

Universelles Feldkommunikationssystem

Englische Fassung EN 50170 : 1996 Band 1/3 P-NET

DIN**EN 50170/1**

ICS 35.100.01; 35.160; 35.200

Deskriptoren: P-NET, Feldbus, OSI, Anwendungsschicht

General purpose field communication system;

English version EN 50170 : 1996 Volume 1/3 P-NET

Système de communication de terrain pour application générale;

Version anglaise EN 50170 : 1996 Volume 1/3 P-NET

Die Europäische Norm EN 50170 : 1996 Band 1/3 P-NET hat den Status einer Deutschen Norm.

Nationales Vorwort

Die vorliegende Norm besteht aus drei Bänden und ist wie folgt gegliedert:

- Band 1/3 übernimmt die Dänischen Normen der Reihe DSF 21906 (P-NET).
- Band 2/3 übernimmt die Deutschen Normen DIN 19245-1, DIN 19245-2 und den Entwurf zur DIN 19245-3 (PROFIBUS).
- Band 3/3 übernimmt die Französischen Normen der Reihe NF C46-6XX (WorldFIP).

Die Europäische Norm EN 50170 besteht nur in einer englischen Sprachfassung, weil sie nicht unmittelbar im Zusammenhang mit Rechtsvorschriften steht und nicht als Sicherheitsnorm anzusehen ist. Es kann davon ausgegangen werden, daß die Anwender dieser Norm über hinreichende englische Sprachkenntnisse verfügen. Für die meisten der verwendeten Begriffe existieren keine gebräuchlichen deutschen Begriffe, da sich die deutschen Anwender in der Regel ebenfalls der englischen Begriffe bedienen.

Das nationale Arbeitsgremium UK 951.3 "Feldbus" der Deutschen Elektrotechnischen Kommission im DIN und VDE (DKE) ist für diese Deutsche Norm zuständig.

Für den Fall einer undatierten Verweisung im normativen Text (Verweisung auf eine Norm oder andere Unterlage ohne Angabe des Ausgabedatums und ohne Hinweis auf eine Abschnittsnummer, eine Tabelle, ein Bild usw.) bezieht sich die Verweisung auf die jeweils neueste gültige Ausgabe der in Bezug genommenen Norm oder anderen Unterlage.

Für den Fall einer datierten Verweisung im normativen Text bezieht sich die Verweisung immer auf die in Bezug genommene Ausgabe der Norm oder anderen Unterlage.

Fortsetzung Seite 2
und 98 Seiten EN

Deutsche Elektrotechnische Kommission im DIN und VDE (DKE)

Der Zusammenhang der zitierten Normen und anderen Unterlagen mit den entsprechenden Deutschen Normen und anderen Unterlagen ist nachstehend wiedergegeben. Zum Zeitpunkt der Veröffentlichung dieser Norm waren die angegebenen Ausgaben gültig.

Europäische Norm	Internationale Norm	Deutsche Norm	Klassifikation im VDE-Vorschriftenwerk
–	ISO/IEC 646 : 1991	DIN 66003 : 1974-06	–
EN 29506-1 : 1993	ISO/IEC 9506-1 : 1990	DIN 66306-1 : 1992-09	–
–	ISO/IEC 8825 : 1990	DIN 66333 : 1993-09	–
EN 60870-5-1 : 1993	IEC 870-5-1 : 1990	DIN EN 60870-5-1 : 1994-07	–
EN 60870-5-2 : 1993	IEC 870-5-2 : 1992	DIN EN 60870-5-2 : 1994-07	–
EN 61131-2 : 1994	IEC 1131-2 : 1992	DIN EN 61131-2 (VDE 0411 Teil 500) : 1995-05	VDE 0411 Teil 500
EN ISO/IEC 7498-1 : 1995	ISO/IEC 7498-1 : 1994	DIN EN ISO/IEC 7498-1 : 1995-12	–
–	ISO 1177 : 1985	DIN ISO 1177 : 1989-11	–

Nationaler Anhang NA (informativ)

Literaturhinweise

DIN 41652-1

Steckverbinder für die Einschubtechnik, trapezförmig, runde Kontakte Ø 1 mm; Gemeinsame Einbaumerkmale und Maße; Bauformenübersicht

DIN 66003

Informationsverarbeitung; 7-Bit-Code

DIN 66259-3

Elektrische Eigenschaften der Schnittstellenleitungen; Doppelstrom, symmetrisch, bis 10 Mbit/s

DIN 66306-1

Industrielle Automation und Integration – Festlegung der Nachrichtenformate für Fertigungszwecke – Definition der Dienste; Identisch mit ISO/IEC 9506-1 : 1990

DIN 66333

Informationstechnik; Kommunikation Offener Systeme; Basis-Codierungsregeln zur Notation Eins für darstellungsunabhängige Syntax; Identisch mit ISO/IEC 8825 : 1990

