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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 ..... **vii**

Introduction ..... **viii**

1 Scope **1**

2 Normative references **1**

3 Terms, definitions, symbols and abbreviated terms **1**
3.1 Terms and definitions 1
3.2 Symbols 2
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 5
5.5 Test case architecture 5
5.6 Classification 6
5.7 Test system requirements 6
5.7.1 Generation of LIN frames 6
5.7.2 Standard requirements for the test cases 6
5.7.3 Special requirements for bit timing testing 6
5.7.4 Test system for IUT as slave node 6
5.7.5 Sleep state verification for IUT as slave node 6
5.8 Test system definition 7
5.9 Global predefinitions for the test setup 7
5.9.1 Configuration of IUT and test system 7
5.9.2 Default delays for frame headers 9
5.9.3 Default bit rate 9
5.9.4 Time measurement 9
5.9.5 Default spaces between the different frame parts of a LIN message 9

6 Essential test cases before test start **10**
6.1 General 10
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 10

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 11
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 12
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 13
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 14
7.10 [PT-CT 12] Unknown frame reception, IUT as slave 15
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 16
7.13 [PT-CT 15] Bit rate tolerance, IUT as master 17
7.14 [PT-CT 16] Bit rate tolerance, IUT as slave without making use of synchronization 17
7.15 [PT-CT 17] Bit rate tolerance, IUT as slave with making use of synchronization 18
7.16 Length of response 18
7.16.1 [PT-CT 18] Length of response, IUT as slave 18

7.16.2 [PT-CT 19] Length of response, IUT as master 19
7.16.3 [PT-CT 20] Acceptance of response field, IUT as slave 20
7.17 Verification of schedule table timing 21
7.17.1 [PT-CT 21] Verification of jitter, IUT as master 21
7.17.2 [PT-CT 22] Schedule table management, IUT as master 22
7.18 [PT-CT 23] Sample point test, IUT as slave 22
7.19 [PT-CT 24] Initialization time, IUT as slave 23

8 Communication without failure 24
8.1 Variation of LIN identifier 24
8.1.1 [PT-CT 25] Variation of LIN PID, IUT as master 24
8.1.2 [PT-CT 26] Variation of LIN PIDs of subscribed frames, IUT as slave 24
8.1.3 [PT-CT 27] Variation of LIN identifier of published frames, IUT as slave 25
8.2 Transmission of the checksum byte 25
8.2.1 [PT-CT 28] Transmission of the checksum byte “classic checksum”, IUT as slave 25
8.2.2 [PT-CT 29] Transmission of the checksum byte “enhanced checksum”, IUT as slave 26
8.2.3 [PT-CT 30] Transmission of the checksum byte “classic checksum”, IUT as master 26
8.2.4 [PT-CT 31] Transmission of the checksum byte of unconditional frames, IUT as master 26
8.3 Unused bits 27
8.3.1 [PT-CT 32] Unused bits, IUT as master 27
8.3.2 [PT-CT 33] Unused bits, IUT as slave 27
8.4 Reserved frame 28
8.4.1 [PT-CT 34] Reserved frame, IUT as slave 28
8.5 [PT-CT 35] Diagnostic frame master request, IUT as master 28
8.6 Supported frames according to the IUT specification 29
8.6.1 [PT-CT 36] Supported Tx frames according to the IUT specification, IUT as slave 29
8.6.2 [PT-CT 37] Supported Rx frames according to the IUT specification, IUT as slave 29

9 Communication with failure 30
9.1 General 30
9.2 [PT-CT 38] Bit error, IUT as slave 30
9.3 [PT-CT 39] Framing error in header of published frame, IUT as slave 31
9.4 [PT-CT 40] Framing error in response field of subscribed frame, IUT as slave 32
9.5 [PT-CT 41] Checksum error by inversion, IUT as slave 32
9.6 [PT-CT 42] Checksum error by carry, IUT as slave 32
9.7 [PT-CT 43] Communication robustness, IUT as slave 33

10 Event triggered frames 33
10.1 General 33
10.2 [PT-CT 44] Event triggered frame, IUT as slave 33
10.3 Event triggered frame with collision 34
10.3.1 [PT-CT 45] Event triggered frame with collision resolving, IUT as slave 34
10.3.2 [PT-CT 46] Event triggered frame with errors in collision resolving, IUT as slave 34
10.3.3 [PT-CT 47] Event triggered frame with collision resolving, IUT as master 35
10.3.4 [PT-CT 48] Error in transmitted frame with collision, IUT as slave 35

11 Status management 36
11.1 [PT-CT 49] Error in received frame, IUT as slave 36
11.2 [PT-CT 50] Error in transmitted frame, IUT as slave 36
11.3 [PT-CT 51] response_error signal handling, IUT as slave 37

12 Sleep/wake up/power mode tests 37
12.1 [PT-CT 52] Send “go-to-sleep command”, IUT as master 37
12.2 [PT-CT 53] Receive “go-to-sleep command”, IUT as slave 38
12.3 [PT-CT 54] Receive a wake up signal, IUT as master 39

