BS ISO 14230-1:2012

BSI Standards Publication

Road vehicles — Diagnostic communication over K-Line (DoK-Line)

Part 1: Physical layer

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee AUE/16, Electrical and electronic equipment.

A list of organizations represented on this committee can be obtained on request to its secretary.

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ISBN 978 0 580 69678 7

ICS 43.180

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 June 2012.

Amendments issued since publication

Date	Text affected

BS ISO 14230-1:2012

INTERNATIONAL STANDARD

ISO 14230-1

Second edition
2012-06-01

Road vehicles — Diagnostic communication over K-Line (DoK-Line)

Part 1: Physical layer

Véhicules routiers — Communication de diagnostic sur la ligne K (DoK-Line)

Partie 1: Couche physique

Reference number
ISO 14230-1:2012(E)

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Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
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Published in Switzerland

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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.

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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.

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 14230-1 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

This second edition cancels and replaces the first edition (ISO 14230-1:1999), which has been technically revised.

ISO 14230 consists of the following parts, under the general title *Road vehicles — Diagnostic communication over K-Line (DoK-Line)*:

— *Part 1: Physical layer*

— *Part 2: Data link layer*

— *Part 3: Application layer*

— *Part 4: Requirements for emission-related systems*

Introduction

ISO 14230 has been established in order to define common requirements for vehicle diagnostic systems implemented on K-Line (UART based) communication link, as specified in this part of ISO 14230.

To achieve this, it is based on the Open Systems Interconnection (OSI) Basic Reference Model in accordance with ISO/IEC 7498-1 and ISO/IEC 10731, which structures communication systems into seven layers. When mapped on this model, the services specified by ISO 14230 are broken down into the following.

a) Diagnostic services (layer 7), specified in ISO 14229-6, ISO 14229-1;

b) Presentation layer (layer 6):

— vehicle manufacturer specific,

— legislated OBD: specified in ISO 15031-2, ISO 15031-5, ISO 15031-6, SAE J1930-DA, SAE J1979-DA, SAE J2012-DA,

— legislated WWH-OBD: specified in ISO 27145-2, SAE J1930-DA, SAE J1979-DA, SAE J2012-DA, SAE J1939 Appendix C (SPNs), SAE J1939-73 Appendix A (FMIs);

c) Session layer services (layer 5):

— legislated OBD: specified in ISO 14229-2,

— legislated WWH-OBD: specified in ISO 14229-2;

d) Transport layer services (layer 4), specified in ISO 14230-2;

e) Network layer services (layer 3), specified in ISO 14230-2;

f) Data link layer (layer 2), specified in ISO 14230-4, ISO 14230-2;

g) Physical layer (layer 1), specified in ISO 15765-4, ISO 14230-1.

This breakdown is shown in Table 1.

Table 1 — Enhanced and legislated OBD diagnostic specifications applicable to the OSI layers

<table>
<tr><th>Applicability</th><th>OSI 7 layer</th><th>Vehicle manufacturer enhanced diagnostics</th><th colspan="2">Legislated OBD (On-Board Diagnostics)</th><th colspan="2">Legislated WWH-OBD (On-Board Diagnostics)</th></tr>
<tr><td rowspan="8">Seven layers according to ISO 7498-1 and ISO/IEC 10731</td><td>Application (layer 7)</td><td>ISO 14229-1, ISO 14229-6</td><td colspan="2">ISO 15031-5</td><td colspan="2">ISO 14229-1, ISO 27145-3</td></tr>
<tr><td>Presentation (layer 6)</td><td>vehicle manufacturer specific</td><td colspan="2">ISO 15031-2, ISO 15031-5, ISO 15031-6, SAE J1930-DA, SAE J1979-DA, SAE J2012-DA</td><td colspan="2">ISO 27145-2, SAE 1930-DA, SAE J1979-DA, SAE J2012-DA, SAE J1939:2011 Appendix C (SPNs), SAE J1939-73:2010 Appendix A (FMIs)</td></tr>
<tr><td>Session (layer 5)</td><td colspan="5">ISO 14229-2</td></tr>
<tr><td>Transport (layer 4)</td><td rowspan="2">ISO 14230-2</td><td rowspan="2">ISO 15765-2</td><td rowspan="4">ISO 15765-4</td><td>ISO 15765-4, ISO 15765-2</td><td rowspan="4">ISO 27145-4</td></tr>
<tr><td>Network (layer 3)</td><td rowspan="3">ISO 15765-4, ISO 11898-1, ISO 11898-2</td></tr>
<tr><td>Data link (layer 2)</td><td>ISO 14230-2</td><td rowspan="2">ISO 11898-1, ISO 11898-2</td></tr>
<tr><td>Physical (layer 1)</td><td>ISO 14230-1</td></tr>
</table>

The application layer services covered by ISO 14229-6 have been defined in compliance with diagnostic services established in ISO 14229-1 and ISO 15031-5, but are not limited to use only with them. ISO 14229-6 is also compatible with most diagnostic services defined in national standards or vehicle manufacturers' specifications.

