

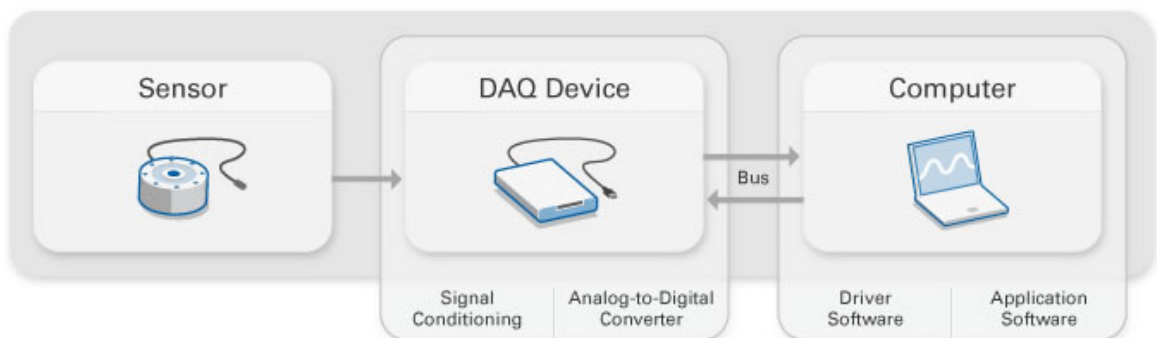


BUYERS' GUIDE

Data Acquisition Systems

When should you opt for a Data Acquisition System? When is an Oscilloscope good enough? Who are the leading suppliers? What are the features to keep an eye when selecting the right DAQ for your requirement? Answers to these questions, and more...

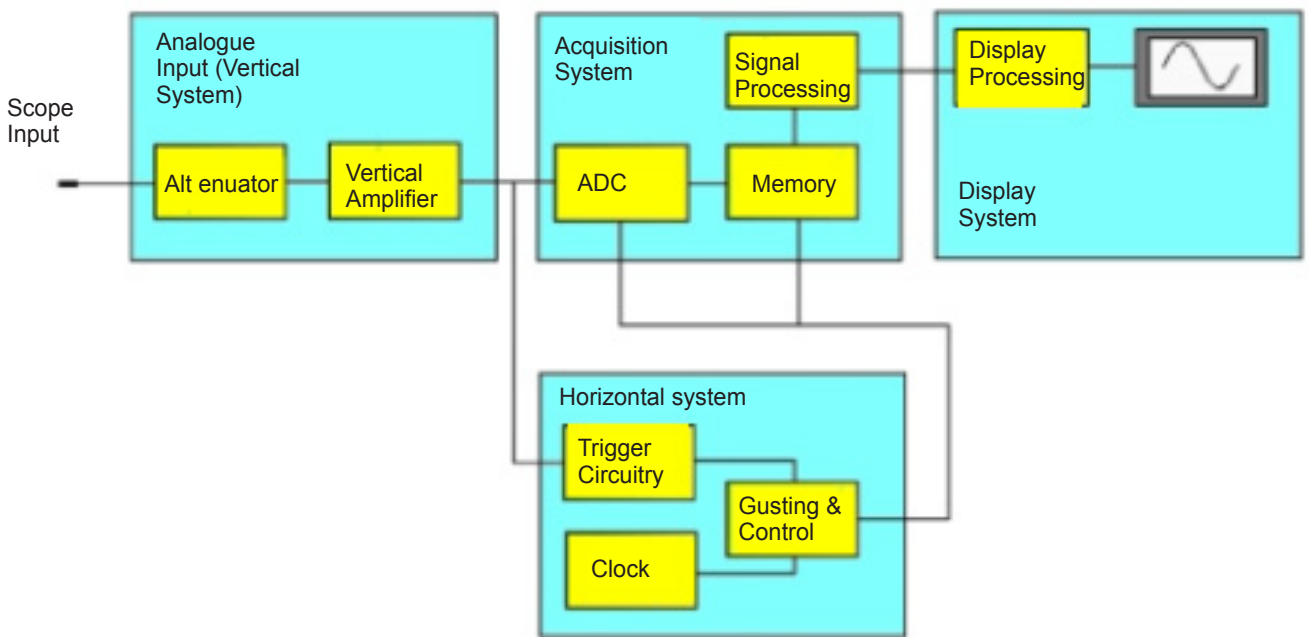
Data acquisition (DAQ) is the process of measuring an electrical or physical phenomenon such as voltage, current, temperature, pressure, vibration or sound with the help of a computing device. A DAQ system consists of sensors, DAQ measurement hardware, and a computer with application software.



