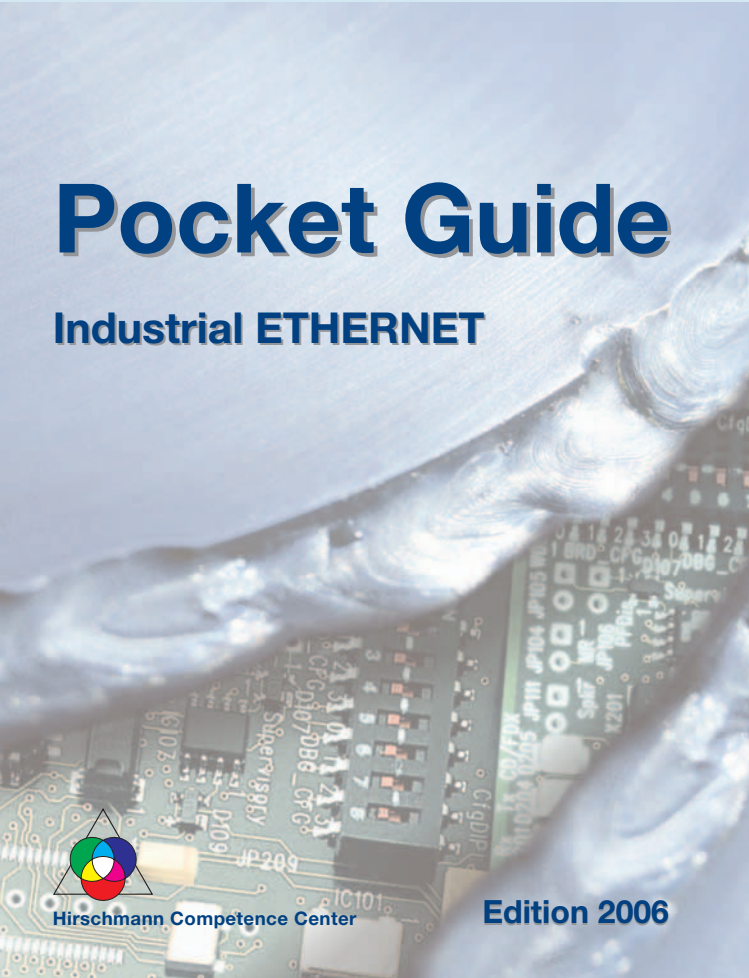
HIRSCHMANN

Hirschmann Automation and Control GmbH

Pocket Guide

Industrial ETHERNET



Hirschmann Competence Center

Edition 2006

In 1984 Hirschmann created the first fiber optic ETHERNET network at the University of Stuttgart. In 1990 Hirschmann also invented the "Redundant ETHERNET Ring" and finally in 1998 we brought out the HIPER-Ring (Hirschmann Performance Redundancy Ring) in switched ETHERNET.

Hirschmann is the only manufacturer worldwide offer a universal product range for setting up high-performance, high-availablity industrial networks. From the networking of production lines via the control room using SCADA applications to the enterprise environment - vertical integration - everything from a single source.

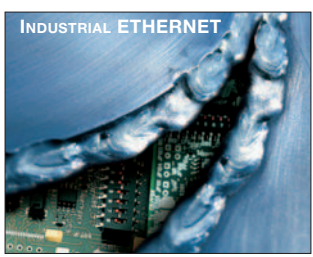
Contents

1 Know-How for the World of Networks

From management level down to the device level – integrated industrial network solutions from Hirschmann convince with maximum performance at optimum cost.

ETHERNET as a uniform standard over all levels – this idea moved Hirschmann much earlier than it did others.

We were therefore able to demonstrate a pioneering spirit in several ways: in 1984, we built the University of Stuttgart fiber optic network. The result was a global premiere for ETHERNET over fiber optic networks. In 1990, we came out with the "ETHERNET ring", our next innovation and thereby laid the foundation for all mission critical applications in power station construction, transportation, the chemical industry and in all spheres where security and high levels of accessibility cannot be compromised. Three years later, we introduced the first media converter for field bus systems and finally in 1998 we brought out the HIPER-Ring* in switched ETHERNET. We are justly proud of these achievements. However, what do these benefits mean to you?



* Hirschmann Performance Redundancy Ring

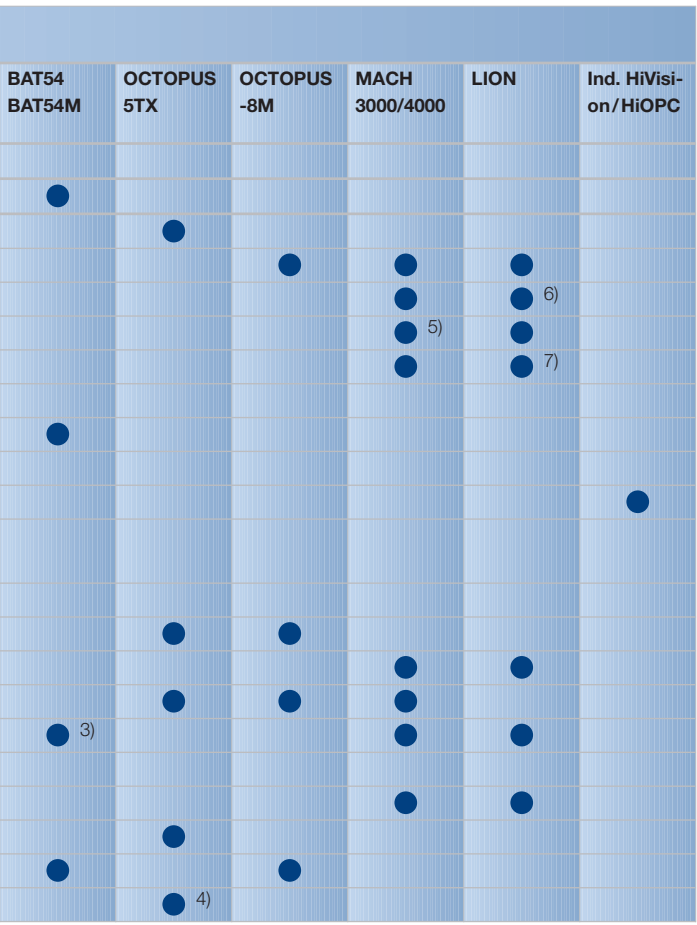
Today Hirschmann is one of the most highly experienced manufacturers of industrial network solutions based on ETHERNET. As an expert in system components, accessories and unified management software with a global presence, we make available our comprehensive expertise to our clients. Moreover, it is obvious that whoever thinks more about ETHERNET will also think further into the future. For this reason, we are thinking mainly about you and your applications in our innovations: our products for automation technology that leave our factories are fit to handle the electromagnetic interference field stresses and higher operating temperatures and mechanical stresses that you encounter.

With regards to the speed and the universality of a company-wide network solution, we are peerless in the speed with which we innovate solutions. As regards redundancy and higher accessibility, we have traditionally been more than just one step ahead of the others: if there is a breakdown in a transmission segment, it takes a HIPER-Ring from Hirschmann only a fraction of a second to create a bypass. This ensures security in data transmission, is even better for your business, and downtimes in production are rapidly eliminated.

2 Hirschmann Products

	Product Families		
Functions	**OpenRail RS…**	**OpenRail MS…**	**EAGLE**
Transceivers	●		
Hubs	●		
Unmanaged switches	●		
Managed switches	●	●	
Modular switches		●	
Workgroup switches			
Routing switches		●	
Security(Firewall/VPN)			●
Wireless			
Audio Video transmission			
Diagnosis and configuration software			
Product Characteristics			
Installation and supply			
- DIN Rail 35 mm	●	●	●
- 19"-Rack	●	●	●
- 24 VDC	●	●	●
- 230 VAC			
Operating temperature			
- 0 °C to +50 °C			
- 0 °C to +60 °C	●	●	●
- –25 °C to +60 °C			
- –40 °C to +70 °C	● [1)]	● [2)]	

[1)] RS…-EEC [2)] MS…-EEC



[3] via PoE- adapter

[4] OCTOPUS 5TX-EEC

[5] MACH 3001

[6] SmartLion

[7] PowerLion

2 Hirschmann Products (continuation)

Product Characteristics	Product Families		
	OpenRail RS...	OpenRail MS...	EAGLE
- Protection type: IP 20/30	●	●	●
- Protection type: IP 65/67			
Port count (Hubs or switches)			
- 1 to 4	●	●	●
- 4 to 8	●	●	
- 8 to 24	●	●	
- > 24	●	●	
Standard			
- ETHERNET (10 Mbps)	●	●	●
- Fast-ETHERNET (100 Mbps)	●	●	●
- Gigabit-ETHERNET (1000 Mbps)	●	●	
Redundancy			
- Ring structure (HIPER-Ring)	●	●	
- Dual Homing	●	●	●
- Redundant coupling	●	●	●
- Spanning Tree	●	●	
- Rapid Spanning Tree	●	●	
- Link Aggregation		●	
Service			
- Web based Mgment /SNMP Support	●	●	●
- Portmirroring [1)]	●	●	
- RMON	●	●	
- VLAN	●	●	●
- IP-Multicast Strg (IGMP and GMRP)	●	●	

[1)] Connection mirroring for rail switches

BAT54 BAT54M	OCTOPUS 5TX	OCTOPUS -8M	MACH 3000/4000	LION	Ind. HiVisi- on/HiOPC
			●	●	
●	●	●			
●	●			●	
		●			
			●	●	
●	●	●	●	●	
●	●	●	●	●	
			●	●	
		●	●		
		●	●		
●		●	●		
		●	●	●	
		●	●	●	
		●	●	●	
●		●	●	●	
		●	●	●	
		●	●	●	
●		●	●	●	
		●	●	●	

2 Hirschmann Products (continuation)

	Product Families		
Product Characteristics	**OpenRail RS…**	**OpenRail MS…**	**EAGLE**
Service (continuation)			
- Access control (Port security)	●	●	●
- Password control	●	●	●
- Auto configuration adapter [1)]	●	●	●
- Signal contact	●	●	●
Approvals			
- UL/CSA	●	●	●
- Germanischer Lloyd	●	●	●
Field of Application			
Machines (Printing machines, machine tools, generators, etc.)	●	●	●
Installations (Manufacturing cells, sewage treatment plants, windparks, etc.)	●	●	●
Offices (Production planning, MIS, ERP, MES, etc.)			●
Buildings (Production halls, administration buildings, process control, etc.)	●	●	●
Locations/Backbone (Factories, power stations, etc.)	●	●	●
Roads/transport media (Metros, tunnels, motorways, pipelines, shipping, etc.)	●	●	●

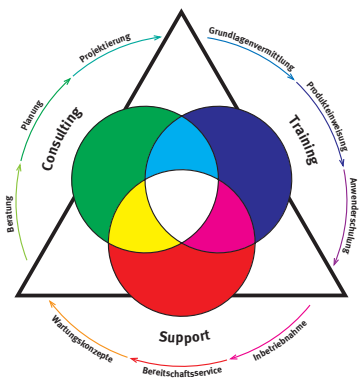
[1)] is supported

BAT54 BAT54M	OCTOPUS 5TX	OCTOPUS -8M	MACH 3000/4000	LION	Ind. HiVisi- on/HiOPC
●		●	●	●	
●		●	●	●	
			●		
●	●	●	●	●	
	●	●			●
●	●	●	●		●
●			●	●	●
●	●	●	●	●	●
●			●		●
●	●	●	●		●

3 Hirschmann Competence Center

Cutting edge products alone will not guarantee a successful customer relationship over the long term. First and foremost, comprehensive worldwide service makes a difference. In this globally competitive marketplace the Hirschmann Competence Center, with its complete range of innovative services, boasts three major advantages:

- The tailored Consulting service ranges from an initial consultation, through actual network planning, up to entire project management.
- The Training program offers technology and product courses, customized training seminars, as well as the opportunity to become certified.
- Support begins with professional installation, and provides the highest network availability through a rapid help desk service and flexible maintenance programs.



The details of which service components you would like to take advantage of is naturally up to you. Simply speak with the experts from the Hirschmann Competence Center – and get precisely the support that you need.

Help Desk:
+49-1805-14-1538

Service information on the Internet:
www.hicomcenter.com

4 High-availability industrial network design with the HIPER-Ring*

In switched Ethernet networks with their many point-to-point connections, there are various ways to increase the availability of the network.

Probably the most familiar office solution is the spanning tree protocol (STP) or rapid spanning tree protocol (RSTP), which can be used to create redundant ring structures.

Alternatively, Hirschmann and Siemens offer the HIPER-Ring*, a solution which is also based on a ring structure and is specially designed for the requirements of industrial applications.

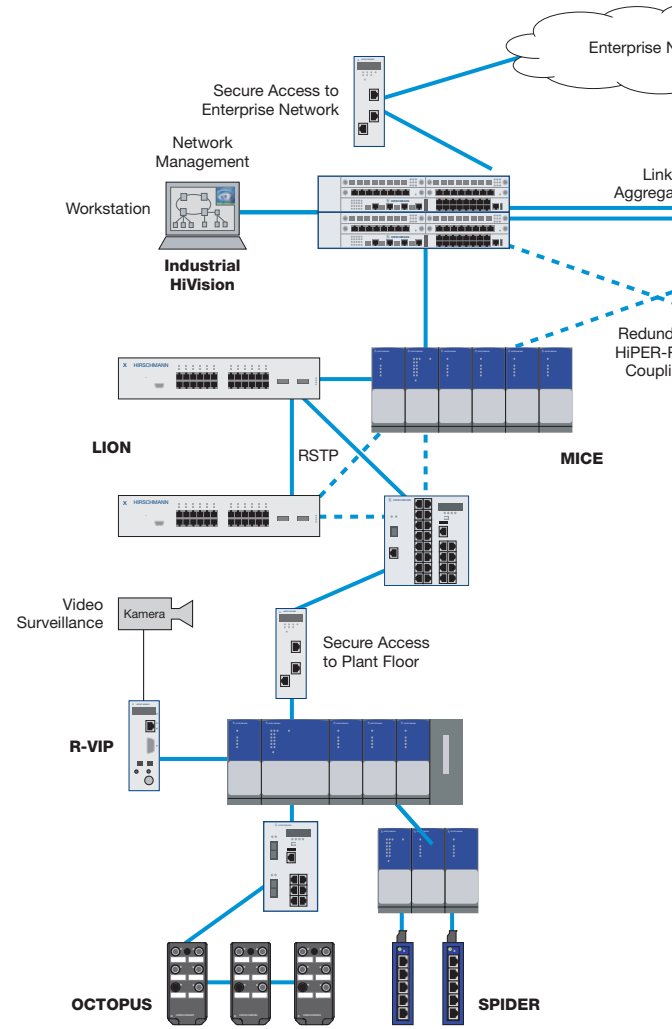
While it normally takes more than 30 seconds to compensate for a line failure with STP and one second with RSTP, with the HIPER-Ring it takes less than half a second, no matter how many switches there are. In addition, the ring structure is much simpler.

