

KIM2

Installation manual



Reference:

KINEIS-MI-24-0069

Issue:

1.2

Date:

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A. Revision history

Issue	Date	Modifications
1.0	March 5 th , 2024	Document creation
1.1	March 14 th , 2024	Add new required statements
1.2	May 06 th , 2024	Clarification about FCC rules

B. Related documents

RDx	Reference	Title
RD1	KINEIS-NT-22-0600-KIM2 Datasheet v0.4	Datasheet
RD2	KINEIS-MI-22-0601 - KIM2 Integration manual v0.3	Integration manual
RD3	KDB 447498 D01 General RF Exposure Guidance v06	General RF Exposure Guidance
RD4	CFR-2009-title47-vol1-part15	FCC part 15

C. Glossary/Acronyms

Acronym	Signification
CNES	Centre National d'Etudes Spatiales
EESS	Earth Exploration-Satellite Service
EIRP	Equivalent Isotropic Radiated Power
EUT	Equipment Under Test
FCC	Federal Communication Commission
FIFO	Firs In, First Out
ID	Identifier Device
ITU	International Telecommunications Union
MPE	Maximum Permissive Exposure
MSS	Mobile Satellite Service
OEM	Original Equipment Manufacturers
PAG	Pre-Approval Guidance
PCB	Printed Circuit Board
RF	Radio Frequency
SAR	Specific Absorption Rate

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. Product Description

For further details, please consult the datasheet [RD1], the most complete document about this module description.

1. Functional description

KIM2 is a Kinéis compliant transceiver: it enables sending messages of 19 Bytes of user data to Kinéis satellites and receiving messages of 16 Bytes from Kinéis satellites. The module is controlled by AT commands indicating the uplink message payload and requested service, then performs the RF signal modulation processing to transmit the data to the satellite. When asked for a downlink message, it performs the demodulation and informs the host microcontroller with AT commands.

Kim2 module main functions:

- Uplink messages formatting and RF Signal generation
- Downlink message reception (data downlink and uplink acknowledgment)
- Kinéis bidirectional protocol management
- Message queue management (*future releases*)
- Transmission profiles management (*future releases*)
- Energy-saving deep sleep mode (*future releases*)

The KIM2 block diagram shown below depicts the sections of the module:

- MCU (Microcontroller Unit) embedding the firmware, with UART and GPIO interface
- Integrated transceiver (I/Q processor and RF modulator) and internal clock system (TCXO)
- RF Front-End including TX power amplifiers and harmonic filter, TX/RX switch, LNA (Low-Noise Amplifier) for the reception and RX SAW filter
- Power section with DC supply

