

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Electronic railway equipment – Train communication network (TCN) –
Part 3-1: Multifunction Vehicle Bus (MVB)**

**Matériel électronique ferroviaire – Réseau embarqué de train (TCN) –
Partie 3-1: Bus de Véhicule Multifonctions (MVB)**



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTRONIC RAILWAY EQUIPMENT –
TRAIN COMMUNICATION NETWORK (TCN) –****Part 3-1: Multifunction Vehicle Bus (MVB)**

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International Standard IEC 61375-3-1 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways.

This first edition cancels and replaces the clauses of IEC 61375-1, second edition, published in 2007, relevant to the specification of MVB and constitutes a technical revision.

It was prepared taking into account IEC 61375-1 third edition.

The text of this standard is based on the following documents:

FDIS	Report on voting
9/1644/FDIS	9/1668/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of IEC 61375 series, under the general title *Electronic railway equipment – Train communication network (TCN)*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

This part of IEC 61375 specifies one component of the Train Communication Network, the Multifunction Vehicle Bus (MVB), a serial data communication bus designed primarily, but not exclusively, for interconnecting equipment where interoperability and interchangeability are needed.

This part specifies:

- a) the physical media in single-line and double-line configurations;
- b) the signalling and the redundancy handling;
- c) the format and timing of the transmitted frame and telegrams;
- d) the organisation of the bus traffic;
- e) the allocation of Mastership;
- f) the management of the bus;
- g) the Link Layer interface and the layer management interface.

This part is structured following the OSI layers of a reference MVB device as shown in Figure 1:

Clause 4 Physical Layer

- Electrical medium for short distance (RS-485, 20,0 m)
- Electrical medium for middle distance (transformer-coupled, 200,0 m)
- Optical fibre for long distances (glass fibres, 2,0 km)

Clause 5 Medium-dependent signalling

- Frame encoding and decoding
- Line Unit interface
- Physical redundancy handling

Clause 6 Frames and telegrams

- Master Frame and Slave Frame encoding, Telegram timing

Clause 7 Link Layer Control

- Addressing
- Master Frame and Slave Frame format

Clause 8 Medium allocation

- Periodic Polling
- Event Polling
- Devices Scan

Clause 9 Mastership transfer

- Regular and exceptional mastership transfer

Clause 10 Link Layer Interface

- Link Process Data Interface (LPI),
- Link Message Data Interface (LMI),
- Link Supervision Interface (LSI).

Clause 11 Real-Time Protocols

Clause 12 Gateway Function

Clause 13 Network Management

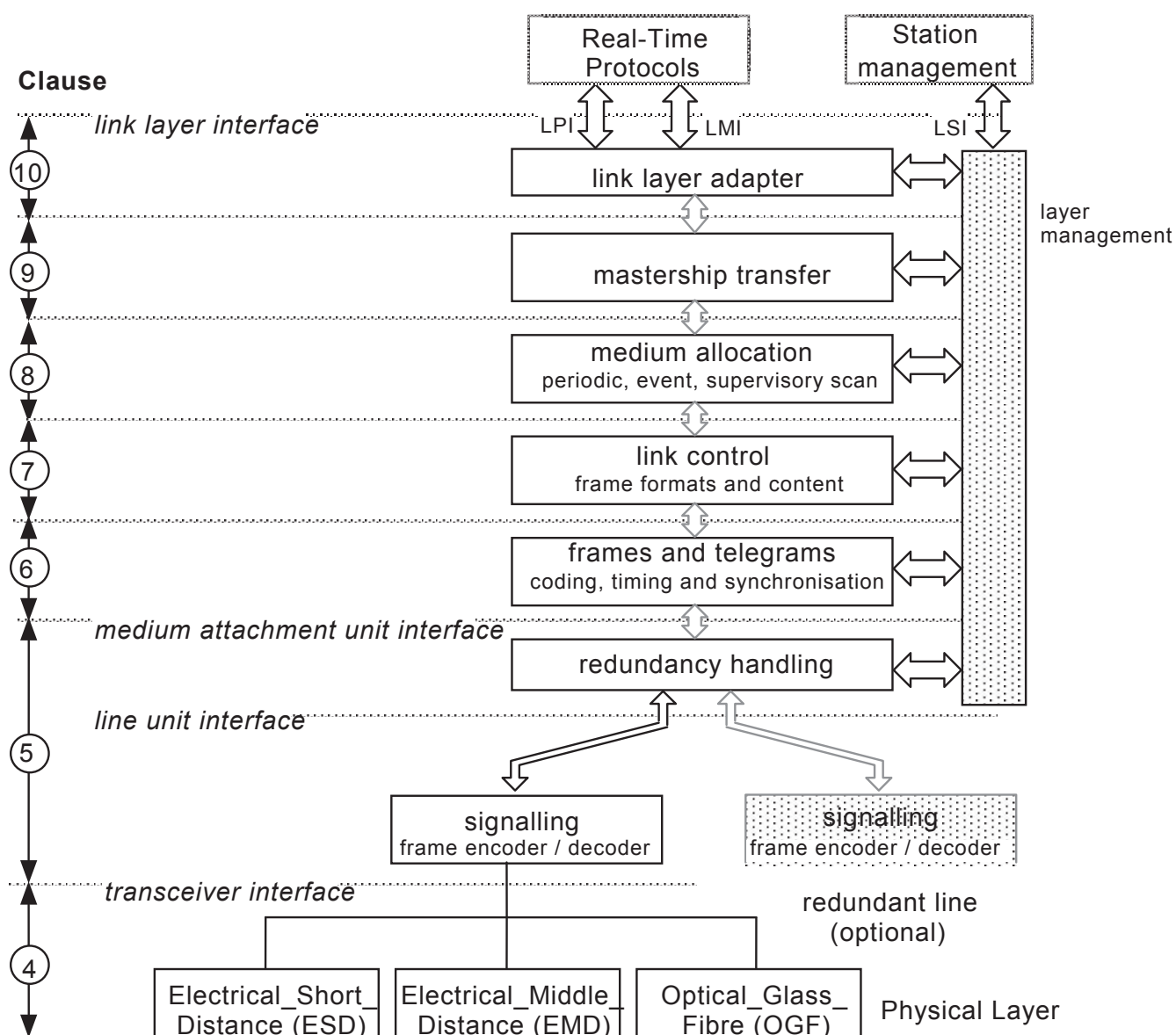


Figure 1 – Reference device and structure of the document

ELECTRONIC RAILWAY EQUIPMENT – TRAIN COMMUNICATION NETWORK (TCN) –

Part 3-1: Multifunction Vehicle Bus (MVB)

1 Scope

This part of IEC 61375 applies where MVB is required.

2 Normative references

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

IEC 60245-1, *Rubber insulated cables – Rated voltages up to and including 450/750 V – Part 1: General requirements*

IEC 60304, *Standard colours for insulation for low-frequency cables and wires*

IEC 60332-1-1, *Tests on electric and optical fibre cables under fire conditions – Part 1-1: Test for vertical flame propagation for a single insulated wire or cable – Apparatus*

IEC 60571, *Electronic equipment used on rail vehicles*

IEC 60794-1-1, *Optical fibre cables – Part 1-1: Generic specification – General*

IEC 60807 (all parts), *Rectangular connectors for frequencies below 3 MHz*

IEC 60870-5-1, *Telecontrol equipment and systems – Part 5: Transmission protocols – Section One: Transmission frame formats*

IEC 61375-2-1, *Electronic railway equipment – Train Communication Network (TCN) – Part 2-1: Wire Train Bus (WTB)*

ISO/IEC 8482, *Information technology – Telecommunications and information exchange between systems – Twisted pair multipoint interconnections*

ISO/IEC 8802-2, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 2: Logical link control*

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

ISO/IEC 8825 (all parts), *Information technology – ASN.1 encoding rules*

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

ISO/IEC 13239, *Information technology – Telecommunications and information exchange between systems – High-level data link control (HDLC) procedures*

ITU-T Recommendation Z.100, *Specification and Description Language (SDL)*

3 Terms and definitions, abbreviations and conventions

3.1 Terms and definitions

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

NOTE Keywords in this standard are written with the first letter of each word in upper case and, when they are composed of two or several words, these are joined by an underscore. This convention allows keywords to be tracked in the documents.

