

KIM2

Integration manual



Reference:

KINEIS-MI-22-0397

Issue:

0.7

Date:

17/04/2025

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1. Introduction

Kinéis products make satellite connectivity easy to access and it is our goal to make integration and industrialization process as streamlined as possible.

The KIM2 module developed by Kinéis is a low-power transceiver module based on Kinéis standards and fully certified by Kinéis. The module is specifically designed for ease of use, to shorten development time and thus decrease time to market. It offers IoT device manufacturers the possibility to integrate their end devices quickly and easily into the Kinéis network and is available for industrialization of satellite-connected devices in large volumes.

It enables communication with all the Kinéis polar LEO satellites and provides global connectivity to IoT devices for data collection and positioning. The use of Kinéis RF signals and protocols ensures very low power consumption for device within line-of-sight of Kinéis satellites.

This document is an integration manual for the KIM2 transceiver module by Kinéis, complementing the component datasheet.

This manual will bring you information regarding:

- Typical application circuit
- UART interface
- Transmission and reception protocols, including message formatting and communication strategies

For further assistance, feel free to contact Kinéis at the following link: <https://www.kineis.com/contact/>

A. Revision history

Issue	Date	Modifications
0.1		Document creation
0.2		Engineering Samples release for Beta Testing
0.3	Dec. 6, 2023	Engineering Samples release for Beta Testing with new features: <ul style="list-style-type: none"> - Implementation of radio configuration - Availability of LD-A2 modulation (low-data rate Argos-2: ± 1.1rad BPSK, 400bits/s)
0.4	Mar. 1 st , 2023	Add the radio configuration process for deployment Add chapter for KIM2 FW upgrade on Engineering samples
0.5	14 May 2024	Modifications on programming and debug paragraph Add chapter to low power management and WAKE_UP pin usage.
0.6	24 Feb. 2025	Add the factory zone to flash in case of upgrade from old kimx_fw version Change on LDK payload size
0.7	17 April. 2025	Precise reflashing new firmware in KIM2 RCONF management and MAC config added.

B. Related documents

- RD1 : KINEIS-NT-22-0600 - KIM2 Datasheet
- RD2 : KnsStack_AtCmds_APIs.official
- **RD3** : KINEIS-MU-2019-0094 Satellite pass predictions - User guide
- RD4 : Radio_conf_management_user_guide

C. Versioning

HW release	FW release	Datasheet version	Integration manual version
Engineering samples	KIM2_v1.0	KIM2 Datasheet v0.2	KIM2 Integration manual v0.2
Engineering Samples	df88832__0x1,Oct 18 2023_07:37:19	KIM2 Datasheet v0.3	KIM2 Integration manual v0.3
Engineering Samples	df88832__0x1,Oct 18 2023_07:37:19	KIM2 Datasheet v0.3	KIM2 Integration manual v0.4
Engineering Samples	In evolution	KIM2 Datasheet v0.5	KIM2 Integration manual v0.x

D. Next features

Below is a list of features that will be implemented in the next releases:

- Software management KIM_INT pins
- MAC improvement (satellite detection etc...)

