CHAPTER 2 INTRODUCTION TO AS-i FIELDBUS

2.1 Introduction

The AS-i (Actuator Sensor Interface) protocol was created in Germany in 1994 by a consortium of factory automation suppliers. The AS-i is the simple and effective networking system for the field level. As an open, non-proprietary bus system, it transfers process and machine related digital and analog signals. It also acts as a universal interface between basic digital actuators and sensors and higher level controls.

What makes it so outstanding is the fact that the AS-i system distinguishes itself by providing such a high degree of simplicity and effectiveness. When compared to other Fieldbus systems, it is by far the most favorably priced networking solution. It is therefore no surprise that AS-i has established itself to become a permanent benchmark in industrial automation. This is not only because it is extremely simple to handle and quick to install, but also because it is especially flexible when it comes to retrofits.

AS-i has since gained acceptance in process industries due to its high power capability, simplicity of installation and operation, and low cost. On the average, this system can reduce the global cost of installations by 25% compared with traditional cabling [5].

2.2 AS-i Position

As we mention before, a plant can be divided into different automation levels. Not all the levels are always present in every plant, but certain sub-areas, such as the actuator-sensor level and the field level are always present. The various levels are linked via bus systems. The higher the position of these bus systems in the hierarchy, the greater the requirements as far as data volume and user-friendliness are concerned [6]. As seen in Figure 2-1 AS-i has established itself at the lowest automation level, where it is located below the Fieldbuses [7].

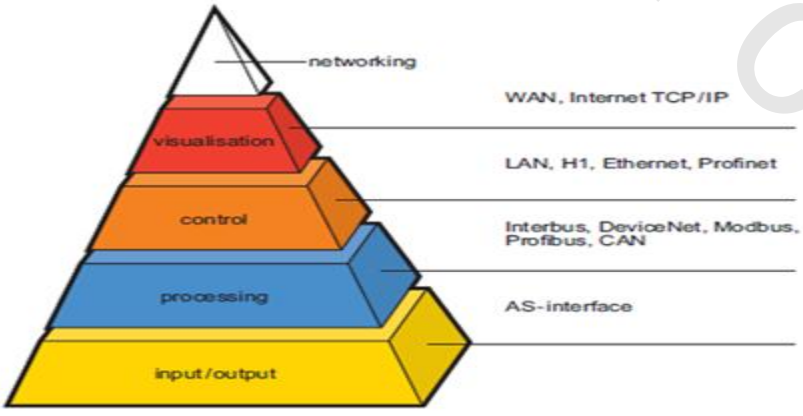

Figure 2-1 AS-i in the automation pyramid

2.3 AS-i Strong Points

There are several advantages for applying AS-i Fieldbus system in the plant which are listed below [8]:

1) AS-i is a normalized interfacing system: totally defined within the EN 50-295 and IEC62026 standard.
2) AS-i is designed primarily for binary (on-off) sensors and actuators although analogue elements are also easily incorporated.
3) AS-i is a non-proprietary open standard: warranty that products are interchangeable, as proven by the certification delivered by AS-i association. Figure 2-2 shows the AS-i certification symbol (shadow logo).
4) AS-i is a deterministic system with very short response times: transmission of data within a given time is warranted.
5) Power and bus communications are on same pair of wires
6) AS-i offers great flexibility in network topology as the network can be: star, line, tree/branch, etc.
7) The automation system can be easily modified or extended.
8) Cost reduction in cabling, no need for separate junction boxes, marshalling boxes, and individual terminations.
9) Reduction of design & installation time.

Figure 2-2 The AS- i certification symbol (shadow logo)

2.4 Conventional Cabling Scheme Versus AS-i Cabling Scheme

2.4.1 Conventional Cabling Scheme

Figure 2-3 shows a conventional wiring scheme. This example shows a conveyor utilizing both digital inputs and outputs for the control and monitoring of the operation. Conventional wiring schemes often specify that digital input and output signals are cabled separately leading to an increase in cabling.