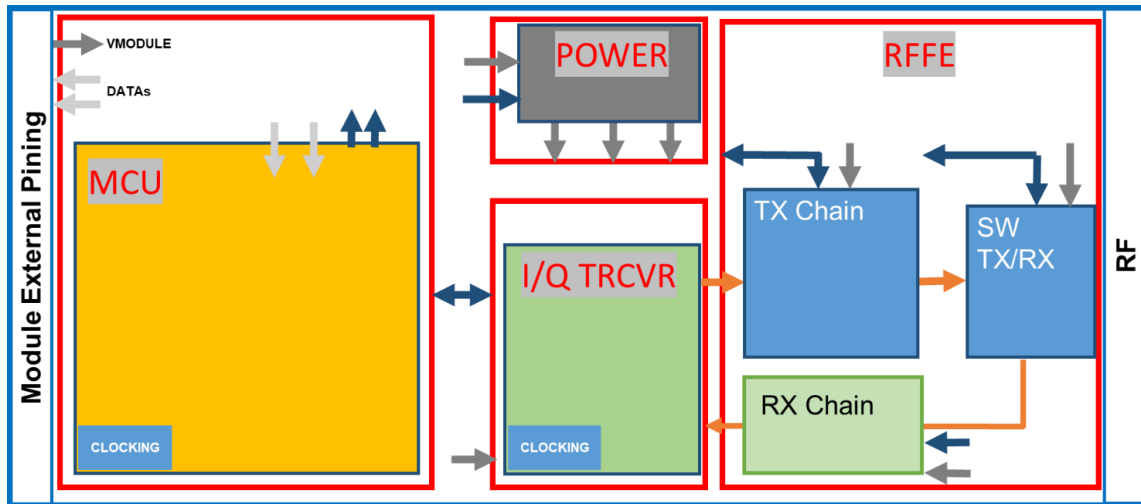


Figure 1: KIM2 functional diagram

2. Main characteristics

Specification	Description
RF Tx standard Power	27dBm (500mW)
TX Frequency Range	399.9 - 403 MHz
RX Frequency Range	400.6 - 400.7 MHz (Kinéis satellite Downlink frequencies)
TX Modulations	Kinéis low-data rate (LD-K) modulation (± 1.1 rad BPSK) Argos low-data rate (LD-A2) modulation (± 1.1 rad BPSK) Argos low-data rate (VLD-A4) modulation (± 1.1 rad BPSK)
RX Modulation	Kinéis downlink (DLK) modulation (± 1.1 rad BPSK)
TX data rates	200 bits/s with VLD-A4 modulation 300 bits/s with LD-K modulation 400 bits/s with LD-A2 modulation
RX data rate	320 bits/s with DLK modulation
Power Supply	3.6VDC typical
Communication Interface	3.3V UART
DC, Digital & RF Connections	Board edge connection
Package	48-pin surface-mount module
Operating temperature	-40°C to +85°C
Storage temperature	-40°C to +90°C
Size	36.6 x 25.4 x 5 mm ³

3. Pad assignments

The KIM2 is an SMT module with 48 pins dedicated to RF signal transmission and reception, power supply, interface, and control. Ground connections are dispatched along the module to ensure good electrical grounding and mechanical hold. RF pins are 50ohm output