2. Typical application circuit

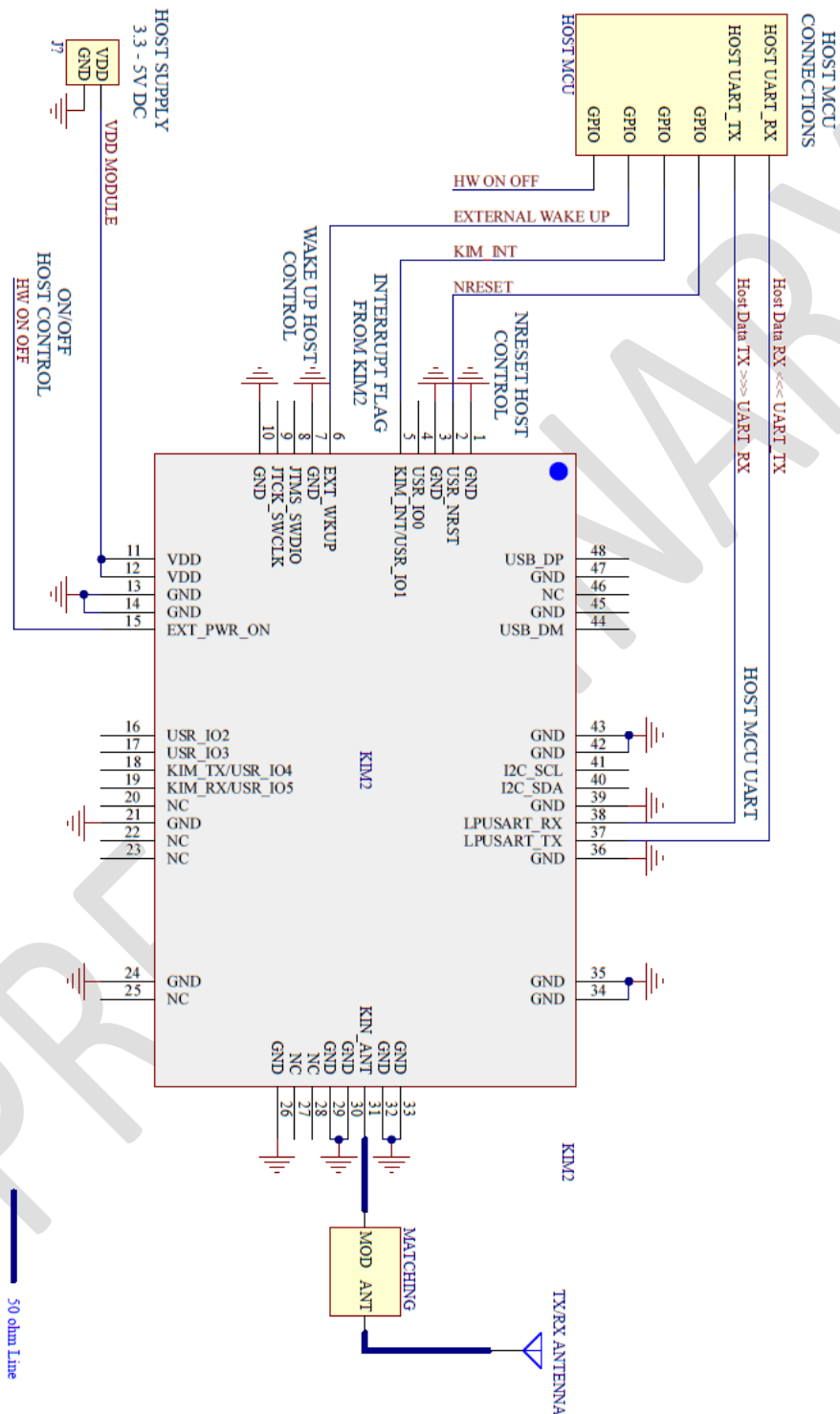


Figure 1: Typical integration of MCU with the KIM2

A. Commands / controls

KIM2 must be powered with 3.3V to 5V DC supply between VDD pins and GND pins, and all GND pins connected to the ground plane.

The microcontroller unit (MCU) can control the KIM2 through UART communication and GPIOs:

- UART interface needs two pins for the two-way communication: LPUSART_TX and LPUSART_RX
- EXT_PWR_ON input pin must be actively controlled to power on the module (High), and can be controlled to put the module in OFF mode (Low) : Keep it High when using all MAC profiles different to BASIC mode to keep alive KIM2 RTC running in low power mode.
- EXT_WAKE_UP input pin is used when EXT_PWR_ON is high to allow KIM2 to switch into low power mode when needed by kineis stack inside the module. Keep WAKE_UP pin in high state, during all AT command sending and set it to low state when no AT command sending.
- USR_Nrst input pin can be used to reset the module

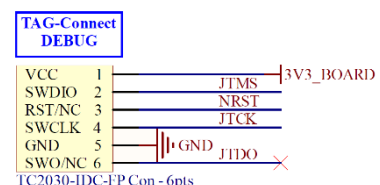
The following pins will be available in future firmware releases:

- KIM_INT output pin is used by the module to wake up the host microcontroller (active state = high): tis pin will reset automatically into low state when KIM2 interrupt registers will be red by application MCU through UART.

An antenna matched at 50Ω for the right frequency must be connected on the KIN_ANT pin.

B. Programming and debug

Since the KIM2 is still engineering sample version, it is recommended to include the footprint for the programming connector to the host PCB to be able to upgrade the firmware with future releases.



The connector reference is TC2030 by Tag-Connect, the schematics are shown in the picture on the right and the footprint is available at <https://www.tag-connect.com/product/tc2030-idc-nl>

