Plant Services

SPECIAL REPORT

# Wireless digital switches enable new control possibilities


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Creating Industrial-Grade Switch Solutions without Cables

Plant Services
SPECIAL REPORT

**CONTENTS**



# *Wireless digital switches enable* new control possibilities

Until recently, there has been little available in the way of wireless devices for generating and receiving simple “on-off” signals

**By Peter Engstrom, Steute Industrial Controls, Inc.**

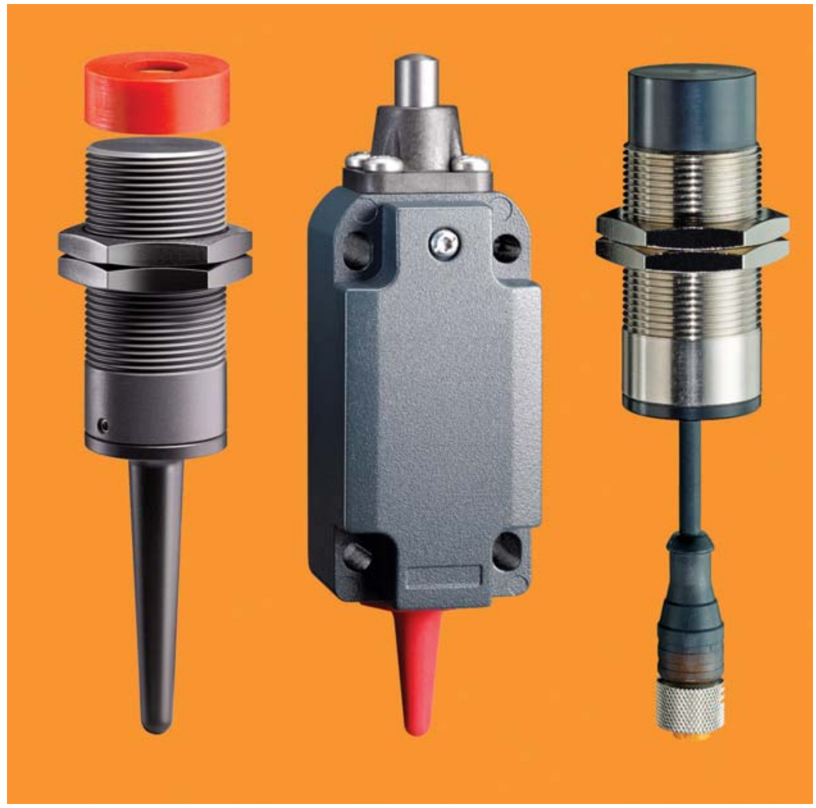


Figure 1. Wireless magnetic, limit and inductive switches

Clearly wireless technology has been widely accepted and embraced in the industrial community. New and evolving standards, the availability of a wide range of devices, and the demonstrated performance of a large, installed base each serve as testimony to their efficacy.

However, while there is a large selection of devices for monitoring, transmitting, receiving and processing continuously variable parameters (such as flow, temperature, pressure et al), there has been little available in the way of wireless devices for generating and receiving simple “on-off” signals for machine start/stop control, presence/position sensing, counting, alarm signaling, process control, and other desired digital inputs.

This is now changing with the development and introduction of a number of robust, reliable digital contact and non-contact switches, sensors, and related accessories. Available and emerging control components include:

- Mechanical limit switches
- Contact-type presence sensing switches
- Non-contact magnetic sensors
- Non-contact inductive sensors
- Pull-wire switches
- Pushbutton switches
- Momentary and maintained selector switches
- Key-operated switches
- Snap switches
- Rocker switches
- Photoelectric presence sensors
- Foot switches
- Door handle systems with integral push button control functions.

The realization of these new wireless digital control inputs (examples of which are shown in Figure 1 and Figure 2) has been the result of a number of notable technical developments. Among these are:

- The design and production of robust, energy harvesting mechanisms (energy generators) capable of meeting the duty cycle and life

Figure 2. Wireless pushbutton, selector and key-operated switches

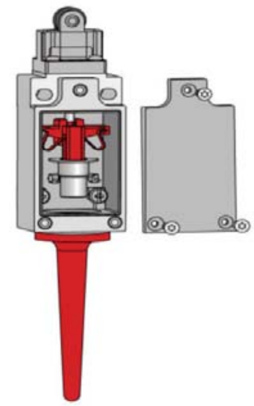


Figure 3. Limit Switch with Energy Generator

expectancy requirements typically encountered in industrial applications. One effective technique is shown in Figure 3, in which a permanent magnet is moved through an electrical coil by the motion of the switch actuator. This creates sufficient electrical energy to transmit an encrypted, wireless telegram to a "paired" receiver within the signal's range. These generators, designed with mechanical life expectancies in excess of 1 million operations, eliminate the need for a battery power source in a variety of mechanically-actuated switches (e.g. limit, pull-wire, pushbutton, selector, key-operated, and foot switches).

- The design of transmitter electronics that require little power and permit bidirectional communications between transmitters and receivers. Transmission protocols feature short telegrams for minimal transmission-time durations.

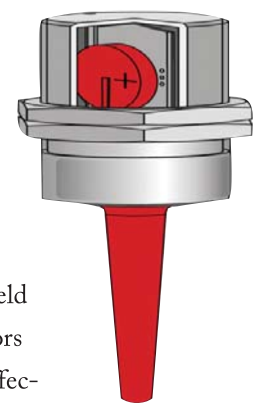
- The use of solar energy or high energy-density, long-life batteries where mechanical energy generators are not feasible (see Figure 4).

- The application and use of noise-immune wireless frequencies (e.g. 868 MHz, 915 MHz, and 2.4 GHz) that are nationally or globally accepted standards in industrial control applications.

| Frequency | 868 MHz | 915 MHz | 2.4 GHz |
|---|---|---|---|
| # of Channels | 1 | 1 | 32 |
| Data Rate | 66 kBit/s | 66 kBit/s | 250 kBit/s |
| Telegram Length | 4 to 7 bytes | 4 to 7 bytes | 16 bytes |

| Frequency | Accepted Norm in: |
|---|---|
| 868 MHz | Europe |
| 915 MHz | North America |
| 2.4 GHz | Worldwide |

Figure 4. Magnetic Switch with Battery Power Source



- The design of field strength monitors that facilitate effective installation, and maintenance of the communication links.

The potential benefits offered by these reliable, wireless control solutions include the following:

*Lower installation costs.* The elimination of wired infrastructure materials (i.e., cable, connectors, conduit, cable tray, junction boxes, strain reliefs, et. al.) and their associated installation labor can result in significant savings (see Figure 5). Such economies can be even more significant for switches and sensors that are located relatively far from their termination point, or which require armored, shielded, or other premium-priced cabling.

*Reduced maintenance costs.* The elimination of cabling also reduces the potential for cable damage and related repair or maintenance costs.

*Increased system uptime.* As maintenance requirements are reduced, system uptime and productivity can be increased.

*Flexible control system "topology."* The availability of wireless switches and sensors enables the control system designer to place digital inputs in remote and hard-to-access-with-cable locations. In addition, switches can be easily added to an existing machine or work cell.

*New potential solutions for selected EX applications.* The inherent low power operating characteristics permit use of ATEX-IECEx-certified wireless switches/sensors in selected explosion-hazardous areas without need for intrinsically-safe barriers, encapsulation or other costly protection method.

*New potential solutions for applications where wiring or wiring-maintenance is deemed impractical or not economically feasible.*

- Remote locations where distributed electrical power is not readily available.
- Rotary equipment where flexible cables wear or suffer damage.
- Rotary equipment requiring slip rings.
- Locations where cable runs are extremely long or the installation cost is considered excessive.

*Reduced personnel costs.* Use of wireless switches may allow reduction in personnel costs in applications in which digital information is now collected locally by human messenger. Examples are local in-situ production counts and assembly station stock status.

## TYPICAL & POTENTIAL APPLICATIONS

Since these devices are relatively new, many potential applications have yet to be identified and realized. Among the applications already experiencing one or more of these benefits are:

- Valve position monitoring
- Remote crane control
- Remote point presence or position sensing
- Assembly station inventory management systems
- Fire vent position monitoring
- Tank level monitoring

Figure 5. The reduction or elimination of wired infrastructure materials can generate considerable labor savings.

