Atomic GPS Base Arduino Tutorial

1. Preparation

- Environment setup: Refer to Arduino IDE Quick Start to complete IDE installation, install the corresponding board package for the development board in use, as well as the required driver libraries.
- Required libraries:
  - M5Unified
  - M5GFX
  - TinyGPSPlus

> **Note**
>
> You need to download the library version adapted for M5Stack devices from GitHub. Library link: TinyGPSPlus - M5Stack GitHub. Do not download from the Arduino Library Manager. (If you have questions, refer to this tutorial)

- Required hardware products:
  - AtomS3R
  - Atomic GPS Base

2. Example Program

- In this tutorial, the main controller is AtomS3R paired with the Atomic GPS Base. The GPS module in this base communicates via UART, **but the main controller can only receive data returned by the module** and cannot send data to it. The microSD card part communicates via SPI. Modify the pin definitions in the program according to the actual wiring; when stacked, the corresponding IOs are `G5 (RX)`, `G6 (MOSI)`, `G7 (CLK)`, and `G8 (MISO)`.

2.1 GPS Data Acquisition

Note

The baud rate of this GPS module is fixed at 9600 and cannot be changed; otherwise, data cannot be effectively obtained.

cpp

```cpp
#include "M5Unified.h"
#include "M5GFX.h"
#include "MultipleSatellite.h"

static const int RXPin = 5, TXPin = -1;// RXPin should be connected to GPS TX, TXPin is not used in

MultipleSatellite gps(Serial2, 9600, SERIAL_8N1, RXPin, TXPin);// Baud rate is fixed at 9600 for thi

void setup() {
    M5.begin();
    Serial.begin(115200);
    gps.begin();
    Serial.println(F("A simple demonstration of TinyGPSPlus with Atomic GPS Base"));
    Serial.print(F("Testing TinyGPSPlus library v. "));
    Serial.println(TinyGPSPlus::libraryVersion());
    Serial.println();
    delay(1000);
    M5.Display.setFont(&fonts::FreeMonoBold9pt7b);
}

void loop() {
    // Update data
    gps.updateGPS();
    displayInfo();
    delay(100);
}

void displayInfo(void) {
    Serial.print(F("Location: "));
    Serial.printf("satellites:%d\n", gps.satellites.value());

    if (gps.location.isUpdated()) {
        Serial.print(gps.location.lat(), 6);
        Serial.print(F(","));
        Serial.print(gps.location.lng(), 6);
        Serial.print(F("\n"));

        M5.Display.fillRect(0, 0, 128, 128, BLACK);
        M5.Display.setCursor(0, 0);
        M5.Display.printf("Sat: %d\nLat: %d\nlng: %d\n",
                          (uint8_t)gps.satellites.value(),
                          (uint8_t)gps.location.lat(),
                          (uint8_t)gps.location.lng());
    } else {
        M5.Display.fillRect(0, 0, 128, 128, BLACK);
        M5.Display.setCursor(0, 0);
        M5.Display.print("Sat: ----\n");
        M5.Display.print("Lat: ----\n");
        M5.Display.print("Lng: ----\n");
        Serial.print(F("Location no update\n"));
```

```
    }

    Serial.print(F("Date/Time: "));
    if (gps.date.isUpdated()) {
        Serial.print(gps.date.month());
        Serial.print(F("/"));
        Serial.print(gps.date.day());
        Serial.print(F("/"));
        Serial.print(gps.date.year());
        M5.Display.fillRect(0, 80, 128, 128, BLACK);
        M5.Display.setCursor(0, 80);
        M5.Display.printf("%d/%d/%d\n", gps.date.month(),
                          gps.date.day(), gps.date.year());
    } else {
        Serial.print(F("Date no update"));
    }

    Serial.print(F(" "));
    if (gps.time.isUpdated()) {
        if (gps.time.hour() < 10) Serial.print(F("0"));
        Serial.print(gps.time.hour());
        Serial.print(F(":"));
        if (gps.time.minute() < 10) Serial.print(F("0"));
        Serial.print(gps.time.minute());
        Serial.print(F(":"));
        if (gps.time.second() < 10) Serial.print(F("0"));
        Serial.print(gps.time.second());
        Serial.print(F("."));
        if (gps.time.centisecond() < 10) Serial.print(F("0"));
        Serial.print(gps.time.centisecond());
        M5.Display.fillRect(0, 128, 128, 60, BLACK);
        M5.Display.setCursor(0, 96);
        M5.Display.printf("Time: \n%d:%d:%d.%d", gps.time.hour(), gps.time.minute(),
                          gps.time.second(),gps.time.centisecond());
    } else {
        Serial.print(F("Time no update"));
    }
    Serial.println();
    delay(1000);
}
```

