Johnson counter, Decimal counter, walking 0/1, ROM Logic, custom[5]
Custom Patterns File	Import and export custom data as *.csv, *.txt or *.tdms file
Channel-to-Channel Skew	2 ns, typical

Overvoltage Protection	Short-circuit to ground, ±20 V

[1], [2] Configurable within WaveForms. Selected setting shared with all DIOs and Trigger IOs.
[3] Internal to the FPGA and configurable within WaveForms. Selected setting shared with all DIOs and Trigger IOs.
[4], [5] More options may be available in the latest version of the WaveForms software.

Horizontal System

Maximum Sampling Rate	125 MS/s () per channel
Fine System Frequency Adjustment	50 MHz () to 125 MHz ()[1]
Logic Analyzer Buffer Memory	Up to 128 MS per channel [2][3]
Pattern Generator Buffer Memory	Up to 32,768 samples per channel[4]

For longer acquisitions, Record mode allows streaming acquisition data into host computer RAM () (up to 200 MS) or to a file on the host computer disk (theoretically unlimited) at potentially reduced rates. Achievable sample rates and recording lengths depend on various factors, including host computer specifications and USB activity.

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.

[1] Adjustable through the WaveForms Device Options. Shared with Analog Inputs, Analog Output.
[2] Buffer size is limited to 16,384 samples when supplied power is insufficient to run DDR memory.
[3], [4] Different preset buffer sizes can be chosen based on device configuration within the WaveForms Device Manager. See the Device Configurations section of this document for more info.

Arbitrary Waveform Generator (Wavegen)

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

Vertical System

Number of Channels	1
Output Type	Single-ended
Connector Type	BNC
Standard Functions	Sine, square, triangle, sawtooth, ramp up, ramp down, DC voltage, noise, trapezium, others

Advanced Waveforms	Sweep, modulation and summing (phase, AM, FM), math, play mode, custom Raw, averaged, or filtered Scope input data
Output Voltage Range	±5 V
Resolution	14 bits[1)]
Absolute Resolution	166 µV (| Vout | ≤ 1.25 V) 665 µV (| Vout | > 1.25 V)
Accuracy	±10 mV ± 0.5% (| Vout | ≤ 1.25 V) ±25 mV ± 0.5% (| Vout | > 1.25 V)
Output Impedance	50 Ω
Bandwidth	15 MHz @ -3 dB[2)]
Sweep Modes	Frequency and Amplitude. Up and down with selectable start/stop frequencies and settable time increments
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 Current Drive	30 mA maximum[3)]
Slew Rate	400 V/µs (10 V step)
Overvoltage Protection	Short-circuit to ground, ±15 V

DC Offset Range

Range	Full Scale	Offset	Offset Accuracy
Low range	2.5 V peak-to-peak	±1.25 V	±10 mV ± 0.5%
High range	10 V peak-to-peak	±5 V	±25 mV ± 0.5%

Horizontal System

Maximum Sample Rate	125 MS/s per channel
Fine System Frequency Adjustment	50 MHz to 125 MHz[4)]
Buffer Size	Up to 32,768 samples per channel[5)6)]

1), 6) Each channel also has a pair of 16-bit buffers used to store up to 32,768 samples of FM/PM and AM/SUM modulation parameters in DDR configurations. 2,048 samples in BRAM configuration.
2) When using a probe with the appropriate frequency response.
3) Maximum value for distortion-free generation. Up to 40 mA can be supplied before hardware cutoff.
4) Adjustable through the WaveForms Device Options. Shared with Analog Inputs and Digital I/O.
5) Different preset buffer sizes can be chosen based on device configuration within the WaveForms Device Manager. See the Device Configurations section of this document for more info.

Pattern Generator

Shares digital input/output channels with Mixed Signal Oscilloscope: See the Digital Channels specifications for characteristics.

Trigger System

Trigger Features

Trigger Sources	Oscilloscope analog channels, Arbitrary waveform generator start, Digital I/O lines, External triggers (TRIG1/TRIG2), Manual
Trigger Modes	None, Auto, Manual (Forced Trigger), Single
Analog Trigger	Edge, pulse, transition, condition, level, hysteresis, hold-off
Digital Trigger	Edge, level, pattern, glitch
Analog/Oscilloscope Trigger Resolution	8 to 20 ns, depending on system frequency, 10 ns by default 1)
Digital/Logic Analyzer Trigger Resolution	8 to 20 ns, depending on system frequency, 10 ns by default 2)

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1), 2) WaveForms uses interpolation for much more accurate value positioning.

External Triggers (T1/T2) Characteristics

Trigger 1 and Trigger 2 are connected to two pins in the 2×16 MTE connector.

Trigger 1 can be used to export or import a reference clock for the purposes of device synchronization.

See the Digital Channels specifications for the electrical characteristics of the External Triggers.