DAQ System

How's a Data Acquisition System (DAQ) different from an Oscilloscope?

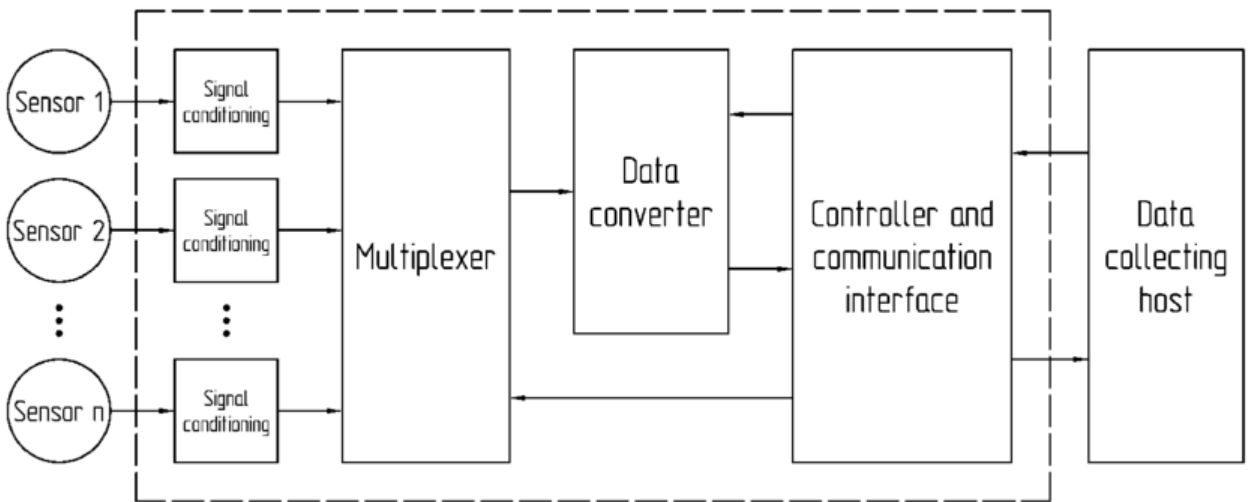
An oscilloscope is a device for visualising a voltage that is changing over time. It plots the voltage on a screen in exactly the way you would expect, with the voltage on the vertical axis and time on the horizontal axis. You can change the range of either axis over several orders of magnitude by way of knobs on the front. The scope receives the voltage from input on the front panel and the time from an internal clock. Some scopes have more than one input or channels so that you can plot multiple voltages at once.



Typical digital oscilloscope block diagram

The primary purpose of the data acquisition system is to acquire and store data. But they can also provide real-time and post-recording visualisation and analysis of the data. Furthermore, most data acquisition systems have a built-in capability for analytical and report generation.

Typical multi-channel Data Acquisition System:



In a nutshell...

