

# Saleae Logic Pro 16 USB Logic Analyzer



## Key Features

| Feature                               | Description  |
|---------------------------------------|--|
| <b>Channels</b>                       | Sixteen digital inputs, sixteen analog inputs (shared with digital channels)   |
| <b>Maximum Sample Rates</b>           | Digital: 500 MSPS @ 4 channels, 100 MSPS @ 16 channels (USB 3.0 required)<br>Analog: 50 MSPS @ 3 channels, 12.5 MSPS @ 13 channels, 6.25 MSPS @ 16 channel   |
| <b>Bandwidth</b>                      | Digital: 100 MHz square wave when sampling at 500 MSPS<br>Analog: 5 MHz when sampling at 50 MSPS   |
| <b>Trigger</b>                        | Edge or pulse width trigger  |
| <b>Software</b>                       | Cross-platform Windows, Mac and Linux support  |
| <b>Supported Protocols</b>            | Serial, SPI, I2C, Atmel SWI, Biss-C, CAN, DMX-512, HD44780, HDLC, I2S, JTAG, LIN, MDIO, MIDI, Manchester, Modbus, 1-Wire, PS/2 Keyboard & Mouse, SMBus, SWD, Synchronous Parallel, USB, UNI/O  |
| <b>Capture Buffer Length</b>          | Limited by installed memory and digital data density. When recording analog at 50 MSPS, captures 10-60 seconds usually possible. Without analog, buffer length is dependent on digital activity density. 1 MHz SPI: up to 10 Minutes. I2C – several hours – 9600 baud serial – over 1 day. |
| <b>Analog Resolution</b>              | 12 bits, 4.88 mV per LSB   |
| <b>Analog Input Range</b>             | -10V to 10V  |
| <b>Supported digital IO standards</b> | 1.2V, 1.8V, 2.5V, 3.3V, 5.0V, RS-232, +12V TTL   |

### What is a Logic Analyzer?

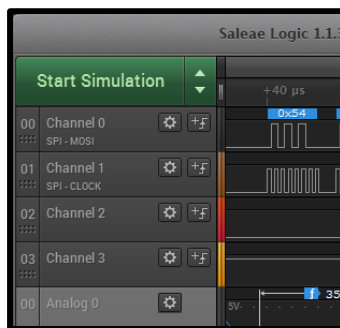
Logic analyzers are great for debugging embedded applications.

They operate by sampling a digital input connected to a device under test (DUT) and then displaying the recording on your computer.

This is great for debugging a wide range of embedded problems. For instance, If an I2C device isn't responding, you can record SDA and SCL to see if the start condition, device address, and ACK/NAK bit frame look right. It is a huge help for any project with a microcontroller, FPGA or ARM chip.

### Easy-to-use Software

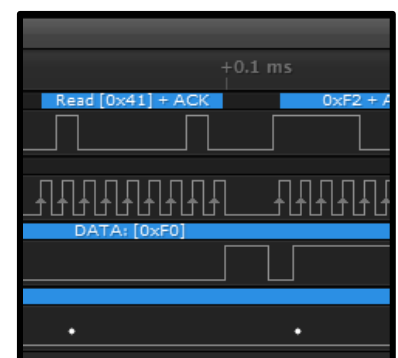
The Saleae Logic devices connect to your PC over USB. Just download the software at [www.saleae.com](http://www.saleae.com).



Navigate your data easily and intuitively with Logic's fluid and fully animated mouse-driven interface. Drag the display with the mouse, zoom with the scroll wheel, even toss the display to find nearby events.

### Protocol Decoding

The Saleae products support decoding for over 20 different protocols. This means when you record those SPI messages, or a CAN bus, you won't need to stare at transitions and clock edges. Instead, just add the protocol decoder and read the data entire bytes – or even transactions at a time.



