FN990 Family

SW user guide

1VV0301750 preliminary Rev.0 – 2021-12-20

APPLICABILITY TABLE

PRODUCTS
FN990A40

CONTENTS

1. INTRODUCTION

1.1. Scope

This document introduces Telit FN990 family module and presents possible and recommended Software solutions to develop a product based on the FN990 family module. All the features and solutions described are applicable to all FN990 family variants, where "FN990 family" refers to the variants listed in the applicability table.

1.2. Audience

This document is intended for system integrators that are using the Telit FN990 family module in their products.

1.3. Contact Information, Support

For technical support and general questions please-mail:

- *TS-EMEA@telit.com*
- *TS-AMERICAS@telit.com*
- *TS-APAC@telit.com*
- *TS-SRD@telit.com*
- *TS-ONEEDGE@telit.com*

Alternatively, use:

https://www.telit.com/contact-us/

For detailed information about where you can buy the Telit modules or for recommendations on accessories and components visit:

http://www.telit.com

Our aim is to make this guide as helpful as possible. Keep us informed of your comments and suggestions for improvements.

Telit appreciates the user feedback on our information.

1.4. Symbol Conventions

	**Danger:** This information MUST be followed or catastrophic equipment failure or personal injury may occur.
	**Warning:** Alerts the user on important steps about the module integration.
	**Note/Tip:** Provides advice and suggestions that may be useful when integrating the module.
	**Electro-static Discharge:** Notifies the user to take proper grounding precautions before handling the product.

Table 1: Symbol Conventions

All dates are in ISO 8601 format, that is YYYY-MM-DD.

1.5. Related Documents

- FN990 family AT Commands Reference Guide, 80691ST11097A
- Telit QMI Command Reference Guide, 80000ST11094A
- FN990_HW_Design_Guide, 1VV0301752
- Telit_Modules_Linux_USB_Drivers_User_Guide, 1VV0301371
- Telit_WHQL_Drivers_Installer_User_Guide, 1VV0301360
- uxfp User Guide, 1VV0301613

2. HIGH LEVEL SW ARCHITECTURE

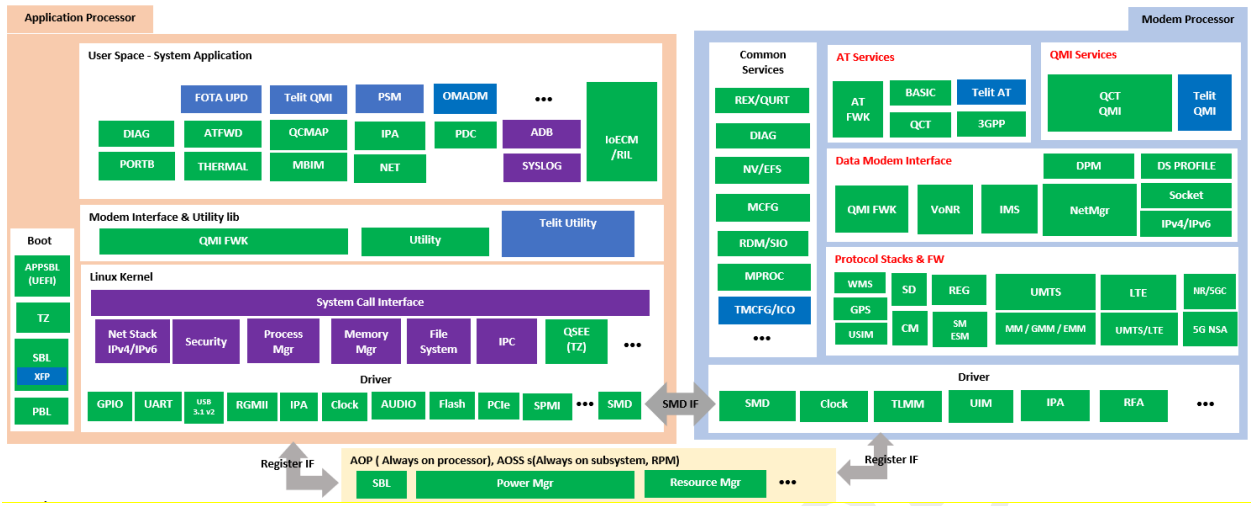


Figure 1: General System Architecture

2.1. Information for SW Package

2.1.1. SW Image Concept

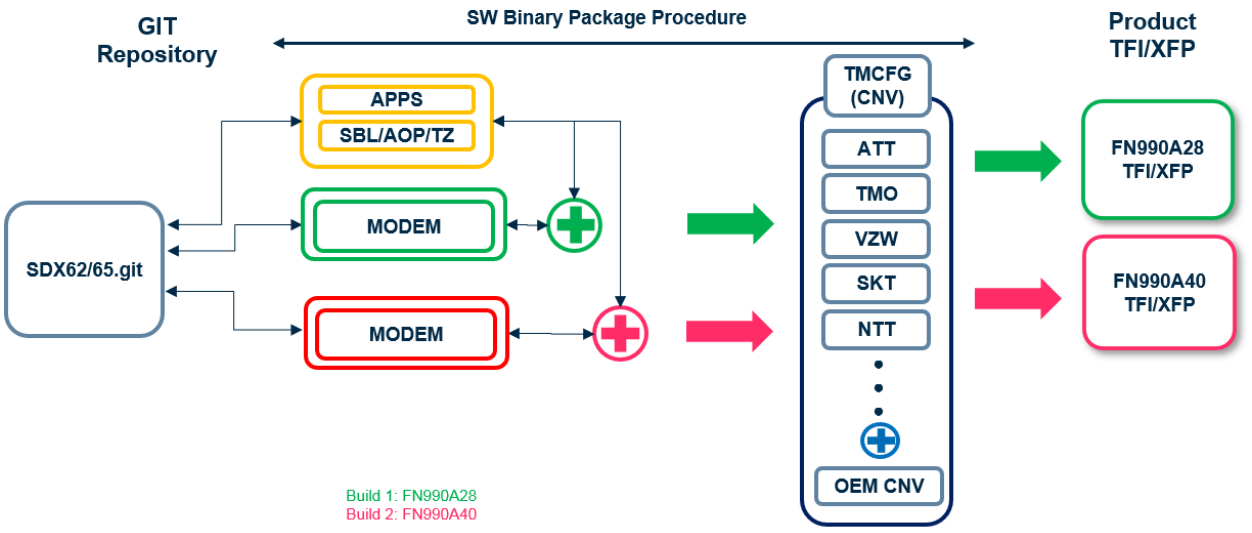


Figure 2: General System Architecture

- SW package has some parts of sub image
- Boot area (SBL/AOP/TZ), Modem image, Application image
- All image are built by each environment

- CNV file consist of network operator configuriton and OEM configuration
- TFI/XFP file has all image boot/modem/application/cnv

2.1.2. Basic Concept for SW Package

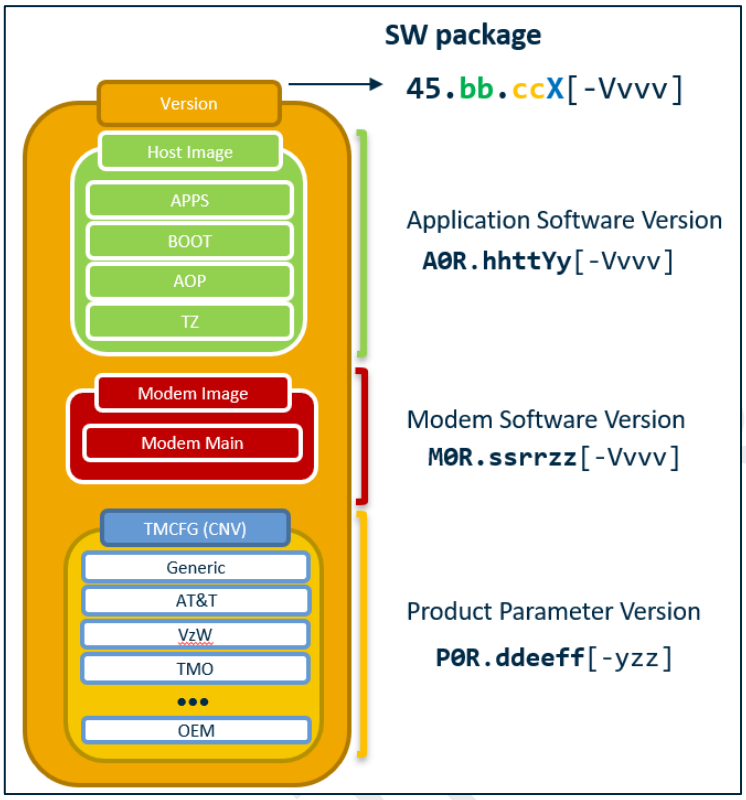


Figure 3: delivered SW package information

2.1.2.1. Package version

Platform Version: 45

bb = Major version

cc = Variant (00:FN990A28, 01:FN990A40)

X = minor package version

V: build type (Beta , Alpha , Test)

vvv: build number (000-999)

2.1.2.2. Application version

hh = Major software version

Y = release version

y = extended version (on top of 'Y' base)

V: build type (Beta , Alpha , Test)

vvv: build number (000-999)

2.1.2.3. Modem version

ss = product variant (00: FN990A28, 01: FN990A40, 02: FN990A48..)

rr = major software version

zz = release version

V: build type (Beta , Alpha , Test)

vvv: build number (000-999)

2.1.2.4. Production parameter version

dd: MNO id (00: GEN GCF,01: GEN PTCRB,10: ATT,11: TMO,12: VZW,20: SKT,30: NTT, ...)

Index	Mobile Network Operator	
	Region	Operator
00	Rest of World	Generic-GCF
01	North America	Generic-PTCRB
10	North America	AT&T
11	North America	T-Mobile
12	North America	Verizon
14	North America	Bell
15	North America	Rogers
16	North America	Telus
20	Korea	SK Telecom
21	Korea	SK Telecom Dongle
30	Japan	NTT
TBD.		

Table 2: Supported network configurations

ee: CNV version number

ff: CNV extension number

yzz: OEM PRI version

This file is shown only if OEM CNV (customer configuration files) is activated

y – OEM ID (1-9) , zz – PRI version number (1-99)

2.1.3. How to Check Current SW Version

AT#SWPKGV – Show SW package version

<Telit Software Package Version>-<Production Parameters Version>

<Modem Version>

<Production Parameters Version>

<Application Version>

OK

Example

```
AT#SWPKGV
45.00.011-B007-P0R.001200
M0R.010001-B007
A0R.010010-B007
```

AT+GMR or AT#CGMR – Show modem version

Example

```
AT+GMR
M0R.010001-B007
```

AT+GMM

Example

```
AT+GMM
FN990A40
```

AT#CGMF – Show product parameter version

Example

```
AT#CGMF
P0R.001200
```

AT#FWSWITCH – Change FW(CNV) network configuration

Example
• Generic GCF config

```
AT#FWSWITCH=0
OK
```

2.1.4. How to Use Auto Firmware Switch Feature

TBD.

3. FUNCTIONAL DESCRIPTION

3.1. General Functionality and Main Features

The FN990 cellular module family features 5G NR / LTE and multi-RAT modems along with a powerful on-chip application processor and a rich set of interfaces.

Some product features are listed below:

- Multi RAT cellular modem for data communication
  - 3GPP Rel 16, 5GNR compliant
  - 5GNR sub-6
    - 256 QAM for UL/DL
    - Support of n77, n78, and n79 bands
  - LTE Cat20 / Cat18 (2Gbps/200Mbps DL/UL)
  - WCDMA up to DC HSPA+ Rel. 9
  - Support of SIM profile switching
- Super speed serial interfaces:
  - USB 3.1 Gen2
  - PCI Express Gen4 1-Lane
- Tools for firmware update (TFI)
- Stream download protocol (SDL)
- M.2 form factor

3.2. Application System Overview

The Application Processor is a 32-bit ARM Cortex-A7 up to 1.5 GHz with Linux operating system. The following software runs on the application processor:

- Telit Unified AT command set is the main control interface, including the following:
  - Hayes standard AT command set
  - Standard 3GPP AT command and GPRS-specific commands.
  - Standard 3GPP AT commands for SMS (Short Message Service) and CBS (Cell Broadcast Service)

3.2.1. Location Subsystem

The following key features are offered by the Location subsystem:

- Support for GPS, GLONASS, BeiDou/Compass Phase II, Galileo and QZSS.
- Supports the following Satellite Based Augmentation Systems (SBAS): WAAS, EGNOS, MSAS (tracked for cross correlation improvement only).
- Support for Receiver Autonomous Integrity Monitoring (RAIM) & Fault Detection and Exclusion (FDE), internal to the receiver.
- Support of service data (Ephemerides, location, time...) provided by the customer application to ensure a faster Time To First Fix (TTFF) through SUPL.
- NMEA-0183 output on USB.

3.2.2. USB Interface

The FN990 family includes a USB3.1 Gen2 compliant Universal Serial Bus (USB) which operates at USB super-speed (up to 10Gbits/sec).

The USB port is typically used for:

- Flashing of firmware and module configuration
- Production testing
- Accessing the Application Processor's filesystem (debug bridge)
- AT command access (2 modem ports)
- Network Interfaces, RmNet/MBIM/RNDIS/ECM
- Diagnostic monitoring and debugging
- NMEA data to an external host

The following standardized device classes can be supported:

- CDC-ACM, ECM, MBIM, RNDIS, RMNET (Qualcomm proprietary)

3.2.2.1. USB Compositions

The following USB compositions are available:

1070 - DIAG + ADB + RMNET + NMEA + MODEM + MODEM + AUX

1071 - DIAG + ADB + MBIM + NMEA + MODEM + MODEM + AUX

1072 - RNDIS + DIAG + ADB + NMEA + MODEM + MODEM + AUX

1073 - DIAG + ADB + ECM + NMEA + MODEM + MODEM + AUX

1075 - ADB + AUX (For only PCIe-EP mode)

The USB composition can be changed by using the #USBCFG command.

Danger: FN990 complied with *Universal Serial Bus Specification, Revision 3.1 (August 11, 2014 or later)*. If the host USB controller complied with just *Universal Serial Bus Specification, Revision 3.0 (June 6, 2011*), customer should check timing parameters of Protocol layer with a host controller chipset vendor, especially, about *tHostTransactionTimeout.*

Note: FN990 family doesn't support hot-plug on USB.

Note: If PCIe EP is used, USB 0x1055 PID is selected.

3.2.3. PCI Express Interface

TBD

3.2.4. Time Services

The time daemon manages the system time between the modem and application processor.

The time daemon service starts at boot and reads the RTC time from /dev/rtc0.

Note: modem and application is not synchronize at running time currnetly.

3.2.4.1. Time Update

Mobile devices have an internal timer system and the time and time zone can be manually updated. Due to the inaccuracies of the device-specific internal timer system, each device deviates with time over a period. There are various network standards to periodically synchronize the device time with the network-provided wall clock time:

Network Identity and Time Zone (NITZ)

NITZ is a mechanism for provisioning local time, date, and network provider identity information to mobile devices over a wireless network. NITZ is currently an optional part of the official 3GPP standard.

The NITZ standard allows the network to "transfer its current identity, universal time, DST, and LTZ, but each is optional and support varies depending on radio access network vendor and operators."

With NITZ, the accuracy of the time information is in the order of minutes.

3.2.4.2. System Time Base

Real-time time base

The real time is the wall clock time used by the UI to display the current system time. Generally, this time is updated and synchronized with the time information from the network, for example, as the modem uses standard network time protocols, such as NTP or NITZ. During synchronization, this time can go forward or backward with regards to the network time.

Monotonic time base

The monotonic time is the time elapsed since epoch time (January 01, 1980) or some random start time. As this time is not used for displaying the UI or alarm setup, the start time is not relevant.

The monotonic time always moves forward in time but does not reflect the time of the wall clock in any specific way. In the current implementation, CLOCK_MONOTONIC resembles the jiffies tick count in that it starts at 0 when the system boots and monotonically increases from there.

The monotonic time is used by the kernel and user for all relative time events, because this time never goes backward.

3.2.5. Data Connection

3.2.5.1. QCMAP_CLI

QCMAP_CLI is a QC user space application allowing to activate a PDP context along with network interface setup, firewall configuration, DNS etc.

This is a GUI application which resides in the /usr/bin directory.

3.3. Basic Operations

Note: The basic commands are to be compatible with the existing Telit model but it may not be supported by changing the chipset and SW architecture.

3.3.1. Command Syntax

In the next paragraphs the following notations are used:

<cr> represents the Carriage Return Character (13)

<lf> represents the Line Feed Character (10)

<xx> represents a parameter with changing name is in place of the double x. (< and > characters are only for limiting the parameter and must not be issued to the terminal).

[<xx>] represents an optional parameter whatever name is in place of the xx.

[and] characters are only for limiting the optional parameter and must not be issued to the terminal).

3.3.2. Command Response Timeout

Every command issued to the Telit modules returns a result response if response codes are enabled (default). The time required to process the given command and return the response varies, depending on the type of the command. The commands that do not interact with the SIM/UICC or the network, and only involve internal set up settings or readings, have an immediate response, depending on the configuration of the SIM/UICC (for example, a number of contacts stored in the phonebook, number of stored SMS), or on the network the command may interact with.

The table below lists only the commands whose interaction with the SIM/UICC or the network could lead to long response timings. When not otherwise specified, timing refers to the set command. For phonebook and SMS writing and reading related commands, the timing refers to to the commands issued after completing the sorting of the phonebook.