- Hatch and access port monitoring
- Hopper flap/diverter monitoring
- Safety shower/eyewash station alarm monitoring
- Rotary machinery
- Automatic door control
- Door monitoring
- Explosive environments

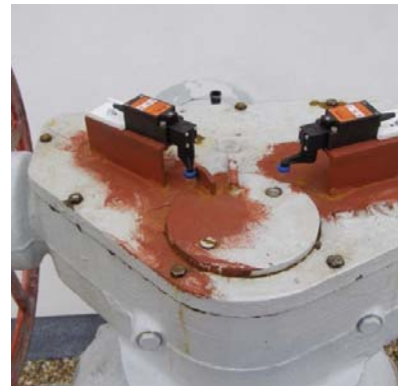
## APPLICATION: AUTOMOTIVE ASSEMBLY LINE INVENTORY MANAGEMENT SYSTEM

In this application, assembly line workers require several different components to complete each assembly (see Figure 6). In the past, they would place a "stock requirement" card in a pick-up location as additional parts were required. Periodically a "messenger" would retrieve these cards and take them to the stock room at which point replenishments would be dispatched to the assembly cell.

The "messenger" has been eliminated by placing wireless limit switches underneath the

Figure 6. Application example – inventory management system

Figure 7. Application example – valve position monitoring



second "bin" position on each track containing multiple bins of one of the assembly components. As the leading bin on each track empties, it is physically removed to allow the next bin in the track to slide into the first bin position.

When the last bin of parts in each track slides into the first position, the second position in the track becomes vacant. The absence of a bin in the feed track changes the state of the wireless limit switch, sending an encrypted signal to the central stock location. This signal alerts the stock room of an emerging need for additional quantities of the specific part associated with received signal. Required parts are then dispatched to the assembly cell.

Benefits realized included:
• Low installation costs.
• Personnel cost savings … elimination of the "Messenger".
• Faster stock replenishment.
• Reduced assembly cell downtime.
• Increased productivity.

**APPLICATION: VALVE POSITION MONITORING**

For this application it was desired that the open and closed positions of the manually-operated valves be detected and respective control signals sent to the control center in a natural gas pumping station (see Figure 7). To achieve this, two wireless electromechanical limit switches could be fixed to the valve head, with each actuated by a "flag/cam" mounted to the valve head.

By design, these ATEX-IECEx rated position switches would operate at an extremely low voltage and current level, well below any power level capable of producing a spark. Each would transmit a "safe" signal to wireless receiver mounted outside the explosion-risk area.

Benefits realized included:
• Greatly reduced maintenance, with no batteries or cables to replace.
• Lower installation costs, with no cables to run and protect from the switches to the control cabinet.
• Lower component costs, due to the elimination of expensive Ex-

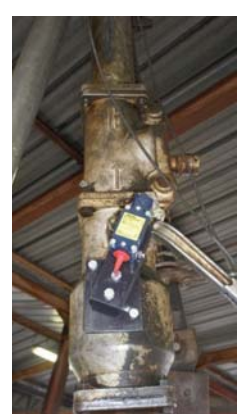


Figure 8. Application example – tank truck filler pipe position monitoring

rated cables and connectors.
- "Radioed" signals, which allowed the control cabinets to be located outside the explosion-risk area.
- Safe operation in Zone 1 and Zone 2 explosion-risk areas.

## APPLICATION: TANK TRUCK "FILLER PIPE" POSITION MONITORING

Wireless switches can be of value in a refinery's tank truck filling facility where the goal is to assure that the neck of the fuel filling pipe is properly positioned above the opening in the tank truck being loaded, before beginning the filling operation (see Figure 8).

Originally, filling pipe position was monitored using conventional cabled limit switches. While this solution was functional, the electrical cables from the switches to the control panel quickly wore or were damaged by the frequent movement and/or from chafing by the fuel pipe. Replacing the "cabled" switches with wireless functional-equivalents would eliminate the problem, resulting in a reliable, robust, long-term solution.

Benefits realized included:

- Greatly reduced maintenance, with no batteries or cables to replace.
- Low installation costs, with no cables to run and protect from the switches to the control cabinet.
- Safe operation in an explosion-risk area. ◻

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# *Hook and mast:* Position monitored

Wireless switchgear enables reliable, affordable monitoring of crane hook positioning and the extension of telescopic parts

**By Andreas Schenk, Steute**

Figure 1. The Sky Worker PTK 27 aluminum trailer crane was developed especially for compact spaces.

*Note: A version of this article first appeared in the September 2016 issue of GIT Sicherheit.*

When a telescopic crane lifts up a load, the hook block must not be allowed to crash into the boom head. This is prevented by a so-called upper limit switch: When the hook block reaches its upper limit, a position switch sends a signal to the control panel and the hoist drive is automatically stopped.

This functionality usually requires power and signal cables. They are guided up to the top of the mast over the extendable telescopic parts and therefore need to be flexible. For this reason, nearly all telescopic cranes – from small cranes for roofers to 500-ton giants – are fitted with (often very visible) spring-driven cable reels to wind and unwind the cables

Wireless means cable-free: with this motto in mind, Paus decided to fit its Sky Worker PTK 27 crane series with special control components for enhancing operating performance and reliability. Wireless switching devices monitor the position of the crane hook and the extension status of the telescopic parts. The crane engineers have managed to develop a solution which is as reliable as it is affordable.

Figure 2. A wireless pull wire switch causes the winch to stop when the hook block reaches its upper limit

## WIRELESS MEANS NO SPRING-DRIVEN CABLE REEL

The Sky Worker PTK 27 trailer crane built by Paus manages without cable reels and instead exploits the freedom offered by radio communication. When the hook block reaches its upper limit, a wireless pull wire switch confirms this by sending a remote control signal to the receiver unit. For the crane manufacturer this is doubly advantageous. Firstly, construction is simpler, which is an important factor when moving parts are involved. Secondly, construction is cheaper.

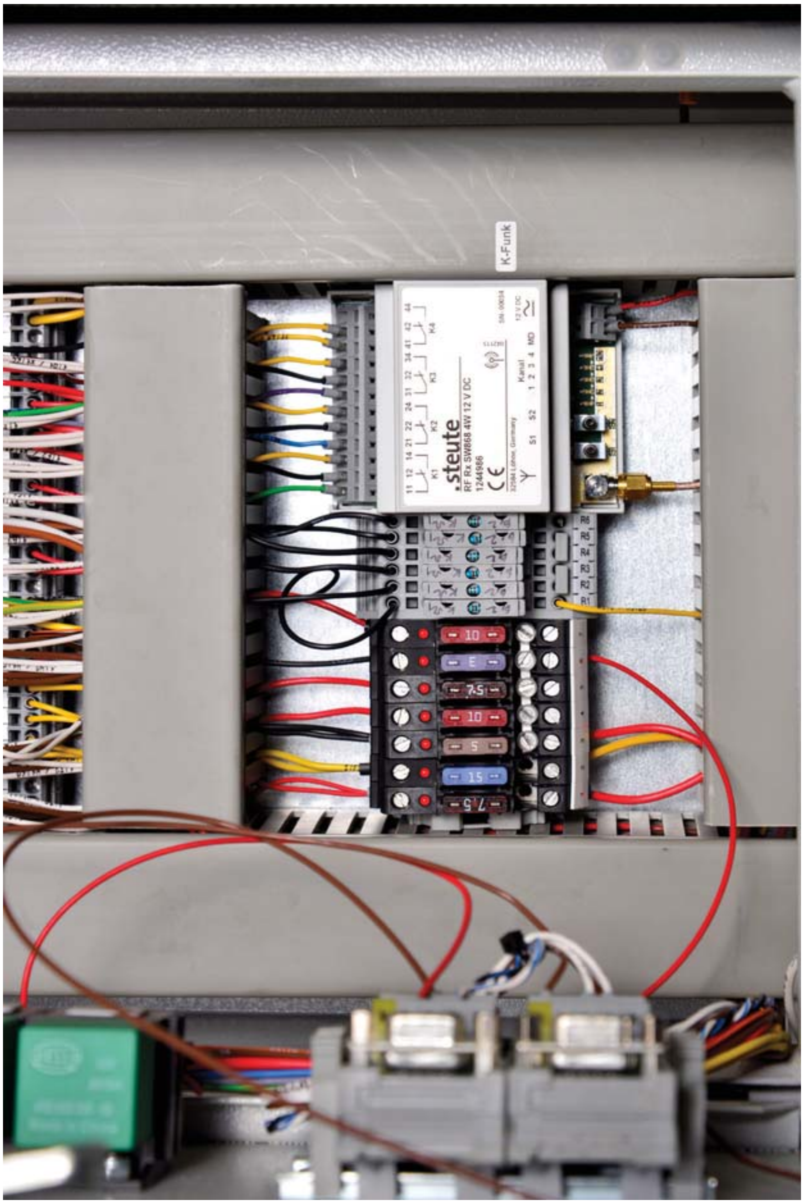



Figure 3. The receiver unit for the remote control switches is well protected within the instrument panel.

