coronis SYSTEMS

Wavecard - Waveport

User Manual

Coronis Systems

Waveport , Wavecard 25 mW and 500 mW products

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Revision History

Rev.	Description	Author	Date	Comments
1	Original document	RCS	Jan 2005	
2	FCC approvals added	RCS	July 2005	
3	Test mode updates, minor corrections	RCS	Sept. 2005	
4	Review and update	RCS/MMA	Nov. 2005	

Supported firmware

Card	Compatible Firmware
Wavecard 25 mW	2.01 and higher
Wavecard 500 mW	4.01 and higher

FCC APPROVAL

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

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

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1. INTRODUCTION

Wavecard allows you to establish Wavenis wireless links between modules in wireless mesh networks, typically for machine-to-machine data communications, access control, security, and track 'n trace applications. The module is driven through a USART link (RS232 or TTL) by an embedded client application running on a connected host module, or by an application running on a PC (via installed Wavenis drivers).

Coronis Systems Wavecard and Waveport products use the same Wavenis wireless board. Therefore, this document covers both products, as well as Waveport module with serial, USB, or compact flash connectors. We will generally refer to Wavecard, except where there are specific differences between products

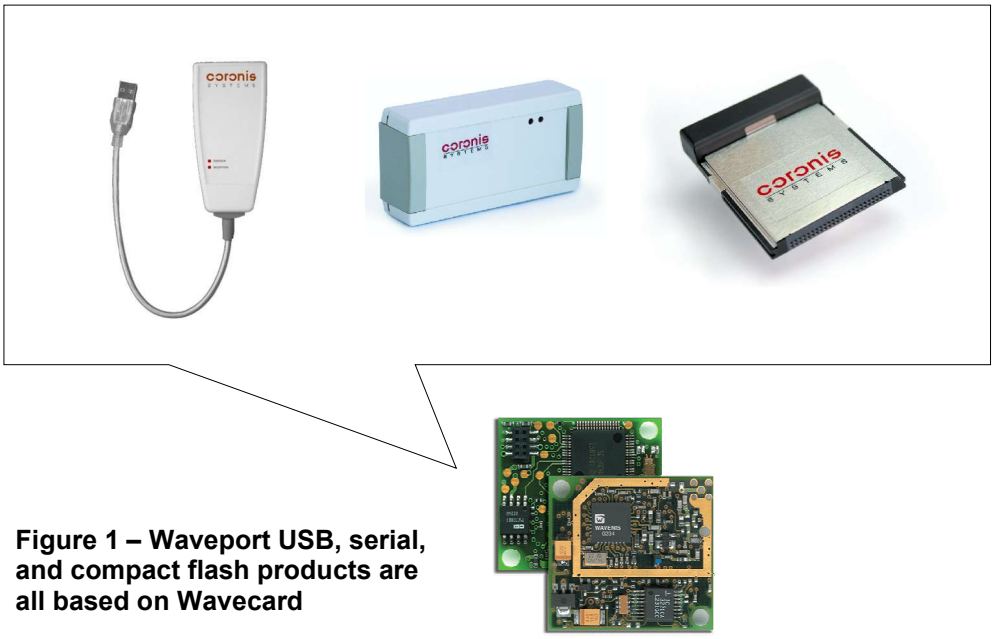


Figure 1 – Waveport USB, serial, and compact flash products are all based on Wavecard

Wavecard's role is to:

- Send data frames wirelessly between host modules
- Notify the host module about received frames

Each Wavecard needs to be connected to a host module in order to exchange data. However, Wavecard *can* process some specific frames without being connected to a host. These exchanges are called *Service Exchanges*, and are mainly used for installation and maintenance procedures.

1.1 Scope of this document

The purpose of this document is to present:

- A low-level description of the exchange protocol used to drive the Wavecard wireless board through an asynchronous serial RS232 (±12V) or TTL level (0-3V) interface
- The Wavecard electrical interface
- The Wavecard mechanical interface

1.1.1 Terms

This document provides specifications for using supplied Wavenis DLLs for Windows as well as for writing your own. This allows you to use Wavecard as a wireless modem that can be integrated into existing modules or driven by a specific host module with its own micro-controller.

As mentioned above, this document is valid for both Wavecard and Waveport products. The main difference is that Waveport is a ready-to-use Wavenis network interface for PCs with USB, serial, or compact flash (type II) connectors.

In this documentation, *host* refers to the module or subsystem that drives the Wavecard; *radio board* indicates Wavecard equipment.

1.1.2 Usage scenarios

Use Waveport to establish Wavenis connections from your PC.

Integrate Wavecard into your own projects or prototypes.

2. RS232 SERIAL PROTOCOL PRESENTATION

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

- 8 data bits
- 1 stop bit
- No parity
- Speed: 9600 baud (please contact us if your application requires other speeds)

2.1 Basic data exchange

In most cases, the host module initiates data exchange, but either the host or the radio board can do it.

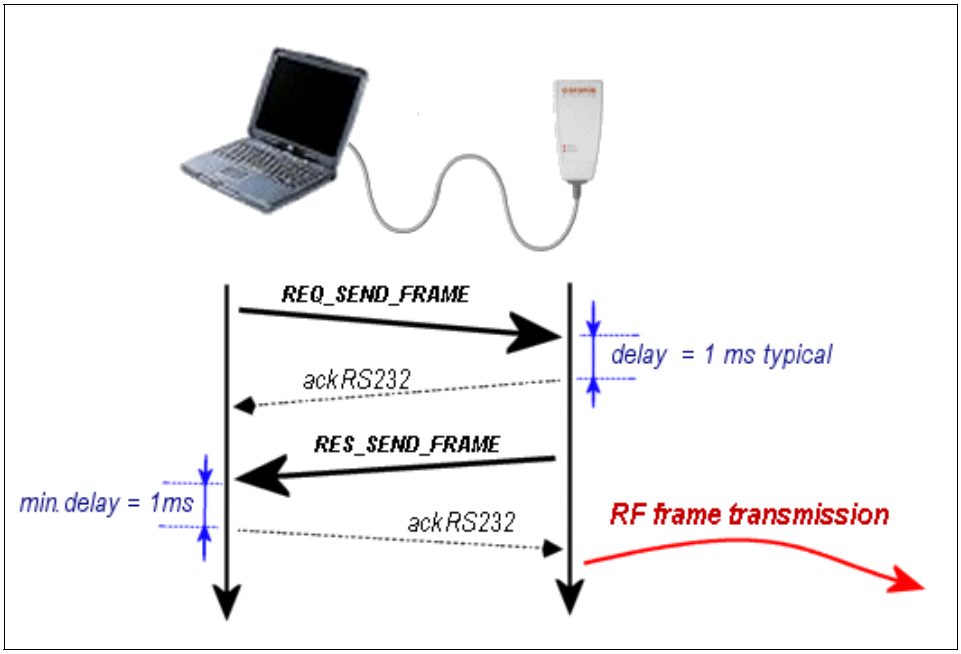


Figure 2 – Overview of data exchange between a Waveport modem and host

2.1.1 Low-level acknowledgement

Serial frames exchanged between a host and radio board are always managed by an acknowledge mechanism.

In order to take processing time into account on the radio board, a minimum latency time of 1 ms must be respected between frame reception and transmission of the corresponding acknowledgement.

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

Time-out = 500 ms

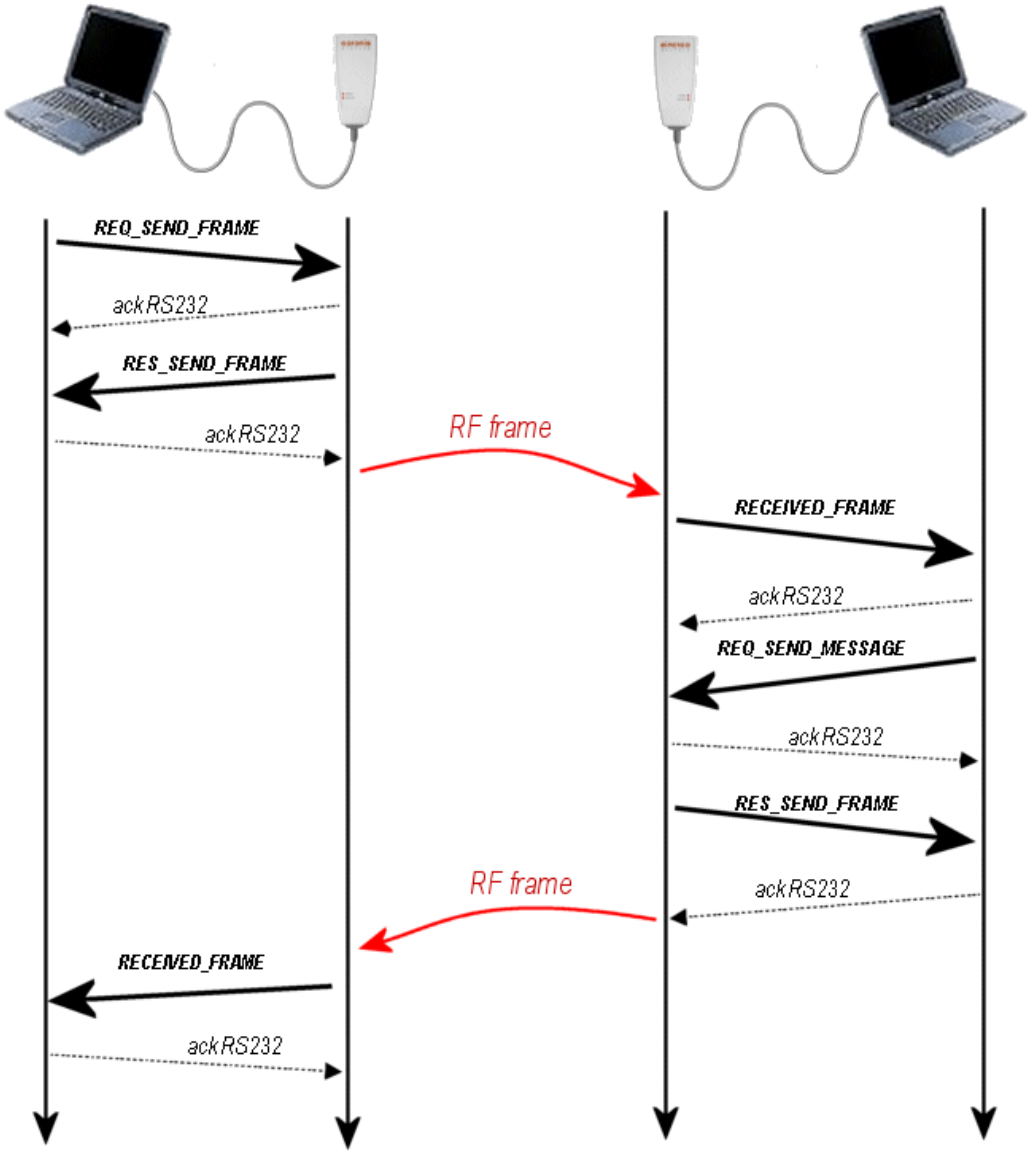
retry count = 3

2.1.2 Request / response mechanism

Some exchanges require using a request/response mechanism. In this case, a high-level *acknowledgement* (command prefix: RES) is initiated by the RF board following the request frame (command prefix: REQ) sent by the host.

Request frames are identified by “REQ_XXX_XXX” (i.e. REQ_SEND_FRAME)

High-level acknowledgement frames are identified by “RES_XXX_XXX” (i.e. RES_SEND_FRAME).



In this example, the RECEIVED_FRAME frame is the response to the REQ_SEND_FRAME request. High-level acknowledgement of the request is identified by the RES_SEND_FRAME frame.

2.2 Format of exchanged frames

2.2.1 Wake-up and synchronization mechanism

Wavecard normally stays in *standby* mode to optimize power consumption, waking up either:

- To poll for radio activity periodically
- When a serial frame is received from host equipment

In order to give the radio board time to wake up, a synchronization character is needed before the data in the serial frame. This character is 0xFF in hexadecimal notation.

To be consistent, the radio board also precedes its frame transmissions with this synchronization character.

2.2.2 Frame description

The standard frame format is as follows:

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

- Minimum frame size is 6 bytes.
- Maximum frame size is 256 bytes.
- Frame length (byte LENGTH) is computed from its own position through the included CRC. SYNC, STX, and ETX bytes are not included in the length.

To ensure the integrity of information transmitted between the host and radio board, a 16-bit CRC code is computed on overall frame data, not including STX and ETX characters (byte LENGTH is inserted in the CRC).

The CRC code is computed by dividing the binary frame sequence by the following polynomial:

$$X16 + X12 + X5 + 1$$

Sample code for this is shown on the following page.

2.2.3 Sample CRC code (C language)

This example shows how to compute CRC on a fixed frame length equal to 9.

```
#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);
}
```

Notes:

- The computed CRC is: 41D2 hexadecimal
- The LSB and MSB bytes must then be inverted before storing them in the frame.

2.3 Command description

This chapter describes the format of serial bus data frames. The distinction between frames is made using the *CMD* fields representing the command (or action) to carry out.

The types of available commands can be split into three categories:

- Control type commands
- Application commands
- Service type commands

2.3.1 Control commands

These commands are used for low-level acknowledgement of serial frames.

CMD	Name	Description	Data field format
0x06	ACK	Acknowledgement frame: Sent by the receiver after receiving a request/response frame type that was supported and understood.	No data field
0x15	NAK	Non-acknowledgement frame: Sent by the receiver after receiving a request/response frame that was not understood.	No data field
0x00	ERROR	Error frame: Sent by the receiver after receiving a request/response frame that was understood but not supported.	Byte 1: 0x01: unknown command

2.3.2 Application commands

Application type commands use the request/response mechanism. There are two types of application type commands: (1) those relating to parameter settings and board configuration, and (2) those related to radio frame exchanges.

Commands related to parameter settings

- Read or update internal parameters
- Read or select radio operating channel when FHSS is deselected
- Read or select the radio communication mode
- Read or select radio board transmission power
- Activate Wavenis RF ASIC RSSI threshold auto-correction
- Modify serial link baud rate
- Read RSSI level of a remote module
- Reading Wavecard RSSI level following an exchange with a remote module
- Read Wavecard firmware version
- Set Wavecard to test mode

Commands related to radio frame exchanges

Radio exchanges are composed of several transmission/reception modes. In some cases it is possible to receive several consecutive radio frames (multi-frame mode which is accessible in reception only).

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

Frame exchange mode

Wavecard sends a request and waits for a response from remote module.

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

Wavecard sends a request without waiting for a response from the remote module.

After sending a frame, the Wavecard radio board goes back to listening on the serial RS232 link. This command may be used for simple data transfer between Wavecard modules.

Relay mode

When a remote module is beyond a transmitting module's radio range, relay mode may be used to forward frames via intermediate nodes (*repeaters*). The maximum number of repeaters is 3.

The modes below allow selective and non-selective exchange with several remote modules at once:

Polling

This mode is used to address requests to a known list of remote modules. Responses are sent to the host that issued the request when all remote modules have responded, or after a time-out.

The list of remote modules is configured with a parameter setting command (see chapter 3).

Broadcast

This mode allows a Wavecard to issue a request to all remote modules within radio range of the transmitter. Broadcast may also be limited to a selected group of modules.

