MM002-xx-EU AT Commands

From nemeuswiki

AT commands are used as an interface with Nemeus Communication modules. Modules can be driven at 3 different levels:

- Radio level: embedded AT server uses RF SX127x driver API (LoRa™and FSK modulations can be used).
- LoRa™WAN level: embedded AT server uses LoRa™WAN library API(available only when the library is present in embedded software).
- SIGFOX™ level: embedded AT server uses SIGFOX™ library API(available only when the library is present in embedded software).

When radio level is used, no device personalization is required, it is up to AT client application to implement network layer according to the network the device is attached (the module doesn't know the network).

When LoRa™WAN level is used, the device is personalized with the following parameters:

- Whatever the activation type, a 64 bits device unique identifier.
- When Activation By Personalization (ABP) is used:
  - An AES128 network security key for MIC computation and encryptionof MAC control commands on port 0.
  - An AES128 application security key for encryption of applicationpayloads (not required when data encryption is disabled on themodule).
- When Over The Air Activation (OTAA) is used:
  - A 64 bits application unique identifier.
  - An AES128 application Key used to derive the network andapplication security keys.

In first software versions (before 15W40) the module generates unique identifiers and keys, these default LoRa™WAN personalization parameters are modifiable by AT commands. It allows customers to personalize their devices according to the network operator rules.

In further software versions, modules are personalized with Nemeus OUI during production phase and they can't be modified. In this case the device unique identifier is read-only and the AES128 keys are hidden. The application unique identifier is still modifiable by AT command.

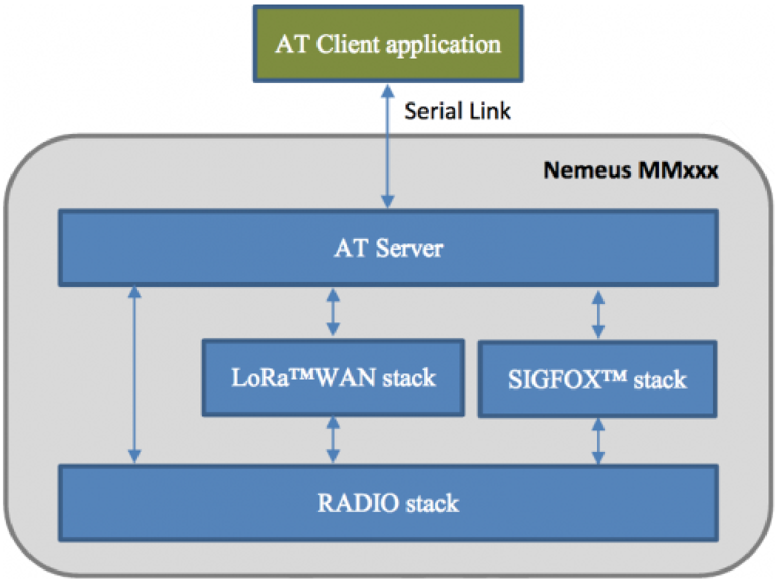
When SIGFOX™ level is used, the device is personalized with the following parameters:

- The read-only device unique identifier.
- The hidden AES128 security key.
- The initial read-only Portability Access Code (PAC).

Before driving the module, the AT client application must activate the level it wants to use.

Only one level can be activated at a time.

When activating a level, a previously activated level is automatically deactivated.



For evaluation/test purpose, Nemeus recommends to use NemeusATK java application to drive the module.

Contents

1 UART configuration

The UART configuration for Modem connection is as follows:

- Baud Rate : 38400
- Data : 8 bits
- Parity : None
- Stop : 1 bit
- Flow control : None
- End line character : <LF>

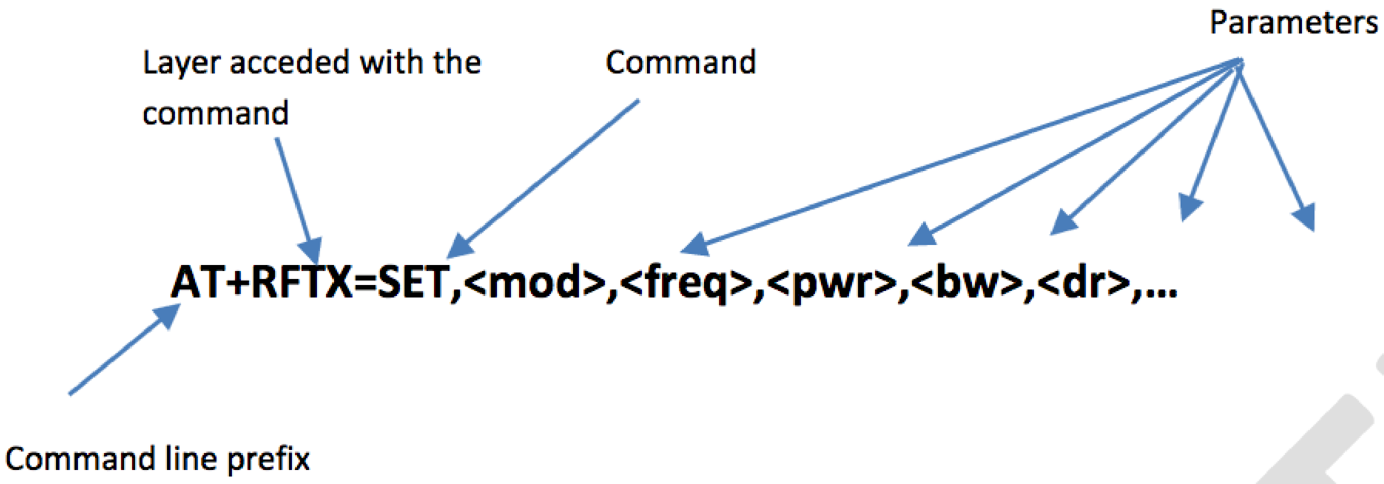
E.g. Typical configuration given by ‘stty’ command on linux:

```
speed 38400 baud; rows 0; columns 0; line = 0;

intr = ^C; quit = ^\; erase = ^?; kill = ^U; eof = ^D; eol = <undef>; eol2 = <undef>;swtch = <undef>; start = ^Q; stop = ^S; susp = ^Z; rprnt = ^R; werase = ^W; lnext = ^V;flush = ^O; min = 1; time = 0;

-parenb -parodd cs8 hupcl -cstopb cread clocal –crtsct signbrk -brkint -ignpar -parmrk -inpck -istrip -inlcr -igncr -icrnl -ixon -ixoff –iuclc -ixany -imaxbel -iutf8

-opost -olcuc -ocrnl -onlcr -onocr -onlret -ofill -ofdel nl0 cr0 tab0 bs0 vt0 ff0 -isig -icanon -iexten -echo -echoe -echok -echonl -noflsh -xcase -tostop –echoprt -echoctl -echoke
```

2 AT commands

At command are split according to communication layers. This is a list of main AT commands for SW given in ‘compatibility’ paragraph. The full list and limitation can be found in SW delivery note.

Formalism is the following:


Parameters
Layer acceded with the command
Command
AT+RFTX=SET,<mod>,<freq>,<pwr>,<bw>,<dr>,...
Command line prefix

For each group among RF, RFRX, RFTX, MAC and SFX, the command AT+<group>= HELP describes available sub-commands. Example:

```
AT+MAC= HELP
+MAC: <cmd>,<param_1>,…,<param_N>
+MAC: <cmd> are ON,OFF,?,SET,SCH,RCH,STI,RTI,SRX,RRX,SNDTXT,SNDBIN,RCVTXT,RCVBIN,STOPRCV,SNDLCR,DEVUID,DEVADDR,APPUID,APPKEY,NSKEY,APPSKEY
+MAC: <cmd>? Lists parameters of <cmd> if any
OK
```

When a sub-command has parameter, AT+<group>= <cmd>? Describes the parameter list. Example:

```
AT+MAC=SNDTXT?
+MAC: SNDTXT,<textpayload>,<nbrepeat>,<port>,<mode>
OK
```

When command is unknown “command not found (‘try help’)” is returned.

AT commands are not cancelable, thus AT client application must wait for AT response before sending a new command.

3 Generic Parameter description

Following table describes mains parameters used with AT commands.