2.2 SD Card Read/Write

cpp

```cpp
#include <SPI.h>
#include <SD.h>
#include <M5Unified.h>
#include <M5GFX.h>

// ------------------- Pin Definitions -------------------
#define SD_SPI_CS_PIN     -1   // Chip Select pin
#define SD_SPI_SCK_PIN    7    // SPI Clock pin
#define SD_SPI_MISO_PIN   8    // SPI MISO pin
#define SD_SPI_MOSI_PIN   6    // SPI MOSI pin

// Function prototypes
void listDir(fs::FS &fs, const char * dirname, uint8_t levels);// List contents of a directory (sup
void createDir(fs::FS &fs, const char * path);// Create a new directory
void removeDir(fs::FS &fs, const char * path);// Remove an existing directory (must be empty)
void readFile(fs::FS &fs, const char * path);// Read contents of a file and print to serial
void writeFile(fs::FS &fs, const char * path, const char * message);// Write content to a file (ove
void appendFile(fs::FS &fs, const char * path, const char * message);// Append content to the end o
void renameFile(fs::FS &fs, const char * path1, const char * path2);// Rename a file from path1 to
void deleteFile(fs::FS &fs, const char * path);// Delete a file
void testFileIO(fs::FS &fs, const char * path);// Test file I/O speed (read and write performance)

void setup() {
  M5.begin();
  M5.Display.clear();
  M5.Display.setFont(&fonts::FreeMonoBold9pt7b);
  Serial.begin(115200);
  Serial.println("<-------microSD Example------->");

  // ------------------- SD Card Initialization -------------------
  // Initialize SPI bus with specified pins (SCK, MISO, MOSI, CS)
  SPI.begin(SD_SPI_SCK_PIN, SD_SPI_MISO_PIN, SD_SPI_MOSI_PIN, SD_SPI_CS_PIN);
  Serial.println("SD Init...");
  M5.Display.drawCenterString("SD Init...", 64, 0);

  // Attempt to initialize SD card with 25MHz SPI clock speed
  if (!SD.begin(SD_SPI_CS_PIN, SPI, 25000000)) {
    Serial.println("SD Error!");
    M5.Display.clear();
    M5.Display.drawCenterString("SD Error!", 64, 50);
    while (1);  // Infinite loop prevents further execution on failure
  } else {
    Serial.println("SD Ready");
    M5.Display.clear();
    M5.Display.drawCenterString("SD Ready", 64, 0);
  }

  // Get the type of SD card inserted
  uint8_t cardType = SD.cardType();
  if(cardType == CARD_NONE){
```

```
    Serial.println("No SD card attached");
    return;  // Exit setup() early if no card is present
  }
  M5.Display.setTextColor(TFT_YELLOW);
  Serial.print("SD Card Type: ");
  if(cardType == CARD_MMC){
    Serial.println("MMC");
    M5.Display.drawString("MMC", 5, 20);
  } else if(cardType == CARD_SD){
    Serial.println("SDSC");  // Standard Capacity SD card (<=2GB)
    M5.Display.drawString("SDSC", 5, 20);
  } else if(cardType == CARD_SDHC){
    Serial.println("SDHC");  // High Capacity SD card (2GB-32GB)
    M5.Display.drawString("SDHC", 5, 20);
  } else {
    Serial.println("UNKNOWN");  // Unrecognized card type
    M5.Display.drawString("UNKNOWN", 5, 20);
  }

  // Calculate total and used SD card capacity in MB (1MB = 1024*1024 bytes)
  uint64_t cardSize = SD.totalBytes() / (1024 * 1024);
  uint64_t usedSize = SD.usedBytes() / (1024 * 1024);
  Serial.printf("SD Card Size: %lluMB\n", cardSize);
  Serial.printf("SD Card Uesd Size: %lluMB\n", usedSize);
  M5.Display.setCursor(5, 40);
  M5.Display.printf("%llu/%lluMB", usedSize, cardSize);
  // Some delay is required here to ensure that the code above is executed completely; otherwise, t
  delay(500);

  // Execute a sequence of SD card operations to demonstrate functionality
  listDir(SD, "/", 0);          // List root directory (non-recursive)
  createDir(SD, "/mydir");      // Create a new directory named "mydir"
  listDir(SD, "/", 0);          // List root directory again to verify creation
  removeDir(SD, "/mydir");      // Delete the "mydir" directory
  listDir(SD, "/", 2);          // List root directory with 2 levels of recursion
  writeFile(SD, "/hello.txt", "Hello ");  // Create "hello.txt" and write initial content
  appendFile(SD, "/hello.txt", "World!\n");  // Append content to "hello.txt"
  readFile(SD, "/hello.txt");   // Read and print content of "hello.txt"
  renameFile(SD, "/hello.txt", "/test.txt");  // Rename "hello.txt" to "test.txt"
  readFile(SD, "/test.txt");    // Read renamed file to verify
  testFileIO(SD, "/test.txt");  // Test read/write speed of "test.txt"
  // Print final total and used space after all operations
  Serial.printf("Total space: %lluMB\n", SD.totalBytes() / (1024 * 1024));
  Serial.printf("Used space: %lluMB\n", SD.usedBytes() / (1024 * 1024));
  deleteFile(SD, "/test.txt");  // Delete the test file to clean up
}

void loop() {
}

// ------------------- Directory Listing Function -------------------
// fs: File system object (e.g., SD for SD card)
// dirname: Path of the directory to list
```

```
// levels: Number of recursive levels to list (0 = only current directory)
void listDir(fs::FS &fs, const char * dirname, uint8_t levels){
  Serial.printf("Listing directory: %s\n", dirname);

  File root = fs.open(dirname);
  if(!root){
    Serial.println("Failed to open directory");
    return;
  }
  // Verify the opened object is a directory (not a file)
  if(!root.isDirectory()){
    Serial.println("Not a directory");
    return;
  }

  // Open the first file/directory in the target directory
  File file = root.openNextFile();
  // Iterate through all files/directories in the target directory
  while(file){
    if(file.isDirectory()){
      Serial.print("  DIR : ");
      Serial.println(file.name());
      // Recursively list subdirectories if levels > 0
      if(levels){
        listDir(fs, file.name(), levels - 1);
      }
    } else {
      Serial.print("  FILE: ");
      Serial.print(file.name());
      Serial.print("  SIZE: ");
      Serial.println(file.size());
    }
    // Move to the next file/directory
    file = root.openNextFile();
  }
}

// ------------------- Directory Creation Function -------------------
// fs: File system object
// path: Full path of the directory to create
void createDir(fs::FS &fs, const char * path){
  Serial.printf("Creating Dir: %s\n", path);
  if(fs.mkdir(path)){
    Serial.println("Dir created");
  } else {
    Serial.println("mkdir failed");
  }
}

// ------------------- Directory Removal Function -------------------
// fs: File system object
// path: Full path of the directory to remove (must be empty)
void removeDir(fs::FS &fs, const char * path){
```