PRELIMINARY

C. State transition diagram

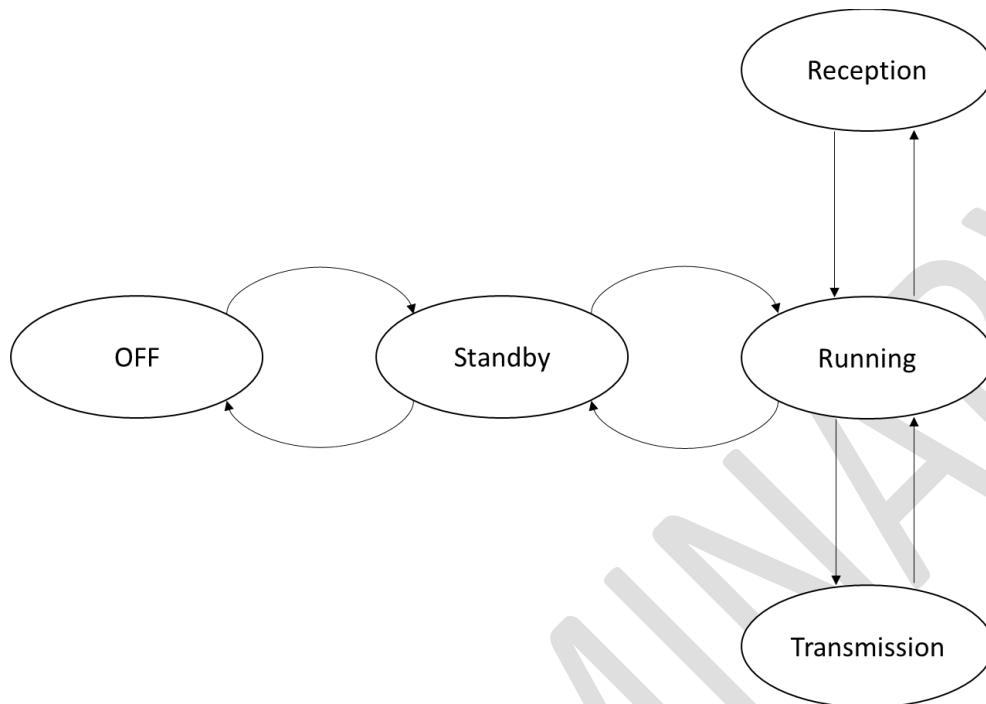


Figure 2: KIM2 state diagram

When the KIM2 is powered at VDD, it can follow different modes:

- **OFF** mode: when the EXT_PWR_EN pin is low, MCU power supply is off, power supply of analog parts is disabled too and the consumption is very low (quiescent current of the internal regulator).
- **Standby** mode: when the ON/OFF pin is high, this is the default mode. The RF digital processor is waiting for AT commands, allowing the transition to the Running Mode. This mode is optimized for low power consumption if WAKE_UP pin is set to Low state.
- **Running** mode: this mode is activated when the RF digital processor receives an AT command, for the duration of execution of the AT command.
- **Transmission** mode: this mode is activated when the RF digital processor receives a transmission AT command. It activates the TCXO and the internal power amplifiers, and a signal is transmitted to the antenna corresponding to the specified Kinéis message.
- **Reception** mode: this mode is activated when a transmission command calls for the reception of a downlink message (acknowledgment or downlink user message)

3. UART Communication

The KIM2 serial interface uses a basic TTL 3.3V level signals with UART protocol (RX link is 5V-tolerant).

UART interface uses fixed parameters:

SPECIFICATION	DESCRIPTION
Baud Rate	9600
Data bits	8 bits
Parity	None
Stop Bits	1 bit
Flow Control	No

Table 1 : UART Setting

A. AT commands syntax

The AT command or response will be a sentence terminated by <CR><LF> on both sides of communication.

There are three types of extended AT commands:

- Information type read-only commands, allowing to read values saved in the module:
`AT+CMD=?`
- Parameter type commands, allowing to set one or several values or parameters (parameters written within square brackets [] are optional):
`AT+CMD=<parameter1>,<parameter2>[,<optional_parameter>]`
- Action type commands, invoking a function of the equipment, which generally involve more than the simple storage of a value for later use (ex: Transmission command)
`AT+CMD=`

For each AT command, there will be the following possible responses:

- +OK, means the command is accepted and will be executed
- +ERROR=<errorno> means an error occurred during the execution of the command
 - Possible values, for <errorno> parameter, are detailed in §b **Error responses**

Spontaneous notifications can also be sent from the module with the format +CMD=<parameter>.

Timing constraints: Once an AT command has been sent to module, one shall not send again a new command until previous has been completed with a response.

User shall wait at minimum 10ms before sending a new command after previous is completed.

B. AT commands description

1. General commands

WARNING : Before any AT commands sending, it is necessary on last firmware version to maintain the EXT_WAKEUP pin to high state to keep alive the kim2. When EXT_WAKEUP pin is low, KIM2 is going into sleep mode but will be able to wakeup automatically when some frame scheduling/processing will be needed by KIM2 itself. Its RTC is still running, and any RAM configuration is kept in this low power mode.

Any new AT command set relative to firmware upgrades inside KIM2 will be described in the attached AT command set with versioning of this AT command set.

AT+VERSION=?

a. Ping

PING - Communication test	
AT+PING=?	Test the communication with the KIM2

b. Firmware version

FW – Read Firmware version	
AT+FW=?	<p>Read the firmware version from KIM2 module</p> <p>Answer: +FW=<fw_version></p> <p>Parameter:</p> <ul style="list-style-type: none"> <fw_version> – Firmware version flashed into the module

VERSION – Read AT COMMAND version	
AT+VERSION=?	<p>Read the at command set version from KIM2 module</p> <p>Answer: +VERSION=<AT CMD set version >, <list of AT command supported></p>

c. ID number

ID – Read Kinéis ID number	
AT+ID=?	<p>Read the Kinéis decimal ID number of the module (used to operate the device on the Services Portal)</p> <p>Answer: +ID=<id_number></p> <p>Parameters:</p> <ul style="list-style-type: none"> <id_number> – Kinéis ID number in decimal format

d. Address

ADDR - Read Kinéis address	
AT+ADDR=?	<p>Read the Kinéis hexadecimal address of the module (used by the module in the radio frame building)</p> <p>Answer: +ADDR=<addr></p> <p>Parameters:</p> <ul style="list-style-type: none"> • <addr> - Kinéis address in hexadecimal format (8 digits)

2. Configuration commands

e. Radio configuration

Radio configuration is an array of 16 bytes released by Kineis when end user application is determined and well known. This configuration can be done during mass production or later during the deployment phase. A default value is present in all KIM2. For a dedicated application, please contact Kineis to fill the application form and receive the corresponding radio config array.

