A Brief Overview of AI-Thinker A9G Module

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Abstract: The Ai-Thinker A9G module is a small, low-power device with features such as GPS, GPRS and GSM, making it ideal for various IoT applications such as remote monitoring, tracking and wireless communication. This paper gives an overview of the Ai-Thinker A9G: the setup process, using AT Commands and SDK to enable and use its features.

IndexTerms - **Ai-Thinker A9G, GPS, GSM, MQTT.**

INTRODUCTION

The Ai-Thinker A9G module is a small, low-power device with GPS, GPRS, and GSM capabilities, making it an ideal module for a variety of IoT applications such as remote monitoring, wireless communication and especially tracking. "A Brief Overview of Ai-Thinker A9G Module" is an introductory paper describing the Ai-Thinker A9G module.

This Paper focuses on how the A9G module can be used as a tracker with its unique features at the same time while giving an elaborate step-by-step process on setting up the device as well as using AT commands to enable features like GPS location and Cellular Network Connectivity. Also using SDK, custom firmware could be uploaded on the module. In this paper, custom firmware was uploaded to establish an MQTT connection.

OVERVIEW OF THE MODULE

The A9G development module has basic telephone/message, GPRS network communication, and GPS/BDS dual-mode positioning functions. The module consists of battery charging management, microphone, speaker interface, USB communication interface, TF card slot, SPI interface, I2C2 interface, and ADC interface.

A. Features

- GSM/GPRS module, 800/900/1800/1900 MHz
- Low power mode, with an average current of 2mA or less
- Supports digital and analogue audio, as well as HR, FR, EFR, and AMR voice coding
- Voice calls and SMS are supported
- Protocol stack for embedded network services
- Serial port firmware support.

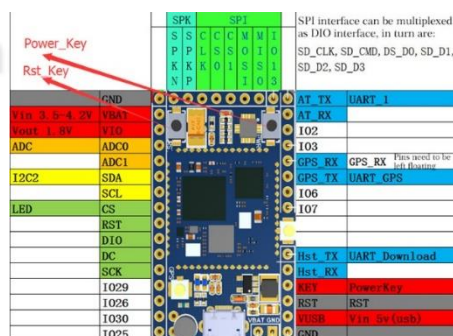### B. Pin diagram of the module

Figure 1 Pin Diagram of Ai-Thinker A9G Module

When using the Ai-Thinker A9G, the connections must be correct; otherwise, issues such as the module not being detected by the computer or being unable to burn the firmware onto the module will occur. Figure 1. depicts the module's Pin diagram in extensive detail.

BURNING THE FIRMWARE

To use the AT commands to enable features such as GPS and GSM/GPRS, the serial tool firmware must be burned onto the module to enable serial communication with the module.

The serial tool allows the device to receive AT commands, which are then used to enable features such as GPS, GPRS, and HTTP connections.

This allows the device to collect information such as location and send it via a network connection to a server such as MQTT or upload it to an HTTP webpage, which is among the basic requirements of a tracker.

A. Steps to burn Firmware

Firstly, download the files firmwarw_tool_v2.1.7z, ai-thinker_a9_a9g_at_v02.02.20190915r.rar, aithinker_serial_tool_v1.2.3.7z [1][2][3]. Then connect the USB to a TTL converter and the AI-Thinker A9G module as seen in Figure 2. Insert a SIM card in the A9G module. Then connect the USB to TTL converter to your PC using a Mini USB type B cable.
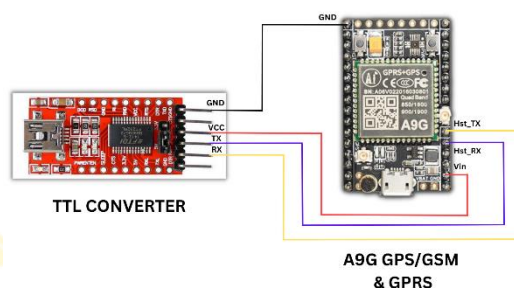

Figure 2 TX and RX Connection to burn the firmware

In the same folder, open the file "fpupgrade.exe". Click on "…", navigate to the extracted file "Ai-Thinker_A9_A9G_AT_V02.02.20190915R(2).afw" and select it. Check the following checkboxes and then click on "Start". (Note: the "Progress" should show "Connected"). Once the firmware is burnt on the module, the "Progress" should show "Passed" as in Figure 3. Disconnect the module from the PC. Then make the following changes to the connections.