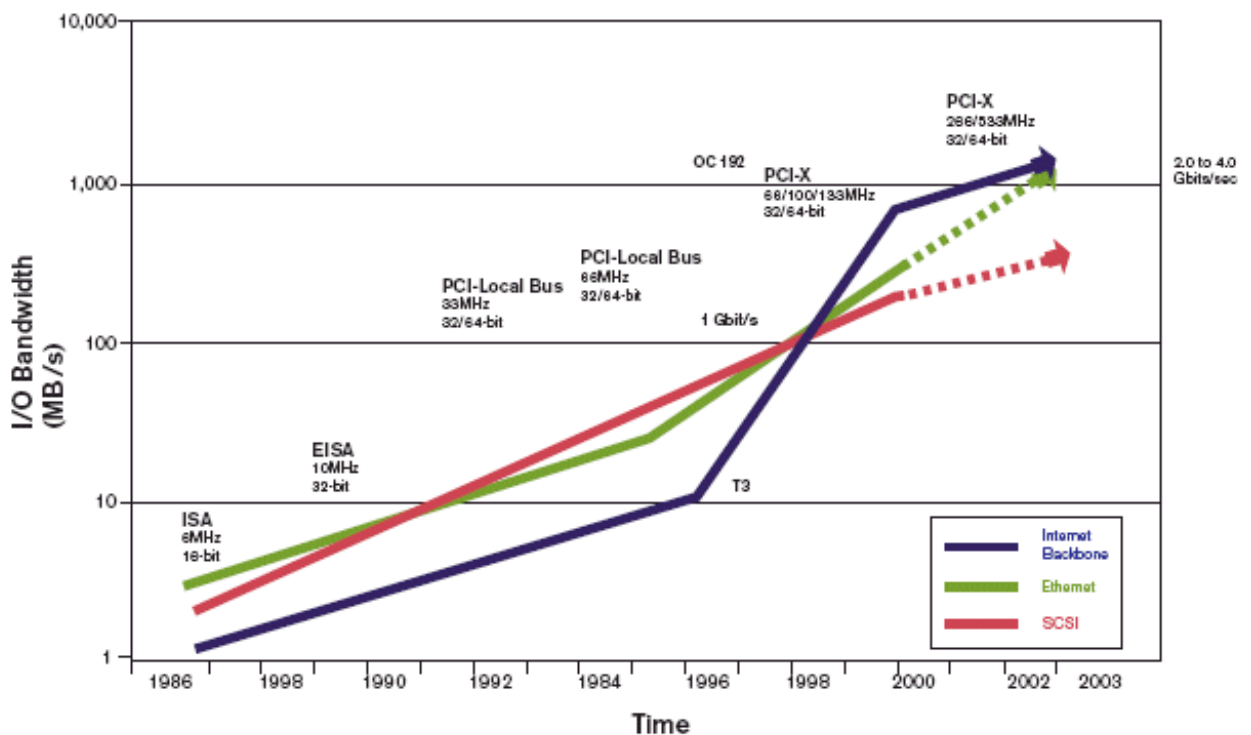
- Both oscilloscopes and DAQs have a data acquisition module but the acquisition system of an oscilloscope provides limited functionality and a limited number of channels.
- Data acquisition systems provide a high range of resolution of 16 - 24 bits but in scopes, the range usually starts from 8 bits and goes up to 16 bits (max).
- The function of an oscilloscope is to show how voltage changes with respect to time. Whereas, the function of a DAQ is to store data over a period of time, which is configurable.
- Due to the low resolution of scopes, they can sample at a high rate compared to DAQs. Usually, a scope's sampling rate starts from GSa/s and for a DAQ, that might be KSa/s or possibly MSa/s.
- Scopes usually consist of 2-4 channels. DAQs can have many more, usually more than 8 channels.
- When it comes to cost, scopes are generally cheap compared to a multi-channel DAQ.
- DAQ has an option to expand its functionality by adding various I/O modules with configurable slots but in scopes, there are no such options.

What's New?