The expansion options are also very interesting. The maximum switching time of 500 ms is guaranteed for up to 50 devices supported by the HIPER-Ring concept. If optical devices are used, distances of up to 90 km can be covered, which means the network can be expanded to well over 3000 km.

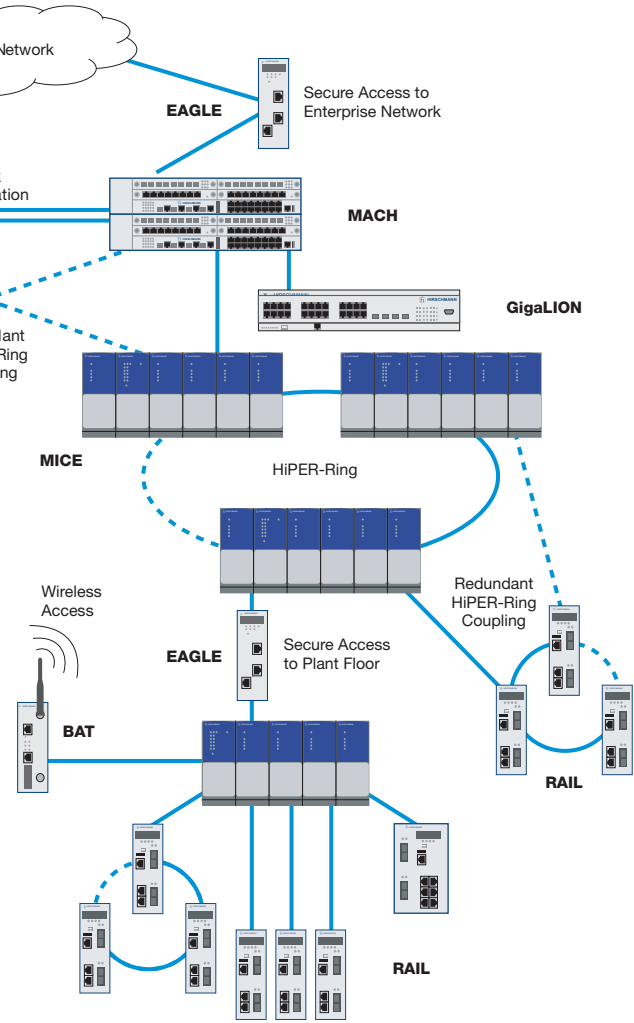
The networks mostly consist of several autonomous subsystems, each based on a HIPER-Ring. In order to guarantee redundancy across networks, additional methods must be used. The redundant HIPER-Ring coupling connects the ring structures to each other. It offers the same industry-compatible features as the HIPER-Ring, which means in the event of a fault such as a cable break, it switches from the damaged cable to the redundant one in less than 500 ms.

Another method for the redundant connection of network segments and components is link aggregation. This is where there are at least two connection lines between two switches. In addition to line and port redundancy, link aggregation allows the connection bandwidth to be scaled in increments of 10 Mbit/s, 100 Mbit/s or 1000 Mbit/s and multiple full duplex connections do be bundled with the same data rate.

* Hirschmann Performance Redundancy Ring



Redundancy techniques in industrial networks


Network
EAGLE
Secure Access to
Enterprise Network
MACH
GigaLION
MICE
HiPER-Ring
Wireless
Access
Redundant
HiPER-Ring
Coupling
EAGLE
Secure Access
to Plant Floor
BAT
RAIL
RAIL

5 Glossary

3DES	See ”DES“
AC	Access Client. Radio based communication unit, which must announce itself at the Access Point (→ AP). Only after successful authentication, the access client can send data to the network or receive and/or request data from the network. (→ Wireless LAN).
ACK	Acknowledge. A name for a positive acknowledgment of receipt. The ACK is a part of the communication protocols and responsible for the acknowledgment of receipt of the transmission.
Access protocol	Access method that regulates access to the medium. ETHERNET: CSMA/CD Token-Ring: Token FDDI: Append Token WLAN: CSMA/CA
Access method	See access protocol.
ADSL	Asymmetric Digital Subscriber Line. Interface to Wide Area Network.
AES	Advanced Encryption Standard. Encryption standard with 128-, 192- and 256-Bit-keys. This symmetrical encryption standard was developed to replace the earlier → DES standard.
Aging	Function to update data especially the address buffer. An address is marked ”old“ after expiration of a time and will be deleted at next cycle if it is not learned anew.
AP	Access Point. In wireless networks the access point is the → bridge to the wired networks. It can be attached directly to ethernet, token ring or atm. The access point is connected with all nodes "access clients" and takes over the central functions like roaming or security. (→ Wireless LAN).
´API	Application Programming Interface.

ARP	Address Resolution Protocol. Internet protocol used to map an IP address to a MAC address. Compare with → RARP.
ARS	Automatic Rate Selection. Independent choice of transmission rate by the Access Point (→ AP) as a function of the connecting quality (distance).
ASN.1	Abstract Syntax Notation One. Programming language of → MIB.
ATM	Asynchronous Transfer Mode. International standard for cell relay in which multiple service types (such as voice, video, or data) are conveyed in fixed-length (53-byte) cells. Mainly used in WAN applications.
AUI	Attachment unit interface. Interface between transceiver and ETHERNET controller (cable length up to 50 m).
Autocrossing	A function that enables automatic crossing of transmission and reception lines on twisted pair interfaces. Switches that support this function can be connected to each other over a 1:1 wire cable instead of a crossover cable.
Autonegotiation	Detects at a port the transmission parameters of the connected device, such as speed, duplex mode, flow control and adapts to them.
Autopolarity	A function of devices with 10Base-T or 100Base TX interface for automatic correction of wiring errors in twisted pair cables that lead to a polarity reversal of the data signals.
Autosensing	A function that enables a device to automatically detect the data rate (10 Mbps or 100 Mbps) and to transmit and receive at this data rate.
Backpressure	Simulates a collision in HDX mode using a jam signal. → Flow-Control
Bandwidth	Measurement of the amount of data which can be transmitted in one second. For an individual link this is equivalent to the line speed, for example 10 Mbps, 22 Gbps.

Bandwidth Length Product	For estimation which distance is supported by a multi-mode-fiber at a certain data rate (speed). The gross rate has to be used e.g. 125 Mbps at Fast ETHERNET.
BFOC	Bayonet Fiber Optical Connector. Also known as an ST® connector (trade mark of AT&T). Fiber connector with bayonet attachment. The only connector standardized for 10 Mbps ETHERNET. Suitable for multi-mode and single-mode fiber, as well as POF.
BGNW	The BGNW (Benutzergruppe Netzwerke) is a German association of leading international users and manufacturers of network systems. It is a manufacturer-neutral and independent forum. The goal of this association is the advanced training and exchange of experience of the members, and the development of recommendations of networkplanning, networkinstallation and maintenance of networks. More information: http://www.bgnw.de/
BGP	Border Gateway Protocol. Interdomain routing protocol in → WAN.
BLP	→ Bandwidth Length Product
BNC	Bayonet Neill Concelmann. Connector used to connect 10BASE2 coaxial cable to a → MAU.
BOOTP	Bootstrap Protocol. Delivers a statically assigned IP address to a specific MAC address. Routeable in comparison to → RARP.
BPDU	Bridge Protocol Data Unit. A control frame between bridges, used by Spanning Tree.
Bridge	See Switch.
Broadcast	Data packet that will be sent to all nodes on a network. Hubs and Switches are transparent for Broadcasts. Broadcasts cannot cross routers. Compare with Multicast and Unicast.
BT	Bit Time. Duration of a bit.
CCITT	Comité Consultatif International Téléphonique et Télégraphique. Now called the → ITU-T.

CCK	Complentary Code Keying. CCK is used with the 11 Mbps version of the 802.11-LAN (802.11b) and can pack several bits into a symbol. Thus a higher data transmission rate is possible.
CD	Collision Detect.
CENELEC	Comité Européen de Normalisation Elektrotechnique (European Committee for Electrotechnical Standardization). Responsible for the harmonization of electrotechnical standards in the European Union (e.g. EN 50173, …).
CHAP	Challenge Handshake Authentication Protocol. PPP authentication method. Passwords are transmitted after being encoded with a random number. Compare with → PAP.
Cheapernet	Coax cable in accordance with the ETHERNET standard 10BASE2. Synonyms: Thinwire, RG58.
CLI	1. Command Line Interface. 2. Calling Line Idendification
Concentrator	See ”Hub“.
CoS	Class of Service. A network with class of service has the ability to deliver data traffic with a minimum amount of delay in an environment in which many users share the same network. CoS classifies traffic into categories such as high, medium, and low (gold, silver, and bronze).
CRC	Cyclic Redundancy Check. Error-checking technique in which the frame recipient calculates a remainder by dividing frame contents by a prime binary divisor and compares the calculated remainder to a value stored in the frame by the sending node. See also FCS.
CSMA/CD	Carrier Sense Multiple Access Collision Detect. Media-access mechanism wherein devices ready to transmit data first check the channel for a carrier. If no carrier is sensed for a specific period of time, a device can transmit. If two devices transmit at once, a collision occurs and is detected by all colliding devices. This collision subsequently delays retransmissions from those devices for some random length of time. CSMA/CD access is used by ETHERNET and IEEE 802.3.

Cut-Through	A device using cut-through packet switching reads, processes, and forwards packets as soon as the destination address is looked up and the outgoing port determined. Also known as on-the-fly packet switching. See also Store & Forward.
DA	See Destination address.
DBPSK	Differential Binary Phase Shift Keying. DBPSK is a modulation procedure of which is used with the → DSSS transmission method according to standard 802.11 for systems with 1 Mps.
DCE	Data Communication Equipment, e.g. printer, modem. See also DTE.
DES	Data Encryption Standard. Symmetric encryption algorithm. For encryption and decryption the same secret key is used. Thus every station need to know this key in order to encrypt/ decrypt . DES uses a 56 bit key. 3DES consists of three separate DES cryptographic operations, each performed with a different 56 bit key. The key length of 3DES is thus 168 bit.
Destination address	Used with ETHERNET, IP, etc. The address to which a data packet is sent.
DeviceNet	DeviceNet incorporates CAN technology and provides a low-cost industrial network used to connect industrial devices such as limit switches, photoelectric cells, valve manifolds, motor starters, drives, and operator displays to PLCs and PCs.
DHCP	Dynamic Host Configuration Protocol. Provides a mechanism for allocating IP addresses dynamically so that addresses can be reused when hosts no longer need them.
DNS	Domain Name System. System used in the Internet for translating names of network nodes into addresses.
Domain	Broadcast domain: Network area which can only be bordered by a router, and through which a Broadcast can freely travel. Collision domain: Network area which is bordered by a switch or router, within which collisions can occur.

DQPSK	Differential Quaternary Phase Shift Keying. DQPSK is a modulation procedure of which is used with the → DSSS transmission method according to standard 802.11 for systems with 1 Mps or 2 Mps.
DSC	Duplex straight connector. See also SC.
DSL	Digital Subscriber Line. Provides a technologie, in order to use the internet with 1,5 Mbps (via copper lines).
DSSS	Direct Sequence Spread Spectrum. DSSS is a transmission method according to standard 802.11. The procedure changes the narrow-band by coding to a wide-band signal. In this way the entire frequency band can be used. Thus a higher data transmission rate as well as a lower susceptibility to interference is possible.
DTE	Data Terminal Equipment, e.g. computer. See also DCE. Difference to DCE: Pin assignment.
Dual Homing	Network topology in which a device is connected to the network by way of two independent access points (points of attachment). One access point is the primary connection, and the other is a standby connection that is activated in the event of a failure of the primary connection.
DVMRP	Distance Vector Multicast Routing Protocol. Internetwork gateway protocol, largely based on RIP, that implements a typical dense mode IP multicast scheme. DVMRP uses IGMP to exchange routing datagrams with its neighbors.
DWDM	Dense Wavelength Division Multiplex.
Dynamic DNS	Assigns always the same name also if the IP-address of one client changes. See also DNS.
EANTC	European Advanced Networking Test Center.
EIA	Electronic Industries Association. Standardization body.
ELED	Edge-emitting LED.
EMC	Electromagnetic compatibility. Electromagnetic interferece and electromagnetic emissions, class A/B.

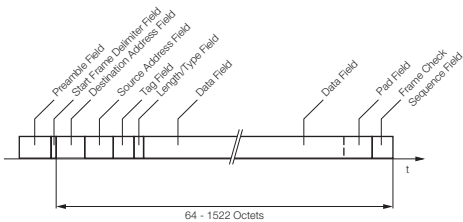
EN — European norm (standard). See also CENELEC.

ESD — Electro Static Discharge.

ETHERNET — The first experimental ETHERNET system was developed in the early 1970s by Bob Metcalfe and David Boggs of the Xerox Palo Alto Research Center (PARC). In 1983, the Institute of Electrical and Electronic Engineers (IEEE) released the first IEEE standard for ETHERNET technology. It was developed by the 802.3 Working Group of the IEEE 802 Committee. The formal title of the standard was IEEE 802.3 Carrier Sense Multiple Access with Collision Detection (→ CSMA/CD) Access Method and Physical Layer Specifications. ETHERNET has a variable packet length between 64 and 1522 byte included the TAG field.

EtherNet/IP — EtherNet/IP is an ETHERNET implementation designed for industrial applications, built on standard TCP/IP protocol and shares a common application layer with DeviceNet thus facilitating the exchange of information between device-level networks and plant level information systems.

ETHERNET Packet — Term for an ETHERNET data packet. It contains the destination and source address field (DA or SA) apart from the actual payload data, the TAG field (4 bytes, optional) and the length/type field.



FCS — Frame Check Sequence. Checksum at the end of an ETHERNET frame, which is calculated and appended by the transmitter. The receiver recalculates this checksum based on the contents of the frame, and compares the two values. See also CRC.

FDB	Forwarding Data Base. Address table of a switch for the decision at which port to transmit a frame. The table assigns MAC addresses to the port via which the respective device can be reached. The table is updated regularly (→ Aging).
FDDI	Fiber Distributed Data Interface. Data network, standardized by ISO 9314 and ANSI X3T9.5 as well as X3T12.
FDX	Full Duplex. Transmission mode of a component: simultaneous transmission and reception is possible. No access control procedure is necessary. See also HDX.
Flow Control	Procedure used when an exit port is overloaded, and data is being lost from the buffer: The incoming port indicates to an end device that the device should stop sending data. In half duplex mode this is achieved by simulating collisions. In full duplex mode, special ”Pause“ frames are used
F/O	Fiber optics
Frame Relay	Modified version of the X.25 protocol used in WANs.
FTP	1. File Transfer Protocol. A layer 5 protocol which runs over TCP. Can also be used across WANs. 2. Foiled Twisted-Pair.
FTTD	Fiber To The Desk.
Full Duplex	→ FDX
GARP	Generic Attribute Registration Protocol. A family of protocols used to exchange information between switches at layer 2. Currently the family consists of → GMRP and → GVRP.
Gateway	Components above layer 2 of the ISO/OSI reference model. At layer 3 the gateway is usually a router. Converts between protocols like IP to IPX.
GBIC	Gigabit interface converter. See also SFP
Gbps	Gigabits per second, Gbit/s.
GMRP	→ GARP Multicast Registration Protocol
GVRP	→ GARP VLAN Registration Protocol.