DIN EN 60870-5-1

Fernwirkleinrichtungen und -systeme – Teil 5: Übertragungsprotokolle; Hauptabschnitt 1: Telegrammformate (IEC 870-5-1 : 1990); Deutsche Fassung EN 60870-5-1 : 1993

DIN EN 60870-5-2

Fernwirkleinrichtungen und -systeme – Teil 5: Übertragungsprotokolle; Hauptabschnitt 2: Übertragungsprozeduren der Verbindungsschicht (IEC 870-5-2 : 1992); Deutsche Fassung EN 60870-5-2 : 1993

DIN EN 61131-2 (VDE 0411 Teil 500)

Speicherprogrammierbare Steuerungen – Teil 2: Betriebsmittelanforderungen und Prüfungen (IEC 1131-2 : 1992); Deutsche Fassung EN 61131-2 : 1994

DIN EN ISO/IEC 7498-1

Informationstechnik – Kommunikation Offener Systeme – Teil 1: Basis-Referenzmodell: Basismodell (ISO/IEC 7498-1 : 1994); Englische Fassung EN ISO/IEC 7498-1 : 1995

DIN ISO 1177

Datenkommunikation; Zeichendarstellung bei Serienübergabe; Identisch mit ISO 1177 : 1985

DIN ISO/IEC 8802-2

Lokale und Regionale Netze – Spezielle Festlegungen – Teil 2: LLC; Identisch mit ISO/IEC 8802-2 : 1994

DIN VDE 0160 (VDE 0160)

Ausrüstung von Starkstromanlagen mit elektronischen Betriebsmitteln

Normen der Reihe DIN VDE 0800 (VDE 0800)

Fernmeldetechnik

Weitere Schriftstücke, auf die in dieser Norm verwiesen wird (z. B. die amerikanische Norm EIA 485), können über die Abteilung Auslandsnormenverkauf des Beuth Verlages, 10772 Berlin, Tel.: 030/26 01-0, bezogen werden.

ICS 35.100.01; 35.200

Descriptors: Fieldbus, FIP, PROFIBUS, P-NET, open systems, physical layer, data link layer, application layer, periodic and aperiodic services, network management

English version

General purpose field communication system

This European Standard was approved by CENELEC on 1996-07-02. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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 one official version (English). 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.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

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

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Structure of the document and overall
table of contents

This standard contains three fieldbus concepts, which are in widespread use and which are already standards or pre-standards on national level of some European countries. The three concepts are well known under the name of P-NET, PROFIBUS and WorldFIP. Due to universal use of the overall standard the TC65CX decided to collate the concepts into one standard document and to name it "General Purpose Field Communication System" (GPFCS). Thus manufacturers and users have to refer to only one document while searching for an appropriate solution of their communication needs and they will still have the possibility to make a choice fulfilling their requirements.

In order to give the reader a clear orientation, the standard is divided into three volumes and each volume is divided into well known parts, following the IEC 1158 project subdivision developed by the IEC SC65C WG6 as a guideline.

The part numbering of this document reads as follows: After the EN number the first digit indicates the part of the standard, the second digit indicates the volume which contains the part.

Example: Under EN 50170-6-2 the reader will find Part 6 in volume 2, which is the Application Layer protocol specification of volume 2.

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This European Standard was prepared by the Technical Committee CENELEC TC 65CX, Fieldbus.

The text of the draft was submitted to the formal vote and was approved by CENELEC as EN 50170 on 1996-07-02.

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) 1997-06-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1997-06-01

In accordance with CEN/CENELEC Memorandum 8 on Standardization and Intellectual Property Rights (IPR), the CENELEC Central Secretariat received a declaration from the three consortia, i.e. PROFIBUS, FIP and P-NET (which are being endorsed as the European Fieldbus solutions with this standard) that

- either there are no IPR rights linked to the specification (FIP and P-NET);
- or that a non-exclusive license is given, free of charge (PROFIBUS).

Some reservation is however to be made to the use of the P-NET® logo, which is limited to members of the International P-Net user Organization ApS. The conditions of using the logo are mentioned in the relevant part of this standard.

Current situation in the European market

The market today is using several well recognised solutions which meet the user needs.

Users and manufacturers in European industry have invested research and development efforts to make fieldbuses becoming a reality in the industrial automation market.

Consequently Europe decided to take advantage of its leadership in technological know-how and product development, in order to ensure return on the investment that have been made in the past.

TC65CX has selected three solutions to define EN 50170 which are standardised in a European country, market proven, open, validated and for each of which conformance tests exist.

The existence of standardised European fieldbus solutions gives therefore stability and certainty to the industry in all European nations and offers the possibility of gaining experience with the new technology today.

A European standard must be available to avoid that too many proprietary de facto solutions occupy the market. Since the completion of future applicable developments in IEC SC65C is still pending, users and manufacturers need today a few cost effective solutions which are applicable to most field devices today.

