Tampere University of Technology

ASE – 9456 Factory Communication Systems

Assignment 2

INTERBUS Telegram Analysis

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Q1. If the baud rate of the serial adapter is 19200 kbps, why the time bit time of the INTERBUS bus was 2µs?

From the INTERBUS specifications, we know that the max speed for data transmission for INTERBUS is 500 kbps. So, if the baud rate of the serial adapter is 19200 kbps, however, INTERBUS master will maintain the speed of 500 Kbps. Which gives us the transmission time of 1 / (500*1000) = 2 µs. That's why the bit time of the INTERBUS bus was 2 µs.

Q2. Describe the structure and fields of the IDLE telegram that you captured during the lab session. Provide the values you got for each of the fields. Provide a screenshot of your capture.

In the lab, we captured the telegram of INTERBUS protocol following the steps provided. In our case, we got the observable signal with Volt/div = 10V and Time/div = 2.5 µs. We recorded the signal packets using the NI Signal Express software that is compatible with the oscilloscope. From the recorded log, we picked a suitable telegram which looks like the following:

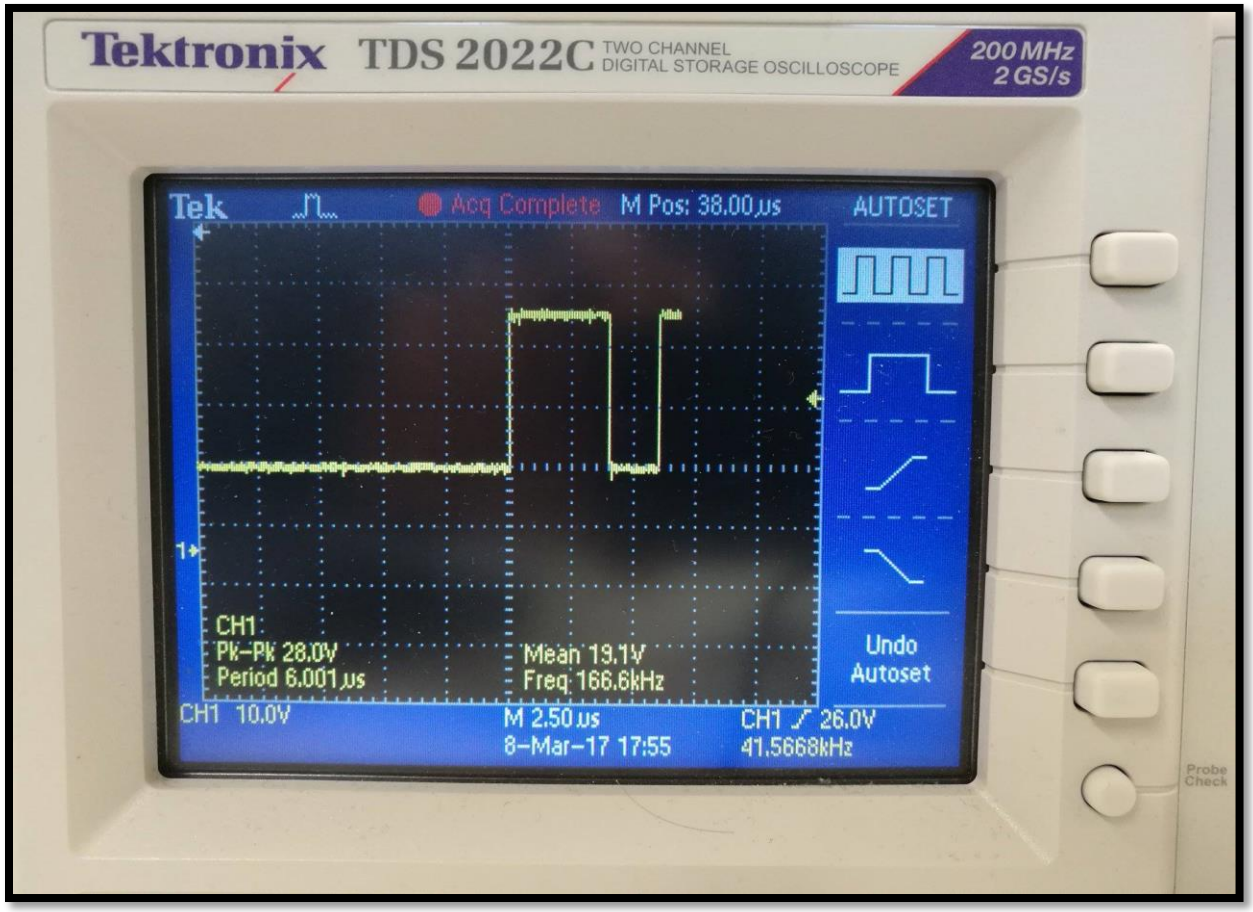

Fig 1: INTERBUS Signal in the Oscilloscope

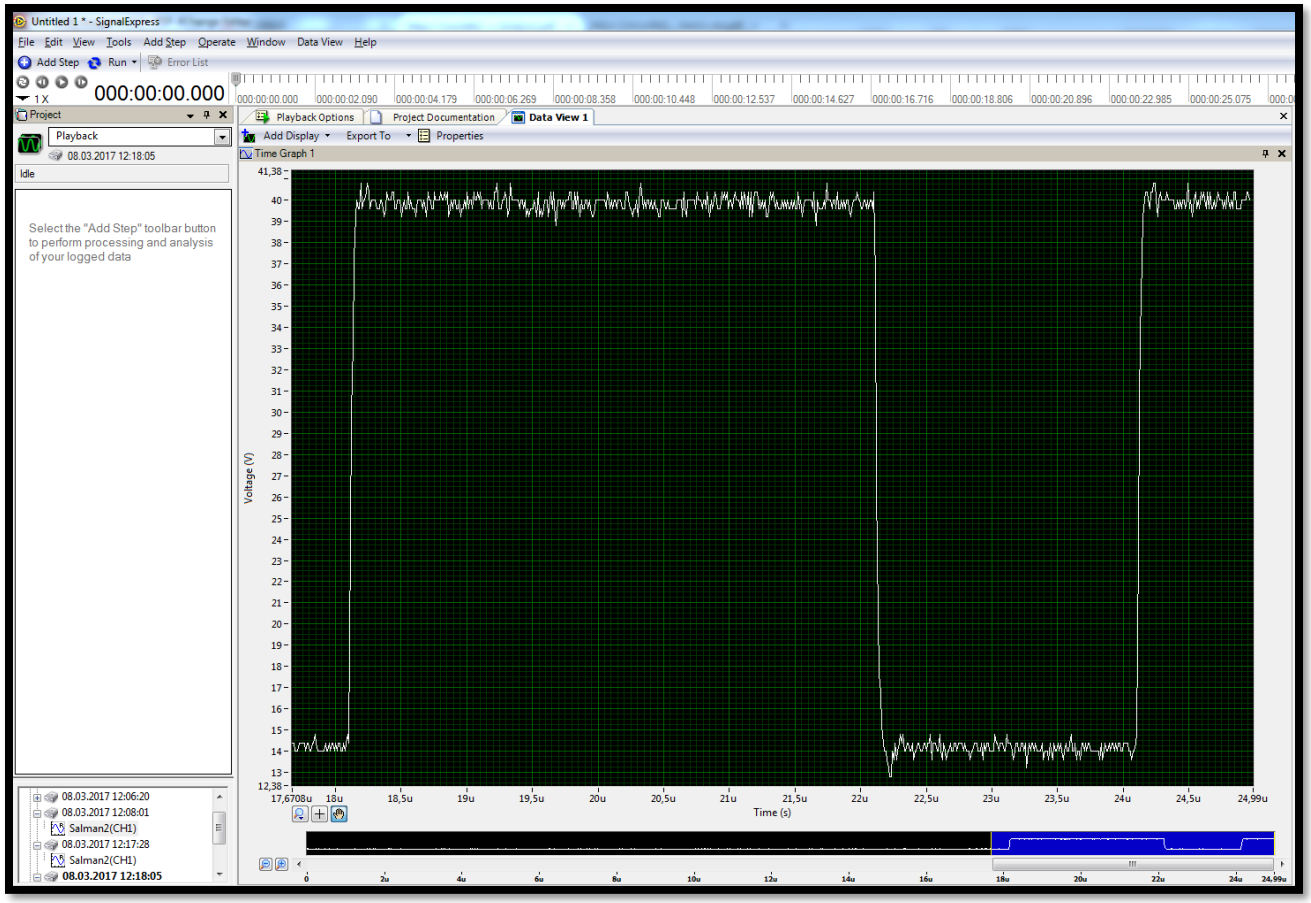

Fig 2: Acquired INTERBUS telegram from the NI Signal Express

We analyzed the captured telegram. From the specification of the INTERBUS telegram we know that it is an IDLE telegram. According to the IDLE telegram specification we should have got 5 bits. We calculated the number of bits by applying the cursors and 2 µs bit time. The number of bits we got was 4. The bits we got was:

1	1	0	1

As we know the START bit or ST is always "1" and the STOP bit or SP is "0" for asynchronous communication, we assume that we missed the last bit in the telegram and for the convenience of analyzing we guessed the last bit as 0. So, the table now looks like this with the added bit.

