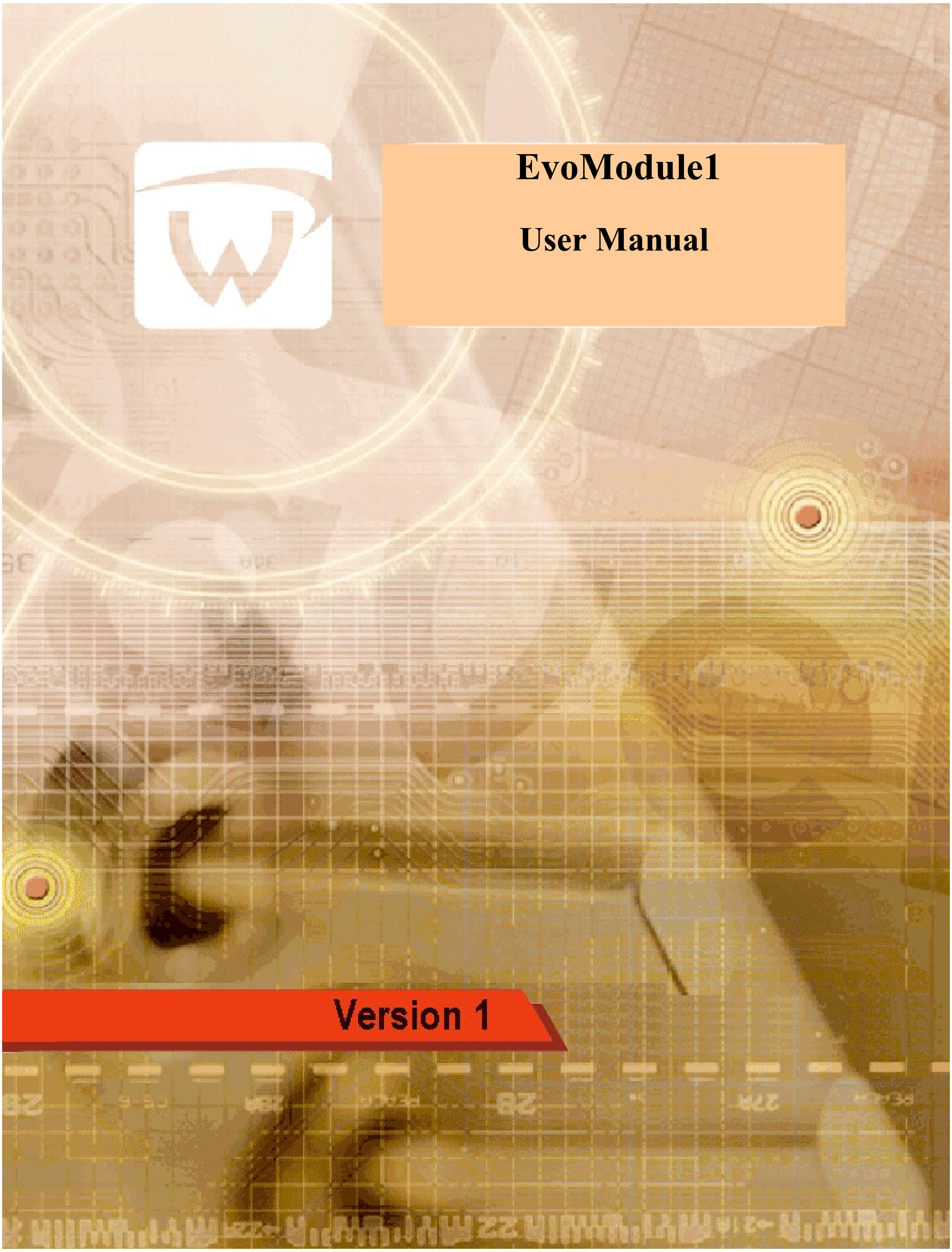


EvoModule1

User Manual

Version 1

REVISIONS HISTORY

Rev. #	Description	Auteur	Date	Commentaires
1	Original document	PGN	19/09/08	Version 1
2	updated	PGN	11/06/08	version2

➢ FIRMWARE VERSIONS OF SUPPORTED WAVECARD INTEGRATED INTO THE EVOMODULE1

WaveCard 500mW : **Compatible with the version v4.01, and later**

This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions : this device may not cause harmful interference, and this device must accept any interference received, including interference that may cause undesired operation.

Caution : any changes or modifications not expressly approved by Coronis-Systems could void the user's authority to operate the equipment.

TABLE OF CONTENTS

1. INTRODUCTION

The EvoModule1 Integrates a Wavecard 500mW.

The WAVECARD equipment acts like a RS232 Radio frequency gateway.

This device is driven through a USART link (RS232 or TTL) by a client application (called HOST in the continuation of this document) embedded on a microcontroller or on a PC equipment.

The main features of the WAVECARD are :

- to send a frame on the RF medium depending on Host equipment
- to inform Host equipment about received frame

Exchanges between two WAVECARD require that each one is connected to a Host device.

However, Wavecard can process some specific frames without Host connected. These exchanges are called *Service Exchanges* and are mainly used for installation and maintenance procedures.(cf. §4).

The purpose of this document is to present:

- the low level of the exchange protocol to drive the Wavecard radio board through an asynchronous serial RS232 interface (±12V) or compliant with TTL level (0-3V) ;
- the electrical interface of the Wavecard radio board ;
- the mechanical interface of the Wavecard radio board ;

This document serves as a specification to drive a DLL driving library on PC environment in the case the Wavecard radio board is used as a RF Modem either to be integrated in a existing electronic device or to be driven by a specific CPU mother board.

This document is also useful for the Waveport equipment. Waveport is a PC connected oriented RF modem based on the Wavecard.

In this document the Host term is used to speak about the equipment or sub-equipment that is driving the Wavecard radio board. The radio board term indicates the Wavecard equipment .

2. RS232 SERIAL PROTOCOL PRESENTATION

This protocol is dedicated to an asynchronous RS232 or TTL link between the host and the radio board.

- Transmission format :
  - 8 bits data,
  - 1 stop bit,
  - no parity
- Transmission speed : 9600 baud (contact us for other speed : marketing@coronis-systems.com)

2.1- Exchanges principle

The host or the radio board can take the initiative of the exchange. Nevertheless in the high majority of the cases, the host will take the initiative.

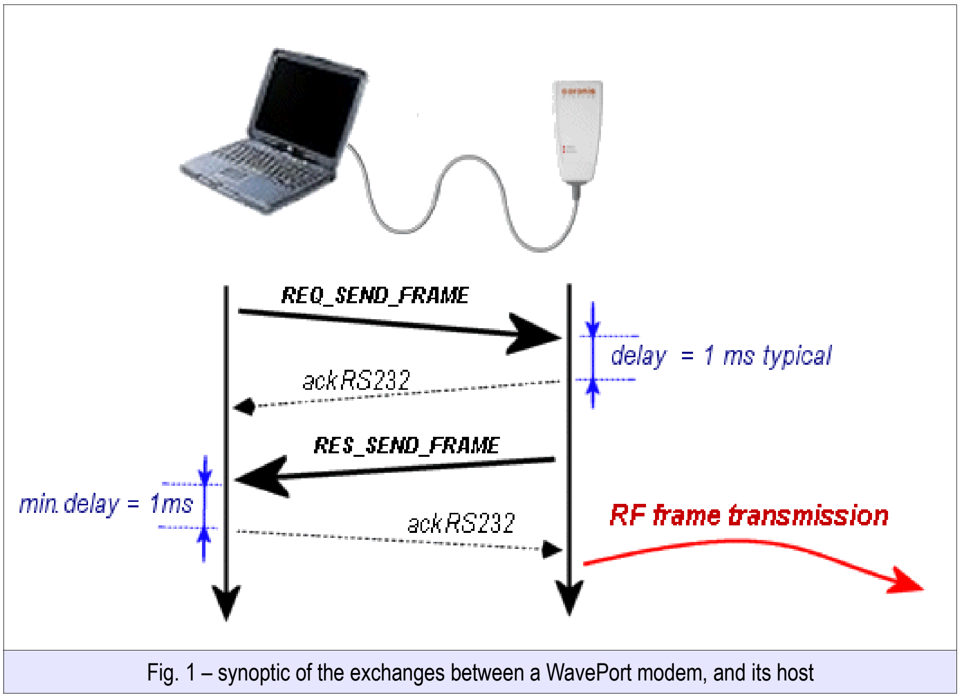


Fig. 1 – synoptic of the exchanges between a WavePort modem, and its host

2.1.1 - Low level acknowledge

In all the cases, the serial frames exchanged between the host and the radio board are managed by an acknowledge mechanism.

A minimum latency time of **1 ms** must be respected between the frame reception and the corresponding acknowledge emission in order to respect the radio board processing time after a frame reception.

If the Acknowledge frame is not received by the initiator, it can decide to re-send several times the frame (retries mechanism). The RF default setting is :

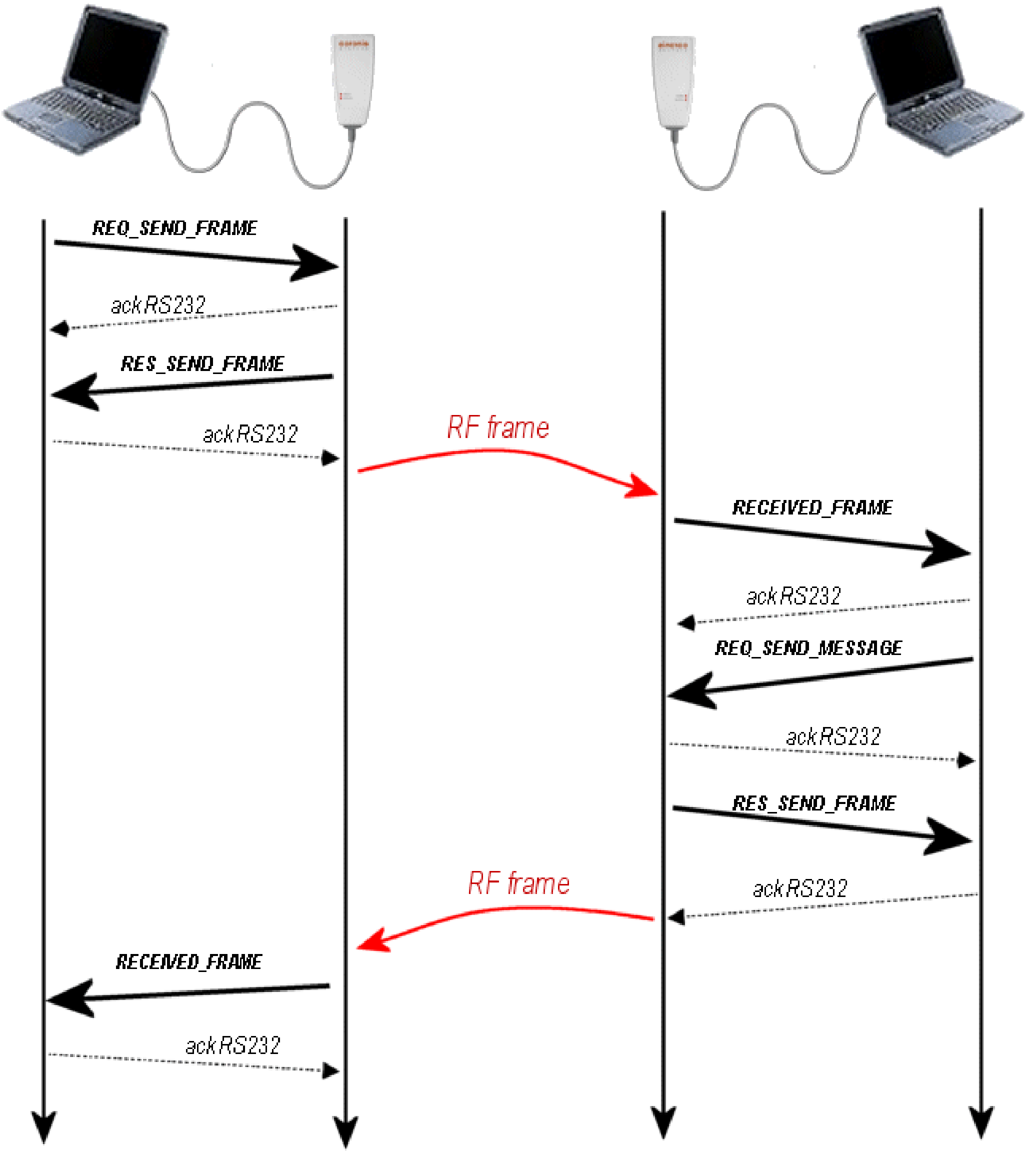
- Time-out = 500 ms
- repetition number = 3

2.1.2 - Request/ Response principle

Some exchanges need a Request/response mechanism.

In this case , an high level acknowledge (RES prefix command) is initiated by the RF board following the request frame (REQ prefix command) sent by the host.

> *The request frame are identified by REQ_XXX_XXX*
> *example : REQ_SEND_FRAME*
>
> *The high level acknowledge frame are identified by RES_XXX_XXX*
> *example : RES_SEND_FRAME*



In this example, from the request transmitter side, the frame RECEIVED_FRAME is the response associated to the request REQ_SEND_FRAME.

The high level acknowledgement of the request is identified by the RES_SEND_FRAME frame.

2.2- Exchanged frames format

2.2.1 - Wake Up and synchronization mechanism

In the purpose to optimize power consumption, the Wavecard is in a STANDBY mode and is wakening up either :

- periodically to poll a radio activity ;
- on a serial frame reception coming from the host equipment.

A synchronization character is needed before the data in the serial frame to give time to the radio board to wake up. This character is in hexadecimal notation : 0xFF.

To be homogeneous, the radio board precedes as well its frames emissions with this synchronization character.

2.2.2 - Frame description

The frames format is standardized as following :

SYNC	STX	LENGTH	CMD	DATA	CRC	ETX
1 byte	1 byte	1 byte	1 byte	De 0 à 250 bytes	2 bytes	1 byte
Synchro. character	Start of transmission character	Frame length	Command	Data	Control Redundancy Check LSB First	End of transmission character
0xFF	**0x02**					**0x03**

LENGTH

Note : *- The frame minimum size is 6 bytes.*
- The frame maximum size is 256 bytes.

The frame length (byte LENGTH) is computed from its own position until the included CRC. Bytes SYNC, STX and ETX are not included in the length.

To insure transmitted information integrity between the host and the radio board, a CRC code on 16 bits is computed on overall frame data excepted STX and ETX characters (the byte LENGTH is inserted in the CRC).

The CRC code is computed by a division of the frame binary sequence by the following polynomial:

$$X^{16} + X^{12} + X^{5} + 1$$

A coding example is indicated on the next page.

CRC principle coding in C language :

```
#include <iostream.h>
#include <stdio.h>
#include <string.h>

void main ( )
{
int Poly = 0x8408;
int lg = 9;
unsigned int Frame [] = { 0x0B, 0x20, 0x43, 0x06, 0x01, 0x00, 0x00, 0x02, 0X01};
unsigned int Crc;
int j, i_bits, carry;

Crc = 0;
for ( j=0 ; j < lg ; j++ )
        {
        Crc = Crc ^ Frame[j] ;

        for ( i_bits=0 ; i_bits < 8 ; i_bits++ )
                {
                carry = Crc & 1 ;
                Crc = Crc / 2 ;
                if ( carry )
                        {
                        Crc = Crc ^ Poly;
                        }
                }
        }
printf ( “CRC = %x “, Crc);
}
```

The computed CRC is the following : 41D2 hexadecimal
Then LSB byte and MSB byte must be inverted before storage in the frame.

This example allows to compute a CRC on a fix frame length equal to 9.

2.3- Commands description

All the frames circulating on the serial bus are formatted as described in chapter 2.2.2. The distinction between the various frames is carried out via the 'CMD' fields representing the command (or the action) to carry out.

The available commands types can be classified in three parts :

- Control type commands
- Applicative commands
- Service type commands

2.3.1 - Control type commands

This commands are used for the low level acknowledgement of the serial frames.

CMD	NAME	DESCRIPTION	DATA FIELD FORMAT
0x06	ACK	Acknowledge Frame : Sent by the receiver after reception of a Request /Response frame type supported and understood.	No data field.
0x15	NAK	Non Acknowledge Frame : Sent by the receiver after reception of a Request /Response frame not understood.	No data field.
0x00	ERROR	Error frame : Sent by the receiver after reception of a Request/response frame understood but not supported.	Byte 1 : 0x01 : unknown command.

2.3.2 - Applicative type commands

The applicative type commands use the Request/response mechanism.

We distinguish two parts in the applicative type commands : the commands relating to the parameter setting and the configuration of the board ; and in addition the commands relating to radio exchanges.

➢ **Commands relating to the parameter setting**

- Read, or update the internal parameters,
- Read, or select the radio operating channel when FHSS is deselected,
- Read, or select the RF medium physical mode,
- Read, or select the radio board emission power,
- Activation of the Wavenis RF Asic RSSI threshold autocorrection,
- Modification of the serial link baudrate,
- Reading the RSSI level of a distant equipment,
- Reading the RSSI level of the wavecard, following an exchange with a distant equipment,
- Reading the firmware version of the WaveCard,
- Set the WaveCard into a test mode.

➢ Commands relating to radio exchanges

The radio exchanges are composed of several modes of transmission/reception. With in certain cases, the possibility of receiving several consecutive radio frames (multi frames mode, accessible in reception only).

The following modes allow **point-to-point** exchanges :

- **'Frame Exchange' mode** : This mode allows to emit a request, with waiting of a radio response from the distant equipment.

  Following the radio frame sending, the Wavecard radio board stay in radio reception during a time (fixed by default at 2s, cf. RADIO_USER_TIMEOUT) in order to receive the response from the addressed equipment. During this time the serial RS232 link is not managed. This command is particularly intended to read CORONIS SYSTEMS radio modules used to collect remote information (temperature, humidity, meters index, ...).

- **'Message' mode** : allows to emit a request, without waiting of a radio response from the distant equipment.

  After radio frame emission, the Wavecard radio board is listening again the serial RS232 link. This command is suited to a simple data transfer between several Wavecard equipments.

Moreover exchanges of the point-to-point types have an additional mode which allow to reach a module out of radio range of the transmitter, by relaying the frames via other equipments.

- **'Relaying' mode** : this functionality allow to use a radio equipment to repeat a frame which is not initially intended to him.

  This functionality is used when the transmitter equipment, and the recipient of the request are out of radio range. The maximum number of repeaters is limited to 3.

The remaining modes allow exchanges with several distant equipments, in a selective way or not.

- **'Polling' mode** : allows to address a request to a list of known distant equipment. The response is sent to the host, transmitter of the request, when all the distant equipment responded, or on time-out.

  In this case, the list of the distant equipments is configured via a command of parameter setting (see chapter 3)

- **'Broadcast' mode** : allows to address a request to all the distant equipment within radio range of the transmitter, or only to a group of equipment in radio range of the transmitter.

- **Particular Case: multi-frames reception**

  Multi frame mode allows multi frame exchange between the Wavecard/Waveport (considered like the master of the exchange) and one of the telemetry equipments of the Coronis Systems product family (WaveTherm, WaveFlow, WaveSens, ...).
  Current version of Wavecard does not allow multi frame mode between two Wavecard/Waveport equipments.