3.1.1

address

identifier of a communication partner, of which several types exist, depending on the layer

3.1.2

agent

application process in a Station which accesses the local managed objects on behalf of the Manager

3.1.3

Aperiodic Data

transmission of Process Data on a demand basis. This service is not used

3.1.4

Application Layer

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

3.1.5

Application Layer Interface

definition of the services offered by the Application Layer

3.1.6

Application Messages Adapter

code directly called by the application implementing the Messages services

3.1.7

Application Messages Interface

definition of the Messages services

3.1.8

Application Process

communicating entity, implemented for instance by a task

3.1.9

Application Processor

processor which runs a communicating Application Process

3.1.10

Application Supervision Interface

definition of the Supervision services available in particular to the Agent

3.1.11

Application Variables Adapter

code directly called by the application implementing the Variables services

3.1.12

Application Variables Interface

definition of the Variables services

3.1.13

arbiter

device, or common protocol followed by several devices, which selects one of several devices competing for mastership

3.1.14

Auxiliary Channel

channel used for detecting additional Nodes

3.1.15

Basic Period

bus activity is divided into periods. The shortest is the Basic Period, which consists of a Periodic Phase (for Periodic Data) and of a Sporadic Phase (for Message Data and Supervisory Data)

3.1.16

big-endian

ordering scheme for storing or transmitting data in which the most significant part of a multiple-octet data is stored at the lowest octet address, and transmitted first

3.1.17

bit-stuffing

method specified by ISO/IEC 13239 to prevent Frame Data from being misinterpreted as a Flag, consisting of inserting an additional "0" symbol after each string of five "1" symbols and removing this "0" at reception

3.1.18

bridge

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

3.1.19

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

3.1.20

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

3.1.21

Bus Administrator

device capable of becoming Master of the MVB

3.1.22

Bus Controller

processor or integrated circuit in charge of the Link Layer of communication



Documents

Document Sharing Hub

3.1.23**Bus Switch**

switch or relay within a WTB Node which connects electrically the cable sections of the two directions

3.1.24**Caller**

Application Process which initialises a message exchange

3.1.25**Check Sequence**

method of error detection based on appending to the transmitted useful data a checksum or a cyclic redundancy check (CRC) calculated on the useful data

3.1.26**Check Variable**

Process Variable of type antivalent boolean protecting another Process Variable

3.1.27**Check Offset**

bit offset of a Check Variable within a Dataset

3.1.28**Closed Train**

train consisting of a set of vehicles, where the composition does not change during normal operation, for instance metro, suburban train, or high-speed train units

3.1.29**composition**

number and characteristics of the vehicles forming a train

3.1.30**configuration**

definition of the topology of a bus, 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

3.1.31**Connect Confirm**

response of the Consumer to the Connect Request of the Producer

3.1.32**Connect Request**

first packet of a message sent from Producer to Consumer

3.1.33**Consist**

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

3.1.34**Consist network**

bus connecting equipment within a consist, e.g. the MVB, and which conforms or adapts to the TCN Real-Time protocols as described in this document

3.1.35

consistency

Dataset consisting of several elements is consistent if all elements are read or written in one indivisible operation

3.1.36

Consumer

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

3.1.37

continuity vehicle

vehicle without an operational Train Bus Node, but carrying a section of the bus to connect passively the Train Bus of its adjacent vehicles.

3.1.38

conversation

data exchange at the Application Layer, consisting of a Call Message and a Reply Message (the latter is missing in the multicast protocol). A conversation starts with the first Connect Request frame and ceases when the last acknowledgement for the Reply Message has been received or is no longer expected

3.1.39

datagram

frame containing all information necessary to forward it to its final destination, without knowledge of previous frame's contents. Datagrams do not use a previous connection establishment and they are not acknowledged at the Link Layer

3.1.40

Dataset

all Process Variables transmitted in one Process Data frame

3.1.41

delimiter

sequence of signals which includes code violation symbols (neither "1" nor "0") which is used to delimit the start (Start Delimiter) and the end (End Delimiter) of a frame, as defined for instance in IEC 61158-2

3.1.42

Destination Device

receiver of a frame at the Link Layer (see: Source Device)

3.1.43

device

unit connected to one or more busses

3.1.44

Device Address

Device Address identifies a device within a bus; On the MVB, the Device Address has 12 bits; On the WTB, the Device Address has 8 bits, the least significant 6 bits being the Node Address.

NOTE A device connected to several busses may have a different Device Address for each bus. Special devices such as repeaters only participate at the Physical Layer and have no Device Address.

3.1.45

Device Status

16-bit word expressing the capabilities and status of an MVB device connection

3.1.46**Direction 1**

one direction of a WTB Node

3.1.47**Direction 2**

other direction of a WTB Node

3.1.48**Electrical Middle Distance**

one of the media of the MVB

3.1.49**Electrical Short Distance**

one of the media of the MVB

3.1.50**End Delimiter**

sequence which ends a frame before the medium returns to idle

3.1.51**End Node**

Node which terminates the two bus segments connected to it but does not establish continuity between them

3.1.52**Event Round**

sequence of polls in which all events pending at the start are read

3.1.53**extension box**

wiring box where the trunk cable is interrupted and passively extended by an extension cable to connect a device

3.1.54**extension cable**

cable inserting a Node in a trunk cable, consisting of two separate twisted wire pairs per line, possibly of smaller cross-section than the trunk cable itself

3.1.55**field device**

device attaching simple sensors and actuators to the bus, outside a rack

3.1.56**final**

receiver of a packet (data or acknowledgement) at the Network Layer. When two devices communicate within the same bus, the final is located in the destination device (see: origin)

3.1.57**Flag**

sequence of "1" and "0" symbols which serves to delimit the beginning or the end of a frame. Flags which would appear in the transmitted data are modified by bit-stuffing, as defined for instance in ISO/IEC 13239

3.1.58

frame

sequence of consecutive symbols sent in one time slot by a transmitter, between two slots where the line is idle.

3.1.59

Frame Check Sequence

16-bit FCS specified in ISO/IEC 13239

3.1.60

Frame Data

data transmitted between the Start Delimiter and the End Delimiter (on the MVB) or between the Preamble and the End Delimiter (on the WTB)

3.1.61

fritting

electrical cleaning of oxidised contacts by applying a breakdown voltage over the contact

3.1.62

Function

Application Process which exchanges messages with another Application Process

3.1.63

Function Directory

directory which maps a Function Identifier to a Station Identifier and vice-versa

3.1.64

Function Identifier

8-bit identifier of a Function

3.1.65

F code

in a Master Frame, indicates the request and the expected response Slave Frame size

3.1.66

gateway

connection between different busses at the Application Layer requiring application-dependent data analysis and protocol conversion

3.1.67

Group Address

address of a multicast group to which a Node belongs

3.1.68

Group Directory

directory which indicates to a Node to which multicast group it pertains

3.1.69

hamming distance

minimum number of bits of a given correct bit sequence, which, if inverted, create a false bit sequence indistinguishable from a correct one

3.1.70

HDLC

High-level Data Link Control, a set of standardised protocols, including ISO/IEC 13239 for data transmission

3.1.71**HDLC Data**

data transmitted in an HDLC frame

3.1.72**Inauguration**

operation executed in case of composition change, which gives all Nodes of the WTB their address relative to the Master, their orientation and the descriptor of all named Nodes on the same bus

3.1.73**Individual Period**

interval between two successive transmissions of the same Process Data from the same source. The Individual Period is a power-of-2 multiple of the Basic Period

3.1.74**instance**

- a) one of several objects which share the same definition (object instance)
- b) one of several (simultaneous or not) executions of the same program (process instance)

3.1.75**integrity**

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

3.1.76**Intermediate Node**

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

3.1.77**jumper cable**

cable connecting the trunk cables of two consecutive vehicles, possibly of a larger cross-section than the trunk cable, and which is plugged by hand in the case of the UIC-cable. There are generally two jumper cables between vehicles

3.1.78**Line**

non-redundant bus. A dual-thread bus consists of two lines

3.1.79**Line Unit**

all circuits providing the electrical attachment to a line

3.1.80**Link Address**

address supplied to the Link Layer to identify to which Bus and to which Device Address a packet is sent or received

3.1.81**Link Control**

field in the HDLC frame which indicates the type of frame

3.1.82**Link Data**

data transported by the Link Layer, but not relevant to it

3.1.83

Link Header

part of a Message Data frame relevant to the Link Layer

3.1.84

Link Layer

layer in the OSI model establishing point-to-point and broadcast connections between devices attached to the same bus

3.1.85

Link Layer Interface

interface between Link Layer and higher communication layers

3.1.86

Link Layer Management

interface controlling the Link Layer for management purposes

3.1.87

little-endian

ordering scheme for storing or transmitting data in which the least significant part of a multiple-octet data is stored at the lowest octet address, and transmitted first

3.1.88

local area network

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

3.1.89

logical link control

protocols and associated frame formats which serve to control the Link Layer

3.1.90

Logical Address

address which is not bound to a specific device (e.g. the Process Data address)

3.1.91

Logical Port

ports of a device used for the Process Data traffic and addressed by the Logical Address

3.1.92

Macro Cycle

number of Basic Periods corresponding to a Macro Period

3.1.93

Macro Period

longest Individual Period, after which the periodic traffic returns to the same pattern, counted in milliseconds

3.1.94

Main Channel

channel over which the main bus traffic is received

3.1.95

Management Message

message exchanged between a Manager and an Agent for Network Management.

3.1.96**Manager**

Function in a Station which is dedicated to Network Management and which sends management Call Messages through System Addresses

3.1.97**marshalling**

allocation of application addresses or names to the Process Variables of a dataset, that, on the WTB, depends on the Node Type and Version

3.1.98**Master**

device which spontaneously sends information on a bus to a number of slave devices. It may give a Slave the right to transmit for one Slave Frame only within a limited time

3.1.99**Master Frame**

frame sent by a Master

3.1.100**Master Start Delimiter**

Start Delimiter of a Master Frame

3.1.101**medium access control**

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

3.1.102**medium dependent interface**

mechanical and electrical interface between the transmission medium and a Medium Attachment Unit

3.1.103**medium**

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

3.1.104**Medium Attachment Unit**

device used as a coupler to the transmission medium

3.1.105**message**

data item transmitted in one or several packets

3.1.106**Messages**

transmission service of the TCN

3.1.107**Message Data**

data transmitted sporadically by the Link Layer in relation to message transmission; the corresponding Link Layer service

3.1.108

messenger

communication stack caring for end-to-end message communication and interfacing to the application

3.1.109

multicast

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

3.1.110

Multifunction Vehicle Bus

MVB

Vehicle Bus to be used for connecting programmable stations and simple sensors/actors.

