THE GERMAN STANDARD
FOR ELECTRONICAL TRACTOR IMPLEMENT DATA COMMUNICATION

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Abstract

Electronic is more and more an integrated part in technique for agriculture. Only a standardization of interfaces can guarantee their use with low costs and without problems in future time.

The following draft describes a communication system between tractor and implement. It is based on a concurrent, but priorizesed bus system. All electronic is used in a decentralized organisation with own electronic in implements and maschines. Electronical participants in the system are related in a multy-master-principle. The organisation is based on the ISO-OSI interconection proposal. Predefined identifiers are responsibel for trouble-free data transfer and initiate the use without viewing to an specific manufacturer. The whole operation with input and output is done from one bus terminal. The data transfer between bus system and On-farm computer is standardized too.

Resume

1. Need of Standardization

Electronic in agriculture becomes more and more of importance. It is used for farm management and production processes. Tasks in management are solved by personal computers mainly. Electronic in the production means process control in the way of monitoring, open loop control and closed loop control. Process control in indoor work is stationary technique. Its connection to the management computer can be realized very simple by installed cables. All parts of a system (subparts) are always connected in the same way.

Process control in outdoor work is a mobile technique. It is used without connection to the On-farm computer. This technique must be able to overtake data from the On-farm computer and return data to it. Beside of this requirements mobile process technique has to allow a variety of combinations between tractor and different implements or machines. Therefore process control in outdoor work has its own requirements for a efficient and economical use of electronics. These are:

- Central operations of all electronics in the rear mounted or drawn implements (machines) from the seat of the driver.
- Connection of machines and implements from different companies without problems.
- Reduction of multiple used, but equal sensors within a tractor-implement combination to a central mounted sensor with data transmission to all users.
- Overtake of predeterminded machine control functions from the On-farm computer.
- Return of collected respective determined process data to the On-farm computer.

2. Concept of standard

The shown requirements lead to a concept of standardization with decentralized electronics.

The central part of the concept is a concurrent, but priorizised bus system. A bus terminal allows the access to the bus and to the bus participants. Each participant has its own intelligence, own sensors and

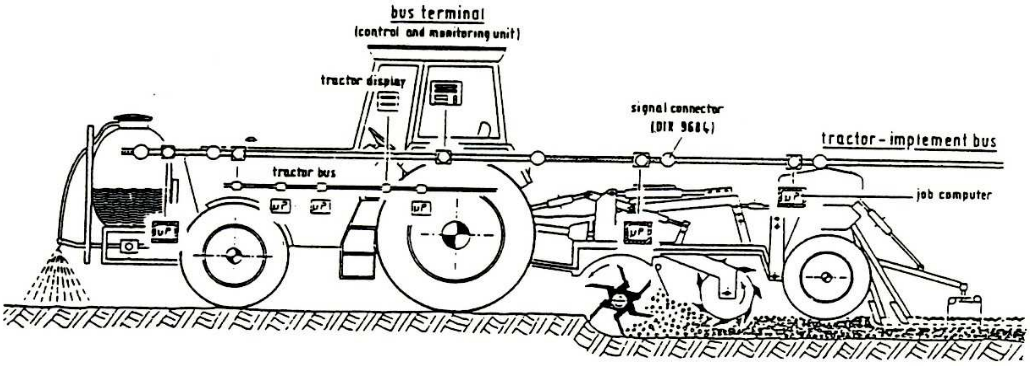

Figure 1: Concept of standardization in DIN 9684

own actuators (so called job computers). All participants are connected in a multi-master-principle.

The tractor with its own electronic is not part of the standardization. It can have an own bus system. In this case a gateway from the tractor bus to the implement bus has to be offered. The number of simultaneous active participants (job computers) is limited to eight. Additionally to it 256 intelligent sensors can be connected simultaneously.

The connection to the On-farm computer is made by a mobile medium. Not the medium, but the sequences of data is fixed up in the standard.

3. Signal connector

For the connection with the bus a standardized signal connector is used (figure 2).

It has two possibilities for data transmission. Four different impulse signal lines are part of the socalled short-time-solution. They offer present available basic signals from sensors in the tractor. Two lines are reserved and make the signal connector available for the bus system.