12.4 [PT-CT 55] Receive a wake up signal, IUT as slave 39
12.5 Send a wake up signal 40
12.5.1 [PT-CT 56] Send a wake up signal, IUT as master and IUT as slave 40
12.5.2 [PT-CT 57] Send a block of wake up signals, IUT as slave 40
12.5.3 [PT-CT 58] Wait after one block of wake up signals, IUT as slave 41
12.5.4 [PT-CT 59] Send a wake up signal, frame header from a master following, IUT as slave 41
12.6 [PT-CT 60] ECU power loss, IUT as master 42
12.7 [PT-CT 61] Powered up with LIN shorted, IUT as master 43
12.8 [PT-CT 62] LIN shorted before scheduling, IUT as master 43
12.9 [PT-CT 63] LIN shorted after start of scheduling, IUT as master 44

13 Sleep state after bus idle 44
13.1 [PT-CT 64] Sleep state after event and bus idle, IUT as slave 44
13.2 [PT-CT 65] Sleep state after bus idle with power up and wake up signal, IUT as slave 45
13.3 [PT-CT 66] Timeout after bus idle, IUT as slave 46

14 Frame ID range assignment 46
14.1 [PT-CT 67] Frame ID range assignment with indirect response, IUT as slave 46
14.2 [PT-CT 68] Frame ID range unassignment with indirect response, IUT as slave 47

15 Wildcards 48
15.1 [PT-CT 69] Request with direct response, IUT as slave 48

16 ReadByIdentifier command 48
16.1 LIN product identification 48
16.1.1 [PT-CT 70] LIN product identification request with direct response, IUT as slave 48
16.1.2 [PT-CT 71] LIN product identification With interleaved unconditional frame, IUT as slave 49
16.2 [PT-CT 72] ReadByIdentifier command with correct NAD, IUT as slave 49
16.3 [PT-CT 73] ReadByIdentifier command with incorrect addressing, IUT as slave 50

17 NAD assignment 51
17.1 General 51
17.2 [PT-CT 74] NAD assignment — Followed by ReadByIdentifier service, IUT as slave 51
17.3 [PT-CT 75] NAD assignment — With positive response, IUT as slave 51
17.4 [PT-CT 76] NAD assignment — Initial NAD, IUT as slave 51

18 Save Configuration 52
18.1 General 52
18.2 [PT-CT 77] Save Configuration — With positive response, IUT as slave 52
18.3 [PT-CT 78] Save Configuration — Save a new NAD, IUT as slave 52
18.4 [PT-CT 79] Save Configuration — Save new frame identifiers, IUT as slave 53

19 Transport protocol 54
19.1 [PT-CT 80] Transport layer functional request, IUT as slave 54
19.2 [PT-CT 81] Abort diagnostic communication with new diagnostic request, IUT as slave 54
19.3 [PT-CT 82] IUT receives a segmented request as specified, IUT as slave 54
19.4 [PT-CT 83] IUT receives a segmented request interleaved with unconditional frame, IUT as slave 55
19.5 [PT-CT 84] IUT receives a segmented request with interleaved functional request, IUT as slave 56
19.6 IUT shall ignore request after timeout 57
19.6.1 [PT-CT 85] IUT shall ignore segmented requests on N_Cr_{Max} timeout, IUT as slave 57
19.6.2 [PT-CT 86] IUT shall observe transport layer N_As_{Max} timeout, IUT as slave 58
19.7 [PT-CT 87] IUT shall ignore segmented requests with wrong sequence numbering, IUT as slave 59
19.8 [PT-CT 88] IUT shall respond with correct segmented response, IUT as slave 60
19.9 IUT sends a segmented response with interleaved unconditional frames 61

19.9.1 [PT-CT 89] IUT sends a segmented response with interleaved unconditional frame, IUT as slave 61
19.9.2 [PT-CT 90] IUT sends a segmented response with interleaved functional request, IUT as slave 62
19.10 [PT-CT 91] IUT shall not respond to slave response header if there is no request before, IUT as slave 63
19.11 [PT-CT 92] IUT shall not respond to slave response header if the response is already sent, IUT as slave 63
19.12 [PT-CT 93] IUT shall abort segmented response on N_Cs_{Max} timeout, IUT as slave 64
Bibliography **66**

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.

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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 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;

— 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 (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 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 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 6:
Protocol conformance test specification

1 Scope

This document specifies the LIN protocol conformance test. This test verifies the conformance of LIN communication controllers with respect to ISO 17987-2 and ISO 17987-3.

This document provides 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 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 17987-2:2016, *Road vehicles — Local Interconnect Network (LIN) — Part 2: Transport protocol and network layer services*

ISO 17987-3:2016, *Road vehicles — Local Interconnect Network (LIN) — Part 3: Protocol specification*

ISO 17987-4:2016, *Road vehicles — Local Interconnect Network (LIN) — Part 4: Electrical Physical Layer (EPL) specification 12V/24V*

3 Terms, definitions, symbols 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
class B device
µC-based LIN device

Note 1 to entry: 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

Note 1 to entry: 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 17987-2:2016, 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 are based on the conventions specified in the OSI service conventions (ISO/IEC 10731) 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 (for 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 initialize 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 document or other parts of the ISO 17987 series.