2.3.3 - Service type commands

Services commands are used to configure the Wavecard or to read radio parameters independently of the connected host equipment.

When the wavecard recognizes Service command, no data are sent to the connected host.

These commands are mainly used to:

- Process detection of a distant RF equipment
- Process a link budget with a distant equipment (RSSI level detection)
- Process the setting of parameters by RF way

the details of the frame format, and its usage is described in chapter 4.

3. SETTING THE INTERNAL PARAMETERS OF THE WAVECARD

The internal parameters of WaveCard are declined in two categories :

- parameters of control (emission power level, channel selection, etc...) carried out by specific frame of type Request/Response. this parameters allows to modify the mode of communication (either serial, and RF).
- Functional parameters (WakeUp period, group number, etc...) carried out by the same frame of writing of internal parameters. this parameters allows to modify the behavior of WaveCard, according to the type of radio exchange used.

> *Attention, the setting parameter commands apply only to a local WaveCard, not to a distant one.*

3.1- Configuration of the functional parameters

The functional parameters are directly related to the default operation of WaveCard, and to the types of radio exchanges used. I.e. according to the type of radio exchange which will be used, the functional parameters will have to be initialized.

Default values are set at the first initialization of the product.

Parameter number	Description	Value	Size (in byte)
0x00	**AWAKENING_PERIOD :** polling period of RF medium radio, in multiples of 100ms	Period in multiples of 100ms (by default, 0x0A for one second) 0 = quasi-permanent reception (every 20ms)	1
0x01	**WAKEUP_TYPE :** Wake Up type used during a frame emission	0 : long Wake Up (default setting) 1 : short Wake Up = 50 ms	1
0x02	**WAKEUP_LENGTH : duration of the Wake up when long wake up is set up.** This value must be higher than the polling period of RF medium radio. Value in multiples of 1ms, defined LSB first	Default value : 1100 ms min value = 20 ms (0x1400) max value = 10 sec. (0x1027)	2
0x03	**WAVECARD_POLLING_GROUP** : Byte containing the Polling Group of the Wavecard.	Byte 1 : Polling_Group by default, Polling_Group = 0x00	1
0x04	**RADIO_ACKNOWLEDGE :** indicates if the radio frames must be acknowledged by the receiver.	0 : no acknowledge (default value) 1 : acknowledge used	1
0x05	**RADIO_ADDRESS : radio board address**	This Value is issue from the manufacturing. In Reading only	6
0x06	**RELAY_ROUTE_STATUS** : Parameter relative to Relay route transmission in each relayed frame received	0x00 : Relay route transmisson deactivated 0x01 : Relay route transmission activated by default, Relay route transmisson deactivated	1
0x07	**RELAY_ROUTE : Table containing the radio addresses for successive repeaters to use to reach the final equipment.**	BYTE 1 : number of repeaters in the route Maximum repeater number = 3 Si BYTE 1 != 0 BYTES 2 à 7 : First repeater radio address …, and so on.	1 à 19

0x08	**POLLING_ROUTE** : Table containing the list of modules radio address to be addressed.	BYTE 2 : number of equipments to interrogate IF BYTE 2 != 0 BYTES 3 to 8 : radio address of the first module..., and so on.	1 à 241
0x09	**GROUP_NUMBER** : Byte containing the number of the group of radio equipment to address in radio polling mode.	Group number by default, GROUP_NUMBER = 0x00	1
0x0A	**POLLING_TIME** : delay between two consecutive emission in polling mode	Value in multiples of 100ms By default, POLLING_TIME = 0x0A	1
0x0C	**RADIO_USER_TIMEOUT** : time-out used for the reception of a response frame	Value in multiples of 100ms default value = 0x14 (2 seconds)	1
0x0E	**EXCHANGE_STATUS** : parameter relative to the error or status frame management activation.	0 : status and error frame deactivated, 1 : error frame activated, 2 : status frame activated, 3 : both status and error frames activated, by default, RECEPT_ERROR_STATUS = 0x00.	1
0x10	**SWITCH_MODE_STATUS** : automatic selection of Radio physical mode used to address an equipment depending on radio address	0 : automatic selection deactivated 1 : automatic selection activated Default value, SWITCH_MODE_STATUS = 0x00	1
0x16	**WAVECARD_MULTICAST_GROUP** : Byte containing the Multicast Group of the Wavecard (available from V2.00 version).	By default, no group selected = 0xFF	1
0x17	BCST_RECEPTION_TIMEOUT : timeout used for the reception of CSMA frame consecutively to REQ_SEND_BROADCAST Command emission (available from firmware V2.01 version)	Valeur in multiples of100ms. Default = 0x3C (6 seconds)	1

3.1.1 - Format of the internal parameters access

The Wavecard equipment manage internal parameters mainly relative to RF features. RS232 commands allow to access these parameters in read or write mode. Default values are set at the first initialization of the product.

REQ_READ_RADIO_PARAM command is used to read parameters and REQ_WRITE_RADIO_PARAM is used to write parameters. **Each parameter must be accessed individually.**

CMD	NOM	DESCRIPTION
0x40	REQ_WRITE_RADIO_PARAM	Request to update the radio parameters
0x41	RES_WRITE_RADIO_PARAM	Response from the radio board to the radio parameters update
0x50	REQ_READ_RADIO_PARAM	Request to read the radio parameters.
0x51	RES_READ_RADIO_PARAM	Response from the radio board to a parameters reading.

Remark : In the command byte coding, the Response frame type are taking the Request command byte value with the LSB bit set to 1.

Data field formats to read or to update the radio parameters is the following :

- Request to read the radio parameters

REQ_READ_RADIO_PARAM				
HEADER	**CMD**	**DATA**	**CRC**	**ETX**
3 bytes	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x05	**0x50**	**Number of the parameter to read**		0x03

- Response from the radio board to a parameters reading

RES_READ_RADIO_PARAM						
HEADER	**CMD**	**DATA**			**CRC**	**ETX**
3 bytes	1 byte	1 byte	1 byte	variable	2 bytes	1 byte
0xFF ; 0x02 ; 0xXX	**0x51**	**Status = 0x00 read ok**	**Parameter number**	**value**		0x03
		Status = 0x01 read error	**-**			

- Request to update the radio parameters

REQ_WRITE_RADIO_PARAM					
HEADER	**CMD**	**DATA**		**CRC**	**ETX**
3 bytes	1 byte	1 byte	variable	2 bytes	1 byte
0xFF ; 0x02 ; 0xXX	**0x40**	**Number of the parameter to update**	**Parameter data**		0x03

- Response from the radio board to the radio parameters update

RES_WRITE_RADIO_PARAM				
HEADER	**CMD**	**DATA**	**CRC**	**ETX**
3 bytes	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x05	**0x41**	**STATUS** **= 0x00 update OK** **= 0x01 update error**		0x03

Timeout management : *The WaveCard can be considered in fault, beyond the value of the following latencies:*

REQ_WRITE_RADIO_PARAM	*2 seconds.*
REQ_READ_RADIO_PARAM	*2 seconds.*

EXAMPLE : configuration of the repeaters table, and activation of error frames.

Between WaveCard (exchange instigator), and the recipient equipment, we have a repeater equipment(radio address : 0X AA AA AA AA AA AA). In addition, we must authorize the error frame, in order to determine which distant equipment caused the error.

- ***Writing new parameters***

<u>repeaters list configuration</u> ***(Request/Response mechanism)***

Request from the host to the WaveCard (REQ_WRITE_RADIO_PARAM)

HEADER			CMD	DATA		CRC	ETX
SYNC	STX	LENGTH		Parameter number	Parameter data		
0xFF	0x02	0x0C	**0x40**	**0x07**	**0x01 ; 0xAAAAAAAAAAAA**	0xXXXX	0x03

Response from the WaveCard to the host (RES_WRITE_RADIO_PARAM)

HEADER			CMD	DATA	CRC	ETX
SYNC	STX	LENGTH		Status of the update		
0xFF	0x02	0x05	0x41	0x00	0xXXXX	0x03

<u>Activation of the error frames</u> ***(Request/Response mechanism)***

Request from the host to the WaveCard (REQ_WRITE_RADIO_PARAM)

HEADER			CMD	DATA		CRC	ETX
SYNC	STX	LENGTH		Parameter number	Parameter data		
0xFF	0x02	0x06	**0x40**	**0x0E**	**0x01**	0xXXXX	0x03

Response from the WaveCard to the host (RES_WRITE_RADIO_PARAM)

HEADER			CMD	DATA	CRC	ETX
SYNC	STX	LENGTH		Status of the update		
0xFF	0x02	0x05	**0x41**	**0x00**	0xXXXX	0x03

3.1.2 - Wake Up and synchronization mechanism

In the purpose to optimize power consumption, the Wavecard is in a STANDBY mode and is wakening up periodically to poll a radio activity. The wakeup period is given by the value of the AWAKENING_PERIOD parameter, expressed in multiples of 100ms (1 second by default).

a) Principle when transmitting, or receiving a frame

When transmitting a frame to a distant equipment, the transmitter begins an awakening preamble called 'WakeUp' being used to awake the receiving equipments which will position then in radio reception. This preamble results in the sending on the radio medium, of a binary succession of symbol.

This awakening preamble (WakeUp) can be of two types,

- **Long WakeUp** : used when transmitting a request towards distant equipment. Its duration can be parameterized by the user (1100ms by default); and is generally equal to the WakeUp period of the equipment to address, plus 100ms, in order to avoid transmitting between two periods of reception.
- **Short WakeUp** : used only when responding to a point-to-point request. Its duration is equal to 50ms, and cannot be configured.

NUM	DESCRIPTION	VALUE	SIZE (in bytes)
0x00	**AWAKENING_PERIOD :** polling period of RF medium radio, in multiples of 100ms	Period in multiples of 100ms (by default, 0x0A for one second) 0 = quasi-permanent reception (every 20ms)	1
0x01	**WAKEUP_TYPE :** Wake Up type used during a frame emission	0 : long Wake Up (default setting) 1 : short Wake Up = 50 ms	1
0x02	**WAKEUP_LENGTH : duration of the Wake up when long wake up is set up.** This value must be higher than the polling period of RF medium radio. Value in multiples of 1ms, defined LSB first	Default value : 1100 ms min value = 20 ms (0x1400) max value = 10 sec. (0x1027)	2

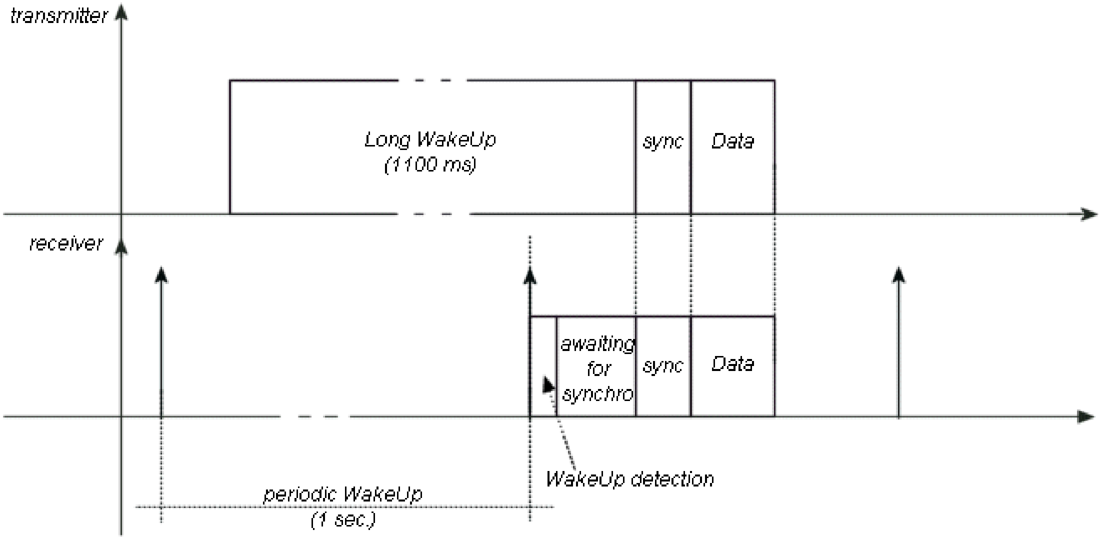
The receiver of the exchange, when it detect WakeUp preamble on the radio medium, carries out the following operations:

- It starts a timeout of waiting for the synchronization word (sync), which the duration is slightly higher than its WakeUp period. This duration cannot be configured.
- It begins a validation phase of the WakeUp preamble (detection of WakeUp). This phase corresponds to the detection of several successive symbols composing the preamble. If the detection fails, the equipment is repositioned in stand-by mode. The time of detection depends on the speed transmission used.

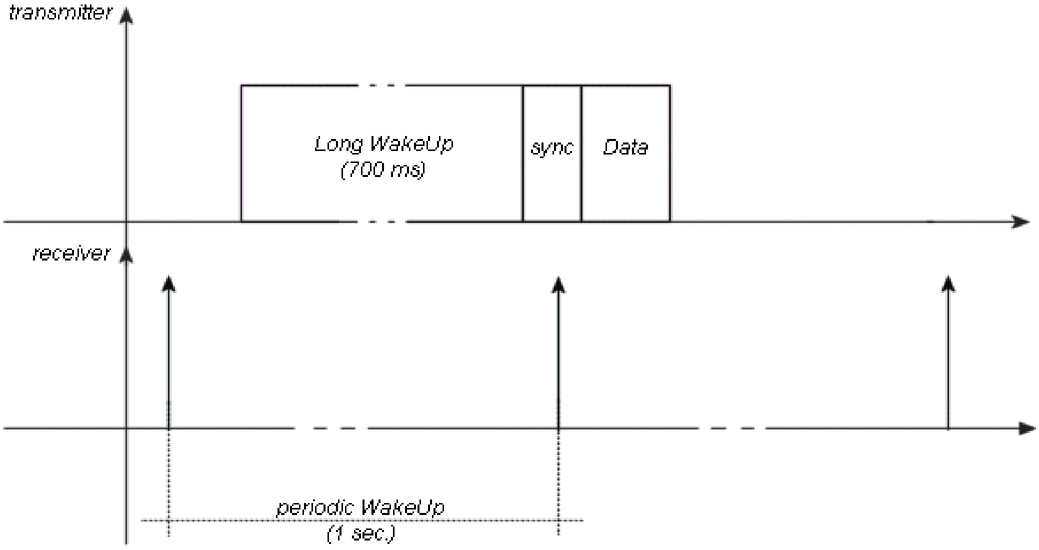
> *The periodic wakeup having to occur when waiting of synchronization, are memorized (in order to preserve the periodicity), but not carried out.*

At the end of the phase of WakeUp, the transmitter equipment send a sequence of synchronization, followed by data to be transmitted.

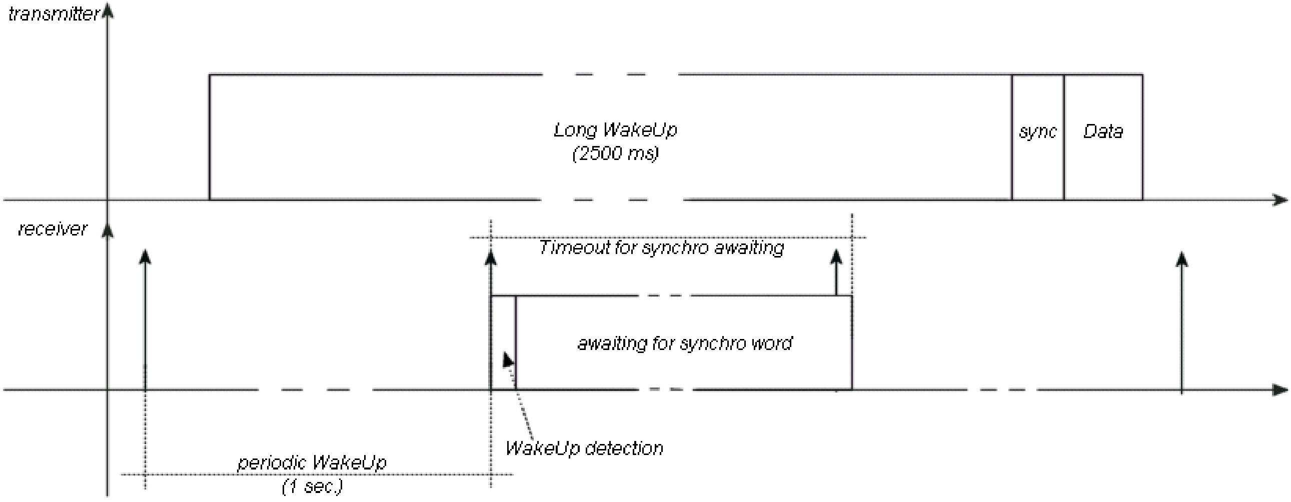
- **Typical case** ***(Long WakeUp = receiver WakeUp period + 100ms)***



- **Case of too short WakeUp** ***(lower than the receiver WakeUp period)***



- **Case of too long WakeUp** ***(much higher than the receiver WakeUp period)***

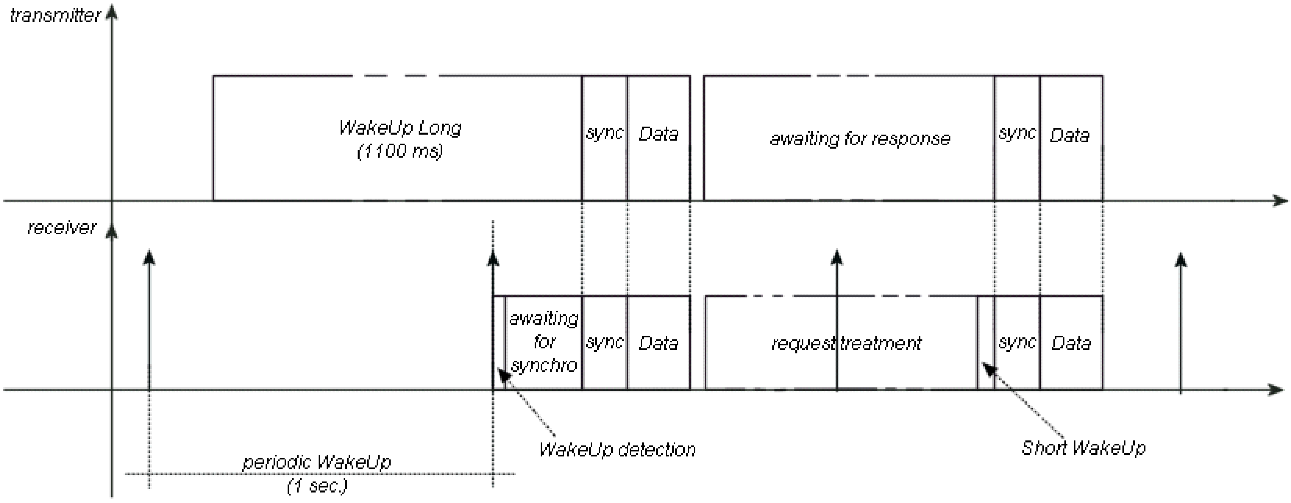


b) Example describing a point-to-point exchange of the type Request / Response.

