Control freak

Digital communications, wireless technologies, and smarter drives and instrumentation: it all adds up to better possibilities for automation and control, says Brian Tinham

Technical pointers

- Fieldbus-based plant instrumentation, drives and other equipment now provide powerful commissioning, operations and diagnostics
- Wireless fieldbus has become a reality, aimed at process plant instruments in the chemical, petrochemical and oil and gas sectors in particular – and is set to transform plant networks
- Flux vector variable speed drives not only deliver significant energy savings; they are also far easier to set up and operate
- Drives increasingly feature built-in PLC functionality
- ATEX does not require plant engineers to specify approved drive-motor packages
- Electric motor makers could serve us better by providing clearer reliability data, based on efficiency and temperature parameters

Let's talk about drives, motors and controls – no, not just the technologies for linear or rotational motion control, important though those are, but also control engineering in, for example, transportation, the process sector and the utilities. Why? Because there's quite a lot happening that could make a difference to plant engineers specifying, installing, commissioning and maintaining all of this stuff.

Among the important aspects to highlight here are: digital plant fieldbus communications and their wireless developments; some of the implications of the ATEX Directive for hazardous areas; and recent improvements in drives overall, in terms of set-up and standalone systems. We should also take a look at some of the issues around motors themselves: high efficiency types, reliability, energy costs and premature failure.

Fieldbus first then, because, if nothing else, since plant managers want to reduce wiring and/or carry out remote monitoring and/or control and/or diagnostics on connected equipment, we need to keep updated.

There are several fieldbus types, developed to serve the quite different signalling needs of four broad application areas: process instrumentation and control; drives, switchgear etc; simple sensors; and tightly integrated microcontroller applications, as in CANbus (controller area network), primarily for vehicle systems. Most interesting to us in this context are the first pair.

There are strictly two (but actually three) main contenders for line-powered instrumentation and control – Foundation Fieldbus H1, Profibus PA and good old HART (developed by Rosemount to run over existing 4—20mA wiring more years ago than I care to remember). High-speed Foundation Fieldbus has been adopted mainly in the oil and gas, petrochemical and chemicals industries, while Profibus PA is stronger in the utilities, pharmaceuticals and food and beverage sectors. Both have seen significant hardware development in the last couple of years, enabling, for example, double the number of transmitters/controllers (up to 16) to hang off a single network segment, even in a hazardous area.

What about HART? Well, far from dying, it's by far the most widely sold (although not actually used) instrumentation grade 'fieldbus' protocol, despite its speed and feature limitations. As Gareth Johnston, fieldbus specialist with ABB, puts it: "The vast majority of instruments are still on 4–20mA HART because it's built into most modern instruments, whether you use it or not." And most would argue it's adequate for many applications, certainly remote diagnostics.

Fieldbus fervour

As for externally-powered drives and switchgear, it's Profibus DP – and, well, good old Modbus is still there, too, developed for Gould (as was) PLCs (programmable logic controllers) back in the '70s. Focusing on Profibus, there are several 'profiles' (versions), for example Profisafe and Profidrive, with extensions aimed at the needs of, well, shutdown systems and drives respectively. Beyond that, it's a similar story of improvements in the network coupling devices, allowing, for example, higher speed, event time-stamping, easier set-up and better redundancy.

Just as important for us, there have been improvements with the network diagnostics on both the Foundation Fieldbus and Profibus types – designed to alert engineers to problems in the network wiring itself. "The newer systems sample the network signals, so that engineers can see noise, signal shapes and instruments disappearing off the bus," explains Johnston. "They can also capture as-commissioned 'signatures' for comparison during subsequent operation and maintenance."

None of which turns out to be the primary reason for specifying fieldbus technologies yet. What most users are paying for is reduced wiring, easier and faster electrical commissioning – and only then the remote device and plant monitoring and control, whether it's for instrumentation (mostly

just on actuators and valve positioners), drives, switchgear, motors or whatever.

But very recent developments may change both the reasons for adopting fieldbus and the rate of uptake. On the one hand, proprietary software for device management looks set to come together over the next few months or years, under an initiative dubbed Future Device Integration. That promises to make integration and configuration, irrespective of your choice of vendor's host control system or PLC, much easier.

