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AGX-832 Module Hardware Integration Guide

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Notice: This guide is preliminary pending final release of the AGX-832 Module and may contain information that is subject to change.

1. Introduction

This document provides information regarding the integration of the AGX-832 Bluetooth Low Energy module in a final product. Following the recommendations of this document will help ensure that the specifications of the module are met and that the best performance possible is achieved.

2. Reference Documents

The following documents should be referenced when creating the design:

- AGX-832 Module Datasheet

3. Document Revision History

Revision	Date	Notes
V0.5.0	12/2/2015	Initial Revision Release

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4. Pinout and Pin Description

In designing your product, you should refer to the module pinout shown below. As the AGX-832 has flexible pin mapping, you can change the purpose of pins after the hardware has already been designed. This helps ensure that changes can be made without requiring hardware modification.

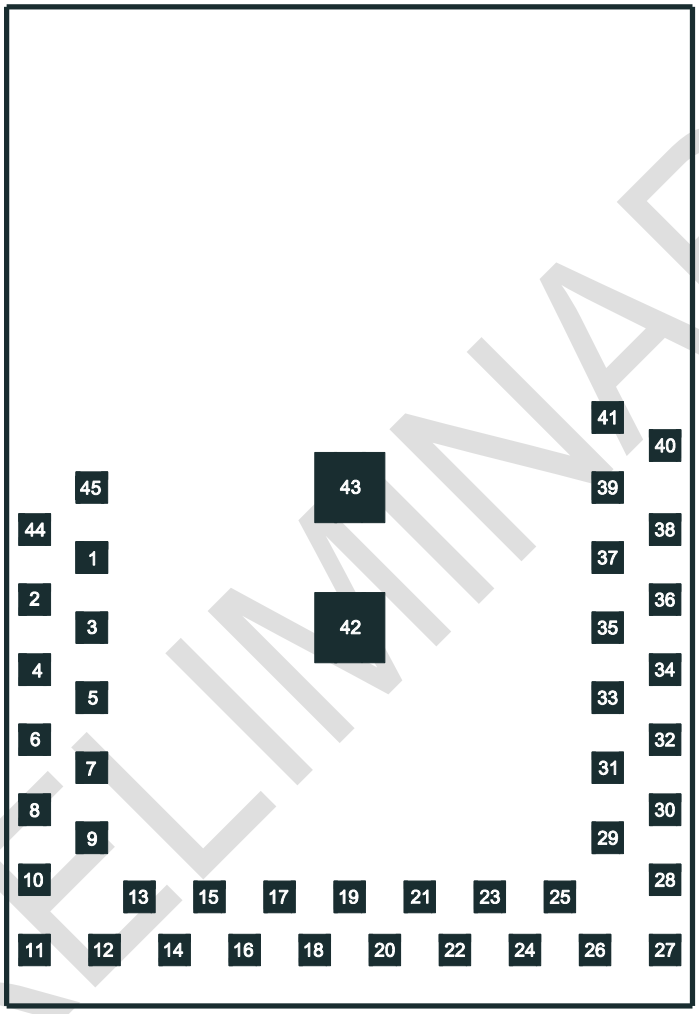


Figure 1 - AGX-832 Module Pinout

Module Pin	Name	I/O Type	Description
16	P0.00/XL1	Digital I/O, Analog	GPIO / 32.768kHz Crystal
18	P0.01/XL2	Digital I/O, Analog	GPIO / 32.768kHz Crystal
10	P0.02/AIN0	Digital I/O, Analog	GPIO / Analog Input 0
17	P0.03/AIN1	Digital I/O, Analog	GPIO / Analog Input 1
15	P0.04/AIN2	Digital I/O, Analog	GPIO / Analog Input 2
14	P0.05AIN3	Digital I/O, Analog	GPIO / Analog Input 3
20	P0.06	Digital I/O	GPIO
21	P0.07	Digital I/O	GPIO
22	P0.08	Digital I/O	GPIO

