Morse Micro

SoftMAC Linux Driver
User Guide

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1 Introduction

Welcome! Start here on your exciting journey towards using Wi-Fi Certified HaLow® (referred to as HaLow from here on) for long-range, reliable Wi-Fi.

This document covers the Linux Driver for MM6108 and MM8108 when operating in SoftMAC mode. For FullMAC operation on the MM8108, please consult the Morse Micro FullMAC Linux Driver 2.1 User Guide.

Because native S1G (IEEE 802.11ah) support in older Linux kernels and mac80211 was limited, the Morse Micro driver takes on a substantial additional responsibility: converting between standard Wi-Fi frame formats as understood by mac80211 and the S1G frame formats required by the hardware. This includes handling differences in frame headers, capability elements, and other format distinctions that mac80211 had no native awareness of.

1.1 Version Applicability

This document applies to the Linux 2.1.x series of drivers from Morse Micro.

N.B. It does not apply to any Morse Micro driver that has been upstreamed to the Linux kernel.

2 Running HaLow in Linux

2.1 Porting

For developers undertaking the process of adapting the Morse Micro Linux driver to a new or custom hardware platform, the definitive resource is the MM APPNOTE-24 - Linux Driver Porting Guide.

This critical application note provides comprehensive, step-by-step instructions, architectural considerations, and best practices necessary to successfully port the driver and software.

2.1.1 Kernel patches

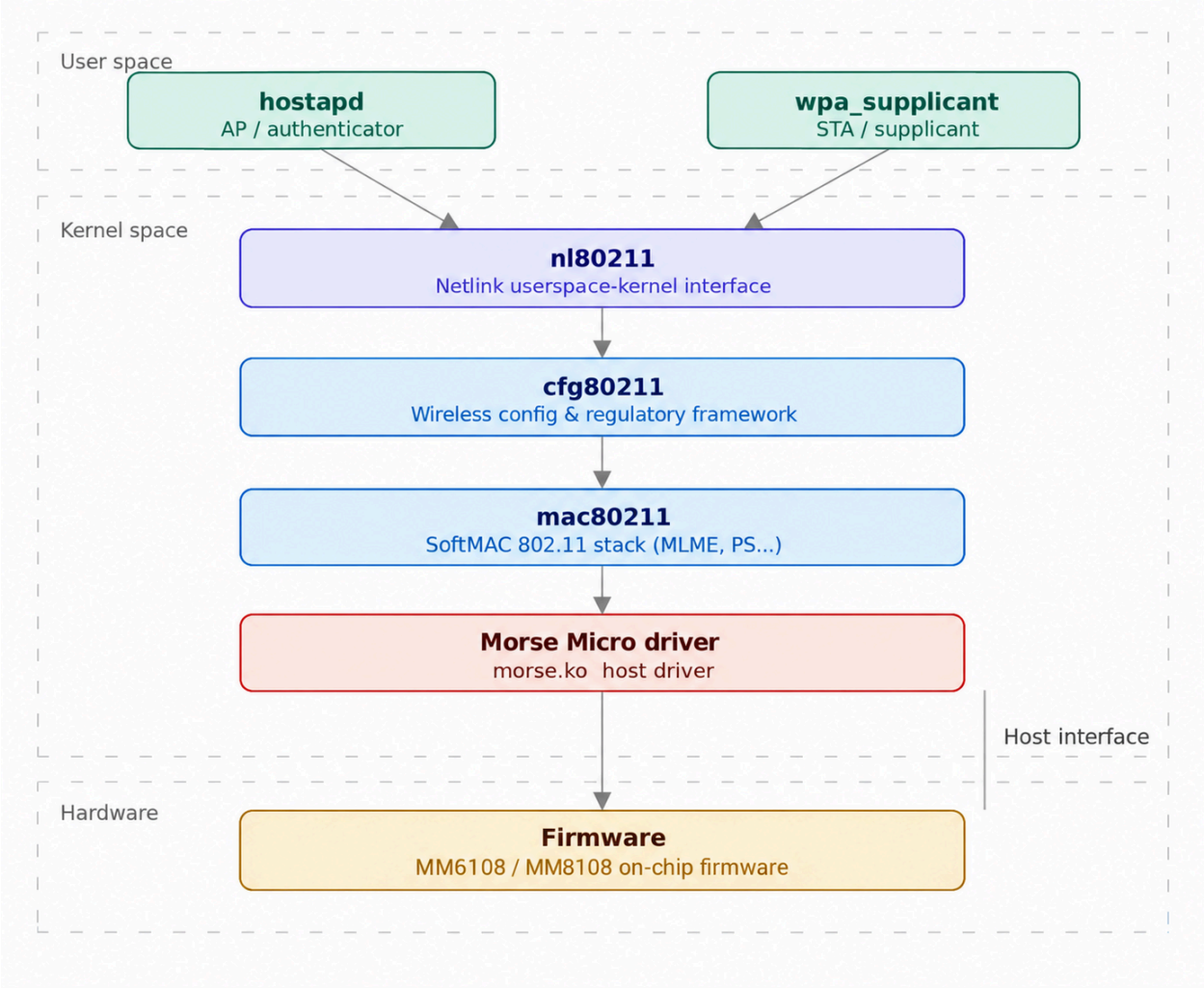
To function correctly, the Morse Micro driver necessitates applying patches to the Linux kernel. Details regarding these essential patches and their compatibility are provided in the Linux Kernel Patches application note.

2.2 Userspace tools

2.2.1 hostap/wpa_supplicant

Configuring a Wi-Fi interface in Linux is a two-layer concern: the kernel driver handles the hardware, but Userspace daemons handle the management plane — authentication, association, and network configuration. For HaLow, as with standard Wi-Fi, this means hostapd and wpa_supplicant.

hostapd is the Userspace daemon responsible for running an access point. It implements the AP-side MLME, handles station authentication and association, and manages security. When running a HaLow AP on Linux, hostapd drives the process — the Morse Micro driver and mac80211 respond to its commands via the cfg80211/nl80211 interface.



wpa_supplicant is the counterpart for station (STA) mode. It manages the connection lifecycle from the client side — scanning, authentication, and association to an AP. For a HaLow device acting as a

sensor node or client, wpa_supplicant is the daemon responsible for establishing and maintaining the connection.

Note that HaLow does not support WPA2. The supported security modes are WPA3-Personal (SAE) and OWE (Opportunistic Wireless Encryption). This is reflected in the configuration for both daemons and is a deliberate part of the 802.11ah specification.

Morse Micro provides patched versions of both daemons — hostapd_s1g and wpa_supplicant_s1g — and these should be used in place of any distribution-provided versions. The patches incorporate Morse Micro bug fixes as well as changes that allow the daemons to present HaLow channels and operating parameters natively, rather than requiring translation workarounds. Unpatched upstream versions are not supported and will not behave correctly with HaLow hardware.

Both daemons communicate with the kernel through the standard nl80211 interface. Since nl80211 as provided by Linux has no native concept of S1G channels or operating classes, HaLow channel and band information is currently mapped onto the 5GHz band. This translation is handled by the driver and the patched daemons, and is largely transparent to the user — but it is worth being aware of when interpreting interface state or diagnostic output from other tools that report band or channel information.

2.2.2 Support Tools - morse_cli, iw

`iw` is the standard Linux Userspace tool for interacting with wireless interfaces via nl80211. It is useful for inspecting interface state, triggering scans, checking station statistics, and querying regulatory and capability information. Since `iw` communicates with nl80211 directly, most of its functionality works with the Morse Micro driver without modification.

However, `iw` has no awareness of S1G-specific concepts such as HaLow channel numbering or operating classes, and will reflect the underlying 5GHz mapping rather than native HaLow values. It is best used for general-purpose diagnostics and interface inspection rather than HaLow-specific configuration or status. For HaLow-accurate information, morse_cli is the better choice.

morse_cli is a Morse Micro-provided command-line tool that exposes functionality specific to the Morse Micro chipset and the Morse Micro driver — things that `iw` has no visibility into. This includes HaLow-specific statistics, hardware state, firmware diagnostics, and configuration options that fall outside the scope of the standard nl80211 interface.

Where `iw` is the right tool for standard Wi-Fi interface management and general diagnostics, morse_cli is the tool to reach for when you need to inspect or control anything specific to HaLow operation or Morse Micro hardware behaviour.

Further information about morse_cli can be found in MM APPNOTE-13 - Morsectrl Guide

3 Modes of Operation

3.1 SoftMAC

In the Wi-Fi driver world, the term SoftMAC describes an architecture where the MAC (Medium Access Control) layer logic runs on the host CPU rather than entirely within the device firmware. This contrasts with a FullMAC design, where the firmware handles MAC-layer operations autonomously and presents a higher-level interface to the host — often just passing fully formed network frames up and down.

With a SoftMAC device, the host kernel (via the Linux mac80211 subsystem) takes on a significant share of the MAC-layer responsibilities. The driver sits between mac80211 and the hardware, translating between the kernel's expectations and what the device firmware actually needs.

Morse Micro Wi-Fi HaLow chipsets support the SoftMAC model, integrating with the Linux mac80211 framework through a conventional cfg80211/mac80211 driver stack.

3.1.1 Firmware vs. Host Responsibility Split

In the Morse Micro ecosystem, responsibilities are divided between the host (kernel + driver) and the device firmware as follows:

Host/mac80211 responsibilities:

- **MLME state machine** — association, authentication, and station management are driven by mac80211 on the host. The driver receives callbacks (e.g., `sta_add`, `bss_info_changed`) and translates these into firmware commands.
- **Rate control** — the rate control algorithm runs on the host and informs the driver of per-packet or per-station TX rate decisions.
- **Beacon generation (AP mode)** — mac80211 constructs beacon frames; the driver passes these to firmware for scheduling and transmission.
- **Scan orchestration** — scan requests originate from cfg80211/mac80211 and are passed to the firmware, which executes the scan in hardware. During a scan, received probe responses and beacons are passed to the host.
- **Power save policy** — mac80211 retains control over whether the device is permitted to enter power save. However, the mechanics of sleep entry and exit — including the transmission of some QoS Null frames — are offloaded to firmware on Morse Micro chipsets. See Dynamic Power Save Offload below.