Values	**Description**	**Type**
<mod>	Modulation to be use	LORA/FSK
<freq>	Carrier frequency	Expressed in Hertz *
<pwr>	Tx power (range depends on Module definition; e.g. MM001 -1dBm to 14dBm)	In dBm *
<bw>	Bandwidth from 125kHz to 500 kHz	In Hertz *
<dr>	Spreading Factor in LoRa mode	6/7 to 12 *

	Data rate in FSK mode	In kb/s
<cr>	Coding Rate (LoRa mode only)	1 to 4
<min/maxdr>	Data rate range	SF7BW125 to SF12BW125, SF7BW250 or FSK50KBPS
<tx/rxcrcon>	Flag for CRC check activation in TX or RX	True or false
<preamble>	Length of the preamble	6 to 65535
<f_dev>	Frequency deviation (FSK mode only)	
<fixed_len>	When true, PHY payload is constant (no header)	True or false
<tx/rxiqinv	Flag for IQ inversion in TX or RX (LoRa mode only)	True or false
<rxw1>	Delay before RX windows 1	In ms
<rxw2>	Delay before RX windows 2 ; NOTE: rx_w2 must be longer than rx_w1.	In ms
<tstamp>	Rx ot Tx timestamp	In ticks
<symbtimeout>	Number of symbols before RX timeout	5 to 1023
<port>	MAC port	0 to 10
<textpayload>	Payload to send or received payload in ASCII	ASCII string
< binarypayload>	Payload to send or received payload in hexadecimal coded in ASCII	ASCII string containing 0 to F characters
<chan>	Identifies one of the 8 MAC channels	0 to 7
<enable>	Indicates the status of a channel	True or false
<nbrepeat>	Number of repetitions when sending a payload. At MAC level this parameter indicates if data confirmed must be used or not (0 means unacked mode>).	0 to N
<interval>	Time interval between repetitions	In ms
<hexaddress>	Address of a registry in hexadecimal	
<nbbytes>		0 to 4
<byteN>	Byte to write	0x00 to 0xFF

<margin>	Link demodulation margin above the demodulation floor computed by the nearest gateway	0 to 254 in dB
<gwcnt>	Number of gateways which received the MAC message	1 to N
<devuid>	Device unique identifier	8 bytes
<devaddr>	Device address (4 LSB of <devuid>)	4 bytes
<more>	Indicates if more downlink data is pending	true or false
<mode>	LoRa MAC transmission mode	0 for confirmed data not 0 for unconfirmed data
<rxw1freq>	Channel frequency used for Rx window 1	In Hz, 0 means same as Tx frequency
<eirp>	Effective Isotropic Radiated Power received in TxParamSetupReq (Asian band only)	In dBm
<updwell>	Uplink dwell time received in TxParamSetupReq (Asian band only)	0 means no limit 1 means 400 ms
<dwdwell>	Downlink dwell time received in TxParamSetupReq (Asian band only)	0 means no limit 1 means 400 ms
<backoff>	Ack mode retransmission back-off procedure	false means disabled true means enabled

- Depends on Module in use

4 Generic Response description

Every AT command send a response of one of the following types:

Values	**Description**	**Visible output**
	Generic	
<CR><LF>OK<CR><LF>	OK response	OK
<CR><LF>ERROR<CR><LF>	ERROR response	ERROR

<CR><LF>ERROR NOACK<CR><LF>	ERROR response due to a missing ACK	ERROR_NOACK
<CR><LF>+MAC:	Response from MAC layer	+MAC:
<CR><LF>+RFTX:	Response from RF layer (TX)	+RFTX:
<CR><LF>+RFRX:	Response from RF layer (RX)	+RFRX:
<CR><LF>+DEBUG:	Response from debug layer	+DEBUG:

5 AT Generic commands

Intentionally left blank

6 AT RF commands

RF commands are dealing with the RF Layer. This layer should be started before using most of RF commands listed in this section (unless stated otherwise).

3 groups of commands exist:

- +RF group: commands common to TX and RX functions.
- +RFTX group: commands dedicated to TX functions.
- +RFRX group: commands dedicated to RX functions.

6.1 AT+RF=HELP

This command is used to know the list of sub-commands.

6.1.1 Response

OK.

6.1.2 Example

```
AT+RF=HELP
+RF: <cmd>
+RF: <cmd> are ON,OFF,?,RPER,SPER,RSW,SSW
+RF: <cmd>? Lists parameters of <cmd> if any
OK
```

6.2 AT+RF=ON

This command is used to start RF layer (Radio driver) and is mandatory in order to use most of RF commands listed in this section (unless otherwise stated).

6.2.1 Response

ERROR is returned if either LoRa™WAN stack or SIGFOX™ stack is using the radio (Tx or Rx is ongoing).

Else OK is returned.

If LoRa™WAN stack was ON (but not using the radio), it is automatically set to OFF.

If SIGFOX™ stack was ON (but not using the radio), it is automatically set to OFF.

6.3 AT+RF=OFF

This command is used to stop RF layer (Radio driver). After calling this command, most of RF commands listed in this section will return ERROR (unless stated otherwise).

RF layer stop (Radio driver).

6.3.1 Response

Always OK.

6.4 AT+RF=?

This command is used to read the current RF layer state.

6.4.1 Response

Always OK.

6.4.2 Example

```
AT+RF=?
+RF: OFF
OK
```

6.5 AT+RF=RPER

This command is used to read the Packet Error Rate state.

6.5.1 Response

Always OK.

6.5.2 Example

```
AT+RF=RPER
+RF: false
OK
```

6.6 AT+RF=SPER,

This command is used to set the Packet Error Rate state and the power offset

The following formalism is used. It can be checked by the AT+RF=SPER?command:

+RF=SPER,<per_state>,<pwroffset>,<loracsoffset>,<fskcsoffset>,<freqcoffset>

<per_state> PER state, unchanged when absent.

<pwroffset> is the Power offset

<loracoffset> is the RSSI Power offset in LoRa (dB)

<fskcoffset> is the RSSI Power offset in Fsk and Sigfox (dB)

<freqcoffset> is the frequency offset in Sigfox (Hz) (Available in 17w01 and newer versions)

When PER state is true, a counter is added at the beginning of Tx frames. This counter is used on Rx side to compute the Packet Error Rate.

6.6.1 Response

OK if <per_state> is “true”, “false” or omitted.

ERROR if <per_state> is syntactically incorrect.

6.6.2 Example

```
AT+RF=SPER,true
OK
```

6.7 AT+RF=RSW

This command is used to read the current LoRa and FSK synchro words. Synchro words are in hexadecimal format (see formalism on SSW command)

6.7.1 Response

Always OK.

6.7.2 Example

```
AT+RF=RSW
+RF: 12,69817E96
OK
```

6.8 AT+RF=SSW,

This command is used to set the synchro words.

AT+RF=SSW,<LoRa_SyncWord>,<Fsk_SyncWord>

<LoRa_SyncWord> LoRa Synchro Word (one byte)

<Fsk_SyncWord> FSK Synchro Word (up to six bytes)

A synchro word is unchanged when related parameter is absent.

6.8.1 Response

OK if parameters are correct or omitted.

ERROR if FSK synchro word is too long (6 bytes/12 hexa digits max) or number of digits is not even.

6.8.2 Example

```
AT+RF=SSW, 12,69817E96
OK
```

6.9 AT+RFTX=HELP

This command is used to know the list of sub-commands.

6.9.1 Response

OK.

6.9.2 Example

```
AT+RFTX=HELP
+RFTX: <cmd>,<param_1>,…,<param_N>
+RFTX: <cmd> are ?,SET,SEND,SNDTXT,SNDBIN,START,STOP
+RFTX: <cmd>? Lists parameters of <cmd> if any
OK
```

6.10 AT+RFTX=?

Read TX parameters. This command does not need the RF layer to be ON.

6.10.1 Response

Always OK.

+RFTX: <mod>,<freq>,<pwr>,<bw>,<dr>,<cr>,<txcrcon>,<preamble>,<fdev>,<fixedlen>,<txiqinv>,<rxw1>,<rxw2>,<tstamp>,<symbtimeout>,<rxiqinv>,<rxcrcon>

6.10.2 Example

```
AT+RFTX=?
+RFTX :  LORA,868100000,14,125000,7,1,true,8,0,false,false,0,0,0,5,false,true
OK
```

6.11 AT+RFTX=SET,

Write Tx parameters. This command does not need the RF layer to be ON. Only modified parameters can be specified.

The following formalism is used. It can be checked by the ***AT+RFTX=SET?*** command:

+RFTX= SET,<mod>,<freq>,<pwr>,<bw>,<dr>,<cr>,<txcrcon>,<preamble>,<fdev>,<fixedlen>,<txiqinv>,<rxw1>,<rxw2>,<tstamp>,<symbtimeout>,<rxiqinv>,<rxcrcon>,<rxaftertx>

The parameters <symbtimeout>, <rxiqinv> and <rxcrcon> are used only when an Rx window is specified.

<tstamp> is the absolute clock time of the module. If the time is over, the frame is immediately transmitted. Usually this timestamp is a delay added to an Rx timestamp (feature not fully implemented)

6.11.1 Response

Always OK.

6.11.2 Example

To set the <pwr> to 12 and the <txcrcon> to false:

```
AT+RFTX=SET,,,12,,,,false
OK
```

6.12 AT+RFTX=SEND, (for test purpose)

Transmit <nb_frames> numbered frames every <interval> ms.

AT+RFTX= SEND,<nb_frames>,<interval>

Default values : <nb_frames> = 1, <interval> = 500 (ms).

If <per_state> is true (see AT+RF=SPER command), transmitted frames contain a counter on 4 bytes followed by a 32 bytes fixed pattern.

This command is used as a generator for Packet Error Rate (PER) computing.

6.12.1 Response

OK if <nb_frames> have been successfully sent.

ERROR if RF layer is OFF or if one frame has not been successfully sent.

6.12.2 Example

```
AT+RFTX=SEND,3,500
OK
```

6.13 AT+RFTX=START (for test purpose)

FSK continuous transmission.

6.13.1 Response

OK if RF layer is ON.

ERROR if RF layer is OFF.

6.13.2 Example

```
AT+RFTX=START
OK
```

6.14 AT+RFTX=STOP (for test purpose)

Stop FSK continuous transmission.

6.14.1 Response

OK if RF layer is ON.