RCONF – Radio configuration	
AT+RCONF=<conf>	<p>Set the radio configuration of the module, provided only by Kinéis</p> <p>Parameter:</p> <ul style="list-style-type: none"> • <conf> – 16-Byte hexadecimal encrypted string (32 digits)
AT+RCONF=?	<p>Read the radio configuration of the module</p> <p>Answer:</p> <p>+RCONF=<freq_min>,<freq_max>,<mod_type>,<rf_level></p> <p>Parameter:</p> <ul style="list-style-type: none"> • <freq_min> – frequency band low bound • <freq_max> – frequency band high bound • <mod_type> – transmission modulation <ul style="list-style-type: none"> o LDA2 o LDK • <rf_level> – conducted output RF level in dBm

f. MAC configuration

KMAC – MAC configuration	
<ul style="list-style-type: none"> AT+KMAC=<mac_prfl_id>[,<mac_config data HEXASCII >] 	<p>Set the MAC configuration of the module, provided by Kinéis</p> <p>Parameter:</p> <ul style="list-style-type: none"> <mac_prfl_id> <p>* 0=none(disabled)</p> <p>* 1=basic</p> <p>* 2=blind</p> <ul style="list-style-type: none"> <mac_config data HEXASCII > <p>* basic => NA (no parameter)</p> <p>* blind => 6bytes in ASCII AT+KMAC=? status</p> <p>examples:</p> <p>AT+KMAC=0 stop current MAC profile (=> profil NONE)</p> <p>AT+KMAC=1 start basic profile</p> <p>AT+KMAC=2,0404F0000000 for blind FIFO containing 4 msg length, 4 repetitions, 240s period</p> <p>AT+KMAC=2,04013C000000 for blind FIFO 1 msg length, 4 repetitions, 60s period</p> <p>WARNING: Call this command to start a MAC profile before sending any AT+TX request</p>
AT+KMAC=?	<p>Read the current KMAC configuration of the module</p> <ul style="list-style-type: none"> Answer: +KMAC=<mac_prfl_id>,<config data>

3. User data commands

a. Transmission of data

TX – Transmission of data	
AT+TX=<data> [,<att_bitmap>]	<p>Transmit a message</p> <p>Parameter:</p> <ul style="list-style-type: none"> • <data> – user data to be transmitted, in a hexadecimal string <ul style="list-style-type: none"> ○ With LDK modulation (as set in the radio configuration): <ul style="list-style-type: none"> ○ Length must be 16 Bytes for data uplink request. ○ With LDA2 modulation (as set in the radio configuration): <ul style="list-style-type: none"> ○ Length must be 4, 8, 12, 16, 20 or 24 Bytes for data uplink ○ Length must be 2, 6, 10, 14, 18 or 22 Bytes for data uplink acknowledgment or data downlink message reception <p><i>If the data specified with the AT+TX command does not follow the proper data length, an error will be returned.</i></p> • <att_bitmap> – attribute bitmap as two hexadecimal digits for the communication protocol (see §4 Communication protocol) <ul style="list-style-type: none"> ○ 0x00: data uplink (default value) ○ 0x01: data downlink request ○ 0x04: data uplink acknowledgment request

+TX=<status>, <data>	<p>Answer from the module after the transmission of data</p> <p>Parameters:</p> <ul style="list-style-type: none"> • <status>: integer that specifies the status <ul style="list-style-type: none"> ○ 0: no error, status depending on communication protocol <ul style="list-style-type: none"> ▪ Data uplink: single transmission has been performed ▪ Data downlink: transmission has been performed and data downlink message has been received ▪ Data uplink acknowledgment: single transmission has been performed and acknowledgment has been received from the satellite ○ Other: see error codes in §b Error responses • <data> – user data transmitted, in a hexadecimal string
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4. User data notifications

a. Reception of a data downlink message

DL – Reception of data downlink message	
+DL=<data>	<p>Reception of a data downlink message</p> <p>Parameter:</p> <ul style="list-style-type: none"> • <data> – user data in a hexadecimal string

