

WebMite RP2350B + Pimoroni RM2

Wi-Fi Warm Restart Failure: Diagnosis and Final Patch

Detailed engineering summary and patch documentation

Target firmware	WebMite MMBasic RP2350B Edition V6.04.00RC1
Target board	WeAct RP2350B Core Board
Wi-Fi module	Pimoroni RM2 Breakout / CYW43439
Validated behavior	CPU RESTART recovered Wi-Fi on the second internal join attempt
Report date	5 October 2026

Result: The CYW43 driver initialized correctly after CPU RESTART, but the first Wi-Fi association attempt returned `PICO_ERROR_CONNECT_FAILED (-8)`. Retrying only that specific failure after a short settle period restored Wi-Fi reliably in the successful V5 diagnostic test.

Note: the clean V6 patch removes diagnostic output while preserving the exact successful retry strategy. It should be regression-tested after compilation and flashing.

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1. Executive summary

Problem. A WeAct RP2350B board using a Pimoroni RM2 CYW43439 Wi-Fi module could connect normally after power-on or a physical RUN/RST reset, but Wi-Fi consistently failed after the WebMite command CPU RESTART or other watchdog/software-triggered restarts.

Key finding. The failure was not caused by the router, the SSID/password, GP23 level, or failure of `cyw43_arch_init_with_country()`. The CYW43 driver re-initialized successfully after CPU RESTART. The failure occurred later, during the first Wi-Fi association attempt, where `cyw43_arch_wifi_connect_timeout_ms()` returned -8 (PICO_ERROR_CONNECT_FAILED).

Solution. The firmware was patched in two places: (1) the software reset path performs a clean CYW43 shutdown, drives `WL_ON` low, releases the RM2 bus pins and waits before triggering the watchdog reset; and (2) `WebConnect()` retries the Wi-Fi association up to three times, but only when the specific error is `PICO_ERROR_CONNECT_FAILED`. A one-second CYW43 poll/settle interval is inserted between retries.

Validated outcome: In the successful V5 test, the first association attempt after CPU RESTART failed with `rc=-8`, while the second attempt succeeded after approximately one second. The interface reached `wifi=1`, `tcpip=3` and received 192.168.178.143 without pressing the physical reset button.

2. Hardware and firmware context

Item	Configuration
MCU board	WeAct RP2350B Core Board
Wi-Fi module	Pimoroni RM2 Breakout using Infineon/Cypress CYW43439
WebMite	MMBasic RP2350B Edition V6.04.00RC1
CPU speed	250 MHz during the main tests
Wi-Fi interface	CYW43 via the Pico-style bus pins
RM2 WL_ON	WeAct GP23
RM2 DAT	WeAct GP24
RM2 CS	WeAct GP25
RM2 CLK	WeAct GP29
Power	3.3 V and GND

Important hardware detail: On the WeAct board, the user KEY circuit was originally connected to GP23 through a 0-ohm resistor. Removing that resistor isolated the KEY circuit from GP23. This fixed the separate cold-start/power-bank problem and allowed the RM2 WL_ON line to behave correctly at power-up.

3. Original problem and observed symptoms

- Cold power-up after the GP23/KEY hardware correction: Wi-Fi connected normally.
- Physical RUN/RST button: Wi-Fi connected normally every time.
- CPU RESTART: WebMite restarted, but Wi-Fi did not reconnect.
- Watchdog hardware restart: same Wi-Fi failure.
- OPTION changes that trigger a software/CPU restart: same Wi-Fi failure.
- Lowering CPU speed to 150 MHz did not solve the warm-restart issue.

- The FritzBox/router was not the cause; normal cold boots and physical resets connected correctly.

Observed behavior before the patch

```
Connected to 192.168.178.143 port 23
> cpu restart
Disconnected
Connection to 192.168.178.143 FAILED!!

Physical RST -> Wi-Fi OK
```

4. Hardware finding on GP23 / KEY circuit

Before the firmware investigation, the WeAct board had a separate hardware interaction on GP23. The board labels the user button as KEY@23, and a 0-ohm resistor tied the KEY circuit to GP23. Because the RM2 uses GP23 as WL_ON, that board-level connection could disturb the Wi-Fi enable line, especially during power-up from a power bank.

After the 0-ohm resistor was removed, cold power-up became reliable. This was an important prerequisite because it proved that the RM2 hardware wiring and power-up path could operate correctly when GP23 was no longer loaded by the KEY circuit.