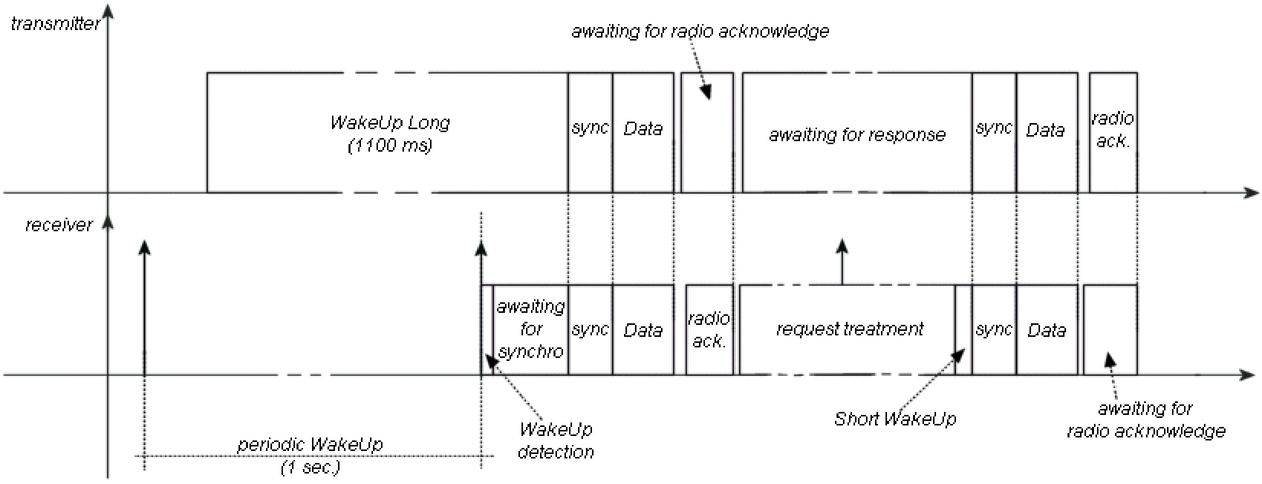
When using a point-to-point exchange of the type request/ Response, the transmission of the request is made in the same way that previously. But the transmitter, after the sending of the data, awaits for a response, during a time which can be configured by the RADIO_USER_TIMEOUT parameter (0x0C).

The receiver, after treatment of the request, will return its response by using a specific WakeUp preamble, called short WakeUp (Long WakeUp being useless since the transmitter is already in phase of reception).

- **Exchange without radio acknowledge**



- **Exchange with radio acknowledge**



Configuration example of the parameters of wakeup management.

during an exchange between two WaveCard, where between two idle periods the transmitter must quickly transmit data to the receiver.

1- Send a command of parameter modification to the receiver of the exchange, to modify its WakeUp period to 0 (quasi-permanent reception) ;

2- Configure WakeUp_Length parameter of the transmitter with 40ms ;

3- transmit the data to the receiver ;

4- To send a command of parameter modification to the receiver of the exchange, to modify its wakeup period to 10s (default value).

5- Configure WakeUp_Length parameter of the transmitter with 1100ms (default value).

3.2- Configuration of the control parameters

The parameters of control allow on the one hand, to modify the mode of radio communication, and serial communication; and furthermore, fetch information on the local module, and the quality of the communication with a distant module.

3.2.1 - selection of the radio operating channel when FHSS is deselected

It is possible to modify the transmission channel Reception via requests of reading, and writing. The commands are as follows,

CMD	NOM	DESCRIPTION
0x60	REQ_SELECT_CHANNEL	Request to select the radio operating channel when FHSS is deselected
0x61	RES_SELECT_CHANNEL	Response to the channel selection request
0x62	REQ_READ_CHANNEL	Request to read the radio operating channel when FHSS is deselected
0x63	RES_READ_CHANNEL	Response to the read channel request

> ***Remark :** These commands are used only when the mode of radio communication is mono-frequency with selection of channel.*

a) reading commands format of the channel used

- Request, from the host to the WaveCard

REQ_READ_CHANNEL			
HEADER	CMD	CRC	ETX
3 bytes	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x04	**0x62**		0x03

- Response, from the WaveCard to the host

RES_READ_CHANNEL					
HEADER	CMD	DATA		CRC	ETX
3 bytes	1 byte	variable		2 bytes	1 byte
0xFF ; 0x02 ; 0xXX	**0x63**	**Status = 0x00** *reading ok*	**Channel number** 1 byte		0x03
		Status = 0x01 *reading error*	-		

b) Writing commands format of the channel to use

- Request, from the host to the WaveCard

REQ_SELECT_CHANNEL				
HEADER	**CMD**	**DATA**	**CRC**	**ETX**
3 bytes	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x05	**0x60**	**Channel number (de 0 à 21)**		0x03

- Response, from the WaveCard to the host

RES_SELECT_CHANNEL				
HEADER	**CMD**	**DATA**	**CRC**	**ETX**
3 bytes	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x05	**0x61**	**Status** (**0x00 : update** OK **; 0x01 : update error**)		0x03

3.2.2 - Selection of the RF medium physical mode

The available physical layer modes, are :

- 868 MHz single channel 4800 baud,
- 868 MHz single channel 4800 bauds Alarm Band,
- 868MHz single channel 9600 bauds with channel selection,
- 868 MHz frequency hopping 9600 baud,
- 868 MHz frequency hopping 19200 baud,
- 869MHz 500mW Band (for Wavecard 25mW radio board, this mode is supported but the emission power is limited).

It is possible to modify the physical layer mode via requests of reading, and writing. The commands are as follow,

CMD	NAME	DESCRIPTION
0x64	REQ_SELECT_PHYCONFIG	Request to select the RF medium physical mode
0x65	RES_SELECT_PHYCONFIG	Response to the physical mode selection request
0x66	REQ_READ_PHYCONFIG	Request to read the RF medium physical mode
0x67	RES_READ_PHYCONFIG	Response to the physical mode reading request

Remark : In the command byte coding, the Response frame type are taking the Request command byte value with the LSB bit set to 1.

a) reading commands format of the physical layer mode

- Request, from the host to the WaveCard

REQ_READ_PHYCONFIG			
HEADER	**CMD**	**CRC**	**ETX**
3 bytes	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x04	**0x66**		0x03

- Response, from the WaveCard to the host

RES_READ_PHYCONFIG					
HEADER	**CMD**	**DATA**		**CRC**	**ETX**
3 bytes	1 byte	variable		2 bytes	1 byte
0xFF ; 0x02 ; 0xXX	**0x67**	**Status = 0x00** *reading ok*	**Transmission mode** 2 bytes		0x03
		Status = 0x01 *reading error*	**-**		

Remark : the following table describes the available physical layer modes

	Value
868 MHz single channel 4800 baud	0x0012
868 MHz single channel 4800 bauds Alarm Band	0x0094
868MHz single channel 9600 bauds with channel selection	0x00A2
868 MHz frequency hopping 9600 baud	0x00A3
868 MHz frequency hopping 19200 baud	0x00B3
869MHz 500mW Band	0x00B6

b) selection commands format of the physical layer mode to use

- Request, from the host to the WaveCard

REQ_SELECT_PHYCONFIG				
HEADER	**CMD**	**DATA**	**CRC**	**ETX**
3 bytes	1 byte	2 bytes	2 bytes	1 byte
0xFF ; 0x02 ; 0x06	**0x64**	**RF transmission mode**		0x03

- Response, from the WaveCard to the host

RES_SELECT_PHYCONFIG				
HEADER	**CMD**	**DATA**	**CRC**	**ETX**
3 bytes	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x05	**0x65**	**Status** (**0x00 : update** OK **; 0x01 : update error**)		0x03

c) Automatic selection of Radio physical mode to use

A parameter allows the WaveCard to choose its mode of transmission, according to the radio address of the distant equipment. Each Wavenis equipment integrates its mode of transmission in its radio address. If parameter SWITCH_MODE_STATUS is activated, then the WaveCard analyzes the mode of transmission of the distant

equipment, and modify its mode accordingly to the distant equipment. If parameter SWITCH_MODE_STATUS is deactivated, the WaveCard communicates with its default transmission mode.

Parameter number	**Description**	**Value**	**Size (in bytes)**
0x10	**SWITCH_MODE_STATUS** : automatic selection of Radio physical mode used to address an equipment depending on radio address (available from firmware V1.00 version)	0 : automatic selection deactivated 1 : automatic selection activated by default, SWITCH_MODE_STATUS = 0x01	1

3.2.3 - Selection of the radio board emission power

Compatibility: This functionality is accessible only on WaveCard 25mW.

It is possible to adjust the radio board emission power of WaveCard, according to the following table (by default, the level is configured to 14dBm):

Parameter value	0x0A	0x09	0x08	0x07	0x06	0x05	0x04	0x03	0x02	0x01	0x00
Power level (dBm)	14	12	11	9,7	7,9	5,5	3,3	2,1	-0,3	-4	-16

Remark : *Output Power values given in the table above are approximative ones (±2dBm). Indeed,Wavecard Radio Board is optimized for 25mW radiated RF Power.*

The modification and reading commands of the power level, are as follows:

CMD	NAME	DESCRIPTION
0x44	REQ_CHANGE_TX_POWER	Request to update radio board emission power
0x45	RES_CHANGE_TX_POWER	Response from the radio board to the emission power update
0x54	REQ_READ_TX_POWER	Request to read radio board emission power
0x55	RES_READ_TX_POWER	Response from the radio board to the emission power read

Remark : *In the command byte coding, the Response frame type are taking the Request command byte value with the LSB bit set to 1.*

a) selection commands format of the emission power

- Request, from the host to the WaveCard

REQ_CHANGE_TX_POWER				
HEADER	CMD	DATA	CRC	ETX
3 bytes	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x05	**0x44**	**Parameter value (0x0A, by default)**		0x03

- Response, from the WaveCard to the host

RES_CHANGE_TX_POWER				
HEADER	CMD	DATA	CRC	ETX
3 bytes	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x05	**0x45**	**Status** **0x00 : update** ok **0x01 :** update error		0x03

b) reading commands format of the emission power

- Request, from the host to the WaveCard

REQ_READ_TX_POWER			
HEADER	**CMD**	**CRC**	**ETX**
3 bytes	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x04	**0x54**		0x03

- Response, from the WaveCard to the host

RES_READ_TX_POWER				
HEADER	**CMD**	**DATA**	**CRC**	**ETX**
3 bytes	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x05	**0x55**	**Parameter value**		0x03

***Remark :** at reset of WaveCard, the power level is repositioned with its default value, 14 dBm (0x0A)*

3.2.4 - Activation of the Wavenis RF Asic RSSI threshold autocorrection

The RSSI threshold autocorrection is a functionality which allows WaveCard to adjust its threshold of reception, according to the ambient noise in a preoccupation with an energy saving.

This functionality is adapted if WaveCard is fed by battery. at RESET of WaveCard, the RSSI threshold autocorrection takes its state by default (i.e, activated).

The modification and reading commands of the autocorrection state, are as follows :

CMD	NAME	DESCRIPTION
0x46	REQ_WRITE_AUTOCORR_STATE	Request to update WAVENIS RF ASIC RSSI Threshold autocorrection state
0x47	RES_WRITE_AUTOCORR_STATE	Response from the radio board to the WAVENIS® RF ASIC autocorrection state update
0x5A	REQ_READ_AUTOCORR_STATE	Request to read WAVENIS RF ASIC RSSI Threshold autocorrection state
0x5B	RES_READ_AUTOCORR_STATE	Response from the radio board to the WAVENIS® RF ASIC autocorrection state read

***Remark :** In the command byte coding, the Response frame type are taking the Request command byte value with the LSB bit set to 1.*

a) Modification commands format of the RSSI threshold autocorrection state

- Request, from the host to the WaveCard

REQ_WRITE_AUTOCORR_STATE				
HEADER	**CMD**	**DATA**	**CRC**	**ETX**
3 bytes	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x05	**0x46**	**RSSI Threshold autocorrection** **0x00** : activated (default value) **0x01** : deactivated		0x03

- Response, from the WaveCard to the host

RES_WRITE_AUTOCORR_STATE				
HEADER	**CMD**	**DATA**	**CRC**	**ETX**
3 bytes	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x05	**0x47**	**Status** **0x00 : update** *ok* **0x01 : update e**rror		0x03

b) Reading commands format of the RSSI threshold autocorrection state

- Request, from the host to the WaveCard

REQ_READ_AUTOCORR_STATE			
HEADER	**CMD**	**CRC**	**ETX**
3 bytes	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x04	**0x5A**		0x03

- Response, from the WaveCard to the host

RES_READ_AUTOCORR_STATE					
HEADER	**CMD**	**DATA**		**CRC**	**ETX**
3 bytes	1 byte	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x06	**0x5B**	**Status** **0x00 : reading** ok **0x01 :** reading error	**Autocorrection state** **0x00** : activated **0x01** : deactivated		0x03

3.2.5 - Selection of the serial baudrate.

It is possible to modify the serial link baudrate, between WaveCard local and its host. In this case, the baudrate is updated only after the current exchange finished (i.e. that the response at the request of modification is done with the same baudrate as the request).

By default, the serial link baudrate is of 9600 bauds (value = 0x00).

Parameter value	0x00	0x01	0x02	0x03	0x04
Baudrate	9600 baud	19200 baud	38400 baud	57600 baud	115200 baud

The modification commands of the baudrate, are as follows :

CMD	NAME	DESCRIPTION
0x42	REQ_CHANGE_UART_BDRATE	Request to update serial link Baudrate
0x43	RES_CHANGE_UART_BDRATE	Response from the radio board to the serial link baudrate update. Serial Link Baudrate is updated once the exchange is ended

***Remark :** In the command byte coding, the Response frame type are taking the Request command byte value with the LSB bit set to 1.*

a) Selection commands format of the baudrate

- Request, from the host to the WaveCard

REQ_CHANGE_UART_BDRATE				
HEADER	**CMD**	**DATA**	**CRC**	**ETX**
3 bytes	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x05	**0x42**	**Parameter value**		0x03

- Response, from the WaveCard to the host

RES_CHANGE_UART_BDRATE				
HEADER	**CMD**	**DATA**	**CRC**	**ETX**
3 bytes	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x05	**0x43**	**Status** **0x00 :** update ok **0x01 :** update error		0x03

3.2.6 - Reading the firmware version of the WaveCard

The reading commands of the firmware version, are as follows :

CMD	NAME	DESCRIPTION
0xA0	REQ_FIRMWARE_VERSION	Request to read the radio board firmware version.
0xA1	RES_FIRMWARE_VERSION	Response from the radio board to the firmware version reading.

Remark : *In the command byte coding, the Response frame type are taking the Request command byte value with the LSB bit set to 1.*

Note : *The WaveCard can be considered in fault, beyond 2 seconds following the reading request.*

a) Commands format

- Request, from the host to the WaveCard

REQ_FIRMWARE_VERSION			
HEADER	**CMD**	**CRC**	**ETX**
3 bytes	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x04	**0xA0**		0x03

- Response, from the WaveCard to the host

RES_FIRMWARE_VERSION						
HEADER	**CMD**	**DATA**			**CRC**	**ETX**
3 bytes	1 byte	1 byte	2 bytes	2 bytes	2 bytes	1 byte
0xFF ; 0x02 ; 0x09	**0xA1**	**Character 'V' in ASCII** **0x56**	**Transmission mode** **(default = 0x00A3)**	**Firmware version**		0x03

Remark : the f*ollowing table describes the available physical layer modes*

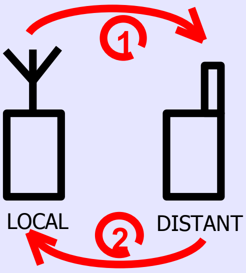
	Value
868 MHz single channel 4800 baud	0x0012
868 MHz single channel 4800 bauds Alarm Band	0x0094
868MHz single channel 9600 bauds with channel selection	0x00A2
868 MHz frequency hopping 9600 baud	0x00A3
868 MHz frequency hopping 19200 baud	0x00B3
869MHz 500mW Band	0x00B6

3.2.7 - Reading the RSSI level (Received Signal Strengh Indicator)

The RSSI level represent the QOS level (Quality Of Service) from a given module. This value can be used to verify the quality of the signals forwarding on the network.

It is possible to take this measurement on a distant module, or the local module. The following examples illustrate the types of measurements being able to be carried out.

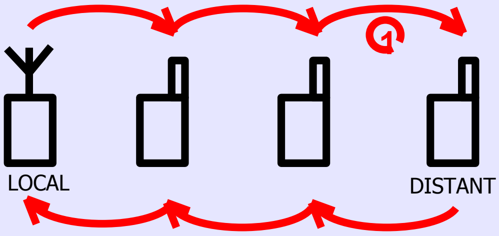
Example 1 : *Reading of RSSI, in Point-to-point mode.*



REQ_READ_REMOTE_RSSI : request the RSSI level of the signal 1. (i.e. the RSSI level on signal 1 reception by the distant equipment)

REQ_READ_LOCAL_RSSI : request the RSSI level of the signal 2. (i.e. the RSSI level on signal 2 reception by the local equipment)

Example 2 : *Request of reading of RSSI level on a distant module, in relaying mode.*



REQ_READ_REMOTE_RSSI : request the RSSI level of the signal 1.

Therefore, to know the RSSI level between the repeaters, it will be necessary to make a request REQ_READ_REMOTE_RSSI on each repeater.

a) Commands

CMD	NAME	DESCRIPTION
0x68	REQ_READ_REMOTE_RSSI	request to read RSSI level from remote equipment.
0x69	RES_READ_REMOTE_RSSI	Response to the read remote RSSI level request.
0x6A	REQ_READ_LOCAL_RSSI	request to read the Wavecard RSSI level on an exchange with a distant equipment.
0x6B	RES_READ_LOCAL_RSSI	Response to the read local RSSI level request.

Remark : *In the command byte coding, the Response frame type are taking the Request command byte value with the LSB bit set to 1.*

b) Format of the commands

- **Request to read RSSI level from a remote equipment :**

This measurement gives RSSI level of a signal received by a distant equipment, coming from the local WaveCard.

- Request

REQ_READ_REMOTE_RSSI				
HEADER	CMD	DATA	CRC	ETX
3 bytes	1 byte	6 bytes	2 bytes	1 byte
0xFF ; 0x02 ; 0x0A	**0x68**	**Remote equipment radio address**		0x03

- Response

RES_READ_REMOTE_RSSI				
HEADER	CMD	DATA	CRC	ETX
3 bytes	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x05	**0x69**	**value of RSSI level on reception of the frame resulting from the wavecard**		0x03

- **Request to read RSSI level from the local equipment :**

This measurement gives RSSI level of a signal received by the local Wavecard, coming from a distant equipment.

