
ST87MXX GNSS Application Note

Purpose and scope

This document gives details on the AT Commands and general usage of the embedded GNSS feature supported by the ST87MXX NB-IoT module.

Document status
Official

1 General information

1.1 Acronyms and terms

Table 1 Definitions of terms

Term	Definition
GALILEO	European Satellite Navigation System
GNSS	Global Navigation Satellite Systems
GPS	Global Positioning System
ME	Mobile Equipment
MSC	Message Sequence Chart
SUPL	Secure User Plane Location
SV	Space Vehicle (= Satellite)
TTFF	Time To First Fix
UART	Universal Asynchronous Receiver Transmitter
URC	Unsolicited Result Code

1.2 Reference documents

The documents listed in [Table 2](#) provide further information.

Table 2 Document references

Reference	Document
[1]	ST87MXX UM AT commands description
[2]	ST87MXX_GNSS_Wi-Fi_Positioning_with_external_LNA_Application_Note

1.3 Revision history

Table 3 Document revision history

Date	Version	Changes
2023-12-05	V1.0	Official release
2024-03-26	V1.1	Update Error and URC list Typo Corrections
2024-10-10	V1.2	Update Error and URC list Update GNSS AT commands and URCs
2025-01-10	V1.3	Remove Error and URC lists Update GNSS AT commands and URCs
2025-07-01	V1.4	Remove AT commands tables and add ST87MXX UM AT commands description reference
2025-07-16	V2.0	Update for release

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2 Overview

2.1 Introduction

2.1.1 Hardware configuration

To properly receive the GNSS signal, an antenna shall be connected to the GNSS port of the module, see [2].

2.2 Command sequence

The GNSS feature of the ST87MXX activation/deactivation sequence consists in three steps:

- **GNSS initialization**: configuration of the GNSS assistance setting and constellation and start the processing,
- **GNSS fix**: activation / deactivation of the position URC display,
- **GNSS de initialization**: turn off of the GNSS processing.

Optionally, for debug purposes, the module can also display additional information such as the **GNSS visible satellites** information.

This document presents the whole GNSS feature usage and most common scenarios.

For the complete description of the commands and parameters, please refer to the AT command user manual [1].

2.3 GNSS assistance management

2.3.1 Overview

The GNSS system can run in three modes:

- **Cold start:** The system uses the GNSS signal to both synchronize to the SV and acquire the assistance data to compute the position.
- **Auto mode:** The system first runs in cold start and for the following runs uses assistance data stored from the previous localisation to compute the
- **Assisted start with SUPL:** The system uses assistance data downloaded from a server using the NBIOT link to compute the position.

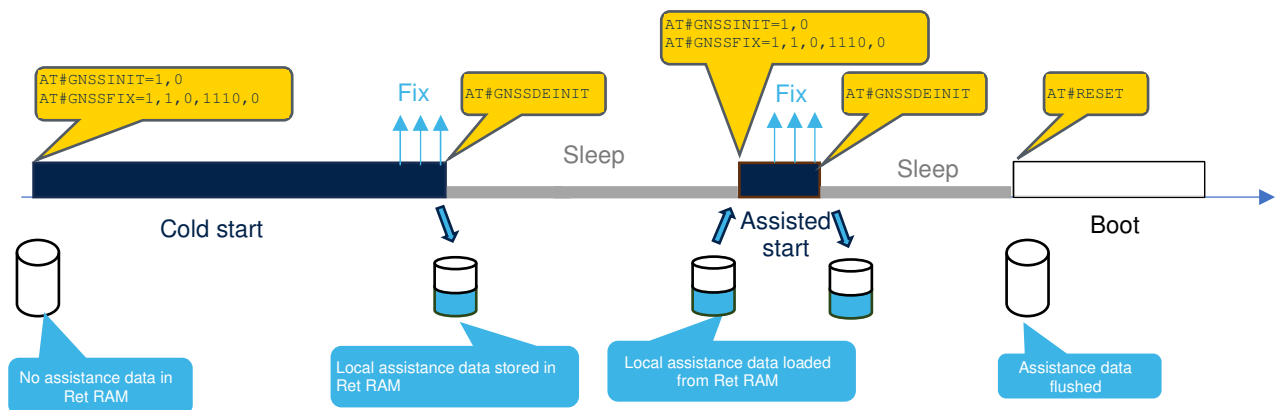
As the data rate of the GNSS signal is very low, it takes time to acquire the assistance data from it. Thus, the Time To First Fix is lower in assisted start than in cold start.