After reviewing some of the DAQs launched in the last 12 months, here's a list of broad trends that have emerged:

1. High speed and multiple interfacing options

- Present-day DAQs are equipped with multiple interface options such as PCIe, PXI, USB-A to USB-C.
- These updated modular designs provide high-speed data transfers of up to 8 GB/s (As per the interface PCIe Gen 3)
- Present updated DAQ hardware is able to scan 450 channels per second. (Keysight - [DAQ973A](#))



2. Multiple Input/Output options

- Basic 2020 DAQ supports more than 14 types of input signals that include temperature, analogue voltages (both AC and DC), strain measurements, AC - DC currents and so on. (From the [datasheet](#) of Keysight Model DAQ973A)



Keysight DAQ973A

3. More expandability

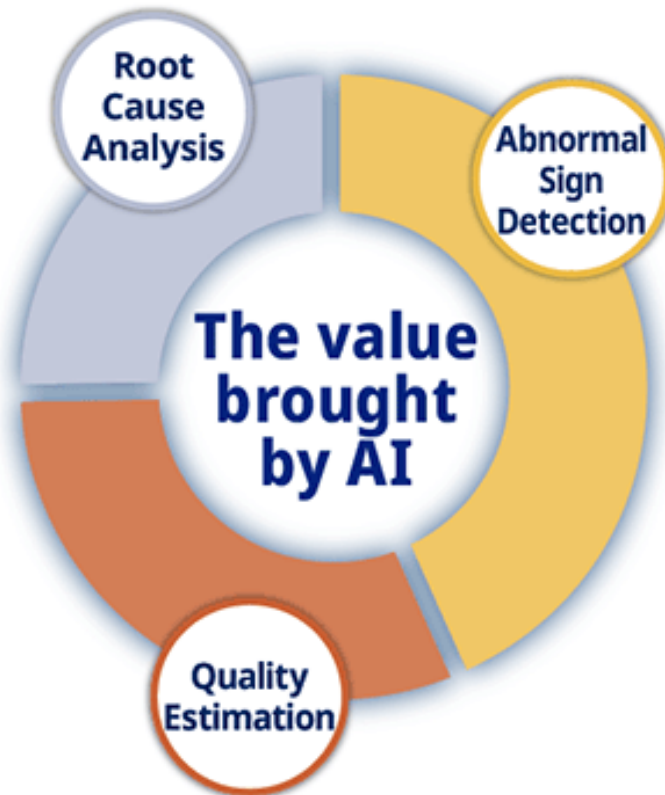
- Expandability is the most crucial feature of a test and measurement equipment. Features like multiple I/O options and slots in the DAQ controller enable as high as 336 channels per device. (Yokogawa India Ltd. - [DL850EV](#))
- Variety of plug-in I/O modules helps to capture the wide range of sensor data with high precision. (Keysight [Plug-in](#))



