KNX telegram decoding

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KNX TELEGRAMS DECODING

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Abstract: This article presents a transversal activity in STI2D having as support the KNX standard including the description of a KNX installation, the properties of KNX telegrams, as well as its decoding. The proposed activities are independent of the nature of the KNX participants so that they can be adapted according to the different specialties of the STI2D. This activity can also be offered to train senior technicians during system testing.

Keywords: *KNX framework, fieldbus, transversal activity*

Abbreviations: *- KNX – KoNneX; - STI2D – Science and Technology for Industry and Sustainable Development;*

I.INTRODUCTION _

The cross-cutting technological education introduced by the reform of the industrial technological series in 2010, should enable all STI2D students to acquire a versatile training allowing them to choose one of the four STI2D specialties.

In this spirit, we offer a transversal activity relating to the KNX fieldbus. The particularity of the KNX bus compared to the other field buses ÿ1-3ÿ is first of all its modernity then its applications in home automation (energy and information management) and in building, therefore particularly well suited to the conduct of cross-functional activities. The KNX bus can also be contextualized according to the specialties of the STI2D: control of actuators or mechanical systems (eg, ÿ4ÿ) for

- the ITEC specialty, control of lighting (eg, DALI/KNX gateway) for the EE specialty, housing supervision
- for the AC specialty, ÿ instrumentation and information processing
- for the SIN specialty.

The objectives of the transversal activity that we propose are to: ÿ understand the organization of a KNX installation from documentary resources (§ **II.3),** ÿ record a KNX telegram and measure each of its properties (period, duration of one bit, logical coding '0' and '1'…, § **II.4),**

ÿ Decode a KNX frame by analyzing it in pieces (control byte, sender address, recipient address, data decoding, etc., § **III.).**

Students have:

ÿ a model using a KNX ÿ4ÿ bus, ÿ electrical diagrams of the KNX installation, ÿ documentary resources in the form of a slideshow describing the KNX standard, ÿ measuring devices: oscilloscope, insulation probe.

II. THE KNX STANDARD

II.1 Description

The KNX standard is both a fieldbus and a communication protocol (TP, PL, RF, and IP).
KNX is also a universal standard for all applications in the field of home automation and building. Since November 2006, the KNX standard has been described by ISO/IEC 14 543-3-x and EN 50 090.
It is the result of the grouping of 3 European standards BatisBUS, EIB, and EHS which decided in 2002 to unite their forces worldwide around a single "KNX association" ÿ5-7ÿ.

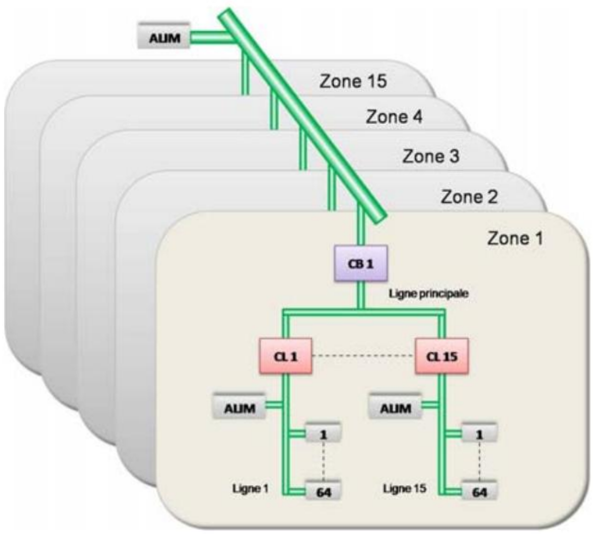


Figure 1: Topology of a KNX installation.

II.2 Industrial applications

The KNX standard inherits the fields of application of the 3 previous standards and is positioned on the management of:

- energy,
- lighting, ÿ

shading (shutters and blinds), ÿ

heating, ventilation, and air conditioning, ÿ automation and remote access,

- security (sensors, alarms), human-
- machine interface, and visualization.

II.3 Topology of a KNX installation

We are initially interested in the topology of a KNX installation, it is a question of understanding using the documents made available the structure of a KNX installation (Fig 1).

