AUT.843 Industrial Communication Systems

Assignment 2

Valtteri Nikkanen	282688
Lauri Nuutinen	283219
Väinö Kurvi	274490

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Signal analysis

We were given a Profibus signal to read and interpret. The signal was opened with NI Signal Express software from which the high and low voltages were read from. This signal is presented in figure 1. We know that the signals baud rate is 12Mbps which means that time to transmit one bit should be around 83ns.

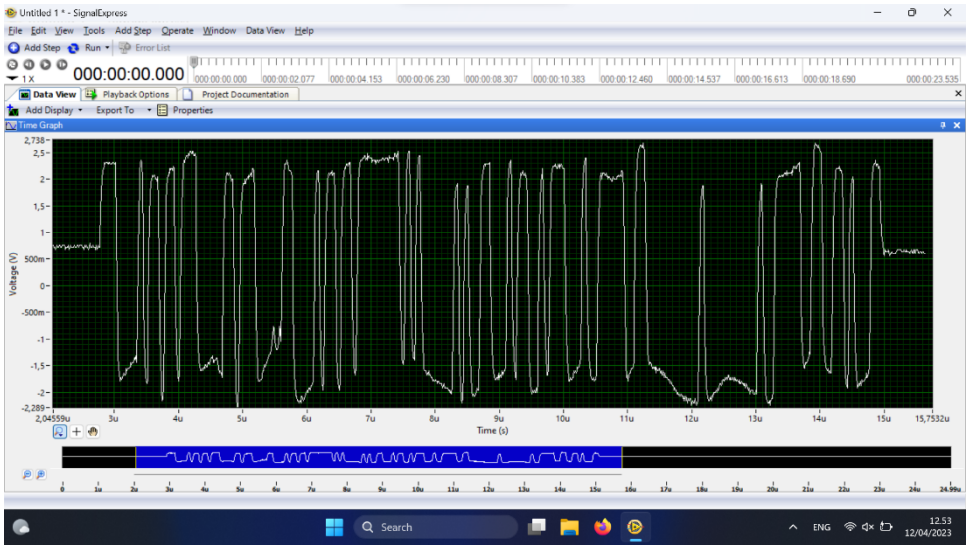

Figure 1: Signal from which the data is read.

From this signal we got the following data which is presented in table 1:

SEGMENTS	LENGTH (ns)	No. of BITS	BIT REPRESENTATION
1	250	3	111
2	340	4	0000
3	80	1	1
4	80	1	0
5	170	2	11
6	80	1	0
7	170	2	11
8	80	1	0
9	240	3	111
10	410	5	00000
11	170	2	11
12	90	1	0
13	240	3	111

14	410	5	00000
15	170	2	11
16	340	4	0000
17	80	1	1
18	80	1	0
19	160	2	11
20	80	1	0
21	160	2	11
22	90	1	0
23	660	8	11111111
24	90	1	0
25	70	1	1
26	80	1	0
27	90	1	1
28	500	6	000000
29	80	1	1
30	80	1	0
31	80	1	1
32	160	2	00
33	180	2	11
34	240	3	000
35	90	1	1
36	80	1	0
37	170	2	11
38	180	2	00
39	80	1	1
40	80	1	0
41	240	3	111
42	240	3	0 00
43	90	1	1
44	170	2	00
45	410	5	11111
46	170	2	00
47	170	2	11
48	830	10	0000000000
49	80	1	1

50	840	10	0000000000
51	80	1	1
52	170	2	00
53	410	5	11111
54	190	2	0 0
55	170	2	11
56	160	2	00
57	170	2	11
58	80	1	0
59	80	1	1
60	250	3	000
61	170	2	11

Table 1: Signal analysis of the signal in figure 1

By knowing that the frame of a Profibus-DP message always starts with a 0 bit we can get the following frames from this data, presented in table 2.

1	00001011011
2	01110000011
3	01110000011
4	00001011011
5	01111111101
6	01000000101
7	00110001011
8	00101110001
9	00111110011
10	00000000001
11	00000000001
12	00111110011
13	00110100011

Table 2: Bits in the signal in figure 1 made to 11-bit frames.

From this data we can then get the byte interpretations for the frames.

Original byte sequence (As acquired from the Oscilloscope) presented in table 3.

FRAME	START BIT	DATA BITS (Original)	PARITY BIT	STOP BIT
1	0	00010110	1	1
2	0	11100000	1	1
3	0	11100000	1	1
4	0	00010110	1	1
5	0	11111111	0	1
6	0	10000001	0	1
7	0	01100010	1	1
8	0	0101 1100	0	1
9	0	01111100	1	1
10	0	00000000	0	1
11	0	00000000	0	1
12	0	01111100	1	1
13	0	01101000	1	1

Table 3: Frames from table 2 split into their components

And by knowing that the Data Bits need to be reversed as Profibus DP sends them in order of Least Significant Bit (LSB) to Most Significant Bit (MSB).