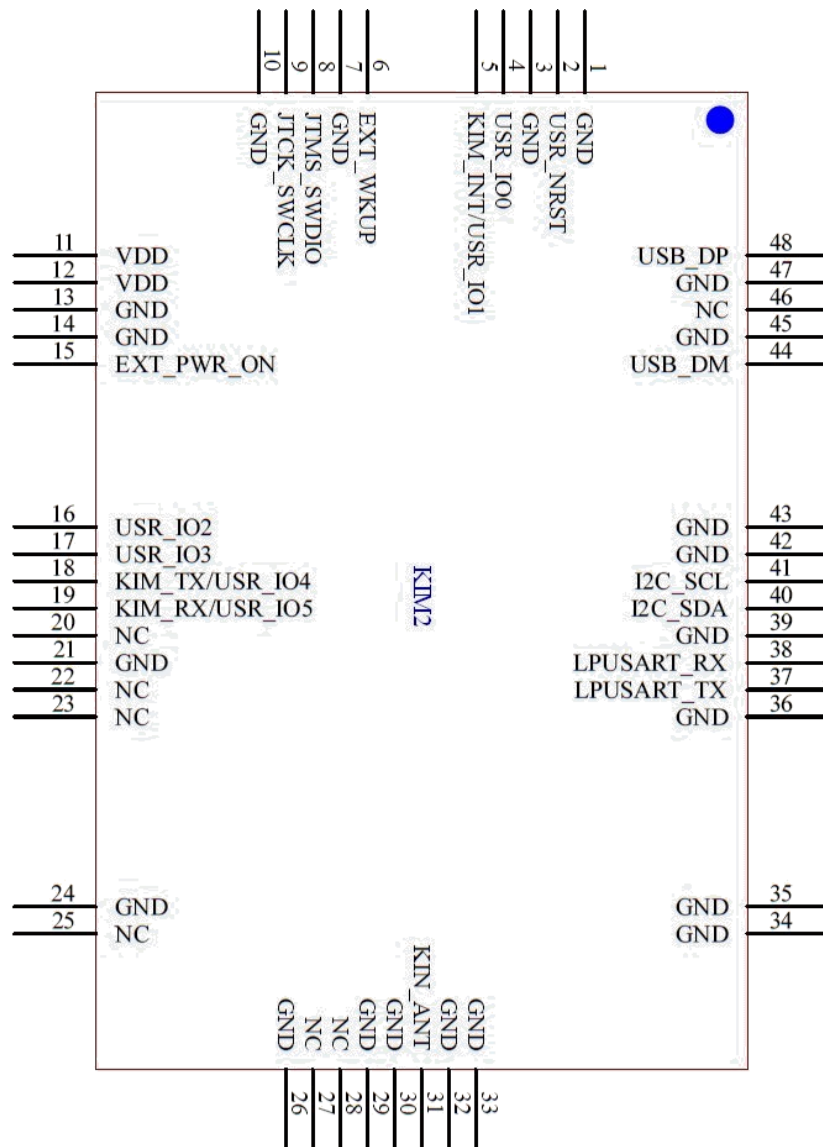


Figure 2: KIM2 pad assignments

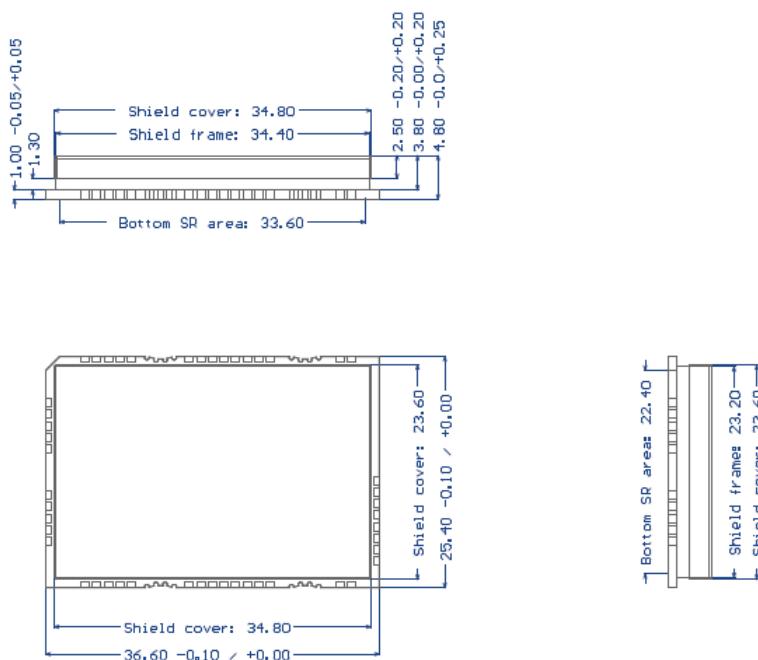
4. Mechanical specifications

The KIM2 is a SMT module with size 36.6 x 25.4 x 5mm and a maximum weight of 6 grammes.

The module is made of FR4 standard PCB with pin indentation on 4 sides, allowing soldering onto a host printed circuit board (PCB) using standard reflow process.

The indentations are metalized to ensure good soldering, and the pitches of the pins are standard to allow placement for low-cost manufacturing process on the host application board.

a. Module size



Dimensions are in mm

Tolerance: ± 0.05 mm unless specified

Shield part tolerance: ± 0.20 mm

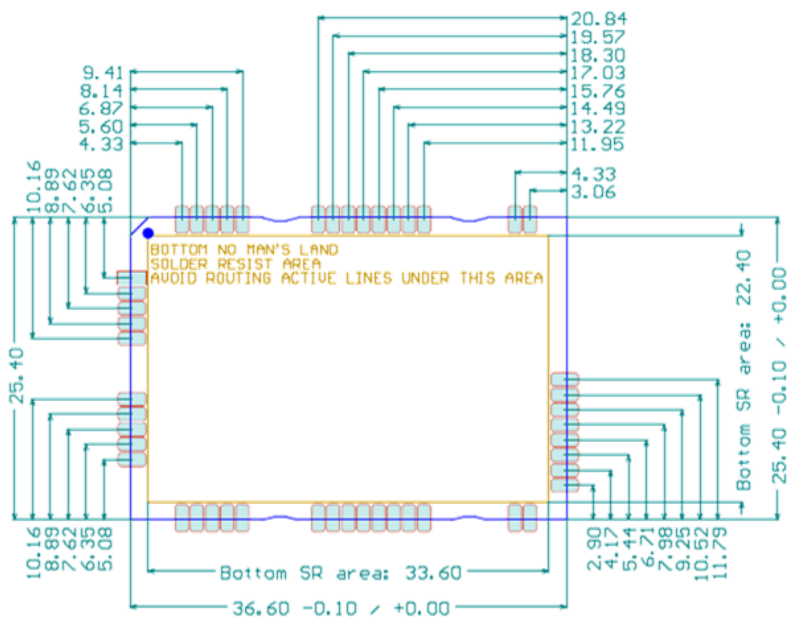
Respect distance of 1.2mm around module without any component