1	1	0	1	0

We know the first bit is the START bit which is 1. The next bit in the table is /SL which defines the inverted signal line. And the next bit is /CR which defines the inverted control signal line. We know that /SL & /CR is inverted in the signal. So, if we consider the inverted bits, /SL and /CR becomes 0 & 1. We can define this from the decoding table from the pdf.

SL	CR	Description
0	0	Use the user data transfer register
1	0	Use the management transfer register
0	1	Use the CRC transfer register after user data sequence
1	1	Use the CRC transfer register after a management sequence

From the table, we can conclude that these two bits, 0 & 1 defines the CRC sequence in the Data cycle. The fourth bit is 0 which obviously means that the telegram is an IDLE telegram. And the STOP bit as we assumed is 0 always.

Q3. Suppose that a master device in INTERBUS sends a Data telegram, with a value of C5h. The register to transfer the data is: user data transfer register. Describe the sequence of bits that you would expect to see in the oscilloscope.

The length of data telegram of INTERBUS is 13 bits. These bits are used to transmit the user data to the devices in INTERBUS network. Below is the structure of the DATA Telegram.

ST	/SL	/CR	0	D0	D1	D2	D3	D4	D5	D6	D7	SP

ST is Start bit on an asynchronous communication and that is always "1". /SL is Inverted signal select line, which indicates the type of cycle. "1" = Application data cycle, "0" = Management cycle. /CR indicates the type of sequence. "1" = Useful data transfer sequence, "0" = Check sequence. The 4th bit is the Marker bit which indicates the type of telegram. "0" = Data telegram, "0" = Idle telegram. From 5th to 12th bit D0 to D7 defines the user data only. The last bit is the Stop bit of an asynchronous communication and that is always "0". From D0 to D7, the least significant bit is sent first. So, the reading pattern is reversed. The SL and CR are also inverted in the wire. As we know the register is user data transfer register, the /SL & /CR should be 0 & 0 and it will be reversed in the wire.

The binary value of C5 h is 11000101

So, the Data telegram in the Oscilloscope should look like:

1	1	1	0	1	0	1	0	0	0	1	1	0

Q3. Explain why it is said that INTERBUS communicates in Full Duplex if just one cable is used to exchange data between master & slaves?

In each master and slaves of the INTERBUS system, they have two buffers, input and output buffer. The exchange of data happens by the help of transmit registers in the slaves. Every slave has one transmit registers. At the end of a cycle the data that are send from the master is transferred from the output buffer of the master to the output buffer of the slaves. Then the data is stored to the input buffer of the slaves and then latched to the transmitting

registers. This transmitting register then sends the data to the input buffer of the master device. For exchanging data INTERBUS uses this buffer exchange to send data between master and all the slaves. Buffer exchange is done in the same time in both direction for inputs and outputs. Both forward and backward lines are operating at the same time in the same cable. So basically, master and slaves can communicate at the same time in both direction. That's how INTERBUS communicates in Full Duplex while having a single cable to exchange data.

