Digital vs. Analog Outputs for LVDT Position Measurement
By Macro Sensors

Process control systems are used in a myriad of industrial applications to optimize operations and ensure a safer, more productive process. Sensors, such as transducers, supply the intelligence for these automated systems, acquiring the data on different parameters, control states and providing feedback in electronic form.

In a process control configuration, sensors convert a mechanical parameter to an electrical signal that is fed into a signal conditioner, which modifies the output signal for further processing, such as into a readout, machine controller or computer. (See graphic 1).

While process instrumentation predominantly uses analog output such as voltages and currents, digital output is gaining preference, as discrete signals are less susceptible to potential interference leading to higher quality and more reliable measurement values, which satisfies the requirements for more complex systems.

Analog Output – How Long the Industry Standard?

For years, analog output and associated process logic controllers (PLCs) have been the mainstay in the industry for process control. Popular applications relating to position measurement include automation tasks such as dimensional gauging ("go/no/go" inspection of complex mechanical parts), servo-loop positioning, valve control monitoring, and manufacturing process control applications.

In these applications, output signals can be voltage (3V, 5V, 10V, +/-5V, +/-12V, +/-15V), current output (4 – 20 mA, 0 – 20 mA) or a combination to accommodate a wide range of controller input requirements.
Photo 1: In an analog configuration, LVDT position sensors interface with single channel LVDT signal conditioners that provide either a low noise 0-10V DC or 4-20mA output for computer readout of dimensional or position measurement.

While voltage outputs are sufficient for many industries, excessive noise generation and voltage drops in specific environments can cause issues for downstream controls. To mitigate this analog voltage signal behavior, the market place has adopted the 4-20mA current output as its sensor signaling standard. This very robust signal allows users to run longer cables from a sensor to the control system with less worry of EMI or noise being induced on the signal. Recalibration to correct for voltage drop due to cabling impedance is also unnecessary.

Analog outputs are generally necessary in environments where digital electronics cannot survive such as in high temperatures. In these cases, an analog signal must be initially generated by an environmentally-resistant sensor for conversion to digital at a benign location.

However, analog output has limitations. Signal can be degraded due to the distance of the cable from the sensor and the operating environment. Certain output signals can experience signal loss or generate noisy signals, which reduces the accuracy of the output. Excessive noise generated from environments such as oil fields and turbines can cause incorrect results and non-linearity errors as analog systems become more complex.

Many of today’s more complex process control systems require communications that can only be delivered by digital output. In these applications, additional signal conditioning and data acquisition equipment is needed to transform the analog output of the transducer into a useable numeric format for use in spreadsheets with other measured results other calculations.

**Digital Output Addresses Limitations of Analog Output**

When sensor signal transmission is critical and networked communications are desirable, digital communications serve as a more reliable and cost effective alternative to analog output.
Digital outputs accurately reflect sensor output and are not subject to cascading errors. With greater immunity to noise, digital systems have a greater capacity to control errors and provide a complete signal from sensors into computer software and other network programs.

In networked communications, digital communications allow for daisy chaining multiple signal conditioners on one bus line and reduce I/C cards, wiring, footprint and installation costs.

One digital network connection can replace multiple analog control wire connections between the process controller and power panels. This configuration is especially useful in applications with a large number of inputs or if each input, or certain ones, must be sampled frequently. A digital RS 485 output supports multi drops where hundreds of devices can be on one bus line.

Similar to the aforementioned assortment of analog signal options, digital transmission is available in a variety of communication protocols and languages (eg. Modbus, CANbus & Ethercat). The added flexibility of these digital systems contributes to the effective design of system integration, while also supporting the prospect of an intuitive interface.

While some engineers may believe that the only reason analog signals have not disappeared is because the engineering world has not agreed upon a single way of powering and communicating, analog communications and control loop process control systems will continue to be used for many years. Selection between analog and digital output depends on a variety of factors including resolution, reliability, environment, redundancy, type of sensors and costs. Why go through the added steps of generating digital output when an application only needs a simple readout?

A comparison of the attributes of analog vs. digital signals can be found at: http://www.diffen.com/difference/Analog_vs_Digital.

How To Go Digital With an Analog Sensor

Digital output can be derived from any standard sensor using an A/D converter or signal conditioner designed to provide a RS-485 digital signal. For example, Macro Sensors EAZY-CAL LVC-4000 LVDT / RVDT Signal Conditioner interfaces with wide range of AC LVDTs, RVDTs, and VR half-bridges and offers customers the option of using either a 4-20 ma analog signal or a digital signal RS-485. Both outputs can be used for different requirements or either based on user preferences. With the use of the RS-485 port, a host computer is able to retrieve measurement data, receive operational status, perform remote calibration, and perform hot swap reconfiguration. Synchronization to other signal conditioners is accomplished by a daisy chain connection to a synchronization bus. One unit will assume the Master function based on DIP switch priority setting. If a fault should occur, the next highest priority unit will take over as Master.

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