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ThingMagic Nano Design Guide



For ThingMagic Nano with Firmware Ver. 1.3.2 and later

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01 Revision B
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Revision Table

Date	Version	Description
3/2015	01 Draft 1	Partial Draft for early-access release
4/2015	01 REV A	First Release for prototype units with 1.3.1 firmware
4/2015	01 Rev B	Second release for GA units with version 1.3.2 firmware <ul style="list-style-type: none">◆ Receive sensitivity values updated (RF Characteristics)◆ Long-term exposure caution updated (ThingMagic Nano Regulatory Information)◆ Thermal limits explained more fully (ThingMagic Nano Carrier Board)◆ Minor Editorial Changes◆ Minor changes following review by Engineering

Communication Regulation Information

**C A U T I O N !**

Please contact ThingMagic support - support@thingmagic.com - before beginning the process of getting regulatory approval for a finished product using the ThingMagic Nano.

ThingMagic Nano Regulatory Information

Federal Communication Commission Interference Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- ◆ Reorient or relocate the receiving antenna.
- ◆ Increase the separation between the equipment and receiver.
- ◆ Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- ◆ Consult the dealer or an experienced radio/TV technician for help.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

**W A R N I N G !****Operation of the ThingMagic Nano module requires professional installation to correctly set the TX power for the RF cable and antenna selected.**

This transmitter module is authorized to be used in other devices only by OEM integrators under the following conditions:

1. To comply with FCC's RF radiation exposure requirements, the antenna(s) used for this transmitter must be installed such that a minimum separation distance of 21 cm is maintained between the radiator (antenna) & user's/nearby people's body at all times and must not be co-located or operating in conjunction with any other antenna or transmitter.
2. The transmitter module must not be co-located with any other antenna or transmitter.

As long as the two conditions above are met, further transmitter testing will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).

Note

In the event that these conditions can not be met (for certain configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

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 manual of the end product.

User Manual Requirement

The user manual for the end product must include the following information in a prominent location;

“To comply with FCC's RF radiation exposure requirements, the antenna(s) used for this transmitter must be installed such that a minimum separation distance of 21 cm is maintained between the radiator (antenna) & user's/nearby people's body at all times and must not be co-located or operating in conjunction with any other antenna or transmitter.”

AND

“The transmitting portion of this device carries with it the following two warnings:

“This device complies with Part 15...”

AND

“Any changes or modifications to the transmitting module not expressly approved by ThingMagic Inc. could void the user’s authority to operate this equipment” “

End Product Labeling

The final end product must be labeled in a visible area with the following:

“Contains Transmitter Module FCC ID: QV5MERCURY6EN”

or

“Contains FCC ID: QV5MERCURY6EN.”

Industry Canada

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropic radiated power (e.i.r.p.) is not more than that necessary for successful communication.

This radio transmitter (identify the device by certification number, or model number if Category II) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device

Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropic ally radiated power (e.i.r.p.) is not more than that permitted for successful communication.

This device has been designed to operate with the antennas listed in [Authorized Antennas](#) table. Antennas not included in these lists are strictly prohibited for use with this device.

To comply with IC RF exposure limits for general population/uncontrolled exposure, the antenna(s) used for this transmitter must be installed to provide a separation distance of

at least 21 cm from all persons and must not be collocated or operating in conjunction with any other antenna or transmitter.

End Product Labeling

The final end product must be labeled in a visible area with the following:

“Contains ThingMagic Inc. ThingMagic Nano (or appropriate model number you’re filing with IC) transmitting module FCC ID: QV5MERCURY6EN (IC: 5407A-MERCURY6EN)”

Industrie Canada

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

Le présent émetteur radio (identifier le dispositif par son numéro de certification ou son numéro de modèle s'il fait partie du matériel de catégorie I) a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

Le fonctionnement de l' appareil est soumis aux deux conditions suivantes:

1. Cet appareil ne doit pas perturber les communications radio, et
2. cet appareil doit supporter toute perturbation, y compris les perturbations qui pourraient provoquer son dysfonctionnement.

