wp_Analog Must Go_rB
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Analog Must Go

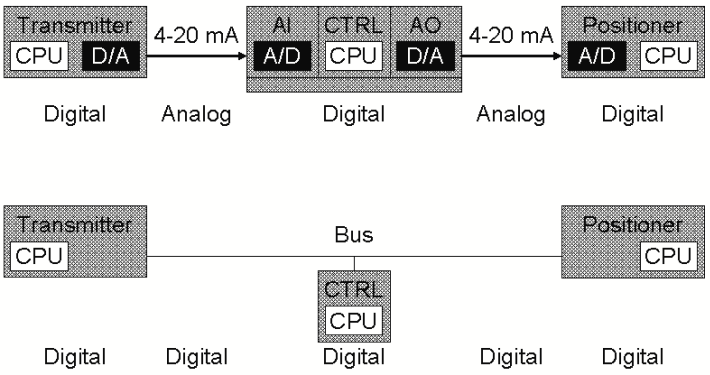
Not only are there advantages of going digital, there are also disadvantages of staying with analog. That is, by forgoing digital communication for instruments, not only do you miss many benefits, you retain problems and procrastinate the inevitable migration. These analog problems also apply if to hybrid "smart" protocols that mix 4-20 mA and digital communication.

Introduction

Not just analog signals like 4-20 mA, but also other hardwired signals such as the discrete on/off, should be eliminated in the control system. An analog signal is a weak link in an otherwise completely digital chain, it affects accuracy, results in slower diagnostics, and is an obstacle to future improvements.

Many parallels can be drawn between the digital developments in the industry with that already seen in the consumer sector. For example, digital audio was first just a matter of making analog storage digital, to enhance fidelity rendering the large LP obsolete. Certainly there were detractors to digital audio, claiming the sound lacked certain qualities. But moving to digital audio enabled a technological revolution, years later when it had established itself main stream. New devices allowed you to copy tunes and compile your own music collection and burn your own disks. Then came MP3 format and file sharing across the Internet (illegal at first, but then legitimate). Soon after came the MP3 players and the compact cassette was also gone, and in no time it was built into mobile phones as well. Many of these things were not foreseen when the CD was first conceived. Similarly, digital in mobile telephony has enabled another revolution. At first it was just a matter of making analog transmission digital, to enhance fidelity. But then text messaging was added, at first just as a missed call notification, but soon adopted by users as an alternative to an actual call. File transfer and browsing followed suit and the mobile phone can also be used as a modem for a PC for to get Internet connection anywhere. Digital photography not only eliminated film to retain fidelity over time, but permits you to view the photo instantly, store, touch up, share over the Internet, selected printing and development etc.

Most properties are measured digitally, processed digitally, stored digitally, displayed digitally, controlled digitally, and even actuated digitally - it does not make sense to transmit them analog when new star-topology fieldbus provides robust digital transmission. The analog domain can in most cases be completely eliminated - it is only a few sensors which are still analog.



Though digital instruments were first introduced to enhance fidelity, they have already enabled many new schemes such as control in the field and firmware download. Initially, on the pure digital

bus solutions, several devices had to share the same wire raising some reliability concerns, but new star-topology schemes get around that. More useful innovations are sure to follow suit.

Accuracy

Measurements from digital sensors such as in pressure, level, and flow transmitters now have very high accuracy, as good as 0.04%. The quantization error alone due to the digital-to-analog and analog-to-digital conversion required for 4-20 mA may be as large as 0.03% plus drift and differences in calibration in transmitter output and system input make a significant contribution to the total probable error of the measurement. Such an error, for example, translates into a large volume for level measurement in a big storage tank. The analog domain must be eliminated to ensure fidelity.

Weak Link

Many possible signal distortions that could occur on a 4-20 mA signal are not possible to detect and will go undetected until manually tested. If loop current is limited to say 17 mA due to increased loop resistance due to corrosion or becomes some other value due to a ground loop introduced by the signal wires getting in touch with a device, conduit, or junction box ground this cannot be detected. Many conceivable faults on a 4-20 mA signal just turn one signal into another valid value that gets accepted by the system. You cannot detect distortions on an analog signal. A system can't tell the difference between a distorted hardwired signal due to induced noise and a genuine process change. The case for on/off signals is even worse as faults such as "stuck" are even more difficult to detect as signal in normal operating conditions remains static for long periods of time. The analog domain must be eliminated to ensure fidelity.

Slower Device Diagnostics

Devices with microprocessors today provide pretty much the same diagnostics because they use the same sensor and transducer modules with the same auxiliary sensors regardless of protocol used or even when the signal is analog. The sensors and transducer modules are therefore designed for the worst case, that is, to operate from 4 mA. However, devices that has completely eliminated 4-20 mA have more current (10 mA or more) and therefore can run the same diagnostics much faster. The 4 mA limitations must be eliminated to provide faster diagnostics.

Future Obstacle

As seen with digital audio, telephony, photography etc. in the consumer industry, it is hard to imagine what marvelous innovations and possibility the future will bring, if you have the platform to use it. Since control systems typically remain in operation for ten to twenty years, putting in analog technology now, delays any possibility of adopting such new technologies as they become available. In the future as sales of pure fieldbus devices exceeds that of analog and smart hybrids, they will no longer be forced to use the same sensors and transducer modules. As it will no longer be necessary to operate on 4 mA, these transducers can have more auxiliary sensors used for better diagnostics and subsequent maintenance savings. More powerful processors enable math intensive algorithms such as FFT (Fast Fourier Transform), for example in analysis of noise and vibration of bearings etc. Analog is not possible for anything where the measurement is more than one single simple number, which limits future instrument possibilities such as sensors for hearing (sound bites) and vision (video clip) in remote applications.

Migrating from hardwire to bus is disruptive and therefore it is tempting to put off modernization to the future. However, by investing in analog, breaking the analog legacy later becomes even more difficult and costly. Using analog the plant will not be ready for future advancements.

Hybrid Compromise

Hybrid solutions such as HART and proprietary instrument protocols combining the 4-20 mA analog signal with slow digital communication, share the disadvantage of analog. Although hybrid instruments still have pretty much the same diagnostics as their pure digital counterparts, this may not be so for long as the pure digital devices are permitted to draw more current, which could soon be used in more powerful devices. Although hybrid instruments provide much the same information as their pure digital counterparts, hybrid solutions invariably have low speed digital communication which makes the retrieval much slower. Hybrid solutions must rely on analog for real-time process signal precisely because the digital is too slow. The slow hybrid solutions mean that these devices don't have features such as firmware download recently introduced in pure digital devices. Thus analog hybrids cannot benefit from easy upgrade of improvements in measurement compensation, diagnostics, and other capability. Plants with a hybrid infrastructure will be missing out on other new interesting possibilities requiring high bandwidth. Low speed hybrids are also obstacles to easy future improvements, as new innovative digital devices and software are only possible with faster buses that are not limited by analog needs.

HART is a compromise that may be utilized when upgrading plants having a lot of existing instrumentation. If in an existing plant all instruments are already HART it may make sense to keep these devices and use a system with HART capability. If all instruments are not HART but include devices with mix of proprietary smart protocol as used by many instrument vendors then it may make more sense to change all of them to one single pure digital protocol. Instruments less than ten years old can often have their circuitry changed to pure digital. Using slower smart hybrids the plant will not be ready for future advancements.

Summary

Analog has disadvantages that can be eliminated using FOUNDATION fieldbus™ H1 or PROFIBUS PA, but not using hybrids.