# Analog Discovery 3 Specifications

These specifications are valid following 30 minutes of warm-up and are typical 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, Tracer, and Script Editor instruments.

**Vertical System**

| | Without BNC Adapter | With BNC Adapter (https://digilent.com/reference/test-and-measurement/bnc-adapter-board/start) |
|---|---|---|
| **Number of Channels** | Two | |
| **Input Type** | Differential | Single-ended |
| **Connector Type** | 100 mil 2×15 MTE Header | BNC[1] |
| **Input Range** | ±2.5 V with respect to ground (5 V peak-to-peak)<br>±25 V with respect to ground (50 V peak-to-peak) | |
| **Resolution** | 14 bits (16-bit with averaging), 14-bit noise[2] | |
| **Absolute Resolution[3]** | 0.336 mV (scale ≤ 0.5 V/div)<br>3.36 mV (scale > 0.5 V/div) | |
| **Accuracy** | ±10 mV ± 0.5% (scale ≤ 0.5 V/div, $V_{inCM}$ = 0 V)<br>±100 mV ± 0.5% (scale > 0.5 V/div, $V_{inCM}$ = 0 V) | |
| **Bandwidth** | 9 MHz @ -3 dB, 2.9 MHz @ -0.5 dB, 0.8 MHz @ -0.1 dB | 30+ MHz @ -3 dB, 15 MHz @ -0.5 dB, 6 MHz @ -0.1 dB[4] |
| **Input Impedance** | 1 MΩ ‖ 24 pF | |
| **Input Coupling** | DC | DC or AC |
| **Vertical Sensitivity (range)** | 200 µV/div to 5 V/div (10 ranges)[5] | |
| **CMMR** | ±0.5% (typical) | |
| **AC Coupling Cut-off Frequency** | N/A | 1.6 Hz () at -3 dB[6] |
| **Acquisition Modes** | average, decimate, min/max, record[7] | |
| **Additional Channels** | On-device FIR filter for both inputs[8], 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% |

[1] Only Analog inputs and Analog outputs use BNC connectors. All other pins pass through the BNC Adapter to a 100 mil 2×15 MTE header.
[2] 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.
[3] 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.
[4] When using a probe with the appropriate frequency response.
[5] The ranges are shown in the Analog Input graph windows within WaveForms.
[6] For a 5 V scope input range and 1.75 Hz () for 50 V scope input range.
[7] Up to 10 MHz () for single channel acquisition.
[8] Up to 16 coefficients.

**Horizontal System**

| | |
|---|---|
| **Maximum Sample Rate** | 125 MS/s () per channel |
| **Fine System Frequency Adjustment** | 50 MHz to 125 MHz[1] |
| **Buffer Size** | up to 32,768 samples per channel[2][3] |
| **Noise Buffer** | 1,024 samples |

The above horizontal system specifications apply to Repeated/Shift/Screen modes. Record mode allows streaming acquisition data into host computer RAM () at up to ~10 MS/s () total, or to a file on the host computer disk at up to ~5 MS/s () total. Achievable sample rates and recording lengths depend on host computer specifications.

[1] Adjustable through the WaveForms Device Options. Shared with Analog Outputs and Digital I/O.
[2] 65,536 samples when a single analog input channel is used.
[3] Different preset buffer sizes can be chosen based on device configuration within the WaveForms Device Manager.

## 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 2×15 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<br>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<br>Output High Voltage, VOH, Min 2.4 V, Max 3.3 V |
| **Slew Rate** | Slow (default), Fast[1] |
| **Drive Strength** | 4 (default), 8, 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 32,768 samples per channel[2)] |
| **Pattern Generator Buffer Memory** | up to 32,768 samples per channel[3)] |

The above horizontal system specifications apply to Repeated/Shift/Screen modes. Record mode allows streaming acquisition data into host computer RAM () at up to ~10 MS/s () total, or to a file on the host computer disk at up to ~5 MS/s () total. Achievable sample rates and recording lengths depend on host computer specifications.

**1)** Adjustable through the WaveForms Device Options. Shared with Analog Inputs, Analog Outputs.
**2), 3)** Different preset buffer sizes can be chosen based on device configuration within the WaveForms Device Manager.

