

# APPLICATION NOTE

|                     |                   |
|---------------------|-------------------|
| <b>Product Name</b> | <b>AI6108L</b>    |
| <b>Version</b>      | <b>A</b>          |
| <b>Doc No</b>       | <b>902-17001</b>  |
| <b>Date</b>         | <b>2023/07/03</b> |



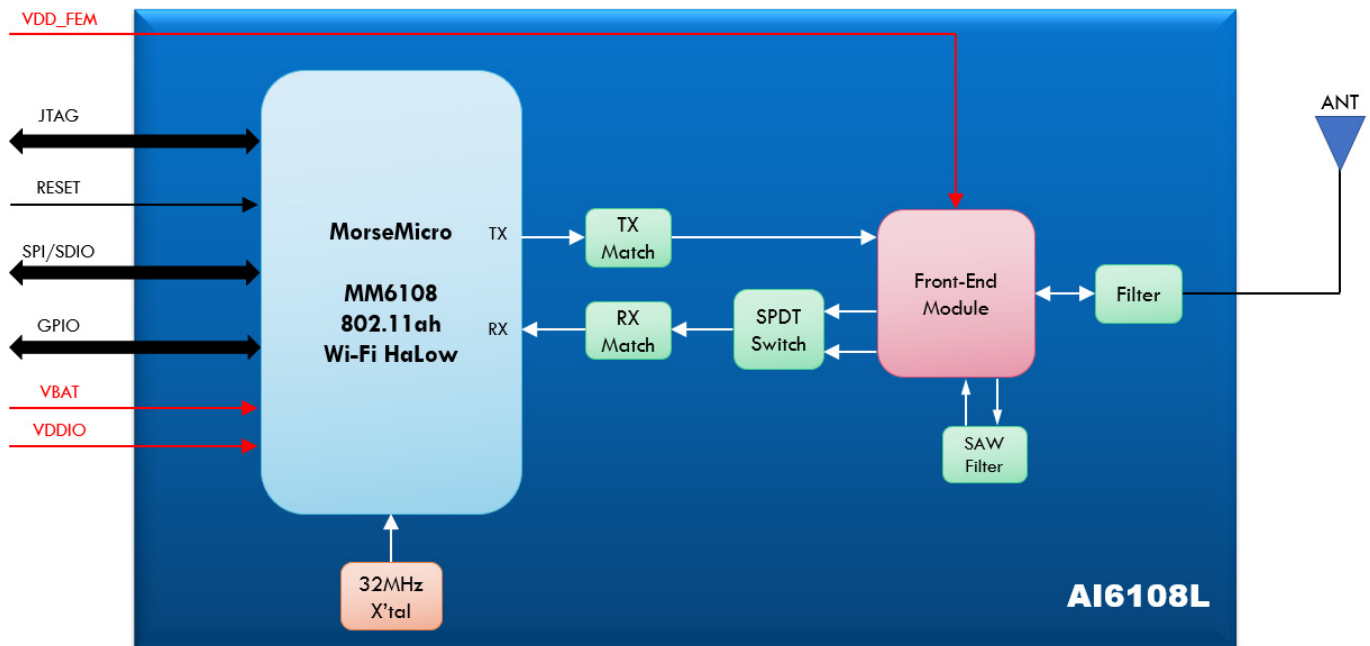
## Document History

| Date       | Revised Contents | Revised By | Version |
|------------|------------------|------------|---------|
| 2023/07/03 | Initial release  | Kenny      | A       |