Note: In case no response is received after the timeout time has been elapsed, then try repeating the last command and if still no response is received until the timeout time, an Unconditional Shutdown MUST be issued and the device must be powered ON again.

Command	Time-Out (Seconds)
+COPS	180 (test command)
+CLCK	15 (SS operation)
	5 (FDN enabling/disabling)
+CPWD	15 (SS operation)
	5 (PIN modification)
+CLIP	15 (read command)
+CLIR	15 (read command)
+CCFC	15
+CCWA	15
+CHLD	60
+CPIN	30
+CPBS	5 (FDN enabling/disabling)
+CPBR	5 (single reading)
	15 (complete reading of a 500 records full phonebook)
+CPBF	10 (string present in 500 records full phonebook)
	5 (string not present)
+CPBW	5
+CACM	5
+CAMM	5
+CPUC	180
+VTS	20 (transmission of full "1234567890*#ABCD" string with no delay between tones, default duration)
+CSCA	5 (read and set commands)
+CSAS	5
+CRES	5
+CMGS	120 after CTRL-Z; 1 to get '>' prompt
+CMSS	120 after CTRL-Z; 1 to get '>' prompt
+CMGW	5 after CTRL-Z; 1 to get '>' prompt
+CMGD	5 (single SMS cancellation)
	25 (cancellation of 50 SMS)
+CNMA	120 after CTRL-Z; 1 to get '>' prompt
+CMGR	5
+CMGL	100

Command	Time-Out (Seconds)
+CGACT	150
+CGATT	90
D	120 (voice call)
	Timeout set with ATS7 (data call)
A	60 (voice call)
	Timeout set with ATS7 (data call)
H	60
+CHUP	60
+COPN	10
+COPL	180
+WS46	10
+CRSM	180
#STSR	30
#CSURV(TBD)	180
#CSURVC(TBD)	180

Table 3: AT command response timeout

3.3.3. Basic AT Commands

3.3.3.1. AT Error Report Format

Disable the Error Report in numerical and verbose format.

AT+CMEE=0

OK

Enable the Error Report in numerical format.

AT+CMEE=1

OK

Enable the Error Report in verbose format.

AT+CMEE=2

3.3.4. RAT and Band Selection

3.3.4.1. RAT Selection

The following AT command selects the technology: UTRAN, EUTRAN, and NR(NG), or automatic.

AT+WS46=[<n>]

<n> - integer type, it is the WDS-Side Stack used by the TA.

22 UTRAN only

28 E-UTRAN only

31 UTRAN and E-UTRAN

36 NG-RAN only

37 NG-RAN and E-UTRAN

38 NG-RAN, E-UTRAN and UTRAN (default)

40 NG-RAN and UTRAN

Note: The <n> parameter is stored in NVM, and the command will take effect on the next power on.

The factory default value depends on each variant.

3.3.4.2. Band Selection

In manual band selection the following AT command selects the current band for each technology GERAN, UTRAN, EUTRAN and NR:

AT#BND=<band>[,<UMTS_band>[,<LTE_band>[,<LTE_band_ext>[,<NSA_NR5G_band_1_64>[,<NSA_NR5G_band_65_128>[,<SA_NR5G_band_1_64>[,<SA_NR5G_band_65_128>]]]]]]]

Examples

AT#BND=0,0,2,2,1,2000,4,2 → selected band: B1 (3G) + B2(4G) + B66(4G) + N1(NSA 5G) + N78(NSA 5G) + N3(SA 5G) + N66(SA 5G)

OK

Note: The input range for supported band are depends on variants.

GERAN is not supported, but we can set this parameter for backward compatibility by 0.

3.3.5. SIM/USIM Management

3.3.5.1. SIM Presence and PIN Request

The following AT command checks if the SIM device needs the PIN code:

AT+CPIN?

Examples

Assume that the SIM is inserted into the module and the PIN code is needed.

AT+CPIN?

+CPIN: SIM PIN

OK

Assume that the SIM is not inserted and Extended Error result code is not enabled. Check if PIN code is needed, just to see the response command:

AT+CPIN?

ERROR

Assume that the SIM is not inserted and Verbose Extended error result code is enabled. Check if PIN code is needed, just to see the response command:

AT+CPIN?

+CME ERROR: SIM not inserted

Assume that the SIM is not inserted and Numerical Extended error result code is enabled. Check if PIN code is needed, just to see the response command:

AT+CPIN?

+CME ERROR: 10

3.3.5.2. Enter PIN Code

Use the following AT command to enter the PIN code:

AT+CPIN=<pin>

Examples

Assume to enter a wrong PIN code, and Extended Error result is not enabled.

AT+CPIN=1235

ERROR

Now, enter the right PIN code:

AT+CPIN=1234

OK

Enable Verbose Extended error result code:

AT+CMEE=2

OK

Enter a wrong PIN code:

AT+CPIN=1235

+CME ERROR: incorrect password.

Note: After 3 PIN code failed attempts, the PIN code is no longer requested and the SIM is locked. Use SIM PUK to enter a new PIN code and unlock the SIM.

3.3.5.3. Enter PUK Code

Enter the following AT command if PUK or PUK2 code is required:

AT+CPIN=<pin>[,<newpin>]

Note: After 10 PUK code failed attempts, the SIM Card is locked and no longer available.

3.3.5.4. SIM Status

Use the following AT command to enable/disable the SIM Status Unsolicited Indication.

AT#QSS=<mode>

Example 1

Enable the unsolicited indication concerning the SIM status change.

AT#QSS=1	enable URCs: #QSS:0/1
OK	
#QSS: 0,0	unsolicited indication: SIM is extracted.
#QSS: 1,0	unsolicited indication: SIM is inserted.

Example 2

AT#QSS=2	enable URCs: #QSS:0/1/2/3
OK	
AT&W0	store the setting on profile 0
OK	
AT&P0	at Power on use profile 0
OK	

Now, power off the module:

#QSS: 0,0	unsolicited indication: SIM is extracted.

Now, power on the module:

#QSS: 1,0	unsolicited indication: SIM is inserted.
AT+CPIN?	
+CPIN: SIM PIN	SIM is locked
OK	
AT+CPIN=<PIN>	enter PIN
OK	
#QSS: 2,0	unsolicited indication: SIM is unlocked.
#QSS: 3,0	unsolicited indication: SMS and Phonebook are accessible

3.3.5.5. SIM Detection Mode

Use the following AT command to manage the SIM Detection Mode:

AT#SIMDET=<mode>

Or

Use the following AT command to enable/disable the SIM Status Unsolicited Indication.

AT#QSS=<mode>

Example

AT#SIMDET?
#SIMDET: 0,0
OK

0 = SIM slot1 is activated.

0 = SIM not inserted, If SIMIN pin is not connected, it is always 0.

AT#QSS?
#QSS: 0,1,0
OK

0 = Disable URC

1 = SIM inserted

0 = SIM slot1

Enable the unsolicited indication concerning the SIM status change.

AT#QSS=1
OK

Now, Insert the SIM into SIM slot2.

AT#SIMDET=1	switch to SIM slot2
OK	
#QSS: 0,0	unsolicited indication, SIM not inserted on SIM slot1.
#QSS: 1,1	unsolicited indication, SIM inserted on SIM slot2.

AT#SIMDET?
#SIMDET: 1,0 1 = SIM slot2 is activated, 0 = If SIMIN pin is not connected, it is always 0.
OK

AT#SIMDET=0	switch to SIM slot1
OK	
#QSS: 0,1	unsolicited indication, SIM not inserted on SIM slot2
#QSS: 1,0	unsolicited indication, SIM inserted on SIM slot1

AT#SIMDET?
#SIMDET: 0,0 0 = SIM slot1 is activated, 0 = If SIMIN pin is not connected, it is always 0.
OK

3.3.5.6. SIM/USIM Access File

AT+CSIM command is used to read/write SIM/USIM files. The format of the AT+CSIM parameters and the sequence of the AT+CSIM commands must be in accordance with the protocol card. The distinction between SIM and USIM <command> format is needed because the AT+CSIM command works directly on the card.

AT+CSIM=<length>,<command>

To read/write card files refer to "FN990_Family_AT_Command_Reference_Guide.doc".

3.3.5.7. MSISDN

MSISDN is a number that uniquely identifies a subscription on the network. MSISDN is defined by the ITU-U Recommendation which defines the numbering plan: a number uniquely identifies a public network termination point and typically consists of three fields, CC (Country Code), NDC (National Destination Code), and SN (Subscriber Number), up to 15 digits in total.

Select the "ON" storage:

AT+CPBS="ON"

OK

Write a new record on the selected storage:

AT+CPBW=1,"+393912457",145,"MyNumber"

OK

Read the just entered number:

AT+CPBF="MyNumber"

+CPBF: 1," +393912457",145,"MyNumber"

OK

3.3.5.8. Preferred Operator List

Use the following AT command to manage the Preferred Operator List stored on SIM/USIM.

AT+CPOL=[<index>][,<format>[,<oper>[,<GSM_AcT>,<GSM_Compact_AcT>,<UTRAN_AcT>,<EUTRAN_AcT>]]]

Examples

Check the supported number of operators in the SIM Preferred Operator List and the format:

AT+CPOL=?

+CPOL: (1-16),(0-2)

OK

The used SIM supports 16 positions; the supported format (2) is numeric. Furthermore, the format (0) is alphanumeric in long format and (1) is alphanumeric in short format.

Reading the entire list:

AT+CPOL?

+CPOL: 1,2,"45005",1,1,1,1

+CPOL: 2,2,"45005",0,0,1,1

+CPOL: 3,2,"00102",1,1,1,1

+CPOL: 4,2,"00101",1,1,0,1

+CPOL: 5,2,"00101",1,1,1,1

+CPOL: 6,2,"111222",1,1,1,1

+CPOL: 7,2,"00102",1,1,1,1

+CPOL: 15,2,"45008",1,1,1,1

+CPOL: 16,2,"45007",0,0,0,1

OK

The meaning of the string "XXXYY" is:

- XXX = Mobile Country Code

- YY = Mobile Network Code

The last 4 digits are the GSM, GSM compact, UTRA and EUTRAN access technology in sequence.

Delete the first entry using a non-existent <format> value just to see the response when the Extended Error result code is enabled:

AT+CPOL=1,3

+CME ERROR: operation not supported

Now, delete the first entry using the right <format> value:

AT+CPOL=1,2

OK

AT+CPOL?

+CPOL: 2,2,"20810",1,1,0,0

+CPOL: 3,2,"23205",1,0,1,0

...

+CPOL: 15,2,"23802",1,1,0,1

+CPOL: 16,2,"24201",1,0,1,1

OK

The entry on first position is deleted

AT+CPOL=1,2,20801,1,1,1,1 < Write a new entry in the first position

OK

Check if the new entry is written on first position:

AT+CPOL?

+CPOL: 1,2,"20801",1,1,1,1 < The new entry is written on first position

+CPOL: 2,2,"20810",1,1,0,0

...

+CPOL: 16,2,"24201",1,0,1,1

OK

3.3.6. Network Information

3.3.6.1. Network Status

Enter the following AT command to verify if the module is registered on a network.

AT+CREG?

3.3.6.1.1. Circuit Service Network Registration Status in UTRAN/E-UTRAN

Send command **AT+CREG?**

Wait for response:

Response	Reason	Action
+CREG: 0,0 **or** **+CREG: 1,0**	SIM not present or damaged or SIM is present and PIN is required to continue operations	Check the inserted SIM/USIM status (Please refer to the "SIM/USIM management" contents)
+CREG: 0,1 **or** **+CREG: 1,1**	Mobile is registered on its home network.	Proceed ahead. Ready to initiate a CS call

Response	Reason	Action
+CREG: 0,2 or +CREG: 1,2	Mobile is currently not registered on any network but is looking for a suitable one to register.	Repeat procedure at "Fast Network Status Check" contents to see if it has found a suitable network to register in
+CREG: 0,3 or +CREG: 1,3	Mobile has found some networks but it is not allowed to register on any of them, no roaming was allowed.	Try in another place or reset, then repeat procedure at "Fast Network Status Check" contents
+CREG: 0,4 or +CREG: 1,4	Mobile is in an unknown network status	Repeat procedure at "Fast Network Status Check" contents to see if it has found a suitable network to register in
+CREG: 0,5 or +CREG: 1,5	Mobile has found some networks and is currently registered in roaming on one of them	Proceed ahead. Ready to CS call

Table 4: Possible scenario with the response of AT+CREG

3.3.6.1.2. Packet Service Network Registration Status in UTRAN

Send command **AT+CGREG?**

Wait for response:

Response	Reason	Action
+CGREG: 0,0 or +CGREG: 1,0	SIM not present or damaged or SIM is present and PIN is required to continue operations	Check the inserted SIM/USIM status (Please refer to the "SIM/USIM management" contents)
+CGREG: 0,1 or +CGREG: 1,1	Mobile is registered on its home network.	Proceed ahead. Ready to initiate a PS call
+CGREG: 0,2 or +CGREG: 1,2	Mobile is currently not registered on any network but is looking for a suitable one to register.	Repeat procedure at "Fast Network Status Check" contents to see if it has found a suitable network to register in
+CGREG: 0,3 or +CGREG: 1,3	Mobile has found some networks but it is not allowed to register on any of them, no roaming was allowed.	Try in another place or reset, then repeat procedure at "Fast Network Status Check" contents
+CGREG: 0,4 or +CGREG: 1,4	Mobile is in an unknown network status	Repeat procedure at "Fast Network Status Check" contents to see if it has found a suitable network to register in
+CGREG: 0,5 or +CGREG: 1,5	Mobile has found some networks and is currently registered in roaming on one of them	Proceed ahead. Ready to PS call

Table 5: Possible scenario with the response of AT+CGREG

3.3.6.1.3. Packet Service Network Registration Status in E-UTRAN

Send command **AT+CEREG?**

Wait for response:

Response	Reason	Action
+CEREG: 0,0 or +CEREG: 1,0	SIM not present or damaged or SIM is present and PIN is required to continue operations	Check the inserted SIM/USIM status (Please refer to the "SIM/USIM management" contents)
+CEREG: 0,1 or +CEREG: 1,1	Mobile is registered on its home network.	Proceed ahead. Ready to initiate a PS call
+CEREG: 0,2 or +CEREG: 1,2	Mobile is currently not registered on any network but is looking for a suitable one to register.	Repeat procedure at "Fast Network Status Check" contents to see if it has found a suitable network to register in
+CEREG: 0,3 or +CEREG: 1,3	Mobile has found some networks but it is not allowed to register on any of them, no roaming was allowed.	Try in another place or reset, then repeat procedure at "Fast Network Status Check" contents
+CEREG: 0,4 or +CEREG: 1,4	Mobile is in an unknown network status	Repeat procedure at "Fast Network Status Check" contents to see if it has found a suitable network to register in
+CEREG: 0,5 or +CEREG: 1,5	Mobile has found some networks and is currently registered in roaming on one of them	Proceed ahead. Ready to PS call

Table 6: Possible scenario with the response of AT+CEREG

Note: When a +CREG/+CGREG/+CEREG: x,1 or +CREG/+CGREG/+CEREG: x,5 response is received, the device is ready to receive a call or SMS. It is possible to jump directly to call setup procedures or the SMS sending procedures.

3.3.6.2. Network Survey(TBD)

Use the following AT command to perform a quick survey through channels belonging to the current band.

AT#CSURV[=[<s>,<e>]]

Parameters: <s> - starting channel, <e> - ending channel

AT#CSURV

Network survey started ...

earfcn: 2500 rxLev: -42 mcc: 450 mnc: 05 cellId: 273 tac: 12556

uarfcn: 10836 rxLev: -62 mcc: 450 mnc: 08 scr code: 1488 cellId: 14909569 lac: 7170 cellStatus: CELL_FORBIDDEN rscp: -65 ecio: -3.5

uarfcn: 10737 rxLev: -48 mcc: 450 mnc: 05 scr code: 224 cellId: 63808804 lac: 8673 cellStatus: CELL_SUITABLE rscp: -51 ecio: -3.5

Network survey ended

OK

AT#CSURVC[=[<s>,<e>]]

Parameters: <s> - starting channel, <e> - ending channel

AT#CSURVC=1000,3000

Network survey started ...

2500,-41,450,05,273,12556

Network survey ended

OK

3.3.7. Network Operator Identification

Use the following AT command to query the module for the Network Operators Identifications. Once the mobile is registered on some network (or even if it returned +CREG/+CGREG/+CEREG:x,3), it is possible to query the mobile for network identifications, codes and names:

- send command **AT+COPS=?**
- wait for response in the format:

+COPS: [list of supported (<stat>,long alphanumeric <oper>,short alphanumeric <oper>,numeric <oper>,< AcT>)s]

[,,(list of supported <mode>s),(list of supported <format>s)]

where:

<stat> operator availability

0 - unknown

1 - Available

2 - current

3 - Forbidden

<AcT> access technology selected

0 GSM (Not Support)

2 UTRAN

7 E-UTRA UTRAN

Note: Since with this command a network scan is done, this command may require a few seconds before the output is provided.

For example:

AT Command

AT+COPS=?

Answer:

+COPS: (2,"","SKTelecom","45005",7),(3,"KT","KT","45008",7),(3,"KOR LG Uplus","LG U+","45006",7),,(0-4),(0-2)

OK

In this case the mobile is registered on the "**SKTelecom**" network which is a network from Korea, code: 450 and Network ID: 05.