ERROR if RF layer is OFF.

6.14.2 Example

```
AT+RFTX=STOP
OK
```

6.15 AT+RFTX=SNDTXT,

Repeat <nbrepeat> text frames every 500 ms.

AT+RFTX= SNDTXT,<txt>,<nbrepeat>

Default values : <nbrepeat> = 1.

<txt> parameter is transmitted as received on serial link, the module doesn’t manage any character set.

If <per_state> is true (see AT+RF=SPER command), a 4 bytes counter is added at the beginning of the frame.

6.15.1 Response

OK if <nbrepeat> have been successfully sent.

ERROR if RF layer is OFF or if one frame has not been successfully sent.

6.15.2 Example

```
AT+RFTX=SNDTXT,HELLO WORLD,3
OK
```

6.16 AT+RFTX=SNDBIN,

Repeat <nbrepeat> binary frames every 500 ms.

AT+RFTX= SNDBIN,<bin>,<nbrepeat>

Default values : <nbrepeat > = 1

<bin> parameter is hexadecimal coded in ASCII (2 ASCII characters for 1 binary byte).

If <per_state> is true (see AT+RF=SPER command), a 4 bytes counter is added at the beginning of the frame.

6.16.1 Response

OK if <nbrepeat> have been successfully sent.

ERROR if RF layer is OFF or if one frame has not been successfully sent.

6.16.2 Example

To send 2 times the 3 bytes 1A 2B 3C:

```
AT+RFTX=SNDBIN,1A2B3C,2
OK
```

6.17 AT+RFRX=HELP

This commandis used to know the list of sub-commands.

6.17.1 Response

OK.

6.17.2 Example

```
AT+RFRX=HELP
+RFRX: <cmd>,<param_1>,…,<param_N>
+RFRX: <cmd> are ?,SET,RECV,START,STOP,CONTRX,LVL
+RFRX: <cmd>? Lists parameters of <cmd> if any
OK
```

6.18 AT+RFRX=?

Read RX parameters.

6.18.1 Response

Always OK.

+RFRX: <mod>,<freq>,<bw>,<dr>,<cr>,<rxcrcon>,<fixedlen>,<rxiqinv>,<*timeout*>,<*symbtimeout*>,<lnaboost>

<*timeout*> and <*symbtimeout*> parameters are no more used by radio stack (they are still present for compatibility with previous module versions).

6.18.2 Example

```
AT+RFRX=?
,true
OK
```

6.19 AT+RFRX=SET,

Set Rx parameters. Only modified parameter can be specified.

The following formalism is used. It can be check by the ***AT+RFRX=SET?***command:<mod>,<freq>,<bw>,<dr>,<cr>,<rxcrcon>,<fixedlen>,<rxiqinv>,<*timeout*>,<*symbtimeout*>,<lnaboost>

<*timeout*> and <*symbtimeout*> parameters are no more used by radio stack (they are still present for compatibility with previous module versions).

6.19.1 Response

Always OK

6.19.2 Example

To set <dr> parameter to 7:

```
AT+RFRX=SET,,,,7
OK
```

6.20 AT+RFRX=RECV (for test purpose)

Single frame reception with PER computation if <per_state> is true (see +RF=SPER command).

RF layer comes back to IDLE state after reception or after AT+RFRX=STOP command.

6.20.1 Response

OK if RF layer is ON and not already receiving.

ERROR if RF layer is OFF or is already receiving.

+RFRX: <per>,<rssi>,<snr>,<crcerr>,<tstamp>,<binary payload>

Then, when a frame is received the unsolicited response below is sent:

If <per_state> is true (see +RF=SPER command):

+RFRX: 100%,-35.00,7.00,0,1521551302,12000000CAFEDECA…

Where 100% is the PER, -35.00 is the RSSI level, 7.00 is the SNR, 0 is “no CRC error”, 1521551302 is the Rx clock time in ms and 12000000CAFEDECA is the received payload, starting with the 4 bytes counter.

If <per_state> is false:

+RFRX: ,-35.00,7.00,0,1521551302,CAFEDECA…

PER is not displayed and the 4 bytes counter is not present in the payload (it means that Tx device also has <per_state> set to false.

After frame reception the Rx is automatically stopped.

6.20.2 Example

```
AT+RFRX=RECV
OK
+RFRX: 100%,-35.00,7.00,0,1521551302,12000000CAFEDECA
```

6.21 AT+RFRX=START (for test purpose)

Continuous reception with PER computation if <per_state> is true (see +RF=SPER command).

RF layer stays in RX until Rx stop command is sent (see AT+RFRX=STOP)

6.21.1 Response

OK if RF layer is ON and not already receiving. ERROR if RF layer is OFF or is already receiving.

When a TX has been performed during Reception, An AT+RFRX=STOP command may be needed to avoid ERROR from this command

After frame reception RF layer stays in RX (RX stop command must be used to leave RX mode).

6.21.2 Example

```
AT+RFRX=START
OK
+RFRX: 100%,-35.00,7.00,0,1521551302,12000000CAFEDECA
+RFRX: 100%,-32.00,7.00,0,1521554506,13000000CAFEDECA
…
```

6.22 AT+RFRX=STOP

Stop single or continuous reception.

6.22.1 Response

OK if RF layer is in RX.

ERROR if RF layer is not in RX.

6.22.2 Example

```
AT+RFRX=STOP
OK
```

6.23 AT+RFRX=CONTRX

Continuous reception without PER computation.

6.23.1 Response

OK if RF layer is ON and not already receiving.

ERROR if RF layer is OFF or is already receiving.

Then, for each received frame, the unsolicited response below is sent:

+RFRX: <rssi>,<snr>,<crcerr>,<tstamp>,<binary payload>

6.24 AT+RFRX=LVL (for test purpose)

Last reception parameters read (RSSI, SNR)

6.24.1 Response

OK if RF layer is ON.

ERROR if RF layer is OFF.

Response information is as below:

+RFRX: LVL,<rssi>,<snr>

6.24.2 Example

```
AT+RFRX=LVL
+RFRX: LVL,-77.00,8.00
OK
```

6.25 Informative examples

6.25.1 LoRa Communication

Below is an example where two Modules are configured to communicate on a specific frequency.

First we setup the Module A and start a continuous RX, then we can setup the Module B.

Module A

```
AT+RF=ON
OK
```

Set the RF ON

```
AT+RFRX=SET,LORA,,125000,7
OK
```

Set some RX parameters. Let the channel to default frequency

```
AT+RFRX=CONTRX
OK
```

Start a Continuous RX

```
…. .
```

Wait RX (set module B)

```
+RFRX: -78.00,3.00,0,152987007,CAFE
```

receive 0xCAFE hexa frame, rssi -78, snr 3, at timestamp 152987007 ms

```
AT+RFRX=STOP
```

Stop continuous Rx

Module B

```
AT+RF=ON
OK
```

Set the RF ON

```
AT+RFTX=SET,LORA,868100000,14,125000,7
OK
```

set Tx modulation LoRa, freq 868100000, Tx power 14dbm, bandwidth 125KHz, SF7

```
AT+RFTX=SNDBIN,CAFE,1
OK
```

send 0xCAFE hexa frame 1 time

```
…..
```

6.25.2 FSK Communication

Below is an example where two Modules are configured to communicate on a specific frequency. For FSK some rules apply on selected "bandwith/datarate" in RX and "frequency deviation/datarate" in TX. This is described in (sx1272 datasheet)

First we setup the Module A and start a continuous RX, then we can setup the Module B.

Module A

```
AT+RF=ON
OK
```

Set the RF ON

```
AT+RFRX=SET,FSK,868100000,125000,1200
OK
```

Set some RX parameters.freq 868100000,Bandwith 125 000, Datarate 1200

```
AT+RFRX=CONTRX
OK
```

Start a Continuous RX

```
…..
```

Wait RX (set module B)

```
+RFRX: -78.00,3.00,0,152987007,CAFE
```

receive 0xCAFE hexa frame, rssi -78, snr 3, at timestamp 152987007 ms

```
AT+RFRX=STOP
```

Stop continuous Rx

Module B

```
AT+RF=ON
OK
```

Set the RF ON

```
AT+RFTX=SET,FSK,868100000,14,,1200,,,,50000
OK
```

set Tx modulation FSK, freq 868100000, Tx power 14dbm, Datarate 1200, Deviation Frequency 50 000

```
AT+RFTX=SNDBIN,CAFE,1
OK
```

send 0xCAFE hexa frame 1 time

```
…..
```

7 AT LoRa™WAN (MAC) commands

3 types of AT strings are specified:

- MAC commands: AT+MAC=<cmd>,<param1>,…,<paramN>.
- MAC solicited responses: +MAC: <param1>,…,<paramN>. These responses are sent in response to MAC commands, just before the OK response, that's the reason why the <cmd> is not present in the solicited responses. Several solicited responses may be sent between the MAC command and the OK response.
- MAC unsolicited responses: +MAC: <cmd>,<param1>,…,<paramN>. These responses are not necessarily sent between the MAC command and the OK response, that's the reason why the <cmd> is present in the unsolicited responses.