Firmware responsibilities:

- **PHY and RF control** — all HaLow physical layer operations, channel access timing, and RF management are handled entirely within firmware.
- **TX scheduling and EDCA** — the firmware manages the actual EDCA queues and airtime arbitration once frames are handed down by the driver.
- **ACK handling and retransmission** — low-level frame exchange (ack, block-ack, retries) is resolved in firmware without host involvement per frame.
- **Hardware crypto offload** — encryption and decryption of data frames is performed by the device, with keys installed by the driver via mac80211 callbacks.
- **Aggregation (A-MPDU)** — session negotiation is handled by mac80211/the driver, but the actual aggregation and deaggregation of frames occurs in firmware.
- **Hardware scan** — on Morse Micro chipsets, channel scanning is executed directly by the firmware, avoiding the overhead of host-driven channel switching. The driver coordinates scan start/stop with mac80211 and passes received probe responses and beacons to mac80211.
- **Dynamic power save offload** — on Morse Micro chipsets, the firmware autonomously manages sleep entry and exit, including generation and transmission of QoS Null frames to signal PS state changes to the AP. Additionally, on MM6108, it can indicate to stations that the AP is in power save. Permission to enter power save remains under mac80211 control; the firmware acts within that boundary to handle the timing-sensitive mechanics.
- **Offloaded protocol features** - on Morse Micro chipsets, ARP response, DHCP client, and keepalive frames can be offloaded from the host to the firmware.

This split means that while the Morse Micro chipset offloads the performance-critical and timing-sensitive lower-layer operations to firmware, the host retains full visibility and control over MAC policy.

3.1.2 Thin LMAC

For deployments requiring an AP to support more than 200 stations, Morse Micro chipsets support an alternative AP operating mode called Thin LMAC. In this mode, certain operations that are ordinarily handled by firmware are moved back to the host:

- Fragmentation — frame fragmentation is performed by the host driver rather than firmware.
- Encryption — cryptographic operations are handled on the host rather than offloaded to the hardware engine.

By shifting this per-station state and processing back to the host, Thin LMAC significantly reduces the firmware memory footprint per associated station. This allows the chipset to scale to up to 2000 associated stations in AP mode — well beyond what is achievable when firmware holds per-STA crypto and fragmentation context.

Thin LMAC does place additional demands on the host platform. While a reasonably capable host CPU is required, the more critical requirement is hardware-accelerated AES support. Performing

per-packet encryption in software at high station counts can be a heavy operation; hardware AES acceleration keeps this overhead manageable. This capability is commonly available on ARM-based platforms — including the Raspberry Pi — via the ARMv8 cryptography extensions, making these a natural fit for Thin LMAC deployments.

3.2 Channelization and Regions

The specific regions and channels your device supports may be limited by hardware design and type approval. The TX Power provided in the below tables represent the absolute maximum allowed in that Region.

3.2.1 Argentina — AR (IEEE 802.11-RevMF)

N.B. This channelization introduces three new channels in addition to the channels in the IEEE 801.11-2024 channelization. For maximum interoperability, it is recommended to use 2024, but for Morse Micro only deployments, this channelization allows for 4/8 MHz channels in the centre of the band with the best performance.

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
28	916.0	1 MHz	30	N/A	N/A
30	917.0	1 MHz	30	N/A	N/A
32	918.0	1 MHz	30	N/A	N/A
34	919.0	1 MHz	30	N/A	N/A
36	920.0	1 MHz	30	N/A	N/A
38	921.0	1 MHz	30	N/A	N/A
40	922.0	1 MHz	30	N/A	N/A
42	923.0	1 MHz	30	N/A	N/A
44	924.0	1 MHz	30	N/A	N/A
46	925.0	1 MHz	30	N/A	N/A
48	926.0	1 MHz	30	N/A	N/A
50	927.0	1 MHz	30	N/A	N/A

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
29	916.5	2 MHz	30	N/A	N/A
33	918.5	2 MHz	30	N/A	N/A
37	920.5	2 MHz	30	N/A	N/A
41	922.5	2 MHz	30	N/A	N/A
45	924.5	2 MHz	30	N/A	N/A
49	926.5	2 MHz	30	N/A	N/A
31	917.5	4 MHz	30	N/A	N/A
51	919.5	4 MHz	30	N/A	N/A
39	921.5	4 MHz	30	N/A	N/A
59	923.5	4 MHz	30	N/A	N/A
47	925.5	4 MHz	30	N/A	N/A
35	919.5	8 MHz	30	N/A	N/A
43	923.5	8 MHz	30	N/A	N/A
55	921.5	8 MHz	30	N/A	N/A

3.2.2 Australia — AU (IEEE 802.11-RevMF)

N.B. This channelization introduces three new channels in addition to the channels in the IEEE 801.11-2024 channelization. For maximum interoperability, it is recommended to use 2024, but for Morse Micro only deployments, this channelization allows for 4/8 MHz channels in the centre of the band with the best performance.

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
28	916.0	1 MHz	30	N/A	N/A
30	917.0	1 MHz	30	N/A	N/A

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
32	918.0	1 MHz	30	N/A	N/A
34	919.0	1 MHz	30	N/A	N/A
36	920.0	1 MHz	30	N/A	N/A
38	921.0	1 MHz	30	N/A	N/A
40	922.0	1 MHz	30	N/A	N/A
42	923.0	1 MHz	30	N/A	N/A
44	924.0	1 MHz	30	N/A	N/A
46	925.0	1 MHz	30	N/A	N/A
48	926.0	1 MHz	30	N/A	N/A
50	927.0	1 MHz	30	N/A	N/A
29	916.5	2 MHz	30	N/A	N/A
33	918.5	2 MHz	30	N/A	N/A
37	920.5	2 MHz	30	N/A	N/A
41	922.5	2 MHz	30	N/A	N/A
45	924.5	2 MHz	30	N/A	N/A
49	926.5	2 MHz	30	N/A	N/A
31	917.5	4 MHz	30	N/A	N/A
51	919.5	4 MHz	30	N/A	N/A
39	921.5	4 MHz	30	N/A	N/A
59	923.5	4 MHz	30	N/A	N/A
47	925.5	4 MHz	30	N/A	N/A
35	919.5	8 MHz	30	N/A	N/A
43	923.5	8 MHz	30	N/A	N/A

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
55	921.5	8 MHz	30	N/A	N/A

3.2.3 Australia — AU_2020 (IEEE 802.11-2020)

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
27	915.5	1 MHz	30	N/A	N/A
29	916.5	1 MHz	30	N/A	N/A
31	917.5	1 MHz	30	N/A	N/A
33	918.5	1 MHz	30	N/A	N/A
35	919.5	1 MHz	30	N/A	N/A
37	920.5	1 MHz	30	N/A	N/A
39	921.5	1 MHz	30	N/A	N/A
41	922.5	1 MHz	30	N/A	N/A
43	923.5	1 MHz	30	N/A	N/A
45	924.5	1 MHz	30	N/A	N/A
47	925.5	1 MHz	30	N/A	N/A
49	926.5	1 MHz	30	N/A	N/A
51	927.5	1 MHz	30	N/A	N/A
30	917.0	2 MHz	30	N/A	N/A
34	919.0	2 MHz	30	N/A	N/A
38	921.0	2 MHz	30	N/A	N/A
42	923.0	2 MHz	30	N/A	N/A

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
46	925.0	2 MHz	30	N/A	N/A
50	927.0	2 MHz	30	N/A	N/A
32	918.0	4 MHz	30	N/A	N/A
40	922.0	4 MHz	30	N/A	N/A
48	926.0	4 MHz	30	N/A	N/A
44	924.0	8 MHz	30	N/A	N/A

3.2.4 Australia — AU_2024 (IEEE 802.11-2024)

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
28	916.0	1 MHz	30	N/A	N/A
30	917.0	1 MHz	30	N/A	N/A
32	918.0	1 MHz	30	N/A	N/A
34	919.0	1 MHz	30	N/A	N/A
36	920.0	1 MHz	30	N/A	N/A
38	921.0	1 MHz	30	N/A	N/A
40	922.0	1 MHz	30	N/A	N/A
42	923.0	1 MHz	30	N/A	N/A
44	924.0	1 MHz	30	N/A	N/A
46	925.0	1 MHz	30	N/A	N/A
48	926.0	1 MHz	30	N/A	N/A
50	927.0	1 MHz	30	N/A	N/A

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
29	916.5	2 MHz	30	N/A	N/A
33	918.5	2 MHz	30	N/A	N/A
37	920.5	2 MHz	30	N/A	N/A
41	922.5	2 MHz	30	N/A	N/A
45	924.5	2 MHz	30	N/A	N/A
49	926.5	2 MHz	30	N/A	N/A
31	917.5	4 MHz	30	N/A	N/A
39	921.5	4 MHz	30	N/A	N/A
47	925.5	4 MHz	30	N/A	N/A
35	919.5	8 MHz	30	N/A	N/A
43	923.5	8 MHz	30	N/A	N/A

3.2.5 Brazil - BR

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
1	902.5	1 MHz	36	N/A	N/A
3	903.5	1 MHz	36	N/A	N/A
5	904.5	1 MHz	36	N/A	N/A
7	905.5	1 MHz	36	N/A	N/A
9	906.5	1 MHz	36	N/A	N/A
2	903.0	2 MHz	36	N/A	N/A
6	905.0	2 MHz	36	N/A	N/A