INTERNATIONAL STANDARD ISO 14230-1:2012(E)

Road vehicles — Diagnostic communication over K-Line (DoK-Line) —

Part 1: Physical layer

1 Scope

This part of ISO 14230 specifies the physical layer, based on ISO 9141, on which the diagnostic services will be implemented. It is based on the physical layer described in ISO 9141-2, but expanded to allow for road vehicles with either 12 V d.c. or 24 V d.c. voltage supply.

NOTE In this part of ISO 14230, values given in parentheses apply to 24 V d.c. systems.

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 7637-1, *Road vehicles — Electrical disturbances from conduction and coupling — Part 1: Definitions and general considerations*

ISO 7637-2, *Road vehicles — Electrical disturbances from conduction and coupling — Part 2: Electrical transient conduction along supply lines only*

ISO 14230-2, *Road vehicles — Diagnostic communication over K-Line (DoK-Line) — Part 2: Data link layer*

ISO 15031-2, *Road vehicles — Communication between vehicle and external equipment for emissions-related diagnostics — Part 2: Guidance on terms, definitions, abbreviations and acronyms*

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 15031-2 and the following apply.

3.1.1
rise time
<transmitters> time taken for the voltage to change from 20 $V_B/100$ to 80 $V_B/100$, where V_B is the vehicle battery voltage

3.1.2
fall time
<transmitters> time taken for the voltage to change from 80 $V_B/100$ to 20 $V_B/100$, where V_B is the vehicle battery voltage

3.2 Abbreviated terms

C_{TE} capacitance contribution of external test equipment and associated cables

C_{OBW} capacitance contribution of on-board wiring

C_{ECU} capacitance contribution of electronic control unit

ECU electronic control unit

EMI electromagnetic interference

NRZ non-return to zero

V_B vehicle battery voltage

4 Conventions

This part of ISO 14230 is based on the conventions discussed in the OSI Service Conventions (ISO/IEC 10731:1994) as they apply for communication services.

5 Document overview

Figure 1 illustrates the most applicable application implementations utilizing the DoK-Line protocol.

