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**Road vehicles — Electrical connections  
between towing and towed vehicles —  
Interchange of digital information —**

**Part 1:**

**Physical layer and data link layer**

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*Véhicules routiers — Connexions électriques entre véhicules tracteurs et  
véhicules tractés — Échange de données numériques —*

*Partie 1: Couche physique et couche liaison de données*

ISO 11992-1:1998

<https://standards.iteh.ai/catalog/standards/sist/2decd805-9849-4b15-b95e-9b67cb975fe5/iso-11992-1-1998>



## 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 voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 11992-1 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

ISO 11992 consists of the following parts under the general title *Road vehicles — Electrical connections between towing and towed vehicles — Interchange of digital information*:

- Part 1: *Physical layer and data link layer*
- Part 2: *Application layer for braking equipment* [ISO 11992-1:1998](https://standards.iteh.ai/catalog/standards/sist/2decd805-9849-4b15-b95e-8b171b975fe5/iso-11992-1-1998)
- Part 3: *Application layer for non-braking equipment*

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Printed in Switzerland

# Road vehicles — Electrical connections between towing and towed vehicles — Interchange of digital information —

## Part 1:

### Physical layer and data link layer

## 1 Scope

This part of ISO 11992 specifies the interchange of digital information between road vehicles with a maximum authorised total mass greater than 3 500 kg, and towed vehicles, including communication between towed vehicles in terms of parameters and requirements of the physical and data link layer of the electrical connection used to connect the electrical and electronic systems.

It also includes conformance tests of the physical layer.

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## 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 11992. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 11992 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 1176:1990, *Road vehicles — Masses — Vocabulary and codes*.

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 7637-2:1990, *Road vehicles — Electrical disturbance by conduction and coupling — Part 2: Commercial vehicles with nominal 24 V supply voltage — Electrical transient conduction along supply lines only*.

ISO 8092-2:1996, *Road vehicles — Connections for on-board electrical wiring harnesses — Part 2: Definitions, test methods and general performance requirements*.

ISO 11898:1993, *Road vehicles — Interchange of digital information — Controller area network (CAN) for high speed communication*, and its Amendment 1:1995.

ISO 11992-2:1998, *Road vehicles — Electrical connections between towing and towed vehicles — Interchange of digital information — Part 2: Application layer for braking equipment*.

ISO 11992-3:1998, *Road vehicles — Electrical connections between towing and towed vehicles — Interchange of digital information — Part 3: Application layer for non-braking equipment*.

### 3 Definitions

For the purposes of this part of ISO 11992, the following definitions apply.

#### 3.1 maximum authorised total mass

vehicle mass determined as a maximum by the administrative authority for operating conditions laid down by that authority [ISO 1176:1990]

#### 3.2 point-to-point connection

electrical connection between two electronic nodes only

#### 3.3 bus

one or more conductors used for transmitting signals

#### 3.4 line conductor

conductive part of cables used for transmitting signals

#### 3.5 CAN\_H, CAN\_L

particular cable and/or contact of the communication connection

#### 3.6 differential transmission

transmission of digital information carried by voltage between the two conductors of the electrical connections (two-wire operation)

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### 4 General specification

The data link layer and the fault confinement entity used for this data link shall be in accordance with ISO 11898 [Controller Area Network (CAN) for high speed communication]; 1998

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### 5 Physical layer

#### 5.1 General requirements

The physical layer shall be a point-to-point connection, in order to ensure satisfactory operation of both the coupled and decoupled trailer.

Stable electrical signals with high signal-to-noise ratio are required even at extreme external operating conditions (salt, oil, moisture, etc.).

The contact resistance and leakage currents shall not become the weak points of the braking equipment during the lifetime of vehicles.

For safety reasons the data transmission shall be monitored, and in the case of a failure, at least one emergency operation shall be provided.

The transmission shall be bi-directional and differential.

