

LEGION™ ADC

256-Channel Analog-to-Digital Converter



Applications

Photoacoustics (Optoacoustics)
X-ray Induced Acoustics
Thermoacoustics
Acoustoelectrics
3D Tomography
Photoacoustic Microscopy (PAM)
2D Imaging
Multi-Sensor Monitoring
Non-Destructive Testing
Transducer Manufacturing
Low Voltage Ultrasonics

The **LEGION™ ADC** unit offers fully parallel operation for simultaneous data acquisition from all channels without multiplexing in an ultra-compact external USB enclosure. Each unit supports 128- and 256-element detectors. Up to 16 ADC units can be operated in parallel to enable an unprecedented 4096 data acquisition channels. Incoming analog signals can be amplified on each channel by a fixed 40 dB using optional, integrated preamplifiers.

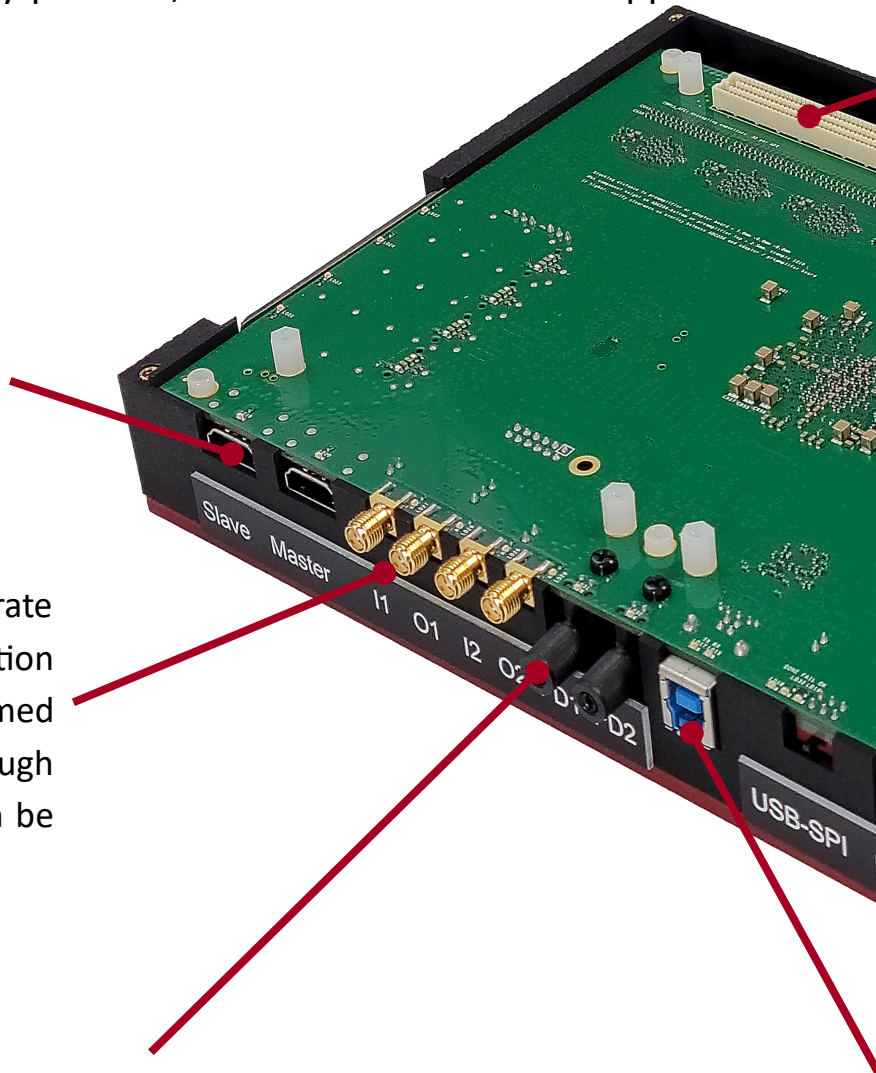
FEATURES

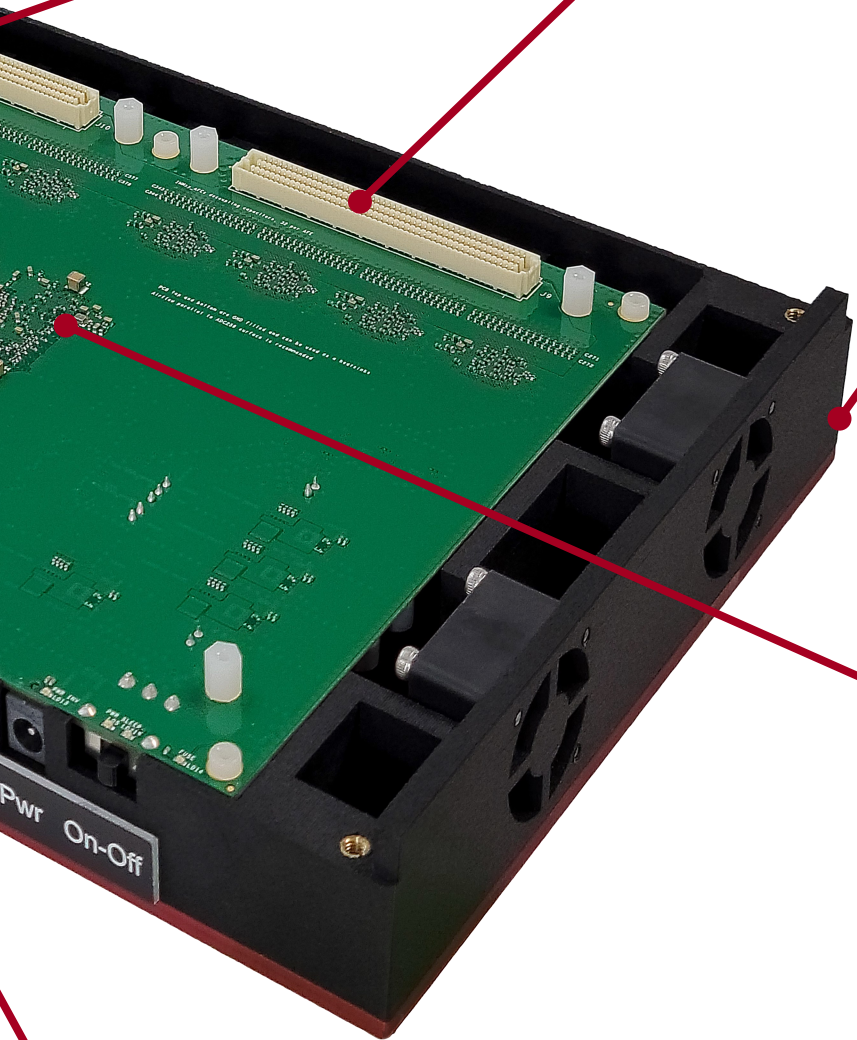
Each LEGION™ ADC undergoes a rigorous quality control process to ensure that all channels and features are operating at the highest level of performance. Thoroughly designed and meticulously planned, the LEGION™ ADC supports a wide range of applications.

Parallel Channels Connect up to 4 units in parallel and up to 16 units using our LEGION hub to acquire more data at fast data acquisition rates.

Programmable Trigger Outputs Generate trigger output at defined rate or repetition of external trigger input with programmed delay. Output trigger supplied through electrically isolated SMA connector can be used for triggering of external devices.

Optical and Electrical Trigger inputs Sync external hardware (e.g. a laser) with data acquisition using electronic or optical IN ports.





Input Connectors The unit comes with two SAMTEC SEAFP series ports on each 128-channel bank. Each port can be fitted with preamplifiers and medical grade connectors that support third-party 128- and 256-element probes.