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
27	915.5	1 MHz	36	N/A	N/A
29	916.5	1 MHz	36	N/A	N/A
31	917.5	1 MHz	36	N/A	N/A
33	918.5	1 MHz	36	N/A	N/A
35	919.5	1 MHz	36	N/A	N/A
37	920.5	1 MHz	36	N/A	N/A
39	921.5	1 MHz	36	N/A	N/A
41	922.5	1 MHz	36	N/A	N/A
43	923.5	1 MHz	36	N/A	N/A
45	924.5	1 MHz	36	N/A	N/A
47	925.5	1 MHz	36	N/A	N/A
49	926.5	1 MHz	36	N/A	N/A
51	927.5	1 MHz	36	N/A	N/A
30	917.0	2 MHz	36	N/A	N/A
34	919.0	2 MHz	36	N/A	N/A
38	921.0	2 MHz	36	N/A	N/A
42	923.0	2 MHz	36	N/A	N/A
46	925.0	2 MHz	36	N/A	N/A
50	927.0	2 MHz	36	N/A	N/A
32	918.0	4 MHz	36	N/A	N/A
40	922.0	4 MHz	36	N/A	N/A
48	926.0	4 MHz	36	N/A	N/A

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
44	924.0	8 MHz	36	N/A	N/A

3.2.6 Canada — CA

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
1	902.5	1 MHz	36	N/A	N/A
3	903.5	1 MHz	36	N/A	N/A
5	904.5	1 MHz	36	N/A	N/A
7	905.5	1 MHz	36	N/A	N/A
9	906.5	1 MHz	36	N/A	N/A
11	907.5	1 MHz	36	N/A	N/A
13	908.5	1 MHz	36	N/A	N/A
15	909.5	1 MHz	36	N/A	N/A
17	910.5	1 MHz	36	N/A	N/A
19	911.5	1 MHz	36	N/A	N/A
21	912.5	1 MHz	36	N/A	N/A
23	913.5	1 MHz	36	N/A	N/A
25	914.5	1 MHz	36	N/A	N/A
27	915.5	1 MHz	36	N/A	N/A
29	916.5	1 MHz	36	N/A	N/A
31	917.5	1 MHz	36	N/A	N/A
33	918.5	1 MHz	36	N/A	N/A
35	919.5	1 MHz	36	N/A	N/A

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
37	920.5	1 MHz	36	N/A	N/A
39	921.5	1 MHz	36	N/A	N/A
41	922.5	1 MHz	36	N/A	N/A
43	923.5	1 MHz	36	N/A	N/A
45	924.5	1 MHz	36	N/A	N/A
47	925.5	1 MHz	36	N/A	N/A
49	926.5	1 MHz	36	N/A	N/A
51	927.5	1 MHz	36	N/A	N/A
2	903.0	2 MHz	36	N/A	N/A
6	905.0	2 MHz	36	N/A	N/A
10	907.0	2 MHz	36	N/A	N/A
14	909.0	2 MHz	36	N/A	N/A
18	911.0	2 MHz	36	N/A	N/A
22	913.0	2 MHz	36	N/A	N/A
26	915.0	2 MHz	36	N/A	N/A
30	917.0	2 MHz	36	N/A	N/A
34	919.0	2 MHz	36	N/A	N/A
38	921.0	2 MHz	36	N/A	N/A
42	923.0	2 MHz	36	N/A	N/A
46	925.0	2 MHz	36	N/A	N/A
50	927.0	2 MHz	36	N/A	N/A
8	906.0	4 MHz	36	N/A	N/A

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
16	910.0	4 MHz	36	N/A	N/A
24	914.0	4 MHz	36	N/A	N/A
32	918.0	4 MHz	36	N/A	N/A
40	922.0	4 MHz	36	N/A	N/A
48	926.0	4 MHz	36	N/A	N/A
12	908.0	8 MHz	36	N/A	N/A
28	916.0	8 MHz	36	N/A	N/A
44	924.0	8 MHz	36	N/A	N/A

3.2.7 Chile — CL (IEEE 802.11-RevMF)

N.B. This channelization introduces three new channels in addition to the channels in the IEEE 801.11-2024 channelization. For maximum interoperability, it is recommended to use 2024, but for Morse Micro only deployments, this channelization allows for 4/8 MHz channels in the centre of the band with the best performance.

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
28	916.0	1 MHz	30	N/A	N/A
30	917.0	1 MHz	30	N/A	N/A
32	918.0	1 MHz	30	N/A	N/A
34	919.0	1 MHz	30	N/A	N/A
36	920.0	1 MHz	30	N/A	N/A
38	921.0	1 MHz	30	N/A	N/A
40	922.0	1 MHz	30	N/A	N/A
42	923.0	1 MHz	30	N/A	N/A

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
44	924.0	1 MHz	30	N/A	N/A
46	925.0	1 MHz	30	N/A	N/A
48	926.0	1 MHz	30	N/A	N/A
50	927.0	1 MHz	30	N/A	N/A
29	916.5	2 MHz	30	N/A	N/A
33	918.5	2 MHz	30	N/A	N/A
37	920.5	2 MHz	30	N/A	N/A
41	922.5	2 MHz	30	N/A	N/A
45	924.5	2 MHz	30	N/A	N/A
49	926.5	2 MHz	30	N/A	N/A
31	917.5	4 MHz	30	N/A	N/A
51	919.5	4 MHz	30	N/A	N/A
39	921.5	4 MHz	30	N/A	N/A
59	923.5	4 MHz	30	N/A	N/A
47	925.5	4 MHz	30	N/A	N/A
35	919.5	8 MHz	30	N/A	N/A
43	923.5	8 MHz	30	N/A	N/A
55	921.5	8 MHz	30	N/A	N/A

3.2.8 Colombia — CO (IEEE 802.11-RevMF)

N.B. This channelization introduces three new channels in addition to the channels in the IEEE 801.11-2024 channelization. For maximum interoperability, it is recommended to use 2024, but for Morse Micro only deployments, this channelization allows for 4/8 MHz channels in the centre of the band with the best performance.

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
28	916.0	1 MHz	30	N/A	N/A
30	917.0	1 MHz	30	N/A	N/A
32	918.0	1 MHz	30	N/A	N/A
34	919.0	1 MHz	30	N/A	N/A
36	920.0	1 MHz	30	N/A	N/A
38	921.0	1 MHz	30	N/A	N/A
40	922.0	1 MHz	30	N/A	N/A
42	923.0	1 MHz	30	N/A	N/A
44	924.0	1 MHz	30	N/A	N/A
46	925.0	1 MHz	30	N/A	N/A
48	926.0	1 MHz	30	N/A	N/A
50	927.0	1 MHz	30	N/A	N/A
29	916.5	2 MHz	30	N/A	N/A
33	918.5	2 MHz	30	N/A	N/A
37	920.5	2 MHz	30	N/A	N/A
41	922.5	2 MHz	30	N/A	N/A
45	924.5	2 MHz	30	N/A	N/A
49	926.5	2 MHz	30	N/A	N/A
31	917.5	4 MHz	30	N/A	N/A
51	919.5	4 MHz	30	N/A	N/A
39	921.5	4 MHz	30	N/A	N/A
59	923.5	4 MHz	30	N/A	N/A
47	925.5	4 MHz	30	N/A	N/A

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
35	919.5	8 MHz	30	N/A	N/A
43	923.5	8 MHz	30	N/A	N/A
55	921.5	8 MHz	30	N/A	N/A

3.2.9 European Union — EU (EN 304 220)

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
1	863.5	1 MHz	16	10%	2.8%
3	864.5	1 MHz	16	10%	2.8%
5	865.5	1 MHz	16	10%	2.8%
7	866.5	1 MHz	16	10%	2.8%
9	867.5	1 MHz	16	10%	2.8%

3.2.10 United Kingdom — GB

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
1	863.5	1 MHz	16	10%	2.8%
3	864.5	1 MHz	16	10%	2.8%
5	865.5	1 MHz	16	10%	2.8%
7	866.5	1 MHz	16	10%	2.8%
9	867.5	1 MHz	16	10%	2.8%
33	917.9	1 MHz	16	10%	2.8%
35	918.9	1 MHz	16	10%	2.8%

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
2	864.0	2 MHz	16	10%	2.8%
6	866.0	2 MHz	16	10%	2.8%

3.2.11 India — IN

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
5	865.5	1 MHz	16	10%	2.8%
7	866.5	1 MHz	16	10%	2.8%
9	867.5	1 MHz	16	10%	2.8%

3.2.12 Japan — JP

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
9	921.0	1 MHz	16	10%	10%
13	923.0	1 MHz	16	10%	10%
15	924.0	1 MHz	16	10%	10%
17	925.0	1 MHz	16	10%	10%
19	926.0	1 MHz	16	10%	10%
21	927.0	1 MHz	16	10%	10%
2	923.5	2 MHz	16	10%	10%
4	924.5	2 MHz	16	10%	10%
6	925.5	2 MHz	16	10%	10%
8	926.5	2 MHz	16	10%	10%

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
36	924.5	4 MHz	16	10%	10%
38	925.5	4 MHz	16	10%	10%

3.2.13 Mexico — MX

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
1	902.5	1 MHz	36	N/A	N/A
3	903.5	1 MHz	36	N/A	N/A
5	904.5	1 MHz	36	N/A	N/A
7	905.5	1 MHz	36	N/A	N/A
9	906.5	1 MHz	36	N/A	N/A
11	907.5	1 MHz	36	N/A	N/A
13	908.5	1 MHz	36	N/A	N/A
15	909.5	1 MHz	36	N/A	N/A
17	910.5	1 MHz	36	N/A	N/A
19	911.5	1 MHz	36	N/A	N/A
21	912.5	1 MHz	36	N/A	N/A
23	913.5	1 MHz	36	N/A	N/A
25	914.5	1 MHz	36	N/A	N/A
27	915.5	1 MHz	36	N/A	N/A
29	916.5	1 MHz	36	N/A	N/A
31	917.5	1 MHz	36	N/A	N/A
33	918.5	1 MHz	36	N/A	N/A

