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The Hidden Costs of "Low Cost" Data Acquisition Systems

Technical Data

The decision to purchase a particular data acquisition system is often based on hardware price alone. This price-only approach to purchasing, however, is often a Trojan Horse with unexpected costs cropping up shortly after purchase. The following discussion presents information to help you evaluate the purchase of small-to-medium-sized data acquisition systems by pointing out potential hidden costs associated with different types of equipment.

The lure of cost-per-channel estimates

Small-to-medium-size data acquisition systems vary from single channel instruments to larger systems with up to one hundred channels. System and instrument configurations range from handheld specialty units to larger portable or fixed acquisition systems. One thing they all have in common from a purchasing viewpoint is an associated cost per channel. In analyzing a data acquisition purchase, cost per channel is one of the universal measurement criteria that engineers and managers use to evaluate potential vendors' equipment. Understandably a heavily-weighted measurement in the evaluation process, this cost-per-channel unit of measure has more potential to undermine your project than any technical specification on a data sheet.

Initial cost-per-channel estimation chart
(systems less than 20 channels)

	Initial cost per channel:* (U.S. dollars)	Estimated cost multiplier range (system cost)	Estimated final system cost per channel
Plug-in Boards	$80–$150	1.3 – 3.0	$104 to $450
Data Loggers	$205–$350	1–1.4	$205 to $490
Front-Ends	$150–$200	1.1 – 1.7	$165 to $340

*Cost includes hardware and software purchase cost but does not include estimate for system integration

From a purchasing standpoint, $150 to $350 per channel seems to be a target range for a majority of industrial applications under 20 channels. Data acquisition equipment manufacturers are aware of this dollar per channel target and in many cases present their products and literature to reflect the lowest possible cost per channel. However, all data acquisition systems are not alike. When evaluating systems, you should consider the overall costs of implementing each type.

Medium-sized data loggers

Medium-sized data loggers typically range from $190 to $350 per channel. Four to forty channels is typical for the majority of portable equipment. The main potential for hidden cost associated with this type of equipment is underestimating or not anticipating future applications for these easily transportable devices. Because of their portability, mid-sized data loggers are often used in a variety of monitoring and recording applications throughout their useful life. Many users configure medium-sized data loggers for specific input types using input cards that plug into the back of the data logger. These input cards range in channel count from one to about twenty, and each card is commonly dedicated to a specific input type such as thermocouple or dc volts. The hidden cost? Purchasing input cards with more channels than you need. Let's take a closer look using the following example.

Example: Medium-sized (20 channels) data logger application
You need to purchase a system to monitor and validate oven zone temperatures and conveyor speed on one oven in your cookie plant. The oven has three zones of two temperatures each (K type thermocouple) and one frequency input from a magnetic pickup for conveyor speed. The data logger you selected has a base price of $2900 with 12 channels of your choice pre-installed, and is expandable in 12 channel increments. You select a thermocouple card (type K) for your 12 pre-installed channels. You also select a dc input card (12 channels) which accepts 0–10V dc for the signal conditioners you had to buy to convert low frequency (0 to 100 RPM conveyer speed) to 0–10V dc to feed to the data logger dc input channel (frequency input is not available on this data logger). Now, let's look at the overall cost of your system on a cost-per-channel basis.

Example (cont.)

Initially, your costs appear to be $2900 (base unit with 12 channels) + $550 (12 dc input channels) = $3450 for 24 channels or $143 per channel—not bad for 24 channels. But wait. You really only use seven channels (6 AC + 1V dc) for this application and you also had to add a frequency signal conditioner at $350. Your per-channel cost restated is $542 per channel! The six unused thermocouple channels, and the nine unused dc channels that you purchased but did not use should also be considered as a system cost in calculating cost per channel. If you ever need to monitor different inputs on your oven, such as the ac current draw of the conveyor motor or fuel flow to the oven burners, your per-channel costs will increase once again with the need for additional input boards or signal conditioners.

Example: 4-input data logger for pump monitoring system

You need a small data logger to monitor five points on several remote pumping stations. You need a frequency input channel for flow rate, two dc channels for monitoring battery and motor performance, and a temperature input for profiling bearing temperature. You select a handheld battery-powered data logger featuring plug-in signal conditioning input modules. Each module is dedicated to a specific sensor type and range.

The base unit cost is $2200, plus $100 per each dc input, $150 for frequency input, and $150 for thermocouple input. The total = $2700, or $540 per channel. If you need to put this new capital investment to work in another project later, purchasing input modules to meet new application requirements adds to the overall cost per channel. This added cost of your data logger is not so obvious because the unused modules are usually relegated to a drawer somewhere out of sight.