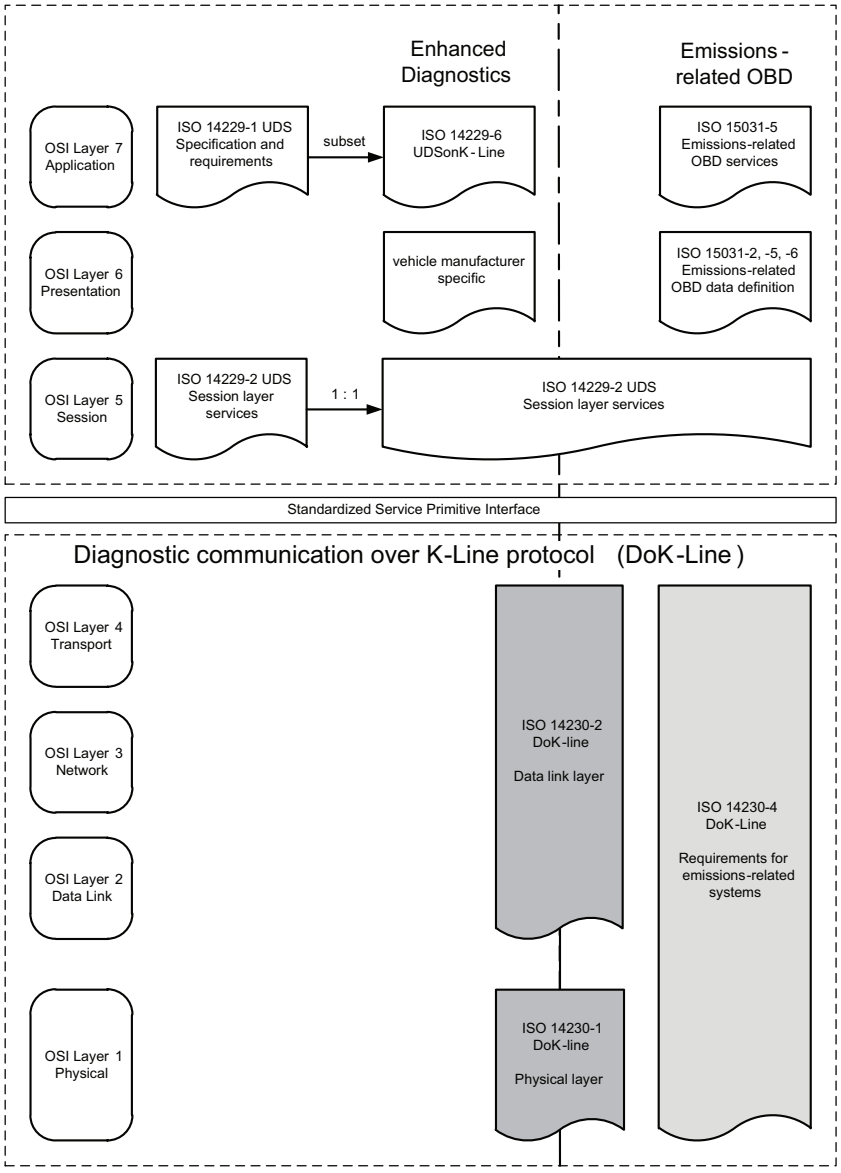


Figure 1 — Diagnostic communication over K-Line document reference according to OSI model

6 Vehicle to external test equipment connection

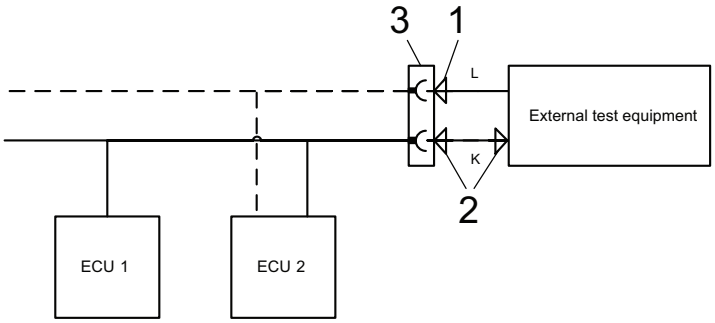
6.1 K- and L-line configurations

Vehicle ECUs which support the protocol described in ISO 14230 shall support either a one-wire (K line only) or a two-wire (K and L) communication connection for diagnosis, test or maintenance. Vehicle battery voltage, V_B, power ground and signal ground shall be provided by the ECU(s) or the vehicle to the tester.

Line K is a bidirectional line. It is used during initialization to convey address information or, in the case of fast initialization, the wake-up pattern from the external test equipment to vehicle ECUs, simultaneously with the L line. After conveying this information, the K line is used for all other diagnostic communications between tester and vehicle ECUs, in both directions. This includes the completion of the initialization sequence and all other communication services as described in ISO 14230-2.

Line L is a unidirectional line and is only used during initialization to convey address information or, in the case of fast initialization, the wake-up pattern from the external test equipment to vehicle ECUs, simultaneously with the K line. At all other times, it should idle in the logic “1” state.

Figure 2 shows the system configurations allowed, indicating the role of each of the lines K and L.



Key

1 unidirectional data flow from external test equipment to ECU 2

2 bidirectional data flow between external test equipment and ECUs 1 and 2

3 vehicle diagnostic connector

Figure 2 — Possible system configurations

6.2 Configuration requirements

If any ECU, either of one type or in combination, are linked on a bus, the system designer shall ensure that the configuration is capable of correct operation. For example, data from one ECU shall not initialize the serial communication of another ECU on the bus and an initialization signal shall not cause more than one ECU to respond simultaneously; it may, however, initialize a number of ECUs on the bus which then respond in an orderly sequential manner.

If lines K and L are used for purposes other than inspection, test and diagnosis, care shall be taken to avoid data collision and incorrect operation in all modes.

7 Signal and communication specifications

7.1 Signal

NOTE On those vehicles fitted with ISO 15031-3 connectors, all measurements should be referenced to the signal ground and battery supply pins of that connector. On other vehicles without ground and supply pins, the battery posts should be used as reference.

