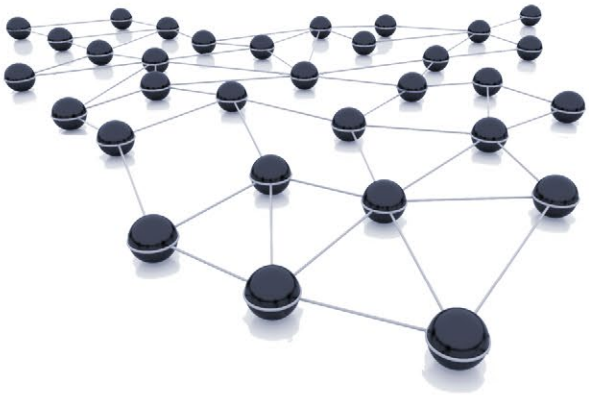
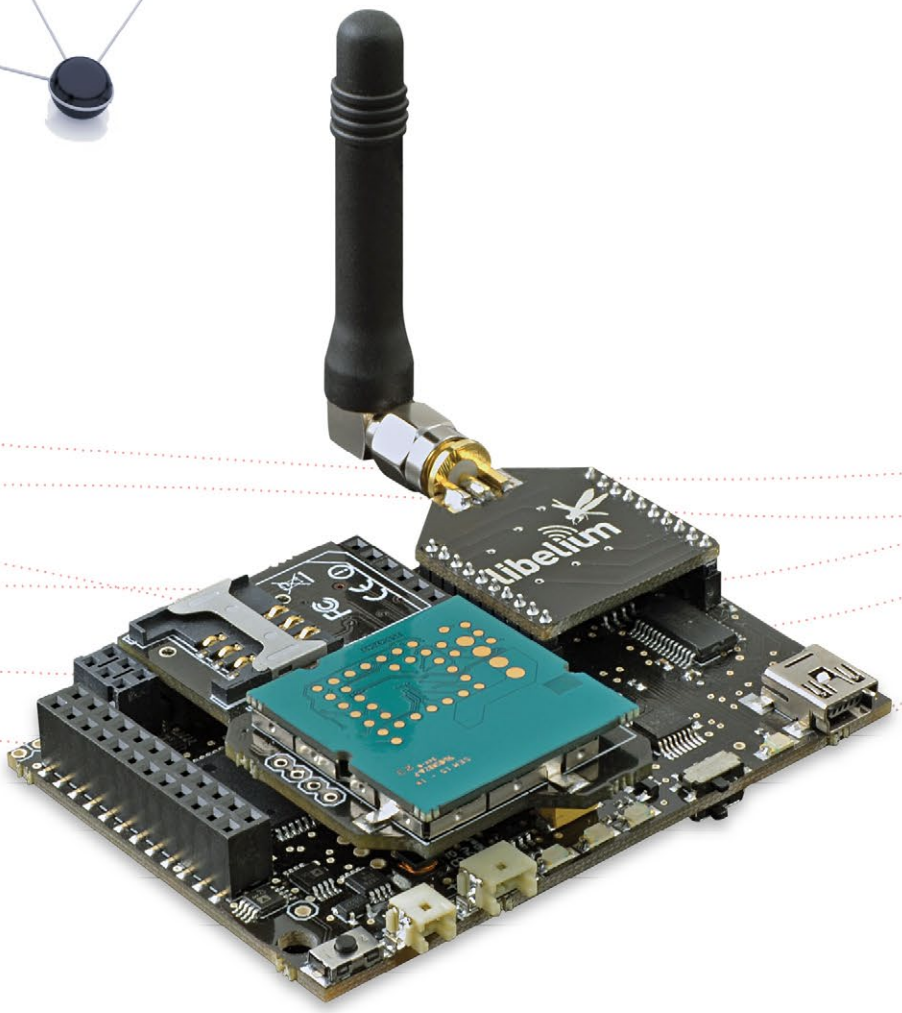
Waspmote 3G

Networking Guide





libelium

waspmote

Document Version: v5.0 - 03/2016

INDEX

1. General Considerations

1.1. Introduction

Important:

Since March 2016, the SIM5218 chipset is retired because the provider, SIMCom, implemented the End Of Life process. Libelium has migrated from that chipset to the SIM5215. This chipset is equivalent in terms of hardware specifications and software handling, but has some important changes, please see the table in the next section.

This guide explains about the new 3G module (with the SIM5215). Previous versions of this guide explained about the retired 3G+GPS module (with the SIM5218).

The 3G/GPRS module for Waspmote allows sensor networks and M2M devices to connect to the Cloud by using high speed WCDMA cellular networks in the same way as Smartphones do. This makes possible sensor nodes send not only discrete sensor information such as temperature or humidity (which can be encoded using just a single number) but also complex streams of information such as photos and videos. This feature allows developers the creation of new **Smart Security** applications.

The 3G/GPRS module for the Waspmote sensor platform offers speed rates of 384 kbps in download mode and also 384 kbps when uploading information to the Cloud.

Each Waspmote sensor node may integrate at the same time a medium range radio such as 802.15.4/ZigBee/Bluetooth/WiFi and one long range 3G radio. This way we can minimize costs by using the mobile network just when really needed.

The 3G communicating module is specially oriented to work with Internet servers implementing internally several application layer protocols which make easier to send the information to the cloud. We can make HTTP and HTTPS (secure mode) navigation, downloading and uploading content to a web server. In the same way FTP and FTPS (secure mode) protocols are also available, which is really useful when your application requires handling files. You can even send and receive mails directly from Waspmote using the SMTP and POP3 clients implemented internally.

Coinciding with the release of the 3G/GPRS module and in order to take part of all the the capabilities Libelium launched the Video Camera Sensor board, which allows to each of the nodes of the sensor network to take photos (640x480), record videos (320x240) and upload them in real time to the Cloud. The Video Camera Sensor board includes 22 high power IR LED's to implement a night vision mode.

The 3G/GPRS module comes with an internal SD Card of 2GB (extended up to 32GB) which is used to store the photos and videos taken by the Video Camera Sensor Board without the need of being handled by the MCU. This ensures we get real speed ranges as the communication is direct between the SD and the 3G/GPRS module.

1.2. 3G vs 3G+GPS vs GPRS vs GPRS+GPS

Comparative table between the 3G and the GPRS module for Waspmote:

Model	3G (SIM5215E)	3G+GPS (SIM5218)	GPRS (SIM900)	GPRS+GPS (SIM928A)
Download speed	384 Kbps	7.2 Mbps	0.02 Mbps	0.02 Mbps
Upload speed	384 Kbps	5.5 Mbps	0.01 Mbps	0.01 Mbps
FTP	Yes	Yes	Yes	Yes
FTPS (Secure)	Yes	Yes	No	No
HTTP	Yes	Yes	Yes	Yes
HTTPS (Secure)	Yes	Yes	No	No
TCP/UDP Sockets	Yes	Yes	Yes	Yes
Mails	Yes	Yes	No	No
GPS	No	Yes (A-GPS + S-GPS + NMEA)	No	Yes, but only NMEA stand-alone mode
Video Camera	Yes (Photo + Video)	Yes (Photo + Video)	No	No
Video Calls	Yes	Yes	No	No
Protocols	WCDMA, GPRS, GSM	HSPA, WCDMA, GPRS, GSM	GPRS/GSM	GPRS/GSM
Frequency Bands	850, 900, 1800, 2100 MHz	850, 900, 1800, 1900, 2100 MHz	850, 900, 1800, 1900 MHz	850, 900, 1800, 1900 MHz
SD Card	Yes (up to 32GB)	Yes (up to 32GB)	No	No

Figure: Comparative table between cellular radio modules.

1.3. Hardware

GSM / GPRS / 3G module

Figure: 3G/GPRS board

Model: SIM5215E

Dual- Band WCDMA/UMTS 900/2100 MHz

Tri-Band GSM/GPRS/EDGE 850/900/1800 MHz

WCDMA (downlink): up to 384 kbps

WCDMA (uplink): up to 384 kbps

TX Power:

- UMTS 2100/900: 0.25 W
- GSM 850/900: 2 W
- DCS 1800: 1 W

Sensitivity: -106dBm

Antenna connector: UFL

External Antenna: 0dBi

Consumption in sleep mode: 1mA

Dimensions (3G/GPRS module): 33 x 62 x 12 mm

Dimensions (3G/GPRS module plugged on Waspmote): 73 x 62 x 20 mm

Actions:

- Videocall, record video and take pictures available with Video Camera Sensor Board
- Support microSD card up to 32GB
- 64MB of internal storage space
- Making/Receiving calls
- Making 'x' tone missed calls
- Sending/Receiving SMS
- Single connection and multiple connections TCP/IP and UDP/IP clients
- TCP/IP server.
- HTTP and HTTPS service
- FTP and FTPS Service (downloading and uploading files)
- Sending/receiving email (SMTP and POP3)
- OTA feature can be performed now by Waspmote's 3G/GPRS module. Refer to the Over the Air Programming Guide for more information:
  http://www.libelium.com/development/waspmote/documentation/over-the-air-programming-guide-otap/