Multi-frame reception

This is a particular case in which multi-frame exchange takes place between a Wavecard or Waveport module (considered to be the *master* of the exchange) and another Wavenis-based telemetry module, such as Wavetherm, Waveflow, Wavesense, etc.

Note: Wavecard does not currently allow multi-frame mode between two Wavecard/Waveport modules.

2.3.3 Service commands

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

When a Wavecard recognizes a service command, no data is sent to the connected host. These commands are mainly used to handle:

- Detection of remote RF modules
- Link budgets with respect to remote modules (RSSI level detection)
- Setting parameters via RF

The details of the frame format and its usage are described in chapter 4.

3. SETTING INTERNAL WAVECARD PARAMETERS

Internal Wavecard parameters can be separated into two categories:

- Control parameters that are carried out by specific types of request/response frames. These parameters (transmission power level, channel selection, etc...) allow you to change the communication mode (either serial and/or RF).
- Functional parameters that are carried out by the same frame as those used for writing internal parameters. These parameters (Wake-up period, group number, etc...) allow you to modify Wavecard behavior according to the type of radio exchange used.

Commands for setting parameters only apply to a local Wavecard, not remote ones.

3.1 Configuring functional parameters

Functional parameters are directly related to Wavecard's default operation, and to the types of radio exchanges used (i.e. functional parameters are initialized according to the intended type of radio exchange).

Default values are set when the unit is first initialized.

Parameter number	Description	Value	Size (bytes)
0x00	AWAKENING_PERIOD: RF polling period, in multiples of 100 ms	Period in multiples of 100ms (by default, 0x0A for one second; max. = 10 sec.) 0 = nearly constant reception (every 20ms)	1
0x01	WAKEUP_TYPE: wake-up type used during frame transmission	0: long wake-up (default setting) 1: short wake-up = 50 ms	1
0x02	WAKEUP_LENGTH: wake-up duration when long wake-up is set used This value must be higher than the RF polling period. Value in multiples of 1 ms, LSB defined first.	Default value: 1100 ms min. value = 20 ms (0x1400) max. value = 10 sec. (0x1027)	2
0x03	WAVECARD_POLLING_GROUP: byte containing the Wavecard polling group.	Byte 1: Polling_Group Default Polling_Group = 0x00	1
0x04	RADIO_ACKNOWLEDGE: indicates whether radio frames should acknowledged by the receiver.	0: no acknowledgement 1: with acknowledgement (default value)	1
0x05	RADIO_ADDRESS: radio board address	This value is set a the factory. Read-only	6
0x06	RELAY_ROUTE_STATUS: Parameter related to relay route transmission in each relayed frame received.	0x00: Relay route transmission deactivated 0x01: Relay route transmission activated By default, relay route transmission is deactivated	1
0x07	RELAY_ROUTE: Table containing the radio addresses for successive repeaters used to reach the destination module.	BYTE 1: number of repeaters in route Maximum number of repeaters = 3 If BYTE 1 != 0 BYTES 2 to 7: First repeater's radio address..., etc.	1 to 19

0x08	POLLING_ROUTE: Table containing the list of module radio address to be queried.	BYTE 2: number of modules to query IF BYTE 2 != 0 BYTES 3 to 8: radio address of the first module..., etc.	1 to 241
0x09	GROUP_NUMBER: Byte containing the group number of radio modules to address in radio polling mode.	Group number Default GROUP_NUMBER = 0x00	1
0x0A	POLLING_TIME: delay between two consecutive transmissions in polling mode	Value in multiples of 100 ms Default POLLING_TIME = 0x0A	1
0x0C	RADIO_USER_TIMEOUT: time-out for receiving a response frame	Value in multiples of 100ms default value = 0x14 (2 seconds)	1
0x0E	EXCHANGE_STATUS: parameter for activating error or status frame management.	0: status and error frames deactivated 1: error frame activated 2: status frame activated 3: both status and error frames activated Default EXCHANGE_STATUS = 0x00.	1
0x10	SWITCH_MODE_STATUS: automatic selection of Radio communication mode used to address an equipment depending on radio address	0: automatic selection deactivated 1: automatic selection activated Default SWITCH_MODE_STATUS = 0x01	1
0x16	WAVECARD_MULTICAST_GROUP: byte containing the Wavecard multicast group (starting with version 2.00).	By default, no group selected = 0xFF	1
0x17	BCST_RECEPTION_TIMEOUT: time-out for receiving CSMA frame following a transmitted REQ_SEND_BROADCAST command (starting with firmware version 2.01)	Value in multiples of100 ms. Default = 0x3C (6 seconds)	1

3.1.1 Format for accessing internal parameters

Wavecard manages internal parameters mainly for RF features. RS232 commands allow you to access these parameters in read or write mode. Default values are set when the module is first used.

REQ_READ_RADIO_PARAM 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 radio parameters
0x41	RES_WRITE_RADIO_PARAM	Radio board response to radio parameter update
0x50	REQ_READ_RADIO_PARAM	Request to read radio parameters
0x51	RES_READ_RADIO_PARAM	Radio board response to parameter reading

In command byte coding, response frames reuse the request command with the LSB bit set to 1.

The format for data fields for reading or updating radio parameters is given below:

- Request to read 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

- Radio board response to parameter reading

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

- Request to update 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

- Radio board response to radio parameter 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

Managing time-outs
Your product may need servicing if you consistently encounter the following latencies. Please contact technical support for more information.

REQ_WRITE_RADIO_PARAM 2 seconds
REQ_READ_RADIO_PARAM 2 seconds

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

3.1.2 Example: Configuring repeater table and activating error frames

In this case there is a repeater module (radio address: 0X AA AA AA AA AA AA) between the Wavecard (initiating the exchange) and the remote module. We must enable error frames in order to determine which remote module caused the error.

Configure repeater list

- Host request 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

- Wavecard response to host (RES_WRITE_RADIO_PARAM)

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

Activate error frames

- Host request to 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

3.2 Wake-up and synchronization

Wavecard optimizes power consumption by using STANDBY mode, waking up periodically to poll for radio activity. The wake-up period is defined by the value of the **AWAKENING_PERIOD** parameter, expressed in multiples of 100 ms (1 second by default).

3.2.1 Transmitting and receiving frames

When transmitting a frame to a remote module, the transmitter begins an awakening procedure called **WakeUp**, which is used to wake receiving modules, which then switch to RF reception mode. A succession of binary symbols are sent by the radio during this preamble procedure.

There are two types of wake-up procedures:

Long wake-up Used when transmitting a request towards a remote module. You may set duration parameters (1100 ms by default), which is generally equal to the wake-up period of the module you are trying to reach, *plus* 100 ms in order to avoid transmitting between two reception periods.

Short wake-up Used only when responding to a point-to-point request. Duration is 50ms and cannot be changed.

NUM	DESCRIPTION	VALUE	SIZE (in bytes)
0x00	AWAKENING_PERIOD RF polling period in multiples of 100 ms	Period in multiples of 100 ms (by default, 0x0A for one second) 0 = nearly constant reception (every 20 ms)	1
0x01	WAKEUP_TYPE Type of wake-up used during frame transmission	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 RF polling period. Value in multiples of 1ms, LSB defined first.	Default value : 1100 ms Min. value = 20 ms (0x1400) Max. value = 10 sec. (0x1027)	2

When the receiving RF module detects the wake-up procedure, it executes the following operations:

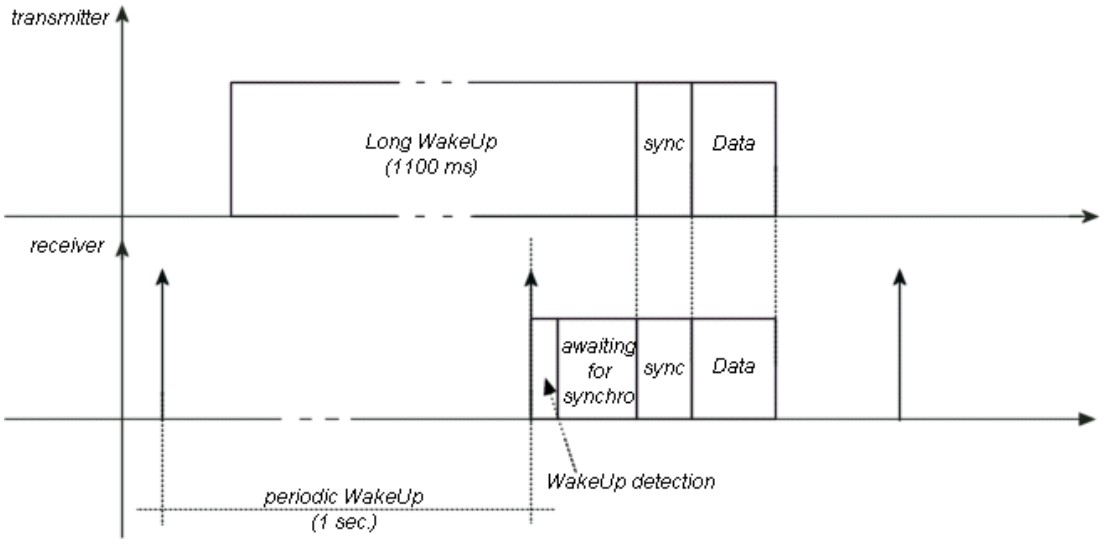
- It starts a time-out to wait for the synchronization word (sync). Duration of the time-out is slightly longer than its WakeUp period, and cannot be changed.
- It begins a phase of validating the WakeUp preamble (WakeUp detection). This phase corresponds to the detection of several successive symbols that compose the preamble. If detection fails, the module returns to stand-by mode. Detection time depends on transmission speed.

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

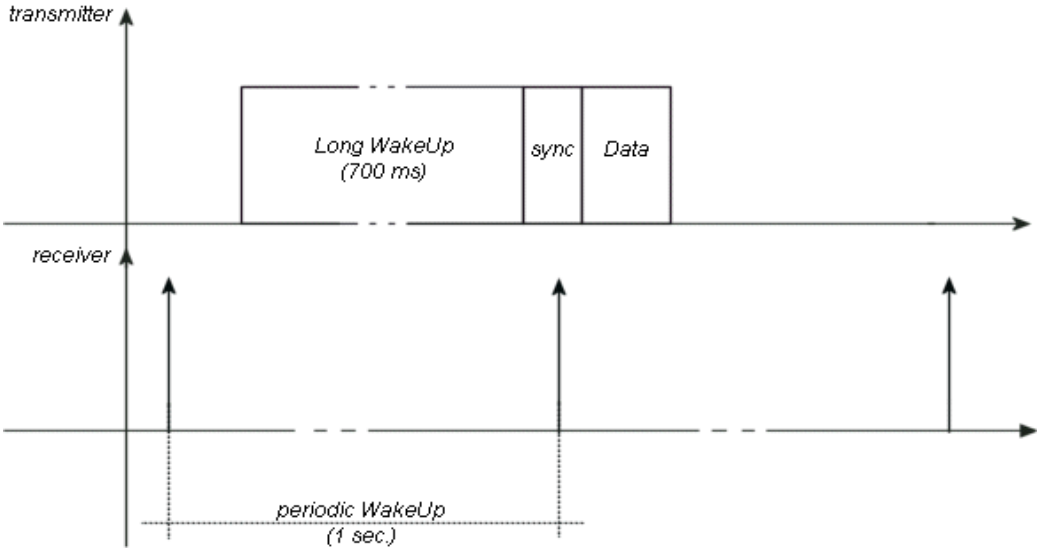
At the end of the the wake-up phase, the transmitter modules sends a synchronization sequence, followed by the data to be transmitted.

3.2.2 Examples of different wake-up conditions

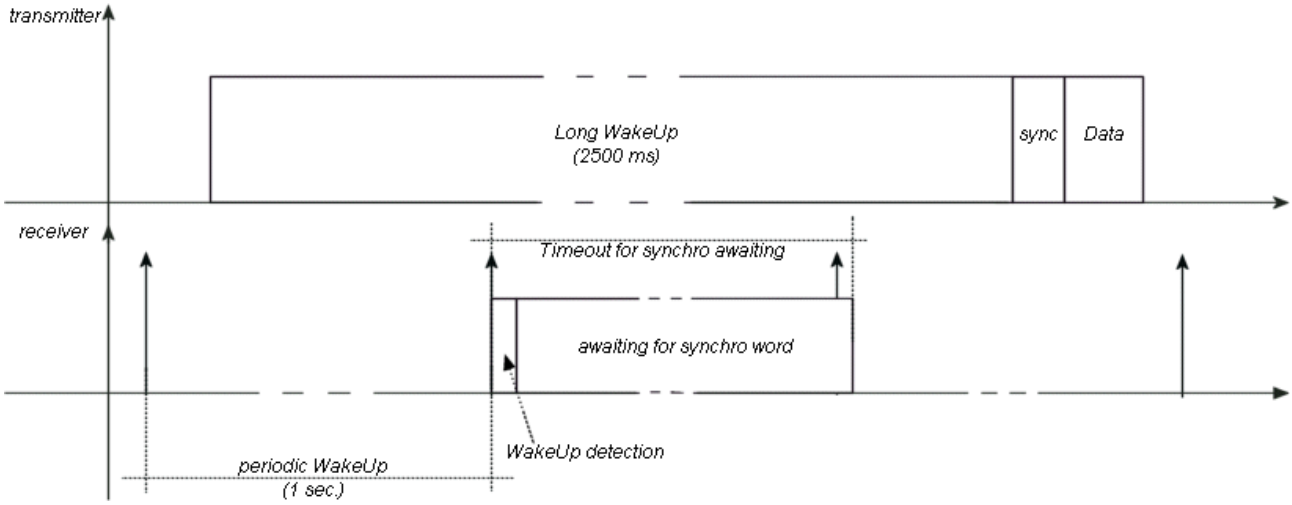
Typical case (Long WakeUp = receiver WakeUp period + 100 ms):



Case where wake-up is too short (lower than the receiver's WakeUp period):



Case where WakeUp is too long (much higher than the receiver's WakeUp period):

