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Entwurf

**Elektronische Betriebsmittel für Bahnen –
Zug-Kommunikations-Netzwerk –
Teil 2-5: ETB – Ethernet Train Backbone
(IEC 9/1629/CDV:2012);
Englische Fassung FprEN 61375-2-5:2012**

Electronic railway equipment –
Train backbone –
Part 2-5: Ethernet Train Backbone
(IEC 9/1629/CDV:2012);
English version FprEN 61375-2-5:2012

Matériel électronique ferroviaire –
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Partie 2-5: Réseau de Train Ethernet
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Anwendungswarnvermerk

Dieser Norm-Entwurf mit Erscheinungsdatum 2012-11-26 wird der Öffentlichkeit zur Prüfung und Stellungnahme vorgelegt.

Weil die beabsichtigte Norm von der vorliegenden Fassung abweichen kann, ist die Anwendung dieses Entwurfes besonders zu vereinbaren.

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Gesamtumfang 100 Seiten

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Nationales Vorwort

Die Englische Fassung des europäischen Dokuments FprEN 61375-2-5:2012 „Elektronische Betriebsmittel für Bahnen – Zug-Kommunikations-Netzwerk – Teil 2-5: ETB – Ethernet Train Backbone“ (Entwurf in der Umfrage) ist unverändert in diesen Norm-Entwurf übernommen worden.

Die Internationale Elektrotechnische Kommission (IEC) und das Europäische Komitee für Elektrotechnische Normung (CENELEC) haben vereinbart, dass ein auf IEC-Ebene erarbeiteter Entwurf für eine Internationale Norm zeitgleich (parallel) bei IEC und CENELEC zur Umfrage (CDV-Stadium) und Abstimmung als FDIS (en: Final Draft International Standard) bzw. Schluss-Entwurf für eine Europäische Norm gestellt wird, um eine Beschleunigung und Straffung der Normungsarbeit zu erreichen. Dem entsprechend ist das internationale Dokument IEC 9/1629/CDV:2012 „Electronic railway equipment – Train backbone – Part 2-5: Ethernet Train Backbone“ unverändert in den Entwurf FprEN 61375-2-5:2012 übernommen worden.

Das internationale Dokument wurde vom TC 9X „Electrical and electronic applications for railways“ der Internationalen Elektrotechnischen Kommission (IEC) erarbeitet.

Bei der Abstimmung zu dem Europäischen Schluss-Entwurf bei CENELEC und dem Internationalen Schluss-Entwurf bei IEC [Final Draft International Standard (FDIS)] sind jeweils nur „JA/NEIN“-Entscheidungen möglich, wobei „NEIN“-Entscheidungen fundiert begründet werden müssen. Dokumente, die bei CENELEC als Europäische Norm angenommen und ratifiziert werden, sind unverändert als Deutsche Normen zu übernehmen.

Für dieses Dokument ist das nationale Arbeitsgremium UK 351.1 „Fahrzeuge“ der DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE (www.dke.de) zuständig.

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Es ist vorgesehen, auch bei der entsprechenden zukünftigen Deutschen Norm auf die deutsche Sprachfassung zu verzichten und diese in der englischsprachigen Fassung zu veröffentlichen. Da sich die Benutzer der Norm der englischen Sprache als Fachsprache bedienen, wird die Englische Fassung der IEC 61375-2-5 veröffentlicht. Zu deren Abschnitt 3, der die Abkürzungen und Begriffe festlegt, wird eine Übersetzung angefertigt und als informativer Nationaler Anhang NA der Norm hinzugefügt. Für viele der verwendeten Begriffe existieren keine gebräuchlichen deutschen Benennungen, da sich die deutschen Anwender in der Regel ebenfalls der englischen Benennungen bedienen. Diese Norm steht nicht in unmittelbarem Zusammenhang mit Rechtsvorschriften und ist nicht als Sicherheitsnorm anzusehen.

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

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Der Zusammenhang der zitierten Normen mit den entsprechenden Deutschen Normen ergibt sich, soweit ein Zusammenhang besteht, grundsätzlich über die Nummer der entsprechenden IEC-Publikation. Beispiel: IEC 60068 ist als EN 60068 als Europäische Norm durch CENELEC übernommen und als DIN EN 60068 ins Deutsche Normenwerk aufgenommen.

CONTENTS

1	Scope	8
2	Normative references.....	8
3	Definitions	9
3.1	Terms and definitions	9
3.2	Symbols and abbreviated terms	16
3.3	Conventions	17
4	ETB Physical layer.....	19
4.1	Train topology.....	19
4.2	Physical characteristics	19
4.3	Power Over Ethernet (PoE).....	29
4.4	ETB physical links redundancy.....	29
5	ETB Data Link layer	32
6	ETB Network layer : IPv4 subnets definition	35
6.1	IP mapping introduction	36
6.2	Topology	36
6.3	Network IP Address Map	37
6.4	Particular hosts IP address	44
6.5	Some use cases	46
6.6	Dynamic IP routing management	49
7	ETB Transport layer.....	51
8	ETB Train Inauguration : TTDP	52
8.1	Contents of this clause	52
8.2	Objectives and Assumptions	52
8.3	ETBN Settings.....	54
8.4	General Behaviour	55
8.5	ETBN Inauguration State Diagram	57
8.6	ETBN peers discovery	59
8.7	TTDP Messages Description.....	60
8.8	TTDP Data Structures.....	74
8.9	TTDP frame timing	79
8.10	Inauguration Train Application Interface	80
8.11	Degraded modes	80
8.12	Some Discovery Timing	82
9	ETB Train Topology Data Base	84
9.1	General	84
9.2	Consist Description Exchanges.....	84
9.3	Train Description Data	85
10	ETB ETBN Redundancy.....	85
11	ETB train naming convention	86
11.1	ETB Organic naming.....	86
11.2	ETB Functional addressing	89
12	ETB Quality of Services	89
12.1	Contents of this clause	89
12.2	Frame forwarding	89
12.3	Priority of inauguration frames	91

12.4	ETB Ingress Rate Limiting	91
12.5	ETB Egress Rate Shaping	91
13	ETB Data Classes	91
13.1	Process Data	92
13.2	Message Data	92
13.3	Stream Data	93
13.4	Best Effort Data	93
13.5	Supervisory Data	93
14	ETB Management and monitoring	93
15	ETB Application interface	94
15.1	Contents of this clause	94
15.2	Abstract Communication Model	94
15.3	ETB Process Data and Message Data Protocols	95
15.4	ETB Protocol Transparency	95
15.5	ETBN Interfaces	95
16	ETB Conformity Statement	97
Annex A Bibliography		98
A.1	IETF Request For Comments	98