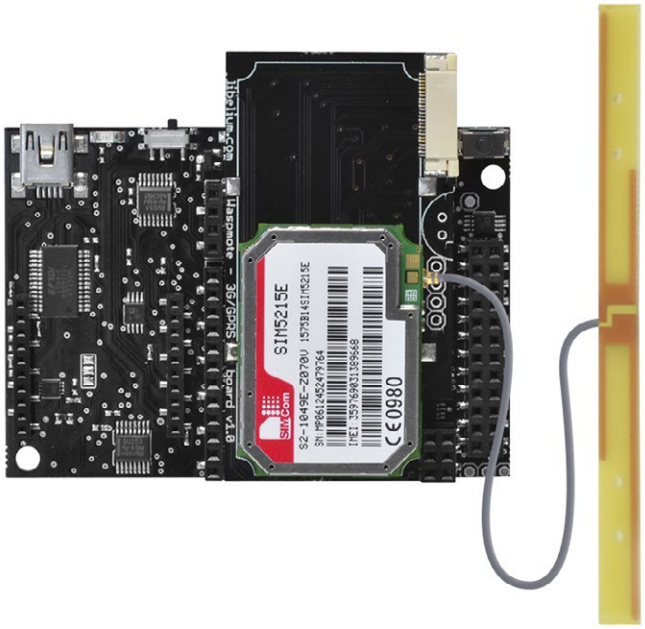


Figure: 3G/GPRS board in Waspmote

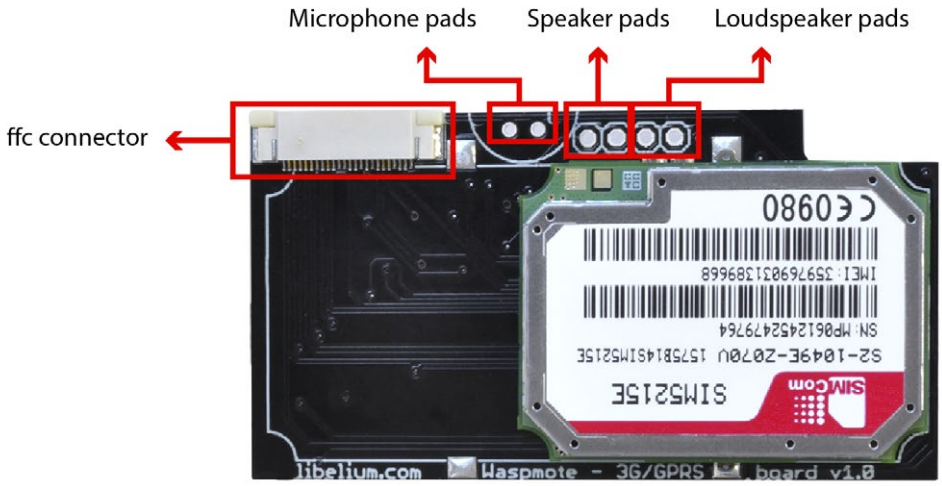


Figure: 3G/GPRS board top

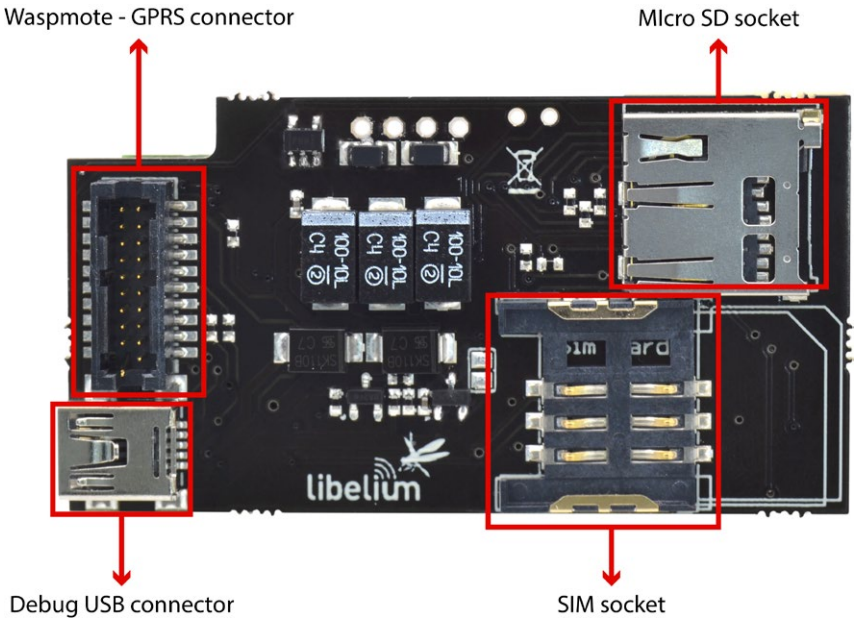


Figure: 3G/GPRS board bottom

1.4. Waspmote Libraries

1.4.1. Waspmote 3G Files

Wasp3G.h ; Wasp3G.cpp

1.4.2. Constructor

In order to start using Waspmote 3G library, an object from class 'Wasp3G' must be created. This object, called '_3G', is created inside Waspmote 3G library and it is public to all libraries. It is used throughout the guide to show how the Waspmote 3G library works.

When creating this constructor, some variables are defined with a value by default, that can be modified later. These variables are:

- `_baudRate` : specifies the baudrate used to communicate with the module (115200 by default).
- `_socket` : specifies the socket used to communicate with the module (socket1 by default).
- `_pwrMode` : specifies the power mode (`_3G_ON` by default).

1.4.3. Working Modes

Some constants have been defined to set the different working modes for the 3G/GPRS module.

- 1: `_3G_ON`. Module is powered on. Starts the module in full functionality.
- 2: `_3G_FULL`. Module is set in full functionality (power consumption around 50mA with peaks around 1-1'4A).
- 3: `_3G_MINIMUM`. Module deactivates RF and SIM (power consumption around 35mA).
- 4: `_3G_RF_OFF`. Module deactivates RF (power consumption around 35mA).
- 5: `_3G_SLEEP`. In this mode the 3G/GPRS module deactivates RF and SIM and enters in sleep mode when the when the periphery equipment stops working. The power consumption in this state is around 1mA.
- 0: `_3G_OFF`. Module is powered off. Supply from the battery are disconnected by the transistors.

When the module communicates with carrier, current peaks between 1-1'4A are produced.

1.4.4. Library fuses

The library for this module is divided in 9 sections and other section with functions and constants that always are active. Each section is activated/deactivated by a fuse. This fuses are located in Wasp3G.h. By default this fuses have a '1' allowing to use the functions. The Wasp3G.h have this fuses:

- `GSM_FUSE`: Call and SMS related funtions and constants
- `CAMERA_FUSE`: Camera related funtions and constants
- `FTP_FUSE`: FTP related funtions and constants
- `MAIL_FUSE`: SMTP and POP3 related funtions and constants
- `HTTP_FUSE`: HTTP and HTTPS related funtions and constants
- `GPS_FUSE`: GPS related funtions and constants
- `IP_FUSE`: TCP and UDP related funtions and constants
- `TRANSMISION_FUSE`: File transmission related funtions and constants
- `OTA_FUSE`: OTA related funtions and constants (`FTP_FUSE` must be '1' too)

For deactivate a section change the '1' in the related fuse by '0'.

Note: *GPS_FUSE is only for use with 3G+GPS module (retired)*

Note: *If you use a function with the related fused with a value of '0', the compiler will give you an error.* ***Please, be carefully when you use the fuses.***

Note: *If you do not use the Videocamera Board, switch the Videocamera fuse to 0.*

1.4.5. Debug modes

The library have two debug modes implemented that allows to the experimented user show the data transmitted and received between the Waspmote and the 3G/GPRS module. The value of the `_3G_debug_mode` constant selects the debug mode:

- '0' Disables all debug messages
- '1' Shows only the commands sent to the 3G/GPRS module and some extra messages
- '2' Shows commands sent to the 3G/GPRS module, the data answered by the module and some extra messages

The constant `_3G_debug_mode` is located in Wasp3G.h file.

1.4.6. Special errors

Some functions can give an extra error code (CME or CMS error codes). This code is stored on `_3G.CME_CMS_code`. To know the description of the code see the appendix.

2. Initialization

2.1. Initializing the 3G/GPRS module

The 3G/GPRS module is connected to a multiplexer, since it is connected to the same microcontroller UART. To start using the 3G/GPRS module, this multiplexer must be switched on and choose the correct combination for the 3G to be selected. This selection is (1,1).

To open the UART and set the multiplexer to the correct combination, a function has been developed. This function powers on (`_3G.setMode(_3G_ON)`) the module too, but doesn't configure the UART.

Example of use:

```
{
  // Configures the Waspmote to work with 3G module and starts it:
  _3G.ON();
}
```

2.2. 3G power modes

The 3G/GPRS module has five different power modes: `_3G_ON`, `_3G_FULL`, `_3G_MINIMUM`, `_3G_OFFLINE`, `_3G_SLEEP` and `_3G_OFF`.

The function setMode will set up the '`pwrMode`' variable to one of the five values, but also configures the Waspmote's pins and sends the serial command to the 3G/GPRS module. It returns '1' on success, '0' and '-2' if error and '-3' when the module starts succesfully with low battery (in which case the user should expect future failures due to not enough power).

The function `getMode()` gets the power mode of the module.

Example of use:

```
{
  uint8_t powerMode=0;
  // Sets the 3G in full functionality:
  _3G.setMode(_3G_FULL);
  // Get _3G power mode:
  powerMode=_3G.getMode ();
}
```

Related variables `_3G.pwrMode` → stores 3G power mode

2.3. Closing communications with the 3G/GPRS module

It closes the UART to which the 3G/GPRS module is connected. It means disconnecting the internal UART drivers inside the ATMEGA1281 processor, but the power mode of the 3G/GPRS module don't change.

Example of use:

```
{
  // Closes UART:
  _3G.close();
}
```

2.4. Switching 3G off

It closes the UART to which the 3G/GPRS module is connected to and turns it off.

Example of use:

```
{
  // Closes UART and turns it off:
  _3G.OFF();
}
```

2.5. Checking the GSM connection

It checks if the module is connected to the network for a time desired by the input parameter.

If the 3G/GPRS module does not connect within these attempts, function exits with '0'.

Example of use:

```
{
  // Waits 60 seconds for connection:
  _3G.check(60);
}
```

This function returns:

- '1' if the module is connected to the carrier
- '0' if not connected

According to Libelium experience, 60 seconds is the recommended timeout for connecting the 3G/GPRS network. The timeout may vary depending on the network range and quality of service. If the user detects this timeout does not allow his 3G/GPRS to connect, he can experiment with higher values. 120 seconds would be the maximum advised timeout: if the 3G/GPRS module cannot connect in 2 minutes, it is better to stop trying and check again in the next loop.

Note for USA users: *We have tested the new 3G shield with the AT&T network which supports natively the GSM and 3G protocols. With other carriers may also work although we haven't tried and thus we can not ensure it. For this reason we recommend to use AT&T SIM cards.*

2.6. Setting time and date from RTC

This function updates the time and the date of the 3G/GPRS module from the RTC.

Example of use:

```
{
  // Updates time and date:
  _3G.setTime();
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if error with CME error response

2.7. Setting operator parameters

When the 3G module uses some services like IP connections (TCP/UDP), HTTP services, SMTP/POP3 or FTP transfers, it's mandatory to configure operator parameters like APN, login and password.

There are two ways to configure these settings. The first one is to use the definitions into the file Wasp3G.h.

```
#define _3G_APN       "apn"
#define _3G_LOGIN     "login"
#define _3G_PASSW     "password"
```

The second one is to use the function `set_APN()`.

Example of use:

```
{
  // If only APN is necessary
  _3G.set_APN("provider_APN");
  // If APN, login and password are necessary
  _3G.set_APN("provider_APN", "login", "password");
}
```

3. SIM related functions

Some functions have been developed to configure some settings related with GSM, specifically with managing calls and SMS.

3.1. Setting the PIN

It sets the PIN to the SIM card.

Example of use:

```
{
  // Sets PIN=1234 to the SIM:
  _3G.setPIN(“1234”);
}
```

This function returns:

- ‘1’ on success
- ‘0’ if error

3.2. Changing PIN number

It changes PIN number of SIM card.

Example of use:

```
{
  // Changes the PIN number from “1234” to “4321”:
  _3G.changePIN(“1234”, “4321”);
}
```

This function returns:

- ‘1’ on success
- ‘0’ if error
- ‘-1’ if CME code are available

3.3. Getting IMSI

It gets the IMSI from the SIM card and it stores the IMSI into `buffer_3G` variable.

Example of use:

```
{
  _3G.getIMSI();
}
```

This function returns:

- ‘1’ on success
- ‘0’ if error

3.4. Getting IMEI

It gets the IMEI from the SIM card and it stores the IMEI into `buffer_3G` variable.

Example of use:

```
{
    _3G.getIMEI();
}
```

This function returns:

- '1' on success
- '0' if error

4. GSM related functions

The fuse `GSM_FUSE` is used to activate or deactivate the functions of this section. If you use a function of this section the fuse must be at '1'.

4.1. Setting information returned when receiving a call

This function configures the information returned by the module when a call is received. It is useful to generate interruptions or to store data from the incoming call.

Example of use:

```
{
  // Sets information returned by the module when incoming call:
   _3G.setInfoIncomingCall();
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if error with CME error code available

4.2. Making calls

It makes a call to the given telephone number.

Note: *the number can be using the country code or only the phone number.*

Example of use:

```
{
  // Makes a call to the desired number:
  _3G.makeCall("*********");
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if no carrier

4.3. Making lost calls

It makes a specified duration lost call to the given telephone number.

Note 1: *the calling time includes the time to send the request to the carrier, so the receiving call time is a bit shorter than the input parameter.*

Note 2: *the number can be using the country code or only the phone number.*

Example of use:

```
{
  // Makes a lost call of 10 seconds to the desired number:
  _3G.makeLostCall("*********",10);
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if no carrier

4.4. Hanging up calls

It hangs up all the active calls.

Example of use:

```
{
  // Hangs all the active calls up:
  _3G.hangUp();
}
```

This function returns:

- '1' on success
- '0' if error

4.5. Setting CLI presentation in incoming calls

This function enables or disables the presentation of the incoming call.

Example of use:

```
{
  _3G.setCLIPresentation(ENABLE);
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if error with CME error code available

4.6. Setting CLI restriction in outcoming calls

This function restricts or enables the presentation of the CLI to the called party when originating a call. Allowed modes `DEFAULT_CLIR`, `INVOKE_CLIR` or `SUPPRESS_CLIR`.

Example of use:

```
{
  // Restricts the CLI for called party:
  _3G.setCLIRestriction(SUPPRESS_CLIR);
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if error with CME error code available

4.7. Gets the phone activity status

This function gets the phone activity status.

Example of use:

```
{
  uint8_t status=0;
  // Stores in 'status' the state of the phone:
  status=_3G.getPhoneActStatus();
}
```

This function returns:

- '0' for error
- '1'= Ready
- '2'= Unknown
- '3'= Ringing
- '4'= Call in progress

4.8. Autoanswer

This function enables or disables the auto-answer function of the 3G/GPRS module. The function wait a number of "rings" and the answer the call. If the number of rings is 0, disables the autoanswer.

Example of use:

```
{
  // Enables autoanswer for wait 2 rings:
  _3G.autoAnswer(2);
}
```

This function returns:

- '1' on success
- '0' if error

4.9. Answer a call

This function answers an incoming call.