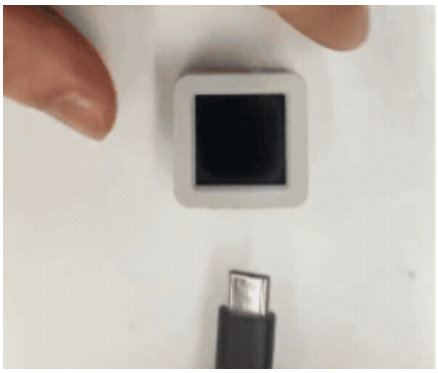
```
  Serial.printf("Removing Dir: %s\n", path);
  if(fs.rmdir(path)){
    Serial.println("Dir removed");
  } else {
    Serial.println("rmdir failed");  // Failure may occur if directory not empty
  }
}

// ------------------ File Reading Function ------------------
// fs: File system object
// path: Full path of the file to read
void readFile(fs::FS &fs, const char * path){
  Serial.printf("Reading file: %s\n", path);

  // Open file in read mode (default mode for fs.open())
  File file = fs.open(path);
  if(!file){
    Serial.println("Failed to open file for reading");
    return;
  }
  Serial.print("Read from file: ");
  // Read all available bytes from file and print to serial
  while(file.available()){
    Serial.write(file.read());
  }
  file.close();
}

// ------------------ File Writing Function ------------------
// fs: File system object
// path: Full path of the file to write
// message: Content to write to the file (overwrites existing content)
void writeFile(fs::FS &fs, const char * path, const char * message){
  Serial.printf("Writing file: %s\n", path);

  // Open file in write mode (creates file if it doesn't exist, overwrites if it does)
  File file = fs.open(path, FILE_WRITE);
  if(!file){
    Serial.println("Failed to open file for writing");
    return;
  }
  if(file.print(message)){
    Serial.println("File written");
  } else {
    Serial.println("Write failed");
  }
  file.close();
}

// ------------------ File Appending Function ------------------
// fs: File system object
// path: Full path of the file to append to
// message: Content to add to the end of the file
```

```
210 void appendFile(fs::FS &fs, const char * path, const char * message){
211   Serial.printf("Appending to file: %s\n", path);
212 
213   // Open file in append mode (preserves existing content, writes to end)
214   File file = fs.open(path, FILE_APPEND);
215   if(!file){
216     Serial.println("Failed to open file for appending");
217     return;
218   }
219   if(file.print(message)){
220     Serial.println("Message appended");
221   } else {
222     Serial.println("Append failed");
223   }
224   file.close();
225 }
226 
227 // ------------------- File Renaming Function -------------------
228 // fs: File system object
229 // path1: Current path/name of the file
230 // path2: New path/name for the file
231 void renameFile(fs::FS &fs, const char * path1, const char * path2){
232   Serial.printf("Renaming file %s to %s\n", path1, path2);
233 
234   if (fs.rename(path1, path2)) {
235     Serial.println("File renamed");
236   } else {
237     Serial.println("Rename failed");  // Failure may occur if target path exists
238   }
239 }
240 
241 // ------------------- File Deletion Function -------------------
242 // fs: File system object
243 // path: Full path of the file to delete
244 void deleteFile(fs::FS &fs, const char * path){
245   Serial.printf("Deleting file: %s\n", path);
246 
247   if(fs.remove(path)){
248     Serial.println("File deleted");
249   } else {
250     Serial.println("Delete failed");  // Failure may occur if file doesn't exist
251   }
252 }
253 
254 // ------------------- File I/O Speed Test Function -------------------
255 // fs: File system object
256 // path: Full path of the file to use for testing
257 void testFileIO(fs::FS &fs, const char * path){
258   File file = fs.open(path);
259   // 512-byte buffer for read/write operations (matches typical sector size)
260   static uint8_t buf[512];
261   size_t len = 0;
262   uint32_t start = millis();  // Record start time for timing
```

