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Road vehicles — Local Interconnect Network (LIN) —

Part 6:
Protocol conformance test specification

Véhicules routiers — Réseau Internet local (LIN) —
Partie 6: Spécification du protocole d'essai de conformité

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Contents

Page

Foreword vi

Introduction vii

1 Scope 1

2 Normative references 1

3 Terms, definitions, symbols and abbreviated terms 1
3.1 Terms and definitions 1
3.2 Symbols 1
3.3 Abbreviated terms 3

4 Conventions 4

5 General test specification considerations 4
5.1 General 4
5.2 Test conditions 4
5.3 Mandatory requirements for IUT as master 4
5.4 Mandatory requirements for IUT as slave 4
5.5 Test case architecture 5
5.6 Classification 5
5.7 Test system requirements 6
5.8 Test system definition 7
5.9 Global predefinitions for the test setup 7

6 Essential test cases before test start 9
6.1 General 9
6.2 [PT-CT 1] Diagnostic frame 'master request', IUT as slave 10
6.3 [PT-CT 2] Diagnostic frame 'slave response', IUT as slave 10
6.4 [PT-CT 3] Error in received frame, IUT as slave 11

7 Timing parameters 11
7.1 General 11
7.2 [PT-CT 4] Length of break field low phase, IUT as master 11
7.3 [PT-CT 5] Variation of length of break field low phase, IUT as slave 12
7.4 [PT-CT 6] Length of break delimiter, IUT as master 12
7.5 [PT-CT 7] Variation of length of break delimiter, IUT as slave 13
7.6 [PT-CT 8] Inconsistent break field error, IUT as slave 13
7.7 [PT-CT 9] Inconsistent sync byte field error, IUT as slave 14
7.8 [PT-CT 10] Verification of the sync byte field, IUT as master 14
7.9 [PT-CT 11] Incomplete frame reception, IUT as slave 15
7.10 [PT-CT 12] Unknown frame reception, IUT as slave 16
7.11 [PT-CT 13] Length of header, IUT as master 16
7.12 [PT-CT 14] Variation of length of header, IUT as slave 17
7.13 [PT-CT 15] Bit rate tolerance, IUT as master 18
7.14 [PT-CT 16] Bit rate tolerance, IUT as slave without making use of synchronization 18
7.15 [PT-CT 17] Bit rate tolerance, IUT as slave with making use of synchronization 19
7.16 Length of response 19
7.17 Verification of schedule table timing 22
7.18 [PT-CT 23] Sample point test, IUT as slave 24
7.19 [PT-CT 24] Initialization time, IUT as slave 25

8 Communication without failure 26
8.1 Variation of LIN identifier 26
8.2 Transmission of the checksum byte 27
8.3 Unused bits 29
8.4 Reserved frame 30
8.5 [PT-CT 35] Diagnostic frame master request, IUT as master 31

8.6 Supported frames according to the IUT specification 31

9 Communication with failure 32
9.1 General 32
9.2 [PT-CT 38] Bit error, IUT as slave 32
9.3 [PT-CT 39] Framing error in header of published frame, IUT as slave 34
9.4 [PT-CT 40] Framing error in response field of subscribed frame, IUT as slave 35
9.5 [PT-CT 41] Checksum error by inversion, IUT as slave 35
9.6 [PT-CT 42] Checksum error by carry, IUT as slave 36
9.7 [PT-CT 43] Communication robustness, IUT as slave 36

10 Event triggered frames 37
10.1 General 37
10.2 [PT-CT 44] Event triggered frame, IUT as slave 37
10.3 Event triggered frame with collision 38

11 Status management 40
11.1 [PT-CT 49] Error in received frame, IUT as slave 40
11.2 [PT-CT 50] Error in transmitted frame, IUT as slave 40
11.3 [PT-CT 51] response_error signal handling, IUT as slave 41