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## FEATURES

- Powerful, Easy-to-use Software
- Deep Sample Buffers
- Highly Portable, USB Attached
- 24 Included Protocol Analyzers
- Automation API
- Custom Protocol Decoder Plugin API
- Edge and Pulse Width Triggering
- Protocol Result Filter and Search
- Measurements, Bookmarks and Timing Markers
- Four Data Export Formats: CSV, Binary, VCD and MATLAB
- Cross Platform Windows, Linux, and OSX

## APPLICATIONS

- Firmware Debugging
- FPGA Debugging
- Functional Verification
- Performance Profiling
- Reverse Engineering
- Protocol Decoding
- Data Logging

## KEY SPECIFICATIONS

- Sixteen Digital Channels
- 500 MSPS Digital Sampling (max)
- 100 MHz Max Digital Bandwidth
- Sixteen Analog Channels
- 50 MSPS Analog Sampling (max)
- 5 MHz Analog Bandwidth
- Recording Length Limited by Available RAM and Density of Recorded Data
- RGB LED, Customizable 24 bit Color
- USB 3.0 Super Speed

## DESCRIPTION

The Saleae Logic Pro 16 USB Logic Analyzer is a 16 channel logic analyzer with each input dual purposed for analog data recording. The device connects to a PC over USB and uses the Saleae Logic Software to record and view digital and analog signals.

A logic analyzer is a debugging tool used to record and view digital signals. It operates by sampling a digital input connected to a device under test (DUT) at a high sample rate. These samples are recorded to a sample buffer, and at the end of the capture, the buffer is displayed in the software for review.

Logic analyzers are great for debugging embedded applications. In the most common case, a developer working on firmware for a microcontroller will write code to communicate with another component, possibly using protocols like serial, I2C, or SPI. To verify the functionality or to diagnose errors in the firmware, a logic analyzer is connected to the digital IO used for communication and records the activity during testing. The recording is then shown on the display so the user can view the actual behavior of the firmware, and compare that with the expected behavior to narrow down and identify the source of the issue – or verify that the operation is correct.

## INCLUDED COMPONENTS

Saleae Logic Pro 16 USB Logic Analyzer, 4x 4 Channel Wire Harnesses, 32 Micro-Gripper Hooks, Saleae Carrying Case, USB 3.0 cable, and a Getting Started Guide



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### PIN CONFIGURATION

|                                    |                                    |                                    |                                    |
|------------------------------------|------------------------------------|------------------------------------|------------------------------------|
| Channel 0<br>[Digital +<br>Analog] | Channel 1<br>[Digital +<br>Analog] | Channel 2<br>[Digital +<br>Analog] | Channel 3<br>[Digital +<br>Analog] |
| Ground                             | Ground                             | Ground                             | Ground                             |

|                                    |                                    |                                    |                                    |
|------------------------------------|------------------------------------|------------------------------------|------------------------------------|
| Channel 4<br>[Digital +<br>Analog] | Channel 5<br>[Digital +<br>Analog] | Channel 6<br>[Digital +<br>Analog] | Channel 7<br>[Digital +<br>Analog] |
| Ground                             | Ground                             | Ground                             | Ground                             |

|                                    |                                    |                                     |                                     |
|------------------------------------|------------------------------------|-------------------------------------|-------------------------------------|
| Channel 8<br>[Digital +<br>Analog] | Channel 9<br>[Digital +<br>Analog] | Channel 10<br>[Digital +<br>Analog] | Channel 11<br>[Digital +<br>Analog] |
| Ground                             | Ground                             | Ground                              | Ground                              |

|                                     |                                     |                                     |                                     |
|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
| Channel 12<br>[Digital +<br>Analog] | Channel 13<br>[Digital +<br>Analog] | Channel 14<br>[Digital +<br>Analog] | Channel 15<br>[Digital +<br>Analog] |
| Ground                              | Ground                              | Ground                              | Ground                              |

### ABSOLUTE MAXIMUM RATINGS

Input Voltage ..... -25.00V to +25.00V

Operating Temperature ..... 0°C to +70°C

### OPERATING RATINGS

Input Voltage ..... -10.00V to +10.00V

Temperature ..... 0°C to +70°C



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## ELECTRICAL CHARACTERISTICS