- Request

REQ_READ_LOCAL_RSSI				
HEADER	CMD	DATA	CRC	ETX
3 bytes	1 byte	6 bytes	2 bytes	1 byte
0xFF ; 0x02 ; 0x0A	**0x6A**	**Radio address of the distant equipment**		0x03

- Response

RES_READ_LOCAL_RSSI				
HEADER	CMD	DATA	CRC	ETX
3 bytes	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x05	**0x6B**	**value of RSSI level of the local wavecard, on reception of the frame resulting from the distant equipment**		0x03

Remark :

min RSSI level :	*0x00*	*0%*
max RSSI level :	*0x2F*	*100%*

saturation is considered with 92%

3.2.8 - TEST Mode

This mode is used for tests of installation, or a characterization of defect.

a) Command

CMD	NAME	DESCRIPTION
0xB0	MODE_TEST	Position the WaveCard module in a test mode

b) Format of the command

MODE_TEST				
HEADER	CMD	DATA	CRC	ETX
3 bytes	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x05	**0xB0**	**Test mode value**		0x03

With,

Test Mode Value	Description
0x00	Permanent reception
0x01	Permanent transmission without modulation
0x02	Permanent transmission with modulation
0x03	Stand by mode

4. SERVICE COMMANDS

Services commands are used to configure the Wavecard or to read radio parameters independently of the connected host equipment. When the wavecard recognizes Service command, no data are sent to the connected host.

These commands are mainly used to :

- Process detection of a distant RF equipment,
- Process a link budget with a distant equipment (RSSI level detection),
- Process the setting of parameters by RF way.

4.1- Description of the commands, and their formats

CMD	NAME	DESCRIPTION
0x80	REQ_SEND_SERVICE	Request to send a service frame with the waiting for the radio response.
0x81	RES_SEND_SERVICE	Response to the REQ_SEND_SERVICE.
0x82	SERVICE_RESPONSE	Received radio frame consecutive to a REQ_SEND_SERVICE transmission.

- Service request

REQ_SEND_SERVICE						
HEADER	CMD	DATA			CRC	ETX
3 bytes	1 byte	6 bytes	1 byte	variable	2 bytes	1 byte
0xFF ; 0x02 ; 0xXX	**0x80**	**radio address of distant radio equipment**	**Service request type**	**Possible parameter(s) related to the request type**		0x03

- Acknowledgement of the service request

RES_SEND_SERVICE				
HEADER	CMD	DATA	CRC	ETX
3 bytes	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x05	**0x81**	**Status** **0x00 : Frame transmission OK** **0x01 : Error frame transmission**		0x03

- Response to the service request

SERVICE_RESPONSE						
HEADER	CMD	DATA			CRC	ETX
3 bytes	1 byte	6 bytes	1 byte	variable	2 bytes	1 byte
0xFF ; 0x02 ; 0xXX	**0x82**	**radio address of distant radio equipment**	**service response type**	**Possible parameter(s) related to the response type**		0x03

4.2- Request types

The transmitter send a service command including a type of request. Each request type, has an associated type of response which is included in the command SERVICE_RESPONSE.

In the command byte coding, the Response type are taking the Request command byte value with the LSB bit set to 1.

- **Request type**

REQUEST TYPE		DESCRIPTION	PARAMETER(S)
NAME	VALUE		
GET_TYPE	0x20	Command used to read equipment type and RSSI Level from distant equipment.	No parameter
GET_FW_VERSION	0x28	Command used to read distant equipment firmware version.	No parameter

- **Response type**

RESPONSE TYPE		DESCRIPTION	PARAMETER(S)
NAME	VALUE		
RESP_GET_TYPE	0xA0	Response to a GET_TYPE command.	Byte 1 : Equipment type Byte 2 : RSSI level Byte 3 : wake-up period Byte 4 : Equipment type
RESP_GET_FW_VERSION	0xA8	Response to a GET_FW_VERSION command.	Byte 1 : 'V' ascii code (0x56) Byte 2 : Default Radio Protocol MSB Byte Byte 3 : Default Radio Protocol LSB Byte Byte 4 : Firmware Version MSB Byte Byte 5 : Firmware Version LSB Byte

4.3- Presence detection principle between WAVECARD

Before establishing a data exchange with a distant equipment, it can be useful to check the presence and the link budget of this device.

The Get_Type Command sent like a « Service Command » allows the distant Wavecard to process an answer independently of the host equipment connected.

Data frame description is as follow :

- **Service request**

REQ_SEND_SERVICE					
HEADER	CMD	DATA		CRC	ETX
3 bytes	1 byte	6 bytes	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x0B	**0x80**	**Radio address of distant radio equipment**	**0x20** **GET_TYPE**		0x03

- **Response to the service request**

SERVICE_RESPONSE						
HEADER	CMD	DATA			CRC	ETX
3 bytes	1 byte	6 bytes	1 byte	4 bytes	2 bytes	1 byte
0xFF ; 0x02 ; 0x0F	**0x82**	**Radio address of distant radio equipment**	**0xA0**	**Paramètres :** **1st byte** : Type corresponding to Wavecard radio board = 0x12 **2nd byte** : RSSI Level **3rd byte**: Distant Wavecard Wake Up period (in second) **4th byte** : Equipment Type connecting to Wavecard (default = 0x12)		0x03

5. COMMUNICATION MODES

The purpose of this part is to explain the methods of use of each four modes of communication, the format of the commands Request/response, and their corresponding parameters.

5.1- 'Frame Exchange’ Mode

This type of radio exchange allows to send a request, then to await a response of the distant equipment.

> *Remark : following the transmission of the radio frame, the WaveCard remains in radio reception, during a time given by the parameter RADIO_USER_TIMEOUT, so as to receive the response of the distant module.*
>
> *During this phase, the RS232 serial connection is not managed. This command is more specifically intended for the reading of CORONIS SYSTEMS telemetry equipment (temperaturemeasurement, moisture, flow, level, management of difital states ...)*

5.1.1 - Configuration of the parameters relating to the 'Frame Exchange' mode

The parameters are accessible by commands REQ_READ_RADIO_PARAM, and REQ_WRITE_RADIO_PARAM (all the parameters are developed in appendix 3).

NUM	DESCRIPTION	VALUE	SIZE (in bytes)
0x04	**RADIO_ACKNOWLEDGE :** indicates if the radio frames must be acknowledged by the receiver.	0 : no acknowledge (default value) 1 : acknowledge used	1
0x06	**RELAY_ROUTE_STATUS** : Parameter relative to Relay route transmission in each relayed frame received	0x00 : Relay route transmisson deactivated 0x01 : Relay route transmission activated by default, Relay route transmisson deactivated	1
0x07	**RELAY_ROUTE : Table containing the radio addresses for successive repeaters to use to reach the final equipment.**	BYTE 1 : number of repeaters in the route Maximum repeater number = 3 If BYTE 1 != 0 BYTES 2 à 7 : First repeater radio address …, and so on.	1 à 19
0x0C	**RADIO_USER_TIMEOUT** : time-out used for the reception of a response frame	Value in multiples of 100ms default value = 0x14 (2 seconds)	1
0x0E	**EXCHANGE_STATUS** : parameter relative to the error or status frame management activation.	0 : status and error frame deactivated, 1 : error frame activated, 2 : status frame activated, 3 : both status and error frames activated, by default, RECEPT_ERROR_STATUS = 0x00.	1

5.1.2 - Description of the commands, and their formats

CMD	NAME	DESCRIPTION
0x20	REQ_SEND_FRAME	Request to send a radio frame with the waiting for the radio response.
0x21	RES_SEND_FRAME	Response from the radio board to the frame emission (response to the request 0x20, 0x22, 0x24, 0x26, 0x28, 0x2A)
0x30	RECEIVED_FRAME	Received radio frame by the radio board.
0x31	RECEPTION_ERROR	Frame indicating error type detected at the issue of last exchange in point to point or relaying mode.
0x35	RECEIVED_FRAME_RELAYED	Received relayed radio frame by the radio board .Reception of this command is possible only if RELAY_ROUTE_STATUS (0x06) parameter is set.

Data frame description is as follow :

- **Request in 'Frame Exchange' mode**

REQ_SEND_FRAME					
HEADER	**CMD**	**DATA**		**CRC**	**ETX**
3 bytes	1 byte	6 bytes	variable	2 bytes	1 byte
0xFF ; 0x02 ; 0xXX	**0x20**	**Radio address from equipment to reach**	**n bytes of data to transmit the maximum size (N bytes) is defined below**		0x03

- **Acknowledgement of the request**

RES_SEND_FRAME				
HEADER	**CMD**	**DATA**	**CRC**	**ETX**
3 bytes	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x05	**0x21**	**Status** **0x00 :** transmission OK **0x01 :** transmission error		0x03

- **Response to the request**

RECEIVED_FRAME					
HEADER	**CMD**	**DATA**		**CRC**	**ETX**
3 bytes	1 byte	6 bytes	variable	2 bytes	1 byte
0xFF ; 0x02 ; 0xXX	**0x30**	**Radio address from transmitter equipment**	**data from received frame the maximum size (N bytes) is defined below**		0x03

Remark : *maximum size definition*
- Point to Point mode : ***Max*** *=* *152 bytes of data*
- Relaying mode : ***Max*** *=* ***152*** *- (2 + 6 x Number of repeaters)*

=> 1 repeater : 144 *bytes of data,*
=> 2 repeaters : 138 *bytes of data****,***
=> 3 repeaters : 132 *bytes of data.*

5.1.3 - Use of the Relaying mode

The relaying mode is only available for point-to-point exchanges ('Frame Exchange' or 'Message' types).

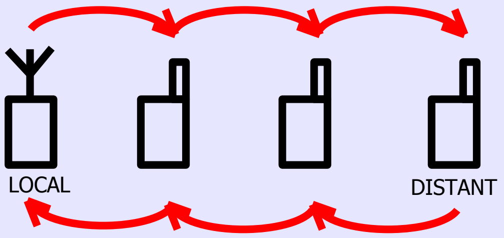
a) On frame transmission

To send a request in Relaying mode to a distant equipment, it is necessary to configure the list of the repeaters, via parameter RELAY_ROUTE. Then to send a request of the type REQ_SEND_FRAME (or REQ_SEND_MESSAGE) to the address of the recipient.

The radio frame is then relayed automatically through the equipments configured in parameter RELAY_ROUTE.

Attention, after sending a request to the recipient, the list of repeaters (RELAY_ROUTE) is automatically re-initialized. It will thus be necessary to reconfigure it to send another request in relaying mode.

***Example : Sending a** REQ_SEND_FRAME request in relaying mode*



Remark : in the case of a REQ_SEND_FRAME request, the routing of the response towards the local equipment is not automatic. It must be configured by the distant host (user application).

Generally, if the frame arriving to the recipient went up towards his Host; then the list of the relay addresses for the return must be configured by the user.

If the frame did not go up towards the Host of the recipient, for example on requests of the type REQ_READ_REMOTE_RSSI, or GET_TYPE; then the recipient reference the response by using the addresses of relay contained in the received frame.

b) On frame reception

Since the firmware version v2.00 (v4.00 for 500mW equipment), it is possible on frame reception in relaying mode, to make go up the relay route towards the host of the receiving module.

To preserve compatibility with the preceding versions, this functionality is activated, or deactivated by functional parameter RELAY_ROUTE_STATUS (0x06) of the receiving module.

According to the value of this parameter, the host will receive one of the following frames :

RELAY_ROUTE_STATUS value	Type of frame transmitted to the host, on reception of a radio frame in relaying mode
0x00 : deactivated	RECEIVED_FRAME (CMD = 0x30)
0x01 : activated	RECEIVED_FRAME_RELAYED (CMD = 0x35)

The format of the types of frame received by the host, are described as follow.

- **Response received by the host, with RELAY_ROUTE_STATUS deactivated**

RECEIVED_FRAME					
HEADER	CMD	DATA		CRC	ETX
3 bytes	1 byte	6 bytes	variable	2 bytes	1 byte
0xFF ; 0x02 ; 0xXX	**0x30**	**Radio address from transmitter equipment**	**data from received frame the maximum size (N bytes) is defined below**		0x03

- **Response received by the host, with RELAY_ROUTE_STATUS activated**

RECEIVED_FRAME_RELAYED							
HEADER	CMD	DATA				CRC	ETX
3 bytes	1 byte	6 bytes	1 byte	variable	variable	2 bytes	1 byte
0xFF ; 0x02 ; 0xXX	**0x35**	**Radio address from transmitter equipment**	**Number of repeaters used**	**Radio addresses of the repeaters used**	**data from received frame the maximum size (N bytes) is defined below**		0x03

The field 'Radio addresses of the repeaters used' can have a size of 6, 12, or 18 bytes, according to the number of repeaters used.

Remark : *maximum size definition*
- Point to Point mode : ***Max*** *= 152 bytes of data*
- Relaying mode : ***Max*** *=* ***152*** *- (2 + 6 x Number of repeaters)*

=> 1 repeater : 144 *bytes of data,*
=> 2 repeaters : 138 *bytes of data,*
=> 3 repeaters : 132 *bytes of data.*

➢ Frame RECEPTION_ERROR format

With this command, the local WaveCard informs its host that a problem appeared at the time of the radio exchange.

This command is forwarded only on the serial link, between the wavecard and its host, it thus does not require an address of recipient.

> ***Note: The error messages are activated only if parameter EXCHANGE_STATUS is positioned with 0x01, or 0x03.***
>
> ***In this last case, status messages are also activated, but does not intervene in this mode, only at the time of the sending of a message without waiting of answer (MESSAGE, and BROADCAST mode).***

- **In Point-to-Point mode**

RECEPTION_ERROR					
HEADER	CMD	DATA		CRC	ETX
3 bytes	1 byte	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x06	**0x31**	**EXCHANGE_MODE** : = 0x01 : Point-to-Point mode	**ERROR_TYPE** : = 0x01 : Distant equipment RF acknowledge not received (useful if acknowledge mechanism is set) = 0x02 : Distant equipment RF response not received.		0x03

- **In Relaying mode**

RECEPTION_ERROR						
HEADER	CMD	DATA			CRC	ETX
3 bytes	1 byte	1 byte	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x06	**0x31**	**EXCHANGE_MODE** : = 0x02 : relaying mode	**0x02** Default value for relaying mode	**RELAY_COUNTER** : = 0x03 No response from the third repeater; = 0x02 No response from the second repeater; = 0x01 No response from the first repeater; = 0x00 No response from the final equipment.		0x03

In both cases, the procedure of sending an error frame depends on parameter RADIO_ACKNOWLEDGE:

- If RADIO_ACKNOWLEDGE is active, and the transmitter does not receive a radio acknowledgement, then the request is re-emitted three times, before sending the error frame.
- If RADIO_ACKNOWLEDGE is inactive, then the error frame is sent after time-out RADIO_USER_TIMEOUT.

5.1.4 - Time-out management

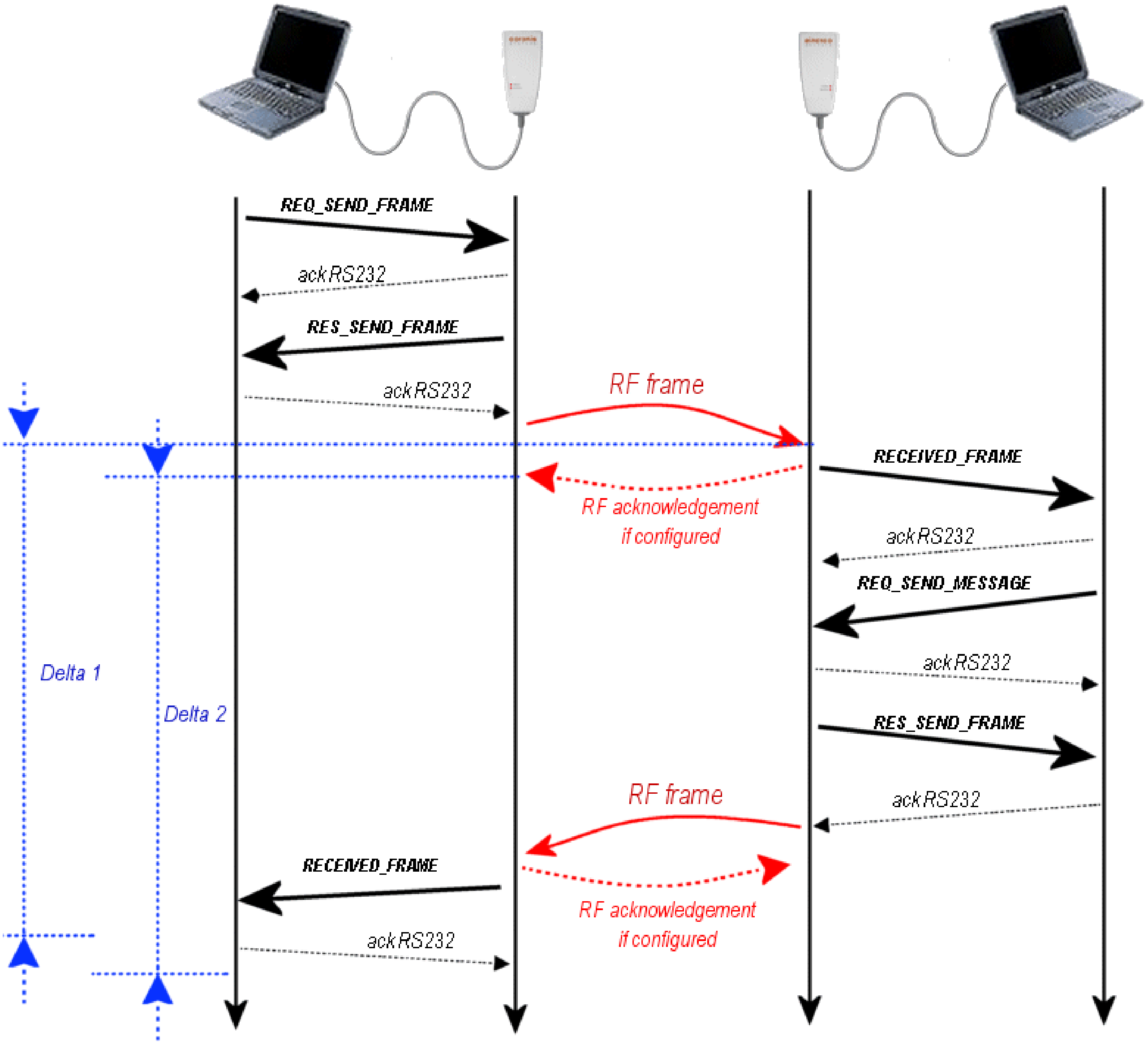
when sending a request with waiting of a response (Frame Exchange), the timeout relating to waiting of the response frame, is given by parameter RADIO_USER_TIMEOUT (2 seconds by default).

The beginning of counting of this timeout depends on another parameter: RADIO_ACKNOWLEDGE.

If RADIO_ACKNOWLEDGE is active, then counting begins on reception of the acknowledgement from the Request. On the other hand, if RADIO_ACKNOWLEDGE is inactive, then the counting of the

timeout begins directly after sending the request on radio medium.

