



DPC: 24/30457351 DC

BSI Group Headquarters

389 Chiswick High Road London W4 4AL

Tel: +44 (0)20 8996 9000

Fax: +44 (0)20 8996 7400

www.bsigroup.com

Date: 29 May 2024

Origin: International

Latest date for receipt of comments: 22 July 2024

Project No. 2022/01337

Responsible committee: AUE/16 Data Communication (Road Vehicles)

Interested committees:

Title: Draft BS ISO 17987-4 Road vehicles - Local Interconnect Network (LIN). Part 4: Electrical physical layer (EPL) specification
12 V/24 V.

Please notify admin.start@bsigroup.com if you are aware of any keywords that might assist in clarifying or identifying the standard or of the content of this standard:

- i) has any issues related to 3rd party IPR, patent or copyright
- ii) affects other national standard(s)
- iii) requires additional national guidance or information

WARNING: THIS IS A DRAFT AND MUST NOT BE REGARDED OR USED AS A BRITISH STANDARD. THIS DRAFT IS NOT CURRENT BEYOND 22 July 2024

This draft is issued to allow comments from interested parties; all comments will be given consideration prior to publication. No acknowledgement will normally be sent. **See overleaf for information on the submission of comments.**

No copying is allowed, in any form, without prior written permission from BSI except as permitted under the Copyright, Designs and Patent Act 1988 or for circulation within a nominating organization for briefing purposes. Electronic circulation is limited to dissemination by e-mail within such an organization by committee members.

Further copies of this draft may be purchased from BSI Shop <http://shop.bsigroup.com> or from BSI Customer Services, Tel: +44(0) 20 8996 9001 or email cservices@bsigroup.com. British, International and foreign standards are also available from BSI Customer Services.

Information on the co-operating organizations represented on the committees referenced above may be obtained from <https://standardsdevelopment.bsigroup.com/>.

Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

- **Annotated drafts are not acceptable and will be rejected.**
- All comments should be submitted online at <https://standardsdevelopment.bsigroup.com/>. You will need to register in order to comment.

Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
------------------	------------------------

1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



DRAFT International Standard

ISO/DIS 17987-4

Road vehicles — Local Interconnect Network (LIN) —

Part 4: Electrical physical layer (EPL) specification 12 V/24 V

Véhicules routiers — Réseau Internet local (LIN) —

*Partie 4: Spécification de la couche électrique physique (EPL)
12V/24V*

ICS: 43.040.15

ISO/TC 22/SC 31

Secretariat: DIN

Voting begins on:
2024-05-29

Voting terminates on:
2024-08-21

This document is circulated as received from the committee secretariat.

THIS DOCUMENT IS A DRAFT CIRCULATED FOR COMMENTS 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 17987-4:2024(en)

Full document details: 24/30457351 DC

© ISO 2024
 **Documents**
Document Sharing Hub



COPYRIGHT PROTECTED DOCUMENT

© ISO 2024

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword	iv
Introduction	v
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	5
4 Conventions	6
5 Electrical physical layer requirements	6
5.1 Bit rate deviation	6
5.1.1 12 V LIN systems: Parameters	6
5.1.2 24 V LIN systems: Parameters	7
5.2 Timing requirements	9
5.2.1 Bit timing	9
5.2.2 Synchronization procedure	9
5.2.3 Bit sample timing	11
5.3 Line driver/receiver	12
5.3.1 General configuration	12
5.3.2 Definition of supply voltages for the physical interface	13
5.3.3 Signal specification	13
5.3.4 12 V LIN systems: Electrical parameters	15
5.3.5 24 V LIN systems: Electrical parameters	19
5.3.6 Line characteristics	22
5.3.7 12 V LIN systems: performance in non-operation supply voltage range	23
5.3.8 24 V LIN systems: performance in non-operation supply voltage range	23
5.3.9 Performance during fault modes	23
5.3.10 ESD/EMI compliance	23
Annex A (informative) LIN peripheral interface design considerations	24
Annex B (normative) LIN AA PROCEDURE C Physical Layer	29
Annex C (normative) LIN AA PROCEDURE D Physical Layer	32
Annex D (normative) LIN AA PROCEDURE E Physical Layer	38
Bibliography	42

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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO *had not* received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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

For an explanation of the voluntary nature of standards, 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee *[or Project Committee]* ISO/TC 22, *Road vehicles*, Subcommittee SC 31, *Data communication*.