Small-sized data loggers

Small data acquisition units typically range in channel count from one to eight channels and are particularly useful as carry-around data collection devices for temporary monitoring at different locations. Many of these smaller data acquisition units contain removable modules for signal conditioning inputs. These modules are usually single channel inputs and, like the mid-size units discussed earlier, the input modules are often dedicated to a specific sensor or input type and cannot be changed without totally replacing the module. The following example shows some of the limitations of this type of hardware scheme.

Computer-based front-ends

Front-ends suffer from the same problem of dedicated input types that plagues the mid-size data loggers. While many front-end units have reasonable initial costs, the inability to fully utilize an input board in a given application can drive cost up dramatically. Many of these boards provide 8 to 20 channels per card and are, almost without exception, dedicated to one input type. This problem, however, is dwarfed by the problem of software.

The largest hidden cost on the computer front-end is unquestionably software. Many manufacturers supply software drivers as a way to let you retrieve information from the unit as a Comma Separated Variable (CSV) file or binary file. Too often, that's not enough. Much of the money invested in a front-end system is spent interfacing the hardware and software to meet the application needs. Off-the-shelf software packages can cost anywhere from $500 to over $5000 depending on functions and complexity.

You should also consider what the software learning curve on some of the more complex packages will be. Software packages that require the operator to learn the full range of instrument command sets or require complex high level statements are among the least cost effective to deal with.

Plug-in boards

This equipment category is ripe for high hidden costs. The term "plug n' play" used by some manufacturers to entice potential users to purchase data acquisition boards has been infamously changed to "plug n' pay" by many who have painfully integrated them into a system. Plug-in boards have similar problems to front-ends and mid-size data loggers, most notably dedicated input types. The most common variety of boards offered today come in 8 or 16 channels of input. All inputs are of the same type, however, presenting the same problems as mentioned earlier —namely, changing out blocks of inputs or using signal conditioners. There are now cards on the market which offer a partial solution to this problem by offering a mix of inputs. These mixed input boards, while a step in the right direction, are still underutilitized if your input requirements don't meet those offered exactly. Signal conditioners play an important role here (at an average cost of $275 per channel), where they are used to convert sensor signals to 0–10V dc to feed input channels on the A/D card not designed for sensor inputs. This technique does allow you to use the full channel capability of the card, but raises the overall system cost as the signal conditioner count increases.

The cost of uncertainty

Another cost often overlooked when selecting equipment and striving for economy is the cost of operating a system with an unknown accuracy. This issue is more likely to come up when integrating plug-in cards than with other types of equipment.

Plug-in cards have accuracy specifications which are published on data sheets to allow you to make an informed decision. What you often are not told is that by the time you are

Example: Plug-in board
You need to monitor eight dc measurements and at least three RTD measurements from a generator test stand. You select a typical plug-in card with 16 channels of dc input that costs you anywhere from $500 to $1400 depending on sampling speed, accuracy and overall quality. This seemingly places the cost per channel between $35 and $90 per channel. To find a more accurate cost, factor in three isolating external signal conditioners for the RTD measurements at $275 average price. Then add a third party software package at $1700 average cost, several hours of hardware integration, time for documentation of system wiring and dip-switch settings and your costs rise rapidly. In this example, the 16 channel card quickly goes from an average of $55 per channel to $225 per channel solely on hardware and software costs with no consideration for man-hours of integration and troubleshooting time, or even the PC used to house and support this application.

finished assembling your system, your total overall accuracy may be nowhere close to that found on the data sheet. The reasons are many. Accuracy can be affected greatly by noise on input lines, ground loops between channels, additional signal conditioning equipment, and by simply placing the data acquisition card into a slot on your computer that is too near a noise source. Noise sources include switching power supplies, video cards, and fax-modems, to name a few. Having full control over scan speed is another source of measurement uncertainty. Noise rejection (and therefore accuracy) and scan speed are inversely related: the faster you scan, the more noise you measure, and the more inaccurate your measurement becomes. This significant point is often overlooked during initial selection and actual operation of systems built from plug-in cards.

Accuracy can be important in many instances where production quantities of expensive materials are being monitored and gauged. Cost per channel where accuracy is needed, yet unknown, can take on a whole new perspective. Only the user can determine the individual cost of an inaccurate system . . . but first you have to know how inaccurate it is. With plug-in cards, verifying system accuracy to meet ISO 9000 or other quality or regulatory standards can prove difficult.