Separation of issues: Removing the 0-ohm resistor solved the cold-start problem. It did not solve CPU RESTART. The warm-restart failure therefore required a firmware fix in addition to the hardware correction.

5. Investigation and failed approaches

Stage	Result
V1 - Post-restart WL_ON low	PicoMite.c was modified so GP23/WL_ON was driven low for approximately 100 ms before the normal CYW43 initialization. Result: firmware built successfully, but CPU RESTART still failed to restore Wi-Fi.
V2 - Pre-watchdog WL_ON low	SoftReset() in misc/External.c drove GP23 low for approximately 200 ms before watchdog_enable(). Result: CPU RESTART still failed.
V3 - CYW43 deinit + bus release + WL_ON low	SoftReset() was expanded to call cyw43_arch_deinit(), clear startupcomplete, hold GP23 low, release GP24/GP25/GP29 as inputs, wait 300 ms, then trigger the watchdog. Result: CPU RESTART still failed.
V4 - Initialization diagnostics	Debug output was added around cyw43_arch_init_with_country() and WebConnect(). It proved that cyw43_arch_init_with_country() returned 0 after both cold boot and CPU RESTART. Therefore the driver itself was initializing correctly.
Connect diagnostics	WebConnect() was instrumented around cyw43_arch_wifi_connect_timeout_ms(). Cold boot returned rc=0; after CPU RESTART it returned rc=-8 after about 3.2 seconds, with Wi-Fi and TCP/IP link status both at -1.
V5 - Controlled retry	WebConnect() was changed to retry PICO_ERROR_CONNECT_FAILED up to two additional times with a one-second CYW43 poll interval. The first attempt after CPU RESTART failed with -8, while attempt 2 succeeded. This was the first software-only warm restart recovery.
V6 - Production cleanup	The diagnostic messages were removed while preserving the successful V5 retry logic and V3 pre-reset cleanup. PicoMite.c was returned to the upstream/original form.

6. Diagnostic instrumentation and evidence

The diagnostics were intentionally added in layers so each stage of the boot and connection sequence could be separated. This prevented further guesswork about timing, GPIO state or router behavior.

6.1 Cold boot / physical reset baseline

```
[RM2DBG] excep=2279501182 restart=0x00040000 cyw43_init=0 gp23=0
PIC049AB1B2ADCC connecting to WiFi...
[RM2RETRY] attempt=1 before wifi=0 tcpip=0 gp23=1
[RM2RETRY] attempt=1 rc=0 elapsed=2992 ms wifi=1 tcpip=3 gp23=1
Connected 192.168.178.143
[RM2DBG] WebConnect returned wifi=1 last=0 gp23=1
```

Interpretation: CYW43 initialization succeeded, the first Wi-Fi join succeeded in about 3.0 seconds, the Wi-Fi link reached the UP state and TCP/IP was active.

6.2 CPU RESTART with retry diagnostics

```
> cpu restart  
[RM2DBG] excep=9993 restart=0xFFFFFFFF cyw43_init=0 gp23=0  
PIC049AB1B2ADCC connecting to WiFi...  
[RM2RETRY] attempt=1 before wifi=0 tcpip=0 gp23=1  
[RM2RETRY] attempt=1 rc=-8 elapsed=3224 ms wifi=-1 tcpip=-1 gp23=1  
[RM2RETRY] attempt=2 before wifi=-1 tcpip=-1 gp23=1  
[RM2RETRY] attempt=2 rc=0 elapsed=3003 ms wifi=1 tcpip=3 gp23=1  
Connected 192.168.178.143  
[RM2DBG] WebConnect returned wifi=1 last=0 gp23=1
```

Critical evidence: The first join failed even though GP23 was high and cyw43_init returned 0. The second join succeeded without another CPU reset or physical RST. This isolated the defect to the first association attempt after a warm restart.

7. Root cause

The observed root cause is a warm-restart state/timing condition in the RP2350B + external RM2/CYW43439 combination. The watchdog/CPU restart path is not equivalent to removing power or asserting the board RUN/RST input. After the software restart, the CYW43 driver can be initialized successfully, but the first station association attempt can immediately enter LINK_FAIL and return PICO_ERROR_CONNECT_FAILED (-8).

This explains why simply holding WL_ON low for a longer period did not solve the problem: the failure was no longer at the enable or driver-init stage. It was specifically the first association transaction after a warm restart.