3.1.111

Multiple Unit Train

train consisting of a set of closed trains, where the composition of the set may change during normal operation

3.1.112

network

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

3.1.113

Network Address

address which identifies a Function or a Station within the network. It can be either a User Address or a System Address

3.1.114

Network Header

part of a Message Data frame relevant to the Network Layer

3.1.115

Network Layer

layer in the OSI model responsible for routing between different busses

3.1.116

Network Management

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

3.1.117

Node

device on the Wire Train Bus, which may act as a gateway between Train Bus and Vehicle Bus

3.1.118

Node Address

address of a Node on the Train Bus (6 bits). It is equal to the least significant 6 bits of the 8-bit Device Address on the WTB

3.1.119

Node Descriptor

24-bit data structure which indicates for a Node its Node Period and its Node Key

3.1.120**Node Directory**

directory which maps the Node Address to the Device Address (one-to-one mapping in WTB)

3.1.121**Node Key**

16-bit identifier selected by the application to identify a Node's type and version. The Master distributes it to all other Nodes after each composition change and before exchanging data

3.1.122**Node Period**

on the WTB, desired Individual Period of a Node (identical to Individual Period except if overload occurs)

3.1.123**octet**

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

3.1.124**Open Train**

train consisting of a set of vehicles where the configuration may change during normal operation, for instance international UIC trains

3.1.125**Optical Glass Fibre**

one of the media of the MVB

3.1.126**origin**

sender of a packet (data or acknowledgement) at the Network Layer. When two devices communicate within the same bus, the Origin is located on the source device (see: final)

3.1.127**packet**

unit of a message (information, acknowledgement or control) transmitted in exactly one Message Data frame

3.1.128**period**

time unit after which a periodic pattern repeats itself

3.1.129**Periodic Data**

Process Data transmitted periodically, at an interval which is the Individual Period

3.1.130**Periodic List**

list of Nodes, addresses or devices to be polled in each period of a Macro Cycle

3.1.131**Periodic Phase**

phase during which the Master polls for Periodic Data according to its Periodic List

* IEC prescribes 'octet' instead of 'byte'.

3.1.132

Physical Address

Device Address on the MVB and the Node Address on the WTB which identify communicating devices on the same bus

3.1.133

Physical Port

Port used for the Message Data or the Supervisory Data traffic and addressed by the Device Address

3.1.134

pitch

distance between adjacent devices on the same electrical bus required to avoid clustering of bus loads

3.1.135

polling

sending of a Master Frame in order to receive a Slave Frame

3.1.136

Port

memory structure which contains data for transmission or reception, and in which a new value overwrites the former value (buffer, not queue). A Port provides means for simultaneous access by the bus and the application(s)

3.1.137

Port Index Table

look-up table which deduces the memory address of a port from the Logical Address of the Process Data

3.1.138

Preamble

sequence of signals heading a frame for the purpose of synchronising the receiver, used on the WTB

3.1.139

Presentation Layer

layer in the OSI model responsible for data representation and conversion

3.1.140

Process Data

source-addressed data broadcast periodically by the link layer in relation with Process Variables transmission; the corresponding Link Layer service

3.1.141

Process Variable

variable expressing the state of a process (e.g. speed, brake command)

3.1.142

Producer

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

3.1.143

Publisher

source of a Dataset for broadcasting (see: Subscriber)

3.1.144**PV Name**

identifier of a Process Variable

3.1.145**PV Set**

set of Process Variables belonging to the same Dataset

3.1.146**queue**

memory storing an ordered set of frames in a first-in, first-out fashion

3.1.147**rack**

equipment containing one or more devices, attached to the same segment

3.1.148**reassembly**

act of regenerating a long message from several packets generated by segmentation

3.1.149**receiver**

electronic device which may receive signals from the physical medium

3.1.150**Receive Queue**

queue for receiving Message Data in a device

3.1.151**regular operation**

normal bus activity as opposed to Inauguration (WTB) or configuration (MVB)

3.1.152**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

3.1.153**Replier**

Application Process which has been requested by the Caller to receive a Call Message and to reply with a Reply Message

3.1.154**residual error rate**

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

3.1.155**router**

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

3.1.156**scan**

polling of devices in a certain sequence for supervisory purposes

3.1.157
section

part of a segment, which is passively connected to another section without terminator in between

3.1.158
segment

piece of cable to which devices are attached, terminated at both ends by its characteristic impedance. Segments may consist of several sections (non-terminated) connected by connectors

3.1.159
segmentation

division of a long message into several shorter frames for transmission

3.1.160
Send Queue

queue for sending Message Data in a device

3.1.161
service

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

3.1.162
Session Header

part of a Message Data frame relevant to the Session Layer

3.1.163
Session Layer

OSI layer in charge of establishing and closing communication

3.1.164
Side A

one side of a vehicle with respect to a WTB Node

3.1.165
Side B

other side of a vehicle with respect to a WTB Node

3.1.166
Slave

device which receives information from the bus or sends information on the bus in response to a request (also called a poll) from the Master

3.1.167
Slave Frame

frame sent by a Slave

3.1.168
Slave Start Delimiter

Start Delimiter of a Slave Frame on the MVB

3.1.169
Source Device

sender of a frame at the Link Layer (see: destination device)

3.1.170**sporadic transmission**

transmission which is made upon demand, when an event external to the network requires it (also called aperiodic, event-driven, demand-driven transmission)

3.1.171**Sporadic Data**

data frames transmitted on demand to carry Message Data or Supervisory Data

3.1.172**Sporadic Phase**

second half of a Basic Period, dedicated to the demand-driven transmission of messages and bus management data

3.1.173**star coupler**

device which takes the light of an optical fibre and redistributes it to several other fibres

3.1.174**Start Delimiter**

delimiter which announces the beginning of a frame on the MVB

3.1.175**Station**

device capable of message communication, by contrast to simple devices, and which supports an Agent Function

3.1.176**Station Directory**

directory which maps a Station Identifier to a Link Address and vice-versa

3.1.177**Station Identifier**

8-bit identifier of a Station

3.1.178**Station Status Word**

16-bit descriptor of the status and capabilities of a Station

3.1.179**Strong Master**

Strong Node is currently Master and will not relinquish mastership until demoted to Weak Node status

3.1.180**Strong Node**

Node selected by the application to become Strong Master. There may be only one Strong Master on a bus segment

3.1.181**stub**

T-connection branching from an electrical bus line (at the tap), connecting a device to the line

3.1.182**Subscriber**

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

3.1.183

Supervisory Data

data transmitted within one bus only for the purpose of Link Layer supervision (e.g. arbitration on the MVB or Inauguration on the WTB)

3.1.184

System Address

Network Address of a Management Message exchanged between Manager and Agent, consisting of Node Address and Station Identifier

3.1.185

tap

place where a segment is tapped. A tap is a three-way electrical fork

3.1.186

Telegram

Master Frame and the corresponding Slave Frame, treated as a whole

3.1.187

terminator

circuit which closes an electrical transmission line, ideally by its characteristic impedance

3.1.188

Terminator Switch

switch which inserts the Terminator at the end of a segment on the WTB

3.1.189

Topography

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

3.1.190

topology

possible cable interconnection and number of devices a given network supports

3.1.191

Topography Counter

counter in a Node which is incremented at each new Inauguration

3.1.192

Traffic Store

shared memory accessed both by the network and the user, which contains the Process Data Port

3.1.193

Train Communication Network

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

3.1.194

Train Bus

bus connecting the vehicles of a train, in particular, the WTB, and which conforms to the TCN protocols

3.1.195

Train Network Management

services of the Network Management for TCN

3.1.196**transceiver**

combination of a transmitter and of a receiver

3.1.197**transmitter**

electronic device which can transmit a signal on the physical medium

3.1.198**Transport Data**

data carried by the Transport Layer, but not relevant to it

3.1.199**Transport Header**

part of a Message Data frame relevant to the Transport Layer

3.1.200**Transport Layer**

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

3.1.201**trunk cable**

cable which runs along the vehicles, as opposed to extension cable or jumper cable

3.1.202**User Address**

Network Address of a User Message exchanged between Functions, consisting of Node Address (or Group Address) and Function Identifier

3.1.203**User Message**

messages exchanged between user Functions

3.1.204**Variables**

transmission service of the TCN

3.1.205**Var_Offset**

bit offset of a Process Variable within a Dataset

3.1.206**Vehicle Descriptor**

application-dependent information about a particular vehicle, such as length and weight

3.1.207**Weak Master**

Weak Node is currently Master and which will relinquish mastership if it finds another, stronger Master

3.1.208**Weak Node**

Node which may take over the bus mastership spontaneously, but which releases it if it detects a stronger Node

3.1.209**Wire Train Bus (WTB)**

Train Bus for frequently coupled and uncoupled vehicles, such as international UIC trains