Figures

Figure 1	ETB train topology	19
Figure 2	ETB Inter car at same potential	24
Figure 3	ETB Inter car not at the same potential	25
Figure 4	ETB Inter consist segment	28
Figure 5	PoE use cases	29
Figure 6	PoE PSE alternative A	29
Figure 7	Redundant train backbone topology	30
Figure 8	Link aggregation model	30
Figure 9	Link aggregation group	31
Figure 10	conversations over LAG	32
Figure 11	Hierarchical consist topology	36
Figure 12	"Closed Train"	37
Figure 13	"subnet id" with single Consist Network	40
Figure 14	"subnet id" with two single Consist Networks	40
Figure 15	Multiple Consist Networks, without fault tolerance	41
Figure 16	"subnet id" with ETBN redundancy	42
Figure 17	"subnet id" in multiple units with ETBN redundancy	42
Figure 18	IP train address space summary	43
Figure 19	Train composed of a single Consist Network	46
Figure 20	Train composed of two single Consist Networks	47
Figure 21	Train composed of single Consist Network with ETBN redundancy*	47
Figure 22	Train composed of two Consist Networks with ETBN redundancy*	48
Figure 23	Train with two Consist Networks in single Consist	48
Figure 24	ETBN top node reference	53
Figure 25	ETBN orientation capability	54
Figure 26	ETB switch in Passive Bypass Setting	55
Figure 27	ETB switch in Intermediate Setting	55
Figure 28	ETB switch in End Node Setting	55
Figure 29	ETBN Inauguration State Diagram	57
Figure 30	TTDP HELLO frame LLDP description	62
Figure 31	LLDP organizationally TLV	63
Figure 32	TTDP ETBNs wake up timing	82
Figure 33	TTDP ETBN failover timing	83
Figure 34	TTDP consist coupling timing	84
Figure 35	Example of ETBN IP routing table without redundancy	86
Figure 36	Example of ETBN IP routing table with redundancy	86
Figure 37	Mandatory ETB train domain definition	88
Figure 38	Abstract communication model for ETB communication	94

Tables

Table 1	ETB Intra Car Physical layer Interface.....	20
Table 2	ETB Inter Car Physical layer Interface.....	22
Table 3	ETB Inter Consist Physical layer Interface.....	26
Table 4	ETB Switch Data Link Layer Interface	32
Table 5	ETB OSI Network layer	35
Table 6	Train Subnet definition.....	38
Table 7	Train subnet decomposition	39
Table 8	Train IP group addresses reserved range.....	44
Table 9	ETBN, ETB IP address	45
Table 10	Hosts IP on train subnet.....	46
Table 11	Application ED Common Interface.....	51
Table 12	ETB switch Port States	54
Table 13	TTDP destination MAC addresses.....	62
Table 14	TTDP destination multicast address	62
Table 15	TTDP HELLO frame.....	63
Table 16	TTDP TOPOLOGY frame.....	66
Table 17	TTDP CSTINFO TLV Datagram.....	72
Table 18	Connectivity Vector	75
Table 19	Connectivity Vector Fields.....	75
Table 20	ETBN Vector.....	75
Table 21	ETBN Vector Fields	76
Table 22	Connectivity Table	77
Table 23	Connectivity Table fields	77
Table 24	Train Network Directory	78
Table 26	Train Network Directory fields	78
Table 27	ETB Switching Priorities.....	90
Table 28	DSCP field mapping.....	91
Table 29	Train Topology Discovery Object.....	95
Table 30	RFC References	98

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTRONIC RAILWAY EQUIPMENT –
TRAIN BACKBONE –**

Part 2-5: Ethernet Train Backbone

FOREWORD

INTRODUCTION

IEC 61375-2-5 defines the Ethernet Train Backbone so as to achieve interoperability between Consists of different types when coupled in the same train composition.

The document follows the ISO-OSI model and specifies the whole protocols stack from the physical layer up to the application layer.

A Protocol Implementation Conformance Statement (PICS) pro-forma shall be specified to allow suppliers to state their conformity to this standard. The PICS pro-forma specification and the related conformity test are not in the scope of this current document.

ELECTRONIC RAILWAY EQUIPMENT – TRAIN BACKBONE –

Part 2-5 : Ethernet Train Backbone

1 Scope

This part of IEC 61375 series of International Standards defines Ethernet Train Backbone (ETB) requirements to fulfil open train data communication system based on Ethernet technology.

Respect of this standard ensure interoperability between local consist subnets whatever consist network technology (see IEC 61375-1 for more details).

All consist network definitions shall take in account this current part to preserve interoperability.

This standard may be additionally applicable to closed trains and multiple unit trains when so agreed between purchaser and supplier.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61076-2-101 ed. 2.0 *Connectors for electronic equipment - Product requirements - Part 2-101: Circular connectors - Detail specification for M12 connectors with screw-locking.*

IEC 61156 *Multicore and symmetrical pair/quad cables for digital communications*

IEC 61375-1 *Electronic railway equipment – Train Communication Network – Part 1 :TCN - Train Communication Network - General Architecture*

IEC 61375-2-1 *Electronic railway equipment – Train Communication Network – Part 2.1: WTB - Wire Train Bus*

IEC 61375-2-3 *Electronic railway equipment – Train Communication Network – Part 2.3 – TCN - Communication Profile*

IEC 61375-3-4 *Electronic railway equipment – Train Communication Network – Part 3.4: ECN - Ethernet Consist Network*

IEC 61784-2 *Industrial communication networks - Profiles - Part 2: Additional fieldbus profiles for real-time networks based on ISO/IEC 8802-3*

IEC 61918 *Industrial communication networks – Installation of communication networks in industrial premises*

IEC 60571 *Electronic equipment used on rail vehicles*

IEEE 802.1AB *IEEE Standard for Local and metropolitan area networks - Station and Media Access Control Connectivity Discovery*

IEEE 802.1AX *IEEE Standard for Local and metropolitan area networks - Link Aggregation*

IEEE 802.1D *IEEE Standard for Local and metropolitan area networks - Media Access Control (MAC) Bridges*

IEEE 802.1Q *IEEE Standard for Local and metropolitan area networks - Virtual Bridged Local Area Networks*

IEEE 802.2 *IEEE Standard for Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 2: Logical Link Control*

IEEE 802.3 *IEEE Standard for Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*

ISO/IEC 7498 *Information Processing Systems – Open System Interconnection – Basic Reference Model.*

ISO/IEC 8824 (all parts) *Information technology – Abstract Syntax Notation One (ASN.1)*

ISO/IEC 9646 (all parts) *Information technology – Open Systems Interconnection – Conformance testing methodology and framework*

