START HERE

01

Send by BLE; verify by Wi-Fi

Use Bluetooth Low Energy (BLE) to deliver training Wi-Fi settings to your ESP32-S3. Then prove a fresh startup joins the router. Allow about 30 minutes, including practice.

Recognize what you need



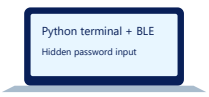
ESP32-S3-N16R8 board

MicroPython v1.29, SPIRAM_OCT; leave peripherals disconnected.



USB data cable

Power, install and recovery through native USB.



Computer with BLE

Python 3.13, a terminal and a working Bluetooth adapter.



Training router

Isolated 2.4 GHz WPA2-Personal network with DHCP enabled.

> **Use non-sensitive training credentials only.** This simple lab link does not enforce authenticated encryption. Nearby devices could read or replace its traffic. Do not use a home, school or work password. Stored settings are plain text.

First complete ML-C03/04 USB setup and ML-C09 backup/recovery. The worked desktop route uses Bleak 3.0.2 on Windows 11 build 22000+, macOS 10.15+, or Linux with BlueZ 5.55+. Allow Bluetooth access for your terminal/Python. No phone app is required.

THE IDEA

02

Follow the two radio paths

The computer is the **BLE client**: it discovers and sends. The board is the **peripheral**: it offers the setup service. The board then becomes a Wi-Fi **station**, joining your router.

1 · Computer → board

BLE carries the settings.



USB supplies power + recovery.

2 · Board → router

Wi-Fi joins the network.



BLE connected ≠ Wi-Fi connected.

Two different links do two different jobs. A BLE connection alone says nothing about the router connection.

Use the supplied application

These files implement the **Molo-C12 lab protocol, version 1**. Stock MicroPython does not automatically interpret these commands or this filename. Keep the example files together.

On the board

`main.py` starts `ble_setup.py`. `protocol.py` validates commands; `lab_config.py` validates the saved file.

On the computer

`ble_client.py` scans, checks the service, subscribes, hides password entry and shows only redacted status notifications.

Point and explain: trace the path that carries credentials, then the path that obtains an IP address. The USB cable stays connected for power and recovery.

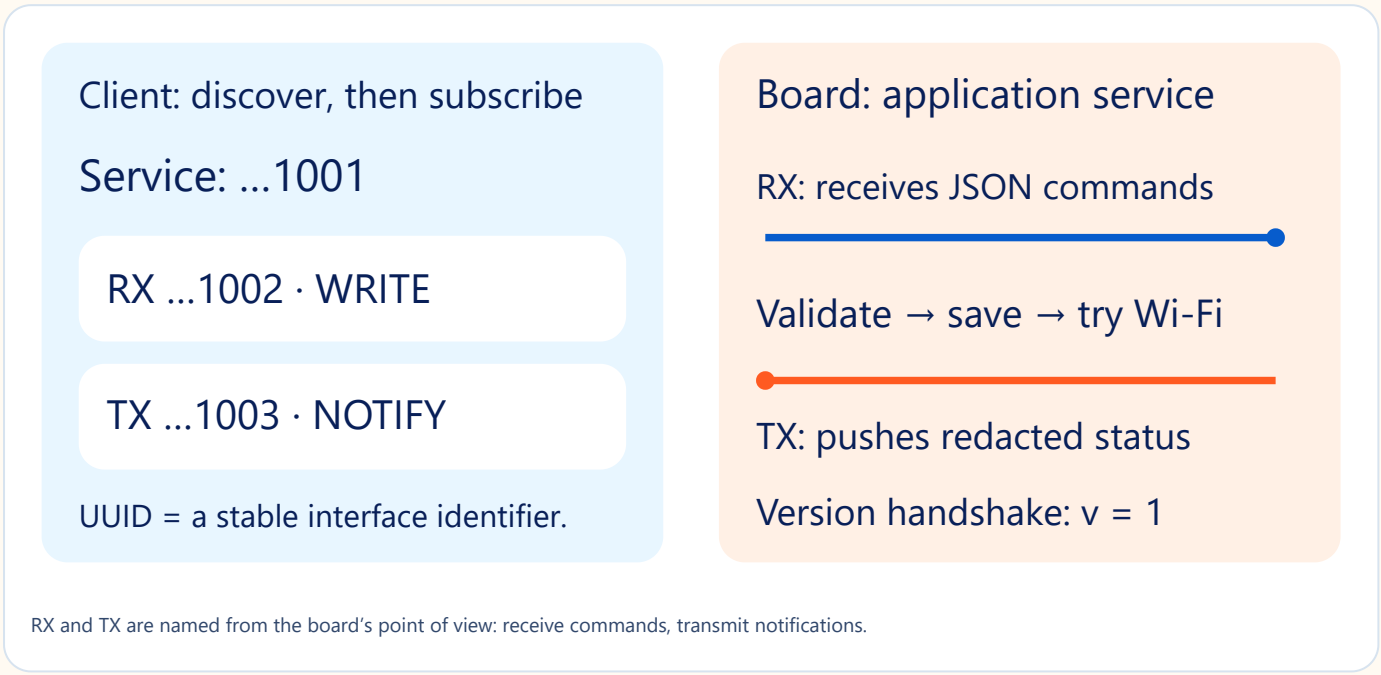
lab_config.py protocol.py ble_setup.py main.py ble_client.py README.md test_lab.py