Example of use:

```
{
  // Answers an incomming call:
  _3G.answerCall();
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if there isn't an incoming call

4.10. Generating DTMF tones

This function generate a DTMF tone according the code listed below:

- '0' - Stop the sound tone
- '1' - DTMF tone for 1 key, duration 100ms
- '2' - DTMF tone for 2 key, duration 100ms
- '3' - DTMF tone for 3 key, duration 100ms
- '4' - DTMF tone for 4 key, duration 100ms
- '5' - DTMF tone for 5 key, duration 100ms
- '6' - DTMF tone for 6 key, duration 100ms
- '7' - DTMF tone for 7 key, duration 100ms
- '8' - DTMF tone for 8 key, duration 100ms
- '9' - DTMF tone for 9 key, duration 100ms
- '10' - DTMF tone for 0 key, duration 100ms
- '11' - DTMF tone for A key, duration 100ms
- '12' - DTMF tone for B key, duration 100ms
- '13' - DTMF tone for C key, duration 100ms
- '14' - DTMF tone for D key, duration 100ms
- '15' - DTMF tone for # key, duration 100ms
- '16' - DTMF tone for * key, duration 100ms
- '17' - Subscriber busy sound, duration always
- '18' - Congestion sound, duration always
- '19' - Error information sound, duration 1330*3ms
- '20' - Number unobtainable sound, duration 1330*3ms
- '21' - Authentication failure sound, duration 1330*3ms
- '22' - Radio path acknowledgement sound, duration 700*1ms
- '23' - Radio path not available sound, duration 400*4ms
- '24' - CEPT call waiting sound, duration 4000*2ms
- '25' - CEPT ringing sound, duration always
- '26' - CEPT dial tone, duration always

Example of use:

```
{
  // Generate subscriber busy sound:
  _3G.generateTone(17);
  delay(5000);
  // Stops the sound:
  _3G.generateTone(0);
}
```

This function returns:

- '1' on success
- '0' if error

4.11. Ringer level

This function controls the ringer level of the loudspeaker for incoming call alert. Allowed values: '0' for mute and '1' to '5' for volume level.

Example of use:

```
{
  // Answers an incomming call:
  _3G.ringerLevel(4);
}
```

This function returns:

- '1' on success
- '0' if error

4.12. Setting Information returned when receiving an SMS

This function configures the information returned by the module when an SMS is received. It is useful to generate interruptions or to store data from the incoming SMS.

Example of use:

```
{
  //Sets information returned by the module when incoming SMS
  _3G.setInfoIncomingSMS();
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if error with CMS error code available
- '-3' if error setting the memory
- '-4' if error setting the memory with CMS error code available

4.13. Setting Mode for SMS

It sets the text mode for the SMS.

Example of use:

```
{
  //Sets text mode for sms:
  _3G.setTextModeSMS();
}
```

This function returns:

- '1' on success
- '0' if error

4.14. Sending SMS

It sends an SMS to the specified number.

Note: *the maximum length is 160 Bytes (160 characters).*

Example of use:

```
{
  // Sends this text in a SMS to the desired number
  _3G.sendSMS("Hello World!","6********");
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if error with CMS error code available

4.15. Getting the number of SMS stored in SIM card

This function gets the number of total SMS stored in the SIM card.

Example of use:

```
{
  uint8_t total_SMS=0;
  // Gets the total SMS in SIM card:
  total_SMS=_3G.getTotalSMS();
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if error with CMS error code available

4.16. Deleting SMS

This function deletes an SMS stored in the SIM card. It's advisable use first the function `getTotalSMS()` in order to know the number of SMS.

Example of use:

```
{
  // Deletes the SMS in the 2 index:
  total_SMS=_3G.getTotalSMS();
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if error with CMS error code available

5. File system related functions

5.1. Description

The file system is used to store files in a hierarchical (tree) structure, and there are some definitions and conventions to use the Module.

Local storage space is mapped to "C:", and storage space of present storage card is mapped to "D:". In both "C:" and "D:" directories, module creates four directories named "Picture", "Audio", "Video" and "VideoCall" automatically; "Picture" is used to store static image when taking picture by camera, "Audio" is used to store audio file, "Video" is used to store video file when recording by camera, and "VideoCall" is used to store media file which is recorded during a video call.

The size of the C: unit is 64MB. The microSD card store up to 32GB of information.

Some functions have been developed to work with this file system.

5.2. Go to the root directory of desired unit

The function `goRoot(unit)` selects the 'unit' to work ('0' for C: unit and '1' for D:), not for save the files created by the module, and goes to the root directory (C: or D:).

Example of use:

```
{
  // changes to microSD card and goes to the root
  _3G.goRoot(1);
}
```

This function returns:

- '1' on success
- '0' if error

5.3. Changing directory

It changes the directory in the working unit to the directory given as a parameter.

Example of use:

```
{
  // changes to "Picture" directory
  _3G.cd("Picture");
}
```

This function returns:

- '1' on success
- '0' if error

5.4. Getting file size

It gets the size of a file given as a parameter in the current directory.

Example of use:

```
{
  int32_t sizeFile;
 // gets the size of “file.txt”
 sizeFile= _3G.getFileSize(“file.txt”);
}
```

This function returns:

- The size of the file
- ‘-2’ if error

5.5. Deleting files

It deletes a file in the current directory.

Example of use:

```
{
 // deletes “file.txt”
 _3G.del(“file.txt”);
}
```

This function returns:

- ‘1’ on success
- ‘0’ if error

5.6. MicroSD is present

It checks if the microSD card is present.

Example of use:

```
{
 uint8_t present;
 // checks if microSD is present
 present=SD.isSD() ;
}
```

This function returns:

- ‘1’ if is present
- ‘’0’ if not present

5.7. List subdirectories/files in current directory

`ls(type_of_ls)` stores in `buffer_3G` a list of the files and/or subdirectories in the current directory. The function needs a number as input parameter that indicates the kind of the list to do. '0' for list the directories and the files, '1' for list only subdirectories and '2' for list only files.

Example of use:

```
{
  // lists the files in the current directory:
  _3G.ls(2);
}
```

This function returns:

- '1' on success
- '0' if error
- '2' if no data

5.8. Getting files from 3G/GPRS to Waspmote

The function `getXModemFile('origin_file', 'destiny_path')` allows to get files from the current directory of the 3G/GPRS Board and saves it in Waspmote's microSD card. '`origin_file`' is the name of the file to get. `destiny_path` is the path with the name to store the file in Waspmote's microSD card.

Example of use:

```
{
  // Gets the test1.txt from 3G/GPRS board and stores it in /dir1/t001.txt:
  _3G.getXModemFile("test.txt", "/dir1/t001.txt");
}
```

This function returns:

- '1' if success
- '0' if error
- '-2' if error going to root directory in Waspmote's SD
- '-3' if error creating the file in Waspmote
- '-4' if error if file not exist in 3G/GPRS module
- '-5' if error getting the file

6. Camera related functions

Waspmote 3G/GPRS module is capable to take pictures and videos and store in the memory of the module or in its external microSD card. To use camera functions the Videocamera Sensor Board is required. This board, the 3G/GPRS Board, allows to Waspmote take pictures in jpg format with a resolution up to VGA quality (640 x 480) and record video in mp4 format with a resolution up to QVGA quality (320 x 240).

Figure: Video Camera Sensor Board

The Video Camera Sensor Board uses 22 IR LEDs to give extra illumination and record with few light or in the night. To eliminate the IR distortion when the board is used with natural light, the board has a filter exchanger with a IR light filter. The board has two sockets for a luminosity sensor and a IR sensor. With the information of these sensors the users can select the proper filter and, if is necessary, to use the IR LEDs.

The Video Camera Sensor Board also includes a presence sensor (PIR), to generate an interruption on Waspmote and take a picture or record a video when a person passes by, this feature is specially designed for security and surveillance applications.

Note: *If you use the Videocamera Board, switch the Videocamera fuse to 1.*

6.1. Connecting the camera

To connect the Videocamera Sensor Board to the Waspmote 3G board, refer to Videocamera Sensor Guide.

6.2. Starting the camera

The camera must be started before the use. To start the camera use the function `startCamera()`.

Example of use:

```
{
  // Starts the camera:
  _3G.startCamera();
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if camera not detected
- '-3' if camera is already started.

6.3. Stopping the camera

When do not use the camera, the function `stopCamera()` stops and turns off the camera reducing the power consumption.

Example of use:

```
{
  // Stops the camera:
  _3G.stopCamera();
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if camera not started

6.4. Configuration of the camera

The camera can be configured in some parameters. Each one have its own function.

Note: *the camera must be started to start the configuration.*

6.4.1. Resolution

The camera can be configured with 6 different resolutions. The next table shows the resolution, the number of horizontal and vertical pixels and the library parameter to use with the function.

Resolution	H x V (pixels)	library parameter
STAMP	80x48	0
QQVGA	160x120	1
QCIF	176x144	2
QVGA	320x240	3
CIF	352x288	4
VGA	640x480	5

Figure: Resolutions and library parameters

The highest resolution for pictures are VGA (5) and for videos are QVGA (3).

Example of use:

```
{
  // Sets QVGA resolution
  _3G.cameraResolution(3);
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if camera not detected
- '-3' if camera not started

6.4.2. Brightness

The camera have seven levels of brightness, from 0 to 6 (0 is the lowest, 6 is the highest).

Example of use:

```
{
  // Sets highest brightness
  _3G.cameraBrightness(6);
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if camera not started
- '-3' if camera is in invalid state

6.4.3. Rotation

The image of the camera can be rotated in steps of 90 degrees: 0, 90, 180 and 270.

Example of use:

```
{
  // Rotates the camera 90 degrees
  _3G.cameraRotation("90");
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if camera not started
- '-3' if camera is in invalid state

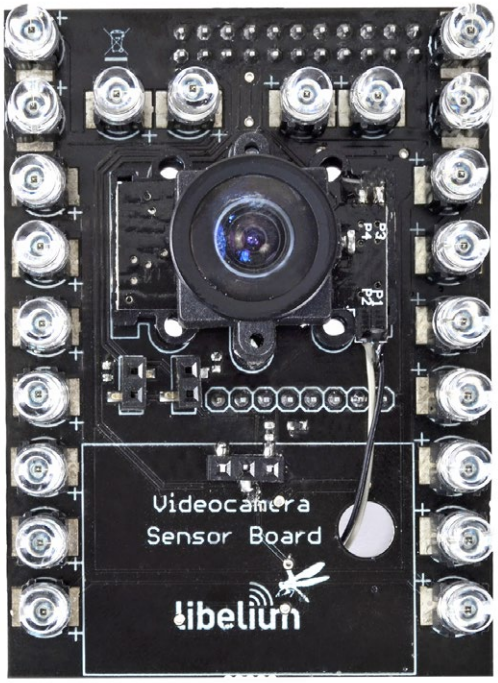


Figure: Video Camera Sensor Board with 0º rotation

6.4.4. FPS

For record a video 3 different FPS can be selected. The parameters are '0' for 7.5 FPS, '1' for 10 FPS and '2' for 15 FPS

Example of use:

```
{
  // Selects 15 fps
  _3G.cameraFPS(2);
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if camera not started
- '-3' if camera is in invalid state

6.4.5. Picture name

The name of the pictures can be customized by the user. The name can have up to 20 characters. The name is only a part of the whole name; the whole name is namexxxx.jpg where xxxx is an index of the picture after user defined name.

Example of use:

```
{
  // Sets the name of the pictures
  // The final name is → Test_name_xxxx.jpg
  _3G.pictureName("Test_name_");
}
```

This function returns:

- '1' on success
- '0' if error

6.4.6. Adding time stamp on pictures

The function `pictureTimeStamp()` allows to add a time stamp with the date and time of the 3G/GPRS module.

Example of use:

```
{
  // Adds time stamp
  _3G.pictureTimeStamp(1);

  // Don't add time stamp
  _3G.pictureTimeStamp(0);
}
```

This function returns:

- '1' on success
- '0' if error

6.5. Taking pictures

The function `takePicture()` takes a picture and stores it in the folder "Picture". To select if store in the module memory or the external microSD card use the function `selectStorage()`.

Example of use:

```
{
  // Takes a picture:
  _3G.takePicture ();
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if camera not started
- '-3' if camera is in invalid state
- '-4' if there isn't memory enough

6.6. Recording videos

There are 4 functions related with recording a video:

- `startVideo()`. Starts the recording of the video
- `pauseVideo()`. Pauses the recording of the video
- `resumeVideo()`. Resumes the recording of the video
- `stopVideo()`. Stops the recording of the video

Example of use:

```
{
  // Starts the recording:
  _3G.startVideo();

  // Records 15 seconds and pauses:
  delay(15000);
  _3G.pauseVideo();

  // Waits 5 seconds and resumes the record:
  delay(5000);
  _3G.resumeVideo();

  // Records 15 seconds and stops:
  delay(15000);
  _3G.stopVideo();

}
```

The function `startVideo()` returns:

- '1' on success
- '0' if error
- '-2' if camera not started
- '-3' if camera is in invalid state
- '-4' if there isn't memory enough

The functions `pauseVideo()`, `resumeVideo()` and `stopVideo()` return:

- '1' on success
- '0' if error
- '-2' if camera not started
- '-3' if camera is in invalid state

6.7. Making videocalls

It makes a videocall to the given telephone number. To do this you can use the function `makeVideoCall(phone_number, record)`. The input parameter `record` allow to record the videocall. '0' not record video, '1' only record far-end video, '2' only record near-end video and '3' record both far-end and near-end, The video files have been saved in the folder VideoCall/

Example of use:

```
{
  // Makes a videocall and record both far-end and near-end:
  _3G.makeVideoCall("**********", 3);
}
```

This function returns:

- '1' if success
- '0' if error
- '-1' if error connecting to the other party,
- '-2' if error with setup or the other party hangs the call
- '-3' if error connecting the videocall
- '-4' if error recording the call (videocall is active)

To hang a videocall use the function `hangVideoCall()`.