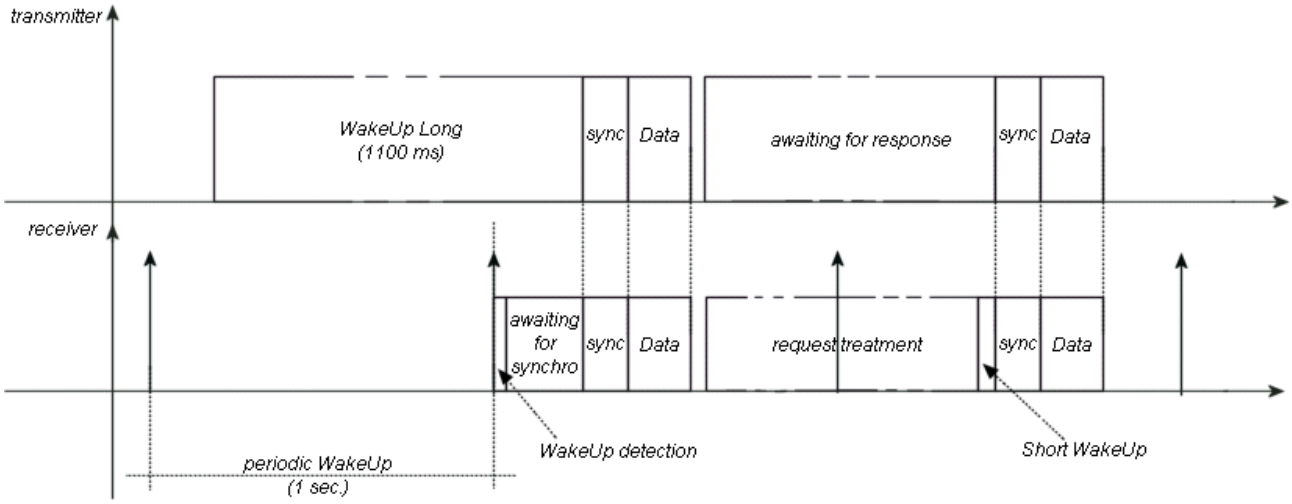


3.2.3 Example of point-to-point request / response exchange

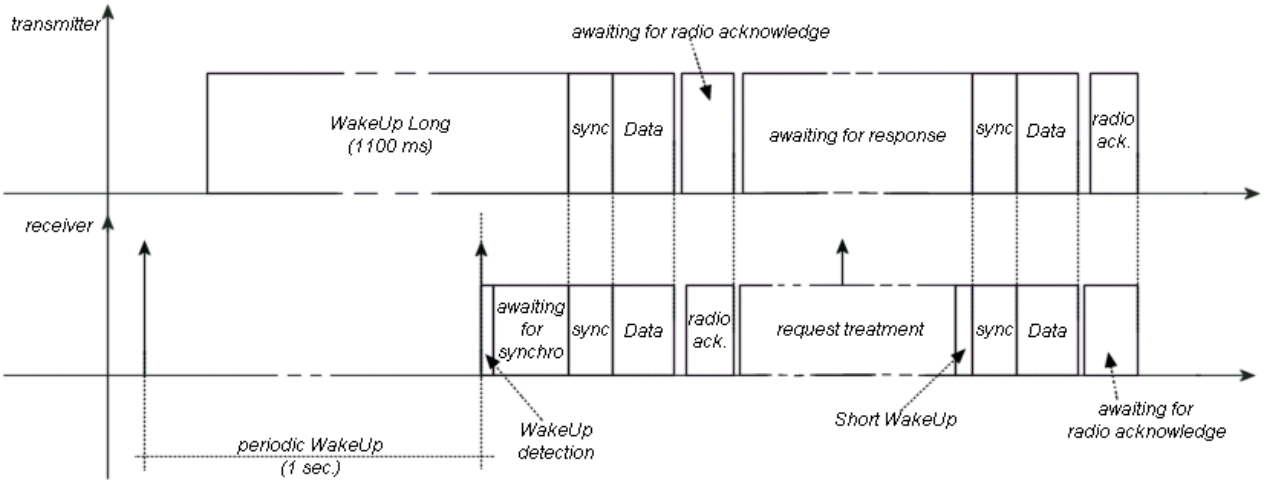
When using a point-to-point (request/response) exchange, the request is transmitted in the same manner as before. However, in this case, the transmitter waits for a response after sending the data. The time-out period for this can be configured using the **RADIO_USER_TIMEOUT** parameter (0x0C).

After processing the request, the receiver returns its response by using a specific WakeUp preamble, called short WakeUp (Long WakeUp is not applicable since the transmitter is already in the receiving phase).

Exchange without radio acknowledgement:



Exchange with radio acknowledgement



Example of parameter configuration for wake-up management

In this example, the transmitter sends data to the receiver quickly between two relatively long idle periods:

1) Send a parameter modification command to the receiver to modify its WakeUp period to 0 (nearly constant reception).
2) Set the transmitter's **WakeUp_Length** parameter to 40 ms.
3) Send the data to the receiver.
4) Send a parameter modification command to the receiver to set its wake-up period to 10 s (default value).
5) Set the transmitter's **WakeUp_Length** parameter to 1100 ms (default value).

3.3 Configuring control parameters

Control parameters are used to:

- Modify RF and serial communications
- Retrieve information about the local module and communication quality with a remote module

3.3.1 Selecting RF communication mode

The following physical layer modes are available:

- 868 MHz single channel, 4800 baud
- 868 MHz single channel, 4800 baud alarm band
- 868 MHz single channel, 9600 baud with channel selection
- 868 MHz frequency hopping, 9600 baud
- 868 MHz frequency hopping, 19200 baud
- 869 MHz, 500mW band (Note: this mode is supported on the Wavecard 25mW radio board, but transmission power is limited).

You may modify the physical layer mode with read and write requests. The commands for this are:

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

In command byte coding, response frames reuse the request command with the LSB bit set to 1.

Format of physical layer mode read commands

- Request (host to Wavecard)

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

- Response (Wavecard to host)

<table>
<tr><th colspan="6">RES_READ_PHYCONFIG</th></tr>
<tr><th>HEADER</th><th>CMD</th><th colspan="2">DATA</th><th>CRC</th><th>ETX</th></tr>
<tr><td>3 bytes</td><td>1 byte</td><td colspan="2">variable</td><td>2 bytes</td><td>1 byte</td></tr>
<tr><td rowspan="2">0xFF ; 0x02 ; 0xXX</td><td rowspan="2">0x67</td><td>Status = 0x00
Read OK</td><td>Transmission mode
2 bytes</td><td rowspan="2"></td><td rowspan="2">0x03</td></tr>
<tr><td>Status = 0x01
Read error</td><td>-</td></tr>
</table>

The table below shows available physical layer modes:

Communication mode	**Value**
433 MHz frequency hopping 9600 baud	0x00A1
868 MHz single channel 4800 baud	0x0012
868 MHz single channel 4800 baud Alarm Band	0x0094
868MHz single channel 9600 baud with channel selection	0x00A2
868 MHz frequency hopping 9600 baud	0x00A3
868 MHz frequency hopping 19200 baud	0x00B3
869MHz 500mW Band	0x00B6
915 MHz frequency hopping 19200 baud	0x00B9

* Wavecard products support 433, 868, *or* 915 MHz (i.e. not all three on the same card).

Format of selection commands for physical layer mode to use

- Request (host to 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 (Wavecard to 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

Automatic selection of communication modes

Each Wavenis module indicates its transmission mode in its radio address. Wavecard uses a parameter in order to select its transmission mode based on the radio address of a remote module. If the SWITCH_MODE_STATUS parameter is activated, Wavecard analyzes the remote module's transmission mode and modifies its own mode accordingly. If the SWITCH_MODE_STATUS parameter 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 communication mode used to address an equipment depending on radio address (available from firmware v1.00)	0 : automatic selection deactivated 1 : automatic selection activated By default: SWITCH_MODE_STATUS = 0x01	1

3.3.2 Selecting radio channel when FHSS is deselected

You may select the Wavecard radio channel using these commands:

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

These commands are used only when the radio communication mode is mono-frequency with channel selection.

Format of read commands for channel used

- Request (host to Wavecard)

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

- Response (Wavecard to host)

<table>
<tr><th colspan="6">RES_READ_CHANNEL</th></tr>
<tr><th>HEADER</th><th>CMD</th><th colspan="2">DATA</th><th>CRC</th><th>ETX</th></tr>
<tr><td>3 bytes</td><td>1 byte</td><td colspan="2">variable</td><td>2 bytes</td><td>1 byte</td></tr>
<tr><td rowspan="2">0xFF ; 0x02 ; 0xXX</td><td rowspan="2">0x63</td><td>Status = 0x00
read OK</td><td>Channel number
1 byte</td><td rowspan="2"></td><td rowspan="2">0x03</td></tr>
<tr><td>Status = 0x01
Read error</td><td>-</td></tr>
</table>

Format of write commands for channel to use

- Request (host to 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 (0 - 21)		0x03

- Response (Wavecard to 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

3.3.3 Selecting radio board transmission power

This function is only available on the Wavecard 25 mW board

You may adjust the transmission power of the Wavecard radio board as indicated in the table below. By default the level is set to 14 dBm.

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

The output power values given here are approximate ((±2dBm). Wavecard radio boards are optimized for 25mW radiated RF Power.

The commands for modifying and reading the power level are:

CMD	Name	Description
0x44	REQ_CHANGE_TX_POWER	Request to update radio board transmission power
0x45	RES_CHANGE_TX_POWER	Radio board response to transmission power update
0x54	REQ_READ_TX_POWER	Request to read radio board transmission power
0x55	RES_READ_TX_POWER	Radio board response to transmission power read

In command byte coding, response frames reuse the request command with the LSB bit set to 1.

Format of commands for selecting transmission power

- Request (host to 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 (Wavecard to 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

Format of commands for reading transmission power

- Request (host to Wavecard)

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

- Response (Wavecard to 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

When the Wavecard is reset, its power level is reset to the default value of 14 dBm (0x0A).

3.3.4 Activating RSSI threshold auto-correction

RSSI threshold auto-correction is a feature that enables Wavecard to adjust its reception threshold according to ambient noise. This feature is consistent with other Wavenis power-saving techniques, and is implemented by battery-powered Wavecard modules at reset. By default RSSI threshold auto-correction is *activated*.

Commands for modifying and reading the auto-correction state are:

CMD	NAME	DESCRIPTION
0x46	REQ_WRITE_AUTOCORR_STATE	Request to update threshold auto-correction state
0x47	RES_WRITE_AUTOCORR_STATE	Radio board response threshold auto-correction state update
0x5A	REQ_READ_AUTOCORR_STATE	Request to read threshold auto-correction state
0x5B	RES_READ_AUTOCORR_STATE	Radio board response to threshold auto-correction state read

Note: In command byte coding, response frames reuse the request command with the LSB bit set to 1.

Format of modification commands for RSSI threshold auto-correction state

- Request (host to 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 auto-correction 0x00: Activated (default value) 0x01: Deactivated		0x03

- Response (Wavecard to 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 error		0x03

Format of commands for reading RSSI threshold auto-correction state

- Request (host to Wavecard)

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

- Response (Wavecard to 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	Auto-correction state 0x00 : activated 0x01 : deactivated		0x03

This parameter returns to its default value after a reset, or after the Wavecard is switched off

3.3.5 Selecting the serial baud rate

You may change the baud rate of the serial link between the Wavecard and its host. When changes are made, the baud rate is updated after the current exchange is finished (i.e. the response for the baud rate change is issued at the same baud rate as the request).

By default, the serial link baud rate is 9600 baud (value = 0x00).

Parameter value	0x00	0x01	0x02	0x03	0x04
Baud rate	9,600 baud	19,200 baud	38,400 baud	57,600 baud	115,200 baud

Commands for changing the baud rate are:

CMD	NAME	DESCRIPTION
0x42	REQ_CHANGE_UART_BDRATE	Request to update serial link baud rate
0x43	RES_CHANGE_UART_BDRATE	Radio board response to the serial link baud rate update. Baud rate is updated once the exchange has ended.

In command byte coding, response frames reuse the request command with the LSB bit set to 1.

Format of baud rate selection commands

- Request (host to 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 (WaveCard to 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

3.3.6 Reading Wavecard firmware version

Commands for reading the Wavecard firmware version are:

CMD	NAME	DESCRIPTION
0xA0	REQ_FIRMWARE_VERSION	Request to read radio board firmware version.
0xA1	RES_FIRMWARE_VERSION	Radio board response to firmware version reading.

In command byte coding, response frames reuse the request command with the LSB bit set to 1.

Wavecard can be considered to be in an error state if more than two seconds elapses following a read request.

Command format

- Request (host to Wavecard)

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

- Response (WaveCard to 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	'V' character in ASCII 0x56	Transmission mode (default = 0x00A3)	Firmware version		0x03

The table below shows available physical layer modes:

Physical layer	Value
433 MHz frequency hopping 9600 baud	0x00A1
868 MHz single channel 4800 baud	0x0012
868 MHz single channel 4800 baud Alarm Band	0x0094
868MHz single channel 9600 baud with channel selection	0x00A2
868 MHz frequency hopping 9600 baud	0x00A3
868 MHz frequency hopping 19200 baud	0x00B3
869MHz 500mW Band	0x00B6
915 MHz frequency hopping 19200 baud	0x00B9

** Wavecard products support 433, 868, or 915 MHz (...not all three on the same card).*

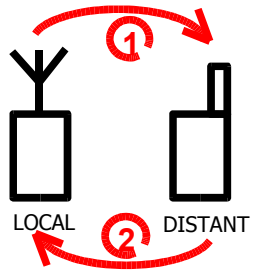
3.3.7 Reading RSSI

The Received Signal Strength Indicator level (RSSI) represents the Quality Of Service (QOS) level for a given Wavecard module. This value can be used to verify signal quality in a given mesh network. You may measure RSSI on local or remote modules. Here are two examples of RSSI measurement:

Example 1: Point-to-point mode

① REQ_READ_REMOTE_RSSI: request RSSI level of signal 1. (i.e. the RSSI level of signal 1 as received by the remote module)

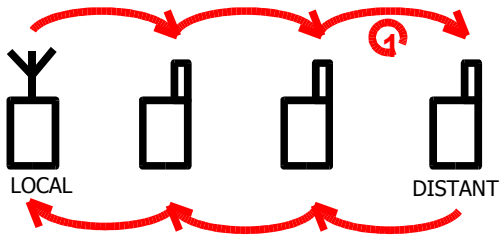
② REQ_READ_LOCAL_RSSI : request the RSSI level of the signal 2. (i.e. the RSSI level on signal 2 reception by the local equipment)



Example 2: Request to read RSSI level on a remote module in relay mode

REQ_READ_REMOTE_RSSI: request RSSI of signal 1.

To obtain the RSSI level between repeaters, it is necessary to issue the REQ_READ_REMOTE_RSSI request on each repeater.



Commands

CMD	NAME	DESCRIPTION
0x68	REQ_READ_REMOTE_RSSI	Request to read RSSI level from remote module
0x69	RES_READ_REMOTE_RSSI	Remote module response to RSSI level request
0x6A	REQ_READ_LOCAL_RSSI	Request to read the Wavecard RSSI level by frame exchange with a remote module.
0x6B	RES_READ_LOCAL_RSSI	Response to local RSSI level request

In command byte coding, response frames reuse the request command with the LSB bit set to 1.

3.3.8 RSSI command format

Request to read RSSI level of a remote module

This measurement gives the remote module's RSSI level.

- 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 module 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 upon frame reception from Wavecard		0x03

Request to read local module's RSSI level

This measurement gives the RSSI level of the local Wavecard by exchanging a frame with a remote module.

- 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 remote module		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 upon receiving the frame sent by a remote module		0x03

Min. RSSI level: 0x00 0%

Max. RSSI level: 0x2F 100%

A reading of 92 - 95% is considered as a saturated signal.

3.3.9 TEST Mode

This mode is used for testing Wavecard installation and for identifying anomalies.

- Command

CMD	NAME	DESCRIPTION
0xB0	MODE_TEST	Set WaveCard into test mode

- Command format

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

In which:

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

You must reset the Wavecard in order to exit the stand-by test mode, as the serial port is also in stand-by mode. To exit the other test modes, send a serial Wavenis frame with 0x00 in the data field, or reset the WaveCard.

