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Road vehicles — Local Interconnect Network (LIN) —

Part 1: General information and use case definition

Véhicules routiers — Réseau Internet local (LIN) —

Partie 1: Information générale et définition des cas d'usage

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 22, *Road vehicles*, Subcommittee SC 31, *Data communication*.

A list of all parts in the ISO 17987 series can be found on the ISO website.

Introduction

ISO 17987 (all parts) specifies the use cases, the communication protocol and the physical layer requirements of an in-vehicle communication network called Local Interconnect Network (LIN).

The LIN protocol as proposed is an automotive focused low speed universal asynchronous receiver transmitter (UART) based network. Some of the key characteristics of the LIN protocol are signal-based communication, schedule table based frame transfer, master/slave communication with error detection, node configuration and diagnostic service transportation.

The LIN protocol is for low-cost automotive control applications, for example, door module and air condition systems. It serves as a communication infrastructure for low-speed control applications in vehicles by providing:

— signal-based communication to exchange information between applications in different nodes;

— bitrate support from 1 kbit/s to 20 kbit/s;

— deterministic schedule table-based frame communication;

— network management that wakes up and puts the LIN cluster into sleep state in a controlled manner;

— status management that provides error handling and error signalling;

— transport layer that allows large amount of data to be transported (such as diagnostic services);

— specification of how to handle diagnostic services;

— electrical physical layer specifications;

— node description language describing properties of slave nodes;

— network description file describing behaviour of communication;

— application programmer's interface.

ISO 17987 (all parts) is based on the open systems interconnection (OSI) Basic Reference Model as specified in ISO/IEC 7498-1 which structures communication systems into seven layers.

The OSI model structures data communication into seven layers called (top down) *application layer* (layer 7), *presentation layer*, *session layer*, *transport layer*, *network layer*, *data link layer* and *physical layer* (layer 1). A subset of these layers is used in ISO 17987 (all parts).

ISO 17987 (all parts) distinguishes between the services provided by a layer to the layer above it and the protocol used by the layer to send a message between the peer entities of that layer. The reason for this distinction is to make the services, especially the application layer services and the transport layer services, reusable also for other types of networks than LIN. In this way, the protocol is hidden from the service user and it is possible to change the protocol if special system requirements demand it.

ISO 17987 (all parts) provides all documents and references required to support the implementation of the requirements related to the following.

— ISO 17987-1: This part provides an overview of the ISO 17987 (all parts) and structure along with the use case definitions and a common set of resources (definitions, references) for use by all subsequent parts.

— ISO 17987-2: This part specifies the requirements related to the transport protocol and the network layer requirements to transport the PDU of a message between LIN nodes.

— ISO 17987-3: This part specifies the requirements for implementations of the LIN protocol on the logical level of abstraction. Hardware-related properties are hidden in the defined constraints.

— ISO 17987-4: This part specifies the requirements for implementations of active hardware components which are necessary to interconnect the protocol implementation.

— ISO/TR 17987-5: This part specifies the LIN application programmers interface (API) and the node configuration and identification services. The node configuration and identification services are specified in the API and define how a slave node is configured and how a slave node uses the identification service.

— ISO 17987-6: This part specifies tests to check the conformance of the LIN protocol implementation according to ISO 17987-2 and ISO 17987-3. This comprises tests for the data link layer, the network layer and the transport layer.

— ISO 17987-7: This part specifies tests to check the conformance of the LIN electrical physical layer implementation (logical level of abstraction) according to ISO 17987-4.

Road vehicles — Local Interconnect Network (LIN) —

Part 1:
General information and use case definition

1 Scope

This document gives an overview of the structure and the partitioning of ISO 17987 (all parts). In addition, it outlines the use case where the ISO 17987 (all parts) will be used. The terminology defined in this document is common for all LIN communication systems and is used throughout ISO 17987 (all parts).

This document has been established in order to define the use cases for LIN.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 17987-4, *Road vehicles — Local Interconnect Network (LIN) — Part 4: Electrical Physical Layer (EPL) specification 12 V/24 V*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
break field
entity that consists of a dominant part, the break and a recessive part, the break delimiter

3.1.2
byte field
10 bit entity, which consists of a dominant start bit, 8 bit payload (least significant bit first) and a recessive stop bit

3.1.3
checksum
frame verification byte

3.1.4
frame
entity that consists of the header and the PDU including payload and a *checksum* (3.1.3) byte at the end

3.1.5
LIN master
unique node in a LIN network that schedules the *frames* (3.1.4) and connected to a back bone network

3.1.6
LIN slave
node that serves the communication requests of a *LIN master* (3.1.5)

3.1.7
master task
task in the *LIN master* (3.1.5) sending all headers on the bus according to *schedule table* (3.1.10)

3.1.8
node address for diagnostics
NAD
diagnostic address assigned to each *LIN slave* (3.1.6) node

3.1.9
protected identifier
8 bit entity containing the 6 bit frame identifier (least significant bits) together with two parity bits

3.1.10
schedule table
list of *frames* (3.1.4) specifies the frames, their order and time distances to each other used for communication on the LIN bus

