The BiSS Interface as an adapted INTERBUS

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In serial data communication the open-source BiSS Interface adapts the main features of the industrial INTERBUS standard with some simplification to create a bidirectional point-to-point connection between the master and slave. INTERBUS is an industrial standard (DIN standard 19258) now widely used to link sensors and actuators up to a processing unit. It was introduced by the company PHOENIX CONTACT in 1987.
As an open-source protocol with over 200 licensees worldwide, BiSS has become a standard in position sensor technology and motor feedback systems and is compatible with the synchronous serial interface (SSI), with improvements regarding speed and line length adaptation, for example.

The following describes the differences and simplifications of BiSS as opposed to INTERBUS, which after more than 20 years have become state of the art in patent-free technology.

INTERBUS in a point-to-point connection

In INTERBUS data is exchanged between master and slave stations. INTERBUS can be used in buses with several subscribers which are linked up as a ring through data channels. The basics and practical application of INTERBUS are described in the standard work on INTERBUS-S by Baginski and Müller, published by Hüthig Buch Verlag in Heidelberg in 1994, to which reference shall be made in the following article. INTERBUS is maintained and supported by INTERBUS Club Deutschland which also proved this report technically. The INTERBUS technology is recently integrated into the Profibus User Organization PNO.

The bus connection is turned into a point-to-point connection using just one single slave, with two data channels for bidirectional communication. This configuration is described in the following, using, by way of example, a parameterizable 24-bit angle encoder as a slave and a processing or control unit as a master.

INTERBUS permits operating modes to be altered, an electronic identification plate to be written to and read out, and blocks of time-uncritical data to be transmitted together with core data in either direction, i.e. to the measuring system and to the processing unit.

BiSS in comparison

In BiSS, clock-synchronized data transmission is cyclic, as it is in INTERBUS. In BiSS the bus is idle between the cycles, whereas INTERBUS transmits status signals during the transmission intervals, generating activity on the bus medium. In INTERBUS various modes of operation can be determined, such as for the configuration and programming of the slave or for the transmission of measurement data to the master, for instance, by comparing and detecting a serial signal as a sequence of bits (as a 5-bit header for one data octet). BiSS-B, on the other hand, can only **select** one of two operating modes at the beginning of a cycle with a temporal condition after an event control to trigger a slave activity. There is thus no continuous monitoring and no comparison with a reference signal when **commuting** from one mode to another, for example. There is no mode selection in BiSS-C at all.

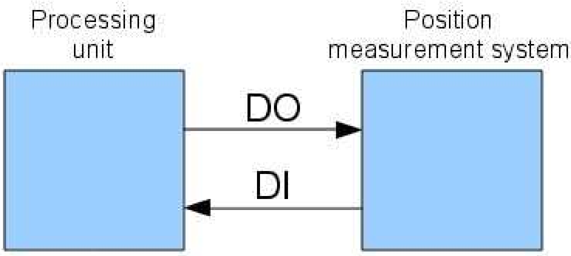
Like INTERBUS with its summation frame protocol, BiSS writes to a fixed cycle protocol. However, the BiSS cycle does not have a request command for the transmission of measurement data (in INTERBUS this is the 5-bit header, with SL and a mark bit with various commands as serial data words, for example), but instead starts with a temporal condition in BiSS-B or simply with the clock in BiSS-C.

Supplementary data is transmitted by INTERBUS in blocks, for example as time-uncritical parameter data within a cycle and in both directions, i.e. to the slave and to the master. Larger amounts of data can be transmitted in segments as broken-down sets of parameter data, cycle for cycle, and recompiled in the receiver.
BiSS does not transmit data blocks or words as supplementary data but just one bit per cycle in a fixed position. BiSS-C works towards the slave with just one clock signal sequence which ends in a low or a high as 1 bit of information and which is patented for iC-Haus.

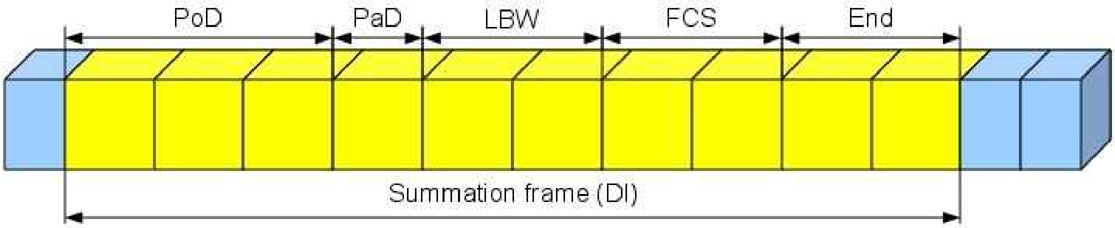
The graphic depicts the protocols for INTERBUS and BiSS-C for a bidirectional master/slave connection between a processing unit and a parameterizable 24-bit encoder as a position measurement system. In INTERBUS the core data rate per cycle for 24 bits of position and 8 bits of parameter data is 32/130. In BiSS this rate is 25/46 for 24 bits of position data and 1 bit of parameter data with a respective 16-bit checksum.
INTERBUS cyclically transmits summation frame protocols on both data channels DO and DI which are 'framed' by status telegrams with 5 bits of information. One summation frame can consist of the following data telegrams, for instance, each of which have a 5-bit header and an 8-bit data word (a coded information octet): 3 x position data (PoD), 1 x parameter data (PaD), 2 x loop check (LBW), 2 x frame check (FCS), and 2 x end detection (End). Loop check or loopback word LBW is a system test sequence; the FCS frame check sequence stores the relevant data content in the summation frame. The header in the data telegram (with SL and mark) is a request command for the transmission of position data to the processing unit, for example. The bus clock – and others – can be separated from the data stream.