- **Diagram of a Point-to-Point exchange**

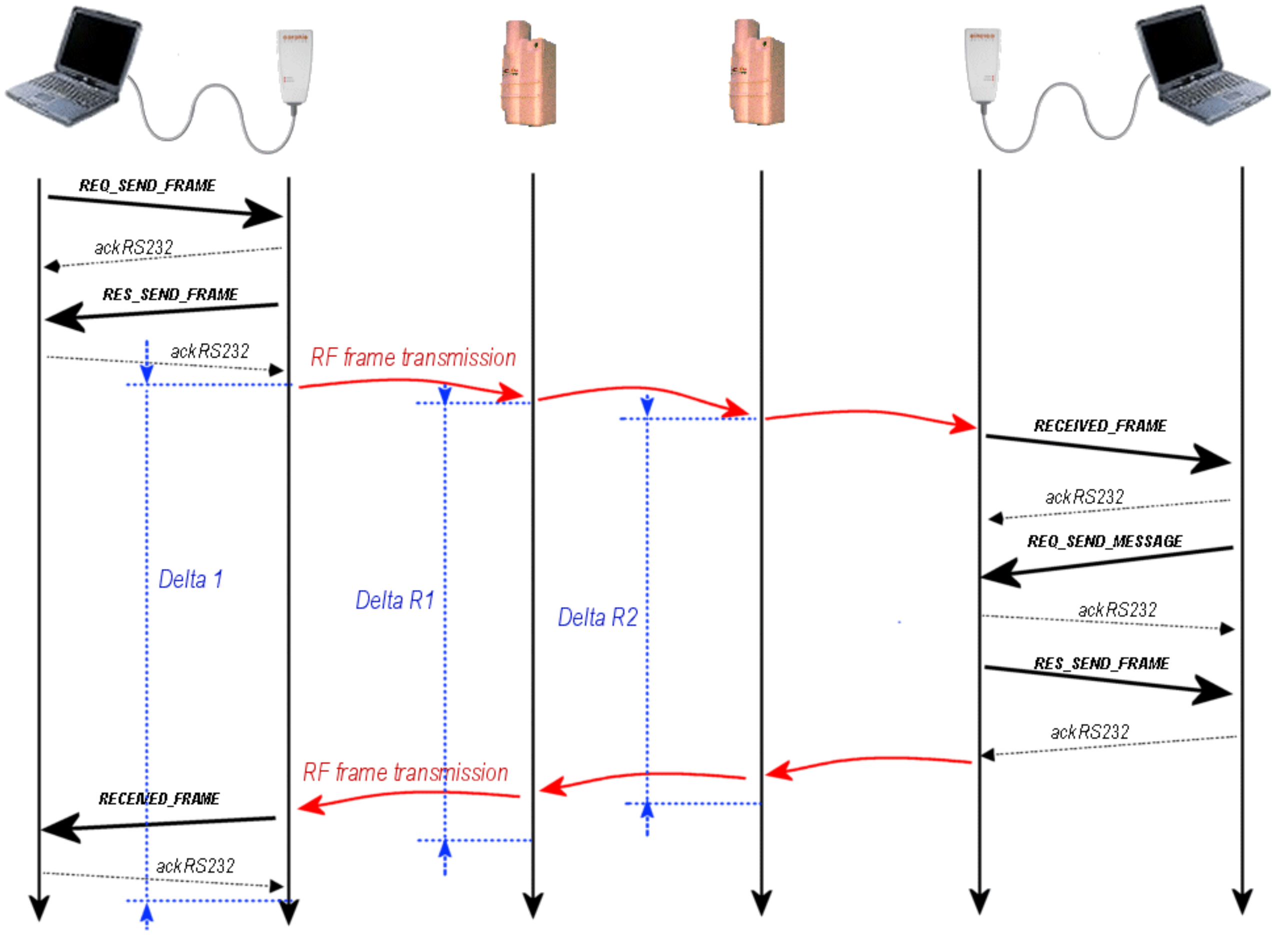


Delta 1 : RADIO_USER_TIMEOUT, with RADIO_ACKNOWLEDGE disabled.

Delta 2: RADIO_USER_TIMEOUT, with RADIO_ACKNOWLEDGE enabled.

Delta 1 = Delta 2 = RADIO_USER_TIMEOUT

- **Diagram in Relaying mode**



In the case of the Relaying mode, the time-out from the transmitter point of view is longer than in Point-to-point mode, because of the transit via the relays.

Time-out RADIO_USER_TIMEOUT is always applied, but does not take into account the relays. This time value will be applied by the last relay, before the recipient (R2 Delta = Radio_User_Timeout).

Remark : the value of the RADIO_USER_TIMEOUT applied by the last relay, is configured in the transmitter; and not in the relay itself.

In fact, in 'relaying' mode, the relay use a value of RADIO_USER_TIMEOUT encapsulated in the radio frame, by the transmitter.

The relay is not using its own parameter settingof RADIO_USER_TIMEOUT, only when it is transmitting; not repeating.

In the diagram, value RADIO_USER_TIMEOUT configured in the transmitter, corresponds to time **Delta R2** applied by Relay 2.

Delta 1, and **Delta R1** are the times evaluated by the corresponding radio equipment. This evaluation depends of the number of relays, the type of WakeUp, its length, and value of parameters RADIO_USER_TIMEOUT; and RADIO_ACKNOWLEDGE.

5.2- 'Message' Mode

This type of radio exchange allows to send a request, without awaiting response from the distant equipment.

After radio frame emission, the Wavecard radio board is listening again the serial RS232 link. This command is suited to a simple data transfer between several Wavecard equipments.

5.2.1 - Configuration of the parameters relating to the 'Message' mode

The parameters are accessible by commands REQ_READ_RADIO_PARAM, and REQ_WRITE_RADIO_PARAM (all the parameters are developed in appendix 3).

NUM	DESCRIPTION	VALEUR	TAILLE (en octets)
0x04	**RADIO_ACKNOWLEDGE :** indicates if the radio frames must be acknowledged by the receiver.	0 : no acknowledge (default value) 1 : acknowledge used	1
0x06	**RELAY_ROUTE_STATUS** : Parameter relative to Relay route transmission in each relayed frame received.	0x00 : Relay route transmisson deactivated 0x01 : Relay route transmission activated by default, Relay route transmisson deactivated	1
0x07	**RELAY_ROUTE : Table containing the radio addresses for successive repeaters to use to reach the final equipment.**	BYTE 1 : number of repeaters in the route Maximum repeater number = 3 If BYTE 1 != 0 BYTES 2 à 7 : First repeater radio address …, and so on.	1 à 19
0x0E	**EXCHANGE_STATUS** : parameter relative to the error or status frame management activation.	0 : status and error frame deactivated, 1 : error frame activated, 2 : status frame activated, 3 : both status and error frames activated, by default, RECEPT_ERROR_STATUS = 0x00.	1

5.2.2 - Description of the commands, and their formats

CMD	NAME	DESCRIPTION
0x22	REQ_SEND_MESSAGE	Request to send a radio frame without the waiting for the radio response.
0X21	RES_SEND_FRAME	Response from the radio board to the frame emission (response to the request 0x20,0x22,0x24,0x26,0x28,0x2A)
0x30	RECEIVED_FRAME	Received radio frame by the radio board.
0x31	RECEPTION_ERROR	Frame indicating error type detected at the issue of last exchange in point to point or relaying mode.
0x35	RECEIVED_FRAME_RELAYED	Received relayed radio frame by the radio board .Reception of this command is possible only if RELAY_ROUTE_STATUS(0x06) parameter is set.
0x37	END_MESSAGE_EXCHANGE	Frame indicating end of message exchange.This frame is returned only after 0x22 & 0x24 & 0x2A Request command. Reception of this frame is conditioned by the parameter EXCHANGE_STATUS value.

The format of the types of frame received by the host, are described as follow.

➢ Request in 'Message' mode

REQ_SEND_MESSAGE					
HEADER	CMD	DATA		CRC	ETX
3 bytes	1 byte	6 bytes	variable	2 bytes	1 byte
0xFF ; 0x02 ; 0xXX	**0x22**	**Radio address from equipment to reach**	**n bytes of data to transmit the maximum size (N bytes) is defined below**		0x03

Remark : *maximum size definition*
- Point to Point mode : ***Max*** *= 152 bytes of data*
- Relaying mode : ***Max = 152*** *- (2 + 6 x Number of repeaters)*

=> 1 repeater : 144 *bytes of data,*
=> 2 repeaters : 138 *bytes of data,*
=> 3 repeaters : 132 *bytes of data.*

➢ Acknowledgement of the request

RES_SEND_FRAME				
HEADER	CMD	DATA	CRC	ETX
3 bytes	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x05	**0x21**	**Status** **0x00 : transmission OK** **0x01 : transmission error**		0x03

➢ Status frame – 0x37 (END_MESSAGE_EXCHANGE)

END_MESSAGE_EXCHANGE				
HEADER	CMD	DATA	CRC	ETX
3 bytes	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0xXX	**0x37**	0x00		0x03

Attention, the reception by the host of this command depends on the activation of status frame in parameter EXCHANGE_STATUS (0x0E).

This command is useful while trying to exchange datas using 0x22 (REQ_SEND_MESSAGE), 0x24 (REQ_SEND_BROADCAST_RESPONSE) and 0x2A (REQ_SEND_BCST_MESSAGE) commands, since it gives Wavecard Radio Board availibility for next RS232 serial link exchange (see diagram,p.46).

5.2.3 - Use of the Relaying mode

The relaying mode is only available for point-to-point exchanges ('Frame Exchange' or 'Message' types).

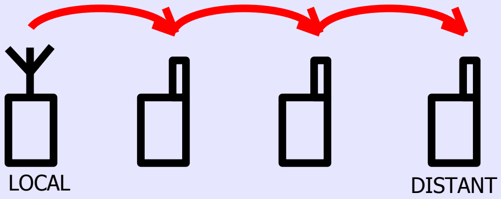
a) On frame transmission

To send a request in Relaying mode to a distant equipment, it is necessary to configure the list of the repeaters, via parameter RELAY_ROUTE. Then to send a request of the type REQ_SEND_FRAME (or REQ_SEND_MESSAGE) to the address of the recipient.

The radio frame is then relayed automatically through the equipments configured in parameter RELAY_ROUTE.

Attention, after sending a request to the recipient, the list of repeaters (RELAY_ROUTE) is automatically re-initialized. It will thus be necessary to reconfigure it to send another request in relaying mode.

***Example : Sending a** REQ_SEND_MESSAGE request in relaying mode*



***Remark : in the case of a** REQ_SEND_MESSAGE request, the recipient doesn't respond.*

b) On frame reception

Since the firmware version v2.00 (v4.00 for 500mW equipment), it is possible on frame reception in relaying mode, to make go up the relay route towards the host of the receiving module.

To preserve compatibility with the preceding versions, this functionality is activated, or deactivated by functional parameter RELAY_ROUTE_STATUS (0x06) of the receiving module (see chapter *5.2.1*)..

According to the value of this parameter, the host will receive one of the following frames :

RELAY_ROUTE_STATUS value	Type of frame transmitted to the host, on reception of a radio frame in relaying mode
0x00 : deactivated	RECEIVED_FRAME (CMD = 0x30)
0x01 : activated	RECEIVED_FRAME_RELAYED (CMD = 0x35)

The format of the types of frame received by the host, are described as follow.

- **Response received by the host, with RELAY_ROUTE_STATUS deactivated**

RECEIVED_FRAME					
HEADER	CMD	DATA		CRC	ETX
3 bytes	1 byte	6 bytes	variable	2 bytes	1 byte
0xFF ; 0x02 ; 0xXX	**0x30**	**Radio address from transmitter equipment**	**data from received frame the maximum size (N bytes) is defined below**		0x03

- **Response received by the host, with RELAY_ROUTE_STATUS activated**

RECEIVED_FRAME_RELAYED							
HEADER	CMD	DATA				CRC	ETX
3 bytes	1 byte	6 bytes	1 byte	variable	variable	2 bytes	1 byte
0xFF ; 0x02 ; 0xXX	**0x35**	**Radio address from transmitter equipment**	**Number of repeaters used**	**Radio addresses of the repeaters used**	**data from received frame the maximum size (N bytes) is defined below**		0x03

The field 'Radio addresses of the repeaters used' can have a size of 6, 12, or 18 bytes, according to the number of repeaters used.

Remark : *maximum size definition*

- Point to Point mode : ***Max*** *= 152 bytes of data*

- Relaying mode : ***Max*** *=* ***152*** *- (2 + 6 x Number of repeaters)*

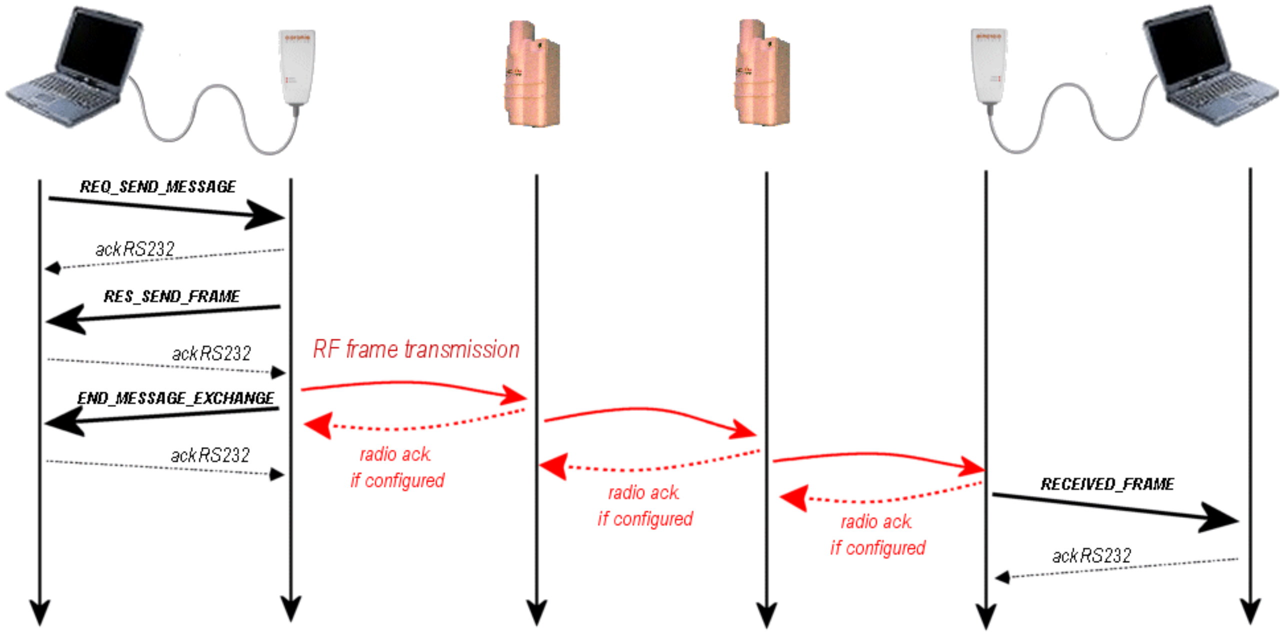
=> 1 repeater : 144 *bytes of data,*

=> 2 repeaters : 138 *bytes of data****,***

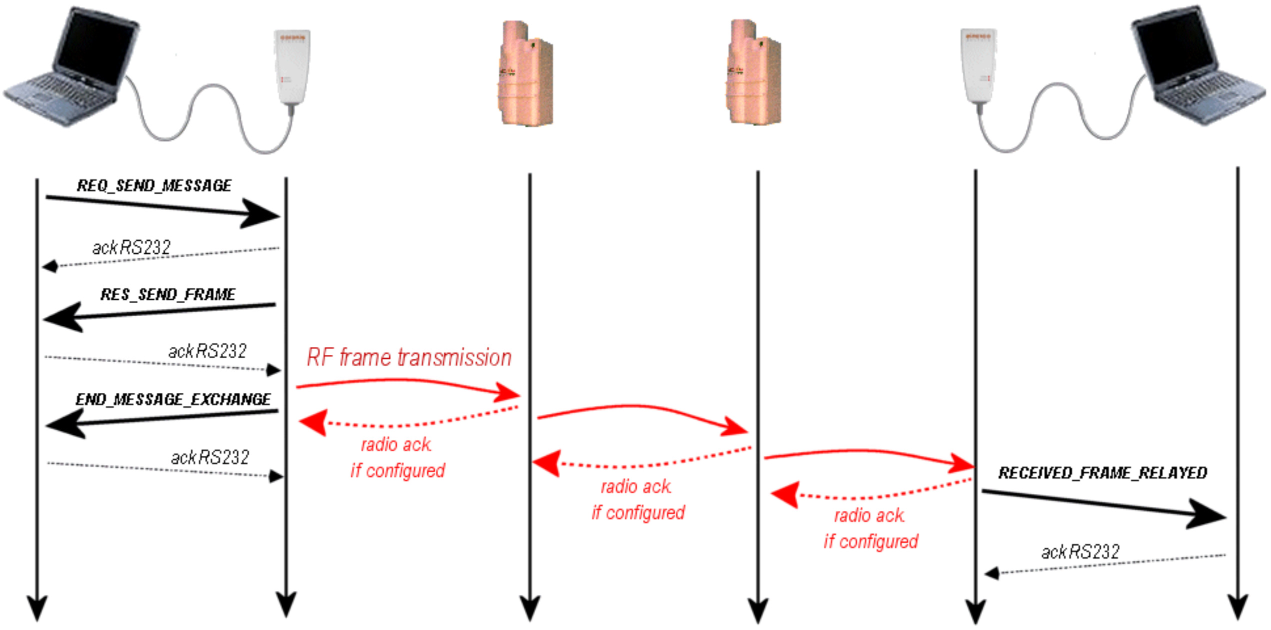
=> 3 repeaters : 132 *bytes of data.*

c) Diagram of the relaying mode

- With RELAY_ROUTE_STATUS parameter deactivated (= 0x00)



- With RELAY_ROUTE_STATUS parameter activated (= 0x01)



➢ Frame RECEPTION_ERROR format

With this command, the local WaveCard informs its host that a problem appeared at the time of the radio exchange.

This command is forwarded only on the serial link, between the wavecard and its host, it thus does not require an address of recipient.

Note: The error messages are activated only if parameter EXCHANGE_STATUS is positioned with 0x01, or 0x03.

- **In 'Point-to-Point' mode**

RECEPTION_ERROR					
HEADER	CMD	DATA		CRC	ETX
3 bytes	1 byte	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x06	**0x31**	**EXCHANGE_MODE** : = 0x01 : Point-to-Point mode	**ERROR_TYPE** : = 0x01 : Distant equipment RF acknowledge not received (useful if acknowledge mechanism is set) = 0x02 : Distant equipment RF response not received.		0x03

- **In 'relaying' mode**

RECEPTION_ERROR						
HEADER	**CMD**	**DATA**			**CRC**	**ETX**
3 bytes	1 byte	1 byte	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x06	**0x31**	**EXCHANGE_MODE** : = 0x02 : relaying mode	**0x02** Default value for relaying mode	**RELAY_COUNTER** : = 0x03 No response from the third repeater; = 0x02 No response from the second repeater; = 0x01 No response from the first repeater; = 0x00 No response from the final equipment.		0x03

Note: *In the MESSAGE mode, the error frame intervene only between the transmitter, and the first repeater. Even if the other repeaters return errors, the transmitting module does not await an answer, and proceeds to another action.*

In both cases, the procedure of sending an error frame depends on parameter RADIO_ACKNOWLEDGE:

- If RADIO_ACKNOWLEDGE is active, and the transmitter does not receive a radio acknowledgement, then the request is re-emitted three times, before sending the error frame.
- If RADIO_ACKNOWLEDGE is inactive, then the error frame is sent after time-out RADIO_USER_TIMEOUT.