On the other hand, fieldbus is going wireless, with process systems giant Emerson among the leaders now offering wire-free digital flow, pressure, temperature and level instrumentation connection for plant monitoring and control loops.

Self-organising networks

Mike Ferris, EMEA marketing manager for Smart Wireless at Emerson Process Management, explains that competing parties are using different technologies, but that Emerson has selected "a self-organising, time-synchronised mesh protocol". Why? "Because, if every device on the network can communicate via every other device, there are multiple redundant routes for data transmission – and that's important with plant environments."

Standards body processes are notoriously (and probably necessarily) long winded, but Emerson is working with ISA SP 100 to get its technology (or something close to it) approved as the wireless fieldbus standard. Ferris is clear that this is one of the keys to adoption. Another is user references and testimonials. And there work is already well underway, with BP, among others, running trials. Ferris says these should demonstrate that wireless plant fieldbus works for ISA Class 5 to Class 3 applications (high latency monitoring through to open loop monitoring and control) – although he believes that it could get to Class 1 fast, closed loop control.

Earlier this year, Emerson formally launched its 2.4GHz Smart Wireless solution in Europe, having already introduced the 900MHz version for North America last October. "We're not suggesting using this for real-time control at this stage," says Ferris. "60% or more of plant requirements today are for process monitoring, so we're positioning Smart Wireless for that. Think of all the points you'd like to measure today but can't, because it's too expensive to run cabling, or too difficult to get access on a tower. This will make a huge impact."

And, for the sceptics, here are a few additional observations. First, this is going through the standards bodies now; second, Emerson is guaranteeing an upgrade path to the standard; and third, key aspects such as security and battery life have been well and truly thought through. Battery life for live nodes, for example, is already five to 10 years, depending on application, with the devices quiescent between transmissions – and Emerson is

Above: Emerson's wireless process level transmitter
Left: ABB high efficiency motors save energy and maintenance costs at soya flour firm Cereform
Far left: ABB drives provide accurate process control at Shotton Paper

Reliability labelling for electric motors

The electric motor industry is being urged to provide clearer reliability data. ABB is driving the initiative and, while general manager Steve Ruddell concedes that the main reason for premature failure is winding breakdown, followed by bearing failures, he insists that engineers need to have transparency into the root causes.

"We believe that many of these failures are a result of motors running too hot. You may be told that your bearing has run dry, but while in some instances this may be down to poor re-greasing, it is also possible that the motor was too hot."

He also warns that motor efficiency ratings (Eff1, Eff2 and Eff3) are being taken as a measure of reliability. "Our experience shows some motors achieve Eff1 status at the cost of significant drawbacks," he says. "These manifest themselves in many ways: increased running temperatures and excessive noise being a couple of examples."

And he has another point: "IEC34-2 sets tolerances for efficiency, which are quite wide. We fear some manufacturers are declaring efficiencies that are at the uppermost of the tolerance band, while delivering motors close to the lower level."

ABB proposes that reliability be defined as the sum of efficiency plus temperature rise, arguing that these elements directly affect the quality and reliability of any motor. The company adds that getting the right balance between efficiency, temperature rise and noise will go a long way to lowering life cycle costs and increasing overall reliability.

Incidentally, a new guide to preventing electric motor failure and reducing energy costs has been published by Whitelegg Machines and Baker Motor Test. The book covers motor monitoring, the benefits of predictive maintenance, points about live and out-of-service monitoring, useful instruments available and energy-saving prediction calculations.

Jeff Whiting of Mitsubishi: "Control is moving to fieldbus"

already into power-scavenging research, which promises to recharge batteries by harnessing, for example, plant vibration and temperature differences.

Returning now to drives, Mitsubishi commercial manager Jeff Whiting agrees that fieldbus represents one of the biggest changes. "Control is moving from hard wiring towards fieldbus connectivity, although not commonly enough, considering the benefits. Wiring costs are lower, because you daisy chain to a number of drives; you get better matching between units; and it transfers all drive data for reporting and control. That means you can look at trends, determine the status of running equipment and do condition monitoring, all on the digital line."