Module Pin	Name	I/O Type	Description
23	P0.09/NFC1	Digital I/O / NFC Input	GPIO / NFC
24	P0.10/NFC2	Digital I/O / NFC Input	GPIO / NFC
26	P0.11	Digital I/O	GPIO
25	P0.12	Digital I/O	GPIO
28	P0.13	Digital I/O	GPIO
29	P0.14	Digital I/O	GPIO / TRACEDATA[3]
30	P0.15	Digital I/O	GPIO / TRACEDATA[2]
31	P0.16	Digital I/O	GPIO / TRACEDATA[1]
32	P0.17	Digital I/O	GPIO / TRACEDATA[0]
33	P0.18	Digital I/O	GPIO
34	P0.19	Digital I/O	GPIO
35	P0.20	Digital I/O	GPIO / TRACECLK
36	P0.21/RESET	Digital I/O	GPIO / System Reset
39	P0.22	Digital I/O	GPIO
40	P0.23	Digital I/O	GPIO
41	P0.24	Digital I/O	GPIO
2	P0.25	Digital I/O	GPIO
3	P0.26	Digital I/O	GPIO
4	P0.27	Digital I/O	GPIO
5	P0.28/AIN4	Digital I/O	GPIO
6	P0.29/AIN5	Digital I/O	GPIO
7	P0.30/AIN6	Digital I/O	GPIO
8	P0.31/AIN7	Digital I/O	GPIO
1, 11, 12,13,19,27 42,43,44,45	GND	Power	Electrical Ground
9	VCC	Power	Power Input V_{CC}
38	SWDIO	Digital I/O	Debugging SWDIO
39	SWCLK	Digital Input	Debugging SWCLK

Table 1 - AGX-832 Module Pinout

Several of the pins have a dedicated purpose such as:

- P0.02 to P0.05 and P0.28 to P0.31 are the only input pins for the internal 12-bit ADC
- P0.09/NFC1 and P0.10/NFC2 are the only pins that can be used to connect an NFC antenna
- P0.14 to P0.17 and P0.20 can be used for parallel trace
- P0.21/RESET has a secondary functionality of resetting the device
- SWDIO and SWCLK are fully dedicated to the Serial Wire Debug interface

5. Module Land Pattern

The following figure shows the recommended PCB Land pads:

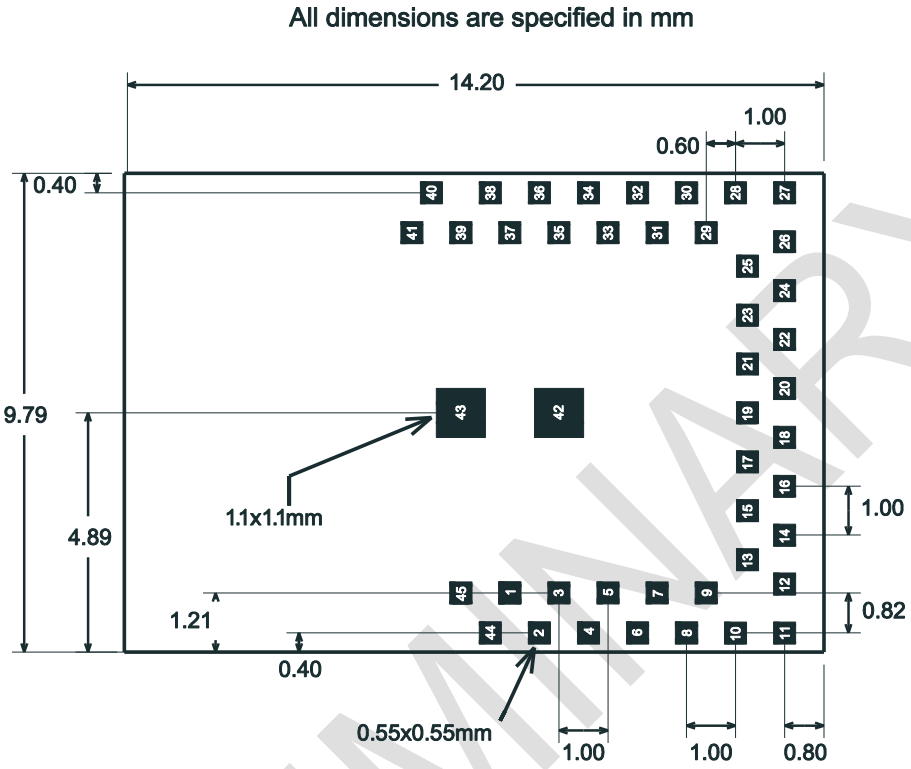


Figure 2 – Recommended Land Pattern

The pad sizes should be 0.55mm x 0.55mm

Argenox provides reference land patterns, 3D Models and other information to speed up your design. These libraries and designs are available for the most common CAD packages including Altium, OrCAD / Allegro, EagleCAD and can be downloaded from the AGX-832 Product Page

6. RF Layout and Placement

Special attention must be paid to the placement and design of the carrier board. Proper design and layout of the module will help provide the performance and range expected of the module.