b. Error responses

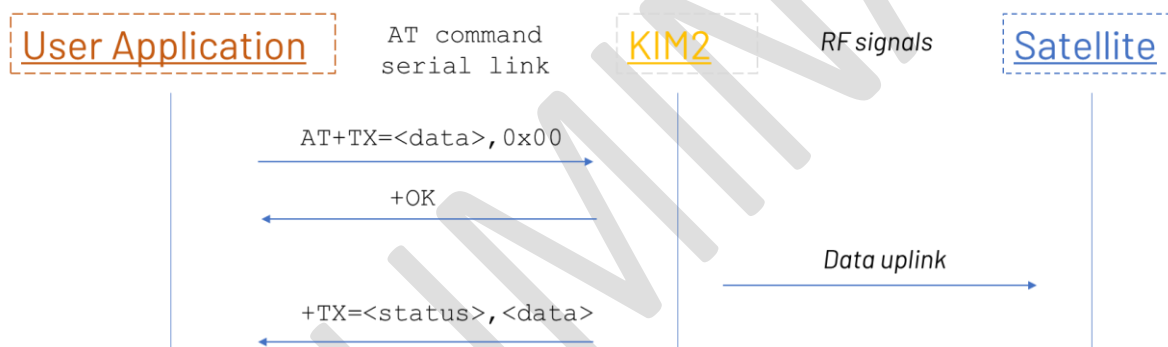
ERROR – Error response	
<pre>+ERROR= <error_code></pre>	<p>Error response from the module to an AT command</p> <p>Parameter: <code><error_code></code> – an integer that specifies the error</p> <p>KNS_STATUS_OK = 0 , <i>/**< status OK */</i></p> <p>KNS_STATUS_ERROR = 1 <i>/**< status generic ERROR, when other one does not fit */</i></p> <p>KNS_STATUS_DISABLED = 2 <i>/**< module/feature is disabled (transceiver, bus, ... */</i></p> <p>KNS_STATUS_BUSY = 3 <i>/**< module is busy (transceiver, bus, ... */</i></p> <p>KNS_STATUS_TIMEOUT = 4 <i>/**< some TX, RX, timeout reached */</i></p> <p>KNS_STATUS_BAD_LEN = 5 <i>/**< TX data frame length error */</i></p> <p>KNS_STATUS_BAD_SETTING = 6 <i>/**< wrong settings: unknown event, static cfg overflow, ... */</i></p> <p><i>In case of any other value, please reach out to Kinéis technical support or refer to KnsStack_AtCmd_API.xls excel sheet</i></p>

4. Communication protocol

Please contact kinéis to find out the best MAC profile to use according to your use case requirements. The different scenarios implemented in the KIM2 are described below.

A. Data uplink

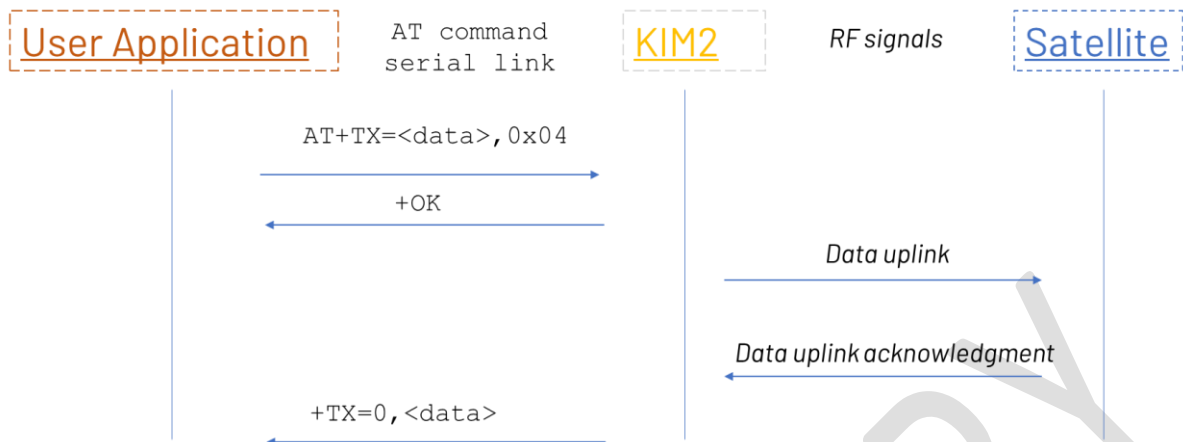
The data uplink service consists in data transmission only. In this scenario, the module is not aware whether the satellite has well received the message or not. Since the module only performs a single transmission, an adapted transmission strategy should be implemented in order to maximize the probability of reception of the message by the satellite.



- Parameter `<status>` has the value 0 if the message is well transmitted by the module (no error). Other possible values are detailed in § **b Error responses**

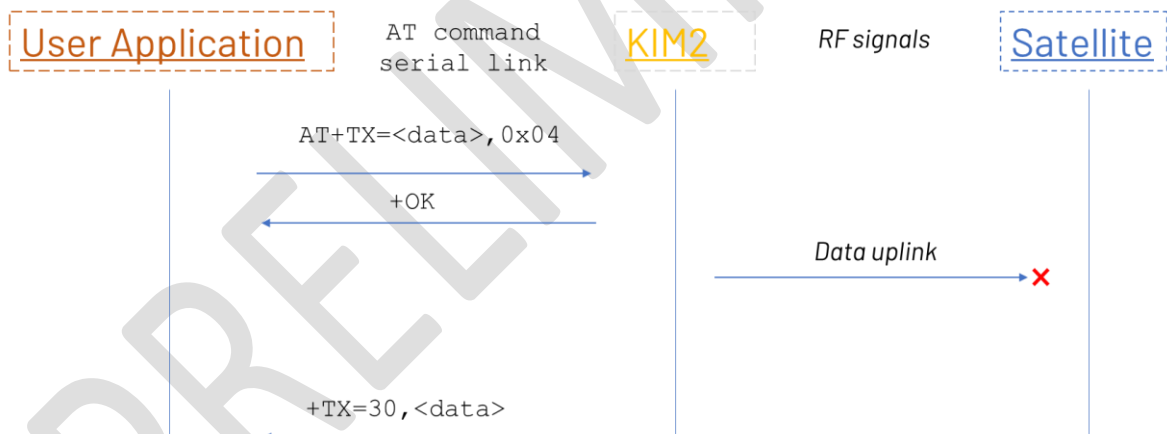
B. Data uplink acknowledgement

The data uplink acknowledgment service consists in data transmission, and reception of an acknowledgment from the satellite to confirm the correct reception of the message. After the transmission of the message with attribute value 0x04, the module switches to reception mode to receive the data uplink acknowledgement.