When an AT client application just need to send and receive frames, the following commands are used:

- AT+MAC=? to know the current MAC mode (ABP or OTAA, Class A or C).
- AT+MAC=OFF and AT+MAC=ON,… to change the MAC mode.
- AT+MAC=DEVADRR and unsolicited +MAC: DEVADDR,… to know the current state of an OTAA device.
- AT+MAC=SNDBIN,… to send uplink frame.
- +MAC: RCVBIN,… when receiving downlink frames and to know Rx windows termination.

All other commands are not really required, they are mainly used by NemeusATK Java application to manage the LoRa™WAN layer (for IOT purpose, device provisioning …).

7.1 AT+MAC=HELP

This commandis used to know the list of sub-commands.

7.1.1 Response

OK.

7.1.2 Example

```
AT+MAC= HELP
+MAC: <cmd>,<param_1>,…,<param_N>
+MAC: <cmd> are ON,OFF,?,SCH,RCH,SDR,RDR,STI,RTI,SRX2,RRX2,SNDTXT,SNDBIN,RCVTXT,RCVBIN,STOPRCV,SNDLCR,DEVUID,DEVADDR,APPUID,APPKEY,NSKEY,APPSKEY
+MAC: <cmd>? Lists parameters of <cmd> if any
OK
```

7.2 AT+MAC=ON,

This command is used to start LoRa™WAN layer and is mandatory in order to use most of MAC commands listed in this section (unless otherwise stated).

If Radio stack was ON, it is automatically set to OFF.

```
AT+MAC=ON,<minor_ver>,<class>,<otaa>
```

- <minor_ver> can be 1 or 3 (default is 3 for LoRa™WAN V1.0). V1 is no more maintained.
- <class> is A or C.
- <otaa> is 0 for ABP and 1 for OTAA.

7.2.1 Response

If SIGFOX™ stack is using the radio ERROR is returned.

Else OK is returned.

7.2.2 Example

Start LoRa™WAN layer in class A with OTAA:

```
AT+MAC=ON,3,A,1
OK
```

7.3 AT+MAC=OFF

Stop LoRa™WAN layer.

7.3.1 Response

Always OK.

7.4 AT+MAC=?

Read current LoRa™WAN layer status.

To change LoRa™WAN layer status, AT+MAC=OFF and AT+MAC=ON,… must be performed.

7.4.1 Response

Always OK.

+MAC: <state>,<minor_ver>,<class>,<ch_pages>,<ism_band>,<otaa>

<state> is ON, OFF or DUAL. DUAL means that LoRa™WAN and SIGFOX™ stacks are both ON.

<minor_ver> can be **V**1 or **V**3 (default is 3 for LoRa™WAN V1.0).

<class> is A or C.

<page> is the number of pages of 16 channels available at LoRa™WAN layer (in terms of memory space).

<ism_band> is 4 for EU433MHz, 7 for China779-787MHz, 8 is EU863-870MHz and 9 for US902-928MHz. ISM band can't be modified dynamically, it is set at compilation time.

<otaa> is 0 or 2 for ABP and 1 for OTAA (2 means ABP, and OTAA is not supported by the module).

7.4.2 Example

A class A US902-928MHz device with 80 channels (5*16) which doesn't support OTAA:

```
AT+MAC=?
+MAC: ON,V3,A,5,9,2
OK
```

7.5 AT+MAC=SNDBIN,

Binary frame transmission.

AT+MAC= SNDBIN,<binpyload>,<nbrepeat>,<port>,<mode>

If <mode> value is 0 then the frame is sent in unacknowledged mode (default value when mode is omitted).

If <mode> value is > 0, then the frame is sent in acknowledged mode.

<nbrepeat> specifies the number of repetitions in acknowledged mode (0 when omitted). In unacknowledged mode nbrep is used instead (see AT+MAC=RDR command).

If <port> is omitted then port 2 is used by default (port 1 is reserved to embedded generic application).

7.5.1 Response

OK if MAC is ON and frame has been successfully sent (and acked if acked mode was requested).

ERROR if MAC is OFF or frame has not been successfully sent (or not acked after repetitions if acked mode was requested).

ERROR also if SIGFOX™ stack is using the radio.

ERROR also when port is reserved regarding LoRa™WAN standard.

7.5.2 Unsolicited responses

The unsolicited responses below are sent when AT client application has registered to receive unsolicited events (see AT+MAC=RCH command).

+MAC: SND,<busytime>

<busytime> is in ms.

This unsolicited response can be sent 2 times:

- One time with busytime > 0 if no channel was free due to duty cycle restriction
- One time with busytime = 0 at Tx time.

+MAC: RCH,<chan>,,,,,<busytime>,<page>

<busytime> is in ms.

Sent for each enabled channel.

7.5.3 Example

```
AT+MAC=SNDBIN,1A2B3C,3,1,0
+MAC: SND,4355
+MAC: SND,0
+MAC: RCH,0,,,,,4480,0
+MAC: RCH,1,,,,,4480,0
+MAC: RCH,2,,,,,4480,0
OK
On duty cycle expiry (4480 ms after the Tx), channels become available:
+MAC: RCH,0,,,,,0,0
+MAC: RCH,1,,,,,0,0
+MAC: RCH,2,,,,,0,0
```

7.6 AT+MAC=RCVBIN,

Register for receiving downlink frames on specified port, payload is output as binary hexa string.

AT+MAC= RCVBIN,<port>

This command is no more required because all downlink frames are routed on serial link except when the port is used by an embedded application.

7.6.1 Response

OK if MAC is ON and port is valid and free.

ERROR if MAC is OFF or port is invalid or port is already used by an embedded application.

7.6.2 Unsolicited Response

+MAC: RCVBIN,<port>,<more>,<binarypayload>,<rssi>,<snr>

When <more> is true, it means that more downlink frames are pending in MAC server. If piggyback setting is disabled and device class is A, LoRa™WAN layer will automatically poll the server to receive more downlink frames.

The RCVBIN unsolicited response is always sent after a Tx, even if no frame has been received. It indicates the end of Rx windows.

For a class A device, it is sent when a downlink frame has been received or at the end of the Rx window 2 (if no downlink frame has been received).

For a class C device, it is sent when a downlink frame has been received or at the end of the Rx window 1 (if no downlink frame has been received).

If the Tx was in ack mode, the RCVBIN is sent before the OK (or ERROR NOACK) response of the Tx (SNDBIN or SNDTXT command).

If the Tx was in unack mode, the RCVBIN is sent after the OK response of the Tx (SNDBIN or SNDTXT command).

7.6.3 Example

```
AT+MAC= RCVBIN,2
OK
```

Then when a frame is received on port 2 and more downlink frames are pending:

```
+MAC: RCVBIN,2,true,1A2B3C4D,-43.00,7.00
```

7.7 AT+MAC=SNDTXT,

It is the same command as AT+MAC=SNDBIN except that the payload is interpreted as text and is transmitted as received on serial link (no translation from hexa ASCII to hexa binary is performed).

AT+MAC= SNDTXT,<textpayload>,<nbrepeat>,<port>,<mode>

Text frame transmission.

If <mode> value is 0 then the frame is sent in unacknowledged mode (default value when mode is omitted).

If <mode> value is > 0, then the frame is sent in acknowledged mode.

<nbrepeat> specifies the number of repetitions in acknowledged mode (0 when omitted). In unacknowledged mode nbrep is used instead (see AT+MAC=RDR command).

If <port> is omitted then port 2 is used by default (port 1 is reserved to embedded generic application)

7.7.1 Response

OK if MAC is ON and frame has been successfully sent (and acked if acked mode was requested).

ERROR if MAC is OFF or frame has not been successfully sent (or not acked after repetitions if acked mode was requested).

ERROR also if SIGFOX™ stack is using the radio.

ERROR also when port is reserved regarding LoRa™WAN standard.

7.7.2 Unsolicited responses

The unsolicited responses below are sent when AT client application has registered to receive unsolicited events (see AT+MAC=RCH command).

+MAC: SND,<busytime>

<busytime> is in ms.

This unsolicited response can be sent 2 times:

- One time with busytime > 0 if no channel was free due to duty cycle restriction
- One time with busytime = 0 at Tx time.

+MAC: RCH,<chan>,,,,,<busytime>,<page>

<busytime> is in ms.

Sent for each enabled channel.

7.7.3 Example

```
AT+MAC= SNDTXT,HELLO WORLD,3,1,0
+MAC: SND,4355
+MAC: SND,0
+MAC: RCH,0,,,,,4480,0
+MAC: RCH,1,,,,,4480,0
+MAC: RCH,2,,,,,4480,0
OK
On duty cycle expiry (4480 ms after the Tx), channels become available:
+MAC: RCH,0,,,,,0,0
+MAC: RCH,1,,,,,0,0
+MAC: RCH,2,,,,,0,0
```

7.8 AT+MAC=RCVTXT,

Register for receiving downlink frames on specified port, payload is output as text string (translation to binary hexa string is not performed).

AT+MAC=RCVTXT,<port>

This command is no more required because all downlink frames are routed on serial link except when the port is used by an embedded application.

By default, downlink payload are processed as binary payload, thus if the AT client application needs to receive the payload as text (without any binary hexa string translation), it must uses this command.

7.8.1 Response

OK if MAC is ON and port is valid and free.

ERROR if MAC is OFF or port is invalid or port is already used by an embedded application.