GATT CONTRACT

Match the service before writing

03

GATT organizes a BLE application into services and characteristics. A characteristic is a named data endpoint. A **UUID** identifies the service or endpoint; it is safer than reusing an old numeric handle.



RX and TX are named from the board's point of view: receive commands, transmit notifications.

Endpoint	Exact UUID / required property
Service	`b6201001-3e67-4d7b-a469-d9aa8c120001`
RX	`b6201002-3e67-4d7b-a469-d9aa8c120001` WRITE with response
TX	`b6201003-3e67-4d7b-a469-d9aa8c120001` NOTIFY

Before any credential write: the client must find this service and both properties, subscribe to TX, then send `{"op":"hello"}` and receive `v: 1, state: ready`. A matching name alone is not identity or security proof.

FRAMING

04

Small packets; complete messages

A message can be longer than one BLE transfer. Our client writes at most **20 bytes** per piece, with a response, and the board sends notifications in the same small pieces. The newline marks the end of a message.

Write one complete command

JSON bytes + newline (LF)

1 · ≤20 | 2 · ≤20 | 3 · ≤20

Fragments can split UTF-8 bytes.

Never decode each fragment alone.

Notify one complete status

Reassemble bytes until LF.

```
{"v": 1,
"state": "saved", ...}
```

384-byte frame limit; no secrets.

Collect bytes first. Decode UTF-8 and JSON only after a complete newline-terminated frame arrives.

Use one bounded, documented format

```
{"op":"configure","config":{
  "schema":1,"ssid":"TRAINING-NAME",
  "password":"HIDDEN INPUT FROM CLIENT"
}}
```

This is a **shape example**, not a command to paste with a real password. The client constructs it in memory. The config has exactly three fields: schema 1, a 1–32 UTF-8-byte SSID and an 8–63 printable ASCII WPA2 passphrase. A frame is limited to 384 bytes.

> **Do not print received bytes or enable packet/debug logging.** Notifications contain only `v`, `state` and `configured`. If a message is incomplete, malformed or lost, reconnect and request a fresh status. Never treat an ATT write response as Wi-Fi success.

USB PREPARATION

05

Install without losing your work

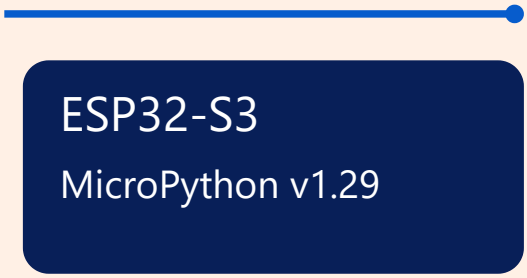
Work from the supplied `examples` folder. Use one board and one USB cable. Front view: antenna up, USB sockets down; native **USB is left**, COM is right. Use native USB.

Computer: examples folder

Back up matching board files first.

- lab_config.py
- protocol.py
- ble_setup.py
- main.py

Native USB · front LEFT



RST starts main.py normally.

Copy helpers first and main.py last. This application replaces what runs at startup.

1. Install desktop tools: `py -m pip install bleak==3.0.2 mpremote`. On macOS/Linux use `python3` in place of `py`.
2. Run `py -m mpremote connect list`. Replace `PORT` below with your runtime serial port. Close other serial programs.
3. List files, then back up every existing file you will replace to a private folder. For example:

```
py -m mpremote connect PORT fs ls
py -m mpremote connect PORT fs cp :main.py main-before-c12.py
py -m mpremote connect PORT fs cp lab_config.py protocol.py ble_setup.py :
py -m mpremote connect PORT fs cp main.py :main.py
```

Repeat the backup direction for an existing lab_config.py, protocol.py or ble_setup.py. Do not overwrite a local backup. If main.py is absent, record that; other backup errors must be resolved before installation. Treat any /lab_wifi.json backup as secret. Keep boot.py unchanged.

> **Start normally:** release BOOT and press upper RST. Wait about 20 seconds if a config already exists. Do not leave a REPL interrupt active. Rediscover the serial port after reset if USB recovery is needed.

