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Road vehicles — Diagnostic systems — Requirements for interchange of digital information

Véhicules routiers — Systèmes de diagnostic — Caractéristiques de l'échange de données numériques

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Contents

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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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 9141 was prepared by Technical Committee ISO/TC 22, *Road vehicles*.

Introduction

This International Standard has been established with a view to specifying the following desirable features for the diagnosis of electronically controlled on-board systems:

1) determination of the electrical requirements of a diagnostic system so that diagnostic equipment having at least minimum functional capability as specified herein will be compatible with any on-board diagnostic system designed in accordance with these specifications;

2) limitation of the number of contacts on electronically controlled systems for unidirectional and bidirectional diagnostic communication;

3) transmission of identifying information, as well as operational status information including actual values of parameter and required values.

The diagnostic communication is expected to fulfil one or more of the following aims:

a) to determine if a system is functioning correctly;

b) to carry out an inspection;

c) to locate deviations from specification and achieve economic repair;

d) to confirm a system has been restored to correct operation;

e) to reset or adjust system operating values in an Electronic Control Unit (ECU) in strict accordance with the vehicle manufacturer's instructions;

f) to give recorded information related to service activities.

This may be accomplished by way of one or more of the following:

a) identification of the components in a system;

b) output of diagnostic information from an ECU;

c) examination of a wide range of sensor and operating parameter values;

d) carrying out specific actions;

e) changes in data held in the ECU in strict accordance with the vehicle manufacturer's instructions.

Road vehicles — Diagnostic systems — Requirements for interchange of digital information

1 Scope

This International Standard specifies the requirements for setting up the interchange of digital information between on-board Electronic Control Units (ECUs) of road vehicles and suitable diagnostic testers. This communication is established in order to facilitate inspection, test diagnosis and adjustment of vehicles, systems and ECUs.

This International Standard does not apply when system-specific diagnostic test equipment is used.

This International Standard does not apply to the use of flashing code techniques.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 4092 : 1988, *Road vehicles — Diagnostic systems for motor vehicles — Vocabulary.*

ISO/TR 7637-0 : 1984, *Road vehicles — Electrical interference by conduction and coupling — Part 0: General and definitions.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 inspection: See ISO 4092.

3.2 test: See ISO 4092.

3.3 diagnosis: See ISO 4092.

3.4 diagnostic tester: See ISO 4092.

This non-built-in equipment may be used in the vehicle.

3.5 system: Assemblage of components performing a specific function, for example an assemblage of an ECU with its associated sensors, actuators and interconnections.

3.6 ECU: Abbreviation of Electronic Control Unit.

3.7 bus: One or more conductors connecting two or more ECUs together with the purpose of communicating with the test equipment.

3.8 NRZ: Abbreviation of Non-Return-to Zero — a method of representing binary signals in which there is no change of signal levels between two successive bits of the same logic level.

3.9 baud rate: Number of binary elements of information transmitted per second on one line.

3.10 LSB: Abbreviation of Least Significant Bit.

3.11 MSB: Abbreviation of Most Significant Bit.

3.12 initialization: Process to activate an ECU for starting communication.

3.13 key words: Identifier of a set of specifications for the subsequent serial communication.

This set of specifications defines:

— the specific function of each communication line;

— the format of the digital information such as the protocol, number and meaning of each of the words exchanged; and

— if a redefinition is desired, the format of data such as baud rate, data coding, word length.

3.14 header: First group of serial data transmitted to the diagnostic tester after initialization (if required) before further data exchange commences.

The header consists of

— baud rate synchronization pattern;

— key words.

3.15 bit time: Duration of one unit of information.

4 General configurations

4.1 ECU shall have one (K) or two (K and L) communication connections for inspection, test and diagnosis. Vehicle battery voltage V_B and common return G to the diagnostic tester shall be provided either from the ECU or from the vehicle. If lines K or L from two or more ECUs are connected together, the resulting system is called a bus system.

Line K is defined as the line which provides information in a serial digital form from ECU to the diagnostic tester. Line K may also be used bidirectionally, in which case it may carry commands or data from the diagnostic tester to the ECU. Line K may also be used to initialize the serial communication.