7.8.2 Unsolicited Response

+MAC: RCVTXT,<port>,<more>,<textpayload>,<rssi>,<snr>

When <more> is true, it means that more downlink frames are pending in MAC server. If piggyback setting is disabled and device class is A, LoRa™WAN layer will automatically poll the server to receive more downlink frames.

7.8.3 Example

```
AT+MAC=RCVTXT,2
OK
```

Then when a frame is received on port 2 and more downlink frames are pending:

```
+MAC: RCVTXT,2,true,HELLO WORLD,-43.00,7.00
```

7.9 AT+MAC= STOPRCV,

Unregister for receiving downlink frames on specified port.

AT+MAC=STOPRCV,<port>

7.9.1 Response

OK if MAC is ON and port is valid.

ERROR if MAC is OFF or port is invalid.

7.10 AT+MAC=SNDLCR,

Send a Link Check Request.

AT+MAC=SNDLCR,<nbrepeat>

<nbrepeat> = 0 means the LCR message is sent in unack mode on port 0.

<nbrepeat> != 0 means the LCR message is sent in ack mode on port 0 with <nbrepeat> transmissions.

7.10.1 Response

OK if MAC is ON and Link Check Answer has been received.

ERROR if MAC is OFF or Link Check Answer has not been received and Tx was in unack mode.

ERROR NOACK if Link Check Answer has not been received and Tx was in ack mode.

ERROR also if SIGFOX™ stack is using the radio.

Received data is sent back as

+MAC: <margin>,<gwcnt>,<rssi>,<snr>

7.10.2 Example

```
AT+MAC=SNDLCR
+MAC: 20,3,-45.00,8.00
OK
```

7.11 AT+MAC=RCH,

Read MAC channels command.

AT+MAC=RCH,<chan>,<page>,<unsol_evt>

<chan> specifies the channel to read (all channels of the page if omitted or if 16)

<page> specifies the channel page (all pages if omitted or if number of available pages returned by AT+MAC=? response).

<unsol_evt> specifies if unsolicited events are required (0 when not required). The unsolicited events inform the AT client application when a MAC parameter has been changed by the LoRa™WAN layer.

7.11.1 Response

OK if parameters are syntactically correct.

For each channel, the following information is output:

+MAC: <chan>,<frequency>,<mindr>,<maxdr>,<dutycycle>,<busytime>,<page>,<rxw1freq>

<chan>: the channel index in the page (0 to 15).

<frequency>: the frequency in Hz (0 means channel is disabled).

<mindr>: minimum datarate allowed on the channel.

<maxdr>: maximum datarate allowed on the channel.

<dutycycle>: restricted duty cycle assigned to the channel (applies only when more restricted than ISM regulation specification).

<busytime>: time in ms before the channel can be used again for Tx (due to duty cycle restrictions).

<page>: channel page (0 to number of available pages returned by AT+MAC=? response).

<rxw1freq>: frequency used to open Rx window 1. 0 means same frequency as <frequency> parameter (available only from LoRaWAN V1.0.2, if the parameter is absent in the response, it means the firmware version is older).

7.11.2 Unsolicited response

The unsolicited response below is sent when <busytime> changes and AT client application has registered to receive unsolicited events (see AT+MAC=RCH command).

+MAC: RCH,<chan>,,,,,<busytime>,<page>

7.11.3 Example

```
AT+MAC=RCH
+MAC: 0,868100000,SF12BW125,SF7BW125,100,0,0,0
+MAC: 1,868300000,SF12BW125,SF7BW125,100,0,0,869525000
+MAC: 2,868500000,SF12BW125,SF7BW125,100,0,0,0
+MAC: 3,868850000,SF12BW125,SF7BW125,1000,0,0,0
…
+MAC: 15,000000000,SF12BW125,FSK50KBPS,1,0,0,0
OK
```

7.12 AT+MAC=SCH,

Set MAC channel command.

AT+MAC=SCH,<chan>,<frequency>,<min_dr>,<max_dr>,<dutycycle>,<page>

Only modified parameters can be specified.

Written parameters are not saved in file system, thus they are lost after a new MAC OFF/ON or a device reset.

The parameter list can be found by ***AT+MAC=SCH?***Command.

<dutycycle> is applied only if it is more restricted than the ISM regulation specification. 1 means 100%, 10 means 10%, 100 means 1%, ...

<rxw1freq> is available only from LoRaWAN V1.0.2

7.12.1 Response

OK if parameters are syntactically correct.

7.12.2 Unsolicited response

The unsolicited response below is sent when LoRa™WAN layer modifies a channel and AT client application has registered to receive unsolicited events (see AT+MAC=RCH command).

+MAC: SCH,<chan>,<frequency>,<mindr>,<maxdr>,<dutycycle>,<page>,<rxw1freq>

7.12.3 Example

To modify channel 0:

```
AT+MAC=SCH,0,868100000,SF12BW125,SF7BW125,100,0,0
OK
```

7.13 AT+MAC= RDR

Read current MAC datarate command.

7.13.1 Response

Always OK.

+MAC: <dr>,<txpwr>,<chanmask>,<chanmaskctrl>,<nbrep>,<eirp>,<updwell>,<dwdwell>

<eirp>, <updwell> and <dwdwell> parameters are present only in case of Asian band firmware

7.13.2 Unsolicited response

The unsolicited response below is sent when current datarate changes and AT client application has registered to receive unsolicited events (see AT+MAC=RCH command).

+MAC: RDR,<dr>,<txpwr>,<chanmask>,<chanmaskctrl>,<nbrep>,<eirp>,<updwell>,<dwdwell>

7.13.3 Example

```
AT+MAC=RDR
+MAC: SF12BW125,11,001F,0,0
OK
```

7.14 AT+MAC=SDR,

Set MAC data rate command.

AT+MAC=SDR,<dr>,<txpwr>,<chanmask>,<chanmaskctrl>,<nbrep>

Only modified parameters can be specified.

Written parameters are not saved in file system, thus they are lost after a new MAC OFF/ON or a device reset.

Set the data rate, Tx power and number of repetitions for uplink transmission (applied to all channels compatible with the datarate). <nbrep> applies only to unconfirmed transmissions.

<chanmask> and <chanmaskctrl> specify the channels usable for uplink access.

The parameter list can be found by ***AT+MAC=SDR?***Command.

<eirp>, <updwell> and <dwdwell> parameters are present only in case of Asian band.

7.14.1 Response

OK if parameters are syntactically correct.

7.14.2 Example

To modify current datarate:

```
AT+MAC=SDR,SF12BW125,10,001F,0,0
```

```
OK
```

7.15 AT+MAC=RTI

Read MAC Time Information command.

Read common channel time information.

7.15.1 Response

Always OK.

+MAC: <rxw1>,*<rxw2>*,<symbtimeout>

7.15.2 Unsolicited response

The unsolicited response below is sent when current time info changes and AT client application has registered to receive unsolicited events (see AT+MAC=RCH command).

+MAC: RTI,<rxw1>,*<rxw2>*,<symbtimeout>

7.15.3 Example

```
AT+MAC= RTI
+MAC: 1000,2000,6
OK
```

7.16 AT+MAC= STI,

Set MAC time information command.

AT+MAC=STI,<rxw1>,<rxw2>,<symbtimeout>

Only modified parameter can be specified.

Written parameters are not saved in file system, thus they are lost after a new MAC OFF/ON or a device reset.

The parameter list can be found by ***AT+MAC=STI?***Command.

The parameters <rxw1> and <symbtimeout> are common to all channels.

The *<rxw2>* parameter is no more used because *<rxw2>* value is set to <rxw1> value + 1000 ms. It is still present for compatibility with old devices.

7.16.1 Response

Always OK.

7.16.2 Example

To modify time info:

```
AT+MAC=STI,1000,,6
OK
```

7.17 AT+MAC=RRX

Read MAC Rx information command.

7.17.1 Response

Always OK.

+MAC: <rx2frequency>,<rx2dr>,<rx1droffset>

7.17.2 Unsolicited response

The unsolicited response below is sent when current Rx info changes and AT client application has registered to receive unsolicited events (see AT+MAC=RCH command).

+MAC: RRX,<rx2frequency>,<rx2dr>,<rx1droffset>

7.17.3 Example

```
AT+MAC=RRX
+MAC: 869525000,SF9BW125,0
OK
```

7.18 AT+MAC=SRX,

Set MAC Rx information command.

Only modified parameters can be specified.

The parameter list can be found by ***AT+MAC=SRX?***Command.

The parameters are common to all channels.

7.18.1 Response

OK if parameters are syntactically correct.

7.18.2 Example

To modify Rx parameters:

```
AT+MAC=SRX,869525000,SF9BW125,0
OK
```

7.19 AT+MAC=RSW

This command is used to read the current LoRa™ and FSK synchro words used by LoRa™WAN layer. Synchro words are in hexadecimal format.

7.19.1 Response

Always OK.

+MAC: <LoRa™ sync_word>,<FSK sync_word>

7.19.2 Example

```
AT+MAC=RSW
+MAC: 34,C194C1
OK
```

7.20 AT+MAC=SSW,

This command is used to set the synchro words used by LoRa™WAN layer.

AT+MAC=SSW,<LoRaSyncWord>,<FskSyncWord>

Only modified parameters can be specified.

A synchro word is unchanged when related parameter is absent.

Synchro words are in hexadecimal.

The parameter list can be found by ***AT+MAC=SSW?***Command.