The nominal supply voltages of the physical layer circuits may be either 12 V or 24 V.

#### 5.2 Physical media

##### 5.2.1 General

The bus consists of two unscreened twisted cables, CAN\_H and CAN\_L, for the transmission of the differential signals. These cables may be part of a multi-core cable. For this physical layer the characteristic impedance has no significant influence, and is therefore left unspecified.

The total length of cable is split into at least three parts, as shown in figure 1. If more connectors are used on each vehicle (ECU connectors, etc.) the total capacitance shall be less than  $C_{busX}$  for each length, as specified in table 1.

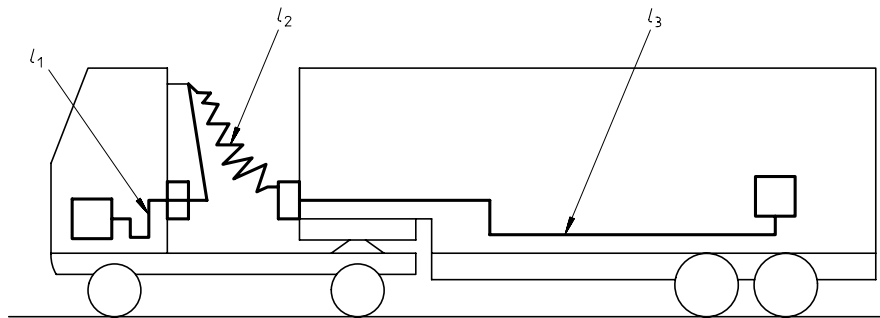


Figure 1 — Cable lengths

### 5.2.2 Parameters related to the cables CAN\_H and CAN\_L

The parameters shall be in accordance with table 1.

## 5.3 Contacts

### 5.3.1 General

The interface provides two contacts for the data transmission, CAN\_H and CAN\_L.

### 5.3.2 Parameters related to the contacts CAN\_H and CAN\_L

The parameters shall be in accordance with table 2.

## 5.4 Physical medium attachment

### 5.4.1 Electrical equivalent circuit diagram

Figure 2 shows the electrical equivalent circuit diagram of one unit of the data link.

CAN\_H and CAN\_L shall be connected to the resistances and voltage sources as specified. The data link shall fulfil the limiting values specified in 5.4.2.

### 5.4.2 "Dominant" and "recessive" status, electrical parameters

#### 5.4.2.1 Transmission levels

CAN\_H and CAN\_L shall be operated with the voltage levels given in figure 3.

The logic state of the bus may be "dominant" or "recessive", as specified in figure 3.

The logic "recessive" state is specified by the following voltage levels of CAN\_H and CAN\_L:

$$V_{CAN\_H} = 1/3 V_s$$

$$V_{CAN\_L} = 2/3 V_s$$

Table 1 — Cable parameters

Parameter	Notation	Unit	Value		
			nominal	max.	min.
Overall cable length <sup>1)</sup>	$l$	m	—	40	—
Cable length in towing vehicle	$l_1$	m	—	15	—
Differential capacitance between CAN_H and CAN_L in towing vehicle	$C_{d1}$	pF	750	—	—
Input capacitance between CAN_H and ground, CAN_L and ground in towing vehicle	$C_{i1}$	pF	750	—	—
Bus capacitance in towing vehicle <sup>2)</sup>	$C_{bus1}$	nF	—	2,4	—
Resistance of CAN_H and CAN_L in towing vehicle	$R_{l1}$	mΩ	—	600	—
Insulation resistance of each CAN_H and CAN_L to ground and $V_{bat}$ in towing vehicle <sup>3)</sup>	$R_{i11}$	MΩ	—	—	15
Insulation resistance between CAN_H and CAN_L in towing vehicle <sup>3)</sup>	$R_{i21}$	MΩ	—	—	15
Coiled cable length	$l_2$	m	—	7	—
Differential capacitance between CAN_H and CAN_L in coiled cable	$C_{d2}$	pF	560	—	—
Input capacitance between CAN_H and ground, CAN_L and ground in coiled cable	$C_{i2}$	pF	700	—	—
Bus capacitance in coiled cable <sup>2)</sup>	$C_{bus2}$	nF	—	1,9	—
Resistance of each CAN_H and CAN_L in coiled cable	$R_{l2}$	mΩ	—	300	—
Insulation resistance of each CAN_H and CAN_L to ground and $V_{bat}$ in coiled cable <sup>3)</sup>	$R_{i12}$	MΩ	—	—	30
Insulation resistance between CAN_H and CAN_L in coiled cable <sup>3)</sup>	$R_{i22}$	MΩ	—	—	30
Cable length in towed vehicle	$l_3$	m	—	18	—
Differential capacitance between CAN_H and CAN_L in towed vehicle	$C_{d3}$	pF	900	—	—
Input capacitance between CAN_H and ground, CAN_L and ground in towed vehicle	$C_{i3}$	pF	900	—	—
Bus capacitance in towed vehicle <sup>2)</sup>	$C_{bus3}$	nF	—	2,9	—
Resistance of each CAN_H and CAN_L in towed vehicle	$R_{l3}$	mΩ	—	700	—
Insulation resistance of each CAN_H and CAN_L to ground and $V_{bat}$ in towed vehicle <sup>3)</sup>	$R_{i13}$	MΩ	—	—	12
Insulation resistance between CAN_H and CAN_L in towed vehicle <sup>3)</sup>	$R_{i23}$	MΩ	—	—	12

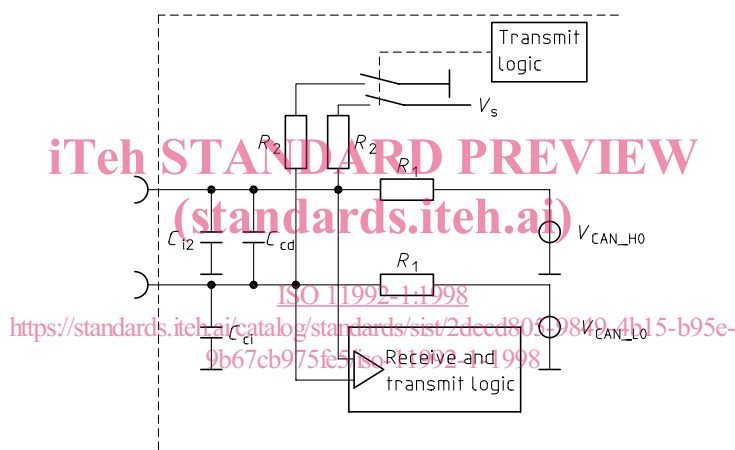
1)  $l = l_1 + l_2 + l_3$

2) The capacitive load for the driving circuit resulting from the cable is  $C_{busx} = C_{ix} + 2 C_{dx}$ , where  $x = 1, 2, 3$ ; including the connector capacitance,  $C_{con}$ .

3) Test method similar to ISO 8092-2.

Table 2 — Contact parameters

Parameter	Notation	Unit	Value		
			nominal	max.	min.
Contact resistance	$R_{\text{con}}$	m $\Omega$	—	10	—
Insulation resistance between CAN_H and CAN_L <sup>2)</sup>	$R_{i1}$	M $\Omega$	—	—	50
Differential capacitance between CAN_H and CAN_L	$C_{\text{cd}}$	pF	5	—	—
Insulation resistance between CAN_H/CAN_L and ground <sup>2)</sup>	$R_{i2}$	M $\Omega$	—	—	50
Input capacitance between CAN_H/CAN_L and ground	$C_{\text{ci}}$	pF	5	—	—
Capacitive load of the connector <sup>1)</sup>	$C_{\text{con}}$	pF	—	20	—
1) The capacitive load for the driving circuit resulting from the connector is: $C_{\text{con}} = C_{\text{ci}} + 2 C_{\text{cd}}$ .					
2) According to ISO 8092-2.					



