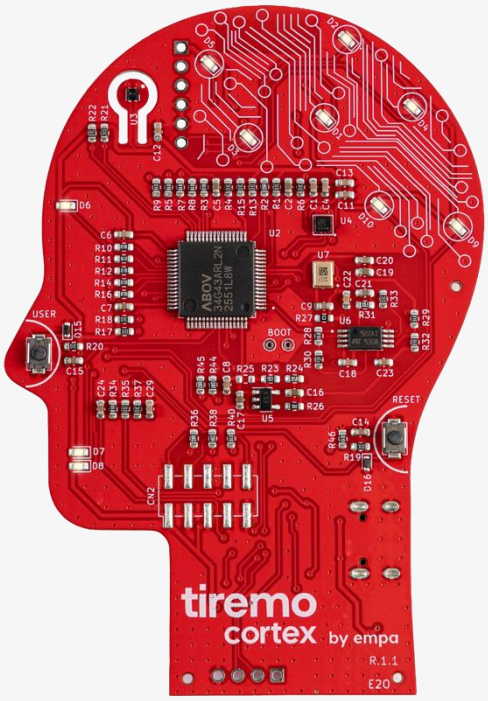
PRODUCT DATASHEET

tiremo cortex

Edge AI & Cloud-IoT Development Board



tiremo.cortex R.1.1

Product Overview

tiremo.cortex is an embedded development board based on the ABOV A34G43ARL2N microcontroller, designed for edge AI, IoT, sensor processing, and wireless applications. The board combines on-device AI inference with motion, environmental, and audio sensing, while providing integrated wireless connectivity and on-board debugging.

- ABOV A34G43ARL2N · 200 MHz Cortex-M4F · 2 MB Flash · 256 KB SRAM
- USB Type-C® · A-LINK SWD programmer
- ESP32-C3-MINI · 2.4 GHz Wi-Fi · Bluetooth 5 LE
- LIS2DE12 accelerometer · SHT40 temperature & humidity
- MP23ABS1 analog MEMS microphone · 10 user LEDs
- USER & RESET buttons · *tiremo* Intelligence ready

M4F	2 MB Flash	Wi-Fi + BLE	3 Sensors	A-LINK

Get your first project running

https://github.com/Empa-Electronics/Tiremo-Cortex-Tutorials · See §13 How To Start

Contents

Document structure for Tiremo® Cortex product datasheet

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1. General Description

Edge intelligence, cloud scale — one board for AIoT development

Tiremo® Cortex is the device-layer hardware of the Tiremo® AIoT platform, developed by Empa Electronics R&D. It provides a unified platform for acquiring sensor data, performing on-device processing and AI inference, and communicating application data over wireless networks.

The board is intended for rapid development and evaluation of embedded AIoT applications, from sensor-driven prototypes to connected edge devices. Applications can be developed, tested, and deployed on the same hardware platform.

The following sections provide detailed information on the hardware architecture, peripherals, interfaces, power system, programming, and software support.

1.1 Typical applications

Gesture / Motion Recognition

Real-time classification from motion data

Environment Monitoring

Temperature and humidity telemetry

Smart Building

Local sensing with wireless reporting

Asset Tracking

Movement detection with remote status reporting

Predictive Maintenance

Vibration and audio anomaly monitoring

Voice Trigger

Audio Pattern Recognition

Wearable Prototyping

Compact, motion-focused experiments

Education / Workshop

Teaching, demonstrations, and accelerator programs

2. Key Features

Hardware highlights at a glance

MCU

ABOV A34G43ARL2N · Arm® Cortex®-M4F · Up to 200 MHz · 2 MB Dual-Bank Flash · 256 KB SRAM · 32 KB Data Flash

Wireless

ESP32-C3-MINI-1 · 2.4 GHz Wi-Fi · Bluetooth 5 LE

Debug & Programming

A-LINK on-board programmer/debugger · USB Type-C® · SWD · Virtual COM · No external probe required

Motion

LIS2DE12TR 3-axis accelerometer · I²C

Climate

SHT40 temperature & relative humidity sensor · I²C

Audio

MP23ABS1 analog MEMS microphone

User Interface

10 user LEDs (D1–D10) · USER button · RESET button

Power

USB Type-C® 5 V input

Expansion & Interfaces

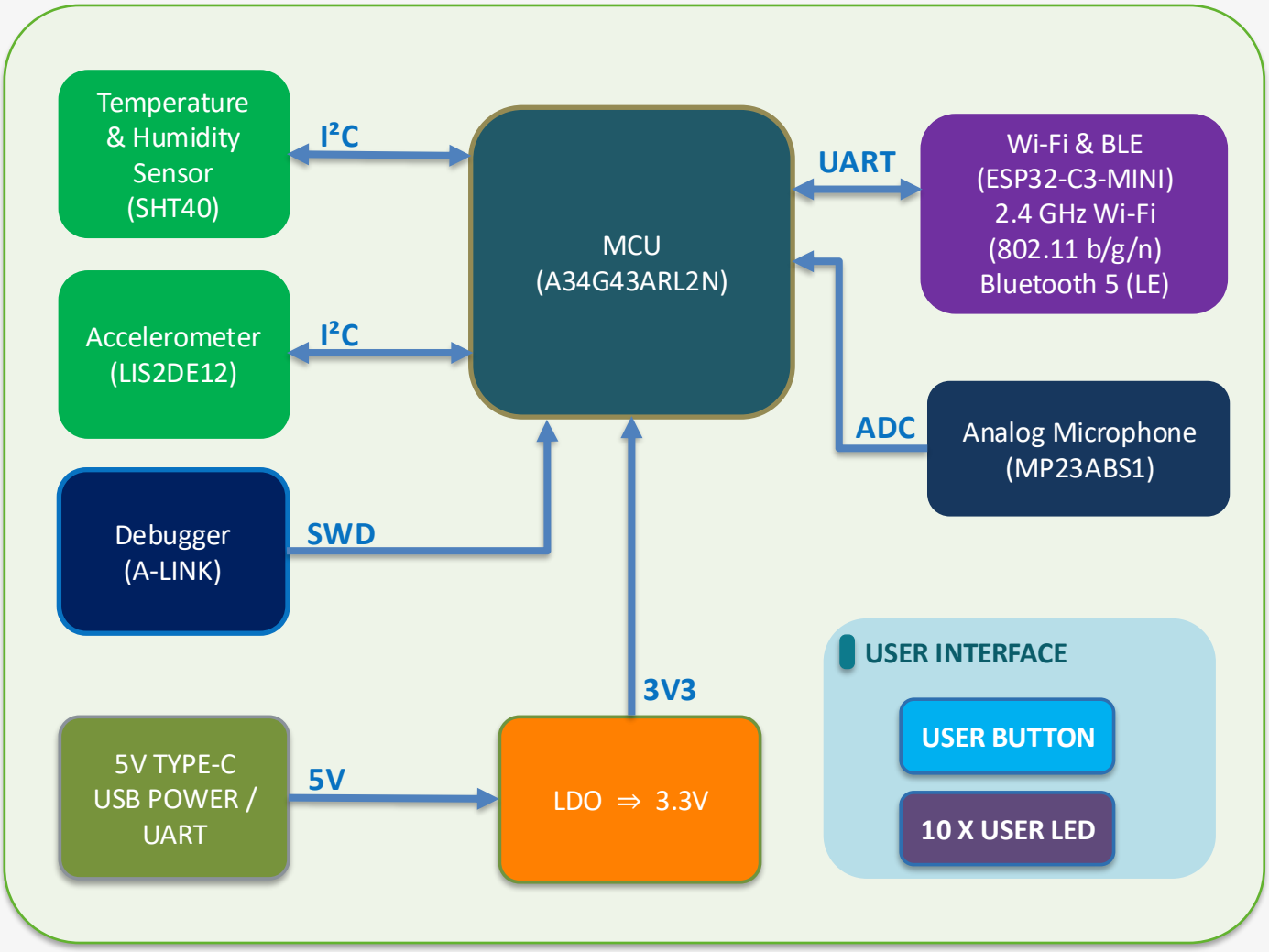
ESP32, SWD, debug UART, and A-LINK firmware headers