FIRST CONFIGURATION

06

Subscribe, then send once

Enable Bluetooth, allow your terminal/Python to use it and close other BLE clients. Power only your training board nearby. The desktop script stops if it sees zero or several matching boards.

Subscribe before sending

1 Discover UUIDs + properties

2 start_notify(TX, callback)

3 Send hello → receive v1 ready

4 Send configure in ≤20B pieces

Notification, not a read loop

Board status changes



Client callback receives it

start_notify installs a callback. Status arrives when the board sends it; this is not repeated characteristic reading.

```
py ble_client.py
```

1. Confirm the one training board by typing YES.
2. Enter the training SSID, then the password at the hidden prompt. If hidden entry is unavailable, the client stops; use an ordinary terminal.
3. The script checks UUIDs/properties, subscribes to TX and verifies the version handshake before sending the configuration.
4. Read the notification sequence. Do not open a second app to inspect the same board during this attempt.

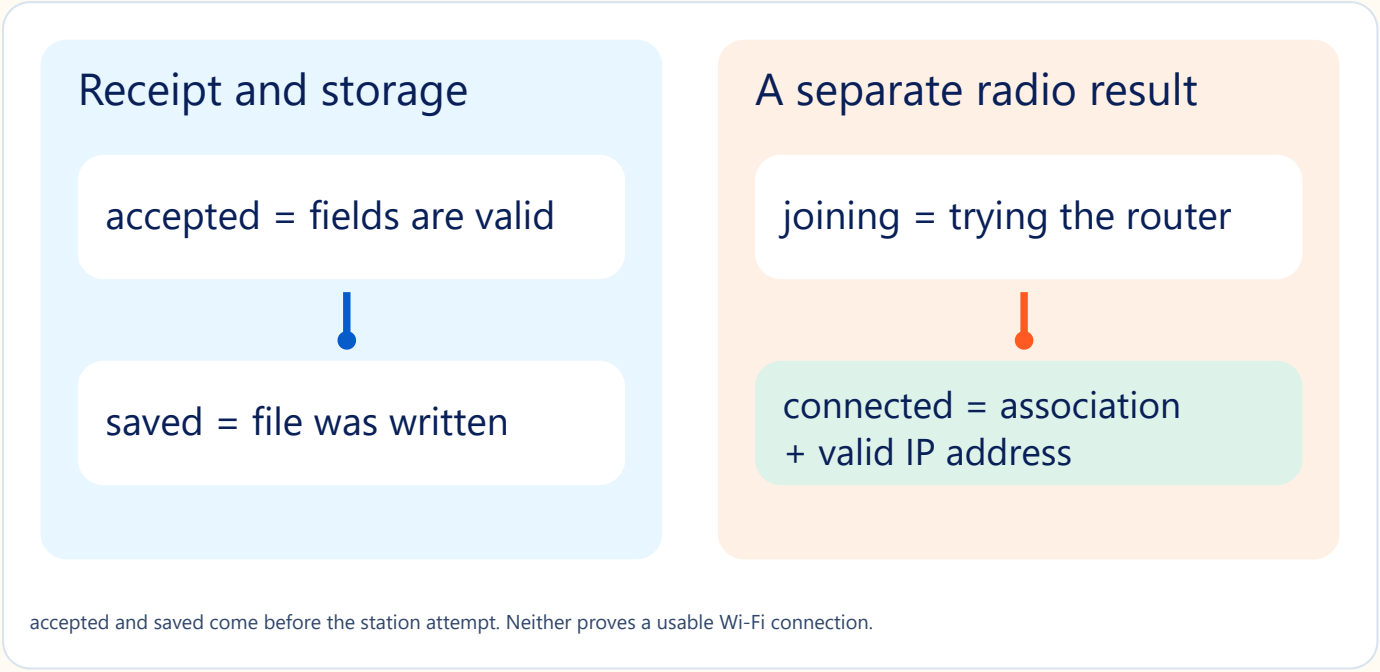
No output after sending? Allow up to 25 seconds for the client's result. A lost notification or dropped link is an incomplete result. Stop, reconnect using `--status` and inspect the current state. Do not blindly resend credentials.

VISIBLE RESULTS

07

Read what each result proves

A write response acknowledges a BLE transfer. The application notifications explain the later stages. The examples below show the **expected sequence** for a successful attempt.



accepted and saved come before the station attempt. Neither proves a usable Wi-Fi connection.

```
{"v":1,"state":"accepted","configured":false}
{"v":1,"state":"saved","configured":true}
{"v":1,"state":"joining","configured":true}
{"v":1,"state":"connected","configured":true}
```

`configured` means a valid saved file exists. It can already be true on a replacement attempt. **connected** uses MicroPython's station `isconnected()`: associated with an access point and holding a valid IP address. It does not prove Internet access or reachability of a particular server.

