KIM1

Integration manual

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TABLE OF CONTENTS

1. Introduction

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

The KIM1 module developed by Kinéis is a low-power transmitter module based on Argos-2 standard and fully certified by Kinéis and CNES (French Space Agency).

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

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 device in large volumes.

This document is an integration manual for the KIM1 transmitter module by Kinéis, complementing the component datasheet (see §**1.3 Related documents** for reference).

This manual will bring you information regarding:

- Typical integration circuit
- UART interface
- Transmission protocol, including message formatting and transmission strategies

***Warning**: Please refer to* **§1.1 Versioning** *below to make sure you are reading the documentation suited to your module version.*

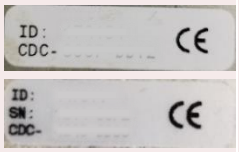
For further assistance, feel free to contact Kinéis at the following link: https://www.kineis.com/contact/

1.1. Versioning

Please refer to the table below to identify the version of the documentation (Datasheet and Integration Manual) related to your module series, considering the following information:

- The hardware (HW) version, determined by the Serial Number
- The firmware (FW) or software (SW) version, determined with the AT command AT+FW=?

***Warning**: most of the time, the Serial Number can be an indication for the FW version looking at the correspondence table below. However, the FW version must be finally determined with the AT command AT+FW=? since the KIM1 may have been reprogrammed with a newer FW version after manufacturing.*

Label	Serial number	Manufacturing FW version	Datasheet reference and version	Integration Manual reference and version
	**0719**-xxxx **1219**-xxxx **0120**-xxxx **0220**-xxxx	KIM_HW1.1_ • SW0.2 • SW1.0 KIM_HW1.3_ • SW1.0 • SW1.1 • SW1.2	*KINEIS-SP-20-0147 KIM1 Datasheet v1.0.pdf*	*KINEIS-NT-19-0018 KIM1 Integration Manual v2.0.pdf*
	**KIM132008**xxxxx	KIM_HW1.3_SW1.3	*KINEIS-SP-20-0147 KIM1 Datasheet v1.2.pdf*	*KINEIS-NT-19-0018 KIM1 Integration Manual v2.0.pdf*
	**KIM132103**xxxxx	KIM1_V1.4	*KINEIS-SP-20-0147 KIM1 Datasheet v1.2.pdf*	*KINEIS-NT-19-0018 KIM1 Integration Manual v2.1.pdf*
	**KIM132109**xxxxx	KIM1_V2.0	*KINEIS-SP-20-0147 KIM1 Datasheet v2.0.pdf*	*KINEIS-NT-19-0018 KIM1 Integration Manual v2.2.pdf*
	**KIM132111**xxxxx **KIM132112**xxxxx **KIM132201**xxxxx	KIM1_V2.1		*KINEIS-NT-19-0018 KIM1 Integration Manual v2.3.pdf*

All further modules will be produced and distributed with the latest hardware and software versions. In case of any doubt regarding your module version and corresponding documentation, do not hesitate to contact us.

1.2. Revision history

Issue	Date	Ref	Modifications
1.0 to 1.6	Apr 23, 2019 to Jul 26, 2019	JI, AJ, SV	Document creation and updates
2.0	Jun 12, 2020	CT	Suppression of the following paragraphs (transferred into KIM1 Datasheet): 1. Product description 2. Device information 3. Electrical characteristics Update of the following paragraphs: 2. Typical application circuit 3. UART communication 4. Transmission protocol
2.1	Feb 8, 2022	CT, VG	• Modification of **§2 Typical application circuit** • Addition of **Boosted 3.3V integration** paragraph • Note about Frequency Use (**§5.3**) [Update corresponding to FW version 1.4] • Modification of KIM1 responses syntax (**§3.1**)

All further modules will be produced and distributed with the latest HW and SW version. In case of any doubt regarding your module version and corresponding documentation, do not hesitate to contact us.