Platform

Compatible with Tiremo® AIoT stack — edge deploy, MQTT, OTA-ready dual-bank Flash

3. Block Diagram

System architecture

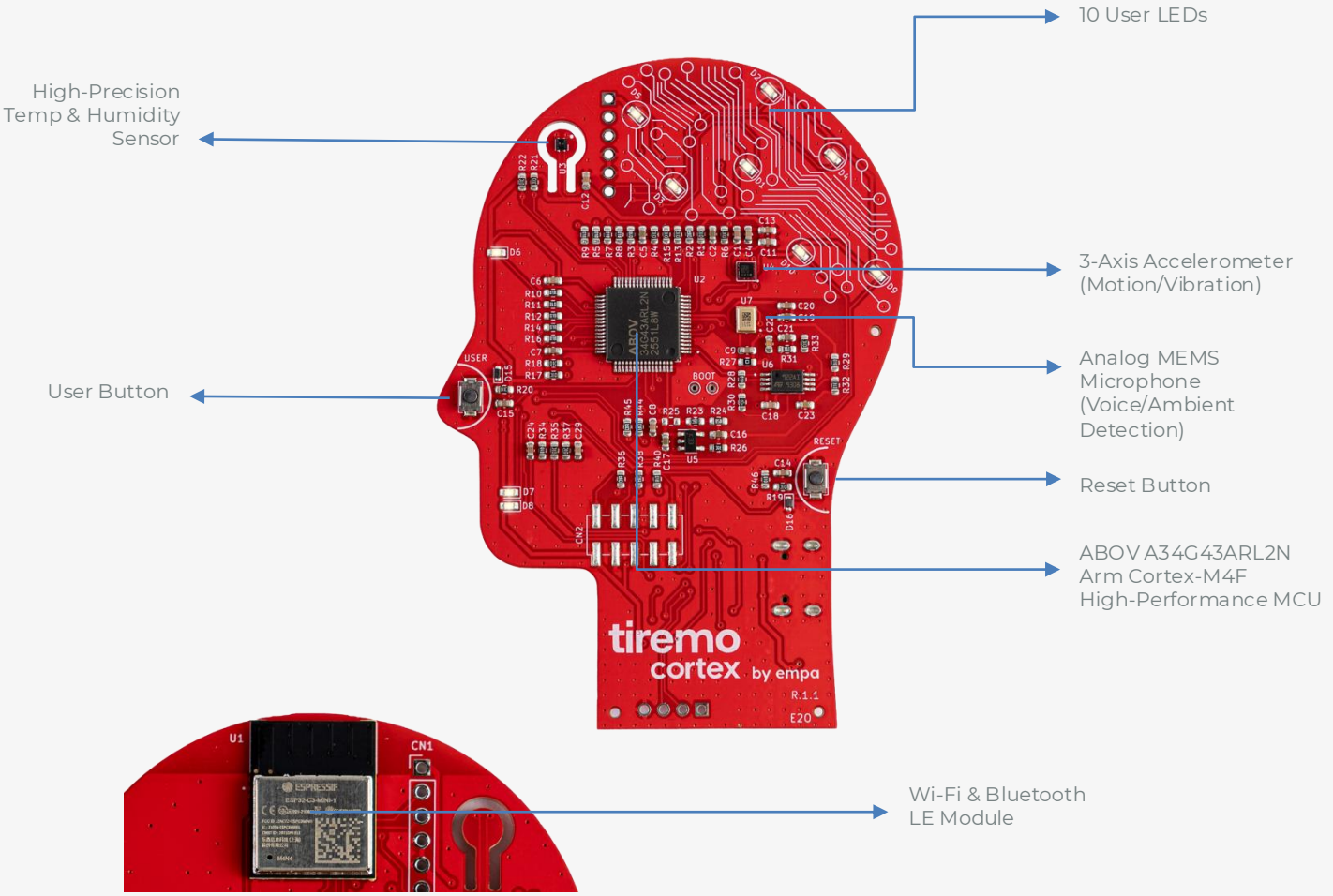


3.1 Architecture notes

The board is built around the A34G43ARL2N MCU, which serves as the main processing unit. The SHT40 temperature and humidity sensor and LIS2DE12 accelerometer communicate with the MCU through the I²C interface. The ESP32-C3-MINI provides Wi-Fi and Bluetooth LE connectivity through a UART interface. The analog microphone signal is sampled by the MCU through its ADC. The USB-C connection provides power to the board and enables programming and debugging through the PC.