The spring-driven cable reels can only be eliminated, however, if the wireless switching devices used are reliable and robust enough to withstand the adverse environments in which cranes are often located. The Paus engineers found the answer in the steute Wireless range: the RF 95 WH/90° pull wire switch is based on a switch series used throughout automation. The wireless variant selected by Paus works with the sWave 868 wireless technology developed by steute especially for industrial applications. It features a bidirectional wireless protocol, as well as excellent transmission reliability without interference from other wireless systems.

A further feature of this technology is energy harvesting. When the hook block reaches its upper limit, the actuator of the pull wire switch (a roller lever) triggers the switching action. A miniaturized electrodynamic energy generator located on the plunger transforms the kinetic energy from the movement into electrical energy. This small amount of energy is completely sufficient to send a signal to the receiver unit and receive confirmation of its arrival.

## WIRELESS SENSORS MONITOR EXTENSION STATUS OF TELESCOPIC MAST

Following successful tests, Paus went into serial production with this new type of upper limit switch – and at the same time took the opportunity to change another functionality from cabled to wireless: a similar application crucial for optimal crane operation.

Since the load bearing capacity of a crane is dependent upon its reach, the crane control system must also monitor the extension status of the telescopic mast. This is usually performed with a mechanical length gauger which is installed – just like the spring-driven cable reel – on the mast.

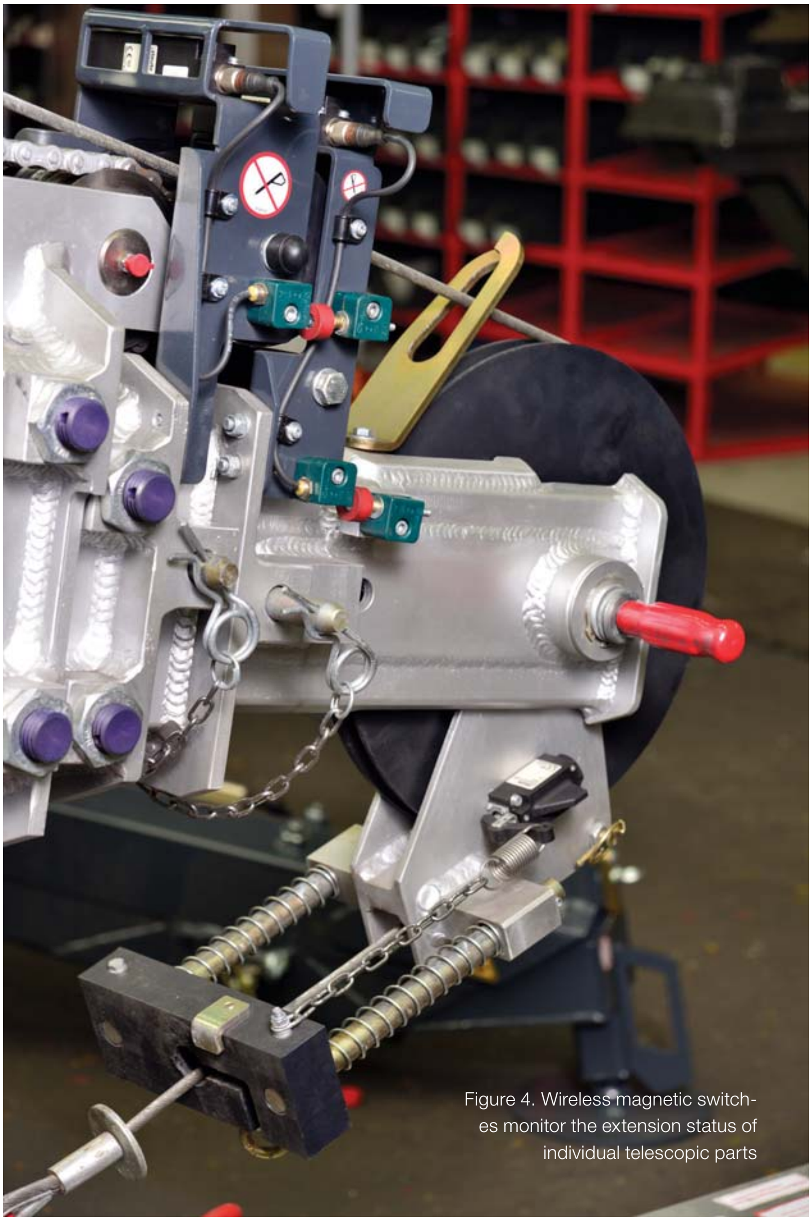


Figure 4. Wireless magnetic switches monitor the extension status of individual telescopic parts

Paus has found a simple solution for this task, and once again with almost no visible components. Wireless magnetic switches are attached to the individual telescopic parts and monitor their position by emitting status signals. A transmission module then transmits these signals to the receiver unit. This means that the crane no longer needs a length gauger, providing the same advantages as the wireless upper limit switch: moving components subject to wear and tear, and thus also to malfunctioning, become unnecessary. Manufacturers and customers both benefit from this cost-saving solution.

The motivation of a machine, plant or vehicle constructor to use wireless devices is usually a desire for a flexible and simple connection between switching device and receiver unit which offers high availability and yet remains affordable. A need always emerges when power and signal cables are complex to install on moving or telescopic machine components (see Figure 4).

The wireless switching devices incorporated in the Sky Worker PTK 27 have been tried and tested on many building sites to date. Engineers in the Paus business division Lifting Technology developed this aluminum trailer crane especially for building trades such as carpenters and roofers. Here their focus was on the necessary combination of performance, reliability and compact installation space.

The newly constructed folding tow mechanism facilitates elimination of a stiff towing bar, thus reducing the crane installation area to a minimum. In addition, passage height can be reduced to under 2m. The performance data of this mobile crane are nevertheless excellent, with a load bearing capacity of 1,000 kg and a mast extension length of 27m. This is appreciated by construction workers and crane hire companies alike. ◻

*Andreas Schenk is product manager for wireless at Steute.*

# *Wireless foot controls enhance operations* at metalworking company

Forster Haustechnik uses swing-folding machine with innovative control to improve ergonomic comfort and increase system availability


(Source: Carl Geisser AG)

Figure 1. Forster Haustechnik AG uses a modern swing-folding machine to create façades.

**By Andreas Schenk, Steute**

*Note: A version of this article was first published in the March 2016 issue of GIT Sicherheit.*

With around twenty employees, Forster Haustechnik AG in Berneck/ Switzerland offers a wide range of specialist services in the areas of heating, plumbing, and metalwork. The company was founded in 1905 and is managed today by Markus and Alexandra Forster, the 4th generation of the family. Forster produces standard and custom-made profiles for façade design, as well as window sills; and for industrial customers also flat profile duct systems. Its specialist fields include the cladding of building façades with steel, chromium steel, and aluminium elements.