- The area of the board directly underneath the antenna should be clear of copper on all layers
- Keep metal away from the antenna as these will affect the radiation pattern and other performance
- The best performance is obtained by having the antenna overhang the carrier board so that it is in air. If this is no possible, a cutout is the best alternative.

The chip antenna used in the AGX832 is only half of the antenna. The other half is created by the ground plane, so it is critical to properly design it or the antenna will suffer detuning.

6.1 Module Placement Recommendations

The following diagram shows several examples of module placement and their recommendation. The PCB is denoted in bright red and indicates PCB with a solid ground plane, whereas lighter red indicates regions of no copper. White areas indicate a board cutout where no PCB material should be present.

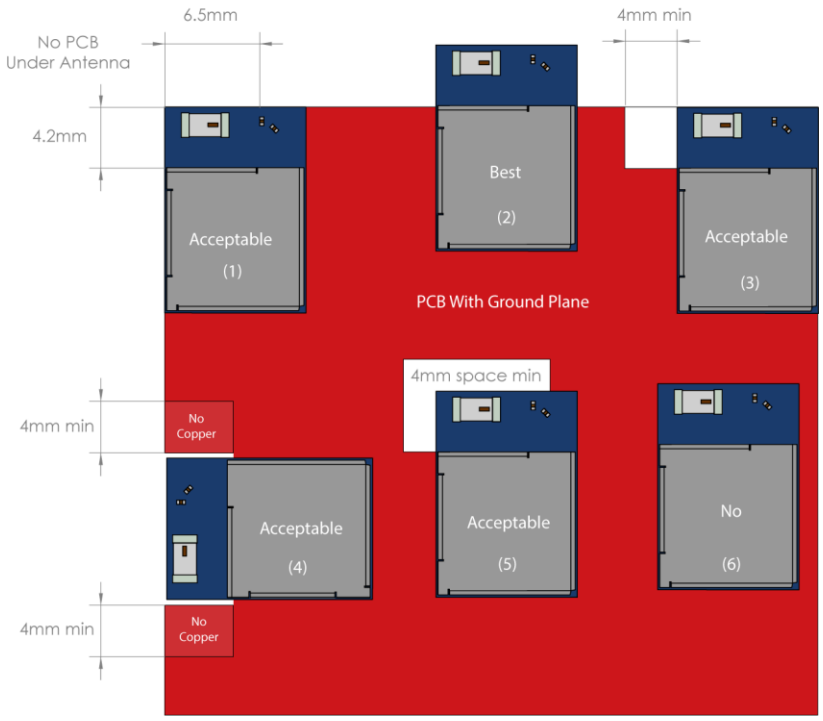


Figure 3 - Module Mounting Options

The following is a discussion of each options:

(1) This option is acceptable since it reduce PCB space, and provides good clearance from the antenna. Note that the 4.2mm by 6.5mm region under the chip antenna must be cleared with no PCB underneath for best performance
(2) This option provides the best performance since it provides maximum clearance for the antenna and results in the antenna being affected the least by the PCB. However, due to the extra space required it is often not possible to use
(3) This option is slightly inferior to (1) because the antenna has less clearance space and it wastes more of the PCB
(4) This option provides clearance when copper must be present and is acceptable although the copper should be cleared as much as possible
(5) This option is used when the module must be used in the center of the board. It is worse than others due to the extra space wasted surrounding the antenna. Ensure as much clearance as possible.
(6) This option shows the module simply placed on the PCB with no clearance of the PCB. Due to the fact that there is a ground plane under the antenna, the range will be severely limited and the module will not operate as expected. DO NOT USE this configuration.

Placing the module facing to the outside of the PCB is best to avoid interference as well as interfering with the circuits and provide the best clearance that the antenna requires.

6.2 Plastic Enclosures

As most products will be enclosed by a plastic, it is important to understand the impact that a plastic enclosure will have on the performance of the antenna.