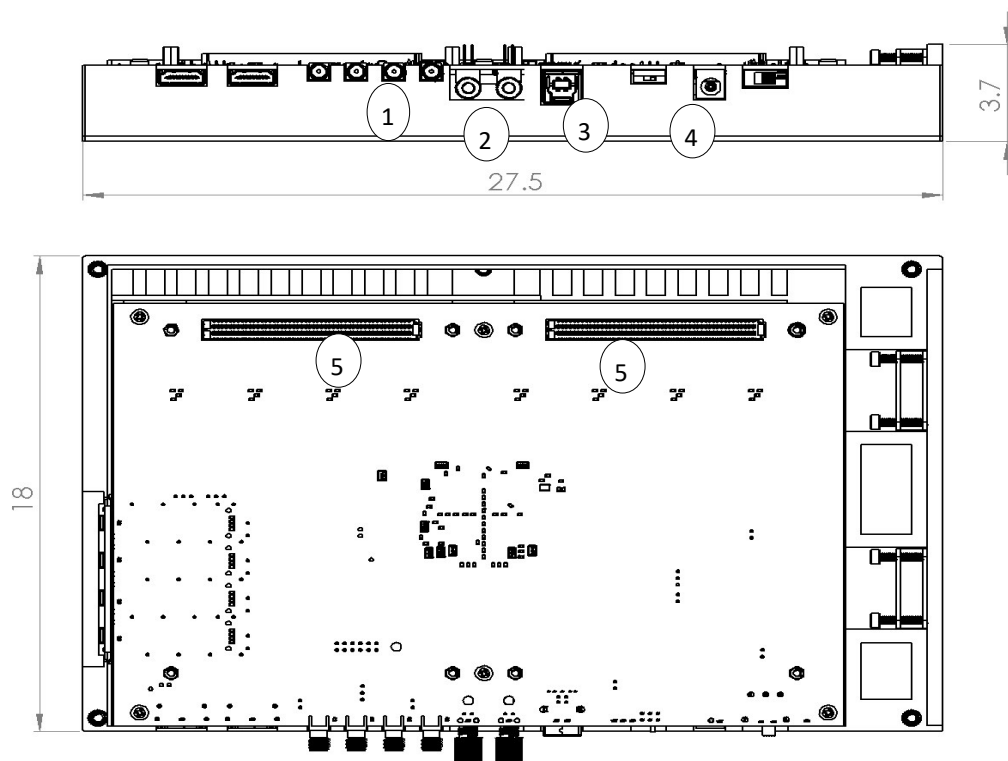
Protective Housings Durable and light plastic enclosures with integrated cooling fans and aluminum panels that protect PCBs from unintended exposure.

Programmable Gain Each analog channel has integrated amplifier with digitally controlled gain. Amplifiers integrated inside ADC chips are controlled using bundled software or a free-of-charge software development kit (SDK).

Streaming ADCs Analog-to-digital conversion is continuous with no buffering or multiplexing allowing faster data transmission and trigger rates. The practical data rate exceeds 90% of 400MBps theoretical data bandwidth of USB 3.0.

SPECIFICATIONS

128 / 256	<i>channels¹</i>
9 to 48 dB <i>(49 to 88 dB)</i>	<i>programmable gain²</i> <i>(w/ optional preamplifiers)</i>
12.5 kHz to 25 MHz <i>(40 kHz to 25 MHz)</i>	<i>analog bandwidth³</i> <i>(w/ optional preamplifiers)</i>
12-bit	<i>resolution</i>
0.3—40 MSPS	<i>sampling rate</i>
50 Ω <i>(2.2 MΩ)</i>	<i>input impedance</i> <i>(w/ optional preamplifiers)</i>
up to 200 Hz / fps	<i>trigger / frame rate⁴</i>
4096	<i>points / frame / channel⁵</i>