7.20.1 Response

OK if parameters are correct or omitted.

ERROR if FSK synchro word is too long (6 bytes/12 hexa digits max) or number of digits is not even.

7.20.2 Example

```
AT+MAC=SSW,34,C194C1
OK
```

7.21 AT+MAC=RVAR

This command is used to read the miscellaneous LoRa™WAN variables.

This variables are Tx/Rx counters, aggregated DC and data encryption.

7.21.1 Response

Always OK.

+MAC: <txcounter>,<rxcounter>,<aggregateddc>,<encryption>

<aggregateddc> values: 1 means 100%, 10 means 10%, 100 means 1%, …

<encryption> values: 0 means no encryption, != 0 means encryption enabled.

7.21.2 Unsolicited response

The unsolicited response below is sent only when current aggregated DC changes and AT client application has registered to receive unsolicited events (see AT+MAC=RCH command).

+MAC: RVAR,,,<aggregateddc>

7.21.3 Example

```
AT+MAC=RVAR
+MAC: 0,0,1,1
OK
```

7.22 AT+MAC=SVAR,

This command is used to set some LoRa™WAN variables.

AT+MAC=SVAR,<txcounter>,<aggregateddc>,<encryption>

Only modified parameters can be specified.

The parameter list can be found by ***AT+MAC=SVAR?***Command.

7.22.1 Response

Always OK.

7.22.2 Example

To disable encryption:

```
AT+MAC=SVAR,,,0
OK
```

7.23 AT+MAC=RADR

This command is used to read the current LoRa™WAN ADR, piggyback and back-off states.

The ack mode retransmission back-off procedure was initially linked to ADR bit. When ADR bit was on/off, the back-off procedure was on/off. From now, the back-off procedure is linked to the back-off state, it allows to enable ADR bit without enabling the back-off procedure. If <backoff> parameter is absent in RADR response, it means that back-off procedure is still linked to ADR bit (older firmware version).

7.23.1 Response

Always OK.

+MAC: <adr>,<piggyback>,<backoff>

<adr>, <piggyback> and <backoff> values: true or false.

7.23.2 Example

```
AT+MAC=RADR
+MAC: true,false,false
OK
```

7.24 AT+MAC=SADR,

This command is used to set some LoRa™WAN ADR and piggyback states.

AT+MAC=SADR,<adr>,<piggyback>,<backoff>

Only modified parameters can be specified.

The parameter list can be found by ***AT+MAC=SADR?***Command.

When ADR state value is changed, ADR ack counter is reset.

7.24.1 Response

OK if parameters are correct.

7.24.2 Example

To enable piggyback:

```
AT+MAC=SADR,,true
OK
```

7.25 AT+MAC=RDEVUID

Read device unique identifier.

Device UID is coded on 8 bytes.

This command obsoletes AT+MAC=DEVUID command.

Old command still works and returns the same response.

7.25.1 Response

Always OK

UID is returned as

+MAC: <devuid>,<rand_seed>,<read_only>

When read_only value is 1, it means that the device unique identifier is built from Nemeus 36 bits OUI (70B3D5326xxxxxxx). In this case the device UID can’t be modified and the security keys are not readable.

7.25.2 Example

```
AT+MAC=RDEVUID
0010203,306A0327,1
OK
```

7.26 AT+MAC=RDEVADDR

Read device address.

This command obsoletes AT+MAC=DEVADDR command.

Old command still works and returns the same solicited response.

Warning: unsolicited response changed, old one is no more sent!!!

7.26.1 Response

Always OK

Address is returned as

+MAC: <devaddr>,<networkid>

In ABP mode, the device address is the 4 LSB of the device unique identifier.

In OTAA mode, the device address is assigned by the network.

7.26.2 Unsolicited response

The unsolicited response below is sent when device is in OTAA mode and at least one AT+MAC=? command has been sent.

+MAC: RDEVADDR,<devaddr>,<networkid>

7.26.3 Example

Read device address of an OTAA device when not yet joint to network:

```
AT+MAC=?
+MAC: ON,V3,A,1,8,1
OK
AT+MAC=RDEVADDR
+MAC: 00000000,000000
OK
```

After receipt of valid join accept, unsolicited response is sent:

```
DEVADDR,0870C367,010203
```

7.27 AT+MAC=SDEVADDR,

This command is used to modify device address when ABP mode is used.

AT+MAC=SDEVADDR,<devaddr>

If MAC layer is on in ABP mode, a MAC off/on is automatically performed.

7.27.1 Response

OK if <devaddr> length is 8 characters.

7.27.2 Example

```
AT+MAC=SDEVADDR,01020304
OK
```

7.28 AT+MAC=RAPPUID

Read application Unique ID.

Application UID is coded on 8 bytes.

By default it is set to 0000000000000000.

It can be modified by sending the following AT command:

AT+GA=DIND,1,8301000008xxxxxxxxxxxxxxxx0000

Where xxxxxxxxxxxxxxxx is the new application UID LSB first.

MAC layer must be restarted to take into account new application UID (AT+MAC=OFF and AT+MAC=ON).

Application UID can also be modified using AT+MAC=SAPPUID,<app_uid>.

This command obsoletes AT+MAC=APPUID command.

Old command still works and returns the same response.

7.28.1 Response

Always OK

Application UID is returned as

+MAC: <appuid>

7.28.2 Example

Read default application UID:

```
AT+MAC=RAPPUID
+MAC: 0000000000000000
OK
```

Set application UID to FEDCBA9876543210:

```
0000
OK
```

Restart MAC layer:

```
AT+MAC=OFF
OK
AT+MAC=ON
OK
```

Read new application UID:

```
AT+MAC=RAPPUID
+MAC: FEDCBA9876543210
OK
```

7.29 AT+MAC=SAPPUID,

This command is used to modify application UID.

AT+MAC=SAPPUID,<appuid>

If MAC layer is on in OTAA mode, a MAC off/on is automatically performed.

7.29.1 Response

OK if <appuid> length is 16 characters.

7.29.2 Example

```
AT+MAC=SAPPUID,0102030405060708
OK
```

7.30 AT+MAC=RAPPKEY

Read application key.

Application Key is coded on 16 bytes.

The byte order is the one you can use when you to register the key at network side.

It has been reversed compared to old AT+MAC=APPKEY response.

This command is available only when device unique identifier is not read only.

This command obsoletes AT+MAC=APPKEY command.

Old command still works and returns the <appkey> in reverse order.

7.30.1 Response

OK when device UID is writable.

ERROR when device UID is read only.

Application key is returned as

+MAC: <appkey>

7.30.2 Example

```
AT+MAC=RAPPKEY
+MAC: A8FA642E2E3245BB9B8CAC7E2456EF3C
OK
```

Old command still returns:

```
AT+MAC=APPKEY
+MAC: 3CEF56247EAC8C9BBB45322E2E64FAA8
OK
```

7.31 AT+MAC=RNSKEY

Read Network Session Key.

Network Session Key is coded on 16 bytes.

The byte order is the one you can use when you to register the key at network side.

It has been reversed compared to old AT+MAC=NSKEY response.

This command is available only when device unique identifier is not read only.

This command obsoletes AT+MAC=NSKEY command.

Old command still works and returns the <nskey> in reverse order.

7.31.1 Response

OK when device UID is writable.

ERROR when device UID is read only.

Network session key is returned as

+MAC: <nskey>

7.31.2 Example

```
AT+MAC=RNSKEY
+MAC: A8F1642E2E32453B9B8CAC7C2456EF72
OK
```

Old command still returns:

```
AT+MAC=NSKEY
+MAC: 72EF56247CAC8C9B3B45322E2E64F1A8
OK
```

7.32 AT+MAC=RAPPSKEY

Read application session key.

Application session key is coded on 16 bytes.

The byte order is the one you can use when you to register the key at network side.

It has been reversed compared to old AT+MAC=APPSKEY response.

This command is available only when device unique identifier is not read only.

This command obsoletes AT+MAC=APPSKEY command.

Old command still works and returns the <appskey> in reverse order.

7.32.1 Response

OK when device UID is writable.

ERROR when device UID is read only.

Application session key is returned as

+MAC: <appskey>

7.32.2 Example

```
AT+MAC=RAPPSKEY
+MAC: A8FA672E2E4245BB9ECCCA7E64F54C38
OK
```

Old command still returns:

```
AT+MAC=APPSKEY
+MAC: 384CF5647ECACC9EBB45422E2E67FAA8
OK
```

7.33 AT+MAC=RMC

Read MultiCast parameters. Multicast is only available from master18Wxx.

7.33.1 Response

OK when the command is supported by the firmware.

ERROR when it is not supported.