5.3- 'Polling' Mode

This mode allows to address a request to a list of predefined distant equipment. The response is sent to the host, transmitter of the request, when all the distant equipments responded; or on timeout. Two types of exchanges in polling mode can be distinguished,

- **Not-selective Polling :** all the distant equipments, configured in POLLING_ROUTE table, are interrogated.
- **Selective Polling** : only a given group of distant equipments, configured in POLLING_ROUTE table, are interrogated.

5.3.1 - Configuration of the parameters relating to the 'Polling' mode

The parameters are accessible by commands REQ_READ_RADIO_PARAM, and REQ_WRITE_RADIO_PARAM (all the parameters are developed in appendix 3).

NUM	DESCRIPTION	VALUE	SIZE (in bytes)
0x03	**WAVECARD_POLLING_GROUP** : Byte containing the Polling Group of the Wavecard.	Byte 1 : Polling_Group by default, Polling_Group = 0x00	1
0x08	**POLLING_ROUTE** : Table containing the list of modules radio address to be addressed.	Byte 2 : number of equipments to interrogate IF Byte 2 != 0 Bytes 3 to 8 : radio address of the first module..., and so on.	1 à 241
0x09	**GROUP_NUMBER** : Byte containing the number of the group of radio equipment to address in radio polling mode.	Group number by default, GROUP_NUMBER = 0x00	1
0x0A	**POLLING_TIME** : delay between two consecutive emission in polling mode	Value in multiples of 100ms By default, POLLING_TIME = 0x0A	1

Example of parameter setting: Writing of the list of the distant equipments, addressed by the polling mode.

In our example, we have two distant pieces of equipment, whose addresses (on 6 bytes) are 0xAAAAAAAAAAAA; and 0xBBBBBBBBBBBB.

We launch a REQ_WRITE_RADIO_PARAM request, by positioning byte CMD with 0x40. Then, in the DATA field, we specify the number of the parameter to be modified, and its corresponding data, according to the following format.

DATA field	
1 byte	variable
Number of the parameter to modify	Parameter data

Thus,

REQ_WRITE_RADIO_PARAM					
Header	CMD	DATA		CRC	ETX
3 bytes	1 byte	1 byte	variable	2 bytes	1 byte
0xFF ; 0x02 ; 0x11	0x40	0x08	0x02 0xAAAAAAAAAAAA; 0xBBBBBBBBBBBB	0xXXXX	0x03

5.3.2 - Description of the commands, and their formats

CMD	NAME	DESCRIPTION
0x21	RES_SEND_FRAME	Response from the radio board to the frame emission (response to the request 0x20, 0x22, 0x24, 0x26, 0x28, 0x2A)
0x26	REQ_SEND_POLLING	Request to send a radio frame with the polling mode.
0x32	RECEIVED_FRAME_POLLING	Received radio frame following a REQ_SEND_POLLING request

The format of the types of frame received by the host, are described as follow.

➢ Request in 'Polling' mode

REQ_SEND_FRAME				
HEADER	CMD	DATA	CRC	ETX
3 bytes	1 byte	variable	2 bytes	1 byte
0xFF ; 0x02 ; 0xXX	**0x26**	**n bytes of data to transmit the maximum size is 152 bytes**		0x03

Remark : *in radio polling mode, it is not necessary to transmit the address of the modules to be interrogated, since they must be configured by the intermediary of the parameter POLLING_ROUTE.*

➢ Acknowledgement of the request

RES_SEND_FRAME				
HEADER	CMD	DATA	CRC	ETX
3 bytes	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x05	**0x21**	**Status 0x00 : transmission OK 0x01 : transmission error**		0x03

➢ Réponse à la requête de type 'Polling'

RECEIVED_FRAME_POLLING						
HEADER	CMD	DATA			CRC	ETX
3 bytes	1 byte	1 byte	6 bytes	variable	2 bytes	1 byte
0xFF ; 0x02 ; 0xXX	**0x32**	STATUT_RECEPTION : = 0 : response OK = 1 : no response from the interrogated equipment	**Radio address of the interrogated equipment**	**data from received frame the maximum size is 152 bytes**		0x03

5.3.3 - Difference between selective, and not-selective Polling mode

Generally, the use of the polling mode (selective, or not-selective) requires the configuration of a table containing the addresses of the modules to be interrogated (POLLING_ROUTE).

When using the selective polling mode, it is necessary to configure on the transmitter side, the group number of modules to be interrogated.

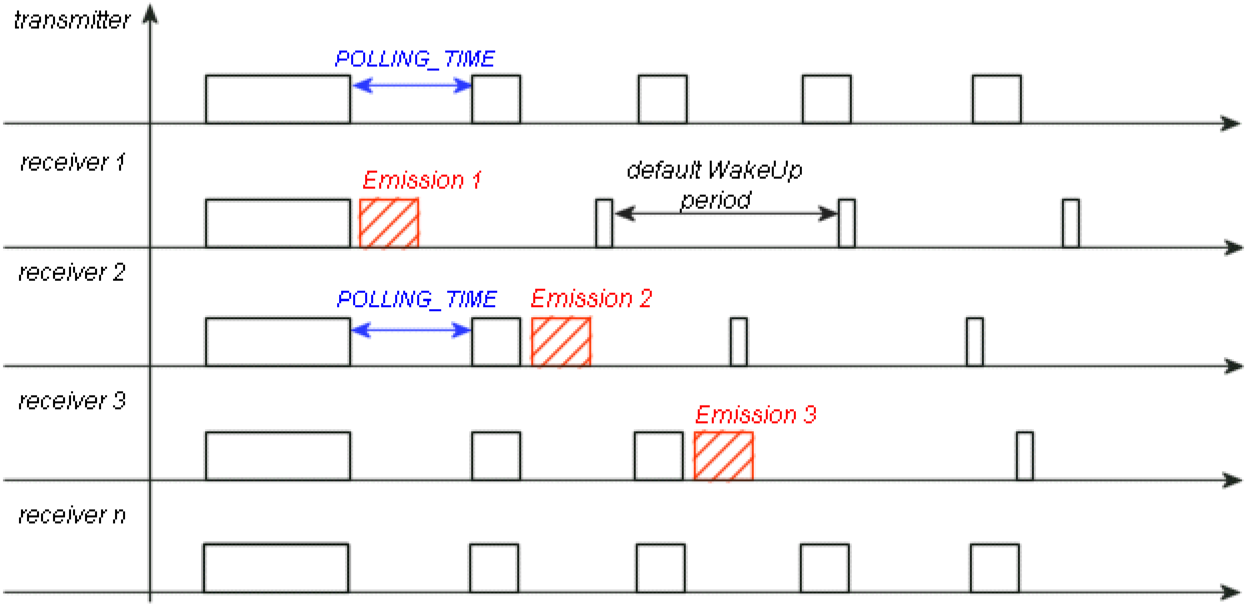
In this way, when sending a request in selective polling mode, only the modules included in the table, with the same group number as configured in the transmitter, will be interrogated.

Contrary to the not-selective polling mode, where all the modules included in the list will be interrogated.

➢ Principle of the not-selective 'polling' mode

When using a not-selective polling, all the modules within radio range are synchronized on the transmitter (short WakeUp, every POLLING_TIME), but only the interrogated modules respond.

- After sending the response, the interrogated modules are re-initialized with their default Wake-Up period.
- The not-interrogated modules are re-initialized with their default WakeUp period, when the transmitter stops its interrogation in Polling mode.



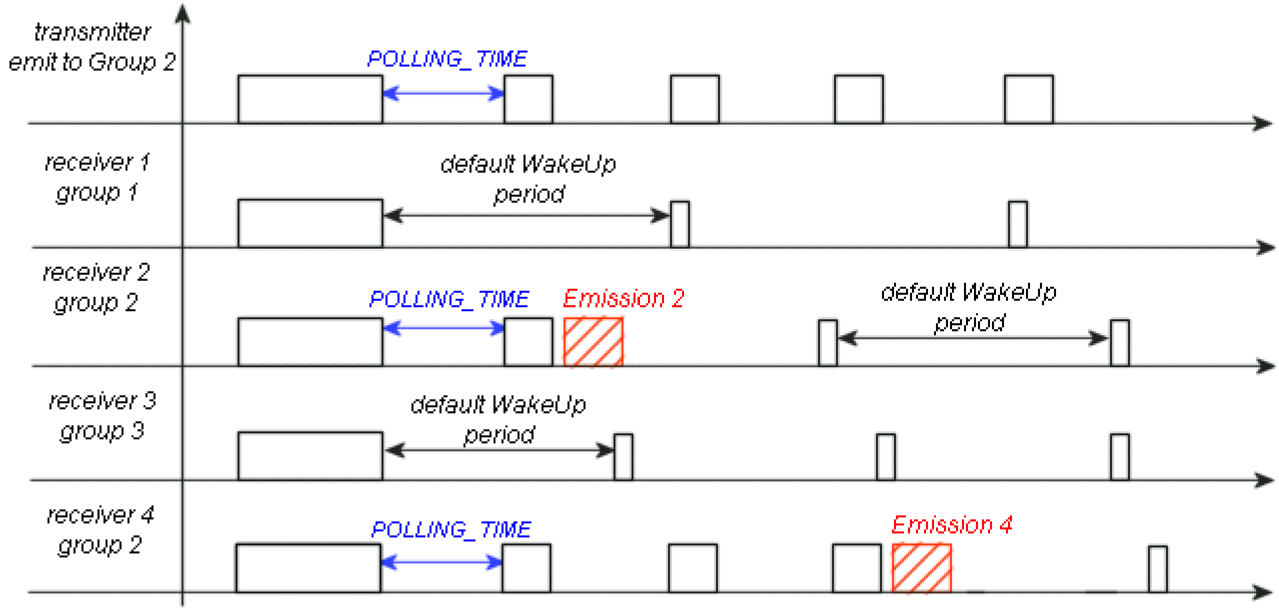
The procedure to initiate a request in not-selective polling mode, is as follows:

- Configure POLLING_ROUTE table, with all the addresses of modules to be interrogated
  Launch a request of internal parameter modification
- Launch a request in 'Polling' mode

➢ Principle of the selective Polling mode

Only the modules which belong to the interrogated group are synchronized on the transmitter. A module will respond to a selective polling request only on the following conditions :

- it belongs to the interrogated group,
- its radio address is contained in the list of the interrogated modules (POLLING_ROUTE).



Synchronization allows a faster response of the modules (Since it don't use Long WakeUp) and optimize consumption.

Attention, when interrogating a WaveTherm module in Polling mode, the reading time of a temperature can be much longer than the default POLLING_TIME value. In this case, this parameter shall be increased consequently.

- DALLAS Probe: reading in 800ms by probe

- Probe PT100, PT1000: the reading time depends on the index of precision. (max. 3 seconds)

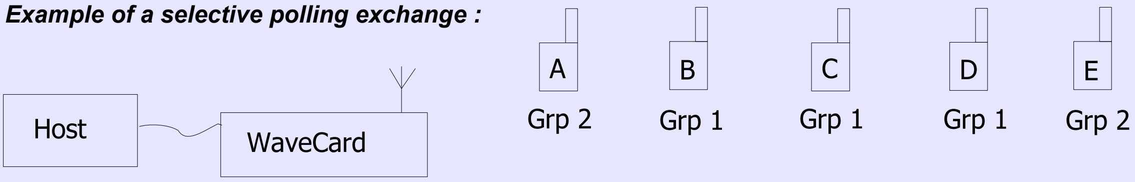
The procedure to be followed, to initiate a request in selective polling mode, is :

- To configure table POLLING_ROUTE, with all the addresses of modules to be interrogated ;
  by transmitting a request of modification of internal parameter
- To configure the group number of each distant equipments contained in the table (POLLING_ROUTE) ;
  by transmitting a request of modification of internal parameter
- To choose the group to interrogate, and transmit the polling request.

When a WaveCard (or WavePort) is the receiver of a selective Polling request, the user must specify to which group WaveCard belongs. For that, it is necessary to configure parameter WAVECARD_POLLING_GROUP, with the number of selected group.

Attention not to confuse this parameter with the parameter GROUP_NUMBER which gives the number of group to be reached, when WaveCard is transmitting a selective Polling request.

Example of a selective polling exchange :



WaveCard is configured like described below,

POLLING_ROUTE
Equipment A address
Equipment B address
Equipment C address
Equipment D address
Equipment E address

GROUP_NUMBER
0x01

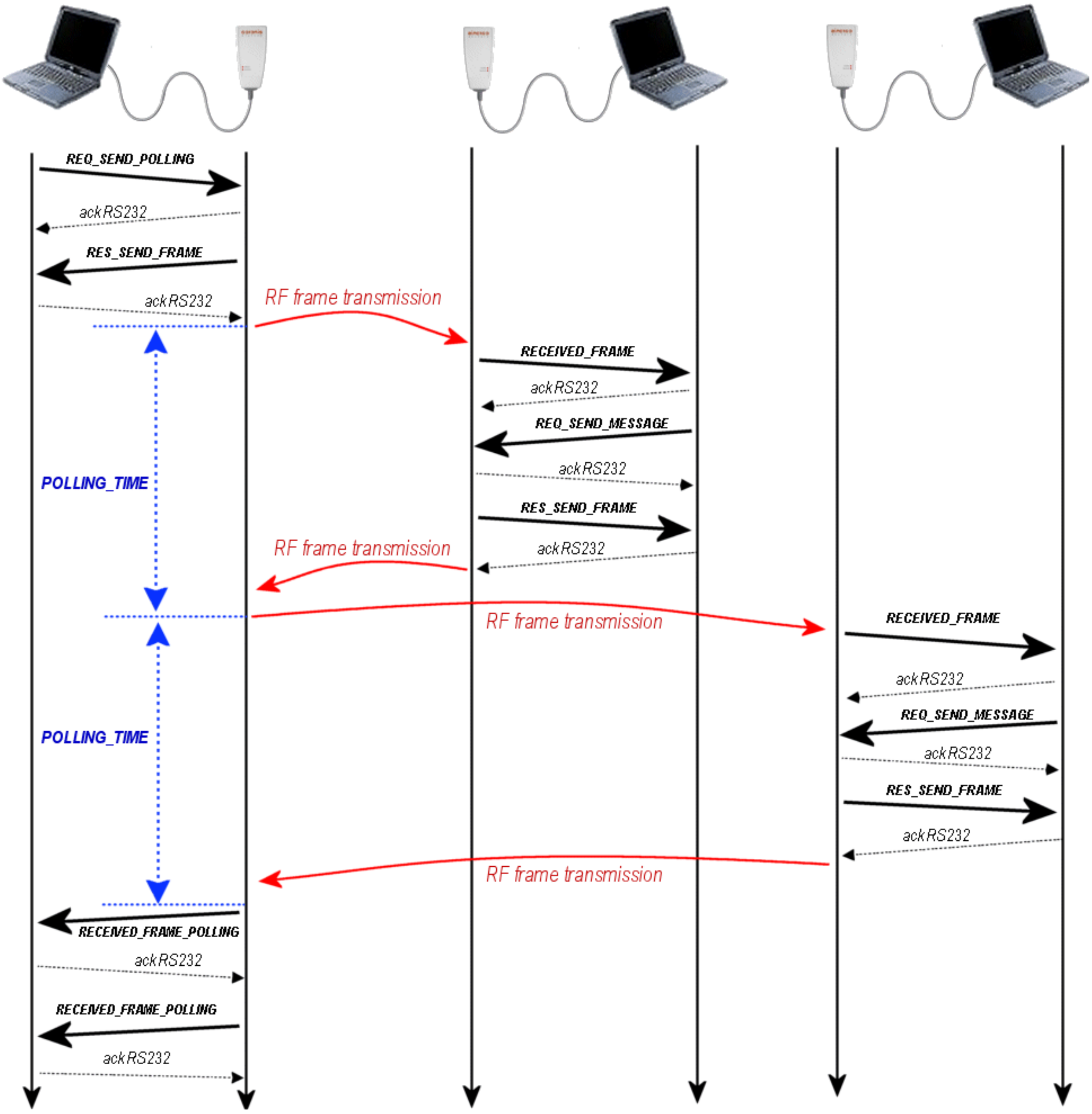
After transmitting the REQ_SEND_POLLING request, the distant equipments react in the following way:

- ***Equipment A : responds to the request****.* *PARTICULAR CASE, this module is the first of table POLLING_ROUTE, and the first polling frame is sent in point-to-point mode;*

- ***Equipment B : responds to the request*** ***(belongs to the interrogated group)***
- ***Equipment C : responds to the request*** ***(belongs to the interrogated group)***
- ***Equipment D : responds to the request*** ***(belongs to the interrogated group)***
- ***Equipment E : no response*** *(doesn't belong to the interrogated group).*

5.3.4 - Diagram of an exchange in polling mode

the following example describes the typical case where the distant WaveCards communicate with their respective host. Indeed, when sending a GET_TYPE request (see chapter XXX) in polling mode; distant WaveCards respond without preliminary dialogue with their host.



POLLING_TIME : after transmitting the radio frame, a timeout is started (configured by POLLING_TIME parameter); and if the equipment doesn't respond before the end of the timeout (1 second by default), then the transmitter send the same radio frame to the next distant equipment. However, if the previous distant equipment responded after this timeout; its response frame would be lost.

