PLAN DE PRUEBAS – Secador de Café con ESP32 (FreeRTOS)

1) OBJETIVO

Validar que el firmware:

• Lee temperatura interna (DS18B20) y temperatura/humedad ambiente (DHT11).

• Controla Peltier + Ventilador con histéresis 40–45 °C (Peltier ON < 40 °C, OFF > 45 °C y ventilador a la inversa).

• Acciona motor por intervalos (por defecto cada 15 min, ON 10 s).

• Watchdog del actor Peltier y deep-sleep a las 36 h.

• Emite logs por Serial con formato conocido.

2) ALCANCE Y CRITERIOS DE ACEPTACIÓN

• Lecturas de sensores válidas cada ~5 .

• Motor ON ≈ 10 s por periodo; scheduler emite permiso.

• START habilita el sistema; STOP apaga actuadores inmediatamente.

• Timestamp correcto con DS3231 (si no está presente, el sistema lo reporta y continúa).

• Sin reinicios ni bloqueos durante pruebas.

3) BANCO DE PRUEBAS – Hardware

• ESP32 DOIT DevKit V1.

• DHT11 (ambiente): DATA -> GPIO 4.

• DS18B20 (interna): DATA -> GPIO 15 con pull-up 4.7 kΩ a 3V3.

• Relés/LED de prueba:

 – Peltier: GPIO 26

 – Ventilador: GPIO 25

 – Motor: GPIO 27

• Botones a GND con pull-up: START GPIO 33, STOP GPIO 32.

• LED alarma (temperatura > 45 °C): GPIO 2.

• Buzzer (temperatura < 40 °C): GPIO 17.

• RTC DS3231: SDA 21, SCL 22 (opcional pero recomendado).

• Fuente: USB 5 V para lógica; para carga real, fuente externa + elevador/driver.

4) BANCO DE PRUEBAS – Software

• Arduino IDE, núcleo ESP32 3.x, baud 115200, CPU 80 MHz.

• Librerías: OneWire, DallasTemperature, DHT, RTClib, WiFi (FreeRTOS incluido).

• Sketch: Secador_Cafe.ino (versión actual).