II.3.1) Using the documents made available to you, give the names of the different components of a KNX field bus in Fig. 1. ÿ PSU: power supply module

ÿ CB: area coupler ÿ CL: line coupler ÿ 1…64: KNX devices

ÿ Link between areas: backbone

II.3.2) Referring to Fig. 1, deduce the maximum number of KNX bus participants. ÿ A backbone connects a maximum of 15 zones via a zone coupler (CB). A zone has a maximum of 15 lines connected to the main line by line couplers (CL). A line can connect a maximum of 64 participants.

The total number of participants is therefore 15×15×64, ie 14,400 possible participants on the installation shown in FIG. 1.

II.3.3) Using the model made available to you, identify the different participants of the KNX bus.

ÿ Double push button; KNX N148 USB gateway; KNX N141 DALI gateway, for example, but this will depend on the study model chosen.

II.3.4) What is the nature of the ALIM power supply of a KNX bus?

ÿ The KNX N125 bus power supply distributes a voltage 29 V constant.

II.3.5) Using the documentation provided, give the physical appearance of a '0' logic level and a '1' logic level on a KNX bus.

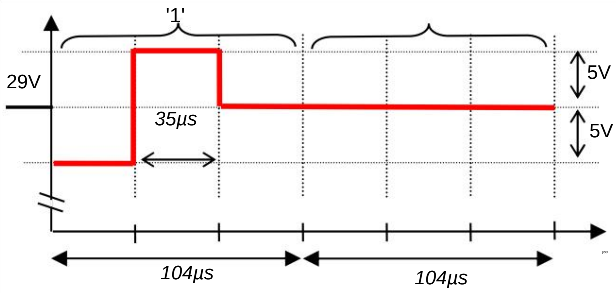


Figure 2: *Coding of the KNX bus logic levels.*

II.4 The KNX frame

In this part we will describe a KNX telegram, its full duration, bit duration, transmission speed, transmission format. Figure 3 describes the structure of a KNX telegram. The bus participants can exchange information using a telegram split into several fields: the control byte field, the address field

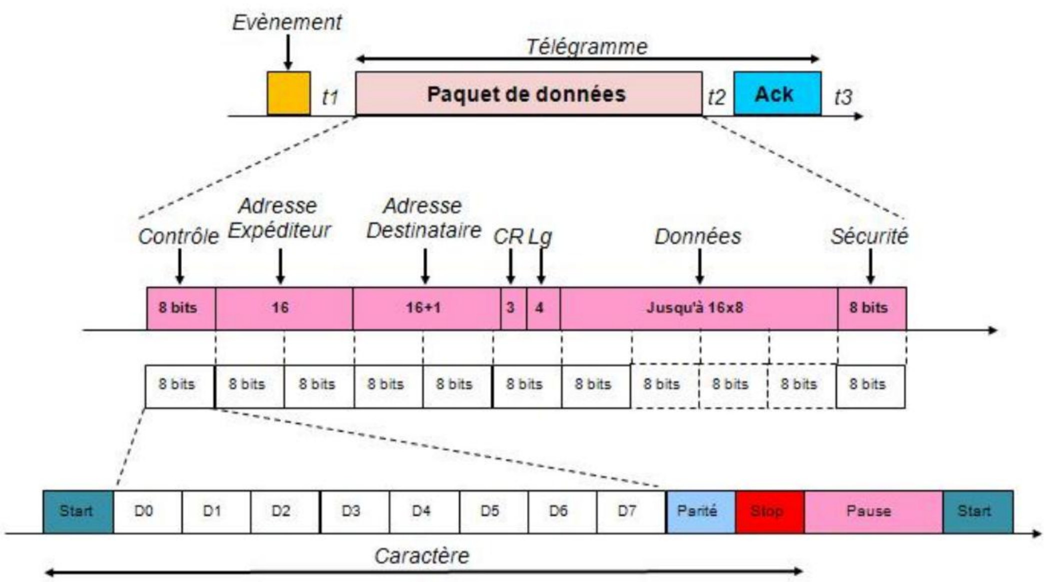


Figure 3: *coding of a KNX telegram.*

sender… Each field is preceded by a “start” bit (a '0') and ends with a parity bit, a stop bit (a '1') and two pause bits (two 1's).