1.3. Related documents

- KINEIS-SP-20-0147 KIM1 Datasheet
- KINEIS-MU-2019-0094 Satellite pass predictions – User guide

2. Typical application circuit

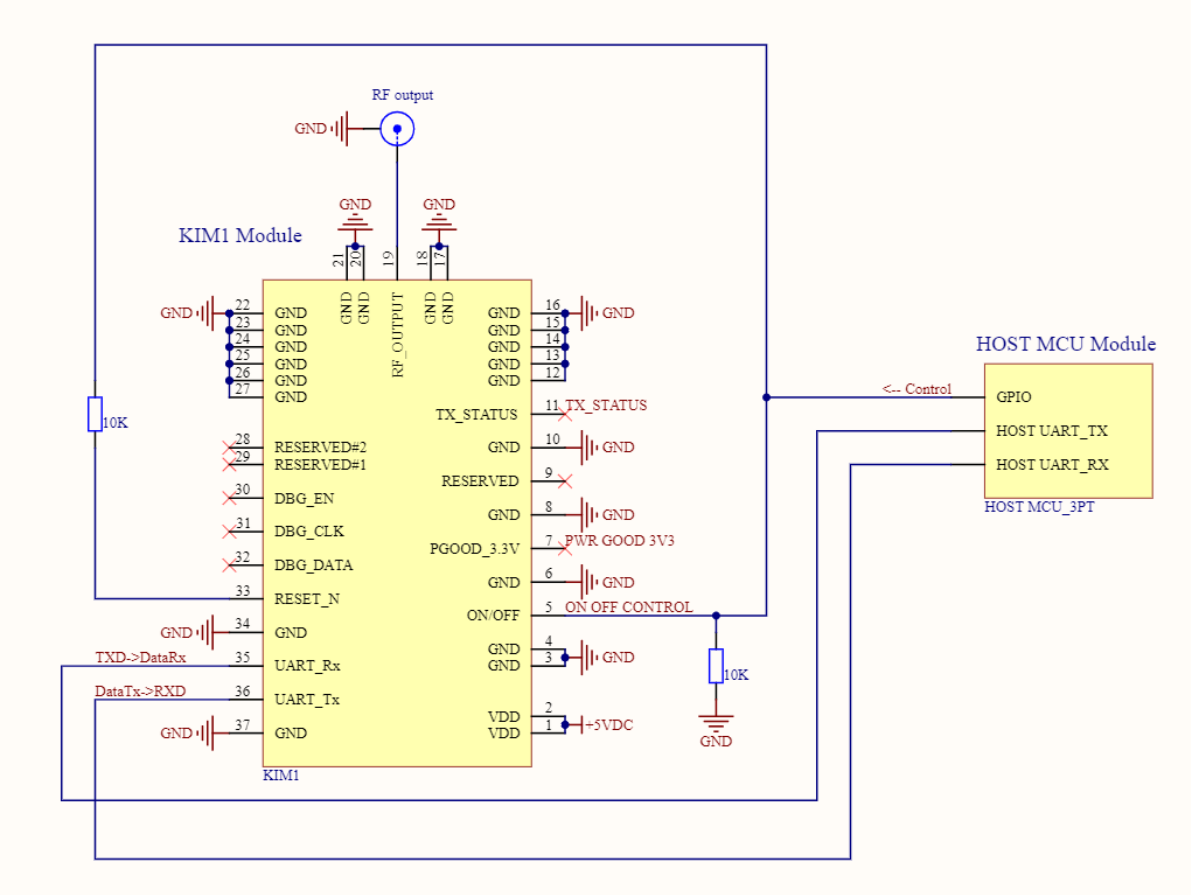


Figure 1: Example of Typical integration of MCU with the KIM1

KIM1 must be powered with 5V typical DC supply voltage between VDD pins and GND pins, and all GND pins connected to the ground plane.

The microcontroller unit (MCU) can control the KIM1 through UART communication and GPIOs:

- UART interface needs two pins for the two-way communication: UART_Tx and UART_Rx
- ON/OFF pin **must be actively terminated** and can be controlled to put the module in OFF mode between two transmissions and have the lowest consumption possible
- RESET_N pin **must be connected to the ON/OFF pin through a 10k resistor**

TX_STATUS pin can be connected to a LED (high when a transmission is occurring)

PWR_GOOD pin can be connected to a LED (high when the module is correctly supplied)

An antenna matched at 50Ω for the transmission frequency must be connected at RF output.

