What is AS-Interface?

Actuator Sensor Interface (AS-Interface) is a simple to install two-wire network for discrete I/O, intelligent sensors, analog and safety data, encoders, light curtains and e-stops. Specifically designed for simplicity and reliability, AS-Interface has extremely fast mounting, start-up and update times, and replaces traditional wiring architectures. It has a totally open topology—there are no limitations on how to route or split network runs. A single unshielded cable with no termination and a very high degree of noise immunity carries both data and power. In addition, AS-Interface is truly an open system, supported by all major PLC manufacturers.

The Development of AS-Interface

AS-Interface was developed by a group of companies that saw the need for a cost-effective, simple and reliable sensor network; designed for discrete sensors and simple output devices that could replace discrete wiring. The original objective was not a universal field bus for all areas of automation, but rather a system for discrete IO only. And so, a consortium of 11 sensor, actuator, and control-system companies—Balluff, Baumer, Elesta, Festo, ifm electronic, Leuze electronic, Pepperl+Fuchs, Sick, Siemens, Turck, and Visolux—started work on this innovative wiring system in 1990. The consortium completed its work in 1993, and ownership of the specification was transferred to AS-International.

AS-International is a nonprofit, member-funded organization of AS-Interface manufacturers. Numerous national organizations exist worldwide. There are over 300 members worldwide and to date, millions of AS-Interface chips are in use around the world.

The AS-Interface Standard

AS-Interface was introduced into the market 1994. Since that time it has become the standard for discrete sensors in automation industries throughout the world. AS-Interface is a wiring replacement system that connects discrete devices such as sensors, solenoids, limit switches, push buttons, valves, and relays to higher-level controllers such as a PC, PLC, CNC or DCS. It is specifically designed for use in automation systems as a digital replacement of traditional parallel wiring at a low connection cost. Due to its single, unshielded, two-wire cable design that transfers signals and power simultaneously; AS-Interface simplifies and significantly reduces installation costs. AS-Interface requires only a single cable to connect I/O modules from any manufacturer. AS-Interface users need no knowledge of bus systems or communication protocols. And, unlike all other networks, AS-Interface doesn’t use shielded cables and terminating resistors. Installing the network is fast and configuration will take less time than other networks. AS-Interface was standardized in 1999 in EN50295 and IEC 62026-2. Only after a module is properly tested can it have the AS-Interface logo.
How Does AS-Interface Operate?

The scanner/gateway automatically controls the communication over the AS-Interface cable. Up to 62 modules can be connected to the network and each module can connect up to eight I/O points. The scanner/gateway calls each module sequentially and awaits each response. If the module fails to respond, the scanner/gateway repeats the request. If there is still no response, the scanner/gateway will record the address of the module and inform the PLC. The scanner/gateway will continue to try to access the unresponsive address. In each cycle, 4 bits of information are transferred from the scanner/gateway unit to each module, and 4 bits are returned.

Interoperability of Pepperl+Fuchs Products with Other AS-Interface Manufacturers

AS-Interface is truly an open, vendor-independent system. Interoperability of certified products is guaranteed by rigid conformance testing so that all AS-Interface products will work well on the same network.

Device Profiles

Each module’s I/O mix and device type are stored in its profile. The I/O code is used to express the inputs and outputs that are used by the module. The ID code expresses the other features of the module. For example, the profile S-0.A means 4 inputs with extended addressing capability.

AS-Interface Topology

The topology of the AS-Interface network is completely open enabling the user to install the system in a layout that best fits each application. Due to its robust operating principle, there are no limits to the structure and any network topology can be used. Because AS-Interface does not use termination, additions are possible without the time consuming task of locating the “end” of the existing network. The power supply and additional modules can also be placed anywhere in the segment. This truly unique approach not only reduces the total network length but also simplifies the installation and results in the shortest possible installation time.
**Network Length**

AS-Interface networks can have a cumulative cable length of 100 meters (328 feet). If larger systems are needed the use of a repeater, that can be located where most convenient, allows extension by another 100 meters. Because repeaters isolate the connected network segments, an AS-Interface power supply must be located in each 100 meter segment. A maximum of 2 repeaters can be used in a single cable run resulting in an overall length of 300 meters. I/O modules can be placed anywhere within the segments. Repeaters are passive on the network and occupy no AS-Interface address.