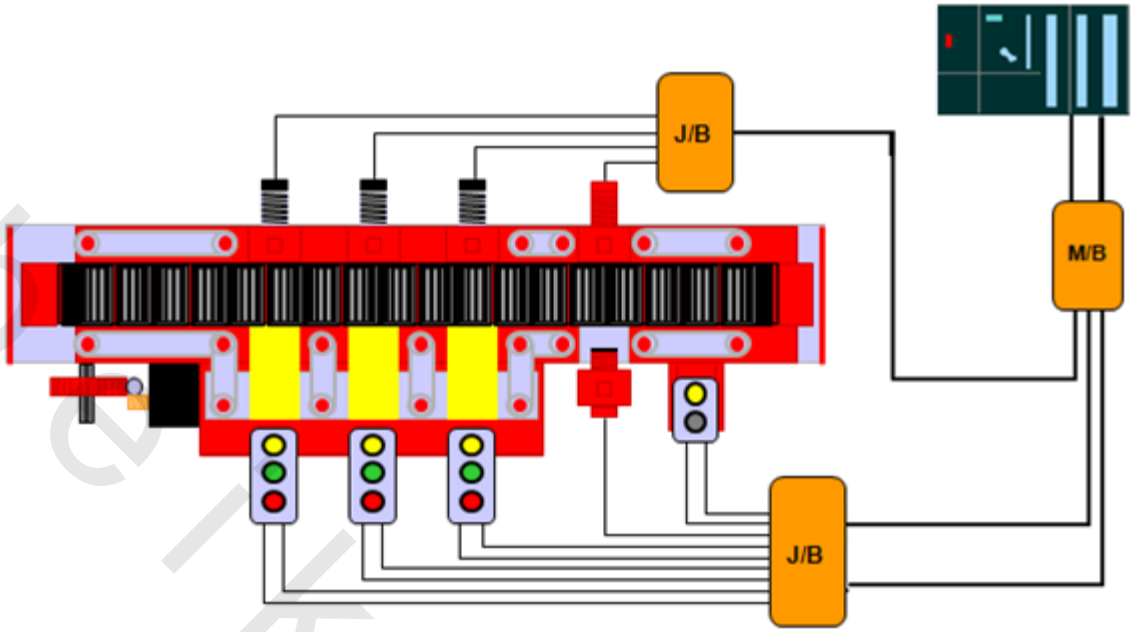

Figure 2-3 Conventional Cabling Scheme

Junction boxes are normally placed in areas where groups of sensors/controls are mounted. To reduce cabling further, multi-core cables are then run into larger marshalling boxes where cabling again can be rationalized into larger multi-core cables. Add to this the amount of time required to install the cables, glands and finally termination and marking of all the individual cores at both ends and all points between the PLC and end devices. Testing is then required to take place to verify that cabling is correct then commissioning can begin [6].

2.4.2 AS-i Cabling Scheme

Consider now the AS-i wiring scheme shown in Figure 2-4. It can be seen that there has been roughly a 60-70% reduction in cabling, no need for separate junction boxes, marshalling boxes, and individual terminations. Our example shows that sensors have been wired into AS-i slave modules via flying leads. These modules are then connected onto the AS-i cable by a simple compression connection. No need for extra tooling. Pushbutton stations are also available as AS-i slave modules reducing the need for further cabling.

These devices are all hooked up to the yellow AS-i cable that is then fed (in this case via coupling modules), into the AS-i master controller in the PLC. Addressing of the sensors/controllers in the PLC program is exactly the same as by conventional wiring methods [6].