Boosted 3.3V integration

The supply voltage tends to be standardized around 3.3V for IoT devices, in order to take advantage of some battery technologies that can range from 3V to 4.2V in supply voltage. To integrate the KIM1 in a design with such a power supply level, Kinéis recommends adding a boost converter to raise the voltage to 5V to provide an adapted power supply to the KIM1.

Possible references for the boost converter are (see component datasheets for more details):

- TPS61236P 8-A Valley Current Synchronous Boost Converter with Constant Current Output Feature from Texas Instrument
- TPS81256 3-W, High Efficiency Step-Up Converter In MicroSiP™ Packaging from Texas Instrument (requiring a limited number of extra components)

3. UART Communication

The KIM1 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	4800
Data bits	8 bits
Parity	None
Stop Bits	1 bit
Flow Control	No

Table 1 : UART Setting

***Warning**: in order to avoid the occurrence of a latch-up effect on the UART serial interface, Kinéis recommends to implement initialization and deinitialization of the UART link respectively before KIM1 power On and after KIM1 power Off in the software controlling the KIM1.*

3.1. AT commands syntax

There are three types of extended AT commands:

- Information type read-only commands: allows to read l the module information.
- Parameter type commands:
  - "Set" to store a value or values for later use
  - "Read" the current value or values stored
- Action type commands: invokes a function of the equipment, which generally involves more than the simple storage of a value for later use. (e.g : Transmission command)

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

- `OK`, means the command is accepted and executed
- `ERROR=<errorno>[,<parameter_index>]` means an error occurred during the execution of the command
  - Possible values for `<errorno> and <parameter_index>` parameters are detailed in **§3.4 Error responses**

The AT command must be a sentence terminated by <CR>, while the response will be a sentence terminated by <CR><LF>.

3.2. 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.

3.3. AT commands description

1. Information type commands

a. ID number

`ID` – **Read Kinéis ID number**	
`AT+ID=?`	Read the Kinéis hexadecimal ID number of the module Answer: `+ID:<id_length>,<id_number>` Parameters: • `<id_length>` – hexadecimal ID number length in bits (value is 28) • `<id_number>` – Kinéis ID number in hexadecimal format (7 digits)

b. Firmware version

`FW` – **Read Firmware version**	
`AT+FW=?`	Read the firmware version from KIM1 module Answer: `+FW:<fw_version>` Parameter: • `<fw_version>` – Firmware version flashed into the module o Format: **`KIM1_Vx.x`** (in this case **`KIM1_V1.4`**)

c. Serial number

`SN` – **Read Serial Number**	
`AT+SN=?`	Read the serial number from KIM1 module Answer: `+SN:<sn>` Parameter: • `<sn>` – KIM1 serial number (14 digits)

2. Parameter type commands

***Warning**: all parameter values configured with the following AT commands are stored and maintained in the KIM1 flash memory, and thus restored after KIM1 power Off and On again. Since the flash memory has a limited number of writing cycles, it is recommended to set the value for each parameter only once.*

a. Frequency band

`BAND` – **Frequency band for transmission**	
`AT+BAND=<band>`	Set the frequency band for transmission Parameter: `<band>` – transmission frequency band, among the following values: • `B1` – [401.620-401.680] (default) • `B2` – [401.540-401.600] • `B3` – [401.470-401.530] • `B4` – [401.390-401.460] • `B5` – [401.320-401.390] • `B6` – [401.120-401.180] • `B7` – [401.020-401.080] • `B8` – [399.980-400.040] • `B9` – [399.910-399.970] Warning: as of February 2022, Kinéis satellites only receive signals on frequency band B1 (default value).
`AT+BAND=?`	Read the frequency band for transmission Answer: `+BAND:<band>` Parameter: • `<band>` – as described above

b. Frequency offset

`FRQ` – **Frequency offset within the band**	
`AT+FRQ=<freq>`	Set the frequency offset within the band for transmission. Parameter: `<freq>` – an integer which specifies the frequency offset within the band, in step of 100 Hz: • between 0 and 800 for bands B4 and B5 • between 0 and 600 for other bands Example for band B1: • 0 for 401.620MHz • 300 for 401.650MHz (default) • 600 for 401.680MHz
`AT+FRQ=?`	Read the frequency offset used by module Answer: `+FRQ:<freq>` Parameter: • `<freq>` – as described above

c. Transmission power

`PWR` – **Transmission power**	

`AT+PWR=<pwr>`	Set the transmission power in mW of the module.
	