## Arbitrary Waveform Generator (Wavegen)

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

### Vertical System

| | **Without BNC Adapter** | **With BNC Adapter (https://digilent.com/reference/test-and-measurement/bnc-adapter-board/start)** |
|---|---|---|
| **Number of Channels** | 2 | |
| **Output Type** | Single-ended | |
| **Connector Type** | 100 mil 2×15 MTE Header | BNC[1)] |
| **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<br>Raw, averaged, or filtered Scope input data | |
| **Output Voltage Range** | ±5 V | |
| **Resolution** | 14 bits[2)] | |

| | Without BNC Adapter | With BNC Adapter (https://digilent.com/reference/test-and-measurement/bnc-adapter-board/start) |
|---|---|---|
| **Absolute Resolution** | 166 µV ( \| Vout \| ≤ 1.25 V)<br>665 µV ( \| Vout \| > 1.25 V) | |
| **Accuracy** | ±10 mV ± 0.5% ( \| Vout \| ≤ 1.25 V)<br>±25 mV ± 0.5% ( \| Vout \| > 1.25 V) | |
| **Output Impedance** | 0 Ω[3] | 0 Ω[4] or 50 Ω (selectable by jumper) |
| **Bandwidth** | 9 MHz @ -3 dB, 2.9 MHz @ -0.5 dB, 0.8 MHz @ -0.1 dB[5] | 12 MHz @ -3 dB, 4 MHz @ -0.5 dB, 1 MHz @ -0.1 dB[6] |
| **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[7] | |
| **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[8] |
| **Buffer Size** | Up to 32,768 samples per channel[9][10] |

**1)** Only Analog inputs and Analog outputs use BNC connectors. All other pins pass through the BNC Adapter to a 100 mil 2×15 MTE header.
**2), 10)** Each channel also has a pair of 16-bit buffers used to store up to 8,192 samples of FM/PM and AM/SUM modulation parameters.
**3), 4)** Output impedance is not precisely controlled.
**5)** When using the included 2×15 flywire signal cable assembly.
**6)** When using a probe with the appropriate frequency response.
**7)** Maximum value for distortion free generation. Up to 40 mA can be supplied before hardware cutoff.
**8)** Adjustable through the WaveForms Device Options. Shared with Analog Inputs and Digital I/O.
**9)** Different preset buffer sizes can be chosen based on device configuration within the WaveForms Device Manager.

## 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] |

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

## External Triggers (TRIG1/TRIG2) Characteristics

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.

# 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 to 9 MHz ()[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) Higher frequencies up to one quarter of the system frequency can be selected within WaveForms but results will be limited by the analog input 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), 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 |

## 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 800 mA or to 2.4 W per channel[2)], whichever limit is reached first |
| **Voltage Readback Resolution** | 8 mV |
| **Connector Type** | 2 pins included in the Header 100 mil 2×15 MTE |

1) Optional tracking of the two supplies available within the Supplies Tool.

# Connectivity

## USB Interfaces

| | |
|---|---|
| **Device Connector** | USB Type-C® .[1)2)] |
| **Host Connector** | USB Type-C® or USB Standard-A [3)4)] |

[1)] USB Type-C® and USB-C® are registered trademarks of USB Implementers Forum.
[2)] USB-C® to USB-C® cable included.
[3)] Device uses USB 2.0 data rates.
[4)] USB Standard-A ports must provide USB 3.2 compatible power when an auxiliary power supply is not used.

# Power Requirements

The Analog Discovery 3 does not require an auxiliary power supply for most functions. An auxiliary power supply is recommended when utilizing a significant amount of power on the programmable power supplies, analog output channels, and digital channels.

| | |
|---|---|
| **Auxiliary Power Supply Voltage** | 5 V |
| **Auxiliary Power Supply Current** | 4 A recommended (3.1 A minimum) |
| **Barrel Connector Size** | 5.5 mm × 2.1 mm (positive inner pin) |

# Physical Characteristics

| | |
|---|---|
| **Dimensions** | 10.0 cm × 10.0 cm × 2.0 cm (L × W × H)<br>(~3.94 in × ~3.94 in × ~0.79 in) |
| **Weight** | 128 g (~4.5 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 |