In most of the IOT applications the data link budget is very low, and the battery life is limited. So, the download of the assistance data from a server is not the most common mode.

That is why the recommended mode for the GNSS is the auto mode where the system will first run in cold start and then in assisted start for the following runs.

2.3.2 Local assistance details

The following chart presents the sequence in Auto mode for assistance data:



The local assistance data remain stored in the retention RAM during sleep periods and are erased at the reset of the system (**AT#RESET**, **AT#PWROFF**).

The local assistance data consists in three parts:

- a precise time,
- a coarse initial position,
- the ephemeris data for the acquired satellites.

The ephemerides are valid a couple of hours, this means that the local assistance data are useful for a limited time and if the time between two consecutive GNSS run is too long, the system will run in Cold start mode.

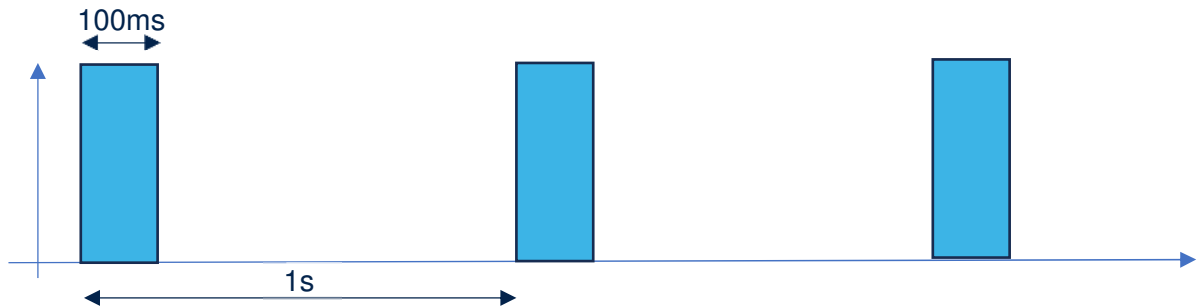
As the data rate of the GNSS signal is very low, it takes about 30 seconds to acquire the ephemeris data. Thus, the Time To First Fix is lower in assisted start than in cold start.

To fully benefit from the local assistance data, it is recommended to let the first cold start fix run for a minute after the first fix. This way the system may accumulate more ephemeris that will be used for the next assisted run.

2.4 PPS feature

2.4.1 Description

The Pulse Per Second signal is generated by the GNSS feature once the position is achieved. The PPS signal is as follows as soon as the fix is achieved:



The activation is done by AT commands using the AT#OPTION mechanism. The activation of the PPS also requires a GPIO configuration to route the signal out of the module.

The PPS output is the **GPIO 10** of the module.

2.4.2 AT commands

To enable the PPS feature, the following setting shall be done prior to starting the GNSS:

AT#GPIOCFG=10, 8	Route the PPS to the GPIO10
AT#OPTION=3, 3, 1	Enable the PPS feature of the GNSS
AT#RESET=1	Save the parameters to the NVM and restart the system

Note that this configuration is saved in the NVM and thus will remain after any system reboot.

To disable the PPS feature, the following sequence shall be sent:

AT#OPTION=3, 3, 0	Disable the PPS feature of the GNSS
AT#GPIOCFG=10, 3	Set back the GPIO10 in input pull down mode
AT#RESET=1	Save the parameters to the NVM and restart the system

3 GNSS scenario examples

3.1 Command descriptions

The GNSS feature of the ST87MXX activation/deactivation sequence consists in three commands:

```
AT#GNSSINIT=<assistance_gnss>,<constellation_id>
[,<context_id>,<supl_server_ip>,<supl_server_port>
[,<supl_session_timeout>[,<security_profile_id>]]]
AT#GNSSFIX=<start_stop>,<event_enable>,<format_type>,<format_argument>[,<period>]
AT#GNSSDEINIT
```

For tuning purpose, the following command allows to display detailed information on the visible Space Vehicules:

```
AT#GNSSSV=<urc_mode>
```

See the AT command user manual [1] for more details on the parameters.

