SLOVENSKI STANDARD
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Low-voltage switchgear and controlgear - Controller and device interface systems - Actuator Sensor interface (AS-i)

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Niederspannungsschaltgeräte - Steuerungs- und Geräte-Interface Systeme - Aktuator Sensor Interface (AS-i)

Appareillage à basse tension - Systèmes d'interface appareil de commande - appareils - Interface capteur-actionneur (AS-i)

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Descriptors: Low-voltage switchgear, control equipment, automatic systems, interfaces sensor-actuator, definition, classification, marking, performance evaluation, equipment specification, tests

English version

Low-voltage switchgear and controlgear
Controller and device interface systems
Actuator Sensor interface (AS-i)

Appareillage à basse tension
Systèmes d'interface appareil de commande - appareils
Interface capteur-actionneur (AS-i)

Niederspannungsschaltgeräte
Steuerungs- und Geräte-Interface Systeme
Aktuator Sensor Interface (AS-i)

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

This European Standard was prepared by the Technical Committee CENELEC TC 17B, Low-voltage switchgear and controlgear including dimensional standardization.

The text of the draft was submitted to the Unique Acceptance Procedure and was approved by CENELEC as EN 50295 on 1998-12-01.

There are patent rights linked to EN 50295:1999. The patent holder, SIEMENS Aktiengesellschaft has declared to grant licences to these patents and corresponding patent applications under fair and reasonable terms in accordance with CEN/CENELEC Memorandum 8.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1999-12-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1999-12-01

Annexes designated "normative" are part of the body of the standard.

In this standard, both annexes A and B are normative.

CONTENTS

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR

Controller-device interface systems

Actuator Sensor interface (AS-i)

1 Scope

This standard specifies requirements for a bit-oriented interface system between a single controlling device and control circuit devices or switching elements as defined in EN 60947-1, connected by an unshielded, untwisted two-wire cable carrying data and power. It also enables the interchangeability of components which have such interfaces.

This standard specifies:

- requirements for interfaces and for electromechanical structures for slaves and masters;
- performance of slaves, electromechanical structures and masters under normal service conditions;
- constructional and performance requirements;
- tests to verify conformance to the requirements.

Specific requirements for the various profiles for slaves and masters are given in annexes A and B.

NOTE 1 – The standardized low-voltage switchgear and controlgear products covered by the EN 60947 series are:

- EN 60947-1: General rules;
- EN 60947-2: Circuit-breakers;
- EN 60947-3: Switches, disconnectors, switch-disconnectors and fuse-combination units;
- EN 60947-4:Contactors and motor-starters;
- EN 60947-5: Control-circuit devices and switching elements;
- EN 60947-6: Multiple function equipment;
- EN 60947-7: Ancillary equipment.

NOTE 2 – Where inputs and outputs (I/O) are described in this standard, their meaning is relative to the master. The meaning relative to the application is the opposite.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 55011:1998, *Industrial, scientific and medical (ISM) radio-frequency equipment – Radio disturbance characteristics - Limits and methods of measurement*

EN 60947-1:1997, *Low-voltage switchgear and controlgear - Part 1: General rules*

EN 60947-5-1:1997, *Low-voltage switchgear and controlgear - Part 5-1: Control circuit devices and switching elements - Electromechanical control circuit devices*

EN 60947-5-2:1997, *Low-voltage switchgear and controlgear - Part 5: Control circuit devices and switching elements - Section 2: Proximity switches*

EN 60998-2-3:1993, *Connecting devices for low-voltage circuits for household and similar purposes - Part 2-3: Particular requirements for connecting devices as separate entities with insulation piercing clamping units*

EN 61000-4-2:1995, *Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 2: Electrostatic discharge immunity test*

EN 61000-4-3:1996, *Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 3: Radiated, radio-frequency, electromagnetic field immunity test*

EN 61000-4-4:1995, *Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 4: Electrical fast transient/burst immunity test*

EN 61131-2:1994, *Programmable controllers – Part 2: Equipment requirements and tests*

HD 384.4.41 S2:1996, *Electrical installation of buildings - Part 4: Protection for safety - Chapter 41: Protection against electric shock (IEC 60364-4-41:1992, mod.)*

3 Definitions, symbols and abbreviations

Alphabetical index of definitions *References*

A

B

D

3.1 Definitions

The following terms and definitions apply to this standard.