ISO/IEC 11801 *Information technology -- Generic cabling for customer premises*

ISO/IEC 61000-4-4 *Testing and measurement techniques - Electrical fast transient/burst immunity test. Basic EMC publication*

ISO/IEC 61000-4-6 *Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields*

UIC CODE 556 *Information transmission in the train (train-bus)*

3 Definitions

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1

Application Layer

upper layer in the OSI model, interfacing directly to the Application

3.1.2

Application Layer Interface

definition of the services offered by the Application Layer

3.1.3

Application process

an element within a real open system which performs the information processing for a particular application

3.1.4

bridge

device which stores and forwards frames from one bus to another on the base of their Link Layer addresses

3.1.5

broadcast

nearly simultaneous transmission of the same information to several destinations. Broadcast in the TCN is not considered reliable, i.e. some destinations may receive the information and others not

3.1.6

bus

communication medium which broadcasts the same information to all attached participants at nearly the same time, allowing all devices to obtain the same sight of its state, at least for the purpose of arbitration

3.1.7

closed train

train composed of one or a set of Consists, where the configuration does not change during normal operation, for instance metro, sub-urban train, or high speed train units.

3.1.8

communication devices

devices connected to Consist Network or Train Backbone with the ability to source and sink data.

3.1.9

composition

number and characteristics of the vehicles forming a train

3.1.10

configuration

definition of the topology of a network, the devices connected to it, their capabilities and the traffic they produce; by extension, the operation of loading the devices with the configuration information before going to regular operation

3.1.11

Consist

train set

rake of coaches

single vehicle or a group of vehicles which are not separated during normal operation. A Consist contains no, one or several Consist networks.

3.1.12**Consist Network (CN)**

communication network interconnecting communication devices in one Consist.

3.1.13**Consist network address**

network address, which does not change after inauguration and which is used to address communication device in the own consist network

3.1.14**Consist Switch (CS)**

Consist Network Node

Network component used in switched technologies (ECN, ETB). See “switch”.

3.1.15**consumer**

receiver of a message at the Transport Layer (see: Producer)

3.1.16**destination device**

receiver of a data packet (see: Source Device)

3.1.17**End Device (ED)**

unit connected to one Consist Network or to one set of Consist Networks prepared for redundancy reasons

3.1.18**end node**

Node which terminates the Train Backbone

3.1.19**function**

Application Process which exchanges messages with another Application Process

3.1.20**gateway**

connection between different communication technologies

3.1.21**group address**

address of a multicast group to which a device belongs

3.1.22**host**

Any addressable unit connected to the network : End Devices, Network Devices,...

3.1.23

inauguration

operation executed in case of composition change, which gives all Nodes of the Train Backbone their Train Backbone address, their orientation and information about all named Nodes on the same backbone

3.1.24

integrity

property of a system to recognize and to reject wrong data in case of malfunction of its parts

3.1.25

intermediate node

Node which establishes continuity between two bus sections connected to it, but does not terminate them

3.1.26

3.1.27

linear topology

topology where the nodes are connected in series, with two nodes each connected to only one other node and all others each connected to two other nodes (that is, connected in the shape of a line).

[IEC 61784-2]

3.1.28

Local Area Network

part of a network characterized by a common medium access and address space

3.1.29

Medium Access Control

sublayer of the Link Layer, which controls the access to the medium (arbitration, mastership transfer, polling)

3.1.30

medium

physical carrier of the signal: electrical wires, optical fibers, etc.

3.1.31

message

data item transmitted in one or several packets

3.1.32

Mobile Train Unit

part of a train which shall be uniquely addressable from ground. A mobile train unit provides one active mobile communication gateway for train to ground communication.

3.1.33

multicast

transmission of the same message to a group of receivers, identified by their Group Address. The word "multicast" is used even if the group includes all receivers

3.1.34**network**

set of possibly different communication systems which interchange information in a commonly agreed way

3.1.35**network address**

address which identifies a communication device on network layer.

3.1.36**Network Device (ND)**

components used to set up Consist Networks and Train Networks. These may be passive components like cables or connectors, active unmanaged components like repeaters, media converters or (unmanaged) switches, or active managed components like gateways, routers and (managed) switches.

3.1.37**network layer**

layer in the OSI model responsible for routing between different busses

3.1.38**network management**

operations necessary to remotely configure, monitor, diagnose and maintain the network

3.1.39**node**

Device on the Train Backbone, which may act as a gateway between Train Backbone and Consist Network

3.1.40**octet**

byte

8-bit word stored in memory or transmitted as a unit

3.1.41**open train**

a train composed of a set of Consists, where the configuration may change during operation, for instance international trains

3.1.42**operator**

enterprise or organization which is operating trains.

3.1.43**packet**

unit of a message (information, acknowledgement or control) transmitted by protocols on network or transport layer.

3.1.44**Producer**

sender of a message at the Transport Layer (see: Consumer)

3.1.45

Publisher

source of a Dataset for broadcasting (see: Subscriber)

3.1.46

receiver

electronic device which may receive signals from the physical medium

3.1.47

repeater

connection at the Physical Layer between bus segments, providing an extension of the bus beyond the limits permitted by passive means. The connected segments operate at the same speed and with the same protocol. The delay introduced by a repeater is in the order of one bit duration

3.1.48

residual error rate

probability of integrity breach (unrecognized wrong bit) per transmitted bit

3.1.49

ring topology

active network where each node is connected in series to two other nodes

[IEC 61918]

NOTE - Ring may also be referred to as loop.

3.1.50

router

connection between two busses at the Network Layer, which forwards datagrams from one bus to another on the base of their Network Address

3.1.51

service

capabilities and features of a sub-system (e.g. a communication layer) provided to a user

3.1.52

Sleep mode

Feature of an end node to be in an inactive activity in order to have a reduced power supply consumption.

3.1.53

sporadic data

transmission of data on a demand basis

3.1.54

subscriber

one of the sinks of a broadcast Dataset (see: Publisher)

3.1.55**switch**

MAC bridge as defined in IEEE 802.1D

3.1.56**topography**

data structure describing the Nodes attached to the Train Backbone, including their address, orientation, position and Node Descriptor

3.1.57**topology**

possible cable interconnection and number of devices a given network supports

3.1.58**topography counter**

counter in a Node which is incremented at each new Inauguration

3.1.59**Train Communication Network**

data communication network for connecting programmable electronic equipment on-board rail vehicles

3.1.60**Train Backbone**

bus connecting the vehicles of a train and which conforms to the TCN protocols

3.1.61**Train Backbone Node**

node device on the Train Backbone which receives a train backbone node number during inauguration. A train backbone node can be used to connect an End Device or a Consist Network to the Train Backbone.