3.2 Abbreviations

ALI	Application Layer Interface, the definition of the semantics of all network services used by the application (a set of primitives, expressed as procedures, constants and data types)
AMA	Application Messages Adapter, the code directly called by the application which implements the Messages service
AMI	Application Messages Interface, the definition of the message services
ANSI	American National Standard Institute, a standardisation body in the United States
ASI	Application Supervision Interface, the definition of the Management services
ASN.1	Abstract Syntax Notation Number 1 on data presentation (ISO/IEC 8824)
AVA	Application Variables Adapter, the code directly called by the application implementing the Process Variable services
AVI	Application Variables Interface, the definition of the Process Variable services
BER	Basic Encoding Rules, a transfer syntax for ASN.1 data types (ISO/IEC 8825)
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
BT	Bit Time, the duration of the transmission of one bit, expressed in μ s
ITU	International Telecommunication Union, the international standardisation body for telecommunications based in Geneva
CRC	Cyclic Redundancy Check, a data integrity check based on polynomial division
DIN	Deutsches Institut für Normung, the German national standardisation body
EIA	Electronics Industries Association, a standardisation body in the United States
EMD	Electrical Middle Distance, one of the media of the MVB
ESD	Electrical Short Distance, one of the media of the MVB
EP	Electro-Pneumatic brake cable as described in UIC leaflet 648
ERRI	European Railways Research Institute, laboratory based in Utrecht, Netherlands
FCS	Frame Check Sequence, an error detection code appended to the transmitted data, as specified in ISO/IEC 13239
GCT	Guidelines for Conformance Test, the conformance testing specified in Annex B of this Standard
HDLC	High-level Data Link Control, a Link Layer protocol whose frame format is defined in ISO/IEC 13239
IEC	International Electrotechnical Commission, Geneva
IEEE	Institute of Electrical and Electronics Engineers, New York
ISO	International Standard Organisation, Geneva

LLC	Logical Link Control, a sub-layer within the Link Layer ruling the data exchange
LME	Layer Management Entity, the entity in charge of supervising a layer on behalf of Network Management
LMI	Layer Management Interface, the services provided by the LME
MAC	Medium Access Control, a sub-layer within the Link Layer ruling which device is entitled to send on the bus
MAU	Medium Attachment Unit, the part of a Node which interfaces electrically to the bus and which provides/accepts binary logic signals
MIB	Management Information Base, the set of all objects accessed by Network Management
MVB	Multifunction Vehicle Bus, a Consist Network.
NRZ	Non-Return to Zero, the simplest encoding scheme in which one bit is represented by one level for a "1" and the other level for a "0", or vice-versa, with a separate clocking
OGF	Optical Glass Fibre, one of the media of the MVB
ORE	Office de Recherches et d'Essais, a UIC laboratory based in Utrecht, Netherlands
OSI	Open System Interconnection, a universal communication model defined in the ISO/IEC 7498
PCTR	Protocol Conformance Test Report, defined in ISO/IEC 9646
PICS	Protocol Implementation Conformance Statement, defined in ISO/IEC 9646
PTA	Process Data to Traffic Store Adapter, the component which accesses one of the Traffic Stores
RIC	Regulation for the reciprocal use of coaches and vans in international traffic, issued by UIC.
RTP	Real-Time Protocols, the common communication protocols given in Clause 11 of this standard
SDL	Specification and Description Language, a specification language defined by ITU-T Z100 Annex D for communication protocols
TCN	Train Communication Network, a set of communicating consist networks and Train Backbones.
TNM	Train Network Management
UIC	International Union of Railways, the international railways operators association
WTB	Wire Train Bus

3.3 Conventions

3.3.1 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 1 The voltage is 20,0 V.

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

EXAMPLE 2 Decimal 20 coded on 8 bits = '0001 0100'B = '14'H

3.3.2 Naming conventions

Keywords in the TCN specifications are written with a capital letter at the beginning.

If the word is composed, the different parts of the name are united with a space.

When a data structure is associated with a keyword, its type consists of the same basic words separated by an underscore.

When the value corresponding to the keyword is transmitted in a message, the corresponding field has the same name as the type, but in lower case.

When the value is passed as parameter, the parameter name has the same name as the field in a message.

In the SDL diagrams, the corresponding variable has the same name as the type, but without underscores.

EXAMPLES

Topo Counter is a counter of the link layer;

It is of the type Topo_Counter, which is an UNSIGNED6.

When its value is transmitted in a message, the corresponding field is called 'topo_counter'.

When its value is transmitted across a procedural interface, the parameter is called 'topo_counter', its C-type is Type_Topo_Counter.

In the SDL diagrams, the variable representing the counter is called TopoCounter.

3.3.3 Time naming conventions

Time values beginning with a lower case (e.g. t mm) are measurable time intervals.

Time values beginning with an uppercase (e.g. T reply) are parameters or time-out values.

3.3.4 Procedural interface conventions

A procedural interface is defined by a set of service primitives, which represent an abstract, implementation-independent interaction between the service user and the service provider.

These primitives are expressed in this standard as procedures in the ANSI C syntax with typed parameters.

This ought to be considered as a semantic description only, which does not imply a particular implementation or language. Any interface which provides the same semantics is allowed.

Conformance to the syntax of this interface cannot be claimed. Implementations are free to change the procedure or parameters names, to add parameters or to split procedures, as long as the specified service is provided.

Interface procedures are defined in the ANSI C syntax using the Courier font.

Procedure names, variables and parameters all appear in lower case.

EXAMPLE 1 Im_send_request

Constants and type definitions all appear in upper case.

EXAMPLE 2 UNSIGNED32

The name of a procedure or of a type is prefixed:

for the Variables service by

- lp_ or LP_ Link Layer
ap_ or AP_ Application Layer

for the Messages service by

- MD_ messages in general
lm_ or LM_ Link Layer
nm_ or NM_ Network Layer
tm_ or TM_ Transport Layer
sm_ or SM_ Session Layer
am_ or AM_ Application Layer

Table 1 shows a template used for procedures and types.

Table 1 – Template for the specification of an interface procedure

Definition	<i>The service or data type is expressed here.</i> <i>In case of an indication procedure, the event which triggers the call is indicated here, beginning with "When"</i> <i>The name and parameters of the service procedure are defined here.</i> <i>In case of an indication procedure, the type of the procedure is specified.</i> <i>Input parameters, output parameters and return parameters are distinguished</i>	
Syntax	<pre>MD_RESULT lm_send_request (/* example */ unsigned, destination, UNSIGNED8 link_control, MD_PACKET * p_packet ENUM8 * status)</pre>	
Input	<i>Input parameters are supplied to the procedure, which is not allowed to modify them</i>	
	destination	The data type "unsigned" is compiler-dependent
	link_control	parameter passed by reference, not modified by the procedure. The data type is an 8-bit word
	p_packet	The "*" denotes a pointer to the p_packet data structure, which is of type MD_PACKET, defined elsewhere in this standard
Output	<i>Output parameters are expected to be modified by the call</i>	
	status	The type ENUM8 is an 8-bit enumeration type
Result	<i>The Result parameter is an optional output parameter which expresses success or failure of the call, but not necessarily of the service</i>	
	MD_RESULT	The Result parameter is of the type: AM_RESULT for the AMI, MD_RESULT for the LMI, LP_RESULT for the LPI, AP_RESULT for the AVI, The template specifies the error codes expected for each procedure individually. The Result parameter is not explicitly described if the only two values expected are: xx_OK = 0 successful completion; xx_FAILURE <> 0 some problem. The result can also be returned as an output parameter in the parameter list, depending on the implementation
Usage	The rules listed after the procedure template indicate how the procedure should be used. Although usage rules are not mandatory, not following them produces unpredictable results	
NOTE Data structures represented in this table are interface specifications which should not be confused with formats of the same data structures when transmitted over a bus, see 3.3.5.		

3.3.5 Specification of transmitted data

The format of transmitted data, single frames as well as whole messages, is specified in two forms:

- a graphical form, which is not normative, but shows the message structure at a glance.
- a textual form based on ASN.1, with encoding rules specified in 6.3 of IEC 61375-2-1.

EXAMPLE 1 A graphical form of a message is shown in Table 2, the corresponding textual form is shown in Table 3.

Table 2 – Example of message structure

first transmitted octet								next transmitted octet								
bit->	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	snu	gni	node_id						station_id							
2	next_station_id								rsv1	Tvd	topo_counter					
4	tnm_key								sif_code (= 3)							
6	parameter 1															
8	parameter 2								parameter 3						par4	
	parameter 5: ARRAY [n] OF (repeat following field (n) times)															
	parameter 5.1															
	parameter 5.2															
	parameter5.3: STRING32															
	(CHARACTER8)								last character or 0							
^octet																

In the graphical form, one line is used for each word of 16 bits, but in Clause 4 (WTB), lines are 8-bit oriented.

Arrays of parameters are preceded by a repetition frame on the top and to its left.

Repetitions can be nested (see parameter 5.3 in Table 4).

If the size of a parameter may be longer than three words, three lines are allocated for it and the middle one has a shaded border.