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
35	919.5	1 MHz	36	N/A	N/A
37	920.5	1 MHz	36	N/A	N/A
39	921.5	1 MHz	36	N/A	N/A
41	922.5	1 MHz	36	N/A	N/A
43	923.5	1 MHz	36	N/A	N/A
45	924.5	1 MHz	36	N/A	N/A
47	925.5	1 MHz	36	N/A	N/A
49	926.5	1 MHz	36	N/A	N/A
51	927.5	1 MHz	36	N/A	N/A
2	903.0	2 MHz	36	N/A	N/A
6	905.0	2 MHz	36	N/A	N/A
10	907.0	2 MHz	36	N/A	N/A
14	909.0	2 MHz	36	N/A	N/A
18	911.0	2 MHz	36	N/A	N/A
22	913.0	2 MHz	36	N/A	N/A
26	915.0	2 MHz	36	N/A	N/A
30	917.0	2 MHz	36	N/A	N/A
34	919.0	2 MHz	36	N/A	N/A
38	921.0	2 MHz	36	N/A	N/A
42	923.0	2 MHz	36	N/A	N/A
46	925.0	2 MHz	36	N/A	N/A
50	927.0	2 MHz	36	N/A	N/A

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
8	906.0	4 MHz	36	N/A	N/A
16	910.0	4 MHz	36	N/A	N/A
24	914.0	4 MHz	36	N/A	N/A
32	918.0	4 MHz	36	N/A	N/A
40	922.0	4 MHz	36	N/A	N/A
48	926.0	4 MHz	36	N/A	N/A
12	908.0	8 MHz	36	N/A	N/A
28	916.0	8 MHz	36	N/A	N/A
44	924.0	8 MHz	36	N/A	N/A

3.2.14 New Zealand — NZ

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
27	915.5	1 MHz	30	N/A	N/A
29	916.5	1 MHz	30	N/A	N/A
31	917.5	1 MHz	30	N/A	N/A
33	918.5	1 MHz	30	N/A	N/A
35	919.5	1 MHz	30	N/A	N/A
37	920.5	1 MHz	36	N/A	N/A
39	921.5	1 MHz	36	N/A	N/A
41	922.5	1 MHz	36	N/A	N/A
43	923.5	1 MHz	36	N/A	N/A
45	924.5	1 MHz	36	N/A	N/A

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
47	925.5	1 MHz	36	N/A	N/A
49	926.5	1 MHz	36	N/A	N/A
51	927.5	1 MHz	36	N/A	N/A
30	917.0	2 MHz	30	N/A	N/A
34	919.0	2 MHz	30	N/A	N/A
38	921.0	2 MHz	36	N/A	N/A
42	923.0	2 MHz	36	N/A	N/A
46	925.0	2 MHz	36	N/A	N/A
50	927.0	2 MHz	36	N/A	N/A
32	918.0	4 MHz	30	N/A	N/A
40	922.0	4 MHz	36	N/A	N/A
48	926.0	4 MHz	36	N/A	N/A
44	924.0	8 MHz	36	N/A	N/A

3.2.15 Singapore — SG

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
7	866.5	1 MHz	29	N/A	N/A
9	867.5	1 MHz	29	N/A	N/A
11	868.5	1 MHz	29	N/A	N/A
37	920.5	1 MHz	22	N/A	N/A
39	921.5	1 MHz	22	N/A	N/A
41	922.5	1 MHz	22	N/A	N/A

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
43	923.5	1 MHz	22	N/A	N/A
45	924.5	1 MHz	22	N/A	N/A
10	868.0	2 MHz	29	N/A	N/A
38	921.0	2 MHz	22	N/A	N/A
42	923.0	2 MHz	22	N/A	N/A
40	922.0	4 MHz	22	N/A	N/A

3.2.16 South Korea — KR

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
1	918.0	1 MHz	4	N/A	N/A
3	919.0	1 MHz	4	N/A	N/A
5	920.0	1 MHz	4	N/A	N/A
7	921.0	1 MHz	4	N/A	N/A
9	922.0	1 MHz	10	N/A	N/A
11	923.0	1 MHz	10	N/A	N/A
18	926.5	1 MHz	17	N/A	N/A
20	927.5	1 MHz	17	N/A	N/A
22	928.5	1 MHz	17	N/A	N/A
24	929.5	1 MHz	17	N/A	N/A
2	918.5	2 MHz	4	N/A	N/A
6	920.5	2 MHz	4	N/A	N/A
10	922.5	2 MHz	10	N/A	N/A

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
19	927.0	2 MHz	20	N/A	N/A
23	929.0	2 MHz	20	N/A	N/A
8	921.5	4 MHz	4	N/A	N/A

3.2.17 United States — US

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
1	902.5	1 MHz	36	N/A	N/A
3	903.5	1 MHz	36	N/A	N/A
5	904.5	1 MHz	36	N/A	N/A
7	905.5	1 MHz	36	N/A	N/A
9	906.5	1 MHz	36	N/A	N/A
11	907.5	1 MHz	36	N/A	N/A
13	908.5	1 MHz	36	N/A	N/A
15	909.5	1 MHz	36	N/A	N/A
17	910.5	1 MHz	36	N/A	N/A
19	911.5	1 MHz	36	N/A	N/A
21	912.5	1 MHz	36	N/A	N/A
23	913.5	1 MHz	36	N/A	N/A
25	914.5	1 MHz	36	N/A	N/A
27	915.5	1 MHz	36	N/A	N/A
29	916.5	1 MHz	36	N/A	N/A
31	917.5	1 MHz	36	N/A	N/A

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
33	918.5	1 MHz	36	N/A	N/A
35	919.5	1 MHz	36	N/A	N/A
37	920.5	1 MHz	36	N/A	N/A
39	921.5	1 MHz	36	N/A	N/A
41	922.5	1 MHz	36	N/A	N/A
43	923.5	1 MHz	36	N/A	N/A
45	924.5	1 MHz	36	N/A	N/A
47	925.5	1 MHz	36	N/A	N/A
49	926.5	1 MHz	36	N/A	N/A
51	927.5	1 MHz	36	N/A	N/A
2	903.0	2 MHz	36	N/A	N/A
6	905.0	2 MHz	36	N/A	N/A
10	907.0	2 MHz	36	N/A	N/A
14	909.0	2 MHz	36	N/A	N/A
18	911.0	2 MHz	36	N/A	N/A
22	913.0	2 MHz	36	N/A	N/A
26	915.0	2 MHz	36	N/A	N/A
30	917.0	2 MHz	36	N/A	N/A
34	919.0	2 MHz	36	N/A	N/A
38	921.0	2 MHz	36	N/A	N/A
42	923.0	2 MHz	36	N/A	N/A
46	925.0	2 MHz	36	N/A	N/A

Channel	Center Freq (MHz)	Bandwidth	Max TX Power (dBm)	AP Duty Cycle	STA Duty Cycle
50	927.0	2 MHz	36	N/A	N/A
8	906.0	4 MHz	36	N/A	N/A
16	910.0	4 MHz	36	N/A	N/A
24	914.0	4 MHz	36	N/A	N/A
32	918.0	4 MHz	36	N/A	N/A
40	922.0	4 MHz	36	N/A	N/A
48	926.0	4 MHz	36	N/A	N/A
12	908.0	8 MHz	36	N/A	N/A
28	916.0	8 MHz	36	N/A	N/A
44	924.0	8 MHz	36	N/A	N/A

4 Configuration

4.1 Driver Options - module parameters

Module parameters can be set at load time via `modprobe morse <param>=<value>` or at runtime by writing to `/sys/module/morse/parameters/<param>` where the permissions allow it.

If a parameter is passed to modprobe multiple times, only the last value will be used.

Parameters marked **read-only** can only be set at module load time.

4.1.1 Device Identity & Initialization

Parameter	Type	Default	Description
macaddr_suffix	string	00:00:00	Sets the last three octets of the MAC address (format: "XX:XX:XX"). The default value 00:00:00 causes these octets to be randomised. Ignored if the hardware has a programmed MAC address. Supersedes macaddr_octet.
macaddr_octet	byte	0xFF	Sets only the final octet of the MAC address. 0xFF causes it to be randomised. Ignored if the hardware has a programmed MAC address, or if macaddr_suffix is set. **Deprecated**
serial	string	"default"	Overrides the board ID string used to select the correct Board Configuration File (BCF). Useful when the hardware OTP does not contain a valid board ID.
bcf	string	(empty)	Path to a specific BCF (Board Configuration File) to load. When empty, the driver selects

Parameter	Type	Default	Description
			the BCF automatically based on the board ID.
fw_bin_file	string	(empty)	Path to the firmware binary to load. When empty, the driver selects firmware automatically.
enable_otp_check	bool	true	Validate the device OTP (One-Time Programmable) memory during initialisation. Disable only for development on hardware with unprogrammed or corrupt OTP.
enable_ext_xtal_init	bool	false	Enable the external crystal initialisation sequence for MM610x hardware. Required when an external TCXO is fitted.
log_modparams_on_boot	bool	true	Log all module parameter values to the kernel log during driver initialisation. Useful for diagnostics; disable to reduce boot log verbosity.
slow_clock_mode	uint	0	The slow clock source selection mode. 0 = auto selection 1 = force to internal clock **MM8108 only**