EN 50170 objective

Given the above mentioned considerations EN 50170 points out the following objectives:

- it is a good solution to fill the gap until IEC 1158 is both complete and proven, and to extend the scope of Fieldbus to many industrial domains,
- it clarifies the situation in Europe with three open standards out of over 50 mainly private solutions. This reduction of the variety of concepts will encourage the manufacturers to develop field devices that are compatible to concepts included in EN 50170. This will increase the competition based on an open neutral communication technology between manufacturers of field equipment to the benefit of the user,

- it eliminates problems of limited availability and monopoly. EN 50170 is, for the time being, the only comprehensive specification fulfilling a variety of user needs for fieldbuses. The specification is complete for all the layers, industrially mature and there are proven applications worldwide. It is the inherent nature of standardisation to avoid monopoly situations by making specifications accessible to the public, ensuring that there are no exclusive intellectual rights owned by a single organisation. As a consequence, EC harmonisation policy has chosen open standards as the basis for products used in public procurement.

From this point of view, EN 50170 is fully in compliance with CENELEC standardisation principles

International standardisation effort

Efforts of numerous fieldbus standards organisations and projects such as the development of the IFC, ISP, WorldFIP, or Fieldbus Foundation have governed this trend in the area of fieldbus communications. Still missing, however, is a world-wide fieldbus standard for field devices and field instruments.

While, outside Europe, discussions are still going on about the fieldbus concepts, European fieldbus solutions are becoming commodity items in many application domains.

Taking into account the development process of the specification of the international fieldbus in the IEC SC65C WG6, which up to now resulted in the publication of the common IEC/CENELEC publication on the physical layer IEC IS 1158-2/EN 61158-2, the following statements are obvious and they should be taken into account while considering the results of CENELEC TC 65CX.

Standardised profiles are needed to allow inter-working between devices in given industrial domains. The NWIP (New Work Item Proposal) « profiles for process control and manufacturing » is approved inside IEC SC65C WG1, but no work has started yet.

Even if IEC fieldbus standard compliant products may be made available after completion of the specification and its industrial implementation, the definition of conformance test requirements has not yet started.

However, the NWIP « conformance testing » is approved within IEC SC65C WG6, but there are still no plans to start the work effort.

The international standard status

The publication of a complete and proven international fieldbus standard can be expected in three to five years at the earliest.

The only approved standard IEC IS 1158-2/EN 61158-2 is receiving several series of amendments either to amend the existing specification or to add new media, which will not directly inter-communicate, unless there are additional adaptations.

Ultimate aim of international fieldbus standardisation

IEC SC 65C and CENELEC TC65CX will continue to strive for an international fieldbus base standard, several international standardised profiles and internationally standardised conformance test methods within the IEC SC65C. TC65CX has already agreed to adopt the results of SC65C on fieldbus once the work is complete and proven. To assess this, they will propose to European nations an explicit vote to publish IEC 1158 project specifications as an EN.

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Usage of EN 50170

According to the history and the decision of TC65CX neither to develop any new compromise nor re-write the actual concepts on the market, the reader should pay his dedicated

ATTENTION
to the following notes:

- "The EN 50170 contains the following three different specifications without attempting to develop any compromise or to mix them as per the PAS principles:

EN 50170 volume 1 (based on and technically identical to DK 502058 and DK 502066)

EN 50170 volume 2 (based on and technically identical to DIN 19245 series)

EN 50170 volume 3 (based on and technically identical to NFC46602, NFC 46603, NFC46605, NFC46606, NFC46606_A1, NFC46607, NFC46607_A1, IEC IS1158-2).

The concepts of these specification are different from each other and therefore they cannot communicate together unless there are additional adaptations. For each implementation, you have to select the one which suits the users' application needs"

- Each one of the three concepts has been described according to ISO/OSI layering even if for performance considerations the layers structure adopted in each concept is simplified and does not comply in detail with the classical one. This limits the combination, reduces the variety of solutions easing the inter-operability inside each concept. The interoperability between the three concepts contained in this standard is not foreseen and may be achieved by other means in the users application only.

- 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 fieldbus; Several levels of protection exist, that cover connectors, physical layer coding, different speeds and effective network management.

- IEC based solutions will not solve more easily those safety problems of connecting a device which is not allowed on that bus. Several hazards will still exist due to variations of the versions of the physical layer (connector is not mandatory, neither is the insulation via a transformer), also different options in the Data Link which may corrupt the Link Active Scheduler timing schedule.

Conformance testing

It is stated by CLC/TC65CX that one (or more) Competence Body has to be accredited by the appropriate authority as soon as possible, in order to certify the products as compliant to the possible concepts of EN 50170, so that users may be provided with the correct elements to select products for their fieldbus applications. Meanwhile each product supplier has to declare, under his own responsibility, which EN 50170 concept he uses, and to what extend within that given concept, his product is compliant to. To facilitate this TC 65CX will publish after EN 50170 has been approved the appropriate set of PICS (Protocol Implementation Conformance Statements) pro-forma.