Dimension are in cm. Weight 1-1.5 kg depending on configuration

- | | |
|--|---|
| 1. Two sets of programmable electrical trigger input and output (isolated SMA connectors) | 4. 12VDC 5A power connector (power supply included) |
| 2. Two optical trigger inputs for connecting patch fibers allow precise triggering from external light sources | 5. Samtec SEAFP series input connector per 128-channels |
| 3. USB 3.0 port for high data transmission | |

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- (1) Single unit supports 128- and 256-channel configurations. Multiple units support up to 4096-channel configurations.
 - (2) Depends on mode selection. Measured using signal generator and oscilloscope with 50 Ω input.
 - (3) @ -6 dB. Depends on probe, mode and parameter selection (low pass programmable filters available).
 - (4) with 4096 points per channel. Rates up to 400 Hz supported when using 128-channels only. Depends on PC specifications.

Minimum PC Requirements: 6th generation Genuine Intel® quad-core processor, 8 GB DDR RAM. USB3 port on Intel® host controller, 500 GB PCIe 3.0 x4 SSD w/ heatsink, Microsoft Windows 10 64-bit Home. Recommended PC Requirements: Current generation 6+ core processor, 16+ GB DDR RAM, USB3 port, 1 TB PCIe 3.0 x4 SSD w/ heatsink (e.g. Samsung 970 Pro), Microsoft Windows 10 64-bit Pro

SOFTWARE

The LEGION™ ADC Standalone Software Package included with every unit is based on the MATLAB® computing environment and provides complete control over all unit functions. A free-of-charge backend SDK written in C++ is compatible with many frontend languages such as LabView, MATLAB®, etc.

The image displays two windows from the software interface. The left window is the 'Configuration manager', which shows a tree view of the system configuration. The right window is the 'Capture and trigger settings' dialog, which provides detailed control over the ADC's capture and trigger parameters.

Configuration manager

- Devices ...
 - Device 1, Master, 10182022...
- Data loggers ...
 - Ultrasound ...
 - AFE5832 ...
- AFE5832LP ...
 - Configured devices **1**
 - Configured ADC **1-8**
 - HPF corner frequency **20 kHz**
 - LPF cutoff frequency **25 MHz**
 - PGA gain **27 dB**
 - LNA gain **21 dB**
 - Enable low power mode **No**
 - Enable low latency **No**
 - Attenuator, dB **0**
 - AFE5818 ...
- Capture ...
- Trigger ...
 - Outputs ...
 - Input names ...
 - Slave delays ...
 - Generator frequency, Hz **20**
 - Connect to generator **No**
 - Inputs delay, cycles **0**
 - Inputs guard, cycles **10**
 - Enabled trigger inputs **1-4**
 - Inverted trigger inputs