3.1.1
active slave
slave connected to the AS-i line and capable of communicating as specified in this standard

3.1.2
Actuator Sensor interface (AS-i)
set of interfaces and serial communication method for the connection of low-voltage switchgear, controlgear and other simple devices to a controller

3.1.3
address
numerical parameter between 0 and 31 which specifies a node of an AS-i network

NOTE – Address 0 is reserved for slaves which have not had an address assigned.

3.1.4
address assignment
replacement of the existing address of the AS-i slave with a new address

3.1.5
AS-i cycle
set of up to 33 transactions

NOTE – A transaction may, in case of a detected fault, include one master request or slave response retransmission.

3.1.6
AS-i input
physical (external) or logical (internal) slave input port (see figure 1)

3.1.7
AS-i line
two-wire cable utilized by AS-i slaves and the AS-i master for transferring information and power

3.1.8
AS-i master
unit on the AS-i line that manages the communication between the slaves and the controller

3.1.9
AS-i network
network composed of AS-i master, slaves, power supply and line

3.1.10
AS-i output
physical (external) or logical (internal) slave output port (see figure 1)

3.1.11
AS-i power supply
combined d.c. supply and decoupling circuit needed for an AS-i network

3.1.12
AS-i slave
physical and logical means of connecting the application devices (actuator, sensor, or other components) to the AS-i line

NOTE – A slave may be a stand-alone device or part of another device.

3.1.13
bit time (effective)
duration of the transmission of one bit (T_{bit})

3.1.14
decoupling circuit
part of the AS-i power supply for decoupling the d.c. source and for conditioning the physical data transmission within the AS-i network

3.1.15
field devices
items connected to the AS-i slave

NOTE 1 – Examples are actuators, sensors, push-buttons, indicator lights.

NOTE 2 – "Intelligent" field devices also include integrated AS-i circuitry.

3.1.16
I/O configuration (I/O code)
set of four bits which defines the direction of data flow at the four I/O ports of a slave

3.1.17
identification code (ID code)
set of four bits which defines the type of slave profile for a given I/O configuration

3.1.18
master pause
time between the last bit of a master request and the first bit of the slave response at the master

3.1.19
master request
data or parameter or function sent from the master to a single slave

3.1.20
non-volatile stored data
data that remains unchanged following power interruption

3.1.21
operation address
address of the AS-i slave other than the zero address

3.1.22
output current limit I_{Lim}
output current of the power supply which cannot be exceeded under all environmental and load conditions

3.1.23
send pause
period after receipt of the slave response during which no transmission occurs

3.1.24
slave pause
minimum time between the last bit of a slave response and the start of the first bit of the next master request

3.1.25
slave response
message from the slave to the master after a master request has been received and processed without error. The content of this response is either data or the result of a command

3.1.26
transaction
combination of a master request, master pause, slave response and send pause (see figure 5)

3.1.27
volatile stored data
data that may change following power interruption

3.1.28
zero address
special address reserved for the online assignment of a new address to an AS-i slave

3.2 Symbols and abbreviations

APF	AS-i Power Failure
APM	Alternate Pulse Modulation
APO	AS-i Power-ON
AS-i	Actuator Sensor interface
T_{bit}	bit time
TS	Transaction Status
U_b	power supply voltage
U_{send}	peak value of the voltage pulses
$u(t)$	pulse waveform

4 Classification

4.1 Overview

AS-i is usually applied at the lowest level in a multi-level automation hierarchy. AS-i concentrates on the typical requirements to connect binary elements with a controller.

AS-i can be used as an interface physically integrated into field devices e.g. actuators, sensors, or other devices and elements themselves, allowing design of "intelligent" binary actuators, sensors, or other devices and elements. Alternatively AS-i may be used in separate modules, each providing an interface for up to four conventional actuators and/or sensors or other devices and elements.

The AS-i structure contains two different types of interface, three logical and five physical as shown in figure 1.

Logically, the AS-i system is a master-slave communication system composed of a single master and up to 31 slaves. The master sends data and parameters to each specific slave. The slave passes the data to the output ports or processes the requested procedure (e.g. reset_slave) and returns the input data or the result of the successfully processed procedure to the master.