Table 3 – Example of textual message form (corresponding to Table 2)

```

Call_Mgt_Message ::= RECORD
{
  snu                BOOLEAN1 (=1)      -- this '1' means that message
                                         uses system addressing
  gni                BOOLEAN1 (=0)      -- this '0' means that final
                                         is an individual device
  node_id            UNSIGNED6          -- 6-bit node address of final
  station_id         UNSIGNED8          -- 8-bit identifier of the
                                         station
  next_station_id    UNSIGNED8          -- 8-bit identifier of next
                                         station
  rsv1              BOOLEAN1 (=0)      -- this bit is always 0
  tvd               BOOLEAN1          -- this bit indicates if
                                         topography counter is valid
  topo_counter       UNSIGNED6          -- 6-bit topography counter
  tnm_key            UNSIGNED8,         -- announces a network
                                         management call message.
  sif_code           UNSIGNED8,         -- there is a different
                                         SIF_code for each
                                         Management Message
  parameter1         INTEGER16,        -- a 16-bit value. If the
                                         parameter has less than 16
                                         bits, the value is right-
                                         justified and sign-extended
                                         (e.g. one single octet is
                                         transmitted as the second
                                         octet).
  parameter2         INTEGER8,         -- this value is transmitted
                                         in the most significant
                                         part of a word.
  parameter3         UNSIGNED6         -- this value is transmitted
                                         in the least significant
                                         octet, but the lower two
                                         bits of that octet are
                                         reserved for parameter4.
  par4              ANTIVALENT2        -- parameter4 has two bits
  parameter5         ARRAY [n] OF     -- parameter5 represents a
                                         structured data to be
                                         {
                                         -- repeated n times,
                                         containing:
                                         parameter5.1      INTEGER16      -- first parameter of the
                                         repeated field
                                         parameter5.2      UNIPOLAR4.16    -- second parameter of the
                                         repeated field
                                         parameter5.3      STRING32      -- third parameter is a string
                                         (array of up to 32 8-bit
                                         characters);
                                         - a string is closed by a
                                         '0' character, or by two
                                         such '0' characters to
                                         align on a 16-bit word
                                         boundary;
                                         - a void string consists of
                                         32 '0' characters;
                                         - the actual size of a
                                         string is deduced from the
                                         number of significant
                                         characters before the zero.
                                         },
}

```

Fields names begin with a lower case letter, their type begins with an upper case. Sometimes, the same type is used as a transmission format, in which case only the first letter is upper case, and as a C-type, in which case the whole type is in upper case.

EXAMPLE 2 Am_Result (transmission format) and AM_RESULT (C-type of an interface procedure).

3.3.6 State diagram conventions

The transport protocol state machine is described as in ISO/IEC 8802-2 (Logical Link Layer) in the form of a table, which specifies the transitions between the possible states in which a state machine may be.

Transitions between states are governed by events, coming from the Network Layer (inbound packets), from the Session Layer (commands) or from time-outs.

An action depending on the event is executed before leaving the state. This action defines the next state.

Figure 2 shows an example of a state transition diagram.

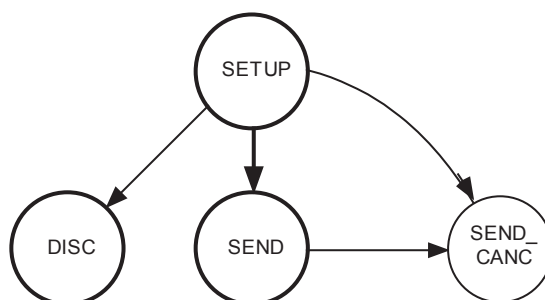


Figure 2 – State transition example

From “SETUP”, the machine may go to three different states, DISC, SEND or SEND_CANC.

The transition between these states are governed as Table 4 shows.

Table 4 – State transitions table

Current state	Event	Action(s)	Next state (if <> current)
SETUP	rcv_DR	close_send (DR_reason);	DISC
	rcv_CC AND (conn_ref = CC_conn_ref)	IF (eot) THEN close_send (AM_OK); ELSE credit:= CC_credit; send_not_yet:= credit; send_data_or_cancel; END;	DISC SEND or SEND_CANC
	TMO AND (rep_cnt = MAX_REP_CNT)	close_send (AM_CONN_TMO_ERR);	DISC

According to Table 4, there are three events which cause a transition from SETUP to the DISC state:

- a) rcv_DR (received Disconnect_Request, a network event). The corresponding action consists in closing the connection (close_send) before going to state DISC;
- b) another network event (received Connect_Confirm with correct reference), leading either to state DISC, SEND or SEND_CANCEL, depending on the outcome of the send_data or cancel procedure;
- c) A time-out conditioned by the predicate (rep_cnt = MAX_REP_CNT), which also causes the closing of the connection.

4 Physical Layer

4.1 Topology

4.1.1 Segments

An MVB shall consist of one or several bus segments of the following media:

- a) ESD: an Electrical Short Distance medium using a pair of wires with differential transmission according to the RS-485 standard, supporting up to 32 devices over a distance of 20,0 m without need for galvanic separation, and over longer distances when using galvanic isolation, as specified in 4.4.
- b) EMD: an Electrical Middle Distance medium, using a shielded, twisted wire pair, supporting up to 32 devices over a distance of 200,0 m and allowing transformers for galvanic isolation, as specified in 4.5.
- c) OGF: an Optical Glass Fibre medium, using optical fibres bussed through a star coupler, over a distance up to 2,0 km, intended for critical environments such as locomotives, as specified in 4.6.

4.1.2 Couplers

MVB segments shall be interconnected by couplers of one of the following types:

- a) repeater for connecting different media;
- b) star couplers for forming optical fibres into a bus.

EXAMPLE An MVB configuration, shown in Figure 3, consists of an ESD segment supporting a bus administrator, several devices within and outside of a rack and a gateway, an EMD segment supporting several devices and a bus administrator, and an OGF segment supporting a number of devices. Segments are interconnected by repeaters. The star coupler consists of an ESD segment which, in this example, supports no devices. Each segment in Figure 3 could be duplicated to increase availability.

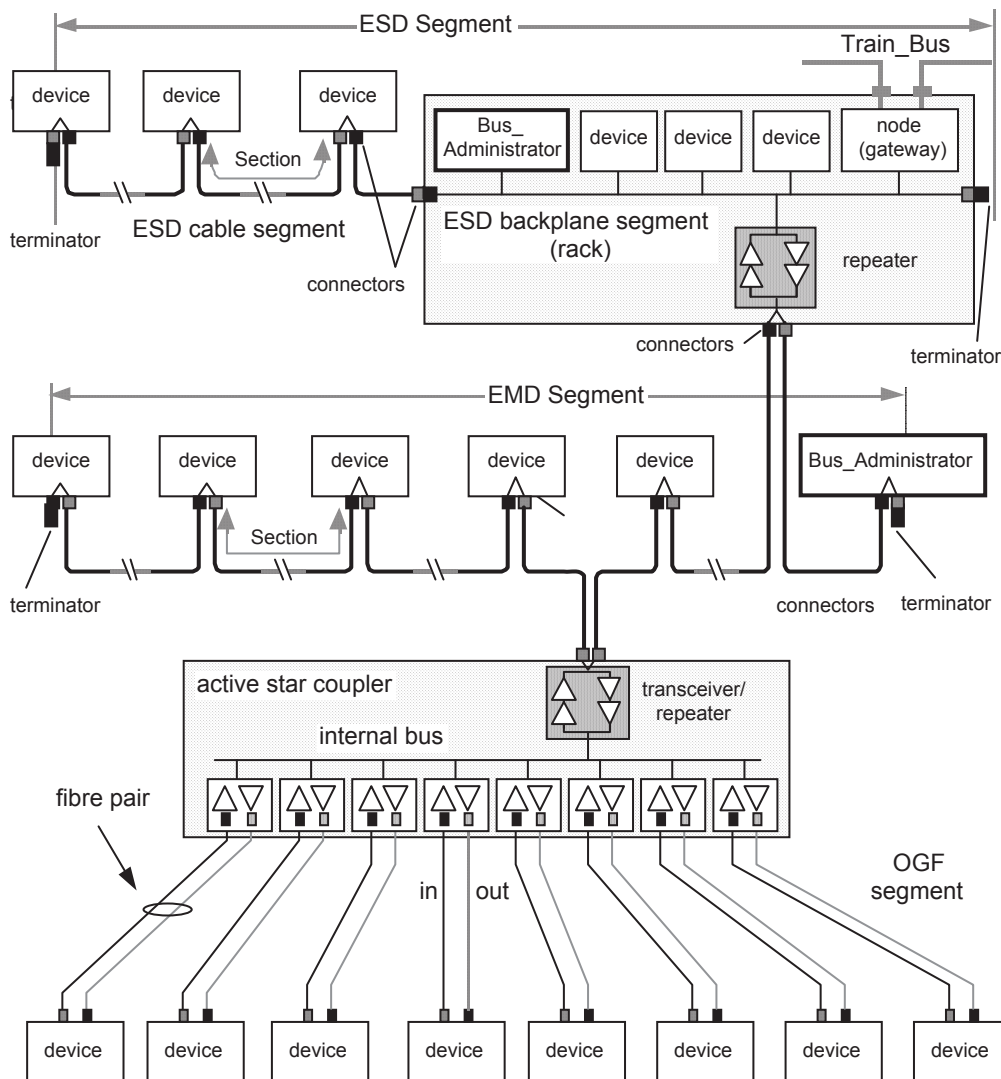


Figure 3 – MVB configuration

4.1.3 Double-line segments

As an option, a segment may be duplicated to increase availability (double-line segment).

An MVB may consist of a combination of double-line segments and single-line segments interconnected by bus couplers.

4.2 Device classes

4.2.1 Capabilities

There exist five classes of devices attached to the MVB, which differ in their capabilities.

MVB devices shall provide a subset of the following six capabilities listed in Table 5.

Table 5 – MVB devices capabilities

Capability	Description	Class
Device_Status	the device is able to send its Device_Status when polled	1, 2, 3, 4, 5
Process_Data	the device is able to send Process Data when polled and to receive Process Data from other devices	1, 2, 3, 4, 5
Message_Data	the device is able to send Message Data when polled and to receive Message Data from other devices. This capability implies that the devices are able to execute the Real-Time Protocols and have a Network Management Agent.	2, 3, 4, 5
User_Programmable	the device is able to be down-loaded with User Application programs. This capability implies the Message_Data capability.	3, 4, 5
Bus_Administrator	the device is able to act as a master. This capability implies the Message_Data, Process_Data and Device_Status capabilities and the ability to read the Device_Status of all other devices.	4, 5
TCN_Gateway	the device is able to access at least another bus (MVB or other). This capability implies the Device_Status, Process_Data and Message_Data capabilities, and the presence of a router if at least two of the busses obey to the Real-Time Protocols.	5

4.2.2 Class 0 devices

Class 0 devices are not requested to support any capability.