A wide variety of state-of-the-art machinery is on hand for the various processing techniques involved, such as welding, punching, bending and creasing, as well as cutting. Forster relies on Swiss precision for its bending processes, purchasing a ZR swing- folding machine from Thalmann Maschinenbau AG. This robust and fully hydraulic machine was developed especially for metalworking companies and can be adapted to different requirements using a variety of accessories (see Figure 1).

Among these optional accessories is a wireless foot control for activating the various functions of the bending machine. This foot control is made by steute Schaltgeräte GmbH & Co. KG and communicates with the receiver in the control cabinet via a safe wireless protocol. Doing away with a conventional cabled switch improves ergonomic comfort and increases the availability of the system because it cannot fail due to cable damage.

## WIRELESS PROTOCOL FOR SAFETY APPLICATIONS

The foot control uses the safe “sWave 2.4 Ghz-safe” wireless protocol, developed by steute and based on the physical layer of the IEEE 802.15.1 standard. The foot control is particularly suited for use in rough industrial environments due to its high reliability, guaranteed by the Frequency Hopping Spread Spectrum over 79 channels and the adaptive Frequency Hopping process, as well as its very good coexistence with other wireless systems.

As one would expect from safe applications, the overall transmitter/receiver system is fundamentally designed with two channels. Foot controls and receiver units can be clearly assigned to one another, meaning that several safe foot controls can work in parallel within one wireless zone. This feature is important at Forster, where a very long functional distance of the machine means that it is always operated by one of two foot controls.

The foot controls are battery-powered, facilitating a highly available bidirectional wireless connection. The system, comprising the wireless foot control and the receiver unit (see Figures 2 and 3), is EC type-examination tested and categorised according to ISO EN 13849-1 in performance level (PL) d, as well as safety integrated level (SIL) 2 according to IEC 62061.

The wireless connection between foot control and receiver unit is maintained as long as the operator is actuating the foot control. Evaluation of the wireless signals is performed by a compact combination of wireless receiver and safety relay module installed inside the control cabinet. The assigned short antenna is mounted on top of the control cabinet.

One additional feature of the steute foot controls is a low

Figure 2. Wireless foot controls improve ergonomic comfort, safety and availability, not least in adverse environments.


(Source: Carl Geisser AG)

Figure 3. The receivers and evaluation units of the two wireless foot controls are installed inside the control cabinet

pedal height, which is an important prerequisite for simple and non- tiring actuation. The foot controls also are extremely stable on the ground, facilitating both ergonomic and intuitive operation, and their metal housings can withstand high levels of wear and tear, which together with the high quality of their switching inserts means a long life even in adverse environments.

## REAL BENEFITS FOR USERS

Originally, the wireless safe foot controls were developed for special operating modes like "set up" and "process observation". These modes enable machines to be operated according to standards with opened guard doors and reduced speed, as long as the user actuates the foot pedal or keeps it depressed in the mid-position.

Since then, however, it has become clear that wireless foot controls such as these can also be advantageous in other applications. A foundry (also in Switzerland), for example, uses wireless safe foot controls in order to avoid failure of cables through casting splashes – a problem well known in many foundries and other fields involving hot fluids, and one which can be solved by using wireless communication.

At Forster Haustechnik AG, both managers and workers clearly see the benefits provided by wireless foot controls. "The wireless system functions perfectly, and the operators of the system have quickly got used to positioning the foot control wherever it feels most comfortable, without having to worry about tripping over any cables," says Reto Forster, responsible for the areas metalwork/ sheet metal forming. "This means that they can monitor processes optimally at all times." □

*Andreas Schenk is product manager for wireless at Steute.*

# *Goal:* Avoid congestion while dispatching 850 custom orders per day

Figure 1. Some customers might ask themselves just how the huge variety of fitted kitchen components is produced and organised on site.

Figure 2. Individual packages at Häcker Kitchens come together on one of 50 staging belts. An antenna collects the signals from the 50 push-button switches and converts them to TCP/IP.

Häcker Kitchens deploys wireless switchgear in their dispatch zone to achieve precise production control and shipping efficiency

**By Andreas Schenk, Steute**

*Note: A version of this article was first published in the April 2016 issue of SPS Magazin.*

Anybody who has ever bought a fitted kitchen knows just how many different combinations and optional extras manufacturers like to offer. More than 60 different cupboard doors, all manner of cabinet types and drawers, countless different handles – seemingly nothing is impossible (see Figure 1)

Häcker Kitchens is Germany's third-largest kitchen manufacturer, and produces 850 top-quality kitchens per day, with each one is different. To achieve this production rate, many different separate parts must brought together as outgoing goods "just in time" and then dispatched. If one then takes into account that in the dispatch zone, directly behind the loading bay, around 50 staging belts (see Figure 2) bring together the individual elements for a consignment from their various production areas (cabinet modules, white goods, plinths, worktops, fitting parts or hinges), the sheer speed of the flow becomes clear: each belt has to be emptied and refilled 17 times a day.

This process demands a high degree of automation and extremely precise production control. Network-compatible wireless switching devices are installed at one of the few manual interfaces within the production flow. Operators use the switches to inform the ERP system that a staging belt is free for the next consignment.

Although Häcker Kitchens loads its own lorry trailers manually, the staging belts which bring together the individual consignments are loaded completely automatically. The goods come out of their various production areas on conveyor belts set into the floor, are scanned centrally following quality control, and then are distributed to the 50 staging belts.

In practice this looks like a steady flow of packages all finding their way through the conveyor system and turning off at the point where they belong. This is only possible because every incoming order is broken down and timed so that all the individual parts from all the production areas involved are ready for loading at almost precisely the same time. The control parameter for the entire production process is therefore the joint deadline.

One of the company's material handling challenges is to avoid any kind of congestion on the 50 staging belts behind the loading bay. The staff therefore have to set priorities: which belt needs to be emptied next, which order loaded? This information is visualised on a large screen displayed prominently in the middle of the dispatch zone and is used by the staff for orientation when planning which order to work on next (see Figure 3).

The screen is the front end of a central ERP system developed by Häcker – the "Häcker Application SErver" (HASE) controls and monitors the entire production process in real time and assigns orders to the different staging belts collecting the necessary individual packages within a very short time slot.

The only thing which the HASE software does not know is when an order has been loaded and the belt is empty and ready for the next consignment. As Marc Babenhauserheide, IT project manager at Häcker, says: "This is one of only very few manual interfaces in the entire production process." The operator therefore has to send the information "belt empty" to the HASE system, which can then immediately guide the next consignment towards it.

For this Häcker had to install a compact control unit for each belt, and had to solve a small connection problem: because the conveyor technology is set into the floor, the laying of cables would have meant a considerable effort. The company opted for a simpler solution – wireless data transmission – and they chose switchgear from the steute wireless range. The push-button switches from the steute RF BF 74 series do not require an external power supply because they are fitted with an electrodynamic energy generator, which transforms the kinetic energy created by pushing the button into electrical energy used to send a radio signal to the antennae of the two receiver units.

An additional feature of this series is its multiple network compatibility. At Häcker the wireless switches are connected to a bidirectional gateway which converts signals to the universal Internet/Ethernet protocol TCP/IP. The interface conforms to the IEEE802.3 standard with a transmission rate of 100/10Mbit/s. Since the signals from the wireless switches are evaluated by the ERP system directly, steute created an individual interface connecting the wireless system to the HASE software. Häcker also chose to integrate the command devices within stable metal columns to incorporate further robustness.

Figure 3. Screen showing the staging belts ready for loading. By pressing the push-button switch, a message is sent to the ERP system: the belt is now empty and ready for a new consignment.

At Häcker the realised solution with a TCP/IP connection exactly fulfilled the brief: the ERP system receives the information that a staging belt has become free directly, and the installation costs were minimal. ◻

*Andreas Schenk is product manager for wireless at Steute.*

# *Wireless switchgear* now "integrable"

How to construct a reliable, cable-free infrastructure within an industrial environment

**By Andreas Schenk, Steute**

Note: A version of this article was first published in the February 2016 issue of Industrielle Automation.