3.2 GPS cold start use case

3.2.1 Parameters

Here is an example of AT commands sequence to start the system in GPS in cold start.

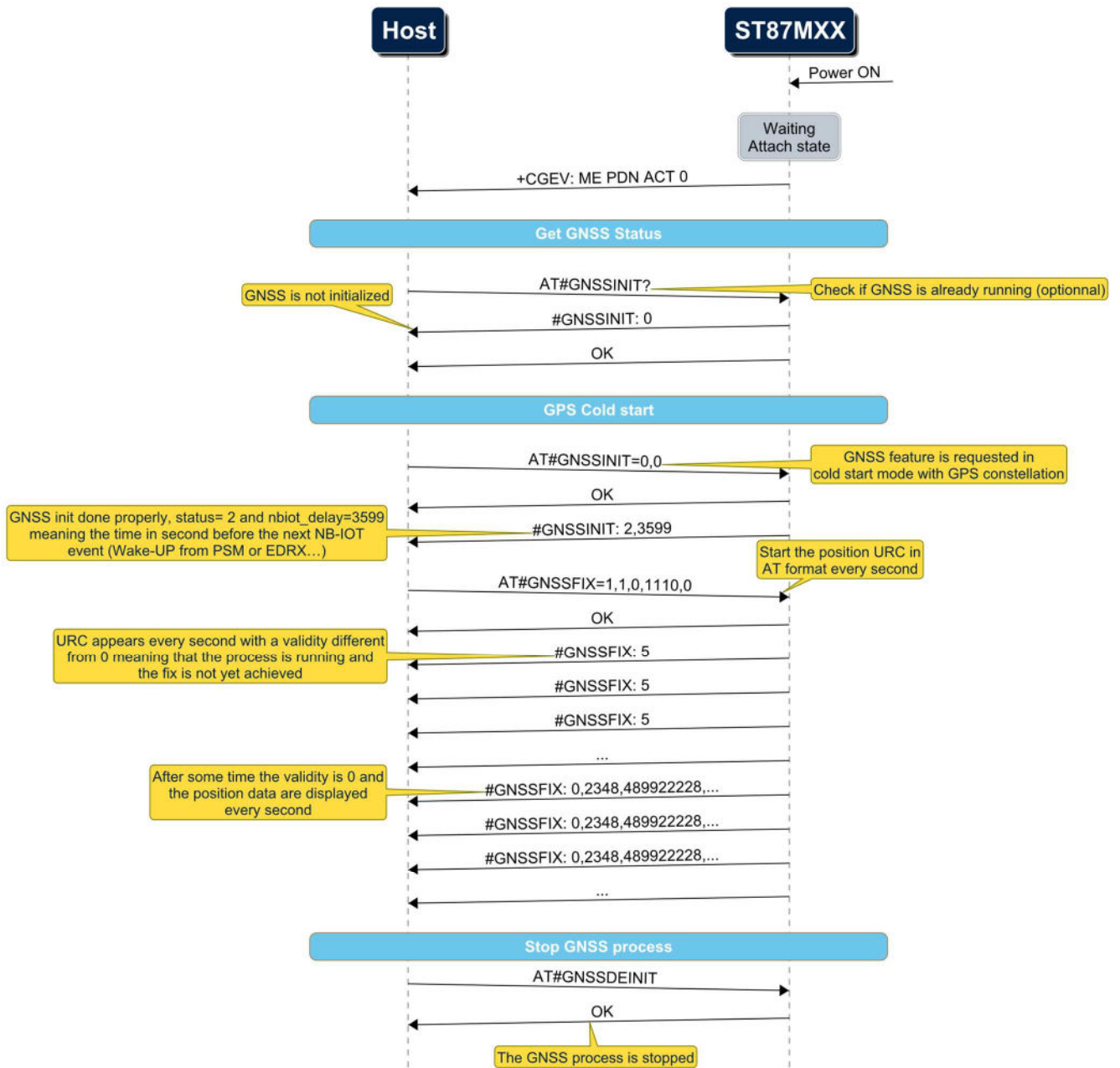
The initialization parameters are set as follows:

```
<assistance_gnss> = 0 for Cold start,
<constellation_id> = 0 for GPS constellation
```