4.1.2 Country & Regulatory

Parameter	Type	Default	Description
country	string	AU	Two-letter ISO 3166-1 alpha-2 country code (e.g., "US", "AU", "JP") specifying the regulatory

Parameter	Type	Default	Description
			domain to apply. This determines the permitted channels, bandwidths, and transmit power limits. Must match the country in which the device is deployed.
channelization_scheme	uint	3 (RevMF)	Selects the 802.11ah channelization to use for Australia (AU). Does not affect other regions. Values: 1 = IEEE 802.11-2020 2 = IEEE 802.11-2024 3 = IEEE 802.11-RevMF (default). Read-only at runtime. **This module parameter is provided to the dot11ah module.**

4.1.3 PHY, Rate Control & Transmission

Parameter	Type	Default	Description
mcs_mask	uint	0x3FF	Bitmask of permitted Modulation and Coding Scheme (MCS) indices for both TX and RX. Bit N enables MCS N. The default 0x3FF enables all of MCS 0–9. Example: 0x07 restricts to MCS 0–2 only. This will be negotiated between devices at association time.
mcs10_mode	uint	0 (disabled)	Controls use of MCS 10 (1 MHz, 150 kbps, extended range). Values: 0 = disabled 1 = forced on 2 = automatic

Parameter	Type	Default	Description
			This is deprecated and was previously used before MMRC.
max_rates	uint	4	Maximum number of different MCS rates the rate control algorithm will try for a single frame before dropping it.
max_rate_tries	uint	1	Maximum number of transmission attempts per rate before stepping down to the next lower rate.
enable_sgi_rc	bool	true	Allow the rate control algorithm to select Short Guard Interval (SGI)
enable_trav_pilot	bool	true	Enable travelling pilots, an 802.11ah mechanism that improves channel estimation in long-range or mobile environments.
enable_subbands	uint	2 (enabled)	Controls sub-band transmission. Values: 0 = disabled (all frames use the full operating bandwidth) 1 = management frames only use sub-bands 2 = fully enabled (data frames also use sub-bands). Sub-band transmission improves coexistence in congested spectrum.
enable_rts_8mhz	bool	false	Enable RTS/CTS protection for 8 MHz channel transmissions. Adds overhead but can improve reliability in environments with

Parameter	Type	Default	Description
			hidden nodes. It will reduce peak throughput.
enable_cts_to_self	bool	false	Use CTS-to-self instead of RTS/CTS for channel protection. Lower overhead than RTS/CTS but does not protect against hidden nodes.
tx_max_power_mbm	int	2200	Maximum transmit power in mBm (millidBm; 100 mBm = 1 dBm). Default of 2200 mBm = 22 dBm. The actual transmit power is capped at the lower of this value and the regulatory limit for the current channel.

4.1.3.1 Fixed-rate parameters

Only take effect when `enable_fixed_rate=1`:

Parameter	Type	Default	Description
enable_fixed_rate	bool	false	Bypass the rate control algorithm and transmit all frames at a fixed MCS/bandwidth/GI. Intended for testing and characterisation only.
fixed_mcs	int	4	MCS index to use when enable_fixed_rate is enabled.
fixed_bw	int	2	Bandwidth in MHz to use when enable_fixed_rate is enabled (1, 2, 4, or 8).
fixed_ss	int	1	Number of spatial streams to use when enable_fixed_rate is enabled.

Parameter	Type	Default	Description
fixed_guard	int	0	Guard interval to use when enable_fixed_rate is enabled. 0 = long GI, 1 = short GI.

4.1.4 Power Management

Parameter	Type	Default	Description
enable_ps	uint	2	Power save mode for STA operation. Values: 0 = disabled (radio always on), 1 = protocol enabled (respects AP-signalled DTIM but driver controls entry/exit), 2 = fully enabled (driver and firmware cooperate for maximum power saving). This must be set to 2 to use AP power management on MM6108.
enable_dynamic_ps_offload	bool	true	Offload dynamic power save timing decisions to firmware. When enabled, the firmware automatically adjusts the listen interval based on traffic conditions, reducing CPU wakeups.
enable_pre_assoc_ps	bool	false	Enable pre-association power save on the station interface. **N.B.** Generally, mac80211 won't enable power save until after association. Enabling this will let the chip enter snooze before association.
sdio_clk_debugfs	string	(empty)	Path to the SDIO clock frequency file in debugfs (e.g. /sys/kernel/debug/mmc0/ios). When set, the driver automatically lowers the SDIO

Parameter	Type	Default	Description
			clock during power save to reduce current consumption.

4.1.5 Duty Cycle & Spectrum Management

These parameters apply to regions that impose a transmit duty cycle limit, such as EU and JP.

Parameter	Type	Default	Description
enable_auto_duty_cycle	bool	true	Automatically configure the transmit duty cycle to comply with regional regulations. When disabled, duty cycle limiting must be managed externally.
duty_cycle_mode	uint	0 (spread)	Behavior when the duty cycle limit is approached. 0 = spread: distributes transmissions evenly over time, maintaining low latency. 1 = burst: transmits as fast as possible early in the window, then pauses.
duty_cycle_probe_retry_threshold	uint	2500	Duty cycle utilization percentage in hundredths of a percent (0–10000) above which probe request and response retries are disabled. Reduces management frame overhead when the duty cycle budget is nearly exhausted.
enable_auto_mpsw	bool	true	Automatically configure the Minimum Packet Spacing Window (MPSW), which enforces a minimum gap between successive transmissions. Required in the Japan regulatory domain.

4.1.6 Scanning

Parameter	Type	Default	Description
enable_hw_scan	bool	true	Enable hardware-assisted (offloaded) scanning for SoftMAC mode. Hardware scan allows the chip to scan channels autonomously without full driver involvement, reducing CPU load and improving scan reliability.
hw_scan_prim_deconstruct	uint	0	Limits hardware scan channel deconstruction to a specific bandwidth: 0 = deconstruct to both 1 MHz and 2 MHz sub-channels, 1 = 1 MHz only, 2 = 2 MHz only. Read-only at runtime.
enable_sched_scan	bool	true	Enable scheduled scanning
enable_1mhz_probes	bool	true	Send all probe requests at 1MHz
enable_scan_result_cache	bool	false	Enable the ability for the scan results to be replayed back to mac80211 from a cache file
hw_scan_replay_limit	uint	0	Number of hardware scans that replay cached results (decrements to zero)

4.1.7 Beaconing

Parameter	Type	Default	Description
rsn_beacon_mode	uint	0 (disabled)	Controls insertion of RSN (Robust Security Network) Information Elements into beacons.

Parameter	Type	Default	Description
			0 = disabled (RSN IEs omitted) 1 = long beacons only 2 = all beacons Wi-Fi HaLow does not require the IE in beacons, but some deployments that utilize passive scan will require it.
enable_short_bcn_as_dtim_override	int	-1	Overrides whether the short beacon acts as the DTIM beacon
enable_mbssid_ie	bool	false	Enable Multiple BSSID (MBSSID) IE support in beacons and probe responses. Required when running multiple virtual APs sharing the same radio.
enable_bcn_change_seq_monitor	bool	false	Monitor the Change Sequence field in S1G beacons. When a change is detected, the driver triggers a re-association to pick up updated network parameters. Useful in deployments where AP configuration changes frequently.

4.1.8 Security

Parameter	Type	Default	Description
no_hwcrypt	bool	false	Disable hardware (on-chip) encryption and fall back to software encryption. Only for debugging encryption issues; hardware encryption should be used in production for performance and reliability.

Parameter	Type	Default	Description
enable_cac	bool	false	Enable Centralized Authentication Control (CAC), an 802.11ah feature that allows an AP to rate-limit association attempts in large-scale IoT deployments.

4.1.9 TX Queue & Aggregation

Parameter	Type	Default	Description
max_txq_len	uint	32	Maximum number of frames held in the driver TX queue waiting to be sent to the chip.
tx_queued_lifetime_ms	uint	1000	Maximum time in milliseconds a frame may wait in the TX queue before being discarded. Frames that wait longer than this are dropped to prevent stale data delivery.
tx_status_lifetime_ms	uint	15000	Maximum time in milliseconds after a frame is handed to the chip before it is considered lost if no TX status is received.
max_aggregation_count	uint	0	Maximum number of frames the receiver will accept in a single A-MPDU aggregate. 0 uses the firmware default.

4.1.10 Multicast

Parameter	Type	Default	Description
max_mc_frames	uint	-1	Maximum multicast frames after DTIM (-1 for auto/dynamic and 0 for unlimited)
enable_mcast_whitelist	bool	true	Enable multicast address whitelisting in firmware. Only multicast frames destined for registered group addresses are forwarded to the host, reducing unnecessary wakeups.
enable_mcast_rate_control	bool	false	Track channel conditions and transmit multicast frames at the highest viable MCS, bandwidth, and GI rather than the lowest rate. Improves multicast throughput but may reduce range for some clients.

4.1.11 Offloads & Client Features

Parameter	Type	Default	Description
enable_arp_offload	bool	false	Offload ARP response handling to firmware. The chip responds to ARP requests for its own IP address without waking the host, significantly reducing power consumption in sleep-heavy deployments.
enable_dhcpc_offload	bool	false	Offload DHCP client lease renewal to firmware. The chip handles DHCP renewal exchanges, allowing the host to remain in a low-power state for longer.

Parameter	Type	Default	Description
dhcpc_lease_update_script	string	"/morse/scripts/dhcpc_update.sh"	Path to a script invoked by the driver to update the interface IP address when the DHCP offload is in use
enable_ibss_probe_filtering	bool	true	Filter out probe requests from IBSS (ad-hoc) devices in firmware before they are passed to the host. Reduces unnecessary processing of frames from non-infrastructure devices.