Half Duplex	→ HDX
HASH	Checksum, securing the integrity of information.
HCS ®	Hard Polymer Cladded Silica. Plastic fiber with a quartz glass core. See also PCF, POF.
HDX	Half Duplex. Transmission mode of a component. Transmission and reception of data are possible, but not simultaneously. Half duplex ETHERNET requires the CSMA/CD access method. See also FDX.
HIPER-Ring	For ETHERNET networks Hirschmann has developed the HIPER-Ring (Hirschmann Performance Redundancy Ring) based on the concept of the Spanning Tree Protocol. The HIPER-Ring significantly increases the availability of the network and facility: while with Spanning Tree 30 seconds typically elapse before the failure of a link is compensated, with HIPER-Ring this takes less than half a second. Furthermore the structure is considerably simplified with a possibility of expansion of up to 50 devices.
HiRRP	Hirschmann Router Redundanz Protokoll. Protocol to control a redundant router. If one of the routers fails, within 800 ms the remaining router completely takes over the tasks of the other one
Hop	Passage of a data packet between two network nodes (for example, between two routers).
HSRP	Hot Standby Routing Protocol. Protocol which accommodates redundant routers. See also VRRP.
HTML	Hypertext Markup Language.
HTTP	Hypertext Transfer Protocol. The protocol used by Web browsers and Web servers to transfer files, such as text and graphic files.
HTTPS	→ HTTP Secure. Paketwise encrypted HTTP communication.
Hub	Components at layer 1 of the ISO/OSI reference model. Regenerates the amplitude and signal shape of the incoming signals, and transmits them out of all ports. Synonyms: Star coupler, Concentrator.

IAONA	IAONA (Industrial Automation Open Networking Alliance Europe e.V.) Europe was founded in 1999 at the SPS/IPC/ Drives in Nuremberg (with HIRSCHMANN as one of the establishment company) as an alliance of meanwhile more than 130 leading international manufacturers and users of automation systems. It pursues the aim of establishing ETHERNET as the standard application in every industrial environment at an international level. Sense of this is to realise a general, interfaceless communication through all levels of an enterprise. This refers to all fields of plant automation, process automation, and building automation. More information: http://www.iaona-eu.com/
ICMP	Internet Control Message Protocol. Best known use: Ping.
ID	Identifier.
IDA	Interface for Distributed Automation. Open interface, which runs over TCP/IP, used in automation.
IEC	International Electrotechnical Commission. Standardization body.
IEEE	Institute of Electrical and Electronics Engineers. Standards body for LANs, with responsibility for the 802.3 (ETHERNET) and 802.1 (Switches) standards.
IETF	Internet Engineering Task Force.
IFG	Inter Frame Gap. Minimum gap between frames. Synonym: Inter Packet Gap (IPG).
IGMP	Internet Group Management Protocol. Layer 3 protocol for Multicast control. See also GMRP.
IGMP Snooping	Internet Group Management Protocol Snooping. A function in which switches investigate IGMP packets and allocate membership of a participant to a multicast group to the respective port. Thereby muliticasts can also be switched specifically to those segments in which the participants of a group are located.
IGP	Interior Gateway Protocol.
IGRP	Interior Gateway Routing Protocol.

Internet Protocol	See IP.
IP	Internet Protocol. A layer 3 communications protocol, most widely used (> 80 %). IPv4: Version 4 = 4 byte addresses IPv6: Version 6 = 16 byte addresses IPnG = IPv6
IP address	A logical address, assigned by a network manager. Address format (v4): 4 bytes in decimal code, separated by dots, for example 192.178.2.1. See also Network Mask.
IPnG	IP next generation. Communications protocol, see IP.
IPsec	IP Security. Standard, which uses encryption to verify the authenticity of the sender and ensure the confidentiality and integrity of the data in IP. Layer 3 → VPNs connections are configured with IPSec (using → 3DES for instance).
IPv4	IP Version 4. Communications protocol, see IP.
IPv6	IP version 6. Communications protocol, see IP.
IPX	Internetwork Packet Exchange. NetWare network layer protocol used for transferring data from servers to workstations. IPX is similar to TCP/IP.
ISDN	Integrated Services Digital Network. WAN communication protocol.
ISO	International Organization for Standardization. International standardization body.
ISO/OSI	→ OSI model
ISP	Internet Service Provider.
ITU-T	IInternational Telecommunication Union, Telecommunication Standardization Sector. Standardization body.
Jabber	A faulty ETHERNET frame with more than 1518 bytes.
Jitter	Deviation in signal timing.
Kbps	Kilobits per second, kbit/s.

L2TP	Layer 2 Tunneling Protocol. For configuration of → VPN-Tunnels on layer 2. See also IPsec.
LACP	Link Aggregation Control Protocol.
LAN	Local Area Network. Local data network, e.g. ETHERNET, FDDI, and Token Ring. See also Wireless LAN.
LAP	Link Access Protocol.
Latency	Time difference between the reception and retransmission of data, mostly between the last received bit and the first retransmitted bit.
LED	Light Emitting Diode.
Link-Aggregation	Combining several physical ports (maximum 4) to create one virtual port. Data is transmitted in parallel, with redundancy in the event of port loss. Standard IEEE 802.3. Also known as Trunking.
LLC	Logical Link Control. Layer 2b.
LSB	Least Significant Bit.
LX	Long Wavelength (Gbit-Ethernet).
MAC	Media Access Control.
MAC address	Hardware address on a network component. MAC addresses are assigned by the device manufacturer. Address format: 6 bytes in Hex, separated by colons, for example 00:80:63:01:A2:B3.
MAN	Metropolitan Area Network. To connect → LANs within a city.
Management	Administration, configuration, and supervision of network components. The management agent in the component to be managed communicates with the management station (PC) via the SNMP management protocol.
MAU	Medium Attachment Unit. → Transceiver.
Mbps	Megabits per second, Mbit/s.
MD5	Message Digest 5. See also → Hash-Algorithm.

MDI	Medium Dependent Interface.
MDI-X	MDI-Crossover, see also MDI.
MIB	Management Information Base. Contains a description of the objects and functions of a network device.
MII	Media Independent Interface.
mini-GBIC	Mini gigabit interface converter, see alsor SFP.
MLPPP	Multilink PPP. See also PPP.
MPLS	Multiprotocol Label Switching. Layer-3 protool.
MSB	Most Significant Bit.
MTBF	Mean Time Between Failure.
MTTR	Max Time To Repair.
Multicast	Data packet intended for a group of devices, for example all Hirschmann devices.
Multi-mode fiber	Fiber optic cables that are distinguished through core diameters of comparable size. The typical core diameter for step-index fiber optic cables is 100 µm for glass fibers, 200 µm for PCS/HCS ® fibers and 980 µm for POF fibers. The graded index fibers on the other hand have a typical core diameter 50 or 62.5 µm.. Because of this relatively large core diameter, the light in multi-mode fibers spreads over several paths and modes. See also Single-mode fiber.
NAT	Network Address Translation.
NAT-T	NAT-Traversal. If there is a → NAT-Gateway inbetween two → IPsec end points IPsec does not work, as the IP-addresses of the end points are also encrypted. NAT-T solves this problem. NAT-T is enable automatically during the handshake if required (and supported).
NetBEUI	NetBIOS Extended User Interface. Enhanced version of the NetBIOS protocol used by network operating systems such as LAN Manager, LAN Server, Windows for Workgroups, and Windows NT.

Network Mask — The network mask marks all bits in an IP address for identifying the network and the subnetwork. See also IP address.

Binary notation

IP address	10010101.11011010.00010011.01011010
Network mask	11111111.11111111.11111111.00000000
-> Subnetwork	10010101.11011010.00010011.00000000

Decimal notation

IP address	149.218.19.90
Network mask	255.255.255.0
-> Subnetwork	149.218.19.0

Available address range

Host addresses	149.218.19.1 to 149.218.19.254
Broadcast address	149.218.19.255

NEXT — Near End Cross Talk.

NIC — Network Interface Card.

NMS — Network Management System.

Node — Participant in a data network (PC, printer, switch, hub, etc.).

NRZ — Non Return to Zero. Signal code. See also NRZI.

NRZI — Non Return to Zero Invert. Signa code. See also NRZ.

NVRAM — Non-Volatile RAM. RAM that retains its contents when a unit is powered off.

ODVA — ODVA (Open Device Vendor Association) is the organization that manages the DeviceNet and EtherNet/IP network technology and standards in addition to promoting their worldwide adoption in industrial automation.

OID — Object ID.

OLE — OLE (Object Linking and Embedding) is a window technology to transfer different datas between devices.

OPC — OLE for Process Control. Protocol used in process control, to provide a standardized method of exchanging data between devices.

OSI — Open Systems Interconnection. International standardization program created by → ISO and → ITU-T to develop standards for data networking that facilitate multivendor equipment interoperability.

OSI model	A model which describes communication in a network. The functionality of the hardware is divided into seven layers. The lowest layer (Physical Layer) describes the physical media.
OSPF	Open Shortest Path First. Protocol for exchanging routing information between routers. Faster than → RIP, and suitable for use in large networks.
OTDR	Optical Time Domain Reflectometer. Analyser.
OUI	Organizationally Unique Identifier. The first three bytes of a → MAC address, indicating the manufacturer of the module.
Packet size	ETHERNET: 64 … 1518 byte (1522 with VLAN tag), FDDI:… 4500 byte.
PAP	Password Authentication Protocol. PPP authentication method. Passwords are transmitted unencoded. PAP is based on user names.
Parallel Detection	Part of the → Autonegotiation function. This allows a device to configure itself correctly when attached to another device which does not support autonegotiation. A port detects the line speed using FLP or NLP, and configures itself for 100 Mbps or 10 Mbps. For duplex mode, HDX is always used.
PCF	Plastic Cladding Silica Fiber. Plastic fiber with a quartz glass core. See also POF, HCS ®.
PD	Powered Device. Defines the end device (like a IP telephone) in the draft IEEE P802.3af standard (DTE Power via MDI) which defines how to support power over twisted pair cabel over ETHERNET.
PDU	Protocol Data Unit.
PHY	Physical sublayer. Physical level/component (at layer 1b).
PIMF	Pair In Metal Foil (data cable). See STP.
PLC	Programmable Logic Control.
PMD	Physical Medium Dependent. Physical level/component (at layer 1a).
POE	Power over Ethernet.

POF	Polymere Optical Fiber. Siehe auch HCS ®, PCF.
POL	Power over LAN.
Port Mirroring	The data traffic of a port (in/out) is copied to another port (mirrored), in order that it can be viewed using a protocol analyser.
Port Trunking	see Link Aggregation.
PPP	Point-to-Point Protocol. Provides router-to-router and host-to-network connections. PPP works with several network layer protocols, such as IP, IPX, and ARA. PPP also has built-in security mechanisms, such as CHAP and PAP.
PPPoE	Point-to-Point-Protocol over Ethernet.
pps	Packets per Second.
PPTP	Point-to-Point Tunneling Protocol.
Prioritization	Data packets are given precedence, subject to defined criteria. At layer 2 an additional → Tag field is inserted into the frame. At layer 3 the → TOS field of → IP is used.
Private Key	→ Private/Public Key
Private/Public Key	In asymmetrical encryption algorithms, two keys are used: a Private Key and a Public Key. The public key is made available by the future recipient of the data to those who will later send encrypted data to him/her. The recipient is the only one who has the private key. It is used to decrypt the received data.
PS	Power Supply. See also PSU.
PSE	Power Sourcing Equipment. Defines the power suppyling device (like a switch) in the draft IEEE P802.3af standard (DTE Power via MDI) which defines how to support power over twisted pair cable over ETHERNET.
PSU	Power Supply Unit. See also PS.
PTP	Precision Time Protocol. Protocol for time synchronisation acc. to IEEE 1588, with a precision of less than 1 µs.

Public Key	→ Private/Public Key
PVV	Path Variability Value. Designation in bit times.
QoS	Quality of Service. Measure of performance for a transmission system that reflects its transmission quality and service availability. See also prioritization.
RADIUS	Remote Authentication Dial In User Service. A RADIUS Server authenticates a client, who registers for access with a name and password. The password is transmitted encoded.
RAM	Random Access Memory. Volatile memory.
RARP	Reverse Address Resolution Protocol. Obtains the IP address associated with a specified MAC address. See also BOOTP and DHCP.
RAS	Remote Access System.
Repeater	Layer 1 component which regenerates a signal. Regenerates amplitude, signal edge and clock. Repeater with more than two ports are also known as hubs.
RFC	Request For Comments. Quasi-Standard for Internet, Protocols and Applications, published by the IETF. See 6.3.
RG58	Coax cable with 50 Ω resistance. Also known as Thinwire or 10BASE2.
RIP	Routing Information Protocol. Used to exchange routing information between routers on a LAN. There are two versions: RIP V1 and RIP V2. See also OSPF.
RJ45	Connector for Twisted Pair. Usually for → ETHERNET and → ISDN.
RMON	Remote Monitoring.
Router	Component at layer 3 of the → ISO/OSI reference model. Connects networks at layer 3. Offers additional features such as choosing the best path through a network based on criteria such as path cost.

RS 232 C	Recommended Standard. Serial interface, also known as V.24. Actually an extension of V.24 acc. → CCITT.
RSTP	Rapid Reconfiguration Spanning Tree Protocol.
RSVP	Resource Reservation Protocol. Reserves bandwidth in a → WAN.
RTCP	Realtime Transport Control Protocol.
RTP	Real Time Protocol.
Rx	Receive.
SA	Source Address.
SAN	Storage Area Network. Network for connecting servers and storage sub-systems, such as disks, RAID and Tape Systems. Mostly based on Fibre Channel.
SAP	1. Service Access Point. 2. Service Advertising Protocol.
SC	Straight Connector. See also DSC.
SCADA	Supervision Control And Data Acquisition. Process visualization system for process control and visualization. Based on Windows.
SD	Starting Delimiter.
SDH	Synchronous Digital Hierarchy. European standard that defines a set of rate and format standards that are transmitted using optical signals over fiber. SDH is similar to SONET, with a basic SDH rate of 155.52 Mbps, designated at STM-1.
SFD	Start Frame Delimiter.
SFP	Small form-factor pluggable. A → transceiver for 1 Gbps networks that converts serial electric signals to serial optical signals and vice versa. see also GBIC.
SHA-1	Secure Hash Algorithm 1. See also Hash.