3.1.62**train backbone node number**

node address

node number

Each train backbone node is assigned a number during inauguration, which indicates the position of the train backbone node on the Train Backbone.

3.1.63**train network address**

dynamic address containing the train backbone node number, which is used to address communication devices in other consist networks. This address can change after each inauguration.

3.1.64**Train Network Management**

services of the Network Management for TCN

3.1.65**Wake-up**

Ability for an end node to transit on events from sleep mode to inauguration/normal mode

3.1.66**Transport Layer**

layer of the OSI model responsible for end-to-end flow control and error recovery

3.2 Symbols and abbreviated terms

ANSI	American National Standard Institute, a standardization body in the United States
ALG	Application Layer Gateway
BER	Bit Error Rate, the rate of bit errors in a data stream, mainly caused by noise (random bit errors), but also caused by memory defects in data storing devices (systematic bit errors).
BR	Bit Rate, the rate of data throughput on the medium expressed in bits per second (bit/s) or in hertz (Hz), whichever is appropriate
CAN	Controller Area Network
CLS	Consist Ladder Switch
CN	Consist Network
CPS	Communication Protocol Stack
CRC	Cyclic Redundancy Check, a data integrity check based on polynomial division
CRS	Consist Ring Switch
CS	Consist Switch
DDS	Data Distribution Services
DIN	Deutsches Institut für Normung, the German national standardization body
ECN	Ethernet Consist Network
ED	End Device
EIA	Electronics Industries Association, a standardization body in the United States
ETB	Ethernet Train Backbone
ETBN	Ethernet Train Backbone Node (specialized TBN using Ethernet technology on backbone network side).
FLR	Frame Loss Rate : see IETF RFC 2544 for definition
IEC	International Electrotechnical Commission, Geneva
IEEE	Institute of Electrical and Electronics Engineers, New York
IETF	Internet Engineering Task Force
ISO	International Standard Organization, Geneva
ITU	International Telecommunication Union, the international standardization body for telecommunications based in Geneva
LAG	Link Aggregation Group
MAC	Medium Access Control, a sub-layer within the Link Layer ruling which device is entitled to send on the bus

MCG	Mobile Communication Gateway
MDI	Media Dependent Interface
MTU	Mobile Train Unit
MVB	Multifunction Vehicle Bus
ND	Network Device
OSI	Open System Interconnection, a universal communication model defined in the ISO/IEC 7498
PCS	Physical Coding Sublayer
PCTR	Protocol Conformance Test Report, defined in ISO/IEC 9646
PD	Powered Device (about PoE)
PICS	Protocol Implementation Conformance Statement, defined in ISO/IEC 9646
PMA	Physical Medium Attachment
PMD	Physical Medium Dependent
PoE	Power Over Ethernet, norm IEEE 802.3 clause 33
PSE	Power Source Equipment (about PoE)
RFC	Request For Comments, Internet Standard published by IETF
RTPS	Real-Time Publish-Subscribe
TBN	Train Backbone Node, generic name of a node connect to the train backbone independently of technology used.
TCN	Train Communication Network, a set of communicating vehicle and Train Backbones
TLV	Type/Length/Value
TTDP	Train Topology Discovery Protocol
UIC	International Union of Railways, the international railways operators association
URI	Uniform Resource Identifier
UML	Unified Modeling Language
VLAN	Virtual Local Area Network
WTB	Wire Train Bus

3.3 Conventions

3.3.1 Requirement conventions

Shall and **must** are used to describe mandatory requirements.

Should is used to describe highly recommended requirements.

May is used to describe acceptable features.

Could is used to describe possible ways.

3.3.2 Base of numeric values

This standard uses a decimal representation for all numeric values unless otherwise noted.

Analog and fractional values include a comma.

EXAMPLE – The voltage is 20,0 V.

Binary and hexadecimal values are represented using the ASN.1 (ISO/IEC 8824) convention.

EXAMPLE – Decimal 20 coded on 8 bits = '0001 0100'B = '14'H

3.3.3 Naming conventions

Keywords are written with a capital letter at the beginning.

If the keyword name is composed, the different parts of the name are united with a space, and all parts are beginning with a capital letter.

EXAMPLES – “Train Backbone”, “Consist”, “Consist Network”

Parameters are written with a capital letter at the beginning.

If the parameter name is composed, the different parts of the name are united without a space, and all parts are beginning with a capital letter.

EXAMPLE – “NumberOfConsists”

3.3.4 State diagram conventions

State diagrams are defined following the notation of UML state machines

4 ETB Physical layer

4.1 Train topology

ETB use physical links along the train to connect the active network devices together (ETBN, Repeater, ...). These links are also called physical segments, and shall use passive components as cables and connectors, dedicated to Ethernet.

Along the train, three regions shall be distinguished for the ETB network (see Figure 1 ETB train topology) :

- **Intra Car** : Passive components (cabling) and active network devices inside a car (or locomotive, etc...).
- **Inter Car** : Passive components (cabling) at the interface between 2 cars. This category refers also to optional active network devices outside the car (like under body, etc...).
- **Inter Consist** : Passive components (cabling) at the interface between 2 consists using a manual coupler, or auto coupler. This category refers also to optional active network devices outside the car.

These regions are characterized with a different train context and environment (mechanical, thermal, EMC, etc...). In consequence the cabling, composed of cables and connectors, shall be different on these 3 regions.

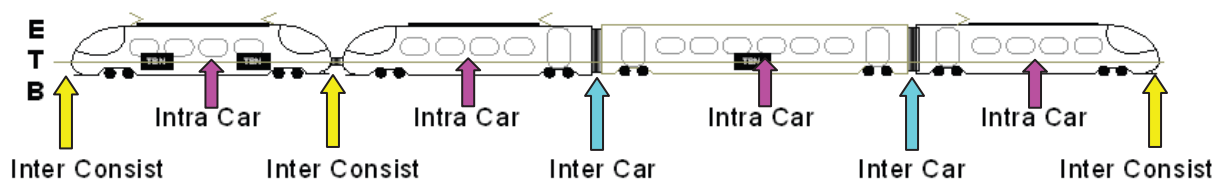


Figure 1 ETB train topology

4.2 Physical characteristics

Following tables summarizes network physical layer requirements for passive components (cables and connectors) and active network devices (ETBN, Repeater,...) depending of the 3 regions defined.

4.2.1 Intra Car physical layer

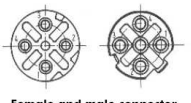
(M : Mandatory, O : Optional, C : Conditional, X : Prohibited)

The table below defines the physical layer requirements.