Figure 3: KIM2 mechanical dimensions

b. PCB Footprint

48 SMD pads 2.2 x 1mm distributed on the 4 sides around module

Positioning of SMD pads are symmetrical on top and bottom side of module

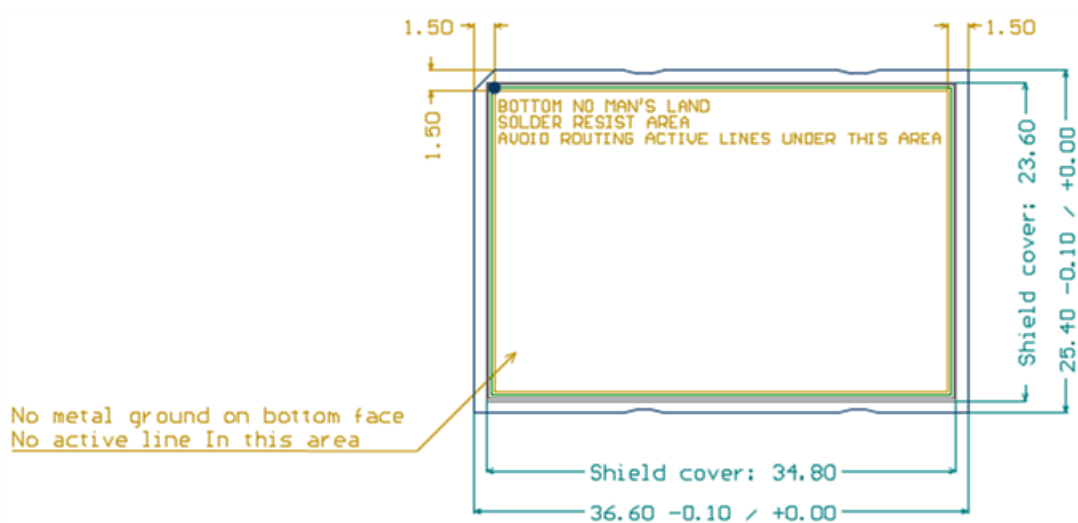


Dimensions are in mm

Tolerance: +/- 0.05mm unless specified

Figure 4: PCB footprint & pitch

Important: The KIM2 module has a solder mask on its bottom side. This solder mask covers the metal tracks and vias. To avoid short-circuit, host board area under the module should be left open without metal ground and/or active lines.



c. Pad details

Pad details

Pin 1: Rectangle pad

Other pins: Rounded rectangle pad

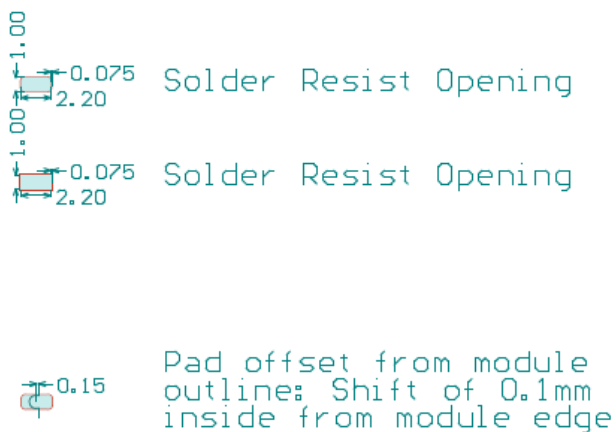


Figure 5: Pad details

Note: Altium library symbol and footprint are available on demand

B. Programing / Control

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) between two transmissions
- USR_Nrst input pin can be used to reset the module

The following pins will be available in future firmware releases:

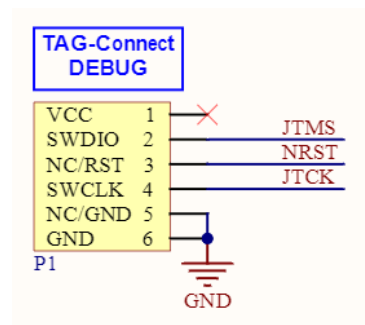
- EXT_WKUP input pin allows the Host MCU to wake up the module (active state = high)
- KIM_INT output pin is used by the module to wake up the host microcontroller (active state = high)

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

Since the KIM2 is at an engineering sample stage, it is recommended to include the footprint for the programming connector to the host PCB in order 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>



The module KIM2 is controlled by the host through AT commands sent to the UART. Please consult the RD2 for a complete description of AT commands.