Single-mode fiber	Fiber optic cable that is characterized by its extremely small core diameter (max. 10 µm). As a result, in this fiber, the light after the cutoff waveline can only get extended along one path – one mode. See also Multi-mode fiber.
SLA	Service Level Agreement.
SLIP	Serial Line Internet Protocol. Standard protocol for point-to-point serial connections using serial interface (e.g V.24) for IP communication.
SMON	Switch Monitoring.
SMTP	Simple Mail Transfer Protocol. Internet protocol providing e-mail services.
SNTP	Simple Network Time Protocol. Protocol for time synchronisation, based on NTP, with a precision of 1 to 50 ms. For higher precision → PTP (Precision Time Protocol acc. to IEEE 1588) is used.
SNAP	Subnetwork Access Protocol.
SNMP	Simple Network Management Protocol. Network management protocol definied by → IETF used almost exclusively in → TCP/IP → LANs to monitor and control network devices, and to manage configurations, statistics collection, performance, and security.
SOHO	Small Office Home Office. Networking solutions and access technologies for offices that are not directly connected to large corporate networks.
Spanning-Tree	Protocol which automatically blocks network loops. Allows the installation of redundant paths, to improve resilience in case of connection failures. Recovery time between 30 to 60 seconds.
SQE	Signal Quality Error. Transmission sent by a transceiver back to the LAN controller (processor) to let the controller know whether the collision circuitry is functional. Also called heartbeat.

SSH	Secure Shell. Allows an encrypted communication via unsecured networks with authentication of the communicaton partners, integrity and confidentialy of the exchanged data.
Star coupler	For active star couplers, see Hub. A passive star coupler is a component used in fiber technology with x entrances and y exits without amplifying the signal.
Store & Forward	A switching mechanism in which the complete packet is saved into a buffer, and then retransmitted. Also see Cut-Through.
STP	1. Shielded Twisted Pair. Two-pair wiring medium. STP cabling has a layer of shielded insulation to reduce EMI. See also PIMF ,UTP. 2. → Spanning Tree Protocol.
Switch	Component at layer 2 of the → OSI reference model. Synonym: Bridge. Unlike a hub, a switch only forwards data to the port where the destination device is connected. This results in separation of segments. No access control mechanism is required between two switches connected in full duplex mode. There are also switches known as Layer 3 and Layer 4 switches, in which some functionality of these layers has been implemented.
SX	Short Wavelenth (Gigabit-Ethernet).
Tag field	Optional field in an ETHERNET frame, inserted after the source address.
TCO	Total Cost of Ownership.
TCP	Transmission Control Protocol. Connection-oriented transport protocol on layer 4 of the TCP/IP protocol stack. See also UDP.
TCP/IP	Transmission Control Protocol/Internet Protocol. Most widely used protocol family from layer 3 upwards. Standardized by the IETF. Protocols included in this family are: Layer 3: IP Layer 4: TCP, UDP Layer 5: TFTP, SMTP, FTP, … Layer 5 contains layers 5 to 7 of the OSI model.

Telnet	Virtual terminal program, using the TCP/IP stack for remote access to a device's user interface over a network.
TFTP	Trivial File Transfer Protocol. Layer 5 protocol, uses → UDP as the transport protocol., therefore use in → LANs.
TIA	Telecommunications Industry Association. Standardization body.
Token-Ring	Data network, standardized by IEEE 802.5, and also a system proprietary to IBM.
TOS	Type Of Service. Field in the IP packet used for → prioritization.
TP	Twisted-Pair. Data cable.
Transceiver	Transmits data signals from an AUI interface on to a medium, for example Twisted Pair. New components already have a transceiver implemented. For older components, there are plug-on transceivers for multi-mode, Twisted Pair or coax.
Trunking	See Link Aggregation.
Transmission rate	Speed of data transmission, and also → bandwidth. ETHERNET: 10, 100, 1000, 10000 Mbps Token Ring: 4 Mbps, 16 Mbps FDDI: 100 Mbps
TTL	Time To Live. Field in an IP header that indicates how many hops are still allowed for the packet, before it will be deleted automatically.
Tx	Transmit.
UDP	User Datagram Protocol. Connectionless transport protocol on layer 4 of the TCP/IP protocol stack. See also TCP.
UL	Underwriters Laboratories. Independent agency within the United States that tests product safety.
Unicast	Data packets that are addressed only to a single device, in contrast to Multicasts and Broadcasts.
UPS	Uninterruptable Power Supply.

URL	Universal Resource Locator. Standardized addressing scheme for accessing hypertextdocuments and other services using a browser. Hirschmann URL: www.hirschmann.com
UTP	Unshielded Twisted-Pair. Cable with unshielded twisted pairs, mostly 4 pairs. See also STP.
VLAN	Virtual LAN, built with switches. Target: Restrict broadcasts only to the part of the network where they are required. Also used to divide up networks for security reasons.
VPN	Virtual Private Network. A VPN connects several separate private networks (subnets) together via a public network, e.g. the Internet, to form a single joint network. A cryptographic protocol is used to ensure confidentiality and authenticity. A VPN thus offers an economical alternative to using dedicated lines to build a nationwide corporate network.
VRRP	Virtual Redundant Router Protocol. Protocol to control a redundant router. See also HSRP.
WAN	Wide Area Network. Public data and transport networks for joining LANs. Transmission protocols: ISDN, Frame-Relay, X.21 SDH, SONET, ATM.
WDM	Wavelength Division Multiplex.
WEP	Wired Equivalent Privacy. WEP is a coding procedure in Wireless LANs according to 802.11 for the protection of the transferred data.
WFQ	Weighted Fair Queuing. Procedure for processing prioritization queues in a switch. For example, the highest queue receives 50 % of the bandwidth, the next 25 % , … .
WiFi	Wireless Fidelity. WiFi is a certifying of Wireless LANs (WLAN) according to standard 802.11which is accomplished by the WECA (Wireless Ethernet Compatibility Alliance). With this certifying interoperability of the wireless LAN products are confirmed. See also http://www.wi fi.net

Wireless LAN	Lokale Netze, die ohne Kabelverbindungen arbeiten.
Wire-speed	Processing packets at the highest physically possible speed.
WLAN	Wireless → LAN. Acc. IEEE 802.11, .15, .16 (Bluetooth).
WWDM	With WWDM-system (Wide Wavelength Division Multiplex) networks with limited fiber can increase channel capacity of the fiber by between two locations. A optically multiplexes some single mode optical signals into one composite optical signal. Using the same fiber optic pair, multiple point-to-point applications can be satisfied. This greatly reduces the cost of intalling more fiber.
WWW	World Wide Web.
X.25	Data Packet Control Protokoll, used for example by Datex-P.
XML	Extended Markup Language.
XNS	Xerox Network Systems.

6 Standards

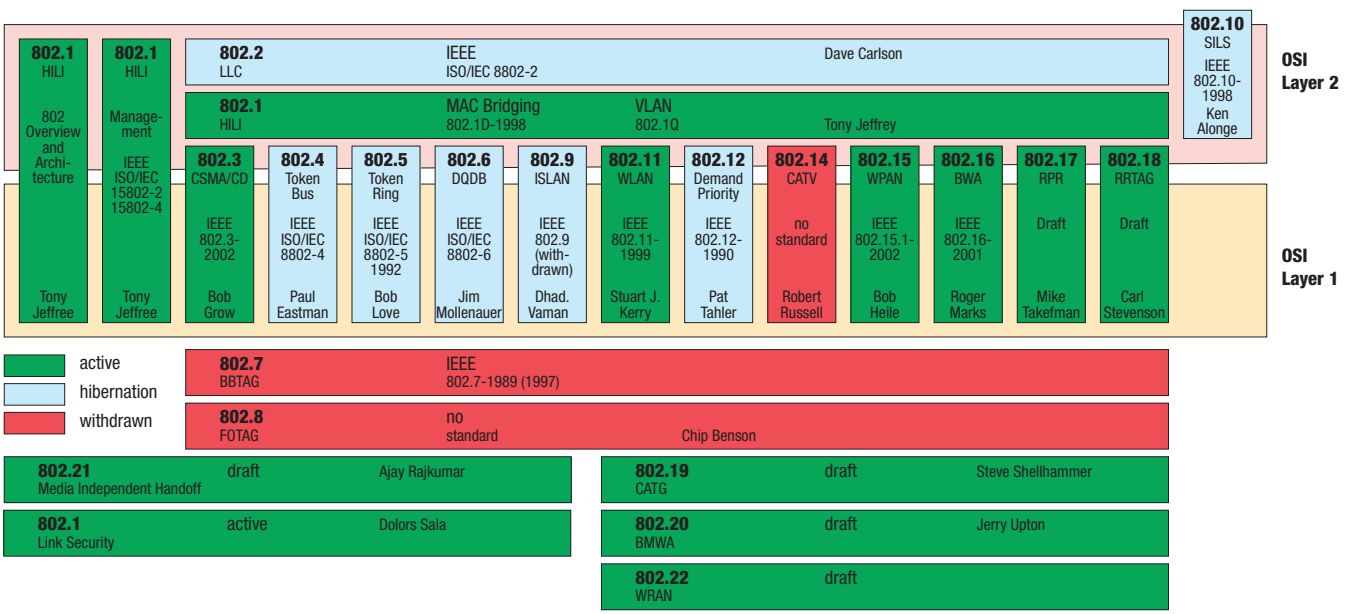
6 Standards

6.1 IEEE-Standards for Local and Metropolitan Area Networks

The IEEE-Standards Association (IEEE-SA) is an organization under which all IEEE (Institute of Electrical and Electronics Engineers) Standards activities and programs will be carried out.

The IEEE 802 LAN/MAN Standards Committee develops Local Area Network standards and Metropolitan Area Network standards. The most widely used standards are for the ETHERNET family, Token Ring, Wireless LAN, Bridging and Virtual Bridged LANs.

The following chapter will give you an overview over some important standards used in network environment.



IEEE 802 Overview and Architecture

IEEE 802	LMSC	LAN MAN Standard Committee
IEEE 802.1	HILI	Higher Level Interface/Link Security
IEEE 802.2	LLC	Logical Link Control
IEEE 802.3	CSMA/CD	Carrier Sense Multiple Access with Collision Detection (ETHERNET)
IEEE 802.4	TBUS	Token Bus
IEEE 802.5	TRING	Token Ring
IEEE 802.6	DQDB	Distributed Queue Dual Bus
IEEE 802.7	BBTAG	Broadband Technical Advisory Group
IEEE 802.8	FOTAG	Fiber Optic Technical Advisory Group
IEEE 802.9	ISLAN	Integrated Services LAN
IEEE 802.10	SILS	Standard for Interoperable LAN Security
IEEE 802.11	WLAN	Wireless LANs
IEEE 802.12	DPAP	Demand Priority Access Protocol
IEEE 802.14	CATV	LANs in Cable Television Networks
IEEE 802.15	WPAN	Wireless Personal Area Networks
IEEE 802.16	BWA	Broadband Wireless Access
IEEE 802.17	RPR	Resilient Packet Ring
IEEE 802.18	RRTAG	Radio Regulatory Technical Advisory Group
IEEE 802.19	CTAG	Coexistence Technical Advisory Group
IEEE 802.20	MBWA	Mobile Broadband Wireless Access
IEEE 802.21	MIH	Media Independent Handoff
IEEE 802.22	WRANs	Wireless Regional Area Networks

IEEE 802.1 Higher Layer Interface Standards/ Link Security

IEEE 802.1aa	Port Based Network Access Control - Amendment
IEEE 802.1AB	Station and Media Access Control Connectivity Discovery
IEEE 802.1AC	Media Access Control (MAC) Service Definition
IEEE 802.1ad	Provider Bridges
IEEE 802.1AE	Media Access Control (MAC) Security
IEEE 802.1af	KeySec
IEEE 802.1ag	Connectivity Fault Management
IEEE 802.1ah	Provider Backbone Bridges
IEEE 802.1aj	Two-port MAC Relay
IEEE 802.1ak	Multiple Registration Protocol
IEEE 802.1B-1995	LAN/MAN Management (ISO/IEC 15802-2: 1995)
IEEE 802.1D-1998	MAC (Media access control) bridges (includes IEEE 802.1p Priority and Dynamic Multicast Filtering, GARP, GMRP)
IEEE 802.1D-2004	MAC bridges
IEEE 802.1E-1994	System load protocol (ISO/IEC 15802-4: 1994)
IEEE 802.1F-1993	Common Definitions and Procedures for IEEE 802 Management Information
IEEE 802.1G-1998	Remote Media Access Control (MAC) bridging (ISO/IEC 15802-5: 1998)
IEEE 802.1H-1997	Media Access Control (MAC) Bridging of ETHERNET V2.0 in Local Area Networks (ISO/IEC TR 11802-5: 1997)
IEEE 802.1i-1992	Fibre Distributed Data Interface (FDDI) Supplement
IEEE 802.1j-1996	Managed objects for MAC bridges

IEEE 802.1k-1993	Discovery and Dynamic Control of Event Forwarding
IEEE 802.1m-1993	Managed Object Definitions and Protocol Implementation Conformance Statement
IEEE 802.1p	Traffic Class Expediting and Dynamic Multicast Filtering
IEEE 802.1Q-2003	Virtual Bridged Local Area Networks (VLAN Tagging, GVRP)
IEEE 802.1r	Media Access Control (MAC) Bridges - GARP
IEEE 802.1s-2002	Virtual Bridged Local Area Networks: Multiple Spanning Trees
IEEE 802.1t-2001	Media Access Control (MAC) Bridges - Amendment
IEEE 802.1u-2001	Virtual Bridged Local Area Networks - Corrigendum
IEEE 802.1v-2001	VLAN Classification by Protocol and Port: Amendment to 802.1Q
IEEE 802.1w-2001	Rapid Reconfiguration (Amendment)
IEEE 802.1X-2001	Port-Based Network Access Control
IEEE 802.1y	Media Access Control (MAC) Bridges – Amendment (802.1D Maintenance)
IEEE 802.1z	Virtual Bridged Local Area Networks - Amendment (802.1Q Maintenance)

ANSI/IEEE 802.3 (ISO/IEC 8802-3) CSMA/CD (Ethernet)