The other network is not available for registration:

Note: This command issues a network request and it may require a long time to respond, as the device has to wait for a response from the network (it can take up to 180 seconds). Do not use this command unless necessary.

3.3.8. Signal Strength & Quality

Let's Assume that the mobile is registered on a Network that can be: UTRAN.

The following AT command can be useful to know the strength & quality of the received signal to have an indication of the reliability of the radio link.

AT+CSQ

Examples

Let's assume that the antenna is not connected to the Telit Module or Network coverage is not present at all.

AT+CSQ

+CSQ: 99,99

OK

The antenna is now connected to the Telit Module and the Network coverage is present. Enter again the previous AT command:

```
AT+CSQ
+CSQ: 17,0
OK
```

17 = <rssi> = Received Signal Strength Indication

0 = <ber> = Bit Error Rate

Now, a wrong parameter is entered just to see the result format when Verbose Extended Error result is enabled

```
AT+CSQ?
+CME ERROR: operation not supported
```

3.3.9. Extended Signal Quality

Let's assume that the mobile is registered on a Network which can be: UTRAN, EUTRAN and NR5G. The following AT command can be useful to know the strength & quality of the received signal to have an indication of the reliability of the radio link.

```
AT+CESQ
```

Examples

Let's assume that the antenna is not connected to the Telit Module or the Network coverage is not present at all.

```
AT+CESQ
+CESQ: 99,99,255,255,255,255,255,255,255
OK
```

Now, the antenna is connected to the Telit Module and the UTRAN Network coverage is present.

Enter again the previous AT command:

```
AT+CESQ
+CESQ: 99,99,94,47,255,255,255,255,255
OK
```

94 = <rscp> = Received Signal Code Power.

47 = <ecno> = Ratio between the received energy per PN chip and the total received power spectral density.

Now, the antenna is connected to the Telit Module and EUTRAN Network coverage is present.

Enter again the previous AT command:

AT+CESQ
+CESQ: 99,99,255,255,32,95,255,255,255
OK

32 = <rsrq> = Reference Signal Received Quality.

95 = <rsrp> = Reference Signal Received Power.

The antenna is now connected to the Telit Module and the NR5G Network coverage is present.

Enter again the previous AT command:

AT+CESQ
+CESQ: 99,99,255,255,255,255,67,106,79
OK

67 = <ss_rsrq> = Reference Signal Received Quality for NR5G.

106 = <ss_rsrp> = Reference Signal Received Power for NR5G.

79 = <ss_sinr> = Reference Signal Received Power for NR5G.

When a wrong parameter is entered and the Verbose Extended Error result is enabled.

AT+CESQ?
+CME ERROR: operation not supported

3.3.10. Fast Network Status Check

Once the module is registered on a network, regardless of the radio access technology (3G, 4G or 5G), it is useful to know the strength of the received signal and the network on which the module is registered. This information is gathered through the following standard AT commands: +CREG, +COPS and +CSQ.

These commands could be not fast in the response due to network response time, especially the +COPS command. If the user objective is to keep his application as general as possible, the standard AT commands above mentioned can be used.

Telit's modules provide proprietary AT commands to gather all the information in a faster and simpler way, they are:

- AT#MONI
- AT#SERVINFO

- AT#RFSTS

Use the following AT command to select cells and collect their information:

<AT#MONI>

UTRAN mode

AT#MONI

#MONI: KOR SK Telecom PSC:14 RSCP:-52 LAC:21E1 Id:3CDA524 EcIo:-8.0
UARFCN:10737 PWR:-44dbm DRX:640 SCR:224

OK

E-UTRAN mode

AT#MONI

#MONI: KOR SK Telecom RSRP:-73 RSRQ:-10 TAC:310C Id:006D90B EARFCN:2500
PWR:-46dbm DRX:1280

OK

5G mode

AT#MONI

#MONI: KOR SK Telecom RSRP:-72 RSRQ:-11 TAC:310C Id:006D90B EARFCN:2500
PWR:-43dbm DRX:1280 NR_BAND:78 NR_BW:100 NR_ULBW:100 NR_CH:640586
NR_ULCH:640586 NR_PWR:-39dbm NR_RSRP:-49 NR_RSRQ:-10 NR_PCI:642
NR_SINR:173 NR_STATE:2 NR_TXPWR:0 NR_DLMOD:0 NR_ULMOD:0

OK

<AT#SERVINFO>

UTRAN mode

Collect only the Serving Cell Network Information:

AT#SERVINFO

#SERVINFO: 10737,-50,"KOR SK Telecom","45005",14,21E1,640,3,-59,"I",01

OK

E-UTRAN mode

Collect only the Serving Cell Network Information:

AT#SERVINFO

#SERVINFO: 2500,-45,"KOR SK Telecom","45005",006D90B,310C,1280,3,-74

OK

5G mode

AT#SERVINFO

#SERVINFO: 2500,-44,"KOR SK Telecom","45005",006D90B,310C,1280,3,-73,640586,640586,-41,-51,-10

OK

<AT#RFSTS>

UTRAN mode

AT#RFSTS

#RFSTS: "450 05",10737,14,-4.5,-54,-50,21E1,01,,640,19,0,1,000,3CDA524,"450051248306381","KOR SK Telecom",3,1

OK

E-UTRAN mode

AT#RFSTS

#RFSTS: "450 05",2500,-75,-45,-11,310C,1,17,1280,19,2,006D90B,"450051248306381","KOR SK Telecom",3,5

OK

5G mode

AT#RFSTS

#RFSTS: "450 05",2500,-77,-49,-10,310C,1,,1280,19,2,006D90B,"450051248306381","KOR SK Telecom",3,5,640586,640586,-52,-42,-10,78,100,100,0

OK

Note: The AT#MONI, AT#SERVINFO and AT#RFSTS commands should only be used to gather information about the network name and signal strength. To check if the module is registered or is looking for a suitable network to register on, use the +CREG or +CEREG command. In fact, if the network signal is too weak and the module loses registration, until a new network is found, the two commands report the last valid values measured and not the real ones. The TA (timing advance parameter) is valid only during a call.

Check the network registration with +CREG or +CEREG command. When the module is registered, query the module for network operator name and signal strength with the AT#MONI command.

3.3.10.1. 3G Network

If a 3G Technology network is available on the air, please use the AT+WS46=22 command to force the module on 3G mode.

Examples

Check if the module is using 3G Technology:

AT+COPS?

+COPS: 0,0,"KOR SK Telecom",2

OK

Yes, it is using 3G Technology.

Select the Serving Cell:

AT#MONI=0

OK

Collect information:

AT#MONI

#MONI: KOR SK Telecom PSC:14 RSCP:-64 LAC:21E1 Id:3CDA520 EcIo:-2.5
UARFCN:10713 PWR:-59 dbm DRX:64 SCR:224

OK

Use the following AT command to collect only the Serving Cell Information:

AT#SERVINFO

#SERVINFO: 10713,-61,"KOR SK Telecom","45005",14,21E1,64,3,-66,"I",01

OK

Use this command to get the current network status.

AT#RFSTS

#RFSTS: "450 05",10713,14,-5.0,-68,-63,21E1,01,,64,19,0,1,001,3CDA520,

"450050217220238","KOR SK Telecom",3,1

OK

3.3.10.2. 4G Network

If a 4G Technology is present on the air, please use the AT+WS46=28 command to force the module on 4G mode.

Examples

Check if the module is using 4G Technology:

AT+COPS?

+COPS: 0,0,"KOR SK Telecom",7

OK

Yes, it is using 4G Technology.

Select the Serving Cell:

AT#MONI=0

OK

Collect information:

AT#MONI

#MONI: KOR SK Telecom RSRP:-79 RSRQ:-9 TAC:310C Id: 06FC047 EARFCN:1350 PWR:-53dbm DRX:128

OK

Use the following AT command to collect only the Serving Cell Information:

AT#SERVINFO

#SERVINFO: 1350,-60,"KOR SK Telecom","45005",06FC047,310C,128,3,-94

OK

Use this command to get the current network status.

AT#RFSTS

#RFSTS: "450 05",1350,-94,-59,-13,310C,255,,128,19,0,06FC047,"450050217220238","KOR SK Telecom"3,3

OK

3.3.10.3. 5G Network

If a 5G Technology is present on the air, please use the AT+WS46=36, 37, 38 or 40 command to access the module on 5G mode.

Examples

Check if the module is using 5G(E-UTRA-NR dual connectivity) Technology:

AT+COPS?

+COPS: 0,0,"KOR SK Telecom",13

OK

Yes, it is using 5G(E-UTRA-NR dual connectivity) Technology.

3.3.11. Voice Call Establishment – Originate

Before setting up the Voice Call, it is assumed that the Telit Module is registered on a network and that the signal strength is sufficient to establish and maintain a reliable radio link.

3.3.11.1. Dialing a Phone Number

Use the following AT command to dial up a phone number.

ATD<number>;

Examples

Call the national number 040-4X92XYX.

ATD0404X92XYX;
OK

Now, call the national number 040-4X92XYX in international format +39-040-4X92XYX.

```
ATD+390404X92XYX;
OK
```

3.3.11.2. Disconnect a Call

Use the following AT command to hang up the current Voice Call:

```
ATH
OK
```

3.3.11.3. Answering an Incoming Call

When an Incoming Call is recognized, the module sends an Unsolicited Code to DTE. Use the following AT command to answer to the call.

```
ATA
OK
```

3.3.12. Software Shutdown

The following command is dedicated to module shutdown.

```
AT#SHDN
OK
```

During shutdown, the module executes the following actions:

- Detachment from the network
- Module power off

For more information about the procedure and timing of the module, please refer to the appropriate HW Design Guide.

Note: If VBATT is maintained and the FULL_CARD_POWER_OFF_N pin is asserted high, the module will automatically turn on after shutdown.

3.4. Advanced Operations

Note: The Advanced commands must compatible with the existing Telit model, but may not be supported by changing the chipset and SW architecture.

3.4.1. Call Management

3.4.1.1. Identifying the Call Type

The module can identify the call type before answering. To carry out this feature, the module provides different ring indications (URC) depending on the type of call. It is up to the user to enable the extended format reporting of incoming calls using the following AT command.

AT+CRC=[<mode>]
OK

Examples

Disable extended format reporting, and then assume that the module receives a call.

AT+CRC=? Check the range value
+CRC: (0,1)
OK

AT+CRC=0 Disable extended format reporting.
OK

AT+CRC?
+CRC: 0
OK

The module detects a call. Ring indications are displayed on DTE:

RING
RING

Now, enable extended format reporting, and then assume the module receives a call.

AT+CRC=1 Enable extended format reporting

OK

AT+CRC? Check if extended format reporting is enabled
+CRC: 1
OK

The module detects a call. Ring indications in extended format are displayed on DTE:

+CRING: VOICE
+CRING: VOICE

3.4.1.2. Identify the Caller

The Telit Module can display the caller's number before answering the call. The Calling Line Indication is shown on DTE after each RING or +CRING indication. The following AT command is used to enable/disable the Calling Line Indication:

AT+CLIP=[<n>]
OK

Examples

Enable extended format reporting and caller number identification, then assume to receive a call.

Enable extended format reporting.

AT+CRC=1
OK

Check if extended format reporting is enabled.

AT+CRC?
+CRC: 1
OK

Check the values range.

AT+CLIP?
+CLIP: 0,1
OK

Enable caller number identification.

AT+CLIP=1
OK

AT+CLIP?
+CLIP: 1,1
OK

The module detects a call; ring indications and Calling Line Identification of the calling party are displayed on DTE:

+CRING: VOICE
+CLIP: "+390404X92XYX",145,"",128,"",0
+CRING: VOICE
+CLIP: "+390404X92XYX",145,"",128,"",0

3.4.1.3. Calling Line Indication

The Telit Module can send the Calling Line Indication (CLI) to the other party through the Network when an outgoing call is established. This indication can be restricted (CLIR) in various ways.

3.4.1.3.1. CLIR Service Status

Use the following AT command to query the CLIR Service status.

AT+CLIR?

Examples

Check the current CLIR settings:

AT+CLIR?
+CLIR: 0,4
OK

<n> = 0 = CLIR module facility in accordance with CLIR Network Service

<m>= 4 = CLIR temporary mode presentation allowed (it is the facility status on the Network)

The <m> parameter reports the status of the service at the Network level. If the CLIR service is not provided by the Network, this service cannot be used and changing the first <n> parameter will not change the CLI presentation to the other party behavior of the Network.

3.4.1.3.2. Restrict/Allow Caller Line ID Indication

Use the following AT command to enable or disable the presentation of the CLI to the called party.

AT+CLIR=[<n>]
OK

Examples

Disable the CLI presentation to the other party permanently.

Read the supported values.

AT+CLIR=?
+CLIR: (0-2)
OK

Read the current Module and Network status.

```
AT+CLIR?
+CLIR: 0,4
OK
```

Set to 1 Module status, CLI not sent.

```
AT+CLIR=1
OK
```

Read the current Module and Network status.

```
AT+CLIR?
+CLIR: 1,4
OK
```

3.4.1.4. Call Barring Control

The Call Barring Service enables the user to control the calls. The user can block all:

- Outgoing calls
- Outgoing international calls
- Outgoing international calls except those for its Country
- Incoming calls
- Incoming calls while roaming.

User can activate or cancel Call Barring using the AT commands described below. Moreover, the user must enter a special access code (Call Barring Access Code) to modify the Call Barring options. The Network Operator provides the Call Barring Code for every subscriber. Hereafter the Call Barring Code is referred to as "Network Password provided by the Network Operator".

The network handles the Call Barring Service, so the module sends a network request and it may take several seconds to receive the network response. Furthermore, all the Call Barring Service AT commands must be used when the module is registered on a network, otherwise an error code is returned.

3.4.1.4.1. Lock/Unlock the Module

Use the following AT command to lock/unlock the Module or a Network facilities:

```
AT+CLCK=<fac>,<mode>[,<passwd>[,<class>]]
```

Read the supported facilities:

```
AT+CLCK=?
+CLCK: ("AB","AC","AG","AI","AO","IR","OI","OX","SC","PN","PU","PP","P
C","PF")
OK
```

3.4.1.4.2. Call Barring Service Status

Use the following AT command to inquire the status of the selected network facility.

```
AT+CLCK=<fac>,2
```

Examples

Check the status of SIM facility:

```
AT+CLCK="SC",2
+CLCK: 1
OK
```

Check the status of a wrong facility just to see the format response. Before doing that verify the Extended Error result code.

```
AT+CMEE?
+CMEE: 2                verbose format
OK

AT+CLCK="S1",2
+CME ERROR: operation not supported
```

Check "IR" network facility status (Bar Incoming Calls status when roaming outside the home country).

```
AT+CLCK=IR,2
+CLCK: 0,1
+CLCK: 0,2
+CLCK: 0,4
OK
```

"IR" network facility is unlocked (0): 1 = voice, 2 = data, 4 = fax.

Check "OI" network facility status (Bar Outgoing (originated) International Calls).

```
AT+CLCK=OI,2
+CLCK: 0,1
+CLCK: 0,2
+CLCK: 0,4
OK
```

"OI" network facility is unlocked (0): 1 = voice, 2 = data, 4 = fax.

Let's assume that the module is not registered. Try to check the "OI" network facility status to see the format response when Extended Error result code is enabled in numeric format.

```
AT+CMEE=1
OK

AT+CLCK=OI,2
+CME ERROR: 100
```

3.4.1.4.3. Bar/Unbar All Incoming Calls

Use the following AT command to change the status of the AI network facility (All Incoming Calls):

```
AT+CLCK=AI,<mode>,<passwd>
```

Examples

Lock and unlock "AI" network facility. Assume that the Network Password provided by Network Operator is 2121.

Check "AI" network facility status:

```
AT+CLCK=AI,2
+CLCK: 0,1
+CLCK: 0,2
+CLCK: 0,4
OK
```

"AI" network facility is unlocked (0): 1 = voice, 2 = data, 4 = fax.

Lock "AI" network facility:

```
AT+CLCK=AI,1,2121
OK
```

Check "AI" facilities status:

```
AT+CLCK=AI,2
+CLCK: 1,8
+CLCK: 1,4
+CLCK: 1,2
OK
```

"AI" network facility is locked (1): 8 = short message service, 4 = fax, 2 = data.

Unlock "AI" facilities:

```
AT+CLCK=AI,0,2121
OK
```

Check “AI” facilities status:

```
AT+CLCK=AI,2
+CLCK: 0,1
+CLCK: 0,2
+CLCK: 0,4
OK
```

“AI” network facility is unlocked (0): 1 = voice, 2 = data, 4 = fax.

3.4.1.4.4. Bar/Unbar Incoming Calls in International Roaming

Use the following AT command to change the status of the “IR” network facility (Incoming Calls when Roaming outside the home country).

```
AT+CLCK=IR,<mode>,<passwd>
```

Examples

Lock and unlock “IR” network facility. Assume that the network password provided by Network Operator is 2121.

Check “IR” network facilities status:

```
AT+CLCK=IR,2
+CLCK: 0,1
+CLCK: 0,2
+CLCK: 0,4
OK
```

“IR” network facility is unlocked (0): 1 = voice, 2 = data, 4 = fax.

Lock “IR” network facility:

```
AT+CLCK=IR,1,2121
OK
```

Check “IR” facilities status:

```
AT+CLCK=IR,2
+CLCK: 1,1
+CLCK: 1,8
+CLCK: 1,4
+CLCK: 1,2
OK
```

“IR” network facility is locked (1): 8 = short message service, 4 = fax, 2 = data.