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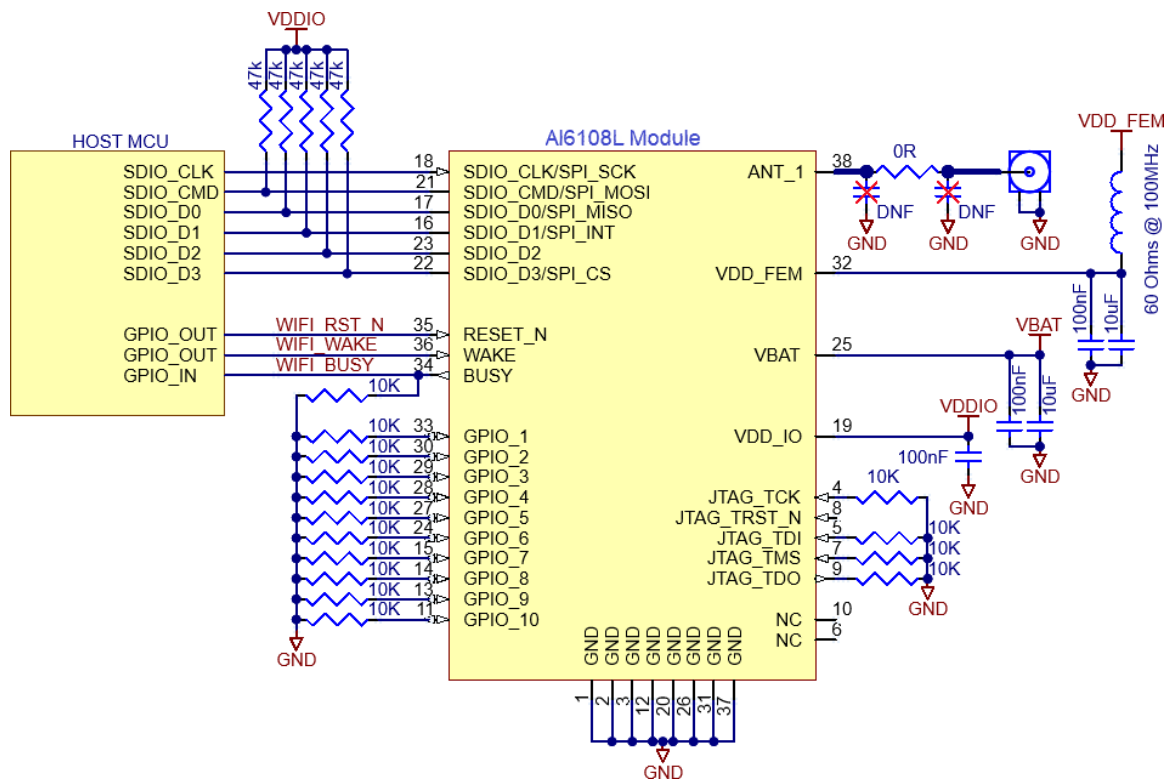
## 1. Block Diagram