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General Purpose Field Communication System
Part 0-1
Introduction

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1 scope

General communication standards for automation systems have come a long way in the last years, bringing the concept of open system interconnection closer to general acceptance and wide spread use.

EN 50170 is a standard specifying a set of solutions named General Purpose Field Communication System. The scope covers complex devices, intelligent field devices as well as simple I/Os. It is not limited to the process industry but it intends to meet the needs of most industrial domains. To date, there is no single concept able to cover the complete range of communication qualities in a simple way.

2 Introduction to General Purpose Field Communication System

2.1 What is a "General Purpose Field Communication System"?

The "general purpose field communication system" is principally a communication means between equipment close to the manufacturing process like sensors and actuators on machines, etc. and the control level equipment. Further precise definition is difficult as it limits the use of this communication technology.

The scope of information transfer goes far beyond of replacing analogue 4 to 20 mA signals. Decentralised intelligent systems need communication from and to devices in a comfortable user or application oriented way. They have to fulfil all requirements of modern industrial Process Measurement and Control Systems (IPMCS), which means high flexibility and adaptability. There is a clear trend in all economical sectors towards the use of intelligent decentralised systems using field communication as a basic functionality.

Nevertheless the "general purpose field communication systems", which will further on be called "fieldbus", can be described by some outstanding characteristics:

Closeness to the physical process

For a long time fieldbus has been considered as the lowest level in the communication hierarchy. The fieldbus connects the sensors, actuators and even complex devices to the control system, independently whether they handle binary or analogue signals. These sensors and actuators are directly installed in the physical process. Consequently the fieldbus builds the borderline between the physical process based on analogue signals and the control domain based on digital information. In the meantime the technical progress leads to more specialised solutions, e. g. ASI, CAN and others, which are summarised by the term "sensor/actuator busses". Systems which are optimised in this direction are not in the scope of this standard.

The equipment located close to the process has integrated more and more intelligence and need to be served by a more general purpose communication system without sacrificing the requirement of transferring in a timely way the primary control information.

Larger areas

The word "field" also associates a larger expansion. While distances up to 10 m are still the domain of parallel or specialised serial busses, fieldbusses cover distances between several 100 m up to 5000 m.

Number of devices, costs

As the fieldbus concept is far away from the initial 4 to 20 mA control loop, the number of devices connected has increased and is considered in the range of ten to several hundred for one bus. In a plant (i.e. chemical plants or offshore platforms) up to ten or more fieldbus segments may be implemented having several thousand devices connected to the busses. The fieldbus is then a technology to interconnect very simple devices to sophisticated ones and there is a need for a range of connecting interfaces where low cost is a dominating requirement.

Time-critical operations

Fieldbus communication systems are oftenly integral part of control functions of automated processes. As such they have to comply with time constraints imposed by the control system. Basic features are predictable time access as well as predictable delivery time. It should also offer resistance to traffic overload in case of burst of events.

Transmission integrity, availability

As this communication system is the only link to the production process, the transmission shall be very reliable. Fieldbusses should therefore offer the following features at minimum:

- transmission integrity with undetected error rate below one error in 20 years
- redundancy capabilities such as dual media or dual busses, ...
- transmission verification (timelines, acknowledgement, ...)

User selection of services

Application have various needs in terms of priority, services integrity, time behaviour and recovery in case of network congestion.

This means that services and quality of services shall be user (or application) selectable.

For a given field equipment, it may have to accomplish this different qualities when used in one or another type of application. Then the fieldbus shall support remote configuration in order to select the proper communication quality as well as the proper local application options.

Integration, open architecture

In addition to the classical client server approach, the fieldbus should support distributed time critical architecture in which the exchanges are done through "variables" which constitute a shared database updated in real time.

Heavy environmental condition

As the fieldbus is close to the process, it is subject to harsh environment and more specifically shall withstand without error high electromagnetic interference. This level of interference is modelled by the "severity 3" of the IEC 801.x standards and enforced by the EEC directive 89/336 (CE mark).

Solutions

All of the above features are engineered in distinct fieldbus solutions. Each of them have privileged certain aspects according to the overall system philosophy.

These solutions are now well established on the market and cannot be reconciled easily in a single solution, without requesting a complete re-engineering of them and finally leading to a distinct profile of the common solution.

The EN 50170 has selected solutions whose functionalities will be integrated by IEC 1158, when available, according to the following set of criteria:

1. Candidates shall be national standard or pre-standard.
2. Candidates shall fit into the scope and policy statement of TC65CX (see documents CLC/TC65CX(SEC)4 and CLC/TC65CX(Bx1/SEC)1).
3. Candidates shall be suitable for comparable usage in applications by providing features such as:
 - bus type topology
 - client/server functionality or producer/consumer functionality with distributed database
 - a complete range of services in Data Link Layer, Application Layer and for System Management
 - bandwidth of candidates shall be appropriate to the number of connected elements
4. Candidates should be documented in English language according to classical OSI/IEC decomposition in layers.
5. The description shall cover all aspects of communication in order to be able to build an open working system.
6. Candidates shall be already in use in commercial products and running in industrial plants (demo is not considered as industrial use).
7. Products should be available in quantities and at low price. Users shall be in the position to make experiences with fieldbus products and be given advice on how to use existing concepts.