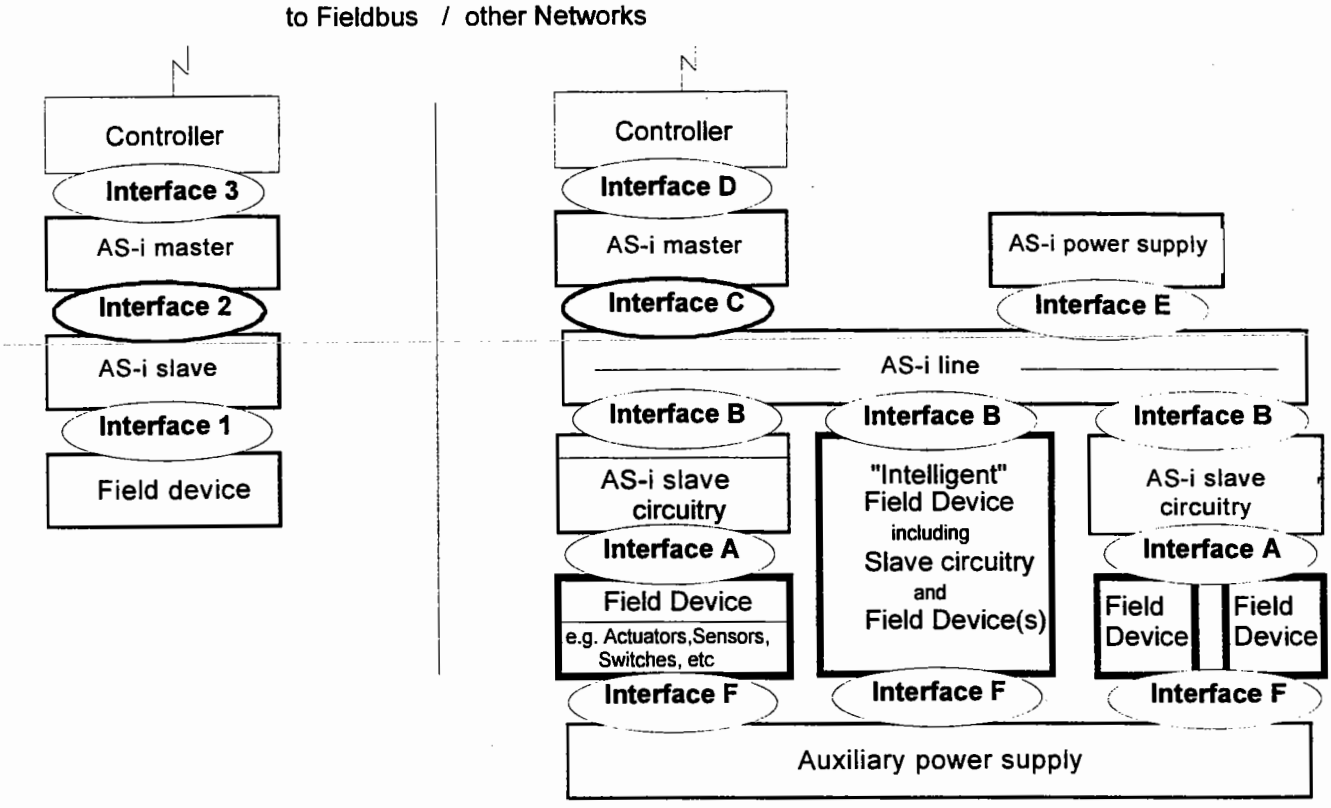

Figure 1 – AS-i components and interfaces

The AS-i concept is independent of the specific field devices. It defines the mechanisms and all the components for the communication with a controlling device and it offers electromechanical structures for a standardized "interconnection system" for installation of actuators, sensors, or other devices and elements.

More than one standard field device may be connected via the physical interface A to the slave.

"Intelligent field devices" contain the slave circuitry, the physical interface A and the field device itself.

Annexes A and B define profiles for common types of devices that can be used in AS-i systems.

4.2 Components and interfaces (see figure 1)

4.2.1 Components

4.2.1.1 AS-i slave

The AS-i slave includes the circuitry that determines the logical and functional behaviour of the unit and which can be accessed by the master via the AS-i line for data exchange, parameterization, and monitoring. It responds to a specific request from the master and it ensures that a malfunction of the attached actuator, sensor or other device or of the slave itself does not disturb the communication between the master and the other slaves in the network.