II.4.1) Using figure 3 as a guide, give the maximum number of bytes contained in a telegram.

Control: 1 byte Data = 16 bytes Address: 2 bytes
Security = 1 byte Recipient = 2 bytes CRC = 1 byte Total = 23 bytes

II.4.2) Taking into account the transmission format of a byte (“start” bit, parity bit, etc.), give the maximum number of bits contained in the telegram. ÿ 23ÿ8+1+1+1+2 = 189 bits maximum

II.4.3) Using figure 2 and previous answers, give the maximum duration of a telegram. ÿ 189 x 104 ÿs = 19,656 ÿs ÿ 19.7 ms

II.4.4) The transmission speed being 9600 bits/s, calculating the duration of a bit, is this consistent with the information in figure 2? ÿ duration 1 bit = 1/9600 s = 104 ÿs, equal to the value indicated in figure 2.

II.4.5) Figure 4 represents a KNX telegram timing diagram, measuring the voltage value when there is no message.

ÿ Figure 4 measures a voltage of approximately 30 V, which conforms to the KNX standard of 29 V.

II.4.6) Measure in figure 3 the duration of a KNX telegram. ÿ Figure 4 measures a KNX telegram duration of 14.7ms, a value less than the maximum duration obtained in question II.4.3).

III. DECODING A KNX TELEGRAM

III.1. Decoding of the control byte The first byte (see Fig.3) is used to define the transmission priority, for example 1011 0100, corresponds in hexadecimal to B4 which according to Tab. 1 is a normal transmission with high priority.

1	0	R	1	P	P	0	0	transmission priority
				0 0				System Priority
				1 0				Alarm priority
				0 1				High priority
				1 1				Low priority
		0						Repeat
		1						Normal transmission

Table 1: *Coding of the control byte*

III.1.1) Fill in the box below in the case of a normal transmission with low priority. It is recalled that the least significant bit is received first.

	D0	D1	D2	D3	D4	D5	D6	D7
Word in binary	0	0	1	1	1	1	0	1
word in hexadecimal	vs				B			