But he also cites other key developments. "The 'usability' of drives has improved no end, because of better drive intelligence and user interfaces. A few years ago, flux vector drive commissioning was a specialist job, involving specifying load inertia, power ratings, poles, inductance and so on. Now, they practically commission themselves."

Not only that, but prices have fallen (about 30% in three years) due to rising sales volumes as users cotton on to the energy savings – themselves still improving as drives map themselves more dynamically to motors. Also, drive ranges are being unified—all the way from the low-end 0.4kW to 850kW in Mitsubishi's case – making training easier. And the future now promises better semiconductor materials, resulting in potentially half the current IGBT switching losses – meaning even better efficiencies. As Whiting puts it: "Half a per cent out of a megawatt drive saves a lot of carbon."

One more point: whereas, to date, Emerson Control Techniques has dominated the market with plug-in control modules, PLC-type functionality is being embedded by Mitsubishi, Hitachi, ABB, Siemens and others. One example is Weg, which has introduced a master CANopen sensor bus on its Vectrue CFW-09 series – enabling the inverters to handle digital control tasks, positioning and synchronisation in applications such as pump control, without the cost of separate PLCs and power supplies.

Cheaper but better

But there's another interesting development set to impact engineers' choices of motors. Stuart Harvey, managing director of Silverteam-Hitachi, says that, whereas to date engineers have had to specify higher cost inverter-rated motors in order to prevent the peak RMS voltages at the motor terminals causing premature failure (dV dt), that will soon change. "We're working on faster operating IGBTs which suppress the motor terminal voltage to two times the RMS maximum, as opposed to the usual four. So users will be able to buy less expensive motors and still get the design life rating."

Finally, what about motor/drive combinations and ATEX (from the French, ATmosphere EXplosible: Equipment and Protective systems for use in Potentially Explosive Atmospheres)? Silverteam's Harvey believes that drives and motors vendors are guilty of scare mongering. "They're basically saying 'ATEX is very complex and you're going to have to use our packages'. But it doesn't matter whose you use – IMO, Fuji, Omron, Hitachi – we all measure the motor core temperature using embedded thermistors."

Eriks Zvaigzne, sales support manager at Brook Crompton, agrees: "There's been a lot said about hazardous areas, but our motors are suitable for use with anybody's inverters, provided they plug in the thermal protection."

It's simply about ensuring the surface temperature of the motor (extrapolated from the thermistors embedded in the windings) doesn't exceed the cut-offs prescribed for the various gas/vapour ignition temperature groups – 135C for T4, 200C for T3 and so on.

Beyond that, from the motor type and cost standpoint, selection still has to be linked to the designated hazardous area class (Class 1 for vapours and gases; Class 2 for dust explosion risks) and zone – flameproof Ex 'd' construction for Zone 1, and type Ex 'n' and sometimes 'e' (non-sparking) motors for reduced hazard Zone 2. PE

Profibus DP fieldbus helps Corus stay on track

ABB inverters, with fibre optic links running Profibus DP, have been proving the power of plant fieldbus communications at Corus' Shotton steel works. They're a key component of its automatic transport systems that position coil shuttle cars ahead of the hot dipping production lines.

The shuttle cars have two axles, each driven by a 45kW induction motor, in turn driven by the drives, controlled by an onboard PLC. In action, the PLC sends a distance-dependent speed reference to the master drive over Profibus DP, which positions the cars to an accuracy of 5mm. The designers specified encoder feedback to give accurate dynamic control of the motors, even at low speeds.

The master drive runs in speed control mode, sending a signal to the follower drive, running in torque mode. That allows for load sharing between the two axles, minimising risk of motors overheats and trips. Phil Tomkinson, of system builder Radway Control Systems, says that using a fibre optic link between the drives ensured a fast response, keeping the drives in step and the motors at the same speed.

As for the fieldbus link: "We used the drives' Profibus DP option to maintain commonality with the communication used in the rest of the system," he explains. It also meant the system could send inverter diagnostic and status information to Corus operators' screens.