Unlock "IR" network facility:

```
AT+CLCK=IR,0,2121
OK
```

Read IR facilities status:

```
AT+CLCK=IR,2
+CLCK: 0,1
+CLCK: 0,2
+CLCK: 0,4
OK
```

"IR" network facility is unlocked (0): 1 = voice, 2 = data, 4 = fax.

3.4.1.4.5. Bar/Unbar All Outgoing Calls

Use the following AT command to change the status of the "AO" network facility (All Outgoing Calls).

```
AT+CLCK=AO,<mode>,<passwd>
```

Examples

Lock and unlock "AO" network facility. Assume the network password provided by Network Operator is 2121.

Check "AO" network facility status:

```
AT+CLCK=AO,2
+CLCK: 0,1
+CLCK: 0,2
+CLCK: 0,4
OK
```

"AO" network facility is unlocked (0): 1 = voice, 2 = data, 4 = fax.

Lock "AO" network facility:

```
AT+CLCK=AO,1,2121
OK
```

Check "AO" network facility status:

```
AT+CLCK=AO,2
+CLCK: 1,8
+CLCK: 1,4
+CLCK: 1,2
OK
```

"AO" network facility is locked (1): 8 = short message service, 4 = fax, 2 = data.

Unlock "AO" network facility:

```
AT+CLCK=AO,0,2121
OK
```

Checking "AO" network facility status:

```
AT+CLCK=AO,2
+CLCK: 0,1
+CLCK: 0,2
+CLCK: 0,4
OK
```

"AO" network facility is unlocked (0): 1 = voice, 2 = data, 4 = fax.

3.4.1.4.6. Bar/Unbar All Outgoing International Calls

Use the following AT command to change the status of the "OI" network facility (Outgoing International Calls).

```
AT+CLCK=OI,<mode>,<passwd>
```

Examples

Lock and unlock "OI" network facility. Assume the network password provided by Network Operator is 2121.

Checking "OI" network facility status:

```
AT+CLCK=OI,2
+CLCK: 0,1
+CLCK: 0,2
+CLCK: 0,4
OK
```

"OI" network facility is unlocked (0): 1 = voice, 2 = data, 4 = fax.

Lock "OI" network facility:

```
AT+CLCK=OI,1,2121
OK
```

Check "OI" network facility status:

```
AT+CLCK=OI,2
+CLCK: 1,1
+CLCK: 1,8
+CLCK: 1,4
+CLCK: 1,2
OK
```

"OI" network facility is locked (1): 1 = voice, 8 = short message service, 4 = fax, 2 = data.

Unlock "OI" network facility:

```
AT+CLCK=OI,0,2121
OK
```

Check "OI" network facility status:

```
AT+CLCK=OI,2
+CLCK: 0,1
+CLCK: 0,2
+CLCK: 0,4
OK
```

"OI" network facility is unlocked (0): 1 = voice, 2 = data, 4 = fax.

3.4.1.4.7. Bar/Unbar All Outgoing International Calls except to Home Country

Use the following AT command to change the status of the "OX" network facility (Outgoing International Calls except to Home Country).

```
AT+CLCK=OX,<mode>,<passwd>
```

Examples

Lock and unlock "OX" network facility. Assume the network password provided by Network Operator is 2121.

Check "OX" network facility status:

```
AT+CLCK=OX,2
+CLCK: 0,1
+CLCK: 0,2
+CLCK: 0,4
OK
```

"OX" network facility is unlocked (0): 1 = voice, 2 = data, 4 = fax.

Lock "OX" network facility. It is a setting not supported by the network:

```
AT+CLCK=OX,1,2121
ERROR
```

Enable extended error result codes in verbose format:

```
AT+CMEE=2
OK
```

Try again to lock "OX" network facility:

```
AT+CLCK=OX,1,2121
+CME ERROR: unknown
```

Check "OX" network facility status:

```
AT+CLCK=OX,2
+CLCK: 0,1
+CLCK: 0,2
+CLCK: 0,4
OK
```

"OX" network facility is unlocked (0): 1 = voice, 2 = data, 4 = fax.

3.4.1.4.8. Unbar All Calls

Use the following AT command to unlock "AB" network facility (All Barring services).

```
AT+CLCK=AB,0,<passwd>
```

Examples

Unlock "AB" network facility. Assume the Network Password provided by Network Operator is 2121.

```
AT+CLCK=AB,0,2121
OK
```

Check "IR" network facility status:

```
AT+CLCK=IR,2
+CLCK: 0,1
+CLCK: 0,2
+CLCK: 0,4
OK
```

"IR" network facility is unlocked (0): 1 = voice, 2 = data, 4 = fax.

Check "OI" network facility status:

```
AT+CLCK=OI,2
+CLCK: 0,1
+CLCK: 0,2
+CLCK: 0,4
OK
```

"OI" network facility is unlocked (0): 1 = voice, 2 = data, 4 = fax.

Check "AI" network facility status:

AT+CLCK=AI,2
+CLCK: 0,1
+CLCK: 0,2
+CLCK: 0,4
OK

"AI" network facility is unlocked (0): 1 = voice, 2 = data, 4 = fax.

3.4.2. DTMF Tones

3.4.2.1. DTMF Transmission on Uplink

Using the following AT command, the module sends the suitable command to the network infrastructure to generate the correspondent DTMF tone on the other audio party. The module embeds the DTMF command in a network message and sends it during the voice call.

AT+VTS=<dtmf>[,duration]

Example:

Check the range of supported values:
AT+VTS=?
(0-9,#,*,A-D,P),(0-255)
OK
Check the tone duration of the single character:
AT+VTD?
1
OK
Dialing the number in voice mode:
ATD04x419x40y;
OK
Send the following sequence of tones:
AT+VTS=123456789
OK
Hang up the voice call:
ATH
OK

3.4.3. SMS Management

The modules provide the SMS Service to store, send, receive, and delete a SMS, which is a short text message up to 160 characters long. Before using the SMS messages, you must configure the Short Message Service.

3.4.3.1. Select SMS Format Type

The Telit Module supports two SMS formats:

- PDU mode
- Text mode

The module uses the PDU format to send a message on the air. The PDU mode enables the user to edit the message in PDU format. If the application supports PDU encoding, it can operate with PDU by selecting that mode and using the appropriate commands.

The present document uses the Text mode to explain how to operate with SMS. Here is the AT command to select the mode.

AT+CMGF=<mode>

Examples

Check the supported range of values:

AT+CMGF=?

+CMGF: (0,1)

OK

Set up Text Mode for the SMS:

AT+CMGF=1

OK

This setting is stored and remains active until the module is turned OFF.

3.4.3.1.1. Set Text Mode Parameters

When SMS format is Text mode, the SMS parameters that usually reside on the header of the PDU must be set apart with the +CSMP command.

AT+CSMP=<fo>,<vp>,<pid>,<dcs>

Example 1

Set the SMS parameters as follow:

- <fo> expressed in binary format, see table below. The binary number expressed in decimal format is 17.

0	0	0	1	0	0	0	1
Module is not requesting a status report	Always 0	Replay Path not requested	Validity period field present in relative format		Always 0	SMS-SUBMIT	

- <vp> validity period (in relative format) = 24 hours is coded into 167 decimal format.
- <pid> protocol identifier.
- <dcs> data coding scheme, default value 0.

AT+CSMP= 17,167,0,0

OK

Example 2

Set the SMS parameters as follow:

- <fo> expressed in binary format, see table below. The binary number expressed in decimal format is 25.

0	0	0	1	1	0	0	1
Module is not requesting a status report	Always 0	Replay Path not requested	Validity period field present in absolute format		Always 0	SMS-SUBMIT	

- <vp> validity period in absolute format represents the expiration date of the message, for example:

  date: 29/06/02; time: 02:20; in the time zone of Italy (+1) is formatted as follows: "29/06/02,02:20:00+1"

- <pid> protocol identifier.
- <dcs> data coding scheme:
  - Default Alphabet
  - Class 0 (immediate display SMS)

Data coding scheme is coded in the following binary format: 11110000, corresponding to 240 in decimal format.

AT+CSMP=25,"29/06/02,02:20:00+1",0,240

OK

Note: Use dcs=0 if no special data coding scheme is needed. Not all the dcs combinations described in the 3GPP TS 23.038 are jointly supported by Networks and Telit Modules: some features may not be implemented on Networks or Telit Modules. This mismatch generates an ERROR result code, use different dcs.

3.4.3.1.2. Character Sets

Use the following AT command to select the character set:

AT+CSCS=<chset>

Here are the supported character sets:

- "GSM" default alphabet
- "IRA" – ITU-T.50
- "8859-1" – ISO 8859 Latin 1
- "PCCP437" – PC character set Code Page 437.
- "UCS2" – 16-bit universal multiple-octet coded character set (ISO/IEC10646)

Examples

Check the supported character sets:

AT+CSCS=?

+CSCS: ("GSM","IRA","8859-1","PCCP437","UCS2")

OK

Check the current character set:

AT+CSCS?

+CSCS: "IRA"

OK

Select a non-existent character set, merely to see the response format:

AT+CSCS="GSA"

ERROR

Enabling the Error report in verbose format:

AT+CMEE=2

OK

Select again a non-existent character set:

AT+CSCS="GSA"

+CME ERROR: operation not supported

3.4.3.1.3. IRA Character Set

The IRA character set is used in Text mode. IRA set defines each character as a 7-bit value: from 0x00 to 0x7F. The table below lists all the supported characters and their hexadecimal code.

Least Significant Nibble	Most Significant Nibble							
	0x	1x	2x	3x	4x	5x	6x	7x
x0			SP[1]	0	@	P		p
x1			!	1	A	Q	a	q
x2			"	2	B	R	b	r
x3			#	3	C	S	c	s
x4			$	4	D	T	d	t
x5			%	5	E	U	e	u
x6			&	6	F	V	f	v
x7			'	7	G	W	g	w
x8			(	8	H	X	h	x
x9			)	9	I	Y	i	y
xA	LF[2]		*	:	J	Z	j	z
xB			+	;	K		k	
xC			,	<	L		l	
xD	CR[3]		-	=	M		m	
xE			.	>	N		n	
xF			/	?	O	£	o	

1 – SP stands for space character

2 – LF stands for Line Feed character

3 – CR stands for Carriage Return character

The following examples show how to use the IRA table:

- Get the IRA code of the character '&': the most significant nibble is 2, the least significant nibble is 6, so the IRA code for the '&' character is the hexadecimal value: 0x26.

- Translate IRA code 0x6B into the corresponding character: the most significant nibble is 6, the least significant nibble is B, the cell at the crossing of column 6 and row B holds the character: "k".

3.4.3.1.4. UCS2 Character Set

The UCS2 Character Set is used in Text mode.

- Phone number 329 05 69 6... converted into "UCS2" format: 3=0033, 2=0032, 9=0039, 0=0030, 5=0035, 6=0036, 9=0039, 6=0036 ...
- Text HELLO converted into UCS2 format: H=0048, E=0045, L=004C, O=004F

3.4.3.2. Read SMSC Number

The module sends the SMS to the SMSC where the message is dispatched to its final destination or is stored until delivery is possible. To ensure the correct functioning of this service, the SMSC number must be configured on the module in accordance with the network operator used.

To read the SMSC number stored on the module, use the following AT command:

AT+CSCA?

Check the stored SMSC number:

AT+CSCA?

+CSCA: "+39X20XX58XX0",145

OK

SMSC number is compliant with the international numbering scheme.

3.4.3.3. Set SMSC Number

Use the following AT command to store a new SMSC number. The old number is overwritten.

AT+CSCA=<number>,<type>

Set up the desired SMSC number in international format:

AT+CSCA=+39X20XX58XX0,145

OK

Enable extended result code in verbose format:

AT+CMEE=2

OK

Enter the command with no parameters:

AT+CSCA=

+CME ERROR: operation not supported

3.4.3.4. Send a SMS

Use the following AT command to send a SMS.

AT+CMGS

Note: To read and set the SMSC number please see Read SMSC Number and Set SMSC Number.

Example 1

Send a SMS to the module itself and do not store it. Use the UCS2 character set.

Select Text Mode.

AT+CMGF=1

OK

Select the UCS2 character set.

AT+CSCS="UCS2"

OK

Set SMS parameters:

AT+CSMP=17,168,0,26

OK

Select how the new received message event is notified by the DCE to the DTE.

AT+CNMI=1,1,0,0,0

OK

Send the message to the module itself. The UCS2 character set is used:

- Phone number 329 05 69 628 is converted into "UCS2" format: 3=0033, 2=0032, 9=0039, 0=0030, 5=0035, 6=0036, 9=0039, 6=0036, 2=0032, 8=0038

- Text CIAO is converted into UCS2 format: C=0043, I=0049, A=0041, O=004F

AT+CMGS=00330032003900300035003600390036003200 38

> 004300490041004F (close the message with Ctrl Z)

+CMGS: 81

OK

The module itself receives the SMS, the following unsolicited indication is shown on DTE:

+CMTI: "SM",3

Note: The SMS was successfully sent to the SMSC and its network reference number is 81. Do not confuse message reference with message index position: the first one indicates the network reference to identify the sent message, the second one – reported by the unsolicited indication – indicates that the module receives the message and is stored in position 3 of the "SM" storage.

Select the "SM" storage as indicated by the unsolicited indication.

AT+CPMS="SM"

+CPMS: 3,50,3,50,3,50

OK

Read the message from the storage position indicated by the unsolicited indication.

AT+CMGR=3

+CMGR: "REC UNREAD","002B00330039003300320039003000350036003900360032003 8",

"00570049004E00440020005300490 04D","08/05/13,12:22:08+08"

004300490041004F

OK

Example 2

Send a SMS to the module itself and do not store it.

Select Text Mode

AT+CMGF=1

OK

Select how the new received message event is notified by the DCE to the DTE.

AT+CNMI=1,1,0,0,0

OK

Send the message to the module itself.

AT+CMGS="+39329X569YYY"

> SEND THE SMS #1 TO ITSELF (close the message with Ctrl Z)

+CMGS: 76

OK

The module itself receives the SMS #1, the following unsolicited indication is shown on DTE:

+CMTI: "SM",1

The SMS was successfully sent to the SMSC and its network reference number is 76. Do not confuse the message reference with the message index position: the first one indicates the network reference for identifying the sent message, the second one – reported by the unsolicited indication – indicates that the module has received the message and is stored in position 1 of the "SM" storage.

Use the unsolicited indication parameter to read the SMS #1 for the first time.

AT+CMGR=1

+CMGR: "REC UNREAD","+39329X569YYY","WIND SIM","08/04/18,13:58:04+08"

SEND THE SMS #1 TO THE MODULE ITSELF

OK

3.4.3.5. Select/Check SMS Storage Type

Telit Modules can provide two type of SMS storage, in agreement with the family of belonging:

- "SM" – SIM Card Memory
- "ME" – Mobile Equipment Memory
- "SR" – Status Report Message Memory.

Use the following AT command to select memory storage:

AT+CPMS=<memr>,<memw>,<mems>

The SMS are usually stored (this is true for both the originated and the received SMS) in the SM/ME storage.

The FN990 family allows the user to select a different storage for the read-delete, write-send, and reception-saving SMS operations.

Examples

AT+CPMS=? Check the supported SMS storage types

+CPMS: (“ME”,“SM”,“SR”),(“SM”,“ME”),(“SM”,“ME”)

OK

AT+CPMS? Check the current active storage type

+CPMS: “SM”,1,50,”SM”,1,50,”SM”,1,50

OK

AT+CPMS=“ME” Select “ME” storage type

+CPMS: 0,50,1,50,1,50

OK

AT+CPMS? Check the current active storage types

+CPMS: “ME”,0,50,”SM”,1,50,”SM”,1,50 Two SMS storage types are active: “ME” and “SM”

OK

3.4.3.6. Store a SMS

Use the following AT command to store a SMS.

AT+CMGW="<da>"

Example

Store a SMS in the "SM" storage, send it to the module itself and read the message in the receiving storage.

AT+CMGF=1 Select Text Mode

OK

AT+CSMP=17,168,0,240 Assume to send a SMS of Class 0

OK

Select how the new received message event is notified by the DCE to the DTE

AT+CNMI=1,1,0,0,0

OK

Store into "SM" the SMS message to be sent to the module itself.

AT+CMGW="+39329X569YYY"

> SEND THE STORED SMS #1 TO THE MODULE ITSELF (close with Ctrl Z or ESC to abort)

+CMGW: 5

OK

Use index 5 to read SMS #1 from "SM" storage type.

AT+CMGR=5

+CMGR: "STO SENT","+39329X569YYY","WIND SIM"

SEND THE STORED SMS # 1 TO MODULE ITSELF

OK

Send the stored SMS #1using the storage position 5 returned by the previous command.

AT+CMSS=5

+CMSS: 78

OK

The module itself receives the SMS #1, the following unsolicited indication is shown on DTE:

+CMTI: "SM",6

Check the current SMS storage type.

AT+CPMS?

+CPMS: "SM",6,30,"SM",6,30,"SM",6,30

OK

Use index 6 to read received SMS #1 from "SM" storage memory.

AT+CMGR=6

+CMGR: "REC UNREAD","+39329X569YYY","WIND SIM","08/04/21,09:56:38+08"

SEND THE STORED SMS # 1 TO THE MODULE ITSELF

OK

Use index 6 to read again received SMS #1 from "SM" storage memory.