ANSI/IEEE Std 802.3-2000 incorporates

802.3-1985	Original 10 Mb/s standard, MAC, PLS, AUI, 10BASE5
802.3-2002	CSMA/CD Access Method and Physical Layer Specification
802.3	Residential Ethernet Study Group
802.3	Power over Ethernet plus Study Group
802.3a-1988 (Clause 10)	10 Mb/s MAU 10BASE2
802.3b-1985 (Clause 11)	10 Mb/s Broadband MAU, 10BROAD36
802.3c-1985 (9.1–9.8)	10 Mb/s Baseband Repeater
802.3d-1987 (9.9)	10 Mb/s Fibre MAU, FOIRL
802.3e-1987 (Clause 12)	1 Mb/s MAU and Hub 1BASE5
802.3F	1BASE5 Multi-point Extension
802.3h-1990 (Clause 5)	10 Mb/s Layer Management, DTEs
802.3i-1990 (Clauses 13 and 14)	10 Mb/s UTP MAU, 10 BASE-TP
802.3j-1993 (Clauses 15–18)	10 Mb/s Fiber MAUs 10BASE-FP,FB, and FL
802.3k-1993 (Clause 19)	10 Mb/s Layer Management, Repeaters
802.3l-1992 (14.10)	10 Mb/s PICS proforma 10BASE-T MAU
802.3m-1995	Maintenance
802.3n-1995	Maintenance
802.3p-1993 (Clause 20)	Management, 10 Mb/s Integrated MAUs
802.3q-1993 (Clause 5)	10 Mb/s Layer Management, GDMO Format
802.3r-1996 (8.8)	Type 10BASE5 Medium Attachment Unit PICS proforma
802.3s-1995	Maintenance

802.3t-1995	120 Ohm informative annex to 10BASE-T
802.3u-1995 (Clauses 21–30)	Type 100BASE-T MAC parameters, Physical Layer, MAUs, and Repeater for 100 Mb/s Operation
802.3v-1995	150 Ohm informative annex to 10BASE-T
802.3w	Enhanced Media Access Control Algorithm
802.3x-1997 and 802.3y-1997	(Revisions to 802.3, Clauses 31 and 32), Full Duplex Operation and Type 100BASE-T2
802.3z-1998 (Clauses 34–39, 41–42)	Type 1000BASE-X MAC Parameters, Physical Layer, Repeater, and Management Parameters for 1000 Mb/s Operation
802.3aa-1998	Maintenance
802.3ab-1999 (Clause 40)	Physical Layer Parameters and Specifications for 1000 Mb/s Operation Over 4 Pair of Category 5 Balanced Copper Cabling, Type 1000BASE-T
802.3ac-1998	Frame Extensions for Virtual Bridged Local Area Network (VLAN) Tagging on 802.3 Networks
802.3ad-2000 (Clause 43)	Aggregation of Multiple Link Segments
802.3ae-2002	Media Access Control (MAC) Parameters, Physical Layer, and Management Parameters for 10 Gb/s Operation
802.3af - 2003	DTE Power via Media Independent Interface (MDI)
802.3ah	Ethernet in the First Mile Task Force.
802.3aj - 2003	Maintenance
802.3ak-2004	10GBASE-CX4
802.3an	10GBASE-T Task Force.
802.3ap	Backplane Ethernet Task Force

802.3aq	10GBASE-LRM Task Force
802.3ar	Congestion Management Task Force
802.3as	Frame Expansion Task Force

ANSI/IEEE 802.11 Wireless LANs

802.11-1999	Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications
802.11a-1999	High-speed Physical Layer in the 5 GHz Band
802.11b-1999	Higher-Speed Physical Layer Extension in the 2.4 GHz Band
802.11c-1998	Supplement for support by IEEE 802.11
802.11d-2001	Amendment 3: Specification for operation in additional regulatory domains
802.11e	Medium Access Method (MAC) Quality of Service Enhancements
802.11f-2003	Inter-Access Point Protocol (IAPP)
802.11g-2003	Further Higher Data Rate Extension in the 2.4 GHz Band > 20Mb/s
802.11h-2003	Spectrum and Transmit Power Management Extensions in the 5 GHz Band in Europe
802.11i	Medium Access Method (MAC) Security Enhancements
802.11j	4.9 GHz - 5 GHz Operation in Japan
802.11k	Radio Resource Management
802.11n	Enhancements for Higher Throughput
802.11m	Maintenance
802.11ma	Technical Corrections and Clarifications
802.11p	Vehicular Access

802.11r	Fast Roaming Fast Handoff
802.11s	Mesh Networking
802.11t	Wireless Performance Prediction

ANSI/IEEE 802.15 Wireless Personal Area Networks

802.15.1-2002	Wireless Personal Area Networks (WPANs) based on the Bluetooth™
802.15.2-2003	Coexistence of Wireless Personal Area Networks with Other Wireless
802.15.3-2003	High Rate WPAN
802.15.4 -2003	Low Rate WPAN
802.15.5 -2004	Networking

ANSI/IEEE 802.16 Broadband Wireless Access

802.16-2001	Air Interface for Fixed Broadband Wireless Access Systems
802.16a-2003	MAC Modifications and Additional Physical Layer for 2-11 GHz
802.16.1b	License-Exempt Frequencies
802.16c-2002	Detailed System Profiles for 10-66 GHz
802.16d	Detailed System Profiles for 2-11 GHz
802.16e	Combined Fixed and Mobile Operation in Licensed Bands
802.16f	MIB
802.16g	Management Plane
802.16h	Coexistence
802.16.1	Air Interface for Fixed Broadband Wireless Access Systems

802.16.2-2004	Coexistence of Broadband Wireless Access Systems
802.16.2a	Amendment to Recommended Practice for Coexistence of Fixed Broadband Wireless Access Systems
802.16.3	Air Interface for Fixed Broadband Wireless Access Systems in Licensed Bands from 2 to 11 GHz

ANSI/IEEE 802.17 Resilient Packet Ring

802.17	Resilient Packet Ring
802.17a	Amendment 4: Support for bridging 802.17 MACs

ANSI/IEEE 802.18 Radio Regulatory TAG

ANSI/IEEE 802.19 Coexistence TAG

ANSI/IEEE 802.20 Mobile Broadband Wireless Access (MBWA)

ANSI/IEEE 802.21 Media Independent Handoff

ANSI/IEEE 802.22 Wireless Regional Area Network

6.2 Extract of Important Standards for Network Components and Network Environment

EN ...

EN 50014	Electrical apparatus for potentially explosive atmospheres; General requirements (IEC 60079-0)
EN 50020	Electrical apparatus for potentially explosive atmospheres; Intrinsic safety (IEC 60079-11)
EN 50081-1	Electromagnetic compatibility (EMC) - Generic emission standard - Part 1: Residential, commercial and light industry
EN 50082-1	Electromagnetic compatibility (EMC) - Generic immunity standard - Part 1: Residential, commercial and light industry
EN 50098-1	Customer premises cabling for information technology - Part 1: ISDN basic access
DIN EN 50173-1	Generic cabling systems - General requirements and office areas (compare ISO/IEC 11801)
DIN EN 50173-2	Generic cabling systems - Office premises (compare ISO/IEC 11801)
DIN EN 50173-3	Generic cabling systems - Industrial premises (compare ISO/IEC 11801)
DIN EN 50173-4	Generic cabling systems - Homes (compare ISO/IEC 11801)
DIN EN 50173-5	Generic cabling systems - Data centres (compare ISO/IEC 11801)
DIN EN 50173-6	Generic cabling systems - Hospitals (compare ISO/IEC 11801)
DIN EN 50173-7	Generic cabling systems - Airports (compare ISO/IEC 11801)
EN 50174-1	Information technology - Cabling installation - Part 1: Specification and quality assurance

EN 50174-2	Information technology - Cabling installation - Part 2: Installation planning and practices inside buildings
EN 50174-3	Information technology - Cabling installation - Part 3: Installation planning and practices outside buildings
EN 50265-2-1	Common test methods for cables under fire coditions Part 2-1: Procedures - 1 kW pre-mixed flame
EN 50281-1-1	Electrical apparatus for use in presence of combustible dust
EN 50288-2-1	Multi-element metallic cables used in analogue and digital communication and control - Part 2-1: Sectional specification for screened cables characterized up to 100 MHz; Horizontal and building backbone cables
EN 50288-4-1	Multi-element metallic cables used in analogue and digital communication and control - Part 4-1: Sectional specification for screened cables characterized up to 600 MHz; Horizontal and building backbone cables
EN 50288-4-2	Multi-element metallic cables used in analogue and digital communication and control - Part 2-2: Sectional specification for screened cables characterized up to 600 MHz; Work area and patch cord cables
EN 50310	Application of equipotential bonding and earthing in buildings with information technology equipment
EN 55022	Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement (IEC/CISPR 22:1997, modified + A1:2000)
EN 55024	Information technology equipment - Immunity characteristics - Limits and methods of measurement (IEC/CISPR 24:1997, modified)
EN 60068-1	Environmental testing - Part 1: General and guidance (IEC 60068-1:1988 + Corrigendum 1988 + A1:1992)
EN 60068-2-2	Basic environmental testing procedures - Part 2: Tests; Tests B: Dry heat (IEC 60068-2-2:1974 + IEC 68-2-2A:1976 + A1:1993)

EN 60068-2-6	Environmental testing - Part 2: Tests; Test Fc: Vibration (sinusoidal) (IEC 60068-2-6:1995 + Corrigendum 1995)
EN 60068-2-14	Environmental testing - Part 2: Tests; Test N: Change of temperature (IEC 60068-2-14:1984 + A1:1986)
EN 60068-2-27	Basic environmental testing procedures - Part 2: Tests; Test Ea and guidance: Shock (IEC 60068-2-27:1987)
EN 60068-2-30	Environmental testing - Part 2: Tests; Test Db and guidance: Damp heat, cyclic (12 and 12 hour cycle) (IEC 60068-2-30:1980 + A1: 1985)
EN 60068-2-32	Basic environmental testing procedures - Part 2: Tests; Test Ed: Free fall (IEC 60068-2-32:1975 + A1: 1982 + A2: 1990)
EN 60512-…	Connectors for electronic equipment/Electromechanical components for electronic equipment - Tests and measurements
EN 60529	Degrees of protection provided by enclosures (IP Code) (IEC 60529: 1998 + A1:1999)
EN 60664-1	Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests (VDE 0110 Part 1) (IEC 60664-1:1992 + A1:2000 + A2:2002)
EN 60794-3	Optical fibre cables - Part 3: Duct, buried and aerial cables; sectional specification (IEC 60794-3:1998)
EN 60811-1-1	Insulating and sheathing materials of electric cables - Common test methods - Part 1-1: General application; Measurement of thickness and overall dimensions; Test for determining the mechanical properties (IEC 60811-1-1:1993 + A1:2001)
EN 60825-1	Safety of laser products - Part 1:Equipment classification, requirements and user's guide (IEC 60825-1:1993 + A1:1997 + A2:2001)
EN 60825-2	Safety of laser products - Part 2: Safety of optical fibre communication systems (IEC 60825-2:2000)

EN 60950	Safety of information technology equipment
ENV 61000-2-2	Electromagnetic compatibility (EMC) - Part 2-2: environment; section 2: compatibility levels for low- frequency conducted disturbances and signalling in public low-voltage power supply systems (IEC 61000-2-2:1990, modified)
EN 61000-3-2	Electromagnetic compatibility (EMC) - Part 3-2: Limits; Limits for harmonic current emissions (equipment input current up to and including 16 A per phase) (IEC 61000-3-2:2000, modified)
EN 61000-4-1	Electromagnetic compatibility (EMC) - Part 4-1: Testing and measurement techniques; Overview of IEC 61000-4 series (IEC 61000-4-1:2000)
EN 61000-4-2	Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 2: Electrostatic discharge immunity test - Basic EMC publication (IEC 61000-4-2:1995)
EN 61000-4-3	Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques; Radiated, radio- frequency, electromagnetic field immunity test (IEC 61000-4-3:2002)
EN 61000-4-4	Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 4: Electrical fast transient/burst immunity test - Basic EMV publication (IEC 61000-4-4:1995)
EN 61000-4-5	Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 5: Surge immunity test (IEC 61000-4-5:1995)
EN 61000-4-6	Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 6: Immunity to conducted disturbances, induced by radio-frequency fields (IEC 61000-4-6:1996)
EN 61000-6-1	Electromagnetic compatibility (EMC) - Part 6-1: Generic standards; Immunity for residental, commercial and light-industrial environments (IEC 61000-6-1:1997, modified)

EN 61000-6-2	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards; Immunity for industrial environments (IEC 61000-6-2:1999, modified)
EN 61000-6-3	Electromagnetic compatibility (EMC) - Part 6-3: Generic standards; Emmision standard for residental, commercial and light-industrial environments (IEC 61000-6-3:1996, modified)
EN 61000-6-4	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards; Emmision standard for industrial environment (IEC 61000-6-4:1997, modified)
EN 61076-2	Connectors for use in d.c., low frequency analogue and digital high speed data applications - Part 2: Circular connectors with asssessed quality - Sectional specification (IEC 61076-2: 1998)
EN 61076-2	Connectors for use in d.c., low frequency analogue and digital high speed data applications - Part 2: Rectangular connectors with asssessed quality - Sectional specification (IEC 61076-3: 1999)
EN 61131-2	Programmable controllers - Part 2: Equipment requirements and test (IEC 61131-2:1992)
EN 61984	Connectors - Safety requirements and tests (IEC 61984:2001)
EN 187000	Generic specification; optical fibre cables
EN 187101	Familiy specification: Optical telecommunication cables to be used in ducts or direct buried application
EN 188000	Generic specification: optical fibres
EN 188100	Sectional specification: Single-mode (SM) optical fibre
EN 188101	Family specification: Single-mode dispersion unshifted (B1.1) optical fibre
EN 188201	Family specification: A1a graded index multi-mode optical fibres

EN 188202	Family specification: A1b graded index multi-mode optical fibres

IEC …

IEC 60079-0	Electrical apparatus for potentially explosive atmospheres; General requirements (EN 50014)
IEC 60038	IEC standard voltages
IEC 60096-1	Radio-frequency cables. Part 1 : General requirements and measuring methods
IEC 60793-2	Optical fibres - Part 2: Product specifications
IEC 60794-2	Optical fibre cables; Part 2: Indoor cables - Sectional specification
IEC 60874-…	Connectors for optical fibres and cables
IEC 60945	Maritime navigation and radiocommunication equipment and systems - General requirements - Methods of testing and required test results
IEC 61850	Communication networks and systems in substations

ISO/IEC …

ISO/IEC 11801	Information technology - Generic cabling for customer premises (compare EN 50173) 2nd edition in 2003
ISO/IEC 14763-…	Information technology - Implementation and operation of customer premises cabling
ISO/IEC 8802-3-…	Information technology - Telecommunications and information exchange between systems - LANs and MANs
ISO/IEC 9314-…	Information processing systems - Fibre Distributed Data Interface (FDDI)

DIN VDE …

DIN VDE 0100-540	Erection of power installations with nominal voltages up to 1000 V; selection and erection of equipment; earthing arrangements, protective conductors, equipotential bonding conductors

UL …

UL 508	Industrial Control Equipment; Standard for Saftey
UL 1604	Industrial Control Equipment for Use in Hazardous Locations
UL 60950	Saftey of Information Technology Equipment

Germanischer Lloyd …

Germanischer Lloyd	Klassifikations- und Bauvorschriften, VI-7-3-Teil 1

EIA/TIA

EIA/TIA-526-14	Optical Power Loss Measurement of Installed Multimode Fiber Cable Plan
EIA/TIA 568-B	Commercial Building Telecommunication Cabling Standard Part 1: General Requirements Part 2: Balanced Twisted-Pair Cabling Components Part 3: Optical Fiber Cabling Components Standard
EIA/TIA-606 A	Administration Standard for Commercial Telecommunications Infrastructureard
J-STD-607-A	Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

6.3 Selection of Request for Comments (RFC) Management

The Requests for Comments (RFC) document series is a set of technical and organizational notes about the Internet (originally the ARPANET). Memos in the RFC series discuss many aspects of computer networking, including protocols, procedures, programs, and concepts.