	Parameter:
	• `<pwr>` – an integer that specifies the transmission power in mW, among the following values:
	  ○ 100
	  ○ 250
	  ○ 500
	  ○ 750
	  ○ 1000 (default)
	
	Note: transmission power is guaranteed and calibrated at manufacturing for 1W configuration. Calibrations for other transmission powers are not guaranteed.

`AT+PWR=?`	Read the transmission power in mW used by module Answer: `+PWR:<pwr>` Parameter: • `<pwr>` – as described above

3. Action type commands

a. Message transmission

`TX` – **Transmit one message**	

`AT+TX=<data>`	Transmit one message
	
	Parameter:
	• `<data>` – user data in a hexadecimal string
	  ○ Maximum length is 248 bits
	  ○ If the data length does not correspond to a value listed in **§4.1.2 Data field,** the module performs zero-padding to complete the incomplete 32-bit block
	
	Answer: `+TX_INFO:1,0` after the message transmission

***Warning**: the transmission period between two transmissions should never be below **60 seconds**.*

3.4. Error responses

ERROR – **Error response**	

ERROR =<error_id>[,
<parameter_index>]
	Error response to an AT command from the KIM1 module.
	
	Parameters:
	• <error_id> – an integer that specifies the error type
	  ○ 3 – Missing parameters
	  ○ 5 – Invalid user data length
	  ○ 7 – Incompatible value for parameter
	  ○ 8 – Unknown AT command
	  ○ In case of any other value, please reach out to Kinéis technical support
	• <parameter_index> – can appear to explicitly inform which parameter has generated the error

4. Transmission protocol

4.1. Message format

The messages transmitted by the KIM1 follow the low-data rate Argos-2 message format shown below:

Low-data rate Argos-2 message format

The KIM1 module performs the message formatting in a transparent way for the integrator:

- Pure Carrier
- Sync Pattern
- Message Length (computed from the specified Data field)
- ID number (hard coded in the KIM1 memory and unmodifiable by the integrator)
- Data (specified with AT+TX command)

***Warning**: for KIM1, the ID number is coded over 28 bits. The first 8 bits of the Data field are thus reserved for the end of the ID number, leaving only 24 bits for the first 32-bit block.*

1. ID number

Each KIM1 module has a unique ID number, expressed in two different formats:

- Hexadecimal format, for integration in the transmitted message (28 bits or 7 hexadecimal digits), programmed into the module and unmodifiable by the integrator
- Decimal format, for online access to the transmitted data, written on the KIM1 marking (see KIM1 Datasheet)

***Warning**: there is no possible conversion between these two formats, only an allocation table. To find out the ID number in one format from the other, please reach out to Kinéis technical support.*

2. Data field

This is the only field that can be specified explicitly by the integrator, with the AT+TX command.
The Data field must be written in hexadecimal format and follow one of the following length values (N being the number of 32-bit blocks, as shown in the message format figure above):

N	Data length (Bytes)	Data length (bits)	Data duration (ms)	Message duration (ms)
1	3	24	60	360
2	7	56	140	440
3	11	88	220	520
4	15	120	300	600
5	19	152	380	680
6	23	184	460	760
7	27	216	540	840
8	31	248	620	920

If the data specified with the AT+TX command does not follow one of these length values, it will be completed with bits at value 0 by the KIM1 until it reaches the next possible length value.
If the data length is greater than 31 Bytes, it will be truncated to 31 Bytes and transmitted by the KIM1.