4.2.1.2 AS-i master

The AS-i master includes the circuitry that determines the logical and functional behaviour of the unit that organizes and monitors the network and schedules the exchange of data, parameters and commands with the AS-i slave via the AS-i line. The AS-i master sends master requests to an AS-i slave and receives slave responses from it.

4.2.1.3 AS-i power supply

The AS-i power supply provides power to the AS-i network and includes the decoupling circuitry.

4.2.1.4 AS-i line

The AS-i line provides the signalling and d.c. power connections between the AS-i devices.

4.2.2 Logical interfaces

4.2.2.1 Interface 1

Interface 1 is the slave interface that connects the AS-i slave with the actuators, sensors, or other devices and elements. It is characterized by several ports, which define the input, output or bi-directional input/output behaviour, the parameterization behaviour of the AS-i slave and the timing of the signals.

4.2.2.2 Interface 2

Interface 2 provides all logical definitions required for data exchange between the AS-i master and slaves. It comprises signalling of encoded information and the network management.

4.2.2.3 Interface 3

Interface 3 provides all functions used by the controller (host) to access the AS-i master for sending and receiving data to and from slaves, sending commands to a slave, to set or to get flags and values for several lists in the master. This interface allows the controller to manage the AS-i master's behaviour and thus the behaviour of the AS-i system. Typical functions include "set something" in the master or "get some information" from the master.

This interface is conceptual in nature and its definition is outside of the scope of this standard. The concrete representation of the interface depends on the implementation. To a large extent, it depends on features of the specific controller system.

4.2.3 Physical interfaces

4.2.3.1 Interface A

Interface A defines the physical connection between the field device and the AS-i slave circuitry including physical interface, signal levels and power requirements if any.

4.2.3.2 Interface B

Interface B defines the physical connection of the AS-i slave circuitry to the AS-i line including physical interface (mechanical and electrical), signal characteristics and power requirements.

4.2.3.3 Interface C

Interface C defines the physical connection of the AS-i master circuitry to the AS-i line including physical interface (mechanical and electrical), signal characteristics and power requirements.

4.2.3.4 Interface D

The definition of the physical interface between the AS-i master and the controller (interface D) is outside of the scope of this standard and shall be provided by the manufacturer.

4.3.2.5 Interface E

Interface E defines the physical connection of the AS-i power supply including the signal decoupling circuit, to the AS-i line.

4.3.2.6 Interface F

Interface F defines the physical interface between the field device and an external auxiliary power supply if any.

5 Characteristics

5.1 AS-i transmission system

5.1.1 General

The AS-i transmission system provides the communication between the AS-i slaves and the AS-i master, i.e. it represents interface 2 between a master and the slaves (see figure 1).

The AS-i system is a digital, serial, multidrop, data communication with actuators and sensors including simultaneous power supply. Subclause 5.1.2 specifies the transmission of data between the master and a specific slave.

5.1.2 Signal characteristics

The characteristics of the transmitted signal and the modulation are defined in this subclause.

The bit time (T_{bit}) shall be 6 µs. Thus the bit rate shall be 166 $^{2}/_{3}$ kbit/s. The maximum deviation from the nominal bit time shall not exceed ± 0,2 %.

The transmission coding and encoding principle shall be as shown in figure 2. Each master request or slave response shall include a start and an end bit. The idle state shall be represented by a "1". Master request or slave response shall be encoded in Manchester II format with alternate pulse modulation (APM). The duration of each bit shall be 6 µs.

A "0" shall be encoded by a period of 3 µs high level followed by a period of 3 µs low level. A "1" shall be encoded by a period of 3 µs low level followed by a period of 3 µs high level. The transmitter shall be implemented as a current sink. The amplitude of the modulation current shall be between 55 mA and 68 mA. Together with the decoupling inductances of the decoupling circuit in the power supply, this current will lead to a negative voltage pulse at each rising edge and a positive voltage pulse at each falling edge. The ideal waveform of the pulses is:

$$u(t) \approx \pm U_{send} \times \sin^2\left(\frac{2\pi}{6\,\mu s}\,t\right)$$

where U_{send} is a constant approximately equal to 2 V (see figure 2).