4.1.12 Advanced MAC Features

Parameter	Type	Default	Description
enable_twt	bool	true	Enable Target Wake Time (TWT), an 802.11ah feature that allows the AP and STA to negotiate scheduled wake times.
enable_page_slicing	bool	false	Enable 802.11ah page slicing, which divides the STA association space into pages and slices so that only a subset of STAs wake for each DTIM.
enable_pv1	bool	false	Enable PV1 (Protocol Version 1) compressed frame format support. PV1 reduces frame overhead for established associations, improving efficiency. **Deprecated.**
enable_airtime_fairness	bool	true	Enable the mac80211 pull-based TX interface for airtime fairness scheduling. Ensures each associated STA

Parameter	Type	Default	Description
			gets a fair share of airtime regardless of traffic pattern. (-1: disable, 0: kernel-dependent, 1: enable)
enable_mac80211_connection_monitor	bool	false	Enable the mac80211 connection monitor, which sends periodic Null-data probe frames to verify the AP is still reachable. Triggers reassociation if the AP stops responding.
enable_wiphy	bool	false	Enable FullMAC mode. See FullMAC driver user guide for more information. **Not applicable to MM6108.**
ocs_type	uint	1 (RAW)	Transport mechanism used for Off-Channel Scan (OCS) operations. 0 = QoS Null frames 1 = RAW (Restricted Access Window) RAW is preferred as it causes less disruption to other clients.
thin_lmac	bool	false	Enable Thin LMAC mode, where additional MAC layer processing such as encryption and fragmentation is handled in the host rather than firmware, to allow up to 2000 STAs. This requires a special firmware binary to be installed on the device.
enable_survey	bool	true	Enable collection of channel survey data (noise floor, channel busy time, etc.), accessible via iw dev <if> survey dump. Adds a

Parameter	Type	Default	Description
			small overhead to channel transitions.

4.1.13 Vendor Information Elements

Parameter	Type	Default	Description
enable_mm_vendor_ie	bool	true	Allow the driver to insert Morse Micro vendor-specific IEs into management frames (beacons, probe responses, association frames). These IEs carry Morse-specific capability and configuration information.
max_total_vendor_ie_bytes	uint	514	Maximum total byte budget for runtime-injected vendor IEs (those added via nl80211 rather than by the driver itself). Limits the amount of frame space that external applications can consume with vendor IEs.

4.1.14 Hardware Bus Interface

4.1.14.1 SPI

Parameter	Type	Default	Description
spi_clock_speed	uint	0	SPI bus clock speed in Hz. 0 uses the platform default speed specified in the device tree. Override only if the platform default is incorrect for the board.

Parameter	Type	Default	Description
spi_inter_block_delay_bytes	uint	0	Number of idle byte periods to insert between SPI transfer blocks. 0 inserts no delay. If you experience SPI errors, you may want to increase this.
spi_use_edge_irq	bool	false	Enable compatibility mode for SPI host controllers that only support edge-triggered interrupts. Most platforms use level-triggered IRQs; only enable this if experiencing missed interrupts.
spi_post_write_status_bytes	uint	4	Amount of extra bytes to clock out on the SPI bus after a byte mode CMD53, to give the chip time to process the write and return a status.

4.1.14.2 SDIO

Parameter	Type	Default	Description
sdio_reset_time	uint	400	Time in milliseconds to wait after an SDIO bus reset. Increase if the SDIO host controller or card needs extra time to stabilise after reset.

4.1.15 LEDs

Parameter	Type	Default	Description
enable_hw_leds	bool	true	**Not supported on MM6108.**

4.1.16 Watchdog & Recovery

Parameter	Type	Default	Description
enable_watchdog	bool	1	Enable the driver watchdog timer, which monitors chip health and triggers recovery if the chip becomes unresponsive.
watchdog_interval_secs	uint	30	Interval in seconds between watchdog health checks.
hw_reload_after_stop	int	5	When the chip signals it has stopped or crashed, the driver will attempt to reload the firmware. If a second stop event occurs within this many seconds of the first, the reload is aborted to prevent a restart loop. Set to -1 to disable reload entirely.
reattach_hw	bool	false	On driver exit, do not reset the chip. On the next module load, attempt to reattach to the existing chip state rather than performing a full reset. Useful for workflows to avoid full reinitialisation.

4.1.17 Firmware Command Handling

Parameter	Type	Default	Description
default_cmd_timeout_ms	uint	600	Timeout in milliseconds for host-to-chip command responses. Increase if commands are timing out on slow or heavily loaded systems.

4.1.18 Coredump & Diagnostics

Parameter	Type	Default	Description
enable_coredump	bool	true	Capture a coredump from the chip when a fatal firmware error occurs. The coredump is passed to the kernel's devcoredump subsystem and can be retrieved from /sys/class/devcoredump/.
coredump_method	uint	1 (bus)	Mechanism used to read the coredump from the chip. 0 = invoke a Userspace script 1 = read directly over the host bus (SPI/SDIO). The bus method is faster and does not require a Userspace helper.
coredump_include	ulong	(chip memory)	Bitmask selecting optional data sections to include in the coredump. Each bit enables a specific memory region or data set. Refer to enum morse_coredump_optional_flags for bit definitions.

4.1.19 Debugging & Testing

Parameter	Type	Default	Description
debug_mask	uint	0x8	The parameter selects the minimum log verbosity level for the driver. It is a bitmask where the lowest set bit takes effect: bit 0 (0x1) enables debug-level logging (most verbose), bit 1 (0x2) enables info and above, bit 2 (0x4) enables warnings and above, and bit 3 (0x8) enables

Parameter	Type	Default	Description
			errors only. Setting no bits disables all logging.
test_mode	uint	0	Enable internal test modes. Only available in builds compiled with CONFIG_MORSE_ENABLE_TEST_MODES. The default value is TEST_MODE_DISABLED Options: 1: Download only: Downloads firmware but skips boot verification 2: Download + get host table pointer: Downloads firmware and reads the host table pointer, skips verification 3: Get the host table pointer only. Skips firmware download/verification; just reads the host table pointer 4: Reset only: Resets the chip and does nothing else (no download, no verification) 5: Bus test: Skips firmware boot; validates that the bus is functional (e.g., data can be read and written correctly) 6: Bus profile: Skips firmware boot; measures the time taken to perform various operations over the bus, helping to identify bus performance issues (**not supported on MM8108**)

4.1.20 SKB Queue Tuning

Parameter	Type	Default	Description
skbq_refill_margin	uint	8	Number of free slots to maintain in the TX queue before accepting more frames. A higher value causes the driver to request new frames sooner, reducing the risk of TX starvation at wider bandwidths.

4.2 Supplicant config

The wpa_supplicant_s1g configuration files expose a large number of options, the majority of which are standard Wi-Fi parameters beyond the scope of this documentation. Rather than enumerating them here, a working example configuration is provided to serve as a practical starting point for common deployments. Additionally, the configuration options introduced or modified by the Morse Micro S1G patches — which control HaLow-specific behaviour — are documented below. For anything beyond these, the upstream wpa_supplicant documentation remains applicable.

4.2.1 Example minimal configuration

```
ctrl_interface=/var/run/wpa_supplicant_s1g
pmf=2
sae_pwe=1
network={
    ssid="MorseMicro"
    key_mgmt=SAE
    pairwise=CCMP
    psk="12345678"
}
```

4.2.2 Global options

These options are set at the top level of `wpa_supplicant.conf`, outside any `network={...}` block.

4.2.2.1 autoscan_jitter

Add jitter to the delay between autoscans, so that a large number of stations do not all scan (and probe) at the same time.

When enabled, the actual scan interval is randomised.

```
autoscan_jitter=0
```

Value	Meaning
0	Disabled
1	Enabled (Default)

4.2.2.2 scan_dwell

Channel dwell period during a scan, in TUs. When non-zero, overrides the default dwell time (30ms active scan, 110ms passive scan). Useful for deployments such as APs with long beacon intervals that are using AP power management and may not always respond to active scans.

```
scan_dwell=0
```

Value	Meaning
0	30 ms active scan 110 ms passive scan (Default)
1-65535	Multiple of the above scan time

4.2.3 Per-network options

These options are set inside a `network={...}` block.

4.2.3.1 S1G channel configuration (IBSS/Mesh)

These options configure the initial channel for IBSS (ad-hoc) and mesh networks operating in S1G.

