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Road vehicles — Local Interconnect Network (LIN) —

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

Véhicules routiers — Réseau Internet local (LIN) —

Partie 7: Spécification d'essai de conformité de la couche électrique physique (EPL)

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Foreword

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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.

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ISO 17987-7 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *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 Local interconnect network (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 kbps to 20 kbps;

— 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;

To achieve this, it is based on the Open Systems Interconnection (OSI) Basic Reference Model specified in ISO/IEC 7498-1 and ISO/IEC 10731, which structures communication systems into seven layers. When mapped on this model, the protocol and physical layer requirements specified by ISO 17987 are structured according to Table°1.

Table°1°—°LIN specifications applicable to the OSI layers

Applicability	OSI seven layer	LIN	Vehicle manufacturer enhanced diagnostics
Seven layer according to ISO°7498-1 and ISO/IEC 10731	Application (layer 7)	ISO 17987-1, ISO 17987-5	ISO°14229-1, ISO°14229-7
	Presentation (layer 6)	ISO 17987-5	vehicle manufacturer specific
	Session (layer 5)	ISO 17987-3	ISO°14229-2
	Transport (layer 4)	ISO 17987-2	
	Network (layer 3)		
	Data link (layer 2)	ISO 17987-3, ISO 17987-6	
	Physical (layer 1)	ISO 17987-4, ISO 17987-7	

ISO 17987 Parts 2, 3, 4, 6 and 7 being the common standards for the OSI layers 1 through 3 for LIN and the vehicle manufacturer enhanced diagnostics.

The vehicle manufacturer enhanced diagnostics column shows application layer services covered by ISO 14229-7 which have been defined in compliance with diagnostic services established in ISO 14229-1, but are not limited to use only with them. ISO 14229-7 is also compatible with most diagnostic services defined in national standards or vehicle manufacturer's specifications. The presentation layer is defined vehicle manufacturer specific. The session layer services are covered by ISO 14229-2. The transport protocol and network layer services are specified in ISO 17987-2.

Road vehicles — Local interconnect network (LIN) — Part 7: Electrical Physical Layer (EPL) conformance test specification

1 Scope

This part of ISO 17987 specifies the conformance test for the electrical physical layer of the LIN communications system.

It is part of this document to define a test that considers ISO 9646 and ISO 17987-4.

The purpose of this document is to provide a standardized way to verify whether a LIN bus driver is compliant to ISO 17987-4. The primary motivation is to ensure a level of interoperability of LIN bus drivers from different sources in a system environment.

This document shall provide all necessary technical information to ensure that test results will be identical even on different test systems, provided that the particular test suite and the test system are compliant to the content of this document.

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 17987-1, *Road vehicles – Local interconnect network (LIN) – Part 1: General information and use case definition*

ISO 17987-2, *Road vehicles – Local interconnect network (LIN) – Part 2: Transport protocol and network layer services*

ISO 17987-3, *Road vehicles – Local interconnect network (LIN) – Part 3: Protocol specification*

ISO 17987-4, *Road vehicles – Local interconnect network (LIN) – Part 4: Electrical Physical Layer (EPL) specification 12V/24V*

ISO 17987-5, *Road vehicles – Local interconnect network (LIN) – Part 5: Application Programmers Interface (API)*

ISO 17987-6, *Road vehicles – Local interconnect network (LIN) – Part 6: Protocol conformance test specification*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definition defined in ISO 17987-4 apply.

3.2 Symbols

%	percentage
µs	microsecond
C1/2	capacitance
C_{COMMON}	capacitance in the communication line
$C`_{LINE}$	line capacitance
C_{BUS}	total bus capacitance
C_{MASTER}	capacitance of master node
C_{REF}	reference capacitance
C_{RXD}	RXD capacitance (LIN receiver, RXD capacitive load condition)
C_{SLAVE}	capacitance of slave node
∈	mathematical symbol: replacement for “is an element of”
d^2V/dt^2	second derivative of Voltage (Volt² per second²)
di/dt	instantaneous rate of current change (amps per second)
D1/2	diode
D_{ser_int}	serial internal diode at Transceiver IC
D_{ser_master}	serial master diode
$F_{TOL\_RES\_MSTR\_A}$	master bit rate tolerances of resonator relative to nominal bitrate in class A systems
$F_{TOL\_RES\_MSTR\_B}$	master bit rate tolerances of resonator relative to nominal bitrate in class B systems
$F_{TOL\_RES\_SLV\_A}$	slave bit rate tolerances of resonator relative to nominal bitrate in class A systems
$F_{TOL\_RES\_SLV\_B}$	slave bit rate tolerances of resonator relative to nominal bitrate in class B systems
$F_{TOL\_SYNCH\_A}$	slave node bit rate tolerance relative to master node bit rate after synchronization in class A systems
$F_{TOL\_SYNCH\_B}$	slave node bit rate tolerance relative to master node bit rate after synchronization in class B systems
$F_{TOL\_UNSYNCH\_A}$	slave node bit rate tolerance relative to nominal bit rate before synchronization in class A systems
$F_{TOL\_UNSYNCH\_B}$	slave node bit rate tolerance relative to nominal bit rate before synchronization in class B systems
I_{BUS}	current into the ECU bus line