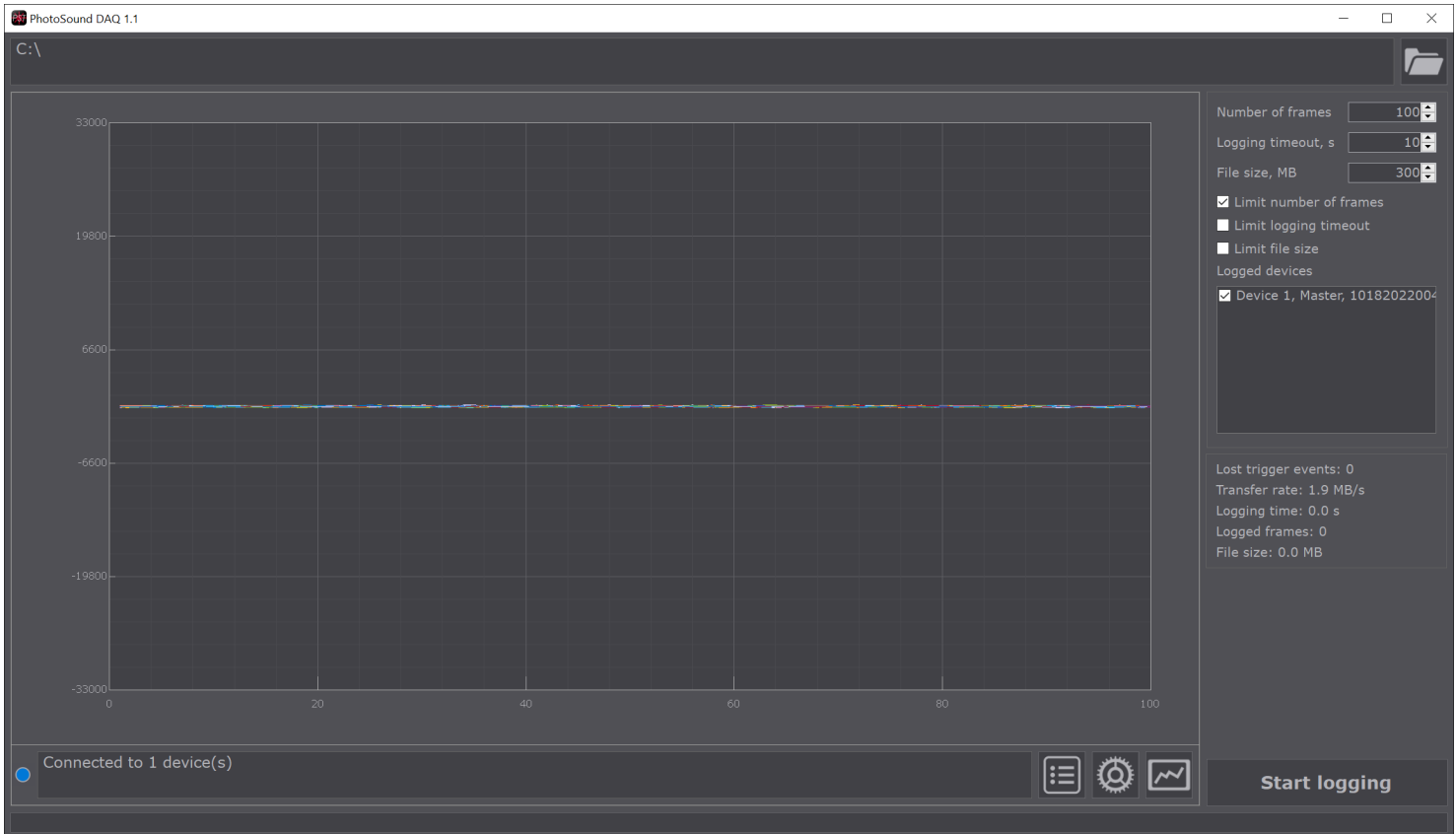
Devices count
Number of connected devices

Capture and trigger settings

- Samples to capture: 4096
- Frames per packet: 1
- Decimation factor: 1
- Wait for trigger
- Enabled ADC:
- Generator frequency, Hz: 20.0
- Capture start delay: 0
- Use generator to start capture
- Enabled trigger inputs:
- Inverted trigger inputs:
- Trigger input 1 "PD1": 0.00 Hz
- Trigger input 2 "I2": 0.00 Hz
- Trigger input 3 "PD2": 100.00 Hz
- Trigger input 4 "I1": 0.00 Hz
- Enable Pulse width, us: 1
- Invert Delay, us: 0
- Connected trigger inputs:
- Connect output to generator
- Update
- Trigger output 1
- Trigger output 2

