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High efficiency communication subsystem for small data packages

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English version

High efficiency communication subsystem for small data packages

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

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 65CX, Fieldbus.

The text of the draft was submitted to the Unique Acceptance Procedure and was approved by CENELEC as EN 50254 on 1998-10-01.

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) 1999-08-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1999-08-01

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High Efficiency Communication Subsystem for Small Data Packages

Volume 1 (Introduction)

Structure of the Document

This European Standard contains one network concept, known as INTERBUS and two ways of using concepts already defined in EN 50170 known as PROFIBUS DP and WorldFIP Profile 1, which are in widespread use and which are already pre-standard at national level in Germany and in France. CENELEC TC 65CX decided to collate these specifications in one European Standard and to name it "High Efficiency Communication Subsystem for Small Data Packages" (HECS).

In order to give the reader a clear orientation, this European Standard is divided into four volumes, Volume one contains general information and the following volumes are specific for each concept. The volumes are devided into parts. The part numbering of this document is the same as in EN 50170 and reads as follows: The first digit after the EN number indicates the part of the volume, the second digit indicates the volume, which contains the part.

Example: Under Part 3-2 the reader will find part 3 in volume 2, which is the Data Link Layer specification of volume 2 (INTERBUS).

Common Background to all Volumes of EN 50254

This European Standard has been prepared by CENELEC Technical Committee 65CX.

For industrial communication several well recognised solutions are used, which meet the user needs. Many of these needs are covered by EN 50170, but there are additional needs such as a highly efficient protocol and a deterministic and predictable constant scan time for inputs and outputs.

Users and manufacturers in European industry have done research and development efforts to highly efficient communication networks a reality in the industrial automation market. CENELEC TC 65CX has selected three specifications for this European Standard which are market proven, open and validated.

According to the decision of TC 65CX to specify this standard according to Publicly Available Specification (ITSTC 1653) which implies neither to develop any new compromise nor to re-write the actual concepts on the market, the reader should pay his dedicated attention to the following notes:

Note 1:
This European Standard contains the following three different specifications without attempting to develop any compromise or to mix them.

EN 50254 Volume 2, based on and identical to E DIN 19258 series
EN 50254 Volume 3, specifies a distinct usage of EN 50170 volume 2
EN 50254 Volume 4, specifies a distinct usage of EN 50170 volume 3

Note 2:
The concepts of these specifications are different from each other and therefore they cannot communicate together unless there are adaptations. For each implementation you have to select the one which suits the user's application needs.

Provisions exist in each concept to detect any attempt to mix products pertaining to other concepts and to avoid that such a mistake will not lead to corrupt the working network ; several levels of protection exist, that cover connectors, physical layer coding, different speeds and effective network management.

High Efficiency Communication Subsystem for Small Data Packages

Part 1-1

General Description

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1 Scope

This European Standard is specifying a set of solutions named « High Efficiency Communication for Small Data Package » (HECS). The scope covers the communication of simple devices such as I/Os or sensors / actuators. It is not specified for a certain industry sector such as manufacturing automation, but is targeted to any application requesting fast access to small data packages with deterministic and predictable access.

High Efficiency Communication Systems for Small Data Packages have proven their utility besides the GPFCS (Genaral Purpose Field Communication Systems) as complementary solution or to answer specific needs links with process efficiency. Having recognised this fact this standard is proposing concepts which have proven the effectiveness in industry for years.

2 General Aspects of High Efficiency Communication

2.1 High Efficiency Communication on the Control Architecture

The control architecture is logically devided into multiple networks, Actuator/Sensor bus, Device bus, Fieldbus, Cell bus, corresponding to different types of data exchange. This decomposition is guided by the aim of keeping the communication flow to a manageable level between all interconnected equipment. But each application system is different and developed with the process.

In order to meet the needs of a scaleable and flexible control architecture, this logical decomposition of networks should be realised by a limited number of physical networks, typically one for small size application or two for classical manufacturing cell.

2.2 Specific Requirements

The HECS constitutes an addition of the GPFCS (general purpose fieldbus communication system) requirements with specific ones to take into account that its connects rather simple devices with limited number of information (typically 16 bits) together with fast access to it by the controlling device (typically 10ms cycle time).