|                                  |   |
|----------------------------------|---|
| Input Impedance                  | 2 M $\Omega$    10 pF   |
| Digital Sampling Rates           | 500***, 100, 50, 25, 12.5, 10, 6.25, 5, 4, 2.5, 2, 1 MSPS                         |
| Analog Sample Rates              | 50, 12.5, 6.25, 3.125, 1.562 MSPS,<br>781.25, 125*, 5*, 1* KSPS, 100*, 10* SPS    |
| Digital Logic Threshold          | Selectable: V <sub>th</sub> +0.6V, V <sub>th</sub> +0.9V, V <sub>th</sub> +01.65V |
| Common Supported Logic Standards | +5.0V, +3.3V, +2.5V, +1.8V, +1.2V,<br>RS-232, RS-485/RS-422, +12V                 |
| Digital Bandwidth                | 100 MHz   |
| Analog Bandwidth (-3db)          | 5 MHz**   |
| ADC Number of Bits               | 12  |
| Analog Input Voltage Range       | -10.0V to +10.0V  |
| Analog Volts per LSB             | 4.88 mV   |
| PC Connection                    | USB 3.0 Super Speed/USB 2.0 High Speed  |

### Notes:

\*Planned sample rates.

\*\*Bandwidth when sampling at 50 MSPS.

\*\*\*500 MSPS digital on up to 4 channels, USB 3.0 required.



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## APPLICATION INFORMATION

The Saleae Logic Software user guide can be located on the Saleae support site:

<http://support.saleae.com>

### System Requirements

Supported Operating Systems: Windows XP (x32), Windows Vista (x32/x64), Windows 7 (x32/x64), Windows 8 (x32/x64), Windows 8.1 (x32/x64), OSX 10.7+, Ubuntu Linux 12.04.2+ (x32/x64)

USB 2.0 high speed ports are required. USB 3.0 ports are required for maximum sample rates.

The Saleae Logic Software can be downloaded from the Saleae website:

<https://www.saleae.com/downloads>

### Sample Buffer Limit

The maximum recording length is determined by the density of activity in the recorded signal, the amount of free memory available to the Logic software, and the exact settings of the capture. More information, as well as recommendations, can be found on the Saleae support site:

<http://support.saleae.com/hc/en-us/articles/203939395>

### Bandwidth vs Sample Rate

In order to accurately record a signal, the sample rate must be sufficiently higher in order to preserve the information in the signal, as detailed in the Nyquist–Shannon sampling theorem. Digital signals must be sampled at least four times faster than the highest frequency component in the signal. Analog signals need to be sampled ten times faster than the fastest frequency component in the signal.

### Active Channels vs Maximum Sample Rate

The maximum sample rates for digital and analog recordings is limited by the available USB bandwidth. Because of this, sampling at the maximum rate is not possible on all channels at once. To find out exactly what sample rates are available, please download the Saleae Logic Software from our website:

<http://www.saleae.com/downloads>

Some example sample rate combinations:

4 channels, digital only, 400 MSPS, USB 3.0

16 channels, digital only, 100 MSPS, USB 3.0

3 channels, analog only, 50 MSPS, USB 3.0

16 channels, analog only, 6.25 MSPS, USB 3.0



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## CONSIDERATIONS

Many additional considerations and suggestions can be found in the Saleae support material on the website:

<http://support.saleae.com>

### USB 3.0 / USB 2.0

The Logic Pro 8 and the Logic Pro 16 can both operate when connected over USB 2.0 or USB 3.0. However, USB 3.0 is required to sample at the advertised sample rates. In addition, Logic Pro 16 can only operate with 8 inputs out of the total of 16 when connected over USB 2.0 due to power restrictions.

The performance drop when using USB 2.0 is approximately a factor of 6. The available sample rates become similar, but not identical to Logic 8.

### Ground Loops

Ground loops introduce risk of damage to the equipment. To mitigate the risk of damage, follow the precautions outlined on the Saleae website:

<http://support.saleae.com/hc/en-us/articles/200671790>

### Over Voltage Protection

The input pins on the new Saleae Logic devices (Logic 4, Logic 8, Logic Pro 8 and Logic Pro 16) have protection for signals within -25.00V to +25.00V for continuous operation. The device can be safely used for normal operation with signals in this range. The analog input on Logic 4 and Logic 8 is limited to +0V to +5V, and will saturate (take on minimum or maximum value) outside of this range. Logic Pro 8 and Logic Pro 16 have an analog input limited to -10V to +10V, and will saturate outside of that range.

### Differential Signals

Each digital input is single ended only. It is recommended to use a differential to single ended receiver to first convert a differential signal to single ended before attempting to record. This is not always necessary. Details can be found on the Saleae support site:

<http://support.saleae.com/hc/en-us/sections/200074169>