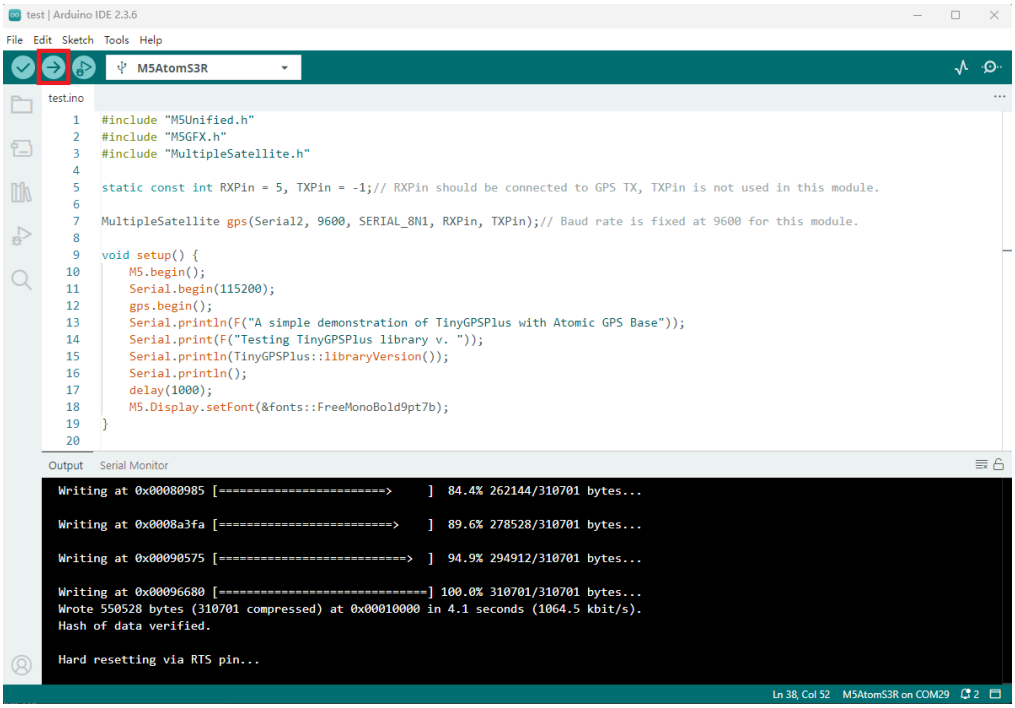
```
  uint32_t end = start;

  // ------------------- Read Speed Test ------------------
  if(file){
    len = file.size();
    size_t flen = len;  // Store original length for output
    start = millis();   // Reset start time for read test
    // Read file in 512-byte chunks (optimizes for sector size)
    while(len){
      size_t toRead = len;
      if(toRead > 512){
        toRead = 512;
      }
      file.read(buf, toRead);  // Read chunk into buffer
      len -= toRead;           // Decrement remaining bytes to read
    }
    // Calculate total read time and print results
    end = millis() - start;
    Serial.printf("%u bytes read for %u ms\n", flen, end);
    file.close();  // Close file after read test
  } else {
    Serial.println("Failed to open file for reading");
  }

  // ------------------- Write Speed Test ------------------
  // Open file in write mode (overwrites existing content)
  file = fs.open(path, FILE_WRITE);
  if(!file){
    Serial.println("Failed to open file for writing");
    return;
  }

  size_t i;
  start = millis();  // Reset start time for write test
  // Write 2048 chunks of 512 bytes (total 1MB of data)
  for(i=0; i<2048; i++){
    file.write(buf, 512);
  }
  // Calculate total write time and print results
  end = millis() - start;
  Serial.printf("%u bytes written for %u ms\n", 2048 * 512, end);
  file.close();  // Close file after write test
}
```