2. International type approval

A. Frequency band use

Kinéis has demonstrated the compliance of its module against international standards such as from the ITU, the FCC and the CE.

A specificity of the Kinéis system is the connected devices must transmit from the ground to the satellites using two frequency bands requiring a license:

- MSS frequency band: 399.9-400.05MHz
- EESS frequency band: 401-403MHz

The mobile satellite service (MSS) frequency band is internationally recognized for kind of applications like Kinéis, hence main responsible organizations have described applicable rules through available standards.

The Earth Exploration-Satellite Service (EESS) frequency band is rather reserved to meteorological-satellite service, but Kinéis is taking over and improving the Argos data collection system which has provided service in the 401-403 MHz band to Federal users for decades.

Hence, Kinéis endorsed by the French Spatial Agency, Centre National Etudes Spatiales (CNES) overseeing the Argos program is also recognized by the International Telecommunication Union (ITU) and the FCC as using this frequency band. Nevertheless, it is usable with limitations. Please contact Kinéis to verify that your application complies with.

A. FCC

1. FCC rules

Kinéis has been granted by the FCC through FCC21-118 (2021, Nov 19th) to use two frequency bands:

- the non-voice, non-geostationary (NVNG) mobile satellite service (MSS) between 399.9-400.05MHz
- the 401-403MHz typically allocated to Earth Exploration-Satellite Service (EESS).

The first band of 399.9-400.05 MHz is consistent to the US table of frequency allocations.

For the second one, Kinéis has obtained a waiver from the FCC to use this frequency band of 401-403 MHz. This waiver is valid as long as, Kinéis devices respect:

- the long-term interference criteria, specified in Table 2 (Type C) of Recommendation ITU-R RS.1263-2 in order to protect the NOAA.
- Using the EEES band: operate at or below the e.i.r.p. limit specified in ITU Radio Regulation No. 5.264A, as modified by WRC-19, subject to any limit that may be adopted in future Commission rulemaking.
- Using the MSS band: comply with ITU Radio Regulation No.5.260A, as modified by WRC-19, regarding the maximum e.i.r.p. limits, subject to any limit that may be adopted in future Commission rulemakings

The FCC standards describe the limits applicable to the devices transmitting in the MSS frequency (a part of the Kinéis devices). In absence of standard from the FCC covering the transmissions in the EEES frequency band (other part of the devices Kinéis), Kinéis has obtained the agreement to test a transmitter in EEES band as a transmitter in MSS band so applying the same methods and limits.

In complement, Kinéis has obtained from the FCC a blanket license covering the typical devices connected to its network, using both frequency bands. This document is referenced SES-LIC-20220314-00271 and specifies mainly the maximum EIRP applied to Kinéis devices.

Consequently, these limits are applicable to the Kinéis modules and by extension to all devices integrating a Kinéis module.

In addition, here is listed the scope also applicable to Kinéis modules and products integrating those modules:

- The EIRP following:
 - FCC 47 CFR Part 25, 25.204
 - FCC 47 CFR Part 2, 2.1046
- The spurious emissions:
 - FCC 47 CFR Part 25, 25.202(f)
 - FCC 47 CFR Part 2, 2.1053
- Occupied bandwidth:
 - FCC 47 CFR Part 2, 2.1049
- Spurious emissions at antenna terminal:
 - FCC 47 CFR Part 2, 2.1051
- Frequency tolerance:
 - FCC 47 CFR Part 2, 2.1055

2. FCC approval

A transmitter already certified can be installed in different end-use products without further request to the FCC, saving time and costs for equipment authorization. However, the integrators of a certified module shall respect all the conditions listed by the grantee.

Kinéis, as the grantee of the FCC approval for this module, has listed hereafter all the points to respect by the host product manufacturer.