4. Hardware Overview

tiremo.cortex R.1.1 · component map



Ref	Component	Function
U2	ABOV A34G43ARL2N	Main MCU, Cortex-M4F 200 MHz, LQFP-64
U1	ESP32-C3-MINI-1	Wi-Fi 2.4 GHz + Bluetooth 5 LE
U10	STM32F103C8Tx	A-LINK on-board SWD debugger / USB
U4	LIS2DE12TR	3-axis accelerometer, I²C, INT1/INT2
U3	SHT40	Temperature & relative humidity, I²C
U7	MP23ABS1TR	Analog MEMS microphone
U6	TS922AIPT	Microphone preamplifier (op-amp)
U8	LD1117S33TR	5 V → 3.3 V main LDO
U5	LDK130	Analog ≈2.7 V (microphone rail)
CN7	USB Type-C®	Power + A-LINK data
SW1 / SW2	RESET / USER	System reset and user button
D1–D10	10× user LED	Visual feedback
D11 / D12	Green / red LED	A-LINK status indicators

5. MCU - A34G43ARL2N

ABOV Semiconductor G4 series · Arm® Cortex®-M4F



A34G43ARL2N MCU

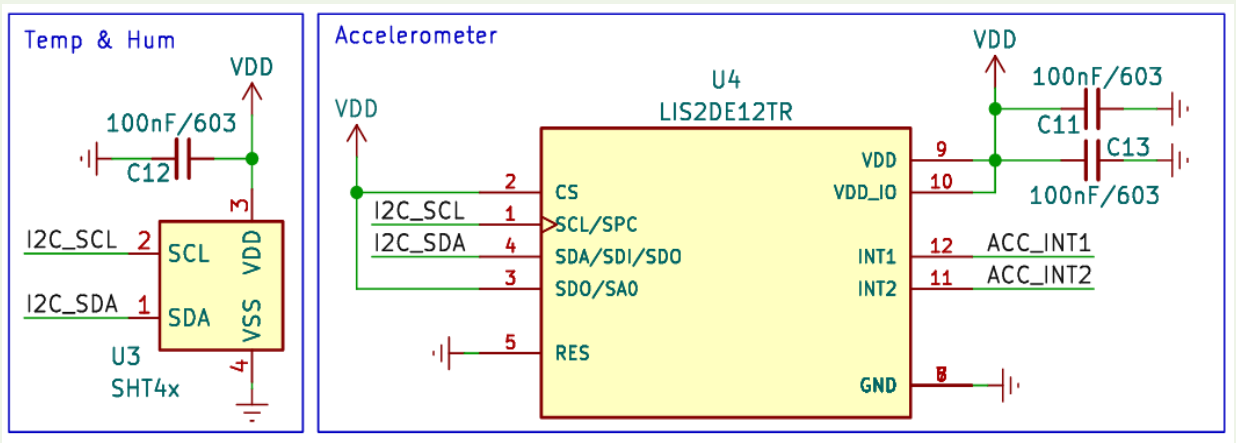
The ABOV A34G43ARL2N is the main microcontroller of the board, based on an Arm Cortex-M4F core with floating-point support. It is designed for embedded applications requiring high processing performance, integrated memory, and a wide range of analog and digital peripherals. The device supports multiple communication interfaces, timers, analog peripherals, and hardware security and system-management features.

Parameter	Value
Core	Arm Cortex-M4F, FPU, up to 200 MHz
Code Flash	2048 KB, Dual Bank, ECC, OTA support
SRAM	256 KB
Data Flash	32 KB, ECC
Package	64-pin LQFP (RL2N), 10×10 mm, 0.5 mm pitch
Operating Voltage	2.7 V … 5.5 V
Operating Temperature	−40 °C … +105 °C
ADC	12-bit, 24 analog input channels, up to 1.5 MSPS
DAC	12-bit, 2 channels
Timers / PWM	16-bit timers, 10 PWM generators
Comparator / RNG	4-channel comparator, 32-bit hardware RNG
Connectivity	UART, SPI, I²C, QSPI, CAN FD
Debug	SWD
Other	CRC, RTCC, LDO, POR, LVI, WDT, FRT, AES-128

6. Pinout & Connectors

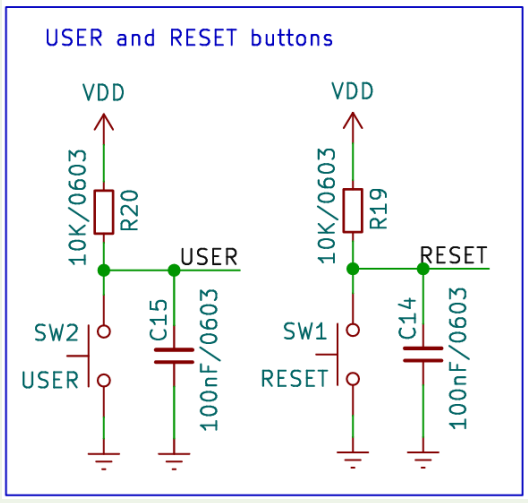
Target MCU A34G43ARL2N (U2) · peripheral map

6.1 I²C2 — SHT40 (U3) & LIS2DE12 (U4) shared bus



Signal	MCU pin	Port / AF	Device	Function
I2C_SCL	30	PB6 · SCL2	U3 + U4	I²C2 clock
I2C_SDA	31	PB7 · SDA2	U3 + U4	I²C2 data
ACC_INT1	6	PA4	U4 INT1	Interrupt
ACC_INT2	7	PA5	U4 INT2	Interrupt