The Fix URC parameters are set as follows:

```
<start_stop> = 1, enable position URC
<event_enable> = 1, enable event
<format_type> = 0, AT format type
<format_argument> = 1110, position, accuracy and satellites data are enabled.
```

3.2.2 MSC



<http://msc-generator.sourceforge.net/v7.2>

3.2.3 Terminal

Below is the sequence obtained in the UART terminal when executing the scenario (in **Bold** the commands sent to the module):

```

AT#GNSSINIT?
#GNSSINIT: 0
OK

AT#GNSSINIT=0,0
OK
#GNSSINIT: 2,65535

AT#GNSSFIX=1,1,0,111
OK
    
```

```
#GNSSFIX: 5
#GNSSFIX: 5
...
#GNSSFIX: 6

#GNSSFIX: 0,2376,468378107,48.133076,-
01.636421,118.7,4.10,6.2,1.4,2.7,2.2,7,01,-1.10,03,-1.3,17,-
3.6,02,1.2,32,0.3,04,-1.4,08,-3.9

#GNSSFIX: 0,2376,468379107,48.133060,-
01.636375,121.7,3.0,3.8,1.4,2.7,2.2,7,01,0.6,03,1.1,17,2.9,02,0.6,32,0.7,04,1.7,
08,0.7

#GNSSFIX: 0,2376,468380107,48.133083,-
01.636405,118.0,2.6,3.3,1.4,2.7,2.2,7,01,0.5,03,-1.10,17,-0.1,02,1.1,32,-
1.4,04,1.6,08,0.7

AT#GNSSDEINIT
OK
```

3.3 Local assistance use case

3.3.1 Parameters

Here is an example of AT commands sequence to start the system in GPS in auto mode, first start in cold start then assisted start using the local assistance.

The initialization parameters are set as follows:

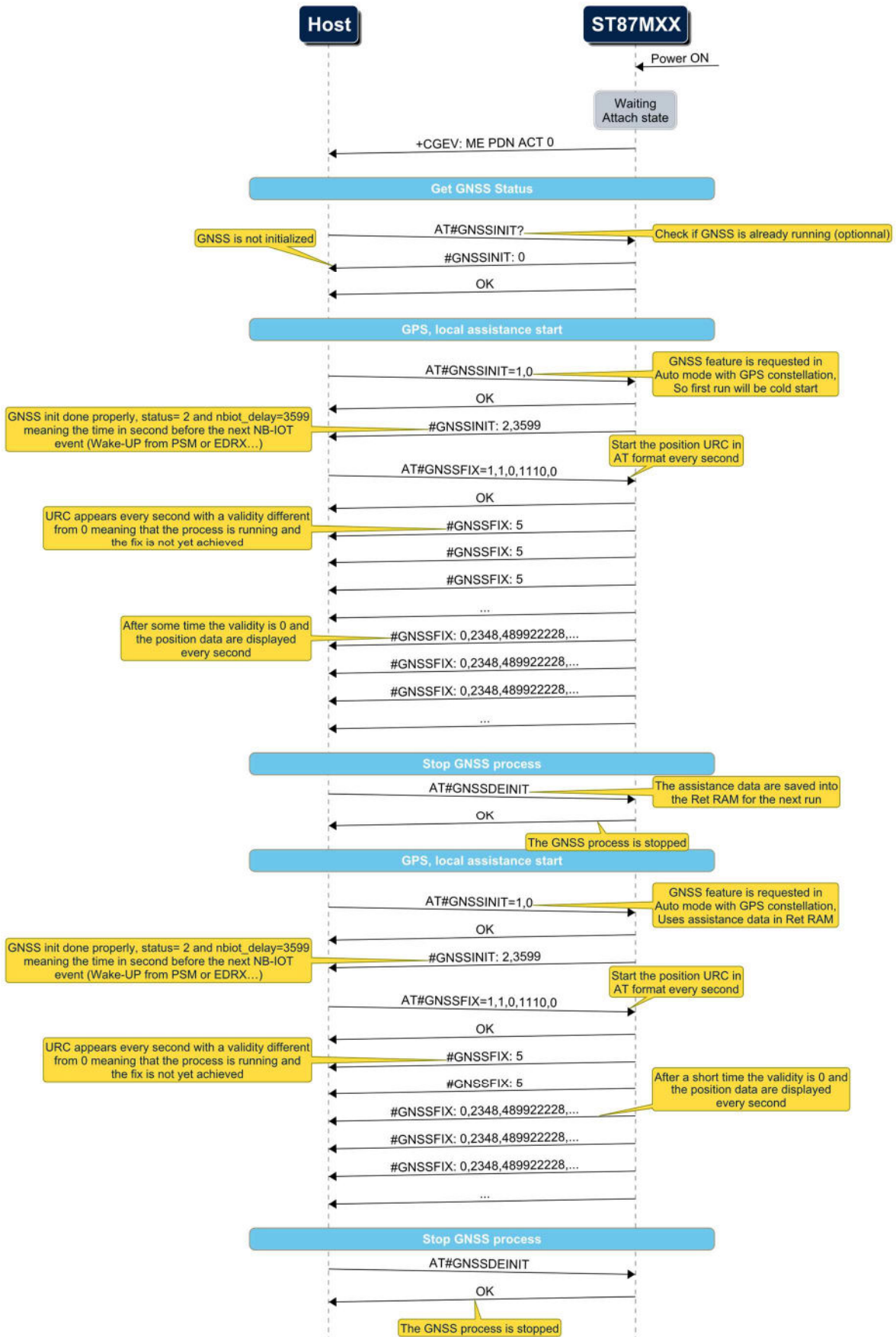
<assistance_gnss> = 1 for Auto mode start,
<constellation_id> = 0 for GPS constellation