Table 1 ETB Intra Car Physical layer Interface

ETB Intra Car Physical layer Interface										
OSI Layers	Requirements	Type	Description							
<table><tr><td>Application</td></tr><tr><td>Presentation</td></tr><tr><td>Session</td></tr><tr><td>Transport</td></tr><tr><td>Network</td></tr><tr><td>Data</td></tr><tr><td>Physical</td></tr></table>	Application	Presentation	Session	Transport	Network	Data	Physical	100 BASE TX Physical Layer Coding, Medium attachment and Medium Dependent Access (PCS, PMA, PMD) for Copper cables	M	Conformance to norm IEEE 802.3 clauses 24 and 25
	Application									
	Presentation									
	Session									
	Transport									
	Network									
	Data									
Physical										
Full Duplex Mode	M	Conformance to norm IEEE 802.3 clause 25 Bidirectional data flow at the same time on TX and RX double pair Ethernet								
Physical Layer auto-Negotiation	X	Conformance to norm IEEE 802.3 clause 28 Prohibited on the ETB backbone.								
Physical Layer crossover	M	Conformance to norm IEEE 802.3 clause 25.4.7 Just one crossover shall be made on a link between 2 ports (ETBN,...)								
Physical layer auto-polarity/auto-sensing	X	Prohibited due to fixed cabling, and non normalized solution								
By-pass relay on ETBN ports	M	If ETB switch is out of order (e.g. powerless) train backbone ports are bypassed								
Power over Ethernet (PoE)	O	Conformance to norm IEEE 802.3 clause 33 Called also: Data terminal equipment (DTE) Power via Medium Dependent Interface (MDI) PSE or PD mode supported See chapter 4.3 for more details.								

Table 1 continued. ETB Intra Car Physical layer Interface

ETB Intra Car Physical layer Interface																							
OSI Layers	Requirements	Type	Description																				
	Connector for active Network Devices M12 D coded	M	Crimped contacts recommended Female connector on active network device, male connector on train cable Conformance to norm IEC 61076-2-101, which define the pin out: <table border="1"> <thead> <tr> <th>Signal</th><th>Function</th><th>Cable wire colour</th><th>M12 D-coding contact number</th></tr> </thead> <tbody> <tr> <td>TD+</td><td>Transmission Data +</td><td>Yellow</td><td>1</td></tr> <tr> <td>TD-</td><td>Transmission Data -</td><td>Orange</td><td>3</td></tr> <tr> <td>RD+</td><td>Receiver Data +</td><td>White</td><td>2</td></tr> <tr> <td>RD-</td><td>Receiver Data -</td><td>Blue</td><td>4</td></tr> </tbody> </table>  Female and male connector	Signal	Function	Cable wire colour	M12 D-coding contact number	TD+	Transmission Data +	Yellow	1	TD-	Transmission Data -	Orange	3	RD+	Receiver Data +	White	2	RD-	Receiver Data -	Blue	4
Signal	Function	Cable wire colour	M12 D-coding contact number																				
TD+	Transmission Data +	Yellow	1																				
TD-	Transmission Data -	Orange	3																				
RD+	Receiver Data +	White	2																				
RD-	Receiver Data -	Blue	4																				
	Connector for interior cabling (between walls, cabinets, container...)	O	Ethernet circular cell arranged in a quartet distribution. Pin out distribution identical to M12: TD+: Contact 1, TD-: Contact 3 RD+: Contact 2, RD-: Contact 4																				
	Cables class D CAT5e	M	Conformance to norm ISO/IEC 11801, IEC 61156 Shielded Twisted Pair (STP) For information only: Gauge recommended is 0,5mm² (AWG20), 0,34mm² (AWG22), or 0,25mm² (AWG24)																				
	Cabling performance	M	-EMC immunity ISO/IEC 61000-4-4 fast transient burst >2KV, ISO/IEC 61000-4-6 RF field; Criteria acceptance type A : During test, Frame Loss Rate (FLR) must be below a trigger value. To be defined depending of application. - Ethernet Certification compliant to norm ISO/IEC 11801 (conformance test category) ▪ Cables shall be compliant with clause 9 ▪ Connectors shall be compliant with clause 10 ▪ Channel shall be compliant with clause 6 Channel comprises passive sections of cable, connecting hardware, work area cords, equipment cords and patch cords.																				

It has to be noted that the number of connectors on an Ethernet physical segment and the length of the cable is not indicated in the table. Instead, a minimum requirement of electric performance and compliance to the norm IEC 11801 is defined. It means, that the electric parameters of a cabling depends not only the number of connectors and the cable length, but also of some more complex parameters like shield, type of connectors, quality of cabling, installation,... As a consequence, it is proposed a global concept of verification in being compliant to the electric Ethernet parameters IEC 11801.

Inside a car, all shields of cables and connectors shall be connected to the mechanical earth of the car. To prevent EMC influences, a cable shield shall be connected on a 360° circular basis in the connector.

4.2.2 Inter Car physical layer

(M : Mandatory, O : Optional, C : Conditional, X : Prohibited)

The table below defines the physical layer requirements.

Table 2 ETB Inter Car Physical layer Interface

ETB Inter Car Physical layer Interface										
OSI Layers	Requirements	Type	Description							
<table><tr><td>Application</td></tr><tr><td>Presentation</td></tr><tr><td>Session</td></tr><tr><td>Transport</td></tr><tr><td>Network</td></tr><tr><td>Data</td></tr><tr><td>Physical</td></tr></table>	Application	Presentation	Session	Transport	Network	Data	Physical	100 BASE TX Physical Layer Coding, Medium attachment and Medium Dependent Access (PCS, PMA, PMD) for Copper cables	M	Conformance to norm IEEE 802.3 clauses 24 and 25
	Application									
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	Session									
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Network										
Data										
Physical										
Full Duplex Mode	M	Conformance to norm IEEE 802.3 clause 25 Bidirectional data flow at the same time on TX and RX double pair Ethernet								
Physical Layer auto-Negotiation	X	Conformance to norm IEEE 802.3 clause 28. Prohibited on the ETB backbone								
Physical Layer crossover	M	Conformance to norm IEEE 802.3 clause 25.4.7 Just one crossover shall be made on a link between 2 ports (ETBN,...)								
Physical layer auto-polarity/auto-sensing	X	Prohibited due to fixed cabling, and non normalized solution								

Table 2 continued- ETB Inter Car Physical layer Interface

ETB Inter Car Physical layer Interface			
OSI Layers	Requirements	Type	Description
	Power over Ethernet (PoE)	O	IEEE 802.3 clause 33 Called also: Data terminal equipment (DTE) Power via Medium Dependent Interface (MDI) PSE or PD mode supported. See chapter 4.3 for more details.
	Connector for inter car	O	Ethernet circular cell arranged in a quartet. Pin out distribution identical to M12: TD+: Contact 1, TD-: Contact 3 RD+: Contact 2, RD-: Contact 4
	Cables class D CAT5e	M	ISO/IEC 11801, IEC 61156 Shielded Twisted Pair (STP) For information only: Gauge recommended for wire is minimum 0,5mm ² (AWG20), or a higher surface (mm ²) due to mechanical constraints
	Cabling performance	M	-EMC immunity ISO/IEC 61000-4-4 fast transient burst >2KV, ISO/IEC 61000-4-6 RF field; Criteria acceptance type A : During test, Frame Loss Rate (FLR) must be below a trigger value. To be defined depending of application. - Ethernet Certification compliant to norm ISO/IEC 11801 (conformance test category) ▪ Cables shall be compliant with clause 9 ▪ Connectors shall be compliant with clause 10 ▪ Channel shall be compliant with clause 6 Channel comprises passive sections of cable, connecting hardware, work area cords, equipment cords and patch cords.