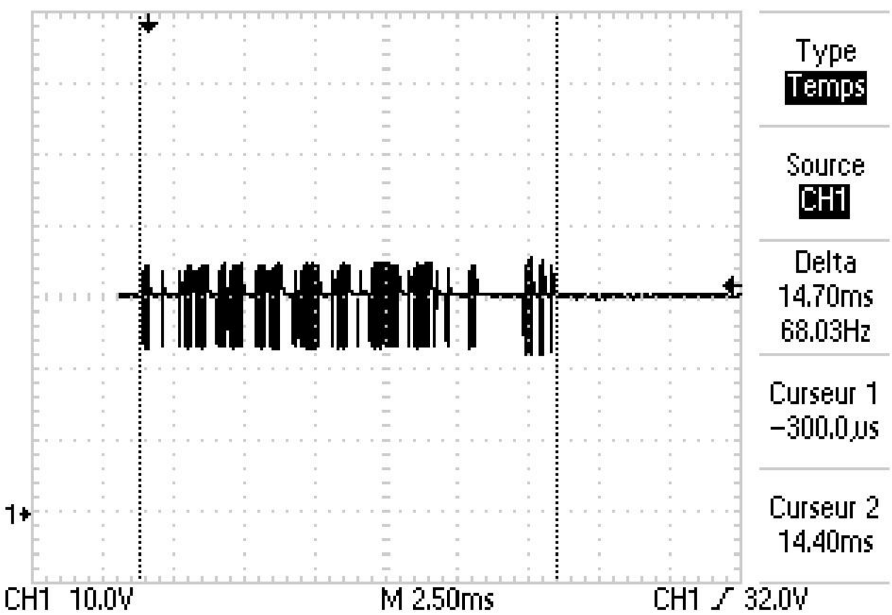


Figure 4: *timing diagram of a KNX telegram.*

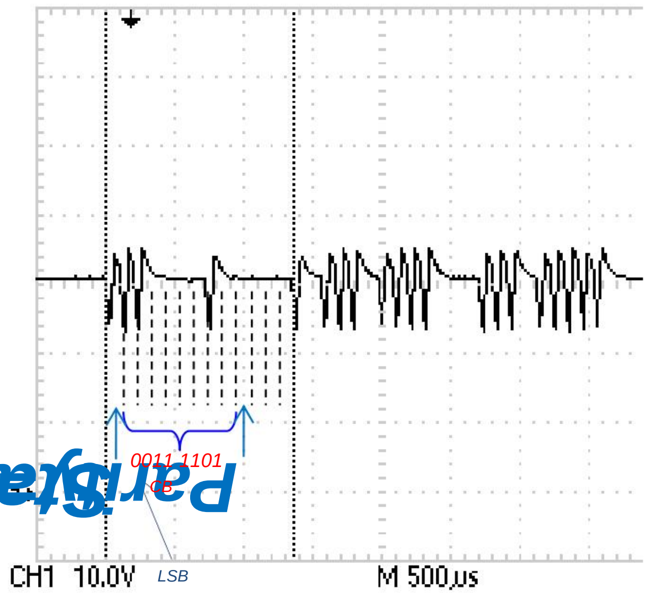


Figure 5: *Decoding the control byte of a KNX telegram.*

III.1.2) Figure 5 gives the start of the KNX telegram, determine the binary word and then its hexadecimal code by filling in the box below:

BYTE OF CONTROL	Bit of start	D0	D1	D2	D3
Binary	*0*	*0*	*0*	*1*	*1*
Hexadecimal	[redacted]	*vs*			
	D4	D5	D6	D7	
Binary	*1*	*1*	*0*	*1*	
Hexadecimal	*B*				
	Bit of parity	Stop bit	Pause	Pause	
Binary	*1*	*1*	*1*	*1*	

III.1.3) Then give the control byte in hexadecimal starting with the most significant bit. ÿ Control byte:

BC

III.1.4) Using table 1 and the control byte obtained previously, give the transmission priority of the telegram represented in figure 1. ÿ B: normal transmission ÿ C: low priority

III.2. Decoding of the sender's address Each participant is identified by a unique 16-bit address of the type:

0 0 0 1 1 0 0 1 0 0	0 1	1 1	1 1 0
1	*9*	*3*	*E*
Zone number	***Line number***	***Participant number***	

In the example above, the sender is in zone 1, on line 9 and in position 62 on this line.

III.2.1) Using the telegram in appendix 1, give the complete address, specifying the zone, the line number and participant number (remember that the least significant bit is received first).

ÿ *The code obtained is 0001 0001 0000 0100 i.e.:*

Area 1 *line 1* *participant 4*

III.3. Decoding the address of the recipient

The address of the recipient is coded on two bytes, but a bit belonging to the nibble of the routing counter (Fig. 3) makes it possible to define if the participant belongs to a group or if it is from a physical address.

III.3.1) We give in appendix 2 the part of the telegram which corresponds to the address of the recipient, determine the binary word and then its hexadecimal code by filling in the box below:

1st BYTE	Bit of start	D0	D1	D2	D3
Binary	*0*	*0*	*0*	*0*	*1*
Hexadecimal	[redacted]	*8*			
	D4	D5	D6	D7	
Binary	*0*	*0*	*0*	*0*	
Hexadecimal	*0*				
	Bit of parity	Stop bit	Pause	Pause	
Binary	*1*	*1*	*1*	*1*	

2nd BYTE	Bit of start	D0	D1	D2	D3
Binary	*0*	*1*	*0*	*0*	*0*
Hexadecimal	[redacted]	*1*			
	D4	D5	D6	D7	
Binary	*0*	*0*	*0*	*0*	
Hexadecimal	*0*				
	Bit of parity	Stop bit	Pause	Pause	
Binary	*0*	*1*	*1*	*1*	

III.3.2) Then give the hexadecimal code of the recipient's address bytes starting with the most significant bit. ÿ Recipient address: 01 08

III.3.3) Give the value of the most significant bit D7 of the routing counter, then specify whether the participant belongs to a group, or whether it is a physical address. ÿ The D7 bit (most significant bit) of the routing counter and length byte is equal to '1' which indicates a group address.