- On sensor/actuator level the information flow is normally vertical between the control devices such as PLC and the sensor/actuators. Today only in seldom cases a horizontal flow between intelligent field devices takes place.
- But field devices are growing in functionality, to carry out functions such as diagnostics, calibration, configuration and data validation. There are significant benefits to distribute also local control functions to field devices, which perform these control functions in a autonomous way by cooperating and interchanging information between themselves.
- This is normally done under the supervision of a controller looking for proper data exchange between those devices, thus leading to truly distributed applications and distributed, consistent systems.

2.2.3 Application areas and their specific requirements

Power generation and distribution

Very specific are the need for robustness against electromagnetic influences which are greater than what is requested by EEC directive.

Very specific are the need for robustness against electromagnetic influences which are greater than what is requested by EEC directive.

Other needs for robustness are dust, hostile chemical agents, temperature and humidity resistance. In case of gas production, special constraints for use in explosive and flammable areas apply.

In addition, fieldbus is used to support high integrity control architectures such as fault tolerant or safety oriented ones. Concerning security it has to show stability even under overflow conditions. Cyclic transmission with period below 10 ms may be required depending on the application.

Chemical plants

The number of devices in chemical plants may be very high. A fieldbus standard should support the segmentation of the fieldbus system (e.g. by specifying of bridging concepts).

Applications in hazardous environments demand the intrinsic safe connections of devices and power distribution over the bus.

In this application area "function blocks" are very common as building blocks of automation systems. A fieldbus system has to support the special functional requirements (e. g. time distribution and scheduling of function blocks).

Manufacturing applications

Applications in this area may have high needs for real-time, high speed operations. Cyclic data transmission periods of 1 ms for axis control and of approx. 25 ms for PLCs are required.

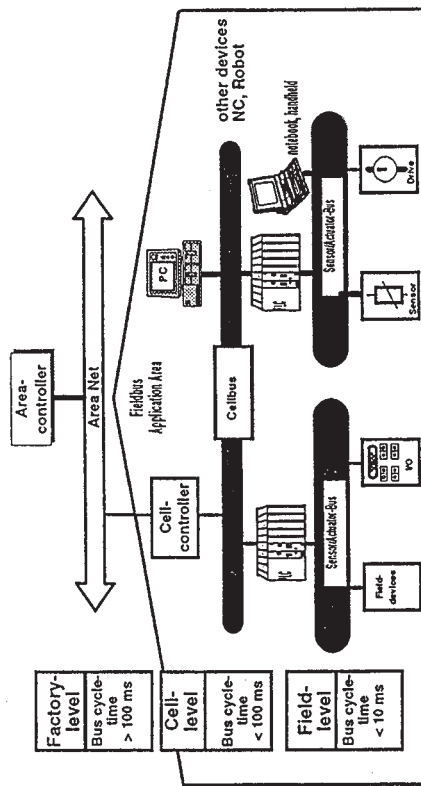


Figure 1: Fieldbus in the control hierarchy.

On the cell level communication typically occurs between the cell controller and the subordinated control devices, e. g. PLCs as well as between the PLCs themselves and other devices such as human operator interfaces, which may be based on general purpose computers.

Electromechanical applications

These applications which makes extensive use of drives, require as well high speed, high EMC immunity and large number of connected devices. Cyclic transmission with period below 10 ms is the current request as well as mixed traffic with rather long messages for service functions.

The last two domains request that devices be represented by variables only in order to be able to develop the control/sequencing scheme without knowing the behaviour and technical details of the equipment.

Off-shore or on-shore gas/oil exploitation and pipeline management

In addition to the constraints imposed by explosive and flammable areas, the environmental conditions require resistance against humidity and corrosion. Very special is the need of weight reduction, which influences especially the cabling concept.

Fieldbus requirement mix

Taking into account that fieldbus can be used at multiple level of the communication architecture in multiple industry sectors, the general purpose communication system has to be tuned to meet the requirements. Thus, to avoid useless complexity, profiles are emerging based on the generic technology.

The occurrence of the IEC standard will not change the need for profiles adapted to system/industry sectors. Then, the key element is how to permit easy migration towards an IEC standard, when time has come. A possible way is to define an "Application Portability Guide" mainly for non time critical tasks.

As a side effect, this will encourage vendors to use the standard features of fieldbuses and refrain them for developing manufacturer specific ones. Instead, they will have developed a generic application and use profiles to meet the proper behaviour/performance required for the applications.