Yokogawa - DL850E / DL850EV Scopecorder

4. **AI enables new software features:**

- Over the past five years, AI has enabled innovations across all sectors of the various industries. Even the test and measurement sector has adopted the AI technology to improve the current acquisition techniques, noise reductions, isolation mechanisms and so on.



- Yokogawa India Ltd.'s industrial AI platform features AI on a stand. It detects and predicts abnormality of equipment using Anomaly Detection, AI analysis data logging software etc. (Yokogawa India Ltd. - [AI solutions](#))

5. Other innovations

- IoT has pushed centralised mechanism to distributed mechanism, that was a bottleneck for T&M equipment. For addressing this, Dewesoft and Yokogawa introduced the distributed data acquisition systems, which are also certified as industrial grade high-performance hardware. (Dewesoft - [Sirius](#), Yokogawa - [Smart 920 MHz Wireless Data Acquisition](#))



Yokogawa - Smart 920 MHz Wireless Data Acquisition

When to consider investing in a DAQ?



Data acquisition is key to any test and measurement application as it allows you to obtain valuable information from an important aspect of the unit under test. Data acquisition systems can acquire data from many different sources including analogue or digital signal sources. They are critical for condition monitoring applications and test and verification applications as well.

DAQs can be considered for use when:

- A user requires high precision (more than 16 bit) signal sampling with a decent sample rate.
- A user requires multiple input options with a high number of channels.
- A user is required to capture various sources of signals such as temperature signal, accelerometer signals, voltage and current signals, etc.
- A user needs a data logging system with expandability options using various I/O modules.

For instance, a user requires only 2 channels with a resolution of 12 bits for a certain application and he/she plans to capture multiple types of signals. So,

which system should be chosen: an oscilloscope or DAQ?

This mainly depends on the following

- The resolution, channel count and the kind of signal to be captured. If a high channel count with a decent sampling rate is required, then DAQ is suitable.
- Also, if multiple sources of signals are to be captured at the same time, then ultimately DAQ is the best choice.
- If a user plans to capture a signal for a long period of time then the DAQs have in-built memory which can store data from days to years.

Typical Data Acquisition Applications

Here's a list of typical applications which demand investment in DAQs...

- Data capture relating to pressure, temperature, strain vibration, flow, voltage and current
- Temperature monitoring
- Load cell monitoring
- Pressure monitoring
- Speed monitoring
- Strain measurement



Key Specifications to Review

When selecting the right DAQ for your application, here's a list of parameters that you should consider:

- 1. Sampling rate:** A good rule of thumb for determining the minimal sampling rate for a given signal is the Nyquist Theorem. It states that the signals should be sampled at twice the frequency of the measured signal to get a satisfactory representation of the acquired signal. For a more precise measurement, it is recommended that a signal be sampled at 5 - 10 times its frequency.
- 2. Resolution:** Sampling rate capability is inversely proportional to resolution. The resolution of most data acquisition hardware is between 12 bits and 24 bits. For example, a high-precision 24-bit device, which may be necessary to adequately characterise a slow-changing temperature, may have a maximum sampling rate of only 60 Hz. Conversely, an 8-bit device may have a sampling rate as high as 1 giga samples per sec (GS/s).
- 3. Types of Sensors or Transducers:** Sensors and transducers are essential to any data acquisition system. They convert physical phenomena such as temperature, pressure, or vibration into an electrical signal — usually voltage — that can be measured by a data acquisition device. Some examples of sensors and transducers include thermocouples, accelerometers, strain gauges and flowmeters.
- 4. Signal Conditioning:** Most sensors or transducers produce signals that have very small amplitudes, include unwanted environmental noise and contain common-mode voltage errors caused by differences in ground potentials. Signal conditioning compensates for these unwanted occurrences using signal amplification, filtering, and electrical isolation. For example, most data acquisition applications are subject to 60 Hz noise

caused by power lines or electrical machinery. By introducing a signal-conditioning device with the appropriate filter, rejection of that unwanted 60 Hz noise is achieved and the quality of the desired signal improves.