**NOTE:** Regardless of cable length and number of repeaters, a maximum of 62 I/O modules can be placed on AS-Interface. Other than that, there are no complicated rules or limitations based on trunk and spur lengths to consider.

**Wiring**

Installation and wiring of AS-Interface is as easy as it gets. First of all, the system is based on a two-conductor power and communication method. Secondly, when using the famous mechanically keyed “yellow flat cable” electrical connections are not only reliable and secure but also extremely fast.

The distinctive yellow cable that typically identifies an AS-Interface system has several additional features that make it stand out. The cable has a special mechanical profile that guarantees a correct connection every time by eliminating the danger of reversing polarity. It utilizes a redundant piercing connection technology that allows the connectors to nestle tightly and securely among the fine copper strands in the core of each of the conductors. The reliability of the connections has been proven repeatedly and has been formally evaluated using the DIN EN-60068-2-64. The self-sealing property (insulation displacement) of the rubber insulation maintains a protection class of up to IP67.

Because the contacts penetrate the insulation to secure an electrical connection, some of the most time-consuming electrical tasks are eliminated. There is no need to cut, strip, apply terminals, or label the wire ends. AS-Interface does not use termination. In fact, adding termination resistors to the network will adversely affect its performance. Workers spend less time pulling long lengths of wire through hard to reach places. The reduction of wires not only decreases the size of the control panel, it increases modularity—machines are easier to disassemble, and easier to reassemble at another site.

**Update Time**

AS-Interface is a deterministic network. Given the number and type of modules, one can determine the network update time. To calculate the total network update time, simply multiply the number of modules...
by 150 microseconds. The cycle time is the same for I/O modules with full or half addresses. Analog nodes, however, are exceptions as they split the data up over several scans.

**Actual scan time of V2.0 Discrete I/O =**

\[(2 + \text{number of addresses up to 31}) \times 156 \mu s\]

**Actual scan time of V2.1 Discrete I/O =**

\[(2 + \text{number of nodes up to 62}) \times 156 \mu s\]

**Actual scan time of an analog module =**

\[(\text{Analog points per module} \times 7) \times (2 + \text{number of nodes}) \times 156 \mu s\]

**Data Integrity and Noise Immunity of AS-Interface**

AS-Interface has been designed from the ground up to be used in tough industrial applications. As a result, AS-Interface is extremely noise immune—as applications involving linear sliding contacts and slip rings impressively prove every day. You can rely on AS-Interface to continue to perform in environments where other systems fail. Nevertheless, an AS-Interface system does not negate the fact that it is important to adhere to good wiring practices in order to make sure that many of the advanced noise management features of AS-Interface are readily available when needed. Pepperl+Fuchs has over 10 years of application experience with AS-Interface. We can help you design an AS-Interface system that is most suitable for your application, assist you in choosing the correct components, and guide you through the installation in order to ensure that your system fulfills your manufacturing requirements.

**Approvals**

All Pepperl+Fuchs AS-Interface devices are constructed to adhere to national and international rules and regulations.

- **CE**
  - All Pepperl+Fuchs modules are CE approved and meet the highest level on electronic noise immunity possible for AS-Interface.

- **UL LISTED**
  - This symbol indicates products have been tested and listed to Underwriters Laboratory standards and is in compliance with both Canadian and U.S. requirements.

- **TUV Rheinland FS**
  - Safety modules with this approval can be used up to category 4 according to EN954 and up to SIL 3 according to IEC 61508

**Round Cable and Flat Cable Connections of AS-Interface**

Although a standard two-wire round cable can be used, the preferred way to install AS-Interface is via the famous yellow flat cable. It provides an efficient installation method and, due to the mechanical keying, guarantees correct polarity. Also, the yellow cable ensures that the network operates at peak electrical performance, regardless of the network length (up to 100 meters) and network topology. On the practical side, AS-Interface cable is sold in 100-meter spools. This eliminates the possibility of inadvertently creating a network that is too long.