4.2.3.1.1 channel

Initial S1G operating channel for IBSS. This may change when it finds the IBSS or mesh network to connect to.

```
channel=44
```

Value	Meaning
x	Channel from section 3.2

4.2.3.1.2 op_class

S1G operating class. Must be specified together with `channel` for IBSS/Mesh. Accepts global operating classes (IEEE 802.11, Table E-4) or S1G-specific regional operating classes (IEEE 802.11, Table E-5).

```
op_class=71
```

Value	Meaning
x	Operating Class from IEEE 802.11, Table E-4 or E-5

4.2.3.1.3 country

Two-letter ISO 3166-1 country code

```
country=AU
```

Value	Meaning
x	Valid Country Code from section 3.2 only

4.2.3.1.4 s1g_prim_chwidth

Primary channel bandwidth when operating in IBSS/Mesh S1G networks.

```
s1g_prim_chwidth=1
```

Value	Meaning
0	1 MHz (For 1 MHz and 2 MHz operating channels
1	2 MHz (Default: For 4 MHz and 8 MHz operating channels)

4.2.3.1.5 s1g_prim_1mhz_chan_index

Primary 1 MHz channel index within the operating channel, used to derive the centre channel. See the hostapd `s1g_prim_1mhz_chan_index` description in Section 4.3.2 for more information.

```
s1g_prim_1mhz_chan_index=0
```

4.2.3.1.6 disable_s1g_sgi

Disable Short Guard Interval (SGI) for S1G networks.

```
disable_s1g_sgi=0
```

Value	Meaning
0	SGI enabled (default)
1	SGI disabled

4.2.3.2 RAW station priority

4.2.3.2.1 raw_sta_priority

Priority used by the AP to assign this STA to a RAW. Transmitted to the AP via the QoS Traffic Capability IE in the association request. Must match a priority configured with `raw={...}` in the AP's hostapd config.

```
raw_sta_priority=0
```

Value	Typical use
0	Normal/best effort (default)
1	Background
2	Background
3	Normal
4	Video
5	Video
6	Voice
7	Voice

4.2.3.3 Authentication control

4.2.3.3.1 cac

Enable Centralized Authentication Control (CAC). When enabled, the STA will not attempt association with an AP while it is advertising a CAC threshold lower than a generated random value.

```
cac=0
```

Value	Meaning
0	Disabled (default)
1	Enabled

4.2.3.4 Target Wake Time (TWT)

4.2.3.4.1 twt_conf={...}

Configure a Target Wake Time agreement with the AP for power-efficient scheduled wake periods.

```
twt_conf={
    enable=0
    flow_id=0
    setup_command=0
    wake_duration_us=0
    wake_interval_us=0
}
```

Parameter	Description
enable	Enable TWT (0 = disabled, 1 = enabled)
flow_id	TWT flow identifier
setup_command	TWT setup command type
wake_duration_us	Duration of each wake window, in microseconds

Parameter	Description
wake_interval_us	Interval between wake windows, in microseconds

---

4.2.3.5 Association and reconnection

4.2.3.5.1 max_away_duration

Maximum duration the AP can be out of reach for this STA (e.g. operating on another channel, in power save, or in another RAW). Communicated to the AP at association. Units are TUs (1 TU = 1.024 ms).

```
max_away_duration=0
```

Value	Meaning
0	Disabled (default)
1 - 65535	Valid values

4.2.3.5.2 auth_retry_backoff

Space-separated list of backoff intervals in seconds between successive failed authentication/association attempts. Each value in turn is used for consecutive failures; the last value is repeated once the list is exhausted. A random value of 0–9 seconds is added to each interval.

```
auth_retry_backoff=5 9 30
```

Value	Meaning
x	Value in seconds

Example: if a STA fails four times with `auth_retry_backoff=5 9 30`, the delays are approximately 5, 9, 30, and 30 seconds. If not set, a built-in default schedule is used.

4.2.3.6 Mesh options

4.2.3.6.1 mesh_beaconless_mode

Enable Morse Micro's proprietary beaconless mesh mode extension.

```
mesh_beaconless_mode=0
```

Value	Meaning
0	Disabled (default)
1	Enabled

4.2.3.6.2 mesh_dynamic_peering

Enable Morse Micro's proprietary dynamic peering extension for mesh networks. When enabled, the mesh node can dynamically manage peer links by kicking out lower-quality peers to make room for better ones.

```
mesh_dynamic_peering=0
```

Value	Meaning
0	Disabled (default)
1	Enabled

4.2.3.6.3 mesh_rssi_margin

RSSI margin (in dB) used when selecting which peer to kick out during dynamic peering. A candidate peer must have an RSSI at least this many dB better than the current peer before a replacement is made.

```
mesh_rssi_margin=5
```

Value	Meaning
5	Default
3 – 30	Valid values

4.2.3.6.4 mesh_blacklist_timeout

Duration in seconds that a kicked-out peer is blacklisted and will not be considered for re-peering.

```
mesh_blacklist_timeout=60
```

Value	Meaning
60	Default
10 – 600	Valid values

4.2.3.6.5 dot11MeshHWMPRootMode

Configure this mesh STA as a root node using Hybrid Wireless Mesh Protocol (HWMP) proactive path selection.

```
dot11MeshHWMPRootMode=0
```

Value	Meaning
0	Not a root node (default)
2	Proactive PREQ, no PREP
3	Proactive PREQ with PREP
4	RANN (Root Announcement)

4.2.3.6.6 dot11MeshGateAnnouncements

Enable mesh gate announcements. A mesh gate is a node with connectivity outside the mesh (e.g., to a wired network).

```
dot11MeshGateAnnouncements=0
```

Value	Meaning
0	Disabled (default)
1	Enabled

4.2.3.7 Mesh Beacon Collision Avoidance (MBCA)

MBCA reduces beacon collisions in mesh networks by coordinating beacon transmission times.

4.2.3.7.1 mbca_config

A bitmask used for enabling MBCA features.

```
mbca_config=1
```

Bit	Flag	Meaning
0 (0x1)	TBTT_SEL_ENABLE	Enable TBTT selection
1 (0x2)	TBTT_ADJ_ENABLE	Enable TBTT adjustment

Default: 1 (TBTT selection enabled).

Allowed values are 0-3:

0: MBCA off

1: selection only (default = TBTT_SEL_ENABLE)

2: adjustment without selection is invalid.

3: selection and adjustment

4.2.3.7.2 mbca_min_beacon_gap_ms

Minimum gap in milliseconds between beacons from different mesh nodes.

```
mbca_min_beacon_gap_ms=10
```

Value	Meaning
10	Default
5 - 100	Valid values

4.2.3.7.3 mbca_tbtt_adj_interval_sec

Interval in seconds between TBTT (Target Beacon Transmission Time) adjustment attempts.

```
mbca_tbtt_adj_interval_sec=60
```

Value	Meaning
60	Default

4.2.3.7.4 dot11MeshBeaconTimingReportInterval

How often (in number of beacons) the beacon timing element is included in mesh beacons. Used by neighbours to learn beacon timing for collision avoidance.

```
dot11MeshBeaconTimingReportInterval=10
```

Value	Meaning
10	Default (every 10th beacon)

4.2.3.7.5 mbss_start_scan_duration_ms

Duration in milliseconds of the initial passive scan performed when starting a mesh network, used to discover existing neighbours before choosing a beacon time.

```
mbss_start_scan_duration_ms=2048
```

Value	Meaning
2048	Default
2048 – 10240	Valid values

4.3 Hostapd config

The hostapd configuration files expose numerous options, the majority of which are standard Wi-Fi parameters beyond the scope of this documentation. Rather than enumerating them here, a working example configuration is provided to serve as a practical starting point for common deployments. Additionally, the configuration options introduced or modified by the Morse Micro S1G patches — which control HaLow-specific behaviour — are documented below. For anything beyond these, the upstream hostapd documentation remains applicable.

4.3.1 Example minimal configuration

```
ctrl_interface=/var/run/hostapd_s1g
interface=wlan0
driver=nl80211
hw_mode=a
ieee80211ah=1
channel=44
op_class=71
country_code=AU
s1g_prim_chwidth=1
s1g_prim_1mhz_chan_index=0
ssid=MorseMicro
beacon_int=100
dtim_period=1
ap_max_inactivity=65536
s1g_capab=[SHORT-GI-ALL]
wpa=2
wpa_key_mgmt=SAE
rsn_pairwise=CCMP
sae_password=12345678
ieee80211w=2
wnm_sleep_mode=1
sae_pwe=1
```

4.3.2 IEEE 802.11ah options

4.3.2.1 ieee80211ah

```
ieee80211ah=1
```

Value	Meaning
0	Disabled (default)
1	Enabled

4.3.2.2 s1g_prim_chwidth

Sub-1 GHz primary channel bandwidth.

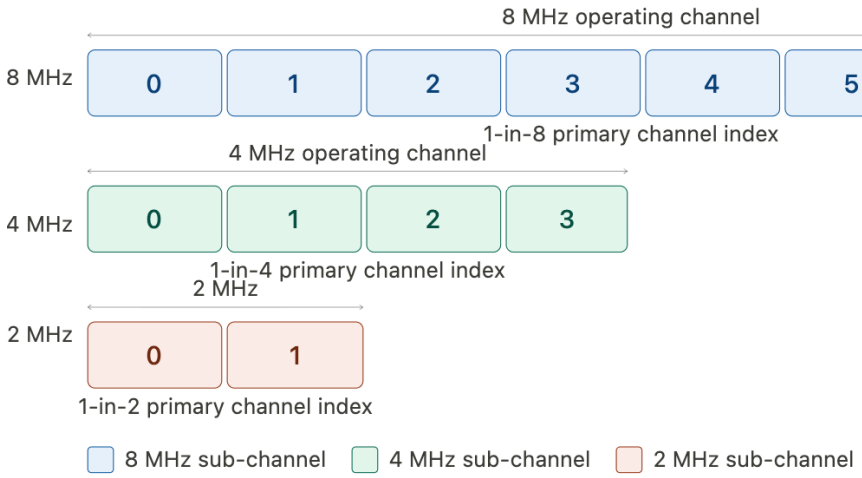
```
s1g_prim_chwidth=1
```

Value	Meaning
0	1 MHz
1	2 MHz (default)

4.3.2.3 s1g_prim_1mhz_chan_index

The index of the primary 1 MHz channel within the operating channel. This is used to derive the centre channel based on the operating and primary channel widths.

```
s1g_prim_1mhz_chan_index=0
```



Operating BW	Valid range
8 MHz	0–7
4 MHz	0–3
2 MHz	0–1
1 MHz	0

4.3.2.4 s1g_capab

S1G capability flags. Specified as a bracketed list.

```
s1g_capab=[SHORT-GI-ALL]
```

Flag	Meaning
[SHORT-GI-1]	Short Guard Interval support for 1 MHz
[SHORT-GI-2]	Short Guard Interval support for 2 MHz
[SHORT-GI-4]	Short Guard Interval support for 4 MHz

Flag	Meaning
[SHORT-GI-8]	Short Guard Interval support for 8 MHz
[SHORT-GI-16]	Short Guard Interval support for 16 MHz *16MHz is not currently supported in hardware; for future use.*
[SHORT-GI-ALL]	Short Guard Interval support for all bandwidths including sub-bandwidths of the operating channel (e.g. enables SGI for 1, 2, and 4 MHz when operating at 4 MHz)

4.3.2.5 s1g_bss_color

BSS color for S1G capabilities, used for spatial reuse.

```
s1g_bss_color=1
```

Value	Meaning
1 - 7	Valid values

4.3.2.6 max_away_duration

Maximum duration the AP can be out of reach from STAs (e.g., while entering power save or operating on another channel). Units are TUs (1 TU = 1.024 ms).

```
max_away_duration=0
```

Value	Meaning
0 - 65535	Valid values (`0` means not set)

4.3.3 RAW (Restricted Access Window)

RAW allows the AP to schedule dedicated medium access windows for groups of STAs, reducing collisions in large deployments.