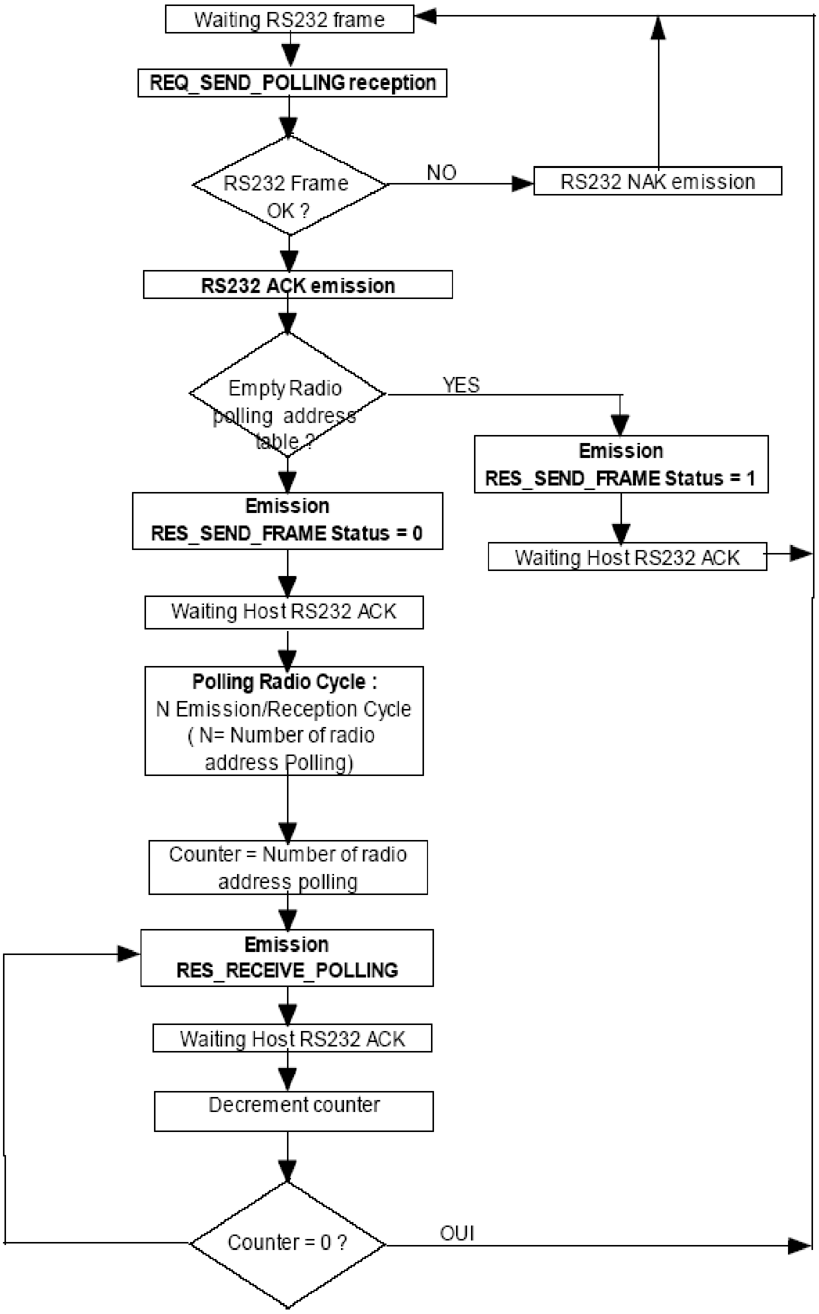
Parameter POLLING_TIME can be modified via the commands of parameter setting.

> *Remark: even if the distant equipment responds before the POLLING_TIME timeout, the next request is sent only after the timeout, for synchronization considerations.*

The low level commands are necessary to recover the RECEIVED_FRAME_POLLING responses.

Indeed, an index is incremented with each reception of a polling response. And when the WaveCard, instigator of the polling exchange does not await new responses anymore, it sends to its host a first RECEIVED_FRAME_POLLING command ;and will await a low level acknowledgement to decrease its index, and to send next RECEIVED_FRAME_POLLING command.

The following diagram describes the operations carried out by the WaveCard following the reception of a REQ_SEND_POLLING command:


Waiting RS232 frame
REQ_SEND_POLLING reception
RS232 Frame OK ?
NO
RS232 NAK emission
RS232 ACK emission
Empty Radio polling address table ?
YES
Emission RES_SEND_FRAME Status = 1
Waiting Host RS232 ACK
Emission RES_SEND_FRAME Status = 0
Waiting Host RS232 ACK
Polling Radio Cycle : N Emission/Reception Cycle (N= Number of radio address Polling)
Counter = Number of radio address polling
Emission RES_RECEIVE_POLLING
Waiting Host RS232 ACK
Decrement counter
Counter = 0 ?
OUI

Remark : Whatever values configured in the RADIO_ACKNOWLEDGE parameter, it is not used during an exchange in polling mode.

5.4- 'Broadcast' mode

This mode allows to address a request to all the equipments in radio range of the transmitter. Thus, it is not necessary to specify the address of the distant equipment to reach.

Depending on the command used, the request can be sent with, or without awaiting for a response (REQ_SEND_BROADCAST, or REQ_SEND_BROADCAST_MESSAGE commands).

In all cases, two types of exchanges in broacast mode can be distinguished,

- **Not-selective Broadcast :** all the distant equipments in radio range of the transmitter, are interrogated.
- **Selective Broadcast** : only a given group of distant equipments in radio range of the transmitter, are interrogated.

5.4.1 - Configuration of the parameters relating to the 'Broadcast' mode

The parameters are accessible by commands REQ_READ_RADIO_PARAM, and REQ_WRITE_RADIO_PARAM (all the parameters are developed in appendix 3).

NUM	DESCRIPTION	VALUE	SIZE (in bytes)
0x0E	**EXCHANGE_STATUS** : parameter relative to the error or status frame management activation (see chapter Erreur : source de la référence non trouvée, Erreur : source de la référence non trouvée, et 5.4).	0 : status and error frame deactivated, 1 : error frame activated, 2 : status frame activated, 3 : both status and error frames activated, by default, RECEPT_ERROR_STATUS = 0x00.	1
0x17	BCST_RECEPTION_TIMEOUT : timeout used for the reception of CSMA frame consecutively to REQ_SEND_BROADCAST Command emission (available from firmware V2.01 version)	Valeur in multiples of100ms. Default = 0x3C (6 seconds)	1

5.4.2 - 'BroadCast' mode without waiting for a response

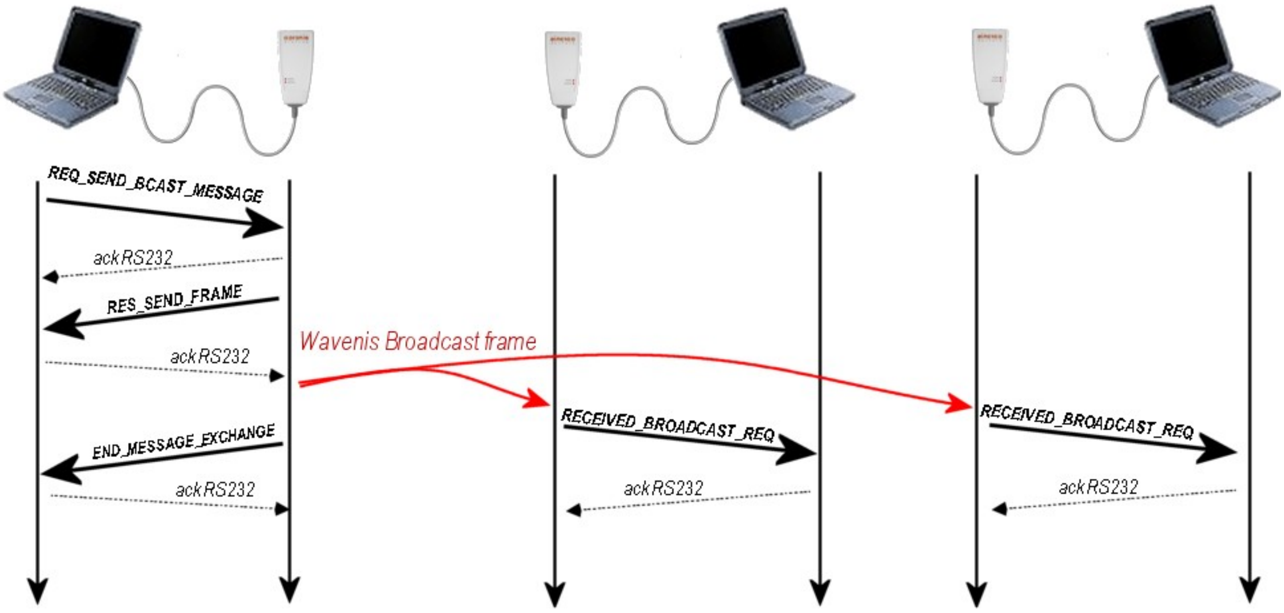
This mode allows to address a request to all the equipments in radio range of the transmitter, without waiting for a response. Depending to the setting of the EXCHANGE_STATUS parameter, the Wavecard will be available for next RS232 serial link exchange :

- After transmitting the broadcast request,
- On reception of the END_MESSAGE_EXCHANGE command.

a) Description of the commands

CMD	NAME	DESCRIPTION
0x21	RES_SEND_FRAME	Response from the radio board to the frame emission (response to the request 0x20, 0x22,0x24, 0x26, 0x28, 0x2A)
0x2A	REQ_SEND_BROADCAST_MESSAGE	Request to send a radio frame in broadcast mode without waiting for radio response.
0x37	END_MESSAGE_EXCHANGE	Frame indicating end of message exchange.This frame is returned only after **0x22 & 0x24 & 0x2A** Request command. Reception of this frame is conditioned by the parameter EXCHANGE_STATUS value.
0x38	RECEIVED_BROADCAST_FRAME	Received a radio frame transmitted in a broadcast mode

b) Example of operations during a broadcast exchange, without waiting for responses



Reception of the END_MESSAGE_EXCHANGE command depends on the activation of the EXCHANGE_STATUS parameter (0x0E). This command allows the equipment host to know exactly the moment from which WaveCard is available for communication RS232.

5.4.3 - 'BroadCast' mode with waiting for responses

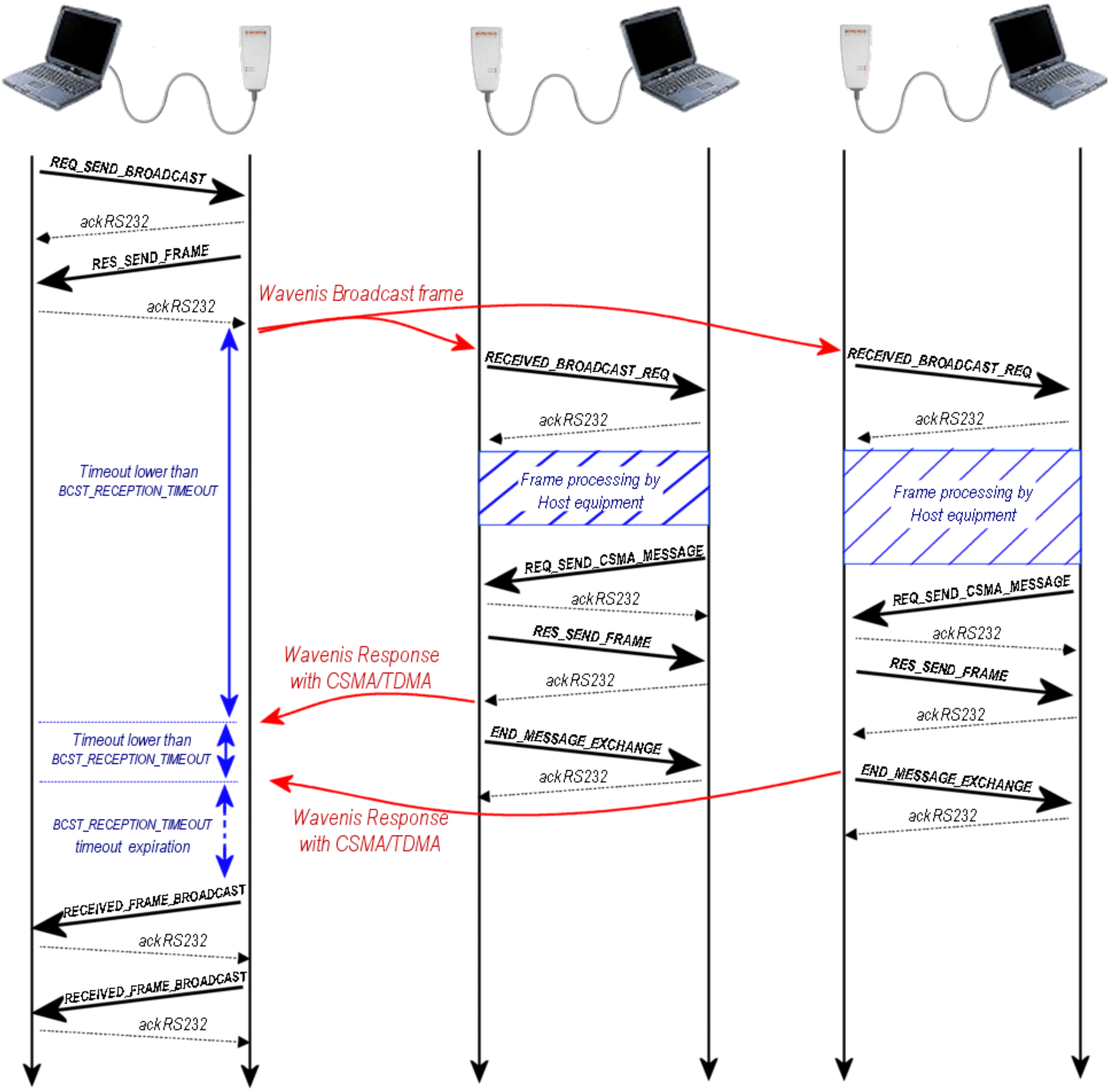
After transmitting a broadcast request, the WaveCard begins a reception phase during which it will memorize all the responses. This phase stops on a timeout configured by BCST_RECEPTION_TIMEOUT parameter (0x17). With each reception of response frame, the timeout is re-initialized.

After timeout, the WaveCard send the responses towards its host, via the serial link connection, frame after frame.

a) Description of the commands

CMD	NAME	DESCRIPTION
0x21	RES_SEND_FRAME	Response from the radio board to the frame emission (response to the request 0x20, 0x22,0x24, 0x26, 0x28, 0x2A)
0x24	REQ_SEND_BROADCAST_RESPONSE	Request to send a radio frame in response to a broadcast frame
0x28	REQ_SEND_BROADCAST	Request to send a radio frame in broadcast mode.
0x34	RECEIVED_BROADCAST_RESPONSE	Received radio frame following a REQ_SEND_BROADCAST request
0x37	END_MESSAGE_EXCHANGE	Frame indicating end of message exchange.This frame is returned only after **0x22 & 0x24 & 0x2A** Request command. Reception of this frame is conditioned by the parameter EXCHANGE_STATUS value.
0x38	RECEIVED_BROADCAST_FRAME	Received a radio frame transmitted in a broadcast mode

b) Example of operations during a broadcast exchange, with waiting for responses



Reception of the END_MESSAGE_EXCHANGE command depends on the activation of the EXCHANGE_STATUS parameter (0x0E). This command allows the equipment host to know exactly the moment from which WaveCard is available for communication RS232.

5.4.4 - Format of the commands – from the request transmitter side

- **Broadcast requests – 0x28 ou 0x2A (REQ_SEND_BROADCAST or REQ_SEND_BROADCAST_MESSAGE)**

REQ_SEND_BROADCAST ou REQ_SEND_BROADCAST_MESSAGE					
HEADER	CMD	DATA		CRC	ETX
3 bytes	1 byte	6 bytes	variable	2 bytes	1 byte
0xFF ; 0x02 ; 0xXX	**0x28**	**Group number to interrogate in broadcast mode**	**n bytes of data to transmit the maximum size is 152 bytes**		0x03

- **Group number to interrogate** : Only the most significant byte (MSByte) really corresponds to the number of group, the 5 other bytes are not significant.

> ***Remark :*** *if the number of group is 0xFF 0xXX 0xXX 0xXX 0xXX 0xXX, all the modules receiving the broadcast frame are authorized to transmit a response.*

- **Acknowledgement of the request – 0x21 (RES_SEND_FRAME)**

RES_SEND_FRAME				
HEADER	CMD	DATA	CRC	ETX
3 bytes	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0x05	**0x21**	**Status** **0x00 : transmission OK** **0x01 : transmission error**		0x03

- **Response to the broadcast request – 0x34 (RECEIVED_BROADCAST_RESPONSE)**

RECEIVED_BROADCAST_RESPONSE								
HEADER	CMD	DATA					CRC	ETX
3 bytes	1 byte	1 byte	1 byte	1 byte	6 bytes	variable	2 bytes	1 byte
0xFF ; 0x02 ; 0xXX	**0x34**	**Status**	**Total number of frames received**	**Frames Index**	**Radio address of the transmitter of the response**	**Received data 152 bytes max.**		0x03

- **Status :** = 0 : reception Ok
  = 1 : indicate that the number of received responses is higher than 255. in this case, only the first 255 responses will be sent to the host.

- **Frames index :** This index is used by the wavecard to know how many responses must be sent to the host. this index is decreased on low level acknowledgement, when the wavecard send a response to its host.

  The host knows that all the responses was sent to him, when the frames index indicates 1.

  This index is also used to check that no frame was lost by ensuring that this value is well decreased with each received frame.

5.4.5 - Format of the commands – from the request receiver side

- **Reception of a broadcast request – 0x38 (RECEIVED_BROADCAST_FRAME)**

RECEIVED_BROADCAST_FRAME					
HEADER	CMD	DATA		CRC	ETX
3 bytes	1 byte	6 bytes	variable	2 bytes	1 byte
0xFF ; 0x02 ; 0xXX	**0x38**	**Radio address of the transmitter of the request**	**n bytes of data the maximum size is 152 bytes**		0x03

- **Transmission of the response to a broadcast request – 0x24 (REQ_SEND_BROADCAST_RESPONSE)**

REQ_SEND_BROADCAST_RESPONSE					
HEADER	CMD	DATA		CRC	ETX
3 bytes	1 byte	6 bytes	variable	2 bytes	1 byte
0xFF ; 0x02 ; 0xXX	**0x24**	**Radio address of the transmitter of the request**	**n bytes of data to transmit the maximum size is 152 bytes**		0x03

Remark : This command can only be used after the reception of a broadcast frame (RECEIVED_BROADCAST_FRAME = 0x38). So, destination radio address of this message could only be this from the emitter of the Broadcast frame.

Use of this command in any other circumpstances could make the Wavecard not available during a few seconds.

- **Status Message – 0x37 (END_MESSAGE_EXCHANGE)**

END_MESSAGE_EXCHANGE				
HEADER	CMD	DATA	CRC	ETX
3 bytes	1 byte	1 byte	2 bytes	1 byte
0xFF ; 0x02 ; 0xXX	**0x37**	0x00		0x03

Attention, use of this command depends on the activation of status message, in parameter EXCHANGE_STATUS (0x0E).

5.4.6 - Use of the selective, or not-selective broadcast mode

To initiate a Broadcast request, either in selective or not-selective mode, there is no particular procedure. The user just has to ensure that the distant modules have their GROUP_NUMBER parameter configured.

Then, the user has to send a broadcast request (with, or without waiting for responses), by configuring 'group number' to adjust selectivity.

- Group number = 0xFF 0xXX 0xXX 0xXX 0xXX 0xXX not-selective mode
- Group number = 0x01 0xXX 0xXX 0xXX 0xXX 0xXX selective mode

In this last case, all the equipments within radio range, having their group number configured with 0x01, will receive the broadcast command.

5.5- ’Multi frames' Mode

Multi frame mode allows multi frame exchange between the Wavecard/Waveport (considered like the master of the exchange) and one of the telemetry equipments of the Coronis Systems product family (WaveTherm, WaveFlow, WaveSens, ...).

Le mode multitrames a été developpé pour permettre le dialogue entre une WaveCard/ WavePort et un module CORONIS de télémétrie. Il n'est accessible dans la version du firmware actuelle, qu'aux utilisateurs pilotant un réseau de modules de télémétrie CORONIS, depuis une WaveCard/ WavePort.

> ***Restrictions relative to the use of multi frame mode:*** *Current version of Wavecard does not allow multi frame mode between two Wavecard/Waveport equipments.*
> *In addition, the firmware version does not allow multi frame mode usage through repeaters.*

5.5.1 - Principle

Wavecard equipment is able to manage reception of successive frames coming from an distant equipment.

Data are first stored in internal memory and restored to host equipment with serial link when RF reception is ended.

The multi frame mechanism is initiate by distant equipment , depending on the quantity of data to transmit, following a point to point request from Wavecard.