Line L is defined as a unidirectional line from the diagnostic tester to the ECU. When it exists, it may be used to initialize the serial communication and/or to carry commands and/or data.

It can be seen from the above, in that the communication on line K may be unidirectional or bidirectional, and that line L may or may not exist, that only the four following configurations may be used:

1) bidirectional line K with unidirectional line L;
2) unidirectional line K with unidirectional line L;
3) bidirectional line K without line L;
4) unidirectional line K without line L.

Other initialization may be used, as an alternative to using the K- and L-lines, in any of these cases.

ECUs using any of the above configurations and which do not run free may have their like communication lines linked on a bus.

Figure 1 shows the various possible system configurations indicating the role of each of the communication lines K and L.

4.2 If any ECUs, 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.

Figure 2 shows the possible bus connections of the various types of ECUs including different means of initialization.

5 Signal and communication specifications

5.1 Signal

5.1.1 For proper operation of the serial communication, both ECU and diagnostic tester shall correctly determine each logic state as follows:

— a logic "0" is equivalent to a voltage level on the line of less than 20 % V_B for transmitter, 30 % for receiver;

— a logic "1" is equivalent to a voltage level on the line of greater than 80 % V_B for transmitter, 70 % for receiver.

In addition, the slope times shall be less than 10 % of the bit time. The slope times are defined as the time taken for the voltage to change from 20 % to 80 %, and 80 % to 20 % V_B for transmitters.

In the case of NRZ-code the bit time is defined as half of the time between the 50 % levels of successive rising or falling edges of alternating "1" and "0" bits.

Figures 3 and 4 illustrate the worst case on signal levels.

For electrical specifications of diagnostic testers, see 8.5 and of ECUs, see 9.2.

5.1.2 For present economic reasons the baud rate shall be limited to 10 kbaud and will be revised as technical and economic factors allow. The minimum baud rate shall be 10 baud.

The transmission speed of the address (see 8.3), if used, shall be 5 baud.

5.2 Communication

5.2.1 The schematics used are shown in figure 5.

5.2.2 The capacitance contributions of the diagnostic tester and cables, C_{TE}, shall not exceed 2 nF.

The sum of the input capacitances of all ECUs (C_{ECU}) on the bus, the capacitance of the on-board serial communication line, C_{OBW}, the capacitance of the diagnostic tester and its cables, C_{TE}, and the baud rate, BR (NRZ-code), shall be chosen such that the following inequality holds:

$$BR < \frac{10^{-4}}{\sum_{i=1}^{n} C_{ECUi} + C_{OBW} + C_{TE}}$$

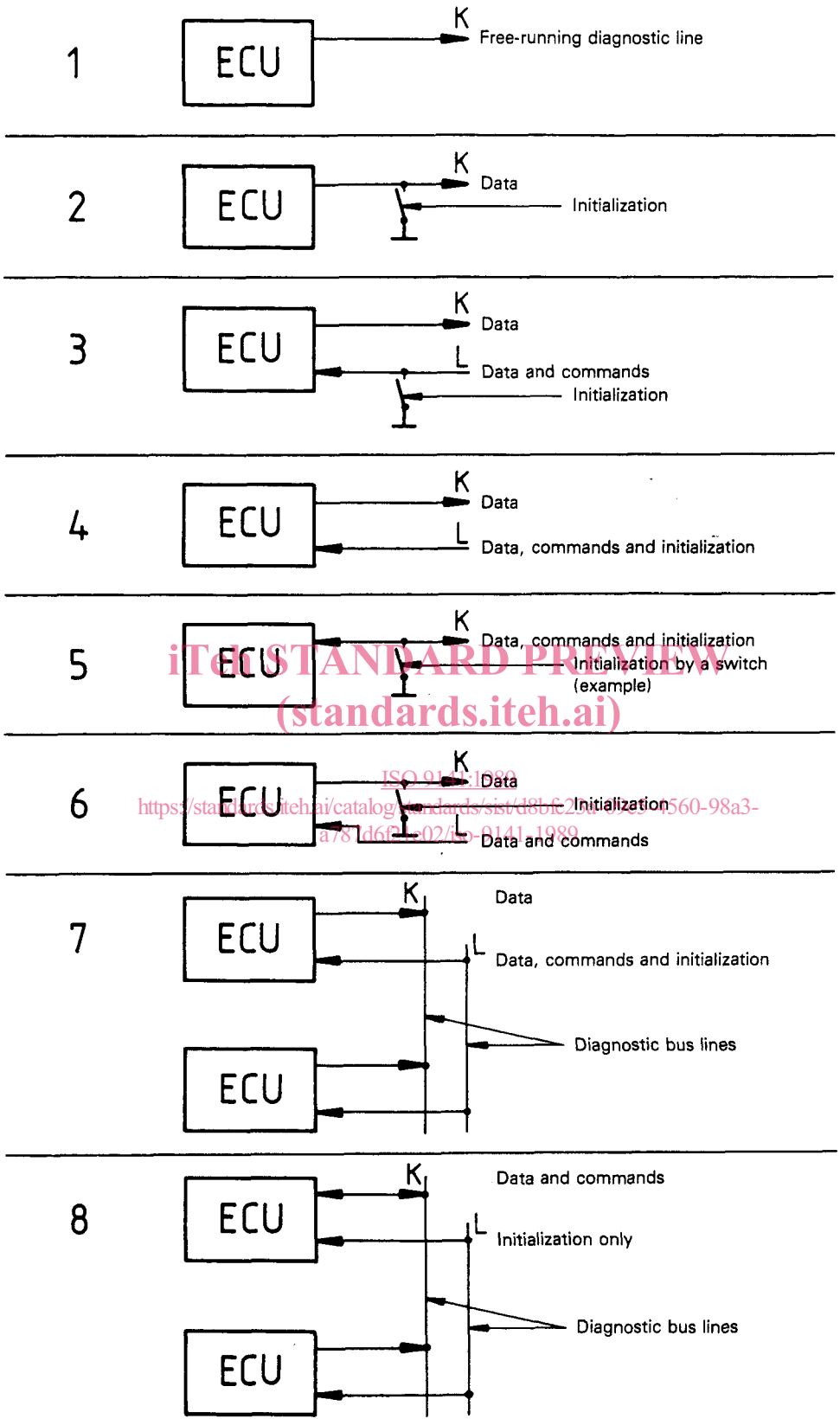
The value, BR, shall be divided by 2 for 24 V systems.

If this calculation results in a baud rate greater than 10 kbaud, reference shall be made to 5.1.2.

As an example, a bus system can be chosen as follows:

n = 5 (number of ECUs)

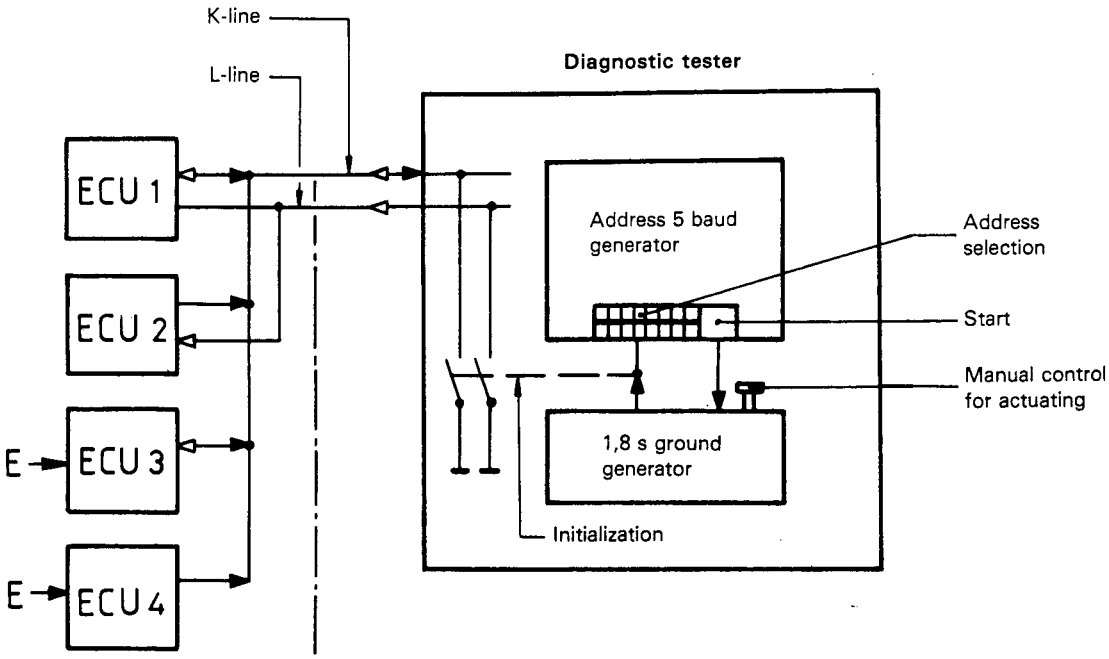
C_{ECU} = 2 nF
C_{OBW} = 3 nF
} Then BR < 6,6 kbaud