It has to be noted that the number of connectors on an Ethernet physical segment and the length of the cable is not indicated in the table. Instead, a minimum requirement of electric performance and compliance to the norm IEC 11801 is defined. It means, that the electric parameters of a cabling depends not only the number of connectors and the cable length, but

also of some more complex parameters like shield, type of connectors, quality of cabling, installation,... As a consequence, it is proposed a global concept of verification in being compliant to the electric Ethernet parameters IEC 11801.

Two use cases have to be considered:

- The two adjacent cars are at the same potential
- The two adjacent cars are at a different potential

4.2.2.1 Inter Car at same potential

A braid connects two adjacent cars which therefore are at the same potential. The Ethernet shield shall have the continuity from car N to car N+1; no interruption of shielding shall be necessary.

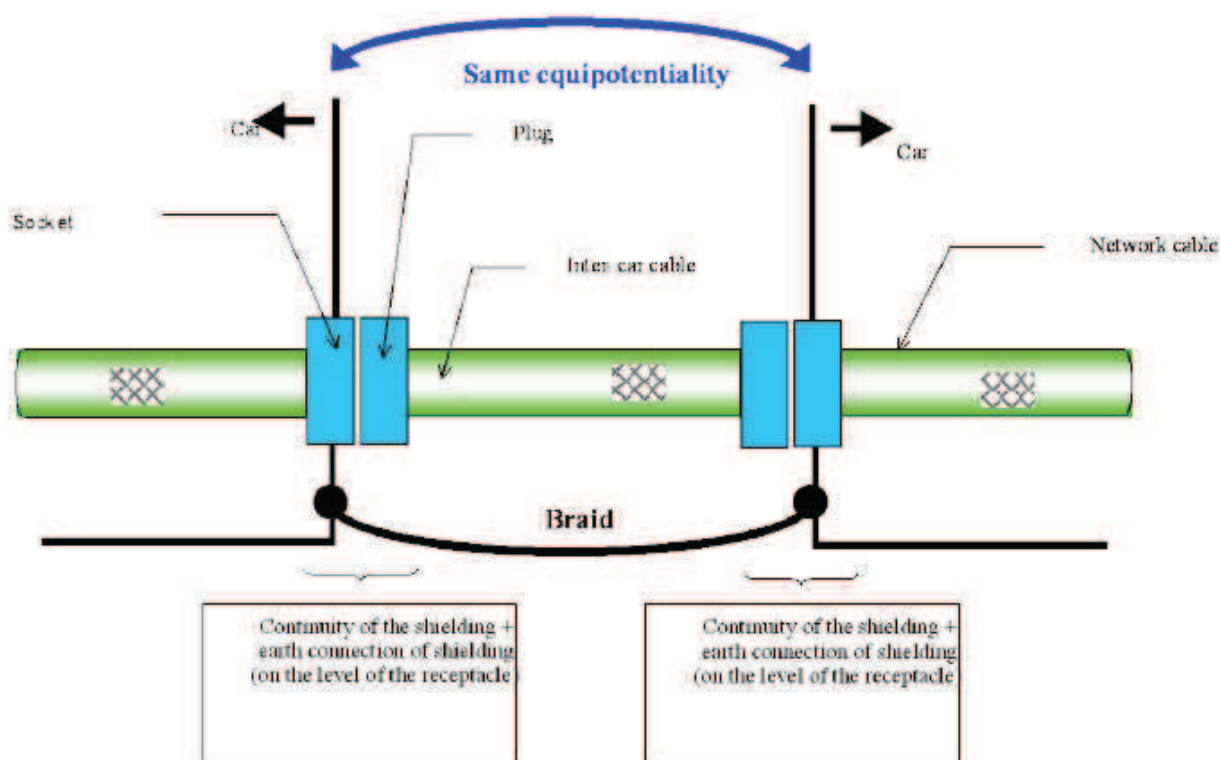


Figure 2 ETB Inter car at same potential

4.2.2.2 Inter Car not at the same potential

In some cases, the inter car cannot be at the same potential: Refurbishment, etc... Therefore, the Ethernet cable shield has to be interrupted to avoid ground current flowing between cars.

