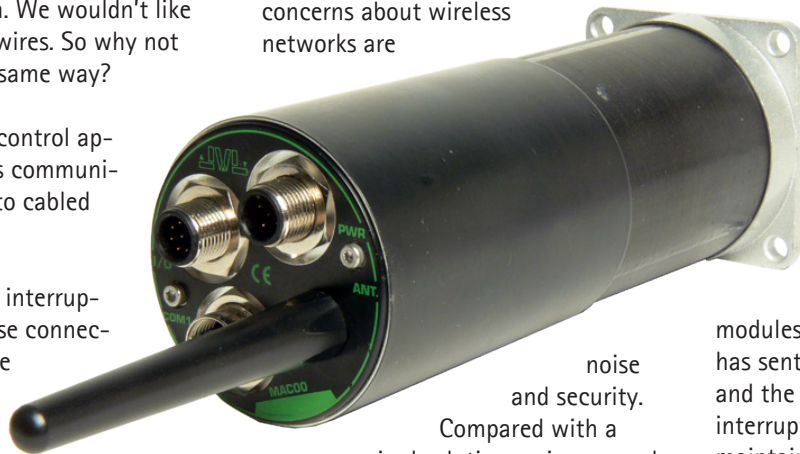# Wireless motor communication really makes sense

People generally move around freely and use wireless communication such as voice and vision. We wouldn't like to be tethered by wires. So why not use motors in the same way?

For many motion-control applications, wireless communication is superior to cabled solutions.

There are no cable interruptions, no more loose connections, and there are large savings to be made during installation and maintenance. The system is more portable and it's easier to switch equipment as well as enable hand-held remote control. Wireless communication provides distributed intelligence and is environmentally friendly.

What about noise?
Two of the most common concerns about wireless networks are noise and security. Compared with a wired solution, noise can only arise in wireless networks in the power cable – it's the only cabling. Power cable noise can in seldom instances cause operational interruptions or breakdown (exactly as wired solutions can). What then about radio-noise? For example, cellular phones and wireless data communication can emit a lot of noise that can delay communication and cause information to be re-sent, but only in the very worst cases do these break communication entirely. However it is important to address such situations and therefore we have included our nano-PLC in all wireless modules. If the master in a network has sent one or more run commands and the communication is delayed or interrupted, the intelligent motor can maintain operation itself and handle the situation until the connection is restored.

What about security?
Can third-parties easily break into a

High-speed MODBUS in MAC400 and MAC800

The latest firmware for MAC400/800 now supports the MODBUS RTU protocol. The implementation supports Read Holding Register and Write Multiple Register commands, which give R/W access to all motor registers at speeds up to 1 Mbit/s, even though standard PC speeds of 9600, 115200 and 230400 bits/s are typically used. The firmware uses the original V1.1 version of the MODBUS protocol for maximum compatibility. For systems that require a 2-wire RS485, use a MAC00-P4 expansion module. For 4-wire RS422, use a MAC00-FSx or MAC00-Bx module.

MODBUS is generally regarded as one of the most used protocols for serial communication in industry today.

Absolute multi-turn encoders in MAC400/800

Both MAC400 and MAC800 are now available with the same type of built-in absolute, multi-turn encoder, with a multi-turn resolution of +/- 2048 complete revolutions, and a single-turn resolution of either 8000 or 8192 (via software selection) with the possibility for higher resolutions.

Motors equipped with absolute encoders will remember their position even if the supply voltage is interrupted, thus making unnecessary any reference run at re-start. Position is stored using a cogwheel so that problems due to exhausted batteries or memory that loses its information do not arise as is the case with other systems.

The complete absolute encoder position is always available to a PLC via any of the serial interfaces or types of fieldbus.

18th-century music recreated

JVL MAC motor drives drums for laser decoding of music

Tom Feilberg of The Royal Danish Collections and Ture Bergstrøm of The Danish Music Museum are in the process of a remarkable restoration of a bureau that once belonged to Danish King Frederik V.

The bureau, which is very large and only just fits in a 4-metre high room, was built in 1757 and executed in the Rococo style. The bureau contains numerous drawers, mirror cabinets and intarsia work. It was an extremely expensive undertaking for its day, and is known to have cost some 6500 Rigsdaler, a fortune at that time.

The bureau at Rosenborg Castle

This bureau also contains a large music box which is mechanically driven by lead weights and contains two large drums with pins. When the drums rotate, the pins could open valves to 24 wooden flutes and activate a 38-string harpsichord. A selection of 14 melodies could be chosen for the flutes and 10 for the harpsichord.

The two large drums for the flutes and harpsichord

In addition, the bureau contains a clockwork (without clock-face) which, driven by its own drum, activates a series of 12 trumpets to mark the time.

Trumpet work with the 12 trumpets

The 24 wooden flutes

The bureau was constructed by the highly esteemed cabinet maker C.F. Lehmann from southern Germany, and the flutes, which are activated by artificial wooden mouthpieces, were made by German constructor G. Crone.

