Lower cost wiring underlines
The role of the bus

THE LARGE PROPORTION OF MACHINE BUILDING TIME TAKEN UP BY WIRING CAN BE CUT CONSIDERABLY USING BUS SYSTEMS, WITH BENEFITS ALL ROUND. BY SIMON MARSDEN*

Electrical wiring takes up a large proportion of the time taken to build a machine, particularly where field devices, such as sensors and actuators, are mounted on the machine or line some distance from the central control cabinet.

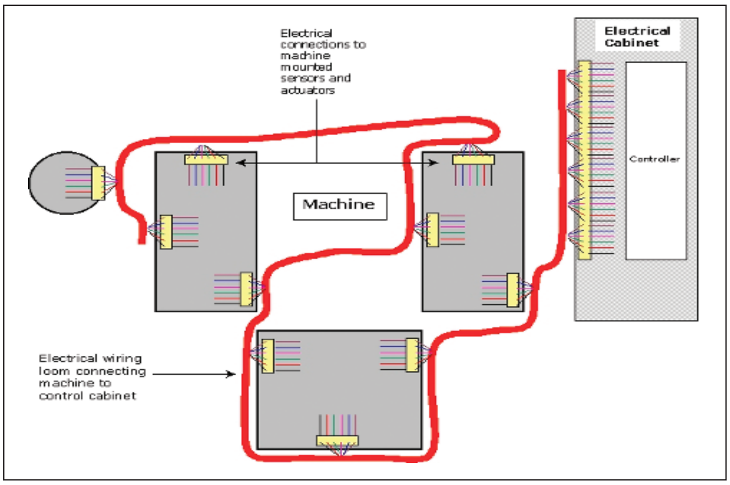
Up to fairly recently, the most common practice of wiring these devices has been to collate all the field wiring and install it into looms or trunking, which is then secured around the machine and run back to the control cabinet.

However, wire saving devices, such as remote i/o bus systems (or fieldbus), overcome many of the issues associated with building up and laying large electrical looms around the machine and are now providing benefits to the machine builder and, ultimately, the user.

They are easy to install, can be readily modified or added to at a later date, significantly reduce build and installation times – with savings of 15-40 per cent compared with traditional cabling methods – and are extremely cost effective, with a typical cost 'per node' (i/o device connected) in the region of £10-£15, including the engineering.

Considerable manual work

Traditionally, connecting machine mounted sensors and actuators to the control system of the machine involves a considerable amount of manual work. First, the components are wired into a locally mounted terminal strip or junction box. Next, wires from the terminals are collated and brought together in a loom which is looped around the machine, connecting up the remaining sub-assemblies. Finally the wiring loom is fed back into the control cabinet.



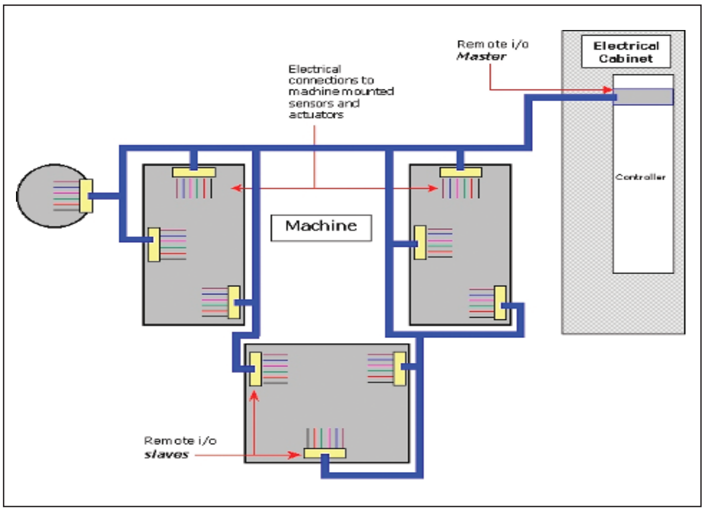
Hardwired: *Traditional wiring loom involves considerable manual work*

Once inside the cabinet the loom is broken down into individual wires, which are again wired into some form of a terminal strip. From here another set of connections are made between the terminal strip and control system, such as the i/o module on a PLC.

The manual work involved is both time consuming and does not readily lend itself to modification in the future. Additionally, with this number of connections there is always the possibility of introducing errors.

During the stages of machine design, building and installation packaging machinery manufacturers will often need to make various changes such as, for example, fitting additional sensors. So how are they connected electrically into the existing control system?

Ideally, any new wiring will be run through the original loom to adhere to good wiring practices and ensure protection. However, space and the distance travelled by the loom could mean this is by no means straightforward and a new loom will need laying – particularly troublesome if the machine is installed and in use.



Fieldbus system: *Offers huge reduction in electrical wiring*

In another situation, the machine may need to be broken down into smaller manageable sub-assemblies suitable for shipment to site. If this dictates removing or disturbing the electrical wiring, there is always the possibility of introducing errors during rewiring on site.

Fieldbus networks

To overcome these issues, many control systems suppliers now offer a range of fieldbus networks. These systems generally operate over two or four wires, with individual devices connected over this network allowing communications back to the central controller.

