DRAFT INTERNATIONAL STANDARD
ISO/DIS 17987-2.2

ISO/TC **22**/SC **31** Secretariat: **DIN**

Voting begins on: **2015-10-05** Voting terminates on: **2015-12-05**

Road vehicles — Local Interconnect Network (LIN) —

Part 2: **Transport protocol and network layer services**

Véhicules routiers — Réseau Internet local (LIN) —

Partie 2: Protocole de transport et couches de services réseau

ICS: 35.240.60; 43.040.15

THIS DOCUMENT IS A DRAFT CIRCULATED FOR COMMENT AND APPROVAL. IT IS THEREFORE SUBJECT TO CHANGE AND MAY NOT BE REFERRED TO AS AN INTERNATIONAL STANDARD UNTIL PUBLISHED AS SUCH.

IN ADDITION TO THEIR EVALUATION AS BEING ACCEPTABLE FOR INDUSTRIAL, TECHNOLOGICAL, COMMERCIAL AND USER PURPOSES, DRAFT INTERNATIONAL STANDARDS MAY ON OCCASION HAVE TO BE CONSIDERED IN THE LIGHT OF THEIR POTENTIAL TO BECOME STANDARDS TO WHICH REFERENCE MAY BE MADE IN NATIONAL REGULATIONS.

RECIPIENTS OF THIS DRAFT ARE INVITED TO SUBMIT, WITH THEIR COMMENTS, NOTIFICATION OF ANY RELEVANT PATENT RIGHTS OF WHICH THEY ARE AWARE AND TO PROVIDE SUPPORTING DOCUMENTATION.

Reference number
ISO/DIS 17987-2.2:2015(E)

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 17987-2 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 31, *Electrical and electronic equipment*.

ISO 17987 consists of the following parts, under the general title *Road vehicles — Local Interconnect Network (LIN)*:

— *Part 1: General information and use case definition*

— *Part 2: Transport protocol and network layer services*

— *Part 3: Protocol specification*

— *Part 4: Electrical Physical Layer (EPL) specification (12 V/24 V)*

— *Part 5: Application Programmers Interface (API)*

— *Part 6: Protocol conformance test specification*

— *Part 7: Electrical Physical Layer (EPL) conformance test specification*

Introduction

This document set specifies the use cases, the communication protocol and 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 UART-based network (Universal Asynchronous Receiver Transmitter). 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 mode 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 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.

ISO 17987 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.

This document set provides all documents and references required to support the implementation of the requirements related to.

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

— Part 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.

— Part 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.

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

— Part 5 (published as a non-normative technical report):
This part specifies the LIN API (Application Programmers Interface) 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.

— Part 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.

— Part 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 2: Transport protocol and network layer services

1 Scope

This part of ISO 17987 specifies a transport protocol and network layer services tailored to meet the requirements of LIN-based vehicle network systems on local interconnect networks. The protocol specifies an unconfirmed communication.

The LIN protocol supports the standardized service primitive interface as specified in ISO 14229-2.

This part of ISO 17987 provides the transport protocol and network layer services to support different application layer implementations like

— Normal communication messages;

— Diagnostic communication messages;

The transport layer defines transportation of data that is contained in one or more frames. The transport layer messages are transported by diagnostic frames. A standardized API is specified for the transport layer.

Use of the transport layer is targeting systems where diagnostics are performed on the backbone bus (e.g. CAN) and where the system builder wants to use the same diagnostic capabilities on the LIN sub-bus clusters. The messages are in fact identical to the ISO 15765-2 and the PDUs carrying the messages are very similar.

The goals of the transport layer are

— low load on LIN master node;

— to provide full (or a subset thereof) diagnostics directly on the LIN slave nodes;

— targeting clusters built with powerful LIN nodes (not the mainstream low cost);

A typical system configuration is shown in Figure 1.

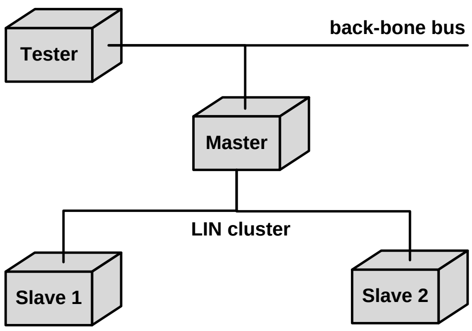

Figure 1 — Typical system setup for a LIN cluster using the transport layer

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.

ISO 17987 (Part 2, 4, 6 and 7), *Road vehicles – Local Interconnect Network (LIN)*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 7498-1 apply.

3.1.1
Broadcast NAD
Any slave node receiving a message with a NAD equal to the broadcast NAD $7F_{16}$ the message is received and processed.

3.1.2
Configured NAD
Each of the slave nodes requires a unique configured NAD which is used for node configuration and identification services as well as UDS services according to ISO 14229-7. The assignment of configured NAD is defined in the LDF.

- The master node can assign new configured NADs to slave nodes supporting the "Assign NAD" service. The configured NAD is in the range [01_{16} – $7D_{16}$].
- An API alternatively used in a slave node to assign the configured NAD.
- The configured NAD is assigned with a static configuration

3.1.3
Functional NAD
($7E_{16}$) Used to broadcast diagnostic requests

3.1.4
Initial NAD
Each of the slave nodes shall have an initial NAD. The combination of initial NAD, Suppler ID and Function ID shall be unique in a LIN cluster. The initial NAD value is constant/static and may be derived before entering the operational state (regular LIN communication) from a pin configuration, EEPROM or slave node position detection algorithms. The initial NAD is used to assign a unique configured NAD. If no initial NAD is defined for a slave node (LDF, NCF) the value is identical to the configured NAD. The initial NAD is in the range of [01_{16} – $7D_{16}$]

3.1.5
P2 timing parameter
Application timing parameter for the ECU(s) and the external test equipment

3.1.6
P2* timing parameter
Enhanced response timing parameter for the ECU(s) application after response pending frame transmission

3.1.7
P4 timing parameter
Timing parameter for the ECU(s) application defining the time between reception of a request and the final response

3.1.8

Proprietary NAD

NAD values in the range [80_{16} – FF_{16}] are used for not standardized communication purpose such as Tier-1 slave node diagnostics.