I_{BUS_LIM}	current limitation for driver dominant state driver on $V_{BUS} = V_{BAT\_max}$ into ECU bus line
$I_{BUS\_NO\_BAT}$	current at ECU bus line when V_{BAT} is disconnected
$I_{BUS\_NO\_GND}$	current at ECU bus line when V_{GND_ECU} is disconnected
$I_{BUS\_PAS\_dom}$	current at ECU bus line when driver off (passive) at dominant LIN-bus-level (V_{BUS} = 0 V and V_{BAT} = 12 V)
$I_{BUS\_PAS\_rec}$	current at ECU bus line when driver off (passive) at recessive LIN-bus-level (8 V < V_{BAT} < 18 V; 8 V < V_{BUS} < 18 V; $V_{BUS} \geq V_{BAT}$
GND_{Device}	GND of ECU
kΩ	kilo ohm
kBit/s	kilo bit per second
LEN_{BUS}	total length of bus line
LIN_{Bus}	LIN network
ms	millisecond
nF	nano farad
pF	pico farad
pF/m	pico farad per meter (line capacitance)
R1/2	resistor
R_{COMMON}	resistor in the communication line
R_{BUS}	total bus-resistor including all slave and master resistors $R_{BUS} = R_{Master} \| R_{Slave1} \| R_{Slave2} \| ... \| R_{SlaveN}$
R_{REF}	reference resistor
R_{master}	master resistor
R_{pull_up}	pull-up resistor
R_{slave}	slave resistor
t_{BFS}	byte field synchronization time
t_{BIT}	basic bit times
t_{EBS}	earliest bit sample time
t_{rx_pd}	propagation delay of receiver
t_{rx_sym}	symmetry of receiver propagation delay rsising edgepropagation delay of receiver
t_{LBS}	latest bit sample time

$t_{rx\_pdf(1)}$ propagation delay time of receiving node 1 at falling (recessive to dominant) LIN bus edge

$t_{rx\_pdf(2)}$ propagation delay time of receiving node 2 at falling (recessive to dominant) LIN bus edge

$t_{rx\_pdr(1)}$ propagation delay time of receiving node 1 at rising (dominant to recessive) LIN bus edge

$t_{rx\_pdr(2)}$ propagation delay time of receiving node 2 at rising (dominant to recessive) LIN bus edge

t_{SR} sample window repetition time

$TH_{Dom(max)}$ maximum dominant threshold of receiving node (Volt)

$TH_{Dom(min)}$ minimum dominant threshold of receiving node (Volt)

$TH_{Rec(max)}$ maximum recessive threshold of receiving node (Volt)

$TH_{Rec(min)}$ minimum recessive threshold of receiving node (Volt)

V voltage

V_{ANODE} voltage at the anode of the diode

V_{BAT} voltage across the ECU supply connectors

$V_{BATTERY}$ voltage across the vehicle battery connectors

$V_{BS1/2}$ battery shift

V_{BUS} voltage on the LIN bus

V_{BUS_CNT} center point of receiver threshold

V_{BUS_dom} receiver dominant voltage

V_{BUS_rec} receiver recessive voltage

$V_{CATHODE}$ voltage at the cathode of the diode

$V_{CC1/2}$ positive power supply voltage (e.g. 5 V)

$V_{D1/2}$ voltage at diode between anode and cathode

V_{Dom} dominant voltage

$V_{GND1/2}$ ground shift

$V_{GND\_BATTERY}$ battery ground voltage

V_{GND_ECU} voltage on the local ECU ground connector with respect to vehicle battery ground connector ($V_{GND\_BATTERY}$)

V_{HYS} receiver hysteresis voltage

V_{IUT}	voltage at IUT supply pins
$V_{PS1/2}$	voltage at remote power supply no.1/no.2
V_{Rec}	recessive voltage
$V_{SerDiode}$	voltage drop at the serial diodes
V_{Shift_BAT}	battery shift
$V_{Shift\_Difference}$	difference between battery shift and GND shift
V_{Shift_GND}	GND shift
V_{SUP}	voltage at transceiver supply pins
V_{SUP_Device}	voltage at ECU supply pins
$V_{SUP\_NON\_OP}$	voltage which the device is not destroyed; no guarantee of correct operation
V_{th_dom}	receiver threshold voltage of the recessive to dominant LIN bus edge
V_{th_rec}	receiver threshold voltage of the dominant to recessive LIN bus edge
$\Delta F/F_{Nom}$	deviation from nominal bit rate
τ	time constant
Ω	ohm