6.2 Buttons

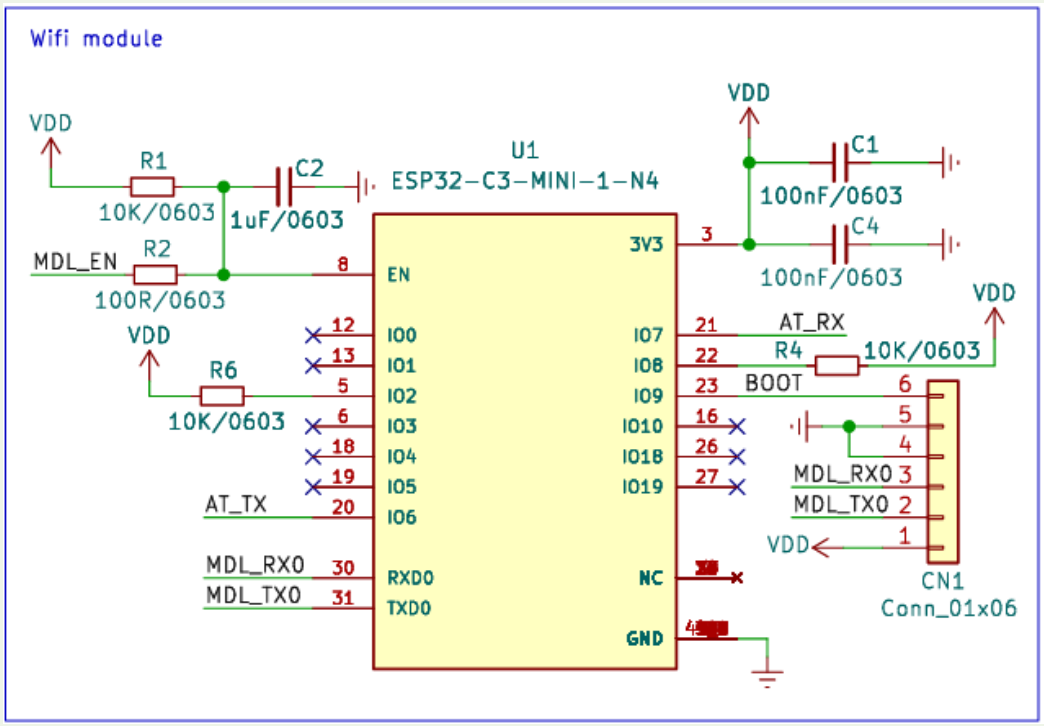


Button	Ref	MCU Pin	Port	Function
USER	SW2	56	PC9	Software input
RESET	SW1	57	PC10 nRESET	Hardware reset

6. Pinout & Connectors

Target MCU A34G43ARL2N (U2) · peripheral map

6.3 ESP32-C3 MCU side

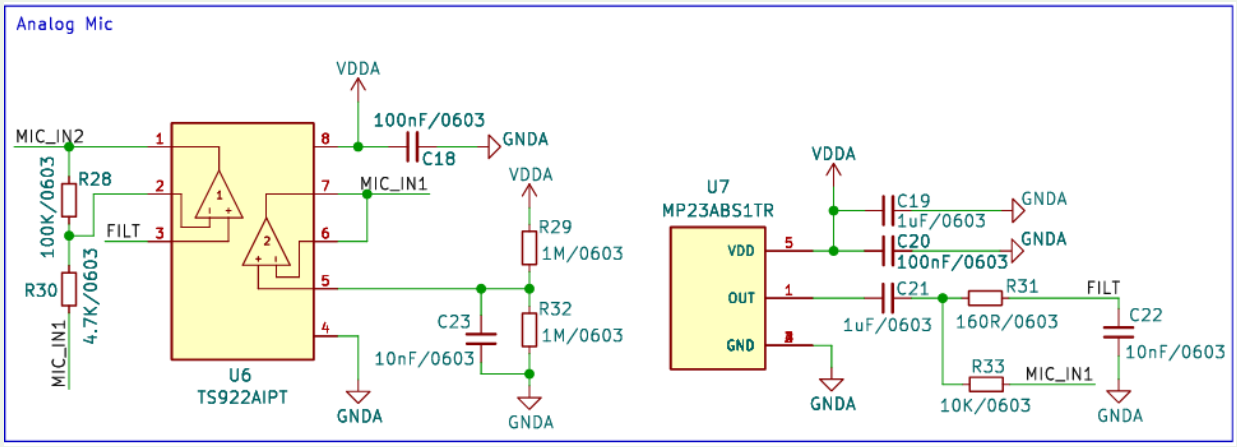


Net	MCU Pin	Port	ESP32	Function
AT_RX	12	PA8 RXD2	TX	UART2 RX · AT reply
AT_TX	13	PA9 TXD2	RX	UART2 TX · AT cmd
MDL_EN	16	PA12	EN	Module enable
MDL_TX0/RX0	—	CN1	UART0	Flash/console only

6. Pinout & Connectors

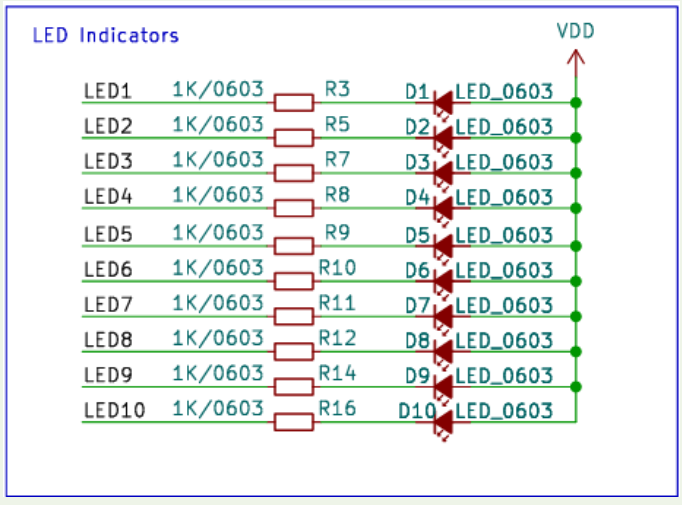
Target MCU A34G43ARL2N (U2) · peripheral map

6.4 Analog mic → ADC



Signal	MCU Pin	Port	Source
MIC_IN2	2	PA0 · AN0	TS922 output
FILT path	—	Analog FE	U7 → filter → U6

6.5 User LEDs (D1–D10)

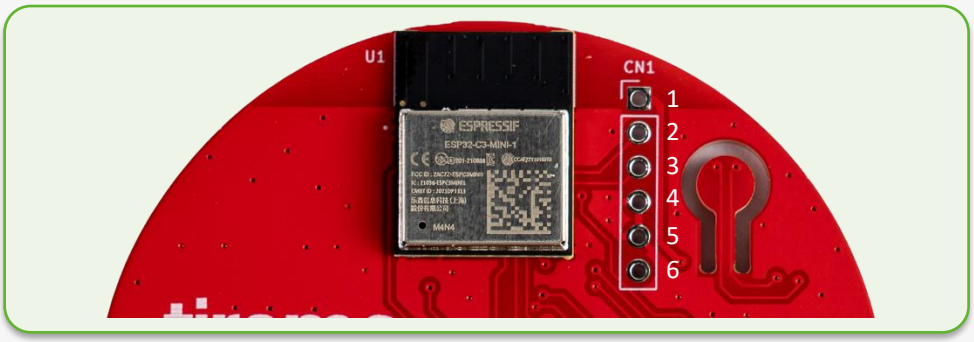


LED	Pin	Port
LED1	28	PB4
LED2	35	PB9
LED3	27	PF7
LED4	29	PB5
LED5	36	PB10
LED6	37	PB11
LED7	38	PB12
LED8	39	PB13
LED9	40	PB14
LED10	41	PB15