3.1.11
slave task
task in a LIN node responsible for listening to all headers on the bus and reacting accordingly, i.e. either publish a frame response or subscribe to it (or ignore it)

3.1.12
sync byte field
byte with fixed value located between the *break field* (3.1.1) and the *protected identifier* (3.1.9)

3.2 Abbreviated terms

API	application programmers interface
LDF	LIN description file
NAD	node address for diagnostics
OEM	original equipment manufacturer
OSI	open systems interconnection
PDU	protocol data unit
PID	protected identifier
SAP	service access point
UC	use case
UDS	unified diagnostic services

4 Conventions

ISO 17987 (all parts) is based on the conventions specified in the OSI Service Conventions (see ISO/IEC 10731) as they apply for physical layer, data link layer, network and transport protocol and diagnostic services.

5 Use case overview and principles

5.1 Basic principles for use case definition

Basic principles have been established as a guideline to define the use cases:

— pointing out features which support usual operating modes of networked systems in OEM's products;

— pointing out features which support future expected properties of networked systems in OEM's products;

— comparing the contrast between normal operating functionalities in the absence of errors and limp-home operation functionalities in the presence of errors.

5.2 Use case clusters

This subclause defines use case clusters of the LIN communications system.

Table 1 provides an overview of the main LIN use case clusters. A main LIN use case cluster may have one or more use case definitions.

Table 1 — LIN communications system main use case clusters

Main title of use case cluster	Description
LIN master task	The purpose of these use cases is the description of LIN specific frame handling in the LIN master node based on schedule tables comprising frame order and timing.
LIN slave task	The purpose of these use cases is the description of main tasks slave nodes. Besides the frame processing, other tasks are reporting of errors to the LIN network, the reconfiguration of slave nodes and diagnostic capabilities.
LIN communication protocol	The purpose of these use cases is the description of the protocol-driven property range of systems and applications when using LIN for their internal communication.
LIN physical layer	The purpose of these use cases is the description of the electrical physical layer properties when interconnecting the logical links of the distributed LIN ECUs by electrical hardware components inside a vehicle.
LIN network management	The purpose of these use cases is the description of the LIN network management.

6 LIN communications system use case definition

6.1 UC 1 LIN master task cluster

6.1.1 UC 1.1 Generate LIN frame header

Table 2 specifies the use case of the generation of the LIN frame header.

Table 2 — Generate LIN frame header

Item	Definition
Goal	Run the communication according to the schedule table.
Actor	LIN master task
Use case input	Schedule frame is due for transportation
Use case output	Generating correct headers
Brief description	The master task is responsible for generating correct headers, i.e. deciding which frame shall be sent and for maintaining the correct timing between frames.
Classification	Mandatory

6.2 UC 2 LIN slave task cluster

6.2.1 UC 2.1 Break/sync byte field sequence detector

Table 3 specifies the use case of the break/sync byte field sequence detector.

Table 3 — Break/sync byte field sequence detector

Use case name	Break/sync byte field sequence detector
Goal	Monitoring for presence of break/sync byte field.
Actor	LIN slave task in a slave node
Use case input	Operational mode
Use case output	Detecting the beginning of a new frame
Brief description	The detector is required to be synchronized at the beginning of the protected identifier of a frame and be able to receive the protected identifier field correctly.
Classification	Mandatory

6.2.2 UC 2.2 LIN frame processor

Table 4 specifies the use case to transmit and receive LIN frame responses.

Table 4 — LIN frame processor

Use case name	LIN frame processor
Goal	Transmitting the frame response when it is the publisher and receiving the frame response when it is the subscriber.
Actor	LIN slave task
Use case input	Beginning of new frame
Use case output	Transmitted data from and to the node
Brief description	The task evaluates the protected identifier (slave node: protected identifier is received, master node: protected identifier is taken from schedule slot definition), decides if the frame is Rx, Tx or if the node is not addressed. In case of Tx/Rx, the response data and checksum is transmitted/received. In case of not addressed, the response is ignored.
Classification	Mandatory

6.2.3 UC 2.3 Slave node configuration

Table 5 specifies the use case to perform a slave node configuration.

Table 5 — Slave node configuration

Use case name	Slave node configuration
Goal	Adapt a slave node to a new LIN cluster.
Actor	LIN master and LIN slave node
Use case input	LDF of LIN cluster
Use case output	Slave node with adapted configured NAD and PIDs according to the LDF
Brief description	If a slave node is reused in a new network, some parameters have to be adapted to allow communication without conflicts. The master node can assign a slave node a new configured NAD and a new set of PIDs to perform this adaptation. Depending on the capabilities of the slave node, the new configuration is saved to volatile or non-volatile. Diagnostic messages are used for this configuration task with service IDs in the range $B0_{16}$ to $B8_{16}$.
Classification	Optional

6.2.4 UC 2.4 Slave error status reporting

Table 6 specifies the use case of slave error status reporting.