3.3 Abbreviated terms

AC	alternate current
API	application programmers interface
ASIC	application specific integrated circuit
BFS	byte field synchronization
DC	direct current
EBS	earliest bit sample
EMC	electromagnetic compatibility
EMI	electromagnetic interference
EPL	electrical physical layer
ESD	electrostatic discharge
GND	ground

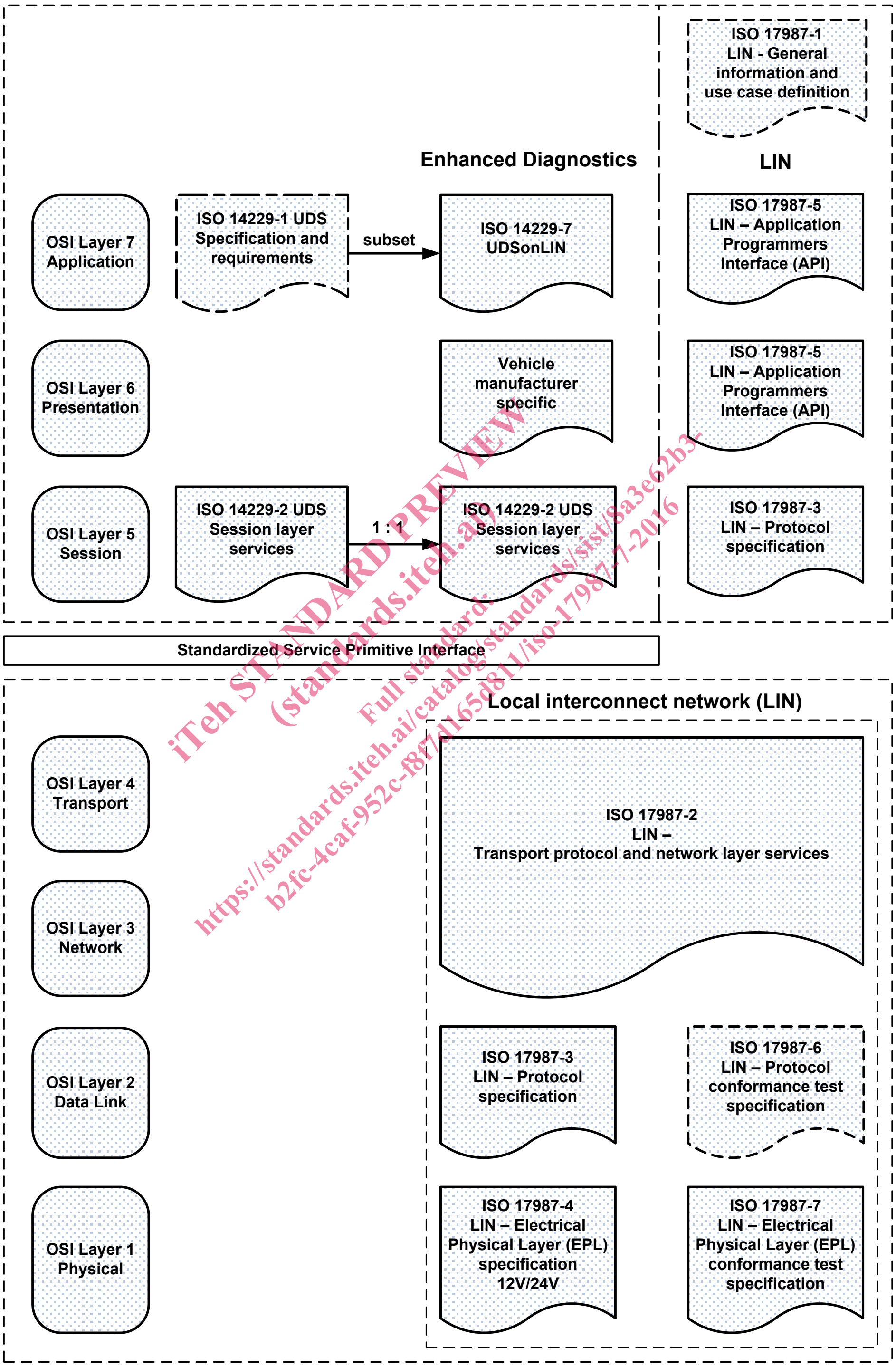
IUT	implementation under test
LBS	latest bit sample
Max	maximum
Min	minimum
no.	number
OSI	open systems interconnection
PDU	protocol data unit
RC	RC time constant τ ($\tau = C_{BUS} * R_{BUS}$)
RX	RX pin of the transceiver
RXD	receive data
SBC	system basis chip
SR	sample window repetition
TRX	transceiver
TX	TX pin of the transceiver
TXD	transmit data
Typ	typical
UART	universal asynchronous receiver transmitter

4 Conventions

ISO 17987 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, network & transport protocol and diagnostic services.

5 Document overview

Figure°1 illustrates the document reference according to OSI model.



Figure°1°— LIN document reference according to OSI model