Technical Information

Wireless Proximity Switches

V3

Functional description
1 Wireless proximity switches

Today, inductive proximity switches are a natural component for controlling all kinds of machines. They are able to signalize e.g. movements of the machine to the controller reliably and contactless. Since inductive proximity switches only detect metal parts, they are relatively immune against pollution and only deliver wrong signals in very rare cases. In summary, one can say that due to their available wide product variety, inductive proximity switches would be a perfect component, easy to implement into machines and working highly reliable, if they would not require cables for their power supply and the signal transmission to the machine controller.

And this is exactly where the completely new concept of wireless proximity switches is able to provide the solution: Power supply of the sensor as well as information transmission to the machine controller are performed wireless, without any cables.

2 Power supply by an electromagnetic field

The power transmission is based on the principle of a coreless transformer: Two pairs of inductance coils (the so-called primary loops) mounted on two opposite sides of a manufacturing cell generate an unmodulated rotating electromagnetic field with a frequency of 120 kHz. The corresponding signals are provided by two power supplies operating in resonance and connected to each other via a synchronization cable.

The primary loops are made of a high-frequency stranded wire installed in one or two windings along the manufacturing cell’s grille in installation conduits or by clamping. The size of the primary loops can range from 1 x 1 m² up to 3 x 6 m². Proportional to the size of the primary loops, the distance of two opposite primary loops to each other can range from 1 m to 3 m. This results in possible volumes between 1 x 1 x 1 m³ and 3 x 6 x 3 m³.

To enable energy reception the wireless proximity switches are equipped with ferrite cubes which are wrapped in three directions with one coil each. If supplemented by a rectifier and a voltage regulator, this results in an omnidirectional energy receiver which is able to ensure reliable energy supply independent of the orientation of the sensor within the electromagnetic field.

3 Communication using adapted Bluetooth technology

The communication hardware is based on the Bluetooth technology operating in the 2.4 GHz ISM band. However, the requirements for the data transmission between proximity switches and the machine controller are higher than for the most common Bluetooth applications where high volume of data are to be transmitted with lower demands regarding the time. The data of an inductive proximity switch contain only a few bits but have to be transmitted to the machine controller very fast and reliable. This is why the communication method of the wireless proximity switches has been designed completely new.

The „heart“ within a network of wireless proximity switches is a so-called input module the input side of which is connected to a transmitting and a receiving antenna and which communicates with the machine controller via an ABB fieldbus plug. On the input module, one of several frequency sets within the 2.4 GHz ISM band can be selected for communication. Each frequency is divided in time slots which enables the input module to communicate with up to 120 wireless proximity switches.

To meet the high demands regarding the transmission speed and reliability even if it is used near other radio transmission systems or other possible sources of interference, the input module has been designed for full-duplex operation (transmission and reception in parallel). It is able to simultaneously process signals with very different field strengths (up to a ratio of 1 : 1.000.000) and provides special interference suppression.

For protection against interference by other radio transmission systems operating in the same frequency range, the input module and the wireless proximity switches use a special frequency hopping method which performs cyclic frequency alternation. Communication reliability is additionally increased by cyclic switching between the transmitting and the receiving antenna of the input module.
The combination of these communication methods guarantees that the signals of a wireless proximity switch can be received by the input module normally within less than 10 ms even under unfavorable receiving conditions.

A novelty compared with conventional proximity switches (defects of which are normally not detected until the machine controller expects their signal) is that wireless proximity switches signalize their presence twice a second if the signal does not change. This way, defective proximity switches can be detected instantly.

4 Low-power sensor technology

Supplying the wireless proximity switch via an electromagnetic field can only be implemented successfully in practice if the energy consumption of the sensor is as economic as possible: The average power consumption of the wireless proximity switches is only a few milliwatts. More than three quarters of the operating power is required for the reliable data transmission. Logically, the transmitter/receiver is in an extremely power-saving stand-by mode as long as it doesn’t have to signalize a signal change or a presence message. For the transmission of signals it is activated step-by-step. Including the signal transmission time, this process takes only 2 ms.

The energy balance of wireless proximity switches is designed for up to five signal changes per second, corresponding to a switching frequency of 2.5 Hz. This switching frequency combined with the fast transmission to the input module predestine wireless proximity switches to be used in assembly machines and production lines.

5 Available from M8x1 to M30x1.5

Wireless proximity switches consist of two parts: For metal detection purposes sensor heads from M8x1 up to M30x1.5 are available as flush mountable and not flush mountable types. They are suitable for nominal switching distances between 1.5 mm and 15 mm. For energy supply, signal transmission and man-machine communication purposes one communication module is available for all sensor heads. The connection of the communication module to the sensor head is performed as usual by means of a M12x1 connector with a sleeve nut.

6 Simple and clear operation

As soon as they are located within an electromagnetic field, wireless proximity switches are able to detect metal objects independent of an input module and to indicate this with the yellow LED on the operator side of the communication module. In order to transmit this information to a machine controller, the brand-new proximity switch has to be assigned to an input module. This is performed in three steps:

- The user switches the input module into configuration mode.
- He selects a free input.
- He presses the membrane push-button of the corresponding wireless proximity switch.

As a result, the wireless proximity switch establishes a connection to the input module using a configuration frequency which is preset for all devices ex works and then receives its individual frequency / time slot combination for operation. The import of these data is indicated to the operator by the green LED on the communication module which lights up then. The configuration of the wireless proximity switch is now completed.

During operation, the green LED informs the user about the state of the proximity switch when pressing the button. A so-called wave signaling function from the wireless proximity switch to the input module as well as vice versa enables the unique assignment of the individual proximity switches (via LED signal) to the sixty inputs of the input module (via indication on the LCD display).

The input module displays a common message as soon as it does no longer receive presence messages from at least one configured proximity switch. This way the user is informed about correct operation of the wireless proximity switches much more reliable than with conventional sensors. These information can be processed by the machine controller and are available for diagnosis on their operating panels.