Also the deterministic aspect of the communication exchanges is mandatory to predict the control behaviour of the control scheme.

All the data which are to processed by the controller are to come from the same cycle in order to be consistent (same sample time). Conversely the outputs should be activated at the same time. The target is to have with remote I/Os the same features as with local I/Os for a controlling device.

2.3 Selection Criteria

This European Standard has selected solutions according to the following criteria :

1 Candidates shall be national standard or pre-standard.

2 Candidates shall fit into the scope and the policy statement of TC65CX (CLC/TC65CX(SEC)4 and CLC/TC65CX(BXL/SEC)1).

3 Candidates should be documented in English language according to classical OSI/IEC decomposition in layers.

4 Candidates shall be already in use in commercial products and running in industrial plants (demo is not considered as industrial use).

5 Products should be available in quantities and at low price. Users shall be in the position to make experiences with simple I/O communications and be given advice how to use existing conceptions.

6 Products of the candidates shall be available from several sources and commercialised openly.

7 The physical layer of candidates shall be able to satisfy the IEC 801-2,801-3,801-4,801-5 and 801-6, class 3, for industrial use.

8 Candidates shall have appropriate mechanisms for transmission error detection.

9 The specification shall be open, widely accepted, well documented, stable and support interoperability.

10 The documentation of the candidates should - in line with the procedures and conditions of CENELEC - be free of intellectual Property Rights and Copyright aspects.

11 The specification shall be complete and describe the necessary interfaces in such a detail that no problems may arise for implementation purposes.

12 There must be no restriction related to testing the implementation.

13 Candidates shall support time critical requirements such as:

13.1 Time-critical messages shall be short enough to be sent without segmentation.

13.2 Non-time-critical PDUs shall not prejudice the delivery of time-critical PDUs.

13.3 Candidates shall cope with dynamic sequencing.

13.4 Predictability of message transfer times and transaction time is necessary.

13.5 Agreed probability of interaction/transaction completion time is necessary.

13.6 Temporal coherence is required.

14 Candidates shall have an application interface which supports the direct access to the I/O image through a local data base.

15 For the scenarios A and B candidates should have a complete cycle time (reading all inputs and writing all outputs) of not greater than 10 ms, at industrial speed over a minimum distance of 100 m.

Benchmark scenario A :

- Number of stations 31
- Number of inputs data per station 16 bits
- Number of outputs data per station 8 bits

Benchmark scenario B :

- Number of stations : 24
- Station 1 to 8 16 bits input
- Station 9 to 16 16 bits output
- Station 17 to 24 16 bits and 16 bit output

16 Candidates should provide a specification for the calculation of the cycle time.

3 Main Features of EN 50254 Volume 2 (INTERBUS)

This network is a digital, serial communication system for communication between control systems (e.g. programmable logic controllers, PLCs) and devices for the entire field of industrial sensors and actuators. These devices include simple limit switches and valves, as well as measuring sensors, measuring transducers, actuators but also complex high-tech control systems, such as controlled drives, wrenching and

process controllers, etc. This concept combines the requirements of Actuator/Sensor busses and Device busses, it is optimised, but not limited to factory automation applications.

The networks main characteristics are:

- master-slave concept
- ring structure with a one-total-frame protocol
- tree topology for the arrangement of devices
- little protocol overhead for cyclic input/output data
- input/output data oriented and message oriented services
- input/output data and messages are transferred concurrently
- message transfer does influence input/output data transfer only by a small fixed amount of time
- enhanced error detection facilities, such as CRC, stop bit, time-out check and loop back word (total frame transmission control word).
- 2 wire ring with a transmission speed of 500 kbits/sec

User benefits of the network are:

- fixed and predictable cycle time for a given network configuration
- scan of input/output data in a time constant and consistent way
- easy installation and maintenance; no device adresses are needed
- enhanced network diagnostic features; errors can be traced down to the ring segment and the device
- combination of simple and complex devices in one network

EN 50254 volume 2 has been published as a German Prestandard E DIN 19258 series (known as INTERBUS).