5) EVIDENCIA (espacios para insertar fotos y capturas)

```
[2080-13-32 00:06:00] [Sens] T_IN=22.19 | AMB: T=24.4 RH=43
[2105-25-105 105:105] [Ctrl] T_IN=22.19 => Peltier ON (EN)
[2105-25-105 105:105] [Act] Peltier=ON, Fan=OFF
[2080-13-32 00:06:00] [Sens] T_IN=22.19 | AMB: T=24.1 RH=43
[2080-13-32 00:06:00] [Sens] T_IN=22.25 | AMB: T=24.1 RH=43
[2080-13-32 00:06:00] [Sens] T_IN=22.25 | AMB: T=24.1 RH=43
[2080-13-32 00:06:00] [Sens] T_IN=22.25 | AMB: T=24.1 RH=43
[2080-13-32 00:06:00] [Sens] T_IN=22.25 | AMB: T=24.1 RH=43
[2080-13-32 00:06:00] [Sens] T_IN=22.31 | AMB: T=24.1 RH=43
[2080-13-32 00:06:00] [Sens] T_IN=22.44 | AMB: T=24.1 RH=44
[2080-13-32 00:06:00] [Sens] T_IN=22.50 | AMB: T=24.1 RH=44
[2080-13-32 00:06:00] [Sens] T_IN=22.56 | AMB: T=24.1 RH=43
[2080-13-32 00:06:00] [Sens] T_IN=22.62 | AMB: T=24.1 RH=43
[2105-25-105 105:105] [MotorSched] permiso emitido (cada 1 min)
[2105-25-105 105:105] [Motor] ON 10 s
[2080-13-32 00:06:00] [Sens] T_IN=22.69 | AMB: T=24.1 RH=43
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[2080-13-32 00:06:00] [Sens] T_IN=21.50 | AMB: T=23.4 RH=45
[2080-13-32 00:06:00] [Sens] T_IN=21.56 | AMB: T=23.4 RH=45
[2045-82-25 45:160:0] [MotorSched] permiso emitido (cada 1 min)
[2045-82-25 45:160:0] [Motor] ON 10 s
[2080-13-32 00:06:00] [Sens] T_IN=21.62 | AMB: T=23.4 RH=45
[2113-45-165 00:06:0] [Sens] T_IN=21.62 | AMB: T=23.4 RH=44
[2045-82-25 45:160:0] [Motor] OFF
[2113-45-165 00:06:0] [Sens] T_IN=21.69 | AMB: T=23.4 RH=44
[2113-45-165 00:06:0] [Sens] T_IN=21.75 | AMB: T=23.4 RH=44
[2113-45-165 00:06:0] [Sens] T_IN=21.75 | AMB: T=23.4 RH=44
[2113-45-165 00:06:0] [Sens] T_IN=21.81 | AMB: T=23.4 RH=44
[2113-45-165 00:06:0] [Sens] T_IN=21.81 | AMB: T=23.4 RH=44
[2113-45-165 00:06:0] [Sens] T_IN=21.87 | AMB: T=23.4 RH=44
[2113-45-165 00:06:0] [Sens] T_IN=21.87 | AMB: T=23.4 RH=44
[2080-13-32 00:06:00] [Sens] T_IN=21.94 | AMB: T=23.7 RH=45
[2113-45-165 00:06:0] [Sens] T_IN=21.94 | AMB: T=23.8 RH=44
[2113-45-165 00:06:0] [Sens] T_IN=22.00 | AMB: T=23.8 RH=44
[2045-82-25 45:160:0] [MotorSched] permiso emitido (cada 1 min)
[2045-82-25 45:160:0] [Motor] ON 10 s
[2113-45-165 00:06:0] [Sens] T_IN=22.00 | AMB: T=23.8 RH=44
[2113-45-165 00:06:0] [Sens] T_IN=22.06 | AMB: T=23.8 RH=44
[2045-82-25 45:160:0] [Motor] OFF
[2113-45-165 00:06:0] [Sens] T_IN=22.13 | AMB: T=23.8 RH=44
[2113-45-165 00:06:0] [Sens] T_IN=22.13 | AMB: T=23.8 RH=44
[2113-45-165 00:06:0] [Sens] T_IN=22.13 | AMB: T=23.8 RH=44
[2113-45-165 00:06:0] [Sens] T_IN=22.19 | AMB: T=23.8 RH=44
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[2045-82-25 45:160:0]  [Motor] OFF
[2080-13-32 00:06:00]  [Sens] T_IN=-- | AMB: T=24.8 RH=42
[2080-13-32 00:06:00]  [Sens] T_IN=-- | AMB: T=24.8 RH=42
[2080-13-32 00:06:00]  [Sens] T_IN=-- | AMB: T=24.8 RH=43
[2080-13-32 00:06:00]  [Sens] T_IN=-- | AMB: T=24.8 RH=42
[2000-00-00 00:00:00]  [Sens] T_IN=-- | AMB: T=24.8 RH=42
[2000-00-00 00:00:00]  [Sens] T_IN=-- | AMB: T=24.8 RH=42
[2000-00-00 00:00:00]  [Sens] T_IN=-- | AMB: T=24.8 RH=42
[2080-13-32 00:06:00]  [Sens] T_IN=-- | AMB: T=24.8 RH=42
[2000-00-00 00:00:00]  [Sens] T_IN=-- | AMB: T=24.8 RH=42
[2080-13-32 00:06:00]  [Sens] T_IN=-- | AMB: T=24.8 RH=42
[2045-82-25 45:160:0]  [MotorSched] permiso emitido (cada 1 min)
[2045-82-25 45:160:0]  [Motor] ON 10 s
[2080-13-32 00:06:00]  [Sens] T_IN=-- | AMB: T=24.8 RH=42
[2080-13-32 00:06:00]  [Sens] T_IN=-- | AMB: T=24.8 RH=43
[2045-82-25 45:160:0]  [Motor] OFF
[2080-13-32 00:06:00]  [Sens] T_IN=-- | AMB: T=24.8 RH=43
[2000-00-00 00:00:00]  [Sens] T_IN=-- | AMB: T=24.8 RH=42
[2000-00-00 00:00:00]  [Sens] T_IN=-- | AMB: T=24.8 RH=42
[2000-00-00 00:00:00]  [Sens] T_IN=-- | AMB: T=24.8 RH=42
[2000-00-00 00:00:00]  [Sens] T_IN=-- | AMB: T=24.8 RH=42
[2080-13-32 00:06:00]  [Sens] T_IN=-- | AMB: T=24.8 RH=42
[2080-13-32 00:06:00]  [Sens] T_IN=-- | AMB: T=24.5 RH=42
```

```
[2080-13-32 00:06:00]  [Sens] T_IN=21.56 | AMB: T=-- RH=--
[2105-25-105 105:105]  [Ctrl] T_IN=21.56 => Peltier ON (EN)
[2105-25-105 105:105]  [Act] Peltier=ON, Fan=OFF
[2080-13-32 00:06:00]  [Sens] T_IN=21.69 | AMB: T=-- RH=--
[2080-13-32 00:06:00]  [Sens] T_IN=22.69 | AMB: T=-- RH=--
[2080-13-32 00:06:00]  [Sens] T_IN=23.62 | AMB: T=-- RH=--
[2080-13-32 00:06:00]  [Sens] T_IN=24.19 | AMB: T=-- RH=--
[2080-13-32 00:06:00]  [Sens] T_IN=24.25 | AMB: T=-- RH=--
[2080-13-32 00:06:00]  [Sens] T_IN=24.19 | AMB: T=-- RH=--
[2080-13-32 00:06:00]  [Sens] T_IN=24.12 | AMB: T=-- RH=--
[2080-13-32 00:06:00]  [Sens] T_IN=24.00 | AMB: T=-- RH=--
[2080-13-32 00:06:00]  [Sens] T_IN=23.87 | AMB: T=-- RH=--
[2080-13-32 00:06:00]  [Sens] T_IN=23.81 | AMB: T=-- RH=--
[2105-25-105 105:105]  [Motor] ON 10 s
[2105-25-105 105:105]  [MotorSched] permiso emitido (cada 1 min)
[2080-13-32 00:06:00]  [Sens] T_IN=23.75 | AMB: T=-- RH=--
[2080-13-32 00:06:00]  [Sens] T_IN=23.69 | AMB: T=-- RH=--
```