For proper operation of the serial communication, both ECU and external test equipment shall correctly determine each logic state as follows:

— a logic “0” is equivalent to a voltage level on the line of less than $20V_B/100$ for transmitter, and $30V_B/100$ for receiver;

— a logic “1” is equivalent to a voltage level on the line of greater than $80V_B/100$ for transmitter, and $70V_B/100$ for receiver.

In addition, the slope times shall be less than 10 % (15 %) of the bit time.

Voltage levels between $30V_B/100$ and $70V_B/100$ may be detected as either logic “0” or logic “1”.

NRZ coding shall be used. The bit time is defined as half the time between the $50V_B/100$ levels of successive rising or falling edges of alternating “1” and “0” bits.

Figure 3 illustrates the worst case on signal levels. For electrical specifications of the external test equipment, see 8.2; for ECUs, see 9.3.

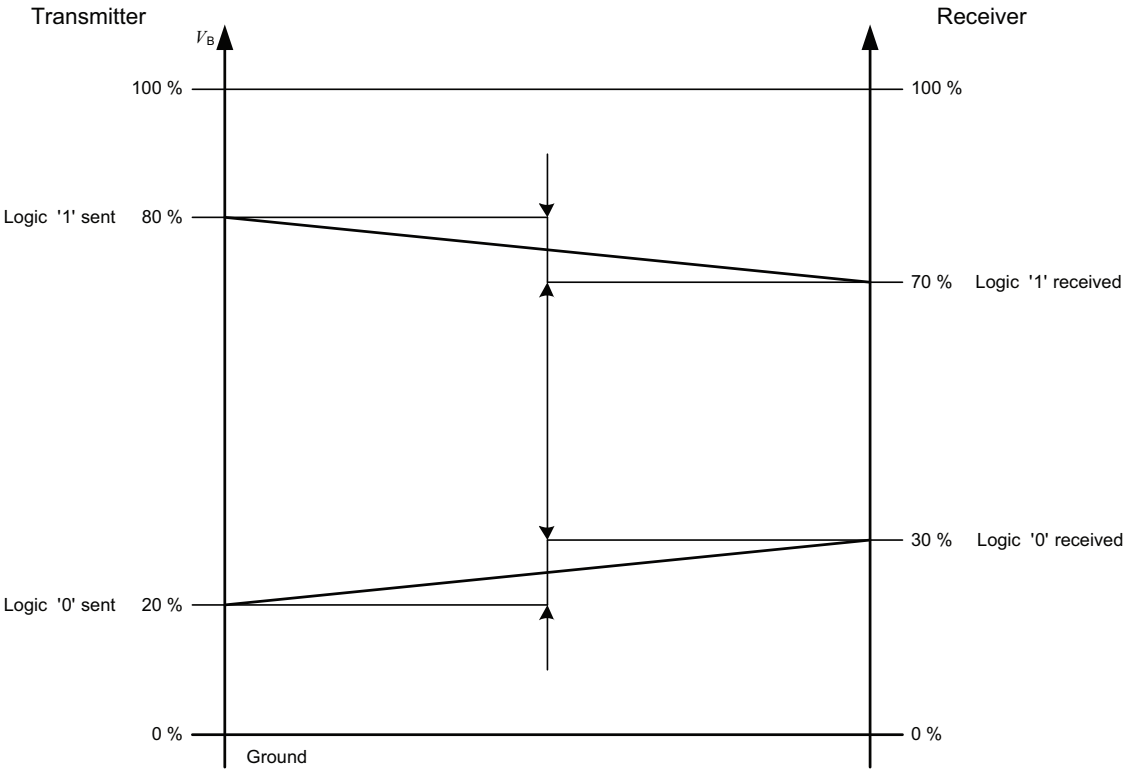


Figure 3 — Signal voltage levels, worst-case values

7.2 Communication specification

7.2.1 Communication schematics

The configuration is shown schematically in Figure 4.