The arrow indicates direction of data flow

The switch indicates initialization

Figure 1 — Possible system configurations



ECU solution Nos. 1 and 2:

When these types are connected on a bus, particular means of comparing signals between lines K and L are necessary in order to avoid unintended initialization.

ECU solution Nos. 3 and 4:

These types cannot be connected on a diagnostic bus unless separate wake-up lines exist or specific means prevent unintended initialization of any ECU by the exchange of data.

Figure 2 — Bus system of various types of ECU

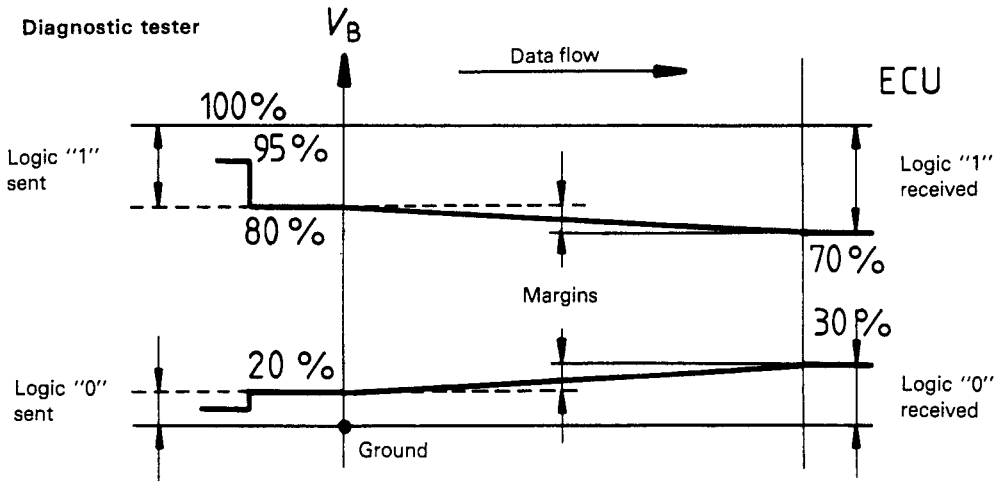


Figure 3 — Signal voltage levels, data flow from the diagnostic tester to ECU: worst-case values