4 Main Features of EN 50254 Volume 3 (PROFIBUS-DP Profile)

EN 50170 Volume 2 specifies a communication system consisting of two variations. Both variations use the same Physical and Data Link Layer. Therefore both variations can operate in a network simultaneously on the same medium.

EN 50170 volume 2 parts 5 and 6, known as PROFIBUS-FMS, is optimized for the communication between intelligent devices. It offers powerful application services and is suitable for the transmission of large data packages. PROFIBUS-FMS specifies a complete Application Layer Protocol. It offers an enormous flexibility but on the other hand it causes a notable protocol overhead.

EN 50170 volume 2 part 8, known as PROFIBUS-DP, is optimized for simple I/O communication of small data packages, e. g. connecting binary I/Os with their related automation systems (PLC). This variation offers reduced functionality along with enormous increased protocol efficiency. This enables the transmission of one Kbyte input and output data in less than one millisecond.

PROFIBUS - DP offers the following features:

- reliable transmission protocol, Hamming Distance, HD=4
- optimised services for fast and efficient communication
- one message cycle transfers input and output data
- due to the reduced functionality and the lean protocol stack, single chip ASICs are available, implementing the complete protocol at a favourable price
- transmission speeds as defined in EN 50170, volume 2
- flexible and powerful diagnosis capabilities
- simple configuration, complete specification of the device characteristics included in EN 50170 volume 2
- computable and reliable message transfer and transaction time
- mixed operation with PROFIBUS-FMS

For a communication architecture based on EN 50170 volume 2, it is possible according to conformance classes to define different levels of communication interface while guaranteeing communication interoperability. The purpose of the volume 3 of this European Standard is to define a profile based on EN 50170 volume 2 part 8 (PROFIBUS-DP) for simple devices requiring fast communication.

The profile will not change the performances level of the communication network as defined in the EN 50170 volume 2.

5 Main Features of EN 50254 Volume 4 (WorldFIP Profile 1)

Simple and sophisticated devices should co-work on the same network, but without oversizing the communication interface of the simple device.

For a communication architecture based on EN 50170 volume 3, it is possible according to conformance classes to define different levels of communication interface while guaranteeing communication interoperability. The purpose of the volume 4 of this European Standard is to define a profile for simple device requiring fast communication.

The characteristics of this profile will provide the device with :

- easy interconnection with ready made user interface
- transmission speeds as defined in EN 50170 volume 3
- high EMC resistance level 3 and higher
- high integrity, the request for fast communication does not allow for time reasons to retransmit or verify transmission quality. Thus the residual error rate is below 10^{-18} for a raw error rate of 10^{-3} . Such an integrity makes retransmission not necessary
- media redundancy for application requiring high availability

The definition of the profile will specify :

- a reduced set of communication services based on the time critical services MPS. The time qualifiers **refreshment** and **promptness** are mandatory in order to ensure the data user of the quality of the information received,
- a limited address space for efficient decoding and reduced level of configuration,
- a limited volume of data to be transmitted both in term of quantity and individual length. Again the objective is to size the communication to the real need of the devices.

The profile will not change the performances level of the communication network as defined in the EN 50170 volume 3. Then high quality control with fast response time can be developed irrespective of wether the device is simple or sophisticated.

This profile has been registered as NF C 46 638, High efficiency communication for small data packages-WorldFIP profile 1.

High Efficiency Communication Subsystem for Small Data Packages

Volume 2 (INTERBUS)

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FOREWORD

All parts of the volume 2 describe together a complete sensor/actuator network.

The parts of volume 2 being:

Part 1-2: General Description and System Architecture
Part 2-2: Physical Layer
Part 3-2: Data Link Layer

The sensor/actuator network is a digital, serial communication system for communication between control systems (e.g. programmable logic controllers, PLC) and devices for the entire field of industrial sensors and actuators. These devices include simple limit switches and valves, as well as measuring sensors, measuring transducers, actuators but also complex high-tech control systems, such as controlled drives, wrenching controllers, process controllers, etc.

The use of the Data Link Layer services for the transmission of parameter data blocks via the parameter channel will be described in a technical report which is being prepared by the CENELEC Technical Committee 65CX.