Reversed Byte data (Just Octet only) presented in table 4.

FRAME	START BIT	DATA BITS (Reversed)	PARITY BIT	STOP BIT
1	0	01101000	1	1
2	0	00000111	1	1
3	0	00000111	1	1
4	0	01101000	1	1
5	0	11111111	0	1
6	0	10000001	0	1
7	0	01000110	1	1
8	0	0011 1010	0	1
9	0	00111110	1	1
10	0	00000000	0	1
11	0	00000000	0	1
12	0	00111110	1	1
13	0	00010110	1	1

Table 4: Data byte flipped from table 3

Frame interpretations

We now have all the data in the correct order for each of the 13 frames of the message. Below are the interpretations for each of the frames in the Profibus DP message.

Frame 1:

Data: 01101000 which is 68H which matches to telegram format SD2

Frame 2:

Data: 00000111 which is 7H for the length of the Net Data Length LE

Frame 3:

Data: 00000111 which is 7H for the length repeated LEr

Frame 4:

Data: 01101000 which is 68H for the SD as it should be

Frame 5:

Data: 11111111 which is FF in hexadecimal and is the destination address DA

Frame 6:

Data: 10000001 which is 81H and is the source address SA

Frame 7:

Data: 01000110 which is 46H and is the function code FC which is "**SDN high"**

b7 = 1 (Request, Send/Request frame)

b6 and b5 = 00 (Request with No Ack)

b4 to b1 = 0110 and corresponds to 6 in decimal format

Frame 8:

Data: 00111010 which is 3A in hexadecimal and is the DSAP or the destination service access port

Frame 9:

Data: 00111110 which is 3E in hexadecimal and is SSAP and is the source service access port

Frame 10:

Data: 00000000 which is 0H and is the first DU frame

Frame 11:

Data: 00000000 which is 0H and is the second DU frame

Frame 12:

Data: 00111110 which is 3E the FCS or frame checking sequence

Frame 13:

Data: 00010110 which is 16H which is ED or End Delimeter and is 16H as it always should be.

Questions

1. Identify the telegram you got following the measurement analysis in (4) above. Provide the decoded frames in a table. Mention the problems you had in interpreting the signal (if any). What can you say about the Destination Address (DA) frame?

Problems. We had slight issues at the start when trying to interpret the correct frames of the Profiibus message before we remembered that the start bit for a frame is always 0 which then enabled us to discard the first “111” in the signal analysis and left us with the correct amount of bits which then mapped nicely to a message.

The destination address or DA frame is only 1’s which then transforms into FF in hexadecimal. This means something about the destination of the message. As it is the largest possible address it is likely that the message is to be broadcasted into the network.

2. In industrial buses, why are terminal resistors needed?

They help to mitigate back reflection in the industrial bus which might cause voltage drop downs and signal distortion in the mission ciritcal communications.

3. Create a Profibus DP message with the given information:

   Suppose a PROFIBUS master (address: 1) sends a message to a slave (address: 11).
   The message has the next characteristics:
   a. The telegram is: Telegram with variable data unit.
   b. The function code is: Send Data with No acknowledge, low priority.
   c. The data to be sent is two bytes: 3EH and 7FH
   Place in a table the sequence of bits that you would expect to see in the
   oscilloscope. Include the start bit, parity bit, stop bit.
   Use one row for each of the telegram frames
   Put the bits in the order as if you would see them directly from the oscilloscope.
   It is not necessary to compute the Frame Checking Sequence (FCS)

The data of the specified message is presented in table 5.

FRAME	START BIT	DATA BITS (Original)	PARITY BIT	STOP BIT
1 SD2	0	00010110	1	1
2 LE	0	11100000	1	1
3 LEr	0	11100000	1	1
4 SD	0	00010110	1	1
5 DA	0	10001000	0	1
6 SA	0	10000000	1	1
7 FC	0	00100010	0	1
8 DSAP	0	00111100	0	1
9 SSAP	0	01111100	1	1
10 DU1	0	01111100	1	1
11 DU2	0	11111110	1	1
12 FCS	0	FCS		1
13 ED	0	01101000	1	1

Table 5: Byte sequence of supposed message in question 3

4. Calculate the communication overhead of the telegram assumed in the previous question.

Communication overhead is the number of bytes that the header consists of, which is 11 bytes.

5. PROFIBUS can run at different baud rates. What should be considered when selecting the baud rate?

One should always take the lowest baud rate which meets the requirements of the system. As higher baudrates can lead to worse network stability, data integrity issues and impedance missmatches.