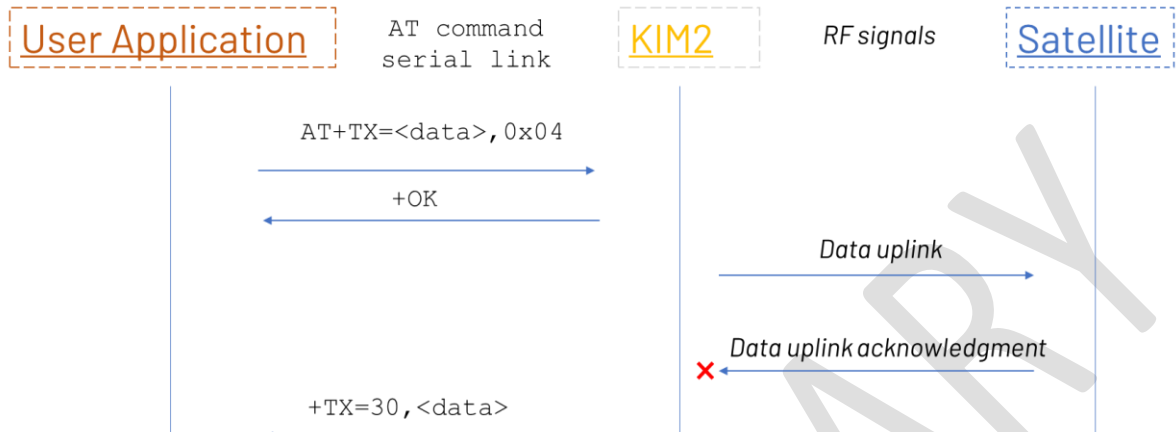


If the data uplink acknowledgement is not received by the module after the timeout period, the response from the module to the user application has the parameter `<status>` with value 30 to indicate a timeout. This situation can happen in two cases:

- When the uplink data message is not received and thus the uplink data acknowledgment not transmitted by the satellite:

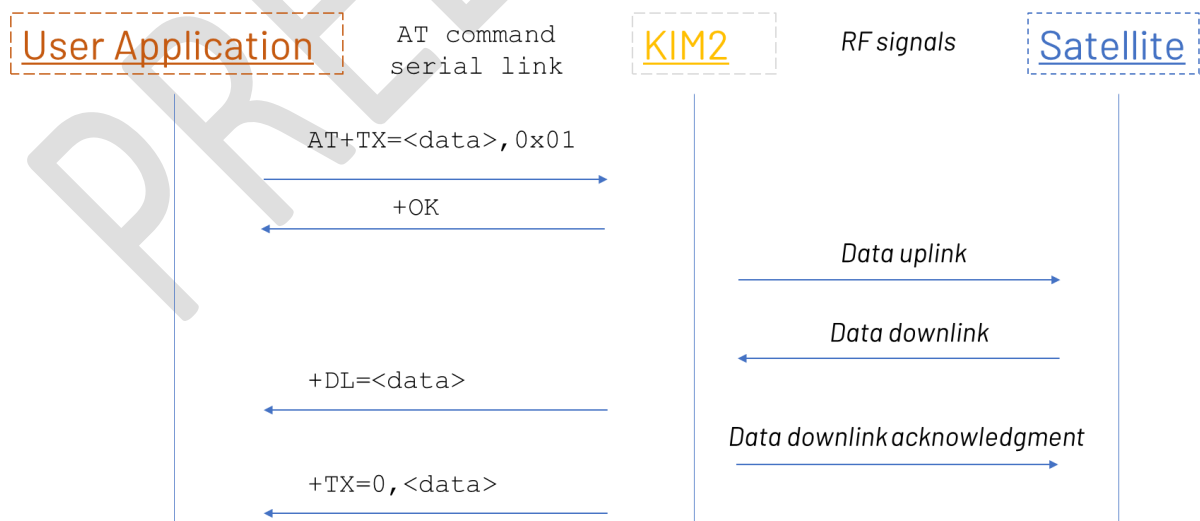


- When the uplink data message is well received by the satellite, the uplink data message acknowledgement is transmitted by the satellite but not received by the module:



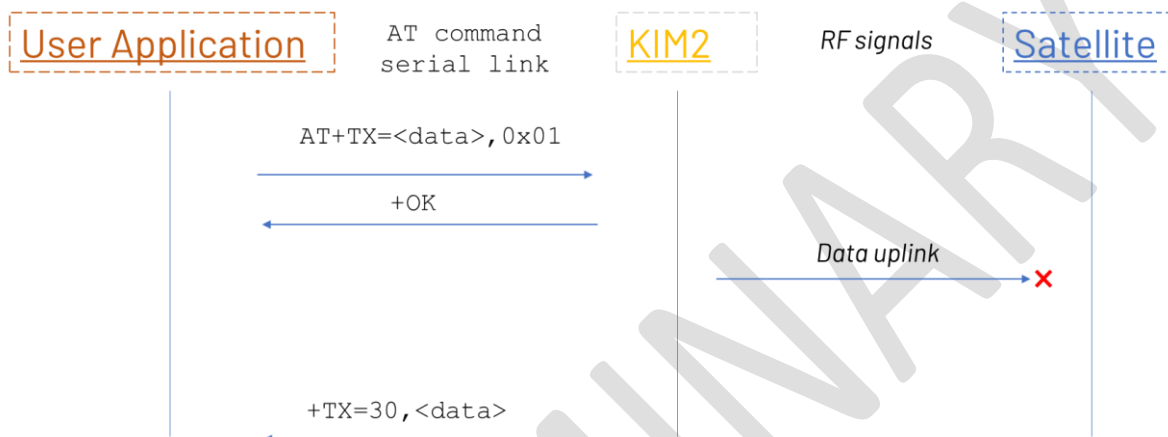
C. Data downlink

The data downlink service consists in receiving a data downlink message, previously been programmed by the end user, from the satellite. The reception of a data downlink message must be triggered by an uplink message with attribute value 0x01. After the transmission of the message, the module switches to reception mode to receive the data downlink message, then back to transmission mode to transmit the data downlink acknowledgment.

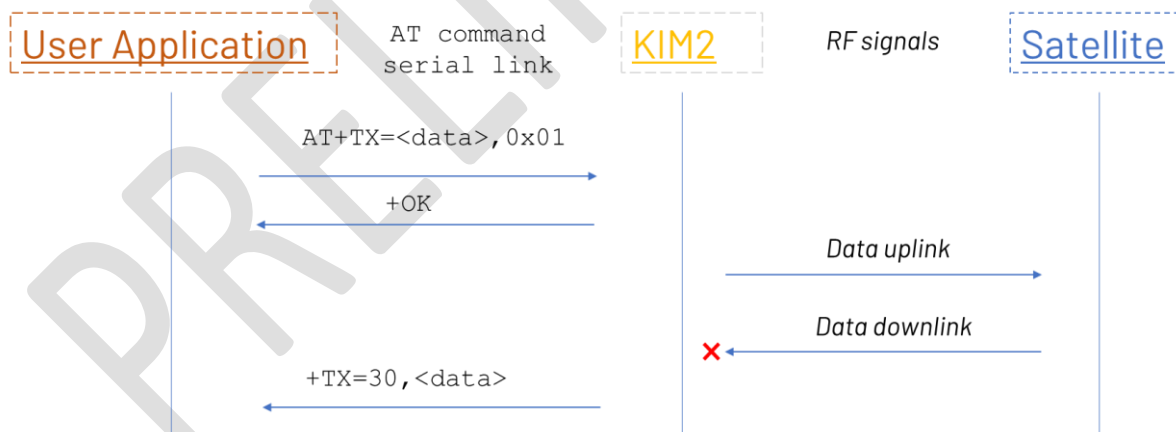


If the data downlink is not received by the module after the timeout period, the response from the module to the user application has the parameter `<status>` with value 30 to indicate a timeout. This situation can happen in two cases:

- When the uplink data message is not received and thus the downlink data message not transmitted by the satellite:



- When the uplink data message is well received by the satellite, the downlink data message is transmitted by the satellite but not received by the module:



5. Firmware upgrade

Using ST Link tool:

WARNING : Do NOT use "erase all flash" feature to keep credentials and factory settings inside the module.

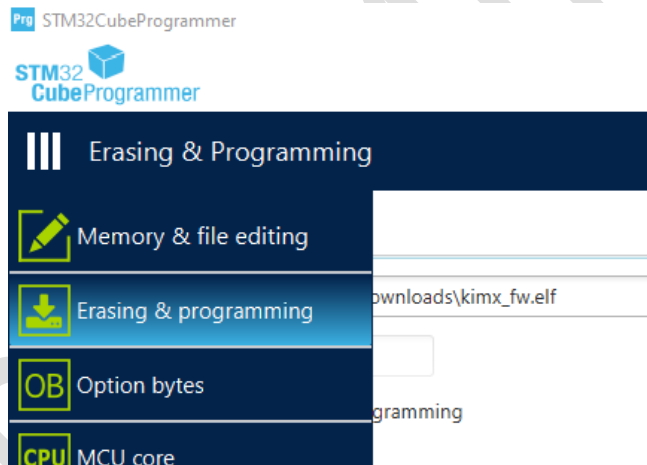
/// flashing with STLINK

1-start CUBE programmer

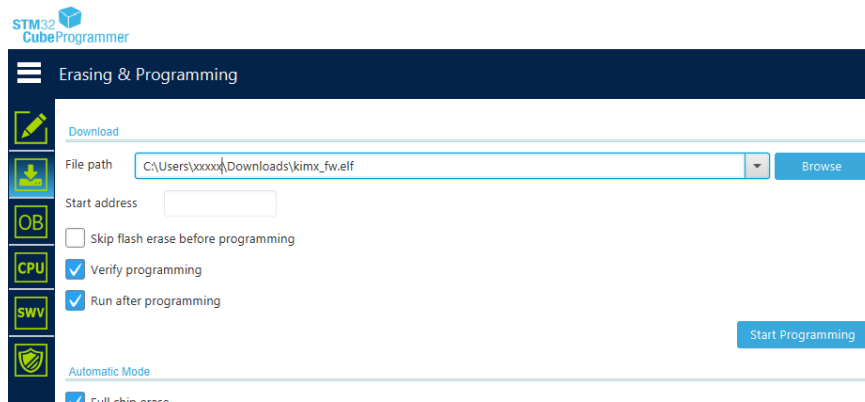
2-connect the tag connect on the board (if shield nucleo kim2)