The Capture and Trigger Settings Window

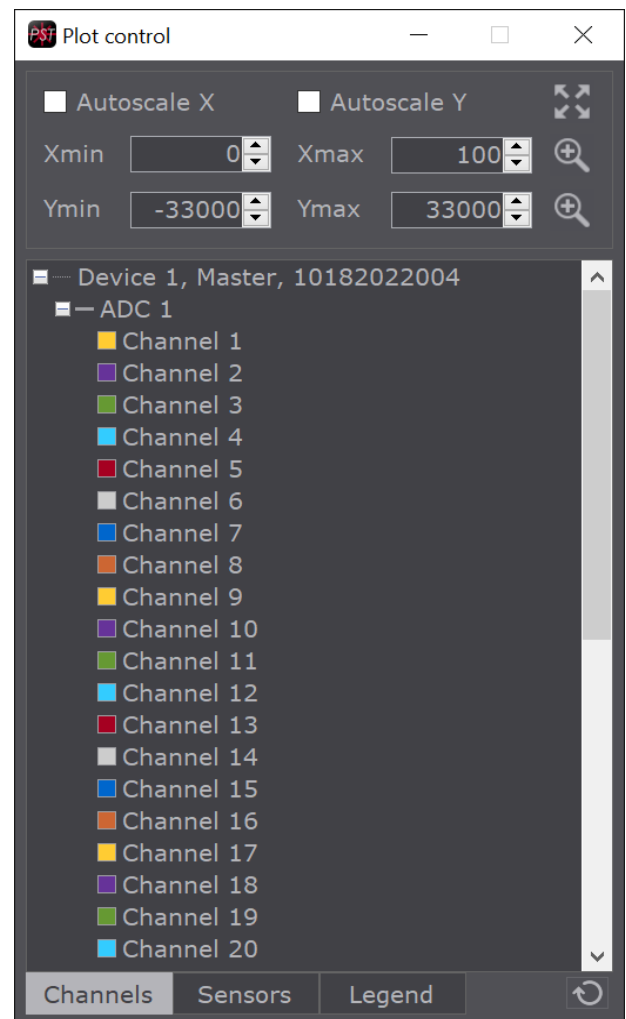
provides settings for trigger inputs/outputs, the internal signal generator parameters, and trigger output parameters. In the trigger selection table, one of five available inputs (two optical, two external electrical and the internal signal generator) are available to the user. The capture settings control for the number of samples to capture, packet size, decimation factor and more. Samples can be captured from one bank of 128-channels (128-element probe setup) or all 256-channels. Directories can be setup for storing the captured data per device.



The Main Viewer Window displays the list of channels to show/hide on each device and the virtual oscilloscope. The default channel mapping can be reassigned to match the variety of ways in which third-party probes are connected.

The Plot Control Window controls the channels selected for display as well as the scale of the plot in the main window. Additionally a sensors map can be assigned to view signals from specific elements.

Configurations Manager Window allows for entering the various gain, attenuation, and filter settings. These settings include low and high pass frequency cutoff, corner filter, gain compensation and more. Each 128-channel bank can be configured across all connected devices.