NOTE —  $V_{\text{CAN\_H0}}$  = Voltage source of CAN\_H for recessive state, value (see 5.4.2.1).

$V_{\text{CAN\_L0}}$  = Voltage source of CAN\_L for recessive state, value (see 5.4.2.1).

Figure 2 — Electrical equivalent circuit diagram of one data link unit

The logic "dominant" state is specified by the following voltage levels of CAN\_H and CAN\_L:

$$V_{\text{CAN\_H}} = 2/3 V_s$$

$$V_{\text{CAN\_L}} = 1/3 V_s$$

where  $V_s$  is the supply voltage of the data link units connected to the bus.

The differential voltage  $V_{\text{diff}}$  is

$$V_{\text{diff}} = V_{\text{CAN\_L}} - V_{\text{CAN\_H}}$$

This results in a value of

$$V_{\text{diff}} = 1/3 V_s \text{ at "recessive" state, and}$$

$$V_{\text{diff}} = -1/3 V_s \text{ at "dominant" state.}$$

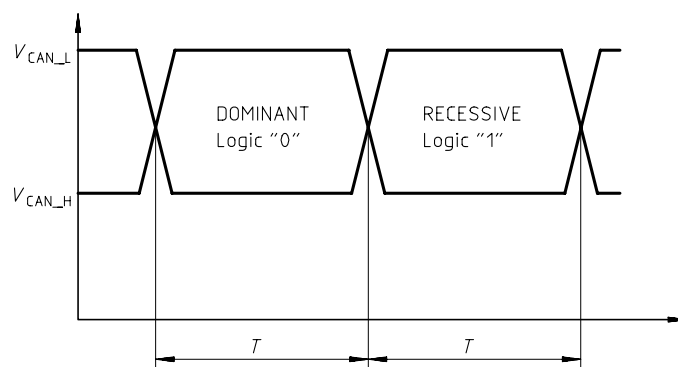


Figure 3 — Specification of "dominant" and "recessive" state of CAN\_H and CAN\_L

#### 5.4.2.2 Ratings

The voltage levels of  $V_s$ ,  $V_{CAN\_H}$  and  $V_{CAN\_L}$  shall be within the voltage ranges specified in tables 3 and 4 as appropriate and as in table 5.

The interface operating voltage  $V_s$  is the on-board supply voltage for the commercial vehicle and the trailer interface as shown in figure 4. If internal protection circuits (such as filters) are used,  $V_{CAN\_H}$  and  $V_{CAN\_L}$  shall fulfil the specified requirements of tables 6 and 7. The time constant  $t_F$  shown in figure 5 specifies the delay of voltage change between  $V_s$  and  $V_{CAN\_H}$  or  $V_{CAN\_L}$  in the case of any changes of  $V_s$ . Electrical interference along supply lines, defined in ISO 7637-1 and ISO 7637-2, may interrupt the communication for less than 10 ms. No failure reaction shall occur during this time.

