ISO/TC22/SC3/WG1/TF1 N **109**

MAY 1994

ISO/WD 14230-1 - Road Vehicles - Diagnostic Systems - Keyword Protocol 2000 - Physical layer

1 Scope

This part of ISO 14230 describes 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 vehicles with either 12 or 24 voltage supply.

2 Normative References

This following standard contain provisions which, through reference in this text, constitute provisions of this International standard. At the time of publication, the editions were indicated were valid. All standards are subject to revision, and parties to agreement based on this International standards 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 7637-1 : 1990, Road vehicles - Electrical disturbance by conduction and coupling - Part 1 : Passenger cars and light commercial vehicles with nominal 12 V supply voltage - Electrical transient conduction along supply lines only.

ISO 9141 : 1989, Road vehicles - Diagnostic systems - Requirements for interchange of digital information.

ISO 9141-2 : 1993, Road vehicles - Diagnostic systems - Part 2 : CARB requirements for interchange of digital information.

ISO/WD 14230-2 : , Keyword protocol 2000 - Part 2 : Data link layer.

ISO/WD 14230-3 : , Keyword protocol 2000 - Part 3 : Implementation.

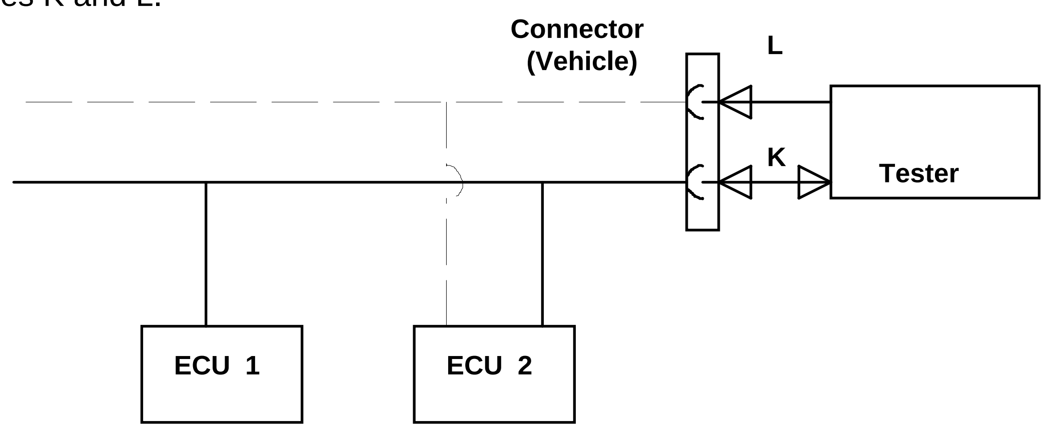
SAE J1962 :, Diagnostic connector.

3 Definitions

According to ISO 9141.

4 Allowed configurations

4.1 Vehicle ECUs which support the protocol described in this document 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 bi-directional line. It is used during initialisation to convey address information or ,in the case of fast initialisation , the wake up pattern from the diagnostic tester 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 initialisation sequence and all other communication services as described in ISO 14230-2 and the subsequent communication as described in ISO 14230 Parts 2 and 3.
Line L is an unidirectional line and is only used during initialisation to convey address information or ,in the case of fast initialisation , the wake up pattern from the diagnostic testers to vehicle ECUs, simultaneously with the K line. At all other times it should idle in the logic "1" state.
Figure 1 shows the system configurations allowed , indicating the role of each of the lines K and L.



The arrows indicate the direction of data flow.

Figure 1- Possible system configurations.

4.2 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 initialise the serial communication of another ECU on the bus and an initialisation signal shall not cause more than one ECU to respond simultaneously; it may , however , initialise 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.

5 Signal and communication specifications

Note:On those vehicles fitted with *SAE J1962* 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 .