VERSATILE

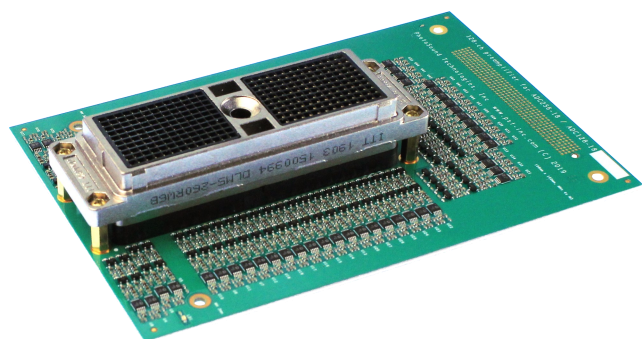
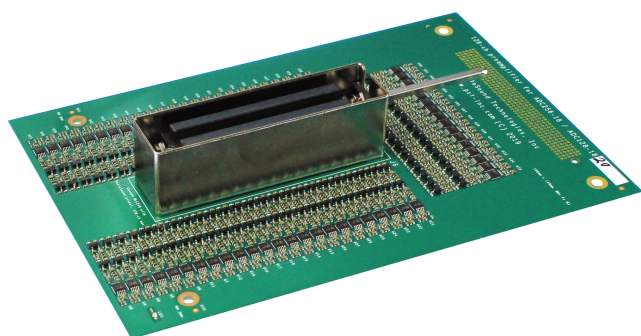
R1.2 Legion ADC - Max Data Transfer with Various Decimation Factors					
Effective Sampling rate (MS/s)	Decimation Factor*	# Samples Per Frame	Frame Acquisition Time (µs)	Max Trigger Rate (Hz)	Transfer Speed** (MB/s)
40.0000	1	4096	102.4	244	366
40.0000	1	2048	51.2	485	363.8
40.0000	1	1024	25.6	958	359.3
40.0000	1	512	12.8	1,872	351.1
40.0000	1	256	6.4	3,559	333.8
40.0000	1	128	3.2	6,557	307.7
20.0000	2	4096	204.8	238	357
20.0000	2	2048	102.4	473	354.8
20.0000	2	1024	51.2	935	350.7
10.0000	4	4096	409.6	227	340.5
10.0000	4	2048	204.8	451	338.3
10.0000	4	1024	102.4	893	334.9
5.0000	8	4096	819.2	207	310.5
5.0000	8	2048	409.6	413	309
5.0000	8	1024	204.8	818	306.8
2.5000	16	4096	1,638.4	177	265.5
2.5000	16	2048	819.2	353	264.8
2.5000	16	1024	409.6	701	262.9
2.0000	20	4096	2,048.0	165	247.5
2.0000	20	2048	1,024.0	329	246.8
2.0000	20	1024	512.0	654	245.3
1.6667	24	4096	2,457.6	155	232.5
1.6667	24	2048	1,228.8	308	231
1.6667	24	1024	614.4	613	229.9
1.2500	32	4096	3,276.8	137	205.5
1.2500	32	2048	1,638.4	274	205.5
1.2500	32	1024	819.2	544	204
0.6250	64	4096	6,553.6	94	141
0.6250	64	2048	3,276.8	189	141.8
0.6250	64	1024	1,638.4	376	141
0.3125	128	4096	13,107.2	58	87

*Decimation Factor down samples the fixed 40 MSPS rate of the Legion ADC by the factor specified. This does not physically change the sampling rate of the Legion ADC but instead drops the sampling events in the memory buffer needed to reach the specified down sampled sampling rate. The dropped events are equally temporally spaced. Thus, the sampling rate of the output data transmitted to the PC is equal to the sampling rate of the ADC divided by the Decimation Factor.

**Test performed using AMD-based PC operated by Windows 10 Pro . Actual results may vary depending on system and operating conditions.

OPTIONAL PREAMPS

Optional 122 Channel preamplification boards add an additional 40 dB of fixed gain and change the input from low (50 Ω) to high (2.2 M Ω) impedance. Preamplifiers on each channel measure only 2 x 25mm, resulting in an overall compact design. The entire assembly (ADC+AMP) is integrated into a single, protective housing.



Medical Grade Cannon QLC260

Compact, 260-pin connector for newer probes and ring-arrays. Each channel is connected to a signal and ground pin to minimize crosstalk. Cannon QLC260 connectors have superior shielding which reduces noise. Recommended for high element count ring arrays.

Medical Grade Cannon DLM260

Popular 260-pin connector used in many third-party ADCs and ultrasound products. Typical configuration consists of connecting one board to half the number of channels for 128-element probes.