The Fix URC parameters are set as follows:

<start_stop> = 1, enable position URC
<event_enable> = 1, enable event
<format_type> = 0, AT format type
<format_argument> = 1110, position, accuracy and satellites data are enabled.

See the AT command user manual [1] for more details on the parameters.

3.3.2 MSC



<http://msc-generator.sourceforge.net/v7.2>

3.3.1 Terminal

Below is the sequence obtained in the UART terminal when executing the scenario (in **Bold** the commands sent to the module):

```

AT#GNSSINIT?
#GNSSINIT: 0
OK

AT#GNSSINIT=1,0
OK
#GNSSINIT: 2,65535

AT#GNSSFIX=1,1,0,111
OK
#GNSSFIX: 5
#GNSSFIX: 5
...

#GNSSFIX: 0,2376,468378107,48.133076,-
01.636421,118.7,4.10,6.2,1.4,2.7,2.2,7,01,-1.10,03,-1.3,17,-
3.6,02,1.2,32,0.3,04,-1.4,08,-3.9

#GNSSFIX: 0,2376,468379107,48.133060,-
01.636375,121.7,3.0,3.8,1.4,2.7,2.2,7,01,0.6,03,1.1,17,2.9,02,0.6,32,0.7,04,1.7,
08,0.7

#GNSSFIX: 0,2376,468380107,48.133083,-
01.636405,118.0,2.6,3.3,1.4,2.7,2.2,7,01,0.5,03,-1.10,17,-0.1,02,1.1,32,-
1.4,04,1.6,08,0.7

AT#GNSSDEINIT
OK

AT#GNSSINIT=1,0
OK
#GNSSINIT: 2,65535

AT#GNSSFIX=1,1,0,111
OK
#GNSSFIX: 5

#GNSSFIX: 0,2376,468378107,48.133076,-
01.636421,118.7,4.10,6.2,1.4,2.7,2.2,7,01,-1.10,03,-1.3,17,-
3.6,02,1.2,32,0.3,04,-1.4,08,-3.9

#GNSSFIX: 0,2376,468379107,48.133060,-
01.636375,121.7,3.0,3.8,1.4,2.7,2.2,7,01,0.6,03,1.1,17,2.9,02,0.6,32,0.7,04,1.7,
08,0.7

#GNSSFIX: 0,2376,468380107,48.133083,-
01.636405,118.0,2.6,3.3,1.4,2.7,2.2,7,01,0.5,03,-1.10,17,-0.1,02,1.1,32,-
1.4,04,1.6,08,0.7

AT#GNSSDEINIT
OK

```

3.4 SUPL assistance use case

3.4.1 Parameters

Here is an example of AT commands sequence to start the system in GPS in SUPL assistance mode and the display in NMEA mode.