This second edition cancels and replaces the first edition (ISO 17987-1:2016), which has been technically revised.

The main changes are as follows:

- Master and Slave terms used for the LIN node types in ISO 17987:2016 (all parts) are replaced within this standard with inclusive language terms **commander** and **responder**. This also applies for abbreviations and file formats NCF and LDF;

Tbd.;

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

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, Commander/responder 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 responder 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^[12] 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 responder node is configured and how a responder 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 this document.

Road vehicles — Local Interconnect Network (LIN) —

Part 4: Electrical physical layer (EPL) specification 12 V/24 V

1 Scope

This document specifies the 12 V and 24 V electrical physical layers (EPL) of the LIN communications system.

The electrical physical layer for LIN is designed for low-cost networks with bit rates up to 20 kbit/s to connect automotive electronic control units (ECUs). The medium that is used is a single wire for each receiver and transmitter with reference to ground.

This document includes the definition of electrical characteristics of the transmission itself and also the documentation of basic functionality for bus driver devices.

All parameters in this document are defined for the ambient temperature range from $-40\text{ }^{\circ}\text{C}$ to $125\text{ }^{\circ}\text{C}$.

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.

IEC 61000-4-2, *Electromagnetic compatibility (EMC) — Part 4-2: Testing and measurement techniques — Electrostatic discharge immunity test*

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 <https://www.electropedia.org>
- ISO Online browsing platform: available at <https://www.iso.org/obp/ui>

3.1.1

BR_Range_20K

LIN systems which operate at speeds up to 20 kbit/s

3.1.2

BR_Range_20K 12 V

12 V LIN systems which operate at speeds up to 20 kbit/s

3.1.3

BR_Range_20K 24 V

24 V LIN systems which operate at speeds up to 20 kbit/s

3.1.4

BR_Range_10K

LIN systems which operate at speeds up to 10,417 kbit/s

3.1.5

BR_Range_10K 12 V

12 V LIN systems which operate at speeds up to 10,417 kbit/s

3.1.6

BR_Range_10K 24 V

24 V LIN systems which operate at speeds up to 10,417 kbit/s

3.2 Symbols

%	percentage
μs	microsecond
C'_{LINE}	line capacitance
C_{BUS}	total bus capacitance
$C_{\text{COMMANDER}}$	capacitance of commander node
C_{RXD}	RXD capacitance (LIN receiver, RXD capacitive load condition)
$C_{\text{RESPONDER}}$	capacitance of responder node
d^2V/dt^2	second derivative of voltage (Volt ² per second ²)
di/dt	instantaneous rate of current change (amps per second)
$D_{\text{Rev\_Batt}}$	reverse battery supply protection diode
$D_{\text{ser\_int}}$	serial internal diode at transceiver IC
$D_{\text{ser\_commander}}$	serial commander diode
$F_{\text{TOL\_RES\_COMMANDER}}$	commander bit rate deviation from nominal bit rate
$F_{\text{TOL\_RES\_COMMANDER\_A}}$	commander bit rate deviation from nominal bit rate in BR_Range_20K systems
$F_{\text{TOL\_RES\_COMMANDER\_B}}$	commander bit rate deviation from nominal bit rate in BR_Range_10K systems
$F_{\text{TOL\_RES\_RESPONDER}}$	responder bit rate deviation from nominal bit rate
$F_{\text{TOL\_RES\_RESPONDER\_A}}$	responder bit rate deviation from nominal bit rate in BR_Range_20K systems
$F_{\text{TOL\_RES\_RESPONDER\_B}}$	responder bit rate deviation from nominal bit rate in BR_Range_10K systems
$F_{\text{TOL\_RES\_RESPONDER\_1}}$	responder node 1 bit rate deviation from nominal bit rate
$F_{\text{TOL\_RES\_RESPONDER\_2}}$	responder node 2 bit rate deviation from nominal bit rate
$F_{\text{TOL\_RESPONDER\_to\_RESPONDER}}$	responder node to responder node bit rate deviation
$F_{\text{TOL\_SYNCH}}$	responder node bit rate deviation from commander node bit rate after synchronization
$F_{\text{TOL\_SYNCH\_A}}$	responder node bit rate deviation from commander node bit rate after synchronization in BR_Range_20K systems