5. **Expandability:** A data acquisition project may require measurement of many points (sometimes there may be as many as a few thousand points). Each point of measurement is known as a channel. If the user is handling a project where the number of measurement channels is likely to have further expansion, it is advisable to select the kind of data acquisition system that has better expandability. Some data acquisition systems provide slots where the user can plug-in cards to extend the number of measurement channels. If all the slots are occupied, a separate container known as the extender chassis or I/O expander can be used to accommodate the additional cards. The data acquisition systems mainframe will then be the master unit controlling the operation of the slave extender chassis. With this arrangement, a single system can provide up to a few thousand measurement channels. However, adding more channels to the system will usually slow down the access time to each channel; it is a trade-off the user should carefully consider while expanding the system.
6. **Speed or scan rate:** The speed of a data acquisition system is counted in channels/second (Ch/s), which is the number of channels the data acquisition system can scan in a second. For commercially available data acquisition systems, the speed ranges from as low as 10 to 20 Ch/s to as high as over 80,000 Ch/s. A high-speed data acquisition system is usually used for acquiring signals that can change at high speed, such as signals from electronic circuits, electronic equipment, etc. The cross-talk induced between the neighbouring channels of this type of DAQ is quite high, therefore the acquired signal cannot be too weak.
7. **Channel count:** It refers to the number of channels a system provides and the no. of channels that can be added when required at a minimal

DAQs Comparison Sheet

Brand	Model	Price (in INR)	Scan Rate (Ch/sec)	Max Channel capacity	Digitizer Channels	Sample Rate	Resolution (Bits)	Accuracy (%)	No. of types of input signals	Auto Calibration Support	Software support	
BK Precision		#NAME?	NA	Up to 72 channels	NA	1 MSa/s	14 - 16 (Based on the module)	NA		No	Yes (Sefram Viewer)	
BK Precision	DAS1700	#NAME?	NA	Up to 72 channels	NA	1 MSa/s	14 - 16 (Based on the module)	NA		No	Yes (Sefram Viewer)	
Dataq Instruments	DI-4108-U	#NAME?	NA	up to 8 channels	NA	160 KSa/s	12 - 16 bit			NA	Yes (WinDaq/Lite)	
Dataq Instruments	DI-4108-E	#NAME?	NA	up to 8 channels	NA	160 KSa/s	12 - 16 bit			NA	Yes (WinDaq/Lite)	
Dataq Instruments	DI-4718B-E	#NAME?	NA	up to 8 channels	NA	160 KSa/s	16 bit			Yes	Yes (WinDaq/Lite)	
Dewesoft	SIRIUS	NA	NA	8 Channels		200 KSa/s		±0.05 % of reading		Yes	Yes (Dewesoft X Professional)	
Dewesoft	R8rt	NA	NA	64 Channels		200 KSa/s		±0.05 % of reading		Yes	Yes (Dewesoft X Professional)	
Fluke Technologies	2638A/60	NA	45 channels/sec	60 Channels	NA	NA		0.0037 % DCV accuracy	NA	No	Yes	
Fluke Technologies	2638A/40	NA	45 channels/sec	40 Channels	NA	NA		0.0037 % DCV accuracy	NA	No	Yes	
Fluke Technologies	2638A/20	NA	45 channels/sec	20 Channels	NA	NA		0.0037 % DCV accuracy	NA	No	Yes	
Fluke Technologies	1586A	NA	10 Channels/sec	up to 40 Channels	NA	NA		0.0037 % DCV accuracy	NA	No	NA	
Keysight	DAQ970A		450 Channels/sec	4-120 channels		800 KSa/s		0.003 DVC accuracy		Yes	Yes (BenchVue)	
Keysight	DAQ973A	184,508	450 Channels/sec	4-120 channels		800 KSa/s		0.003 DVC accuracy		Yes	Yes (BenchVue)	
Nvis Technologies	Nvis 632C8	NA	8 Channels/sec	8 channels	NA	NA		NA	NA	No	Yes	
Nvis Technologies	Nvis 632iC8	NA	8 Channels/sec	8 channels	NA	NA		NA	NA	No	Yes	
Nvis Technologies	Nvis 632C16	NA	16 Channels/sec	16 Channels	NA	NA		NA	NA	No	Yes	
Nvis Technologies	Nvis 632iC32	NA	32 Channels/sec	16 Channels	NA	NA		NA	NA	No	Yes	
Pico technology	PicoLog 1012	#NAME?	NA	12 Channels	NA	1 MSa/s		1% of full scale	NA	No	Yes (PicoScope)	
Pico technology	PicoLog 1216	#NAME?	NA	16 Channels	NA	1 MSa/s		0.5% of full scale	NA	No	Yes (PicoScope)	
RIGOL Technology	M300	#NAME?	60 channels/sec	Up to 320 channels	NA	NA		NA	NA	No	Yes (Ultra Acquire base)	
RIGOL Technology	M301	#NAME?	60 channels/sec	Up to 320 channels	NA	NA		NA	NA	No	Yes (Ultra Acquire base)	
RIGOL Technology		#NAME?	60 channels/sec	Up to 320 channels	NA	NA		NA	NA	No	Yes (Ultra Acquire base)	
Tektronix	DAQ6510	147,000	800 channels/sec	Up to 80 channels	NA	1 MSa/s		0.0025 DVC accuracy		Limited not fully supported	Yes (LabView)	
Tektronix	DAQ6510/7700	186,000	800 channels/sec	Up to 20 channels	NA	1 MSa/s		0.0025 DVC accuracy		Yes	Yes (LabView)	
Yokogawa India Ltd.	SL1000	NA	NA	up to 128 Channels	NA	100 MSa/s (Module based)		0.0050 % DCV accuracy		Yes	Yes (XViewer)	
Yokogawa India Ltd.	DL850E	NA	NA	up to 128 Channels	NA	100 MSa/s (Module based)		NA		Yes	Yes (XViewer)	
Yokogawa India Ltd.	DL850EV	NA	NA	up to 336 Channels	NA	100 MSa/s (Module based)		NA		Yes	Yes (XViewer)	
Yokogawa India Ltd.	DL350	NA	NA	up to 8 channels	NA	100 MSa/s (Module based)		NA	NA	No	Yes (XViewer)	