AT+CMGR=6

+CMGR: "REC READ","+39329X569YYY","WIND SIM","08/04/21,09:56:38+08"

SEND THE STORED SMS # 1 TO THE MODULE ITSELF

OK

3.4.3.7. Send a Stored SMS

A SMS stored in the "SM" storage type is sent using the following AT command. Its storage location index is needed.

AT+CMSS=<index>

Example

Send the stored SMS to the module itself:

Select Text Mode

AT+CMGF=1

OK

Select "SM" storage to read SMS

AT+CPMS="SM"

+CPMS: 1,50,1,50,1,50

OK

Read the SMS stored on position 1.

AT+CMGR=1

+CMGR: "STO SENT","+39329X569YYY","WIND SIM"

SEND THE STORED SMS # 1 TO MODULE ITSELF

OK

Select how the new received message event is indicated by the DCE to the DTE.

AT+CNMI=1,1,0,0,0

OK

Send the stored SMS # 1 message to module itself.

AT+CMSS=1

+CMSS: 79

OK

The module itself receives the SMS #1, the following unsolicited indication is shown on DTE:

+CMTI: "SM",2

3.4.3.8. Delete an SMS

Use the following AT command to delete an SMS stored on the "SM" storage type.

AT+CMGD=<index>

Example

Deleting an SMS stored in "SM" storage type:

AT+CPMS="SM" Select memory storage

+CPMS: 13,50,13,50,13,50

OK

AT+CMGD=? Check the SMS

+CMGD: (1,2,3,4,5,6,7,8,9,10,11,12,13),(0-4)

OK

Delete SMS in memory position 1.

AT+CMGD=1

OK

Check if the SMS is deleted:

AT+CMGD=?

+CMGD: (2,3,4,5,6,7,8,9,10,11,12,13),(0-4)

OK

Delete all SMS. Disregard the first parameter of the +CMGD.

AT+CMGD=1,4

OK

AT+CMGD=?

+CMGD: (),(0-4)

OK

3.4.3.9. Read an SMS

An SMS is read with the following command:

AT+CMGR=<index>

Example

AT+CPMS?

+CPMS: "SM",1,50,"SM",1,50,"SM",1,50

OK

Read the SMS #1, for the first time, in storage memory "SM", position 1:

AT+CMGR=1

+CMGR: "STO SENT","+39329X569YYY","WIND SIM"

SEND THE STORED SMS # 1 TO MODULE ITSELT

OK

3.4.3.10. SMS Status

SMSs can be gathered into 5 different groups depending on their Status:

- REC UNREAD: received messages still not read
- REC READ: received messages already read
- STO UNSENT: written messages not yet sent
- STO SENT: written messages already sent
- ALL: all types of messages

Use the following AT command to query the SMS status:

AT+CMGL=<stat>

Check if Text Mode is active

AT+CMGF?

+CMGF: 1 Text Mode is active

OK

Check the supported SMS status

AT+CMGL=?

+CMGL: ("REC UNREAD", "REC READ", "STO UNSENT", "STO SENT", "ALL")

OK

Check the available SMS storage type

AT+CPMS?

+CPMS: "SM",6,30, "SM",6,30, "SM",6,30

OK

List all the SMSs stored on "SM" storage with their Status.

AT+CMGL="ALL"

+CMGL: 1,"REC READ", •••• SMS body ••••

+CMGL: 2,"REC READ", •••• SMS body ••••

+CMGL: 3,"REC READ", •••• SMS body ••••

+CMGL: 4,"STO SENT", •••• SMS body ••••

+CMGL: 5,"STO SENT", •••• SMS body ••••

+CMGL: 6,"REC READ", •••• SMS body ••••

OK

List the SMSs stored on "SM" storage with their Status=STO SENT

AT+CMGL="STO SENT"

+CMGL: 4,"STO SENT", •••• SMS body ••••

+CMGL: 5,"STO SENT", •••• SMS body ••••

OK

3.4.3.11. Cell Broadcast Service

GSM Standard specifies two different types of SMS:

- SMS Point to Point (SMS/PP),
- SMS Cell Broadcast (SMS/CB).

The first type can send a text message up to 160 characters from one module to another (as mentioned in the previous paragraphs), the second type allows the Network simultaneously send a message to all the modules contained in the defined area including one or more radio cells. The availability and the implementation of the Cell Broadcast Service are strictly connected to the Network Operator of the subscriber.

Use the following AT command to enable the Cell Broadcast Service:

AT+CSCB=[<mode>[,<mids>[,<dcss>]]]

Select Text Mode.

AT+CMGF=1

OK

Select the District service.

AT+CSCB=0,50,0

OK

Select how the new received message event is indicated by the DCE to the DTE.

AT+CNMI=2,0,2,0,0

OK

After a while the "District" broadcast message is displayed on the DTE.

+CBM: 24,50,1,1,1

TRIESTE

+CBM: 4120,50,2,1,1

TRIESTE

+CBM: 8216,50,1,1,1

TRIESTE

+CBM: 12312,50,2,1,1

TRIESTE

The network operator can provide the following list of Services, it is not mandatory.

<mids>	Service Name
000	Index
010	Flashes
020	Hospitals
022	Doctors
024	Pharmacy
030	Long Distant Road Reports
032	Local Road Reports
034	Taxis
040	Weather
050	District
052	Network Information
054	Operator Services
056	Directory Inquiries (national)
057	Directory Inquiries (international)
058	Customer Care (national)
059	Customer Care (international)

Table 7: Service Name

3.4.4. Phonebook Management

The user can access the different Phonebook types, stored on the SIM card or on the NVM memory, through the dedicated AT commands. The modules support the Phonebooks described in the following sub-chapters.

3.4.4.1. Phonebook Types

The choice of the Phonebook type must be the first Phonebook operation. Once storage is selected, it is no longer needed to select it again as long as the desired storage remains the same, and the module is turned off.

<storage>

- "SM" - SIM Phonebook: is used to store and recall phone numbers.
- "FD" - SIM Fixed Dialing-Phonebook: It is accessible by means of the PIN2 code. E.g.: if the "FD" storage holds the following string numbers 0432, 040, the module can call only phone numbers starting with one of the two string numbers.
- "LD" - SIM Last-Dialing-Phonebook: is the list of the last dialed phone numbers; it is updated automatically in SIM. +CPBW command can only be used to delete phone numbers.
- "MC" - NVM Missed-Calls-Phonebook: is the list of the received calls not answered. It is updated automatically. +CPBW command can only be used to delete phone numbers.
- "RC" - NVM Received-Calls-List: is the list of the received and answered calls. It is updated automatically. +CPBW command can only be used to delete phone numbers.
- "DC" - NVM Last-Dialing-Phonebook: is the list of the last dialed phone numbers stored on the module (NVM); it is updated automatically. +CPBW command can only be used to delete phone numbers.
- "MB" - SIM Mail-Box-List: is a read only list of the phone mailbox numbers. The MB must be supported by SIM.
- "ME" - NVM Module Phonebook: is used to store and recall phone numbers.
- "EN" - SIM Emergency List: is a read only list of the emergency phone numbers stored on SIM.
- "ON" - SIM Own Number: is the list of the SIM numbers, e.g.: SIM number for voice call and SIM number for data call.
- "SD" - SIM Service Dialing Numbers: (SDN) phonebook. +CPBW is not applicable for this storage.

3.4.4.2. Select Phonebook Memory Storage

Use the following AT command to select the Phonebook Memory Storage:

AT+CPBS=<storage>

Examples

AT+CPBS=? Read the supported range of Phonebook Storages
+CPBS: ("SM","FD","LD","MC","RC","DC","ME","EN","ON","MB","SD")

OK

AT+CPBS? Read the current phonebook storage
+CPBS: "SM",19,250

OK

3.4.4.3. Search Phonebook Entries

Use the following AT command to search a Phonebook entry.

AT+CPBF=<findtext>

Examples

Read the current Phonebook storage and select "SM" storage:

AT+CPBS?
+CPBS: "MC",0,20
OK

AT+CPBS="SM"
OK

AT+CPBS?
+CPBS: "SM",10,250
OK

Look for entries having name starting with "FA" on the selected storage:

AT+CPBF="FA"
+CPBF: 7,"+39404192",145,"Fabio",0,"","",129,"",""
+CPBF: 9,"040492",129,"Fabrizio",0,"","",129,"",""

OK

Look for an entry not present in the selected storage. Before doing so, verify if the Extended Error result code is enabled.

AT+CMEE?
+CMEE: 2

OK

AT+CPBF="FAUSTO"
+CME ERROR: not found

Note: The delete command overwrites the <index> record number with an empty record.

3.4.5. GNSS Management

3.4.5.1. Introduction

The FN990(m) module is equipped with IZat™ Gen 9 GNSS receiver controllable by the modem using a set of AT commands or dedicated NMEA sentences.

3.4.5.2. FN990(m) Serial Ports

4 serial ports are available on the module:

- MODEM #1 USB SERIAL PORT
- MODEM #2 USB SERIAL PORT
- AUX USB SERIAL PORT
- NMEA USB SERIAL PORT

3.4.5.3. WGS84

GPS receivers perform initial position and speed calculations using an earth-centered earth-fixed (ECEF) coordinate system. The results may be converted to an earth model (geoid) defined by the selected datum. For the FN990(m) module, the default datum is WGS 84 (World Geodetic System 1984) which provides a worldwide common grid system that can be translated into local coordinate systems or map dates. (Local map dates best fit to the local shape of the earth and not valid worldwide)

3.4.5.4. NMEA 0183

NMEA 0183 is a specification created by the National Marine Electronics Association (NMEA) that defines the interface between other marine electronic equipment. The standard allows marine electronics to interface with computers and other marine equipment. GPS receiver communication is defined within this specification. The supported version is **4.10.**

The provided NMEA sentences are:

GGA GPS Fix Data. Time, position and fix type data.

GLL Geographic Position - Latitude/Longitude

GSA GPS receiver operating mode, satellites used in the position solution and DOP values.

GSV The number of GPS satellites in view satellite ID numbers, elevation, azimuth, and SNR values.

RMC Time, date, position, course and speed data.

VTG Course and speed information relative to the ground

GNS GNSS fix data.

Note: The NMEA USB port provides the following sentences with $GPSNMUN command: GGA, GLL, GSA, GSV, RMC, VTG.

The NMEA USB port provides the following sentences with $GPSNMUNEX command: GNS.

3.4.5.4.1. GGA – Global Position System Fixed Data

This sentence provides time, position, and fixes related data for a GPS Receiver. Table 14: GGA Data Format contains the values for the following example:

$GPGGA,161229.48,3723.247522,N,12158.341622,W,1,07,1.0,72.1,M,18.0,M,,*18

Name	Example	Unit	Description
Message ID	$GPGGA		GGA protocol header GP : GPS Talker ID GA : GALILEO Talker ID BD : Beidou Talker ID
UTC Time	161229.48		hhmmss.ss
Latitude	3723.247522		ddmm.mmmmmm
N/S Indicator	N		N=north or S=south

Name	Example	Unit	Description
Longitude	12158.341622		dddmm.mmmmmm
E/W Indicator	W		E=east or W=west
Position Fix Indicator	1		See Table 15: Position Fix Indicator
Satellites Used	07		Range 0 to 12
HDOP	1.0		Horizontal Dilution of Precision
MSL Altitude	72.1	meters	Antenna Altitude above/below mean-sea-level (geoid).
Units	M	meters	Units of antenna altitude
Geoid Separation	18.0	meters	The difference between the WGS-84 earth ellipsoid and the mean-sea-level (geoid), "-" means mean-sea-level below ellipsoid.
Units	M	meters	Units of geoidal separation
Age of Diff. Corr.		second	Null fields when DGPS is not used
Diff. Ref. Station ID			Null fields when DGPS is not used / 0000-1023
Checksum	*18		
<CR> <LF>			End of message termination

Table 8: GGA Data Format

Value	Description
0	Fix not available or invalid
1	GPS SPS Mode, fix valid
2	Differential GPS, SPS Mode, fix valid
3	GPS PPS Mode, fix valid
4	Real Time Kinematic
5	Float RTK
6	Estimated (dead reckoning) Mode
7	Manual Input Mode
8	Simulator Mode

Table 9: Position Fix Indicator

3.4.5.4.2. GLL - Geographic Position - Latitude/Longitude

This sentence provides latitude and longitude of the vessel's position, the time of position fix and the status. Table 16: GLL Data Format contains the values for the following example:

$GPGLL,3723.247522,N,12158.341622,W,161229.48,A,A*41

Name	Example	Unit	Description
Message ID	$GPGLL		GLL protocol header GP: GPS Talker ID
Latitude	3723.247522		ddmm.mmmmmm
N/S Indicator	N		N=north or S=south
Longitude	12158.341622		dddmm.mmmmmm
E/W Indicator	W		E=east or W=west
UTC Time	161229.48		hhmmss.ss
Status	A		A=data valid or V=data not valid
Mode Indicator	A		See Table 17: Mode Indicator
Checksum	*41		
<CR> <LF>			End of message termination

Table 10: GLL Data Format

Value	Description
N	Fix not available or invalid
A	GPS SPS Mode, fix valid
D	Differential GPS, SPS Mode, fix valid
P	GPS PPS Mode, fix valid
R	Real Time Kinematic
F	Float RTK
E	Estimated (dead reckoning) Mode
M	Manual Input Mode
S	Simulator Mode

Table 11: Mode Indicator

3.4.5.4.3. GSA - GNSS DOP and Active Satellites

This sentence reports the GPS receiver's operating mode, the satellites used in the navigation solution reported by the GGA sentence and the DOP values. Table 18: GSA Data Format contains the values for the following example:

$GPGSA,A,3,07,02,26,27,09,04,15, , , , , ,1.8,1.0,1.5,1*33

Name	Example	Unit	Description
Message ID	$GPGSA		GSA protocol header GP: GPS Talker ID GA : GALILEO Talker ID BD : Beidou Talker ID GN : GNSS Talker ID
Mode 1	A		See Table 19: Mode 1
Mode 2	3		See Table 20: Mode 2
Satellite Used1. Satellite used in solution.1	07		SV on Channel 1 GPS : 1-32 SBAS : 33-64 (offset 87) GLONASS : 65-96. GALILEO :1-36 (offset 300) BEIDOU :1-37 (offset 200) QZSS: 1-5 (offset 192)
Satellite Used1	02		Sv on Channel 2
....			
Satellite Used1			
PDOP	1.8		Position Dilution Of Precision
HDOP	1.0		Horizontal Dilution Of Precision.
VDOP	1.5		Vertical Dilution Of Precision.
GNSS System ID	1		1=GPS 2=GLONASS 3=GALILEO 4=BEIDOU 5=QZSS
Checksum	*33		
<CR> <LF>			End of message termination

Table 12: GSA Data Format

Value	Description
M	Manual—forced to operate in 2D or 3D mode
A	2D Automatic—allowed to automatically switch 2D/3D

Table 13: Mode 1

Value	Description
1	Fix not available
2	2D (<4 SVs used)
3	3D (>3 SVs used)

Table 14: Mode 2

3.4.5.4.4. GSV - GNSS Satellites in View

This sentence reports the number of satellites (SV) in view, satellite ID numbers, elevation, azimuth and SNR value. Since there could be four satellites information per transmission if the number of satellites in view is greater, separated GSV sentences will be generated.

The number of sentences within the transmission and the total to be transmitted is shown in the first 2 fields of the sentence. Table 21: GSV Data Format contains the values for the following example:

$GPGSV,2,1,07,07,79,048,42,02,51,062,43,26,36,256,42,27,27,138,42,1*71

$GPGSV,2,2,07,09,23,313,42,04,19,159,41,15,12,041,42,1*41

Name	Example	Unit	Description
Message ID	$GPGSV		GSV protocol header GP: GPS Talker ID GL: GLONASS Talker ID GA : GALILEO Talker ID BD: BEIDOU Talker ID GN: GNSS Talker ID
Number of Messages	2		Range 1 to 3
Message Number1	1		Range 1 to 3
Satellites in View	07		
Satellite ID	07		Channel 1 GPS : 1-32 SBAS : 33-64 (offset 87) GLONASS : 65-96. GALILEO :1-36 (offset 300) BEIDOU :1-37 (offset 200) QZSS: 1-5 (offset 192)
Elevation	79	degrees	
Azimuth	048	degrees	
SNR (C/No)	42	dBHz	
....	....	....	
Satellite ID	27		Channel 4
Elevation	27	degrees	Channel 4 (Maximum 90)
Azimuth	138	degrees	Channel 4 (True, Range 0 to 359)
SNR (C/No)	42	dBHz	Range 0 to 99, null when not tracking
Signal ID	1		GPS, SBAS: 1 (L1C/A), 8(L5) GLONASS: 1 (L1C/A)

Name	Example	Unit	Description
			GALILEO: 7(L1B/C), 1(E5A) BEIDOU: 1(B1I), 5(B2A) QZSS: 1 (L1C/A),8(L5)
GNSS System ID	1		**Optional in case GNSS Talker ID(GN)** 1=GPS 2=GLONASS 3=GALILEO 4=BEIDOU 5=QZSS
Checksum	*71		
<CR> <LF>			End of message termination

Table 15: GSV Data Format

3.4.5.4.5. RMC - Recommended Minimum Specific GNSS Data

This sentence reports Time, date, position, and course and speed data. Table 22: RMC Data Format contains the values for the following example:

$GPRMC,161229.48,A,3723.247533,N,12158.341633,W,0.13,309.62,281118,6.1,W,A,V*10

Name	Example	Unit	Description
Message ID	$GPRMC		RMC protocol header GP: GPS Talker ID GA : GALILEO Talker ID BD: Beidou Talker ID
UTC Time	161229.48		hhmmss.ss
Status	A		A=data valid or V=data not valid
Latitude	3723.247533		ddmm.mmmmmm
N/S Indicator	N		N=north or S=south
Longitude	12158.341633		dddmm.mmmmmm
E/W Indicator	W		E=east or W=west
Speed Over Ground	0.13	knots	
Course Over Ground	309.62	degrees	True
Date	281118		ddmmyy
Magnetic Variation	6.1	degrees	E=east or W=west
Mag variation direction	W		E/W. E subtracts mag var from true, W adds mag var to true.
Mode Indicator	A		See Table 17: Mode Indicator

Name	Example	Unit	Description
Navigational status Indicator	V		V (equipment is not providing navigational status indication).
Checksum	*10		
<CR> <LF>			End of message termination

Table 16: RMC Data Format

3.4.5.4.6. VTG - Course over Ground and Ground Speed

This sentence reports the actual course and speed over the ground.