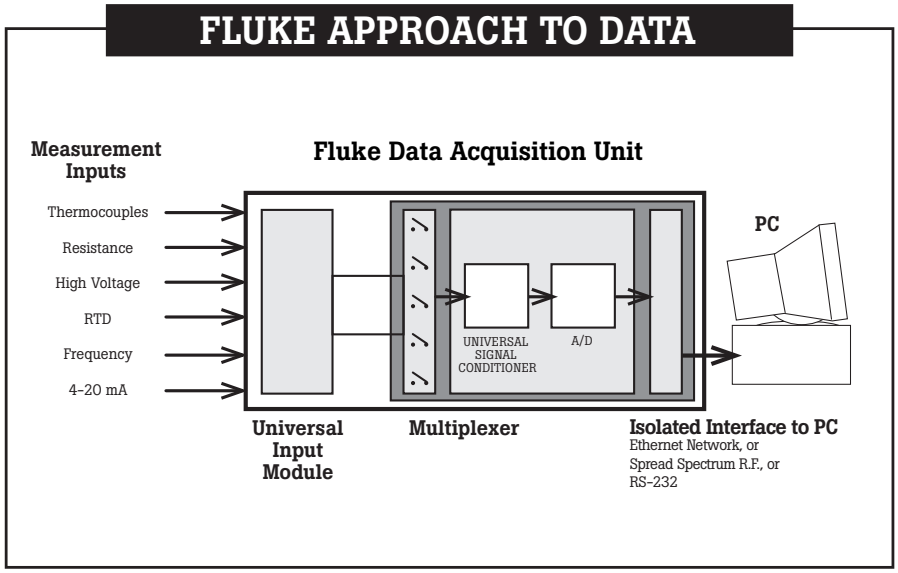
Software

Commercial software manufacturers have struggled for years to develop easy-to-use software packages that serve the needs of all customers. Packaged software can range from a few hundred dollars to several thousand dollars and still not address all your specific needs.

PC plug-in boards typically come with software drivers that allow you to call the board from within a software program. Many board manufacturers include programs which allow you to obtain data and display it on the computer screen or save it to disk. However, these tools must still be integrated by the user to produce useful information. Putting information into a useful form requires a degree of programming proficiency, and can turn into a continuing software project that eats up manpower and rarely gives a return on the invested time. In many cases the project ends up sequestered to a secluded corner of the plant to gather dust.

Fluke data acquisition products: A fresh perspective on cost-per-channel

Fluke's approach to product development has led to some effective solutions to the problems discussed above. Fluke has developed a family of data acquisition products that have a unique signal conditioning input stage. This input stage can be configured easily by the user, in the field, to any input or sensor type that may be required. This system virtually eliminates the need for external signal conditioning because of the ability to configure any channel to accept any input type. This highly flexible programmable input stage also eliminates the problem of having to purchase additional input cards to support a single input type as is the situation seen with mid-sized and front-end systems.



Fluke's data acquisition tools include a Universal Input Module which eliminates the need for—and expense of—external signal conditioning.

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Fluke 2600 Series Data Acquisition Products

	Programmable Signal Conditioning	Communication to PC	Windows Software[1]	Windows Compatible, DOS Based SW	Trend/Plot Included in Software
NetDAQ 2640A 2641A 2645A 2646A	•	Ethernet	•		(Advanced Trending) •
Wireless Logger 2625A/WL	•	Spread Spectrum RF Modem	•		•
Data Bucket 2635A 2635T	• •	PCMCIA memory cards and RS-232 PCMCIA memory card	•[2] •	• •	• •
Data Logger 2625A	•	RS-232	•[2]	•	•
Data Acquisition Unit 2620A 2620A/05 2620T	• •	RS-232 or IEEE 488 RS-232 or IEEE 488	• •	• •	• •

1 With Dynamic Data Exchange (DDE)
2 Using Wireless Logger for Windows software

The Hydra Series (2620A Data Acquisition Unit, 2625A Data Logger, 2635A Data Bucket, as well as the 2625A/WL Wireless Logger) and all 2640 series NetDAQ Networked Data Acquisition Units incorporate this programmable signal conditioning stage. The flexibility of this system ensures that future applications can be addressed easily at any time, without additional expense for signal conditioners. Specifications of accuracy on any channel are seldom in question because the internal circuitry constitutes a closed system with respect to all signal conditioning functions, with no outside influences or inaccuracies contributed by external signal conditioners. Custom, integrated A/D converters and robust multiplexing techniques minimize noise and ground loop effects to known published levels.

All Fluke 2600 Series data acquisition products have 20 programmable analog input channels and supporting software available for configuration, data collection and trending. The 2625A/WL Wireless Logger and all 264XA series NetDAQ products can be expanded to 400 measurement channels. Fluke software products have an intuitive Windows interface which offers "point and click" configuration, setup, and report generation. This interface helps eliminate extensive learning curves and provides the user with setup times measured in minutes or hours instead of days or weeks.

Having an understanding of where hidden costs may lurk in various types of data acquisition equipment can help you avoid unanticipated cost overruns and give you a better opportunity to achieve your project schedule and budget goals.

Fluke. *Keeping your world up and running.*

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