	Interface support	Expandability Options	Display	Storage	Type	Dimensions in mm (W x H x D)	Weight in Kgs	Warranty (years)	Others	Remarks
	USB, LAN	Compatible with four different I/O modules	15.4 inch touchscreen	500 GB SSD internal memory (2 TB optional)	Bench Top	370 x 440 x 195			Data-sheet	It has onboard printer, WiFi logging
	USB, LAN, CAN and LIN	Compatible with four different I/O modules	15.4 inch touchscreen	500 GB SSD internal memory (2 TB optional)	Portable	271 x 472 x 154			Data-sheet	Battery powered optional, GPS and IRIG timing options, WiFi logging
	USB	Channel stretch multi-unit synchronization up to 16 instruments	NA	SD card storage option	Portable	169 x 28 x 83		NA	Data-sheet	
	USB, LAN	Channel stretch multi-unit synchronization up to 16 instruments	NA	SD card storage option	Portable	169 x 28 x 83		NA	Data-sheet	
	USB, LAN	Channel stretch multi-unit synchronization up to 16 instruments	NA	SD card storage option	Bench Top	104 x 38 x 138		NA	Data-sheet	Channel stretch support up to 128 analog channels and 112 digital ports.
	USB, Ethercat	SIRIUS slices can be used as a stand-alone DAQ units or stacked and daisy chained together into larger channel count system with simple click-mechanism	NA	Internal upto 960 GB SSD	Portable	265 x 150 x 75		NA	Data-sheet	It is a kind of racks where you can expand the functionality with multiple racks conneted eachother using ethercat interface.
	USB, Ethercat	Can be conneted to other sirus slices racks to increase channel count	NA	Internal upto 960 GB SSD	Portable	265 x 150 x 75		NA	Data-sheet	It is a kind of racks where you can expand the functionality with multiple racks conneted eachother using ethercat interface.
	USB,LAN, SCPI	NA	Available	Extrernal USB logging	Bench Top	150 x 285 x 385		NA	Data-sheet	
	USB,LAN, SCPI	NA	Available	Extrernal USB logging	Bench Top	150 x 285 x 385		NA	Data-sheet	
	USB,LAN, SCPI	NA	Available	Extrernal USB logging	Bench Top	150 x 285 x 385		NA	Data-sheet	
	USB	NA	Available	Extrernal USB logging	Bench Top	NA	NA	NA	Data-sheet	Oldest DAS from fluke
	LAN and USB	3-slot mainframes	Large 4.3" color display	Extrernal USB, LAN logging	Bench Top	261 x 103 x 378		NA	Data-sheet	
	LAN, USB and GPIB	3-slot mainframes	Large 4.3" color display	Extrernal USB, LAN logging	Bench Top	261 x 103 x 378		NA	Data-sheet	
	USB	NA	NA	Extrernal USB logging	Portable	NA		NA	Data-sheet	Nvis 63X series DAQ are useful for sensing and controlling Analog and Digital signals only
	USB, Ethernet	NA	NA	Extrernal USB logging	Portable	NA		NA	Data-sheet	Nvis 63X series DAQ are useful for sensing and controlling Analog and Digital signals only
	USB	NA	NA	Extrernal USB logging	Portable	NA		NA	Data-sheet	Nvis 63X series DAQ are useful for sensing and controlling Analog and Digital signals only
	USB, Ethernet	NA	NA	Extrernal USB logging	Portable	NA		NA	Data-sheet	Nvis 63X series DAQ are useful for sensing and controlling Analog and Digital signals only
	USB	Using the new PicoLog software you can connect up to 20 Pico data loggers to one PC – giving you a potential 320-channel PicoLog 1000 Series data acquisition system	NA	Extrernal USB logging	Portable	45 x 100 x 140			Data-sheet	
	USB	Using the new PicoLog software you can connect up to 20 Pico data loggers to one PC – giving you a potential 320-channel PicoLog 1000 Series data acquisition system	NA	Extrernal USB logging	Portable	45 x 100 x 140			Data-sheet	
	USB, LAN, GPIB and RS232	5 slots compatible with various I/O modules	4.3 inches LCD	Extrernal USB logging	Bench Top	239 x 159 x 373		NA	Data-sheet	This model will not get any inbuilt I/O modules
	USB, LAN, GPIB and RS232	5 slots compatible with various I/O modules	4.3 inches LCD	Extrernal USB logging	Bench Top	239 x 159 x 373		NA	Data-sheet	This model includes MC3065 DMM Module
	USB, LAN, GPIB and RS232	5 slots compatible with various I/O modules	4.3 inches LCD	Extrernal USB logging	Bench Top	239 x 159 x 373		NA	Data-sheet	This model includes MC3065 DMM and MC3120 Module
	LAN, USB, GPIB, RS-232, and TSP-Link	12 plugin switch modules	Large, 5-inch (12.7 cm) multi-touch capacitive touchscreen	Extrernal USB, LAN logging	Bench Top	224 x 107 x 387			Data-sheet	
	LAN, USB, GPIB, RS-232, and TSP-Link	Only 1 plugin switch modules	Large, 5-inch (12.7 cm) multi-touch capacitive touchscreen	Extrernal USB, LAN logging	Bench Top	224 x 107 x 387			Data-sheet	
	USB, LAN	Eight module slots are available	NA	Build-in hard disk 500 GB	Bench Top	319 x 154 x 350		NA	Data-sheet	It is a scopecoder which can be used as oscilloscope as well as data acquisition system up to some extent.
	USB, LAN	Eight module slots are available	10.4-inch TFT color LCD monito	Built-in HDD/(HD1 option) 2.5 inch, 500GB, FAT32	Bench Top	355 x 259 x180			Data-sheet	It is a scopecoder which can be used as oscilloscope as well as data acquisition system up to some extent.
	USB, LAN	Eight module slots are available	10.4-inch TFT color LCD monito	Built-in HDD/(HD1 option) 2.5 inch, 500GB, FAT32	Bench Top	355 x 259 x180			Data-sheet	It is a scopecoder which can be used as oscilloscope as well as data acquisition system up to some extent.
	USB	NA	Resistive touch screen	SD card storage option	Portable	NA	NA	NA	Data-sheet	