It also explains why a physical reset appeared reliable: a hardware RUN/RST event resets the system state more comprehensively and gives the external Wi-Fi device and host interface a cleaner restart boundary. The software watchdog restart left enough residual timing/state to make the first association unreliable, even though the driver then reported successful initialization.

Important distinction: The patch does not treat every Wi-Fi error as retryable. It retries only PICO_ERROR_CONNECT_FAILED, because authentication errors and other configuration errors should not be hidden by repeated attempts.

8. Final patch architecture

The clean V6 patch consists of two coordinated changes. The first prepares the external RM2 before a watchdog reset. The second makes WebConnect() tolerant of the known one-shot association failure that can occur after warm restart.

Location	Purpose	Action
misc/External.c / SoftReset()	Prepare RM2 before watchdog reset	Deinitialize CYW43, set startupcomplete=0, pull GP23 low, release GP24/25/29, wait 300 ms, then continue with the existing watchdog reset.
net/WiFi.c / WebConnect()	Recover from first warm-restart association failure	Try cyw43_arch_wifi_connect_timeout_ms() up to 3 times, but repeat only when return code is PICO_ERROR_CONNECT_FAILED . Poll for about 1 second between attempts.
PicoMite.c	No production modification	Diagnostic instrumentation is removed. The final clean file matches the original upstream source.

9. Detailed patch: misc/External.c

The reset patch is placed inside SoftReset(int code), immediately before the existing watchdog_enable(1, 1) call. It is compiled only for WebMite on RP2350.

Required include

```
#ifdef PICOMITEWEB
#include "pico/cyw43_arch.h"
#endif
```

SoftReset() patch

```

void SoftReset(int code)
{
    _excep_code = code;
#ifdef USBKEYBOARD
    USBenabled = false;
    uSec(50000);
#endif

    #if defined(PICOMITEWEB) && defined(rp2350)
        /*
         * RM2/CYW43439 warm-reset preparation.
         * Cleanly stop CYW43, release its bus pins and keep WL_ON LOW
         * before triggering the RP2350 watchdog reset.
         */
        if (startupcomplete)
        {
            cyw43_arch_deinit();
            startupcomplete = 0;
        }

        gpio_init(23);
        gpio_disable_pulls(23);
        gpio_put(23, 0);
        gpio_set_dir(23, GPIO_OUT);

        gpio_init(24);
        gpio_disable_pulls(24);
        gpio_set_dir(24, GPIO_IN);

        gpio_init(25);
        gpio_disable_pulls(25);
        gpio_set_dir(25, GPIO_IN);

        gpio_init(29);
        gpio_disable_pulls(29);
        gpio_set_dir(29, GPIO_IN);

        uSec(300000);
    #endif

    watchdog_enable(1, 1);
    while (1) {}
}

```

cyw43_arch_deinit(): Stops the CYW43 architecture cleanly before the RP2350 is reset. This is preferable to resetting the host while the Wi-Fi stack is still active.

startupcomplete = 0: Prevents code from continuing to regard the previous Wi-Fi stack instance as initialized during the reset transition.

GP23 LOW: Forces the RM2 WL_ON signal low before the watchdog reset.

GP24/GP25/GP29 to input: Releases DAT, CS and CLK instead of leaving host-driven bus states active during the reset interval.

300 ms delay: Provides a clear off/settle period before the watchdog is triggered. Earlier shorter-only WL_ON approaches were not sufficient on their own.

10. Detailed patch: net/WiFi.c

The final retry logic replaces the original single call to `cyw43_arch_wifi_connect_timeout_ms()`. All of the existing success/failure handling after that call remains unchanged.

Production retry block

```
int connect_result = PICO_ERROR_CONNECT_FAILED;

// A warm RP2350 reset can leave the first CYW43 join attempt in LINK_FAIL.
// Retry that specific failure up to two more times before giving up.
for (int rm2_attempt = 1; rm2_attempt <= 3; rm2_attempt++)
{
    connect_result = cyw43_arch_wifi_connect_timeout_ms(
        (char *)Option.SSID,
        (char *)(*Option.PASSWORD ? Option.PASSWORD : NULL),
        (*Option.PASSWORD ? CYW43_AUTH_WPA2_MIXED_PSK : CYW43_AUTH_OPEN),
        30000);

    if (connect_result == 0)
        break;

    if (connect_result != PICO_ERROR_CONNECT_FAILED || rm2_attempt == 3)
        break;

    // Give the poll backend one second to settle before the next join.
    for (int rm2_wait = 0; rm2_wait < 100; rm2_wait++)
    {
        cyw43_arch_poll();
        uSec(10000);
    }
}
```

Initialization: `connect_result` starts at `PICO_ERROR_CONNECT_FAILED` so the variable always has a defined state before the loop.