Figure 3 Firmware burnt successfully

To run the AT Commands Connect the Tx to AT_Rx and the Rx to AT_Tx as seen in Figure 4. Connect the module to the PC again, and then open the "AiThinker Serial Tool V1.2.3.exe" file Select the "PortNum", and then click on "Open Serial". Once, it displays "Ready" on the serial monitor you are ready to send some AT commands to the Ai-Thinker A9G module.
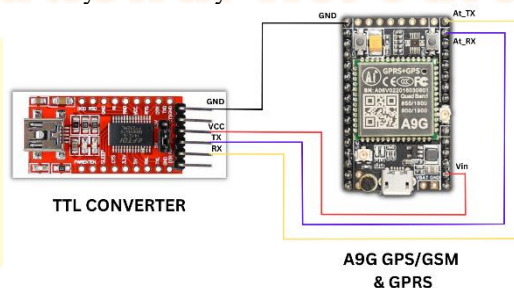

Figure 4 TX and RX Connection for running AT commands

B. AT Commands

"AT" stands for Attention and is primarily used to send commands to configure devices, that connect with MCU (multipoint control unit) and UART (universal asynchronous receiver-transmitter). It is a simple procedure in which the MCU sends commands to the GSM/GPRS module via a serial port (UART). Since the A9G module includes a bootloader, AT commands can be used to control it and transmit commands. Some AT commands that can help you with the following tasks:

Table 1 List of AT Commands for GPS and GSM

Command	Function	Note
AT+GPS=1	To enable GPS	Power on the GPS module and Start the GPS navigation
AT+GPS=0	To disable GPS	Power off the GPS module
AT+GPS=0	To start reading GPS data and display it on the monitor	The data returned by this command is in NMEA format which needs to be converted to get into a readable form.
AT+CGPSPWR	To turn on or turn off the GPS Power supply	This command is used for GPS Power Control. The available modes are: 0: OFF or 1: ON
AT+CGNSMOD=<mode>	To set the GPS navigation mode	The available modes are 0: Standalone mode 1: MS-Based mode (Mobile Station-Based) 2: MS-Assisted mode (Mobile Station-Assisted) 3: MS-Based preferred, MS-Assisted allowed 4: MS-Assisted preferred, MS-Based allowed
AT+CGNSTST=<interval>	To set the GPS NMEA output interval	Set the GPS NMEA output interval
AT+CSQ	To get the GSM signal strength	Get the GSM signal strength

Using the commands listed in Table 1, the Location in latitude and longitude format can be found as seen in Figure 5.
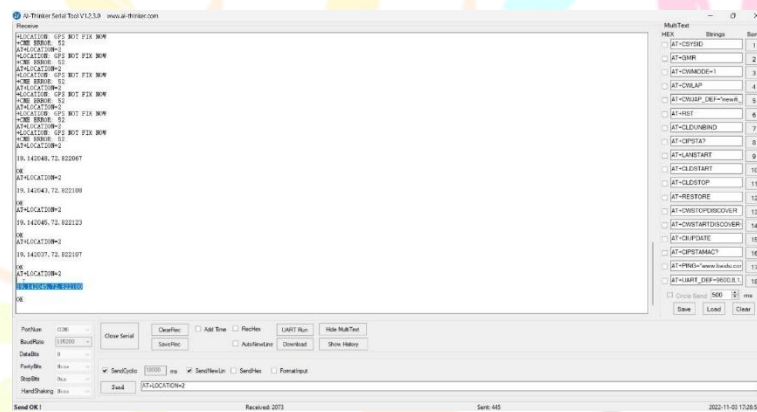

Figure 5 Location in latitude and longitude format

Similarly, commands for HTTP and Internet Connectivity can be seen in Table 2.

Table 2 List of AT commands for HTTP and Internet connectivity

Command	Function	Note
AT+CGATT=1 AT+CGDCONT=1,"IP", "<APN>" AT+CGACT=1,1	To establish a GPRS connection, attach to the GPRS network, Set the Access Point Name (APN), Activate the PDP context	Replace APN with the Access Point Name provided by your cellular network operator.
AT+CGACT=0,1	To deactivate the PDP context	-
AT+CGATT? AT+CGACT?	Check the GPRS network attachment status. Check the PDP context activation status	-
AT+HTTPINIT AT+HTTPPARA="URL", "<url>" AT+HTTPACTION=0 AT+HTTPREAD AT+HTTPTERM	Initialize the HTTP service. Set the URL of the target web page. Execute the HTTP GET request. Read the HTTP response. Terminate the HTTP service	Replace <url> with the URL of the target web page you want to access.

Table 3 shows the List of AT commands that can also be used to send and receive SMS or dial a phone number.