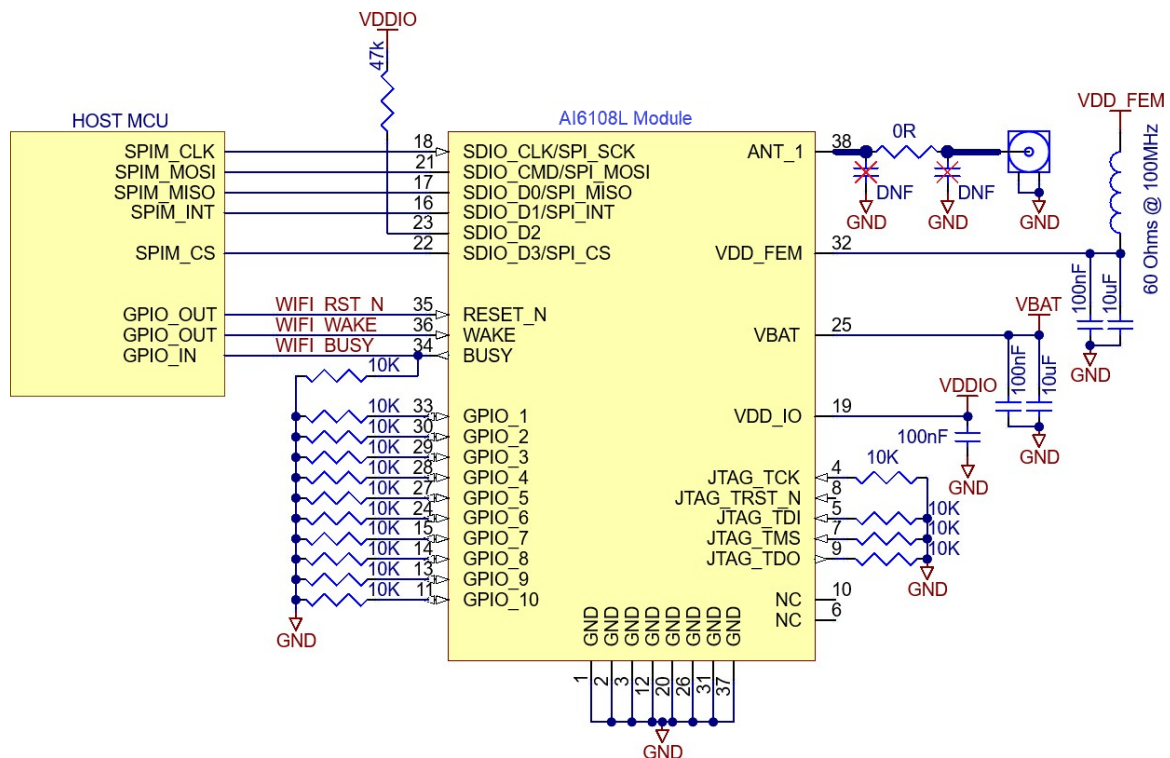
### Specification

|                     |                                            |
|---------------------|--------------------------------------------|
| Product Description | IEEE 802.11ah Sub-1 GHz Wi-Fi HaLow module |
| Main Chipset        | Morse Micro MM6108                         |
| Frequency Range     | 902 – 928 MHz                              |
| Modulation          | BPSK, QPSK, 16-QAM, 64-QAM                 |
| Channel Bandwidth   | 1 / 2 / 4 / 8 MHz                          |
| Host Interface      | SDIO / SPI                                 |
| Package             | LGA type module with shielding cover       |
| Dimension           | 18.5 mm x 14 mm x 2.15 mm (Max.)           |

## 2. Application Circuit



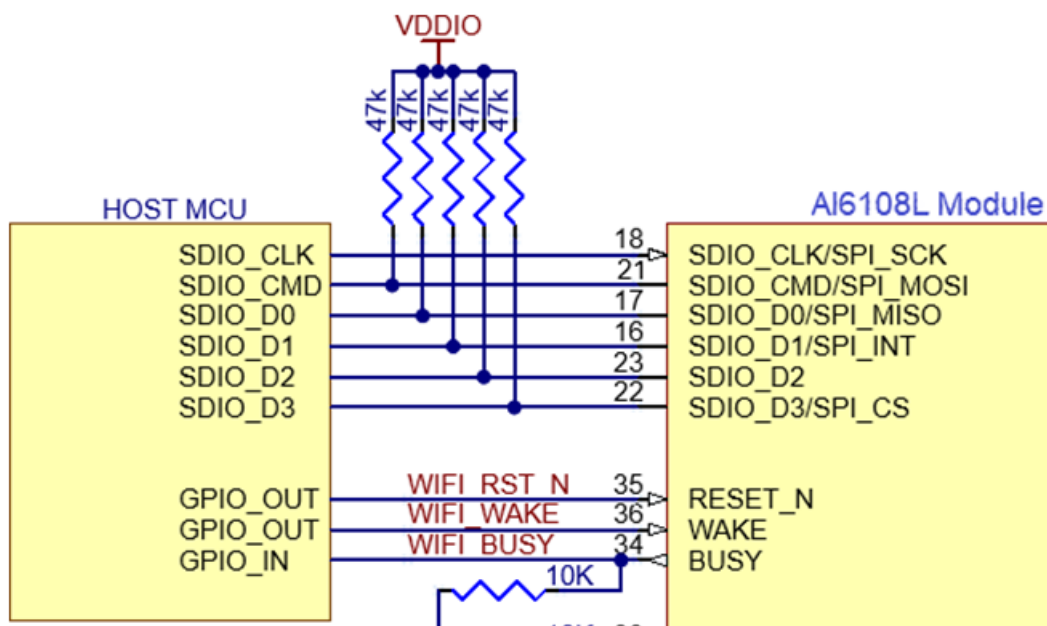
SDIO configuration



SPI configuration

## 2-1. SDIO Host Requirements

- The host should support SDIO v2.0 with SDIO clock speeds of up to 50 MHz. Slower clock speeds will impact the maximum achievable throughput.
- At a minimum, 2 x GPIOs are required as a CMOS output to drive the RESET and WAKE signals. If power save is used, a third GPIO is needed, set as a CMOS input to receive the BUSY signal from the module.
- The SDIO data and command lines should be pulled up with 10k-100k resistors as per the [SDIO 2.0 specification](#).