The initialization parameters are set as follows:

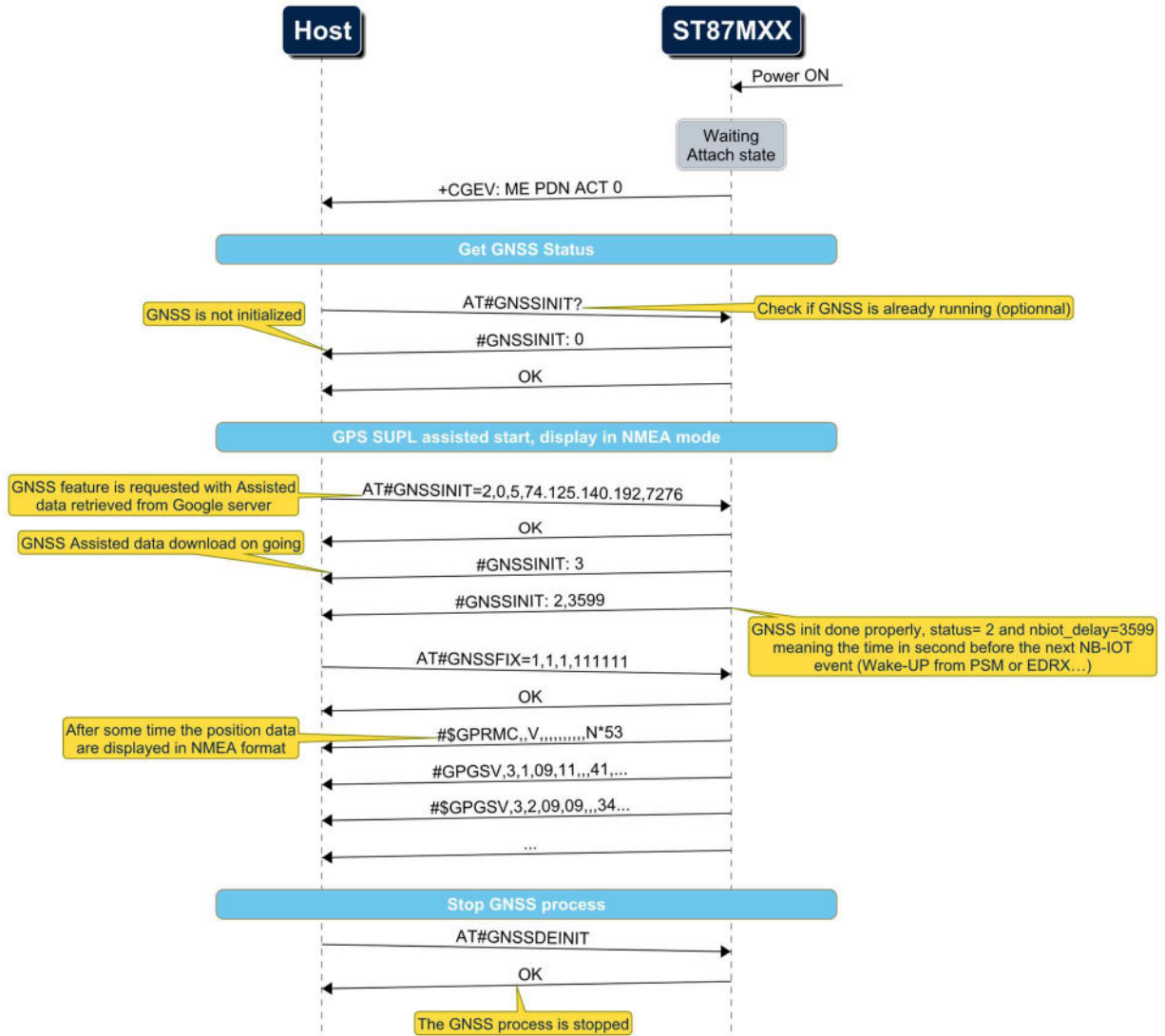
```
<assistance_gnss> = 2 for assistance data download enabled  
<constellation_id> = 0 for GPS constellation  
<context_id> = 5  
<supl_server_ip> = 74.125.140.192  
,<supl_server_port> = 7276
```

The Fix URC parameters are set as follows:

```
<start_stop> = 1, enable position URC  
<event_enable> = 1, enable event  
<format_type> = 1, NMEA format type  
<format_argument> = 111111 all NMEA messages are enabled
```

See the AT command user manual [1] for more details on the parameters.