Device Configurations

The Analog Discovery Pro (ADP2230) has several different configurations which can be applied, primarily affecting the analog input, analog output, and digital I/O buffer sizes available to the user. Available selections depend on the amount of power available to the device through either USB or the Auxiliary power supply connector.

The 3.7 W power requirement for DDR Memory configurations can be satisfied by either a suitable Auxiliary power supply or by a standard USB 3.0 port.

Configuration	Power Requirement	Scope Buffer Size	Wavegen Buffer Size	Logic Buffer Size	Patterns Buffer Size
1 (Auto, Default)	WaveForms automatically selects configuration #2 or #3, depending on available power				
2 (Block RAM () Memory Only)	>2.7 W	32 kS per channel, 2 kS noise buffer for each channel	16 kS	16 kS per channel	16 kS per channel
3 (DDR Memory)	>3.7 W	64 MS per channel, 1 kS noise buffer for each channel	32 kS	128 MS per channel	32 kS per channel
4 (DDR Memory, Oscilloscope prioritized)	>3.7 W	128 MS per channel, 1 kS noise buffer for each channel	32 kS	The Logic and Protocol Analyzers are not supported in this configuration.	32 kS per channel

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.

Additional Features

Spectrum Analyzer

Frequency Range	0 Hz () to half of system clock frequency (50 MHz () default)
Display Modes	Magnitude, average, peak hold, min hold, count
Y Axis	Logarithmic (dBṼ, dBu, dBm) or linear (volts)
X Axis	Linear or Logarithmic
Power Spectrum Algorithms	FFT, CZT
Windowing Functions	Rectangular, Triangular, Hamming, Hann, Cosine, Blackman-Harris, Flat Top, Kaiser

Network Analyzer

Frequency Range	20 µHz up to one-quarter of the system clock frequency (25 MHz () by default) [1], up to 10,001 steps
Display Modes	Magnitude, Phase
Y Axis	Linear or Logarithmic
X Axis	Linear or Logarithmic
Plots	Bode, Time, FFT, Nichols, Nyquist

[1] Results may be limited by the analog input and output bandwidth of the hardware.

Protocol Analyzer

Shares digital input/output channels with Mixed Signal Oscilloscope: See the Digital Channels specifications.

Protocols[1]	UART, SPI, I2C, CAN, CEC, JTAG, SWD, AVR

[1] This functionality is implemented by WaveForms software on the host system.

Impedance Analyzer

Frequency Range	20 µHz to one-quarter of the system clock frequency (25 MHz () default) [1], up to 10,001 steps
Display Modes	Magnitude, Phase
Y Axis	Linear or Logarithmic
X Axis	Linear or Logarithmic
Plots	Bode, Time, FFT, Nichols, Nyquist, Custom

[1] Results may be limited by the analog input and output bandwidth of the hardware.

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, round, floor, ceiling
Operands	All analog and digital input channels, reference waveforms, time, constants, Pi
Custom Channels	Butterworth, Chebyshev, Lock-In Amplifier

Programmable Power Supply

Number of Channels	2
Voltage Range	0.5 V to 5 V, -0.5 V to -5 V[1)]
Current Output	Up to 1 A or to 3 W per channel[2)], whichever limit is reached first
Voltage Readback Resolution	8 mV
Connector Type	2 pins per channel included in the 2×16 MTE connector

[1)] Optional tracking of the two supplies available within the Supplies Tool.
[2)] While using AUX power supply or USB Type-C connection capable of delivering 3 A.

Connectivity

USB Interfaces

Device Connector	USB Type-C® 3.2 Gen 1, 5 Gbps [1)2)]
Host Connector	USB Type-C® or USB Standard-A [3)]

[1)] USB Type-C® and USB-C® are registered trademarks of USB Implementers Forum.
[2)] USB-C® to USB-C® cable included that is USB 3.2 compatible and capable of 5 Gbps transfer speeds

3) If used with a USB Standard-A port and no auxiliary power supply, the port must provide USB 3.2 compatible power

Power Requirements

The Analog Discovery Pro (ADP2230) does not necessarily require an auxiliary power supply to function, however, one is provided in the kit in case host-supplied power is insufficient. An auxiliary power supply is recommended when utilizing a significant amount of power on the programmable power supplies, analog output channel, and digital channels.

Auxiliary Power Supply Voltage	5 V
Auxiliary Power Supply Current	4 A recommended (3 A minimum)
Barrel Connector Size	5.5 mm × 2.1 mm (positive inner pin)

Physical Characteristics

Dimensions	134.2 mm × 144.0 mm × 37.9 mm (L × W × H) (~5.28 in × ~5.67 in × ~1.49 in)[1]
Weight	464 g (~16.4 oz)

Environmental

Ambient Operating Temperature	0 °C to 40 °C (32 °F to 104 °F)
Storage Temperature	-20 °C to 60 °C (-4 °F to 140 °F)
Operating Humidity	10% to 90% RH non-condensing
Storage Humidity	5% to 95% RH non-condensing
Pollution Degree	2
Maximum Altitude	2000 m