Example of use:

```
{
  // Hangs the active videocall:
  _3G.hangVideoCall();
}
```

This function returns:

- '1' if success
- '0' if error

6.8. Setting the video quality

The video quality can be selected with the function `VideoCallQuality(VideoQuality)`. The parameter `VideoQuality` can be between 5 for 5 for high quality image or 15 for high motion profile.

Note: *This function can be used only when videocall is in idle state, and the setting is available until power off.*

Example of use:

```
{
  // Sets high quality image:
  _3G.VideoCallQuality(5);
}
```

This function returns:

- '1' if success
- '0' if error

6.9. Sending DMTF tones

DMTF tones can be sent during a videocall. Allowed tones are 0–9, * and #.

Example of use:

```
{
  // Sends an example string:
  _3G.VideoCallDMTF("0123456789*#);
}
```

This function returns:

- '1' if success
- '0' if error

7. FTP and FTPS

7.1. Creating your own FTP server

First, you should get a server. This server will receive your frames and store them. There is no need to purchase a physical server since there a companies that offer remote servers.

> ***Note:*** *The server used by Libelium to realize the upload and download tests is a Pure-FTPD server (**www.pureftpd.org**) and it is hosted into a OVH server (**www.ovh.com**). The Pure-FTPD server has the settings by default:*
>
> - *TLS encryption support: Optional*
> - *TLS cipher suite: High-Medium + TLSv1*
> - *Allow anonymous logins: No*
> - *Allow anonymous uploads: No*
> - *Maximum load for anonymous downloads: 4*
> - *Maximum idle time (minutes): 15*
> - *Maximum connections: 50*
> - *Maximum connections per IP address: 8*
> - *Allow logins with root password: Yes*
> - *Broken clients compatibility: No*
>
> *From Libelium, we recommend the use of this server hosting provider to obtain good results to upload and download files, but **we can't guarantee the perfect performance of the FTP server**.*
>
> *Also, Libelium has tested with Guebs hosting (**www.guebs.com**) with good results.*

Follow the next steps to create your own FTP server using the terminal:

1 - Install the pure-ftpd server:

```
sudo apt-get install pure-ftpd
```

2 - Stop the server:

```
sudo /etc/init.d/pure-ftpd stop
```

3 - Before creating the user, it is necessary create a directory to stored the received data:
sudo mkdir /home/ftp and inclide a false shell. To check if the shell exist:

```
sudo more /etc/shells
```

4 - If it isn't the line `/bin/false`, edit the file, for example with vim, and include it:

```
sudo vim /etc/shells
```

5 - After creating a new folder to store data, you have to create a group and a user with false shell, because this type of user don't need a valid shell (more secure), therefore select `/bin/false` shell for user and `/dev/null` as directory:

```
sudo groupadd ftpgroup
sudo useradd -g ftpgroup -d /dev/null -s /bin/false user1
```

6 - Modify folder permissions:

```
sudo chown -R user1 /home/ftp
sudo chmod -R 755  /home/ftp
```

7 - Add the new user to the pure-ftpd database:

```
sudo pure-pw useradd username -u ftpuser -g ftpgroup -d /home/ftp
```

Set the user password when it request.

8 - Update the pure-ftpd database:

```
sudo pure-pw mkdb
```

9 - When the users are include in the ftp, start the server:

```
sudo /etc/init.d/pure-ftpd start
```

Remeber to open the ports in your router. After this, you will be able to receive FTP transmissions on your server. We advise to use FileZilla to visualize and manage your FTP server.

7.2. FTP related functions

7.2.1. Setting FTP parameters

Before to upload and download files from a FTP server, you need to configure the parameters of the FTP server. The parameters in order are: server address (can be an IP address or a domain name), port, user name, password, mode (1 for passive and 0 for proactive) and type (A for ASCII or I for binary).

Example of use:

```
{
  // Setting FTP parameters
  _3G.configureFTP("ftp_address", "ftp_port", "user_name", "password", 1, "I");
}
```

This function returns:

- '1' on success
- '-2' if error setting the connection parameters (APN)
- '-3' if error setting the FTP server
- '-4' if error setting the FTP port
- '-5' if error setting the FTP mode
- '-6' if error setting the FTP type
- '-7' if error setting the user name
- '-8' if error setting the FTP password
- '-13' if error setting the FTP server with if CME error available
- '-14' if error setting the FTP port with CME error available
- '-15' if error setting the FTP mode with CME error available
- '-16' if error setting the FTP type with CME error available
- '-17' if error setting the user name with CME error available
- '-18' if error setting the FTP password with CME error available

7.2.2. Uploading files from Waspmote

To upload a file from Waspmote's SD card you can use the function `uploadData(SD_origin, FTP_destination)`. `SD_origin` and `FTP_destination` are strings that contains the complete path with the file name. The strings must be start with the character '/', for example "/filename" or "/directory/filename".

Example of use:

```
{
  // Uploading a file from Waspmote
  _3G.uploadData("/SD_path/SD_file_name", "/FTP_path/FTP_file_name");
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if error with CME code (FTP error)
- '-3' if error getting file size from SD

7.2.3. Uploading files from 3G/GPRS module

To upload a file from the SD card of the 3G/GPRS module you can use the function `uploadFile(3G_folder, FTP_destination_path)`. `3G_folder` is a number that indicates the folder that contains the file to upload. Allowed values for `3G_folder`:

- 0 – current directory
- 1 – "C:/Picture" directory
- 2 – "C:/Video" directory
- 3 – "C:/VideoCall" directory
- 4 – "D:/Picture" directory
- 5 – "D:/Video" directory
- 6 – "D:/VideoCall" directory
- 7 – "C:/Audio" directory
- 8 – "D:/Audio" directory

`FTP_desitanion` is a string that contains the complete path with the file name. The string must be start with the character '/', for example "/filename" or "/directory/filename".

Example of use:

```
{
  // Uploading a file from Video directory in the 3G microSD card
  _3G. uploadFile(5, "/FTP_path/FTP_file_name");
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if error with CME code (FTP error)
- '-3' if error getting the file of the size to upload

7.2.4. Downloading files to Waspmote

To download a file to Waspmote's SD card you can use the function `downloadData(FTP_origin, SD_destination, max_time)`. `FTP_origin` and `SD_desitanion` are strings that contains the complete path with the file name. The strings must be start with the character '/', for example "/filename" or "/directory/filename". `max_time` is the total time in seconds to download the file from the server.

Example of use:

```
{
  // Downloading a file from Waspmote
  _3G.downloadData("/FTP_path/FTP_file_name", "/FTP_path/FTP_file_name", 180);
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if error with CME code (FTP error)
- '-3' if error sending the file from 3G/GPRS module to Waspmote SD

7.2.5. Downloading files to 3G/GPRS module

To download a file to the SD card of the 3G/GPRS module you can use the function `downloadFile(FTP_path, SD_destination_folder, max_time)`. `SD_destination_folder` is a number that indicates the destiny folder to the downloaded file. Allowed values for `SD_destination_folder`:

- 0 – current directory
- 1 – "C:/Picture" directory
- 2 – "C:/Video" directory
- 3 – "C:/VideoCall" directory
- 4 – "D:/Picture" directory
- 5 – "D:/Video" directory
- 6 – "D:/VideoCall" directory
- 7 – "C:/Audio" directory
- 8 – "D:/Audio" directory

`FTP_desitanion` is a string that contains the complete path with the file name. The string must be start with the character '/', for example "/filename" or "/directory/filename". `max_time` is the total time in seconds to download the file from the server.

Example of use:

```
{
  // Downloading a file from FTP to Video directory
  _3G. downloadFile("/FTP_path/FTP_file_name", 5, 180 );
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if error with CME code (FTP error)

7.3. FTPS related functions

Note: *the 3G/GPRS module doesn't support FTPS server with certificate authentication. An explicit FTPS server without certificate authentication must be used with these functions.*

7.3.1. Log into FTPS server

Before to upload or download files from a FTPS server, you need to log into the FTPS server. The parameters needed to log into the server in order are: server address (can be an IP address or a domain name), port, user name and password.

Example of use:

```
{
  // Setting FTPS parameters
  _3G.loginFPTS("ftp_address", "ftps_port", "user_name", "password");
}
```

This function returns:

- '1' on success
- '-2' if error setting the connection parameters (APN)
- '-3' if error acquiring the SSL stack
- '-4' error login into the server
- '-5' if timeout when logs in

7.3.2. Uploading files from Waspmote

To upload a file from Waspmote's SD card you can use the function `uploadDataSecure(SD_origin, FTPS_destination)`. `SD_origin` and `FTPS_destination` are strings that contains the complete path with the file name. The strings must be start with the character '/', for example "/filename" or "/directory/filename".

Example of use:

```
{
  // Uploading a file from Waspmote
  _3G.uploadDataSecure("/SD_path/SD_file_name", "/FTPS_path/FTPS_file_name");
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if error with CME code (FTP error)
- '-3' if error getting file size from SD

7.3.3. Uploading files from 3G/GPRS module

To upload a file from the SD card of the 3G/GPRS module you can use the function `uploadFileSecure(3G_folder, FTPS_destination_path)`. `3G_folder` is a number that indicates the folder that contains the file to upload. Allowed values for `3G_folder`:

- 0 – current directory
- 1 – "C:/Picture" directory
- 2 – "C:/Video" directory
- 3 – "C:/VideoCall" directory
- 4 – "D:/Picture" directory
- 5 – "D:/Video" directory
- 6 – "D:/VideoCall" directory
- 7 – "C:/Audio" directory
- 8 – "D:/Audio" directory

`FTPS_desitanion` is a string that contains the complete path with the file name. The string must be start with the character '/', for example "/filename" or "/directory/filename".

Example of use:

```
{
  // Uploading a file from Video directory in the 3G microSD card
  _3G. uploadFileSecure(5, "/FTPS_path/FTPS_file_name");
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if error with CME code (FTP error)
- '-3' if error getting the file of the size to upload

7.3.4. Downloading files to Waspmote

To download a file to Waspmote's SD card you can use the function `downloadDataSecure(FTPS_origin, SD_destination)`. `FTPS_origin` and `SD_desitanion` are strings that contains the complete path with the file name. The strings must be start with the character '/', for example "/filename" or "/directory/filename".