6. Pinout & Connectors

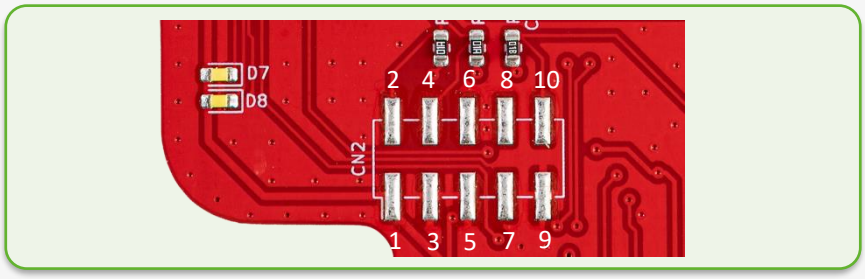
Header pinouts · USB-C = power + A-LINK

6.6 CN1 · ESP32-C3 direct access (1×6)



Pin	Net	ESP32	Purpose
1	VDD	3V3	Module 3.3 V
2	MDL_TX0	TXD0	ESP32 serial TX
3	MDL_RX0	RXD0	ESP32 serial RX
4	GND	GND	GND
5	GND	GND	GND
6	BOOT	IO9	BOOT

6.7 CN2 · Debug (10-pin Arm Cortex SWD)

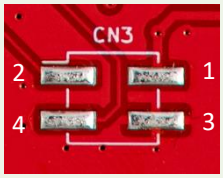


Pin	Net	MCU	Purpose
1	VDD	3.3 V	Target reference (VTref)
2	SWDIO	PC1 · Pin 45	Serial Wire data
3 / 5 / 9	GND	GND	Ground
4	SWCLK	PC0 · Pin 44	Serial Wire clock
6 / 7 / 8	NC	—	Not connected
10	RESET	PC10 · nRESET · Pin 57	Target reset

6. Pinout & Connectors

Header pinouts · USB-C = power + A-LINK

6.8 CN3 · DBG_UART



Pin	Net	MCU	Purpose
1	DBG_RX0	PC14 · Pin 60	UART0 RX
2	VDD	3.3 V	External USB-UART VCC
3	DBG_TX0	PC15 · Pin 59	UART0 TX (log)
4	GND	GND	Ground

6.9 CN4 · A_LINK_FW



Pin	Net	STM32	Purpose
1	VDD	3.3 V	A-LINK supply
2	STM_DIO	SWDIO	Program A-LINK
3	STM_CLK	SWCLK	A-LINK SWD clock
4	GND	GND	Ground

6.10 Test Points



Pin	Net	Signal
1	TP1	GND
2	TP2	BOOT

7. Sensors & Peripherals

Motion, climate and audio — three edge-AI sources on board



7.1

LIS2DE12TR

ST “femto” ultra-low-power 3-axis accelerometer. I²C on board; INT1 and INT2 routed to the MCU.

Parameter	Value
Interface	I²C / SPI
Full scale	±2 / ±4 / ±8 / ±16 g
ODR	1 Hz … 5.3 kHz
Current Consumption	down to ~2 µA
Output	8-bit
Features	Free-fall, 6D/4D, temperature
Package	LGA-12, 2.0 × 2.0 × 1.0 mm

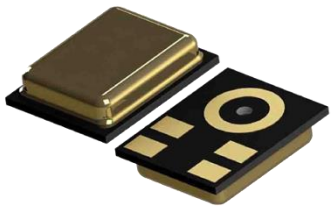


7.2

SHT40

Sensirion 4th-gen 16-bit RH and temperature sensor. I²C up to 1 MHz; very short measurement time.

Parameter	Value
Interface	I²C, up to 1 MHz
Resolution	16-bit
Accuracy	±0.2 °C / ±1.8 %RH
Address	0x44
Supply Voltage	1.08 V – 3.6 V
Package	DFN-4, 1.5 × 1.5 mm
Current Consumption	Avg. 0.4 µA



7.3

MP23ABS1

High-SNR analog bottom-port MEMS microphone with low power consumption and enhanced RF immunity.

Parameter	Value
Type	Capacitive MEMS, analog
Sensitivity	−38 dBV ±1 dB @ 94 dBSPL, 1 kHz
Signal-to-Noise Ratio	64 dB typ.
Acoustic Overload Point	130 dBSPL typ.
Supply Voltage	1.52 V – 3.6 V
Current Consumption	150 µA max
Package	RHLGA, 3.5 × 2.65 × 0.98 mm

8. Communication Interfaces

Wired buses on MCU · wireless via ESP32-C3



8.1 ESP32-C3-MINI-1

Compact Wi-Fi and Bluetooth LE module based on a single-core 32-bit RISC-V processor, providing wireless connectivity and a range of integrated peripherals.