NOTE Class 0 includes special devices, such as repeaters or star couplers, which do not participate in the application data exchange or participate in another way (for instance with another protocol).

4.2.3 Class 1 devices

Class 1 devices shall offer the capabilities: Device_Status and Process_Data.

NOTE In these devices, the Port_Address of the Process Data may be tied to their Device_Address, for instance, the Port_Address may be identical to the Device_Address.

4.2.4 Class 2 devices

Class 2 devices shall offer the capabilities: Device_Status, Process_Data and Message_Data.

NOTE Class 2 devices are intelligent field devices which can be configured over the bus, but not programmed.

4.2.5 Class 3 devices

Class 3 devices shall offer the capabilities: Device_Status, Process_Data, Message_Data and User_Programmable.

4.2.6 Class 4 devices

Class 4 devices shall offer the capabilities: Device_Status, Process_Data, Message_Data and Bus_Administrator.

NOTE The User_Programmable capability is optional.

4.2.7 Class 5 devices

Class 5 devices shall offer the capabilities: Device_Status, Process_Data, Message_Data and TCN_Gateway.

Class 5 devices may offer the Bus_Administrator capability.

NOTE Gateways with Bus_Administrator capability can synchronise the busses.

4.2.8 Device Attachment

Three different device attachments are considered:

- a) ESD: Devices equipped with the connectors carrying ESD signals according to 4.4;
- b) EMD: Devices equipped with the connectors carrying EMD signals according to 4.5;
- c) OGF: Devices equipped with the connectors carrying ESD signals according to 4.6.

NOTE A device may support more than one attachment.

4.3 Specifications common to all media

4.3.1 Signalling speed

The signalling speed shall be 1,5 Mbit/s $\pm$ 0,01 %, using Manchester encoding (BR = 1,5 MHz or 1,5 Mbit/s, BT = 666,7 ns).

4.3.2 Propagation delays

Between any two devices, the reply delay, including propagation delays and repeater delays and assuming a worst-case source delay of $T_{\text{source_max}}$ (see 6.2.3), shall not be larger than $T_{\text{reply_def}} = 42,7 \mu\text{s}$ (see 6.2.2), except if the bus is operated in Extended Reply Mode.

If the worst case propagation delay is larger than $T_{\text{reply_def}}$, the bus may be operated in Extended Reply Delay mode, provided that the worst case round-trip delay $T_{\text{reply_max}}$ is entered as a configuration parameter of all connected devices.

The difference between the maximum and the minimum propagation delay on two consecutive telegrams, considering overall propagation and repeater delays, shall at no place exceed 4,0 BT.

The sum of the interframe spacings from one master frame to another master frame shall be larger than 9,0 BT.

NOTE 1 The default value of $T_{\text{reply_def}}$ of 42,7 μs limits the number of repeaters to four, and the transmitted distance to 2,0 km. Using a value larger than $T_{\text{reply_def}}$ is possible with certain precautions explained in the Extended Reply Delay mode (6.2.4.2).

NOTE 2 Fluctuations in propagation delay could reduce the interframe spacing and cause frame overlap. Repeaters may increase the interframe spacing, but overrun may occur if the above requirement is exceeded.

NOTE 3 Imposing a minimum sum of interframe spacings prevents a pair of fast master and slave from overrunning slower listeners.

4.3.3 Transceiver interface

The transceiver interface specifies for all types of media the interface between the Bus_Controller and the transceivers within a device.

This interface can remain internal to a device, but it is recommended to make it available for testing. This interface is not covered by conformance testing.

The transceiver interface is defined as an electrical interface operating with binary signals.

The transceiver interface assumes that the medium takes two distinct levels, a HIGH level and a LOW level. The HIGH and LOW levels are defined for each media.

If exposed, the transceiver interface shall consist of the following signals:

- a) TxS: Transmitter_Signal

This signal controls the level of the medium. It is "0" when the medium is at the LOW level, or a "1" when the medium is at the HIGH level.

b) TxE: Transmitter_Enable

This signal becomes "1" to enable the transmitter. This signal is not needed for optical transmission. Its timing is defined for each medium.

c) RxS: Receiver_Signal

This signal expresses the state of the medium. It is "0" when the line is at the LOW level, "1" when the line is at the HIGH level. The receiver interprets undefined levels, either as LOW or as HIGH. There is no defined level when no transmitter is active, although some media define an idle level (generally LOW).

Figure 4 illustrates the transceiver interface for all three media.

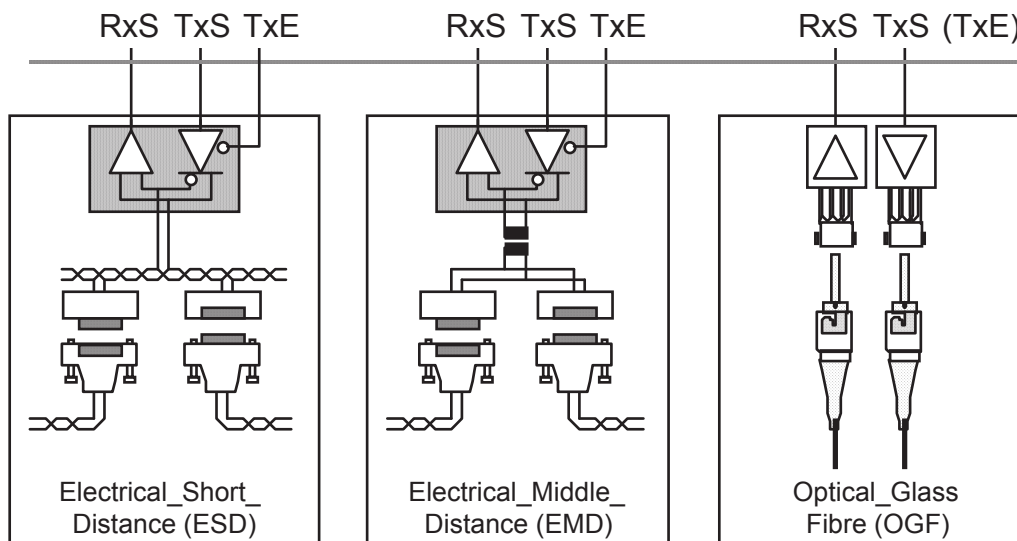


Figure 4 – Transceiver interface

4.3.4 Redundant medium (option)

For applications which need a high availability, this subclause defines a redundancy scheme, in which the bus may be either fully duplicated (all segments are double-line) or partially duplicated (include single-line segments and double-line segments). In case this option is used, the following specifications apply.

4.3.4.1 Identification

A double-line segment shall consist of two lines, operated in parallel.

All devices connected to a double-line segment shall identify the same line as Line_A, and the other line as Line_B.

4.3.4.2 Layout

The layout of the busses and their loading shall ensure close propagation conditions on both lines of a double-line segment, to meet 5.2.2.2.

The layout shall take precautions to ensure fail-independence of the redundant lines.

4.3.4.3 Connection between single-line and double-line segments

When a double-line segment is connected to another double-line segment by a repeater, there shall be an independent repeater for each Line_A and Line_B, and the identification of Line_A and Line_B shall be maintained over this connection.

When a double-line segment is connected to a single-line segment by one repeater, the repeater shall be connected to both lines on one side and to one line on the other, as specified in 5.3.2.

4.4 Electrical Short Distance medium (choice)

The specifications of the Electrical Short Distance medium allow segments with up to 32 devices over a distance of up to 20 m without galvanic separation. Actually, the covered distance and the number of devices are limited by the distortion caused by cables, connectors and devices, by the ground quality and by the disturbance levels, and can be increased by providing galvanic isolation.

4.4.1 ESD topology

The ESD medium shall consist of two conductors (with an additional equipotential conductor), terminated and biased at each end, to which the devices are attached by short stubs.

EXAMPLE The principle connection of an ESD segment is shown in Figure 5.