4. SERVICE COMMANDS

Services commands are used to configure Wavecard modules or to read radio parameters independently of the connected host equipment. No data is sent to the connected host when a Wavecard recognizes a service command.

These commands are mainly used to handle:

- Detecting remote RF modules
- Link budgets with remote modules (RSSI levels)
- Setting parameters via RF

4.1 Command description and formats

CMD	NAME	DESCRIPTION
0x80	REQ_SEND_SERVICE	Request to send a service frame (and wait for response)
0x81	RES_SEND_SERVICE	REQ_SEND_SERVICE response
0x82	SERVICE_RESPONSE	Frame received following 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 remote radio module	Service request type	Parameter(s) related to request type		0x03

- Service request acknowledgement

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: Frame transmission error		0x03

- Service request response

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 remote radio module	Service response type	Parameter(s) related to response type		0x03

4.2 Request types

The transmitting module sends a service command that includes a *request type*. Each *request type* has an associated *response type* which is included in the SERVICE_RESPONSE command.

In command byte coding, response frames reuse the request command 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 remote equipment.	n/a
GET_FW_VERSION	0x28	Command used to read firmware version in remote module.	n/a

- Response type

RESPONSE TYPE		DESCRIPTION	PARAMETER(S)
NAME	VALUE		
RESP_GET_TYPE	0xA0	Response to GET_TYPE command.	Byte 1: module type Byte 2: RSSI level Byte 3: Wake-up period Byte 4: module type
RESP_GET_FW_VERSION	0xA8	Response to GET_FW_VERSION command.	Byte 1: 'V' in 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 Detecting presence of Wavecard (Wavenis) modules

It may be useful to check the presence and link budget of a remote module before pursuing data exchange operations. The **Get_Type Command** is sent like a service command, allowing a remote Wavecard to process a response independently of its host equipment. Here is a description of the data frame:

- 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 remote module**	**0x20 GET_TYPE**		0x03

- Service request response

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 remote radio module**	**0xA0**	**Parameters:** **1st byte**: Type corresponding to Wavecard radio board = 0x12 **2nd byte**: RSSI level **3rd byte**: Remote Wavecard wake-up period (in seconds) **4th byte**: module type connecting to Wavecard (default = 0x12)		0x03

5. COMMUNICATION MODES

This chapter covers:

- The methods for using Wavecard's four communication modes
- Command format
- Corresponding parameters

5.1 Frame exchange mode

This type of radio exchange allows you to send a request and then wait for a response from remote modules.

Following transmission of a radio frame, the Wavecard radio stays in reception mode for a period specified by the parameter **RADIO_USER_TIMEOUT**. This allows the unit to receive a response from the remote module.

The RS232 serial connection is not managed during this phase. This command is generally intended for reading Wavenis-based telemetry modules (temperature measurement, humidity, liquid flow, tank levels, digital state management).

5.1.1 Configuring parameters

Frame exchange parameters are accessible **REQ_READ_RADIO_PARAM** and **REQ_WRITE_RADIO_PARAM**. Parameter details are provided in Appendix III of this guide.

NUM	DESCRIPTION	VALUE	SIZE (in bytes)
0x04	RADIO_ACKNOWLEDGE Indicates whether or not radio frames should be acknowledged by receiver.	0: no acknowledgement 1: with acknowledgement (default value)	1
0x06	RELAY_ROUTE_STATUS Parameter related to relay route transmission in each relayed frame received.	0x00: Relay route transmission deactivated 0x01: Relay route transmission activated By default, relay route transmission is deactivated.	1
0x07	RELAY_ROUTE Table containing radio addresses of successive repeaters used to reach the end module.	BYTE 1: number of repeaters in route. Maximum number of repeaters = 3 If BYTE 1 != 0 BYTES 2 to 7: Radio address of first repeater …, etc.	1 to 19
0x0C	RADIO_USER_TIMEOUT Specifies time-out for receiving response frames	Value in multiples of 100 ms Default value = 0x14 (2 seconds)	1

0x0E	EXCHANGE_STATUS Parameter for activating or deactivating error or status frame management.	0: both status and error frames 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 Commands and formats

CMD	NAME	DESCRIPTION
0x20	REQ_SEND_FRAME	Request to send a radio frame and wait for radio response.
0x21	RES_SEND_FRAME	Radio board response to frame transmission (response to requests 0x20, 0x22, 0x24, 0x26, 0x28, 0x2A)
0x30	RECEIVED_FRAME	Frame received by radio board.
0x31	RECEPTION_ERROR	Frame indicating error type detected at the end of the last exchange in point-to-point or relay mode.
0x35	RECEIVED_FRAME_RELAYED	Relay frame received by the radio board. Reception of this command is possible only if the RELAY_ROUTE_STATUS (0x06) parameter is set.

Here is a description of data frames:

- 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 of target module	n bytes of data to transmit Maximum size (N bytes) is defined below		0x03

- Request acknowledgement

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

- Request response

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

Defining maximum size

- Point to Point mode **Max =** 152 bytes of data
- Relay 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 Using relay mode

Relay mode is only available for point-to-point exchanges (*frame exchange* or *message* types).

Frame transmission

To send a request to a remote module using relay mode, you must configure a repeater list with RELAY_ROUTE. When you send a request such as REQ_SEND_FRAME (or REQ_SEND_MESSAGE) to the receiver's address, the radio frame is relayed automatically through the modules configured by RELAY_ROUTE.

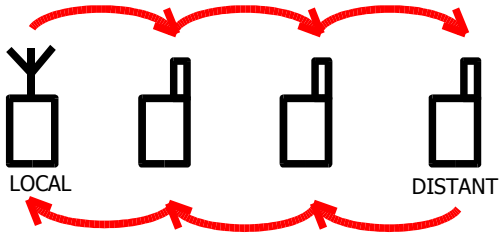
After sending a request to a recipient, the repeater list (RELAY_ROUTE) is automatically re-initialized. You must therefore reconfigure it in order to send another request in relay mode.

Here is an example of sending a REQ_SEND_FRAME request in relay mode:

When **REQ_SEND_FRAME** is used, the return routing of the response from the remote module is not automatic; it must be configured by the application running on the remote module.

Generally speaking, if a frame is received in a remote module and transferred to its host, the list of the relay addresses for the return trip will need to be configured by the application.

If the frame was not passed on to the receiver's host, then the response automatically uses the relay information contained in the received frame. This is the case with requests such as REQ_READ_REMOTE_RSSI and GET_TYPE.



Frame reception

Starting with firmware version v2.00 (v4.00 for 500mW modules), the relay route may be passed from a received frame to the receiving module's host. To ensure compatibility with previous versions, this functionality is activated or deactivated by RELAY_ROUTE_STATUS (0x06) parameter on the receiving module. Depending on the value of this parameter, the host will receive one of the following frames:

RELAY_ROUTE_STATUS value	Type of frame transmitted to host when receiving a frame in relay mode
0x00: deactivated	RECEIVED_FRAME (CMD = 0x30)
0x01: activated	RECEIVED_FRAME_RELAYED (CMD = 0x35)

Here is the format of these frame types:

- Response received by host (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 of transmitting module**	**Data from received frame Maximum size (N bytes) is defined below**		0x03

- Response received by host (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 of transmitting module**	**Number of repeaters used**	**Radio addresses of repeaters**	**Data from received frame Maximum size (N bytes) is defined below**		0x03

The field containing the radio addresses of the repeaters can be 6, 12, or 18 bytes, depending on the number of repeaters used.

Defining maximum size

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

RECEPTION_ERROR frame format

With this command, the local Wavecard informs its host that a problem occurred during the exchange. This command is forwarded between the Wavecard and its host using the serial link, and therefore does not require a recipient's address.

Error messages are activated only if the **EXCHANGE_STATUS** parameter is set to 0x01 or 0x03.

In the latter case, status messages are also activated but are not used in this mode, but only when messages are sent without waiting for an answer (MESSAGE and BROADCAST modes).

- 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: RF acknowledgement not received from remote module (useful if acknowledgement mechanism is set) = 0x02: RF response not received from remote module		0x03

- In relay 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: relay mode	0x02 Default value for relay mode	RELAY_COUNTER : = 0x03 No response from third repeater = 0x02 No response from second repeater = 0x01 No response from the first repeater = 0x00 No response from end-point module.		0x03

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

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

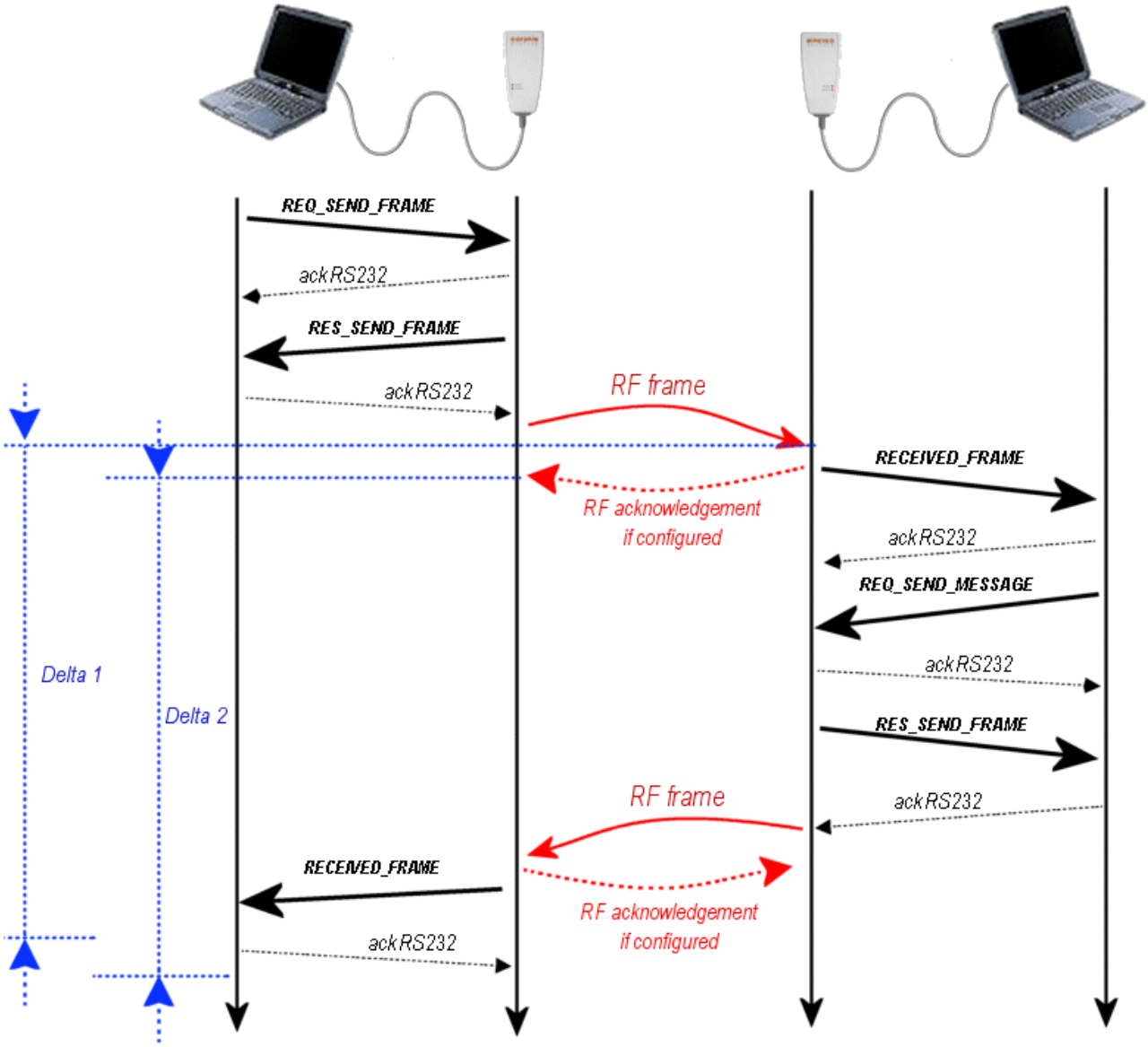
5.1.4 Managing time-outs

When sending a request and waiting for a response (frame exchange), the time-out period for the response frame is given by parameter **RADIO_USER_TIMEOUT**. By default the value is 2 seconds.

The beginning of the time-out period depends on the **RADIO_ACKNOWLEDGE** parameter:

- If RADIO_ACKNOWLEDGE is active, counting begins upon reception of the request acknowledgement
- If RADIO_ACKNOWLEDGE is inactive, time-out counting begins directly after the request is sent

Point-to-Point exchange:

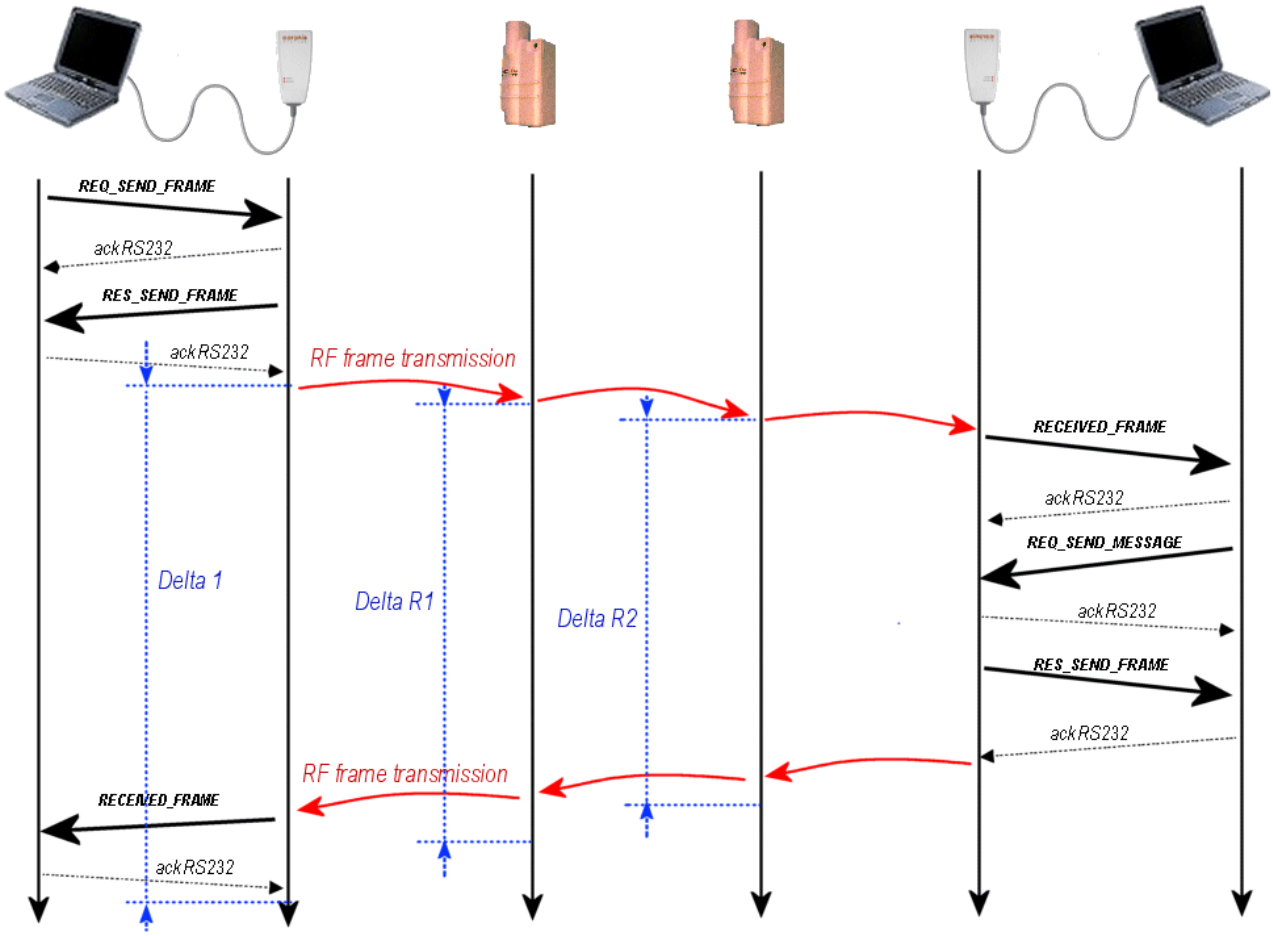


Delta 1: RADIO_USER_TIMEOUT, with RADIO_ACKNOWLEDGE disabled.