Attempt 1: WebMite performs the same 30-second-timeout connection API call as before. On normal cold boot this normally succeeds immediately.

Immediate success: If `connect_result == 0`, the loop exits and the existing WebMite Connected / server startup code runs unchanged.

Selective retry: Only `PICO_ERROR_CONNECT_FAILED` is retried. This is the exact error measured after CPU RESTART.

Settle interval: Between retryable failures, `cyw43_arch_poll()` is called 100 times with 10 ms spacing, giving roughly one second of service/settling time.

Maximum attempts: Three total attempts are allowed. Therefore the patch avoids an infinite connection loop inside firmware startup.

Other errors: Authentication failure, malformed configuration, timeout variants or other non--8 errors leave the loop immediately and continue into WebMite's original error reporting.

11. Why the solution works

The diagnostic sequence demonstrated that the first post-restart association failure is transient. The RM2/CYW43439 is not permanently unusable after CPU RESTART: without another reset, a second association request succeeds approximately one second later. The patch therefore changes the recovery strategy from "reset the whole CPU again" to "retry the network association that actually failed."

This is also conceptually similar to the proven BASIC workaround used on a Pico 2 W with WebMite 6.02, where a program watches `MM.INFO(IP ADDRESS)` and performs CPU RESTART if the address remains 0.0.0.0. The firmware patch is cleaner for this RP2350B/RM2 case because it handles the retry inside `WebConnect()` and does not require restarting the complete user program.

Practical advantage: A temporary first-join failure no longer forces a second full reboot. User state, BASIC startup behavior and peripheral initialization do not need to be repeated solely because the first Wi-Fi association returned -8.

12. Build, integration and verification procedure

The patch was developed against the official PicoMite/WebMite V6.04.00RC1 source tree and built for WEBRP2350. The working environment used Pico SDK 2.3.0 and Arm GNU Toolchain 13.3.Rel1.

Build environment and build command

```
$env:PICO_SDK_PATH="C:\Users\Herodes\.pico-sdk\sdk\2.3.0"\n$env:Path="C:\Users\Herodes\.pico-  
sdk\toolchain\13_3_Rel1\bin;$env:Path"\n$pyexe = py -c "import sys;  
print(sys.executable)"\n$env:Path="$(Split-Path $pyexe);$env:Path"\nngit diff --check\n.  
\buildpicomite.bat WEBRP2350
```

The generated image is normally written as:

```
.\uf2\WebMiteRP2350V6.04.00RC1.uf2
```

For the clean final patch it can be copied to a distinct filename, for example:

```
Copy-Item .\uf2\WebMiteRP2350V6.04.00RC1.uf2 .\uf2\WebMiteRP2350V6.04.00RC1_RM2_FINAL_V6.uf2
```

13. Expected behavior and failure handling

Condition	Expected firmware behavior	Result
Normal cold boot	Attempt 1 normally succeeds.	No additional delay beyond normal Wi-Fi association.
Warm restart, first join returns -8	Wait about 1 second, then retry.	Attempt 2 or 3 can restore Wi-Fi automatically.
Bad password / authentication failure	No repeated -8-specific retry if the return code is a different error.	Existing WebMite failure handling remains visible.
All three -8 attempts fail	Exit retry loop and run existing WebMite failure path.	WiFiconnected remains 0; failure is not hidden.
No SSID configured	Original WebConnect() alternate path remains unchanged.	No behavioral change intended.

Recommended regression test sequence:

1. Cold power-off for at least 20 seconds, then power on: verify Wi-Fi connects.
2. Issue CPU RESTART from the USB console: verify Wi-Fi reconnects without pressing physical RST.
3. Repeat CPU RESTART at least 10 times to look for intermittent failures.
4. Trigger an OPTION change that causes a software restart and verify Wi-Fi recovery.
5. Test with the unit powered from the intended power bank/supply, not only from USB.
6. Confirm that Telnet, UDP/TCP services and TFTP (if enabled) are reopened after reconnection.
7. If practical, test a deliberately incorrect password once and verify that the patch does not enter an endless retry cycle.