3 Main features of EN 50170, Volume 1 (P-NET®)

Features:

- The EN 50170 Volume 1 (P-NET®) uses the RS485 multi-drop standard, with asynchronous transmission at 76800 bits/sec.
- Multi-masters: Several masters can be connected to the same bus.
- Multi-buses: Several buses can be interconnected into a larger network through gateways, which are part of the standard.
- High level language support

EN 50170 Volume 1 corresponds to the P-NET® Standard which originally was published by the International P-NET User Organisation Aps, P.O. Box 192, DK-8600 Silkeborg, Denmark.

P-NET® is a registered trademark of International P-NET User Organisation Aps. The use of the P-NET® logo, is free of any obligations for all members of the International P-NET User Organisation Aps.

4 Main features of EN 50170, Volume 2 (PROFIBUS)

EN 50170 Volume 2 supports simple input/output devices to be connected to a central station as well as comprising a distributed automation system using more sophisticated devices, e.g., Programmable Logical Controllers.

The definition is composed of master and slave stations. A master is able to control the bus access. Slaves are only able to acknowledge a received message or to transfer data on request by a master. A token circulates in a logical ring between masters (multi-master system). If the system contains only one master, no token passing is necessary (master-slave system).

EN 50170 Volume 2 has been published as German standards (known as PROFIBUS) in three parts comprising:

(1) DIN 19245 Part 1 - 1990

- Physical Layer providing an EIA RS 485 Interface supporting data rates from 9.6 Kbit/s up to 1500 Kbit/s to connect up to 32 devices (127 using repeaters)
- Data Link Layer designated to control the bus access (token passing) and to allow a high data integrity of HD=4.

(2) DIN 19245 Part 2 - 1990

- Application Layer Fieldbus Messaging Specification (FMS) defining communication objects similar to ISO/IEC 9506, MMS, (e.g., variables, program invocation) and services on those objects like read, write or start and stop.

- Application Layer Lower Layer Interface (LLI) serves to adapt the FMS to the various definitions of the Data Link Layer.

(3) DIN E 19245 - 1993

- Optimised version dedicated to time-critical communication between centralised systems and distributed peripherals. It is based on DIN 19245 Part 1 and defines a specific application for mainly cyclic data distribution and powerful system synchronisation, configuration, and diagnosis.

EN 50170, Volume 2 has been defined according to following normative references:

DIN 19 241-2:1985	Messen, Steuern, Regeln; Bitserielles Prozessbus-Schnittstellensystem; Elemente des Übertragungsprotokolls und Nachrichtenstruktur	ISO 7498/4:1989	Information processing systems; Open System Interconnection; Basic Reference Model; Part 4: Management Framework
DIN 66 259-3:1983	Electrical characteristics for balanced double-current interchange circuits	ISO 8824:1987	Information processing systems; Open System Interconnection; Specification of Abstract Syntax Notation One (ASN.1)
DIN 57800/ VDE 0800:1984	Fernmeldetechnik; Errichtung und Betrieb der Anlagen	ISO 8825:1987	Information Processing Systems; Open System Interconnection; Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1)
DIN VDE 0160:1988	Ausrüstung von Starkstromanlagen mit elektronischen Betriebsmittel	ISO TR 8509:1987	Information Processing Systems; Open System Interconnection - Service Conventions
CCITT V.11:1976	Electrical Characteristics for balanced double-current interchange circuits for general use with integrated circuit equipment in the field of data communications.	IEEE 754:1985	IEEE Standard for Binary Floating-Point Arithmetic
CCITT V.24:1964	List of definitions for interchange circuits between data terminal equipment and data circuit-terminating equipment.	DIN 41 652 Teil 1 (draft)	Steckverbindungen in der Nachrichtentechnik; trapezförmig, runde Kontakte 1 mm
IEC 807-3:1990	Rectangular connectors for frequencies below 3 MHz Part 3: Detail specification for a range of connectors with trapezoidal shaped metal shells and round contacts Removable crimp contact types with closed crimp barrels, rear insertion/rear extraction	DIN 66003	Informationsverarbeitung; 7-Bit-Code
IEC 870-5-1:1990	Telecontrol equipment and systems; part 5: transmission protocols; section 1: transmission frame formats	DIN EN 66306 Teil 1	Industrielle Automation und Integration; Festlegung der Nachrichtenformate für Fertigungszwecke; Definition der Dienste; Identisch mit ISO/IEC 9506-1:1990
IEC 870-5-2:1992	Telecontrol equipment and systems; part 5: transmission protocols; section 2: link transmission procedures	DIN ISO 2375	Datenverarbeitung; Verfahren zur Registrierung von "Escape-Sequenzen"
IEC 955:1989	Process data highway, type C (PROWAY C), for distributed process control systems	5	Main features of EN 50170, Volume 3 (WorldFIP)
IEC 1131-2:1992	Programmable controllers - Part 2: Equipment requirements and tests		The EN 50170 Volume 3 (WorldFIP) has been originally developed under the FIP initiative in the early 80s. The stress has been given to fulfil the control aspects for all the potential applications in various industrial domains.
ISO 1177:1985	Information processing - Character structure for start/stop and synchronous character oriented transmission		EN 50170, Volume 3 is described under the so-called reduced OSI architecture but includes in fact a dual stack above the data link layer.
ISO 2022:1986	Information processing - ISO 7-bit and 8-bit coded character sets - Code extension techniques		The EN 50170 Volume 3 architecture is divided into:
DIN ISO 7498:1984	Information processing systems; Open Systems Interconnection; Basic Reference Model		Architecture and General presentation part 1-3
ISO 8802-2:1989	Information Processing Systems - Local area networks - Part 2: Logical link control		Physical layers twisted pair part 2-3-1 fibre optics part 2-3-3
ISO/IEC JTC 1/ SC 6 N 4960:1988	Standards for Local Area Networks: Logical Link Control - Type 3 Operation, Acknowledged Connectionless Service		Data Link Layer part 3-3
EIA RS-422-A:1978	Electrical Characteristics of balanced Voltage digital Interface Circuits		Application Layer MPS (periodic and aperiodic data exchanges) part 3-5-1 SubMMS (client server messaging) part 3-5-2 MCS (messaging common services) part 3-6 The MCS part is providing common resources to SubMMS to support the equivalent to OSI "association" between communicating entities
EIA RS-485:1983	Standard for electrical Characteristics of Generators and Receivers for use in balanced digital Multipoint Systems		Network management