Figure 1. Wireless networks optimise the flow of information and materials to and from industrial work stations

Wireless communication gives companies and users a whole new level of freedom, overcoming the restrictions posed by cabled installations. Control and regulation processes, for example, become far more flexible if designed with modern human-machine interfaces. In addition, the cost of installing cables in areas difficult to access can be saved.

Integrated communication across all company levels is realizable with a recently developed wireless network. Wireless switching devices are networked and then integrated in superordinate IT systems, opening up new perspectives for wireless controls in industrial applications.

The range of wireless equipment available to plant teams has·expanded considerably over the past few years. Not only are a wide variety of radio-compatible switches and control units now available, but also different wireless technologies (for example with and without transmission confirmation), power supplies (energy harvesting·or battery power), and accessories such as repeaters, I/O units, USB receivers and TCP/IP gateways. In addition, separate wireless technologies are available for explosive environments ("Wireless Ex") and for the transmitting and receiving of safety-related signals ("sWave-safe").

In fact, solution providers are starting to expand beyond simply offering wireless switchgear, and can deliver completely new platforms for integrating these wireless switching devices at field level, as well as in customer IT, thereby replacing point-to-point connections.

## ACCESS POINTS BUNDLE SIGNALS AT FIELD LEVEL

The access points are installed across the transmission area and communicate with the wireless switchgear. Each access point can manage approximately 100 wireless switches. If more wireless sensors are required within the transmission area of an access point, additional access points can be registered within the system.

When a switching device sends a signal, the latter takes a fixed route through the access points. If transmission should fail at the first access point, the second one is called upon, etc. This guarantees very high transmission reliability.

A database runs on the corresponding application server, collecting all information at field level and passing it on, either directly or via

Figure 2. One of the first user examples of an integrated wireless solution was an E-Kanban system for the automatic replenishing of work stations

middleware, to the customer IT platform (enterprise resource planning/ERP, production data acquisition/PDA, condition monitoring/CMS, warehouse management/WMS), if required also via web-services to multi-site IT systems. This guarantees uninterrupted communication from the individual switching device right up to the top of the company IT hierarchy.

The network can easily be configured for the requirements in question via a web server. The database can also be adapted to individual user needs and wishes. The system uses an exceptionally stable and yet low-energy wireless protocol within the universally available 868/915 MHz band, reaching the receiver unit with high reliability and transmission quality. In addition to electromechanical wireless switchgear (position switches, foot controls, pull wire switches .), it is also possible to integrate wireless sensors (e.g. magnetic switches) and wireless command devices.

**PROJECTS IN PRACTICE**

Wireless represents the next logical developmental step towards integrating switchgear in the industrial data world. Customer-specific network solutions, with their own application servers and proprietary interfaces to in-house IT, provide new ways of exchanging information and data across various levels and in completely different branches and applications, as well as in production environments designed according to the principles of the Internet of Things. An uninterrupted flow of information is a key prerequisite for efficient (semi-)automated manufacture of complex products in small quantities.

One example is an E-Kanban system for replenishing work stations with parts. Here wireless position switches and/or sensors detect the existence or removal of Kanban containers. They use the stable and yet low-energy wireless protocol sWave 868/915, reaching the receiver unit in question with high reliability and transmission quality. In this example the wireless signals are sent directly to the Kanban control centre, with the interface or middleware custom-developed.

A similar system was developed or rather configured for the outgoing goods department of a major German kitchen manufacturer. Using wireless switchgear, this system monitors the occupancy of around 50 accumulating conveyors prior to loading onto lorries. Wireless push buttons transmit their information directly to the

Figure 3. Via a wireless switch, the user sends the information that a consignment has been loaded from an accumulating conveyor

user ERP. The information generated by the wireless push buttons is visualised on a central screen in the outgoing goods department. Target applications for this technology include E- Kanban, material flow management, and andon (visual management).

*Andreas Schenk is product manager for wireless at Steute.*

Figure 4. Visual management using the andon principle is also integrated in the wireless network solution

# *The evolving* automation architecture

The Internet of Things is driving analytic advantage across manufacturing assets – is your plant ready?

**By Jack Tison, Panduit, for IIPA**

Studies show that 86% of manufacturers are investing in the Internet of Things (IoT) as they go after an estimated $4 trillion in benefits for manufacturing applications. Why now?

The cost of sensors, networking, storage and computing have dropped dramatically. New architecture models and technologies have emerged that ease deployment and accelerate time to value. Operations can increase overall equipment effectiveness (OEE) and create new value through insights locked in both existing control systems and by adding new sensors to track asset health and processing conditions.

Traditional automation architectures will continue to evolve to make machines and process skids grow ever smarter. However, there is a complication: these equipment assets need to be connected to the plantwide enterprise in order to unlock data and allow for wider scale and more innovative analytic approaches. This plantwide network fabric is critical for advancing IoT.

Meanwhile, new approaches to acquiring sensor data through wireless mesh networks have been developed. These sensor networks do not directly connect to critical automation control systems, but instead connect to computing resources close to the edge and to private/hybrid cloud resources. These new network architecture models advance what we can collaboratively achieve together as end users and vendor communities.

What is the key to faster and larger return on investment (ROI)? It lies in leveraging reference models, architectures, and ecosystems to go from opportunity assessment, to pilot project, to full scale value creation. The exciting part about these new IoT approaches is the potential to innovate on an ongoing, sustainable basis with access to deeper, richer data and more powerful, flexible, data analytics.

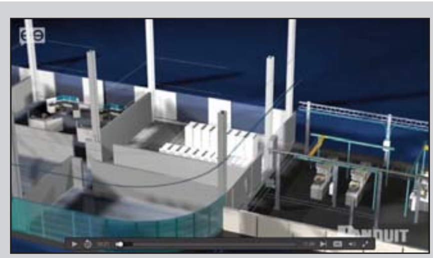
Let's look at three key areas to grow your IoT architecture:

- *Connecting Plant and Enterprise.* A foundational IP network fabric that follows a validated architecture with security and scalability will enable connecting people, processes and technology. This requires collaboration between IT and OT to execute. Maturity

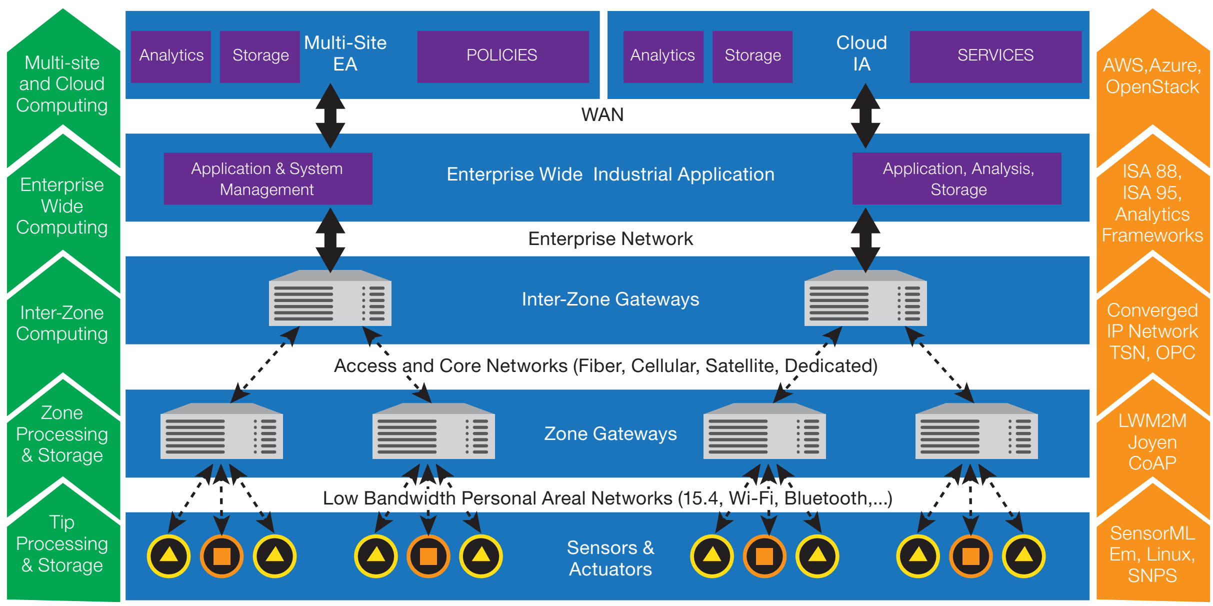
**SUPPORTING VIDEO:**

Panduit's Jack Tison discusses the evolving automation network architecture, and how IT and OT are converging on the plant floor to help organizations stay competitive in the age of the Internet of Things (IoT):

http://www.meettheboss.tv/video/internet-things-your-architecture-ready



## IOT ARCHITECTURE




Partner ecosystems have articulated architecture models and advanced solutions that help reduce the risk of adoption, and increased the return on investment and the return on assets.

models exist to help frame the task at hand. A holistic architecture provides the power and flexibility to take advantage of innovations in sensing, computing, and mobile data access that are transforming value creation. value creation. Use the Converged PlantWide Ethernet (CPwE) architectures to provide the foundation for connecting the plant floor to the enterprise with defense-in-depth security, including an industrial demilitarized zone (iDMZ).