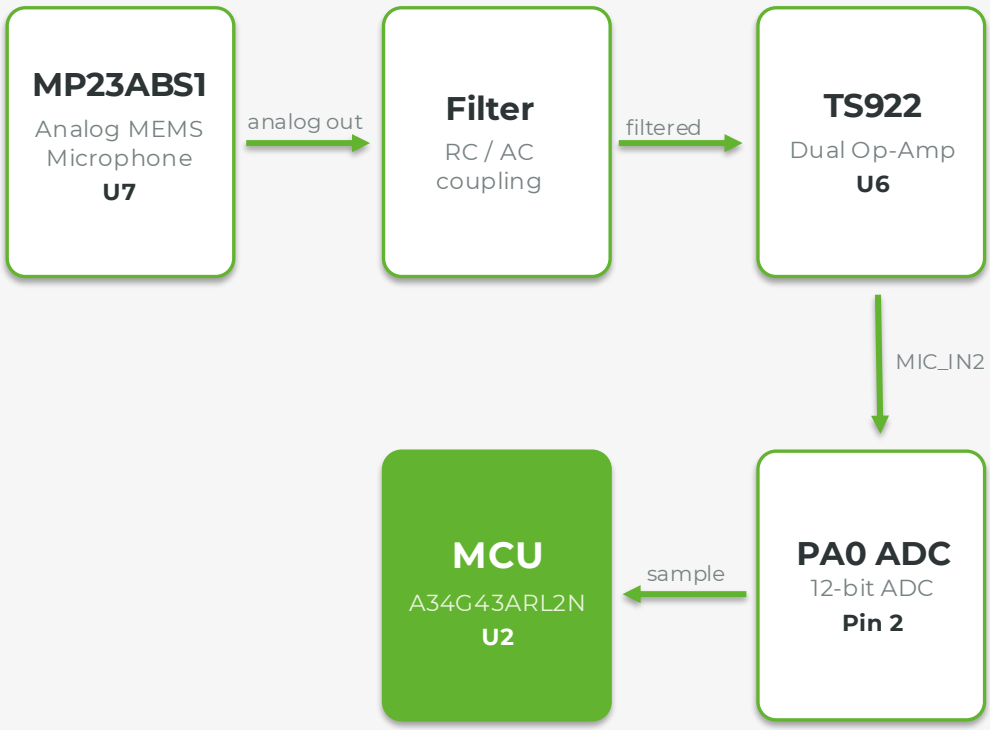
Feature	ESP32-C3-MINI-1
CPU	32-bit RISC-V single-core, ≤ 160 MHz
Flash	4 MB embedded
SRAM	400 KB + 8 KB RTC SRAM
Wi-Fi	IEEE 802.11 b/g/n, 2.4 GHz, up to 150 Mbps, 20 / 40 MHz bandwidth
Bluetooth	Bluetooth 5 LE, Bluetooth Mesh, 125 / 500 kbps, 1 / 2 Mbps
Interfaces	SPI, UART, I²C, I²S, USB Serial/JTAG
Supply Voltage	3.0 V – 3.6 V

9. Analog Interfaces

Microphone front-end and MCU ADC path

The audio path is a dedicated analog chain: MP23ABS1 (U7) → passive filter → TS922AIPT dual op-amp (U6) → MCU PA0 (AN0) 12-bit ADC. The front-end is powered from the separate ≈2.7 V VDDA rail (U5 LDK130) to improve noise performance versus the 3.3 V digital domain.

Signal path



Analog supply · VDDA domain



10. Debug & Programming

A-LINK on-board SWD · optional external probe

10.1 A-LINK (U10 STM32F103C8Tx)

A-LINK is an on-board debug and programming interface based on the STM32F103C8Tx. It connects to the PC through the USB Type-C connector CN7 and provides target MCU programming, debugging, and Virtual COM Port (VCP) functionality.

For day-to-day development, no external debugger is required. The target MCU can be programmed and debugged directly through CN7 using the on-board A-LINK.

In addition, the board provides dedicated debug pins on CN2. The target MCU can be accessed through the SWD interface on CN2 using an external A-LINK when required.

Available debug and programming interfaces are:

CN7 — USB Type-C: Main interface for A-LINK programming, debugging, and Virtual COM Port.

CN2 — SWD Interface: Provides SWD access for an external A-LINK.

CN3 — Debug UART: Provides UART0 access for debug log output.

CN4 (A_LINK_FW): Reserved for updating the firmware of the on-board A-LINK controller.

D11 — Green LED: A-LINK status indication.

D12 — Red LED: A-LINK status/error indication.

10.2 Boot Mode

To place the target MCU into boot/programming mode, short TP1 and TP2 together before starting the boot or programming procedure.

After the programming or boot procedure is completed, remove the short between TP1 and TP2 and reset the board so that the MCU starts in normal application mode.

11. Edge AI on *tiremo.cortex*

Inference on the Cortex-M4F · Edge and Cloud with *tiremo* Intelligence

Edge AI solutions with on-device inference run on *tiremo.cortex* with the ABOV A34G43ARL2N Arm® Cortex®-M4F MCU, so no additional AI accelerator or NPU is required to deploy sensor-scale AI applications. *tiremo* Intelligence exports edge-ready models for *tiremo.cortex*, accelerated with CMSIS-NN on the M4F FPU.

11.1 Where the Edge AI solution runs

Inference host

A34G43ARL2N · Arm® Cortex®-M4F with FPU · up to 200 MHz

Acceleration

CMSIS-NN kernels speed up the neural network inference on the Cortex-M4F.

On-board AI sources

Gesture, environment, and coarse acoustic events can feed the AI solutions.

Connectivity

ESP32-C3 is radio only and publishes inference results over Wi-Fi / BLE.

11.2 Edge and Cloud

Edge

The compiled model runs on the Cortex-M4F. Classical machine learning or statistical models compile to a standalone C library; neural nets run as TensorFlow Lite Micro. Intelligence emits a generated library; firmware calls the API and can publish results over MQTT.

Cloud

The model selected for the AI solution can run as an ONNX-based endpoint. The board publishes telemetry; *tiremo* Intelligence serves an easy-to-use cloud deployment option without changing anything in the device software.

A Solution on Tiremo® Intelligence can use Edge, Cloud, or both on the same product fleet. For worked examples on this board, see the *tiremo.cortex* tutorials.

12. *tiremo* Intelligence

No-code AI · hardware-aware model search · Edge and Cloud deployment

tiremo Intelligence is the no-code AutoML layer of the *tiremo.AIoT* platform. It trains from live device recordings, historic telemetry, or uploaded datasets, then deploys a selected model to the fleet. Model search is hardware-aware: RAM and flash are scored with accuracy so the chosen model can run on *tiremo.cortex*.

12.1 Memory envelope

tiremo.cortex

256 KB SRAM and 2 MB Flash are available for AI usage. Firmware and the model share this silicon.

Intelligence defaults

For this board, Max RAM is limited to 256 KB. The 1024 KB Flash ceiling already fits one OTA bank.

12.2 Backends and runtimes

Parameter	On Tiremo® Cortex
Chip SRAM	256 KB
Chip Flash	2 MB dual-bank, ECC, OTA
Core Type	Arm Cortex-M4F for version R.1.1
On-device acceleration	CMSIS-NN when enabled
Edge · classical ML	Standalone C (no ML runtime)
Edge · neural nets	TensorFlow Lite Micro · float32 / int8
Edge package	Generated C / TFLM library, integrated in firmware
Cloud inference	ONNX endpoint on published telemetry
Tasks	Classification · Anomaly detection · Regression · Forecasting

For details, see docs.tiremo.ai/intelligence

13. How To Start

Program the board and run the example application in minutes

What is *tiremo.cortex* Hub?

tiremo.cortex Hub is the development side of the board: one repository holding the tutorials, the board support files, and tdf.py — the framework that builds, programs, and monitors from a single command.