Table 23: VTG Data Format contains the values for the following example:

$GPVTG,309.62,T, ,M,0.13,N,0.2,K,A*23

Name	Example	Unit	Description
Message ID	$GPVTG		VTG protocol header GP: GPS Talker ID GA : GALILEO Talker ID BD : Beidou Talker ID
Course	309.62		Measured heading
Reference	T		True
Course		degrees	Measured heading
Reference	M		Magnetic
Speed	0.13	knots	Measured horizontal speed
Units	N	Knots	
Speed	0.2	km/hr	Measured horizontal speed
Units	K		Kilometers per hour
Mode Indicator	A		See Table 17: Mode Indicator
Checksum	*23		
<CR> <LF>			End of message termination

Table 17: VTG Data Format

3.4.5.4.7. GNS - GNSS Fix Data

This sentence reports the GNSS fix data.

Table 24: GNS Data Format contains the values for the following example:

$GNGNS,084509.00,3731.283789,N,12655.755481,E,ANNNN,07,1.2,110.7,18.0,,,V*26

Name	Example	Unit	Description
Message ID	$GNGNS		GNS protocol header GP: GPS Talker ID GL: GLONASS Talker ID GA : GALILEO Talker ID BD: BEIDOU Talker ID GN: GNSS Talker ID
UTC Time	084509.00		hhmmss.ss
Latitude	3731.283789		ddmm.mmmmmm
N/S Indicator	N		N=north or S=south
Longitude	12655.755481		dddmm.mmmmmm
E/W Indicator	E		E=east or W=west
Mode Indicator	ANNNN		Fixed length field; contains five characters, The first symbol relates to GPS The second one – to GLONASS The third one – to GALILEO The fourth one – to BEIDOU The fifth one – to QZSS See Table 17: Mode Indicator
Satellites Used	07		Number of satellites in use, (Gps+Glonass+Galileo+Beidou+Qzss)
HDOP	1.2		Horizontal Dilution Of Precision.
MSL Altitude	110.7	meters	Antenna Altitude above/below mean-sea-level (geoid)
Geoid Separation	18.0		The difference between the WGS-84 earth ellipsoid and the mean-sea-level (geoid), "-" means mean-sea-level below ellipsoid.
Age of Diff. Corr.		second	Null fields when DGPS is not used
Diff. Ref. Station ID			Null fields when DGPS is not used / 0000-1023
Navigational Status	V		V (Equipment is not providing navigational status indication)
Checksum	*26		
<CR> <LF>			End of message termination

Table 18: GNS Data Format

3.4.5.5. Checking GNSS Device Functionality

After a proper power on, the device is ready to receive the AT commands on the MODEM serial port.

When the **$GPSP** command is issued, The GNSS receiver will also be powered on and will start scanning for available GNSS signals.

The NMEA sentence must be present on the NMEA USB port (default 115200 bps, 8, n, 1) when the **$GPSNMUN** command is issued.

3.4.5.6. Controlling GNSS Receiver

The FN990(m) module is equipped with a set of AT commands that allow its configuration and use through the MODEM serial port.

3.4.5.6.1. Power Control of GNSS Receiver

The GNSS receiver is by default switched off at the first power on. If is necessary to switch it on or off, it is possible to use the AT$GPSP command. The GNSS receiver is usable if the module is switched on (or at least in power saving). This command also switches off the GNSS receiver supply. Actually, the GNSS receiver On or Off means GNSS positioning session Start or Stop.

Syntax of the command **AT$GPSP=<status>**

Where:

<status> - 0 Stop GNSS positioning session (default), 1 Start GNSS positioning session, ? Returns the range of values accepted

AT$GPSP? will return the current status.

Example 1: (to switch on the GNSS)

AT$GPSP=1<CR>

OK

Example 2: (to know the status)

AT$GPSP?<CR>

The answer will be:

$GPSP: 0

OK

3.4.5.6.2. GNSS Reset

With the command **AT$GPSR=<reset_type>** is possible to reset the GNSS module.

Parrameter:

<reset_type>

0 - Factory reset: This option clears all GPS memory including clock drift.

1 - Coldstart (No Almanac, No Ephemeris): this option clears all data that is currently stored in the GPS receiver internal memory including location, almanac, ephemeris, and time. However the stored clock drift, is retained.

2 - Warmstart (No ephemeris): this option clears all initialization data in the GPS receiver and subsequently reloads the data currently displayed in the Receiver Initialization Setup screen. The almanac is retained but the ephemeris arecleared.

3 - Hotstart (with stored Almanac and Ephemeris): the GPS receiver restarts by using the values stored in the internal memory of the GPS receiver; validated ephemeris and almanac.

Example:

It is available to set <**reset_type**> in non-controlled mode.

Let's suppose to perform a cold start of the GNSS receiver.

AT$GPSR=1<CR>

OK

The Receiver will clear all the parameters in its memory and it will start a scanning of the available satellites.

AT$GPSP=1<CR>

OK

It is available in controlled mode too.

AT$GPSP=1<CR>

OK

Let's suppose to perform a cold start of the GNSS receiver.

AT$GPSR=1<CR>

OK

The Receiver will clear all the parameters in its memory and it will start a new scanning of the available satellites.

3.4.5.6.3. GNSS Antenna Management

The GNSS receiver needs an active antenna. This antenna could be supplied by the module. 3.1V DC power is supplied to the GNSS antenna port. By default the antenna supply is set to OFF.

Refer to the following **$GPSANTPORT** command to configure the port and type of GNSS antenna.

The syntax is AT$GPSANTPORT=<type>

Parameter:

<type> : Enabled Port type

0 – Disable GNSS on AUX Port and GNSS Port. (GNSS Off)

1 – Enable GNSS on AUX port and disable GNSS on GNSS port; Internal LNA On, DC-Bias Off. (Passive antenna on Aux Port)

2 – Enable GNSS on GNSS port and disable GNSS on AUX port; Internal LNA On, DC-Bias Off. (Passive antenna on GNSS Port) (**Default**)

3 – Enable GNSS on GNSS port and disable GNSS on AUX port; Internal LNA Off, DC-Bias On. (Active antenna on GNSS Port)

4 – Enable GNSS on GNSS port and disable GNSS on AUX port; Internal LNA On, DC-Bias On. (Active antenna on GNSS Port, High Gain)

3.4.5.6.4. GNSS Parameters Save

This command allows saving the set parameters in the module's memory

Syntax of the command

AT$GPSSAV

3.4.5.6.5. Restore GNSS Parameters

This command allows restoring the factory default parameters for the GNSS module

Syntax of the command:

AT$GPSRST

After this command, the module should be restarted to update the settings.

Note: When $GPSRST command is issued, if the GNSS session is already started, the GNSS session will be stopped to restore the GNSS Parameters with to factory default.

3.4.5.6.6. Read Acquired GNSS Position

This command allows reading the acquired position of the GNSS receiver

Command syntax

AT$GPSACP

The response syntax is:

$GPSACP:<UTC>,<latitude>,<longitude>,<hdop>,<altitude>,<fix>,<cog>,<spkm>,<spkn>,<date>,<nsat_gps>,<nsat_glonass>

The fields contain the following information:

<UTC> - UTC time (hhmmss.sss) referred to GGA sentence

<latitude> - format is ddmm.mmmmmm N/S (referred to GGA sentence)

where:

dd – degrees - 00..90

mm.mmmmmm - minutes - 00.000000..59.999999

N/S: North / South

<longitude> - format is dddmm.mmmmmm E/W (referred to GGA sentence)

where:

ddd - degrees - 000..180

mm.mmmmmm - minutes - 00.000000..59.999999

E/W: East / West

<hdop> - x.x - Horizontal Diluition of Precision (referred to GGA sentence)

<altitude> - xxxx.x Altitude - mean-sea-level (geoid) in meters (referred to GGA sentence)

<fix> -

0 or 1 -Invalid Fix

2 - 2D fix

3 - 3D fix

<cog> - ddd.mm - Course over Ground (degrees, True) (referred to VTG sentence)

where:

ddd - degrees - 000..360

mm – minutes - 00..59

<spkm> - xxxx.x Speed over ground (Km/hr) (referred to VTG sentence)

<spkn> - xxxx.x- Speed over ground (knots) (referred to VTG sentence)

<date> - ddmmyy Date of Fix (referred to RMC sentence)

where:

dd - day - 01..31

mm – month - 01..12

yy – year - 00..99 - 2000 to 2099

<nsat > - nn - Total number of GNSS satellites in use (referred to GNS sentence)

- 00..99

Example:

$GPSACP: 080220,3206.402028N,03450.267836E,1.1,3.3,0,0.0,0.0,0.0,030613,18

OK

3.5. Packet Switched Data Operations

3.5.1. USB Tethering Connection

3.5.1.1. Dial-Up Networking

Dial-up is a legacy method to access the internet service using the public switched telephone network. The DTE uses an attached modem to send and receive internet protocol packets so it is limited to support high speed data rates on LTE & NR technology.

It is not recommended to use this method for internet access.

3.5.1.2. Standard ECM/RNDIS

ECM stands for Ethernet Control Model and is an Ethernet emulation protocol defined by the USB Implementers Forum. RNDIS (Remote Network Driver Interface Specification) is a Microsoft proprietary protocol used mostly on top of USB, providing a virtual Ethernet link to most versions of the Windows and Linux operating system.

Firstly, USB is configured to support ECM or RNDIS by issuing AT#USBCFG command.

AT#USBCFG=<composition>

For ECM, <composition> is set 3.

For RNDIS, <composition> is set 0.

After executing the command, the module automatically reboots and the Host reconfigures the USB composition accordingly.

ECM and RNDIS session can be established by running AT#ICMCONNECT command.

AT#ICMCONNECT=<Cmd>,<Cid>,[<userIPType>]

Please refer to AT command guide document for more information on ECM/RNDIS control commands

ECM and RNDIS provides private IP address to the tethered TE (Host PC) even if the module has network-assigned IP address and communicates with WWAN N/W using NATing.

3.5.1.3. MBIM/RmNet

MBIM is a communication class subclass specification for the Mobile broadband interface model. It is a protocol by which USB hosts and mobile broadband devices can efficiently exchange control commands and data frames. MBIM extends the Network Control Model (NCM) as a protocol between the host and USB devices, with the difference that devices transfer raw IP packets instead of packets with 802.3 headers. The Mobile Broadband Interface Model (MBIM) class driver is an inbox driver provided my Microsoft; no third-party driver is required.

RmNet is a Qualcomm proprietary mobile broadband network interface, which emulates the network interface for the connected TE and allowing for the module to behave as a network adapter. RmNet relies on a control interface for any control signaling between TE and MS to initiate a data session on demand and send any notifications. The control interface is called as QMI(Qualcomm MSM Interface).

USB needs to be configured to support these types of interfaces by issuing AT#USBCFG command.

AT#USBCFG=<composition>

For RmNet, <composition> is set 1.

For MBIM, <composition> is set 2.

After running the command, DUT automatically reboots and then Host reconfigures the USB composition accordingly.

There are no AT commands that control the data session on these N/W interfaces. Instead, customer applications need to prepare their own connection manager or open source solution on Linux environment.

MBIM/RmNet provides network-assigned IP address to the tethered TE(Host PC) and the module just performs a data modem role such as forwarding incoming packets from the tethered PC to the remote network or vice versa without manipulating received packets such as NATing whereas RNDIS/ECM changes destination or source IP address from public to private or vice versa in handling incoming packets from N/W or outgoing packets to NW respectively.

3.6. GPIO Control

FN990(m) provides various GPIO pins, which can be configured by means of the AT command as Input or Output.

User applications, through AT#GPIO command, can control external user equipment connected to the GPIO pins. Simple or null circuitries are needed to perform the required hardware interface.

3.6.1. Set GPIO Pin as Output

Use the following AT command to set a GPIO as output with Low or High status.

AT#GPIO=<pin>,<mode>,1

Example.

- Set GPIO3 pin as output with low status:

  AT#GPIO=3,0,1
  OK

- Set GPIO3 pin as output with high status:

  AT#GPIO=3,1,1
  OK

3.6.2. Set GPIO Pin as Input

Use the following AT command to set a GPIO as input with internal pull-up/down.

AT#GPIO=<pin>,<mode>,0

Example.

- Set GPIO7 pin as input with internal pull-down:

  AT#GPIO=7,4,0
  OK

- Set GPIO7 pin as input with internal pull-up:

  AT#GPIO=7,3,0
  OK

3.6.3. Read GPIO Pin Status

Use the following AT command to read a GPIO status.

AT#GPIO=<pin>,2

Example.

Set GPIO3 pin as output with low status.

```
AT#GPIO=3,0,1
OK
```

Set GPIO4 pin as input with internal pull-down.

```
AT#GPIO=4,4,0
OK
```

Now, connect GPIO3 with GPIO4 physically and then check the GPIO4 status.

```
AT#GPIO=4,2
#GPIO: 0,0,4          GPIO4 status is low by GPIO3 pin

OK
```

Set GPIO3 pin as output with high status.

```
AT#GPIO=3,1,1
OK
```

Check GPIO4 status.

```
AT#GPIO=4,2
#GPIO: 0,1,4          GPIO4 status is high by GPIO3 pin

OK
```

Check GPIO3 status.

```
AT#GPIO=3,2
#GPIO: 1,1            GPIO3 status is high as configured before
OK
```

Note: GPIO_01, GPIO_06, GPIO_07 and GPIO_08 are assigned to DVI alternate function for audio as default.

GPIO_09 and GPIO_10 are assigned to I2C alternate function as default.

GPIO_13 is assigned as W_DISABLE2_N for GNSS disable as default.

3.7. Fast Shutdown (TBD)

TBD

3.8. Shutdown Indication (TBD)

TBD

3.9. mmWave Configuration(TBD)

For FN990 customer can use mmWave configuration commands for MMWANT active.

- MMWANT command
- USRMMWx command

3.9.1. General Information

The Customer uses the MMWANT command for each QTM Antennas supplied with the mmWave configuration.

If Customers are using the Telit EVB, they can use this command without the mmWave calibration action.

If Customers use their own application, they need mmWave calibration and to backup the mmWave calibration data in the Telit the mmWave user region.

If they do not perform backup the process(ex.#USRMMWC=1), the mmWave calibration will be removed after a new firmware upgrade.

- MMWANT and USRMMWx commands allow
- MMWANT and USRMMWx commands disallow

3.9.2. Usage of MMWANT Command

Customers can use the MMWANT commands to activate specific the mmWave ANT base on the TELIT EVB.

This command writes several of the mmWave NV items which is related to the mmWave ANT activation and only allows setting for the mmWave supported variants.

<MMWANT command set>

- AT#MMWANT=0

  Delete the mmWave antenna configuration NV values.
- AT#MMWANT=1

  Configure the mmWave QTM525-2.
- AT#MMWANT=2

  Configure the mmWave QTM525-5.

- **AT#MMWANT=3**

  Configure the mmWave QTM527-1.

- **AT#MMWANT=4**

  Configure the mmWave QTM527-2.

<MMWANT command read>

- **AT#MMWANT?**

  #MMWANT: 99 -> "99" means the mmWave not support.

  #MMWANT: 0,0020 -> "0" means the mmWave not configure.

  #MMWANT: 1,0010 -> "1" means the QTM 525-2 ANT configure.

3.9.3. Usage of USRMMWx Commands

- **AT#USRMMWS – User MMWAVE Selection**

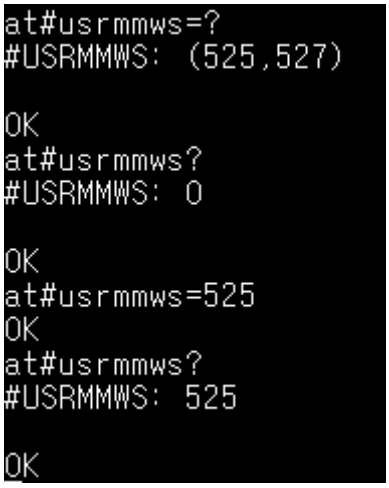
The Customer should set the mmWave antenna information at first.

If Customers do not set this command, they couldn't control the USRMMWx commands.

AT#USRMMWS=?
#USRMMWS: (525,527)
OK

AT#USRMMWS=525
OK

AT#USRMMWS?
#USRMMWS: 525
OK



- **AT#USRMMWW – User MMWAVE write**

If Customers have mmWave configuration data on the PC, they can write these data on the User temp region with this command.