12 Sleep / wake up / power mode tests 42
12.1 [PT-CT 52] Send 'go-to-sleep command', IUT as master 42
12.2 [PT-CT 53] Receive 'go-to-sleep command', IUT as slave 42
12.3 [PT-CT 54] Receive a wake up signal, IUT as master 43
12.4 [PT-CT 55] Receive a wake up signal, IUT as slave 44
12.5 Send a wake up signal 45
12.6 [PT-CT 60] ECU power loss, IUT as master 47
12.7 [PT-CT 61] Powered up with LIN shorted, IUT as master 48
12.8 [PT-CT 62] LIN shorted before scheduling, IUT as master 49
12.9 [PT-CT 63] LIN shorted after start of scheduling, IUT as master 50

13 Sleep state after bus idle 50
13.1 [PT-CT 64] Sleep state after event and bus idle, IUT as slave 50
13.2 [PT-CT 65] Sleep state after bus idle with power up and wake up signal, IUT as slave 51
13.3 [PT-CT 66] Timeout after bus idle, IUT as slave 52

14 Frame ID range assignment 53
14.1 [PT-CT 67] Frame ID range assignment with indirect response, IUT as slave 53
14.2 [PT-CT 68] Frame ID range unassignment with indirect response, IUT as slave 54

15 Wildcards 55
15.1 [PT-CT 69] Request with direct response, IUT as slave 55

16 ReadByIdentifier command 56
16.1 LIN product identification 56
16.2 [PT-CT 72] ReadByIdentifier command with correct NAD, IUT as slave 57
16.3 [PT-CT 73] ReadByIdentifier command with incorrect addressing, IUT as slave 57

17 NAD assignment 58
17.1 General 58
17.2 [PT-CT 74] NAD assignment – followed by ReadByIdentifier service, IUT as slave 58
17.3 [PT-CT 75] NAD assignment – with positive response, IUT as slave 59
17.4 [PT-CT 76] NAD assignment – initial NAD, IUT as slave 59

18 Save Configuration 61
18.1 General 61
18.2 [PT-CT 77] Save Configuration – with positive response, IUT as slave 61
18.3 [PT-CT 78] Save Configuration – save a new NAD, IUT as slave 61
18.4 [PT-CT 79] Save Configuration – save new frame identifiers, IUT as slave 62

19 Transport protocol 62
19.1 [PT-CT 80] Transport layer functional request, IUT as slave 62
19.2 [PT-CT 81] Abort diagnostic communication with new diagnostic request, IUT as slave 63
19.3 [PT-CT 82] IUT receives a segmented request as specified, IUT as slave 63
19.4 [PT-CT 83] IUT receives a segmented request interleaved with unconditional frame, IUT as slave 64

19.5 [PT-CT 84] IUT receives a segmented request with interleaved functional request, IUT as slave ... 65
19.6 IUT shall ignore request after timeout ... 66
19.7 [PT-CT 87] IUT shall ignore segmented requests with wrong sequence numbering, IUT as slave ... 68
19.8 [PT-CT 88] IUT shall respond with correct segmented response, IUT as slave ... 69
19.9 IUT sends a segmented response with interleaved unconditional frames ... 70
19.10 [PT-CT 91] IUT shall not respond to slave response header if there is no request before, IUT as slave ... 73
19.11 [PT-CT 92] IUT shall not respond to slave response header if the response is already sent, IUT as slave ... 73
19.12 [PT-CT 93] IUT shall abort segmented response on N_Cs_{Max} timeout, IUT as slave ... 73

Bibliography ... 75

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 17987-6 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 31, *Electrical and electronic equipment*.

This second/third/... edition cancels and replaces the first/second/... edition (), [clause(s) / subclause(s) / table(s) / figure(s) / annex(es)] of which [has / have] been technically revised.

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

— *Part 6: Protocol conformance test specification*

— *Part [n]:*

— *Part [n+1]:*

— *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;

— Bit rate 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 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 6: Protocol conformance test specification

1 Scope

This part of ISO 17987 specifies the LIN protocol conformance test. This test verifies the conformance of LIN communication controllers with respect to ISO 17987-2 LIN transport protocol and network layer services and ISO 17987-3 LIN protocol specification.