Overview and link to all RFCs

http://www.ietf.org (The Internet Engineering Task Force)
http://rfc.fh-koeln.de/doc/rfc/html/rfc.html

Standards and Protocols

RFC 768	User Datagram Protocol (UDP)
RFC 791	Internet Protocol DARPA Internet Program Protocol Specification (IP)
RFC 792	Internet Control Message Protocol DARPA Internet Program Protocol Specification (ICMP)
RFC 793	Transmission Control Protocol DARPA Internet Program Protocol Specification (TCP)
RFC 826	ETHERNET Address Resolution Protocol (ARP)
RFC 854	TELNET Protocol Specification
RFC 950	Internet Standard Subnetting Procedure
RFC 951	BOOTSTRAP PROTOCOL (BOOTP), updated by RFC 1395, RFC 1497, RFC 1532 and RFC 1542
RFC 1006	ISO Transport Service on top of the TCP Version: 3
RFC 1058	Routing Information Protocol (Updated by RFC 1388, RFC 1723)
RFC 1112	Host Extensions for IP Multicasting, updated by RFC 2236
RFC 1122	Requirements for Internet Hosts - Communication Layers

RFC 1256	ICMP Router Discovery Messages
RFC 1350	The TFTP Protocol (Revision 2)
RFC 1812	Requirements for IP Version 4 Routers
RFC 1990	The PPP Multilink Protocol (MP)
RFC 2131	Dynamic Host Configuration Protocol (DHCP)
RFC 2132	DHCP Options and BOOTP Vendor Extensions
RFC 2328	OSPF Version 2
RFC 2338	Virtual Router Redundancy Protocol
RFC 2453	RIP Version 2
RFC 2616	Hypertext Transfer Protocol - HTTP/1.1

Management

RFC 1155	Structure and Identification of Management Information for TCP/IP-based Internets (SMIv1)
RFC 1157	A Simple Network Management Protocol (SNMPv1)
RFC 1212	Concise MIB definitions (SNMPv1)
RFC 1213	MIB for Network Management of TCP/IP Based Internets (MIB II), updated by RFC 2011 … 2013
RFC 1493	Definitions of Managed Objects for Bridges (Bridge MIB)
RFC 1513	Token Ring Extensions to the Remote Network Monitoring MIB
RFC 1643	ETHERNET MIB
RFC 1716	Towards Requirements for IP Routers
RFC 1717	The PPP Multilink Protocol (MP)
RFC 1724	RIP Version 2 MIB Extension
RFC 1757	Remote Network Monitoring MIB (RMON)
RFC 1812	Requirements for IP Version 4 Routers

RFC 1850	OSPF Version 2 MIB
RFC 1901…1910	SNMP V2
RFC 1945	Hypertext Transfer Protocol - HTTP/1.0
RFC 2021	Remote Network Monitoring MIB Version 2 (RMON-2)
RFC 2037	Entity MIB using SMIv2
RFC 2068	Hypertext Transfer Protocol - HTTP/1.1
RFC 2096	IP Forwarding Table MIB
RFC 2131	Dynamic Host Configuration Protocol (DHCP)
RFC 2132	DHCP Options and BOOTP Vendor Extensions
RFC 2236	Internet Group Management Protocol, Version 2 (IGMPv2)
RFC 2239	802.3 MAU MIB
RFC 2570…2576	SNMP V3
RFC 2613	Remote Network Monitoring MIB Extensions for Switched Networks (SMON)
RFC 2674	Definitions of Managed Objects for Bridges with Traffic Classes, Multicast Filtering and Virtual LAN Extensions
RFC 2737	Entity MIB (Version 2)
RFC 2819	Remote Network Monitoring Management Information Base (RMON)

7 Cabling

7.1 European cabling standards

EN 50173 (1995)	Generic cabling systems
EN 50173-1	Generic cabling systems - General requirements and office areas
EN 50173-1 (200.)	- General requirements
EN 50173-2	- Office premises
EN 50173-3	Generic cabling systems - Industrial premises
EN 50173-4	Generic cabling systems - Homes
EN 50173-5	Generic cabling systems - Data centres
EN 50173-6	Generic cabling systems - Hospitals
EN 50173-7	Generic cabling systems - Airports

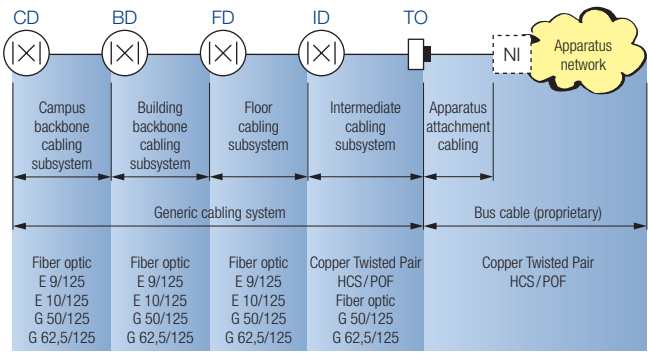
Applicable international standard: ISO/IEC 11801

7.2 European installation standards

EN 50174	Information technology - Cabling installation
EN 50174-1	Information technology - Cabling installation Specification and quality assurance
EN 50174-2	Information technology - Cabling installation Installation planning and practices inside buildings
EN 50174-3	Information technology - Cabling installation Installation planning and practices between buildings

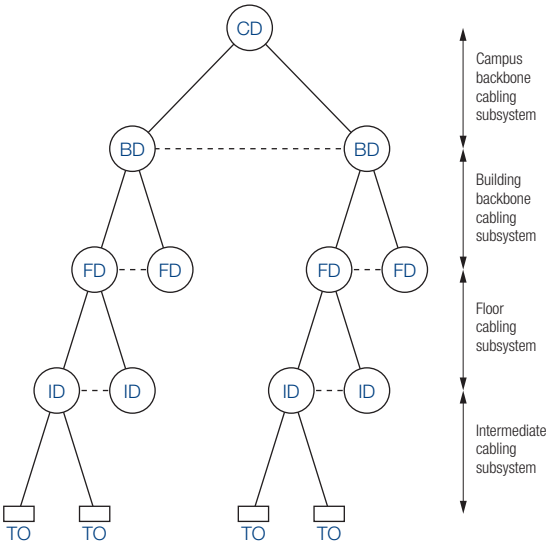
7.3 Cabling systems for any application

Industrial Premises, EN 50173-3 (draft)



CD = Campus Distributor
BD = Building Distributor
FD = Floor Distributor
ID = Intermediate Distributor
TO = Telecommunication Outlet
NI = Network Interface

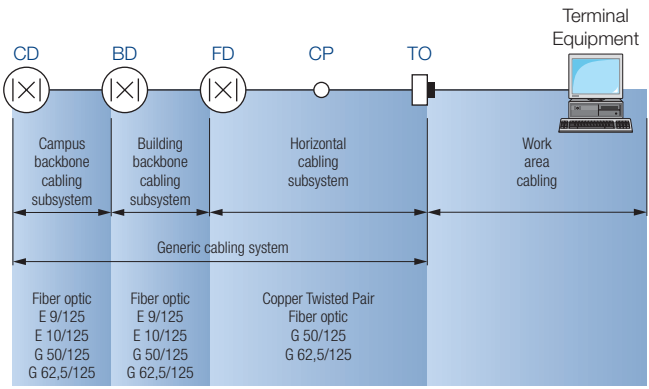
Structure of generic cabling in the industry



CD = Campus Distributor
BD = Building Distributor
FD = Floor Distributor
ID = Intermediate Distributor
TO = Telecommunication Outlet
NI = Network Interface

Hierarchical structure of generic cabling for industrial premises

Commercial Premises, EN 50173-1



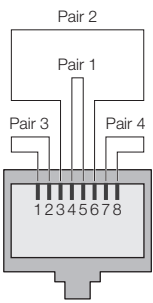
CD = Campus Distributor
BD = Building Distributor
FD = Floor Distributor
CP = Consolidation Point
TO = Telecommunication Outlet

Structure of generic cabling in the office

7.4 ETHERNET RJ45 Wiring Patterns

The eight position modular jack exists with different pin configurations, the EIA/TIA T568A and the EIA/TIA T568B. The Twisted Pair cable has to be terminated to an eight position modular jack and wired to one standard. The mainly used standard is EIA/TIA T568B, and the less common standard is EIA/TIA T568A (AT&T).

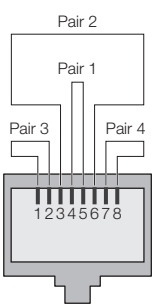
MDI (EIA/TIA T568A)



Socket

Pin	Wire color code	Assignment 10BASE-T, 100BASE-TX	Assignment 1000BASE-TX
1	WHT/GRN	Tx+	BI_DA+
2	GRN	Tx–	BI_DA–
3	WHT/ORG	Rx+	BI_DB+
4	BLU		BI_DC+
5	WHT/BLU		BI_DC–
6	ORG	Rx–	BI_DB–
7	WHT/BRN		BI_DD+
8	BRN		BI_DD–

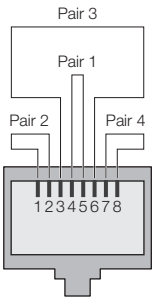
MDI-X



Socket

Pin	Wire color code	Assignment 10BASE-T, 100BASE-TX	Assignment 1000BASE-TX
1	WHT/ORG	Rx+	BI_DB+
2	ORG	Rx–	BI_DB–
3	WHT/GRN	Tx+	BI_DA+
4	BLU		BI_DD+
5	WHT/BLU		BI_DD–
6	GRN	Tx–	BI_DA–
7	WHT/BRN		BI_DC+
8	BRN		BI_DC–

MDI (EIA/TIA T568B)

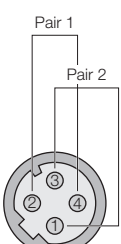


Socket

Pin	Wire color code	Assignment 10BASE-T, 100BASE-TX	Assignment 1000BASE-TX
1	WHT/ORG	Tx+	BI_DA+
2	ORG	Tx–	BI_DA–
3	WHT/GRN	Rx+	BI_DB+
4	BLU		BI_DC+
5	WHT/BLU		BI_DC–
6	GRN	Rx–	BI_DB–
7	WHT/BRN		BI_DD+
8	BRN		BI_DD–

Note: Other technologies like Token-Ring, FDDI etc. use another pin layouts.

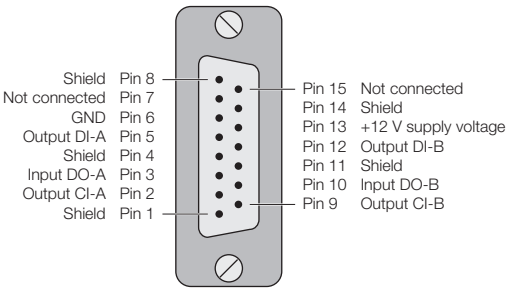
7.5 ETHERNET M12 Wiring Patterns



Pin	Wire color code	Assignment 10BASE-T, 100BASE-TX
1	BLU/YEL	Tx+
2	YEL/WHT	Rx+
3	WHT/ORG	Tx-
4	ORG/BLU	Rx-

D Key for Industrial ETHERNET (socket)

7.6 AUI Wiring Patterns



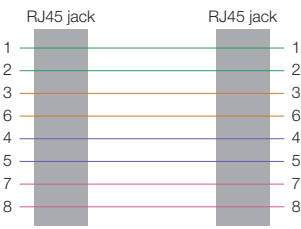
Pin assignment AUI Interface (plug)

7.7 ETHERNET RJ45 Cables

In ETHERNET networks there are two different patch cables, a straight through cable and a crossover cable.

Straight through or 1:1 patch cable

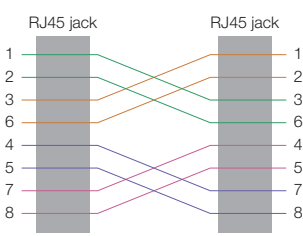
A straight through cable will be used to connect an ETHERNET switch to a computer's network adaptor.



Crossover cable

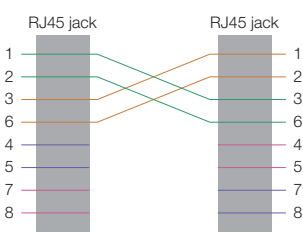
The crossover cable will be used to connect two ETHERNET switches together, or two computers together through their network adaptors.

10/100/1000 Mbps cable (fully crossed cable)



Note:
Suitable for all ETHERNET technologies

10/100 Mbps cable (partly crossed cable)

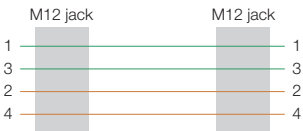


Note:
Not suitable for Gigabit ETHERNET, because this technology uses all pins.

7.8 ETHERNET M12/M12- and M12/RJ45 Cables

Straight through or 1:1 patch cable M12/M12

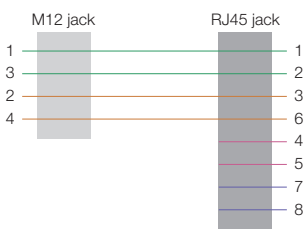
A straight through cable will be used to connect an ETHERNET-Switch with M12 socket to an other ETHERNET device with M12 socket.



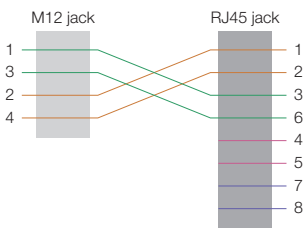
Patch cable M12/RJ45

A patch cable M12/RJ 45 will be used to connect an ETHERNET-Switch with M12 socket to an other ETHERNET device with RJ45 socket.