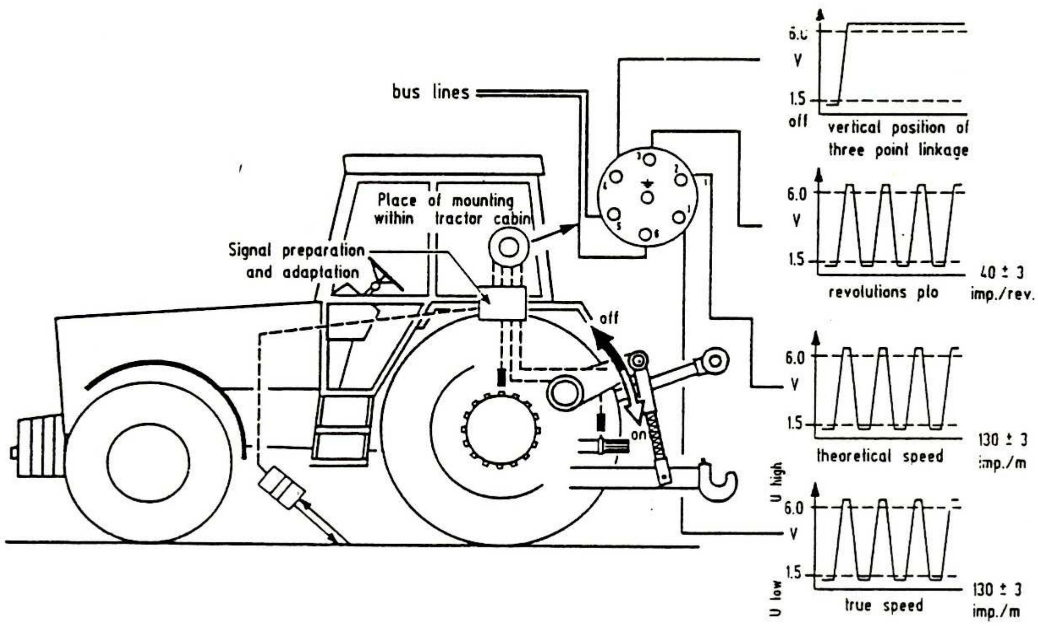

Figure 2: Signal connector (DIN 9684, part I) /2/

3.1 Impuls signals

Lines with impulses are used for the following signals:

- theoretical speed with 130 impulses/m
- true speed with 130 impulses/m
- revolutions of PTO with 40 impulses/revolution
- position of the three-point-linkage (variabel) with low = down = on
  high = above = off

The impulses are defined with their least and maximum hight and with defined flank stepness.

3.2 Bus lines

Beside this four pins there are two pins for the bus system. With it the present available socket on a tractor will be usable tomorrow as well as in the time after tomorrow. For these lines the physical interface and the protocol is defined.

4. Bus system

The bus system was chosen after pretences were made, to avoid a specific agricultural bus system. More over it seems, that only standard products from a large serial production of the car industry offers low price electronic. At the time of choise two different systems were available:

- the C^2D-bus by CRYSLER
- the CAN-protocoll by BOSCH /1/

Against the system made by CRYSLER the CAN-protocoll by BOSCH has a lot of advantages. These are besides a higher transfer rate and a bigger width of arbitration above all in a lot of hardware integrated points:

- message errection
- response acknowledgement
- error detection
- error messages
- automatic repeat of datatransfer in error cases
- error signalling

The physical interface for the bus system is beeing tested in some different forms by BOSCH and will be standardized at the end of these tests (autumn 1989).

5. Identifier list

The identification of commands, implements and data is realized by the CAN-identifiers within the first 11 bits. It has the following form (figure 3):

For the 11 bit broad arbitration a system with different priorities has been created (table 1).

The implement type determination results from Table 2.

For data transmission the identifiers out of Table 1 and the bits from the following byte are used for identification. So there are 2^{12} = 4 096 different possibilities. About 600 identifications are used of it as present. It can be expected, that they can fulfill the needs within the next

