Nederlandse norm

NEN-ISO 22896

(en)

Road vehicles - Deployment and sensor bus for occupant safety systems (ISO 22896:2006,IDT)

ICS 43.040.80

november 2006

Als Nederlandse norm is aanvaard:

- ISO 22896:2006,IDT

Normcommissie 345 042 "Wegvoertuigen"

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INTERNATIONAL STANDARD

ISO 22896

First edition
2006-11-15

Road vehicles — Deployment and sensor bus for occupant safety systems

Véhicules routiers — Bus de déploiement et de capteurs pour les systèmes de sécurité des occupants

Reference number
ISO 22896:2006(E)

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Published in Switzerland

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Foreword

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ISO 22896 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

Road vehicles — Deployment and sensor bus for occupant safety systems

1 Scope

This International Standard is a specification of a serial communications bus protocol for automotive occupant restraint systems. It covers Physical Layer and Data Link Layer and those parts of the Application Layer that are not supplier-specific.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
analogue safing
using a special *bus level* (*LS0-level*) for confirmation of deploy messages

2.2
bitmap addressing
method of addressing one or several slaves at a time by assigning each bit of the address field to a different *slave*

2.3
bus level
one out of four levels of the differential bus voltage, whereof one forms the *Power Phase* and the other three are used for representation of a data bit during the *Data Phase*

2.4
command
part of a *D-Frame*, transmitted by the master, defining the purpose of the frame

2.5
CRC field
part of a *D-Frame* or *S-Frame*

2.6
data field
part of a *D-Frame*

2.7
Data Phase
part of a data bit providing the bit value

2.8
deploy command family
four commands for control of *deployable devices*

2.9
deployable device
irreversible actuator

2.10
D-Frame
type of frame primarily used for diagnostic communication and actuation of *deployable devices*

2.11
differential bus voltage
differential voltage between the two bus wires

2.12
duty cycle
percentage of a bit time that is assigned to the *Power Phase*

2.13
E-bit
bit in a *D-Frame* indicating an error or a "read" command

2.14
half-rate
mode used for sensors that shall not reply in every *S-Frame*

2.15
hold-up capacitor
capacitor supplying power to a *slave* during the *Data Phase*

2.16
latency time
worst-case duration between the occurrence of an interrupt requesting event in the sensor and the actual start of an *S-Frame* polling message

2.17
LS0-level
bus level indicating an error, a bus interrupt or a "0" with *analogue safing*

2.18
L0-level
bus level indicating a "0"

2.19
L1-level
bus level indicating a "1"

2.20
master
device responsible for communication on the bus and for power distribution over the bus

2.21
Multi-Sharing
mode used in *S-Frames* for dynamic assignment of slave data to the first slot

2.22
node
master or slave

2.23
point-to-point addressing
addressing used for communication between the *master* and one *slave*

2.24
power level
bus level forming the *Power Phase*

2.25
Power Phase
part of a data bit during which the *master* transmits the *power level*

2.26
R-bit
reserved bit in *D-frames* for future definition

2.27
SEL-bit
bit used in *S-Frames* to control *slaves* configured for *half-rate* mode

2.28
S-Frame
type of frame used by the *master* to collect dynamic data from *slaves* periodically

2.29
signal address
address assigned to peculiar signals provided by *slaves,* used in *S-Frames* for *Multi-Sharing*

2.30
slave
device that is connected to the bus and is not the *master*

2.31
slave address bitmap
part of a *D-Frame* in which each bit corresponds to one *slave*

2.32
slot
part of an *S-Frame* assigned to a certain *slave* to be filled with its data

2.33
Slot Length
determines the number of data bits that a *slot* consists of

2.34
Sub-Slot
sub-section of a *slot*

2.35
T-bit
first bit of a frame, used to define the frame type (*S*- or *D-Frame*)

3 Abbreviations

ACU Airbag Control Unit

ASIC Application-Specific Integrated Circuit

CRC Cyclic Redundancy Check

ECU Electronic Control Unit

HSD	High Side Driver
INT	Interrupt
LSB	Least Significant Bit
LSD	Low Side Driver
MSA	Multi-Sharing Address
MSB	Most Significant Bit
MTP	Multi Time Programmable
NVM	Non Volatile Memory
ORC	Occupant Restraint Controller
OTP	One Time Programmable
RAM	Random Access Memory
RCM	Restraint Control Module
ROM	Read Only Memory
SDM	Sensing and Diagnostic Module
SEL	Select
SOF	Start Of Frame
SSB	Slot Start Bit

4 General

Automotive occupant restraint systems are controlled by a Sensing and Diagnostic Module (SDM), also called Airbag Control Unit (ACU), Restraint Control Module (RCM) or Occupant Restraint Controller (ORC), which is connected to peripheral devices:

— dynamic sensors with high update rates, e.g. for remote front and side impact sensing;

— static sensors with low update rates, e.g. buckle switches, seat position and occupancy sensors;

— actuators, especially deployable devices, e.g. squibs.

The SDM is also referred to as “master”; the peripheral devices are also referred to as “slaves”.