Example of use:

```
{
  // Downloading a file from Waspmote
  _3G.downloadDataSecure("/FTPS_path/FTPS_file_name", "/FTPS_path/FTPS_file_name");
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if error with CME code (FTP error)
- '-3' if error sending the file from 3G/GPRS module to Waspmote SD

7.3.5. Downloading files to 3G/GPRS module

To download a file to the SD card of the 3G/GPRS module you can use the function `downloadFileSecure(FTPS_path, SD_destination_folder, max_time)`. `SD_destination_folder` is a number that indicates the destiny folder to the downloaded file. Allowed values for `SD_destination_folder`:

- 0 – current directory
- 1 – "C:/Picture" directory
- 2 – "C:/Video" directory
- 3 – "C:/VideoCall" directory
- 4 – "D:/Picture" directory
- 5 – "D:/Video" directory
- 6 – "D:/VideoCall" directory
- 7 – "C:/Audio" directory
- 8 – "D:/Audio" directory

`FTPS_desitanion` is a string that contains the complete path with the file name. The string must be start with the character '/', for example "/filename" or "/directory/filename". `max_time` is the total time in seconds to download the file from the server.

Example of use:

```
{
  // Downloading a file from FTPS to Video directory
  _3G. downloadFileSecure("/FTPS_path/FTPS_file_name", 5, 180 );
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if error with CME code (FTP error)

7.3.6. Log out the FTPS server

Once the uploads or downloads have been completed use the function

Example of use:

```
{
  // Setting FTP parameters
  _3G.logoutFPTS();
}
```

This function returns:

- '1' on success
- '-2' if error logging out of the server
- '-3' if error releasing the SSL stack

8. SMTP and POP3 related functions

Note: *to use these features the email servers must work without SSL function.*

8.1. Sending email with SMTP

8.1.1. Setting the SMTP server

This function set SMTP server address and server's port number. SMTP client will initiate TCP session with the specified server to send an e-mail. If SMTP server requires authentication the function must have the user_name and the password. If the process of sending an e-mail is ongoing, the function returns -1 directly.

Example of use:

```
{
  // Sets the SMTP server without authentication :
  setSMTPserver("smtp.server.com", 110,);
  // Sets the SMTP server with authentication :
  setSMTPserver("smtp.server.com", 110, "user_name", "password");
}
```

This function returns:

- '1' if success
- '0' if error setting username and password
- '-1' if error setting server and port

8.1.2. Setting the sender address and name

This function sets the sender mail address and name.

```
{
  // Sets the sender mail address and the name:
  setSMTPfrom("senders_mail.@email.com", "sender");
}
```

This function returns:

- '1' if success
- '0' if error

8.1.3. Setting the recipient address and name

The function `setSMTPrecipient(kind, index, mail_address, name)` sets the recipient mail address and name. For set a normal recipient `kind` parameter must be 0, 1 for Carbon Copy recipient and 2 for Blind Carbon Copy recipient. The 3G/GPRS module allows five recipients of each kind (`index` from 0 to 4).

```
{
  // Sets a normal recipient:
  setSMTPrecipient(0, 0, recipient_TO@email.com, normal_recicpient);
  // Sets a Carbon Copy recipient:
  setSMTPrecipient(1, 2, recipient_CC@email.com, Carcon_Copy_recicpient);
  // Sets a normal recipient:
  setSMTPrecipient(2, 4, recipient_BCC@email.com,
                     Blind_Carbon_Copy_recicpient);
}
```

This function returns:

- '1' if success
- '0' if error

8.1.4. Setting the subject and the body

These functions sets the subject of the email and the body. After an e-mail is sent successfully, the subject and the body will be cleared, if unsuccessfully, they won't be cleared. Subject and email body are printable ASCII text up to 512 characters each one.

If the process of sending an e-mail is ongoing, these functions will return '0' directly.

```
{
  // Sets the subject:
  setSMTPsubject("Subject of the email");
  // Sets the body:
  setSMTPbody("This is the body of the email");
}
```

These functions returns:

- '1' if success
- '0' if error

8.1.5. Attaching files

The 3G/GPRS module can attach up to 10 files (0 to 9) to the email. The total size of all attachments can't exceed 10MB. To attach a file to the email the file must be in the current directory. Please, refer to the File system related functions chapter to know how to go to the correct folder.

If the process of sending an e-mail is ongoing, these functions will return '0' directly.

Example of use:

```
{
  // Attach a picture:
  setSMTPattach( 1, "picture.jpg");
}
```

This function returns:

- '1' if success
- '0' if error

8.1.6. Sending the email

This functions sends the email.

Example of use:

```
{
  // Sends the email:
  setSMTPsend();
}
```

This function returns:

- '1' on success
- '0' if error setting the APN
- '-2' error sending the email
- '-3' if error setting the APN with CME error code available

8.2. Receiving emails with POP3

8.2.1. Setting the POP3 server parameters

This function sets the parameters for the POP3 server.

Example of use:

```
{
  // Configures the SMTP server:
  setPOP3server(“pop.server.com”, 110, “username”, ”password”);
}
```

This function returns:

- ‘1’ on success
- ‘0’ if error setting the APN
- ‘-2’ error sending the email
- ‘-3’ if error setting the APN with CME error code available

8.2.2. Getting a list of emails

This function get a list with the total number of emails.

Example of use:

```
{
  // Configures the SMTP server:
  total_email = getPOP3list();
}
```

This function returns:

- the total number of emails
- ‘-2’ if error logging in the POP3 server
- ‘-3’ getting the e-mail number and total size

8.2.3. Getting the header of an email

This function gets the header of the email specified in index and stores it in `buffer_3G`.

Example of use:

```
{
  // Configures the SMTP server:
  getPOP3header(6);
}
```

This function returns:

- ‘1’ on success
- ‘-1’ if error logging in the POP3 server
- ‘-2’ if error getting the header of the e-mail

8.2.4. Getting an email

This function gets the e-mail specified in index and stores it in the location selected with `selectStorage()`. After retrieving an e-mail successfully, POP3 client will create a directory and save the email's header and body into file system as file "EmailYYMMDDHHMMSSXYZ.TXT", and save each attachment as a file under the same directory.

Example of use:

```
{
  // Configures the SMTP server:
  getPOP3mail(6);
}
```

This function returns:

- '1' on success
- '-1' if error logging in the POP3 server
- '-2' if error getting the e-mail

8.2.5. Deleting an email

This function deletes the e-mail specified in index. The function only marks an email on the server to delete it, and after POP3 client logs out POP3 server and closes the session normally, the marked email is deleted on the server.

Example of use:

```
{
  // Configures the SMTP server:
  deletePOP3mail(2);
}
```

This function returns:

- '1' on success
- '-1' if error logging in the POP3 server
- '-2' if error deleting the e-mail

9. HTTP and HTTPS

9.1. HTTP connections

HTTP is a great protocol because it is a standard, simple and light way to send information to web servers.

Libelium has created a little web service in order to allow GPRS, WiFi or 3G modules users to test the HTTP mode. This web service is a little code, written in PHP, which is continuously listening to the HTTP port (port number 80) of our test server "pruebas.libelium.com". This is a kind of RESTful service. GPRS, WiFi or 3G modules can send HTTP instances to our web service.

HTTP instances should have the following structures so that our web service can understand.

9.1.1. GET method

In GET method the data are sent to the server append to the main URL with the '?' character. The base sentence to perform GET method is shown below:

```
pruebas.libelium.com/getpost_frame_parser.php?<variable1=value1>&<variable2=value2>&<...>&vie
w=html
```

Where:

- `getpost_frame_parser.php?` : It is the main URL, where the web service is running.
- `<variable1=value1>` : It is a couple with the variable name and value which we want the web service to parse.
- `view=html` : It is an optional argument. It shows a "pretty" response (HTML formatted)

All arguments must be separated by "&". The variable name and value must be separated by "=".

Some examples:

```
pruebas.libelium.com/getpost_frame_parser.php?var1=3.1415
pruebas.libelium.com/getpost_frame_parser.php?var1=3.1415&view=html
pruebas.libelium.com/getpost_frame_parser.php?var1=3.1415&var2=123456&var3=hello&view=html
```

9.1.2. POST method

Unlike GET method, with POST method the data are sent to the server into an extra data field. The URL only includes the site name and the PHP direction:

```
pruebas.libelium.com/getpost_frame_parser.php
```

The data field is very similar as the used in GET method:

```
<variable1=value1>&<variable2=value2>&<...>&view=html
```

Where:

- `<variable1=value1>` : It is a couple with the variable name and value which we want the web service to parse.
  All arguments must be separated by "&". The variable name and value must be separated by "=".

Some examples of data field:

```
pruebas.libelium.com/getpost_frame_parser.php?variable1=3.141592
pruebas.libelium.com/getpost_frame_parser.php?var1=3.1415&var2=123456&var3=hello
```

9.1.3. Server response

If the web service receives one instance with the appropriate format, some actions will happen:

- the web service grabs the string and parses it. So the PHP code creates couples with the variables name and value.
- the web service responses to the sender device (to the sender IP) with an HTML-formatted reply.

Figure: Operating with the web service from a PC browser

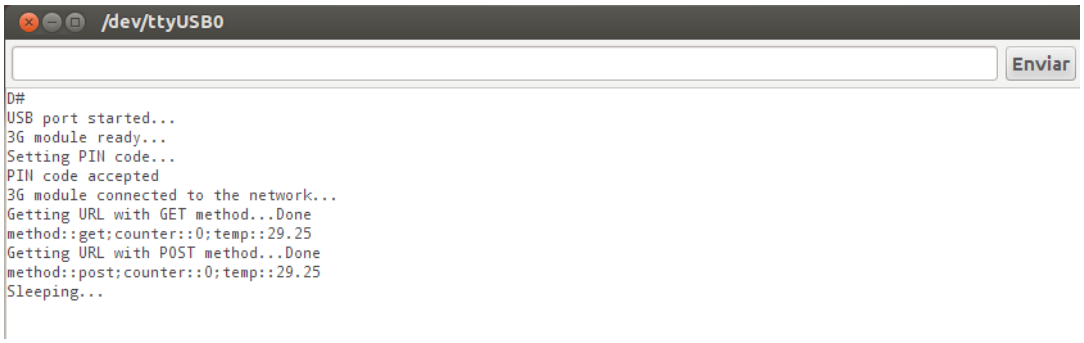


Figure: Operating with the web service from a Waspmote 3G

Remember this PHP code is really simple and is offered with the only purpose of testing, **without any warranty**. The source code is available here:

downloads.libelium.com/waspmote-html-get-post-php-parser-tester.zip

The user may find it interesting to copy this code and make it run on his own server (physical or virtual). If the user wants to go further, he can complete the code. For example, once the couples are parsed, the user can modify the PHP to save data into a txt file, or insert couples into a database, or include a timestamp...

9.2. Reading an URL

The function `readURL(url, port, procedure)` is used to launch a HTTP operation like GET or POST,

It accesses to the specified URL and stores the info read in the `buffer_3G` variable.

Note: `Buffer_3G` *is limited to 512 bytes. If the answer from the HTTP server is greater than 512 bytes data may be lost. The size of the buffer can be incremented changing the value of the constant* `#define BUFFER_SIZE` *in Wasp3G.h.*

Example of use:

```
{
  // Sends a GET procedure to www.url.com
  _3G.readURL("www.url.com", 80, "GET /index HTTP/1.1\r\nHost:
  www.url.com\r\nUser-Agent: Waspmote\r\nContent-Length: 0\r\n\r\n");

  // Shows the answer from www.url.com
        USB.println(_3G.buffer_3G);
}
```

This function returns:

- '1' on success
- '-1' if error setting APN, username and password
- '-2' if error opening a HTTP session
- '-3' if error receiving data or timeout waiting data
- '-4' if error changing the baudrate (data received is OK)
- '-5' if unknown error for HTTP
- '-6' if HTTP task is busy
- '-7' if fail to resolve server address
- '-8' if HTTP timeout
- '-9' if fail to transfer data
- '-10' if memory error
- '-11' if invalid parameter
- '-12' if network error
- '-15' if error setting APN, username and password with CME_error code available
- '-16' if error opening a HTTP session with CME_error code available

Reading an URL using GET and POST methods example:

http://www.libelium.com/development/waspmote/examples/3g-15-getting-url/

9.3. Sending a frame to Meshlium

The function sendHTTPframe(url, port, data, length, method) has been developed to send a frame from Waspmote to Meshlium. Meshlium will parse the frame and will store in the internal database. This function requires the next parameters:

- url: IP address from Meshlium
- port: HTTP port from Meshlium
- data: variable `frame.buffer` from the frame generated
- length: variable `frame.length` from the frame generated
- method: GET or POST

The response from Meshlium will be stored in `buffer_3G` variable.