The steps on this page get the board running. Hub is what you use after that.

Hub link

Tutorials	tdf.py	Board support	Docs
Example projects, ready to build	Build · flash · monitor	Pin maps, clocks, linker scripts	API reference and notes

13.1 Onboarding to *tiremo.cortex* Hub

01 **Clone**
The repository

02 **Set up**
Toolchain, once

03 **Run tutorial 01**
Unmodified

04 **Change one line**
Rebuild, reflash

Once step 04 works, the same loop applies to every project on the board. Section 14 walks through an example.

Start here

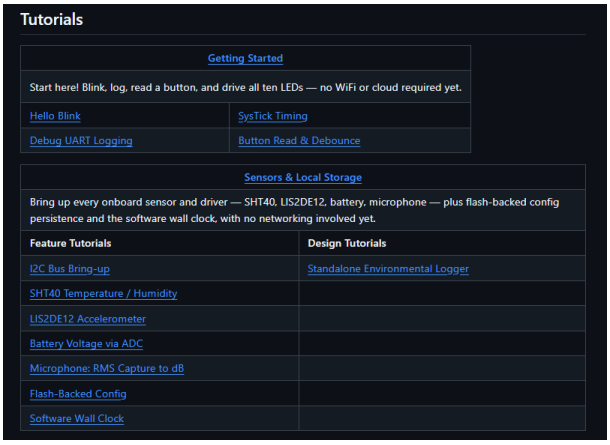
https://github.com/Empa-Electronics/Tiremo-Cortex-Tutorials

Then continue with §14 · Example Project

14. Example Project

From a programmed board to your own firmware, built with tdf.py

14.1 Select what you want to learn

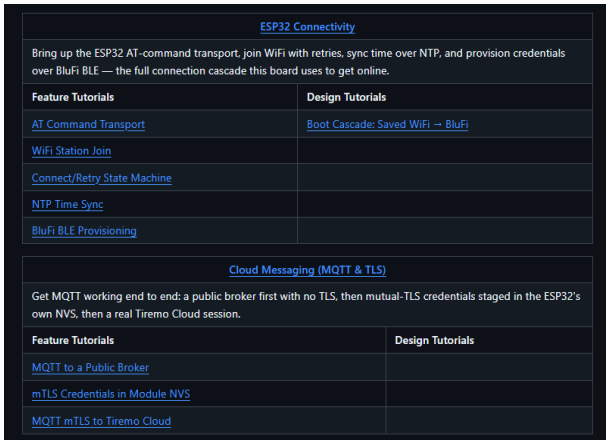


Tutorials

Getting Started	
Start here! Blink, log, read a button, and drive all ten LEDs — no WiFi or cloud required yet.	
Hello Blink	SysTick Timing
Debug UART Logging	Button Read & Debounce

Sensors & Local Storage	
Bring up every onboard sensor and driver — SHT40, LIS2DE12, battery, microphone — plus flash-backed config persistence and the software wall clock, with no networking involved yet.	
Feature Tutorials	**Design Tutorials**
I2C Bus Bring-up	Standalone Environmental Logger
SHT40 Temperature / Humidity	
LIS2DE12 Accelerometer	
Battery Voltage via ADC	
Microphone: RMS Capture to dB	
Flash-Backed Config	
Software Wall Clock	

Tutorial index · pick a path

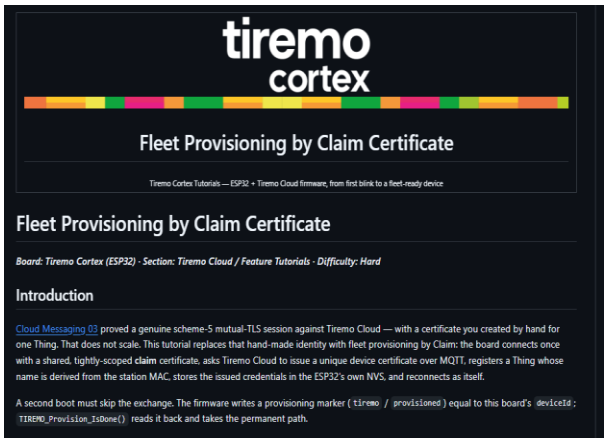


ESP32 Connectivity	
Bring up the ESP32 AT-command transport, join WiFi with retries, sync time over NTP, and provision credentials over BluFi BLE — the full connection cascade this board uses to get online.	
Feature Tutorials	**Design Tutorials**
AT Command Transport	Boot Cascade: Saved WiFi → BluFi
WiFi Station Join	
Connect/Retry State Machine	
NTP Time Sync	
BluFi BLE Provisioning	

Cloud Messaging (MQTT & TLS)	
Get MQTT working end to end: a public broker first with no TLS, then mutual-TLS credentials staged in the ESP32's own NVS, then a real Tiremo Cloud session.	
Feature Tutorials	**Design Tutorials**
MQTT to a Public Broker	
mTLS Credentials in Module NVS	
MQTT mTLS to Tiremo Cloud	

Open a tutorial · read, then build

14.2 Learn the features



tiremo cortex

Fleet Provisioning by Claim Certificate

Tiremo Cortex Tutorials — ESP32 + Tiremo Cloud firmware, from first blink to a fleet-ready device

Fleet Provisioning by Claim Certificate

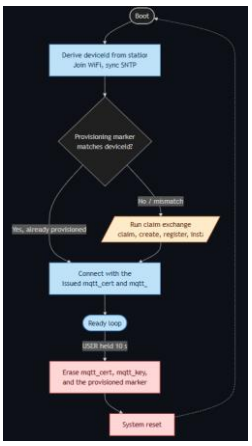
Board: Tiremo Cortex (ESP32) · Section: Tiremo Cloud / Feature Tutorials · Difficulty: Hard

Introduction

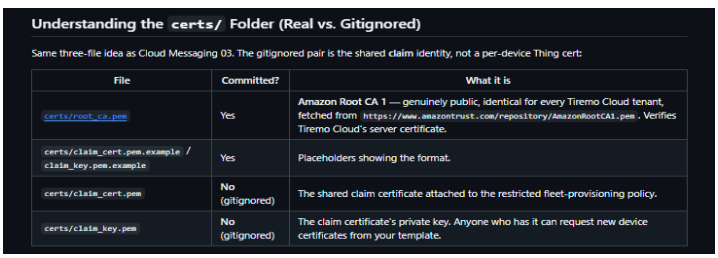
Cloud Messaging 03 proved a genuine scheme-5 mutual-TLS session against Tiremo Cloud — with a certificate you created by hand for one Thing. That does not scale. This tutorial replaces that hand-made identity with fleet provisioning by Claim: the board connects once with a shared, tightly-scoped **claim** certificate, asks Tiremo Cloud to issue a unique device certificate over MQTT, registers a Thing whose name is derived from the station MAC, stores the issued credentials in the ESP32's own NVS, and reconnects as itself.