cost. Generally, data acquisition systems have 8 channels without any external multiplexer. If a user is working on an application that needs 4 channels, then it is wise to choose a DAQ model which supports more than 4 channels. Although some DAQ models are capable of increasing the channel count using a multiplexer module, which affects the scan rate of the system.

8. **Types of measurements:** An entry-level DAQ capable of measuring 8 different kinds of measurements and high-end DAQ can go up to 20+ types of measurements. Some of the common measurements are DC voltages and currents, AC voltages and currents, temperature, capacitance and frequency. The user has to check the datasheet of the DAQ for measurement capabilities that the system can support with or without I/O modules.
9. **Auto calibration support:** Various DAQ systems are capable of automatically performing a self-test when the unit is switched on and calibration usually happens using an OEM's software. This corrects any offset (drift effects) within the amplifiers/ DAQ unit. Even if the system has auto-calibration technology, it is recommended to use hardware calibration services the OEM usually provides once a year.
10. **Software support:** Many data acquisition systems come bundled with a dedicated software package that lets users set up, configure and display many variables such as analogue frequency, counter and digital I/O channels in real-time. It also configures acquisition parameters such as trigger events, stop events and acquisition-scan rates. These are necessary functions, of course, to run and interrupt the data. However, the platform you purchase should not be limited to operating only with the manufacturer's supplied software. You should expect more flexibility, such as compatibility with several vendor software. These could include LabView, DASyLab and MatLAB.

-
11. **Interface options:** New models of DAQ have multiple interface options, most common being GPIB, PCI, Ethernet, USB and Serial bus. The General Purpose Interface Bus (GPIB) has been used for many years for controlling and it continues to survive. It is an 8-bit standard and can transfer data up to 8 Mbytes/s over a robust shielded cable connected to as many as 14 instruments simultaneously. The new generation 64-bit PCI-X specifications allow different rates of data transfer, anywhere from 512MB to 1GB per second. Ethernet theoretical standard transfer rates are 10 Mb/s, 100 Mb/s and 1Gb/s, although a real-world physical system may not fully realize these claims. Ethernet supports remote control by multiple users at different locations and is often used with inexpensive gateways. The user needs to choose the interface based on the application requirements, such as whether a user needs real-time view or the DAQ's internal storage is too low to store the data. The user can then choose a PCI-e based interface which has high bandwidth and greater speeds.
 12. **Storage Media:** The host PCs usually store the data captured by the data acquisition system. However, some data acquisition systems come with additional memory to supplement the PC. It samples at full speed and lets the PC handle other tasks, transparently. This is particularly helpful when a PC's communication port or disks are too slow to keep up with the sample rate of the acquisition system. The external memory can accept the data at full speed and transfer it to the computer at a slower rate. This acquisition continues until the full capacity of the memory is reached or the test completes. The memory can also operate as a storage buffer and transfer the data to the PC at the end of the test. During the testing period, the PC is entirely free to handle other tasks.
 13. **Specifications of Inbuilt - digitizer:** A digitizer is a hardware device that receives analogue information, such as analogue electrical pulses and records it digitally. Some DAQ models are integrated with the digitizer, which provides additional capabilities. The inbuilt digitizer further

enhances the resolution by decreasing the sample rate. But only a few OEMs and models have inbuilt digitizer and some models will have the I/O digitizer module as an expansion option.

- Cost:** The price of a data acquisition system usually relates to its degree of sophistication, channel capacity, immunity to electrical noise and resistance to harsh industrial environments (such as temperature, dirt, mechanical vibration, etc.). To minimise the expenses, the user should choose a system that just suits the requirements. There is no point in purchasing an expensive, sophisticated system without fully utilising all its features. For small scale measurements in a “clean” environment (e.g. a laboratory or an electronics factory), very often a simple card type data acquisition system will be sufficient.

SUPPLIERS OF DAQ SYSTEMS

Brand	Country	Website
BK Precision	USA	https://www.bkprecision.com/data-acquisition-recorders
Dataq instruments	USA	https://www.dataq.com/data-acquisition/
Dewesoft	Slovenia	https://dewesoft.com/products/daq-systems
Fluke Technologies	USA	https://www.fluke.com/en-us/products/precision-measurement/data-acquisition
Keysight	USA	https://www.keysight.com/en/pc-1000000676%3Aepsg%3AAppr/data-acquisition-daq?cc=US&lc=eng
National Instruments	USA	https://www.ni.com/en-in/shop/data-acquisition.html
NVIS	India	https://www.nvistech.com/data-acquisition
PICO	UK	https://www.picotech.com/products/data-logger
RIGOL	China	https://www.rigolna.com/products/data-acquisition/m300-system/
Tektronix	USA	https://www.tektronixindia.com/data-acquisition-and-logging-systems.php
Yokogawa	Japan	https://www.yokogawa.com/solutions/products-platforms/data-acquisition/

Note: Key suppliers of DAQs listed in alphabetical order