In addition to using the yellow AS-Interface network cable, a black, mechanically keyed flat cable supplies auxiliary power. The auxiliary power is used to power output devices, such as lights, valves, or actuators. Both cables are offered in standard and oil-resistant versions.

Power Rail can also be used to carry the AS-Interface network. This method connects all modules on the same DIN rail without daisy chaining wire between them.

**Shielding or No Shielding**

In general, AS-Interface uses unshielded cable. If shielded cable is used, it is important to connect the shielded wire to a solid machine ground wherever the data/power leads are exposed. Essentially, shielding is used for mechanical protection, not noise immunity.

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**NOTE: Under no circumstance must one of the AS-Interface leads be grounded.**

AS-Interface utilizes a floating signal and derives much of its noise immunity from this fact. Tying one lead to ground may interfere with AS-Interface communications. Data transmission of AS-Interface is at 167 kHz and, therefore, requires no shielding, no termination and no twisted pairs.
Flat Cable Piercing Technology

In addition to being the fastest installation method, the AS-Interface flat cable offers other benefits resulting in long-term performance and reliability.

Redundant piercing—Redundant electrical connections are established when the AS-Interface flat cable is placed on a Pepperl+Fuchs I/O module. The reliability of those connections has been proven time and again and has been formally evaluated using the DIN EN-60068-2-64 standard.

Applications

Easy machine connection/breakdown/reassembly

AS-Interface is the ideal solution to wire modular systems. During the build phase, modules are placed on various sections of the machine, and sensors/actuators are connected. Quick-Blocks and molded cordsets are used between the individual conveyor/machine sections. Breaking down the machine is as easy as removing the cordsets. No cutting. No splicing. No wire bundles hanging off the module during shipment.

Slip Ring and Sliding Contact Wiring

AS-Interface is the wiring method of choice when I/O is required on a continuously rotating machine.

With AS-Interface, only two conductors are necessary to get up to 434 I/O back to a PLC. Therefore, it is no longer necessary to over size the slip rings. With its high noise immunity AS-Interface will easily deal with the electrical noise generated by the sliding contacts.

The same concept has also been successfully transferred to applications with linear sliders. Only the I/O modules are placed on the carrier system while the PLC remains separate, at a more convenient location. Since this system is controlled by a small number of PLCs, software modifications are quickly and easily accomplished. Additionally, adding I/O on the carriers is trouble-free, uncomplicated, and fast.

Safety

It is also possible to route safety data (door interlocks, e-stops) over AS-Interface. AS-Interface has a solution to your safety requirements with a system called Safety at Work that allows networking of safety devices using a standard AS-Interface network. With the Safety at Work system, safety devices benefit from all of the advantages that AS-Interface brings to the table. Safety input status is directly available to the PLC without the need for additional wiring to auxiliary contacts. The safe outputs on the SafetyMonitor (the safety relay in a hardwired system) can also be retrieved by the PLC without the need for additional wiring.
Repositioning of Work Stations During System Start-up

Frequently, workstations need to be redesigned, modified or moved. While this is a common occurrence, only AS-Interface has the flexibility to address it fully and offer a simple, efficient, cost-effective solution. If a module needs to be moved to a different location, it can simply be removed from the yellow cable and relocated where it will best fit the application. The piercings at the original location in the cable will self-heal. The same is true when larger groups of I/O modules, including safety devices, are moved.

Quick Change Tools On Robotic Arms

Many robotic applications frequently require a change of end arms within the same work cell. While this is possible with other networks, AS-Interface is so versatile that a scanner is able to recognize the I/O components on the new end arm in a fraction of a second. By the time the mechanical connections are complete, the I/O system is available.