3.2 Symbols

%	percentage
µs	microsecond
ms	millisecond
|	The vertical bar indicates choice. Either the left hand side or the right hand side of the vertical bar shall appear

3.3 Abbreviated terms

API	application programmers interface
BNF	Bachus-Naur format
CF	ConsecutiveFrame
FF	FirstFrame
LDF	LIN description file
L_Data	data link data
MRF	master request frame
N_AI	network address information
N_As	network layer timing parameter As
N_As_{max}	timeout on As
N_Cr	network layer timing parameter Cr
N_Cr_{max}	timeout on Cr
N_Cs	network layer timing parameter Cs
N_Cs_{max}	timeout on Cs
N_Data	network data
N_PCI	network protocol control information
N_PCItype	network protocol control information type
N_PDU	network protocol data unit

N_SA	network source address
N_SDU	network service data unit
N_TAtype	network target address type
N_USData	network layer LIN data transfer service name
NAD	node address for slave nodes
NCF	node capability file
NCL	node capability language
NRC	negative response code
NWL	network layer
OBD	on-board diagnostics
OSI	Open Systems Interconnection
PDU	protocol data unit
PID	protected identifier
RSID	response service identifier
SF	SingleFrame
SID	service identifier
SN	SequenceNumber
SRF	slave response frame
ST_{min}	SeparationTime minimum

4 Conventions

ISO 17987 (all parts) and ISO 14229-7 [5] are based on the conventions specified in the OSI Service Conventions (ISO/IEC 10731) [2] as they apply for physical layer, protocol, transport protocol & network layer services and diagnostic services.

5 Network management

5.1.1 Network management general information

Network management in a LIN cluster refers to cluster wake up and go-to-sleep only. Other network management features, e.g. configuration detection and limp home management are left to the application.

5.1.2 LIN node communication state diagram

The state diagram in Figure 2 shows the behaviour model for LIN communication state.

— Bus Sleep
Bus Sleep state is entered after first connection to power source and the system initialization, reset or when a go-to-sleep command is transmitted by the master or received by the slave node. The level on the bus is set to recessive. Only the wake up signal may be transmitted on the cluster.

— Operational
The protocol behaviour (transmitting and receiving frames) specified in this document only applies to the Operational state.

Note: The LIN 'Bus Sleep' state does not necessarily correlate to the node's power state.

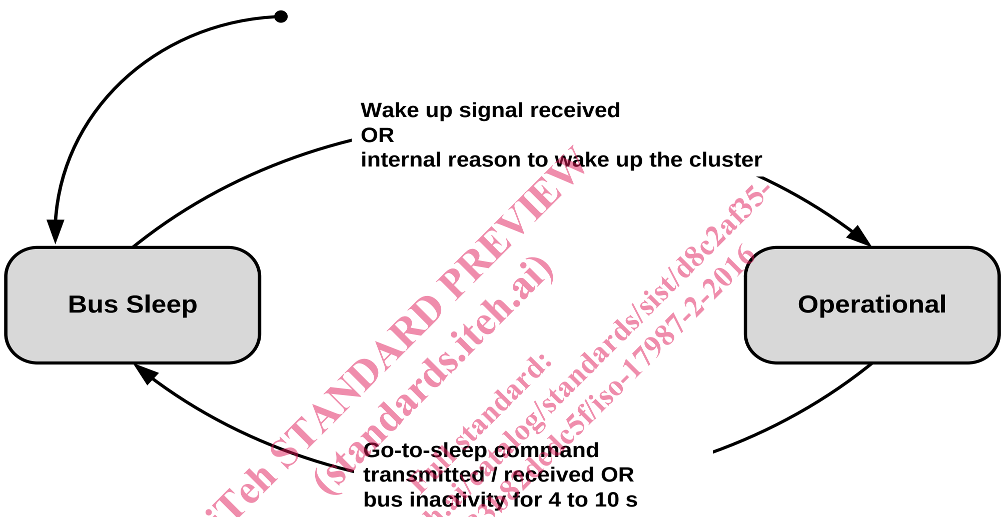

Figure 2 — LIN node communication state diagram

5.1.3 Wake up

5.1.3.1 Wake up general information

Any node in a sleeping LIN cluster may request a wake up, by transmitting a wake up signal. The wake up signal is started by forcing the bus to the dominant state for 250 µs to 5 ms, and is valid with the return of the bus signal to the recessive state.

5.1.3.2 Master generated wake up

The master node may issue a break field, e.g. by issuing an ordinary header since the break acts as a wake up signal (in this case the master shall be aware of that this frame may not be processed by the slave nodes since they may not yet awake and ready to listen to headers).

Every slave node (connected to power) should detect the wake up signal (a dominant pulse longer than 150 µs followed by a rising edge of the bus signal) and be ready to listen to bus commands within 100 ms, measured from the ending edge of the dominant pulse, see Figure 3. The check for the rising edge shall be done by the transceiver and also could be done by the microcontroller LIN interface.

A detection threshold of 150 µs combined with a 250 µs pulse generation gives a detection margin that is enough for uncalibrated slave nodes. Following the detection of the wake up pulse, the Slave task machine