<QTM 525>

QTM configuration rfnv items:
29640,29652,29770,30000,30001,30002,30003,30013,30014,30015,30030

size: 1-16548

<QTM 527>

QTM configuration rfnv items:

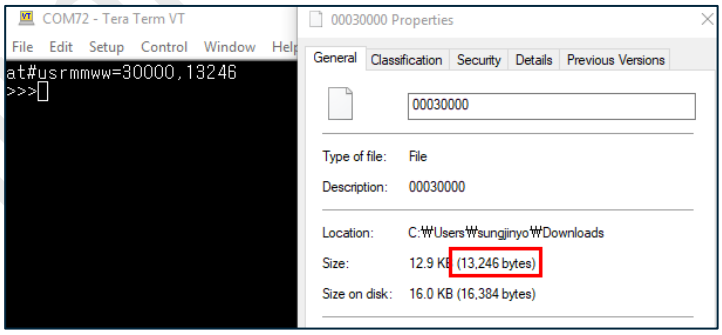
29640,29652,30000,30002,30003,30013,30014,30015,30030

size: 1-77316

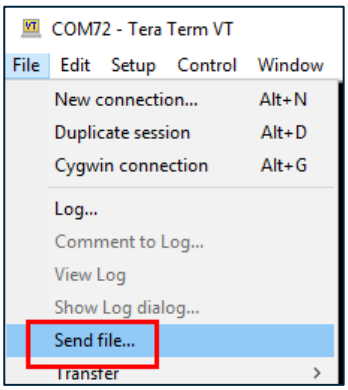
```
at#usrmmws?
#USRMMWS: 525

OK
at#usrmmww=?
#USRMMWW: (29640,29652,29770,30000,30001,30002,30003,30013,30014,30015,30030),(1-16548)

OK
at#usrmmws=527
OK
at#usrmmww=?
#USRMMWW: (29640,29652,30000,30002,30003,30013,30014,30015,30030),(1-77316)

OK
```

<How to write the data with Tera Term>

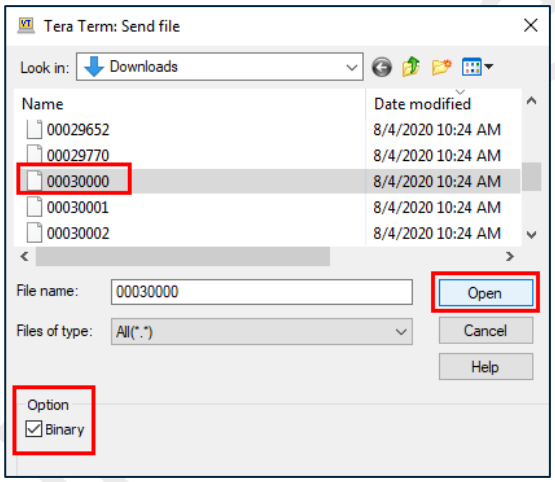
1. Set the NV item id and size.



2. Run the Send file.



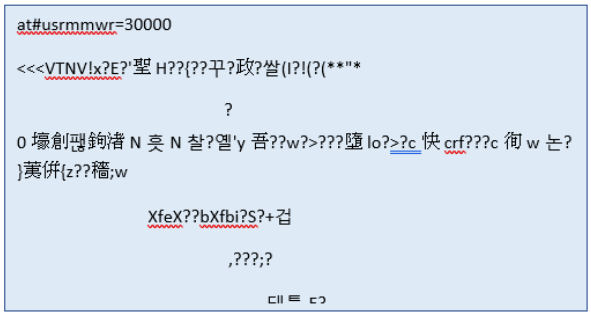
3. Select and open the files. The "Binary" Option must be checked. If the file is sent without the "Binary" Option selected, wrong hex values will be transferred.



4. Confirm the data write on the user temp reigon.

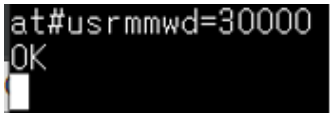
- **AT#USRMMWR – User MMWAVE read**

Customers can read mmWave data located on the User temp region.



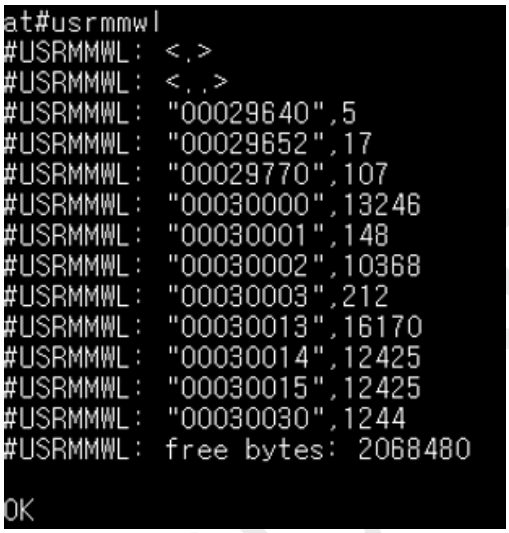
- **AT# USRMMWD – User MMWAVE delete**

Customers can delete mmWave data which is located on the User temp region.



- **AT# USRMMWL – User MMWAVE list**

Customers can confirm mmWave data which is stored on the User temp region.



- **AT# USRMMWC – User MMWAVE control**

1. AT#USRMMWC=0

Write the user mmWave data saved in the User Temp region to the QC rfnv region

2. AT#USRMMWC=1

Backup the user mmWave data on the User region.

If customers don't set this command, the mmWave data will be deleted after firmware upgrade.

3. AT#USRMMWC=2

The Customer can restore mmWave data from the User region.

4. AT#USRMMWC=3

Delete restored mmWave data on the User region and QC RFNV region.

3.9.4. How to Handle this Command on the Product Line.

- **Telit EVB use case**

If the Customer uses Telit EVB, the below process to the mmWave active can be used.

1. AT#MMWANT=1 (QTM525-2 antenna configuration)

2. AT#REBOOT
3. AT#USRMMWC=1(Backup the user mmWave data on the User region)
4. Test the QTM525-2 online call
5. Case of customer change the QTM 525-5 Antenna.
6. AT#MMWANT=0 (Erase the QTM525-2 antenna configuration)
7. AT#REBOOT
8. AT#MMWANT=2
9. AT#REBOOT
10. AT#USRMMWC=1(Backup the user mmWave data on the User region)
11. Test the QTM525-5 online call

- **Customer Application use case**

If customers are using their own application, the below process to the mmWave active can be used.

1. AT#MMWANT=1 (configure the QTM525-2 antenna)
2. AT#REBOOT
3. Perform the mmWave beamforming characterization and calibration on the customer side.
4. AT#USRMMWC=1 (Backup the user mmWave data on the User region)
5. Test the QTM525-2 online call
6. If Customers have re-calibration,
7. AT#USRMMWC=1 after finishing the mmWave re-calibration

Test the QTM525-2 online call

4. SERVICE AND FIRMWARE UPDATE

4.1. Firmware Update

The Telit Modules firmware is updated through the USB Interface.

If not already included in the design, it is suggested to provide a USB interface on the User Printed Circuit Board (where the Telit Module is soldered) to perform the physical connection between the Telit module and a Windows-based PC. This simple circuitry makes the firmware updating easy when a new firmware version is released.

During the User Application development or evaluation phase of the Telit module, the USB port implemented on the **Telit Evaluation Board (Telit EVB)** can be used to connect the Telit module to a Windows-based PC on which a dedicated tool for firmware updating is running.

Telit provides the User with two tools to update the firmware of the module. The following paragraphs describe them.

Note: The firmware update tools (TFI/XFP) do not support multi-device update at the same time and do not support update when multi-devices are connected on the same PC. Please proceed with the firmware update by connecting only one device to the PC.

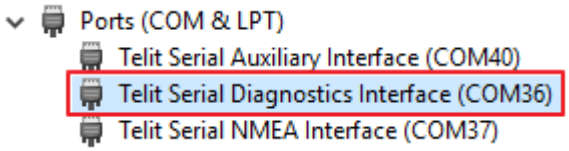
4.1.1. TFI Update

The firmware update can be performed with a specific software tool provided by Telit running on Windows-based PCs. The program will erase the contents of the flash memory, then the program will write to the flash memory. “FN990m_xxx_TFI.exe” file includes a binary image. The binary image included in the TFI package will be checked with the SHA256 hash before the start of the TFI firmware update procedure. The TFI will stop updating if data corruption has been detected.

When downloading by TFI, the modem slot will be updated as follows:

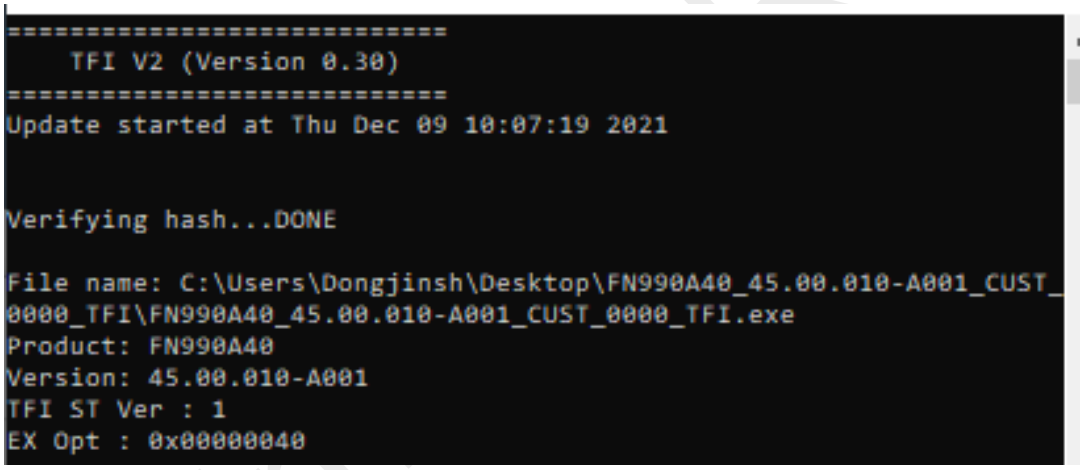
The following is the TFI update procedure.

1. Before updating with TFI, please check “Telit Serial Diagnostics Interface” in the Windows device manager.



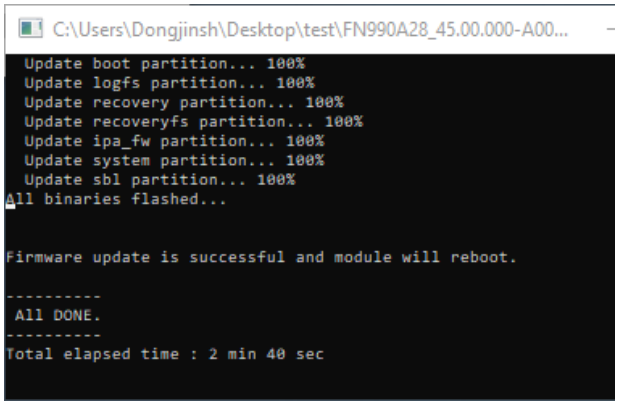
2. If you run FN990m_xxx_TFI.exe, Windows CMD prompt will be popped up.

3. TFI downloader automatically detects “Telit Serial Diagnostics Interface” and starts the download.



4. The Modem will reset several times during the upgrade process.

5. Wait for the end of programming completed message

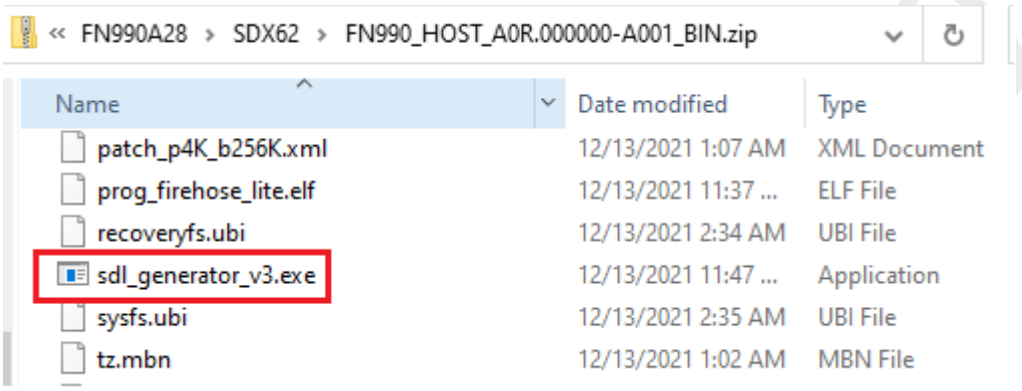


6. Telit FN990 family module is now programmed with the new firmware.

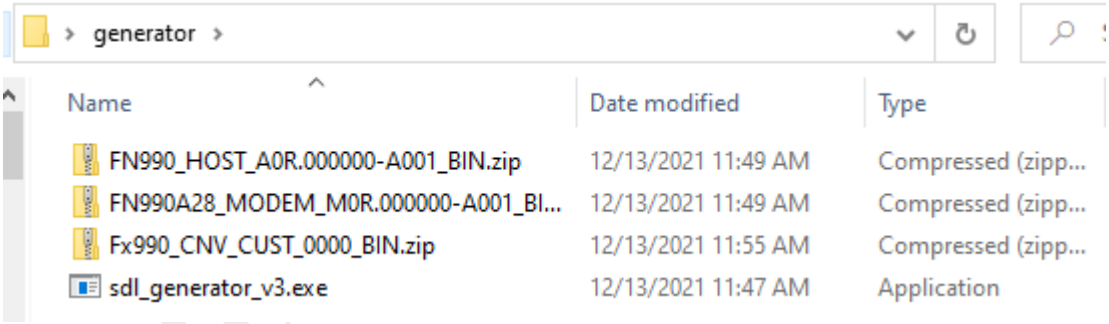
4.1.2. XFP Generator

For FN990(m), the streaming binary generator is a tool to generate custom streaming binaries on the Windows OS. You can generate your own streaming binary with below process.

1. Extract and copy the sdl_generator directory into the workspace from the HOST_BIN package (Please always use the latest version)

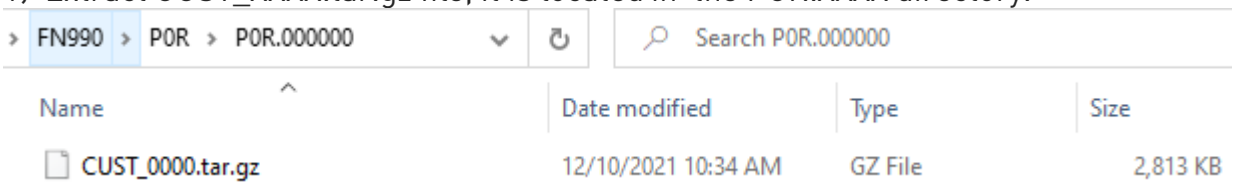


2. Copy all the BIN packages what you want to include in the streaming binary into the workspace

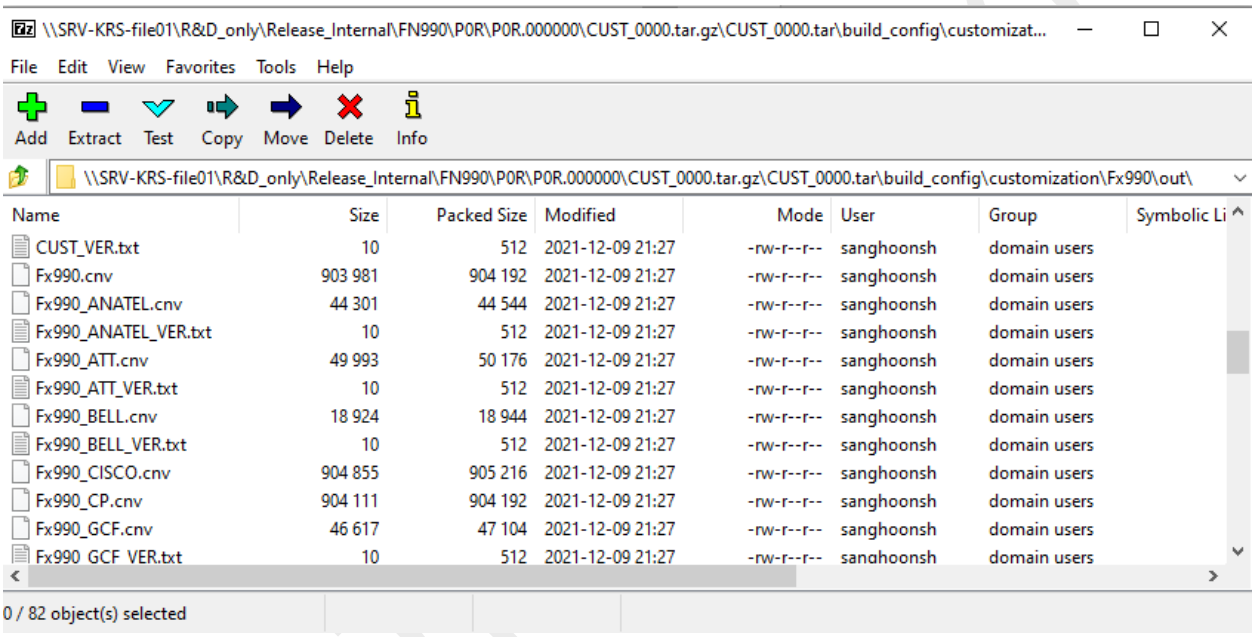


In case of generate binary with CNV binary, follow below steps

1) Extract CUST_XXXX.tar.gz file, it is located in the P0R.XXXX directory.