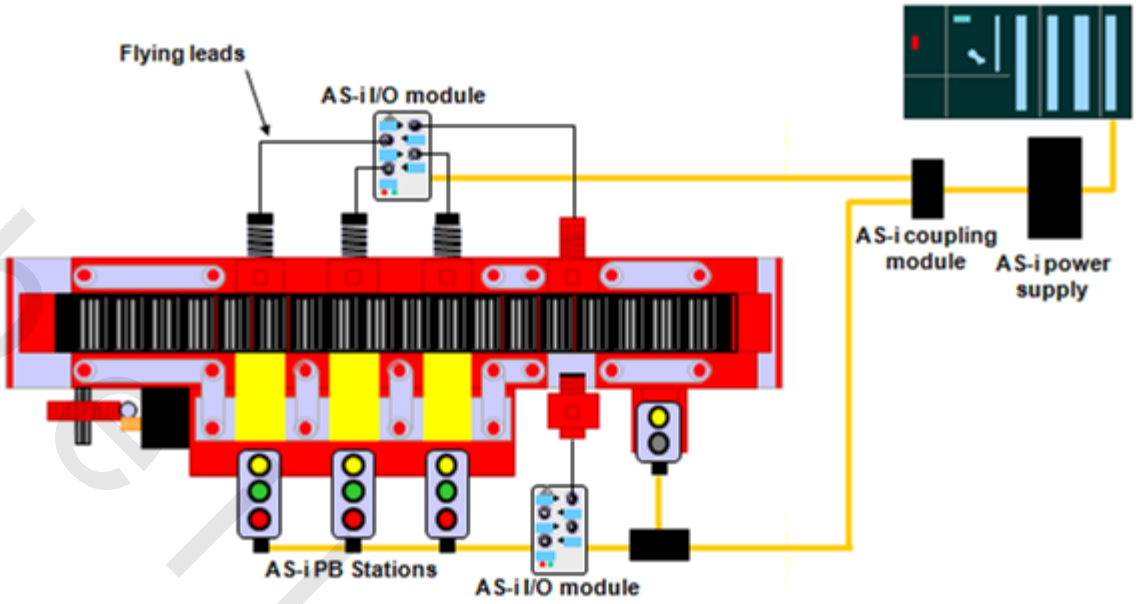

Figure 2-4 AS-i Cabling Scheme

2.5 Principal Performance Characteristics

Principal performance characteristics consists of 7 main points [8]:

2.5.1 Protocol

AS-i is a master-slave system. Slaves are managed by a single master that interrogates each slave present on the cable in turn and waits for its response.

2.5.2 Number of Slaves

31 max.(specification V2.0). Each slave has its own address.
62 max.(specification V2.1 using A/B Technology). Each slave has its own address.

2.5.3 Query Cycle

5 ms max. for 31 On/Off slaves and 10 ms for 62 On/Off slaves.
Maximum number of On/off inputs/outputs per slave are 4I+4O per slave for V2.0 and 4I+3O per slave for V2.1.

2.5.4 Total Number of Traditional Input/Output Signals Connectable to the AS-i

124 I/124 O for V2.0 and 248 I/ 186 O for V2.1.

2.5.5 Transmission Medium

A cable (2x1.5 mm²) unshielded wires, carrying the power supply for peripherals as well as logical signals.

2.5.6 Maximum System Length

100 m, extendible to 600 m using repeaters and extension plugs. This is applicable for all cables and extension cables forming part of the system.