• *Scaling sensors with wireless mesh networks.* Emerging wireless mesh solutions that connect to the IP network fabric provide the ability to cost-effectively deploy many wireless sensors across a plant floor. The inherent robustness, flexibility, and ease of deployment can be real game changers when calculating ROI or return on assets. The ability to cost effectively add more sensors on desirable variables can provide predictive diagnostics and system optimization inputs that could only be dreamed about in the past, without requiring rip-replace or risking complications to existing automation systems and networks.

• *Computing at the edge.* Analyzing data close to the machine or process is not a new concept, as evidenced by the continued success and evolution of industrial controllers. For IoT, the need to

*86% of manufacturers are investing in IoT as they go after an estimated $4 Trillion in benefits for manufacturing applications. Why now?*

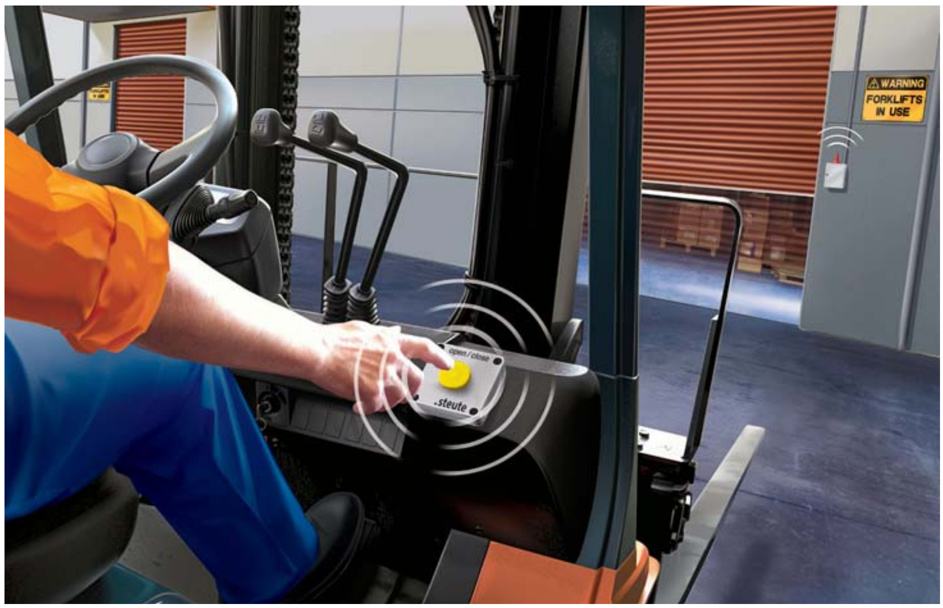
process data in industrial real-time means that latency must be reduced in the computing and storage strategy for data from new wireless sensors and other new connected assets like video. The approach to send all data to a public cloud for processing may not be timely enough for most manufacturing environments, not to mention the bandwidth and storage issues, as well as costs that may occur in some examples. Thus, intelligent gateways and routers can provide compute services that enable local real-time decision making capabilities.

Consider how you will assess and explore these new models and technologies in order to innovate and compete. Market leaders have started down this path already so you will not be alone. A great place to start is by education and training from organizations such as Industrial IP Advantage (www.industrial-ip.org), by becoming involved in organizations such as the IoT World Forum, and by developing your own proof of concepts of these emerging models with eco-system partners. Manufacturing is changing so the time to act is now. ◻

*Jack Tison is SVP Emerging Business and former CTO at Panduit, a world-class developer and provider of leading-edge solutions that connect, manage and automate the physical infrastructure. Panduit, with Cisco and Rockwell Automation, established Industrial IP Advantage (IIPA) in 2013. In cooperation with ODVA, IIPA provides thought leadership on how manufacturing and industrial companies can build more successful businesses by deploying a secure, holistic digital communications fabric based on standard, unmodified use of the Internet Protocol. Discover more at www.industrial-ip.org.*

White Paper

# **FAQ's** About STEUTE's Industrial-Grade Wireless Components




## Introduction:

In the past, the majority of wireless industrial control devices available have been for the monitoring, transmitting, receiving and processing of continuously variable (analog) parameters such as temperature, pressure, flow, humidity and speed. More recently an array of wireless components has emerged that generate and receive simple "on-off" signals for start/stop control, presence/position sensing, counting, alarm signaling, high/low level detection, and other desired digital inputs.

With their availability, interested users have posed a number of questions as they strove to become familiar with the design, performance and application of these new control solutions.

The following represent a compilation of those most frequently asked questions as they relate to our family of industrial-grade wireless components and accessories (e.g. receivers, range extenders, antennas, power supplies, field strength monitors). We trust that they will be of value in understanding if and how these devices may satisfy your application requirements.

Should you not find the answer to your question(s), or need additional information, please do not hesitate to contact us. We will be pleased to address your requirements.


Wireless presence detectors ... non-contact magnetic sensor, contact-type limit switch, non-contact inductive sensor

**QUESTION 1:** What types of functional wireless devices are currently available?

**ANSWER:** STEUTE's present range of wireless industrial-grade control components include:

- Limit switches*
- Miniature position switches
- Non-contact magnetic sensors
- Non-contact inductive sensors
- Pull-wire switches*
- Push button command stations*
- Selector switch command stations*
- Key-operated switch command stations*
- Foot switches*
- Door handles with integrated push buttons
- Universal wireless transmitters
- Receivers with relay outputs
- Receivers with bus-compatible outputs
- Range extenders
- Antennas

*Energy harvesting (battery-less) units

**QUESTION 2:** What is "energy harvesting"?

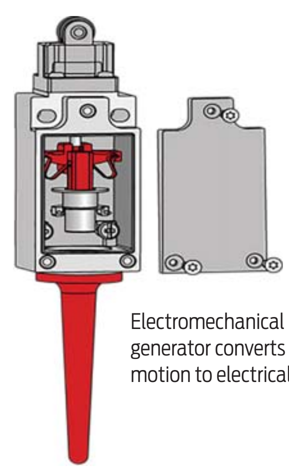
**ANSWER:** Energy harvesting refers to the capturing of available sources of energy (such as wind, light, mechanical motion, thermal energy, et al) and storing/converting it into other forms of energy (such as electrical) for use as needed. Well-known energy harvesting devices include solar cells, wind turbines and hydroelectric generators.

**QUESTION 3:** How do the STEUTE wireless switches operate without a battery power source?

**ANSWER:** Those wireless switches designed for battery-less operation use "energy harvesting" techniques for powering the devices' transmitter electronics. For STEUTE, these techniques are the use of a solar cell or an "electrodynamic energy generator" to respectively convert light energy and mechanical energy into electrical energy.

**QUESTION 4:** What is an "Electrodynamic Energy Generator" and how does it work?

**ANSWER:** STEUTE's electrodynamic energy generators are typically a design element of those wireless switches characterized by mechanical actuation ... such as limit switches, foot switches, or pull-wire switches. The "generator" consists of a permanent magnet and an electrical coil. The mechanical actuation of the switch moves the magnet through the coil, generating an electrical current in the coil. This electrical energy is sufficient to allow the Transmitter to send wireless "telegrams" (control signals) to the Receiver, process confirmation of receipt of the signal by the Receiver, and resend the signal if its receipt has not been confirmed.