Note: *`Buffer_3G` is limited to 512 bytes. If the answer from the HTTP server is greater than 512 bytes data may be lost. The size of the buffer can be incrmented changing the value of the constant `#define BUFFER_SIZE` in Wasp3G.h.*

Example of use:

```
{
  // Sends a frame with GET procedure
  _3G.sendHTTPframe("www.url.com", 80, frame.buffer, frame.length, GET);

  // Shows the answer from www.url.com
        USB.println(_3G.buffer_3G);
}
```

This function returns:

- '1' on success
- '-1' if error setting APN, username and password
- '-2' if error opening a HTTP session
- '-3' if error receiving data or timeout waiting data
- '-4' if error changing the baudrate (data received is OK)
- '-5' if unknown error for HTTP
- '-6' if HTTP task is busy
- '-7' if fail to resolve server address
- '-8' if HTTP timeout
- '-9' if fail to transfer data
- '-10' if memory error
- '-11' if invalid parameter
- '-12' if network error
- '-15' if error setting APN, username and password with CME_error code available
- '-16' if error opening a HTTP session with CME_error code available
- '-17' if url response its not OK (HTTP code 200)
- '-18' if content-length field not found
- '-19' if data field not found

Sending a frame to Meshlium using GET and POST methods example:
http://www.libelium.com/development/waspmote/examples/3g-15b-sending-a-frame-to-meshlium/

9.4. HTTPS connections

Hypertext Transfer Protocol Secure (HTTPS) is a combination of the Hypertext Transfer Protocol (HTTP) with SSL/TLS protocol to provide encrypted communication and secure identification of a network web server. HTTPS is the result of simply layering the Hypertext Transfer Protocol (HTTP) on top of the SSL/TLS protocol, thus adding the security capabilities of SSL/TLS to standard HTTP communications. The figure is:

SSL/TLS allows an SSL-enabled server to authenticate itself to an SSL-enabled client, and if necessary, allows the client to authenticate itself to the server. After the authentication and cryptology parameter negotiation, a secure channel is established so that the client and server can exchange information in a secure way.

SSL/TLS Features

- Support SSL 3.0 and TLS 1.0
- Support SSL client only
- Support 512 bits and 1024 bits exportable and non-exportable cipher suits
- Support RSA and Ephemeral Diffie-Hellman key exchange method
- Support RSA (with MD5, SHA1 or MD2) and DSS signature algorithm

- Support Mutual authentication
- Support SSL re-handshake
- Support DES, 3DES, AES, RC2, and ARCFOUR (compatible with RC4) algorithms.
- Support resumed handshake.
- Support user interaction in certificate processing.

9.4.1. HTTPS function

The function `readURL(url, port, procedure)` is used to launch a HTTPS operation like GET or POST.

It accesses to the specified URL and stores the info read in the `buffer_3G` variable.

Note: `Buffer_3G` *is limited to 512 bytes. If the answer from the HTTPs server is greater than 512 bytes data may be lost. The size of the buffer can be incremented changing the value of the constant* `#define BUFFER_SIZE` *in Wasp3G.h.*

Example of use:

```
{
  // Sends a GET procedure to www.urls.com
  _3G.readURLS("www.urls.com", 80, "GET /index HTTP/1.1\r\nHost:
  www.urls.com\r\nUser-Agent: Waspmote\r\nContent-Length: 0\r\n\r\n");

  // Shows the answer from www.urls.com
        USB.println(_3G.buffer_3G);
}
```

This function returns:

- '1' on success
- '-1' if unknown error
- '-2' if 3G module is busy
- '-3' if server closed
- '-4' if timeout
- '-5' if transfer failed
- '-6' if memory error
- '-7' if invalid parameter
- '-8' if network error
- '-10' if error setting APN, username and password
- '-11' if error acquiring HTTPS protocol stack
- '-12' if error opening a HTTPS session
- '-13' if error changing baudrate
- '-14' if error storing HTTPS request in the output buffer
- '-15' if error sending the HTTPS request to the url
- '-16' if error with the receive command
- '-17' if error closing the session (data received is OK)
- '-18' if error releasing the SSL stack (data received is OK)
- '-19' if error changing the baudrate (data received is OK)
- '-20' if error receiving data or timeout waiting data and
- '-25' if error setting username and password with CME_error code available

10. TCP and UDP connections

Waspmote 3G/GPRS module allows 3 different working modes for TCP and UDP connections. The first one is the single client mode. In this mode, only can connect with a TCP or UDP server. The second one is the multi client mode, with the capacity to work with 10 connections simultaneously. The last one is the server mode. In this mode, the module acts as a TCP server allowing up to 10 clients.

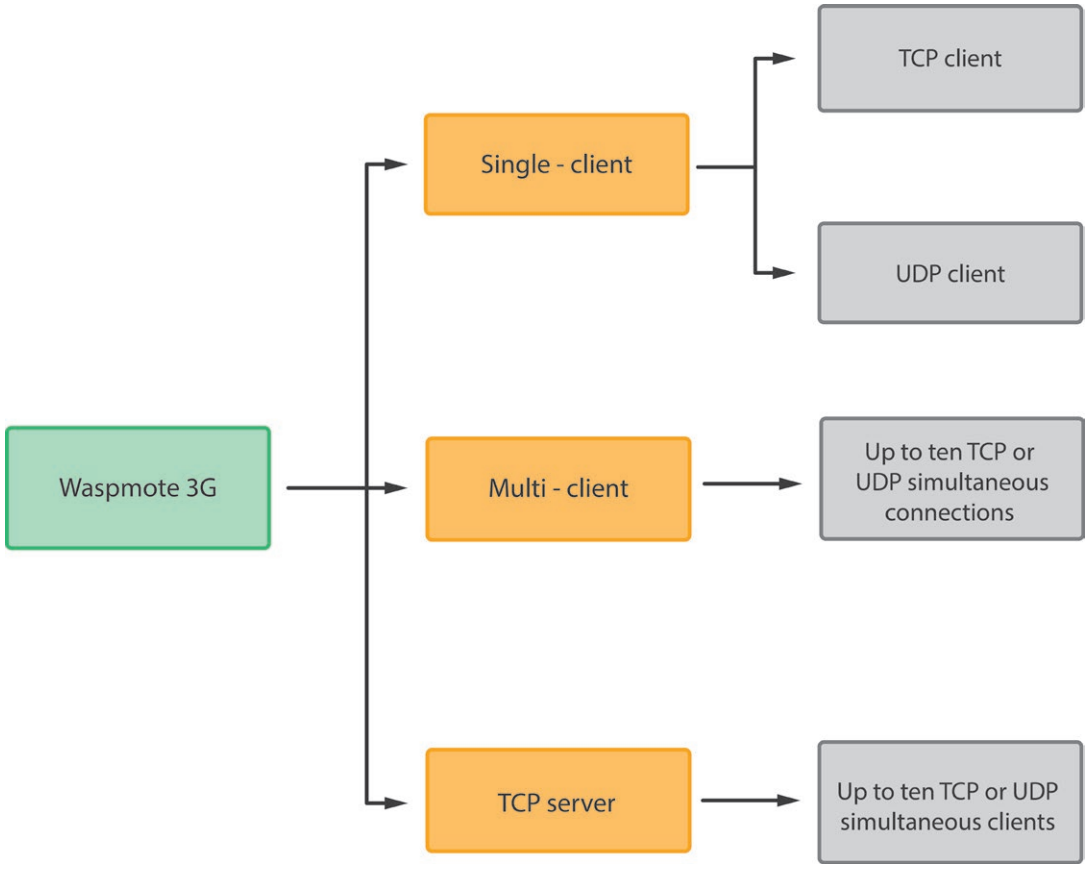


Figure: Different working modes

Some functions can return special error codes (CME error code or IP error code). When an error code is available, it will be stored in `CME_CMS_code` variable. This code can give some extra information about the reason of the error. To know the signification of the code see the appendix CME error codes.

TCP connections maybe need more time than UDP connections. The main reason is the feedback received by the module from the server indicating that the data have been sent successfully or not. With UDP connections there aren't that feedback.

10.1. Configuration of the 3G/GPRS module for TCP and UDP

Before to open a TCP socket, UDP socket or TCP server, the 3G/GPRS module must be configured with some parameters such as APN, user name (if required), password (if required), number of retries to send and the delay to send the IP packets. These parameters are defined in Wasp3G.h. If the profile doesn't use the user name and the password, `_3G_LOGIN` and `_3G_PASSW` can be commented.

Example of use:

```
{
  // Configures the module for TCP or UDP:
  _3G.configureTCP_UDP();
}
```

Related constants of Wasp3G.h

```
#define _3G_APN “myapn”
#define _3G_LOGIN “user_name”
#define _3G_PASSW “password”
#define RETRIES        “10”
#define DELAY_SEND      “0”
```

This function returns:

- ‘1’ on success
- ‘0’ if error
- ‘-2’ if error with CME code is available
- ‘-3’ if error configuring IP parameters.

10.2. Getting the IP assigned to the module

The function `getIP()` gets the IP assigned to the module by the network provider. The IP address is stored in `buffer_3G`.

Example of use:

```
{
  // Gets the IP assigned:
  _3G.getIP();
}
```

This function returns:

- ‘1’ on success
- ‘0’ if error
- ‘-2’ if error with IP error code available

10.3. Query a IP address from a domain name

This function obtains the IP address from a given domain name. The IP address is stored in `buffer_3G`.

Example of use:

```
{
  // Query the IP address from a domain name
  _3G.QueryIPfromDomain(“www.libelium.com”);
}
```

This function returns:

- ‘1’ on success
- ‘0’ if error

10.4. Query a domain name from a IP address

This function obtains the IP address from a given domain name. The IP address is stored in `buffer_3G`.

Example of use:

```
{
  // Query the domain from the give IP
  _3G.QueryIPfromDomain("80.58.0.33");
}
```

This function returns:

- '1' on success
- '0' if error

10.5. Working in single client mode

In the single client mode, only one connection can be established with a server. This connection can be TCP or UDP.

The steps to work in this mode are the next:

- 1. Create a TCP or UDP socket
- 2. Send and receive data
- 3. Close the socket

10.5.1. Creating a socket

A socket can be created with the function `createSocket()`. The parameters needed for create a TCP or UDP socket are different. For a TCP socket you need to specify: working mode (`TCP_CLIENT`), IP address of the server and port of the server. For an UDP socket only need to specify the working mode.

Example of use:

```
{
  // Creating a TCP socket:
  _3G.createSocket(TCP_CLIENT, "90.12.54.132", 5566);
  // Creating a UDP socket:
  _3G.createSocket(UDP_CLIENT);
}
```

This function returns:

- '1' on success
- '-2' if error opening the network
- '-3' if error opening the network with CME error code available
- '-4' if error opening the network with IP error code available
- '-5' if error opening the TCP connection or starting the TCP server
- '-6' if error opening the TCP connection or starting the TCP server with IP error code available.

10.5.2. Sending and receiving data

`sendData()` is the function for send data to an opened socket. For send data to a TCP socket you only needs the string of data to send. For send data to a UDP socket, you need the string of data to send, the IP address and the port.

Example of use:

```
{
  // Sending data to a TCP socket:
  _3G.sendData("TCP test string");

  // Sending data to a UDP socket:
  _3G.sendData("UDP test string", "90.12.54.132", 5566);
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if error with IP error code available

For receive data Waspmote must execute the function `manageIncomingData()`. This function executes the proper functions and returns a number with the type of data. For IP data this function returns '3'. The IP address of the sender is stored in `IP_dir` and the data in `buffer_3G`. For more information about the function `manageIncomingData()`, see the description of the function at this guide.

10.5.3. Closing the socket

To close an opened socket the function `closeSocket()` must be used. This function doesn't need parameters.

Example of use:

```
{
  // Closes the socket:
  _3G.closeSocket();
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if error with IP error code available

10.6. Working in multi client mode

In the multi client mode, the 3G/GPRS module can establish up to 10 connections with different servers. These connections can be TCP or UDP.

The steps to work in this mode are the next:

- 1. Enable the multi client mode
- 2. Create a socket
- 3. Send and receive data
- 4. Close the socket

10.6.1. Enable the multi client mode

The function `createSocket()` with the parameter `MULTI_CONNECTION` must be used to enable the multi client mode.