> **Success check:** see accepted, saved and connected from one complete attempt. Then perform the restart test on the next page; a live connection alone does not prove the file will be used at startup.

PERSISTENCE TEST

Prove the saved settings restart

08

The board saves the same `/lab_wifi.json` schema used in ML-C09 and ML-C11. The startup app explicitly loads it. Test that path without sending the password again.

After a successful send

Close the BLE client.

Press RST; BOOT released.

Wait about 20 seconds.

The saved file drives this attempt.

A fresh connection

ble_client.py --status

state: connected

No credentials sent again.

Saved data survived the restart.

A fresh BLE session asks for a redacted snapshot after normal startup.

1. Let the configuration client finish and disconnect.
2. Press upper **RST** with lower **BOOT released**. Wait about 20 seconds for the bounded station attempt.
3. Run the status-only command below, confirm your board and read its notification.

```
py ble_client.py --status
Expected: {"v":1,"state":"connected","configured":true}
```

connected + true

The normal-startup attempt used a valid saved file and reached station connection with an IP. No credential message was sent in this check.

saved / joining / timeout

Wait if still joining; reconnect for another snapshot. A timeout still needs network troubleshooting. missing means no valid saved config was loaded.

> The app keeps advertising for this training exercise. After the lab, clear the training settings and restore your previous startup files. A production design also needs authenticated setup, limited access and an explicit provisioning lifecycle.

APP AND OS CACHE

09

Recover a stale service table

After a firmware or service change, the client or operating system can remember an old GATT table. A familiar board name may then show missing or wrong endpoints. Stop before sending credentials.

Stale client / OS table

Old UUID / missing NOTIFY

Wrong characteristic handle

STOP before sending credentials.

Reopening the app may not clear OS.

Recover, then verify again

Disconnect other BLE clients.

Remove stale device cache if needed.

Rescan → inspect UUIDs/properties.

Subscribe → v1 ready → configure.

Never guess a handle number.

Reconnecting the application and removing an OS cache are different actions. Always rediscover and verify afterward.

1. Close all BLE apps/scripts, disconnect and press RST. Confirm the intended ML-C12 files are installed. Rescan using the supplied client.
2. If a general BLE app is used for inspection, refresh its services or clear that app's saved device entry. Do not write arbitrary handles.
3. If the OS still returns the old table, use its device-removal controls. On Linux BlueZ 5.62+, remove only the identified board with `bluetoothctl -- remove BOARD_ADDRESS`, then rescan. Earlier BlueZ caches may need administrator help.
4. On Windows, remove the board's saved Bluetooth device entry if one exists, then rescan. macOS cache removal has no universal Bleak recipe: restart the client/Bluetooth and use USB to confirm the app; get platform help if the mismatch persists.

> **Gate the next attempt:** correct service UUID, RX WRITE, TX NOTIFY, then subscribe and receive version 1 ready. If any check fails, keep credentials unsent and use USB recovery.

FINISH THE LAB

Practise failure and recovery

10

saved → joining → timeout

File exists; Wi-Fi did not finish.

Check 2.4 GHz WPA2 settings.

Check spelling, range and DHCP.

Reconnect BLE and send corrected data.

USB remains the fallback

Stop client; attach native USB.

Interrupt the app at the REPL.

Clear only /lab_wifi.json if needed.

RST → missing → reconfigure.

Delete is not secure flash erasure.

The station attempt stops after 15 seconds. A timeout does not invalidate a successfully saved file.

Visible result	Next action
missing / invalid	Check schema and reconfigure; never display the raw saved file.
save_failed	Stop; use USB to check free space and files. Do not claim settings were saved.
timeout / connect_failed	Check training router power, 2.4 GHz WPA2, SSID/password, range and DHCP. Retry corrected data once the prior attempt ends.
busy	Wait for the current attempt, then reconnect and request status.

Explain before acting

A: saved followed by timeout. Which stage succeeded, and what do you check next? **B:** RX exists but TX lacks NOTIFY. Should you send the password?

Check your answers: A: storage succeeded; the station join/IP stage did not. Check the training network. B: no; recover/verify the GATT table first.

Clear training data and restore

Stop the BLE client. Connect native USB, open `py -m mpremote connect PORT repl` and press Ctrl-C. At the REPL:

```
import lab_config
print(lab_config.clear())
```

This removes only /lab_wifi.json and stops the station; it does not securely erase flash or other backups. Exit with Ctrl-], restore your backed-up startup/helper files, or remove only the course files that did not exist before. Press RST. Keep a USB recovery path available.