3. Compile and Upload

- Download mode: Devices must enter download mode before program flashing; this varies with the main controller. See the Arduino IDE Quick Start page's device program download tutorial list for specific instructions.
- For AtomS3R, press and hold the reset button (about 2 seconds) until the internal green LED lights up, then release. The device is now in download mode and ready for flashing.



- Select the device port, click the compile/upload button in the top left of Arduino IDE, and wait for compilation and upload to complete.



4. Example Output

- Satellite Positioning: This product uses a built-in antenna without an external one, so use outdoors in open areas like playgrounds or rooftops. First-time satellite acquisition is slow, taking several minutes. Please be patient while the device searches for satellites and obtains coordinates.

- SD Card Read/Write: After powering on, the screen displays as shown below. Operations such as creating, reading, and deleting folders/files on the card are printed to the serial monitor.

> **Note**
>
> 1. Ensure a microSD card formatted as **FAT32** is correctly inserted before running this example. 2. In this demonstration, the microSD card is blank. The "System Volume Information" folder appearing in the serial output is an automatically generated hidden folder by the OS when connected to a computer and can be ignored. To delete it, enable hidden file display on your computer and remove it.

Serial output:

```
<-------microSD Example------->
SD Init...
SD Ready
SD Card Type: SDHC
SD Card Size: 15185MB
SD Card Uesd Size: 0MB
Listing directory: /
  DIR : System Volume Information
Creating Dir: /mydir
Dir created
Listing directory: /
  DIR : System Volume Information
  DIR : mydir
Removing Dir: /mydir
Dir removed
Listing directory: /
  DIR : System Volume Information
Listing directory: System Volume Information
Failed to open directory
Writing file: /hello.txt
File written
Appending to file: /hello.txt
Message appended
Reading file: /hello.txt
Read from file: Hello World!
Renaming file /hello.txt to /test.txt
File renamed
Reading file: /test.txt
Read from file: Hello World!
13 bytes read for 1 ms
1048576 bytes written for 866 ms
Total space: 15185MB
Used space: 1MB
Deleting file: /test.txt
File deleted
```