$F_{TOL\_SYNCH\_B}$	responder node bit rate deviation from commander node bit rate after synchronization in BR_Range_10K systems
$F_{TOL\_SYNCH\_BDM}$	deviation of synchronized responder bit rate to the commander node bit rate
$F_{TOL\_SYNCH\_1}$	responder node 1 bit rate deviation from commander node bit rate after synchronization
$F_{TOL\_SYNCH\_2}$	responder node 2 bit rate deviation from commander node bit rate after synchronization
$F_{TOL\_UNSYNCH}$	responder node bit rate deviation from nominal bit rate before synchronization
$F_{TOL\_UNSYNCH\_A}$	responder node bit rate deviation from nominal bit rate before synchronization in BR_Range_20K systems
$F_{TOL\_UNSYNCH\_B}$	responder node bit rate deviation from nominal bit rate before synchronization in BR_Range_10K 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
$I_{BUS\_PAS\_rec}$	current at ECU bus line when driver off (passive) at recessive LIN bus level
GND_{Device}	GND of ECU
k Ω	kilo ohm
kbit/s	kilo bit per second
LEN_{BUS}	total length of LIN bus line
LIN_{Bus}	LIN network
ms	millisecond
nF	nano farad
pF	pico farad
pF/m	pico farad per meter (line capacitance)
R_{BUS}	total bus-resistor including all responder node and commander node resistors $R_{BUS} = R_{COMMANDER} R_{RESPONDER\_1} R_{RESPONDER\_2} \dots R_{RESPONDER\_N}$
$R_{COMMANDER}$	commander resistor with default range
R_{pull_up}	pull-up resistor
$R_{RESPONDER}$	responder resistor
$R_{RESPONDER\_SMALL}$	precise responder resistor with small range
t_{BFS}	byte field synchronization time

t_{BIT}	basic bit times
t_{EBS}	earliest bit sample time
$t_{\text{rx\_pd}}$	propagation delay of receiver
$t_{\text{rx\_sym}}$	symmetry of receiver propagation delay rising edge propagation delay of receiver
t_{LBS}	latest bit sample time
$t_{\text{rx\_pdf}}$	propagation delay time of receiving node at falling (recessive to dominant) LIN bus edge
$t_{\text{rx\_pdr}}$	propagation delay time of receiving node at rising (dominant to recessive) LIN bus edge
t_{SR}	sample window repetition time
$TH_{\text{Dom(max)}}$	max. dominant threshold of receiving node (Volt)
$TH_{\text{Dom(min)}}$	min. dominant threshold of receiving node (Volt)
$TH_{\text{Rec(max)}}$	max. recessive threshold of receiving node (Volt)
$TH_{\text{Rec(min)}}$	min. 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_{BUS}	voltage on the LIN bus
$V_{\text{BUS\_CNT}}$	centre point of receiver threshold
$V_{\text{BUS\_rec}}$	receiver recessive voltage
V_{CATHODE}	voltage at the cathode of the diode
$V_{\text{GND\_BATTERY}}$	battery ground voltage
$V_{\text{GND\_ECU}}$	voltage on the local ECU ground connector with respect to vehicle battery ground connector ($V_{\text{GND\_BATTERY}}$)
V_{HYS}	receiver hysteresis voltage
V_{Rec}	recessive voltage
V_{SerDiode}	voltage drop at the serial diodes
$V_{\text{Shift\_BAT}}$	battery shift
$V_{\text{Shift\_Difference}}$	difference between battery shift and GND shift
$V_{\text{Shift\_GND}}$	GND shift
V_{SUP}	voltage at transceiver supply pins
$V_{\text{SUP\_NON\_OP}}$	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
$\Delta F/F_{COMMANDER}$	deviation of node bit rate from the commander node bit rate
$\Delta F/F_{Nom}$	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
ECU	electronic control unit
EMC	electromagnetic compatibility
EMI	electromagnetic interference
EPL	electrical physical layer
ESD	electrostatic discharge
EVT	event
GND	ground
LBS	latest bit sample
Max.	maximum
Min.	minimum
OSI	open systems interconnection
RC	RC time constant τ ($\tau = C_{BUS} \times R_{BUS}$)
RX	Rx pin of the transceiver
RXD	receive data
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 (all parts) and ISO 14229-7^[6] are based on the conventions specified in the OSI Service Conventions (see ISO/IEC 10731^[13]) as they apply for physical layer, protocol, network and transport protocol and diagnostic services.