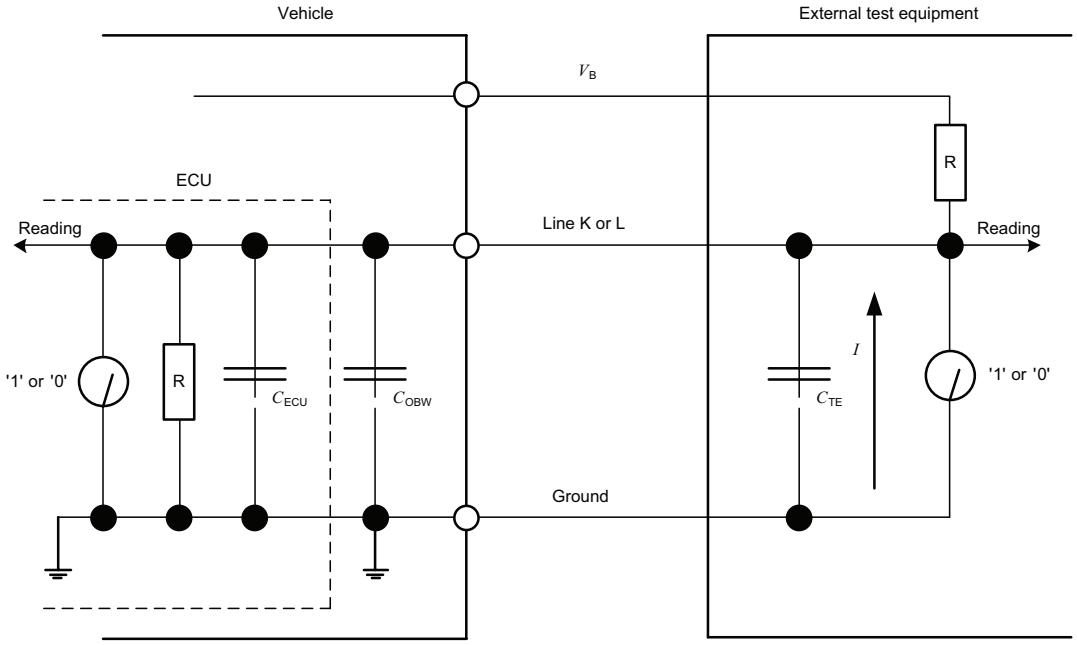


Figure 4 — Communication schematics

7.2.2 Capacitance contribution

The capacitance contribution of the external test equipment and associated cables are termed C_{TE}. The capacitance contribution of the on-board wiring is termed C_{OBW}. The sum of the input capacitance of all the ECUs on the bus is defined thus:

$$C_{ECU} = \sum_{i=1}^{n} C_{ECU_i}$$

where n is the number of ECUs on the bus.

Values for C_{ECU}, C_{OBW} and C_{TE} shall be selected such that:

— for vehicles with 12 V nominal supply, $C_{ECU} + C_{OBW} \leq 7{,}2$ nF and $C_{TE} \leq 2$ nF

— for vehicles with 24 V nominal supply, $C_{ECU} + C_{OBW} \leq 5$ nF and $C_{TE} \leq 2$ nF.

These values are derived from the circuit resistance and baud rate tolerances (see Clauses 8 and 9), allowed slope times and switching thresholds (see 7.1) and assuming a maximum communication speed of 10,4 kBd. If a higher or lower maximum communication speed is chosen, the designer will reduce or increase the allowed capacitance accordingly. The formula to be used is given in ISO 9141.

8 Requirements of external test equipment

8.1 Minimum functional requirements

The external test equipment shall be capable of supporting the initialization methods and the communication protocol as described in ISO 14230-2.

8.2 Electrical specifications

8.2.1 Working temperature requirements

The specifications in 8.2.2 to 8.2.6 shall apply over a working temperature range of 0 C to 50 C. They apply to nominal 12 V (24 V) systems for which the external test equipment shall operate correctly in the range 8 V to 16 V (16 V to 32 V) of the vehicle battery voltage, V_B.

Manufacturers of external test equipment are encouraged to extend these limits of correct operation for vehicle battery voltage, V_B, and working temperature.

8.2.2 External test equipment pull-up of lines K and L

For lines K and L of the external test equipment not connected to an ECU, each line shall be internally pulled up to V_B via a nominal 510 Ω (1 kΩ) resistor.

When the external test equipment is linked to an ECU, it shall meet the following requirements:

a) Transmission state

   1) At logic "1" the external test equipment shall have an equivalent voltage source greater than $90V_B/100$, sourced from the vehicle battery supply, V_B, and an equivalent resistance of 510 Ω × (1 ± 5 %) [1 kΩ × (1 ± 5 %)].

   2) At logic "0" the external test equipment shall have an equivalent voltage of less than $10V_B/100$, at a maximum sink current of 100 mA.

b) Receiving state

   1) The equivalent resistance on the line K of the external test equipment shall be 510 Ω × (1 ± 5 %) [1 kΩ × (1 ± 5 %)].