A typical antenna can be represented by an LC resonating circuit. An antenna provides best performance when it is resonating in the bandwidth of interest. Such frequency depends as follows:

$$f = \frac{1}{\sqrt{LC}}$$

Therefore, any increase in the inductance L or Capacitance C will result in lowered frequency, which makes the antenna radiate less power.

When a plastic enclosure is introduced to the electric field of the antenna it will have the effect of increasing the effective capacitance and ultimately the frequency will go down. The best approach is to place as much clearance as possible between the plastic and the antenna to reduce this effect.

As most RF modules are tuned in free air, the plastic will reduce the frequency if located too close. The best performance is obtained when the RF circuit and antenna is tuned to the actual system taking into account the plastic and all other elements in the environment. However, such tuning is not possible in a module since it will result of a change that will invalidate the FCC, IC and other certifications.

If your system has unique requirements, please contact Argenox for guidance on customizing the module for your system.

6.3 Effect of Metals Nearby

Another significant source of issues for RF is the presence of metal near the antenna. Metal also produces an effect on the electric field and change the radiation pattern or create nulls where no signal is received. Any nearby metal may affect the antenna significantly and reduce the range. It's therefore critical to keep any metal way at least 7 to 8mm from the module. Your design should place any metal as far away as possible

6.4 Effects of Large Ground plane

In some cases, the product may contain or may be placed on top of a large ground metallic plane. If this plane is significant enough it may significantly affect the antenna and its efficiency. In this case it is best to place the module so that it is perpendicular to the plane. This will help reduce the effect the ground plane has. As we've noted, it's important to keep the module as far away from these metallic objects.

6.5 Other recommendations

- No traces or wires should get near the antenna because they will interfere with the field.
- Check that any metallic screws or items are far away from the antenna and module
- If any metallic pain is used, ensure that it is not painted near the antenna or enclosing the antenna

7. Low Frequency Clock

A major design decision when designing with the AGX832 is whether to add an external 32.768 kHz crystal or external clock signal (if such signal is available elsewhere in the system).

The addition of the crystal implies an added cost to the system as well as space, but ensure that the system can operate at the lowest power and great accuracy not otherwise possible.

If your product is not battery powered, then the decision is simplified since the system can simply use the high frequency 32MHz clock source. However, since most BLE products are battery powered, it's important to consider carefully whether it will benefit from an external crystal

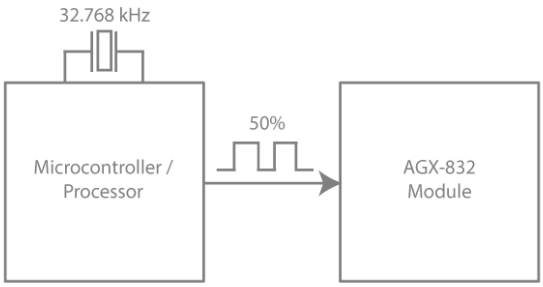
7.1 External Crystal

A 32.768 kHz crystal can be used to source an accurate signal and achieve the lowest power consumption.

Please see datasheet for specifications.

7.2 External LFCLK Source Signal

The AGX-832 can also accept an external 32.768 kHz signal generated by a single-ended oscillator such as an external oscillator or microcontroller. Sharing a 32.768 kHz crystal between devices can allow savings on cost, but care must be taken to ensure that the signal meets the required specifications.



This feature is preliminary. Please contact Argenox for more information on specifications.

Note: The nRF52832 cannot provide a 32.768 kHz clock output to another device in the system.

8. General Design Recommendations

8.1 GPIOs near RF and Crystals

Radio performance parameters, such as sensitivity, may be affected by high frequency digital I/O with large sink/source current close to the Radio power supply and antenna pins.

The following pins should only be driven low and used for low frequency or static control. Please note that this issue affects all designs using nRF52832 whether discrete or module.

Module Pin	GPIO Name
39	P0.22
40	P0.23
41	P0.24
2	P0.25
3	P0.26
5	P0.28/AIN4
6	P0.29/AIN5
7	P0.30/AIN6
8	P0.31/AIN7

For more information please refer to section 18.2.1 of Nordic's nRF52832 Objective Datasheet

In cases where certain pins must be used for high frequency, Argenox may provide testing of the final system to measure the performance effect.

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