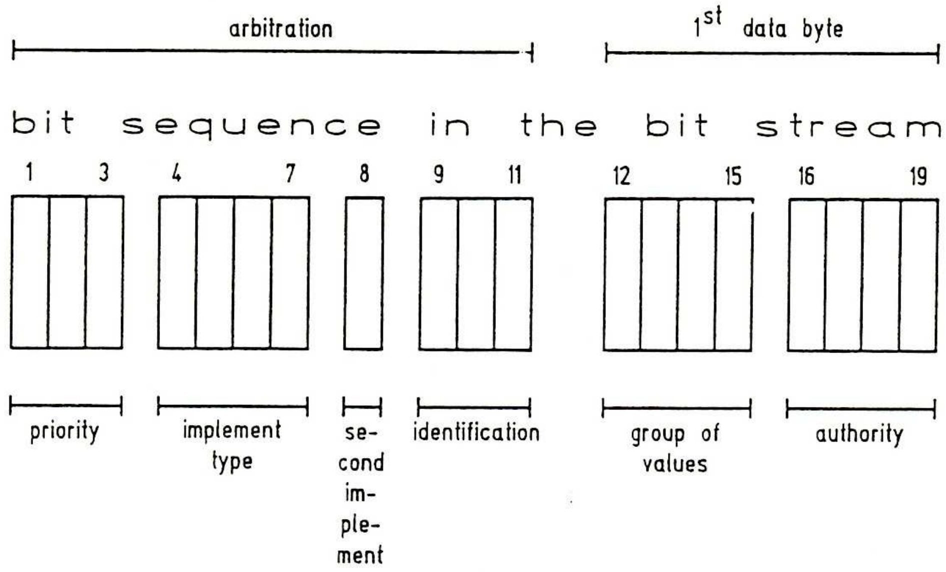

Figure 3: Identifiersystem in DIN 9684 (tractor-implement bus system)

Table 1: Priorities in DIN 9684 (tractor-implement bus system)

five years. After that, an authorized group has to make a continuation (based on an upward compatibility).

priority	bit no. 1 3	4 7	8	9 11	
0	0 0 0	imp. type	0/1	sender	actuator value
1	0 0 1	imp. type	0/1	sender	sensor value
2	0 1 0	imp. type	0/1	sender	call for sensor value
3	0 1 1	0 0 0 0	0	sender	broadcast command
	0 1 1	imp. type	0/1	sender	command to specific address
4	1 0 0	identification			remote sensor / actuator
5	1 0 1	0 0 0 0	0	sender	alarm
	1 0 1	imp. type	0/1	0 0 0	initialisation request
	1 0 1	imp. type	0/1	identity	initialisation identification
6	1 1 0	imp. type	0/1	sender	data transfer
7	1 1 1	0 0 0 0	0	sender	display data (ASCII)
	1 1 1	0 0 0 0	1	sender	display data (grafic)

first zero is winner

imp. type = implement type

Table 2: Implement determination in DIN 9684

No.	bit seq.	implement type	examples
0	0 0 0 0	terminal functions	
1	0 0 0 1	tractor functions	true speed, pto torque
2	0 0 1 0	primary soil preparation	plough, chiselplough
3	0 0 1 1	secundary soil "	seed bed combination
4	0 1 0 0	seed	seed drill
5	0 1 0 1	fertilizing	distributor, liquid manure
6	0 1 1 0	plant protection	sprayer
7	0 1 1 1	cereal harvesting	combine, cereal transport
8	1 0 0 0	root harvesting	potatoes, sugar beets
9	1 0 0 1	forage harvesting	gras, hay, corn silage
10	1 0 1 0	irrigation	pump, pipedrum
11	1 0 1 1	transport	spezific transport
12	1 1 0 0	indoor work	silage transport
13	1 1 0 1		
14	1 1 1 0	forest, special crops	
15	1 1 1 1	municipal jobs, others	snowplough

The data transmission in the following bytes after the idendification is done either in integer or in long integer size.

6. Bus terminal

The bus terminal is used for the initialization, for input (implement control) and for output (display) of the fitted job computers. To avoid design restrictions by different manufacturers, in the standard the whole dialog between bus terminal and job computer has been transfered to the job computers. They use for their in- and output a virtual terminal. This can be taken by the tractor driver as his real terminal and allow him the interaction with one of the connected job computers.

Thus, the standard can be reduced to a maximum length of a data and to the required number of soft- and hardkeys. An additional definition of the used bixels for the ASCII-chars and for different grafic elements allows the consideration of both terminal types. Nevertheless, the expenditure of needed software at the bus terminal is growing.

7. Data transfer to the On-farm computer

For the data transfer from and to the On-farm computer only the data identification is standardized. It is identical with the identifier system and leads to a throug going data handling in all the different systems.

From the point of hardware, the realization can be done either on chip-cards with a read-/write-socket in the bus terminal or in a RAM-box as an own job computer. It also can be realized by an installed data line between the On-farm computer and tractor hall.

8. Literature

1 - BOSCH   CAN Specification. Stuttgart: Robert BOSCH GmbH., 1987.

2 - DIN 9684 Schnittstellen zur Signalübertragung (Punkt-zu-Punkt-Verbindung) Berlin: Beuth-Verlag, 1989.