This document shall provide all necessary technical information to ensure that test results are 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 (Part 2, 3, 4 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 following terms and definitions apply.

3.1.1
class B device
µC-based LIN device. These are devices where it is possible to take measurements on the Rx and Tx interface circuits between the µC and the transceiver.

3.1.2
class C device
integrated LIN devices (ECU) with µC and transceiver. These are devices where it is not possible to take measurements on the Rx and Tx interface circuits between the µC and the transceiver.

3.2 Symbols

$F_{TOL\_RES\_MASTER}$	bit rate tolerance of the master node (absolute value), according to ISO 17987-3	%
$F_{TOL\_RES\_SLAVE}$	bit rate tolerance of a slave node without making use of synchronization (absolute value), according to ISO 17987-3	%
F_{TOL_SYNC}	bit rate tolerance of a slave node making use of synchronization (relative value to master node after synchronization, valid for the complete message), according to ISO 17987-3	%

F_{TOL_UNSYNC}	bit rate tolerance of a slave node making use of synchronization, according to ISO 17987-3	%
T_{AWAKE}	measured time between end of Wake up signal and start of break of a header	s
T_{BIT}	Length of a bit (time), depending on the bit rate	s
$T_{BIT\_MAX\_MASTER}$	$T_{BIT\_MAX\_MASTER} = T_{BIT} (1 - F_{TOL\_RES\_MASTER})$	s
$T_{BIT\_MIN\_MASTER}$	$T_{BIT\_MIN\_MASTER} = T_{BIT} (1 + F_{TOL\_RES\_MASTER})$	s
$T_{BIT\_NOM\_MASTER}$	$T_{BIT\_NOM\_MASTER} = T_{BIT}$	s
T_{BRKDEL}	break delimiter, according to ISO 17987-3	1 – 14,6 T_{BIT}
T_{BRKDEL_MAX}	calculated maximum of break delimiter: $T_{HEADER\_MAX} – (T_{BRKFLD\_MIN} + 20\ T_{BIT})$	14,6 T_{BIT}
T_{BRKDEL_MIN}	minimum of break delimiter, according to ISO 17987-3	1 T_{BIT}
T_{BRKFLD}	break field low phase, according to ISO 17987-3	13 -26,6 T_{BIT}
T_{BRKFLD_MAX}	calculated maximum of break field low phase: $T_{HEADER\_MAX} – (T_{BRKDEL\_MIN} + 20\ T_{BIT})$	26,6 T_{BIT}
T_{BRKFLD_MIN}	minimum of break field low phase, according to ISO 17987-3	13 T_{BIT}
T_{FRAME}	length of a 8 byte frame, according to ISO 17987-3 (see frame length) $T_{FRAME} = T_{HEADER} + T_{RESPONSE}$	124 – 173,6 T_{BIT}
T_{FRAME_MAX}	maximum length of a 8 byte frame, according to ISO 17987-3	173,6 T_{BIT}
T_{FRAME_MIN}	minimum length of a 8 byte frame, according to ISO 17987-3	124 T_{BIT}
$T_{FRAME\_SLOT\_MEASURE}$	shall be measured between falling edges of the break field	s
$T_{FRAME\_SLOT\_SPECIFIED}$	the length is specified in the LDF	s
$T_{H\_INTERBYTE}$	inter-byte space between sync byte field and protected identifier	0 – 13,6 T_{BIT}
T_{HEADER}	length of the header of a message frame based on T_{BIT} nominal	34 – 47,6 T_{BIT}
T_{HEADER_MAX}	maximum length of the header of a message frame, according to ISO 17987-3	47,6 T_{BIT}
T_{HEADER_MIN}	minimum length of the header of a message frame, according to ISO 17987-3	34 T_{BIT}
$T_{JITTER\_DEFINED}$	jitter according LDF or NCF of the IUT	s
$T_{JITTER\_MEASURE}$	measured jitter as described in ISO 17987-3 (see frame slot)	s
$T_{RESPONSE\_MAX}$	maximum response length	126 T_{BIT}
$T_{RESPONSE\_MIN}$	nominal response length	90 T_{BIT}
T_{SLEEP}	measured time after that a slave node enters automatically a sleep state ISO 17987-2 (see 5.1.4)	s