M12 to RJ45 MDI-X



M12 to RJ45 MDI



7.9 Application Classes for Balanced Copper Cabling Systems (100 Ω)

Application class	Frequency	Application	Cable	Validity
Class A	up to 100 kHz	Low frequency applications, e.g. Telephony, ISDN		Valid
Class B	up to 16 MHz	Medium bit rate data applications, e.g. e.g. Telephony, ISDN		Valid
Class C	up to 20 MHz	Data applications, e.g. Telephony, ISDN, Token Ring, ETHERNET	Cat 3	Valid
Class D	up to 100/125 MHz	Data applications, e.g. Telephony, ISDN, Token Ring, ETHERNET, Fast ETHERNET (Gigabit ETHERNET), FDDI, TPDDI, 100 VG Anylan	Cat 5	Valid
Class E	up to 250 MHz	Data applications, e.g. Telephony, ISDN, Token Ring, ETHERNET, Fast ETHERNET, Gigabit ETHERNET, FDDI, TPDDI, 100 VG Anylan, ATM In discussion: 10 Gbit ETHERNET, min. 55 m	Cat 6	Valid
Class F	up to 600 MHz	Data applications In discussion: 10 Gbit ETHERNET, min. 100 m	Cat 7	Valid
Class G	up to 1200 MHz	CATV applications (video) with max. 50 m cable length	Cat 8	Draft

7.10 Link Lengths for 10/100/1000/10000 Mbps ETHERNET

	Medium	Cable	Length [1]
ETHERNET	AUI		50 m
	10BASE2	Thin ETHERNET	185 m
	10BASE5	Thick ETHERNET	500 m
	10BASE-T	Twisted Pair	100 m
	10BASE-FL	62.5 µm, 50 µm Multi-mode OF	2000 m
Fast ETHERNET	100BASE-TX	Twisted Pair	100 m
	100BASE-FX	62.5 µm, 50 µm Multi-mode OF HDX	412 m
		62.5 µm, 50 µm Multi-mode OF FDX	2000 m
Gigabit ETHERNET	1000BASE-CX	Twinax STP, 150 Ω	25 m
	1000BASE-T	Twisted Pair, Cat. 5, 100 Ω	100 m
	1000BASE-SX 850 nm	62.5 µm Multi-mode OF	275 m
		50 µm Multi-mode OF	550 m
	1000BASE-LX 1310 nm	62.5 µm Multi-mode OF	550 m
		50 µm Multi-mode OF	550 m
		10 µm Single-mode OF	5000 m
10 Gigabit ETHERNET	10GBASE-LX4 WWDM	Single-mode OF	10000 m
	10GBASE-LX4 WWDM	Multi-mode OF	300 m
	10GBASE-SR/SW 850 nm	Multi-mode OF 50 µm 62.5 µm	82 m 26 m
	10GBASE-LR/LW 1310 nm	Single-mode OF	10000 m
	10GBASE-ER/EW 1550 nm	Single-mode OF	40000 m

[1] not less than that value

7.11 Large Core Fiber Specifications

Attenuation and modal bandwidth

Category	Maximum attenuation [dB/km]			Minimum modal bandwidth [MHz · km] (overfilled launch)		
	660 nm	850 nm	1300 nm	660 nm	850 nm	1300 nm
POF	200	–	–	1	–	–
HCS®	NA	10.0	10.0	–	5	5

Note: 520 nm in discussion

Classification

Category	Class	Type of fiber	Max. guaranteed transmission length
POF	OF 25	LCF-M1	25 m
POF	OF 50	LCF-M1	50 m
HCS®	OF 100	LCF-M2	100 m

Note: OF 25 and OF 200 in discussion

POF = Plastic Cladding Silica Fiber - Plastic fiber with a quartz glass core
HCS® = Hard Polymer Cladded Silica - Plastic fiber with a quartz glass core
LCF = Large Core Fiber
LCF-M1: POF (980/1000 µm) as A4d as IEC 60793-2-40
LCF-M2: POF (200/230 µm) as A3c as IEC 60793-2-30

7.12 Link specifications of glass fibers (Draft)

Attenuations and Bandwidts for Overfilled and Laser Launch

		Largest attenuation [dB/km]		Minimum band-width for overfilled launch [MHz · km]		Minimum band-width for eff. laser launch [MHz · km]
Fiber type	Core	850 nm	1300 nm	850 nm	1300 nm	850 nm
OM 1	50 µm 62.5 µm	3.5	1.5	200	500	Not specified
OM 2	50 µm 62.5 µm	3.5	1.5	500	500	Not specified
OM 3	50 µm	3.5	1.5	1500	500	2000

OM … = Optical Multi-mode fiber type …

Note: Fiber type OS 1 (Optical Single-mode): attenuation 1.0 dB/km at 1310 nm and 1550 nm.
Fiber type OS 2 (Optical Single-mode): attenuation 0.4 dB/km at 1310 nm and 1550 nm.

Channel Attenuation and Length

	Attenuation [dB]					Max. length [m]
	Multi-mode fiber (OM 1; OM 2, OM 3)			Single-mode fiber (OS 1, OS2)		
Class	660 nm	850 nm	1300 nm	1310 nm	1550 nm	
OF 50	18.0	–	–	–	–	50
OF 100	4.0	–	–	–	–	100
OF 300	–	2.55	1.95	1.80	1.80	300
OF 500	–	3.25	2.25	2.00	2.00	500
OF 2000	–	8.50	4.50	3.50	3.50	2000

In discussion OF 5000 und OF 10000 (only with fiber type OS 2)

Specification for 10 Mbps to 1 Gbps

	Fiber-type							
	OM 1		OM 2		OM 3		OS 1	
Application	850nm	1300nm	850nm	1300nm	850nm	1300nm	1310nm	1550nm
FOIRL	OF 2000		OF 2000		OF 2000			
10BASE-FL, -FP and -FB	OF 2000		OF 2000		OF 2000			
100BASE-FX		OF 2000		OF 2000		OF 2000		
1000BASE-SX	OF 300		OF 500		OF 500			
1000BASE-LX		OF 500		OF 500		OF 500	OF 2000	

Specification for 10 Gbps

	Fiber-type					
	OM 1		OM 2		OM 3	
Application	850nm	1300nm	850nm	1300nm	850nm	1300nm
10BASE-LX4		OF 300		OF 300		OF 300
10BASE-ER/EW						
10BASE-SR/SW					OF 300	
10BASE-LR/LW						

	Fiber-type			
	OS 1		OS 2	
Application	1310nm	1550nm	1310nm	1550nm
10BASE-LX4	OF 2000			
10BASE-ER/EW		OF 2000		OF 5000 OF 10000
10BASE-SR/SW				
10BASE-LR/LW	OF 2000		OF 5000 OF 10000	

7.13 Channel length equations

Glass fibers

		Implementation equations		
Multimode	**Class**	**Wavelength**		**Maximum length [m]**
OM 1/OM 2/OM 3		**850 nm**	**1300 nm**	
	OF 300	l = 735 – 214x – 90y	l = 1300 – 500x – 200y	300
	OF 500	l = 935 – 214x – 90y	l = 1500 – 500x – 200y	500
	OF 2000	l = 2435 – 214x – 90y	l = 3000 – 500x – 200y	2000
Singlemode		**1310 nm**	**1550 nm**	
OS 1	OF 300	l = 1800 – 750x – 300y	l = 1800 – 750x – 300y	300
	OF 500	l = 2000 – 750x – 300y	l = 2000 – 750x – 300y	500
	OF 2000	l = 3500 – 750x – 300y	l = 3500 – 750x – 300y	2000
OS2	OF 300	l = 1800 – 750x – 300y	l = 1800 – 750x – 300y	300
	OF 500	l = 2000 – 750x – 300y	l = 2000 – 750x – 300y	500
	OF 2000	l = 3500 – 750x – 300y	l = 3500 – 750x – 300y	2000
	OF 5000	l = 10000 – 1875x – 750y	l = 10000 – 1875x – 750y	5000
	OF 10000	l = 15000 – 1875x – 750y	l = 15000 – 1875x – 750y	10000

l = length of the channel [m]
x = total number of mated connections in the channel
y = total number of splices in the channel

Large Core Fibers

		Implementation equations		
Multimode	**Class**	**Wavelength**		**Maximum length [m]**
		660 nm	**850/1300 nm**	
POF	OF 25	l = 65 – 10x		25
	OF 50	l = 90 – 10x		50
HCS®	OF 100		l = 900 – 200x	100

l = length of the channel [m]

x = total number of mated connections in the channel

7.14 Ambient conditions in the MICE concept

The MICE classes

	Class		
	1 (light duty)	**2** (medium duty)	**3** (heavy duty)
Mechanical rating	M_1	M_2	M_3
Ingress rating	I_1	I_2	I_3
Climatic rating	C_1	C_2	C_3
Electromagnetic Rating	E_1	E_2	E_3

“Pure” classes

$M_1I_1C_1E_1$ = Office

$M_2I_2C_2E_2$ = Fitted in switch cabinet (light duty IP 20)

$M_3I_3C_3E_3$ = Fitted without switch cabinet (heavy duty IP 67)

“Mixed classes” - flexible adaptation to the anvironment

$M_2I_3C_3E_1$

Details of the MICE classes

Mechanical rating	**Class M 1**	**Class M 2**	**Class M 3**
Shock/bump Peak acceleration	40 ms^{-2}	100 ms^{-2}	250 ms^{-2}
Vibration Displacement amplitude (2-9 Hz) Acceleration amplitude (9-500 Hz)	1.5 mm 5 ms^{-2}	7.0 mm 20 ms^{-2}	15.0 mm 50 ms^{-2}
Tensile force	see IEC 61981 (in preparation)	see IEC 61981 (in preparation)	see IEC 61981 (in preparation)
Crush	45 N	1100 N	2200 N
Impact	1 J	10 J	30 J
Ingress rating	**Class I 1**	**Class I 2**	**Class I 3**
Particulate ingress (dia max.)	12,5 mm	50 µm	50 µm
Water ingress	non-protected	intermittent water jet	intermittent water jet and immersion
Climatic rating	**Class C 1**	**Class C 2**	**Class C 3**
Ambient temperature	-10 °C to +60 °C	-25 °C to +70 °C	-40 to +70 °C
Rate of change of temperature	0.1 °C per min	1.0 °C per min	3.0 °C per min
Humidity	5% to 85% non condensing	5% to 95% condensing	5% to 95% condensing

ffs = for further study

Details of the MICE classes (continuation)

Electromagnetic rating	Class E_1	Class E_2	Class E_3
Immunity against …			
Electrostatic discharge (ESD) Contact Air	 4 kV 8 kV	 4 kV 8 kV	 4 kV 8 kV
Electromagnetic field	3 V/m at 80-2000 MHz, 1 V/m at 2000-27000 MHz	3 V/m at 80-2000 MHz, 1 V/m at 2000-27000 MHz	10 V/m at 80-1000 MHz, 3 V/m at 1400-2000 MHz, 1 V/m at 2000-2700 MHz
Conducted Immunity	3 V at 0.15-80 MHz	3 V at 0.15-80 MHz	10 V at 0.15-80 MHz
Fast transients (burst) Power line	 500 V	 1000 V	 2000 V
Surge voltage Signal line: line/earth	 500 V	 1000 V	 1000 V

7.15 Data cables (copper) for industrial communication (IAONA PI V4)

Parameters	Values	Notes
Ambient temperature	0 °C to +55 °C	Installation > 5 °C
Storage temperature	-25 °C to +70°C	IEC 61131-2
Temperature shock	+5 °C to +55 °C, 3 °C/min	IEC 61131-2; test N b
Humidity (operating)	10 to 95 %, non condensing	IEC 60068-2-30, variante 2
Shock	15 g, 11 ms; acc. to EN 60068-2-27 or IEC 60068-2-27 criterion: no mechanical or functional changes	
Vibration	5 g at 10 to 150 Hz; acc. to EN 60068-2-6 or IEC 60068-2-6, criterion A	
Category (minimum requirement)	EN 50288-2-1 or IEC 61156, 100 MHz EN 50173-1 or ISO/IEC 11801, Cat. 5	
Electrical	ISO/IEC11801 Cat 5 minimum	
Permanent cabling		
Conductor cross section min./max.	AWG 24/1 to AWG 22/1 corresponding to 0.202 to 0.325 mm^2	
Max. cable length	100 m	Greater lengths are possible if the channel parameters are met by using better components
Shielding	Braided shielded and/or braided foiled shielded	Optional: individually screened

Parameters	Values		Notes
Flexible cabling			
Conductor cross section min./max.	AWG 26/7 to AWG 24/7 correspon-ding to 0.140 bis 0.226 mm ^{2}	AWG 22/7 ccorrespon-ding to 0.34 mm ^{2}	Conductors with higher strand count are allowed for greater cable flexibility
Max. cable length	Approx. 50 m for reliable operation	Up to 100 m for reliable operation	Greater lengths possible according to calculation
Chemical interference	Based on applicatin, e.g. resistant against oil, acid etc.		
Number of pairs	2 pairs: 10/100 Mps Ethernet	4 pairs: 10/100/1000 Mps Ethernet	
Minimum bending radius	According to EN 50173:2002 or ISO/IEC 11801		
Color codes	EIA/TIA 568-B		
Halogen free	IEC 60754-2, IEC 61034		
Shielding	Braided shielded and/or braided foiled shielded overall		Optional: individually screened and overall screened
Flame resistance	IEC 60332-1, EN 50265-2-1		

7.16 Cable sheath materials

	PVC (Polyvinyl chloride)	**FRNC** (Thermoplastic polyolefine)	**PE** (Polyethylene)	**PUR** (Polyurethane)
DIN VDE short designation	Y	H	2Y	11Y
Temperature limits	-40 °C to +115 °C	-25 °C to +70 °C	-35 °C to +85 °C	-40 °C to +85 °C
UV resistance	Yes	Yes	Yes	Yes
Flame resistance	Very good	Very good	No	Good
Halogen-free	No, fires generate toxicand corro-sive gases	Yes	Yes	Yes, halogens are added to low fire spreading PUR
Oil resistance	Good	No	Good	Very good
Chemical resistance	Good	No	Good	Very good
Wear resistance	Good	Low	Good	Very good
Food safety	No	No	yes	No
Water absorption	Low	High	Very low	Low
Outdoor laying	Yes	Yes, if inside protective PE tube	Yes	Yes
Typical use	For laying outdoors and mobile use	For fixed laying indoors and outdoors: for highest fire safety standards	For laying out-doors: suitable for the food and beverages industry	For use in cable guiding chains in very dirty conditions

8 Quick-Start for Hirschmann Products

Hirschmann Product	Login/ Password	IP Address
BAT 11b	admin/admin	BAT Discovery V2.25
BAT54/BAT54M	admin/private	192.168.1.1
EAGLE	admin/private root/root	HiDiscovery or webinterface
ETS 12/24	--/hirma www-login: admin / hirma	configuration --system
ETPS 22		
ETS 14/16/30/32 **FES 08/16**	admin/switch	BOOT IP
FEH 12	admin/--	Segment Configuration --IP Configuration
FEH 24	admin/hirma	--TCP/IP Parameters configuration --System Restart Setting
FES/GES	hirma www: set-/get-community	a. System Configuration Menu e. IP Address
Foundry Fastiron	-- www: login: set pwd: private	--conf t --interface ve 1 --ip addr 0.0.0.0/24
GES-24TP/PLUS	admin/private	=--Management Setup Menu --Network Configuration --IP Configuration
GRS	admin/--	vlan_1 --IP MASK CREATE