Example of use:

```
{
  // Enables the multi client mode:
  _3G.createSocket(MULTI_CONNECTION);
}
```

This function returns:

- '1' on success
- '-2' if error opening the network
- '-3' if error opening the network with CME error code available
- '-4' if error opening the network with IP error code available

10.6.2. Creating sockets

To open a socket in multi client mode the function `createMultiSocket()`, must be used. To open a TCP socket the next parameters must be specified: number of the link, IP address of the server and port of the server. To open a UDP socket only need the number of the link and the listen port.

Example of use:

```
{
  // Creates a TCP connection in multi client mode:
  _3G.createMultiSocket(2, "90.12.54.132", 5566);
  // Creates a UDP connection in multi client mode:
  _3G.createMultiSocket(1, 156);
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if not configured in multi client mode
- '-3' if network is closed
- '-4' error opening the connection with CME error code available
- '-5' error opening the connection with IP error code available

10.6.3. Sending and receiving data

To send data to a TCP connection the parameters needed are the number of the connection and the string of data. For send data to a UDP connection the parameters are the number of the connection, the string of data, the IP address of the server and the port of the server.

Example of use:

```
{
  // Sending data to a TCP socket:
  _3G.sendData(2, "TCP test string");

  // Sending data to a UDP socket:
  _3G.sendData(1, "UDP test string", "90.12.54.136", 5577);
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if error with IP error code available

For receive data Waspmote must execute the function `manageIncomingData()`. This function executes the proper functions and returns a number with the type of data. For IP data this function returns '3'. The IP address of the sender is stored in `IP_dir` and the data in `buffer_3G`. For more information about the function `manageIncomingData()`, see the description of the function at this guide.

10.6.4. Closing the socket

To close an opened connection the function `closeMultiSocket()` must be used. This function needs number of the connection to close.

Example of use:

```
{
  // Closes the specify socket:
  _3G.closeMultiSocket(2);
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if error with IP error code available

10.7. Working in TCP server mode

The 3G/GPRS module can be used as a TCP server. In this working mode, the 3G/GPRS module can accept up to 10 TCP clients.

10.7.1. Creating the server

A TCP server can be created with the function `createSocket()`. The parameters needed are the working mode `TCP_SERVER` and the port of the server.

Example of use:

```
{
  // Creates a TCP server:
  _3G.createSocket(TCP_SERVER, 80);
}
```

This function returns:

- '1' on success
- '-2' if error opening the network
- '-3' if error opening the network with CME error code available
- '-4' if error opening the network with IP error code available
- '-5' if error opening the TCP connection or starting the TCP server
- '-6' if error opening the TCP connection or starting the TCP server with IP error code available

10.7.2. Listing the clients

The function `listClients()` creates in `buffer_3G` a list of the clients connected to the TCP server. Each line shows: the number of the client, the IP address of the client and the port of the client.

Example of use:

```
{
  // Lists the clients:
  _3G.listClients();
}
```

Example of data stored in `buffer_3G`:

```
{
  0, 80.58.0.32, 620
  1, 194.40.125.10, 800
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if error with IP error code available

10.7.3. Activate a client

To send and receive data from a client, first must activated. The number of client starts in 0.

Example of use:

```
{
  // Opens the client number 2:
  _3G.openClient(2);
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if error with IP error code available

10.7.4. Sending and receiving data

To send data to an active client use the function `sendData()`.

Example of use:

```
{
  // Sending data to an active client:
  _3G.sendData("Test string");
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if error with IP error code available

For receive data Waspmote must execute the function `manageIncomingData()`. This function executes the proper functions and returns a number with the type of data. For IP data this function returns '3'. The IP address of the sender is stored in `IP_dir` and the data in `buffer_3G`. For more information about the function `manageIncomingData()`, see the description of the function at this guide.

10.7.5. Disconnecting a client

The function `closeClient()` closes an active client.

Example of use:

```
{
  // Opens the client number 2:
  _3G.closeClient(2);
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if error with IP error code available

10.7.6. Closing the server

To close the TCP server the function `closeSocket()` must be used. This function doesn't need parameters.

Example of use:

```
{
  // Closes the TCP server:
  _3G.closeSocket();
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if error with IP error code available

11. Miscellaneous functions

11.1. Managing incoming data

It waits for incoming calls, SMSs or TCP/UDP data up to 20 seconds. It executes the function `readCall()` if a call is received, `readSMS()` if an SMS is received and `readIPData()`.

Example of use:

```
{
  // Stores in answer the kind of data received
  answer = _3G.manageIncomingData(); // Manages incoming data
}
```

This function returns:

- '1' for call, Stores the phone number in `buffer_3G`
- '2' for SMS. Stores `tlfNumber` and `buffer_3G` variables the tlf number and text of the incoming SMS
- '3' for IP data. Stores the IP address from the sender in `IP_dir` and the data in `buffer_3G`
- '0' for error or not data

Note 1: *the phone number has a maximum length of 15 characters, including country code.*

Note 2: *the SMS text and the TCP/UDP data string has a maximum size of* `buffer_3G` *length.*

11.2. Getting RSSI level

This function gets the RSSI level from the network and stores it in `buffer_3G` in dBm.

Example of use:

```
{
  // Getting RSSI level:
  USB.println(_3G.getRSSI(), DEC);
}
```

This function returns:

- the value in -dBm
- '0' if error

11.3. Getting cell system information

This function inquires serving cell and neighbours cell system information in GSM.

Example of use:

```
{
  // Gets the cell system information:
  _3G.getCellsysInfo();
  // Shows the information:
  USB.println(_3G.buffer_3G);
}
```

This function returns:

- '1' on success
- '0' if error
- '-1' if timeout
- '-2' if error restoring the baudrate (data are valid)

Information is stored in `buffer_3G` with this format:

```
[SCELL],ARFCN:9,MCC:214,MNC:07,LAC:5002,ID:2432,BSIC:63,RXLev:-95dbm,C1:8,C2:8,TA:0,TXPWR:0
[NCell1],ARFCN:60,MCC:214,MNC:07,LAC:5002,ID:4433,BSIC:37,RXLev:-97dbm,C1:5,C2:5
```

- [SCELL]: indicate serving cell
- [NCELLn]: available neighbour cell index
- ARFCN: assigned radio channel
- MCC: mobile country code
- MNC: mobile network code
- LAC: localization area code
- ID: cell identifier
- BSIC: base station identification code
- RXLev: received signal strength in dBm
- TA: timing advance
- C1: Coefficient for base station selection
- C2: Coefficient for Cell re-selection
- TXPWR: UE TX power in dBm. If no TX, the value is 0.

When the 3G/GPRS module is in dedicated mode (for example in a call is in progress) the parameters MCC, MNC, LAC, ID, C1 and C2 for the neighbour cells are not showed.

11.4. Getting cell channel information

This function inquires serving cell channel information in GSM when a call is in progress.

Example of use:

```
{
  // Gets the cell channel information:
  _3G.getCellchannel();
  // Shows the information:
  USB.println(_3G.buffer_3G);
}
```

This function returns:

- '1' on success
- '0' if error

Information is stored in `buffer_3G` with this format:

```
ARFCN:11,BISC: 4,HSN: 1,MAIO: 1,TN: 2,HF: 1,TSC: 4,TCH: 3
```

- ARFCN: assigned radio channel
- BSIC: base station identification code
- HSN: hopping sequence number
- MAIO: mobile allocation index offset
- TN: timeslot number
- HF: hopping flag
- TSC: training sequence code
- TCH: channel type

11.5. Getting serving cell radio parameters

This function inquires serving cell radio parameter in GSM when a call is in progress.

Example of use:

```
{
  // Gets serving cell radio parameters:
  _3G.getCellradioparam();
  // Shows the information:
  USB.println(_3G.buffer_3G);
}
```

This function returns:

- '1' on success
- '0' if error

Information is stored in `buffer_3G` with this format:

```
ARFCN:9,RXLevFull: -96dbm,RXLevSub: -96dbm,RXQualFull: 4,RXQualSub: 3,PWRC:1,DTX: 1,RLT: 32
```

- ARFCN: assigned radio channel
- RXLevFull: received full signal strength in dBm
- RXLevSub: received sub signal strength in dBm
- RXQualFull: full quality of reception
- RXQualSub: sub quality of reception
- PWRC: power control
- DTX: DTX indicator
- RLT: radio link timeout

11.6. Setting preferred service domain

This function sets the preferred service domain. Allowed values are '0' for CS (Circuit Switched), '1' for PS (Packet Switched) and '2' for CS+PS.

Example of use:

```
{
  // Selects CS+PS:
  _3G.setPreferedServiceDomain(2);
}
```

This function returns:

- '1' on success
- '0' if error

11.7. Scanning the network band channels

This function scans the network band channels and stores in `buffer_3G` the data from the channels. You must to specify a start channel and an end channel. The parameter `mode` selects if the output will be a verbose output (0) or only numeric data (1).

Example of use:

```
{
  // Scans channels from 23 to 33 with verbose output:
  _3G.scanNetworkchannels(11, 20, 0);
  // Shows the information:
  USB.println(_3G.buffer_3G);
}
```

This function returns:

- '1' on success
- '0' if error

Information is stored in `buffer_3G` with this format when verbose output is selected:

For BCCH-Carrier:

arfcn:<arfcn_value>,bsic:<bsic_value>,dBm:<dBm_value>,mcc: <mcc_value>,mnc:<mnc_value>,lac:<lac_value>,cellId:<cellId>,cellStatus: <cellStasus>,numArfcn:<num_afrcn>,arfcn:<list of arfcns>,numChannels: <num_channel>,array:<list of channels>

For non BCCH-Carrier:

arfch:<arfcn_value>,dBm:<dBm_value>

Information is stored in `buffer_3G` with this format when numeric output is selected:

For BCCH-Carrier:

<arfcn_value>,<bsic_value>,<dBm_value>,<mcc_value>,<mnc_value>,<lac_value>,<cellId>,<cellStasus>,<num_afrcn>,<list of arfcns>,<num_channel>,<list of channels>

For non BCCH-Carrier:

<arfcn_value>,<dBm_value>

- <arfcn_value> : carrier assigned radio channel (BCCH – Broadcast Control Channel)
- <bsic_value> : base station identification code
- <dBm_value> : the value of dBm
- <mcc_value>: mobile country code
- <mnc_value> : mobile network code
- <lac_value> : localization area code
- <cellId> : cell identifier
- <cellStatus> : cell status, this parameter indicates the following statuses:
  - CELL_SUITABLE indicates the C0 is a suitable cell
  - CELL_LOW_PRIORITY indicates the cell is low priority based on the system information received
  - CELL_FORBIDDEN indicates the cell is forbidden
  - CELL_BARRED indicates the cell is barred based on the system information received
  - CELL_LOW_LEVEL indicates the cell RXLEV is low
  - CELL_OTHER indicates none of the above, e.g. exelusion timer running, no BCCH available , etc.
- <num_arfcn> : number of valid channels

- <list of arfcns> : list arfcns BCCH allocation, and the total number is <num_arfcn>
- <num_channel> : number of valid channels
- <list of channels> : list channels, and the total number is <num_channels>
- <arfcn_index> : the index of arfcn, and the minimum value is zero

11.8. Getting UE system information

This function inquires the UE system information. The information returned in '`buffer_3G`' is different from 2G network and 3G network.

Example of use:

```
{
  // Gets UE system information:
  _3G.getUEsysInfo();
  // Shows the information:
  USB.println(_3G.buffer_3G);
}
```

This function returns:

- '1' on success
- '0' if error

Information is stored in `buffer_3G` with this format:

For a 2G cell:

<System Mode>,<Operation Mode>,<MCC><MNC> ,<LAC>,<Cell ID>,<Absolute RF Ch Num>, < RxLev >, <Track LO Adjust>,<C1-C2>

For a 3G cell:

<System Mode>,<Operation Mode>,<MCC>,<MNC>,<LAC>,<Cell ID>,<Frequency Band>,<PSC>,<Freq>, <SSC>,<EC/IO>,<RSCP >,<Qual>,<RxLev>,<TXPWR>

- <System Mode> : System mode, values: "NO SERVICE", "GSM" or "WCDMA".
- <Operation Mode> : UE operation mode, values: "Online","Offline","Factory Test Mode","Reset", "Low Power Mode".
- <MCC> : Mobile Country Code (first part of the PLMN code)
- <MNC> : Mobile Network Code (second part of the PLMN code)
- <LAC> : Location Area Code (hexadecimal digits)
- <Cell ID> : Service-cell ID.
- <Absolute RF Ch Num> : AFRCN for service-cell.
- <Track LO Adjust> : Track LO Adjust
- <C1> : Coefficient for base station selection
- <C2> : Coefficient for Cell re-selection
- <Frequency Band> : Frequency Band of active set
- <PSC> : Primary synchronization code of active set.
- <Freq> : Downlink frequency of active set.
- <SSC> : Secondary synchronization code of active set
- <EC/IO> : Ec/Io value
- <RSCP> : Received Signal Code Power
- <Qual> : Quality value for base station selection
- <RxLev> : RX level value for base station selection
- <TXPWR> : UE TX power in dBm. If no TX, the value is 500.