2.5.7 Voltage Distributed Through the Cable

30 V DC (AS-i + and AS-i -). This means that standard 24 V sensors can be connected to AS-i splitter boxes.

2.6 New A/B Technology

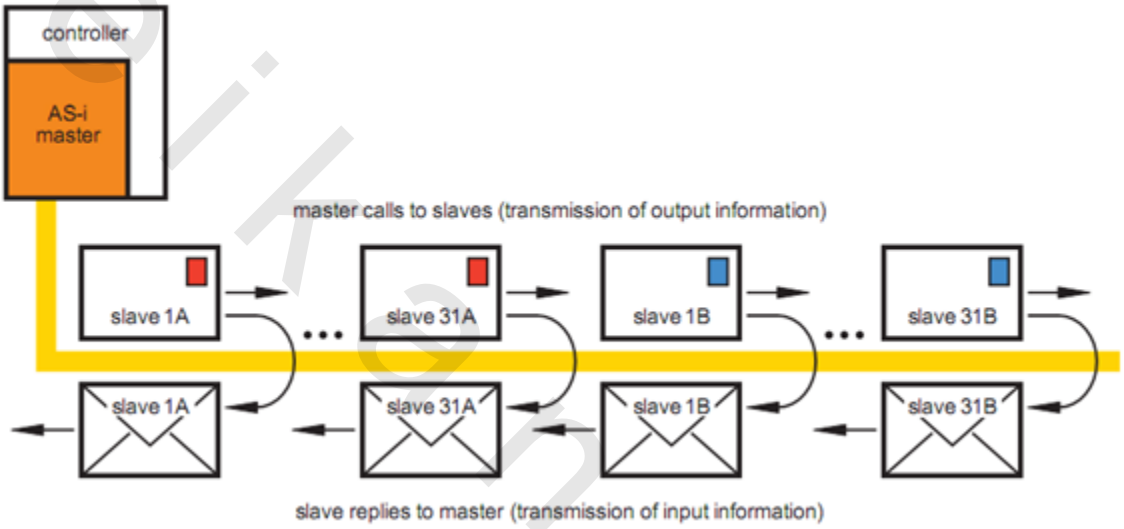

Figure 2-5 New A/B Technology in V 2.1

Figure 2-5 illustrate the new A/B technology which is applied for the AS-i salve configuration from the version 2.1. A salve address range is from (1A… to 31B), this can increase the no of slaves from 31slaves to 62 slaves [7].

The communication cycle is structured in the sequence:

1) The master calls all the A and single slaves
2) The master calls all the B and single slaves
3) The B and single slaves reply to the master
4) The A and single slaves reply to the master

2.7 AS-i System Architecture

AS-i system architecture is divided in 3 main types [9]:

2.7.1 Topology up to 100 m

AS-i systems may employ any type of topology and thus, can be adapted perfectly to the needs of the application. A new "branch" may be connected at any point. No line adaptor

resistors or terminators are required. The sensors and actuators may be positioned at any point on the system, at any distance from each other, thus allowing them to be ideally located on the machine as shown in Figure 2-6.

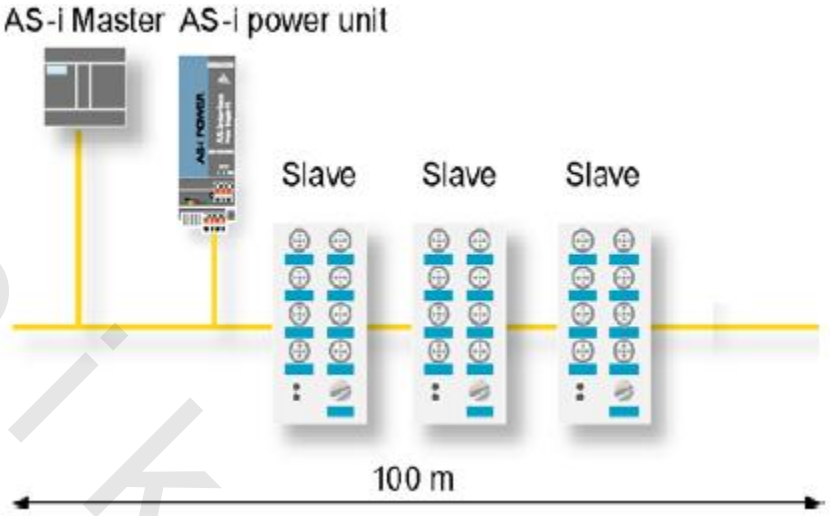

Figure 2-6 AS-i Topology up to 100 m

2.7.2 Extension up to 300 m

The extension is made using the repeater as shown in Figure 2-7. This repeater may be placed anywhere along the AS-i cable. It regenerates the signal and decouples the two segments. Consequently, an AS-i power supply is necessary behind the repeater. The repeater introduces a delay in the data transmission. Due to this delay, a maximum of two repeaters may be put in series. Thus, it is possible to be at a distance of up to 300 m from the master using AS-i.