Then, integrators can benefit of the FCC ID granted by the FCC to Kinéis.

a. Statements

According to the definition of mobile and fixed device is described in Part 2.1091(b), this device is a mobile device. And the following conditions must be met:

1. This modular approval is limited to OEM installation for mobile and fixed applications only. The antenna installation and operating configurations of this transmitter, including any applicable source-based timeaveraging duty factor, antenna gain and cable loss must satisfy MPE categorical exclusion requirements of 2.1091.
2. The module integrators shall use an antenna never exceeding a maximum gain of 2dBi, otherwise it would void the benefice of the FCC ID and require a new/complete application to the FCC.
3. The EUT is a mobile device; maintain at least a 20cm separation between the EUT and the user's body and must not transmit simultaneously with any other antenna or transmitter.
4. The host end product must include a user manual that clearly defines operating requirements and conditions that must be observed to ensure compliance with current FCC RF exposure guidelines.
5. The Kinéis module as a transmitter, is only FCC authorized for the specific rules listed on the grant (see also the corresponding paragraph in this document). The host manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification.
6. The user's manual shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.
7. The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as show in this manual.

b. Limited module procedure

The FCC lists the conditions applicable to a single modular transmitter in §15.212(a)(1).

The Kinéis module KIM2 does not comply with all these points as the module does not have a permanently-attached antenna. Hence, it has been only approved as a limited single-modular transmitter.

(1) Antenna

(a) Procedure

Two antennas have been tested associated with the Kinéis module KIM2 and complying with the FCC 47 CFR part 25. Both are parts of the FCC ID granted to this module.

- Coil antenna: Linx, reference ANT-418-HETH (maximum gain = 0dBi)
- Sleeve Dipole antenna: PROCOM, reference CXL70-1Lw/I (maximum gain = 2dBi)

Both antennas are not provided by Kinéis with the module but can be supplied by classical component distributors.

To use the FCC ID granted to Kinéis, a module integrator shall demonstrate the compliance, providing a radiated test report indicating:

- The maximum EIRP value following: CFR 47, Part 25, 25.204
- The radiation pattern, for 3 orientations when the host orientation is undefined.
- The spurious emissions following: CFR 47, Part 25, 25.202(f)

This test report shall be provided to Kinéis in any case such as:

- Using one of the antenna types described
- Using new antennas of the same type even with a lower gain
- Using an entirely new antenna type other than coil and sleeve dipole

Although, these documents won't be provided to the FCC in this context of PAG, Kinéis as the grantee is responsible of these verifications. The reports demonstrating the compliance could be required by the FCC to Kinéis in case of inspection.

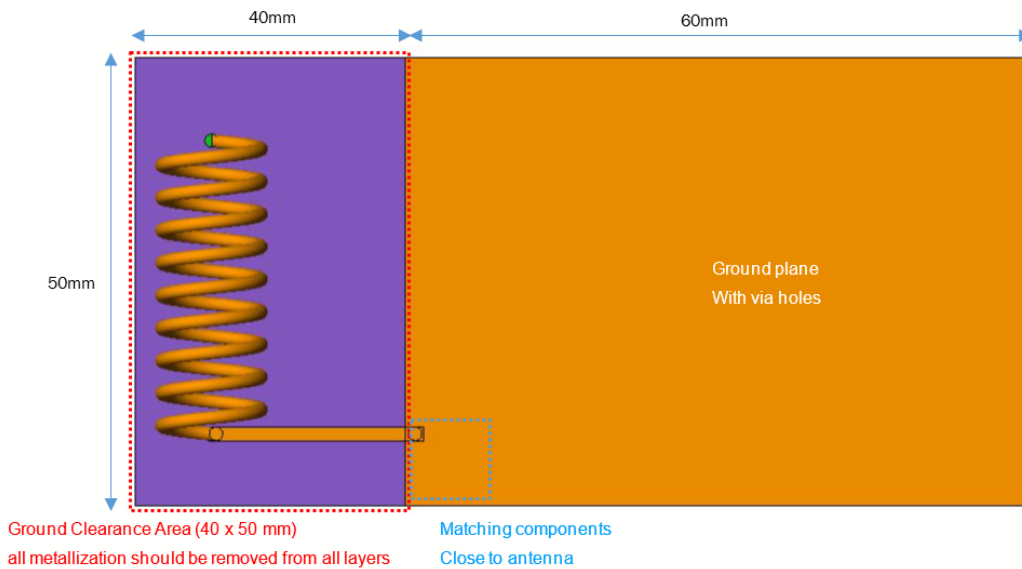
If the EIRP measurement gives a result greater than the maximum declared by Kinéis (2dBi), that would require a permissive change to file by Kinéis which would not be necessarily achieved.