Multicast parameters are returned as

+MAC: <addr>,<addr_mask>,<group_mask>,<fcnt_dw>,<net_skey>,<app_skey>

```
 - <addr>: the multicast address (32 bits)
 - <addr_mask>: the significant part of the multicast address (More Significant bits) coded on 32 bits.
 - <group_mask>: the groups the device can receive (32 bits => groups 0 to 31).
 - <fcnt_dw>: the current value of the downlink frame counter (32 bits).
 - <net_skey>: the network security key for integrity checking (128 bits).
 - <app_skey>: the application security key for payload ciphering (128 bits).
```

The address mask specifies which part of the received address is processed as an address and which part is processed as a group. The address mask can take the following values:

```
 - 0x00000000: the multicast function is disabled
 - 0xFFFFFFFF: only 1 group is possible
 - 0xFFFFFFFE: 2 groups are possible
 - 0xFFFFFFFC: 4 groups are possible
 - 0xFFFFFFF8: 8 groups are possible
 - 0xFFFFFFF0: 16 groups are possible
 - 0xFFFFFFE0: 32 groups are possible
```

7.33.2 Example

```
AT+MAC=RMC
+MAC: 789ABCDE,FFFFFFFC,00000007,0,0102030405060708090A0B0C0D0E0F00,0102030405060708090A0B0C0D0E0F00
OK
```

With such parameters, the following received addresses are processed:

```
- 0x789ABCDC: valid multicast address, group 0 is accepted because bit0 of group mask is set
- 0x789ABCDD: valid multicast address, group 1 is accepted because bit1 of group mask is set
- 0x789ABCDE: valid multicast address, group 2 is accepted because bit2 of group mask is set
- 0x789ABCDF: valid multicast address, group 3 is rejected because bit3 of group mask is not set
```

When the address is accepted (valid multicast address and accepted group) then the MIC is computed thanks to network security key. If the computed MIC matches with the received MIC then the payload is deciphered thanks to application security key and the resulting payload is pushed to the application addressed by the LoRaWAN port.

7.34 AT+MAC=SMC

Set MultiCast parameters. Multicast is only available from master18Wxx.

```
AT+MAC=SMC,<addr>,<addr_mask>,<group_mask>,<fcnt_dw>,<net_skey>,<app_skey>
```

See AT+MAC=RMC for parameter description.

The multicast parameters are not saved in non volatile memory, thus they are lost after a cold reset (reset pin or power-cycle).

7.34.1 Response

OK when the command is supported by the firmware and the parameters are valid.

ERROR when it is not supported or parameters are invalid (especially <group_mask> parameter which can take 7 different values).

7.34.2 Example

```
AT+MAC=SMC,789ABCDE,FFFFFFFC,00000007,0,0102030405060708090A0B0C0D0E0F00,0102030405060708090A0B0C0D0E0F00
OK
```

7.35 Informative examples

7.35.1 Device start

AT client application can detect a device start or restart when the unsolicited response +DEBUG: START,<version> is received. Depending on initialization timing, AT client application is not sure to receive this unsolicited response, that’s the reason why it is recommended that AT client application use AT+MAC=? command to synchronize with the device.

OTAA case:

```
+DEBUG: START,Nemeus-mm002-MASTER_NEMEUS_15W39-data-manager
AT+MAC=?
+MAC: ON,V3,A,1,8,1
OK
AT+MAC=RDEVADDR
+MAC: 00000000,000000
OK
+MAC: RDEVADDR,0870C367,010203
```

The device is ready to send uplink frames.

ABP case:

```
+DEBUG: START,Nemeus-mm002-MASTER_NEMEUS_15W39-data-manager
AT+MAC=?
+MAC: ON,V3,A,1,8,0
OK
```

The device is ready to send uplink frames.

7.35.2 Send unconfirmed binary frame

No downlink frame:

```
AT+MAC=SNDBIN,CAFE,0,2,0
OK
+MAC: RCVBIN,2,false,,0.00,0.00
```

One downlink frame:

```
AT+MAC=SNDBIN,CAFE,0,2,0
OK
+MAC: RCVBIN,2,false,DECA,-85.00,7.00
```

Two downlink frames and piggyback is not set:

```
AT+MAC=SNDBIN,CAFE,0,2,0
OK
+MAC: RCVBIN,2,true,DECA,-55.00,10.00
+MAC: RCVBIN,2,false,DEFC,-73.00,9.00
```

Two downlink frames and piggyback is set:

```
AT+MAC=SNDBIN,CAFE,0,2,0
OK
+MAC: RCVBIN,2,true,DECA,-55.00,10.00
AT+MAC=SNDBIN,,0,2,0
OK
+MAC: RCVBIN,2,false,DEFC,-73.00,9.00
```

7.35.3 Send confirmed binary frame

Ack received, no downlink frame:

```
AT+MAC=SNDBIN,CAFE,0,2,1
+MAC: RCVBIN,0,false,,-60.00,7.00
OK
```

Ack not received:

```
AT+MAC=SNDBIN,CAFE,0,2,1
+MAC: RCVBIN,2,false,,0.00,0.00
ERROR NOACK
```

One downlink frame:

```
AT+MAC=SNDBIN,CAFE,0,2,1
+MAC: RCVBIN,2,false,DECA,-85.00,7.00
OK
```

Two downlink frames and piggyback is not set:

```
AT+MAC=SNDBIN,CAFE,0,2,1
+MAC: RCVBIN,2,true,DECA,-55.00,10.00
OK
+MAC: RCVBIN,2,false,DEFC,-73.00,9.00
```

Two downlink frames and piggyback is set:

```
AT+MAC=SNDBIN,CAFE,0,2,1
+MAC: RCVBIN,2,true,DECA,-55.00,10.00
OK
AT+MAC=SNDBIN,,0,2,1
+MAC: RCVBIN,2,false,DEFC,-73.00,9.00
OK
```

8 AT SIGFOX™ commands

These commands are available only on Nemeus modules embedding SIGFOX™ library. If the library is not embedded then ERROR is returned.

3 type of AT strings are specified:

- SF commands: AT+SF=<cmd>,<param1>,…,<paramN>.
- SF solicited responses: +SF: <param1>,…,<paramN>. These responses are sent in response to SF commands, just before the OK response, that's the reason why the <cmd> is not present in the solicited responses. Several solicited responses may be sent between the SF command and the OK response.
- SF unsolicited responses: +SF: <cmd>,<param1>,…,<paramN>. These responses are not necessarily sent between the SF command and the OK response, that's the reason why the <cmd> is present in the unsolicited responses.

When an AT client application just need to send and receive frames, the following commands are used:

- AT+SF=? to know the current SIGFOX™ layer state.
- AT+SF=OFF and AT+SF=ON to stop and start SIGFOX™ layer.
- AT+SF=SNDBIN,… to send uplink frame.
- AT+SF=SNDBIT,… to send uplink bit.
- AT+SF=SNDOOB to send uplink out of band message (keep alive messages).
- +SF: RCVBIN,… when receiving downlink frames.

All other commands are not really required, they are mainly used to configure SIGFOX™ layer and to perform SIGFOX™ qualification tests.

SIGFOX™ proprietary AT command set is also supported but not described in this document.

8.1 AT+SF=HELP

This commandis used to know the list of sub-commands.

8.1.1 Response

OK.

8.1.2 Example

```
AT+SF=HELP
+SF: <cmd>,<param_1>,…,<param_N>
+SF: <cmd> are ON,OFF,?,SNDBIN,SNDBIT,SNDOOB,SREP,RREP,STXF,RTXF,SRXF,RRXF,STXP,RTXP
+SF: <cmd>? Lists parameters of <cmd> if any
OK
```

8.2 AT+SF=ON

This command is used to start SIGFOX™ layer and is mandatory in order to use most of SF commands listed in this section (unless otherwise stated).

If Radio stack was ON, it is automatically set to OFF.

8.2.1 Response

If LoRa™WAN stack is using the radio ERROR is returned.

Else OK is returned.

8.2.2 Example

```
AT+SF=ON
OK
```

8.3 AT+SF=OFF

Stop SIGFOX™ layer.

8.3.1 Response

If SIGFOX™ stack is using the radio ERROR is returned.

Else OK is returned.

8.3.2 Example

```
AT+SF=OFF
OK
```

8.4 AT+SF=?

Read current SIGFOX™ layer status.

8.4.1 Response

If SIGFOX™ library is embedded OK is returned.

Else ERROR is returned.

+SF: <state>,<NMS_lib_ver>,<SFX_lib_ver>,<dev_id>,<initial_pac>

<state> is ON, OFF or DUAL. DUAL means that LoRa™WAN and SIGFOX™ stacks are both ON.

<NMS_lib_ver> is the version of Nemeus library used to communicate with SIGFOX™ network.

<SFX_lib_ver> is the version of SIGFOX™ library.

<dev_id> is the device unique identifier on SIGFOX™ network.

<initial_pac> is the first Portability Access Code used to register the device on SIGFOX™ network. It is used one time for first registration.

8.4.2 Example

```
AT+SF=?
+SF: ON,NMS-SFX-LIB-1.2,UDL1-1.6.0,000ABCDE,0123456789ABCDEF
OK
```

8.5 AT+SF=SNDBIN,

Binary frame transmission.

AT+SF=SNDBIN,<binpayload>,<ack>

If <ack> value is 0 then the frame is sent in unacknowledged mode (default value when <ack> is omitted).

If <ack> value is 1, then the frame is sent in acknowledged mode.

The frame is sent when channel becomes free regarding duty cycle limitations.

8.5.1 Response

+SF: <time_on_air> is sent just before the solicited response OK. The time on air is in ms, it is used by client application to manage duty cycle.

OK if SIGFOX™ layer is ON and frame has been successfully sent (and acked if ack mode was requested).

ERROR if SIGFOX™ layer is OFF or frame has not been successfully sent (or not acked after repetitions if ack mode was requested).

8.5.2 Unsolicited responses

An indication about Tx date:

+SF: SND,<busytime>

<busytime> is in ms.