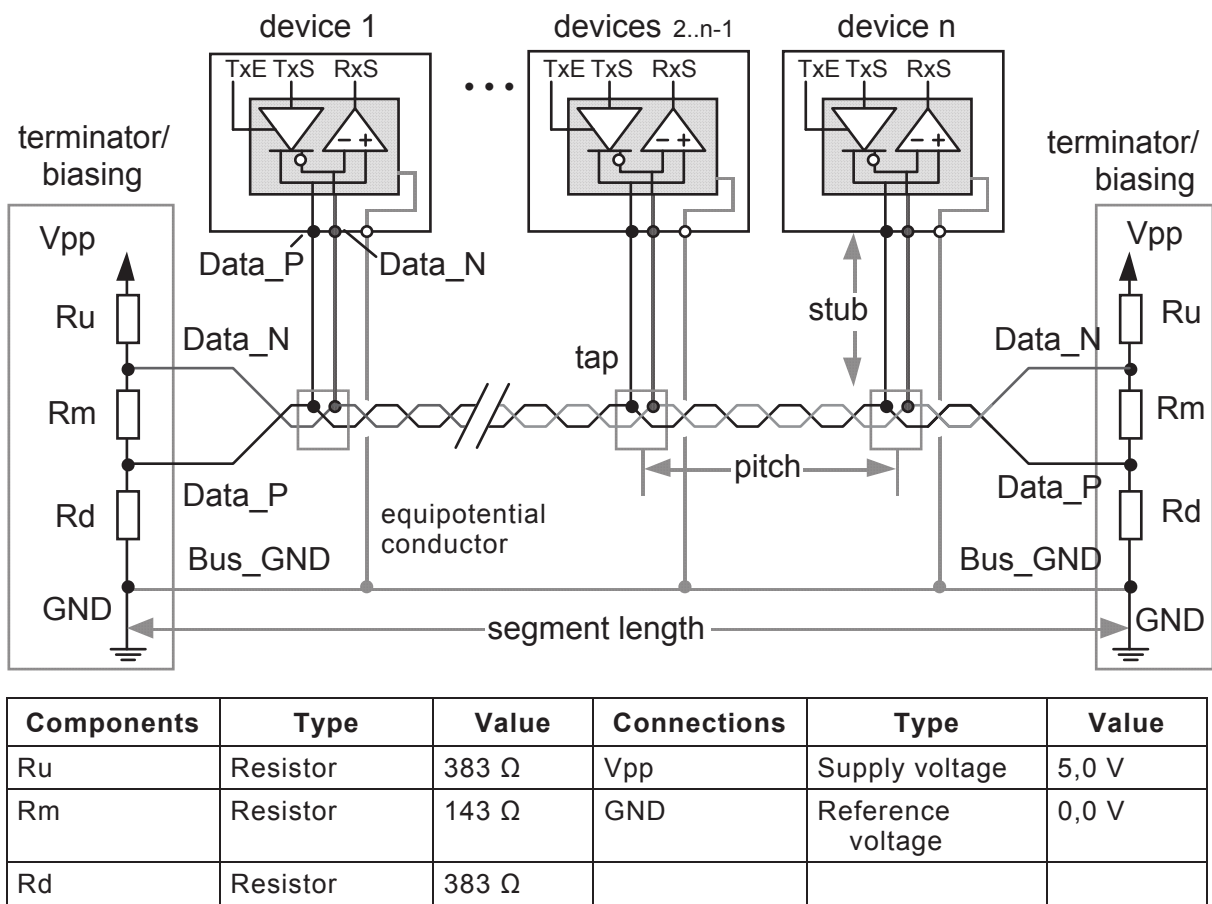


Figure 5 – Example of ESD segment

4.4.2 ESD configuration rules

4.4.2.1 ESD transmission medium

An ESD line shall consist of a pair of conductors, preferably twisted and shielded, with an equipotential conductor running in parallel.

4.4.2.2 ESD identification

The two conductors of a line shall be named Data_P and Data_N.

Throughout a line, the conductors Data_P and Data_N shall be marked distinctly.

The identity of the conductors shall be maintained at all connection or splicing points.

The equipotential conductor shall be called Bus_GND and marked distinctly.

4.4.2.3 ESD characteristic impedance

The characteristic impedance of the unloaded line shall be $120,0 \Omega \pm 10 \%$ at 1,0 BR.

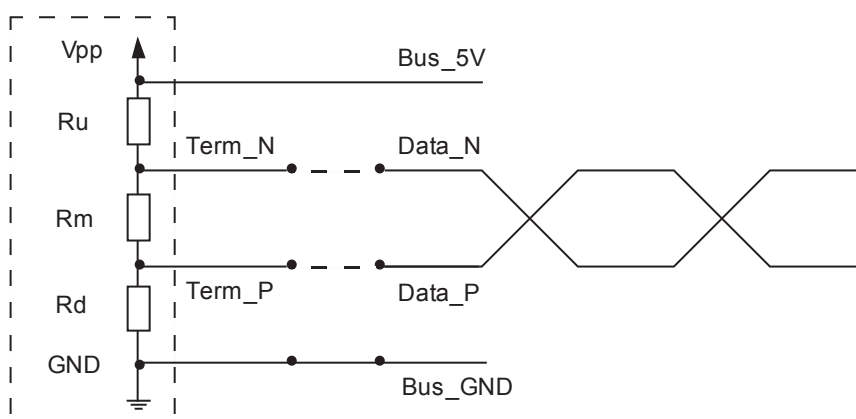
4.4.2.4 ESD terminator

An ESD segment shall be terminated electrically at each end by a terminator.

The terminator shall present an impedance of $120,0 \Omega \pm 2 \%$ measured at 1,0 BR.

The terminator shall bias the wire pair, so that the potential of the Data_P wire is lower by at least $0,750 \text{ V} \pm 10 \%$ with respect to the Data_N wire when no transmitter is active.

EXAMPLE The terminator shown in Figure 6 presents an impedance of $120,5 \Omega$ and biases the line with about 0,786 V. Note that the Vpp source shall have a very low inner impedance in the frequency range of 0,5 BT until 2 BT in order that the equivalent terminator impedance seen by the line is within the specified tolerance. Resistors are belonging from the E96 series 1 % tolerance.



Components	Type	Value	Connections	Type	Value
Ru	Resistor	383Ω	Vpp	supply voltage	5,0 V
Rm	Resistor	143Ω	GND	reference voltage	0,0 V
Rd	Resistor	383Ω			

Figure 6 – Example of terminator

4.4.2.5 ESD attenuation due to the medium

The total voltage attenuation between any two devices located on the same line shall not exceed 8,0 dB.

For this test, the attenuation is measured by applying at one terminator a sinusoidal signal of differential amplitude of $4,0 \text{ Vpp} \pm 10 \%$ ($1,414 \text{ V r.m.s.}$) at 2,0 BR, and by measuring the signal at the other terminator.

4.4.2.6 ESD jitter due to devices, connectors and cabling

A line, with all devices and connectors in place, terminated by its characteristic impedance shall add no more than $\pm 0,1 \text{ BT}$ of edge jitter, referenced to the idealised zero-crossings.

For this test, jitter is measured by driving the line at one terminator by a source of differential amplitude $4,0 \text{ Vpp} \pm 10 \%$, centred on 0,0 V, through a source impedance of $22,0 \Omega \pm 10 \%$ and generating as signal a pseudo-random sequence of "0" and "1" Manchester symbols with a repetition period of at least 511 bits, the signal being measured at the other terminator.

NOTE 1 Interference and reflection due to impedance mismatches between the line sections, stubs, connectors or load clustering can introduce jitter in the timing of the zero-crossings.

NOTE 2 This test method is specified in ISO/IEC 8802-3.

4.4.3 ESD section specifications

The ESD specifications apply to two kinds of sections:

- a) the backplane section is used in enclosures, such as racks and cabinets, where no galvanic separation is required, over distances of up to 20,0 m;
- b) the cable section is used to connect devices outside of enclosures, with or without galvanic separation. In case galvanic separation is used, distances of up to 200,0 m can be covered.

4.4.3.1 ESD backplane section

If a backplane bus is used as a medium, the following specifications apply.

The maximum extension of a stub shall be 10,0 cm, measured from the track to the transceiver input.

The pitch between adjacent taps shall be not less than 2,0 cm to avoid load clustering.

4.4.3.2 ESD cable section

If a cable section is used as a medium, the specifications of the EMD cable shall apply.

In addition, the following specifications hold:

- a) a cable used for ESD shall carry at least one equipotential wire per line pair;
- b) the equipotential wire of an ESD cable shall be identified as A.Bus_GND (for Line_A) and B.Bus_GND (for Line_B, in case two redundant lines are used).

NOTE The cross-sectional area of the equipotential wire may be different from that of the data wire pair.

4.4.4 ESD shielding

The shield of the cable shall be connected to the casing of each connector, which shall be of conductive material.

The casing of the connector shall make electrical contact with the receptacle of the device when inserted.

The shield of the cable shall not be used in place of Bus_GND.

4.4.5 ESD medium-dependent interface

NOTE The Medium-dependent interface is described for a double-line segment, even when this option is not used.

4.4.5.1 ESD attachment

A device shall be attached to Line_A and/or Line_B through independent connection points, identified as shown in Figure 7 as:

- A.Data_P and A.Data_N; respectively
- B.Data_P and B.Data_N.

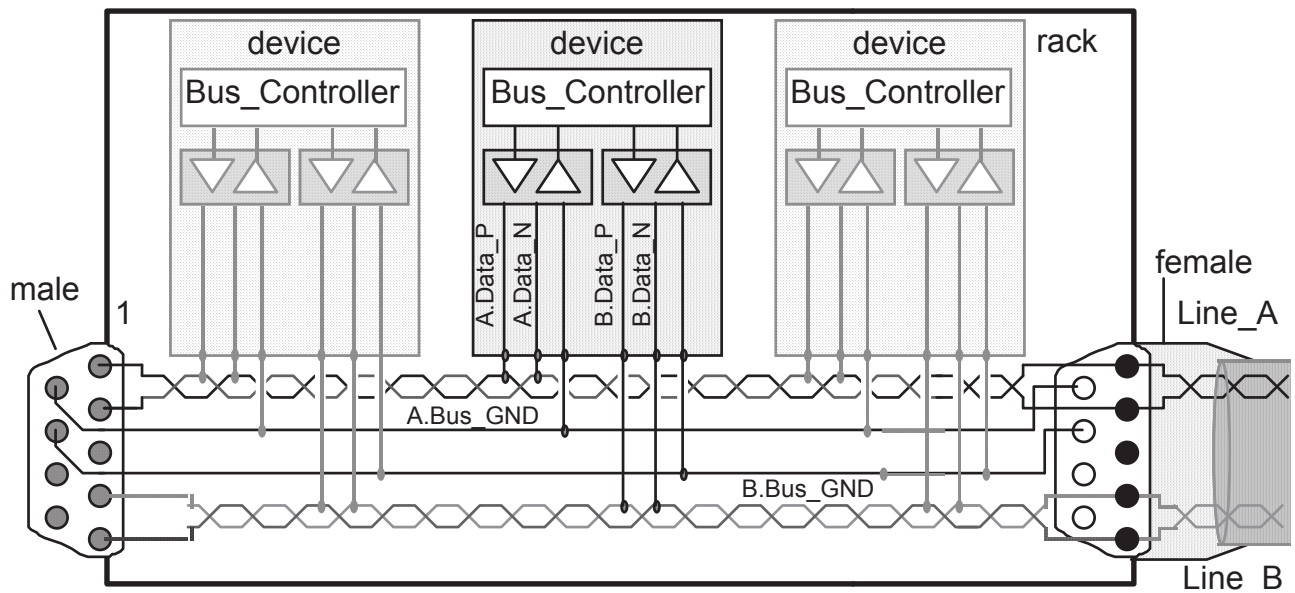


Figure 7 – ESD backplane section (double-line)

NOTE 1 This scheme encompasses a redundancy scheme in which the two redundant lines use independent twisted pairs sharing the same cable and connector. This scheme offers protection against wire, pin contact and transceiver failure, but not against cable rupture or connector removal. Field experience shows that the risks of the latter are minor.