5.5.2 - Format of the received frames

➢ **Reception of a 'multi frame' – 0x36**

RECEIVED_MULTIFRAME								
HEADER	**CMD**	**DATA**					**CRC**	**ETX**
3 bytes	1 byte	1 byte	1 byte	1 byte	6 bytes	variable	2 bytes	1 byte
0xFF ; 0x02 ; 0xXX	**0x36**	**Status**	**Total number of received frames**	**Frames index**	**Radio address of the transmitter of the response**	**Received data 152 bytes max.**		0x03

- **Status :** = 0 : reception Ok
  = 1 : indicate that the number of received responses is higher than 255. in this case, only the first 255 responses will be sent to the host.

- **Frames index :** This index is used by the wavecard to know how many responses must be sent to the host. this index is decreased on low level acknowledgement, when the wavecard send a response to its host.

  The host knows that all the responses was sent to him, when the frames index indicates 1.

  This index is also used to check that no frame was lost by ensuring that this value is well decreased with each received frame.

6. ANTENNA

The EvoModule1 has been certified with a rated power maximum off 0,490 Watts within the US ISM frequency band (902MHz to 928 MHz).

Therefore the antenna to be used has to be compliant with the following technical characteristics.

6.1- Antenna

→ Antenna Type : QuaterWave, HalfWave and Dipole antenna type are usable

→ Maximum antenna Gain : 6 dBd or 8.15 dBi

→ frequency range : 902 – 928 MHz (Nevertheless MultiBand antenna type are usable)

→ Preferred Tuned frequency : 915 MHz

→ Min.Power : 1Watt or 30 dBm

as an example please find down below the description of a LAIRD Antenna (FG9026)

→ frequency range : 902 – 928 MHz

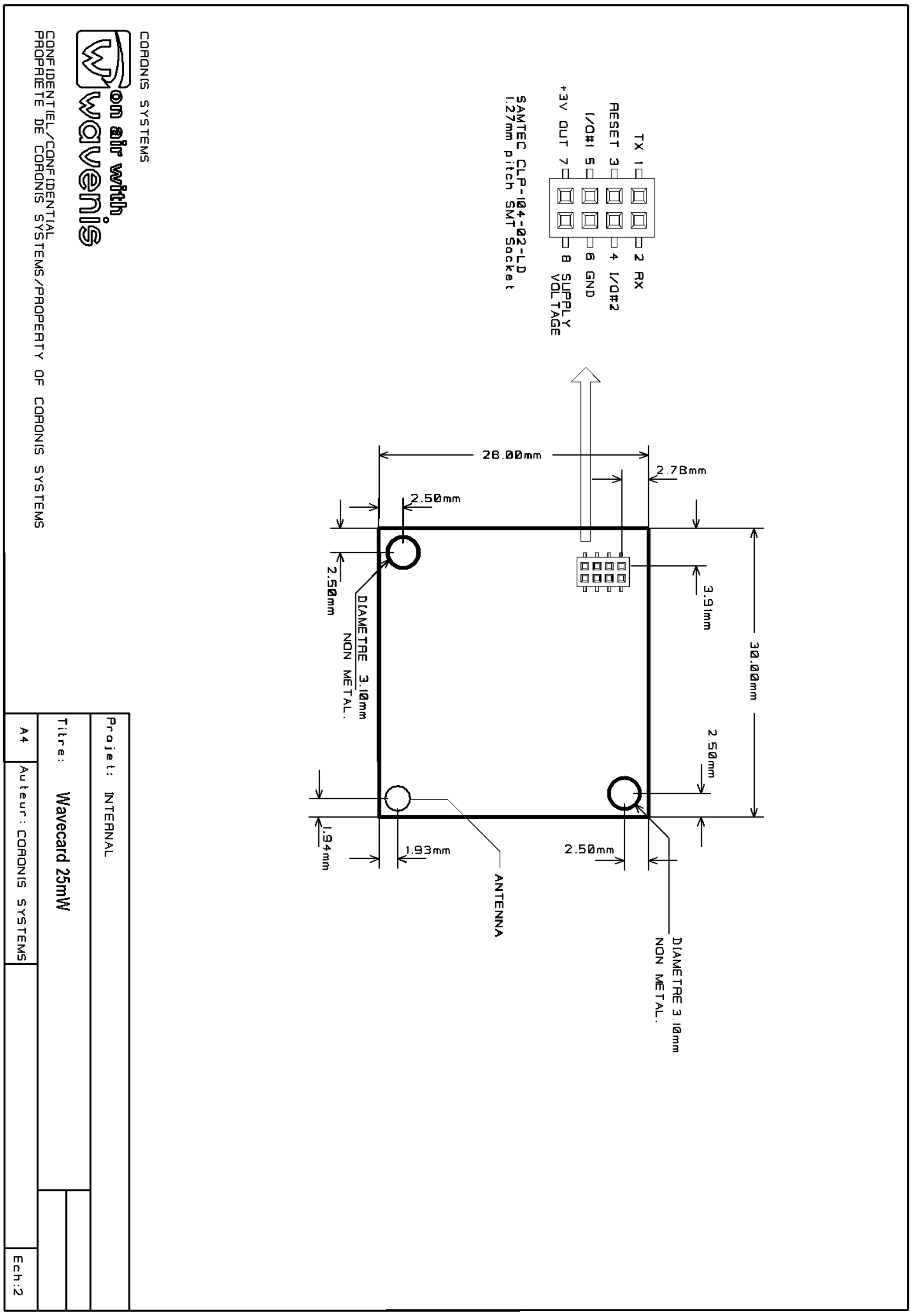
→ tuned frequency : 915 MHz

→ Gain : 6 dBd or 8.15 dBi

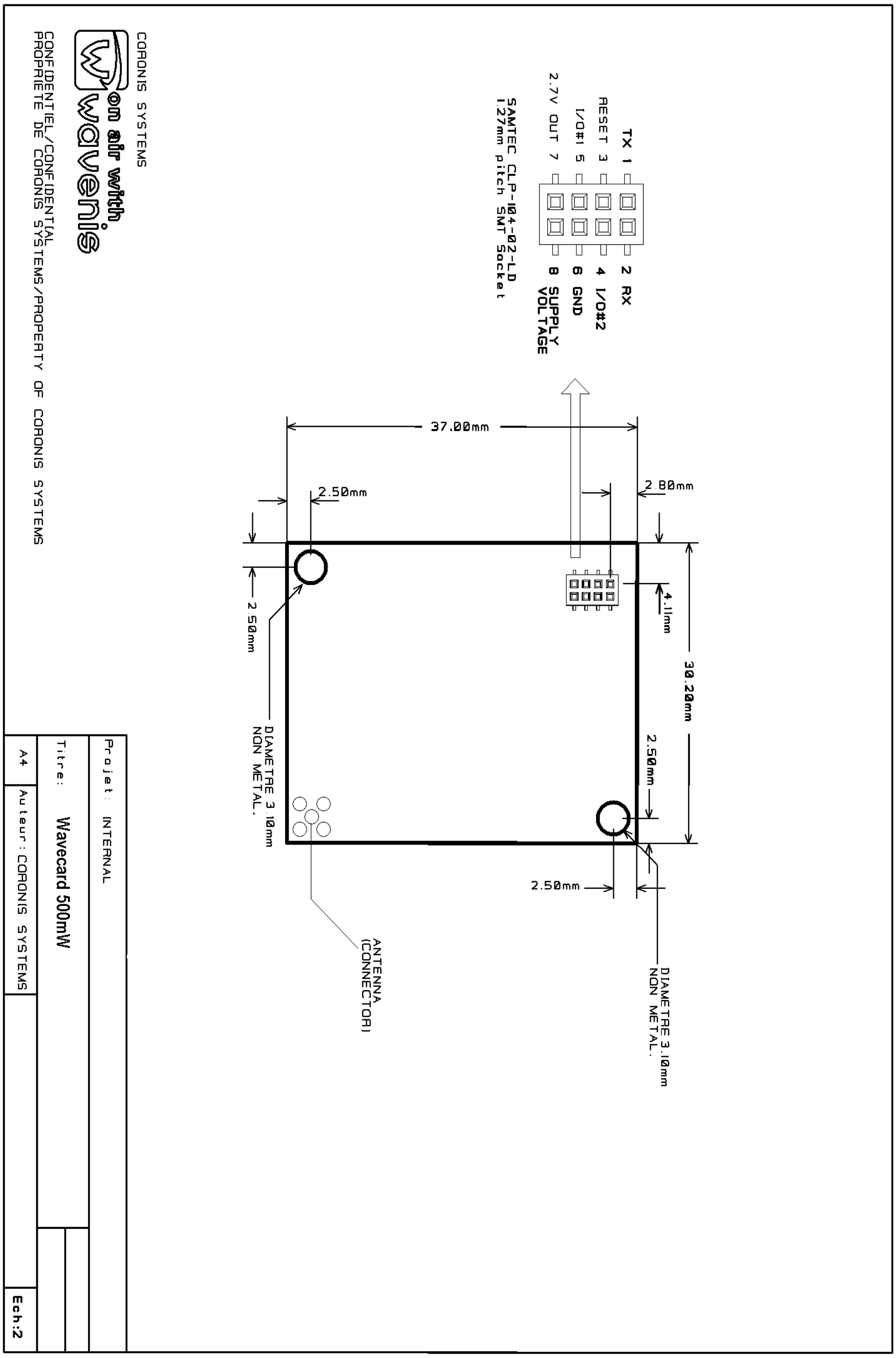
→ Min Power : 1 Watt or 30 dBm

APPENDIX 1 : Mechanical description of the WAVECARD

➢ WaveCard - 25mW



➢ WaveCard - 500mW



APPENDIX 2 : Electric interface of the WAVECARD

WaveCard - 25mW

PIN #	PIN NAME	DESCRIPTION	INPUT / OUTPUT
1	*TX*	TX RS232 signal	OUTPUT
2	*RX*	RX RS232 signal	INPUT
3	*RESET*	RESET input (active to high level)	INPUT
4	*OUT2*	Not used	OUTPUT
5	*OUT1*	output active (level 1) when reception is on	OUTPUT
6	*GND*	ground	OUTPUT
7	*+3V OUT*	3V regulated output voltage (10mA available)	OUTPUT
8	*SUPPLY VOLTAGE*	input supply voltage (4V to 5.5V) minimum current 45mA	INPUT

WaveCard - 500mW

PIN #	PIN NAME	DESCRIPTION	INPUT / OUTPUT
1	*TX*	TX RS232 signal (0 ;+2,7Vmax)	OUTPUT
2	*RX*	RX RS232 signal (0 ;+2,7Vmax)	INPUT
3	*RESET*	RESET input (active to high level)	INPUT
4	*OUT2*	Not used	OUTPUT
5	*OUT1*	output active (high level) when periodic reception is on	OUTPUT
6	*GND*	ground	OUTPUT
7	*+2,7V OUT*	2,7V regulated output voltage (10mA available)	OUTPUT
8	*SUPPLY VOLTAGE*	input supply voltage [3V à 4,3V] • 700mA minimum current peak	INPUT

APPENDIX 3 : List of the functional parameters

Parameter number	Description	Value	Size (bytes)
0x00	**AWAKENING_PERIOD :** polling period of RF medium radio, in multiples of 100ms	Period in multiples of 100ms (by default, 0x0A for one second) 0 = quasi-permanent reception (every 20ms)	1
0x01	**WAKEUP_TYPE :** Wake Up type used during a frame emission	0 : long Wake Up (default setting) 1 : short Wake Up = 50 ms	1
0x02	**WAKEUP_LENGTH : duration of the Wake up when long wake up is set up.** This value must be higher than the polling period of RF medium radio. Value in multiples of 1ms, defined LSB first	Default value : 1100 ms min value = 20 ms (0x1400) max value = 10 sec. (0x1027)	2
0x03	**WAVECARD_POLLING_GROUP** : Byte containing the Polling Group of the Wavecard.	Byte 1 : Polling_Group by default, Polling_Group = 0x00	1
0x04	**RADIO_ACKNOWLEDGE :** indicates if the radio frames must be acknowledged by the receiver.	0 : no acknowledge (default value) 1 : acknowledge used	1
0x05	**RADIO_ADDRESS : radio board address**	This Value is issue from the manufacturing. In Reading only	6
0x06	**RELAY_ROUTE_STATUS** : Parameter relative to Relay route transmission in each relayed frame received.	0x00 : Relay route transmisson deactivated 0x01 : Relay route transmission activated by default, Relay route transmisson deactivated	1
0x07	**RELAY_ROUTE : Table containing the radio addresses for successive repeaters to use to reach the final equipment.**	BYTE 1 : number of repeaters in the route Maximum repeater number = 3 If BYTE 1 != 0 BYTES 2 à 7 : First repeater radio address …, and so on.	1 à 19
0x08	**POLLING_ROUTE** : Table containing the list of modules radio address to be addressed.	BYTE 2 : number of equipments to interrogate IF BYTE 2 != 0 BYTES 3 to 8 : radio address of the first module..., and so on.	1 à 241
0x09	**GROUP_NUMBER** : Byte containing the number of the group of radio equipment to address in radio polling mode.	Group number by default, GROUP_NUMBER = 0x00	1
0x0A	**POLLING_TIME** : delay between two consecutive emission in polling mode	Value in multiples of 100ms By default, POLLING_TIME = 0x0A	1
0x0C	**RADIO_USER_TIMEOUT** : time-out used for the reception of a response frame	Value in multiples of 100ms default value = 0x14 (2 seconds)	1
0x0E	**EXCHANGE_STATUS** : parameter relative to the error or status frame management activation.	0 : status and error frame deactivated, 1 : error frame activated, 2 : status frame activated, 3 : both status and error frames activated, by default, RECEPT_ERROR_STATUS = 0x00.	1
0x10	**SWITCH_MODE_STATUS** : automatic selection of Radio physical mode used to address an equipment depending on radio address	0 : automatic selection deactivated 1 : automatic selection activated Default value, SWITCH_MODE_STATUS = 0x00	1
0x16	**WAVECARD_MULTICAST_GROUP** : Byte containing the Multicast Group of the Wavecard (available from V2.00 version).	By default, no group selected = 0xFF	1
0x17	BCST_RECEPTION_TIMEOUT : timeout used for the reception of CSMA frame consecutively to REQ_SEND_BROADCAST Command emission (available from firmware V2.01 version)	Valeur in multiples of100ms. Default = 0x3C (6 seconds)	1

APPENDIX 4 : List of the commands of parameters setting

CMD	Name	Description
0x40	REQ_WRITE_RADIO_PARAM	Request to update the radio parameters
0x41	RES_WRITE_RADIO_PARAM	Response from the radio board to the radio parameters update
0x42	REQ_CHANGE_UART_BDRATE	Request to update serial link Baudrate
0x43	RES_CHANGE_UART_BAUDRATE	Response from the radio board to the serial link baudrate update. Serial Link Baudrate is updated once the exchange is ended
0x44	REQ_CHANGE_TX_POWER(1)	Request to update radio board emission power
0x45	RES_CHANGE_TX_POWER(1)	Response from the radio board to the emission power update
0x46	REQ_WRITE_AUTOCORR_STATE	Request to update WAVENIS RF ASIC RSSI Threshold autocorrection state
0x47	RES_WRITE_AUTOCORR_STATE	Response from the radio board to the WAVENIS RF ASIC autocorrection state update
0x50	REQ_READ_RADIO_PARAM	Request to read the radio parameters.
0x51	RES_READ_RADIO_PARAM	Response from the radio board to a parameters reading.
0x54	REQ_READ_TX_POWER	Request to read radio board emission power
0x55	RES_READ_TX_POWER	Response from the radio board to the emission power reading
0x5A	REQ_READ_AUTOCORR_STATE	Request to read WAVENIS RF ASIC RSSI Threshold autocorrection state
0x5B	RES_READ_AUTOCORR_STATE	Response from the radio board to the WAVENIS RF ASIC autocorrection state reading.
0x60	REQ_SELECT_CHANNEL	Request to select the radio operating channel when FHSS is deselected
0x61	RES_SELECT_CHANNEL	Response to the channel selection request
0x62	REQ_READ_CHANNEL	Request to read the radio operating channel when FHSS is deselected
0x63	RES_READ_CHANNEL	Response to the read channel request
0x64	REQ_SELECT_PHYCONFIG	Request to select the RF medium physical mode
0x65	RES_SELECT_PHYCONFIG	Response to the physical mode selection request
0x66	REQ_READ_PHYCONFIG	Request to read the RF medium physical mode
0x67	RES_READ_PHYCONFIG	Response to the physical mode reading request
0x68	REQ_READ_REMOTE_RSSI	request to read RSSI level from remote equipment
0x69	RES_READ_REMOTE_RSSI	Response to the read remote RSSI level request
0x6A	REQ_READ_LOCAL_RSSI	Request to read the Wavecard RSSI level on an exchange with a distant equipment
0x6B	RES_READ_LOCAL_RSSI	Response to the read local RSSI level request
0xA0	REQ_FIRMWARE_VERSION	Request to read the radio board firmware version.
0xA1	RES_FIRMWARE_VERSION	Response from the radio board to the firmware version reading.
0xB0	MODE_TEST	Put the Wavecard in a selected test mode

(1) : These commands are accessible only on 25mW Wavecard radio board.

APPENDICE 5 : List of the commands of data transmission

CMD	NAME	DESCRIPTION
0x20	REQ_SEND_FRAME	Request to send a radio frame with the waiting for the radio response.
0x21	RES_SEND_FRAME	Response from the radio board to the frame emission (response to the request 0x20, 0x22,0x24, 0x26, 0x28, 0x2A)
0x22	REQ_SEND_MESSAGE	Request to send a radio frame without the waiting for the radio response.
0x24	REQ_SEND_BROADCAST_RESPONSE	Request to send a radio frame in response to a broadcast frame
0x26	REQ_SEND_POLLING	Request to send a radio frame with the polling mode.
0x28	REQ_SEND_BROADCAST	Request to send a radio frame in broadcast mode.
0x2A	REQ_SEND_BROADCAST_MESSAGE	Request to send a radio frame in broadcast mode without waiting for radio response.
0x30	RECEIVED_FRAME	Received radio frame by the radio board.
0x31	RECEPTION_ERROR	Frame indicating error type detected at the issue of last exchange in point to point or relaying mode.
0x32	RECEIVED_FRAME_POLLING	Received radio frame following a REQ_SEND_POLLING request
0x34	RECEIVED_BROADCAST_RESPONSE	Received radio frame following a REQ_SEND_BROADCAST request
0x35	RECEIVED_FRAME_RELAYED	Received relayed radio frame by the radio board .Reception of this command is possible only if RELAY_ROUTE_STATUS(0x06) parameter is set.
0x36	RECEIVED_MULTIFRAME	Received radio frame in multi frame mode. Indicates that following frames are pending.
0x37	END_MESSAGE_EXCHANGE	Frame indicating end of message exchange.This frame is returned only after **0x22 & 0x24 & 0x2A** Request command. Reception of this frame is conditioned by the parameter EXCHANGE_STATUS value.
0x38	RECEIVED_BROADCAST_FRAME	Received a radio frame transmitted in a broadcast mode