Delta 2: RADIO_USER_TIMEOUT, with RADIO_ACKNOWLEDGE enabled.

Delta 1 = Delta 2 = RADIO_USER_TIMEOUT

Relay mode diagram:



When relay mode is used, the time-out (with respect to the transmitter) is not the same as with point-to-point mode because of the additional time it takes to pass through intermediate nodes. The time-out specified by **RADIO_USER_TIMEOUT** is still applied, but it does not take relays into account. The time-out value will be applied by the last relay before the end-point receiver (R2 Delta = Radio_User_Timeout).

The value of **RADIO_USER_TIMEOUT** applied by the last repeater is configured in the transmitter, not in the repeater itself.

In relay mode, repeaters use the **RADIO_USER_TIMEOUT** value encapsulated in the transmitter's frame. Repeaters only uses its own **RADIO_USER_TIMEOUT** setting when transmitting, not repeating.

In the above diagram, the value of **RADIO_USER_TIMEOUT** (set by the transmitter) corresponds to time **Delta R2** applied by Relay 2.

Delta 1 and **Delta R1** are evaluated by the corresponding radio module, depending on the number of relays (repeaters), the type of wake-up, duration, and the values of **RADIO_USER_TIMEOUT** and **RADIO_ACKNOWLEDGE**.

5.2 Message mode

This type of radio exchange allows you to send requests without waiting for remote modules to respond. After sending a frame the Wavecard board listens on its RS232 serial link. Commands in message mode are mostly used for simple data transfer between several Wavecard modules.

5.2.1 Configuring message mode parameters

Parameters are accessible using commands REQ_READ_RADIO_PARAM and REQ_WRITE_RADIO_PARAM (parameter details are provided in Appendix III).

NUM	DESCRIPTION	VALUE	SIZE (in bytes)
0x04	RADIO_ACKNOWLEDGE: indicates whether or not radio frames should be acknowledged by receiver.	0: no acknowledgement 1: with acknowledgement (default value)	1
0x06	RELAY_ROUTE_STATUS: Parameter related to relay route transmission in each relayed frame received.	0x00: Relay route transmission deactivated 0x01: Relay route transmission activated By default, relay route transmission is deactivated.	1
0x07	RELAY_ROUTE: Table containing radio addresses of successive repeaters used to reach the end module.	BYTE 1: number of repeaters in route. Maximum number of repeaters = 3 If BYTE 1 != 0 BYTES 2 to 7: Radio address of first repeater …, etc.	1 to 19
0x0E	EXCHANGE_STATUS: parameter for activating or deactivating error or status frame management.	0: both status and error frames 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 Commands and formats

CMD	NAME	DESCRIPTION
0x22	REQ_SEND_MESSAGE	Request to send a radio frame and wait for radio response.
0X21	RES_SEND_FRAME	Radio board response to frame transmission (response to requests 0x20, 0x22, 0x24, 0x26, 0x28, 0x2A)
0x30	RECEIVED_FRAME	Frame received by radio board.
0x31	RECEPTION_ERROR	Frame indicating error type detected at the end of the last exchange in point-to-point or relay mode.
0x35	RECEIVED_FRAME_RELAYED	Relay frame received by the radio board. Reception of this command is possible only if the RELAY_ROUTE_STATUS (0x06) parameter is set.
0x37	END_MESSAGE_EXCHANGE	Frame indicating the end of message exchange. This frame is returned only after a 0x22 & 0x24, or 0x2A request command. Reception of this frame depends on the value of EXCHANGE_STATUS.

The formats of frame types received by the host are:

- Message mode request

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 of target module	n bytes of data to transmit Maximum size (N bytes) is defined below		0x03

Defining maximum size

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

- Request acknowledgement

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

Reception of this command by the host depends on whether or not status frames are activated using the parameter EXCHANGE_STATUS (0x0E).

This command is useful for exchanging data using 0x22 (REQ_SEND_MESSAGE), 0x24 (REQ_SEND_BROADCAST_RESPONSE), and 0x2A (REQ_SEND_BCST_MESSAGE) since it leaves the Wavecard radio board available for subsequent RS232 serial link exchanges (see diagram on page 48).

5.2.3 Using relay mode

Relay mode is only available for point-to-point exchanges (*frame exchange* or *message* types).

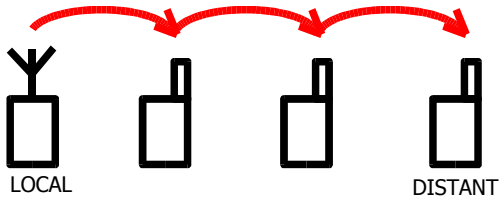
Frame transmission

To send a request to a remote module using relay mode, you must configure a repeater list with **RELAY_ROUTE**. When you send a request such as **REQ_SEND_FRAME** (or **REQ_SEND_MESSAGE**) to the receiver's address, the radio frame is relayed automatically through the modules configured by **RELAY_ROUTE**.

After sending a request to a recipient, the repeater list (**RELAY_ROUTE**) is automatically re-initialized. You must therefore reconfigure it in order to send another request in relay mode.

Here is an example of sending a **REQ_SEND_MESSAGE** request in relay mode:

Note: Recipients don't respond to **REQ_SEND_MESSAGE** requests.



Frame reception

Starting with firmware version v2.00 (v4.00 for 500mW modules), the relay route may be passed from a received frame to the receiving module's host. To ensure compatibility with previous versions, this functionality is activated or deactivated by RELAY_ROUTE_STATUS (0x06) parameter on the receiving module.

Depending on the value of this parameter, the host will receive one of the following frames:

RELAY_ROUTE_STATUS value	Type of frame transmitted to host when receiving a frame in relay mode
0x00: deactivated	RECEIVED_FRAME (CMD = 0x30)
0x01: activated	RECEIVED_FRAME_RELAYED (CMD = 0x35)

Here is the format of these frame types:

- Response received by host (**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 of transmitting module	Data from received frame Maximum size (N bytes) is defined below		0x03

- Response received by host (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 of transmitting module	Number of repeaters used	Radio addresses of repeaters	Data from received frame Maximum size (N bytes) is defined below		0x03

The field containing the radio addresses of the repeaters can be 6, 12, or 18 bytes, depending on the number of repeaters used.

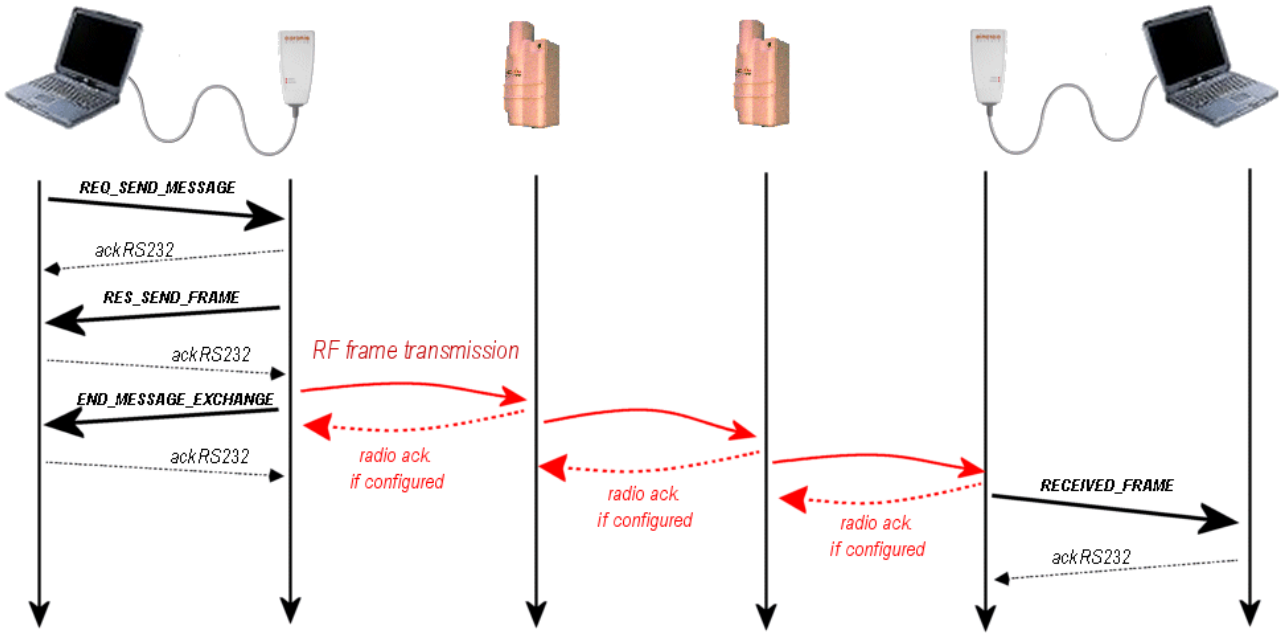
Defining maximum size

- Point to Point mode **Max =** 152 bytes of data
- Relay mode **Max = 152** – (2 + 6 x Number of repeaters)

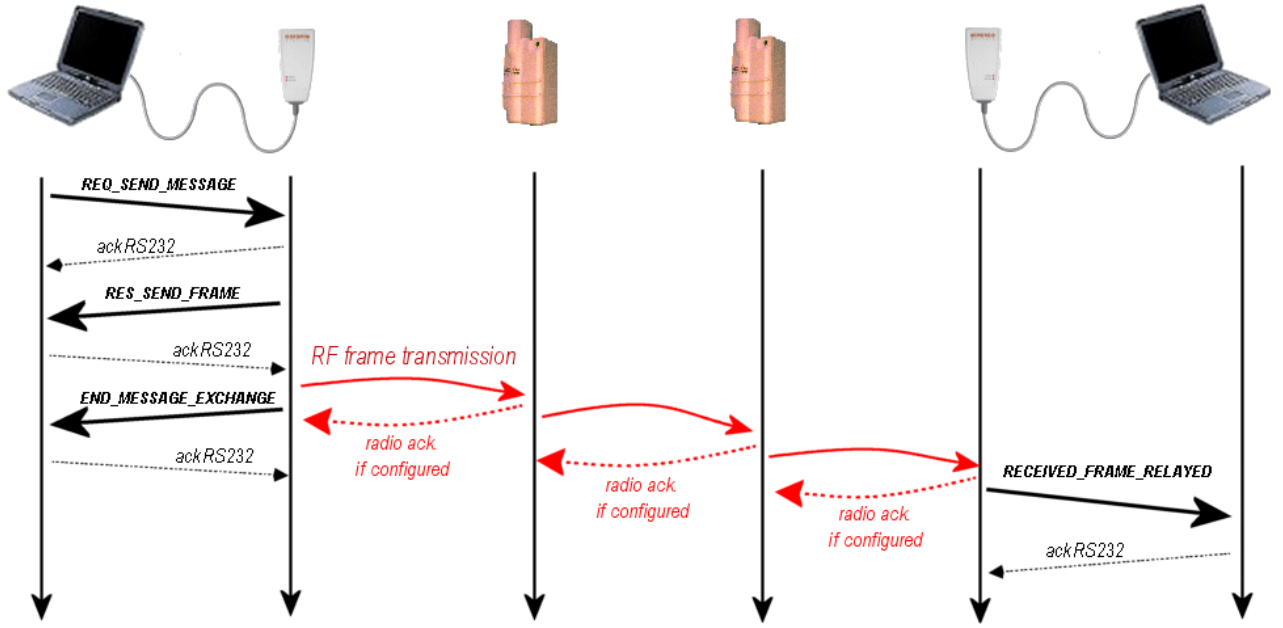
  => 1 repeater: 144 bytes of data
  => 2 repeaters: 138 bytes of data
  => 3 repeaters: 132 bytes of data

Relay mode diagram

- With RELAY_ROUTE_STATUS parameter deactivated (= 0x00)



- With RELAY_ROUTE_STATUS parameter activated (= 0x01)



RECEPTION_ERROR frame format

With this command, the local WaveCard informs its host that a problem occurred during the exchange. This command is forwarded between the Wavecard and its host using the serial link, and therefore does not require a recipient's address.

Error messages are activated only if the EXCHANGE_STATUS parameter is set to 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: RF acknowledgement not received from remote module (useful if acknowledgement mechanism is set) = 0x02: RF response not received from remote module		0x03

- In relay 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: relay mode	**0x02** Default value for relay mode	**RELAY_COUNTER** : = 0x03 No response from third repeater = 0x02 No response from second repeater = 0x01 No response from the first repeater = 0x00 No response from end-point module.		0x03

Error frames in message mode only intervene between the transmitter and the first repeater. Even if the other repeaters return errors, the transmitting module does not wait for an answer and proceeds to another action.

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

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

5.3 Polling mode

Polling mode allows you to send a request to a predefined list of remote modules. Responses are sent to the host that originated the request when all remote modules have responded or after a time-out. The are two types of exchanges in polling mode:

Non-selective polling All remote modules designated in the POLLING_ROUTE table are queried.

Selective polling Only a selected group of remote modules listed in the POLLING_ROUTE are queried.

5.3.1 Configuring polling mode parameters

Polling mode parameters are accessible via REQ_READ_RADIO_PARAM, and REQ_WRITE_RADIO_PARAM commands (a complete list is provided in Appendix III).