Using select signal SL the master can choose between a data and an identification cycle. The corresponding data telegrams are transmitted between two INTERBUS subscribers on the outward and return line. An identification cycle is also used to transmit error and control information. Using the SL bit thus effects a switch between a programming mode with register access and measurement mode with measurement data transmission. Synchronization occurs during the transmission of measurement data, for example with each first clock of a data sequence, i.e. after each 13th bit, with which clock transmission also takes place.

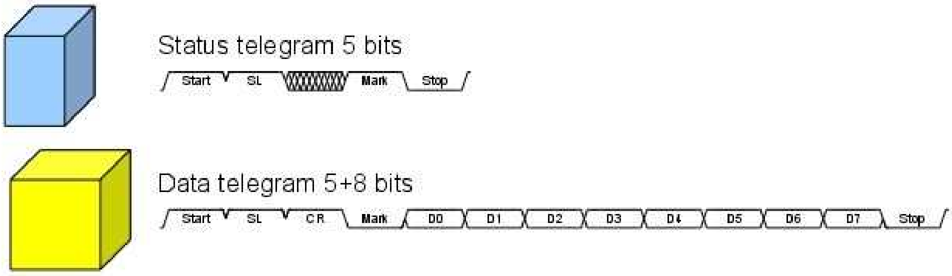
The BiSS protocol is also cyclic and fixed but has neither status telegrams in the transmission intervals, the header, nor the loop check. The BiSS master thus does not send a request command but starts straight from bus idle with the position data readout cycle, including check data. The slave is always in sensor mode and cannot be commuted. With this continuous transmission of sensor data BiSS proves advantageous to digital motor control units which are not interrupted by commutation to a programming mode.
The line to the slave has merely clock signals and one single bit of information through the high or low level at the end of the cycle – and no time-critical data.



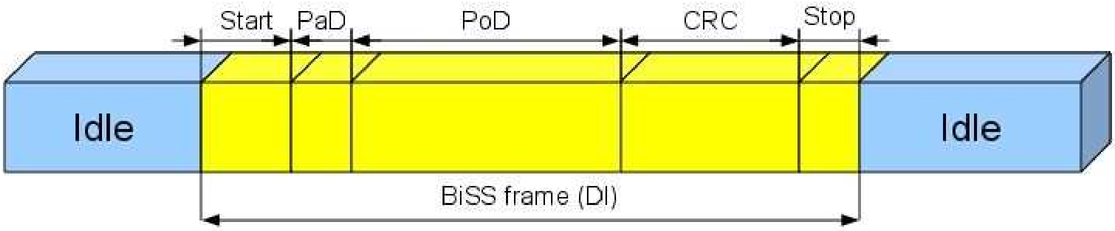
INTERBUS



Core data: 32 bits
Summation frame: 130 bits



BiSS-C



Core data: 25 bits
BiSS frame: 46 bits

Key:
PoD: position data (24 bits)
PaD: parameter data (8 bits or 1 bit)
LBW: loopback word (16 bits)
FCS: frame check sequence (16 bits)
End: end detection (16 bits)
Start: start sequence (4 bits)
CRC: checksum (16 bits)
Stop: stop sequence (1 bit)

Time-uncritical supplementary data
In the INTERBUS data area highly dynamic (time-critical) data or process data (such as position data) is transmitted from the encoder quickly and cyclically. If device-specific parameter or diagnostic data is allocated to a slave (acting as a position measurement device, for example) as further time-uncritical data, additional data subareas have to be created within the transmission protocol or summation frame which again consist of a 5-bit header with a data octet (PaD). Via these additional areas larger amounts of data can then be transmitted in segments as broken-down sets of parameter data, cycle for cycle, and recompiled in the receiver. Data blocks of this time-uncritical supplementary data are thus transferred in each transmission cycle in the summation frame in segments at various intervals – both in the data channel to the measuring system and in the data channel to the processing unit.

BiSS does not transmit information to the slave in data blocks but always as one single bit per cycle at the end of the clock cycle. The transmission of time-uncritical parameter data thus always takes several cycles. Time-uncritical data is also transmitted to the processing unit in segments of 1 bit with the start sequence and **before** the time-critical position data from the encoder. This temporal delay of 1 bit is accepted as being negligible. In this sequence, on initial operation or startup of a machine a specific interruption or abort can be made after this bit in order to shorten the cycle by omitting the position data.

To summarize, BiSS includes the main features of INTERBUS in an adapted form and has also simplified them to achieve a high core data rate and less hardware use. BiSS thus stands out as a bidirectional interface that can be used in buses for serial communication with highly integrated sensors, such as those used in position electronics, for example. The features of INTERBUS are not fully exploited on the point-to-point device level; with its fast bus communication INTERBUS aims for a higher level at which increased amounts of supplementary data are transmitted for the programming of bus subscribers, for instance.