NOTE – In a real AS-i system, the falling edge of the pulses is flattened due to the behaviour of the decoupling circuit and the physical properties of the AS-i line.

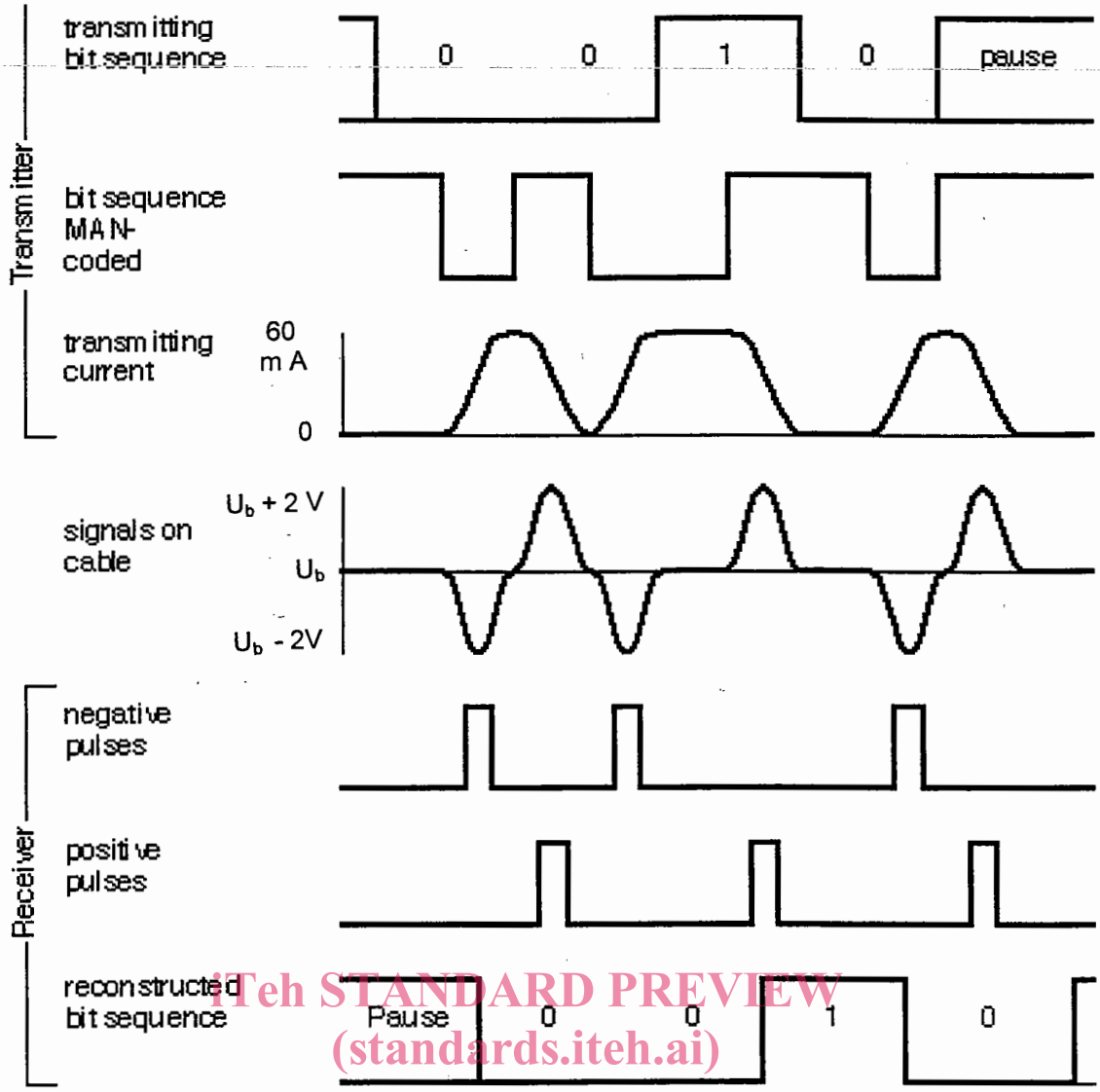

Figure 2 – Transmission coding and encoding principle

5.1.3 Power and data distribution

The simultaneous transmission of data and power on the AS-i line requires technical provisions for decoupling data and power.