5 Electrical physical layer requirements

5.1 Bit rate deviation

The bit rate deviation of the LIN medium describes the bit rate deviation from a referenced bit rate. It is the sum of the following parameters:

- inaccuracy of setting the bit rate (systematic failure due to granularity of the configurable bit rate);
- clock deviation over temperature and supply voltage range;
- clock source stability of the responder node starting from the end of the sync byte field up to the end of the entire LIN frame (last sampled bit) when performing synchronization;
- bit time measurement failure of the responder node;
- clock source stability of the commander node starting from the end of the sync byte field up to the end of the entire LIN frame (last transmitted bit).

On-chip clock may achieve a frequency deviation of better than $\pm 14\%$ with internal calibration. This bit rate deviation better than $\pm 14\%$ is sufficient to detect a break field in the message stream. The subsequent bit rate adaptation using the sync byte field ensures the proper reception and transmission of the message. The on-chip oscillator shall allow for accurate bite rate measurement and generation for the remainder of the message frame, taking into account effects of anything, which affects the bit rate, such as temperature and voltage drift during operation.

The bit rates on the LIN bus are specified in the range of 1 kbit/s to 20 kbit/s. The specific bit rate used on a LIN bus is defined as the nominal bit rate, F_{Nom} .

In case a non-LIN electrical physical layer (e.g. ISO 11898-1,^[2] ISO 11898-2^[3]) is used, the bit rate may have to be adjusted.

5.1.1 12 V LIN systems: Parameters

[Table 1](#) defines the bit rate deviation from nominal bit rate.

Table 1 — Bit rate deviation from nominal bit rate

Number	Bit rate deviation	Name	$\Delta F/F_{\text{Nom}}$
Param 1	Commander node (deviation from nominal bit rate)	$F_{\text{TOL\_RES\_COMMANDER}}$	$<\pm 0,5 \%$
Param 2	Responder node without making use of synchronization (deviation from nominal bit rate)	$F_{\text{TOL\_RES\_RESPONDER}}$	$<\pm 1,5 \%$
Param 3	Deviation of responder node bit rate from the nominal bit rate before synchronization; relevant for nodes making use of synchronization and direct break detection. This parameter in microprocessor-based nodes with sync/break detection that is triggering the bit rate synchronization processing in software. It ensures that the break is detected.	$F_{\text{TOL\_UNSYNCH}}$	$<\pm 14 \%$

[Table 2](#) defines the responder node bit rate deviation from commander node bit rate.

Table 2 — Responder node bit rate deviation from commander node bit rate

Number	Bit rate deviation	Name	$\Delta F/F_{\text{COMMANDER}}$
Param 4	Deviation of responder node bit rate from the commander node bit rate after synchronization; relevant for nodes making use of synchronization; any responder node shall stay within this deviation for all fields of a frame which follow the sync byte field.	$F_{\text{TOL\_SYNCH}}$	$<\pm 2 \%$

[Table 3](#) defines the bit rate deviation for responder to responder communication.

Table 3 — Bit rate deviation for responder to responder communication

Number	Bit rate deviation	Name	$\Delta F/F_{\text{COMMANDER}}$
Param 5	For communication between any two nodes (i.e. data stream from one responder to another responder), their bit rate shall not differ by more than $F_{\text{TOL\_RESPONDER\_to\_RESPONDER}}$. The following condition shall be checked for: a) $ F_{\text{TOL_RES_RESPONDER_1}} - F_{\text{TOL_RES_RESPONDER_2}} < F_{\text{TOL_RESPONDER_to_RESPONDER}}$ b) $ F_{\text{TOL_SYNCH_1}} - F_{\text{TOL_SYNCH_2}} < F_{\text{TOL_RESPONDER_to_RESPONDER}}$ c) $ (F_{\text{TOL_RES_COMMANDER}} + F_{\text{TOL_SYNCH_1}}) - F_{\text{TOL_RES_RESPONDER_2}} < F_{\text{TOL_RESPONDER_to_RESPONDER}}$	$F_{\text{TOL\_RESPONDER\_to\_RESPONDER}}$	$<\pm 2 \%$

5.1.2 24 V LIN systems: Parameters

The required accuracy is dependent on the used bit rate range. See [Table 15](#) and also ISO 17987-2.

[Table 4](#) defines the bit rate deviation from nominal bit rate in BR_Range_20K systems.