11.9. Show network system mode

This function shows network system mode.

Example of use:

```
{
  // Shows network mode:
  USB.println(_3G.showsNetworkMode(), DEC);
}
```

This function returns:

- '1' for no service
- '2' for GSM
- '3' for GPRS
- '4' for EGPRS (EDGE)
- '5' for WCDMA
- '6' for HSDPA only
- '7' for HSUPA only
- '8' for HSPA (HSDPA and HSUPA)
- '0' if error
- '-1' if error with CME error code available

Values 6, 7 and 8 are included only for compatibility with the former 3G+GPS module.

11.10. Shows system information in WCDMA

This function shows the mobile phone system information in WCDMA mode. The information are stored in `buffer_3G`.

Example of use:

```
{
  // Gets WCDMA system information:
  _3G.WCDMAsysInfo();
  // Shows the information:
  USB.println(_3G.buffer_3G);
}
```

This function returns:

- '1' on success
- '0' if error

Information is stored in `buffer_3G` with this format:

Active SET,<ActiveSET Cells Num>,<ActiveSET Cell1 PSC>,<ActiveSET Cell1 Freq>,<ActiveSET Cell1 SSC>, <ActiveSET Cell1 Sttd>,<ActiveSET Cell1 TotEcio>,<ActiveSET Cell1 Ecio>,<ActiveSET Cell1 Rscp>,<UTMS_SETS Cell TPC>,<UTMS_SETS Cell SecCpichOvsf>, <ActiveSET Cell1 WinSize> ,... more active cells.

Sync Neighbor SET,<SyncSET Cells Num>,<SyncSET Cell1 PSC>,<SyncSET Cell1 Freq>,<SyncSET Cell1 SSC>,< SyncSET Cell1 Sttd>,< SyncSET Cell1 TotEcio>,< SyncSET Cell1 Ecio>,< SyncSET Cell1 Rscp>,< SyncSET Cell1 WinSize> ,... more sync neighbor cells.

Async Neighbor SET,<AsyncSET Cells Num>,< AsyncSET Cell1 PSC>,< AsyncSET Cell1 Freq>,< AsyncSET Cell1 SSC>,< AsyncSET Cell1 Sttd>,< AsyncSET Cell1 TotEcio>,< AsyncSET Cell1 Ecio>,< AsyncSET Cell1 Rscp>,< AsyncSET Cell1 WinSize> ,... more async neighbor cells.

- <UTMS_SETS Cells Num> : cells number
- <UTMS_SETS Cell 1-n PSC> : primary synchronization code of the cell
- <UTMS_SETS Cell 1-n Freq> : downlink frequency of the cell
- <UTMS_SETS Cell 1-n SSC> : secondary synchronization code
- <UTMS_SETS Cell 1-n Sttd> : if the CPICH of this cell uses STTD
- <UTMS_SETS Cell 1-n TotEcio> : the total Ec/Io in the best paths found in a sweep
- <UTMS_SETS Cell 1-n 1 Ecio> : Ec/Io
- <UTMS_SETS Cell 1-n Rscp> : CPICH RSCP
- <UTMS_SETS Cell 1-n TPC> : Forward power control combination
- <UTMS_SETS Cell 1-n SecCpichOvsf>: OVSF code of the secondary CPICH
- <UTMS_SETS Cell 1-n WinSize>: search window size for this cell

UTMS_SETS contains:

- ActiveSET : active set
- SyncSET: neighbour (monitored) set for neighbours whose timing is known
- AsyncSET: neighbour (monitored) set for neighbours whose timing is unknown

11.11. Setting network system mode preference

This function sets network system mode preference. The values for the input parameter are: '0' for automatic, '13' for GSM only and '14' for WCDMA only.

Example of use:

```
{
  // Sets network system mode for WCDMA only:
  _3G.setNetworkMode(14);
}
```

This function returns:

- '1' on success
- '0' if error

11.12. Setting the preferences for order of acquisitions

This function sets the preferences for order acquisitions mode. The input parameter specifies the order: '0' for automatic, '1' GSM,WCDMA and '2' for WCDMA,GSM.

Example of use:

```
{
  // Sets the order to work first with WCDMA:
  _3G.modeAcquisitionsOrder(2);
}
```

This function returns:

- '1' on success
- '0' if error

11.13. Choosing the storage location

This function selects the location (local storage or SD card storage) of store the data captured by the 3G/GPRS module as pictures, video or emails. The values for input parameter can be: '0' for local storage and '1' for SD card storage.

Example of use:

```
{
  // Selects microSD card to store data:
  _3G.selectStorage(1);
}
```

This function returns:

- '1' on success
- '0' or '-2' if error

11.14. Changing the baudrate

This function changes the baudrate between Waspmote and 3G/GPRS module. This function also changes the UART's baudrate in Waspmote. The allowed baudrates are: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200. Higher values don't work properly in Waspmote.

Example of use:

```
{
  // Sets baudrate to 38400 bauds:
  _3G.changeBaudrate(38400);
}
```

This function returns:

- '1' on success
- '0' or '-2' if error

11.15. Sending AT commands to the 3G/GPRS module

This function allows to the user to send AT commands to the 3G/GPRS module and read the answer from it. The command must a string without the "AT". The answer is stored in `buffer_3G` with this format.

Example of use:

```
{
  // Sends "AT+CREG":
  _3G.sendATCommand("+CREG?");
  // Shows the answer:
  USB.println(_3G.buffer_3G);
}
```

This function returns:

- '1' on success
- '0' if error

11.16. Choosing audio output

This functions selects the output for the audio. Allowed values are '0' for speaker and '1' for loudspeaker.

Example of use:

```
{
  // Selects the loudspeaker for audio:
  _3G.selectAudioOutput(1);
}
```

This function returns:

- '1' on success
- '0' if error

11.17. Setting the gain level of the microphone

This function sets the gain level of the microphone. The input values are:' 0' for mute and '1' to '16' for gain level. Mute only can be used into a call.

Example of use:

```
{
  // Sets max gain for the microphne amplifier:
  _3G.micGain(16);
}
```

This function returns:

- '1' on success
- '0' if error

11.18. Setting the loudspeaker volume

This function sets the level of the loudspeaker. The input values are:' 0' for mute and '1' to '5' for volume level.

Example of use:

```
{
  // Sets mmute for the loudspeaker:
  _3G.loudspeakerLevel(0);
}
```

This function returns:

- '1' on success
- '0' if error

11.19. Getting module information

The function `whoamI()` get the model of the module and saves it in `buffer_GPRS`. The function `firmware_version()` get the firmware of the module and saves it in `buffer_GPRS`.

These functions return '1' on success, '0' if error.

Example of use:

```
{
        USB.print(F("WhoamI: "));
        GPRS_Pro.whoamI();
        USB.println(GPRS_Pro.buffer_GPRS);
        USB.print(F("Firmware version: "));
        GPRS_Pro.firmware_version();
        USB.println(GPRS_Pro.buffer_GPRS);
}
```

12. API changelog

Keep track of the software changes on this link:

www.libelium.com/development/waspmote/documentation/changelog/#3G

13. Documentation changelog

From v4.9 to v5.0:

- Many changes due to chipset change: now the 3G module integrates a SIM5215 chipset, which does not have a GPS receiver and is slower

From v4.8 to v4.9:

- Reference to the new GPRS+GPS module version (chipset SIM908)

From v4.7 to v4.8:

- Link to the new online API changelog

From v4.6 to v4.7:

- Added new chapter "Geolocation tracker application example"
- Added the new GPRS+GPS module to the comparative table
- API changelog updated to API v011
- Added new section "Setting operator parameters" in chapter "Initialization"

From v4.5 to v4.6:

- New section "Sending a frame" added in chapter "HTTP and HTTPS".
- API changelog updated

From v4.4 to v4.5:

- API changelog updated

From v4.3 to v4.4:

- Added new section "HTTP connections" added in chapter "HTTP and HTTPS".
- Added new section "GET method" added in chapter "HTTP and HTTPS".
- Added new section "POST method" added in chapter "HTTP and HTTPS".
- Added new section "Server response" added in chapter "HTTP and HTTPS".
- Section "HTTP" changes to "Reading an URL"

From v4.2 to v4.3:

- API changelog updated

From v4.1 to v4.2:

- New section "Getting module information" added in chapter "Miscelaneous functions".
- Added return codes in section "3G power modes".
- Section "Checking the GSM connection" has been updated.
- OTA feature added in section "Hardware".
- Added new section "Creating your own FTP server" in chapter "FTP and FTPS".
- API changelog updated.

From v4.0 to v4.1:

- Added notes about carriers in US in sections "Hardware" and "Checking the GSM connection".

Apendix A. CME error codes

CME error code	Description	CME error code	Description
0	phone failure	112	Location area not allowed
1	no connection to phone	113	Roaming not allowed in this location area
2	phone adaptor link reserved	132	service option not supported
3	operation not allowed	133	requested service option not subscribed
4	operation not supported	134	service option temporarily out of order
5	PH-SIM PIN required	148	unspecified GPRS error
6	PH-FSIM PIN required	149	PDP authentication failure
7	PH-FSIM PUK required	150	invalid mobile class
10	SIM not inserted	257	network rejected request
11	SIM PIN required	258	retry operation
12	SIM PUK required	259	invalid deflected to number
13	SIM failure	260	deflected to own number
14	SIM busy	261	unknown subscriber
15	SIM wrong	262	service not available
16	incorrect password	263	unknown class specified
17	SIM PIN2 required	264	unknown network message
18	SIM PUK2 required	273	minimum TFTS per PDP address violated
20	memory full	274	TFT precedence index not unique
21	invalid index	275	invalid parameter combination
22	not found	201	Unknown error for FTP
23	memory failure	202	FTP task is busy
24	text string too long	203	Failed to resolve server address
25	invalid characters in text string	204	FTP timeout
26	dial string too long	205	Failed to read file
27	invalid characters in dial string	206	Failed to write file
30	no network service	207	It's not allowed in current state
31	network timeout	208	Failed to login
32	network not allowed - emergency calls only	209	Failed to logout
40	network personalization PIN required	210	Failed to transfer data
41	network personalization PUK required	211	FTP command rejected by server
42	network subset personalization PIN required	212	Memory error
43	network subset personalization PUK required	213	Invalid parameter
44	service provider personalization PIN required	214	Network error
45	service provider personalization PUK required	220	Unknown error fot HTTP
46	corporate personalization PIN required	221	HTTP task is busy
47	corporate personalization PUK required	222	Failed to resolve server address
100	Unknown	223	HTTP timeout
103	Illegal MESSAGE	224	Failed to transfer data
106	Illegal ME	225	Memory error
107	GPRS services not allowed	226	Invalid parameter
111	PLMN not allowed	227	Network error

Apendix B. CMS error codes

CME error code	Description	CME error code	Description
300	ME failure	316	SIM PUK required
301	SMS service of ME reserved	317	SIM PIN2 required
302	Operation not allowed	318	SIM PUK2 required
303	Operation not supported	320	Memory failure
304	Invalid PDU mode parameter	321	Invalid memory index
305	Invalid text mode parameter	322	Memory full
310	SIM not inserted	330	SMSC address unknown
311	SIM PIN required	331	no network service
312	PH-SIM PIN required	332	Network timeout
313	SIM failure	340	NO +CNMA ACK EXPECTED
314	SIM busy	342	SMS size more than expected
315	SIM wrong	500	unknown error