III.4. Routing counter and length

The byte corresponding to the routing counter and data length breaks down as follows:

D7	D6	D5	D4	D3	D2	D1	D0
Group address = 1	Routing counter			Data length			
Physical address = 0							

Appendix 3 gives us the telegram including the routing counter and data length assembly.

III.4.1) From the telegram in appendix 3, fill in the box below, remember that the least significant bit is received first:

CR+Lg	Bit of start	D0	D1	D2	D3
Binary	*0*	*1*	*0*	*0*	*0*
	D4	D5	D6	D7	
Binary	*0*	*1*	*1*	*1*	
	Bit of parity	Stop bit	Pause	Pause	
Binary	*0*	*1*	*1*	*1*	

III.4.2) What is the role of the routing counter? Give its default value. ÿ

The most significant bit ('1' in our case) indicates that the recipient is a group address. If the latter is equal to '0', it will be a physical address. ÿ Bits D6 D5 D4 ie 110 represents the routing counter which specifies the maximum number of telegram forwardings, 6 in our case, this is a default value. ÿ Bits D3 D2 D1 and D0 ie 0001 indicates that the data will be coded on two bytes (see appendix 6).

III.4.3) Give the hexadecimal code of the byte corresponding to the routing and length counter. ÿ

1110 0001 i.e. the following hexadecimal code: E1

III.5. Data decoding

III.5.1) The data is coded on 2 bytes, we consider the telegram of appendix 4. Fill in the box below, remembering that the characters are transmitted from the least significant bit first to the most significant bit last :

1st BYTE	Bit of start	D0	D1	D2	D3
Binary	*0*	*0*	*0*	*0*	*0*
	D4	D5	D6	D7	
Binary	*0*	*0*	*0*	*0*	
	Bit of Parity	Stop bit	Pause	Pause	
Binary	*0*	*1*	*1*	*1*	

2nd BYTE	Bit of start	D0	D1	D2	D3
Binary	*0*	*1*	*0*	*0*	*0*
	D4	D5	D6	D7	
Binary	*0*	*0*	*0*	*1*	
	Bit of Parity	Bit of stop	Pause	Pause	
Binary	*0*	*1*	*1*	*1*	

III.5.2) Give the hexadecimal code of the two bytes corresponding to the data. ÿ 0000 0000 1000 0001

i.e. the following hexadecimal code: 00 81.

In the KNX standard, when an action is performed (eg: switching on a lamp, closing a contact), the data code is 0081 (the least significant bit is at '1' to validate the action) . To perform the opposite action (eg: switching off a lamp, opening a contact) the code is 0080 (the least significant bit is at '0' to validate the action).

III.5.3) From the previous information, give the meaning of the data byte. ÿ Action of closing a contact.

III.6. Decoding the security byte

The security byte is used to check the conformity of telegram reception by detecting any errors. This byte is in odd parity, we check bit by bit the number of 1, which will give us the value of the security byte. For example, if we consider the following KNX telegram:

BC 12 0A 33 03 E1 00 81 ***0B*** CC

BC	***1***	0	***1***	***1***	***1***	***1***	0	0
12	0	0	0	***1***	0	0	***1***	0
0A	0	0	0	0	***1***	0	***1***	0
33	0	0	***1***	***1***	0	0	***1***	***1***
03	0	0	0	0	0	0	***1***	***1***
E1	***1***	***1***	***1***	0	0	0	0	***1***
00	0	0	0	0	0	0	0	0
81	***1***	0	0	0	0	0	0	***1***
Number of 1	***3***	***1***	***3***	***3***	***2***	***1***	***4***	***4***
Safety byte	***0***	***0***	***0***	***0***	***1***	***0***	***1***	***1***
Hex code	***0***				***B***			

III.6.1) From the different hexadecimal codes obtained previously, complete the table below:

Check byte	1 0 1 1 1 1 0 0	
Sender address on 2 bytes	0 0 0 1	0 0 0 1
	0 0 0 0 0 1 0 0	
Recipient address on 2 bytes	0 0 0 0 1 0 0 0	
	0 0 0 0 0 0 0 1	
CR and LG	1 1 1 0 0 0 0 1	
2-byte data	0 0 0 0 0 0 0 0	
	1 0 0 0 0 0 0 1	
Number of 1	3 1 2 2 2 2 0 4	
Security byte	0 0 1 1 1 1 1 1	
Code in hexadecimal	3	F

