The Digital Drive

Jonas Berge explains how variable speed drives can become an integral part of the digital plant architecture.

The final control element that first comes to mind for process applications is the control valve, but variable speed drives (VSD) – also variously to as a variable frequency drives (VFD), adjustable frequency drives, or frequency converters – are also used as final elements in closed loop flow or pressure control.

Some of the traditional process-industry applications for AC drives include control of pumps for water and other liquids, fans and blowers, and conveyor belts for coal, timber, ore, and other raw materials as well as finished bulk products like cement or byproducts such as ash. Other applications include compressors, extruders, mixers, agitators, chippers, and mills.

A few variations of the makeup of a single or three-phase AC drive exist, but the main building blocks and principle of operation are the same. The mains AC supply is first converted to DC by a rectifier. An intermediate circuit next filters and regulates the DC level. Lastly the inverter converts the DC to AC output at a frequency corresponding to the remote setpoint from the control system to achieve the desired speed, and voltage for optimal magnetization of the motor.

The output waveform generation technique is the main differentiator between AC drives. The principal component in a modern inverter circuit is the insulated gate bipolar transistor (IGBT), a power semiconductor (which often take the place of the earlier thyristors) to switch the DC to AC.

When it comes to setup, the sheer amount of configuration options available in a variable speed drive can seem overwhelming to technicians who have to commission them. A drive can have hundreds of parameters to customize AC motor controls for different applications. Most AC drives also have useful diagnostics about the motor and drive system and some even have predictive diagnostics.

To help technicians more easily setup applications and diagnose problems, drive manufacturers now use electronic device description language (EDDL) to make drives easy to setup and diagnose by defining how the drives are displayed in the system.

Bus technology and EDDL provide the ability to integrate instrumentation and controls with electrical and switchgear, enabling plants to freely select control system and electrical system independently, yet enjoy the ease of use as a result of tight integration.

Taking the bus

Drives have many control signals from the DCS as well as discrete and analog status feedback signals to the DCS (see Table 1). Hardwiring all of these individual signals can be very expensive.

Besides this large amount of wiring, such traditionally hardwired systems typically require many analog and discrete input and output cards, and many system tags for each drive. Lots of engineering work is required to size and plan the I/O and labor for installation and testing. Changes late in the project often require major rework and cause delays.

Due to these high costs, many signals are often not connected. As a result, drive capability is not fully utilized, and plant personnel are left without the opportunity to better manage the drives and control the process because key information is not conveyed

Bus technology offers a better solution: using a

Control Signals from DCS	Feedback Signals to DCS	
• Reverse/forward direction • Jog • Shut-down • Several preset speed selectors • Several acceleration and deceleration selectors • Clear fault • Local/remote • Auto/manual • Increase speed • Decrease speed • Preset stop selection • Several different speed sources	• General fault alarm • Speed switch • Frequency switch • Temperature switch • Motor current switch • Torque switch • Overload • Line loss • Running • Drive ready • Running forward • Running backward • Breaking • Remote	• Frequency • Motor current • Torque • Power • Voltage • Speed error • Controller setpoint • PV • Error • Controller output

Table 1: Typical variable speed drive control and feedback signals.

single pair of wires for many drives instead of many pairs of wires for each drive. This eliminates a huge amount of cable, conduit, tray, marshalling, installation, I/O cards, and testing – significantly reducing project cost.

Each bus cable can support all the control and feedback signals for multiple drives, as well as providing access to remote configuration and diagnostics. And these latter functions can be done without opening the electrical panel. Because signals are "soft" marshalled, last minute changes to the project are easily accommodated as no I/O cards have to be added or wiring laid to connect additional drives or incorporate additional control signals or status feedback from a drive in the control strategy.

Managing devices

Many process plants use different bus technologies for different applications: A typical installation may use Foundation fieldbus for process control and alarms, hardwired Hart for instruments on safety systems, WirelessHart for indication, and Profibus-DP for motor controls.

As a result, technicians may be required to interact with multiple technologies in order to maintain a mix of different kinds of instrumentation like pressure and temperature transmitters and valves, as well as motor controls including drives and motor starters.

In the past, hand operation, drive configuration and diagnostics were often done locally in the electrical equipment room from a small local display and keypad on the face of the drive, or using specialized software and cables for each manufacturer's drive. More than one software application, each with its unique look and feel, would be required if small and large drives come from different manufacturers, and as drives from other manufacturers come into the plant as part of maintenance replacement.

But it is difficult for technicians to master different programs for each brand or type of device or drive, slowing work down. The software and diagnostics may even fall into disuse. Additionally, there is the issue of gaining IT department approval of each software application and keeping it up to date. Device-specific software drivers accessed from within one shared frame program have the same problems.

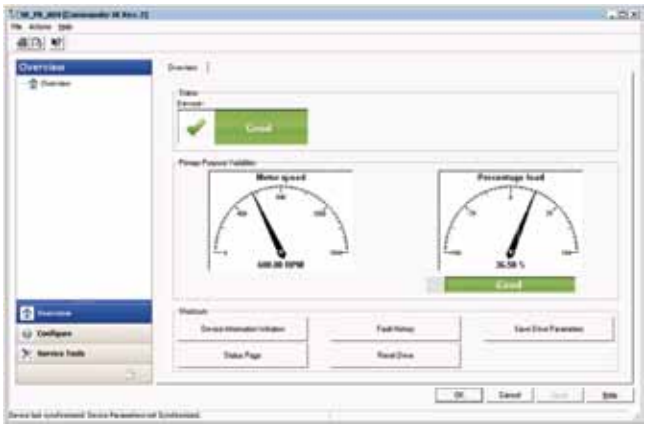
The EDDL standard (IEC 61804-3) provides a solution to these problems. Electronic device description language is the only device integration technology which is an integral part of the Hart, Foundation fieldbus, Profibus, and WirelessHart standards. EDDL (www.eddl.org) enables all devices using these protocols to be managed from the same intelligent device management software throughout their life-cycle. That is, the same universal software that manages the drive over Profibus-DP also manages instrumentation on Foundation fieldbus, Hart, and WirelessHart.