4.2. Transmission strategy

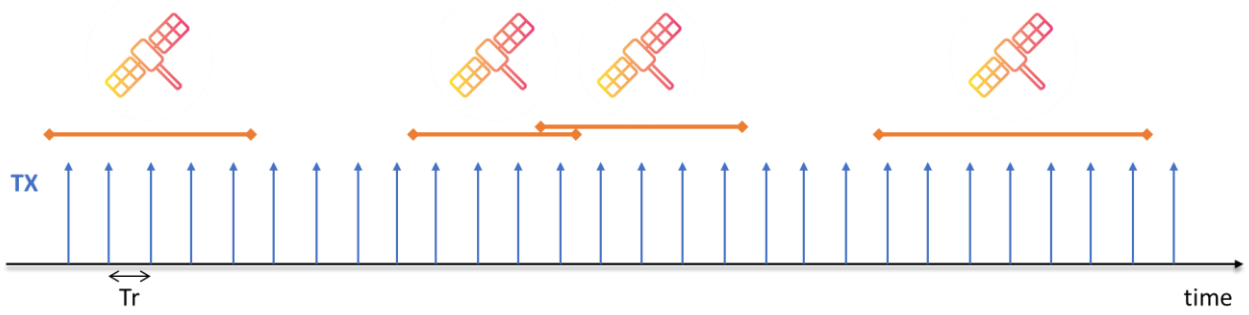
Kinéis system offers the possibility to collect short messages of up to 31 Bytes of useful data in a regular basis. With 8 satellites available today and more to come, Kinéis system provides many timeslots per day in which data can be transmitted to the satellites, enabling to collect up to 2kB of useful data per day.

Depending on the latitude of the terminal, the satellite passes occur more or less often and the revisit time varies. Transmitting data between the satellite passes means that they will not be received by any satellite, and it can be very costly for the terminal in power consumption.

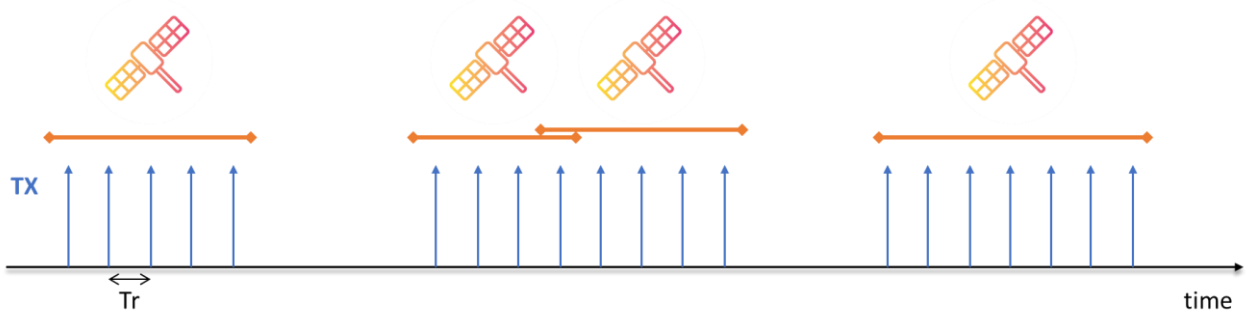
Kinéis can offer transmission strategy recommendations to define the best transmission strategy to optimize power consumption and maximize the probability of good reception of your data by the system.

2 types of transmission strategies are possible with the KIM1:

- Random periodic transmission: the device does not know anything about satellites passes, it can only transmit randomly. Depending on satellite availability, it will transmit more messages than necessary.



- Transmission on satellite passes, thanks a satellite pass prediction algorithm developed for embedded targets and provided by Kinéis, thus saving on battery power and increasing the probability of good reception by the satellites.



Tr *is the repetition period of a message transmission by the KIM1 and* ***must not be set below 60 seconds***.

5. Additional information

5.1. Contact & support

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

5.2. Legal Notices

Kinéis reserves the right to make changes, corrections, enhancements, modifications, and improvements to their products and/or to this document at any time without notice. Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

Kinéis products are warranted as per contract and general purchase condition, as long as they are used under the conditions described in the datasheet and the integration manual.

5.3. 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 your application with Kim1 respect those limitations.