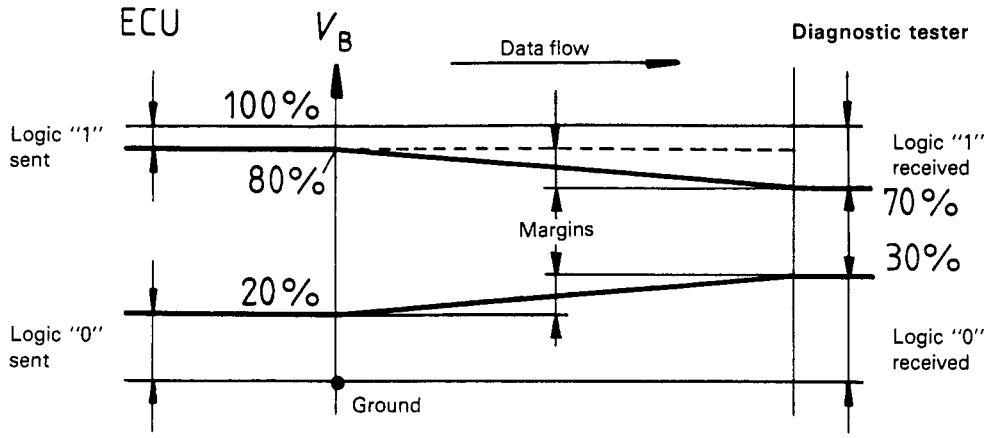


Figure 4 — Signal voltage levels, data flow from ECU to the diagnostic tester: worst-case values

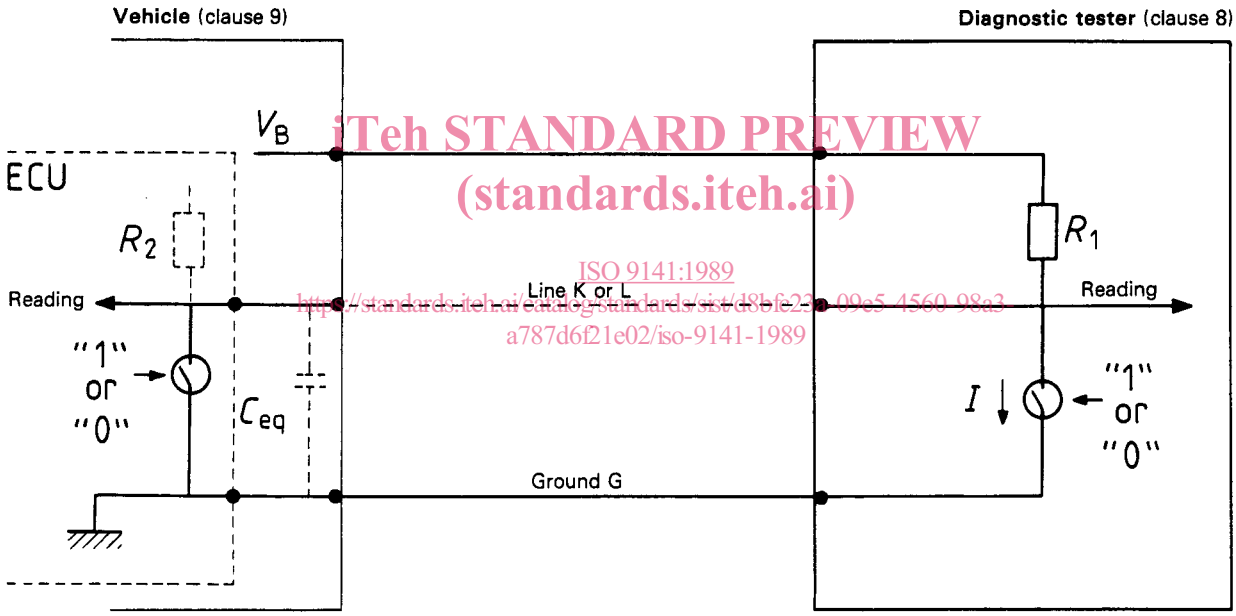


Figure 5 — Communication — Schematics

6 Initialization of the ECU prior to serial communication

For those ECUs which require initialization in order to communicate with the diagnostic tester, this initialization may be achieved by one of the following:

— through specific external means other than line K or line L (e.g. a configuration of sensors, push-buttons or turning the ignition key to "on");

— through an initialization signal output from the diagnostic tester which may be one of the following:

a) a logic "0" of duration 1,8 s ± 0,01 s on lines K and L simultaneously, or on line K or L; this time is chosen to distinguish it from the maximum logic "0" duration of the 5 baud address and the minimum period of grounding by wire;

b) a 5 baud address code which shall comprise a one-byte word constructed as the key word on lines K and L simultaneously, or on line K or L;

NOTE — The ECU may recognize an intialization signal on line K, or L, or both.

— through a ground connection applied to lines K and/or L for a duration greater than 2 s.

These choices are shown in figure 6.

Alternatively, the communication may be free-running (not requiring initialization).