## 2-2. SPI Host Requirements

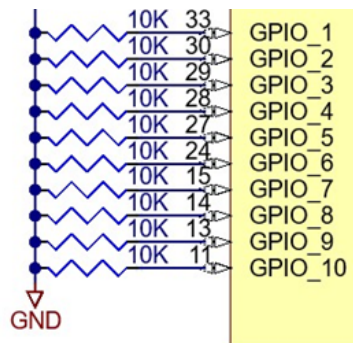
- When selecting a CPU host to interface via SPI to the AI6108L module, consider the following recommendations to achieve the best throughput:
  - The host should support level-triggered interrupts.
  - The host should support full-duplex SPI mode.
  - The host should support DMA backed transactions on the SPI bus.
- Standard SPI can achieve up to 25 Mbps at 50 MHz but this will reduce significantly if there is no DMA support. For example, an SPI interface with an 8-byte buffer per transaction might only achieve 2Mbps throughput on the SPI bus.

## 2-3. Power Management

- AI6108L module power is derived from a 3.0 to 3.6V supply provided on pins VBAT and VDD\_FEM. VBAT powers the internal circuitry of the MM6108 chipset and VDD\_FEM powers the on-module ultra-long-range power amplifier(FEM).
- VDDIO sets the IO voltage of the MM6108 chipset and should be connected to the same power supply as the host MCU.
- There are no strict power-up sequencing requirements; however the voltage on VDDIO must not exceed VBAT.

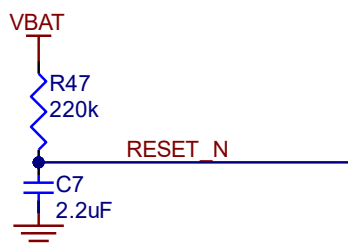
## 2-4. Digital Interfaces

- All unused GPIOs should be tied to GND via a 10k pull-down resistor to ensure they do not float. Failure to do so will result in a higher leakage current on the VDDIO supply.

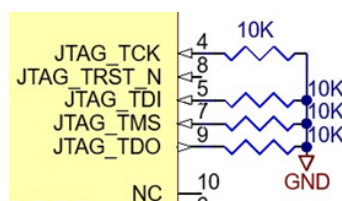


## 2-5. Other Schematic

- RESET\_N  
System Reset, Active Low.



- JTAG  
JTAG pins should be tied to GND via a 10k pull down resistor.



## 3. Layout Guide

### 3-1. Power Trace Management

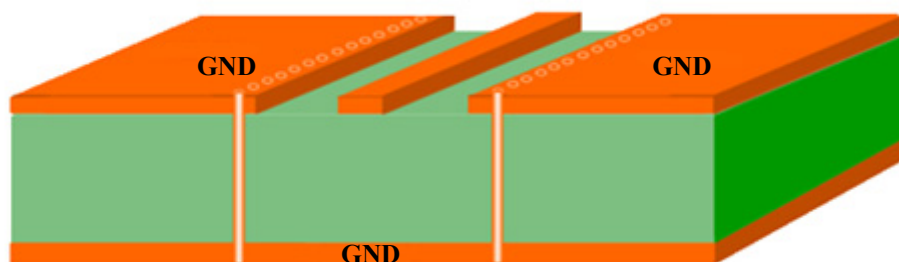
- Power traces should be directly connected with regulator outputs. And add 10uF bypass capacitors close to module on each power trace.
- Never let power trace cross another one including signal trace.

### 3-2. Ground Management

- Please ensure the regional first layer used to mount module is complete to the ground.
- The ground plane on both sides of RF trace needs to add via holes and. We recommend the distance between adding via holes less than  $1/8\lambda$ .

### 3-3. RF Trace Management

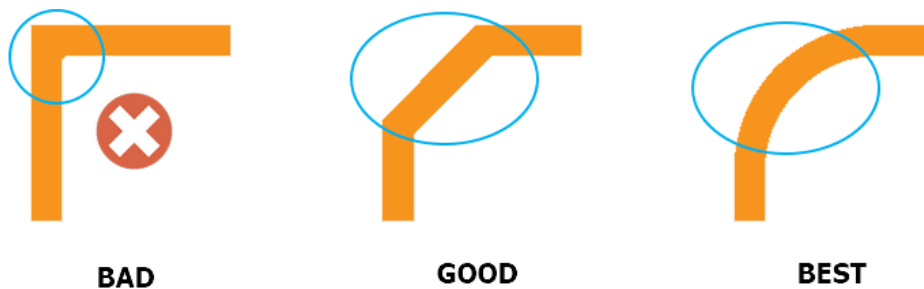
- RF traces should be kept as short and straight as possible.
- Keep RF traces away from noisy signals and power supplies.
- CPWG model is recommended for RF trace calculation, which has better EMC and RF capability. And please discuss with PCB manufacturer to evaluate and keep RF trace in 50 ohm.