Table 6 — Slave error status reporting

Use case name	Slave error status reporting
Goal	Provide the master node error status information.
Actor	Slave task in a slave node
Use case input	Data link layer communication monitoring
Use case output	Status signal response_error which is transmitted in one of the slave node transmit frames.
Brief description	The data link layer permanently monitors the LIN communication. If an error is detected in the response field of a frame that is either received or transmitted by the slave node, the response_error signal is set. The master node can evaluate and aggregate this status from each slave node and derive a cluster status from this. The slave node conformance test uses this status signal to observe the correct behaviour of the slave node.
Classification	Mandatory for slave nodes, cluster status aggregation is optional for the master node

6.2.5 UC 2.5 Diagnostic slave node capabilities

Table 7 specifies the use case of diagnostic slave node capabilities.

Table 7 — Diagnostic slave node capabilities

Use case name	Diagnostic slave node capabilities
Goal	Provide slave node diagnostic capabilities to a master or diagnostic testing tool.
Actor	Slave node as a diagnostic server, master as a diagnostic client
Use case input	Slave node diagnostic session layer
Use case output	UDS-based diagnostic communication
Brief description	Depending on the diagnostic class of a slave node, different level of diagnostic capabilities are provided. Slave nodes of diagnostic class II and III provide UDS-based services that allow a diagnostic client to access information such as serial number, fault states or even allow the reprogramming of slave node parameters or application program code. NOTE Class I slave nodes only require signal-based diagnostics.
Classification	Mandatory for diagnostic class II and III slave nodes.

6.3 UC 3 LIN communication protocol cluster

6.3.1 UC 3.1 Synchronization

Table 8 specifies the use case of synchronization.

Table 8 — Synchronization

Use case name	Synchronization
Goal	The node has the possibility to synchronize on the bitrate.
Actor	LIN slave node
Use case input	Sync byte field
Use case output	Slave node synchronized on master bitrate
Brief description	The synchronization procedure is based on measurements between falling edges of the sync byte field.
Classification	Mandatory – Optional for slave nodes with precise bit time capabilities that deviate less than specified in ISO 17987-4:—, 5.1.

6.3.2 UC 3.2 Checksum

Table 9 specifies the use case of checksum.

Table 9 — Checksum

Use case name	Checksum
Goal	Check for correct received frames.
Actor	LIN slave task
Use case input	Checksum
Use case output	Received valid data
Brief description	The checksum is used to validate the received frame.
Classification	Mandatory

6.3.3 UC 3.3 Slave bitrate detection

Table 10 specifies the use case of slave bitrate detection.

Table 10 — Slave bitrate detection

Use case name	Slave bitrate detection
Goal	Adapt communication speed to a LIN cluster.
Actor	Slave node
Use case input	Bitrate of the LIN master
Use case output	Adaptation of the slave node bitrate configuration
Brief description	Slave nodes which are used in different LIN cluster may support bitrate detection to adapt to different bitrate used in each cluster (e.g. 19,2 kbit/s and 9,6 kbit/s). After initialization, the first received LIN header will be measured (sync byte field) by the slave node and the bitrate register configuration will then be adapted accordingly. Slave nodes are by default not capable to handle the first frame in the LIN communication sequence due to adaptation of the bitrate during reception of the header. The second frame should be correctly handled by the slave node. The bitrate in a LIN cluster does not change during runtime but is constant.
Classification	Optional

6.4 UC 4 LIN physical layer cluster

6.4.1 UC 4.1 Performance in non-operation supply voltage range

Table 11 specifies the use case of performance in non-operation supply voltage range.

Table 11 — Performance in non-operation supply voltage range

Use case name	Performance in non-operation supply voltage range
Goal	Faultless communication during over-/undervoltage of one node.
Actor	Transceiver
Use case input	Over-/undervoltage
Use case output	Faultless communication
Brief description	The transmitter and receiver shall provide a recessive state.
Classification	Mandatory

6.4.2 UC 4.2 Loss of supply voltage

Table 12 specifies the use case of loss of supply voltage.

Table 12 — Loss of supply voltage

Use case name	Loss of supply voltage
Goal	Faultless communication during loss off supply voltage or ground of one node.
Actor	Transceiver
Use case input	Loss of supply connection
Use case output	Faultless communication
Brief description	The ECUs with loss of connection shall not interfere with normal communication among the remaining LIN participants.
Classification	Mandatory

6.5 UC 5 LIN network management

6.5.1 UC 5.1 LIN cluster network management

Table 13 specifies the use case of the LIN cluster network management.

Table 13 — LIN cluster network management

Use case name	LIN cluster network management
Goal	Energy saving, consistent network state transition between sleep and operational state.
Actor	LIN master node and LIN slave nodes
Use case input	Communication demand in one node, sleep demand in the master node
Use case output	Wake up frame or go-to-sleep command and transition to appropriate network state
Brief description	LIN communication is established if one LIN node has communication demand. Therefore, a wake-up frame can be transmitted by each LIN node in a sleeping LIN cluster. The master node starts communication by starting scheduling after some time. If the master node transmits a go-to-sleep command, all nodes enter sleep state. If the communication line is broken, all LIN nodes enter the sleep state after a defined timeout. NOTE This refers to LIN bus network management and not internal node power mode.
Classification	Mandatory for all slave and master nodes with sleep capabilities

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