Table 3 — Voltage ranges for 24 V nominal voltage systems

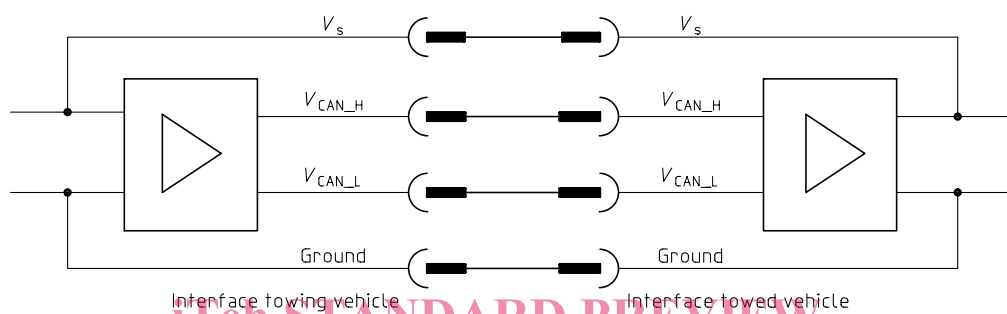
Parameter	Notation	Unit	Voltage		
			min.	nominal	max.
Interface operating voltage	$V_s$	V	16	—	32
Voltage at bus connection	$V_{CAN\_H}$	V	0	—	32
	$V_{CAN\_L}$				
Interface supply current (nominal operation)	$I_s$	mA	—	—	60

Table 4 — Voltage ranges for 12 V nominal voltage systems

Parameter	Notation	Unit	Voltage		
			min.	nominal	max.
Interface operating voltage	$V_s$	V	9	—	16
Voltage at bus connection	$V_{CAN\_H}$	V	0	—	16
	$V_{CAN\_L}$				
Interface supply current (nominal operation)	$I_s$	mA	—	—	30

Table 5 — Ground offset ranges

Parameter	Notation	Unit	Voltage	
			min.	max.
Ground offset between the two interfaces during two-wire operation <sup>1)</sup>	$V_{os}$	V	$-V_s/8$	$V_s/8$
Ground offset between the two interfaces during one-wire operation <sup>1)</sup>	$V_{os}$	V	$-V_s/16$	$V_s/16$
1) The ground offset $V_{os}$ is related to the supply voltage of the interface of the towing vehicle.				

Figure 4 — Specification of  $V_s$ 

#### 5.4.2.3 d.c. parameters

The d.c. parameters of an interface shall be within the ranges specified in tables 6 and 7 as appropriate.

The parameters are valid for two-wire operation, and for non-affected parts of the interface in the case of one-wire operation.

Table 6 — d.c. parameters at "recessive" state

Parameter	Notation	Unit	Value		
			min.	nominal	max.
Voltage level (data link disconnected)	$V_{CAN\_H}$	V	$0,32 V_s$	$0,33 V_s$	$0,35 V_s$
	$V_{CAN\_L}$		$0,65 V_s$	$0,67 V_s$	$0,68 V_s$
Differential voltage	$V_{diff}$		—	$0,33 V_s$	—
Threshold of differential voltage for receiving a recessive bit	$V$		0	—	0,65
Input resistance	$R_1$	$\Omega$	570	600	630
Current through connector <sup>1)</sup>	$I_{CAN\_H}$	mA	—	0	—
	$I_{CAN\_L}$				
1) With the two connectors mated.					

Table 7 — d.c. parameters at "dominant" state

Parameter	Notation	Unit	Value		
			min.	nominal	max.
Voltage level <sup>1)</sup>	$V_{CAN\_H}$	V	$0,64 V_s$	$0,67 V_s$	$0,70 V_s$
	$V_{CAN\_L}$		$0,30 V_s$	$0,33 V_s$	$0,36 V_s$
Differential voltage	$V_{diff}$		—	$-0,33 V_s$	—
Threshold of differential voltage for receiving a dominant bit	$V_{diff-th}$		$-0,65$	—	0
Current through connector for the whole range of $V_s$ <sup>2)</sup>	$I_{CAN\_H}$	mA	—	13,3	—
	$I_{CAN\_L}$			(6,6)	
Serial resistance <sup>3)</sup>	$R_2$	$\Omega$	285	300	315

1) Two interfaces coupled with the connector, only one transmits.

2) Two interfaces coupled. The value within brackets applies to 12 V nominal voltage systems; those without brackets apply to 24 V nominal voltage systems.

3) Including the serial resistance of the switch (compare with figure 2).

#### 5.4.2.4 a.c. parameters

The requirements of the a.c. parameters shall be within the ranges specified in table 8.