Example of ADC unit with 2x Cannon QLC260 AMPs



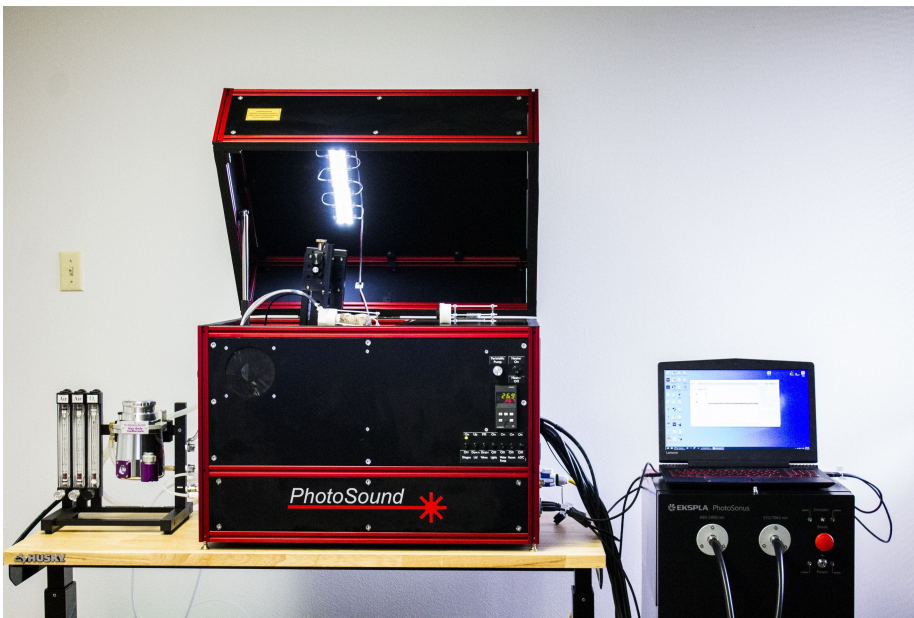
Example of ADC unit with 1x Cannon DLM260 AMP

DESIGN. BUILD.

The LEGION™ ADC is the perfect data acquisition solution for the most challenging application and system integration requirements. PhotoSound engineers excel in designing advanced technology with high channel counts, low signal acquisition in high noise environments, photonic light source synchronization and RF shielded components.

High Channel Count Platforms

Connect up to 16 LEGION™ ADC units in parallel with 512- and 1024- transducer ring arrays and up to 200 Hz high repetition rate, high power tunable laser systems. Push the limits of imaging and data acquisition technology!



Custom Real-time PhotoAcoustic Tomography Platform designed by PhotoSound®

ACQUIRE.

Multi-Modal 3D Tomography

Reinvent optical imaging through multi-modal platforms that combine high resolution photoacoustic technology, powered by the LEGION™ ADC, with conventional fluorescence and bioluminescence tomography.



PhotoSound® **TRITOM™**, discover the power of light and sound



PhotoSound® **MoleculUS™**, ultrasonic imaging with molecular analysis

UltraSound PhotoAcoustic (USPA) Imaging

Combine the photoacoustic optimized LEGION™ ADC (preamps, laser triggering, receive only, etc.) with transmit/receive ultrasound optimized electronics. Co-register familiar ultrasound features with molecular analysis data provided by high resolution photoacoustic imaging.



About PhotoSound®

PhotoSound Technologies, Inc. was founded in September 2015 in Houston, Texas USA to develop and manufacture new imaging products and technologies. Deriving its name from Alexander Graham Bell's discovery of the production of sound by light, PhotoSound excels in research, development and manufacturing of specialized equipment for biomedical applications based on photoacoustics.

The company developed and patented the first commercially available imaging instrument based on Photoacoustic Fluorescent Tomography (PAFT) and manufactures unique data acquisition systems with up to 256 channels on a single board with the ability to run up to 16 boards in parallel with a synchronization hub.

Engineers and application scientists at PhotoSound possess some of the best expertise in the market with skills in tunable laser development, transducer implementation and complex ADC/AMP board designs. All employees at PhotoSound are committed to provide every customer with the highest quality products and services with short delivery times and competitive pricing.

Version LEGION.001.2023 © 2023

All specifications are subject to change without notice.

The LEGION™ ADC ECCN classification is EAR99.

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