Electromechanical energy generator converts mechanical motion to electrical power

**QUESTION 5:** What is the typical mechanical life an "electrodynamic generator"?

**ANSWER:** STEUTE's proprietary electrodynamic generator designs have a mechanical life expectancy in excess of 1 million actuations.

**QUESTION 6:** What is the battery life for those devices that are battery powered?

**ANSWER:** Battery life is a function of several factors. These include battery cell size, battery energy density and the frequency of switch/sensor actuation. Depending upon the specific STEUTE switch or sensor, the battery life can range from several months to several years. Typical battery life for various duty cycles is provided with our device specifications.

**QUESTION 7:** Do STEUTE's wireless components have the required third-party Certifications?

**ANSWER:** STEUTE's wireless, industrial-grade products requiring third-party certification have the necessary Certifications for the intended countries of use ...e.g. cCSAus, FCC, IC, et al.

Products certified to required Standards

**QUESTION 8:** Why don't the wireless Transmitters have UL or CSA certification?

**ANSWER:** STEUTE's wireless Transmitters (switches & sensors) are of such low energy/low power that they do not represent a safety hazard and do not require UL/CSA safety Certification.

**QUESTION 9:** Are STEUTE's wireless industrial components suitable for use in machine guarding/safety applications?

**ANSWER:** Such applications typically require redundant signals to meet the safety Standards. Hence they would need to have independent, redundant control signals ... each operating at its own unique frequency. Since most of STEUTE's wireless devices operate at a single frequency (e.g. 868 MHz or 915 MHz) they are not intended, nor suitable, for use in safety applications. The sole exception at this time is our safety foot switch which frequency hops in the 2.4 GHz band ... providing the redundancy required for safety applications. The current design is safety-rated at SIL Category 2, Performance Level PL d.


Only selected wireless products are suitable for "safety applications"

**QUESTION 10:** What is the typical transmission distance for these wireless devices?

**ANSWER:** Due to the diversity of installation environments and conditions, wireless device manufacturers cannot state an absolute transmission distance for a given transmitter. However, for evaluation and comparison, they typically provide nominal transmission distances indoors and outside (in "free air"). Depending upon the model of transmitter, STEUTE's nominal indoor transmission distance is in the range of 30 to 50 meters and their nominal outdoor transmission distance is in the range of 400 to 700 meters. Actual transmission distances will be affected by structures and/or equipment in the wireless signal's path. If in doubt of the efficacy of the application, it is suggested that the user conduct an in-situ evaluation of the Transmitter(s) and Receiver(s) in their specific situation. STEUTE offers hand-held, "signal strength monitors" to aid in this process.

**QUESTION 11:** Can these transmission distances be increased?

**ANSWER:** Yes. STEUTE offers "Repeaters" for this purpose. Up to two such Repeaters can be used to extend the transmission range between a Transmitter and the Receiver to which it has been paired.

**QUESTION 12:** What is the effect of various construction materials in the transmission path of the wireless telegram?

**ANSWER:** Since the wireless signals are electromagnetic waves, some signal attenuation is not uncommon from the Transmitter to its Receiver. In addition to the signal strength being inversely proportional to the square of the distance between the Transmitter and its Receiver, sensing range can be affected by walls/objects in the transmission path.

**Typical signal attenuation (at our operating frequencies of 868 MHz and 915 MHz) for various materials of construction are shown below.**

| Materials | Typical Signal Attenuation |
|---|---|
| Wood, gypsum, uncoated glass | 0 to 10% |
| Brick, stone, press board | 5 to 35% |
| Armored concrete | 10 to 90% |
| Metal, aluminum lamination | 90 to 100% |

**QUESTION 13:** What is a "Repeater", and what is its benefit?

**ANSWER:** A "Repeater" is a signal amplifier that can be located at some point in the Transmitter to Receiver signal path. It extends the range between the Transmitter and its Receiver.

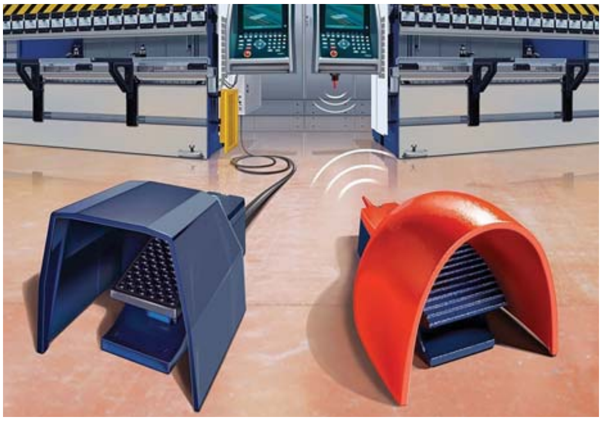
**QUESTION 14:** Are tools or instruments available that can aid in the evaluation/installation/ maintenance of a STEUTE wireless system?

**ANSWER:** STEUTE offers a Field Strength Monitor for this purpose. While it does not have the "gain" of the Receiver and its' antenna, it will enable a user to identify the Transmitter, count telegrams received, see the relative strength of the signal at various points in the transmission path and to confirm receipt of the transmitted signal at the wireless Receiver's location prior to actual installation of the Receiver.

**QUESTION 15:** What is a "Field Strength Monitor"?

**ANSWER:** STEUTE's Field Strength Monitor is a portable, battery-powered, hand-held receiver that can be used to check wireless signal strength at various distances/locations from the Transmitter and aid in the installation of the wireless components. It features a digital LCD display (e.g. to identify the Transmitter being monitored, provide an indication of the signal strength in % at that location, and display the number of telegrams received from the specific Transmitter being monitored). It is a useful tool for evaluating, installing and maintaining STEUTE wireless systems.


Hand-held Field Strength Monitor aids in system installation and maintenance



**QUESTION 16:** At what frequencies do the STEUTE wireless industrial control components operate, and why were these frequencies selected?

**ANSWER:** STEUTE's wireless Transmitters (switches & sensors) for non-safety applications are available for 868 MHz and 915 MHz operations. These are the preferred frequencies for industrial control in Europe and the USA-Canada respectively. STEUTE's safety-rated foot controls utilize frequency-hopping technology in the 2.4 GHz band (accepted worldwide).

**QUESTION 17:** How does STEUTE's SW868 MHz and SW915 MHz wireless technology differ from other single-frequency wireless protocols?

**ANSWER:** STEUTE's SW868 MHz and SW915 MHz Transmitters and Receivers are designed to operate bidirectionally. Upon receipt of a wireless signal, their Receivers transmit a "signal received confirmation signal" back to the Transmitter. The Transmitters have the ability to process this confirmation of receipt, and to re-send the signal should the receipt of the transmitted signal not be confirmed. This bidirectional capability adds a heightened dimension to the system's reliability. In addition, STEUTE's electrodynamic energy generators are designed for industrial-grade switch life expectancies (more than 1 million actuations).

**QUESTION 18:** What output signal options are available from STEUTE's range of wireless Receivers?

**ANSWER:** STEUTE's current family of Wireless Receivers include units with discrete relay outputs, PNP, TCP/IP, USB and RS232 Serial outputs. Other output protocols are in development and will soon be available.



**QUESTION 19:** How does one establish a communications link (e.g. "pair") a STEUTE Transmitter with one of its' wireless Receivers?

**ANSWER:** "Pairing" is easily accomplished through a brief series of pairing steps using the front-panel accessible and easily-operable programming buttons and built-in status LEDs on the Receiver. For example, the steps to pair a Transmitter (switch/sensor) with STEUTE's 915 MHz single-channel Receiver with discrete relay outputs include:

**(1) Press programming button on the Receiver for 1 second. Green LED flashes slowly (2Hz).**

**(2) Actuate wireless switch/sensor being "paired" (taught in). Orange LED flashes.**

**(3) Press programming button again for 1 second to exit "pairing" (teach in) mode. Green LED stays lit.**

**QUESTION 20:** How does one remove a Transmitter from a Receiver with which it has been previously "paired"?

**ANSWER:** Removing a previously "paired" Transmitter is easily accomplished through a brief series of steps using the front-panel accessible and easily-operable programming buttons and LEDs built into the Receiver.