8 Quick-Start

SNMP Community	SNMP Traps	Save Config	Exit	Telnet	WWW	Terminal Cable 9600,8,N,1	Standard Communities ro/rw
–	–	–	–	–	+	–	–
webinterface	webinterface	save	exit	+	+	–	public/private
webinterface	webinterface	active immidiately	–	no, but ssh	https	MIKE	public/private
security --community access	configuration --traps --destination	configuration --config-files	# --EXIT	+	+	MIKE 9600boot/19200	public/service
SNMP CONFIG	SNMP CONFIG	BOOT UPDATE ALL	EXIT	+	–	DB9 Nullmodem f:f	public/private
SNMP Configuration --SNMP Communities	SNMP Configuration --IP Trap Managers	Segment Configuration --Save to EEPROM	Exit	–	+	DB9 1:1 Nullmodem f:f	public/private
SNMP Manager Configuration	SNMP Trap Manager Configuration	save	Logoff	+	+	DB9 1:1 f:m	public/private
a. System Configuration Menu a. SNMP Configuration Menu	a. System Configuration Menu a. SNMP Configuration Menu c. Trap Destination	g. Save Configuration	i. Logout	+	+	DB9 1:1 f:m	public/private
--conf t --snmp-serv comm <name> ro/rw	--conf t --snmp-serv host 0.0.0.0	write mem	exit	+	+	DB9 1:1 f:f	public/private
=--Management Setup Menu --SNMP Configuration --SNMP Communities	--Management Setup Menu --SNMP Configuration --IP Trap Managers	–	exit	+	+	Nullmodem	public/private
--ip --snmp --read-/write-community <User ID> {enable/disable}	--ip --snmp traphost <ipaddr> {community <community string> create/delete}	save [card:<filename>/ emm:<filename>]	exit	+	–	DB9 Nullmodem f:f	public/public

8 Quick-Start

8 Quick-Start for Hirschmann Products (continuation)

Hirschmann Product	Login/ Password	IP Address	SNMP Community	SNMP Traps	Save Config
LION-24 TP **GigaLION** **PowerLION**	admin/admin admin/private admin/private	configure interface vlan 1 ip address <A.B.C.D>	configure SNMP-Server community <string> ro/rw	configure SNMP-Server enable traps SNMP-Server host <A.B.C.D>	copy running-config startup-config
SmartLION	admin/private	Switch Configuration Administration Configuration IP Configuration	Protocol Related Configuration SNMP Configuration Community Strings	Protocol Related Configuration SNMP Configuration Trap Managers	Save Configuration
MACH 3000	private (public ro)	System Parameter --IP Address	=password	in HiVision -- Agent Configuration	Configuration --save/load config
MACH 4000 **MS20/ MS30** **Power MICE** **RS20/ RS30** **OCTOPUS-8M**	admin/private	# network protocol none # network parms <IP> <mask> <gateway>	<config>#snmp-server community <name>	<config>#snmptrap public <IP>	#copy s n
MICE **MS2108-2, MS3124-4**	admin/private (user/public ro)	System Parameter --IP Address	-password	in HiVision -- Agent Configuration	Configuration --save/load config
MICE **MS4128-5**	admin/private (user/public ro)	enable network protocol none network parms <A.B.C.D>	enable configure SNMP-Server community ro/rw <string>	enable configure SNMP-Server enable traps SNMPtrap public <A.B.C.D> SNMPtrap mode public <A.B.C.D>	"copy system: running-config NRAM: startup config"
MIKE	MIKE	configuration --system	security --community access	configuration --traps --destination	configuration --config-files
MultiMIKE	– –				
MR8/ESTP6	user/public	config --system --ip parameter	security --community access	security --traps	file --setup --save config
RMS	admin/hirma	--n --i	--n --s	--n --s	[RETURN] Quit With Saving
RS2	private (public ro)	System Parameter --IP Address	=password	in HiVision -- Agent Configuration	Configuration --save/load config
R-VIP T	no password	"i"	–	–	active immidiately

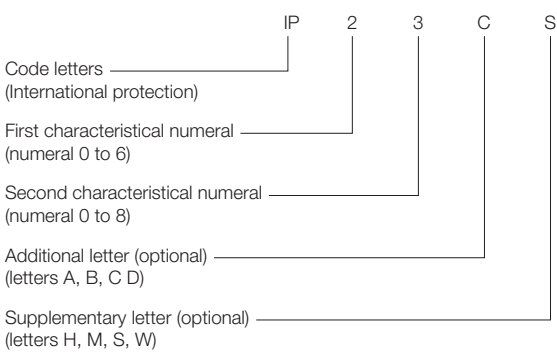
Exit	Telnet	WWW	Terminal Cable 9600,8,N,1	Standard Communities ro/rw
exit	+	+	Nullmodem	+/–
esc/logout	yes	yes	1:1	public/private
Main Menu --Logout	+	+	MIKE	public/private
exit/logout	yes	+	MIKE	public/private
Main Menu --Logout	–	+	MIKE	public/private
exit	+	+	Nullmodem f:f	public/private
# --EXIT	+	–	MIKE 9600boot/19200	public/service
file --exit	+	–	MIKE	public/service
--q	+	–	RJ11 auf DB9 (supplied with)	public/private
Main Menu --Logout	–	+	MIKE	public/private
–	–	+	19200, 8, N, 1	–

9 IP Code (Degrees of Protection)

The standard DIN EN 60529 ”Degrees of protection provided by enclosures (IP code)“ describes a system for classifying the degrees of protection provided by the enclosures of electrical equipment. It gives definitions for degrees of protection as regards:

- protection of persons against access to hazardous parts inside the enclosure
- protection of the equipment inside the enclosure against ingrees of solid foreign objects
- protection of the equipment inside the enclosure against harmful effects due to the ingress of water.

Arrangement of the IP code



Where a characteristic numeral is not required to be specified, it shall be replaced by the letter ”X“.
Additional letters and/or supplementary letters may be omitted without replacement.

Additional letters

are only used
- if the actual protection against to hazardous parts is higher than that indicated by the first characteristical numeral or
- if only the protection against access to hazardous parts is indicated, the first characteristic numeral being then replaced by an X.

Supplementary letters

In the relevant product standard, supplementary information may be indicated by a supplementary letter following the second characteristic numeral or the addtitional letter.

Example

An enclosure with the IP 23 CS IP-Code designation

2 - protects persons against access to hazardous parts with fingers
- protects the equipment inside the enclosure against ingress of solid foreign objects having a diameter of 12 mm and greater

3 - protects the equipment inside the enclosure against the harmful effects due to water sprayed against the enclosure

C - protects persons handling with tools having a diameter of 2.5 mm and greater and a length not exceeding 100 mm against access to hazardous parts

S - is tested for protection against harmful effects due to the ingress of water when all the parts of the equipment are stationary.

See also the following page for this.

Degrees of Protection

First characteristic numeral			Second characteristic numeral	
	Protection against acces to hazardous parts	**Protection against solid foreign objects**		**Protection against water**
0	Non-protected	Non-protected	**0**	Non-protected
1	With the back of the hand	Solid foreign objects of 50 mm Ø and greater	**1**	Protected against vertically falling water drops
2	With a finger or similar sized objects	Solid foreign objects of 12 mm Ø and greater	**2**	Protected against vertically falling water drops when enclosure tilted up to 15°
3	With a tool of 2.5 mm Ø and greater	Solid foreign objects of 2.5 mm Ø and greater	**3**	Protected against spraying water (at an angle up to 60° on either side of the vertical)
4	With a wire of 1 mm Ø and greater	Solid foreign objects of 1 mm Ø and greater	**4**	Protected against splashing water
5	With a wire of 1 mm Ø and greater	Dust-protected	**5**	Protected against water jets
6	With a wire of 1 mm Ø and greater	Dust-tight	**6**	Protected against powerful water jets
			7	Protected against temporary immersion of water
			8	Protected against continuous immersion of water
			9 K	Protected against powerful water jets 80 - 100 bar (cleaner)

Additional letters		Supplementary letters	
	Protection against acces to hazardous parts		**Supplementary information**
A	With the back of the hand	**H**	High-voltage apparatus
B	With a finger or similar sized objects	**M**	Tested to harmful effects due to the ingress of water when the movable parts of the equipment are in motion
C	With a tool of 2.5 mm Ø and greater	**S**	Tested to harmful effects due to the ingress of water when the movable parts of the equipment are stationary
D	With a wire of 1 mm Ø and greater	**W**	Suitable for use under specified weather conditions and provided with additional protective features or processes

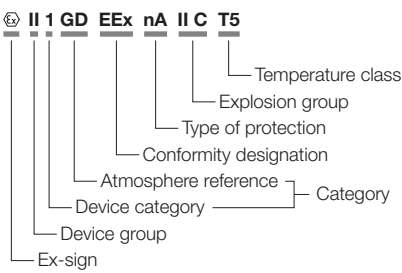
10 Explosion protection

Since June 1 2003, all devices and protection systems used in areas at risk of explosion must comply with the European Directive 94/9/EG (ATEX 95) (ATEX = Atmosphères Explosibles).

The European Union has thus created a basis for binding and consistent standards for character, installation and maintenance regarding explosion protection for systems, devices and components.

The systems, devices and components are labelled according to a standard pattern. The label shows which areas the devices and protection systems can be used in.

Example label
(See the following pages for an explanation))



Ex-sign	Explanation
	EC examination mark (zone 0, 1, 20 and 21) respectively Manufacturer's declaration (zone 2 and 22)

Device group	Explanation
I	Firedamp protection, mining safety
II	all other areas

Device category	Explanation
1	can be used in zones 0 or 20 (see below)
2	can be used in zones 1 or 21 (see below)
3	can be used in zones 2 or 22 (see below)

Zone		Probability of there being an explosive atmosphere containing dust or gas	Time in which there is an explosive atmosphere containing dust or gas
Gas	Dust		
0	20	Constantly, for lengthy periods, frequently, more often than not	>1000 h per year
1	21	Occasionally, during normal operation	10 - 1000 h per year
2	22	Rarely, briefly	<10 h per year

Atmosphere	Explanation
G	Gas
D	Dust

Category	Degree of protection	Protection guarantee	Operating conditions	Type test by designated authority
1G and 1D	Very high	Two errors may occur independently of each other	Devices remain in operation if there is an explosive atmosphere.	Required
2G and 2D	High	Suitable for normal operation and frequently expected faults. An error may occur.		Required
3G and 3D	Normal	Suitable for normal operation		Not required*

* Type test by designated authority is not required after standardization - manufacturer's declaration suffices.

Conformity designation	Explanation
EEx	Complies with the valid EN standards

Ignition protection	Explanation	Standard
o	Oil immersion	EN 50015/IEC 60079-6
p	Pressurisation	EN 50016/IEC 60079-2
q	Powder filling	EN 50017/IEC 60079-5
d	Pressure-proof housing	EN 50018/IEC 60079-1
e	Increased safety	EN/IEC 60079-7
i ia ib	Intrinsic safety - required for Zone 0 - adequate for Zone 1 (and 2)	EN 50020/IEC 60079-11
m	Encapsulation	
n nA nC nR nL nZ	Electrical equipment for zone 2 - non-sparking - protected contacts - vapour-proof housing - limited energy - n pressurisation	EN/IEC 60079-15

Explosion group (gas)	Explanation
I	Methane (mining)
II	Strip mining Subgroups: IIA Acetone, ammonia, ethyl alcohol, benzin, benzene, methane, propane, carbon monoxide, … IIB Ethylene, town gas, diethyl ether, … IIC Hydrogen, sulphurhydrocarbon, acetylene (ethyne), …

Temperature classes	Ignition temperature range of the mixtures	Permissible surface temperature of the electrical equipment
T1	> 450 °C	450 °C
T2	> 300 … 450 °C	300 °C
T3	> 200 … 300 °C	200 °C
T4	> 135 … 200 °C	135 °C
T5	> 100 … 135 °C	100 °C
T6	> 85 … 100 °C	85 °C

11 Popular Industrial Automation Protocols on ETHERNET

There is a clear trend in automation technology and process control towards open and transparent system solutions. These are increasingly based on control via PCs with intranet or internet access.
The most important standards are TCI/IP communications protocols and ETHERNET network structures. Many controllers, PLCs and distributed controller systems (DCS) already have an ETHERNET interface. Although the ETHERNET standard used in automation technology is the same as that used in offices, the requirements for network products are considerably different.
In common industrial applications the network is expected to operate reliably under extreme conditions such as electromagnetic interference, high operating temperatures and high mechanical load.
Now that ETHERNET has firmly established itself on the control level, it will continue to penetrate field applications. However, “hard” real time is now demanded of ETHERNET, and various manufacturers and bodies are working on a solution to this.

The following is a list of important manufacturers, associations and consortia working on a standard or recommendations for Realtime, ETHERNET and Industrial ETHERNET:

IEEE	**I**nstitute of **E**lectrical and **E**lectronics **E**ngineers, Inc.	http://www.ieee.org
IAONA	**I**ndustrial **A**utomation **O**pen **N**etworking **A**lliance	http://www.iaona.org
ODVA	**O**pen **D**eviceNet **V**endor **A**ssociation	http://www.odva.org
IDA	**I**nterface for **D**istributed **A**utomation	http://www.ida-group.org
PROFINET	Ethernet-based communication standard of the PROFIBUS user organization	http://www.ad.siemens.de/profinet
ETG	**E**therCAT **T**echnology **G**roup	http://www.ethercat.org

IGS	**I**nteressen**g**emeinschaft **S**ERCOS interface e.V	http://www.sercos.de
EPSG	**E**THERNET **P**owerlink **S**tandardization **G**roup	http://www.ethernet-powerlink.org
IEC	**I**nternational **E**lectrotechnical **C**ommission	http://www.iec.ch
ZVEI	**Z**entral**V**erband **E**lektrotechnik- und Elektronik**I**ndustrie e.V	http://www.zvei.org

Example: Realtime with industrial Ethernet

The EPSG is working on the technical development, propagation and standardization of real-time data transfer via Ethernet. This is all based on ETHERNET Powerlink and standards such as IEEE 1588. ETHERNET Powerlink provides the EPSG with a reliable real-time Ethernet technology which has been in use for over a year in industrial series applications. No other technology is anywhere near as mature or robust. The excellent system properties such as cross traffic, TCP/IP support and accuracy in the sub-microsecond range allow it to be used even in the most demanding real-time applications.

Main fatures:

- Deterministic operation
- Open standard
- No jitter <1 µs
- Cycle times <200 µs
- Configurable number of users
- Synchronisation of distributed users to <1 µs
- Transparent asynchronous access to all users with all standard protocols
- Founding companies: B&R, Hirschmann Automation and Control, Lenze, Kuka Roboter and the Zürcher Hochschule Winterthur

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