Otherwise, the host product manufacturer is required to take responsibility of the module through a change in FCC ID (new application).

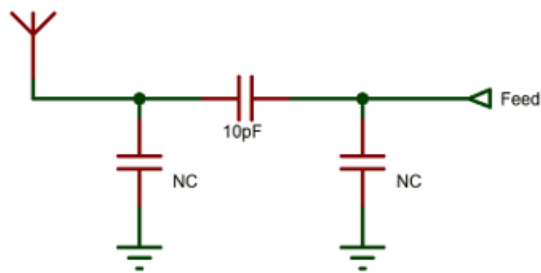
The radiation pattern is required by Kinéis to ensure a proper working to connect to the Kinéis system.

(b) **Coil antenna installation**

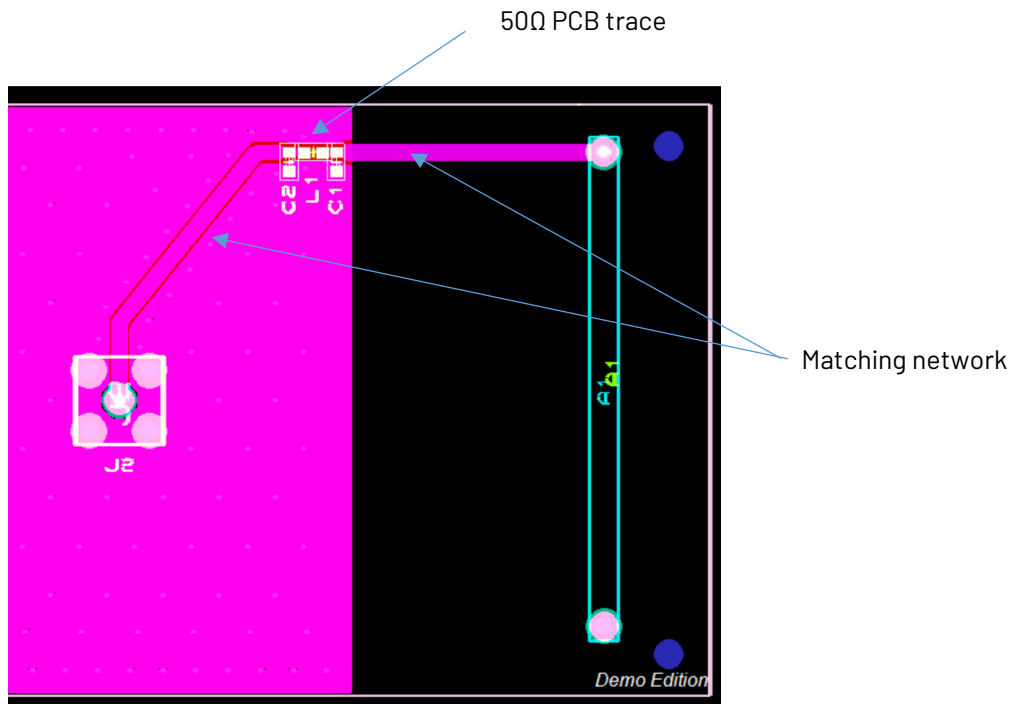
1. The coil antenna, reference ANT-418-HETH by LINX must be welded on a printed circuit board. The ground plane of this PCB acts as a reflector so the whole antenna + PCB stands for a reference design. The dimensions of the PCB are the following:



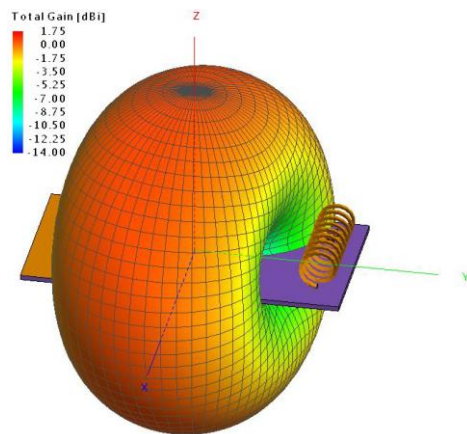
2. This antenna must be adapted in impedance to match with 50Ω at the used frequency.
3. A 50Ω trace must be designed between the module and the antenna.
4. A matching network is required to compensate the desadaptation always depending on the integration. A such matching network must be used:



5. An example of integration is given below:



- The coil antenna on its PCB is advised to be installed in vertical position (not as illustrated on simulation view) to benefit of a maximum radiation pattern oriented to the horizon.