8.2.3 Fast initialization and communication baud rates

The external test equipment shall maintain fast initialization and communication baud rates to ± 0,5 % of nominal values where specified by the protocol. Where determined by measurement, the baud rate shall be maintained to ± 1 %. The 5 bd address shall be transmitted with a tolerance of ± 0,5 %.

8.2.4 Bit time requirements

For each byte the external test equipment shall be capable of determining the status of any bit, the transitions of which are shifted by not more than 30 % of the bit time relative to their calculated position in time.

8.2.5 Voltage requirements

The external test equipment shall not transfer to the open lines K and L any voltage higher than V_B or 40 V, whichever is the lower, or any voltage which is lower than – 1 V. This includes suppression of voltage excursions of V_B as detailed in ISO 7637-1 for 12 V electrical systems and in ISO 7637-2 for 24 V systems.

8.2.6 Capacitance requirements

The total capacitance of the external test equipment and its cable and connector shall not exceed 2 nF.

9 Requirements of ECU

9.1 Minimum functional requirements

The combined impedances defined in 8.2.6 are the primary constraints. For guidance only, the average values per ECU on a system with 10 ECUs connected are given. This value may change if a different number of ECUs are connected.

No capacitance value per ECU is given for 24 V systems, but the total vehicle capacitance shall conform to the limits given in Clause 7.

9.2 Input and output lines

ECUs shall have one (K) or two (K and L) connections as defined in 6.1. V_B and ground shall also be made available to the external test equipment but need not come directly from the ECU.

9.3 Electrical specifications

9.3.1 Line K

At logic “1”, or in the receiving state, the ECU shall behave like a resistance to ground of at least 50 kΩ (100 kΩ).

If an internal resistance is used between line K and V_B, the value shall not be less than 100 kΩ (200 kΩ).

The capacitance of line K with respect to ground of each ECU should not exceed 500 pF.

In case of problems (e.g. with EMI) the vehicle manufacturer’s system designer may use a different specification, but attention shall be paid to the maximum value of the capacitance of the vehicle which is given by the summation of C_{OBW} and C_{ECU}. This value shall not exceed the limits specified in 7.2.2.

At logic “0” the ECU shall have an equivalent sink resistance not more than 110 Ω (220 Ω) between line K and ground. In addition the sink resistance shall be designed so the slope time of the falling edge is as defined in 7.1.

When the serial communication of the ECU is not in operation and the external test equipment is connected, the output of the ECU shall be at logic “1”.

9.3.2 Line L

The input resistance to ground shall be at least 50 kΩ (100 kΩ).

If an internal resistance is used between line L and V_B, the value shall not be less than 100 kΩ (200 kΩ).

The capacitance of line L with respect to ground of each ECU should not exceed 500 pF.

9.3.3 Lines K and L

The input/output circuitry of the ECUs shall withstand transitions and overvoltage present on the external test equipment lines K and L via the external test equipment source resistance, limited as below.

a) K and L shall withstand:

   — 20 V d.c. permanent (36 V d.c. permanent);

   — 24 V d.c. for 30 min (42 V d.c. for 30 min);

   — 30 V d.c. for 1 min (48 V d.c. for 1 min).

b) K and L shall also withstand pulses 3a and 3b according to ISO 7637-1 for 12 V electrical systems and to ISO 7637-2 for 24 V electrical systems, where the maximum positive voltage shall be an absolute value of 40 V (60 V), and the worst-case negative voltage will be − 1 V relative to ground.

9.4 Minimum functional capabilities

The ECU shall be capable of supporting the communication protocol and at least one of the initialization methods described in ISO 14230-2. It shall be capable of ignoring the initialization of other ECUs on the bus if they respond to different methods of initialization to its own.

The ECU shall transmit messages with bit rates within ± 1,7 % (± 1 %) of nominal rate when a baud rate is specified by the protocol.

10 Wiring requirements

The capacitance of each serial communication line built into the vehicle shall not exceed 2 nF with respect to vehicle signal ground, when measured without any ECU connected.

V_B and ground shall be made available to the external test equipment but need not come directly from an ECU.

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[19] ISO 27145-3, *Road vehicles — Implementation of World-Wide Harmonized On-Board Diagnostics (WWH-OBD) communication requirements — Part 3: Common message dictionary*[2)]

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1) Under development.

2) To be published.

ICS 43.180

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