It can be sent 2 times:

- One time with busytime > 0 if Tx subband was not free due to duty cycle restriction
- One time with busytime = 0 at Tx time.

The unsolicited response below is sent when ack mode was requested.

+SF: RCVBIN,<binpayload>,<rssi>

8.5.3 Example

```
AT+SF=SNDBIN,CAFE,1
+SF: SND,4576
+SF: SND,0
+SF: 6282
OK
+SF: RCVBIN,0123456789ABCDEF,-85.00
```

8.6 AT+SF=SNDBIT,

Bit transmission.

AT+SF=SNDBIT,<bitvalue>,<ack>

If <ack> value is 0 then the bit is sent in unacknowledged mode (default value when <ack> is omitted).

If <ack> value is 1, then the bit is sent in acknowledged mode.

8.6.1 Response

+SF: <time_on_air> is sent just before the solicited response OK. The time on air is in ms, it is used by client application to manage duty cycle.

OK if SIGFOX™ layer is ON and frame has been successfully sent (and acked if ack mode was requested).

ERROR if SIGFOX™ layer is OFF or frame has not been successfully sent (or not acked after repetitions if ack mode was requested).

8.6.2 Unsolicited responses

An indication about Tx date:

+SF: SND,<busytime>

<busytime> is in ms.

It can be sent 2 times:

- One time with busytime > 0 if Tx subband was not free due to duty cycle restriction
- One time with busytime = 0 at Tx time.

The unsolicited response below is sent when ack mode was requested.

+SF: RCVBIN,<binpayload>,<rssi>

8.6.3 Example

```
AT+SF=SNDBIT,0,1
+SF: SND,6422
+SF: SND,0
+SF: 4589
OK
+SF: RCVBIN,0123456789ABCDEF,-85.00
```

8.7 AT+SF=SNDOOB

Out Of Band message transmission.

8.7.1 Response

+SF: <time_on_air> is sent just before the solicited response OK. The time on air is in ms, it can be used by client application to manage duty cycle.

OK if SIGFOX™ layer is ON and frame has been successfully sent.

ERROR if SIGFOX™ layer is OFF or frame has not been successfully sent.

8.7.2 Unsolicited responses

An indication about Tx date:

+SF: SND,<busytime>

<busytime> is in ms.

It can be sent 2 times:

- One time with busytime > 0 if Tx subband was not free due to duty cycle restriction
- One time with busytime = 0 at Tx time.

8.7.3 Example

```
AT+SF=SNDOOB
+SF: SND,3987
+SF: SND,0
+SF: 4589
OK
```

8.8 AT+SF=RREP

Read Tx repetitions used in acked mode.

8.8.1 Response

+SF: <repeat> is sent just before the solicited response OK.

Default value is 2 repetitions.

Always OK.

8.8.2 Example

```
AT+SF=RREP
+SF: 2
OK
```

8.9 AT+SF=SREP,

Set Tx repetitions used in acked mode.

AT+SF=SREP,<repeatnb>

8.9.1 Response

Default value is 2 repetitions.

OK if number of repetitions <= 2.

ERROR if number of repetitions > 2.

8.9.2 Example

```
AT+SF=SREP,1
OK
AT+SF=SREP,3
ERROR
```

8.10 AT+SF=RTXF

Read output carrier macro channel.

8.10.1 Response

+SF: <tx_frequency> is sent just before the solicited response OK.

Default value is 868130000 Hz.

Always OK.

8.10.2 Example

```
AT+SF=RTXF
+SF: 868130000
OK
```

8.11 AT+SF=STXF,

Set output carrier macro channel.

8.11.1 Response

OK if 863000000 <= tx_frequency <= 870000000.

ERROR if tx_frequency is not in valid range.

8.11.2 Example

```
AT+SF=STXF,868200000
OK
AT+SF=STXF,862200000
ERROR
```

8.12 AT+SF=RRXF

Read reception carrier macro channel.

8.12.1 Response

+SF: <rx_frequency> is sent just before the solicited response OK.

Default value is 869525000 Hz.

Always OK.

8.12.2 Example

```
AT+SF=RRXF
+SF: 869525000
OK
```

8.13 AT+SF=SRXF,

Set reception carrier macro channel.

AT+SF=SRXF,<rx_frequency>

8.13.1 Response

OK if 863000000 <= rx_frequency <= 870000000.

ERROR if rx_frequency is not in valid range.

8.13.2 Example

```
AT+SF=SRXF,869525000
OK
AT+SF=SRXF,869525000
ERROR
```

8.14 AT+SF=RTXP (for test purpose)

Read Tx power applied to FSK continuous wave

8.14.1 Response

+SF: <tx_power> is sent just before the solicited response OK.

Default value is 14 dBm.

Always OK.

8.14.2 Example

```
AT+SF=RTXP
+SF: 14
OK
```

8.15 AT+SF=STXP (for test purpose)

Set Tx power applied to FSK continuous wave

8.15.1 Response

OK if tx_power <= 14 dBm.

ERROR if tx_power > 14 dBm.

8.15.2 Example

```
AT+SF=STXP,10
OK
AT+SF=STXP,20
ERROR
```

9 AT Generic command

AT Generic command can be used to activate/deactivate some generic functionalities.

9.1 AT+GA= DIND,1,8801

This command is use to know the status of PowerSaving.

9.1.1 Response

+GA : DIND,1,0801<pwr_state>

Always OK.

pwr_state 00 powersaving OFF pwr_state 01 powersaving ON

9.1.2 Example

```
AT+GA= DIND,1,8801
```

+GA : DIND,1,080100

OK.

9.2 AT+GA= DIND,1,8802<pwr_state>

WARNING: CONNECT CORRECTLY THE WAKEUP PIN BEFORE ACTIVATION OF POWERSAVING
This command is use to set the PowerSaving. pwr_state 00 powersaving OFF pwr_state 01 powersaving ON

PowerSaving can be activated once after boot-up, and from this point will go in stop mode as soon as possible and is wake-up by RTC or Wakeup pin. Please note that once power-saving is activated, user should toggle wake-up pin before sending an AT command.

If the module is reset, the powersaving is set back to OFF. So User should ensure setting it to ON after any reset

9.2.1 Response

Always OK.

9.2.2 Example

```
AT+GA= DIND,1,880201
```

OK

10 AT debug command

AT debug command can be used to activate/deactivate some debug functionalities.

10.1 AT+DEBUG= HELP

This commandis use to know the list of sub-commands.

10.1.1 Response

OK.

10.1.2 Example

```
AT+DEBUG= HELP
+DEBUG: <cmd>,<param_1>,…,<param_N>
+DEBUG: <cmd> are MVER,MVOFF,MVON,MV?,MEOFF,MEON,ME?,MPOFF,MPON,MP?,RREAD,RWRITE
+DEBUG: <cmd>? Lists parameters of <cmd> if any
OK
```

10.2 AT+DEBUG=MVER

Read Mcu software version.

Furthermore, when the device boots the software version is sent as an unsolicited response:

+DEBUG: START,<version>

This unsolicited response can be used to detect a reset of the device.

10.2.1 Response

Always OK.

+DEBUG: MVER,<version>

10.2.2 Example

AT boot:

```
+DEBUG: START,Nemeus 1.x
```

When requested:

```
AT+DEBUG= MVER
+DEBUG: MVER,Nemeus 1.x
OK
```

10.3 AT+DEBUG= MVOFF

Disable Mcu Verbose print on the UART

10.3.1 Response

Always OK.

10.3.2 Example

```
AT+DEBUG= MVOFF
OK
```

10.4 AT+DEBUG= MVON

Enable Mcu Verbose print on the UART

10.4.1 Response

OK if software is compiled with debug traces.

ERROR if software is compiled without debug traces.

10.4.2 Example

```
AT+DEBUG= MVON
OK
```

10.5 AT+DEBUG= MV?

Read current verbose mode.

10.5.1 Response

Always OK.

+DEBUG: <verbose>

10.5.2 Example

```
AT+DEBUG= MV?
+DEBUG: MVON
OK
```

10.6 AT+DEBUG= MEOFF

Disable UART echo mode.

10.6.1 Response

Always OK.

10.6.2 Example

```
AT+DEBUG= MEOFF
OK
```

10.7 AT+DEBUG= MEON

Enable UART echo mode.

10.7.1 Response

Always OK.

10.7.2 Example

```
AT+DEBUG= MEON
OK
```

10.8 AT+DEBUG= ME?

Read current echo mode.

10.8.1 Response

Always OK.

+DEBUG: <echo>

10.8.2 Example

```
AT+DEBUG= ME?
+DEBUG: MEON
OK
```

10.9 AT+DEBUG= MPOFF

Disable the sending of shell prompt on UART.

10.9.1 Response

Always OK.

10.9.2 Example

```
AT+DEBUG= MPOFF
OK
```

10.10 AT+DEBUG= MPON

Enable the sending of shell prompt on UART.

10.10.1 Response

Always OK.

10.10.2 Example

```
AT+DEBUG= MPON
OK
```

10.11 AT+DEBUG= MP?

Read current prompt mode.

10.11.1 Response

Always OK.

+DEBUG: <prompt>

10.11.2 Example

```
AT+DEBUG= MP?
+DEBUG: MPON
OK
```

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