14. Limitations and recommendations

- The measured and validated hardware combination is WeAct RP2350B + external Pimoroni RM2/CYW43439. Other RP2350B boards may route the CYW43 pins differently.
- The GPIO numbers in the reset patch are hardware-specific: GP23=WL_ON, GP24=DAT, GP25=CS, GP29=CLK for this design.
- The solution was developed against WebMite MMBasic RP2350B Edition V6.04.00RC1. Future releases may change WebConnect(), reset handling or CYW43 integration; the patch should be reviewed before porting.
- V5 is the diagnostic build that demonstrated successful warm-restart recovery. V6 removes diagnostics but preserves the same retry strategy; final V6 should be regression-tested after compilation/flashing.
- The 0-ohm resistor removal on the WeAct KEY@23 circuit is a separate hardware prerequisite for this setup. Firmware should not be expected to compensate for a board-level circuit still loading WL_ON.
- Do not change the one-second settle delay or three-attempt limit without testing. Those values were selected from the observed behavior and avoid excessive boot delay.

Recommended upstream-style implementation: If this behavior is submitted upstream, keep the retry narrowly scoped to PICO_ERROR_CONNECT_FAILED and guard any RM2-specific reset GPIO code so it does not alter unrelated Pico W or RP2350 Wi-Fi targets.

Appendix A. Full patch excerpts

The production changes are intentionally small. PicoMite.c does not require a permanent modification. The relevant changes are the SoftReset() preparation in misc/External.c and the selective connection retry in net/WiFi.c.

A.1 misc/External.c

```
#ifdef PICOMITEWEB
#include "pico/cyw43_arch.h"
#endif

...

#if defined(PICOMITEWEB) && defined(rp2350)
if (startupcomplete)
{
    cyw43_arch_deinit();
    startupcomplete = 0;
}

gpio_init(23);
gpio_disable_pulls(23);
gpio_put(23, 0);
gpio_set_dir(23, GPIO_OUT);

gpio_init(24);
gpio_disable_pulls(24);
gpio_set_dir(24, GPIO_IN);

gpio_init(25);
gpio_disable_pulls(25);
gpio_set_dir(25, GPIO_IN);

gpio_init(29);
gpio_disable_pulls(29);
gpio_set_dir(29, GPIO_IN);

uSec(300000);
#endif

watchdog_enable(1, 1);
while (1) {}
```

A.2 net/WiFi.c

```
int connect_result = PICO_ERROR_CONNECT_FAILED;

for (int rm2_attempt = 1; rm2_attempt <= 3; rm2_attempt++)
{
    connect_result = cyw43_arch_wifi_connect_timeout_ms(
        (char *)Option.SSID,
        (char *)(*Option.PASSWORD ? Option.PASSWORD : NULL),
        (*Option.PASSWORD ? CYW43_AUTH_WPA2_MIXED_PSK : CYW43_AUTH_OPEN),
        30000);

    if (connect_result == 0)
        break;

    if (connect_result != PICO_ERROR_CONNECT_FAILED || rm2_attempt == 3)
        break;

    for (int rm2_wait = 0; rm2_wait < 100; rm2_wait++)
    {
        cyw43_arch_poll();
        uSec(10000);
    }
}
```

Appendix B. Key diagnostic logs

```
NORMAL START
[RM2DBG] ... cyw43_init=0 gp23=0
[RM2RETRY] attempt=1 before wifi=0 tcpip=0 gp23=1
[RM2RETRY] attempt=1 rc=0 elapsed=2992 ms wifi=1 tcpip=3 gp23=1
Connected 192.168.178.143

CPU RESTART
[RM2DBG] ... cyw43_init=0 gp23=0
[RM2RETRY] attempt=1 before wifi=0 tcpip=0 gp23=1
[RM2RETRY] attempt=1 rc=-8 elapsed=3224 ms wifi=-1 tcpip=-1 gp23=1
[RM2RETRY] attempt=2 before wifi=-1 tcpip=-1 gp23=1
[RM2RETRY] attempt=2 rc=0 elapsed=3003 ms wifi=1 tcpip=3 gp23=1
Connected 192.168.178.143
```

End of report. This document records the observed behavior and the patch developed for the specified hardware/firmware combination.