NOTE 2 In applications where separate connectors and cables are required, the connector pin-out should be the same as for the two-connector attachment and it should have the same polarity (male or female) as a single line section.

4.4.5.2 ESD connector

Where interchangeability is required, devices shall be attached to the cable as follows:

- each device shall be inserted into the cable by two 9-pin Sub-D 9 connectors using metric screws (IEC 60807), called Connector_1 and Connector_2;
- the connector shall have a shielded, conductive casing connected to the cable shield and which makes an electrical contact with the receptacle when fastened;
- it shall be possible to connect and fasten cable connectors together, so as to provide cable and shield continuity;
- the connector (male or female) shall have the pin assignment indicated in Table 6;

- e) the connector receptacles shall be marked with “MVB-S1” and “MVB-S2” to identify the ESD medium;
- f) a cable section or a backplane section shall bear a male connector at one extremity and a female connector at the other extremity;
- g) the connectors shall have the polarity and arrangement shown in Figure 8;
- h) Connector_1 shall use the male connector on the device and the female on the cable;
- i) Connector_2 shall use the female connector on the device and the male on the cable;
- j) a device or a rack shall provide through the connector for each line a power supply of $5,0\text{ V} \pm 5\%$ with a minimum supply capability of 20,0 mA and limited to 300,0 mA, whose ground is connected to the equipotential conductor;

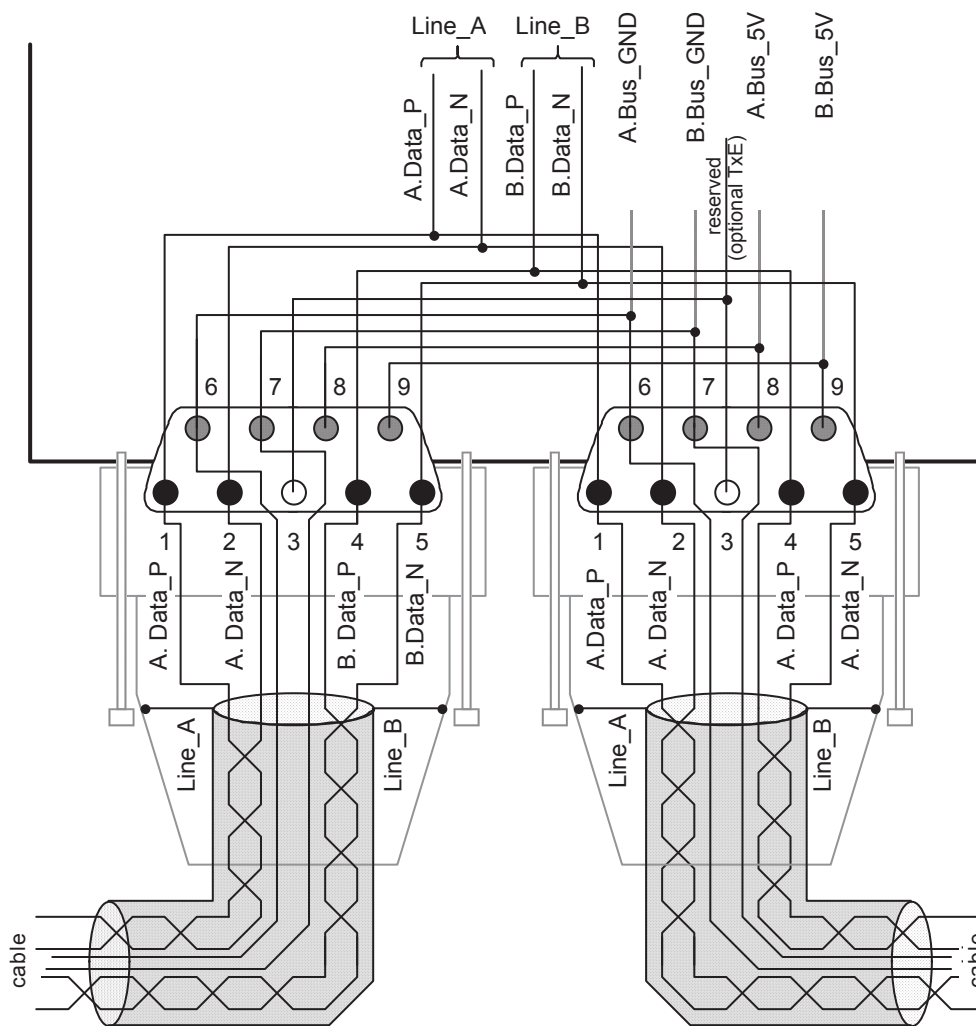


Figure 8 – ESD connector arrangement

Table 6 – Pin assignment for the ESD connector

1	A.Data_P, positive wire Line_A	6	A.Bus_GND, ground Line_A
2	A.Data_N, negative wire Line_A	7	B.Bus_GND, ground Line_B
3	TxE, see 4.3.3 (optional)	8	A.Bus_5V, positive supply Line_A
4	B.Data_P, positive wire Line_B	9	B.Bus_5V, positive supply Line_B
5	B.Data_N, negative wire Line_B		

NOTE 1 It is recommended to arrange the two connectors side by side on the front plate of a device, Connector_1 on the left and Connector_2 on the right, to thread the wiring neatly.

NOTE 2 It may be necessary to ensure that the connector case is isolated from the device case if connection of the device cases is not advisable, for instance when large stray currents are expected.

4.4.5.3 ESD connector of the terminator

The terminator shall be included into a connector, to be plugged into the empty receptacle of a device located at the end of the segment, according to the wiring shown in Figure 9:

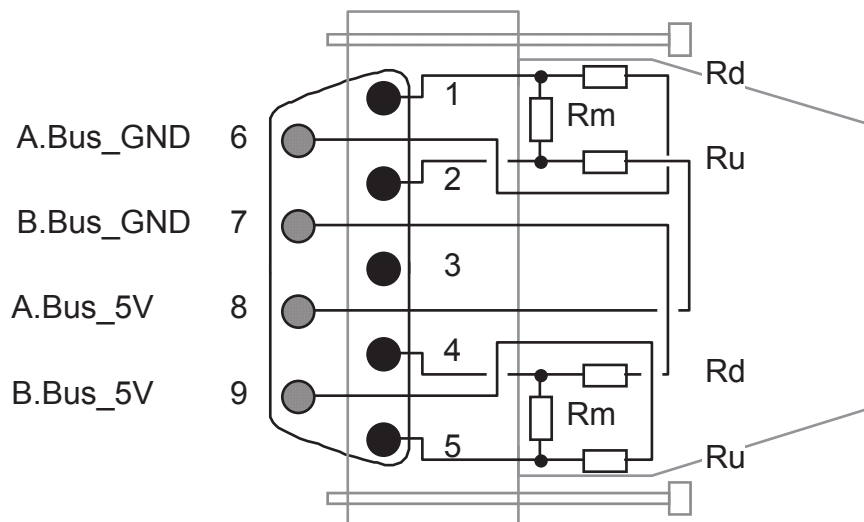


Figure 9 – ESD terminator connector arrangement

The connector containing the terminator for ESD shall be marked with a “MVB-S1”, respectively “MVB-S2”.

NOTE There are two kinds of terminator connector, male and female. The connectors for terminating ESD and EMD are distinct.

4.4.6 ESD Line_Unit specifications

4.4.6.1 ESD conventions (guideline)

The characteristics of each device are measured at the points where the line is attached to the device, Data_P, Data_N and Bus_GND, as shown in Figure 7.

When measuring a transmitter, the circuit of the receiver is in the normal receiving state. When measuring a receiver, the circuit of its transmitter is in a high impedance state.

If the device is attached through connectors, these are included into the measurement.

4.4.6.2 ESD insertion losses of a device

The load presented by a device shall conform to ISO/IEC 8482 (RS-485).

NOTE ISO/IEC 8482 specifies this value as 12 k at 1,0 BR.

4.4.7 ESD signal wave form

The medium shall take two distinct levels:

- a) a HIGH level in which voltage U_p on Data_P is greater than voltage U_n on Data_N, which shall correspond to a HIGH level of the TxS or RxS signals;