3.4.2 MSC



<http://msc-generator.sourceforge.net/v7.2>

3.4.1 Terminal

Below is the sequence obtained in the UART terminal when executing the scenario (in **Bold** the commands sent to the module):

```

AT#GNSSINIT?
#GNSSINIT: 0
OK

AT#GNSSINIT=2, 0, 5, 74.125.140.192, 7276
OK
#GNSSINIT: 3
#GNSSINIT: 2, 65535

AT#GNSSFIX=1, 1, 0, 111
OK
#GNSSFIX: 5
#GNSSFIX: 5
...

#GNSSFIX: 0, 2376, 468378107, 48.133076, -
01.636421, 118.7, 4.10, 6.2, 1.4, 2.7, 2.2, 7, 01, -1.10, 03, -1.3, 17, -
    
```

```

3.6,02,1.2,32,0.3,04,-1.4,08,-3.9

#GNSSFIX: 0,2376,468379107,48.133060,-
01.636375,121.7,3.0,3.8,1.4,2.7,2.2,7,01,0.6,03,1.1,17,2.9,02,0.6,32,0.7,04,1.7,
08,0.7

#GNSSFIX: 0,2376,468380107,48.133083,-
01.636405,118.0,2.6,3.3,1.4,2.7,2.2,7,01,0.5,03,-1.10,17,-0.1,02,1.1,32,-
1.4,04,1.6,08,0.7

AT#GNSSDEINIT
OK

AT#GNSSINIT=1,0
OK
#GNSSINIT: 2,65535

AT#GNSSFIX=1,1,1,111111
OK
$GPRMC,,V,,,,,,,,,N*53
$GPGSV,3,1,09,11,,,41,28,,, -1,30,,,43,20,,,39*6D
$GPGSV,3,2,09,09,,,34,01,,, -1,06,,,38,13,,,37*69
$GPGSV,3,3,09,07,,,35*71
GPRMC,091213.757,A,4809.2226,N,00134.309,W,,19.6,081223,, ,A*56
$GPVTG,19.6,T,,M,,N,,K,A*33
$GPGGA,091213,4809.2226,N,00134.309,W,1,07,1.6,120.6,M,,M,, ,*7E
$GPGSA,A,3,11,30,20,09,06,13,07,,,,,3.3,1.6,*10
$GPGSV,3,1,09,11,,,41,28,,, -1,30,,,43,20,,,39*6D
$GPGSV,3,2,09,09,,,34,01,,, -1,06,,,38,13,,,37*69
$GPGSV,3,3,09,07,,,35*71
$GPGLL,4809.2226,N,00134.309,W,091213,A,A*60
...
AT#GNSSDEINIT
OK