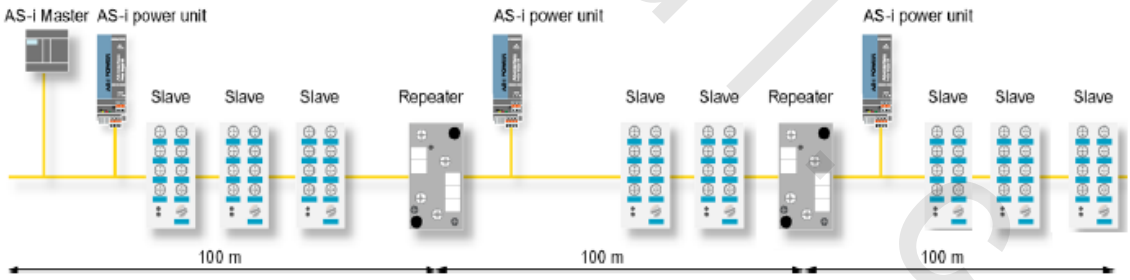

Figure 2-7 AS-i network Extension up to 300 m

2.7.3 Extension up to 600 m

The maximum possible network dimension can be extended by using repeater in combination with the extension plug. It should be note that if using the repeater in combination with the extension plug it is not allowed connecting repeaters in series. Therefore, the maximum distance Master-Slave is 400 m as shown in Figure 2-8, and the absolute maximum distance is 600 m if the master is located in the middle of the network.

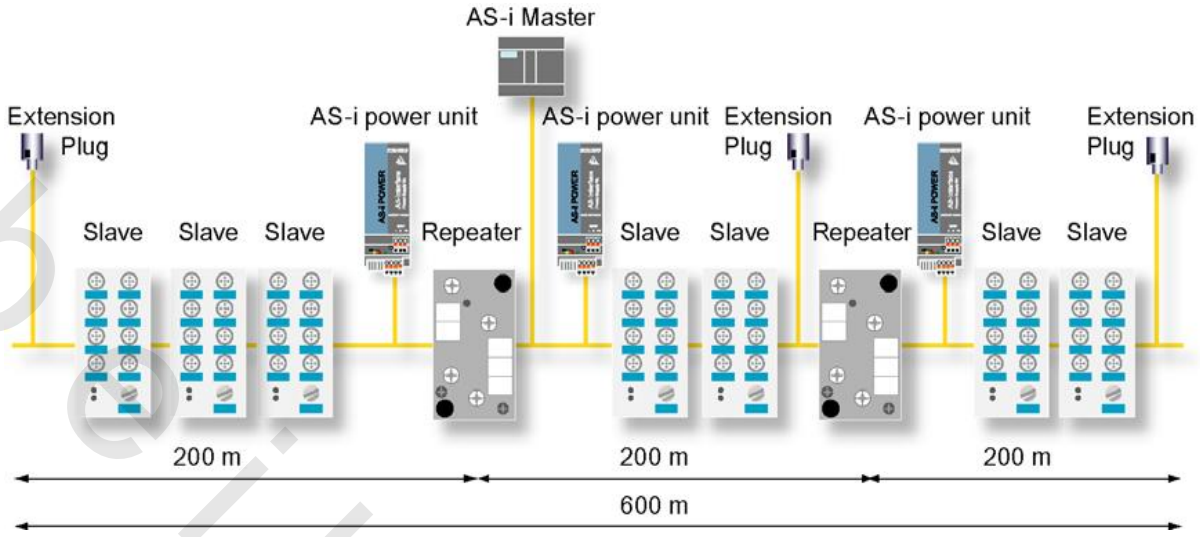

Figure 2-8 AS-i network Extension up to 600 m

2.8 AS- interface Version 3.0

Table 2-1 illustrates the AS-i (V3.0) features [9]:

Table 2-1 AS-i (V3.0) Features

Number of Slaves	62
I/O Range	496 I+496 O
Transmission	Rating Current up to 8A
Media	Unshielded Twin core 2 x 1.5mm2
Max Cycle	20 ms
Number of Analogue Slaves	62
Access Method	Master/Slave
Max Cable Length	100 m Extension with Repeater up to 600m

2.9 Summary

AS-Interface is designed as a simple system for quick data exchange of binary signals. The biggest advantage of AS-Interface is the quick, low cost and uncomplicated installation of the system.