NUM	DESCRIPTION	VALUE	SIZE (in bytes)
0x03	WAVECARD_POLLING_GROUP: Byte containing the Wavecard's polling group.	Byte 1: Polling_Group By default, Polling_Group = 0x00	1
0x08	POLLING_ROUTE: Table containing the radio addresses of remote modules to query.	Byte 2 : number of modules to query IF Byte 2 != 0 Bytes 3 to 8 : radio address of the first module, second module, etc.	1 to 241
0x09	GROUP_NUMBER: Byte containing the group number of the remote modules to query in polling mode.	Group number By default, GROUP_NUMBER = 0x00	1
0x0A	POLLING_TIME: time delay between two consecutive transmissions in polling mode	Value in multiples of 100 ms By default, POLLING_TIME = 0x0A	1

Example

This example shows how to write list of the remote modules to query in polling mode. Suppose we have two remote modules, whose 6-byte addresses are 0xAAAAAAAAAAAA and 0xBBBBBBBBBBBB. Launch a **REQ_WRITE_RADIO_PARAM** request, setting the CMD byte to 0x40. Then, in the DATA field, specify the number of the parameter to be modified and corresponding data using 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 Commands and formats

CMD	NAME	DESCRIPTION
0x21	RES_SEND_FRAME	Radio board response to frame transmission (response to the request 0x20, 0x22, 0x24, 0x26, 0x28, 0x2A)
0x26	REQ_SEND_POLLING	Request to send a radio frame in polling mode.
0x32	RECEIVED_FRAME_POLLING	Radio frame received following a REQ_SEND_POLLING request

Here are the formats of frame types received by the host:

- Polling mode request

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** **Maximum size is 152 bytes**		0x03

In radio polling mode, you do not have to transmit the addresses of the modules you wish to query, as they must be configured using the POLLING_ROUTE parameter.

- Request acknowledgement

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 a polling request

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	STATUS_RECEPTION = 0: response OK = 1: no response from queried module	Radio address of queried module	Data from received frame Maximum size is 152 bytes		0x03

5.3.3 Selective vs. non-selective polling mode

Generally, you need to configure a table containing the addresses of the modules to be queried (POLLING_ROUTE) in polling mode (selective or not-selective).

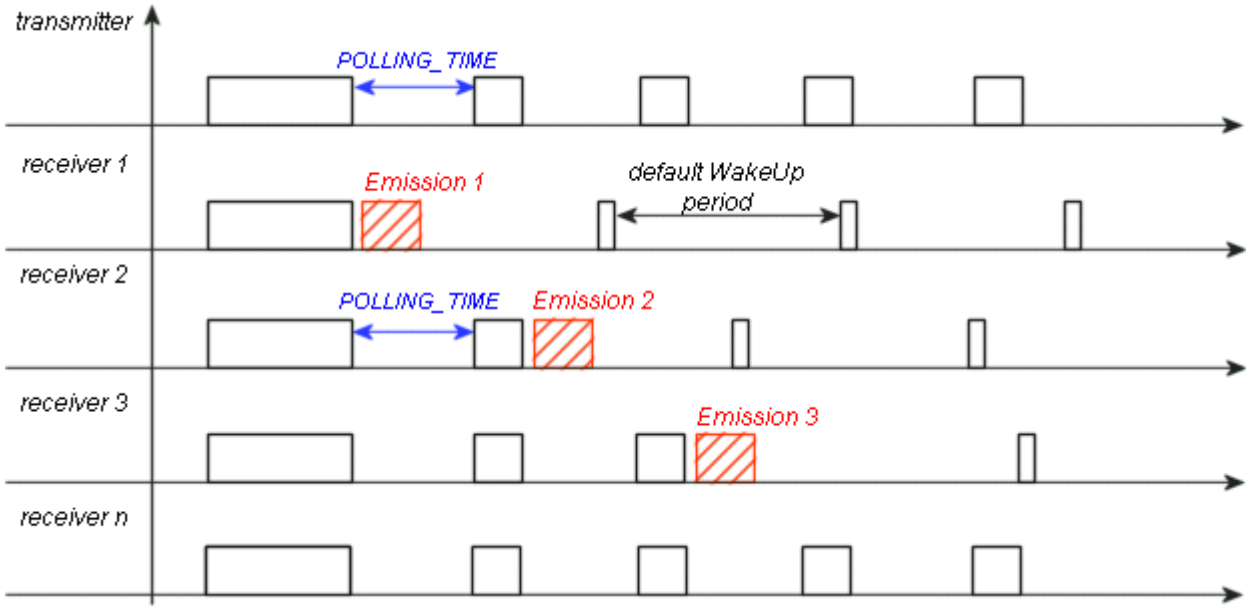
When using *selective polling*, you need to configure (on the transmitter side) the group number of modules to be queried. That way, requests sent in selective polling mode are only sent to the modules included in the table with the same group number as that configured in the transmitter.

This is different from non-selective polling mode, where all modules included in the list will be queried.

Principle of non-selective polling mode

When using non-selective polling, all modules within radio range are synchronized with the transmitter (short WakeUp, every POLLING_TIME), but only queried modules respond.

- After sending a response, queried modules are re-initialized with their default wake-up period.
- Non-queried modules are re-initialized with their default wake-up period when the transmitter stops its query in polling mode.



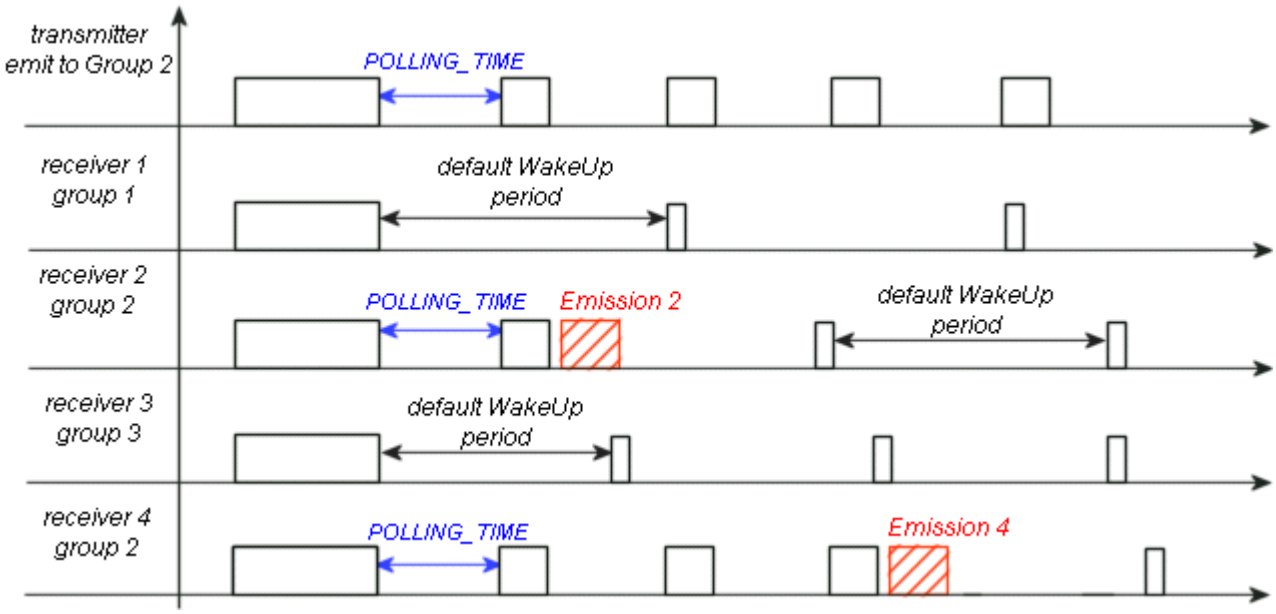
The procedure to initiate a request in non-selective polling mode is:

- Configure a POLLING_ROUTE table containing the addresses of all the modules to be queried (*Launch a request to modify internal parameters)*
- Launch a request in polling mode

Principle of selective polling

Only the modules belonging to the queried group are synchronized with the transmitter. A particular module will respond to a selective polling request if:

- It belongs to the queried group
- Its radio address is contained in the list of queried modules (POLLING_ROUTE)



Since it doesn't use long WakeUp, synchronization speeds up module response and optimizes consumption.

When querying a Wavetherm module in polling mode, the time it takes to read a temperature may be much longer than the default POLLING_TIME value. In that case, the parameter should be increased accordingly.

- DALLAS probe: readings take around 800ms per probe
- PT100, PT1000 probe: reading time depends on the precision index (max. 3 seconds)

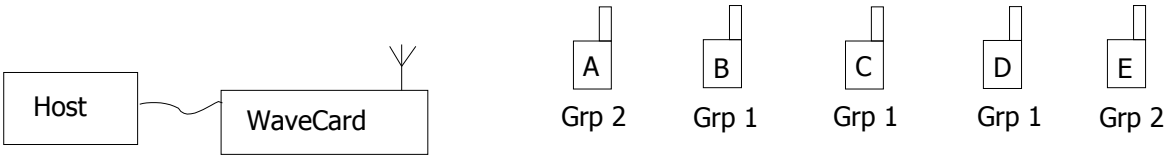
Follow this procedure to initiate a request in selective polling mode:

- Configure a POLLING_ROUTE table containing all the addresses of modules to be queried; transmit a request to modify internal parameters.
- Configure the group number of each remote module contained in the table (POLLING_ROUTE) ;
- transmit a request to modify internal parameters.
- Choose the group to query and transmit the polling request.

When a Wavecard or Waveport module 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.

Be careful not to confuse this parameter with the parameter **GROUP_NUMBER**, which gives the number of group to be queried when Wavecard transmits a selective polling request.

Example of a selective polling exchange



Wavecard is configured as shown here:

POLLING_ROUTE
module A address
module B address
module C address
module D address
module E address

GROUP_NUMBER
0x01

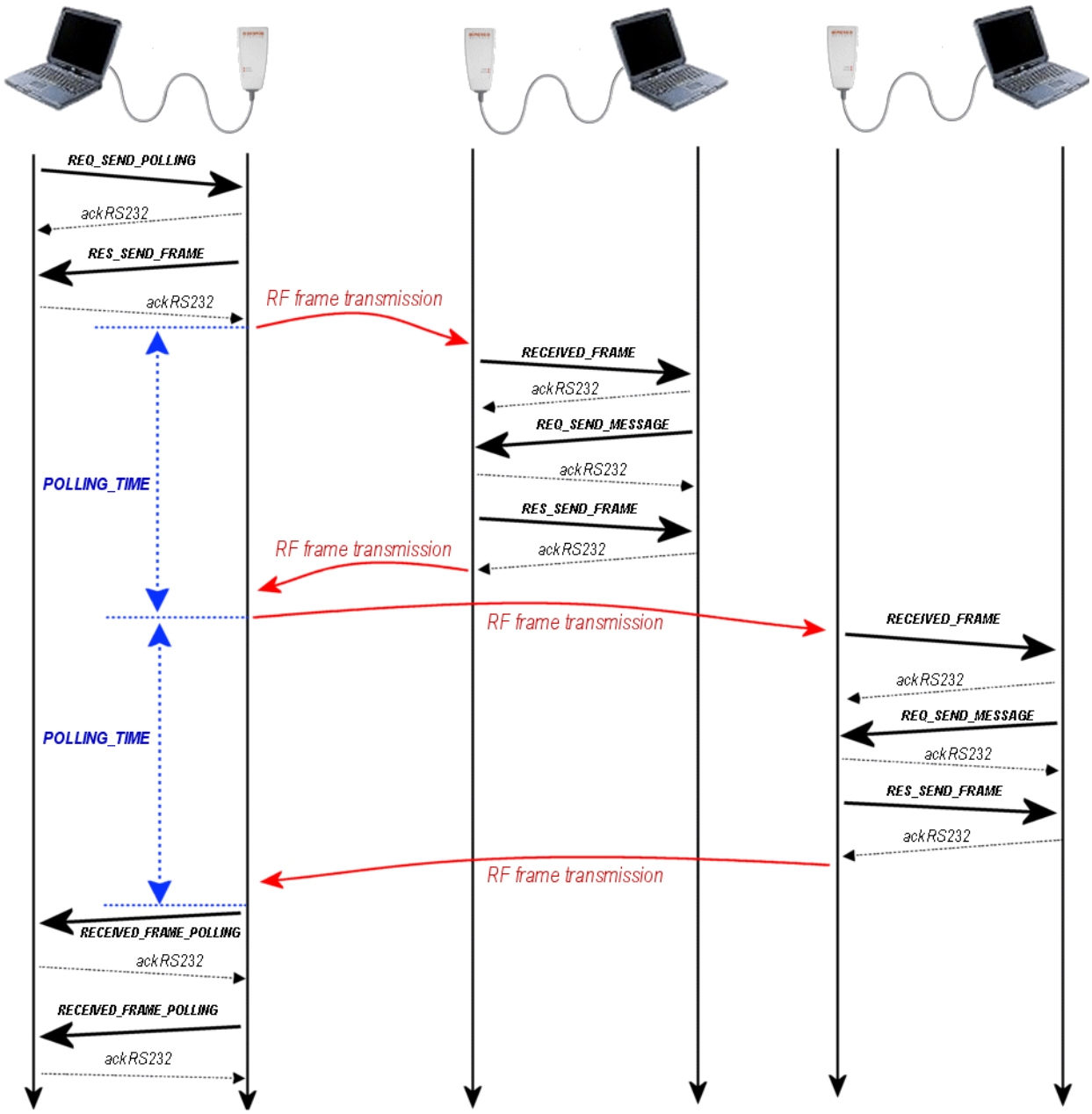
After a **REQ_SEND_POLLING** request is transmitted, remote modules can react differently, for example:

- **module A : responds to the request**. (PARTICULAR CASE) Since this module is the first in the POLLING_ROUTE table, the first polling frame is sent in non-optimized point-to-point mode

- **module B : responds to the request (member of queried group)**
- **module C : responds to the request (member of queried group)**
- **module D : responds to the request (member of queried group)**
- **module E : no response** (not a member of queried group)

5.3.4 Diagram of a polling mode exchange

This diagram shows a typical case where remote Wavecards communicate with their respective hosts. When sending a GET_TYPE request (see chapter 4) in polling mode, remote Wavecards respond without preliminary dialogue with their host.