5.1 Signal

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

(Values for 24 volt systems appear in paranthesis)

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

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

In addition , the slope times shall be less than 10% (15%) of the bit time. The slope times are defined as the time taken for the voltage to change from 20% to 80% V_B ,and from 80% to 20% V_B for transmitters.
Voltage levels between 30% and 70% of V_B 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 50% V_B levels of successive rising or falling edges of alternating " 1 " and " 0 " bits.
Figure 2 illustrates the worst case on signal levels. For electrical specifications of diagnostic testers see 6.2 for ECUs, see 7.2

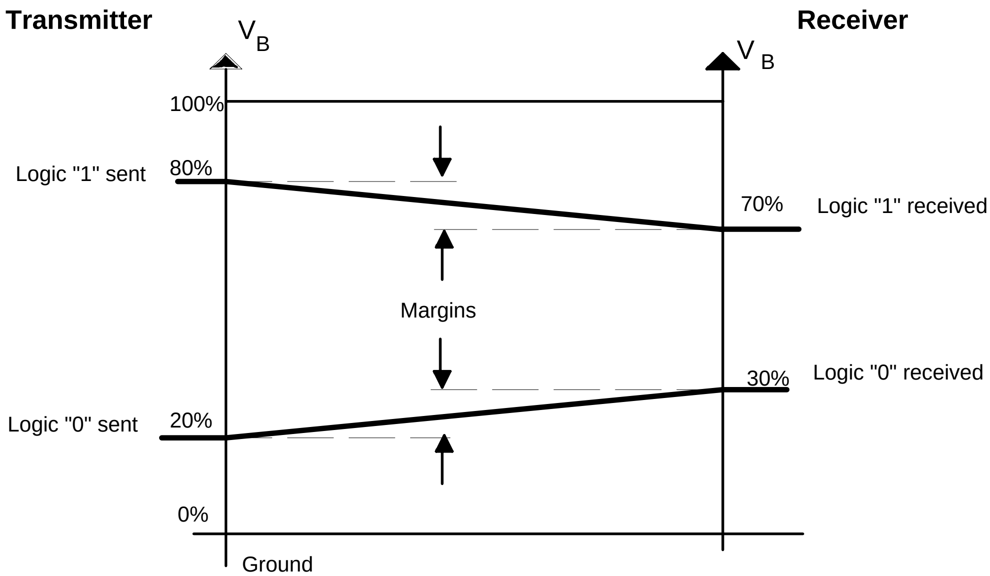


Figure 2– Signal voltage levels , worst case values.

5.2 Communication specification

5.2.1 The configuration is shown schematically in Figure 3

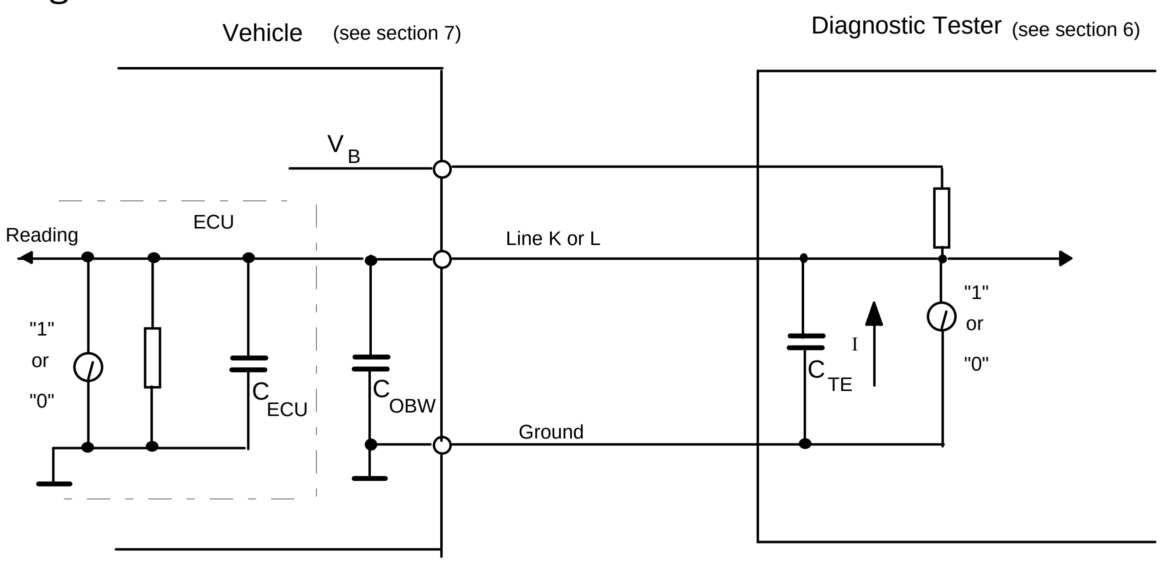


Figure 3- Communication schematic

5.2.2 The capacitance contribution of the diagnostic tester 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} and C_{OBW} must be selected such that