**(1) Press programming button on the Receiver for 5 seconds. Green LED flashes quickly (5HZ).**

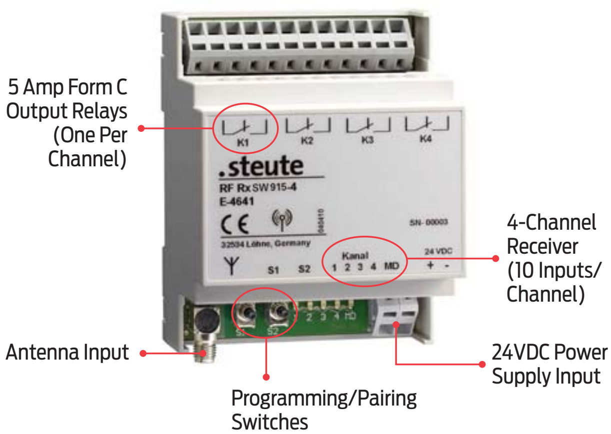
**(2) Actuate the wireless switch/sensor to be deleted. Orange LED flashes.**

**(3) Press programming button again for 1 second to exit "delete" mode. Green LED stays lit.**

**QUESTION 21:** How many Transmitters (switches/sensors) can be monitored by a single Receiver?

**ANSWER:** STEUTE's discrete relay output Receivers are designed to accept signals from up to ten (10) individual Transmitters per channel. Thus a single channel Receiver can monitor up to (10) different switch inputs controlling its output relay. A four-channel Receiver can monitor up to (40) different switch/sensor inputs … (10) inputs for each of its four discrete output control relays. Bus-compatible Receivers offer the possibility of monitoring up to 40 individual SW868 MHz or SW915 MHz transmitters.

**4-Channel Wireless Receiver**




Easy to program wireless Receivers provide application versatility

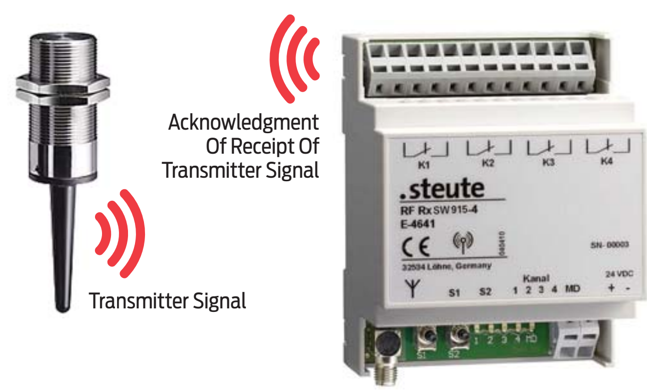
**QUESTION 22:** What is the response time from switch/sensor actuation until the Receiver output changes state?

**ANSWER:** Typical response time for STEUTE's SW868 MHz and SW915 MHz devices is less than 10 ms. Typical response time for STEUTE's 2.4 GHz multi-channel, frequency-hopping technology is less than 200 ms.

**QUESTION 23:** What is meant by "bidirectional" communication?

**ANSWER:** STEUTE has designed many of their Transmitters and Receivers to communicate in both directions … e.g. from the Transmitter to the Receiver and from the Receiver to the Transmitter. This capability enhances system reliability. For example, it enables the system to be designed such that Receivers can send an "acknowledgement signal" to the Transmitter upon receipt of its transmitted signal. Should the Transmitter not receive this acknowledgement signal within 16 ms of its original transmission, it can resend the telegram a second time.

**Biderectional Communication**




Bidirectional communication between Transmitters and Receivers enhances system reliability

**QUESTION 24:** What is the minimum number of components required to realize a wireless control function?

**ANSWER:** A system requires a Transmitter, a Receiver, a Receiver antenna, and 24 VDC power for the receiver. The Transmitter may be any of STEUTE's many wireless switches, sensors and command devices. A Universal Transmitter is also available for integration of commercially-available, cabled, dry contact devices as well as 24 Volt PNP devices.

**QUESTION 25:** What steps has STEUTE taken to optimize the reliability of their wireless industrial automation components and systems?

**ANSWER:** The following are among the available design features of STEUTE's industrial automation component program intended to optimize reliability:

- **Use of bidirectional communications between Transmitters and Receivers (e.g. acknowledgement signals, redundant transmissions, et al)**
- **Use of short telegrams to minimize in-air time**
- **Use of battery charge status monitoring**
- **Use of transmitter "status" signals**
- **Use of frequency-hopping(for 2.4 GHz devices)**
- **Use of unique, encrypted telegrams from each Transmitter**
- **Use of listen-before-talk (LBT) technology**

**QUESTION 26:** What is the benefit of STEUTE's listen-before-talk (LBT) technology?

**ANSWER:** STEUTE's listen-before-talk technology has been designed for those applications involving a large number of Transmitters where the probability of simultaneous transmission from one or more Transmitters is high. This feature repeatedly listens to determine if there is another telegram at the same frequency in the air, prior to sending its telegram. If it detects the presence of another telegram, it waits a programmed interval, and listens again ... sending its telegram when no other telegram is present. In so doing it greatly reduces the possibility of losing a telegram due to a "collision" ... enhancing system reliability in highly (wireless component) populated applications.

**QUESTION 27:** What is STEUTE's Universal Wireless Transmitter, and how can it be used?

**ANSWER:** Depending upon the model, STEUTE's Universal Wireless Transmitter can also be used with sensors and switches that feature a normally-open dry contact or a PNP output. The transmitter converts the sensor/switch output signal to a wireless telegram compatible with our family of 868 MHz and 915 MHz Receivers. It is available as a battery-powered unit, or for use with 10 VDC to 30 VDC power input. The battery-powered unit can be used with STEUTE's family of wireless inductive sensors or with conventional cabled switches having a normally-open dry contact closure. The external voltage powered unit can be used with conventional cabled switches having a normally-open dry contact closure or cabled 24 VDC sensor PNP output.

**QUESTION 28:** Is a programmable logic controller or computer required?

**ANSWER:** For many simple applications, it is not necessary to have additional control logic. STEUTE Receivers are equipped with up to 4 programmable form C relays ... each with a maximum load rating of 6A/250 VAC, 2A/24 VDC.

**QUESTION 29:** How may STEUTE wireless equipment be used in a PLC or computer operated system?

**ANSWER:** There are several approaches to interconnect STEUTE wireless into a system. Receiver relay contact outputs may be used as direct inputs to the control system. STEUTE also has available Receivers with RS232 and TCP/IP communication protocols. Information regarding the data telegram structure is available for download from our website at www.steutewireless.com

.steute Wireless

Creating Industrial-Grade Switch Solutions without Cables

Remote crane control is among the many new applications benefitting from the availability of these robust, reliable digital components.

**QUESTION 30:** If a system requires each wireless Transmitter to be recognized independently, is it required to have a contact output available for each device?

**ANSWER:** It would be possible to do this using our multi-channel Receivers equipped with a relay output for each channel. However, for more complex applications, using the network communications capabilities of the selected Receivers may be more suitable.

**QUESTION 31:** What are some of the applications that have benefitted from the use of STEUTE's wireless components?

**ANSWER:** Since these devices are relatively new, many potential applications have yet to be identified and realized. However, the following are among the applications already experiencing benefits of the wireless technology:

- **Valve position monitoring**
- **Remote crane control**
- **Remote point presence or position sensing**
- **Assembly station inventory management systems**
- **Fire vent position monitoring**
- **Tank level monitoring**
- **Hatch and access port monitoring**
- **Hopper flap/diverter monitoring**
- **Safety shower/eyewash station alarm monitoring**
- **Rotary machinery**
- **Automatic door control**
- **Adjustable cut-to-length control**
- **Door monitoring**
- **Presence/position sensing in explosive environments**

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