- The maximum gain of such antenna between 399-403MHz is specified to 0dBi.

(c) Sleeve dipole antenna

A sleeve dipole antenna, reference CXL70-1Lw/I by PROCOM has been tested with the Kinéis module as compliant.

1. This antenna is advised to be installed in vertical position (as illustrated) to benefit of a maximum radiation pattern oriented to the horizon.



2. During the test for the FCC approval, Kinéis has used:
 - an adapter type / SMA
 - a coaxial cable 1m long, SMA/SMA.
 - A longer coaxial cable can be used, tending toward a gain reduction.



3. Otherwise, this antenna does not be modified to remain aligned with its specification and complies with the FCC ID granted.

(2) RF exposure

(a) Definition

As explained in RD[3] §7:

- To be considered as a **mobile device**, a minimum test separation distance ≥ 20 cm is required between the antenna and radiating structures of the device and nearby persons.
- Devices operating in standalone mobile device exposure conditions may contain a single transmitter or multiple transmitters that do **not transmit simultaneously**.

(b) Statement

Kinéis benefited of RF exposure exemption, related to human exposure to electromagnetic fields laid out in FCC CFR Title 47 Part 1.1307, for its module based on this statement:

- The frequency used is between [399.9 -403MHz]
- The power output is 27dBm
- The duty cycle is 0.7%
- The maximum gain is 2.2 dBi
- The minimum separation from a human body is 20 centimeters (mobile)
- Simultaneous transmission is not supported.

With the KIM2 module:

- The frequency is set only by Kinéis during the manufacturing process.
- The power output is fixed during the manufacturing process.
- The duty cycle is fixed as the medium access is only managed by the module firmware, never transmitting under a period of 60s.

Hence, remains variable, depending on the integration case:

- The maximum gain of the antenna; please refer to the antenna's constraints paragraphs.
- The minimum separation from a human body.
- Simultaneous transmissions.

(c) Procedure

To benefit of the Kinéis certification grant, the module integrator shall provide to Kinéis an installation manual of his product (the module host), clearly detailing the installation method and specifying a minimum separation distance of 20cm.

Then, this installation manual shall be provided by the host manufacturer to all product users.

Following the module integration in the end-device, if one of the items filed by Kinéis is no longer respected, that would void the approval and require to take responsibility of the module through a change in FCC ID (new application).

3. Label

The module is a radiofrequency device requiring the compliance with the FCC standards, then when approved by the FCC, it shall bear the granted FCC ID to inform the users.

For a host using a certified modular with a standard fixed label, if the module FCC ID is not visible when installed in the host, or if the host is marketed so that end users do not have straightforward commonly used methods for access to remove the module so that the FCC ID of the module is visible; then an additional permanent label referring to the enclosed module shall indicate:

“Contains FCC ID: 2A96E-KIM2-HW1FW1”

FCC ID is formed as: xxxxx-yyyyyyyy where 2A96E is the grantee code for Kinéis.

This marking could be a physical or e-label depending on the case.

The principle of marking requirements is given in [RD4] §15.19 and more detailed in KDB 784748.

4. Additional testing

Additional guidance for testing host products is given in KDB Publication 996369 D04Module Integration Guide.

Kinéis modules provide a test mode dedicated to the measurement in laboratory which could be required to verify the maximum EIRP or the spurious level. Thanks to an AT command, it is possible to set the module in continuous wave, pure carrier or modulated following one of the available modulations.

Please contact Kinéis to know how set the module in this test mode.

This mode is allowed for testing in laboratory only and strictly forbidden outdoor.

When the host product integrates several transmitters pay attention to avoid the simultaneous transmissions. As explain, in RF exposure paragraph that could void the approval and require to take responsibility of the module through a change in FCC ID (new application). On this way, you should have to test again the Kinéis module using the test mode of continuous wave alternatively with standard transmission commands.

If required to the host manufactured performing additional tests, Kinéis can proposed an equipment allowing to send/receive some frames to the module using the radiofrequency link and displaying the results of these communications.