A second boot must skip the exchange. The firmware writes a provisioning marker (`tiremo` / `provisioned`) equal to this board's `deviceId` ; `TIREMO_Provision_IsDone()` reads it back and takes the permanent path.

Connectivity & cloud messaging paths



Provisioning lifecycle



Understanding the `certs/` Folder (Real vs. Gitignored)

Same three-file idea as Cloud Messaging 03. The gitignored pair is the shared **claim** identity, not a per-device Thing cert:

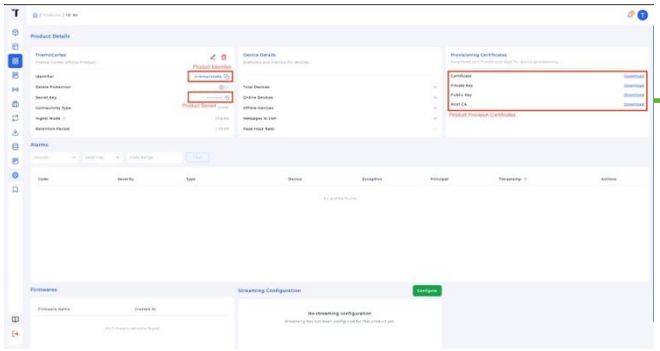
File	Committed?	What it is
`certs/root_ca.pem`	Yes	**Amazon Root CA 1** — genuinely public, identical for every Tiremo Cloud tenant, fetched from `https://www.amazontrust.com/repository/AmazonRootCA1.pem` . Verifies Tiremo Cloud's server certificate.
`certs/claim_cert.pem.example` / `claim_key.pem.example`	Yes	Placeholders showing the format.
`certs/claim_cert.pem`	No (gitignored)	The shared claim certificate attached to the restricted fleet-provisioning policy.
`certs/claim_key.pem`	No (gitignored)	The claim certificate's private key. Anyone who has it can request new device certificates from your template.

certs/ folder · real files vs gitignored claim identity

14. Example Project

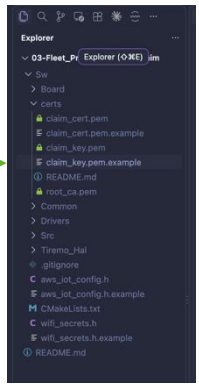
From a programmed board to your own firmware, built with tdf.py

14.3 Master both Cloud and Embedded



Get certificates and configs from *tiremo*

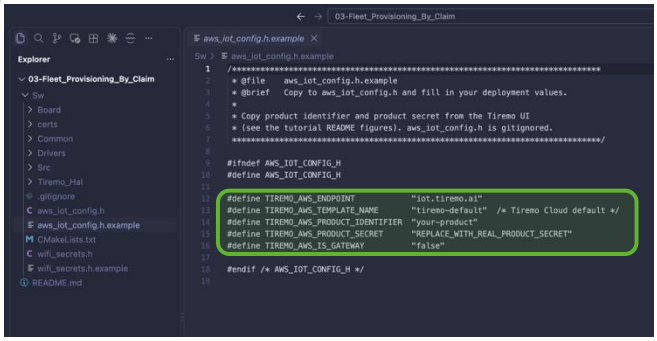
Product identifier, product secret and certificate files



Copy them into the project certs/ folder

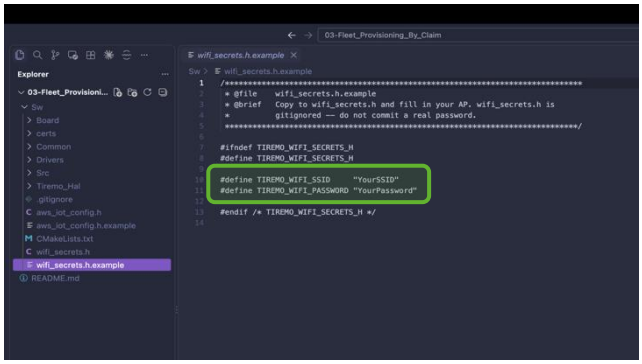
claim_cert.pem · claim_key.pem · root_ca.pem

14.4 Integrate your *tiremo* configurations



Set your *tiremo* provisioning configs

aws_iot_config.h · product identifier and secret



Set your Wi-Fi SSID and password

wifi_secrets.h · network name and password

14.5 Then build and run

```
tdf.py build
tdf.py flash
tdf.py monitor
```

tdf.py build · flash · monitor

```
[INFO] Fleet_Provisioning_By_Claim: boot
[INFO] identity: deviceId=30eda0806324 clientId=<product>_30eda0806324
[INFO] ESP32: online, SNTP epoch=...
[INFO] provision: no matching marker
[INFO] provision: write claim certificate (...)
[INFO] provision: claim MQTT connected
[INFO] provision: CreateKeysAndCertificate
[INFO] provision: RegisterThing deviceIdentifier=30eda0806324
[INFO] provision: registered Thing ...
[INFO] provision: complete; permanent MQTT connected
[INFO] provision: ready deviceId=30eda0806324
```

Watch the board come online

15. Ordering Information

Order codes · kit contents · sales & support

Date	HW Rev	Description

15.1 Kit contents

01	02	03	04	05
Board	**USB-C cable**	**Quick start**	**Safety leaflet**	**GitHub insert**
tiremo.cortex development board	Optional / kit accessory	First-run card	Compliance insert	Tutorials repository URL

15.2 Sales & support

Empa Electronics

Hardware · Cloud · Support

WEB

empa.com/tiremo

Product page and documentation

ADDRESS

IDTM İş Blokları A1, Kat:4

Yeşilköy / İstanbul

E-MAIL

tiremo@empa.com

Technical questions and sales

GITHUB

Tiremo-Cortex-Tutorials

Examples, Hub and tdf.py

16. Revision History

Hardware and datasheet change log

16.1 Hardware revisions

Date	HW Rev	Description

16.2 Datasheet revisions

Date	Doc Rev	Description