III.6.2) Appendix 5 represents the part of the telegram concerning the security byte. Determine the binary word and then its hexadecimal code by filling in the box below:

Security byte	Bit of start	D0	D1	D2	D3
Binary	0	1	1	1	1
	D4	D5	D6	D7	
Binary	1	1	0	0	
	Bit of parity	Stop bit	Pause	Pause	
Binary	0	1	1	1	

ÿ 1111 0011 i.e. the following hexadecimal code: 3F

III.6.3) Compare the two hexadecimal security codes obtained (III.6.1) and III.6.2)). ÿ The two hexadecimal security codes are identical and equal to 3F.

III.7. Validation of a telegram Figure 6 represents a complete telegram, the transmission of which is followed by a response coded on 8 bits indicating to the transmitter whether the message has been received correctly or not, or even by indicate if the bus is busy.

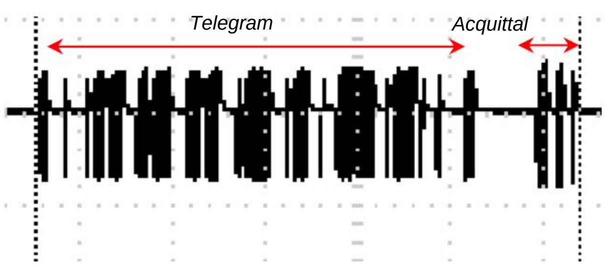


Figure 6: *timing diagram of a KNX telegram and its acknowledgment signal.*

The table below gives the three possible codes for acknowledgment.

0 0 0 0 1 1 0 0	NAK (incorrect reception)	0C
1 1 0 0 0 0 0 0	BUSY	C0
1 1 0 0 1 1 0 0	ACK (good reception)	CC

IV. **CONCLUSION**

The programming of components using the KNX standard is done using the ETS4 software. This allows the creation of an industrial project in several stages, i.e. the definition of the number of participants (switches, lights, blinds, etc.), to insert them into an architecture (conference room, stores, etc.) . Then, using a catalog of components (Hager, Schneider, etc.), download the parameters to the various participants. The ETS4 software then automatically adjusts the status of the participants, the coding of the KNX telegrams is then automatically defined when you place yourself in the user position.

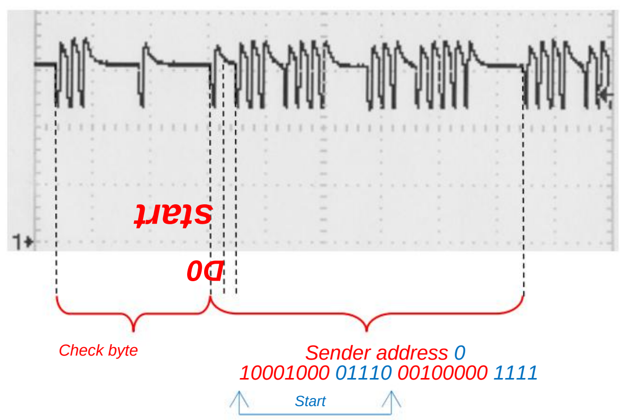
The KNX standard now occupies a prominent place in home automation and building. KNX certification is compulsory for its installation (40 hours of training over a week in a training center authorized by the "KNX association" ÿ5ÿ).

It is to better prepare our future technicians that we are introducing the KNX standard into the STI2D transversal activity. This activity also aims to broaden the knowledge and skills of our future students during projects and system tests in BTS Electrotechnics ÿ8-9ÿ. We are currently developing a lighting model using a DALI KNX N141 gateway type participant. This marquette will allow us to introduce in BTS the DALI protocol coupled with the KNX standard for the Electrical Engineering part, and the variation of lighting of fluorescent tubes for the Applied Physics part during system tests.