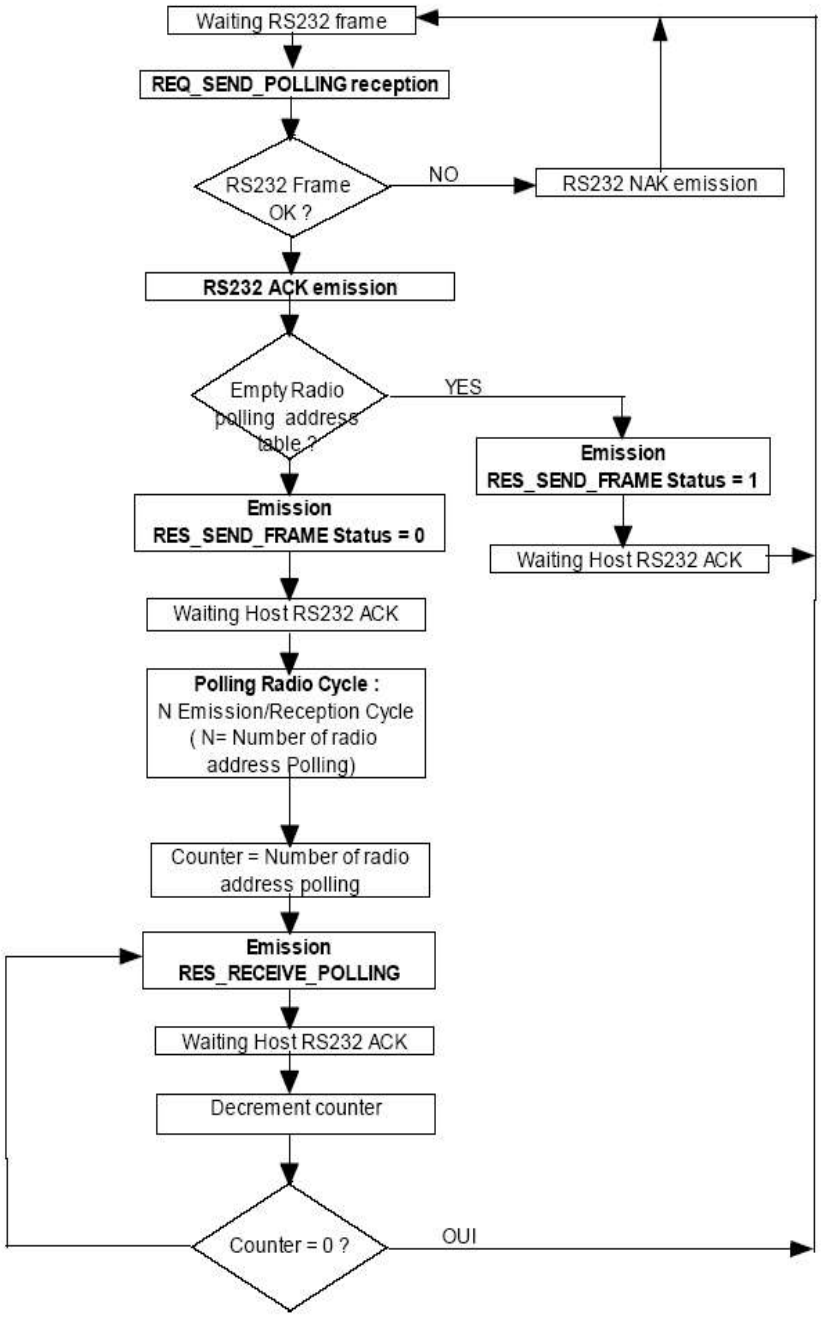
POLLING_TIME : a time-out is started (set by POLLING_TIME) after the radio frame is transmitted. If modules do not respond before the end of the time-out (by default 1 second), then the transmitter sends the same radio frame to the next remote module. If the previous remote module responds after the time-out, its response frame is lost.

The **POLLING_TIME** parameter can be modified using parameter setting commands.

For synchronization reasons, even if a remote module responds before the end of the **POLLING_TIME** time-out, the next request is sent only after the time-out.

Low-level commands are used to gather RECEIVED_FRAME_POLLING responses. An index is incremented upon reception of each polling response. When the WaveCard that initiated the polling exchange is not longer expecting new responses, it sends its host a first RECEIVED_FRAME_POLLING command, and will then wait for low-level acknowledgement to decrease its index and send the next RECEIVED_FRAME_POLLING command.

The following diagram shows the operations carried out by a Wavecard board following reception of a REQ_SEND_POLLING command:



Polling mode exchanges do not use the values set in the RADIO_ACKNOWLEDGE parameter.

5.4 Broadcast mode

This mode allows a transmitter to address a request to all Wavenis modules within radio range. You do not have to specify the address of each remote module.

Depending on the command used, requests can either wait or not wait for a response (**REQ_SEND_BROADCAST** or **REQ_SEND_BROADCAST_MESSAGE** commands). In either case, there are two types of exchange in broadcast mode:

- **Non-selective broadcast**: queries all modules within radio range
- **Selective broadcast**: only queries a given group of modules within radio range

5.4.1 Configuring broadcast mode parameters

Parameters are accessible using **REQ_READ_RADIO_PARAM** and **REQ_WRITE_RADIO_PARAM** commands (all parameters are listed in Appendix III).

NUM	DESCRIPTION	VALUE	SIZE (in bytes)
0x0E	EXCHANGE_STATUS : parameter related to the activation of error and/or status frame management (see chapters 3 and 5).	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 time-out used for CSMA frame reception following a REQ_SEND_BROADCAST command transmission (starting with firmware v2.01)	Value multiples of100 ms. Default = 0x3C (6 seconds)	1

5.4.2 Using broadcast mode (without waiting for response)

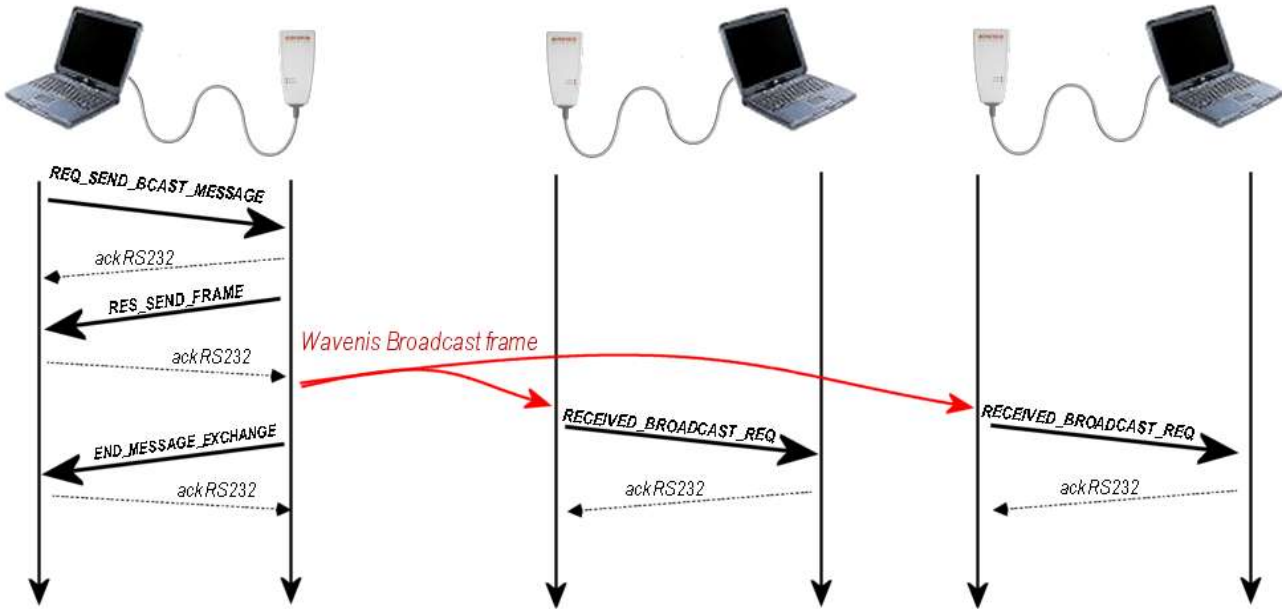
This mode allows you to address a request to all Wavenis modules within radio range of the transmitter without waiting for responses. Depending to the EXCHANGE_STATUS settings, the local Wavecard is ready for further RS232 serial link exchanges:

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

Command description

CMD	NAME	DESCRIPTION
0x21	RES_SEND_FRAME	Radio board response to frame transmission (response to 0x20, 0x22,0x24, 0x26, 0x28, 0x2A request)
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 following a 0x22 & 0x24 & 0x2A request command. Reception of this frame depends on the value of the EXCHANGE_STATUS parameter.
0x38	RECEIVED_BROADCAST_FRAME	Received a radio frame transmitted in broadcast mode

Example: broadcast exchange without waiting for responses



Reception of the **END_MESSAGE_EXCHANGE** command depends on activation of the **EXCHANGE_STATUS** parameter (0x0E). This command allows host equipment to know exactly when the Wavecard is ready for RS232 communication.

5.4.3 Using broadcast mode (waiting for responses)

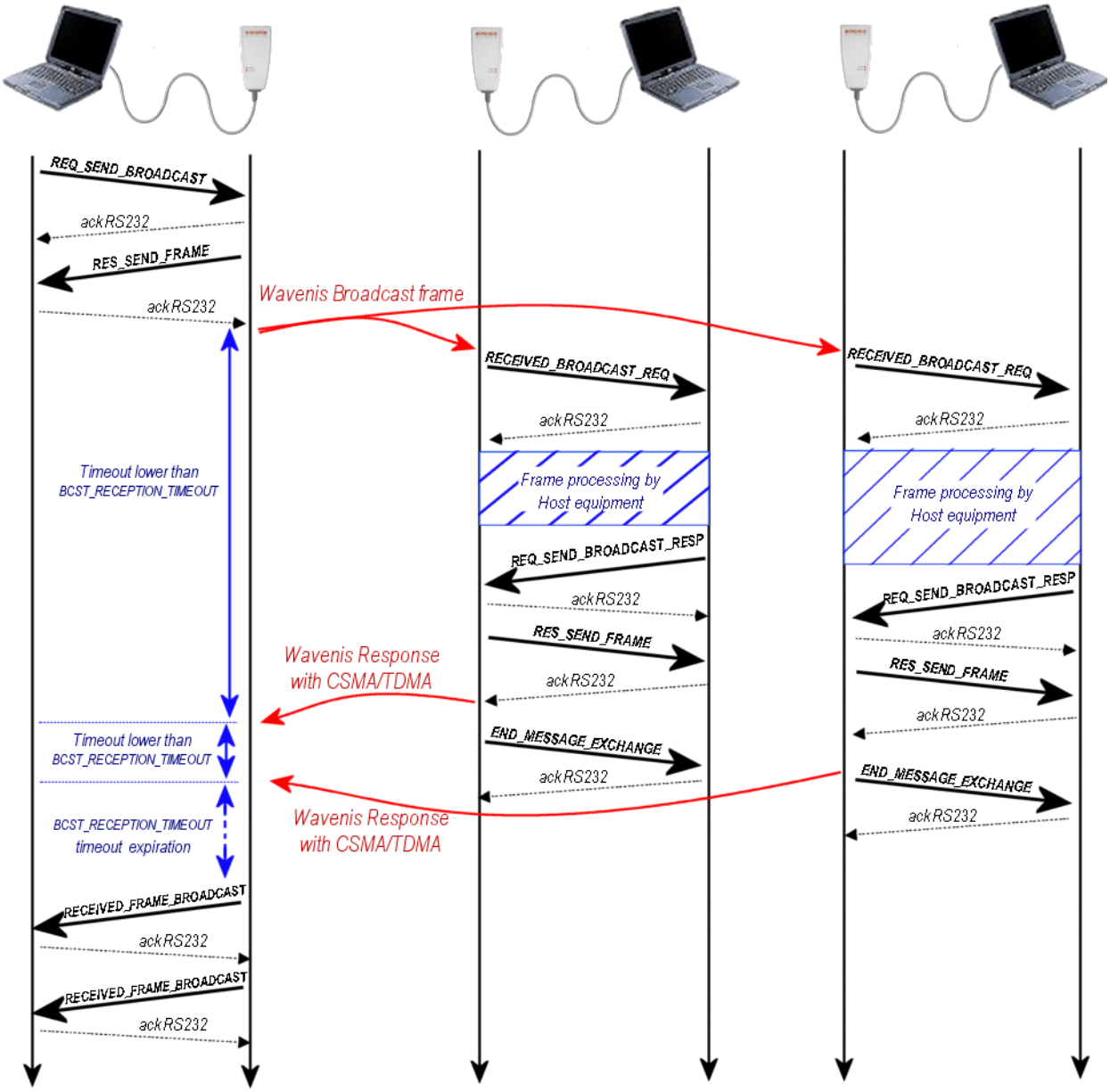
After transmitting a broadcast request, Wavecard switches to reception mode, during which time it will record all responses from remote modules. This phase ends after the time-out set by BCST_RECEPTION_TIMEOUT (0x17).

The time-out is reinitialized with each reception of a response frame. After the time-out, WaveCard forwards responses to its host via serial link, frame after frame.

Command description

CMD	NAME	DESCRIPTION
0x21	RES_SEND_FRAME	Radio board response to frame transmission (response to 0x20, 0x22,0x24, 0x26, 0x28, 0x2A request)
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 a 0x22 & 0x24 & 0x2A request command. Reception of this frame depends on the value of EXCHANGE_STATUS.
0x38	RECEIVED_BROADCAST_FRAME	Received a radio frame transmitted in broadcast mode

Example: broadcast exchange waiting for responses



Reception of the END_MESSAGE_EXCHANGE command depends on the EXCHANGE_STATUS parameter (0x0E). This command allows host equipment to know exactly when the Wavecard is ready for RS232 communication.

5.4.4 Command format from the transmitter side

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

REQ_SEND_BROADCAST or 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 query in broadcast mode	n bytes of data to transmit Maximum size is 152 bytes		0x03

- **Group number to query**: Only the most significant byte (MSByte) corresponds to the group number. The 5 other bytes are not significant.

If the group number is 0xFF 0xXX 0xXX 0xXX 0xXX 0xXX, all modules that receive 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 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	Frame Index	Radio address of the response transmitter	Received data 152 bytes max.		0x03

Status : = 0: reception OK
= 1: indicates that the number of received responses is higher than 255. In this case, only the first 255 responses are forwarded to the host.

Frame index: This index is used by the Wavecard to know how many responses are to be forwarded to the host. This index is decremented on low-level acknowledgement when the Wavecard send a response to its host. The host knows that all responses have been sent when the frame index is 1. By ensuring that this value is properly decremented with each received frame, this index is also used to confirm that no frames were lost.

5.4.5 Command format from the 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 request transmitter	n bytes of data 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 request transmitter	n bytes of data to transmit Maximum size is 152 bytes		0x03

This command can only be used after receiving a broadcast frame (RECEIVED_BROADCAST_FRAME = 0x38). Thus, the destination radio address of this message can only be that of the module that transmitted the initial broadcast frame.

Using this command in any other conditions could render Wavecard unavailable for 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

Use of this command requires status messages to be activated in **EXCHANGE_STATUS** (0x0E).

5.4.6 Using selective and non-selective broadcast modes

There is no specific procedure for initiating a broadcast request in selective or non-selective modes. You just have to make sure that remote modules have their GROUP_NUMBER parameter configured.

Simply issue a broadcast request (with or without waiting for responses) with “group number” configured to adjust selection.

- Group number = 0xFF 0xXX 0xXX 0xXX 0xXX 0xXX non-selective mode
- Group number = 0x01 0xXX 0xXX 0xXX 0xXX 0xXX selective mode

In the second case (selective mode), all Wavenis modules within radio range whose group number is set to 0x01 will receive the broadcast command.

5.5 Multi-frame mode

From the user's perspective, multi-frame mode is used only for reception. That is, Wavecard they can receive data in multi-frame mode but they cannot transmit.

Restrictions for using multi-frame mode:

- Wavecard does not currently offer multi-frame mode between two Wavecard/Waveport modules.
- Current firmware version does not allow multi-frame mode operation via repeaters.

5.5.1 Overview

Wavecard equipment can manage reception of successive frames sent by a remote module. Data is first stored in internal memory, then transferred to the host module via serial link when RF reception is complete.

Depending on the quantity of data to transmit, multi-frame operation is initiated by remote modules following a point-to-point request from a Wavecard module.