6) CASOS DE PRUEBA (detalle)

T1 – Lectura DHT11 (AMB)

Preparación: DHT11 en GPIO 4. Pasos: encender, abrir Serial 115200; verificar cada ~5 s "AMB: T=xx.x RH=yy". Esperado: valores válidos. Evidencia: captura.

T2 – Lectura DS18B20 (T_IN)

Preparación: DS18B20 en GPIO 15 con 4.7 kΩ a 3V3. Pasos: verificar cada ~5 s "T_IN=xx.xx". Si −127.00/"--", revisar pull-up/cableado. Evidencia: captura.

T3 – Histéresis Peltier

Pasos: elevar/disminuir T_IN (aire tibio/ambiente). Esperado:

• T_IN < 40.0 -> buzzer ON; Peltier ON; Fan OFF; log [Ctrl]/[Act].

• T_IN > 45.0 -> LED alarma ON; Peltier OFF; Fan ON; log [Ctrl]/[Act].

T4 – Ventilador inverso

Esperado: Fan ON cuando Peltier OFF y viceversa. Evidencia: [Act].

T5 – Motor por intervalos (con LED sustituto)

Pasos: esperar permiso del scheduler -> "[MotorSched] permiso emitido…", "[Motor] ON 10 s", "[Motor] OFF". Evidencia: captura + foto LED.

T7 – Watchdog del actor

Pasos: forzar ausencia de keep-alive (o esperar) -> "[Peltier] Watchdog -> OFF (fan ON)".

T8 – Timestamp DS3231

Pasos: conectar RTC; verificar "[RTC] OK (hora válida)" y timestamps correctos en cada línea. Sin RTC, el sistema avisa pero opera.

T9 – Robustez de lecturas

Pasos: observar 5–10 min; no deben aparecer series largas de "--"/NaN.

T10 – Límite 36 h (deep-sleep)

Método rápido: cambiar temporalmente RUN_LIMIT_HOURS a 0.01 h (~36 s) y confirmar "[Supervisor] ... -> deep sleep".

7) OBSERVACIONES

• DS18B20 marcó −127.00 hasta colocar pull-up de 4.7 kΩ y revisar GND/3V3.

• Sin DS3231, timestamps inválidos, debemos conseguir el implemento para que ya nos de un buen resultado.

• Motor real requiere fuente y driver; para lógica se usó LED sustituto.

• Ventilador verificado "inverso" a Peltier (requisito cumplido).

10) CONCLUSIÓN

El firmware cumple los requerimientos funcionales en pruebas de banco. Falta validar con carga real (Peltier/ventilador/motor con su fuente) y ejecutar la prueba de 36 h (o la versión acelerada) para cerrar el criterio de deep-sleep.

11)ANEXOS