part 3-7

The network management is able to manage stack using MPS or SubMMS and is using the application layer services provided by the stack; It does imposes a specific set of service but uses those available.

EN 50170 Volume 3 (WorldFIP) has been standardised as French national standards according to the following schedule:

NF C 46602 application layer MPS published April 1990

NF C 46603 data link layer published June 1990

NF C 46604 physical layer published may 90 revised April 1993 and superseded by EN61158-2 in 1994

NF C 46605 network management published December 1990

NF C 46606 application layer messaging published May 1993

NF C 46606 A1 application layer, use of MMS for Fieldbus published in June 1995

NF C 46607 physical layer fibre optics published in May 1991

NF C 46607/A1 Physical layer fibre optics published in May 1993

General Purpose Field Communication System

Part 1-1

General Description of EN 50170 Volume 1

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1 General Description of EN 50170 Volume 1

This description provides an overview on the models, services and characteristics of EN 50170 Volume 1, also known under the name „P-NET“.

Features:

- EN 50170 Vol. 1 uses the RS485 multi-drop standard, with asynchronous transmission at 76800 bits/sec.
- Multi-masters: Several masters can be connected to the same bus.
- Multi-buses: Several buses can be interconnected into a larger network through gateways, which are part of the standard.
- High level language support

Right of use.

EN 50170 Volume 1 corresponds to the P-NET® Standard which originally was published by the International P-NET User Organization ApS, P.O. Box 192, DK-8600 Silkeborg, Denmark.

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1.1 Principles of EN 50170 Volume 1

EN 50170 Vol. 1 is a multi-master and multi-net standard. All communication is based on a principle, where a Master sends a request and the addressed Slave returns a response. Not only can several masters be connected to each bus segment, but a complex network holding a great number of bus segments can be built also.

Communication is routed through the different bus-segments by means of gateways with two or more bus interfaces for EN 50170 Vol. 1. This means that any master on the network can transparently access any node within the network without the need for special programs in the gateways or masters. This feature is a part of the EN 50170 Vol. 1 protocol and is built into the standard operating system.

The segmentation also makes it possible to have independent local traffic on each bus-segment, which increases the data throughput throughout the total system.

These multi-bus features, provide a natural redundancy and makes the total plant installation very robust with respect to errors. A system can be expanded while the remaining production systems continue to run. It is a feature of the EN 50170 Vol. 1 topology that it need not be of a hierarchical structure.

An example of a slave could be, a weight transmitter, where the analogue signal from a built in or remote load cell, is continuously converted, scaled and stored within the memory of the slave. When a request is received from a master, the slave will immediately respond with the latest stored result. Error checking is also continuously performed within the slave, and the master is notified if an error has occurred, within any response message. Using this principle, it is thus possible to respond immediately to a request from a master, to read or write measurement or other data in a slave. A slave must return the response to the master within at most 390 µs following the master's request.

This reduces the need for multiple requests for a single variable, or even continuous polling until a result is ready. The immediate response eliminates the need for buffers to queue the requests or polling from different masters.

Special procedures have been included in the EN 50170 Vol. 1 standard, making it possible to change the node address of a single node on the network by means of its unique serial number. This gives the opportunity to set-up node addresses to individual nodes, while the system is running. A node is delivered with the node address set to zero, and this node address is reserved in the standard for the purpose of initializing nodes while the network is running. Dipswitches and other mechanical mechanisms can thus be avoided, because the serial number is stored in EEPROM. Using an EEPROM makes it possible to build hermetically sealed nodes for EN 50170 Vol. 1 (e.g. IP-67).