When one or more RAWs are defined, STAs are assigned Association IDs (AIDs) based on their RAW priority:

Priority	AID range
0	1 – 255
1	256 – 511
2	512 – 767
3	768 – 1023
4	1024 – 1279
5	1280 – 1535
6	1536 – 1791
7	1792 – 2007

If no RAWs are defined, AIDs are assigned from 1–2007 without priority grouping.

4.3.3.1 raw

Enable or disable the RAW feature.

```
raw=1
```

Value	Meaning
0	Disabled (default)
1	Enabled

4.3.3.2 raw={...}

Configure a RAW. Up to 8 RAWs can be defined, one per priority level (0–7). RAWs are ordered in the beacon from highest to lowest priority among those enabled.

Ensure the sum of all `start_time_us` and `duration_us` values does not exceed the beacon interval (typically 102,400 µs for a 100 TU beacon). Otherwise, RAWs may be truncated or absent.

```
raw={
    priority=7
    enabled=1
    start_time_us=4096
    duration_us=19700
    slots=1
    cross_slot=0
    max_beacon_spread=3
    nominal_stas_per_beacon=2
    praw_period=0
    praw_start_offset=0
}
```

4.3.3.2.1 priority

Required; must be specified first.

Priority of this RAW. Determines which AID range STAs are assigned to. Higher value = higher priority.

Value	Meaning
0 - 7	Valid values

4.3.3.2.2 enabled

Whether this RAW is active when hostapd starts.

Value	Meaning
0	Disabled
1	Enabled

4.3.3.2.3 start_time_us

Start time of the RAW in microseconds.

- For non-PRAWs: referenced from the end of the beacon or the end of the preceding RAW.
- For PRAWs: referenced from the end of the beacon carrying the PRAW configuration.

Default: `4096`. Recommended value for the highest-priority (first) enabled RAW.

4.3.3.2.4 duration_us

Duration of the RAW in microseconds. Default: `26900`. Minimum: `500`.

4.3.3.2.5 slots

Number of equal-length access slots within the RAW.

Value	Meaning
1	Default
1 - 63	Valid values

4.3.3.2.6 cross_slot

Whether cross-slot boundary bleed-over is allowed. If enabled, a device is allowed to transmit across the end of its boundary; otherwise, if it would exceed its slot time, it must not transmit.

Value	Meaning
0	Disabled (default)
1	Enabled

4.3.3.2.7 max_beacon_spread

When beacon spreading is enabled, the maximum number of beacons to spread a RAW's STAs over. `0` means no maximum (default). Mutually exclusive with PRAW (`praw_period > 0`).

4.3.3.2.8 nominal_stas_per_beacon

The preferred number of STAs to schedule in this RAW per beacon when using beacon spreading. If `STAs / nominal_stas_per_beacon` exceeds `max_beacon_spread`, more STAs will be included per beacon. `0` disables beacon spreading (default). Mutually exclusive with PRAW.

4.3.3.2.9 praw_period

Period of a Periodic RAW (PRAW) in beacons. The PRAW will be active every `praw_period` beacons. `0` disables PRAW (default). Mutually exclusive with beacon spreading.

Value	Meaning
0	Default
0 - 255	Valid values

4.3.3.2.10 praw_start_offset

Offset within the PRAW period at which this PRAW becomes active. Must be less than `praw_period` when PRAW is enabled.

Value	Meaning
0	Default
0 - 255	Valid values

5 Features

5.1 Hardware & Interfaces

- SDIO
- SPI (specifically SDIO over SPI)
- USB (MM8108 only)

5.2 PHY/Radio

- Channel bandwidths: 1, 2, 4, and 8 MHz
- MCS rates: 0–10
- Short guard interval (SGI)
- Travelling pilots
- Frame fragmentation

5.3 Network Interface Modes

- Station (infrastructure client)
- Access Point (AP)
- IBSS (ad-hoc)
- Mesh Point (802.11s)
- Monitor mode

5.4 802.11ah-Specific MAC Features

- TWT (Target Wake Time) — requester/responder, up to 8 agreements, grouping
- Page Slicing — large-scale deployment association management
- RAW (Restricted Access Window) — IoT channel access control
- CAC — centralized association rate limiting
- NDP Block Ack
- Non-TIM mode
- Dynamic AID assignment

5.5 Transmission & Rate Control

- A-MPDU aggregation
- A-MSDU aggregation (MM8108 only)
- RTS/CTS and CTS-to-self protection
- Airtime Fairness (when configured for mac80211 pull-based scheduling)

5.6 Power Management

- 802.11 power save
- AP power management (MM6108 only)
- Dynamic power save offload — firmware-managed timing
- U-APSD (Unscheduled automatic power save delivery)
- WoWLAN (Wake-on-wireless LAN)

5.7 Security

- Hardware crypto acceleration
- Management Frame Protection (MFP) — 802.11w
- RSN (Robust Security Network) — flexible IE control
- Per-STA GTK (required for mesh)
- WPA3 Personal
- WPA3 Enterprise
- Opportunistic Wireless Encryption
- CCMP/AES

5.8 Offloads (Firmware-Handled)

- ARP offload — firmware replies to ARP requests
- ICMP offload - firmware replies to ICMP echo requests
- DHCP client offload — firmware handles DHCP renewal
- BSS keepalive - firmware handles the BSS keepalive procedure
- TCP keepalive - sends periodic TCP keepalive frames for a single stream
- Probe Response Offload — used in AP power management
- Multicast filtering — whitelist-based delivery

5.9 Scanning & Association

- Hardware-assisted full/partial channel scanning
- Scheduled scan — up to 12 scan plans, 6 match sets
- Configurable scan dwell time

5.10 Regulatory & Spectrum

- Duty cycle compliance (spread or burst modes)
- Minimum Packet Spacing Window (MPSW)
- Channel survey/noise floor reporting
- Driver-provided 802.11ah regulatory database

5.11 Mesh Networking (802.11s)

- Mesh Peering Management (MPM), authenticated peering
- MBCA (Mesh Beacon Collision Avoidance)
- Beaconless mode, dynamic peer discovery

5.12 Multi-BSS & Beaconing

- MBSSID (Multiple BSSID/virtual APs)
- Independent beacon intervals per interface
- Short beacon as DTIM option

5.13 Debugging & Diagnostics

- DebugFS integration
- Watchdog health monitoring with firmware recovery
- Configurable log verbosity (error/warn/info/debug)

5.14 Vendor Extensions

- nl80211 vendor command framework
- Custom vendor IEs (up to 514 bytes at runtime)

6 Glossary of Acronyms

Acronym	Definition
A-MPDU	Aggregate MAC Protocol Data Unit
AES	Advanced Encryption Standard
AID	Association ID
AP	Access Point
ARP	Address Resolution Protocol
BCF	Board Configuration File
BSS	Basic Service Set
CAC	Centralized Authentication Control
CCMP	Counter Mode with Cipher Block Chaining Message Authentication Code Protocol
CTS	Clear to Send
DHCP	Dynamic Host Configuration Protocol
DTIM	Delivery Traffic Indication Message
EDCA	Enhanced Distributed Channel Access
GI	Guard Interval
GTK	Group Temporal Key
HWMP	Hybrid Wireless Mesh Protocol
IBSS	Independent Basic Service Set
IE	Information Element
JTAG	Joint Test Action Group, an industry-standard interface primarily used for debugging embedded hardware
LMAC	Lower MAC

Acronym	Definition
MAC	Medium Access Control
MBCA	Mesh Beacon Collision Avoidance
MBSSID	Multiple Basic Service Set Identifier
MCS	Modulation and Coding Scheme
MFP	Management Frame Protection
MLME	MAC Layer Management Entity
MPM	Mesh Peering Management
MPSW	Minimum Packet Spacing Window
NDP	Null Data Packet
OCS	Offchannel Scan
OTP	One-Time Programmable
OWE	Opportunistic Wireless Encryption
PHY	Physical Layer
PRAW	Periodic Restricted Access Window
PS	Power Save
PV1	Protocol version 1
RAW	Restricted Access Window
RF	Radio Frequency
RSN	Robust Security Network
RTS	Request to Send
RX	Receive
S1G	Sub-1 GHz
SAE	Simultaneous Authentication of Equals

Acronym	Definition
SDIO	Secure Digital Input Output
SGI	Short Guard Interval
SPI	Serial Peripheral Interface
STA	Station
TBTT	Target Beacon Transmission Time
TU	Time Unit (1.024ms)
TWT	Target Wake Time
TX	Transmit
U-APSD	Unscheduled Automatic Power Save Delivery
WoWLAN	Wake on Wireless LAN
WPA2	Wi-Fi Protected Access 2
WPA3	Wi-Fi Protected Access 3

7 Revision History

Version Number	Release Date	Release Notes
1	21 Oct 2026	User Guide for Software Release 2.1

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