The music box is quite unique in that it is the earliest known type with more than one instrument and uses real wooden flutes instead of organ pipes.

The mechanism does not work anymore as the drums have suffered some damage and neglect over the years, are partially deformed and have become oval. The harpsichord is completely missing but a search is currently on to find it.

Tom Feilberg and Ture Bergstrøm have however embarked on decoding the music on the large drums so that it again can be recreated and heard more than 250 years after it was originally laid down.

To achieve this, the drums have been mounted on bearings and are rotated by a MAC140-A1 motor equipped with module MAC00-B1 and HTRG planetary gear. The drums are rotated at

a rate of 0.5 RPM, which corresponds approximately to the original speed.

With each revolution, the location of a single row of pins around the circumference of the drum is determined with a resolution of 75000/revolution. This is achieved using a scanner from Scantech, who also supply the required software. The location of each pin is determined by the MAC motor's encoder. When all consecutive 24 circular rows (in the case of the flute instrument) have been decoded, an electronic 'image' of the music is obtained. This is then exported in text format and thereafter converted to midi music-format. In the transforma-
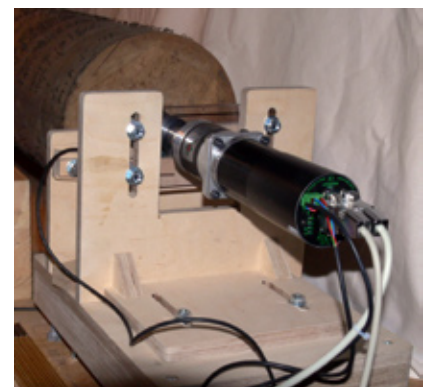
MAC motor and HTRG gear that rotate the drums
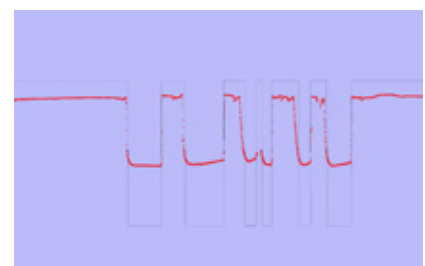
Excerpt of encoding on the drums. The individual position and duration can clearly be read and digitalized.

tion, however, substantial mathematical correction of the data is required to compensate for defects in the drums.

At JVL, we have been very pleased and interested to take part in such a project, where the latest technology is being used to preserve part of our Danish cultural heritage. Already a large portion of the music hidden away in the drums of this beautiful antique has been recreated.

wireless network? Bluetooth (BT) offers the possibility of a password of 1...14 characters and can be configured as 'invisible' so the network does not appear if scanned for BT equipment. And like one's own private wireless network, WLAN offers several features for security and supports strong encryption. The 802.15.4 standard operates with 64-bit node-IDs and passwords.

In summary, it can be said that wireless motor communication is not well suited to high-speed applications or precise synchronisation of many axes — or if the highest degree of security against break-in/hacking is required. In all other situations wireless motor communication is worth considering.

New wireless module
The newest JVL wireless communications module, MAC00-FZ4, provides an energy-efficient and environmentally friendly means of motor control.

The unique advantages of this new module are its basic simplicity, its ability to address a large number of motors from a central control computer, and the further means to operate in a 'mesh' network using the ZigBee protocol and robust IEEE 802.15.4 wireless technology. The extremely low power consumption also makes this technology ideal for battery-driven remote control, where battery life can be measured in years, not days or weeks.

Which type of wireless network should I choose?

Bluetooth
MAC00-FBx interface modules use Bluetooth protocol. This is the most simple and most standardised protocol used, e.g. in cellular phones and PCs. Bluetooth is a natural choice for small installations with up to 7 motors within an unimpeded range of up to approximately 150 m from the controller.

Suitable remote controls and cellular phones with Java applets can be used as control units, but a PC with built-in USB can also be used as an inexpensive solution.

Wireless LAN (WLAN)
MAC00-EWx interface modules use WLAN technology, known from home and office networks. This technology is far more advanced than Bluetooth and supports a far greater number of motors, up to several million on a single network. It can be configured to operate with most existing WLAN networks and supports strong encryption, DHCP and many other established technologies.
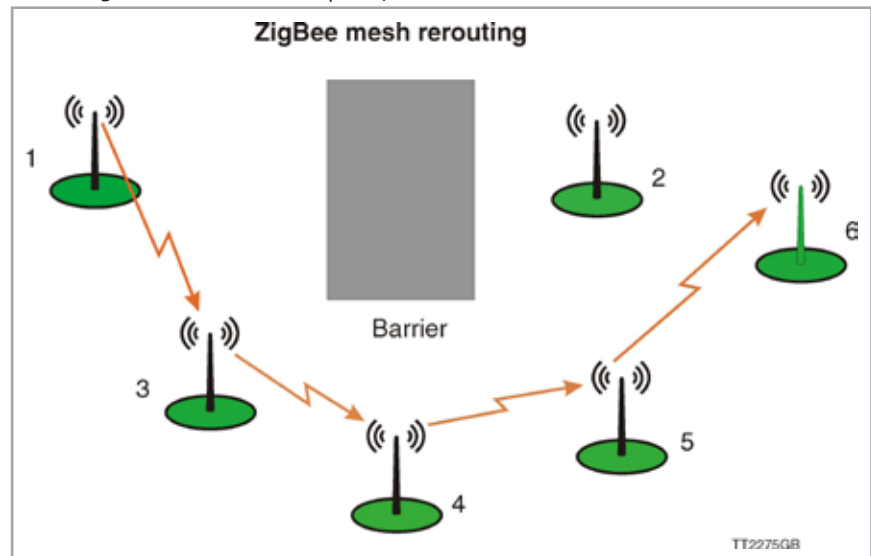
Remote diagnostics and control can occur over an existing Ethernet and it is possible to even connect a motor via the internet using suitable standard equipment.