The bus provides a two-wire connection between the SDM and the peripheral devices and supplies power to the slaves. It offers bi-directional communication. The master’s bus interface sends energy into the bus, the slave’s bus interface extracts power from the bus. The master determines the bus speed and initiates all communication by sending message frames on the bus. Slaves may transmit their data within these frames when requested by the master. Smart dynamic sensors (defined in 5.3) may send an interrupt to the master while the bus is idle or while there is diagnostic communication on the bus. The master’s reaction to the interrupt is application specific and typically lets the master stop diagnostic communication and start polling of impact data instead.

The data is usually coded using differential bus voltage. On a bus, where several transmitters are sharing the same wiring, using voltage as the data signal has a significant advantage over current, because it enables the transmitter to verify the data that it sent on the bus. This is the most reliable way to detect bus collisions, e.g. when two sensors are transmitting their data at the same time. For less critical data like diagnostics, reply data from slaves can be coded using current, which allows connection of deployable slaves to the bus via isolation resistors (see 6.6.4.2).

5 System architecture

5.1 General

The specification covers sensor busses, deployment busses and combined sensor/deployment busses.

The bus shall support 64 slave addresses, of which three shall be reserved for special purposes. The actual number of slaves that can be connected to one bus is limited by the supply current for the slaves and by the pin capacitance of the slaves (see also Clause 6). Bandwidth limits shall also be considered.

NOTE A single slave can incorporate the functionality of several slave addresses.

5.2 Deployment bus

The deployment bus shall support deployable devices and static sensors. The bus shall provide point-to-point messages for diagnostic communications between master and slaves. Since the deployment bus shall support fast selective deployment of several deployable devices, the bus shall also provide a special deploy message, which allows individual deployment control of up to 12 devices at a time. There shall be four deploy messages available, each controlling 12 device addresses:

— address range 0b000000 – 0b001011;

— address range 0b010000 – 0b011011;

— address range 0b100000 – 0b101011;

— address range 0b110000 – 0b111011.

In this way, up to $4 \times 12 = 48$ deployable devices can be controlled by one bus. The address 0b000000 should not be used as a slave address, because this address shall be the default address of all slaves that have not been programmed yet. See also 7.2.1, 7.3.2 and 7.4.8.

The deployment bus shall provide communication with and without a special “safing” signal, which may be used for additional differentiation between diagnostic communication and actual deploy commands.

5.3 Sensor bus

The sensor bus shall support static and dynamic sensors. There may be two types of dynamic sensors.

— **Raw-data sensors** send time-critical data periodically to the SDM.

— **Smart sensors** send time-critical data event-driven only.

Smart sensors can easily coexist with static sensors on the same bus.

NOTE Raw-data sensors usually occupy the bus bandwidth all the time, while smart sensors usually need the full bandwidth only for a short time during an event.

EXAMPLE In the absence of an event, the master can poll diagnostic data and/or static sensor data from all slaves. When an event occurs, a smart sensor can stop this communication by sending an interrupt to the master and to the other slaves. The master can then assign the full bus bandwidth for exclusive communication of time-critical data from smart sensors to the master.

The number of smart sensors that can be connected to the bus is usually limited by the ratio between the available bandwidth and the latency time requirements for this data transfer. Additional static sensors on the bus do not contribute to the latency time, but they contribute to the physical bus load, which also limits the number of slaves (see Clause 6) on the bus.

On a sensor bus, the “safing” signal, known from the deployment bus, shall be used for error indication and optionally for the interrupt capability of smart sensors.

Since raw-data sensors usually are not required to send bus interrupts, they may be implemented without this option. Devices (master and slaves) made for raw-data sensor busses should either not have bus interrupt capability or provide a means to disable the bus interrupt function in a reliable way.

5.4 Combined sensor and deployment bus

On a combined sensor and deployment bus, all types of slaves that are connected to the same bus would have to share the available bandwidth and the available bus power. This shall be taken into account when designing such a mixed system.

The “safing”-level LS0 shall be used on the one hand for confirmation of deploy messages (i.e. LS0 transmitted by the master), and on the other hand for signalling bus collisions (i.e. LS0 transmitted by a dynamic sensor during an S-Frame) or for interrupting communication (i.e. LS0 transmitted by a smart sensor during a D-Frame). The deployment and sensor bus protocol shall ensure that the relevant function of the LS0-level can be clearly identified by all nodes (see 8.5.4).

6 Physical Layer

6.1 Bus medium

The bus can use unshielded twisted pair or untwisted cable (see Table 3). The maximum bus length depends on the bus topology (see 6.2).

6.2 Bus topology

6.2.1 Parallel configuration

For a parallel bus configuration, each slave shall be directly connected to the two bus wires Bus-A and Bus-B (see Figure 1).

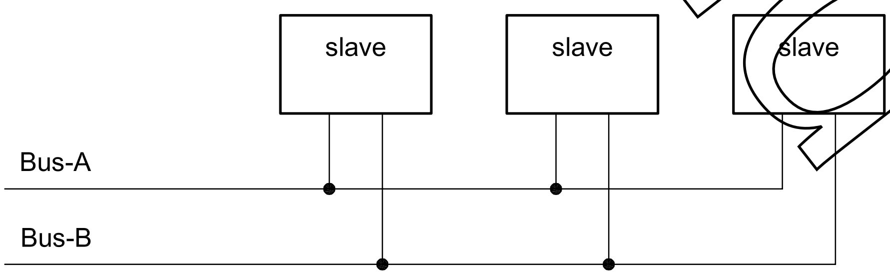

Figure 1 — Parallel connection of slaves to the bus

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