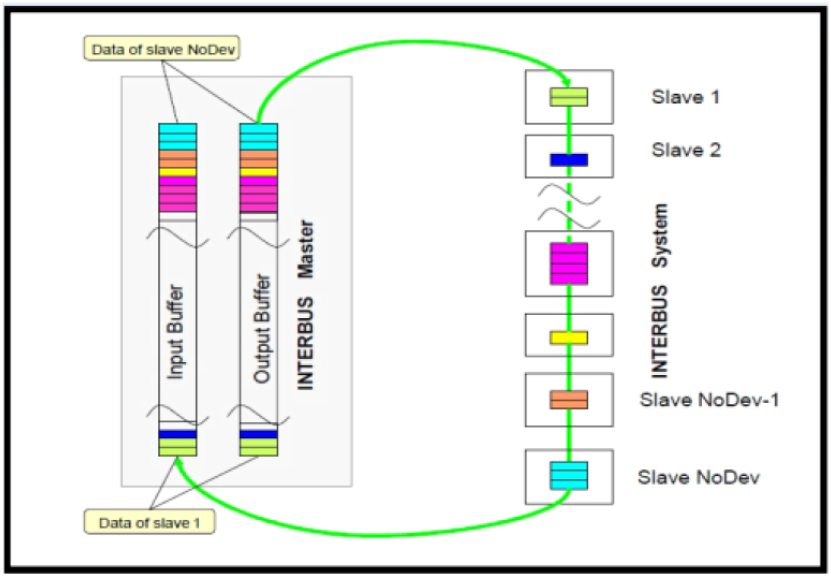

Fig 3: Buffer exchange between master & slaves in INTERBUS

Q3. Compare INTERBUS with PROFIBUS. Use a table to highlight the differences. Explain about the overheads of both the protocols.

We know that there are several PROFIBUS technologies. Here the answers are explained considering PROFIBUS DP.

Characteristics	INTERBUS	PROFIBUS
Network Type	Master/Slave Fieldbus communication	Multiple Master/slave Fieldbus technology
Max Station	1 master and up to 511 slaves	Multiple masters and up to 127 slaves
Topology	Active ring topology with branches	Bus topology using central line or bus is wired through the system
Installation	Cable length max. 400m between 2 slave devices and up to 13km in total.	Cable length max. 1 Km between 2 devices using

	Alternatively, Fiber Optic media can be used.	4 repeaters. Cable and Fiber optic can be used.
Data Speed	500Kbit/sec or 2 Mbit/sec	12 Mbit/sec
Data/PDU	Maximum 64 bytes/PDU	246 bytes/PDU
Network Features	Fast and efficient Fieldbus communication system optimized for cyclic I/O data transfer	Faster, better installation, longer operation
Protocol	I/O oriented protocol	Message oriented protocol
Transmission Type	Full Duplex	Half Duplex

A PROFIBUS DP telegram message contains 11 bytes of overhead which is also referred as telegram header. All headers are of 11 bytes eccept data exchange telegrams. Data exchange telegrams are of 9 bytes with DSAP and SSAP dropped. From the below picture, all the fields and their functions can be seen.

SD	1 byte	Start Delimiter (used to distinguish telegram format).
LE	1 byte	Net Data Length (DU) + DA + SA + FC + DSAP + SSAP.
LEr	1 byte	Length *repeated*.
DA	1 byte	Destination Address– Where this message goes to.
SA	1 byte	Source Address – Where this message came from. The address of the sending station.
FC	1 byte	Function Code (FC=Type/Priority of this message). Used to identify the type of telegram, such as request, acknowledgement, or response telegrams (FC=13 signals diagnostic data). See below.
DSAP	1 byte	Destination Service Access Point (COM port of receiver). The destination station uses this to determine which service is to be executed.
SSAP	1 byte	Source Service Access Point (COM port of sender).
DU	1 to 32b (or 1-244b)	Data Units/ Net Data from 1 to 244 bytes.
FCS	1 byte	Frame Checking Sequence (ASIC addition of the bytes within the specified length).
ED	1 byte	End Delimiter (always 16H).

Fig 4. Overhead structure of PROFIBUS-DP

In INTERBUS there are two types of telegrams. IDLE telegram & Data Telegram. IDLE telegram is only 5 bits of size and it generates activity on the bus medium when there is pause in transmission. The data telegrams are of 13 bits length and there is 8 bits of data from D0 to D7. INTERBUS communication uses summation frame method. This method combines all the sensor & actuator values from all the slave devices into

one single message and this message is sent to all the devices simultaneously. This Summation frame consists of Data/Management sequence + CRC sequence. Management and data cycles provide access to the management and user data registers. The management cycle is used for initialization and configuration of the system. It is initiated at first for one time and after that the user data cycle is run. In the management cycle master sends 2 bytes of control data for each slave and slave send their identification to the master. Then master sends 2 bytes of Loopback word in order to specify the management frame. And at the end 4 bytes of CRC and Checksum is used for the protection of data. It is used after every data and management cycle.

Q6. Is it true to say that structure of INTERBUS network is like a bus structure?

Interbus is a single master ring structure where all devices are connected to the bus system. In the INTERBUS topology the single bus devices can be differentiated by means of their position in the system. There are controller boards, bus terminal modules, remote bus devices, installation remote bus devices and local bus devices. Unlike other ring structures, data forward and backward line are connected with only one cable and makes it possible to connect as many devices and branches up to 16 level deep. The structure is more like “open tree” structure not bus structure.