The complexity of WLAN set-ups and maintenance means that it is well-suited for organisations with IT capacity.

If the many, numerous features of a WLAN system are not required, other wireless technologies may be a better option. Many organisations use WLAN for development and switch to simpler technology in the final product.

The IEEE 802.15.x standard
MAC00-FZx interface modules are based on the wireless communication standard IEEE 802.15.4. In brief, this standard uses 12 different frequencies, called channels, to control up to 12 individual networks within a range of a few hundred metres. The standard describes three frequency bands. MAC00-FZx modules use the 2.4GHz band which in most countries can be used without a license. The data bandwidth is low but this is intentional, since the

standard is made e.g. for building automation, where low power consumption is important with battery operation and speed is less critical.

ZigBee
It is possible to install additional firmware in the FZ4x module to enable a higher-level protocol called Zig-Bee which is a good choice for Mesh networks. A mesh network resembles a spider's web or fishnet. Data traffic passes through a mesh network and automatically finds its way to one or several nodes. If the network is changed or some nodes are out of operation, it repairs itself by routing through other nodes. It is thus far more robust than networks with static transmission paths. In a mesh network, data from the first node can reach any other node independent of distance providing there

are sufficient transmitters/receivers.

More information
For broader insight to wireless communication, visit JVL's web site and read about the many applications where wireless communication provides the solution when combined with JVL's integrated motors and their significantly superior reliability.

Motor/Gear combinations

JVL motors with gears for almost any application

With JVL's integrated motors, it is easy to select gears from a wide selection for any application — worm gears, low-cost planetary gears, precision planetary gears with high performance and backlash-free robot gears.

Worm gears
If cost is important and you also require a 90 degree angle, worm gears should be your first choice.

Use the MAC141-A1AFAG which is a standard MAC141 motor with an 8 mm shaft and round flange: it fits directly onto all HFOS worm gears.

Low-cost planetary gears
If the application is cost-sensitive and you do not require high-performance and precision, the HMGH planetary

gears are the right choice.

Precision planetary gears
When you need an honest, hard-working planetary gear, consider our HTRG series.

We can provide these gears with a standard backlash of 15 or 10 arcmin (1+2 stage) and also with high-precision reduced backlash of either 5 or 3 arcmin.

Backlash-free robot gears
Combine a bearing and backlash-free gear in one unit with the HSPG Spinea robot gear.
Unbeatable specifications and performance have made companies such as KUKA and ABB use these gears in their robots, which must operate perfectly around the clock, seven days a week. These gears are also very well-suited for turntables, antennae, cameras, radar installation, and e.g. tools in moulding machines.
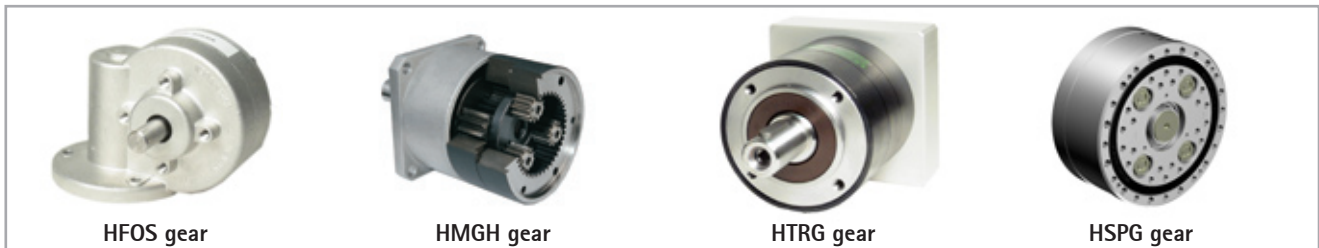
HFOS gear	**HMGH gear**	**HTRG gear**	**HSPG gear**

JVL on tour in the USA

Our agent in Michigan, USA, H.H. Barnum, has equipped a large bus as a mobile exhibition to showcase a selection of JVL's product range. The bus has visited a very large number of leading companies in the states of Michigan, Ohio and Indiana throughout the summer.

Our man in the USA, Mike Fischer, reports a very enthusiastic reception of JVL's products. We have great expectations of the American market and regard this well-received tour as evidence of our representative's confidence in JVL products.

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