```

3.1 Display SV details

3.1.1 Parameters

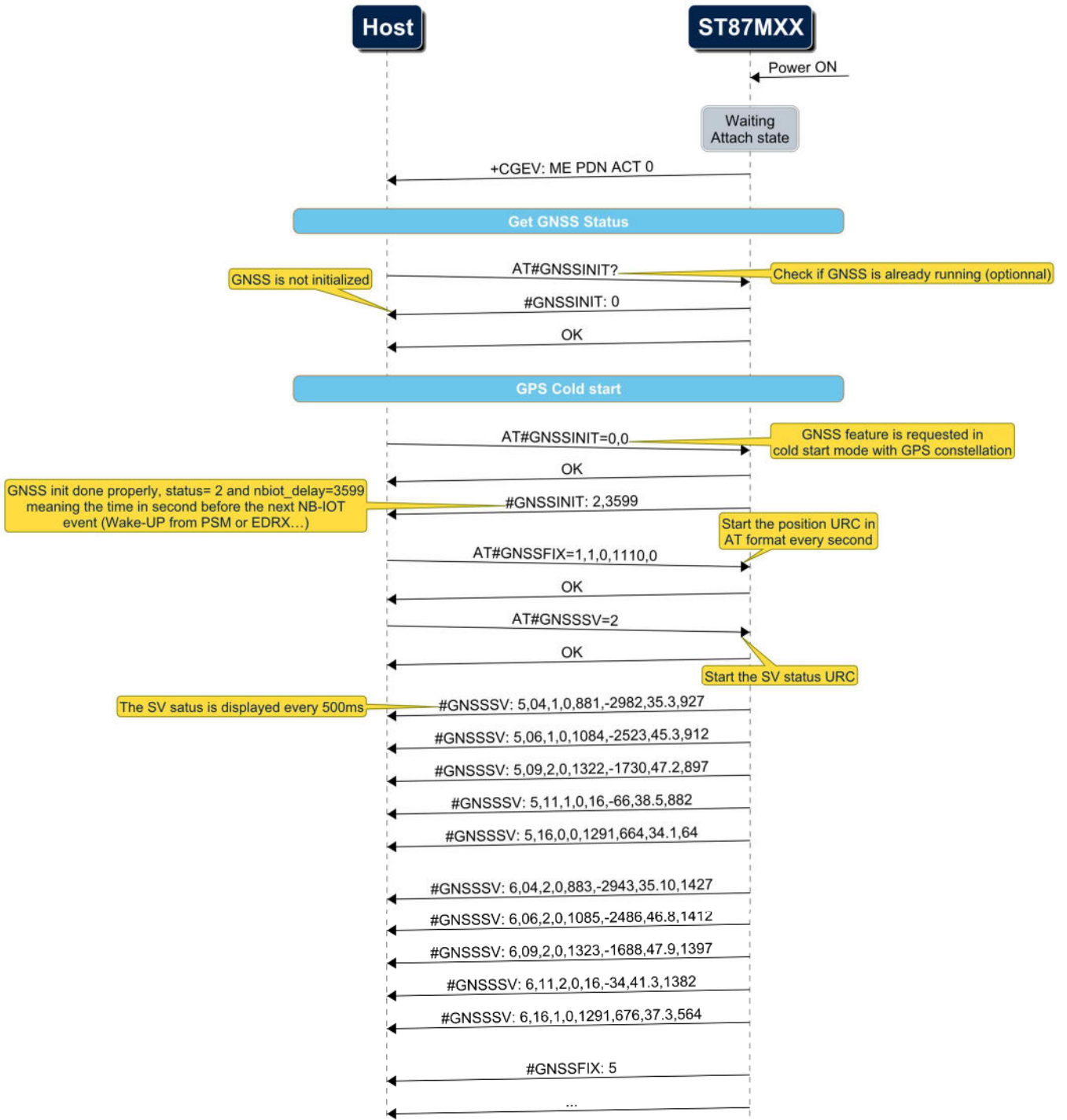
Here is an example of AT commands sequence to display the details on the visible SV when the GNSS system is running in the #GNSSSV URC. Please note that this URC is used by the GUI GNSS panel to display the status of the system.

To display the full details on the visible SV, the command is as follows:

AT#GNSSSV=2

See the AT command user manual [1] for more details on the parameters.

3.1.2 MSC



<http://msc-generator.sourceforge.net> v7.2

3.1.1 Terminal

Below is the sequence obtained in the UART terminal when executing the scenario (in **Bold** the commands sent to the module):

```
AT#GNSSINIT?
#GNSSINIT: 0
OK

AT#GNSSINIT=0,0
OK
#GNSSINIT: 2,65535

AT#GNSSFIX=1,1,0,111
OK
AT#GNSSSV=2
OK

#GNSSSV: 5,04,1,0,881,-2982,35.3,927
#GNSSSV: 5,06,1,0,1084,-2523,45.3,912
#GNSSSV: 5,09,2,0,1322,-1730,47.2,897
#GNSSSV: 5,11,1,0,16,-66,38.5,882
#GNSSSV: 5,16,0,0,1291,664,34.1,64

#GNSSSV: 6,04,2,0,883,-2943,35.10,1427
#GNSSSV: 6,06,2,0,1085,-2486,46.8,1412
#GNSSSV: 6,09,2,0,1323,-1688,47.9,1397
#GNSSSV: 6,11,2,0,16,-34,41.3,1382
#GNSSSV: 6,16,1,0,1291,676,37.3,564
#GNSSSV: 6,07,0,0,1592,798,32.2,272

#GNSSFIX: 5
...
```

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