1.2 Protocol overview

EN 50170 Vol. 1 is specified and implemented according to the Open Systems Interconnection Reference Model on layer 1, 2, 3, 4, and 7. The usage of the application layer (Layer 7) provides the plug-compatibility in relation to semantics, and the other layers provide the physical plug-compatibility.

Well defined application layer profiles for individual I/O points, gives a well defined Application Interface for programmers.

The I/O interfaces in the different nodes are defined as objects, which contain not only real time data but also predefined function switches, diagnostics, maintenance data and error messages. Within EN 50170 Vol. 1, such an object is declared as a Channel, and channel structures are defined for digital I/O, analog I/O, weight transmitters, printers, etc.

The standardization of the single I/O points instead of complete nodes on the bus makes it possible from a master's point of view, to exchange similar I/O's defined within different manufactures' nodes. Nodes can have different I/O structures. For example one node might have 16 Digital I/O + 2 analog I/O, and another node 8 Digital I/O + 4 Analog I/O, but a single I/O will be seen as the same by the master, no matter what kind of node it is part of.

Associated with the Application layer within EN 50170 Vol. 1, is the data format standardization, which includes reals, bytes, strings, boolean, but also more complex entities, as arrays and records. All measurement values sent over the bus are already scaled in engineering units.

The Manufacturing Message Specification, MMS (ISO 9506) may be used on layer 7, as an intelligent interface between EN 50170 Vol. 1 and other networks, (e.g. Ethernet, Token Ring, MAP, etc.) using a variety of protocols. MMS provides a well defined interface between the field and the management area for software platforms, such as production planning, and monitoring system, at the management level. Typically, the MMS interface is used for non time critical communication.

1.3 Advantages of the EN 50170 Vol. 1 protocol

Slaves respond almost immediately after receiving a request. This requirement allows up to nearly 300 confirmed messages a second to be made on the fieldbus. A confirmed service is a combination of a master request and a slave response.

The result of a measurement made by a slave is presented to a master in a pre-processed form, in SI (metrical) engineering units. The benefits within the masters, is significant, since no repetitive scaling or conversion need to be performed by the master(s), leading to considerable savings of processing power. The distributed processing power can be increased further, by adding masters, each of which allows several tasks to run simultaneously.

For example, a temperature measurement is represented by a floating point real value, following the IEEE 754 standard, and the temperature value is presented to all masters in centigrade. Identifiers used for accessing the physical variable on the network, are mapped via a 'software' list. This list is generated while the application program is being compiled. Therefore, no real time translation is required, leading to very fast data access.

Multi-master access to the Physical Layer is performed using a virtual token passing principle between masters. After a given master's bus access, the token is passed to the next master in a cyclic fashion. The maximum data length in one transmission is limited to 56 data bytes, for ensuring real time data collection.

The passing of the virtual token takes place within only 130 μ s or 10 bit periods, and no data is actually sent over the bus. A single network can have up to 32 masters with equal priority.

Within multi-master and multi-net systems, all masters have equal priority, and there is no hierarchy which needs to be managed. Consequently, bussytems following EN 50170 Vol. 1 does not require any arbitrator function. The virtual token passing is 5-20 times more efficient than software arbitration.

There are 3 basic types of devices (nodes) that can be connected to a EN 50170 Vol. 1 network: Slaves, Masters and Gateways. These 3 types are described in the following section.

1.4 Slaves

The function of the slaves is to reply to requests or acknowledge data from the masters. In all slaves there is a memory map of the global variables, called the SOFTWARE LIST. The typical behaviour of the slave is to respond immediately after a request is received, with data that are already in the memory. A typical delay for response is 150 μ s, and the maximum delay allowed is 390 μ s at 76.8 kb/s

Because of the immediate response, the slaves only needs to serve one master at a time. This means there will be no instruction queues, and the maximum response time can always be calculated.

1.5 Masters

A master is the only device allowed to send a request on the bus. The request can only be sent to slaves. Typically, a master runs a program which performs a part of the process control in a plant. The number of masters is normally low compared to the number of slaves, and the micro-processors in the masters are normally much more powerful than in the slaves. Consequently, the fundamental idea of the EN 50170 Vol. 1 is to let the masters do all the complicated work and the slaves do only the simple work. The communication kernel for EN 50170 Vol. 1 in a slave needs only 1-2 kbyte of program code. This makes it possible to use one low cost 8 bit single chip micro-processors for the communication protocol service as well as for sensor measurement and control. The EN 50170 Vol. 1 uses a Reduced Instruction Set, with only 7 basic instructions.

This "RISC" idea results in very high throughput and bus efficiency but leaves a little more work for the master.

The Multi-master bus access system uses a time controlled token with fast "hand over" from master to master without sending frames on the bus.