3.3 Abbreviated terms

AC	alternate current
API	application programming interface
BFS	byte field synchronization
CF	transport layer consecutive frame
DC	direct current
EBS	earliest bit sample
EMC	electromagnetic compatibility
EMI	electromagnetic interference
EPL	electrical physical layer
ESD	electrostatic discharge
FF	transport layer first frame
GND	ground
IUT	implementation under test
LBS	latest bit sample
Max	maximum
Min	minimum
NVM	non-volatile memory
no.	number
OSI	open systems interconnection
PID	protected identifier
PDU	protocol data unit
PT-CT	LIN data link layer, network layer and transport layer protocol conformance test
RSID	response service identifier
Rx	Rx pin of the transceiver
RXD	receive data
SF	transport layer single frame
SID	service identifier
SR	sample window repetition

TC	test case
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 and transport protocol and diagnostic services.

5 General test specification considerations

5.1 General

This test specification is not able to cover all contingencies. Due to the fact of the missing vehicle environment, it is possible that the IUT's behaviour differs.

5.2 Test conditions

The tests shall be done at temperature in the range of 15 °C to 35 °C.

5.3 Mandatory requirements for IUT as master

The LDF is mandatory to perform the LIN conformance tests for IUT as master.

If the LDF is not able to describe all features of the IUT, an additional device specific datasheet is necessary (for example used diagnostic services).

Depending on the implementation of the IUT as master, it is allowed to use all possible master request frames (e.g. instead of TST_FRM_ASSIGNIDRANGE) for testing, except mandatory supported frames.

IUT initialization is required before each test case. Deviations are marked in the test case respectively.

5.4 Mandatory requirements for IUT as slave

The NCF or alternatively the LDF is mandatory to perform the LIN conformance tests for IUT as slave.

The used test tool shall verify the syntax of the NCF/LDF for plausibility (not for the content).

The NCF/LDF shall match with the implementation of the device.

If the NCF/LDF is not able to describe all features of the IUT, an additional device specific datasheet is necessary (for example used diagnostic services).

If an IUT is not fully configured after reset, an IUT initialization is required before each test case, except if the AssignFrameIdentifierRange command is part of the test. Preconfigured slaves are fully configured after reset. Deviations are marked in the test case respectively.

5.5 Test case architecture

In the description of each test case it is specified for which device type the test case is applicable, for master or slave.

Each specification of a test case consists of five parts:

- Set Up
  - defines the IUT as master or slave;
  - defines settings for the Implementation Under Test (IUT) and the test system (details see 5.9.1);
  - defines the bit rate for the respective test case;
- System Init
  - defines to what state the IUT shall have been set before starting the execution of the test. If not otherwise defined, the IUT as master sends requests respective the IUT as slave waits for requests;
  - an initialization of the IUT shall be performed before each test case. To initialise the IUT a reset is carried out and thereafter the IUT shall be reconfigured e.g. by a Frame ID configuration process;
- Test
  - defines the way of stimulating the IUT;
  - If more than one step is defined in this field, the steps shall be executed in the order as they are stated in the document;
- Verification
  - defines the expected behaviour of the IUT when executing the test steps,
- Reference
  - defines the reference to this or other parts of ISO 17987.

5.6 Classification

The classification describes the LIN integration level.

Table 1 defines the classification.

Table 1 — Classification

No.	Classification	Description	Comment
1	Class A Device	Transceiver devices	Data Link Layer and Node Configuration / Network Management Tests not applicable
2	Class B Device	µC based devices	IUT as master or slave with Rx and Tx pin connectors
3	Class C Device	integrated devices (ECU) with µC and transceiver	IUT as master or slave with analog LIN bus connector available