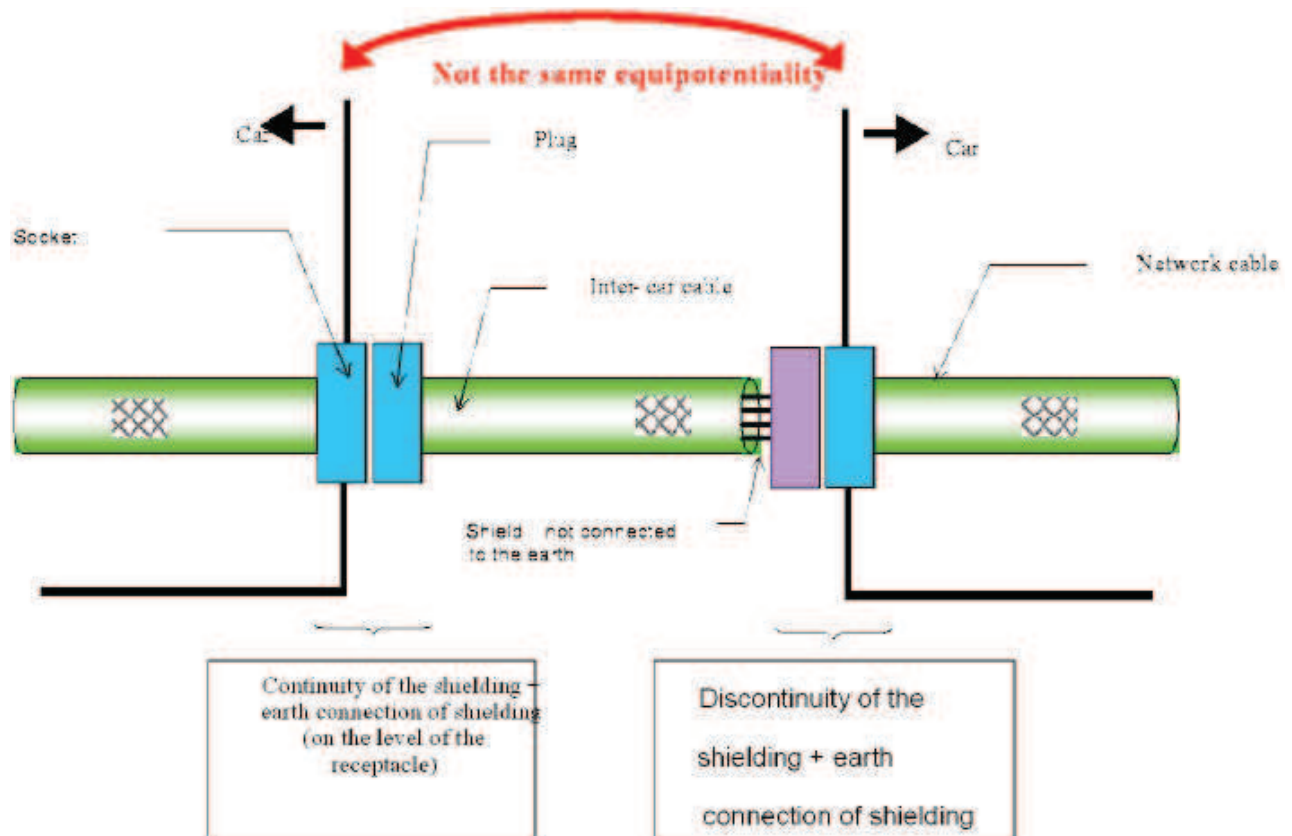


Figure 3 ETB Inter car not at the same potential

Note : The implementation of the shielding solution is not in the scope of this specification.

4.2.3 Inter Consist physical layer

(M : Mandatory, O : Optional, C : Conditional, X : Prohibited)

The table below defines the physical layer requirements.

Table 3 ETB Inter Consist Physical layer Interface

ETB Inter Consist Physical layer Interface										
OSI Layers	Requirements	Type	Description							
<table><tr><td>Application</td></tr><tr><td>Presentation</td></tr><tr><td>Session</td></tr><tr><td>Transport</td></tr><tr><td>Network</td></tr><tr><td>Data</td></tr><tr><td>Physical</td></tr></table>	Application	Presentation	Session	Transport	Network	Data	Physical	100 BASE TX Physical Layer Coding, Medium attachment and Medium Dependent Access (PCS, PMA, PMD) for Copper cables	M	Conformance to norm IEEE 802.3 clauses 24 and 25
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Full Duplex Mode	M	Conformance to norm IEEE 802.3 clause 25 Bidirectional data flow at the same time on TX and RX double pair Ethernet								
Physical Layer auto-Negotiation	X	Conformance to norm IEEE 802.3 clause 28. Prohibited on the ETB backbone								
Physical Layer crossover	M	Conformance to norm IEEE 802.3 clause 25.4.7 Just one crossover shall be made on a link between 2 ports (ETBN,...) Straight (MDI) on the male connector auto coupler side, crossover (MDI-X) on the female connector auto coupler side								
Physical layer auto-polarity/auto-sensing	X	Prohibited due to fixed cabling, and non normalized solution								
Power over Ethernet (PoE)	O	IEEE 802.3 clause 33 Called also: Data terminal equipment (DTE) Power via Medium Dependent Interface (MDI) PSE or PD mode supported. See chapter 4.3 for more details.								

Table 3 continued- ETB Inter Consist Physical layer Interface

ETB Inter Consist Physical layer Interface			
OSI Layers	Requirements	Type	Description
	Connector for inter consist	O	Ethernet circular cell arranged in a quartet. Pin out distribution identical to M12 : TD+: Contact 1, TD-: Contact 3 RD+: Contact 2, RD-: Contact 4
	Cables class D CAT5e	M	ISO/IEC 11801, IEC 61156 Shielded Twisted Pair (STP) For information only: Gauge recommended for wire is minimum 0,5mm² (AWG20), or a higher surface (mm²) due to mechanical constraints
	Cabling performance	M	-EMC immunity ISO/IEC 61000-4-4 fast transient burst >2KV, ISO/IEC 61000-4-6 RF field; Criteria acceptance type A : During test, Frame Loss Rate (FLR must be below a trigger value. To be defined depending of application. - Ethernet Certification compliant to norm ISO/IEC 11801 (conformance test category) ▪ Cables shall be compliant with clause 9 ▪ Connectors shall be compliant with clause 10 ▪ Channel shall be compliant with clause 6 Channel comprises passive sections of cable, connecting hardware, work area cords, equipment cords and patch cords.
	Consist orientation Reversing	C	Refers to the change of orientation of a consist In case to support consist orientation reversing, the Ethernet link between ETBNs shall be doubled in order to manage the consist reversing.

It has to be noted that the number of connectors on a physical Ethernet segment and the length of the cable is not indicated in the table. Instead, a minimum requirement of electric performance and compliance to the norm IEC 11801 is defined. It means, that the electric parameters of a cabling depends not only the number of connectors and the cable length, but also of some more complex parameters like shield, type of connectors, quality of cabling.

installation,... As a consequence, it is proposed a global concept of verification in being compliant to the electric Ethernet parameters IEC 11801.

Typically, the same potential between 2 consists cannot be assured. In this case, the interruption of the Ethernet cable shield shall be required.