$C_{ECU} + C_{OBW} \leq 7.2\text{nF}$ and $C_{TE} \leq 2\text{nF}$
$(C_{ECU} + C_{OBW} \leq 5.0\text{nF}$ and $C_{TE} \leq 2\text{nF})$

(first values are for vehicles with nominal 12V supply, values in parentheses are for 24V vehicle battery voltage systems)

These values are derived from the circuit resistance and baud rate tolerances (sections 6 and 7) ,alowed slope times and switching thresholds (section 5.1) and assuming a maximum communication speed of 10,4 KB. If a higher or lower maximum communication speed is chosen then the designer will reduce or increase the allowed capacitance accordingly . The formula to be used is described in ISO 9141.

6 Requirements of the diagnostic tester

6.1 Minimum functional requirements

The diagnostic tester shall be capable of supporting the initialisation methods and the communication protocol described in ISO 14230-2.

6.2 Electrical specifications

(first values are for vehicles with nominal 12V supply, values in parentheses are for 24V vehicle battery voltage systems)

These specifications shall apply over a working temperature range of 0 °C to 50° C.
The following specifications shall apply to nominal 12V (24V) systems for which the diagnostic tester 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 diagnostic testers are encouraged to extend the limits of correct operation for vehicle battery voltage V_B and working temperature.

6.2.1 For lines K and L of the diagnostic tester not connected to an ECU, each line shall be internally pulled up to V_B via a nominal 510 Ω (1KΩ) resistor.

Transmission state

- At logic " 1 " the diagnostic tester shall have an equivalent voltage source greater than 90 % V_B ,sourced from the vehicle battery supply V_B ,
and an equivalent resistance of 510 Ω ± 5 % (1KΩ ± 5 %).

- At logic " 0 " the diagnostic tester shall have an equivalent voltage of less than 10 % of V_B, at a maximum sink current of 100mA.

Receiving state
- The equivalent resistance on the line K of the diagnostic tester shall be 510 Ω ± 5% (1KΩ ± 5 %) to V_B.

6.2.2 The diagnostic tester will maintain fast initialisation 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 baud address shall be transmitted with a tolerance of ± 0,5 %

6.2.3 For each byte the diagnostic tester 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.

6.2.4 The diagnostic tester shall not transfer to the open lines K and L any voltage higher than V_B or 40V , whichever is the lower , or any voltage which is lower than -1V. This includes suppression of voltage excursions of V_B as detailed in ISO/TR 7637

6.2.5 The diagnostic tester shall expect a resistance of at least 5kΩ (10kΩ) to vehicle signal ground and at least 10kΩ (20kΩ) to V_B on lines K and L when connected to the vehicle.

6.2.6 The total capacitance of the diagnostic tester and its cable and connector shall not exceed 2nF.

7 Requirements of the ECU

The combined impedance defined in clause 6.2.5 are the primary constraints. For guidance only the average values per ECU on a system with ten ECUs connected is given.(24V values in paranthesis).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 section 5.

7.1 Input and output lines

ECUs shall have one(K) or two (K and L) connections as defined in 4.1. V_B and Ground shall also be made available to the tester but need not come directly from the ECU.

7.2 Electrical specifications

7.2.1 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 100kΩ (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 can choose a different specification, but attention must 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 5.2.2.

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 in 5.1 .
When the serial communication of the ECU is not in operation and the diagnostic tester is connected , the output of the ECU shall be at a logic " 1 ".

7.2.2 Line L

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

7.2.3 Lines K and L

The input/output circuitry of the ECUs shall withstand transitions and over voltage present on the diagnostic tester lines K and L via the diagnostic tester source resistance, limited as below.

K and L shall withstand

20 V dc permanent(36 V dc permanent)
24 V dc for 30 min (42 V dc for 30 min)
30 V dc for 1 min (48 V dc for 1 min).

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

7.3 Minimum functional capabilities

The ECU shall be capable of supporting the communication protocol and at least one of the initialisation methods described in ISO 14230-2 . It will be capable of ignoring the initialisation of other ECUs on the bus if they respond to different methods of initialisation to its own.
The ECU will transmit messages with bit rates within ± 1,7 % (± 1 % for 24 V systems) of nominal where a baud rate is specified by the protocol.

8 Requirements of the wiring

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 diagnostic tester but need not come directly from an ECU.