Pour réduire le risque d'interférence aux autres utilisateurs, le type d'antenne et son gain doivent être choisis de façon que la puissance isotrope rayonnée équivalente (PIRE) ne dépasse pas celle nécessaire pour une communication réussie.

L' appareil a été conçu pour fonctionner avec les antennes énumérés dans les tables Antennes Autorisées ([Authorized Antennas](#)). Il est strictement interdit de l' utiliser l' appareil avec des antennes qui ne sont pas inclus dans ces listes.

Au but de conformer aux limites d'exposition RF pour la population générale (exposition non-contrôlée), les antennes utilisés doivent être installés à une distance d'au moins 25

cm de toute personne et ne doivent pas être installé en proximité ou utilisé en conjonction avec un autre antenne ou transmetteur.

Marquage sur l' étiquette du produit complet dans un endroit visible: "Contient ThingMagic transmetteur, FCC ID: QV5MERCURY6EN (IC:5407A-MERCURY6EN)"

Authorized Antennas

This device has been designed to operate with the antennas listed in [Authorized Antennas](#). Antennas not included in this list are strictly prohibited for use with this device.

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Introduction

The ThingMagic® Nano® embedded module is an RFID reader that you can integrate with other systems to create RFID-enabled products.

Applications to control the ThingMagic Nano modules and derivative products can be written using the high level MercuryAPI. The MercuryAPI supports Java, “.NET” and C programming environments. The MercuryAPI Software Development Kit (SDK) contains sample applications and source code to help developers get started demonstrating and developing functionality. For more information on the MercuryAPI see the MercuryAPI Programmers Guide and the MercuryAPI SDK, available on the ThingMagic website.

This document is intended for hardware designers and software developers. It describes the hardware specifications and firmware functionality of the ThingMagic Nano module and provides guidance on how to incorporate the module within a third-party host system. The document is broken down into the following sections:

- ◆ [Hardware Overview](#) - Detailed specifications of the ThingMagic Nano hardware. This section should be read in its entirety before designing hardware or attempting to operate the ThingMagic Nano module in hardware other than the ThingMagic Dev Kit.
- ◆ [Hardware Integration](#) - Describes the ideal attributes of a main board which incorporates the ThingMagic Nano module.
- ◆ [Firmware Overview](#) - A detailed description of the ThingMagic Nano firmware components including the bootloader and application firmware.
- ◆ [Communication Protocol](#) - An overview of the low level serial communications protocol used by the ThingMagic Nano.
- ◆ [Functionality of the ThingMagic Nano](#) - Detailed descriptions of the ThingMagic Nano features and functionality that are supported through the use of the MercuryAPI.
- ◆ [Appendix A: Error Messages](#) - Lists ThingMagic Nano Error Codes and provides causes and suggested solutions for when they are encountered.
- ◆ [Appendix B: Getting Started - Dev Kit](#) - Quick Start guide to getting connected to the ThingMagic Nano Developer’s Kit and using the Demo Applications included with the MercuryAPI SDK.
- ◆ [Appendix C: Environmental Considerations](#) - Details about environmental factors that should be considered relating to reader performance and survivability.

Specifications Summary

The table below summarizes the specifications of the ThingMagic Nano module. Many of these specifications are discussed in further detail in the [Hardware Overview](#) chapter.

Physical	
Dimensions	22 mm L x 26 mm W x 3.0 mm H (.866 in L x 1.024 in W x 0.118 in H)
Tag / Transponder Protocols	
RFID Protocol Support	EPCglobal Gen 2 (ISO 18000-6C) with nominal backscatter rate of 250 kbps
RF Interface	
Antennas	Single 50 Ω connection (board-edge)
RF Power Output	Separate read and write levels, command-adjustable from 0 dBm to 27 dBm in 0.01 dB steps