The immediate benefits are obvious: a huge reduction in wiring around the machine, with the use of wiring looms significantly reduced. Additionally, the system can be easily modified should any additional devices be required.

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What's more there are few restrictions as to where these additional devices are physically connected on the fieldbus system, since each component has its own unique address or register in the control system.

Indeed, some fieldbus systems offer advantages other than simple labour saving, with advanced built-in diagnostics and maintenance functions providing the user with detailed information on the serviceability of the system, without the need for additional programming.

The basic way in which these fieldbus systems operate is on a master/slave relationship. The remote master continually monitors the status of each individual slave device connected to it, then updates the CPU. At the same time, via the remote master, the CPU can turn individual slaves – or addresses – on or off as required by the control software.

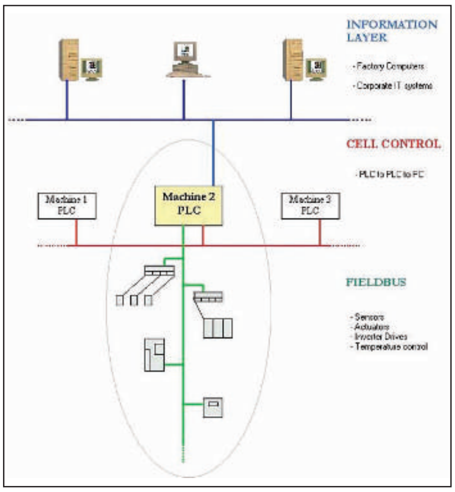
Timing restrictions

However, it is important to recognise that fieldbus systems operate on a cyclical basis and therefore have some timing restrictions. Therefore, the following examples need to be carefully considered when designing a control system using a fieldbus system:

If a slave device changes state immediately after the remote master has interrogated it, the control system will not register the fact until the remote master has completed another cycle, or scan. Therefore the control system can lag the i/o devices by as much as one scan, which could be several hundred milli-seconds! Additionally, in some fast applications, slave devices could change status several times during a single scan. In many control systems these situations would be unacceptable.

Fieldbus scan times can vary depending on which fieldbus technology is used – some being faster than others – the number and type of slave devices connected, and the control system software

Device level bus systems, some times termed bit bus, provide simple logic control and are therefore well suited to sensors and actuators.



Communications network: *Linking the machine into the factory wide information system*

Here only small sized packets of data are transmitted and received, although some device level bus systems also offer enhanced capabilities such as the ability to configure and collect data from connected devices.

In some applications, bus systems may be required to operate at 'cell' level; these tend to use medium sized packets of data for applications requiring increased communications and data handling capabilities. This could include supporting transmission of time-critical data between a number of processors or intelligent devices.

Other communications systems require large size packets of data, especially where complete process or factory control is required. In these applications, numerous separate tasks may need co-ordinating, where advanced configuration, data collection, scheduling and control is performed. These systems tend to be IT based, linking factory automation systems to computer networks, such as at the enterprise level, using Ethernet communications.

Communications standards

There are many fieldbus systems on the market suitable for device level control, the majority of which are open – the communications protocols are well documented and readily available – and conform to pre-determined standards.

In meeting these standards manufacturers submit their products to the relevant fieldbus governing body for testing to ensure compliance. Once approved, a product is listed as being compliant. Therefore, selecting components from this list guarantees compatibility.

At device level, no one standard will suit all applications – choosing between them depends on individual circumstances.

Considerations include the amount and type of data to be transmitted; speed of response of the system; complexity of control required; and ensuring the components required for the application are adequately supported from a range of control system suppliers. ■

Examples of fieldbus systems

DeviceNet: Originally developed by Allen Bradley in the early 1990s, deviceNet is now well supported by the majority of leading control system vendors.

Designed for device level control, such as sensors and actuators, it is aimed at ease of installation and low cost per node (the connection for each i/o device). However, even though it is a relatively simple system it is still capable of interrogation and diagnosing field devices. Additionally, some suppliers allow masters-to-master communications.

AS-I (Actuator-Sensor Interface): As the name implies it is designed for device level control and features plug-in electromechanical connections. It operates over a two-wire cable carrying data and power over a distance of up to 100 metres, more if repeaters are used. Like DeviceNet it is a low cost solution designed with simplicity in mind.

Interbus: This is a high performance, ring-based, distributed device network for manufacturing and process control, which is supported by over 300 third-party i/o device manufacturers worldwide.

Profibus (PROcess FIeld BUS): This was introduced in the late 1980s with Siemens backing, for applications in manufacturing, process and building automation. It is now widely supported by thousands of vendors and components alike. Variants of Profibus allow its use at device level, or at production and enterprise levels and process control applications needing complex communications capabilities.

Ethernet: Finally, it is worth mentioning Ethernet as a means of control.

Developed in the early 1970s by Xerox Corporation, it was first used to link computers to printers. Since then it has become the most popular and widely deployed network technology in the world.

Industrial Ethernet is becoming increasingly used in factory environments for linking manufacturing information and production control systems into corporate IT systems.

Although not yet widely adopted at device level , it was logical that this technology would migrate down to this level. This is especially interesting, since machines and devices using this technology can be remotely monitored in 'real-time' over the Internet.