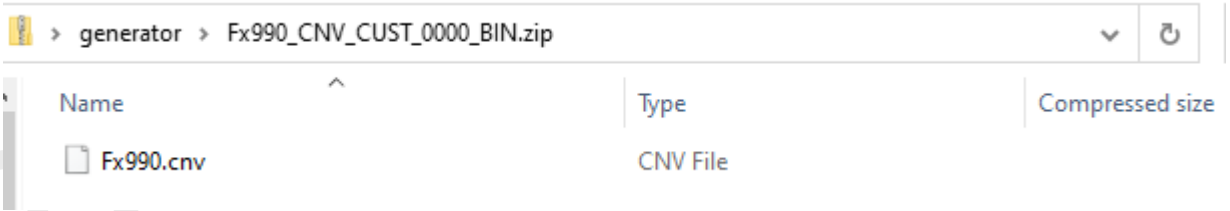


2) Copy Fx990_YYYY.cnv file to workspace.



In the workspace directory, zip the cnv file and name it as like Fx990_CUST_VER_BIN.zip

e.g) Fx990_CUST_0000_BIN.zip

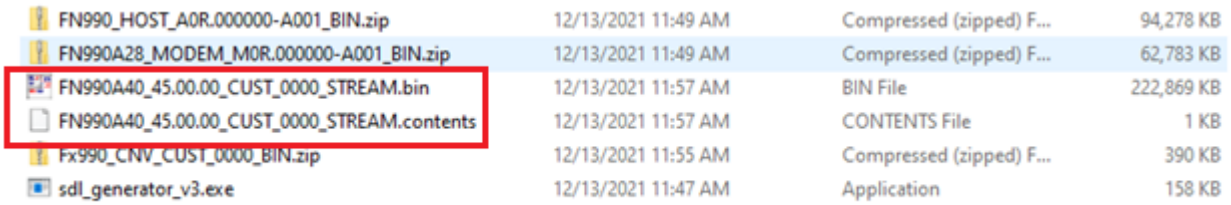


3. Open CMD and execute sdl_generator_v3 exe with below format
   sdl_generator_v3 <PRODUCT> <PACKAGE VERSION>
   <PRODUCT> : the name of the product. E.g.> FN990A40
   <PACKAGE VERSION> : the streaming binary package version string. The format is 45.00.xxx. E.g.> 45.00.X00-B001

   The sdl_generator will search the BIN package and start generation after decompressing the BIN packages.

```
C:\Users\Dongjinsh\Desktop\generator>sdl_generator_v3.exe FN990A28 45.00.00
INFO: Start searching package at C:\Users\Dongjinsh\Desktop\generator (dest = C:\Users\Dongjinsh\Desktop\generator\temp)

INFO: Skip dir .
INFO: Skip dir ..
INFO: Checking FN990A28_MODEM_M0R.000000-A001_BIN.zip
INFO: Extracting FN990A28_MODEM_M0R.000000-A001_BIN.zip - image (MODEM), Version (M0R.000000-A001), signed (0)
INFO: Checking FN990A40_45.00.00_CUST_0000_STREAM.bin
INFO: Checking FN990A40_45.00.00_CUST_0000_STREAM.contents
INFO: Checking FN990_HOST_A0R.000000-A001_BIN.zip
INFO: Extracting FN990_HOST_A0R.000000-A001_BIN.zip - image (HOST), Version (A0R.000000-A001), signed (0)
INFO: Checking Fx990_CNV_CUST_0000_BIN.zip
INFO: Extracting Fx990_CNV_CUST_0000_BIN.zip - image (CNV), Version (CUST_0000), signed (0)
INFO: Checking sdl_generator_v3.exe
INFO: Skip dir temp
INFO: CNV file name = Fx990.cnv

ERROR: There are 3 binaries to merge.
INFO: ---------------------------
INFO:       SDL Generator V3.02
INFO: ---------------------------
INFO: PRODUCT: FN990A28
INFO: PKG VER: 45.00.00
INFO: HOST VER: A0R.000000-A001
INFO: M0 VER: M0R.000000-A001
INFO: CNV0 VER: CUST_0000
INFO: OUTPUT: FN990A28_45.00.00_CUST_0000_STREAM.bin
INFO: BLOCK SIZE: 32768
INFO: DEBUG LEVEL: 0
```

4. Check generated binary and contents file.



   The "contents" file shown each sub-system version string included in the bin

```
PRODUCT: FN990A40
PKG VER: 45.00.00
HOST VER: A0R.000000-A001
M0 VER: M0R.000000-A001
CNV0 VER: CUST_0000
```

Option	Description	Example
-o <OUTPUT NAME>	Set the binary name. It will be automatically determined if this option is not used.	-o test.bin
-p <PACKET SIZE>	Set the maximum packet size. Default is 32768	-p 8196
-b <BIN_PATH>	Change the location of the BIN package from same folder with exe to the <BIN_PATH>	-b c:\bin\
-d <DEBUG_LEVEL>	Set the debug level during download the streaming binary	-d 1
-v	Output more detailed debug log of the generator	-v

Table 19: all the supported option parameters of the sdl_generator_v3

4.1.3. XFP Update

For FN990(m), the XFP is a firmware update method provided by Telit for porting to the customer's host unit. The XFP firmware image has CRC for each block and this CRC value transferred to the module with the binary data. The update will be stopped if any corrupted data is detected on the module.

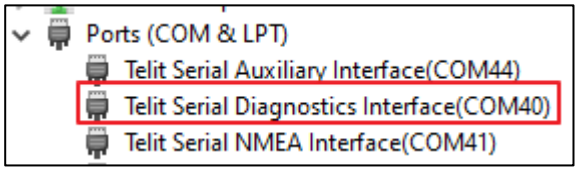
FN990(m) has modem slot and XFP stream binary has one image that are pre-determined which slot will be written to. When downloading streaming binary with XFP, modem slot will be erased and updated.

4.1.3.1. Windows OS < TBD >

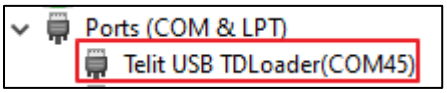
Telit provides the Windows XFP tool to perform the module firmware update with the XFP binary. It runs on Windows based PCs. It erases the flash memory contents, and then downloads the new firmware to the flash memory.

Please follow the steps below to perform the firmware update with the Windows XFP tool.

1) Power up the module and check that the 'Telit Serial Diagnostics Interface' port is enumerated.

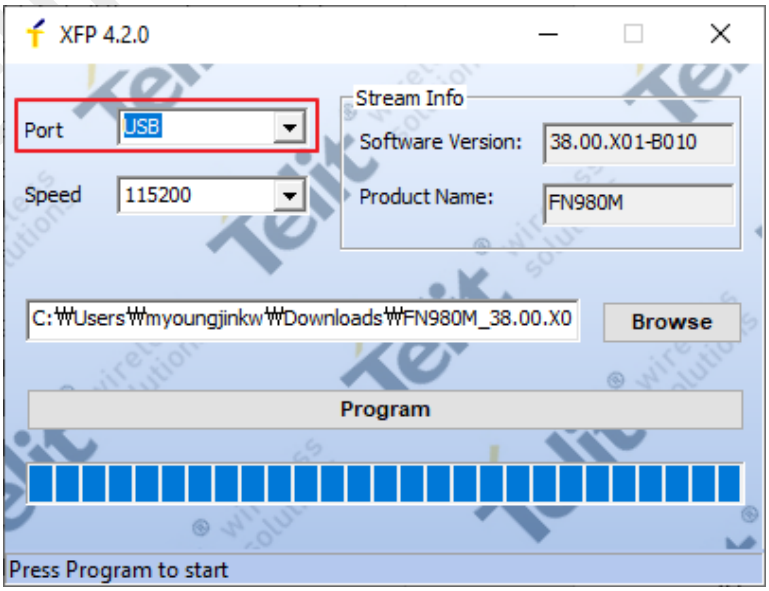


Note: The 'Telit USB TDLoader' port with PID 0x9010 will be enumerated when the module is in streaming download mode.

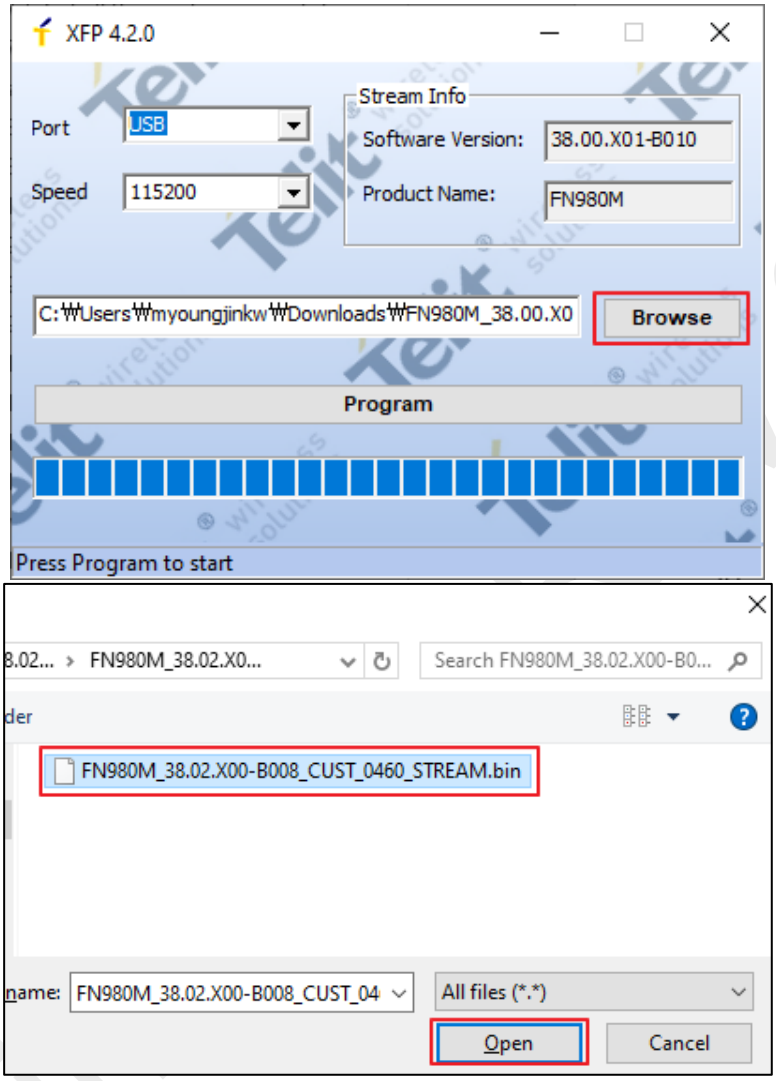


2) Run the 'Xfp.exe', the following windows are displayed. Please press 'OK' button after you finish to read the notice.

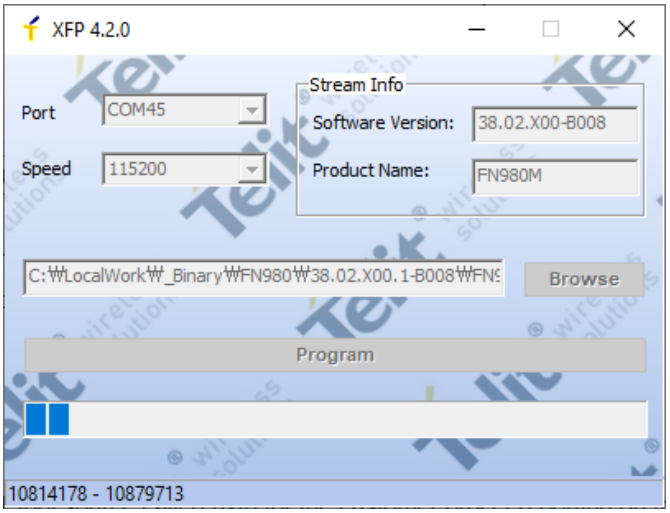
3) Please select 'USB' in the port combo box



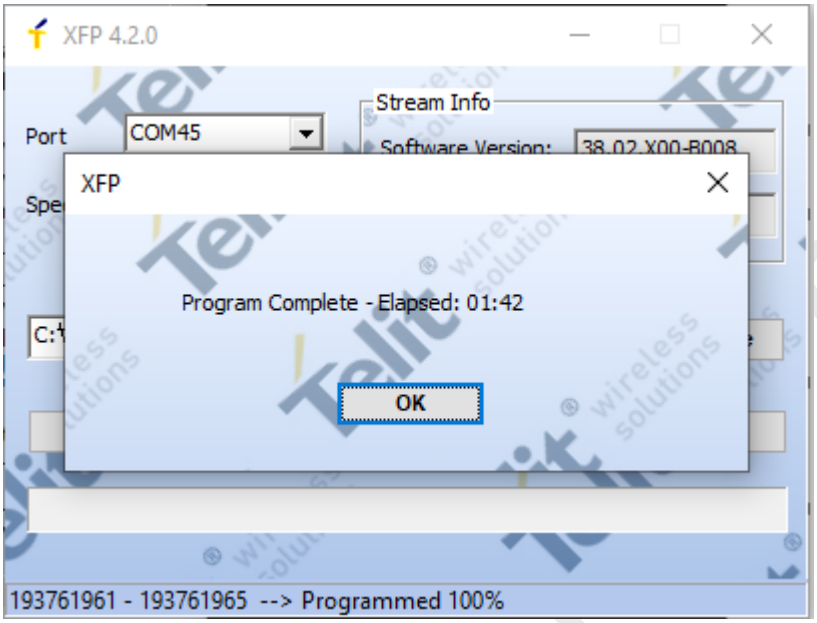
4) Press the 'Browse' button and select stream binary what you like to use for update.



5) Press the 'Program' button for start update. The progress bar will be increased during update.



6) The following pop-up will be displayed on the screen when the module update has been successfully done.



4.1.3.2. Linux OS

- Telit will supply reference HOST tool source called uxfp for the customer proceed porting on the own host. More detailed information described in uxfp User Guide(1VV0301613_uxfp_User_Guide)

5. GUIDELINE TO TEST GIGA BYTES TROUGHPUT BASED ON 5G-NR

5.1. Requirements (TBD.)

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Make sure the use of this product is allowed in your country and in the environment required. The use of this product may be dangerous and has to be avoided in areas where:

- it can interfere with other electronic devices, particularly in environments such as hospitals, airports, aircrafts, etc.
- there is a risk of explosion such as gasoline stations, oil refineries, etc. It is the responsibility of the user to enforce the country regulation and the specific environment regulation.

Do not disassemble the product; any mark of tampering will compromise the warranty validity. We recommend following the instructions of the hardware user guides for correct wiring of the product. The product has to be supplied with a stabilized voltage source and the wiring has to be conformed to the security and fire prevention regulations. The product has to be handled with care, avoiding any contact with the pins because electrostatic discharges may damage the product itself. Same cautions have to be taken for the SIM, checking carefully the instruction for its use. Do not insert or remove the SIM when the product is in power saving mode.

The system integrator is responsible for the functioning of the final product. Therefore, the external components of the module, as well as any project or installation issue, have to be handled with care. Any interference may cause the risk of disturbing the GSM network or external devices or having an impact on the security system. Should there be any doubt, please refer to the technical documentation and the regulations in force. Every module has to be equipped with a proper antenna with specific characteristics. The antenna has to be installed carefully in order to avoid any interference with other electronic devices and has to guarantee a minimum distance from the body (20 cm). In case this requirement cannot be satisfied, the system integrator has to assess the final product against the SAR regulation.

The equipment is intended to be installed in a restricted area location.

The equipment must be supplied by an external specific limited power source in compliance with the standard EN 62368-1:2014.

The European Community provides some Directives for the electronic equipment introduced on the market. All of the relevant information is available on the European Community website:

https://ec.europa.eu/growth/sectors/electrical-engineering_en

7. GLOSSARY

APN	Access Point Name
BCCH	Broadcast Control Channel
CS	Circuit-Switched
DCE	Data Circuit-Terminating Equipment
DRX	Discontinuous Reception
DTE	Data Terminal Equipment
DTMF	Dual Tone Multiple Frequency
DTR	Data Terminal Ready
GERAN	GSM EDGE Radio Access Network
GPIO	General Purpose Input Output
HSPA+	Evolved High Speed Packet Access
DC HSPA+	Dual-Carrier HSPA
IMS	IP Multimedia Subsystem
IRA	International Reference Alphabet
ME	Mobile Equipment
MSISDN	Mobile Station International Subscriber Directory Number
NMEA	National Marine Electronics Association
NVM	Non-Volatile Memory
NR	New Radio
PDN	Public Data Network
PDP	Packet Data Protocol
PDU	Protocol Data Unit
PIN	Personal Identification Number
PPP	Point to Point Protocol
QoS	Quality of Service
RTC	Real Time Clock
SIM	Subscriber Identification Module
SMS	Short Message Service
SMSC	Short Message Service Center
TCP/IP	Transmission Control Protocol / Internet Protocol

TTY	Text Telephone Typewriter
UART	Universal Asynchronous Receiver Transmitter
UE	User Equipment
USB	Universal Serial Bus
URC	Unsolicited Result Code
USIM	Universal Subscriber Identification Module
UTRAN	Universal Terrestrial Radio Access Network
WCDMA	Wideband Code Division Multiple Access

8. DOCUMENT HISTORY

Revision	Date	Changes
preliminary	2021-12-20	First issue

From Mod.0818 rev.3

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