5.5.2 Received frame format

- Multi-frame reception – 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 frames received	Frames index	Radio address of the response transmitter	Received data 152 bytes max.		0x03

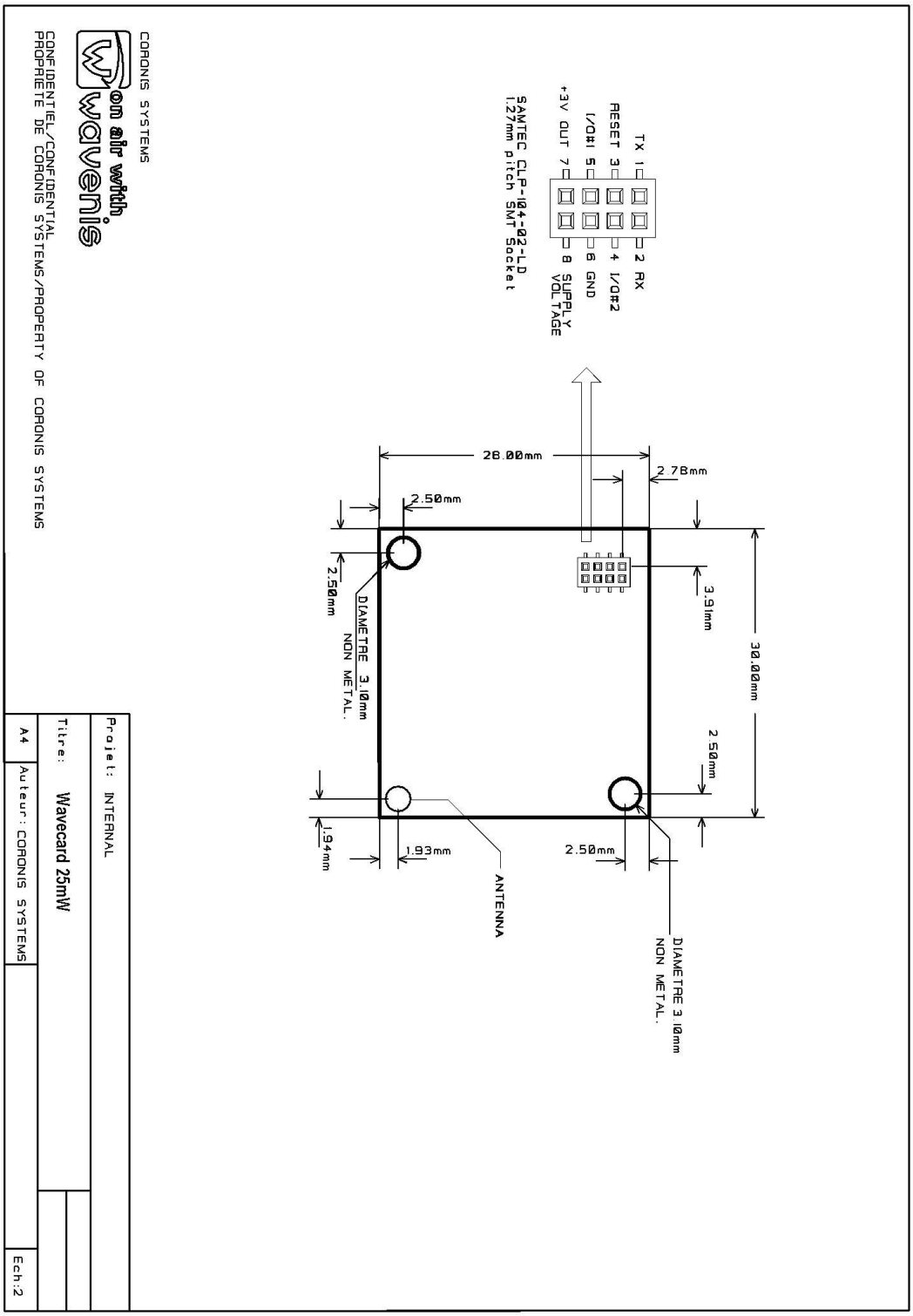
Status = 0: reception OK
= 1: indicates that the number of received responses is higher than 255. In this case, only the first 255 responses are forwarded to the host.

Frame index This index is used by the Wavecard to know how many responses are to be forwarded to the host. This index is decremented on low-level acknowledgement when the Wavecard send a response to its host.

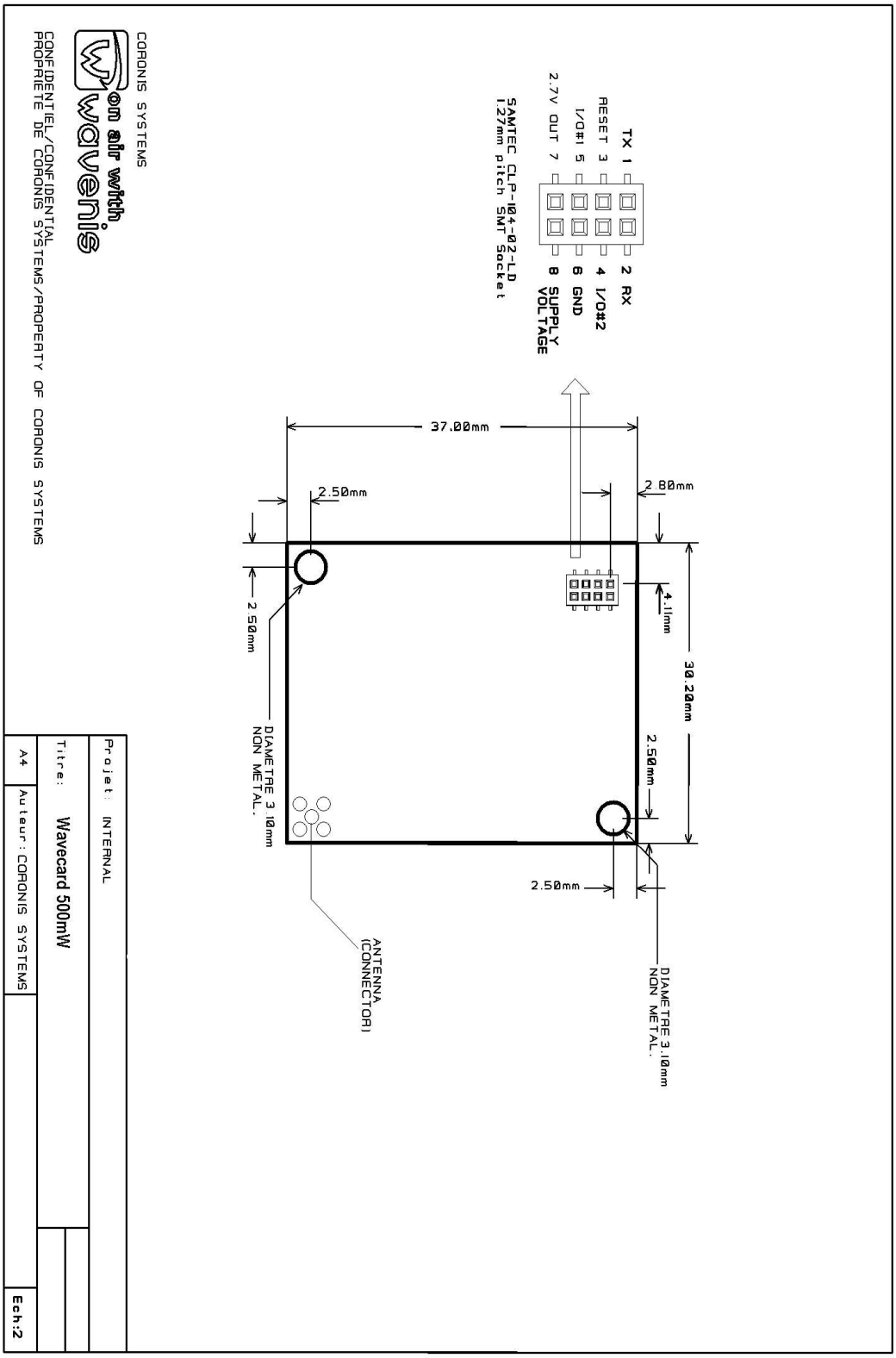
The host knows that all responses have been sent when the frame index is 1. By ensuring that this value is properly decremented with each received frame, this index is also used to confirm that no frames were lost.

Appendix I – Wavecard physical layout

- 25mW Wavecard



- 500mW Wavecard



Appendix II – Wavecard electronic interface

- 25mW WaveCard

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, min.: 100 ms)	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 (3.3V to 4.5V) Minimum current 45mA	INPUT

- 500mW WaveCard

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, min. 100 ms)	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 [3,3V à 4,3V] • 700mA minimum current peak	INPUT

Appendix III – Parameter list

Parameter number	Description	Value	Size (bytes)
0x00	AWAKENING_PERIOD RF radio medium polling period, in multiples of 100 ms	Period in multiples of 100 ms (by default, 0x0A for one second) 0 = nearly continuous reception (every 20 ms)	1
0x01	WAKEUP_TYPE Wake-up type used during frame transmission	0: long Wake Up (default setting) 1: short Wake Up = 50 ms	1
0x02	WAKEUP_LENGTH Duration of wake-up when long wake-up is used This value must be higher than the RF polling period. Value in multiples of 1 ms, 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 Wavecard's polling group number.	Byte 1: Polling_Group by default, Polling_Group = 0x00	1
0x04	RADIO_ACKNOWLEDGE Indicates whether or not radio frames must be acknowledged by the receiver.	0: no acknowledgement 1: acknowledgement used (default value)	1
0x05	RADIO_ADDRESS Radio board address	This value assigned at the factory. Read-only.	6
0x06	RELAY_ROUTE_STATUS Parameter related to relay route transmission in each relayed frame received.	0x00: Relay route transmission deactivated 0x01: Relay route transmission activated By default, Relay route transmission deactivated	1
0x07	RELAY_ROUTE Table containing the radio of successive repeaters used to to reach an end-point.	BYTE 1: number of repeaters in route Maximum number of repeaters = 3 If BYTE 1 != 0 BYTES 2 - 7: First repeater radio address, etc.	1 to 19
0x08	POLLING_ROUTE Table containing the list of radio address to be queried.	BYTE 2 : number of modules to query IF BYTE 2 != 0 BYTES 3 to 8 : radio address of the first module, etc.	1 to 241
0x09	GROUP_NUMBER: Byte containing the group number of the modules to address in radio polling mode.	Group number By default, GROUP_NUMBER = 0x00	1
0x0A	POLLING_TIME Delay between two transmissions in polling mode	Value in multiples of 100 ms By default, POLLING_TIME = 0x0A	1
0x0C	RADIO_USER_TIMEOUT Time-out used for receiving a response frame	Value in multiples of 100 ms Default value = 0x14 (2 seconds)	1
0x0E	EXCHANGE_STATUS Parameter related to activation or error and/or status frame management.	0: status and error frame deactivated 1: error frame activated 2: status frame activated 3: both status and error frames activated By default, EXCHANGE_STATUS = 0x00	1
0x10	SWITCH_MODE_STATUS: Automatic selection of RF communication mode used to address a module using its radio address	0: automatic selection deactivated 1: automatic selection activated Default value, SWITCH_MODE_STATUS = 0x01	1
0x16	WAVECARD_MULTICAST_GROUP Byte containing the Wavecard's multicast group (available starting with firmware v2.00).	By default, no group selected = 0xFF	1
0x17	BCST_RECEPTION_TIMEOUT time-out for receiving CSMA frame following a REQ_SEND_BROADCAST command transmission (available starting with firmware v2.01)	Value in multiples of100 ms. Default = 0x3C (6 seconds)	1

Appendix IV – Parameter setting commands

CMD	Name	Description
0x40	REQ_WRITE_RADIO_PARAM	Request to update radio parameters
0x41	RES_WRITE_RADIO_PARAM	Radio board response to radio parameter update
0x42	REQ_CHANGE_UART_BDRATE	Request to update serial link baud rate
0x43	RES_CHANGE_UART_BAUDRATE	Radio board response to the serial link baud rate update. Serial link baud rate is updated after has ended
0x44	REQ_CHANGE_TX_POWER(1)	Request to update radio board transmission power
0x45	RES_CHANGE_TX_POWER(1)	Radio board response to transmission power update
0x46	REQ_WRITE_AUTOCORR_STATE	Request to update WAVENIS RF ASIC RSSI threshold auto-correction state
0x47	RES_WRITE_AUTOCORR_STATE	Radio board response to WAVENIS RF ASIC auto-correction state update
0x50	REQ_READ_RADIO_PARAM	Request to read radio parameters
0x51	RES_READ_RADIO_PARAM	Radio board response to parameter reading request
0x54	REQ_READ_TX_POWER	Request to read radio board transmission power
0x55	RES_READ_TX_POWER	Radio board response to the transmission power reading
0x5A	REQ_READ_AUTOCORR_STATE	Request to read WAVENIS RF ASIC RSSI threshold auto-correction state
0x5B	RES_READ_AUTOCORR_STATE	Radio board response to WAVENIS RF ASIC auto-correction state reading.
0x60	REQ_SELECT_CHANNEL	Request to select operating radio channel when FHSS is deselected
0x61	RES_SELECT_CHANNEL	Response to channel selection request
0x62	REQ_READ_CHANNEL	Request to read the operating radio channel when FHSS is deselected
0x63	RES_READ_CHANNEL	Response to read channel request
0x64	REQ_SELECT_PHYCONFIG	Request to select RF medium communication mode
0x65	RES_SELECT_PHYCONFIG	Response to communication mode selection request
0x66	REQ_READ_PHYCONFIG	Request to read RF medium communication mode
0x67	RES_READ_PHYCONFIG	Response to communication mode read request
0x68	REQ_READ_REMOTE_RSSI	Request to read RSSI level from remote module
0x69	RES_READ_REMOTE_RSSI	Response to the read remote RSSI level request
0x6A	REQ_READ_LOCAL_RSSI	Request to read the local Wavecard RSSI level via an exchange with a remote module
0x6B	RES_READ_LOCAL_RSSI	Response to the read local RSSI level request
0xA0	REQ_FIRMWARE_VERSION	Request to read radio board firmware version
0xA1	RES_FIRMWARE_VERSION	Radio board response to firmware version reading
0xB0	MODE_TEST	Switch Wavecard into a selected test mode

(1) : Commands available only on Wavecard 25mW radio board

Appendix V – Data transmission commands

CMD	NAME	DESCRIPTION
0x20	REQ_SEND_FRAME	Request to send a radio frame and to wait for the radio response.
0x21	RES_SEND_FRAME	Radio board response to the frame transmission (response to 0x20, 0x22,0x24, 0x26, 0x28, 0x2A request)
0x22	REQ_SEND_MESSAGE	Request to send a radio frame without waiting for 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 in 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	Radio frame received by the radio board.
0x31	RECEPTION_ERROR	Frame indicating error type detected following last exchange in point-to-point or relay 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 radio frame relayed by the radio board. Reception of this command is possible only if the RELAY_ROUTE_STATUS(0x06) parameter is set.
0x36	RECEIVED_MULTIFRAME	Received radio frame in multi-frame mode. Indicates that subsequent frames are pending.
0x37	END_MESSAGE_EXCHANGE	Frame indicating end of message exchange. This frame is returned only after 0x22 & 0x24 & 0x2A request commands. Reception of this frame depends on the value of EXCHANGE_STATUS.
0x38	RECEIVED_BROADCAST_FRAME	Received a radio frame transmitted in broadcast mode