#### 5.4.3 Bus failure management

Transient errors (e.g. according to ISO 7637) are automatically handled by the CAN protocol as specified in ISO 11898.

When a node is set to the bus-off state due to a more permanent failure, it shall immediately be reset to resume communication.

Failure handling depends on the shortest nominal transmission repetition time  $t_r$  for all messages transmitted by the interface (as in ISO 11992-2 or ISO 11992-3). Failures in the data transmission that are only present for less than  $5t_r$  shall not be indicated. In this case the interface shall remain in the two-wire-operation mode.

Table 8 — a.c. parameters

Parameter	Notation	Unit	Value		
			min.	nominal	max.
Bit time without synchronisation (logical)	$t$	$\mu\text{s}$	7,999 2	8,0	8,000 8
Internal signal delay time <sup>1)</sup>	$t_{\text{del}}$	$\mu\text{s}$	—	—	0,4
Sample point <sup>2)</sup>	$t$	$\mu\text{s}$	$6 + t_{\text{sjw}}$	—	7
Input capacitance of one interface <sup>3)</sup>	$C_i$	pF	—	400	—
Differential input capacitance <sup>4)</sup>	$C_d$		—	100	—
Bus input capacitance <sup>5)</sup>	$C_{\text{bus}}$		—	600	800
Time constant of supply filter <sup>6)</sup>	$t_F$	ms	—	—	5

1) Period of time between transmit logic input signal and receive logic output signal at state transition, bus length  $\approx 0$  m.

2) See 5.5.2.

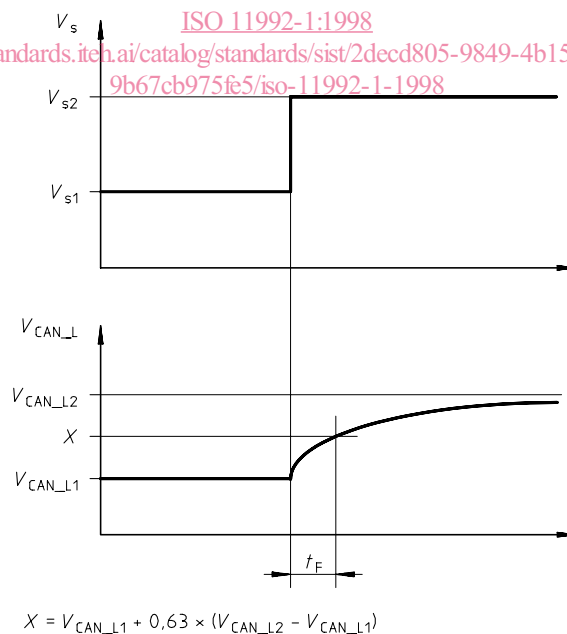
3) Capacitance between CAN\_H and ground, CAN\_L and ground, with the connector disconnected, see figure 2.

4) Capacitance between CAN\_H and CAN\_L with the connector disconnected.

5) The capacitive load for the driving circuit resulting from the electronic unit is  $C_{\text{bus}} = C_i + 2 C_d$ ,  
measured with disconnected connector.

6) See figure 5.

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Figure 5 — Example of time constant  $t_F$ 

Several open and short failures can occur that may influence operation. These are shown in figure 6. An electrical circuit shall be provided to avoid a total breakdown of the data transmission during bus failures. This circuit shall allow to change from the two-wire-operation mode to a one-wire-operation mode using only one of the two cables, CAN\_H or CAN\_L. This allows data transmission to be maintained in the case of an interruption of CAN\_H or CAN\_L, or a short circuit of one cable to ground or to supply voltage, or a short circuit between CAN\_H and CAN\_L (cases 1, 2, 3, 4, 5, 6 and 7 in figure 6). Data transmission is no longer possible if both cables are affected by a short circuit (except a short circuit between CAN\_H and CAN\_L) or interruption (case 8).