Annex 1 (sender's address)

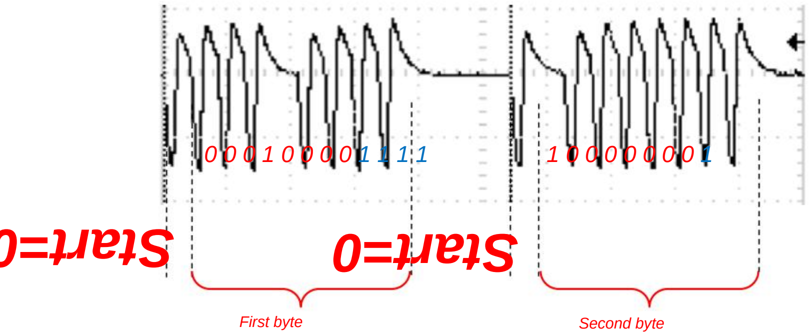
Timebase: 500µs/ div

Caliber: 10V/ div



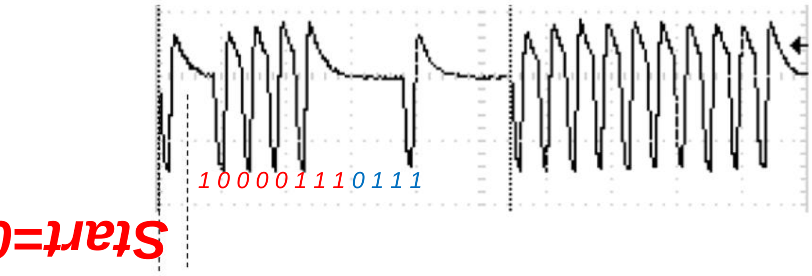
Appendix 2 (recipient address)

Timebase: 250µs/ div
Caliber: 10V/ div



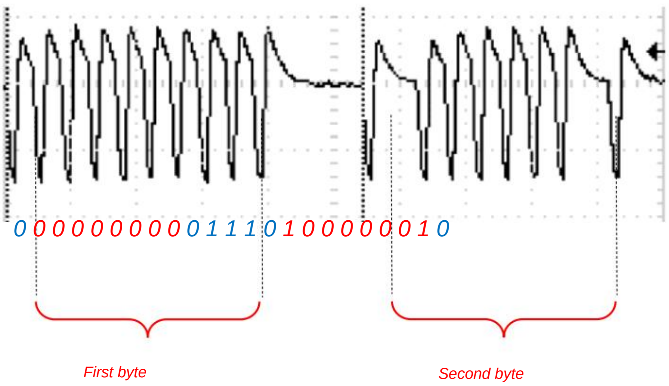
Annex 3 (CR and Lg)

Timebase: 250µs/ div
Caliber: 10V/ div



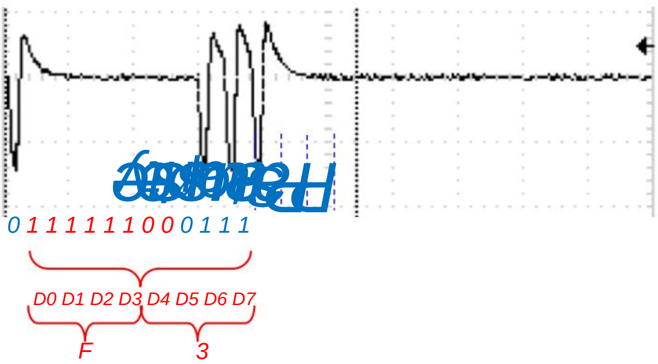
Appendix 4 (Data decoding)

Timebase: 250µs/ div
Caliber: 10V/ div



Appendix 5 (Security Byte)

Timebase: 250µs/ div
Caliber: 10V/ div



Appendix 6 (data length)

LONGUEUR DES DONNEES				
0	0	0	0	1 octet
0	0	0	1	2 octets
0	0	1	0	3 octets
0	0	1	1	4 octets
0	1	0	0	5 octets
0	1	0	1	6 octets
0	1	1	0	7 octets
0	1	1	1	8 octets
1	0	0	0	9 octets
1	0	0	1	10 octets
1	0	1	0	11 octets
1	0	1	1	12 octets
1	1	0	0	13 octets
1	1	0	1	14 octets
1	1	1	0	15 octets
1	1	1	1	16 octets

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