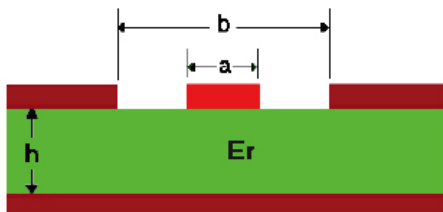


## APPLICATION NOTE [www.acsip.com.tw](http://www.acsip.com.tw)

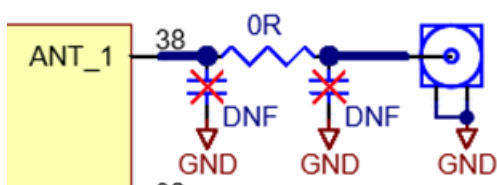
- Do not use right angles in the RF trace, it is better to use 45° bend or radius to change direction.



- The values of a and b will affect each other, it is best to control it not to be too wide from the width and gap of the output pad of the module.



- Suggest reserving 'PI' matching circuit between module and Antenna.



For 'PI' matching components (L / C / R), use components that are sized close to the nominal trace width. e.g., for 10mil RF traces, use 0402 components, for 5mil trace width (on very thin PCB's) use 0201 components. Try to avoid larger 0603 or 0805 parts as they have larger parasitic capacitance and create impedance mismatches.



## OEM/Integrators Installation Manual

Important Notice to OEM integrators

1. This module is limited to OEM installation ONLY.
2. This module is limited to installation in mobile or fixed applications, according to Part 2.1091(b).
3. The separate approval is required for all other operating configurations, including portable configurations with respect to Part 2.1093 and different antenna configurations
4. For FCC Part 15.31 (h) and (k): The host manufacturer is responsible for additional testing to verify compliance as a composite system.

When testing the host device for compliance with Part 15 Subpart B, the host manufacturer is required to show compliance with Part 15 Subpart B while the transmitter module(s) are installed and operating.

The modules should be transmitting and the evaluation should confirm that the module's intentional emissions are compliant (i.e., fundamental and out of band emissions).

The host manufacturer must verify that there are no additional unintentional emissions other than what is permitted in Part 15 Subpart B or emissions are complaint with the transmitter(s) rule(s).

The Grantee will provide guidance to the host manufacturer for Part 15 B requirements if needed.

### Important Note

Notice that any deviation(s) from the defined parameters of the antenna trace, as described by the instructions, require that the host product manufacturer must notify to AcSiP that they wish to change the antenna trace design. In this case, a Class II permissive change application is required to be filed by the AcSiP, or the host manufacturer can take responsibility through the change in FCC ID (new application) procedure followed by a Class II permissive change application.

### End Product Labeling

When the module is installed in the host device, the FCC ID label must be visible through a window on the final device or it must be visible when an access panel, door or cover is easily re-moved. If not, a second label must be placed on the outside of the final device that contains the following text: "Contains FCC ID: 2ADWC-AI6108L". The FCC ID can be used only when all FCC compliance requirements are met.

## Antenna

1. The antenna must be installed such that 20 cm is maintained between the antenna and users,
2. The transmitter module may not be co-located with any other transmitter or antenna.

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID cannot 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. To comply with FCC regulations limiting both maximum RF output power and human exposure to RF radiation, maximum antenna gain (including cable loss) must not exceed.

| Technology | Frequency Range (MHz) | Antenna Type | Max Peak Gain (dBi) |
|------------|-----------------------|--------------|---------------------|
| 802.11ah   | 863 ~ 928MHz          | Dipole       | 1.6                 |

## Manual Information to the End User

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.

## Federal Communication Commission Interference Statement

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.

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.

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

## List of applicable FCC rules

This module has been tested and found to comply with part 22, part 24, part 27, part 90 requirements for Modular Approval.

The modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product as being Part 15 Subpart B compliant (when it also contains unintentional radiator digital circuitry), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

## This device is intended only for OEM integrators under the following conditions: (For module device use)

1. The antenna must be installed such that 20 cm is maintained between the antenna and users, and
2. The transmitter module may not be co-located with any other transmitter or antenna.

As long as 2 conditions above are met, further transmitter test 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.

## Radiation Exposure Statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm between the radiator & your body.