This means that variable speed drives can now be commissioned, configured and diagnosed from the same intelligent device management software as the plant's field instrumentation – software that also provides around-the-clock device alert monitoring.

Look & feel

Because EDDL uses a standard text file format, support for a new drive type can easily be added by simply copying its EDDL file onto the computer, without need for the challenges associated with software installation, and no license key administration. Keeping the system up to date with new devices is easy. Moreover, because EDDL files are not driver software, they are not made obsolete by a new Windows version, and conversely, new EDDL files do not make the workstation operating system obsolete, protecting investments in devices and systems.

EDDL files do not interfere with files for other devices or with software on the system, thus maintaining robustness. EDDL is therefore the only device integration technology permitted on the DCS itself – for instance, to display critical diagnostics that enable



An at-a-glance overview of drive operation and health via EDDL gauges on the dashboard.

operators to distinguish a drive problem from a process problem.

Because the device management software renders the displays for all devices with the content and structure defined by the manufacturer, but with a common look and feel regardless of manufacturer, type, or protocol, the mix of devices is displayed consistent and is easy to use.

With EDDL, there is no need to install and learn many different programs for device diagnostics and configuration, thus making it easier for technicians to manage the great mix of devices in the plant and complete their work faster. Intelligent device management software will become a natural part of daily work practices.

Drive manufacturers have started to use EDDL to define how their drive is displayed by the control system. Drives digitally integrate with the DCS and the intelligent device management software, making use of their visualization software, alarm and event logging, audit trail, and historian. A separate system is not required. That is, all device alerts can be seen in one place. When a drive fault is detected, the drive can be checked from the device management software without going to the equipment room or opening electrical panels.

Existing intelligent device management applications can also be upgraded to EDDL without having to change the devices. For systems that do not yet have device management software, there are several ways to add it to a system, including gateways, multiplexers, and wireless adapters.

Technicians' tasks

The consistent displays provided by EDDL make it possible for the system to deliver the information that technicians need to maintain devices and drives.

For instance, human interface displays are task-based, with the device overview page using easy-to-read dial gauges to display overall status and operational information such as speed and load. And an additional view also identifies manufacturer, drive model number, rating, version, and includes a product photo to help in locating the drive in the equipment room.

When it comes to setup, a drive is a sophisticated device, and depending on the application there are many settings to be made. However, EDDL wizards created by drive manufacturers' experts can guide the technician. He can, for example, choose fan/pump, compressor, conveyor, or general application and then follow the wizard step-by-step in entering only the required information.

The wizard shows only valid options based on prior selections, and verifies entered values. In this way, the technicians are not misled or confused by irrelevant settings, and they cannot miss required entries. Time is saved by reducing mistakes.

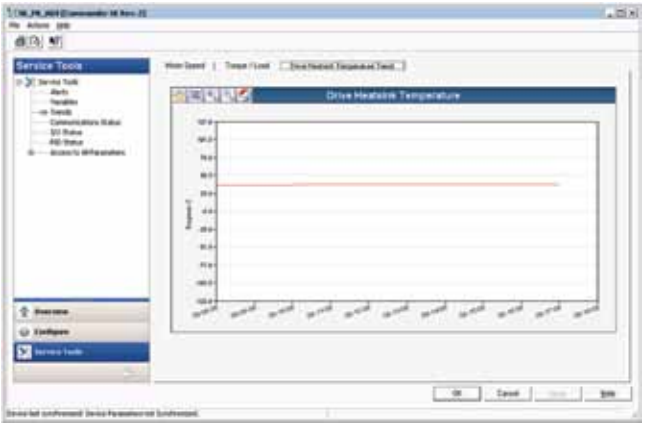
For setup, driver-manufacturer-created wizards with help text and illustrations guide the technician step-by-step

On screen, identification information, setup parameters, and diagnostic indicators are labeled with readable descriptions rather than cryptic mnemonics or just the numbered registers of the past. Help text and illustrations give plant technicians access to the know-how of the drive manufacturer's specialists.

Drive diagnostics include alerts for low AC supply voltage, loss or imbalance of phase, motor and breaking resistor over current, over speed, excessive mechanical load, overheating of IGBT or motor, high heat sink temperature, and motor too small for drive.

Drives have internal variables such as heat sink temperature and load/torque which are useful for troubleshooting but which generally are not logged in the DCS or historian. However, EDDL trend chart displays shown in the device management software make it easy to follow temperature increase over time or correlate to certain conditions.

For "hand operation", the operator can override the control system signal from the device management software, taking control of the drive just like setting speed from local keypad on the face of the drive, but without going to the equipment room or opening electrical panels.



Trend charts make it possible to correlate drive temperature to speed, torque, and load.

Digital advantage

Bus technology in combination with EDDL offers a number of advantages over individually hardwired signals. These advantages range from lower installation cost, shorter commissioning, and greater flexibility to accommodate late changes, to setup and diagnostics from the control room.

EDDL wizards, graphics, hierarchical menu structure, and easy-to-read labels also help technicians save time and avoid errors. As a result, intelligent device management software and diagnostics will become a natural part of daily maintenance practices.

Seamless integration of motor controls with the DCS, even if they come from different manufacturers, is also enabled by EDDL. Plants are no longer forced to buy the control system and electrical system from the same supplier to get tight integration between the systems. Variable speed drives become an integral part of the digital plant architecture that uses the power of field intelligence to improve plant performance. **CEA**

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