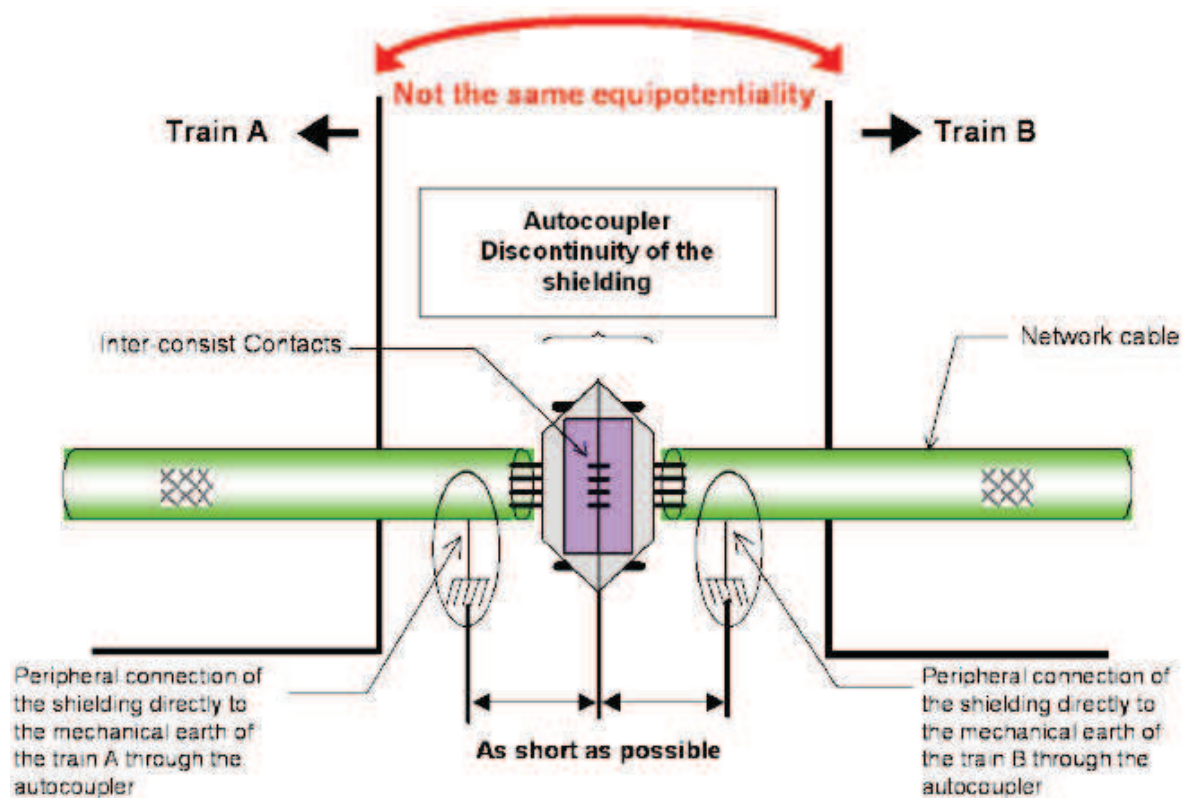


Figure 4 ETB Inter consist segment

Note : The implementation of the shielding solution is not in the scope of this specification.

4.3 Power Over Ethernet (PoE)

Following figure gives some use cases of PoE usage.

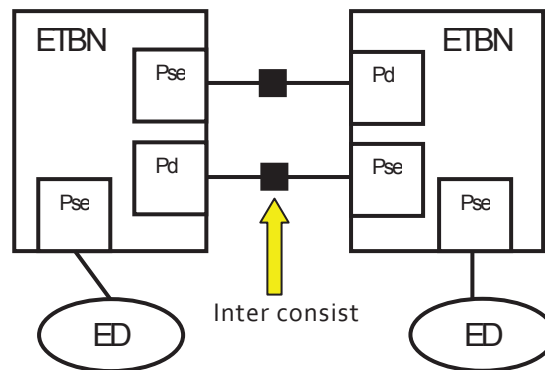


Figure 5 PoE use cases

In intra-car PoE could be used to power an ED (CCTV,...). The ND Ethernet port acts as a PSE (Power Source Equipment).

In inter-car and inter-consist, PoE could be used to power an ND. A PSE interface shall be connected to a PD interface. In case of ETB link redundancy, PSE and PD interfaces shall be alternated in order to keep a symmetrical rotation of car.

Figure 6 shows the connection between PSE and PD. The alternative A of PoE norm IEEE802.3 clause 33 shall be used because only two pairs are used (Tx/Rx).

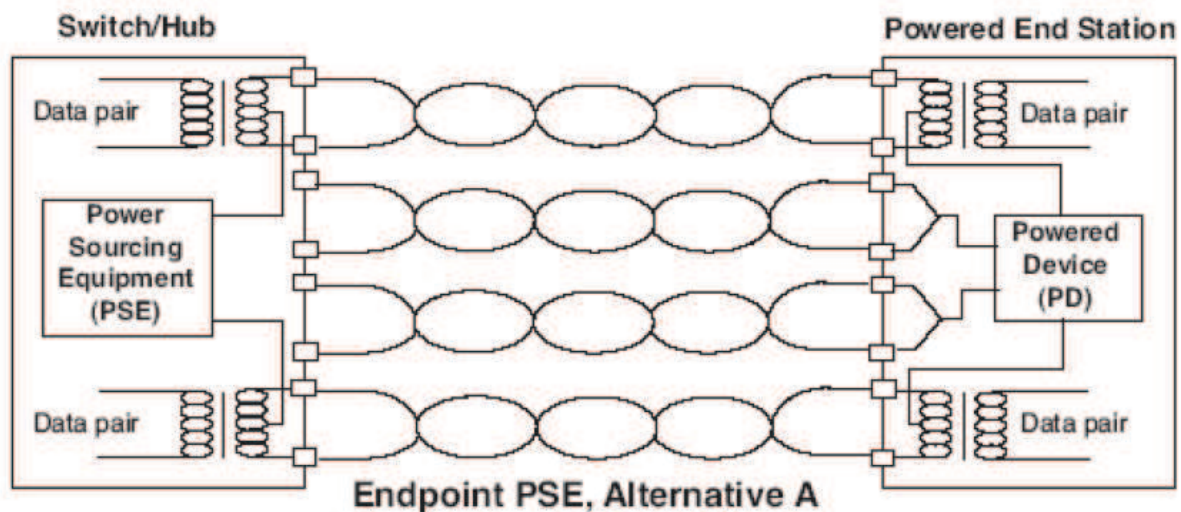


Figure 6 PoE PSE alternative A

4.4 ETB physical links redundancy

The document IEC 61375-1 General architecture described the requirements of the train backbone redundancy (in it, see §5.2.3 “Train Backbone based on switched technology”) :

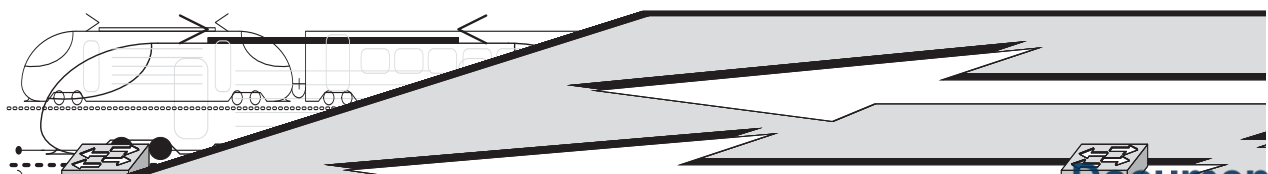


Figure 7 Redundant train backbone topology