Valve Tops

Valves have been controlled by AS-Interface for many years and remain a prime example for network efficiency. Typically, a valve top has two sensors (indicating the open and closed position of the valve) and one or two coils that drive the valve into position. AS-Interface utilizes a small I/O module that is integrated into the valve top. As a result, connecting a large number of valves to a PLC or DCS is reduced to running a single two-conductor cable between the DCS and the valves. It can’t get any simpler.

2.0 Specification vs. 2.1 Specification: How to Expand to 62 Modules

In its original (2.0) specification, AS-Interface accommodates 31 I/O modules where each module uses one, complete address between 1 and 31. With recent enhancements, AS-Interface 2.1 allows I/O modules to take up only one half of an address. Therefore, scanners/gateways that support this addressing scheme are able to communicate with up to 62 modules on a network. This is accomplished with full forward and backward compatibility where modules that use a full address offer up to 4 inputs and 4 outputs, and modules with one half of an address provide 4 inputs and 3 outputs. AS-Interface 2.0 supports up to 124 inputs and 124 outputs, AS-Interface 2.1 supports up to 248 inputs and 186 outputs.

Any scanner/gateway can communicate with any type of node. Whole-address modules and half-address modules may be used within the same AS-Interface network. However, the following rules must be observed:

• When an address number is assigned to a whole-address module (5, 6, 7...), that address number cannot be used for a half-address module (5A or 5B, 6A or 6B, 7A or 7B...). Another number must be selected. Likewise, an address number assigned to
a half-address module (5A or 5B, 6A or 6B, 7A or 7B...) cannot be used for a whole-address module (5, 6, 7...).

- When an address number is assigned to a half-address module (9A), the other half of the address number (9B) can be used by another half-address module.
- When a half-address module is used on a scanner/gateway that does not support A/B addressing, that module must be set to an A address (3A). No additional modules can be used at that address (3B, for example, cannot be used). Also, the control/system must not turn on or use output D3 or parameter P3.

**NOTE:**
- Analog modules always use a full address only.
- Safety at Work modules always use a full address only.

### Standard AS-Interface Components

#### Requirements

- **AS-Interface scanner or gateway:** This may be a P+F version or made directly by the PLC manufacturer
- **AS-Interface power supply:** Every AS-Interface network must have a single power supply with AS-Interface decoupling circuitry. If a repeater is used, an additional power supply is required for each.
- **Cable:** This can be the patented flat cable with the piercing technology or any round cable that meets AS-Interface specifications.
- **I/O modules:** Any I/O module from any manufacturer will work, but the Pepperl+Fuchs modules are guaranteed AS-Interface compliant and will work for years to come.
- **24V external power supply:** Only required if externally powered outputs are used. The standard supply in your cabinet will work very well.
Safety at Work

AS-Interface Safety at Work (SaW) is a system that enables networking of safety devices (safety door switches, e-stops, safety light curtains, etc.) using a standard AS-Interface network. With SaW, users can quickly implement a safety system that satisfies the rules and regulations needed for Category 4, SIL 3 safety. The simplicity of the successful AS-Interface is retained and is a major reason for users to implement SaW systems. The following features make SaW unique and powerful:

• Control I/O and Safety information on the same network
• Usable up to Safety Category 4, SIL 3
• Does not require a Safety PLC
• Automatic single node replacement is supported
• SafetyMonitor allows implementation of both simple and powerful safety procedures

• Adding additional safety devices is simple and fast
• Add SafetyNodes wherever needed, even during final phases of the project
• Each SafetyNode requires one whole address; 31 SafetyNodes per network
• Place monitor anywhere on the AS-Interface network—not necessary to be close to SafetyNodes
• Monitor the status of safety inputs and safety relays directly on AS-Interface to the PLC.
• The SafetyMonitor does not require an address
• Assign an address to read the states of OSSDs
• Certified according EN 954 and EIC 61508 from TÜV Rheinland and all are UL approved
• Configured using VAZ-SW-SIMON software