3-click on connect on CUBE programmer

Select Erasing and Programming



4-choose the elf file (//// NOT THE BIN !!!)



5-click on "Start Programming"

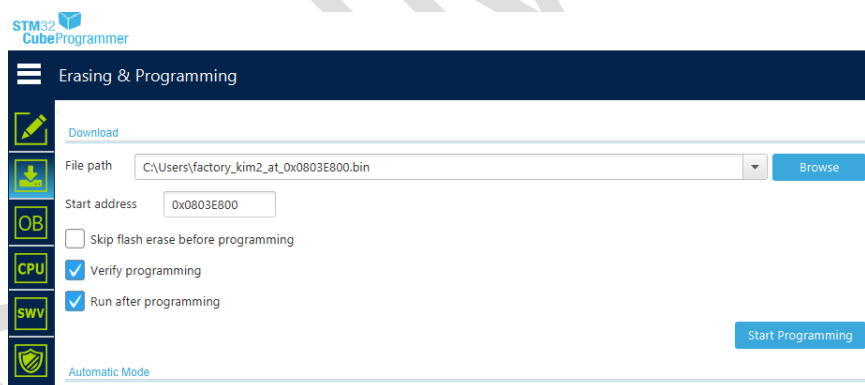
Your KIM2 has been upgraded !

Important Note in case of upgrading from old kim2 firmware versions :

If you had an old version of the kimx_fw (**FW=df88832__0x1**), you must flash a factory zone here

6- load the factory.bin (provided by kinéis) at the 0x0803E800

7-click on start Programming



Using Jlink tool:

JLinkExe ~/flash_kimx.jlink

WARNING : Do NOT use "erase all flash" feature to keep credentials and factory settings inside the module.

Flash_kimx.jlink file content:

```
device STM32G491CC
si 1
speed 4000
r
h
loadfile ~/build/kimx_fw.elf
#if you had old version of the kimx-fw ( FW=df88832__0x1xx)
#you have to flash the calibration flash block to run properly fw
loadfile ~/factory.bin 0x0803E800

exit
```

6. Additional information

A. Contact & support

Product information, technical support and commercial contact are available from Kinéis at the following link: <https://www.kineis.com/contact/>

B. Legal Notices

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C. Frequency Use



The frequency band 401-403MHz is designated by International Telecommunication Union (ITU) as usable for Global satellite data collection and positioning system as ARGOS.

The Centre National Etudes Spatiales (CNES) is in charge of Argos program. The CNES endorses Kinéis to operate the frequency band allocated to Argos.

This frequency band is usable with limitations. Please contact Kinéis to verify that your application with KIM2 respect those limitations.

The application targeted by KIM2 integrators must be analyzed by kineis. After this analysis, Kineis will generate the Radio Configuration the integrator will have to push into the module before any TX operations on the kineis network.

The frequency band 401-403MHz is designated by International Telecommunication Union (ITU) as usable for Earth Exploration-Satellite Service, including the Global satellite data collection and positioning system, which is ARGOS, now operates by Kinéis company.

The French space agency CNES (Centre National d'Etudes Spatiales) manages the Argos program and endorses Kinéis though many operating parts.

The EESS frequency band being usable with limitations, please contact Kinéis to verify that your application with KIM1 is in respect of those limitations.

As soon as the new satellite constellation will be in orbit, Kinéis will use in addition the frequency band 399.9-400.05MHz, designated as the MSS band (Mobile-Satellite Service).

The Federal Communications Commission (FCC) of USA has authorized Kinéis to use both frequency bands, MSS and EESS through a license registered under the reference SES-LIC-20220314-00271.

2. Kineis Radio configuration

For operational deployment, kineis provides a Radio Configuration mechanism to set inside the KIM2.

Kineis radio configuration is a data structure containing:

- Modulation type (LDA2, LDK, VLDA4)
- RF level
- Frequency range in ESS or MSS bands

This is the result of kineis analysis according to a customer application declaration. This radio configuration is a direct input of the kineis stack to compute the TX frequency and the modulation to use for transmission.

The application declaration will be submitted to kineis to be analysed. Kinéis will then check the main deployment parameters to organize efficiently the deployment of the new devices without impacting capacity of the system: number of devices, services to support, geographical zone for future deployment.

WARNING: KIM2 could have no Radio Configuration inside. This configuration has to be requested to kinéis following the RD4 document.

Without RCONF, it is impossible to transmit with KIM2 module.

PRELIMINARY