Regulatory	<p>Pre-configured for the following regions:</p> <ul style="list-style-type: none"> ▪ FCC (NA, SA) 917.4-927.2 MHz ▪ ETSI (EU) 865.6-867.6 MHz ▪ TRAI (India) 865-867 MHz ▪ KCC (Korea) 917-923.5 MHz ▪ MIC (Japan) 916.8 – 923.4 MHz ▪ ACMA (Australia) 920-926 MHz ▪ SRRC-MII (P.R.China) 920.1-924.9 MHz ▪ ‘Open’ (Customizable channel plan; 859-873 MHz and 915-930 MHz)
Data/Control Interface	
Physical	41 board-edge connections providing access to RF, DC power, communication, and GPIO signals
Control/Data Interfaces	<ul style="list-style-type: none"> ▪ UART; 3.3V logic levels ▪ 9.6 to 921.6 kbps data rate ▪ Enable control
GPIO Sensors and Indicators	<p>Four 3.3V bidirectional ports;</p> <p>Configurable as input (sensor) or output (indicator)</p>
API support	.NET, Java, and Embedded “C” APIs
Power	

<p>DC Power Required</p>	<p>DC Voltage: 3.3 to 5.5 V for +25 dBm out</p> <p>3.7 to 5.5 V for +27 dBm out</p> <p>Nominal DC power consumption when reading:</p> <p>3.6 W@ 5 VDC for +27 dBm out</p> <p>3.3 W@ 5 VDC for +25 dBm out</p> <p>1.5 W@ 5 VDC for 0 dBm out</p>
<p>Idle Power Consumption</p>	<ul style="list-style-type: none"> ▪ 0.84 W in ready mode ▪ 0.015 W in sleep mode ▪ 0.00025 W in shutdown mode
<p>Environment</p>	
<p>Certification</p>	<ul style="list-style-type: none"> ▪ FCC 47 CFR Ch. 1 Part 15 ▪ Industrie Canada RSS-210 ▪ ETSI EN 302 208 v1.4.1
<p>Operating Temp.</p>	<p>-20C to +60C (case temperature)</p>
<p>Storage Temp.</p>	<p>-40C to +85C</p>
<p>Shock and Vibration</p>	<p>Survives 1 meter drop during handling</p>
<p>Performance</p>	
<p>Boot time</p>	<ul style="list-style-type: none"> ▪ Less than 150 msec for initial boot after firmware download ▪ Less than 30 msec for subsequent boots.
<p>Read/Write Performance</p>	<ul style="list-style-type: none"> ▪ Up to 150 tags/sec to read 96-bit EPC ▪ 80 msec typical for standard write of 96-bit EPC

Hardware Overview

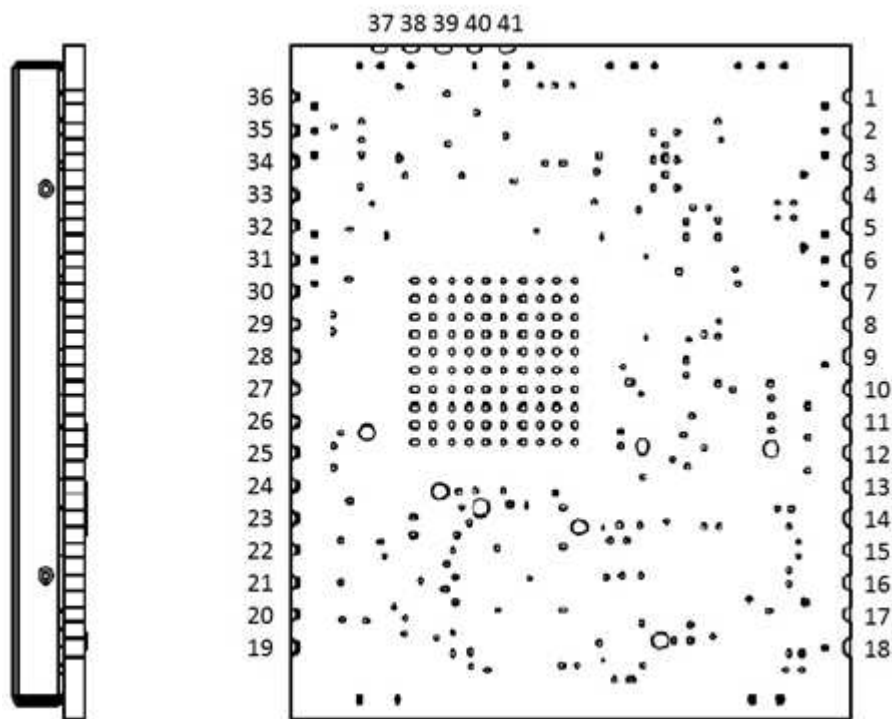
The following section provides detailed specifications of the ThingMagic Nano hardware including:

- ◆ [Hardware Interfaces](#)
- ◆ [DC Power Requirements](#)
- ◆ [RF Characteristics](#)
- ◆ [Environmental Specifications](#)
- ◆ [Authorized Antennas](#)
- ◆ [Physical Dimensions](#)
- ◆ [Tape-and-Reel Dimensions](#)

Hardware Interfaces

Module Pin-out

Connections are made to the module using 41 edge pads (“vias”) that allow the module to be surface mounted to a main board. Here is a bottom view of the module, showing the numerical interfaces of the module:



The document sections that follow explain in detail how these connections are used.

Antenna Connections

The ThingMagic Nano supports one monostatic bidirectional RF antenna through edge vias. See [Hardware Integration](#) for antenna edge via locations and layout guidelines.

The maximum RF power that can be delivered to a 50 ohm load from each port is 0.5 Watts, or +27 dBm (regulatory requirements permitting).

Antenna Requirements

The performance of the ThingMagic Nano is affected by antenna quality. Antennas that provide good 50 ohm match at the operating frequency band perform best. Specified performance is achieved with antennas providing 17 dB return loss (VSWR of 1.33) or better across the operating band. Damage to the module will not occur for any return loss of 1 dB or greater. Damage may occur if antennas are disconnected during operation or if the module sees an open or short circuit at its antenna port.

Antenna Detection



C A U T I O N !



Like the Micro module, but unlike the M6e and M5e modules, the ThingMagic Nano does not support automatic antenna detection. When writing applications to control the ThingMagic Nano you must explicitly specify that antenna 1 is to be used. Using the MercuryAPI, this requires creation of a “SimpleReadPlan” object with the list of antennas set and that object set as the active /reader/read/plan. For more information see the MercuryAPI Programmers Guide | Level 2 API | Advanced Reading | “ReadPlan” section.

Digital/Power Interfaces

The edge “via” connections provides power, serial communications signals, an enable control, and access to the GPIO lines to the ThingMagic Nano module.

See [Hardware Integration](#) for pinout details of both connections and layout guidelines

ThingMagic Nano Digital Connector Signal Definition

Edge Via Pin #	Signal	Signal Direction (In/Out of ThingMagic Nano)	Notes
1-9, 18-19	GND	Signal Return	Must connect all GND pins to ground as they also serve to remove heat from the module
10	Vout	DC Power Output	3.4V DC output. Maximum load 5 mA. Turns off when ENABLE is pulled low. Leave unconnected if not used.
11	ENABLE	Enable/Shut-down	TTL input that turns the module off and reduces its power consumption to nearly zero. Hi=Enable, Low=Shutdown module If left unconnected, module will stay in ENABLE state.
12	GPIO1	Bidirectional GPIO	Each line configurable as input or output interface (by default it is an input with internal pull-down).
13	GPIO2	Bidirectional GPIO	
14	GPIO3	Bidirectional GPIO	
15	GPIO4	Bidirectional GPIO	
16,17	Vin	Power Supply Input	3.3 to 5.5VDC. Pins 16 and 17 are internally connected. Connect the DC power source to both pins to ensure sufficient current carrying capacity.
20	UART_TX	In	UART Serial input, 3.3V logic
21	UART_RX	Out	UART Serial output, 3.3V logic
22-28	RFU	Reserved	Reserved for future use - leave unconnected
39	RF	RF Transmit and Receive	Interface to antenna
38-39, 40-41	GND	RF Ground	Must connect all GND pins to ground as they also serve to remove heat from the module