Table 3 AT commands for SMS and Calling functions

Command	Function	Example
ATD<number>	To dial a phone number	ATD+1234567890;
AT+CHUP	To hang up a call	-
ATA	To answer an incoming call	-
AT+CLVL=<level>	To set the audio volume	AT+CLVL=80 (The level range is 0 to 100.)
AT+CMUT=<mute>	To mute/unmute the microphone during a call	AT+CMUT=1 (to mute the microphone 0 means unmuted, and 1 means muted)
AT+CMGF=1	To send an SMS	Enter the recipient's phone number < message>
AT+CMGF=1	To read a received SMS	Set the message format to text mode AT+CMGL="ALL". List all received messages
AT+CMGD=<index>	To delete a received SMS	Delete the message with the specified index

SDK ON CHIP DEVELOPMENT

Another Method that can be used to run programs on the Ai-Thinker A9G Module is by using SDK on chip development. In this method, no external MCU is required. The firmware is burnt directly to the module. The advantage of this method is that it saves hardware resources.

A. Burning MQTT Firmware

Download the following files, "CSDTK42_Update2_18_7_27.7z" and "GPRS_C_SDK_V2129.zip" from [4], open the "CSDTK42_Update2_18_7_27" folder and run the "config_env_admin.bat" file as administrator. Open the "mqtt" folder present in the "GPRS_C_SDK_V2129/GPRS_C_SDK/demo" folder. Now open the "src" folder and open the "demo_mqtt.c" file in Notepad.

It is important to set the APN (Access Point Network) of your service provider, and MQTT server username-password. This username-password will match the MQTT dashboard details.

Similarly changes in the header file such as MQTT server IP address, port number, username, Subscribe Topic, Publish Topic, Publish Interval, and Publish Payload need to be edited. Here we have used an open MQTT server from "test.mosquitto.org".

The next step is to run the "./build.bat demo mqtt" command in the administrative Powershell in the project directory where the MQTT file is present. Connect the TTL converter and the Ai-Thinker A9G module as seen in Figure 2. Using the software "coolwatcher.exe" set the profile as 8955 and click "ok". This will prompt a new window stating module is connected successfully. Set the flash programmer file and LOD file, then click burn. After burning, select the second LOD file and then burn it again. After burning is complete, activate the tracer from the plugin's menu and set the trace levels. Then start the tracer. The module first attempt to register to the network, and then publish data on the MQTT server as seen in Figure 7.
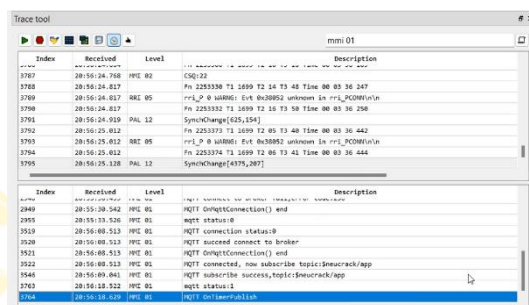

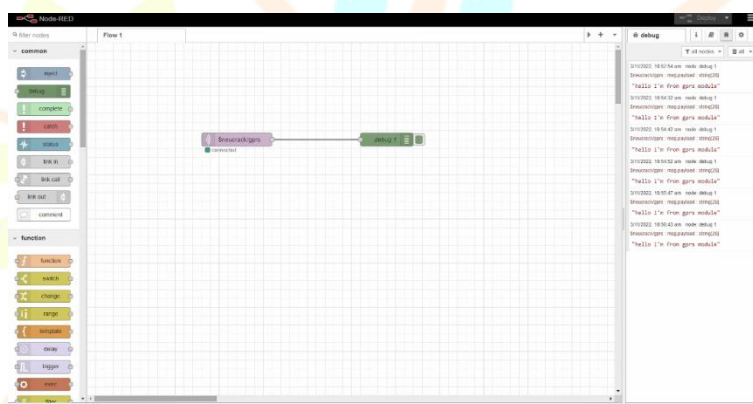Figure 6 MQTT connection succeeded

Figure 7 Node-Red MQTT Connection and Output

Using an MQTT dashboard the data sent from the Ai-Thinker A9G can be viewed. The MQTT dashboard must use the same username-password and the publish topic. This establishes a connection between the two devices. Thus, being able to view the published data on a dashboard.

Here we have used node-red along with the MQTT block. This allows us to establish an MQTT connection directly to the module, and thus view the message published by the device i.e., the Ai-Thinker A9G module.

APPLICATIONS

Using Features like GPS and GPRS to establish remote connections as described in the paper, applications such as remote monitoring and tracking. This makes the Ai-Thinker A9G module the ideal board due to its small size and low power needs.

CONCLUSION

This paper gives a detailed explanation of the Ai-Thinker A9G, its setup process as well as using AT Commands and SDK to enable features like GPS to get location as well as using MQTT to establish a remote connection to publish and read data using a dashboard.

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